

ROGERS LABS, INC.

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

**ENGINEERING TEST REPORT
FOR
APPLICATION of
GRANT of CERTIFICATION**

FOR
CFR 47, PART 15C - INTENTIONAL RADIATORS
Paragraph 15.247
Spread Spectrum Frequency Hopping System

For

NEVCO SCOREBOARD COMPANY

301 East Harris Avenue
Greenville, IL 62246
Mary Gayle Nevinger,
President

WIRELESS CONTROLLER
Model: ZW-3 WIRELESS CONTROLLER
Frequency 902-928 MHz
FCC ID#: PLH-ZW3

Test Date: April 24, 2002

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:	3
1) APPLICABLE STANDARDS & TEST PROCEDURES	3
2.1033(b) Application for Certification	4
2) EQUIPMENT TESTED	5
3) EQUIPMENT FUNCTION AND TESTING PROCEDURES	5
4) EQUIPMENT AND CABLE CONFIGURATIONS	5
Conducted Emission Test Procedure	5
Radiated Emission Test Procedure:	6
5) LIST OF TEST EQUIPMENT	6
6) UNITS OF MEASUREMENTS	7
7) TEST SITE LOCATIONS	8
8) SUBPART B – UNINTENTIONAL RADIATORS	8
Conducted EMI	8
Radiated EMI	12
Data: Conducted Emissions (7 Highest Emissions OEM Power supply)	15
Data: Conducted Emissions (7 Highest Emissions Phihong power supply)	16
Data: General Radiated Emissions from EUT (6 Highest Emissions)	16
Summary of Results for Conducted Emissions	16
Summary of Results for General Radiated Emissions	17
Statement of Modifications and Deviations	17
9) SUBPART C - INTENTIONAL RADIATORS	17
15.203 Antenna Requirements	17
15.205 Restricted Bands of Operation	17
Data: Emissions in Restricted Bands	18
Summary of Results for Radiated Emissions in Restricted Bands:	18
15.209 Radiated Emissions Limits; General Requirements	19
Radiated EMI	19
Data: General Radiated Emissions from EUT (6 Highest Emissions)	20
Summary of Results for General Radiated Emissions:	20
15.247 Operation in the Band 902-928 MHz	20
Data: Radiated Emissions from EUT	26
Summary of Results for Radiated Emissions of Intentional Radiator	26
Statement of Modifications and Deviations	27

FORWARD:

The following is submitted for consideration in obtaining a Grant of Certification for spread spectrum frequency hopping intentional radiators per CFR Paragraph 15.247.

Name of Applicant:

NEVCO SCOREBOARD COMPANY
301 East Harris Avenue
Greenville, IL 62246

Model: ZW-3 WIRELESS CONTROLLER Spread Spectrum Frequency Hopping Controller System

FCC I.D.: PLH-ZW3.

Frequency Range: 902-928 MHz.

Operating Power: 200 mW Effective Radiated power.

1) Applicable Standards & Test Procedures

a) In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2000, 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 Paragraph 15.247 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-3 WIRELESS CONTROLLER
FCC I.D.: PLH-ZW3

(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 5.84 GHz frequency band.

2) Equipment Tested

<u>Equipment</u>	<u>Model</u>	<u>FCC I.D. #</u>
EUT	ZW-3 WIRELESS CONTROLLER	PLH-ZW3

3) Equipment Function and Testing Procedures

The EUT is a 902-928 MHz radio transmitter used to transmit data for control to a remote scoreboard for display. The ZW-3 WIRELESS CONTROLLER is a wireless link used for transmitting information from one location to another. The unit typically operates from a wall power supply connected to the utility power source. The unit has a BNC port located at the rear of the equipment for connection to the scoreboard. Communications to and from the EUT to the scoreboard are passed along this cable connection. The unit has no other provision to connect to external peripheral equipment. The EUT was tested in a standard equipment configuration 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 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 ROGERS LABS, INC. Nevco Scoreboard Company
4405 W. 259th Terrace MODEL: ZW-3 Frequency Hopping Spread Spectrum Controller
Louisburg, KS 66053 Test #: 020423 FCCID#: PLH-ZW3
Phone/Fax: (913) 837-3214 Test to: FCC Parts 2 and 15c (15.247) Page 5 of 30
ZW3TestRpt.doc 5/30/2002

lines of the system were isolated from the power source using a standard LISN with a 50 μ Hy choke. EMI was coupled to the spectrum analyzer through a 0.1 μ F 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 1.5meter 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 antema 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. Radiated emission measurements above 1000 MHz were performed using both peak and average detector functions. Peak amplitudes were not

ROGERS LABS, INC. Nevco Scoreboard Company
4405 W. 259th Terrace MODEL: ZW-3 Frequency Hopping Spread Spectrum Controller
Louisburg, KS 66053 Test #: 020423 FCCID#: PLH-ZW3
Phone/Fax: (913) 837-3214 Test to: FCC Parts 2 and 15c (15.247) Page 6 of 30

above 20 dB over the average limits and average measurement readings recorded in the report

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		
<u>EQUIPMENT</u>	<u>MFG.</u>	<u>MODEL</u>	<u>CAL. DATES</u>	<u>DUe.</u>
LISN	Comp. Design	1762	10/01	10/02
Antenna	ARA	BCD-235-B	7/01	7/02
Antenna	EMCO	3147	10/01	10/02
Antenna	EMCO	3143	4/01	4/02
Analyzer	HP	8591EM	7/01	7/02

6) Units of Measurements

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

Radiated EMI: Data is in dB μ V/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. 25th 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. 25th 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 typical equipment 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 screen room 80cm 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 80cm from the rear of the supporting equipment of the EUT. All power cords except the EUT were then powered from the second LISN.

Two power supply manufacturers' power supplies were tested for this unit with data taken for both. The power supplies tested were an OEM model SYS10891509L-W2 and a Phihong model PSC15A

ROGERS LABS, INC.

4405 W. 259th Terrace

Louisburg, KS 66053

Phone/Fax: (913) 837-3214

Nevco Scoreboard Company

MODEL: ZW-3 Frequency Hopping Spread Spectrum Controller

Test #: 020423 FCCID#: PLH-ZW3

Test to: FCC Parts 2 and 15c (15.247) Page 8 of 30

090S. EMI was coupled to the spectrum analyzer through a 0.1 μ F 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.

