ROGERS LABS, INC.
4405 West 259th Terrace
Louisburg, KS 66053
Phone / Fax (913) 837-3214

ENGINEERING TEST REPORT
FOR
APLLICATION of
GRANT of CERTIFICATION

FOR

CFR 47, PART 15C - INTENTIONAL RADIATORS
Paragraphs 15.247 and 15.249
Spread Spectrum Frequency Hopping System
And Operation in the 902-928 MHz band

For

NEVCO SCOREBOARD COMPANY
301 East Harris Avenue
Greenville, IL 62246
Gayla Moore,
President

WIRELESS CONTROLLER
Model: ZW-4 WIRELESS CONTROLLER
Frequency 902-928 MHz
FCC ID#: PLH-ZW4

Test Date: June 10, 2004

Certifying Engineer: Scot D Rogers
Scot D. Rogers
ROGERS LABS, INC.
4405 West 259th Terrace
Louisburg, KS 66053
Phone: (913) 837-3214
FAX: (913) 837-3214

TABLE OF CONTENTS

FORWARD:

The following is submitted for consideration in obtaining a Grant of Certification for an intentional radiator operating in one of two modes, spread spectrum frequency hopping intentional radiator per CFR Paragraph 15.247 or operation in the 902-928 MHz band per CFR paragraph 15.249.

Name of Applicant: NEVCO SCOREBOARD COMPANY
301 East Harris Avenue
Greenville, IL 62246

Model: ZW-4 WIRELESS CONTROLLER.

FCC I.D.: PLH-ZW4.

Frequency Range: 902-928 MHz.

Operating Power: 27 mW (measured at antenna connection on PCB) under 15.247 FHSS or Less than 50 mV/m @ 3 Meters (94 dBµV/m @ 3 meters) under 15.249 (0.3 mW measured at antenna connection on PCB).

1) Applicable Standards & Test Procedures

a) In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2003, Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057, applicable parts of paragraph 15, Part 15C Paragraphs 15.247 and 15.249, and FCC document DA00-705 the following is submitted:

b) Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in the ANSI 63.4-1992 Document FCC and documents DA00-1407 and DA00-705.

2.1033(b) Application for Certification

(1) Manufacturer: NEVCO SCOREBOARD COMPANY
301 East Harris Avenue
Greenville, IL 62246

(2) Identification: Model: ZW-4 WIRELESS CONTROLLER
FCC I.D.: PLH-ZW4

(3) Instruction Book:

Refer to Exhibit for Instruction Manual.

(4) Description of Circuit Functions:

Refer to Exhibit of Operational Description.

(5) Block Diagram with Frequencies:

Refer to Exhibit of Operational Description.

(6) Report of Measurements:

Follows in this Report.

(7) Photographs: Construction, Component Placement, etc.:

Refer to Exhibit for photographs of equipment.

(8) No Peripheral Equipment was Necessary.

(9) Transition Provisions of 15.37 are not being requested.

(10) Frequency hopping Spread Spectrum transmitters:

Compliance with 15.247(a)(1) and the receiver bandwidth requirement are demonstrated in this report and exhibits.

(11) Not Applicable. The EUT is not a Scanning Receiver.

(12) Not Applicable. The EUT does not operate in the 59-64 GHz frequency band.

2) Equipment Tested

Equipment	Model	FCC I.D.#
EUT	ZW-4 WIRELESS CONTROLLER	PLH-ZW4

3) Equipment Function and Testing Procedures

The EUT is a 902-928 MHz radio transmitter used to transmit data for control of a remote scoreboard for display. The ZW-4 WIRELESS CONTROLLER is a wireless link used for transmitting control information from one location to another. The unit typically operates from a wall power supply connected to the utility power source. The unit has no provision to connect to external peripheral equipment. The transmitter functions in one of two modes determined automatically without user intervention. The modes of operation are as a spread spectrum frequency hopping unit operating with the high power output and as a single channel transmitter operating at the low power setting. Upon power up the device scans the 902-928 frequency band to determine if there are remote displays to control. If a low power single channel device response is found the unit will automatically function in the single channel, low power mode of operation. If a spread spectrum device response is received, the unit will automatically function as a spread spectrum device. The EUT was tested in all standard equipment configurations and through all modes of operation.

4) Equipment and Cable Configurations

Conducted Emission Test Procedure

The unit typically operates from the manufacturer supplied twelve-volt wall supply transformer. For testing purposes, the manufacturer supplied twelve-volt wall transformer was used to power the unit. The test setup including the EUT was arranged in a typical equipment configuration and placed on a 1 x 1.5-meter wooden bench, 0.8 meters high located in a screen room. The power lines of the system were isolated from the power source using a standard LISN with a 50µHy choke. EMI was coupled to the spectrum analyzer through a 0.1 µF capacitor internal to the LISN. The LISN was positioned on the floor beneath the wooden bench supporting the EUT. The power lines and cables were draped over the back edge of the table.

Radiated Emission Test Procedure:

The EUT was placed on a rotatable 1 x 1.5-meter wooden platform, 0.8 meters above the ground plane at a distance of 3 meters from the FSM antenna. EMI energy was maximized by equipment placement, raising and lowering the FSM antenna, changing the antenna polarization, and by rotating the turntable. Each emission was maximized before data was taken using a spectrum analyzer. Refer to photographs in the test setup exhibit for EUT placement.

5) List of Test Equipment

A Hewlett Packard 8591EM Spectrum Analyzer was used as the measuring device for the emissions testing of frequencies below 1 GHz. A Hewlett Packard 8562A Spectrum Analyzer was used as the measuring device for testing the emissions at frequencies above 1 GHz. The analyzer settings used are described in the following table. Refer to the appendix for a complete list of Test Equipment.

HP 8591 EM ANALYZER SETTINGS		
CONDUCTED EMISSIONS:		
RBW	AVG. BW	DETECTOR FUNCTION
9 kHz	30 kHz	Peak / Quasi Peak
RADIATED EMISSIONS:		
RBW	AVG. BW	DETECTOR FUNCTION
120 kHz	300 kHz	Peak / Quasi Peak
HP 8562A ANALYZER SETTINGS		
RBW	VIDEO BW	DETECTOR FUNCTION
100 kHz	100 kHz	PEAK
1 MHz	1 MHz	Peak / Average

EQUIPMENT	MFG.	MODEL	CAL. DATE	DUE.
LISN	Comp. Design	FCC-LISN-2-MOD.CD	10/03	10/04
LISN	Comp. Design	1762	2/04	2/05
Antenna	ARA	BCD-235-B	10/03	10/04
Antenna	EMCO	3147	10/03	10/04
Antenna	EMCO	3143	5/04	5/05
Analyzer	HP	8591EM	5/04	5/05
Analyzer	HP	8562A	2/04	2/05

6) Units of Measurements

Conducted EMI: Data is in dBµV; dB referenced to one microvolt.

Radiated EMI: Data is in dBµV/m; dB/m referenced to one microvolt per meter.

7) Test Site Locations

Conducted EMI: The AC powerline conducted emissions tests were performed in a shielded screen room located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS.

Radiated EMI: The radiated emissions tests were performed At the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS.

Site Approval: Refer to Appendix for FCC Site Approval Letter, Reference # 90910.

8) SUBPART B – UNINTENTIONAL RADIATORS

Conducted EMI

The EUT was arranged in a typicalequipment configuration and placed on a 1 x 1.5-meter wooden bench 80 cm above the conducting ground plane, floor of a screen room. The bench was positioned 40 cm away from the wall of the screen room. The LISN was positioned on the floor of the screenroom 80-cm from the rear of the EUT. The manufacturer supplied AC power

wall adapter for the EUT was connected to the LISN. A second LISN was positioned on the floor of the screen room 80 cm from the rear of the supporting equipment of the EUT. All power cords except the EUT were then powered from the second LISN. EMI was coupled to the spectrum analyzer through a 0.1 µF capacitor, internal to the LISN. Power line conducted emissions testing were carried out individually for each current carrying conductor of the EUT. The excess length of lead between the system and the LISN receptacle was folded back and forth to form a bundle not exceeding 40 cm in length. The screen room, conducting ground plane, analyzer, and LISN were bonded together to the protective earth ground. Preliminary testing was performed to identify the frequency of each radio frequency emission displaying the highest amplitude. The cables were repositioned to obtain maximum amplitude of measured EMI level. Once the worst-case configuration was identified, plots were made of the EMI from 0.15 MHz to 30 MHz then the data was recorded with maximum conducted emissions levels. Refer to figures one and two for plots of the conducted emissions.

