Technologies Corporation
EMC Test Laboratory
Cedar Rapids, IA

MEASUREMENT/TECHNICAL REPORT

Intermec Technologies Corporation
RF Identification (RFID) 915 PC Card –6
915 MHz Spread Spectrum Transmitter

REPORT NO: 010416-1

DATE: April 16, 2001

This report concerns: Original Grant ___X___ Class II change _____
Equipment Type: 902-928 MHz Frequency Hopping Spread Spectrum Transceiver, FCC 15.247 Industry Canada RSS-210 Issue 4, RSS-102 Issue 1
Request issue of the grant immediately upon completion of review.
Measurement procedure used: ANSI C63.4-1992 and as described within this test report.

Report Prepared by:	Report Prepared For:
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This report contains data that is outside the NVLAP scope of accreditation.

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SECTION NUMBER

APPENDIXES (may be file attachments for electronic applications of approval)

xxx = file extension .doc or .pdf

1.0 COMPLIANCE CERTIFICATION

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

FCC SECTION	CANADA RSS-210	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. Methods
15.203, 15.204	5.5	Antenna Description(s)
2.925, 15.19	5.10	Labeling
15.21	5.11, 14.0	Information to the User
15.247 (a, b, c, d, e), 15.209	5.7-5.9.2	Transmitter Characteristics
15.215	6.4	Freq. & Power Stability, Volts
15.109	7.3	Receiver Radiated Emissions
15.207, 15.107	6.6, 7.4	AC Line Conducted Emissions
1.1307 (b)(1)	14.0 & RSS-102	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.

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

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
EMC Test Laboratory
550 Second Street S.E.
Cedar Rapids, Iowa 52401

The scope of accreditation at the EMC Test Laboratory 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/CIS22a** IEC/CISPR 22:1993: Limits and methods of measurement of radio disturbance characteristics of information technology equipment, Amendment 1:1995, and Amendment 2:1996. **12/CIS22b** CNS 13438:1997: 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.

EMC 017

Interference Technology International

Dave Fry — Date 07/02/01
Dave Fry, Regulatory Engineer II (mm/dd/yy)

Robert Kraus — Date
Robert Kraus, Staff RF Engineer (mm/dd/yy)

CERTIFIED NARTE ENGINEER

National Association of Radio and Telecommunications Engineers

1.1 Measurement Uncertainties:

Radiated Emissions On 3 Meter Open Area Test Site

30-90 MHz has an Expanded Measurement Uncertainty of +/- 3.42 dB.
90-200 MHz has an Expanded Measurement Uncertainty of +/- 3.33 dB.
200-1000 MHz has an Expanded Measurement Uncertainty of +/- 4.76 dB.
1-2 GHz has an Expanded Measurement Uncertainty of +/- 2.54 dB.
2-12.5 GHz has an Expanded Measurement Uncertainty of +/- 3.62 dB.
12.5-18 GHz has an Expanded Measurement Uncertainty of +/- 4.02 dB.

Radiated Emissions On 1 Meter Open Area Test Site

1-2 GHz has an Expanded Measurement Uncertainty of +/- 4.28 dB.
2-12.5 GHz has an Expanded Measurement Uncertainty of +/- 4.88 dB.
12.5-18 GHz has an Expanded Measurement Uncertainty of +/- 5.18 dB.
18-26.5 GHz has an Expanded Measurement Uncertainty of +/- 5.72 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 +/- 0.84 dB..
2.0-5.8 GHz has an Expanded Measurement Uncertainty of +/- 1.07 dB.
5.8-20 GHz has an Expanded Measurement Uncertainty of +/- 1.28 dB.
20-22 GHz has an Expanded Measurement Uncertainty of +/- 1.78 dB.

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

0-1.0 GHz has an Expanded Measurement Uncertainty of +/- 1.26 dB.
1.0-2.0 GHz has an Expanded Measurement Uncertainty of +/- 1.28 dB.
2.0-5.8 GHz has an Expanded Measurement Uncertainty of +/- 2.12 dB.
5.8-12.5 GHz has an Expanded Measurement Uncertainty of +/- 2.45 dB.
12.5-20 GHz has an Expanded Measurement Uncertainty of +/- 2.94 dB.
20-22 GHz has an Expanded Measurement Uncertainty of +/- 3.76 dB.

AC Line Conducted

0.15-30 MHz has an Expanded Measurement Uncertainty of +/- 1.34 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 Certification for a type 2 PCMCIA spread spectrum radio module operating as a frequency hopper in the 902-928 MHz radio band. The 915 PC Card –6 is a radio used for communicating to RF Identification (RFID) tags operating in the same frequency band. The tags allow tracking and inventory of packages, laundry and pallets using RF energy to turn on, interrogate and write information to the RF tags.

The 915 PC Card –6 radio is used within various mobile and laptop computers as well as within stationary units that interfaces to mainframe computers other terminal devices.

The 915 PC Card –6 radio is manufactured by Intermec Technologies Corporation and will be marketed as an OEM radio to other companies with the possibility of re-labeling. The conditions of re-labeling will address modification restrictions and antennas restrictions to inform the end user of their regulatory requirements and responsibilities.

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 5 antennas. All antennas marketed by Intermec for the 915 PC Card –6 radio satisfies the unique connection requirements outlined in the FCC and Canada rules.

The PC Card is intended for global marketing therefore must comply to the CISPR 22 (EN55022) Class B digital emissions. The Intermec, Cedar Rapids, EMC Test Lab will perform testing for compliance for digital emissions to the CISPR 22 Class B limits and issue separate reports addressing the integration in Intermec products as well a report showing use in a laptop computer. Based on these tests and reports the Class B Declaration of Conformity can be used for United States marketing. Canada will accept a self-declaration for compliance to ICES-003.

The radio module shown herein is a pre-production model. The antennas listed herein are also pre-production versions.

Transmitter modular approval, conditional requirements.

1) The transmitter has its own shielding and is tested herein extended outside of a laptop PC. The shield is a standard PCMCIA metal container added during manufacturing. Instructions to end-users and resellers will warn of possible regulatory consequences for modifying the radio in any manner.

2) As a PCMCIA card (PC card), only data and power is presented to the radio, all modulation and control of the transmitter is contained within the PC card.

3) The transmitter operates across a voltage range of +5.0V +/- 5%. Internal power output controls and operating frequency maintains operation within the parameters defined in the regulations. Test data within shows the transmitter characteristics across the specified voltage range.

4) The PC card uses an antenna connector that meets the unique coupler requirements. The antennas offered for sale with the transmitter DO NOT require professional installation.

5) The radio is extended on commercially available PC card extension. The radio is extended two inches (5-cm) beyond the host laptop. The extender allows the radio to be placed horizontal and vertical for a complete evaluation of the radiated characteristics of the shielding on the radio. AC power to the laptop and Intermec 6110 operated the unit during testing. AC line conducted emissions are presented herein.

6) As a PC card, the radio is typically accessible to the end user. In Intermec products that restrict access to the radio the exterior of those units will contain an external label that users the “Contains TX FCC ID: EHARFID915PCC-6”. Resellers will also be instructed to label the exterior of products where access to the PC card is restricted.

7) The PC card as manufactured is completely controlled by the onboard processor. There are no influences to the operation of the transmitter the end user can induce that will operate the radio outside of scope of the regulations. Intermec service and manufacturing are the only persons with the equipment to alter the internal radio software that controls transmitter power, operating frequencies, hop sequences and duty cycle. All internal software is placed under revision control within Intermec with restrictions under the supervision of Intermec Safety and Compliance manager. Resellers and integrators will be informed of the operating voltage requirements for the PC card.

8) The transmitter herein was tested with the antennas listed. Compliance to RF exposure requirements for all the antennas offered for sale by Intermec is included within this application for approval. Sales information regarding OEM resellers will inform those entities of their regulatory obligations to use the Intermec antennas as presented herein or to seek approval through the appropriate regulatory agency. Instructions to resellers will also define the requirements to show the integrated radio meets the unintentional emissions requirements where appropriate.

