ProSoft
TECHNOLOGY

Where Automation Connects.

Wireless Oil Network

Diagram | Parts List | Site Details | Link Details

	Part Name	Part #	Description
1	Antenna	A2424NJ-DB	24 dBi Directional N jack parabolic, 2.4GHz
2	Extension Cable	C60M40-40-100	100ft LMR 600 N Plug --> N plug cable
3	Lightning Proctector	LP-24002	N jack --> N jack BH lightning protection w/hardw
4	Conversion Cable	C19M10-40-002	2ft LMR 195 RA RP-SMA --> N plug cable
5	Radio	RLX-FHE-SA	2.4 GHz Frequency Hopping Wireless Ethernet Switch

Site Details:	
Site Name	Pump1
Latitude	23.80152
Longitude	47.39415
EIRP	18dBm
Cable/Antenna Gain	18dBm
Max EIRP	20dBm

ProSoft
Software

PSW-PWD

ProSoft Software

ProSoft Wireless Designer

July 08, 2009

USER MANUAL

Your Feedback Please

We always want you to feel that you made the right decision to use our products. If you have suggestions, comments, compliments or complaints about the product, documentation or support, please write or call us.

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, and are available at no charge from our web site: www.prosoft-technology.com

Printed documentation is available for purchase. Contact ProSoft Technology for pricing and availability.

Asia Pacific: +603.7724.2080

Europe, Middle East, Africa: +33 (0) 5.3436.87.20

Latin America: +1.281.298.9109

North America: +1.661.716.5100

Contents

1   ProSoft Wireless Designer

ProSoft Wireless Designer is an application (computer program) that simplifies the task of designing your ProSoft Wireless network, and specifying the components for your installation.

ProSoft Wireless Designer is a fast, accurate way to develop a comprehensive specification list and Bill of Materials for your wireless network. Use ProSoft Wireless Designer to specify:

- Radios
- Cables
- Lightning Protection
- Connectors
- Antennas

ProSoft Wireless Designer simplifies the task of planning and specifying your ProSoft Wireless network. The easy to use, wizard-based interface creates a visual layout of your radios and sites, and generates a complete Bill of Materials including radios and accessories.

Updates

You can always find the latest version of ProSoft Wireless Designer from the ProSoft web site at www.prosoft-technology.com

ProSoft Technical Support strongly recommends keeping your computer updated with the current Windows service packs and hot fixes. Go to http://windowsupdate.microsoft.com (http://windowsupdate.microsoft.com) to download and install the latest updates for your Windows operating system.

Where to Find the Manuals

For help configuring a specific module, refer to the online manuals (documentation) for your module. You can find the manuals on the CD-ROM supplied with your module, or you can download them from the ProSoft web site at www.prosoft-technology.com.

ProSoft Wireless Designer Online Help

ProSoft Wireless Designer comes with an extensive online help system that explains in detail how to use the program. If you have used other Windows applications, you may already be familiar with using online help systems. If online help is new to you, or you would like to refresh your memory, refer to Basic Principles (page 79) for "how-to" information on Windows help.

1.1   Purpose of this Guide

The ProSoft Wireless Designer is designed to assist those involved in designing, planning, and installing industrial wireless networks.

Given the complexity of industrial data communications, this guide takes the reader step-by-step through the process of:

- Understanding Wireless Communications
- Designing Wireless Networks
- Performing Path Studies and Site Survey Procedures
- Selecting modems, antennas, and cables
- Maintaining and troubleshooting wireless networks
- Generating a Parts List to simplify ordering all the necessary components

The last section of this guide contains complete specifications for RadioLinx Wireless Modems, ProLinx Wireless Gateways, InRAx/ProTalk Wireless PLC modules, antennas, cables, and other wireless accessories.

ProSoft Technology's Wireless Support Team is available to assist with wireless network design, path studies, and product selection. ProSoft Technology offers Site Survey services (call for a price quote) and will lend wireless products for testing.

1.2   How to Get Help

ProSoft Technology has several ways for customers to acquire knowledge fast! In an all encompassing support page, technical support is now right at your fingertips. Here you get the ProSoft Knowledgebase, a community of experts and experienced end-users on our bulletin board, as well as presentations, one-on-one chat, on the go tutorials and streaming media training.

Knowledgebase: Type a question into our knowledgebase search engine. Answers come from a technical support knowledge database built from helping inquisitive customers like you.

Frequently Asked Questions: If you want to know ProSoft Support's top ten questions asked, just click on our FAQ. Using an FAQ could get you the answers you need immediately. Check back regularly for updates.

Bulletin Board: Here's a public forum just for you. Make comments, ask questions, and get to know ProSoft's automation community. Register, login, and join the discussion.

Live Chat (8am to 5pm PST): Communicate with a Technical Support Engineer online. This is just one more way to get one-on-one support from our knowledgeable support staff.

Downloads: Look no further. Get manuals, datasheets, configuration utilities, and more.

Training: Get help through our online tutorials and streaming media training series.

Contact: You can always call or email with your technical support questions. Also, if you have any comments or suggestions, please let us know.

Go to www.prosoft-technology.com/support (http://www.prosoft-technology.com/support) or call +1.661.716.5100

1.3   Functional Specifications

- 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

1.4   System Requirements

ProSoft Wireless Designer is designed for computers running Microsoft Windows and Microsoft .NET Framework version 2.0 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 2.0 is not supported on Windows 95 or Windows NT 4, or Windows 3.x.

It is highly recommended for all platforms that you upgrade to the latest Windows Service Pack and critical updates available from http://www.windowsupdate.com to ensure the best compatibility and security.

1.5 Installation

Installation is straightforward if you follow these steps:

To install ProSoft Wireless Designer:

1   Verify that your computer meets the hardware and operating system requirements.

> **Important:** You must have "Administrator" rights on your computer to install this application.
> **Important:** Please open and read the release notes on the CD before starting the installation. The release notes are located in the root directory of the CD-ROM.

2   Insert the ProSoft Wireless Designer CD-ROM in an available CD-ROM drive in your computer.
3   On most computers, the installation program will start automatically within a few seconds. If the installation does not start automatically on your computer, click the Start button, choose Run, and then type `explorer`. Click OK to start Windows Explorer. In Windows Explorer, open the My Computer icon and navigate to the CD-ROM drive. Double-click the file "Setup.exe". This action starts the installation wizard.
4   Follow the instructions on the installation wizard to install the program.
5   Click **Finish** to complete the installation. If you are prompted to restart your computer, save your work in any applications that are running, close the applications, and allow the computer to restart.

2   Using ProSoft Wireless Designer

2.1   Starting ProSoft Wireless Designer

To start ProSoft Wireless Designer:

1   Click the Start button, and then choose Programs.
2   In the Programs menu, choose ProSoft Technology.
3   In the ProSoft Technology menu, choose ProSoft Wireless Designer
4   To configure a new site, choose **Design a New Network** or **Open an Existing Network.**

Tip: The installation program includes a sample application that you can use to familiarize yourself with ProSoft Wireless Designer. The file is named "Wireless Oil Network.wdd", in your ProSoft Wireless Designer installation folder, normally `C:\Program Files\ProSoft\ProSoft Wireless Designer`

2.2   Setting Application Preferences

Use the Settings (page 36) dialog box to view or modify the following application settings and document for ProSoft Wireless Designer.

Global preferences (applies to all documents)

- Measuring Units

Document preferences (applies to current network design only)

The following preferences take effect for any new sites that you add to the current network design. Changes in this section do not apply to existing sites.

- Network Name (enter the network name in this field)
- Default site parts (click the button for each item to view or modify)
- Region (choose the region or country from the dropdown list)
- Environment (select indoor or outdoor)
- Site Font (click the button to select font size and style)
- Site Image Size (click the button to select small, medium or large radio icon)
- Draw to Scale (select or clear the checkbox)
- Show link details (select or clear the checkbox)

2.2.1 Customizing Application Colors

Use the Customize Application Colors (page 37) dialog box to select or customize the color scheme for the Network Details, Diagram and Parts views.

To customize application colors:

1   Open the View menu, and then choose Customize Colors.
2   On the Customize Application Colors dialog box, choose a color scheme from the dropdown list, or create your own color scheme.
3   To create a customized color scheme, click the button for an item (for example, Background, Cell color, and so on).
4   On the color dialog box, click to select a basic color, or use the custom colors palette to create a color.

2.3   About the Sample Application

ProSoft has provided a sample application consisting of a variety of sites, relays and devices, to show how a wireless network might be designed.

To open the sample application

1   Open the File menu, and then choose Open.
2   In the Open Document dialog box, choose **Wireless Oil Network.wdd**, and then click Open.

The sample application describes a network that connects the Headquarters site through a series of relay points, to a remote office ten miles away, and then to a pair of pumps approximately two miles from the remote office.

The following illustration shows the Diagram view, with each site (radio) and its link relationship to the next site.

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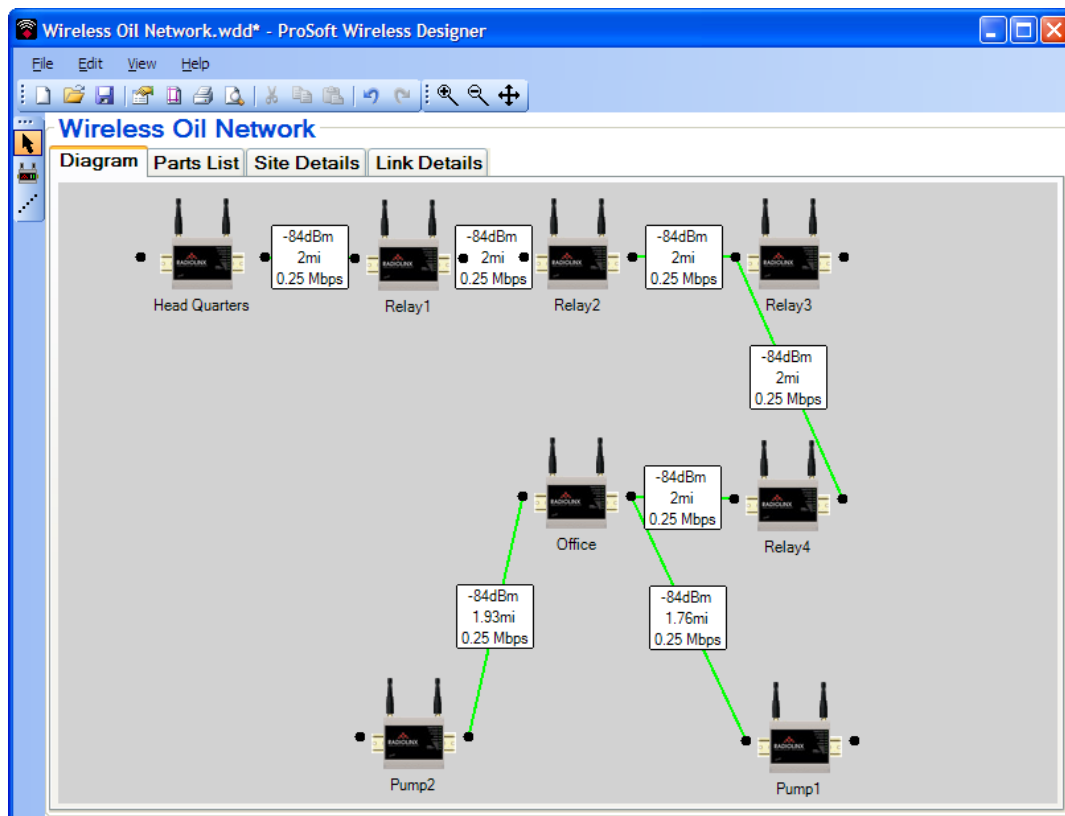
In the Diagram view, you can double-click a site (radio) or a link, and view or modify the properties. The following illustration shows the properties for the Office site.
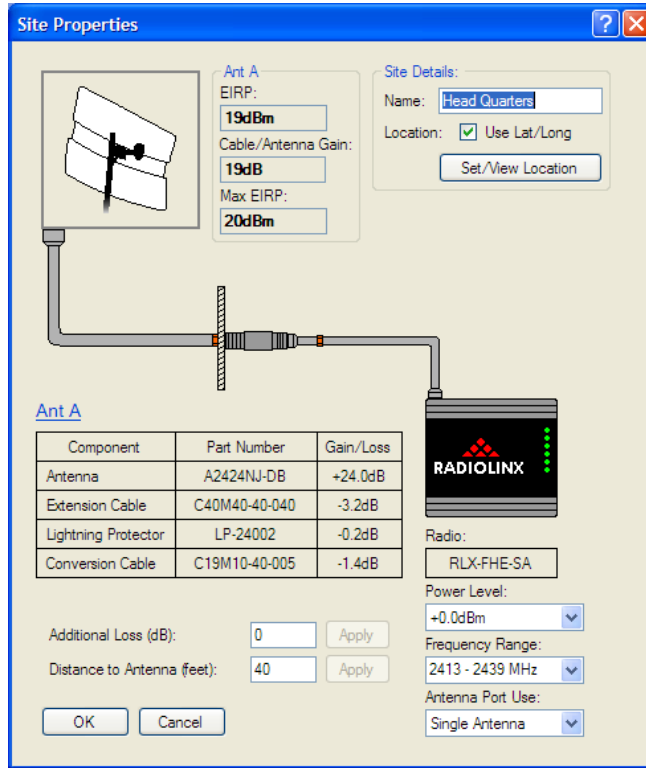
Click on any of the icons or buttons in this dialog box to see additional information, or to change your selections. The following illustration shows the Antenna Selection dialog box, which opens when you click the Antenna icon.
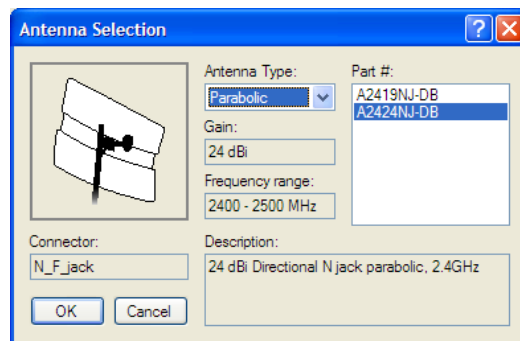
On the Antenna Selection dialog box (and other dialog boxes that link from the Site Properties dialog box), you can use the dropdown lists or text boxes to change your selections.

