



# FLEXLINE 3500 Low Voltage Motor Control Centers and Switchgear Assemblies

Bulletin Number 3500



***Allen-Bradley***

by ROCKWELL AUTOMATION

User Manual

Original Instructions

# Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

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

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

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

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



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



**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

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

These labels may also be on or inside the equipment to provide specific precautions.



**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.



**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.



**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

The following icon may appear in the text of this document.



Identifies information that is useful and can help to make a process easier to do or easier to understand.

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**Notes:**

## About This Publication

Provides information on the FLEXLINE™ 3500 motor control center, including receiving and handling, commissioning, EtherNet/IP™ network connectivity and maintenance.

## Download Firmware, AOP, EDS, and Other Files

Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes from the Product Compatibility and Download Center at [rok.auto/pcdc](http://rok.auto/pcdc).

## Additional Resources

These documents contain additional information concerning related products from Rockwell Automation. You can view or download publications at [rok.auto/literature](http://rok.auto/literature).

Resource	Description
FLEXLINE 3500 Low Voltage Motor Control Centers and Switchgear Assemblies Selection Guide, publication <a href="#">FLXLN-SG001</a>	Provides information on system architecture, structure, power systems, unit design, and unit type for FLEXLINE 3500 motor control centers.
Rockwell Automation Power Control Designer, <a href="https://powercontrol.advisor.rockwellautomation.com/">https://powercontrol.advisor.rockwellautomation.com/</a>	Develop a customized motor control center lineup or VFD drive and receive configuration specifications.
EtherNet/IP Network Devices User Manual, <a href="#">ENET-UM006</a>	Describes how to configure and use EtherNet/IP devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, <a href="#">ENET-RM002</a>	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
System Security Design Guidelines Reference Manual, <a href="#">SECURE-RM001</a>	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication <a href="#">IC-TD002</a>	Provides a quick reference tool for Allen-Bradley industrial automation controls and assemblies.
Industrial Automation Wiring and Grounding Guidelines, publication <a href="#">1770-4.1</a>	Provides general guidelines for installing a Rockwell Automation industrial system.
ProposalWorks™ configuration software, <a href="http://rok.auto/systemtools">rok.auto/systemtools</a>	Helps configure complete, valid catalog numbers and build complete quotes based on detailed product information.
Rockwell Automation Global SCCR tool, <a href="http://rok.auto/sccr">rok.auto/sccr</a>	Provides coordinated high-fault branch circuit solutions for motor starters, soft starters, and component drives.
Product Certifications website, <a href="http://rok.auto/certifications">rok.auto/certifications</a>	Provides declarations of conformity, certificates, and other certification details.

**Notes:**



## FLEXLINE 3500 Motor Control Center

### Overview

FLEXLINE™ 3500 motor control centers (MCCs) offer AC Drives, direct-on-line starters (DOL), direct-on-line reversing starters (DOLR), and Feeder units with a full range of IEC components such as AC drives, circuit breakers, overloads, contactors, and other devices.

Figure 1 - FLEXLINE 3500 MCC



The FLEXLINE 3500 MCC provides withdrawable or fixed units with IP degree up to IP54 and internal separation up to 4B. The FLEXLINE 3500 MCC provides intelligent control with common communication protocols that are easily networked in the MCC.

In addition to a complete line of motor control equipment, the FLEXLINE 3500 MCC also packages power distribution equipment. Your FLEXLINE 3500 MCC can include air circuit breakers, feeders, mains, main-tie-mains, and transformers for an integrated, low voltage power package.

FLEXLINE 3500 MCCs feature:

- Withdrawable units or fixed units
- High unit density, up to 27 units per column
- Rotary handles
- Three or four wire power system capability
- Top-mounted, main bus up to 6000 A
- Air circuit breaker mains and feeders available
- Standard safety features like arc-ignition protected zones and isolated unit power stab assemblies help protect employees and keep your process up and running

# Column and Shipping Block Structure

A typical FLEXLINE 3500 column consists of a functional unit space with a vertical cable compartment at the side or rear, main busbars at the top, and a horizontal cable compartment at the bottom. Column definition also applies to full-height units (frame-mounted) without side or rear cable compartment.

A typical FLEXLINE 3500 shipping block is one or more columns that are mounted in a single frame that must be shipped as one piece.

Columns and shipping blocks are described in terms of modules. Each module is approximately 192 mm (8 in.) wide by 192 mm (8 in.) tall.

Shipping blocks are secured at the installation site by bolting together clearance holes in the supports.

You can combine both fixed and withdrawable units up to form 4B in the same column (option 4B is not available in 1 x 1, 1.5 x 1, and MPI unit configurations). Fault containment is enhanced with partition plates on every column to help prevent a fault from cascading throughout the structure and limiting equipment damage. The cable compartment can be in either the front or the rear side of the assembly.

Figure 2 - Typical Column Configuration

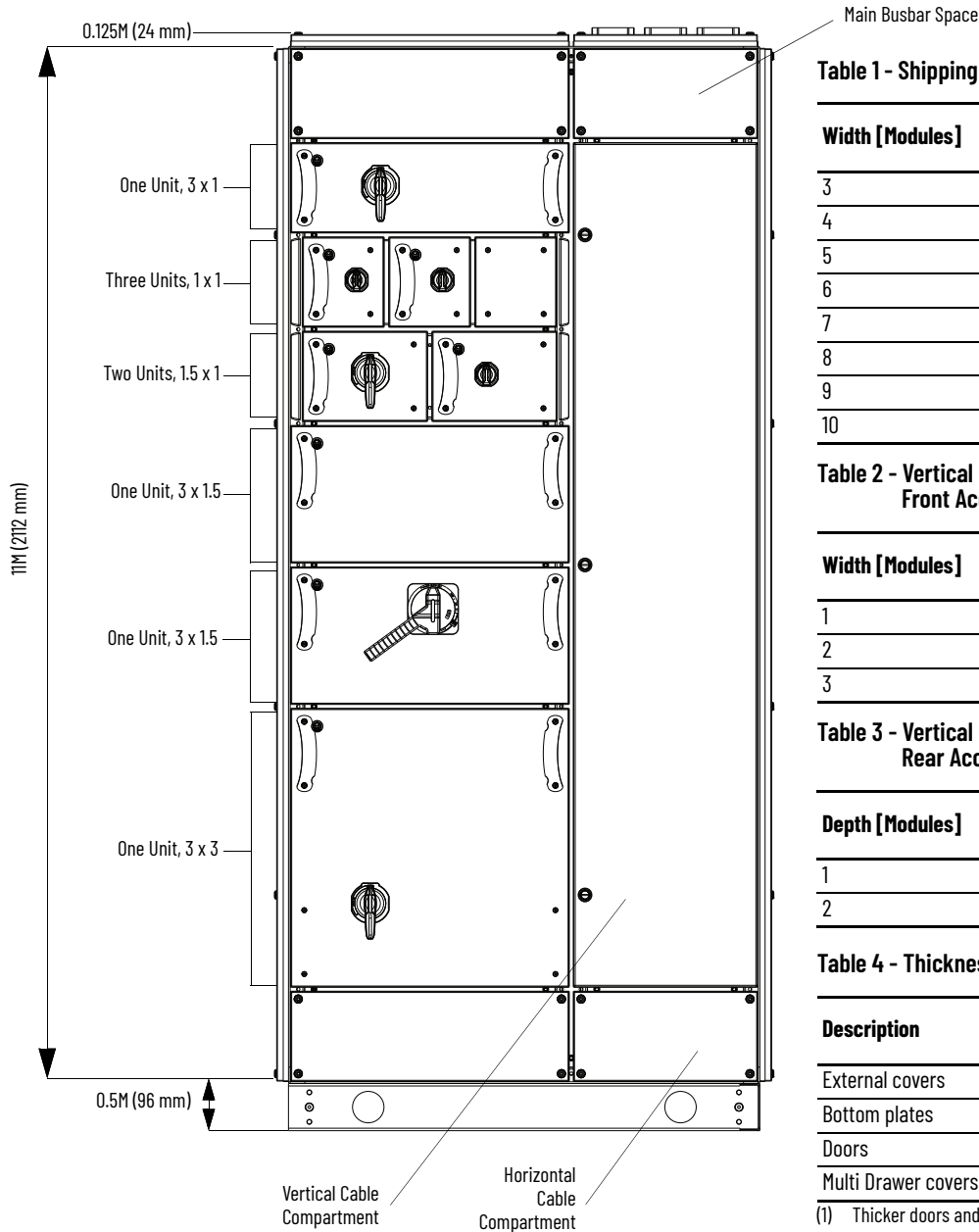


Table 1 - Shipping Block Sizes

Width [Modules]	Length	
	mm	in.
3	576	22.7
4	768	30.2
5	960	37.8
6	1152	45.4
7	1344	52.9
8	1536	60.5
9	1728	68.0
10	1920	75.6

Table 2 - Vertical Cable Compartment Size for Front Access

Width [Modules]	Length	
	mm	in.
1	192	7.6
2	384	15.1
3	576	22.7

Table 3 - Vertical Cable Compartment Size for Rear Access

Depth [Modules]	Length	
	mm	in.
1	192	7.6
2	384	15.1

Table 4 - Thickness, Nominal<sup>(1)</sup>

Description	Length	
	mm	in.
External covers	1.25	0.05
Bottom plates	1.5	0.06
Doors	1.5	0.06
Multi Drawer covers	1.25	0.05

(1) Thicker doors and covers available on request.

Figure 3 - Typical Column With Withdrawable Units

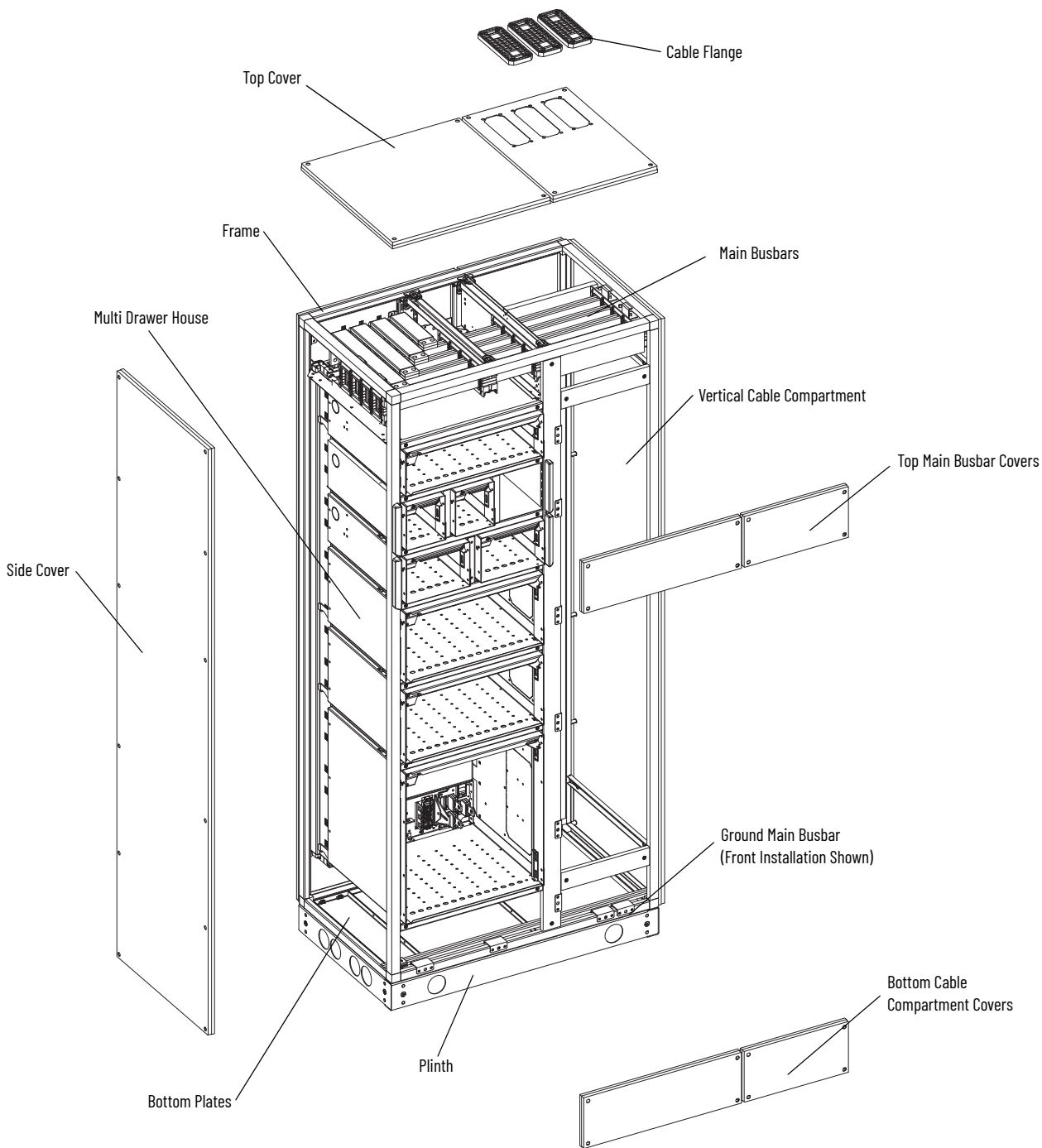


Table 5 - Weight<sup>(1)</sup>, Approx

Shipping Block Size [WxHxD]	Unit Space [Module]	Cable Compartment Size [Module]	Total Weight, kg	
			With S2000HD Busbar System	With S7000 Busbar System
4 x 11 x 3	3	1	690	710
5 x 11 x 3	3	2	720	750
6 x 11 x 3	3	3	750	790
8 x 11 x 3	(2x) 3	(2x) 1	1320	1400
9 x 11 x 3	(2x) 3	1 and 2	1350	1440
10 x 11 x 3	(2x) 3	(2x) 2	1370	1480

(1) Weights shown are for an MCC column with eight units. Many factors (number of units, horizontal power bus, wireway width, column depth, and shipment packaging) affect the actual weight. The packing slip that is shipped with an MCC unit shows the exact shipping weight.

## Column and Shipping Block Dimensions

Dimensions are in millimeters (inches) [modules] unless otherwise noted. Dimensions are not to be used for manufacturing purposes.

**IMPORTANT** External covers add 24 mm (0.9 in.) so the overall dimensions may differ than what is shown.

Figure 4 - Front Access Single Column With S2000HD Busbar Configuration, 5 Modules Wide, IP54

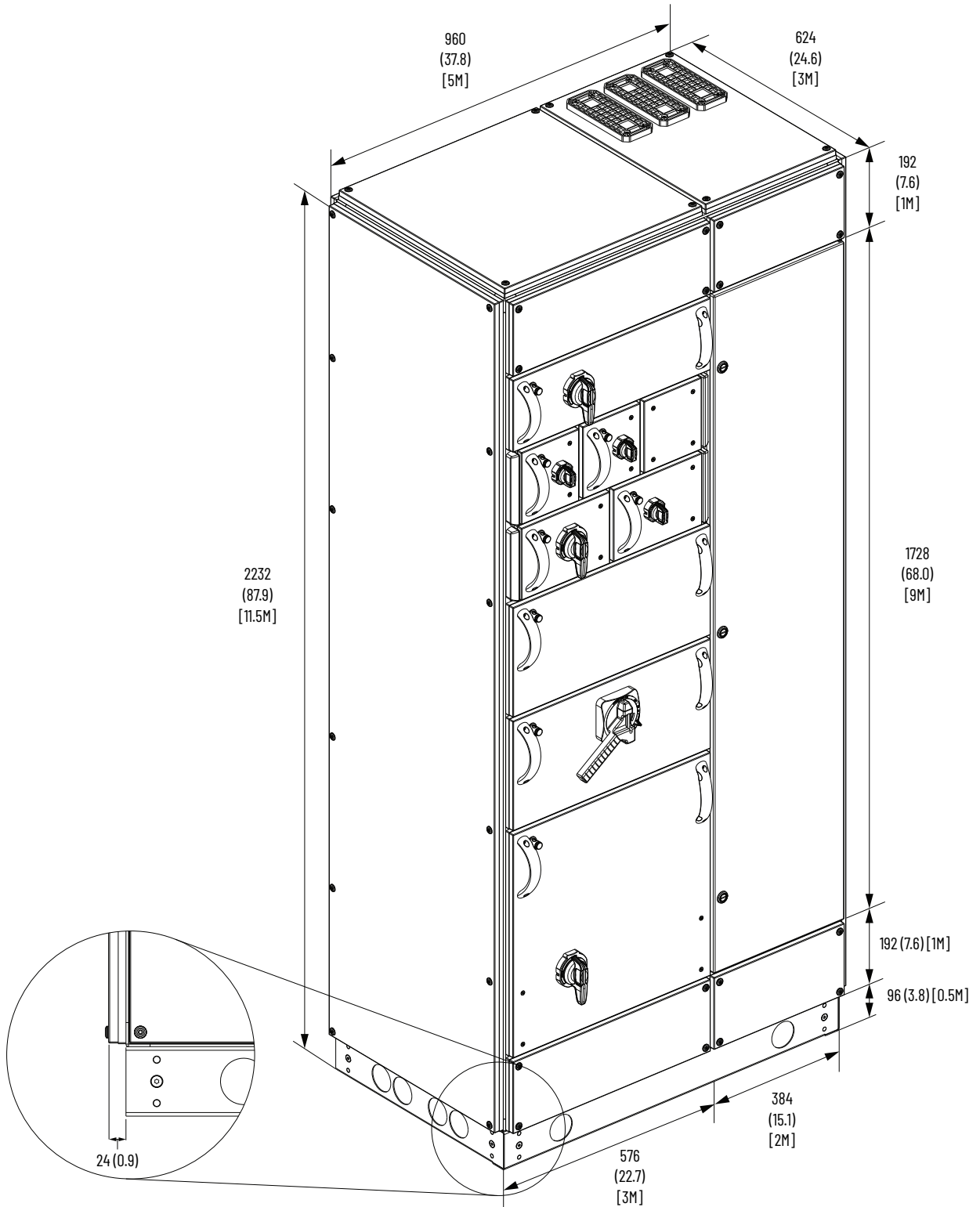


Figure 5 - Two Front Access Columns in One Shipping Block with a S2000HD Busbar Configuration, 10 Modules Wide, IP54

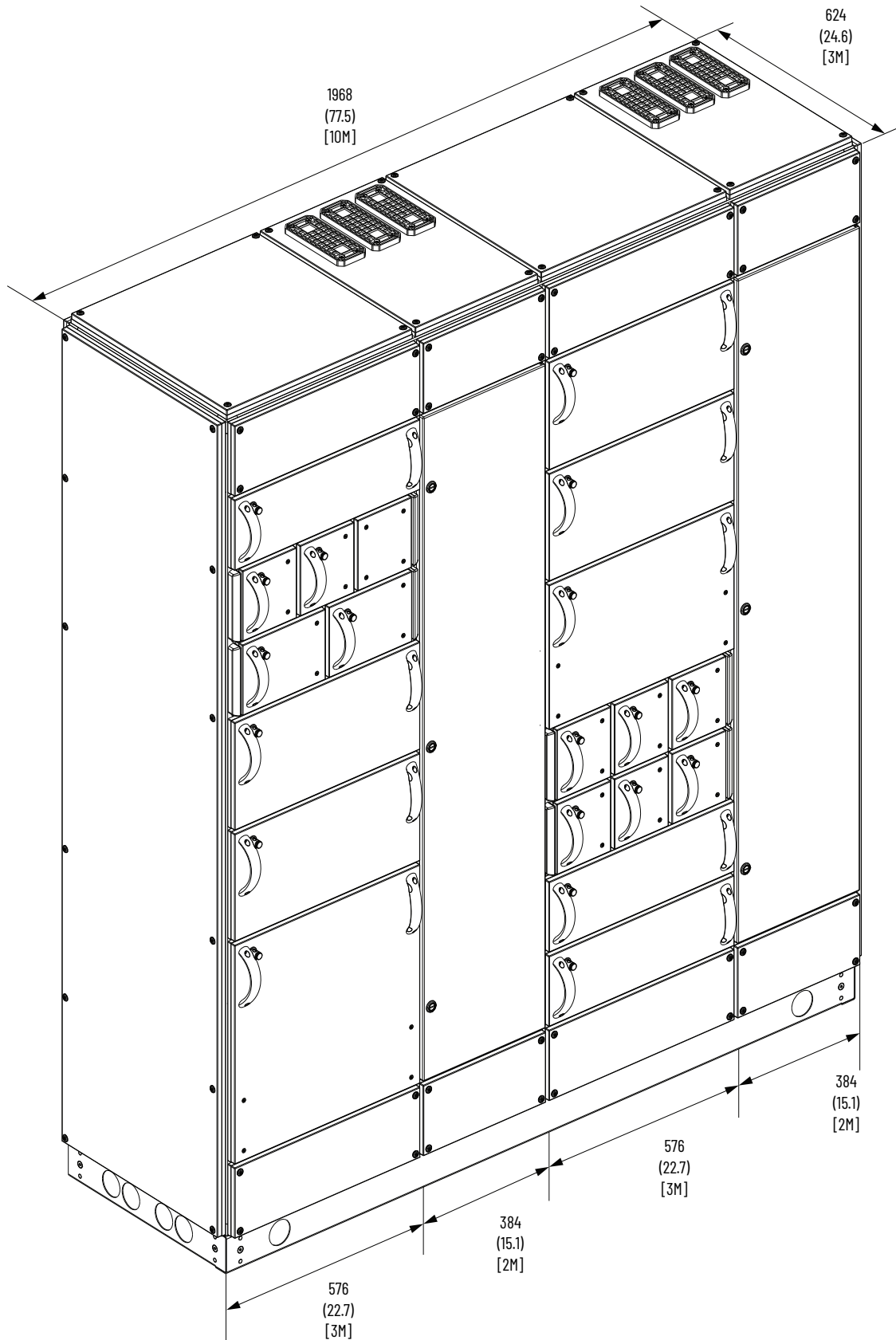


Figure 6 - Rear Access Single Column with S2000HD Busbar Configuration, 3 Modules Wide, IP54

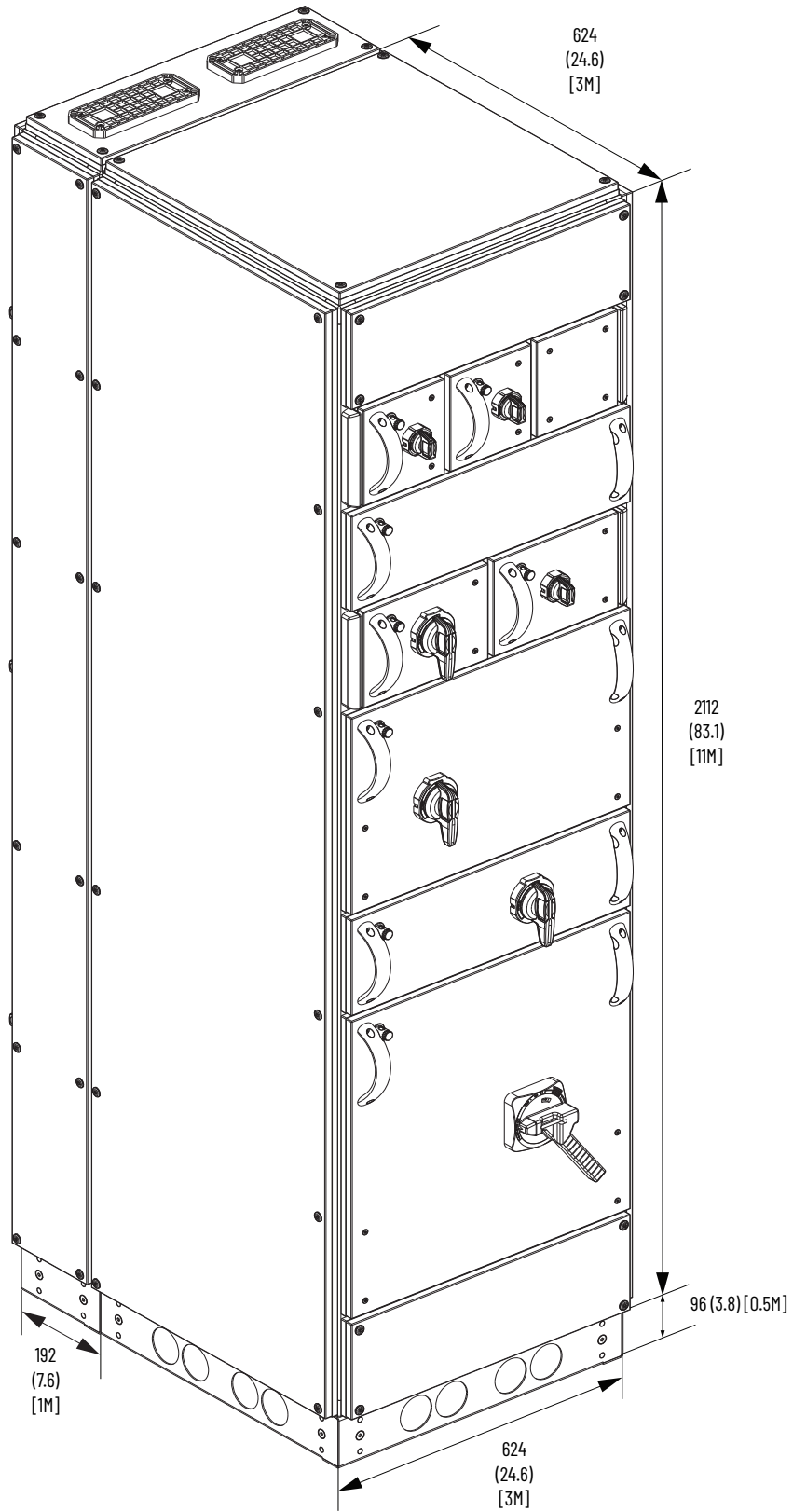
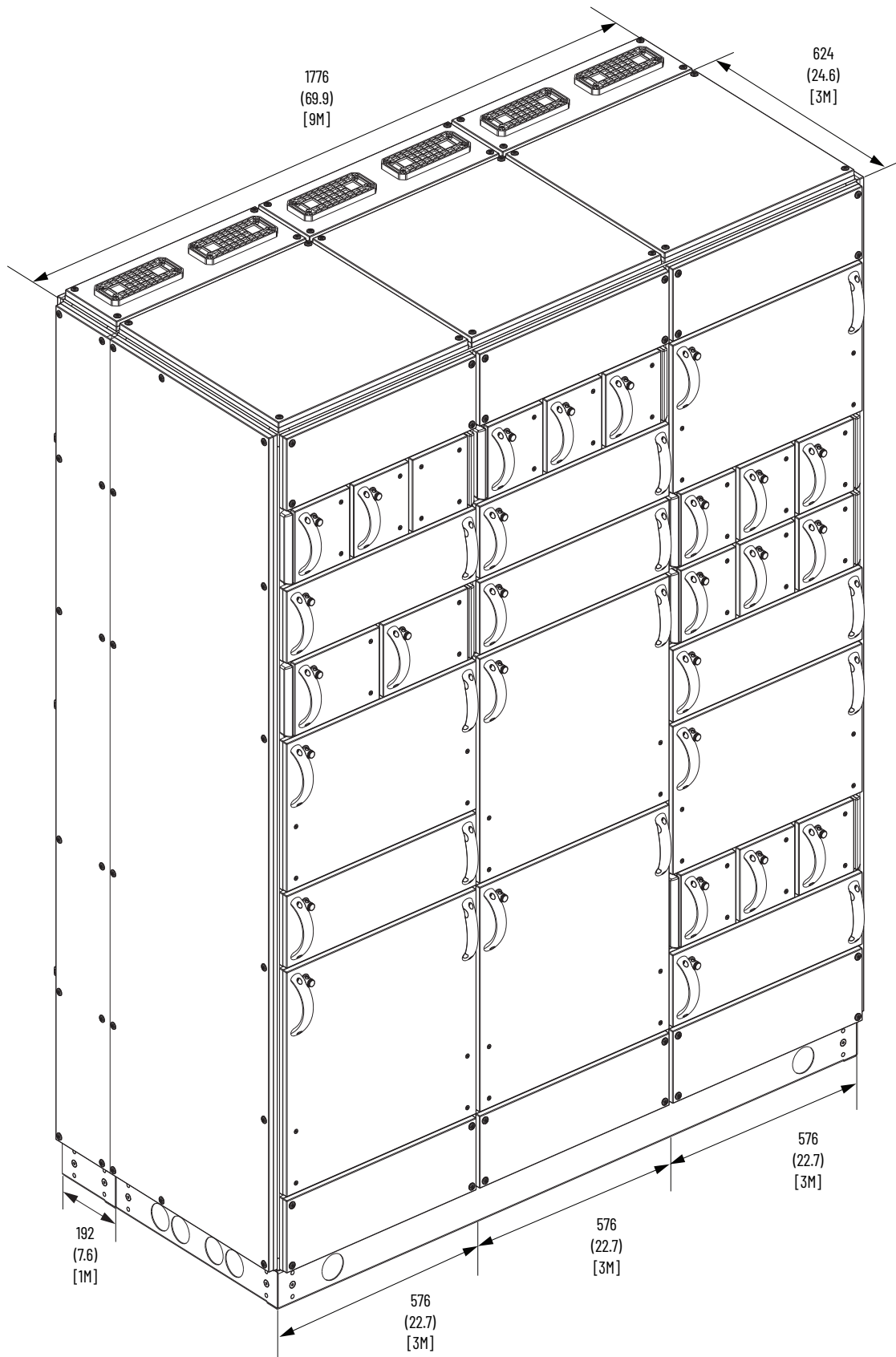


Figure 7 - Three Rear Access Columns in a Single Shipping Block With S2000HD Busbar Configuration, 9 Modules Wide, IP54



# Unit Structure

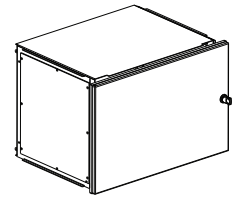
There are two types of units used in your FLEXLINE 3500 MCC, fixed or withdrawable.