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

2.3 Tested Systems Details

Items tested:			
Model Number (Serial Number)	FCC ID:	Description	Cable Description
915 PC Card –6 Radio PCB PN: 144-886-003 SN: prototype "B"	EHARFID915PCC–6	Type II PCMCIA frequency hopping spread spectrum	Module testing shown in PCMCIA extension. Antenna cables represent the shortest versions used.
Dell Expression Lap-top PN: 04949 SN: 2RVX-5180	AK8PD475SC	Host computer	No peripherals or cables attached to show maximum radio emissions.
Dell Charger PN: 73463 SN: T4037851	-	universal charger	detachable shielded AC cord, unshielded DC cable to mobile computer
6110 PN: 245-192-002/002 SN: 4351515	not applicable FCC DoC	mobile computer	No peripherals or cables attached to show maximum radio emissions. Integral Fractal patch or dipole antenna
6110 Charger PN: UP0351A-12P SN: 95047257	-	universal charger	detachable shielded AC cord, unshielded DC cable to mobile computer
Antennas tested for this report that will be used with the 915 PC Card –6 radio:			
Patch Antenna for 6110 PN: 805-593-001	-	Fractal 7.5x7.5-cm (3x3 inch) 0 dBi panel antenna	8 centimeter (3 inch) RG316 with MMCX miniature connectors. This antenna will be used with mobile computers.
Dipole Antenna for 6110 PN: 805-594-001	-	Fractal 2x7-cm (1.7x2.7 inch) 2.2 dBi dipole antenna	8 centimeter (3 inch) RG316 with MMCX miniature connectors. This antenna will be used with mobile computers.
High Gain Panel Antenna PN: 805-590-001 Mfg PN: P6C-915	-	Mobile Mark 15x15x2.5-cm(6x6x1 inch) 2 dBi panel antenna	122 centimeter (4 feet) RG316 with MMCX miniature connectors.
High Gain Raised Panel Antenna PN: 805-589-001 Mfg PN: H9185	-	Astron 15x15x15-cm (6x6x6 inch) 2 dBi raised panel antenna	122 centimeter (4 feet) RG316 with MMCX miniature connectors.
Antennas not tested for this report that will be used with the 915 PC Card –6 radio:			
High Gain Panel Antenna PN: 805-591-001 Mfg PN: 503033DR	-	Tecom Industries 18x18x2.5-cm (7x7x1 inch) 2 dBi panel antenna	122 centimeter (4 feet) RG316 with MMCX miniature connectors.

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, 5.17, 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 915 PC Card –6 radio is capable of operating the radio continuously in transmit modes locked on channel or hop using a pre-programmed pseudo-random hop sequence. The test software is set to operate on channel 07, 40 or 73. The transmitter test sends pseudo-random data continuously or CW on the selected channel.

Channel 07 transmit = 902.625 MHz
Channel 40 transmit = 915.000 MHz
Channel 73 transmit = 927.375 MHz

These channels represent the low, middle and highest channels of operation within the band of 902 – 928 MHz.

Per FCC regulations the transmitter emissions are measured to the 10^{th} harmonic, or 9.28 GHz. Canadian regulations for transmitters require testing to the 5^{th} harmonic. Receiver emissions are not presented here because the receiver is enabled with the transmitter during operation. All testing of the transmitter includes any spurious emissions the receiver may generate.

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 from 30 to 1000 MHz are tested at a three-meter distance using a Quasi-Peak detector with a 120 kHz measurement bandwidth (BW).

Radiated emissions from 1 to 10 GHz are tested at three-meter measurement distance with a preamplifier to improve the measurement sensitivity. Average measurements above 1 GHz 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.

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 report number 577-500-971, dated November 6, 2000, and submitted to the Federal Communication Commission USA, and accepted in a letter dated December 8, 2000 for ANSI C63.4: 1992 testing. The test site was also submitted to Industry Canada for the performance of radiated measurements and is reference by the file number IC 3909. Test site complies too CISPR Publication 22: 1993, Clauses 10 and 11 for methods of measurements for radiated and conducted emissions testing.

3.0 PRODUCT LABELING AND INFORMATION TO THE USER

3.1 PRODUCT LABELING

See Appendix A for label and label placements diagrams.

3.2 INFORMATION TO THE USER

The appendixes L and M show the compliance insert for the stand-alone 915 PC Card (010416L1.xxx) and the 6110 handheld terminal (010416M1.xxx). These document inserts are shipped with each product.

4.0 THEORIES OF OPERATION

Proprietary Intermec Technologies document. Confidentiality requested for this document. See appendix I. 010416I1.xxx

5.0 BLOCK DIAGRAM

Proprietary Intermec Technologies document. Confidentiality requested for this document. See appendix I. 010416J1.xxx

6.0 SCHEMATICS

Proprietary Intermec Technologies document. Confidentiality requested for this document. See appendix J. 010416K1.xxx

7.0 CONDUCTED AND RADIATED EMISSIONS TEST DATA

The following tests and results are recorded within this section.

Antenna Description

Frequency Hopping Spread Spectrum (FHSS) 20 dB Bandwidth

FHSS Transmitter Duty Cycle

FHSS Channel Occupancy and Dwell Time

Peak Output Power

Out of Band Emissions, Transmitter Conducted and Radiated

Frequency and Power Stability Across Voltage

Receiver Radiated Emissions

AC Wireline Conducted Emissions

RF Safety, Exposure Limits

EQUIPMENT: 915 PC Card –6 Radio Module

NAME OF TEST: Antenna Description

FCC RULE NUMBER: 15.203, 15.204
CANADA RSS-210 Par.: 5.5

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: June 14, 2001

SET UP: Not applicable

TEST RESULTS:
The antennas for the 915 PC Card –6 radio interface using a miniature MMCX connector. The remote antennas are provided from their suppliers with these miniature coaxial connectors. Antennas sold for the 915 PC Card –6 will only be offered through Intermec Technologies.

In the event the radio is marketed as an OEM device to another system integrator, antenna types and connector restrictions will be communicated to re-seller. Their regulatory obligations will be made clear as a condition for re-selling and or re-labeling of the 915 PC Card.

The highest antenna gain Intermec Technologies is offering for sale is + 3.0 dBi. The transmitter peak power is +30.0 dBm. Adding the antenna gain to the transmitter power totals +33.0 dBm. This total is –3.0 dB below the maximum ERP of +36 dBm allowed under FCC or Industry Canada rules.

Antenna Descriptions: Antennas for the 915 MHz PCMCIA RFID reader

Fractal Patch - is a 3"x3" right hand circular polarized patch antenna from Fractal Antenna Systems (FAS), complete with 4 inch RG316 cable and right angle MMCX connector. The FAS part number is NA (Not Available), the Intermec part number is 805-593-001. Nominal gain is 0 dBi, for a 50 ohm system, return loss is > 10 dB over the 902-928 MHz band. This is one of the antennas to be used with Intermec Technologies mobile computers i.e. 6110, 6400, and 2415.

Fractal Dipole - is a 1.7"x2.7" linearly polarized PCB dipole antenna from Fractal Antenna Systems. The FAS part number is NA; the Intermec part number is 805-594-001. Nominal gain is 0 dBd, for a 50 ohm system, return loss is > 10 dB over the 902-928 MHz band. This is one of the antennas to be used with Intermec Technologies mobile computers i.e. 6110, 6400, and 2415.

6"x6"x1" Patch - is a right hand circularly polarized patch antenna from Mobile Mark, complete with 4 feet RG316 cable and MMCX connector. The Mobile Mark part number is P6C-915, the Intermec part number is 805-590-001. Nominal gain is 2 dBi, for a 50 ohm system, return loss is > 10 dB over the 902-928 MHz band. This will be one of the laptop remote antennas.

