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Radiolinx[®]
RLX-IFHE

RadioLinx Industrial Wireless
RadioLinx[®] Industrial Frequency
Hopping Ethernet Radios

November 22, 2011

USER MANUAL

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RLX-IFHE User Manual

November 22, 2011

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ProSoft Technology[®] Product Documentation

In an effort to conserve paper, ProSoft Technology no longer includes printed manuals with our product shipments. User Manuals, Datasheets, Sample Ladder Files, and Configuration Files are provided on the enclosed CD-ROM in Adobe[®] Acrobat Reader file format (.PDFs). These product documentation files may also be freely downloaded from our web site: www.prosoft-technology.com

Important Safety Information

The following Information and warnings pertaining to the radio module must be heeded.

WARNING – EXPLOSION HAZARD – DO NOT REPLACE ANTENNAS UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.

"THIS DEVICE CONTAINS A TRANSMITTER MODULE, FCC ID: . PLEASE SEE FCC ID LABEL ON BACK OF DEVICE."

"THIS DEVICE USES AN INTERNAL COMPACT FLASH RADIO MODULE AS THE PRIMARY RADIO COMPONENT. THE COMPACT FLASH RADIO MODULE DOES NOT HAVE AN FCC ID LABEL. THE COMPACT FLASH RADIO MODULE HAS NO USER SERVICEABLE PARTS."

"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 UNDESIRE OPERATION."

"CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY THE PARTY RESPONSIBLE FOR COMPLIANCE COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT."

Industry Canada Requirements

"THIS DEVICE HAS BEEN DESIGNED TO OPERATE WITH AN ANTENNA HAVING A MAXIMUM GAIN OF 24 dB. AN ANTENNA HAVING A HIGHER GAIN IS STRICTLY PROHIBITED PER REGULATIONS OF INDUSTRY CANADA. THE REQUIRED ANTENNA IMPEDANCE IS 50 OHMS."

"TO REDUCE POTENTIAL RADIO INTERFERENCE TO OTHER USERS, THE ANTENNA TYPE AND ITS GAIN SHOULD BE CHOSEN SUCH THAT THE EQUIVALENT ISOTROPICALLY RADIATED POWER (EIRP) IS NOT MORE THAN THAT REQUIRED FOR SUCCESSFUL COMMUNICATION."

"THE INSTALLER OF THIS RADIO EQUIPMENT MUST INSURE THAT THE ANTENNA IS LOCATED OR POINTED SUCH THAT IT DOES NOT EMIT RF FIELD IN EXCESS OF HEALTH CANADA LIMITS FOR THE GENERAL POPULATION; CONSULT SAFETY CODE 6, OBTAINABLE FROM HEALTH CANADA."

RLX-IFHxE Recommended Antennas

Recommended Antennas

Part Number	Max Gain	Part Number	Max Gain	Part Number	Max Gain
A902S-OA	2 dBi	A2424NJ-DB	24 dBi	A2410NJ-DY	10 dBi
A907NJ-OC	7 dBi	A082503-80-OBH	3 dBi	A2415NJ-DY	15 dBi
A908NJ-DY	8 dBi	A911NJ-DY	11 dBi	A2402S-OS	2 dBi
A2402S-OSLP	2 dBi	A2403NBH-OC	3 dBi	A2404NBHW-OC	4 dBi
A2404NJ-OC	4 dBi	A2405S-OA	5 dBi	A2405S-OM	5 dBi
A2505S-OS	5 dBi	A2406NJ-OC	6 dBi	A2406NJ-OCD	6 dBi
A2408NJ-OC	8 dBi	A2409NJ-OCD	9 dBi	A2415NJ-OC	15 dBi
A902NJ-OC	2 dBi	A902S-OA	2 dBi	A903NBH-OC	3 dBi
A903S-OM	3 dBi	A905NJ-OC	5 dBi	A907NJ-OC	7 dBi
A2408NJ-DP	8 dBi	A2413NJ-DP	13 dBi	A2416NJ-DP	16 dBi
A2419NJ-DP	19 dBi	A912NJ-DP	12 dBi	A2419NJ-DB	19 dBi

Antenna spacing requirements for user safety

It is important to keep the radio's antenna a safe distance from the user. To meet the requirements of FCC part 2.1091 for radio frequency radiation exposure, this radio must be used in such a way as to guarantee at least 20 cm between the antenna and users. Greater distances are required for high-gain antennas. The FCC requires a minimum distance of $1 \text{ mW} \cdot \text{cm}^2$ power density from the user (or 20 cm, whichever is greater).

If a specific application requires proximity of less than 20 cm, the application must be approved through the FCC for compliance to part 2.1093.

Important Installation Instructions

WARNING – EXPLOSION HAZARD – DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.

AVERTISSEMENT – RISQUE D'EXPLOSION – AVANT DE DÉCONNECTER L'EQUIPMENT, COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DÉSIGNÉ NON DANGEREUX.

EU Requirements

1. For outdoor use, France has a frequency restriction of 2.4 GHz to 2.454 GHz for an output power greater than 10 mW and below 100 mW.
2. For outdoor use in France, the output power is restricted to 10 mW in the frequency range of 2.454 GHz to 2.4835 GHz.
3. 5.15 GHz to 5.35 GHz is restricted to 200 mW EIRP throughout the European Union.

RadioLinx IFH: FCC Part 15 & Industry Canada Rules

The statements contained in this "Regulatory Approvals" section are required. If the ProSoft Technology, RadioLinx wireless modem and switches are used as a component of any device, these statements must be a component of that device's product documentation.

RadioLinx IFHE: COMPLIANCE STATEMENT

The ProSoft Technology, RadioLinx devices comply with Part 15 of the FCC Rules as well as Industry Canada Rules. Operation is subject to the following two conditions:

- this device may not cause harmful interference, and,
- this device must accept any interference received, including interference that may cause undesired operation.

In Canada, this device is to be operated indoors only and away from windows to provide maximum shielding and to prevent radio interference to the Canadian licensed service. Equipment (or its transmit antenna) that is installed outdoors in Canada is subject to licensing.

Note: The ProSoft Technology, RadioLinx module is labeled with an FCC ID number and a Canadian Certification Number. If this label is not visible when installed in an end-device, the outside of the device **MUST** also display a label referring to the enclosed RadioLinx. Use wording on the label similar to the following:

RLX-IFH9E: "Transmitter Module FCC ID: NS906P21, Canada 3143AO6P21"

RLX-IFH24E: "Transmitter Module FCC ID: IC NS907P23, Canada 3143AO7P23"

OR

RLX-IFH9E: "This device contains Transmitter Module FCC ID: NS906P21, Canada 3143AO6P21"

RLX-IFH24E: "This device contains Transmitter Module FCC ID: NS907P23, Canada 3143AO7P23"

WARNING: Changes or modifications to this radio module not expressly approved by its manufacturer, ProSoft Technology, may void the user's authority to operate the equipment.

Agency Approvals & Certifications

Wireless Approvals

Visit our web site at www.prosoft-technology.com for current wireless approval information.

Hazardous Locations

ANSI/ISA	12.12.01 groups A, B, C, D
CSA	C22.2 No. 213-M1987
ATEX	EN60079-0 and EN60079-15

Ordinary Locations

CSA/CB	EN60950 N. America & W. Europe
FCC/IC	Part 15, Class A and ICES-03
ETSI	ETSI EN300 328 and ETSI EN301 893

Agency Approvals & Certifications



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Wireless Approvals

Visit our website at www.prosoft-technology.com for current wireless approval information.

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Guide to the RLX-IFHE User Manual

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Introduction (Must Do)	□	Start Here (page 12)	This section introduces the customer to the module. Included are: package contents, system requirements, hardware installation, and basic configuration.
Configuring the Radios	□	Set Up the Network (page 24) Set Up the Master Radio (page 35) Add Remote Radios and Repeaters (page 40) Save the Radio Configuration (page 39)	This section describes the procedure for designing and configuring a network of RLX-IFHE radios.
Installing the Radios	□	Radio Hardware (page 56) Connecting antennas (page 56) Connecting Radios to a Device Network (page 58)	This section describes how to install the radio hardware, connect antennas, and connect the radios to networked devices.
Diagnostic and Troubleshooting	□	Verify Communication (page 50) Diagnostics and Troubleshooting (page 67, page 68)	This section describes how to verify communications with the network. Diagnostic and Troubleshooting procedures.
Reference Physical Installation Antenna Selection Glossary	□	Reference (page 79) Product Specifications (page 13)	These sections contain general references associated with this product, Specifications, and the Functional Overview.
Support, Service, and Warranty Index	□	Support, Service and Warranty (page 99)	This section contains Support, Service and Warranty information. Index of chapters.

1 Start Here

In This Chapter

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1.1 About the RadioLinx Industrial Frequency Hopping Radios

1.1.1 Product Specifications - RLX-IFH9E

The RLX-IFH9E provides powerful and secure wireless Ethernet communications and is well suited for demanding, long-range (up to 30+ miles) SCADA and other Ethernet applications in tough environments. Operating in the license-free 900 MHz band, the RLX-IFH9E penetrates foliage and walls / ceilings better than higher frequency radios. The RLX-IFH9E is user configurable as a master, repeater and remote radio and employs the 128 bit AES encryption algorithm approved by the United States government for top secret information.

RLX-IFH9E radios are quickly and easily configured using the included, graphical ControlScape software. An OPC server software is also included and allows users to monitor radio network health with any OPC client based HMI software.

Radio Specifications

Frequency	902 MHz to 928 MHz
Protocols	All standard IEEE 802.3 protocols
Security	128 bit AES encryption
Network Topology	Point-to-point, point-to-multipoint, store and forward repeater
Error Detection	32 bit CRC, ARQ (Automatic Resend Query)
Radio Type	Frequency Hopping Spread Spectrum
Transmit Power (Programmable)	100 mW to 1 W (Programmable) 20 dBm to 30 dBm (Programmable)
Channel data rates	1.1 Mbps or 345 kbps (Programmable)
Receiver Sensitivity (Typical)	1.1 Mbps: -98 dBm @ 10 ⁻⁶ BER 345 kbps: -106 dBm @ 10 ⁻⁶ BER
Outdoor Range	30+ miles pt-pt with high gain directional antennas and RF line-of-sight

Hardware Specifications

Enclosure	Extruded aluminum with DIN and panel mount
Size	117 x 112 x 41 mm / 4.6 x 4.4 x 1.6 inches (W x H x D)
Ethernet Port	10/100 Base-T connector, shielded RJ45 IEEE 802.3, 802.3u, 802.3x
Serial Data Port	RS-232, DB9 / RS-422 and RS-485 300 bps to 230 kbps
Antenna Ports	(1) RP-SMA connector
Weight	1.0 lbs (454g)
Operating Temp	-40°F to 149°F (-40°C to +65°C)
Humidity	Up to 100% RH, without condensation
Vibration	IEC 60068-2-6 (20g, 3-Axis)
Shock	IEC 60068-2-27 (5g, 10 Hz to 150 Hz)
External Power	9 Vdc to 24 Vdc
Power Consumption	12 W peak

1.1.2 Product Specifications - RLX-IFH24E

The RLX-IFH24E provides powerful and secure wireless Ethernet communications and is well suited for demanding, long-range (up to 15+ miles) SCADA and other Ethernet applications in tough environments. Operating in the internationally license-free 2.4 GHz band, the RLX-IFH24E offers an alternative when 900 MHz radios cannot be used due to government regulations, band saturation, or customer preference. The RLX-IFH24E is user configurable as a master, repeater and remote radio and employs the 128 bit AES encryption algorithm approved by the United States government for top secret information. RLX-IFH24E radios are quickly and easily configured using the included, graphical ControlScape software. An OPC server software is also included and allows users to monitor radio network health with any OPC client based HMI software.

Radio Specifications

Frequency	2.400 GHz to 2.4835 GHz
Protocols	All standard IEEE 802.3 protocols
Security	128 bit AES encryption
Network Topology	Point-to-point, point-to-multipoint, store and forward repeater
Error Detection	32 bit CRC, ARQ (Automatic Resend Query)
Radio Type	Frequency Hopping Spread Spectrum
Transmit Power	100 mW to 1W (FCC - A model – Programmable) 10 mW to 100 mW (ETSI - E model – Programmable)
Channel data rates	1.1 Mbps or 345 kbps (Programmable)
Receiver Sensitivity (Typical)	1.1 Mbps: -98 dBm @ 10-6 BER 345 kbps: -106 dBm @ 10-6 BER
Outdoor Range	15+ miles pt-pt with high gain directional antennas and RF line-of-sight (Americas version)

Hardware Specifications

Enclosure	Extruded aluminum with DIN and panel mount
Size	117 x 112 x 41 mm / 4.6 x 4.4 x 1.6 inches (W x H x D)
Ethernet Port	10/100 Base-T connector, shielded RJ45 IEEE 802.3, 802.3u, 802.3x
Serial Data Port	RS-232, DB9/ RS-422 and RS-485 300 bps to 230 kbps
Antenna Ports	(1) RP-SMA connector
Weight	1.0 lbs (454 g)
Operating Temp	-40 °F to 149 °F (-40 °C to +65 °C)
Humidity	Up to 100% RH, with no condensation
Vibration	IEC 60068-2-6 (20g, 3-axis)
Shock	IEC 60068-2-27 (5g, 10 Hz to 150 Hz)
External Power	9 Vdc to 24 Vdc
Power Consumption	12 W peak

1.2 Package Contents

The following components are included with your RLX-IFHE radio, and are all required for installation and configuration.

Important: Before beginning the installation, please verify that all of the following items are present.

Qty.	Part Name	Part Number	Part Description
1	RLX-IFHE Radio	RLX-IFHE	RadioLinx® Industrial Frequency Hopping Ethernet Radios
1	Cable	085-1007	DB9 M/F, 6 foot Straight Thru Serial Cable
1	Cable	Cable #15, RS232	For RS232 Connection to the CFG Port
1	Cable	RL-CBL025	5-foot Ethernet Straight-Thru Cable (Gray)
1	Cable	RL-CBL024	5-foot Ethernet Crossover Cable (Red)
1	Antenna	A2502S-OA A902S-OA	2dBi Omni Articulating Antenna (RLX-IFH24E) 2dBi Omni Articulating Antenna (RLX-IFH9E)
1	Power Supply	RL-PS007-2	AC Power Adapter, 12V1.6A w/2 pin & 4 plug Set
1	ProSoft Solutions CD		Contains sample programs, utilities and documentation for the RLX-IFHE module.

If any of these components are missing, please contact ProSoft Technology Support for replacement parts.

1.3 System Requirements

The following system requirements are the recommended minimum specifications to successfully install and run ControlScape FH:

- Microsoft Windows compatible PC
- Windows 2000 with Service Pack 2 or higher, or Windows XP Professional with Service Pack 2 or higher, or Windows 2003.
- 300 mHz Pentium processor (or equivalent)
- 128 megabytes of RAM
- 20 megabytes of free disk space
- Ethernet hub with standard RJ45 Ethernet cable

or

Ethernet port with RJ45 crossover cable for direct connection to module

In addition, you will need

- A connection to an existing wired or wireless Ethernet network, with a Static or Dynamic IP address for your computer
- Static IP address, Subnet Mask and Gateway address for each RadioLinx device you plan to install. Obtain this information from your system administrator.

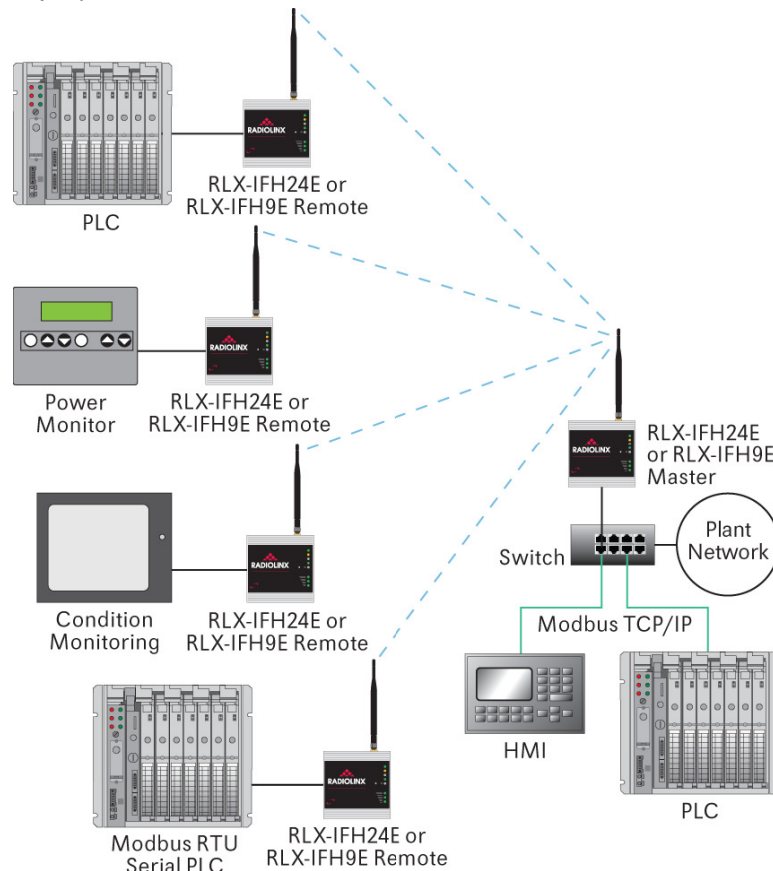
1.4 Installing ControlScape FH Configuration Software

- 1 Insert the ProSoft Solutions CD in your CD-ROM drive. On most computers, a menu screen will open automatically. If you do not see a menu within a few seconds, follow these steps:
 - a Click the Start button, and then choose Run.
 - b In the Run dialog box, click the Browse button.
 - c In the Browse dialog box, click "My Computer". In the list of drives, choose the CD-ROM drive where you inserted the ProSoft Solutions CD.
 - d Select the file **prosoft.exe**, and then click Open.
 - e On the Run dialog box, click OK.
- 2 On the CD-ROM menu, select Setup Software under RLX-FH Frequency Hopping. This action opens the Setup Wizard for ControlScape FH.
- 3 Follow the instructions on the installation wizard to install the program with its default location and settings.
- 4 When the installation finishes, you may be prompted to restart your computer if certain files were in use during installation. The updated files will be installed during the restart process.

1.5 Planning the Network

Before you configure and install the network, you should create a plan for it. To begin, determine where you need radios and then choose locations for them accordingly. For example, you might decide to install your master radio near a PC in a central plant location (You can use the PC to configure the radios through ControlScape FH). If the plant is an oil refinery, for example, you might decide to install radios near the oil tanks.

The following illustration shows how a radio network of RLX-IFH24E radios could be deployed to connect a variety of PLCs using a variety of industrial protocols. You could deploy a similar network of RLX-IFH9E radios.



