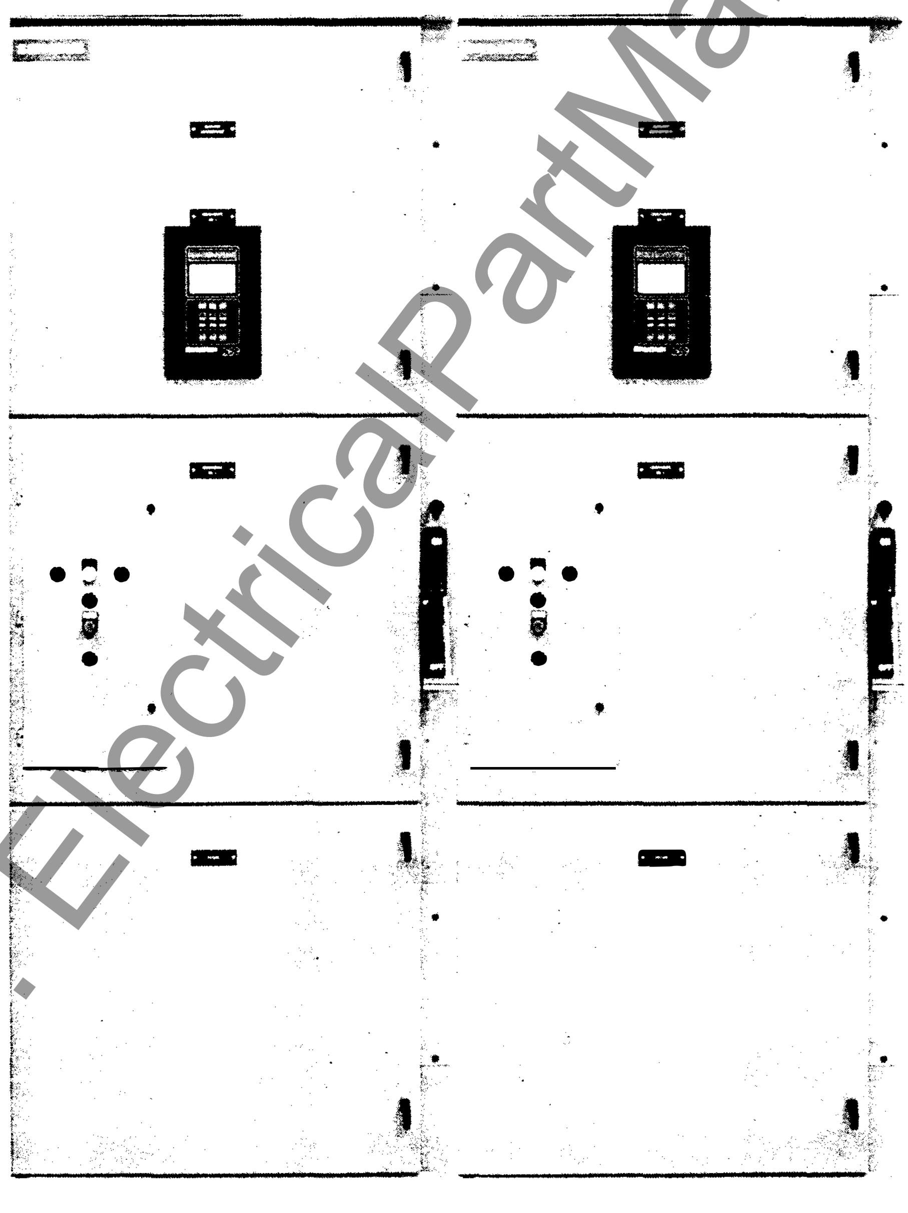
SIEMENS

Series 81000™ Controller

with Draw-Out Vacuum Contactors

2300, 4000 and 6600 Volts AC (Utilization Voltage)
2400, 4160 and 6900 Volts AC (Distribution Voltage)

Instructions
Installation
Operation
Maintenance
MVC-9018



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Introduction and Safety

WARNING

Working in or around electrical equipment can cause shock, burn or electrocution if accidental contact is made with energized parts.

Turn off power supplying this equipment before any adjustments, servicing, wiring, parts replacement, or before any act requiring physical contact with electrical working components of this equipment is performed.

The successful and safe operation of motor control equipment is dependent upon proper handling, installation, operation and maintenance, as well as upon proper design and manufacture. Failure to follow certain fundamental installation and maintenance requirements may lead to personal injury and the failure and loss of control equipment, as well as damage to other property.

Qualified Person

For the purpose of this manual and product labels, a qualified person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he has the following qualifications:

(a) Is qualified and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.

(b) Is qualified in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc. in accordance with established safety practices.

Danger

For the purpose of this manual and product labels, **DANGER,** indicates death, severe personal injury or substantial property damage will result if proper precautions are not taken.

Warning

For the purpose of this manual and product labels, **WARNING,** indicates death, severe personal injury or substantial property damage can result if proper precautions are not taken.

Caution

For the purpose of this manual and product labels, **CAUTION** indicates minor personal injury or property damage can result if proper precautions are not taken.

Siemens medium voltage controllers are built in accordance with the latest applicable provisions of the National Electrical Code, Underwriters' Laboratories Standards and Procedures, NEMA Standards, and the National Electrical Safety Code. These publications and this instruction manual should be thoroughly read and understood prior to beginning any work on this equipment.

These instructions are prepared as a guide to handling, installation, operation, and maintenance of all types of Series 81000™ controllers. Since individual starters and controllers are designed for specific applications, the components and functions are dictated by the purchaser's specifications and needs.

Separate instructions covering components are not included in this publication, but are available upon request. The purchaser should read these instructions and determine applicability to his particular controller by referring to the nameplate data on the controller and to the electrical diagrams supplied with the controller.

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NOTE
These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens sales office

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General

The Siemens Series 81000™ controller is an integrated system of contactors and components arranged for convenient access into units within a common enclosure consisting of one or more free standing structural sections. Each section is 36 inches wide, 36 inches deep, and 90 inches high. Refer to **Figure 1.**

The Series 81000 controller is a modular design which can be arranged to meet specific customer specifications and needs. Each section is designed to accept up to three starters with one low voltage control panel for each starter. The unit height may be either 30, 45 or 60 inches.

The upper units of 1-high and 2-high controllers may contain a low voltage panel or space for future add-on starters.

In general, each starter unit is divided into medium voltage and low voltage compartments, each with its own separate door and interior barriers between the two. The medium voltage compartment contains the contactor cell module upon which the shutter racking mechanisms, line and load connections, and mechanical and electrical interlocks are mounted. The cell module can be either 29.88 inches or 33.50 inches deep. The latter can only be mounted in the lower unit.

The medium voltage compartment also houses the current transformers and the contactor.

In order to open the medium voltage unit door, the contactor must be de-energized and completely racked-out and the door unlatched. Low voltage doors may be entered without disconnecting the power, but this must be done with extreme care and caution.

The electrical power : distributed through the optional main horizontal bus which extends the entire length of the controller. The bus may be mounted behind the upper low voltage unit or inside a 10 inch high top hat. See **Figure 2**. Each vertical section containing provisions for draw-out contactors is fed by cables or vertical bus system which is connected to the horizontal bus.

The cables or vertical bus system in turn supplies power through the stab assembly mounted on the cell module.

The horizontal and vertical bus or cable system is isolated from the front by means of barriers.

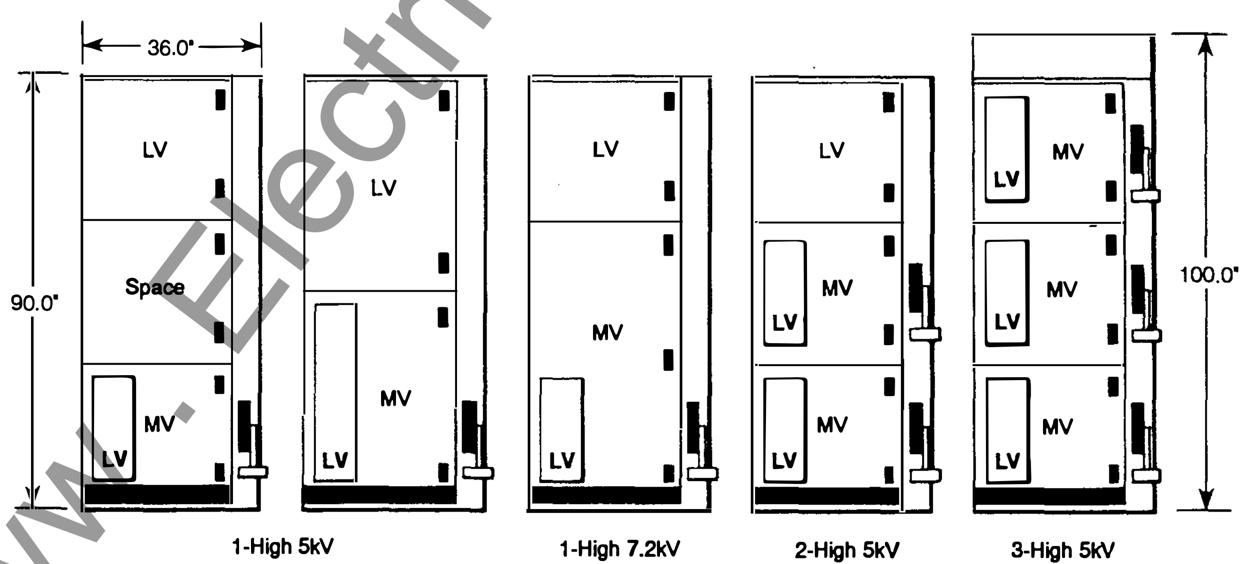

Figure 1. Typical Construction

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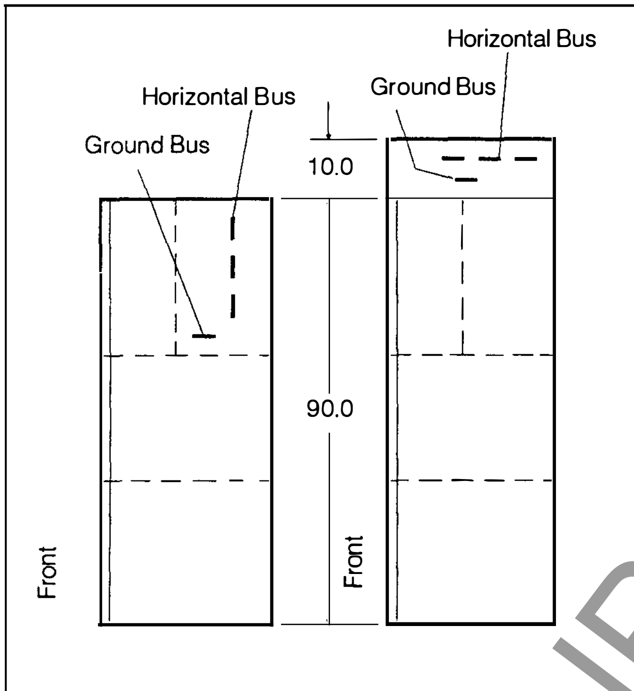

Figure 2. Alternate Bus Locations (Side View)

Basic Impulse Level

All Series 81000 controllers have a basic impulse level of 60kV crest, excluding control transformers, starting reactors and autotransformers.

Dielectric Test

All controllers are factory tested at 2.25 x nameplate voltage plus 2000 volts.

Ratings

The Series 81000 controllers are rated in accordance with **Table 1**, as well as the nameplate on front of the enclosure.

Medium Voltage Contactors

Siemens Type 90H35 (5 kV) and Type 90H37 (7.2 kV) contactors are used in Series 81000 controllers. The 90H35 contactor can accept 5 kV power fuses rated 2R through 24R. The 90H37 contactor can accept 7.2 kV fuses rated 3R through 18R.

Type 90H35 contactors with single or double barrel fuses can be installed in any compartment of one, two and three-high 5 kV controllers. Type 90H37 contactors can only be installed in one-high 7.2 kV controllers.

Contactor Ratings

Contactor Type	Maximum Voltage Rating	Enclosed Continuous Ampere Rating	Interrupting Capacity		kV Impulse Level (BIL)
			Unfused Contactor (kA)	Fused Class E2 Controller (MVA)	
90H35	5.0 kV	360	5 kV@ 2.3-4.6 kV	200 @ 2.3 kV 350 @ 4.0 kV 400 @ 4.6 kV	60
90H37	7.2 kV	310	5 kA @ 6.6 kV	5 kA @ 6.6 kV	60

Auxiliary Contacts: Each contactor is equipped with 3 N.O. and 4 N.C. auxiliary contacts for customer use.
These contacts are rated 600V, 10A (NEMA Class A600).
NOTE: On drawout contactors, 2 N.O. and 2 N.C. contacts are available for customer use.

Contactor Type	3 Phase Horsepower Rating at Utilization Voltage									Maximum Motor Fuse Rating	Transformer Loads				
	2300V			4000-4600V			6600V				Maximum 3-Phase kVA at Distribution Voltage				Maximum Transf Fuse Rating
	Syn. Motors		Ind. Motors	Syn. Motors		Ind. Motors	Syn. Motors		Ind. Motors						
	0.8PF	1.0PF		0.8PF	1.0PF		0.8PF	1.0PF			2400V	4160V	4800V	6900V	
90H35	1500	1750	1500	2500	3000	2500	—	—	—	24R	1500	2500	2500	—	450E
90H37	—	—	—	—	—	—	3500	4500	3500	18R	—	—	—	1500	200E

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Isolation and Automatic Shutter Mechanisms

Non-load break finger type stab assemblies provide the means for manual isolation of the power circuit, in accordance with NEMA Standards requirements.

The shutter mechanism operation is directly controlled by the position of the racking mechanism, and the movable insulated shutter is linked to the racking cams, **Figure 3**.

As the handle of the racking mechanism is moved towards the "ON" position, the insulated shutter uncovers the line stab assembly just prior to insertion of the contactor line and load stab fingers, **Figure 4.**

In the reverse operation, when the handle is moved towards the "OFF" position, the insulated shutter covers the line stab assembly, thus effectively isolating all live high voltage parts, **Figure 5.**

Labels on the stationary shutter clearly indicate if the isolating means is "OPENED" (DISENGAGED).

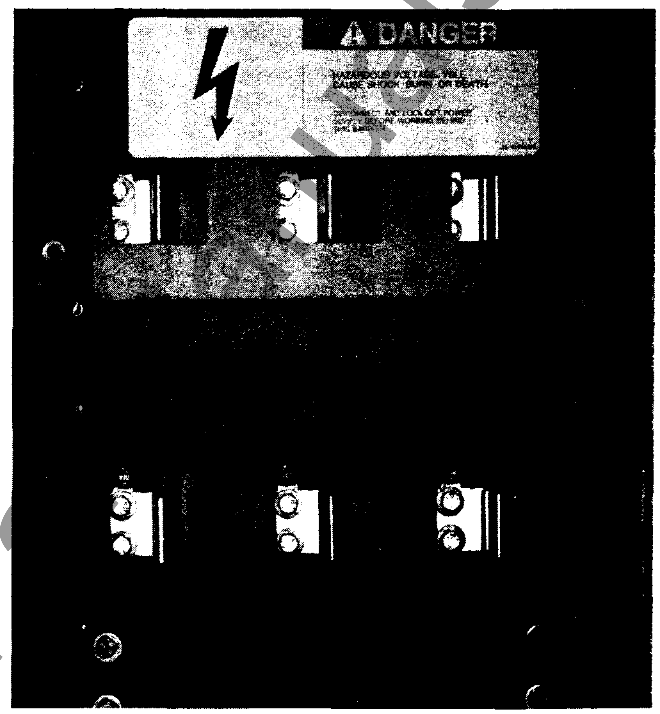

Figure 4. Stab Assembly "ON" Position

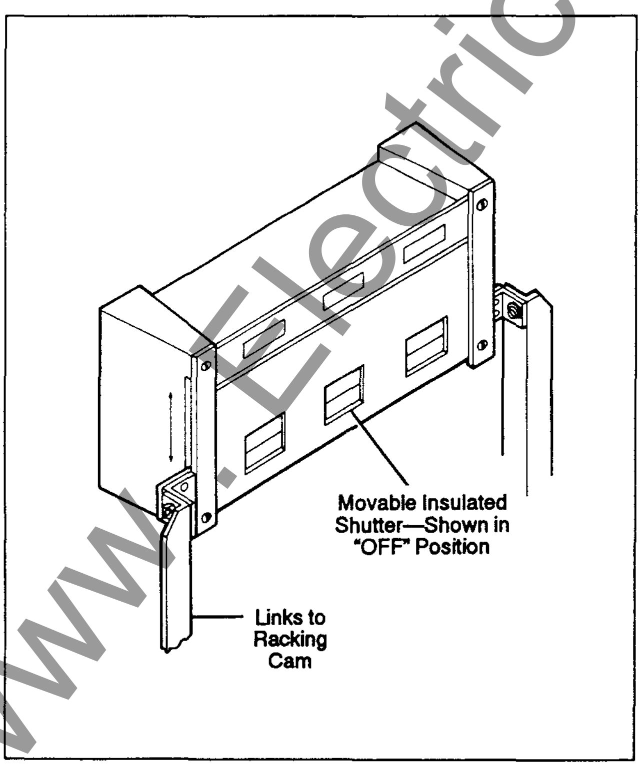

Figure 3. Shutter Mechanism

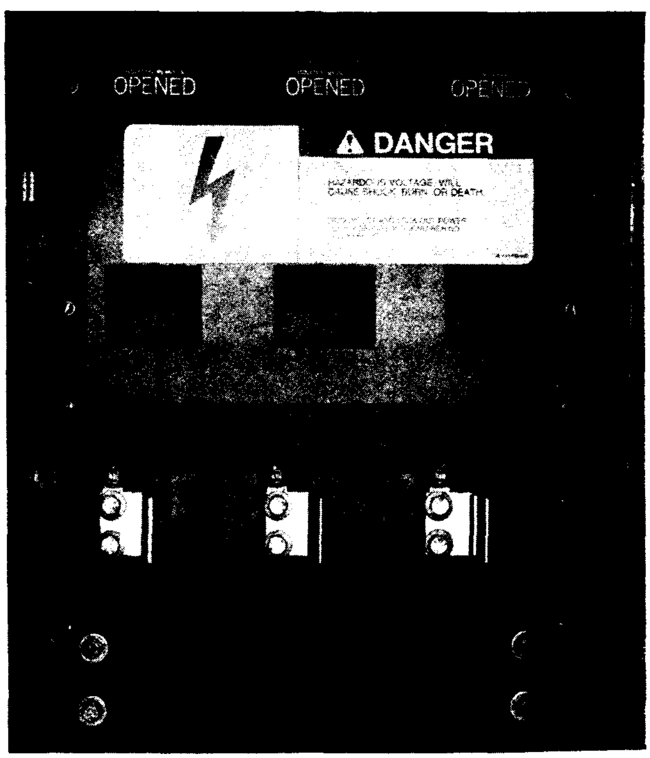

Figure 5. Shutter Shown in "OFF" Position

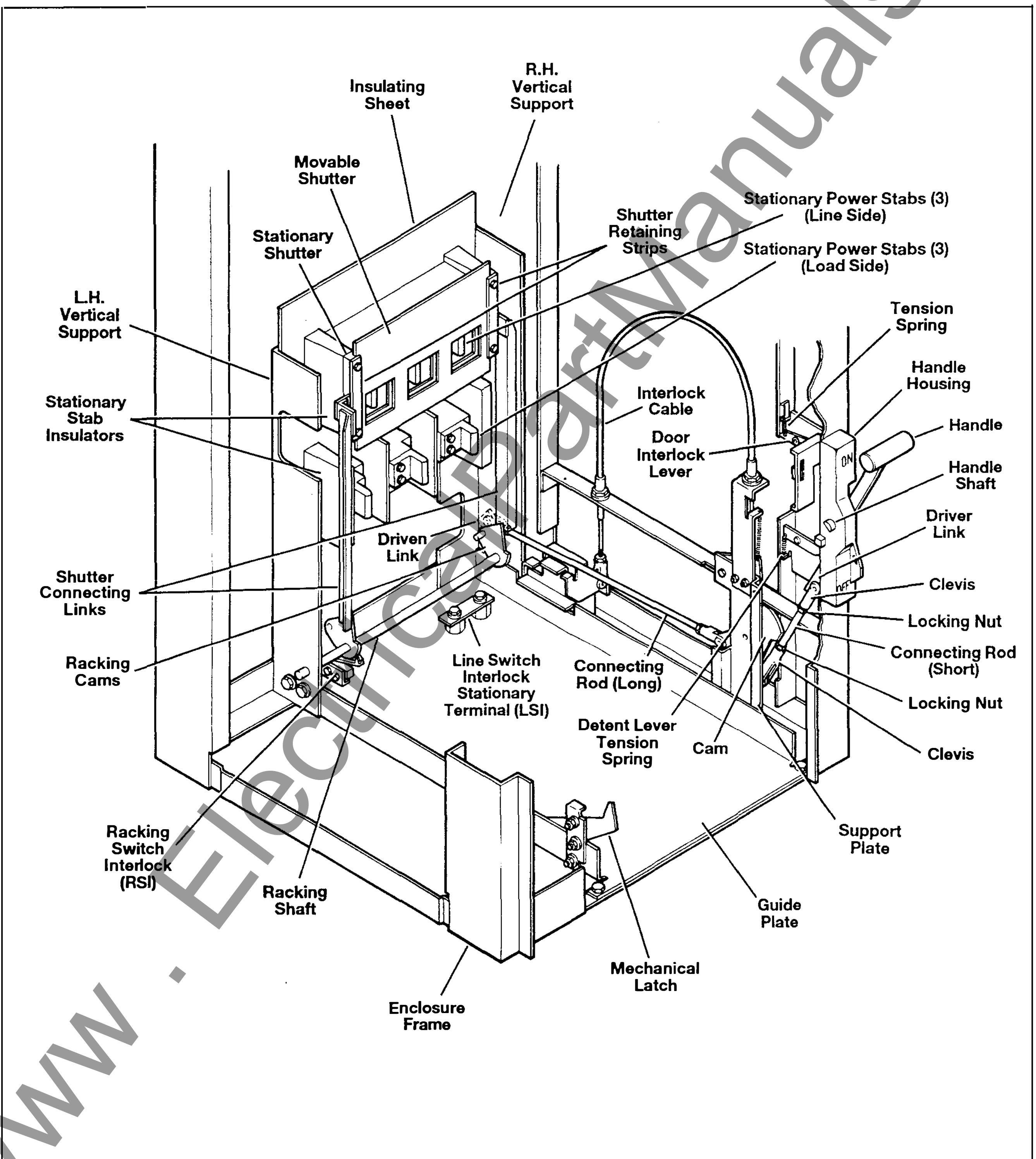

Figure 6. Cell Module

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Racking Mechanism and Mechanical Interlocks

Convenient and smooth racking operation for draw-out contactors is provided by a compound four-bar mechanism operated by an external, enclosure mounted handle. The handle can be locked with up to three padlocks in the "OFF" position.