7"x7"x1" Patch - is a right hand circularly polarized patch antenna from Tecom Industries, complete with 4 feet RG316 cable and MMCX connector. The Tecom part number is 503033DR; the Intermec part number is 805-591-001. Nominal gain is 2 dBi, for a 50 ohm system, return loss is > 10 dB over the 902-928 MHz band. This will be one of the laptop remote antennas.

6"x6"x6" Elevated Patch - is a right hand circularly polarized raised patch antenna from Astron Antenna, complete with 4 feet cable and MMCX connector. The Astron part number is H9185; the Intermec part number is 805-589-001. Nominal gain is 3 dBi, for a 50 ohm system, return loss is > 15 dB over the 902-928 MHz band. This will be one of the laptop remote antennas.

EQUIPMENT: 915 PC Card –6 Radio Module

NAME OF TEST: Bandwidth, Number of Channels, Duty Cycle and Occupancy

FCC RULE NUMBER: 15.247 (a)(1)(ii)
CANADA RSS-210 Par.: 6.2.2 (o)

MINIMUM STANDARD:
(a)(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

TEST EQUIPMENT:	Spectrum Analyzer	HP 8566B
	Attenuator	HP 8491-20 dB

PERFORMED BY: Dave Fry Date: April 13, 2001

TEST PROCEDURE:

Note: The radio module utilizes internal test software to generate a transmitter pattern of random ones and zeros in either selected channel or hopping mode.

1. Using the test setup of figure 1, adjust the spectrum analyzer to sweep from 902-928 MHz with a resolution bandwidth of 500 kHz. Set the transmitter for hopping mode channels 07-73. Peak hold and plot showing channel utilization.

2. Using the test setup of figure 1, adjust the spectrum analyzer to 500 kHz span centered at 902 MHz with a resolution and video bandwidth of 30 kHz. Enable the transmitter to selected channel 07 and peak hold the analyzer. Indicate the 20-dB bandwidth using Δ markers. Plot and identify the marker positions. Repeat for channels 40 and 73.

3. Adjust the analyzer to span 0 Hz at 915.000 MHz with resolution bandwidth of 30 kHz and video bandwidth of 30 kHz. Activate the transmitter in hopping mode. Using single 4 second sweep select a display showing channel 40 keyed up on the transmitter. Utilizing the Δ function indicate the time between transmissions on channel 40 and plot.

4. Adjust the analyzer for a 100 milli-second sweep time and use video trigger. Place the marker on the end of the transmitter on time. Plot the transmit time to show the transmitter duty cycle.

MEASUREMENT DATA:
67 channels are utilized within the allowed spectrum. The worst case 20 dB channel bandwidth was 98.6 kHz for channel 40 of the transmitter. The time between hops on a selected channel is 2.700 seconds. The average number of hops in a 20-second period will be 7.407. The time spent on each channel is 41.3 milli-seconds (msec). The average transmit time in an average 20-second window will be 305.93 msec. See the plots from the spectrum analyzer on appendix C.

TEST EQUIPMENT: Spectrum Analyzer HP 8566B
Attenuator HP 8491- 20 dB

PERFORMED BY: Dave Fry Date: April 13, 2001

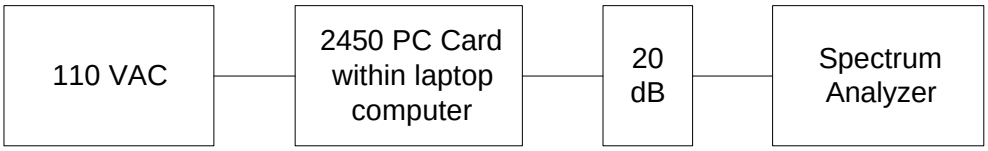


Figure 1.

TEST RESULTS: Conforms. The transmitter has an operating bandwidth less than 250 kHz. The transmitter is on frequency less than 0.4-seconds in an average 20-second period. See appendix C (010416E1.xxx) for plots.

See Appendix I (010416I1.xxx) for details on radio hopping sequences and conditions for transmission interruption and restarting to address the equal usage of each channel on average.

Frequency, Channel Number	902.625 MHz, low Ch. 07	915.000 MHz, mid Ch. 40	927.375 MHz, high Ch. 73
B.W. kHz	96.8	98.6	98.0

EQUIPMENT: 915 PC Card –6 Radio Module

NAME OF TEST: Peak Power Output

FCC RULE NUMBER: 15.247 (b)(2)(3)
MINIMUM STANDARD:
(b) The maximum peak output power of the intentional radiator shall not exceed the following:

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(3) Except as shown below, if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the above stated values by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

CANADA RSS-210 Par.: 6.2.2(o)
MINIMUM STANDARD:

Output Power and EIRP Limits
For the band 2400-2483.5 MHz, the transmitter output power shall not exceed 1.0 watt. See (d) below for special conditions.

For the bands 902-928 MHz and 5725-5850 MHz, the transmitter output power shall not exceed 1.0 watt and the EIRP shall not exceed 4 watts. However, point-to-point systems in the 5725-5850 MHz band are permitted any EIRP necessary for satisfactory operation by increase in antenna gain. Point-to-multipoint systems and multiple co-located transmitters transmitting the same information are **prohibited** from using this high EIRP category.

TEST PROCEDURE:

Note: The 915 PC Card –6 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.

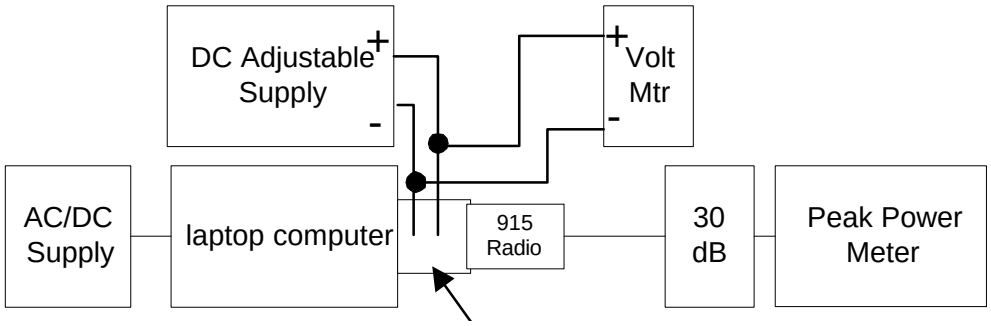
(2) Set DC supply to +5.00 volts. Activate the transmitter on the low channel, 902.625 MHz, and record the peak output power observed on the power meter. Repeat for 4.75 and 5.25 volts

(3) Repeat 1 and 2 using the middle and high channels, 915.000 and 927.375 MHz.

TEST EQUIPMENT:	Power Meter	Giga-Tronics 8541
	Attenuator	Narda 4779-10 dB
	Attenuator	Narda 4779-20 dB
	DC Supply	Racal-Dana
	Voltmeter	Fluke 8060A

PERFORMED BY: Robert Kraus Date: June 12, 2001

SET UP:



PCMCIA Extension with
5V cut for external supply

Figure 2.

TEST RESULTS:
Conforms. The transmitter has transmitter peak power of 29.7 dBm or 933 milliwatts. This is 67 milliwatts below the 1-watt limit. Intermec is specifying the transmit power over the production run to be +29.5 dBm +/- 0.5dB. The power measured for this particular radio is to be considered typical for most of the radios manufactured.