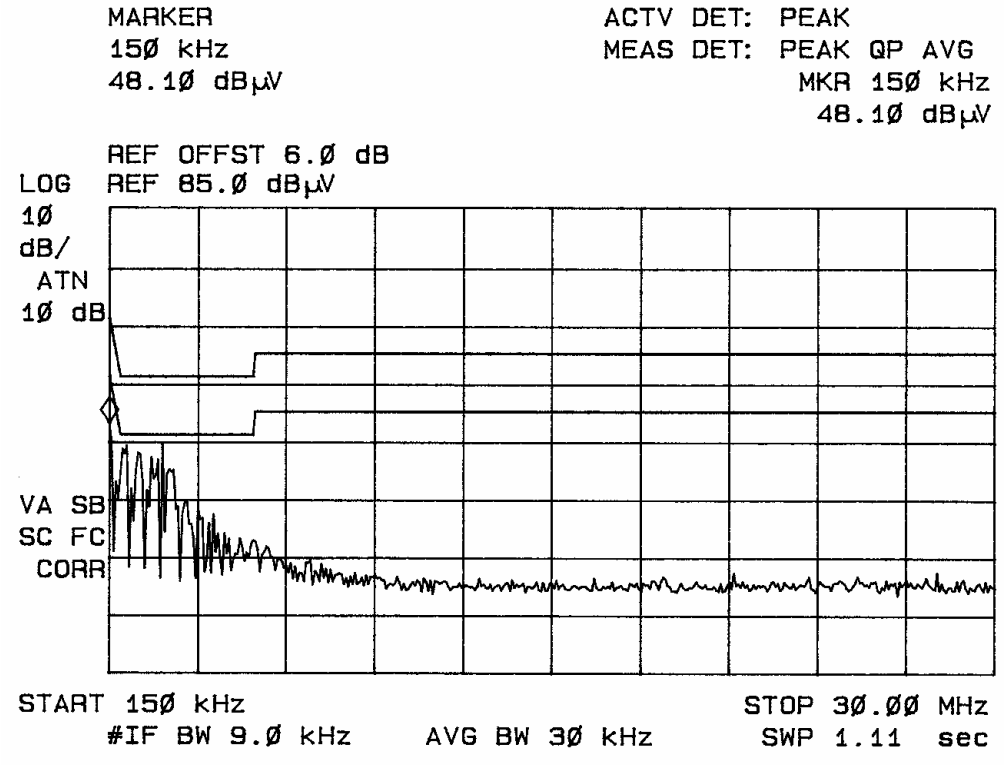

Figure 1 Conducted Emissions Line 1.

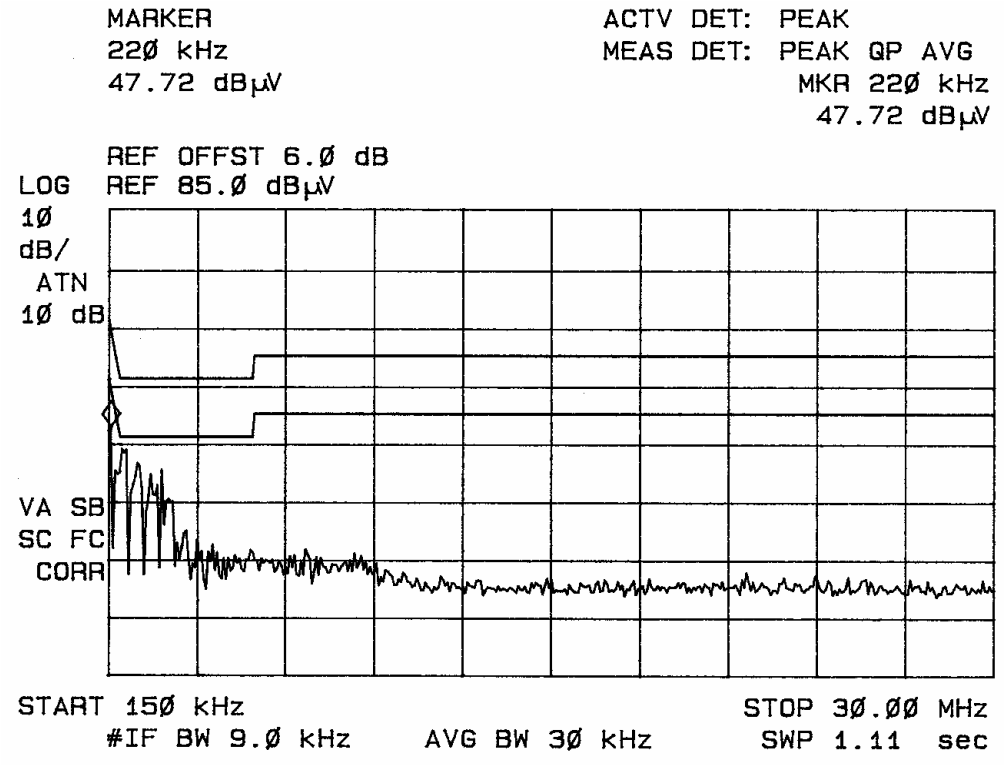

Figure 2 Conducted Emissions Line 2.

Radiated EMI

The EUT was arranged in a typical equipment configuration and operated through all of its various modes. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Radiated emissions measurements were performed to identify the frequencies, which produced the highest emissions. Plots were made of the frequency spectrum from 30 MHz to 10,000 MHz for the preliminary testing. Refer to figures three through six for plots of the radiated emissions spectrum taken in a screen room for the 15.247 mode of operation and figures seven through 10 for plots of the radiated emissions spectrum taken in a screen room for the 15.249 mode of operation. The highest radiated emission was then re-maximized at this location before final radiated emissions measurements were performed. Final data was taken with the EUT located at the OATS at a distance of 3 meters between the EUT and the receiving antenna. The frequency spectrum from 30 MHz to 10,000 MHz was searched for radiated emissions. Measured emission levels were maximized by EUT placement on the table, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna position between horizontal and vertical polarization. Antennas used were Broadband Biconical from 30 to 200 MHz, Biconilog from 30 to 1000 MHz, Log Periodic from 200 MHz to 5 GHz and or, pyramidal

horns and mixers from 4 GHz to 10 GHz, notch filters and appropriate amplifiers were utilized.

Sample Calculations:

RFS = Radiated Field Strength

dBµV/m @ 3m = dBµV + A.F. - Amplifier Gain

dBµV/m @ 3m = 40.1 + 8.0 - 30

= 18.1

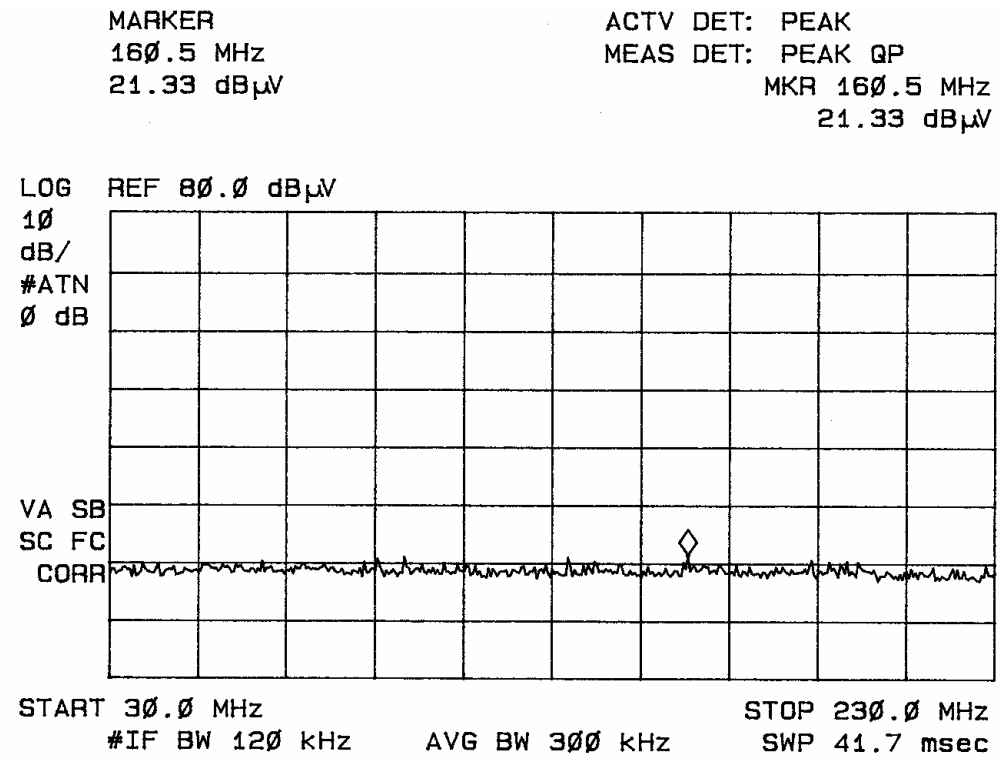

Figure 3 Radiated Emissions taken at 1 meter in screen room.