Mechanical and electrical interlocks are provided in association with the racking mechanism to perform the following functions.

Medium Voltage Compartment Door Interlock

The racking handle is interlocked with the door such that the handle cannot be moved to the "ON" position while the door is open. Refer to **Figure 7**.

WARNING

The interlock may be defeated only by authorized and qualified personnel by pushing the door interlock lever upward by means of the screwdriver or other appropriate means. Do not attempt to defeat the interlock unless all incoming power is disconnected.

Door-Handle Interlock

The door-handle interlock (2) prohibits closing or opening of the medium voltage compartment door except when the handle is in the "OFF" position. The flat profile on the end of the handle shaft will not allow the door-handle interlock to pass in or out unless the handle is in the "OFF" position. Refer to **Figure 7.**

WARNING

The door-handle interlock should be defeated only in the event of a malfunction in the racking mechanism. To prevent serious injury and equipment damage through accidental contact with energized wiring or bus system. Disconnect and lock-out incoming power and control voltage sources before attempting to defeat the interlock. Never defeat this interlock if the red contactor engagement light is on.

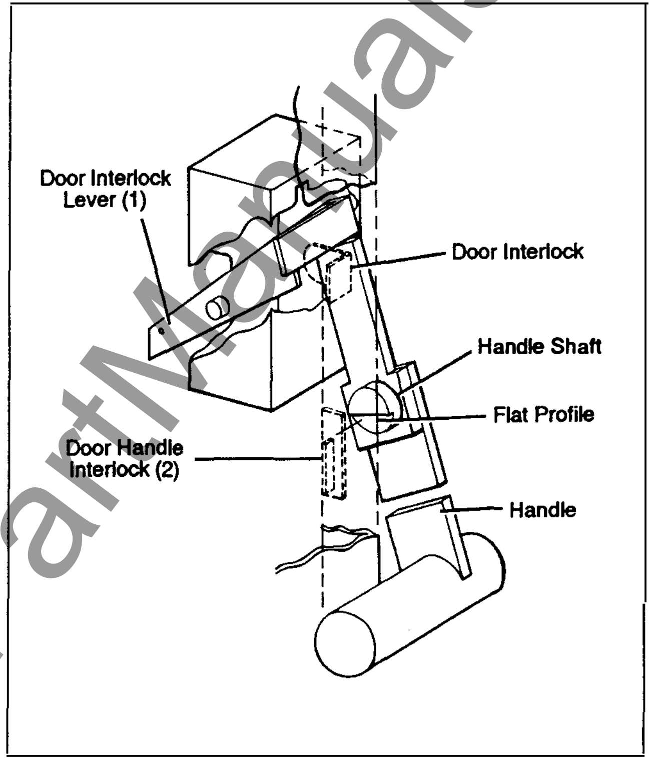

Figure 7. Door-Handle Interlock

This interlock may be defeated only by authorized and qualified personnel requiring access to the unit in case of emergency.

The defeater can be reached by removing a plastic cap from the lower part of the handle housing, then by removing the Allen-Head set screw. The handle can then be moved to the "OFF" position allowing the door to be opened. Refer to **Figure 8.**

After the malfunction has been corrected, the controller should be restored to normal operation by reversing the procedure used to defeat the interlock.

Contactor Interlock

To prevent accidental insertion or withdrawal of the contactor when it is energized, a cable actuated interlock lever moves to engage the notches in the cam when the contactor is energized, thus preventing motion of the racking mechanism. The cable actuated plunger is shown in **Figures 10, 11, 12** and **13.**

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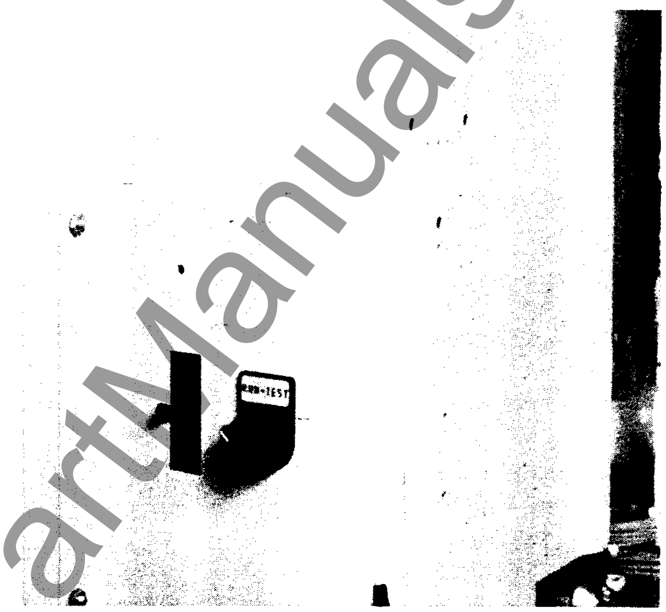
Figure 8. Procedure for Defeating the Door-Handle Interlock



Test Switch

A test switch is provided to switch from run to test mode. The switch is located on the back side of the door, mounted on the low voltage compartment. See **Figure 9**. With the contactor racked out and the door opened, the test mode can be selected by rotating the switch to the test mode. With the switch in the test mode, the contactor can be electrically operated in it's racked out position. Once the test has been completed, the contactor can be placed in operation by switching to the run mode, closing the door and racking in the contactor by operating the racking handle.

	WARNING
	Serious injury and equipment damage can result if the operating handle is forcibly operated.

Mechanical Latch

The mechanical latch is mounted on the left hand side of the guide plate and serves to locate and hold the contactor in the disengaged (test) position. The latch is released by manually pivoting the latch assembly upward and rolling the contactor out of the enclosure. Refer to **Figures 12** and **13**

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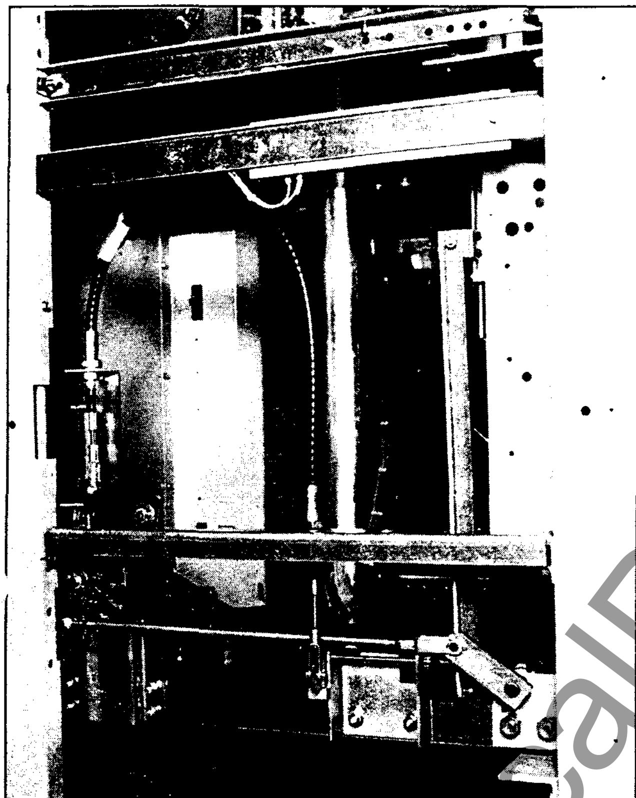

Figure 10. Cable Actuated Interlock (Side Sheet Removed)

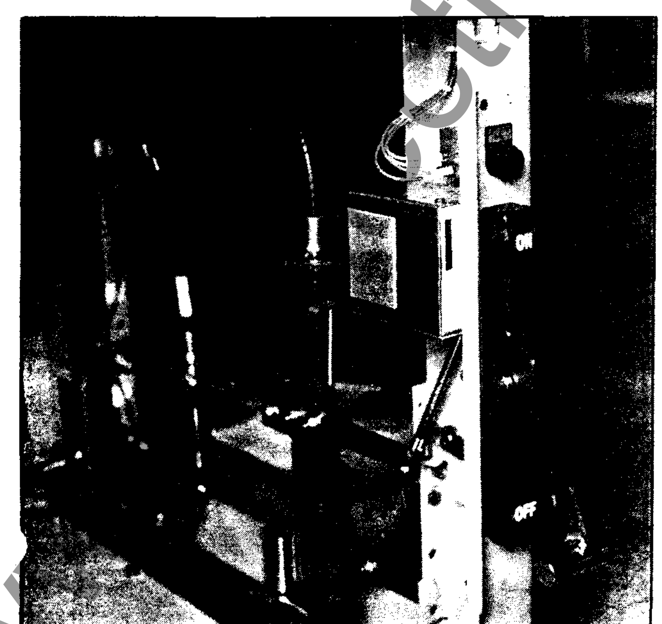

Figure 11. Cable Actuated Interlock and Racking Mechaism

Detent Lever

This lever is provided to prohibit relative motion between stab fingers and stab assembly. Slight initial force is required on the handle when moving it from the "ON" to the "OFF" position to free the driver link pin from the retaining slot in the detent lever. Refer to **Figures 12** and **13**

Contactor Engagement Warning Light

A red warning light, mounted above the handle housing is energized only when the contactor is fully engaged, and incoming power is present, independent of the condition of the contactor or the door. When the handle is moved to the "OFF" position, the red warning light should always go out, indicating the contactor is fully disengaged and isolated from the stab assembly. Refer to **Figure 14.**

If the handle is moved to "OFF" and the red light stays on, the racking mechanism is not operating properly and the contactor is engaged. **Do not attempt to open the high voltage door.** Disconnect and lock out all incoming power and refer to the "Troubleshooting" section.

WARNING

Serious injury and equipment damage can occur through accidental contact with energized conductors or wires if work is attempted inside the controller while the red contactor engagement indicating light is on.

In order to test the contactor engagement warning light using the customer's test power source, a push-to-test feature is provided. A routine test of the light should be included in the controller maintenance plan.

Line Switch Interlock (LSI)

All control power derived from the secondary of the control power transformer is carried from the contactor to the low voltage control panel through a set of contact fingers mounted on the rear of the contactor. Refer to **Figure 15**.

These contact fingers, along with the mating contact block which is stationary-mounted on the guide plate, make up the Line Switch Interlock (LSI).

The function of this interlock is to break all load on the CPT secondary prior to disengagement of the main power stabs as the contactor is racked out.

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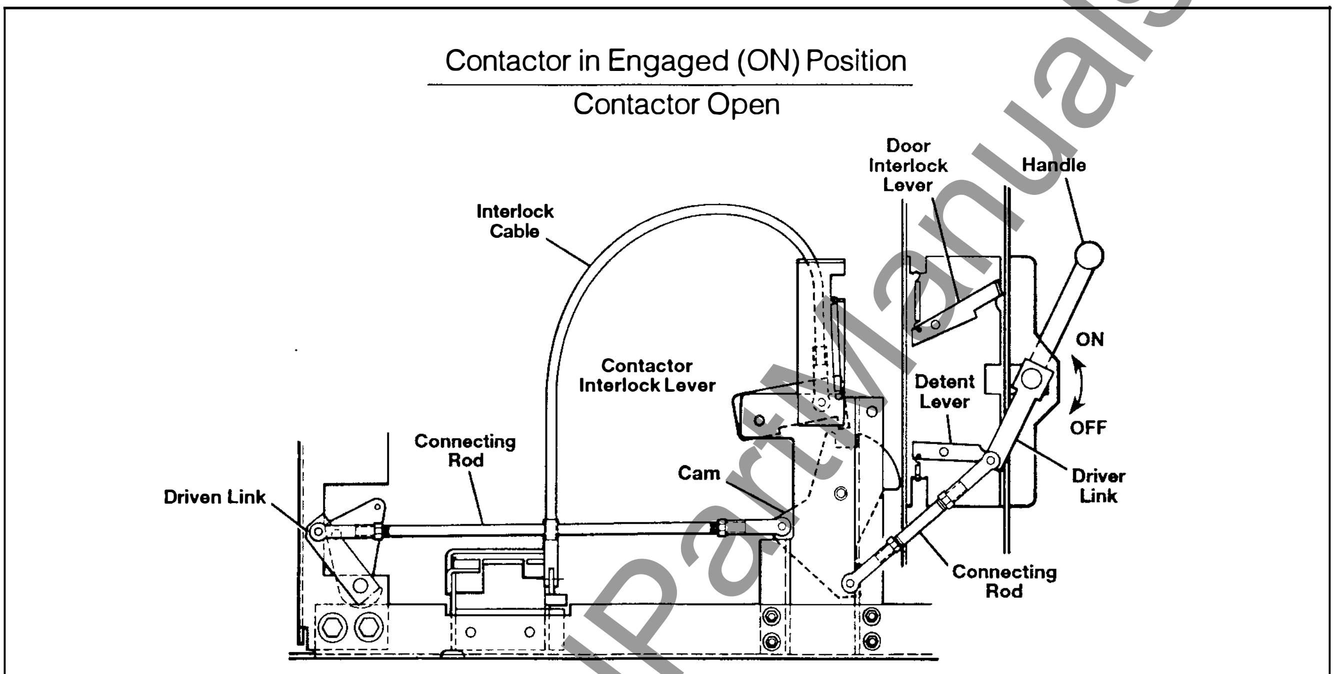

Figure 12. Racking Mechanism—Handle in "ON" Position

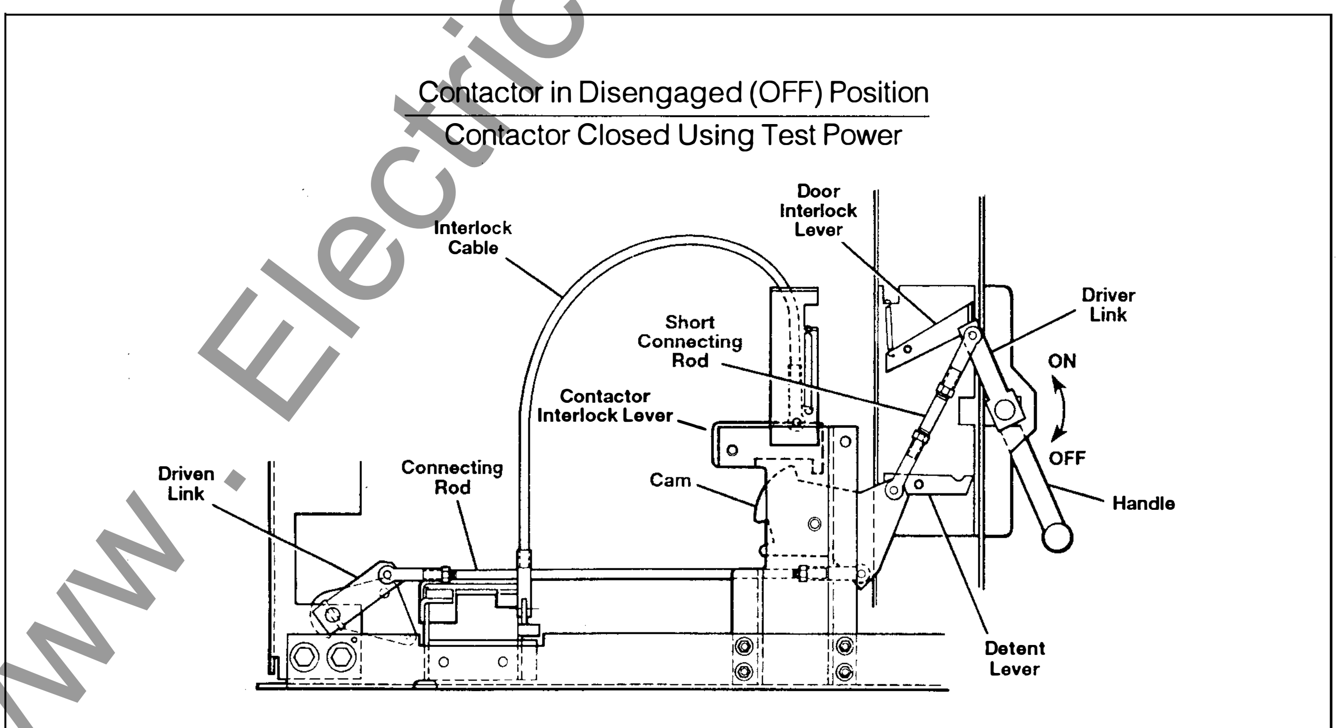

Figure 13. Racking Mechanism—Handle in "OFF" Position

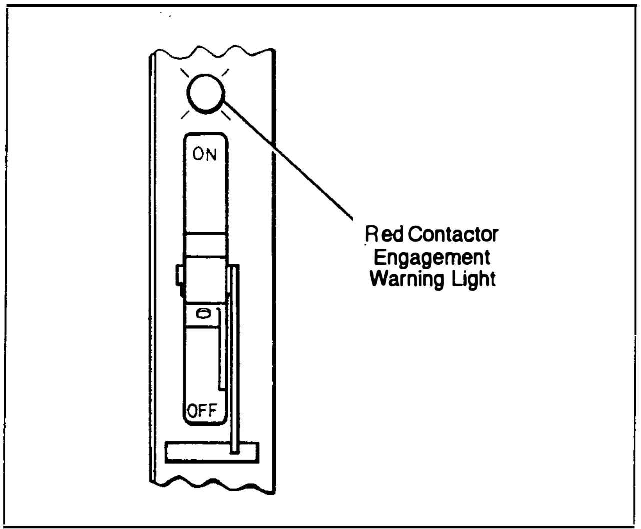

Figure 14. Contactor Engagement Warning Light

Racking Switch Interlock (RSI)

The Racking Switch Interlock (RSI) is a micro-switch mounted on the guide plate which functions to prevent operation of the contactor on the test power when it is in the engaged ("ON") position. As the racking handle is moved from "OFF" to "ON" the normally closed RSI contact opens and isolates the test source from the control circuit. Refer to **Figure 15.**

Power Fuses

ANSI "R" rated current-limiting fuses Type FM are used for motor starting duty in 5 kV Class E2 controllers. ANSI "R" rated fuses Type A720R manufactured by Gould are used for motor starting duty in 7.2 kV Class E2 controllers. ANSI "E" rated fuses are used for most other applications.

