

 **Allen-Bradley**

# Medium Voltage Contactor (Series D)

Bulletin 1502 • 400A  
2400 to 7200 volts

User Manual

**Rockwell  
Automation**

## Important User Information

Solid state equipment has operational characteristics differing from those of electro-mechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at <http://www.ab.com/manuals/gi>) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of these differences, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual we use notes to make you aware of safety considerations.

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### WARNING



Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

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### IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

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### ATTENTION



Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you:

- identify a hazard
- avoid a hazard
- recognize the consequence

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### SHOCK HAZARD



Labels may be located on or inside the equipment to alert people that dangerous voltage may be present.

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### BURN HAZARD



Labels may be located on or inside the equipment to alert people that surfaces may be at a dangerous temperature.

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## Product Description

### Scope

This User Manual applies to the Allen-Bradley, Bulletin 1502 (Series D), 400 A electrically held vacuum contactors, designed for applications in the 2400 to 7200 volt range.

### Contactors Description

The contactor is suitable for all types of AC loads, for example: three-phase motors, transformers, power capacitors and resistive heating loads.

The contactor uses three (3) vacuum interrupters (hereafter referred to as vacuum bottles) operated by an electromagnet assembly through a mechanical linkage. They are resistant to most adverse atmospheric conditions and provide long mechanical and electrical life.

The contactors are utilized in various starter and drive configurations, for example: full-voltage non-reversing, full-voltage reversing, two-speed, reduced voltage, synchronous, drive input/output and bypass applications. They are generally fixed mounted within the structures and the line and load terminations are made at the rear of the device. In most configurations, the main contactor is mechanically interlocked with the external operating handle and isolating switch.

Bulletin 1502 electrically held vacuum contactors are available in 120-volt and 230-volt control configurations. Mechanically latched contactors are only available in 120-volt control configurations.



Figure 1.1 – 400A Contactor

### Vacuum Bottle Description

Each vacuum bottle (Figure 1.2) consists of two contacts enclosed in a ceramic housing: an upper contact mounted to a fixed shaft, and a lower contact mounted to a movable shaft. A stainless steel bellows ensures the vacuum integrity of the bottle while letting the lower contact move towards and away from the fixed contact.

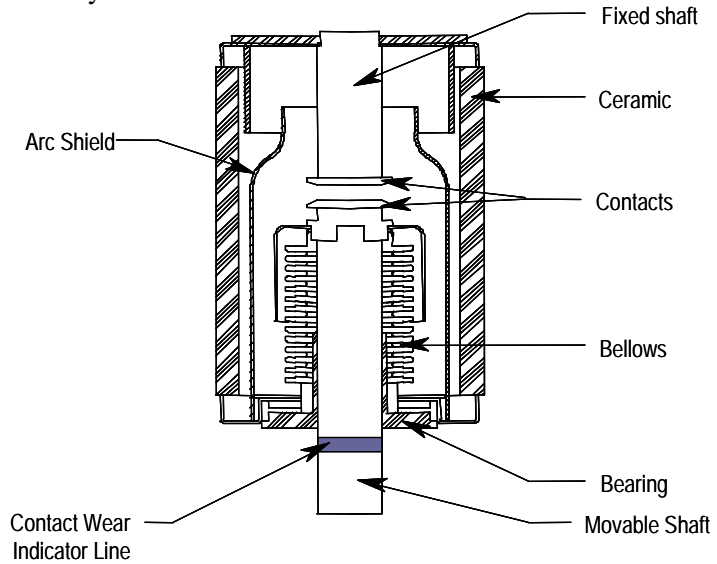


Figure 1.2 – Vacuum Bottle Cross Section

## Standard Electrically Held Contactor Operation

The standard electrically held contactor consists of three vacuum bottles. An electro-magnet assembly and a mechanical linkage are used to close the contacts (Figure 1.3).

- When the control circuit is energized, the current creates an electromagnet in the closing coil and hold-in coil.
- The electromagnet pulls the armature plate towards the coils' core, rotating the shaft and causing the actuator plate to move upwards.
- As the actuator plate moves, it pushes the insulator and movable shaft up, closing the contacts in the vacuum bottle.
- The control circuit economizing/auxiliary contacts, on the left side of the contactor, change from the normally closed state to open as the contactor closes. This de-energizes the closing coil.
- The hold-in coil remains energized and keeps the contactor closed.
- De-energizing the hold-in coil opens the contactor.

**Note:** The contactor requires external control relays and a rectification circuit to control the standard DC closing and hold-in coils on the contactor. (Refer to Chapter 3 for typical control schematics.)

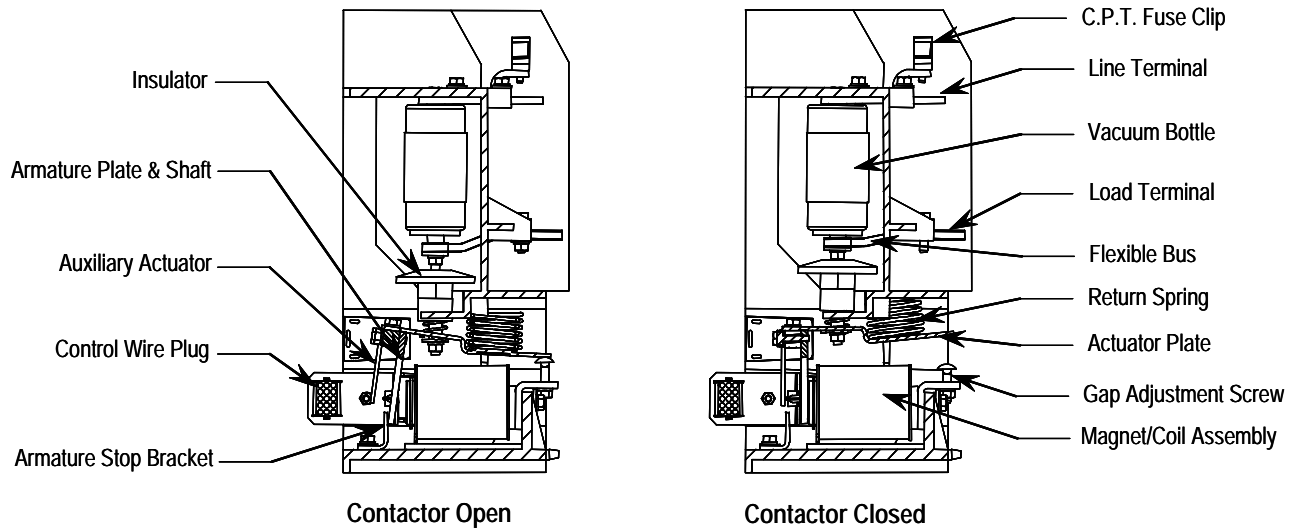


Figure 1.3 – Vacuum Contactor Operation

### Mechanically Latched Contactor Operation

The mechanically latched contactor operates in much the same way as the electrically held with only a few exceptions.

- When the control circuit is energized, current flows only to the closing coil and creates an electromagnet (the hold-in coil is not supplied).
- Once the contactor is closed, a spring-loaded mechanism moves a roller against the armature plate to hold it against the electromagnetic core.
- The contactor can be opened electrically by energizing a trip coil which pulls the latch away from the armature, or by a push button mounted on the power cell door that mechanically releases the contactor.

### Contactors Identification

Each contactor is identified with a rating label (Figure 1.4) attached to the armature plate at the front of the contactor. The rating label information includes the Catalog Number (Cat.), Series Letter (Ser.), Voltage Rating, Non-Enclosed Current Rating, Interrupting Capacity, Altitude Range (in meters), CSA and UL markings.

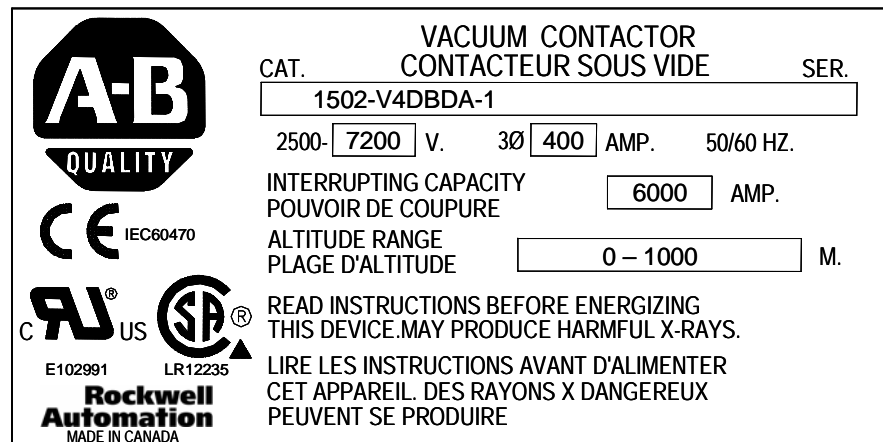


Figure 1.4 – Contactor Rating Label (400A)



**Contactor Catalog Number Explanation**

The following catalog number explanation is used to identify the contactor and should be used when contacting your local Rockwell Automation Sales office, or the factory, for assistance.

Table 1.A – Contactor Catalog Number Explanation

<b>1502</b>	<b>-</b>	<b>V</b>	<b>4</b>	<b>D</b>	<b>B</b>	<b>D</b>	<b>A</b>	<b>-</b>	<b>1</b>
First Position		Second Position	Third Position	Fourth Position	Fifth Position	Sixth Position	Seventh Position		Eighth Position
Bulletin Number <b>1502</b>		Contactor Type and Interlock <b>V</b> = Vacuum, <b>VD</b> = Vacuum, (Drawout) <b>VC</b> = Vacuum, Optimized for IntelliVAC control	Contactor Size <b>4</b> = 400 A	Nominal Line Voltage <b>D</b> = 7200 V	Fuse Mounting Provisions <b>B</b> = 5000 V <b>C</b> = 7200 V	Coil Voltage <b>D</b> = 110 V DC <b>E</b> = 207 V DC	Function <b>Refer to TABLE 1.B</b>		Altitude Code (meters) <b>0</b> = -1000 – 5000 <b>1</b> = 0 – 1000 <b>2</b> = 1001–2000 <b>3</b> = 2001–3000 <b>4</b> = 3001–4000 <b>5</b> = 4001–5000

Table 1.B – Vacuum Contactor Function

<p><b>A</b> = 3 pole, electrically held contactor  <b>B</b> = 3 pole, mechanically latched contactor with electrical and mechanical release  <b>D</b> = 3 pole, electrically held contactor with fast drop-out</p>
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**Contactor Specifications**

**Contactor Ampere Rating**

**400A**

Continuous current rating ❶ .....	400 amps
Maximum rated voltage .....	7.2 kV
Maximum ambient temperature (for rated current) .....	40°C (104°F)
Frequency rating .....	50/60 Hz
Short circuit interruption current rating:	
– 1500 V to 5000 V (RMS sym.) .....	6300 amps
– 7200 V (RMS sym.) .....	6000 amps ❷
Short circuit withstand at rated voltage .....	60 kA peak
Dielectric voltage withstand (for 60 seconds) .....	18.2 kV/20 kV (IEC)
Make & break capability at rated voltage .....	4.0 kA
Short time capability (for 1 second) .....	6.0 kA
(for 30 seconds) .....	2.4 kA
Basic Impulse Level (B.I.L.) withstand ❶ .....	60 kV
Mechanical life (operations): ❸	
– electrically held .....	2,500,000
– mechanical latch .....	100,000
Electrical Life (operations) ❸ .....	1,000,000
Standard altitude rating .....	1000 m (3,300 ft)
Max. altitude limit with spring replacement .....	5000 m (16,500 ft)
Chopping current (average RMS) .....	0.5 amps
Switching frequency:	
– electrically held .....	600 ops/hr
– mechanical latch .....	150 ops/hr
Coil inrush current:	
• At 120 VAC:	
– electrically held .....	7.3 amps
– mechanical latch .....	11.5 amps
• At 230 VAC:	
– electrically held .....	8.3 amps
– mechanical latch .....	N/A

❶ The continuous current rating and B.I.L. withstand are de-rated for altitudes above 1000 m (3300 ft). Refer to Altitude Adjustment in Chapter 4 for details.  
 ❷ IEC rating at 7200 V (RMS sym.) – 5300 amps.  
 ❸ Provided routine maintenance is performed as detailed in this manual.

Contactor Ampere Rating

400A

Mechanical latch trip coil inrush current

- At 120 VAC ..... 5.1 amps
- At 230 VAC ..... N/A

Coil continuous (economized) current

- At 120 VAC ..... 0.13 amps
- At 230 VAC ..... 0.11 amps

Coil pick-up voltage

- At 120 VAC ④ ..... 102 VAC
- At 230 VAC ..... 190 VAC

Coil drop-out voltage

- At 120 VAC ④ ..... 75 VAC
- At 230 VAC ..... 140 VAC

Mechanical latch trip coil voltage

- At 120 VAC ..... 102 VAC
- At 230 VAC ..... N/A

Maximum closing time ⑤

- (60 Hz) ..... 9.6 cycles (160 msec)
- (50 Hz) ..... 8 cycles (160 msec)

Maximum opening time ⑤

- normal drop-out (60 Hz) ..... 9.6 cycles (160 msec)
- normal drop-out (50 Hz) ..... 8 cycles (160 msec)
- fast drop-out (60 Hz) ..... 3 cycles 50 msec)
- fast drop-out (50 Hz) ..... 2.5 cycles (50 msec)

Mechanical latch maximum trip time ⑤

- (60 Hz) ..... 3 cycles (50 msec)
- (50 Hz) ..... 2.5 cycles (50 msec)

Capacitor Switching (KVAR max.)

- 2400 V ..... 800
- 4160 V ..... 1400
- 6900 V ..... 2000

④ The 120 VAC control voltage is rectified for the contactor coils.

⑤ At rated control voltage

**Contactors Specifications  
(cont.)**

**Contactors Ampere Rating**

**400A**

Contact gap ..... 4.8 mm (0.19 in.)

Contact pressure ..... 16 kg (35 lb)

Weight ..... 21.8 kg (48 lb)

**Auxiliary contacts:**

- electrically held ..... 2 N.O., 2 N.C.
- mechanical latch ..... 3 N.O., 2 N.C.

