PRELIMINARY
March 1, 1998

INTELLIGENT WIRELESS SYSTEMS INC.

RF-49

TRANSCEIVER

USER'S GUIDE

RF-49-003B

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The RF-49 Transceiver is an intentional radiator in the 49.878 MHz frequency range. It is the responsibility of the customer to insure compliance with, and to obtain appropriate approvals from, applicable regulatory agencies. IWS will take a packaged version of the RF-49 through the FCC Certification process to insure that the RF-49 is certifiable. The certification testing is done with a specific antenna and any change to the RF-49 or the antenna will void the certification. Any product which has been certified using the RF-49, must be labeled with the following statement:

> This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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Electrical Interface

The RF-49 Transceiver requires a connection to a Neuron® Chip and an external antenna. To accommodate these connections, two connectors, J1 and J2 are provided on board. A third connector, J3, permits electronic adjustment of the receiver sensitivity and provides access to the carrier detector output for monitoring purposes. The connectors are a series of via holes spaced 0.100 inches apart to accept printed circuit board headers. No headers are soldered in place during manufacture of the RF-49 Transceiver so that the user can connect with wires if preferred.

Connector Locations

The location of the three connectors, J1, J2, and J3 is shown below:

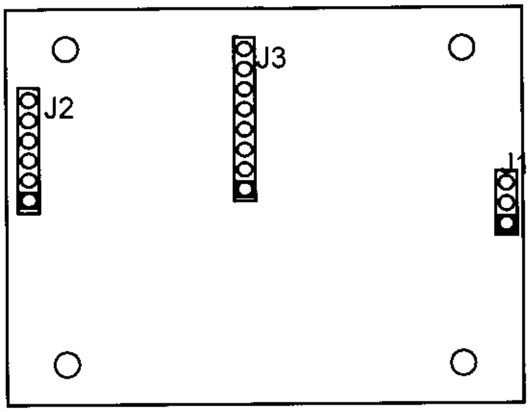


Figure 2.1 Location of J1, J2 and J3

The pin assignments for each of the three connectors is described below:

J1 RF Connector

Table 2.2 Description of the 3-pin J1 RF Connector

Pin #	Pin Name	Description
1	RF GND	Antenna Ground
2	RF Out	RF Input/Output to Antenna
3	RF GND	Antenna Ground

J2 Communications Connector

Table 2-1 Description of the 6-pin J2 Communications Connector

Pin #	Pin Name	Dir.	Description
1	TX/RX	Input	Transmit Enable, connects to CP2 pin of the Neuron Chip communications port*. See Figure 6.1.
2	TX Mod	Input	Transmit Data. Connects to CP1 pin of the Neuron Chip communications port*. See Figure 6.1.
3	RX Mod	Output	Receive Data. Connects to CP0 pin of the Neuron Chip communications port*. See figure 6.1.
4	Sleep	Input	Sleep input. Connects to CP3 pin of the Neuron Chip communications port*. See figure 6.1.
5	VCC		Power supply input. Connects to a +7 to +14 volt DC unregulated power supply.
6	GND		Ground connection.

*For a detailed description of the functionality of the Neuron Chip communications port, refer to the *Neuron 3120^{TM} and Neuron 3150^{TM} Chip Data Book 005-0018-01F,* or refer to Motorola or Toshiba data books.

J3 Configuration/Test Connector

Table 2-3 Description of the 8-pin J3 Configuration/Test Connector

Pin #	Pin Name	Dir.	Description
1	RSSI	Output	For IWS test use
2	AUDIO	Output	For IWS test use
3	CO LED	Output	Carrier detect output (optional LED)
4	5V	N/A	VCC for optional LED
5	5V	N/A	+5vDC regulated supply
6	CD0	Input	Carrier detect sensitivity configuration (LSB)
7	5V	N/A	+5vDC regulated supply
8	CD1	Input	Carrier detect sensitivity configuration (MSB)

Carrier Detect Sensitivity Selection

The Carrier Detect Sensitivity may be selected using the CD0 and CD1 pins of the J3 Configuration/Test connector according to table 2-4 below:

Table 2-4 Possible carrier detect sensitivity values based on the state of the CD0 and CD1 pins of Connector J3.

