Installation and Wiring

In This Chapter...

Safety Guidelines

NOTE: *Products with CE marks perform their required functions safely and adhere to relevant standards as specified by CE directives provided they are used according to their intended purpose and that the instructions in this manual are adhered to. The protection provided by the equipment may be impaired if this equipment is used in a manner not specified in this manual. A listing of our international affiliates is available on our Web site: http://www.automationdirect.com*

WARNING: Providing a safe operating environment for personnel and equipment is your responsibility and should be your primary goal during system planning and installation. Automation systems can fail and may result in situations that can cause serious injury to personnel or damage to equipment. Do not rely on the automation system alone to provide a safe operating environment. You should use external electromechanical devices, such as relays or limit switches, that are independent of the PLC application to provide protection for any part of the system that may cause personal injury or damage. Every automation application is different, so there may be special requirements for your particular application. Make sure you follow all national, state, and local government requirements for the proper installation and use of your equipment.

Plan for Safety

The best way to provide a safe operating environment is to make personnel and equipment safety part of the planning process. You should examine every aspect of the system to determine which areas are critical to operator or machine safety. If you are not familiar with PLC system installation practices, or your company does not have established installation guidelines, you should obtain additional information from the following sources.

- NEMA — The National Electrical Manufacturers Association, located in Washington, D.C. publishes many different documents that discuss standards for industrial control systems. You can order these publications directly from NEMA. Some of these include:
  - ICS 1, General Standards for Industrial Control and Systems
  - ICS 3, Industrial Systems
  - ICS 6, Enclosures for Industrial Control Systems
- NEC — The National Electrical Code provides regulations concerning the installation and use of various types of electrical equipment. Copies of the NEC Handbook can often be obtained from your local electrical equipment distributor or your local library.
- Local and State Agencies — many local governments and state governments have additional requirements above and beyond those described in the NEC Handbook. Check with your local Electrical Inspector or Fire Marshall office for information.

Three Levels of Protection

The publications mentioned provide many ideas and requirements for system safety. At a minimum, you should follow these regulations. Also, you should use the following techniques, which provide three levels of system control.

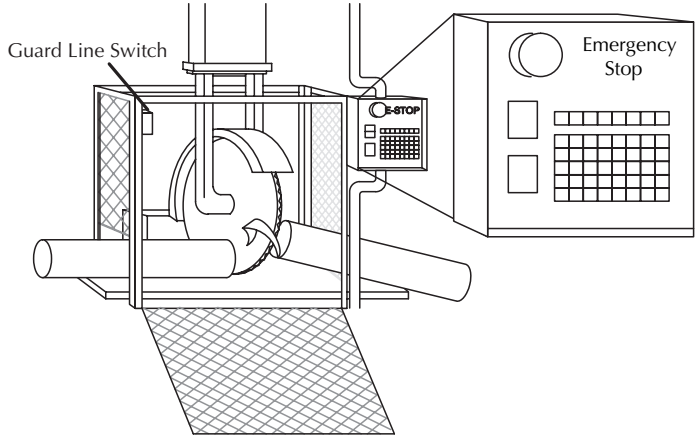
- Emergency stop switch for disconnecting system power
- Mechanical disconnect for output terminal power
- Orderly system shutdown sequence in the control program

Emergency Stops

It is recommended that emergency stop circuits be incorporated into every control system. For maximum safety, these circuits must not be wired into the controller, but should be hardwired externally. The emergency stop switches should be easily accessed by the operator and are generally wired into a master control relay (MCR) or a safety control relay (SCR) that will remove power from the I/O system in an emergency.

MCRs and SCRs provide a convenient means for removing power from the I/O system during an emergency situation. By de-energizing an MCR (or SCR) coil, power to the input (optional) and output devices is removed. This event occurs when any emergency stop switch opens. However, the controller continues to receive power and operate even though all its inputs and outputs are disabled.

The MCR circuit could be extended by placing a controller fault relay (closed during normal operation) in series with any other emergency stop conditions. This would cause the MCR circuit to drop the I/O power in case of a controller failure (memory error, I/O communications error, etc.).



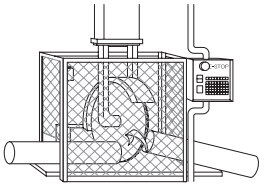
Emergency Power Disconnect

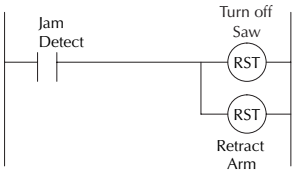
A properly rated emergency power disconnect should be used to power the system as a means of removing the power from the entire control system. It may be necessary to install a capacitor across the disconnect to protect against a condition known as "outrush". This condition occurs when the output Triacs are turned off by powering off the disconnect, thus causing the energy stored in the inductive loads to seek the shortest distance to ground, which is often through the Triacs.