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Notice that when you select a different antenna type or part number (for example), the information in the Description fields in the dialog box is updated to match your new selection.
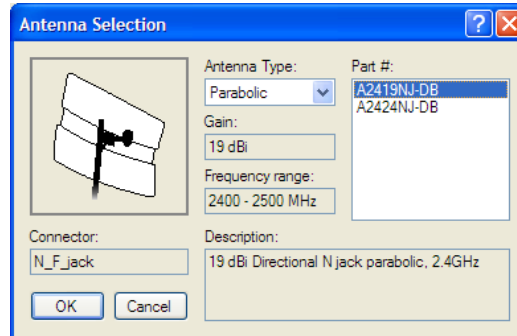
The following illustrations show some of the other dialog boxes linked to the Site Properties dialog box.
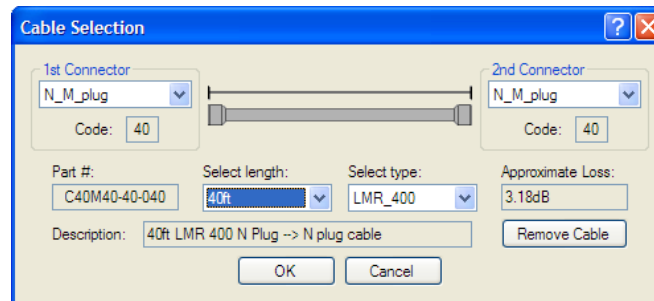
In some cases, changing a selection may cause conflicts with other equipment you have selected. For example, if you click the Radio icon, the following message box will open.
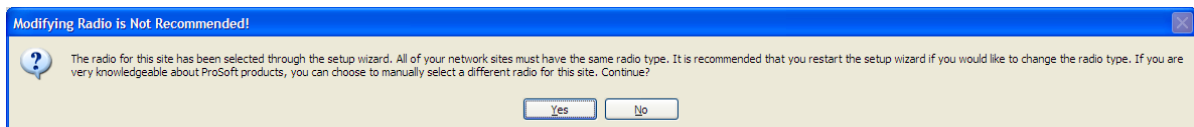
This warning does not stop you from selecting a different radio, however you should understand the changes this will require for your site design.

When you click Yes on this message box, the Radio Selection dialog box opens.
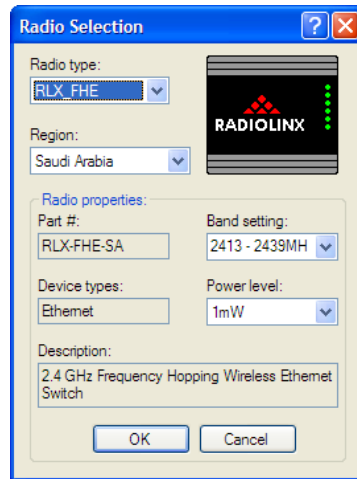
The following illustration shows the Link Properties dialog box, which opens when you double-click a link (the colored line joining two radios).
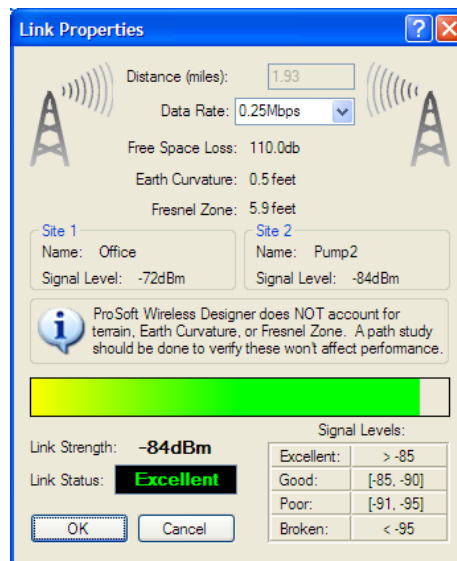
The Link Properties dialog box shows the signal levels and link status for the link, based on the antenna, cable and connector types selected for the two sites, as well as the distance in miles or kilometers between the two radios.

Notice that the information on this dialog box is based on the two antennas having a clear line of sight, without obstructions such as trees, terrain or structures.

The following illustration shows a link that attempts to cover a distance beyond the transmission capabilities of the radios and antennas.
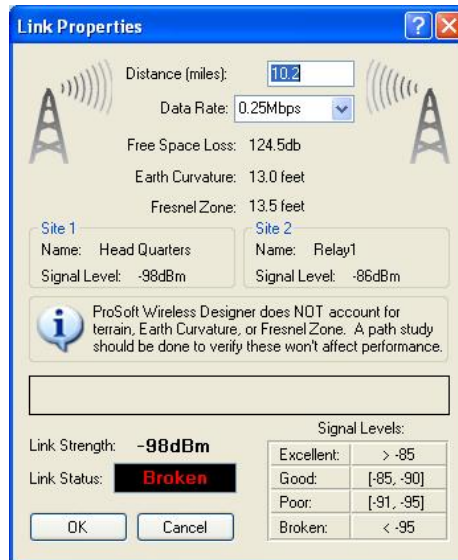
If the signal must negotiate a distance longer than the maximum range of the two radios, or if a direct line of sight is is not possible because of the physical features of your site, you will need to add relay points to accommodate your design.
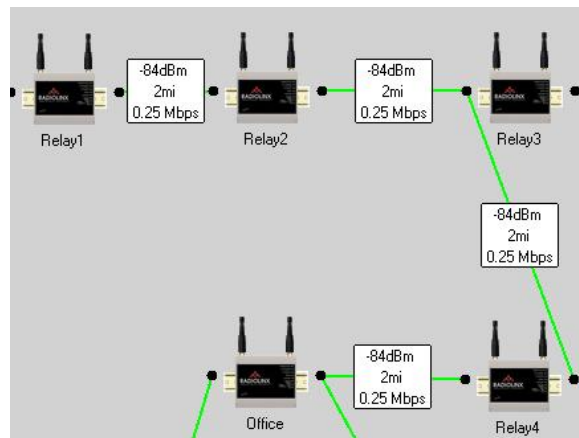
To add a relay point, click the right mouse button to open a shortcut menu, and then choose Site Tool.
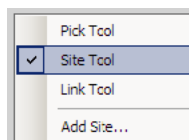
Click the left mouse button in the Diagram area, and fill in the Enter New Site Data dialog box.
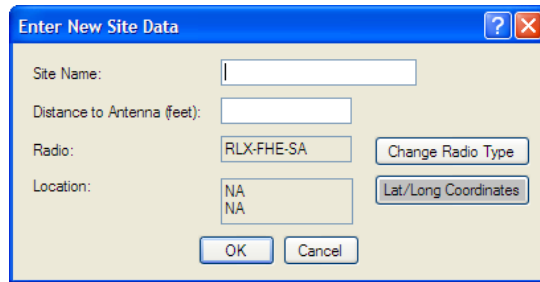
> **Tip:** If you enter the Latitude and Longitude coordinates for each site, ProSoft Wireless Designer will calculate the link distance automatically. Click the Lat/Long Coordinates button to enter the coordinates.

Notice that you can enter the coordinates in a variety of ways. Select the tab that shows the coordinate entry format to use. In the following illustration, the decimal coordinates were entered from the display on a handheld GPS device placed at the proposed location for the site. Be sure to specify the correct North/South and East/West position for your coordinates.
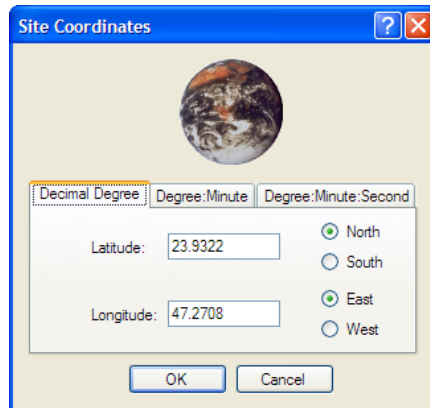
The following illustrations show the Parts List, Site Details and Link Details for the sample application.

Wireless Oil Network

Diagram | Parts List | Site Details | Link Details

Part #	Quantity	Description
RLX-FHE-SA	8	2.4 GHz Frequency Hopping Wireless Ethernet Switch
LP-24002	8	N jack --> N jack BH lightning protection w/hardw
A2424NJ-DB	3	24 dBi Directional N jack parabolic, 2.4GHz
C19M10-40-002	7	2ft LMR 195 RA RP-SMA --> N plug cable
C60M40-40-100	1	100ft LMR 600 N Plug --> N plug cable
C60M40-40-080	1	80ft LMR 600 N Plug --> N plug cable
A2409NJ-OCD	5	Antenna, 9dBi omni N jack heavy duty - with mounting hardware, 2.4GHz
C40M40-40-005	1	5ft LMR 400 N Plug --> N plug cable
C19M10-40-005	1	5ft LMR 195 RA RP-SMA --> N plug cable
C40M40-40-040	1	40ft LMR 400 N Plug --> N plug cable
C40M40-40-002	4	2ft LMR 400 N Plug --> N plug cable
RLX-WPK001	1	RF Connector Weatherproofing Kit

Notice that the Site Details and Link Details tabs show details for only one site or link at a time. Use the Next and Previous buttons to view the rest of the sites and links in the sample application.

Wireless Oil Network

Diagram | Parts List | Site Details | Link Details

	Part Name	Part #	Description
1	Antenna	A2424NJ-DB	24 dBi Directional N jack parabolic, 2.4GHz
2	Extension Cable	C60M40-40-100	100ft LMR 600 N Plug --> N plug cable
3	Lightning Proctector	LP-24002	N jack --> N jack BH lightning protection w/hardw
4	Conversion Cable	C19M10-40-002	2ft LMR 195 RA RP-SMA --> N plug cable
5	Radio	RLX-FHE-SA	2.4 GHz Frequency Hopping Wireless Ethernet Switch

Site Details:	
Site Name	Pump1
Latitude	23.80152
Longitude	47.39415
EIRP	18dBm
Cable/Antenna Gain	18dBm
Max EIRP	20dBm

Wireless Oil Network

	Diagram	Parts List	Site Details	**Link Details**

Category	Field	Value
Link Details:	First Site	Office
	Second Site	Pump1
	Signal Level	-84dBm
	Status	Excellent
	Distance	1.76mi

[< Previous]   Link 1 of 7   [Next >]

2.4   Designing a New Network

ProSoft Wireless Designer uses a setup wizard to gather the information it needs to recommend the components required by your wireless network.