Auxiliary contact rating ..... A600

**Product Approvals**

- UL347
- CSA22.2 No. 14 and T.I.L. D-21
- IEC60470
- CE Mark

## Receiving and Handling

### Receiving

The contactors have been tested both mechanically and electrically before leaving the factory. Immediately upon receiving the contactor, remove the packing material and check the contactor for possible shipping damage. If damage is found, do not discard any of the packaging material and, if possible, note the damage on the “Bill of Lading” before accepting the shipment. Report any damage immediately to the claims office of the common carrier. Provide a description of the damage and as much identification as possible.

### Preliminary Inspection

- Check for any cracks or breaks due to impact.
- Push on armature plate to ensure mechanisms are in good working order.
- Use a HiPot tester to ensure vacuum bottle integrity (refer to Vacuum Bottle Integrity Test later in this Chapter).

### Handling

The contactor weighs approximately 48 lb (21.8 kg) and it is possible for one (1) person to safely handle the contactor for a short time. When transporting the contactor over longer distances or sustained lifting, a fork lift should be considered.

When a forklift is used to handle the equipment, the following precautions should be taken:

- Keep the contactor in an upright position.
- Carefully balance the contactor on the forks.
- Use a safety strap to steady the contactor and avoid shifting or tipping.
- Avoid excessive speeds and sudden starts, stops and turns.
- Never lift a contactor above an area where personnel are located.

### Pre-Energization Inspection

Before placing the contactor in service, inspect it carefully for possible damage sustained in transit or maintenance:

- Check housing for any cracks or breaks due to impact.
- Push on the armature plate and rotating shaft to ensure mechanism is in good working order.
- Inspect the contactor for dirt, stray or loose hardware, tools or metal chips. Vacuum clean the contactor if necessary.

## Storage

If it is necessary to store the contactor before it is put into service, be certain to store it in a clean, dry, dust- and condensation-free area. Do not store contactor outdoors.

Storage temperature should be maintained between -20°C to 65°C (-4°F to 149°F). If storage temperature fluctuates or if humidity exceeds 85%, space heaters should be used to prevent condensation.

## Vacuum Bottle Integrity Test

The internal dielectric condition and vacuum integrity of the vacuum bottles is determined by this test.

Power Frequency Dielectric Tests for new dry equipment are defined in Clause 8.9 of NEMA ICS 3-2 and Clause 8.4 of ICS1. Periodic field testing (every 50,000 operations, or annually, whichever occurs first) will ensure that vacuum bottle integrity exists. The tests are to be performed as shown in Table 2.A.

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**ATTENTION**

Do not apply a voltage higher than 25,000 volts across the open contacts of a vacuum bottle. Dangerous x-ray emissions may be produced.

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**ATTENTION**

Vacuum bottles are thoroughly tested at the factory; however, mishandling during shipment may cause damage. It is very important to perform the vacuum bottle integrity test before energizing the contactor for the first time, and before it is returned to service after maintenance or repair; otherwise perform the test annually. Failure to perform this test may result in personal injury or damage to the equipment if the vacuum bottle integrity fails.

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**ATTENTION**

High voltage testing is potentially hazardous. Use caution when performing the Hi-pot test. Failure to do so may result in severe burns, injury or death.

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High-potential test instruments can be purchased to perform the vacuum bottle integrity test. A Megger cannot be used to measure vacuum integrity because the voltage is too low. One of the following AC Hi-pot testers is recommended as a test instrument.

<b>MANUFACTURER</b>	<b>ADDRESS</b>
Mitsubishi Type VI #4U17	Chicago, Ill., USA
Jennings Model JHP-70A	San Jose, CA., USA
Hipotronics Model 7BT 60A	Brewster, NY, USA

1. Clean the outside of the vacuum bottles with a non-linting cloth or industrial wipe before performing the test.
2. The contactor may be tested while it is in the power cell. The line connection of the contactor must be disconnected and the ground lead from the Hi-pot tester must be connected to the load side of the contactor. Any fuses in the top of the contactor must be removed.
3. With the contactor in the open position, connect the test leads to the contactor power terminals as shown in Figure 2.1. It is recommended that an AC Hi-pot tester be used. Use the test voltage indicated in Table 2.A. Test each vacuum bottle individually.
4. If no breakdown occurs the vacuum bottle is in an acceptable condition. If a breakdown occurs, repeat the test once more. If the vacuum bottle fails a second time, it must be replaced. If no breakdown occurs in the second test, the vacuum bottle is in an acceptable condition.

**IMPORTANT**

If one vacuum bottle fails, Rockwell Automation recommends the replacement of all three vacuum bottles, if the unit has been in service.

5. After the high potential voltage is removed from the vacuum bottles, the metal end caps of the vacuum bottles should be discharged with a grounding rod to remove any residual electrical charge.

## Vacuum Bottle Integrity Test (cont.)

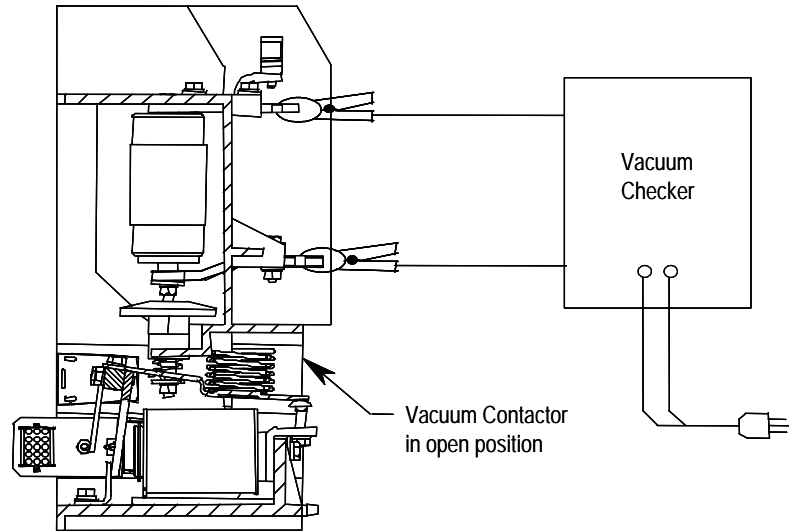


Figure 2.1 – Vacuum Bottle Integrity Test Circuit

Table 2.A – Vacuum Integrity Testing Values

Test ❶	Dielectric Test Voltage (AC)		Allowable Leakage
	System	Duration	
Vacuum Integrity	16.0 kV	60 s	< 5 mA

❶ The vacuum integrity cannot be tested using a Megger, as the voltage of a Megger is too low.

The allowable leakage current value shown in Table 2.A is exclusive of leakage due to test equipment leads. The test setup leakage can be determined by running the dielectric test with test leads not connected to the contactor and noting the maximum leakage current. If this value is more than 2 milliamperes, it should be added to the value shown in Table 2.A when testing the vacuum bottles.

**NOTE:** Rockwell Automation does not recommend DC Hi-pot testing because the values obtained during the test may not be a reliable indication of vacuum bottle integrity. Some specific DC "GO–NO GO" testers may provide suitable "defective" readings.



DC Hi-pot testing is unreliable because of a phenomenon known as Cathode Ray Tube Effect. This occurs when one contact of the vacuum bottle has a deformity, such as a burr or deposit, while the other contact remains flat and true. This sets up leakage currents which flow from a small surface to a large surface in one direction and vice versa when the polarity of the tester is changed. The resultant current is large in one direction which would incorrectly indicate a faulty vacuum bottle.

At best, DC testing will verify only some degree of vacuum integrity. It will not give any indication of the degree of vacuum since the contact surface can change with each operation of the vacuum contactor. AC testing, on the other hand, will provide reliable vacuum integrity indication. As well, the degree of vacuum within the bottle can be determined by comparing initial test results to the present readings. Increases in leakage current indicates a reduction in vacuum within the vacuum bottle.

For these reasons, Rockwell Automation recommends AC testing as the best and most reliable method of testing vacuum bottles.

A suitable GO–NO GO DC test unit is:

<b>MANUFACTURER</b>	<b>ADDRESS</b>
Programma, Model VIDAR	Santa Rosa, CA, USA

## Insulation Resistance Test

Use a 1000 volt Megger to verify that the resistance from phase to phase or phase to ground is greater than 500 megohms.



## Installation

### Mounting

The electrically held and the mechanically latched contactors are fixed mounted (bolted down) in the controller's cabinet. Two retaining tabs at the rear of the contactor's molded base can be used for mounting. The two mounting slots at the front of the contactor's molded base are used to secure the contactor with 1/4-in. bolts. The appropriate mounting configuration is provided inside the power cells of Allen-Bradley controllers. If the contactor is supplied as a OEM component for installation in a custom application, refer to the dimensional information in Figure 3.1. If the contactor is to be mounted in an enclosure designed by an OEM, make sure there is a minimum of 3 inches (76 mm) of air space between live parts (terminals and vacuum bottles) and any part of the enclosure.

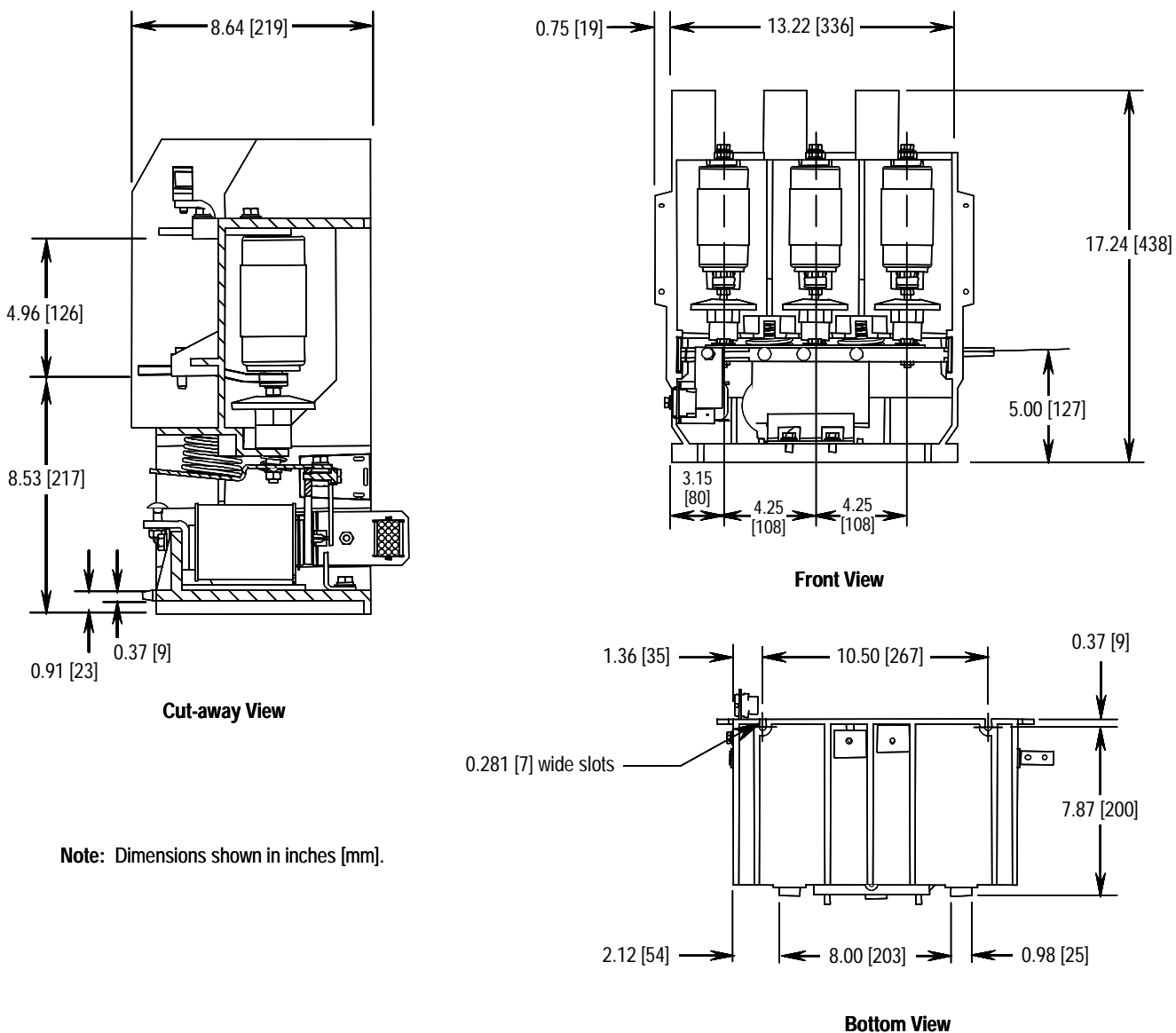


Figure 3.1 – Contactor Mounting Details

## Electrical Connections

A wire harness connects the control wiring to the contactor from the low voltage control panel. The harness connects to a wire plug on the lower left side of the contactor. If the contactor is supplied as an OEM component for installation in a custom application, an optional control panel with connecting wire harness is available from Rockwell Automation.

Connect incoming power to the line side terminals at the top, rear of the contactor near the control fuse clips. Use 3/8-in. (10 mm) bolts torqued to 20 ft/lbs. (292 N/m) to secure the connection.

Connect outgoing power to the load side terminals halfway down the rear of the contactor. Use 3/8-in. (10 mm) bolts torqued to 20 ft/lbs. (292 N/m) to secure the connection.

For mechanically latched contactors, ensure the manual trip button in the cabinet door is in line with the trip lever on the contactor.

