Intermec
Technologies Corporation
Norand Mobile Systems Division
EMC Test Laboratory

MEASUREMENT/TECHNICAL REPORT

Intermec Technologies Corporation
2126
2.4 GHz Spread Spectrum Transmitter

REPORT NO: 981030-1

DATE: October 30 , 1998

This report concerns: Original Grant ___X___ Class II change ________	
Equipment Type: 2400- 2483.5 MHz Direct Sequence Spread Spectrum Transceiver, FCC 15.247 and Industry Canada GL-36 Issue 4, RSS-210 Issue 2	
Request issue of the grant immediately upon completion of review.	
Measurement procedure used: ANSI C63.4-1992 and as described within this test report.	
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This report contains data that is outside the NVLAP scope of accreditation.

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1.0 COMPLIANCE CERTIFICATION

The electromagnetic compatibility test and data evaluations findings of this report have been prepared by the Norand EMC Test Lab of Norand Corporation in accordance with applicable specifications instructions required per-

FCC SECTION	CANADA RSS-210/GL-36	TEST NAME
15.33, 15.35	4.0/ __	Range of Meas., Meas. Detectors
15.15, 15.31	5.3, 5.8, 9.0, 11.0/ __	General Requirements, Meas. Stds,
15.203, 15.204	5.5/1.1	Antenna Description(s)
2.925, 15.19	5.9, 8.9/__	Labeling
15.21	5.10/4.0	Information to the User
15.247 (a, b, c, d, e), 15.209	__/B1.2(a,b,c,d)	Transmitter Characteristics
15.215	6.4/ __	Freq. & Power Stability, Volts & Temp.
15.109	7.3/3.3	Receiver Radiated Emissions
15.207, 15.107	6.6, 7.4/3.2	AC Line Conducted Emissions, TX, RX
1.1307 (b)(1)	_ / _	RF Safety, Exposure Limits

The data, data evaluation and equipment configuration represented herein are a true and accurate representation of the measurements of the test sample's electromagnetic compatibility characteristics as of the dates and at the times of the test under the conditions herein specified. The data presented herein is traceable to the National Institute of Standards and Technology.

NVLAP®

Accredited by the National Institute of Standards and Technology, National Voluntary Laboratory Accreditation Program for the specific scope of accreditation under Lab Code 100269-0.

Intermec Technologies Corporation
Norand Mobile System Division
EMC Test Lab
550 Second Street SE
Cedar Rapids, Iowa 52401

________________________________ Date_______________
Dave Fry mm/dd/yy
Regulatory Engineer

________________________________ Date_______________
Scott Holub mm/dd/yy
Staff Engineer

The scope of accreditation at the EMC Test Lab is limited to NVLAP codes:
12/CIS22 IEC/CISPR 22:1993, Limits and methods of measurement of radio disturbance characteristics of information technology equipment.
12/F01 FCC Method - 47 CFR Part 15 - Digital Devices. **12/F01a** Conducted Emissions, Power Lines, 450 kHz to 30 MHz. **12/F01b** Radiated Emissions.
12/T51 AS/NZS 3548: Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment.

This report is not an endorsement of the tested product by NVLAP or any agency of the U.S. Government.

1.1 Measurement Uncertainties:

3 meter Open Area Test Site (Radiated Emissions)

30-90 MHz has an Expanded Measurement Uncertainty of +/- 3.49 dB.
90-200 MHz has an Expanded Measurement Uncertainty of +/- 3.38 dB.
200-1000 MHz has an Expanded Measurement Uncertainty of +/- 4.77 dB.

1 meter Open Area Test Site (Radiated Emissions)

1-5.8 GHz has an Expanded Measurement Uncertainty of +/- 5.20 dB.
5.8-18 GHz has an Expanded Measurement Uncertainty of +/- 5.55 dB.
18-26.5 GHz has an Expanded Measurement Uncertainty of +/- 6.25 dB.

Receiver and Transmitter Conducted Generator Substitution Measurements with HP83630A RF Generator, HP8566B Spectrum Analyzer and HP85685A Preselector

0-2.0 GHz has an Expanded Measurement Uncertainty of +/- 0.85 dB.
2.0-5.8 GHz has an Expanded Measurement Uncertainty of +/- 0.99 dB.
5.8-20 GHz has an Expanded Measurement Uncertainty of +/- 1.21 dB.
20-22 GHz has an Expanded Measurement Uncertainty of +/- 1.39 dB.

Receiver and Transmitter Direct Conducted Measurements using HP8566B Spectrum Analyzer and HP85685A Preselector

0-1.0 GHz has an Expanded Measurement Uncertainty of +/- 2.36 dB.
1.0-2.0 GHz has an Expanded Measurement Uncertainty of +/- 3.50 dB.
2.0-2.5 GHz has an Expanded Measurement Uncertainty of +/- 0.85 dB.
2.5-5.8 GHz has an Expanded Measurement Uncertainty of +/- 2.12 dB.
5.8-20 GHz has an Expanded Measurement Uncertainty of +/- 2.85 dB.
20-22 GHz has an Expanded Measurement Uncertainty of +/- 3.70 dB.

AC Line Conducted

0.15-30 MHz has an Expanded Measurement Uncertainty of +/- 2.40 dB.

Confidence Statement

The measurement uncertainty statements above use a Coverage Factor K = 2.
The Coverage Factor K = 2 equates to an approximate confidence level of 95%.

2.0 GENERAL INFORMATION

2.1 Product Description

This report addresses the request for certification for a type 2 PCMCIA spread spectrum radio module operating in the 2.4-2.4835 GHz radio band. The 2126 radio will be used as a wireless LAN within various mobile computers and in base units that interfaces to a mainframe computers other terminal devices.

The 2126 radio is provided to Intermec Technologies Corp. by Lucent Technologies Corp. and is the OEM version of the WaveLAN™ radio Lucent offers for sale. This radio operates using direct sequence spread spectrum technology. The radio features 11 direct sequence channels that are selected by the system administrator. These selectable channels allow several systems to operate within close proximity of each other without interference. Other than channel selection, there are no adjustments to the radio.

The radio has two antenna ports to allow diversity in the receive mode, the ports are identified a A and B in this report. Port A is the only transmit port.

This report shows the PC card as a stand alone module to show the radio is designed to comply with the FCC and Canadian requirements without any additional shielding or filtering. The test data within shows radio characteristics when used with four antenna configurations: 1) integral patch antenna, 2) high gain omni directional dipole, 3) high gain panel and 4) high gain yagi. These represent the highest gain antennas to be used, included is a list and photographs of additional antennas to be used. The additional antennas were not tested as they are of lower gain. All antennas marketed with the 2126 radio satisfies the unique connection requirements outlined in the FCC and Canada rules.

Intermec has decided the systems with the 2126 radio will be offered for sale as commercial devices, not to be offered for sale to the general public for use in residential areas. Digital emissions will be verified for Class A devices. Several of the mobile computers that will interface to the 2126 radio are required to meet FCC Class B emissions. To cover both issues, the digital emissions of the 2126 radio will be tested to demonstrate compliance to the Class B requirement under the FCC Declaration of Conformity. The digital emissions concerns related to the 2126 radio, when incorporated within the final product, will be addressed in separate reports.

The system is also intended for global marketing therefore must comply to the CISPR 22 (EN55022) Class B emissions. The Norand Mobile Systems Division EMC Test Lab will perform testing for compliance for digital emissions to the CISPR 22 Class B limits. Based on these tests and reports the Class A verified or Class B Declaration of Conformity can be used for United States marketing. Canada will accept either classification as a self-declaration for compliance to ICES-003.

The radio module shown herein is a production model. The remote antennas listed herein are production versions, only the one integral patch antenna is a prototype.

2.2 Related Submittal(s)/Grants(s) None

2.3 Tested Systems Details

Items tested:			
Model Number (Serial Number)	FCC ID:	Description	Cable Description
2126 PC Card Radio PN: not available SN: 98UT09300032	EHA2126	Type II PCMCIA direct sequence spread spectrum	Module testing shown in PCMCIA extension. Antenna cables represent the shortest versions used.
6710 PN: not available SN: prototype	-	ethernet access point	detachable shielded AC cord, shielded RS232 diagnostics cable with remote PC for testing
6400 Config:6400A151200504 SN: 90090800540	not applicable FCC DoC	mobile computer	standard shielded RS-232 cable and DC charger cable. Integral Radiall antenna
6400 Charger PN: SN:	-	universal charger	detachable shielded AC cord, unshielded DC cable to mobile computer
Antennas tested for this report that will be used with the 2126 radio:			
Integral Patch Antenna PN: R380.500.005 SN: not available	-	Radiall 4.5 dBi directional	Mobile computer antenna uses the miniature connectors that interface directly to the radio. This antenna will be integrated within the mobile computer and remain inaccessible to the end user.
High Gain Dipole Antenna PN: OD9-2400 SN: not available	-	Mobile Mark 9 dBi omni directional	1 meter RG8 with reverse N and TNC connectors. Base units utilize an internal miniature conn. cable.
High Gain Panel Antenna PN: 063366 SN: not available	-	Larsen 14 dBi directional	1 meter RG8 with reverse N and TNC connectors. Base units utilize an internal miniature conn. cable.
High Gain Yagi Antenna PN: 063365 SN: not available	-	Cushcraft 15 dBi directional	1 meter RG8 with reverse N and TNC connectors. Base units utilize an internal miniature conn. cable.

Antennas not tested that will be used with the 2126 radio:			
Dipole Antenna PN: 066147 SN: not available	-	Centurion 1 dBi omni directional	Direct connect to reverse TNC connectors. Base units utilize an internal miniature conn. cable.
Dipole Antenna PN: S2403BP SN: not available	-	Cushcraft 3 dBi omni directional	1 meter RG8 with reverse N and TNC connectors. Base units utilize an internal miniature conn. cable.
Dipole Antenna PN: OD6-2400 SN: not available	-	Mobile Mark 6 dBi omni directional	1 meter RG8 with reverse N and TNC connectors. Base units utilize an internal miniature conn. cable.
Dipole Antenna PN: 505040 SN: not available	-	Tecom 8 dBi omni directional	1 meter RG8 with reverse N and TNC connectors. Base units utilize an internal miniature conn. cable.
Small Patch Antenna PN: 505022 SN: not available	-	Tecom 5 dBi directional	1 meter RG8 with reverse N and TNC connectors. Base units utilize an internal miniature conn. cable.
Small Patch Antenna PN: S2406PL SN: not available	-	Cushcraft 6 dBi directional	1 meter RG8 with reverse N and TNC connectors. Base units utilize an internal miniature conn. cable.
Bi-directional Patch Antenna PN: 245BD5W SN: not available	-	Xertex 6 dBi directional	1 meter RG8 with reverse N and TNC connectors. Base units utilize an internal miniature conn. cable.
Small Patch Antenna PN: 1324.19.0002 SN: not available	-	Huber & Suhner 8.5 dBi directional	1 meter RG8 with reverse N and TNC connectors. Base units utilize an internal miniature conn. cable.
Patch Antenna PN: not available SN: not available	-	Xertex 9 dBi directional	1 meter RG8 with reverse N and TNC connectors. Base units utilize an internal miniature conn. cable.

