Getting Started

Quick Reference Guide

Parts List
Installation Instructions

Important

Please review this entire document and all information included with this product before beginning installation or setup. Save these instructions as reference material for product installation and maintenance.

Section I - Heating System

Introduction

This heater is a component part for a heating system typically used to heat open-top process tanks containing aqueous electroplating chemistry.

IA – Heater System Requirements

Listed below are **minimum** system requirements. Shutoff provides the ability to interrupt power if predetermined values are exceeded.

- **Ground Fault Detection** to detect ground fault leakage ((heater power conducted through earth ground) and shut-off if current exceeds value.
- **Heater Sheath Temperature Detection** to shut-off if heater sheath temperature exceeds value.
- **High Solution Temperature Detection** to shut-off if the solution temperature exceeds value.
- **Solution Level Detection** to shut-off if the solution level falls below value, exposing the heater's Hot Zone. This helps prevent an overheat hazard.
- **Temperature Control** with sensor detection for failed (open or shorted) temperature sensors to prevent an overheat hazard, as heating control circuitry permits heater power until the temperature reaches its set value.
- **Total earth ground resistance** is less than 5 ohms; including resistance from grounding conductors connecting heater to earth ground.







Electric immersion heaters will ignite many plastic tanks such as polypropylene and polyethylene, and can subject personnel to a shock hazard if not properly installed and maintained. All heaters must be equipped with a thermal over temperature device such as a P1, P2, or P3 type, and must have liquid level control to reduce the potential of fire. ***It is the customer's responsibility to purchase, install and maintain thermal and liquid level protection.***

Prior to removing and inspecting heaters, it is strongly recommended that you turn off all power. Although the heater and tank are grounded, the probability of full line voltage resident in the tank is high if heater sheath fails. Adhere to all System Requirements in electric immersion heater applications to help prevent electrical shock. If heater is improperly installed and maintained or installed without a properly engineered control system, a serious fire and personnel hazard is present.

Do not use electric immersion heaters to heat flammable solutions.

IB – General Guidelines

Always follow installation instructions, wiring diagrams and these general guidelines to ensure optimal performance and heater life longevity.

Cooldown Before Removal

Never remove heaters from solution while at operating temperature as personnel may be exposed to hot surfaces, Quartz heaters may fracture and fluoropolymer heaters may melt. Power down and allow heater to cool for five to ten (5–10) minutes before removal or drainage.

Heater Cleaning and Maintenance

Sludge and particle buildup on or around heater results in excessive temperatures and increased corrosion that shorten life of heater. Ensure installation provides sufficient excess power line for easy cleaning/maintenance. Check heaters frequently for buildup and clean if accumulation is present.

- Turn off Power before beginning maintenance. Wear protective clothing for tank contents prior to removal and inspection.
- Use care when maintaining heaters. Scraping the surface can destroy fluoropolymer sheaths, remove passivation surfaces on metal heaters and chip quartz surfaces. Never hammer heaters to remove built-up deposits
- Consult with your process supplier for chemical sludge removal procedures

Replacement Protectors

Use only manufacturer's Over Temperature Protectors for replacement and follow factory-supplied instructions for Protector 1 Series or Protector 2 Series protectors, or it could be rendered ineffective.

IC – General Wiring Notes

Power Wiring

Size/route power wires to latest edition NEC; connect to manufacturer temperature controller.

Multiple protector wiring

Refer to Figures 2, and 5–7 in this booklet for multiple protector wiring in a single installation.

Three phase current rating

The three phase current on single phase heater nameplates only applies when field installing/ assembling three (3) identical single phase heaters in a three phase delta arrangement. Each element rated at phase-to-phase voltage.

ID – Heater Installation

Caution

Quartz and Fluoropolymer heaters are very fragile and require care when handling and assembling.
Use extreme care when handling equipment, as fluoropolymer sheaths can be irreparably damaged by the slightest nick or cut. Never use knives or any other sharp instrument to open heater wrapping.

