Intermec
Technologies Corporation
EMC Test Laboratory
Cedar Rapids, IA

MEASUREMENT/TECHNICAL REPORT

Intermec Technologies Corporation
RM915L Legacy Radio
915 MHz Spread Spectrum Transmitter

REPORT NO: 040525-1

DATE: May 25, 2004

This report concerns: Original Grant _____ Class II Change ____X____

CE: This device has shown compliance with the conducted emissions limits in 15.107, 15.207, or 18.307 adopted under FCC 02-157 (ET Docket 98-80). The device may be marketed after July 11, 2005, and is not affected by the 15.37(j) or 18.123 transition provisions.

Equipment Type: 902-928 MHz Direct Sequence Spread Spectrum Transceiver,
FCC 15.247
Industry Canada RSS-210 Issue 5, RSS-102 Issue 1

Report for new power amplifier IC continues to show compliance.

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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SECTION NUMBER

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
15.207, 15.107	6.6, 7.4/3.2	AC Line Conducted Emissions, TX, RX
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®

NVLAP LAB CODE 100269-0

Accredited by the National Institute of Standards and Technology, National Voluntary Laboratory Accreditation Program.

The scope of accreditations addressed in this report is limited to NVLAP codes:
[12/FCC15b] ANSI C63.4 (2001) with FCC Method - 47 CFR Part 15, Subpart B: Unintentional Radiators
[12/FCC15c] ANSI C63.4 (2001) with FCC Method - 47 CFR Part 15, Subpart C: Intentional Radiators
[12/T51] AS/NZS CISPR 22 (2002) and AS/NZS 3548 (1997) Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment
*[12/RSS210]*RSS-210, Issue 5 (November 2001)Low Power Licence-Exempt Radiocommunication Devices
[12/RSS210a] RSS-210, Issue 5, Amendment 2 (April 26, 2003)

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

EMC 017

Interference Technology International

Dave Fry — Date 07-09-04
Dave Fry — mm/dd/yy
NCE, EMC Engineer III

Signature — Date
Signature — mm/dd/yy

Print Name and Title

CERTIFIED NARTE ENGINEER

National Association of Radio and Telecommunications Engineers

1.1 Measurement Uncertainties:

ESI 40 Receiver / Spectrum Analyzer

Radiated Emissions on 3 Meter Open Area Test Site

30-300 MHz	has an Expanded Measurement Uncertainty of + 3.04 -3.99 dB
200-1000 MHz	has an Expanded Measurement Uncertainty of + 4.59 -3.01 dB
1-5 GHz without pre-amp	has an Expanded Measurement Uncertainty of + 2.99 -2.93 dB
1-5 GHz	has an Expanded Measurement Uncertainty of + 3.16 –3.11 dB
5-18 GHz	has an Expanded Measurement Uncertainty of + 3.20 –3.15 dB

AC Line Conducted Emissions

0.15-30 MHz	has an Expanded Measurement Uncertainty of + 0.59 -0.44 dB

Generator Substitution Radiated Measurements Using the 3 Meter Open Area Test Site

30-50 MHz	has an Expanded Measurement Uncertainty of + 2.94 -2.98 dB
50-1000 MHz	has an Expanded Measurement Uncertainty of + 2.85 -2.86 dB
1-12.5 GHz	has an Expanded Measurement Uncertainty of + 2.76 -2.81 dB

Receiver and Transmitter Conducted, Generator Substitution Measurements with
HP83630A RF Generator and ESI 40 Receiver / Spectrum Analyzer

50-7000 MHz	has an Expanded Measurement Uncertainty of + 0.88 -0.88 dB
7- 20 GHz	has an Expanded Measurement Uncertainty of + 1.01 -1.02 dB
20-26.5 GHz	has an Expanded Measurement Uncertainty of + 1.23 -1.27 dB
26.5-40 GHz	has an Expanded Measurement Uncertainty of + 1.55 -1.63 dB

Receiver and Transmitter Direct Measurements of Conducted Emissions with
ESI 40 Receiver / Spectrum Analyzer

9 kHz-5 GHz	has an Expanded Measurement Uncertainty of + 0.56 -0.56 dB
5-7 GHz	has an Expanded Measurement Uncertainty of + 0.74 -0.75 dB
7-20 GHz	has an Expanded Measurement Uncertainty of + 1.16 -1.18 dB
20-26.5 GHz	has an Expanded Measurement Uncertainty of + 1.40 -1.46 dB
26.5-40 GHz	has an Expanded Measurement Uncertainty of + 1.73 -1.88 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