After an emergency shutdown or any other type of power interruption, there may be requirements that must be met before the control program can be restarted. For example, there may be specific register values that must be established (or maintained from the state prior to the shutdown) before operations can resume. In this case, you may want to use retentive memory locations, or include constants in the control program to insure a known starting point.

Orderly System Shutdown

Ideally, the first level of fault detection is the control program, which can identify machine problems. Certain shutdown sequences should be performed. The types of problems are usually things such as jammed parts, etc., that do not pose a risk of personal injury or equipment damage.





WARNING: The control program must not be the only form of protection for any problems that may result in a risk of personal injury or equipment damage.

Hardware Installation

Before installing the Protos X I/O system, there are several things that need to be taken into consideration. The first of these considerations is the hardware configuration.

Hardware Configuration

A basic Protos X configuration will consist of a bus coupler, discrete or analog I/O terminals, and an end terminal. There are several limitations which must be considered when setting up the hardware.

1. Each bus coupler has a maximum number of terminals (64) which can be attached to the bus coupler assembly. The PX- MOD and PX-TCP1 allow expansion above the single assembly maximum (64) to the maximum number of terminals (255) by using the bus expansion terminals. The PX-TCP2 does not allow more than the maximum of 64 terminals per assembly. However since the PX-TCP2 has a built in switch, other PX-TCP2 modules can be easily connected for additional terminals.
2. Each bus coupler has 512 Bytes of input mapping and 512 Bytes of output mapping that can be used for terminal I/O points. Each I/O terminal used on the assembly will consume part of the 512 Bytes for I/O mapping. Discrete I/O will consume 1 bit of data per channel. So if you have a two-point input terminal it will consume two bits of one byte of the 512 input bytes allowed. If you have an eight-point output terminal it will consume one byte of the 512 output bytes.
3. Analog modules will consume different amounts of I/O mapping depending on which bus coupler is used. For the PX-TCP1 and PX-TCP2, each analog channel will consume four input bytes and four output bytes regardless if it is an input or output terminal. With the PX-MOD bus coupler, each analog channel will only consume 2 input bytes or 2 output bytes. It will consume input bytes if the terminal is an input terminal and output bytes if the terminal is a output terminal.
4. Each bus coupler has a coupler I/O Bus power budget. This power budget must not be exceeded as there is no internal protection in the coupler and damage to the bus coupler will occur. The specs for each terminal lists the amount of current (in milliamps) it consumes from the I/O Bus. The available I/O Bus power supplied per bus coupler is listed in the individual specs for each bus coupler. Determine the power requirements (power supplied and power consumed) of your system before installing the hardware. See example below.

Power Budget Example

This example shows how to calculate the power budget for a typical Protos X system. It is constructed using a PX-MOD Bus Coupler and six I/O Terminals. It is recommended you construct a similar table for your system. Follow the steps below to determine your power budget.

1. Using a chart similar to the one on the following page, fill in columns 1 and 2.
2. Using the specification tables for each module, enter the current supplied and current used by each device (columns 3).
3. Add together the current used by the system (row C) for column 3 and put the total in the row labeled “Maximum Current Required” (row D).
4. Subtract the calculated “Maximum Current Required” (row D), from the “Current Supplied” and place the difference in the row labeled “Remaining Current Available” (row E).

5. If "Maximum Current Required" is greater than "Current Supplied" in column 3, the power budget will be exceeded. It will be unsafe to use this configuration, and you will need to restructure your I/O configuration.

A	Column 1	Column 2	Column 3
	Terminal	Terminal Type	I/O Bus (from Coupler)
B	CURRENT SUPPLIED		
	PX-MOD	Bus Coupler	1000mA
C	CURRENT REQUIRED		
	PX-144 PX-172-1 PX-322-1 PX-312 PX-244-1 PX-412	4 pt DC Discrete Input 2 pt AC Discrete Input 2 ch RTD Input 2 ch DC Analog Input 4 pt DC Discrete Output 2 ch DC Analog Output	5mA 3mA 60mA 65mA 9mA 75mA
D	Maximum Current Required		217mA
E	Remaining Current Available		783mA

