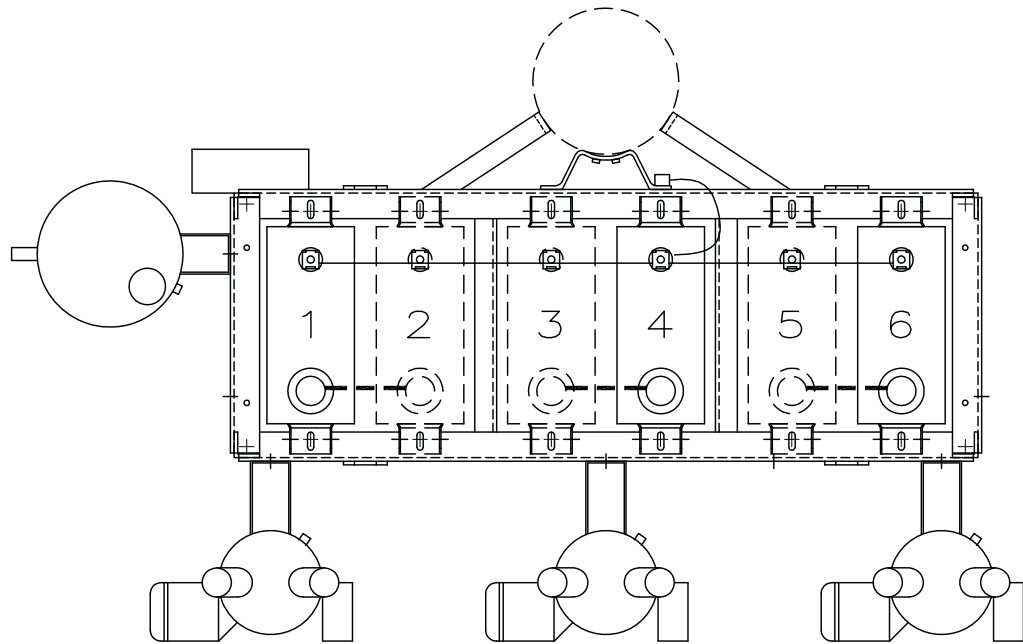


## Pole-Mounted Three-Phase Capacitor Bank Installation Operation and Maintenance Instructions



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# Pole-Mounted Three-Phase Capacitor Bank Installation



## Safety for life



Eaton meets or exceeds all applicable industry standards relating to product safety in its Cooper Power™ series products. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Eaton employees involved in product design, manufacture, marketing, and service.

We strongly urge that you always follow all locally approved safety procedures and safety instructions when working around high voltage lines and equipment, and support our “Safety For Life” mission.

## Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as arc flash clothing, safety glasses, face shield, hard hat, rubber gloves, clampstick, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

### Hazard Statement Definitions

This manual may contain four types of hazard statements:

---

#### DANGER

---

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

---

#### WARNING

---

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

---

#### CAUTION

---

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

---

#### CAUTION

---

Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage only.

---

### Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

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#### DANGER

---

**Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment.**

G103.3

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#### WARNING

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**Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling or maintenance can result in death, severe personal injury, and equipment damage.**

G101.0

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#### WARNING

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**This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury and equipment damage.**

G102.1

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#### WARNING

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**Power distribution and transmission equipment must be properly selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install or maintain power distribution and transmission equipment can result in death, severe personal injury, and equipment damage.**

G122.2

## Product information

### Introduction

MN230003EN covers instructions for mounting capacitor bank assemblies on poles. (The single-phase capacitors in these assemblies are furnished in hermetically sealed cases containing pack assemblies impregnated with a dielectric fluid; refer to MN230002EN for installation, maintenance, and field-testing instructions of individual capacitors.) Where applicable, the requirements of national and/or local codes and insurance underwriters must be followed.

### Read this manual first

Read and understand the contents of this manual and follow all locally approved procedures and safety practices before installing or operating this equipment.

### Additional Information

These instructions cannot cover all details or variations in the equipment, procedures, or process described nor provide directions for meeting every possible contingency during installation, operation, or maintenance. For additional information, contact your representative.

### Acceptance and initial inspection

Each capacitor bank assembly shipped is in good condition when it leaves the factory. Immediately upon receipt of a capacitor bank shipment:

1. Check each capacitor nameplate to make sure the rating is correct for the application.
2. Check the bank and each capacitor case and bushing for signs of rough handling and shipping damage. Check each capacitor case for fluid leaks.

