DATARADIO COR Ltd.
Corporate Headquarters and Manufacturing Operations
299 Johnson Avenue, Suite 110
Waseca, MN 56093-0833 USA
Phone: 507-833-8819 Fax: 507-833-6748

FCC Part 15.247 Certification Application
for FCC ID: NP4-242-5099-100

Industry Canada RSS 210 Application

Test Report
And Technical Documentation
For Dataradio COR Ltd.
HiPR-900™
Frequency Hopping Wireless Modem

AFFIDAVIT

The technical data included in this report has been accumulated through tests that were performed by me or by engineers under my direction. To the best of my knowledge, all of the data is true and correct.

Mark Christensen
Director of Product Development, Dataradio COR Ltd.

Table of Contents

Dataradio COR Ltd.
Waseca, Minnesota

Engineering Statement of Matthew Schellin:

The application consisting of the attached engineering exhibit and associated FCC form 731 has been prepared in support of a request for Certification. Certification is requested for the Dataradio COR Ltd (DRL) HiPR-900 Frequency-hopping Spread-spectrum Wireless Modem. The assembled unit will be marketed under the model name HiPR-900 and identified by the FCC number **NP4-242-5099-100** and DRL part# 242-5099-100. The HiPR-900 frequency-hopping spread-spectrum wireless modem operates pursuant to FCC Part(s) 15.247 of the Rules and Regulations.

EXISTING CONDITIONS

The units utilized for these Certification measurements were obtained from prototypes. The transceiver is designed to operate on frequencies ranging from 902 MHz to 928 MHz. The frequency tolerance of the transceiver is .00010% or 1.0 part per million. The frequency stability of the transceiver is controlled by a temperature compensated crystal oscillator (TCXO) operating at 16.0 MHz.

PROPOSED CONDITIONS

It is proposed to certify the HiPR-900, 902-928 MHz wireless modem for operation in the band of frequencies previously outlined. The applicant anticipates marketing the device for use in wireless transmission of data.

PERFORMANCE MEASUREMENTS

All Certification measurements were conducted in accordance with the Rules and Regulations Section 15.247 from the FCC web side updated 2/9/05. FCC Public Notice docket DA 00-705 titled Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems dated March 30, 2000 was also used as a reference guide.

Industry Canada measurements were conducted in accordance with the Rules and Regulations of RSS-210, Issue 5 dated November 2001.

Equipment performance measurements were made in the engineering laboratory and on the FCC certified Open Area Test Site at Dataradio COR Ltd., located at 299 Johnson Avenue in Waseca, Minnesota (FCC Reg num: 152034, IC Reg num: IC 5573). All measurements were made and recorded by myself or under my direction. The performance measurements were made between February 9, 2005 and April 14, 2005.

CONCLUSION

Given the results of the measurements contained herein, the applicant requests that Certification be granted for the HiPR-900, 902-928 MHz wireless modem as tested for data communications.

________________________________ April 14, 2005
Matthew Schellin
Electrical Engineer II, Dataradio COR Ltd.

1 Qualifications of Engineering Personnel

NAME:	**Charles M. Pollock III**
TITLE:	Principal Engineer (Dataradio COR Ltd.)
TECHNICAL EDUCATION:	BSEE University of Arizona 1984
TECHNICAL EXPERIENCE:	20 years experience in analog and radio frequency communications.

NAME:	**Matthew Schellin**
TITLE:	Electrical Engineer II (Dataradio COR Ltd.)
TECHNICAL EDUCATION:	Bachelor of Science Degree in Electrical Engineering (2000) from Minnesota State University, Mankato.
TECHNICAL EXPERIENCE:	4.5 years experience in analog and radio frequency communications.

NAME:	**Constantin Pintilei**
TITLE:	R&D Test Engineer (DATARADIO Inc.)
TECHNICAL EDUCATION:	Bachelor of Science Degree in Radiotechnique Electronic Engineering (1993) Technical University of Iasi, Romania.
TECHNICAL EXPERIENCE:	12 Years experience in radio frequency measurements.

2 GENERAL INFORMATION

The following report has been generated for FCC Certification of the Dataradio 902-928 MHz wireless modem, part number 242-5099-100. Unless otherwise noted, all of the measurements were conducted following the procedures set forth in the TIA/EIA-603 standards.

MODEL NUMBER:	HiPR-900
PART NUMBER:	242-5099-100
MANUFACTURER:	Dataradio COR Ltd., Waseca, MN 56093 DATARADIO Inc., Town of Mount Royal, Quebec, Canada, H4P 1H7
FCC ID NUMBER:	NP4-242-5099-100
RULES AND REGS:	FCC Part (s) 15.247 Industry Canada RSS-210
FREQUENCY RANGE:	902.000 MHz – 928.000 MHz
SERIAL NUMBER (S):	PLT2 B-001
MAXIMUM POWER RATING:	1.00 Watts (.1 to 1 watt variable)
MODULATION TYPE:	2/4-FSK
NUMBER OF CHANNELS:	51 Channel Modem
INPUT IMPEDANCE:	50 ohms, Nominal
VOLTAGE REQUIREMENTS:	10-30 VDC or IEEE 802.3af Power-over-Ethernet (PoE)

EQUIPMENT IDENTIFICATION:

TRADE NAME	DESCRIPTION	DRI PART NUMBER
Transceiver	902-928 MHz RF Transceiver	023-5099-310
HiPR-900	Modem/Controller	255-03453-002
HiPR-900	Transceiver/Modem	242-5099-100

3 Test Facilities

The following tests:

15.247(c)	Spurious Radiation Emissions
15.205	Restricted Bands of Operation

were performed at:

FCC certified Open Area Test Site
Dataradio COR Ltd.
299 Johnson Avenue, Suite 110
Waseca, MN 56093-0833

FCC Reg num: 152034
IC Reg num: IC 5573

All other testing was performed:

Engineering laboratory
Dataradio COR Ltd.
299 Johnson Avenue
Waseca, MN 56093

4 Antenna Compliance

4.1 Antenna Requirement

FCC Rule: 15.203
IC Rule: 5.5

FCC Docket DA 00-705 description:

Describe how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT. The exception is in those cases where the EUT must be professionally installed. In order to demonstrate that professional installation is required, the following three points must be addressed: (a) the application (or intended use) of the EUT, (b) the installation requirements of the EUT, and (c) the method by which the EUT will be marketed.

Description of compliance:

This product must be professionally installed so compliance with the unique antenna connector or a permanently attached antenna is not required.

To demonstrate that professional installation is required, the following three points have been addressed:

(a) the application (or intended use) of the EUT
The HiPR-900 is intended to be used in the SCADA & Data Acquisition market. The HiPR-900 will be professionally installed within an enclosure along with other professionally installed equipment, such as a RTU, etc.

(b) the installation requirements of the EUT
The professional installer is responsible for ensuring Radiation Exposure Limits and EIRP (36 dBm) limits are not exceeded.

(c) the method by which the EUT will be marketed.
The method in which the unit will be sold is direct sales to system installers.

4.2 External Radio Frequency Power Amplifiers and Antenna Modifications

FCC Rule: 15.204
IC Rule: 5.8

Docket DA 00-705 description:

External power amplifiers are prohibited. The following information for the highest gain of each type of antenna proposed for use with the EUT is provide below:

(a) type (e.g., Yagi, patch, grid, dish, etc.)
(b) manufacturer and model number
(c) gain with reference to an isotropic radiator.

Type	Manufacturer	Part Number	Gain (dBi)
Yagi	Maxrad	BMOY8903	8.5
Omni Directional	Maxrad	MFB 9153	5.1
Directional Panel	Maxrad	MP8066	8.1
Whip	Maxrad	MEXR-902-BN	2.5

5 Test Results

5.1 Carrier Frequency Separation

FCC Rule: 15.247(a)(1)
IC Rule: 6.2.2(o)(a1)

Specification: 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.

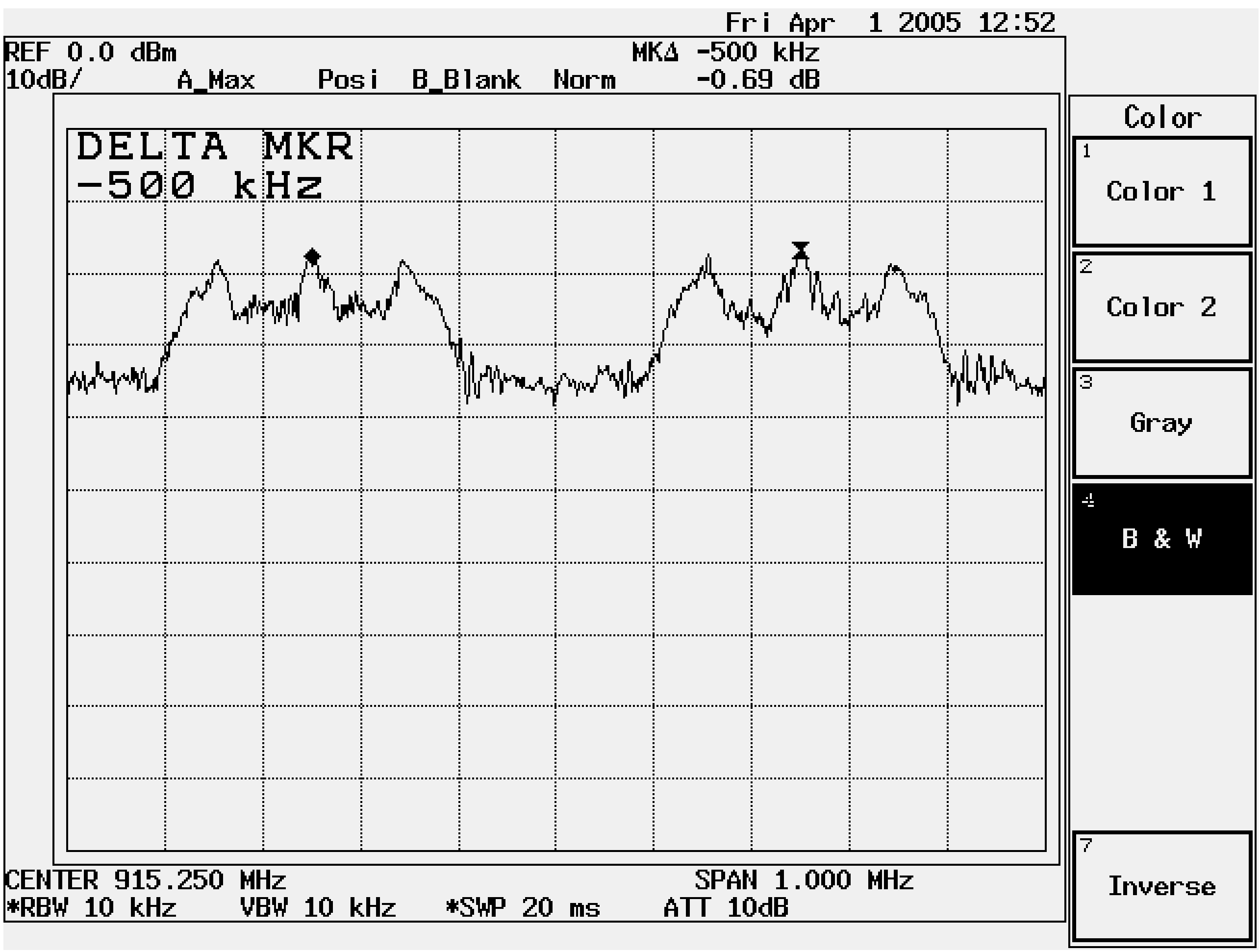
Test Equipment: Advantest R3162 Spectrum Analyzer

Procedure:

Span = 1 MHz
RBW = 10 kHz
VBW = RBW
Sweep = auto
Detector function = peak
Trace = max hold

Trace was allowed to stabilize. Using the marker-delta function the separation between the peaks of the adjacent channels was determined.

