SQUARE D
Instruction Bulletin

Bulletin No. 50006-376-01
August, 1995
Raleigh, NC, USA

Class 8198 ISO-FLEX® Medium Voltage Controller
Model 3, Series B
Installation and Maintenance

TABLE OF CONTENTS

Reference No. 8198-6
Supersedes 8198-6 dated 9/88

Controller operating instructions are covered in the following bulletins:

- 50006-376-02: NEMA Type 3R controllers
- 50006-376-03: Full voltage non-reversing and latched controllers
- 50006-376-04: Reduced voltage autotransformer and primary reactor controllers
- 50006-376-05: Full voltage non-reversing brushless synchronous controllers
- 50006-376-06: Full voltage non-reversing synchronous controllers
- 50006-376-07: Two-speed / reversing controllers

PRECAUTIONS

⚠ DANGER

HAZARDOUS VOLTAGE.

- **Read and understand this bulletin in its entirety before installing or operating the controller. Installation, adjustment, repair and maintenance must be performed by qualified personnel.**
- **Disconnect all power from controller and contactor before installation or maintenance and verify the controller is deenergized from external power feedback sources through the load connections.**
- **Install all barriers and close all doors before applying power or starting and stopping the controller.**
- **User is responsible for conforming to all applicable code requirements with respect to grounding all equipment.**
- **Do not energize controller if any mechanical or electrical interlock is inoperative. Consult your local Square D sales office immediately.**

Before servicing controller:

- **Disconnect all power supplies.**
- **Place a "DO NOT TURN ON" label on power supply disconnect(s).**
- **Lock disconnect(s) in open position.**

Electrical shock will cause severe injury or death.

Power circuits with high voltage and high fault capacity can present a risk of severe electrical shock or burn. Study the following list of precautions and follow them during equipment installation, operation and servicing:

- If motor controllers and / or contactors are to be stored prior to installation, they must be protected from the weather and be kept free of condensation and dust.
- Use extreme care when moving or positioning controllers (even if crated) as they contain devices and mechanisms which may be damaged by rough handling.
- Be sure all barriers and terminal covers are in place before operating controllers.
- Be sure current transformer secondary circuit is complete. When thermal overload relays are supplied, be sure current setting adjustment is properly selected.
- Check operation of each electrical and mechanical interlock before connecting line power cables. Refer to "CHECKING THE INTERLOCKS" on page 14.
- Only **authorized personnel** should be permitted to operate or service the contactor and controller.

TERMS

- **VERTICAL SECTION:** free-standing unit, available in NEMA 1, NEMA 1 with gasketed doors, and NEMA 3R or NEMA 12 enclosures with or without horizontal power bus.
- **CONTROLLER:** free-standing unit consisting of one or more vertical sections. Contains medium voltage devices mounted in the medium voltage compartment and low voltage devices mounted in a separate, isolated low voltage compartment.
- **LOW VOLTAGE COMPARTMENT:** area behind the upper compartment door. Contains terminal blocks on the right side wall, control relays on the back panel and door-mounted equipment (overload relay, meters, push buttons, etc.) on the low voltage compartment door.
- **MEDIUM VOLTAGE COMPARTMENT:** area behind the low voltage compartment and all controller doors except the low voltage compartment door. Contains isolation switch, power fuses, medium voltage contactor, current transformer assembly, control power transformer, line and load cables and other medium voltage equipment.

CONTROLLER RATINGS

Refer to the nameplate on the controller medium voltage compartment door for detailed ratings applicable to a specific controller. Basic controller maximum ratings follow NEMA Standard ICS No. 2-324 as indicated in Table 1.

Table 1 Medium Voltage Controller Ratings [1]

	Contactor Rating		2300 V / 60 Hz	4000 V / 60 Hz	4600 V / 60 Hz
	NEMA Size	Amperes (Enclosed)			
Squirrel Cage Motors	H3	360	1500 hp	2500 hp	2500 hp
Wound Rotor Motors	H3	360	1500 hp	2500 hp	2500 hp
Synchronous Motors: 0.8 power factor	H3	360	1500 hp	2500 hp	2500 hp
1.0 power factor	H3	360	1750 hp	3000 hp	3000 hp
Interrupting Rating – Class E2 (fused)	H3	360	200 MVA	350 MVA	400 MVA
Basic Impulse Level	H3	360	60 kV	60 kV	60 kV

[1] Ratings apply to controllers in NEMA 1 enclosure when installed in maximum ambient temperature of 40 °C.

POWER FUSE COORDINATION

When a controller has a vacuum contactor used with 24R fuses, proper coordination between the contactor and fuses is ensured by delaying contactor opening time. This is accomplished by factory installation of a 30 ohm, 3 watt resistor connected in the main contactor coil circuit. The resistor is mounted on the control terminal board in the low voltage compartment.

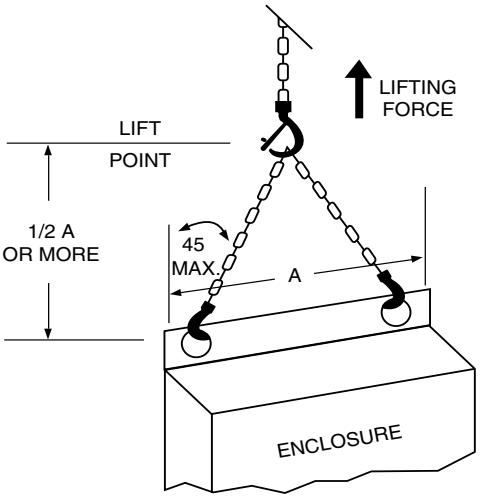
Vacuum contactors used with 18R and smaller fuses do not have, or need, the resistor for proper coordination between the contactor and power fuses. If a vacuum contactor is modified for higher horsepower drives requiring 24R fuses, the 30 ohm resistor must be added to the proper control terminal board connections (refer to label on inside of medium voltage compartment door for proper connection points).

If a 24R fuse is installed, the total fuse clearing time must not exceed 0.28 second at 7,300 amperes. The following recommended fuses meet this requirement:

- Buss JCL-24R
- Gould Shawmut A480R-24R
- GEC English Electric KDBX-24R
- Carbone-Ferraz A48-24R
- General Electric EJ2-24R

LIFTING THE CONTROLLER

Lifting angles are provided on each controller for handling. See Figure 2 for proper use of sling when lifting controller. Do not pass ropes or cables through lift holes; use slings with safety hooks or shackles.



⚠ WARNING

HANDLING AND LIFTING HAZARD.

Keep area below any equipment being lifted clear of all personnel and property. Use lifting method shown here.

Failure to observe this precaution can result in equipment damage, severe personal injury or death.

Figure 2 Lifting the Controller

RECEIVING AND PRELIMINARY INSPECTION

Before installing the controller:

- Visually examine the shipping crate for shipping damage. If it is damaged, note the area and carefully inspect the contents when unpacking to see if they are also damaged. If damage is found, notify the carrier and your local Square D sales office.
- The contactor and all control devices are shipped installed in the controller. Check the packing list against the order to make sure shipment is complete and the correct components are received.
- When unpacking, be careful not to damage contents by inserting tools into crates. Use a nail puller and wire cutter. Do not insert pry bar in crate to force open.
- Inspect components as follows:
  1. Visually verify that all internal hardware and components are properly seated, securely fastened and undamaged. Inspect all parts for secure mounting and good electrical connections.
  2. Check that the enclosure is not damaged.
  3. Check all doors for free movement. To open doors, follow instructions on controller nameplate located on front of medium voltage compartment door. Swing doors to ensure free movement.
  4. The contactor is shipped inside the enclosure. With the medium voltage compartment door open, verify the contactor was not damaged in shipment. Remove all tie straps and packing material. See bulletin 50006-316-01 (Series D) or 50006-316-03 (Series B & C) for additional details on contactor inspection.
  5. Close the medium voltage compartment door and secure per instructions on controller nameplate. Operate the isolation switch handle to check for free movement. If movement is not free, check for mechanical interference.
  6. Check that wiring harnesses are securely fastened.

> **⚠ CAUTION**
>
> **DAMAGED EQUIPMENT HAZARD.**
>
> **Do not operate or install any controller that appears damaged.**
>
> Failure to observe this precaution can result in equipment damage or personal injury.

CONTROLLER INSTALLATION

Mounting

Class 8198 controllers are completely accessible from the front. Space is required in front of the controller enclosure for contactor removal, on the left side of the controller enclosure for maximum door openings and on the right side of the controller enclosure for maximum swing of the low voltage compartment door. Figure 3 shows the clearance requirements. Be sure enclosure is level and fully supported when mounted. Enclosure should be bolted in place. If enclosure is not securely supported and level, doors may not swing properly.