If initial inspection of a capacitor bank indicates a damaged bushing, dented or bulged capacitor case, a fluid leak, or damaged bank, immediately file a claim with the carrier and notify Eaton, 1520 Emerald Road, Greenwood, SC 29646.

3. If shorting wires are provided for transportation/storage, verify that these have been removed prior to energization.
4. Tighten all bolts that may have loosened during shipment. Tighten the capacitor terminal clamp nuts to a torque of 16–19 ft.-lb.
5. Check for proper wiring of the capacitor units. Refer to Figure 1
6. Verify electrical clearances around and within pole-mounted capacitor bank.
7. If switches are provided with the capacitor bank, the switch contacts must remain closed during transportation and handling.
8. Test and operate all switches and secondary accessory equipment.
9. Ensure the capacitor bank frame is properly grounded per utility grounding practices.
10. Optionally, a thermal scan may be performed on all electrical connections to check for overheated electrical joints. The thermal scan must be performed after a minimum of two (2) hours of continuous energization. Pay particular attention to the capacitor terminal temperatures.

### Handling and storage

Be careful during handling and storage of the capacitor bank assembly. If it is to be stored for any length of time prior to installation, provide a clean, dry storage area. Equipment must remain in the upright position during handling, storage, and installation.

### Standards

ISO 9001 Certified Quality Management System.

### Documentation

Each pole-mounted capacitor bank is shipped with a copy of the instruction manual, general arrangement drawing, and bill of materials.

## Safety precaution

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### DANGER

---

**Hazardous voltage. Explosion hazard. Do not energize a capacitor unit that has been shorted terminal-to-terminal or that has bulged or otherwise damaged tank. Failure to comply will result in death or severe personal injury.**

---

### WARNING

---

**Hazardous voltage. Residual capacitive voltage may be present in the capacitor units after de-energizing. Follow the appropriate shorting procedure to discharge any residual voltage. Failure to comply can cause serious injury or death.**

Before any work is performed on the capacitor bank the following procedure should be completed as a minimum requirement:

1. If switches are provided, electrically or manually open all of the switches.
2. Open the fuse cutouts.
3. DO NOT ground the capacitor bank immediately after the bank has been disconnected from the system. For capacitor banks with capacitor units containing discharge resistors designed to discharge the capacitor unit from peak rated voltage to less than 50 V in five minutes, allow five minutes before grounding. For capacitor banks with units containing discharge resistors designed to discharge the capacitor unit from peak rated voltage to less than 75 V in 10 minutes, allow 10 minutes before grounding. In the absence of design information, wait 10 minutes before grounding.
4. Ground all parts after de-energization and before touching frames or terminals. Ground the neutral of ungrounded capacitor banks.
5. For a fixed pole-mounted capacitor bank, ground the jumper leads on the source side of the capacitor unit between the fuses cutout and capacitor unit terminal. For a switched capacitor bank, ground the jumper leads on the source side of the capacitor unit between the capacitor switch and the capacitor unit terminal.
6. Before handling, short circuit the terminals of all capacitor units.
7. Do not re-energize a capacitor that has possibly failed. Indications of failure include bulged or damaged tank, capacitance that is out of specified tolerance, operated fuse cutout, or indications of external arcing.
8. Use all precautions for capacitor equipment in the same manner as listed under the utilities regulations for high tension equipment.

## Installation procedure

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### CAUTION

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**Lift a capacitor rack by the lifting eyes on the rack frame. Do not lift the rack assembly by the capacitor unit hangers.**

For switched capacitor banks, open all switches prior to installing the capacitor bank on the pole.

## Mounting instructions

### User-furnished hardware:

#### Capacitor bank mounting

- Two 3/4-in. bolts. (Required length is determined by pole diameter.)
- Two 3/4-in. lockwashers.
- Four 3/4-in. washers.
- Two 3/4-in. nuts.

#### Pole brace mounting

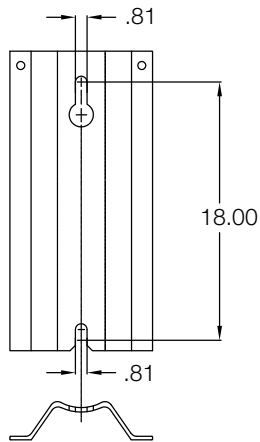
- Two 1/2-in. lagscrews or thru bolts.