Results: Carrier Frequency Separation = 500 kHz (Maximum 20dB BW = 500 kHz)



5.2 20 dB Bandwidth

FCC Rule: 15.247(a)(1)
IC Rule: 6.2.2(o)(a1)

Specification: The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Equipment: Agilent Spectrum Analyzer

Procedure:

Span = 1 MHz
RBW = 5.1 kHz
VBW = auto
Sweep = auto
Detector function = peak
Trace = max hold

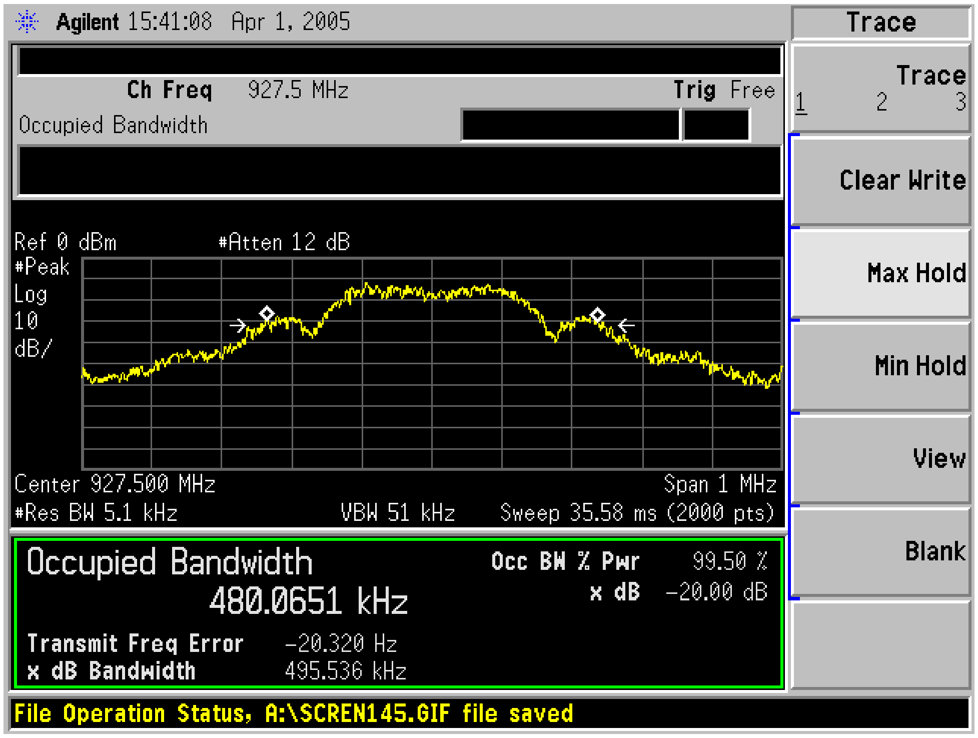
The HiPR-900 was transmitting random data at its maximum data rate at 256 kbps and 512 kbps. Measurements were performed at the high end of the band, 927.5 MHz. The trace was allowed to stabilize. The 20dB bandwidth was found by setting the Occupied Band Width (OBW) function of the spectrum analyzer at 99.5%. See following plots.

Results (See following plots):

Plot	Bit Rate	20 dB BW
1	256 kbps	480kHz
2	512 kbps	482kHz

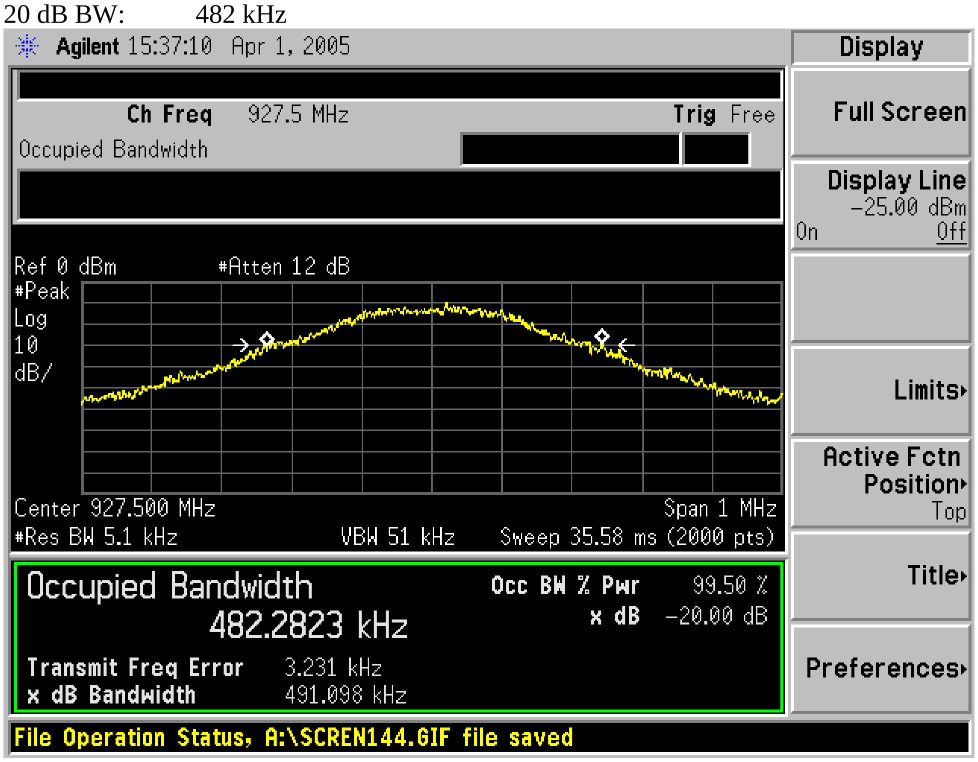
Plot 1

Bit Rate: 256 kbps
20 dB BW: 480 kHz



Plot 2

Bit Rate: 512 kbps
20 dB BW: 482 kHz



5.3 System Receiver Input Bandwidth

FCC Rule: 15.247(a)(1)
IC Rule: 6.2.2(o)(a1)

Specification: 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.

Results: The maximum 20 dB Bandwidth is 500 kHz, The transmit bandwidth is 488 kHz and the receiver IF bandwidth is similar, which complies with section 15.247(a)(1) of the FCC rules and section 6.2.2(o)(a1) of the IC rules. A single system with one master and multiple remotes will have the same System ID for all units; hence all units will be synced to the same channel at any given time.

5.4 Number of Hopping Frequencies

FCC Rule: 15.247(a)(1)(i)
IC Rule: 6.2.2(o)(a2)

Test Equipment: Advantest R3162 Spectrum Analyzer

Number of Hopping Frequencies: 51

Specification: If the 20 dB BW of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies; if the 20 dB BW of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.

Procedure:
The RF band from 902 – 928 MHz has a 500kHz guard band on each end and the remaining spectrum (902.5-927.5MHz) is used for hopping. These frequencies are divided into 51 (500kHz) channels.

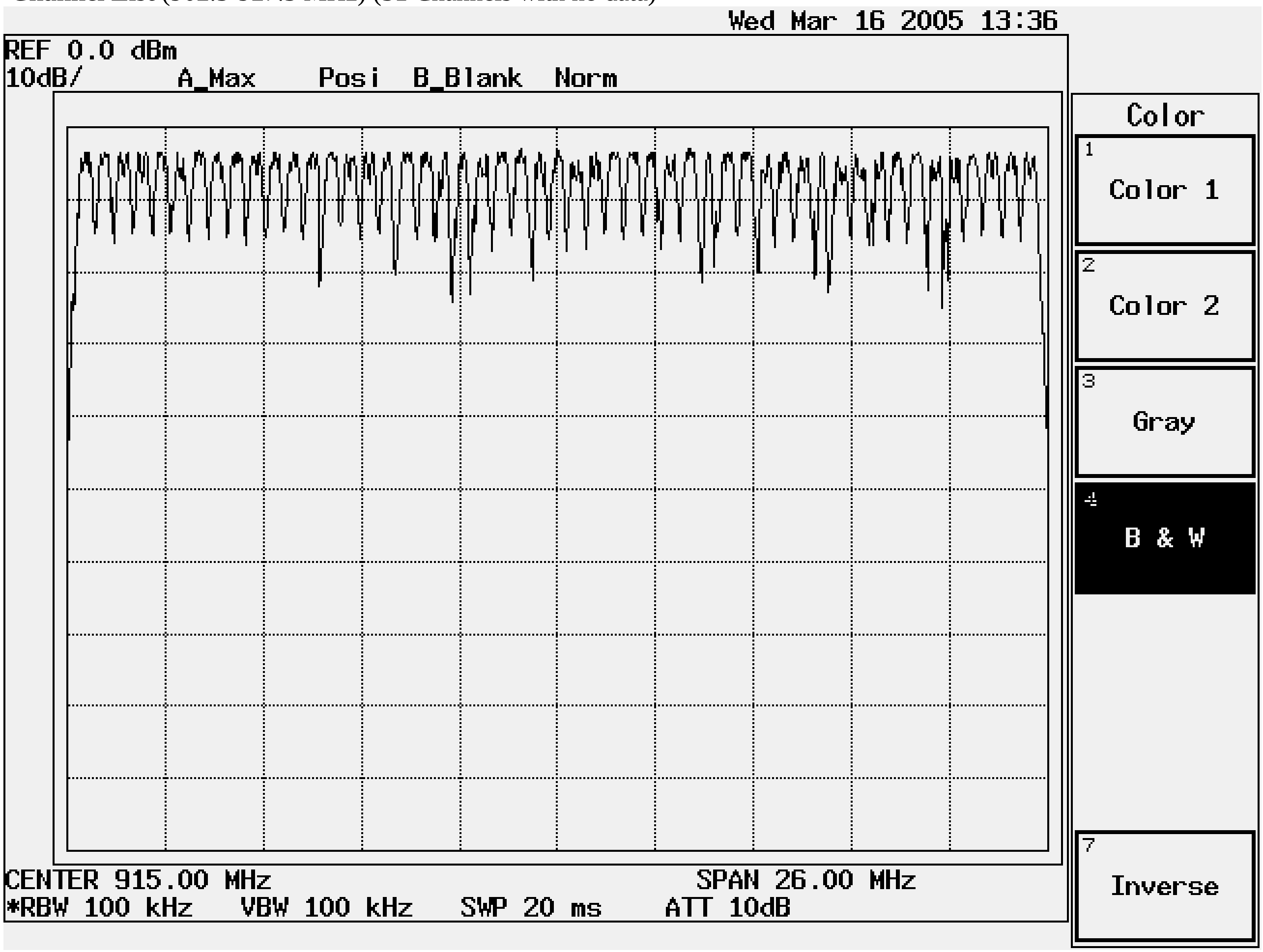
Nothing will prevent two or more remotes, with the same System ID, from transmitting on the same frequency if they transmit at the same time. The units have no internal algorithms that can or will allow for coordination with other transmitters. Multiple transmitters can have different System ID codes, which differentiates the pseudo random sequence but does not guarantee avoidance of simultaneous occupancy of individual hopping frequencies.