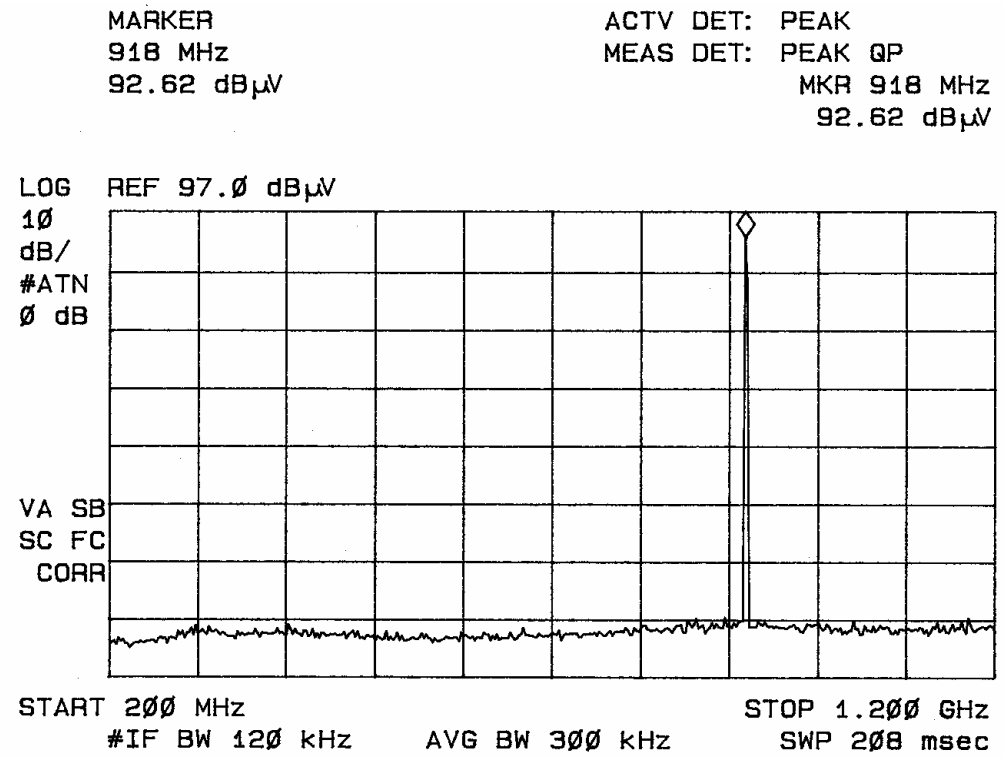

Figure 4 Radiated Emissions taken at 1 meter in screen room.