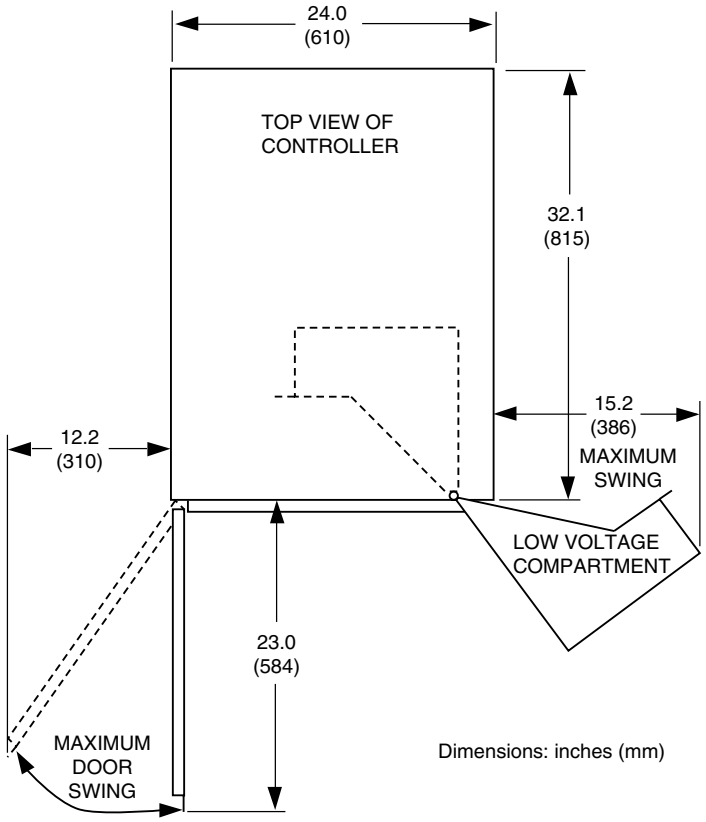


Figure 3 Controller Clearances

The controller design allows controller installation without removing the contactor.

Line Cable Terminations

Single and multiple controller arrangements are available for terminating line cables. When NEMA Type 3R enclosures are furnished, entries for line and load cables should be from the bottom only. To check the specific arrangement supplied for your equipment, refer to the drawings furnished with your order.

Single Controller

To connect incoming line power to a single controller:

1. Terminate line cable on terminals (Fig. 4, item A) for top cable entry. For bottom cable entry, the cable terminations are reversed.
2. Maximum size cable: one 500 MCM or two 250 MCM cables per phase.

Multiple Controllers

Two or more controllers can be bused together by a horizontal power bus (Fig. 5, item B).

1. Line cable terminations on terminals (Fig. 5, item A) in incoming line cable compartment (Fig. 5, item C).
2. Cable entry from top or bottom.
3. Maximum size cable: two 750 MCM cables per phase for 1200 A maximum bus or four 750 MCM cables per phase for 2400 A maximum bus.

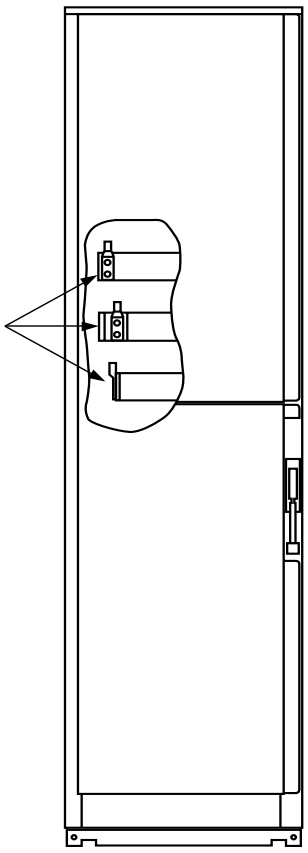


Figure 4 Line Cable Terminations – Single Controller

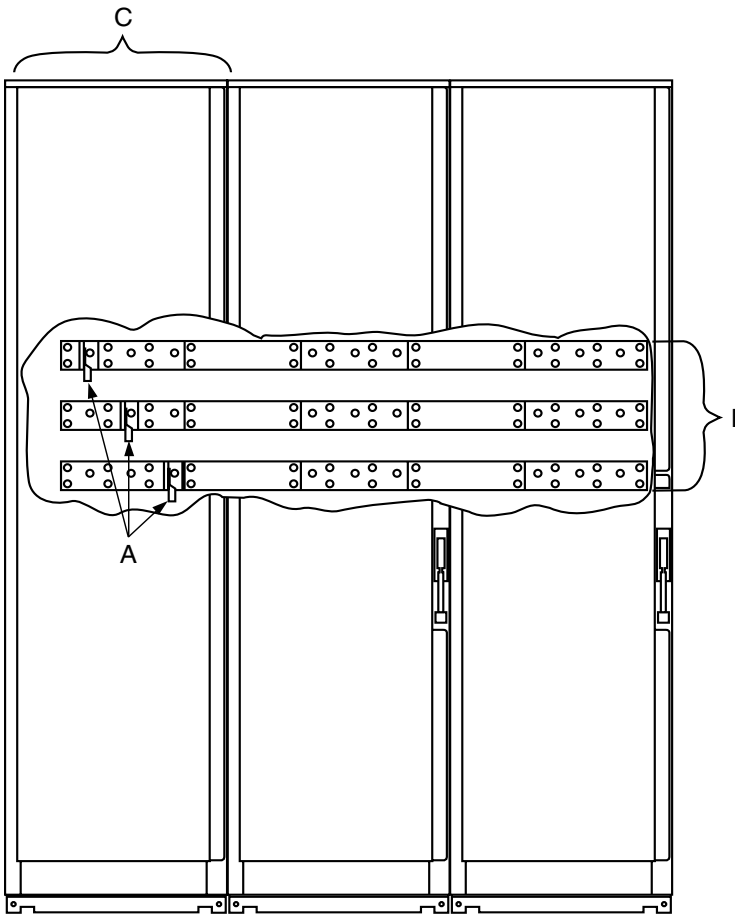


Figure 5 Line Cable Terminations – Multiple Controllers

Power and Ground Bus Connections Between Shipping Sections

If the motor control center consists of two or more shipping sections, power bus and ground bus splice bars are supplied and should be added after the sections are firmly in place. The splice bus bars and necessary hardware are mounted inside the controller on the back panel, to the left of the power fuses. For additional details, see the instructions included with the splice bars.

Recommended tightening torques:

- Tighten each 5/16" bolt to 140 lb-in
- Tighten each 3/8" bolt (power and ground bus, Figure 6) to 250 lb-in

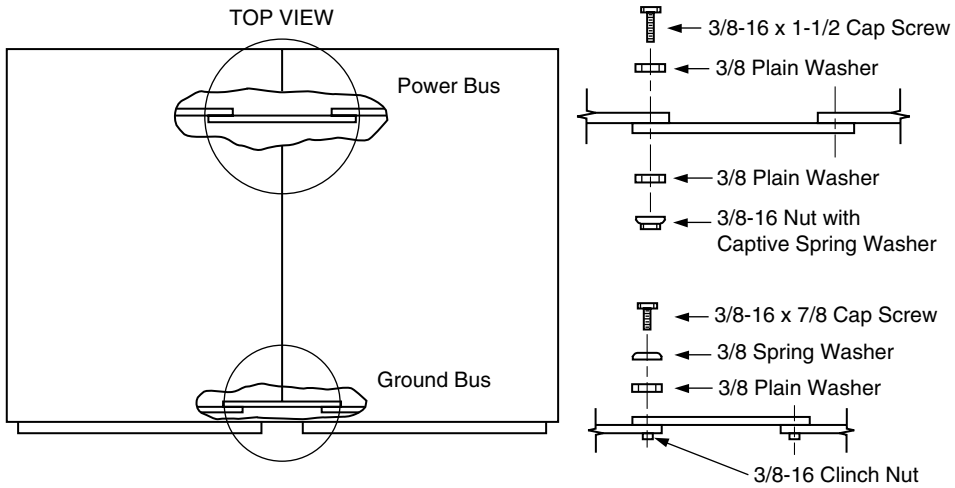


Figure 6 Power and Ground Bus Coupling

Power Cable Connections

NOTE: Two-hole lugs must be used to prevent rotation of lugs. Use 3/8" bolts (maximum 1-1/2" long), nuts and spring washers for power cable connections.

Line Cable Connections

For top entry of line cables, use 5-1/2" x 5-1/2" opening at top left rear (front view) of vertical section. For bottom entry, use 5-1/2" x 5-1/2" opening at left rear corner of bottom plate. For exact opening locations, see outline drawing supplied with equipment.

Line terminals are located behind the isolation switch barrier. To connect line cables:

1. Verify isolation switch is in the OFF (open) position and all power is disconnected from controller and contactor.
2. Remove screws (Fig. 7, item A).
3. Push front portion of horizontal barrier (Fig. 7, item B) down into medium voltage compartment. When horizontal barrier is in a vertical position, remove it by disengaging it from slot in vertical barrier (Fig. 7, item C).
4. Loosen nuts (Fig. 7, item D) and thumb screws (Fig. 7, item E).
5. Move vertical barrier (Fig. 7, item C) forward, allowing slotted holes to clear nuts (Fig. 7, item D).
6. Remove barrier (Fig. 7, item C). Thumb screws (Fig. 7, item E) remain held captive to barrier.
7. Loosen low voltage compartment retaining nut (Fig. 8, item F).
8. Pull low voltage compartment (Fig. 8, item G) forward and swing it to the right.
9. Remove screw (Fig. 9, item H) and bus access barrier (Fig. 9, item J).
10. Loosen bolts (Fig. 9, item K). Remove isolation switch barrier (Fig. 9, item L).
11. Connect incoming line cables to terminals (recommended tightening torque: 250 to 265 lb-in). Phase sequence of incoming line cable from top to bottom is L1, L2, L3, as viewed from front of controller. Stress cones may be added in the space above or below incoming line terminals. Make sure cables are supported by cable clamps (located on the left rear side of enclosure).
12. Reinstall all barriers and secure low voltage compartment.