2.4 Test Methodology

This section addresses the following:
FCC Sections 15.15 General Requirements, 15.31 Measurement Standards, 15.33 Range of Measurement, and 15.35 Measurement Detectors

Industry Canada RSS-210 sections; 4.0 Instrumentation, 5.3 Test Method, 5.8 Measurement Bandwidths, 5.16, Digital Circuits Emissions, 6.3 Restricted Bands and Unwanted Emissions Frequencies, 9.0 AC Wireline Conducted Measurement Method, 11.0 Radiation Measurement Method

Per FCC rules 15.31 (k) the measurements on an intentional radiator operating over a range greater than 10 MHz requires testing on channels at the bottom, middle and top of the range of operation.

The test software of the 2126 radio is capable of operating the radio continuously in either transmit or receive modes. The test software is set to operate on channel 01, 07 or 11. The transmitter test sends pseudo-random data continuously on the selected channel.

Channel 01 transmit = 2412 MHz, receive local oscillator = 2060 MHz
Channel 07 transmit = 2442 MHz, receive local oscillator = 2090 MHz
Channel 11 transmit = 2462 MHz, receive local oscillator = 2110 MHz

These channels represent the low, middle and highest channels of operation within the USA and Canada operation band of 2.4 to 2.4835 GHz

Per FCC regulations the transmitter emissions are measured to the tenth harmonic, or 24.8 GHz. Canadian regulations for transmitters require testing to the 2nd harmonic. Receiver emissions are not required per current FCC rules, however Canada requires emissions testing to the 5 harmonic. Under the FCC rules, when not exempt, receiver emissions are required must be tested to the 5th harmonic of the highest local oscillator or 11.85 GHz. The RX radiated emissions are shown to FCC general requirements under 15.109 and RSS-210 section 7.2 and 7.3. The RX emissions are also measured using a conducted or direct measurement at the antenna terminals as allowed per Canada GL-36.

Where possible ANSI C63.4, 1992 is referenced during radiated and AC wireline conducted emissions testing. Details on measurement equipment, set-up, test details and calculations are presented within each specific test section.

Radiated emissions below 1000 MHz are tested at a three-meter distance using a Quasi-Peak detector with a 120 kHz measurement bandwidth (BW).

Emissions above 1000 MHz are tested at one-meter measurement distance with a preamplifier to improve the measurement sensitivity. Above 18 GHz measurements are made within the instrumentation room because the excessive cable losses for the open area test site cable will not show emissions measurements below the specified limit. Manual product positioning at a half-meter distance is used to locate any potential emissions above 18 GHz. The antenna and product heights are then positioned to maximized any emissions discovered with the final measurement made at a one-meter distance.

Average measurements above 1000 MHz are made with a spectrum analyzer on a 100 MHz span with Resolution BW 1 MHz and Video BW of 3 kHz. Peak measurements are made using the spectrum analyzer on a 100 MHz span with Resolution BW and Video BW of 1 MHz, these settings are detailed on the spreadsheet test results.

Measurements or limits are corrected for distance by using the inverse linear distance extrapolation, 20 dB/decade.

Refer to the photographs in appendix A and test setup figures in section 6 for details.

2.5 TEST FACILITY:

The location of the open area test site and conducted measurement facility used to collect the radiated data is 90 West Cemetery Road, Fairfax, Iowa 52228. This site has been fully described in a report dated; October 15, 1997, submitted to the Federal Communication Commission USA, and accepted in a letter dated February 6, 1998 (31040/SIT 1300F2) for ANSI C63.4: 1992 testing.

Test site complies with CISPR Publication 22: 1993, Clauses 10 and 11 for methods of measurements for radiated and conducted emissions testing.

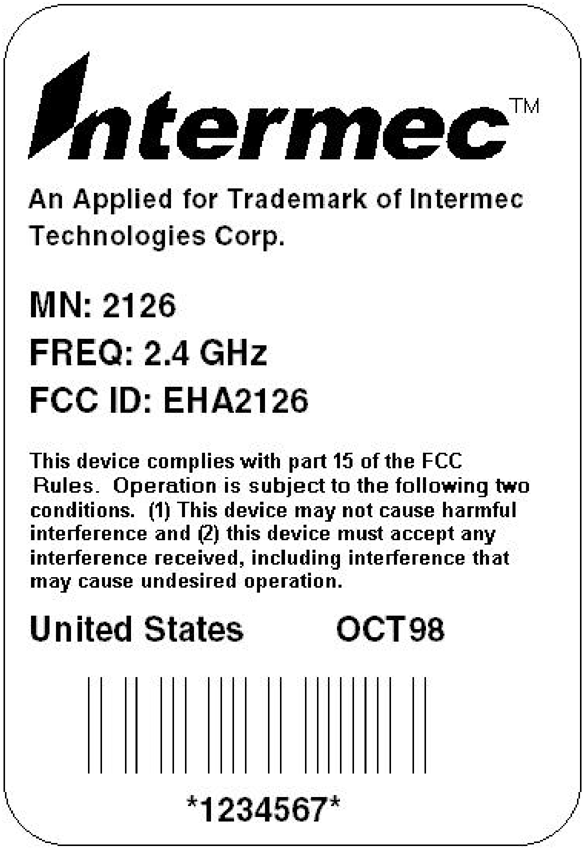
The Industry Canada has received a description of the open area test site and finds it complies with RSP-100 Issue 7 section 3.3. Reference file number “IC1223”.

3.0 PRODUCT LABELING AND INFORMATION TO THE USER

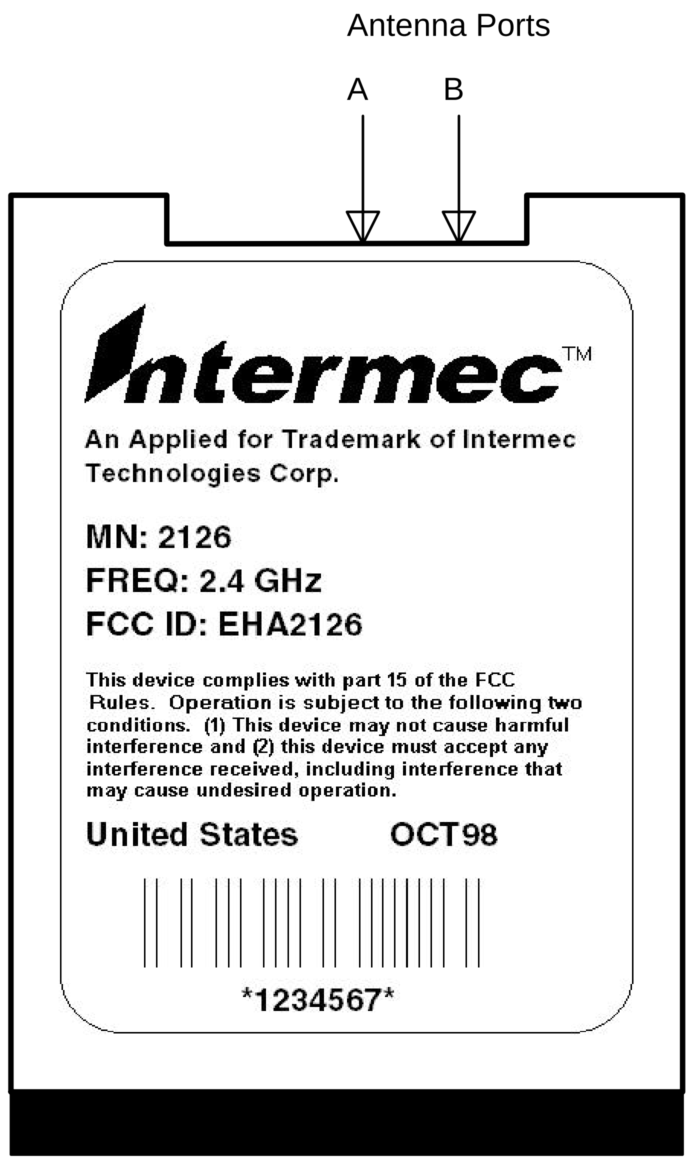
3.1 PRODUCT LABELING

See the following diagrams showing the labels for the radio module as well as placements.

Module label



Placement on the radio module



3.2 INFORMATION TO THE USER

The appendixes M and N show the users guide for the 6710 access point (981030M1.pdf) and the 6400 mobile computer (981030N1.pdf). These documents also contain the Declaration of Conformity inserts supplied and shipped with each product.

4.0 THEORIES OF OPERATION

Proprietary Lucent Technologies documents, will be made available upon request.

5.0 SCHEMATICS

Proprietary Lucent Technologies documents, will be made available upon request.

6.0 Conducted and Radiated Emissions Test Data

The following tests and results are recorded within this section.