#### Control wiring

- Compression-type entrance bushing.
- Control and low-voltage supply cable.

## Procedure

1. On an 18-in. center on the pole, drill two holes for the 3/4-in. bolts.
2. Insert the two 3/4-in. bolts through the holes, using washers and lockwashers as needed. Thread the nuts onto the bolts but do not tighten.
3. Using the lifting eyes on the capacitor bank frame, lift the capacitor bank, positioning it at the pole so that the bolts can slip into the slots on the capacitor bank pole-mounting bracket. (Figure 2)
4. Lower the capacitor bank onto the bolts.
5. Tighten the nuts on the bolts securely.

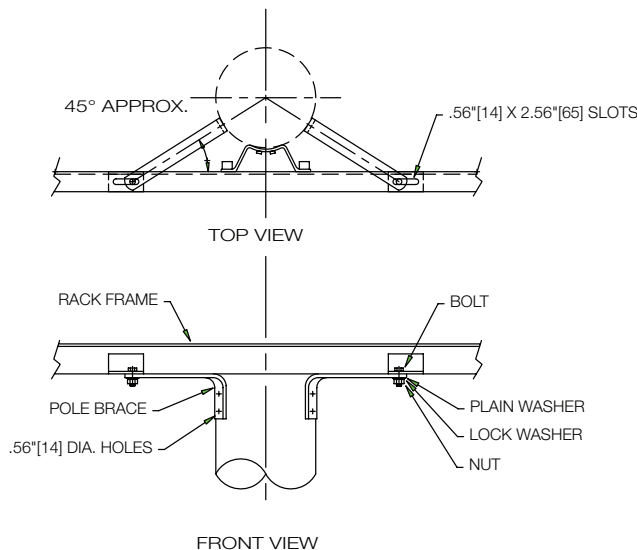


**Figure 1. Pole-mounting bracket**

## Pole brace installation

After the capacitor bank has been securely mounted on the pole, install the pole braces (not supplied for 3 unit frames):

1. Using the furnished hardware, attach one end of a brace to the slot located under the capacitor mounting angle on the capacitor bank frame as shown in Figure 3, but do not tighten the nut on the bolt.
2. Place the other end of the brace against the pole at an angle of approximately 45° and fasten with a 1/2-in. lagscrew or thru bolt.
3. For a snug fit, force the end of the brace attached to the capacitor bank toward the pole and tighten the nut and bolt in the capacitor bank frame.
4. Repeat steps 1, 2, and 3 for the other brace.



**Figure 2. Pole brace installation**

## Control wiring instructions

Switches are factory-wired to the junction box on pole-mounted banks. If the control cable and/or potential transformer is not supplied by Eaton, then the control cable and the potential transformers, or low voltage supply, must be user-supplied. To connect the user-supplied control cable and low-voltage supply cable to the terminals in the junction box:

1. Insert the control cable through the bottom junction box hole using a compression-type entrance bushing.
2. Insert the low-voltage supply cable into the junction box using a compression-type entrance bushing.
3. Wire the control cable and the low-voltage supply cable as shown on inside of the junction box cover.

## Electrical connections

The conductor used to connect the capacitor bank to the system should have a continuous current rating of at least 35 percent more than the nominal phase current rating of the bank.

The assembly of all electrical connections is of vital importance to the proper operation of the capacitor bank. All electrical connections should be made in accordance with the instruction manual.

## Grounding

A clamp type terminal is provided on each capacitor bank frame located on the frame mounting bracket. The terminal can accept a #12 AWG to a #1 AWG solid copper conductor. It is recommended that the capacitor bank frames be solidly grounded.

## Fusing

The capacitor bank must be protected by properly sized fuses that will enable the bank to be rapidly disconnected from the system before damage occurs to the bank in the event of a fault. The fuse link should be sized accordingly to allow fast operation of the fuse and be able to withstand inrush currents from switching and line transients and outrush current through external faults without melting the fuse link. Eaton can recommend proper fusing if requested.

## Surge arresters

It is recommended that pole-mounted capacitor banks be protected against overvoltages due to lightning or switching surges with surge arresters. To protect the capacitor bank from the high overvoltages associated with a switch restrike, the arresters should be applied as close to the capacitor bank as possible.

# Pole-Mounted Three-Phase Capacitor Bank Installation

## Operation

### Service conditions and operation

Refer to the applicable codes and standards such as IEEE Std 18™ standard, IEEE Std 1036™ standard, and or IEC 60871-1.