## Fixed Units

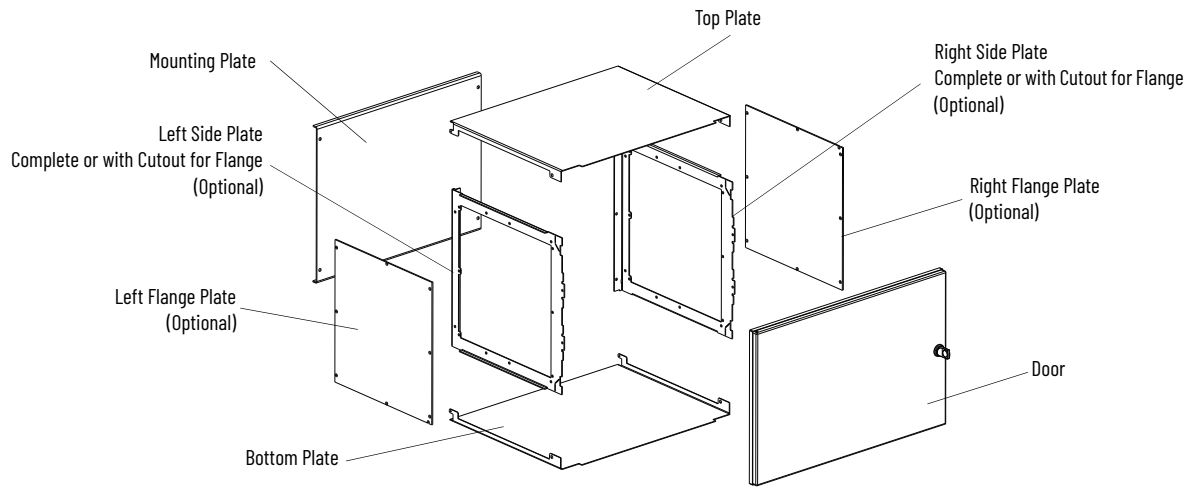
### Multi-purpose Inserts (MPIs)

3M Width x 2M Height x 1.5M Depth

Multi-purpose Inserts are designed as a box providing separation between other units. Components are mounted on mounting plate. Various sizes are available.



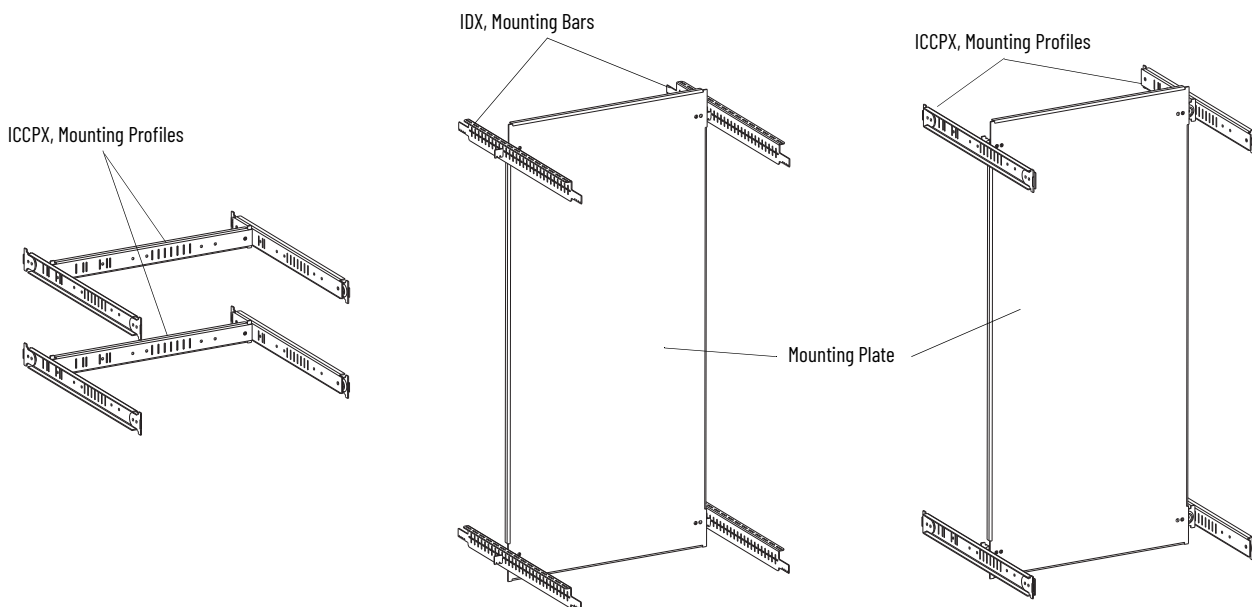
**Figure 8 - Multi-purpose Insert Components**



### Mounting Plates and Mounting Profiles

Mounting plates and mounting profiles (which are mounted directly to the frame) can be used for larger components. Various sizes and configurations are available.

**Figure 9 - Mounting Plate, Mounting Bars, and Mounting Profile**



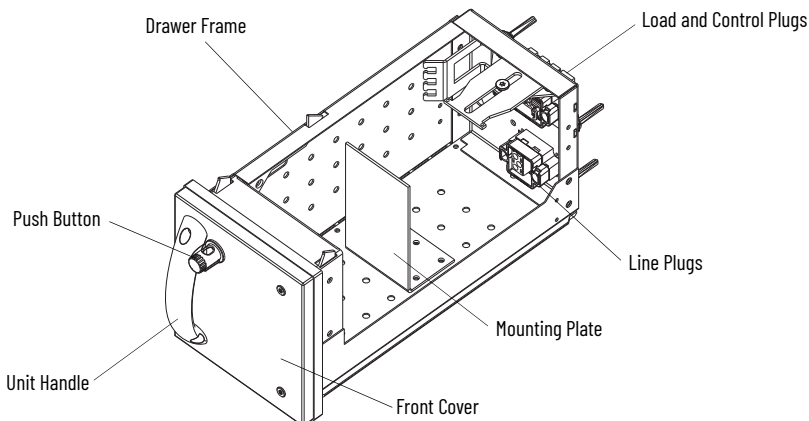


## Withdrawable Units

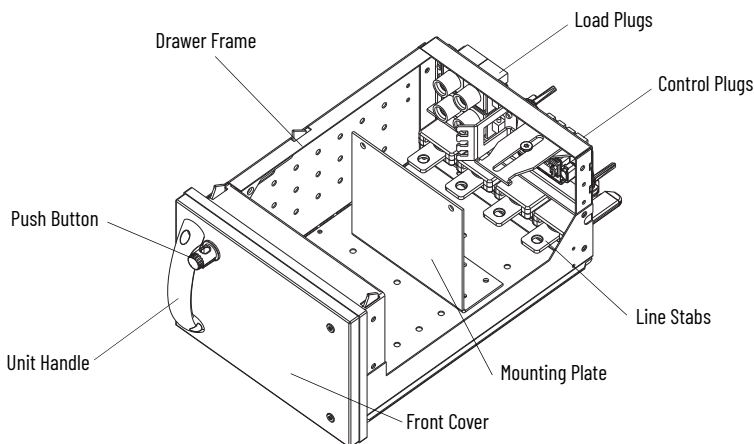
### Multi Drawer

Multi Drawer is a drawer unit that can be operated without disconnecting the main supply of the panel. A mechanical interlock helps to prevent the unit from being withdrawn while the main switch is in the ON/I position. An additional mechanical interlock helps to prevent the unit from being withdrawn or inserted when the unit main switch is closed.

**Figure 10 - Withdrawable Unit, 1 x 1 Configuration**



**Figure 11 - Withdrawable Unit, 1.5 x 1 Configuration**



**Figure 12 - Withdrawable Unit, 3 x 1 Configuration**

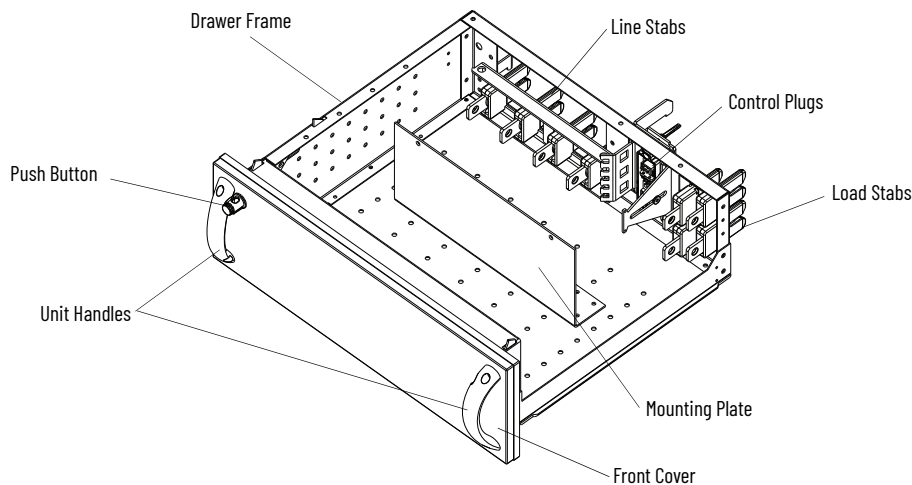
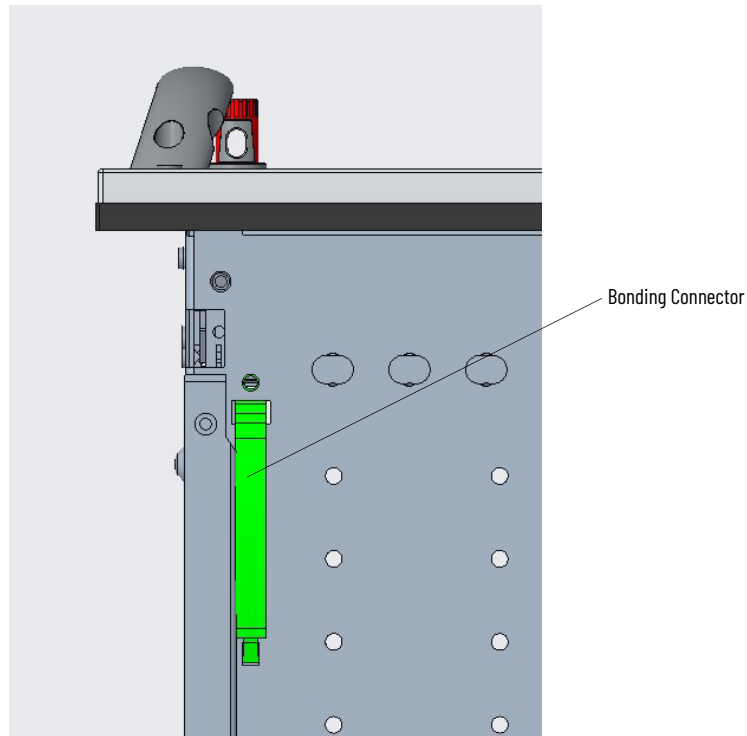


Figure 13 - Bonding Connector (Bottom View of Unit)



### Withdrawable Unit Specifications

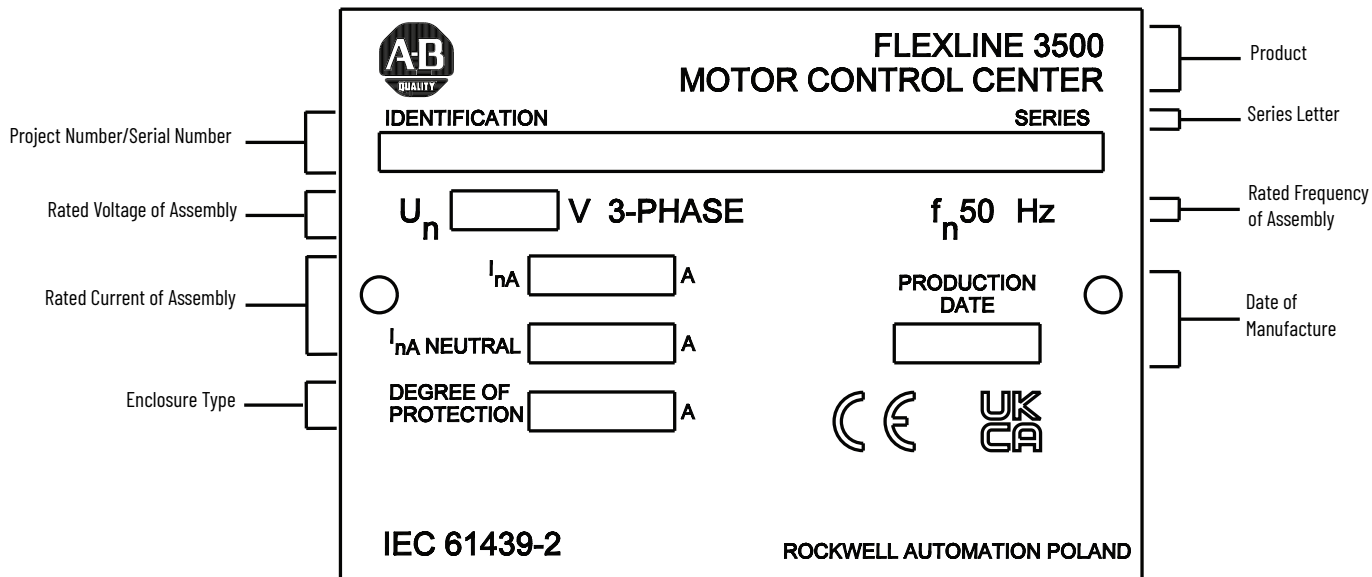
- The withdrawable units are made as WWW (line, load, control) as described in IEC 61439-2, 3.101.X, and 8.5.101<sup>(a)</sup>
- RJ45 connection can be included in every outgoing unit and are fully withdrawable
- You can combine RJ45 and normal auxiliary circuits in the same withdrawable plug
- The inlet plug of the withdrawable unit is connected on an easily replaceable plug which is mounted on the busbar or unit adapter (in Multi Drawer 1 x 1 and 1.5 x 1 configurations)
- You can lock the withdrawable unit with a padlock in Test, Disconnected, Detached, and Off positions
- The withdrawable unit has a Protective Earth (PE) connection in both connected and test position. While changing from one position to another, the drawer is also connected to Protective Earth
- Flexible connections inside the unit can be made of insulated braided copper with a solid end
- Withdrawable units 1/3 (1 x 1) and 1/2 (1.5 x 1) are installed side by side
- 3 units (1 x 1) and 2 units (1.5 x 1) are in one row (see [Figure 2 on page 10](#))
- Withdrawable units can still be installed and removed after years of dependable service
- The withdrawable system supports reconfiguration when the panel is live
- You can use the withdrawable unit as a bus coupler

(a) W for withdrawable connections; connections that are switched on or switched off by bringing the functional unit into connected or disconnected condition.

## Nameplate Data

In compliance with IEC 61439-1, FLEXLINE 3500 MCCs are supplied with a nameplate on the enclosure, typically on main incoming line unit.

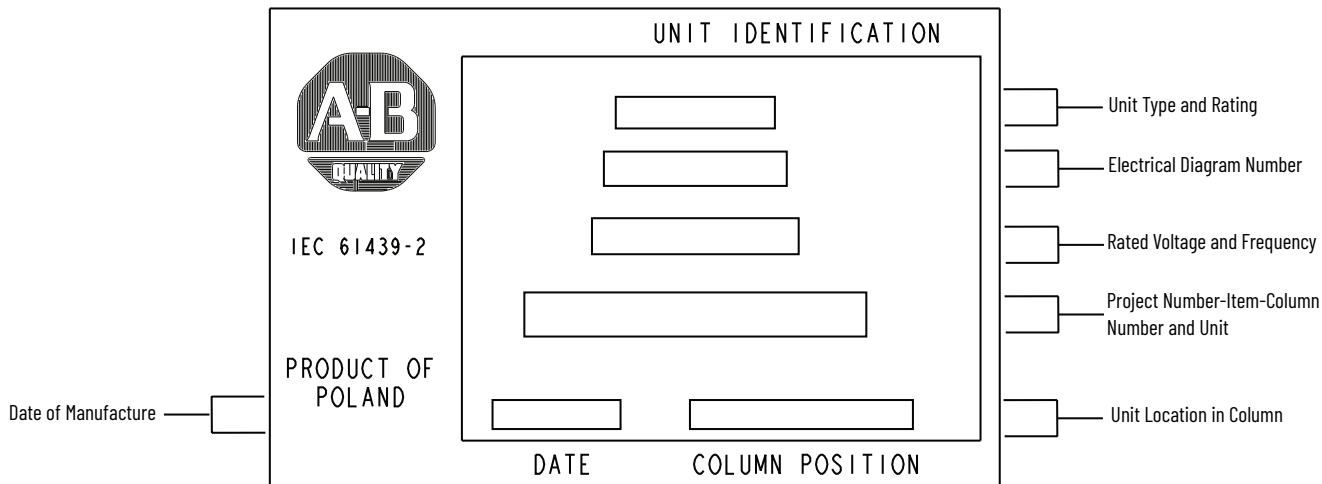
Figure 14 - FLEXLINE 3500 Nameplate



Each unit is also shipped with an identification label.

The project number or serial number and series letter are required to properly identify the equipment to sales or factory personnel.

Figure 15 - FLEXLINE 3500 Identification Label



## Certifications

Standards	IEC 60204-1:2016 +AMD1:2021 IEC 61439-1:2020 IEC 61439-2:2020  IEC/TR 61641	Safety of machinery – Electrical equipment of machines; Part 1: General requirements Low-voltage switchgear and controlgear assemblies; Part 1: General requirements Low-voltage switchgear and controlgear assemblies; Part 2: Power switchgear and controlgear assemblies Enclosed low-voltage switchgear and controlgear assemblies – guide for testing under conditions or arcing due to internal fault
EC Directives	2011/65/EU 2015/863 2014/30/EU 2014/35/EU	RoHS Directive  EMC Directive Low Voltage Directive
Certifications and Markings	CE Conformance Marked DEKRA Seismic UKCA (UK)	
Rated Voltages	Rated Operating Voltage, $U_e$ Rated Frequency, $f_n$ Rated Insulation Voltage, $U_i$	≤690V, 3 Phase 50...60 Hz ≤1000V, 3 Phase
Rated Busbar Currents	Continuous Current Rating, $I_e$ Short Circuit Peak Withstand, $I_{pk}$ Short Time Withstand Rating, $I_{cw}$ Neutral (N)	Main bus ≤6000 A; Distribution bus ≤2000 A per column Main bus ≤264 kA; Distribution bus ≤220 kA Main bus ≤120 kA for 1 second; Distribution bus ≤100 kA for 1 second Full or half-rated
Creepage Distances and Clearances	Rated Impulse Withstand Voltage, $U_{imp}$ Material Group (Overvoltage Category) Pollution Degree	6 kV, 8 kV, or 12 kV IIIa (175 ≤ CTI < 400) 3
Bus Material and Plating <sup>(1)</sup>	Horizontal Power Bus Vertical Distribution Bus Protective Earth Conductor (PE)	Copper, unplated Copper, unplated Copper, unplated
Degrees of Protection	IEC 60529	Up to IP54
Forms of Separation	IEC 61439-2	Forms 2b, 3b, 4b
Units <sup>(2)</sup>	Unit Size (approx) Units per Column (max) Withdrawable Unit Sizes (width x height)	192 mm high x 192 mm wide = 1 module (7.6 x 7.6 in.) 27 1 x 1, 1.5 x 1, 3 x 1, 3 x 1.5, 3 x 2, 3 x 3 modules
Structural Surface Treatments	Interior Exterior Exterior Top and Side Covers	RAL 7035 Light gray paint with galvanized mounting plate RAL 7035 Light gray paint (additional colors available as custom option) RAL 9005 Black
Environment	Storage Temperature Operating (Ambient) Temperature Altitude External mechanical impact (IK code) Corrosion class	-25...+55 °C (-13...+131 °F) -5...+40 °C <sup>(3)</sup> (23...104 °F) with up to 95% noncondensing humidity ≤1000 m (3280 ft) without derating; derating over 1000 m (3280 ft) Up to IK10 Minimum C2H, according to ISO 12944-2

(1) Tin-plated copper available upon request. Consult Rockwell Automation for other plating options.

(2) Unit size is described in terms of modules.

(3) The average temperature over a 24-hour period must not exceed 35 °C (95 °F).

## Arc Flash Containment

In addition to the standard safety features built into every FLEXLINE 3500 motor control centers, optional ArcShield™ technology provides enhanced arc resistance capabilities to meet your safety program.

ArcShield technology helps mitigate and protect personnel & equipment from the dangers of an arc flash incident. The technology helps contain an arc fault for the entire duration it takes the protective device to clear the fault.

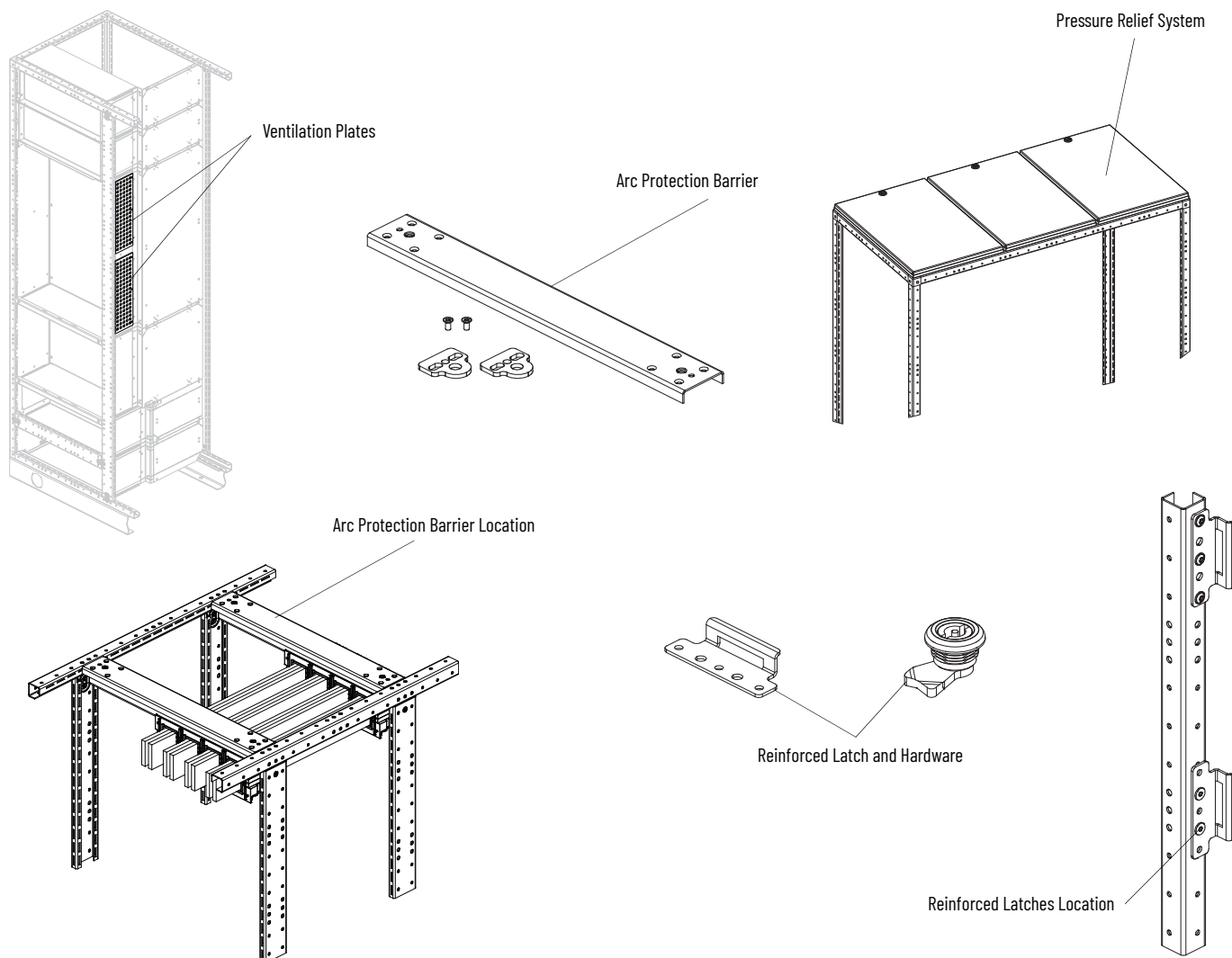
Motor control centers with ArcShield are tested with third-party validation against the IEC/TR 61641 standard that defines tests under conditions of arcing due to internal fault.

To deliver this type of safety and performance, an ArcShield MCC contains the following features:

- Reinforced bracing at the top
- Exhaust gas channeling to the top of the MCC
- Pressure relief systems for managed emissions
- Reinforced latches that keep the MCC doors closed
- Patented arc-resistant baffles that allow ventilation, yet provide arc resistance
- Optional optical and current sensing technologies for added MCC protection
- Separation between MD inserts and distribution busbar system

Contact your local Rockwell Automation sales office to learn of available ArcShield options.

