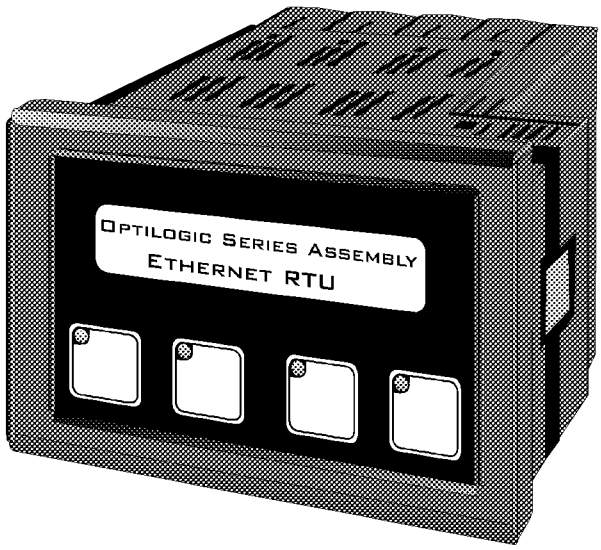
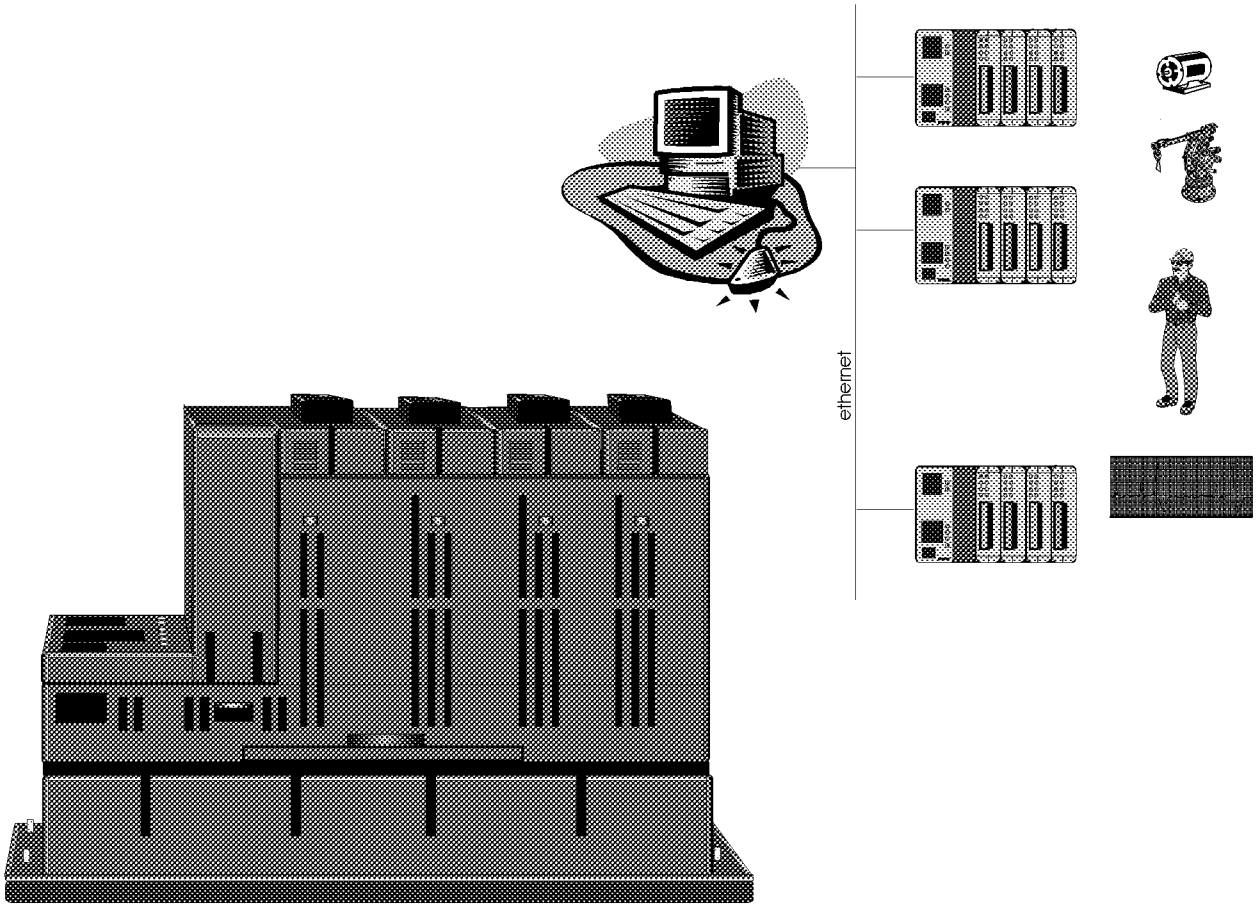


Opti*Logic*
Remote Terminal Units



Optimation, Inc.

(256)883-3050
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Optimation
Optimal Automation for Industry

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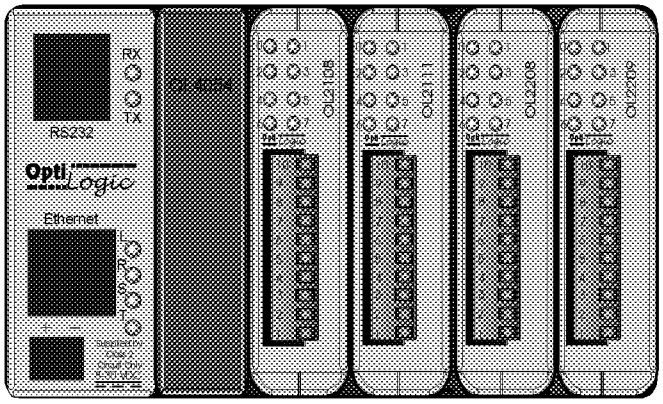
OptiLogic Remote Terminal Unit

Table of Contents

Revision History

Issue	Date	Pages	Description
Original	8/99	1-37	Original release
1.1	1/00	27 41	Added collision avoidance section Added Ethernet timing specs

OptiLogic Remote Terminal Unit



1.0 Introduction

Optimation's OptiLogic™ remote terminal units provide point of use I/O and operator panel capabilities with a high speed link to a PC. They are designed to be a flexible, high performance, low cost I/O subsystem for PC based data acquisition and control systems.

One of many available OptiLogic Operator Panels

OptiLogic Ethernet remote terminal units (RTUs) are modular in design. They allow you to plug together any combination of analog and digital inputs and outputs that will fit in the available slots. The card cage base snaps onto a standard DIN rail for back panel mounting. If an operator panel is required, the base snaps onto any of a variety of available OptiLogic operator panels which can, in turn, be panel mounted. The Ethernet connection provides a 10BaseT (10 MBPS) connection to the network.

A system built with OptiLogic RTUs allows you to monitor and control equipment and systems locally or spread throughout a building. A PC with a standard Ethernet connection can serve as the central controller. Input data, output control and operator panel operation are only a millisecond response away.

If you are a software professional, you can easily develop your own software to run on the PC and interface OptiLogic RTUs. A Software Development Kit (SDK) is available from Optimation for such purposes.

If you are not a software professional, or you are looking for a more efficient way to develop your application, easy to use development packages are available from companies such as Think & Do. These development packages allow you to develop and maintain your system with easy to use graphical programming. By using a graphical programming package, you can have your system up and operating reliably in no time.

The following pages should provide the basic information necessary to get your OptiLogic system up and running. More detailed information on each of the available I/O modules and operator panels is available in separate documentation.

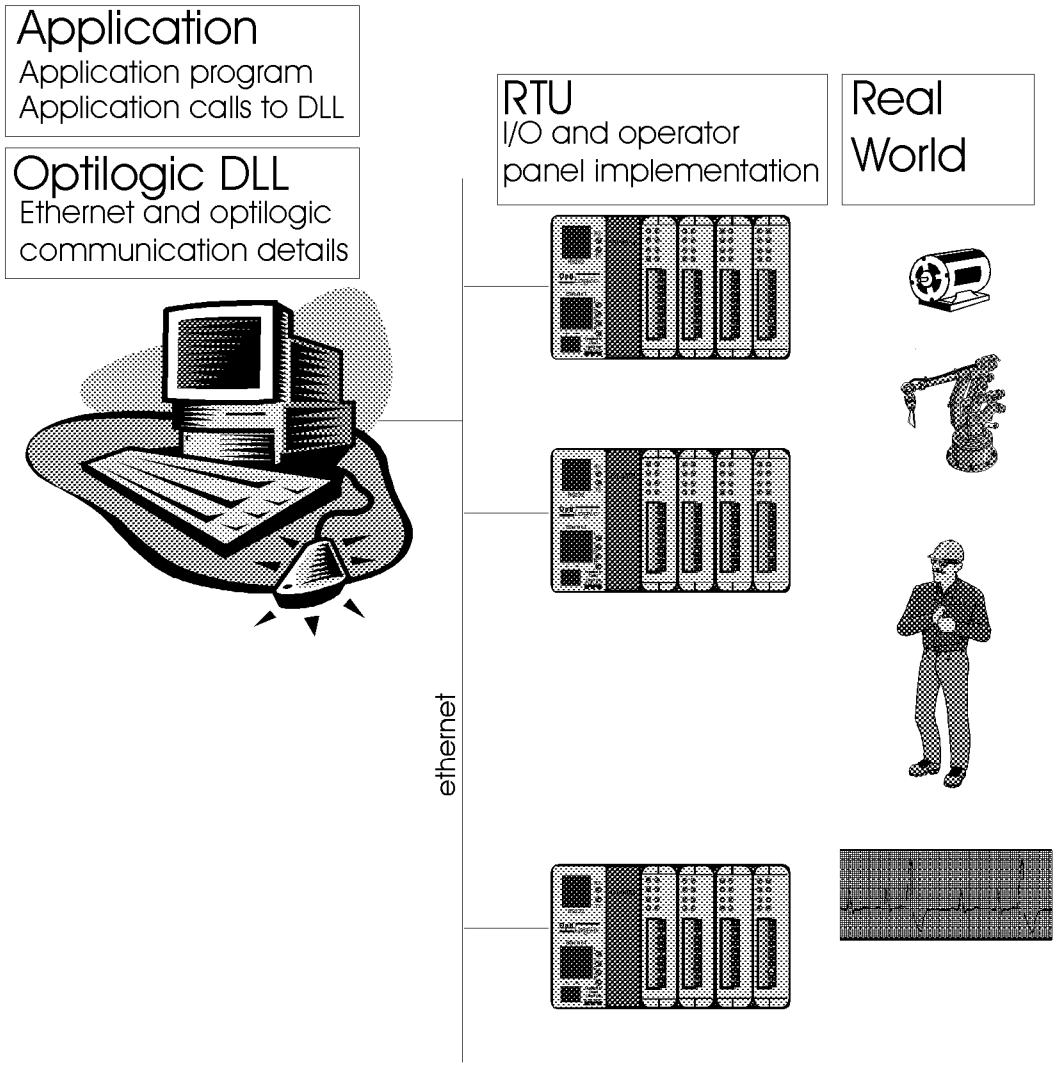
2.0 System Overview

Before we get into the details, lets take a look at the basic system architecture. The figure below illustrates a typical system.

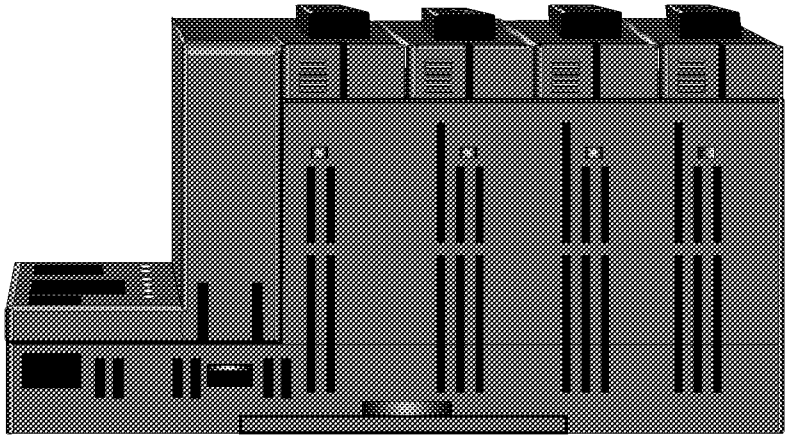
OptiLogic RTUs can be placed at the point of interface, anywhere within a building. They will communicate over an Ethernet connection back to a host PC. A system can easily incorporate from one to 99 RTUs. More than 99 RTUs can be handled with some extra configuration.

The host PC will communicate with each RTU over an Ethernet communications link. The link operates a data rate of 10MBPS (10,000,000 bits per second). At that rate, even a large system transfers all of the necessary data from host to RTU, and from RTU to host in a matter of milliseconds. With this type of communications, you can monitor and control a large system over hundreds of feet from a central PC in real time.

For deterministic Ethernet communications we recommend an **isolated** network for connecting OptiLogic RTUs to your PC based controller. For systems that are less time critical, other devices may be attached.