1 Unpack your equipment and thoroughly inspect each product for damage that may have occurred during shipping. Should damage exist, notify the carrier immediately for instruction on filing claims.

Do not operate damaged products.

2 Locate the heater nameplate tag, stamped on metal coils or on the fluoropolymer coil wrapping, which provides voltage and amperage information. Identify heater style and refer to the packing list and purchase order to verify you have the correct equipment; see Figures 1–3 for reference.

3 If all data matches, review installation location to identify and verify the following items:

- line voltage and heater voltage are in agreement.
- Over Temperature Protector/fused disconnect or circuit breaker is correct, of sufficient capacity, and sized per NEC, latest edition.
- process tank is equipped with a Low Solution Level Detection shut-off device.
- you have the correct sized temperature controller (thermostat) for heater voltage and amperage requirements; controller contains required circuitry for the Over Temperature Protector and Low Solution Level Detector. Heater sheath material and solution to be heated are compatible. If voltage or material is incorrect, do not install or operate heater.

4 For Quartz heaters, continue to step 5, for other types of heaters, continue to step 8.

5 Quartz Heaters are fragile; Use care when handling and assembling. Turn head cover counterclockwise to remove.

6 Tilt the tube slightly and slowly insert the heating element assembly until seated.

7 Route the wires through the conduit opening in the head. Pitch heater electrical conduit down and away from heater head for drainage.