Load Cable Connections

For top entry of load cables, use 5-1/2" x 5-1/2" opening at the top left middle (front view) of the vertical section. For bottom entry, use 5-1/2" x 5-1/2" opening at the bottom left middle of the vertical section. For exact location of each opening, refer to the outline drawing supplied with the equipment.

Load terminals are located in the load cable connection box (Fig. 10, item A), mounted on left side wall of vertical section. To connect load cables:

1. Verify isolation switch is in the OFF (open) position and all power is disconnected from controller and contactor.
2. Remove horizontal barrier (Fig. 7, item B) and vertical barrier (Fig. 7, item C). Refer to steps 2 through 6 in "Line Cable Connections".
3. Route load cables through top of controller and behind low voltage compartment.
4. Remove clear plastic barrier from load cable connection box.
   NOTE: Load cable terminal pads (Fig. 10, item B) point up for connection to load cables entering from top of controller. If load cables enter from bottom, reposition terminal pads to point down by removing bolts (Fig. 10, item C), rotating pads 180° clockwise and reinstalling bolts.
5. Connect outgoing load cables to proper load terminals (recommended tightening torque: 250 to 265 lb-in). Phase sequence of load cable from left to right (or front to rear) is T1, T2, T3, as viewed from front of controller. Make sure top exit cables are supported by cable clamps mounted on left side wall of enclosure, and that cables are positioned to prevent interference with contactor.
6. Reinstall all barriers.

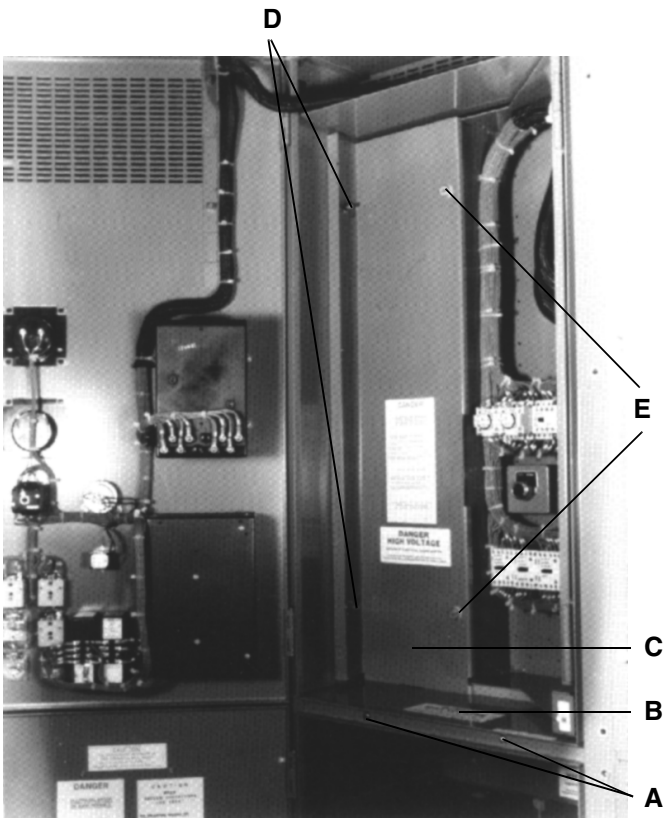


Figure 7 Removing Horizontal Barrier

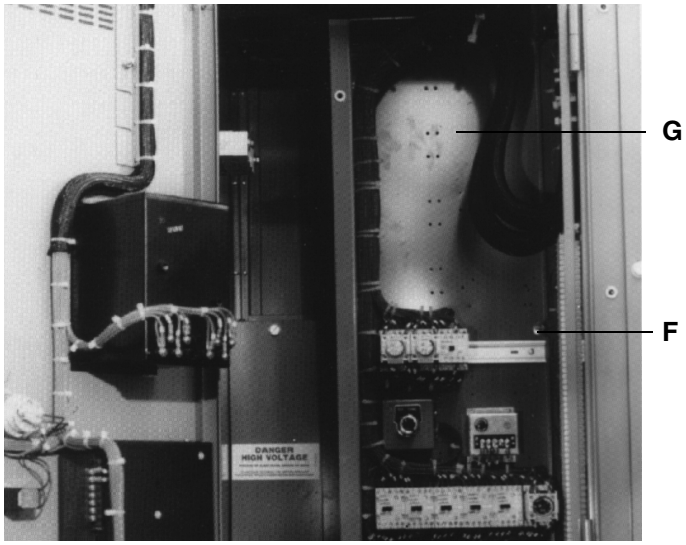


Figure 8 Opening Low Voltage Compartment

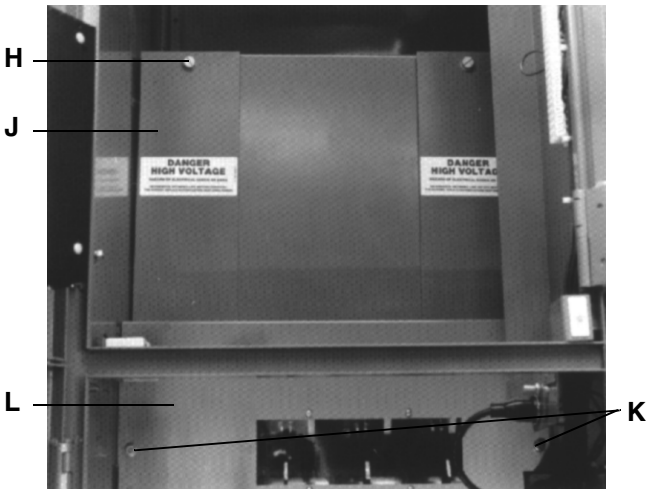


Figure 9 Removing Bus Access and Isolation Switch Barriers

⚠ DANGER

HAZARDOUS VOLTAGE.

All barriers must be reinstalled over line terminals before controller is energized.

Electrical shock will cause severe injury or death.

⚠ WARNING

HAZARDOUS VOLTAGE.

Load cable connection box barrier must be installed over load terminals before controller is energized.

Failure to observe this precaution could result in severe injury or death.

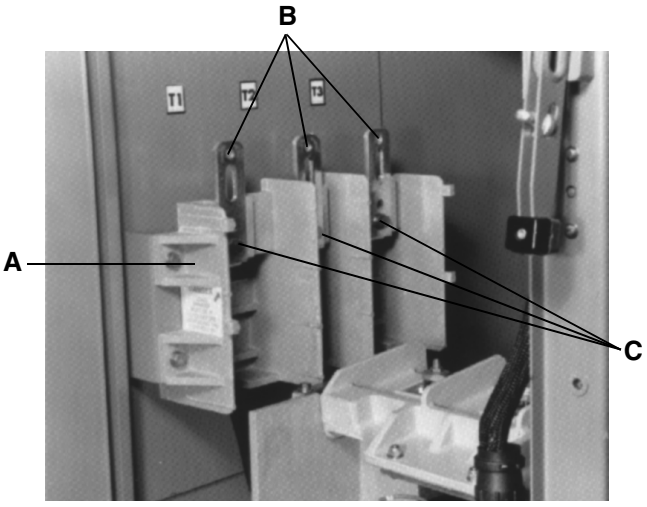


Figure 10 Load Terminals

REMOVING THE CONTACTOR

The controller design allows work to be performed on the controller without removing the contactor. If contactors must be removed, follow the instructions below:

1. Open isolation switch by moving isolation switch handle down to the OFF position. This disconnects all power from the contactor and / or controller.
2. Verify isolation switch is in the OFF (open) position:
   a. Open medium voltage compartment door, carefully avoiding any potentially live parts.
   b. View the isolation switch blades through the viewing window in the isolation switch barrier.
   c. If blades are not in the open position, close the door and deenergize incoming line power before proceeding.
   d. Verify controller is deenergized from external power feedback sources through the load connections.

⚠ DANGER

HAZARDOUS VOLTAGE.

Disconnect all power from controller before working inside controller.

Electrical shock will cause severe injury or death.

3. Refer to Figure 11. Disconnect the contactor control cable by turning the control cable plug lock nut counterclockwise and lifting plug.
4. Refer to Figure 12. Disconnect the line connections by removing nuts and washers (item A) from contactor line bus.
5. Disconnect the load cables by removing nuts and washers from threaded studs on contactor load terminals, located at bottom rear of contactor.
6. Refer to Figure 12. Remove bolts and washers (item B), located on the contactor support plate.
7. Slide contactor to the left and then forward. Remove contactor from controller by lifting as shown in Figure 13. Do not use contactor line or load bus to lift contactor (see Caution in Figure 13).

Figure 11 Disconnecting Contactor Control Cable

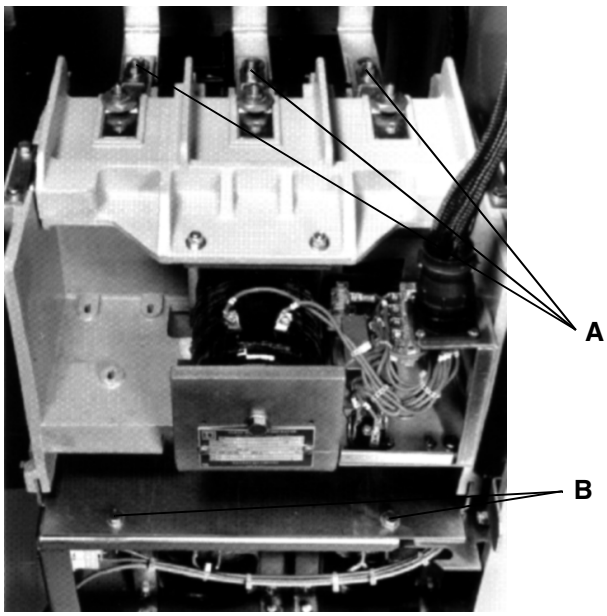


Figure 12 Contactor Bolts and Line Connections

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD.