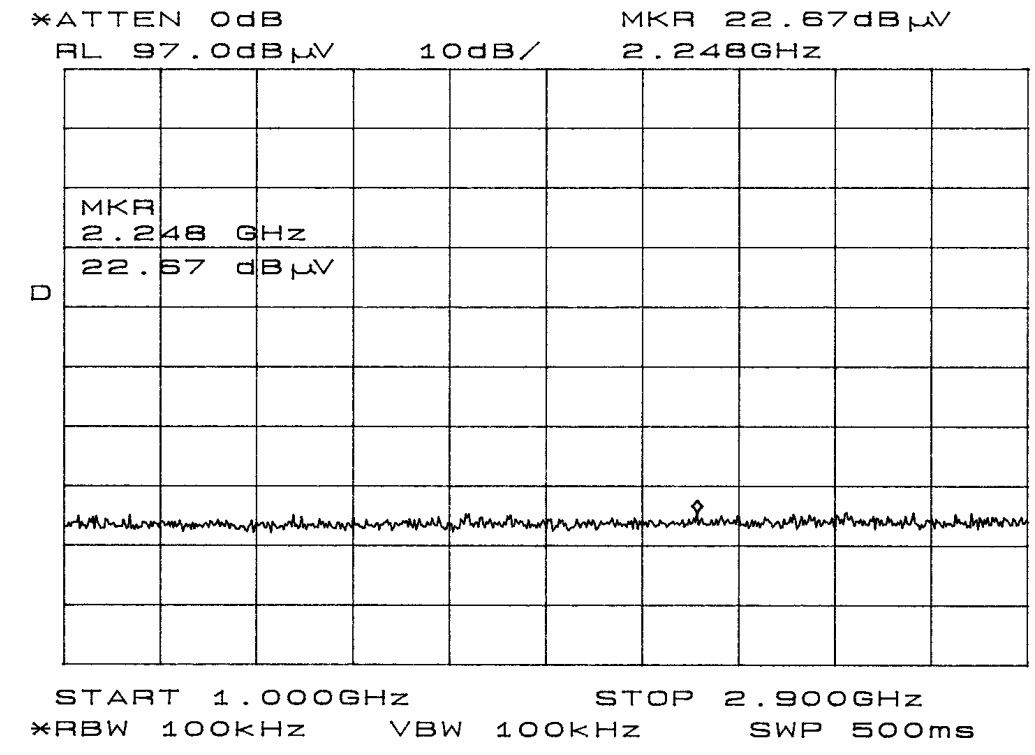

Figure 5 Radiated Emissions taken at 1 meter in screen room

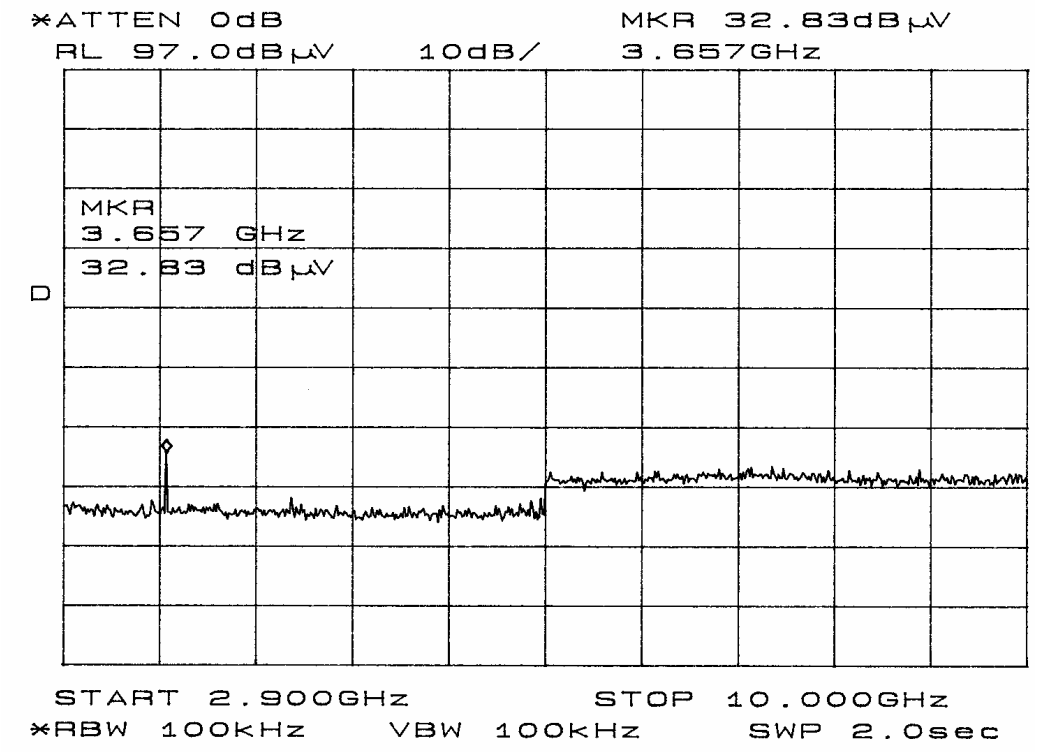

Figure 6 Radiated Emissions taken at 1 meter in screen room

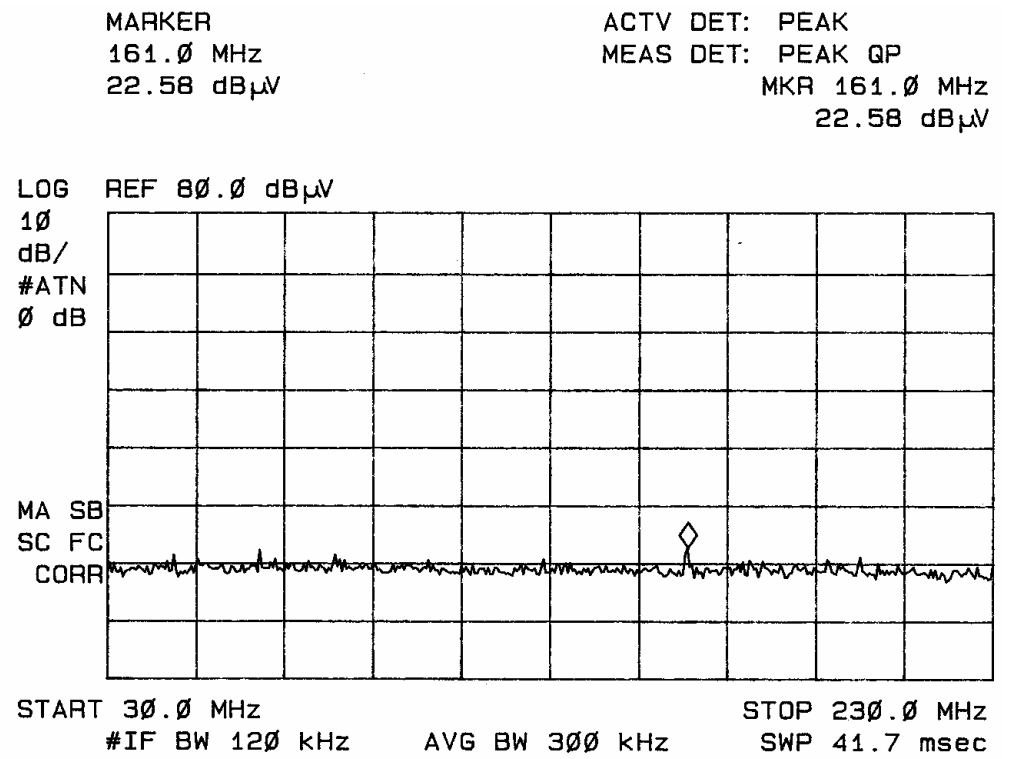

Figure 7 Radiated Emissions taken at 1 meter in screen room.

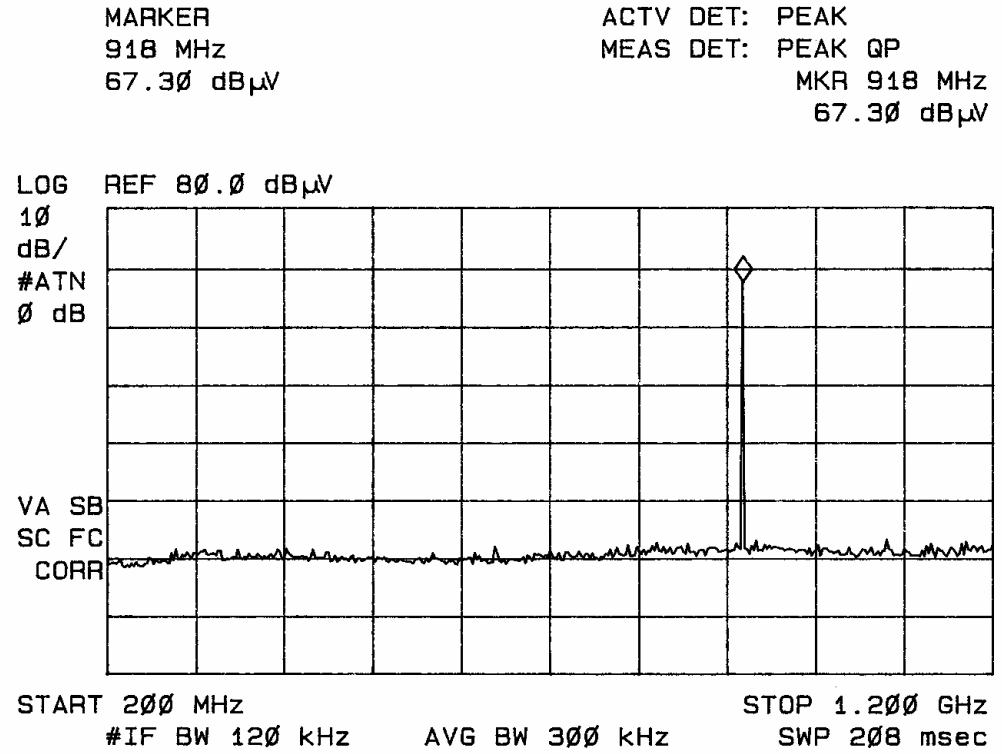

Figure 8 Radiated Emissions taken at 1 meter in screen room.

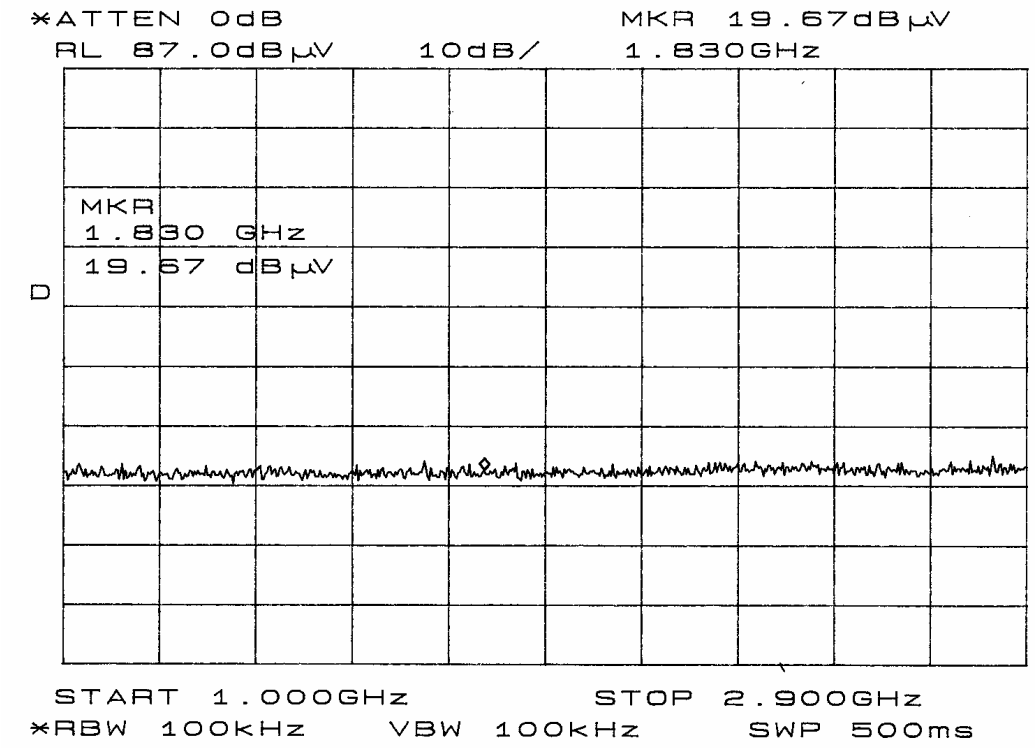

Figure 9 Radiated Emissions taken at 1 meter in screen room.