Antenna Description

Direct Sequence 6 dB Bandwidth

Peak Output Power

Out of Band Emissions, Transmitter Conducted and Radiated

Direct Sequence Power Spectral Density

Processing Gain

Frequency and Power Stability Across Voltage and Temperature

Receiver Radiated Emissions

AC Wireline Conducted Emissions, Transmitter and Receiver Operation

RF Safety, Exposure Limits

EQUIPMENT:	2126 Radio Module
NAME OF TEST:	Antenna Description
FCC RULE NUMBER:	15.203, 15.204
CANADA GL-36 Par.:	1.1
MINIMUM STANDARD:	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. Antenna Gain in excess of 6 dBi shall be added to the measured RF power before using the specified power limits.
TEST PROCEDURE:	Inspection
TEST EQUIPMENT:	Not applicable
PERFORMED BY:	Dave Fry Date: November 3, 1998
SET UP:	Not applicable
TEST RESULTS:	The base antennas for the 2126 radio interface to the base using a reverse sex TNC connector. The antennas are provided from their suppliers with reverse sex N connectors. The integral antennas used with the radio use miniature coaxial connectors. The highest antenna gain is +15 dBi. The transmitter peak power is +15.7 dBm. Adding the antenna gain to the transmitter power totals +30.7 dBm. This total is -5.3 dB below the maximum ERP of +36 dBm allowed under FCC or Industry Canada rules.
MEASUREMENT DATA:	Not applicable

EQUIPMENT: 2126 Radio Module

NAME OF TEST: Direct Sequence 6 dB Bandwidth

FCC RULE NUMBER: 15.247 (a)(2)

MINIMUM STANDARD: For direct sequence systems, the minimum 6 dB bandwidth shall be at least 500 kHz

TEST PROCEDURE:

Note: The 2126 radio utilizes internal test software to generate a transmitter pattern of random ones and zeros. The transmitter channels represent the low, mid and high for operation in North American.

1. Using the test setup of figure 1, adjust the spectrum analyzer to span 2 MHz with a resolution bandwidth of 100 kHz and amplitude of 5 dB/div. centered on 2412.

2. Activate the transmitter and record the output on the spectrum analyzer and measure the 6 dB bandwidth.

3. Repeat 1 and 2 using the mid and high channels, 2442 and 2462 MHz.

TEST EQUIPMENT: Spectrum Analyzer HP 8566B
Attenuator HP 8491-10 dB

PERFORMED BY: Dave Fry Date: October 29, 1998

SET UP:

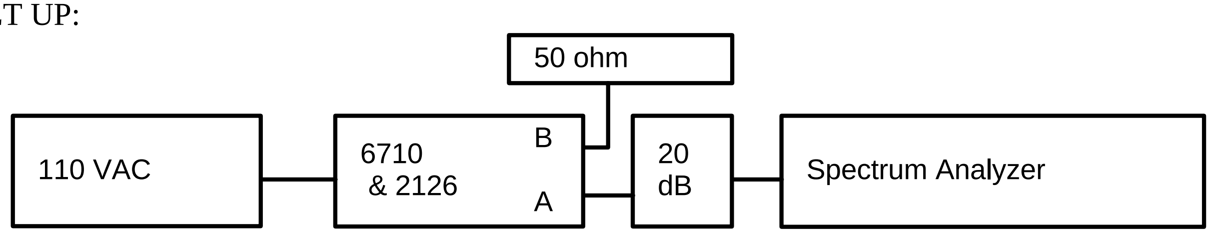


Figure 1.

TEST RESULTS: Conforms. The transmitter has an operating bandwidth greater than 500 kHz. See appendix C (981030C1.pdf) for plots.

Frequency, Channel Number	2412 MHz, low Ch. 01		2442 MHz, mid Ch. 07		2462 MHz, high Ch. 11	
Data Rate	1 MB	2 MB	1 MB	2 MB	1 MB	2 MB
B.W. MHz	10.20	9.90	10.15	9.65	10.20	9.70

EQUIPMENT: 2126 Radio Module

NAME OF TEST: Peak Power Output

FCC RULE NUMBER: 15.247 (b)(1)(3)

MINIMUM STANDARD: (b) The maximum peak output power of the intentional radiator shall not exceed the following:
(1) For frequency hopping systems operating in the 2400–2483.5 MHz or 5725–5850 MHz band and for all direct sequence systems: 1 watt.
(3) Except as shown in paragraphs (b)(3) (i), (ii) and (iii) of this section, 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 stated values in paragraphs (b)(1) or (b)(2) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

CANADA GL-36: B1.2 (c) and 1.1

MINIMUM STANDARD: The maximum peak power output of the transmitter shall not exceed one watt.

TEST PROCEDURE:

Note: The 2126 radio utilizes internal test software to generate a transmitter pattern of random ones and zeros. The transmitter channels represent the low, mid and high for operation in North American.

1. Verify the calibration on the power meter and attenuator then setup the test as in figure 2.

2. Activate the transmitter on the low channel, 2412 MHz, and record the peak output power observed on the power meter.

3. Repeat 1 and 2 using the mid and high channels, 2442 and 2462 MHz.

TEST EQUIPMENT:	Power Meter	Giga-Tronics 8541
	Attenuator	HP 8491-10 dB
PERFORMED BY:	Dave Fry	Date: October 29, 1998

SET UP:

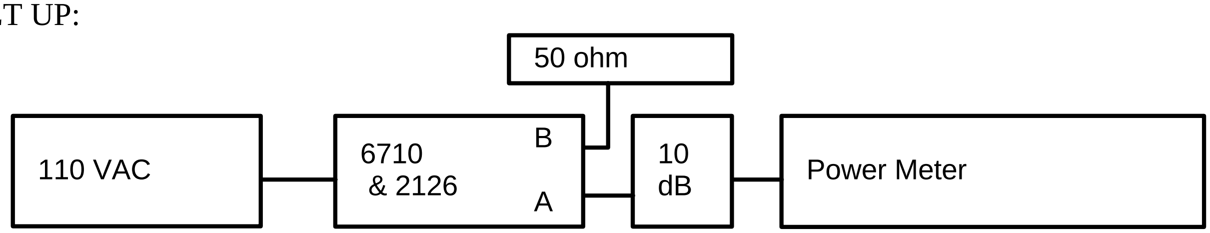


Figure 2.

TEST RESULTS:

Conforms. The transmitter has transmitter peak power of 15.7 dBm or 37.2 milliwatts. This is 962.8 milliwatts below the 1 watt limit.

Antennas to be used with the transmitter have a highest gain of +15 dBi. The total system Effective Radiated Power is calculated as:

Tp + Ag = ERP

15.7 + 15 = 30.7 dBm or 1.17 watts

Transmitter Power = Tp (dBm)
Antenna Gain = Ag (dBi)
Effective Radiated Power = ERP (dBm and watts)

Specified limit is calculated as:

30 Tp + 6 Ag = +36 dBm or 4 watts ERP

MEASUREMENT DATA:

Conducted measurement at the antenna connector.

Freq. / Channel	Power Meter Reading (dBm)	Attenuation (dB)	Calculated Power (dBm)	Margin below +30 dBm Limit (dB)
2412 MHz / Ch. 01	5.5	10.2	15.7	-14.3
2442 MHz / Ch. 07	5.3	10.2	15.5	-14.5
2462 MHz / Ch. 11	5.4	10.2	15.6	-14.4

EQUIPMENT: 2126 Radio Module

NAME OF TEST: Out of Band Emissions

FCC RULE NUMBER: 15.247 (c)
CANADA GL-36 Par.: B1.2 (d)

MINIMUM STANDARD: (c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)). GL-36 reference Table 3.

TEST PROCEDURE: Initial testing records the conducted emissions of the transmitter. Plot the near band emissions on a 140 MHz span centered on 2442 MHz using 100 kHz video and resolution bandwidths. Enable the end channels and recording the delta from the peak of each channel to the highest emission outside the allowable band. Detail the near band edge emissions by centering each specified band edge and plot on a 50 MHz span. Again record the delta from the transmitter peak to the highest out of band emission. Complete plotting the transmitter emissions by showing the following spans. 0-2, 2-4, 4-6, 6-11, 11-16 and 16-22.5 GHz. Identify any emissions observed above the measurement noise floor.

Record the radiated emissions using the testing methodology described in section 2.4. Measure the transmitter power and spurious emissions. Using the three-meter measurement distance and test receiver, scan and measure transmitter related spurious emissions from 30 to 1000 MHz. A measurement distance of one meter and an amplifier between the horn antenna and spectrum analyzer, measure emissions above 1000 MHz. Refer to section 2.4, Test Methodology, for more details on testing above 1000 MHz.

TEST EQUIPMENT:	Antenna, bi-conical	EMCO 3110
	Antenna, log periodic	EMCO 3146
	Antenna, DRG horn	EMCO 3115
	Antenna, DRG horn	EMCO 3116
	Receiver	Rohde & Schwarz ESVP
	High Pass Filter	Cir-Q-Tel R9H-1G5/10G-28A
	High Pass Filter	K&L 13SH10-3000/T24000-0/0
	Microwave amplifier	HP 8449B
	Spectrum Analyzer	HP 8566B
	Mixer	HP11970K
	Amplifier	HP11975A

PERFORMED BY: Dave Fry Date: Oct. 20-Nov. 6, 1998

TEST SETUP: Transmitter Conducted Emission

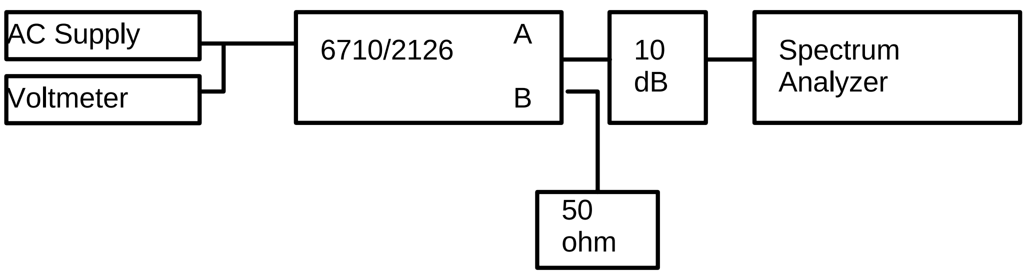


Figure 3.