Do not use contactor line or load bus to move or lift contactor. Each bus is aligned at the factory.

Failure to observe these precautions could cause breakage or misalignment, resulting in personal injury or equipment damage.

Figure 13 Removing the Contactor

INSTALLING THE CONTACTOR

⚠ DANGER

HAZARDOUS VOLTAGE.

Disconnect all power from controller before working inside controller.

Electrical shock will cause severe injury or death.

Check that the contactor nameplate information (Class, Type and Form) matches contactor information on label located on inside of controller medium voltage compartment door.

1. Open isolation switch by moving isolation switch handle down to the OFF position. This disconnects all power from the contactor and / or controller.
2. Verify isolation switch is in the OFF (open) position:
   a. Open medium voltage compartment door, carefully avoiding any potentially live parts.
   b. View the isolation switch blades through the viewing window in the isolation switch barrier.
   c. If blades are not in the open position, close the door and deenergize incoming line power before proceeding.
   d. Verify controller is deenergized from external power feedback sources through the load connections.
3. Lift contactor as shown below. Do not use contactor line or load bus to lift contactor (see Caution in Figure 13).

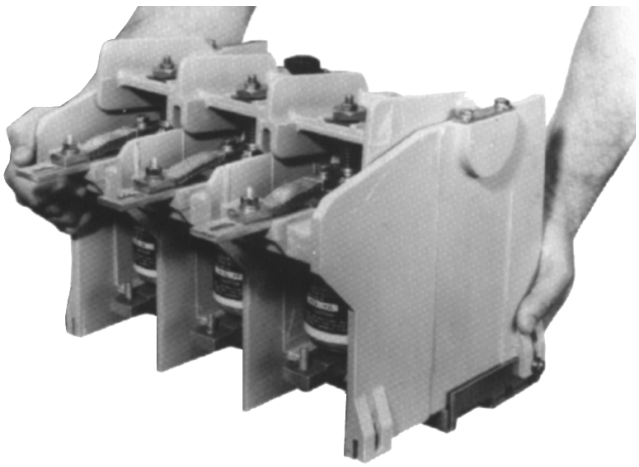


Figure 14 Lifting the Contactor

4. Refer to Figure 13. Place contactor on pan inside controller section so that contactor coil is viewed from front of controller.

5. Slide contactor into section until holes in contactor support plate line up with holes in pan.
6. Connect contactor support plate to pan by installing bolts and washers (Fig. 12, item B).
7. Connect load cables to contactor load terminals (at bottom rear of contactor).
8. Connect line connections to contactor line bus by installing nuts and washers (Fig. 12, item A).
9. Refer to Figure 11. Connect contactor control cable to contactor by pushing cable plug into contactor plug receptacle and turning control cable plug lock nut clockwise.

LOW VOLTAGE CONTROL

Low Voltage Connections

Low voltage control wire conduit openings are provided for both top and bottom entry. For top entry of control wires, use 2" x 2" opening at the right front corner (front view) of vertical section. For bottom entry, use 2" x 2" opening at the bottom right middle of vertical section. For exact location of each opening, see the outline drawing supplied with the equipment.

Low Voltage Compartment

To open the low voltage compartment door:

1. Open isolation switch by moving isolation switch handle down to the OFF position. This disconnects all power from the contactor and / or controller.
2. Verify isolation switch is in the OFF (open) position:
   a. Open medium voltage compartment door, carefully avoiding any potentially live parts.
   b. View the isolation switch blades through the viewing window in the isolation switch barrier.
   c. If blades are not in the open position, close the door and deenergize incoming line power before proceeding.
   d. Verify controller is deenergized from external power feedback sources through the load connections.

⚠ DANGER

HAZARDOUS VOLTAGE.

Disconnect all power from controller before working inside controller.

Electrical shock will cause severe injury or death.

⚠ WARNING

HAZARDOUS VOLTAGE.

If controller is supplied with separate or multiple sources of control power, control voltage may be present inside low voltage compartment and on terminals of door-mounted equipment even though isolation switch is open. Use extreme caution when working on energized equipment.

Failure to observe this precaution may cause shock or burn, resulting in severe injury or death.

3. Turn thumb screws (Fig. 15, item A) counter-clockwise.
4. Swing door to left and out of the way for access to devices and terminal blocks. If access to low voltage compartment is attempted while controller is energized, it will automatically deenergize when the door interlock (Fig. 15, item B) opens.

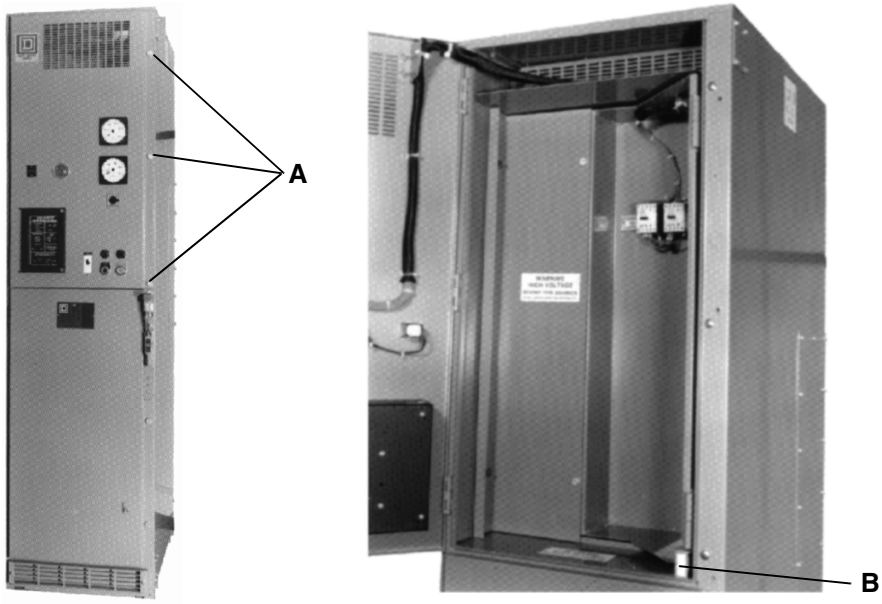


Figure 15 Low Voltage Compartment

In emergency situations, **qualified personnel** may use the following procedure to bypass the door interlock:

1. Insert a small tool through hole (Fig. 16, item A) below the isolation switch handle and depress defeat switch.
2. While holding switch depressed, unlatch and open low voltage compartment door until interlock (Fig. 16, item B) can be operated by pulling plunger to fully extended position. Tool may be removed after activating interlock.
3. To close while energized, hold defeat switch depressed with small tool. Close and latch door, then remove tool.

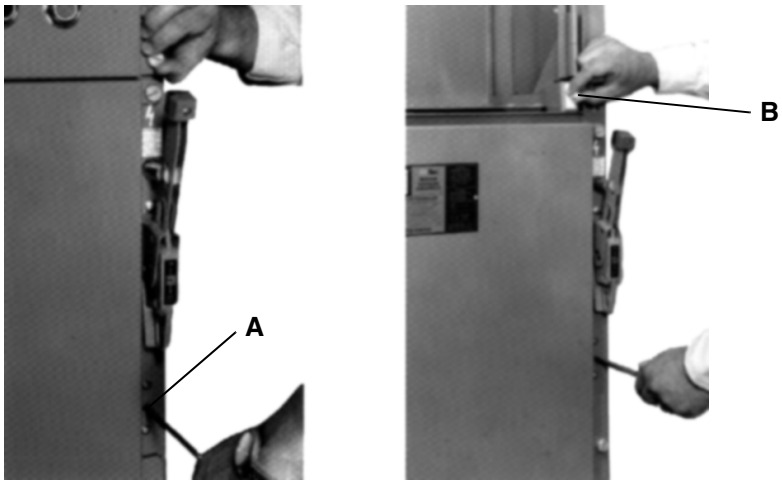


Figure 16 Defeating the Low Voltage Compartment Interlock

CHECKING THE INTERLOCKS

A combination of five electrical and mechanical interlocks provide personnel and equipment protection. It is important to check the operation of these interlocks before energizing the controller.

⚠ DANGER

HAZARDOUS VOLTAGE.

Do not energize controller if any mechanical or electrical interlock is inoperative. Consult your local Square D sales office immediately.

Failure to observe this precaution will cause shock or burn, resulting in severe injury or death.

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD.

Do not use excessive force when testing interlocks.

Failure to observe this precaution could damage the interlock mechanisms.

Follow these procedures before checking any interlock:

1. Open isolation switch by moving isolation switch handle down to the OFF position. This disconnects all power from the contactor and / or controller.
2. Verify isolation switch is in the OFF (open) position:
   a. Open medium voltage compartment door, carefully avoiding any potentially live parts.
   b. View the isolation switch blades through the viewing window in the isolation switch barrier.
   c. If blades are not in the open position, close the door and deenergize incoming line power before proceeding.
   d. Verify controller is deenergized from external power feedback sources through the load connections.

⚠ DANGER

HAZARDOUS VOLTAGE.

Disconnect all power from controller before working inside controller.