To design a new network

1   Start ProSoft Wireless Designer.
2   On the splash screen, choose Design a New Network.

[Design New Network]

Tip: If ProSoft Wireless Designer is already running, open the File menu, and then choose New.

3   Enter the network name (page 37). Choose an informative name to identify the location and purpose for the network, and then click OK to continue.
4   On the first wizard page, choose the environment: indoor or outdoor. This choice determines the type of antennas and other components to use.
5   Choose the radio type from the dropdown list.
  o   Chose "I don't know" if you would like ProSoft Wireless Designer to recommend the radio based on your answers on the next wizard pages, for example Ethernet or Serial, and with or without 802.11x connectivity.
  o   If you already know the type of radio to use, select the radio part number from the dropdown list.

6   Choose the country or region where the radio will be installed. Each country or region where these radios are sold has its own regulations for frequency range, channels, and output power for wireless networks.
7   Chose whether to draw the network to scale, or to let you arrange the network yourself.
8   Review the wizard summary for correctness, and then click Finish to add the first site (radio) to your network.

2.5   Adding a Site

When you have finished creating the network, you will be prompted to add a site.

To add a site:

1   In the Enter New Site Data (page 35) dialog box, enter the site name and the distance between the radio and the antenna.

Note: ProSoft Wireless Designer allows you to choose the measurement units to use (English or Metric). If you prefer to enter these values in Metric units (meters, kilometers) instead of English units (feet, miles), open the Edit menu, choose Settings, and then on the Settings (page 36) dialog box, choose Metric.

2   If you know the latitude and longitude coordinates, click the Lat/Long Coordinates button to enter them in the Site Coordinates (page 32) dialog box now.
3   Open the File menu, and then choose Save. ProSoft Wireless Designer will save your network using a file name based on the network name you entered.

Tip: Use the Copy and Paste commands on the Edit menu to quickly create duplicates of parts of your network, for example if your network design includes a number of similarly configured sites and links.

2.5.1   Adding another Site

A radio network consists of two or more sites (radios) connected by links. In order for your network to communicate, you must add at least one more site.

To add another site

1   Click the right mouse button in the Network Diagram view, and then choose Add Site.
2   On the Enter New Site Data (page 35) dialog box, enter the site name, distance between radio and antenna and, if you know the latitude and longitude for the site, click the Lat/Long Coordinates button to add the site coordinates.
3   Click OK.
4   Open the File menu, and then choose Save.

2.5.2 Entering Site Coordinates

ProSoft Wireless Designer uses the site coordinates to calculate the precise distance between sites. Use the tabs to choose the data entry format compatible with your GPS (Global Positioning System) device, or enter the known geographical coordinates for the site.

To enter Site Coordinates

1 Determine the latitude and longitude coordinates for the site, using a GPS device, or from known coordinates.
2 Right click on a site, and then choose Properties.
3 On the Site Properties (page 30) dialog box, click the Location button to open the Site Coordinates (page 32) dialog box.
4 Select the tab that best matches the coordinates (Decimal, Degree:Minute, or Degree:Minute:Second)
5 Enter the site coordinates. Be sure to select the correct North/South and East/West orientation.

2.6   Viewing Site Properties

The Site Properties (page 30) dialog box shows you all the components and computed values associated with the current site. Use this dialog box to view or modify the settings for Antennas, (page 31) Cables, (page 31) Radio (page 33) and Accessories. (page 32)

To view Site Properties

1 In the Network Diagram view, select the Site to view, and then right-click to select Properties.
2 In the Site Properties dialog box, click the icons or buttons for each component to view or modify the selections.

Important: The Antenna, Cables and Accessories in the Site Properties are chosen by ProSoft Wireless Designer based on the default items selected in the Settings dialog box. You may need to modify those choices for each site to accommodate the specific requirements for each location.

2.7   Adding a Link

In order for each site to communicate with its neighbor, you must create a link. The link contains information on the distance between sites, which ProSoft Wireless Designer uses to estimate the signal strength and link quality.

To add a link:

1   Click the right mouse button in the Network Diagram view, and then choose Link Tool.
2   Move the mouse pointer to the first site, then drag the mouse pointer to the second site.

Tip: "Drag" means click and hold the left mouse button at the starting point, and continue holding the left mouse button as you move the mouse pointer to the ending point. Release the left mouse button to finish.

3   In the Enter New Link Data (page 35) dialog box, enter the distance between the sites.
4   Open the File menu, and then choose Save.

Tip: If you have already entered Latitude and Longitude coordinates for the two sites, ProSoft Wireless Designer will calculate the link distance automatically.

2.8   Viewing Link Properties

The Link Properties (page 34) dialog box shows you information about the link between two sites (radios), including distance, signal strength and link status. Signal levels and link status are computed from the link distance and the combination of components for the two sites.

To view Link Properties

1   In the Network Diagram view, double-click the Link to view
2   In the Link Properties dialog box, review the distance and link qualities, and make a note of any changes that may be required to improve link performance.

2.9   Adding Antennas

Antennas are selected for you automatically, based on information you provided in the setup wizard.

To view or change the antenna for a site

1   Right click on a site, and then choose Properties.
2   On the Site Properties (page 30) dialog box, click the Antenna icon to open the Antenna Selection (page 31) dialog box.
3   Use the dropdown lists to choose the antenna type and antenna part number.
4   Click OK to save your changes, or click Cancel to discard without saving.

2.10   Adding Cables

Cables are selected for you automatically, based on information you provided in the setup wizard.

To view or change the cables for a site

1   Right click on a site, and then choose Properties.
2   On the Site Properties (page 30) dialog box, click the Extension Cable or Conversion Cable buttons to open the Cable Selection (page 31) dialog box.
3   Use the dropdown lists to choose the connector types, length and cable type.
4   Click OK to save your changes, or click Cancel to discard without saving.

2.11   Adding Lightning Protection

If you choose "outdoor", lightning protection (page 75) is selected automatically.

To view or change the lightning protector for a site

1   Right click on a site, and then choose Properties.
2   On the Site Properties (page 30) dialog box, click the Lightning Protector button to open the Lightning Protector (page 32) dialog box.
3   Select (check) or clear (uncheck) the Enable Lightning Protector check box.
4   Use the dropdown lists to choose the antenna type and antenna part number.
5   Click OK to save your changes, or click Cancel to discard without saving.

Important: Outdoor antennas and radios ordinarily require lightning protection, to reduce the likelihood damage to equipment or injury to personnel in case of lightning strike.
Lightning protection should be installed as close to the antenna as possible, and requires a minimum 6 gauge wire (not supplied) connecting the lightning protector to ground. When properly installed with a heavy gauge ground wire, the lightning protector is capable of protecting against multiple lightning strikes.

2.12   Modifying an Existing Network

When you save your network, ProSoft Wireless Designer creates a file containing information about your sites, links and accessories, so that you can view or modify your network design later.

Tip: ProSoft has provided a sample application consisting of a variety of sites, relays and devices, to show how a wireless network might be designed. The file name is **Wireless Oil Network.wdd**, Refer to About the Sample Application (page 13) to see how to use this file.

To open an existing network:

1   Open the File menu, and then choose Open.
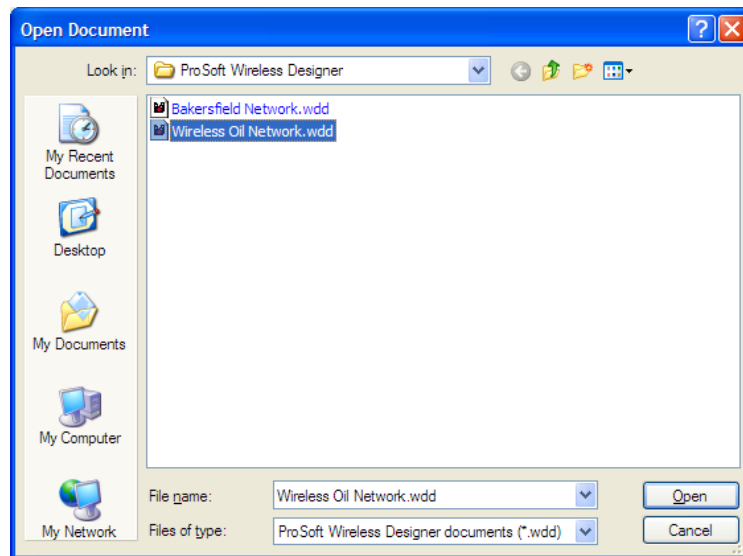
2   Select the file, and then click Open.

Tip: ProSoft Wireless Designer remembers the last location where you opened or saved files. When you use ProSoft Wireless Designer for the first time, it uses its installation folder (normally `C:\Program Files\ProSoft\ProSoft Wireless Designer`).

2.13   Saving a Network

You should save your work frequently when you are designing a network. You can open the saved file later to view or modify your network design.

To save a network design

1   Open the File menu, and then choose Save.
2   ProSoft Wireless Designer will save your network using a file name based on the network name you entered.

2.14   Exporting Wizard Choices

You can export the setup wizard choices for your network design into a variety of file formats, for use in other applications. The information in the exported file may be useful for technical support and diagnostics.

The available formats are

- .csv (comma separated values) for spreadsheets / databases
- .txt (plain text) for word processor / email
- .xml for whatever supports xml

To export wizard choices:

1   Open the File menu, and then choose Export Wizard Choices.
2   Choose the location for the export files
3   Select the file format in the Save as type dropdown list.
4   Click Save.

> **Tip:** ProSoft Wireless Designer remembers the last location where you opened or saved files. When you use ProSoft Wireless Designer for the first time, it uses its installation folder (normally `C:\Program Files\ProSoft\ProSoft Wireless Designer`).

2.15   Exporting Site Details

You can export the site details for your network design into a variety of file formats, for use in other applications.

The available formats are

- .csv (comma separated values) for spreadsheets / databases
- .txt (plain text) for word processor / email
- .xml for whatever supports xml

To export wizard choices:

1   Open the File menu, and then choose **Export Network Details / Site Details**.
2   Choose the location for the export files
3   Select the file format in the Save as type dropdown list.
4   Click Save.

> **Tip:** ProSoft Wireless Designer remembers the last location where you opened or saved files. When you use ProSoft Wireless Designer for the first time, it uses its installation folder (normally `C:\Program Files\ProSoft\ProSoft Wireless Designer`).

2.16 Exporting Link Details

You can export the link details for your network design into a variety of file formats, for use in other applications.

The available formats are

- .csv (comma separated values) for spreadsheets / databases
- .txt (plain text) for word processor / email
- .xml for whatever supports xml

To export wizard choices:

1 Open the File menu, and then choose **Export Network Details / Link Details**.
2 Choose the location for the export files
3 Select the file format in the Save as type dropdown list.
4 Click Save.

> **Tip:** ProSoft Wireless Designer remembers the last location where you opened or saved files. When you use ProSoft Wireless Designer for the first time, it uses its installation folder (normally `C:\Program Files\ProSoft\ProSoft Wireless Designer`).

2.17 Exporting a Parts List

You can export a parts list for your network design into a variety of file formats, for use in other applications.

The available formats are

- .csv (comma separated values) for spreadsheets / databases
- .txt (plain text) for word processor / email
- .xml for whatever supports xml

To export wizard choices:

1 Open the File menu, and then choose Export Parts List
2 Choose the location for the export files
3 Select the file format in the Save as type dropdown list.
4 Click Save.

> **Tip:** ProSoft Wireless Designer remembers the last location where you opened or saved files. When you use ProSoft Wireless Designer for the first time, it uses its installation folder (normally `C:\Program Files\ProSoft\ProSoft Wireless Designer`).