3.0 OptiLogic Base Description

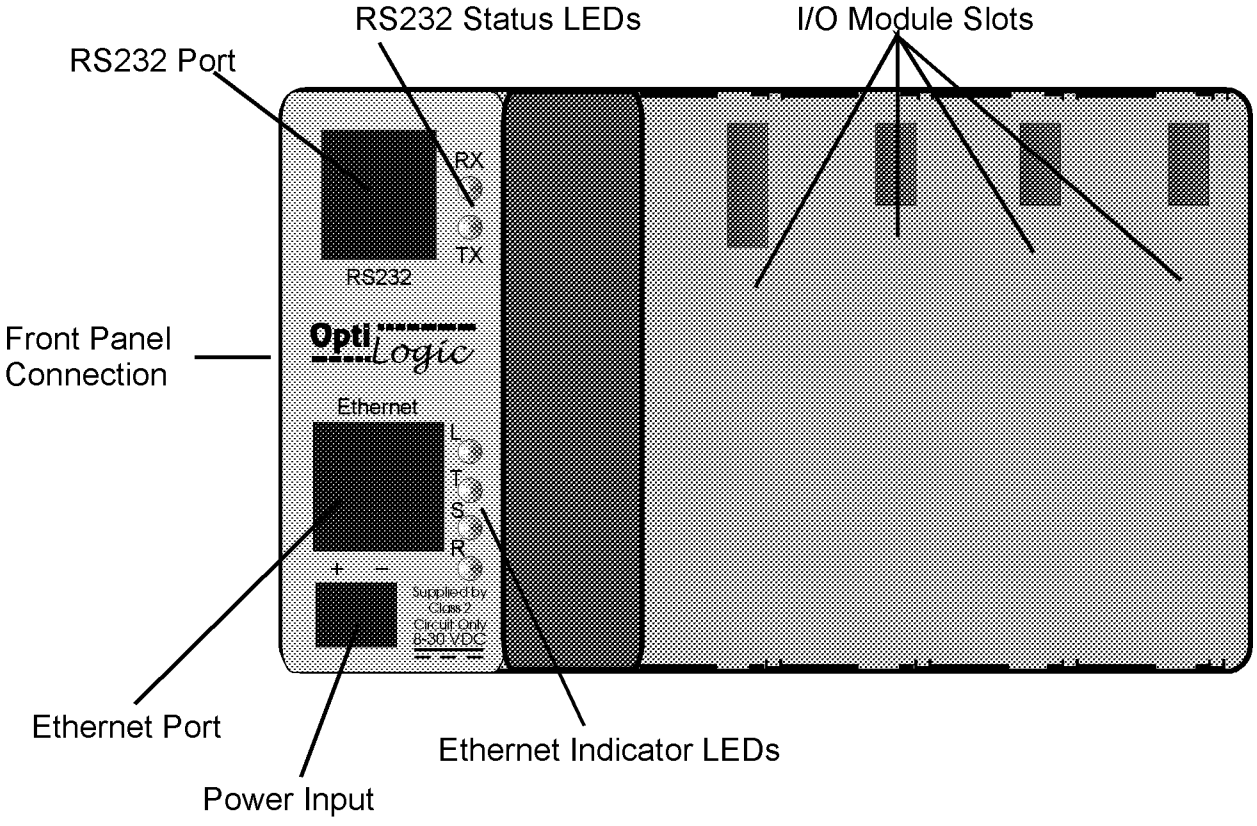


OptiLogic RTU Base

An OptiLogic Ethernet RTU base consists of a card cage containing an OptiLogic motherboard. The base unit has a built in Ethernet port, as well as an RS232 port. The Ethernet port is the interface to the larger system. The RS232 port is provided for general purpose communications (as defined by your application program). It is also designed to allow you to load future program upgrades (to incorporate the ability to interface future I/O boards and operator panels) into the base.

The figure below shows an OptiLogic Ethernet RTU base. The particular base shown is a 4 slot base. Bases with different numbers of slots are available and have the same basic features.

The communications ports both have status indicator LEDs which provide you with visible indications of each port's operation. The RS232 port indicates when transmit (TX) and

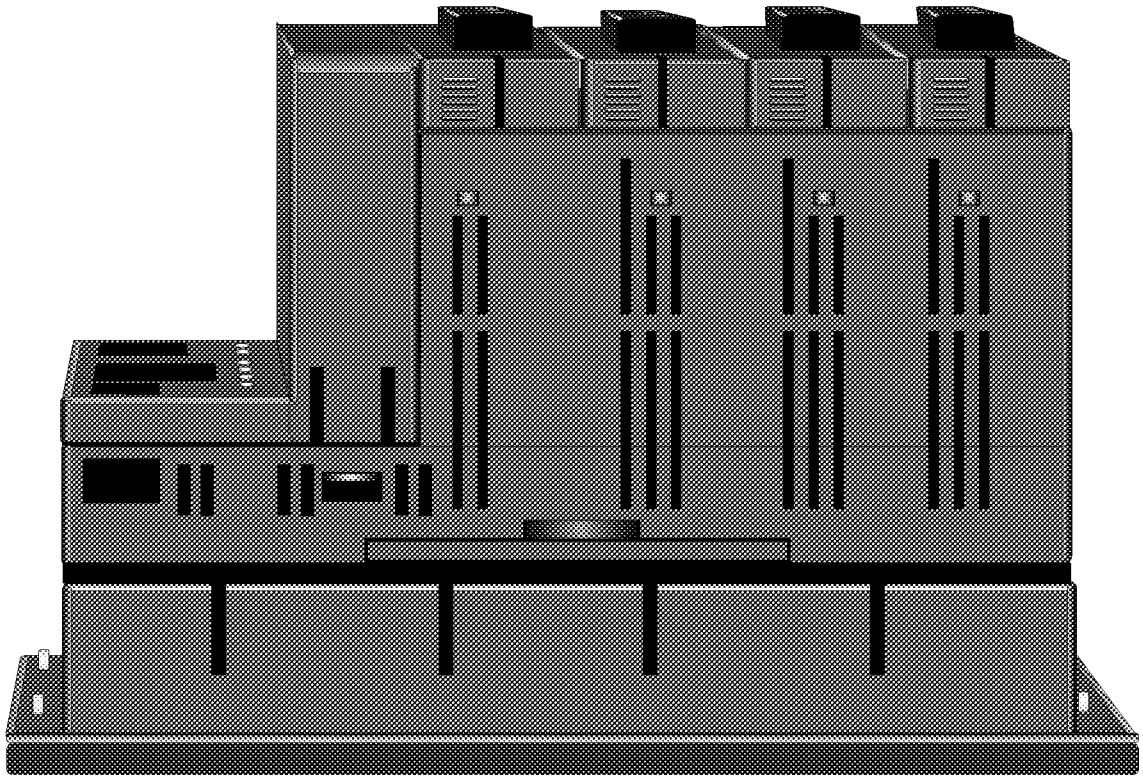


receive (RX) are active. The Ethernet port provides indications for good Ethernet link connection (L) and Ethernet port access by the base processor (S) as well as transmit (T) and receive (R) indicators.

Power must be provided to the unit by an external DC power supply. Any DC voltage within the range of 8-30VDC is acceptable.

Input and output modules can be plugged into the slots in the base. Most modules can plug into any base slot (including slot 0). Slot 0, has some extra features for a couple of specialty modules. Those modules are documented as slot 0 specific. They are also obvious, in that they have 12 pin connectors rather than 8.

The OptiLogic base can snap onto a standard DIN rail. It also can snap onto the DIN rail built into OptiLogic operator panels. When incorporating an OptiLogic operator panel, the cable connection on the side of the RTU base is used.



Base with Attached Operator Panel

4.0 Frequently Asked Questions

Q. What is Ethernet?

A. Ethernet is the most common communication standard for use by local area networks in existence today. It is a communication standard which defines cable type and signaling methods to use in a local-area-network (LAN). An Ethernet network transmits packets of information between connected devices at speeds of 10 to 100 million bits per second (Mbps). Twisted pair 10BaseT ethernet is the most widely used ethernet technology due to its low cost, high reliability and 10 Mbps speed. Products manufactured by multiple vendors can communicate using common software protocols.

Q. What does the OptiLogic RTU do?

A. The OptiLogic RTU is designed to allow automatic communication of I/O and operator panel data with properly configured PC-based control software. Special application interface routines (available from Optimation) are used by the PC-based master to request I/O data using Ethernet. This manual will provide details for properly installing the OptiLogic RTU in preparation for communications to a master control system.

Q. What is a protocol ?

A. A protocol is a definition of message formats that allows computers to connect with one another, transmitting messages which are understandable to both the sender and the receiver. There are "layers" of protocols. A high level layer, such as IPX or TCP/IP, transports packets of information from one point to another. A lower level protocol, such as Optimation's OptiLogic protocol contains the specific information and commands that allow the system to work.

Q. Which high level protocols are supported by the OptiLogic RTU ?

OptiLogic RTUs support both of the most common high level protocols - IPX and UDP/IP. IPX is a protocol developed by the long time LAN market leader Novel. UDP/IP is a communications link to TCP/IP; the protocol used on the internet.

Q. What are the particular strengths and limitations of IPX ?

IPX is easier to set up than UDP/IP. Since it is also a somewhat simpler protocol, it normally requires less CPU time in the host CPU - yielding slightly better message turn around. If the system uses a private local network, IPX is recommended. The limitation of IPX is that it cannot be transmitted though a network router. If your network is a large routed network, use UDP/IP.

Q. What are the particular strengths and limitations of UDP/IP?

UDP/IP is compatible with TCP/IP. It is routable anywhere. It is therefore recommended for any large network which contains network routers. It is a little more complicated to set up. It provides no real advantages for a smaller, local network - therefore IPX is recommended for smaller, local networks.

Q. What software must be present on my PC to allow it to communicate with OptiLogic RTUs?

A. Optimation provides link software (a DLL or dynamically linked library) that handles the communications between your application software and the RTUs. This DLL is incorporated in the graphical programming packages designed to interface OptiLogic. This makes it totally transparent to you, the user. Alternatively, you can create custom software using our Software Development Kit (SDK) for PC-based systems. See our Internet Web site at (http://www.optimate.com.)

Q. Which Ethernet packets are recognized by the OptiLogic RTU slave?

A. OptiLogic RTUs support IEEE 802.2, IEEE 802.3, Ethernet 2, and SNAP Ethernet packets. The module will respond to IPX or UDP/IP messages which are initiated using proprietary application interface software (Optimate DLL). Use of the Optimate DLL eliminates the need to know any of the ethernet details.

Q. What are standards and should I be concerned about them?

A. Standards are developed to provide guidelines for physical and logical network topologies. Below is a short list of most commonly used Ethernet cabling standards and their key characteristics.

- 10Base-2-Thin coaxial cable , which supports a maximum of 30 stations per unrepeated network and is limited to 185 meters (607ft.) per cable segment.
- 10Base-5 - Thick coaxial cable, which supports a maximum of 100 stations and is limited to 500 meters (1,640ft.) per unrepeated segment.
- 10Base-F - Plastic or Glass Fiber Optic maximum of 1024 stations and distances depend on signaling technology and medium used but can commonly support up to 2 Kilometers.
- 10Base-T - Unshielded Twisted Pair, which supports a maximum of 1024 stations with a segment of 100 meters, but distance is truly based on signal loss in decibels (less than 11.5dB loss source to destination).

More Ethernet standards information may be found by searching the following Internet Web site: http://standards.ieee.org

Q. Which Ethernet specifications are required to install an OptiLogic RTU system?

A. None. Detailed Ethernet specifications are not necessary for implementing the OptiLogic RTU system.

Q. Can an Ethernet System be Determinsitic ?

A. YES. Determinism means that you can count on a consistent, reasonable time from when a message is transmitted from the host until a response is received from the RTU. For OptiLogic systems with a small number of bases (5 or less), determinism is inherent with no special handling. For large systems, the simple employment of store and forward switches will eliminate the collision domains and ensure determinism.

5.0 Configuring Your RTU

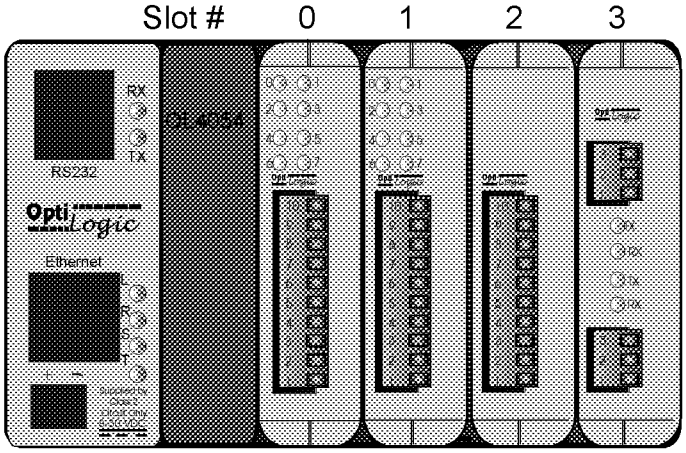
Each OptiLogic application will differ in the number and type of I/O, the operator panels used (if any) and how the devices must be distributed. The modular design of the OptiLogic system allows you to mix and match to meet your exact system requirements.

System configuration entails an early process of defining exactly what type and quantity of I/O you need at each location. If operator interaction, alarm annunciation, or status display are required at the various points, the appropriate operator panel should be chosen. Once that is done, you can custom tailor your RTUs by selecting and installing standard I/O modules in your OptiLogic base units and snapping the appropriate operator panel onto each.

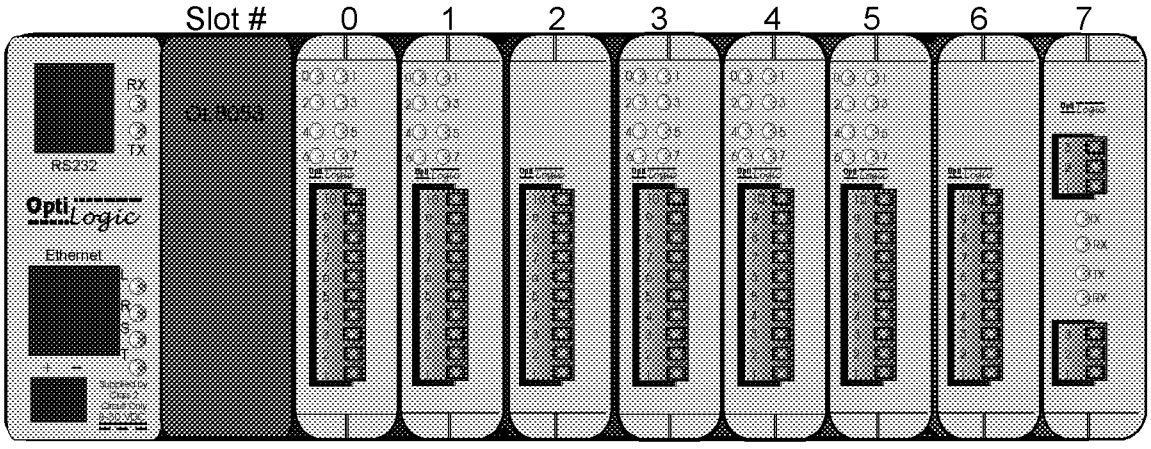
5.1 Slot Numbering

Each module will occupy one slot in the RTU base. Each slot position is numbered as shown below. The slot number will provide a reference to your application program for selecting the appropriate module for each particular operation.