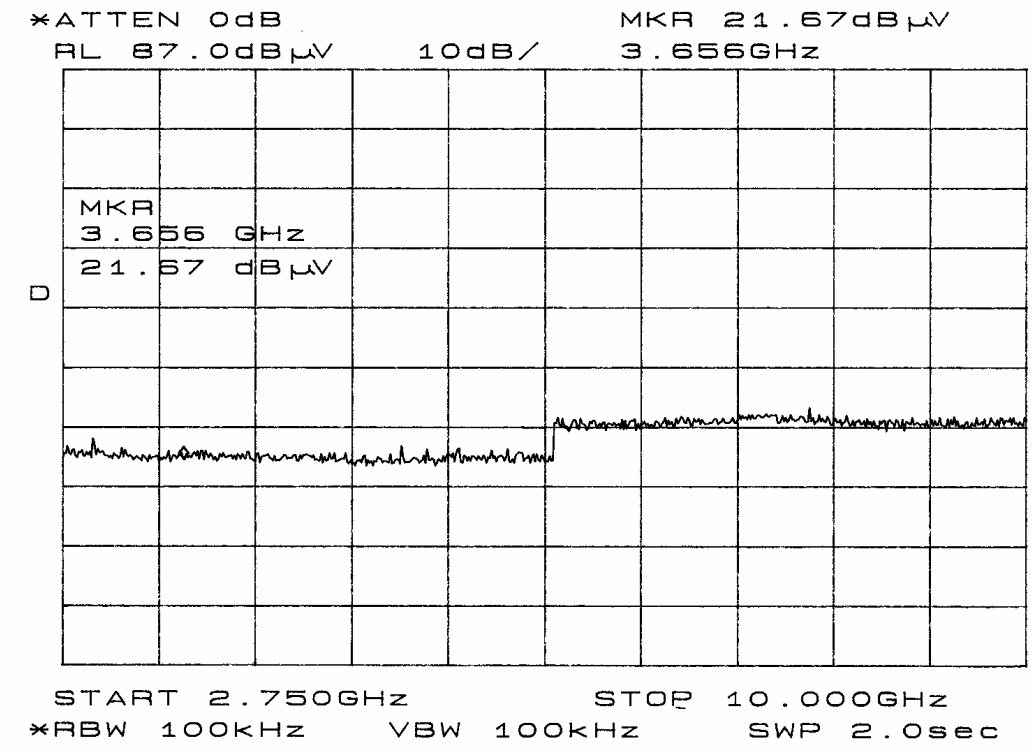

Figure 10 Radiated Emissions taken at 1 meter in screen room.

Data: Conducted Emissions (7 Highest Emissions)

Frequency band (MHz)	L1 Level (dBµV)			L2 Level (dBµV)			CISPR 22 Limit Q.P. Ave(dBµV)
	Peak	Q.P.	AVE	Peak	Q.P.	AVE	
0.15 – 0.5	48.1	40.9	19.5	47.7	43.6	29.1	66 – 56 / 56 - 46
0.5 – 5	45.4	44.3	36.0	44.7	44.0	41.9	56 / 46
5 – 10	28.0	24.3	13.3	27.6	23.4	12.3	60 / 50
10 – 15	19.7	15.2	8.9	22.5	17.3	9.6	60 / 50
15 – 20	19.7	15.1	8.8	20.1	15.9	9.1	60 / 50
20 – 25	22.7	15.1	8.9	21.3	15.9	9.2	60 / 50
25 – 30	20.6	15.2	9.0	20.8	15.4	9.0	60 / 50

Other emissions present had amplitudes at least 10 dB below the limit.

Data: General Radiated Emissions from EUT (6 Highest Emissions)

Frequency in MHz	FSM Horz. (dBµV)	FSM Vert. (dBµV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	FCC Class B Limit @ 3m (dBµV/m)
81.0	40.1	46.0	8.0	30	18.1	24.0	40.0
112.0	42.3	38.6	7.1	30	19.4	15.7	43.5
128.0	51.2	48.9	7.9	30	29.1	26.8	43.5
160.0	48.6	40.7	8.9	30	27.5	19.6	43.5
192.0	40.0	39.8	10.7	30	20.7	20.5	43.5
309.6	36.2	37.2	14.1	30	20.3	21.3	46.0

Other emissions present had amplitudes at least 10 dB below the limit.

Summary of Results for Conducted Emissions

The conducted emissions for the EUT meet the requirements for CISPR 22 and FCC Part 15B CLASS B Digital Devices. The EUT had an 11.7 dB (Quasi-Peak) minimum margin below the limit, and a 4.1 dB minimum margin below the CISPR average limit. Measurements were taken using the peak, quasi peak, and average, measurement function for each emissions amplitude and were below the limits stated in the specification. Other emissions were present with recorded data representing worst-case amplitudes.

Summary of Results for Radiated Emissions

The radiated emissions for the EUT meet the requirements for CISPR 22 and FCC Part 15B CLASS B Digital Devices. The EUT had a 14.4 dB minimum margin below the Quasi-Peak limit. Other emissions were present with amplitudes at least 10 dB below the limit.

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to meet the CISPR 22 or FCC Part 15B CLASS B emissions standards. There were no deviations to the specifications.

9) Subpart C - Intentional Radiators

As per CFR Part 15, Subpart C, paragraphs 15.247 and 15.249 the following information is submitted.

15.203 Antenna Requirements

The unit is produced with a permanently attached antenna and is not user serviceable or removable. The requirements of 15.203 are met there are no deviations or exceptions to the specification.

15.205 Restricted Bands of Operation

Spurious emissions falling in the restricted frequency bands of operation were measured at the OATS. The EUT utilizes frequency, determining circuitry, which generates harmonics falling in the restricted bands. Emissions were checked at the OATS, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. No other significant emission was observed which fell into the restricted bands of operation.

Sample Calculations:
RFS (dBµV/m @ 3m) = FSM(dBµV) + A.F.(dB)- Gain(dB)
= 42.3 + 7.1 - 30
= 19.4

Data: Emissions in Restricted Bands

Frequency in MHz	FSM Horz. (dBµV)	FSM Vert. (dBµV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	FCC Class B Limit @ 3m (dBµV/m)
112.0	42.3	38.6	7.1	30	19.4	15.7	40.0
128.0	51.2	48.9	7.9	30	29.1	26.8	43.5
2707.2	21.0	33.1	35.5	22.5	34.0	46.1	54.0
2745.0	24.3	21.5	35.3	22.5	37.1	34.3	54.0
2782.8	30.5	24.8	35.5	22.5	43.5	37.8	54.0
3609.6	23.6	26.6	39.8	22.5	40.9	43.9	54.0
3660.0	26.5	28.5	39.8	22.5	43.8	45.8	54.0
3710.4	27.1	30.3	39.8	22.5	44.4	47.6	54.0
4512.0	21.5	25.0	44.3	22.5	43.3	46.8	54.0
4575.0	22.5	22.8	44.2	22.5	44.2	44.5	54.0
4638.0	24.3	25.8	44.0	22.5	45.8	47.3	54.0

Summary of Results for Radiated Emissions in Restricted Bands:

The radiated emissions for the EUT meetthe requirements for FCC Part 15C Intentional Radiators. The EUT had a 6.4-dB minimum margin below the limits. No other emissions where found in the restricted frequency bands Other emissions were present with amplitudes at least 10 dB below the FCC limits.

15.209 Radiated Emissions Limits; General Requirements

Radiated EMI

The EUT was arranged in a typical equipment configuration and operated through all of its various modes. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Radiated emissions measurements were performed to identify the frequencies, which produced the highest emissions. Emissions were checked in the screen room from 30 to 10,000 MHz and plots were made of the frequency

spectrum from 30 MHz to 10,000 MHz for the preliminary testing. The highest radiated emission was then re-maximized at this location before final radiated emissions measurements were performed. Final data was taken with the EUT located at the open field test site at a distance of 3 meters between the EUT and the receiving antenna. The frequency spectrum from 30 MHz to 10,000 MHz was searched for radiated emissions. Measured emission levels were maximized by EUT placement on the table, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna polarization between horizontal and vertical. Antennas used were Broadband Biconical from 30 MHz to 200 MHz, Biconilog from 30 MHz to 1000 MHz, Log Periodic from 200 MHz to 5 GHz, and/or Pyramidal Horns from 4 GHz to 10 GHz.

Sample Calculations:

RFS = Radiated Field Strength

dBµV/m @ 3m = dBµV + A.F.- Amplifier Gain

dBµV/m @ 3m = 40.1 + 8.0 - 30

= 18.1

Data: General Radiated Emissions from EUT (6 Highest Emissions)

Frequency in MHz	FSM Horz. (dBµV)	FSM Vert. (dBµV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	FCC Class B Limit @ 3m (dBµV/m)
81.0	40.1	46.0	8.0	30	18.1	24.0	40.0
112.0	42.3	38.6	7.1	30	19.4	15.7	43.5
128.0	51.2	48.9	7.9	30	29.1	26.8	43.5
160.0	48.6	40.7	8.9	30	27.5	19.6	43.5
192.0	40.0	39.8	10.7	30	20.7	20.5	43.5
309.6	36.2	37.2	14.1	30	20.3	21.3	46.0

Other emissions present had amplitudes at least 10 dB below the limit.