Antennas to be used with the transmitter have a highest gain of +3.0 dBi. The total system Effective Isotropic Radiated Power is calculated as:

Tp + Ag = EIRP

30 + 3.0 = 33 dBm or 2.0 watts EIRP

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

Specified limit is calculated as:

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

MEASUREMENT DATA:

Conducted measurement at the antenna connector. PC Card voltage +5.00

Freq. / Channel	Power Meter Reading (dBm)	Attenuation (dB)	Calculated Power (dBm)	Margin below +30 dBm Limit (dB)
902.625 MHz / Ch. 07	-0.3	30.0	29.7	-0.3
915.000 MHz / Ch. 40	-0.4	30.0	29.6	-0.4
927.375 MHz / Ch. 73	-0.4	30.0	29.6	-0.4

Conducted measurement at the antenna connector. PC Card voltage +4.75

Freq. / Channel	Power Meter Reading (dBm)	Attenuation (dB)	Calculated Power (dBm)	Margin below +30 dBm Limit (dB)
902.625 MHz / Ch. 07	-0.3	30.0	29.7	-0.3
915.000 MHz / Ch. 40	-0.4	30.0	29.6	-0.4
927.375 MHz / Ch. 73	-0.4	30.0	29.6	-0.4

Conducted measurement at the antenna connector. PC Card voltage +5.25

Freq. / Channel	Power Meter Reading (dBm)	Attenuation (dB)	Calculated Power (dBm)	Margin below +30 dBm Limit (dB)
902.625 MHz / Ch. 07	-0.3	30.0	29.7	-0.3
915.000 MHz / Ch. 40	-0.4	30.0	29.6	-0.4
927.375 MHz / Ch. 73	-0.4	30.0	29.6	-0.4

EQUIPMENT: 915 PC Card –6 Radio Module

NAME OF TEST: Out of Band Emissions

FCC RULE NUMBER: 15.247 (c)
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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

CANADA RSS-210 Par.: 6.2.2, (o)(e1)
MINIMUM STANDARD:
(e1) **Out of Band Emissions:** In any 100 kHz bandwidth outside the operating frequency bands, between 30 MHz and 5 times the carrier frequency, the unwanted emission spectral density shall be either at least 20 dB below the inband spectral density, or shall not exceed the levels specified in Table 3, whichever is less stringent. **Note:** For frequency hopping systems, the inband density S_i shall be measured with the hopping sequence stopped at the lowest channel and the highest channel in turn, as well as with the hopping running normally. The 20 dB shall be with reference to the lowest of the three S_i values.

TEST PROCEDURE:
1. Determine the cable loss and actual attenuator values for the measurement system at 915 MHz. Use this value to calculate the in-band peak power and the limit. The limit calculated will be used to identify the limit on the conducted spurious emissions plots.

Attenuator and cable loss	20.4 dB
In-band peak measured	+9.1 dBm
Calculated in-band power	+29.5 dBm
Limit	-20.0 dB
Limit (Generator Sub.)	+9.5 dBm

2. Using the setup diagramed in figure 3, record the conducted emissions of the transmitter. Plot the near band emissions on a 65 MHz span centered on 915.000 MHz using 100 kHz video and resolution bandwidths. Enable the end channels with modulation and recording the delta from the peak of each channel to the highest emission outside the allowable band. Plot the low channel in black and the highest channel in red. Placing the highest inband peak on the top graticule of the spectrum analyzer best shows the limit for the near-band plots, the limit is 20 dB down from the inband peak.

3. Show the out of band emissions on a 260 MHz span centered on 902 MHz. The plot the transmitter operating on the highest and lowest channels with modulation. This plot shows compliance to the out of band emissions beyond the 65 MHz span in step 2. Plot and identify the limits.

4. Detail the near band-edge emissions by centering each specified band edge and plot on a 4 MHz span. Show the end channels as a steady state CW then overlay the modulated end channel on the same plot. Repeat the modulated plot with the transmitter in hop mode. Record the delta from the transmitter peak to the highest out of band emission.

5. Complete plotting the transmitter out of band emissions by showing the following spans. 0-1.5, 1.5-2.5, 2.5-5 and 5-10 GHz. Use the setup diagramed in figure 4 for the plots above 1.5 GHz. Identify any emissions observed above the measurement noise floor. Indicate the limit on each plot by calculating the limit based on the transmitter inband peak power and correcting for the losses in the cable and attenuation used. The generator substitution of the limit swept across the plot.

6. Record the radiated emissions using the testing methodology described in section 2.4 to measure the 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 three meters and an amplifier between the horn antenna and spectrum analyzer, measure emissions from1 – 10 GHz. 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
	Microwave amplifier	HP 8449B
	Spectrum Analyzer	HP 8566B
	Mixer	HP11970K
	Amplifier	HP11975A
PERFORMED BY:	Robert Kraus	Date: April 9 - June 14, 2001

TEST SETUP: Transmitter Conducted Emission

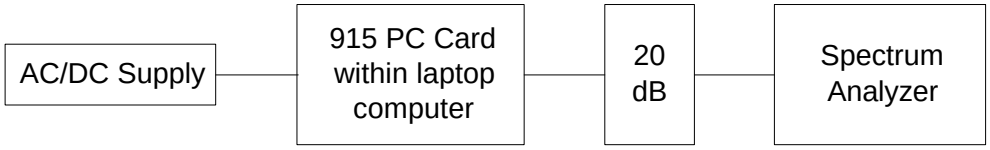


Figure 3.

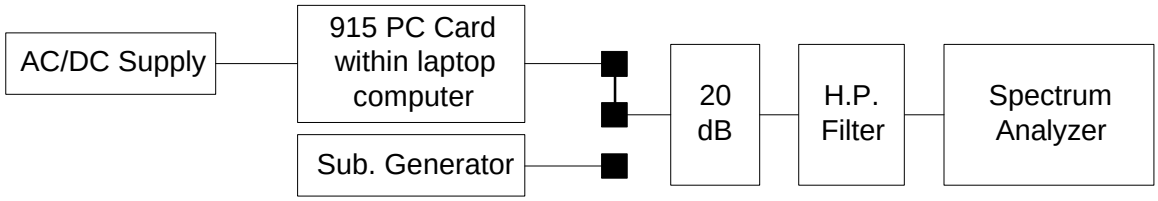


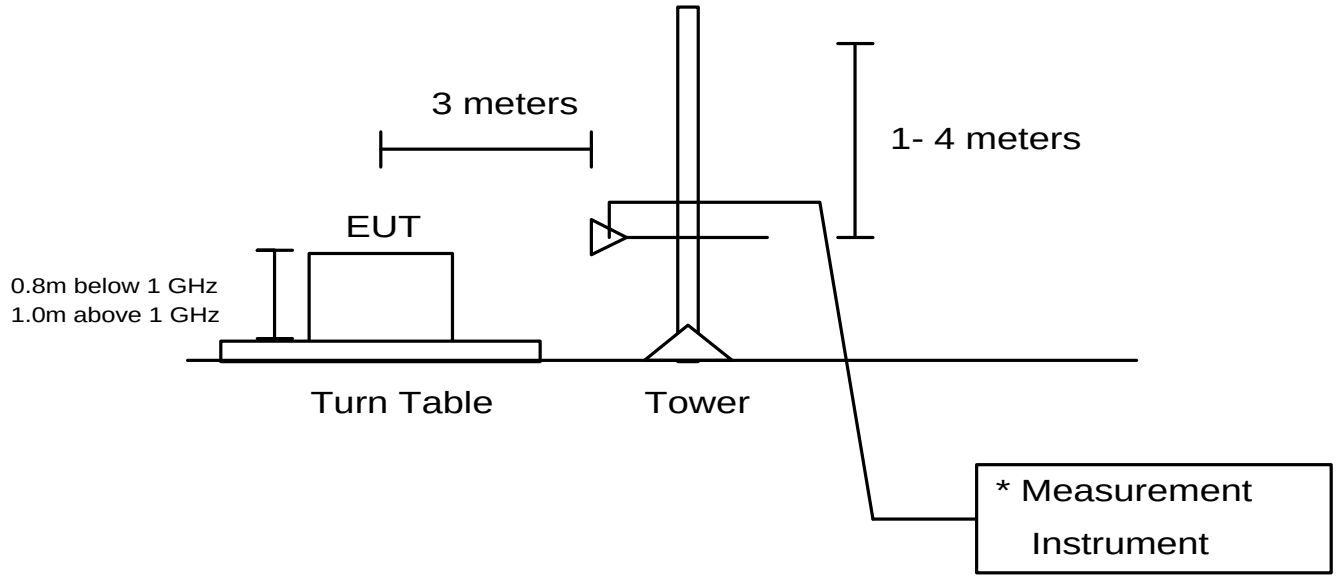
Figure 4.