Slot numbering is simply left to right, starting with slot number '0'.



OL4054 4 Slot Base



OL8058 8 Slot Base

5.2 Available Modules

The following is a list of I/O and operator panel modules available at the time of this printing. Keep in mind that the OptiLogic Series is a new product line. Many more modules will be available in the near future. To get a current list of available modules, visit our web site at http://www.optimate.com

5.2.1 Available I/O Modules

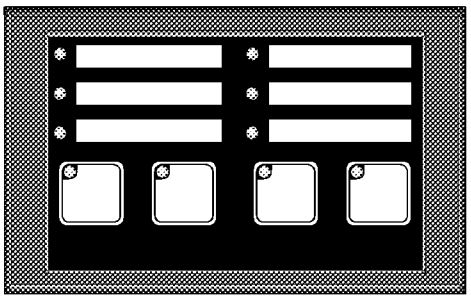
The following I/O modules are currently available (generally off the shelf).

Digital Input	
OL2201	8 Digital input simulator (toggle switch input)
OL2208	8 DC (10-30VDC) In
OL2211	8 AC (80-132VAC) In
OL2252	2 high speed counter (up to 20 kHz) inputs. 6 additional inputs configurable as general purpose DC inputs or control signals
Digital Outputs	
OL2108	8 Relay (2A resistive @ 24VDC, 1A @120VAC)
OL2109	8 Transistor (500mA sink)
OL2111	8 AC Solid State Relay (1A)
Analog Inputs	
OL2408	8 channel 0-5VDC or 0-10VDC in
Communications	
OL2602	2 Port RS232

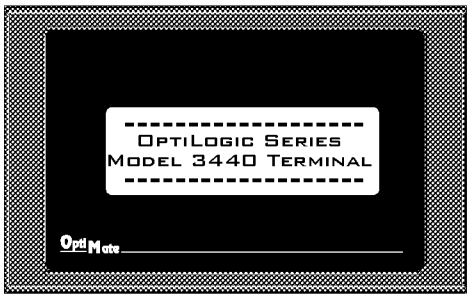
5.2.2 Available Operator Panels

The following is a list of currently available OptiLogic Operator Panels.

Pushbutton/ Indicator Panels	
OL3406	6 Indicator/4 Pushbutton
Alphanumeric Display	
OL3440	4 Line x 20 Character backlit LCD alphanumeric display
Terminal Panels	
OL3420	2 Line x 20 character backlit LCD display, 4 pushbuttons
OL3850	2 line x 20 character backlit LCD display, 5 user definable pushbuttons, numeric keypad, 3 indicator light bars

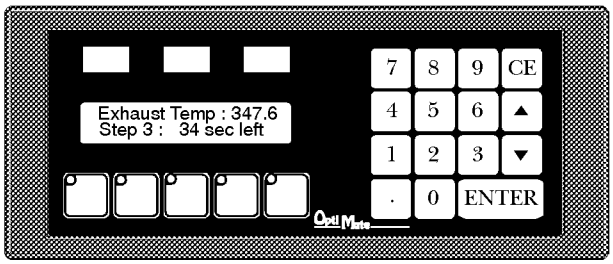


OL3406 Pushbutton/Indicator Panel



OL3440 Alphanumeric Display

OL3420 Alphanumeric Terminal



OL3850 Operator Terminal

5.3 Addressing the RTU

Each device on an Ethernet network must have a unique 48-bit IEEE assigned Ethernet address. We've taken care of that. Each RTU is assigned an address at the time of manufacture. You never have to see it or deal with it.

If you are implementing an IPX protocol system, or are implementing a TCP/IP system with a DHCP server, the only address you need to be concerned with is the OptiLogic RTU address, covered in the next section. If you are implementing a TCP/IP system and need or want to set a fixed IP address, a utility program is available to download that address.

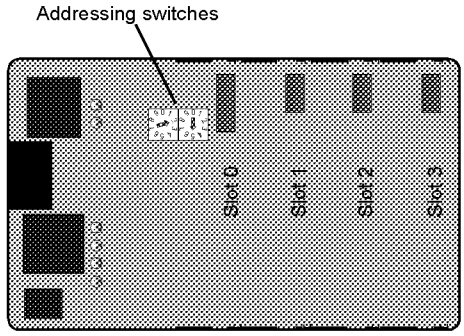
5.3.1 Setting the OptiLogic RTU Address

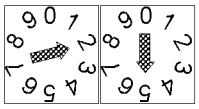
The addressing that you, the system designer, must set is the address set via rotary address switches in the RTU base. Each OptiLogic RTU in your system must have its own unique address. This address, a value between 1 and 99, is how the software in the master PC identifies each RTU.

To get to the address switches, you must first remove the end cover from the base unit. To do this, simply squeeze the latching tabs, shown in the figure below, and lift the cover off.

Removing the end cover will expose the RTU base mother board. The address switches will be found near the connector for slot 0.

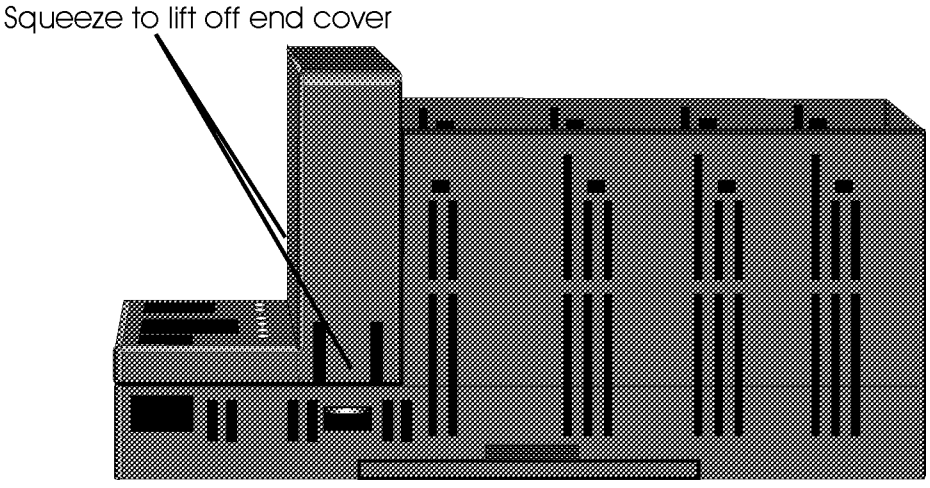
To set the RTU address simply rotate the rotary switches to the desired value. The switch on the left is the "tens" digit. The switch on the right is the "ones" digit. A small flat blade screw driver is the only tool you need. The address shown on the figure below is "25".





Exploded view

Remember that each RTU in your system must have its own unique address, which is set prior to applying power to the RTU. Duplicate addresses will cause system communications to fail.



5.3.2 Setting the IP Address

If you are implementing an ethernet system using TCP/IP, each RTU must have an IP address. This IP address can either be downloaded to each RTU as a "fixed" address, or it can be allocated dynamically in a system that has a DHCP server.

DHCP servers are generally found in existing systems that are used as a general data network, passing files, email, etc. throughout an office environment. If you are connecting into such a network, the OptiLogic RTUs are designed to automatically accept and use a dynamically allocated IP address provided by the DHCP server. The only requirement is that the RTU must not have a fixed IP address already assigned. The address allocation and use is totally transparent.

If an RTU already has a fixed IP address, and you want to change its operation to accept its address from a DHCP server, that can be accomplished. The OptiLogic Update Tool can be used to clear the fixed IP address

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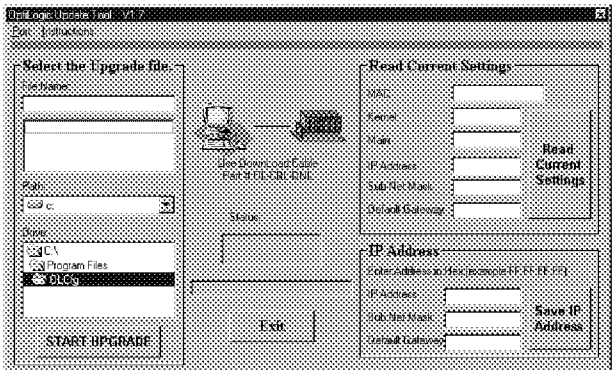
Optimation provides the OptiLogic Update Tool to allow you to update and upgrade your RTUs at any time. The OptiLogic Update Tool is a software utility that can be used to load new code into the RTU base, check existing software version information, and set the IP address. It can be downloaded from the Optimation web site, www.optimate.com, and runs on any PC compatible that runs Windows 95, NT or higher. You will also need a download cable, Optimation part # - OL-CBL-DNL.

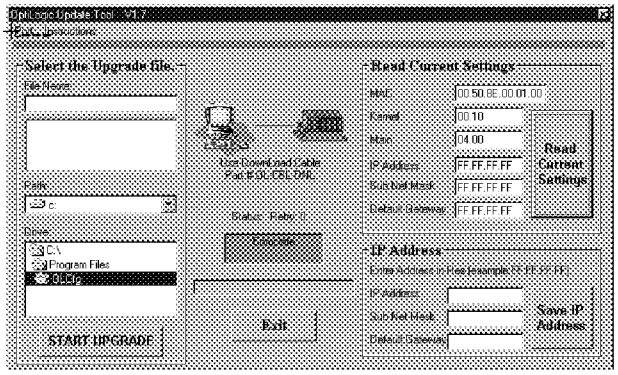
This manual will simply touch on the highlights for setting, clearing or changing an IP address.

To get the OptiLogic Update Tool, simply go to www.optimate.com. Go to the Software Downloads page. Download and install the software on your computer.

When you start the OptiLogic Update Tool, the following screen will appear. Notice that in the upper left hand corner, there are two pull downs for port selection and instructions. Select the PC's comm port that you will use, then follow th instructions.



If you read back the RTU's current settings, you will get a display similar to the one shown below. Note that if the IP address is all F's, as shown, there is no IP address set. To set



the address, follow the instructions. To clear the IP address, follow the instructions & enter all F's as the address.

5.4 Calculating Your Power Budget

Each I/O module and operator panel that you attach to your RTU requires a certain maximum amount of power to operate. Each RTU base has a limit on the total amount of power available to power I/O modules and operator panels.

Always ensure that the total maximum power required by the I/O modules and operator panel does not exceed the power supplied by the RTU base. To determine your total power requirements, simply add the maximum power required by each module and operator panel.

Power Supplied

RTU Base Type	*5V current available*
OL4054	2.8A
OL8058	2.8A

Power Required (I/O Modules)

Module Type	*Description*	*5V current required*
OL2108	Relay Out	375mA
OL2109	DC Out	140mA
OL2111	SS Relay Out	120mA
OL2201	Input Simulator	60mA
OL2208	DC In	60mA
OL2211	AC In	100mA
OL2252	Dual counter	100mA
OL2408	8 chan A->D	100mA
OL2602	RS232	110mA

Power Required (Operator Panels)

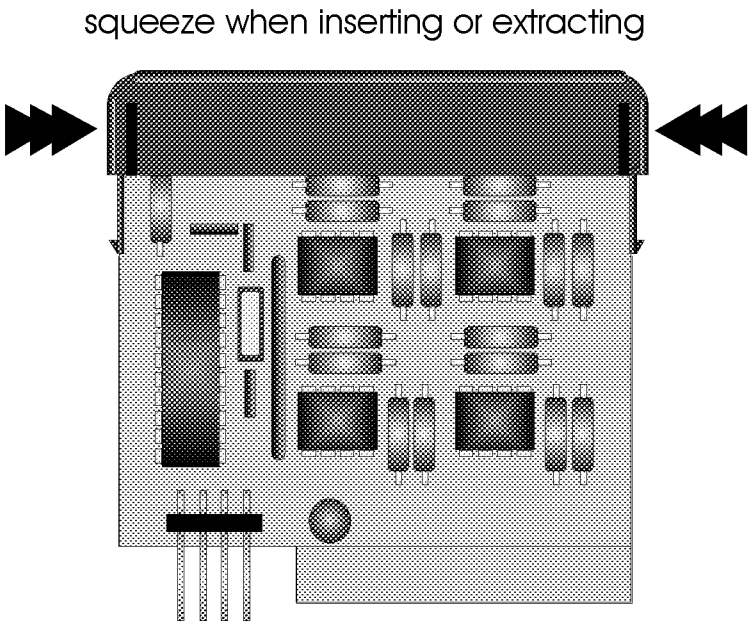
Panel Type	*Description*	*5V current required*
OL3406	PB/Indicator	50 mA
OL3420	Terminal	115 mA
OL3440	A/N Display	150 mA
OL3850	Terminal	525 mA

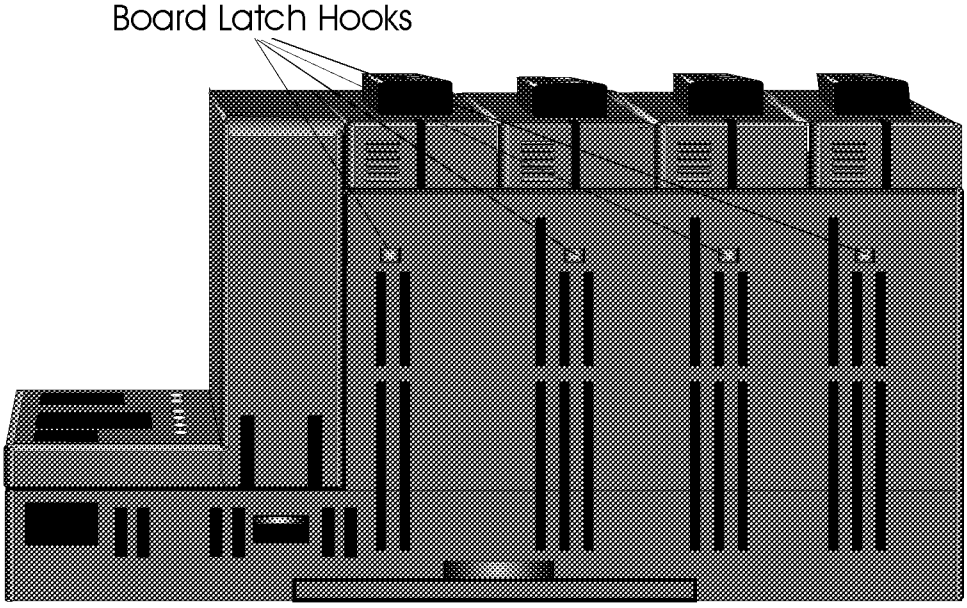
5.5 Installing I/O Modules

Each RTU bas has a number of slots available for installing I/O modules. The number varies according to the base.