2.18   Printing

You can print the current view (Network Diagram, Parts List, Site Details or Link Details. ProSoft Wireless Designer offers the following options to customize the appearance of printed pages:

To view or modify Print Settings

1   Open the File menu, and then choose Application Print Settings.
2   On the Print Settings (page 35) dialog box, select print scale, background color and header font preferences.

To view or modify Page Layout

1   Open the File menu, and then choose Page Layout
2   On the Page Setup dialog box, select paper size, source, orientation and margins.

To view a Print Preview

1   Open the File menu, and then choose Print Preview.
2   Review the preview, and modify the print settings or page layout as needed.

To Print the current view

1   Open the File menu, and then choose Print.
2   Select the printer, page range and number of copies to print
3   Click the Print to use the selected printer to print your pages.

3   ProSoft Wireless Designer User Interface

ProSoft Wireless Designer uses standard Windows (page 79) menus, keyboard and mouse controls. The following topics describe the ProSoft Wireless Designer user interface, and provide tips on how to design your network and create a Bill of Materials or parts list to place your order, or to document your installation.

3.1   Site Properties dialog box

This dialog box opens when you right-click the Site (radio) icon and choose Properties in the Network Diagram (page 38)view. Use this dialog box to view or change the hardware selection information for this site.

- **Antenna Icon:** Shows a drawing of the selected antenna. Click this icon to open the Antenna Selection (page 31) dialog box.
- **Site Details:** Type the name of the site in this field. The site name is displayed in the Network Diagram view. Choose an informative name for your site, for example "Headquarters," or "Relay", or "Remote site", to identify the location and purpose for the site.
- **Set/View Location:** Click this button to open the Site Coordinates (page 32) dialog box, to view or enter latitude and longitude coordinates for the site. ProSoft Wireless Designer uses the site coordinates to calculate the precise distance between sites.
- **Location:** Select (check) this check box to use the site lat/long coordinates to determine site location and link distance(s).
- **EIRP:** Equivalent isotropically radiated power (EIRP) is effective power that is radiated from the antenna. It is the net result of the radio transmit power plus antenna gain minus all losses from cables and lightning protection. This value is calculated based on the hardware specified for this site.
- **Cable/Antenna gain:** This is the amount of antenna gain minus all losses from cables and lightning protection. This value is calculated based on the hardware specified for this site.
- **Max EIRP:** This is the maximum EIRP value allowed for the particular region and configuration selected. If your configuration exceeds the maximum allowable EIRP, a message box will open, and the color of the EIRP text changes to red.
- **Antenna:** This is the part number for the specified antenna. Click this button to open the Antenna Selection dialog box.
- **Extension cable:** This is the part number for the specified extension cable. Click this button to open the Cable Selection (page 31) dialog box.
- **Lightning protector:** This is the part number for the specified lightning protector. Click this button to open the Lightning Protector Selector (page 32) dialog box.
- **Conversion cable:** This is the part number for the specified conversion cable. Click this button to open the Cable Selection (page 31) dialog box.
- **Additional Loss [dB]:** Enter an amount of miscellaneous loss for any components that might not be included.
- **Distance to antenna:** Enter the distance in feet or meters between the radio and the antenna.
- **Radio:** The part number for the specified radio. Click this button open the Radio Selection dialog box (page 33). Note that the radio type is selected for you automatically, based on your answers to the setup wizard. If you change the radio type to a radio that is not compatible with the rest of the site, the new radio will not be able to communicate with the network.
- **Power level:** Choose the transmit power level for this radio from the dropdown list.
- **Frequency range:** The frequency range in MHz for the specified radio.
- **Antenna Port Use:** This dropdown box is used to switch between the single antenna site properties dialog and the two antenna site properties dialog.

3.2   Antenna Selection dialog box

This dialog box opens when you click the Antenna icon on the Site Properties (page 30) dialog box. Use this dialog box to view or change (page 23) the antenna type specified for the site.

- **Antenna Icon:** Shows a drawing of the selected antenna.
- **Connector:** Shows the connector type specified for the antenna, for example N_F_jack.
- **Antenna Type:** Antennas are grouped into categories, for example Omni, Parabolic, Patch or Yagi. Open the dropdown list to choose a different antenna type.
- **Gain:** This is the gain in dBi for the specified antenna.
- **Frequency range:** This is the frequency range in MHz for the specified antenna.
- **Description**: This is a brief description of the specified antenna, for example "24 dBi Directional N jack parabolic".
- **Part #:** This is a list of part numbers for antennas of this type. Select the antenna type from the list box. Notice that the information fields on this dialog box change as you select different part numbers.

3.3   Cable Selection dialog box

This dialog box opens when you click the Conversion cable or Extension cable buttons on the Site Properties (page 30) dialog box. Use this dialog box to view or change (page 24) the cable type specified for the site.

- **Cable Icon:** Shows a drawing of the selected cable.
- **1st Connector, 2nd Connector:** Shows the connector type specified for each end of the cable. Use the dropdown list for each connector to choose a different connector type.
- **Code:** Shows the part numbering code corresponding to that connector
- **Part #:** This is the part number for the selected cable.
- **Description:** This is a brief description for the selected cable, for example "40ft LMR 400 N plug --> N plug cable".
- **Select length:** This is the length in feet or meters for the selected cable. Use the dropdown list to choose a different cable length.
- **Select type:** This is the cable type for the specified cable, for example LMR_400. Use the dropdown list to choose a different cable type.
- **Approximate Loss:** This is the approximate signal loss for the specified cable, for example 2.56 dB. Signal loss is calculated based on the cable type, connectors, and cable length.
- **Remove Cable:** Click this button to remove the cable from the specification. Note that the cables and connectors specified for your site include all the necessary adaptors to connect the various components. A message box will open if you attempt to delete a cable that provides necessary connections between components.

3.4   Lighting Protector dialog box

This dialog box opens when you click the Lightning Protector icon on the Site
Properties (page 30) dialog box. Use this dialog box to include or exclude
lightning protection (page 24) hardware for your site.

Important: Outdoor antennas and radios ordinarily require lightning protection, to reduce the
likelihood damage to equipment or injury to personnel in case of lightning strike.
Lightning protection (page 75) should be installed as close to the antenna as possible, and requires
a minimum 6 gauge wire (not supplied) connecting the lightning protector to ground. When properly
installed with a heavy gauge ground wire, the lightning protector is capable of protecting against
multiple lightning strikes.

- **Enable lightning protector:** Select (check) this option if this site requires
  lightning protection hardware.

3.5   Site Coordinates dialog box

This dialog box opens when you click the Location button on the Site Properties
(page 30) dialog box. Use this dialog box to view or enter Latitude and Longitude
(page 22) coordinates for this site. ProSoft Wireless Designer uses the site
coordinates to calculate the precise distance between sites. Use the tabs to
choose the data entry format compatible with your GPS (Global Positioning
System) device, or enter the known geographical coordinates for the site.

- **Decimal Degree:** Click this tab to enter coordinates in Decimal Degree
  format, for example "23.932168"
- **Degree: Minute:** Click this tab to enter coordinates in Degree:Minute format,
  for example "23:55.93008"
- **Degreee: Minute: Second**: Click this tab to enter coordinates in
  Degree:Minute:Second format, for example "23:55:55.804"
- **Latitude:** Degrees latitude relative to the Equator (0 degrees)
- **North:** Select North for locations north of the equator
- **South:** Select South for locations south of the equator
- **Longitude:** Degrees longitude relative to the Greenwich Meridian (0
  degrees)
- **East:** Select East for locations east of the Greenwich Meridian
- **West:** Select West for locations west of the Greenwich Meridian

3.6   Radio Selection dialog box

This dialog box opens when you click the Radio icon in the Site Properties (page 30) dialog box. Use this dialog box to view or modify the radio settings for the site. Note that the radio type is selected for you automatically, based on your answers to the setup wizard. If you change the radio type to a radio that is not compatible with the rest of the site, the new radio will not be able to communicate with the network.

- **Radio type:** Choose the radio type from the dropdown list.
- **Region:** Each country or region where these radios are sold has its own regulations for frequency range, channels, and output power for wireless networks. Open the dropdown list to choose the country where this radio will be used.
- **Part #:** This is the part number for the specified radio, based on the selected radio type and country.
- **Band setting:** This is the frequency range in MHz supported by the selected radio.
- **Device types:** This is the protocol type or types supported by the selected radio.
- **Power level:** Choose the output strength for this radio from the dropdown list.
- **Description:** This is a brief description of the selected radio, for example "2.4 GHz Frequency Hopping Wireless Ethernet Switch".

3.7 Link Properties dialog box

This dialog box opens when you double-click the Link (colored line) connecting two sites in the Network Diagram View (page 38).
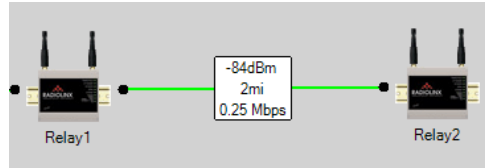
Use this dialog box to view or change the distance of the link, and to view the calculated link strength and status for the link.

- **Distance:** Enter the distance in miles between sites for this link.
- **Data Rate:** This is the rate that RF packets are being transferred.
- **Free Space Loss:** This is the loss of signal strength between two sites.
- **Earth Curvature:** The calculated curvature of the earth between Site 1 and Site 2.
- **Fresnel Zone:** The calculated Fresnel zone between Site 1 and Site 2. The Fresnel zone defines the unobstructed area around the direct path of the signal.
- **Name:** The name of each site associated with this link.
- **Signal level:** The signal level for each site associated with this link.
- **Signal levels (Excellent, Good, Poor, or Broken):** These are the values in dBm that ProSoft Wireless Designer uses to predict the status of the link.
- **Link strength:** This is the strength in dBm calculated by ProSoft Wireless Designer, based on the hardware selected for each site in the link, and the distance between the two sites.
- **Link status:** This is the status (excellent, good, poor, or broken) predicted by ProSoft Wireless Designer, based on the hardware selected for each site in the link, and the distance between the two sites.

Important: These values are calculated by ProSoft Wireless Designer based on the hardware specifications and link distances you provide for the network design. Other factors, including terrain and interference from other devices may affect the actual signal properties when the network is deployed.

3.8   Enter New Link Data dialog box

This dialog box opens when you select the Link Tool, and then drag a new link between two sites in the Network Diagram (page 38) view. Use this dialog box to specify the distance between sites. ProSoft Wireless Designer uses this information to calculate link strength and status for the link.

▪ **Distance:** Enter the distance between the two sites connected by this link.

3.9   Enter New Site Data dialog box

This dialog box opens when you select the Site Tool, and then click in the Network Diagram (page 38) view to add a new Site (radio) to your network.

▪ **Enter a name for this site:** Type the name of the site in this field. The site name is displayed in the Network Diagram view. Choose an informative name for your site, for example "Headquarters," or "Relay", or "Remote site", to identify the location and purpose for the site.
▪ **Distance between radio and antenna:** Enter the distance between the radio and its antenna. ProSoft Wireless Designer uses this information to specify cables, connections and antennas for the site.
▪ **Change Radio Type**: Click this button to open the Radio Type Selector dialog box, where you can a new radio type.
▪ **Lat/Long Coordinates:** Click this button to open the Site Coordinates (page 32) dialog box, where you can enter the latitude and longitude coordinates for the site.

3.10   Print Settings dialog box

This dialog box opens when you open the File menu (page 40), and then choose Application Print Settings. Use this dialog box to customize the way your network diagram (page 38), parts list (page 39), site details (page 39) or link details (page 39) should appear when printed.

▪ **Print scale:** ProSoft Wireless Designer normally fits the text or diagram automatically to the page dimensions you select in the Page Setup dialog box. If you prefer, uncheck the Fit to page checkbox to choose the scale (magnification) yourself.
▪ **Fit to page:** When this box is selected (checked), ProSoft Wireless Designer scales the text or diagram automatically to the page dimensions you select in the Printer Preferences dialog box for your printer.
▪ **Draw background color:** When this box is selected (checked), ProSoft Wireless Designer prints the background color along with the data from the view you are printing. Uncheck this box if you prefer to print the data without printing the background color.
▪ **Adjust Header Font:** Click this button to choose a different font, style and size for the header and footer text that ProSoft Wireless Designer prints on each page. The header and footer text include the Network Name, Network View and Page Number. Use the Print Preview command to view pages before printing.