Electrical shock will cause severe injury or death.

Low Voltage Compartment Interlock

The low voltage compartment door interlock (Fig. 15, item B) is an electrical interlock that deenergizes the controller when the low voltage door is opened. To check the operation of the low voltage compartment door interlock:

1. Verify isolation switch is in the OFF (open) position and all power is disconnected from controller and contactor.
2. Perform a continuity test at terminal blocks located inside low voltage compartment (refer to wiring diagram supplied with equipment). There should be circuit continuity when the electrical interlock plunger is either held in the depressed position or pulled to the fully extended position.

Medium Voltage Compartment Interlock

A handle interlock lever (Fig. 17, item A) prevents opening the medium voltage compartment door when the isolation switch is closed. The medium voltage door interlock (Fig. 17, item B) combined with the handle interlock lever prevents closing the isolation switch when the medium voltage compartment door is open. To check operation of the interlock:

1. Verify isolation switch is in the OFF (open) position and all power is disconnected from controller and contactor.
2. Close the medium voltage compartment door and isolation switch. Try to open the door. The door must not open.
3. Open the isolation switch and then open medium voltage compartment door.
4. Press down on handle interlock lever (Fig. 17, item A) and try to close isolation switch by moving the switch handle slowly toward the ON position. Do not use excessive force. Door interlock must prevent isolation switch from being closed.

Isolation Switch Handle Interlock

The isolation switch handle thumb screw interlock (Fig. 18, item A) is an electrical interlock that prevents opening the isolation switch when the control circuit is energized. To check operation of the isolation switch handle interlock:

1. Verify isolation switch is in the OFF (open) position and all power is disconnected from controller and contactor.
2. Perform a continuity test at terminal blocks located inside low voltage compartment (refer to wiring diagram supplied with equipment). There should be circuit continuity when the thumb screw interlock is fully engaged. The circuit should be open when the thumb screw interlock is disengaged.

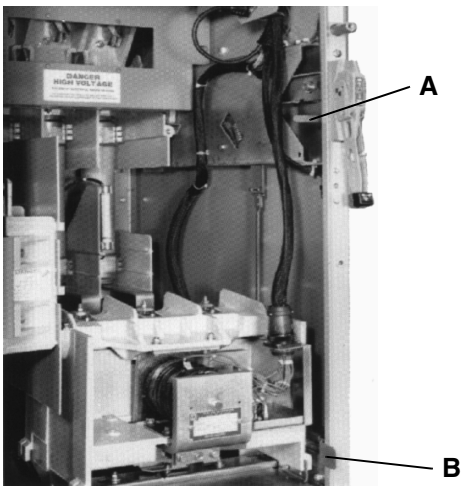


Figure 17 Medium Voltage Compartment Interlock

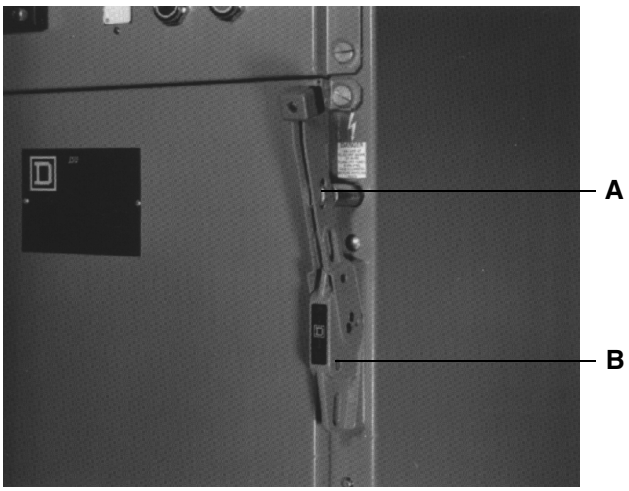


Figure 18 Isolation Switch Handle Interlock

Contactor Interlock Slider

The contactor interlock slider prevents opening or closing the isolation switch when the contactor power contacts are closed. To check operation of the contactor interlock slider:

1. Verify isolation switch is in the OFF (open) position and all power is disconnected from controller and contactor.
2. Manually close the contactor. See bulletin 50006-316-01 (Series D) or 50006-316-03 (Series B & C) for instructions on operating the contactor manually.
3. Close and secure the medium voltage compartment door. Try to close the isolation switch and verify that the contactor interlock slider prevents operation of isolation switch when contactor is closed (this verification only needs to be performed with the isolation switch in the OFF position).
4. Reassemble contactor to operational mode.

Isolation Switch Mechanism

To check operation of the isolation switch mechanism:

1. Verify isolation switch is in the OFF (open) position and all power is disconnected from controller and contactor.
2. Open the medium voltage door.
3. Press down on the handle interlock lever (Fig. 19, item A) and hold while moving isolation switch handle (Fig. 19, item B) towards the ON position until it stops. Do not use excessive force (see Caution on page 14).
4. While maintaining the handle in this position using minimum amount of pressure, press in on the door interlock push bar (Fig. 19, item C) and simultaneously continue moving the operating handle until it is in the ON position. The isolation switch should now be closed.
5. Pull handle down to open isolation switch. Switch is fully open when the bail arm (Fig. 19, item D) is against its stop (Fig. 19, item E) and switch blades are about an inch from inside face of viewing window in isolation switch barrier.
6. Repeat steps 2 through 5 to verify that mechanisms operate freely.

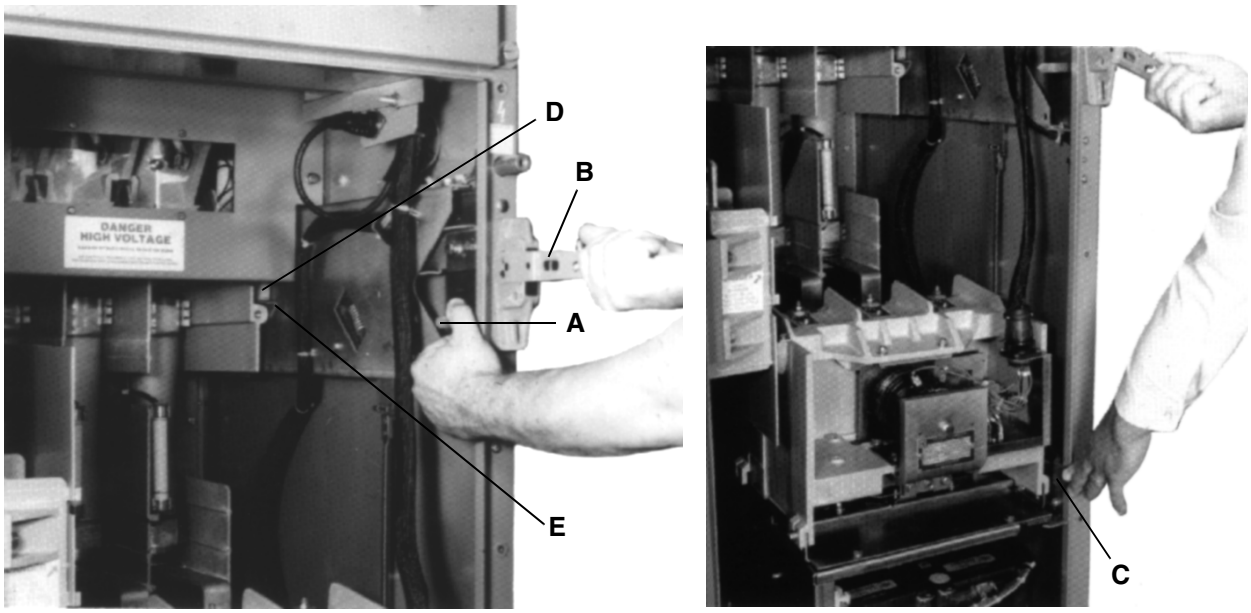


Figure 19 Isolation Switch Mechanism

STARTUP PROCEDURE

Before operating the controller, follow this procedure to test the control circuit and contactor:

1. Open isolation switch by moving isolation switch handle down to the OFF position. This disconnects all power from the contactor and / or controller.
2. Verify isolation switch is in the OFF (open) position:
   a. Open the medium voltage controller door, carefully avoiding any potentially live parts.
   b. View the isolation switch blades through the viewing window in the isolation switch barrier.
   c. If blades are not in the open position, close the door and deenergize incoming line power before proceeding.
   d. Verify controller is deenergized from external power feedback sources through the load connections.

⚠ DANGER

HAZARDOUS VOLTAGE.

Disconnect all power from controller before working inside controller.

Electrical shock will cause severe injury or death.

3. Refer to Figure 20. The test cord (item A) is located in the medium voltage compartment. Unplug the test cord from the receptacle (item B) located in the front right corner of medium voltage contactor compartment.
4. Plug the test cord into a grounded (3-wire) extension cord (item C).
5. Plug the other end of the extension cord into a grounded 120 VAC circuit.
6. Verify that the low voltage compartment door is closed.
7. Check that control cord is securely fastened to contactor.
8. Referring to the elementary wiring diagram supplied with the controller, check the control circuit sequence.

NOTE: For energizing and testing of contactor only (in or out of enclosure), use optional contactor portable test cord (Square D part number 51034-241-50).