Additional information about Type FM fuses regarding selection, application, and specifications is available in factory publication numbers CC-3281.

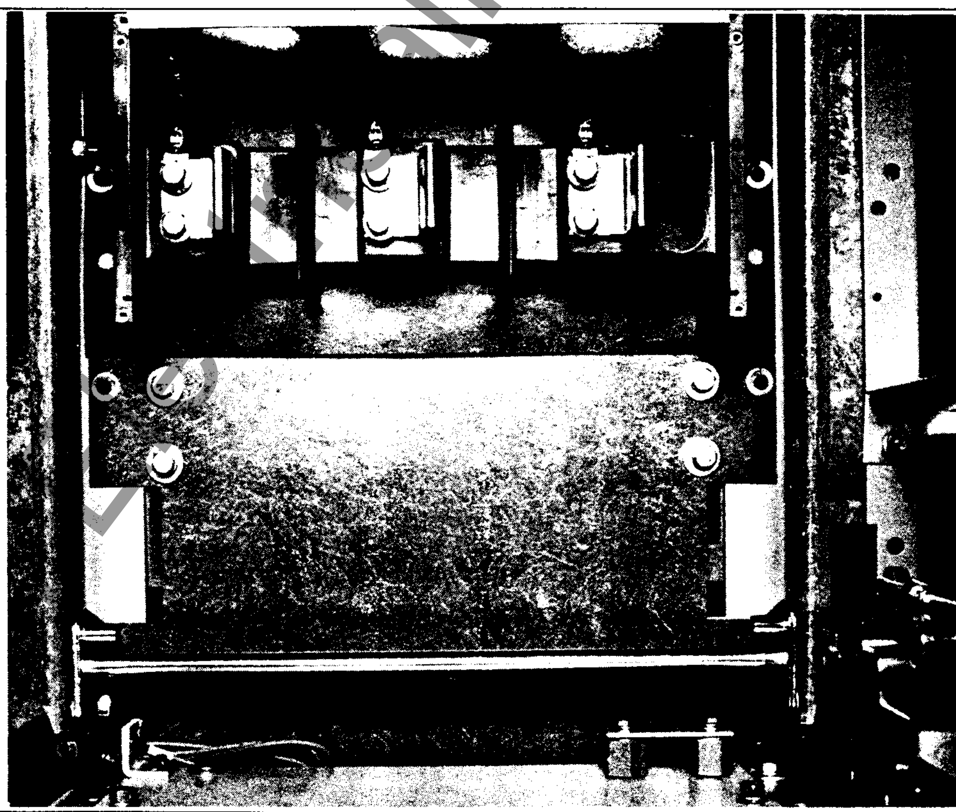

Figure 15. Location of Racking Switch Interlock and Line Switch Interlock in Cubicle

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Table 2. Power Fuses

Maximum Design Volts	Catalog Number	Current Designation	Continuous Ampere Rating at 40°C	Interrupting Rating 50/60 Hz
5080	48FM2R-4G	2R (Single Barrel)	70	Single-Phase 80,000 Amperes RMS Asymmetrical 50,000 Amperes RMS Symmetrical Three-Phase 440 MVA Symmetrical
	48FM3R-4G	3R	100	
	48FM4R-4G	4R	130	
	48FM6R-4G	6R	170	
	48FM9R-4G	9R	200	
	48FM12R-4G	12R	230	
	48FM18R-5G	18R (Double Barrel)	390	
	48FM24R-5G	24R	450	
7200	A720R-3R	3R (Single Barrel)	100	Single-Phase 80,000 Amperes RMS Asymmetrical 50,000 Amperes RMS Symmetrical Three-Phase 620 MVA Symmetrical
	A720R-4R	4R	130	
	A720R-6R	6R	170	
	A720R-9R	9R	200	
	A720R-18R	12R (Double Barrel)	230	
	A720R-18R	18R	390	

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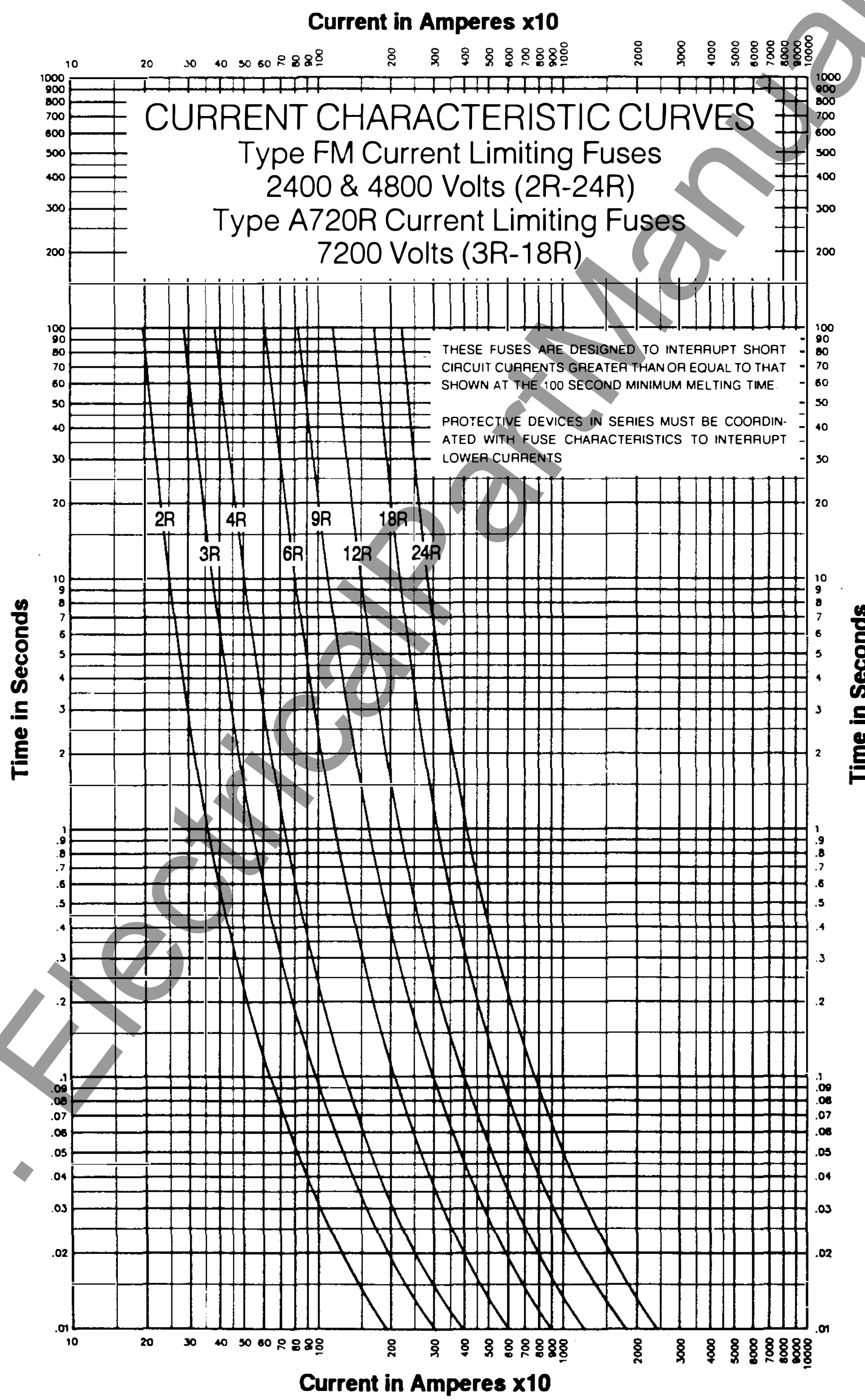

Figure 16. Current Characteristic Curves—Clearing Times

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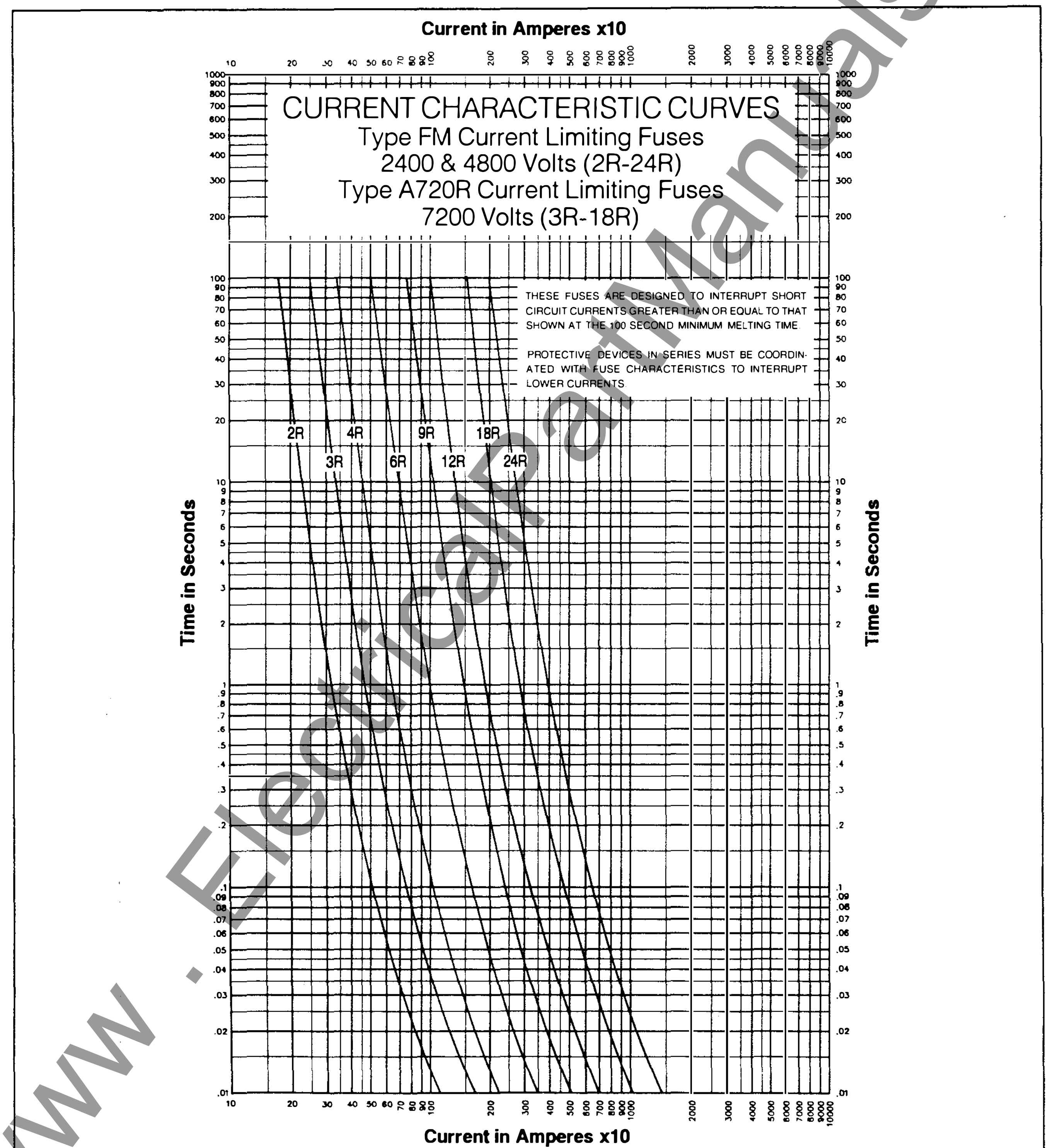

Figure 17. Current Characteristic Curves—Minimum Melting

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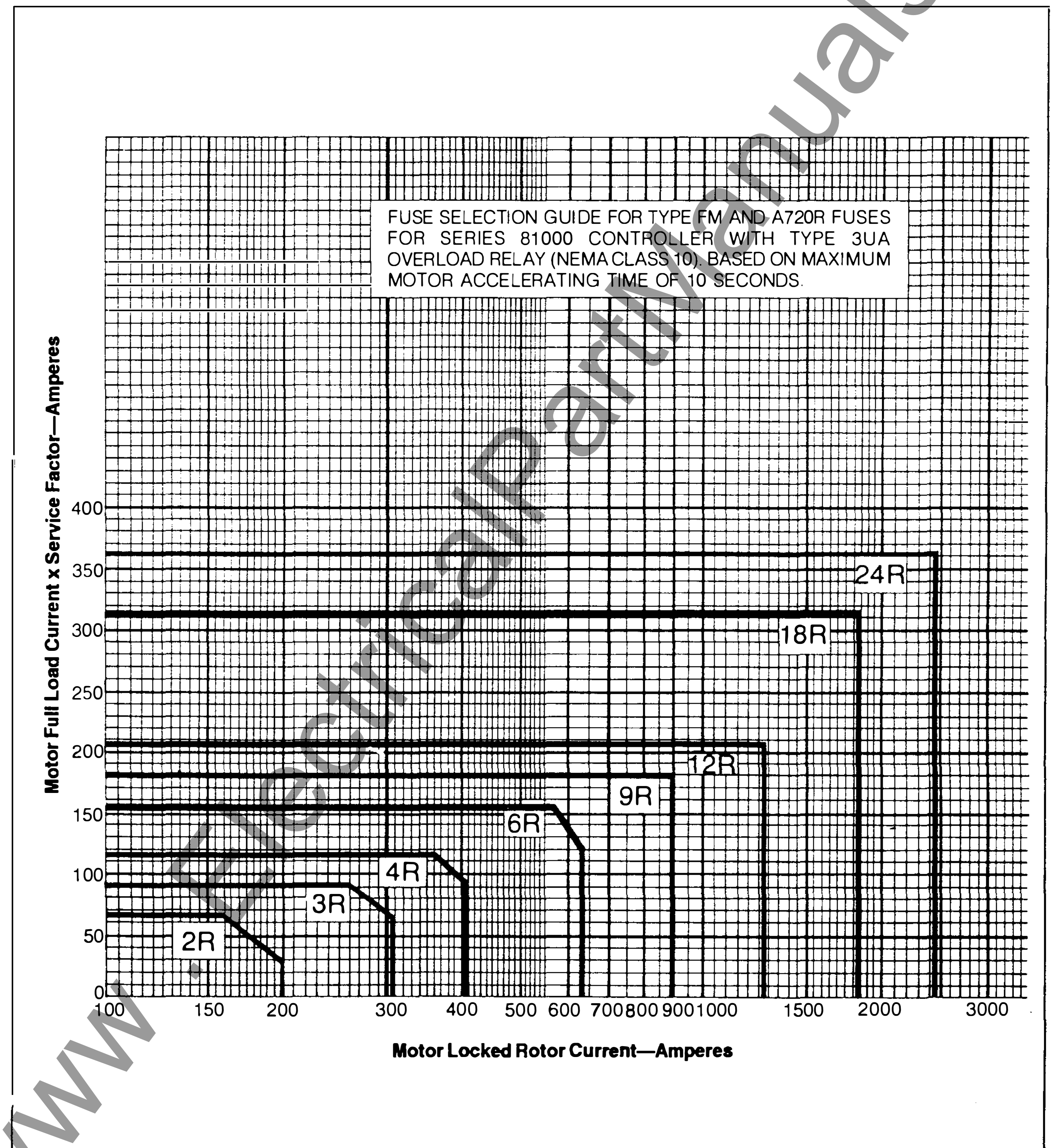

Figure 18. Fuse Selection Guide—Motor FLA X Service Factor—Amperes

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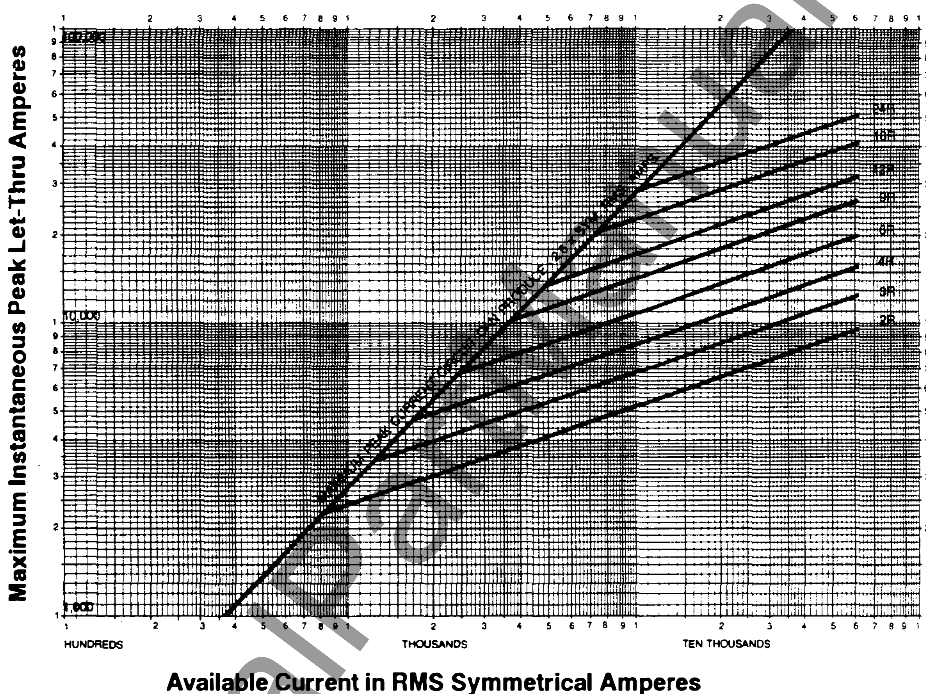
Type FM
Fuse
2R-24R
5kV



Type A720R
Fuse
3R-18R
7.2kV

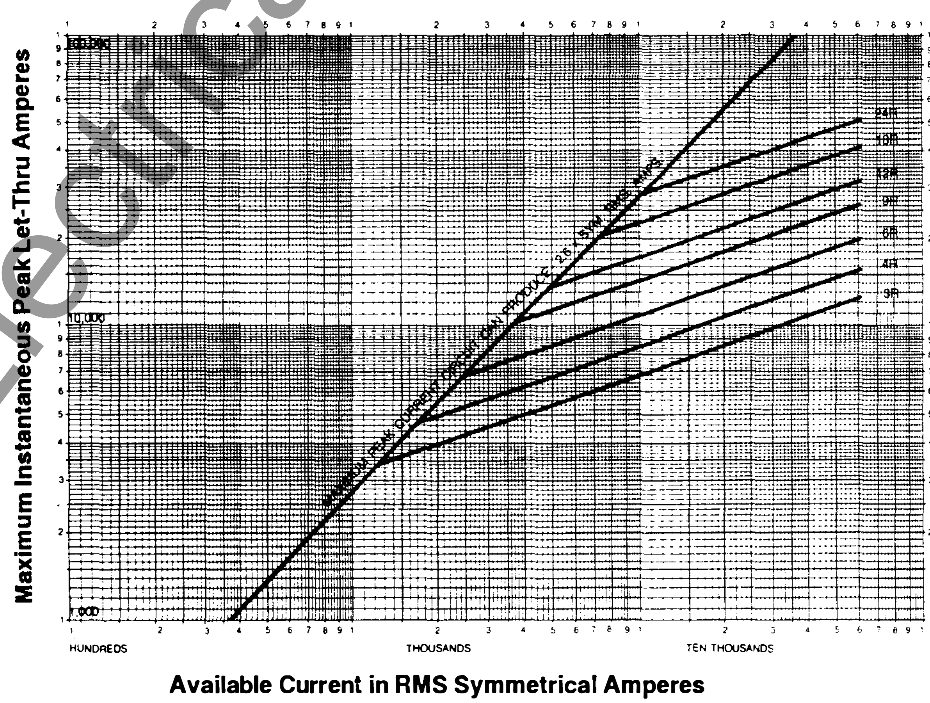


Figure 19. Current Limiting Characteristics of Type FM and Type A720R

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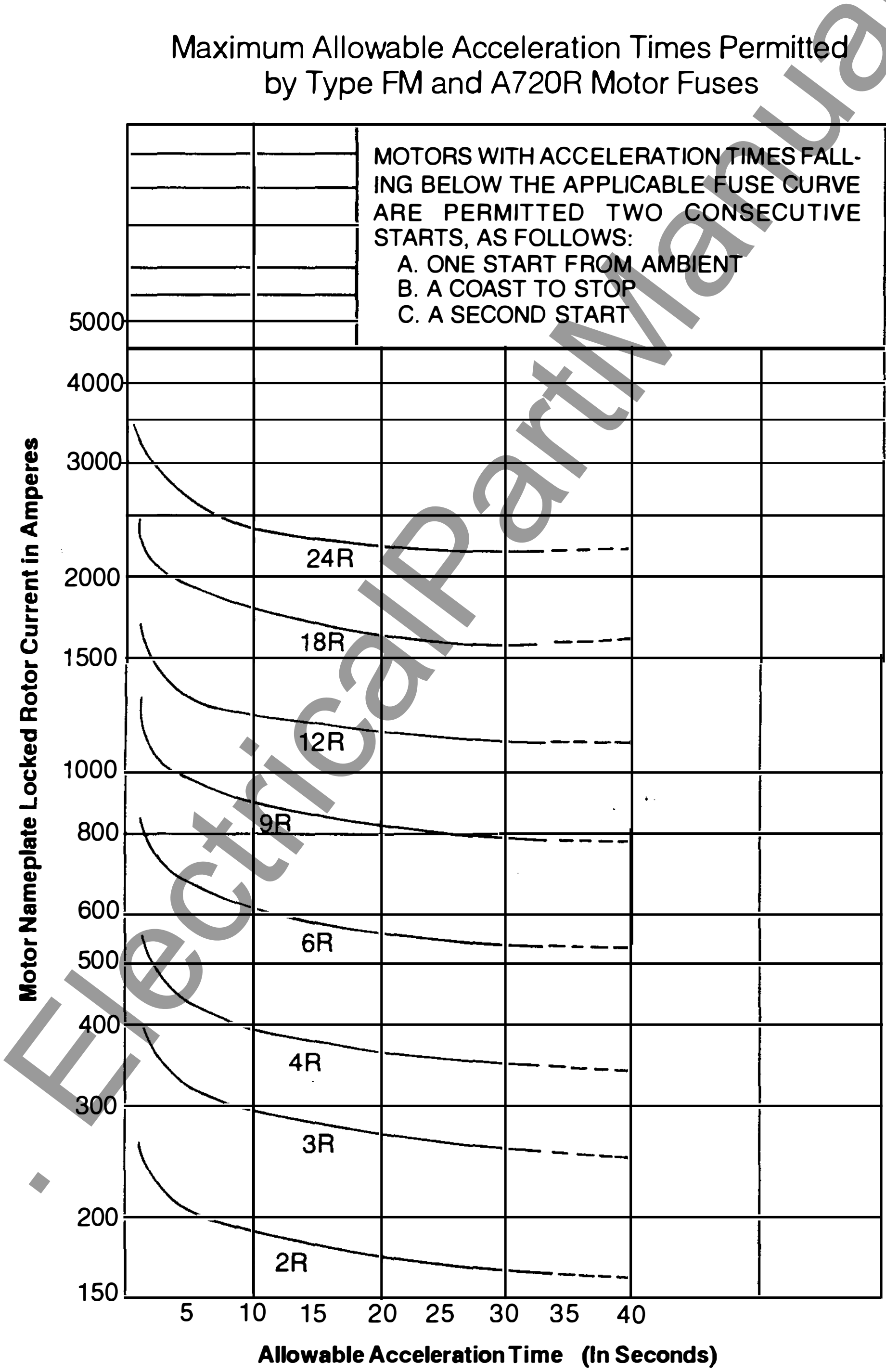