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: Transmitter Radiated Spurious Emissions

Open area test site at the Intermec EMC Test Facility
Three-meter test range 30 MHz - 10 GHz.
Above 1 GHz the product was raised to 1-meter height to better align the horn antenna to potential emissions from the radio module.

Review the following diagrams for setup details. Refer to the photographs in appendix A (010416B1.xxx) for placement 915 PC Card –6 radio.



* 30-1000 MHz, Rohde & Schwarz receiver or
1-10 GHz, HP8566B Spectrum Analyzer with preamplifier and high-pass filter

TEST RESULTS: Transmitter conducted emissions conform.
The 915 PC Card –6 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. The band from 30 to 9280 MHz was examined, the only significant emissions were above 1000 MHz. See Appendix F (010416F1.xxx) for plots showing compliance.

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. The attached calculation spreadsheets show the de-rating the measurement limit for 50% duty cycle, or -6 dB. The 50% de-rating is a conservative figure, duty cycles for operation is nearer the 40-45% on time for 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 FHSS 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 45%. (See the following plot, showing the transmitter duty cycle plotted on an the spectrum analyzer.) 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 = 0.045, or 45 %

the calculation for de-rating for a 45% is shown below:

(1dB@100% x .45 log) 20 = -6.9 dB de-rating for 45% 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 appendix G shows the measured emissions for a 100% transmit duty cycle. The de-rating is added to the average limit to show the margins of compliance for the duty cycle calculated above. The data shows all emissions compared to the limits outlined in 15.209 for restricted bands. The data summary below highlights the highest emissions in those restricted bands.

Plots showing the transmitter duty cycle on the spectrum analyzer are included in appendix E.

To show modular compliance the first antenna data presented shows the radio on an extension card and placed horizontally, then data is collected with the radio placed vertically. The 6110 hand-held terminal is a portable unit, both unit vertical and horizontal data is also presented. (See setup photographs in appendix B.)

<u>915 PC Card –6 radio extended horizontal</u>

with Mobile Mark panel antenna (see appendix G, 010416G1.xxx, for the data spreadsheets)	The highest <u>AVERAGE</u> field strength of the out of band transmitter radiated emissions is 63.0 dB(µV)/m measured at a distance of three-meter for 2707.875 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 57.0 dB(µV)/m. That is –7.0 dB relative to the limit of 54 dB(µV)/m at three-meter.

AVERAGE EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
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
07 / 2707.88	V	49.6	-6.0	43.6	54.0	-10.4
07 / 2707.88	H	53.0	-6.0	47.0	54.0	-7.0
40 / 2745.00	V	47.3	-6.0	41.3	54.0	-12.7
40 / 2745.00	H	52.5	-6.0	46.5	54.0	-7.5
73 / 2782.13	V	48.3	-6.0	42.3	54.0	-11.7
73 / 2782.13	H	50.2	-6.0	44.2	54.0	-9.8

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 38.8 dB(µV)/m measured at a distance of three-meter for 384 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna horizontally polarized. That is –7.2 dB relative to the limit of 46 dB(µV)/m at three-meter. (no duty cycle correction can be applied to QP or Pk data).

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@3M	margin dB
07, 40, 73 / 384	QP	V	33.8	46.0	-12.2
07, 40, 73 / 384	QP	H	38.8	46.0	-7.2
07 / 9026.25	Pk	V	55.0	74.0	-19.0
07 / 9026.25	Pk	H	55.0	74.0	-19.0
40 / 9150	Pk	V	54.9	74.0	-19.1
40 / 9150	Pk	H	54.9	74.0	-19.1
73 / 9273.8	Pk	V	54.6	74.0	-19.4
73 / 9273.8	Pk	H	54.6	74.0	-19.4

915 PC Card –6 radio extended vertical

with Mobile Mark panel antenna (see appendix G, 010416G1.xxx, for the data spreadsheets)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 53.5 dB(µV)/m measured at a distance of three-meter for 2782.125 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna vertically polarized. Applying the 6 dB duty cycle correction the emissions are 47.5 dB(µV)/m. That is –6.5 dB relative to the limit of 54 dB(µV)/m at three-meter.

AVERAGE EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
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
07 / 2707.88	V	50.7	-6.0	44.7	54.0	-9.3
07 / 2707.88	H	49.5	-6.0	43.5	54.0	-10.5
40 / 2745.00	V	49.9	-6.0	43.9	54.0	-10.1
40 / 6405.00	V	48.0	-6.0	42.0	54.0	-12.0
73 / 2782.13	V	53.5	-6.0	47.5	54.0	-6.5
73 / 2782.13	H	52.5	-6.0	46.5	54.0	-7.5

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 38.8 dB(µV)/m measured at a distance of three-meter for 384 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna horizontally polarized. That is –7.2 dB relative to the limit of 46 dB(µV)/m at three -meter. (no duty cycle correction can be applied to QP or Pk data)

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@3M	margin dB
07, 40, 73 / 384	QP	V	33.8	46.0	-12.2
07, 40, 73 / 384	QP	H	38.8	46.0	-7.2
07 / 9026.25	Pk	V	54.9	74.0	-19.1
07 / 9026.25	Pk	H	54.9	74.0	-19.1
40 / 9150	Pk	V	54.3	74.0	-19.7
40 / 9150	Pk	H	54.3	74.0	-19.7
73 / 2782.13	Pk	V	55.7	74.0	-18.3
73 / 2782.13	Pk	H	54.5	74.0	-19.5

915 PC Card –6 radio extended horizontal

with Astron raised panel antenna (see appendix G, 010416G1.xxx, for the data spreadsheet)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 54.6 dB(µV)/m measured at a distance of three-meter for 2707.875 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 48.6 dB(µV)/m. That is –5.4 dB relative to the limit of 54 dB(µV)/m at three -meter.

AVERAGE EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
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
07 / 2707.88	V	51.0	-6.0	45.0	54.0	-9.0
07 / 2707.88	H	54.6	-6.0	48.6	54.0	-5.4
40 / 2745.00	V	47.5	-6.0	41.5	54.0	-12.5
40 / 2745.00	H	50.8	-6.0	44.8	54.0	-9.2
73 / 2782.13	V	50.5	-6.0	44.5	54.0	-9.5
73 / 2782.13	H	52.1	-6.0	46.1	54.0	-7.9

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 38.8 dB(µV)/m measured at a distance of three-meter for 384 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna horizontally polarized. That is –7.2 dB relative to the limit of 46 dB(µV)/m at three -meter. (no duty cycle correction can be applied to QP or Pk data)

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@3M	margin dB
07, 40, 73 / 384	QP	V	33.8	46.0	-12.2
07, 40, 73 / 384	QP	H	38.8	46.0	-7.2
07 / 2707.88	Pk	H	55.9	74.0	-18.1
07 / 9026.25	Pk	V	55.6	74.0	-18.4
40 / 9150	Pk	V	55.0	74.0	-19.0
40 / 9150	Pk	H	55.0	74.0	-19.0
73 / 2782.13	Pk	H	54.4	74.0	-19.6
73 / 9273.8	Pk	V	54.4	74.0	-19.6

915 PC Card –6 radio within 6110 hand held terminal placed horizontal

with Fractal dipole mobile computer antenna (see appendix G, 010416G1.xxx, for the data spreadsheets)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 55.3 dB(µV)/m measured at a distance of three-meter for 1805.25 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 49.3 dB(µV)/m. That is –4.7 dB relative to the limit of 54 dB(µV)/m at three -meter.

