ITS Intertek Testing Services

Intertek Testing Services NA, Inc.
70 Codman Hill Road
Boxborough, MA 01719
Tel (978) 263-2662
Fax (978) 635-9534

Date: August 5, 1998

TO: **Richard Fabina**
Federal Communications Commission

FROM: Michael J. Peters
Staff Engineer / Emissions

RE: Additional information request for FCC ID: NCABR132V200LXUS

Mr. Fabina,

The following addresses the requests for information you sent on July 20, 1998 via email. The responses are numbered the same as the original questions.

1. Provide the peak level of radiated emissions in the restricted bands listed in Section 15.205. In accordance with Section 15.35(b) of the FCC Rules, there is both a peak and average field strength limit on radiated emissions above 1000 MHz. Compliance with both of these limits must be demonstrated. You only provided average measurements. See items 3 and 4 below.

All measurements above 1000 MHZ were made with a peak detector as specified in B.6.2 of the application. An average measurement is determined by subtracting an average factor from the peak reading, however, an average factor was not applied. Since the peak measurements meet the average limits, both peak and average measurements meet the applicable requirements.

Also note, that no emissions were detected other than the those in the transmit band. Harmonic measurements are noise floor readings.

2. Provide the average level of an AC line conducted emission and describe how the three conditions at the end of Section 15.207(b) are met when 13 dB was subtracted from the CISPR quasi-peak level of an emission.

Three conditions:

1) The measuring instrumentation with the average detector shall employ a linear IF amplifier:

Please see the pages following the line-conducted data table. One is a page from the Hewlett Packard 8546A EMI Receiver specifications (The instrument used for line-conducted emissions testing) and the second is CISPR 16-1 Annex E.1 *Response of Pre-detector Stages*. The HP page indicates the receiver is CISPR 16 compliant and Annex E indicates that average value is proportional to pulse repetition rate (aka linear).

2) Care must be taken not to exceed the dynamic range of the measuring instrument when measuring an emission with a low duty cycle:

If the duty cycle of the measured emissions were very low, the measured average emissions would drop to the noise floor. The one emission in question dropped 12 dB from the quasi-peak measurement, therefore the measured emissions were not outside the dynamic range of the measurement receiver.

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3) The test report required for verification or for an application for a grant of equipment authorization shall contain all details supporting the use of this option:

This was not done until now. If it had, it would be unnecessary to justify the measurements now.

FCC Part 15.107 & 15.207 Conducted Emissions Table for the BR 132

Frequency (MHz)	Reading Line 1 (dBuV)	Reading Line 2 (dBuV)	Limit (dBuV)	Margin (dB)
0.492	38qp	38qp	48	-10
	33av	32av		
0.688	40qp	41qp	48	-7
	35av	35av		
1.471	43qp	42qp	48	-5
	34av	33av		
2.000	49qp	47qp	48	+1
	37av	35av		-12*
2.391	41qp	39qp	48	-6
	33av	31av		
3.321	32qp	32qp	48	-16
	22av	22av		

* QP measurement was reduced by 13 dB to compare with the limit.

Date: February 24, 1998 Engineer: Kouma Sinn

General Specifications: HP 8546A EMI Receiver

Temperature Range	
Operating*	0 °C to +55 °C
Storage	−20 °C to +65 °C

* Disk drive +5 °C to +45 °C.

EMI Compatibility
Receiver is in compliance with CISPR Pub. 16.
Receiver radiated and conducted emissions performance is in compliance with CISPR Pub. 11/1990 Group 1 Class A.
Receiver susceptibility performance is in compliance with CISPR Pub. 16 at 3 V/m field strength.

Inputs	
Low frequency	Type N, 50 Ω, 9 kHz to 50 MHz
High frequency	Type N, 50 Ω, 9 kHz to 6.5 GHz

Detectors	
Measurement	Peak, Quasi-Peak, and Average Quasi-Peak and Average time constants conform with CISPR Pub.16.
Overload	Broadband RF (band 1 and 2 only) and IF

IF Bandwidths	
Measurement	200 Hz, 9 kHz, and 120 kHz (6dB bandwidths which conform to CISPR Pub.16)
Diagnostic	30 Hz to 3 MHz, 3 dB bandwidths in 1,3,10 steps (±20% characteristic), and 5 MHz. Four-pole synchronously-tuned, approximately Gaussian shape.

Averaging Bandwidths	30 Hz to 1 MHz in 1,3,10 steps (±30% characteristic), and 3 MHz. Post-detection single pole low-pass filters. 1,3,10 Hz digital filters with anti-aliasing

Input Attenuator	
Range	0 to 50 dB
Linearity Test Attenuator	4 dB

Preamplification	12 dB (Band 1 and 2) 27 dB ±4 dB (Band 3 and Bypass)

Demodulation	AM and FM

Disk Drive	Internal 3.5 inch disk drive, compatible with 1.44 MByte DOS and LIF format disks

Annex E
(normative)

Response of average and peak measuring receivers
(subclause 4.2.1)

E.1 Response of pre-detector stages

It has been shown* that the area under the envelope of the impulse response curve of a narrowband circuit having a symmetrical frequency characteristic is independent of the bandwidth, and is given by:

$$\int_{-\infty}^{+\infty} A(t)dt = 2\upsilon\tau G_0$$

where

υ and τ are the amplitude and duration of a rectangular pulse for which $B_{imp}\,\tau << 1$ and G_0 is the gain of the circuit at the centre frequency.

This theorem is valid only in the case of a non-oscillating envelope. The oscillatory envelope is characteristic of double-tuned circuits, and unless a phase sensitive detector is used, it may be necessary to compensate by calibration the error introduced by the oscillatory response. In the case of critical coupling, the second peak of the envelope is about 8,3 % of the first one.

As long as pulses do not overlap in the output of the IF amplifier, the average value is proportional to the pulse repetition rate, n.

Therefore, the average voltage is equal to $2\upsilon\tau G_0 n$.

In view of equation (1), it is not considered meaningful to define an effective bandwidth for an average measuring receiver.

E.2 Overload factor

For calculation of overload factor and for use in connection with peak measuring receivers, it is useful to define a quantity known as the effective impulse bandwidth of the pre-detector circuit as follows:

$$B_{imp} = A(t)_{max} / 2G_0$$

where

$A(t)_{max}$ is the peak envelope output of the intermediate-frequency stages with a unit impulse applied.

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* *"Response of ideal radio noise meter to continuous sine-wave, recurrent impulses, and random noise"* by David B. Geselowitz, IRE Transactions, RFI, Vol. RFI-3, no. 1, pp 2-11, May, 1961. See also, *"Impulse excitation of a cascade of series tuned circuits"* by S. Sabaroff, Proc. IRE, Vol. 32, pp 758-760, December 1944.

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3. Confirm that the hopping of this transmitter was stopped to the three channels measured for average radiated emission field strength levels. The transmitter must be stopped to one channel and continuously transmitting normal data on one of three channels as specified in Section 15.31(m) of the Rules.

Please see section C.0.2 of the application. This specifies that hopping was stopped at three frequencies (low, middle and high) for fundamental and harmonic measurements and the search for emissions was done while operating normally (hopping).

If I understand you correctly, you are asking if the measurements were made while transmitting continuously at three different frequencies simultaneously. This is not the case and is not an appropriate way of testing a spread spectrum frequency hopping transmitter since the nature of the device does not allow the transmission at more than one frequency at a time.

Under 15.31© it specifies that swept frequency equipment (I believe FHSS can loosely be defined as such) that the sweeping be stopped at frequencies chosen for measurement. ANSI C63.4:1992 Section 13.1.1 Operating Conditions seems to combine 15.31 © and (m) together and is my basis for stopping the hopping as performed in the testing. I understand that if the device had the capability to operate at more than one frequency at a time it would be appropriate to test with it operating at those frequencies simultaneously

4. What resolution bandwidth (RBW) and video bandwidth (VBW) is used for both peak and average field strength radiated emission levels.

The following table indicates the resolution bandwidth used for different frequencies measured.

Frequency (MHZ)	Resolution Bandwidth (KHz)	Video Bandwidth (KHz)
2482.5 +	*30 KHz*	*30 KHz*

Note that no spurious emissions were detected below the transmit band. The harmonic measurements made were noise floor. No emissions were detected above the transmit band.

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RE: Additional information request for FCC ID: NCABR132V200LXUS

5. RBW and VBW of measuring instrument during conducted antenna emission measurements.

Frequency (MHZ)	Resolution Bandwidth (KHz)	Video Bandwidth (KHz)
30 - 1000	*120*	*300*
1000 +	*1000**	*1000**

** Except for as shown on question 6.*

6. RBW and VBW of measuring instrument during output power measurements.

Frequency (MHZ)	Resolution Bandwidth (KHz)	Video Bandwidth (KHz)
2400 - 2483.5	10,000	10,000

7. Photo of the top of the RF board with the shields removed to show component location underneath it in accordance with Section 2.1033(b)(7). Since the photos are not labeled, you will have to figure out which board I'm talking about by looking at what photos were provided.

A Photo of the top of this board is at the end of this document.

8. Photo of the top of the digital board with the RF shields removed to show component location underneath it.

A Photo of the top of this board is at the end of this document.

9. The installer/user must be provided with specific information which will help him install this transmitter in such a manner that people will not be exposed to RF energy in excess of the Commission's guidelines. Please provide such information for the high gain, omni-directional antennas that are not professionally installed and confirm that it will be included into the final version of the user's manual for this transmitter. See Section 3 of Supplement C to OET Bulletin 65 for further guidance regarding MPE distances.

I believe what you are refering to is Table 1 on Page 24 that specify guidelines for high gain antennas. WaveAccess' Installation manual refers in several places to OET guidelines and warnings against pointing antennas in the direction of human traffic areas. The following indicates the page and subject for each warning in the instruction manual. Since specific labeling

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requirements are not specified, the below indicated instructions and warning meet the intent of the guidelines.

Page	*Section*	*Description*
6	*2.2 The waveLyNX Antennae*	*Indicates must be professionally installed*
11	*2.3.1 Placement of Antenna*	*Indicates must be professionally installed Indicates safe distance of 1 foot and instructs on position and warning signs*
12	*2.3.1.1 Indoors*	*Indicates must be pointed away from human traffic areas*
13	*2.3.1.2 Outdoors*	*Indicates BR 132 emits high frequency RF energy and warns against close proximity*

10. For your information - Test set-up diagrams and descriptions are needed for all tests on a spread spectrum transmitter. Otherwise, we cannot tell if you have tested a device properly and we will have to pre-grant sample test a transmitter before we issue a grant of Certification.

Following the Photos are diagrams of the equipment setup for each of the tests. I hope that these diagrams are sufficient to answer your concerns of measurement setup. ITS policy is to adhere to the guidelines of ANSI C63.4 in the measurement of intentional and un-intentional emissions and characteristics measurements.