8 Install heater head cover; screw on clockwise until tight. (Continue to step 9)

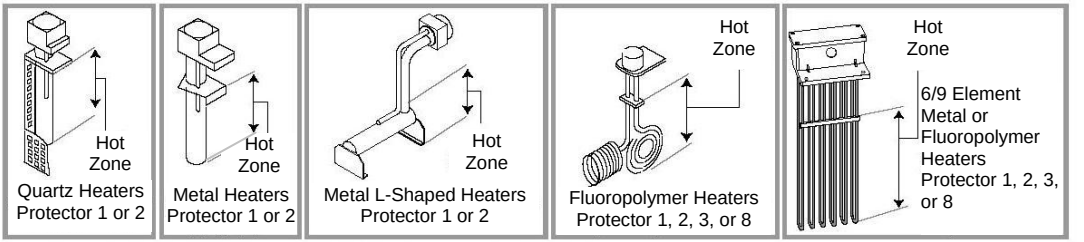


Figure 1 Typical Heaters and their Over Temperature Protectors

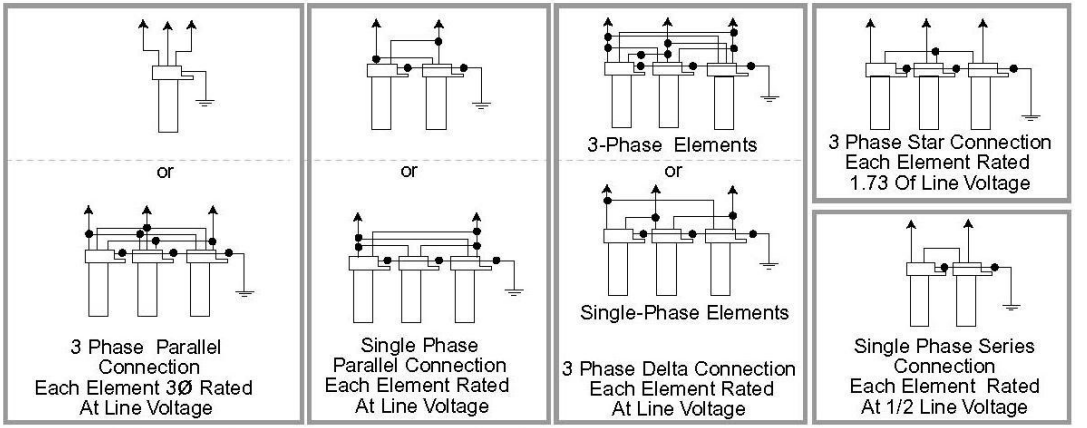


Figure 2 Single and Three Phase Connection Wiring Diagrams

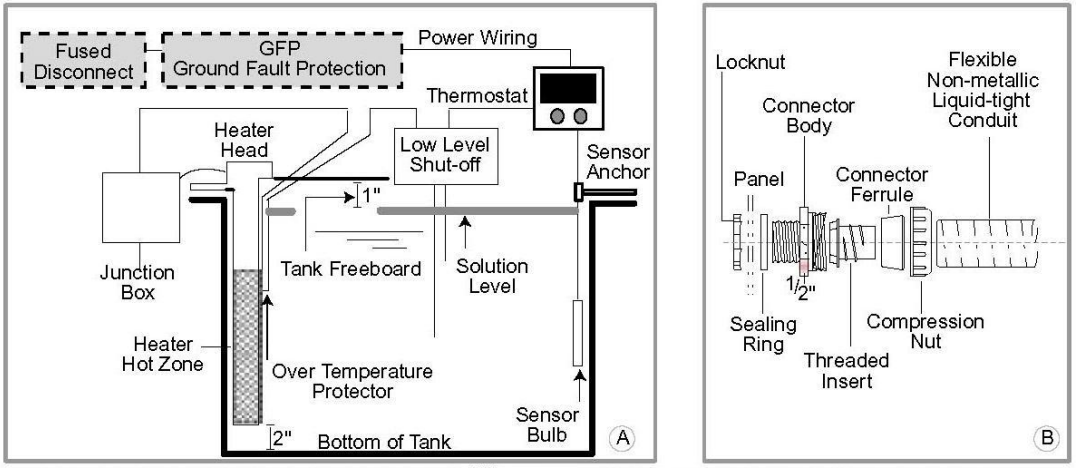


Figure 3 Typical Installation in a Process Tank (A), Flexible Non-Metallic Conduit Connector Installation (B)

Heaters need to be mounted in locations away from contact with work, and the heater heads should be protected from splashing, dripping and excessive moisture. Do not operate electric heaters under covers and always provide adequate ventilation.

(Heater Installation continued)

9 Carefully Mount heater (and guard if applicable) securely to tank.

- Hot Zone must be totally immersed at all times – the cold length of the heater must be long enough to prevent exposing the top of the heater Hot Zone.
- Low Solution Level Detection with heater power shut-off provides the ability to interrupt heater power if the solution level falls, exposing the heater Hot Zone. **Level controls must be used.**
- Minimum 1" clearance between heater sheath and tank at all points.
- A one inch (1") minimum tank freeboard above the heater Hot Zone is required to prolong heater life. If solution level drops below the hot zone, it may shorten the life of the heater and may pose a significant fire hazard in plastic or plastic lined tanks.
- Minimum 2" clearance above any parts accumulation /sludge on bottom of tank.
- Isolate heaters from any electrified source. Heaters should not contact anodes, cathodes, any electrified portions of tank, racks or parts at any time.
- Connect the heater ground leads to the building ground (or rectifier ground) to prevent voltage potential difference.
- Heater heads should be protected from splashing, dripping and excessive moisture. Do not operate heaters under covers and always provide adequate ventilation.

10 Route heater power lead wires along with ground lead and protector leads through conduit. Size and route power wiring to NEC latest edition. Standard wiring consists of the following colored wire:

- black—power leads
- green—ground lead
- yellow, blue, white or red—Over Temperature Protector leads (color is dependent upon protector designation and temperature rating)

Other wiring color combinations are available; consult factory for details.

If installing flexible nonmetallic conduit, properly install connector ferrule to ensure liquid-tight operation.

11 Install the control. Secure the sensor or place in a suitable thermowell to prevent movement that could lead to erroneous readings and a dangerous overheat condition.

