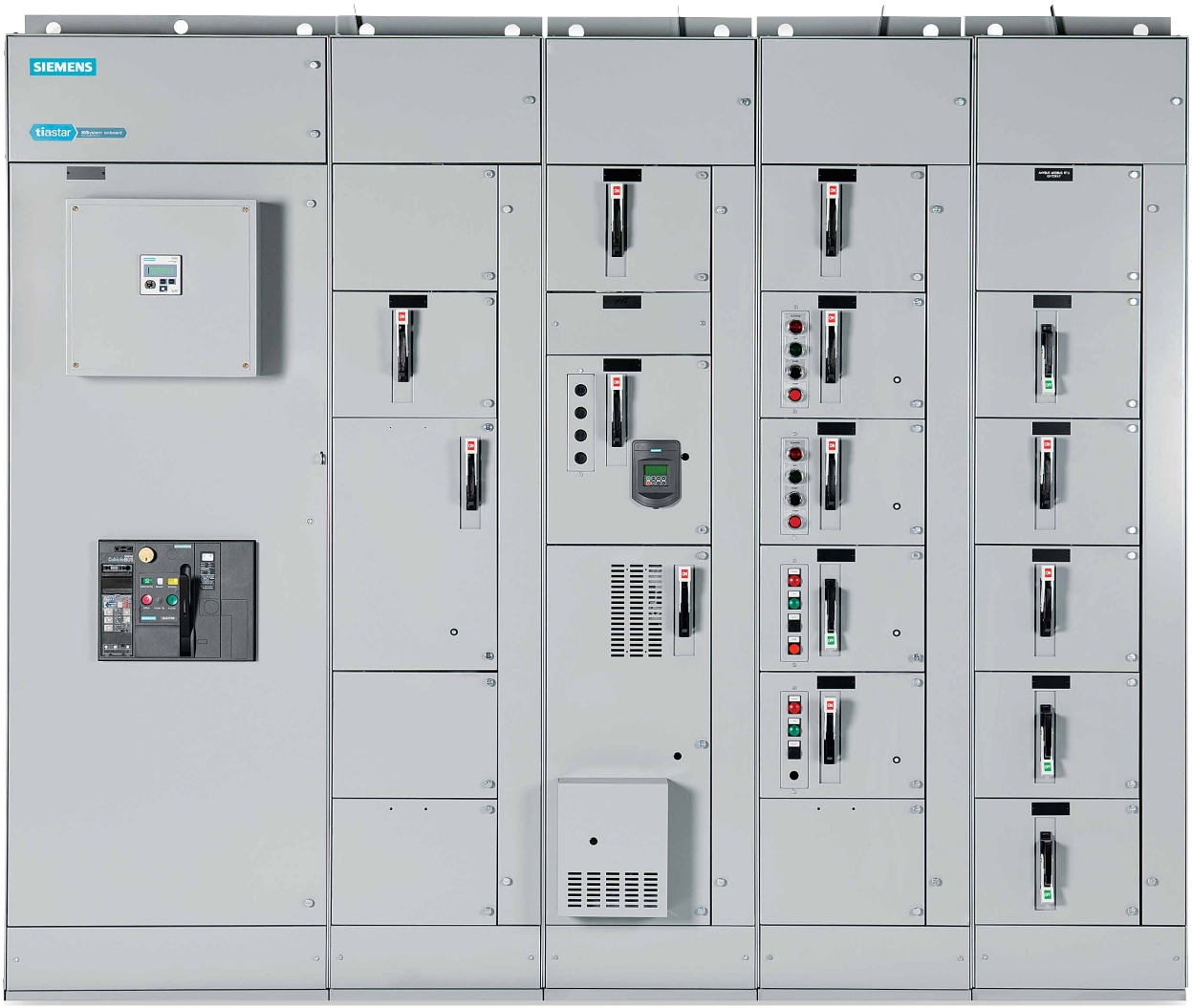
SIEMENS

INSTRUCTION MANUAL

tiastar™

Motor Control Centers
usa.siemens.com/mcc



⚠ DANGER

Hazardous voltage.
Will cause death or serious injury.
Always de-energize and ground the equipment before maintenance. Read and understand this manual before installing, operating or maintaining the equipment. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel may result in dangerous conditions which may cause death or serious injury, or equipment or property damage. Follow all safety instructions contained herein.

This equipment contains hazardous voltages. Death, serious personal injury, or property damage can result if safety instructions are not followed. Only qualified personnel should work on or around this equipment after becoming thoroughly familiar with all warnings, safety notices, and maintenance procedures contained herein.

The successful and safe operation of this equipment is dependent upon proper handling, installation, operation and maintenance.

Signal words

The signal words "**DANGER**", "**WARNING**" and "**CAUTION**" used in this manual indicate the degree of hazard that may be encountered by the user. These words are defined as:

⚠ DANGER

For the purpose of this manual and product labels, **DANGER** indicates an imminently hazardous situation which, if not avoided will result in death or serious injury.

⚠ WARNING

For the purpose of this manual and product labels, **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

For the purpose of this manual and product labels, **CAUTION** indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Qualified person

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

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

(b) is trained 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.

(c) is trained in rendering first aid.

Table of contents

Important

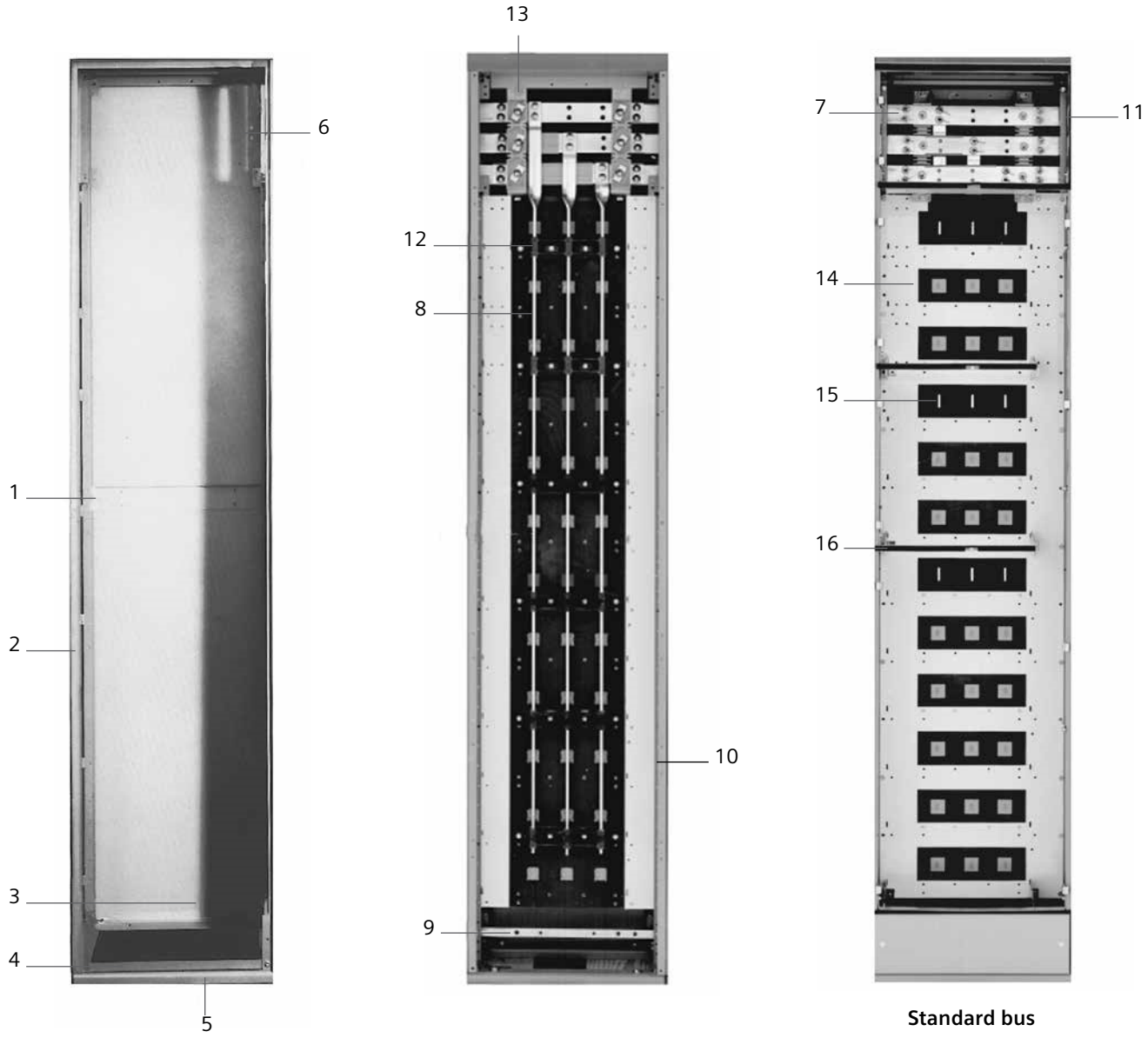
These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens sales office. The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens. Any statements contained herein do not create new warranties or modify the existing warranty.

Arc Resistant Equipment Special Considerations:

For Arc Resistant Equipment, see also the supplemental Instruction and Installation Guide for Type 2A Arc Resistant Motor Control Center E87010-A0098-T004-A5-MCC.

General information

1.1 Parts illustrations

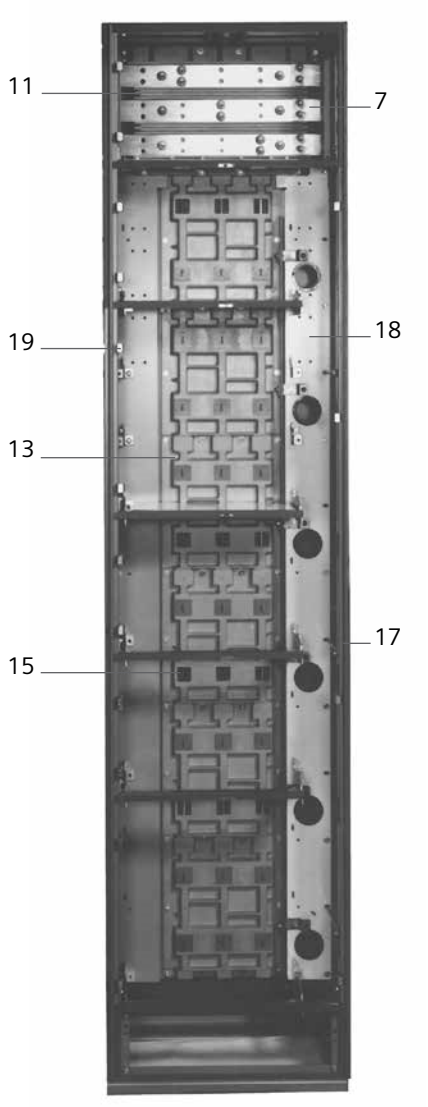


Standard bus

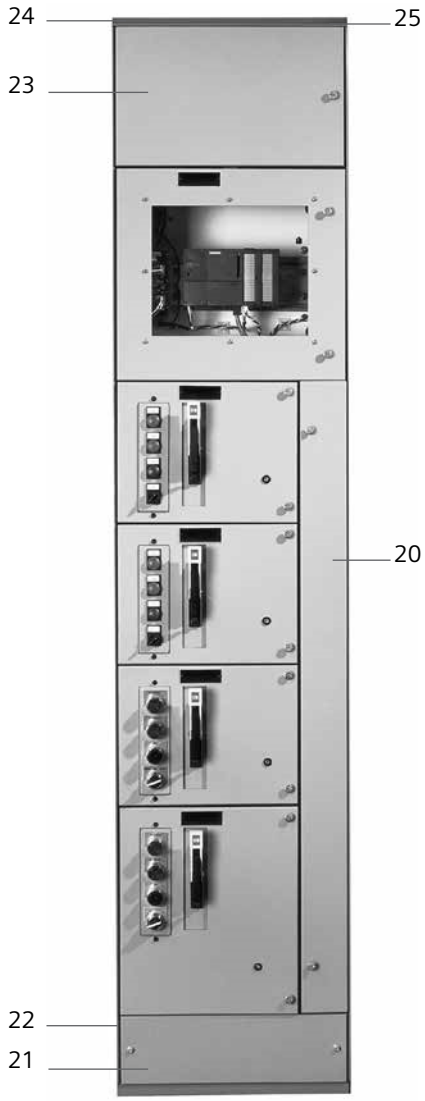
Key to section construction features

1. Rear brace
2. Side sheet assembly (on outer of motor control centers)
3. Bottom wireway
4 Front bottom base channel
5. Channel sills
6. Top wireway
7. Horizontal bus
8. Vertical bus, 300 A, 600 A, and 800 A
9. Horizontal ground bus
10. Divider side sheet assembly (between adjoining sections)
11. Horizontal bus support
12. Standard vertical bus brace
13. Horizontal bus support (rear view)
14. Standard vertical bus barrier
15. Unit stab holes
16. Unit support assembly

1.1 Parts illustrations (continued)



Optional insulated vertical bus



Key to section construction features (continued)

17. Wiretie support
18. Vertical wireway
19. Removable door hinge
20. Vertical wireway door
21. Bottom horizontal wireway (6") and formed cover plate
22. Bottom end cover plate
23. Top horizontal wireway and floor (wireway 12" high)
24. Top plates
25. Lifting angle

Receiving and handling

2.1 Receiving

Upon receipt of the motor control center, an immediate inspection should be made for any damage which may have occurred during shipment. The inspection should begin with the packaging material and proceed to the equipment within. Be sure to look for concealed damage and do not discard the packing 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.

The Siemens sales office should be notified immediately if damage or loss is discovered. A description of the damage and as much identification information as possible should be given.

⚠ WARNING

Heavy equipment.
Can cause death or serious personal injury.
Exercise extreme care when handling the motor control center. Handle upright only. Do not tilt. A crane or hoist should be used if at all possible. Exercise all safety pre-cautions outlined in the following discussion.

2.2 Handling

The motor control centers are shipped in groups of one to four vertical frames which are mounted on wooden shipping skids.

For lifting the shipping group from the bottom, the fork lift or pallet jack must be inserted in either end under the pallet and not the front or rear, as shown in Figure 4. A narrow fork pallet jack (23" width or less) is recommended.

The lifting angles for each shipping group is attached to the associated wooden shipping skid. For lifting the shipping groups with a crane, as shown in Figure 1, the lifting angle must be removed from the skid and mounted to the top of associated shipping group. A 3/4" wrench/socket can be used to secure the lifting angle using the 1/2" bolts provided on top of the assembly.

Note: Refer to section 5.5.1 for the recommended tightening torque requirements.

1. Handle the motor control center with care to avoid damage to components and to the frame or its finish.
2. Handle the motor control center in an upright position only. Motor control centers are normally front heavy and frequently top heavy. Balance the load carefully and steady the motor control center, as necessary, while moving. Some motor control center interiors may contain heavy equipment, such as transformers mounted within, that could be adversely affected by tilting.
3. Know the capabilities of the moving means available to handle the weight of the motor control center. Adequate handling facilities should be available. The following table gives the approximate weights of single vertical frames and will be helpful in determining the required capacity of the handling means. If a vertical frame contains power factor correction capacitors, reactors, or a large transformer, sufficient additional weight handling capacity must be allowed.

NEMA 1, Gasketed, and 12 structures only

Frame	Weight
20" (508 mm) W x 15" (381 mm) D front only	550 lb.
20" (508 mm W x 20" (508 mm) D front only	600 lb.
30" (762 mm) W x 15" (381 mm) D front only	600 lb.
30" (762 mm) W x 20" (508 mm) D front only	650 lb.

4. It is recommended that a crane or hoist be used to handle the MCC if at all possible. If a crane or hoist is not available and other handling means are necessary, extreme care must be exercised to ensure that the equipment is secured during the movement and placement operations to prevent tipping and falling. Jacks, prybars, dollies, roller lifts, and similar devices all require supplementary blocking beneath the MCC and restraints to prevent tipping. These devices are not recommended due to the hazards implicit in their use.

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The following precautions should be taken when moving an MCC with a crane or hoist:

1. Select rigging lengths to compensate for any unequal weight distribution and to maintain the motor control center in an upright position.
2. Spreader bar should be used in conjunction with lifting cables to provide vertical lift on lifting angle to avoid angle failure or crushing or both. Spreader base is not furnished with equipment.
3. Do not allow the angle between the lifting cables and vertical to exceed 45° as shown in Figure 2.
4. Do not pass ropes or cables through lifting brackets. Use only slings with safety hooks or shackles.
5. Never lift an MCC above an area where personnel are located.

Note: The height of the lift point above the spreader bar should be at least one half "A," the distance between lift holes. This assures a safe angle of 45 degrees or less.

Figure 1: Lifting a motor control center with an overhead crane.

