

TEST EQUIPMENT LIST FOR ROGERS CONSULTING LABS, INC.

The equipment is used daily and kept in good calibration and operating condition. Calibration of critical items are checked for accuracy each time used.

List of Test Equipment:

Calibration Date:

Scope: Tektronix 2230	2/98
Wattmeter: Bird 43 with Load Bird 8085	2/98
Power Supplies: Sorensen SRL 20-25, DCR 150, DCR 140	2/98
H/V Power Supply: Fluke Model: 408B (SN:573)	2/98
R.F. Generator: Boonton 102F	2/98
R.F. Generator: HP 606A	2/98
R.F. Generator: HP 8614A	2/98
R.F. Generator: HP 8640B	2/98
Spectrum Analyzer: HP 8562A,	2/98
Mixers: 11517A, 11980A & 11980K	
HP Adapters: 11518, 11519, 11520	
Spectrum Analyzer: HP 8591 EM	6/97
Frequency Counter: Weston 1255	2/98
Frequency Counter: Leader LDC 825	2/98
Antenna: EMCO Log Periodic	9/97
Antenna: BCD 235/BNC Antenna Research	9/97
Antenna: EMCO Dipole Set 3121C	2/98
Antenna: C.D. B-100	2/98
Antenna: Solar 9229-1 & 9230-1	2/98
Antenna: EMCO 6509	2/98
Microline Freq. Meter: Model 27B	2/98
Dana Modulation Meter: Model 9008	2/98
Audio Oscillator: H.P. 200CD	2/98
R.F. Power Amp 65W Model: 470-A-1000	9/97
R.F. Power Amp 50W M185- 10-500	9/97
R.F. PreAmp CPPA-102	9/97
Shielded Room 5 M x 3 M x 2.5 M (100 dB Integrity)	
LISN 50 $\mu$ Hy/50 ohm/0.1 $\mu$ f	9/97
LISN Compliance Eng. 240/20	2/98
SCS Power Amp Model: 2350A	2/98
Power Amp A.R. Model: 10W 1000M7	2/98
Linear Amp Mini Circuits: ZHL-1A (2 Units)	2/98
Combiner Unit Mini Circuits: ZSC-2-1 (2 Units)	2/98
ELGAR Model: 1751	2/98
ELGAR Model: TG 704A-3D	2/98
ELGAR Model: 400SD (PB)	2/98
ESD Test Set 2000i	10/95
Fast Transient Burst Generator Model: EFT/B-100	10/95
Current Probe: Singer CP-105	8/97
Current Probe: Solar 9108-1N	8/97
Field Intensity Meter: EFM-018	10/95

02/01/98

## Application for Certification per CFR 2.1033

Name of Applicant:

INTELLIGENT WIRELESS SYSTEMS, INC.  
 7301 Mission Rd., Suite 206  
 Shawnee Mission, KS 66208-3005  
 Model: RF 49

FCC I.D.: MS4 VA  
 Frequency Range: 49.875 MHz  
 Operating Power: 79.8 dBµV/m @ 3 Meters

### Applicable Standards & Test Procedures

- a) In accordance with Part 1, Subpart G, Paragraphs 1.1103; Part 2, Subpart J, Paragraphs 2.907, 2.925, 2.926, 2.1031 through 2.1043, and Part 15, Subpart B, Paragraphs 15.19(A)(3), 15.21, 15.31, 15.33, 15.35, 15.201 (B), 15.203, 15.204(C), 15.205, 15.207(A), 15.209(A), and 15.235 of the Code of Federal Regulations, dated October 1, 1997. The transition provisions in Paragraph 15.37 are not being requested.
- b) Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in the ANSI 63.4-1992 Document.

### Equipment Tested

<u>EUT</u>	<u>FCC I.D.#</u>
RF 49	MS4 VA

ROGERS CONSULTING LABS, INC.  
 11701 Craig  
 Overland Park, KS 66210  
 Phone/Fax: (913) 339-6072

INTELLIGENT WIRELESS SYSTEMS, INC.  
 MODEL: RF 49 SN: ENGL  
 Test #: 980323  
 Test to: FCC Parts 2 & 15B

## Equipment Function and Testing Procedures

The EUT is a single channel transceiver used for adding radio communications to a LONWORKS<sup>®</sup> Network. The unit allows communications to the network and can include nodes located in remote buildings, equipment or control devices. The RF 49 transceiver can be used to incorporate wireless nodes to an otherwise hard wired network.