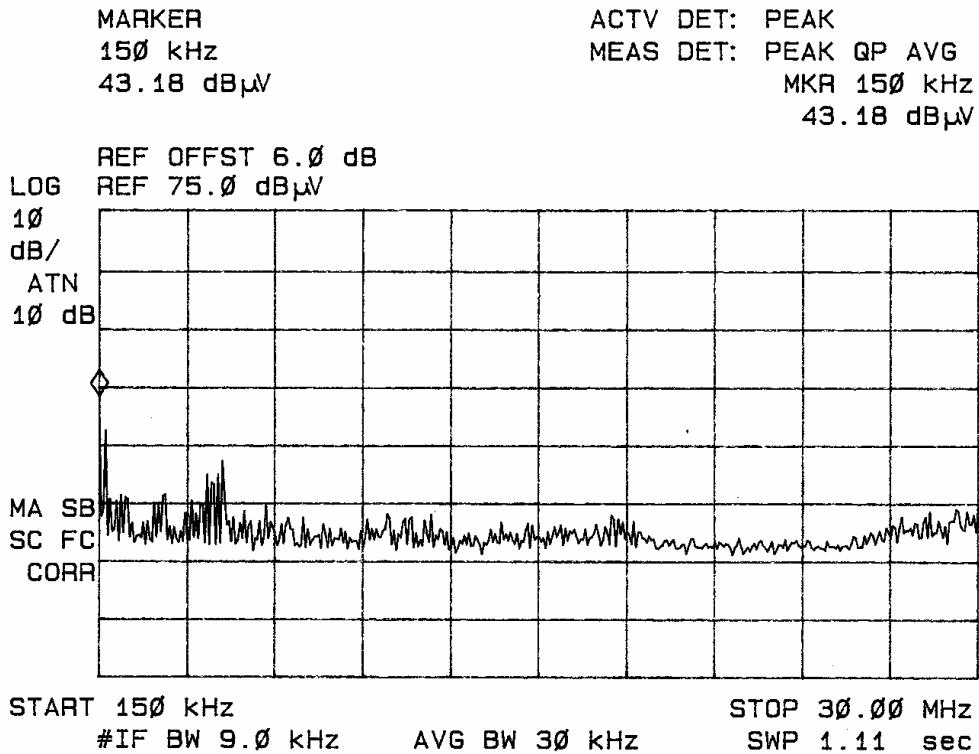


Figure 1 Conducted Emissions Line 1(OEM power supply).

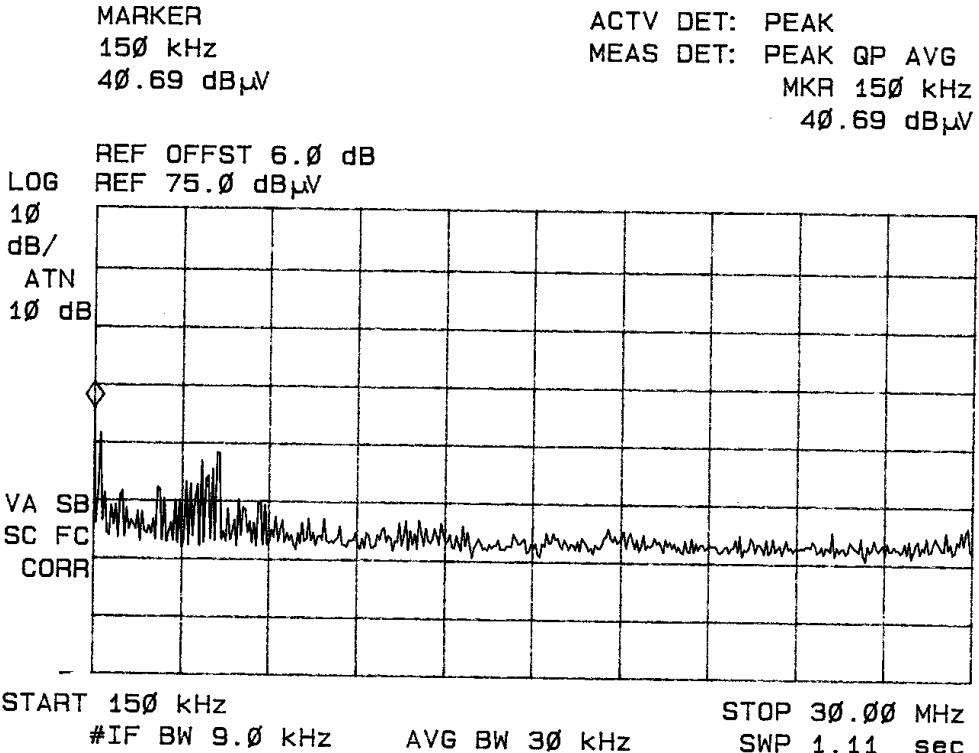


Figure 2 Conducted Emissions Line 2(OEM power supply).

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

Nevco Scoreboard Company
MODEL: ZW-3 Frequency Hopping Spread Spectrum Controller
Test #: 020423 FCCID#: PLH-ZW3
Test to: FCC Parts 2 and 15c (15.247) Page 10 of 30
ZW3testRpt.doc 5/30/2002