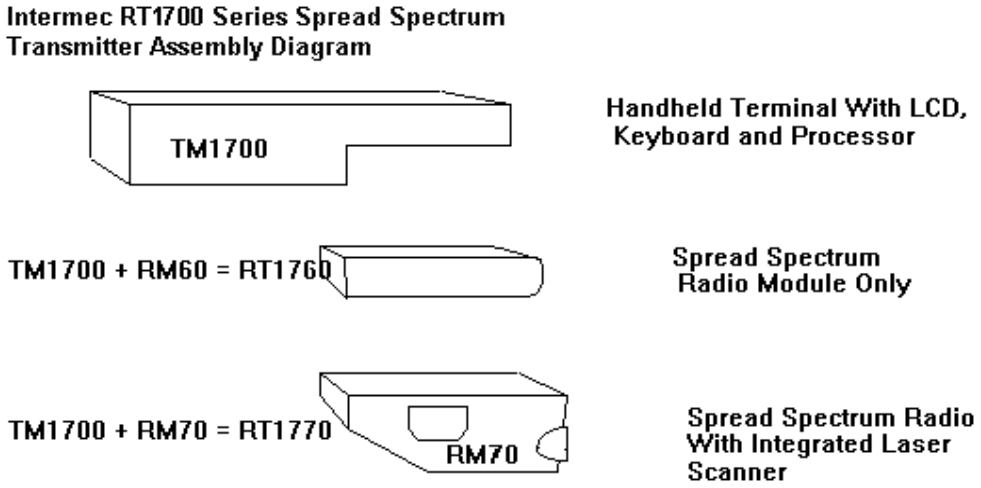
2.1 Product Description

This report addresses a Class II Permissive Change for the FCC ID: EHARM915L radio (Falcon). The radio modulator integrated circuit (IC) U84 is no longer available therefore a substitute device is shown in this report. The data represented within shows the radio continues to exhibit the same modulation content, transmitter power and spurious emissions. The results show lower margins of compliance than the radio as originally filed with the FCC and Industry Canada. This report shows the margins for the modified radio.

The radio remains a 902-928 MHz direct sequence spread spectrum (DSSS) transmitter that Intermec Technologies Corporation uses in the (older) legacy version portable terminals for real time inventory control in the warehouses and commercial environment.

The original testing showed the radio configuration representing the worst case system for emissions is the RM70. The only data collected herein is representative of the RM70.

The RM70 represents the fully optioned module that integrates a laser scanner within the plastic case of the unit. The RM60 radio module is a non-scanning unit. The radio boards and radio shield remain the same in the RM60, RM70 and RT5960.



This radio has 3 operating modes, 2 modes are full 902-928 MHz spectrum usage (modes 1 and 3), and the last mode (mode 2) is channeled with channels approx. 5 MHz wide. These modes are manually selected and set by the site survey personal for that site. The channeled mode also has digital masking that allows 2 systems to operate on the same channel without interference to either system (modes 2a and 2b).

2.1 Product Description, continued

Mode	data rate kbps	channels / freq. available
1	225	1 / 902-928 MHz
2a	90	7 / 907.5, 910, 912.5, 915, 917.5, 920, 922.5 MHz
2b	90	7 / 907.5, 910, 912.5, 915, 917.5, 920, 922.5 MHz
3	450	1 / 902-928 MHz

This PC board relay out will eliminate the cut and jumper modification to substitute the modulator IC. The measurement data for this report is collected from modified production radios within production version RT1700.

The final product is globally marketing, where the 902-928 MHz transmitter is allowed, therefore must comply to the CISPR 22 (EN55022) Class B digital emissions. The Intermec, Cedar Rapids, EMC Test Lab has perform testing for compliance for digital emissions to the CISPR 22 Class B limits and issue separate reports addressing the integration in Intermec products. Based on these tests and reports the Class B Declaration of Conformity is used for United States marketing. Canada will accept a self-declaration for compliance to ICES-003.

2.2 Related Submittal(s)/Grants(s)
Original Grant FCC ID: EHARM915L Date: August 28, 1996

Industry Canada IC 1008 102 269 5 17 Date: 1996-12-27
Models: RM60, RM70, RM70LR, RM70VIN and RT5960

2.3 Tested Systems Details Items tested:

Model Number (Serial Number)	FCC ID:	Description	Cable Description
RM70 PN: 705-382-005/002 SN: Prototype	EHARM915L	902-928 MHz DSSS with laser scanner decal folded dipole ant.	N/A
TM1700 terminal PN: 225-493-021/003 SN: 3106267	DoC	terminal module	external battery eliminator attached
NC1100 PN: 851-022-001 SN: Not Available	-	Charger 120VAC 60 Hz Wall-wart AC-DC	2 meter unshielded

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; 4.1 Instrumentation, 4.2 Measurement Bandwidths, 5.3 Test Method, 5.17, Digital Circuits Emissions, 5.18 Modular Construction, 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 internal test software of the RT1700 with the 902-928 MHz spread spectrum transmitter radio assembly is capable of operating the radio continuously in either transmit or receive modes.

The radio operates in 3 modes. Modes 1 and 3 are full 902-928 MHz. Mode 1 sends data at 225 kbps and mode 3 is 450 kbps. Both modes use the same chipping rate. Mode 2 is a 5 MHz channel that sends 90 kbps data rate; this mode uses a slower chipping rate than modes 1 and 3.

Data to be presented on alternate antennas will be the following:

Mode	channel	portable unit placement
2b	low	vertical and horizontal
3	middle	vertical and horizontal
2b	high	vertical and horizontal

Testing for all modes would be very time consuming as well as produce a large amount of test data as testing is required for both the average limit an peak emissions limit. In addition some of the legacy units/antennas are portable and therefore are being tested with the unit placed vertically, horizontally and then sideways.