**Figure 16 - ArcShield Column Protection Hardware**



**Notes:**

## Receiving, Handling, and Storage

### Receiving

---

**IMPORTANT** Delivery of equipment from Rockwell Automation to the carrier is considered delivery to the buyer. The carrier becomes liable for any damage that occurs during transit. It is then the buyer's responsibility to notify the proper party if damage is found. The buyer may forfeit any right to recovery for loss or damages by failing to comply with the following steps.

---

FLEXLINE 3500 MCCs are shipped upright as one shipping block. Each shipping block is bolted to the shipping skid and covered with clear plastic wrap. Protection is for upright shipping and is not waterproof or water-resistant. Equipment that extends from the structures is also protected.

Heavy-duty export packaging is similar to standard packaging, but uses a polywrap suitable for occasional water spray. In addition, wood framing and sheeting surround the columns. The heavy-duty export packaging is not water-resistant, waterproof, or intended for long-term storage.

1. Upon delivery of the low voltage drive, inspect the shipment for lost items and any damage that may have occurred during transit. Refer to the packing slip for a list of items included in the shipment.



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**ATTENTION:** If the product/package appears to have been damaged and/or if the Tilt Watch indicator on the export crate is activated, it is recommended to unpack the equipment immediately and inspect the product for additional concealed damage or to understand if the load shifted which creates an unbalanced lift.

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2. In the event that there is evidence of loss or damage, the buyer must follow this procedure:
  - Note on the delivery receipt that the equipment being received is damaged.
  - Contact the carrier that made the delivery and schedule an inspection.
  - Inform the local Rockwell Automation representative that the equipment is damaged.
  - Retain all product packaging for review by the carrier's inspector.
  - Concealed damage must be reported to the carrier and the local Rockwell Automation representative within 24 hours.
  - Rockwell Automation field service engineers are not able to determine the degree of damage or recommended repairs. Only LVMCC Post Shipment Technical Support can make recommendations that will be supported by Rockwell Automation and the LVMCC business unit.

For further assistance, contact your Rockwell Automation representative.

## Packing and Shipping

FLEXLINE 3500 LVMCC shipping blocks are shipped upright only.

- The shipping block is bolted to the shipping skid and covered with clear plastic wrap. All four corners are protected with angle boards and equipment that extends from the structures is also protected with the use of wood or solid paper spacers.
- Packing is for upright shipping only and the packaging protection is not waterproof or water-resistant. All MCCs should be stored in an environmentally protected area - during distribution and up to installation. Extended storage may require space heaters and other considerations.
- All MCC shipping blocks are labeled with customer shipping information, international handling symbols that promote proper storage, handling, and safety instructions. See [Table 6](#).
- LVMCC shipping blocks are shipped with a TiltWatch monitor that indicates if the package was tipped 80° beyond vertical. DO NOT move package if indicator was activated as the contents within may have shifted, producing an unstable lift and/or is damaged. See [Figure 17](#).
- Any unattached items, such as splice kits and installation hardware, are typically boxed, labeled, and packed together with the MCC. During receiving and handling, check for any boxed items that are not packed together with the MCC.
- Unit orders are packed and shipped in boxes complete with shipping and customer information and are placed in shipping skids if necessary.
- All wood materials are heat-treated and marked as required by ISPM-15 International Standard for Phytosanitary Measures - Regulation of Wood Packaging Material in International Trade.
- For truck shipments, the number of shipping blocks that you can load into a truck depends on the dimensions of the shipping block.
- For customer pickup, we recommend that you bring and use an appropriate number of buckle and ratchet straps.

### Air or Ocean Freight

- A plywood crate cap is added over the entire shipping block for additional protection. Weather resistant packaging with desiccants (to absorb moisture) are provided.
- Air or ocean packing adds extra weight to the shipping block.
- Air and ocean freight is dependent on the logistics services used, the shipping destination and the shipping height restrictions for that region. Check with local carrier for specific information.

Figure 17 - TiltWatch Monitor




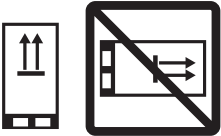
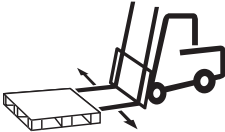






## International Handling Icon Examples

[Table 6](#) outlines the international handling icons on an LVMCC.

**Table 6 - International Handling Icons**

Icon	Meaning	Description
	Keep Dry	Keep shipping column away from direct rain or water.
	Fragile	Contents of the transport package are fragile. Handle with care.
	This Way Up	Indicates correct upright position of the transport package.
	Do Not Lay Down	Indicates the shipping column must be kept upright at all times. Do not lay the shipping column down on its side.
	Extend Forks	Indicates that the operator must extend the forks of the forklift to the widest position that will lift the pallet/skid.
	Top Heavy	Indicates the package is top heavy and may tip over easily.
	Strap to Mast	Indicates the package must be strapped/secured to the forklift mast. Tilt toward the mast for additional security.

## Handling



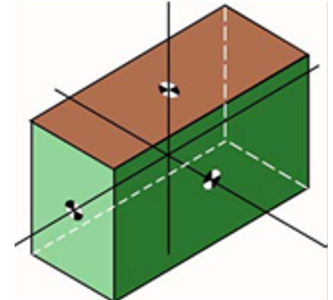
**ATTENTION:** Follow local codes and guidelines in addition to your company safety procedures when you handle motor control centers. To avoid personal injury and structural damage to the motor control center, do not attempt to lift or move the motor control center by any means other than those listed in this publication. Motor control centers are top- and front-heavy.

The following guidelines are provided to help avoid personal injury and equipment damage during handling, and to facilitate moving the motor control center at the installation site.

Due to the various possible MCC configurations, there are different center of gravity (CG) positions within the MCC is possible along the overall drive length.

If you are lifting the MCC from the:

- **Short/width side:** The CG for the lift is generally on the center of the skid width. Extend the fork tines to the widest position to ensure the CG is between the tines.
- **Board/length side:** The CG can be off center the skid based on the MCC configuration. Test lifts may be required to determine the approximate CG location.



To prevent distortion and minimize tipping, keep the shipping skid bolted to the MCC until delivered to the final installation area.

Handle the motor control center carefully to avoid damage to the units, columns, and paint. Keep the motor control center in an upright position. Failure to comply with this method can lead to busbar, unit, and enclosure damage. The motor control center should not have been tipped or laid flat during shipment. Before moving the motor control center, verify that the route is clear of all obstructions and that fellow workers are a safe distance away.



**ATTENTION:** The carrying method should be chosen according to the weight of the MCC. Shipping weights can be found on the packing slip that is included with each shipment.

The following are acceptable methods of handling MCC columns within the receiving facility.

- With shipping skid
  - Forklift
  - Lifting sling
- Without shipping skid (applicable only during installation in final location)
  - Lifting sling

## With Shipping Skid

If your MCC is shipped with a shipping skid, you can use a forklift or lifting sling.

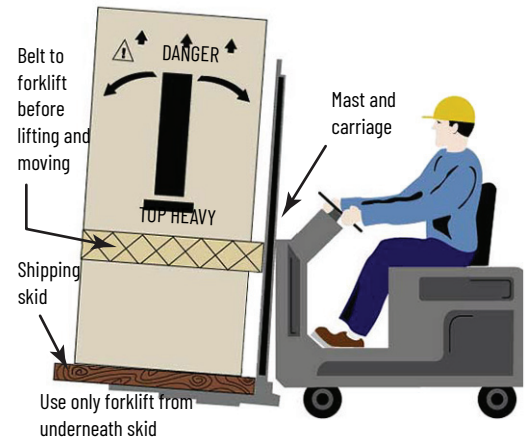
### Forklifting

FLEXLINE 3500 motor control centers have shipping skids that facilitate the insertion of lift truck forks, with fork access from each side. Refer to the following forklifting procedure.



**ATTENTION:** Verify that the forklift truck can handle the weight and size of the motor control center safely. Shipping weights can be found on the packing slip included with each shipment.

1. Forklift only from underneath the shipping skid, using the skid to support the load with the appropriate safety factor. Carefully position the motor control center on the forks for proper balance, noting that motor control centers are top-and front-heavy. Make sure that the forks support the load. Keep the load against the carriage. Tilt the load backward toward the lift truck's mast.
2. Use a belt to secure the motor control center to the forklift truck.
3. Start and stop the forklift truck gradually and slowly, avoiding jerky movements. When traveling with the load, drive slowly with the forks carried as low as possible, consistent with safe operation.



## Lifting Sling

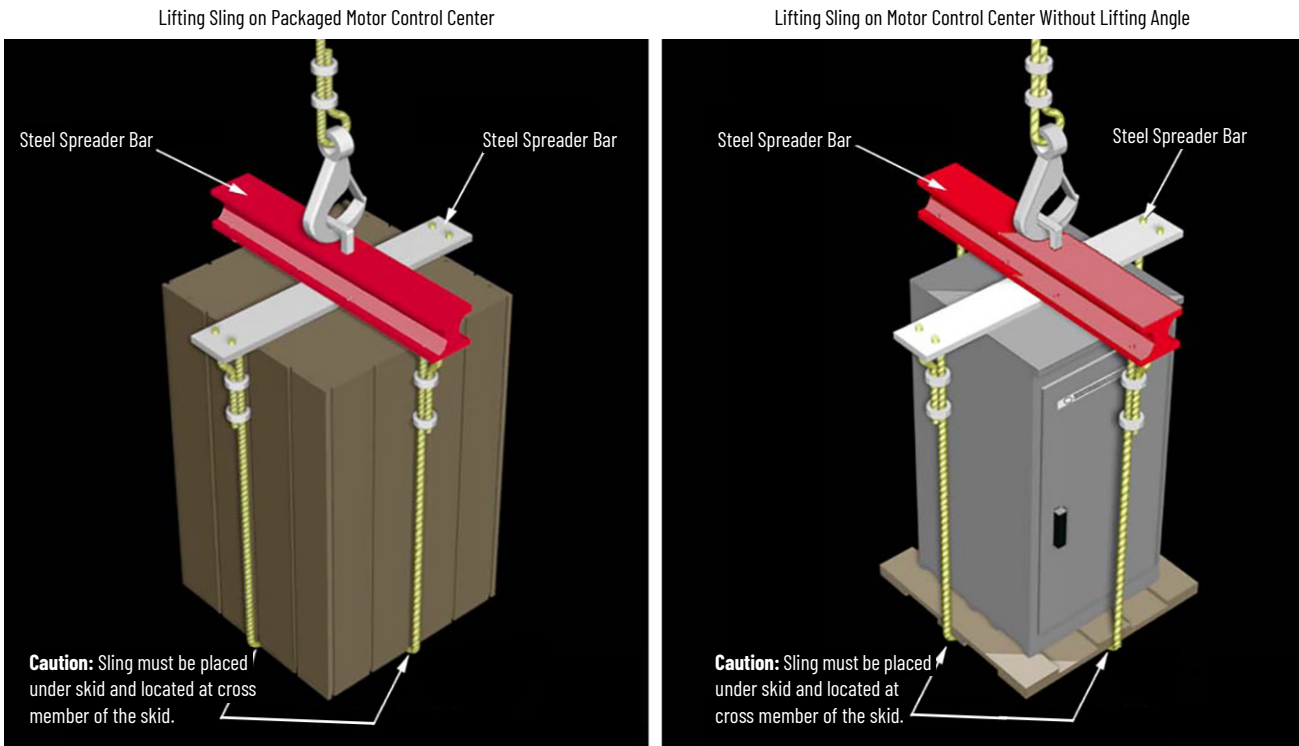


**ATTENTION:** Verify that the lifting equipment can safely handle the weight and size of the motor control center. Shipping weights are located on the packing slip that is included with each shipment.

Using a lifting sling is the preferred method for overhead lifting of heavy duty/export packaged columns, but it may be used for other types of columns. Refer to the following procedure.

1. Place the lifting sling under the shipping platform. Verify that the lifting sling has no slack, remains in place under the load, and is located at the cross member of the skid. The spreader bar must have a larger span (overhang) than the motor control center load.
2. Carefully stabilize the motor control center during handling. All rigging must be designed to support the load (refer to the packing slip for weight) with the appropriate safety factor.

**Figure 18 - Lifting Sling a Motor Control Center**



## Without Shipping Skid

### Lifting Sling



**ATTENTION:** Follow this procedure if the MCC is located in the final installation area.



**ATTENTION:** Verify that the lifting equipment can safely handle the weight and size of the motor control center. Shipping weights are located on the packing slip that is included with each shipment.

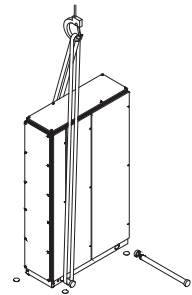
Follow this procedure if the max weight of the MCC is 1200 kg.

1. Remove the hole covers in the plinth.
2. Feed the lifting sling through the holes in the plinth.
3. Verify that the lifting sling has no slack and remains in place under the load.

The spreader bar must have a larger span (overhang) than the motor control center load.

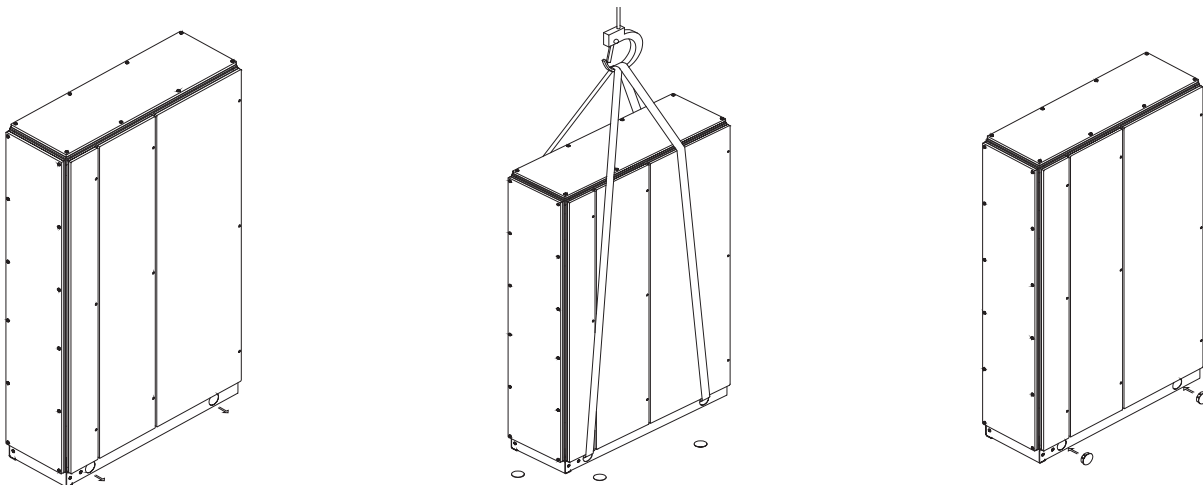


Alternatively, 2 in. pipes with adequate strength can be used to install the lifting slings. Secure the ends of the pipe to prevent the sling from sliding off the end.



4. Carefully stabilize the motor control center during handling. All rigging must be designed to support the load (refer to the packing slip for weight) with the appropriate safety factor.
5. Use plugs to cover holes in the plinth.

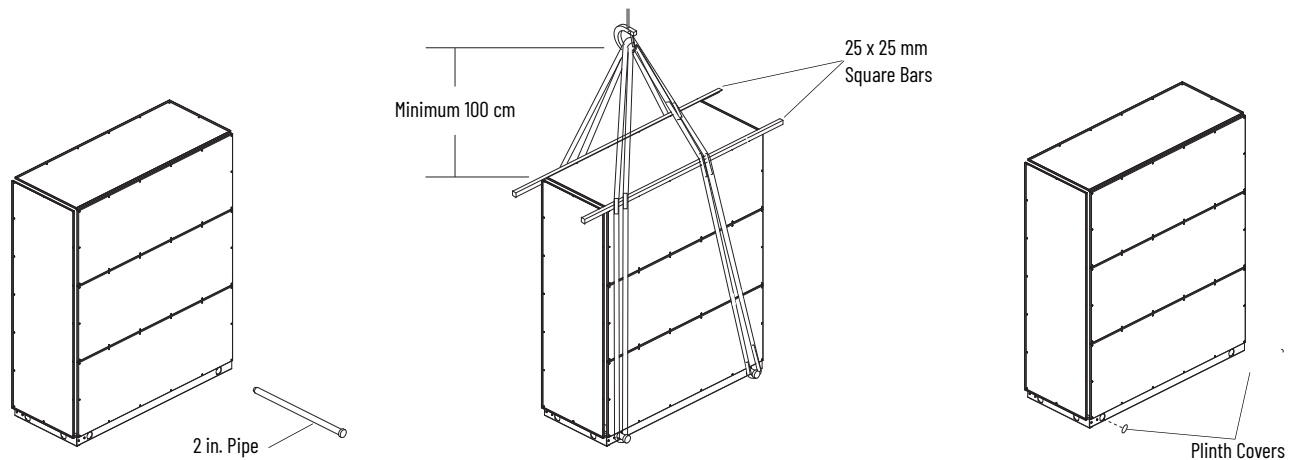
**Figure 19 - Using a Lifting Sling, 1200 kg Weight Limit**



Follow this procedure if the max weight of the MCC is 1750 kg.

1. Remove the hole covers in the plinth.
2. Place 2 in. pipes with adequate strength through the holes in the plinth. Secure the ends of the pipe to prevent the sling from sliding off the end of the pipe.
3. Verify that the lifting sling has no slack and remains in place under the load.  
The spreader bar must have a larger span (overhang) than the motor control center load.
4. Use 25 x 25 mm square bar to reinforce the top of the enclosure.
5. Carefully stabilize the motor control center during handling. All rigging must be designed to support the load (refer to the packing slip for weight) with the appropriate safety factor.
6. Use plugs to cover holes in the plinth.

**Figure 20 - Using a Lifting Sling, 1750 kg Weight Limit**



## Storage

If it is necessary to store the FLEXLINE 3500 for any length of time, take the following precautions:

- Wrap the MCC in a covering of heavy-duty plastic or similar material to help prevent the entry of dirt and dust.
- Store the MCC in a clean, dry place if it is not installed and energized immediately. Maintain a storage temperature between  $-25...+55^{\circ}\text{C}$  ( $-13...+131^{\circ}\text{F}$ ). If the storage temperature fluctuates or humidity exceeds 60%, use a space heater to prevent condensation. We recommend that you store a motor control center in a heated building that offers adequate air circulation and protection from dirt and water.
- FLEXLINE 3500 MCCs are designed for indoor applications and do not have sufficient packaging for outdoor storage. If they are to be stored outdoors, install temporary electrical heating to help prevent condensation and add packaging for protection from the outside elements. A space heater that is rated at 200 watts per shipping block is adequate for the average motor control center. Remove all loose packaging and flammable materials before you energize the space heaters.

## Install Columns

### Location Planning

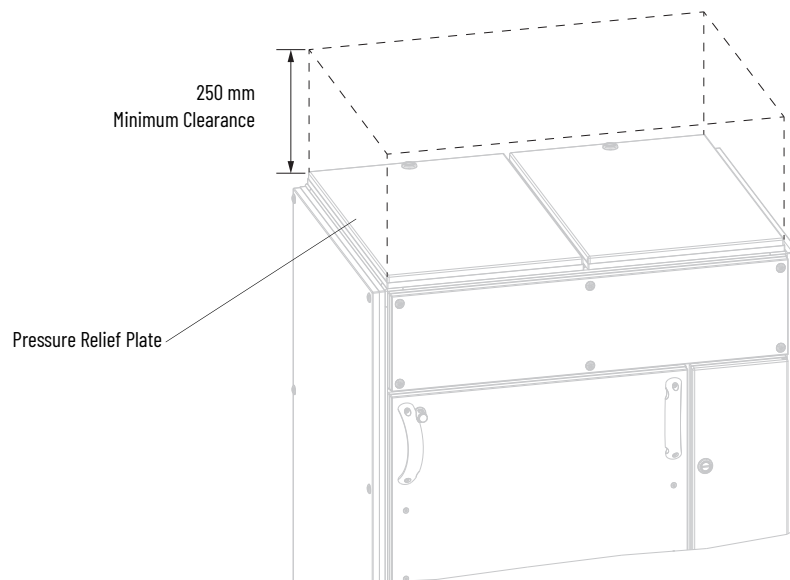
When you plan the location for your FLEXLINE™ 3500 MCC, consider the following:

- Cable entry and exit points
- Busways
- Overall height of installation area
- Alignment with other equipment
- Future needs
- Environment

The area must be level and the environment must be compatible with the degree of protection that is provided by the enclosure.

### ArcShield Clearance Space

Provide a minimum 250 mm of clearance space above the MCC to vent the pressure relief plates if there is an arc flash event.



**ATTENTION:** Do not step on the pressure relief plate, which can cause it to not to work properly during an arc flash event.

### Environment

FLEXLINE 3500 MCCs are designed to operate under the service conditions described in IEC 61439-2. Variations in temperature and relative humidity can potentially cause occasional condensation.

#### *Temperature*

When you operate an MCC, ambient air temperature must remain in the range of  $-5...+40\text{ }^{\circ}\text{C}$  ( $23...104\text{ }^{\circ}\text{F}$ ). The average temperature over a 24-hour period must not exceed  $35\text{ }^{\circ}\text{C}$  ( $95\text{ }^{\circ}\text{F}$ ).

### Humidity

Noncondensing humidity is permissible up to 95% at the maximum temperature of 40 °C (104 °F), with the average temperature not to exceed 35 °C (95 °F) over a 24-hour period.

### Altitude

The FLEXLINE 3500 MCC is designed to operate at installation sites at altitudes up to 1000 m (3281 ft) above sea level without derating. If the altitude at your installation site exceeds 1000 m (3281 ft) above sea level, contact your Rockwell Automation® representative for derating information.

### Pollution Degree

FLEXLINE 3500 MCCs are designed for use in a pollution degree 3 environment. IEC 61439-2 defines pollution degree 3 as, “conductive pollution occurs or dry, non-conductive pollution occurs that become conductive due to condensation.”

## Seismic Capabilities

The FLEXLINE 3500 MCC has fulfilled an earthquake simulation test according to the IEC 60068-2-57 Test Ff: Vibration - Time-history method. As Required Response Spectra, RRS:a, the spectra given in Annexes B and D of the document HN20-E-53 2ème edition Octobre 1994 were used.

The earthquake simulation tests were done with biaxial horizontal and vertical multi frequency motions. The ZPA-level at the SSE test was 1 G in the horizontal directions and 0.8 G in the vertical. The total uncertainty in the measurement chains, including the computer programs used for analyzing data, is estimated to be less than 5%. The error in the sampling frequency of the A/D-converter is less than 0.5%.

During all earthquake test runs, the vibrator table acceleration was sampled and Test Response Spectra (TRSa) were calculated. During the seismic test runs, the contact function of the contactor inside the cubicle were monitored. No contact bounces were detected during the seismic test runs.

To obtain seismic withstandability, each individual FLEXLINE 3500 lineup must be installed per the seismic panel installation requirements.

Other related seismic standards:

- Uniform Building Code, UBC
- AS 1170.4-1993

IEE Std 693-1997 Seismic Design of Substations

## Prepare Installation Site

Documentation packages that are shipped with assembled MCCs include an elevation drawing of a floor plan layout. To secure a shipping block to the foundation, see the provided floor plan layout and the following procedures.

See [Chapter 4 on page 51](#) for cable and conduit routing instructions.

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**IMPORTANT** The floor surface must be level.

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**IMPORTANT** Certain configurations with a vented enclosure (for example, IP43) require air gaps behind the lineup.

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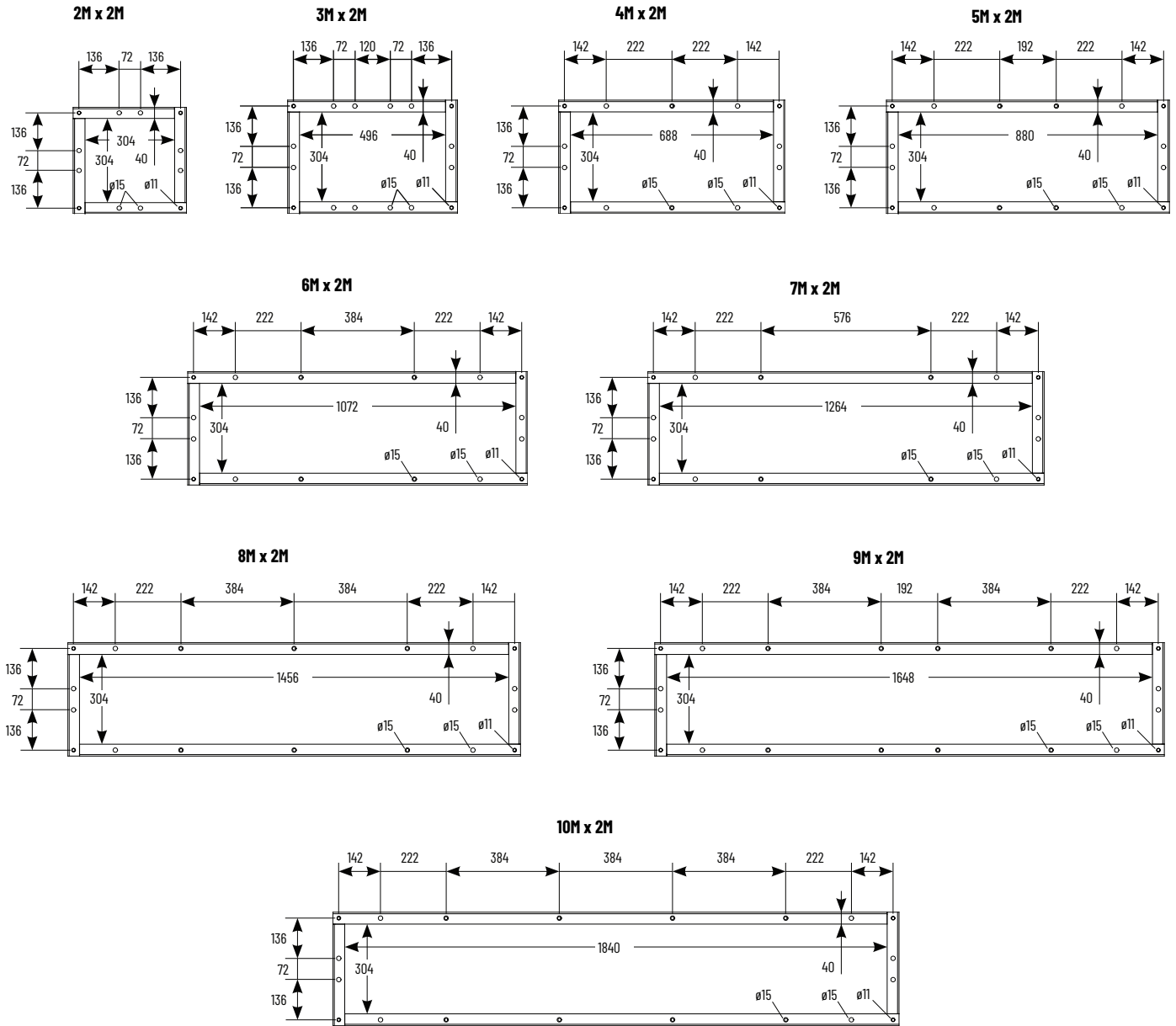
MCC shipping blocks are bolted to a foundation via a plinth.