3.11   Settings dialog box

This dialog box opens when you open the Edit menu (page 40), and then choose Settings. Use this dialog box to view or change (page 12) the Application settings and Document settings that ProSoft Wireless Designer should use for its user interface, and for new networks, sites, and regions. In most cases, you can change these default (predefined) settings from the Site Properties dialog box.

- **Measuring Units:** Choose English (feet, miles) or Metric (meters, kilometers).
- **Disable warnings:** Click this box to remove warnings that a user would frequently see.
- **Network name:** This field contains the network name for the current network. To change the network name, enter the new name in this field.
- **Radio:** Click this button to open the Radio Selection dialog box, and then choose the default radio to use for new sites.
- **Lightning protector:** This field is provided for information only, and lists the part number for the specified lightning protector.
- **Cabled antenna:** Click this button to open the Antenna Selection dialog box, and then choose the default Directional antenna (Parabolic, Patch or Yagi) to use for new sites.
- **Direct mount antenna:** Click this button to open the Antenna Selection dialog box, and then choose the default Omnidirectional antenna to use for new sites.
- **Conversion cable length:** Enter the default length for the conversion cable to use for new sites.
- **Band:** This is the default band that a new site would default to when added.
- **Environment:** Select Outdoor or Indoor for the environment to use for new sites.
- **Site font:** Click this button to choose the font, style and size to use in the captions for sites and links in the Network Diagram view.
- **Site image size:** Click this button to open the Select Site Image dialog box, and then choose the image size (small, medium, large) to use for sites in the Network Diagram view.
- **Draw to scale:** Select (check) this check box to arrange Sites (radios) by distance in the Network view.
- **Show link details:** This checkbox controls whether the site details box is displayed inbetween the links.

3.12   Customize Application Colors dialog box

This dialog box opens when you open the View menu, and then choose
Customize Colors (page 12). Use this dialog box to choose a predefined color
scheme (for example, Blue, Orange, Brown, White, and so on), or customize
your own color scheme.

3.13   Select Site Image dialog box

This dialog box opens when you click the Site Image Size button on the Settings
(page 36) dialog box. Use this dialog box to choose the image size (small,
medium, large) for sites (radios) in the Network Diagram view.

3.14   Network Name dialog box

This dialog box opens when you open the File menu, and then select New. Use
this dialog box to create and name a new wireless network.

- **Network Name**: Enter the name for your network in this field.
- **This Network is**: Select whether its an indoor or outdoor network.

3.15 Network Diagram View

The Network Diagram view is a symbolic layout of your wireless network. A wireless network consists of sites (radios plus their associated cables, antennas and accessories), plus links between sites.

When you create a wireless network, you first specify a network name, then add sites, and then links. While you design your network, ProSoft Wireless Designer calculates distances, signal strength and required hardware, and then provides that information in a comprehensive parts list that you can use to order the necessary components from your ProSoft distributor.

The following illustration shows the Network Diagram view for the Wireless Oil Network sample configuration.
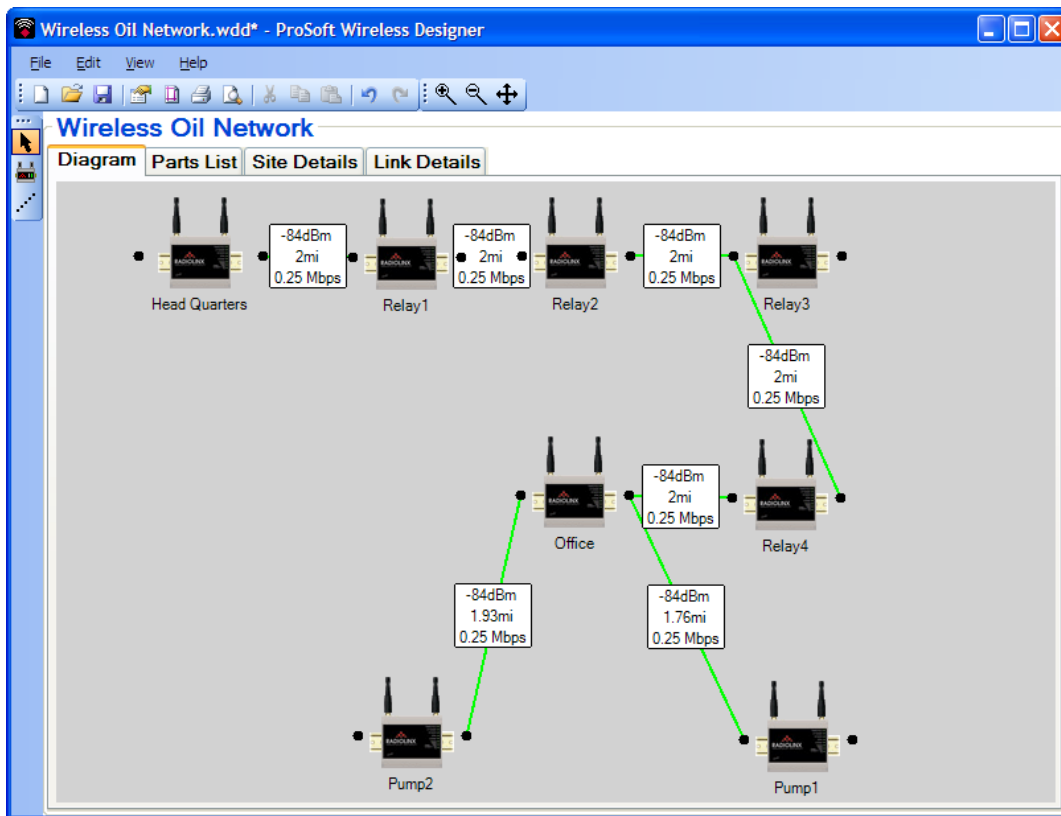
- Use the buttons on the Zoom tool bar to enlarge, reduce, or fit the diagram to the size of the window.
- Use the mouse wheel to scroll up and down within the window.
- Press and hold the [Ctrl] key and use the mouse wheel to zoom in and out.
- Press and hold the [Shift] key and use the mouse wheel to scroll left and right.

3.16   Network Parts List

Click the Parts List tab to view part numbers, quantities and descriptions for each of the components required for your network design.

Open the File menu and then choose Export Parts List to create a file that you can import into a variety of other applications. Choices include Comma Separated Values (.csv) for spreadsheets and database applications, Text (.txt) for word processors, or XML (.xml) for applications that support eXtensible Markup Language.

Tip: Use the mouse to drag-select all or part of the parts list, and copy it to the clipboard. You can paste the clipboard directly into a word processor or spreadsheet.

3.17   Network Site Details

Click the Site Details tab to view detailed information about each site.

Open the File menu and then choose **Export Network Details / Site Details** to create a file that you can import into a variety of other applications. Choices include Comma Separated Values (.csv) for spreadsheets and database applications, Text (.txt) for word processors, or XML (.xml) for applications that support eXtensible Markup Language.

Tip: Use the mouse to drag-select all or part of the site details and copy it to the clipboard. You can paste the clipboard directly into a word processor or spreadsheet.

Notice that the Site Details tab shows details for only one site at a time. Use the Next and Previous buttons to view the rest of the sites in your network.

3.18   Network Link Details

Click the Link Details tab to view detailed information about each link.

Open the File menu and then choose **Export Network Details / Link Details** to create a file that you can import into a variety of other applications. Choices include Comma Separated Values (.csv) for spreadsheets and database applications, Text (.txt) for word processors, or XML (.xml) for applications that support eXtensible Markup Language.

Tip: Use the mouse to drag-select all or part of the link details and copy it to the clipboard. You can paste the clipboard directly into a word processor or spreadsheet.

Notice that the Link Details tab shows details for only one link at a time. Use the Next and Previous buttons to view the rest of the links in your network.

3.19 File Menu

Use the commands on the File Menu to create, open, save or rename project files, or to exit (close) the ProSoft Wireless Designer.

- **New:** Starts the Network Design Wizard, which gathers information to create a new ProSoft Wireless Designer network design document.
- **Open:** Opens an existing network design document.
- **Close:** Closes the current network design document.
- **Save:** Saves the current network design document without closing, so you can continue editing.
- **Save as:** Saves the current network design document, allowing you to change the file name.
- **Export Wizard Choices:** Saves a copy of the selections you made in the Network Design Wizard, in CSV (spreadsheet), TXT (text) or XML format, for use in other applications.
- **Export Network Details:** Saves a copy of the Site details or Link details, in CSV (spreadsheet), TXT (text) or XML format, for use in other applications.
- **Export Parts List:** Saves a copy of the Parts List, in CSV (spreadsheet), TXT (text) or XML format, for use in other applications.
- **Application Print Settings:** Opens the Print Settings (page 35) dialog box, to customize the appearance of pages you print from ProSoft Wireless Designer.
- **Page Layout:** Opens the Page Layout dialog box, to customize the paper size orientation and margins of pages you print from ProSoft Wireless Designer.
- **Print:** Opens the Print dialog box, to select and print pages from ProSoft Wireless Designer.
- **Print Preview:** Opens the Print Preview dialog box, to show you how the pages will look when you print them.
- **Exit:** Closes ProSoft Wireless Designer.

3.20 Edit Menu

Use the Edit menu to view or change system settings, and to copy, paste or delete an item in the Network Diagram view, or to copy all or part of the Parts List, Site Details or Link Details to the Windows clipboard.

- **Undo:** Undoes (reverts) the last editor action.
- **Redo:** Redoes an editor action after an Undo.
- **Settings:** Opens the Settings (page 36) dialog box, to view and change the default values for ProSoft Wireless Designer
- **Cut:** Copies and deletes the selected site or link in order to paste it in another location.
- **Copy:** Copies the selected site or link in order to paste it in another location.
- **Paste:** Pastes the selected site or link that was copied or cut.

3.21 View Menu

Use the View Menu to customize application colors, show or hide the Tool Bars, or expand or condense the Network View to fit the current window size.

- **Customize Colors:** Opens the Customize Application Colors (page 37) dialog box, to choose a predefined color scheme (for example, Blue, Orange, Brown, White, and so on), or customize your own color scheme.
- **Update View Size:** Centers the Sites (radios) and Links in the Network Diagram (page 38) view in the current window.
- **Toolbars:** Hides or un-hides the selected toolbar. (page 41)

3.22 Help Menu

Use the Help Menu to view the help pages for ProSoft Wireless Designer, or to view version information for the program.

3.23 Toolbars

Toolbars display frequently-used commands in graphic form, and provide an alternative method of choosing commands.

To turn toolbars on or off, open the View menu, select Toolbars, and then choose the toolbar to view or hide.

- Standard

- Toolbox

- Zoom

Drag a toolbar by its "handle" to reposition it in the ProSoft Wireless Designer.

4 Glossary of Terms

8

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 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 Setup/Diagnostic software (for Frequency Hopping radios), or RadioLinx IH Browser Setup/Diagnostic software (for Industrial Hotspot and Industrial Broadband radios).

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 Hz (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 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. CB or walkie-talkie radios are an example of a half-duplex communication system. Either parties on 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 gigabit (GHz) is one billion hertz. The standard US electrical power frequency is 60 Hz. 802.11a devices operate in the 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), with decimals between them. 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 WiFi 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.

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. In 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 tht can be used on a given data packet. If 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 networks. 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   Planning and Implementing Wireless Networks

In This Chapter

ProSoft Technology provides various levels of technical support and application assistance to ensure the success of RadioLinx applications. Applications may vary in complexity, from a pair of radios communicating across a factory floor to hundreds of radios spread over a large metropolitan area.

The following sections suggest typical questions for each area of concern and the support available from planning your communication network and order configuration to site review and verification.

- Define the Application
- Plan the Network
- Perform Path Studies
- Request a Quote
- Install and Test the Network

5.1   Define the Application

How will the end devices communicate with each other?

Industrial automation equipment uses a wide range of interfaces and protocols for communication. Some methods are easily adaptable to wireless, while others are difficult, and in a few cases, impossible to integrate wireless.