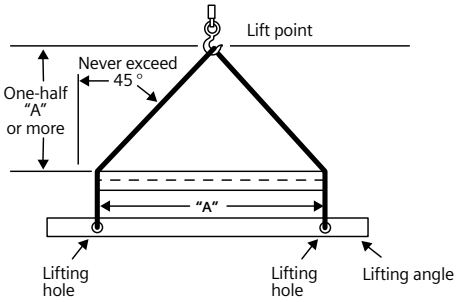

Figure 2: Proper method for lifting a motor control center

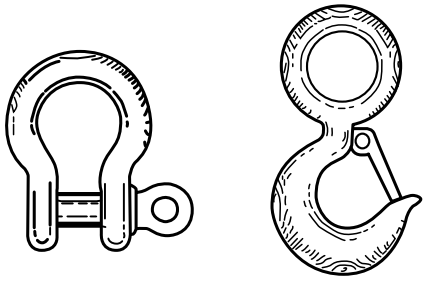

Figure 3: Load rated safety hook and shackle

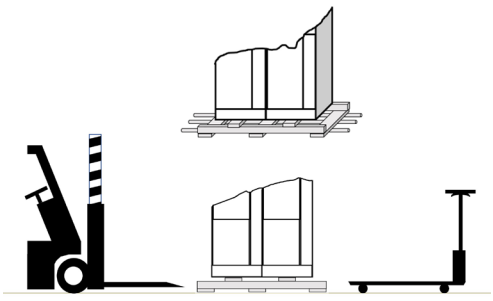

Figure 4: Motor Control Center, roller, and forklift handling

The following precautions should be taken when moving an MCC with a forklift:

1. Make sure the load is properly balanced on the forks.
2. Place protective material between the MCC and forklift to prevent bending and scratching.
3. Securely strap the MCC to the forklift to prevent shifting or tipping.
4. Excessive speeds and sudden starts, stops, and turns must be avoided when handling the MCC.
5. Lift the MCC only high enough to clear obstructions on the floor.
6. Take care to avoid collisions with structures, other equipment,or personnel when moving the MCC.
7. Never lift an MCC above an area where personnel are located.

The following precautions should be taken when moving an MCC by rolling on pipes:

1. Use enough people and restraining devices to prevent tipping.
2. The surface over which the MCC is rolled must be level, clean and free of obstructions. **NEVER ROLL AN MCC ON AN INCLINED SURFACE.**
3. It should be recognized that rolling an MCC is especially hazardous to fingers, hands, and feet and is susceptible to tipping. Measures should be taken to eliminate these hazards.
4. All pipes must be the same outside diameter and should have no flat spots. Only steel pipe should be used for this purpose.

⚠ WARNING

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2.3 Skid removal

Skid removal should be performed just prior to final placement of the motor control center and is achieved by first removing the bottom horizontal wireway covers which allows access to the skid lag bolts. Attach crane rigging to lifting angle on top of MCC structure. Apply sufficient tension on the 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 MCC lifted, the skids removed, the MCC 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 the instructions in the Installation section of this manual. Close doors and reinstall covers as soon as possible to eliminate intrusion of dirt and foreign materials into the MCC enclosure.

2.4 Storage

A motor control center or separate unit, which is not installed and energized immediately, should be stored in a clean dry space where a uniform temperature prevents condensation. Preferably, it should be stored in a heated building, with adequate air circulation and protected from dirt and water. Motor control centers and units should be stored where they are not subject to mechanical damage.

If the motor control center is to be stored for any length of time, prior to installation, restore the packing for protection during that period. Where conditions permit, leave the packing intact until the motor control center or sections are at their final installation position. If the packing is removed, cover the top and openings of the equipment during the construction period to protect them against dust and debris.

If the equipment is to be stored in a cool or damp area, do not completely cover the equipment, but provide heat to prevent condensation of moisture in the equipment. If the control center has been ordered with space heaters, connect to a temporary feed for heat. A simple method of heating the motor control center when space heaters are not ordered is to place a standard 120V/15W lamp inside the bottom of each vertical section.

An unenergized outdoor motor control center should be kept dry internally by installing temporary heating (see previous paragraphs), or by energizing optional self-contained space heaters.

Any scratches or gouges suffered from shipping or handling should be touched up to prevent rusting.

Installation

3.1 Installation quick check list – indoor MCCs only

Receiving

- ☐ Inspect package for damage.
- ☐ After unpacking, inspect equipment for damage in transit.
- ☐ If damaged or incomplete, please notify Siemens sales office with identification of parts, description of damage, and photographs.

Handling

- ☐ Simplify handling by leaving equipment on shipping skid.
- ☐ Use the lifting angle provided for moving the equipment.
- ☐ Take care to use the proper method of moving a motor control center.

Storage

- ☐ Store in a clean, dry space at moderate temperature.
- ☐ Cover with a canvas or heavy-duty plastic cover.
- ☐ If storage area is cool or damp, cover equipment completely and heat to prevent condensation.

Location selection

- ☐ Flat and level floor.
- ☐ Overhead clearance.
- ☐ Accessibility front and rear (if required).
- ☐ Protection from splash and drip, dust, and heat.
- ☐ Space for future expansion.
- ☐ If bottom conduit entry is used, conduit should be in place and stubbed up before equipment is installed.

Installation method

- ☐ Grout into the foundation.
- ☐ Weld channel sills to steel leveling plates.
- ☐ Imbedded anchor bolts in the floor.

Field assembly
(Instruction sheet included with shipment)

- ☐ Remove hardware and horizontal bus connecting links from shipping splits.
- ☐ Install first shipping split.
- ☐ Remove end cover plates of structures to be joined (if required).
- ☐ Carefully align second split with first. Bolt structures together at four corners and middle, front, and rear.
- ☐ Remove horizontal wireway barrier to expose horizontal bus.
- ☐ Connect horizontal buses with bus links. Torque bolts to 20 lbf-ft
- ☐ Grommet top and bottom horizontal wireways.
- ☐ Install heater coils. (Check selection against motor nameplate data.)
- ☐ Install fuses.

Conduit entry at top

- ☐ Remove top plates from structure.
- ☐ Cut conduit entry holes in top plates.
- ☐ Reinstall top plates.
- ☐ Install conduits

Incoming line connections

- ☐ Choose the shortest, most direct route from remote mains.
- ☐ If cables cannot be directly routed to terminals, provide adequate space for clamping the cables.
- ☐ Torque incoming lines to main lugs only at 85 lbf-ft
- ☐ Torque all incoming connections to main circuit breakers and fusible disconnects as per the breaker or disconnect manufacturer's recommendations. The torque requirements are found on a label located on the disconnecting device.

Outgoing power and control wiring

- ☐ Disengage plug-in unit stabs from vertical bus. Connect control and power wiring to units.
- ☐ Use stranded wire.
- ☐ Leave enough slack to permit partial withdrawal of unit to test position for maintenance.
- ☐ Pull wiring between units through vertical and horizontal wireway securing wires in the vertical wireway with wire from wire ties provided.
- ☐ Route wiring between sections through the top or bottom horizontal wireways.
- ☐ Reinsert plug-in units to engage stabs.

Pre-operation checks

- ☐ Test insulation resistance of all circuits with the control center as ground.
- ☐ Remove restraining devices from contactors and shunts from current transformers. Make sure that all parts of magnetic devices operate freely.
- ☐ Check electrical interlocks for proper contact operation.
- ☐ Make sure that each motor is connected to its proper starter.
- ☐ Check all timers for proper time interval setting and contact operation.
- ☐ Check fusible disconnect starters for proper fuse size.
- ☐ Clean the control center. Rid it of all extraneous material. Use a vacuum cleaner, not compressed air.
- ☐ **Check all connections for mechanical and electrical tightness.**
- ☐ Close all access plates and doors.

Energizing motor control centers

- ☐ Make sure all unit disconnect handles and control center mains are turned to OFF.
- ☐ Turn on remote mains.
- ☐ Turn on motor control center main circuit breakers or fusible disconnects.
- ☐ Turn on unit disconnect handles one by one.
- ☐ Jog motors to check for proper rotation.
- ☐ Adjust ETI breakers.

Insulation (Megger) test *(see page 27)*

Note: This checklist is not exhaustive and particular applications may require further procedures.

3.2 Operating environment

The motor control center conforms with the provisions of NEMA Standard ICS 1, Altitude Class 2KM which defines the usual service condition for electromagnetic control. It is designed for indoor use where the temperature inside the control center is higher than the ambient temperature. The control center is capable of carrying its rated load when the ambient temperature does not exceed 40 °C and the altitude does not exceed 6,600 feet above sea level. Where unusual service conditions exist or where temperature or altitude limitations are exceeded, the control center construction, ratings, or protection may require alteration. Some examples of unusual service conditions are excessive moisture, vibration, or dust.

3.3 Site preparation

Installation shall be in accordance with the National Electrical Code, ANSI, and NFPA 70 Standards. Unless the motor control center has been designed for unusual service conditions, it should not be located where it will be exposed to ambient temperatures above 40 °C (104 °F), corrosive or explosive fumes, dust, vapors, dripping or standing water, abnormal vibration, shock or tilting, or other unusual operating conditions.

The motor control center should be installed in a clean, dry, heated place with good ventilation and it should be readily accessible for scheduled maintenance. A flat, level, concrete surface should be prepared for the mounting site. If the mounting site is not flat and level, the motor control center must be shimmed where necessary to prevent distortion of the structure.

All conduit entering from the bottom should be in place and stubbed up about two inches above the finished floor level before installing the control center. Refer to the MCC lead sheet plan view located in the information packet for specific conduit area dimensions.

Note: Conduit should not extend more than 2 1/2 inches above the floor surface.

3.4 Mounting

Motor control centers may be mounted by many different fastening systems including true drop in, cast in place, powder actuated, or threaded insert fasteners. See Figure 6 for anchor bolt locations. The bolt pattern is dependent on frame width, depth, location in the line-up. Refer to the structure mounting detail included on the L1 layout drawing lead sheet. The coordination between bolts and the MCC should be verified prior to attempting installation. Expandable inserts in predrilled holes or embedded '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".

Grouting the sill channels is another method of fastening. This method requires the foundation to be grooved as shown to accept the sill channels. See Figure 7 for details.

Welding the steel base or sill channels to a steel floor plate is an alternate mounting method. See Figure 6 for details.

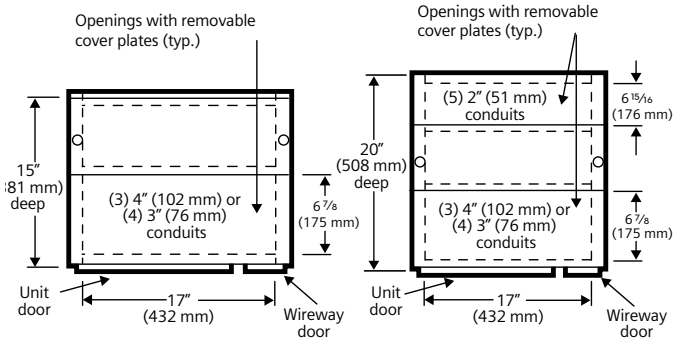
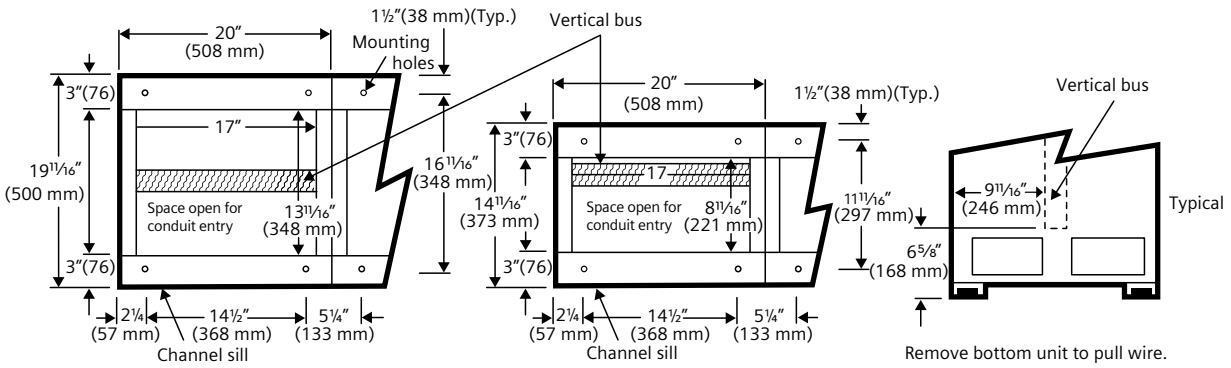


Figure 5: Top conduit entry: 15" 20"

Note:
Rear top plate can be used for conduit on 20" (508 mm) deep MCC. Cables can then be run from rear to front through optional wireway holes to connect units.

This is an example only and should not be used for construction. Refer to the drawing package supplied with the MCC for conduit and mounting information for specific MCC.

All dimensions shown in inches.



Shaded area indicates conduit entry.
All dimensions are shown in inches unless otherwise specified.

Figure 6: Anchor bolt location and bottom conduit entry: 15" 20"

Reversible bottom end-cover plates cover the bottom horizontal wireway, ground bus opening, and the end channels. They perform this function if the section is mounted on its sills, or if the section with sills is grouted into the floor, the plates are simply rotated 180°. See Figure 9.

If the control center is located on structural steel platforms over grids, it is recommended that the center be modified with bottom plates.

Note: To comply with NEC 380-8(a) Height Requirements, the customer should ascertain that the operating personnel's working base is at the same level as the MCC base.

3.5 Top and bottom covers

Top covers are provided on all motor control centers as an integral part of the enclosure. Bottom covers are supplied on certain types of construction such as NEMA 12. These covers should be removed only for the purpose of piercing holes for conduit or wire entry and must be immediately replaced to reduce the possibility that falling material, tools, or personnel could unintentionally contact the bus system or other live parts.

Note: This is an example only, not for construction. Customer to refer to drawing package supplied with the MCC for conduit and mounting information for their specific MCC.

All dimensions shown in inches unless otherwise specified.

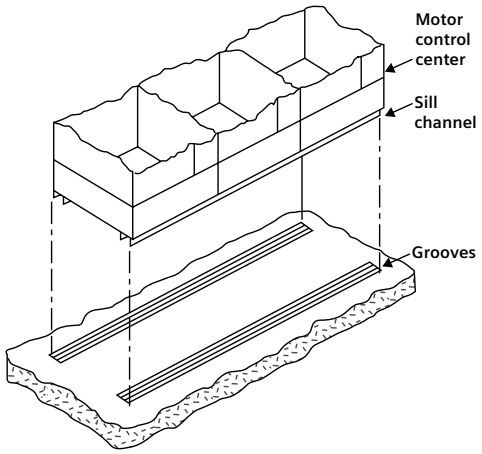


Figure 7: Grouting method of fastening MCC

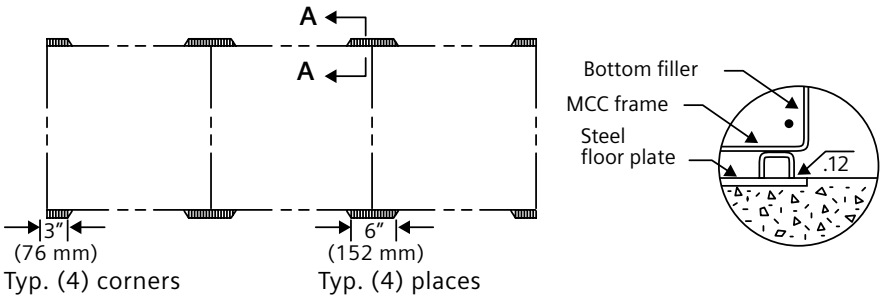


Figure 8: Welded installation

Figure 9: Reversible bottom end-cover plates

3.6 Installation of seismic qualified structures

Siemens tiastar MCCs are qualified to withstand seismic activity as specified in IBC 2012, CBC 2013, IBC 2015, CBC 2016 and IEEE 693. This includes all tiastar MCCs, all NEMA types and MCC sizes. tiastar MCCs are rated at importance factor 1.5.[1] The seismic qualifications include mounting locations from ground level to roof top.

The motor control center should be anchored to the floor with appropriate hardware and 1/2" bolts. For seismically qualified MCC installations, all mounting holes supplied in the standard base channel sills must be used. Welding is also an acceptable method of mounting, if the installation instructions are followed.

1) Importance factor 1.5 identifies components whose post-event operation is essential to supporting life, safety, and/or if the components contain materials that would be dangerous to building occupants if released during an earthquake.

3.7 Joining shipping sections

Shipping sections consist of up to four vertical frames shipped as a single unit. It is often necessary to join two or more shipping sections at the job site. All necessary electrical and structural joining components are provided and the following procedures are recommended.

Note: Splice plates for horizontal bus are supplied in a separate cardboard box. There is signage on the MCC indicating where to find them.

1. Position the first shipping section into place on the foundation and level.
2. Remove the front horizontal bus barrier and the side covers (if applicable) from the end(s) to be joined. If the rear is accessible, the back cover plates should be removed from the two adjoining sections.
3. Position the second shipping section on the foundation adjacent to the first and level it. The horizontal bus should be inspected for proper positioning and alignment at this time.
4. Bolt structures together at six points (see Figure 11). If access to the rear of the structures is restricted, the rear center bolt may be omitted.
5. Assemble the bus bar links to join the horizontal power bus and neutral bus, if supplied, in the two shipping sections as shown on page 14. The horizontal and neutral buses may differ in size, therefore the links must be matched to the proper bars. All links and associated mounting hardware are provided with the motor control center.
6. Torque all bus connections to 20 lbf-ft
7. If the motor control center has interwiring, connect the interunit wiring between shipping sections.
8. Join the ground bus between the two adjacent sections. The Ground Bus Section in the manual details this procedure.
9. If there are other shipping sections to be joined, repeat steps 1 through 8 above.
10. Secure the motor control center to the foundation.
11. NEMA 3R enclosure sections should be securely joined and sealed to prohibit intrusion of dust and moisture.