Figure 20. Maximum Allowable Acceleration Times

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Receiving

An immediate inspection should be made for any damage which may have occurred during shipment upon receipt of this equipment. The inspection should include examination of the packaging material and the equipment within. Be sure to look for concealed damage and **do not** discard the packaging material. If damage is found, note damage on Bill of Lading prior to accepting receipt of the shipment, if possible.

NOTE

The way visible shipping damage is treated by the consignee prior to signing the delivery receipt can determine the outcome of the damage claim to be filed. Notification to the carrier within the 15 day limit on concealed damage is essential if loss resulting from unsettled claims is to be eliminated or minimized.

A claim should be immediately filed with the carrier, and the Siemens sales office should be notified if damage or loss is discovered. A description of the damage and as much identification information as possible should accompany the claim.

WARNING

Serious injury and equipment damage can occur if the Series 81000™ high voltage controller is moved with a wire rope "come along", pried, or otherwise handled except by attachment to the noted lifting brackets or angles.

Always handle the contoller in the vertical position. Restraints may be necessary to prevent tipping during handling. Since equipment is top heavy and front heavy, jacks, pry bars, dollies, roller lifts and similar devices for lifting, handling, moving and lowering all require supplemental blocking beneath the controller and restraints to prevent tipping. These devices are not recommended due to the hazards implicit in their use.

Handling

Lifting

The Series 81000 controllers are shipped in a group of one to three vertical sections which are mounted on wooden shipping skids. For 90-inch high controllers, lifting brackets are provided for single frames, see **Figure 21**, along with an equalizing bar.

Controllers with top mounted horizontal bus will be provided with side mounted lifting angles. Refer to **Figure 23.**

Adequate handling facilities should be available. Each vertical section, with contactors, weighs approximately 1500 lbs. If a vertical section contains power factor correction capacitors, reactors, or large transformers, sufficient additional weight handling capacity must be allowed.

It is recommended that a crane or hoist be used to handle the controller if at all possible, if a crane or hoist is not available, and other handling means are necessary, extreme care must be exercised to insure that the equipment is secured during the movement and placement operations to prevent tipping and falling.

Moving Controller with Crane or Hoist

The following precautions should be taken when moving the controller with a crane of hoist:

1. Do not remove the wooden shipping skid until final installation position is reached.
2. Keep the controller in an upright position only.
3. Select rigging lengths to compensate for any unequal weight distribution.
4. Do not allow the angle between the lifting cables and vertical to exceed 45°.
5. Do not pass ropes or cables through lifting brackets. Use only slings with safety hooks or shackles.
6. If overhead restrictions do not permit lifting by top mounted brackets, or angles, the controller may be underslung from the base. The sling load must be distributed evenly and padding or spreader bars must be used to avoid scarring and structural damage.
7. Never lift the controller above an area where personnel are located.

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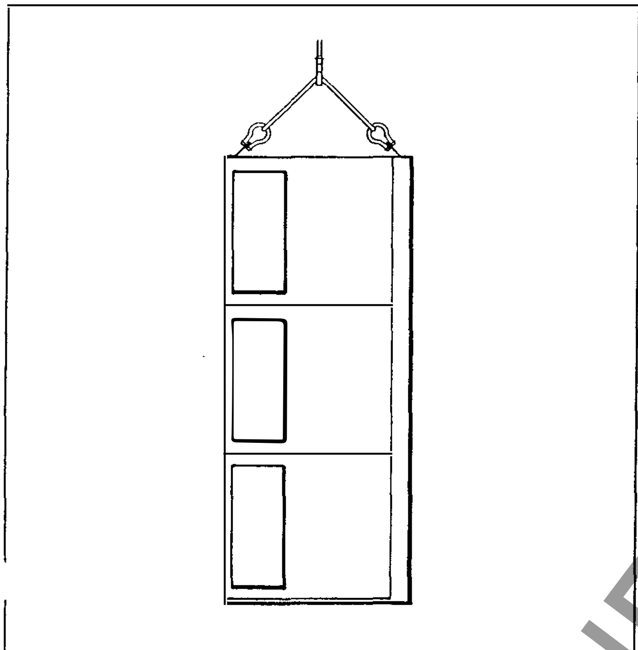

Figure 21. Lifting for Single Unit

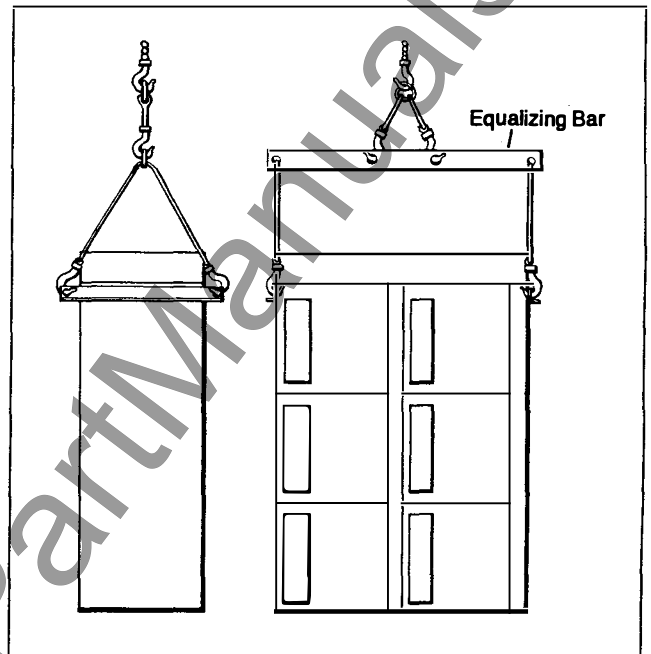

Figure 23. Lifting for Units with Top Mounted Bus

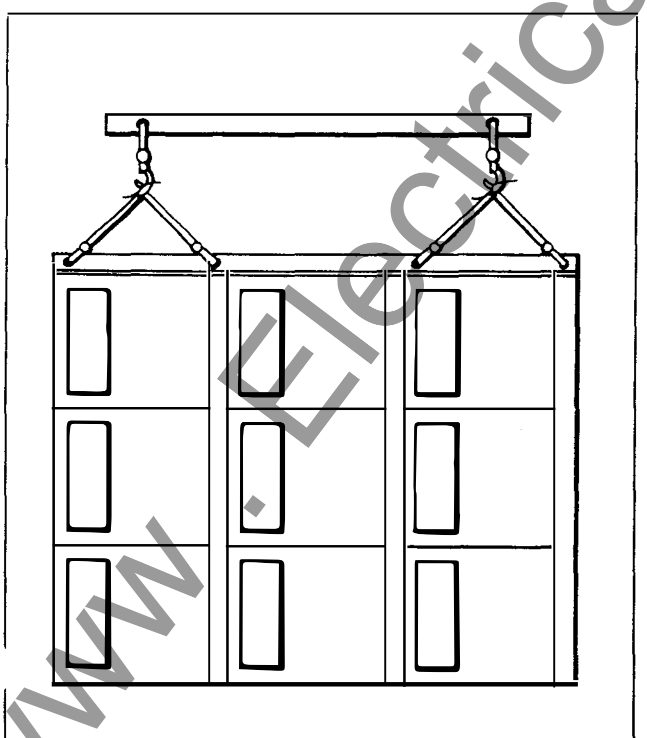

Figure 22. Lifting for 2 or 3 Section Line-Up

Moving the Controller with a Forklift

The following precautions should be taken when moving the controller with a forklift:

1. Do not remove the wooden shipping skid until final installation position is reached.
2. Keep the controller in an upright position only.
3. Make sure the load is properly balanced on the forks.
4. Place protective material between the controller and forklift to prevent bending and scratching.
5. Securely strap the controller to the forklift to prevent shifting or tipping.
6. Excessive speeds and sudden starts, stops, and turns must be avoided when handling the controller.
7. Lift the controller only high enough to clear obstructions on the floor.
8. Take care to avoid collisions with structures, other equipment, or personnel when moving the controller.
9. Never lift the controller above an area where personnel are located.

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Moving the Controller by Rolling on Pipes

The following precautions should be taken when moving the controller by rolling on pipes:

1. Do not remove the wooden shipping skid until final installation position is reached.
2. Keep the controller in an upright position.
3. Use enough people and restraining devices to prevent tipping.
4. The surface over which the controller is rolled must be level, clean, and free of obstructions. **Never roll a controller on an inclined surface.**
5. It should be recognized that rolling a controller is especially hazardous to fingers, hands, and feet and the controller is susceptible to tipping. Measures should be taken to eliminate these hazards.
6. All pipes must be the same outside diameter and should have no flat spots. Only steel pipe should be used for this purpose.

Skid Removal

Controllers are normally shipped with the contactors installed and braced in the vertical section(s). To facilitate handling of the contactors, it is recommended that they not be removed from their shipping positions until after the vertical section or group of vertical sections has been removed from the wooden shipping skid and set into final position. At this time, the contactors may be removed by unbolting the retaining bracket which secures the left front contactor wheel to the guideplate.

Skid removal should be performed just prior to final placement of the controller and is achieved by removing the skid lag bolts. Install the lifting brackets or angles to the top of the controller (torque bolts to 40-50 ft. lbs.) and attach the crane rigging to remove all slack without lifting the equipment. This is a recommended safety measure to reduce the possibility of tipping. The lag bolts may now be removed, the controller lifted, the skids removed, the controller lowered into place, and the anchor bolts secured. The last operation should be performed with adequate rigging tension to prevent tipping. After all additional shipping sections are secured in a similar manner, sections and bus bars should be joined in accordance with recommended torque values.

Close doors as soon as possible to eliminate intrusion of dirt and foreign materials in the controller enclosure.

Storage

If the controller cannot be placed into service reasonably soon after its receipt, it must be stored in a clean, dry, dust and condensation free environment. Do not store equipment outdoors. To prevent condensation, a standard 150 watt light bulb connected to burn continuously should be placed in the bottom of each vertical frame. If the equipment was supplied with space heaters, these may be energized in lieu of the light bulbs.

Any scratches or gouges suffered from shipping or handling should be touched up with a can of spray paint to prevent rusting.

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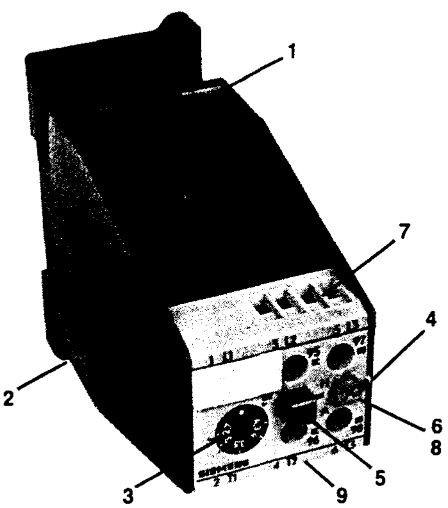

1. Line Terminals
2. Load Terminals
3. Adjustment Knob
4. Trip Indicator
5. Test Button
6. Reset Button
7. Contact Terminals
8. Manual or Automatic Reset
9. Tamper Proof Cover

Figure 24. Type 3UA Overload Relay

General

This section is intended to guide the user in the selection, application and setting of the Type 3UA thermal overload relay, when used in medium voltage (2.3-6.6kV) motor control applications. This information supplements that given in general instruction sheet CC3274. It is essential that the information contained here be studied carefully to ensure proper coordination between overload relay and power fuse characteristics.

Overload Relay Operation

The Type 3UA overload relay is designed and factory-calibrated to provide over-temperature protection for the windings of U-Frame and T-Frame three-phase AC motors. The relay will shut down the motor and/or activate warning alarms under conditions of motor overloading, single-phasing, prolonged acceleration and certain conditions of frequent restarting operations. The internal heaters are energized from 5 amp secondary windings to individual phase current transformers.

Application

Squirrel cage, synchronous and wound-rotor 3-phase motors all have voltage and current ratings which may be protected by the Type 3UA overload relay regardless of the type of starting employed. The application table (**Table 3**) provides the current ranges and corresponding relay catalog numbers for specific motor full load currents divided by the appropriate current transformer ratios.

Markings on the relay adjustment dial denote full load amps. Tripping current is 125% of dial setting. The adjustment dial should be set on the basis of full load current marked on the motor nameplate or on the basis of actual measured running current.

For motors with a marked service factor not less than 1.15, or motors with a marked temperature rise not over 40°C, use the formula below for determining the dial setting:

$$\text{Dial Setting (for 1.15 SF)} = \frac{\text{N.P. Full Load Current}}{\text{Current Transformer Ratio}}$$

In case overload relay tripping occurs during motor starting or at maximum running conditions, the overload relay dial setting can be increased by a factor not to exceed 1.12 times the value determined by the above formula in accordance with NEC Article 430-34.

For all other motors rated for continuous duty including motors with a marked service factor of 1.0, use the formula below for determining the dial setting:

$$\text{Dial Setting (for 1.0 SF)} = \frac{(0.92)\ (\text{N.P. Full Load Current})}{\text{Current Transformer Ratio}}$$

In case overload relay tripping occurs during motor starting or at maximum running conditions, the overload relay dial setting can be increased by a factor not to exceed 1.04 times the value determined by the above formula in accordance with NEC Article 430-34.

> **NOTE**
>
> If the motor is a hermetically sealed type (sometimes used for air conditioning or refrigeration drives) a magnetic type overload relay is normally required due to the inherent limited thermal winding capacities of these motors. Check application.

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After the dial setting has been determined, the relay having a current range that will include the dial setting should be chosen. The dial setting must be made on each relay for the individual motor application.

For example, for a particular motor, nameplate full load current is 200 amps, nameplate service factor is 1.15 and current transformer ratio is 300/5 amps. Then, using the first formula,

$$\text{Dial Setting} = \frac{200}{300/5} = 3.33$$

The relay with a range that will include the dial setting of 3.33 amps must therefore be used. From **Table 3** below, relay catalog number 3UA59 00-1E would be chosen having a setting range from 2.5 to 4.0 amps. This setting permits the motor to run up to its full service factor before tripping will occur. Note that relay 3UA59 00-1F (3.2-5.0 amps) could have been chosen for this application. Either relay will work and selection is optional.

Table 3. Application

Minimum Amps	Maximum Amps	Relay Catalog No.
1.6	2.5	3UA59 00-1C
2.0	3.2	3UA59 00-1D
2.5	4.0	3UA59 00-1E
3.2	5.0	3UA59 00-1F

Cyclic Starting

Thermal overload relays accumulate heat on operation and approximately two minutes cooling time should elapse before attempting to reset relays after tripping has occurred. Even though the relay can be successfully reset, its operating time on restart after tripping may be considerably shorter than that from a cold start. Approximately one hour cooling time is required for the relays to cool completely to room temperature after they have been de-energized.

Thermal overload relays will trip due to accumulated heat from jogging or frequent restarting operations. However, thermal overload relays may not protect motors completely if frequent restarting after tripping attempted because the cooling time of the motors which they are protecting is considerably longer than that of the relay elements. Jogging and cyclic starting should be kept to an absolute minimum to prolong motor and controller life.

Cyclic Loading

Thermal overload relays may have a tendency to over protect motors which serve highly fluctuating loads. With this type of loading, the operating elements of the thermal overload relays tend to accumulate the heat produced by the load peaks and cause tripping even though the effective loading may be well within motor rating.

The effect of pulsating type of drive can be determined by calculating the root-mean-square value from a recording current chart or by using a planimeter with a current chart showing a typical load cycle. Should tripping occur when the effective loading is within the rating of the motor, the setting of the relay can be proportionally increased to correspond to the effective loading. If a satisfactory setting cannot be obtained, the factory should be consulted after full details of application and loading are obtained.

Single-Phasing

The Type 3UA thermal overload relay provides protection for three-phase motors against overheating in the event of a single-phase or phase current unbalance condition. When any one of the three phases is opened, the relay senses this and its curve shifts to a faster time-current characteristic, thus making it more sensitive to the higher single phase current. If the relay trips, it could be due to either a normal three-phase overload or single phase condition.

Causes for Relay Tripping

Should overload relay tripping occur from a cold start-up, abnormal starting conditions exist. The line voltage should remain close to normal even while the motor is drawing high starting current. The torque that the motor will develop is proportional to the square of the applied voltage. For example, should the line voltage drop 10% from normal, the motor will develop approximately 80% as much torque as on rated terminal voltage. Any loss in developed torque may produce a marginal acceleration condition. Such loads as pumps, compressors, fans, etc., are normally started unloaded.

Improper operation of the unloading features may extend the accelerating time to cause overload relays to operate. Certain high inertia loads may inherently have accelerating times in excess of that which overload relays will tolerate without tripping. This condition may exist on drives such as hammermill or impactors, roll and jaw crushers, large blowers, flywheel m-g sets, chippers, etc.

Where motors have been established as suitable for the normally long accelerating times, it may be necessary to bypass the overload relays during the starting interval. This can be done by the addition of controlled shorting contacts. Problems of this nature should be referred to the factory with complete operational details. The motor load current should always be measured when relay tripping occurs. The most common cause of relay tripping is the simple fact that the motors are overloaded during operation.

Operational Checks

Under normal operating conditions overload relays never operate. After prolonged periods in certain atmospheres, (corrosive, dusty, or gummy) it is possible that they may not operate properly. The following operational test will demonstrate if the overload relay is functioning properly at the existing calibration setting. This operational test should be included as a part of the periodic maintenance schedule.