### Inrush and fault current

For a switched capacitor bank when the switch is closed, a high frequency, high-magnitude current flows into the bank attempting to equalize the system and capacitor voltages. If the bank is isolated from other banks, the inrush current is limited by the inductance of the source and the capacitance of the bank. If two or more capacitor banks are connected on the same bus, very high magnitude and frequency currents are possible.

Current outrush from a capacitor bank may also be a concern if a fault develops in the vicinity of the capacitor bank or a breaker closes into a nearby fault. Eaton's capacitors will satisfactorily withstand these high magnitude and high frequency currents. However, other equipment such as capacitor bank switching device, fuses, and other devices may not withstand these currents. It is recommended that the factory be consulted when the banks will be switched back-to-back or anytime there is doubt regarding the magnitude and frequency of the currents, or the suitability of the installation.

### Switching

Upon de-energization of the bank, wait ten (10) minutes prior to re-energization. Successive rapid switching can result in the failure of the capacitor units. Capacitor controllers generally have adjustable close inhibit settings.

## Maintenance instructions



**Hazardous voltage. Contact with high voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment.**

### Capacitor bank

Eaton's capacitor banks require very little maintenance. Periodic maintenance should include the following:

1. Visual examination of the capacitor bank looking for foreign materials and damaged or excessively dirty components.
2. Visual examination of all capacitor units looking for damaged or excessively dirty bushings, leakage, or unusual swelling.

3. Visually examine all electrical connection for signs of overheating. Optionally, a thermal scan may be performed on all electrical connections to check for overheated electrical joints. The thermal scan must be performed after a minimum of two (2) hours of continuous energization. Pay particular attention to the capacitor terminal temperatures.
4. Examine all metal parts for signs of corrosion.

### Switches

The switches should be inspected and tested periodically depending on the operating conditions and the number of switch operations. Refer to the switch service manuals for specific inspection and testing instructions.

### Field testing

Occasionally, it is necessary to field test capacitors to determine if any damage or failure has occurred. This is particularly important if the capacitors have been subjected to unusual service conditions or if a fuse has operated.

Checking the capacitance of a unit with a low voltage capacitance meter is the best way to determine whether or not the capacitor is partially failed.

## Bills of material

Typical bill of material for a fixed pole-mounted capacitor bank.

(Item numbers correspond to bubbles on top level capacitor bank drawing.)

Item	Description
1	Capacitor
2	Frame
6	Surge arrester
7	Capacitor protective cap
12	Arrester mounting bracket assembly
14	High voltage wire
15	Protective tubing for high voltage wire
16	Neutral tag
18	Shorting wire
19	Shorting wire tag
20	Common ground hardware
31	Reactor
32	Fuse cutout
33	Fuse link



## Pole-Mounted Three-Phase Capacitor Bank Installation

Typical bill of material for a switched pole-mounted capacitor bank.

(Item numbers correspond to bubbles on top level capacitor bank drawing.)

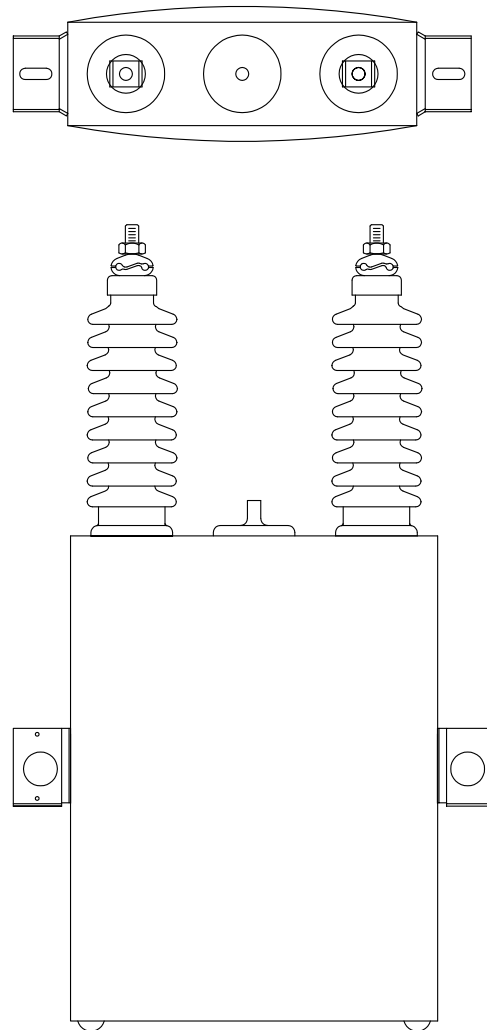
Item	Description
1	Capacitor
2	Frame
3	Switch
4	Junction box
5	Control power transformer (CPT)
6	Surge arrester
7	Capacitor protective cap
8	Switch protective cap
9	Switch protective cap
10	Cpt protective cap
11	Switch&cpt mounting hardware
12	Arrester mounting bracket assembly
13	Switch&cpt tank grounding wire
14	High voltage wire
15	Protective tubing for wire
16	Neutral tag
17	Cpt lead&arrester crimps
18	Shorting wire
19	Shorting tag
20	Common ground hardware
21	Loop wire upward tag
22	Junction box mounting straps
28	Control
29	Control sensor
30	Neutral sensor
31	Reactor
32	Fuse cutout
33	Fuse link
34	Current sensor cable