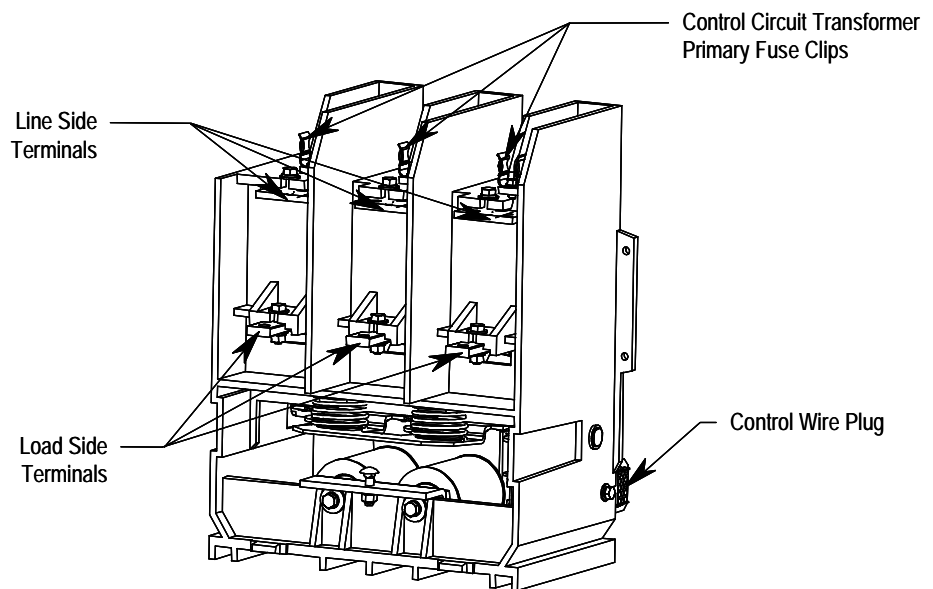
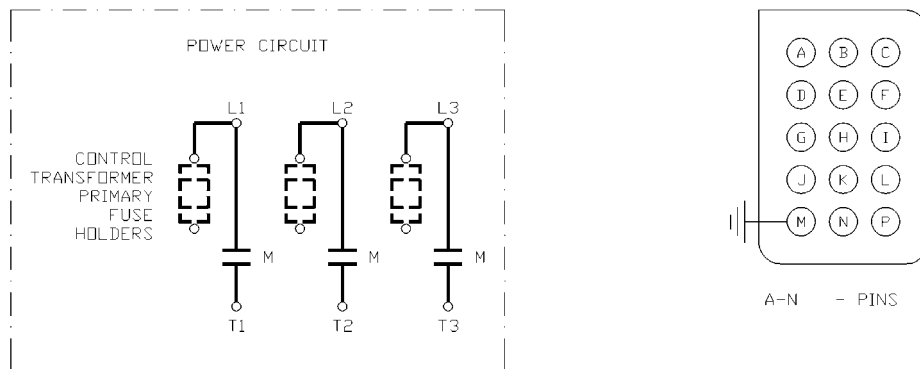
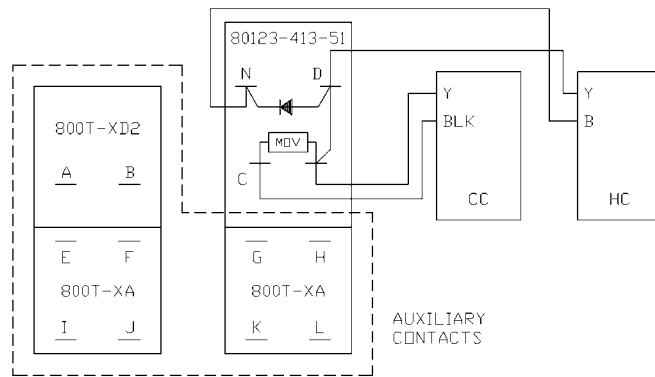


Figure 3.2 – Electrical Connections (Rear View)

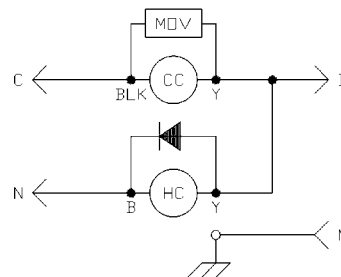
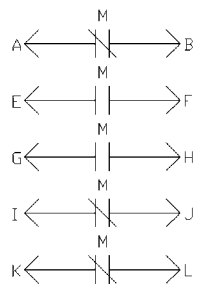
### Wiring and Schematic Diagrams

WIRING DIAGRAM  
400A VACUUM CONTACTOR  
120V COIL, NORMAL DROP OUT



SCHEMATIC  
400A VACUUM CONTACTOR  
120V COIL, NORMAL DROP OUT

AUXILIARY CONTACTS

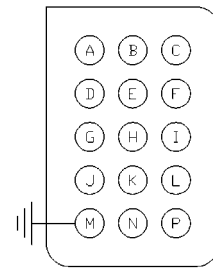
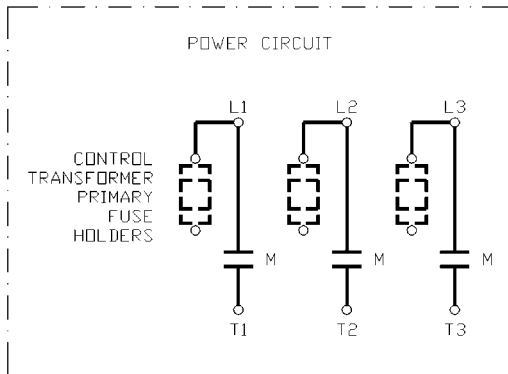
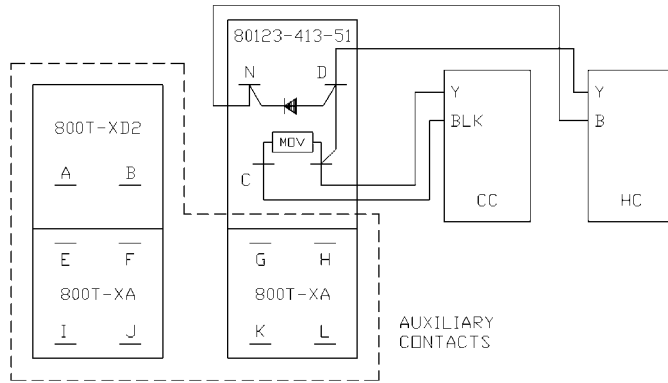


CC - CLOSING COIL  
HC - HOLDING COIL

Figure 3.3 – Wiring Diagram • Electrically Held Contactor, 120 V AC (Normal Drop-out Time)

Wiring and Schematic Diagrams  
(cont.)

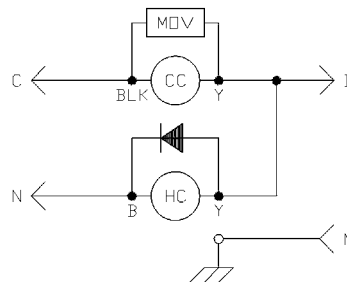
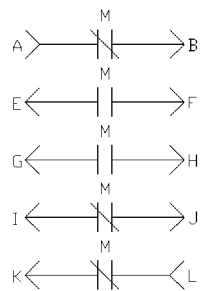
WIRING DIAGRAM  
400A VACUUM CONTACTOR  
230V COIL, NORMAL DROP OUT



B,C,D,E,F,G,H,I,J,K & N PINS  
A,L & M - SOCKETS  
P - NOT USED

SCHEMATIC  
400A VACUUM CONTACTOR  
230V COIL, NORMAL DROP OUT

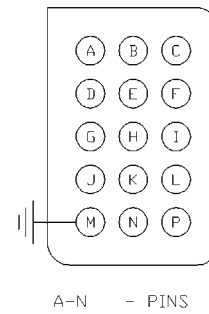
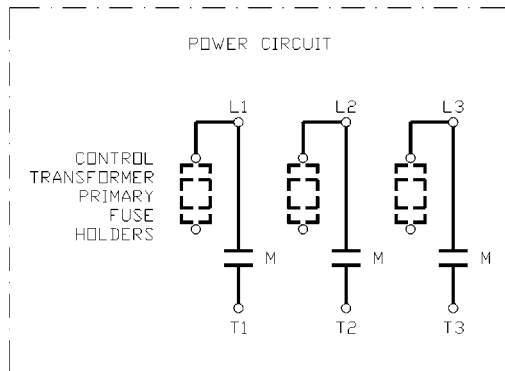
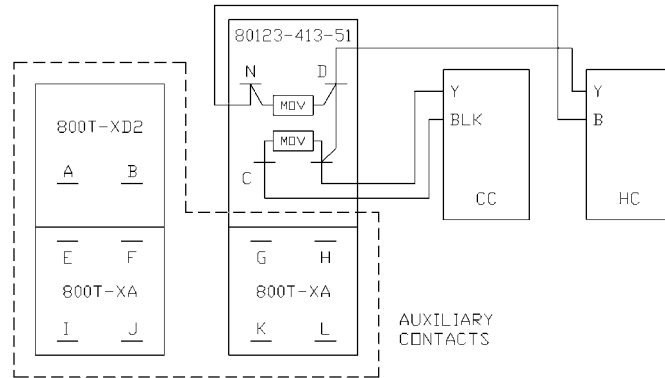
AUXILIARY CONTACTS



CC - CLOSING COIL  
HC - HOLDING COIL

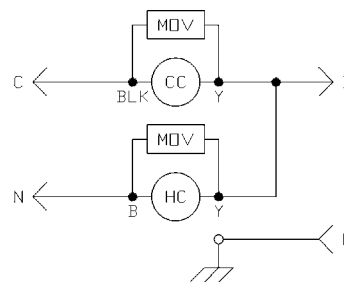
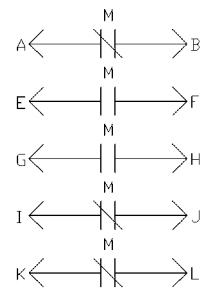
Figure 3.4 – Wiring Diagram • Electrically Held Contactor, 230 V AC (Normal Drop-Out Time)

WIRING DIAGRAM  
400A VACUUM CONTACTOR  
120V COIL, FAST DROP OUT



SCHEMATIC  
400A VACUUM CONTACTOR  
120V COIL, FAST DROP OUT

AUXILIARY CONTACTS



CC - CLOSING COIL  
HC - HOLDING COIL

Figure 3.5 – Wiring Diagram • Electrically Held Contactor, 120 V AC (Fast Drop-Out Time)

### Wiring and Schematic Diagrams (cont.)

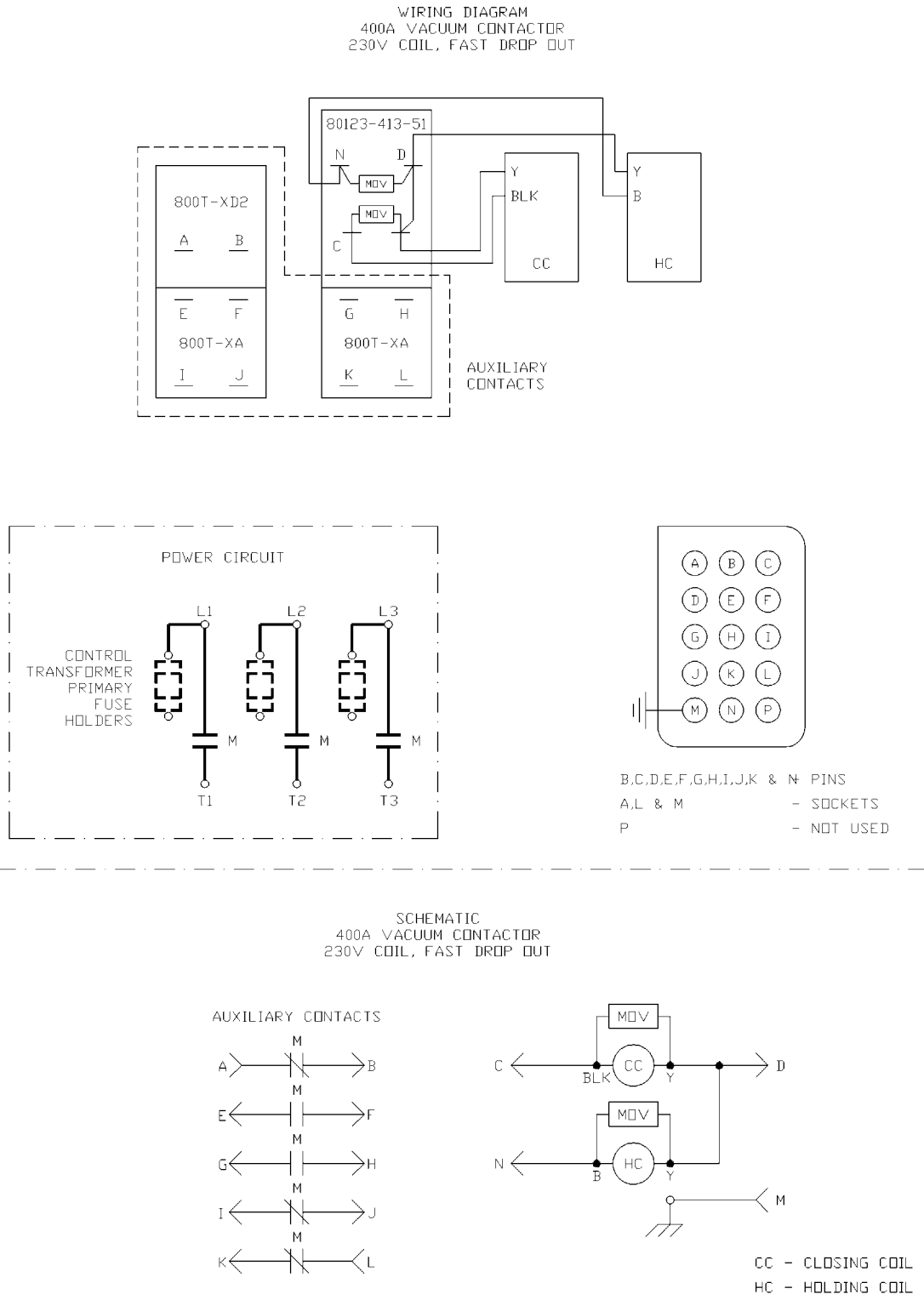
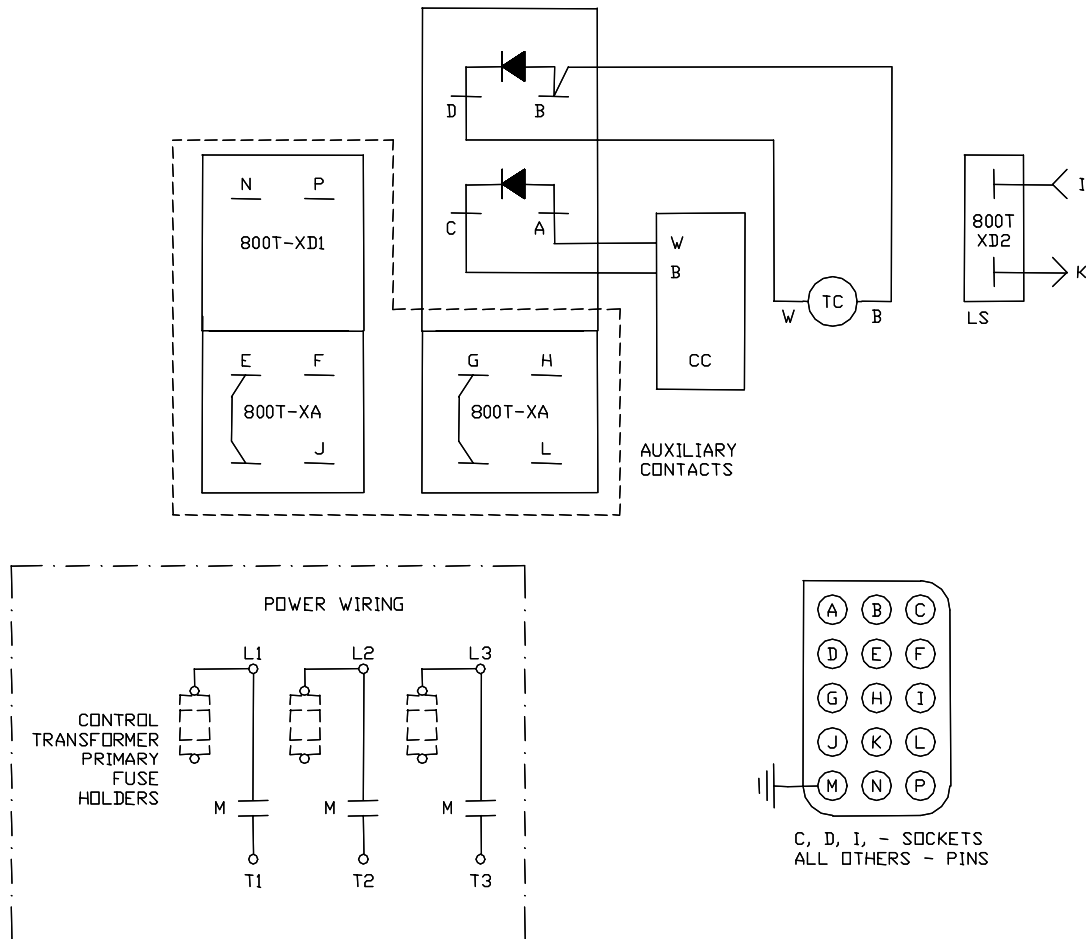