Install the top of the sensor bulb below the minimum liquid level and always above the bottom of the heater. A mislocation or floating sensor can result in an overheat condition which could result in a significant fire hazard in plastic tanks.

12 Set low level shut-off at least 1" above the top of heater Hot Zone.

13 Install the junction box per NEC latest edition. Mount on an ambient surface. Using approved splice connectors, install a 60° Celsius wire (minimum—based on nameplate amperage).

IE – Conduit Installation

See Figure 3 for illustration of Conduit.

1 Cut conduit end square.

2 Apply compression nut over end of conduit.

3 Apply connector ferrule over end of conduit.

4 Place threaded insert into end of conduit.

5 Place conduit with insert, ferrule and nut into the connector body until the insert sits firmly in the bottom of the connector body interior.

6 Slip the connector ferrule along the conduit until it is seated against the connector body.

7 Hand tighten the compression nut firmly onto the connector body threads.

8 Place sealing ring onto the connector body.

9 Insert assembly into a 7/8" diameter (or appropriately sized) hole in panel or box opening.

10 Secure the assembled connector into the panel or box using the locknut, making sure that the sealing ring is between the connector body and the panel or box.

Section II – Protector 1 Series Over Temperature Protectors

The Protector 1 Series Over Temperature Protectors utilize a eutectic switch with a pre-specified One-Shot melt temperature. Devices of this type are recommended for all heater installations. The One-Shot characteristic can alert operators to identify and remedy the cause of over temperature conditions as they replace spent fuses.
The UL/CSA rating permits direct connection in many applications for economical installations. All three-phase installations or those whose heater power requirements exceed the amperage or voltage rating require a power contactor to provide an indirect heating load connection.

UL Rating Requirements

- 15 amps at 120VAC or 240 VAC

Per UL requirements, you must purchase replacement protectors from the manufacturer.

Model #	Item #	Heater Material	Heater Style	Bath Temp
P1	6021-18-R	Metal	over the side	to 180°F/82°C
P4	6022-18-R	Metal	over the side	to 230°F/110°C
P5	6023-18-R	Metal	over the side	to 300°F/149°C
P1	6021-85-R	Metal	L-shaped	to 180°F/82°C
P4	6022-85-R	Metal	L-shaped	to 230°F/110°C
P5	6023-85-R	Metal	L-shaped	to 300°F/149°C
P1	6032-26-R	Fluoropolymer	over the side	to 190°F/88°C
P1	6032-48-R	Fluoropolymer	L-shaped	to 190°F/88°C
P1	6032-26-R	Quartz	over the side	to 180°F/82°C
P4	6033-26-R	Quartz	over the side	to 230°F/110°C

Table 1: Protector 1 Series Specifications

IIA – Protector 1 Series Installation

Caution

Follow the replacement procedures outlined in this document. Failure to do so may result in a fire heater failure or premature burnout. Note UL Rating Requirements when determining heater system wiring.

- *PTFE Systems—For steps 7, 8 and 11, take care not to damage or move the protector well. If you do, the heater must be factory-repaired.*
- *All Systems—After step 10, if moisture reoccurs, do not return the heater to service. Consult factory for advice.*

1 Shut off /lock out heater electrical power.
2 Remove and retain Heater Head cover.
3 In the Heater Head, mark where the spent Protector leads exit the Protector well.
4 Note the location of the Wire Nuts secured to the spent Protector leads (for re-connection).
5 Remove and retain Wire Nuts, separate wires.
6 Remove and retain Electrical Insulation Putty from the spent Protector.
7 Remove and retain the spent Protector.
8 Using the spent Protector leads as a measuring guide, cut and strip the new Protector leads to a similar length.
9 Line up Protectors and transfer marks from the spent Protector leads to the new leads.
10 Examine the Protector well for moisture by inserting a long wooden dowel or similar suitable device. If moist, thoroughly dry the well using cloth swabs or similar means.