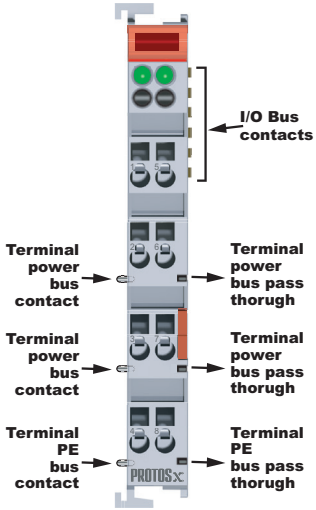
Terminal I/O Bus Wiring Options

There are different Terminal I/O Bus wiring options per terminal chosen. Some of the terminals offer access to the Terminal I/O Bus power through connection points on the front of the terminals. Usually the lower point count discrete terminals will offer this option. However with terminals having a higher point count, these connection points are not available. If Terminal I/O Bus power is needed for external devices, the PX-949 Power Distribution Terminal provides access through eight connection points to the 24VDC and 0V on the bus. There are also a couple of terminals that can be used to isolate (PX-908) or add an external voltage source to the Terminal I/O Bus. The PX-940 can be used as a 24VDC power supply terminal to connect an external 24VDC power source to the Terminal I/O Bus. The PX-970 can be used as a 120/230 VAC power source to the Terminal I/O Bus. In the assembly, neither of these terminals connect to the terminal power bus on their left side. Instead, they will carry the externally connected power source to the terminals attached on the right as long as the modules support terminal power transfer.

Terminal Placement

It is very important to understand the placement of the terminals in an assembly. Always start the assembly with a Bus Coupler and add terminals from left to right, ending with a Bus End Terminal or Bus Expansion End Terminal, attaching each terminal as shown in the System Installation section which follows.

In an assembly there is an I/O Bus, which passes data and power from the Bus Coupler to the Bus End Terminal via six I/O Bus contacts. There is also a Terminal Power Bus, which can provide power to the terminals and/or field devices via the terminal connections. Power is passed via two or three contacts located on the sides of the terminals. Not all terminals pass Terminal Bus Power, and the voltages on the bus can vary. Because of this, there are four conditions to take into consideration. These conditions can be found in the General Specifications table for each terminal unit (See Chapter 2 for terminal specifications).



General Specifications	
Operating Temp	32 to 131 °F (0 to 55 °C)
Storage Temp	13 to 185 °F (-25 to 85 °C)
Relative Humidity	5% to 95%, non-condensing
Environment Air	No corrosive gases permitted
Mounting/ Orientation Restrictions	35mm DIN rail/None
Vibration	Conforms to EN 60068-2-6
Shock	Conforms to EN 60068-2-27/ EN 60068-2-29
Noise Immunity	Conforms to EN 61000-6-2/ EN 61000-6-4
Protection Class	IP20
Weight	55g
Dimensions (WxHxD)	12 x 100 x 68.8 mm (0.47 x 3.94 x 2.71 in)
a *Adjacent Mounting on Bus Terminals with Power Contact*	Yes, DC only
b *Adjacent Mounting on Bus Terminals without Power Contact*	No
c *Passes Terminal Bus Power*	Yes
d *Passes PE Bus*	No
*Agency Approvals**	UL/cUL File No. E157382, CE

a. Adjacent Mounting on Bus Terminals with Power Contact: Terminals where Yes is shown can be mounted to the right of a terminal that passes power. Some terminals will specify DC Only or AC Only and should only be mounted adjacent to a terminal that passes the same voltage.

b. Adjacent Mounting on Bus Terminals without Power Contact: Terminals where Yes is shown do not use power from the Terminal Power Bus. These would be the Power Feed Terminals, Power Separation Terminal, and some of the Analog I/O Terminals.

c. Passes Terminal Bus Power: Terminals where No is indicated, do not pass power through the Terminal Power Bus. These would be the End Terminals, Power Separation Terminal, and some of the Analog I/O Terminals.

d. Passes PE Bus: Terminals where Yes is shown use PE (earth ground) from the Terminal Power Bus. These would be the Power Feed Terminals and any Discrete I/O Terminals that support 4-wire field devices.

System Installation and Removal

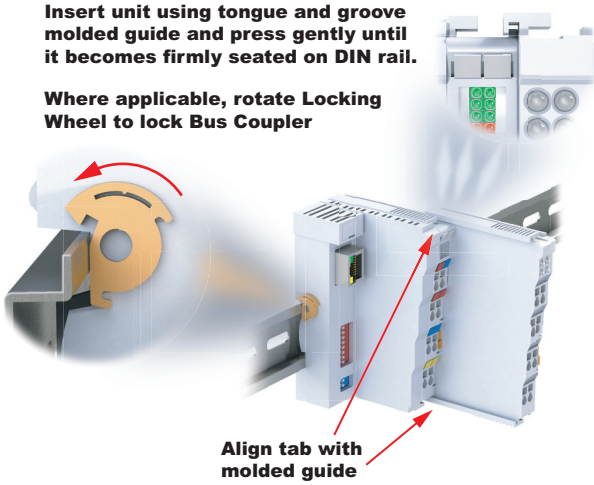
Bus Coupler Installation

Attach a Bus Coupler onto a 35mm DIN rail and secure it into position using the DIN rail locking wheel (where applicable) located on the left side of the coupler.