## Equipment and Cable Configurations

### ***Conducted Emission Test Procedure:***

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 50  $\mu$ Hy choke. EMI was coupled to the spectrum analyzer through a 0.1  $\mu$ 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 1.5 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 photos in Appendix for EUT placement.

### List of Test Equipment

A Hewlett Packard 8591EM Spectrum Analyzer was used as the measuring device for the emissions testing of frequencies below 1.8 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 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

## Units of Measurements

Conducted EMI: Data is in dB $\mu$ V; dB referenced to one microvolt.

Radiated EMI: Data is in dB $\mu$ V/m; dB/m referenced to one microvolt per meter.

## Test Site Locations

**Conducted EMI:** The AC powerline conducted emissions tests were performed in a shielded screen room located at Rogers Consulting Labs, Inc., 11701 Craig, Overland Park, KS.

**Radiated EMI:** The radiated emissions tests were performed at Rogers Consulting Labs, Inc. 3 meters Open Area Test Site (OATS) located in Paola, KS.

**Site Approval:** Refer to Appendix for FCC Site Approval Letter, Reference 31040/SIT 1300F2, Dated October 15, 1996.

## Measurement Procedures

### **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 80 cm from the rear of the EUT. The power cord of the EUT was connected to the LISN. EMI was

coupled to the spectrum analyzer through a 0.1  $\mu$ F capacitor, internal to the LISN. Power line conducted emissions testing was 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 frequencies of the emissions which had the highest amplitudes. 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.

**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 1000 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 1000 MHz was searched for radiated emissions. Measured emission levels were maximized by EUT placement on the table, changing cable location, 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, Log Periodic from 200 MHz to 5 GHz and/or Biconilog from 30 MHz to 1000 MHz.

### **Subpart C - Intentional Radiators**

As per CFR Part 15, subpart C. The following information is submitted:

#### **15.203 Antenna Requirements:**

The unit is to be marketed in two packaging configurations, as an O.E.M. printed circuit board or enclosed in a small project box. The unit tested was enclosed in a project box. These units have an antenna permanently attached to the case. The printed circuit boards will be sold with the approved antenna with the stipulation that each configuration must be tested and certified for compliance with the CFR.

**Restricted Bands of Operation Per 15.205:**

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 were observed which fell into the restricted bands of operation.

**Data 15.205 Radiated (3 Highest Emissions):**

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)
249.375	42.3	52.4	12.4	35	19.7	29.8	46.0

No other emissions found in the restricted bands.

Sample Calculations:

$$\begin{aligned} \text{Computed Peak (dB}\mu\text{V/m @ 3m)} &= \text{FSM (dB}\mu\text{V)} + \text{A.F. (dB)} - \text{Gain (dB)} \\ &= 42.3 + 12.4 - 35.0 \\ &= 19.7 \end{aligned}$$

**Data Conducted (6 Highest Emissions) 15.207**

Frequency in MHz	Level L1 in dBμV	Level L2 in dBμV	Limit in dBμV
.45	35.2	35.2	48.0
.5	34.2	34.7	48.0
.55	34.0	34.7	48.0
.6	33.1	33.7	48.0
.65	31.9	33.8	48.0
25.0	22.5	27.3	48.0

Other emissions were present with amplitudes at least 10 dB below limits.



**Data Radiated (6 Highest Emissions) 15.209**

Emission Freq. (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)
49.8	61.8	71.0	8.8	0	70.6	79.8	80.0
149.6	55.1	63.3	10.5	35.0	30.6	38.8	43.5
225.0	50.3	59.7	11.5	35.0	26.8	36.2	46.0
275.0	48.5	55.6	13.5	35.0	27.0	34.1	46.0
325.0	47.7	54.3	15.4	35.0	28.1	34.7	46.0
375.0	48.1	56.4	15.6	35.0	28.7	37.0	46.0

Other emissions were present with amplitudes at least 10 dB below limits.