3.8 Ground bus

All hardware and links are supplied for joining the ground bus between two shipping sections. This joining may be accomplished by loosening the screw securing the connection link so that the link pivots freely. Remove the screw securing the ground bus in the adjacent frame to which the link will attach. Pivot the free end of the link such that the hole is aligned with the bolt, then reassemble the screw and link assembly. Tighten hardware. See Figure 10.

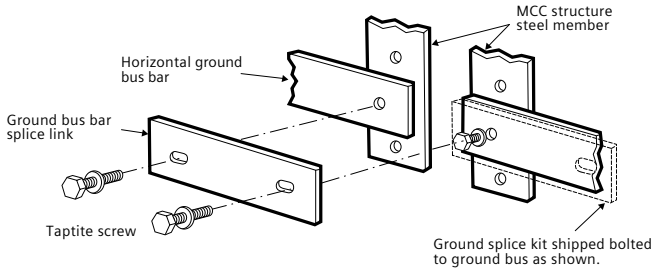
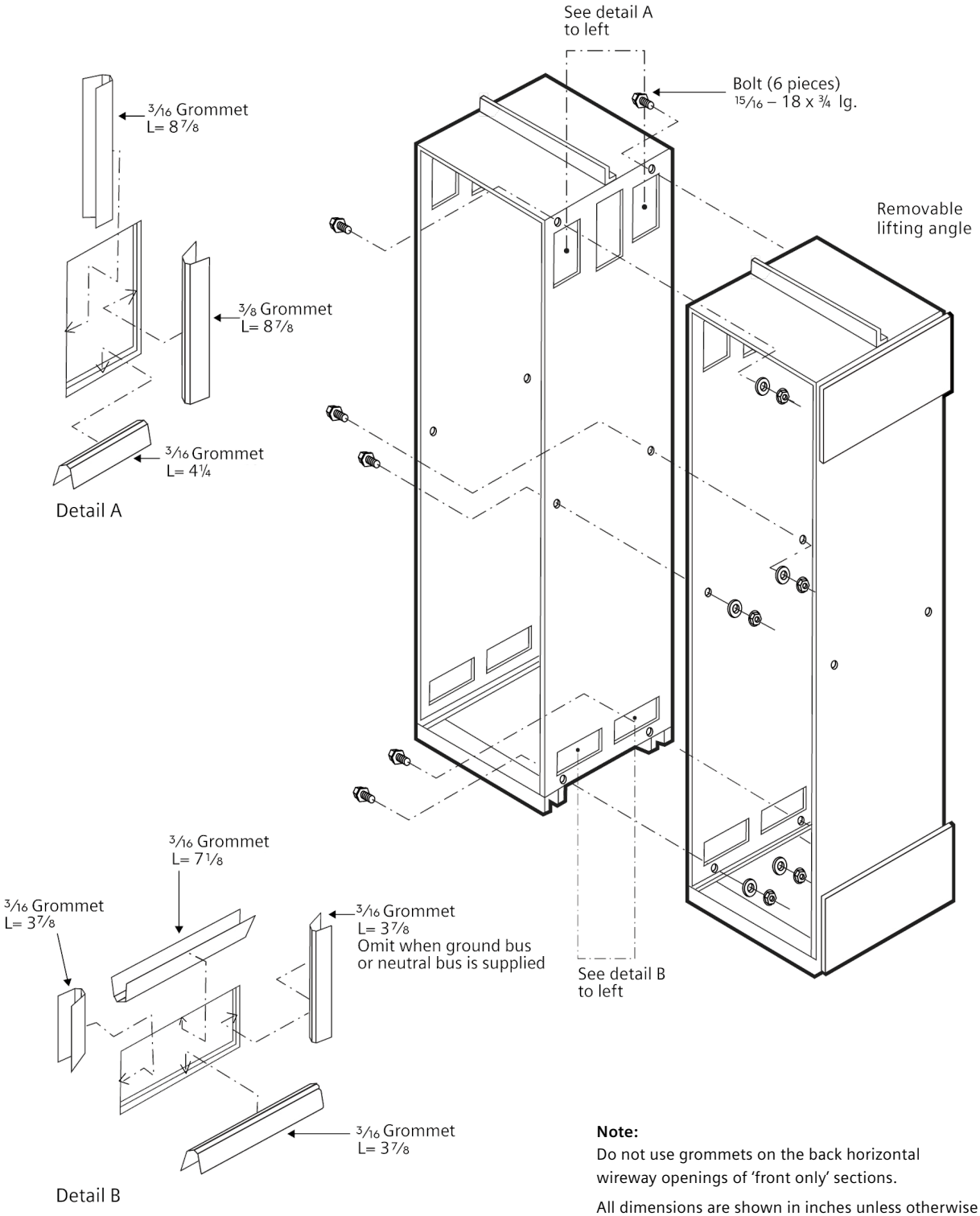


Figure 10: 300 A and 600 A horizontal ground bus connection



Note:
Do not use grommets on the back horizontal wireway openings of 'front only' sections.

All dimensions are shown in inches unless otherwise specified.

Figure 11

3.9 Splice kits

Note: For complete splice kit installation details, refer to instructions supplied with splice kits.

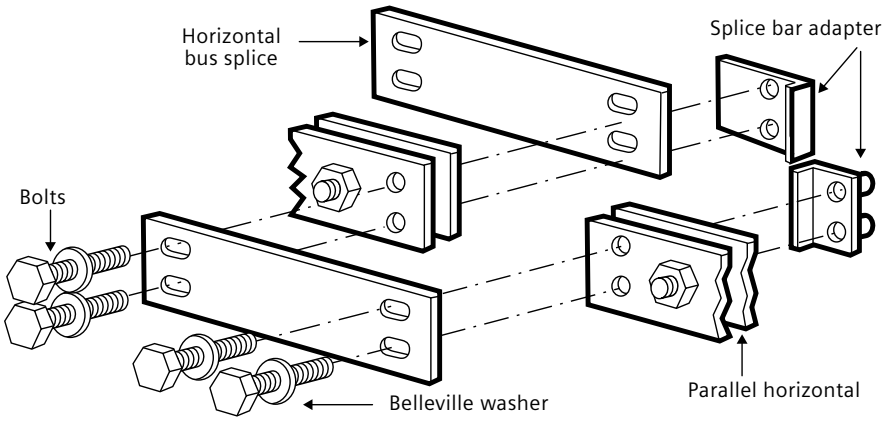


Figure 12: 1,200 A, 1,800 A L1 connection

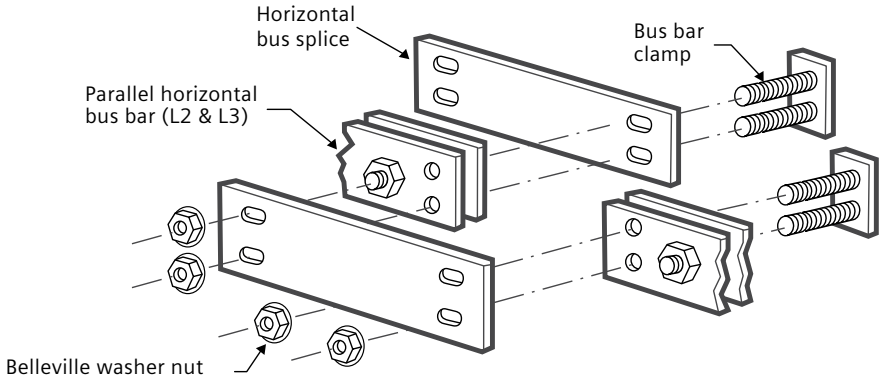


Figure 13: 1,200 A, 1,800 A L2 and L3 connection
1,200 A, 1,800 A neutral bus connection

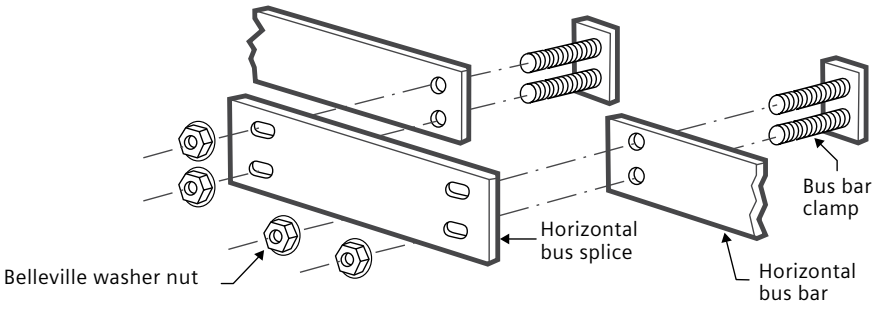


Figure 14: 600 A, 800 A main bus connection
600 A, 800 A neutral bus connection
600 A horizontal ground bus connection

3.10 Pull box installation

Refer to Figure 15 for the following procedure.

1. Remove top front conduit plate (A) from motor control center structure by removing two screws (B). There are two front plates on back-to-back motor control centers.
2. Remove two rear screws (C).
3. Remove the top two screws holding on the bus insulator cover (E). Do this to both sides of a back-to-back motor control center.
4. Install barrier (F) and replace the screws from step 3.
5. Remove top plate of pull box (G).
6. Place pull box on MCC and screw down using four 1/4 - 20 x 3/4" taptite screws. The rear mounting holes may have to be drilled on front only motor control centers. Use the pull box/top hat as a drilling template.
7. Replace top plate that was removed in step five.

3.11 Incoming power connections

Note: Remove top covers before cutting holes for conduit to prevent metal chips from falling into the motor control center. Conduits should be carefully installed to prevent moisture or water from entering and accumulating within the enclosure. All conduits (including stubs) should be bonded to the motor control center. After all shipping sections are in place, leveled, and joined together into a single motor control center, cables may be pulled and top entry conduit may be installed. Bottom entry conduit will have been stubbed through the floor at the proper locations prior to placement of the motor control center. The incoming source cables may be connected at this time, however, the power source disconnecting means must remain open and locked out until all wiring is completed and the entire system has been checked out.

Care must be exercised to make sure that the lugs which have been provided are suitable for use with the type of cables being installed in the motor control center. If crimp lugs are supplied, use only the crimping tool recommended by the lug manufacturer.

Care should be exercised in stripping insulation from the conductors to prevent nicking the conductor. Tighten all screw lugs and bolted electrical connections to the specified torque listed in the table in the maintenance section of this instruction manual.

To minimize the length of unsupported cable, the shortest, most direct routing should be chosen. However, the largest practical bending radii should be maintained to avoid damaging the insulation and to avoid causing terminals to loosen. All cables entering the motor control center must be adequately supported and restrained to withstand the maximum fault current capable of being delivered by the source. The recommended distances between straps for 80 pound rated strap is 6 inches for 25 kA bracing, 4 inches for 42 kA bracing and 3 inches for 65 kA bracing. Using a strap rated less than 80 pounds will require the spacing distances to be reduced. For 100 kA bracing, cables must be supported in accordance with the special instructions provided with the motor control center.

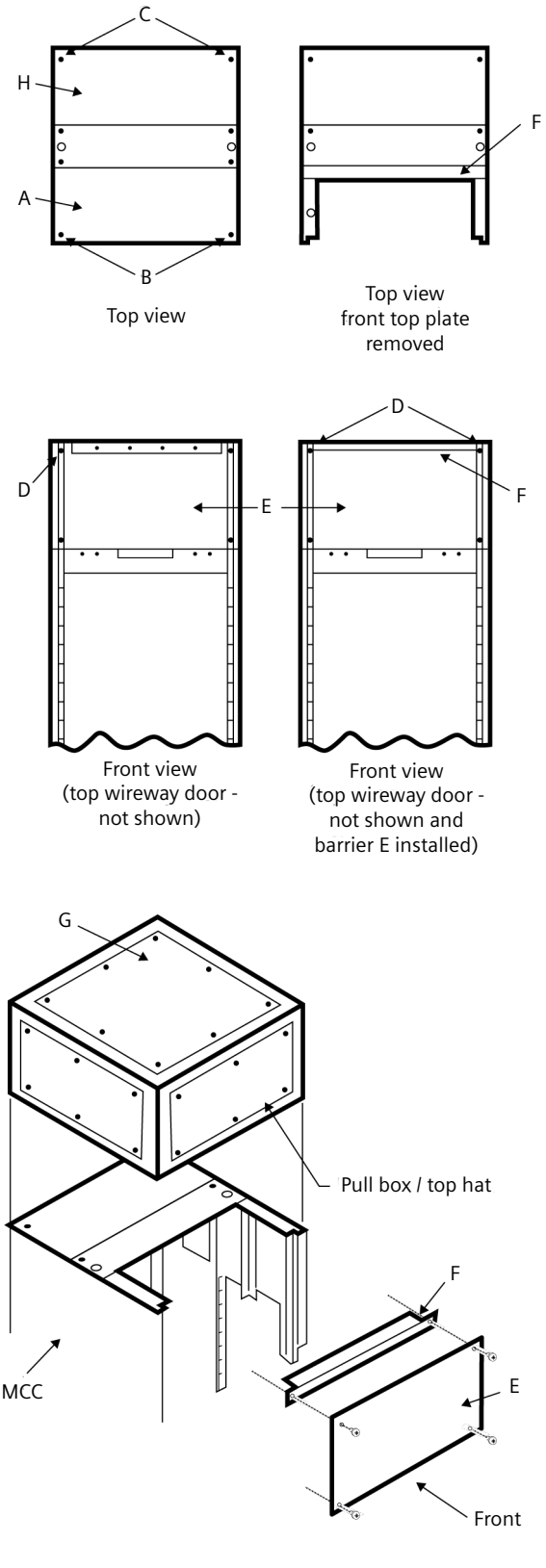

C
H
A
B
Top view
F
Top view
front top plate
removed
D
D
E
F
Front view
(top wireway door -
not shown)
Front view
(top wireway door -
not shown and
barrier E installed)
G
Pull box / top hat
F
E
MCC
Front

Figure 15

3.12 Incoming line termination arrangements – main lug only (MLO)

Horizontal lugs are available with 600 A, 42,000 A symmetrical bracing only (refer to Figure 16 on next page).

Special lugs, such as NEMA two-hole compression lugs, can be accommodated. Consult Siemens for space requirements.

Amperes / bracing (A/K)	Location	Incoming cable size	Figure reference next page	Wire-bending spare dimensions A inches (mm)	Total assembly height dimensions B inches (mm)	Required unit space dimensions C inches (mm)
600/42	Top	Quantity = 2 #4 - 350 kcmil Cu	16	13 (330)	12 (305)	0
600/42-65	Top	Quantity = 2 #2 - 600 kcmil Cu	17	16 (406)	24 (610)	12 (305)
600/85-100	Top	Quantity = 2 #2 - 600 kcmil Cu	18	20 (508)	30 (762)	18 (457)
600/42[1]	Bottom	Quantity = 2 #4 - 350 kcmil Cu	19	13 (330)	18 (457)	12 (305)
600/65[1]	Bottom	Quantity = 2 #4 - 350 kcmil Cu	19	13 (330)	24 (610)	18 (457)
800/42-65	Top	Quantity = 2 #2 - 600 kcmil Cu	17	16 (406)	24 (610)	12 (305)
800/85-100	Top	Quantity = 2 #2 - 600 kcmil Cu	18	20 (508)	30 (762)	18 (457)
800/42-65[2]	Bottom	Quantity = 2 #2 - 600 kcmil Cu	20	18 (457)	30 (762)	24 (610)
1,200/42-100	Top	Quantity = 3 #2 - 600 kcmil Cu	18	20 (508)	30 (762)	18 (457)
1,200/42-65[2]	Bottom	Quantity = 3 #2 - 600 kcmil Cu	20	18 (457)	30 (762)	24 (610)
1,600/42-100	Top	Quantity = 4 #2 - 600 kcmil Cu	18	20 (508)	30 (762)	18 (457)
1,600/42-65[2]	Bottom	Quantity = 4 #2 - 600 kcmil Cu	20	18 (457)	30 (762)	24 (610)
2,000/42-100[1]	Top	Quantity = 6 #2 - 600 kcmil Cu	21	29 (737)	48 (1,219)	36 (914)
2,000/42-100[2]	Bottom	Quantity = 6 #2 - 600 kcmil Cu	22	46 (1,168)	72 (1,829)	72 (1,829)
2,500/42-100[2]	Top	Quantity = 6 #2 - 600 kcmil Cu	21	29 (737)	48 (1,219)	36 (914)
2,500/42-100[2]	Bottom	Quantity = 6 #2 - 600 kcmil Cu	22	46 (1,168)	72 (1,829)	72 (1,829)

1. Space behind structure not available.
2. Entire rear of structure not available.
3. Optional lugs available. Contact factory for size and rating.