- Ensure no material is left in the well.
- Once dry, ensure that no further moisture is seeping into the Protector well. If moisture reoccurs, **do not return the heater to service**. Consult factory for advice.

11 Insert new Protector into the dry, empty well until Protector bottoms out. Verify position is at the bottom of the well by feeling it through the Protector or using a push rod.

- Use the Protector lead insulation marks to make sure leads are lined up with the top of the Protector well in the heater head. If the marks are above the top of the well, there is a possibility the Protector is not fully inserted.
- **Unsafe operating conditions exist** if heater is used with an improperly positioned Protector.

12 Reinstall connecting wires to the wire nuts.
13 Reapply Electrical Insulation Putty. Seal the well opening to prevent moisture from entering.

14 Examine the heater head. If necessary, replace Heater Head Cover and Head Gasket. If provided, cover hold-down screws to ensure a moisture tight seal when reinstalled.
15 Reinstall the new assembly.
16 Examine conduit connection at heater head; repair for liquid tight connection, if necessary.
17 Reconnect power to return heater to normal operating service.

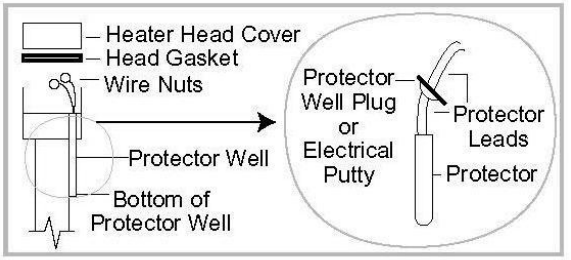
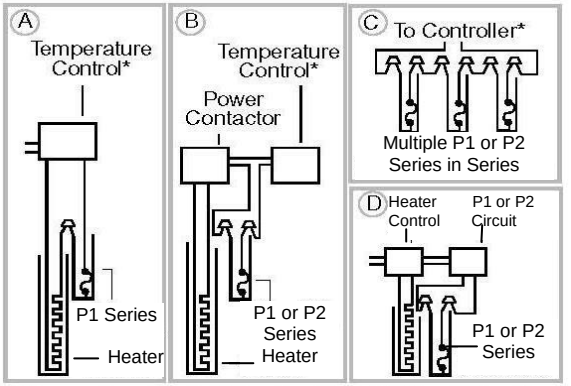


Figure 4 Typical Over Temperature Protector Installation



***Temperature control requires reset circuitry for Protector 2 Series operation.**

Figure 5 General Wiring — Single Phase (A), Polyphase (B)

Section III – Protector 2 Series Over Temperature Protectors

The Protector 2 Series Over Temperature Protectors are recommended for heaters in metal or plastic tanks. The slow make/slow break bimetallic thermostat has a pre-specified switch temperature. The slow break characteristic coupled with a push button reset feature is extremely useful when a high temperature or low liquid level occurs.

UL Rating Requirements

- 2.6 amps at 120 VAC
  Per UL requirements, you must purchase replacement protectors from the manufacturer.

Model #	Item #	Heater Material	Heater Style	Bath Temp
P2	2804-18-R	Metal	over the side	to 180°F/82°C
P6	4047-18-R	Metal	over the side	to 230°F/110°C
P7	2805-18-R	Metal	over the side	to 300°F/149°C
P2	2804-85-R	Metal	L-shaped	to 180°F/82°C
P6	4047-85-R	Metal	L-shaped	to 230°F/110°C
P7	2805-18-R	Metal	L-shaped	to 300°F/149°C
P2	4575-26-R	Fluoropolymer	over the side	to 190°F/88°C
P8	5163-120-R	Fluoropolymer	over the side	to 210°F/99°C
P2	4575-48-R	Fluoropolymer	L-shaped	to 190°F/88°C
P8	5163-120-R	Fluoropolymer	L-shaped	to 210°F/99°C
P2	4575-26-R	Quartz	over the side	to 180°F/82°C
P6	5580-48-R	Quartz	over the side	to 230°F/110°C

Table 2: Protector 2 Series Specifications

IIIA – Protector 2 Series Installation

Warning
Never use a Protector 2 Series Over Temperature Protector to directly switch heater power. Always follow the replacement procedures outlined in this Installation Sheet. Failure to do so may result in a fire or premature heater burnout.