Sample Calculations:

RFS = Radiated Field Strength

$\text{dB}\mu\text{V/m @ 3m} = \text{dB}\mu\text{V} + \text{A.F.} - \text{Amplifier Gain}$

$\text{dB}\mu\text{V/m @ 3m} = 61.8 + 8.8$

$= 70.6$

**15.235 Operation Within the Band 49.82-49.90 MHz**

a. The field strength of any emission within the band 49.82 to 49.90 MHz shall not exceed 80.0 dBµV/m @ 3 meters. The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The EUT was tested for this condition and found to comply. The highest peak emission from the EUT was found to be 79.8 dBµV/m @ 3 meters. This level was measured using the peak detector function on the spectrum analyzer. The unit is designed to operate in a non-continuous

mode with the transmitter on time determined by the system design and controlled by the neuron chip.

b. The field strength of emissions appearing between the band edges and up to 10 kHz above and below the band edges shall be attenuated at least 26 dB below the level of the carrier. The EUT was setup in a screen room with the FSM antenna located 1 meter away. The frequency spectrum from 49.81 to 49.92 MHz scanned and the results plotted (See Figure 1). The highest emission in the band edges was below the peak amplitude of the carrier. Therefore, the requirement was met.

**Data 15.235 Intentional and Spurious Emissions:**

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)
49.875	61.8	71.0	8.8	0	70.6	79.8	80.0
149.625	55.1	63.3	10.58	35	30.6	38.8	43.5
199.500	45.8	55.2	10.8	35	21.6	31.0	43.5
249.375	42.3	52.4	12.4	35	19.7	29.8	46.0
299.250	48.3	55.4	14.8	35	28.1	34.4	46.0
349.125	46.4	53.6	15.9	35	27.3	34.5	46.0

Other emissions were present with amplitudes at least 10 dB below limits.