CD1	CD0	Carrier Detect Sensitivity (typical @ +25° C
N/C	N/C	-105 dBm ±5 dBm (most sensitive)
N/C	+5VDC	-95dBm ±5 dBm
+5VDC	N/C	-85 dBm ±5 dBm
+5VDC	+5VDC	-75 dBm ±5 dBm (least sensitive)

A 5VDC pin is provided next to each one of the CD pins on the J3 connector in order to simplify the task of setting the sensitivity. Figure 2.2 below, illustrates the positioning of the jumpers for selecting each of the four sensitivity options.

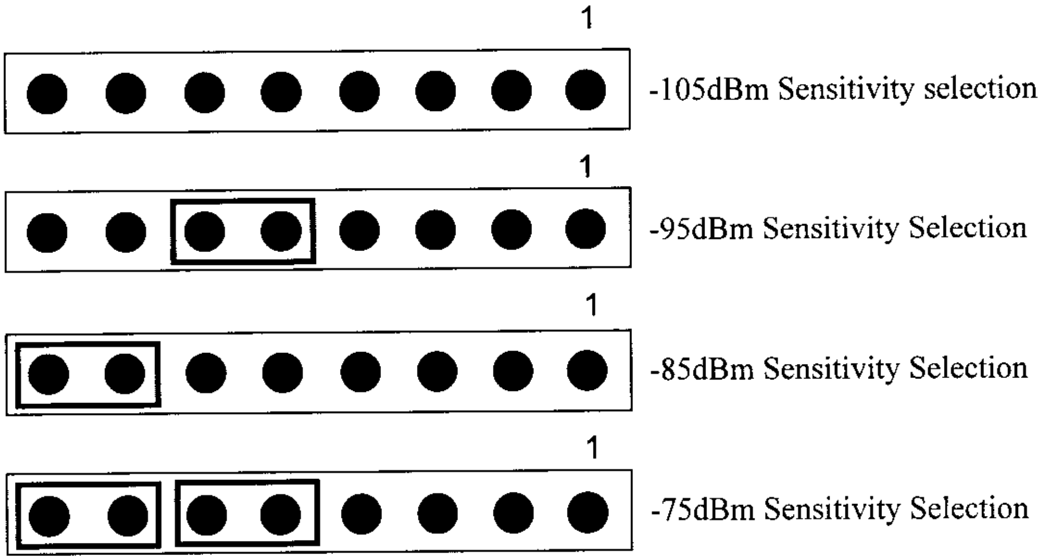


Figure 2.2 Jumper positions on connector J3 for selecting different carrier detect sensitivities.

The RF-49 Transceiver is shipped from the factory with the carrier detect sensitivity set at the most sensitive setting (no jumpers in). A discussion on the proper setting of the CD sensitivity is presented in Chapter 6, *Design Issues*.

Carrier Detect LED

An optional LED may be connected to CO LED pin 3 of the J3 Configuration/Test connector, as shown in figure 2.3. This LED can then be used as an easy way to detect the presence of a transmitter carrier, or interfering noise within the same frequency band on the RF medium. Note that the presence of a carrier does not necessarily imply valid data.

Figure 2.3 Connection of the Carrier Detect LED to the RF-49 Transceiver

The carrier detect LED may be used for diagnostic purposes when testing a system made up of several nodes; in addition it can be used to check activity on the RF network.

To simplify the connection of the carrier detect LED, the adjacent pin on the J3 connector provides the ground return. When connected as shown in figure 2.3, the LED will light when a carrier is detected.