Each slot has card guides along each side and a connector on the motherboard. To install an I/O module, place the module's PC board in the top and bottom card guides (note that the board will not be tightly retained until it is approximatel```y ¾ inch into the card guide).

As you push the module into its mating connector, squeeze the ends together. This will allow the board latches to travel inside the card cage. When you have pushed the board into its mating connector and released, the latches should hook the card cage and keep the module in place.





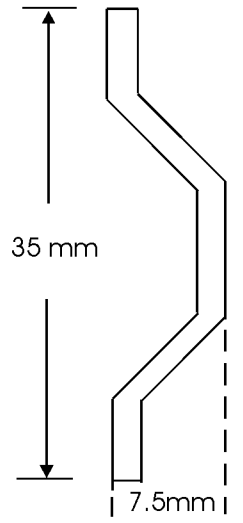
5.6 Mounting Guidelines

OptiLogic RTUs are intended to be mounted on a standard DIN rail. That DIN rail can be a commercial DIN rail attached to any flat surface. It can also be the DIN rail built into OptiLogic operator panels.

5.6.1 Mounting the Base

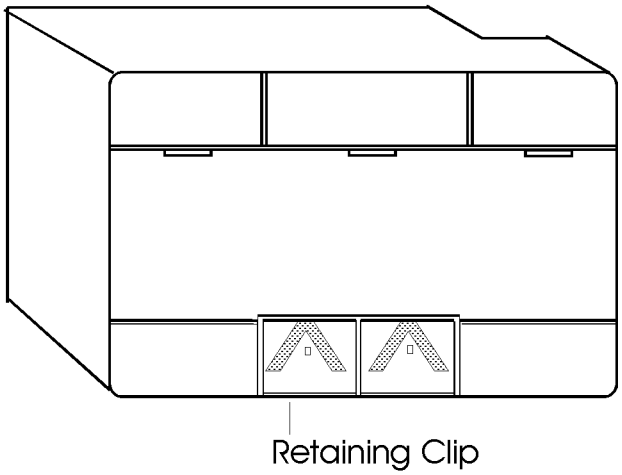
A DIN rail is simply a standard "U" shaped channel which is designed to be mounted horizontally on any flat surface. DIN rail can be purchased at nearly any electrical supply outlet, as well as through the PLC Direct catalog.

There are a few standard DIN rail sizes available. Pictured below is a cross sectional view of the standard 35 mm DIN rail the RTU base is designed to clamp on. The key dimensions are the 35mm overall width and a minimum 7.5mm height. The precise channel shape is not important.



DIN Rail Dimensions

Take a look at the bottom side of the RTU base. It will appear as shown in the figure below.



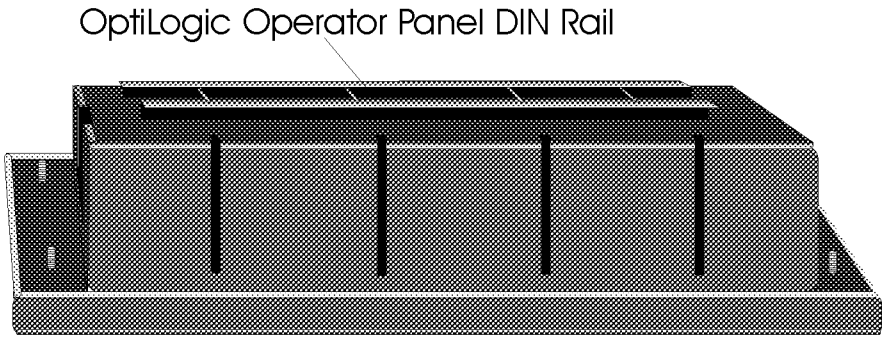
As shown in the figure, there is a DIN rail channel that runs lengthwise across the middle of the RTU base's bottom side. At the top of that channel are three overhanging hooks. At the bottom of the channel there is a sliding retaining clip.

The process of installing a base on a DIN rail is as follows.

- Pull the retaining clip back from the center of the base. It should pull back about 1/8 inch. The retaining clip on an uninstalled unit can be pulled back with your fingers.
- Place the RTU base on the ***horizontal*** DIN rail with the three overhanging hooks over the top of the rail. Mounting must be horizontal to allow convection air flow for cooling.
- Rock the RTU base down flat against the bottom of the DIN rail.
- Push the retaining clip closed to hook the bottom rib of the DIN rail.

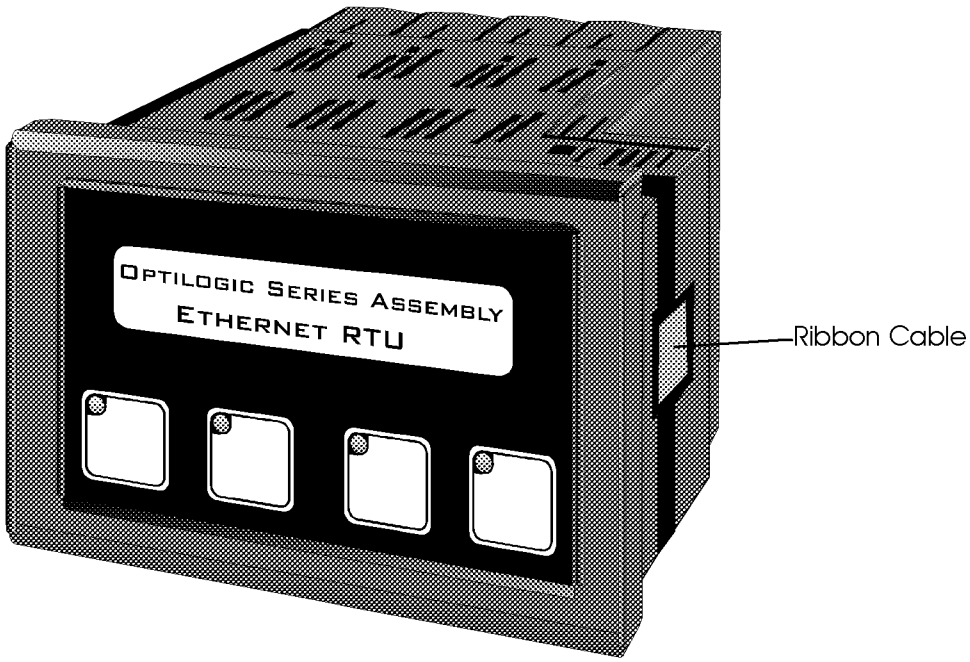
5.6.2 Mounting the RTU Base to an Operator Panel

The OptiLogic RTU base can also be mounted to any OptiLogic operator panel. As shown in the figure below, OptiLogic operator panels have a built in DIN rail for mounting the base.



The mounting process is exactly the same as described for mounting to a DIN rail. Be sure that your orientation is right so the connectors on the base and the front panel line up. An OptiLogic RTU base attached to an OptiLogic operator panel should look like the figure below.

The short ribbon cable, which comes with the operator panel should be used to provide the connection between the RTU base and the operator panel.



6.0 Network Configuration

A network is simply a system for interconnecting devices that talk to each other. In an Ethernet network, one transmitter connects to one receiver.

What makes Ethernet a multidrop network are devices called "hubs" and "switches", which connect to multiple Ethernet devices. On a hub or switch, each connection has a separate transmitter and receiver. A hub or switch contains several such transceivers, all interconnected in the internal electronics of the hub or switch.

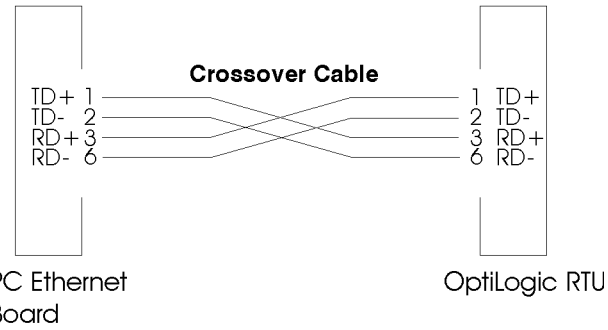
The following sections discuss interconnection using the term hub. Any of the configurations apply equally well to a switch. The differences between a hub and a switch and where to use each is covered in section 6.3

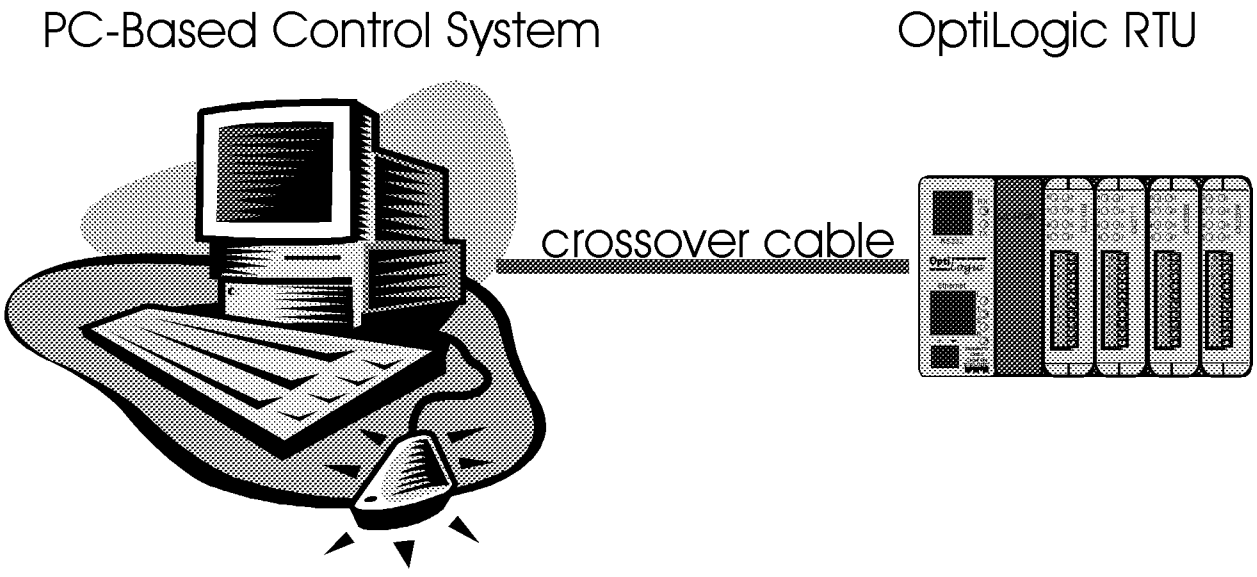
In an OptiLogic RTU system, there should be a single *master*, the host PC. All physical media interconnections should be made to commercial building wiring standards EIA/TIA-568 and the specification for Unshielded Twisted Pair cable defined in the TIA/EIA TSB40-A specifications. For best case 10Base-T wiring, we recommend using all category 5 type cabling for connecting your OptiLogic RTU network.

6.1.1 Point to Point Connection

The simplest system is a point to point connection. Point to point connections, as illustrated below, require only a ***crossover*** type patch cable.

An Ethernet crossover cable, shown below, connects the transmitter on one side, with the receiver on the other. This is a category 5 type UTP crossover patch cable. Cable length is limited to less than 100 meters.

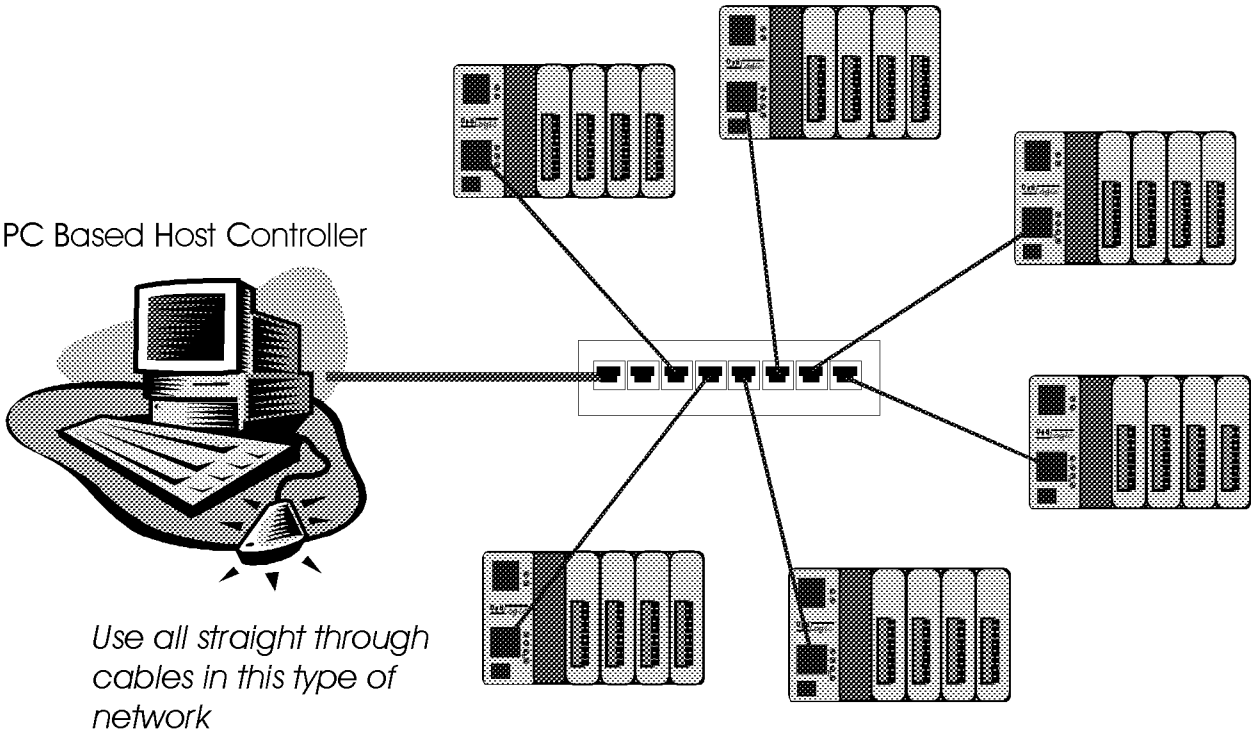




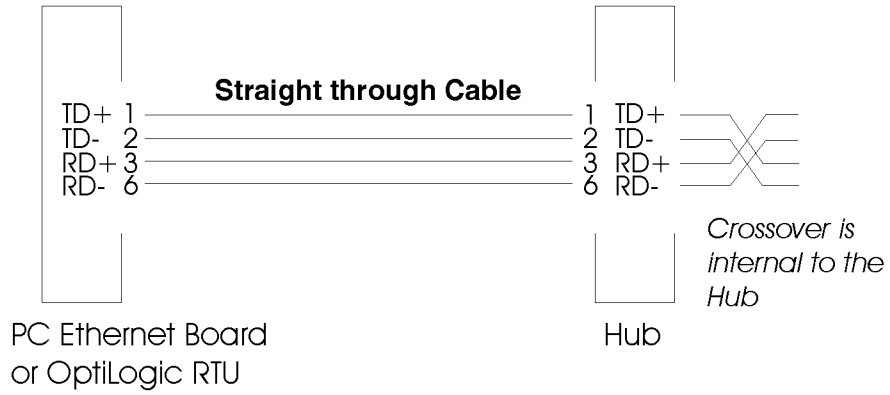
6.1.2 Single Hub Connections

The next level of complexity is a single hub system. Hubs are commonly available with anywhere from 4 to 24 connections.