Most Ethernet protocols (for example, Modbus TCP/IP, EtherNet IP) and serial protocols (for example, ASCII and RTU, DF1, DNP 3.0) adapt easily to wireless. Fieldbus interfaces (for example, PROFIBUS, HART, DeviceNet) and deterministic networks (for example, ControlNet) on the other hand are more difficult as they were typically not designed to support wireless communications.

When designing wireless networks, it is important to review the interface and protocol options of the automation equipment and then choose the best approach for wireless networking.

What are the bandwidth and latency requirements?

Bandwidth (data rate) and latency (delay time) are important considerations when designing a wireless network. There are many different factors that impact bandwidth and latency requirements including the application process, amount of I/O at each site, number of devices/sites sharing the network, interface/protocol, and if multimedia data types are used.

For SCADA applications where RTUs are polled from a central PLC, bandwidth requirements are minimal and latency time can be hundreds of milliseconds (or longer) without impacting the process or usability of the system.

This is because update times for SCADA systems are usually acceptable once every minute two. For this type of system, a relatively slow wireless network may suffice and be the best choice. However, if video data is also included across the wireless network, then data rate is very important as the video data requires much greater bandwidth.

If wireless is used to transmit I/O, then how quickly does the program need to read/write to each point? Will the process suffer if the I/O is delayed? Will delays cause process errors in closed loop systems? Will safety or machine integrity be compromised if data is lost? If so, it may be better to use remote controllers (PLCs) for local I/O control and wireless network for exchanging data and commands.

The bandwidth (data rate) and latency (packet delay) of the wireless network is a key consideration when choosing wireless technologies and wireless network design.

Who will need access to the wireless network?

Wireless networks are frequently used to connect workers to plant networks throughout a facility. These wireless local area networks (WLANs) create wireless "hotspots" for connecting laptops, PDAs, and other portable devices to the network.

WLANs are commonly used by maintenance engineers to access automation programs and diagnostic tools when at the machine that failed. Other popular uses of WLANs include warehouse automation, process control, and production monitoring.

When designing a wireless LAN for portable access, it is important to know where in the plant the works will need network access. It is also important to ensure that the WLAN and all portable devices support the same wireless RF and security standards.

Does the Equipment Move?

Another popular usage of industrial wireless is to communicate with controllers, HMIs, or I/O devices on moving equipment. Integrating wireless into systems that use overhead cranes, transfer cars, rotating platforms and automatic guided vehicles (AGVs) can reduce mechanical failures and improve production.

When designing a wireless network for this type of application, it is important to consider where the devices will move for proper RF network coverage.

Will the equipment be relocated over time?

For processes that move over time (such as mining operations) industrial wireless can save significant costs since cabling does not need to be re-installed every time the process moves. When designing a wireless network for this purpose, it is prudent to understand the long term plans for the process (where it will move) and design the wireless network accordingly.

Are there any special regulations and environmental requirements?

It is important to find out the local government regulations regarding RF use. The wireless network hardware must meet the RF and certification requirements of that country. This is specific to the country of installation and can impact frequency band, RF power output, and RF modulation methods. Local regulations may limit the performance of the wireless network.

Also, some installation sites (such as oil and gas systems) require special certifications for installation in hazardous rate locations where explosive materials may be present. It is important to have proper approvals such as Class I, Division 2 or ATEX for these installations.

Each site requires a power source to power the wireless modem. If power is not available (such as for a repeater site), then a battery with solar recharge may be required.

Finally, review of environmental conditions of each site is necessary to ensure network reliability and hardware life. It is important to choose wireless equipment that meets the temperature requirements (often extreme at industrial sites) and protect the equipment from moisture and corrosive materials.

5.2   Plan the Network

Once the application is defined, the next step is to plan the network. This includes selecting the wireless technology, modem hardware, antenna types and antenna coax.

What is the network topology?

The simplest wireless topology is point-to-point where two sites are connected together for data exchange.

For SCADA networks, the most common topology is point-to-multipoint where one master site communicates (and collects information) from multiple remote sites.

Star Topologies are similar to point-to-multipoint topologies but permit communication between all sites, not just master to remote/remote to master. The most common example of a Star Topology is wireless networks for portable computer access where an access point in the center of the star.

Does my WLAN extend indoors and outdoors?

Do PDAs, laptops, or other mobile and roaming devices need access?

What are my security requirements?

How many and how far away are my sites or users?

Will I need to add a repeater site?

Are there subnet requirements?

What accessories are required and does the vendor supply these necessary components?

5.3   Perform Path Planning Studies

Path planning services is an essential part of an outdoor wireless solution providing an accurate account of items and budgetary costs required for the project. A Site Audit should be performed to collect GPS, obstruction, and existing structure data. This data supplies the RadioLinx Application Engineer pertinent information to provide a summary report for each site and path. The path planning report is generated indicating a complete radio bill of materials, antenna types, gain, height, tilt angle and location requirements, calculated fade margins, and a graphical path profile for each site and network topological terrain map. The report will also assist system integrators with initial design specifications for testing and verifying each path link.

The following questions should be answered during path planning studies:

- What tools are available to determine link quality?
- How is path terrain visualized?
- What are the Line-of-Sight (LoS) obstructions?
- What types of antennas will be required?
- How high will antennas need to be mounted and will an antenna mast or tower be required?
- Are there antenna height restrictions?

5.3.1 Sample Path Study

A Path Study or Terrain Analysis is the initial step in the configuration of an RF network. It can be used for evaluation before an Onsite Survey is performed and can be considered as a proof of concept. A path study does not guarantee RF links. Man made objects such as buildings, towers and highways, trees and other foliage may not be displayed or calculated with the Path Study Report unless otherwise identified. These obstructions to RF line-of-site need to be considered during a site audit. Any obstructions within the RF path should be accounted for by providing the locations and height. The following information provides the user with recommended antenna height AGL and path profile of each site from the base location. Make sure antennas are above buildings, trees, foliage, and other obstructions.

If line-of-sight is not achieved, levels will be degraded. The Fresnel2 zone (shown in the following examples) requires freedom from any obstructions.

5.3.2 Central Office M-Lower Mader Tank

	Central Office	Lower Mader Tank (M)
Elevation (feet)	687.34	1007.21
Latitude	34 17 09.00 N	34 17 03.00
Longitude	118 48 47.00 W	118 47 08.00 W
True Azimuth (degrees)	94.17	274.18
Vertical Angle (degrees)	2.38	-2.39
Antenna Model	A2410NJ-DY	A2414NJ-DY
Antenna Height (feet)	18.00	45.00
Antenna Gain (dBi)	10.00	14.00
(dbm)	7.85	11.85
TX Line Type	C40M40-40-040	CVX540-40-100
TX Line Length (feet)	40.0	100.0
Tx Line Unit Loss (dB/100 feet)	6.70	2.20
Tx Line Loss (dB)	2.68	2.20
Connector Loss (dB)	0.40	0.40
Miscellaneous Loss (dB)	1.50	1.50
Frequency (MHz)	2400.0	
Polarization	Vertical	
Path Length (mi)	1.58	
Free Space Loss (dB)	108.16	
Net Path Loss (dB)	92.84	92.84
Radio Model	RLX-IH	RLX-IH
Tx Power (Watts)	0.20	0.20
(dBm)	23.00	23.00
Effective Radiated Power	0.42 Watts	1.19 Watts
(dBm)	6.27	30.75
RX Sensitivity (µv)	11.21	11.21
	Central Office	Lower Mader Tank (M)
(dBm)	-86.00	-86.00
RX Signal (µv)	71.99	71.99
(dBm)	-69.84	-69.84
RX Field Strength (µv/m)	3012.58	1798.62
Fade Margin (dB)	16.16	16.16

Notes

Line of Sight (LoS): Required for proper signal strength. Line of Sight means you can see the location at which you are trying to get an RF signal to. If the location is 5 miles or more, binoculars or a telescope can be used.

Fresnel Zone: An elliptic sphere between the two end points of the connections, which has to be free from obstructions.

The sample report does not contain all path information for the sample network, however, additional graphs and path information are provided with recommendations for each network path with an actual RadioLinx Path Planning Report.

6 Physical Installation and Reliability Assurance

It may be necessary for complex networks and paths with complicated terrains to visit each site for quality and reliability assurance. The site surveyor will measure radio reception for signal strength, background noise, packet errors, and data throughput. Completing the survey assures the customer and verifies the RadioLinx bill-of-material quotation and the networked system will operate with acceptable reliability.

7   Selecting Equipment

In This Chapter

Selecting the proper equipment consists of:

- Determining the Required Gain
- Determining Gain Loss Due to Cabling
- Calculating Total Gain
- Making Your Selections

7.1   Determining the Required Gain

- Identify the unobstructed distance between RadioLinx antennas from the table.
- Find the row that corresponds to the distance between the antennas.
- Find the Link Gain in the appropriate row. The Net dB is based upon an antenna installed at a 16 foot (5 meters) height.
- For example, if the unobstructed distance between RadioLinx devices is 5 miles (8 km), the Net dB required is 19 dB.

Net dB	North America 250mW Max. Distance		Europe EIRP 100mW Max. Distance	
	Miles	Kilometers	Miles	Kilometers
4	2	3.2	1.4	2.3
6	2.5	4	1.6	2.6
9	3	4.8	2	3.2
11	3.4	5.5	2.3	3.7
13	3.4	5.5	2.5	4
15	4.3	6.8	2.8	4.5
17	4.8	7.7	3.2	5
19	5.3	8.6	3.5	5.6
22	6.3	10	4.2	6.8
24	7.6	12	4.8	7.7
26	8	12.8	5	8
28	9	14.5	6	9.7
30	10	16	6.7	10.8

Net dB	North America 250mW Max. Distance		Europe EIRP 100mW Max. Distance	
	Miles	Kilometers	Miles	Kilometers
32	11.3	18	7.5	12
35	13.4	21.5	9	14.5
37	15	24	10	16

Net dB is the gain of the antenna minus the cable loss. A 10 dB margin has been included in the above calculations.

Wireless Path Distance		60% Fresnel Zone		Approximate Earth Curvature		Antenna AGL Height with no Obstructions	
mi	km	feet	m	feet	m	feet	m
1	1.6	10	3	3	0.9	13	4
5	8	30	9	5	1.5	35	10.7
10	16	44	13	13	4	57	17
15	24	55	16.7	28	8.5	83	25

Additional antenna height will improve the maximum distance and will require a Path Feasibility Study to help determine a new height. A Path Study will better determine the appropriate antenna height and net dB gain required for a given path. Path Study and Site Survey services are available from ProSoft Technology.

7.2   Calculate Total Gain

The "Link Gain" is a composite of the gains of each of the antennas (the Master antenna and the Remote antenna) as well as any cable loss. For example, if you want to communicate over a 5 mile (8 km) unobstructed distance, you should include at least 19 dB of Link Gain. If you are using 4 feet of cable on the Master side and 10 feet of cable on the Remote side, you need to determine what the cable loss is by using the previous chart.

Example:

Cable loss at the Master:	2 dB (4ft, 1.22m)
Cable loss at the Remote:	5 dB (10ft, 3.0m)
Total Cable Loss:	7 dB

You need 19dBi and you already know you will have 7dB gain loss due to cabling. In order to ensure that you have antennas that will cover the cable loss, the Required Gain must be added to the Cable Loss.

Required gain for 5 miles (8 km):	19 dB
Total cable loss:	+7 dBi
Required gain for antenna selection	26 dB

You can now select antennas based on the Calculated Gain Value of 26 dBi. The gain of each of your antennas must be equal to or greater than this value.

More gain provides more distance. It makes no difference whether the gain is on the Master or the Remote antenna. The available gain is the sum of both antennas. Based on this, you could select an antenna at the Master site with a gain of 11 dBi and an antenna at the Remote site with a gain of 15 dBi totaling 26 dBi.

The calculation now looks like this:

Gain Required:	19 dBi (5 mile (8km) distance)
Master Antenna Gain:	11 dBi
Remote Antenna Gain:	15 dBi
Total Antenna Gain:	26 dBi
Total Cable Loss:	7 dBi

7.3   Determining Gain Loss Due to Cabling

The length of the cable connecting an antenna to a RadioLinx modem or wireless Ethernet switch affects overall antenna gain. The following table shows approximate dB loss per 10 feet of cable.