Below is a list of channel frequencies.

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	902.50	17	911.00	34	919.50
1	903.00	18	911.50	35	920.00
2	903.50	19	912.00	36	920.50
3	904.00	20	912.50	37	921.00
4	904.50	21	913.00	38	921.50
5	905.00	22	913.50	39	922.00
6	905.50	23	914.00	40	922.50
7	906.00	24	914.50	41	923.00
8	906.50	25	915.00	42	923.50
9	907.00	26	915.50	43	924.00
10	907.50	27	916.00	44	924.50
11	908.00	28	916.50	45	925.00
12	908.50	29	917.00	46	925.50
13	909.00	30	917.50	47	926.00
14	909.50	31	918.00	48	926.50
15	910.00	32	918.50	49	927.00
16	910.50	33	919.00	50	927.50

See following plot of the channel list.

Channel List (902.5-927.5 MHz) (51 Channels with no data)



5.5 Time of Occupancy (Dwell Time)

FCC Rule: 15.247(a)(1)(i)
IC Rule: 6.2.2(o)(a2)

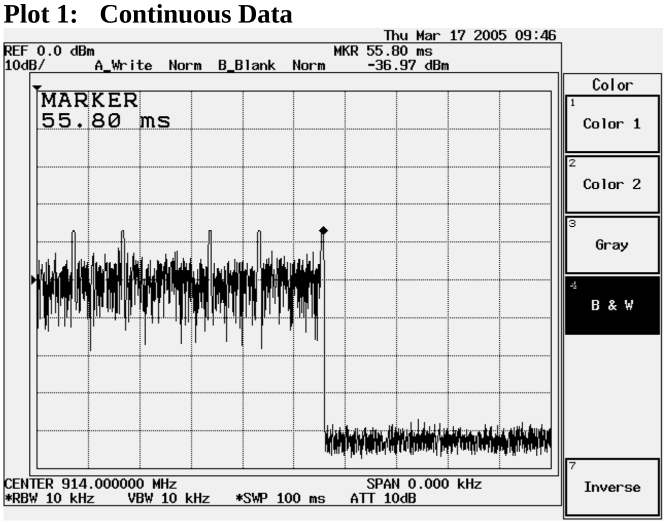
Specification: For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is more than 250 kHz, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

Test Equipment: Advantest R3162 Spectrum Analyzer

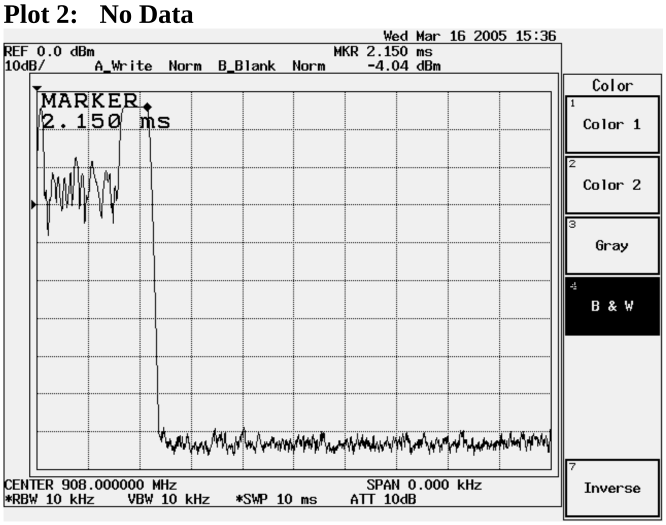
Procedure:
Continuous data was sent to the modem and the dwell time was captured on the Spectrum Analyzer. (see plot 1)
No data was sent to the modem and the dwell time was captured on the Spectrum Analyzer. (see plot 2)
See attachment entitled "Hopping Description" for description of hopping.

Measured Results: Plot 1: Continuous Data: Data plus Sync information = 55.80 ms
Plot 2: No Data (Sync Dwell): 2.15 ms

Plot 1: Continuous Data



Plot 2: No Data



5.6 Peak Output Power

FCC Rule: 15.247(b)(2)
IC Rule: 6.2.2(o)(a2)

Specification: For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels

Test Equipment: HP436A Power Meter

Procedure: The HiPR-900 was set to transmit an unmodulated carrier at each frequency listed below. An HP436A power meter was used to measure the peak power. After correcting for cable loss the following results were obtained.

Circuit Description: A directional coupler senses the forward power and feeds a DC signal to the non-inverting terminal of opamp U550(comparator). The modem sets the reference voltage for the comparator (U550), power out can be adjusted in approximately .5 dB increments. U550 regulates the power control line voltage of the PA (U501, RF2173) maintaining a stable output power over temperature, load and supply voltage. Transistor Q550 protects the control line input of the PA.

Results:

Peak Power Out Vs. Frequency

902.5 MHz	**915 MHz**	**927.5 MHz**
29.95 dBm (989 mW)	29.91 dBm (979 mW)	29.87 dBm (971 mW)

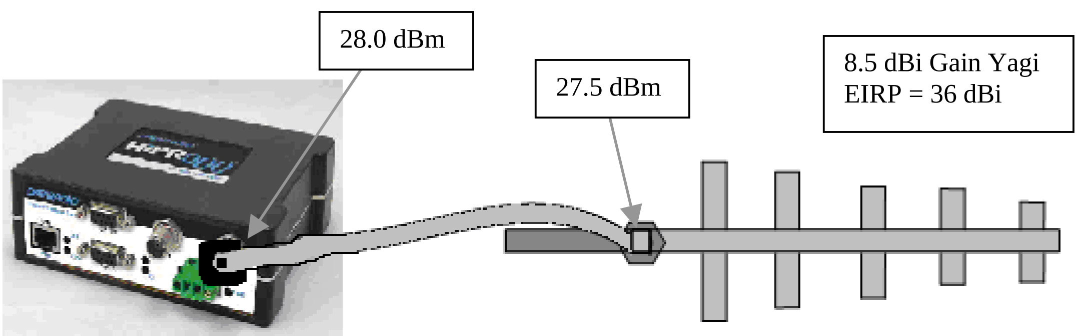
5.7 *De Facto* EIRP Limit

FCC Rule [15.247(b)(3)]: If transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator is reduced below 30 dBm by the amount in dB that the directional gain of the antenna exceeds 6 dBi. Cable loss is taken into account so that the power seen at the antenna input is the lesser of 30 dBm or 36 dBm minus directional gain of antenna in dB. The minimum cable length used would be zero in the instance where the antenna is attached directly to the antenna port without an interconnecting cable. It is the responsibility of the professional system installer to make sure the HiPR-900 is operated in compliance with the FCC rules. The HiPR-900 was tested with an 8.5 dBi Yagi, 5.1 dBi Omni, 8.1 dBi Panel Mount, and a ½ wave whip antenna. These would be the maximum gain antennas of each type used by the professional installer.

IC Rule [6.2.2(o)(a2)]: The output power is not to exceed 1.0 watt and the EIRP not to exceed 6 dBW if the hopset uses 50 or more frequencies.

Example Calculation:
Yagi Antenna = 8.5 dBi Exceeds 6 dBi by 2.5 dB (8.5 dB – 6 dB) so antenna power must be reduced by **2.5 dB**
Cable Loss = 0.5 dB

HiPR-900 is reduced by 2.5 dB plus 0.5 dB to account for cable loss so:
30 dBm – 2.5 dB + 0.5 dB = **28.0 dBm** at antenna port of hopper
after 0.5 dB loss through cable: 28.0 dBm – 0.5 dB = **27.5 dBm** input to Antenna which is a reduction of **2.5 dB**



5.8 RF Exposure Compliance Requirements

FCC Rule: 1.1307, 1.1310, 2.1091(b)(d), 2.1093
IC Rule: RSS-210 (14), Exemption Clause RSS-102(4.3)

Description of Compliance: The HiPR-900 is intended to be used in the SCADA (Supervisory Control And Data Acquisition) market and will be mounted with a fixed RTU (Remote Terminal Unit). The HiPR-900 will be professionally installed in such a way that a minimum separation distance of more than 20 cm will be maintained between the radiating structure and any person so it is classified as a mobile. A typical installation would be with the antenna mounted on a tower, in rare instances a ½ wave whip antenna would be used. In either installation the antenna would be mounted greater than the minimum distance calculated below.

The calculation for the more stringent specification, a General Population/Uncontrolled Mobile device according to section 2.1091(b) and section 1.1310 Note 2 is shown below:

Limits for General Population/Uncontrolled Exposure:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density mW/cm^2	Averaging Time (minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f2)	30
30-300	27.5	0.073	0.2	30
300-1500	---	---	f/1500	30
1500-100,000	---	---	1.0	30

Environmental Specification: f (MHz) / 1500 mW/cm^2
f (902 MHz) / 1500 mW/cm^2 = **.6 mW/cm^2** (worse case)

$S = (PG) / (4\pi R^2)$ (OET Bulletin 65)

where: S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (in appropriate units, e.g., mW)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

Distance Calculation:

Maximum Antenna Gain: 8.5 dBi Yagi $10^{(8.5dBi / 10)}$ = 7.08
Power input to antenna: 27.5dBm = $10^{(27.5dBm / 10)}$ =562 mW
.6 mW/cm^2 = (562mW * 7.08) / $(4\pi R^2)$ ➔ **Minimum Distance = 22.97 cm**

5.9 Band-edge Compliance of RF Conducted Emissions

FCC Rule: 15.247(c)
IC Rule 6.2.2(o)(e1):

Specification: 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.