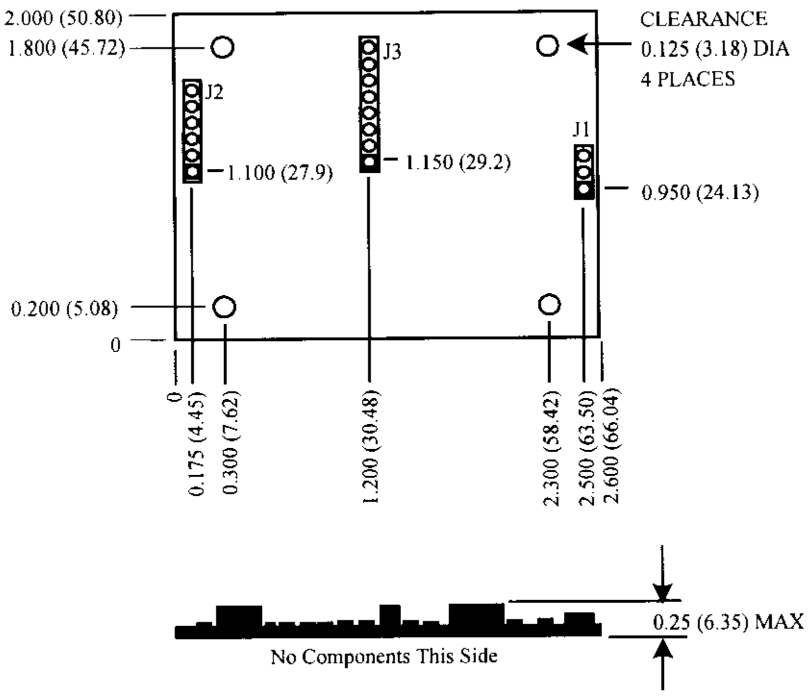
In the presence of the carrier, the CO LED pin provides +1VDC voltage through an on board 300Ω resistor. In the absence of the carrier, this pin is tied to VCC through a 100KΩ on-board resistor. The CO LED pin may be connected to an I/O pin of the Neuron Chip. The application program running on the node is then notified of the presence of the carrier.

3

Mechanical Information

This chapter discusses the mechanical outline, mounting hole positioning and the connector positioning of the RF-49 Transceiver.

Mechanical Outline



Dimensions In Inches (mm)

Figure 3.1 Mechanical Outline of the RF-49 Transceiver

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Power Requirements

This chapter discusses the power supply requirements of the RF-49 Transceiver. Power-saving suggestions and software tips are also included.

Transceiver Requirements

The RF-49 Transceiver can operate within a voltage range of +7 to +15 volts DC. Each mode of the transceiver (transmit, receive and sleep) has a different current requirement. The highest amount of power is required when the transceiver is transmitting. Therefore the power supply must be chosen with that in mind. See Table 7-1 for the exact requirements for each mode of operation.

It is possible for the RF-49 Transceiver to be configured by IWS to operate from a +5 VDC regulated supply. This involves eliminating the voltage regulator on the RF-49 printed circuit board and adding an inductor to bridge the resulting gaps. This may be desirable when using the RF-49 embedded in a system.

Power Supply Recommendations

The RF-49 Transceiver may be powered by a separate power supply or by the same source which powers the attached Neuron Chip.

A switching power supply is not recommended due to the large level of high frequency noise associated with this type of supply. If it is necessary to use a switching power supply, make sure the fundamental and harmonics of its switching frequency are well away from the 455 KHz If frequency of the RF-49 Transceiver.

Power Saving Techniques

The RF-49 Transceiver may be powered by a 9 volt transistor battery. In this case, it is desirable to extend battery life by reducing the average current requirements of the system as much as possible.

Reducing the current consumption of a LonWorks RF node can be accomplished in two ways, by putting the Neuron Chip to sleep, or by putting both the Neuron Chip and the attached RF transceiver to sleep. **NOTE**: If the transceiver is put to sleep, the Neuron Chip can not be awakened by data over the RF link. During the sleep mode, the receiver and the transceiver power supply are both powered down.

A Neuron Chip can be put to sleep through the use of the application level sleep command. This command forces the Neuron Chip to enter a low power mode in which no further processing (application or network) will take place.

The flush command can be used in conjunction with the sleep command in order to flush the Neuron Chip of all pending network updates as well as all outstanding outgoing and incoming messages.

For a complete description of the sleep and flush commands, refer to the *Neuron C Programmer's Guide* (Echelon Corporation's Number 078-0002-01A).

There are three ways of waking up a Neuron Chip: 1) grounding the service pin, 2) I/O activity (on a user-specified pin), or 3) communication activity on the channel.

If only the Neuron Chip (and not the RF-49 Transceiver) is put to sleep, any one of the above activities may wake up the node. Once the node has performed its intended activity, the application program can put the Neuron Chip back to sleep by using the flush and sleep commands.

As mentioned, it is also possible to put the transceiver to sleep along with the Neuron Chip. This is accomplished through the use of the COMM_IGNORE flag of the sleep command. This flag effectively tells the Neuron Chip to ignore any network activity and to activate the sleep pin of the communication port. The sleep COMM_IGNORE flag with the sleep command requires the *comm_ignore* field of the corresponding flush command to be set to TRUE.