Cable Type	dB Loss per 10 feet
RG-316	4.2
LMR195	1.8
LMR400	0.67
LMR600	0.44
LMR1200	0.23
LDF4	0.35
LDF5	0.20
LDF7	0.13
VXL5	0.22

Determine how much cable you will need by measuring the distance between where your RadioLinx modem or wireless Ethernet switch will be placed and the proposed location of the antenna in feet.

Repeat this process for the remote RadioLinx modem or wireless Ethernet switch.

Now use the previous chart to determine how much gain loss you will have to calculate when choosing your equipment. This will give you your Cable Gain Loss.

```
Total Antenna Gain minus Total Cable Loss = Antenna Gain
```

or

```
26 dBi – 7 dBi = 19 dBi
```

You can now choose equipment based on this information.

8   Antenna Selection Considerations

In This Chapter

8.1   Understanding Antenna Attributes

RadioLinx antennas come in a variety of types. All types are categorized by three important electrical characteristics:

- Antenna Pattern
- Antenna Gain
- Antenna Polarity

8.1.1   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.

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

8.1.2 Antenna Polarity

Antenna polarity refers to the direction that the electromagnetic field lines point as energy radiates away from the antenna. In general, antenna polarization is elliptical. The simplest and most common form of this elliptical polarization is simply a straight line, or linear polarization. Of the transmitted power that reaches a receiving antenna, only the portion that has the same polarization as the receiving antenna polarization is actually received.

For example, if the transmit antenna polarization is linear pointed in the vertical direction (vertical polarization), and the receive 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 receive antenna has horizontal polarization, theoretically, no power would be received. If the two antennas have linear polarizations orientated at 45 degrees to each other, half of the possible maximum power will be received.

8.1.3 Voltage Standing Wave Radio (VSWR)

VSWR represents the degree with which an antenna is matched to the radio system impedance. Modern day antennas do not require tuning for optimum performance. VSWR is one of the easiest parameters to measure and VSWR meters are becoming very popular antenna installation tools. Most modern antennas, receivers, and transmitters are designed for peak performance when operating into a 50-Ohm transmission line. If the VSWR is too high, the transmitter power may be reduced as well as the strength of the received signal. The typical commercial standard for maximum allowable VSWR across the entire bandwidth of a system is 1.5:1. This means that the antenna impedance must be somewhere between 37.5 and 75 Ohms. A VSWR of 2:1 or greater is usually considered unacceptable (for receiving purposes only) since it increases losses in the transmission line. Incidentally, decreasing your VSWR below 1.5:1 will often be expensive and will have little noticeable performance improvement. You should specify the maximum VSWR and operating frequency bandwidth when specifying your antenna.

8.1.4 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 distributed equally in all directions. An antenna's gain describes 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, the narrower the beam width, and vice versa. The amount of power that is received by the receiving antenna is proportioned to:

```
(transmitter power) x (transmit antenna gain)
x (receive antenna gain)
```

The antenna gain and transmit power can therefore be traded off. For example, doubling ones antenna gain has the same effect as doubling the transmitter's power. Doubling both antenna gains has the same effect as quadrupling the transmitter's power.

8.2 Antenna Types

There are various types of antennas available for RadioLinx radios but all basically fall into one of two categories; omnidirectional and directional (see Antenna Patterns).

In a nutshell, omnidirectional antennas are used when signals need to link to multiple sites, whereas, a directional antenna are used to link to a single site. In addition, gain and distance determine what antenna type should be used.

8.2.1 Collinear Array Antenna

This antenna is typically composed of several linear antennas (like the 1/2 wave whip) stacked on top of each other. The more stacked elements within the collinear array, the longer the antenna and the more gain it has.

The following types of antennas are available from ProSoft Technology:

- 2dBi Multi-band Swivel Antenna 2.4/5 GHz
- 2.4 GHz Base Station Antenna (4 dBi, 6 dBi, and 8 dBi)
- 2.4 GHz Heavy Duty Antenna (6 dBi and 9 dBi)
- 2.4 GHz Panel/Patch Antenna (8 dBi, 13 dBi, and 19 dBi)
- 2.4 GHz Parabolic Antenna (19 dBi and 24 dBi)
- 2.4 GHz Straight Antenna (2 dBi and 5dBi)
- 2.4 GHz Whipless Antenna (3 dBi)
- 2.4 GHz Yagi Antenna (10 dBi and 15 dBi)
- 2.4 GHz Magnetic Mount Antenna (5 dBi)
- 2.4 GHz Omni Base Station Antenna (15 dBi)
- 2.4 GHz Halfwave Antenna (2 dBi)
- 5 GHz Base Station Antenna (12 dBi)
- 5 GHz Heavy Duty Antenna (6 dBi and 9 dBi)
- 5 GHz Panel/Patch Antenna (19 dBi and 24 dBi)
- 5 GHz Parabolic Antenna (26 dBi and 29 dBi)

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The antenna pattern is toroidal; its azimuth beam width is 360° (omnidirectional); its vertical beam width depends on its length (the number of stacked elements), such that more elements produce a narrower beam width.

The antenna gain, typically 5 to 10 dBi, also depends on the length (number of stacked elements), such that more elements produce a higher gain.

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

8.2.2 Yagi Array Antenna

A Yagi antenna is composed of an array of linear elements, 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 feed 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 the end with the shorter elements. The actual pattern depends on the overall geometry, including the number of elements, element spacing, element length, and so on. In some cases, the antenna is enclosed in a protective tube that hides the actual antenna geometry.

8.2.3 1/2 Straight Whip or 1/2 Articulating Whip

This is the most commonly used antenna type and does not require a ground plane. These antennas are about 5 inches long and is typically connected to a remote radio (directly to the enclosure).

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

The antenna gain, typically 6 to 15 dBi, also varies with antenna geometry, but is generally proportional to the length (where longer length produces higher gain). The antenna polarity is linear (parallel to the elements, perpendicular to the boom).

An articulating antenna bends at the connection and functions the same as a non-articulating antenna.

8.2.4 1/4 Whip Antenna

This antenna is about 2.5 inches long and does require a ground plane mounting below the antenna and over the top surface of the radio. The 1/4 whip works well with belt mounted radios but does not radiate well out the top of the antenna. Because of this, it must remain vertical.

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July 8, 2009

8.2.5 Parabolic Reflector Antenna

A parabolic reflector antenna consists of a parabolic shaped dish and a feed antenna located in the 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, producing a high-gain beam.

8.3   Considering The Signal Path (Line-of-Sight)

Obstructions that block the signal path can greatly deflate the radio carrier because of the frequency range used in operation. The only way to ensure constant, solid communications is to make sure that the antennas are actually visible to each other. For line-of-sight, you should be able to visibly see the remote location's antenna from the main site. Longer distances may require the use of binoculars. There should be no obstructions between the antennas. This includes trees, buildings, hills, and so on. Checking for direct visibility is best addressed using survey laser equipment or a Site Survey Kit.

When considering the path, also consider whether the RadioLinx Master talks with multiple RadioLinx Remotes. Antennas achieve gain by focusing the beam of energy. If the beam is focused, the antenna cannot communicate as well in all directions. Therefore, if a RadioLinx Master needs to communicate with multiple RadioLinx Remotes, an antenna will have to be selected that has a pattern that can see all RadioLinx Remotes.

The antenna pattern is a beam pointed away from the concave side of the dish (beam width varies with the size of the reflector and the antenna construction).

The antenna gain varies with the size of the reflector and the antenna construction. Typical values are 15 to 30 dBi.

The antenna polarity depends on the feed antenna polarization.

8.4   Antenna Mounting Considerations

Not only is the relationship between the antenna and the earth improved by mounting the antenna higher (resulting in a better range), but the probability of interrupting the line-of-sight is reduced.

Avoid mounting next to solid objects (walls, buildings, towers, or girders). The resulting reflected radio energy causes drastically reduced efficiency. A minimum of six feet is a good general rule to avoid reflection.

Not only do you want to stay away from sources of electric noise (power lines, electrical motors, solenoids, high power radio sources, or any high voltage power usage), but you want to avoid the possibility of electrical shock which can be fatal.

8.5   Considering Antenna Direction

In order to have gain, a Yagi or Parabolic antenna takes its signal strength from all around and points it in one general direction. This makes the Yagi or Parabolic "Directional". This means that is must be orientated one particular way so the radio signal is pointed toward the antenna of the device with which you want to communicate.

The omni antenna is designed to be usable from any direction (hence the name). As a result, it doesn't have the straight-line range of the Yagi. Because the omni distributes its radio energy in more of a donut shape, be sure that the main part is oriented straight up and down, with the feed line at the bottom. In the base, there are four angled wires called "ground radials" which should be rotated until they are angled downward for best efficiency.

9   Lightning Protection

Antenna manufacturers are often asked about lightning and whether their antenna is lightning proof. This is not a simple question to answer. In this application note we will attempt to describe some of the statistical properties of lightning strikes and give some recommendations on how to best protect your installation from damage due to a lightning strike.

It is important to point out at the start that lightning protection is primarily a function of how much time and money you are willing to spend. Obviously, the more expensive the radio and the importance of system connectivity, the more robust your protection should be.

9.1   An Introduction to Lightning

Lightning has been around since the beginning of time. In fact, at this very moment, lightning is striking somewhere on the earth. In the lower 48 US states and Canada, lightning is most prevalent in Florida (with an average of 70 to 100 storm days per year!) and the Rocky Mountains especially in the Colorado area (with an average of 70 storm days per year). In California and the Northern parts of the USA and Canada the likelihood of encountering lightning diminishes to about 10 to 30 storm days per year. Lightning is most common starting in the spring and ending in the fall with a large peak in the summer but it can occur at any time of the year.

9.2   The Nature of Lightning

Lightning can form and stay in the upper atmosphere. This is often a beautiful sight to behold as the bolts jump from cloud to cloud. On the other hand, when lightning leaves the clouds and strikes the ground or a tall object, it can inflict instant destruction and even death to those unfortunate to be near the strike.

The energy present in a lightning bolt can be considerable and a direct hit will inflict the maximum damage. It is estimated that a typical bolt may contain a potential of millions (1,000,000's) of volts thus generating currents up to 100,000 amperes! That is very destructive energy. At the same time, the heat in the bolt can have a temperature up to 30,000 K, hot enough to start fires.

A lightning bolt will often drag or jump along the ground. Therefore, there can be considerable damage in a wide area (even hundred's of feet) surrounding the strike. Just ask a dairy farmer what happened to his cows that tried to hide beneath a tree that had a direct lightning strike.

9.3   Lightning Protection in General

Lightning protection must be examined from four distinct directions. First off, the place where the antenna is mounted (such as on a tower) is important. Then there must be input protection from the lightning strike itself, typically in the form of a huge and rapid build up of voltage and current at the input to the radio. Thirdly, a proper ground system must be employed to rapidly conduct the lightning bolt energy away from the radio. Finally, protection is required at the output or main power supply such as the line voltage supply (for example, the 115 VAC we obtain from a line cord). Let's discuss each of them separately.

9.4   Antenna Mounting

It is well known that lightning statistically strikes the highest electrical conductor in an area and then follows the lowest resistance and shortest path to ground. Because antennas are usually mounted in high places, they are very susceptible to lightning strikes. Most antennas have a metallic boom and the elements are often attached directly to the boom so they are a likely target for a lightning strike.

Therefore, the antenna location and how it is mounted is probably the most controversial topic when any discussion of lightning occurs. Ben Franklin gave rise to the theory that the lightning was electricity and found this out when he almost was killed by a lightning strike conducted down the wire holding down his kite. Franklin is sometimes credited with the ball discharger and the pointed rods on houses. As a result, to this day lightning rods with grounding wires are a part of folk law and many are installed on high buildings and homes, especially in areas prone to lightning activity. Properly installed and grounded, these devices surely do work.

Nowadays, new controversy has resulted with the use of spline balls, static dischargers and wicks mounted on antennas and the top of towers. These devices are said to provide a constant discharge thus decreasing the potential for a direct strike. Some users claim a diminished amount of direct hits after installing these devices.