AVERAGE EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
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
07 / 1805.25	H	55.3	-6.0	49.3	54.0	-4.7
07 / 2707.88	V	53.1	-6.0	47.1	54.0	-6.9
40 / 1830.00	H	49.7	-6.0	43.7	54.0	-10.3
40 / 2745.00	V	54.0	-6.0	48.0	54.0	-6.0
73 / 2782.13	V	52.3	-6.0	46.3	54.0	-7.7
73 / 2782.13	H	54.2	-6.0	48.2	54.0	-5.8

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 57.9 dB(µV)/m measured at a distance of three-meter for 2782.125 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna horizontally polarized. That is –16.1 dB relative to the limit of 74 dB(µV)/m at three -meter. (no duty cycle correction can be applied to QP or Pk data)

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@3M	margin dB
07, 40, 73 / 384	QP	V	27.6	46.0	-18.4
07, 40, 73 / 384	QP	H	28.7	46.0	-17.3
07 / 1805.25	Pk	H	56.0	74.0	-18.0
07 / 2707.88	Pk	V	56.1	74.0	-17.9
40 / 2745	Pk	V	55.5	74.0	-18.5
40 / 9150	Pk	H	54.9	74.0	-19.1
73 / 2782.13	Pk	V	55.6	74.0	-18.4
73 / 2782.13	Pk	H	57.9	74.0	-16.1

915 PC Card –6 radio within 6110 hand held terminal placed vertically

with Fractal dipole mobile computer antenna (see appendix G, 010416G1.xxx, for the data spreadsheets)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 57.0 dB(µV)/m measured at a distance of three-meter for 12205 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 51.0 dB(µV)/m. That is –3.0 dB relative to the limit of 54 dB(µV)/m at three -meter.

AVERAGE EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
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
07 / 2707.88	V	52.7	-6.0	46.7	54.0	-7.3
07 / 2707.88	H	54.5	-6.0	48.5	54.0	-5.5
40 / 2745.00	V	50.6	-6.0	44.6	54.0	-9.4
40 / 2745.00	H	55.4	-6.0	49.4	54.0	-4.6
73 / 2782.13	H	57.0	-6.0	51.0	54.0	-3.0
73 / 6491.63	H	48.8	-6.0	42.8	54.0	-11.2

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 58.7 dB(µV)/m measured at a distance of three-meter for 2782.125 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna horizontally polarized. That is –15.3 dB relative to the limit of 74 dB(µV)/m at three-meter. (no duty cycle correction can be applied to QP or Pk data)

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@3M	margin dB
07, 40, 73 / 384	QP	V	28.4	46.0	-17.6
07, 40, 73 / 384	QP	H	27.9	46.0	-18.1
07 / 2707.88	Pk	H	56.4	74.0	-17.6
07 / 9026.25	Pk	V	55.0	74.0	-19.0
40 / 2745.00	Pk	H	56.9	74.0	-17.1
40 / 6405.00	Pk	H	55.2	74.0	-18.8
73 / 2782.13	Pk	H	58.7	74.0	-15.3
73 / 6491.63	Pk	H	53.8	74.0	-20.2

915 PC Card –6 radio within 6110 hand held terminal placed horizontally

with Fractal patch mobile computer antenna (see appendix G, 010416G1.xxx, for the data spreadsheets)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 55.2 dB(µV)/m measured at a distance of three-meter for 1830.00 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna vertically polarized. Applying the 6 dB duty cycle correction the emissions are 49.2 dB(µV)/m. That is –4.8 dB relative to the limit of 54 dB(µV)/m at three-meter.

AVERAGE EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
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
07 / 1805.25	V	54.4	-6.0	48.4	54.0	-5.6
07 / 2707.88	H	55.1	-6.0	49.1	54.0	-4.9
40 / 1830.00	V	55.2	-6.0	49.2	54.0	-4.8
40 / 1830.00	H	51.1	-6.0	45.1	54.0	-8.9
73 / 1854.75	V	52.3	-6.0	46.3	54.0	-7.7
73 / 2782.13	H	50.8	-6.0	44.8	54.0	-9.2

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 57.2 dB(µV)/m measured at a distance of three-meter for 22320 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna horizontally polarized. That is –16.8 dB relative to the limit of 74 dB(µV)/m at three-meter. (no duty cycle correction can be applied to QP or Pk data)

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@3M	margin dB
07, 40, 73 / 384	QP	V	27.4	46.0	-18.6
07, 40, 73 / 384	QP	H	29.0	46.0	-17.0
07 / 1805.25	Pk	V	55.1	74.0	-18.9
07 / 2707.88	Pk	H	57.2	74.0	-16.8
40 / 1830.00	Pk	V	56.0	74.0	-18.0
40 / 9150.00	Pk	H	53.4	74.0	-20.6
73 / 9273.8	Pk	V	55.3	74.0	-18.7
73 / 9273.8	Pk	H	55.3	74.0	-18.7

915 PC Card –6 radio within 6110 hand held terminal placed vertically

with Fractal panel mobile computer antenna (see appendix G, 010416G1.xxx, for the data spreadsheets)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 56.4 dB(µV)/m measured at a distance of three-meter for 2707.875 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 50.4 dB(µV)/m. That is –3.6 dB relative to the limit of 54 dB(µV)/m at three-meter.

AVERAGE EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
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
07 / 1805.25	V	52.8	-6.0	46.8	54.0	-7.2
07 / 2707.88	H	56.4	-6.0	50.4	54.0	-3.6
40 / 1830.00	H	52.1	-6.0	46.1	54.0	-7.9
40 / 2745.00	H	52.3	-6.0	46.3	54.0	-7.7
73 / 1854.75	H	52.3	-6.0	46.3	54.0	-7.7
73 / 2782.13	H	50.4	-6.0	44.4	54.0	-9.6

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 57.8 dB(µV)/m measured at a distance of three-meter for 2707.875 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna horizontally polarized. That is –16.2 dB relative to the limit of 74 dB(µV)/m at three-meter. (no duty cycle correction can be applied to QP or Pk data)

QUASI-PEAK AND PEAK EMISSIONS

Highest emissions observed for this radio/terminal and antenna configuration.
Complete data is contained in the Spreadsheet Appendix or file attachments

Ch. / MHz	Detector QP or Pk	Meas. Polarity	dB(uV)/M	limit dB(uV)/M@3M	margin dB
07, 40, 73 / 384	QP	V	28.7	46.0	-17.3
07, 40, 73 / 384	QP	H	27.6	46.0	-18.4
07 / 2707.88	Pk	H	57.8	74.0	-16.2
07 / 9026.25	Pk	H	53.9	74.0	-20.1
40 / 2745.00	Pk	H	54.3	74.0	-19.7
40 / 9150.00	Pk	V	53.3	74.0	-20.7
73 / 9273.8	Pk	V	54.6	74.0	-19.4
73 / 9273.8	Pk	H	54.6	74.0	-19.4

MEASUREMENT DATA: Observe the appendix F (010416F1.xxx) that shows the transmitter conducted measurements. The appendix G (010416G1.xxx) file attachment spreadsheets show the 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 @ 3 mtr) / 20] anti log = 501.2 µV/m @ 3 mtr

or µV/m to dB(µV)/m

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

These spreadsheets include the calculation for duty cycle de-rating by adding 6 dB to the average limits. De-rating correction is not allowed for the peak and quasi-peak emissions.

54 dB (µV)/m @ 3 mtr + 6 dB (correction) = 60 dB (µV)/m @ 3 mtr

EQUIPMENT: 915 PC Card –6 Radio Module

NAME OF TEST: Frequency and Power Stability Across Voltage

FCC RULE NUMBER: None
CANADA RSS-210 Par.: 6.4

MINIMUM STANDARD:
This test is not required be either the FCC or Industry Canada. It is presented to show the stability of the 915 PC Card –6 radio module. Laptop computers operate from an AC supply or operate on rechargeable batteries. This provides a highly regulated power to operate the 915 PC Card –6 radio. The mobile computers operates from a six-cell batteries of varying make up. Most common are MNiH (metal nickel-hydride) and Nicad (nickel-cadmium). Internal to the Intermec mobile computers is low battery cut-off circuits and voltage regulators to power the microprocessor and support circuitry. The cut-off for low battery does not allow the regulated voltages provided to microprocessors to fall below the 4.75 VDC level. The regulated voltage specified for the 915 PC Card is 5.0 volts +/- 5% from the host computer. The transmitter power as well as frequency stability are presented across the above voltage range. The power shall remain below the limits specified for maximum transmitter power. The operating frequency shall demonstrate stability to remain in-band at all channels of the transmitter.