Test Equipment: Advantest R3162 Spectrum Analyzer

Procedure:

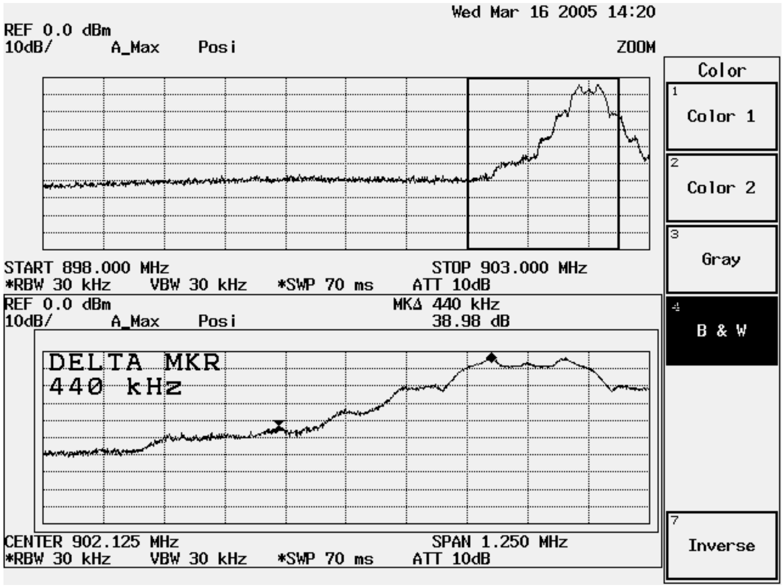
The modem was set to transmit at 256 kbps and 512 kbps. The trace was allowed to stabilize. The marker was set on the emission at the highest modulation product outside of the band (902-928 Mhz). The marker-delta function was enabled and the marker-to-peak function was used to move the marker to the peak of the in-band emission. Using the R3162 spectrum analyzer's multi-screen feature a 5.0 MHz span is shown on the top of the screen and a zoomed in picture of the out of band emission is shown on the bottom. The first four plots show the out of band emissions with the hopping function disabled (transmit on single channel).

The modem was set to transmit at 256 kbps and 512 kbps with the hopping feature enabled. The trace was allowed to stabilize. The marker was set on the emission at the highest modulation product outside of the band (902-928 Mhz). The marker-delta function was enabled and the marker-to-peak function was used to move the marker to the peak of the in-band emission. The next four plots show the out of band emissions with the hopping function enabled.

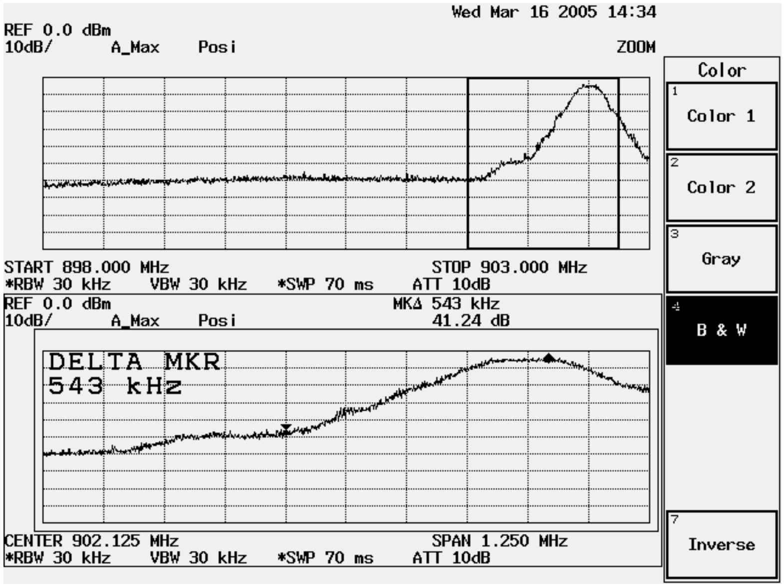
Results:

(see following pages)

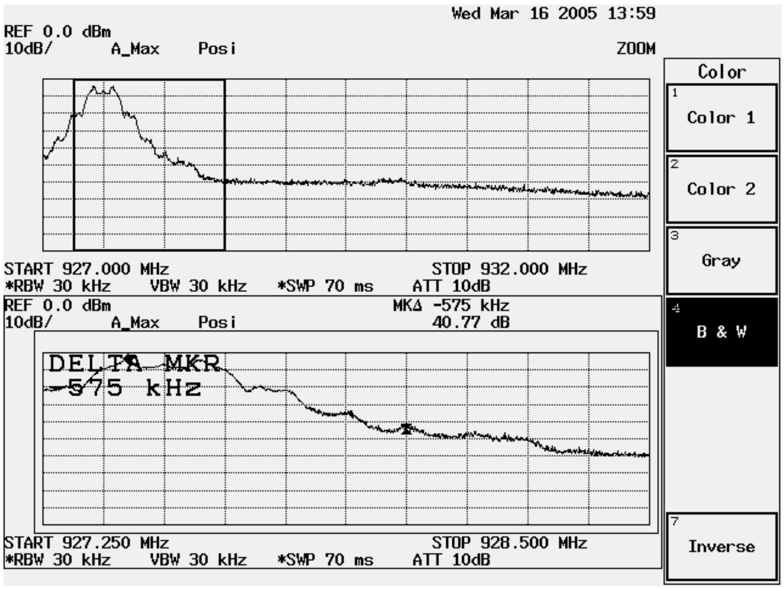
902.5 MHz
256 kbps
Hopping Disabled



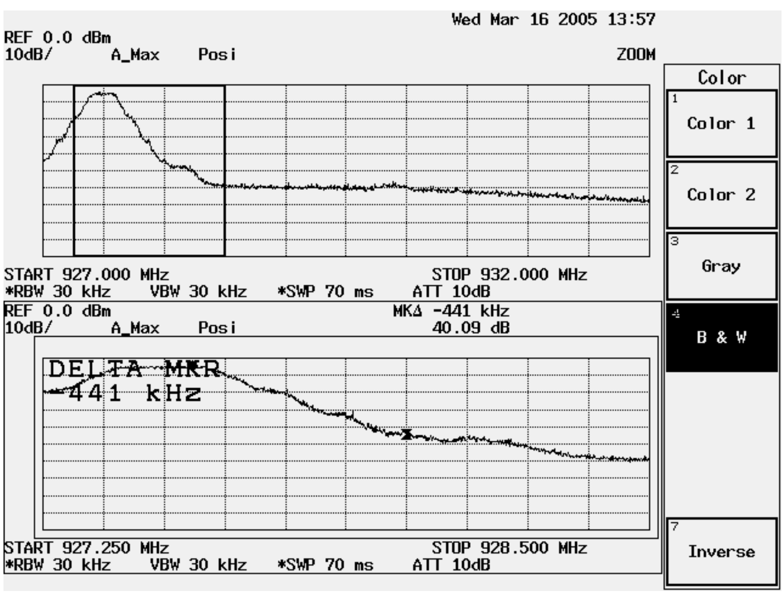
902.5 MHz
512 kbps
Hopping Disabled



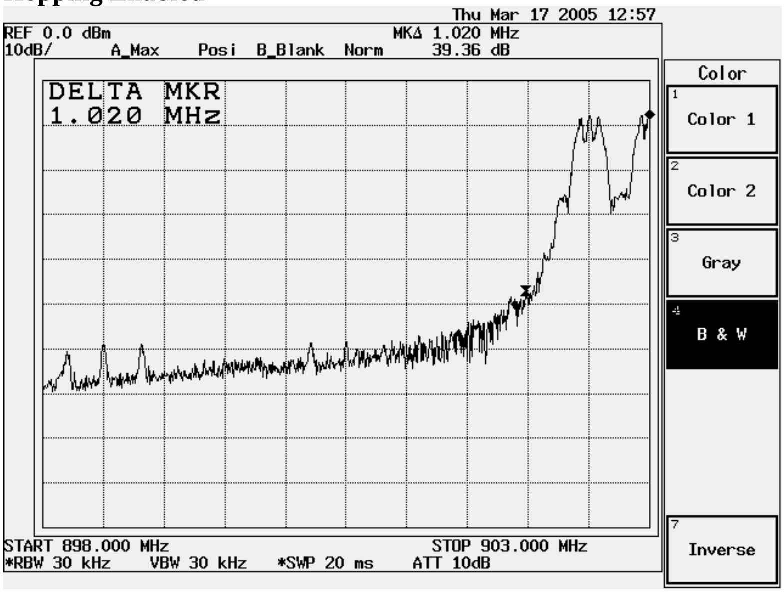
927.5 MHz
256 kbps
Hopping Disabled



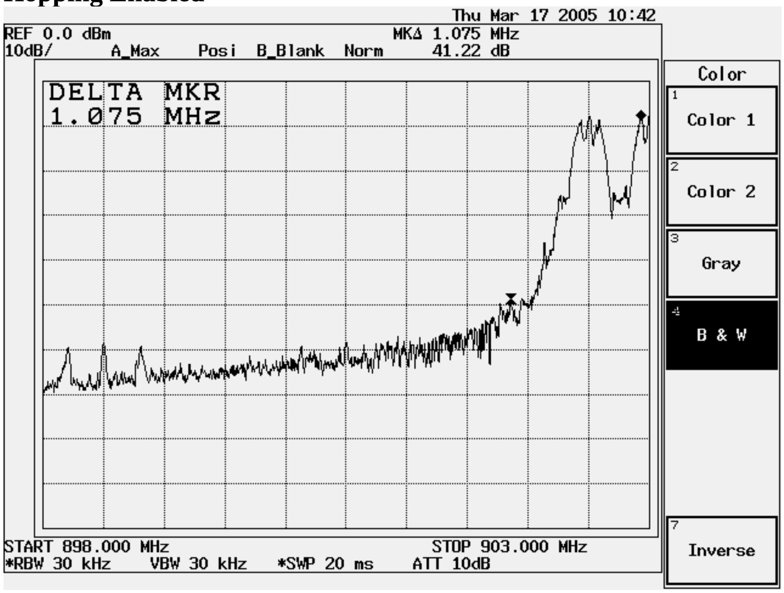
927.5 MHz
512 kbps
Hopping Disabled



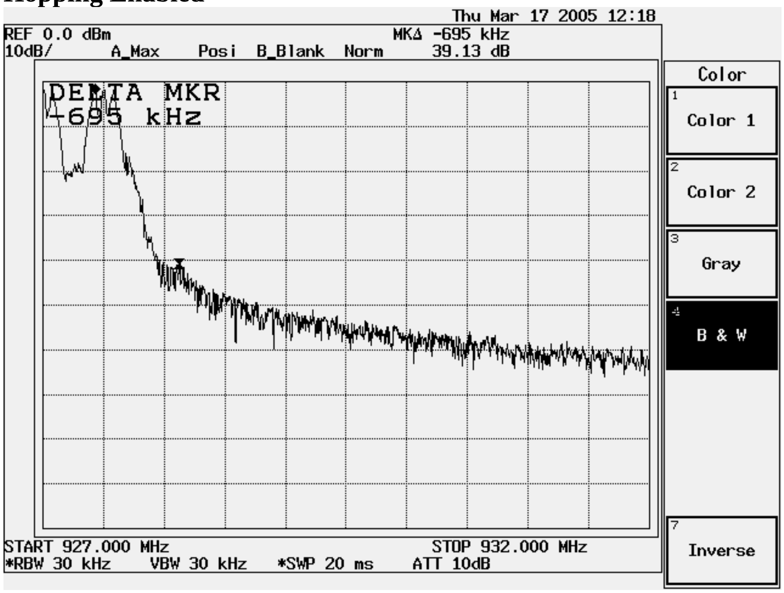
Low End of Band
256 kbps
Hopping Enabled