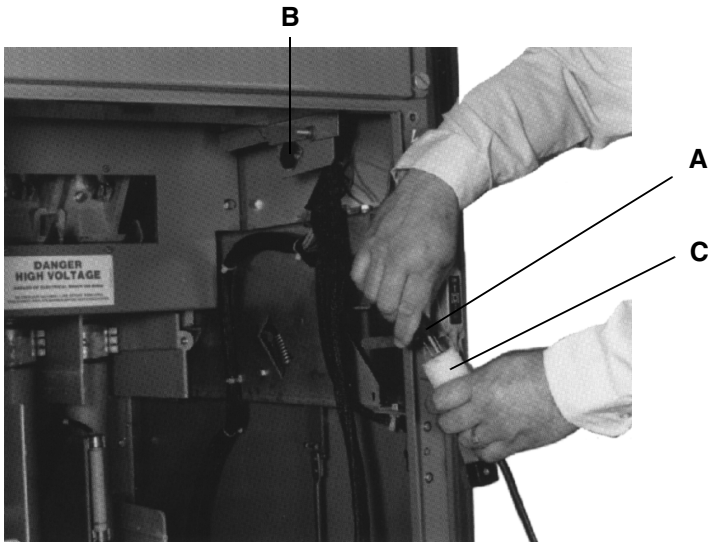


Figure 20 Controller Test Circuit

OPERATION

To operate the controller:

1. Be sure the test cord is removed and its plug is replaced in the receptacle.
2. Close and secure the medium voltage and low voltage compartment doors.
3. Apply medium voltage power to the incoming line. Raise the isolating switch handle to the ON position and tighten handle interlock thumb screw.
4. Depress START button. Sequence should follow the elementary wiring diagram supplied with the controller.
5. If controller fails to operate, refer to “TROUBLESHOOTING” on page 21.

MAINTENANCE AND REPAIRS

Disconnecting Power

Follow these procedures before performing any maintenance or repair:

1. Open isolation switch by moving isolation switch handle down to the OFF position. This disconnects all power from the contactor and / or controller.
2. Verify isolation switch is in the OPEN position:
   a. Open medium voltage compartment door, carefully avoiding any potentially live parts.
   b. View the isolation switch blades through the viewing window in the isolation switch barrier.
   c. If blades are not in the open position, close the door and deenergize incoming line power before proceeding.
   d. Verify controller is deenergized from external power feedback sources through the load connections.

⚠ DANGER

HAZARDOUS VOLTAGE.

- **Read and understand this bulletin in its entirety before installing or operating the controller. Installation, adjustment, repair and maintenance must be performed by qualified personnel.**
- **Disconnect all power from controller and contactor before installation or maintenance and verify the controller is deenergized from external power feedback sources through the load connections.**
- **Install all barriers and close all doors before applying power or starting and stopping the controller.**
- **User is responsible for conforming to all applicable code requirements with respect to grounding all equipment.**
- **Do not energize controller if any mechanical or electrical interlock is inoperative. Consult your local Square D sales office immediately.**

Before servicing controller:

- **Disconnect all power supplies.**
- **Place a "DO NOT TURN ON" label on power supply disconnect(s).**
- **Lock disconnect(s) in open position.**

Electrical shock will cause severe injury or death.

Most routine maintenance can be performed while the contactor is installed in the controller section. For details on contactor maintenance and repair, refer to bulletin 50006-316-01 (Series D) or 50006-316-03 (Series B & C).

Replacing the Power Fuse

Fuse size and rating are determined by motor full load and locked rotor currents. Fuse size information is on the nameplate of the controller, located on the medium voltage door. Be sure replacement fuse is identical to original fuse.

If a 24R fuse is used with a vacuum contactor, only the following fuses should be used:

- Buss JCL-24R
- Gould Shawmut A480R-24R
- GEC English Electric KDBX-24R
- Carbone-Ferraz A48-24R
- General Electric EJ2-24R
- For details, see “POWER FUSE COORDINATION” on page 3.

To replace the power fuse:

1. Pull fuse from top fuse clip and then from lower clip.
2. Install new fuse, making sure it is centered between the fuse clips and is firmly held by the fuse clips at top and bottom.

Replacing the Control Transformer Primary Fuses

The control transformer primary fuses are located between the current limiting power fuses (see Figure 1 on page 1). Control transformer primary fuses are selected on the basis of transformer rating. Make sure replacement fuse is identical to original fuse.

To replace a control transformer primary fuse:

1. Verify isolation switch is in the OFF (open) position and all power is disconnected from controller and contactor.
2. Pull fuse from top fuse clip and then from lower clip.
3. Install new fuse, making sure it is centered between the fuse clips and is firmly held by the fuse clips at top and bottom.

Control Transformer Replacement

The control transformer(s) is located on bottom plate of the medium voltage section, directly below the contactor. To replace a control transformer:

1. Verify isolation switch is in the OFF (open) position and all power is disconnected from controller and contactor.

⚠ DANGER

HAZARDOUS VOLTAGE.

Be sure incoming line power is deenergized before proceeding. Verify controller is deenergized from external power feedback sources connected to the load terminals.

Electrical shock will cause severe injury or death.

2. Disconnect secondary (low voltage) wires at the transformer terminals.
3. Disconnect primary leads at the transformer primary fuse clips.
4. Remove the four bolts and washers holding transformer mounting feet to bottom plate.
5. Replace control transformer.
6. Reinstall bolts and washers holding transformer mounting feet to bottom plate.
7. Route transformer primary leads as shown in Figure 21 on the next page.
8. Reconnect the primary leads at the transformer primary fuse clips.
9. Reconnect the secondary wires to the transformer terminals.

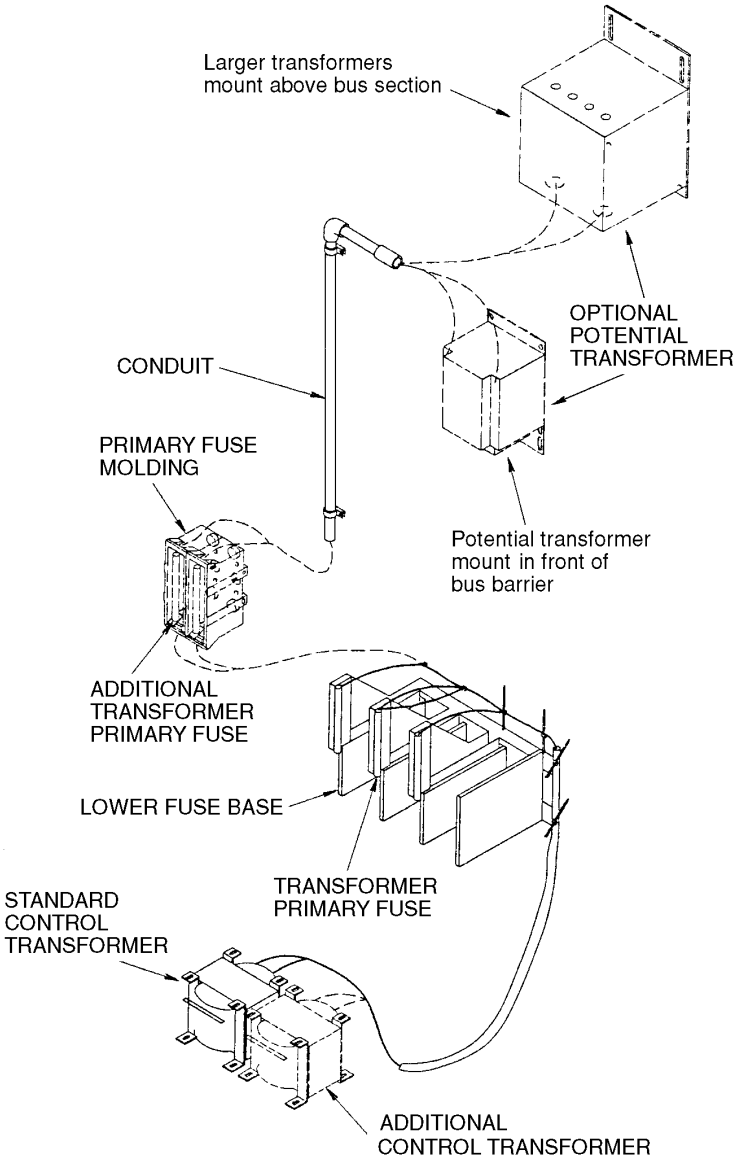


Figure 21 Routing the Transformer Primary Leads

Isolation Switch Maintenance

Before shipping, contacting surfaces of the isolation switch blades are coated with a special deoxidizing lubricant (Square D part no. PJC 7201). The switch blades must be coated with this deoxidizing lubricant at all times. **Under no circumstances should any other lubricant be used on these surfaces.**

To maintain the isolation switch, perform these procedures after every 500 operations or at least annually:

1. Verify isolation switch is in the OFF (open) position and all power is disconnected from controller and contactor.
2. Remove switch barrier.
3. Apply the special deoxidizing lubricant to entire contact area of switch blades.
4. Lubricate pivot points of switch handle mechanism with a multi-purpose grease, such as Cosmolube (Square D part number 1615-100120).
5. Reinstall switch barrier.
6. Close medium voltage door and reenergize the controller.

Routine Maintenance

To maintain the controller, perform these procedures annually:

1. Verify isolation switch is in the OFF (open) position and all power is disconnected from controller and contactor.
2. Be sure all connections are tight.
3. Be sure all molded parts and insulating surfaces are clean and free of foreign materials.
4. Lubricate isolation switch (see "Isolation Switch Maintenance").