The multiple Ethernet ports on a hub allow physical star type network wiring. The hub is typically placed in the center of the system. Individual cables are run between the hub and each RTU.

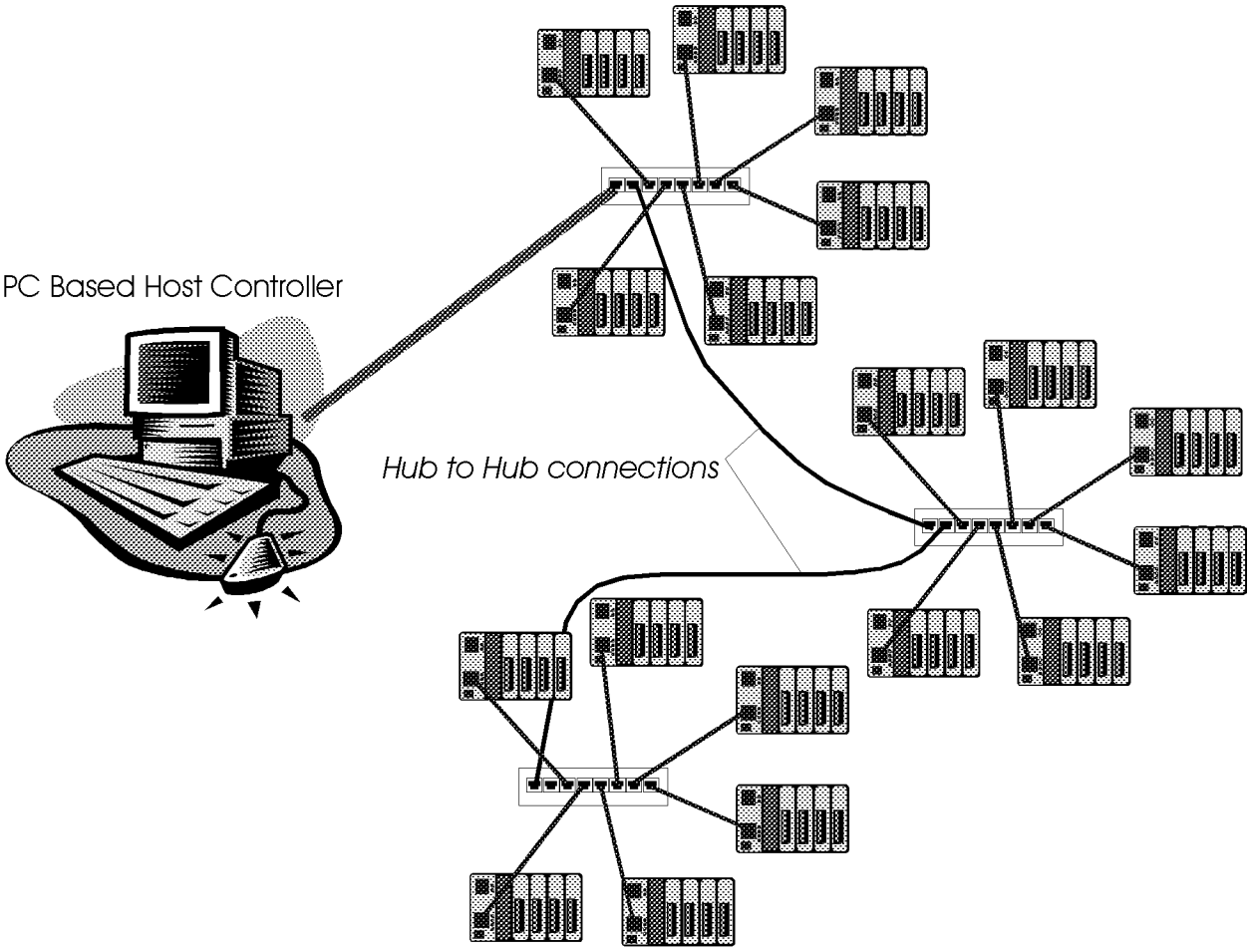


Crossovers are made internal to the hub. Therefore, in a single hub system, all connections are straight-through. Remember that for 10Base-T, each cable connection is limited to 100 meters in length.



6.1.3 Multi-Hub Networks

A maximum of five repeater, or switching, hubs may be connected in a single LAN network. These hubs provide a means for connecting multiple segments together. Each hub is commonly placed centrally to the group of RTUs that is serves. This is a cost effective solution to large distributed systems.



Multi-Hub System

In a multi-hub system, all connections between the PC and a hub, or an RTU and a hub are straight-through. All connections between hubs are crossover.

6.2 Ethernet Connection Guide

Ethernet 10Base-T is a flexible, low cost method of cabling local area networks. OptiLogic RTUs must be connected using 10Base-T compatible products. All Ethernet 10Base-T implementation details are defined by the EIA/TIA standard 568A. This standard specifies UTP, an acronym for Unshielded Twisted Pair cable, to be between all nodes on a given 10Base-T network. UTP cables are rated according to their data-carrying ability (bandwidth) and rated by "category" number. The standard specifies category 3, 4, or 5 cable may be used with Ethernet 10Base-T applications. IEEE Ethernet standards limit cable length between nodes to 100 meters (328 feet). The distance limitation is based on the maximum cable signal loss of 11.5 decibels between the source and destination. Due to emerging high speed standards and product capabilities, many sites now install UTP category 5 type cables exclusively. We recommend category 5 cable for all OptiLogic connections.

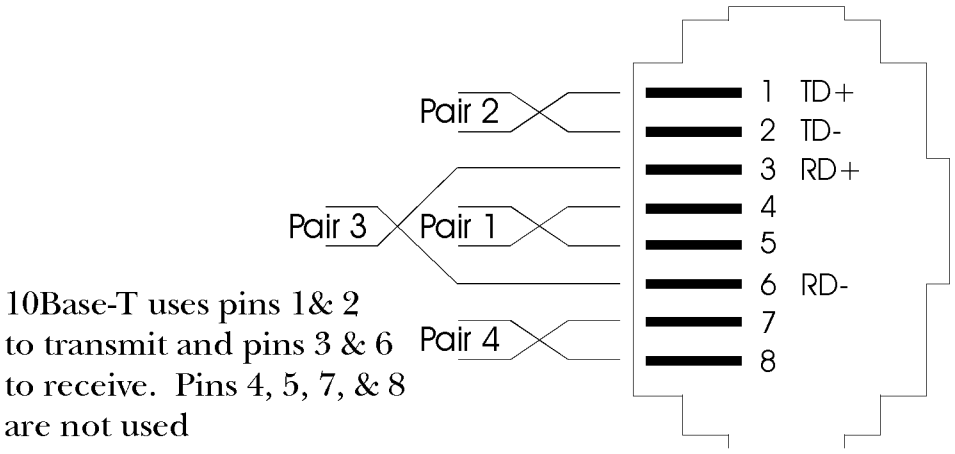
6.2.1 UTP Cable Characteristics

Cabling is the foundation of any network; if it's incorrect or unstable all other communications characteristics will be unreliable. The most critical aspect of UTP cabling is the maintaining of correct conductor pairing throughout the network. Commonly four-pair (8 wire) 24 AWG thermoplastic insulated solid conductor wire with a 100 ohm impedance and total diameter of less than 6.35mm (0.25 inch) should be used with Ethernet 10Base-T networks. To ensure correct pairing, network vendors offer patch cables (straight-through and crossover) which are assembled with connectors.

6.2.2 Cable Connectors

OptiLogic RTUs interface the network via the standard 8-pin extension port compatible with RJ45 type connectors. RJ45 type connectors are designed to accommodate rounded PVC outer jacket UTP cable. The strain relief for the cable is provided by the part of the RJ45 connector that acts as a wedge against the outer jacket. The wedge is pressed and locked tightly against the cable jacket when the connector is crimped into place.

A 10Base-T RJ45 connection is shown below.



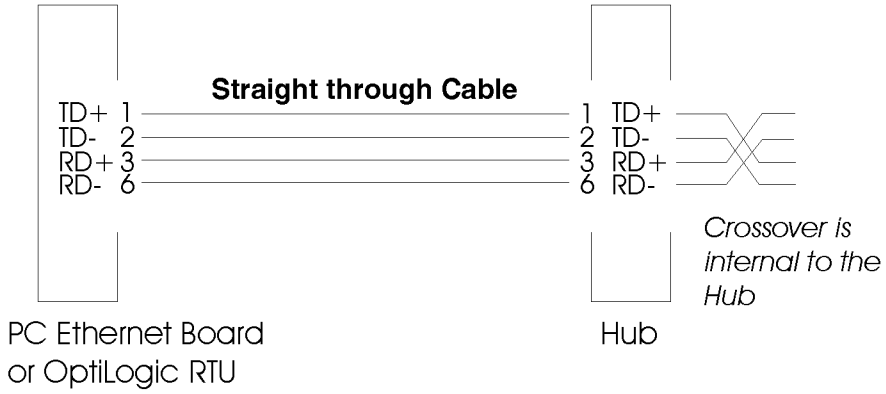
Warning: Do not attempt to save money by using two pair or flat type cable with RJ45 connectors. The RJ45 connectors will not securely fasten onto the cable jacket.

6.2.3 10Base-T Connections

Most hardware ports on Ethernet 10Base-T equipment are wired MDI-X (meaning medium dependent interface crossover) so you can use straight-through cable for interconnecting the network devices. This allows for proper alignment of transmitter and receiver circuits according to 10Base-T networking standards. For hub-to-hub connections, a crossover type cable is commonly required. The figures below illustrate pin assignment and signal names for straight-through and crossover type Ethernet patch cables.

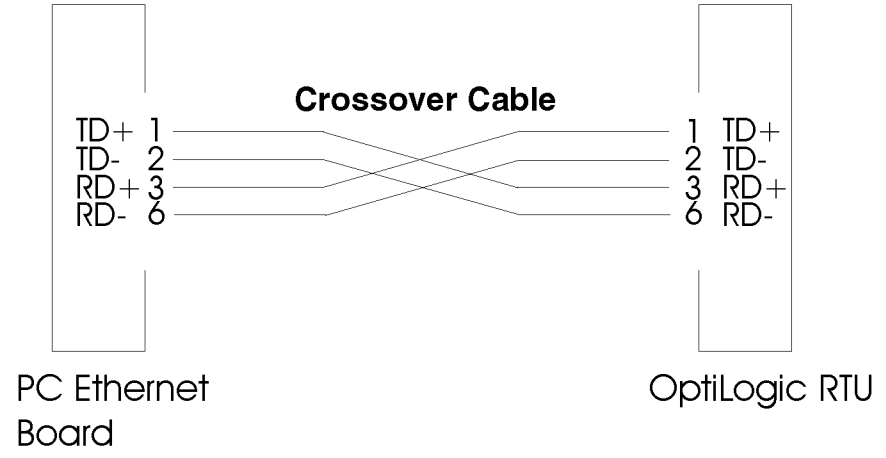
6.2.4 Straight-through Patch Cable

A straight-through cable is commonly used to connect Ethernet 10Base-T devices to a hub. Pre-assembled patch cables are available from various network product vendors. RJ45 connectors are attached at both ends of an assembled patch cable. We recommend using a category 5, UTP cable type for all OptiLogic network connections.



6.2.5 Crossover Patch Cable

Crossover type patch cables are used to connect between hubs or switches. This type of patch cable must also be used for all point to point connections, such as a PC-based controller and OptiLogic RTU. Therefore, it is also called a point-to-point cable.



6.3 Collision Avoidance

It is important to understand the basic nature of ethernet in order to maximize performance. With an understanding of the basics and application of the appropriate network architecture, an ethernet system can be fast and deterministic.

Ethernet in a collision/backoff type network technology. When a device needs to talk on the line, it and it senses that the line is not active, it begins transmission. Collisions occur when two or more devices begin transmission at approximately the same time. Each device monitors for this situation and if a collision is sensed, each device will stop transmission and go into a "backoff".

Ethernet backoff operates in a random, exponential manner. The first time a collision occurs, each device will back off for a random time within a range of very short time periods (microseconds). If the next time the device tries to talk another collision occurs there is another collision, the random time will be within a larger time range. Each successive collision/backoff will be within a larger range, up to a limit in the 100 millisecond range. When the backoff time gets large, it can affect system determinism.