I had a FCC Engineer comment on their willingness to accept this test method for showing the worst modes on alternate antennas without testing all modes for transmitter radiated emissions.

Gregory Czumak (FCC Engineer) verbal response summary May 1, 1996;
As mode 1 and 3 have the highest chipping rates and mode 3 transmits the highest data rate use mode 3 for all center channel testing. Mode 2 is a narrower transmitter mode; use the lowest and highest channels to show characteristics at the ends of the available spectrum.

Transmitter Radiated and Conducted Emissions

Radiated tests to be performed on mode 3 for the center channel and mode 2 low and high channels. Conducted emissions needs run from 0 to 10 GHz in the same modes.

All transmitter radiated emissions measurements were made with the transmitter operating at a 100% duty cycle. The 100% duty cycle data is presented on the spreadsheets that calculate the emissions to the limit.

This data contained with the transmitter radiated emissions section of this report.

Details on the de-rating calculation for duty cycle are included in the transmitter radiated emissions test section of the original report. Portions of the original report will be repeated for clarification.

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 section of the radio is not altered.

Where possible ANSI C63.4, 1992 is referenced during radiated emissions testing. Details on measurement equipment, set-up, test details and calculations are presented within the 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 10 Hz. 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 diagrams and test setup figures in section 8.0 for details.

2.5 TEST FACILITY:

The location of the open area test site and conducted measurement facility used to collect the test data is 90 West Cemetery Road, Fairfax, Iowa 52228. The laboratory is accredited with a scope covering the required measurements and was deemed competent to test and submit test data for equipment subject to verification, Declaration of Conformity, and certification under FCC Section 2.948(d).
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 for methods of measurements for radiated and conducted emissions testing.

3.0 PHOTOGRAPHS

- 3.1 External pictures appendix A
- 3.2 Internal pictures appendix B
- 3.3 Test setup pictures appendix C

4.0 PRODUCT LABELING AND INFORMATION TO THE USER

4.1 PRODUCT LABELING

Remains as originally filed.

4.2 INFORMATION TO THE USER

Remains as originally filed.

5.0 THEORIES OF OPERATION

Remains as originally filed.

6.0 BLOCK DIAGRAM

Remains as originally filed.

7.0 SCHEMATICS

Proprietary Intermec Technologies document. Confidentiality requested for this document. See appendix F. 040525F1.xxx

8.0 CONDUCTED AND RADIATED EMISSIONS TEST DATA

The following tests and results are recorded within this section.

Peak Output Power

Out of Band Emissions, Transmitter Conducted and Radiated

AC Wireline Conducted Emissions

RF Safety, Exposure Limits

EQUIPMENT: RM915L Radio Module

NAME OF TEST: Peak Power Output

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

(3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. (

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

Output Power and EIRP Limits

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. However, remote stations of point-to-multipoint systems shall be permitted to operate at the point-to-point EIRP limit provided that the higher EIRP is achieved by employing higher gain directional antennas and not higher transmitter output powers.

TEST PROCEDURE:

Note: The RM915L 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) Setup the test as in figure 2.

(2) Set DC supply to +7.5 volts. Activate the transmitter on the low channel, 907.5 MHz, and record the peak output power observed on the power meter.

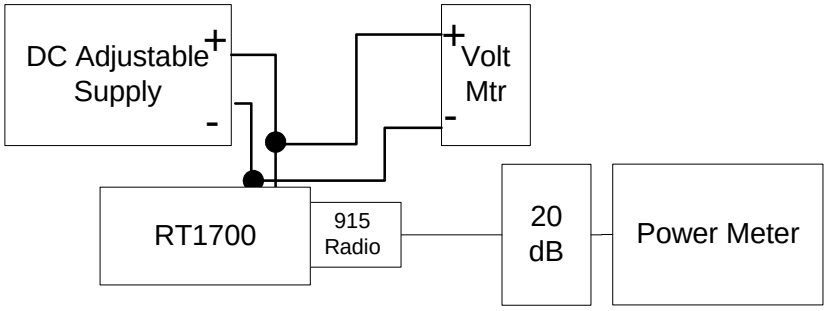
(3) Repeat 1 and 2 using the middle and high channels, 915.000 and 922.5 MHz.

TEST EQUIPMENT:

	Power Meter	Giga-Tronics 8541
	Attenuator	HP 8491-20 dB
	DC Supply	HP6200A
	Voltmeter	Fluke 77

PERFORMED BY: Dave Fry Date: June 21, 2004

SET UP:



TX Power

Figure 2.

TEST RESULTS:
Conforms. The transmitter has transmitter peak power of 335 milliwatts. This is 665 milliwatts below the 1-watt limit. The power measured for this particular radio is to be considered typical for most of the radios manufactured.