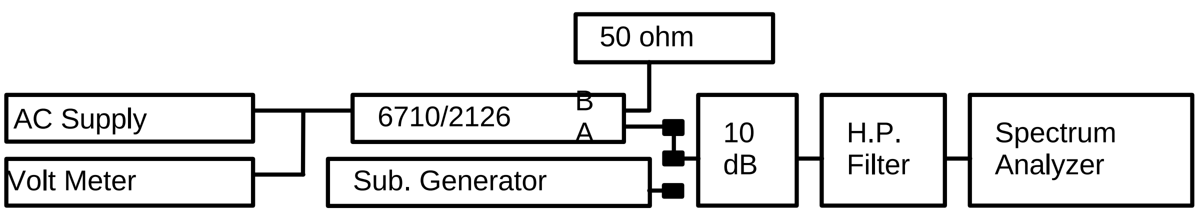


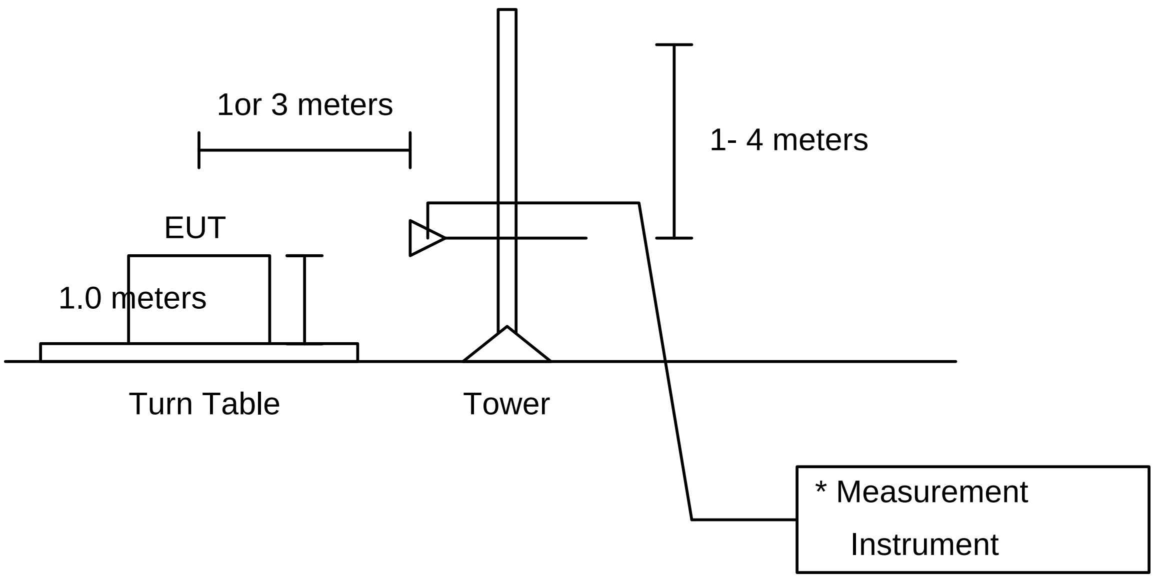
Figure 4.

Note: The high pass filter in figure 4 eliminates the creation of a falsely high amplitude on the harmonics of the transmitter. This occurs when the power of the transmitter over drives the input stage of the spectrum analyzer. A generator substitution determines the actual level of any spurious emissions observed.

TEST SETUP: Receiver Radiated Spurious Emissions

Open area test site at the Norand EMC Test Facility
Three-meter test range below 1000 MHz.
One-meter test range above 1000 MHz.

Review the following diagrams for setup details. Refer to the photographs in appendix A (981030A1.pdf) for placement 2126 radio.



* 30-1000 MHz, Rohde & Schwarz receiver or
1-18 GHz, HP8566B Spectrum Analyzer with preamplifier and high-pass filter or 18-25 GHz, HP8566B, high-pass filter with preamplifier and mixer

TEST RESULTS: Conforms. The 2126 radio module complies with the FCC and Industry Canada requirements. Transmitter conducted emissions plots show the transmitter emissions, other than harmonics, outside of the band are 40 dB below the level of the fundamental and greater than 20 dB below the limit.

Below is listed the Average and Peak radiated measurements for each antenna specified for use with the radio module. The data presented below calculates the AVERAGE emissions by recording the 100% duty cycle emissions, see the attached calculation spreadsheets, then de-rating the measurement for 50% duty cycle, or -6 dB. The 50% de-rating is a conservative figure, duty cycles for the base operation is nearer the 30-40% on time for duty cycle. Portable or terminal operation operated radios operate with a 10% or less duty cycle.

Duty cycle determination of the worst case average emissions shown with the duty cycle emissions reduction. As outlined in the FCC Public Notice: Guidance on Measurements for DSSS Systems the average data is to be de-rated by a duty cycle calculation. The radio presented herein has transmitter duty cycle of less than 40%. (See the following plot, showing the transmitter duty cycle plotted on an oscilloscope.) The calculated emissions reduction for this radio is 6 dB based on the calculation for a 50% duty cycle.

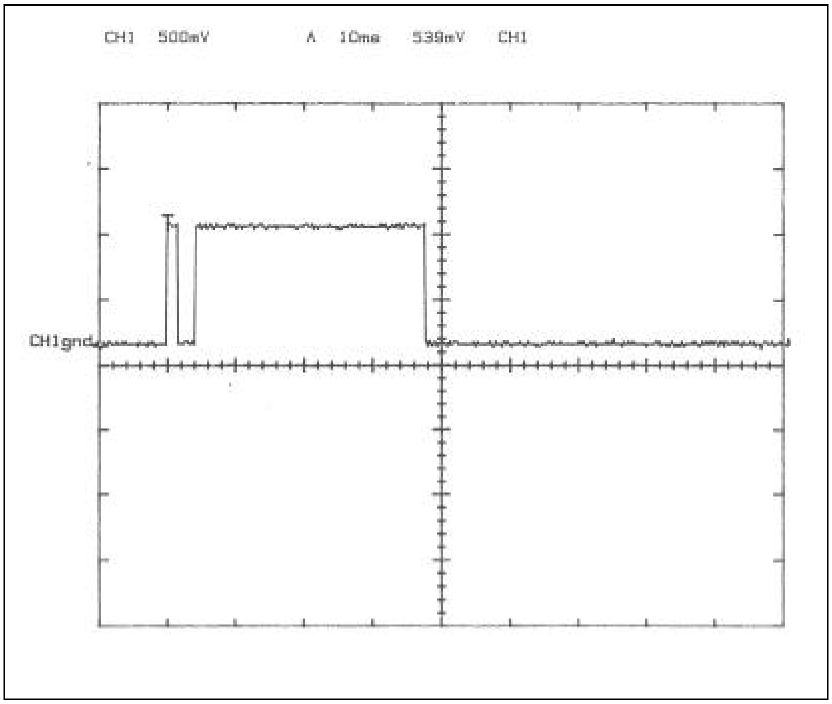
the Tx time within 0.1 second period = 0.037, or 37 %

the calculation for de-rating for a 37% is shown below:

(1dB@100% x .37 log) 20 = -8.6 dB de-rating for 37% in dB

Applying the same formula for a 50% duty cycle results in a -6.0 dB de-rating for the AVERAGE emissions when measured at 100% duty cycle and measurement taken in dB(µV) (microvolts).

The spreadsheet data appendixes F-H shows the measured emissions for a 100% transmit duty cycle.



Plot showing the transmitter for 1 MB data rate duty cycle plotted on an oscilloscope.
The first pulse is the terminals request for poll and the second pulse is a data packet.
The 2 MB data rate has a lower duty cycle, the 1 MB plot above shows the worst condition.

To show modular compliance the first antenna data presented shows the radio placed horizontally, then data is collected with the radio placed vertically. (see setup photographs in appendix A)

2126 radio horizontal with Radiall integral patch antenna (see appendix F, 981030F1.pdf, for 100% duty cycle test data)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 56.6 dB(μV)/m measured at a distance of one-meter for 4824 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna horizontally polarized. Applying the 6 dB duty cycle correction the emissions are 50.6 dB(μV)/m. That is -13.4 dB relative to the limit of 64 dB(μV)/m at one-meter.

AVERAGE EMISSIONS

Highest emissions observed above the measurement noise floor.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. /MHz	Meas. Polarity	100% dB(uV)/M	duty cycle conversion dB	50% dB(uV)/M	limit dB(uV)/M @1M	margin dB
01 / 4824	V	54.4	-6.0	48.4	64.0	-15.6
01 / 4824	H	56.6	-6.0	50.6	64.0	-13.4
07 / 4884	V	51.7	-6.0	45.7	64.0	-18.3
07 / 4884	H	56.6	-6.0	50.6	64.0	-13.4
11 / 4924	V	48.8	-6.0	42.8	64.0	-21.2
11 / 4924	H	48.2	-6.0	42.2	64.0	-21.8

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 36.4 dB(μV)/m measured at a distance of three-meters for 704 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna horizontally polarized. That is -9.6 dB relative to the limit of 46 dB(μV)/m at three-meters. (no duty cycle correction can be applied to QP or Pk data)

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed above the measurement noise floor.
Complete data is contained in the Spreadsheet Appendix or file attachments

d* indicates distance of 1 meters for emissions >1GHz or 3 meters for <1 GHz

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@ d*	margin dB
01 / 4824	Pk	V	58.0	84.0	-26.0
01 / 4824	Pk	H	59.7	84.0	-24.3
07 / 704	QP	V	36.1	46.0	-9.9
07 / 704	QP	H	36.4	46.0	-9.6
07 / 4884	Pk	V	56.0	84.0	-28.0
07 / 4884	Pk	H	60.4	84.0	-23.6
11 / 4924	Pk	V	53.3	84.0	-30.7
11 / 4924	Pk	H	53.6	84.0	-30.4

2126 radio vertical with Radiall integral patch antenna (see appendix G, 981030G1.pdf, for 100% duty cycle test data)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 62.0 dB(μV)/m measured at a distance of one-meter for 4824 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna horizontally polarized. Applying the 6 dB duty cycle correction the emissions are 56.0 dB(μV)/m. That is -8.0 dB relative to the limit of 64 dB(μV)/m at one-meter.