Figure 3.6 – Wiring Diagram • Electrically Held Contactor, 230 V AC (Fast Drop-Out Time)



WIRING DIAGRAM  
400A MECHANICALLY LATCHED CONTACTOR



SCHEMATIC  
400A MECHANICALLY LATCHED CONTACTOR

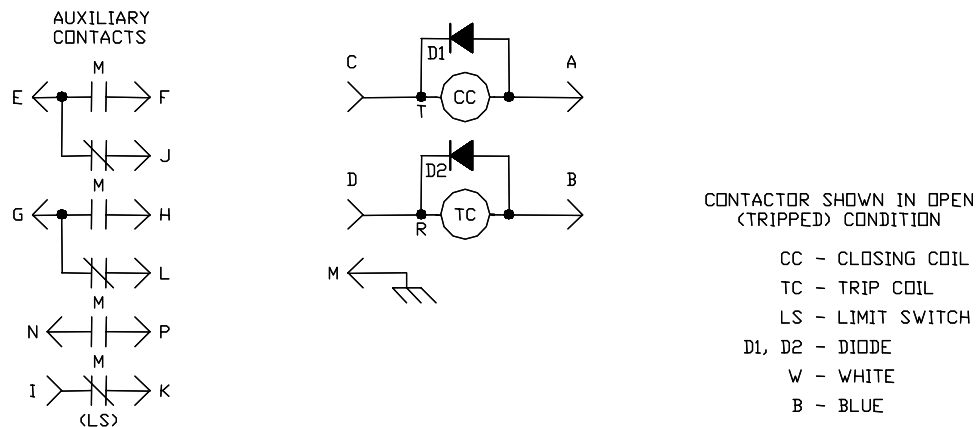


Figure 3.7 – Wiring Diagram • Mechanically Latched Contactor (120 V AC)

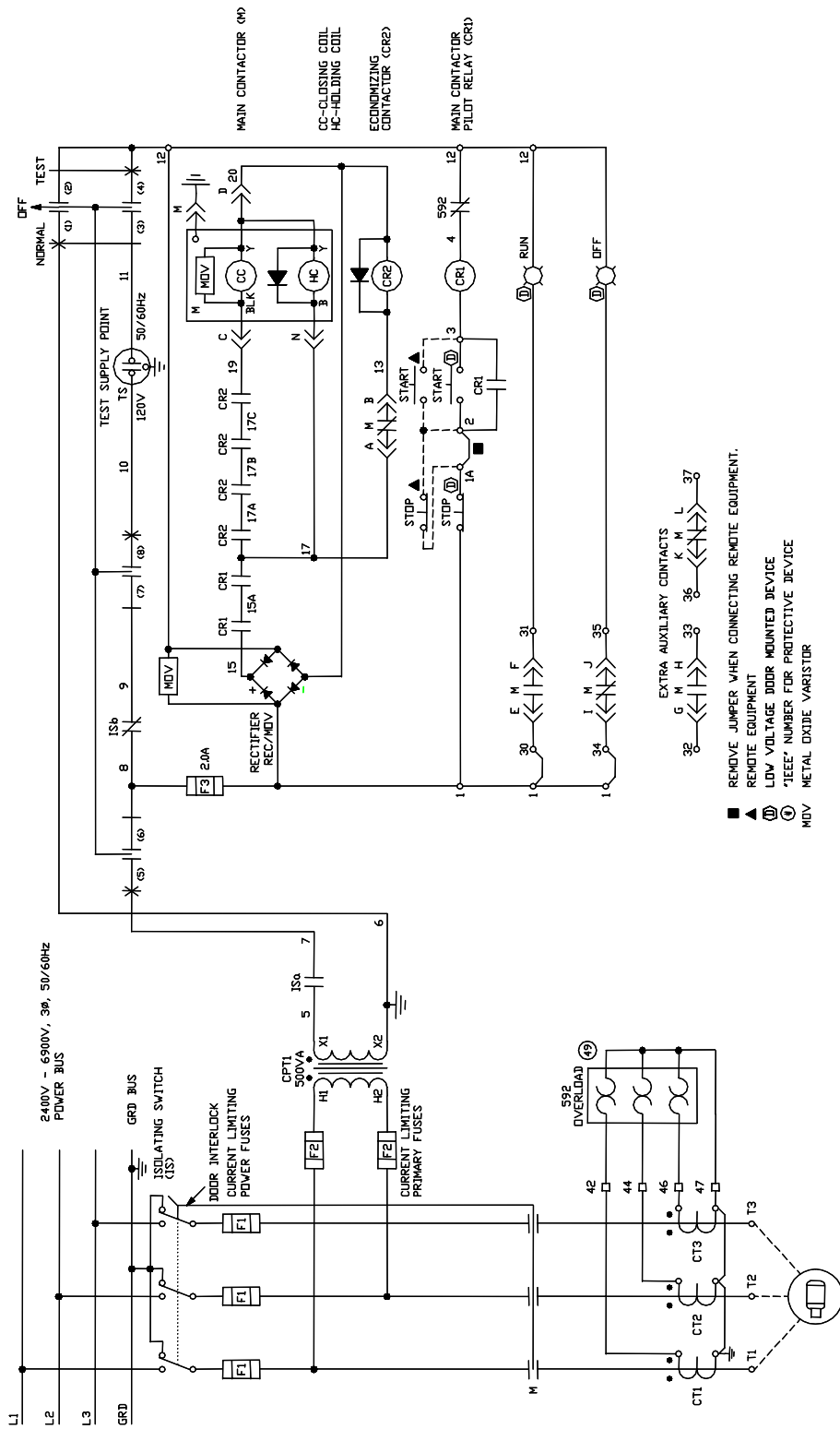


Figure 3.8 - Typical Electrical Diagram for 400 amp Full-Voltage Non-Reversing (FVNR) Controller with Electrically Held Contactor, 120 V AC (Normal Drop-out Time)

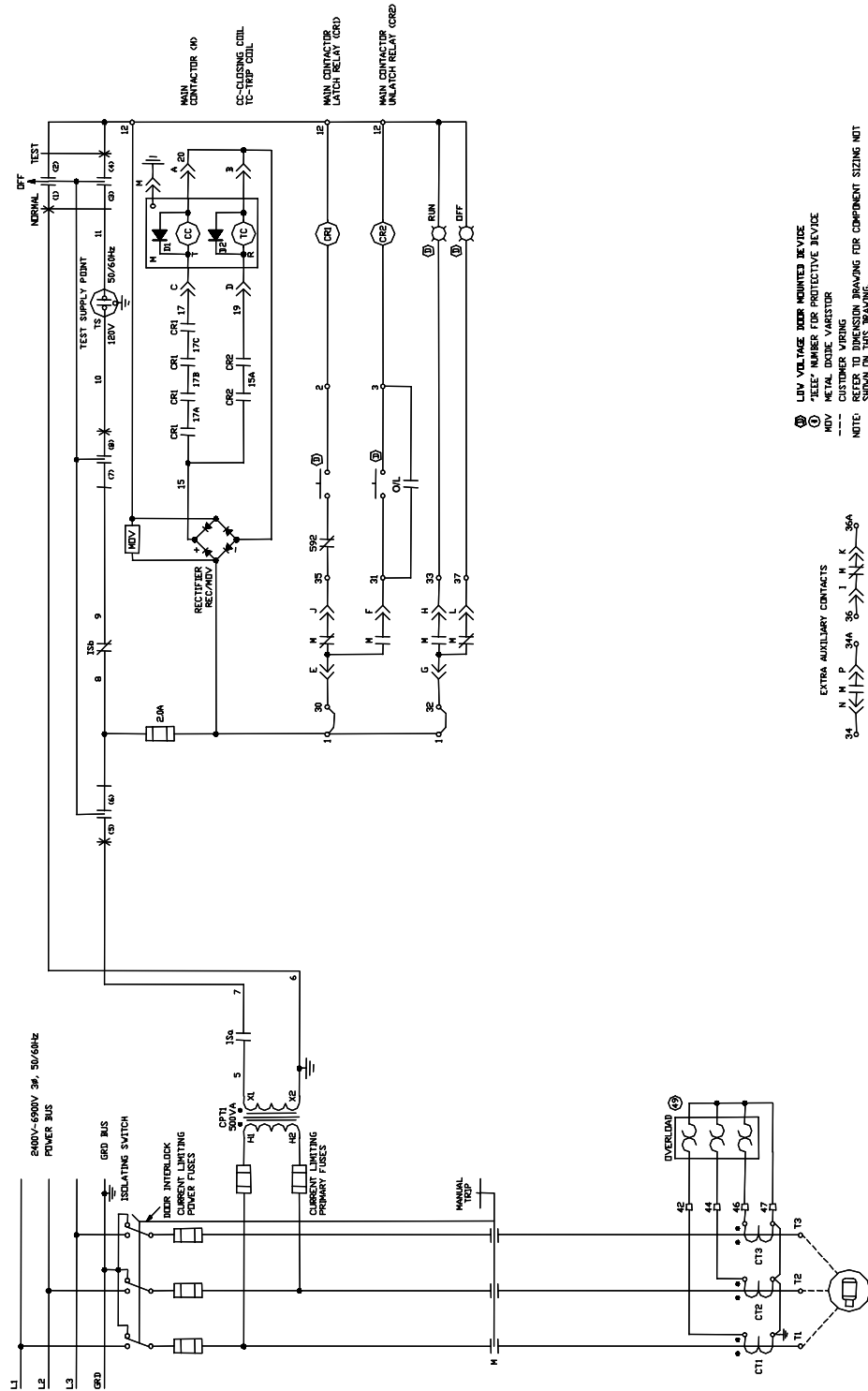


Figure 3.9 – Typical Electrical Diagram for 400 amp Full-Voltage Non-Reversing (FVNR) Controller with Mechanically Latched Contactor, 120 V AC



## Maintenance

### Tool Requirements

**Important:** Some components of this product incorporate Imperial hardware. Rockwell Automation recommends the use of the appropriate tools to successfully complete the maintenance procedures on these components. If you cannot obtain such tools, contact your area Rockwell Automation sales office for assistance.

When maintenance is performed on the vacuum contactor, the following tools may be required:

- 3/8-in. drive ratchet wrench with extension
- 3/8-in. drive torque wrench
- Standard 3/8-in. drive sockets: 7/16 in., 1/2 in.
- Open end wrenches: 7/16 in., 1/2 in.
- Slot head screwdrivers: 1/8-in. wide, 1/4-in. wide
- External retaining ring pliers (STANLEY-PROTO #393 or equivalent)
- Feeler gauge set (0.030 in. [0.76 mm] and 0.075 in. [1.91 mm])
- Feeler gauge set (0.010 in. [0.25 mm]) **Mechanical Latch**
- 2-inch C-Clamp
- Armature clamping fixture (A-B Part No. 80154-149-51)
- Digital caliper capable of depth measurement
- High potential tester

### Recommended Torque Values

Part of the contactor may have to be disassembled for maintenance or replacement. There are appropriate torque requirements for particular bolt sizes when reassembling the contactor. For the following bolt sizes, use the specified torque values listed below:

1/4-in. Hardware	6 ft-lb (8 N-m)
5/16-in. Hardware	11 ft-lb (15 N-m)
3/8-in. Hardware	20 ft-lb (27 N-m)

### Routine Maintenance

#### ATTENTION



Before performing any maintenance on the contactor, refer to the User Manual of the starter configuration in which the contactor is installed for all service instructions and procedures. Failure to do so may result in injury to personnel or damage to the controller or contactor.