MEASUREMENT DATA:

Conducted measurement at the antenna connector. Voltage +7.50

Freq. / Channel	Power Meter Reading (W)	Power (dBm)	Limit (W)	Margin below 1 Watt Limit (Watts)
907.5 MHz / Ch. 11	0.2619	24.182	1.0	0.7381
915.0 MHz / Ch. 26	0.3099	24.912	1.0	0.6902
922.5 MHz / Ch. 41	0.3354	25.255	1.0	0.6646

EQUIPMENT: RM915L 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 in band spectral density, or shall not exceed the levels specified in Table 3, whichever is less stringent. **Note:** For frequency hopping systems, the in band 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	20.2 dB
In-band peak measured	-5.5 dBm
Calculated in-band power	+14.7 dBm
Limit	-20.0 dB
Limit	+5.3 dBm

2. Using the setup diagramed in figure 3, record the conducted emissions of the transmitter. Sweep the in-band emissions on a 26 MHz span centered on 915.000 MHz using 100 kHz video and resolution bandwidths. Enable the end channels as needed with modulation and recording the peak of each channel to the highest emission. Perform a peak search and set the highest emission as the reference level on the spectrum analyzer display.

3. 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 as needed with modulation and recording the delta from the peak of each channel to the highest emission outside the allowable band. The spectrum analyzer best shows the limit for the near-band plots by setting the display line -20 dB down from the in band peak. Display line F1 and F2 to show 902 and 928 MHz band edges.

4. 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 3. Plot and identify the limits and band edges. Repeat steps 1-4 showing all operating modes of the transmitter and end channels as needed to show compliance for the near band emissions.

5. Complete plotting the transmitter out of band emissions by showing the following spans. 0-2.5, 2.5-5 and 5-10 GHz. Identify any emissions observed above the measurement noise floor. Indicate the limit on each plot by keeping the reference and display line at the same settings while creating these plots.

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 from 1 – 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
	Attenuator	HP 8491-20 dB
	Receiver	Rohde & Schwarz ESI-40
	Microwave amplifier	HP 8449B
	DC Supply	HP6200A
	Voltmeter	Fluke 77

PERFORMED BY: Dave Fry Date: June 22-24, 2004

SET UP:

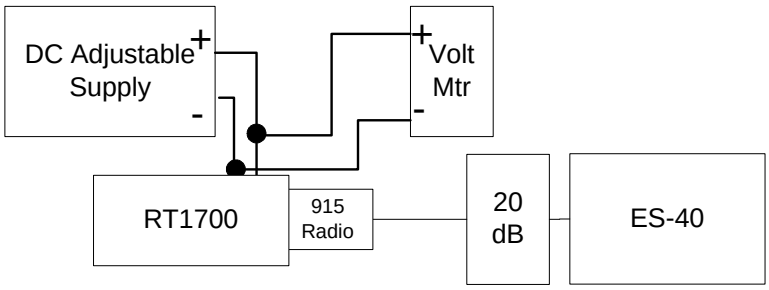
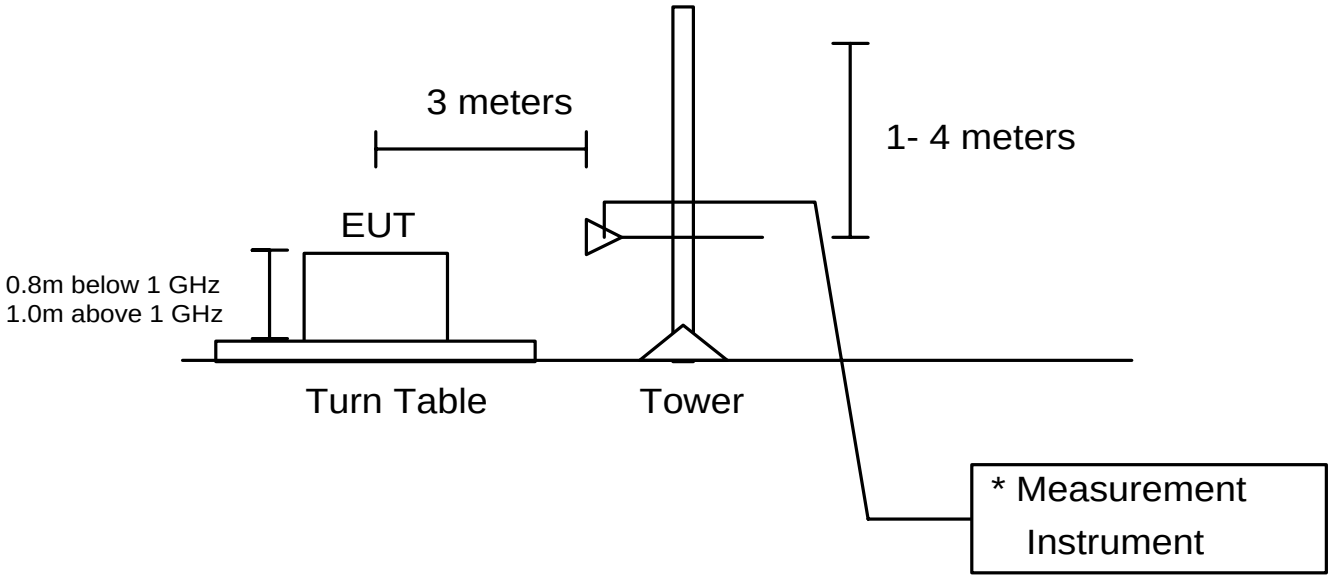


Figure 3.