AVERAGE EMISSIONS

Highest emissions observed above the measurement noise floor.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. /MHz	Meas. Polarity	100% dB(uV)/M	duty cycle conversion dB	50% dB(uV)/M	limit dB(uV)/M @1M	margin dB
01 / 4824	V	57.7	-6.0	51.7	64.0	-12.3
01 / 4824	H	62.0	-6.0	56.0	64.0	-8.0
07 / 4884	V	58.4	-6.0	52.4	64.0	-11.6
07 / 4884	H	58.5	-6.0	52.5	64.0	-11.5
11 / 4924	V	59.0	-6.0	53.0	64.0	-11.0
11 / 4924	H	59.9	-6.0	53.9	64.0	-10.1

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 37.3 dB(μV)/m measured at a distance of three-meters for 704 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna vertically polarized. That is -8.7 dB relative to the limit of 46 dB(μV)/m at three-meters. (no duty cycle correction can be applied to QP or Pk data)

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed above the measurement noise floor.
Complete data is contained in the Spreadsheet Appendix or file attachments
d* indicates distance of 1 meters for emissions >1GHz or 3 meters for <1 GHz

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@ d*	margin dB
01 / 4824	Pk	V	60.7	84.0	-23.3
01 / 4824	Pk	H	64.6	84.0	-19.4
07 / 704	QP	V	37.3	46.0	-8.7
07 / 704	QP	H	34.4	46.0	-11.6
07 / 4884	Pk	V	61.3	84.0	-22.7
07 / 4884	Pk	H	61.7	84.0	-22.3
11 / 4924	Pk	V	61.9	84.0	-22.1
11 / 4924	Pk	H	63.4	84.0	-20.6

2126 radio horizontal with Mobile Mark 9 dBi omni-directional antenna (see appendix H, 981030H.pdf, for 100% duty cycle test data)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 66.8 dB(μV)/m measured at a distance of one-meter for 4884 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna vertically polarized. Applying the 6 dB duty cycle correction the emissions are 60.8 dB(μV)/m. That is -3.2 dB relative to the limit of 64 dB(μV)/m at one-meter.

AVERAGE EMISSIONS

Highest emissions observed above the measurement noise floor.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. /MHz	Meas. Polarity	100% dB(uV)/M	duty cycle conversion dB	50% dB(uV)/M	limit dB(uV)/M @1M	margin dB
01 / 4824	H	63.9	-6.0	57.9	64.0	-6.1
01 / 7236	H	59.9	-6.0	53.9	64.0	-10.1
07 / 4884	V	66.8	-6.0	60.8	64.0	-3.2
07 / 4884	H	62.8	-6.0	56.8	64.0	-7.2
11 / 4924	V	64.6	-6.0	58.6	64.0	-5.4
11 / 7386	H	61.0	-6.0	55.0	64.0	-9.0

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 70.1 dB(μV)/m measured at a distance of one-meter for 4884 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna vertically polarized. That is -13.9 dB relative to the limit of 84 dB(μV)/m at one-meter. (no duty cycle correction can be applied to QP or Pk data)

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed above the measurement noise floor.
Complete data is contained in the Spreadsheet Appendix or file attachments
d* indicates distance of 1 meters for emissions >1GHz or 3 meters for <1 GHz

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@ d*	margin dB
01 / 4824	Pk	V	67.1	84.0	-16.9
01 / 7236	Pk	H	63.9	84.0	-20.1
07 / 704	QP	V	27.3	46.0	-18.7
07 / 704	QP	H	27.4	46.0	-18.6
07 / 4884	Pk	V	70.1	84.0	-13.9
07 / 4884	Pk	H	65.8	84.0	-18.2
11 / 4924	Pk	V	67.7	84.0	-16.3
11 / 7386	Pk	H	65.2	84.0	-18.8

2126 radio horizontal with Larsen 14 dBi panel antenna (see appendix I, 981030I1.pdf, for 100% duty cycle test data)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 68.2 dB(μV)/m measured at a distance of one-meter for 4884 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna vertically polarized. Applying the 6 dB duty cycle correction the emissions are 62.2 dB(μV)/m. That is -1.8 dB relative to the limit of 64 dB(μV)/m at one-meter.

AVERAGE EMISSIONS

Highest emissions observed above the measurement noise floor.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. /MHz	Meas. Polarity	100% dB(uV)/M	duty cycle conversion dB	50% dB(uV)/M	limit dB(uV)/M @1M	margin dB
01 / 1408	V	61.0	-6.0	55.0	64.0	-9.0
01 / 1760	V	59.9	-6.0	53.9	64.0	-10.1
07 / 4884	V	68.2	-6.0	62.2	64.0	-1.8
07 / 4884	H	64.9	-6.0	58.9	64.0	-5.1
11 / 4924	V	66.1	-6.0	60.1	64.0	-3.9
11 / 4924	H	63.1	-6.0	57.1	64.0	-6.9

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 71.5 dB(μV)/m measured at a distance of one-meter for 4884 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna vertically polarized. That is -12.5 dB relative to the limit of 84 dB(μV)/m at one-meter. (no duty cycle correction can be applied to QP or Pk data)

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed above the measurement noise floor.
Complete data is contained in the Spreadsheet Appendix or file attachments
d* indicates distance of 1 meters for emissions >1GHz or 3 meters for <1 GHz

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@ d*	margin dB
01 / 1760	Pk	V	68.5	84.0	-15.5
01 / 1760	Pk	H	67.4	84.0	-16.6
07 / 704	QP	V	27.2	46.0	-18.8
07 / 704	QP	H	27.2	46.0	-18.8
07 / 1760	Pk	V	68.3	84.0	-15.7
07 / 4884	Pk	V	71.5	84.0	-12.5
11 / 1760	Pk	V	68.3	84.0	-15.7
11 / 4924	Pk	V	68.9	84.0	-15.1

2126 radio horizontal with Cushcraft 15 dBi yagi antenna (see appendix J, 981030J1.pdf, for 100% duty cycle test data)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 65.6 dB(μV)/m measured at a distance of one-meter for 4884 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna vertically polarized. Applying the 6 dB duty cycle correction the emissions are 59.6 dB(μV)/m. That is -4.4 dB relative to the limit of 64 dB(μV)/m at one-meter.

AVERAGE EMISSIONS

Highest emissions observed above the measurement noise floor.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. /MHz	Meas. Polarity	100% dB(uV)/M	duty cycle conversion dB	50% dB(uV)/M	limit dB(uV)/M @1M	margin dB
01 / 1760	V	55.7	-6.0	49.7	64.0	-14.3
01 / 4824	V	57.6	-6.0	51.6	64.0	-12.4
02 / 4884	V	65.6	-6.0	59.6	64.0	-4.4
02 / 4884	H	59.6	-6.0	53.6	64.0	-10.4
11 / 4924	V	62.3	-6.0	56.3	64.0	-7.7
11 / 4924	H	58.4	-6.0	52.4	64.0	-11.6

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 68.6 dB(μV)/m measured at a distance of one-meter for 4884 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna vertically polarized. That is -15.4 dB relative to the limit of 84 dB(μV)/m at one-meter. (no duty cycle correction can be applied to QP or Pk data)

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed above the measurement noise floor.
Complete data is contained in the Spreadsheet Appendix or file attachments
d* indicates distance of 1 meters for emissions >1GHz or 3 meters for <1 GHz

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@ d*	margin dB
01 / 1760	Pk	V	66.0	84.0	-18.0
01 / 1760	Pk	H	66.5	84.0	-17.5
07 / 704	QP	V	27.2	46.0	-18.8
07 / 704	QP	H	27.2	46.0	-18.8
07 / 1760	Pk	H	66.5	84.0	-17.5
07 / 4884	Pk	V	68.6	84.0	-15.4
11 / 1760	Pk	V	65.9	84.0	-18.1
11 / 1760	Pk	H	66.1	84.0	-17.9

MEASUREMENT DATA: Observe the appendix 981030C1.pdf, that show the transmitter conducted measurements. The appendixes F-J (981030F1.pdf ....G1.pdf, ...H1.pdf, ...I1.pdf and ...J1.pdf) file attachment spreadsheets show the radiated emissions data tabulated and graphically in dB(μV)/m. The conversion for calculating dB(μV)/m/m to μV/m follows.

[(dB (μV)/m)/ 20] anti log = μV/m
[(54 dB (μV)/m @ 1 mtr) / 20] anti log = 501.2 μV/m @ 1 mtr

or μV/m to dB(μV)/m

20 (log μV/m) = dB (μV)/m
20 (log 500 μV/m) = 54 dB (μV)/m

Limit conversion, three-meter to one-meter (mtr)

54 dB (μV)/m @ 3 mtrs + 10 dB = 64 dB (μV)/m @ 1 mtr

EQUIPMENT: 2126 Radio Module

NAME OF TEST: Direct Sequence Power Spectral Density

FCC RULE NUMBER: 15.247 (d)

MINIMUM STANDARD: 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.

CANADA GL-36 Par.: B1.2 (a)

MINIMUM STANDARD: For direct sequence systems, the transmitted power density averaged over any 1 second interval shall not be greater than 8 dBm in any 3 kHz bandwidth.

TEST PROCEDURE:

Note: The 2126 radio utilizes internal test software to generate a transmitter pattern of random ones and zeros. The transmitter channels represent the low, mid and high for operation in North American.

1. Measure the RF cable and attenuator losses for the setup in figure 5. Record the losses to calculate the actual power spectral density for the measurements below.

2. Using the test setup of figure 5, adjust the spectrum analyzer to span 10 MHz with a resolution and video bandwidth of 3 kHz centered on 2412.

3. Activate the transmitter, peak hold the trace and peak search the highest emission point. Plot the results.

4. Re-center the spectrum analyzer on the peak emission and change the span to 750 kHz and the sweep time to 250 seconds. Again, once the trace completes, peak search the highest emission and plot the results.

5. Repeat 2 and 4 using the mid and high channels, 2442 and 2462 MHz.

TEST EQUIPMENT: Spectrum Analyzer HP 8566B
Attenuator HP 8491-10 dB

PERFORMED BY: Dave Fry Date: October 29, 1998

SET UP:

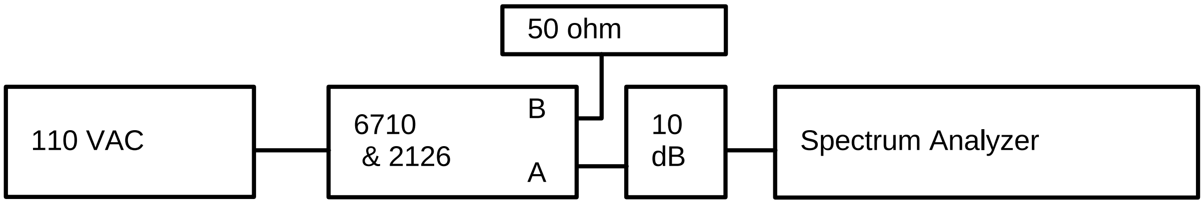


Figure 5.

TEST RESULTS: Conforms. The transmitter has a Power Spectral Density less than 8 dBm.