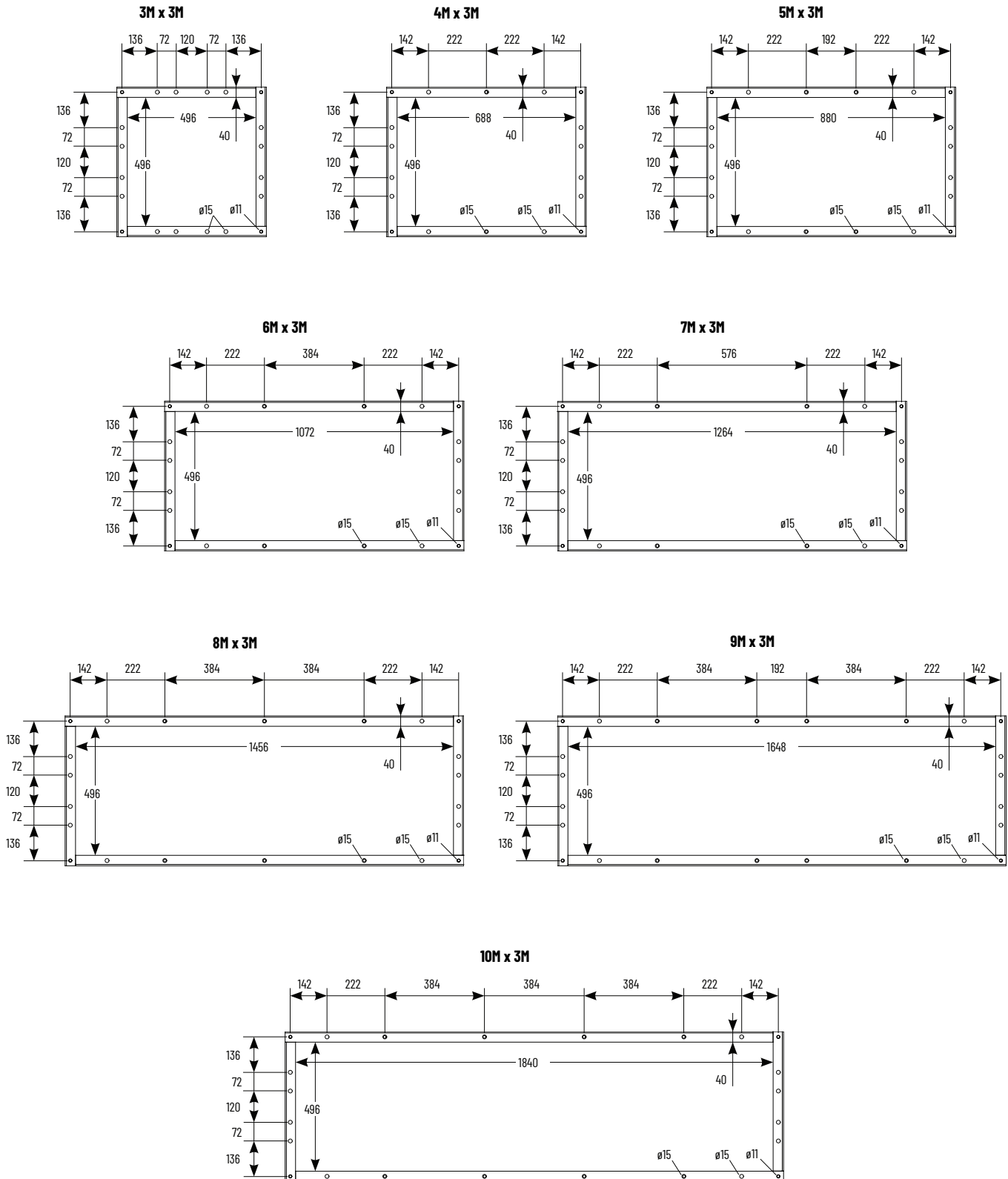
## Plinth Frame Dimensions, 2M Depth

Figure 23 - Plinth Frame Dimensions, 2M Deep



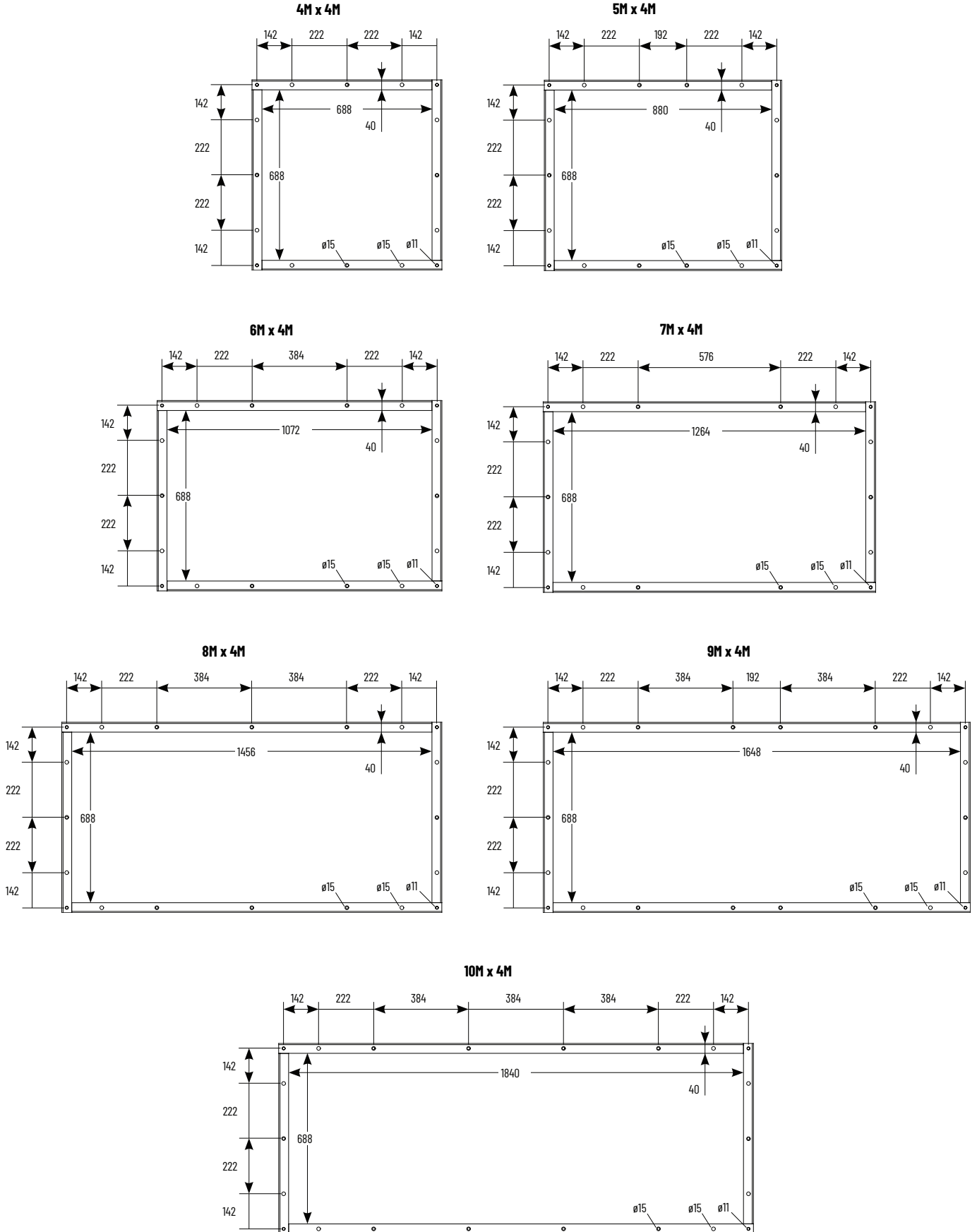
## Plinth Frame Dimensions, 3M Depth

Figure 24 - Plinth Frame Dimensions, 3M Deep



## Plinth Frame Dimensions, 4M Depth

Figure 25 - Plinth Frame Dimensions, 4M Deep



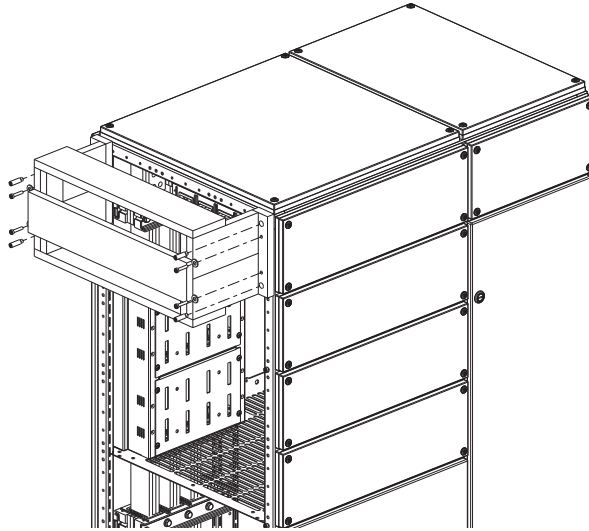
## Remove Packing Materials

When the FLEXLINE 3500 shipping columns have been delivered to the site of installation, remove the packaging material. Save any manuals and data sheets for future reference.



**ATTENTION:** To avoid personal injury, use caution when the motor control center is not secured. Motor control centers are top and front heavy.

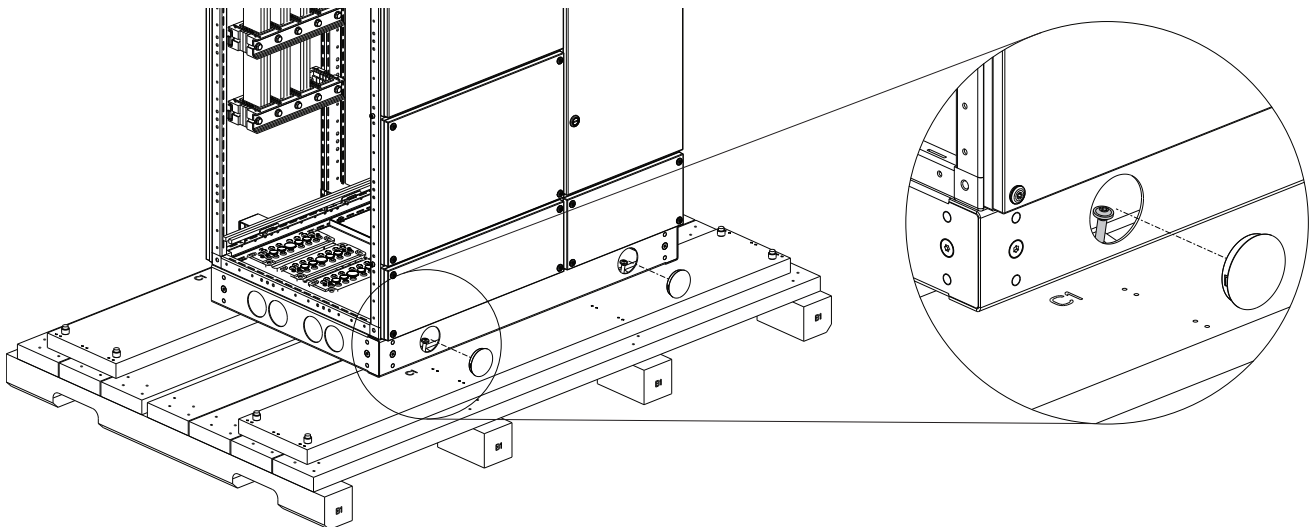
1. Remove the packing box around the horizontal bus (if present) and remove the four screws and four locating pins and discard.



2. Remove the plugs from the plinth and set aside.

**IMPORTANT** Keep these plugs. They must be reinstalled after the shipping block has been secured to the floor.

3. Remove and discard the hardware that secures each shipping block from the shipping skid.



**ATTENTION:** Once the bolts are removed, the shipping block is no longer secured on the skid.

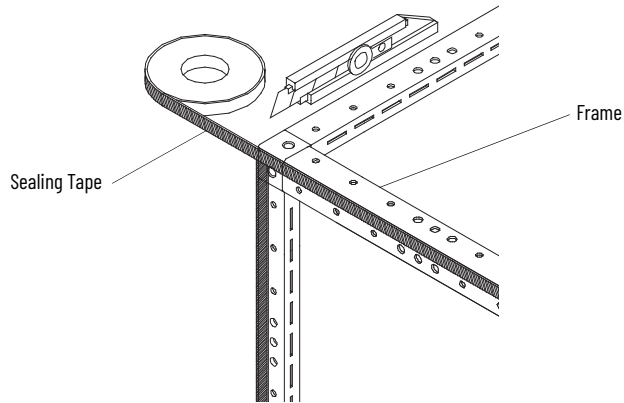
You can now remove the shipping block from the shipping skid (see [Chapter 2 on page 23](#)).

## Seal IP54 Enclosures Before Connection

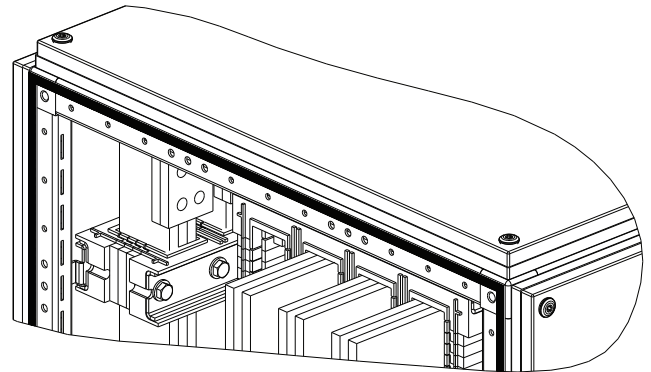
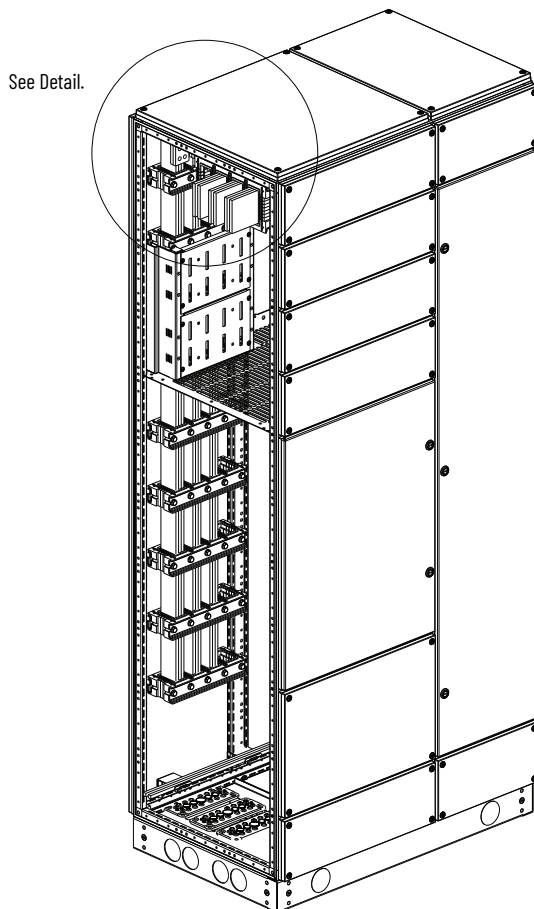


The following steps only apply to IP54 enclosures.

1. Remove the sealing tape provided in the splice kit.
2. Apply a continuous strip of sealing tape around the outside edge of the frame.



3. Continue around the entire edge of the frame, ensuring there are no gaps between the strips.



## Locate Bus Splice Kits

A removable label designates where the provided power bus splice kits are stored at shipment.

Splice kit contents will vary depending on your FLEXLINE 3500 MCC configuration. The typical splice kit contents outlined below is inclusive of each busbar type, but the quantity and lengths are not the same.



Locate the splice kits and set aside for later use.

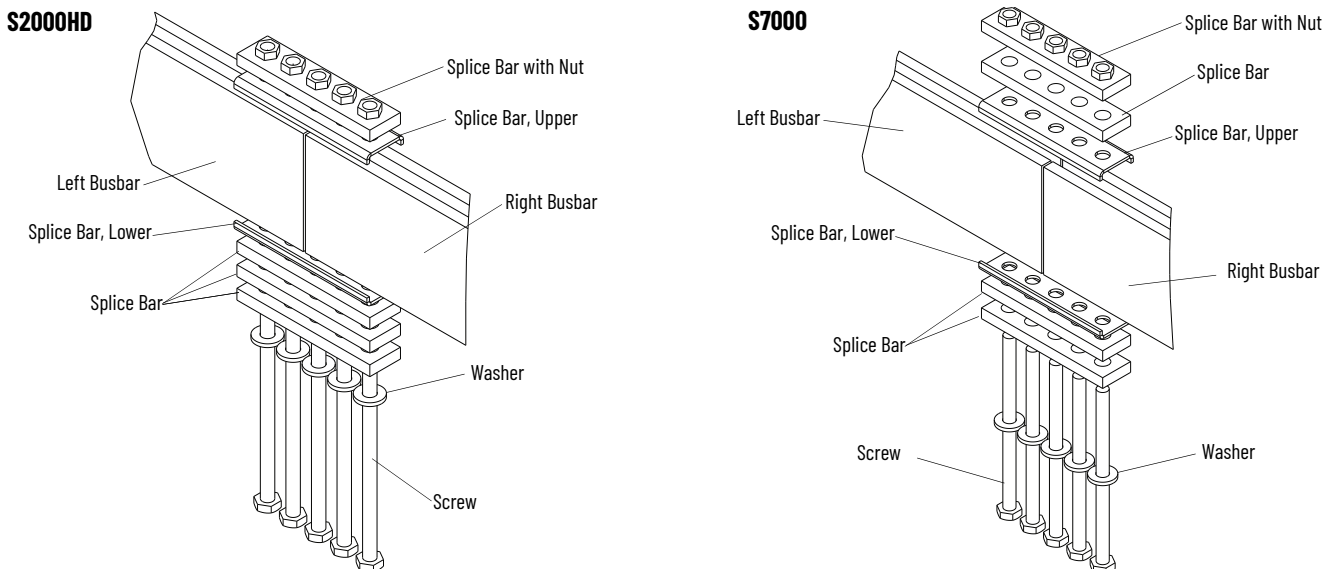
**IMPORTANT** Quantity of hardware provided is dependent on your busbar configuration.

**Table 7 - Typical Main Busbar Splice Kit Contents**

Busbar Type	Component	Quantity
S2000HD	Splice bar	1
	Splice bar, upper	6 or 8
	Splice bar, lower	Varies <sup>(1)</sup>
	Splice bar with self-clinching nut	3 or 4
	Cross-recessed pan head tapping screw	2
	Hex cap screw	15 or 20
	Spring washer, conical	15 or 20
S7000	Splice bar	2
	Splice bar, upper	Varies <sup>(1)</sup>
	Splice bar, lower	Varies <sup>(1)</sup>
	Splice bar with (without <sup>(1)</sup> ) self-clinching nut	Varies <sup>(1)</sup>
	Hex cap screw	Varies <sup>(1)</sup>
	Spring washer, conical	Varies <sup>(1)</sup>
PE	Splice bar, upper	2
	Splice bar, lower	2 or 3
	Hex cap screw, fully threaded	2
	Spring washer, conical	2
	Busbar clamp, M10	2

(1) Dependent on busbar configuration.

**Figure 26 - Typical Main Busbar Splice Contents**



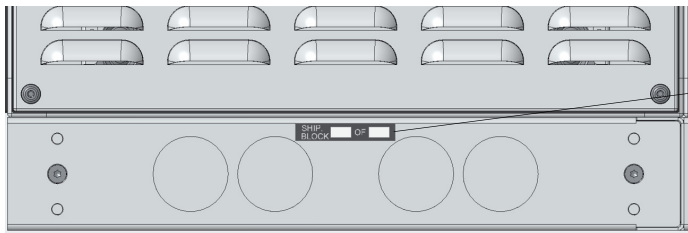
## Position and Secure the Motor Control Center

**IMPORTANT** Adding columns to existing MCCs should be considered during ordering. Network capabilities, voltage and current rating, short circuit withstand, and IP rating must be consistent for the complete lineup.

Shipping blocks must be installed in sequential order. See the sequence label located on the plinth.

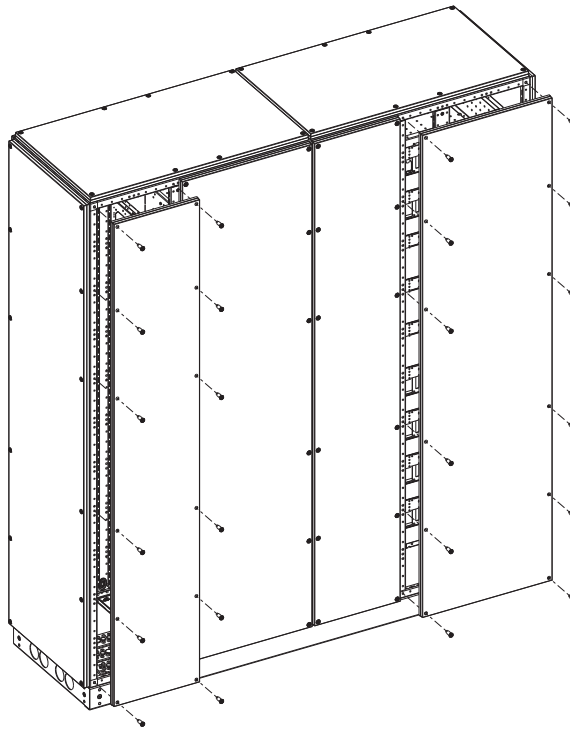
Follow these procedures to position your FLEXLINE 3500 MCC.

1. Documentation packages that are shipped with MCCs include an elevation drawing of a floor plan layout. Locate and use this floor plan layout to position your MCC.
2. Identify the left-most shipping block.  
See the sequence labels located on each shipping block plinth.



SHIP. BLOCK  OF

3. Remove the M8 Torx (T30) hardware and remove the back covers on either end of the shipping block. Set the hardware and covers aside.

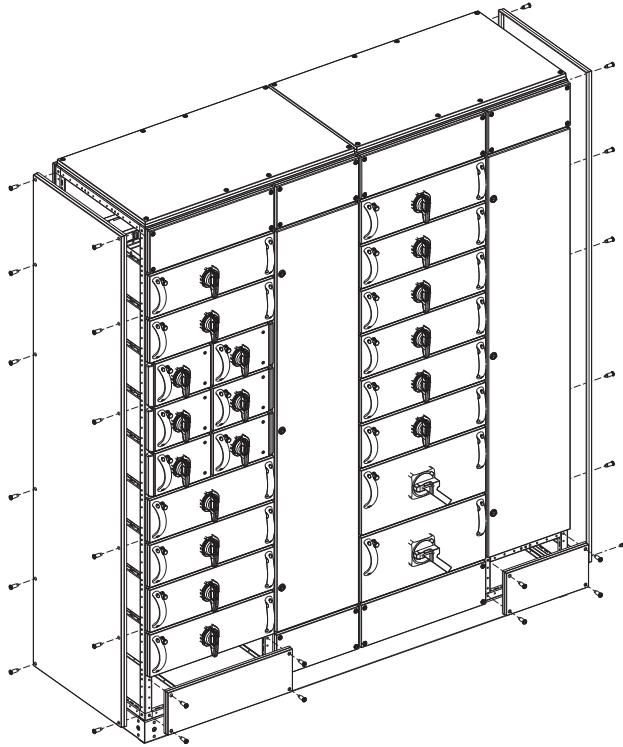




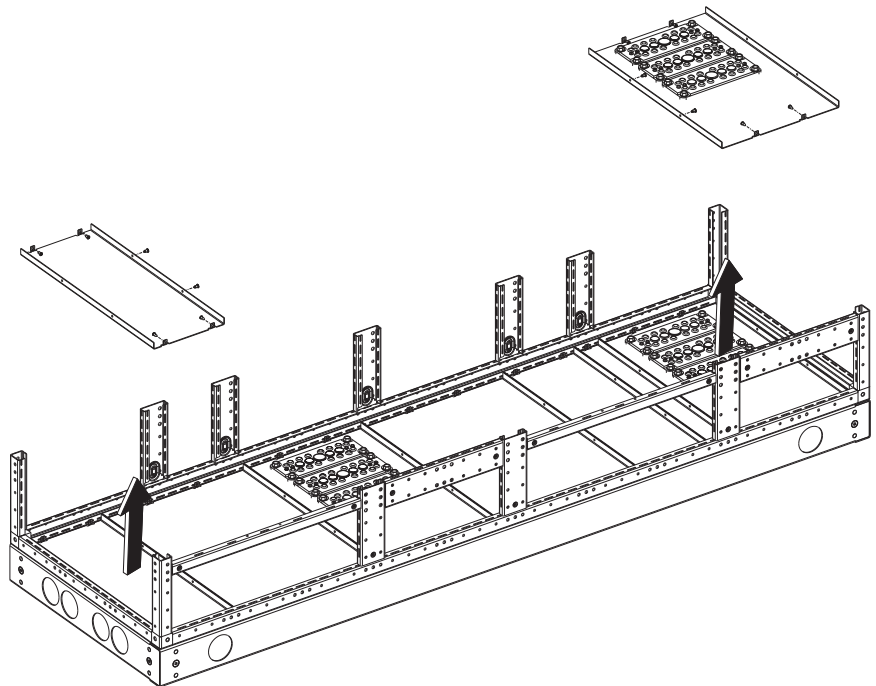
- Remove M8 Torx (T30) hardware and remove two bottom cable compartment covers and two side covers and set aside.

**IMPORTANT**

Side covers only need to be removed on the left- or right-most shipping block. The shipping blocks in the middle of a lineup do not have side covers.



- Remove M5 Torx (T20) hardware that secures the bottom plates on either end of the shipping block. Set the hardware and the bottom plates aside.

**IMPORTANT**

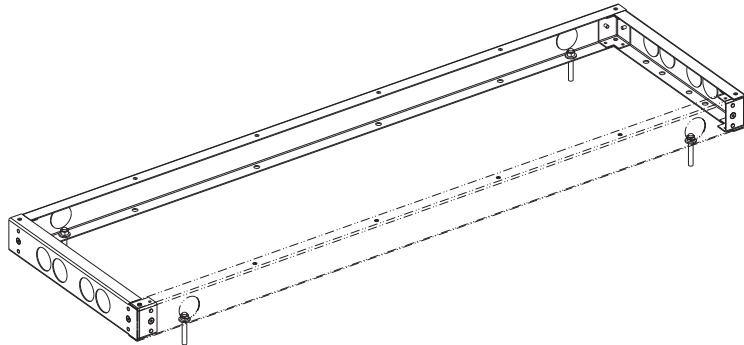
The number and size of the bottom plates will vary based on your MCC configuration.

6. Position the first shipping block in sequence in the location where it will be installed.
7. Insert four steel M12 wedge anchor bolts through the holes in the plinth and secure according to the bolt manufacturer's instructions.

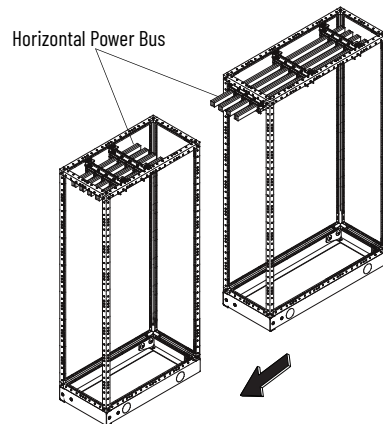
Enclosure not shown for clarity.



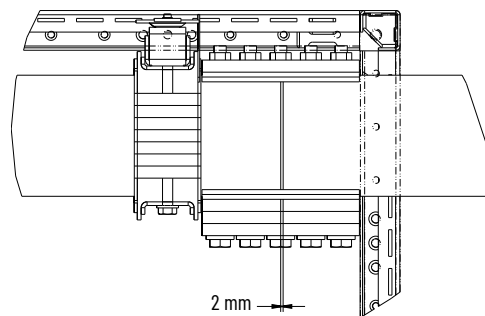
**ATTENTION:** For seismic applications, secure the plinth frame to the foundation using every hole.