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 C (040525C1.xxx) for placement RM915L radio.



* 30-1000 MHz, Rohde & Schwarz ESI-40 receiver or
1-10 GHz, R&S ESI-40 with preamplifier and high-pass filter

TEST RESULTS: Transmitter radiated emissions conform.

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 25% duty cycle, or -6 dB. The 25% de-rating is a conservative figure, duty cycles for operation is nearer the 20-22% 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 23%. Plots showing the transmitter duty cycle on and oscilloscope are in the original report 960422-1, 577-500-603. The calculated emissions reduction for this radio is 12 dB based on the calculation for a 25% duty cycle.

the TX time within 0.1 second period = 0.023, or 23 %

the calculation for de-rating for a 23% is shown below:

(1dB@100% x 0.23 log) 20 = -12.8 dB de-rating for 23% in dB

Applying the same formula for a 25% duty cycle results in a -12.0 dB de-rating for the AVERAGE emissions when measured at 100% duty cycle and measurement taken in dB(µV) (microvolts).

The original application used (1dB@100% x .023 log) 10 = de-rating (dB) or –6.4 dB. Rounded to (1dB@100% x .025 log) 10 = de-rating (dB) or –6 dB.

The spreadsheet data appendix E 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.

To show modular compliance the antenna data presented shows the radio on an unshielded plastic cased unit placed vertically, then data is collected with the radio placed horizontally and once again with the unit on its side. (See setup photographs in appendix A.)

RM915L radio vertically (x axis)

RT1700 and RM70 with decal antenna (see appendix E, 040525E1.xxx, for the data spreadsheets)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 65.9 dB(µV)/m measured at a distance of three-meters for 5445 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna vertically polarized. Applying the 12 dB duty cycle correction the emissions are 53.9 dB(µV)/m. That is –0.1 dB relative to the limit of 54 dB(µV)/m at three-meters.

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	25% dB(uV)/M	limit dB(uV)/M @1M	margin dB
11 / 5445	V	65.9	-12.0	53.9	54.0	-0.1
11 / 5445	H	64.1	-12.0	52.1	54.0	-1.9
26 / 2745	V	49.1	-12.0	37.1	54.0	-16.9
26 / 3660	H	50.1	-12.0	38.1	54.0	-15.9
41 / 8303	V	46.8	-12.0	34.8	54.0	-19.2
41 / 8303	H	45.9	-12.0	33.9	54.0	-20.1

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 73.4 dB(µV)/m measured at a distance of three-meters for 5490 MHz. The emissions was observed during testing of the unit placed vertically and the measurement antenna vertically polarized. That is –0.6 dB relative to the limit of 74 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 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
11 / 836.5	QP	H	38.2	48.0	-9.8
11 / 851.5	QP	H	36.5	48.0	-11.5
11 / 5445	Pk	V	72.5	74.0	-1.5
11 / 5445	Pk	H	72.4	74.0	-1.6
26 / 5490	Pk	V	73.4	74.0	-0.6
26 / 5490	Pk	H	69.0	74.0	-5.0
41 / 5535	Pk	V	72.0	74.0	-2.0
41 / 5535	Pk	H	68.8	74.0	-5.2

RM915L radio horizontal (y axis)

RT1700 and RM70 with decal antenna (see appendix E, 040525E1.xxx, for the data spreadsheets)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 65.5 dB(µV)/m measured at a distance of three-meters for 5445 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna horizontally polarized. Applying the 12 dB duty cycle correction the emissions are 53.5 dB(µV)/m. That is –0.5 dB relative to the limit of 54 dB(µV)/m at three-meters.

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	25% dB(uV)/M	limit dB(uV)/M @1M	margin dB
11 / 5445	V	62.9	-12.0	50.9	54.0	-3.1
11 / 5445	H	65.5	-12.0	53.5	54.0	-0.5
26 / 3660	V	52.1	-12.0	40.1	54.0	-13.9
26 / 3660	H	49.4	-12.0	37.4	54.0	-16.6
41 / 3690	V	47.4	-12.0	35.4	54.0	-18.6
41 / 8303	H	46.8	-12.0	34.8	54.0	-19.2

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 73.7 dB(µV)/m measured at a distance of three-meters for 5445 MHz. The emissions was observed during testing of the unit placed horizontally and the measurement antenna horizontally polarized. That is –0.3 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
11 / 836.5	QP	H	42.0	48.0	-6.0
11 / 851.5	QP	H	38.9	48.0	-9.1
11 / 5445	Pk	V	71.6	74.0	-2.4
11 / 5445	Pk	H	73.7	74.0	-0.3
26 / 5490	Pk	V	72.2	74.0	-1.8
26 / 5490	Pk	H	73.4	74.0	-0.6
41 / 5535	Pk	V	71.1	74.0	-2.9
41 / 5535	Pk	H	70.4	74.0	-3.6

RM915L radio sideways (z axis)

RT1700 and RM70 with decal antenna (see appendix E, 040525E1.xxx, for the data spreadsheets)

The highest AVERAGE field strength of the out of band transmitter radiated emissions is 65.1 dB(µV)/m measured at a distance of three-meters for 5445 MHz. The emissions was observed during testing of the unit placed sideways and the measurement antenna vertically polarized. Applying the 12 dB duty cycle correction the emissions are 53.1 dB(µV)/m. That is –0.9 dB relative to the limit of 54 dB(µV)/m at three-meters.