The next important issue is how to link the radios. Unless the radios are very close together, you must make sure that each pair of radio antennas in the network has a line of sight between them. In other words, you must be able to see from one antenna to another, either with the naked eye or binoculars.

If a line of sight does not exist between antennas, you must choose a site for installing a repeater radio, which will create a bridge between the radio antennas. As part of your planning, you may need to conduct a site survey. ProSoft Technology can perform this survey, you can do it yourself, or you can hire a surveyor.

The simplest way to design the physical network of radios, antennas, connectors, cables, amplifiers and other accessories, is to use ProSoft Wireless Designer (page 21). This application determines your hardware needs based on your answers to a few questions, and then generates a Bill of Materials specifying all the components you will need for your installation.

Consider printing your network plan from ProSoft Wireless Designer for references as you configure your network in ControlScape FH.

Protect radios from direct exposure to weather, and provide an adequate, stable power source. Make sure that your plan complies with the radio's power requirements (page 56) and cable specifications (page 59, page 16, page 38, page 17).

Important: Radios and antennas must be located at least 8 inches (20 cm) away from personnel.

1.5.1 Installation Questions

Answer the following questions to make your installation easier, and to familiarize yourself with your system and what you want to do.

How many radios in your network?

Static IP Address, Subnet Mask and Gateway addresses for each RadioLinx device

Connection to an existing wired or wireless Ethernet network, either directly from the PC, or through an Ethernet switch or hub

Master ID

Repeater ID

Remote ID

Locations

Is there a Line of Sight between them?

Selected the appropriate antennas for your network?

What type of network protocols do you need to support?

What type of cable connections do your network devices require?

1.5.2 ProSoft Wireless Designer

ProSoft Wireless Designer simplifies the task of specifying a ProSoft Wireless installation, and provides a variety of views containing an accurate description of each site in a wireless network, including:

- Visual diagram of site layout
- Location (latitude/longitude, based on GPS coordinates)
- Radio type, frequency range, and country-specific channel and power requirements
- Length, type and estimated signal loss for cables
- Required accessories, including lightning protection, cable adaptors and antennas
- Complete parts list

Use *ProSoft Wireless Designer* when conducting a site audit for a customer, and then provide the customer with a complete list of components and a detailed description for each site and link. Customers can use this information to understand and visualize their network, and provide necessary information for technical support and maintenance.

- Contains a database of all currently available RadioLinx radios, antennas, cables, connectors and accessories
- Exports Parts List, Site and Link Details, and Wizard settings into a variety of common file formats, for import into applications such as spreadsheets, databases and word processors
- Checks wireless link feasibility based on path length and recommended accessories
- Predicts signal strength based on distance, local regulations and hardware choices
- Fully documents your ProSoft Wireless network plan

Functional Specifications

The ProSoft WirelessN Discovery Tool supports the following network discovery and monitoring activities:

- Discover and view the list of radios in the network
- Display graphically the current network topology and display parent-child links between various radios in the network
- Scan the network on demand
- Save and load network snapshots
- Upload and download configuration files to/from radio devices
- Upgrade Radio firmware

System Requirements

ProSoft WirelessN Discovery Tool is designed for computers running Microsoft Windows and Microsoft .NET Framework version 3.0 or newer.

Minimum hardware requirements are:

- 400 MHz or faster Pentium PC
- 128 MB RAM
- CD-ROM drive
- 280 MB available hard drive space

The Microsoft .NET Framework version 3.0 is not supported on Windows 95, Windows NT 4, or Windows 3.x.

It is highly recommended for all platforms that you upgrade to the latest Windows Service Pack and install all critical updates available from Microsoft to ensure the best compatibility and security.

1.6 Configuring the Radios

Configuration of your RLX-IFHE radios consists of the following steps:

- Start ControlScape FH (page 23)
- Plug In the Cables (page 38)
- Set Up the Network (page 24)
- Set Up the Master Radio (page 35)
- Add Remote Radios (page 40)
- Add Repeaters (page 41)
- Graphically Define the RF link (page 43)
- Save the Network Configuration (page 45)
- Save the Radio Configuration (page 39)

1.6.1 Start ControlScape FH

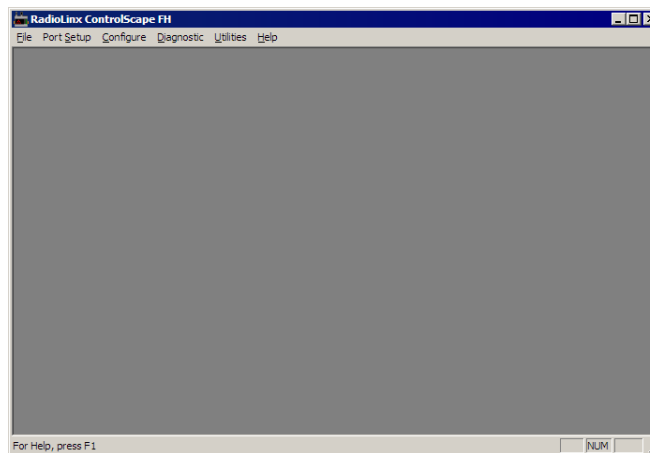
You will use an application (software program) called ControlScape FH to configure the RLX-IFHE radios and the radio network. If you have not already installed ControlScape FH, please do so now. Refer to Install ControlScape FH Configuration Software (page 18) for information on how to install the program.

To start ControlScape

- 1 Click the Start button, and then choose Programs
- 2 In the Programs menu, navigate to the ProSoft Technology folder, and then choose RadioLinx ControlScape FH.



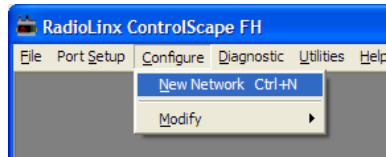
- 3 Allow a few moments for the program to load. When the program has finished loading, you will see a screen like this:



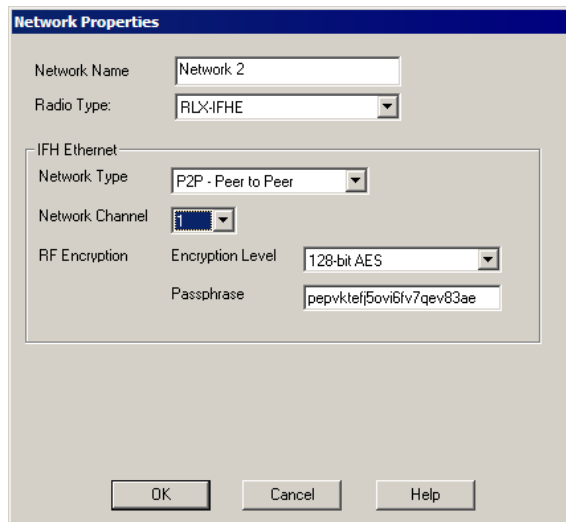
1.6.2 Set Up the Network

From the ControlScape FH **Main Menu**, select:

- **Configure**
 - **New Network**



A Network Properties dialog box is displayed where the basic parameters of the new network are defined. The items on this dialog box depend on what type of radio you select. The following example shows a RadioLinx IFHE (Industrial Frequency Hopping Ethernet) radio.



Network Types - IFH Radios

Note: Available network types depend on the type of radio you are configuring. Not all network types are available on all radios. Only the SSE and PTP network types can be chosen for new networks. ControlScape still supports all of the legacy network types for users with networks of those types. The SSE type is replacing those networks as it provides the flexibility of the E2E and P2P network types with the performance of the PMP network type or better.

IFH Radios

- P2P - Peer to Peer (page 27)
- PMP - Point to Multipoint (page 28)
- E2E - Everyone to Everyone (page 28)
- PTP - Point to Point (page 30)
- SSE - Smart Switched Ethernet (page 33)

Note: There is only one Master radio for each network.

SNMP Interface

The RLX-IFHxE radios also support the Simple Network Management Protocol (SNMP). This interface can be used to get status information or configure the radio using a third party SNMP client. The radio acts as a server to respond to requests sent by the user. The standard method for providing the set of possible data that can be retrieved and settings that can be modified is through a specially formatted text file with the extension .MIB. The MIB file for the RLX-IFHxE radios is located on the CD that ships with your product and on the ProSoft webpage for the RLX-IFHxE product.

SNMP uses a series of numbers separated by a decimal point to indicate the unique value that is being accessed. These are called Object Identifiers (OIDs). While the SNMP standard specifies certain generic OIDs, the most useful are usually the custom OIDs for a product. The information in the MIB file describes the custom OIDs to which the RLX-IFHxE SNMP server will respond. This information includes the OID number and name, whether that OID is read-only or read/write, the type of the value that this OID will retrieve or can be set, and sometimes information about what that value means. The file is setup hierarchically with groups of OIDs contained within a higher level OID. Each OID specifies a higher order name and a number. The higher order name identifies the series of numbers before the final number. The full OID would then be that series along with the number specified in the OID description.

This is an example entry:

```
radioOperationMode  OBJECT-TYPE
                    SYNTAX INTEGER { master(0), repeater(1), remote(2) }
                    ACCESS read-write
                    STATUS mandatory
                    DESCRIPTION "Radio Operation Mode: 0 - Master 1 -
Repeater 2 - Slave."
                    ::= { radioConfig 2 }
```

- radioOperationMode is the name of the OID.
- The values it accepts and returns is an INTEGER. The valid values of the integer are 0, 1, and 2 which have a meaning of master, repeater, and remote respectively.
- This OID allows both read and write capability.
- The last line specifies the OID number series. radioConfig is the higher level OID to which radioOperationMode belongs. 2 is the number for this OID within the radioConfig group. The radioConfig group is described in a different entry.

The SNMP standard provides a special OID group for custom OIDs. This special OID group is named 'enterprises'. The MIB file only contains OIDs within this group. The MIB file, while legible to humans, is organized for use by a program and can be difficult to follow by just looking at the contents of the file. This is due to the fractured format of the information. As in the example, if you want to determine an OID number series, you look at the OID specification for the entry, but it only gives you the number of the last digit. To complete the number series, it would require finding each levels entry and value one at a time in the MIB (or in the SNMP standard, for OID numbers at the enterprises level or higher).

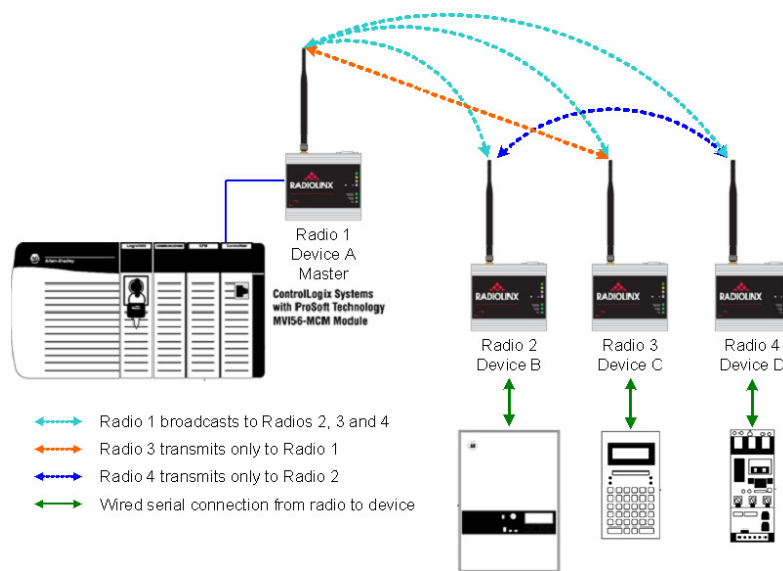
In addition to the OIDs, there are a couple of parameters that are necessary in order to successfully communicate with the radio over SNMP. For SNMPv1 there are community names that are required to access the RLX-IFHxE over SNMP. For SNMPv3, a username and password are required. See the following table for this information.

SNMP Parameter	Value
Read Only Community Name	Public
Write Community Name	Private
SNMP v3 Username	Prosoft
SNMPv3 Password	Password

Peer to Peer Networks

Peer-to-Peer (P2P) supports communication (through the Master) between two or more remote units. Each radio can be configured to send its messages to one other radio, or to broadcast to all radios in the network.

In the following illustration, the master radio is configured to broadcast to both radios. Each remote radio is configured to send data back to the master.

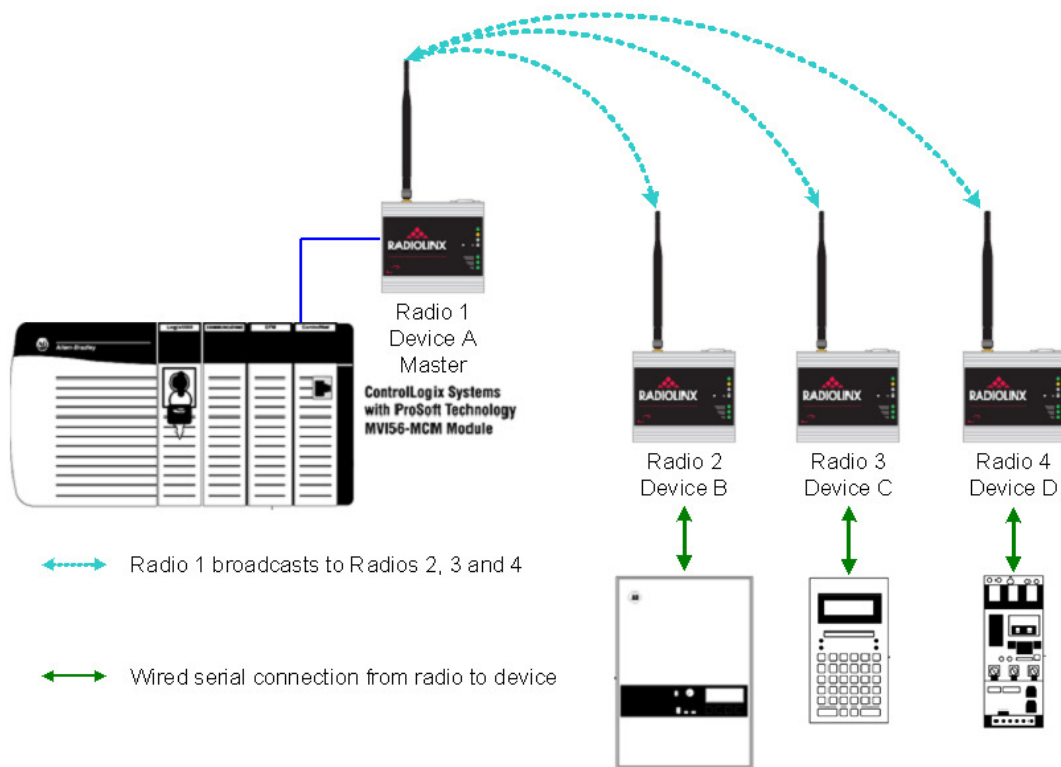


Point to Multipoint Networks

Point to Multipoint configuration creates the network to broadcast data from the Master radio to the other radios in the network. All of the other radios return their data to the Master radio.

A Point to Multipoint network is well suited for a polled network such as Modbus RTU, DF1 or Modbus TCP/IP. Communications from remote radios is directed back to master radio. Master radio broadcasts to all other radios.

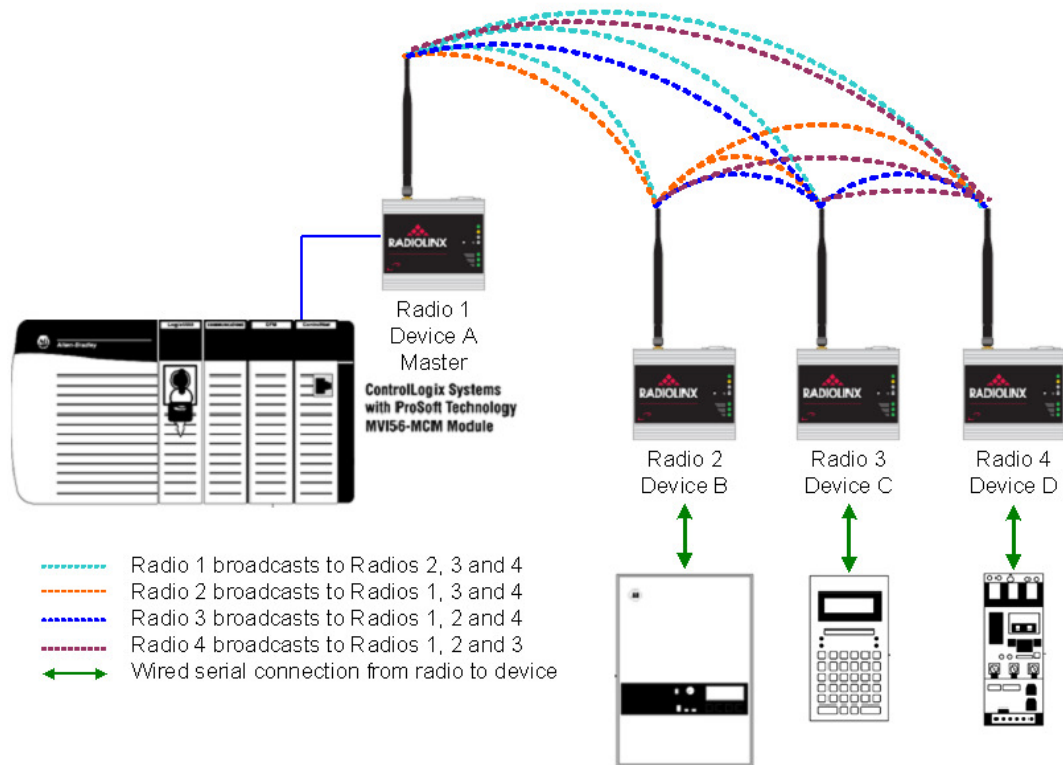
In the following illustration, the Master radio is configured to broadcast data to Radios 2, 3 and 4.