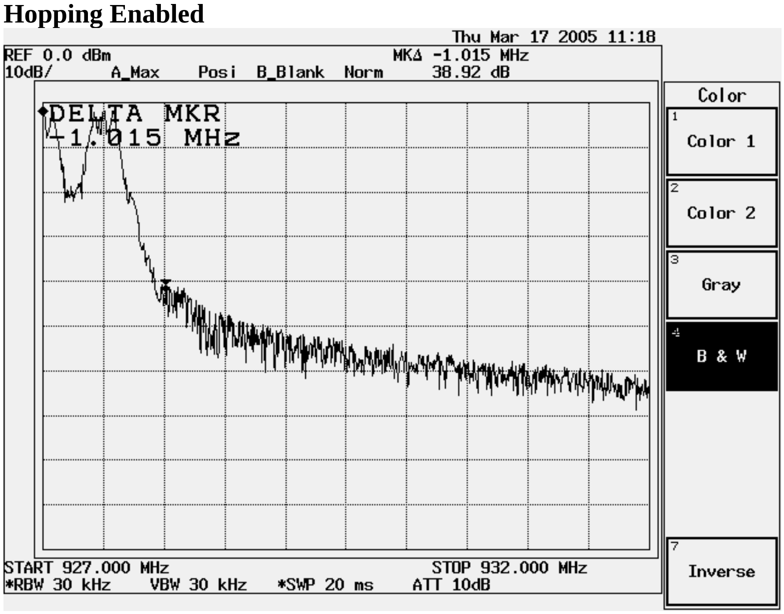
Low End of Band
512 kbps
Hopping Enabled



High End of Band
256 kbps
Hopping Enabled



High End of Band
512 kbps
Hopping Enabled



5.10 Spurious RF Conducted Emissions

FCC Rule: 15.247(c)
IC Rule 6.2.2(o)(e1), 6.3:

Specification: 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.

Test Equipment:

Advantest R3162	Spectrum Analyzer
Agilent E8257D	Signal Generator (Reference Generator)
POE	Power Supply

Procedure:
The EUT was tested from the lowest frequency generated up through the 10th harmonic. A substitution generator was used to find the loss (cables, attenuator) between the EUT and the spectrum analyzer. See Table below for summary.

Sample Calculation (2nd Harmonic of 902 MHz):

Measured on Spectrum Analyzer: -63 dBm

Correct for cable loss: -63 dBm – (-30.3 dB) = -32.7 dBm

Reference to Carrier: -32.7 dBm - 30 dB = -62.7 dBc

Results:

Freq Tuned (MHz)	902.5					Spec	Margin	
Harmonic	Freq (GHz)	EUT	Loss	dBm	dBc	dBc	dBc	Pass/Fail
2.0	1805.0	-63.0	-30.3	-32.7	-62.7	-20	42.7	Pass
3.0	2707.5	-75.0	-30.7	-44.3	-74.3	-20	54.3	Pass
4.0	3610.0	-85.0	-31.9	-53.1	-83.1	-20	63.1	Pass
5.0	4512.5	-90.5	-31.8	-58.7	-88.7	-20	68.7	Pass
6.0	5415.0	-88.0	-34.5	-53.5	-83.5	-20	63.5	Pass
7.0	6317.5	-93.0	-31.7	-61.3	-91.3	-20	71.3	Pass
8.0	7220.0	-95.0	-32.9	-62.1	-92.1	-20	72.1	Pass
9.0	8122.5	-95.0	-32.9	-62.1	-92.1	-20	92.1	Pass
10.0	9025.0	-95.0	-33.0	-62.0	-92.0	-20	72.0	Pass

Freq Tuned (MHz)	915.0					Spec	Margin	
Harmonic	Freq (GHz)	EUT	Loss	dBm	dBc	dBc	dBc	Pass/Fail
2.0	1830.0	-63.0	-30.2	-32.8	-62.8	-20	42.8	Pass
3.0	2745.0	-78.5	-31.6	-46.9	-76.9	-20	56.9	Pass
4.0	3660.0	-86.0	-30.9	-55.1	-85.1	-20	65.1	Pass
5.0	4575.0	-90.0	-32.3	-57.7	-87.7	-20	67.7	Pass
6.0	5490.0	-87.0	-33.4	-53.6	-83.6	-20	63.6	Pass
7.0	6405.0	-95.0	-31.4	-63.6	-93.6	-20	73.6	Pass
8.0	7320.0	-95.0	-32.2	-62.8	-92.8	-20	72.8	Pass
9.0	8235.0	-95.0	-33.0	-62.1	-92.1	-20	72.1	Pass
10.0	9150.0	-95.0	-33.0	-62.0	-92.0	-20	72.0	Pass

Freq Tuned (MHz)	927.5					Spec	Margin	
Harmonic	Freq (GHz)	EUT	Loss	dBm	dBc	dBc	dBc	Pass/Fail
2.0	1855.0	-64.0	-30.5	-33.5	-63.5	-20	43.5	Pass
3.0	2782.5	-80.0	-31.2	-48.8	-78.8	-20	58.8	Pass
4.0	3710.0	-90.0	-32.2	-57.8	-87.8	-20	67.8	Pass
5.0	4637.5	-90.0	-32.9	-57.1	-87.1	-20	67.1	Pass
6.0	5565.0	-84.0	-32.8	-51.2	-81.2	-20	61.2	Pass
7.0	6492.5	-84.4	-31.8	-52.6	-82.6	-20	62.6	Pass
8.0	7420.0	-90.3	-32.2	-58.1	-88.1	-20	68.1	Pass
9.0	8347.5	-89.3	-33.0	-56.3	-86.3	-20	66.3	Pass
10.0	9275.0	-95.0	-33.3	-61.7	-91.7	-20	71.7	Pass

Additional Spurs

902 MHz	Freq	EUT	Loss	dBm	dBc	Spec dBc	Margin dBc	Pass/ Fail
	541.000	-89.0	-30.1	-58.9	-88.9	-20	68.9	Pass
	661.500	-83.0	-30.0	-53.0	-83.0	-20	63.0	Pass
	792.000	-78.0	-30.0	-48.0	-78.0	-20	58.0	Pass
	870.500	-84.0	-30.1	-53.9	-83.9	-20	63.9	Pass
	886.500	-72.0	-30.2	-41.8	-71.8	-20	51.8	Pass
	900.000	-60.0	-29.9	-30.1	-60.1	-20	40.1	Pass
	901.860	-50.0	-29.9	-20.1	-50.1	-20	30.1	Pass
	901.864	-60.0	-29.9	-30.1	-60.1	-20	40.1	Pass
	903.136	-60.0	-29.9	-30.1	-60.1	-20	40.1	Pass
	903.140	-50.0	-29.9	-20.1	-50.1	-20	30.1	Pass
	905.000	-60.0	-29.9	-30.1	-60.1	-20	40.1	Pass
	918.500	-71.0	-30.2	-40.8	-70.8	-20	50.8	Pass
	934.500	-83.0	-30.1	-52.9	-82.9	-20	62.9	Pass
	1023.000	-77.0	-30.2	-46.8	-76.8	-20	56.8	Pass
	1143.500	-88.0	-30.4	-57.6	-87.6	-20	67.6	Pass

915 MHz	Freq	EUT	Loss	dBm	dBc	Spec dBc	Margin dBc	Pass/ Fail
	674.000	-73.0	-30.1	-42.9	-72.9	-20	52.9	Pass
	794.500	-77.0	-30.1	-46.9	-76.9	-20	56.9	Pass
	888.500	-68.0	-30.2	-37.8	-67.8	-20	47.8	Pass
	892.500	-69.0	-30.2	-38.8	-68.8	-20	48.8	Pass
	896.900	-77.0	-29.9	-47.1	-77.1	-20	57.1	Pass
	899.000	-65.0	-30.2	-34.9	-64.9	-20	44.9	Pass
	914.360	-55.0	-29.9	-25.1	-55.1	-20	35.1	Pass
	914.364	-58.5	-29.9	-28.6	-58.6	-20	38.6	Pass
	915.636	-57.0	-29.9	-27.1	-57.1	-20	37.1	Pass
	915.640	-52.0	-29.9	-22.1	-52.1	-20	32.1	Pass
	923.500	-82.0	-29.8	-52.2	-82.2	-20	62.2	Pass
	931.000	-65.0	-30.0	-35.0	-65.0	-20	35.0	Pass
	933.100	-78.0	-29.9	-48.1	-78.1	-20	58.1	Pass
	937.500	-69.0	-30.2	-38.8	-68.8	-20	48.8	Pass
	941.500	-68.0	-30.1	-37.9	-67.9	-20	47.9	Pass
	1035.500	-75.0	-30.2	-44.8	-74.8	-20	54.8	Pass
	1156.000	-81.0	-30.4	-50.6	-80.6	-20	60.6	Pass

928 MHz	Freq	EUT	Loss	dBm	dBc	Spec dBc	Margin dBc	Pass/ Fail
	686.500	-87.5	-30.2	-57.3	-87.3	-20	67.3	Pass
	807.000	-86.0	-30.1	-55.9	-85.9	-20	65.9	Pass
	888.900	-87.0	-30.2	-56.8	-86.8	-20	66.8	Pass
	895.500	-86.5	-30.2	-56.3	-86.3	-20	66.3	Pass
	903.000	-85.0	-29.9	-55.1	-85.1	-20	65.1	Pass
	904.000	-88.0	-30.1	-57.9	-87.9	-20	67.9	Pass
	909.400	-75.0	-30.2	-44.8	-74.8	-20	54.8	Pass
	911.500	-70.0	-30.2	-39.9	-69.9	-20	49.9	Pass
	915.000	-59.0	-30.2	-28.8	-58.8	-20	38.8	Pass
	919.000	-82.0	-29.8	-52.2	-82.2	-20	62.2	Pass
	926.860	-50.0	-29.8	-20.2	-50.2	-20	30.2	Pass
	926.864	-56.0	-29.8	-26.2	-56.2	-20	36.2	Pass
	928.136	-60.0	-29.9	-30.1	-60.1	-20	40.1	Pass
	936.000	-86.0	-29.8	-56.2	-86.2	-20	66.2	Pass
	940.000	-89.0	-30.2	-58.8	-88.8	-20	68.8	Pass
	943.500	-70.0	-30.1	-39.9	-69.9	-20	49.9	Pass
	945.600	-75.0	-30.1	-44.9	-74.9	-20	54.9	Pass
	951.000	-87.0	-30.2	-56.8	-86.8	-20	66.8	Pass
	952.000	-85.0	-29.9	-55.2	-85.2	-20	65.2	Pass
	959.500	-86.0	-30.2	-55.8	-85.8	-20	65.8	Pass
	966.100	-86.0	-30.2	-55.8	-85.8	-20	65.8	Pass
	1048.000	-85.0	-30.3	-54.7	-84.7	-20	64.7	Pass

5.11 Spurious RF Radiated Emissions

FCC Rule: 15.247(c), 15.209, 15.35(b)
IC Rule 6.2.2(o)(e1), 6.3:

Specification: Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a). Table 15.209 lists limits for measurements employing a average detector for radiated emissions. Section 15.35(b) states the limit for measurements employing peak detectors is 20 dB greater than average detectors. For frequencies above 1 GHz, 20 dB above 500 µV/m is 5000 µV/m.