A consequence of putting the RF-49 Transceiver to sleep is that the node can only be awakened through the first two options mentioned above, namely Service pin or I/O pin activity. The system designer must insure the occurrence of one of these events prior to when the node is expected to be awake.

The following is an example of Neuron C code that can be used to put both the Neuron Chip and the RF Transceiver to sleep. This particular example allows the node to wake up on service pin, communication port or I/O activity.

```
#pragma scheduler_reset          // Turn off round robin
                                 // scheduling

IO_4 input bit io_switch;        // Declare an input pin
...
when

...
when (TRUE) {                    // This is the second to

                                 //last when statement

      flush (FALSE);

}
when (flush_completes) {
      sleep (0, io_switch);      // Go to sleep; wake up

                                 // on io_switch activity

}
```

5

Antenna Requirements

This chapter discusses the antenna design considerations for the RF-49 Transceiver. Two alternatives are discussed in addition to the impact of antenna selection on the effective range of the module.

Overview

The construction and position of the antenna, as well as the design of the antenna-matching network, play a significant role in determining the performance of the RF-49 Transceiver. An antenna that offers the best range and overall performance is:

1. Tuned to the frequency of the transceiver
2. Used as polarized pairs, offered with minimal signal loss, positioned to provide line-of-sight signaling, and available with impedance matching (50Ω).

The operating frequency and gain of the antenna is a function of its effective length and configuration. Whip antennae achieve the effective length by virtue of the combined lengths of their elements. Stubby helical antennae use wire wound cores to achieve the effective length in a small space. The antenna that is selected for use with the RF-49 Transceiver should be tuned for operation at 49.878MHz with a 50Ω real impedance at that frequency.

The polarization of an antenna determines the orientation in which it broadcasts and receives radio waves. All antennae have a polarization pattern that is determined by their construction and orientation. The best performance will be obtained from the RF-49 Transceivers when the antennae are polarized in the same direction, allowing the radiated energy to be transmitted and received with maximum efficiency. One simple way to insure correct antenna polarization is to use the same type of antenna on all RF-49 Transceivers, and to orient all of the antennae in the same, optimal plane.

There are two basic types of antennae for the transceiver application: loop and monopole. Each type offers its own set of advantages in terms of size, ease of use, and effective range.

Loop Antenna

A loop antenna consists of a loop or loops of wire between pins 2 and 1 or 3 of RF-49 Transceiver connector J1. The loop can consist of multiple wire turns, but they should be wound in the same plane. The gain of a loop antenna is proportional to the area enclosed by the loop, and loop antennae are generally used where the antenna must be compact, as in a small portable device. Unlike a monopole antenna, a loop antenna does not require a ground plane reference, again making it ideal for portable applications.

The polarization of a loop antenna is along the direction of the wires that form the turn(s). Loop antennae range in area between a few centimeters to many square meters.

Monopole (whip) Antenna

Any straight wire can be used as a monopole antenna by connecting it to pin 2 of RF-49 Transceiver connector J1. The polarization of a monopole is parallel with the wire and a vertically oriented monopole will have a vertical polarization. In general, the longer the length of a monopole antenna, the better its performance. A good practical limit for the size of a wire antenna is between 20cm (8") for a poor but functioning antenna, to 152cm (60") for a high performance, quarter wavelength antenna.

A monopole antenna requires a ground plane reference. A ground plane consists of a conductive surface that is perpendicular to the monopole antenna. A person holding the RF-49 Transceiver can also serve as the ground plane. For optimal performance, the ground plane should be electrically connected to pin 1 or pin 3 of the RF-49 Transceiver J1. Within reason, the larger the ground plane, the better the antenna will perform. A ground plane can be approximated with a wire grid or with wire radials perpendicular to the antenna. If it is impractical to provide a true ground plane, then another straight wire can be extended opposite the antenna, thereby forming a dipole.

Impedance Matching

Antennae generally need an impedance matching network to correct for impedance mismatches between the antenna and the transceiver. The transceiver impedance is 50 ohms real. The impedance of the monopole antenna at 49.878MHz is modeled as a small resistance in series with a small capacitance. The exact values depend on the length of the wire and the size of the ground plane. The matching network usually consists of a series inductor to resonate out the capacitance resulting in a real impedance. For short dipoles, most of the resulting real impedance is usually lost in the matching inductor. For this reason, it is difficult to radiate efficiently from a short dipole. For optimal performance, a tapped resonator or transformer should be used to match to the real impedance of the transceiver (50Ω) to values between 35 Ω and 75 Ω.