8. Place the second shipping block next to the first shipping block over the holes in the foundation that you drilled in [Prepare Installation Site on page 32](#). Verify that the cabinets are level and joining holes are aligned.



After connecting the shipping block, the distance between the main horizontal power busbars is approximately 2 mm apart.



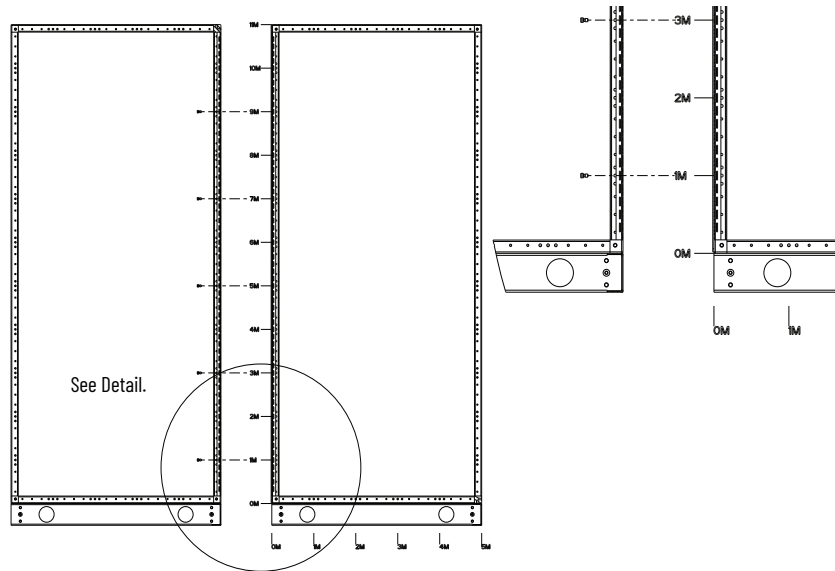
The horizontal power bus does not extend past the left-most shipping block.

9. Insert four steel M12 wedge anchor bolts through the holes in the second plinth and secure according to the bolt manufacturer's instructions. Repeat for remaining shipping blocks.
10. Reinstall the bottom plates removed in [step 5](#) torque M5 Torx (T20) hardware to 3.6 N•m.
11. Reinstall the bottom wireway covers and side covers removed in [step 4](#) and torque M8 Torx (T30) hardware to 9 N•m.
12. Reinstall the back cover removed in [step 3](#) torque M8 Torx (T30) hardware to 9 N•m.

## Join Shipping Blocks

FLEXLINE 3500 MCC shipping blocks have joining holes in the frame that align with each module. In applications with normal vibration levels, hardware is installed at every other module. Joining holes are in groups of three. Hardware is installed in the middle hole.

Figure 27 - Joining Holes Location in a Shipping Block

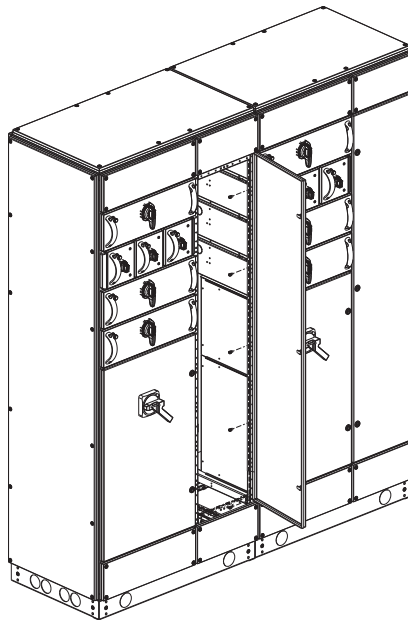


**ATTENTION:** Join Shipping Blocks is done **after** all shipping blocks have been secured to a foundation. Do NOT use the hardware to draw the shipping blocks together.

### Join Side Shipping Blocks

1. Starting with the first shipping block, use the M8 x 12 hardware that is included in the splice kit to fasten the joining holes together at every other module starting from the bottom.

**IMPORTANT** In high vibration environments, install hardware at every module.



2. Torque all fastened bolts to 18 N•m.
3. After side shipping blocks have been joined, inspect and clean them before closing. For the recommended procedures, see [step 20](#) on [page 75](#).

## Splice the Power Bus



**ATTENTION:** To help prevent severe injury or death, de-energize all power sources that are connected to the FLEXLINE 3500 lineup before you join and splice the shipping blocks. Follow EN 50110 requirements, and local codes and guidelines.

**IMPORTANT NO-OX-ID Use-** Do not get any busbar corrosion inhibitor on the bus splicing hardware. It keeps the hardware from being properly torqued and damage can occur.

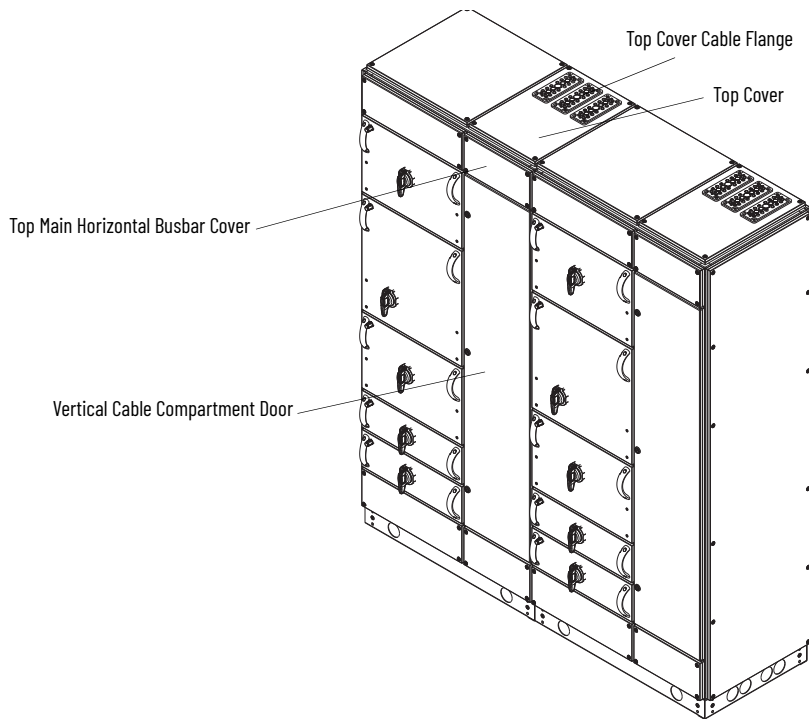
Power bus consists of the main horizontal bus and neutral bus (if present). Based on the current rating of the power bus, the splice kit contains the appropriate splice bars and corresponding hardware. The following procedures describe methods for splicing power buses that are based on the ampere rating of the busbars.

For additional splicing information related to specific FLEXLINE 3500 MCC configurations, see the elevation drawing that is shipped in the documentation package.

### Access the S2000HD Power Bus

Follow this procedure to access the S2000HD power bus.

1. Open the vertical cable compartment door using a flathead screwdriver.
2. Remove M8 Torx (T30) hardware that secures the top main horizontal busbar cover to the frame.

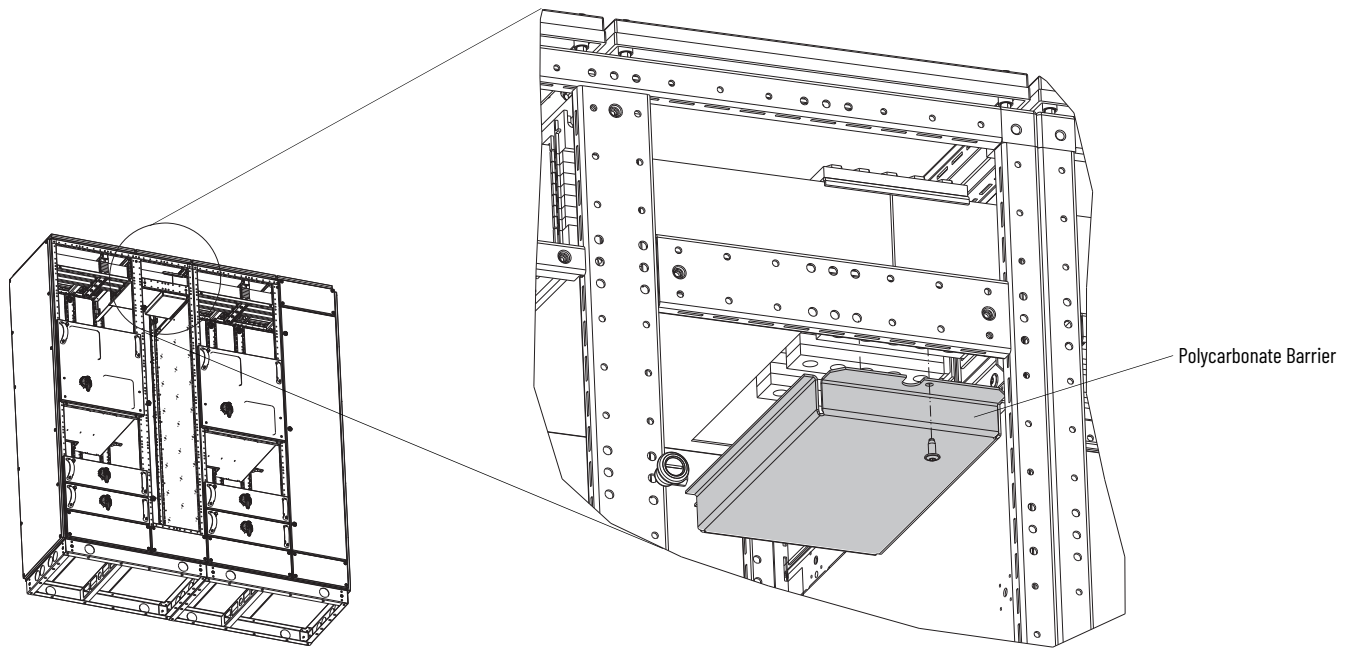


3. Remove M8 Torx (T30) hardware that secures the top cover to the frame.



**ATTENTION:** Do NOT step on the top cover or top cover cable flange.

4. Remove M6 Torx (T30) hardware and set the polycarbonate barrier aside.

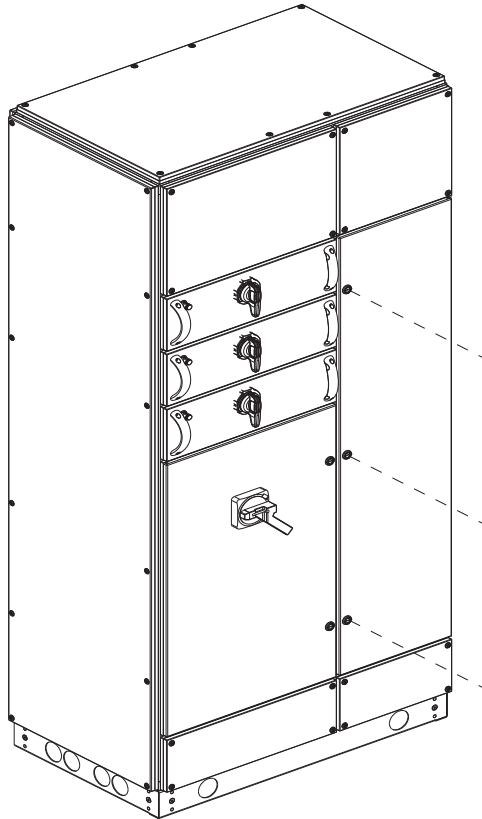


The S2000HD power busbars are now accessible.

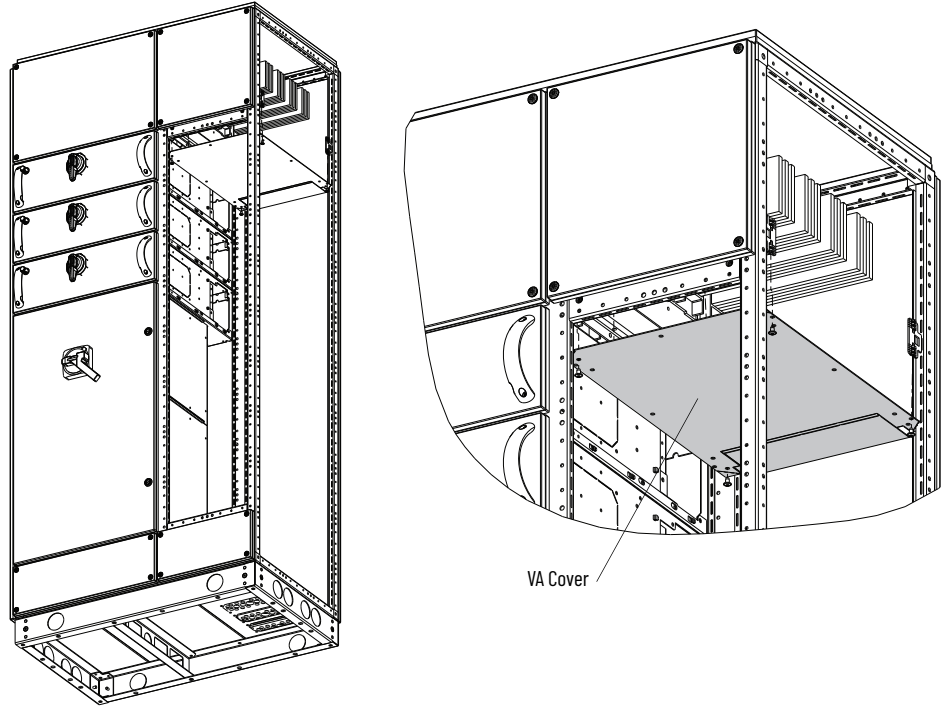
### Access the S7000 Power Bus

Follow this procedure to access the S7000 power bus.

1. Open the vertical cable compartment door using a flathead screwdriver.



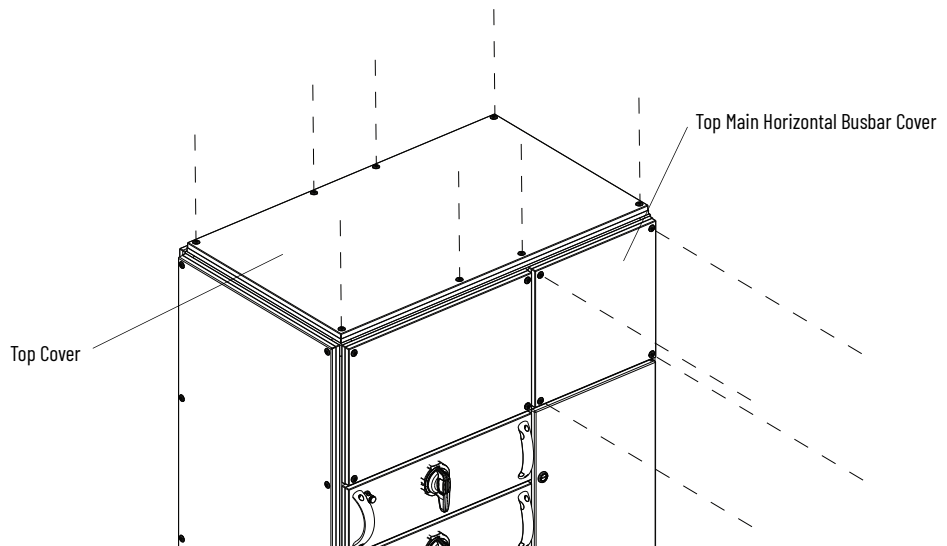
2. Remove the M6 Torx (T30) hardware that holds the VA cover in the vertical cable compartment. Set the hardware and VA cover aside.



3. Remove M8 Torx (T30) hardware that secures the top main horizontal busbar cover to the frame.
4. Remove M8 Torx (T30) hardware that secures the top cover to the frame.



**ATTENTION:** Do NOT step on the top cover or top cover cable flange.



The S7000 power busbars are now accessible.

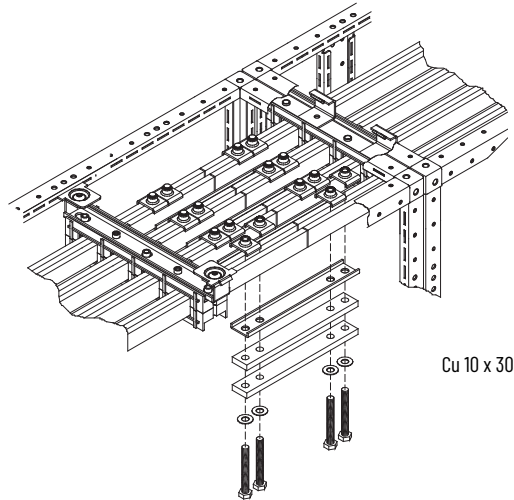
## Splicing The Power Bus



**ATTENTION:** Do not step on cover plates, coverings, or cable flanges.

Follow these procedures to splice the power bus.

1. Open the bus splice kit that you removed from the shipping block as instructed in [Locate Bus Splice Kits on page 39](#).
2. Assemble splice bars and hardware. Depending on your busbar configuration:
  - see [Figure 28 on page 47](#) for S2000HD busbar configuration
  - see [Figure 29 on page 48](#) for S7000 busbar configuration



3. Repeat for each phase of busbar and, if present, the neutral bar.
4. Tighten hardware to 40 N•m.

**IMPORTANT** Do not grease or lubricate hardware.

5. If you have an S2000HD busbar configuration:
  - Reinstall the polycarbonate cover and torque M6 Torx (T30) hardware to 7 N•m.
 If you have an S7000 busbar configuration:
  - Reinstall the VA cover and torque M6 Torx (T30) hardware to 7 N•m.
6. Reinstall the top cover and top main horizontal busbar cover and torque M8 Torx (T30) hardware to 9 N•m.

**Figure 28 - S2000HD Power Bus Splicing Configurations**

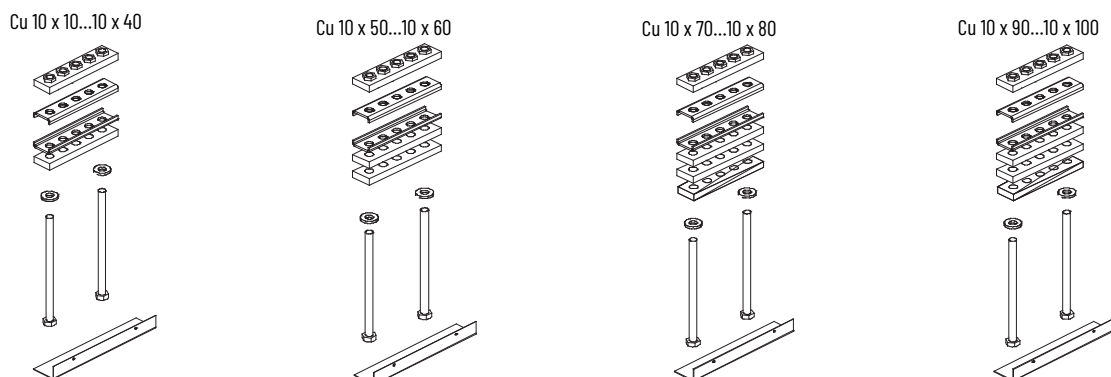
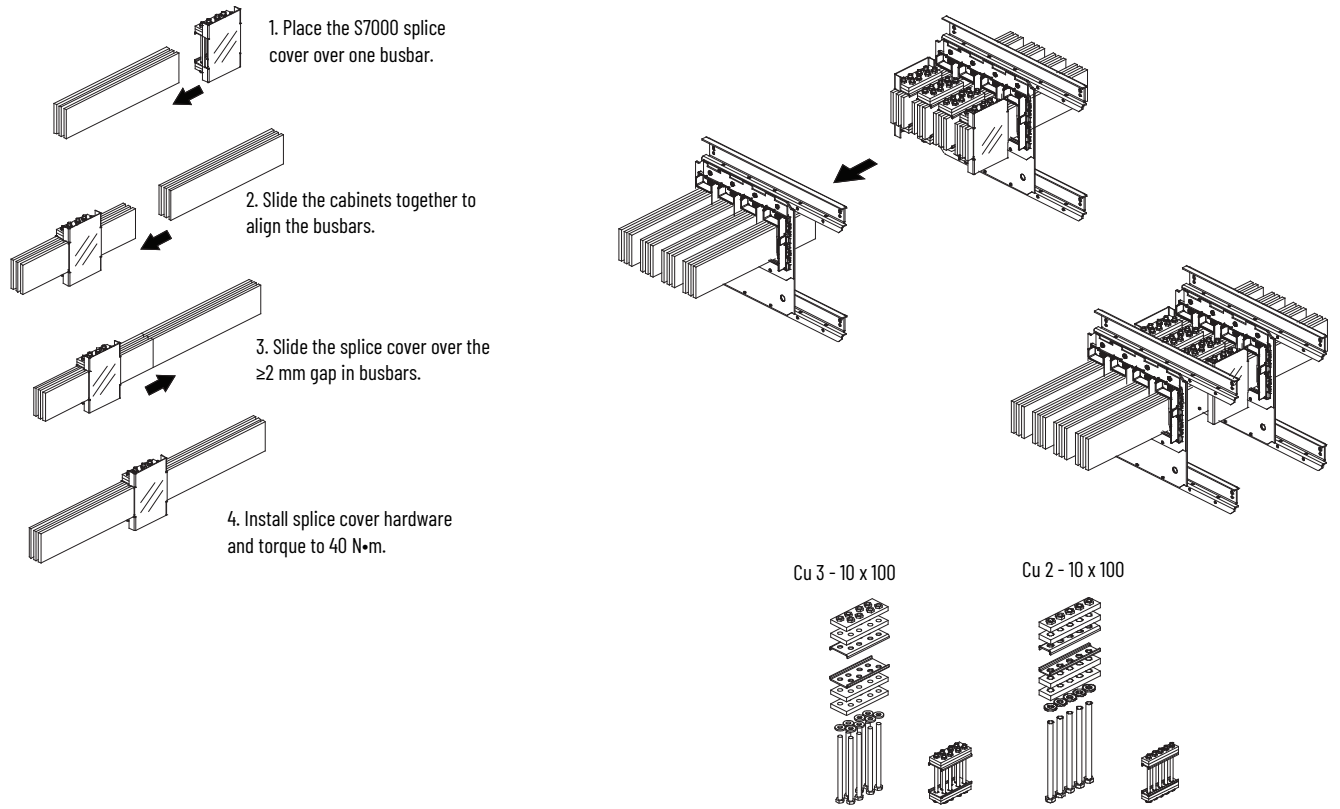
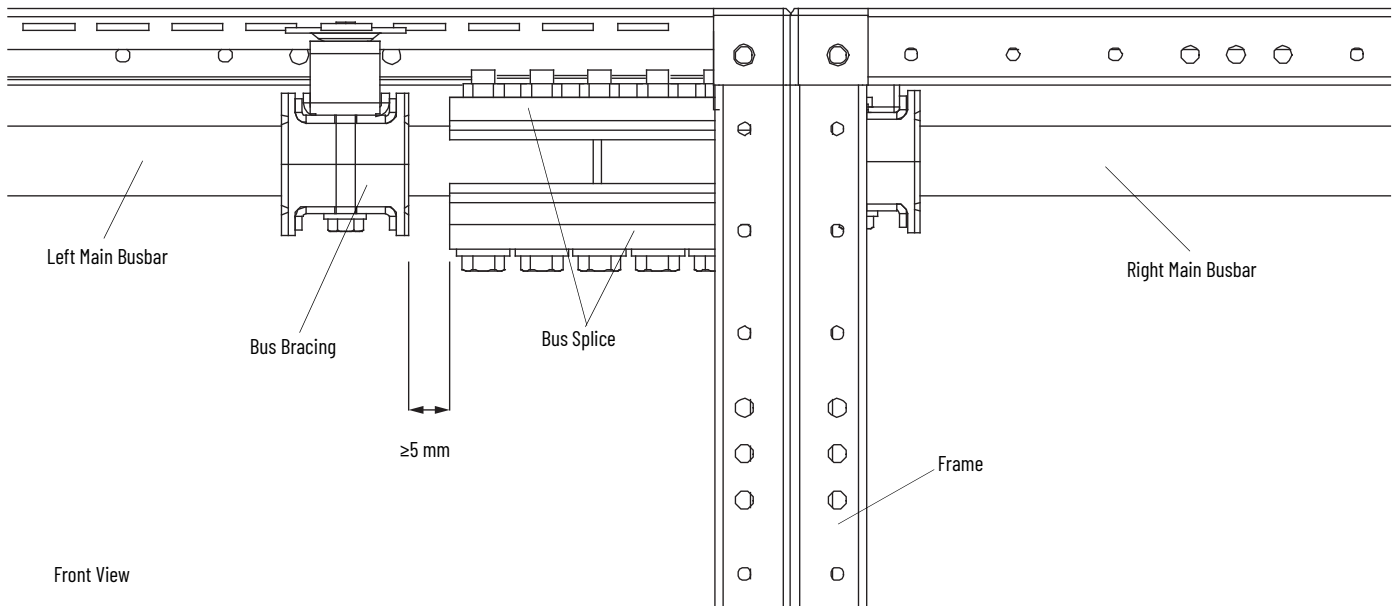


Figure 29 - S7000 Power Bus Splicing Configurations



During installation, the bus splice must be mounted equally on the left and right main busbars. In some cases, the bus bracing could be located close the bus splice. Install the bus splice at least 5 mm from the bus bracing.

Figure 30 - Bus Splice and Bus Bracing



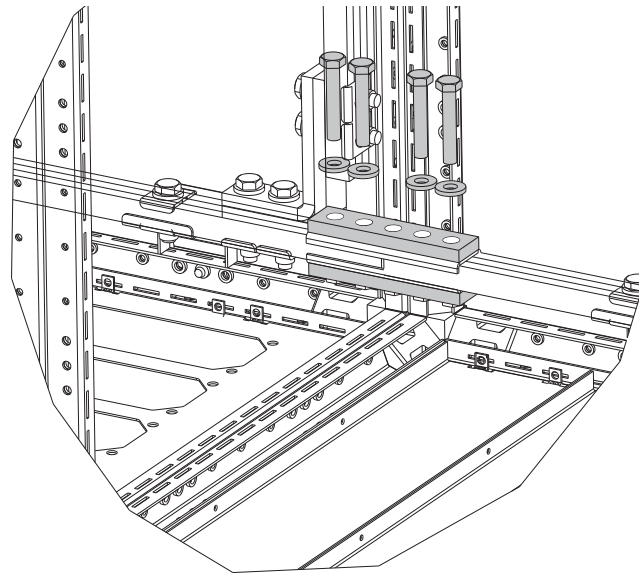


## Splice the Protective Earth (PE) Conductor

The PE conductor is in the bottom horizontal cable compartment. To access the PE conductor, open the vertical cable compartment.

Follow these procedures to splice the Protective Earth Conductor.

1. Locate the PE splice bars.  
PE splice bars are in the splice kit that is shipped with the shipping block. See [Locate Bus Splice Kits on page 39](#).
2. Use the PE splice bars to join the horizontal PE of each shipping block and assemble the splice bars and hardware.



3. Tighten splice hardware to 40 N•m.

---

**IMPORTANT** Do not grease or lubricate hardware.

---

4. Reinstall the horizontal cable compartment cover (if removed) and torque M8 Torx (T30) hardware to 9 N•m.

**Notes:**

## Install Cable

When you install cable, verify that it is installed according to appropriate codes and standards. Multi-conductor cables, cable trays, cable ducts, and conduit are all acceptable methods of routing cable to your MCC.