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	25% dB(uV)/M	limit dB(uV)/M @1M	margin dB
11 / 5445	V	65.1	-12.0	53.1	54.0	-0.9
11 / 5445	H	62.8	-12.0	50.8	54.0	-3.2
26 / 3660	V	46.2	-12.0	34.2	54.0	-19.8
26 / 3660	H	51.3	-12.0	39.3	54.0	-14.7
41 / 3690	H	48.9	-12.0	36.9	54.0	-17.1
41 / 8303	V	46.8	-12.0	34.8	54.0	-19.2

The highest Quasi-Peak or PEAK field strength of the out of band transmitter radiated emissions relative to the limit is 73.7 dB(µV)/m measured at a distance of three-meters for 5445 MHz. The emissions were observed during testing of the unit placed sideways and the measurement antenna vertically polarized. That is –0.3 dB relative to the limit of 74 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 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
11 / 836.5	QP	V	38.9	48.0	-9.1
11 / 851.5	QP	V	37.9	48.0	-10.1
11 / 5445	Pk	V	73.7	74.0	-0.3
11 / 5445	Pk	H	71.4	74.0	-2.6
26 / 5490	Pk	V	73.7	74.0	-0.3
26 / 5490	Pk	H	71.1	74.0	-2.9
41 / 5535	Pk	V	71.9	74.0	-2.1
41 / 5535	Pk	H	68.2	74.0	-5.8

MEASUREMENT DATA: The appendix E (040525E1.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 12 dB to the average limits. De-rating correction is not allowed for the peak and quasi-peak emissions.

54 dB (µV)/m @ 3 mtr + 12 dB (correction) = 66 dB (µV)/m @ 3 mtr

EQUIPMENT: RM915L 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 § 15.207 Conducted limits.
(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that 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 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz) Conducted limit (dBμV)

	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

Canada RSS-210 6.6, 7.4 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).
(b) Transmitters marketed for use only in a commercial, industrial or business environment and not intended for use in homes are permitted a limit of 1000 microvolts (0.45 - 1.705 MHz) and 3000 microvolts (1.705 - 30 MHz).

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 pre-scan 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.