The Protector 2 Series Over Temperature Protector is electrically installed with a holding circuit and a power contactor to energize the heater.
See Figure 5B, C and D for Protector 2 Series wiring.

Section IV – P3 and P8
Over Temperature Protectors

The P3/P8 series is recommended for fluoropolymer sheathed heaters where over temperature could result in sheath damage and/or fire hazard.

P3/P8 works with P3-A, the Over Temperature Board, to provide sheath and fire hazard protection through the power contactor. P3-A is a temperature controller switch with built-in thermocouple testing, momentary "on-board" reset holding circuitry and output contacts that interconnect with the process temperature controller and heater power contactor. The enable terminals provide the ability for loop devices such as level probes, high temperature cutoffs, and so on, to interrupt heater power. You can install a virtually endless loop of interrupt devices (normally closed), linked together in series. See Convert P3/P8/P1/P2 For Loop Devices.

The P3/P8 miniature insulated thermocouple, installed between the heater surface and fluoropolymer sheath, extends to P3-A with a factory installed temperature set point. This provides the ability for P3-A to check P3/P8 thermocouple status and interrupt the heater power contactor/heater power in the event of an over temperature condition or thermocouple failure. An on-board LED provides indication of proper function. In most cases, you can field-convert P3-A for over temperature protection of fluoropolymer heaters with P1 or P2. See Convert P3-A For P1/P2 Operation.

Multiple P3/P8s require multiple P3-A Boards wired to the heater power contactor.

IVA – P3 and P8 Installation



Hazardous voltage environments—only qualified electricians should perform Converted P3-A Board Tests and Troubleshooting which occurs in an open enclosure. Use Extreme care as live circuits are exposed, posing electrocution risk. Proper tools, procedures and protective insulating gloves are required.

The P3/P8 extension wires operate at millivolt levels; exercise care when installing this system to ensure proper function. Never apply power of any voltage level to the P3/P8 extension wires, as irreparable damage will result.

Never attempt field adjustment of the over temperature set point (dropout temperature) as this can initiate dangerous operating conditions. The over temperature set point is factory adjusted to afford protection for the heater sheath, nonmetallic tanks, tank linings and auxiliary equipment.

Extend Factory / Replacement Wiring

Use only #20 AWG or larger type J thermocouple extension wire when connecting the on-board relay to the power contactor and alarm circuitry to minimize line loss and associated temperature error.

Always observe polarity at all connections.

- red lead (negative) is wired to J-
- white lead (positive) is wired to J+

Convert P3-A For P1/P2 Operation

1 Remove thermocouple lead; Figure 7A.
2 Remove and retain enable jumper, Figure 7B.
3 Install enable jumper at Thermocouple terminals J- and J+, Figure 7D.
4 Install P2 or P1 at Enable Terminals.
5 Verify conversion before placing heater in service; perform Converted P3/P3-A Tests.

Convert P3/P8/P1/P2 For Loop Devices

1 On the existing enable loop, Figure 7C, disconnect one leg of the enable circuit.
2 Install any gauge jumper wire across J- and J+, Figure 7E.
3 Tie P2 or P1 into loop, Figure 7E.
4 Verify conversion before placing heater in service; perform Converted P3/P8A Tests.