3.12 Main lugs

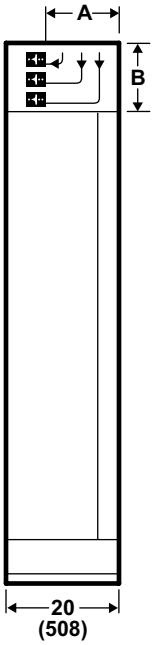


Figure 16

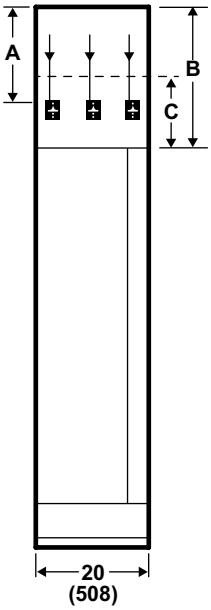


Figure 17

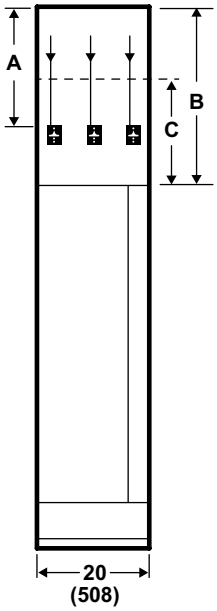


Figure 18

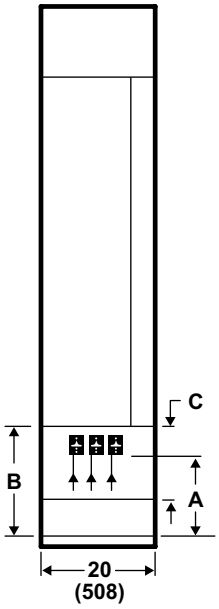


Figure 19

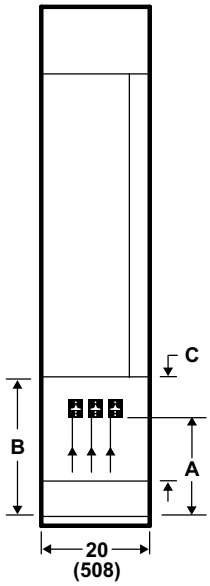


Figure 20

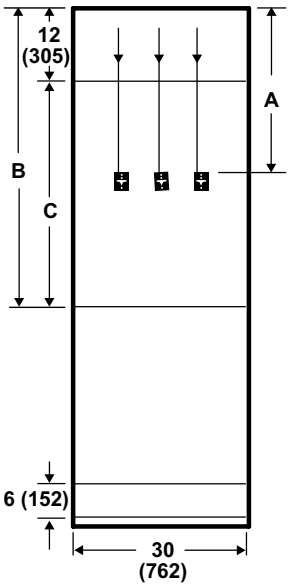


Figure 21

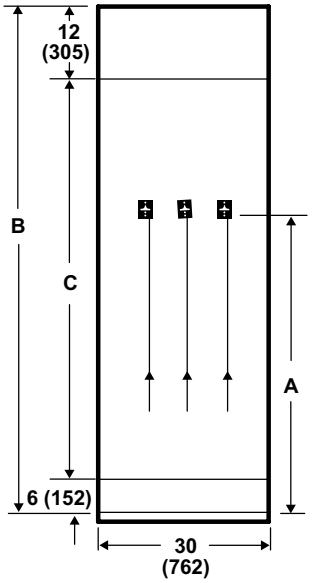


Figure 22

All dimensions are shown in inches (mm) unless otherwise specified.

3.13 Incoming line termination arrangements –main circuit breakers (MCB)

Molded-case, thermal-magnetic circuit breakers, molded-case, solid-state circuit breakers, and insulated case WL power circuit breakers can be used as mains in the LV MCC. These circuit breakers are 80-percent rated. 100-percent rated options are also available per the below.

Circuit Breaker Frame A	Location	Incoming cable size	Figure reference next page	Wire-bending spare dimensions A inches (mm)	Total assembly height dimensions B inches (mm)	Required unit space dimensions C inches (mm)
125	Top	Quantity = 1[5] #3 - 3/0 Cu	23	14 (356)	24 (610)	12 (305)
125	Bottom	Quantity = 1[5] #3 - 3/0 Cu	26	8 (203)	24 (610)	18 (457)
250	Top	Quantity = 1 #6 - 350 kcmil Cu	24	15 (381)	30 (762)	18 (457)
250	Bottom	Quantity = 1 #6 - 350 kcmil Cu	27	15 (381)	36 (914)	30 (762)
400[7,8]	Top	Quantity = 1 #6 - 350 kcmil Cu	24	15 (381)	30 (762)	18 (457)
400[7,8]	Bottom	Quantity = 2 3/0 - 500 kcmil Cu	28	15 (381)	42 (1,067)	36 (914)
600[7,8]	Top	Quantity = 2 3/0 - 500 kcmil Cu	24	15 (381)	30 (762)	18 (457)
600[7,8]	Bottom	Quantity = 2 3/0 - 500 kcmil Cu	28	15 (381)	42 (1,067)	36 (914)
800[1,8]	Top	Quantity = 3 #1 - 500 kcmil Cu	25	22 (559)	48 (1,219)	36 (914)
800[2,6,8]	Bottom	Quantity = 3 #1 - 500 kcmil Cu	29	22 (559)	54 (1,372)	48 (1,219)
1,200[1,8]	Top	Quantity = 4 250 - 500 kcmil Cu	25	22 (559)	48 (1,219)	36 (914)
1,200[2,3,6,8]	Bottom	Quantity = 4 250 - 500 kcmil Cu	29	22 (559)	54 (1,372)	48 (1,219)
1,600[3,8]	Top	Quantity = 4 300 - 600 kcmil Cu	32	30 (762)	90 (2,286)	72 (1,829)
1,600[3,8]	Bottom	Quantity = 4 300 - 600 kcmil Cu	33	30 (762)	90 (2,286)	72 (1,829)
2,000[3]	Top	Quantity = 6 300 - 600 kcmil Cu	30	32 (813)	90 (2,286)	72 (1,829)
2,000[3]	Bottom	Quantity = 6 300 - 600 kcmil Cu	33	26 (660)	90 (2,286)	72 (1,829)
800[4]	Top	Quantity = 2 #1 - 600 kcmil Cu	29	28 (711)	90 (2,286)	72 (1,829)
800[4]	Bottom	Quantity = 2 #1 - 600 kcmil Cu	30	25 (635)	90 (2,286)	72 (1,829)
1,200[4]	Top	Quantity = 4 250 - 600 kcmil Cu	29	28 (711)	90 (2,286)	72 (1,829)
1,200[4]	Bottom	Quantity = 4 250 - 600 kcmil Cu	30	25 (635)	90 (2,286)	72 (1,829)
1,600[4]	Top	Quantity = 4 300 - 600 kcmil Cu	30	28 (711)	90 (2,286)	72 (1,829)
1,600[4]	Bottom	Quantity = 4 300 - 600 kcmil Cu	31	25 (635)	90 (2,286)	72 (1,829)
2,000[4]	Top	Quantity = 6 300 - 600 kcmil Cu	30	28 (711)	90 (2,286)	72 (1,829)
2,000[4]	Bottom	Quantity = 6 300 - 600 kcmil Cu	31	25 (635)	90 (2,286)	72 (1,829)
2,500[4]	Top	Quantity = 6 300 - 600 kcmil Cu	30	28 (711)	90 (2,286)	72 (1,829)
2,500[4]	Bottom	Quantity = 6 300 - 600 kcmil Cu	31	25 (635)	90 (2,286)	72 (1,829)

1. Space in rear of structure not available.
2. Entire rear of structure not available.
3. Molded-case circuit breakers.
4. WL power circuit breakers.
5. 15-25 A lug size 12-10 Al, 14-10 Cu; 30-100 A, 10-1/0 Cu.
6. 800 A - 1,200 A not available in back-to-back bottom mounting.
7. Stab opening at bottom of unit not available in rear.
8. 100% rated circuit breaker option available; unit size may increase.
9. Optional lugs available. Contact factory for size and rating.

Note: All circuit breakers are calibrated for 40 °C (104 °F).

3.13 Main circuit breakers

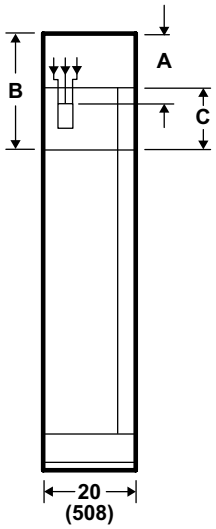


Figure 23

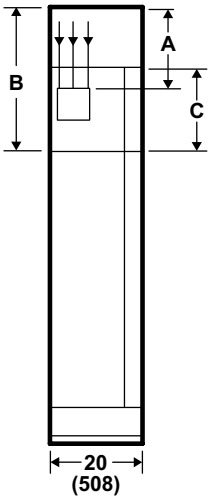


Figure 24

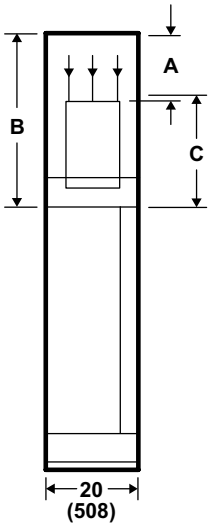


Figure 25

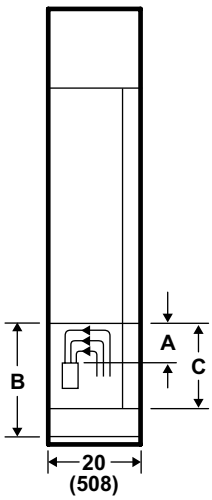


Figure 26

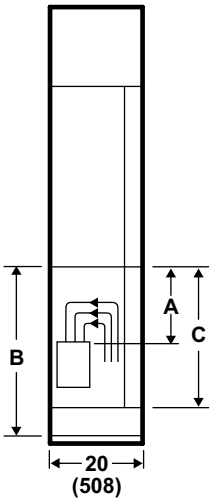


Figure 27

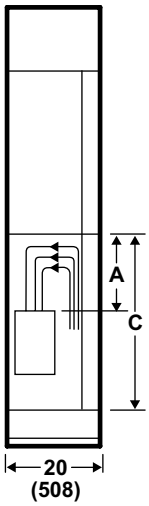


Figure 28

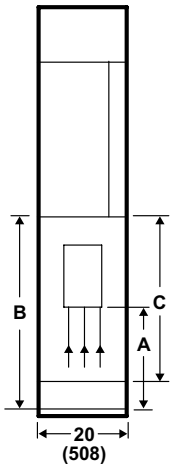


Figure 29

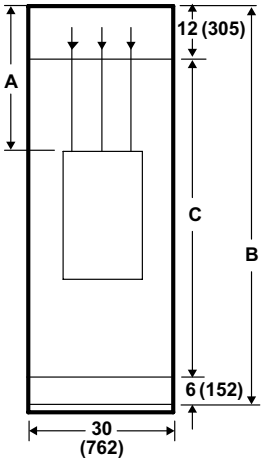


Figure 30

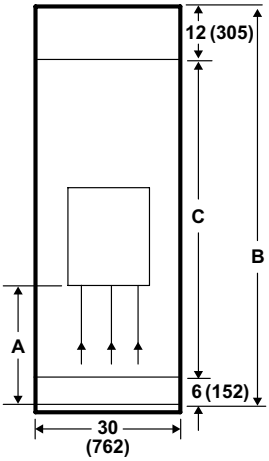


Figure 31

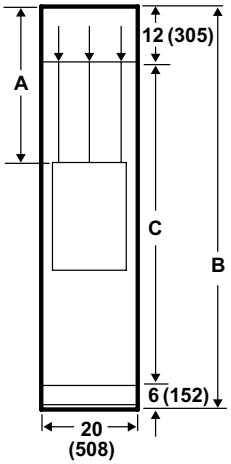


Figure 32

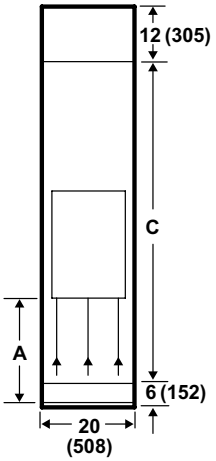


Figure 33

All dimensions are shown in inches (mm) unless otherwise specified.

3.14 Incoming line arrangements – main disconnect switches (MDS)

Main fusible switches consist of the following:

- 600 A to 100 A, Class R fuse clips
- 200 A to 600 A, Class R fuse holder
- 800 A to 1,200 A, Class L fuse holder

Fusible disconnect switch/clips (A)	Location	Incoming cable size	Figure reference next page	Wire-bending spare dimensions A inches (mm)	Total assembly height dimensions B inches (mm)	Required unit space dimensions C inches (mm)
60/30 or 60	Top	Quantity = 1 #14 - #14 Cu	34	14 (356)	24 (610)	12 (305)
60/30 or 60	Bottom	Quantity = 1 #14 - #14 Cu	39	8 (203)	24 (610)	18 (457)
100/100	Top	Quantity = 1 #14 - #14 Cu	35	13 (330)	30 (762)	18 (457)
100/100	Bottom	Quantity = 1 #14 - #14 Cu	40	7 (178)	30 (762)	24 (610)
200/200	Top	Quantity = 1 #6 - 350 kcmil Cu	36	16 (406)	42 (1,067)	30 (762)
200/200	Bottom	Quantity = 1 #6 - 350 kcmil Cu	41	10 (254)	48 (1,219)	42 (1,067)
400/400	Top	Quantity = 2 3/0 - 500 kcmil Cu	37	14 (356)	48 (1,219)	36 (914)
400/400	Bottom	Quantity = 2 3/0 - 500 kcmil Cu	42	14 (356)	60 (1,524)	54 (1,372)
600/600	Top	Quantity = 2 3/0 - 500 kcmil Cu	37	14 (356)	48 (1,219)	36 (914)
600/600	Bottom	Quantity = 2 3/0 - 500 kcmil Cu	42	14 (356)	60 (1,524)	54 (1,372)
800/800[1]	Top	Quantity = 3 250 - 500 kcmil Cu	44	22 (559)	90 (2,286)	72 (1,829)
800/800[1]	Bottom	Quantity = 3 250 - 500 kcmil Cu	43	22 (559)	90 (2,286)	72 (1,829)
1,200/1,200[1]	Top	Quantity = 4 250 - 500 kcmil Cu	44	22 (559)	90 (2,286)	72 (1,829)
1,200/1,200[1]	Bottom	Quantity = 4 250 - 500 kcmil Cu	43	22 (559)	90 (2,286)	72 (1,829)

1. Space in rear of structure not available.
2. Optional lugs available. Contact factory for size and rating.

3.14 Main disconnect switches

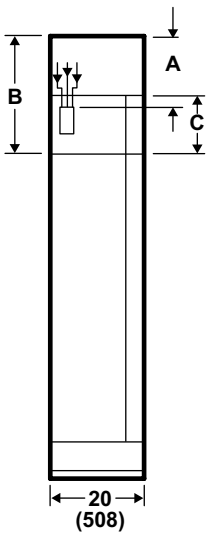


Figure 34

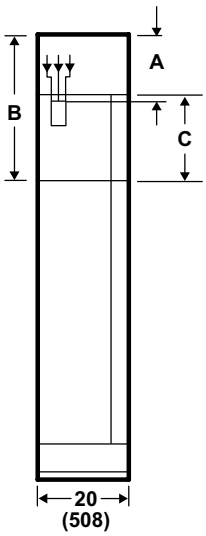


Figure 35

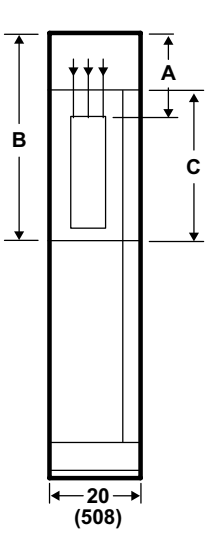


Figure 36

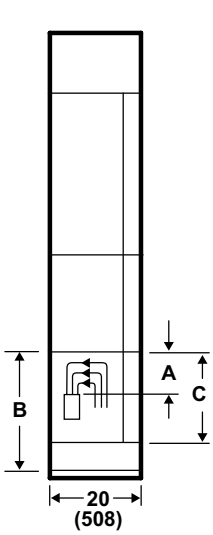


Figure 37

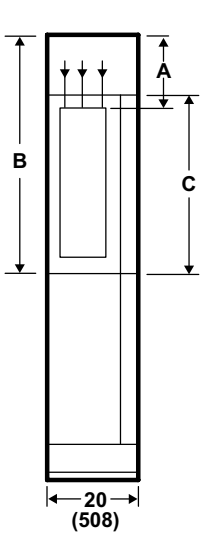


Figure 38

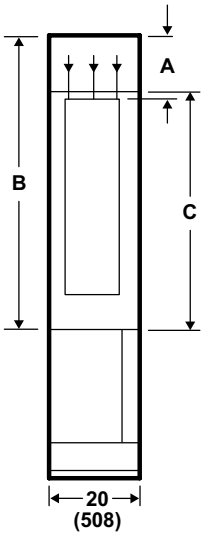


Figure 39

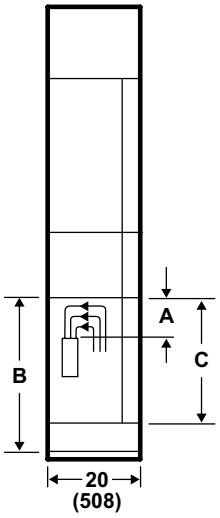


Figure 40

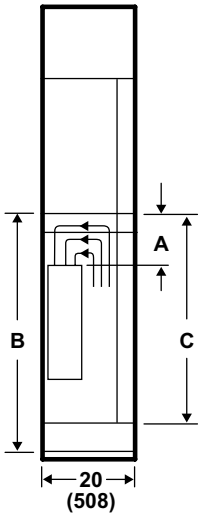


Figure 41

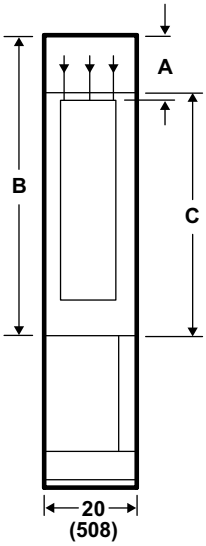


Figure 42

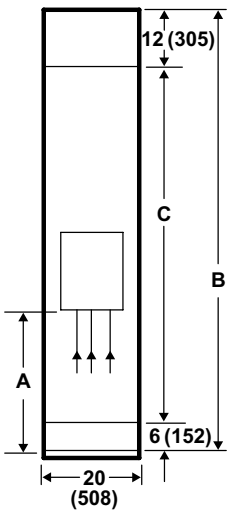


Figure 43

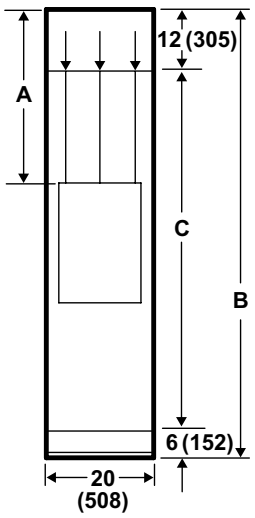


Figure 44

All dimensions are shown in inches (mm) unless otherwise specified.