---

**IMPORTANT** All installed cable must be compatible with the enclosure rating of the MCC. Cable entry and exit points must be properly sealed so water and moisture cannot enter or accumulate inside the enclosure.

---

Inside the MCC enclosure, route cable away from the PE conductor to avoid damage. Position cable so bends are minimized and relative vertical alignment to incoming connections is maintained. Final cable connections must not place any additional strain on the termination blocks.

See the documentation package shipped with your MCC for the following information:

- Approximate cable entry locations
- Space availability for incoming cables
- PE conductor locations
- Wiring schemes for main fusible disconnects, main circuit breakers, and incoming line compartments

## Lugs

Verify that the compatibility of wire size, type, and stranding for the power lugs is furnished. Use correct lugs in all applications. Crimp compression lugs with manufacturer recommended tools.

**Table 8 - Lug Information - Connection Point Designed for Cable Lugs According to DIN 46235**

Application	Trip Rating [A]	Number Of Cables Per Phase, Max	Cable Size [mm <sup>2</sup> ], Max	Screw DIN 931/ISO 4014	Tightening Torque Reference <sup>(1)</sup> [N•m]
Multi Drawer 3 x 1, 3 x 2, 3 x 3	≤400	2	120	M10, CL8.8	40
Main Feeder with MCCB 140G-M	≤800	6	150	M12, CL8.8	70
Main Feeder with MCCB 140G-N	≤1200	6	150		
Main/Feeder with ACB E1.2	≤1600	8	120		
		6	240		
		4	400		
Main/Feeder with ACB E2.2	≤2500	20	120		
		8	240		
		6	400		
Main/Feeder with ACB E4.2	≤4000	20	240		
		10	400		
Main/Feeder with ACB E6.2	≤6300	40	240		
		20	400		

(1) Calculate the torque value based on the characteristics of the connecting hardware.

---

**IMPORTANT** Use the MCC electrical schematics and wiring diagrams to verify field wiring connection points.

The minimum cable size for customer wiring is 2.5 mm<sup>2</sup> (14 AWG).

Double hole lugs are not supported.

---

## Incoming Line Lug Compartment

Top or bottom incoming line lug compartments are available. Base the lug selection on the size, number, and type of conductor.

The following guidelines to select lugs are based on incoming line available short circuit current,  $I_{sc}$ .

$I_{sc} \leq 50,000$  amperes RMS symmetrical use **mechanical screw** or **crimp/compression** type lugs.

$I_{sc} > 50,000$  amperes RMS symmetrical **crimp/compression** type lugs are recommended.

## Main Disconnecting Means

For information on incoming termination, see the documentation package that is shipped with your MCC.

For main disconnects or circuit breakers, use the lugs provided.

## Cable Bracing

The FLEXLINE™ 3500 MCC bus work system has been tested and is qualified to withstand forces that exceed the short circuit withstand ratings for the MCC. Incoming line cables and outgoing feeder cables must be supported to withstand the same short circuit forces. Follow appropriate codes and standards when bracing incoming and outgoing cables.

There are many sizes and types of cables, and different means by which the cables can be supported. Cabling must be secured or braced for the weight of the cable and if there is a fault.

---

**IMPORTANT** Position cable so bends are minimized and relative vertical alignment to incoming connections is maintained. Final cable connections must not place any additional strain on the termination blocks.

---

Follow the guidelines addressed in IEC Standard 60364-5-52.

## Internal Separation

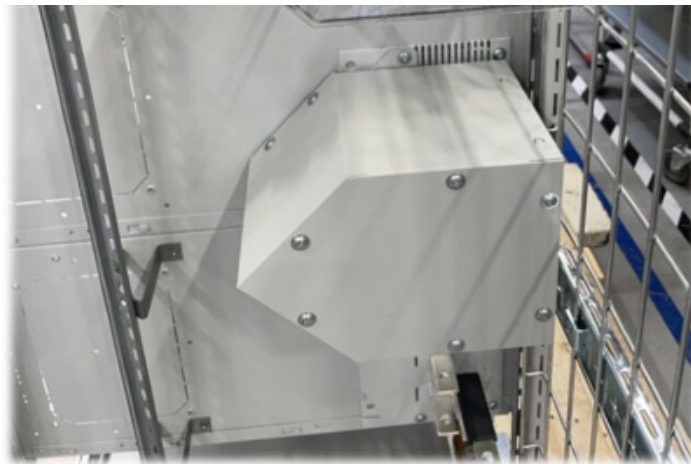
Standard internal separation within the MCC is IEC 61439-2 Form 3b. The following IEC 61439-2 separation forms are also available as options.

- Form 4b: Terminals for external conductors are enclosed in metallic partitions. The termination for each functional unit has its own integral glanding facility.

Figure 31 - FLEXLINE 3500 MCC Rear Access



Figure 32 - FLEXLINE 3500 MCC Front Access



The metal box does not have cutouts for routing outgoing cables. The cable gland / bushing should be selected and installed based on the outgoing wire size. Protect the cutouts to avoid damage of wire. Support each wire as you install it so a strong connection is made. Do not overtighten the screws. See torque values in [Table 9](#).

Table 9 - Torque Values for Separation Forms

Cap Screw Size	N•m
M6 Torx hex head socket	7.0

**IMPORTANT** You can strip the holes if you over-torque the screws.

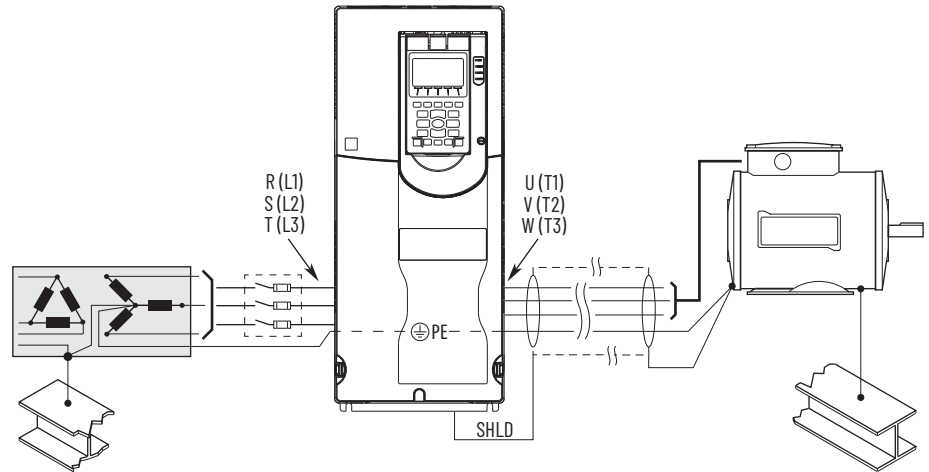
## Installation Requirements Related to EN 61800-3 and the EMC Directive

At the motor end, the motor cable shield or conduit must terminate in a shielded connector, which must be properly installed in an earthed motor wiring box that is attached to the motor. The motor-wiring box cover must be installed and earthed.

Output power wiring to the motor must use cable with a braided shield providing 75% or greater coverage, or the cables must be housed in metal conduit, or equivalent shielding must be provided. Continuous shielding must be provided from the drive enclosure to the motor enclosure. Both ends of the motor cable shield (or conduit) must terminate with a low-impedance connection to earth.

For more information, see the user manual for your specific variable frequency drive.

**Figure 33 - Recommended Grounding Scheme**

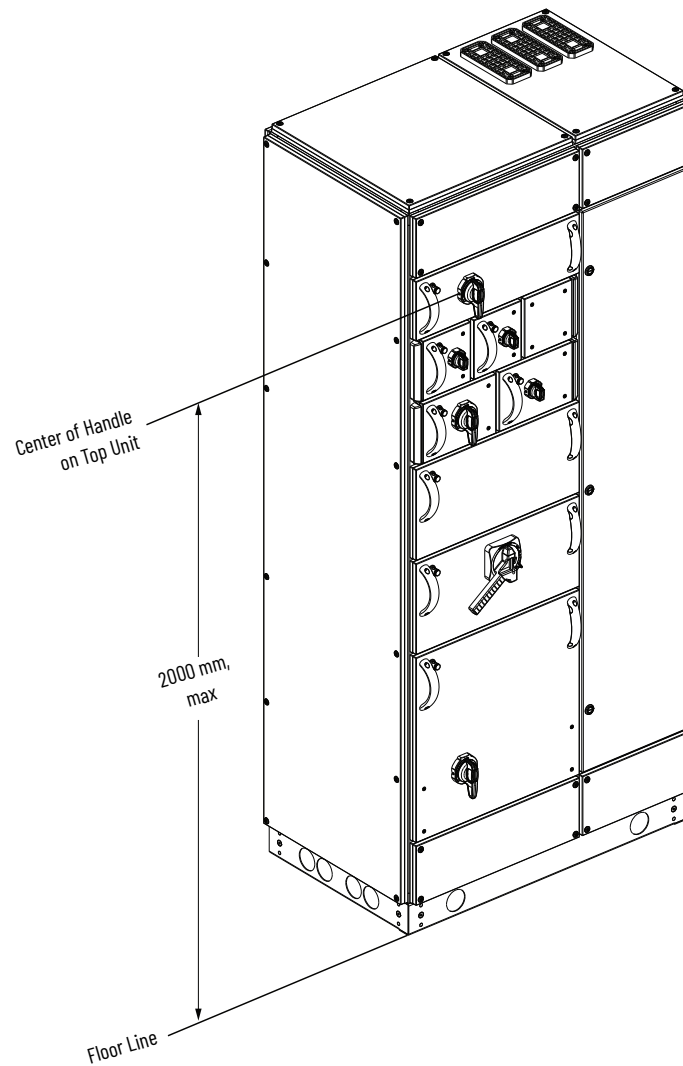


## Door Latches, Operator Handles, and Unit Interlocks

### Height Considerations

In accordance with IEC 61439-1, operating devices (push buttons and handles) must be no more than 2000 mm above floor level. If the MCC is mounted on an elevated surface, the height from the floor to the center of the top handles must be checked for compliance.

Figure 34 - Operator Handle Height



## Door Latches

### Quarter-turn Door Latches

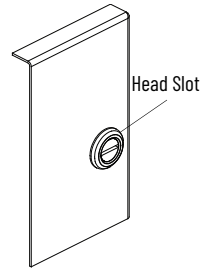
Latches are provided on each unit door to hold the door closed and isolate the column. You can rotate the door latches by using a standard slotted screwdriver in the head slot.

Open the door latches as follows.

1. Rotate each door latch a quarter turn (90°) until its head slot is vertical.
2. Open the door once all latches are in the open position.

Close and lock the door latches as follows.

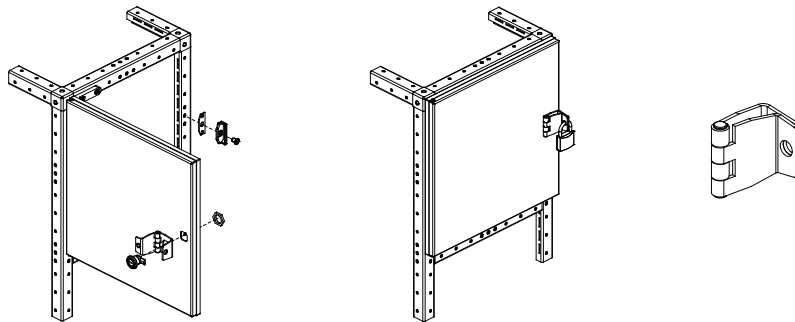
1. Close the door.
2. Use a slotted screwdriver to rotate each door latch a quarter turn (90°) until all slots are horizontal.



Latch shown in horizontal (closed) position.

An additional security option is to install a hinged latch around the head slot to insert a padlock.




Figure 35 - Hinged Lock



## Rotary-operator Handles

Rotary-operator handles are available in three sizes for FLEXLINE™ 3500 MCCs. Because of their design and functionality, each size can require different instructions to modify or to lock in different positions. The following table details the different rotary-operator handle sizes.

Table 10 - Available Rotary-operator Handle Sizes

Handle Size <sup>(1)</sup>	Cat. No.	Color
 <p>Small</p>	<ul style="list-style-type: none"> <li>• 140MT-SB</li> <li>• 140MT-SY</li> </ul>	<ul style="list-style-type: none"> <li>• Black</li> <li>• Red/yellow</li> </ul>
 <p>Medium</p>	<ul style="list-style-type: none"> <li>• 140U-PB</li> <li>• 140U-PY</li> </ul>	<ul style="list-style-type: none"> <li>• Black</li> <li>• Red/yellow</li> </ul>
 <p>Large</p>	<ul style="list-style-type: none"> <li>• 140U-HM4</li> <li>• 140U-HM4E</li> </ul>	<ul style="list-style-type: none"> <li>• Black</li> <li>• Red/yellow</li> </ul>

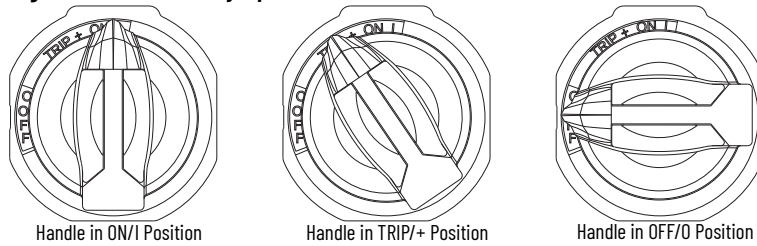
(1) Handle pictures are not to scale.



## Small Rotary-operator Handles (Cat. Nos. 140MT-SB and 140MT-SY)

The following is a brief summary of operating instructions for small rotary-operator handles. For additional information, see publication [140MT-INO06](#).

**Figure 36 - Small Rotary-operator Handle Positions**



### Open the Unit Door

1. Turn the small rotary-operator handle to the OFF/O position.
2. Release the door latches.
3. Grasp the small rotary-operator handle and pull the unit door toward you to open.

### Close the Unit Door

1. Verify that the small rotary-operator handle is in the OFF/O position.
2. Close the unit door.
3. Secure the door latches.

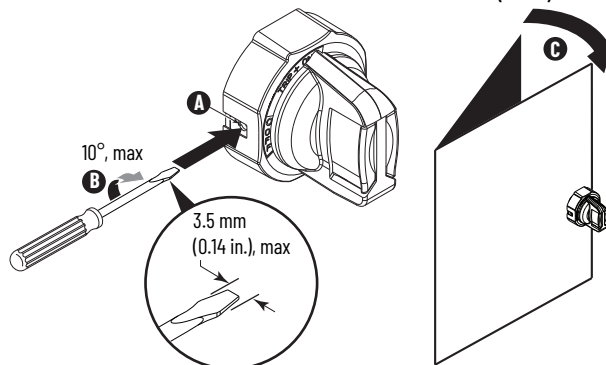
### Open the Unit Door in the ON/I Position



**ATTENTION:** Follow local codes and guidelines with requirements of EN 50110 when you work on energized equipment.

When the unit door is closed and the small rotary-operator handle is in the ON/I or TRIP/+ position, a defeater screw must be deliberately operated to open the unit door.

1. Release the door latches.
2. Locate the defeater screw on the side of the small rotary-operator handle near the OFF/O position (A).
3. Use a screwdriver to turn the defeater screw 10° (max) clockwise (B).



4. Carefully open the unit door (C).

### Operator Handles for Circuit Breakers

If there is a circuit breaker fault, the circuit breaker operator handle moves to the TRIP/+ position. Only reset the circuit breaker after the cause of the fault has been determined and corrected.

Follow these procedures to reset the circuit breaker.

1. Turn the small rotary-operator handle to the OFF/O position.
2. After the fault has been corrected, verify that it is safe to re-energize the unit and turn the small rotary-operator handle to the ON/I position.

### Lock Units in the OFF/O Position



**ATTENTION:** Follow all company safety and lockout procedures, and local codes when you perform this procedure.

Follow these procedures to lock a unit in the OFF/O position.

1. Turn the small rotary-operator handle to the OFF/O position.
2. Push and hold the middle section of the operator handle.  
The lock opening is now visible.
3. Insert and secure the lock.  
Up to three 8 mm (shackle diameter) locks can be inserted.



### Lock Units in the ON/I Position

Locking units in the ON/I position requires user modification.



**ATTENTION:** Locking a small rotary-operator handle in the ON/I position can conflict with local codes and emergency shutdown requirements.

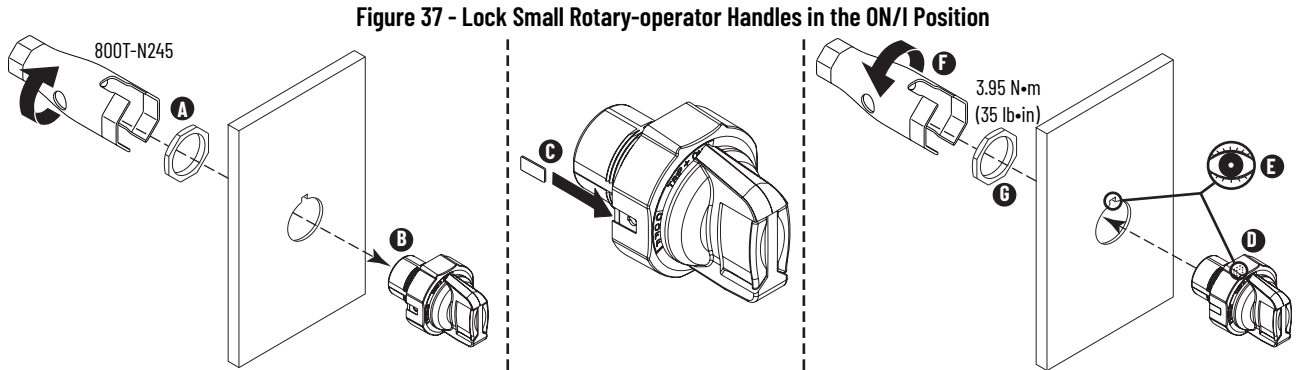
To modify the operator handle so it remains locked in the ON/I position, perform the following steps.



**WARNING:** To help prevent electrical shock, disconnect from the power source before you modify any small rotary-operator handle.

1. Verify that the small rotary-operator handle to be modified is in the ON/I position.
2. Release the door latches.
3. Open the door to access the locking nut that secures the small rotary-operator handle to the door.
4. With the appropriate tool, remove the locking nut from the small rotary-operator handle body (A in [Figure 37 on page 59](#)).
5. Remove the small rotary-operator handle from the door (B).
6. Slide the provided defeater plug into the slot to prohibit access to the defeater screw (C).

7. Reinstall the small rotary-operator handle into the door (D).  
For proper installation, align the notch on the back of the small rotary-operator handle with the corresponding slot in the door (E).
8. With the appropriate tool, reinstall the locking nut on the small rotary-operator handle (F).
9. Torque the locking nut to 3.95 N•m (G).
10. Close the door.
11. Secure the door latches.



### Medium Rotary-operator Handles (Cat. Nos. 140U-PB and 140U-PY)

The following is a brief summary of operating instructions for medium rotary-operator handles.

#### *Open the Unit Door*

1. Turn the medium rotary-operator handle to the OFF/O position.
2. Release the door latches.
3. Grasp the medium rotary-operator handle and pull the unit door toward you to open.

#### *Close the Unit Door*

1. Verify that the medium rotary-operator handle is in the OFF/O position.
2. Close the unit door.
3. Secure the door latches.

#### *Operator Handles for Circuit Breakers*

If there is a circuit breaker fault, the circuit breaker operator handle moves to the TRIP/+ position. Only reset the circuit breaker after the cause of the fault has been determined and corrected. Follow these procedures to reset the circuit breaker.

1. Turn the circuit breaker handle from the TRIP/+ position to the OFF/O position.
2. Turn the circuit breaker handle from the OFF/O position to the RESET position.
3. Locate and correct the fault.
4. Verify that it is safe to re-energize the unit.
5. Turn the handle from the RESET position to the ON/I position.

*Lock Units in the OFF/O Position*

**ATTENTION:** Follow all company safety and lockout procedures and local codes when you perform this procedure.

Follow these procedures to lock a unit in the OFF/O position.

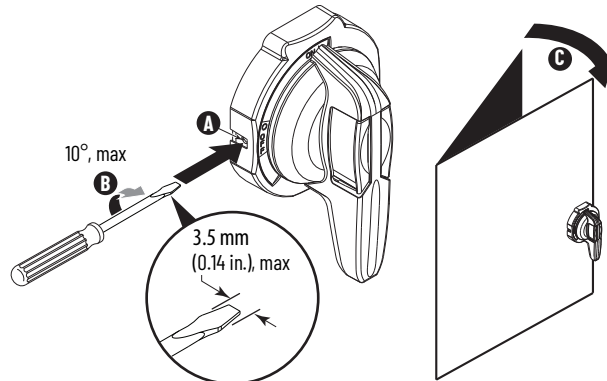
1. The medium rotary-operator handle must be in the OFF/O position.
2. Push and hold the middle section of the operator handle.  
The lock opening is now visible.
3. Insert and secure a lock.  
Up to three 8 mm (shackle diameter) locks can be inserted.

*Open the Unit Door in the ON/I Position*

**ATTENTION:** Follow local codes and guidelines with requirements of EN 50110 when you work on energized equipment.

When the unit door is closed and the medium rotary-operator handle is in the ON/I or TRIP/+ position, a defearer screw must be deliberately operated to open the unit door.

1. Release the door latches.
2. Locate the defearer screw on the side of the medium rotary-operator handle near the OFF/O position (A).
3. Use a screwdriver to turn the defearer screw 10° (max) clockwise (B).



4. Carefully open the unit door (C).

*Lock Units in the ON/I Position*

With medium rotary-operator handles, there are two ways to lock units in the ON/I position. Both ways require user modification.



**ATTENTION:** Locking a medium rotary-operator handle in the ON/I position can conflict with local codes and emergency shutdown requirements.

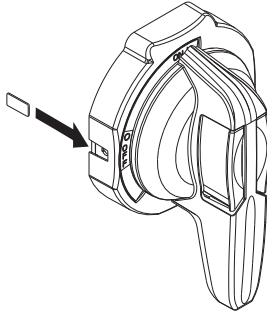
To modify the operator handle so it remains locked in the ON/I position, perform either of the following ways.



**WARNING:** To help prevent electrical shock, disconnect from the power source before you modify any medium rotary-operator handle.

### Lock the Unit in the ON/I Position With a Defeater Plug

1. Verify that the medium rotary-operator handle to be modified is in the ON/I position.
2. Release the door latches.
3. Open the door to access the backside of the medium rotary-operator handle.
4. With a screwdriver, remove the two screws that secure the medium rotary-operator handle body to the door (A in [Figure 38 on page 62](#)).
5. Remove the medium rotary-operator handle from the door.
6. Slide the provided defeater plug into the defeater screw slot to help prevent access to the defeater screw.

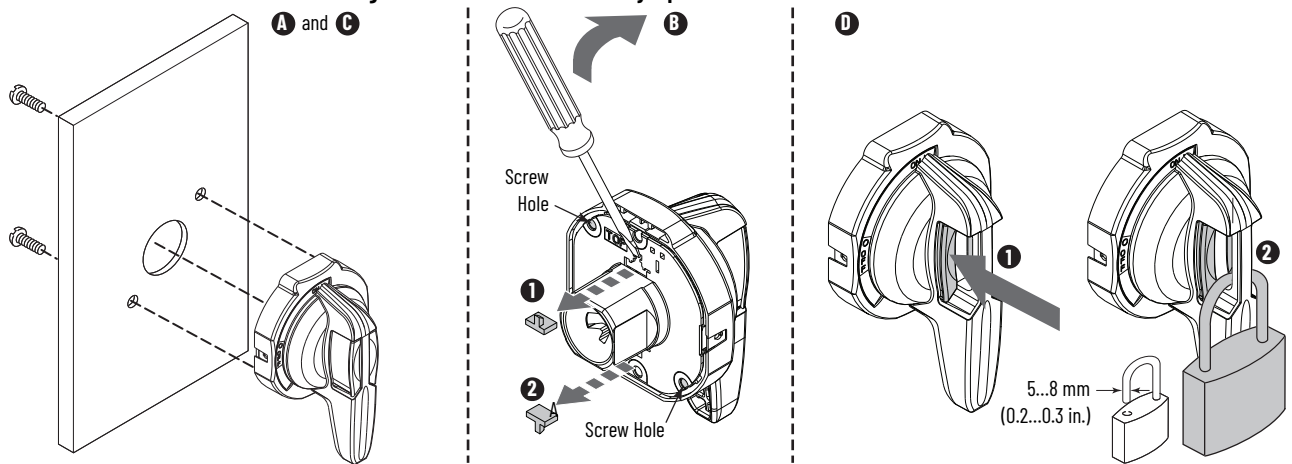


7. With the two screws that you previously removed, reinstall the medium rotary-operator handle into the door (C in [Figure 38 on page 62](#)).
8. Close the door.

### Lock the Unit in the ON/I Position With Locks

1. Verify that the medium rotary-operator handle to be modified is in the ON/I position.
2. Release the door latches.
3. Open the door to access the backside of the medium rotary-operator handle.
4. With a screwdriver, remove the two screws that secure the medium rotary-operator handle body to the door (A in [Figure 38](#)).
5. Remove the medium rotary-operator handle from the door.
6. With the screwdriver, remove the two tabs (B in [Figure 38](#)).
7. With the two screws that you previously removed, reinstall the medium rotary-operator handle into the door (C in [Figure 38](#)).
8. Close the door.
9. Push and hold the middle section of the operator handle.  
The lock opening is now visible (1 in D of [Figure 38](#)).
10. Insert and secure a lock (2 in D of [Figure 38](#)).  
Up to three 8 mm (shackle diameter) locks can be inserted.

Figure 38 - Lock Medium Rotary-operator Handles in the ON/I Position

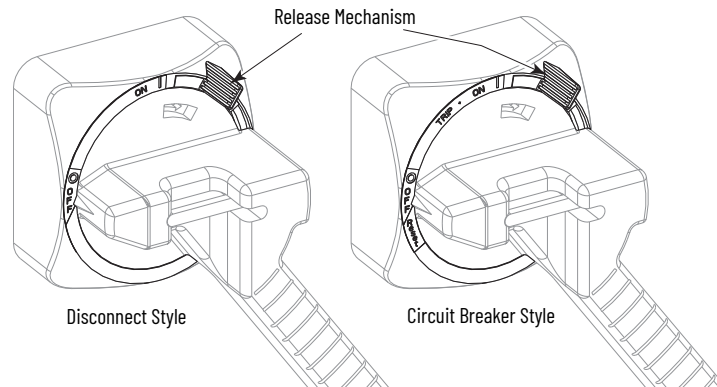


### Large Rotary-operator Handles (Cat. Nos. 140U-HM4 and 140U-HM4E)

The following is a brief summary of operating instructions for large rotary-operator handles available for disconnects or circuit breakers.

For additional disconnect handle information, see publication [190-IN007](#).

Figure 39 - Large Rotary-operator Handle Styles



#### Open the Unit Door

Follow these procedures to open the unit door.

1. Verify that the large rotary-operator handle is in the OFF/O position.
2. Release the door latches.
3. Hold the large rotary-operator handle in the OFF/O position while you push the release mechanism down.
4. Carefully open the unit door.

#### Close the Unit Door

1. Verify that the large rotary-operator handle is in the OFF/O position.
2. Slowly close the door until contact with the large rotary-operator handle is made.
3. Hold the large rotary-operator handle in the OFF/O position while you close the door.
4. Close the door and secure the door latches.