## Routine Maintenance (cont.)

**ATTENTION**

To avoid shock hazards, lock out incoming power and disconnect the control plug from the contactor before working on the unit. Verify with a hot stick or meter that all circuits are voltage free. Failure to do so may result in severe burns, injury or death.

The following should be carried out on an annual basis or whenever a contactor is serviced:

### 1. Cleaning

- Ensure that metal chips or filings are cleaned from around the electromagnet assembly (coil core pole face and mating armature plate) as they may affect proper operation of the contactor. Vacuum clean if necessary.

**Note:** Do not use compressed air to clean or remove dirt from surfaces or the enclosure as it will only redistribute the dirt.

- If dirty, clean the white ceramic area of vacuum bottles with a clean lint-free cloth.

### 2. Main Contact Inspection

- Visually inspect the wear of the main contacts with the contactor energized. When any part of the wear indicator line, located on the front side of the hex shaft, moves up into the bearing, replace all three vacuum bottles. (Refer to Figure 4.1).

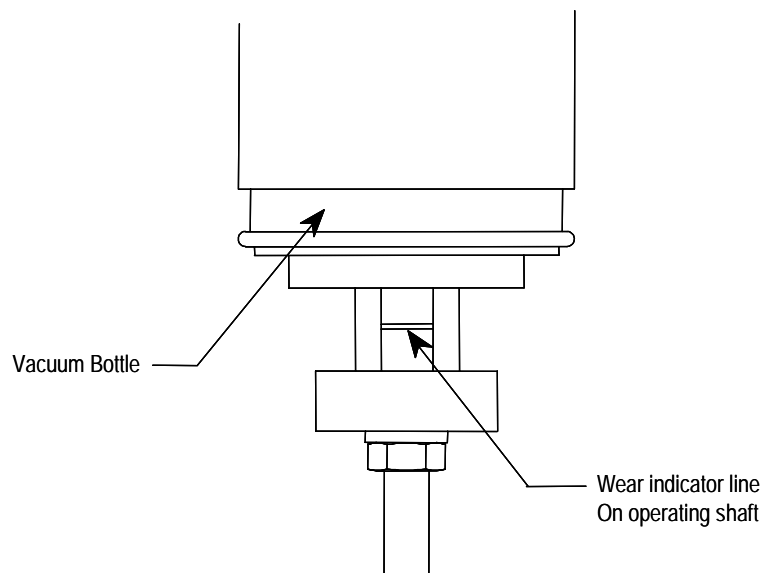


Figure 4.1 – Vacuum Bottle Wear Indicator

### 3. HiPot test (Refer to Page 2-2)

- Check the vacuum bottle integrity.
- Check the insulation resistance.

### 4. Lubrication

- Using Aeroshell No. 7 (1 oz. tube, Part No. 40025-198-01) grease the actuator plate where the overtravel springs and washers make contact (Figure 4.2).

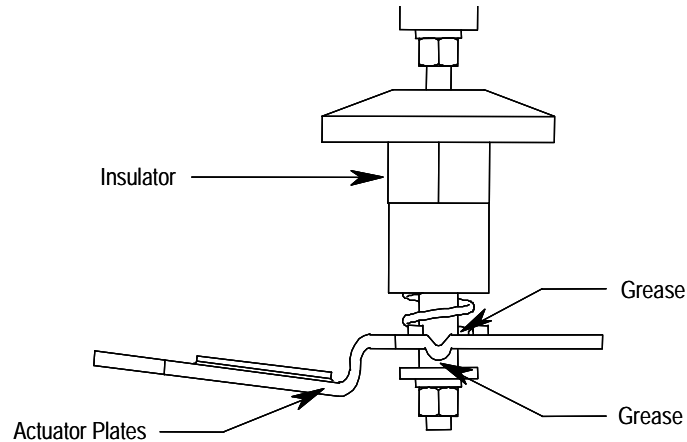


Figure 4.2 – Grease Locations

- Using Aeroshell No. 7 (1 oz. tube, Part No. 40025-198-01) grease the pivot shaft at the bearing points on the mechanical latch mechanism option (Figure 4.3).

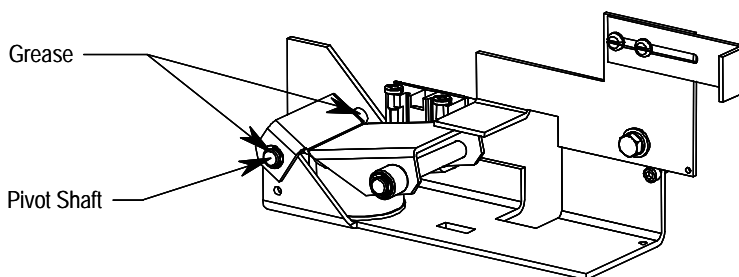


Figure 4.3 – Mechanical Latch Grease Locations

**NOTE:** Do not grease the armature shaft plastic bearings. These bearings are self-lubricating and do not require grease.

## Vacuum Bottle Replacement and Set-Up Procedure

Under normal conditions, vacuum bottles will last up to 1,000,000 operations; however, all three bottles must be replaced if any wear indicator line reaches the bearing (regardless of the number of operations).

Use the following procedure to remove and replace the vacuum bottles. This procedure can be performed with the contactor remaining in the power cell of the controller. Refer to Chapter 6 for the part number(s) required for this procedure.

### ATTENTION



To avoid shock hazards, lock out incoming power and disconnect the control plug from the contactor before working on the unit. Verify with a hot stick or meter that all circuits are voltage free. Failure to do so may result in severe burns, injury or death.

1. Before removing the vacuum bottles, mark the installed bottles clearly to avoid confusing them with the replacement vacuum bottles.
2. If the contactor has not been removed from the starter, first remove the lower terminal connections at the rear of the contactor.
3. Remove the load terminal retaining bolt at the rear of the contactor, and the vacuum bottle mounting bolt at the top of the contactor (Figure 4.4).

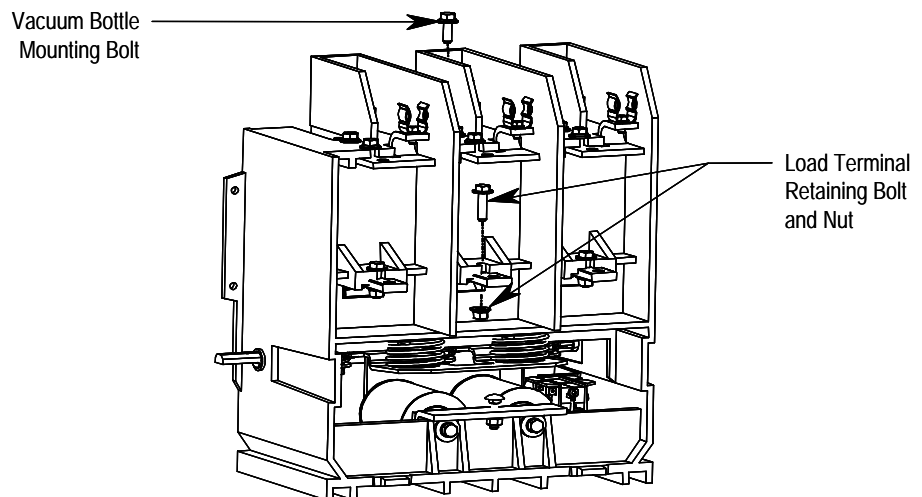


Figure 4.4 – Mounting and Retaining Bolt Removal

4. Loosen the load terminal nut on one bottle assembly, tilt the bottle forward (out of the contactor) and unscrew it from the insulator stud as shown in Figure 4.5. Repeat this for the two remaining bottles. The load terminals, insulators and overtravel spring assemblies remain in the contactor as shown in Figure 4.5.



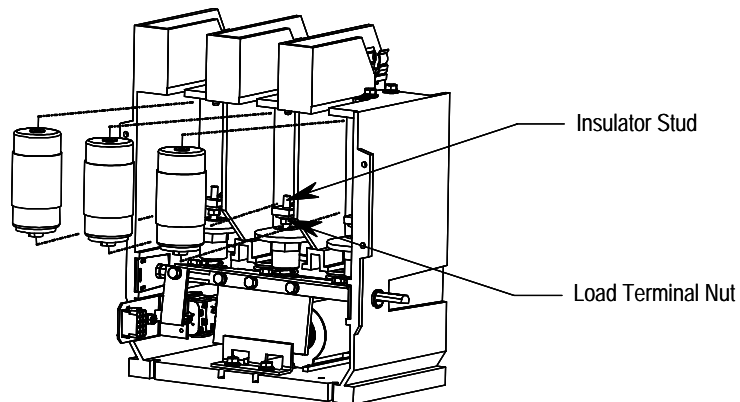


Figure 4.5 - Removal of Vacuum Bottles

5. Install a new bottle by tilting an insulator forward and threading the bottle onto the stud (reverse of Step 3). Take care to ensure the threads are aligned as cross-threading can occur. Thread the bottle down, leaving a gap of approximately  $4.82 \text{ mm} \pm 0.25 \text{ mm}$  ( $0.190 \text{ in.} \pm 0.01 \text{ in.}$ ) between the top of the bottle and the bottom surface of the line terminal, as shown in Figure 4.6. Use inside calipers and a micrometer, or another accurate measuring tool, to set the gap. This gap is precisely calibrated later in this section. The wear indicator line on the bottom of the bottle's movable shaft must be facing forward (i.e. visible from the front of the contactor). Repeat this step for the remaining two bottles.

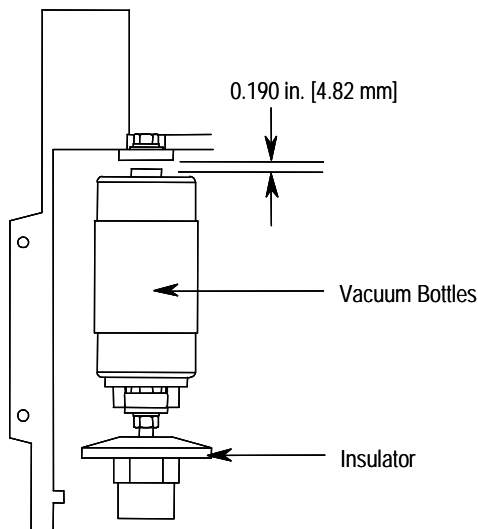


Figure 4.6 - Establishing Contact Gap

6. Install the load terminal retaining bolts at the rear of the contactor. Leave the load terminal nuts loose for fine adjustment of the overtravel and contact gap. Install the vacuum bottle mounting bolts at the top of the contactor (reverse of step 2). Take care to ensure the threads are aligned as cross-threading can occur. Hold the bottle to prevent it from turning while torquing the vacuum bottle mounting bolts.

## Vacuum Bottle Replacement and Set-up Procedure (cont.)

7. Close the contactor by using the TEST control circuit in the starter. Insert a feeler gauge of 0.065 in. (1.65 mm) into the overtravel gap of a bottle assembly (Figure 4.7). Rotate the insulator until the gap is correctly set. Repeat this step for the two remaining bottles. This step must be performed accurately because it establishes synchronization between the three vacuum bottles.

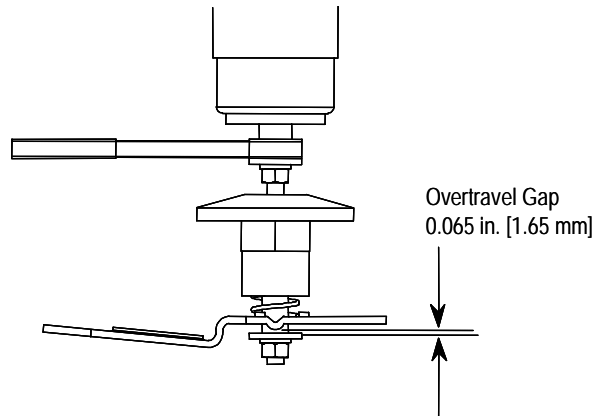


Figure 4.7 – Establishing Overtravel

8. With the contactor still energized, measure dimension A1 for all three bottles (Figure 4.8). De-energize (drop out) the contactor and measure dimension A2 for all three bottles. The contact gap is the difference of A2 minus A1. Record the gap for all three bottles.

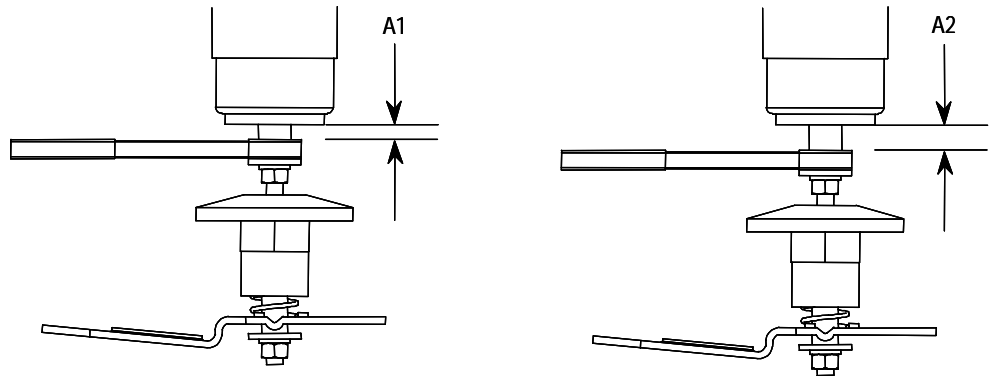


Figure 4.8 – Measuring Contact Gap

9. The contact gaps must be synchronized within 0.02 in. (0.5 mm). If the gaps are not synchronized, rotate the insulators as required to achieve this. Make sure the overtravel remains a minimum of 0.065 in. (1.65 mm) on each bottle.
10. Tighten the load terminal nut on each bottle assembly. To do this without damaging the bellows, apply wrenches to the load terminal nut and to the flattened section of the movable bottle shaft. Tighten the load terminal nut while holding the bottle shaft steady. Be careful not to turn the insulator as this will change the gap.
11. The final contact gap for all three bottles must be between 0.180 in. and 0.200 in. (4.57 mm and 5.08 mm). If this is the case, the replacement procedure is complete. If further adjustment is required, all three gaps can be adjusted simultaneously by loosening the stop bracket bolts and adjusting the height of the gap adjustment screw at the rear of the contactor as shown in Figure 4.9. To adjust the height of the screw, first loosen the locking nut.
12. When the gap is correct, tighten the gap adjustment screw locking nut. Position the stop bracket lightly against the armature plate and tighten the bolts securing the stop in position. Make sure that the actuator plate contacts the gap adjustment screw and the armature plate contacts the stop bracket as shown in Figure 4.9.