Data Rate Channel / Freq. (MHz)	Measured PSD (dBm)	Cable and Atten. Loss (dB)	Calculated PSD (dBm)
1 MB			
01 / 2412	-24.8	10.7	-14.1
07 / 2442	-24.3	10.7	-13.6
11 / 2462	-23.9	10.7	-13.2
2 MB			
01 / 2412	-19.1	10.7	-8.4
07 / 2442	-18.8	10.7	-8.1
11 / 2462	-18.7	10.7	-8.0

See appendix C (981030C1.pdf) for detailed plots showing PSD.

EQUIPMENT: 2126 Radio Module

NAME OF TEST: Processing Gain

FCC RULE NUMBER: 15.247 (d)
CANADA GL-36 Par.: B1.2 (b)

MINIMUM STANDARD: (e) 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.

TEST PROCEDURE: See attached appendix L (981030L1.pdf) from Lucent Technologies.

TEST EQUIPMENT: See attached appendix L (981030L1.pdf) from Lucent Technologies.

PERFORMED BY: See attached appendix L (981030L1.pdf) from Lucent Technologies.

SET UP: See attached appendix L (981030L1.pdf) from Lucent Technologies.

TEST RESULTS: Complies with the requirements, See attached appendix L (981030L1.pdf) from Lucent Technologies.

MEASUREMENT DATA: See attached appendix L (981030L1.pdf) from Lucent Technologies.

EQUIPMENT: 2126 Radio Module

NAME OF TEST: Frequency and Power Stability Across Voltage

FCC RULE NUMBER: None

MINIMUM STANDARD: This test is not required be either the FCC or Industry Canada. It is presented to show the stability of the 2126 radio module. 6710 Access Point operates from AC power and uses a universal input AC supply. This provides a highly regulated power to operate the 2126 radio. The mobile computers operates from a six-cell batteries of varying make up. Most common are NiH (nickel-hydride) and Nicad (nickel-cadmium). The expected voltage range for the pack is 8.0 volts to a computer sensed low voltage cut-off of 6.8 volts. The nominal voltage for the 2126 PC Card is 5.0 volts. The transmitter power as well as frequency stability are presented across the above voltage range.

TEST PROCEDURE: Record the transmitter frequency and power at nominal voltage. Vary the operating voltage across the expected range and record the transmitter power and frequency at 0.25 volt increments. See set-up figure 6.

TEST EQUIPMENT:

Vector Signal Analyzer	HP89410A
Variable DC Supply	Tektronix PS282
Volt Meter	Fluke

PERFORMED BY: Scott Holub Date: Nov. 16, 1998

TEST SET UP: Voltage Stability Set Up

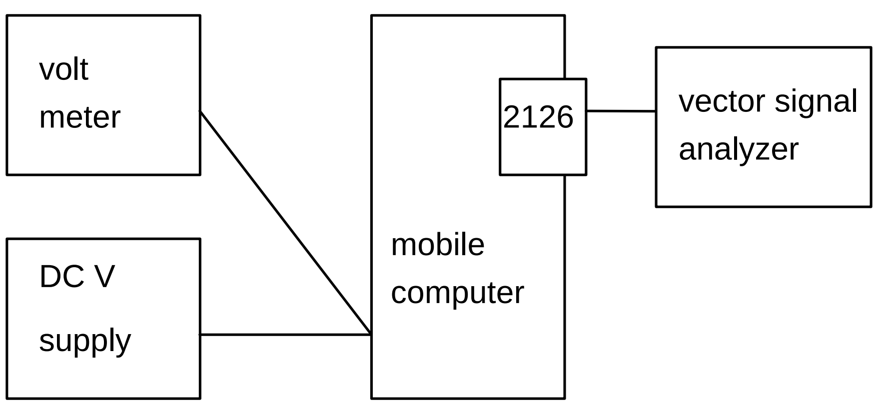


Figure 6.

NAME OF TEST: Freq. and Power Stability Across Voltage and Temp, continued,

TEST RESULTS: The 2126 radio shows the transmitter maintains power and remains on frequency across the normal voltage range expected when operated within a mobile computer.

While operated across voltage range of +8.0 to +6.5 volts DC, the transmitter frequency and power is unaffected. A change of -0.123 to + 0.071 milliwatts was observed in transmitter power. No measurable change was observed in the transmitter frequency.

MEASUREMENT DATA: Power Output and Frequency versus Voltage

Nominal test voltage is 7.15V. Battery discharge cutoff for the mobile computers is 6.5V and after charging will be as high as 8.0V.

HP 89410A Vector Signal Analyzer 16-Nov-98
s/n 3416A01518
options 1C2AY7AY9AYA AYBUFGUG7
Calibration Date 9/98

				Ref. Delta	
Voltage (+DC)		Freq. (MHz)	Power (mW)	Freq. (MHz)	Power (mW)
5.40		2411.981	10.063	0	0.071
5.65		2411.981	10.078	0	0.056
5.90		2411.981	10.118	0	0.016
6.15		2411.981	10.202	0	-0.068
6.40		2411.981	10.069	0	0.065
6.65		2411.981	10.125	0	0.009
6.90		2411.981	10.150	0	-0.016
ref. 7.15		2411.981	10.134	-	-
7.40		2411.981	10.063	0	0.071
7.65		2411.981	10.125	0	0.009
7.90		2411.981	10.118	0	0.016
8.15		2411.981	10.158	0	-0.024
8.40		2411.981	10.257	0	-0.123

The PC Card requirements for regulation on the 2126 radio board keeps the power output constant. There is no means for the factory to adjust power.

EQUIPMENT: 2126 Radio Module

NAME OF TEST: Receiver Spurious Emissions (radiated)

FCC RULE: 15.109 (a)
CANADA GL-36 Par.: 3.3

MINIMUM STANDARD:

FCC Rules Section 15.109 Radiated emission limits.

(a) Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of three-meters shall not exceed the following values:

Frequency of Emission (MHz)	Field Strength (microvolts/meter)
30 - 88	100
88 - 216	150
216 - 960	200
Above 960	500

(c) In the emission tables above, the tighter limit applies at the band edges. Sections 15.33 and 15.35 which specify the frequency range over which radiated emissions are to be measured and the detector functions and other measurement standards apply.

Canada Specification, GL-36 Par. 3.3 Receiver Spurious Emissions:
The search for spurious emissions shall be from the lowest frequency internally generated or used in the device (local oscillator frequency, intermediate frequency or carrier frequency) or 30 MHz, whichever is the higher frequency, to the 5th harmonic of the highest frequency generated or used, without exceeding 23 GHz. Minimum Standard: Receiver radiated spurious emissions in each polarization (vertical and horizontal) shall not exceed the limits of Table 3. If measured at the antenna terminals, the emission power at any frequency shall not exceed 2 nanowatts.

TEST PROCEDURE: Initial testing records the conducted emissions of the receiver. Plot the receiver emissions by showing the following spans; 0-2, 2-7 and 7-12 GHz. Identify any emissions observed above the measurement noise floor. See set-up figure 7.

Record the receiver radiated emissions using the testing methodology described in section 2.4. Utilizing the three-meter measurement distance and test receiver, scan and measure receiver related spurious emissions from 30 to 1000 MHz. A measurement distance of one meter and an amplifier between the horn antenna and spectrum analyzer, measure emissions above 1000 MHz. Refer to section 2.4, Test Methodology, for more details on testing above 1000 MHz.

TEST EQUIPMENT:

Antenna, bi-conical	EMCO 3110
Antenna, log periodic	EMCO 3146
Antenna, DRG horn	EMCO 3115
Receiver	Rohde & Schwarz ESVP
Spectrum Analyzer	HP 8566B
Microwave amplifier	HP 8449B

PERFORMED BY: Dave Fry Date: Oct. 20-Nov. 6, 1998

TEST SETUP: Receiver Conducted Spurious Emissions

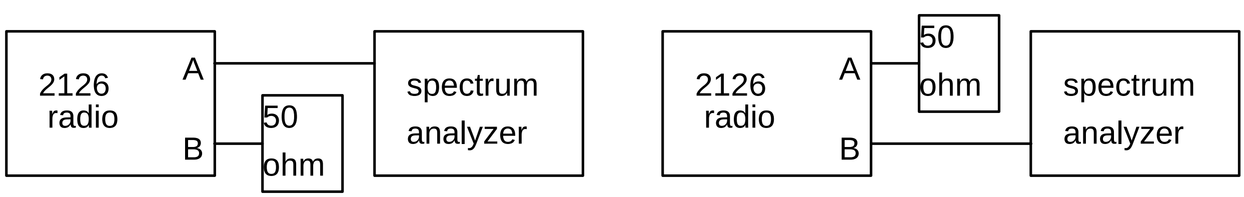
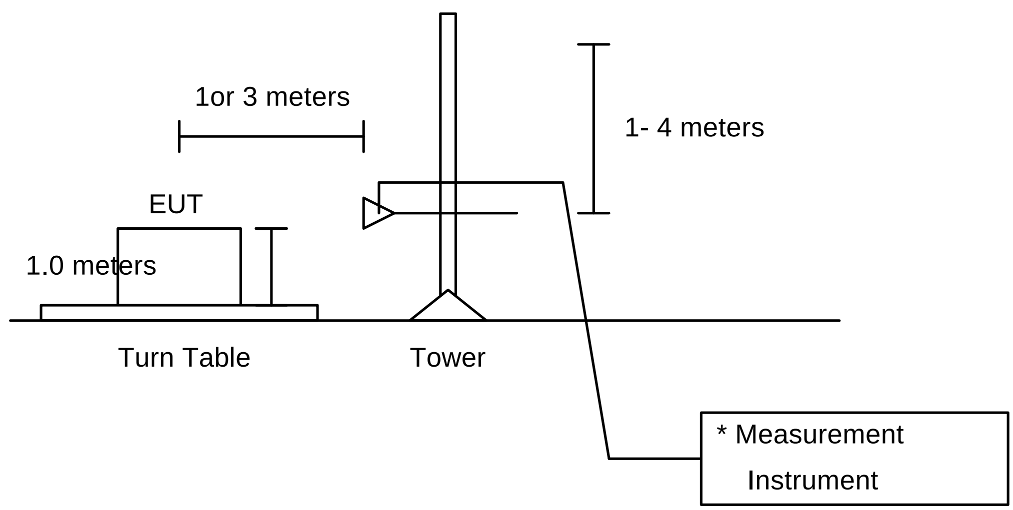


Figure 7.

TEST SETUP: Receiver Radiated Spurious Emissions

Open area test site at the Norand EMC Test Facility
Three-meter test range below 1000 MHz.
One-meter test range above 1000 MHz.