Test Precautions

Observe the following precautions while making the operational test:

1. All relay components must be at the same temperature at the start of each test run. It may be necessary to wait approximately one hour between each test run.
2. If the relay is used to set the load, then it should cool one hour before proceeding with the test.
3. The current must be held at the test value during the test run.
4. If a laboratory type ammeter is not available, then allowance must be made for the inaccuracy of standard meters

Operational Test

Refer to **Figure 25** for test equipment required and connections. Proceed as follows:

1. Check dial setting of relay as outlined in "Application" section of these instructions.
2. Adjust variable autotransformer to supply three times the current indicated on the overload relay dial. Relay should trip in 17-37 seconds.

NOTE

A slight adjustment of the dial setting may be necessary to arrive at this trip time. If a slight adjustment is made, it is recommended that the 100% current test be made as outlined below.

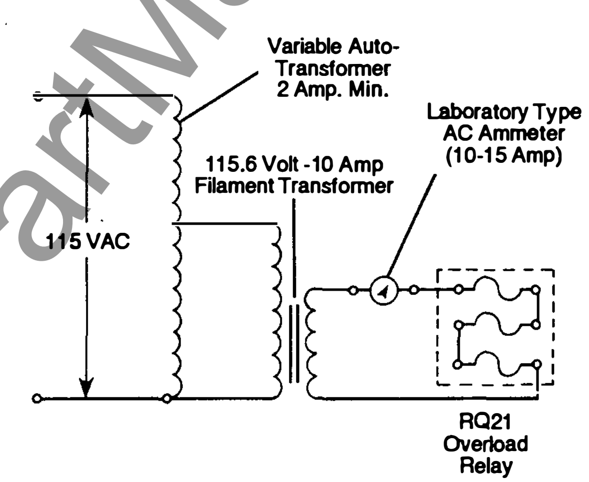

Figure 25. Connections and Equipment for Operational Test or Calibration of Type 3UA Overload Relay

100% Current Test

The 100% current test provides a close check of relay operation. Proceed as follows:

1. Apply 115% of the dial setting current through all three elements of the relay. Relay should not trip within 3/4 hour.
2. Apply 125% of the dial setting current through all three elements of the relay. Relay should trip within 3/4 hour.

All relay operating elements must have cooled down to room temperature before repeating the test or the trip times will be substantially faster than indicated. Should a motor be running near full load and jam or stall, the relays will trip in approximately one-fourth of the time from a cold start. Should careful checking of any relays reveal them to be significantly out of calibration, they may have been subjected to tampering or handling damage and should be replaced.

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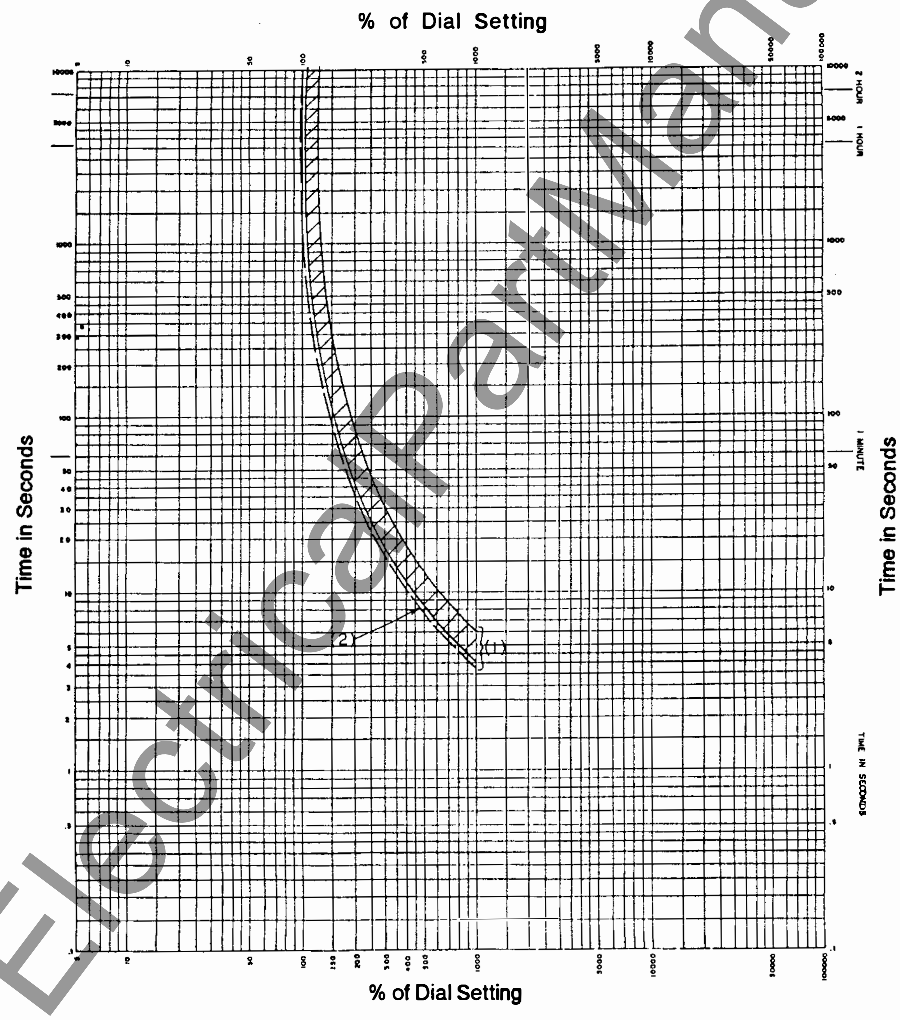
Current Characteristic Curves
Type 3UA Thermal Overload Relay—NEMA Class 10
Cat. No. 3UA5900-1E, Setting Range 2.5-4.0 Amp
Medium Voltage Control Applications



NOTES:

1. Curves are based on "cold" start at 25°C ambient. For full running condition tripping times are lowered to 25% of indicated values.
2. Band (1) shows maximum and minimum tripping characteristics for normal three-phase balanced load.
3. Curve (2) shows maximum tripping times for single-phase conditions.
4. Motor (line) current is equal to overload relay current multiplied by current transformer ratio.

Relay Cat. No.	Setting Range
3UA59 00-1C	1.6-2.5 Amps
3UA59 00-1D	2.0-3.2 Amps
3UA59 00-1E	2.5-4.0 Amps
3UA59 00-1F	3.2-5.0 Amps

Figure 26. Current Characteristic Curves of Type 3UA Overload Relay

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Coordination with Current-Limiting Motor Fuses

The overload relay time-current characteristics must be selected so that the power fuses are protected against unnecessary operation or damage during motor starting or overload conditions. In a properly coordinated system, the overload relay will operate to open the main contactor before the fuse melts under motor locked-rotor-conditions. The combination of Type 3UA overload relay and power fuse rating supplied in Series 81000 controllers is factory-selected to provide proper fuse coordination and optimum motor protection.

Proper coordination also ensures that the motor fuse cannot be subjected to currents below its minimum interrupting rating (currents which require over 100 seconds to melt the fuse) for a period of time long enough to cause over-heating and damage to the fuse. The overload relay must be set to trip and open the contactor at currents in this range before the fuse becomes so over-heated that it cannot interrupt.

The overload relay and fuse characteristics can be compared by overlaying the transparent time-current curve for the overload relay with the fuse minimum melting time curves (refer to CC-3281 for Type FM curves). The curves should be positioned one over the other on a light table so that the 100% current mark on the overload curve is aligned with the current on the fuse curve corresponding to the dial setting (motor FLA) on the overload relay. For proper fuse protection, the intersection of the two curves must occur at a point under 100 seconds.

NOTE

Installation of power factor correction capacitors can affect overload relay trip setting.

If the capacitors are connected to the load (motor) side of the current transformers or directly to the motor, the overloads must be derated. A five percent decrease in the trip setting would be a nominal requirement. To accurately determine the proper setting, operate the motor with the capacitors disconnected and measure the secondary current of the current transformers. Connect the capacitors and again measure the secondary current. Calculate the percentage difference and decrease the trip setting accordingly.

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General

This section discusses the overvoltages generated in a circuit due to the use of vacuum interrupters to switch currents and provides guidelines for applying surge protection.

Overvoltage caused by current chopping is not peculiar to vacuum, since it has been observed in most interruption media, it is no longer the problem it was once thought to be with the use of modern contact materials.

On the other hand, multiple reignition transient problems are possible under certain conditions, when using vacuum contactors regardless of the chopping current rating of the vacuum interrupter.

Protection against overvoltages caused by multiple reignitions will also provide protection from virtual chopping due to multiple reignitions. Hence protection for multiple reignitions is the primary concern in applying vacuum contactors.

Conditions for Overvoltages Due to Multiple Reignition:

1. Motor with locked rotor current of 600 amps or less is switched off under locked rotor condition, that is, while the motor is not fully up to speed yet, such as during start up or jogging conditions.
2. The main contacts of the vacuum interrupter part at an instant of time less than 0.5 milliseconds before the natural sinusoidal zero of current. This condition is theoretically possible 18% of the time for a three phase system.

Overvoltage Protective Devices

If the locked rotor current is 600 amps or less where multiple reignitions may be possible, then surge protection is recommended. Consult factory for application. For such applications, Siemens Series 81000 Controllers are provided with Type 3EF1 surge limiters, connected as shown in **Figure 27**. These devices will limit the magnitude of the surge voltage to a level about equivalent to that found in air-break or other types of interrupters.

The Type 3EF1 surge limiter is intended for installation within the controller. It will handle the switching transients produced by vacuum contactors but is not designed to be exposed to the large discharge currents produced by lightning strikes.

Larger station-type surge arrestors should be installed ahead of the controller if it is connected to incoming lines subject to lighting strikes.

The 3EF1 surge limiter consists of a non-linear resistor installed in a hermetically sealed tube. For the 6.0kV and 7.5kV limiters, a spark-gap assembly is provided in series with the non-linear resistor, in the sealed tube. The non-linear resistor is a metal-oxide varistor whose resistance decreases out of proportion with rising voltage. Three voltage ratings are provided as shown in **Table 4**.

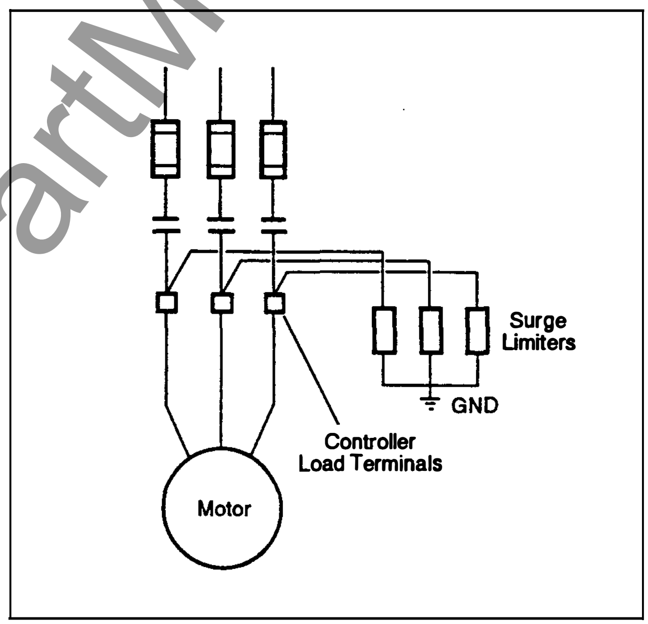

Figure 27. Typical Connection for Surge Limiters

Table 4. Voltage Ratings of Surge Limiters.

System Voltage	Limiter Voltage	Part Number
2.3 kV	3.0 kV	18-741-413-501
4.0 kV	6.0 kV	18-741-413-502
6.6 kV	7.5 kV	18-741-413-503

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WARNING

Accidental contact with energized wiring or bus system can cause electric shock, burn or electrocution.

Disconnect and lock-out incoming power and control voltage sources before beginning work on this or any other electrical equipment.

Check all control circuit terminals with a voltmeter to make certain that the equipment is totally de-energized. Use only approved high voltage test equipment to check voltage on power terminals. Do not attempt to measure high voltage with a volt-ohm meter.

It is recommended that a safety ground be connected to the power bus after the system has been de-energized, and prior to working on the equipment. Follow the procedure outlined in the pre-energization check section of this manual before power is restored.

Site Preparation and Mounting

Installation shall be in accordance with the National Electrical Code, ANSI, and NFPA 70 Standards.

The controller should be installed in a clean, dry, heated place with good ventilation. It should be readily accessible for cleaning and inspection and should be carefully set up and leveled on its supporting foundation and secured in place. If the mounting site is not flat and level, the controller must be shimmed where necessary to prevent distortion of the frame.

The controller can be mounted by many different fastening systems including true drop in, cast in place, power actuated, or threaded insert fasteners. See **Figures 28** and **29** for anchor bolt locations. The bolt pattern is dependent on frame, location in the line-up and whether or not sill channels are furnished. The group arrangement drawing for each controller details the anchor bolt locations. The coordination between the bolts and the controller should be verified prior to attempting installation. Expandable inserts in pre-drilled holes or imbedded "L" bolts are recommended. Wooden plugs driven into holes in masonry or concrete are not recommended for anchoring inserts and should never be used. The bolt size must be 1/2". Welding the steel base or sill channels to a steel floor plate is an alternate mounting method especially recommended in areas subject to seismic activity.

Grouting the sill channels as indicated in **Figure 30**, is another method of fastening. This method requires the foundation to be grooved to accept the sill channels. The actual groove dimensions must be coordinated with the floor plan layout on the group arrangement drawing included in the controller information packet.

General Pre-Installation Inspection

1. Check all parts for secure mounting and good electrical connections. Inspect visually for overall good condition.
2. Inspect frame for dents and other damage. Swing doors to make sure they pivot easily.
3. Operate the racking mechanism to insure free and smooth operation. Inspect the stab assembly and shutter mechanism.
4. Manually operate the contactor armature assembly for free and smooth operation. Check fuses for sure fit in clips. Check fuse clips for deformities and secure mounting.
5. Check control circuit plug and receptacles for bent pins and other damage.
6. Make sure that cable clamps and insulators are in good condition.

Grounding

Each controller's frame must be grounded. This connection must be made before making any power connection. If a ground bus is furnished, the ground connection should be made to the ground bus. The control and instrumentation circuits are grounded to the enclosure. This connection can be temporarily removed for test purposes, but it must be reconnected before the control is returned to operation.

Electrical Connection

To simplify line and load cable connections, the contactors and the horizontal barriers between units may be removed. Be sure to disconnect the control plug before attempting to remove the contactor.

Line connections should be made first. See **Figures 32, 33, 34** and **35** for details.

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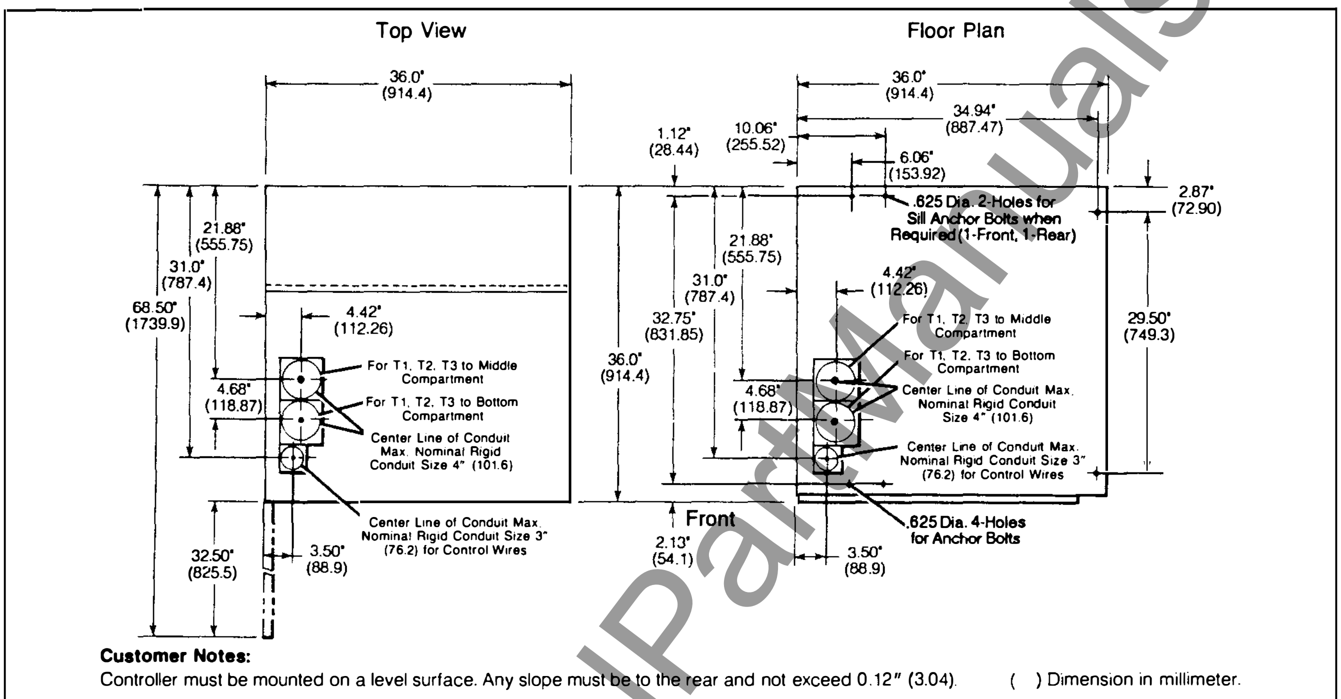

Figure 28. Top View and Typical Floor Plan with Bus Located in Top Compartment

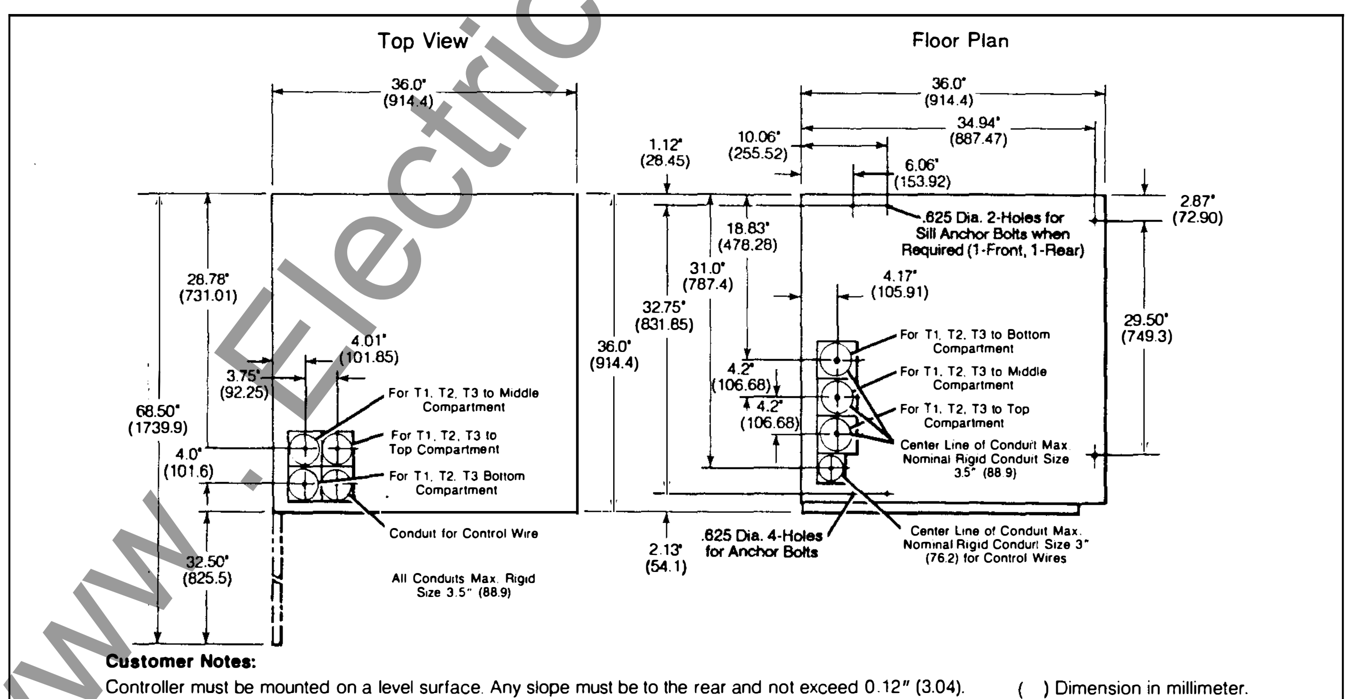

Figure 29. Top View and Typical Floor Plan with Bus on Top Cubicle

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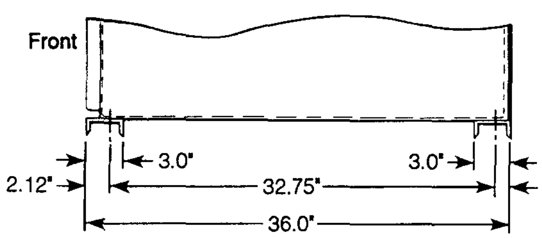

Figure 30. Typical Side View with Sill Channels When Required

Load terminals are connected directly to the current transformers located on the left side of the starter unit. Vertical cable conduits are provided for top or bottom load cable connection. See **Figure 31**. Typical conduit space for top or bottom entry of load cables and control wires is given in **Figures 28** and **29**.