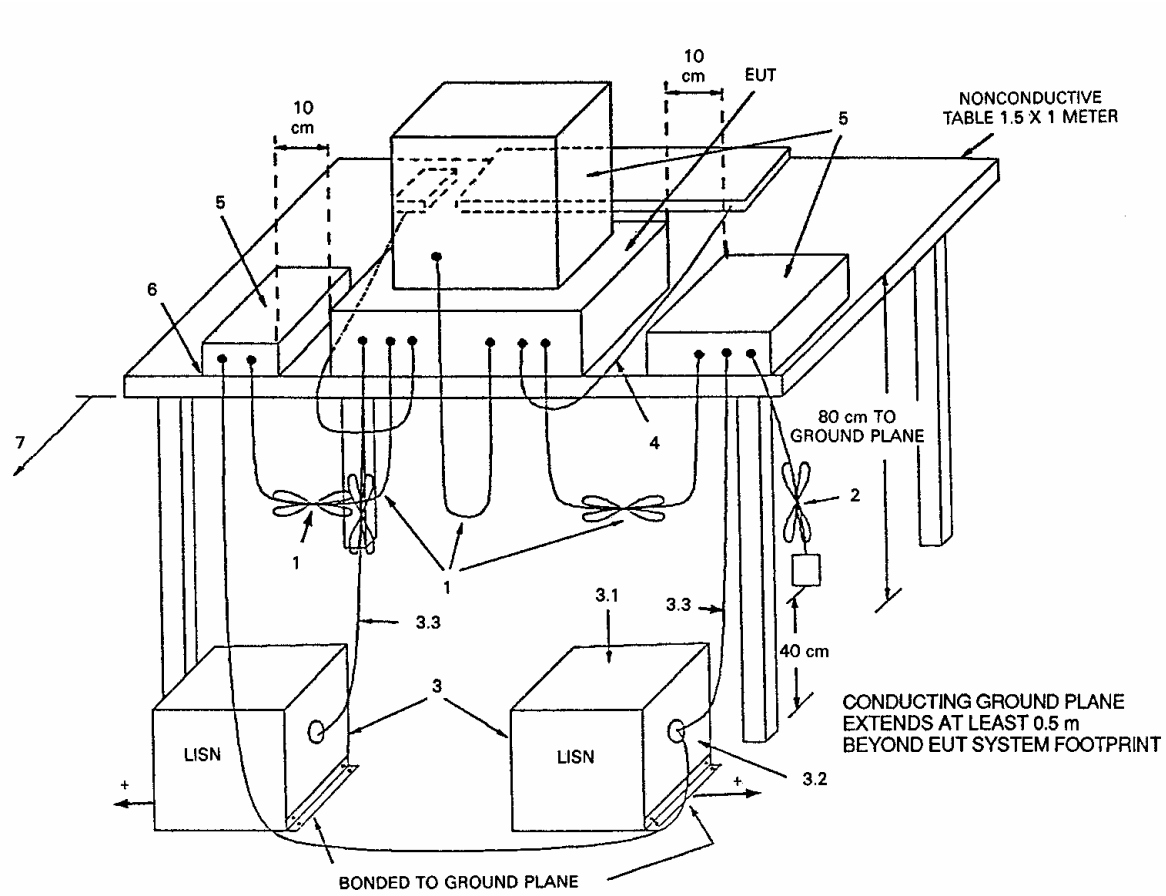
General and Environmental Conditions

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 25 C, pressure 30.1 inches and relative humidity of 43 %.

TEST EQUIPMENT:	LISN	Rohde & Schwarz, ESH3.Z5
	EMI Test Receiver	Rohde & Schwarz, ESI-40
PERFORMED BY:	Dave Fry	Date: June 30, 2004

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.

MEASURED DATA: Judgment: For FCC testing; Passed by -20.5 dB of margin. Calculations were made at 0.174 MHz with the corrected QP level of 44.30 dBuV. This then is subtracted from the limit of 64.80 dBuV.

Unless otherwise noted, all final measurements are made using an average or quasi-peak detector and a 9 kHz measurement bandwidth with the data being compared to the CISPR quasi-peak and average limit.

Conducted Emission Measurement Data

CISPR Average Data Compared to CISPR Average Class B Limit.
CISPR Quasi-Peak Data Compared to CISPR Quasi-Peak Class B Limit.
120 VAC, 60 Hz
Conducted emissions results obtained with a Rohde and Schwarz LISN.

MEASUREMENT RESULT: "CE L1_fin AV"

6/30/04 2:02PM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.174000	11.50	-0.10	54.80	43.20	L1	GND
0.294000	9.20	0.10	50.40	41.30	L1	GND
0.330000	8.90	0.00	49.50	40.50	L1	GND
6.762000	-3.40	0.20	50.00	53.40	L1	GND
28.680000	-4.60	0.00	50.00	54.60	L1	GND

MEASUREMENT RESULT: "CE L1_fin QP"

6/30/04 2:02PM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.174000	44.30	-0.10	64.80	20.50	L1	GND
0.252000	40.50	0.00	61.70	21.20	L1	GND
0.330000	38.00	0.00	59.50	21.50	L1	GND
4.212000	-0.70	0.20	56.00	56.70	L1	GND
29.826000	7.70	0.00	60.00	52.30	L1	GND

MEASUREMENT RESULT: "CE N_fin AV"

6/30/04 2:12PM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.204000	12.30	-0.10	53.50	41.20	N	GND
0.282000	9.90	0.10	50.80	40.90	N	GND
0.360000	6.90	0.00	48.70	41.80	N	GND
0.468000	4.70	0.00	46.50	41.90	N	GND
4.620000	-4.20	0.30	46.00	50.20	N	GND
29.820000	-1.20	0.30	50.00	51.20	N	GND

MEASUREMENT RESULT: "CE N_fin QP"

6/30/04 2:12PM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.162000	43.40	-0.10	65.40	22.00	N	GND
0.240000	41.30	0.00	62.10	20.80	N	GND
0.360000	37.40	0.00	58.70	21.40	N	GND
0.684000	23.30	0.10	56.00	32.70	N	GND
4.692000	-0.70	0.30	56.00	56.70	N	GND
16.752000	-0.20	0.20	60.00	60.20	N	GND
29.340000	6.10	0.30	60.00	53.90	N	GND

CALCULATIONS AND CONVERSION FACTORS:

The conducted emissions are calculated using the following. The receiver reading is added to the correction factor "Transd (dB)" (includes LISN insertion loss, RF cable loss and filter loss (if used)) to create “Level (dBµV)”. The “LIMIT” is subtracted from “Level” to show "Margin". Margin will be displayed as a positive margin below the limit.

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: RM915L Radio Module

NAME OF TEST: RF Exposure Safety

FCC RULE NUMBER: **§ 1.1310 Radiofrequency radiation exposure limits.**

The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in § 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of § 2.1093 of this chapter. Further information on evaluating compliance with these limits can be found in the FCC's OST/OET Bulletin Number 65, ''Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation.''

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f^2)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f^2)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density
NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/ controlled limits apply provided he or she is made aware of the potential for exposure.
NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be ex-posed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

§ 2.1091 Radiofrequency radiation exposure evaluation: mobile devices.

(a) Requirements of this section are a consequence of Commission responsibilities under the National Environmental Policy Act to evaluate the environmental significance of its actions. See subpart I of part 1 of this chapter, in particular § 1.1307(b).

(b) For purposes of this section, a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20-centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. In this context, the term ''fixed location'' means that the device is physically secured at one location and is not able to be easily moved to another location. Transmitting devices designed to be used by consumers or workers that

can be easily relocated, such as wireless devices associated with a personal computer, are considered to be mobile devices if they meet the 20-centimeter separation requirement.