Don't worry. This can all be handled easily and inexpensively.

In a small network, collisions are rare & multiple collisions are extremely rare. As a general rule, systems with 5 or fewer RTUs don't require any special handling and operate perfectly well using hubs discussed in the previous sections.

In larger systems, the use of store and forward switches can eliminate the potential collision problems.

6.3.1 The Difference between a "Store and Forward" Switch and a Hub

While switches and hubs look very similar, there are differences that can affect network operation.

A hub is a device that, when it receives a message its input side will pass it along to all legs of its output side. This results in most messages on a given leg being for devices not attached to that leg. The other important characteristic of a hub is that collisions occur in hubs & result in the backoffs just described.

A store and forward switch is more intelligent than a hub. A store and forward switch will only pass along messages, on a given leg, to devices that are attached to that leg. This results in a reduction in network traffic. A store and forward switch also buffers received messages and retransmits them when the line is free. In doing so it eliminates collisions, maximizes throughput and eliminates the possibility of long backoffs.

Store and forward switches are more expensive than hubs. However, the cost difference is very small in relation to the total cost of a large system.

This topic is handled in more detail in application notes available from Optimation.

7.0 Installation

7.1 Become Familiar with Your Application and Equipment

The first step in installing your system, is to become familiar with system requirements and all equipment involved. A major part of this task can be accomplished by reading this manual, as well as manuals on I/O modules, operator panels, and controller software to be used in the application. Other information can be gleaned from your application specifications - whether detailed written specs or simply an understanding of the application requirements.

From this information you should be able to define exactly what equipment will be required, including quantities and required physical locations of each.

7.2 Organize and Prepare Your Equipment

Ensure that you have all of the required RTUs, I/O boards, operator panels, cabling, hubs and PC equipment required for your application. The PC-based control system used must have the proper Ethernet hardware and software configuration to communicate with the OptiLogic RTUs.

The minimum parts needed are as follows:

- OptiLogic RTU base(s)
- OptiLogic I/O and operator panel modules
- 10Base-T patch cables for connecting the entire network
- Power supplies for powering the RTUs
- Hook up wire for I/O sensors and actuators
- PC with Ethernet board installed (for running PC-based control software)
- Mounting hardware, such as DIN rail
- Assembly tools, such as screwdrivers, wire strippers, etc.

7.3 Network Operating System

Please check the following requirements when choosing your PC configuration.

- Windows NT, Windows 95 or Windows 98 compatible Pentium 133 (or higher). If you are using Think&Do, it must be Windows NT.
- 16MB RAM (32MB for Think&Do)
- CD-ROM drive
- For Think&DO - color monitor with at least 800x600 resolution
- Ethernet network card

7.4 Install the Ethernet Network Card

Proper installation of the I/O network card is very important. The OptiLogic DLL software will use it to communicate with the RTUs. Installation will vary slightly, depending on the particular brand of Ethernet card used. However, typical installation will follow this basic sequence.

1) Remove power to your PC by unplugging the power cord.
2) Remove the cover of the PC housing to allow access to the PC motherboard and adapter cards.
3) Locate an empty slot of the type that matches your Ethernet card (either ISA or PCI slot).
4) Most network cards are software configurable. However, there are cards that require hardware configuration. If your card is hardware configurable, with jumpers or DIP

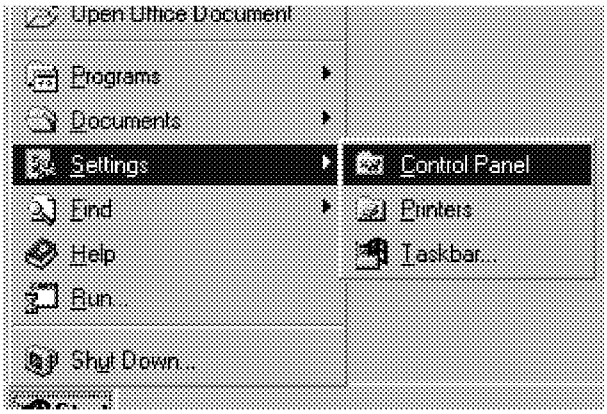
switches, set it up for a)interrupt level = 10, b) I/O address = 0300h c)plug & play off
5) Remove the slot cover and install the I/O network in the slot. Secure it with the screw.
6) Replace the cover on the PC housing.
7) Apply power to the PC. If there are any interrupt or address conflicts which you can detect, it is best to resolve them before going any further.

7.5 Network Adapter Card Configuration

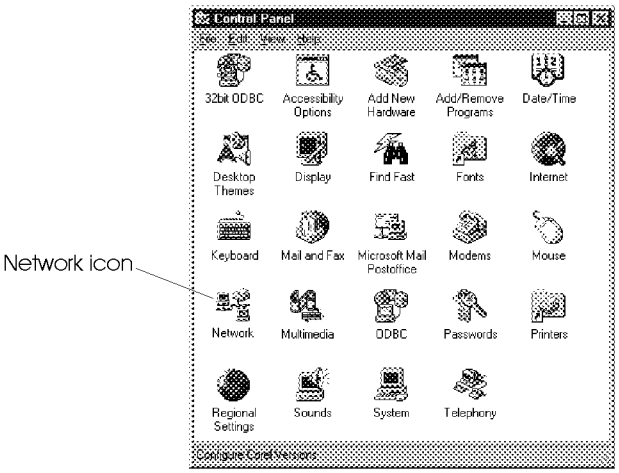
To configure a network adapter card, first do the following:

1) Locate the manufacturer's installation disk that came with your network adapter. The disk contains drivers which you will need to install.
2) If you need to install two network cards, ensure that they are configured to have unique I/O addresses and unique interrupts. The best way to verify these settings is to power up the PC using a DOS or Windows 95/98 boot disk and then running the network card's setup utility that was shipped with the card. Write down the configuration for each card so you can use the information during NT setup (if using NT). If you have to configure cards, we suggest setting one card to I/O address 300h and interrupt 10, and the other to I/O address 304h and interrupt 11, unless there are other devices using these settings.

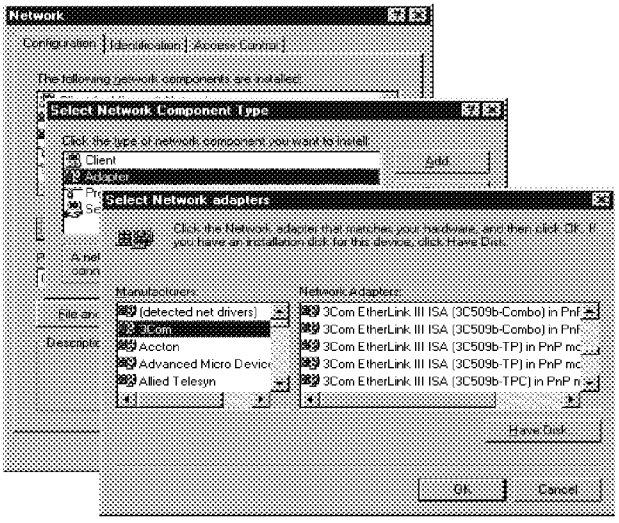
Using the *Start* Menu select *Settings*.., then *Control Panel*.



From the Control Panel, double click the Network icon. This will enable you to add a network card to the Windows configuration for your system.

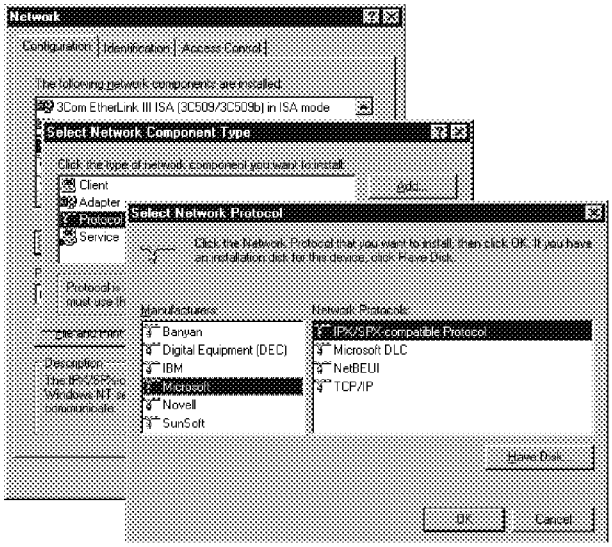


In the *Network* dialog box, select the *Adapters* tab, then Add ..., to access the list of adapter cards.



- If you see the name of your network adapter card on the list, select it and click OK.
- If you do not see the name of your network adapter card, then insert the manufacturer's disk in drive A and select *Have Disk* to continue. This will load the driver from the disk to the Windows configuration.

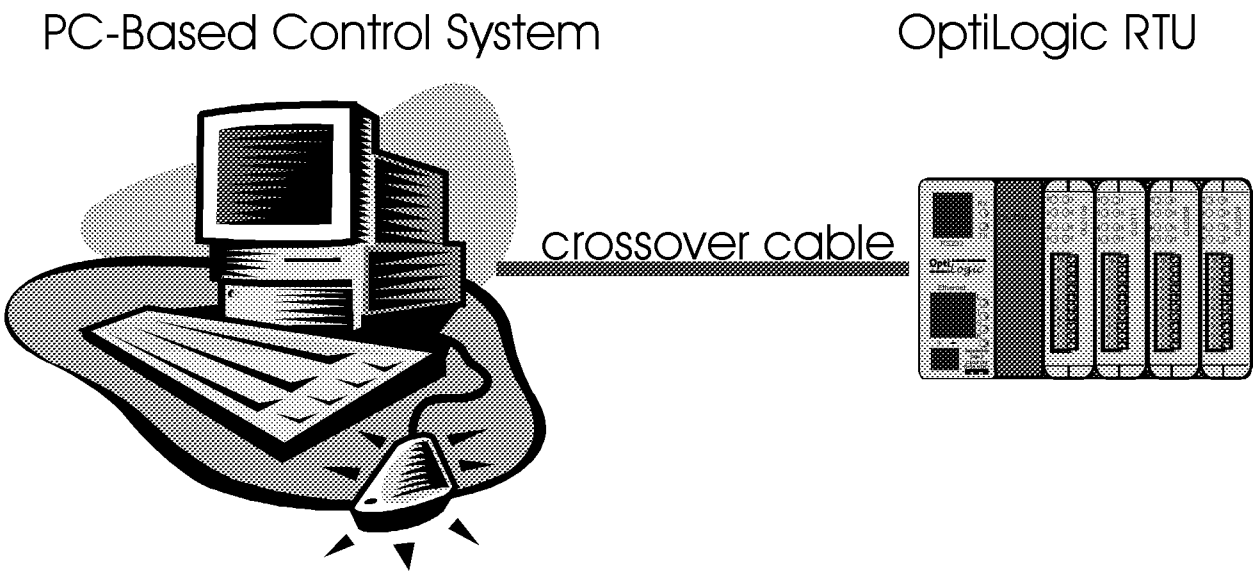
After adding a new adapter card, you will need to reboot your computer. This will load the driver and make the network card active and available. Be sure you restart your computer at this time.



7.6 Initial PC Checkout

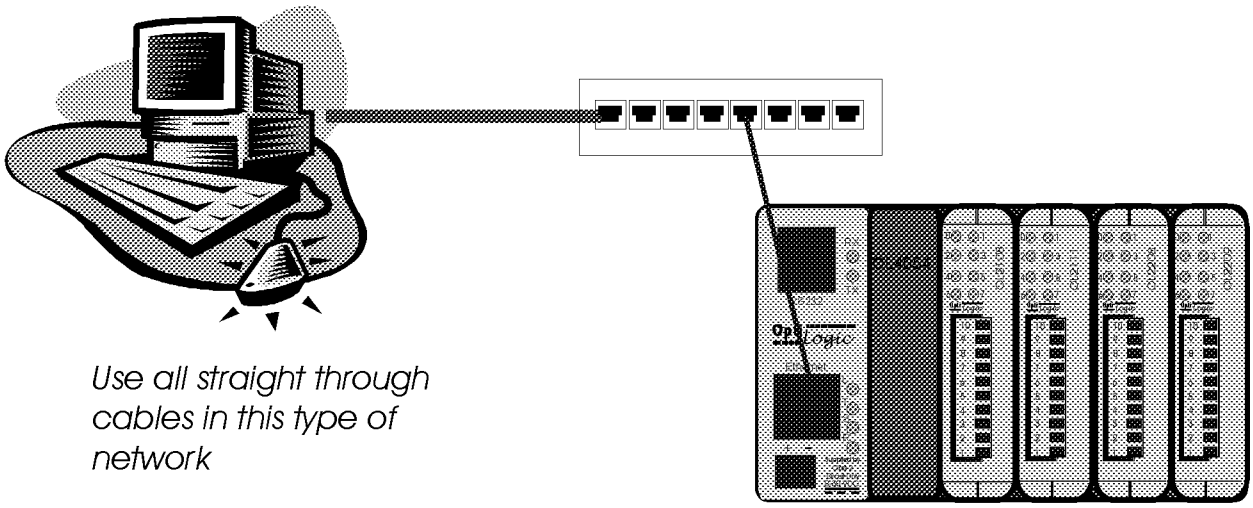
At this point we recommend that you set up a small, single RTU system to check out your PC configurations. This can be done in either of two ways depending on what cables and equipment you have on hand.

If you have a crossover cable (discussed on previous pages), simply connect the PC ethernet port to a single OptiLogic RTU, via the crossover cable. Connect DC power (12 or 24VDC supply) to the OptiLogic power input. This configuration is shown below.



If you do not have a crossover cable, set up the same basic arrangement through a hub as shown below. Apply power to the hub and RTU.