- - -

I hope the above and attached are sufficient to grant the certification of the WaveAccess SM 132. If you have any questions or comments, please do not hesitate to contact me. I can be reached by phone at (978) 635-8507, by facsimile at (978) 266-9308 or by email at mjp@itsqs.com.

Best Regards,

Michael J. Peters
Staff Engineer / Emissions

Encl.. Circuit Board Photos
Equipment setup diagrams
FAX: (301) 344-2050

Intertek Testing Services NA, Inc.

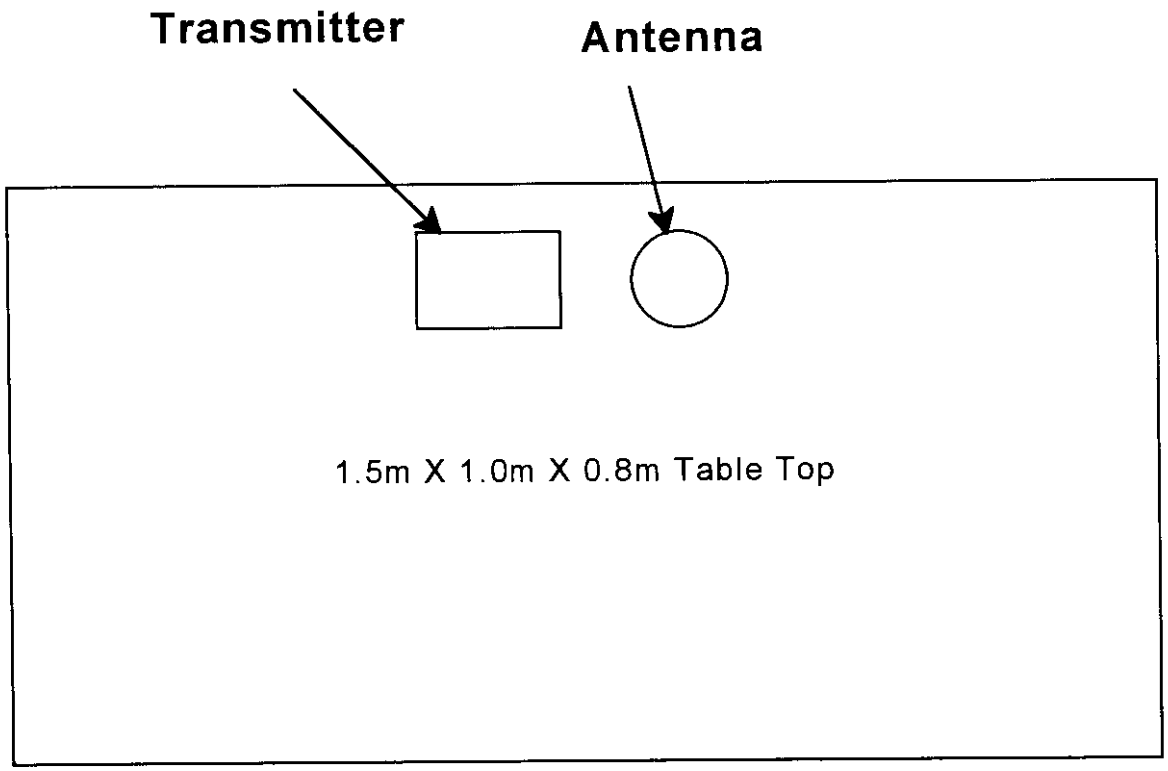


Figure 1 - Measurement Setup for Radiated Emissions above 2483.5 MHz

Intertek Testing Services NA, Inc.

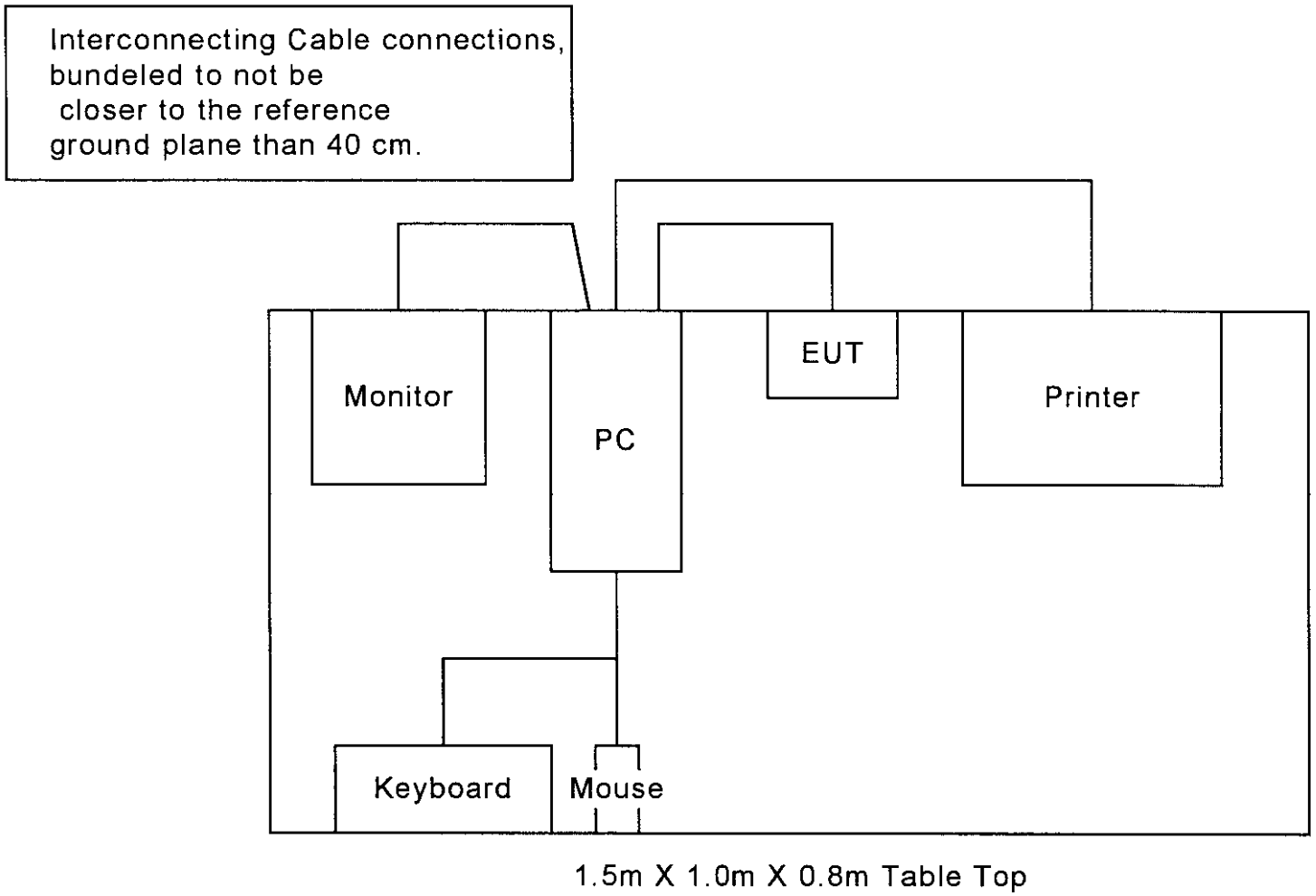


Figure 2 - Radiated Emissions Setup for Unintentional emissions below 2400 MHz
Same setup is used for Line-conducted and antenna conducted emissions. Note that the antenna for the EUT is integral with the transmitter with this setup.

Exhibit B General Information

B.1.0 (2.201) Emission, Modulation & Transmission Characteristics

The emissions designator is determined as follows:

The bandwidth of the spread spectrum is: 79 MHZ

First Symbol - Type of Modulation: Combination of angle, pulse & amplitude (W)

Second Symbol - Nature of Signal(s) Modulating the Carrier: Single channel digital (1)

Third Symbol - Type of Information to be Transmitted: Data (D)

Therefore the emission designator is as follows

79M0W1D

B.1.1 (2.202) Bandwidth

Bandwidth criteria is contained in C.8.6 of this application. Bandwidth measurements were made in accordance with ANSI C63.4(1992).

B.2.0 (2.907) Certification

The WaveAccess waveLyNX BR132 has been tested to the applicable requirements of Part 15 of the FCC rules and requires certification for un-licenced operation.

B.2.1 (2.909) Responsible Party

WaveAccess Ltd.
P.O. Box 2473
10 Hayezira Street
Ra'anana, Israel 43663
Phone: 011-972-9-748-2606
Fax: 011-972-9-748-3218

Description	Section of FCC Rules	Report Location	Page Number
Emission, Modulation & Transmission Characteristics	2.201	B.1.0	2
Bandwidth	2.202	B.1.1	2
Certification	2.907	B.2.0	2
Responsible Party	2.909	B.2.1	2
Identification	2.925	B.2.2	3
FCC Identifier	2.926	B.2.3	3
Measurement Procedure	2.947	B.3.0	3
Description of Measurement Facility	2.948	B.3.1	6
Application for Certification	2.1033	B.4.0	8
Form 731	a)	B.4.1	8
Technical Report 1) Name and Address of Manufacturer/Applicant 2) FCC Identifier 3) Installation and Operating Instructions 4) Brief Description of circuit functions and operation 5) Block Diagram 6) Radiated and Conducted Emissions Test Procedure Date Location Device Tested Sample Calculation 7) Photographs 8) Peripherals tested with 11) FHSS Receiver Characteristics	b)	B.4.2 B.4.2.1 B.4.2.2 B.4.2.3 B.4.2.4 B.4.2.5 B.4.2.6 B.4.2.7 B.4.2.8 B.4.2.9	8 8 8 8 8 9 9 9 9 11
Application Fee and 731 Form	c)	B.4.3	11
Measurement Procedure	2.1041	B.3.0	3

Description	Section of FCC Rules	Report Location	Page Number
Information on Identification Label	2.1045	B.5.0	11
General Technical Requirements a) Good Engineering Judgement b) User controls	15.15	B.5.1	12
Labelling Requirements (3)	15.19	B.5.2	12
Information to User	15.21	B.5.3	12
Special Accessories	15.27	B.5.4	12
Measurement Standards (a)(6) ANSI C63.4(1992) (c) Swept Frequency (d) Open Area Test Site	15.31	B.6.0	12
Frequency Range of Radiated Emissions (a)(1) To the 10th Harmonic (b)(1) To the 5th Harmonic	15.33	B.6.1	12
Measurement Detector and Bandwidth	15.35	B.6.2	13
Equipment Authorization of Unintentional Radiators (a) Class B PC Peripheral - Certification (b) Receiver - Exempt	15.101	B.7.0	13
Information to User (b) Class B User Manual Instructions	15.105	B.8.0	13
Conducted Limits	15.107	C.1.0	16
Radiated Emission Limits	15.109	C.2.0	17
Antenna Power Conduction Limits for Receivers	15.111	C.3.0	17
Equipment Authorization Procedure	15.201	B.7.0	13
Antenna Requirement	15.203	C.4.0	17
Restricted Bands of Operation	15.205	C.6.0	17
Conducted Limits	15.207	C.7.0	18
Radiated Emissions Limits: General Requirements	15.209	C.6 .0	17
External Amplifier and Antenna Modification	15.204	C.5.0	17