Review the following diagrams for setup details. Refer to appendix A for placement of the 2126 radio.



* 30-1000 MHz, Rohde & Schwarz receiver or
1-18 GHz, HP8566B Spectrum Analyzer with preamplifier and high-pass filter

TEST RESULTS: Conforms. The 2126 radio module complies with the FCC and Industry Canada requirements. QP measurements were made below 1000 MHz and Average measurements were recorded above 1000 MHz. Below is listed the measurements for each antenna specified for use with the radio module.

2126 radio module with Radial integral patch antenna (see 981030F1.pdf and 981030G1.pdf)	The highest measured spurious emission from the receiver was 38.3 dB(µV)/m at three-meters for 176 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna horizontally polarized. That is -5.3 dB relative to the limit of 43.5 dB(µV)/m at three-meters.
2126 radio with 9 dBi dipole from Mobile Mark (see 981030H1.pdf)	The highest measured spurious emission from the receiver was 27.7 dB(µV)/m at three-meters for 44 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna vertically polarized. That is -11.3 dB relative to the limit of 39 dB(µV)/m at three-meters.
2126 radio with 14 dBi panel antenna from Larsen (see 981030I1.pdf)	The highest measured spurious emission from the receiver was 36.3 dB(µV)/m at three-meters for 176 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna horizontally polarized. That is -7.3 dB relative to the limit of 43.5 dB(µV)/m at three-meters.
2126 radio with 15 dBi yagi antenna from Cushcraft (see 981030J1.pdf)	The highest measured spurious emission from the receiver was 41.3 dB(µV)/m at three-meters for 176 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna horizontally polarized. That is -2.3 dB relative to the limit of 43.5 dB(µV)/m at three-meters.

See appendixes F-J for spreadsheets that show the emissions measured for the 2126 radio module with the antennas listed above.

MEASUREMENT DATA: Observe appendix D (981030D1.pdf) showing the conducted emissions on radio port A and B. In the spreadsheet appendixes F-J (981030F1.pdf ....G1.pdf, ...H1.pdf, ...I1.pdf and ...J1.pdf) see pages 9-10 and 17 that show all the receiver radiated emissions data tabulated and graphically in dB(µV)/m. The conversion for calculating dB (µV)/m to µV/m follows.

[(dB (µV)/m)/ 20] anti log = µV/m
[(54 dB (µV)/m @ 1 mtr) / 20] anti log = 501.2 µV/m @ 1 mtr

or µV/m to dB(µV)/m/m

20 (log µV/m) = dB (µV)/m
20 (log 500 µV/m) = 54 dB (µV)/m

Limit conversion, three-meter to one-meter (mtr)

54 dB (µV)/m @ 3 mtrs + 10 dB = 64 dB (µV)/m @ 1 mtr

EQUIPMENT: 2126 Radio Module

NAME OF TEST: TX, RX AC Wireline Conducted Emissions

FCC RULE NUMBER: 15.209 (a)
CANADA RSS-210 Par: 6.6-7.4
CANADA GL-36 Par.: 3.2

MINIMUM STANDARD:

FCC Rules

Section 15.207 Conducted limits.

(a) For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 450 kHz to 30 MHz shall not exceed 250 microvolts. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

Canada RSS-210 6.6, 7.4

Transmitter AC wireline conducted emissions: This is a measurement of the extent of unwanted emissions conducted back into the AC electrical network by LPDs. Note that this test is only for unwanted emissions and not the wanted conducted emissions of AC Carrier Current devices described in section 8.3. This test applies when the device has any one or more of the following characteristics:

(i) The carrier frequency is within 0.45-30 MHz;
(ii) The equipment power supply contains switching circuitry (any frequency);
(iii) Internal clock or local oscillator frequency is within 0.45-30 MHz.

To claim test exemption, the engineering brief or test report shall contain a statement that the conditions of test exemption are met. More information on this is in section 9. The test on the transmitter may be combined with the test of section 7.4 on the receiver.

Minimum standard:

(a) On any frequency or frequencies within the band of 0.45-30 MHz, the measured RF voltage (CISPR meter) shall not exceed 250 microvolts (across 50 ohms).
This test is applicable to battery operated devices that permit operation while connected to AC line powered battery chargers.

GL-36 3.2 Power Line Conducted Emissions:

Devices intended to be connected to AC wire lines must be tested for power line conducted emissions. Minimum Standard: On any frequency or frequencies within the band of 0.45-30 MHz, the measured RF voltage shall not exceed 250 microvolts (across 50 ohms).

TEST PROCEDURE:

As referenced in ANSI C63.4, 1992 place the EUT on a wooden table inside a shield room. Connect the AC power supply to the LISN mounted on the floor behind the table. Measure from .15 to 30 MHz the conducted emissions while the radio is transmitting, then repeat with the radio in receive mode. Preliminary testing was made using a spectrum analyzer to determine the maximum emissions placement of the EUT. Final measurements were made and plots of the conducted emissions were produced. The spectrum analyzer was used in a prescan and swept the frequency range from .15 to 30 MHz using the peak detector as compared to the FCC Class B limit.

Quasi-peak measurements of the highest emissions were made with the test receiver. The tabulated data is contained with the measurement data section.

Refer to appendix A for photographs of the maximum emissions placement of the EUT during AC wireline conducted testing.

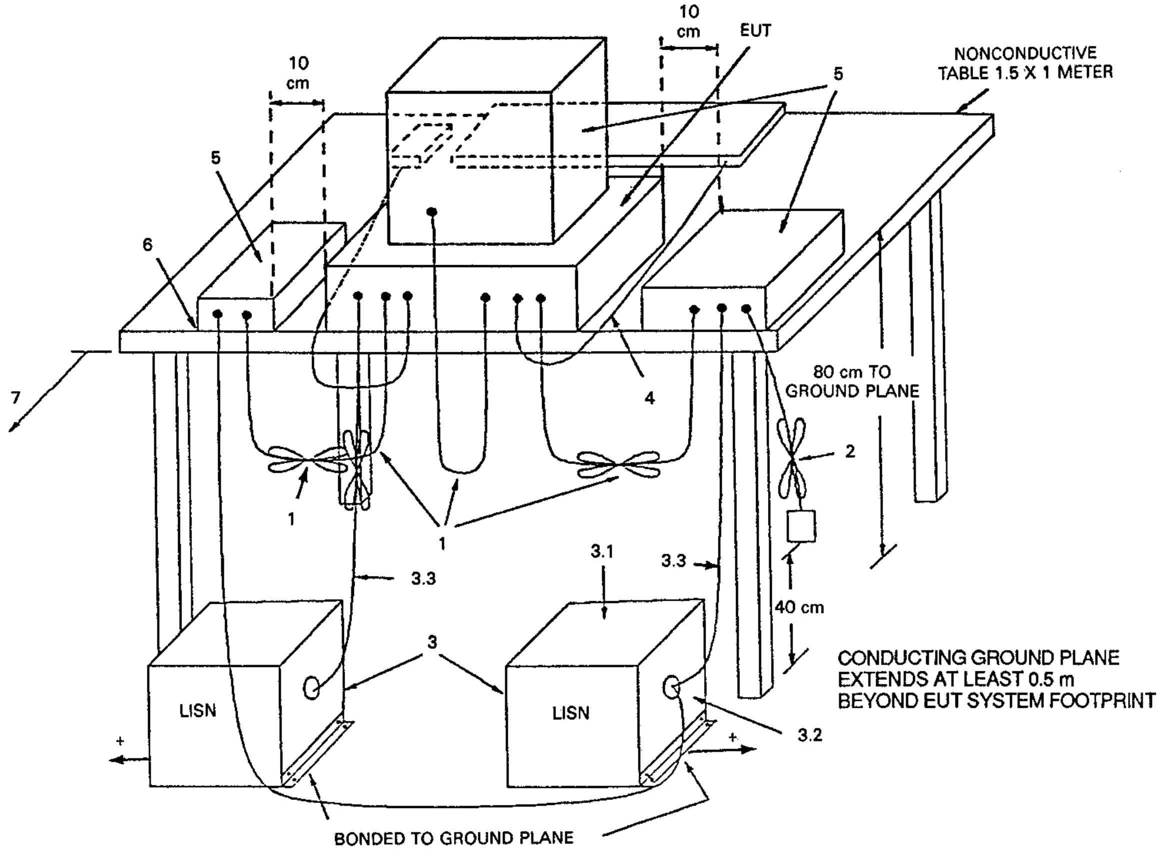
General And Environmental Conditions

For FCC and Industry Canada, testing was performed within a shield room, setup as described in ANSI C63.4-1992 section 5.2. The EUT was powered by single phase 120 Volts ~ 60 Hz AC power.

Environmental conditions at the time of testing were a temperature 23 C and relative humidity of 45 %.

TEST EQUIPMENT:	LISN	EMCO 3825/2R
	LISN	Rohde & Schwarz, ESH3.Z5
	Receiver	Rohde & Schwarz, ESH3
	Spectrum Analyzer	HP 8591A
PERFORMED BY:	Dave Fry	Date: Nov. 12 - Dec. 11, 1998

NAME OF TEST: AC Wireline Conducted Emissions, TX and RX



+LISNs may have to be moved to the side to meet 3.3 below.

LEGEND:

1. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth forming a bundle 30 to 40 cm long, hanging approximately in the middle between ground plane and table.
2. I/O cables that are connected to a peripheral shall be bundled in center. The end of the cable may be terminated if required using correct terminating impedance. The total length shall not exceed 1 m.
3. EUT connected to one LISN. Unused LISN connectors shall be terminated in 50 Ω LISN can be placed on top of, or immediately beneath, ground plane.
   3.1 All other equipment powered from second LISN.
   3.2 Multiple outlet strip can be used for multiple power cords of non-EUT equipment.
   3.3 LISN at least 80 cm from nearest part of EUT chassis.
   Cables of hand-operated devices, such as keyboards, mouses, etc., have to be placed as close as possible to the host.
4. Non-EUT components being tested.
5. Rear of EUT, including peripherals, shall be all aligned and flush with rear of tabletop.
6. Rear of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the floor ground plane.

Test Configuration
Tabletop Equipment Conducted Emissions

NAME OF TEST: AC Wireline Conducted Emissions, TX and RX

TEST RESULTS: Complies with FCC and Industry Canada (IC) requirements while operated at 120 VAC. Listed below are the operation configuration and AC voltage.