Figure 5.1 illustrates the matching network circuits described above. Component values vary depending on the type of antenna used.

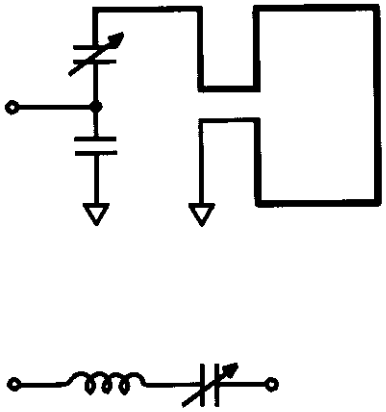

Figure 5.1 Impedance matching Network Examples

RF Propagation

RF signal attenuation as a function of distance varies greatly depending on the environment in which the transceiver is operating. In general, the lowest attenuation occurs in free space. Practical situations which approach the free space ideal are those in which both receive and transmit antennae are located high off the ground with no obstructions in the line of sight between the antennae.

Obstructions in the path of the antennae will cause increased loss in the RF signal, the amount of which depends on the size and construction of the objects. Electrically conductive objects have an infinite attenuation and may completely reflect the signal. Antennae should be placed as far away from metal objects as possible (other than the ground plane itself). A large metal object can improve performance if it is used as a ground plane for a monopole antenna.

Reflections caused by obstructions can interact with one another as well as with the original radio wave, thereby causing three dimensional standing wave patterns. These patterns have high Q cancellations where approximately equal waves are out of phase. This leads to a phenomenon called Rayleigh fading, so called because of the Rayleigh probability distribution of power versus distance. Rayleigh fading can cause the RF signal to fade by 10 to 20 dB in some locations relative to adjacent locations. The fading is a function of the locations of the transmitter and receiver and the objects around them.

When commissioning a fixed (non-portable) RF system using distant RF-49 Transceivers, it is possible that movement of a transceiver by as little as 15cm (6") can drastically improve RF communications, especially inside enclosed areas such as buildings. An RF-49 Transceiver might reliably communicate with a second RF-49 unit, but not reach a third RF-49 unit that is actually closer to it than the second one. Radio signaling within buildings is particularly susceptible to Rayleigh fading and blockage because of the large number of metal objects that are present. Practically speaking, problems of this nature are likely to occur only on the periphery of the operating range of the RF-49 Transceiver.

6

Design Issues

This chapter discusses the design issues related to implementing a LONWORKS control module operating on the radio frequency medium using the RF-49 Transceiver. EMI issues are discussed. In addition, other interference sources and their effect on performances are presented. LONWORKS interoperability and regulatory agency certification are discussed.

Sleep Mode

If the RF-49 is used in a LonWorks network where the Neuron Chip is used in the sleep mode, and a data stream is used to wake up the Neuron, the data stream can not be sent via an RF signal. In a normal RF-49 to Neuron connection, when the Neuron is asleep there is no voltage at the Neuron's communication port CP3 and the RF-49 is completely powered down. In this state, the RF-49 will not process a received signal nor will it transmit even if transmit pin is enabled. The solution is to maintain a 5 VDC level on pin 4 of J2 on the RF-49. This will keep the RF-49's receiver operational.

EMI Design Issues

There are basically two forms of electromagnetic interference that one must be concerned about when designing with the RF-49 Transceiver: radiated and conducted. Each type poses a unique set of problems and challenges when trying to implement a low cost compact system with reasonable performance.

Radiated EMI

The RF-49 Transceiver antenna must be unshielded in order to receive the energy from remotely located RF-49 Transceivers. The lack of shielding leaves the antenna vulnerable to radiated noise from the Neuron Chip or its associated application electronics. This digital noise will interfere with the reception of radio signals and thereby dramatically reduce the range of the RF-49 Transceiver.

The best way to minimize radiated noise is to electrically shield the sources of that noise using metallic enclosures. Since cables entering or exiting the RF-49 Transceiver enclosure can act as radiating antennas, these cables should be filtered using a capacitor or ferrite beads. If an antenna ground plane is used, the ground plane itself can be used to shield the antenna from sources of noise. This method can be used when it is impractical to shield a source of noise that is in a fixed location relative to the RF-49 Transceiver.