Summary of Results for Radiated Emissions:

The radiated emissions for the EUT meet the requirements for FCC Part 15C Intentional Radiators. The EUT had a 14.4 dB minimum margin below the quasi-peak limits. Other emissions were present with amplitudes at least 10 dB below the FCC Limits.

15.247 Operation in the Band 902-928 MHz

The power output was measured on an open field test site at a three-meter distance. Data was taken per Paragraph 2.1046(a) and 15.247. The 902 and 928 MHz band edges are protected due to the 902.4 – 927.6 MHz channels used for frequency of operation. Refer to figures eleven through fifteen showing plots taken for the EUT displaying compliance with the specifications.

(a) The EUT is a frequency hopping spread spectrum intentional radiator utilizing at least 25 hopping channels. The 20-dB bandwidth of 280 kHz meets the requirements of

greater than 250 and less than 500 kHz wide with the average time of occupancy on any frequency not greater than 0.4 seconds within a ten-second-time period.

Information showing compliance for time of occupancy and hopping sequence are displayed below.

The ZW-4 WIRELESS CONTROLLER continuously steps through a list of 53 channel frequencies, dwelling on channel for of 2.05 milliseconds per frequency. This equates to one channel taking 2.05 mS to complete, moving through the 53 channels takes 108.65 milliseconds. During a 20 second period, each channel will be active for 20/0.10865 or 184 times. Since the channel is active for 2.05 mS, the total channel occupancy for a 20 second interval is 184 times 2.05 mS which equates to 377.3 mS, which is below the 400 mS within a 20 second period requirement. The frequencies are spaced 300 kilohertz apart and the sequence was determined at random.

(b) The maximum peak output power of the unit was measured at the open area test site since the unit has provision to connect to the antenna port. The amplitudes of each emission and spurious emission were measured at a distance of 3 meters from the FSM antenna at the OATS. The amplitude of each emission was maximized by varying the FSM antenna height, polarization, and by rotating the turntable. A Biconilog Antenna was used for measuring emissions from 30 to 1000 MHz, Log Periodic Antenna for 200 to 5000 MHz, and Pyramidal Horn Antennas from 4 GHz to 10 GHz. Emissions were measured in dBµV/m at three-meters.

Sample calculation.

dBµv/m@ 3m = FSM + A.F. - cable loss - amplifier gain
= 105.8 + 23.2 – 2.5 - 25
= 106.5

(c) The band edges are protected due to the frequency of operation of the EUT.

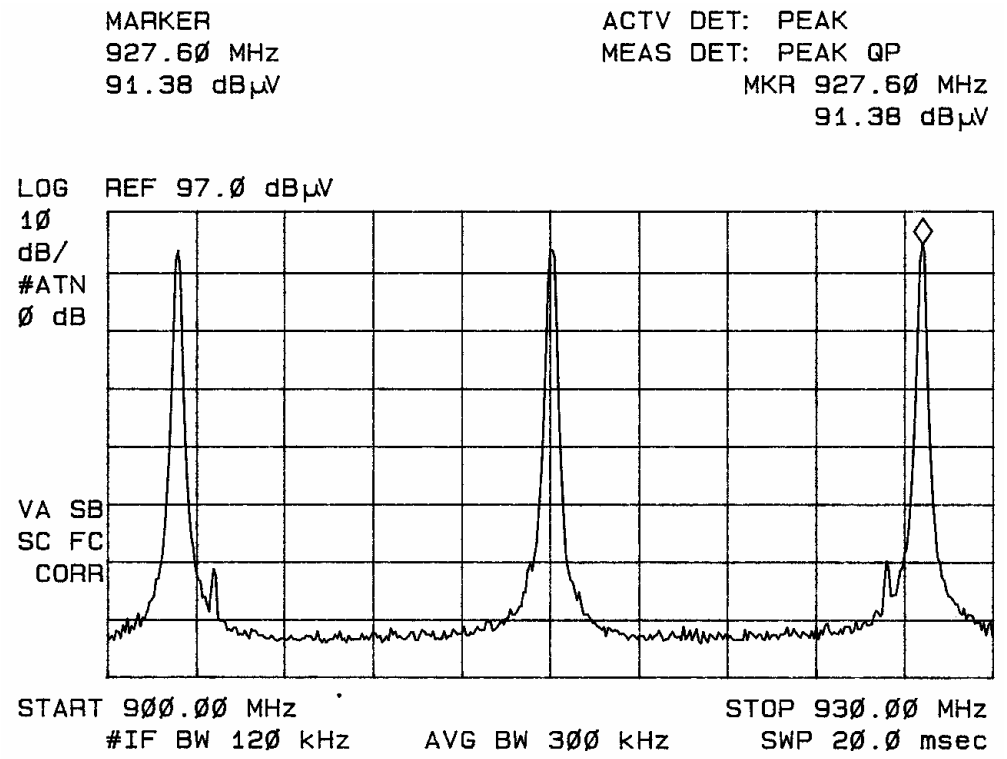

Figure 11 Maximum Power output (data taken with near field probe in screen room.)

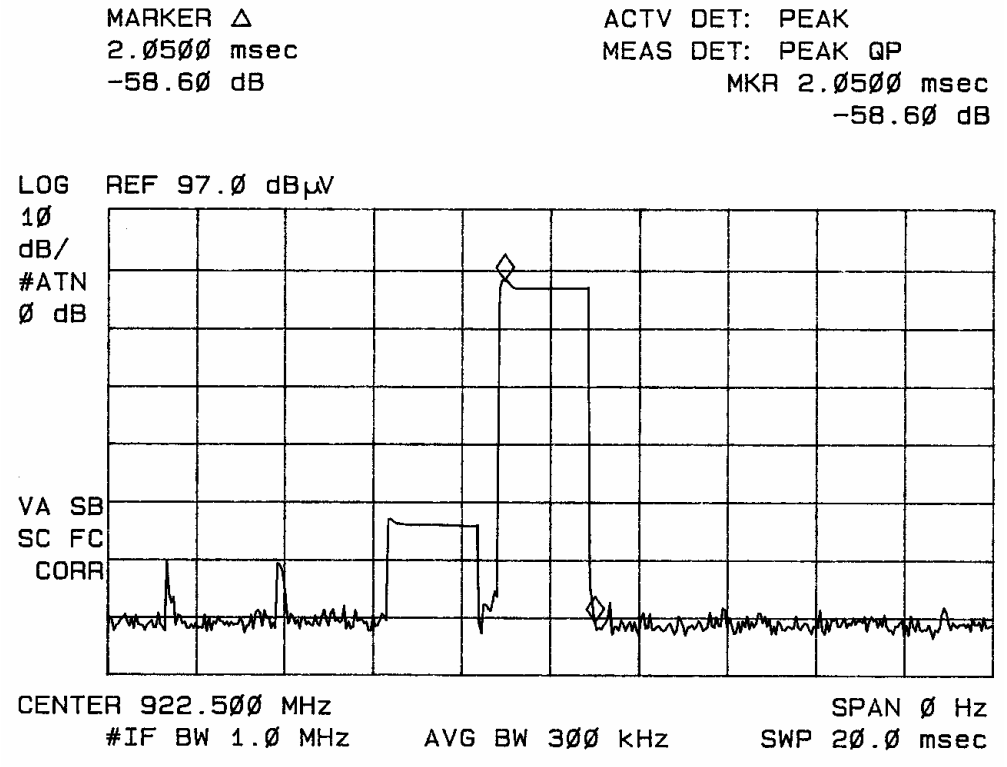

Figure 12 Dwell Time of Occupancy.