### Equipment description

#### Capacitor units

Single phase capacitor units are used in the pole-mounted capacitor banks. The single phase capacitor can be configured with either a single or double bushing configuration. The capacitors contain a non-PCB dielectric fluid hermetically sealed within a stainless steel tank. Eaton's capacitor units contain internal discharge resistors which reduces any residual voltage present on the capacitor unit after removal from service.

Refer to document MN230002EN for the capacitor unit installation and maintenance instructions.

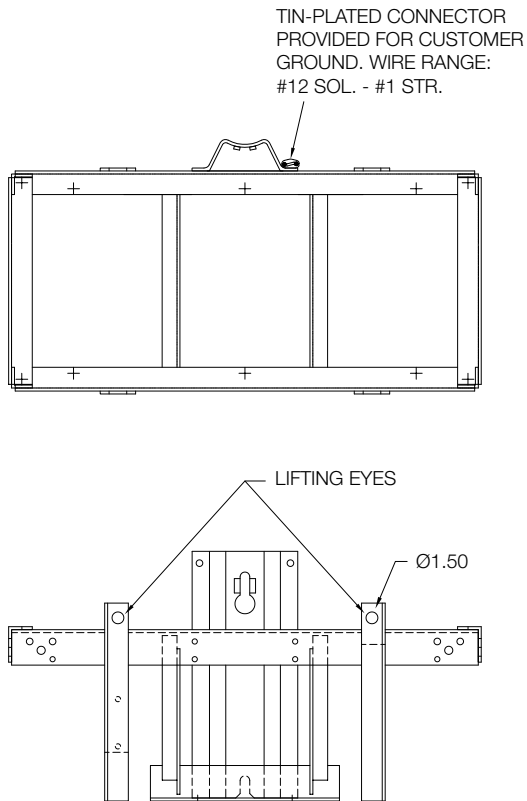


**Figure 3. Capacitor unit**

#### Mounting frame

The pole-mounted capacitor bank frames are made from aluminum. Steel frames are available upon request. The capacitor bank frames are available in 3, 6, 9, and 12 unit configurations. The frames are designed to support the capacitor units and other optional components. The frames are also designed to maintain the proper electrical clearances of the components mounted on the frame.

## Pole-Mounted Three-Phase Capacitor Bank Installation



**Figure 4. Capacitor bank mounting frame**

### Vacuum switches

Vacuum switches are available as an option to provide switching for the pole-mounted capacitor bank. The switches are available with a motor or solenoid operator which can be operated remotely or locally.

Refer to the vacuum switch installation and operation instructions for additional information. If not provided with the capacitor bank, contact your local Eaton's Cooper Power series product representative or Eaton's Cooper Power series product service center.



**Figure 5. Vacuum switch**

### Oil-filled switches

Eaton's Cooper Power series oil-filled switches are available as an option to provide switching for the pole-mounted capacitor bank. The switches are available with a motor operator and can be operated remotely or locally.

Refer to the oil-filled switch installation and operation instructions for additional information. If not provided with the capacitor bank, contact your local Cooper Power series product representative or Eaton's Cooper Power series product service center.



**Figure 6. Oil-filled switch**

### Control power transformers

Potential transformers are available as an option to provide control power to the switches and other components included with the pole-mounted capacitor bank.

Refer to the transformer installation and operation instructions for additional information. If not provided with the capacitor bank, contact your local Cooper Power series product representative or Cooper Power series product service center.