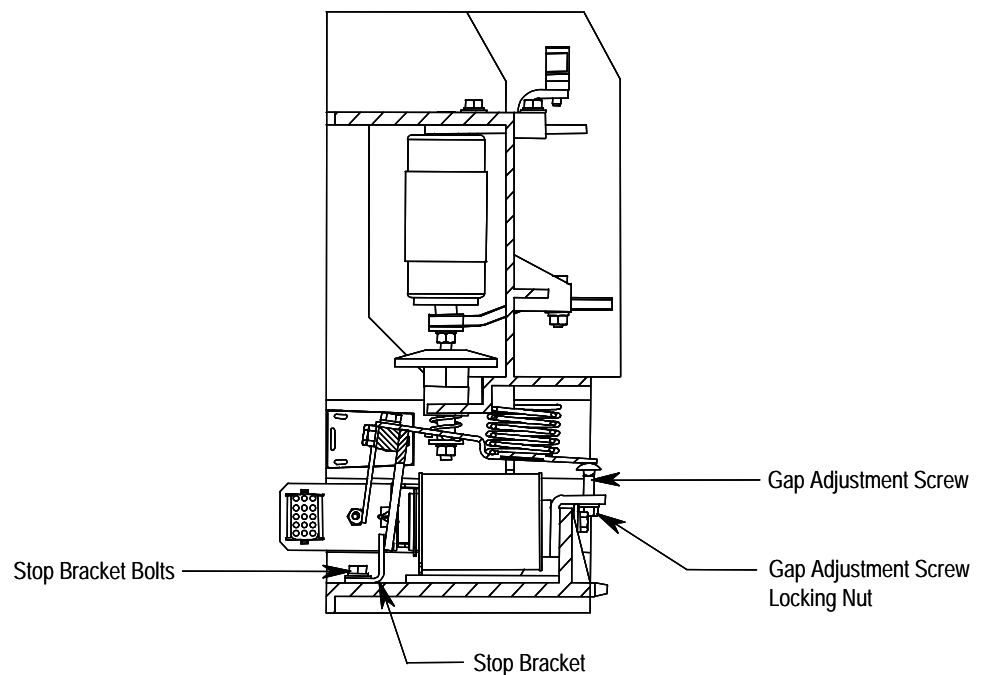


Figure 4.9 – Contact Gap Adjustment

## Coil Replacement Procedure

**ATTENTION**

To avoid shock hazards, lock out incoming power and disconnect the control plug from the contactor before working on the unit. Verify with a hot stick or meter that all circuits are voltage free. Failure to do so may result in severe burns, injury or death.

Refer to Chapter 6 for the part number(s) required for this procedure.

1. Remove the auxiliary actuator, front stop bracket and armature plate as shown in Figure 4.10. Note: do not remove the bolts which secure the stop bracket, simply loosen them and slide the bracket out (on older contactors, the bolts must be removed from the underside of the contactor housing in order to remove the stop bracket).

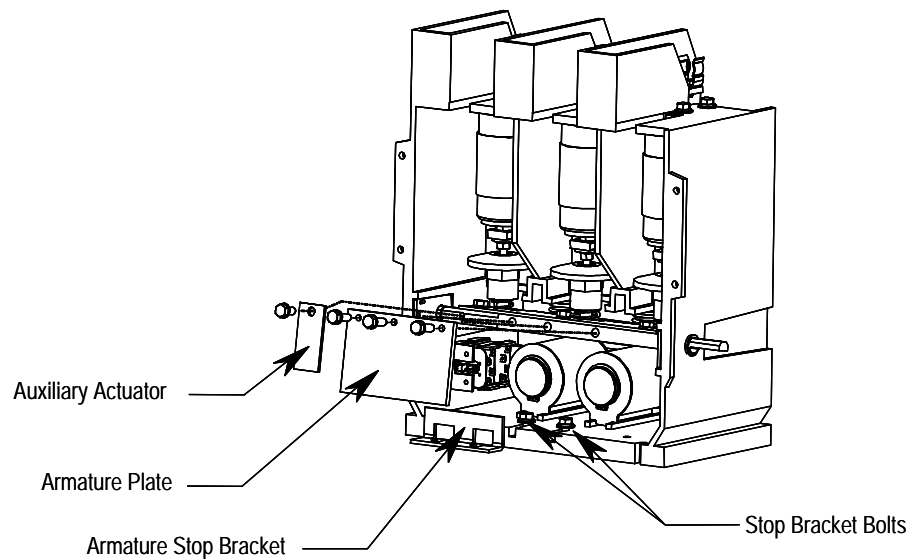


Figure 4.10 – Access to Coils

2. Remove the retaining ring from the core of the coil you wish to replace as shown in Figure 4.11.
3. Loosen the auxiliary assembly retaining bolt and slide the assembly and the coil forward and out of the contactor as shown in Figure 4.11.

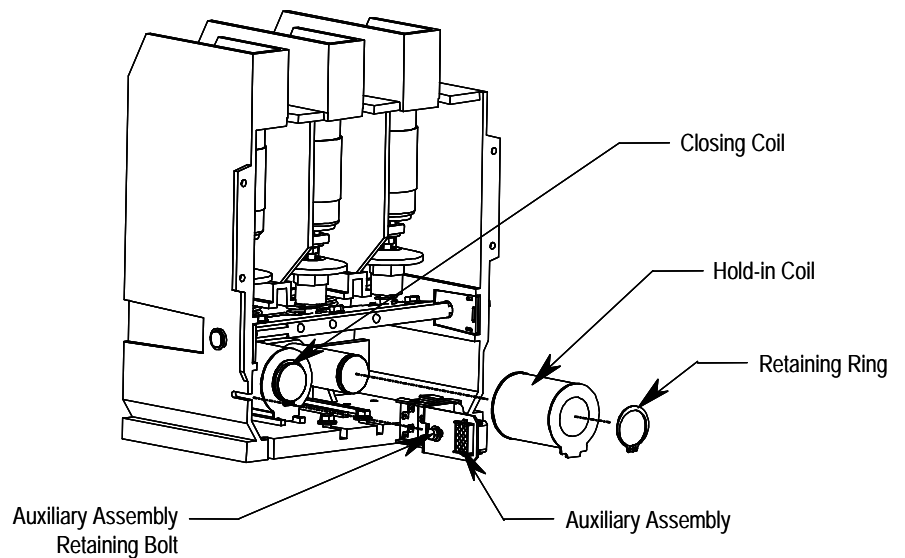


Figure 4.11 – Coil Removal

4. Disconnect the coil leads (take note of their location). Connect the leads of the new coil, making sure that all metal-oxide varistors (MOVs) and/or diodes are secure. Refer to the appropriate wiring diagram in this manual if further control wiring details are required.
5. Slide the new coil into position and install the retaining ring on the core. Install the auxiliary assembly leaving the retaining bolt loose for adjustment later. See the Auxiliary Contact Set-up Procedure (page 4-10) for determining the position of the auxiliary assembly.
6. Install the armature plate, auxiliary actuator and stop bracket. Position the stop bracket by resting it lightly against the armature plate.

## Auxiliary Contact Set-up Procedure

**Important:** This procedure applies to adjustment of existing auxiliaries and installation of new auxiliaries. Under normal conditions, auxiliaries will last at least 1,000,000 operations. If auxiliary contacts must be replaced, discard the entire assembly and install a new assembly. This is easier than replacing a single contact block.

Refer to Chapter 6 for the part number(s) required for this procedure.

To facilitate the set-up procedure, the contactor is held closed mechanically by means of a clamping fixture as shown in Figure 4.4. It is important that the contactor is held closed tightly with the armature plate against the magnet cores when gauging the over-travel and auxiliary positioning.

To aid in closing the contactor mechanically, a clamping fixture is required. Allen-Bradley part number **80154-149-51** is recommended.

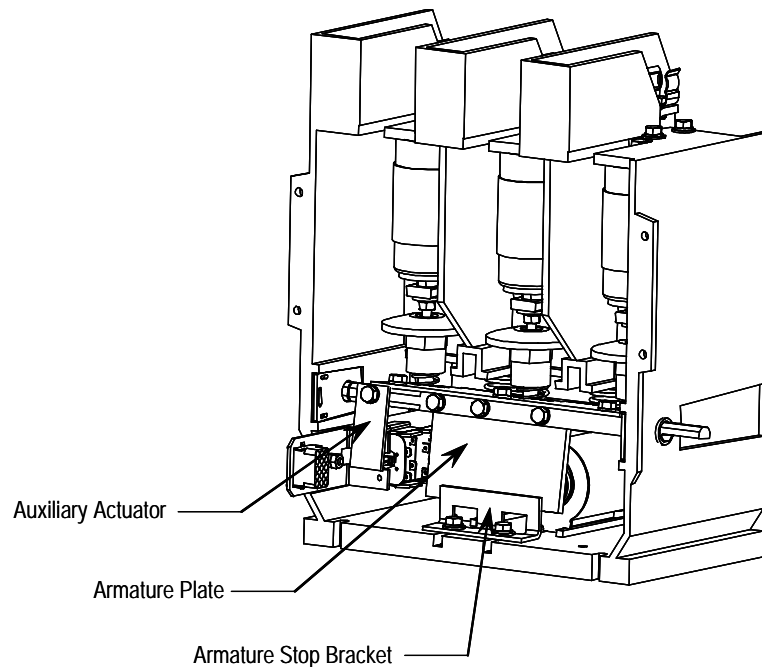


Figure 4.12 – Contactor Components

1. Loosen the nuts on the auxiliary assembly retaining bolt. This will require loosening and removal of the first nut which secures a ground wire at this location. Leave one nut loosened just enough to permit the assembly to slide along the adjustment slot as shown in Figure 4.13.

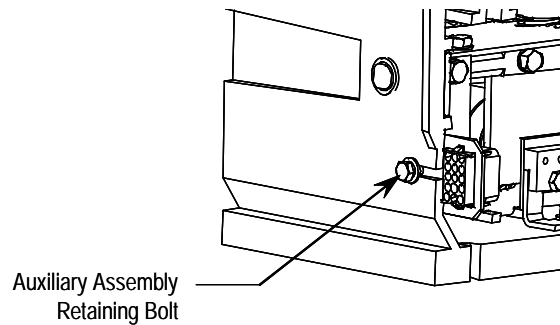


Figure 4.13 – Auxiliary Contact Adjustment

2. Slide the clamping fixture (part number 80154-149-51) over the top of the armature stop bracket, Figure 4.14. Finger-tighten the two outside fixture mounting bolts against the armature stop bracket. You may have to push the armature plate a little to the rear to put the clamp in place.

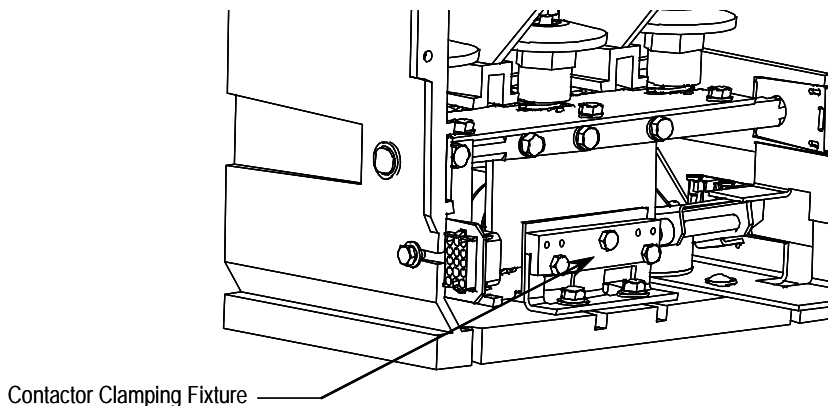


Figure 4.14 – Clamping Contactor Closed

3. Place a 5/8" wrench on the main shaft of the contactor, pull down and close the contactor (Figure 4.15) while finger-tightening the top middle screw on the clamping fixture. (Care should be taken not to bend the actuator stop plate).

## Auxiliary Contact Set-up Procedure (cont.)

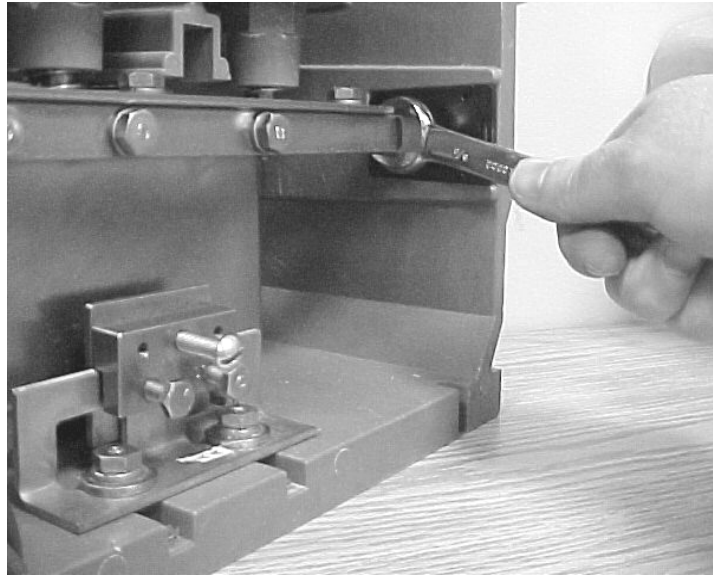


Figure 4.15 – Closing the Contactor with the aid of a wrench

4. After the top screw is finger tight, continue to tighten this screw with a hand tool. Note: The armature stop bracket will flex a little; this is acceptable but do not over-tighten and bend the armature stop plate. It is important that the armature plate is held tightly against the magnet cores. The contactor must be fully closed.
5. Place a wide blade 0.030 in. (0.76 mm) feeler gauge between the plastic auxiliary actuator tips and the steel actuator plate. To aid the installation of the feeler gauge, the gauge can be put in place as the clamping block screw is being finger tightened (Step 3). Reference Figures 4.16 and 4.17.