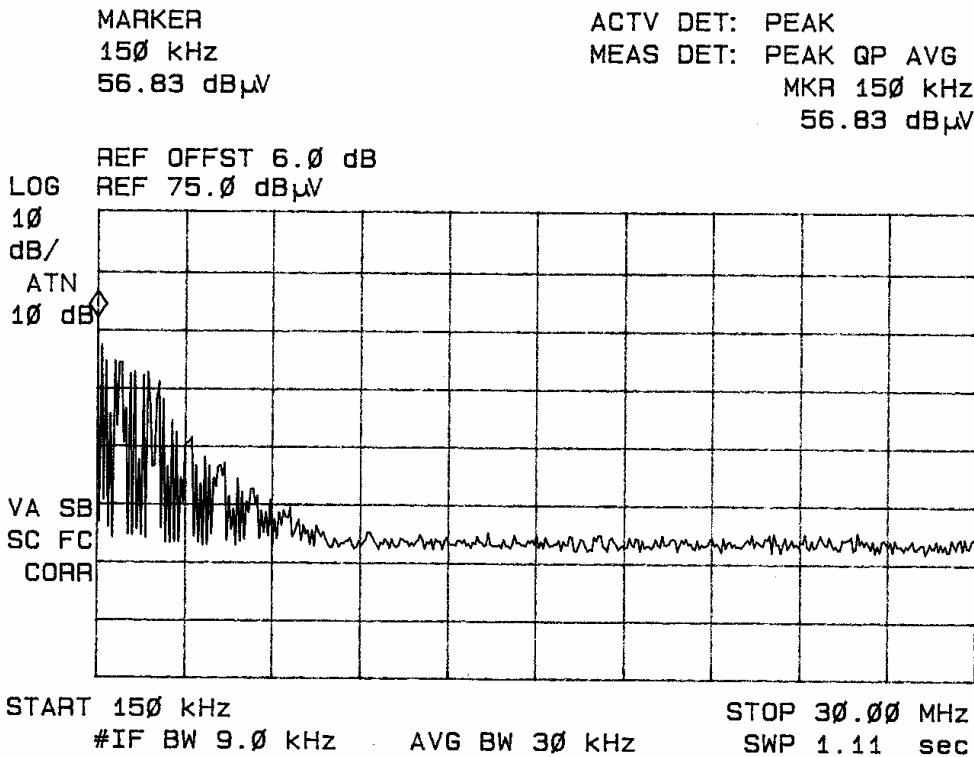


Figure 3 Conducted Emissions Line 1(Phihong power supply).

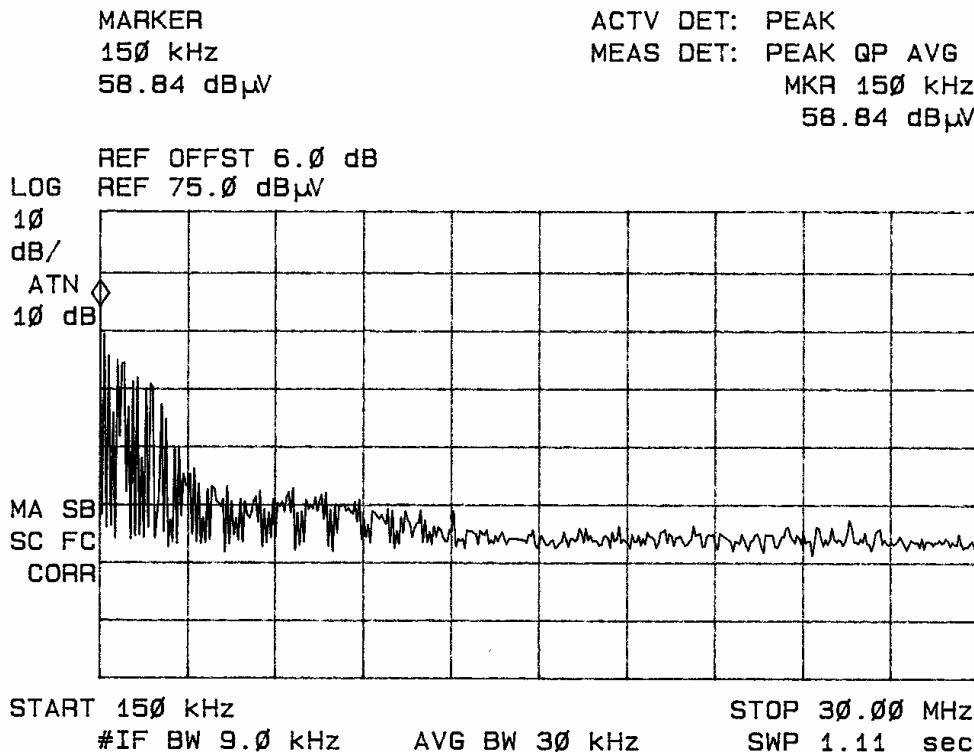


Figure 4 Conducted Emissions Line 2(Phihong power supply).

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 five through eight for plots of the radiated emissions spectrum taken in a screen room. 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:

ROGERS LABS, INC. Nevco Scoreboard Company
4405 W. 259th Terrace MODEL: ZW-3 Frequency Hopping Spread Spectrum Controller
Louisburg, KS 66053 Test #: 020423 FCCID#: PLH-ZW3
Phone/Fax: (913) 837-3214 Test to: FCC Parts 2 and 15c (15.247) Page 12 of 30
ZW3TestRpt.doc 5/30/2002

RFS = Radiated Field Strength
 dB μ V/m @ 3m = dB μ V + A.F. - Amplifier Gain
 dB μ V/m @ 3m = 44.4 + 8.5 - 35
 = 17.9

MARKER
 132.0 MHz
 31.61 dB μ V

ACTV DET: PEAK
 MEAS DET: PEAK QP
 MKR 132.0 MHz
 31.61 dB μ V

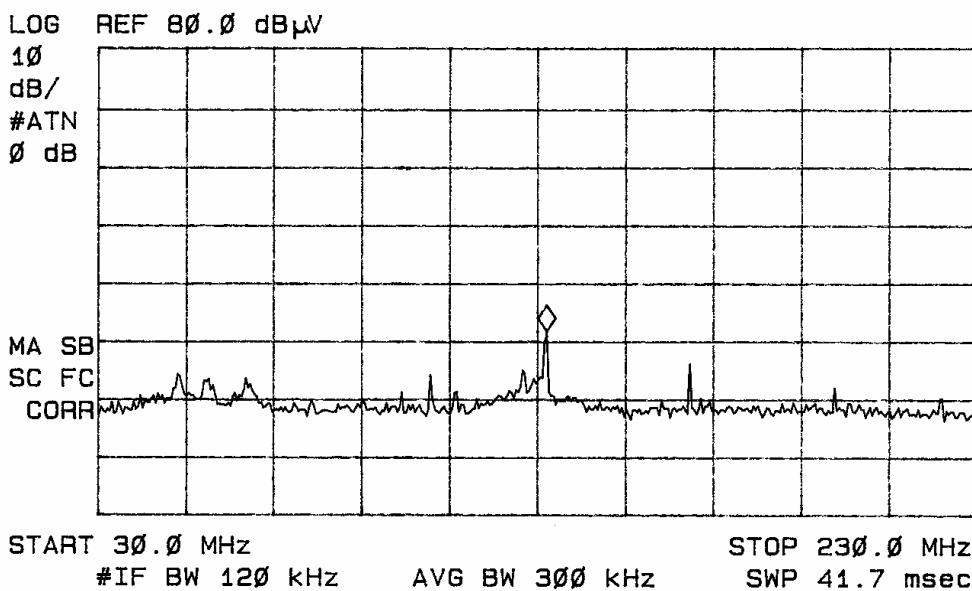


Figure 5 Radiated Emissions taken at 1 meter in screen room.