**Figure 7. Control power transformer**

## Surge arresters

Surge arresters are available as an option to protect against over voltages and transients.

Refer to document MN235006EN/ Old S235-35-1 for the surge arrester installation instructions.



Figure 8. Surge arrester

## Current-limiting reactors

Reactors are available as an option to protect the capacitors and capacitor switches from excessive inrush currents. Refer to document CCM52B for mounting instructions.

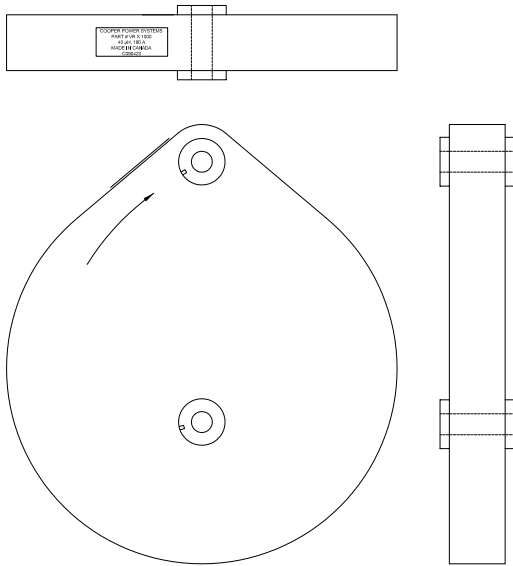


Figure 9. Current-limiting reactor

## Fuse cutouts

Fuse cutouts are available as an option to protect the capacitors. Fuse cutouts will allow the capacitors to be rapidly disconnected from the system before any damage occurs in the event of a fault.

Refer to document MN132007EN for the fuse cutout installation instructions.

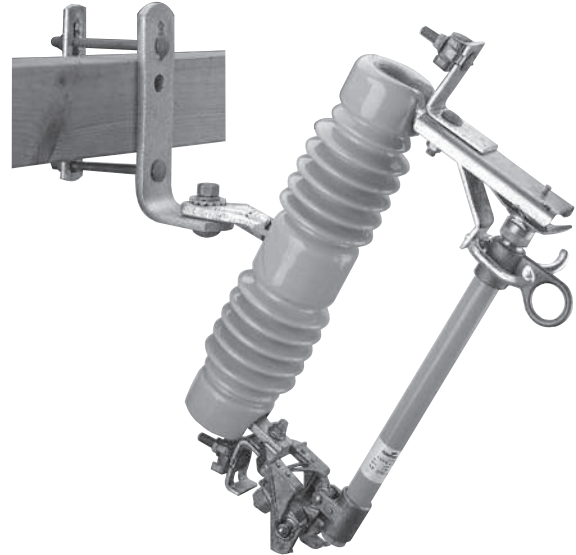


Figure 10. Fuse cutout

## Sensors

Voltage and current sensors are available as an option to monitor the line voltage or current and neutral voltage and current.

Refer to the sensor installation and operation instructions for additional information. If not provided with the capacitor bank, contact your local Eaton's Cooper Power series product representative or Eaton's Cooper Power series product service center.

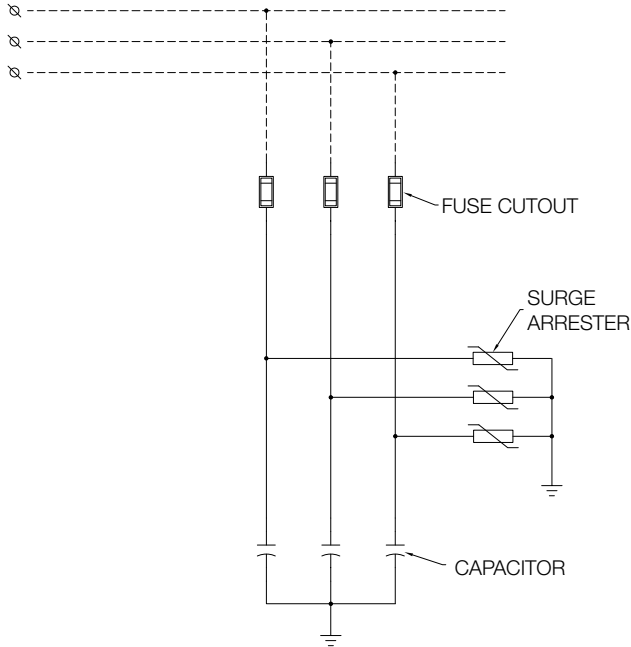
## Capacitor controllers

Capacitor controllers are available as an option to provide local or remote operation of the switches. Capacitor controllers are available with various control options such as VAR, voltage, power factor, temperature, and time.