Contactor Repairs

Do not attempt major repairs with the contactor in the enclosure. For contactor removal and installation procedures, see "REMOVING THE CONTACTOR" on page 10. Remove contactor and refer to bulletin 50006-316-01 (Series D) or 50006-316-03 (Series B & C) for details on contactor and for contactor parts list. Reinstall contactor after performing necessary repairs.

TROUBLESHOOTING

Follow the precautions below when troubleshooting the controller:

- Disconnect all power (see procedure below).
- Do not remove the isolation switch barrier under any circumstances unless all power is disconnected from the controller.
- While operating the controller from the main power, be sure that all doors are closed and properly secured.
- Access to the low voltage compartment, with the medium voltage compartment door closed and the isolation switch in the closed position, may be gained for checking control devices and circuitry (see "LOW VOLTAGE CONTROL" on page 12). However, extreme care must be exercised due to the presence of live terminals.
- The medium voltage compartment must only be accessed with the isolation switch in the open position, except for the situation described in "Emergency Access".

Before performing any troubleshooting procedure:

1. Open isolation switch by moving isolation switch handle down to the OFF position. This disconnects all power from the contactor and / or controller.
2. Verify isolation switch is in the OFF (open) position:
   a. Open medium voltage compartment door, carefully avoiding any potentially live parts.
   b. View the isolation switch blades through the viewing window in the isolation switch barrier.
   c. If blades are not in the open position, close the door and deenergize incoming line power before proceeding.
   d. Verify controller is deenergized from external power feedback sources through the load connections.

⚠ DANGER

HAZARDOUS VOLTAGE.

Disconnect all power from controller before troubleshooting controller.

Electrical shock will cause severe injury or death.

Emergency Access

In certain situations, the medium voltage compartment door of the controller can only be opened with the isolation switch closed (if the contact tips on the contactor are welded, for example). Emergency access may be obtained as follows:

1. Follow instructions on controller nameplate located on front of controller medium voltage compartment door.
2. Using electrically insulated screwdriver, bypasss interlock by turning screw (item B in Figure 18 on page 15) clockwise and open door.

Controller Control Circuit Sequence

To check control circuit sequence, refer to the elementary wiring diagram supplied with the controller. The following documents explain basic control circuit sequence using standard elementary wiring diagrams:

- 50006-376-03 — Full voltage non-reversing and latched controllers
- 50006-376-04 — Reduced voltage autotransformer and primary reactor controllers
- 50006-376-05 — Full voltage non-reversing brushless synchronous controllers
- 50006-376-06 — Full voltage non-reversing sychronous controllers
- 50006-376-07 — Two-speed / reversing controllers

External Test Voltage

The controller test cord (Figure 20, item A) must be used when testing the contactor and control circuit from an external 120 VAC power source. This disconnects the control transformer from the control circuit.

Inoperative Controller

Before troubleshooting an inoperative controller, be sure that:

1. Medium voltage compartment door is closed and secured.
2. Isolation switch handle is in the ON position.
3. Isolation switch handle thumb screw is tightened clockwise and fully engages the isolation switch electrical interlock (ISHI).
4. All devices such as overload, ground fault and motor protective relays are reset.
5. Low voltage compartment door is closed and secured.

If the controller still does not operate, identify the problem and follow the instructions in Table 2.

Table 2 Troubleshooting Chart

Symptom	Possible Cause	Action
Isolation switch handle cannot be placed in ON position.	1. Medium voltage compartment door not fully closed or latched.	1. MV: Close door and engage latch.
Load does not energize even though contactor and pilot light(s) operate.	1. Power connections not complete.	1. MV: Verify that all power connections are tight.
Contactor does not operate properly even though control relay operates.	1. Control cable plug defective or disengaged from contactor plug receptacle. 2. Low control voltage. 3. Contactor service required.	1. MV: Check plug cable and receptacle (see "INSTALLING THE CONTACTOR" on page 11). 2. LV: Check that control voltage is 102 to 120 VAC. 3. MV: Refer to Troubleshooting section in contactor bulletin.
Control relay does not operate.	1. Control circuit fuse open. 2. Inoperative low voltage compartment door interlock. 3. Control transformer primary or secondary fuse(s) open. 4. Test plug defective or disengaged from receptacle. 5. Power fuse(s) open. 6. Inoperative isolation switch handle thumb screw interlock. 7. Control sequence incomplete. 8. Defective control relay.	1. LV: Check control fuse mounted above terminal board and replace if open. 2. LV: Check interlock (see "Low Voltage Compartment Interlock" on page 14). 3. MV: Check fuses and replace if open. 4. MV: Refer to "STARTUP PROCEDURE" on page 16 and check plug cable and receptacle. 5. MV: Check fuses and replace if open. *Note: open power fuses may indicate other problems. A complete check of the controller and cabling should be made for possible damage from short circuit overcurrent condition.* 6. MV: Check interlock (see "Isolation Switch Handle Interlock" on page 15). 7. LV: Check control sequence, referring to wiring diagram supplied with controller. Verify that all external and remote control devices operate properly. 8. LV: Check relay and replace if defective.
Isolation switch handle can not be moved to the OFF position.	1. Isolation switch blades or contactor contact tips welded together.	1. Verify all power is disconnected from controller (see "Disconnecting Power" on page 18). 2. MV: To access medium voltage compartment, follow instructions in "Emergency Access" on page 22. 3. Welded contacts on vacuum contactor require replacement of the vacuum bottle assembly(s). Refer to contactor 50006-316-01 (Series D) or 50006-316-03 (Series B & C) for replacement procedures. 4. Check for open power fuses and inspect controller for damage as result of possible overcurrent condition.
LV = Access required to low voltage compartment; MV = Access required to medium voltage compartment.		

REPLACEMENT PARTS

Table 3 Parts List for Low Voltage Compartment

Item	Part No.	Description	Item	Part No.	Description
1	22906-10040	Thumb Screw	10	9001 KR1B 9001 KA2	Start Push Button (Black) Normally-Open Contact Block
2	23615-00220	Nylon Washer			
3	29929-00002	"X" Washer	11 [1]	52905-014-50	GROUND-CENSOR® Relay, Type GA
4 [1]	[2]	Voltmeter	12 [1]	9065 SSRO-200S1	Multi-Function Motor Protector Module
5 [1]	[2]	Ammeter	13 [1]	[2]	Elapsed Time Meter
6 [1]	[2]	Meter Selector Switch	14 [1]	[2]	Operations Counter
7	9001 KP1R9	Indicating Light (Red)	15	[2]	Control Relay (120 V, 60 Hz Coil)
8 [1]	9001 KP1G9	Indicating Light (Green)	16	9080 GF6	Control Circuit Fuse Block and Fuse Puller
9	9001 KR1R 9001 KA3	Stop Push Button (Red) Normally-Closed Contact Block	17	9080 GR6	Control Circuit Terminal Block
			18	26202-02010	Electrical Interlock Switch

[1] Optional equipment, not supplied unless specified on factory order.
[2] Refer to device identification table supplied with factory order.