Everyone to Everyone Networks

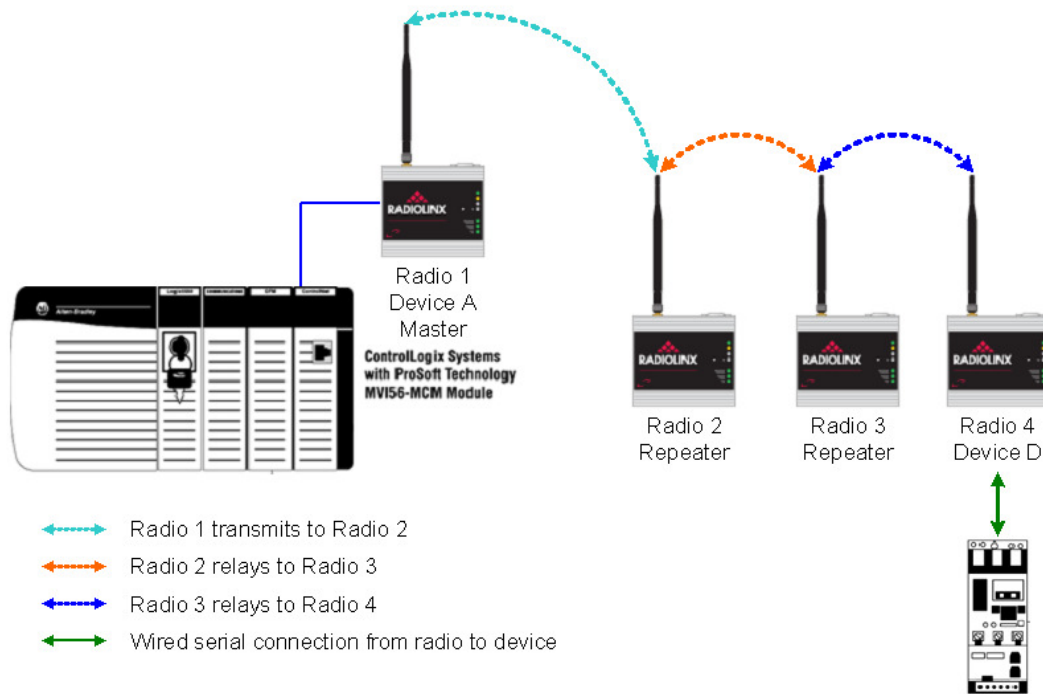
Everyone-to-Everyone (E2E) configuration creates a network where all units communicate with all other units, through the Master. Note that this mode is very bandwidth-intensive, because all data is transmitted to all radios.

In the following illustration, each radio broadcasts to all the other radios.



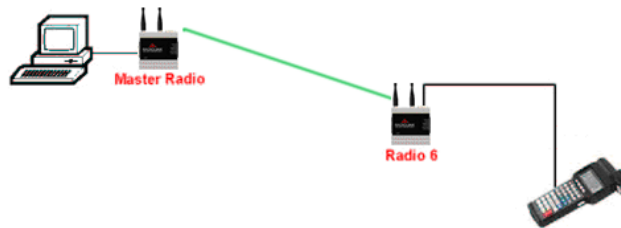
Point to Point Networks

Point-to-Point configuration transfers data between two radios (points) in the network. In the network shown below, the Master Radio and Radio 4 transfer data between each other. Radios 2 and 3 only act as bridges to get the data between them.



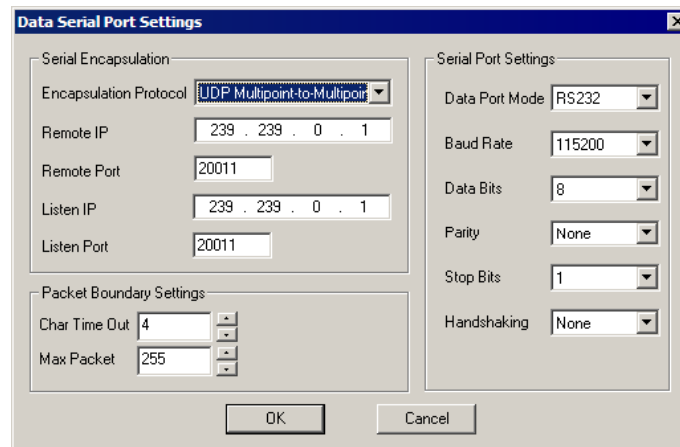
Serial Protocol Encapsulation

The RadioLinx RLX-IFHE contains its own IP protocol stack that is configured with a local area network IP address. The radios are configured to send to and receive from a socket interface. A serial message is encapsulated into an Ethernet packet and is delivered to the socket, where the serial server extracts the serial data stream from the Ethernet packets and outputs it to the RS-232 serial port. Bi-directional serial communication is supported in some modes.



Legacy serial-only HMI software can be used with Ethernet by installing a third-party COM port redirection driver on the host computer. The redirection driver provides the client services to establish and maintain a TCP socket connection with the serial server while simulating a PC COM port to the HMI application.

Click the Radio Configuration button on the Radio Configuration dialog box to configure encapsulation settings.

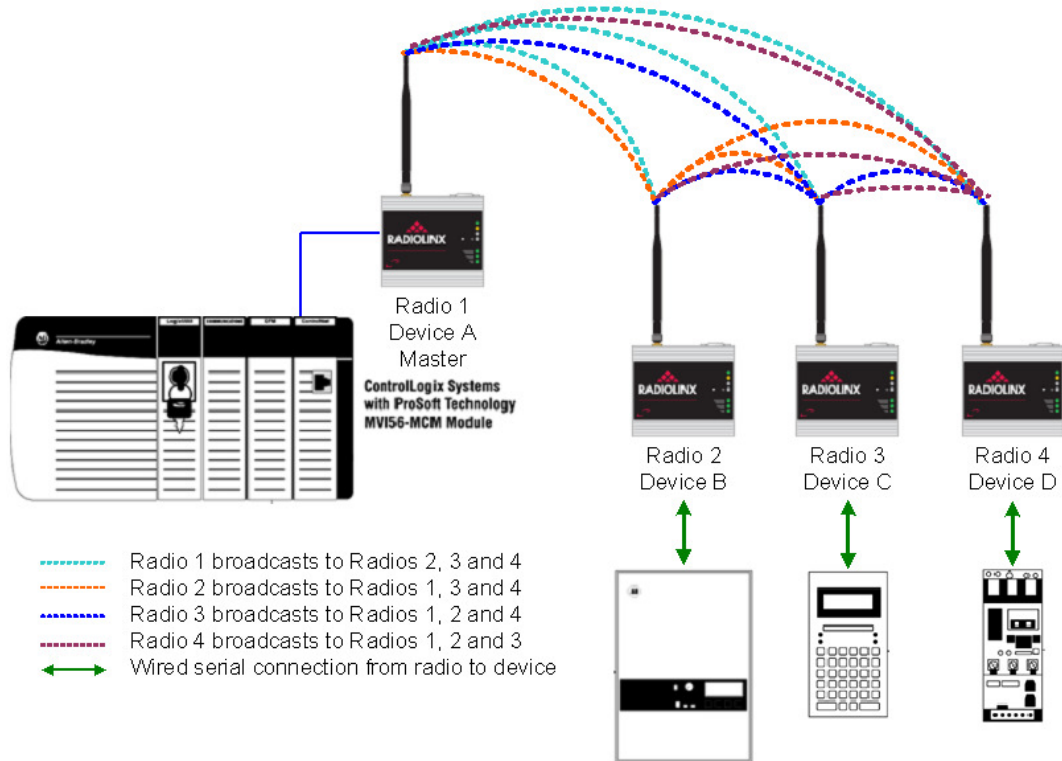


The RLX-IFHE radio supports the following serial encapsulation protocols.

- **TCP Client** - Serial data is encapsulated into a TCP packet. This radio will initiate a communication with a TCP server, either another radio or another device. TCP can be more reliable than UDP, but uses more bandwidth.
- **TCP Server** - Radio receives data from a TCP Client. TCP can be more reliable than UDP, but uses more bandwidth.
- **TCP Client/Server** - Radio can both send and receive TCP traffic. This radio will initiate a communication with a TCP server, whether it be another radio or another device. It will also receive data from a TCP Client. TCP can be more reliable than UDP, but uses more bandwidth.
- **UDP Point-to-Point** - UDP is the standard method for encapsulation. Point-to-Point allows this device to send to another IP address and to receive UDP data.
- **UDP Point-Multipoint (Point)** - UDP is the standard method for encapsulation. UDP point to multipoint allows many device to send to and receive data from a single device. As a point, the device will sent to and receive from many devices.
- **UDP Point-Multipoint (Multipoint)** - UDP is the standard method for encapsulation. UDP point to multipoint allows many device to send to and receive data from a single device. As a multipoint, the device will sent to and receive from one device.
- **UDP Multipoint-to-Multipoint** - UDP is the standard method for encapsulation. UDP multipoint allows this device to send data to and receive data from many devices.

Smart Switched Ethernet

Smart Switched Ethernet (SSE) configuration creates a network suitable for any communication pattern between the radios. It efficiently determines whether to broadcast to all radios or direct to a single radio on a packet by packet basis. In the following illustration, each radio is able to communicate with any or all other radios.



Changing Network Type

Users now have the ability to change their network to either SSE or PTP (assuming their network conforms to the PTP restrictions) from another network type. This is done selecting Configure->Modify and clicking their network. Once open in the configuration view, selecting Radio Network from the Properties menu will bring up a Network Properties dialog. From this dialog they can choose a new network type from the Network Type drop down box. This will require reconfiguration of radio in the network and cannot be reversed to return to any of the obsolete network types once the network file is saved.

1.6.3 General Radio Configuration

Note: If possible, you should configure all the radios side by side in an office setting and make sure they link before you install them in the field. If feasible, it would be even better if you could set up the entire system in the office and make sure your equipment communicates properly through the radio network.

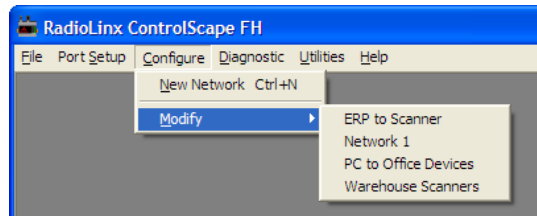
Important: If the radios are close enough to each other that their received signal strength is greater than -40dBm, performance may be degraded. Disconnect antennas from radios during bench testing, or move the radios further apart from each other.

Configure the radios themselves after the network is designed. Radios are configured **ONE AT A TIME USING THE CONFIGURATION PC.**

Use the specified cable (page 38) and connect the radio to an Ethernet switch or hub (gray cable) or directly to the Configuration PC's Ethernet port (red cable).

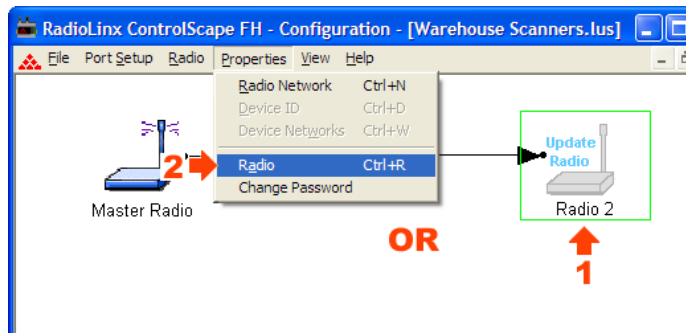
Access the **Radio Configuration** dialog box to set network-specific parameters for each individual radio. Starting from the ControlScope FH **Main Menu**, select:

- **Configure**
 - **Modify** (the network by name)

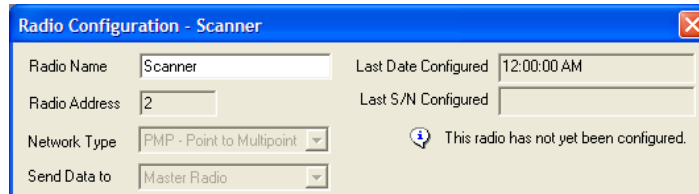


The **Graphical Layout Screen** is displayed. There are two different methods of bringing the dialog box up from the screen:

- double-click the **icon of the radio to be configured**,
- OR**
- select the **icon of the radio to be configured** by selecting it with a single left-click of the mouse and then choose the following menu items:
 - **Properties / Radio**



The Radio Configuration dialog box is displayed - the image of the dialog box is different depending on which network type (page 25) the radio is incorporated into.



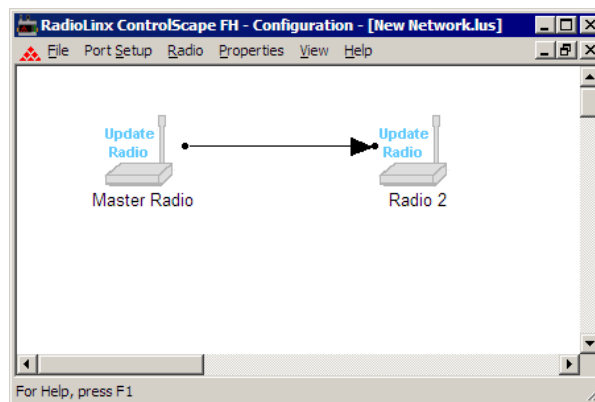
Continue to configure the radios depending on their network type:

Note: The network types available depend on the type of radio you select. Not all network types are supported on all radios. Refer to the user manual for your radio to determine what network types are available.

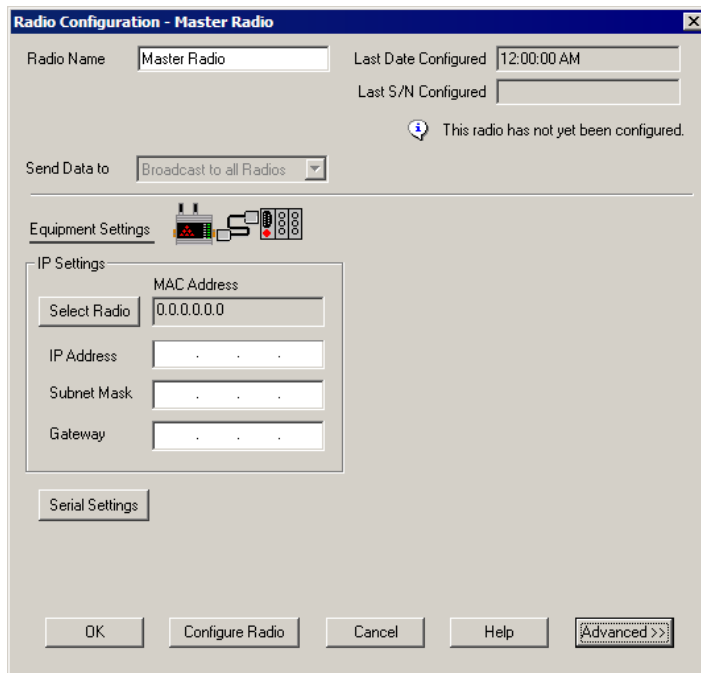
1.6.4 Set Up the Master Radio

RadioLinx IFH radios are designed to act as a "wire replacement" to connect a local device (for example, a PLC) with one or more remote devices (for example, another PLC, an HMI, or a field device such as a valve, meter, bar code scanner, or other measurement or control device).

Every radio network requires one Master radio, and one or more Remote radios. When you create a new network, ControlScope FH automatically populates the network with a pair of radios, as shown in the following illustration.

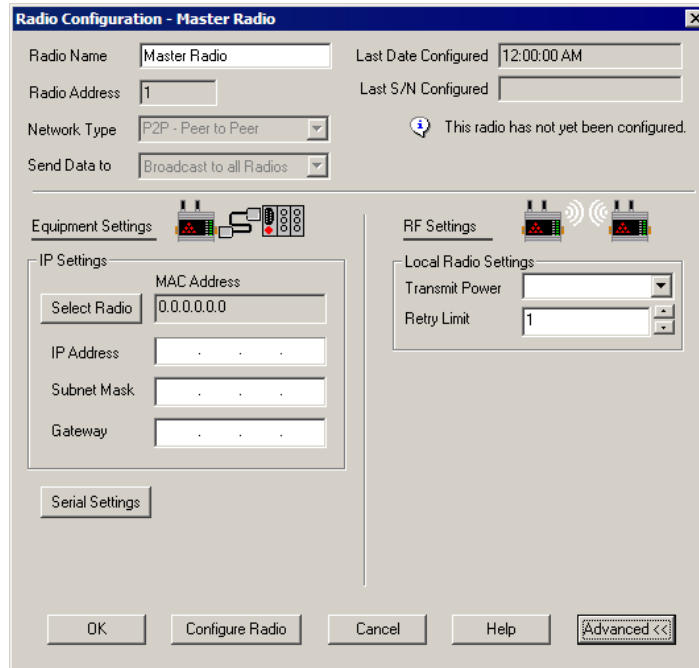


Double-click the left mouse button on the Master Radio to open the Radio Properties dialog box.



Most of the settings on this dialog box are straightforward. The default settings will work with many devices without modification, however you will need to assign an IP address, subnet mask and default gateway for each radio on the network. If you are using Serial Protocol Encapsulation (page 31) to transmit serial data over the wireless network, you may also need to know the communication parameters to use if the wired device requires different settings. This information is normally available in the user manuals for the device.

Certain devices may require additional configuration, if the default configuration is not adequate for reliable data transfer. For example, you may need to adjust transmit power to reduce interference with other devices transmitting on the same frequency, or to fine-tune the packet settings to accommodate timing and packet size requirements for an industrial protocol. Click the Advanced button to make these additional options visible.



When you have finished making your selections, click OK to save the radio configuration.

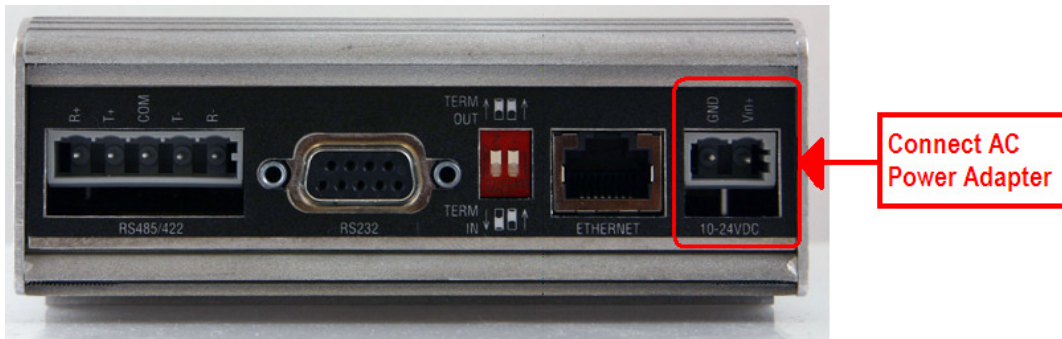
Plug In the Cables

You must transfer these settings to the Master radio in order for these changes to take effect. ControlScape FH will update the radio's internal settings through the Ethernet connection between your computer and the radio.

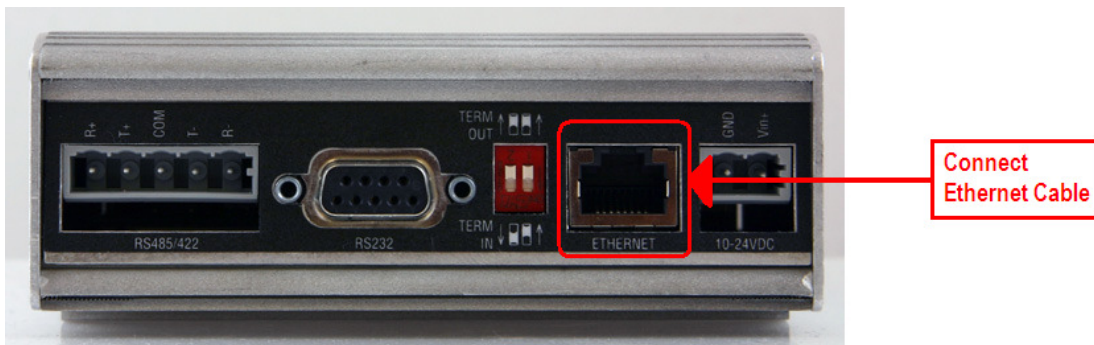
Important: The serial port on the bottom of the radio, labeled RS-232, is reserved for connections to external network devices, and cannot be used to configure the radio.