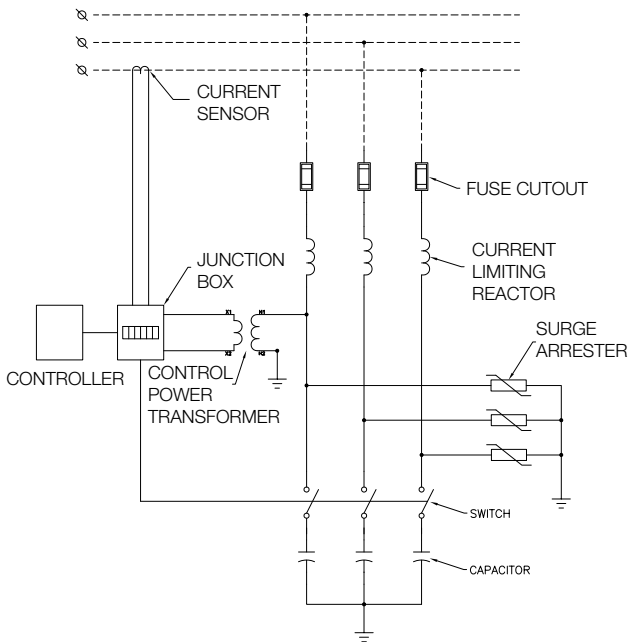
Refer to the controller installation and operation instructions for additional information. If not provided with the capacitor bank, contact your local Cooper Power series product representative or Eaton's Cooper Power series product service center.

# Pole-Mounted Three-Phase Capacitor Bank Installation

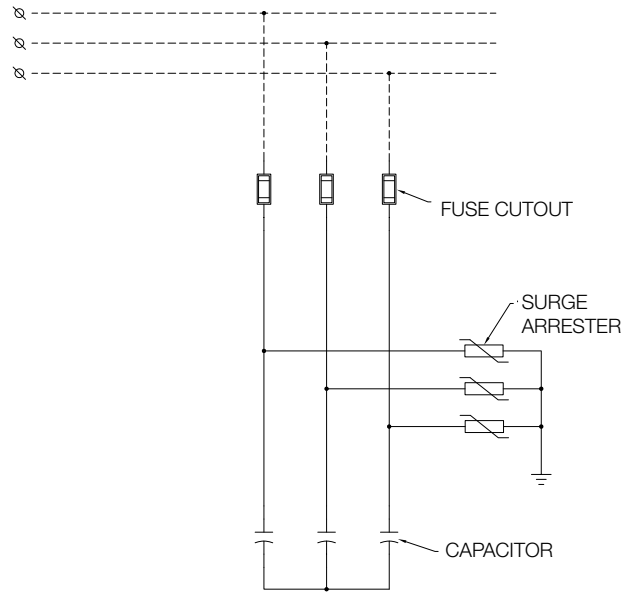
## Wiring diagrams



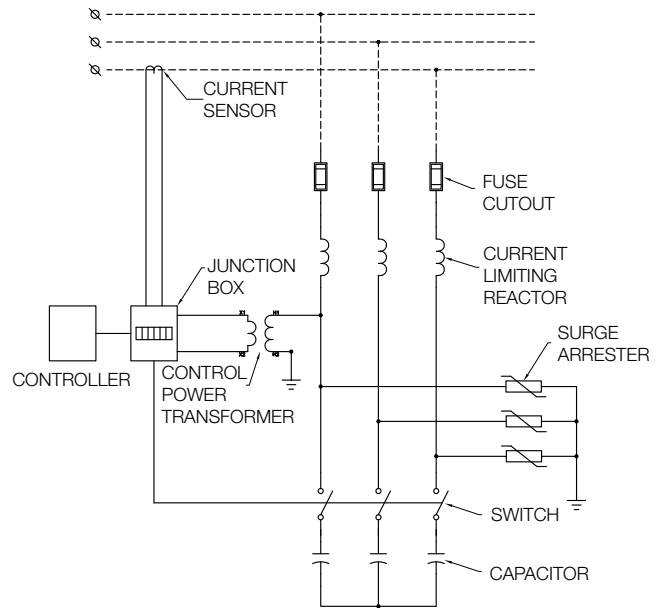
**Figure 11. Fixed grounded wye capacitor bank**