Section of FCC Rules	Description	Report Location	Page Number
15.247	Operation within the Bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.	C.8.0	19
	(a) Frequency Hopping Spread Spectrum	C.8.1	19
	(1) Channel Separation	C.8.2	19
	Pseudorandum Operation	C.8.3	19
	Channel usage (equal on average)	C.8.4	19
	Receiver characteristics	C.8.5	19
	(ii) Number of Hopping Frequencies	C.8.6	19
	20 dBc Bandwidth	C.8.7	20
	Average Time of Occupancy	C.8.8	21
	(b) (1) Output Power	C.8.9	21
	(3)(i) Fixed Point-to-Point Operation	C.8.10	22
	(iii) Point-to-Point Installation Instructions	C.8.11	23
	(4) Public exposure to RF (1.1307)	C.8.12	23
	(c) Conducted Spurious Emissions	C.8.13	24
	Restricted bands Radiated Emissions		
	(g) Hopping for Long/Short Periods	C.8.14	24
	(h) Hopping Intelligence	C.8.15	24

B.2.2 (2.925) Identification

a)(1) The FCC identifier is indicated on the FORM 731.

a)(2) Labeling information is contained in D.3.0 of this application.

The waveLyNX BR132 is both a spread spectrum transmitter and a Class B computer peripheral. WaveAccess would like to market the product under a single FCC identifier.

B.2.3 (2.926) FCC Identifier

The FCC identifier is indicated on the FORM 731.

It is, FCC ID: NCABR132V200LXUS

B.3.0 (2.947 & 2.1041) Measurement Procedure

Test Equipment List:

Some of the following measurement equipment were used during compliance testing:

EQUIPMENT LIST TABLE 1					
Abbr	Equipment	Manufacturer	Model	Serial	Cal Due
ANT1	BROADBAND ANTENNA	COMPLIANCE DESIGN	B1000	1649, 1650, 1651	25Apr98
ANT2	BROADBAND ANTENNA	COMPLIANCE DESIGN	B1000	1831, 1850, 1852	11Jun98
ANT3	BROADBAND ANTENNA	COMPLIANCE DESIGN	B1000	668, 523, 533	15Apr98
ANT4	BROADBAND ANTENNA	COMPLIANCE DESIGN	B1000	3317, 3245, 3352	03Jul98
ANT5	BROADBAND ANTENNA	COMPLIANCE DESIGN	B1000	1670, 1671, 1672	29May98
CLMP1	ABSORBING CLAMP	FISCHER CUSTOM	F-201	122	30Apr98
CLMP2	ABSORBING CLAMP	FISCHER CUSTOM	F-201	297	16Jan99
DIP1	TUNED DIPOLE SET	COMPLIANCE DESIGN	A100	402	30-Jan-99
DIP2	TUNED DIPOLE SET	COMPLIANCE DESIGN	A100	506	24Jun98
DIP3	TUNED DIPOLE SET	COMPLIANCE DESIGN	A100	3947	23Jan99
HORN1	HORN ANTENNA	EMCO	3115	4632	03Jul98
HORN2	HORN ANTENNA	EMCO	3115	4675	02Sep98
HORN3	HORN ANTENNA	EMCO	3116	2090	11Feb99
HP1	SPECTRUM ANALYZER	HEWLETT PACKARD	8591	3308A01445	12May98
HP2	SPECTRUM ANALYZER	HEWLETT PACKARD	8591	3346A02319	25Jun98
HP3	SPECTRUM ANALYZER	HEWLETT PACKARD	8593A	3009A00659	30Apr98
LISN1	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	871083	15Jan99
LISN10	LISN	SOLAR ELECTRONICS	9252-50-R-24-BNC	941712	24May98
LISN11	LISN	SOLAR ELECTRONICS	9252-50-R-24-BNC	941713	23May98
LISN12	LISN	SOLAR ELECTRONICS	9252-50-R-24-BNC	941714	25Aug98
LISN13	LISN	SOLAR ELECTRONICS	9252-50-R-24-BNC	955107	15Jan99
LISN14	LISN	SOLAR ELECTRONICS	6338-5-TS-50-N	871131	27Jan99
LISN15	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	865575	1/10/98
LISN2	LISN	SOLAR ELECTRONICS	6338-5-TS-50-N	871132	27Jan99
LISN3	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	8379114	14Jan99
LISN4	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	837929	15Jan99
LISN5	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	934610	05Jun98
LISN6	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	934611	23May98
LISN7	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	934612	05Jun98
LISN8	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	871047	08Jul98
LISN8	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	871055	08Jul98

EQUIPMENT LIST TABLE 2					
Abbr	Equipment	Manufacturer	Model	Serial	Cal Due
LISN8	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	883147	08Jul98
LISN8	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	883151	08Jul98
LISN9	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	953947	14Jan99
LISN9	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	953948	14Jan99
LISN9	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	953949	14Jan99
LISN9	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	953950	14Jan99
LOG1	BICONOLOG ANTENNA	EMCO	3142	1116	1/13/99
LOG2	BICONOLOG ANTENNA	EMCO	3142	1223	12/6/98
LOOP1	LOOP ANTENNA	EMPIRE DEVICES	LG105	61	17Jan99
LOOP2	LOOP ANTENNA	EMPIRE DEVICES	LP105	905	17Jan99
LOOP3	LOOP ANTENNA	EMCO	6509	9612-1403	05Jun98
PRB1	LINE PROBE	SOLAR ELECTRONICS	8614-1	932725	24May98
PRB2	LINE PROBE	SOLAR ELECTRONICS	8614-1	932731	08Jul98
PRB3	LINE PROBE	SOLAR ELECTRONICS	9533-1	955905	24May98
PRE1	PREAMPLIFIER	COMPLIANCE DESIGN	P950	1648	02Apr98
PRE2	PREAMPLIFIER	COMPLIANCE DESIGN	P950	5107	02Apr98
PRE3	PREAMPLIFIER	COMPLIANCE DESIGN	P950	1828	02Apr98
PRE4	PREAMPLIFIER	COMPLIANCE DESIGN	P950	1844	02Apr98
PRE5	PREAMPLIFIER	COMPLIANCE DESIGN	P950	PROTO1	02Apr98
PRE6	PREAMPLIFIER	HEWLETT PACKARD	8447D	1937A03354	10Apr98
PRE7	PREAMPLIFIER	HEWLETT PACKARD	8447D	2944A08718	16Apr98
PRE8	PREAMPLIFIER	MITEQ	NSP4000-NF	507145	9/25/98
REC1	RECEIVER	HEWLETT PACKARD	8542	3520A00125	06Nov98
REC1	RF FILTER	HEWLETT PACKARD	85420	3427A00126	06Nov98
REC2	RECEIVER	HEWLETT PACKARD	85422	3625A00188	04Jan99
REC2	RF FILTER	HEWLETT PACKARD	8542	3427A00177	04Jan99
REC3	RECEIVER	HEWLETT PACKARD	8546A	3325A00160	09May98
REC3	RECEIVER	HEWLETT PACKARD	8546A	3330A00158	09May98
SCOPE1	OSCILLOSCOPE	TEKTRONIX	TDS380	B011379	07Oct98
SIG1	SIGNAL GENERATOR	HEWLETT PACKARD	8648B	3537A01040	10Apr99
TEK1	SPECTRUM ANALYZER	TEKTRONIX	2784	B010153	25Apr98

AC Wireline Conducted Measurement Method

Measurement Procedure

The transmitter shall be operated at its maximum power output. For a transceiver, the receiver portion can be tested at the same time as the transmitter.

The conducted emissions shall be measured with a 50 ohm/50 microhenry (μH) line impedance stabilization network (LISN).

A ground plane or screen is required for power line conducted measurements. This ground plane is to consist of a conducting floor and at least one vertical earth-grounded conducting surface. Each surface shall be at least 2.0 x 2.0 metres.

The EUT shall be placed 40 centimetres from the vertical grounded surface, and shall be kept at least 80 centimetres from any other earth-grounded conducting surface. The EUT shall be placed at a distance of 80 centimetres from the LISN and connected thereto by the AC power cord. Power cords with leads in excess of the 80 centimetres separating the EUT from the LISN shall be folded back and forth so as to form a bundle not exceeding 30 centimetres in length located at the LISN. The electrical bond between the LISN enclosure and the ground plane is ensured prior to the test.

Radiation Measurement Method

Measuring Distance

The following is a description of a "3-metre test site". Measurements using a calibrated site of greater dimensions are permitted, with the field strength extrapolated to the specified distance of the technical standard using an inverse linear distance extrapolation, i.e. 20 dB/decade.

Open Field Test Site

Intertek Testing Services emissions test sites at 593 Massachusetts Avenue, Boxborough Massachusetts are registered with the FCC (Last updated as of January 16, 1997) and under the NAVLAP program (NAVLAP Lab Code: 100270-0).

Equipment Test Platform

The EUT is oriented in the manner in which it is designed to operate and placed on a nonconducting turntable 1.0 metre above ground; refer to Figure A(b). The table is capable of being rotated through 360 degrees in azimuth. The power supply and other external cables are fed through a hole in the centre of the table and extended downwards.

All available accessories are connected to the EUT by interconnection cables supplied by the manufacturer. Excess cables are folded back and forth to form a bundle 30 to 40 cm in length and placed on the test platform. It is also draped over the edge of the platform provided that it is kept at least 40 cm above the ground plane.

Measurement Method

Extend the EUT antenna fully and operate the EUT in its normal mode of operation. The EUT's radiated spectrum shall be measured using a tuned dipole (or other standard antenna herein known as the measurement antenna) in the vertical plane of polarization.

The tuned dipole shall be located horizontally 3 metres from the EUT and it shall be mounted on a non-conducting mast that permits the antenna height to be varied between 1.0 and 4.0 metres. The lower element of the vertical dipole shall be kept at least 25 centimetres above the ground plane for any measurement.

The received signal shall be coupled to a spectrum analyzer. The EUT shall be rotated through a total of 360 degrees in azimuth and the height of the measurement antenna varied between 1.0 and 4.0 metres to find the maximum field strength. Record the frequency and the field strength.

The above test is to be repeated with the measurement antenna in the horizontal polarization. In lieu of separate measurements using the measurement antenna first in the vertical and then in the horizontal polarizations, as described above, it is permissible that the measurement antenna polarization be rotated to maximize each field strength reading.