Bus Terminal Installation

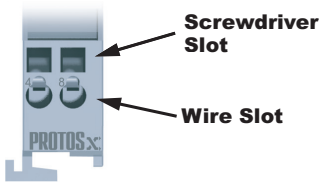
To add a bus terminal, insert unit onto right side of Bus Coupler using the tongue and groove at the top and bottom of the unit, pressing gently until it snaps onto the DIN rail.

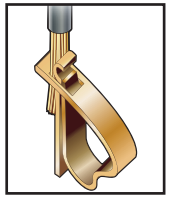
NOTE: *A proper connection cannot be made by sliding the units together on the DIN rail. When correctly installed, no significant gap can be seen between the attached units. Bus connection is made through the six slide contacts located on the upper right side of the units. Add up to 64 bus terminals per Bus Coupler, including a bus end terminal.*



Wiring Connections

Wire connection is made through a spring clamp style terminal. This terminal is designed for a single-conductor solid or stranded wire. Wire connection is made by firmly pushing the screwdriver into the screwdriver slot, inserting the wire into the wire slot and removing the screwdriver, locking the wire into position.



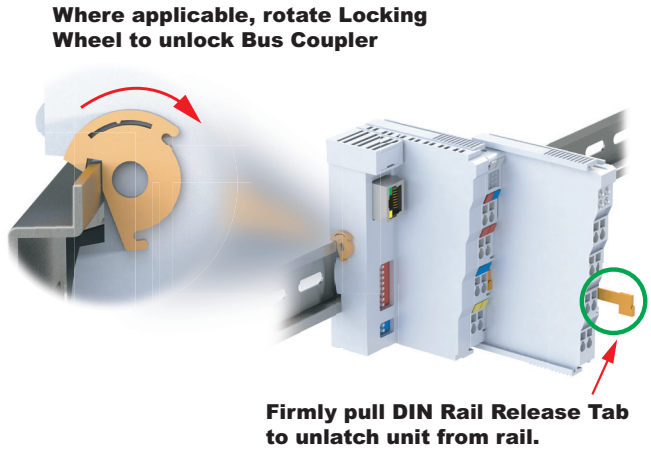


Wiring Specifications	
Connection Type	Spring Clamp Terminals
Wire Gauge/Wire Cross Section*	28–14 AWG / 0.08–2.5 mm2
Wire Stripping Length	8mm

** For Thermocouple terminals, a thermocouple extension wire is recommended*

Removing the Bus Coupler and Bus Terminals

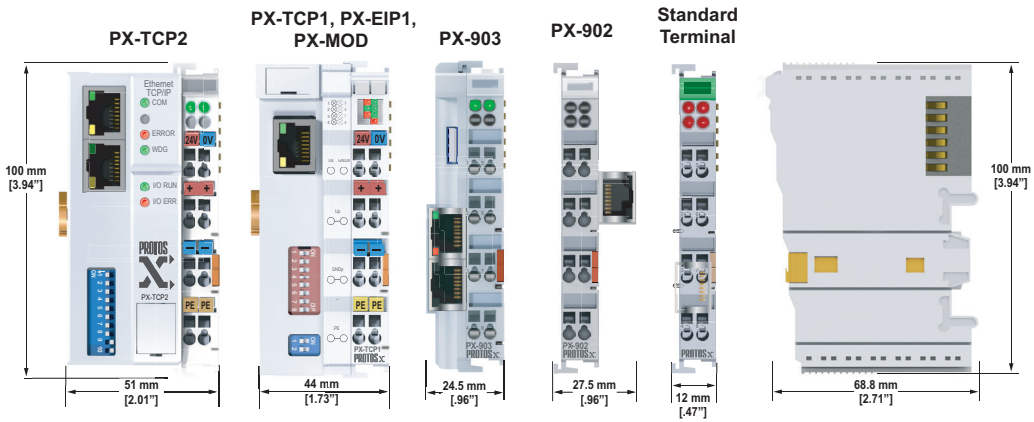
A locking mechanism prevents individual units from being pulled off. For bus terminal removal, pull the orange DIN rail release tab firmly to unlatch the unit from the rail. If attached to other terminal units, slide unit forward until released. For Bus Couplers with locking wheels, release the DIN rail locking wheel, then pull firmly on DIN rail release tab.



Terminal Dimensions and Spacing Requirements

Use the following diagrams to make sure the Protos X system can be installed in your application. Protos X terminals require 35mm DIN rail for mounting and there are no orientation restrictions.

It is important to check the Protos X dimensions against the conditions required for your application.



Also, to ensure proper airflow for cooling purposes, units should be spaced, at a minimum, as shown below.