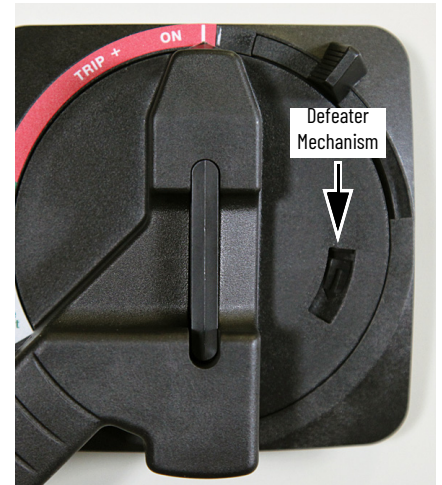
*Open the Unit Door in the ON/I Position*

**ATTENTION:** Follow local codes and guidelines, and the requirements of EN 50110 when you work on energized equipment.

When the unit door is closed and the large rotary-operator handle is in the ON/I position, a defeater mechanism must be deliberately operated to open the unit door (for example, to open the door of an energized unit).

Follow these procedures to open a door with the large rotary-operator handle in the ON/I position.

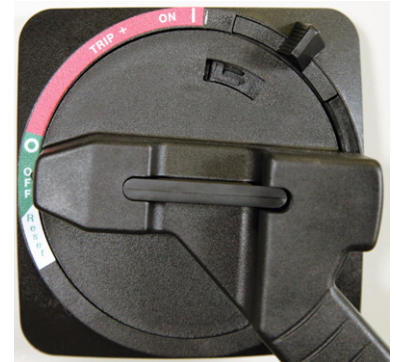
1. Release the door latches.
2. Locate the defeater mechanism on the right side of the handle.
3. Use a screwdriver to push the defeater mechanism in the direction of the arrow.
4. Carefully open the unit door.

*Operator Handles for Circuit Breakers*

If there is a circuit breaker fault, the circuit breaker operator handle moves to the TRIP/+ position. Only reset the circuit breaker after the cause of the fault has been determined and corrected.

Follow these procedures to reset the circuit breaker.

1. Turn the circuit breaker handle from the TRIP/+ position to the OFF/O position.
2. Turn the circuit breaker handle from the OFF/O position to the RESET position.
3. Locate and correct the fault.
4. Verify that it is safe to re-energize the unit.
5. Turn the handle from the RESET position to the ON/I position.

*Lock Units in the OFF/O Position*

**ATTENTION:** Follow all company safety and lockout procedures and local codes when performing this procedure.

1. The large rotary-operator handle must be in the OFF/O position.
2. Pull the middle section of the operator handle toward you.  
The lock opening is now visible.
3. Insert and secure the lock.  
Up to three 8 mm (shackle diameter) locks can be inserted.

### Lock Units in the ON/I Position

Locking units in the ON/I position requires user modification.



**ATTENTION:** Locking an operating handle in the ON/I position can conflict with local codes and emergency shutdown requirements.

---

1. Verify that the large rotary-operator handle to be modified is in the ON/I position.
2. Release the door latches.
3. Open the door to access the backside of the large rotary-operator handle.
4. With a screwdriver, remove the four screws that secure the large rotary-operator handle body to the door (A in [Figure 40 on page 65](#)).
5. Remove the large rotary-operator handle from the door.

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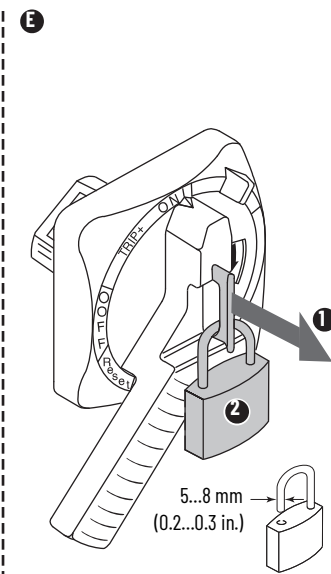
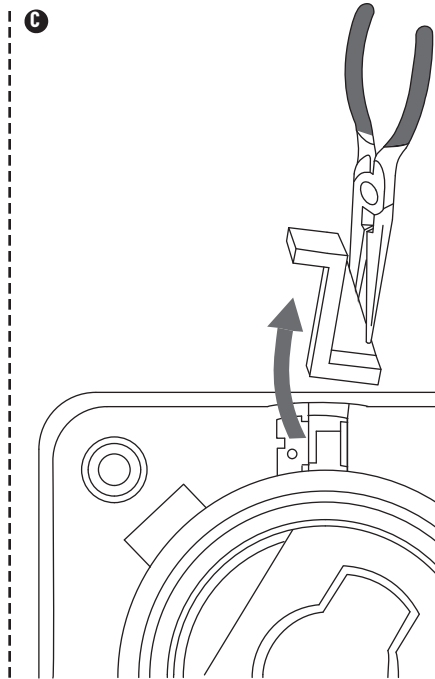
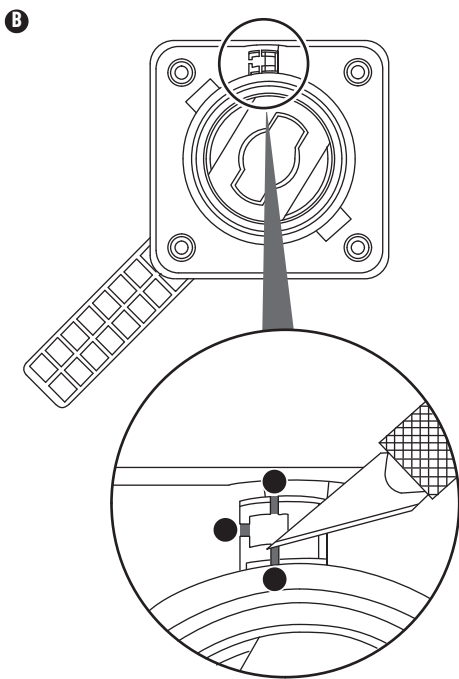
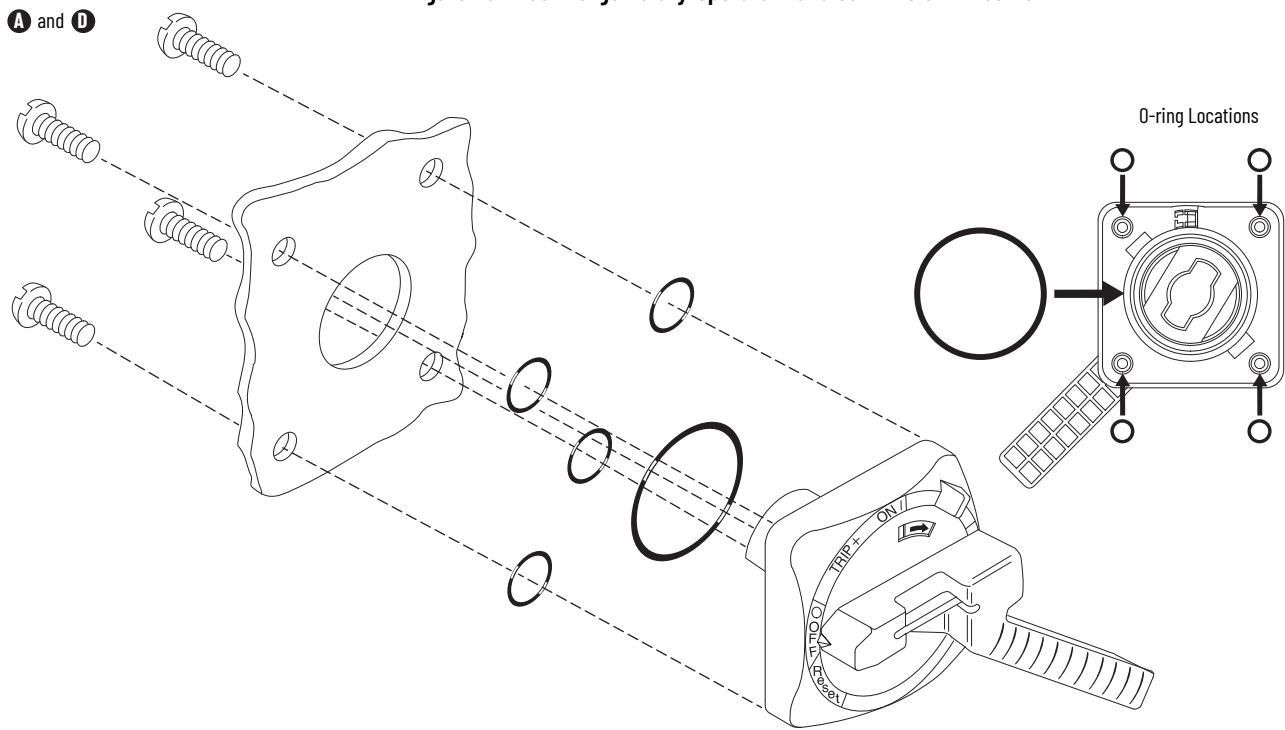
**IMPORTANT** Place the four screws and the five O-rings aside so they can be reinstalled.

---

6. With a sharp blade, cut the three stems that anchor the locking tab (B in [Figure 40 on page 65](#)).
7. With a long nose plier, remove the locking tab from the large rotary-operator handle (C in [Figure 40 on page 65](#)).
8. Reinstall the five O-rings in the appropriate locations on the backside of the large rotary-handle (A in [Figure 40 on page 65](#)).
9. With the four screws that you previously removed, reinstall the large rotary-operator handle into the door (D in [Figure 40 on page 65](#)).
10. Close the door.
11. Push and hold the middle section of the operator handle.  
The lock opening is now visible (1 in E of [Figure 40 on page 65](#)).
12. Insert and secure an 8 mm lock (2 in E of [Figure 40 on page 65](#)).  
Up to three 8 mm (shackle diameter) locks can be inserted.



Figure 40 - Lock Large Rotary-operator Handles in the ON/I Position



## Unit Interlocks



**ATTENTION:** Do not attempt to install or remove a unit while the unit main switch is in the ON/I position.

A unit interlock is provided with each withdrawable unit. Unit interlocks help prevent units from being removed from or inserted into a column while the operator handle is in the ON/I position.

**Notes:**

## Install and Remove Units

### Unit Size

Unit size is described in terms of modules. Each Multi Drawer 1 x 1 module is approximately 192 mm wide by 192 mm tall.

FLEXLINE™ 3500 MCCs are available with many combinations of withdrawable and fixed units.

See [Unit Structure on page 16](#) for more information.

### Withdrawable Units

#### Withdrawable Unit Connections

All withdrawable units have withdrawable line, load, control, network, and PE connections. Outgoing load and control connections from these units are made in the vertical cable compartment. All withdrawable units use a sliding track for ease of insertion and removal.

See [Withdrawable Units on page 17](#) for more information.

#### Operating Positions for All Withdrawable Units

Withdrawable units have four operating positions: **Connected**, **Test**, **Disconnected**, and **Released**. Detents are present to confirm that the unit is in one of the four positions. An interlock helps prevent the unit from being inserted or removed while the branch circuit device is in the ON/I position. Stabs are provided to make the line and load connections. A first make, last break PE contact is also provided. See the following descriptions for additional information about the features of each position.

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**IMPORTANT** The load connector is engaged in the test position for MD 1 x 1 configuration.

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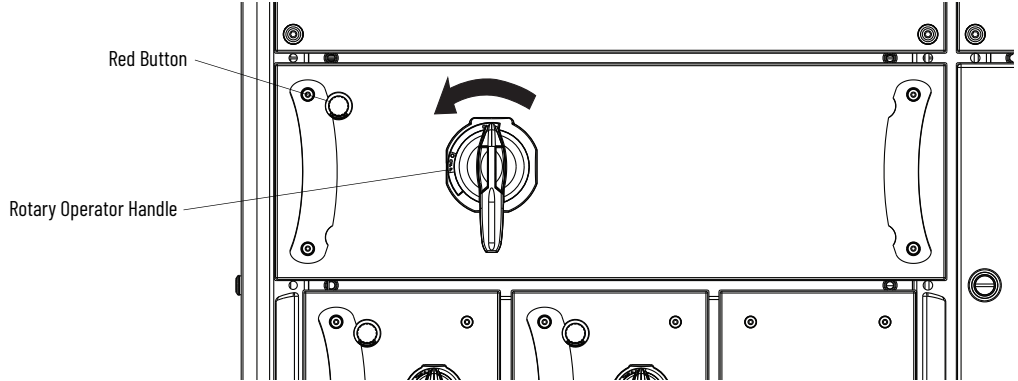
Position	Description
Connected	Line, load, control, network, and PE connections are all engaged. Units can be locked in the Connected position.
Test	Control, network, and PE connections are engaged. Line and load connections are isolated. In this position, you can verify control and network wiring, and unit functionality. Units can be locked in the Test position.
Disconnected	An isolated position where the unit remains housed in the column and the PE connection is engaged, but no other connections are present. Units can be locked in the Disconnected position.
Released	Withdrawable units can be removed from the columns to isolate them from all connections. Released units can be locked to help protect against insertion.

Select an Operating Position on a Standard Withdrawable Unit

**IMPORTANT** The unit housing parts must be in place before you install the unit.

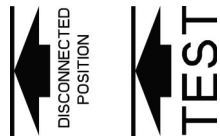
**IMPORTANT** The control circuit and communication plugs installed in the structure must be compatible with plugs installed on unit.

1. Turn the rotary operator handle on the unit cover to the OFF/O position.

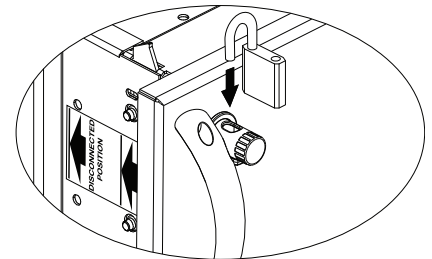


2. Press the red button located on the top left of the unit cover.
3. Pull the unit to your desired location.

**IMPORTANT** There is a label on the side of the unit to indicate in what position the unit is located.



4. Release the red button the lock the unit in position.
5. For lockout and tagout configurations, turn the red button 90° clockwise or counterclockwise to a vertical position. The unit is locked and cannot be withdrawn.



The label is visible when the unit is withdrawn to confirm the desired position is selected.

Figure 41 - Position Indicator



## Safety Guidelines to Install and Remove All Withdrawable Units



**ATTENTION:** De-energize, lock out, and tag out all sources of power to the MCC when you install or remove MCC units. If MCC units are installed or removed with power that is applied to the main power bus, follow established electrical safety work practices. For further information, see the publication, NFPA 70E: Standard for Electrical Safety in the Workplace.



**ATTENTION:** If power sources are connected to the motor control center, use extreme caution when you insert units. All busbars and the line sides of the inserted units are energized and contact with these parts can cause injury or death.



**ATTENTION:** To increase operator safety and help prevent equipment damage, we recommend that two people install or remove 3 x 2 or 3 x 3 withdrawable units that are in the upper two modules or over 1600 mm above floor level.



**ATTENTION:** Withdrawable units have covers which are integral parts of unit. Do not remove the cover when the unit is installed.

Units with operator handles, switches, and disconnects must be in the OFF/O position before units are inserted or removed.

Do not attempt to install or remove a unit when the unit main switch is in the ON/I position.

Before inserting or removing a withdrawable unit, the hole in the red button on the cover must be in the horizontal position (see [Figure 42](#)).

**Figure 42 - Withdrawable Unit Button Alignment**



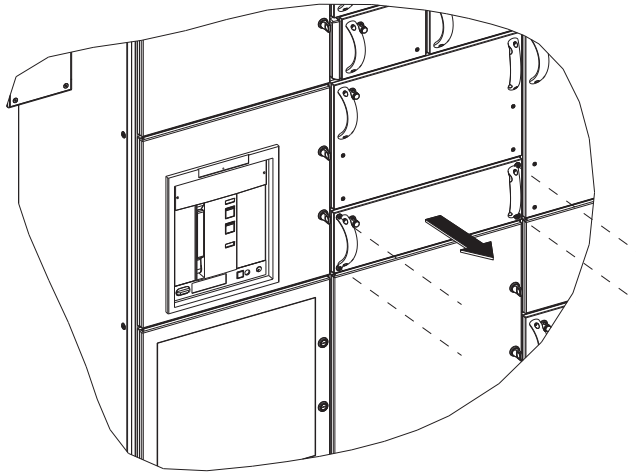
## Insert a Withdrawable Unit

**IMPORTANT** The unit housing parts must be in place before you install the unit.

**IMPORTANT** The control circuit and communication plugs that are installed in the structure must be compatible with plugs installed on the unit.

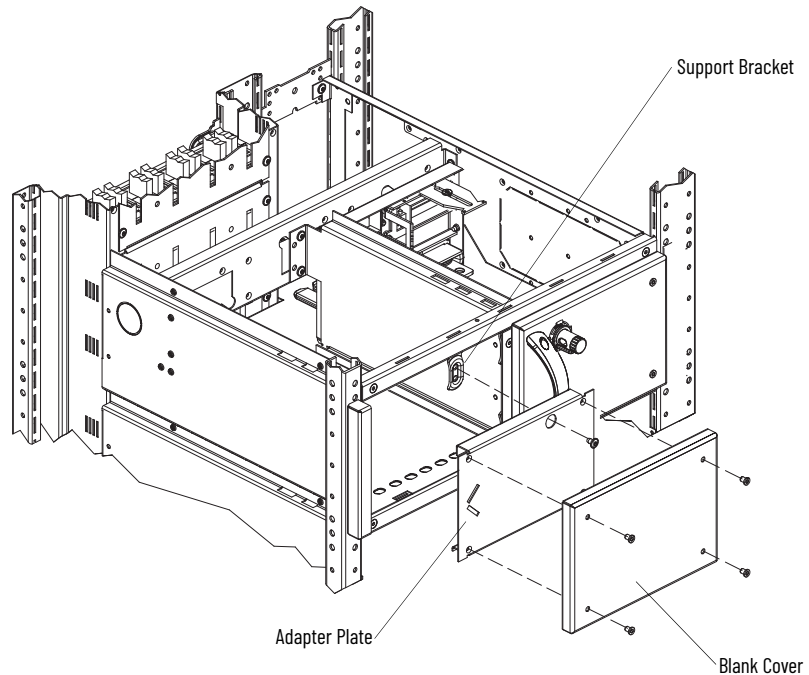
Follow these procedures to insert a withdrawable unit. If you are installing the same unit, or if you are replacing an existing unit, proceed to [step 2](#).

1. If a blank cover is installed where the withdrawable unit will be installed, remove four M8 Torx (T30) bolts and remove the cover.

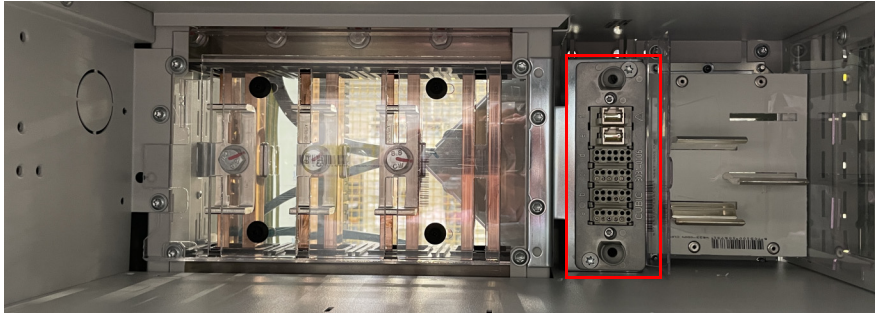


1 x 1 and 1.5 x 1 Multi Drawer units have an additional adapter plate and support bracket that must be removed.

- a. Remove four M6 Torx (T20) bolts and remove the blank cover.
- b. Remove one M6 Torx (T30) screw and remove the adapter plate.
- c. Remove the support bracket.



2. Verify that the unit plugs are compatible with the column housing plugs.



3. Lift the unit using the handle(s) and slide into the column until it reaches your desired position (Disconnected, Test, Connected).  
Distribution bus shutters automatically open as the unit is inserted.

## Remove a Withdrawable Unit

Withdrawable units are installed by the factory and shipped with the MCC.

Follow this procedure to remove a withdrawable unit from a column.

1. Press the red button located on the top left side of the unit cover.
2. Use the cover handle(s) to pull out the unit.
3. Slide the unit out of the column.  
Shutters close automatically as the unit is removed.

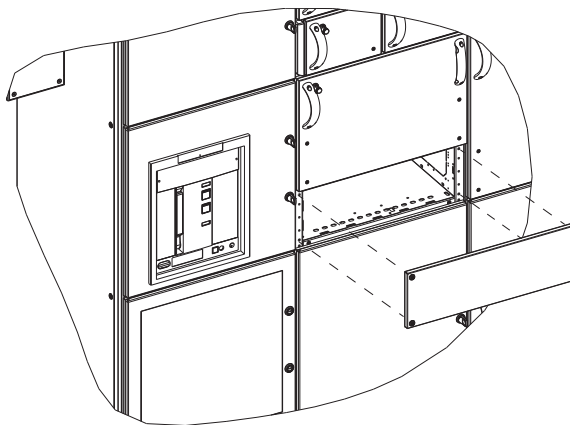
If you are replacing or reinstalling the existing withdrawable unit, see [Insert a Withdrawable Unit on page 70](#).

If you are not using the space and wish to leave it empty, a blank cover must be installed to ensure the required degree of protection (IP rating). See [Install Blank Cover on page 71](#).

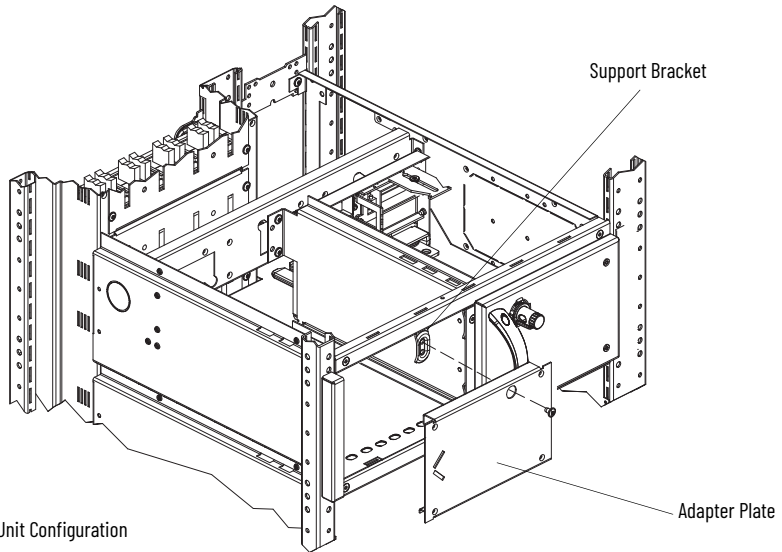
## Install Blank Cover

Follow this procedure to install a blank cover in a column.

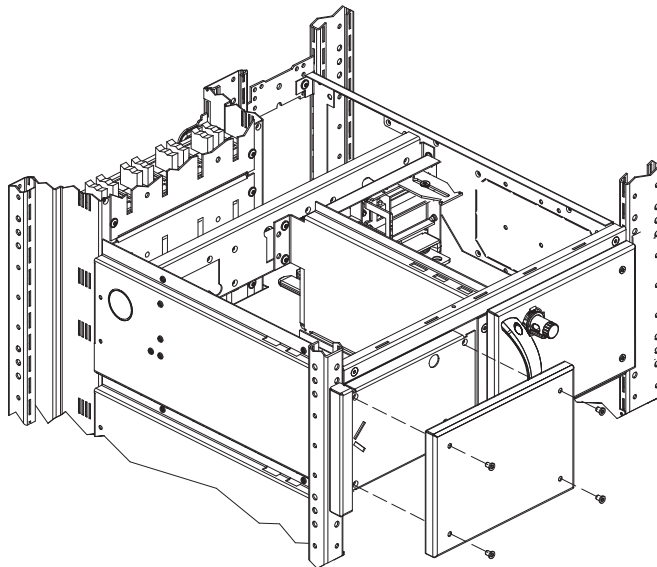
1. Align the blank cover with the empty housing in the column.  
If you have a 1 x 1 or 1.5 x 1 unit configuration, see [step a](#). For all other configurations, continue to [step 2](#).



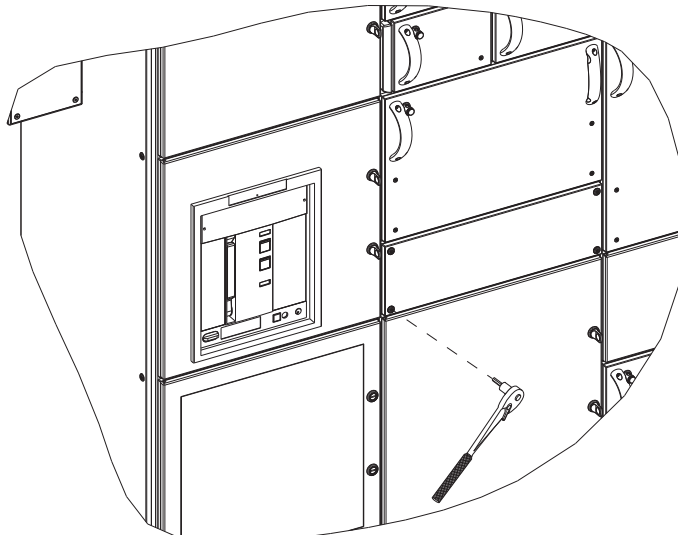
- a. Install the adapter plate support bracket.
- b. Install the adapter plate to the support bracket using M6 Torx (T30) hardware (5.6 N•m).



- c. If you have a 1 x 1 or 1.5 x 1 unit configuration, fasten the cover to the adapter plate with four M6 Torx (T20) bolts (5.6 N•m).



- 2. Fasten the cover with four M8 Torx (T30) bolts (9 N•m).





## Commissioning

### Introduction

This chapter provides guidance for the startup of a newly installed FLEXLINE™ 3500 MCC.

We recommend that you make an itemized list that includes the following:

- Serial number
- Number of columns
- Number of units and their corresponding voltage
- Current ratings
- Kilowatt ratings
- Types of circuits
- Fuse sizes
- Circuit breaker ratings and trip settings
- Other important data

Save this itemized list in a file with other MCC data, such as component manuals, MCC manuals, overload relay instructions, and wiring diagrams.

### Pre-commissioning Checklist



**ATTENTION:** Follow applicable company safety procedures.



**ATTENTION:** To help protect the safety of personnel who perform the pre-energizing check, verify that the remote MCC power sources are disconnected and locked in the OFF/O position. Follow EN 50110 requirements, and local codes and guidelines. Use a voltmeter to verify that the remote MCC power sources are disconnected.



**ATTENTION:** Power factor correction capacitors (PFCCs) must be applied correctly. Temporarily disconnect PFCCs when they are connected to the motor circuit, and the startup procedure requires the respective motors to be jogged, inched, or bumped (rotation direction check). For additional assistance, contact your Rockwell Automation representative.



**ATTENTION:** Verify that motor acceleration times are within specific application specifications. Excessive start currents and/or acceleration times can cause inverse time circuit breakers, power fuses, overload relays, and other components to overheat and/or shut down equipment.

The following procedures must be executed by only a 'skilled person' as defined by IEC 195-04-01 and 3.52 of IEC 60204-1, as follows:

'Skilled person: Person with relevant education and experience to enable him or her to perceive risks and to avoid hazards that operation or maintenance of a product can create.'

Follow these procedures to complete the pre-commissioning checklist.