3.15 Load and control wiring

All interconnections between devices within each control unit are prewired at the factory. Field wiring to each control unit should be made in accordance with the wiring diagram indicated on the lead sheet for that particular unit. The lead sheet and wiring diagrams are included in the information packet. When wiring or performing any maintenance on plug-in units, disengage the stabs by withdrawing the unit. Refer to page 24, "Plug-In unit removal" section. Wiring done with the unit in this position will ensure adequate cable slack to allow unit withdrawal to the same position when future maintenance is required. Always use stranded wire.

The vertical wiring between control units or between a control unit and conduit should be pulled through the vertical wireway on the right side of the frame. These wires should then be tied or laced together and the resulting bundle then securely fastened to the wire supports. Interconnecting wiring between control units should be routed through the top or bottom horizontal wireways.

Installation and wiring must be in accordance with NFPA-70, ANSI, the National Electrical Code, and any other applicable regional codes or regulations.

3.15.1 NEMA type A wiring

Motor control centers with NEMA type A wiring do not include terminal blocks. All field wiring, both power and control, should be connected directly to the individual components.

3.15.2 NEMA type B wiring

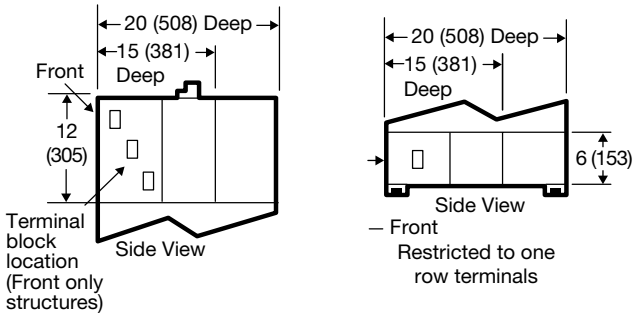
Motor Control Centers with NEMA type B wiring include terminal blocks for control circuit connections.

NEMA type B user field load wiring for combination motor control units size 3 or smaller shall be designated as B-D or B-T, according to the following:

- B-D connects directly to the device terminals, which are located immediately adjacent, and readily accessible, to the vertical wireway.
- B-T connects directly to a load terminal block in, or adjacent to, the unit.

3.15.3 NEMA type C wiring

Motor control centers equipped with NEMA type C wiring include all the features described for NEMA type B wiring in addition to master terminal blocks located at either the top or bottom horizontal wireway. (Figure 46) Motor control center units are factory wired to their master terminal blocks.



Type C Terminal Blocks: Standard Location in Top Horizontal Wireway
dimensions shown in inches (mm)

Figure 45: Master terminal block location

The motor control center lead sheet, located in the information packet, indicates the type of wiring provided for this installation.

Figure 46: Type "C" wiring terminal

Field terminations: NEMA classes and types

	Class I types				Class II types		
Description	**A**	**B-D**	**B-T**	**C**	**B-D**	**B-T**	**C**
Terminals furnished							
• For all control connections		X	X	X	X	X	X
• For starter load connections			X	X		X	X
Terminals mounted							
• On control unit		X	X	X	X	X	X
• In master terminal compartment			X				X
Interwiring							
• Between units in the same motor control center					X	X	X

3.16 Field additions

Field additions may be made to the motor control center if the current rating of the main or vertical bus is not exceeded. The preparation of the floor and conduit is the same as in a new installation. Any new shipping section will contain all of the necessary hardware and bus connecting links. De-energize the existing motor control center and remove the top and bottom side covers from the new and existing vertical frames which are to be joined. After joining the structures per the instructions in the installation section of this manual, perform the pre-energization checks outlined in the operation section of this instruction manual.

Additions to motor control centers fall into two general categories: additions of structures and additions or replacement of plug-in units. The addition of structures is similar to the installation of motor control centers which have been shipped in several sections. When mounting methods or models of new and existing sections differ, care must be exercised to ensure proper alignment of horizontal bus. The new structures are then treated the same as in a new installation. This is discussed in detail in the Joining Shipping Sections portion of this manual.

3.17 Plug-in unit removal

⚠ DANGER

Hazardous voltage.
Will cause death or serious personal injury.
Energized vertical bus may be partially exposed through the access holes in the barrier when the unit is not fully inserted. Use extreme caution when performing any wiring or maintenance with the unit withdrawn.

1. Put the disconnect operating handle in the “OFF” position (Figure 47). The interlocking mechanism will not permit removing or inserting the unit with the handle in the“ON” position.

Figure 47

2. Unscrew the multi-turn latch on bottom plate of the unit. Rotate the latch until it disengages from the separator angle. ***Note:*** *High density (6”) units do not utilize a multi-turn latch.*

Figure 48

3. Open vertical wireway door.
4. Move the unit to the “test” position by opening the racking lever (Figure 49) on the top barrier plate while pulling on the supplementary installation handle on the bottom barrier plate (Figure 50). The unit can be padlocked in the test position (Figure 51).

Figure 49

Figure 50

Figure 51

5. Disconnect control and load wiring.
6. Remove the unit by tilting and sliding out (Figures 52, 53, 54).

Figure 52

Figure 53

Figure 54

7. Pilot devices are mounted in a pilot device panel attaches to the unit door with two captive screws. To remove the pilot device panel from the unit door, loosen the bottom screw a couple of turns, then loosen the top screw to release the top of the pilot device panel. Tilt the top of the pilot device panel away from the back of the unit door and lift the pilot device panel off of the unit door. The top mounting screw is captive to the unit door while the bottom mounting screw is captive to the pilot device panel.
8. Once the pilot device panel has been removed from the unit door, tabs located on the metal pilot device panel allow the pilot devices mounted on the motor control center unit for unit removal and service.

9. To re-install the pilot device panel on the unit door, place the bottom pilot device panel screw in the slot at the bottom of the pilot device panel cut out. Push the pilot device panel against the inside of the unit door and tighten both pilot device panel mounting screws.

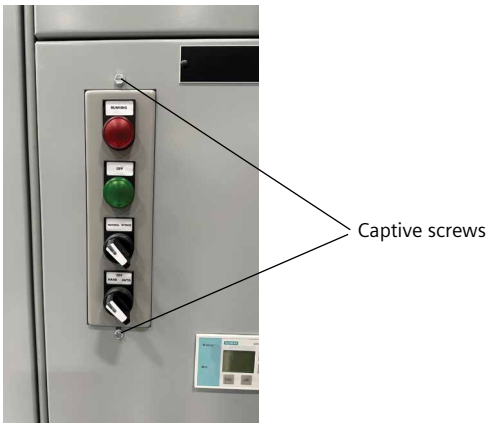


Figure 55

Figure 56

Figure 57

10. If so equipped, the SAMMS panel may be released by loosening the captive screw a few turns, then swinging the panel to the right to gain access to components mounted behind it.

11. The drawout unit should be protected from abuse, dust, and moisture while it is out of the motor control.

12. Latch unit door over open space by rotating the top 1/4 turn latch so that the arrow is pointing up (Figure 58).

Figure 58

3.18 Plug-in unit addition

DANGER

Hazardous voltage.
Will cause death or serious personal injury.
Energized vertical bus may be partially exposed through the access holes in the barrier when the unit is not fully inserted. Use extreme caution when performing any wiring or maintenance with the unit withdrawn.

1. Remove the blank door by removing the hinge pins, closing the door halfway, and pulling it off the hinges.
2. Remove the door gasket angle (intermediate angle) by removing the screw which fastens it to the separator angle and tipping slightly to remove the formed tab at top from the slot in the shelf bracket above.
3. If necessary, install the unit support assembly by inserting the shelf brackets at a slight angle into the appropriate holes in the vertical bus support angle and snapping into place. Secure the support assembly with the two screws provided. One screw fastens the right-hand shelf bracket to the vertical bus support angle. The second screw fastens the separator angle to the left side of the structure.
4. Remove the appropriate unit stab hole covers.
5. Mount the unit door by placing it on the hinges while half open. Open completely and insert the hinge pins.
6. Plug-In: Move the unit operator handle to the "OFF" position. Slide the control unit into place on the support assembly. Complete unit engagement by sliding over the stop on the shelf brackets with the supplementary installation handle on the bottom barrier plate and closing the racking lever in the top barrier plate. Engage the multi-turn locking latch on the bottom plate of the unit to the separator angle and tighten the screw.

Note: High density (6") units do not utilize a multi-turn latch.

7. Fix mounted: For the location of the panel mounting brackets, see the fixed mounted panel diagram in Figure 63. Use the bracket with the tab for the top mounting holes.
8. Follow procedures for connecting outgoing power and control wiring.
9. Close the door and perform all pre-operation check procedures.

Figure 59: Operating handle in "OFF" position

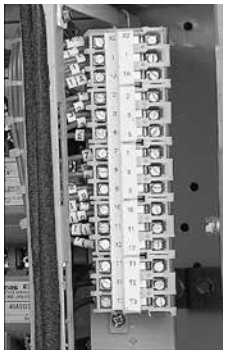


Figure 60: Terminal blocks on swing plate

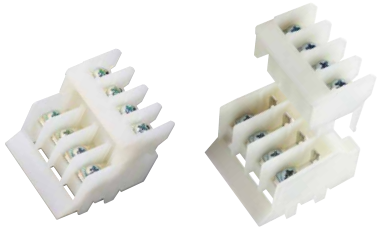


Figure 61: Pull apart terminal blocks

Figure 62: Padlocking in "test" position

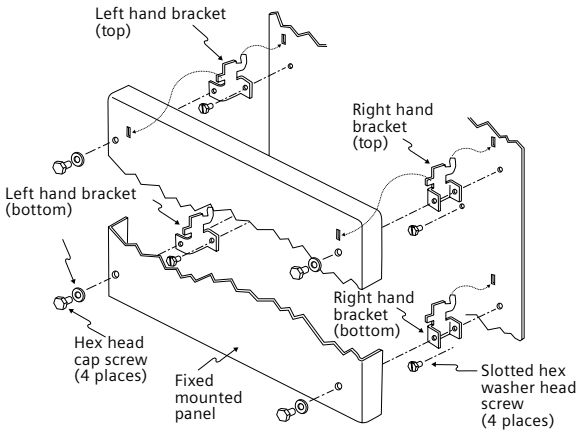


Figure 63: Fixed mounted panel diagram

3.19 High density unit installation

DANGER

Hazardous voltage.
Will cause death or serious personal injury.
Energized vertical bus may be partially exposed through the access holes in the barrier when the unit is not fully inserted. Use extreme caution when performing any wiring or maintenance with the unit withdrawn.

3.19.1 Coil removal

1. For easy coil replacement, remove the unit from the structure.
2. Loosen screw “A” which secures the cover.
3. Rotate the cover as shown in Figure 64 around the pivot point.
4. Disconnect wiring to coil.
5. Remove coil through top of unit.

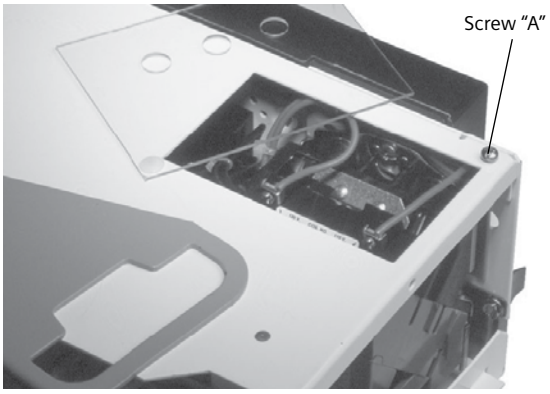


Figure 64

3.19.2 Terminal block swing plate

1. To wire the unit, rotate the terminal block swing plate as shown in Figure 65.
2. Route the wires from he vertical wireway into the unit behind the right unit side angle.

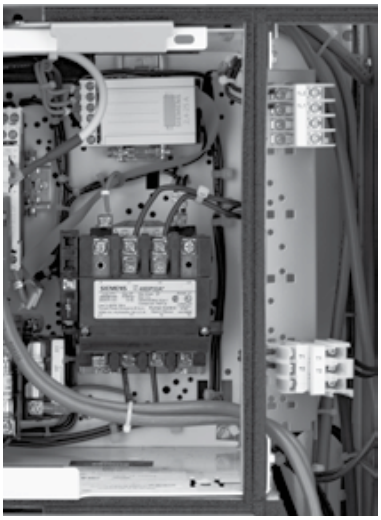


Figure 65

3.19.3 Arc cover access slots

Withdraw the unit for access to the arc cover screws through the slots in the unit bottom plate as shown in Figure 66.

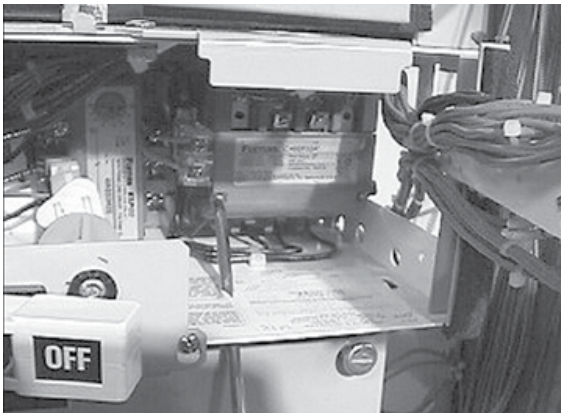


Figure 66

3.19.4 Hinge installation

1. Remove the existing hinge (if present) in the 6” space.
2. Install the unit support bracket per 89-H2B installation manual unit only.
3. Locate and install the new hinge with the two mounting screws.
4. Install the door using two new hinge pins supplied with the unit.

3.19.5 Terminal block swing plate

1. Remove the unit from the structure.
2. Loosen screw “B” shown in Figure 67.
3. Lift the handle bracket and pull forward to disengage.
4. Rotate the left side of the unit open as shown in Figure 59.
5. When closing the unit, the handle must be in the “OFF” position.

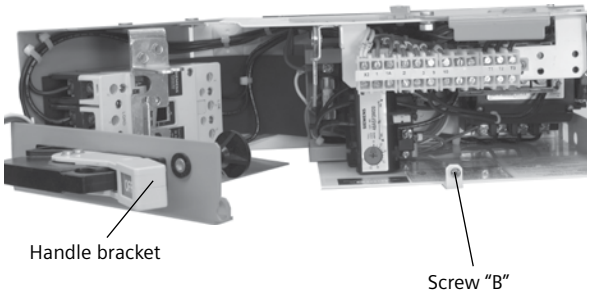


Figure 67

DANGER

Hazardous voltage.
Will cause death or serious personal injury.
The main disconnect must be in the OFF position during all megger testing of the motor control center. Devices such as solid-state components, capacitor units, or any other devices which are not designed to withstand megger voltage, should be disconnected before testing the rest of the motor control center.

3.20 Insulation (Megger) test

Take resistance measurements before a motor control center is placed into service, after installation or maintenance. When performing resistance measurements in motor control centers use an insulation tester (Megger) with a potential of 500-1000 V.

Take readings between each phase and from each phase to ground. This should be done with the branch disconnects “OFF” and again, with the branch disconnects “ON”.

3.20.1 Branch disconnects “OFF”

Typically readings taken with all disconnects in the “OFF” position should be between 5-20 megaohms. New equipment which was stored in a damp area may register lower upon initial startup. If readings are above one megaohm during start-up the following procedure may be observed to help dry the motor control center. Energize several individual control units. If individual readings are above one megaohm, energize additional units. After the equipment has been in operation for 48 hours, the readings should be in the 5-20 megaohm range. If at any time megger readings are below 5 megaohm (one megohm during start-up) consult your local Siemens sales office.

3.20.2 Branch disconnects “ON”

Before taking a reading with the branch disconnects “ON”, disconnect all devices completing circuits between phases or between phases and neutral such as control transformers. Readings observed may be slightly lower than the “OFF” readings, but the start-up one megohm lower limit still applies.

Record the megger readings on the tables below. Abrupt changes in resistive values may be an indication of potential failure. Even sudden changes within the 5-20 megaohm range may be an advance signal of insulation failure. The early detection of faulty insulation components can save costly repairs and downtime.

⚠ DANGER

Hazardous voltage.
Will cause death or serious personal injury.
The main disconnect must be in the OFF position during all megger testing of the motor control center. Devices such as solid-state components, capacitor units, or any other devices which are not designed to withstand megger voltage, should be disconnected before testing the rest of the motor control center.