MARKER
915 MHz
87.54 dB μ V

ACTV DET: PEAK
MEAS DET: PEAK QP
MKR 915 MHz
87.54 dB μ V

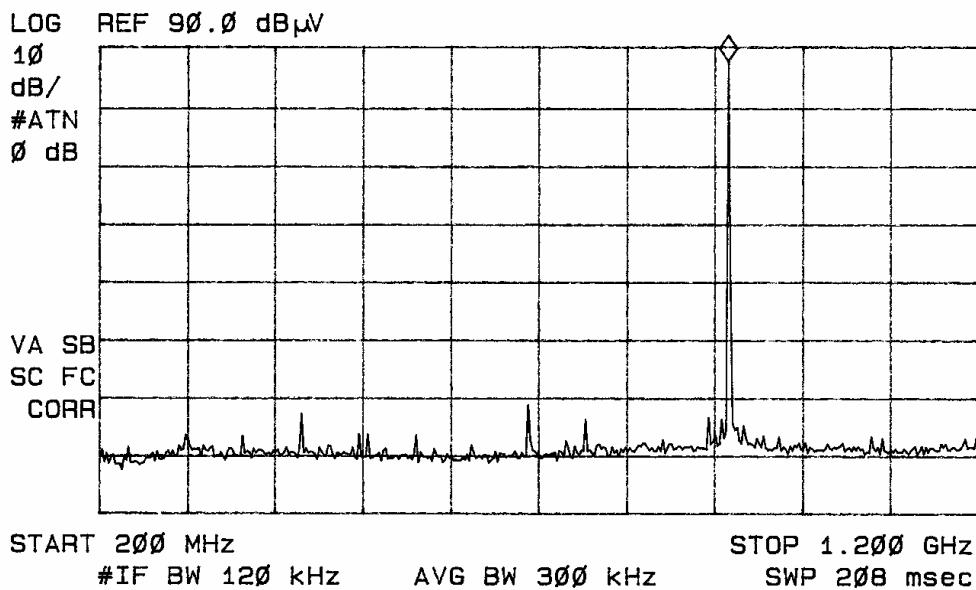


Figure 6 Radiated Emissions taken at 1 meter in screen room.

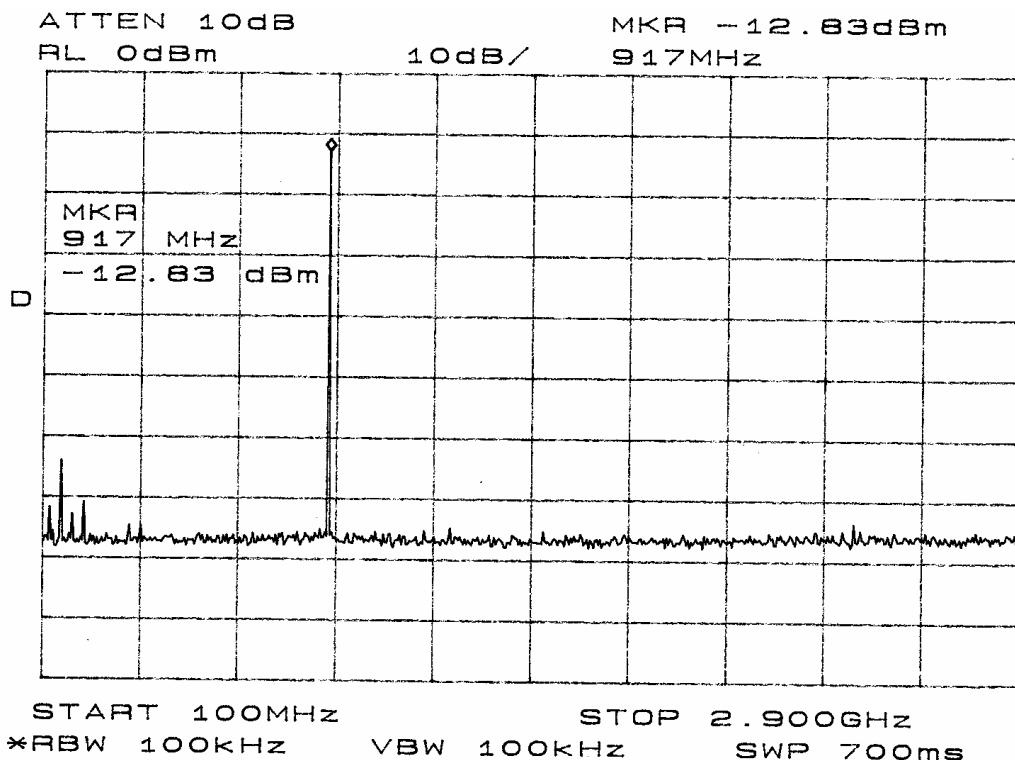


Figure 7 Radiated Emissions taken at 1 meter in screen room

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

Nevco Scoreboard Company
MODEL: ZW-3 Frequency Hopping Spread Spectrum Controller
Test #: 020423 FCCID#: PLH-ZW3
Test to: FCC Parts 2 and 15c (15.247) Page 14 of 30
ZW3testRpt.doc 5/30/2002