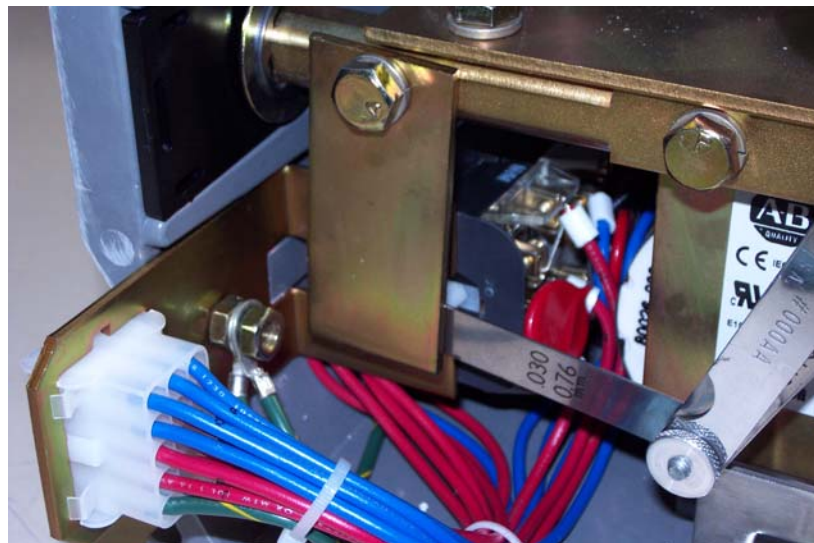


Figure 4.16 – Gauging the Contacts



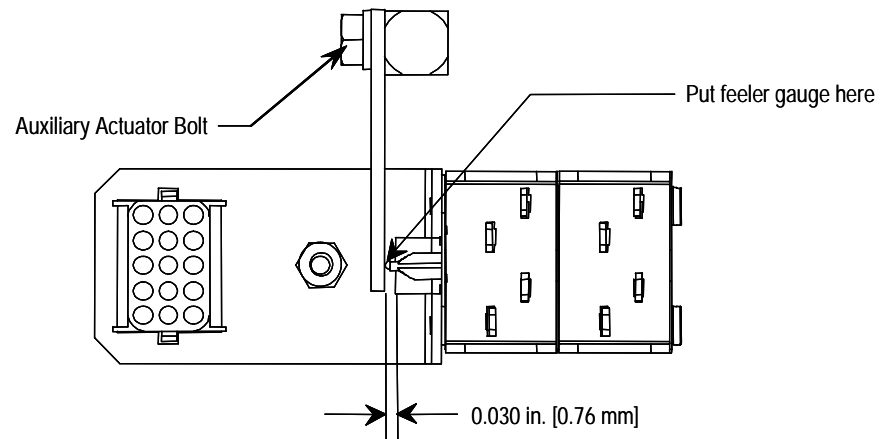


Figure 4.17 – Gauging Auxiliary Contact Location

6. With the gauge in place, slide the assembly forward until the contact actuator bottoms out. With the gauge still in place, carefully tighten the auxiliary assembly retaining nut.
- Important:** Always use a wrench to hold the bolt head as you tighten the nut. Make sure the auxiliary assembly does not move as you tighten the nut.
7. When the first nut is tightened, slide out and remove the feeler gauge.
  8. Reinstall the green ground wire on the auxiliary assembly retaining bolt. Install and carefully tighten the second nut.
  9. Slowly loosen the top screw of the contactor clamping fixture to remove the pressure on the armature plate. Loosen the two mounting screws on the contactor clamping fixture. Remove the fixture.
  10. Energize the control circuit in “TEST” mode and exercise the contactor to verify set-up. Contactor should open and close smoothly and solidly.

## Mechanical Latch Trip Coil Replacement Procedure

The following procedure requires the removal of the contactor from the cabinet (open contactor first).

- Remove the two mounting bolts at the front of the contactor.
- Disconnect the incoming and load line connections at the rear of the contactor.
- Disconnect the interlock rod from the operating lever on the right side of the contactor.
- Remove the contactor from the cabinet.

1. Remove the three latch mechanism mounting nuts on the underside of the contactor housing as shown in Figure 4.18 (on earlier series contactors there are four bolts). It is easiest to do this with the contactor lying on its back.

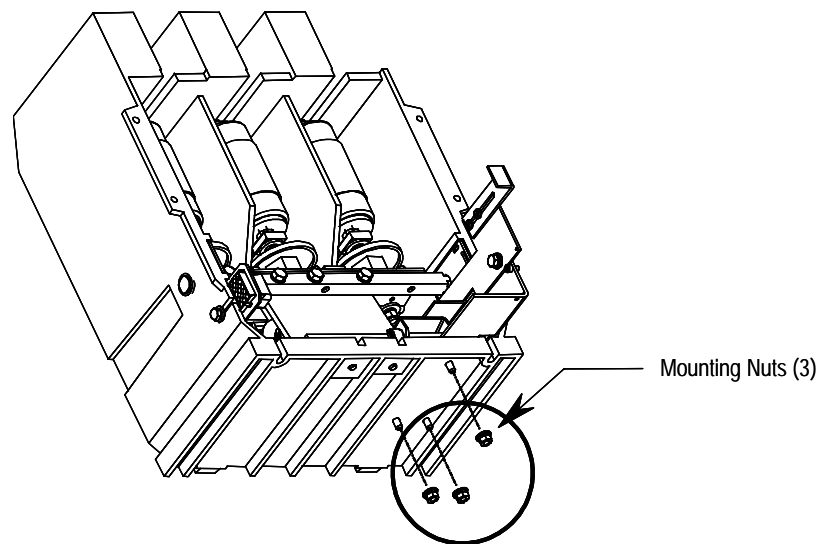


Figure 4.18 – Removal of Mechanical Latch Mounting Nuts

2. Remove the armature plate and front stop as shown in Figure 4.19.

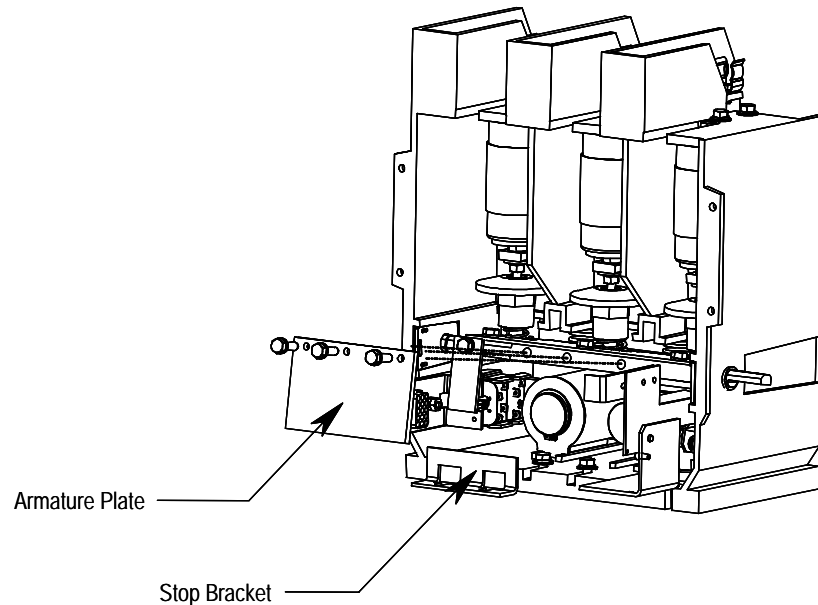


Figure 4.19 – Access to Mechanical Latch

3. Disconnect the trip coil leads from the auxiliary assembly. Take note of the lead termination points.
4. Pull the latch assembly forward and out of the contactor as shown in Figure 4.20. The loose mounting bolts can be re-installed later. The trip coil leads are secured with wire ties at the back of the contactor, clip the ties to allow removal of the leads.

**Note:** On older contactors, the trip coil leads are routed under the closing coil. If it is difficult to remove the leads, loosen the closing core mounting bolt to allow the coil to be tilted up slightly and pull the leads out, then tighten the core mounting bolt immediately. **Do not loosen both core mounting bolts at the same time.**

## Mechanical Latch Trip Coil Replacement Procedure (cont.)

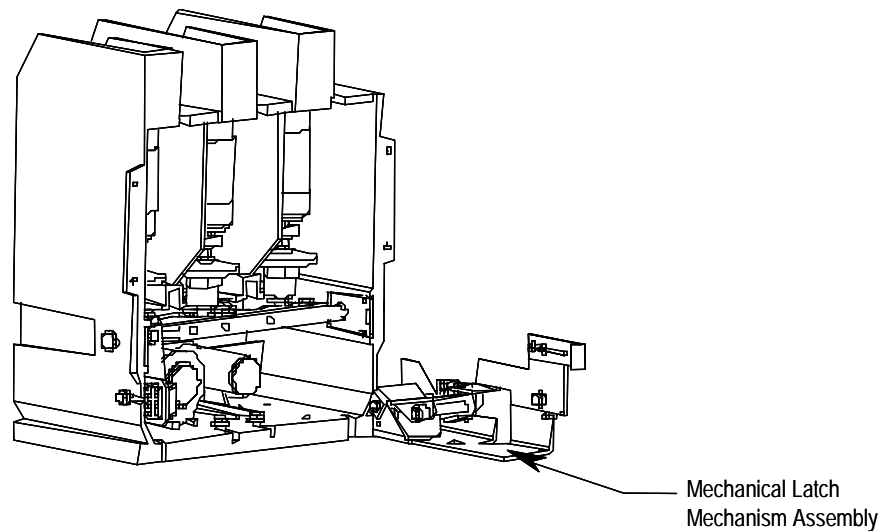


Figure 4.20 – Access to Replace Coil

5. Remove the roller shaft retaining ring on the right-hand side, and slide the roller shaft out to the left. Remove the trip core mounting screw as shown in Figure 4.21 and remove the coil and core (earlier version contactors with four latch mounting bolts do not have a trip core mounting screw).

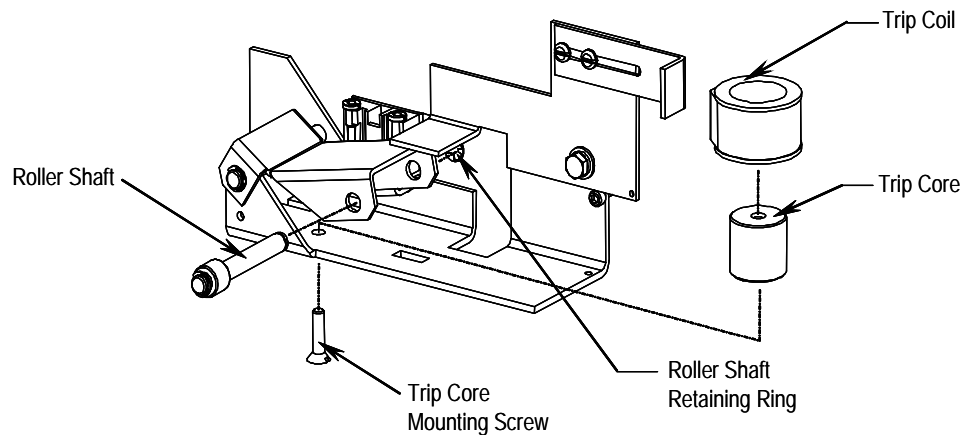


Figure 4.21 – Removal of Trip Coil

6. Install the new coil onto the core. Slide the core and coil into position with the leads toward the back of the contactor and install the core mounting screw. Replace the roller shaft and re-install the retaining ring.
7. Position the latch mechanism in the contactor and install the mounting bolts leaving them loose for adjustment.

8. Route the trip coil leads as shown in Figure 4.22 and reconnect them to the auxiliary terminals. Secure the leads to the back panel of the housing with wire ties. Refer to the appropriate wiring diagram in this manual if control wiring details are required.

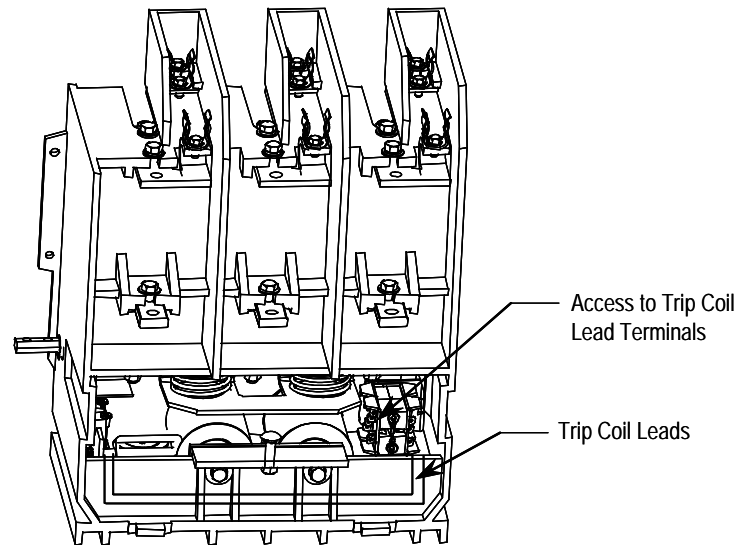


Figure 4.22 – Trip Coil Lead Routing

9. Replace the armature plate and the front stop. Position the front stop by resting it lightly against the armature plate.
10. See the Mechanically Latched Contactor Set-up Procedure (page 4-18) for establishing the position of the latch mechanism.

## Mechanically Latched Contactor Set-Up Procedure

1. The overtravel, contact gap and auxiliary set-up procedures are the same for mechanically latched contactors as they are for electrically held contactors except that instead of energizing the contactor with the “TEST” circuit, the contactor must be held closed mechanically by means of a clamp or special fixture as shown in Figure 4.23. It is important that the contactor is held closed tightly with the armature against the magnet cores when gauging the overtravel, contact gap, and auxiliary positioning. Allen-Bradley part number 80154-149-51 is recommended, however, a C-clamp can be used at the rear of the contactor to pull up the actuator plate (care must be taken not to overtighten the C-clamp and bend the actuator plate).