TEST PROCEDURE:
(1) Using the set-up in figure 5, record the transmitter frequency and power at nominal voltage. Vary the operating voltage across the expected range in 0.05 increments and record the transmitter power and frequency. Perform this test for DC operation across the voltage range of 5.00 +/- 5%.

TEST EQUIPMENT:	Frequency Counter	HP5385A
	Power Meter	Giga-Tronics 8541C
	Attenuator	Narada 4779-10
	Attenuator	Narada 4779-20
	Variable DC Supply	Racal-Dana
	Volt Meter	Fluke 8060A

PERFORMED BY: Robert Kraus Date: June 12, 2001

TEST SET UP: Voltage Stability Set Up

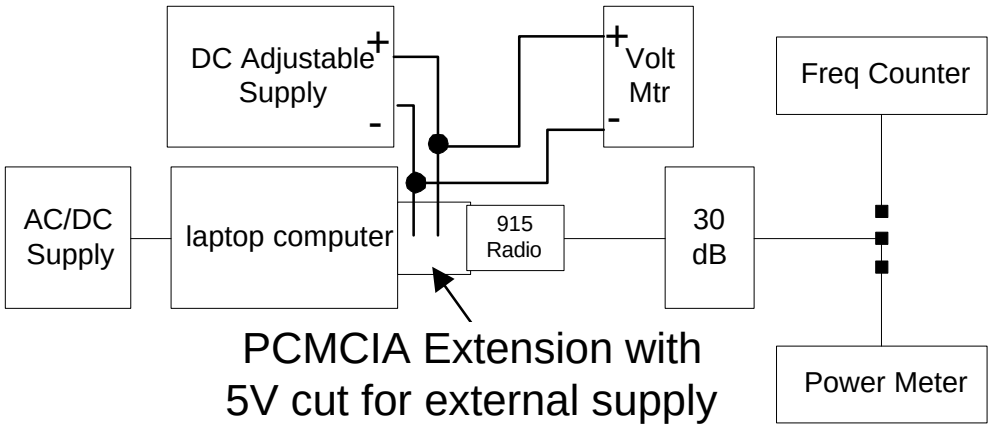


Figure 5.

TEST RESULTS: The 915 PC Card –6 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 +5.0 volts +/- 5% DC, the transmitter frequency and power is unaffected. A change of -0.04 to + 0.00 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 5.00V. The specified range of the radio is 5v +/- 5% or 4.75 to 5.25V.

				Ref Delta	
DCV		MHz	dBm	MHz	dB
5.25		915.046	29.65	0	-0.03
5.20		915.046	29.66	0	-0.02
5.15		915.046	29.67	0	-0.01
5.10		915.046	29.68	0	0.00
5.05		915.046	29.68	0	0.00
ref. 5.00		915.046	29.68	-	-
4.95		915.046	29.68	0	0.00
4.90		915.046	29.67	0	-0.01
4.85		915.046	29.66	0	-0.02
4.80		915.046	29.65	0	-0.03
4.75		915.046	29.64	0	-0.04

EQUIPMENT:	915 PC Card –6 Radio Module
NAME OF TEST:	Receiver Spurious Emissions (radiated)
FCC RULE: CANADA RSS-210 Par.:	15.109 (a) 7.3
MINIMUM STANDARD:	Not Applicable for this radio. The receiver operates simultaneously with the transmitter to read the RFID tag. Any reciever spurious emissions emanating from the radio receiver are measured during transmitter operation. In normal use it is impossible to have only receiver emissions.
TEST PROCEDURE:	Not applicable
TEST EQUIPMENT:	Not applicable
PERFORMED BY:	Dave Fry Date: June 14, 2001
TEST SETUP:	Not applicable
TEST RESULTS:	Not applicable

EQUIPMENT: 915 PC Card –6 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

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.

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

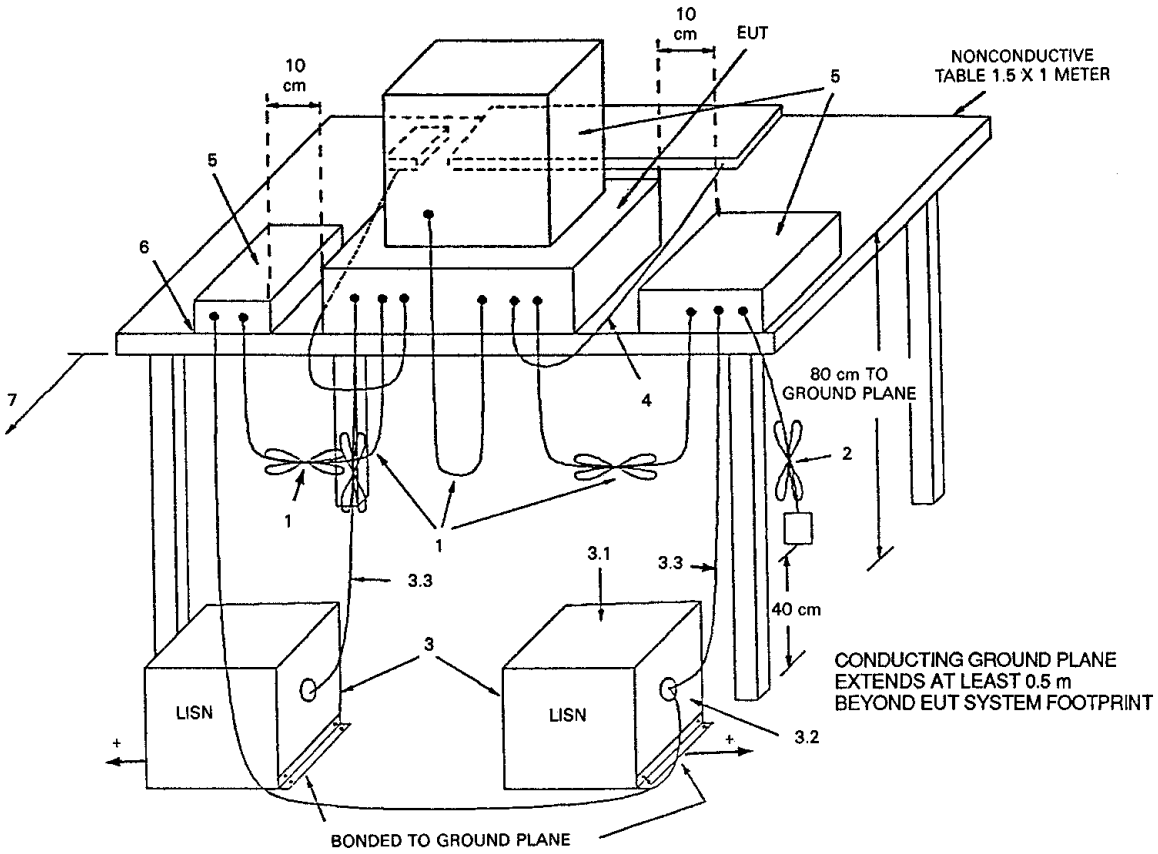
For FCC and Industry Canada, testing was performed within a shield room, setup as described in ANSI C63.4-1992 section 5.2. The EUT was powered by single phase 120 Volts ~ 60 Hz AC power. 230 Volt operation was tested using 50 Hz AC power.

Environmental conditions at the time of testing were a temperature 21 C and relative humidity of 35 %.