MARKER  $\Delta$   
33.3 kHz  
-30.75 dB

ACTV DET: PEAK  
MEAS DET: PEAK QP  
MKR 33.3 kHz  
-30.75 dB

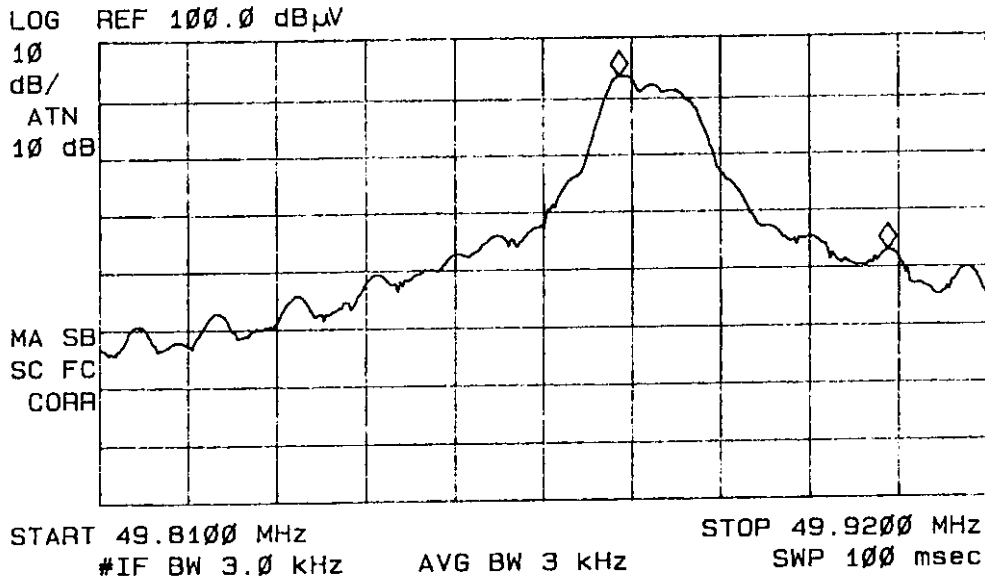


Figure 1 Band Edges

MARKER  
50.0 MHz  
92.86 dB $\mu$ V

ACTV DET: PEAK  
MEAS DET: PEAK QP  
MKR 50.0 MHz  
92.86 dB $\mu$ V

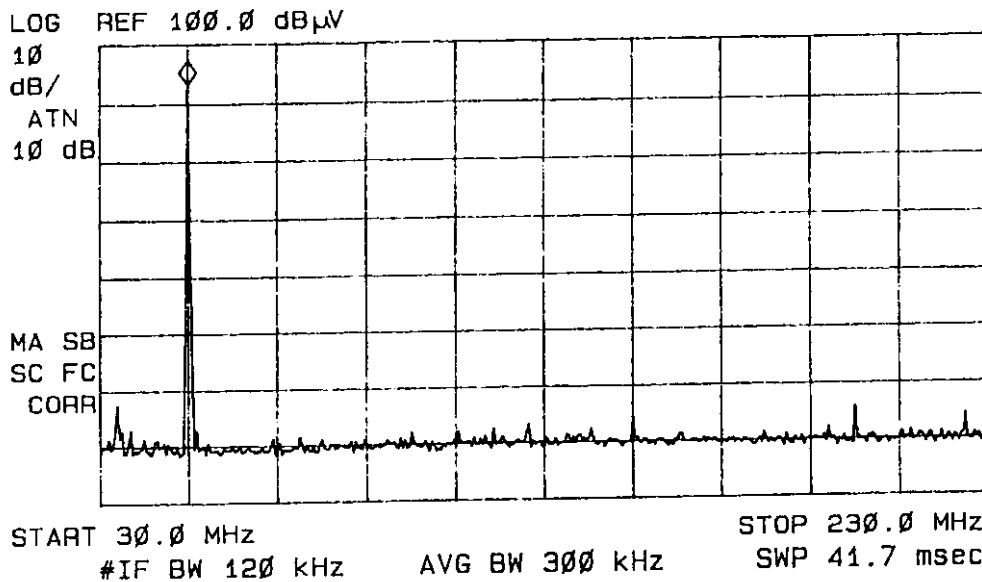


Figure 2 Radiated Emissions @ 1 Meter in Screen Room

REF LEVEL  
100.0 dBµV

ACTV DET: PEAK  
MEAS DET: PEAK QP  
MKR 251.8 MHz  
38.28 dBµV

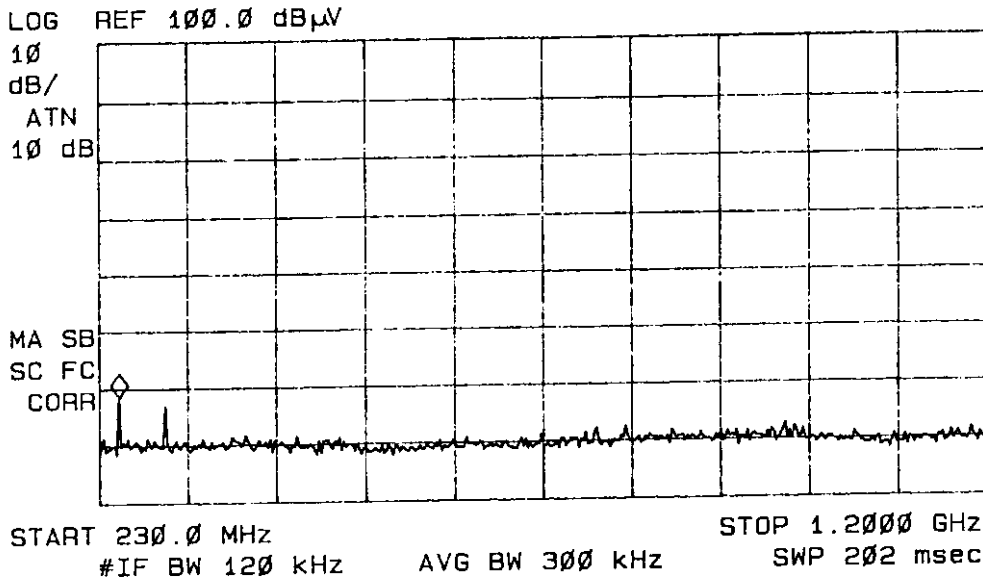


Figure 3 Radiated Emissions @ 1 Meter in Screen Room

## SUMMARY OF RESULTS

### ***Radiated Emissions:***

The radiated emissions for the EUT meets the requirements for FCC Part 15C Intentional Radiators. There are no measurable emissions in the restricted bands other than those recorded in this report.

### ***Statement of Modifications:***

No modifications to the EUT were required for the unit to meet the FCC, Part 15B, Class B Emissions Standards. There were no deviations to the specifications.