For hand-held or body-worn devices, the device shall be tested in three orthogonal planes: lying on its side, back, and on its end.

The EUT shall be de-activated and the residual field strength due to the ambient RF noise measured. To ensure that the EUT field strength measurement is not significantly influenced by ambient RF noise, the latter level shall be at least 6 dB below that of the EUT signal.

B.4.0 (2.1033) Application for Certification

B.4.1 (2.1033) Form 731

The FORM 731 is contained in Exhibit A of this application.

B.4.2 (2.1033) Technical Report

B.4.2.1 Name and Address of Manufacturer/Applicant

See B.2.1 of this application for the Manufacturer.

B.4.2.2 FCC Identifier

See Form 731 in Exhibit A of this application.

B.4.2.3 Installation and Operating Instructions

See D.8.0 of this application for the instruction manual.

B.4.2.4 Brief Description of circuit functions and operation

The waveLyNX BR132 wireless bridge is a unit which connects a 10BaseT local area network to another such network at distances of up to 20 miles. This is done by employing two units which constitute a point to point RF link at the ISM band of 2.4 Ghz. Both units employ a frequency hopping spread spectrum radio covering 79 channels of 1 MHz each.

Data rates of 3.2 and 1.6 Mbps (using 16QAM and QPSK modulation techniques, respectively) are supported and switched automatically as dictated by the channel conditions.

B.4.2.5 Block Diagram

See D.5.0 for a block diagram of the device.

B.4.2.6 Radiated and Conducted Emissions

Exhibit C of the application contain the results of radiated and conducted emissions testing, specifically:

FCC Section	Application Section	Description
15.107	C.1.0	Unintentional radiator conducted emissions
15.109	C.2.0	Unintentional radiated radiated emissions
15.205	C.6.0	Restricted Bands of operation
15.207	C.7.0	Intentional radiator conducted emissions
15.209	C.7.0	Radiated emissions: General Requirement
15.247(c)	C.8.13 C.8.14	Conducted Spurious Emissions Restricted Bands Radiated Emissions

B.4.2.7 Photographs

See D.1.0 for detailed photographs of the device.

B.4.2.8 Peripherals and support equipment

Printer: Hewlett Packard DeskJet 600C
M/N: C4547A
S/N: SG62B1H0CX
FCC ID: B94C2184X

B.4.2.8 Peripherals and support equipment (con't)

Monitor:	NANAO M/N: MA-1760 S/N: A7585023-USM FCC ID: GCJMA-1760
Mouse:	Microsoft P/N: 58267 S/N: 00865704 FCC ID: C3KSMP1
Keyboard:	SIIG M/N: KB1927 Wintouch S/N: SIIGJ22C60003464 FCC ID: FK2SIIGSKB104W
Laptop:	Texas Instrument (remotely located) M/N: NSK82WW/T1 S/N: K8265304031A FCC ID: Not Labeled
Power Supply:	WaveAccess M/N: WA410-06220-0-1 S/N: 0273 FCC ID: Not Applicable
	Linksys 5-Port Workgroup Hub (remotely located) M/N: EW5HUB S/N: Not Labeled FCC ID: KFYPH5
	Delta Electronics (remotely located) M/N: ADP-36HB S/N: A5614019957 FCC ID: Not Applicable

B.4.2.8 Peripherals and support equipment (con't)

Ethernet Bridge: WaveAccess (remotely located)
M/N: waveLyNX BR132
S/N: Not Labeled
FCC ID: Not Labeled

Cables:

(1) Parallel Cable (2.5m, shielded, metal hood)
(1) 10BaseT Cable [EXT1] (14m, unshielded, plastic hood)
(1) 10BaseT Cable [EXT2] (8m, unshielded, plastic hood)
(1) 10BaseT Cable (1m, unshielded, plastic hood)
(2) AC Power Cords (2m, shielded, metal hood)
(1) Serial Cable (3m, unshielded, plastic hood)
(1) Video Cable (2m, shielded, metal hood)

B.4.2.9 FHSS Receiver Characteristics

The receiver operates in the same frequency band as the transmitter and utilizes the same pseudorandom hopping characteristics.

B.4.3 (2.1033(c)) Application FEE and 731 Form

The waveLyNX BR132 is one device that falls under two parts of the FCC rules, FCC Part 15, Subpart B Class A and FCC Part 15, Subpart C 15.247. One application, one certification, FCC identifier and application fee is required.

B.5.0 (2.1045(a)) Information and Identification Label

See Sections B.2.2, B.2.3 & D.3.0 of this application for applicable labeling requirements and instructions.

B.5.1 (15.15) General Technical Information

b) User Controls - The device does not have any external controls accessible to the user that can be adjusted and operated in violation of the limits of this Standard. The manual instructs the installer how to set up the transmitter based on the antenna used in operation.

B.5.2 (15.19) Labeling Requirements

The complete labeling and label location drawings are included in Exhibit D.3.

B.5.3 (15.21) Information to User

Cautions to the user are contained in the instruction manual on Page iii.

B.5.4 (15.27) Special Accessories

Accessories and peripheral equipment that are normally required to be connected to the device in actual use are connected with representative cable lengths for the tests, if applicable.

B.6.0 (15.31) Measurement Standards

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.4 (1992). All measurements were performed in Open Area Test Sites. All Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application, Exhibit C.1.1.

B.6.1 (15.33) Frequency Range of Radiated Emissions

For Subpart B Operation: The highest frequency is 80 MHz	Emissions were investigated to 1000 MHz
For Subpart C Operation: The highest frequency is 2,480 MHz	Emissions were investegated to the 10th Harmonic

B.6.2 (15.35) Measurement Detector and Bandwidth

When performing measurements the following table was used to determine the appropriate detector and resolution banddwidth

Frequency Range (MHz)	Detector*	RBW (KHz)
0.450 to 30	Quasi-Peak	9
30 to 1000	Quasi-Peak	120
1000 +	Average	1000**

* When measurements are specified with an average detector and the emission has a known duty cycle, a peak reading is recorded and an average factor is subtracted from the measurement.
** Lower resolution bandwidth may be used to compensate for high noise floor readings. When this is done, the presence of pulse desensitization was verified.

B.7.0 (15.101 & 15.201) Equipment Authorization of Unintentional Radiators

Under 15.101 of the FCC rules the device is a Class B computer peripheral subject to cerification.

Under 15.201 of the FCC rules the device is a spread spectrum frequency hopping transmitter, subject to certification.

B.8.0 (15.105) Information to the User

An instruction manual is provided in Exhibit D.8.

Exhibit C Results of Compliance Tests

C.0.0 System Test Configuration

C.0.1 Justification

The transmitter was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in ANSI C63.4 (1992).

During testing, the peripheral locations were not varied with respect to the main unit.

The arrangement of the cables dangling from the rear of the table was varied to the extent possible to produce the maximum emissions.

For maximizing emissions, the system was rotated through 360°, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the data.

C.0.2 EUT Exercising Software

The unit was configured to transmit continuously on three different frequencies; high, medium and low. Radiated emissions testing was performed with hop stopped and while hopping. During emissions testing of the unintentional radiator, the device was installed a a computer peripheral within the guidelines of ANSI C63.4(1992).

C.0.3 General Equipment Information

RECEIVER

FREQUENCY RANGE	2400-2483.5 MHz
NO. OF CHANNELS	78
TUNABLE BANDS	N/A
DESIGNATED RECEPTION MODE AND BANDWIDTH:	Spread Spectrum Frequency Hopping 79 MHz
INTERMEDIATE FREQUENCY(IES)	N/A
INPUT IMPEDANCE	N/A
OUTPUT IMPEDANCE	50 ohms
AUDIO POWER OUTPUT Manufacturers rating	N/A
CRYSTAL FREQUENCY(IES)	Same as Transmitter

TRANSMITTER

FREQUENCY RANGE	2400-2483.5 MHz
NO. OF CHANNELS	78
BANDWIDTH	79 MHz
TYPE OF EMISSION	Spread Spectrum Frequency Hopping
OUTPUT IMPEDANCE	50 ohms
CRYSTAL FREQUENCY(IES)	0.8, 3.6864, 6.4, 10.0, 20, 26.666, 32 & 80 MHz
POWER OUTPUT: Manufacturers rating	0.063 watts

C.1.0 (15.107) Conducted Limits

PERFORMED BY: Kouma Sinn DATE: February 23, 1998

The following page(s) are tables and graphs containing the results of line-conducted emissions testing. To summarize:

Table #	Frequency (MHz)	Worst-case Margin (dB)	Next Highest Margin (dB)	Pass/ Fail
2	0.492	-10*	-12*	Pass

*In accordance with 15.107(d) and 15.207(b) a 13 dB reduction factor was applied due to the average readings being 6 dB (or greater) lower than the quasi-peak.

Table:2

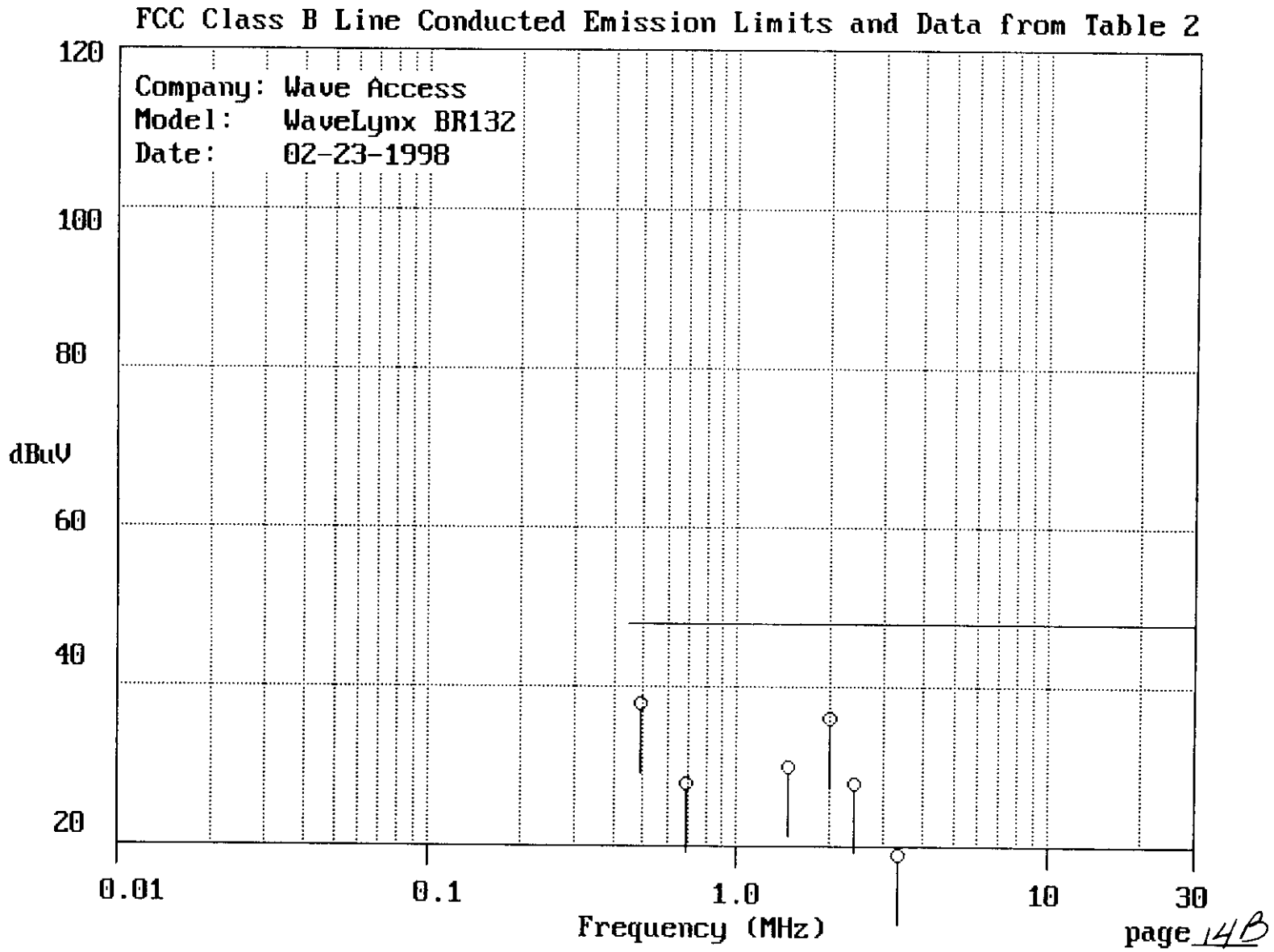
Company: Wave Access Model: WaveLynx BR132