PC Based Host Controller

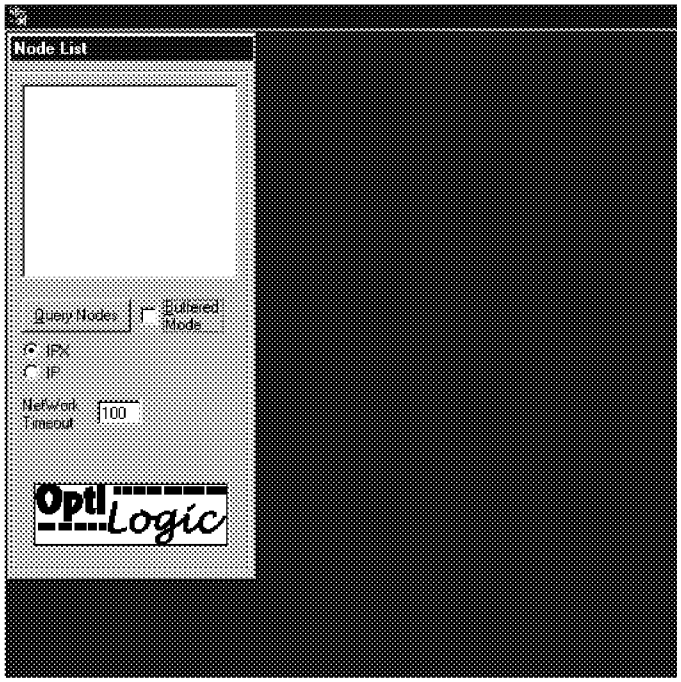


Use all straight through cables in this type of network

In either configuration, the first thing to check is if "Link" lights appear on the RTU. If you are connecting through a hub, link lights should appear on both the RTU connection and the PC connection. If the link lights do not appear you probably have a bad connection.

The next step is to run the program "OL_QuickStart". This program is found on the "OptiLogic Tools CD". Install the program from the CD, then run it from your Start Menu

7.6.1 QuickStart Verification of PC Ethernet Board



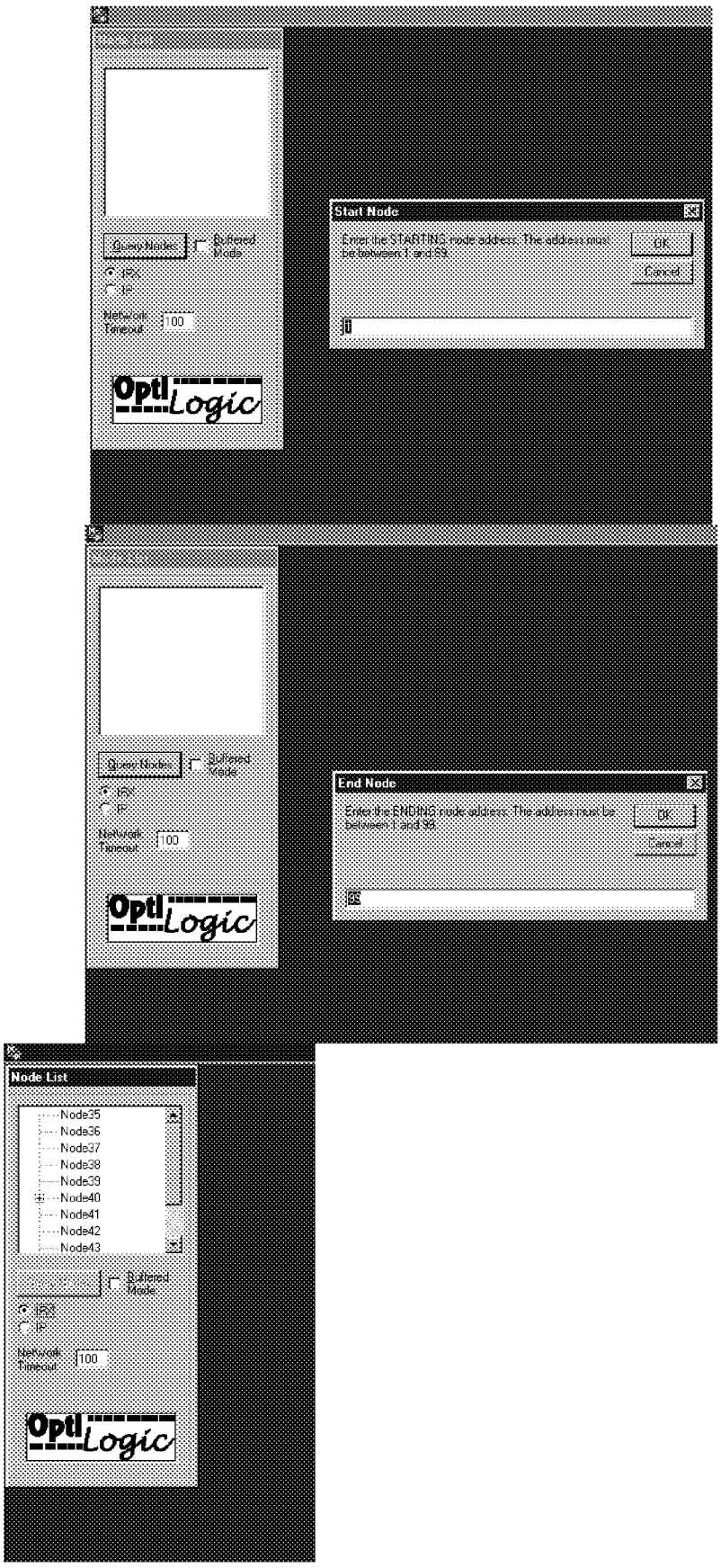
Quickstart is more fully documented later in this manual under "System Startup". This description is simply intended to allow you to perform enough QuickStart operations to verify that your PC's ethernet board is properly installed and set up.

When you click on the OL_QuickStart icon, a screen like the one shown on the right should come up. When it does, use your mouse to select the protocol you want to use (IPX or IP), then select "Query Nodes".

The QuickStart program first must find the attached RTU's or network nodes. It will ask you to enter the range of node numbers to search for RTUs. The node number is the address that you dial in on the RTU's rotary address switches.

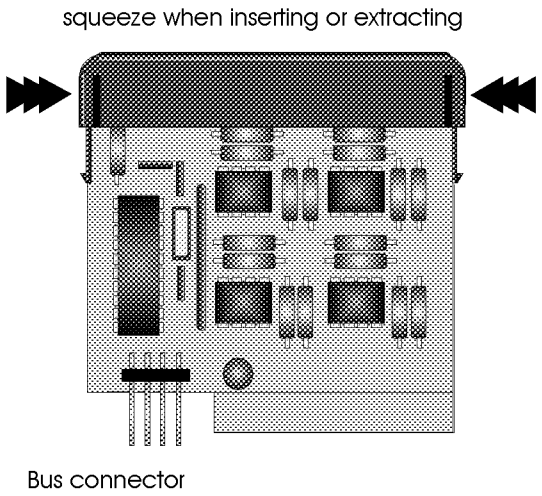
Enter a node range that includes the attached RTU. Once a range is entered, the QuickStart program will begin querying all addresses in the range. The larger the range, the longer it will take to check all addresses. Once it finds the RTU(s), a "+" sign will be placed beside the node address on the node list.

Simply finding the attached node verifies the network card installation and setup. If you would like to experiment with the node, see the more detailed OL_QuickStart instructions in the Start Up section of this manual.

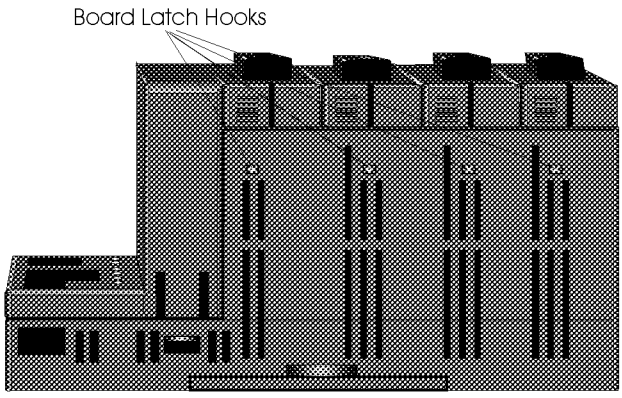


7.7 Installing the I/O Modules

Insert the I/O modules into the base. The procedure is covered in detail in the preceding pages. Line up the module with the card slots,



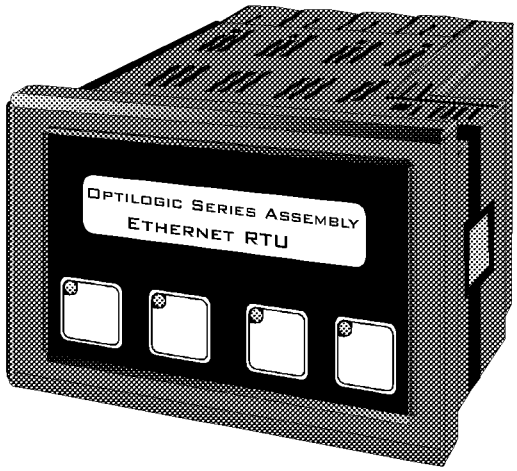
squeeze the cover to allow the latches to travel inside the cage, insert the board into the card cage slot (it will not be held firmly in place until it is approximately ¾ inch into the card cage. Press the card down until the connector is inserted fully into its mating motherboard connector and the latches snap to hook the module in place.



To extract a module, squeeze the ends together and pull the module out.

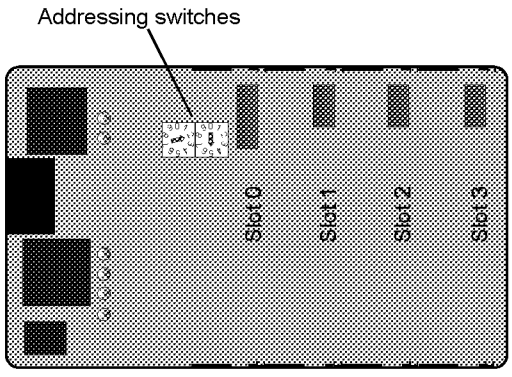
7.8 Install Operator Panels (if required)

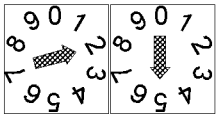
Mount the RTU base to the associated operator panel. The process is detailed in preceding pages. Remember to line up the base connector with the operator panel connector.



7.9 Address Each RTU Base

Each RTU base must have its own unique address. Set the address by dialing it in on the rotary switches (refer to details on preceding pages).





7.10 Install OptiLogic RTUs at Points of Application

Each RTU is normally installed at a different physical location. Mounting of I/O only RTUs is on DIN rail.

RTUs with operator panels are panel mounted through a panel cutout. See specifications for cutout sizes. When properly installed, the operator panel will seal against the panel.

7.11 Provide Power to each RTU

Each RTU must be powered by a DC power supply which supplies power within the 8-30VDC range. Typically, a standard 12 or 24VDC power supply is used.

7.12 Cabling and Connections

All OptiLogic Cabling must comply with Ethernet 10Base-T commercial installation standards (EIA/TIA 568A). These standards are available from the American National Standards Institute (ANSI) (phone #(212)642-4900). Cabling has been covered in more detail in preceding pages. Remember the following cabling requirements.

For this connection	Use this type cable
Hub to Switch	Crossover
Hub to Hub	Crossover
PC Workstation to OptiLogic RTU	Crossover
PC Workstation to Hub	Straight-through
Hub to OptiLogic RTU	Straight-through

7.13 Ethernet Networking Rules

When designing a 10Base-T network, use the following general rules to the EIA/IEEE Ethernet standards.

For large systems use the **5-4-3-2-1** general rule when connecting various 10Base-T network components. The general rules are as follows:

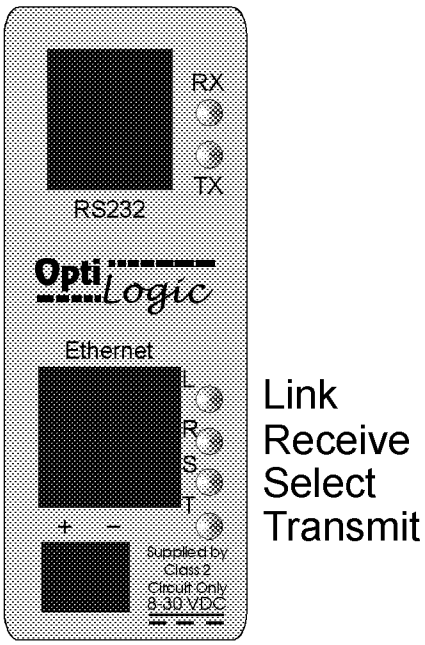
- ***Five*** hubs are allowed
- ***Four*** segments per given Ethernet LAN
- ***Three*** hubs can have nodes attached
- ***Two*** hubs can't be populated and are extensions only
- All of this makes ***one*** collision domain within the logical topology

8.0 System Start Up

The following pages cover general hardware start-up. The specific system startup operation is dependent upon system software. That operation must be covered in separate software documentation.

8.1 Diagnostic LEDs

The first thing to look at when the RTU is installed, connected to a hub or PC and everything is powered up, is the diagnostic LEDs.



The first thing that happens when the RTU is powered up is that is checks its operating program. This process takes a couple of seconds. If the operating program does not check out, the RS232 TX (transmit) LED will flash at a rate of about 1 flash per second. If this should happen, the base must be loaded with operating software.

After the startup program check (as long a programming cable is not plugged into the RS232 port), the base will enter its main program. At this point, the Select LED should be on indicating the program is interfacing the ethernet electronics.

The next thing to look at is the Link (L) LED. If it is on, there is a good ethernet link. Ethernet devices send a periodic "link pulse". The ethernet receiver on the other side looks for this link signal. If it is received, the link LED will light. Link LEDs should be on, both on the RTU and the hub.

If the link LEDs do not come on, one of the following problems probably exists.