Branch Disconnects OFF

Date							
Phase to phase							
A-B							
B-C							
C-A							
Phase to ground							
A-GND							
B-GND							
C-GND							

Branch Disconnects ON

Date							
Phase to phase							
A-B							
B-C							
C-A							
Phase to ground							
A-GND							
B-GND							
C-GND							

Operation

4.1 Pre-energization checks

After installation, field addition, or maintenance, perform the following checks before energizing equipment:

1. Check all connections for tightness, both mechanical and electrical. Factory connections may loosen during shipment and storage. It is of utmost importance to inspect all connections and bolted joints for tightness prior to energizing the equipment.
2. Compare all circuits for agreement with the wiring diagrams which are provided with the motor control center. Be sure that each motor is connected to its intended starter.
3. Verify that inserts or automatic shutters are installed in all exposed openings in the vertical bus barriers.
4. Inspect the motor control center for accumulation of dust or dirt. If required, clean the MCC as explained in the Maintenance section of this manual.

⚠ DANGER

Hazardous voltage.
Will cause death or serious personal injury.
Dielectric or megger testing should only be conducted by qualified personnel. Refer to test device instructions for safety instructions.

5. Test the motor control center power circuit for possible short circuits and grounds. A dielectric test at 2 times the nominal system voltage plus 1000 volts applied for one minute between phases and from all phases to ground is the preferred method. The maximum allowable leakage current is 1.5 mA per 1000 test volts applied. If a high-pot tester is not available, then a megger test using a 500 or 1000 volt megger is a suitable second choice. The minimum allowable resistance measured from phase to phase and from phase to ground is one megohm. Be sure to disconnect any control devices,control power transformer, etc, from the circuit which could be damaged by the test voltage.

⚠ DANGER

Hazardous voltage.
Will cause death or serious personal injury.
Never operate any contactor, relay, or switch unless its arc chute is properly installed and secured and undamaged.

6. Manually exercise all switches, circuit breakers, contactors, magnetic devices, and other operating mechanisms several times to make certain they are properly aligned and operate freely. Some contactors are shipped with restraining devices to minimize vibration effects during shipment.

   Be sure that all such restraints have been removed. None of these devices must ever be blocked in the “ON” position. Check all electrical interlocks for proper contact operation. Check all mechanical interlocks for proper freedom and operation.

7. Check all timers for proper interval setting and contact operation.
8. Check overload relay trip setting and verify that they are adjusted per the instructions given for the overload relay in this instruction manual.

⚠ WARNING

Explosive hazard.
Installation of fuses of insufficient interruption rating can cause death or serious personal injury.
To ensure proper coordination and sufficient capacity to interrupt the available fault current, always install replacement fuses with UL class, continuous current rating, type, and interrupting capacity identical to the original. Never defeat rejection mechanisms which are provided to prevent the installation of the wrong type of fuses.

9. Check all power circuit fuses and control fuses to verify that they are sized in accordance with the National Electrical Code application requirements.

10. Current transformers to which customer devices will be connected, are shipped with their secondaries shorted. All shorting devices should be removed when the secondary connections to these transformers are completed. Make sure that the current transformer secondary is complete. Current transformers must not be energized with their secondaries open circuited.
11. Check all devices for missing or broken parts, proper spring tension, free movement, rusting or corrosion, dirt, and excessive wear. Make all necessary repairs.
12. Check all electrical relays, meters, and instruments to verify that connections are made properly and that the devices function properly. Verify that adjustable voltage and current trip mechanisms are set to the proper values.
13. Make sure that no fuses, overload relays, incomplete sequence relays, shunt trips, ground fault protection assemblies, electrical interlocks, or trip contacts from any of these devices are strapped, bypassed, or defeated in any manner.
14. Turn all circuit breakers and fusible switches to the “OFF” position.
15. Make sure that all barriers, braces, and shields are installed in the equipment as intended.
16. Check the integrity of all bus mounting means and cable connections to the bus. Make certain that field wiring is clear of line bus and physically secured to withstand the effects of the largest fault current which the supply system is capable of delivering. Make sure that control wires or power cables are not touching the power bus.
17. Verify that all ground connections have been properly made. The sections of the motor control center which were shipped separately must be connected in such a way to assure a continuous grounding path.
18. Install covers, install units, close and secure doors, make certain that no wires are pinched and that all enclosure parts are properly aligned and secured.
19. Make sure the door interlocks on all disconnect operators are properly adjusted and secured. If adjustment is required, use the procedure explained in the Maintenance section of this instruction manual.
20. Disconnect any safety grounds which have been connected to the power bus.
21. Check all connections for mechanical and electrical tightness.

4.2 Energizing equipment

⚠ DANGER

Hazardous voltage.
Failure to check this equipment prior to energization can cause death or serious personal injury.
All pre-energized checks outlined in this instruction manual must be performed before the equipment is energized by Qualified Personnel only.

1. In order to minimize risk of injury or damage, or both, there should be no load on the motor control center when it is energized. Turn off all of the downstream leads, including those such as distribution equipment and other devices which are remote from the motor control center.
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 main devices, then the feeder devices, and then the branch-circuit devices. With barriers (if applicable) in place, and unit doors closed and latched, turn the devices on with a firm positive motion. Protective devices that are not quick-acting should not be “teased” into the closed position.
3. After all disconnect devices have been closed, loads such as lighting circuits, starters, contactors, heaters, and motors, may be turned on to verify that the system operates as intended.

4.3 Permissible loading of motor control centers

1. For motor control centers without main overcurrent protective devices, the total continuous load current through the horizontal bus should not exceed the current rating of the motor control center.
2. For motor control centers with a single main overcurrent protective device, the total continuous load current on the protective device should not exceed 80 percent of its ampere rating unless the device is rated to carry 100 percent of its ampere rating, in an enclosure.
3. For motor control centers with multiple main overcurrent protective devices, the total continuous current through the horizontal bus should not exceed the current rating of the motor control center. The total continuous load current on each overcurrent protective device should not exceed 80 percent of its ampere rating unless the device is rated to carry 100 percent of its ampere rating, in an enclosure.
4. For branch-circuit overcurrent protective devices in a motor control center, the total continuous load current on the protective device should not exceed 80 percent of its ampere rating unless the device is rated to carry 100 percent of its ampere rating, in an enclosure.
5. The maximum short-circuit current rating of the entire motor control center is the smallest of the following:

    a. the rating of the bus structure, or
    b. the lowest rating of the motor control units, or
    c. the lowest rating of the feeder units.

This motor control center rating is clearly indicated on the lead sheet located in the information packet.

Maintenance

5.1 Maintenance quick check list

Failure to properly maintain the equipment can result in death, serious injury, or product failure. The instructions contained herein should be carefully reviewed, understood, and followed. The following maintenance procedures must be performed regularly.

Scheduling

- ☐ Schedule maintenance appropriate to the severity of service.
- ☐ Consider environment (dampness, heat, and dust), severity of operations, and the importance of the machinery being controlled.
- ☐ Control unit maintenance should coincide with inspection of the motor being controlled.
- ☐ Buswork inspection entails shutting down the entire control center.

Cleaning (Page 34)

- ☐ Use a vacuum cleaner, not compressed air.
- ☐ Excess deposits of foreign materials signify faulty gasketing.
- ☐ Pay particular attention to conductive deposits.

Loose connections (Page 35)

- ☐ Periodic checking of tightness of connections promotes reliability and reduces heating.
- ☐ Overheating and discolorations signify loose connections.
- ☐ Torque horizontal bus bolts to 20 lbf-ft
- ☐ Torque incoming line connections to main lugs only to 85 lbf-ft
- ☐ Torque all incoming connections to main circuit breakers and fusible disconnects as per the breaker or disconnect manufacturer's recommendations. The torque requirements will be found on a label located on the disconnecting device.

Test position plug-in units (Page 24)

- ☐ Unscrew the locking latch in the lower front left-hand corner and disengage latch from separator angle.
- ☐ Release the racking lever in the top barrier plate.
- ☐ Slide unit out to the positive stop on the shelf brackets.
- ☐ As many as two padlocks may be used to lock unit in "test" position to prevent accidental stab engagement.

Contacts

- ☐ Make sure that all contacts are free from extraneous materials, excess pitting or burning.
- ☐ Check for spring pressure.
- ☐ Lubricate stab connections with approved lubricant.

Locking in engaged position (Page 35)

- ☐ To lock in "ON", drill out the indentations on the disconnect operating handle and insert a padlock.
- ☐ To lock in "OFF", as many as three padlocks may be inserted in the disconnect operating handle.

Field additions of sections (Page 13)

- ☐ For field additions of sections, follow the same procedure as for the field assembly of shipping splits.

Addition and replacement of control units (Pages 24-27)

- ☐ De-energize motor control center incoming line connections

Adding to a blank unit space (Page 25)

- ☐ Open blank door.
- ☐ Remove hinge pins with door open.
- ☐ Close door halfway and remove door.
- ☐ If necessary, install unit support assembly and blank covers or doors.
- ☐ Insert shelf brackets at a slight angle into vertical bus support angle and snap into place.
- ☐ Secure brackets by fastening the right-hand bracket to bus support angle and the separator angle to the left side of structure with the two screws provided.
- ☐ Mount unit door. (Opposite procedure of removing blank door.)
- ☐ Remove (if required) unit stab hole covers.
- ☐ Verify that stab is lubricated with approved lubricant*.
- ☐ Slide control unit into place with disconnect handle "OFF".
- ☐ Complete engagement by closing racking lever. Engage locking latch to separator angle and screw down.
- ☐ Connect outgoing power and control wiring.
- ☐ Close door and perform pre-operation checks (see page 29).

Replacing with unit of the same size (Page 24)

- ☐ If possible, deenergize motor control center.
- ☐ Move disconnect operating handle to "OFF".
- ☐ Open door, loosen and disengage locking latch.
- ☐ Open vertical wireway door.
- ☐ Move unit to .test. position.
- ☐ Disconnect control and load wiring
- ☐ Remove unit by tilting and sliding out.
- ☐ Reverse procedure for replacement unit.
- ☐ Perform pre-operation checks (Pages 29-30)

Rearranging control units of different sizes (Page 24)

- ☐ Remove all necessary units, doors and unit support assemblies.
- ☐ Realign support assemblies where appropriate.
- ☐ Remove stab hole covers where appropriate (and cover the stab hole covers that will not be used).
- ☐ Mount unit doors.
- ☐ Install rearranged units.

Insulation test (Megger) (Page 27)

*Mobilgrease 28

This checklist does not represent an exhaustive survey of maintenance steps necessary to ensure safe operation of the equipment. Particular applications may require further procedures. 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.

Dangerous voltages are present in the equipment which can cause death, serious injury, or property damage. Always de-energize and ground the equipment before maintenance. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment, tampering by unqualified personnel, will result in dangerous conditions which can cause death, serious injury, or equipment damage. Follow all safety instructions contained herein.

DANGER

Hazardous voltage.
Failure to check this equipment prior to energization can cause death or serious personal injury.
1) Disconnect and lockout incoming power and control voltage sources before beginning work on this or any other electrical equipment.
2) Check all power and control circuit terminals with a voltmeter to make certain that the equipment is totally de-energized.
3) Ensure that only qualified personnel be instructed and authorized to use the defeater mechanism to gain access to an de-energized compartment.
4) Never attempt to withdraw unit or disconnect any terminations when the defeater mechanism has been used to open the compartment door.

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.

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 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. This manual should be reviewed and retained in a location readily accessible for reference during maintenance of this equipment.

The customer must establish a periodic maintenance program to ensure trouble-free and safe operation. The frequency of inspection, periodic cleaning, and preventive 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 preventive 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.

The following items should be included in any maintenance checklist. For more details read the succeeding pages.

- General inspection of the MCC
- Periodic cleaning
- Tightening torques
- Stab fingers and vertical bus
- Circuit breaker/disconnect operator
- Mechanical interlocks

A specific checklist of routine preventive maintenance requirements is recommended for each item of equipment, as well as a log book to record the maintenance history.

5.2 General Inspection of the MCC

1. Carefully inspect the doors, enclosure sides, and deadfront surfaces over all units for excessive heat. As a general rule, a temperature which the palm of the hand cannot stand for about 3 seconds may indicate trouble.
2. Inspect the motor control center 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 MCC. Look for any accumulation of dust or dirt. Clean as explained in the Periodic Cleaning section.
3. Loose electrical connections can cause overheating that can lead to equipment malfunction or failure. Loose bonding or grounding can compromise safety and/or function. Terminals crews, lugs, bus connections, bonding and grounding connections should be inspected for tightness and retightened securely as required. Recommended tightening torques are shown in the Recommended Tightening Torque section of this manual. Fuse clips should be checked for signs of overheating, looseness, or inadequate spring pressure, and replaced if necessary. All terminals,connections, and conductors should be examined for evidence of overheating, corrosion, or pitting. Any parts found to be damaged should be replaced, using parts supplied or recommended by Siemens. Evidence of overheating may include discolored conductors, terminals, or parts; or melted, charred, or burned insulation.

4. Examine insulation on conductors for overheating or chafing against metal edges that could progress into an insulation failure. Any damaged conductors should be replaced. Replacement conductors should be rerouted,braced, or shielded if needed to avoid similar damage in future operation. Temporary wiring should be removed or replaced by permanent wiring.

5. Operate each switch or circuit breaker several times to insure that all mechanisms are free and in proper working order. Check the operation of the mechanical safety interlocks provided with the operator (see section on Circuit Breaker/ Disconnect Operator).Never attempt to operate a switch or circuit breaker by use of excessive force.
6. Visually inspect instruments and pilot lights. Replace defective pilot lights. Check instrument calibrations.
7. Check all devices for missing or broken parts, proper spring tension, free movement, rusting or corrosion, dirt, and excessive wear. Perform periodic maintenance on components as detailed in the component instruction books.
8. Recommended to go along with the maintenance program for a motor control center is an adequate stock of renewal parts. This is important where service becomes a critical factor or downtime is extremely expensive. The items kept in stock will depend on the type of motor control center and its application. Typical items kept in stock should include contact kits, magnet coils, and fuses. When ordering renewal parts, the following information must be provided.
    1. Complete part numbers of items required.
    2. Quantity of parts required.
    3. Description of parts.
    4. Motor control center catalog number. The catalog number is found on the control center nameplate located on front of the center.
    5. Unit identification number. The number is located on a label on the side of the control unit for which the ordered parts are needed.

See the Siemens control catalog and the following replacement part publications for starters.

0 - 1 3/4	14 - GCF	4	14 - GJB
2 - 2 1/2	14 - GFF	4 1/2 - 5	14 - GKF
3 - 3 1/2	14 - GHF	6	14 - GMF

5.3 Periodic cleaning

Accumulation of dust and foreign material such as coal dust, cement dust, or lampblack must be removed from all control equipment and all surfaces must be wiped clean at regular intervals. Dirty, wet, or contaminated parts should be replaced unless they can be cleaned effectively. Dust can collect moisture, causing voltage breakdown and it can reduce the effectiveness of heat sinks.

Control equipment parts should be cleaned by vacuuming or wiping with a dry cloth or soft brush. Use care to avoid damaging delicate parts.
Liquid cleaners, including spray cleaners, are not recommended due to the possibility of residues. Compressed air is not recommended for cleaning because it will only distribute contaminants on other surfaces, and may damage delicate parts. The inside bottom of the motor control center should also be cleaned, including removal of any hardware or debris, so that any new or unusual wear or loss of parts occurring after the inspection may be more readily detected during subsequent maintenance. Inspect the motor control center for any signs of previous wetness or dripping inside the controller.

Condensation in conduits or dripping from an outside source is a common cause of failure.
Seal off any conduits that have dripped condensate, and provide an alternative means for the conduit to drain. 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. Replace and thoroughly dry and clean any accumulation of deposited material from previous wettings.

5.4 Stab fingers and vertical bus

Look for wear of the tin plating where the unit stab fingers engage the vertical bus. The plating is part of the environmental protection system. Oxide and/or other films can form on exposed bus resulting in a poor contact.

Lubricate stab connection points with an approved lubricant. These parts must be replaced when the plating is worn to the point where copper can be seen because contact resistance becomes higher, increasing the heat generated at the contact point.

5.5 Recommended tightening torques

When making bolted assemblies, the following considerations should be generally followed. The tightening torques are determined by the size of hardware used.

1. **Metal-to-metal** – Apply standard tightening torque as listed:

Recommended tightening torques

Thread size	Torque (lbf-in)
8 - 32	20
10 - 32	27 - 32
1/4 - 20	75
5/16 - 18	100
3/8 - 16	247
1/2 - 13	613

2. **Metal-to-insert molded in compound part** – Apply 2/3 of standard tightening torque.
3. **Compound-to-compound** – Apply 1/2 of standard tighten in torque.
4. Control Terminals – 11 lbf-in.
5. Tighten box type incoming cable lug set screws to the recommended values shown on the circuit breaker or device. If no label is present the recommended value is 85 lbf-ft.
6. Tighten bolted bus connections to 20 lbf-ft.
7. 400 A and 600 A fixed mounted unit clamp assembly bolts should be tightened to 35 lbf-ft.

5.6 Disconnect operating handle adjustment

DANGER

Hazardous voltage.
Will cause death or serious personal injury.

Disconnect power before working on this equipment.