Another way to minimize noise is to move the antenna as far away from the noise source as possible. This can be done by using a 50Ω coaxial lead-in cable between the RF-49 Transceiver and the antenna/matching network.

The RF-49 Transceiver itself is also sensitive to electrical noise, although not as sensitive as the antenna. Since the RF-49 Transceiver can be located directly adjacent to the antenna, it may be preferable to move the combination RF-49/antenna away from the noise sources. This technique will reduce directly radiated noise, but is susceptible to noise pickup through the interconnecting cabling between the RF-49 Transceiver and the Neuron Chip and application electronics. For this reason, the communication cable should be shielded and filtered. The shield should be grounded to the RF-49

Transceiver mounting hole that is closest to pin 3 of J2. Note that this mounting hole is the only one, which is connected to RF ground.

Wires extending from the application electronics to sensors, indicators, switches and other electronics can also act as potential radiators. These wires should be kept short and should be both shielded and filtered.

Conducted EMI

The RF-49 Transceiver is connected to the Neuron Chip via the 6 pin communication connector J2. Four of these connections are digital logic for data and control, while two connections are for +5VDC input power and ground. Noise from these six lines can affect transceiver performance, causing degradation in range. While the RF-49 Transceiver includes some filtering on all six of these lines, additional filtering may be needed if good sensitivity is desired. The four logic connections should be filtered with at least one RC network with a time constant of a few microseconds. See figure 6.1. This will attenuate the digital noise due to switching inside the Neuron Chip. Higher order filtering can be used provided that the 3dB cutoff is kept above 10 KHz so as not to disrupt data integrity.

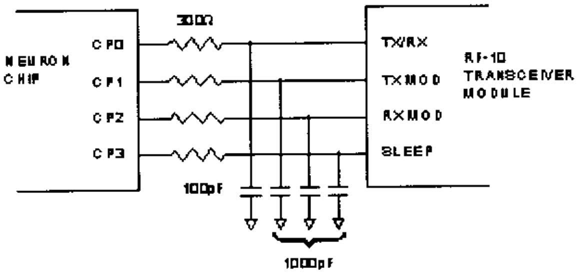

Figure 6.1 Typical filtering between the RF-49 and Neuron Chip

The power supply lines should also be free from digital noise. It is recommended that a switching power supply not be used because of the high frequency noise associated with these devices. If a switching power supply must be used, then it is recommended that the fundamental and harmonics of the switching frequency be far away from 455KHz, the highly sensitive IF frequency of the transceiver.

Interference and carrier Detect Sensitivity Setting

Interference comes from both electromagnetic emissions (EMI) and from intentional radiators. EMI interference was covered in the previous section. Intentional radiators can be from Neuron Chip and non-Neuron Chip sources, and can manifest in two ways: that which rises above the carrier detect level (CD+), and that which falls below this level (CD-).

The Carrier Detect Sensitivity (CDS) control provides a four-level adjustment that lets you change the receivers input power threshold when you want to cause a "busy" channel indication. If the input power level is below the threshold set by CDS control, then the Neuron Chip receives a "vacant" channel signal. If the power level rises above the CDS control threshold, then a "busy" channel is asserted.

Level 0 is the most sensitive CDS setting and allows the reception of incoming packets down to -108dBm. This high sensitivity level provides the longest possible range. However, it also exposes the transceiver to low-level noise from nearby electrical equipment and radios. If this noise reaches a high enough level, it can cause the RF-49 Transceiver to sense that a valid carrier has been detected, triggering a channel "busy" indication and causing the Neuron Chip to continuously search the incoming data for a valid packet. If no valid incoming packet is detected, only noise, then the Neuron Chip may miss incoming packets and will not be able to transmit any packets because it falsely senses that the channel is "busy". The noise will result in either lower throughput or complete failure of the communication channel.

CD+ interference caused by a Neuron Chip packet from a different network have a relatively short duration. The node will decode the packet and determine whether or not it is intended for it. In a properly designed system, a node will not mistake another node's message for its own. Since the LonWorks system was designed to handle many simultaneous users, this type of information does not generally cause a problem assuming there is sufficient bandwidth to handle transmissions from different networks.