Notes: L-C scan (13 dB substraction from Qp reading was applied)

FCC Class B Conducted Emissions

Frequency (MHz)	Reading Side A (dBuV)	Reading Side B (dBuV)	Class B Limit (dBuV)	Margin (dB)
0.492	38	38	48	-10
0.688	27	28	48	-20
1.471	30	29	48	-18
2.000	36	34	48	-12
2.391	28	26	48	-20
3.321	19	19	48	-29

Test Engineer: Kouma Sinn Test Date: 02-23-1998


FCC Class B Line Conducted Emission Limits and Data from Table 2
Company: Wave Access
Model: WaveLynx BR132
Date: 02-23-1998
120
100
80
dBuV
60
40
20
0.01
0.1
1.0
10
30
Frequency (MHz)

C.2.0 (15.109) Radiated Emissions Limits

Results of radiated emissions testing is contained in section C.7.0 of this application.

C.3.0 (15.111) Antenna Power Conduction Limits for Receivers

The receiver operates above 960 MHz and is therefore exempt from the requirement.

C.4.0 (15.203) Antenna Requirement

The DP02 antannas are attached directly to the box using non-standard connectors (reversed polarized SMA) and consequently are the only antennas that don't require professional installation. All the other antennas, which require professional installation, must use the 2 foot RG-58 (with reverse polarized SMA), plus the 20 foot (or longer) RG-8 cables to connect to the bridge box.

C.5.0 (15.204) External Amplifier and Antenna Modification

The installer/user is warned against the use of external amplifiers and antenna modifications in FCC Warning, page iii and Section 2.3.1, pages 11 and 12 of the user manual.

C.6.0 (15.205) Conducted Limits

See section C.1.0 of this application for conducted measurement results. The device is a single unit and the conducted emissions measurements need only be measured once.

C.7.0 (15.207 & 15.209) Radiated Emissions Limits and Restricted Bands of Operation

PERFORMED BY: Kouma Sinn
DATE: February 23, 1998 and June 16, 1997

Table #	Modulation	Antenna	Transmit Frequency (MHz)	Measured Frequency (MHz)	Net Reading (μV/m)	Limit (μV/m)	Margin (dB)	Pass/ Fail
5	QPSK	Standard	Hopping	220.0,700.0&740.0	141	200	-3	Pass
1	QPSK	Parabolic Grid (PG24) BR132	2402	4804.0	141	500	-11	Pass
1B	QPSK		2440	4880.0	251	500	-6	Pass
1D	QPSK		2480	4960.0	251	500	-6	Pass
2	QPSK	Yagi (YG14) BR132	2402	4804.0	158	500	-10	Pass
2B	QPSK		2440	4880.0	224	500	-7	Pass
2D	QPSK		2480	7440.0	224	500	-7	Pass
3	QPSK	Omni (OM12) BR132	2402	19216.0	200	500	-8	Pass
3B	QPSK		2440	19520.0	200	500	-8	Pass
3D	QPSK		2480	22320.0	112	500	-13	Pass
4	QPSK	Planar (PN20) (CU132)	2402	19216.0	282	500	-5	Pass
4B	QPSK		2440	7320.0	89	500	-15	Pass
4D	QPSK		2480	4960.0	126	500	-12	Pass
1	QPSK	Sector (ST 16) CU132	2402	19216.0	282	500	-5	Pass
2	QPSK		2440	19520.0	251	500	-6	Pass
3	QPSK		2480	19840.0	282	500	-5	Pass
13	QPSK	Parabolic Grid (PS19)	2402	19216.0	282	500	-5	Pass
14	QPSK		2440	19520.0	251	500	-6	Pass
15	QPSK		2480	19840.0	251	500	-5	Pass

Note: Testing was performed on the BR132 antennas (PG24, YG14 and OM12) on June 16, 1997. The results of the testing are indicated here, however the data tables are contained in the original application (FCC ID: NCABR132V100LXUS). The testing with CU132 is consistent with the results originally obtained with the BR132.

Intertek Testing Services

Emissions Site 1 Boxborough, MA

Table:1

Company: Wave Access

Model: WaveLynx BR132

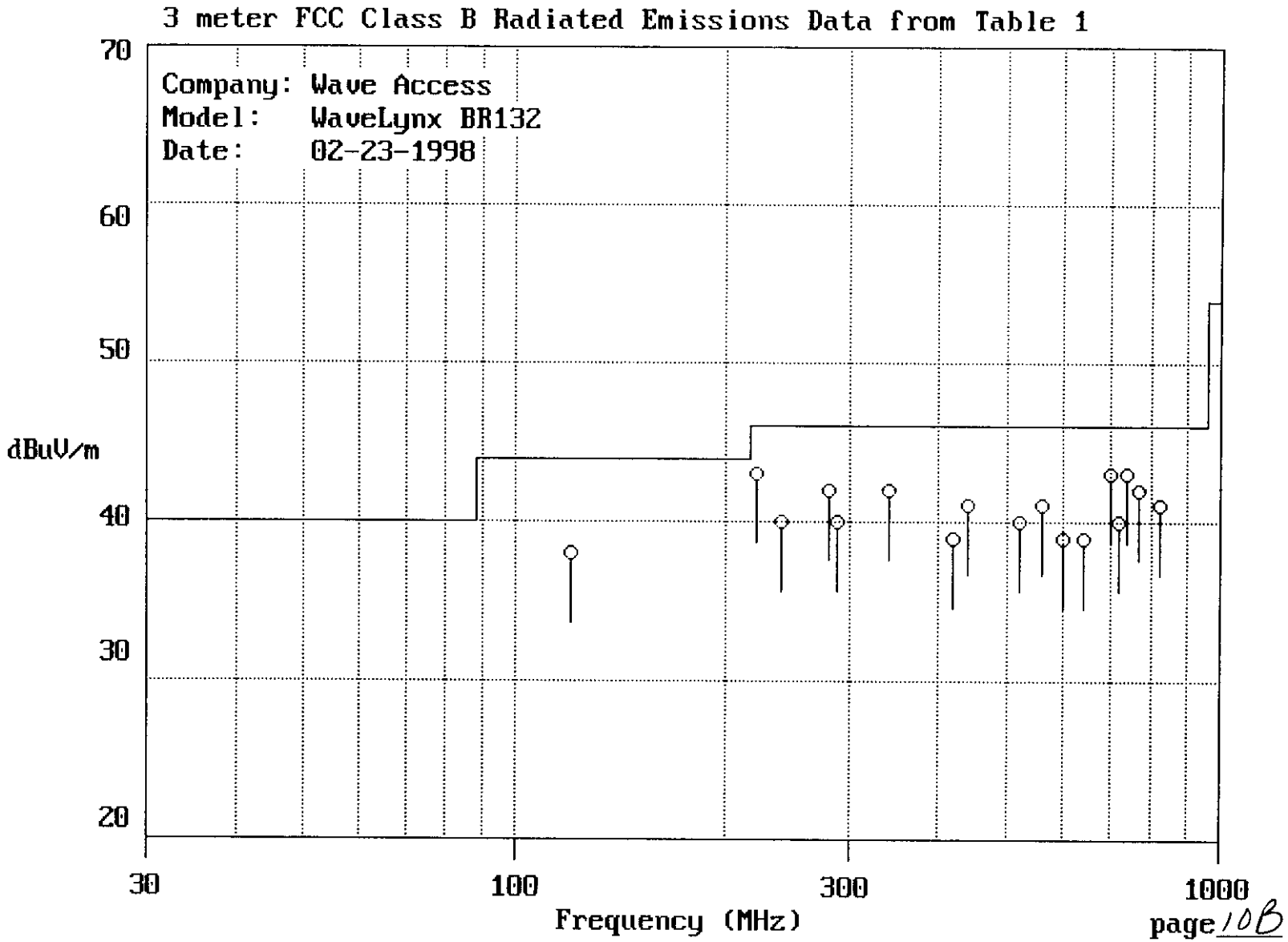
Notes: Radiated scan at 3 meters

FCC Class B Radiated Emissions

Antenna Polarity	Frequency (MHz)	Reading (dBuV)	Antenna Factor (dB)	Net at 3 meter (dBuV/m)	Class B Limit (dBuV/m)	Margin (dB)
V	120.0	25.0	13	38	44	-6
V	220.0	24.0	19	43	46	-3
H	240.0	20.0	20	40	46	-6
H	280.0	20.0	22	42	46	-4
H	288.0	18.0	22	40	46	-6
H	340.0	18.0	24	42	46	-4
H	420.0	13.0	26	39	46	-7
H	440.0	15.0	26	41	46	-5
V	520.0	13.0	27	40	46	-6
H	560.0	13.0	28	41	46	-5
V	600.0	11.0	28	39	46	-7
V	640.0	10.0	29	39	46	-7
V	700.0	13.0	30	43	46	-3
V	720.0	10.0	30	40	46	-6
V	740.0	13.0	30	43	46	-3
V	768.0	12.0	30	42	46	-4
H	820.0	8.0	33	41	46	-5