15.209 Radiated emission limits, general requirements
(For Quasi-Peak Detectors below 1 GHz and Average Detectors above 1 GHz):

Frequency (MHz)	Field Strength (µV/m)	Measurement Distance (meters)
0.009-0.490	2400/F (kHz)	300
0.490-1.705	24000/F (kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Sample Calculation:

1) Signal measured on spectrum analyzer:	-71.02 dBm	
2) Add cable loss to spectrum analyzer measurement:	-71.02 dBm + 7 dB =	-64.02 dBm
3) Convert signal to dBµV by adding 107 dB:	-64 dBm + 107 dB =	42.98 dBµV
4) Add Antenna Correction Factor (ACF):	42.98 dBµV + 31 dB =	73.98 dBµV/m
5) Convert to µV/m = $10^{((dB\mu V/m)/20)}$	$10^{((73.98\ dB\mu V/m)/20)}$ =	5000 µV/m

Test Equipment:

Advantest R3162	Spectrum Analyzer
HP 8563E	Spectrum Analyzer
CGL611B	Bilog Antenna (Receiving Antenna for frequencies below 1 GHz)
EMCO 3115	Horn Antenna (Receiving Antenna for frequencies above 1 GHz)
BMOY8903	Maxrad 8.5 dBi Yagi
MFB 9153	Maxrad 5.1 dBi Omni Directional
MP8066	Maxrad 8.1 dBi Panel mount
MEXR-902-BN	Maxrad 2.5 dBi ½ Wave Whip

Procedure: TIA/EIA 603, 2.2.12, DA 00-705

Used a QP detector for frequencies below 1 GHz and a peak detector for frequencies above 1 GHz. Used the limits of 15.209 for frequencies below 1 GHz and used 20 dB over the average limit (5000 µV/m) for frequencies above 1 GHz. Listed the spurs that were within 20 dB of the limits. Radiated emissions that fall in the restricted bands were tested up to the 10th harmonic. The point at which the transmitter harmonics and restricted bands overlapped were measured at the high and low end.

Example 1: 2nd Harmonic of neither 902 (1804) nor 928 (1856) landed in a restricted band
Tested: 2nd Harmonic Not Tested

Example 2: 3rd Harmonic of 902 (2706) and 928 (2784) fall within the restricted band 2655-2900 MHz
Tested: 2706 and 2784 MHz

Example 3: 8th Harmonic of 906.25 (7250) falls into the low end of the restricted band 7250 MHz
8th Harmonic of 928 (7424) falls within restricted band 7250-7750 MHz
Tested: 7250 and 7424 MHz Summary shown in Table 1 on next page

Table 5.11.1: Summary of Overlap Between Transmitter Harmonics/Spurs and Restricted Bands

	902	928	Restricted Bands		High Low Freq of Interference			
Harmonic	Frequency of Harmonics (MHz)				Low edge of band		High edge of band	
					Tuned	Freq	Tuned	Freq
2	1804	1856			NA	NA	NA	NA
3	2706	2784	2655	2900	902	2706	928	2784
4	3608	3712	3600	4400	902	3608	928	3712
5	4510	4640	4500	5150	902	4510	928	4640
6	5412	5568	5350	5460	902	5412	910	5460
7	6314	6496			NA	NA	NA	NA
8	7216	7424	7250	7750	906.25	7250	928	7424
9	8118	8352	8025	8500	902	8118	928	8352
10	9020	9280	9000	9200	902	9020	920	9200

Frequency Tuned	Spur		Restricted Bands	
	Freq (MHz)	Source		
902.5	961.52		960	1240
	1023	1st LO + 2 * 2nd LO	960	1240
915	964	8 * 2nd LO	960	1240
	986.5		960	1240
	1035.5	1st LO + 2 * 2nd LO	960	1240
927.5	964	8 * 2nd LO	960	1240
	966.1		960	1240
	975.0		960	1240
	1048	1st LO + 2 * 2nd LO	960	1240

Table 5.11.2: Measured RF Radiated Emissions Summary with Whip Antenna:

Freq Tuned (MHz)	Harmonic	Freq (spur) (MHz)		ACF (dB)	Spectrum Anaylyzer (dBm)	Conversion To (dBuV)	Cable Loss (dB)	Extrapolate Distance (Meters)	Field Intensity (uV/m)	Limit (uV/m)	Margin (uV/m)	Pass/ Fail
902.5		961.52	H	24.0	-93.7	13.32	4.67	3	126	500	374	Pass
			V	24.0	-94.1	12.94	4.67	3	120	500	380	Pass
915		964	H	24.0	-94.0	13.00	4.67	3	121	500	379	Pass
			V	24.0	-94.0	13.00	4.67	3	121	500	379	Pass
927.5		964	H	24.0	-93.1	13.90	4.67	3	134	500	366	Pass
			V	24.0	-93.2	13.76	4.67	3	132	500	368	Pass
927.5		966.12	H	24.0	-93.7	13.32	4.67	3	126	500	374	Pass
			V	24.0	-93.9	13.08	4.67	3	122	500	378	Pass
927.5		975	H	24.0	-92.1	14.94	4.67	3	152	500	348	Pass
			V	24.0	-93.0	14.01	4.67	3	136	500	364	Pass
915		986.52	H	24.0	-94.0	13.00	4.67	3	121	500	379	Pass
			V	24.0	-94.0	13.00	4.67	3	121	500	379	Pass
902.5		1023	H	25.4	-100.9	6.10	5.67	3	72	5000	4928	Pass
			V	25.4	-94.5	12.50	5.67	3	151	5000	4849	Pass
915		1035.5	H	25.4	-97.0	9.98	4.83	3	102	5000	4898	Pass
			V	25.4	-95.5	11.50	4.83	3	122	5000	4878	Pass
927.5		1048	H	25.4	-97.3	9.70	4.83	3	99	5000	4901	Pass
			V	25.4	-97.7	9.33	4.83	3	95	5000	4905	Pass
902.5	3	2707.5	H	31.0	-88.4	18.64	12.33	3	1255	5000	3745	Pass
			V	31.0	-89.1	17.88	12.33	3	1149	5000	3851	Pass
927.5	3	2782.5	H	31.2	-94.6	12.37	10.50	3	505	5000	4495	Pass
			V	31.2	-95.7	11.28	10.50	3	446	5000	4554	Pass
902.5	4	3610	H	33.3	-90.0	17.00	8.50	3	871	5000	4129	Pass
			V	33.3	-92.7	14.30	8.50	3	638	5000	4362	Pass
927.5	4	3710	H	33.5	-92.3	14.70	8.87	3	714	5000	4286	Pass
			V	33.5	-94.1	12.90	8.87	3	580	5000	4420	Pass

Table 5.11.3: Measured RF Radiated Emissions Summary with Yagi Antenna:

Freq Tuned (MHz)	Harmonic	Freq (spur) (MHz)		ACF (dB)	Spectrum Anaylyzer (dBm)	Conversion To (dBuV)	Cable Loss (dB)	Extrapolate Distance (Meters)	Field Intensity (uV/m)	Limit (uV/m)	Margin (uV/m)	Pass/ Fail
902.5		961.52	H	24.0	-93.4	13.60	4.67	3	130	500	370	Pass
			V	24.0	-94.0	13.01	4.67	3	121	500	379	Pass
915		964	H	24.0	-90.0	16.96	4.67	3	191	500	309	Pass
			V	24.0	-94.0	12.98	4.67	3	121	500	379	Pass
927.5		964	H	24.0	-93.5	13.53	4.67	3	129	500	371	Pass
			V	24.0	-94.0	12.96	4.67	3	121	500	379	Pass
927.5		966.12	H	24.0	-91.0	15.96	4.67	3	170	500	330	Pass
			V	24.0	-93.0	14.01	4.67	3	136	500	364	Pass
927.5		975	H	24.0	-88.2	18.79	4.67	3	236	500	264	Pass
			V	24.0	-91.0	15.97	4.67	3	171	500	329	Pass
915		986.52	H	24.0	-94.0	13.01	4.67	3	121	500	379	Pass
			V	24.0	-93.7	13.27	4.67	3	125	500	375	Pass
902.5		1023	H	25.4	-86.7	20.33	5.67	3	372	5000	4628	Pass
			V	25.4	-97.3	9.67	5.67	3	109	5000	4891	Pass
915		1035.5	H	25.4	-85.5	21.50	4.83	3	386	5000	4614	Pass
			V	25.4	-95.2	11.83	4.83	3	127	5000	4873	Pass
927.5		1048	H	25.4	-93.8	13.17	4.83	3	148	5000	4852	Pass
			V	25.4	-99.3	7.67	4.83	3	79	5000	4921	Pass
902.5	3	2707.5	H	31.0	-81.7	25.33	12.33	3	2710	5000	2290	Pass
			V	31.0	-85.2	21.83	12.33	3	1811	5000	3189	Pass
927.5	3	2782.5	H	31.2	-83.5	23.50	10.50	3	1820	5000	3180	Pass
			V	31.2	-82.8	24.17	10.50	3	1966	5000	3034	Pass
902.5	4	3610	H	33.3	-100.2	6.80	8.50	3	269	5000	4731	Pass
			V	33.3	-99.8	7.17	8.50	3	281	5000	4719	Pass
927.5	4	3710	H	33.5	-97.8	9.17	8.87	3	378	5000	4622	Pass
			V	33.5	-94.7	12.33	8.87	3	543	5000	4457	Pass

Table 5.11.4: Measured RF Radiated Emissions Summary with Omni Antenna:

Freq Tuned (MHz)	Harmonic	Freq (spur) (MHz)		ACF (dB)	Spectrum Anaylyzer (dBm)	Conversion To (dBuV)	Cable Loss (dB)	Extrapolate Distance (Meters)	Field Intensity (uV/m)	Limit (uV/m)	Margin (uV/m)	Pass/ Fail
902.5		961.52	H	24.0	-98.0	8.96	4.67	3	76	500	424	Pass
			V	24.0	-98.5	8.48	4.67	3	72	500	428	Pass
915		964	H	24.0	-92.4	14.60	4.67	3	146	500	354	Pass
			V	24.0	-92.4	14.60	4.67	3	146	500	354	Pass
927.5		964	H	24.0	-93.0	13.98	4.67	3	136	500	364	Pass
			V	24.0	-92.7	14.29	4.67	3	141	500	359	Pass
927.5		966.12	H	24.0	-94.0	12.96	4.67	3	121	500	379	Pass
			V	24.0	-93.2	13.81	4.67	3	133	500	367	Pass
927.5		975	H	24.0	-91.9	15.13	4.67	3	155	500	345	Pass
			V	24.0	-88.6	18.44	4.67	3	227	500	273	Pass
915		986.52	H	24.0	-94.0	13.00	4.67	3	121	500	379	Pass
			V	24.0	-94.0	13.00	4.67	3	121	500	379	Pass
902.5		1023	H	25.4	-94.5	12.50	5.67	3	151	5000	4849	Pass
			V	25.4	-93.3	13.67	5.67	3	173	5000	4827	Pass
915		1035.5	H	25.4	-92.0	15.00	4.83	3	183	5000	4817	Pass
			V	25.4	-91.0	16.00	4.83	3	205	5000	4795	Pass
927.5		1048	H	25.4	-96.0	11.00	4.83	3	115	5000	4885	Pass
			V	25.4	-95.8	11.17	4.83	3	117	5000	4883	Pass
902.5	3	2707.5	H	31.0	-88.7	18.33	12.33	3	1211	5000	3789	Pass
			V	31.0	-87.7	19.33	12.33	3	1358	5000	3642	Pass
927.5	3	2782.5	H	31.2	-94.3	12.70	10.50	3	525	5000	4475	Pass
			V	31.2	-94.5	12.48	10.50	3	512	5000	4488	Pass
902.5	4	3610	H	33.3	-99.3	7.70	8.50	3	299	5000	4701	Pass
			V	33.3	-99.0	8.00	8.50	3	309	5000	4691	Pass
927.5	4	3710	H	33.5	-97.7	9.33	8.87	3	385	5000	4615	Pass
			V	33.5	-97.5	9.50	8.87	3	392	5000	4608	Pass

Table 5.11.5: Measured RF Radiated Emissions Summary with Panel Mount Antenna:

Freq Tuned (MHz)	Harmonic	Freq (spur) (MHz)		ACF (dB)	Spectrum Anaylyzer (dBm)	Conversion To (dBuV)	Cable Loss (dB)	Extrapolate Distance (Meters)	Field Intensity (uV/m)	Limit (uV/m)	Margin (uV/m)	Pass/ Fail
902.5		961.52	H	24.0	-93.2	13.79	4.67	3	133	500	367	Pass
			V	24.0	-93.4	13.56	4.67	3	129	500	371	Pass
915		964	H	24.0	-94.0	13.00	4.67	3	121	500	379	Pass
			V	24.0	-94.0	13.00	4.67	3	121	500	379	Pass
927.5		964	H	24.0	-93.5	13.52	4.67	3	129	500	371	Pass
			V	24.0	-93.8	13.20	4.67	3	124	500	376	Pass
927.5		966.12	H	24.0	-92.1	14.93	4.67	3	151	500	349	Pass
			V	24.0	-94.0	13.00	4.67	3	121	500	379	Pass
927.5		975	H	24.0	-91.6	15.38	4.67	3	159	500	341	Pass
			V	24.0	-85.2	21.79	4.67	3	333	500	167	Pass
915		986.52	H	24.0	-93.6	13.38	4.67	3	127	500	373	Pass
			V	24.0	-93.8	13.24	4.67	3	125	500	375	Pass
902.5		1023	H	25.4	-94.8	12.17	5.67	3	145	5000	4855	Pass
			V	25.4	-95.5	11.50	5.67	3	134	5000	4866	Pass
915		1035.5	H	25.4	-94.7	12.33	4.83	3	134	5000	4866	Pass
			V	25.4	-91.2	15.83	4.83	3	201	5000	4799	Pass
927.5		1048	H	25.4	-91.5	15.50	4.83	3	193	5000	4807	Pass
			V	25.4	-96.5	10.50	4.83	3	109	5000	4891	Pass
902.5	3	2707.5	H	31.0	-80.5	26.50	12.33	3	3101	5000	1899	Pass
			V	31.0	-83.7	23.33	12.33	3	2153	5000	2847	Pass
927.5	3	2782.5	H	31.2	-90.7	16.33	10.50	3	797	5000	4203	Pass
			V	31.2	-91.3	15.67	10.50	3	739	5000	4261	Pass
902.5	4	3610	H	33.3	-100.0	7.00	8.50	3	275	5000	4725	Pass
			V	33.3	-97.2	9.83	8.50	3	382	5000	4618	Pass
927.5	4	3710	H	33.5	-100.3	6.70	8.87	3	284	5000	4716	Pass
			V	33.5	-99.3	7.67	8.87	3	318	5000	4682	Pass

5.12 Antenna Power Conduction Limits for Receivers

FCC Rule: 15.111
IC Rule 7.2

Specification: In addition to the radiated emission limits, receivers that operate (tune) in the frequency range 30 to 960 MHz and CB receivers that provide terminals for the connection of an external receiving antenna may be tested to demonstrate compliance with the provisions of §15.109 with the antenna terminals shielded and terminated with a resistive termination equal to the impedance specified for the antenna, provided these receivers also comply with the following: with the receiver antenna terminal connected to a resistive termination equal to the impedance specified or employed for the antenna, the power at the antenna terminal at any frequency within the range of measurements specified in §15.33 shall not exceed 2.0 nanowatts (-57 dBm).

Test Equipment: Advantest R3162 Spectrum Analyzer

Procedure: The receiver was tuned to 902.5, 915 and 927.5 MHz. A spectrum analyzer was used to measure the conducted level of the LO. See results below.

Receiver Conducted Spurious

Main Rx (Tx/Rx)

Tuned (MHz): 1st IF (MHz):	902.5 -109.8		915 -109.8		927.5 -109.8	
Harmonic	Freq (MHz)	Spur Level (dBm)	Freq (MHz)	Spur Level (dBm)	Freq (MHz)	Spur Level (dBm)
1	792.70	-86.5	805.20	-85.4	817.70	-84.5
2	1585.40	-91.2	1610.40	-89.6	1635.40	-85.2
3	2378.10	-104.0	2415.60	-104.0	2453.10	-101.8
4	3170.80	-95.2	3220.80	-87.4	3270.80	-90.4
5	3963.50	-104.0	4026.00	-104.0	4088.50	-103.0
6	4756.20	-99.4	4831.20	-94.5	4906.20	-93.7
7	5548.90	-102.0	5636.40	-104.0	5723.90	-102.0
8	6341.60	-102.5	6441.60	-103.0	6541.60	-96.3
9	7134.30	-102.5	7246.80	-104.0	7359.30	-100.7
10	7927.00	-104.0	8052.00	-104.0	8177.00	-102.0

PD Rx (Rx only)

Tuned (MHz): 1st IF (MHz):	902.5 -109.8		915 -109.8		927.5 -109.8	
Harmonic	Freq (MHz)	Spur Level (dBm)	Freq (MHz)	Spur Level (dBm)	Freq (MHz)	Spur Level (dBm)
1	792.70	-90.0	805.20	-88.3	817.70	-86.4
2	1585.40	-96.6	1610.40	-90.4	1635.40	-84.5
3	2378.10	-97.6	2415.60	-99.5	2453.10	-99.3
4	3170.80	-96.3	3220.80	-90.7	3270.80	-95.4
5	3963.50	-104.0	4026.00	-105.0	4088.50	-103.0
6	4756.20	-103.0	4831.20	-103.0	4906.20	-104.0
7	5548.90	-97.1	5636.40	-101.0	5723.90	-99.5
8	6341.60	-102.0	6441.60	-100.0	6541.60	-99.2
9	7134.30	-100.0	7246.80	-101.9	7359.30	-98.2
10	7927.00	-101.5	8052.00	-104.0	8177.00	-104.0

5.13 Spurious RF Radiated Receiver Emissions (FCC: Non-radiating Load)

FCC Rule: 15.109
IC Rule: 7.3

Specification: The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the following:

FCC 15.109 Radiated emission limits, general requirements (For Average Detectors):

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (meters)
30 - 88	90	10
88 - 216	150	10
216 - 960	210	10
Above 960	300	10

Sample Calculation:

1) Signal measured on spectrum analyzer: -74.8 dBm
2) Add cable loss to spectrum analyzer measurement: -74.8 dBm + 2.7 dB = -72.1 dBm
3) Convert signal to dBμV by adding 107 dB: -72.1 dBm + 107 dB = 34.9 dBμV
4) Add Antenna Correction Factor (ACF): 34.9 dBμV + 22 dB = 56.9 dBμV/m
5) Convert to μV/m = $10^{((dB\mu V/m)/20)}$ $10^{((56.9\ dB\mu V/m)/20)}$ = 700 μV/m
6) Measurements were taken at 3 meters so they need to be extrapolated to 10 meters as specified in section 15.109(b).
   a) Scaling factor from 3 meters to 10 meters => 10/3 => 3 1/3
   b) Power density is proportional to $1/_r2$ where r is the radius or distance.
      P_{10} = Power at 10 meters
      P_3 = Power at 3 meters
      V_{10} = rms Voltage at 10 meters
      V_3 = rms Voltage at 3 meters
      R = terminating load (50 Ω)
      $P_{10} = P_3 / r^2$ => $V_{10}^2/R = V_3^2 /Rr^2$ => $V_{10} = V_3/r$
   c) V_{10} = (μV/m) / (Scaling Factor) => V_{10} = 298.54 / (3 1/3) = **210 μV/m**

Test Equipment:

	HP 8563E	Spectrum Analyzer
	Agilent E8257D	Reference Generator
	POE	Power Supply
	EMCO 3115	Horn Antenna (Receiving Antenna)

Procedure: TIA/EIA 603, 2.2.12

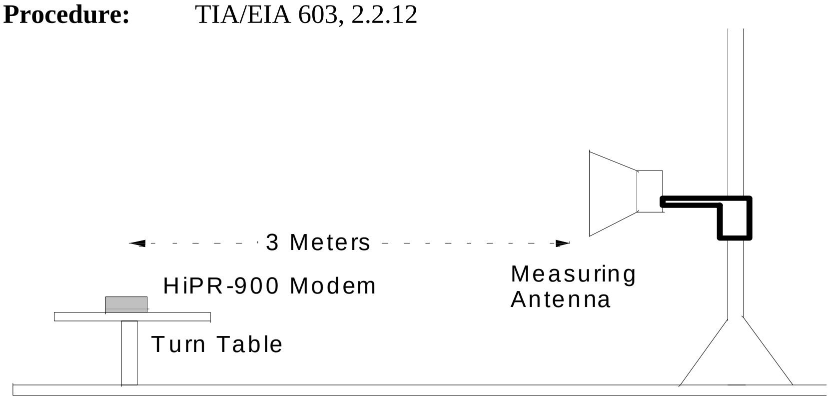


Table 5.13.1: Measured Spurious RF Radiated Receiver Emissions (Field Strength)