CD- interference occurs when the interfering signal is too low to cause a carrier detect. The effect of this type of interference is to increase the probability of a packet error. While not sufficient to cause a carrier detect "busy" signal, the effects of the interference may be enough to distort a low-level signal and cause errors. This effect may occur for both Neuron Chip and non-Neuron Chip interference.

If the interference is caused by a non-Neuron Chip signal, the effects of the interference can be more severe. A powerful, continuous transmitter will block the Neuron Chip from transmitting messages for the duration of the interference. It may also impair, or even block, the ability of the Neuron Chip to receive signals. In some cases unidirectional transmission will still be possible, but bi-directional communications may be blocked. Decreasing the CDS level may help in this situation, but at the expense of decreased range.

To maximize the performance of the RF-49 Transceiver, the CDS setting should always be set to the highest sensitivity level that permits the reception of valid packets without triggering false carrier detect signals. In general, it is recommended that level 0 be used only in noise-free environments, such as open fields, far away from unshielded electrical equipment.

The RF-49 Transceiver includes a Carrier Detect output which allows a light emitting diode (LED) to be illuminated upon detection of the carrier. The LED can be used to determine if noise is causing a problem in a particular environment and set the proper CDS level.

If the noise in a particular application varies with time, the I/O outputs of the Neuron Chip can be used to toggle between different CDS levels. When used in conjunction with some external circuitry and an application program, the Neuron Chip can dynamically change the CDS level, preventing a channel from being blocked during times of high interference, yet extending range when the interference is low.

Regulatory Agency Requirements

At this time, the RF-49 Transceiver has been submitted for testing in the process to achieve certification with the FCC. The RF-49 Transceiver is designed to be FCC-certifiable under Part 15.235 of the Code of Federal Regulations, and may be suitable for approval by other international regulatory agencies in countries that permit intentional radiators in the 49MHz band. The occupied bandwidth and center frequency when used with a Neuron Chip will be within the permissible limit of this regulation. The radiated output power is a function of the type of antenna used and the setting of the RF-49 power output selected. The RF-49 is designed so that for low duty cycle applications, the output power can be factory selected to be 40 milliwatts compared to the normal 10 milliwatts. This higher power version can only be used in applications where the transmitter on time will not exceed 25 milliseconds in any 100 millisecond window. This takes advantage of power averaging measurements allowed by Part 15 of the FCC regulations.

Since application electronics can itself be a source of noise, good design and layout practice should be followed to ensure that this circuitry does not cause excessive radiation, which could cause non-compliance with regulatory agency requirements.

If the RF-49 is packaged in a metal enclosure and uses the same antenna that was used for the IWS FCC Certification, then the label below must be permanently affixed to the outside of the enclosure. This may be a permanent label or may be permanently marked or screened printed to the outside of the enclosure in font large enough to be read without the use of magnification. Any change to the transceiver other than the receiver sensitivity outlined in this Users Guide, including an antenna model number change will void any FCC Certification.

FCC ID: MS4 VA

INTELLIGENT WIRELESS SYSTEMS, INC.
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This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

7

RF-49 Transceiver Specifications

This chapter provides a table of performance specifications for the RF-49 Transceiver.

RF-49 Transceiver Performance Specifications

Table 7-1 Specifications (typical @+25° C unless otherwise specified)

Parameter	Specification
Carrier Frequency	49.878MHz
Signal Bandwidth (20dB)	20KHz
Typical Range	100 m (328feet) open field with Echelon loop antenna
Bit Rate	4.9 kbps
BER (Bit error Rate) Sensitivity	-105dBm @ BER<10^{-5}
Alternate Channel Rejection	45dB
Output Power	10 milliwatt maximum
Input Voltage	+7 to +15VDC
High-Level	4.0V minimum
Low-Level	
SLEEP	0.2V maximum
Other	0.8V maximum
Output Voltage	
High-Level	4.6V minimum @ -30□A
Low-Level	0.4V minimum @ 200□A
Current Consumption	
Sleep Mode	1mA
Receive Mode	15mA
Transmit Mode	50mA
Carrier Detect Sensitivity	Jumper adjustable from -108dBm to-70dBm in four steps
Operating Temperature	-35 to +85°C
Operating Humidity	25 to 95% RH @+40°C, non-condensing
Electrostatic Discharge	No hard failures at 15KV at communication connector or antenna
FCC Certifiable	Part 15.235
Module Dimensions	2.6" x 2" x 0.6" (66mm x 50.8mm x 15.2mm)
Weight	5 oz
Antenna Impedance	50Ω

8

System Development Considerations

This chapter discusses the issues relating to node development using the LONBUILDER Developer's Workbench.