CANADA RSS-210 Par.: 14.0 (see RSS-102)

CANADA RSS-102

4.2 Exemption power levels for portable radios are: - Operation at frequencies below 1.0 GHz with an output power equal to or less than 200 milliwatts (mW); - Operation at frequencies between 1.0 and 2.2 GHz with an output power equal to or less than 100 mW.

4.3 Mobile radios (not portables, see 2.2 for definition) are exempt from RF evaluation if the operating frequency is below 1.5 GHz with effective radiated power (ERP) of 1.5 watts or less (i.e. EIRP of 2.5 watts or less) or above 1.5 GHz with ERP of 3 watts or less (i.e. EIRP of 5 watts or less).

Exposures produced by such radios shall not exceed the exposure limits (see section 3 below) specified in Health Canada's Safety Code 6. Health Canada's address is 775 Brookfield Road, Ottawa, Ontario Canada K1A 1C1; Tel: (613) 954-6699/ Fax: (613) 941-1734; e-mail: alice_mackinnon@hc-sc.gc.ca.

HEALTH CANADA SAFETY CODE 6, 99-EHD-237

Table 5
Exposure Limits for Persons Not Classed As RF and Microwave Exposed Workers (Including the General Public)

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m^2)	5 Averaging Time (min)
0.003–1	280	2.19		6
1–10	$280/f$	$2.19/f$		6
10–30	28	$2.19/f$		6
30–300	28	0.073	2*	6
300–1 500	$1.585f^{0.5}$	$0.0042f^{0.5}$	$f/150$	6
1 500–15 000	61.4	0.163	10	6
15 000–150 000	61.4	0.163	10	$616\,000/f^{1.2}$
150 000–300 000	$0.158f^{0.5}$	$4.21 \times 10^{-4}f^{0.5}$	$6.67 \times 10^{-5}f$	$616\,000/f^{1.2}$

* Power density limit is applicable at frequencies greater than 100 MHz.
Notes: 1. Frequency, f, is in MHz.
2. A power density of 10 W/m^2 is equivalent to 1 mW/cm^2.
3. A magnetic field strength of 1 A/ m corresponds to 1. 257 microtesla (μT) or 12. 57 milligauss (mG).

MINIMUM STANDARD: Summarized within the rules sections above.

PERFORMED BY: Dave Fry Date: July 8, 2004

CALCULATION DATA: Observe the appendix G (040525G1.xxx) that shows the transmitter RF exposure calculations.

WARNING STATEMENTS TO THE USER:

Mobile Computer Usage

The RM915L spread spectrum transmitter RM60 and RM70 utilize two lower gain antennas at the top of the unit. The normal operation keeps the operator as well as nearby persons greater than the 20-cm spacing to comply with the RF exposure requirements.

Calculations show compliance for RF exposure levels during normal operation for scanning. The user initiates transmitter operation when data is entered or scanned. The access point may poll the radios within range the response from the computer terminal is very brief.

During normal operation the operator intent is to laser scan labels on items or enter data on the keyboard. Normal operation directs the radio 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 computer 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 20-cm (8 of and inches) from the antenna while the transmitter is in use.

Mobile Usage with High Gain Antennas

The RM915L spread spectrum transmitter when combined with the RT5960 vehicle mount unit uses higher gain antennas presented in the original report. 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.

Calculations show compliance for body exposure levels with installations where the operator remains greater than 20-cm from the antenna.

Installation according to the Intermec Users Guide directs the radio 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: RT5960
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 805-472-001. Correct antenna mounting is fully described within the Intermec RT5960 Users Guide.
(2) When installing and using Intermec approved antennas associated the RT5960 fork-truck terminal, a 20-cm (8-inch) passing distance must be maintained from any body part of the user or near by persons and the antenna. The antenna must not be touched during transmitter operation.

9.0 EQUIPMENT LIST

EQUIPMENT	MFG/MODEL	SERIAL NO.	CAL. DATE	CYCLE
Antenna, dipole	EMCO 3121C	9812-1414	03/03	24 Mo
Antenna, biconical	EMCO 3110B	1787	09/03	12 Mo
Antenna, log periodic	EMCO 3146	1262	09/03	12 Mo
Antenna, biconical	EMCO 3110B	1185	09/03	12 Mo
Antenna, log periodic	EMCO 3146	3277	09/03	12 Mo
Antenna, DRG Horn	EMCO 3115	4143	06/03	12 Mo
Attenuator	HP 8491-20 dB	36824	05/04	12 Mo.
EMI Test Receiver	Rohde & Schwarz, ESI-40	1088.7490.40	06/04	12 Mo
High Pass Filter	Cir-Q-Tel R9H-1G5/10G-28A	01	05/04	12 Mo.
Power Supply	HP6200A	N/A	On Req.	
Power Meter	Giga-Tronics 8541	010618569	04/04	12 Mo.
Preamplifier	HP 8449B	3008A00439	05/03	24 Mo.
Signal Generator	HP 83630A	3250A00322	04/04	24 Mo.
Voltmeter	Fluke 77	007-2153	12/03	16 Mo.
Test Automation SW	Rohde & Schwarz, ES-K1 V1.6	2492	12/03	N/A

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