Suffice it to say, if at all possible, do not mount your antenna on the highest building or tower. Place it a few feet lower and hopefully the fickle lightning bolt, if it generates a direct hit, will not discharge through the antenna. Furthermore, the boom or mast should be grounded to the mast or tower. More on this shortly. Do not forget to ground guy wires that are used on stabilize towers. They are just as likely to be hit because they extend over a wide area around the tower.

9.5 Input Protection

Input protection is typically provided by a lightning or surge protector at the input (or antenna side) of a radio. There are three major types of lightning protection devices for the radio input. They are the spark gap, the gas discharge tube and the quarter-wavelength (1/4) wavelength shorted stub. Each method has its pluses and minuses.

The spark gap is the oldest know lightning protection having probably been invented by Ben Franklin! Basically it consists of two balls or points closely spaced and directly across the transmission line. When a strike occurs, the high voltage present will jump across the points and be conducted to ground. RF transmission devices for 50 Ohm systems such as this have been around since the 1950's.

The shortcoming with this older device is that it may not protect against a weak or lower voltage strike. Adjustment at the factory may produce varying voltage breakdowns. Furthermore, once a strike is taken, the device may fail or short circuit so maintenance is required.

A more recently developed input protection device is the gas tube. It works in a similar manner to the spark gap but can be designed to operate reliably at much lower voltages down to 100 Volts for low power circuits and 250 Volts or higher for higher power applications. Another advantage is device is that it can be designed to operate over a very broadband frequency range with low VSWR up to about 2 GHz. However, it too must be replaced after a strike although it will not necessarily warn the user by going to a short circuit so preventative maintenance is required.

The quarter wavelength shorting stub is becoming a very popular device, especially above 800 MHz where system bandwidth is generally narrow. It consists of a tuned quarter wavelength shorted coaxial type transmission line that is placed directly across the transmission line. Simple types have a narrow bandwidth, typically 10'-. bandwidth, but are low loss and inexpensive.

The optimum place to locate an input protector is at the entry point to the building where the equipment is located. **Do not forget to provide a low impedance ground connection to the protector as described below**. Always try to keep the lightning and the protection devices outdoors wherever possible!

9.6   Grounding

The most important lightning protection is a good low impedance Earth/ground connection to the associated equipment. The Earth ground connection should be a copper plated rod preferably at least 5 to 8 feet in length driven into the ground. This ground rod should be located as close to the equipment as possible, typically just outside of a building at the entry point of the antenna feedlines.

Greater protection can be provided by using additional ground rods spaced at least 8 feet from and connected to the original rod. Substituting plumbing, power ground return and other "so called" grounds for a ground rod is definitely not recommended.

Finally, there should be a large diameter (#4 AWG or larger) copper wire connecting the equipment to the Earth ground. The shorter the wire, the better. Additional information on grounding can be found in Reference 1.

9.7   Mains and Power Supply Protection

Just because your radio and antenna are miles away from a lightning strike does not mean that you are protected. Lightning often strikes power lines and produces a large voltage surge or spike that can be transmitted for miles on the main power lines.

Therefore, for maximum protection, all power line interfaces should include a transient voltage surge protector. These devices are becoming quite common and inexpensive. Again, there are simple protectors and those that may include additional protection with built-in line inductors. Just make sure that the surge protector is placed between the power lines and the equipment power supply.

9.8   Summary

As stated at the beginning of this paper, lightning damage can be extensive and costly. We have tried to provide you with an overview of things to consider when installing a radio and antenna system but only you can determine how much protection is required. Astron Antennas Co. has access to various lightning protection solutions for most applications. Please call for additional information on lightning protection devices and how they can help protect your investment.

References:

1. "The "Grounds" for Lightning and EMP Protection", by Roger Block, published by PolyPhaser Corporation.

10   Basic Principles

Most of the information needed to help you use is provided in a Help System that is always available whenever you are running . The Help System does not require an Internet connection.

To view the help pages, start , open the **HELP** menu, and then choose **CONTENTS.**

10.1   Using the Help System

Most of the information needed to help you use is provided in a Help System that is always available whenever you are running . The Help System does not require an Internet connection.

To view the help pages, start , open the **HELP** menu, and then choose **CONTENTS.**

10.2   Tool Tips

A Tool Tip is a small help window that pops up when you rest the mouse pointer over a button, an icon, a menu command, or a part of a window that is "sensitive" to the mouse. Tool Tips provide a brief description of the button or icon's purpose.

Many parts of the window provide Tool Tips. These can be very useful to help you with buttons or commands that you do not use very often.

10.3   Review of Windows mouse and keyboard controls

The Microsoft Windows operating system, and most Windows compatible applications, including the PSW-PWD, use the computer keyboard and mouse in a standard way. This makes it easier for computer users to learn to use new applications quickly.

The computer you use in the field may be a desktop PC or a laptop PC. Desktop PCs typically have a keyboard and mouse (pointing device) connected to the computer by cables, or sometimes by a wireless link. Laptop PCs have a built-in keyboard and often have a built-in pointing device such as a touch pad or a trackball. Most laptops also allow you to connect a standard computer mouse if you prefer it to the built-in pointing device.

10.4 Using the Mouse

As you move the mouse around on your desk, you will see an arrow (or other shape) moving around on the computer screen. You use the mouse or pointing device to "point" to a menu, a button, or a data item on the screen. In the PSW-PWD, you click and release the mouse buttons (left and right) to select a menu item, to push a button on the screen, to select one or more data items, or to open a "shortcut" menu.

Most people will click the left mouse button with the right index finger, and the right mouse button with the right middle finger. You can use the Windows Control Panel to reverse the operation of the mouse buttons, for example if you prefer to use your left hand to operate the mouse rather than your right hand. In this training manual, however, we will refer to the left mouse button and right mouse button as if you are using your right hand on the mouse.

The left and right mouse buttons have different functions in the PSW-PWD.

- Use the left mouse button to select a menu item, click a button or select one or more data items.
- Use the right mouse button to open a "shortcut" menu with commands that are useful for the item or area of the screen where the mouse pointer is currently resting.
- Some commands require a double-click before the command is recognized. "Double-click" means quickly pressing and releasing the left mouse button twice.

Use double-click to:

- Open a file or run a program on your computer's "desktop" area.
- Open and close a folder in the PSW-PWD Tree View window.

10.5 Using the Keyboard

Most of the time, you will be using the keyboard to add or edit data items after you have selected and opened them with the mouse. As a timesaver, however, you can also use the keyboard to do most of the same things you can do with the mouse.

Some useful keyboard shortcuts include:

- Windows System Key Combinations (page 81)
- Dialog Box Commands (page 81)
- Windows Program Key Combinations (page 81)
- General Keyboard-Only Commands (page 82)

10.5.1 Windows System Key Combinations

Key	Action
F1	Help
ALT+TAB	Switch between open programs
ALT+F4	Quit program
SHIFT+DELETE	Delete item permanently

10.5.2 Dialog Box Commands

Key	Action
TAB	Move to the next control in the dialog box
SHIFT+TAB	Move to the previous control in the dialog box
SPACEBAR	If the current control is a button, this clicks the button. If the current control is a check box, this toggles the check box. If the current control is an option, this selects the option.
ENTER	Equivalent to clicking the selected button (the button with the outline)
ESC	Equivalent to clicking the **Cancel** button
ALT+ *underlined letter in dialog box item*	Move to the corresponding item

10.5.3 Windows Program Key Combinations

Key	Action
CTRL+C	Copy
CTRL+X	Cut
CTRL+V	Paste
CTRL+Z	Undo

10.5.4 The Help System

The ProSoft Wireless Designer has a help system that works like a web browser. Each dialog box has its own page in the help system, which explains each item on the dialog box. The help system does not require an internet connection.

To open a help window, use the mouse to click the **Help** button, near the lower right corner of most dialog boxes, or press the F1 key on your keyboard.

Many help pages have **links** that lead you to more information if you need it. Links are always **underlined**. Use your mouse to click the underlined text to "follow a link" and open a help page with more information.

You can use the Search button to search for words or phrases inside a help file. The help system shows you a list of help topics that contain the words you typed in the Search field. Click a topic from the list to view the help page.

You can also use the Index button to see an index of keywords. You can type the first few letters of a keyword to jump directly to the part of the index you would like to view. Each keyword is linked to one or more help topics. Click a keyword to see a list of topics, and then click a topic from the list to view the help page.

10.5.5 General Keyboard-Only Commands

Key	Action
F1	Starts Windows Help
F10	Activates menu bar options
SHIFT+F10	Opens a shortcut menu for the selected item (this is the same as right-clicking an object
ALT+DOWN ARROW	Opens a dropdown list box
ALT+TAB	Switch to another running program (hold down the ALT key and then press the TAB key to view the task-switching window)
ALT+SPACE	Displays the main window's System menu (from the System menu, you can restore, move, resize, minimize, maximize, or close the window)
ALT+ *underlined letter in menu*	Opens the menu
ALT+F4	Closes the current window

10.5.6 Keyboard Shortcuts

Network Diagram View

Action	Command
Delete selection	Del
Select all items	Ctrl-A
Duplicate selection	Ctrl-D
Copy selection	Ctrl-C, Ctrl-Ins
Paste from clipboard	Ctrl-V, Shift-Ins
Cut selection	Ctrl-X
Undo last action	Ctrl-Z
Redo an action that was undone	Ctrl-Shift-Z, Ctrl-Y
Open properties dialog of selected items	Enter
Nudge selection	Arrow keys

Application shortcuts

Action	Command
New document	Ctrl-N
Open document	Ctrl-O
Save document	Ctrl-S
Print document	Ctrl-P
Close document	Ctrl-Q
Select pick tool	Ctrl-1
Select site tool	Ctrl-2
Select link tool	Ctrl-3
Close application	Alt-F4
Context sensitive help	F1

11   Support, Service & Warranty

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 contents of file
   - o   Module Operation
   - o   Configuration/Debug status information
   - o   LED patterns
2   Information about the processor and user data files as viewed through and LED patterns on the processor.
3   Details about the serial devices interfaced, if any.

11.1   How to Contact Us: Technical Support

Internet	Web Site: www.prosoft-technology.com/support
	E-mail address: support@prosoft-technology.com

Asia Pacific

+603.7724.2080, support.asia@prosoft-technology.com
Languages spoken include: Chinese, English

Europe (location in Toulouse, France)

+33 (0) 5.34.36.87.20, support.EMEA@prosoft-technology.com
Languages spoken include: French, English

North America/Latin America (excluding Brasil) (location in California)

+1.661.716.5100, support@prosoft-technology.com
Languages spoken include: English, Spanish
*For technical support calls within the United States, an after-*hours *answering system allows pager access to one of our qualified technical and/or application support engineers at any time to answer your questions.*

Brasil (location in Sao Paulo)

+55-11-5084-5178, eduardo@prosoft-technology.com
Languages spoken include: Portuguese, English

11.2 Return Material Authorization (RMA) Policies and Conditions

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

11.2.1 All Product Returns:

a) In order to return a Product for repair, exchange or otherwise, the Customer must obtain a Returned Material Authorization (RMA) number from ProSoft and comply with ProSoft 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 83). 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, 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 using a shipment method other than that specified by ProSoft 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, and so on.

11.2.2 Procedures for Return of Units Under Warranty:

A Technical Support Engineer must approve the return of Product under ProSoft'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 at designated location referenced on the Return Material Authorization.

11.2.3 Procedures for Return of Units Out of Warranty:

a) Customer sends unit in for evaluation

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:

o   3150 - All
o   3750
o   3600 - All
o   3700
o   3170 - All
o   3250
o   1560 - Can be repaired, only if defect is the power supply
o   1550 - Can be repaired, only if defect is the power supply
o   3350
o   3300
o   1500 - All

11.3   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, 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.

11.3.1 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 years from the date of shipment (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. 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 used replacement parts. 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 warranteed 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.

11.3.2 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.

11.3.3 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 of 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.

11.3.4 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.

11.3.5 Disclaimer of all Other Warranties

The Warranty set forth in What Is Covered By This Warranty (page 85) 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.

11.3.6 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 included, 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.

11.3.7 Time Limit for Bringing Suit

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

11.3.8 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.

11.3.9 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.

11.3.10 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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