LONBUILDER RF Interface

In a typical development environment utilizing the RF medium, the network is first designed and implemented using Neuron Emulator boards and either LONBUILDER RF Transceivers or the IWS RF/TP-10 RF to Twisted Pair Router.

Both the LONBUILDER RF Transceiver or the IWS RF/TP-10 Router operate on the same frequency as the RF-49 and they allow for similar CD sensitivity adjustments as the RF-49 Transceivers.

Once the network's functionality has been verified on the LONBUILDER Developer's Workbench, the network is implemented using custom nodes and RF transceivers. The use of the RF-49 Transceiver allows for an easy-to-use and fully tested off-the-shelf solution for the transceiver.

Hardware Specifications

Once a custom node has been implemented using the RF-49 Transceiver, the LONBUILDER Target Hardware screen must reflect this change having Custom Node as the hardware type.

The Channel definition is the same as the one used for the LONBUILDER Transceiver due to its full compatibility with the RF-49 Transceiver. Refer to the LONBUILDER User's Guide for information on using the LONBUILDER RF Transceiver.

The custom node should now be ready for installation and use by the LONBUILDER Development Station. Alternatively, any other network management tool can be used to download the proper configuration and applicable information to the RF custom node.

Table 8.1 is a list of parameters and their values that are to be used with the RF-49 Transceiver when explicitly downloading the communication parameters over the network. Note that these values are automatically chosen when using a LONBUILDER Development Station with the Transceiver Type set to Radio Frequency.

System Development Considerations

Table 8.1 Transceiver Parameters for the RF-49 Transceiver

Transceiver Type	Radio Frequency
Bit Rate	4.883 Kbps
Minimum Clock Rate	5 MHz
Number of Priority Slots*	0
Oscillator Accuracy*	2000 ppm
Average Packet Size*	15
Collision Detect	No
Bit Sync Threshold	7
Hysteresis	N/A
Filter	N/A
Layer 1 Time Factors	
Preamble Length	3296μs
Receive Start Delay	400μs
Receiver End Delay	0
Indeterminate Time	2000 μs
Minimum Interpacket Time	0
Use Raw Data?	No

* Installation-specific parameter

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Trouble Shooting Guide

This guide is to determine if the RF-49 is a problem in a system application, and is not intended to determine the location of a fault within the RF-49 Transceiver. The tests can be performed with a DC Voltmeter and an oscilloscope with a bandwidth of at least 50 MHz. An LED between pins 3 and 4 of J3 on the RF-49 board is an aid in determining the presence of a carrier in the receiver section. This can also be used as an indicator that a companion transmitter is operating.

Indication	Check
Not receiving signal	1. Pin 4 (Sleep) of J2 must be high (5VDC) for the RF-49 to operate in either receive or transmit mode. 2. Pin 1 (Transmit enable) of J2 must be low, the receiver is switched off when transmitter is enabled by a high at pin 1. 3. If LED is connected, LED is lit when a carrier is detected. Voltage at pin goes low when carrier is present. 4. Antenna is not connected properly or shorted. Antenna should be not be laying on a bench or on a conductive surface and should be oriented in the same direction as the transmitter antenna. 5. Wrong antenna. The selected antenna should be a 50 ohms real at 49.878 MHz. The antenna is connected to the receiver through a band pass filter, which should see a 50 ohm load at the antenna.

Troubleshooting, continued

Not transmitting signal	1. Pin 4 (Sleep) of J2 must be high (5VDC) for the RF-49 to operate in either receive or transmit mode. 2. Pin 1 (Transmit enable) of J2 must high during transmit mode. 3. Antenna is not connected properly or shorted. Antenna should be not be laying on a bench or on a conductive surface and should be oriented in the same direction as the transmitter antenna. 4. Wrong antenna. The selected antenna should be a 50 ohms real at 49.878 MHz. The antenna is connected to the receiver through a band pass filter, which should see a 50 ohm load at the antenna. 5. The presence of RF to the antenna can be verified with an oscilloscope at pin 2 of J1, with the antenna connected. The RF voltage at this point should be in the range of 1 Volt peak-to-peak.