In rare circumstances, such as when changing a circuit breaker or a fusible switch or when a unit is taken apart, it may be necessary to adjust the disconnect operating handle. (The Siemens fusible disconnect switch for 30 A, 60 A, 100 A, and 200 A ratings does not require adjustment.)

1. Perform all disconnect operating handle adjustments with the unit removed from the motor control center or in the“test” position.
2. The adjustable link rod can adjust to increase or decrease its overall length by rotating the sleeve. By rotating the sleeve clockwise the length is increased and by rotating it counterclockwise the length is decreased. A hex nut is provided as part of the adjustable link rod and is tightened against the sleeve to prevent it from going out of adjustment. The hex nut must be loose and sufficiently away from the sleeve to allow it to rotate during the adjustment of the handle.

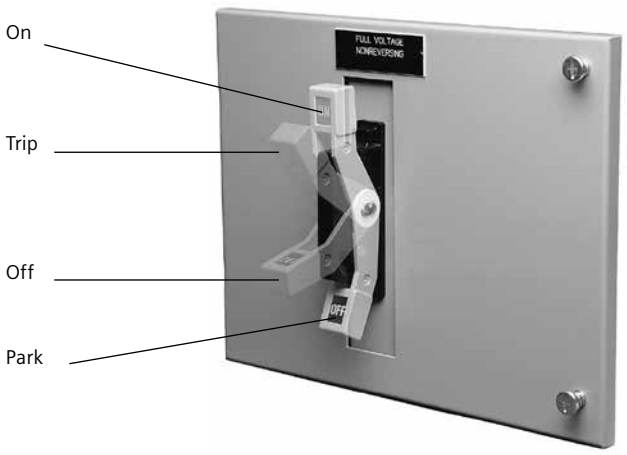


Figure 68

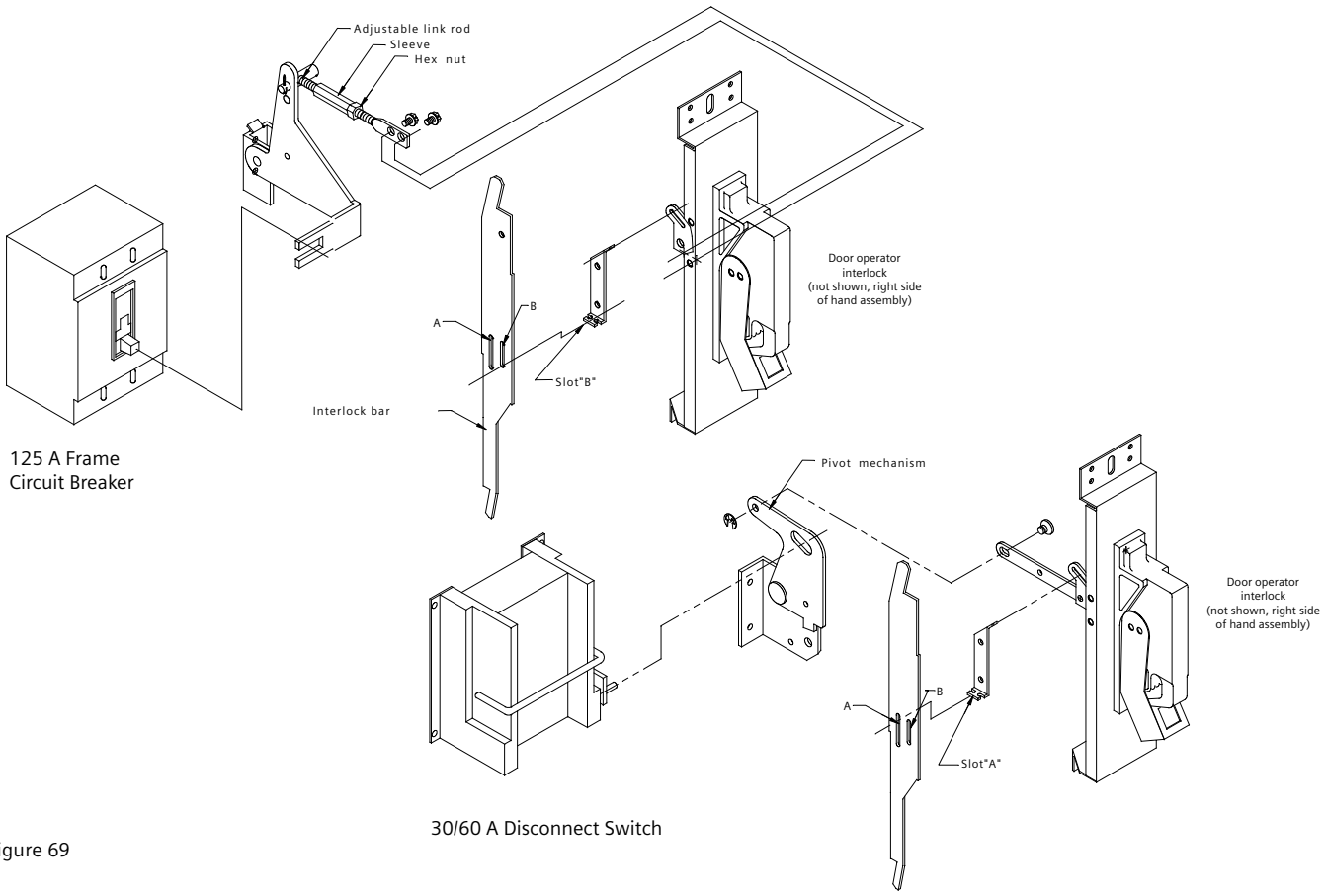


Figure 69

3. The handle assembly must be adjusted to perform the following functions:

Circuit breaker	Disconnect switch
Unit must turn "ON"	Unit must turn "ON"
Unit must turn "OFF"	Unit must turn "OFF"
Unit must indicate "TRIP"	
Unit must "RESET"	

4. Operate the handle from the "ON" position to the "OFF" position and circuit breaker or disconnect switch will turn "OFF".
5. Return the handle to the "ON" position and the circuit breaker or disconnect switch will turn "ON". If it does not, rotate the sleeve slightly clockwise and try again. Repeat this step until the handle assembly turns the unit "ON". Then, repeat step 4.
6.[1] Once steps 4 and 5 have been satisfactorily completed, the adjustment for the disconnect switch will have been completed. Tighten the hex nut against the sleeve to lock in the adjustment. The following steps will now only pertain to circuit breakers.
7. Trip the circuit breaker and the handle should move to a position midway between the "ON" and "RESET" positions. Circuit breakers from different manufacturers require different methods to trip them. One can be tripped by rotating a red button, another by passing a high current at low voltage through one of the poles. (The defeater mechanism should engage.)
8.[1] Now move the handle down past the "OFF" position to reset the circuit breaker. If the circuit breaker resets and can be returned to the "ON" position by the handle, the adjustment has been completed and the hex nut should be tightened against the sleeve. If the circuit breaker does not reset, turn the sleeve counterclockwise slightly and try again. Repeat this step until the breaker resets. Then repeat steps 4-8 to verify that the previous adjustments have not been adversely effected.
9. In the case of both the circuit breaker and disconnect switch,the adjustment should be such they turn on with the knob no closer the 1/8" away from the escutcheon.

1) Always use two wrenches when loosening, adjusting, or tightening the adjustable link rod. One wrench adjusts the hex sleeve while the second wrench holds the hex nut.

A provision is made for qualified persons to defeat the door operator interlock when the handle is in the "ON" position. This is accomplished by turning the defeater screw counterclockwise approximately 1/8 turn until the door is released. It is not necessary to operate the defeater screw to close the unit door. Release the defeater screw and secure the 1/4 turn door fasteners.

This safety interlock also serves to prevent inadvertent closing of the disconnect when the door is open. Authorized personnel may defeat the interlock in this situation by pushing down the exposed interlock arm lever. This releases the interlock so that the protective device may be turned "ON".

5.7 Adjustment notes

No field adjustment to the door interlock mechanism should be necessary under normal operating conditions. However, should adjustment become necessary as a result of mechanical damage or wear, the following procedure is recommended.

With disconnecting device in the "OFF" position, and the unit door open, defeat the interlock by pushing the top of the lever to the left and turn breaker "ON" and "OFF" several times. If the disconnecting device fails to turn "ON" or if operating resistance is experienced, turn protector "OFF". Withdraw the unit and inspect for misalignment of the operator extension(s) or the driver. Make necessary adjustments to correct any misalignment.

5.8 Maintenance after a fault has occurred

The excessive currents occurring during a fault may result in component or bus 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. ICS2-1987, Part ICS 2-302 and make any necessary repairs or replacements prior to placing the equipment into service again. The following procedure is recommended for this inspection.

Bus – Retighten all bus connections. Replace burnt or melted bus or bus with melted, worn, or damaged plating. Replace all insulators showing deterioration, deposits, or cracks.

Enclosure – Inspect the enclosure and doors for evidence of damage such as deformation, displacement of parts, or burning. Extensive damage will require replacement of the entire controller.

5.9 Disconnect means

1. Circuit breakers: Examine the circuit breaker for evidence of possible damage. If there is not apparent evidence of damage,the breaker may be reset and turned "ON." If it is suspected that the circuit breaker has opened several short circuits or if there are signs of possible deterioration, replace the breaker or subject it to the described in Para. AB1-2.38 of the NEMA Standards Publication for "Molded Case Circuit Breakers" before restoring it to service.
2. Disconnect switch: The external operating handle must be capable of opening the switch after a fault. Replace the switch if the external operating handle fails to open it or if visual inspection after opening indicates deterioration beyond normal wear, such as overheating, contact blade or jaw pitting, charring, or insulation breakage.
3. Fuse holders: Replace fuse holders if the insulating mounts, barriers, or fuse clips show signs of deterioration, heating, distortion, or looseness.
4. Operating handle: The disconnecting means must be replaced if the operating handle fails to open and close the disconnect device. The door interlock must be inspected and its proper function verified prior to restoring the controller to service.
5. Stab fingers: (Figure 70) Inspect stab fingers as instructed under Stab Fingers Section and Vertical Bus Section and replace if necessary. Lubricate stab fingers with approved lubricant.

Figure 70: The stab assembly

5.10 Terminals and internal conductors

Replace all damaged parts which show evidence of discoloration, melting, or arcing damage.

5.10.1 Motor starter

1. Contactor – Replace the contacts and contact springs if the contacts are welded or show heat damage, displacement of metal, evidence of binding in the guides, or wear in excess of wear allowance. If deterioration extends beyond the contacts,replace the contactor. Examples of such deterioration include evidence of arcing on the contactor moldings and insulation damage. Arc chutes must be in place and secured prior to operating contactor.
2. Overload relays – a) Any indication of an arc striking or burning the overload relay may require replacement. b) Contact operation must be verified by electrically or mechanically tripping and resetting the relay even if there is no visual indication of damage that would require replacement.
3. Fuses – Always replace all three fuses even though only one or two are open circuited since internal damage suffered by fuses not replaced could result in nuisance shut down later.
4. Perform the pre-energization checks procedures detailed on page 29 herein, before restoring the equipment to service.

5.11 Adjustment of ETI instantaneous trip motor circuit interrupter (1A-125 A)

⚠ DANGER

Hazardous voltage.
Will cause death or serious personal injury.

Disconnect and lock-out all power and control voltage sources supplying the motor circuit interrupter before adjusting trip setting or performing any other maintenance operations.

ETI instantaneous trip motor circuit interrupters are supplied as standard with Size 1 through Size 6 motor starters. The motor circuit interrupter continuous current rating should not be less than 115% of motor full load current (MFLC). The MFLC is obtained from the motor nameplate or from Table 430-150 of the NEC (1999). Use the following procedure to adjust the instantaneous trip setting.

1. Move the operating handle to the “OFF” position and open the unit door.
2. The instantaneous trip circuit breaker is factory set at the LOW position.

To set: determine motor full load current from the motor nameplate. Refer to the table and determine the recommended setting position. Use a screwdriver to set the indicator on the adjustment screw to the appropriate position.

For maximum protection the trip position should be set as low as possible. Turn the adjustment screw counterclockwise to successively lower positions until the breaker trips on motor starting.

After this position is determined, turn the adjustment screw clockwise to the next higher setting for normal operation. The adjustment screw is infinitely adjustable for customer convenience. If the breaker does not trip at the lowest setting leave the indicator at this setting.

3. Adjust the trip setting by rotating the adjustment dial to the position selected in step 2 above.

Ensure that the setting on a magnetic only motor circuit protector does not exceed the maximum allowable setting as defined in the 1999 National Electrical Code, section 430-S2 (C)(3).

5.12 Field testing of the circuit breakers

A test can be performed using the procedure outlined in the following discussion to verify that a circuit breaker trip mechanism is functioning.

1. Wire the three circuit breaker poles in series.
2. Connect the series combination of breaker poles to a variable low voltage high current power source.
3. Gradually increase the current from “0” until the circuit breaker trips. If the circuit breaker fails to trip when the test current reaches 150% of the largest trip setting, the trip unit is not functioning properly and the circuit breaker requires replacement.

5.13 Overload relay

For proper overload relay coordination, the cables on the load side of the overload relay should be sized in accordance with the tables in Article 310 of the National Electrical Code. The wire for motors with full load currents of 100 amperes or less may be selected from the 60 °C or 75 °C column. Select wire from the 75 °C column when the motor current is greater than 100 amperes. When conditions dictate the use of cables larger than these, the relay tripping time may be affected. Another condition which may affect tripping is a long acceleration time such as that caused by a motor driving a high inertia load. If either of these conditions exists, consult Siemens for overload relay application instructions.

3VA Molded Case Circuit Breakers

3VA Molded Case Switch and Motor Circuit Protector

Motor circuit protector TM120M AM[3]

Frame (Breaker Type)	Maximum Ampere Rating	3-Pole Catalog Number	Instantaneous short circuit protection
3VA51 (HEAP)	1	3VA5181-1MU31-0AA0	3 ... 7
		3VA5181-1MH31-0AA0	5 ... 12
	2	3VA5102-1MU31-0AA0	6 ... 14
		3VA5102-1MH31-0AA0	10 ... 24
	3	3VA5103-1MU31-0AA0	9 ... 21
		3VA5103-1MH31-0AA0	15 ... 36
	5	3VA5105-1MU31-0AA0	15 ... 35
		3VA5105-1MH31-0AA0	25 ... 60
	7	3VA5107-1MU31-0AA0	21 ... 49
		3VA5107-1MH31-0AA0	35 84
	10	3VA5191-1MU31-0AA0	30 ... 70
		3VA5191-1MH31-0AA0	50 ... 120
	15	3VA5195-1MU31-0AA0	45 ... 105
		3VA5195-1MH31-0AA0	75 ... 180
	25	3VA5125-1MU31-0AA0	75 ... 175
		3VA5125-1MH31-0AA0	25 ... 300
	30	3VA5130-1MU31-0AA0	90 ... 210
		3VA5130-1MH31-0AA0	150 ... 360
	40	3VA5140-1MU31-0AA0	120 ... 280
		3VA5140-1MH31-0AA0	200 ... 480
	50	3VA5150-1MU31-0AA0	150 ... 350
		3VA5150-1MH31-0AA0	250 ... 600
	70	3VA5170-1MU31-0AA0	210 ... 490
		3VA5170-1MH31-0AA0	350 ... 840
	80	3VA5180-1MU31-0AA0	240 ... 560
		3VA5180-1MH31-0AA0	400 ... 950
	90	3VA5190-1MU31-0AA0	270 ... 630
		3VA5190-1MH31-0AA0	450 ... 1080
	100	3VA5110-1MU31-0AA0	300 ... 700
		3VA5110-1MH31-0AA0	500 ... 1200
	110	3VA5111-1MU31-0AA0	330 ... 770
		3VA5111-1MH31-0AA0	550 ... 1320
	125	3VA5112-1MU31-0AA0	375 ... 875
		3VA5112-1MH31-0AA0	625 ... 1500
3VA52 (HFAP)	150	3VA5215-0MU31-0AA0	450 ... 900
		3VA5215-0MH31-0AA0	900 ... 1800
	200	3VA5220-0MU31-0AA0	600 ... 1200
		3VA5220-0MH31-0AA0	1200 ... 2400
	250	3VA5225-0MU31-0AA0	750 ... 900
		3VA5225-0MH31-0AA0	1250 ... 2500
3VA53 (HJAP)	250	3VA5325-0MU31-0AA0	750 ... 1500
		3VA5325-0MH31-0AA0	1500 ... 3000

Motor circuit protector TM120M AM[2]

Frame (Breaker Type)	Maximum Ampere Rating	3-Pole Catalog Number	Instantaneous short circuit protection
3VA54 (HLAP)	400	3VA5440-0MU31-0AA0	750 ... 1500
		3VA5440-0MH31-0AA0	1200 ... 2400
	500	3VA5450-0MU31-0AA0	1500 ... 3000
		3VA5450-0MH31-0AA0	3000 ... 6000
	600	3VA5460-0MU31-0AA0	1800 ... 3600
		3VA5460-0MH31-0AA0	3000 ... 6000
3VA55 (HMAP)	600	3VA5560-0MH32-0AA0	4800 ... 9600
3VA52 (CFAP)	150	3VA5215-1MU31-0AA0	450 ... 900
		3VA5215-1MH31-0AA0	900 ... 1800
	200	3VA5220-1MU31-0AA0	600 ... 1200
		3VA5220-1MH31-0AA0	1200 ... 2400
	250	3VA5225-1MU31-0AA0	750 ... 900
		3VA5225-1MH31-0AA0	1250 ... 2500
3VA53 (CJAP)	250	3VA5325-1MU31-0AA0	750 ... 1500
		3VA5325-1MH31-0AA0	1500 ... 3000
3VA54 (CLAP)	400	3VA5440-1MU31-0AA0	750 ... 1500
		3VA5440-1MH31-0AA0	2400 ... 4800
	500	3VA5450-1MU31-0AA0	1500 ... 3000
		3VA5450-1MH31-0AA0	3000 ... 6000
	600	3VA5460-1MU31-0AA0	1500 ... 3000
		3VA5460-1MH31-0AA0	3000 ... 6000
3VA55 (CMAP)	600	3VA5560-1MH32-0AA0	4800 ... 9600

1. Rated at 600 Y/347 V AC.
2. SCCR is 100kA at 480 V. SCCR rating is the maximum permissible short circuit current of the MCP in combination with an appropriate overload protection device.
3. SCCR is 65kA at 480 V. SCCR rating is the maximum permissble short circuit current of the MCP in combination with an appropriate overload protection device.