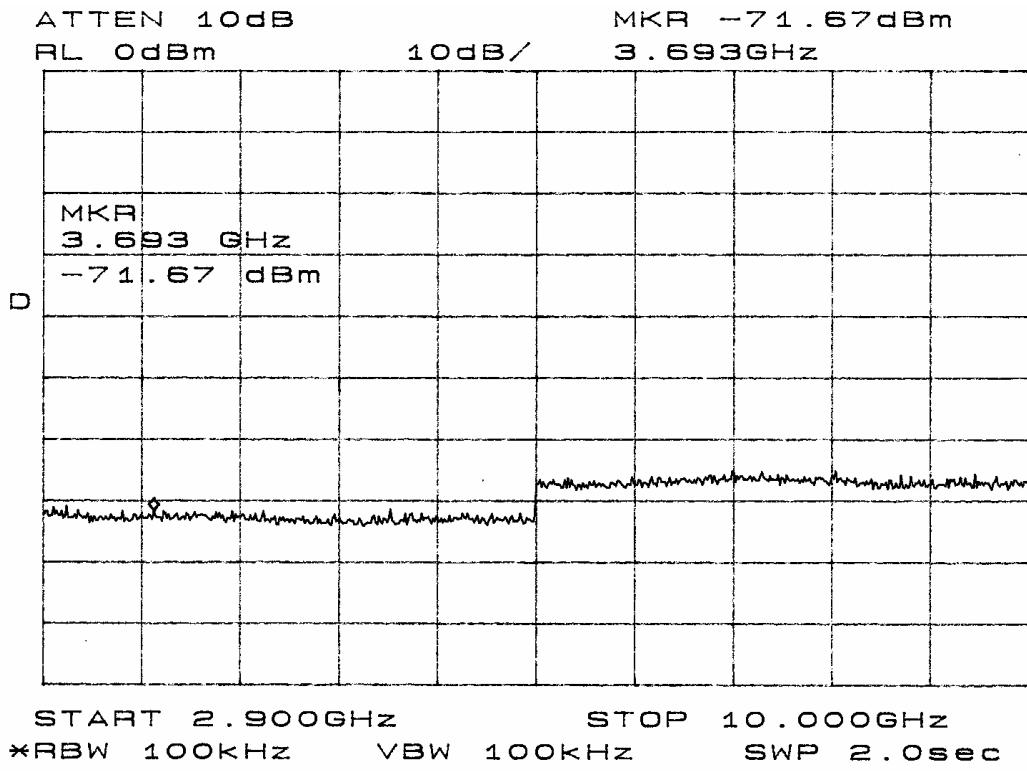


Figure 8 Radiated Emissions taken at 1 meter in screen room

Data: Conducted Emissions (7 Highest Emissions OEM Power supply)

Frequency band (MHz)	L1 Level (dB μ V)			L2 Level (dB μ V)			CISPR 22 Limit	
	Peak	Q.P.	AVE	Peak	Q.P.	AVE	Q.P.	Ave(dB μ V)
0.15 - 0.5	51.8	50.8	40.0	50.1	45.9	35.2	66 - 56	/ 56 - 46
0.5 - 5	33.3	31.1	21.4	35.2	33.1	23.0	56	/ 46
5 - 10	25.1	21.1	12.1	24.8	21.1	11.0	60	/ 50
10 - 15	24.3	20.1	10.3	23.4	17.1	9.1	60	/ 50
15 - 20	23.7	18.7	9.5	22.3	16.6	8.6	60	/ 50
20 - 25	19.3	14.5	8.2	21.5	14.8	8.1	60	/ 50
25 - 30	27.6	21.5	11.4	25.7	18.7	9.5	60	/ 50

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

Data: Conducted Emissions (7 Highest Emissions Phihong power supply)

Frequency band (MHz)	L1 Level (dB μ V)			L2 Level (dB μ V)			CISPR 22 Limit Q.P. Ave(dB μ V)
	Peak	Q.P.	AVE	Peak	Q.P.	AVE	
0.15 - 0.5	59.0	55.2	47.1	64.6	61.7	48.4	66 - 56 / 56 - 46
0.5 - 5	50.4	49.5	23.9	51.2	47.0	24.7	56 / 46
5 - 10	27.3	21.7	11.2	27.0	22.8	13.1	60 / 50
10 - 15	18.8	14.1	7.9	23.7	16.4	9.1	60 / 50
15 - 20	18.9	14.6	8.3	19.4	14.4	8.1	60 / 50
20 - 25	20.0	14.2	8.0	20.2	15.0	8.7	60 / 50
25 - 30	19.1	14.1	7.8	19.0	14.5	8.2	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. (dB μ V)	FSM Vert. (dB μ V)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dB μ V/m)	RFS Vert. @ 3m (dB μ V/m)	FCC Class B Limit @ 3m (dB μ V/m)
47.8	44.4	46.8	8.5	35	17.9	20.3	40.0
132.7	43.4	49.9	7.9	35	16.3	22.8	43.5
163.9	40.3	38.3	8.9	35	14.2	12.2	43.5
688.1	38.0	31.5	21.2	35	24.2	17.7	46.0
751.2	26.2	19.9	22.5	35	13.7	7.4	46.0
891.0	35.9	27.8	23.5	35	24.4	16.3	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, operating from the OEM power supply, had a 15.2dB minimum margin below the quasi peak limit and 16.0 dB minimum margin below the average limit. The EUT, operating from the Phihong power supply, had a 4.3 dB minimum margin below the quasi peak limit and 7.6 dB minimum margin below

the average limit. Other emissions were present with recorded data representing worst-case amplitudes.

Summary of Results for General 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 19.7 dB minimum margin below the 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, paragraph 15.247 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

ROGERS LABS, INC. Nevco Scoreboard Company
4405 W. 259th Terrace MODEL: ZW-3 Frequency Hopping Spread Spectrum Controller
Louisburg, KS 66053 Test #: 020423 FCCID#: PLH-ZW3
Phone/Fax: (913) 837-3214 Test to: FCC Parts 2 and 15c (15.247) Page 17 of 30
ZW3TestRpt.doc 5/30/2002

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:

$$\begin{aligned}
 \text{RFS (dB}\mu\text{V/m @ 3m)} &= \text{FSM(dB}\mu\text{V)} + \text{A.F.(dB)} - \text{Gain(dB)} \\
 &= 30.6 + 7.4 - 35 \\
 &= 3.0
 \end{aligned}$$