TEST EQUIPMENT:	LISN	EMCO 3825/2R
	LISN	Rohde & Schwarz, ESH3.Z5
	Receiver	Rohde & Schwarz, ESH3
	Spectrum Analyzer	HP 8591A

PERFORMED BY: Dave Fry Date: June 7 and 12, 2001

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	Frequency (MHz)	120 VAC 60 Hz Line Side	Spec Limit	Max. TX Emission dB (uV)	TX Em. Margin to Limit dB
Laptop / 915 PC Card –6 radio	0.778	L1	FCC-IC	40.7	-7.3
Laptop / 915 PC Card –6 radio	0.778	N	FCC-IC	40.2	-7.8
6110 / 915 PC Card –6 / charger	0.474	L1	FCC-IC	28.8	-19.2
6110 / 915 PC Card –6 / charger	0.482	N	FCC-IC	26.6	-21.4

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.

Detailed set-up photographs are in appendix B (010416B1.xxx)

AC Wireline Conducted Emissions, 915 PC Card –6 radio module when powered by laptop. See appendix H (010416H1.xxx) showing the spectrum of the peak emissions. The final QP emissions is compared toe her FCC/Industry Canada limit of 48 dB(µV).

AC Wireline Conducted Emissions, 915 PC Card –6 radio module operated with a 6110 on charge. See appendix H (010416H1.xxx) showing the spectrum of the peak emissions. The final QP emissions is compared toe her FCC/Industry Canada limit of 48 dB(µV).

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: 915 PC Card –6 Radio Module

NAME OF TEST: RF Exposure Safety

FCC RULE NUMBER: 1.1307 (b)(1) references 2.1093(b)(2)
specific absorption rate (‘‘SAR’’)

(2) Limits for General Population/Un-controlled exposure: 0.08 W/kg as aver-aged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (de-fined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). General Population/Uncontrolled limits apply when the general public may be exposed, or when persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or do not exercise control over their exposure. Warning labels placed on consumer devices such as cellular telephones will not be sufficient reason to allow these devices to be evaluated subject to limits for occupational/controlled exposure in paragraph (d)(1) of this section.

CANADA RSS-210 Par.: 14.0 (see RSS-102)
CANADA RSS-102
The following specific absorption rate (SAR) limits are reproduced here from Health Canada's Safety Code 6 requirements. The SAR shall meet the following limits: (a) Limits for General Population/Uncontrolled exposure: 0.08 W/kg as averaged over the whole body and spatial peak SAR not exceeding 1.6 W/kg, averaged over any one gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles, where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube).

MINIMUM STANDARD: Summarized within the rules sections above.

PERFORMED BY: CellTech Research Date: May 28-30, 2001
See Appendix N (010416N1.xxx) for CellTech reports for the two 6110 antennas and the three remote antennas used with laptop computers or other devices that support operation of PC cards.

RESULTS:

Mobile Computer Usage

The 915 PC Card –6 spread spectrum transmitter is utilizes two lower gain antennas at the top of the unit. The normal operation keeps the operator as well as nearby persons greater than the 5-cm spacing to comply with the RF exposure requirements.

Tests show compliance for hand exposure levels during normal operation for scanning packages, laundry and pallets. The user must enable the transmitter to read or write the tags. In the event no tags respond to interrogation the transmitter shuts off. The transmitter must be pointed in the direction of objects with RFID tags for the transmitter to remain in operation.

During normal operation the operator intent is to interrogate RFID tags on items. Normal operation directs the reader antenna away from the user and nearby persons. Making the operator aware of the potential for exposure the warning statement below will be included with the information to the user.

WARNING: per the FCC and Canada RF (radio frequency) exposure requirements,

(1) Only the antenna supplied and installed with this unit by Intermec Technologies is to be used with this hand held terminal. The product is configured to ensure compliance to FCC and Canada RF exposure requirements.
(2) The user shall not touch the terminal top (antenna) and is to remain 5-cm (2 of and inches) from the front of the antenna while the transmitter is in use.

Stationary Usage with High Gain Antennas

The 915 PC Card –6 spread spectrum transmitter when combined with the high gain antennas presented in this report creates a RF exposure greater than outlined by the limits when the operator or nearby persons allow their body less than 4-cm from the antenna during operation. The higher exposure for extremities outlined in the regulations would be more typical for normal usage. Installation instructions will highlight antenna placements that will limit the user and nearby persons to RF exposure.

Tests show compliance for body exposure levels with installations where the operator remains greater than 4-cm from the antenna. During normal operation for scanning packages, laundry and pallets the operator's body will not normally be within 4-cm of the antennas.

The user must enable the transmitter to read or write the tags. In the event no tags respond to interrogation the transmitter shuts off. The transmitter must be pointed in the direction of objects with RFID tags for the transmitter to remain in operation.

During normal operation the operator intent is to interrogate RFID tags on items. Installation according to the Intermec Users Guide direct the reader antenna away from the user and nearby persons. Making the operator aware of the potential for exposure the warning statement below will be included with the information to the user.

WARNING: RFID 915 PC Card
Warning: per the FCC and Canadian RF (radio frequency) exposure requirements,

(1) Antennas must be supplied and installed as recommended by Intermec Technologies to ensure compliance to RF exposure requirements. Intermec antenna part number(s) 805-589-001, 805-590-001 and 805-591-001. Correct antenna mounting is fully described within the Intermec RFID 915 PC Card Users Guide.
(2) When installing and using Intermec approved remote antennas associated the RFID reader, a 4-cm (1.5-inch) passing distance must be maintained from any body part of the user or near by persons and the remote antenna. The antenna must not be touched during transmitter operation.
(3) Cables attached to the remote antennas must have a minimum length as provided from Intermec to insure the proper losses to control RF exposure.

8.0 EQUIPMENT LIST

EQUIPMENT	MFG/MODEL	SERIAL NO.	CAL. DATE	CYCLE
Antenna, bi-conical	EMCO 3110	1185	9/00	12 Mo.
Antenna, log periodic	EMCO 3146	1262	9/00	12 Mo.
Antenna, DRG horn	EMCO 3115	2246	1/00	12 Mo.
Antenna, DRG horn	EMCO 3116	9311-2215	1/00	16 Mo.
Attenuator	HP 8491-20 dB	36824	5/00	12 Mo.
Attenuator	Narda 4779-10 10dB	9401	9/00	12 Mo.
Attenuator	Narda 4779-20 20dB	9401	9/00	12 Mo.
Frequency Counter	HP 5385A	2436A01265	9/00	12 Mo.
High Pass Filter	Cir-Q-Tel R9H-1G5/10G-28A	01	5/00	12 Mo.
High Pass Filter	K&L 13SH01-3000/T24000	01	5/00	12 Mo.
LISN	Rhode & Schwarz ESH3-Z5	832479/018	8/00	12 Mo.
LISN	EMCO 3825/2R	1026	10/00	12 Mo.
Mixer	HP 11970K	3003A05374	12/00	24 Mo.
Plotter	HP 7470A	2308A27380	On Req.	
Power Meter	Giga-Tronics 8541C	1834227	9/00	12 Mo.
Power Supply	Racal-Dana DC Supply	N/A	On Req.	
Preamplifier	HP 8449B	3008A00439	5/01	24 Mo.
Preamplifier	HP 11975A	2738A01994	2/00	12 Mo.
Pulse Limiter	Rhode & Schwarz ESH3-Z2	007-6977	9/00	12 Mo.
Receiver	Rohde & Schwarz ESH3	872318/050	3/01	12 Mo.
Receiver	Rohde & Schwarz ESVP	879674/046	1/01	12 Mo.
RF Preselector	HP 85685A	3221A01427	8/00	12 Mo.
Signal Generator	HP 83630A	3250A00322	3/00	24 Mo.
Spectrum Analyzer	HP 8566B	2637A03549	12/00	12 Mo.
Spectrum Analyzer	HP 8591A	3144A02470	1/01	24 Mo.
Voltmeter	Fluke 8060A	4995347	4/01	16 Mo.

On Req. = On Request N/A = Not Available