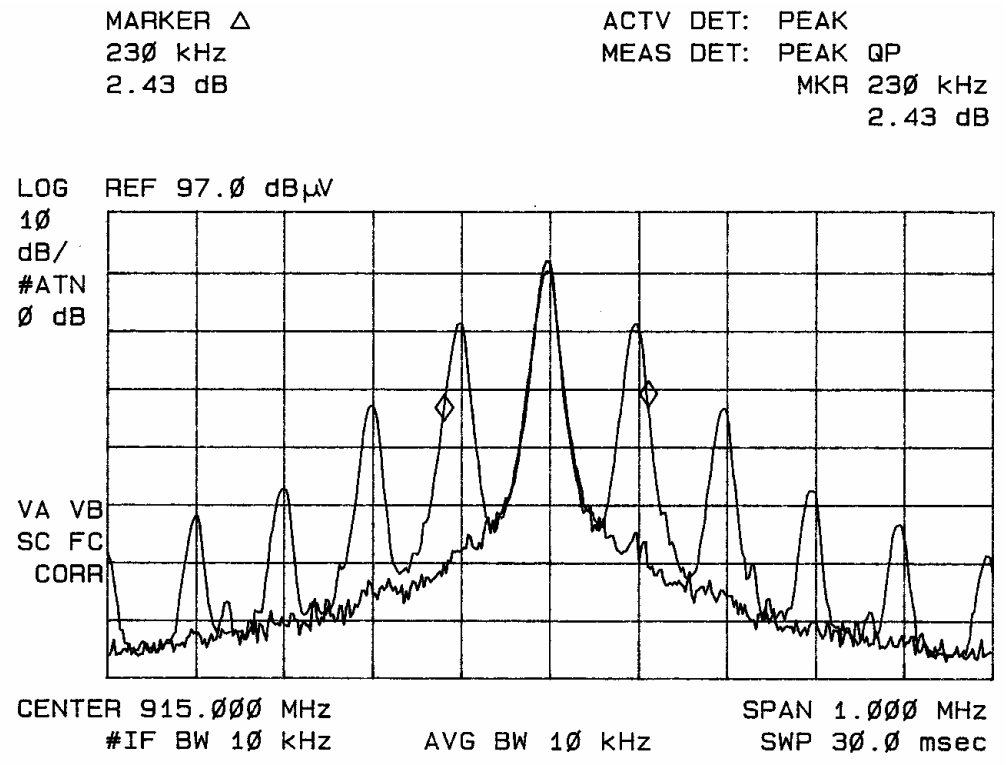

Figure 13 20-dB bandwidth.

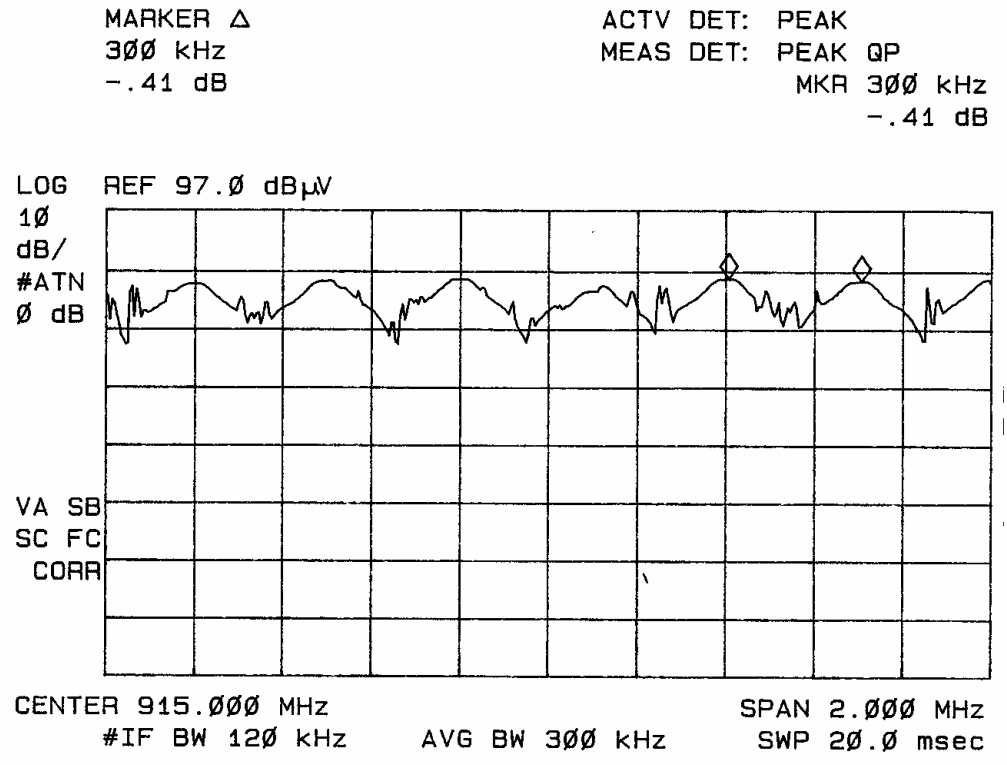

Figure 14 Channel Spacing.

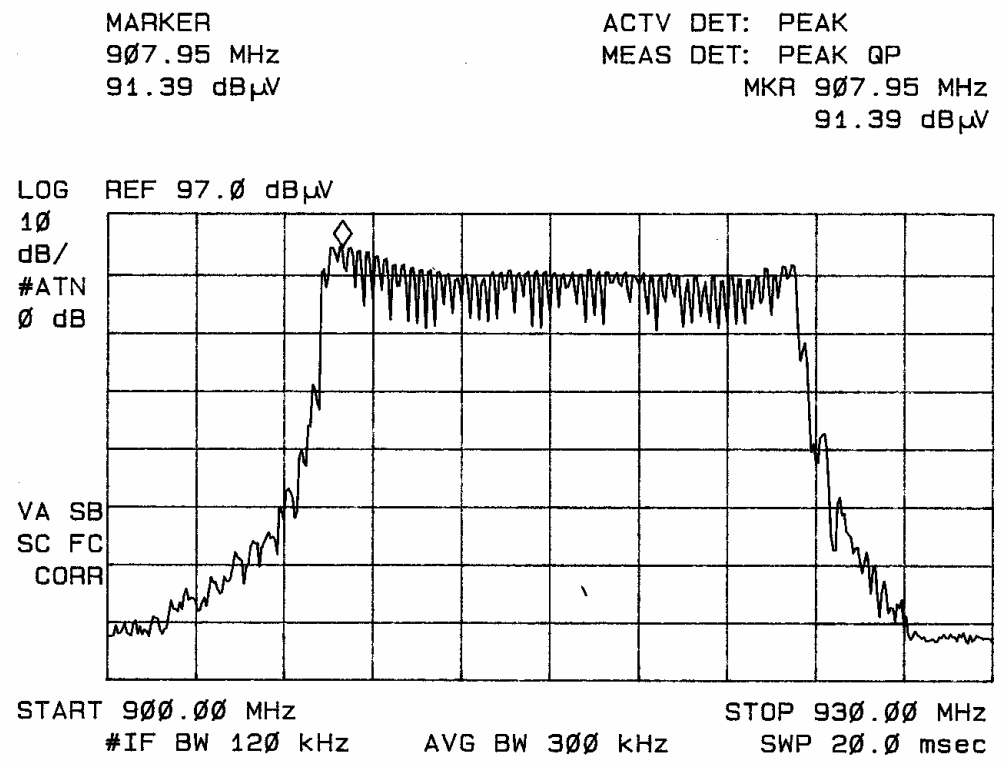

Figure 15 plot showing at least 50 hopping channels.

Data: Radiated Emissions from EUT

Emission Frequency (MHz)	FSM Horz. (dBµV)	FSM Vert. (dBµV)	Ant. Factor (dB)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	Limit @ 3m (dBµV/m)
902.4	105.8	107.1	23.2	22.5	106.5	107.8	- -
1804.8	33.3	37.0	29.9	22.5	40.7	44.4	54.0
2707.2	21.0	33.1	35.5	22.5	34.0	46.1	54.0
3609.6	23.6	26.6	39.8	22.5	40.9	43.9	54.0
4512.0	21.5	25.0	44.3	22.5	43.3	46.8	54.0
915.0	105.7	106.8	23.7	22.5	106.9	108.0	- -
1830.0	30.8	36.6	29.7	22.5	38.0	43.8	54.0
2745.0	24.3	21.5	35.3	22.5	37.1	34.3	54.0
3660.0	26.5	28.5	39.8	22.5	43.8	45.8	54.0
4575.0	22.5	22.8	44.2	22.5	44.2	44.5	54.0
927.6	99.8	101.7	24.1	22.5	101.4	103.3	- -
1855.2	27.6	30.5	29.6	22.5	34.7	37.6	54.0
2782.8	30.5	24.8	35.5	22.5	43.5	37.8	54.0
3710.4	27.1	30.3	39.8	22.5	44.4	47.6	54.0
4638.0	24.3	25.8	44.0	22.5	45.8	47.3	54.0

Data: Antenna Substitution Method for 15.247

Frequency of Emission	Measured Amplitude of EUT emission		Signal level to substitution antenna required to reproduce	
	Horizontal	Vertical	Horizontal	Vertical
(MHz)	dBm	dBm	dBm	dBm
902.4	-1.2	0.1	8.5	9.2
915.0	-1.3	0.8	7.5	8.7
927.6	-7.2	-5.3	2.8	3.7

Summary of Results for Radiated Emissions of Intentional Radiator

The EUT had a 6.4 dB margin below the limit for the harmonic emissions. The radiated emissions for the EUT meet the requirements for FCC Part 15.247 Intentional Radiators. There are no measurable emissions in the restricted bands other than those recorded in this report. Other emissions were present with amplitudes at least 10 dB below the FCC Limits. The specification of 15.247 are met, there are no deviations or exceptions to the requirements.