Important: Please allow sufficient time for the radio to power up and respond to discovery or configuration requests. In some instances, the radio may require up to 90 seconds to become responsive.

- 1 Connect the AC power adapter cord to the port labeled 10 - 24 VDC 6W on the bottom of the radio, and then plug the power adapter into an electrical outlet.



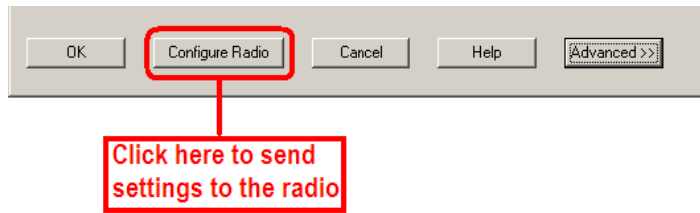
- 2 Connect an Ethernet cable to the ETHERNET port on the bottom of the radio.
 - If you are connecting through an Ethernet switch or hub to the radio, use the Gray (straight-through) cable to connect the radio to the switch or hub.
 - If you are connecting directly from your PC to the radio, use the Red (crossover) cable to connect to the radio from the Ethernet port on your PC.



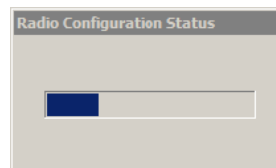
When the radio is powered up, it will go through a brief self-test during which the LEDs on the front of the radio will illuminate. The Power/Status LED should be green, meaning that the radio has power.

Transferring the Configuration to the Master Radio

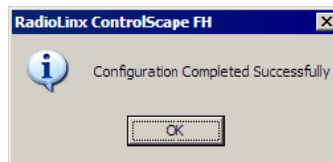
To send the new configuration settings to the Master radio, click the Configure Radio button on the Radio Configuration dialog box.



ControlScape FH will display a progress indicator as it attempts to connect to the radio.



When the configuration is completed successfully, the following message is displayed.



When the configuration has been transferred successfully, ControlScape FH will update the Radio Configuration dialog box with information retrieved from the radio, including the radio's Serial Number and Last Date Configured.

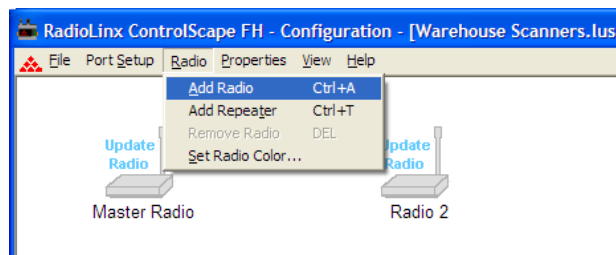
1.6.5 Adding Remote Radios

The radios can be displayed in different colors, or you can use the default color. The color of a radio does not affect the function of the network, *however*, there may be an application that can be more clearly represented with color-coded radios.

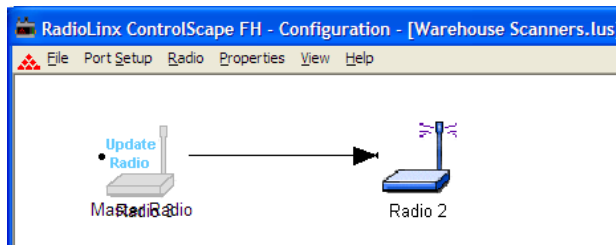
Important: When defining a color, the color must be defined before the radio is added.

From the ControlScape FH **Main Menu**, select:

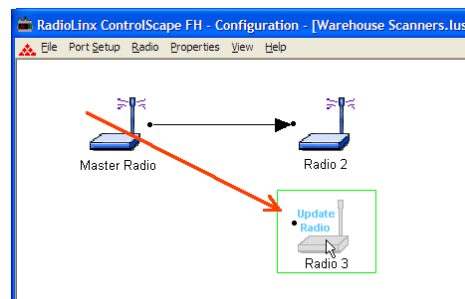
- **Radio**
 - **Add Radio**



The new radio icon image appears and is superimposed over part of the Master Radio icon.



Move (click and drag) the additional Remote radio icon off the Master Radio icon.

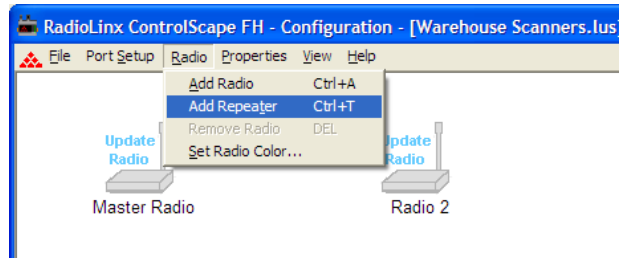


Continue on to Graphically Define the RF Link (page 43) to define the communication links between radios.

Note: See When to Re-Configure Radios (page 47) to ensure all radios will be updated.

1.6.6 Add Repeaters

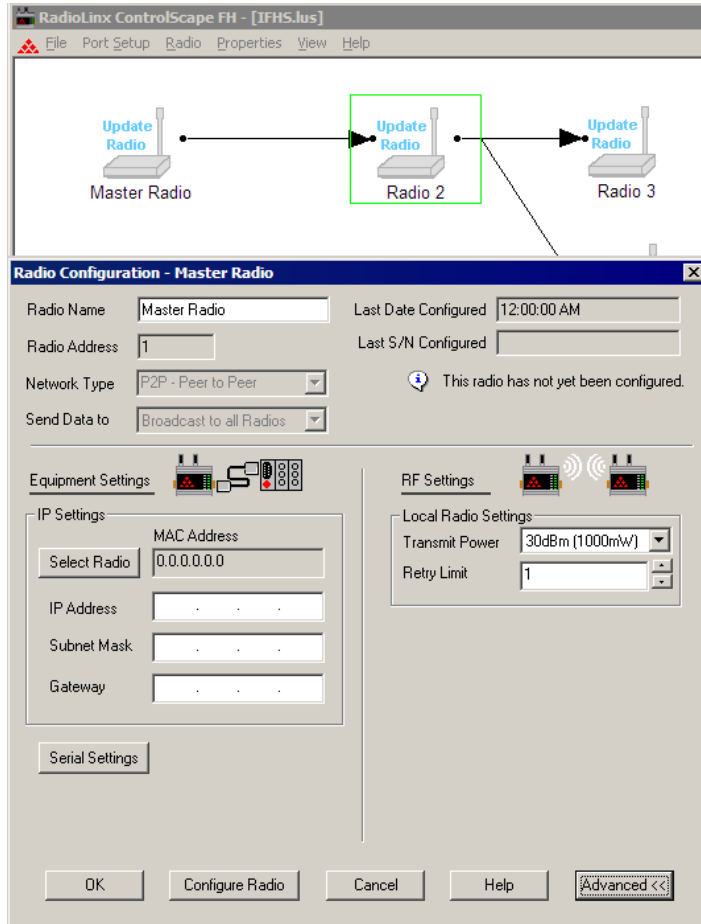
The following illustration shows how to **Add a Repeater** to the Network. After selecting the add repeater function from the menu, a repeater icon will appear on the Graphical User Interface (GUI).



The repeater radio will have a link point (black dot) on both the right and left side of each repeater radio. The remote radio has only one link point located on the left side of the radio. As with all new radios, it will show the radio needs to be updated.



Initially, a new network will start out with a Master radio and a Remote radio connected by the RF link. To add a Repeater, the RF link (page 43) between the Master and Remote will need to be deleted. After the Repeater is in place and RF links are connected, the Repeater's setting can be adjusted.



Important: The items on this dialog box depend on what type of radio you select. The example in this topic shows a RadioLinX IFHE (Industrial Frequency Hopping Ethernet) radio. Refer to the user manual for your radio for an explanation of each configuration item.

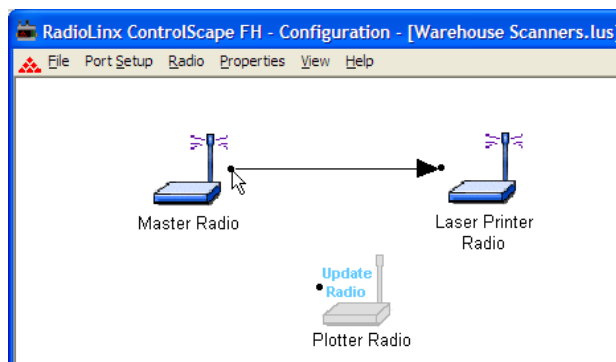
1.6.7 Graphically Defining the RF Link

Radio communication links between radios must be defined. ControlScape FH uses lines between radios to graphically define the RF communication links in a network.

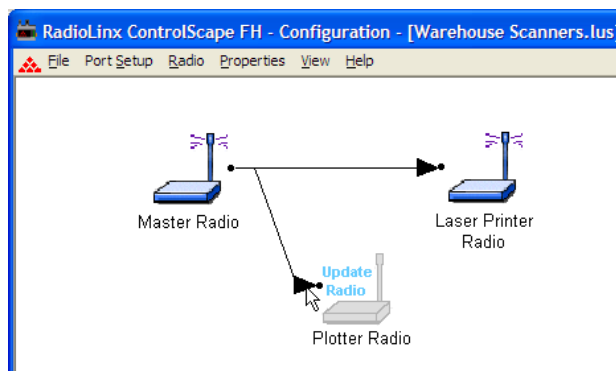
From the network's **Graphical Layout Screen**:

Use the left mouse button to select the Master radio's link point (the black dot to the right of the Master radio icon).

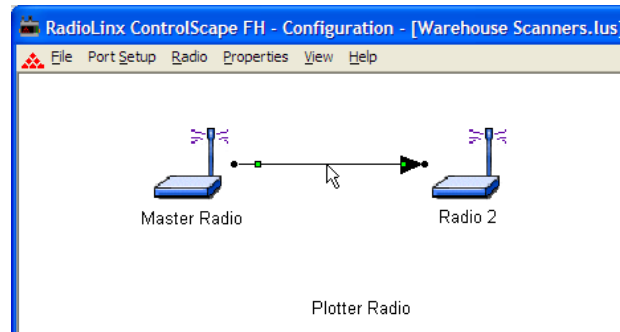
Note: Select the Master radio's link point (only) and not the Master radio icon itself. If the Master radio is selected (surrounded by a colored box), left-click anywhere else on the screen to de-select the Master radio icon.



Hold the left mouse button down and drag the RF link to the Remote radio's link point (located to the left of the Remote radio). As the mouse is being dragged, a line will appear between the Master and Remote radios. **This is the graphical representation of the RF communication link.** After the mouse button is released an arrowhead will appear at the end of the graphical link line at the Remote radio's link point.



To remove a RF link between two radios, select the line between the radios.



Press the Delete key to remove the graphical link line between the radios. Now a repeater could be added between the two radios or the radios could be connected to other radios.

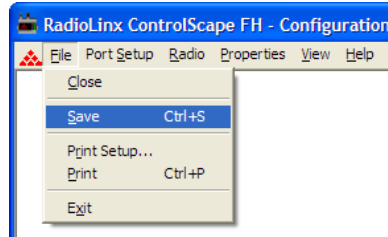
1.6.8 Saving the Network Configuration

Save the Network's definition if:

- A new network has been defined
- Changes have been made to the network's definition

From the **Main Menu**, select:

- **File**
 - **Save**

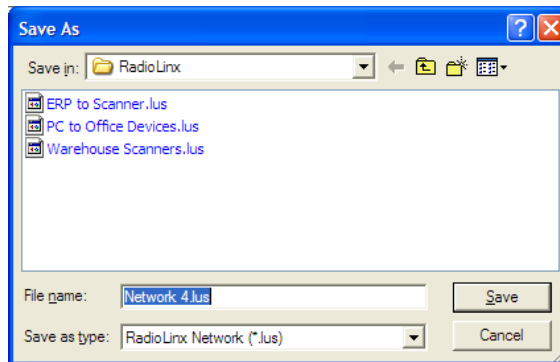


The standard windows **Save As** dialog box will be displayed; the network name can be accepted as it is or it can be edited here.

Note: This is the last time that the network's name can be changed within ControlScape FH. If you need to rename a network you have already saved, you can rename the .LUS file in Windows Explorer.

Select:

- **Save**



Notes: DO NOT change the default directory. The ControlScape FH Setup/Diagnostic Application uses the default directory to maintain network-related data.

The Network's Definition can be printed.

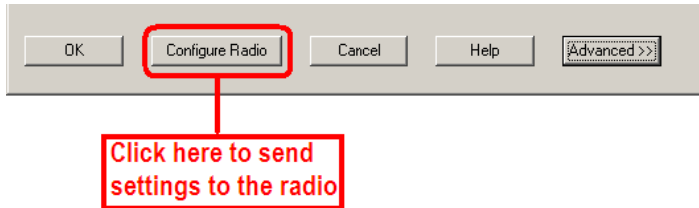
If this is the first time this network has been saved, the Password dialog box appears.



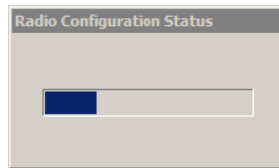
Enter the new password and click **OK**. If no password protection is desired, leave the password blank and click **OK**.

1.6.9 Transfer the Configuration to the Remote Radios

To send the new configuration settings to the Remote radio(s), click the Configure Radio button on the Radio Configuration dialog box.



ControlScape FH will display a progress indicator as it attempts to connect to the radio.

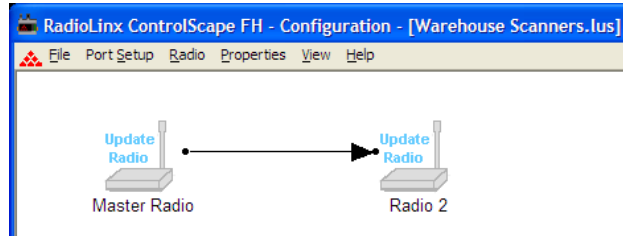


Repeat these steps for each Remote radio on your network.

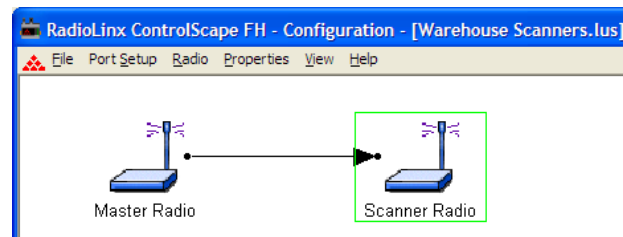
When the configuration has been transferred successfully, ControlScape FH will update the Radio Configuration dialog box with information retrieved from the radio, including the radio's Serial Number and Last Date Configured.

When to Re-Configure Radios

All radios need to be configured before initial installation in a network. In general, after radios are functioning in a network, they do not need to be re-configured if the network changes. The program will instruct when the radios need to be configured, as illustrated below:

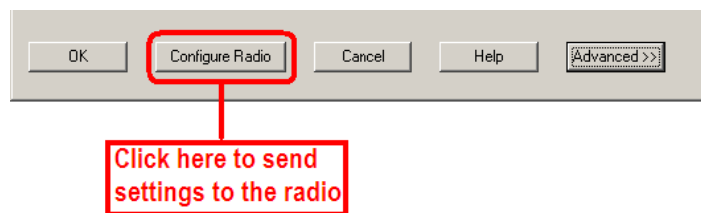


After all the radios are configured, the graphical layout will be displayed as follows:



Reconfiguring a Remote Radio

To reconfigure the Remote radio(s), click the Configure Radio button on the Radio Configuration dialog box.



Repeat these steps for each Remote radio on your network.

1.7 Planning the Physical Installation

A network's performance is affected by attributes specific to the installation site. Consider the following cautions, where possible, to optimize your network installation:

- Design the network to use less than 2048 radios (per network)
- Place radios within the specified 15 miles of each other
- Add repeater to extend distance or where line of sight is limited
- Radios or antennas CANNOT be placed within 8 inches (20 cm) of where people will be

Though radio frequency communication is reliable, sometimes its performance can be affected by intangibles. A good network installation plan includes **time** and **resources** for performance testing and installation changes.

Test the installation plan (page 49) before the network installation is complete.

1.8 Testing the Network Installation Plan

Test proposed installations before finalizing the installation.

After you have configured the network and the radios:

- install the Master radio in its proposed permanent location
- cable the Configuration PC to the Master radio
- place the Remote radios in their proposed locations
- temporarily place each radio's antenna near its proposed mounting location.
The temporary placement of the antenna can be by hand, however, with this testing method, one person must hold the antenna while another monitors the Remote radio's signal strength as displayed on the Configuration PC.

To improve the signal quality of each Remote's communication:

- increase the height of the antenna's placement
- use higher-gain antennas
- increase the radio's transmission power, cable the radio to the Configuration PC, and reconfigure it
- select a new location for the Remote radio and/or its antenna
- decrease the length of antenna cable
- determine and resolve sources of "electrical" noise which may be interfering with the radio transmission
- add a repeater between the radios that are not communicating, or reconfigure an existing radio as a repeater if line of sight is available

Note: See When to Re-Configure Radios (page 47) to ensure all radios are updated.

1.9 Verifying Communication

ControlScape FH provides several ways to verify that the radios are configured and communicating with each other.

1.9.1 Viewing Operating Network

To view a graphical representation of a network's communication links, connect a radio to the Configuration PC.

From the ControlScape FH **Main Menu**, select:

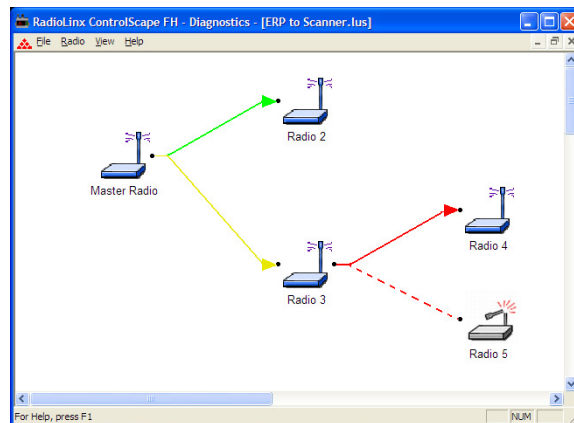
- **Diagnostic / Network**
 - **the network by name** (from the displayed list of configured networks)



Select which radio is connected to the Configuration PC from the Radio Name drop down list. The IP Address of the radio connected to the configuration PC is automatically displayed.

Note: For IFH radios, full network diagnostics are available only when you are connected to the Master radio. If you are connected to a Remote or a Repeater radio, you will only be able to retrieve status information for the radio to which you are currently connected.