Tuned 915 MHz
IF -109.8 MHz

Freq (MHz)		ACF (dB)	**Spectrum Anaylyzer (dBm)**	Conversion To (dBuV)	Cable Loss (dB)	Extrapolate Distance To (Meters)	Field Intensity (uV/m)	Spec (uV/m)	Margin (uV/m)	Pass/Fail
805.2	H	22.00	**-107.9**	-0.90	2.70	10	5	210	205.35	Pass
	V	22.00	**-107.2**	-0.20	2.70	10	5	210	204.96	Pass
1610.4	H	27.30	**-88.6**	18.40	4.00	10	92	300	208.35	Pass
	V	27.30	**-89.2**	17.80	4.00	10	86	300	214.47	Pass
2415.6	H	30.26	**-106.4**	0.60	5.21	10	19	300	280.92	Pass
	V	30.26	**-106.9**	0.10	5.21	10	18	300	281.99	Pass
3220.8	H	32.33	**-106.7**	0.30	8.00	10	32	300	267.74	Pass
	V	32.33	**-106.1**	0.90	8.00	10	35	300	265.44	Pass
4026	H	34.19	**-110.2**	-3.20	7.20	10	24	300	275.64	Pass
	V	34.19	**-109.7**	-2.70	7.20	10	26	300	274.20	Pass
4831.2	H	34.83	**-110.4**	-3.40	8.30	10	29	300	270.92	Pass
	V	34.83	**-109.7**	-2.70	8.30	10	32	300	268.48	Pass
5636.4	H	36.08	**-111.1**	-4.10	9.30	10	35	300	265.24	Pass
	V	36.08	**-109.6**	-2.60	9.30	10	41	300	258.68	Pass
6441.6	H	36.39	**-110.2**	-3.20	10.30	10	45	300	255.16	Pass
	V	36.39	**-110.4**	-3.40	10.30	10	44	300	256.19	Pass
7246.8	H	37.64	**-107.2**	-0.20	12.20	10	91	300	208.98	Pass
	V	37.64	**-106.9**	0.10	12.20	10	94	300	205.78	Pass
8052	H	38.63	**-108.2**	-1.20	13.30	10	103	300	196.81	Pass
	V	38.63	**-108.4**	-1.40	13.30	10	101	300	199.16	Pass

5.14 Spurious RF Radiated Receiver Emissions (IC: Highest Gain Antenna, 8.5 dBi Yagi)

IC Rule: 7.3

Specification: This measurement is to be performed, with the device's antenna connected in its place at a calibrated Open Area Test Site (see section 11).

IC Table 3: Radiated emission limits, general requirements:

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (meters)
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
960 - 1610	500	3
Above 1610	1000	3

Sample Calculation (805.2 MHz, Horizontal, Table 4):

1) Signal measured on spectrum analyzer: -75.2 dBm
2) Add cable loss to spectrum analyzer measurement: -75.2 dBm + 2.7 dB = -72.5 dBm
3) Convert signal to dBμV by adding 107 dB: -72.5 dBm + 107 dB = 34.5 dBμV
4) Add Antenna Correction Factor (ACF): 34.5 dBμV + 22 dB = 56.5 dBμV/m
5) Convert to μV/m = $10^{((dB\mu V/m)/20)}$ $10^{((56.5\ dB\mu V/m)/20)}$ = 200 μV/m

Test Equipment:
HP 8563E Spectrum Analyzer
Agilent E8257D Reference Generator
POE Power Supply
EMCO 3115 Horn Antenna (Receiving Antenna)

Procedure: Maxrad 8.5 dBi Yagi, Model BMOY 8903 was attached to antenna port.
TIA/EIA 603, 2.2.12 method followed

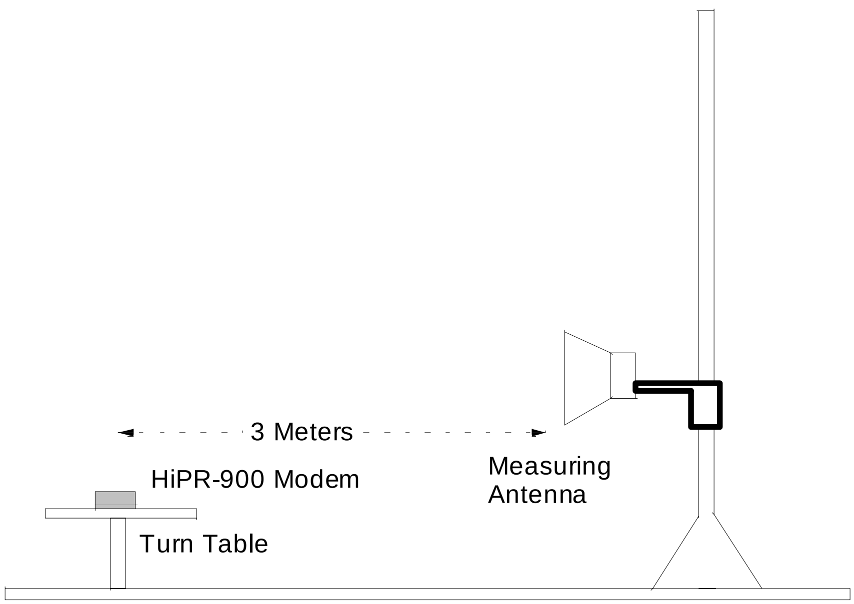


Table 5.14.1: Spurious RF Radiated Receiver Emissions (Field Strength)

Rx/Tx
Tuned 915 MHz
-
IF 109.8 MHz

Freq (MHz)		ACF (dB)	**Spectrum Anaylyzer (dBm)**	Conversion To (dBuV)	Cable Loss (dB)	Extrapolate Distance To (Meters)	Field Intensity (uV/m)	Spec (uV/m)	Margin (uV/m)	Pass/Fail
805.2	H	22.00	**-107.0**	0.00	2.70	10	5	210	204.85	Pass
	V	22.00	**-107.2**	-0.20	2.70	10	5	210	204.96	Pass
1610.4	H	27.30	**-87.5**	19.50	4.00	10	104	300	195.98	Pass
	V	27.30	**-88.1**	18.90	4.00	10	97	300	202.92	Pass
2415.6	H	30.26	**-105.2**	1.80	5.21	10	22	300	278.09	Pass
	V	30.26	**-105.9**	1.10	5.21	10	20	300	279.79	Pass
3220.8	H	32.33	**-106.7**	0.30	8.00	10	32	300	267.74	Pass
	V	32.33	**-106.2**	0.80	8.00	10	34	300	265.83	Pass
4026	H	34.19	**-109.2**	-2.20	7.20	10	27	300	272.67	Pass
	V	34.19	**-109.7**	-2.70	7.20	10	26	300	274.20	Pass

Rx only
Tuned 915 MHz
-
IF 109.8 MHz

Freq (MHz)		ACF (dB)	**Spectrum Anaylyzer (dBm)**	Conversion To (dBuV)	Cable Loss (dB)	Extrapolate Distance To (Meters)	Field Intensity (uV/m)	Spec (uV/m)	Margin (uV/m)	Pass/Fail
805.2	H	22.00	**-107.3**	-0.30	2.70	10	5	210	205.02	Pass
	V	22.00	**-107.5**	-0.50	2.70	10	5	210	205.13	Pass
1610.4	H	27.30	**-88.2**	18.80	4.00	10	96	300	204.03	Pass
	V	27.30	**-88.4**	18.60	4.00	10	94	300	206.22	Pass
2415.6	H	30.26	**-106.0**	1.00	5.21	10	20	300	280.02	Pass
	V	30.26	**-106.2**	0.80	5.21	10	20	300	280.47	Pass
3220.8	H	32.33	**-107.0**	0.00	8.00	10	31	300	268.84	Pass
	V	32.33	**-107.1**	-0.10	8.00	10	31	300	269.19	Pass
4026	H	34.19	**-109.3**	-2.30	7.20	10	27	300	272.98	Pass
	V	34.19	**-109.5**	-2.50	7.20	10	26	300	273.60	Pass

5.15 Conducted Limits (ac Power Line Conducted)

FCC Rule: 15.207, 15.35(b)

Specification:
(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 150 kHz to 30 MHz shall not exceed the limits in the following table. 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.

Frequency of Emission (MHz)	Conducted Limit dBuV	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

Equipment:
Spectrum Analyzer HP8563E
Radio Shack 100W, DC supply 22-504

Procedure:
The procedure outlined in ANSI C63.4-2003 was followed. Unused terminations of the LISN were terminated into 50 ohms. An HP8563E spectrum analyzer was used to make the measurements. The EUT was tested as a table top device, placed 80 cm from the conducting ground plane and 40 cm from the wall of the screen room (vertical ground plane). A PC was used to send data to the EUT to simulate the transmitter in a real world application. A radio shack 100 Watt 13.8 VDC, 3 Amp supply was used, catalog part number 22-504. The 6 highest ac power line conducted emissions relative to the limit were recorded.

Results:
Quasi peak detector's usually measure about 2 dB less than peak detectors. The actual levels using a quasi peak detector would be approximately 2 dB less than shown below or 2dB more margin. The margin shown below measured with a peak detector is sufficient to verify compliance with the levels set forth in 15.207.
Table of Results:

HOT

Using Peak Detector					Limits	
Freq (MHz)	Spur (peak dBm)	Cable Loss (dB)	Correction (dBm)	Spur (dBuV)	Spec (dBuV)	Margin (dB)
1.17	-63.50	0.5	-63.00	44.00	56	12.00
10.79	-67.00	0.5	-66.50	40.50	60	19.50
13.35	-67.33	0.5	-66.83	40.17	60	19.83
13.42	-67.17	0.5	-66.67	40.33	60	19.67
13.66	-66.83	0.5	-66.33	40.67	60	19.33
13.90	-67.50	0.5	-67.00	40.00	60	20.00

Neutral

Using Peak Detector					Limits	
Freq (MHz)	Spur (peak dBm)	Cable Loss (dB)	Correction (dBm)	Spur (dBuV)	Spec (dBuV)	Margin (dB)
1.17	-66.50	0.5	-66.00	41.00	56	15.00
13.35	-67.50	0.5	-67.00	40.00	60	20.00
13.42	-66.33	0.5	-65.83	41.17	60	18.83
13.66	-67.67	0.5	-67.17	39.83	60	20.17
13.78	-67.50	0.5	-67.00	40.00	60	20.00
140.30	-66.00	0.5	-65.50	41.50	60	18.50