Test Engineer: Kouma Sinn

Test Date: 02-23-1998


3 meter FCC Class B Radiated Emissions Data from Table 1
Company: Wave Access
Model: WaveLynx BR132
Date: 02-23-1998
70
60
50
40
30
20
dBuV/m
30
100
300
1000
Frequency (MHz)

Intertek Testing Services

Boxborough, MA

COMPANY: Wave Access
MODEL: CU132

TABLE: 1
Date of Test: 02-23-1998

NOTES: H/S scan with ST16 antenna at 2402 MHz in QPSK mode

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
4804.000	25	20	34	0	0	0	39	89	500	-15
12010.000	25	20	41	0	0	0	46	200	500	-8
19216.000	22	20	47	0	0	0	49	282	500	-5

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

Intertek Testing Services

Boxborough, MA

COMPANY: Wave Access
MODEL: CU132

TABLE: 2
Date of Test: 02-23-1998

NOTES: H/S scan with ST16 antenna at 2440 MHz in QPSK

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
4880.000	25	20	34	0	0	0	39	89	500	-15
7320.000	22	20	39	0	0	0	41	112	500	-13
12200.000	24	20	41	0	0	0	45	178	500	-9
19520.000	22	20	46	0	0	0	48	251	500	-6

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

Intertek Testing Services

Boxborough, MA

COMPANY: Wave Access
MODEL: CU132

TABLE: 3
Date of Test: 02-23-1998

NOTES: H/S scan with ST16 antenna at 2480 MHz in QPSK mode

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
4960.000	20	20	34	0	0	0	34	50	500	-20
7440.000	20	20	40	0	0	0	40	100	500	-14
12400.000	22	20	41	0	0	0	43	141	500	-11
19840.000	23	20	46	0	0	0	49	282	500	-5
22320.000	20	20	48	0	0	0	48	251	500	-6

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

COMPANY: Wave Access
MODEL: CU132

TABLE: 4
Date of Test: 02-23-1998

NOTES: H/S scan with PN20 antenna at 2402 MHz in QPSK mode

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
4804.000	25	20	34	0	0	0	39	89	500	-15
12010.000	25	20	41	0	0	0	46	200	500	-8
19216.000	22	20	47	0	0	0	49	282	500	-5

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

COMPANY: Wave Access
MODEL: CU132

TABLE: 5
Date of Test: 02-23-1998

NOTES: H/S scan with PN20 antenna at 2440 MHz in QPSK mode

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
4880.000	25	20	34	0	0	0	39	89	500	-15
7320.000	22	20	39	0	0	0	41	112	500	-13
12200.000	24	20	41	0	0	0	45	178	500	-9
19520.000	22	20	46	0	0	0	48	251	500	-6

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

Intertek Testing Services

Boxborough, MA

COMPANY: Wave Access
MODEL: CU132

TABLE: 6
Date of Test: 02-23-1998

NOTES: H/S scan with PN20 antenna at 2480 MHz in QPSK mode

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
4960.000	20	20	34	0	0	0	34	50	500	-20
7440.000	20	20	40	0	0	0	40	100	500	-14
12400.000	22	20	41	0	0	0	43	141	500	-11
19840.000	23	20	46	0	0	0	49	282	500	-5
22320.000	20	20	48	0	0	0	48	251	500	-6

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

COMPANY: Wave Access
MODEL: CU132

TABLE: 13
Date of Test: 02-23-1998

NOTES: H/S scan with PS19 antenna at 2402 MHz in QPSK mode

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
4804.000	25	20	34	0	0	0	39	89	500	-15
12010.000	25	20	41	0	0	0	46	200	500	-8
19216.000	22	20	47	0	0	0	49	282	500	-5

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

COMPANY: Wave Access
MODEL: CU132

TABLE: 14
Date of Test: 02-23-1998

NOTES: H/S scan with PS19 antenna at 2440 MHz in QPSK mode

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
4880.000	25	20	34	0	0	0	39	89	500	-15
7320.000	22	20	39	0	0	0	41	112	500	-13
12200.000	24	20	41	0	0	0	45	178	500	-9
19520.000	22	20	46	0	0	0	48	251	500	-6

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

Intertek Testing Services

Boxborough, MA

COMPANY: Wave Access
MODEL: CU132

TABLE: 15
Date of Test: 02-23-1998

NOTES: H/S scan with PS19 antenna at 2480 MHz in QPSK mode

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
4960.000	20	20	34	0	0	0	34	50	500	-20
7440.000	20	20	40	0	0	0	40	100	500	-14
12400.000	22	20	41	0	0	0	43	141	500	-11
19840.000	23	20	46	0	0	0	49	282	500	-5
22320.000	20	20	48	0	0	0	48	251	500	-6

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

C.8.0 (15.247) Operation within the Bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

C.8.1 15.247 (a) Frequency Hopping Spread Spectrum

The transmitter is a spread spectrum frequency hopping transmitter that occupies the 2400 to 2483.5 MHz band.

C.8.2 (15.247 (a)(1)) Channel Separation

Channel Separation is 1 MHz as measured in plot number [ ].

C.8.3 (15.247 (a)(1)) Pseudorandom Operation

See **Exhibit D.9.0 Additional information from WaveAccess** for a description of how the hopping works.

C.8.4 (15.247 (a)(1)) Channel usage

See **Exhibit D.9.0 Additional information from WaveAccess** for a description of how the hopping works.

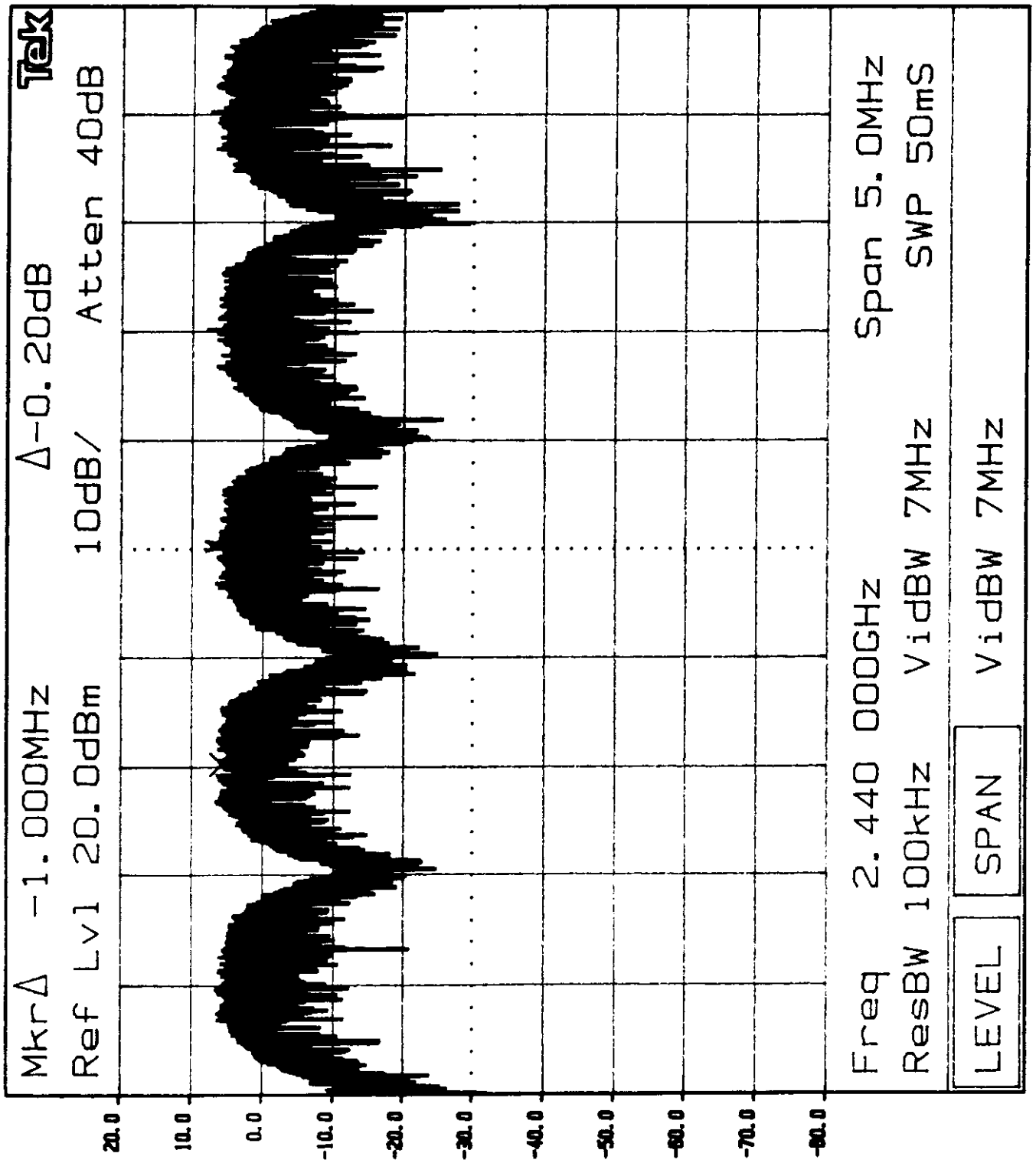
C.8.5 (15.247 (a)(1)) Receiver Characteristics

The receiver operates in Spread Spectrum frequency hopping fashion of the transmitter.

C.8.6 (15.247 (a)(1)(ii)) Number of Hopping Frequencies

Their are 78 hopping frequencies.