Following is the ControlScape FH's graphical representation of a **network with intact communication links**. The functioning RF communication links are represented solid colored lines.



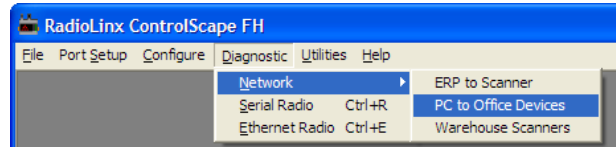
The colored lines indicate the signal strength of each radio, see Viewing Signal Strength. If any of the communication links show red dashed lines see Broken Links in a Radio Network (page 76).

1.9.2 Viewing Signal Strength

After a network is configured, the Signal Strength of the Remote radios can be monitored. This is helpful when the radios are being physically installed (page 48).

To monitor the Remote radio's Signal strength:
From the ControlScape FH **Main Menu**, select:

- **Diagnostic / Network**
 - **the network by name** (from the displayed list of configured networks)



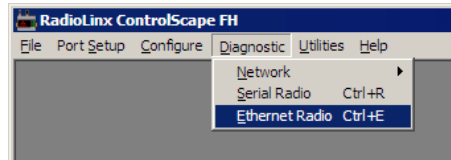
After the network is displayed, double click the Remote radio to open the Radio Status dialog box. This dialog box shows information about the radio, including serial number, hardware and firmware information, and signal strength. The appearance of this dialog box depends on the radio model and type.

1.9.3 Getting Radio Status

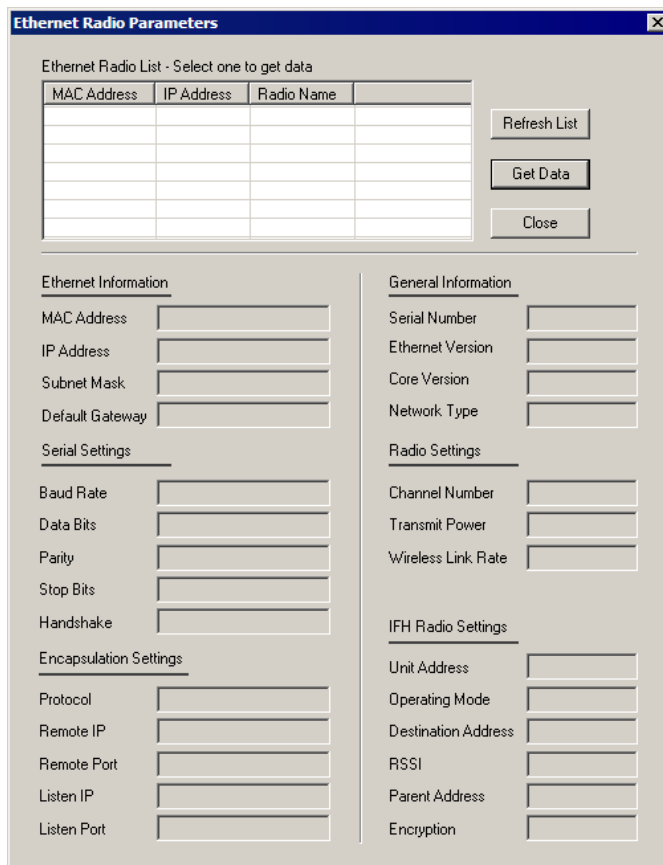
A radio can be queried so that it reports its settings to the Configuration PC. Radios may be queried **directly** (through a cable connected to the Configuration PC) or remotely (through communication with the Master radio cabled to the Configuration PC).

To directly query a radio (either Master or Remote), cable the radio to the Configuration PC (page 38). From the ControlScape FH Setup/Application **Main Menu**, select:

- **Diagnostic**
 - **Radio**



The Radio Parameters dialog box appears. Click the **Get Data** button to receive data. The following illustration shows the Ethernet Radio Parameters dialog **BEFORE** getting data



The following illustration shows the Radio Parameters dialog **AFTER** getting data

Ethernet Radio List - Select one to get data

MAC Address	IP Address	Radio Name	
00:0F:92:00:13:70	192.168.5.183	PPSFT_240...	

Refresh List
Get Data
Close

Ethernet Information

MAC Address: 00:0F:92:00:13:70
IP Address: 192.168.5.183
Subnet Mask: 255.255.248.0
Default Gateway: 192.168.7.4

Serial Settings

Baud Rate: 9600
Data Bits: 1
Parity: None
Stop Bits: 8
Handshake: None

Encapsulation Settings

Protocol: UDP MultiPoint to Multipoi
Remote IP: 239.239.0.1
Remote Port: 20011
Listen IP: 239.239.0.1
Listen Port: 20011

General Information

Serial Number: N/A
Ethernet Version: v5.071ip
Core Version: 0
Network Type: Point to MultiPoi

Radio Settings

Channel Number: N/A
Transmit Power: 20dBm
Wireless Link Rate: 19.2k

IFH Radio Settings

Unit Address: 6976
Operating Mode: Remote
Destination Address: 1
RSSI: -105
Parent Address: 1
Encryption: Disabled

Click the **Close** button to close the **Radio Parameters** dialog box.

2 Installing the Radios

In This Chapter

- ❖ Radio Hardware 56
- ❖ Connecting the Radio to a Network Device 58

Important: If the radios are close enough to each other that their received signal strength is greater than -40dBm, performance may be degraded. Disconnect antennas from radios during bench testing, or move the radios further apart from each other.

Tip: To make it easier to physically identify the radios you are configuring, apply a label to each radio indicating the radio name.

After you have configured each radio using ControlScape FH, you can install the radios and test their performance. Install the radios in their proposed permanent locations, then temporarily place each radio's antenna near its proposed mounting location. The temporary placement of the antenna can be by hand; however, with this testing method, one person must hold the antenna while another monitors the radio's signal strength.

To see how a radio is linked in the network, make sure that the radio is connected to a PC, and then open the Diagnostic menu and choose your network in ControlScape FH.

The Diagnostic view shows a diagram of the network's wireless connections. Use this view to see whether all the radios are linked. Refer to Improve Signal Quality (page 57) for more information on overcoming poor connectivity.

2.1 Radio Hardware

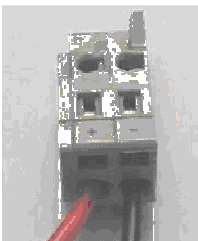
The RLX-IFHE radio consists of the following components:

- One antenna port (page 56)
- LEDs that indicate the status of the radio (page 69)
- Ethernet Port (page 59)
- Serial cable ports (page 58)
- Power connection (page 56)

2.1.1 Radio power requirements

The RLX-IFHE radio accepts voltages between 10 and 24 VDC, with an average power draw of less than 6 watts. A detachable power connector comes with the radio, as shown. The connector terminals are labeled + (positive DC connection) and - (DC ground connection). You can use the provided AC-to-DC power supply adapter that is pre-wired with a power connector, or you can use power from another source, for example the power supply for the PLC or the networked devices.

The DC power wires must be less than 3 m to meet regulatory requirements.



Label	Connect to...
+	10 to 24 VDC
-	DC Ground

2.1.2 Connecting antennas

Each radio must have an antenna connected to the Main antenna port on the radio; without an antenna for each radio, the network will not function.

All antennas for radios that communicate directly with each other should be mounted so they have the same antenna polarity. Small antennas with a reverse-polarity SMA connector can be mounted directly on the radio. Screw the antenna onto the antenna port connector until it is snug.

Larger antennas and antennas that do not have a reverse-gender SMA connector must be mounted separately and connected to the radio using a coaxial antenna cable. Because the antenna cable attenuates the RF signal, use an antenna cable length that is no longer than necessary to ensure optimum performance.

Important: If the radio is to be used in a hazardous location, the radio must be mounted in an enclosure approved for hazardous locations. The radio requires a separate cable connection to the SMA connector that leads to an internal antenna.

Improving Signal Quality

If you need to improve a radio's signal quality, try the following steps:

- Adjust the direction of the high-gain antennas.
- Increase the height of the antenna's placement.
- Use higher-gain antennas or external preamplifiers.
- Select a new location for the radio and/or its antenna.
- Decrease the length of the antenna cable.
- Determine and resolve sources of interfering electrical noise.
- Add a repeater between radios that are not communicating.

2.2 Connecting the Radio to a Network Device

2.2.1 Cable Connections

The application ports on the RLX-IFHE module support Ethernet, RS-232, RS-422, and RS-485 interfaces.



The application ports are located on the bottom of the radio.

- The Ethernet port uses a standard RJ45 connector
- The RS-232 port uses a standard DB9 connector.
- The RS-485/RS-422 port uses a custom connector, supplied with the radio.

Refer to the following diagrams to construct a port cable suitable for your application.

Ethernet Addressing Overview

The IP address of the host computer that runs the setup software, needs to be changed only if you are going to select an IP address for the radios that reside on a different sub network (a network with a different network ID) than the sub network currently configured.

For example, if the setup computer has an IP address of 207.4.1.3 in the TCP/IP client network configuration and you want to program the IP address for the radio to 192.168.15.1, then you will have to set up the host computer with an IP address on the same network (for example, 192.168.15.10). This will allow you to use the setup software to perform radio network diagnostics (See Diagnostics and Troubleshooting on performing network diagnostics).

IP addresses are in the following format: www.xxx.yyy.zzz - called "dot format"
Classes of IP addresses are determined by value of the first "octet" (the "www").

The classes are as follows:

Class	First Octet Value	Network Identifier	Device Identifier	Subnet Mask
A	1 to 126	"w." values	"x.y.z" values	"255.0.0.0"
B	128 to 191	"w.x" values	"x.y" values	"255.255.0.0"
C	192 to 223	"w.x.y" values	"x" values	"255.255.255.0"

The Subnet Mask is used to distinguish the Network ID and the Device ID.

For Example:

- An IP address of 192.168.15.4 is on the Network 192.168.15; and the Device ID is 4.
- An IP address of 10.120.22.75 is on the Network 10 and the Device ID is 120.22.75.

Ethernet Cable Specifications

The recommended cable is category 5 or better. A category 5 cable has four twisted pairs of wire that are color-coded and cannot be swapped. The radio uses only two pairs. One pair uses pins 1 and 2, and the second pair uses pins 3 and 6.

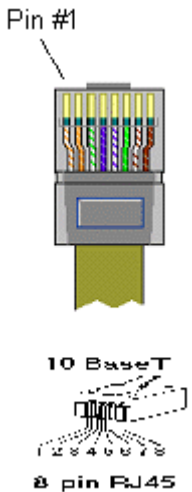
- Use a straight-through cable when connecting the radio to an Ethernet hub or a 10/100 Base-T Ethernet switch. Straight-through cables are used in most cases.
- Use a cross-over cable when connecting the Ethernet radio directly to any device that is NOT a switch or a hub (for example, a direct connection to a PC, PLC, or printer).

Ethernet cabling is like U.S. telephone cables, except that it has eight conductors. Some hubs have one input that can accept either a straight-through or crossover cable, depending on the switch position. In this case, you must ensure that the switch position and cable type agree.

Refer to Ethernet cable configuration (page 59) for a diagram of how to configure Ethernet cable.

Ethernet Cable Configuration

Note: The standard connector view shown is color-coded for a straight-through cable.

Crossover cable			Straight- through cable	
RJ-45 PIN	RJ-45 PIN		RJ-45 PIN	RJ-45 PIN
1 Rx+	3 Tx+		1 Rx+	1 Tx+
2 Rx-	6 Tx-		2 Rx-	2 Tx-
3 Tx+	1 Rx+		3 Tx+	3 Rx+
6 Tx-	2 Rx-		6 Tx-	6 Rx-

Serial Port Basics

PC communications depend primarily on serial and parallel ports to interface the PC to the outside world. A "port" is a connection or plug-in that gives access to the PC. The port allows the computer to communicate with devices such as printers, input devices (serial mouse), and modems.

The serial port is more difficult to interface to than the parallel port because most serial devices require that the serial transmission consists of characters that are converted into a parallel format. This conversion is accomplished with a communications controller chip, (UART: Universal Asynchronous Receiver/Transmitter).

Two common serial interface standards are RS-232 and RS-485. The RS-232 protocol is an industry standard protocol while the RS-485 protocol is commonly used in the industrial automation market.

There are two types of devices to which a serial-cabled device can communicate:

- DCE (Data Communications Equipment): modem, plotter, "RadioLinx Radio Modem".
- DTE (Data Terminal Equipment): PC or terminal

Serial ports have two common connector styles:

- DB25 pin connector
- DB 9 pin connector

Today's typical PC has one parallel port and two DTE serial ports (both are male connectors). To connect two DTE devices to each other, the easiest (and recommended) connection method is with a Null Modem cable (female connectors on each end). This is commonly used as a quick and inexpensive way to transfer files between two PCs without having to install a dedicated network card in each PC.

Note: The RadioLinx radio modem is a DCE device.

The following table contains the pin functions for both the DB25 and the DB9 connectors:

Pin Name	Pin Number DB9 / DB25	Function
Transmit Data (TXD)	Pin 3 / 2	Serial Data Output
Receive Data (RXD)	Pin 2 / 3	Serial Data Input
Clear-To-Send (CTS)	Pin 7 / 4	This line indicates that the modem is ready to exchange data.
Data-Carrier-Detect (DCD)	Pin 1 / 8	This line becomes active when the modem detects a carrier from the modem on the other end of the phone line.
Data-Set-Ready (DSR)	Pin 6 / 6	This tells the UART that the modem is ready to establish a link.
Data-Terminal-Ready (DTR)	Pin 4 / 20	This tells the modem that the UART is ready to exchange data.
Request -To -Send (RTS)	Pin 7 / 4	This line informs the modem that the UART is ready to exchange data.
Ring Indicator (RI)	Pin 9 / 22	Goes active when modem detects a ringing signal

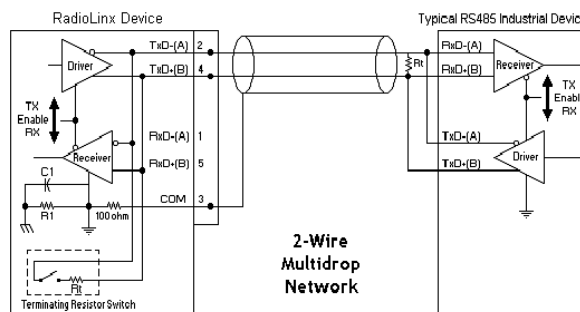
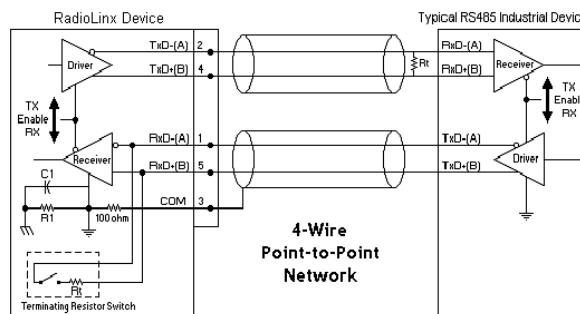
Pin Name	Pin Number	Function
		DB9 / DB25
Signal Ground (SG)	Pin 5 / 7	Signal ground

Communication signals diminish in strength as they travel through cable. The maximum cable lengths for RS-232 are less than RS-485 because the RS-232 interface is more susceptible to noise. The data performance of RS-232 and RS-485 is similar as long as the cable requirements are met. The following table gives an estimation of the cable length requirements for the two serial interface protocols:

Characteristic	RS-232	RS-485
Maximum cable length	100 feet	4000 feet
Maximum bits/sec.	20kbps	100Mbps

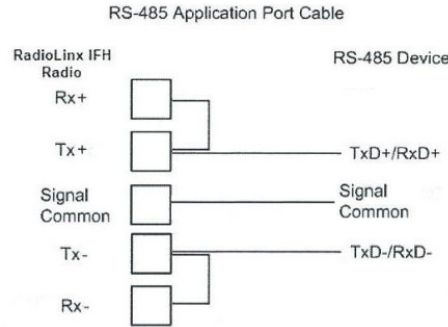
There are different ways to transfer data serially; simplex, half-duplex, and full-duplex. **Simplex** communication mode allows transmission of data in one direction only. In the **half-duplex** mode, data can be transferred in both directions, but not simultaneously. That means data can be transferred over a single pair of wires, but the data can only be transferred in one direction at a time. **Full-duplex** mode utilizes two pairs of wires and the data can be transferred in both directions simultaneously.

Radio RS-485 Cable Specification



RS-485

The RS-485 interface requires a single two or three wire cable. The Common connection is optional and dependent on the RS-485 network. The cable required for this interface is shown below:



Note: The red switch on the bottom of the RLX-IFHE radio allows you to specify whether the termination resistors are external or Internal in regards to the radio's RS-485/RS-422 connector. Terminating resistors are generally not required on the RS-485 network, unless you are experiencing communication problems that can be attributed to signal echoes or reflections. In this case, try changing the settings for termination on the radio.

Radio RS-232 Cable Specifications

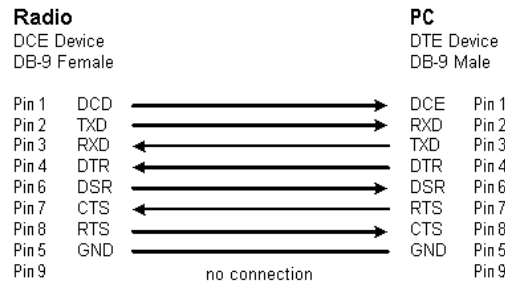
The **Radio** is a DCE device.

The **PC** is a DTE device.