Contactor Installation

Preinstallation Checks

Correct installation of contactors is essential to proper controller operation. Before installing a contactor in any medium voltage compartment, observe the following check list:

1. Check to see that the catalog number, part number and power fuse rating given on the contactor rating label matches the information given on the medium voltage compartment rating label.
2. Check the following items in the contactor for agreement with the information given on the rating label:
   a. Contactor type.
   b. Contactor continuous ampere rating.
   c. Power fuse type, "R" or "E" rating and voltage.
   d. Control transformer primary fuse "E" rating and volt age.

WARNING

Incorrect insertion of contactors or "swapping" of contactors with rating labels which do not match the medium voltage compartment rating label can cause personal injury and major damage to the equipment.

Verify agreement between contactor and compartment label prior to installing contactor. Check to see that the contactor is of the correct type.

Installation

After it has been verified that the correct contactor has been selected for a given medium voltage compartment, the contactor may be installed as follows:

1. Open the medium voltage compartment door (handle must be in "OFF" position, red contactor engagement light must be OFF).
2. Position the contactor in front of the compartment in such a way that the rear contactor wheels are lined up just to the inside of the sides of the guide plate.

NOTE

A lifting device is required to install contactors in middle or upper compartments of two- or three-high designs.

3. Roll the contactor onto the guide plate and into the compartment until it stops. Use the handles on the front of the contactor for this purpose. When the contactor is fully inserted, the mechanical latch should rotate to prevent it from rolling back out of the compartment.
4. Connect the control wiring harness to the contactor by inserting the harness plug into the receptacle on the left side of the contactor.
5. Close and latch the medium voltage compartment door.

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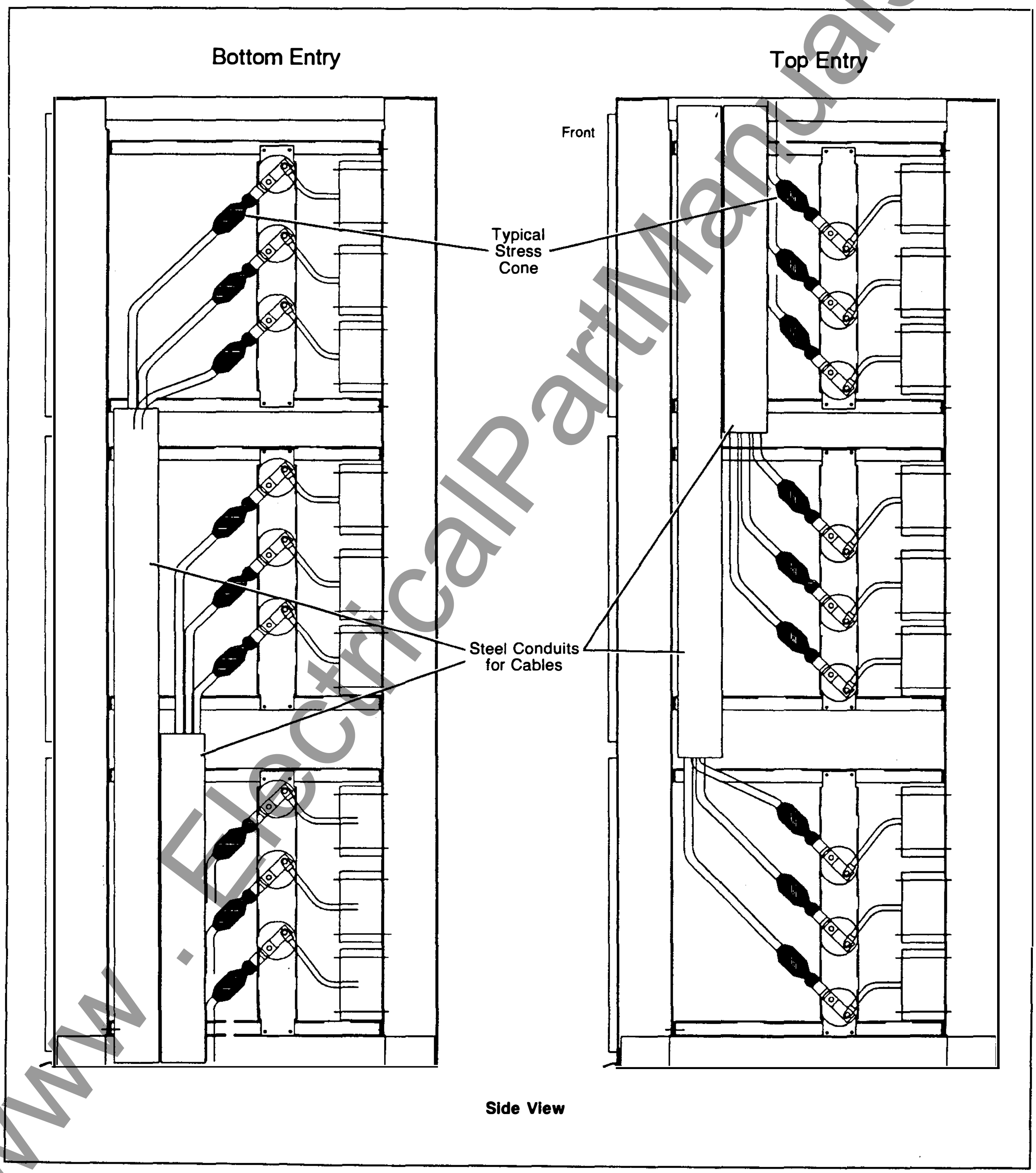

Figure 31. Load Cable Termination

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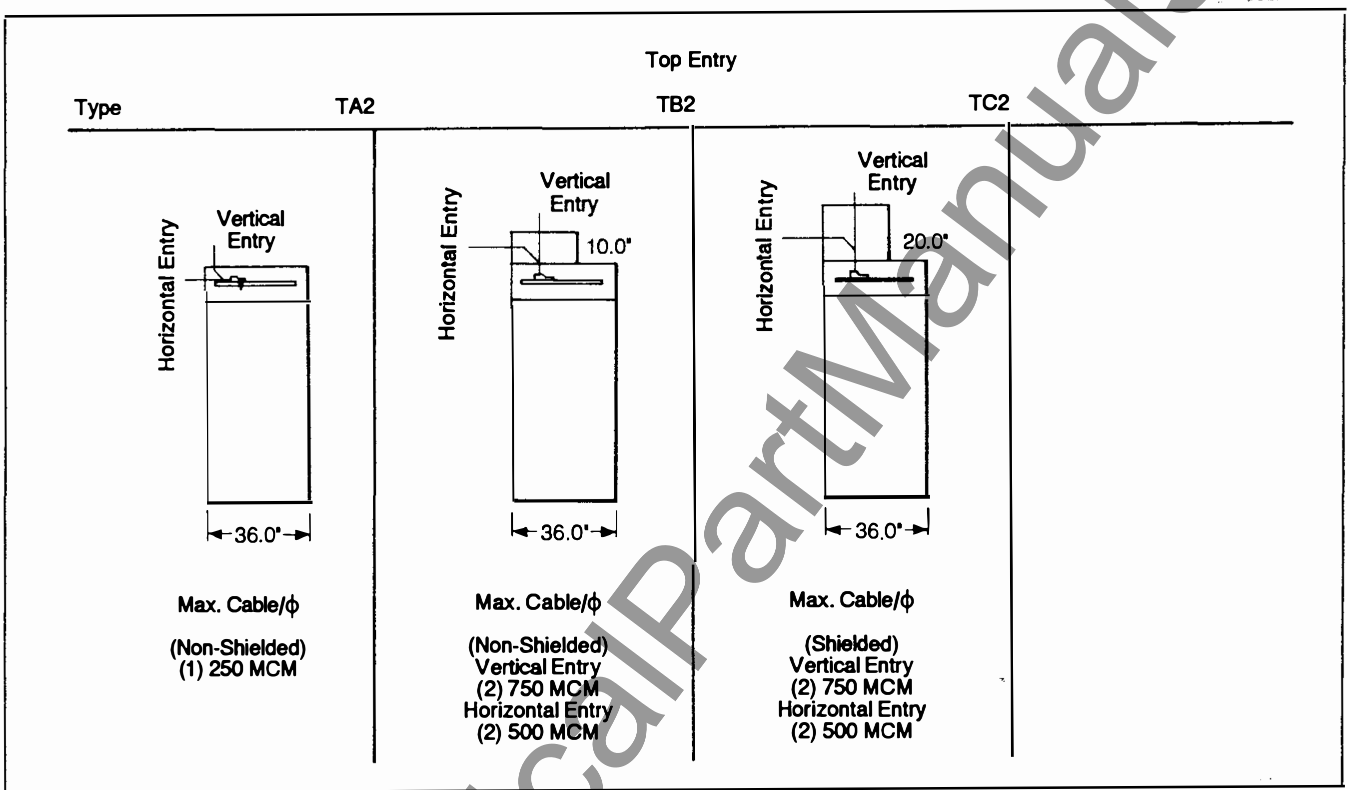

Figure 32. Incoming Line Arrangement with Bus Located on Top of the Cubicle—Top Entry

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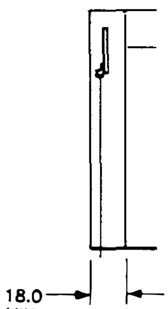
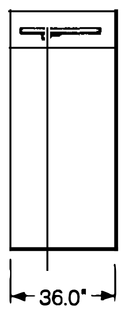
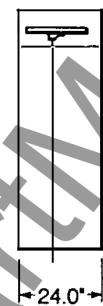
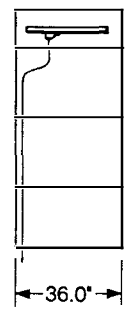
Bottom Entry

Type BA2	BB2	BC2	BD2
			
18.0 MIN.	36.0"	24.0"	36.0"
Max. Cable/ϕ (Non-Shielded) (3) 750 MCM (Shielded) (2) 750 MCM	Max. Cable/ϕ (Non-Shielded) (6) 500 MCM (4) 750 MCM (Shielded) (6) 500 MCM (4) 750 MCM	Max. Cable/ϕ (Non-Shielded) (4) 500 MCM (3) 750 MCM (Shielded) (4) 500 MCM (3) 750 MCM	Max. Cable/ϕ (Non-Shielded) (1) 500 MCM (Shielded) (1) 500 MCM

Bottom Entry

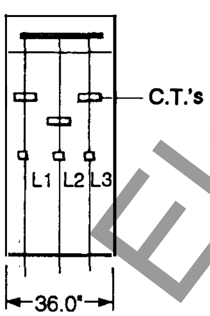
Type BE2			
			
36.0"			
Max. Cable/ϕ (Non-Shielded) (4) 500 MCM (3) 750 MCM (Shielded) (4) 500 MCM (3) 750 MCM			

Figure 33. Incoming Line Arrangement with Bus Located on Top of the Cubicle—Bottom Entry

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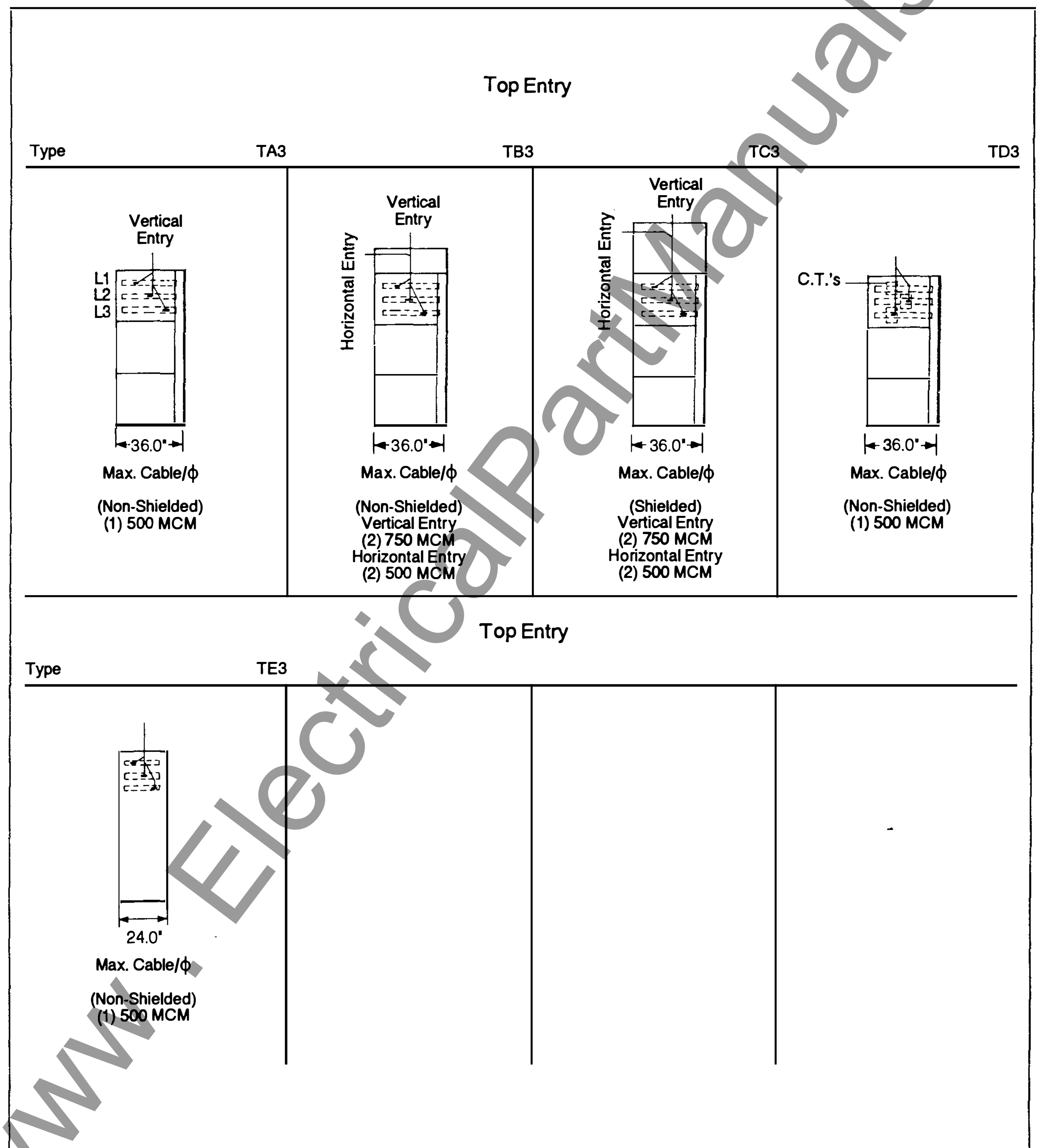

Figure 34. Incoming Line Arrangement with Bus Located on Rear of the Cubicle—Top Entry

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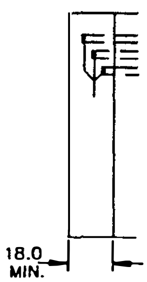
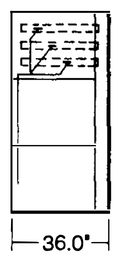
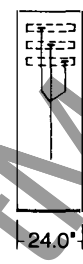
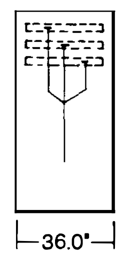
Bottom Entry

Type	BA3	BB3	BC3	BD3
				
	Max. Cable/ϕ **(Non-Shielded)** **(2) 500 MCM** **(Shielded)** **(2) 500 MCM**	**Max. Cable/ϕ** **(Non-Shielded)** **(1) 500 MCM**	**Max. Cable/ϕ** **(Non-Shielded)** **(4) 500 MCM** **(3) 750 MCM** **(Shielded)** **(4) 500 MCM** **(3) 750 MCM**	**Max. Cable/ϕ** **(Non-Shielded)** **(4) 500 MCM** **(3) 750 MCM** **(Shielded)** **(4) 500 MCM** **(3) 750 MCM**

Bottom Entry

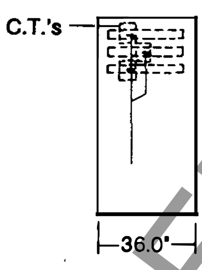
Type	BE3			
				
	Max. Cable/ϕ **(Non-Shielded** **(2) 500 MCM** **(1) 750 MCM** **(Shielded)** **(2) 500 MCM** **(1) 750 MCM**			

Figure 35. Incoming Line Arrangement with Bus Located on Rear of the Cubicle—Bottom Entry

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Power Cable Termination

A termination for an insulated power cable must provide certain basic electrical and mechanical functions. These essential requirements include the following:

1. Connect the insulated cable conductor to electric equipment, bus, or uninsulated conductor to provide a current path.
2. Physically protect and support the end of the cable conductor, insulation, shielding system, and overall jacket, sheath, or armor of the cable.
3. Effectively control electrical gradients to provide both an internal and external dielectric strength to meet desired insulation levels for the cable system.

Series 81000 Controllers

The following general recommendations are offered for proper cable termination in the Series 81000 controllers.

1. Position the cables for maximum clearance between phases, ground, and other cable wire runs.
2. Avoid any possible contact between low voltage wires and medium voltage cables.
3. Prepare cable terminations in accordance with the manufacturer's instructions.
4. If contact between the cable and adjacent bus can't be avoided, tape the bus to approximately 5/32 inches of thickness in the immediate vicinity of the cable contact point so that the surface creepage distance from the cable to the bare bus bar is at least three inches.

Termination of Lead-Covered Cable

Potheads are required to terminate lead-covered cables. A pothead is a hermetically sealed device used to enclose and protect cable ends. It consists of a metallic body with one or more porcelain insulators. Follow the pothead manufacturer's instructions to terminate the cable at the pothead. In general the body is arranged to accept a variety of optional cable entrance sealing fittings, while the porcelains, in turn, are designed to accommodate a number of optional cable conductor and aerial connections.

Termination of Shielded Cables

In order to reduce and control the longitudinal and radial electrical stresses at the termination of the cable end to values within safe working limits of the materials used to make up the terminations, the most common method is to gradually increase the total thickness of insulation at the termination by adding insulating tapes in the form of a cone. The cable shield is carried up the cone surface and terminated at a point near the largest diameter of the cone. This construction is commonly referred to as a stress cone and is illustrated in **Figure 36**. Leakage distance "A" for indoor dry location is recommended to be a minimum of 4 inches for working voltage up to 7200 volts.

NOTE
Consult individual cable supplier for recommended installation procedures and materials.

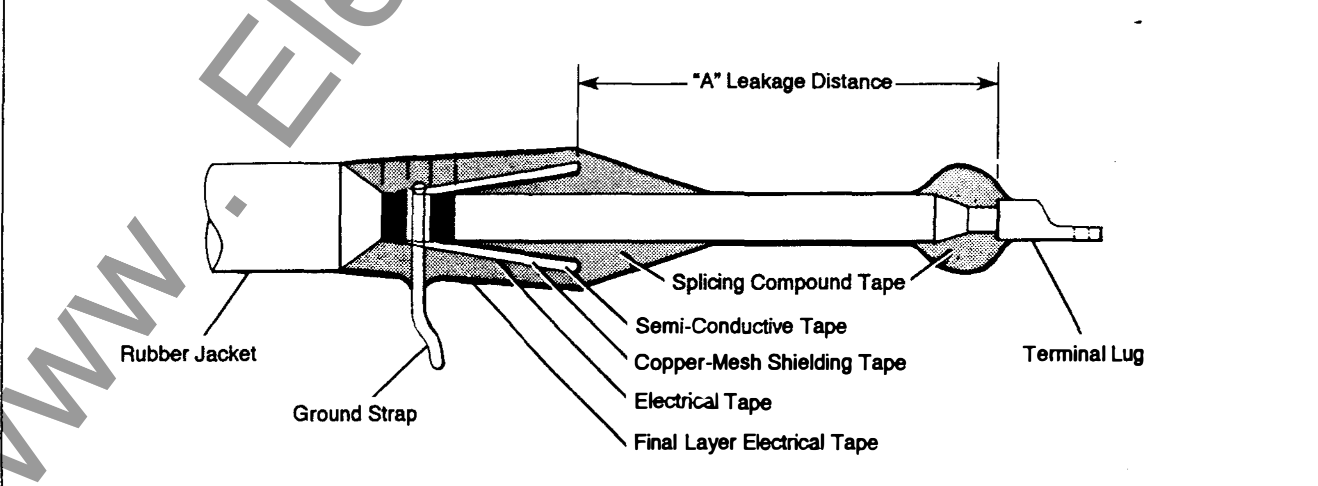

Figure 36. Typical Stress Cone

⚠WARNING

Failure to properly check out this equipment prior to energization can cause serious injury, burn or equipment damage.