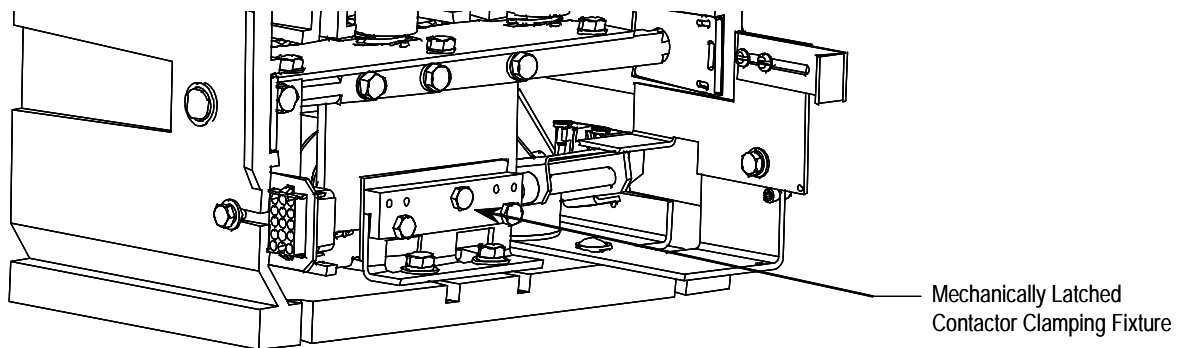


Figure 4.23 – Clamping a Mechanically Latched Contactor Closed

2. Clamp the contactor closed as detailed in Step 1. The latch mechanism should be in place with the mounting bolts loose enough to allow sliding along the adjustment slots.
3. With the contactor lying on its back, insert an .015 in. (0.38 mm) feeler gauge between the latch roller and the armature plate as shown in Figure 4.24. Tighten the mounting bolts (do not overtorque 1/4 inch nuts or 5/16 inch bolts).

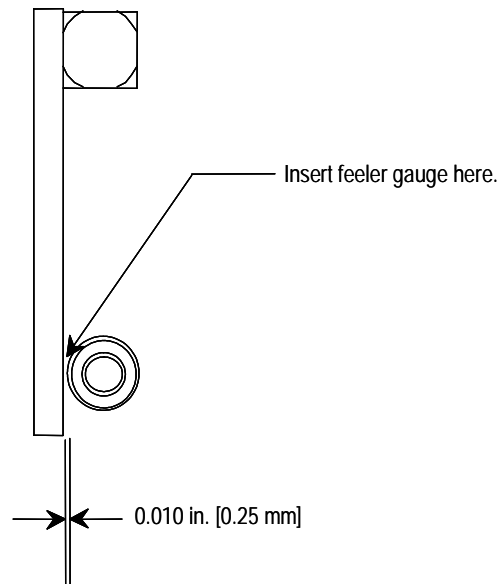


Figure 4.24 – Gauging Mechanical Latch Location

4. With the contactor still clamped, depress the latch lever and release allowing it to spring up. Ensure smooth, unimpeded motion.
5. Remove the clamp and allow the armature to move out against the roller such that the contactor is in the “latched” condition.

**ATTENTION**



The return springs exert a significant force on the armature plate. To avoid injury, do not place fingers between the armature plate and the stop bracket at any time.

6. Using the manual trip lever, trip (drop out) the contactor. Apply 2 to 3 lb. of force to trip the contactor. If too little force is required, the mechanism must be moved away from the armature slightly (toward the front of the contactor). If too great a force is required, the mechanism must be moved toward the armature slightly (toward the back of the contactor). If adjustment is required, the contactor must be clamped closed and the set-up procedure repeated with thicker or thinner feeler gauges as required.

**Important:** This is a sensitive and critical set-up. A few thousandths of an inch makes a noticeable difference in the function of the latch. A mechanism which trips too easily may result in nuisance tripping. A mechanism which requires too much force may result in failure of the coil to trip the latch.

## Altitude Adjustment

Altitude will affect the performance of a vacuum contactor. Atmospheric pressure assists in closing the main contacts by exerting force on the bellows at the movable end of the vacuum bottles. The force is proportional to the difference between the internal bottle pressure and external atmospheric pressure and adjustments to the operating mechanism must be made to balance the change in closing force. The 400 A contactors are equipped with return springs appropriate for the specific altitude they will be operating at.

If a contactor is to be moved to a different altitude, refer to Table 4.A to determine the correct return springs for the new altitude range. Simply replace the springs and correct the rating label information (catalog number, altitude range and current rating) per Table 4.A. Note the change in Basic Impulse Rating (B.I.L.) as it relates to altitude.

Table 4.A – Altitude Range Spring Requirements • 400A Mechanical Latch Contactor

Altitude Range	Spring Part No.	Color Code	Continuous Current Rating	B.I.L. Rating
0-1000 m	80153-567-01	Bronze	400 A	60 kV
1000-2000 m	80026-007-02	Green	390 A	54 kV
2000-3000 m	80026-008-02	Blue	380 A	48 kV
3000-4000 m	80026-009-02	Black	370 A	42 kV
4000-5000 m	80026-010-02	Olive	360 A	36 kV

**Important:** A contactor will only function properly in the altitude range for which it is set up. If functional tests are required, they must be performed at the proper altitude or in a pressure chamber which simulates the proper altitude.



## Troubleshooting

If an operating problem occurs, use the following troubleshooting chart to isolate the cause of the failure and find corrective action. If the corrective action fails to resolve the problem, consult your local Rockwell Automation field support representative.

Table 5.A – Troubleshooting

SYMPTOM	POSSIBLE CAUSE	REMEDY
Contactor Chatters	<ul style="list-style-type: none"> <li>Loose connections in control circuit</li> <li>Coil leads reversed</li> <li>Control voltage too low</li> <li>Faulty hold-in coil</li> <li>Foreign material on magnet</li> <li>Improper set-up of auxiliary contact assembly</li> <li>Faulty auxiliary contacts</li> <li>Faulty CR1 or CR2 interposing relay</li> </ul>	<ul style="list-style-type: none"> <li>Check all connections in control circuit for tightness. Check wiring from the coil to the terminal block assembly.</li> <li>Measure control voltage. Refer to Contactor Specifications for minimum pick-up voltage.</li> <li>Clean magnet cores and armature.</li> <li>Check set-up of auxiliary contact assembly.</li> <li>Check contact cartridges on contactor.</li> <li>Check CR1 and CR2 relay.</li> </ul>
Coil Burnout	<ul style="list-style-type: none"> <li>Coil leads improperly wired</li> <li>Improper set-up of auxiliary contact assembly</li> <li>Control voltage too high</li> </ul>	<ul style="list-style-type: none"> <li>Check wiring from the coil to the terminal block assembly.</li> <li>Check set-up of auxiliary contact assembly.</li> <li>Check for correct control voltage.</li> </ul>
Contactor does not energize	<ul style="list-style-type: none"> <li>Loose connections in control circuit</li> <li>Damaged auxiliary contacts</li> <li>Control voltage too low</li> <li>Improper set-up of auxiliary contact assembly</li> <li>Faulty CR1 or CR2 interposing relay</li> </ul>	<ul style="list-style-type: none"> <li>Check all connections in control circuit for tightness. Check wiring from the coil to the terminal block assembly.</li> <li>Replace auxiliary contact assembly.</li> <li>Measure control voltage. Refer to Contactor specifications for minimum pick-up voltage.</li> <li>Check set-up of auxiliary contact assembly.</li> <li>Check CR1 and CR2 relay.</li> </ul>

If faulty contactor coils are the suspected cause of malfunction, please refer to Table 5.B for typical coil impedance values and check the contactor coils.

Table 5.B – Typical Contactor Coil Impedance Values

Coil Part Number	Description	Impedance ( $\Omega$ ) ❶
80153-576-51	Closing Coil (electrically held) – 120 V AC	14.8
80153-575-51	Hold-in Coil (electrically held) – 120 V AC	826.0
80153-576-52	Closing Coil (electrically held) – 230 V AC	25.0
80153-575-52	Hold-in Coil (electrically held) – 230 V AC	1960.0
80154-134-51 ❷	Closing Coil (mechanical latch) – 120 V AC	9.4
80025-833-01 ❷	Trip Coil (mechanical latch) – 120 V AC	21.0

❶ Impedance values listed have a tolerance of  $\pm 10\%$ . Refer to Chapter 3 for measurement points at the contactor receptacle.

❷ Supplied with mechanical latch option only.



## Spare Parts

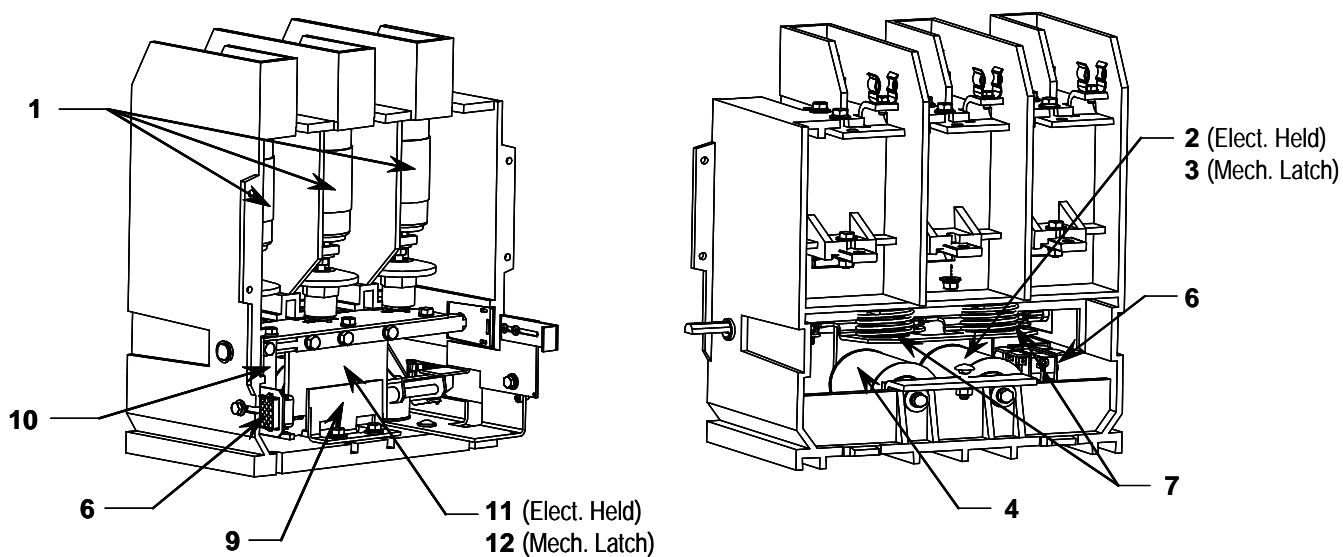


Figure 6.1 – Bulletin 1502 • 400 A Electrically Held Vacuum Contactor

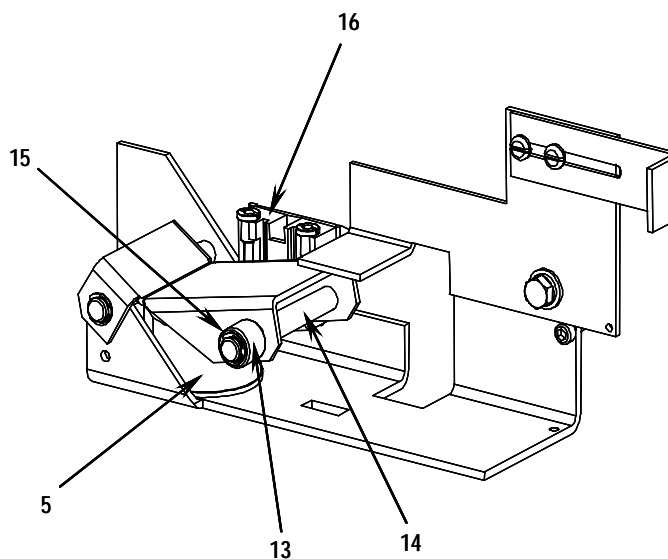


Figure 6.2 – Bulletin 1502 • 400 A Mechanical Latch Assembly

Table 6.A – Spare Parts

Item	Description of Parts 120 V Control		Part Number
			400 A
1	Three (3) Vacuum Bottles ❶		80157-496-52
2	Closing Coil (electrically held)		80153-576-51
3	Closing Coil (mechanical latch)		80154-134-51
4	Hold-in Coil		80153-575-51
5	Mechanical Latch Trip Coil (120 VAC)		80025-833-01
6	Auxiliary Assemblies ❷	Elect. held, normal drop-out	80153-554-52
		Elect. held, fast drop-out	80153-554-56
		Mechanical latch	80153-999-60
7	Return Springs (standard altitude 0-1000 m) ❸		80153-567-01
8	Coil Retaining Ring		28325-042-01
9	Stop Bracket		80153-565-01
10	Auxiliary Actuator Plate		80153-553-02
11	Armature Plate (electrically held)		80153-552-02
12	Armature Plate (mechanical latch)		80153-781-02
13	Mechanical Latch Roller Bearing		80153-748-01
14	Mechanical Latch Roller Bearing Shaft		80153-744-02
15	Mechanical Latch Roller Bearing Shaft Retaining Clip		M-5605
16	Mechanical Latch Auxiliary Contact Block		800T-XD2

Item	Description of Parts 230 V Control		Part Number
			400 A
	Closing Coil ❸		80153-576-52
	Hold-in Coil ❸		80153-575-52
	Auxiliary Assembly ❸		80153-554-59

❶ Rockwell Automation recommends that if the contactor has been in service, all three (3) bottles be replaced at the same time.

❷ The auxiliary assemblies include contact blocks, wire harness, female connector and mounting bracket.

❸ Only available for electrically held contactors.

❹ Refer to Table 4.A for Return Spring part number for higher altitude contactors.



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