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to meet the FCC Part 15C emissions standards. There were no deviations to the specifications.

15.249 Operation in the Band 902-928 MHz

The power output was measured on an open field test site @ 3 meters. Data was taken per Paragraph 2.1046(a) and 15.249.

(a) The EUT was placed on a wooden turntable 0.8 meters above the ground plane and at a distance of 3 meters from the FSM antenna. The amplitude of the carrier frequency was measured using a spectrum analyzer. The amplitude of the emission was then recorded from the analyzer display.

(b) Emissions radiated outside of the specified bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in 15.209, whichever is the lesser attenuation. The amplitudes of each spurious emission were measured at a distance of 3 meters from the FSM antenna at the OATS. The amplitude of each spurious emission was maximized by varying the FSM antenna height, polarization, and by rotating the turntable. A Biconilog Antenna was used for measuring emissions from 30 to 1000 MHz, a Log Periodic Antenna for 200 to 5000 MHz, and Pyramidal Horn Antennas from 4 GHz to 10 GHz. Emissions were measured in dBµV/m @ 3 meters.

Sample calculation.

dBµv/m@ 3m = FSM + A.F. - cable loss - amplifier Gain
= 81.7 + 23.7 – 2.5 - 25
= 82.4

Data: Radiated Emissions from EUT

Emission Frequency (MHz)	FSM Horz. (dBµV)	FSM Vert. (dBµV)	Ant. Factor (dB)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	Limit @ 3m (dBµV/m)
902.4	84.7	89.3	23.2	22.5	85.4	90.0	94
1804.8	24.3	24.0	29.9	22.5	31.7	31.4	54
2707.2	24.3	24.6	35.5	22.5	37.3	37.6	54
3609.6	24.5	25.0	39.8	22.5	41.8	42.3	54
4512.0	24.3	24.3	44.3	22.5	46.1	46.1	54
915.0	79.6	81.8	23.7	22.5	80.8	83.0	94
1830.0	25.5	29.3	29.7	22.5	32.7	36.5	54
2745.0	24.0	24.1	35.3	22.5	36.8	36.8	54
3660.0	24.6	24.8	39.8	22.5	41.9	42.1	54
4575.0	24.3	24.6	44.2	22.5	46.0	46.3	54
927.6	78.0	80.8	24.1	22.5	79.6	82.4	94
1855.2	24.3	24.8	29.6	22.5	31.4	31.9	54
2782.8	24.0	24.1	35.5	22.5	37.0	37.1	54
3710.4	24.3	26.0	39.8	22.5	41.6	43.3	54
4638.0	23.1	24.0	44.0	22.5	44.6	45.5	54

Note: Level was measured @ 3 meter site.

Data: Antenna Substitution Method for 15.249

Frequency of Emission	Measured Amplitude of EUT emission		Signal level to substitution antenna required to reproduce	
	Horizontal	Vertical	Horizontal	Vertical
(MHz)	dBm	dBm	dBm	dBm
902.4	-22.3	-17.7	-13.0	-6.5
915.0	-27.4	-25.2	-17.2	-15.5
927.6	-29.0	-26.2	-20.0	-16.3

Summary of Results for Radiated Emissions of Intentional Radiator

The EUT had a 4.0 dB margin below the limit for the fundamental emission and a 7.7 dB margin below the limit for the harmonic emissions. The radiated emissions for the EUT meet the requirements for FCC Part 15.249 Intentional Radiators. There are no measurable emissions in the restricted bands other than those recorded in this report. Other emissions were present with amplitudes at least 10 dB below the FCC Limits. The specification of 15.204 are met, there are no deviations or exceptions to the requirements.

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to meet the FCC Part 15C emissions standards. There were no deviations to the specifications.

APPENDIX

Model: ZW-4 WIRELESS CONTROLLER

1. Test Equipment List
2. Rogers Qualifications
3. FCC Site Approval Letter

TEST EQUIPMENT LIST FOR ROGERS LABS, INC.

The test equipment used is maintained in calibration and good operating condition. Use of this calibrated equipment ensures measurements are traceable to national standards.

List of Test Equipment:	Calibration Date:
Scope: Tektronix 2230	2/04
Wattmeter: Bird 43 with Load Bird 8085	2/04
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/04
H/V Power Supply: Fluke Model: 408B (SN: 573)	2/04
R.F. Generator: HP 606A	2/04
R.F. Generator: HP 8614A	2/04
R.F. Generator: HP 8640B	2/04
Spectrum Analyzer: HP 8562A,	2/04
Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	
HP Adapters: 11518, 11519, 11520	
Spectrum Analyzer: HP 8591 EM	5/04
Frequency Counter: Leader LDC 825	2/04
Antenna: EMCO Biconilog Model: 3143	5/04
Antenna: EMCO Log Periodic Model: 3147	10/03
Antenna: Antenna Research Biconical Model: BCD 235	10/03
Antenna: EMCO Dipole Set 3121C	2/04
Antenna: C.D. B-101	2/04
Antenna: Solar 9229-1 & 9230-1	2/04
Antenna: EMCO 6509	2/04
Audio Oscillator: H.P. 201CD	2/04
R.F. Power Amp 65W Model: 470-A-1010	2/04
R.F. Power Amp 50W M185-10-501	2/04
R.F. PreAmp CPPA-102	2/04
LISN 50 µHy/50 ohm/0.1 µf	10/03
LISN Compliance Eng. 240/20	2/04
Peavey Power Amp Model: IPS 801	2/04
Power Amp A.R. Model: 10W 1010M7	2/04
Power Amp EIN Model: A301	2/04
ELGAR Model: 1751	2/04
ELGAR Model: TG 704A-3D	2/04
ESD Test Set 2010i	2/04
Fast Transient Burst Generator Model: EFT/B-101	2/04
Current Probe: Singer CP-105	2/04
Current Probe: Solar 9108-1N	2/04
Field Intensity Meter: EFM-018	2/04
KEYTEK Ecat Surge Generator	2/04
Shielded Room 5 M x 3 M x 3.0 M (101 dB Integrity)	

5/20/2004

QUALIFICATIONS

Of

SCOT D. ROGERS, ENGINEER

ROGERS LABS, INC.

Mr. Rogers has approximately 16 years experience in the field of electronics. Six years working in the automated controls industry and 6 years working with the design, development and testing of radio communications and electronic equipment.

POSITIONS HELD:

Systems Engineer:	A/C Controls Mfg. Co., Inc. 6 Years
Electrical Engineer:	Rogers Consulting Labs, Inc. 5 Years
Electrical Engineer:	Rogers Labs, Inc. Current

EDUCATIONAL BACKGROUND:

1) Bachelor of Science Degree in Electrical Engineering from Kansas State University.

2) Bachelor of Science Degree in Business Administration Kansas State University.

3) Several Specialized Training courses and seminars pertaining to Microprocessors and Software programming.

Scot D Rogers

Scot D. Rogers

June 10, 2004
Date

1/11/03

FEDERAL COMMUNICATIONS COMMISSION

Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046

August 15, 2003

Registration Number: 90910

Rogers Labs, Inc.
4405 West 259th Terrace
Louisburg, KS 66053

Attention: Scot Rogers

Re: Measurement facility located at Louisburg
3 & 10 meter site
Date of Renewal: August 15, 2003

Dear Sir or Madam:

Your request for renewal of the registration of the subject measurement facility has been received. The information submitted has been placed in your file and the registration has been renewed. The name of your organization will remain on the list of facilities whose measurement data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Please note that the file must be updated for any changes made to the facility and the registration must be renewed at least every three years.

Measurement facilities that have indicated that they are available to the public to perform measurement services on a fee basis may be found on the FCC website www.fcc.gov under E-Filing, OET Equipment Authorization Electronic Filing, Test Firms.

Sincerely,

Ms. Phyllis Parrish
Information Technician