Data: Emissions in Restricted Bands

Frequency in MHz	FSM Horz. (dB μ V)	FSM Vert. (dB μ V)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dB μ V/m)	RFS Vert. @ 3m (dB μ V/m)	FCC Class B Limit @ 3m (dB μ V/m)
126.0	30.6	30.0	7.4	35	3.0	2.4	43.5
132.7	43.4	49.9	7.9	35	16.3	22.8	43.5
163.9	40.3	38.3	8.9	35	14.2	12.2	43.5
2708.4	33.5	35.5	32.5	21.5	44.5	46.5	54.0
2745.0	30.8	40.8	32.5	21.5	41.8	51.8	54.0
2780.4	32.1	38.6	32.5	21.5	43.1	49.6	54.0
3611.2	24.3	24.6	38.6	21.5	41.4	41.7	54.0
3660.0	25.6	25.0	38.6	21.5	42.7	42.1	54.0
3707.2	28.5	29.5	38.6	21.5	45.6	46.6	54.0
4514.0	24.5	24.5	40.6	21.5	43.6	43.6	54.0
4575.0	24.8	24.6	40.6	21.5	43.9	43.7	54.0
4634.0	28.1	29.0	40.6	21.5	47.2	48.1	54.0

Summary of Results for Radiated Emissions in Restricted Bands:

The radiated emissions for the EUT meet the requirements for FCC Part 15C Intentional Radiators. The EUT had a 2.2-dB minimum margin below the limits. No other emissions were 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 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:

$$\begin{aligned}
 \text{RFS} &= \text{Radiated Field Strength} \\
 \text{dB}\mu\text{V/m} @ 3\text{m} &= \text{dB}\mu\text{V} + \text{A.F.} - \text{Amplifier Gain} \\
 \text{dB}\mu\text{V/m} @ 3\text{m} &= 44.4 + 8.5 - 35 \\
 &= 17.9
 \end{aligned}$$

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

Frequency in MHz	FSM Horz. (dB μ V)	FSM Vert. (dB μ V)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dB μ V/m)	RFS Vert. @ 3m (dB μ V/m)	FCC Class B Limit @ 3m (dB μ V/m)
47.8	44.4	46.8	8.5	35	17.9	20.3	40.0
132.7	43.4	49.9	7.9	35	16.3	22.8	43.5
163.9	40.3	38.3	8.9	35	14.2	12.2	43.5
688.1	38.0	31.5	21.2	35	24.2	17.7	46.0
751.2	26.2	19.9	22.5	35	13.7	7.4	46.0
891.0	35.9	27.8	23.5	35	24.4	16.3	46.0

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

Summary of Results for General Radiated Emissions:

The radiated emissions for the EUT meet the requirements for FCC Part 15C Intentional Radiators. The EUT had a 19.7 dB minimum margin below the 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 nine through thirteen 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 300 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-3 continuously steps through a list of 31 frequencies, cycling through them at a rate of 22.4 milliseconds per frequency. At each 22.4 millisecond step the control transmits for 9.4 milliseconds. The frequencies are spaced 300 kilohertz apart and the sequence was determined at random. The 900 MHz ISM band is divided into two sub-bands. The ZW-3 listens for another ZW-3 on sub-band 1 and uses that subband offset 0 frequency list if it is not being used by another ZW-3 in the area; otherwise, it will scan sub-band two and use the offset 0 frequency list if sub-band 2 is not being used by another ZW-3. Unless a ZW-3 beacon described below is receivable the ZW-3 will not transmit if both subbands are occupied. If a beacon is received then the ZW-3 will synchronize its transmissions to the beacon and pick a band and offset frequency list based on occupancy. With a beacon available there can be 10 ZW-3's operating synchronously in close proximity without interference.

The unit is software controlled with a fixed transmission time of 9.4 mS with a cycle time of 22.4 mS. This equates to one cycle taking 31.8 mS to complete, moving through the 31 channels takes 0.985 seconds. In a tensecond period, the channel is occupied for less than 100 mS, which is below the 400 mS requirement.

(b) The maximum peak output power of the unit was measured at the open area test site since the unit has no 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 dB μ V/m at three-meters.

Sample calculation.

$$\begin{aligned}\text{dB}\mu\text{V/m}@ 3\text{m} &= \text{FSM} + \text{A.F.} + \text{cable loss} \\ &= 84.7 + 23.0 - 2.5 \\ &= 110.2\end{aligned}$$

- (c) The band edges are protected due to the frequency of operation of the EUT.
- (g) Frequency hopping systems are not required to employ all channels during each transmission but must be designed to operate as a frequency hopping system. As described above, the unit complies with the requirements of a frequency hopping spread spectrum device.
- (h) The incorporation of intelligence into the system to coordinate hopping channels has been used to enhance the system. The EUT may not choose a hop set to avoid the simultaneous occupancy of individual channels. The EUT complies with the regulations

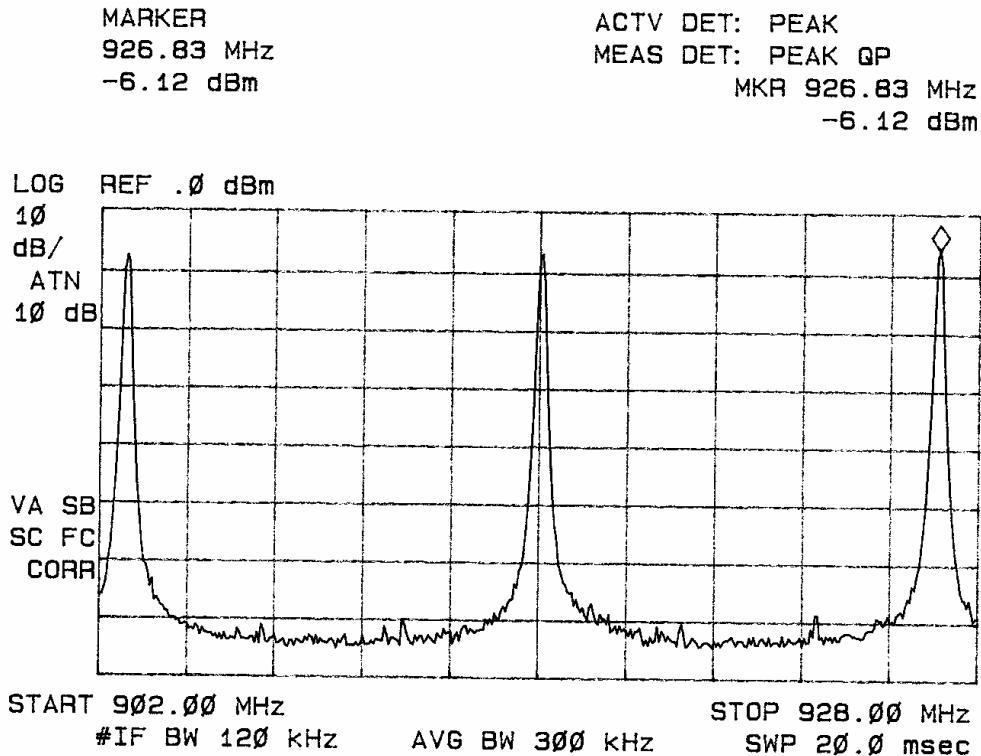


Figure 9 Maximum Power output (data taken with near field probe in screen room)