System	120 VAC 60 Hz Line Side	Spec Limit	Max. TX Emission dB (uV)	TX Em. Margin to Limit dB	Max. RX Emission dB (uV)	RX Em. Margin to Limit dB
6710 / 2126 radio	L1	FCC-IC	35.6	-12.4	35.7	-12.3
6710 / 2126 radio	N	FCC-IC	35.9	-12.1	35.9	-12.1
6400 / 2126 / charger	L1	FCC-IC	24.9	-23.1	28.0	-20.0
6400 / 2126 / charger	N	FCC-IC	25.8	-22..2	30.9	-17.1

Measured Data:

FCC-Industry Canada
120 VAC 60 Hz

For FCC and Industry Canada (IC) testing begins with a swept plot showing the maximum conducted emissions measured with a peak detector. This plot was referenced to make the following final measurements using a quasi-peak detector.

The frequency range used for testing was 450 kHz to 30 MHz. Unless otherwise noted, all final measurements are made using a Quasi-Peak (QP) detector with a 9 kHz measurement bandwidth . The QP data being compared to the QP limit for FCC-IC requirements.

NAME OF TEST: AC Wireline Conducted Emissions, TX and RX

AC Wireline Conducted Emissions, 2126 radio module when powered by 6710 Access Point

FCC- Industry Canada: Quasi-Peak Data Compared To FCC-IC Limit

120V 60 Hz Power Line Hot (L1) or Neutral Freq. MHz	QUASI-PEAK RCVR READING dB(uV)	COR FAC dB	QUASI-PEAK CAL DATA dB(uV)	FCC CLASS B LIMIT dB(uV)	FCC CLASS B MARGIN dB
a	b	c	d	e	f
calculation			d=b+c		f=d-e
TX Mode					
L1 Side					
0.450	15.50	1.61	17.11	48.0	-30.9
8.440	33.00	0.84	33.84	48.0	-14.2
14.060	28.70	1.20	29.90	48.0	-18.1
19.690	34.30	1.30	35.60	48.0	-12.4
N Side					
0.450	15.40	1.61	17.01	48.0	-31.0
8.440	32.90	0.84	33.74	48.0	-14.3
14.060	29.00	1.20	30.20	48.0	-17.8
19.690	34.60	1.30	35.90	48.0	-12.1
RX Mode					
L1 Side					
0.450	11.20	1.61	12.81	48.0	-35.2
8.440	33.10	0.84	33.94	48.0	-14.1
14.060	28.90	1.20	30.10	48.0	-17.9
19.690	34.40	1.30	35.70	48.0	-12.3
N Side					
0.450	13.60	1.61	15.21	48.0	-32.8
8.440	33.00	0.84	33.84	48.0	-14.2
14.060	29.10	1.20	30.30	48.0	-17.7
19.690	34.60	1.30	35.90	48.0	-12.1

Conducted emissions results obtained with a Rohde and Schwarz LISN.

See appendix E (981030E1.pdf) showing the spectrum analyzer plot of the peak emissions.

NAME OF TEST: AC Wireline Conducted Emissions, TX and RX

AC Wireline Conducted Emissions, 2126 radio module operated with a 6400 on AC charge.

FCC- Industry Canada: Quasi-Peak Data Compared To FCC-IC Limit

120V 60 Hz Power Line Hot (L1) or Neutral Freq. MHz	QUASI-PEAK RCVR READING dB(uV)	COR FAC dB	QUASI-PEAK CAL DATA dB(uV)	FCC CLASS B LIMIT dB(uV)	FCC CLASS B MARGIN dB
a	b	c	d	e	f
calculation			d=b+c		f=d-e
TX Mode					
L1 Side					
0.450	18.40	1.61	20.01	48.0	-28.0
2.480	15.80	0.50	16.30	48.0	-31.7
17.490	23.60	1.27	24.87	48.0	-23.1
24.290	17.90	1.47	19.37	48.0	-28.6
N Side					
0.450	18.70	1.61	20.31	48.0	-27.7
0.500	24.30	1.54	25.84	48.0	-22.2
16.000	19.90	1.26	21.16	48.0	-26.8
17.440	18.70	1.27	19.97	48.0	-28.0
RX Mode					
L1 Side					
0.460	26.40	1.59	27.99	48.0	-20.0
5.040	16.10	0.51	16.61	48.0	-31.4
13.560	22.70	1.18	23.88	48.0	-24.1
18.880	20.90	1.29	22.19	48.0	-25.8
N Side					
0.460	29.30	1.59	30.89	48.0	-17.1
0.500	27.30	1.54	28.84	48.0	-19.2
14.310	19.40	1.22	20.62	48.0	-27.4
17.470	23.00	1.27	24.27	48.0	-23.7

Conducted emissions results obtained with a Rohde and Schwarz LISN.

See appendix E (981030E1.pdf) showing the spectrum analyzer plot of the peak emissions.

Conversion Factors: The conversion for calculating dB (µV) to microvolts (µV) follows.

dB (µV) to µV (dB (µV) / 20) anti log = µV

µV to dB (µV) 20 (log µV) = dB (µV)

EQUIPMENT: 2126 Radio Module

NAME OF TEST: RF Exposure Safety

FCC RULE NUMBER: 1.1307 (b)(1) and 2.1093
CANADA RSS-210 Par.: N/A

COMMENT: FCC regulations 15.247 state concerns regarding RF safety. Below are listed particular sections and the interpretations by Intermec Technologies Corporation.

MINIMUM STANDARD: Summarized sections from 47 CFR Parts 1 and 2:

Based on the rules, low power portable devices are exempt from routine environmental evaluation. Further study of the rules allows reference to specific guidelines relevant to RF safety.

Below are sections from FCC OET Bulletin 65 Supplement C, Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields.

Table 1. Applicable Methods to Ensure Compliance for Spread Spectrum Transmitters.

Transmitter or Device Type	EIRP	Applicable Methods to Ensure Compliance
Cordless phone handsets and most other transmitters using monopole or dipole type antennas as an integral part of the device.	_ 0.3 W at 915 MHz or _ 0.2 W at 2450 MHz	These transmitters generally are not expected to exceed MPE limits (0.61 mW/cm at 915 MHz and 1.0 mW/cm at 2450 MHz); special instructions or warnings are normally not necessary to ensure compliance.
Transmitters using external antennas, including Omni, patch, logarithmic, parabolic reflector and dish type antennas. For outdoor operations, antennas generally mounted at remote locations such as the top or side of most buildings where the antennas are at least 20 cm away from nearby persons.	> 2.5 W at 915 MHz (1.5 W ERP) _ 2.5 W at 915 MHz or _ 4 W at 2450 MHz	Professional installation: provide installers with instructions indicating the separation distance between the transmitter/antenna and nearby persons to ensure RF exposure compliance, and to inform installers to ensure compliance through proper installation. Professional installation is preferred for these types of operations. However, end-user installation may require certain additional information to allow persons who do not have professional skills to properly install the antennas to ensure compliance. Transmitters operating at 2.5 W EIRP (1.5 W ERP) or less at 915 MHz, or at 4 W EIRP (2.4 W ERP) or less at 2450 MHz, generally are not expected to exceed MPE limits when nearby persons are 20 cm or more from most antennas; special instructions and warnings are normally not necessary to ensure compliance.

PERFORMED BY: Dave Fry Date: Nov. 5, 1998

RESULTS:

Mobile Computer Usage

The 2126 spread spectrum transmitter is low enough in power to be exempt from warning labels and special instructions when used within a mobile computer. The 4.5 dBi gain antenna and transmitter power combine to create a EIRP of 112 mW.

Base Station Usage With High Gain Antennas

The 2126 spread spectrum transmitter when combined with the high gain antennas presented in this report creates a system power of 1.26 W EIRP. According to the OET 65 Guide, operators are required to be notified to maintain a 20 cm distance between the antenna and any personal. A warning is placed within the 6710 Users Manual to instruct the end users to maintain a 20 cm (4 inch) distance from the antenna when the transmitter is in operation.

RF Safety, Measurement Uncertainty

The transmitter duty cycle is rated at 50 % or less, therefore the worst case power ratings shown above are actually lower. The duty cycle therefore allows for a margin of error to satisfy any measurement uncertainty concerns.

7.0 EQUIPMENT LIST

EQUIPMENT	MFG/MODEL	SERIAL NO.	CAL. DATE	CYCLE
Antenna, bi-conical	EMCO 3110	1185	9/98	12 Mo.
Antenna, log periodic	EMCO 3146	1262	9/98	12 Mo.
Antenna, DRG horn	EMCO 3115	2246	1/98	12 Mo.
Antenna, DRG horn	EMCO 3116	9311-2215	1/98	16 Mo.
Attenuator	HP 8491-10 dB	43380	5/98	12 Mo.
High Pass Filter	Cir-Q-Tel R9H-1G5/10G-28A	01	5/98	12 Mo.
High Pass Filter	K&L 13SH01-3000/T24000	01	5/98	12 Mo.
LISN	Rhode & Schwarz ESH3-Z5	832479/018	8/98	12 Mo
LISN	EMCO 3825/2R	1026	9/98	12 Mo
Mixer	HP 11970K	3003A05374	12/96	24 Mo.
Plotter	HP 7470A	2308A27380	On Req.	
Power Meter	Giga-Tronics 8541	010618569	4/98	12 Mo.
Power Supply	Tektronix PS282	PS282 TW10045	On Req	
Preamplifier	HP 8449B	3008A00439	4/97	24 Mo.
Preamplifier	HP 11975A	2738A01994	2/98	12 Mo.
Pulse Limiter	Rhode & Schwarz ESH3-Z2	007-6977	9/98	12 Mo
Receiver	Rohde & Schwarz ESH3	872318/050	2/98	12 Mo.
Receiver	Rohde & Schwarz ESVP	879674/046	1/98	12 Mo.
RF Preselector	HP 85685A	3221A01427	7/98	12 Mo.
Signal Generator	HP 83630A	3250A00322	2/98	24 Mo.
Spectrum Analyzer	HP 8566B	2637A03549	9/98	12 Mo.
Spectrum Analyzer	HP 8591A	3144A02470	5/98	16 Mo.
Vector Analyzer	HP 89410A	3416A01518	9/98	12 Mo.
Voltmeter	Fluke 77	35300152	5/98	16 Mo.

On Req. = On Request