Perform the following checks before energizing equipment.

Pre-Energization Check

After installation or maintenance, the following checklist should be followed:

1. Retighten all accessible connections in accordance with the torque values provided in **Table 6** of the Maintenance section of this manual.
2. Remove all blocks or other temporary holding means used for shipment from all component devices in the controller interior.
3. Check the integrity of the bus mounting means.
4. Check the enclosure to see that it has not been damaged in such a manner as to reduce electrical spacings.
5. Compare all circuits for agreement with the wiring diagrams which accompany the controller.
6. Make certain that external wiring is clear of bus, and all power wiring is physically secured to withstand the effects of the largest fault current which the supply system is capable of delivering.
7. Verify that all ground connections have been made properly. If sections of the controller were shipped separately, they must be connected in a manner to assure a continuous ground path.
8. Check all devices for damage. Make necessary repairs or replacement prior to energizing.
9. Be sure that each motor is connected to its intended starter. Ascertain that fuse rating is in agreement with the rating specified in the contactor catalog number.
10. Manually exercise all contactors, magnetic devices, and other operating mechanisms to make certain that they are properly aligned and operate freely.
11. With all loads disconnected exercise all electrically operated devices with test power to determine that the devices operate properly. Refer to the wiring diagrams for the required control voltage, frequency, and test power terminal designations required to test the contactor.
12. Test the ground fault protection system (if furnished) in accordance with the manufacturer's instructions.
13. Set the adjustable current and voltage trip mechanisms (if furnished) to proper values.
14. Insure that overload relay current range and setting is in agreement with the full load current and service factor shown on the nameplate of each motor, taking into account the current transformer ratio used in the controller.
15. Make sure that all fuses are completely inserted in the clips.
16. If applicable, remove CT short circuiting jumpers installed for shipment. If short circuiting type terminal blocks are provided, assure that short circuiting screws are removed. Check each current transformers' secondary circuit for continuity through its protective devices to ground. Do not operate a motor controller with a current transformers' secondary protective circuit open.
17. To prevent possible damage to equipment or injury to personnel, check to insure that all parts and barriers that may have been removed during wiring and installation have been properly reinstalled.
18. Before closing the enclosure, remove all metal clips, scrap wire, and other debris from the controller interior. If there is appreciable accumulation of dust or dirt, clean out the controller by using a brush, vacuum cleaner or clean, lint-free rags. DO NOT USE COMPRESSED AIR AS IT WILL ONLY REDISTRIBUTE CONTAMINANTS ON OTHER SURFACES.

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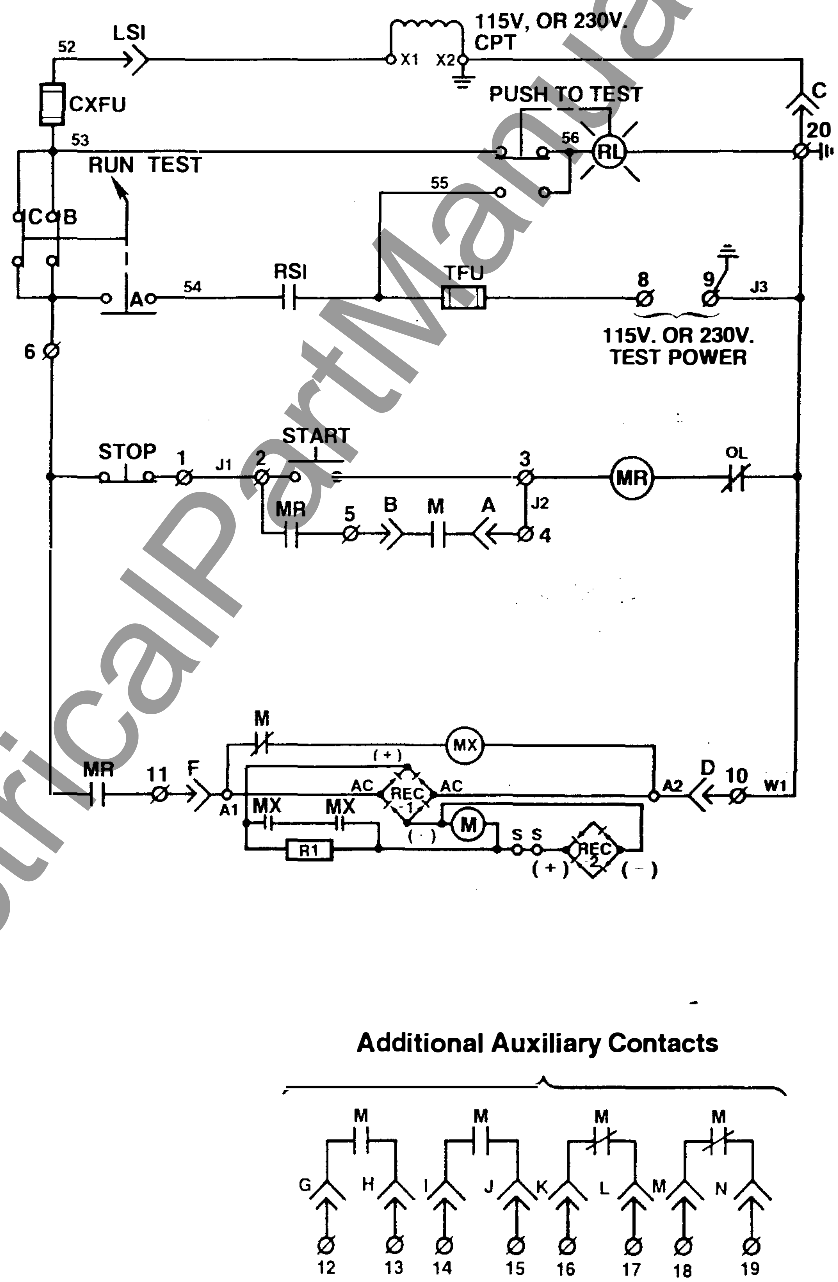
Test Switch Contact Development

	Run	Test
A		X
B	X	
C	X	

X = CONTACTS CLOSED



LEGEND

CPT .... Control Power Transf.
CXFU .. Fuse for CPT Sec.
LSI .... Line Switch Interlock
M ...... Main Contactor
MR .... Master Relay
MX .... Auxiliary Relay
REC ... Rectifier
RL ..... Contactor Engagement
.... Warning Light
R1 ..... Economy Resistor
RSI .... Racking Switch Interlock
TFU .... Fuse for Test Power

Figure 37. Typical Control Circuit Diagram Using Vacuum Contactor

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19. After all of the power and control connections are made and with all incoming power disconnected, conduct an electrical insulation resistance test on the power circuit to insure that the controller is free from short circuits and grounds.

WARNING

Accidental contact with dielectric test equipment can cause shock, burn, electrocution.

Dielectric testing should only be conducted by qualified personnel. Refer to test device instructions for safety instructions.

WARNING

Excessive dielectric test voltages can cause harmful x-radiation to be emitted from vacuum bottles.

Refer to vacuum contactor instruction manual for dielectric test procedures.

A dielectric hi-pot test at 2.25 times the nominal system voltage plus 2000 volts applied for one minute between phases and from all phases to ground is the preferred method. Be sure to disconnect any devices (control power transformer, etc.) from the circuit which could be damaged by the test voltage. If a hi-pot tester is not available, then a megger test at 1000 volts is a suitable second choice.

Since wide variations can occur in insulation values because of atmospheric conditions, contamination and type of test equipment, discrete values cannot be given. However, making and recording tests on new equipment, and again at regular intervals, will give a comparative indication of insulation change. Maintaining a permanent record of these values should be part of the maintenance program.

20. Install covers, close doors, and make certain that no wires are pinched and that all enclosure parts are properly aligned and tightened.

WARNING

Energizing the controller for the first time can be potentially dangerous.

Only qualified personnel should energize the equipment. If faults caused by damage or poor installation practices have not been detected in the checkout procedure described in this manual, serious damage and/or personal injury can result when the power is turned on.

Energizing Equipment

1. There should be no load on the controller when it is energized. Turn off all of the downstream loads, including those such as distribution equipment and other devices which are remote from the controller.
2. The equipment should be energized in sequence by starting at the source end of the system and working towards the load end. In other words, energize the incoming power to the controller or group of controllers, then close the incoming line load break switch if supplied, and then rack in the contactor.
3. After all disconnect devices have been closed, loads such as motors may be operated.

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> **⚠WARNING**
>
> **Accidental contact with energized wiring or bus system can cause electric shock, burn or electrocution.**
>
> Disconnect and lock-out incoming power and control voltage sources before beginning work on this or any other electrical equipment.
>
> Check all control circuit terminals with a voltmeter to make certain that the equipment is totally de-energized. Use only approved high voltage test equipment to check voltage on power terminals. Do not attempt to measure high voltage with a volt-ohm meter.
>
> It is recommended that a safety ground be connected to the power bus after the system has been de-energized, and prior to working on the equipment. Follow the procedure outlined in the pre-energization check section of this manual before power is restored. Only qualified personnel should perform maintenance.

General

For the safety of maintenance personnel as well as others who might be exposed to hazards associated with maintenance activities, the safety related work practices of NFPA 70E, part II, should always be followed when working on electrical equipment. Maintenance personnel should be trained in the safety practices, procedures and requirements that pertain to their respective job assignments.

The customer must establish a periodic program to ensure trouble-free and safe operation. The frequency of inspection, periodic cleaning and preventative maintenance schedule will depend upon the operation conditions. NFPA Publication 70B "Electrical Equipment Maintenance" may be used as a guide to establish such a program. A preventative maintenance program is not intended to cover reconditioning or major repair, but should be designed to reveal, if possible, the need for such actions in time to prevent malfunctions during operation. Specific checklist of routine preventative maintenance is recommended, as well as a log book to record the maintenance history. The following items should be included in any maintenance checklist. For more details read the succeeding pages.

- Mechanical and electrical operation of the controller
- Type 90H35 and 90H37 contactors
- Shutter mechanism and associated parts
- Racking mechanism
- Mechanical interlocks
- Electrical interlocks
- Electrical joints and terminals
- Cleaning
- Tightening torques

Mechanical and Electrical Operation of the Controller

1. Carefully inspect the doors, enclosure sides and dead front surfaces over all units for excessive heat. As a general rule, temperature which the palm of the hand cannot stand for about 3 seconds may indicate trouble. Infra-red heat detectors are available for this purpose of detecting heat problems.
2. Inspect the controller a minimum of once each year, or more often as deemed necessary. Look for any moisture or signs of previous wetness or dripping inside the controller. Condensation in conduits or dripping from an outside source is a common cause of failure.
   a. Seal off any conduits that have dripped condensate, and provide an alternative means for the conduit to drain.
   b. Seal off any cracks or openings which have allowed moisture to enter the enclosure. Eliminate the source of any dripping on the enclosure and any other source of moisture.
   c. Replace and thoroughly dry and clean any insulating material which is damp or wet or shows any accumulation of deposited material from previous wettings. Conduct an electrical insulation resistance test as detailed in Item 19 of "Pre-Energization Check" in the Operation section of this manual, to verify the dielectric integrity of the affected insulation.
3. Check all devices for missing or broken parts, proper spring tension, free movement, rusting or corrosion, dirt and excessive wear.

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4. Examine all readily accessible insulating parts for cracks or breakage and for arc splatter, sooty deposits, oil or arc. Clean off arc splatter, oil and sooty deposits, replace if any signs of burning, charring or carbon tracking are found. Make sure that the dielectric integrity of the affected parts is maintained.
5. Measure resistance across each contactor pole from the line to the load terminal as indicated in **Figure 38**. If the resistance exceeds the values indicated in **Table 5**, loosen connections and perform the following procedure:
   a. Examine all joints for plating wear, replace if necessary.
   b. Clean all surfaces. Replace parts if oxide films are formed.
   c. Examine spring pressure by comparing it to other similar springs, replace if necessary.
   d. Retighten all connections in accordance with the recommended torque values, **Table 6.**
   e. Be sure that the conditions that caused the high resistance values, have been corrected before resuming service.

Table 5. Maximum resistance across line-to-load terminals of each pole of the Series 81000 contactors.

Contactor Type	Fuse "R" Rating	Maximum Resistance (Main Contacts Closed) Milliohms at 20°C
90H35	None	1.0
	2R	10.0
	3R	7.0
	4R	5.5
	6R	4.0
	9R	3.0
	12R	2.5
	18R	2.2
	24R	1.9
90H37	None	1.0
	3R	10.3
	4R	8.2
	6R	5.6
	9R	3.6
	12R	3.3
	18R	2.3

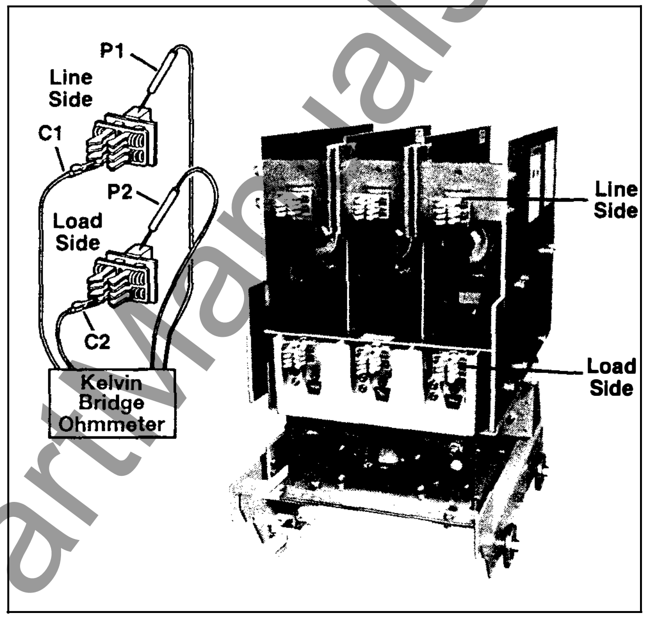

Figure 38. Connection to Measure Contactor's Pole Resistance

Type 90H35 and 90H37 Vacuum Contactors

Complete maintenance instructions for medium voltage contactors are presented in MVC-9028. Refer to those instruction manuals for all problems of maintenance and to CC-5002 for renewal parts.

Shutter Mechanism

⚠WARNING

Energized parts located behind shutter mechanism can cause shock, burn or electrocution.

Disconnect and lock-out incoming power before inspecting or adjusting the shutter mechanism and associated parts.

It is necessary to visually inspect the shutter mechanism components every time the contactor is removed from the cell module. Periodic checks are strongly recommended. Replace broken parts and adjust linkage to provide a bind-free motion.

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Racking Mechanism Adjustment

The racking mechanism for the Series 81000 controllers is designed for smooth and easy operation. The mechanism is factory adjusted and with normal use, no maintenance is required, except for a light coat of grease at the moving joints. When properly adjusted, the racking mechanism will provide the correct amount of line and load power stab finger engagement and LSI engagement shown in **Figure 39**. In order to check for proper engagement of the contactor in the cell, the following procedure is recommended:

1. Disconnect all incoming power.
2. Connect an ohmmeter or buzzer between any one stationary stab terminal and its mating disconnect finger assembly on the contactor.
3. Connect a second ohmmeter or buzzer between the LSI stationary terminal and the LSI finger assembly on the contactor.

⚠WARNING

Hazardous voltage may be developed across the control transformer primary winding.

Disconnect the wire from the LSI finger assembly to the control transformer "X1" terminal before applying any voltage to the LSI. Reconnect the wire after testing is completed.

4. Rack the contact in by moving the handle to the "ON" position. Continuity should be indicated on the power stab and the LSI.
5. Slowly rack the contactor out by moving the handle toward the "OFF" position until the LSI opens as indicated by the ohmmeter. The handle position should be as indicated in **Figures 40**. Continue moving the handle toward "OFF" and observe the point at which the power disconnect finger assembly disengages from the stab terminal. This should occur in 15°-/+5° handle travel past the point at which the LSI opens.
6. If the LSI does not open at the specified handle position, the LSI stationary terminal may be adjusted by loosening the mounting screws and sliding forward or back on the guide plate as necessary. Do not change the location of the LSI finger assembly on the contactor.

	Dim "A"	Dim "B"
Upper or Middle Cell	.07	.57
Lower Cell	.21	.43

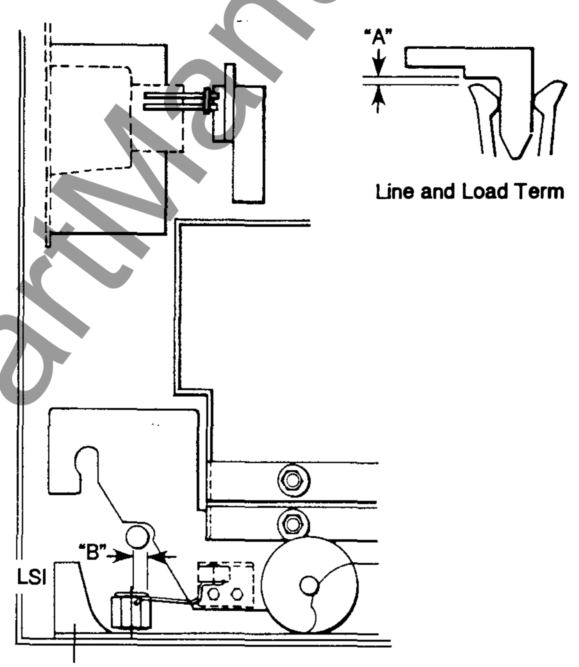

Figure 39. Check for Proper Stab Finger and LSI Connection

If the proper amount of engagement of the power stab fingers and/or the LSI cannot be obtained, perform the following adjustment procedure:

1. Disconnect all incoming power to the controller, open the medium voltage compartment door, rack-out and remove the contactor from the compartment.
2. Loosen the lock nuts on each end of the long connecting rod and adjust the length of the rod by rotating it until the dimension shown in **Figure 41** is obtained. Retighten the lock nuts.
3. Defeat the door interlock lever by pushing it up with a screwdriver and move the handle to the "ON" position. Be sure the driver link pin engages the notch in the detent lever.

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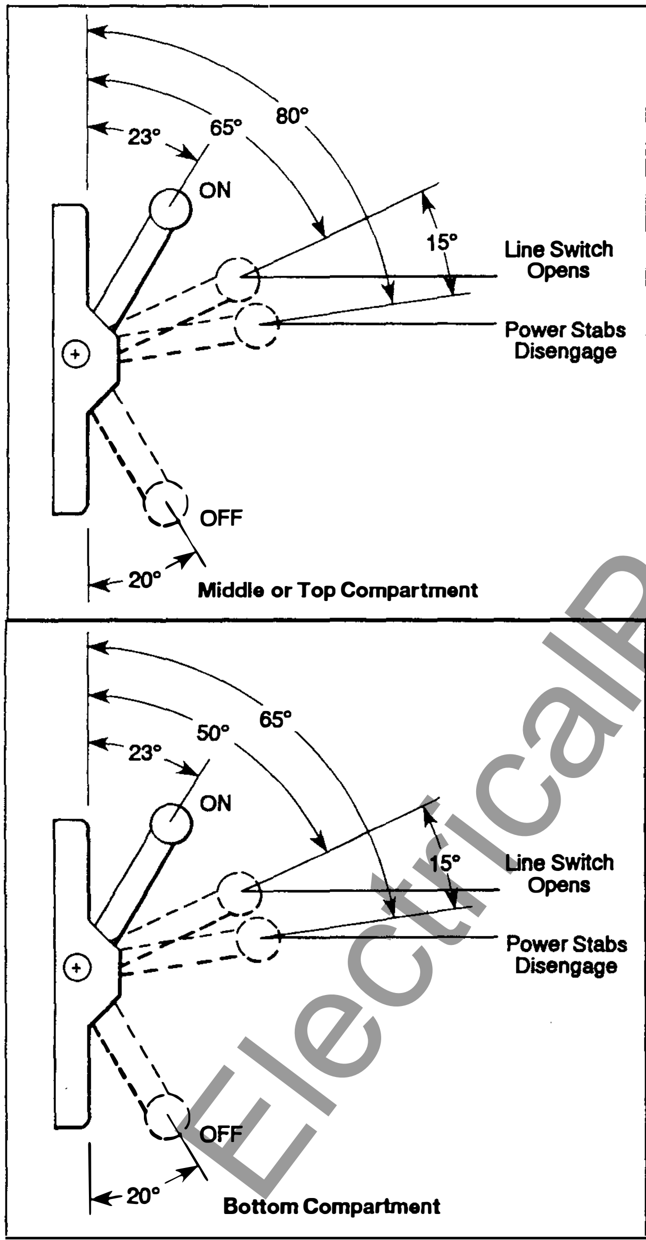

Figure 40. Racking Mechanism Adjustment

4. Manually rotate the contactor interlock lever so that the tab on the end of the lever engages the notch in the cam. Loosen the lock nuts on each end of the short connecting rod and adjust the length of the rod by rotating it until the dimension between the tab and the cam notch shown in **Figure 42** is obtained. Retighten the lock nuts.