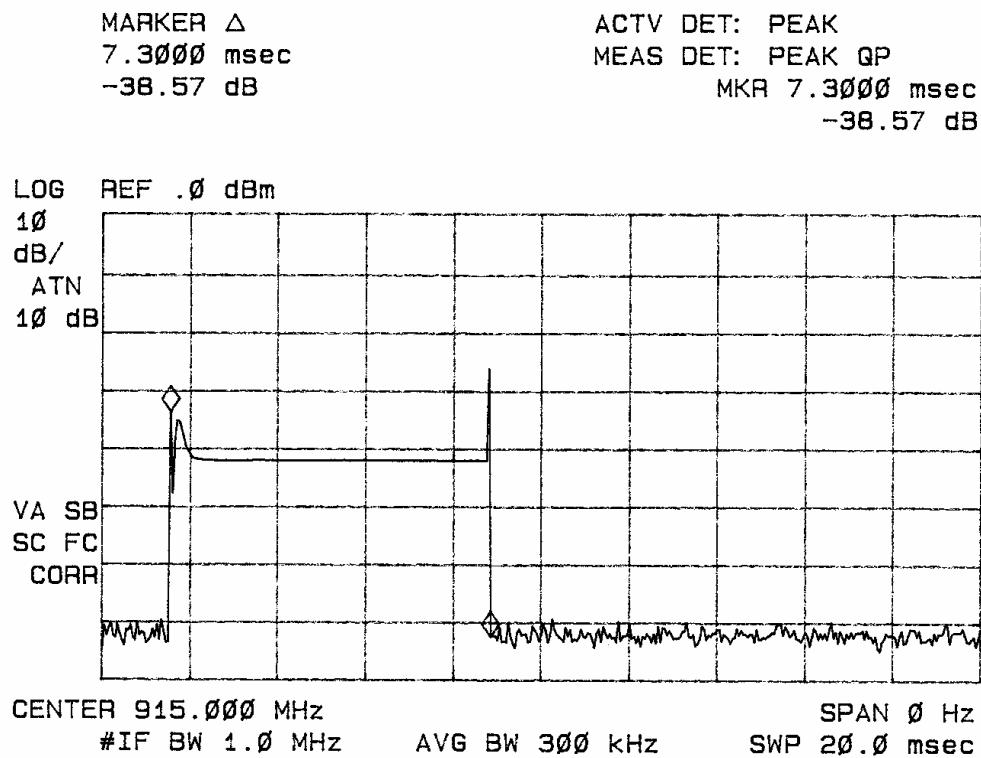


Figure 10 Dwell Time of Occupancy.

MARKER Δ
300 kHz
-2.05 dB

ACTV DET: PEAK
MEAS DET: PEAK QP
MKR 300 kHz
-2.05 dB

LOG REF .0 dBm

10
dB/
ATN
10 dB

MA SB
SC FC
CORR

CENTER 915.000 MHz
#IF BW 10 kHz

AVG BW 10 kHz

SPAN 1.000 MHz
SWP 30.0 msec

Figure 11 20-dB bandwidth.

MARKER Δ
310 kHz
-.12 dB

ACTV DET: PEAK
MEAS DET: PEAK QP
MKR 310 kHz
-.12 dB

LOG REF .0 dBm

10
dB/
ATN
10 dB

VA SB
SC FC
CORR

CENTER 908.000 MHz
#IF BW 100 kHz

AVG BW 30 kHz

SPAN 1.000 MHz
SWP 20.0 msec

Figure 12 Channel Spacing.

MARKER
919.49 MHz
-6.10 dBm

ACTV DET: PEAK
MEAS DET: PEAK QP
MKR 919.49 MHz
-6.10 dBm

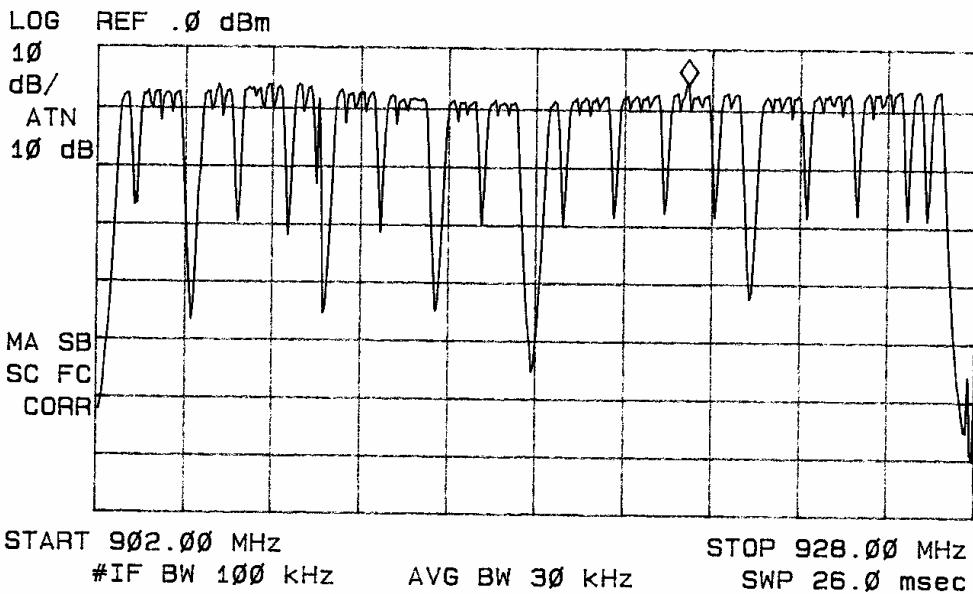


Figure 13 plot showing at least 25 hopping channels.