Troubleshooting and Testing P3/P8/P3-A

P3-A electrically latches by a momentary closure of the reset/start terminals. If P3-A unlatches or is prevented from latching, check for these items:

- Power interruption (incoming power dropout)
- An open condition in enable terminals (if used)

P3/P8 thermocouple temperature above set point

- Broken/open P3/P8 thermocouple or leads

- Reversed thermocouple connection
- Non-illuminated LED—this does not indicate fault condition. If you apply incoming power prior to depressing the reset button, the LED may or may not illuminate (it is wired in the thermocouple "sense" circuitry). Upon reset, the LED should extinguish and remain off.
- Steady Illuminated LED During Reset—Upon attempting to reset, if the LED remains illuminated and the P3-A relay fails to latch you probably have an open (bad or broken) connection. Either one or both thermocouple leads are not connected or open, or the P3/P8 thermocouple in the heater is open.
- P3-A Reset —If the P3-A shuts the controller down after a period of time in operation, and reset attempts result in short time operation only, observe the LED. Prior to reset, an illuminated LED indicates a reversed lead condition or incorrect polarity condition. Examine all connections and correct wiring.
- Shorted Thermocouple Leads—shorted leads will result in an ambient temperature signal. If undetected, this condition can result in damage to heater and/or damage to the tank. Always inspect for and correct any possible shorted or damaged thermocouple leads.

Converted P3/P3-A Tests

Complete tests before placing heater in service:

1 Ensure control set point is above current tank temperature.

2 Turn ON control and press RESET/START. The control alarm should silence and the HEATER ON light should illuminate.

3 If control does not function as described, turn OFF and recheck wiring.

- ensure P2 or P1 is wired to enable terminals
- ensure enable jumper is connected to J- and J+
- with correct wiring and jumper connections verified, repeat step 2 If you successfully perform step 2, continue to step 4

4 Turn OFF power and remove one of the Protector leads connected to enable terminals.

5 Turn ON control and press RESET/START.

6 The control alarm should remain in alarm mode and the HEATER ON light should remain extinguished.

7 If the HEATER ON light is illuminated and/or the control alarm is not in alarm mode, verify at least one lead is disconnected from the enable terminal and repeat step 4

8 If the control alarm remains in alarm mode and the HEATER ON light remains extinguished, reconnect Protector leads to enable terminals.

9 Consult factory for further corrective action.

10 When you successfully complete the tests above, verify wiring for tight connections and place heater into service.

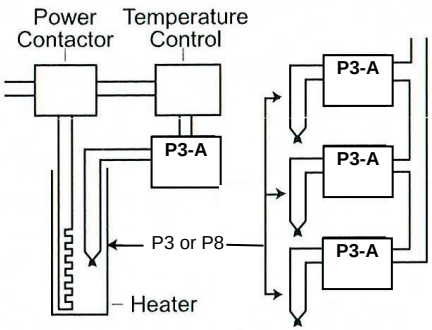


Figure 6 P3/P8 Typical Installation

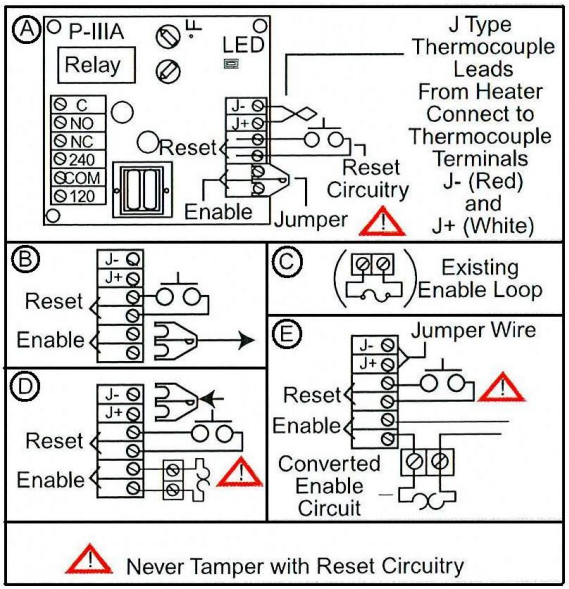


Figure 7 Wiring to Convert P3-A for P1/P2 and Loop Devices