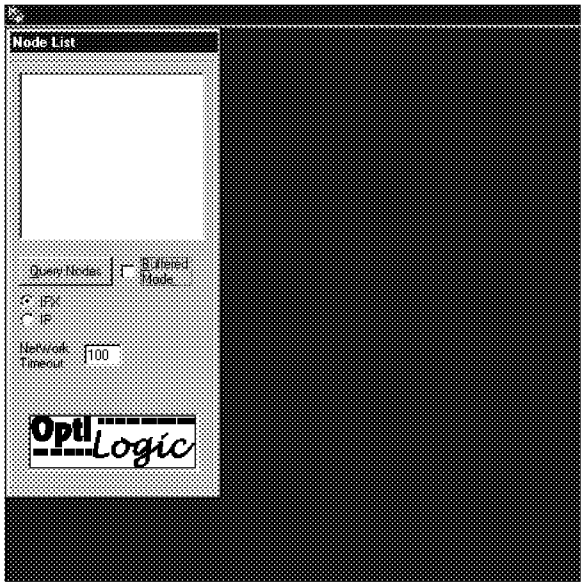
- The cable between the hub and the RTU is defective (improper connections, bad connections, etc.)
- The hub or the RTU is not turned on.

8.2 System QuickStart Software

The OptiLogic System Builder CD (purchased separately) contains a program called OL_QuickStart. This program can be used to communicate with and exercise all of the I/O, operator panel and communications functions. It will allow you to check out all of the hardware in your system.

Install the QuickStart program on your computer. To do so simply click on your Windows Start button (normally in the upper left or lower left corner of your screen). Next, select "Run", then browse your CD drive and select "SetupOLS" and "OK". The installation process will prompt you as necessary.

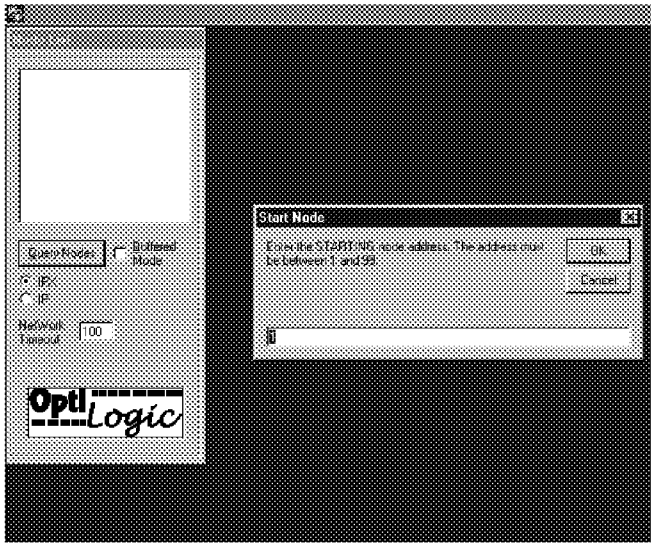
Once you have installed the software, click on the QuickStart icon to start it up. A screen like the one shown below will come up.

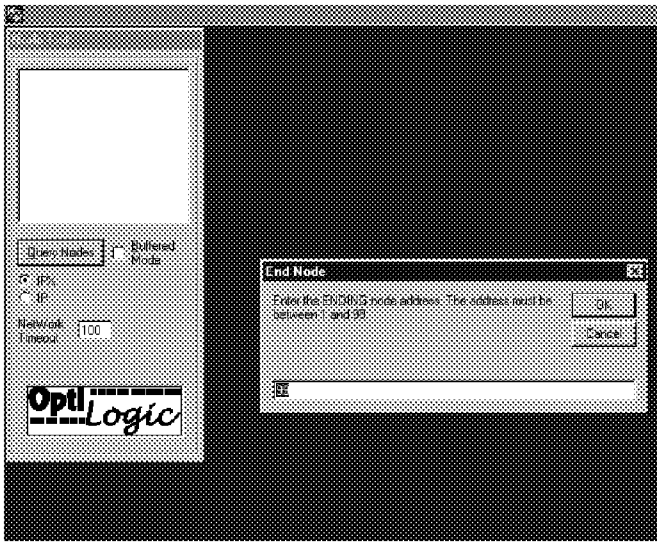


8.2.1 Finding the Attached RTUs

The first step is finding the RTUs that are attached to your network. By this point, you should have installed your RTUs and given each a unique rotary switch address. Select "Query Nodes".

Enter a node range that includes the attached RTU(s). Once a range is entered, the QuickStart program will begin querying all





addresses in the range. The larger the range, the longer it will take to check all addresses. Once it finds the RTU(s), a "+" sign will be placed beside the node address on the node list.

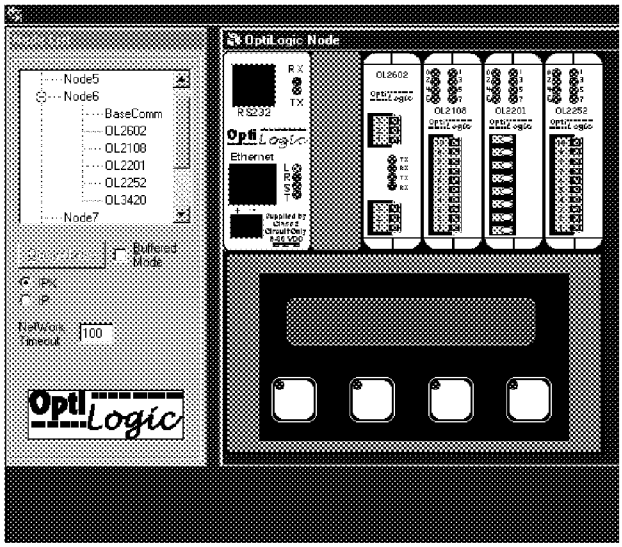
Look through the list of RTUs found and verify that all attached RTUs show up. If RTUs are missing from the list, begin with checking the following.

- Verify that each RTU has a unique address, is powered on and is cabled to a system hub.
- Verify the link light is on both the RTU and the connected hub.
- Check communications, hub by hub from the host computer. There may be a bad cable or bad connection along the line.

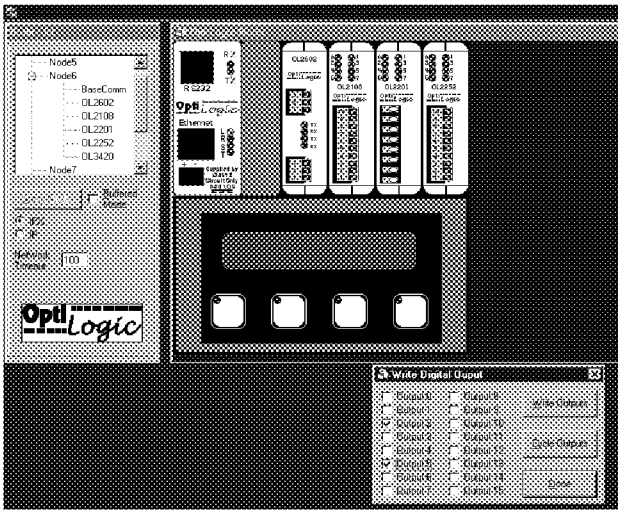
The process of finding network problems on initial start up can be tedious. However, once you've sorted through any problems and brought the system up, you are ready to deal with the system on an operational level.

8.2.2 Exercising an RTU

To exercise a particular RTU, click on its node address in the node list. A display of the RTU and all attached modules will come up as shown below. Click on the "+" sign next to the node number and the expansion list of modules, also shown below, will come up.



Click on a particular module, and its associated function screen will pop up. The figure below shows the function screen for the OL2108 relay output module, located in slot 0.

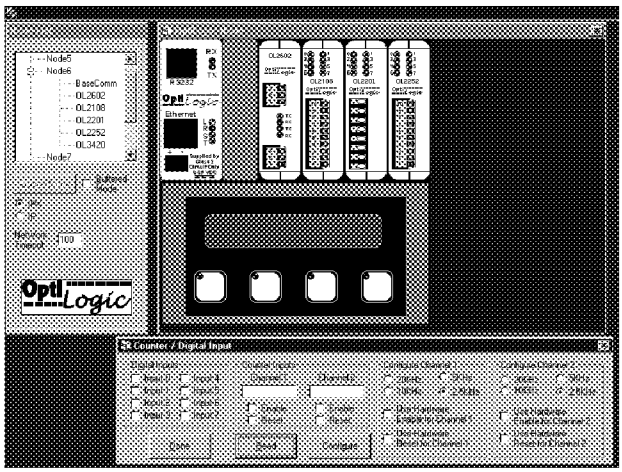


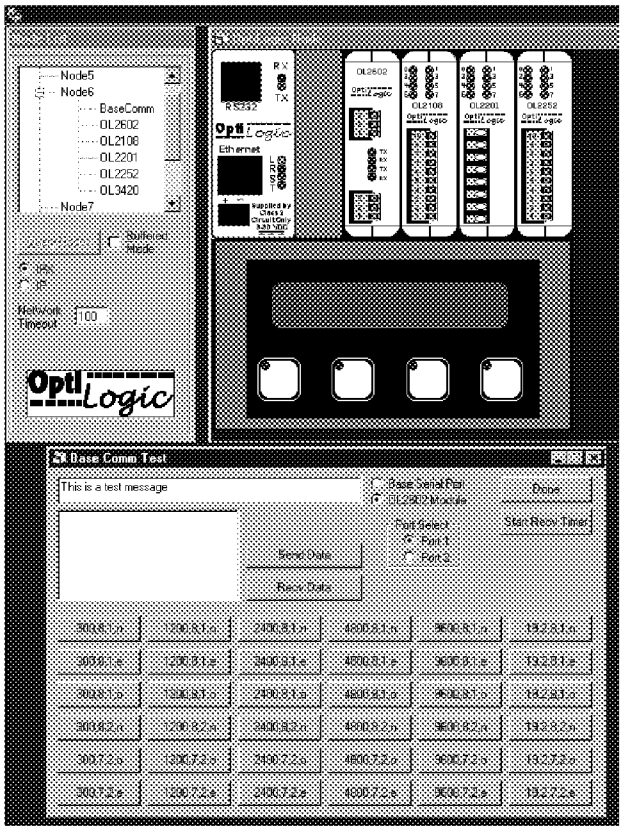
As an example of operation, select a couple of relay points and click "Write Outputs". The relays selected will turn on.

Note : Be careful when selecting the "Cycle Outputs" on a relay module. Don't leave it running long term. Relays are electro-mechanical and will wear.

When you are ready to exercise a different module, first close the function screen of the current module. After this has been done, click on the next module in the Node List. It's pop up function screen will come up.

The figures below show a couple more function screens for the OL2252 Pulse counter and the OL2602 RS232 modules. Operation of





the function software is very intuitive. More detail is given in the OL_QuickStart manual.

9.0 System Development

At this point, you should have all of your system hardware configured, connected and operational. The next step is development and application of system hardware.

There are a number of options for software development. For software professionals who regularly write programs in Visual Basic or Visual C, that option is available. Optimation supplies a DLL that can be used with your program to handle all of the details of communicating your requests and commands to the RTUs. The Software Interface Definition manual (available as a download on our web site), details the required interface.

The better solution, for 98% of all applications, is the use of a software package such as Think & Do for program development. Think & Do is an interactive, graphical, flow chart programming package designed specifically for real time control applications, such as those using OptiLogic RTUs. It already has all of the hooks to the OptiLogic system integrated and fully debugged. Think & Do is designed to give non-professional programmers the ability to develop highly complex applications quickly and easily, with a minimum level of debugging required. When used by professional programmers, Think & Do reduces the program development effort by an order of magnitude.

There are other software packages, similar to Think & Do, available. As time goes on, more of these packages will integrate the OptiLogic system. Call Optimation tech support to discuss your application and allow us to make the appropriate recommendations.

The specifics of software development is the subject of other books and manuals. For Visual Basic and Visual C development, the documentation from Microsoft and other general books on the subject are available. For Think & Do there is a "Quick Start with Think & Do" manual available from Optimation. More detailed information is contained in the Think & Do manuals. For other, third party software packages, consult the manufacturer's documentation.

10.0 Specifications

10.1 OL4054 RTU Base

10.1.1 Physical (RTU Base)

- DIN rail mount to 35mm DIN rail
- Overall dimensions (OL4054)
  4.95"L x 3.25"H x 3.00" D
- Color : Dark gray
- Material : Polycarbonate plastic

10.1.2 Environmental

- Storage Temperature : -20 to 70 C
- Ambient Operating Temperature : 0 to 55C
- Humudity : 0 - 95% non-condensing

10.1.3 Electrical

- Power : 8 - 30 VDC input power
- Minimum load current (no I/O boards or operator panel attached)
  75mA @ 24VDC
  150mA @ 12VDC
- Maximum load current (actual depends on the particular modules attached)
  700 mA @ 24VDC
  1.4A @ 12VDC
- Power Connection : Terminal block, 2 terminal

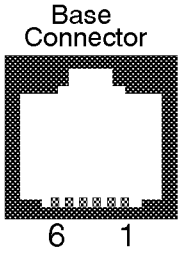
10.1.4 Communications

Ethernet

- Type : 10Base-T ethernet
- Data Rate : 10 Mbps
- Connection : RJ45
- Ethernet Protocols : IPX, TCP.IP

RS232 Port

- Baud rates : 300, 1200, 2400, 4800, 9600, 19.2K (selectable)
- Data bits : 7 or 8 (selectable)
- Parity : odd, even, or none (selectable)
- Stop bits : 1 or 2 (selectable)
- Connection : RJ12



Pin #	Description	Pin #	Description
1	GND	4	Transmit data
2	Reserved (do not connect)	5	5V Power out
3	Receive data	6	GND

10.1.5 Ethernet Base Response Time

The amount of time, from the begining of a message transmission from the host, until the OL4054 base responds is the response time. It is dependent on the number of modules (I/O and operator panel) that he host is communication with, as well as what the modules are.

In buffered mode, multiple RTUs are accessed simultaneously, so the total time is much less than the accumulation of time for each base.

To calculate response time, add the base time and the times for each I/O module or operator panel message.

Device	Time Required (mS)
OL4054 Base	1.6 +/- .3
Digital In (8 point)	.2
Digital Out (8 point)	.2
Analog In (8 channel)	.73
Base comm port (no characters)	.2
OL2602 (no characters)	.15
Transmit or receive characters	.03 each

For example, for a base with 1 digital output 1 analog input and 10 characters on an OL2602 module the time would be :

time=1.6(base) +. 2(DO) +.73(analog). + 15(OL2602) + 10*.03(10 char)

time= 2.98 milliseconds +/- 0.3 milliseconds