Data: Radiated Emissions from EUT

Emission Frequency (MHz)	FSM Horz. (dB μ V)	FSM Vert. (dB μ V)	Ant. Factor (dB)	Amp. Gain (dB)	RFS Horz. @ 3m (dB μ V/m)	RFS Vert. @ 3m (dB μ V/m)	Limit @ 3m (dB μ V/m)
902.8	85.7	92.5	23.0	-2.5	111.2	119.0	- -
1805.6	30.1	41.6	29.9	21.5	38.5	50.0	54.0
2708.4	33.5	35.5	32.5	21.5	44.5	46.5	54.0
3611.2	24.3	24.6	38.6	21.5	41.4	41.7	54.0
4514.0	24.5	24.5	40.6	21.5	43.6	43.6	54.0
915.0	84.5	92.9	23.2	-2.5	110.2	118.6	- -
1830.0	34.0	43.0	29.9	21.5	42.4	51.4	54.0
2745.0	30.8	40.8	32.5	21.5	41.8	51.8	54.0
3660.0	25.6	25.0	38.6	21.5	42.7	42.1	54.0
4575.0	24.8	24.6	40.6	21.5	43.9	43.7	54.0
926.8	84.0	92.8	23.2	-2.5	109.7	118.5	- -
1853.6	34.8	43.1	29.9	21.5	43.2	51.5	54.0
2780.4	32.1	38.6	32.5	21.5	43.1	49.6	54.0
3707.2	28.5	29.5	38.6	21.5	45.6	46.6	54.0
4634.0	28.1	29.0	40.6	21.5	47.2	48.1	54.0

Summary of Results for Radiated Emissions of Intentional Radiator

The EUT had a 1.8dB margin below the limit at the fundamental frequency of operation and 2.2 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

ROGERS LABS, INC. Nevco Scoreboard Company
 4405 W. 259th Terrace MODEL: ZW-3 Frequency Hopping Spread Spectrum Controller
 Louisburg, KS 66053 Test #: 020423 FCCID#: PLH-ZW3
 Phone/Fax: (913) 837-3214 Test to: FCC Parts 2 and 15c (15.247) Page 26 of 30
 ZW3TestRpt.doc 5/30/2002

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.

APPENDIX

Model: ZW-3 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.

<u>List of Test Equipment:</u>	<u>Calibration Date:</u>
Scope: Tektronix 2230	2/02
Wattmeter: Bird 43 with Load Bird 8085	2/02
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/02
H/V Power Supply: Fluke Model: 408B (SN: 573)	2/02
R.F. Generator: HP 606A	2/02
R.F. Generator: HP 8614A	2/02
R.F. Generator: HP 8640B	2/02
Spectrum Analyzer: HP 8562A,	4/01
Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	
HP Adapters: 11518, 11519, 11520	
Spectrum Analyzer: HP 8591 EM	7/01
Frequency Counter: Leader LDC 825	2/02
Antenna: EMCO Biconilog Model: 3143	4/01
Antenna: EMCO Log Periodic Model: 3147	10/01
Antenna: Antenna Research Biconical Model: BCD 235	7/01
Antenna: EMCO Dipole Set 3121C	2/02
Antenna: C.D. B-101	2/02
Antenna: Solar 9229-1 & 9230-1	2/02
Antenna: EMCO 6509	2/02
Audio Oscillator: H.P. 201CD	2/02
R.F. Power Amp 65W Model: 470A-1010	2/02
R.F. Power Amp 50W M185 10-501	2/02
R.F. PreAmp CPPA-102	2/02
Shielded Room 5 M x 3 M x 3.0 M (101 dB Integrity)	
LISN 50 μ Hy/50 ohm/0.1 μ f	10/01
LISN Compliance Eng. 240/20	2/02
Peavey Power Amp Model: IPS 801	2/02
Power Amp A.R. Model: 10W 1010M7	2/02
Power Amp EIN Model: A301	2/02
ELGAR Model: 1751	2/02
ELGAR Model: TG 704A-3D	2/02
ESD Test Set 2010i	2/02
Fast Transient Burst Generator Model: EFT/B101	2/02
Current Probe: Singer CP105	2/02
Current Probe: Solar 91081N	2/02
Field Intensity Meter: EFM018	2/02
KEYTEK Ecat Surge Generator	2/02
02/01/2002	

QUALIFICATIONS
of
SCOT D. ROGERS, ENGINEER
ROGERS LABS, INC.

Mr. Rogers has approximately 13 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

April 24, 2002
Date

1/11/00

FEDERAL COMMUNICATIONS COMMISSION
Laboratory Division
7435 Oakland Mills Road
Columbia, MD. 21046

December 08, 2000

Registration Number: 90910

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

Attention: Scot D. Rogers

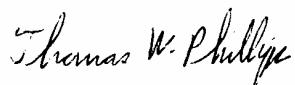
Re: Measurement facility located at Louisburg
3 & 10 meter site
Date of Listing: December 08, 2000

Gentlemen:

Your submission of the description of the subject measurement facility has been reviewed and found to be in compliance with the requirements of Section 2.948 of the FCC Rules. The description has, therefore, been placed on file and the name of your organization added to the Commission's 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 this filing must be updated for any changes made to the facility, and at least every three years from the date of listing the data on file must be certified as current.

If requested, the above mentioned facility has been added to our list of those who perform these measurement services for the public on a fee basis. An up-to-date list of such public test facilities is available on the Internet on the FCC Website at WWW.FCC.GOV, E-Filing, OET Equipment Authorization Electronic Filing.

Sincerely,



Thomas W Phillips
Electronics Engineer

ROGERS LABS, INC. Nevco Scoreboard Company
4405 W. 259th Terrace MODEL: ZW-3 Frequency Hopping Spread Spectrum Controller
Louisburg, KS 66053 Test #: 020423 FCCID#: PLH-ZW3
Phone/Fax: (913) 837-3214 Test to: FCC Parts 2 and 15c (15.247) Page 31 of 30
ZW3TestRpt.doc 5/30/2002