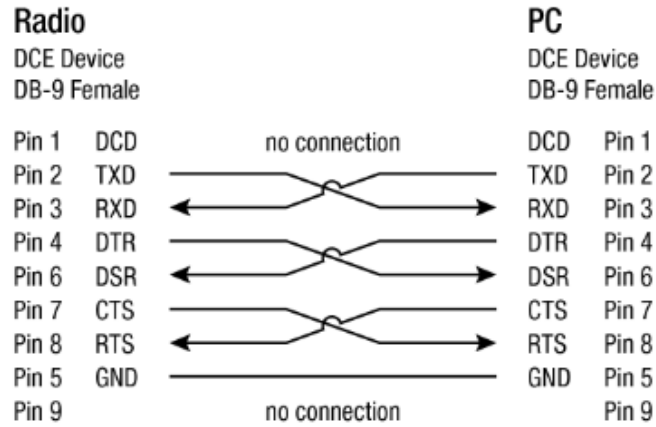
The following shows the wiring of the straight-through DB-9 serial cable used to connect:

- A radio to a PLC, PC, or other DTE device
- A radio to another DCE device

Straight-through Serial Cable

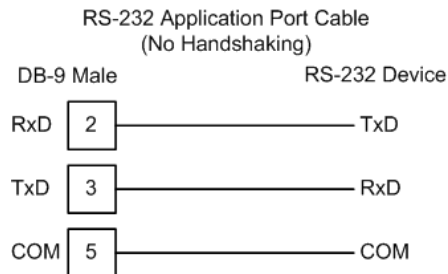


Null Modem Cable Wiring Diagram



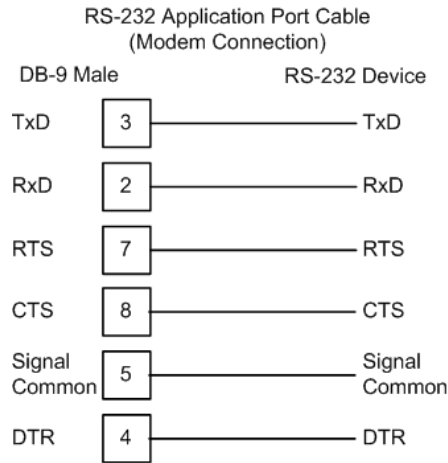
RS-232

When the RS-232 interface is selected, the use of hardware handshaking (control and monitoring of modem signal lines) depends on the requirements of the networked device. If no hardware handshaking will be used, the cable to connect to the port is as shown below:



RS-232 Modem Connection

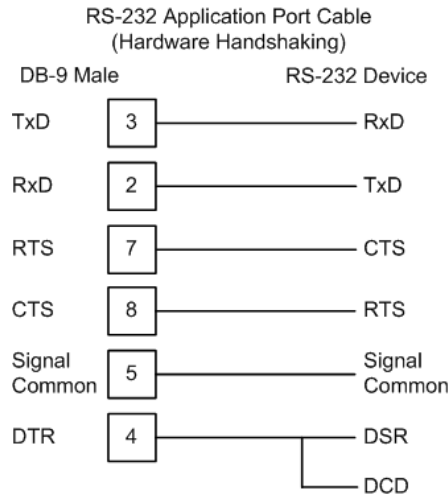
This type of connection is required between the radio and a modem or other communication device.



The "Use CTS Line" parameter for the serial device should be set to 'Yes' for most modem applications.

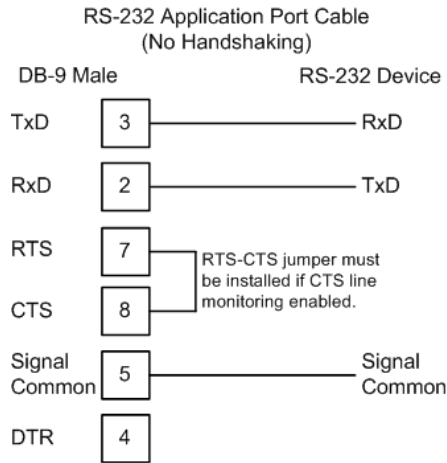
RS-232: Null Modem Connection (Hardware Handshaking)

This type of connection is used when the device connected to the radio requires hardware handshaking (control and monitoring of modem signal lines).



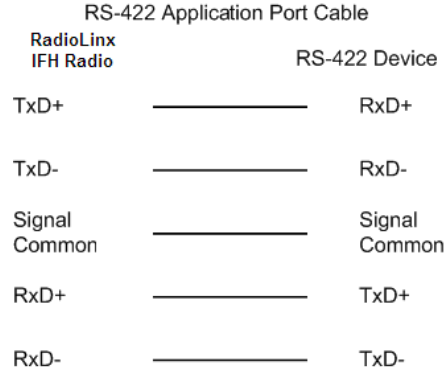
RS-232: Null Modem Connection (No Hardware Handshaking)

This type of connection can be used to connect the radio to a computer or field device communication port.



Note: If the serial device is configured with to use the CTS line, then a jumper is required between the RTS and the CTS line on the radio connection.

RS-422



3 Diagnostics and Troubleshooting

In This Chapter

❖ Diagnostics Overview.....	68
❖ LED Status Indicators.....	69
❖ Sources of Interference	70
❖ Troubleshooting ControlScape FH Error Messages	74
❖ Troubleshooting Missing Radios	76
❖ RadioLinx OPC Server	77

3.1 Diagnostics Overview

Use the **Diagnostic** function in ControlScape FH to:

- **view** a graphical representation of the overall function of a network
- **query** an individual radio and **display** its operating parameters

The information obtained from the diagnostics function can be used to:

- **optimize** network function
- determine the source of failed communication

3.2 LED Status Indicators

The RLX-IFHE front panel includes a set of LEDs that indicate the radio's status. After you first plug in the power cable to the radio, the Power/Status LED should be green, meaning that the radio has power. The RF Transmit and RF Receive LEDs should blink.

LED	Description
Power	This green LED indicates that the radio has power.
Ethernet	If this green LED is illuminated, the Ethernet cable is connected. If this LED is flashing, an Ethernet packet is being transmitted or received.
RF Transmit	This yellow LED indicates RF transmission.
RF Receive	This green LED indicates RF reception.
232 / 485	On (illuminated) for RS-232, Off for RS-485/422
Signal Strength	If only one of these three LEDs is illuminated, then the radio is linked. If two LEDs are illuminated, the radio's signal strength is fair. If all three LEDs are illuminated, the signal strength is good. When a repeater or remote is not linked, the LEDs will illuminate one at a time in a cycle from top to bottom. When the repeater or remote is linked, the LEDs will illuminate from bottom to top, with a blinking LED meaning a median signal strength between the lower LED and the blinking LED.

3.3 Sources of Interference

The RadioLinx radio modem operates more reliably than a radio using conventional technology due to the frequency hopping spread spectrum technique. While RadioLinx radios are less susceptible to interference due to this technique, interference (radio "noise") may still occur. Radios are designed to detect specific radio frequencies. An "interferer" is an unwanted signal that has been transmitted at the same frequency that the radio was designed to detect.

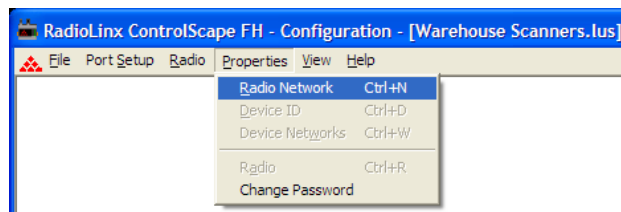
There are many man-made and natural sources of electromagnetic interference (lightning, power lines, switching power supplies, fluorescent lighting, microwave ovens, cordless phones, and so on). To decrease the effects of interference on network function:

- Use a directional (high gain) antenna at the Remote radio locations, if possible
- Verify that each network operating in close proximity to each other has BEEN ASSIGNED TO A DIFFERENT CHANNEL
- Install networks in rural areas (if at all possible) where they will likely encounter less man-made noise than in urban or suburban areas
- Enable encryption
- Change a radio's network output power (refer to the Radio Settings - Transmit Power sections in the Radio Configuration screens for each type of network):
 - **Increase** power to "drown out" competing noise
 - **Decrease** power of the radios on the network if they are interfering with another network in the vicinity

3.3.1 Changing a Network's Channel

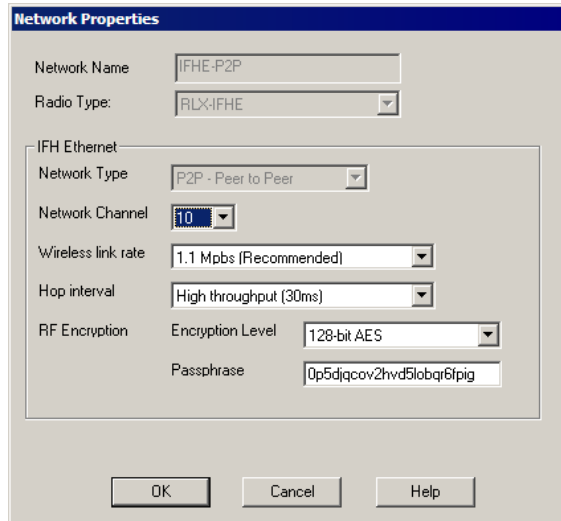
To modify the Network Channel an existing network, select:

- **Properties**
 - **Radio Network**



The Networks Properties dialog box will then display.

Important: The items on this dialog box depend on what type of radio you select. The following example shows a network of RadioLinx IFHE (Industrial Frequency Hopping Ethernet) radios. Refer to the user manual for your radio for an explanation of each configuration item.



Select an unused Network Channel from the drop-down list.

Refer to the user manual for your radio for an explanation of other configuration items on this dialog box.

Note: Some fields are "grayed-out" in this dialog box because these parameters cannot be changed from here.

Note: See When to Re-Configure Radios (page 47) to ensure all radios will be updated.

3.3.2 Viewing Radio Channel Noise Level

All radio networks experience background "noise", known as Electromagnetic Interference (EMI), which consists of such things as stray signals from other radios on the same frequency, or random interference generated by non-radio devices that "leak" or emanate EMI as a by-product or side effect of their actual function. There are also natural sources of EMI, including atmospheric disturbances and sunspots. The "snow" on an unused or distant television channel, or "static" on a car radio when passing under high voltage power lines, are two common examples of background noise.

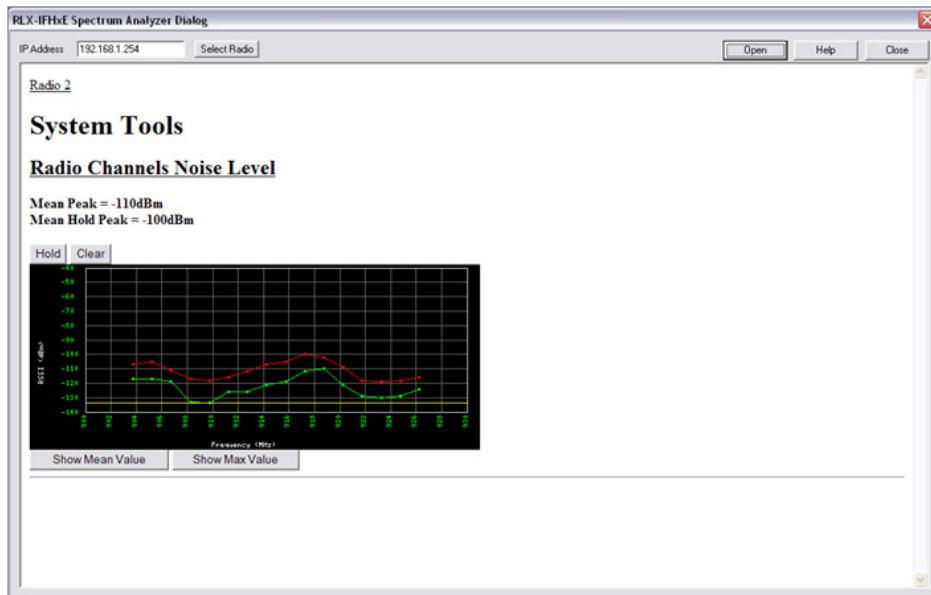
Unwanted noise, or EMI, on a data network can cause data transmission errors, or stop a radio network from functioning at all. Most modern devices, including RadioLinx radios, are designed to prevent unwanted emanation of EMI from the device. Radios are also typically designed to tolerate a certain amount of interference from other devices, however when the amount of noise reaches a certain threshold, typically within 10dB of a link's RSSI, the radio may be unable to distinguish between wanted and unwanted signals.

ControlScape can help you diagnose transmission problems with a graphical representation of radio channel noise. You can use this diagnostic information during a site survey to check for RF signals already present in an area, or to detect network issues caused by RF interference.

To detect the radio channel noise level for a particular radio, open the **UTILITIES** menu, and then choose **IFHE SPECTRUM ANALYZER**. Select the radio by **IP ADDRESS**, and then click **OPEN**. ControlScape will then scan within the radio, and measure the noise in its frequency band. This data can help determine if there is a signal that is interfering with radio communications. The radio will continue to periodically scan its frequency band until you click the **CLOSE** button, or you select a different radio to scan.

Note: The information in this dialog box is valid only for radios accessible through a wired Ethernet network. Scans for radios reachable only over the RF network may not be accurate.

Note: Radio network communications are interrupted while the Spectrum Analyzer is active. Normal communication will resume when you close the dialog box.



3.3.3 IFHE Spectrum Analyzer Dialog Box

The Spectrum Analyzer Dialog Box opens when you open the Utilities menu, and then select IFHE Spectrum Analyzer. Use this dialog box to help diagnose network issues.

The default password to login to the spectrum analyzer is:

Username: admin

Password: admin

Note: The information in this dialog box is valid only for radios accessible through a wired Ethernet network. Scans for radios reachable only over the RF network may not be accurate.

Note: Radio network communications are interrupted while the Spectrum Analyzer is active. Normal communication will resume when you close the dialog box.

- **IP Address:** The IP address for the radio to test. Enter an IP address directly, or click Select Radio to choose a radio.
- **Select Radio:** Opens the Radio Discovery Tool dialog box. Choose a radio from the list, and then click OK to select the radio.
- **Open:** Click to begin testing the radio.
- **Close:** Click to quit testing the radio and close the Spectrum Analyzer dialog box.
- **Noise Level graphs:** The green plot represents the current spectrum values. The red plot represents the maximum value of the green plot over time. The yellow line represents the lowest current value or the current noise floor. Each point represents one of the frequencies on which the radio could hop.
- **Hold:** Click to freeze the peak value graph.
- **Clear:** Click to unfreeze the peak value graph.
- **Show Mean Value:** Displays the average value of the multiple measurements taken on each channel during a scan period.
- **Show Max Value:** Displays the maximum value of the multiple measurements taken on each channel during a scan period.

3.4 Troubleshooting ControlScape FH Error Messages

ControlScape FH displays informative error messages for many types of communication problems. The following topics describe how to interpret these messages.

3.4.1 Radio Configuration Status Dialog Box

The Radio Configuration Status dialog box opens when you attempt to communicate with a radio network in Diagnostic mode, and ControlScape FH is not able to connect with any radios on the network.

- Click Retry to attempt an automatic baud rate detection sequence.
- Click Cancel to quit attempting to connect to a radio.

3.4.2 Invalid Password Dialog Box

The Invalid Password dialog box opens when you enter the network password incorrectly. Check the status of the Caps Lock key on your keyboard, and then try entering the password again.

- **OK:** Click the OK button to save your selection and close the dialog box.
- **Help:** Click the Help button to read the online help for ControlScape.

3.4.3 Check the Ethernet cable

If you connect a radio and the Ethernet LED does not light on the radio, you may have used the wrong cable type. In other words, you may have used a cross-over cable when you should have used a straight-through cable, or vice versa.

Use a straight-through cable when connecting the radio to an Ethernet hub or a 10/100 Base-T Ethernet switch. Straight-through cables are used in most cases.

Use a cross-over cable when connecting the Ethernet radio directly to any device that is NOT a switch or a hub (for example, a direct connection to a PC, PLC, or printer).

3.4.4 Connection Errors

If ControlScape FH is not able to communicate with a radio, it will open a message box describing the problem.



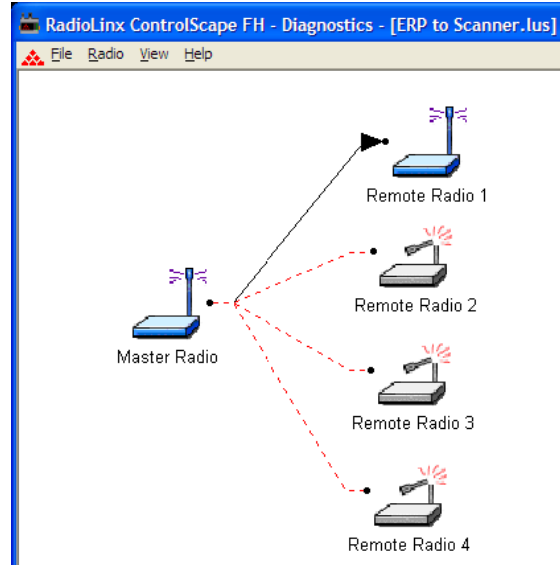
To troubleshoot communication problems, follow these steps:

- Verify that you can communicate with the Master radio through an ethernet cable connection (page 59)
- Verify that the Master radio and remote radios are powered up (page 56)
- Verify that the Remote radios are connected to antennas, (page 56) and are correctly sited (page 57) to receive signals from the Master radio
- Verify that the computer's IP address and the IP addresses of the radios are on the same network (page 58)
- Eliminate sources of interference (page 70).

If you are still unable to connect to a radio, contact ProSoft Technical Support (page 99) for assistance.

3.5 Troubleshooting Missing Radios

To view the communication link any radio can be cabled to the Configuration PC for network diagnostics.



One of the most common reasons radios do not communicate is an incorrect setting in the "Send Data To" field in the Radio Configuration dialog box. Verify that the radio is sending to and receiving from the correct radio ID.

If radios do not communicate, investigate some of the sources of interference (page 70).

3.6 RadioLinx OPC Server

The RadioLinx OPC Server seamlessly links customer applications to RadioLinx radios. Any application that can act as an OPC Client, such as an HMI, can interact with any type of RadioLinx radio. It allows the applications to get signal strength, serial number and throughput information, as well as other useful statistics.

The RadioLinx OPC Server operates in the background on any PC. It independently manages all requests from OPC Clients for information on RadioLinx radios. The OPC Clients are typically HMI programs, but can also be easily monitored by Microsoft Excel. The clients can be programs running either on the same PC as the OPC Server or on a separate PC connected via a network connection.

You can install the RLX OPC Server from the ProSoft Solutions CD-ROM, included with your RLX-IFHE radio.

3.6.1 System Requirements

The following system requirements are the recommended minimum specifications to successfully install and run RadioLinx OPC Driver.

- Microsoft Windows compatible PC
- Windows XP Professional with Service Pack 2 or higher, Windows VISTA, or Windows 2003
- Microsoft .NET Framework version 3.0 or higher
- 300 MHz Pentium processor (or equivalent)
- 128 megabytes of RAM
- 300 megabytes of available disk space

4 Reference

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4.1 Antennas

When you are ready to connect antennas to the radio, see [Connecting antennas](#) (page 56).

You must also consider three important electrical characteristics when selecting antennas:

- Antenna pattern (page 81)
- Antenna gain (page 81)
- Antenna polarity (page 82)
- Antenna location, spacing, and mounting (page 80)

4.1.1 Antenna location, spacing, and mounting

Consider the following points regarding antenna location, spacing, and mounting:

- When placing antennas, ensure a clear line of sight between the master radio's antenna and all of the other radio antennas.
- If the site base contains obstructing terrain or structures, mount the antenna on a tower or rooftop to provide a line-of-sight path. The line-of-sight consideration becomes more important as the transmission path becomes longer.
- Mount the antennas as high off the ground as is practical. The higher an antenna is above the ground, the greater its range.
- Mount the antennas away from massive structures. Radio signals bounce off metal walls, for example, which can compromise a clear signal.
- Mount antennas to minimize the amount of nearby metal structures in the antenna pattern.
- Mount the antennas and install radios away from sources of RF interference.
- Use the shortest possible antenna cable length. Signals lose power over the cable's distance.
- Choose antennas that are appropriate for the network's intended function.
- If antennas are on radios on the same network, mount them so they have the same polarity. If the antennas are on separate networks, mount them so they have a different antenna polarity—for example, mount one antenna vertically and the other horizontally.
- Space radios at least three feet (one meter) apart so they do not overload each other. If antennas must be near each other:
 - Mount omnidirectional antennas directly above each other.
 - Position directional antennas so they do not point at nearby antennas. Place antennas side by side if they point in the same direction. Place antennas back to back if they point in opposite directions.