NOTE

Cells located in bottom compartments are deeper than cells in middle or upper compartments. The racking mechanism linkages for bottom cells are slightly different and must be adjusted differently from those of shorter cells which are located in middle or upper compartments. Depending on cell location, determine the proper dimension between the tab and cam notch from **Figure 42** and adjust the mechanism accordingly.

Mechanical Interlocks

WARNING

Interlocks are designed to help prevent possible equipment damage or personal injury resulting from accidental or intentional misuse of equipment.

Do not attempt to use excessive force or leverage to defeat the mechanical interlocking system and gain access to the high voltage unit. Never attempt to operate this equipment unless all interlocks are installed and operating properly.

All mechanical interlocks are factory adjusted, for smooth and positive operation. With normal use, no maintenance should be required, except for: a) a light coat of grease on the moving parts and pivots and b) adjustment to allow the interlocking levers and latches to pivot freely.

Electrical Interlocks

Line Switch Interlock (LSI)—See Racking Mechanism Adjustment

Racking Switch Interlock (RSI)—Refer to **Figure 6**. Inspect for mechanical and electrical integrity of the switch. To adjust, loosen the two screws connecting the mounting bracket to the guide plate, and locate the roller of the micro-switch under the cam assembly of the rear shaft.

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Electrical Joints and Terminals

Carefully inspect all visible accessible electrical joints and terminals in the bus and wiring system.

1. Retighten bolts and nuts at bus joints if there is any sign of overheating or looseness. Refer to "Recommended Torque Values", **Table 6**.
2. If joints or terminations appear to be badly discolored, corroded or pitted, or show evidence of having been subjected to high temperatures, the parts should be disassembled and cleaned or replaced.
3. Examine all wire or cable connections for evidence of looseness or overheating. Retighten, if necessary. If major discoloration of cable insulation or if cable damage is apparent, replace the damaged portion of the cable.
4. Closely examine fuse clips. If there is any sign of overheating or looseness, check the spring pressure, tightness of clamps, etc. Replace the fuse clips if the spring pressure compares unfavorably with that of other similar fuse clips in the controller. Make sure that fuses are completely inserted.
5. Examine all joints for plating wear, replace if the plating is worn out. Special attention should be paid to the stab fingers under such adverse environmental conditions where sulfur dioxide, chlorine, some hydrocarbons and saltwater exist in the atmosphere. Replace if evidence of copper oxide or other films are formed. Use Siemens contact finger lubricant number 15-171-370-001 to protect the stab finger joint from deterioration. Worn plating on the stabs can result in overheating and may lead to flashover. Plating wear through can be expected after approximately 1500 racking operations.
6. Examine insulation on conductor for overheating or chafing against metal edges that could progress into an insulation failure. Replace any damaged conductors, ensure replacement conductors are braced or shielded if needed to avoid similar damage in future operation.
7. Be sure that any conditions that caused overheating have been corrected.

Recommended Torque

When making bolted assemblies, the following considerations should be generally followed. The recommended torque is determined by the size of hardware used. Refer to **Table 6**.

1. Metal-to-Metal—Apply standard torque.
2. Metal-to-Insert Molded in Compound Part—Apply approximately 2/3 of standard torque.
3. Compound-to-Insert Molded in Compound Part—Apply approximately 1/2 of standard torque.
4. Compound-to-Compound—Apply approximately 1/2 of standard torque.

Periodic Cleaning

Accumulation of dust and foreign material such as coal dust, cement dust, or lamp black must be removed from the controller and all surfaces must be wiped clean at regular intervals. Dust can collect moisture, causing voltage breakdown. Do not use compressed air as it will only redistribute contaminants on other surfaces.

Table 6. Recommended Torque Values

Thread Size	Standard Torque Metal-to-Metal (in.-lbs.)	2/3 Standard Torque Metal-to-Insert (in.-lbs.)	1/2 Standard Torque Compound-to-Insert (in.-lbs.)	1/2 Standard Torque Compound-to-Compound (in.-lbs.)
8-32	14-20	10-14	7-10	7-10
10-32	20-30	13-20	10-15	10-15
1/4-20	40-60	26-40	20-30	20-30
5/16-18	168-228	110-150	84-114	84-114
3/8-16	240-360	160-240	120-180	120-180
1/2-13	480-600	320-400	240-300	240-300

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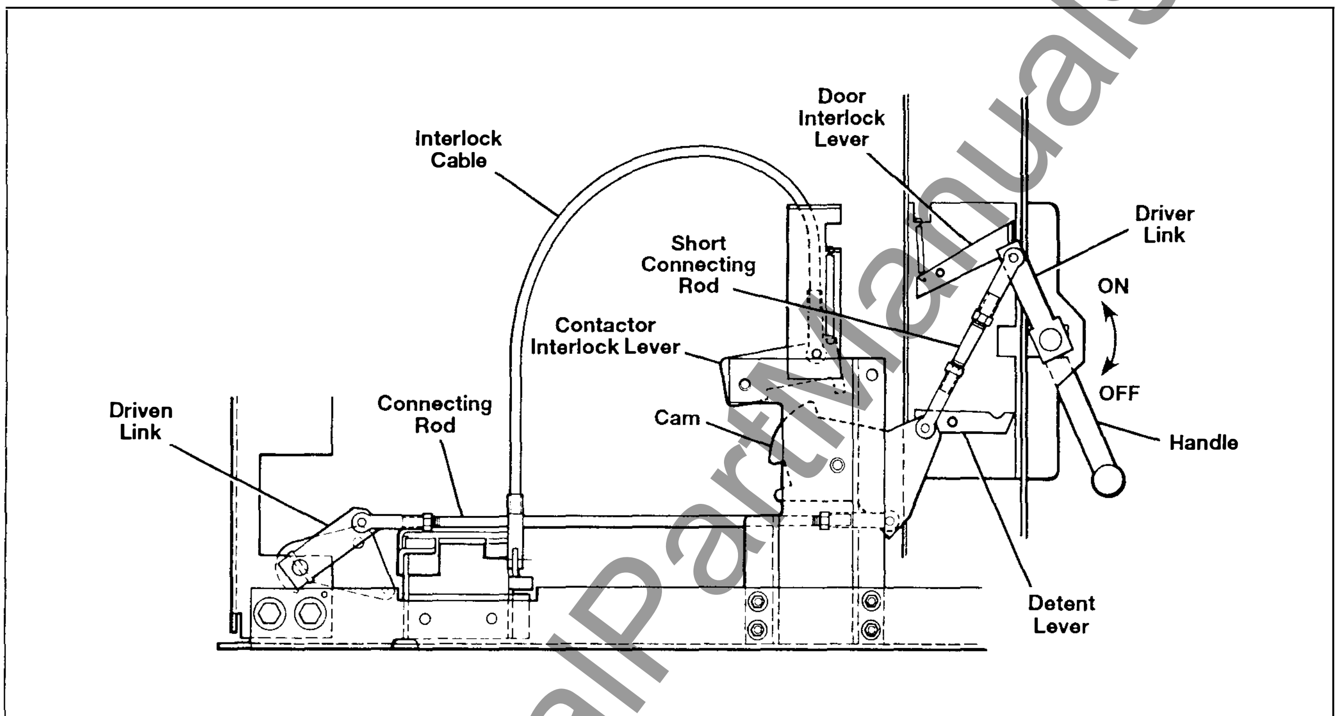

Figure 41. Racking Mechanism Adjustment—"OFF" Position

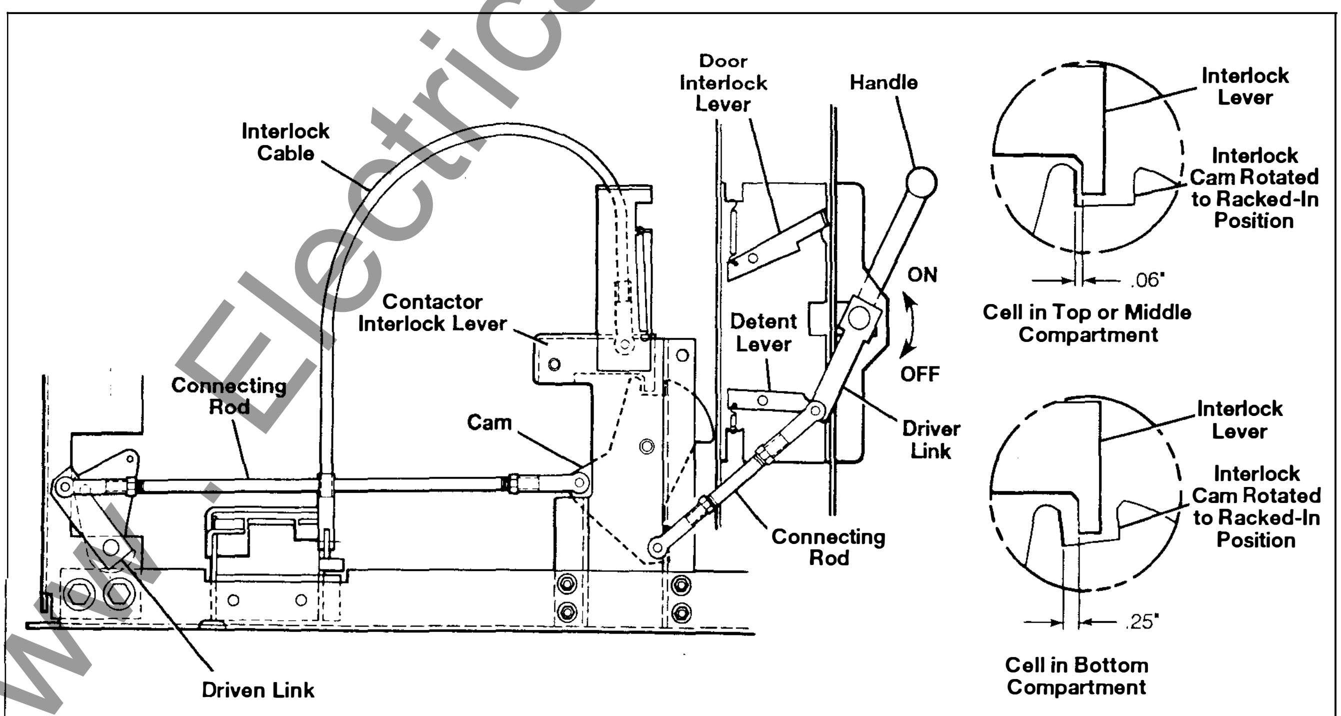

Figure 42. Racking Mechanism Adjustment—"ON" Position

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⚠WARNING

Accidental contact with energized wiring or bus system can cause electric shock, burn or electrocution.

Disconnect and lock-out incoming power and control voltage sources before beginning work on this or any other electrical equipment.

Only qualified personnel should be involved in the inspection and repair procedure and all plant safety procedures must be observed.

Check all control circuit terminals with a voltmeter to make certain that the equipment is totally de-energized. Use only approved high voltage test equipment to check voltage on power terminals. Do not attempt to measure high voltage with a volt-ohm meter.

It is recommended that a safety ground be connected to the power bus after the system has been de-energized, and prior to working on the equipment.

Follow the procedure outlined in the "Pre-Energization Check" section of this manual before power is restored.

General

The excessive currents occurring during a fault may result in structure, component and/or conductor damage due to mechanical distortion, thermal damage, metal deposits or smoke. After a fault, repair the cause of the fault, inspect all equipment per NEMA Standards Publication No. ICS 2-302 and make any necessary repairs or replacement prior to placing the equipment into service again. Be sure that all replacements (if any) are of the proper rating and are suitable for the application. If in doubt consult your field sales representative.

Inspection

The following areas should be inspected after a fault has occurred.

Enclosures

External evidence of enclosure deformation usually is indicative of damage within. Extensive damage will require replacement of the enclosure parts and the enclosed equipment. Insure that door mounted equipment and safety interlocks function properly. Verify that hinge and latch integrity is maintained.

Terminals and Internal Conductors

Replace all damaged parts which show evidence of discoloration, melting or arcing damage. Special attention should be paid to the stab fingers.

Contactor

Refer to factory publication, MVC-9028 Instructions for the Installation, Operation, and Maintenance of Medium Voltage Vacuum Contactors, Type 90H35 and 90H37.

Overload Relays

The complete overload relay must be replaced if burnout of the heater element has occurred. Any indication of an arc striking or burning the overload relay also requires replacement.

If there is no visual indication of damage that would require replacement, contact operation must be verified by electrically or mechanically tripping and resetting the overload relay.

Fuse Holders

Replace fuse holders if the insulation mounts, barriers, or fuse clips show signs of damage, deterioration, heating, distortion or looseness.

Fuses

Always replace all three fuses in a three phase circuit even though only one or two are open circuited since internal damage suffered by fuses not replaced could result in nuisance shut-down later.

Perform the "Pre-Energization Check" procedures detailed in this manual before restoring the equipment to service.

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General

In the event that operating problems are encountered, use the following troubleshooting chart to isolate the cause of the problem and find the remedy. If the corrective action given in the chart fails to correct the difficulty, consult your field sales representative.

The following information is required if it is necessary to write Siemens relative to the equipment problem.

1. Manufacturer's order number and part number, if that information is available.
2. Nameplate data on contactor or controller.
3. Duty cycle and any details of operation.
4. Length of time in service and approximate total number of operations.
5. Voltage, current and frequency.
6. Description of any problem.
7. Any other pertinent information, such as drawing, layout and schematic number.

Table 7. Troubleshooting Chart

PROBLEM	CAUSES	REMEDY
Doors will not close or are out of alignment	Enclosure is not bolted down tightly on prefectly level surface.	Using level, add shims as necessary, and tighten anchoring bolts.
	Enclosure sprung out of shape.	Straighten or repair cubicle.
	Door hinges not properly adjusted.	Remove door hinges. Add or substract shims as necessary.
Binding of racking or shutter mechanism or mechanical interlocks	Warpage or breakage of shutter mechanism or housing components.	Replace shutter mechanism or housing component as required to insure smooth operation.
	Mechanism components are binding.	See maintenance section on adjusting racking, shutter and interlock mechanism.
	Rough handling during transportation or installation.	Adjust mechanism and replace broken parts.
Contactor will not close	Control circuit or main fuse blown.	Inspect fuses, replace if blown.
	Incoming power line not energized.	Close feeder circuit breakers or tie switch.
	Line switch interlock (LSI) is not adjusted properly.	Adjust per instructions in the maintenance section.
	Main contactor coil	Check magnet operation, replace coil as necessary.
	Master Relay (MR) defective.	Check and replace if defective.
	Control power transformer defective.	Check and replace if necessary.
	Overload relay tripped or defective.	Check and replace if necesaary.

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Table 7. Troubleshooting Chart (continued)

PROBLEM	CAUSE	REMEDY
Contactor will not close (con't)	Defective rectifier.	Check rectifier and replace if necessary.
	Selector switch (RUN-TEST) is not in proper position.	Switch should be in the "RUN" position.
	Missing jumpers, loose connections, remote connections, etc.	Check wiring diagram carefully to make sure that all external or alternate connections have been made satisfactorily. This is especially true where remote protective or control devices are used.
Contactor chatter	Loose connection in control circuit.	Tighten connections in control circuit.
	Defective master relay.	Check relay, replace if necessary.
	Defective coil or rectifier	Check main coil and rectifier, replace if necessary.
	High Altitude	Check altitude setting page 7 book MVC9028
	Low control voltage.	Check line voltage.
Burnout of rectifier	Burnout of operating main coil.	Replace main coil and check circuit for shorted terminals, etc.
Overload relays trip during starting or soon after motor is up to speed	Motor overloaded.	Limit starting load and running load to motor capabilities.
	Motor being started too frequently at close intervals.	Jogging and starting operations must be limited to capabilities of the motor. Check starting limitations in motor instruction manual before repeated starts.
	Excessive motor acceleration time.	The starting of high inertia loads may not permit the use of standard overload relay applications. For accelerating times of 10 seconds or more, special overload relay by-pass devices and circuits would usually be required. Contact the factory regarding such problems and supply complete data on locked-rotor starting current and total accelerating time under maximum load conditions.
	Low line voltage.	Line voltage should be maintained between +\- 10% of motor nameplate voltage.

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Table 7. Troubleshooting Chart (continued)

PROBLEM	CAUSE	REMEDY
Overload relays trip during motor operation (con't)	Overload relay not adjusted to motor capabilities.	Adjust relay setting in accordance with instructions for the overload relay. Adjustment should correspond to thermal rating of the motor, including temperature rise, duty and service factor.
	Incorrect relay or relay set incorrectly.	Contact factory.
	Relays set incorrectly.	Set in accordance with relay instructions.
Overload relays fail to trip on overload current	Relay tripping mechanism jammed.	Replace relay.
	Incorrect relay or relay set incorrectly.	Check relay selection and adjustment per overload relay instructions.
	Current transformers with improper ratio or with short-circuited secondary terminals.	Current transformers must have a step-down ratio to correspond to full load motor current and relay selection. Protective jumpers may be provided at current transformer secondary terminals or on terminal block connections to guard against open transformer secondary circuit, and jumpers must be removed before placing equipment in operation.
Blowing of motor power fuses	Short circuit ont he load side of the motor fuses.	Use megger and other test instruments to locate fault and correct.
	Jogging or too frequent starting.	On frequent starting, fuses accumulate abnormal heat and cool more slowly than do overload relays. Since fuses more closely follow cooling and heating of motor windings, successive starting operations must be limited to the safe capacity of the motor to prevent fuse blowing from this cause. Check size rating on fuse nameplate against data label in medium voltage compartment. All three fuses must agree.

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Table 7. Troubleshooting Chart (continued)

PROBLEM	CAUSE	REMEDY
Blowing of motor power fuses (cont')		Fuses are selected on the basis of motor full load current, locked-rotor current and starting time. Approximate sizes can be determined by referring to **Table 2**, in the General Description section of this manual.
	Fuses internally damaged because of improper handling.	Motor power fused are made up of multiple strands of line silver ribbon which may be broken if fuses are dropped or roughly handled. Several individual strands can be broken without the trip target indicating a blown fuse. Handle fuses carefully, installing them in clips on the top of the vacuum contactor with the indicator toward the front.
Blowing of primary control transformer fuses	Shorted primary winding in control transformer.	Replace or repair transformer.
	Fuse may be "open" due to rough handling before installing.	Replace fuse.
	Secondary fuses not properly coordinated.	Melting characteristics of secondary fuse should not intersect melting characteristic of primary fuse. Rating of standard NEC fuse should not exceed twice the secondary current rating.
Blowing of secondary control transformer fuses	Abnormal current or short circuit in control.	Check for faulty operation of economizing relay, shorted magnet coils, shorted rectifiers, grounds, loose or bent connections, mechanical binding in relay and contactor mechanisms, excessive operations and incorrect secondary terminal connections.

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General

Any of the following instruction literature can be ordered by writing:

Siemens Energy & Automation, Inc.
Electrical Apparatus Division
P.O. Box 29503
Raleigh, NC 27626
ATTN: Contract Administration

Instructions for Installation, Operation and Maintenance 5kV Medium Voltage Vacuum Contactors Type 90H3—MVC-9028

Instructions for Installation, Operation and Maintenance-Medium Voltage Contactors Type 90H35 and 90H37 MVC9028.

Description, Current Limiting Fuses, Type FM 2.4 & 4.8 kV for Motor Starting Application — CC3281.

Instruction Sheet and Trip Curve—Type 3UA Thermal Overload Relays — CC3274 & CC3275.

Renewal Parts Book —CC5002.

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