**Figure 12. Switched grounded wye capacitor bank**



**Figure 13. Fixed ungrounded wye capacitor bank**



**Figure 14. Switched ungrounded wye capacitor bank**

# Pole-Mounted Three-Phase Capacitor Bank Installation

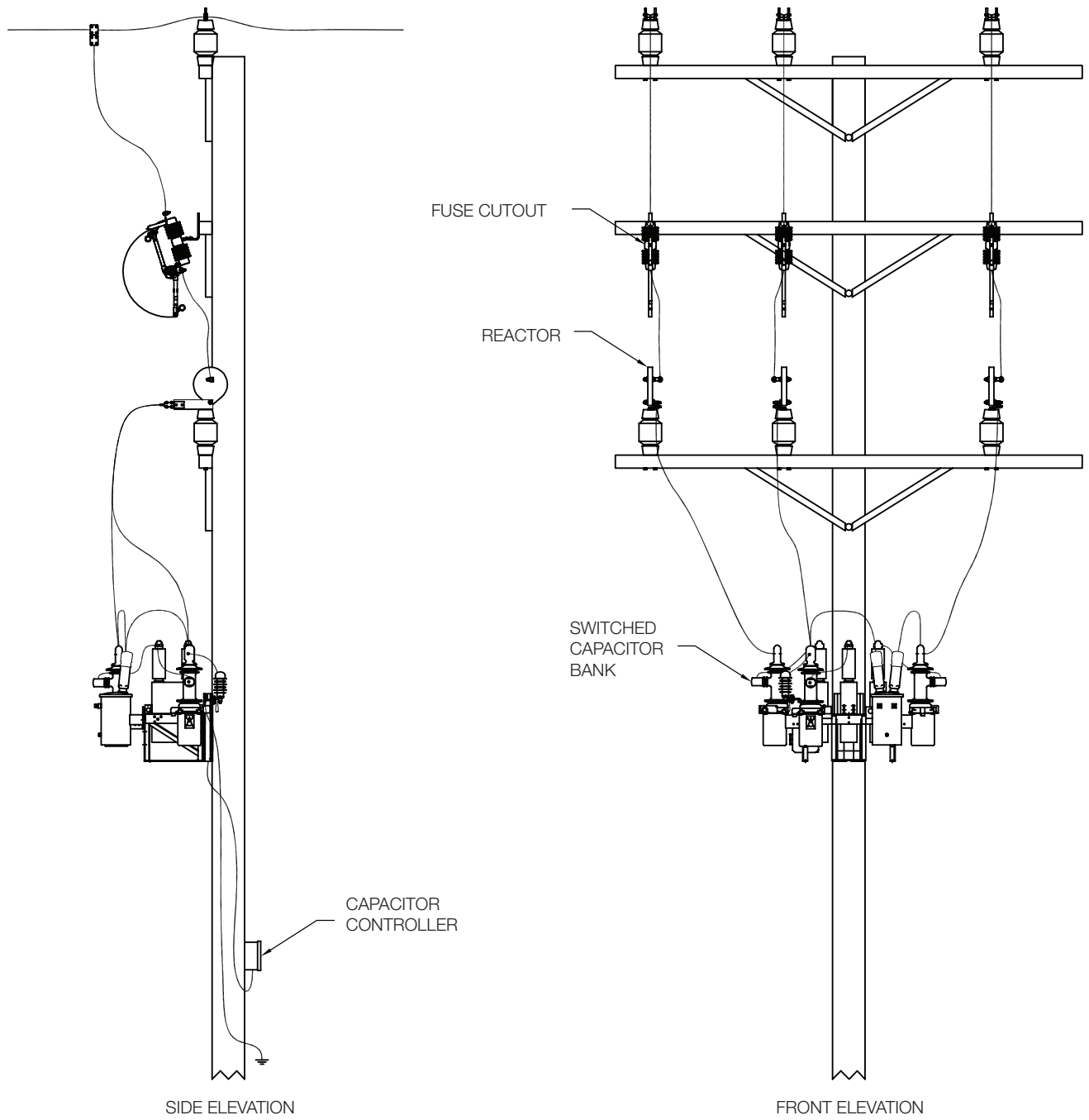


Figure 15. Pole-mounting detail

# Pole-Mounted Three-Phase Capacitor Bank Installation

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