4.1.2 Antenna Pattern

Information between two wireless devices is transferred via electromagnetic energy radiated by one antenna and received by another. The radiated power of most antennas is not uniform in all directions and has varying intensities. The radiated power in various directions is called the pattern of the antenna. Each antenna should be mounted so that its direction of strongest radiation intensity points toward the other antenna or antennas with which it will exchange signals.

Complete antenna patterns are three-dimensional, although often only a two-dimensional slice of the pattern is shown when all the antennas of interest are located in roughly the same horizontal plane, along the ground rather than above or below one another.

A slice taken in a horizontal plane through the center (or looking down on the pattern) is called the azimuth pattern. A view from the side reveals a vertical plane slice called the elevation pattern.

An antenna pattern with equal or nearly equal intensity in all directions is omnidirectional. In two dimensions, an omnidirectional pattern appears as a circle (in three dimensions, an omnidirectional antenna pattern would be a sphere, but no antenna has true omnidirectional pattern in three dimensions). An antenna is considered omnidirectional if one of its two dimensional patterns, either azimuth or elevation pattern, is omnidirectional.

Beamwidth is an angular measurement of how strongly the power is concentrated in a particular direction. Beamwidth is a three dimensional quantity but can be broken into two-dimensional slices just like the antenna pattern. The beamwidth of an omnidirectional pattern is 360 degrees because the power is equal in all directions.

4.1.3 Antenna Gain

Antenna gain is a measure of how strongly an antenna radiates in its direction of maximum radiation intensity compared to how strong the radiation would be if the same power were applied to an antenna that radiated all of its power equally in all directions. Using the antenna pattern, the gain is the distance to the furthest point on the pattern from the origin. For an omnidirectional pattern, the gain is 1, or equivalently 0 dB. The higher the antenna gain is, the narrower the beamwidth, and vice versa.

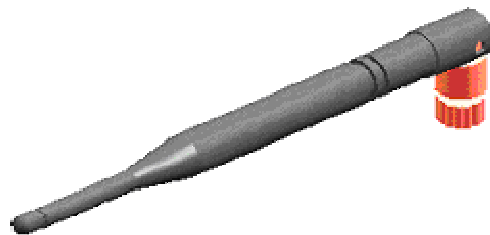
The amount of power received by the receiving antenna is proportional to the transmitter power multiplied by the transmit antenna gain, multiplied by the receiving antenna gain. Therefore, the antenna gains and transmitting power can be traded off. For example, doubling one antenna gain has the same effect as doubling the transmitting power. Doubling both antenna gains has the same effect as quadrupling the transmitting power.

4.1.4 Antenna Polarity

Antenna polarization refers to the direction in which the electromagnetic field lines point as energy radiates away from the antenna. In general, the polarization is elliptical. The simplest and most common form of this elliptical polarization is a straight line, or linear polarization. Of the transmitted power that reaches the receiving antenna, only the portion that has the same polarization as the receiving antenna polarization is actually received. For example, if the transmitting antenna polarization is pointed in the vertical direction (vertical polarization, for short), and the receiving antenna also has vertical polarization, the maximum amount of power possible will be received. On the other hand, if the transmit antenna has vertical polarization and the receiving antenna has horizontal polarization, no power should be received. If the two antennas have linear polarizations oriented at 45° to each other, half of the possible maximum power will be received.

4.1.5 Whip antennas

You can use a 1/2 wave straight whip or 1/2 wave articulating whip (2 dBi) antenna with RLX-IFHE radios. These antennas are the most common type in use today. Such antennas are approximately 5 inches long, and are likely to be connected to a client radio (connected directly to the radio enclosure). These antennas do not require a ground plane. Articulating antennas and non-articulating antennas work in the same way. An articulating antenna bends at the connection.



4.1.6 Collinear array antennas



A collinear array antenna is typically composed of several linear antennas stacked on top of each other. The more stacked elements it has, the longer it is, and the more gain it has. It is fed in on one end.

The antenna pattern is torroidal. Its azimuthal beamwidth is 360° (omnidirectional). Its vertical beamwidth depends on the number of elements/length, where more elements equal narrower beamwidth. The antenna gain also depends on the number of elements/length, where more elements produce higher gain. Typical gain is 5 to 10 dBi.

The antenna polarity is linear, or parallel to the length of the antenna.

4.1.7 Yagi Array Antenna

A yagi antenna is composed of an array of linear elements, each parallel to one another and attached perpendicular to and along the length of a metal boom. The feed is attached to only one of the elements. Elements on one side of the fed element are longer and act as reflectors; elements on the other side are shorter and act as directors. This causes the antenna to radiate in a beam out of the end with the shorter elements. The pattern depends on the overall geometry, including the number of elements, element spacing, element length, and so on. Sometimes the antenna is enclosed in a protective tube hiding the actual antenna geometry.

The antenna pattern (page 81) is a beam pointed along the boom toward the end with the shorter elements. The beamwidth varies with antenna geometry but generally is proportional to the length (where longer length produces a narrower beam).

The antenna gain (page 81) varies with antenna geometry but generally is proportional to the length (where longer length produces higher gain). Typical values are 6 to 15dBi.

The antenna polarity is Linear (parallel to the elements, perpendicular to the boom).



Refer to the Antenna Types overview section for other types of approved antennas.

4.1.8 Parabolic reflector antennas

A parabolic reflector antenna consists of a parabolic shaped dish and a feed antenna located in front of the dish. Power is radiated from the feed antenna toward the reflector. Due to the parabolic shape, the reflector concentrates the radiation into a narrow pattern, resulting in a high-gain beam.

The antenna pattern is a beam pointed away from the concave side of the dish. Beamwidth and antenna gain vary with the size of the reflector and the antenna construction. Typical gain values are 15 to 30 dBi.

The antenna polarity depends on the feed antenna polarization.



Glossary of Terms

Symbols & Numeric

802.11

A group of wireless specifications developed by the IEEE. It details a wireless interface between devices to manage packet traffic.

802.11a

Operates in the 5 GHz frequency range with a maximum 54 Mbit/sec signaling rate.

802.11b

Operates in the 2.4 GHz Industrial, Scientific, and Measurement (ISM) band. Provides signaling rates of up to 11 Mbit/sec and is the most commonly used frequency.

802.11g

Similar to 802.11b but supports signaling rates of up to 54 Mbit/sec. Operates in the heavily used 2.4 GHz ISM band but uses a different radio technology to boost throughput.

802.11i

Sometimes Wi-Fi Protected Access 2 (WPA 2). WPA 2 supports the 128-bit and above advanced encryption Standard, along with 802.1x authentication and key management features.

802.11n

Designed to raise effective WLAN throughput to more than 100 Mbit/sec.

802.11s

Deals with mesh networking.

A

Access Point

A generic term for an 802.11 radio that "attaches" other 802.11 radios (clients) to a wired network. APs can also bridge to one another.

Ad hoc Mode

Wireless network framework in which devices can communicate directly with one another without using an AP or a connection to a regular network.

AES

Advanced Encryption Standard. New standard for encryption adopted by the U.S. government for secure communications.

Amplifier

A device connected to an antenna used to increase the signal strength and amplify weak incoming signals.

Antenna

A device connected to a wireless transceiver that concentrates transmitted and received radio waves to increase signal strength and thus the effective range of a wireless network.

ASCII

American Standard Code for Information Interchange. A communication mode in which each eight-bit byte in a message contains one ASCII character code. ASCII characters (or hexadecimal characters) are sometimes used as a key to encrypt data and ensure its secure transmission.

Association

Process whereby two 802.11 radios establish communications with each other. Requirements for communication include common SSID (network names) and encryption settings.

Authenticate

The process of confirming the identity of someone connecting to a network.

Authentication Server

A back-end database server that confirms the identity of a supplicant to an authenticator in an 802.1x-authenticated network.

B

Band

Another term for spectrum used to indicate a particular set of frequencies. Wireless networking protocols work in either the 2.4 GHz or the 5 GHz bands.

Bandwidth

(See Throughput)

Base Station

See Wireless Gateway

Baud Rate

The speed of communication between devices on the network. All devices must communicate at the same rate.

bps

Bits per Second. A measure of data transmission speed across a network or communications channel; bps is the number of bits that can be sent or received per second.

C

Channel

One portion of the available radio spectrum that all devices on a wireless network use to communicate. Changing the channel on the access point/router can help reduce interference.

Client

A client is a software program, or the device on which that program runs, that makes requests for information from a software program, or the device on which that program runs, in a client-server relationship.

A Client on an Ethernet network is equivalent to a Master on a serial network.

Configuration PC

A Computer that contains the configuration tools for the RLX-IFHE.

D

dBi

Decibels referenced to an "ideal" isotropic radiator in free space; frequently used to express antenna gain

dBm

Decibels referenced to one milliwatt (mW); an "absolute" unit used to measure signal power (transmit power output or received signal strength)

DCE

Data communications equipment. A modem, for example.

Decibel (dB)

A measure of the ratio between two signal levels; used to express gain (or loss) in a system.

Default Gateway

The IP address of a network router where data is sent if the destination IP address is outside the local subnet. The gateway is the device that routes the traffic from the local area network to other networks such as the Internet.

Device-to-Device Network (Peer-to-Peer Network)

Two or more devices that connect using wireless network devices without the use of a centralized wireless access point. Also known as a peer-to-peer network.

DHCP

The dynamic host configuration protocol is an Internet protocol, similar to BootP, for automating the configuration of computers that use TCP/IP. DHCP can be used to automatically assign IP addresses, to deliver IP stack configuration parameters, such as the subnet mask and default router, and to provide other configuration information, such as the addresses for printer, time, and news servers.

Direct Sequence Spread Spectrum

One of two approaches (with frequency hopping spread spectrum) for sorting out overlapping data signals transmitted via radio waves. 802.11b uses DSSS

Directional Antenna

Transmits and receives radio waves off the front of the antenna.

Diversity Antenna

An antenna system that uses multiple antennas to reduce interference and maximize reception and transmission quality.

DTE

Data Terminal Equipment, for example, a computer or terminal.

Dual Band

A device that is capable of operating in two frequencies. On a wireless network, dual-band devices are capable of operating in both the 2.4 GHz (802.11b/g) and 5 GHz (802.11a) bands.

E

EAP

Extensible Authentication Protocol. A protocol that provides an authentication framework for both wireless and wired Ethernet enterprise networks.

EIRP

Equivalent isotropically radiated power (EIRP) is the amount of power that would have to be emitted by an isotropic antenna (that evenly distributes power in all directions and is a theoretical construct) to produce the peak power density observed in the direction of maximum antenna gain.

Encryption

Method of scrambling data so that only the intended viewers can decipher and understand it.

ESD

Electrostatic Discharge. Can cause internal circuit damage to the coprocessor.

ESSID

Extended Service Set Identifier. A name used to identify a wireless network.

F

Firmware

Firmware is the embedded software code that runs in the module to direct module function (similar to the BIOS in a personal computer). This is distinguished from the Setup/Diagnostic Application software that is installed on the Configuration PC.

Frequency Hopping

A radio that rapidly changes its operating frequency several times per second following a pre-determined sequence of frequencies. The transmitting and receiving radios are programmed to follow the same frequency hopping sequence.

Frequency Hopping Spread Spectrum

Changes or hops frequencies in pattern known to both sender and receiver. FHSS is little influenced by radio stations, reflections, or other environmental factors. However, it is much slower than DSSS.

Fresnel Zone

An elliptical area on either side of the straight line of sight that must also be clear for a long-range wireless network to work.

Full-Duplex

A communications circuit or system designed to simultaneously transmit and receive two different streams of data. Telephones are an example of a full-duplex communication system. Both parties on a telephone conversation can talk and listen at the same time. If both talk at the same time, their two signals are not corrupted.

G

Gain

The amount by which an antenna concentrates signal strength in a wireless network.

Gateway

In wireless terms, a gateway is an access point with additional software capabilities such as providing NAT and DHCP.

H

Half-Duplex

A communications circuit or system designed to transmit and receive data, but not both simultaneously. Citizens' Band (CB) or walkie-talkie radios are an example of a half-duplex communication system. Either party to a radio conversation may talk or listen; but both cannot talk at the same time without corrupting each other's signal. If one operator is "talking", the other must be "listening" to have successful communication.

Hz

Hertz. The international unit for measuring frequency equivalent to the older unit of cycles per second. One megahertz (MHz) is one million hertz. One gigahertz (GHz) is one billion hertz. The standard US electrical power frequency is 60 Hz. 802.11a devices operate in the 5 GHz band; 802.11b and g devices operate in the 2.4 GHz band.

I

IEEE

Institute of Electrical and Electronics Engineers, Inc. IEEE is a professional organization with members in over 175 countries and is an authority in technical areas such as computer engineering and telecommunications. IEEE developed the 802.11 specifications.

IP Address

A 32-bit identification number for each node on an Internet Protocol network. These addresses are represented as four sets of 8-bit numbers (numbers from 0 to 255), separated by periods ("dots").

Networks using the TCP/IP Protocol route messages based on the IP address of the destination. Each number can be 0 to 255. For example, 192.168.0.100 could be an IP address. Each node on the network must have a unique IP address.

K

Key

A set of information (often 40 to as much as 256 bits) that is used as a seed to an encryption algorithm to encrypt (scramble) data. Ideally, the key must also be known by the receiver to decrypt the data.

L

LAN

A system of connecting PCs and other devices within the same physical proximity for sharing resources such as internet connections, printers, files, and drives. When Wi-Fi is used to connect the devices, the system is known as a wireless LAN or WLAN.

LED

Light-emitting diode.

Line of Sight (LoS)

A clear line from one antenna to another in a long-range wireless network.

Link point

The graphical point next to a radio icon that represents the connection point for RF communications between radios. An RF connection between two radios is called an RF Link and is represented as a graphical black line between the radio's link points.

M

MAC ID

Media Access Control address. Every 802.11 device has its own MAC address. This is a unique identifier used to provide security for wireless networks. When a network uses a MAC table, only the 802.11 radios that have had their MAC addresses added to the network's MAC table are able to get on the network.

Master device

Device that is connected to the Master radio.

Mbps

Megabits per second, or millions of bits per second. A measure of bandwidth.

Megahertz

A measure of electromagnetic wave frequency equal to one million hertz. Often abbreviated as MHz and used to specify the radio frequency used by wireless devices.

Mesh Networking

Features free standing, non wired network nodes that communicate among one another and form self-configuring networks, with only one node required to hook into a wired LAN. The other nodes are simply plugged into an electrical outlet, so cabling is much less of an issue.

MIC

Message Integrity Check. One of the elements added to the TKIP standard. A "signature" is added by each radio on each packet it transmits. The signature is based on the data in the packet, a 64-bit value (key) and the MAC address of the sender. The MIC allows the receiving radio to verify (check) that the data is not forged.

MIMO

Multiple Input Multiple Output refers to using multiple antennas in a Wi-Fi device to improve performance and throughput. MIMO technology takes advantage of a characteristic called multipath, which occurs when a radio transmission starts out at Point A and the reflects off or passes through surfaces or objects before arriving, via multiple paths, at Point B. MIMO technology uses multiple antennas to collect and organize signals arriving via these paths.

Modbus

The Modbus protocol provides the internal standard that the MODICON® controllers use for parsing messages. During communications on a Modbus network, the protocol determines how each controller will know its device address, recognize a message addressed to it, determine the kind of action to be taken, and extract any data or other information contained in the message. If a reply is required, the controller will construct the reply message and send it using Modbus protocol.

Modem

Stands for MODulator-DEModulator, a device that converts digital signals to analog signals and vice-versa. Analog signals can be transmitted over communications links such as telephone lines.

N

Network

A series of stations or nodes connected by some type of communication medium. A network may consist of a single link or multiple links.

Node

An address or software location on the network.

Null Modem Cable

A specialty cross-communication cable with female connectors on each end used for direct connection between devices when no modems are present. Commonly used as a quick and inexpensive way to transfer files between two PCs without installing a dedicated network card in each PC.

P

Panel Antenna

An antenna type that radiates in only a specific direction. Panel antennas are commonly used for point-to-point situations. Sometimes called Patch antennas.

Parabolic Antenna

An antenna type that radiates a very narrow beam in a specific direction. Parabolic antennas offer the highest gain for long-range point-to-point situations.

Peer-to-Peer Network

Each radio in a Peer-to-Peer network has the ability to receive data from - and transmit data to - any other radio in the network.

Point-Multipoint (Broadcast) Network

A network type where a single master radio sends data to every remote radio in the network. This is done repeatedly until every remote radio individually receives and acknowledges the data. Each remote radio sends pending data to the master radio that receives and acknowledges data sent from each remote. In this configuration, there are multiple remote radios referenced to a single master radio.

Point-Multipoint (Modbus) Network

A network with a single Master radio and multiple Remote radios. The devices cabled to the radios communicate through the Modbus standard protocol. The Master radio sends data to a Remote radio based on the Modbus address of the Modbus device. The data is only sent to the single Remote device based on its address. Each Remote radio sends its data only to the Master radio. The Master and Remote radios acknowledge that data was received correctly.

Point-to-Multipoint

A wireless network in which one point (the access point) serves multiple other points around it. Indoor wireless networks are all point-to-multipoint, and long-range wireless networks that serve multiple clients usually employ either a single omnidirectional antenna or multiple sector antennas.

Point-to-Point Network

A network consisting of a single Master radio and a single Remote radio. All data from the Master is received and acknowledged by one Remote. All data from the single Remote is received and acknowledged by the Master radio.

Poll

A method of electronic communication.

Power Supply

Device that supplies electrical power to the I/O chassis containing the processor, coprocessor, or other modules.

Protocol

The language or packaging of information that is transmitted between nodes on a network.

Q

QoS

Quality of Service. Required to support wireless multimedia applications and advanced traffic management. QoS enables Wi-Fi access points to prioritize traffic and optimize the way shared network resources are allocated among different applications.

R

RADIUS

Remote Access Dial-In Service. This describes a general method for allowing remote users access to a network. It authenticates the user, specifies passwords and access rights to network resources. It also keeps track of accounting for when and how long the user is logged onto the network. It was originally used for dial-in users, accessing corporate networks via modems. It is now being specified as part of the 802.11i standard to control access of users to wireless networks. Any of several protocols can be used by the wireless client to communicate with the RADIUS server to gain access to the network resources. These protocols include EAP-TLS (Windows), LEAP (Cisco) and EAP-TTLS.