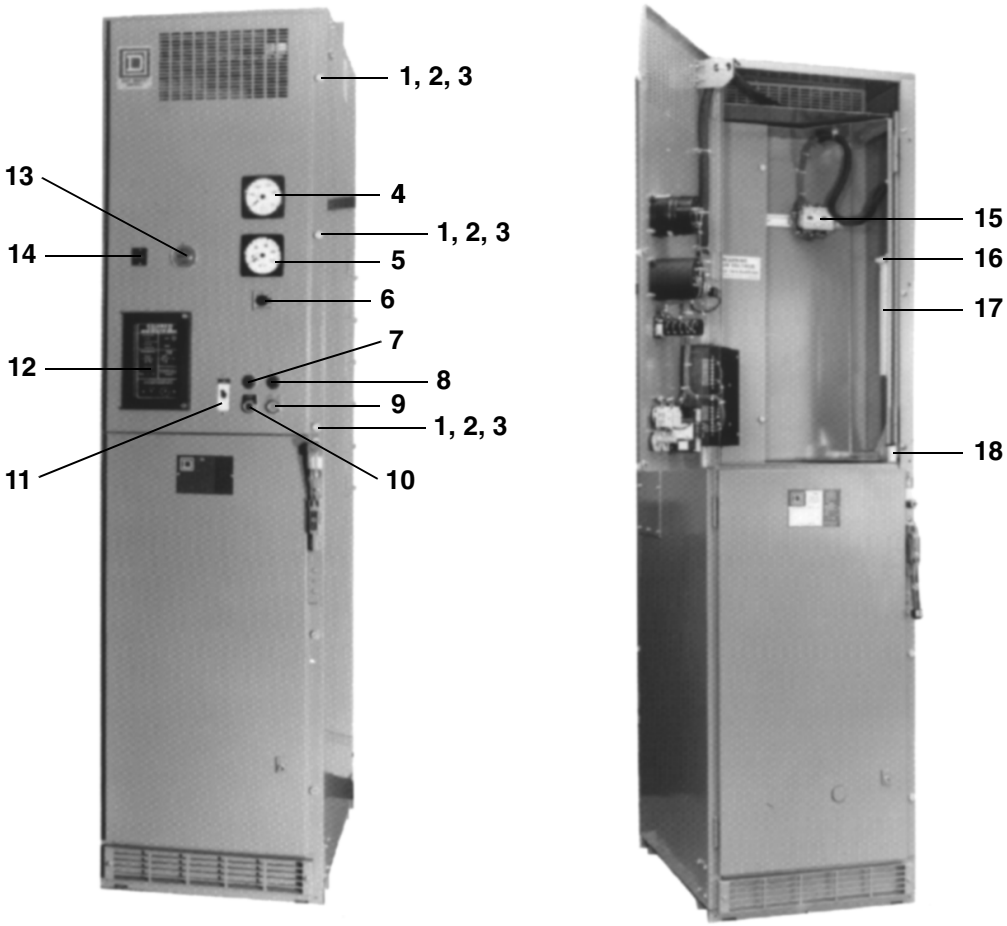


Figure 22 Parts Locations – Low Voltage Compartment

Table 4 Parts List for Medium Voltage Compartment

Item	Part No.	Description	Item	Part No.	Description
1	51190-074-50	Isolation Switch Handle	23	[1]	Contactor
2	31008-467-01	Isolation Switch Handle Interlock Lever	24	31055-164-04	Interlock Threaded Rod
3	31008-004-01	Isolation Switch Handle Gasket for NEMA 3R and NEMA 12 Enclosures	25	51192-115-50	Disconnect Jaw Assembly
4	51192-135-50	Thumb Screw Interlock Actuator Guide & Isolation Switch Handle Mounting Bracket Assembly	26	[2]	5/16-18 x 2 Hex Head Cap Screw
5	51192-134-01	Thumb Screw Interlock Actuator	27	23903-32002	5/16 Spring Water
6	9007-A02	Interlock Snap Screw	28	[2]	5/16 Large Plain Washer
7	29206-00395	Sealing Ring for NEMA 3R & NEMA 12 Enclosures	29	51192-112-01	Isolation Switch Blade
8	25410-02908	Test Receptacle	30	24209-16320	Spring Pin
9	25410-01235	Test Plug	31	23427-02200	5/16 Hex Nut with Lock Washer
10	22906-10040	Medium Voltage Compartment Door Thumb Screw	32	23601-00222	5/16 Plain Washer
11	23615-00220	Nylon Washer	33	[2]	5/16-18 x 1 Hex Head Cap Screw
12	29929-00002	“X” Washer	34	51192-118-50	Flexible Shunt Assembly
13	51192-141-01	Medium Voltage Compartment Door Interlock Hook	35	51192-119-01	Shunt Bus (connects flexible shunt to power fuse clip)
14	30007-527-52	Medium Voltage Compartment Door Interlock Assy.	36	51033-506-01	Power Fuse Clip
17	51192-130-50	Contactor Mounting Shelf	37	51033-507-01	Power Fuse Clip Back-Up Spring
18	9080 GF6	Control Power Transformer Secondary Fuse Block and Fuse Puller	38	[1]	Power Fuse
19	[1]	Control Power Transformer	39	[1]	Control Power Transformer Primary Fuse
	[2]	5/16-18 x 1 Cap Screw	40	51192-138-50	Lower Fuse Base Bus (connects power fuse clip to contactor)
	[2]	5/16 Large Plain Washer	41	K153010	Control Power Transformer Primary Fuse Clip
20	51192-044-50	Door Interlock Push Bar Assy. (Includes item 21)		[2]	10-24 x 1/2 Pan Head Screw
21	50502-602-09	Door Interlock Push Bar Spring		[2]	#10 Lock Washer
22	31004-261-01	Drive Pin		[2]	#10 Plain Washer

[1] Refer to device identification table supplied with factory order.

[2] Standard hardware, listed without a Square D part number, should be obtained from a local hardware supplier.

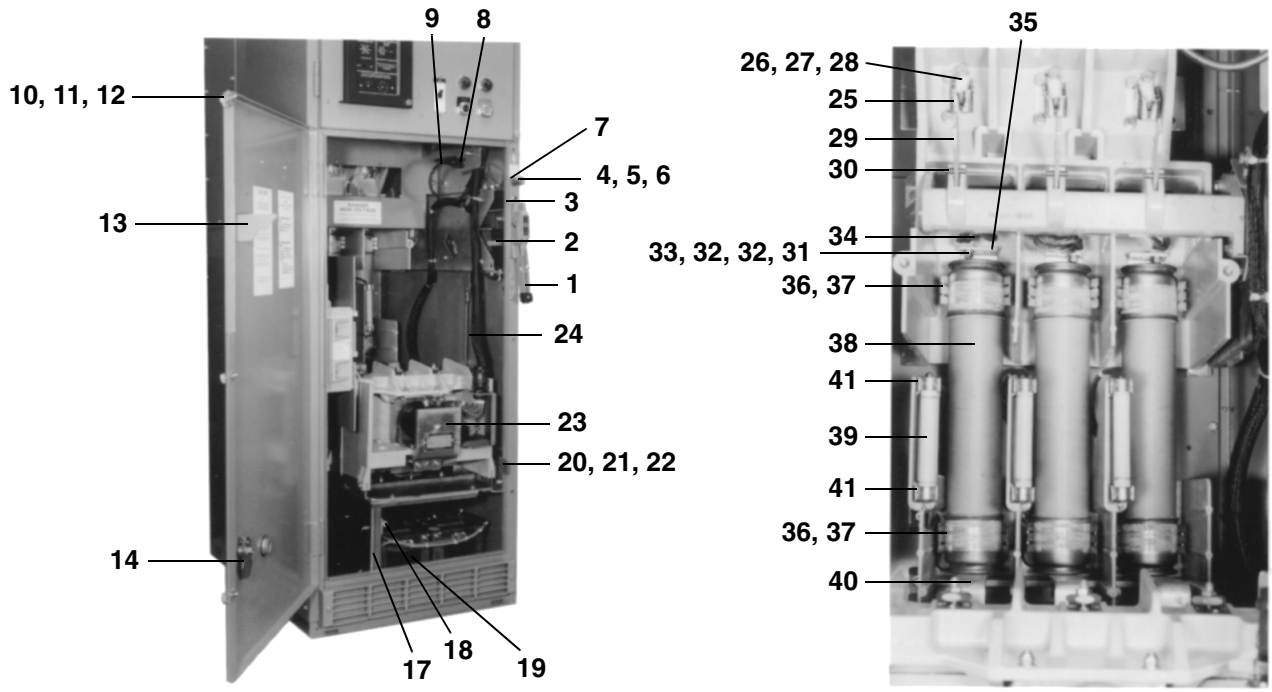


Figure 23 Parts Locations – Medium Voltage Compartment

Table 5 Parts List for Left Wall of Medium Voltage Compartment

Item	Part No.	Description
1	51203-849-01	Cable Clamp Half (two required)
2	51192-436-01	5/16-18 x 4.45” Threaded Rod
3	[1]	5/16 Lock Washer
4	[1]	5/16-18 Hex Nut
5	23502-22002	5/16-18 Retained Nut
6	51192-147-01	Load Cable Connection Box Sidewall Barrier
7	51192-146-01	Connection Box Load Cable Bus Tap
8	[1]	5/16-18 x 1 Cap Screw
9	23903-32002	5/16 Spring Washer
10	51192-145-01	Load Connection Box Bus
11	23601-00222	5/16 Large Plain Washer
12	23502-22001	5/16-18 Cage Nut
13	51190-116-50	Load Cable Connection Box
14	51190-111-01	Load Cable Connection Box Cover (not shown)

[1] Standard hardware, listed without a Square D part number, should be obtained from a local hardware supplier.

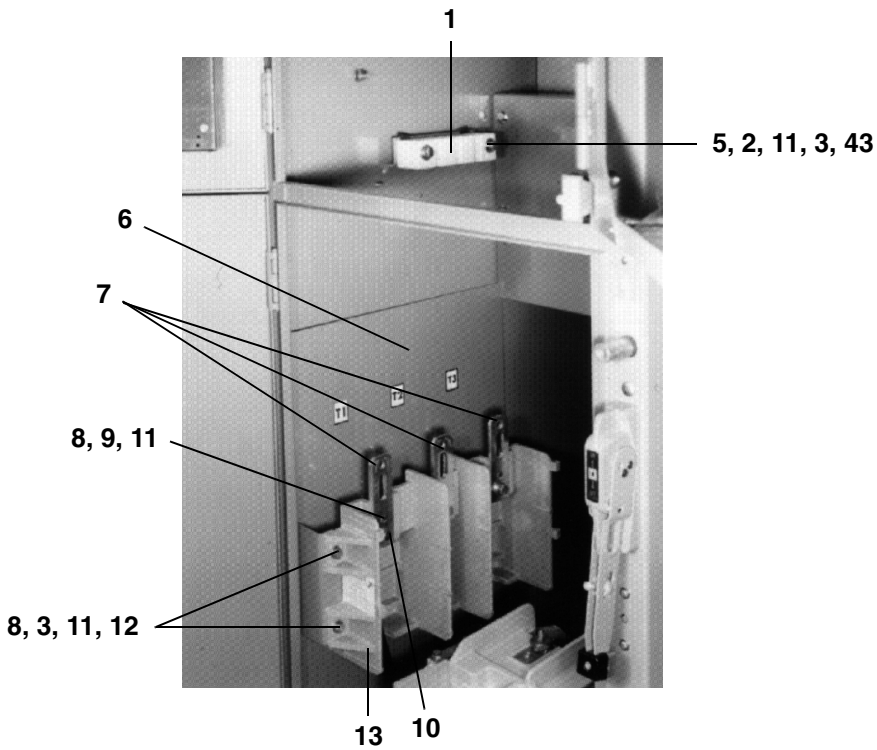


Figure 24 Parts Locations – Left Wall of Medium Voltage Compartment

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