QPSK PLOT #2



105.13 K

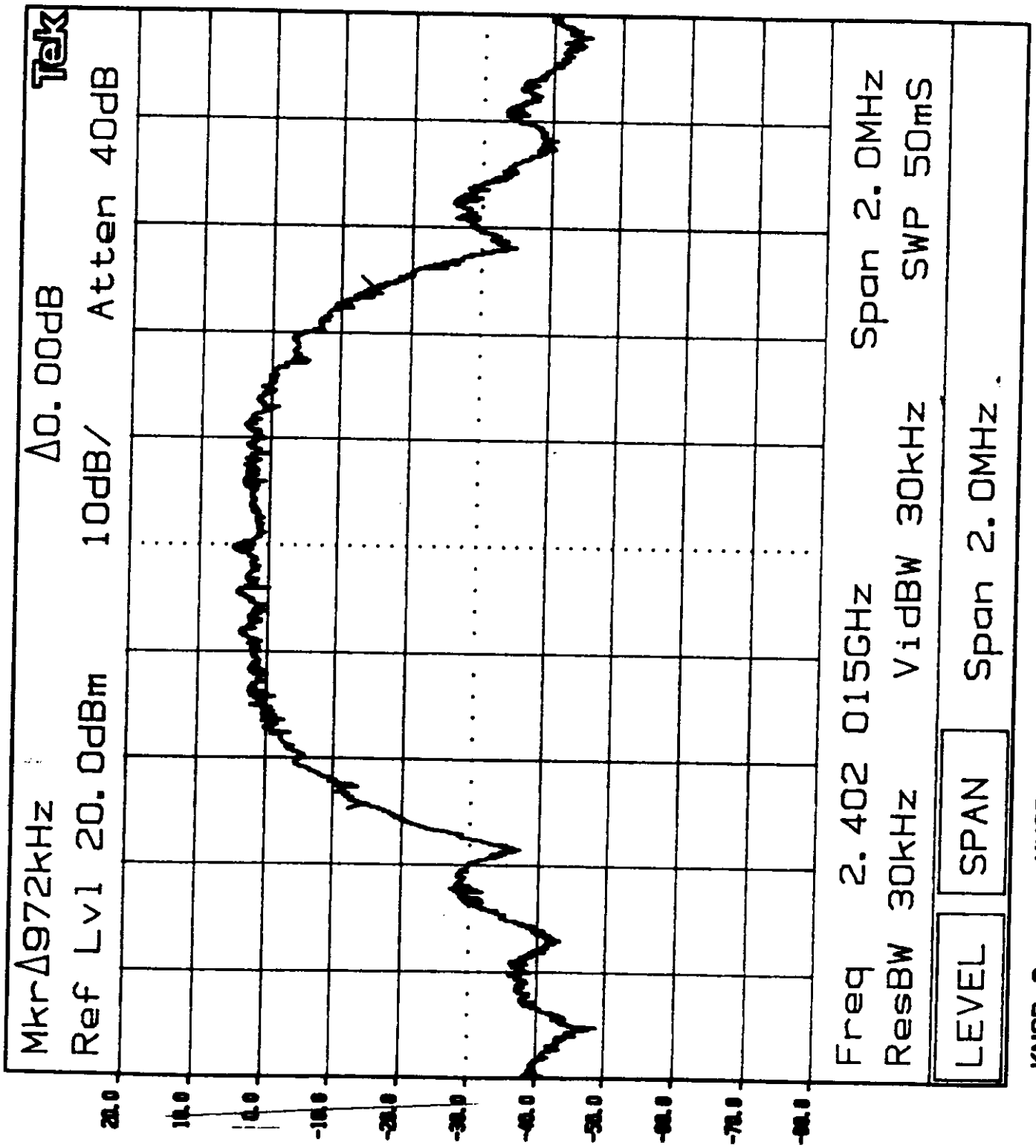
C.8.7 (15.247 (a)(1)(ii)) Bandwidth (20 dBc)

The plots on the following page shows the fundamental emission when modulated. Bandwidth is measured 20 dB below the peak carrier. Resolution bandwidth is chosen to be much less than the bandwidth limit but not below 10 KHz.

Transmit Frequency (MHz)	Measured Bandwidth (KHz)	Bandwidth Limit (KHz)	Pass/Fail	Resolution Bandwidth (KHz)
2402.0	972	1000	Pass	30
2440.0	968	1000	Pass	30
2480.0	962	1000	Pass	30

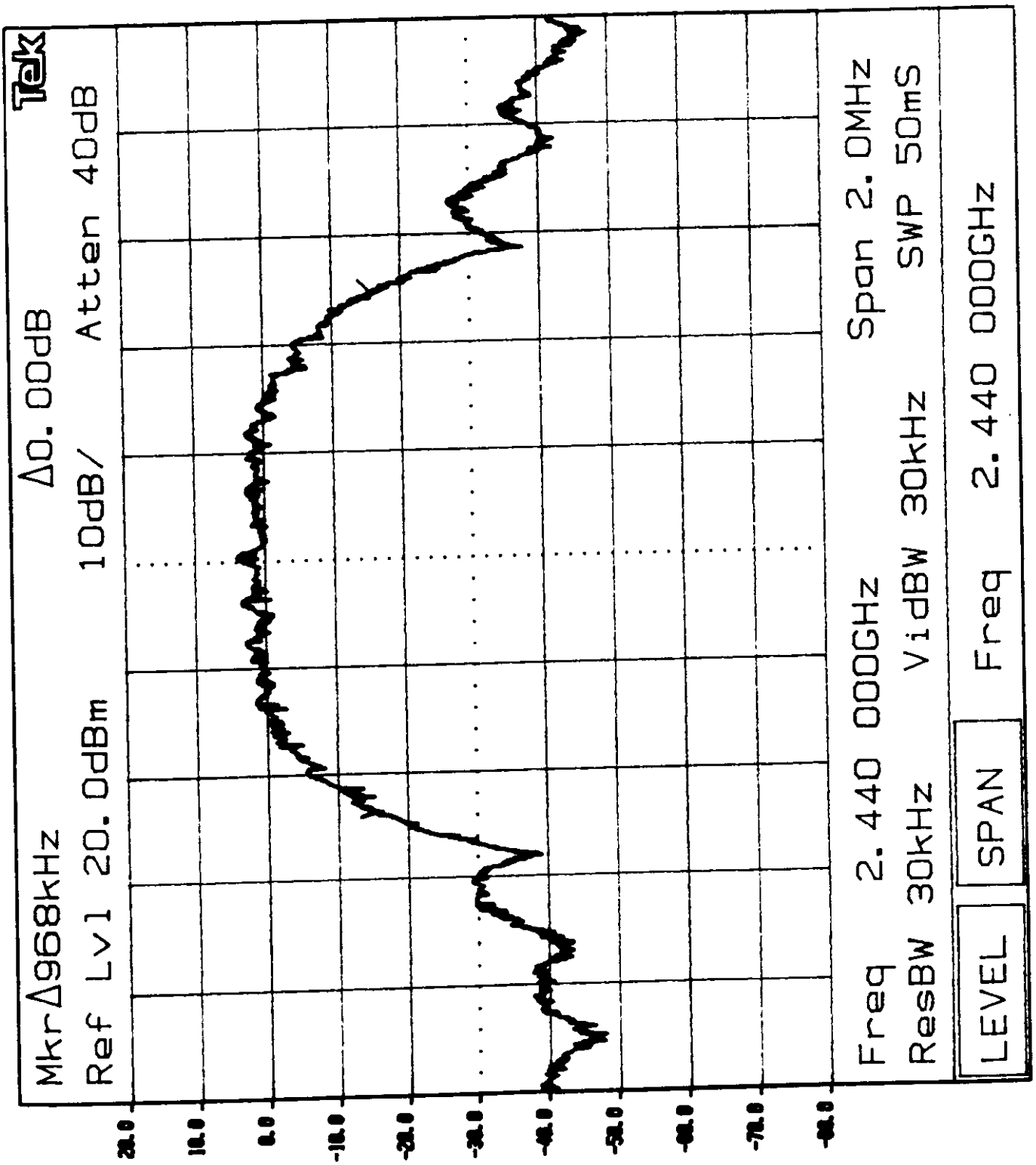
Measurements were made with both types of modulation (QPSK and 16QAM), however QPSK gave worst-case bandwidths and they are what is reported here.

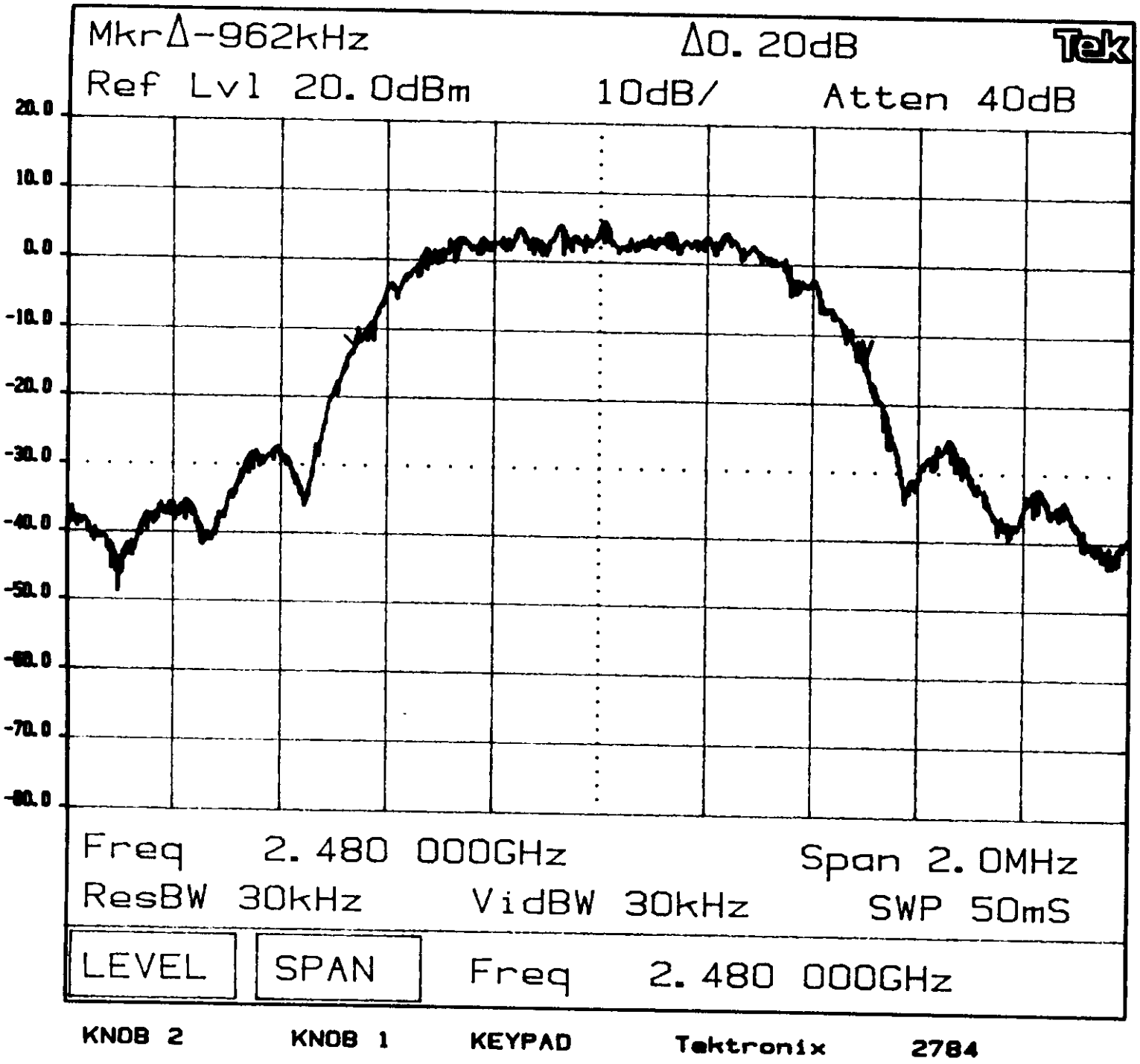
QPSK PLOT #2


Tek
Mkr Δ972kHz
Ref Lvl 20.0dBm
Δ0.00dB
10dB/
Atten 40dB
Freq 2.402 015GHz
Span 2.0MHz
ResBW 30kHz
VidBW 30kHz
SWP 50mS
LEVEL
SPAN
Span 2.0MHz
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784