Range

The distance covered by a wireless network radio device. Depending on the environment and the type of antenna used, Wi-Fi signals can have a range of up to a mile.

Remote Access Point

One of a number of secondary access points in a wireless network that uses WDS to extend its range. Remote access points (sometimes called relay access points) connect to a master access point.

Remote device

Devices connected remote radios

Repeater

A Repeater is a device used to extend the range of a Wi-Fi signal. Placed at the edge of signal reception, a repeater simply receives and re-transmits the signal.

RS-232

Recommended Standard 232; the standard for serial binary signals between DTE and DCE devices.

RTU (Remote Terminal Unit)

Modbus transmission mode where each eight-bit byte in a message contains two four-bit hexadecimal characters. There are two transmission modes (ASCII or RTU). The main advantage of the RTU mode is that its greater character density allows better data throughput than ASCII mode for the same baud rate; each message is transmitted in a continuous stream (See also ASCII, above).

S

Sector Antenna

An antenna type that radiates in only a specific direction. Multiple sector antennas are commonly used in point-to-multipoint situations.

Signal Diversity

A process by which two small dipole antennas are used to send and receive, combining their results for better effect.

Signal Loss

The amount of signal strength that's lost in antenna cable, connectors, and free space. Signal loss is measured in decibels. Also referred to as gain loss.

Signal Strength

The strength of the radio waves in a wireless network.

Simplex

A communications circuit or system designed to either transmit data or receive data, but not both. Broadcast television is an example of simplex communication system. A television station sends a TV signal but cannot receive responses back from the television sets to which it is transmitting. The TV sets can receive the signal from the TV station but cannot transmit back to the station.

Site Survey

A comprehensive facility study performed by network managers to ensure that planned service levels will be met when a new wireless LAN, or additional WLAN segments to an existing network are deployed. Site survey's are usually performed by a radio frequency engineer and used by systems integrators to identify the optimum placement of access points to ensure that planned levels of service are met. Site surveys are sometimes conducted following the deployment to ensure that the WLAN is achieving the necessary level of coverage. Site surveys can also be used to detect rogue access points.

Smart-Switched Ethernet Network

Smart Switched Ethernet (SSE) network is suitable for any communication pattern between the radios. It efficiently determines whether to broadcast to all radios or direct to a single radio on a packet by packet basis.

Spectrum

A range of electromagnetic frequencies.

Spread Spectrum

A form of wireless communication in which a signal's frequency is deliberately varied. This increases bandwidth and lessens the chances of interruption or interception of the transmitted signal.

SSI

Service Set Identifier is a sequence of characters unique to a specific network or network segment that's used by the network and all attached devices to identify themselves and allow devices to connect to the correct network when one or more than one independent network is operating in nearby areas.

Subnet Mask

A mask used to determine what subnet an IP address belongs to. An IP address has two components: the network address, and the host (node or device) address. For example, consider the IP address 150.215.017.009. Assuming this is part of a Class B network (with a subnet mask of 255.255.0.0), the first two numbers (150.215) represent the Class B network address, and the second two numbers (017.009) identify a particular host on this network.

T

TKIP

Temporal Key Integrity Protocol. The wireless security encryption mechanism in Wi-Fi Protected Access. TKIP uses a key hierarchy and key management methodology that removes the predictability that intruders relied upon to exploit the WEP key. It increases the size of the key from 40 to 128 bits and replaces WEP's single static key with keys that are dynamically generated and distributed by an authentication server, providing some 500 trillion possible keys that can be used on a given data packet. It also includes a Message Integrity Check (MIC), designed to prevent the attacker from capturing data packets, altering them, and resending them. By greatly expanding the size of keys, the number of keys in use, and by creating an integrity checking mechanism, TKIP magnifies the complexity and difficulty involved in decoding data on a Wi-Fi network. TKIP greatly increases the strength and complexity of wireless encryption, making it far more difficult (if not impossible) for a would-be intruder to break into a Wi-Fi network.

U

UART

Universal Asynchronous Receiver/Transmitter

W

WAP

Wireless Application Protocol. A set of standards to enable wireless devices to access internet services, such as the World Wide Web and email.

WDS

Wireless Distribution System. Enables access points to communicate with one another in order to extend the range of a wireless network. Used in 802.11g based access points.

WEP

Wired-Equivalent Privacy protocol was specified in the IEEE 802.11 standard to provide a WLAN with a minimal level of security and privacy comparable to a typical wired LAN, using data encryption.

Wi-Fi

A certification mark managed by a trade group called the Wi-Fi Alliance. Wi-Fi certification encompasses numerous standards including 802.11a, 802.11b, 802.11g, WPA, and more. Equipment must pass compatibility testing to receive the Wi-Fi mark.

Wi-Fi CERTIFIED™

The certification standard designating IEEE 802.11-based wireless local area network (WLAN) products that have passed interoperability testing requirements developed and governed by the Wi-Fi alliance.

Wi-Fi Interoperability Certificate

A statement that a product has passed interoperability testing and will work with other Wi-Fi CERTIFIED products.

Wi-Fi Protected Setup

Wi-Fi Protected Setup™ (previously called Wi-Fi Simple Config) is an optional certification program developed by the Wi-Fi alliance designed to ease set up of security enabled Wi-Fi networks in the home and small office environment. Wi-Fi Protected Setup supports methods (pushing a button or entering a PIN into a wizard-type application) that are familiar to most consumers to configure a network and enable security.

Wireless Gateway

Term used to differentiate between an access point and a more-capable device that can share an internet connection, serve DHCP, and bridge between wired and wireless networks.

Wireless Network

Devices connected to a network using a centralized wireless access point.

WLAN

Wireless Local Area Network. A type of local area network in which data is sent and received via high-frequency radio waves rather than cables or wires.

WPA

Wi-Fi Protected Access is a data encryption specification for 802.11 wireless networks that replaces the weaker WEP. It improves on WEP by using dynamic keys, Extensible Authentication Protocol to secure network access, and an encryption method called Temporal Key Integrity Protocol (TKIP) to secure data transmissions.

WPA2

An enhanced version of WPA. It is the official 802.11i standard. It uses Advanced Encryption Standard instead of TKIP. AES supports 128-bit, 192-bit, and 256-bit encryption keys.

Y

Yagi Antenna

An antenna type that radiates in only a specific direction. Yagi antennas are used in point-to-point situations.

5 Support, Service & Warranty

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- ❖ LIMITED WARRANTY..... 103

Contacting Technical Support

ProSoft Technology, Inc. (ProSoft) is committed to providing the most efficient and effective support possible. Before calling, please gather the following information to assist in expediting this process:

- 1 Product Version Number
- 2 System architecture
- 3 Network details

If the issue is hardware related, we will also need information regarding:

- 1 Module configuration and associated ladder files, if any
- 2 Module operation and any unusual behavior
- 3 Configuration/Debug status information
- 4 LED patterns
- 5 Details about the serial, Ethernet or fieldbus devices interfaced to the module, if any.

Note: *For technical support calls within the United States, an after-hours answering system allows 24-hour/7-days-a-week pager access to one of our qualified Technical and/or Application Support Engineers. Detailed contact information for all our worldwide locations is available on the following page.*

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Brasil (location in Sao Paulo)	Tel: +55-11-5083-3776, E-mail: brasil@prosoft-technology.com Languages spoken include: Portuguese, English

5.1 Return Material Authorization (RMA) Policies and Conditions

The following Return Material Authorization (RMA) Policies and Conditions (collectively, "RMA Policies") apply to any returned product. These RMA Policies are subject to change by ProSoft Technology, Inc., without notice. For warranty information, see Limited Warranty (page 103). In the event of any inconsistency between the RMA Policies and the Warranty, the Warranty shall govern.

5.1.1 Returning Any Product

- a) In order to return a Product for repair, exchange, or otherwise, the Customer must obtain a Return Material Authorization (RMA) number from ProSoft Technology and comply with ProSoft Technology shipping instructions.
- b) In the event that the Customer experiences a problem with the Product for any reason, Customer should contact ProSoft Technical Support at one of the telephone numbers listed above (page 99). A Technical Support Engineer will request that you perform several tests in an attempt to isolate the problem. If after completing these tests, the Product is found to be the source of the problem, we will issue an RMA.
- c) All returned Products must be shipped freight prepaid, in the original shipping container or equivalent, to the location specified by ProSoft Technology, and be accompanied by proof of purchase and receipt date. The RMA number is to be prominently marked on the outside of the shipping box. Customer agrees to insure the Product or assume the risk of loss or damage in transit. Products shipped to ProSoft Technology using a shipment method other than that specified by ProSoft Technology, or shipped without an RMA number will be returned to the Customer, freight collect. Contact ProSoft Technical Support for further information.
- d) A 10% restocking fee applies to all warranty credit returns, whereby a Customer has an application change, ordered too many, does not need, etc. Returns for credit require that all accessory parts included in the original box (i.e.; antennas, cables) be returned. Failure to return these items will result in a deduction from the total credit due for each missing item.

5.1.2 Returning Units Under Warranty

A Technical Support Engineer must approve the return of Product under ProSoft Technology's Warranty:

- a) A replacement module will be shipped and invoiced. A purchase order will be required.
- b) Credit for a product under warranty will be issued upon receipt of authorized product by ProSoft Technology at designated location referenced on the Return Material Authorization
 - i. If a defect is found and is determined to be customer generated, or if the defect is otherwise not covered by ProSoft Technology's warranty, there will be no credit given. Customer will be contacted and can request module be returned at their expense;
 - ii. If defect is customer generated and is repairable, customer can authorize ProSoft Technology to repair the unit by providing a purchase order for 30% of the current list price plus freight charges, duties and taxes as applicable.

5.1.3 Returning Units Out of Warranty

- a) Customer sends unit in for evaluation to location specified by ProSoft Technology, freight prepaid.
- b) If no defect is found, Customer will be charged the equivalent of \$100 USD, plus freight charges, duties and taxes as applicable. A new purchase order will be required.
- c) If unit is repaired, charge to Customer will be 30% of current list price (USD) plus freight charges, duties and taxes as applicable. A new purchase order will be required or authorization to use the purchase order submitted for evaluation fee.

The following is a list of non-repairable units:

ScanPort Adapters

- 1500 - All
- 1550 - Can be repaired only if defect is the power supply
- 1560 - Can be repaired only if defect is the power supply

inRAx Modules

- 3150 - All
- 3170 - All
- 3250
- 3300
- 3350
- 3600 - All
- 3700
- 3750
- 3800-MNET

ProLinx Standalone Gateways

- 4xxx - All (No hardware available to do repairs)

5.2 LIMITED WARRANTY

This Limited Warranty ("Warranty") governs all sales of hardware, software, and other products (collectively, "Product") manufactured and/or offered for sale by ProSoft Technology, Incorporated (ProSoft), and all related services provided by ProSoft, including maintenance, repair, warranty exchange, and service programs (collectively, "Services"). By purchasing or using the Product or Services, the individual or entity purchasing or using the Product or Services ("Customer") agrees to all of the terms and provisions (collectively, the "Terms") of this Limited Warranty. All sales of software or other intellectual property are, in addition, subject to any license agreement accompanying such software or other intellectual property.

5.2.1 What Is Covered By This Warranty

- a) *Warranty On New Products:* ProSoft warrants, to the original purchaser, that the Product that is the subject of the sale will (1) conform to and perform in accordance with published specifications prepared, approved and issued by ProSoft, and (2) will be free from defects in material or workmanship; provided these warranties only cover Product that is sold as new. This Warranty expires three (3) years from the date of shipment for Product purchased **on or after** January 1st, 2008, or one (1) year from the date of shipment for Product purchased **before** January 1st, 2008 (the "Warranty Period"). If the Customer discovers within the Warranty Period a failure of the Product to conform to specifications, or a defect in material or workmanship of the Product, the Customer must promptly notify ProSoft by fax, email or telephone. In no event may that notification be received by ProSoft later than 39 months from date of original shipment. Within a reasonable time after notification, ProSoft will correct any failure of the Product to conform to specifications or any defect in material or workmanship of the Product, with either new or remanufactured replacement parts. ProSoft reserves the right, and at its sole discretion, may replace unrepairable units with new or remanufactured equipment. All replacement units will be covered under warranty for the 3 year period commencing from the date of original equipment purchase, not the date of shipment of the replacement unit. Such repair, including both parts and labor, will be performed at ProSoft's expense. All warranty service will be performed at service centers designated by ProSoft.
- b) *Warranty On Services:* Materials and labor performed by ProSoft to repair a verified malfunction or defect are warranted in the terms specified above for new Product, provided said warranty will be for the period remaining on the original new equipment warranty or, if the original warranty is no longer in effect, for a period of 90 days from the date of repair.

5.2.2 What Is Not Covered By This Warranty

- a) ProSoft makes no representation or warranty, expressed or implied, that the operation of software purchased from ProSoft will be uninterrupted or error free or that the functions contained in the software will meet or satisfy the purchaser's intended use or requirements; the Customer assumes complete responsibility for decisions made or actions taken based on information obtained using ProSoft software.
- b) This Warranty does not cover the failure of the Product to perform specified functions, or any other non-conformance, defects, losses or damages caused by or attributable to any of the following: (i) shipping; (ii) improper installation or other failure of Customer to adhere to ProSoft's specifications or instructions; (iii) unauthorized repair or maintenance; (iv) attachments, equipment, options, parts, software, or user-created programming (including, but not limited to, programs developed with any IEC 61131-3, "C" or any variant of "C" programming languages) not furnished by ProSoft; (v) use of the Product for purposes other than those for which it was designed; (vi) any other abuse, misapplication, neglect or misuse by the Customer; (vii) accident, improper testing or causes external to the Product such as, but not limited to, exposure to extremes of temperature or humidity, power failure or power surges; or (viii) disasters such as fire, flood, earthquake, wind and lightning.
- c) The information in this Agreement is subject to change without notice. ProSoft shall not be liable for technical or editorial errors or omissions made herein; nor for incidental or consequential damages resulting from the furnishing, performance or use of this material. The user guide included with your original product purchase from ProSoft contains information protected by copyright. No part of the guide may be duplicated or reproduced in any form without prior written consent from ProSoft.

5.2.3 Disclaimer Regarding High Risk Activities

Product manufactured or supplied by ProSoft is not fault tolerant and is not designed, manufactured or intended for use in hazardous environments requiring fail-safe performance including and without limitation: the operation of nuclear facilities, aircraft navigation or communication systems, air traffic control, direct life support machines or weapons systems in which the failure of the product could lead directly or indirectly to death, personal injury or severe physical or environmental damage (collectively, "high risk activities"). ProSoft specifically disclaims any express or implied warranty of fitness for high risk activities.

5.2.4 Intellectual Property Indemnity

Buyer shall indemnify and hold harmless ProSoft and its employees from and against all liabilities, losses, claims, costs and expenses (including attorney's fees and expenses) related to any claim, investigation, litigation or proceeding (whether or not ProSoft is a party) which arises or is alleged to arise from Buyer's acts or omissions under these Terms or in any way with respect to the Products. Without limiting the foregoing, Buyer (at its own expense) shall indemnify and hold harmless ProSoft and defend or settle any action brought against such Companies to the extent based on a claim that any Product made to Buyer specifications infringed intellectual property rights of another party. ProSoft makes no warranty that the product is or will be delivered free of any person's claiming of patent, trademark, or similar infringement. The Buyer assumes all risks (including the risk of suit) that the product or any use of the product will infringe existing or subsequently issued patents, trademarks, or copyrights.

- a) Any documentation included with Product purchased from ProSoft is protected by copyright and may not be duplicated or reproduced in any form without prior written consent from ProSoft.
- b) ProSoft's technical specifications and documentation that are included with the Product are subject to editing and modification without notice.
- c) Transfer of title shall not operate to convey to Customer any right to make, or have made, any Product supplied by ProSoft.
- d) Customer is granted no right or license to use any software or other intellectual property in any manner or for any purpose not expressly permitted by any license agreement accompanying such software or other intellectual property.
- e) Customer agrees that it shall not, and shall not authorize others to, copy software provided by ProSoft (except as expressly permitted in any license agreement accompanying such software); transfer software to a third party separately from the Product; modify, alter, translate, decode, decompile, disassemble, reverse-engineer or otherwise attempt to derive the source code of the software or create derivative works based on the software; export the software or underlying technology in contravention of applicable US and international export laws and regulations; or use the software other than as authorized in connection with use of Product.
- f) **Additional Restrictions Relating To Software And Other Intellectual Property**

In addition to compliance with the Terms of this Warranty, Customers purchasing software or other intellectual property shall comply with any license agreement accompanying such software or other intellectual property. Failure to do so may void this Warranty with respect to such software and/or other intellectual property.

5.2.5 Disclaimer of all Other Warranties

The Warranty set forth in What Is Covered By This Warranty (page 103) are in lieu of all other warranties, express or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose.

5.2.6 Limitation of Remedies **

In no event will ProSoft or its Dealer be liable for any special, incidental or consequential damages based on breach of warranty, breach of contract, negligence, strict tort or any other legal theory. Damages that ProSoft or its Dealer will not be responsible for include, but are not limited to: Loss of profits; loss of savings or revenue; loss of use of the product or any associated equipment; loss of data; cost of capital; cost of any substitute equipment, facilities, or services; downtime; the claims of third parties including, customers of the Purchaser; and, injury to property.

** Some areas do not allow time limitations on an implied warranty, or allow the exclusion or limitation of incidental or consequential damages. In such areas, the above limitations may not apply. This Warranty gives you specific legal rights, and you may also have other rights which vary from place to place.

5.2.7 Time Limit for Bringing Suit

Any action for breach of warranty must be commenced within 39 months following shipment of the Product.

5.2.8 No Other Warranties

Unless modified in writing and signed by both parties, this Warranty is understood to be the complete and exclusive agreement between the parties, suspending all oral or written prior agreements and all other communications between the parties relating to the subject matter of this Warranty, including statements made by salesperson. No employee of ProSoft or any other party is authorized to make any warranty in addition to those made in this Warranty. The Customer is warned, therefore, to check this Warranty carefully to see that it correctly reflects those terms that are important to the Customer.

5.2.9 Allocation of Risks

This Warranty allocates the risk of product failure between ProSoft and the Customer. This allocation is recognized by both parties and is reflected in the price of the goods. The Customer acknowledges that it has read this Warranty, understands it, and is bound by its Terms.

5.2.10 Controlling Law and Severability

This Warranty shall be governed by and construed in accordance with the laws of the United States and the domestic laws of the State of California, without reference to its conflicts of law provisions. If for any reason a court of competent jurisdiction finds any provisions of this Warranty, or a portion thereof, to be unenforceable, that provision shall be enforced to the maximum extent permissible and the remainder of this Warranty shall remain in full force and effect. Any cause of action with respect to the Product or Services must be instituted in a court of competent jurisdiction in the State of California.

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