I-T-E type ETI setting positions

	Trip settings positions							
Continuous Amps	**LOW**	**2**	**3**	**4**	**5**	**6**	**7**	**HI**
1	2.6	4.5	6	7.5	—	—	—	9
2	7	11	15	19	—	—	—	22
3	10	17	23	30	—	—	—	35
5	16	26	36	46	—	—	—	54
10	30	50	70	85	—	—	—	100
25	55	90	125	155	—	—	—	180
30	80	135	185	235	—	—	—	270
40	115	185	255	325	—	—	—	375
50	180	300	410	520	—	—	—	600
100	315	540	740	890	—	—	—	1000

FXD62A
JXD62H
LXD62H
MXD62A Contact Siemens Sales Office for settings with current limiters.

HEM setting positions

			Trip setting positions					
Catalog Number	**Contact Amps**	**NEMA Starter Size**	**A**	**B**	**C**	**D**	**E**	**F**
HEM3M003L	3	0	9	15	21	27	30	33
HEM3M007L	7	0	21	35	49	63	70	77
HEM3M015L	15	0	45	75	100	135	150	165
HEM3M030L	30	1	90	150	210	270	300	330
HEM3M050L	50	2	150	250	350	450	500	550
HEM3M070L	70	2	210	350	490	630	700	770
HEM3M100L	100	3	300	500	700	900	1000	1100

Troubleshooting

DANGER

Hazardous voltage.
Will cause death or serious personal injury.

Disconnect power before working on this equipment.

In the unlikely 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 Controls relative to the equipment problem.

1. Manufacturer's order number and part number, if 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.

Problem	Probable cause	Corrective action
Doors will not close or out of alignment.	Enclosure is not bolted down tightly.	Using level, add shims as necessary and tighten anchoring bolts.
	Enclosure sprung out of shape. Door hinges not properly adjusted.	Straighten or repair enclosure. Remove door hinges. Add or subtract shims as necessary.
Contactor will not close.	Control circuit or power fuse blown or circuit breaker tripped.	Inspect fuses, replace if blown. Reset circuit breaker.
	Incoming power line not energized.	Close feeder circuit breakers or tie switch.
	Magnet coil defective.	Check magnet operation, replace coil as necessary.
	Interposing relay defective.[1]	Check and replace if defective.
	Control power transformer defective.	Check and replace if necessary.
	Overload relay tripped or defective.	Check and replace if necessary.
	Missing jumper, 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 or hum.	Loose connection in control circuit.	Tighten connections in control circuit.
	Defective interposing relay.[1]	Check relay, replace if necessary.
	Defective coil.	Check main coil, replace if necessary.
	Low control voltage.	Check line voltage.
	Corroded or dirty magnet pole faces.	Clean or replace magnet assembly.
Contacts overheating.	Loose connections. Contacts not mating firmly.	Tighten connections. Check for weak or deformed contact spring, replace if necessary.
	Contact tip eroded.	Replace contacts.

1) Not supplied on all starters.

Problem	Probable cause	Corrective action
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 and control. 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 application. Where accelerating time approaches 12 seconds or more, special overload relay bypass devices and circuits would usually be required. Contact Siemens 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.
Overload relay trips during motor operation.	Motor being overloaded.	Reduce load or correct conditions causing overload.
	Overload relay not adjusted to motor capabilities or sized properly.	Adjust relay setting in accordance with instructions for the overload relay. Adjustment should correspond to thermal rating and service factor. Replace overload if not sized properly.
Overload relay fails 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 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.

Problem	Probable cause	Corrective action
Blowing of motor power fuses.	Short circuit on the 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 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 against motor full load currents and service factor.
	Fuses internally damaged because of improper handling.	Motor power fuses may be damaged, dropped, or roughly handled. Replace with fuse of same type, rating, and voltage.
Blowing of primary control transformer fuses.	Shorted primary wiring in control transformer.	Replace or repair transformer.
	Fuse may be “open” due to rough handling before installing.	Replace with fuse of same type, rating, and voltage.
	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 fuse.	Abnormal current or short circuit in control wiring.	Check for shorted magnet coils, shorted rectifiers, if supplied, grounds, loose or bent connections, mechanical binding in relay and contactor mechanisms, excessive operations, and incorrect secondary terminal connections.

Heater tables

Full load mo. amps		Heater code no.	Max. rat. of prot. device[1]
Min.	Min.		
Size 0 & 1			
0.67	0.72	E14	3
0.73	0.80	E16	3
0.81	0.85	E17	3
0.86	0.92	E18	3
0.93	0.99	E19	3
1.00	1.08	E23	3
1.09	1.23	E24	3
1.24	1.37	E26	3
1.38	1.54	E27	3
1.55	1.69	E28	3
1.70	1.80	E29	3
1.81	1.94	E31	3
1.95	2.07	E32	3
2.08	2.26	E33	3
2.27	2.54	E34	7
2.55	2.69	E36	7
2.70	2.88	E37	7
2.89	3.14	E38	7
3.15	3.40	E39	7
3.41	3.81	E41	7
3.82	4.26	E42	7
4.27	4.62	E44	7
4.63	5.09	E46	7
5.10	5.61	E47	7
5.62	5.91	E48	7
5.92	6.15	E49	15
6.16	6.70	E50	15
6.71	7.54	E51	15
7.55	8.29	E52	15
8.30	8.99	E53	15
9.00	9.85	E54	15
9.86	10.4	E55	15
10.5	12.0	E56	15
12.1	13.6	E57	30
13.7	15.8	E60	30
15.7	17.0	E61	30
17.1	18.4	E62	30
18.5	19.4	E65	30
19.5	21.3	E66	30
21.4	24.4	E67	30
24.5	25.9	E69	30
26.0	26.0	E70	30

Size 1 only D25385-7

Full load mo. amps		Heater code no.	Max. rat. of prot. device[1]
Min.	Min.		
Size 1 3/4			
2.27	2.54	E34	7
2.55	2.69	E36	7
2.70	2.88	E37	7
2.89	3.14	E38	7
3.15	3.40	E39	7
3.41	3.81	E41	7
3.82	4.25	E42	7
4.26	4.62	E44	7
4.63	5.09	E46	7
5.10	5.61	E47	7
5.62	5.91	E48	7
5.92	6.15	E49	15
6.16	6.70	E50	15
6.71	7.54	E51	15
7.55	8.29	E52	15
8.30	8.99	E53	15
9.00	9.85	E54	15
9.86	10.4	E55	15
10.5	12.0	E56	15
12.1	13.6	E57	30
13.7	15.6	E60	30
15.7	17.0	E61	30
17.1	19.4	E62	30
19.5	20.9	E65	30
21.0	22.2	E66	30
22.3	25.3	E67	30
25.4	26.9	E69	50
27.0	30.2	E70	50
30.3	33.3	E72	50

D25556-3

Size 2 & 2 1/2			
10.5	12.0	E56	50
12.1	13.6	E57	50
13.7	15.6	E60	50
15.7	17.1	E61	50
17.2	19.4	E62	50
19.5	20.9	E65	50
21.0	22.2	E66	50
22.3	25.3	E67	50
25.4	26.9	E69	50
27.0	30.2	E70	50
30.3	33.3	E72	50
33.4	35.3	E73	50
35.4	41.5	E74	50
41.6	45.0	E76	100

Size 2 1/2 only D26069-5

Full load mo. amps		Heater code no.	Max. rat. of prot. device[1]
Min.	Min.		
Size 3 & 3 1/2			
33.6	36.4	E70	100
36.5	39.6	E71	100
39.7	43.6	E73	100
43.7	46.5	E73A	100
46.6	51.6	E74	100
51.7	54.4	E76	100
54.5	58.0	E77	100
58.1	63.0	E78	100
63.1	67.7	E79	100
67.8	72.4	E80	100
72.5	80.0	E94	100
80.1	88.1	E96	100
88.2	91.5	E97	150
91.6	96.8	E98	150
96.9	99.0	E99	150
99.1	108	E101	150

Size 3 1/2 only D26801-3

Size 4			
3.15	3.40	E39	7
3.41	3.81	E41	7
3.82	4.26	E42	7
4.27	4.62	E44	7
4.63	5.09	E46	7
5.10	5.61	E47	7
5.62	5.91	E48	7
5.92	6.15	E49	15
6.16	6.70	E50	15
6.71	7.54	E51	15
7.55	8.29	E52	15

D36024-2

Full load mo. amps		Heater code no.	Max. rat. of prot. device[1]
Min.	Min.		
Size 4 1/2 & 5			
98.1	108	E28	250
109	114	E29	250
115	122	E31	250
123	130	E32	250
131	140	E33	250
141	155	E34	250
156	166	E36	250
167	177	E37	250
178	193	E38	400
194	209	E39	400
210	233	E41	400
234	248	E42	400

Size 5 only D25651-5

Size 6			
166	195	E27	400
196	217	E28	400
218	229	E29	400
230	245	E31	400
246	261	E32	400
262	281	E33	400
282	311	E34	400
312	331	E36	400
332	355	E37	400
356	387	E38	600
388	419	E39	600
420	467	E41	600
468	500	E42	600

D-25665-3

DANGER

Hazardous voltage.
Will cause death or serious personal injury.

Automatic reset will continue to reset on two-wire control. When not desired, use three-wire control. Do not use manual trip button when relay is set in automatic reset position.

Heaters shown in the table provide a maximum trip rating of 125% of the motor nameplate amperes, which is suitable for 40 °C motors. For all other motors, select heaters one code number lower than specified in the table, which give a maximum trip rating of approximately 115%.

The tripping current of any heater in a 40 °C ambient is 25% greater than the lower value of motor amperes shown in the table.

Starters do not provide protection from short circuits. A protective device should be provided in accordance with the NEC (CEC in Canada) and not exceed the values shown in the table.

Note: If the rating specified is not a standard size for the circuit breaker manufacturer, use the next largest size.

Wye-Delta starters: If the motor nameplate shows the full load delta line current only, divide this value by 1.73 or multiply by .58 to select the proper heater rating.

Maximum current rating for thermal magnetic circuit breakers is 250% of maximum heater FLA.

Maximum current rating of fuses is:

a. 150% of maximum heater FLA for Class R, K, or L (time delay).

b. 250% of maximum heater FLA for Class K or L (non-time delay).

c. 300% of maximum heater FLA for Class J (non-time delay).

If the calculated rating is between standard sizes, the next larger size may be used. Fuse size may not exceed switch size.

1) Ratings specified are for instantaneous trip circuit breakers.

K "Standard trip" heater elements for ambient temp. comp. bimetal relays

Size								
00, 0	1, 1 3/4	2, 2 1/2	3, 3 1/2	4 (JB)	4 (JG)	4 1/2, 5	6	Heater Code
1.52-1.65	1.52-1.65					98-106	196-213	K21
1.66-1.79	1.66-1.79					107-115	214-231	K22
1.80-1.94	1.80-1.94					116-124	232-249	K23
1.95-2.15	1.95-2.15					125-136	250-273	K24
2.16-2.37	2.16-2.37					137-149	274-299	K26
2.38-2.56	2.38-2.56					150-160	300-321	K27
2.57-2.87	2.57-2.87					161-171	322-343	K28
2.88-3.13	2.88-3.13					172-192	344-385	K29
3.14-3.37	3.14-3.37					193-206	386-413	K31
3.38-3.72	3.38-3.72					207-228	414-457	K32
3.73-4.00	3.73-4.00					229-248	458-514	K33
4.01-4.35	4.01-4.35						515-563	K34
4.36-4.99	4.36-4.99							K36
5.00-5.38	5.00-5.38							K37
5.39-5.79	5.39-5.79							K39
5.80-6.43	5.80-6.43							K41
6.44-6.83	6.44-6.83							K42
6.84-7.83	6.84-7.83							K43
7.84-8.23	7.84-8.23							K49
8.24-9.59	8.24-9.59							K50
9.60-9.90	9.60-9.90	10.0-10.9						K52
10.0-10.7	10.0-10.7	11.0-12.0						K53
10.8-11.6	10.8-11.6	12.1-12.7						K54
11.7-12.3	11.7-12.3	12.8-13.5						K55
12.4-13.4	12.4-13.4	13.6-14.6						K56
13.5-14.2	13.5-14.2	14.7-15.9	14.3-15.6	18.9-20.4				K57
14.3-15.1	14.3-15.1	16.0-16.9	15.7-17.1	20.5-22.1				K58
15.2-17.5	15.2-17.5	17.0-18.2	17.2-18.9	22.2-24.3				K60
17.6-18.7	17.6-18.7	18.3-19.5	19.0-20.7					K61
18.8-20.0	18.8-20.0	19.6-20.9	20.8-22.8					K62
20.1-21.5	20.1-21.5	21.0-23.1	22.9-25.6	24.4-26.7				K63
21.6-23.9	21.6-23.9	23.2-25.4	25.7-27.6	26.8-29.3				K64
24.0-25.8	24.0-25.8	25.5-27.9	27.7-30.3	29.4-32.3				K67
	25.9-29.5	28.0-30.5	30.4-33.3	32.4-35.5				K68
			33.4-36.7	35.6-39.0				K69
	29.6-32.7	30.6-33.5	36.8-40.0	39.1-42.9	49.7-52.3			K70
	32.8-36.0	33.6-37.2	40.1-42.4	43.0-46.5				K72
		37.3-40.7	42.5-46.3	46.6-50.9				K73
		40.8-43.0	46.4-49.6	51.0-55.9				K74
		43.1-47.9	49.7-52.3	56.0-59.1				K75
		48.0-52.7	52.4-57.5	59.2-68.7	52.4-57.5			K76
		52.8-58.3	57.6-63.9	68.0-74.3	57.6-63.0			K77
		58.4-60.0	64.0-67.9	80.8-92.7	63.1-68.1			K78
			68.8-80.7		68.2-74.3			K83
			74.4-77.9		74.4-79.9			K85
			78.0-83.1	92.8-103.9	80.0-87.4			K86
			83.2-91.4	104.0-113.5	87.5-90.0			K87
			91.5-99.9	113.6-127.9	90.1-100.1			K88
			100.0-108		100.1-108.0			K89
					108.1-119.0			K90
				128.0-143.9	119.1-130.0			K92
				144.0-163.9				K94
				164.0-180.0				K96

Heaters shown in the table provide a maximum trip rating of 125% of the motor nameplate amperes, which is suitable for 40 °C motors. For all other motors select heaters one code number lower than specified in the table, which give a maximum trip rating of approximately 115%.

The tripping current of any heater in a 40 °C ambient is 25% greater than the lower value of motor amperes shown in the table.

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Note: If the rating specified is not a standard size for the circuit breaker manufacturer, use the next largest size.

Wye-Delta starters: If the motor nameplate shows the full load delta line current only, divide this value by 1.73 or multiply by .58 to select the proper heater rating.

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c. 300% of maximum heater FLA for Class J (non-time delay).

If the calculated rating is between standard sizes, the next larger size may be used. Fuse size may not exceed switch size.

1) Ratings specified are for instantaneous trip circuit breakers.

Disposal

Siemens equipment is environmentally friendly product predominantly consisting of recyclable materials. For disposal, some disassembly, separation, and professional services handling may be required.

Materials to be handled include but are not limited to:

- Metals: Should be transferred and recycled as mixed scrap metals.
- Plastics: Plastic containing a recycle symbol should be recycled. Plastic lacking the recycle symbol should be discarded as industrial waste.
- Small electronics, insulated cables, and motors: Should be recycled via electronics scrap disposal companies specialized in separating and sorting as described above.
- Batteries: Should be recycled via a recycling company.

Disposal regulations vary from locality to locality and may be modified over time. Specific regulations and guidelines should be verified at the time of waste processing to ensure that current requirements are being fulfilled. For specific assistance in understanding and applying regional regulations and policies or manufacturer's recommendations, refer to the local Siemens service representative for additional information.

⚠ WARNING

Stored energy.
Can cause death, serious injury, or property damage.
Mechanisms contain stored energy, which may be released during disassembly.

Wear suitable protection and take appropriate precautions when disconnecting and removing moving parts.

⚠ WARNING

Heavy objects.
Can cause death or serious injury.
Disassembly may cause an unbalanced load, and could result in falling objects.

Take appropriate precautions in a properly designated workspace to maximize support and stability.

Notes

Notes

Legal Manufacturer

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United States of America

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To request a service or parts quote online, visit: usa.siemens.com/techsupport or e-mail callcenter.industry@siemens.com