QPSK

PLOT #3

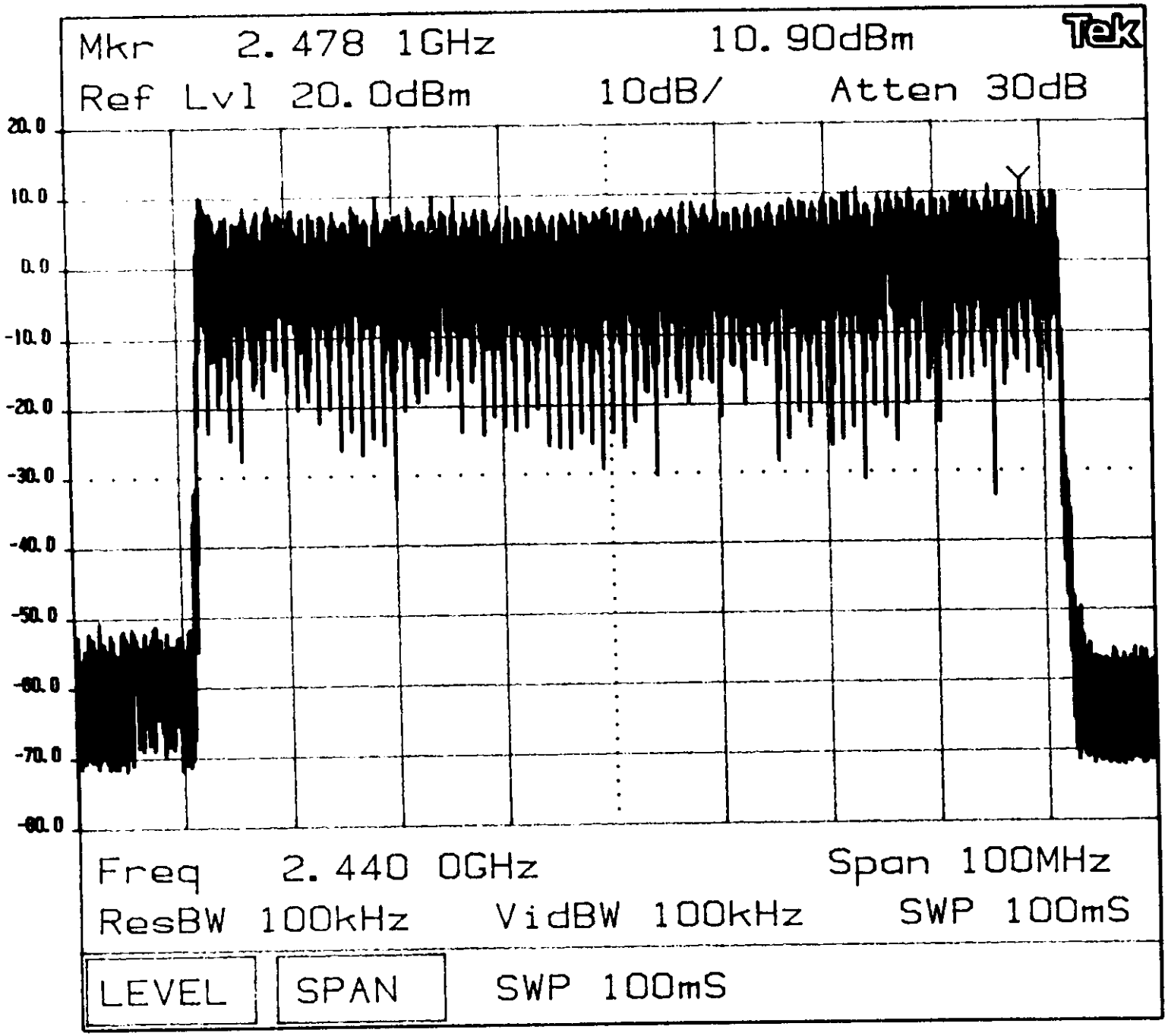

Tek
MkrΔ968kHz
Ref Lvl 20.0dBm
Δ0.00dB
10dB/
Atten 40dB
Freq 2.440 000GHz
ResBW 30kHz
VidBW 30kHz
Span 2.0MHz
SWP 50mS
LEVEL
SPAN
Freq
2.440 000GHz
KNOB 2
KNOB 1
KEYPAD
Tektronix
2784



QPSK

PLOT #4

pg. 1F



QPSK

PLOT #5

Pg. 13A

C.8.8 (15.247 (a)(1)(ii)) Average Time of Occupancy

Time of Occupancy on a single channel	Time period before cycle starts again	Time of Occupancy on a single channel Limt	Time period before cycle starts again (limit)	Pass/ Fail
0.3797 seconds	30 seconds	0.4 seconds	30 seconds	Pass

C.8.9 (15.247 (b)(1)) Output Power

Output Power

The manufacturer's a output power is 0.063 watts and the limit is 1.0 watt.

Output Power Measurements

Transmit Frequency (MHz)	Measured Output Power (dBm)	Output Power (watts)	Limit for Out of Band Emissions (dBm)*
2402.0	16	0.0398	-4
2440.0	16	0.0398	-4
2480.0	17	0.0501	-3

Taking worst-case from all transmit frequencies.

C.8.10 (15.247 (b)(3)(i)) Fixed Point-to-Point Operation

The waveLyNX BR132 is designed to work with several high gain, professionally installed and point-to-point transmitters. When the antennas are installed the parameters are chosen for that antenna in the software and the output power will be adjusted accordingly.

Reduction is based on the antenna gain being better than 6 dB over isotropic.

Antenna Name	P-to-P ? (Yes/No	Gain over Isotropic (dBi)	Total Gain (dBm)	Limit EIRP (dBm)	Pass/Fail
Parabolic Grid	Yes	24	42	36	Pass*
Yagi	Yes	15	33	36	Pass
Omni	No	12	30	36	Pass
Planar	Yes	20	38	36	Pass*
Sector	No	16	34	36	Pass
Grid	Yes	19	37	36	Pass*

*The reduction in output power assumes that the output power is 1 watt (30 dBm). If the sum of the output power gain plus the AG/3 is greater than 30 dBm, a reduction is applied. For the Parabolic Grid antenna, the need to reduce the output power is determined as follows

Antenna Gain = 24 dBi
Maximum allowed = 6 dBi

Reduction is determined by (24 dBi - 6 dBi) / 3 = 6 dB.
The output power must be (30 dBm - 6 dB) = 24 dB. The maximum output power is 18 dBm so no reduction is necessary.

C.8.11 (15.247 (b)(3)(iii)) Point-to-Point Installation Instructions

The instruction manual contains installation instruction for Fixed point-to-point installation. See Exhibit D.8.0 pages 11 through 14 contain antenna installation instructions.

C.8.12 (15.247 (b)(4)) Public Exposure to RF (1.1307)

The instruction manual contained in Exhibit D.8.0 in Section 2.3.1, page(s) 11 and 12 contain warnings about RF exposure.

C.8.13 (15.247 (c)) Conducted Spurious Emissions Restricted bands - Radiated Emissions

PERFORMED BY: Kouma Sinn

DATE: June 16, 1997

Table #	Transmit Frequency (MHz)	Measured Frequency (MHz)	Net Reading (dBm)	Limit (dBm)	Margin (dB)	Pass/ Fail
16	2402	4804	-55	-4	-50	Pass
17	2440	4880	-56	-6	-50	Pass
18	2480	4960	-50	-5	-45	Pass

Measurements were made with the device operating in both QPSK and 16QAM modulation modes. The data for the worst case modes are indicated above and are following, however no emissions were detected within 20 dB of the limit.

C.8.14 (15.247 (g)) Hopping for Long / Short Periods

See **Exhibit D.9.0 Additional information from WaveAccess** for a description of how the hopping works.

C.8.15 (15.247 (h)) Hopping Intelligence

The transmitter does not employ intelligence to effect the hop sequence.

Company: Wave Access Table 16

Type of Test: Conducted Antenna Emissions

Notes: QPSK Mode, 2402 MHz Fundamental Frequency Model: Wavelynx

Frequency (GHz)	Reading (dBm)	Cable Loss (dB)	Net Reading (dBm)	Limit (dBm)	Margin (dB)
2.402	15	0	15	N/A	N/A
4.804	-55	0	-55	-5	-50
7.206	-69	0	-69	-5	-64
9.608	-69	1	-68	-5	-63
12.010	-68	1	-67	-5	-62
14.412	-69	1	-68	-5	-63
16.814	-68	1	-67	-5	-62
19.216	-67	1	-66	-5	-61
21.618	-62	1	-61	-5	-56
24.020	-61	2	-59	-5	-54

Test Engineer: Kouma Sinn Date of Test: June 16, 1997

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Table 17

Company: Wave Access

Type of Test: Conducted Antenna Emissions

Notes: 16QAM Mode, 2440 MHz Fundamental Frequency Model: Wavelynx

Frequency (GHz)	Reading (dBm)	Cable Loss (dB)	Net Reading (dBm)	Limit (dBm)	Margin (dB)
2.440	14	0	14	N/A	N/A
4.880	-56	0	-56	-6	-50
7.320	-70	0	-70	-6	-64
9.760	-69	1	-68	-6	-62
12.200	-68	1	-67	-6	-61
14.640	-68	1	-67	-6	-61
17.080	-67	1	-66	-6	-60
19.250	-66	1	-65	-6	-59
21.960	-63	1	-62	-6	-56
24.400	-61	2	-59	-6	-53

Test Engineer: Kouma Sinn Date of Test: June 16, 1997

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Company: Wave Access

Table 18

Type of Test: Conducted Antenna Emissions

Notes: QPSK Mode, 2480 MHz Fundamental Frequency

Model: Wavelynx

Frequency (GHz)	Reading (dBm)	Cable Loss (dB)	Net Reading (dBm)	Limit (dBm)	Margin (dB)
2.480	15	0	15	N/A	N/A
4.960	-50	0	-50	-5	-45
7.440	-78	0	-78	-5	-73
9.920	-79	1	-78	-5	-73
12.400	-80	1	-79	-5	-74
14.880	-77	1	-76	-5	-61
17.360	-76	1	-75	-5	-70
19.840	-76	1	-75	-5	-70
22.320	-75	1	-74	-5	-69
24.800	-73	2	-71	-5	-66

Test Engineer: Kouma Sinn

Date of Test: June 16, 1997

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Exhibit D Additional Materials

D.2.0 Photographs of the Device