1. Check and verify that the MCC is installed per instructions.  
See [Chapter 3 on page 21](#).
2. Inspect and verify that the MCC is level and secured.
3. Inspect the enclosure and units for damage and verify that electrical clearances have been maintained based on the voltage and impulse rating of the equipment.
4. Remove all blocks or temporary holding means used for shipping component devices in the MCC.
5. Check the integrity of the bus splice connections.



The factory-made horizontal power bus to vertical distribution bus connections are tightened by a computer-controlled torquing system. Therefore, these components do not need torquing by the customer.

6. Check and verify that all PE connections are made according to applicable codes and standards.  
If the PE conductor is not provided or has been removed, verify that the MCC columns are connected with joining hardware to provide a continuous PE path.
7. Perform the following for field wiring:
  - a. Check the field wiring for proper conductor sizing.
  - b. Verify that all incoming and outgoing power wiring is secure, well supported, and braced to withstand the effects of a fault current.  
Brace the cables every 300 mm if the available short circuit current is <42,000 amperes RMS symmetrical.  
Brace the cables every 150 mm if the available short circuit current is ≥42,000 amperes RMS symmetrical.
  - c. Check the integrity of all field connections.  
Recommended torque values that are not found on individual devices can be found on wiring diagrams.
  - d. Check field wired connections that are made to the MCC.  
See wiring diagrams and verify that proper clearances between adjacent phases and/or phases to PE are being maintained.
8. Verify that the voltage and kilowatt ratings on the motor correspond with the MCC unit ratings.
9. Verify that proper overload relays are installed and/or adjusted to relative full-load current shown on the motor rating nameplate.
10. For applications that require power fuses, install fuses in fusible switches in accordance with application requirements.

---

**IMPORTANT** Do not apply grease or NO-OX-ID to fuse ferrules.

---

11. Adjustable circuit protective devices in MCCs are set to the lowest trip setting when shipped from the factory. Verify that the trip settings of these devices are set in accordance with application requirements.



High efficiency motors can have higher locked rotor and inrush currents, which require higher magnetic trip settings.




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**ATTENTION:** Rockwell Automation® AC drives and soft starter units are shipped with preset factory settings such as ramp speed, current limits, switch positions, and readouts. Preset factory settings are not suitable for some applications. For specific startup guidance, see the instruction manuals that are supplied with the MCC.

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12. Set and verify adjustable current, voltage and other settings, according to device instructions or wiring diagrams.  
See the device instruction sheets or manuals that are supplied with the MCC for specific startup guidance.  
Component devices in MCC units (such as transfer switches, power factor correction capacitors, transducers, motor protectors, line monitors, over and undervoltage relays, and motor windings heaters) can require unique startup procedures.
13. Manually exercise all switches, control auxiliary switches, circuit breakers, their respective operators, unit interlocks, trip mechanisms (to test, push the Push to Trip button) and any other operating mechanisms to verify proper operation.
14. Check timing relay settings as required.
15. Verify that the vents are free from obstructions.
16. Check that fans that are used for forced air cooling have:
  - a. Shafts that rotate freely
  - b. Blades with no dust or debris build-up
17. Check that all filters are in place and clean.



We recommend that you establish an in-house program for scheduled cleaning or replacement.

18. Check all current transformers for proper polarity.
  - a. Verify that the transformer secondaries are NOT open, and are either connected to their respective devices or shorted. Reference individual unit wiring diagrams and schematics for proper installation.



**ATTENTION:** Current transformer secondaries shall not be 'open.' To avoid possible injury and electrical shock to personnel, do not energize a current transformer with its secondary open.

- b. Verify that knife disconnect terminal blocks XCT are open before energizing.
  - c. Open current transformers during commissioning.
19. Verify that **all barriers and parts that are removed during the installation process have been reinstalled.**

We recommend that a barrier checklist is developed including such items as, unit location, and barrier location. Save this checklist for future reference.

20. Before you close the enclosure and/or individual units, remove all tools, metal chips, scrap wire, and other debris from the MCC interior.  
If there is an accumulation of dust or dirt, clean out the MCC by using a brush, vacuum cleaner, or a clean, lint-free rag. **DO NOT use compressed air—it redistributes contaminates on other surfaces.**
21. Verify that all withdrawable units are in the **Connected** position.  
Before you close and latch unit and cable compartment doors, verify that wires are not pinched. Column closing plates must be in place.



**ATTENTION:** When you conduct an electrical insulation resistance test, isolate equipment sensitive to high test voltages, such as meters, solid-state devices, motor winding heaters, capacitor units, and transformers.

22. Conduct an electrical insulation resistance test to verify MCC wiring integrity. Conduct this test with an insulation resistance tester with a potential of 500...1000 V.



**ATTENTION:** Verify that all switches or circuit breakers are in the OPEN/I or Off/O positions before an electrical resistance test is conducted.

Conduct this insulation resistance tester test phase-to-phase, phase-to-PE and, when applicable, phase-to-neutral on the MCC bus work. Typical insulation resistance values are 50 MΩ or greater.

Temperature, humidity, or dampness can affect insulation resistance values and considerably lower insulation resistance readings. If the insulation resistance values are less than 1 MΩ (due to dampness, temperature, or humidity) or the MCC has been stored in a damp or humid area, it is recommended the equipment be dried out. Dry out motor cables with a low voltage current or by using space heaters.

Once the equipment is dry, repeat the insulation resistance test. The minimum value for insulation resistance on a new installation at startup or energizing is 1 MΩ. These readings can be recorded in [Table 13 on page 105](#).

Next, check the field wiring (for example, motor cables and/or incoming line cables).

## Commissioning Procedure



**ATTENTION:** Only skilled personnel with proper personal protective equipment can commission a motor control center. Energizing an MCC for the first time is potentially dangerous. Serious damage and/or personal injury can occur. Follow EN 50110 requirements, and local codes and guidelines.



**ATTENTION:** This procedure is provided as a general guideline to energize a newly installed FLEXLINE 3500 MCC and **be used only after the pre-commissioning checklist has been completed.**

Read this procedure in its entirety before beginning the commissioning procedure. If you have any questions or concerns, contact your Rockwell Automation representative.

1. Review other instructions that are supplied for the proper operation of special units such as AC drives and soft starters, with appropriate and skilled personnel.
2. Verify that main and unit main switches are in the OFF/O position so there is no load on the MCC.

Also, verify that associated remote devices are de-energized.

3. Latch doors and secure covers.
4. Fully insert withdrawable units.
5. Energize the MCC remote power source.

If the MCC has a main circuit breaker or disconnect switch that can be operated from a remote location, energizing from the remote location is recommended.

If the MCC main circuit breaker or disconnect switch cannot be energized from a remote location, follow the procedure below.


- De-energize the remote power source
- Close MCC main disconnect or circuit breaker switch.
- Re-energize the MCC remote power source.



**ATTENTION:** Main switch handles must be operated with a firm, direct motion into the closed (ON/I) position.

6. Energize from the source of the system, working toward the loads.  
Energize one unit at a time, beginning with control units then feeder units.

7. Withdrawable units can be commissioned in the Test position. This position helps allow control and network connections to be tested without engaging 3-phase power. See [Chapter 6 on page 67](#) for more information on operating positions.
8. After the disconnect devices have been closed, loads such as lighting circuits, motor starters, and contactors can be energized.
  - a. When power factor correction capacitors are energized with the motor windings and the startup procedure requires that the respective motors be jogged or inched, temporarily disconnect the power factor correction capacitors. For more information on power factor capacitors and MCC units, contact your local Rockwell Automation representative.
  - b. Verify that acceleration times are within application specifications.



Excessive starting currents and/or acceleration times can cause inverse time circuit breakers, power fuses, overload relays, and other components to overheat and/or shut down equipment.
9. Verify that meters are working properly, including voltmeters and ammeters.
10. Reset device settings that were adjusted during installation and commissioning to appropriate operational settings.

**Notes:**

## EtherNet/IP Motor Control Centers

# EtherNet/IP Network Connectivity

Basic information is provided in the following sections.

## Cable Length Limitations

The EtherNet/IP™ network uses fiber or copper twisted-pair wiring. The maximum length of copper twisted-pair wiring is 100 m between devices. There is no cumulative length for the entire network. Fiber cable length varies by cable design. Inside the MCC, all cables are copper twisted-pair.

---

**IMPORTANT** The 100 m maximum length must account for Ethernet cable inside the column. To help determine cable lengths for your application, each MCC is shipped with documentation that identifies the cable length that is used within the MCC. This cable length must be added to the length between the GracePort and the externally connected device.

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## Cable Routing

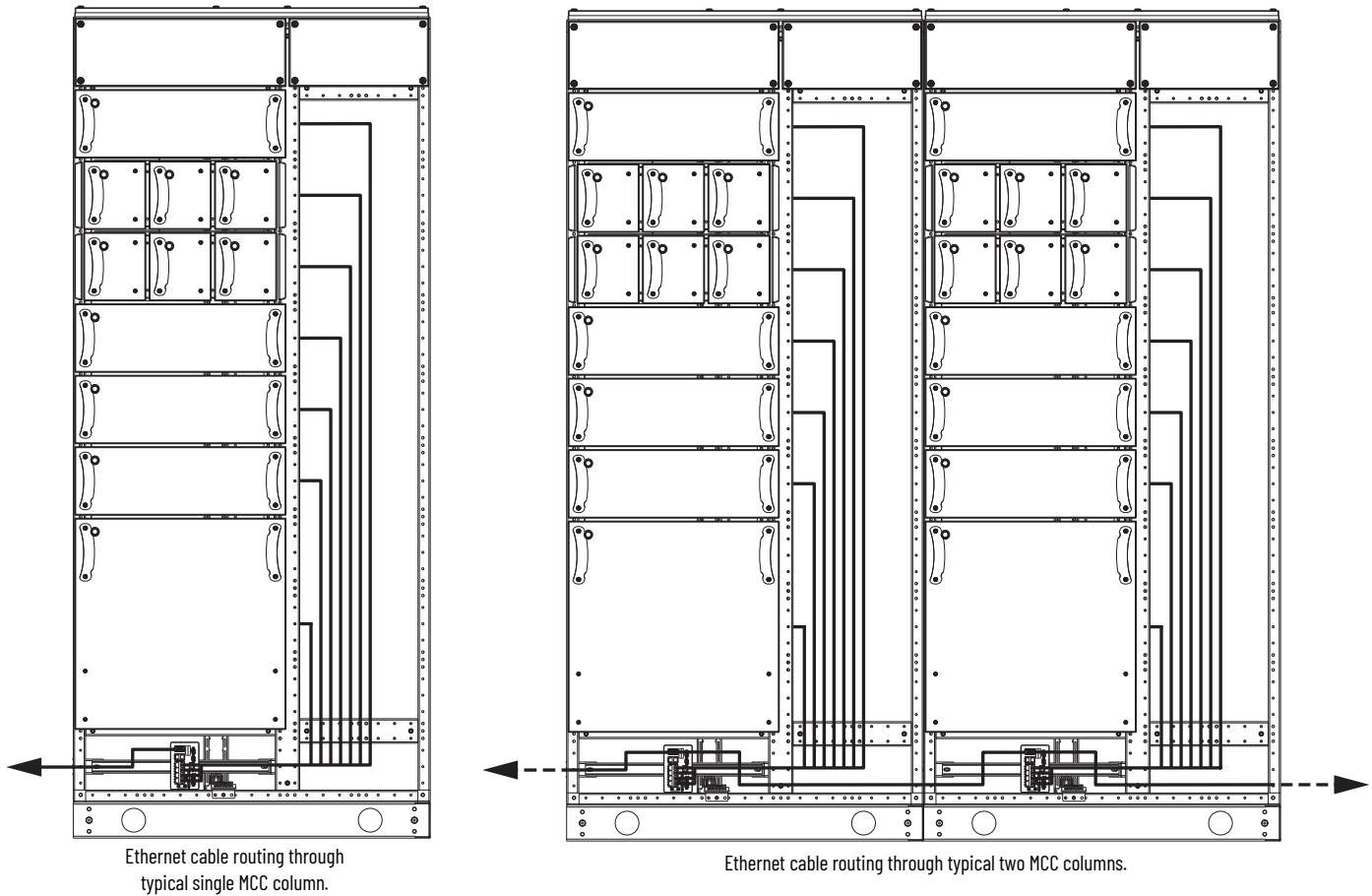
Each column has one or two switches typically mounted in the bottom horizontal cable compartment in the standard configuration. The number of switches in a lineup depends on the number of units in the column. Cables connected to the switch are then routed to EtherNet/IP devices in the column. Up to 40 EtherNet/IP ports can be provided in each FLEXLINE™ 3500 column.

In a standard MCC column, the cable compartment has EtherNet/IP connections equal to the number of units (up to 27) for that column. Devices that require 24V DC to power up must have it supplied based on electrical drawings.

Connection to the EtherNet/IP network and the control plug is made when a unit is in the Connected or Test position.

If you add or remove a unit from the EtherNet/IP system, it does not interrupt the operation of other units in the system.

Figure 43 – EtherNet/IP Network Connections in FLEXLINE 3500 MCC Units



*Determine Cable Lengths*

To help determine cable lengths for your application, each MCC is shipped with documentation that identifies the cable lengths that are used within the MCC.

*MCC Cable Types*



**ATTENTION:** Do not apply high voltage to any installed EtherNet/IP cable system or its connectors.

The FLEXLINE 3500 MCCs use a high-voltage 600V Ethernet cable designed to perform above TIA 568-B.2 and ODVA Ethernet standards. These cables have the following features:

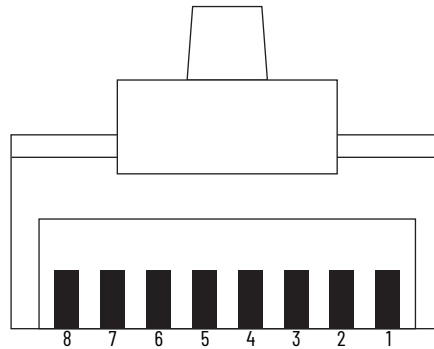
- Foil and braided shield, PVC, eight conductor (four pair)
- 600V PVC cable designed to support high-voltage applications
- On-Machine™ rated cable for use in a cable tray shared with high-voltage power cables
- RJ45 insulation displacement connector available for field terminations
- Wide thermal operating range

**Table 11 – EtherNet/IP Cable Specifications for MCCs**

Certifications	UL and c-UL Listed
Outside diameter	8.13 ± 0.38 mm
Operating temperature	-20...+80 °C
Cable rating	UL, c-UL TYPE CMG; UL PLTC or UL AWM 2570 80C 600V, TIA 568B



Figure 44 - EtherNet/IP Cable Pinout



Pin No.	Cable Color	Description
1	White/Orange	TxData +
2	Orange	TxData -
3	White/Green	Recv Data +
4	Blue	Unused
5	White/Blue	Unused
6	Green	Recv Data -
7	White/Brown	Unused
8	Brown	Unused

## Add an MCC Unit to an EtherNet/IP System

Use this section to add FLEXLINE 3500 MCC units to an EtherNet/IP MCC. Each EtherNet/IP component is factory wired within the unit and has a communication cable that plugs into the device on one end and generally into a vertical cable compartment EtherNet/IP port on the other end.

No. of Conductors	Jacket Material	Cable Type	Cable Rating	Cat. No. <sup>(1)</sup>
8	Teal 600V PVC	Foil and braided shield	(UL) CMX, CMR; c(UL) CMG; (UL) PLTC or AWM 2570 80 °C 600V; TIA-568-B	1585J-M8HBJM-2
	Red 600V PVC			1585J-M8EBJM-2

(1) Replace -2 (2 m) with -5 (5 m), or -10 (10 m) for additional standard cable lengths.

## EtherNet Power Supply

**IMPORTANT** Many EtherNet/IP components require 24V DC power source to operate. The power supply must be EtherNet/IP compatible as specified in the ODVA requirements.

Power supplies that do not satisfy both preceding points can result in damage to the EtherNet/IP signal and components, and failure to comply with local codes and inspection.

A power supply unit that meets EtherNet/IP requirements can be supplied with the MCC. This cable is already connected when the power supply unit ships installed in the MCC. Redundant configurations are also available.

## Connect Power Supplies-Remote or in the MCC Lineup

Connect power supplies according to guidelines to minimize voltage drops in the EtherNet/IP system while providing proper supply voltage to system devices. For detailed connection instruction, see the Converged Plant-wide Ethernet Design and Implementation Guide, publication [ENET-TD001](#).

## Network Power Supply and the Protective Earth Circuit

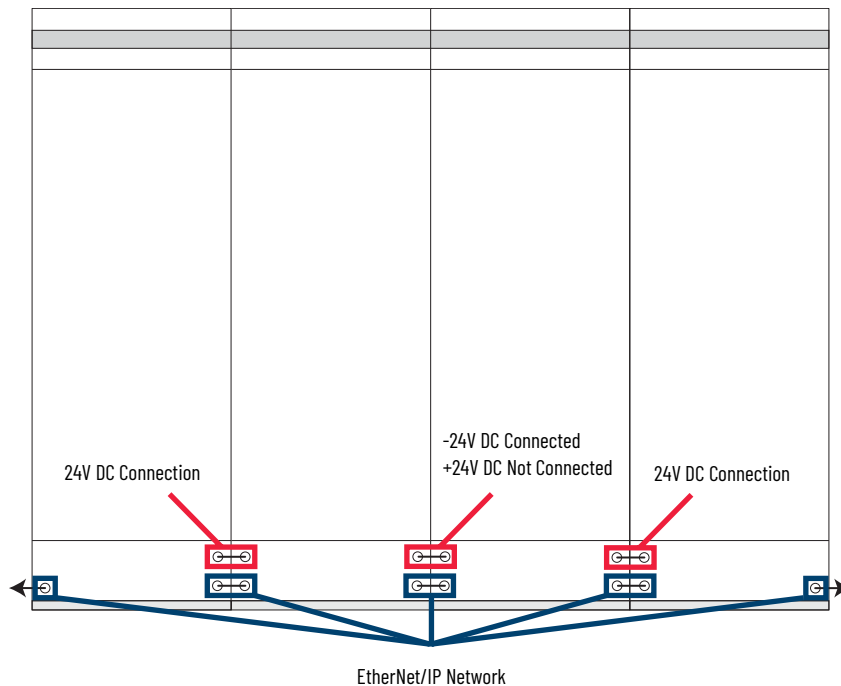
The EtherNet/IP network is grounded at the various components via the component ground. Therefore, no further grounding is needed for the Ethernet cables.

**IMPORTANT** Do not connect the 24V DC common in the power supply bucket to the PE. Doing so violates the grounding guidelines for the various EtherNet/IP components.

## Connecting Two Power Supplies

Install an additional 24V DC Class 1 power supply for MCC lineups with 14 or more columns. When using two supplies, provide a break between the two 24V DC networks. Locate the appropriate break for the two networks and verify that the terminal blocks are not connected between these two columns.

Figure 45 - Connecting Two Power Supplies



Position each power supply so it feeds a maximum of seven columns to the left or right.

## System Design Installation Checklist

When you install an EtherNet/IP MCC, verify the following before you apply power to the network:

- Only one power supply is connected for every 14 sections of MCC.
- The power supply for the system is 24V DC.
- The PE is connected.
- Connections are inspected to detect and correct any loose wires, opens, or shorts.

## Integrated EtherNet/IP Network

IntelliCENTER® MCCs use the EtherNet/IP network to connect the IMC devices in your MCC application to the rest of your plant-wide network. The EtherNet/IP network is an industrial version of an Ethernet network. The network provides one robust and reliable network solution for your entire plant from the site operations to the MCC.

The integrated EtherNet/IP network within your IntelliCENTER MCC is preconfigured, tested, and validated at the factory before shipment. The steps that are completed at the factory reduce the time that you spend to commission your MCC in your plant. You can then spend more time on the optimization of your IntelliCENTER MCC to control effectively your application.

The EtherNet/IP network allows for real-time monitoring and control of your intelligent devices that provides you with the ability to optimize your plant operations. The EtherNet/IP network within the IntelliCENTER EtherNet/IP MCC provides the following features:

- Single industrial network technology for plant-wide multi-discipline network convergence.
  - The EtherNet/IP network is a standard industrial Ethernet network that is managed by ODVA, Inc.
  - Many commercially available products exist and can be attached to the EtherNet/IP network to support your application.
  - Rockwell Automation key Alliance Partners include companies like Cisco® and Panduit, so the network devices you require are available over the EtherNet/IP network.
- Flexible topologies to suit your application:
  - Star
  - Linear
  - Switch-level Ring
  - Device Level Ring
- Layer 2 managed industrial Ethernet switches provide a wide range of features to make sure that your EtherNet/IP network is robust and reliable.
- Industrial Ethernet switches that leverage flexible mounting options and the appropriate quantity of EtherNet/IP ports that are optimized to accommodate your application.
  - Pre-configured EtherNet/IP wiring and connections provide a flexible solution that is easy to maintain and use.
- Rockwell Automation exclusive UL Listed 600V Rated Cat 5e copper industrial Ethernet cable provides electrical immunity.
- Expandability and serviceability of the MCC to support your plant through the life of the lineup.
- Confirms that end device firmware is upgraded to latest available revision as needed.

### Linear/Star Topology

The typical EtherNet/IP network topology that is used in the IntelliCENTER EtherNet/IP MCC is a linear/star topology. The industrial Ethernet switches throughout the MCC lineup are connected in a linear topology via their linear trunk (switch-to-switch) connections. The IMC devices in each section use a star topology to connect to the industrial Ethernet switch level.

The linear/star topology within an IntelliCENTER EtherNet/IP MCC provides the following:

- An easily expandable network architecture
  - Star topology allows IMC devices to be easily added to existing MCC sections within an MCC lineup
  - Switch-level linear topology allows MCC sections to be easily added to the MCC lineup
- A flexible, maintainable, and serviceable network architecture

- Star topology allows IMC devices to be easily moved or removed, as MCC maintenance and lineup changes demand, without impacting the remaining IMC devices
- Switch-level linear topology allows MCC sections to be easily moved or removed, as MCC maintenance and lineup changes demand, without impacting the remainder of the MCC lineup
- ADC, a feature that is supported in Logix controllers (PACs), helps minimize downtime by automatically configuring a replacement IMC device if there is a device failure.

The linear/star topology that is used in an IntelliCENTER EtherNet/IP MCC allows it to be seamlessly integrated into the rest of the plant.

## Switch-level Ring/Star Topology

An increased focus in the MCC market space is the demand for the IMC devices within the integrated network to provide a level of high availability. By definition, high availability is the time that a network or device is fully functioning. Typically, this time includes the ability of a network to ride-through a physical device failure or cable break. For MCC applications, high availability also includes downtime that is associated with hardware or software misconfiguration of the integrated network or IMC devices. For an MCC solution to be truly considered highly available, it must provide the appropriate level of network resiliency, and be easy to configure and maintain both physically and via software. Network resiliency cannot be provided at the cost of losing IMC device serviceability or intuitive network and device configuration.

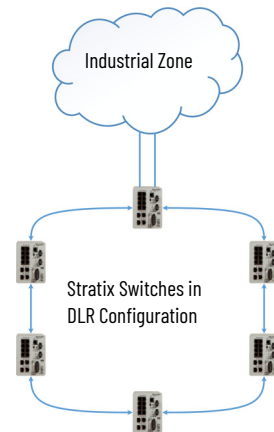
The IntelliCENTER EtherNet/IP MCC is designed to provide ease of use, network resiliency, and serviceability to achieve the desired level of high availability. To build on the typical linear/star topology of an IntelliCENTER EtherNet/IP MCC, the industrial Ethernet switches throughout the MCC lineup can be also connected in a switch-level ring topology. The Device Level Ring (DLR), a protocol that is provided by Stratix managed switches, provides a level of resiliency at the switch level, while the IMC devices in each section still maintain a star topology.

This switch-level ring/star topology provides the same advantages that are described in the [Linear/Star Topology on page 83](#) section, but adds switch-level resiliency. This combination provides the appropriate balance of ease of use, resiliency, and serviceability that is required for high availability within MCC applications.

### *Device Level Ring (DLR)*

In an IntelliCENTER EtherNet/IP MCC, the Stratix industrial Ethernet switch uses the Device Level Ring, or DLR, to provide the switch-level ring redundant path topology. [Figure 46](#) shows an example of a switch-level ring topology that uses DLR.

**Figure 46 - DLR Network Example**



The implementation of the switch-level ring topology within an IntelliCENTER EtherNet/IP MCC is similar to the linear/star topology. But the switch-level ring topology adds a ring industrial Ethernet cable that connects the last MCC section back to the plant-wide network. If one industrial Ethernet cable or industrial Ethernet switch fails, communication is converged in the other direction around the ring to make sure that all other switches are still connected to the network. The convergence of communication provides single fault tolerance at the switch level.

DLR provides an alternative to the Spanning Tree Protocol (STP) to control network loops, handle link failures, and improve convergence time significantly. DLR does not require extra hardware; it is enabled in specific versions of Stratix managed switches, and provides the added resiliency via a switch-level ring redundant path topology. DLR also has security features that help protect ring segments. Unlike other ring protocols, the dedicated requested packet interval (RPI) values of each end device that is connected to the switch does not affect DLR. RPI is discussed more in the next section when an overview of REP is given.

The Switch-level Ring/Star topology that is used in an IntelliCENTER EtherNet/IP MCC allows it to be seamlessly integrated into the rest of the plant-wide network.

## Industrial Ethernet Switch

The industrial Ethernet switch is one of the most critical devices in your EtherNet/IP network because it determines the level of network security, robustness, and flexibility. There are two distinct types of industrial Ethernet switches: unmanaged and managed. Both types of switches serve a common purpose; to provide a method to connect industrial Ethernet devices to an industrial Ethernet network. The way each type of switch controls data on the network varies greatly and can have a significant impact on the performance of your industrial Ethernet network.

### Why an Industrial-Managed Ethernet Switch Is Critical

Industrial unmanaged Ethernet switches are designed to provide quick expansion of an industrial Ethernet network. They are typically unmodifiable or have limited configuration options, and do not provide added features that let you monitor or control how traffic is being forwarded through the switch. This option is attractive because of their lower cost and minimal configuration.

However, the potential for lost packets of data on the network is greatly increased with an industrial unmanaged Ethernet switch due to the potential for Layer 2 faults and broadcast traffic. If you avoid these types of events, you can provide a more robust and reliable network on a plant floor. Additionally, industrial unmanaged Ethernet switches do not provide the advanced security functionality that helps keep your industrial Ethernet network secure.

Industrial-managed Ethernet switches are designed to give you the flexibility and features that help prevent lost data due to Layer 2 faults and broadcast traffic, which is critical to network performance. With an industrial managed Ethernet switch, network segmentation, such as Virtual LANs (VLANs), and network resiliency, such as Device Level Ring (DLR), can be implemented to make sure that network performance is maintained across a complex industrial Ethernet network.

Advanced security, network management, and diagnostics are other critical features that are provided in an industrial managed Ethernet switch. These features make sure that the expected recipient receives the information being sent over the network at the expected time while network issues are allowed to be easily resolved.

The features of an industrial managed Ethernet switch provide a robust and flexible EtherNet/IP network solution, which is why the IntelliCENTER EtherNet/IP MCC leverages an industrial managed Ethernet switch.

## Industrial EtherNet Cable

Due to the high potential for electrical interference in an MCC, the proper industrial Ethernet communication cable is critical to provide excellent reliability and a robust EtherNet/IP network. We recommend against the use of standard copper Ethernet cable. To provide the noise immunity necessary in an MCC, we recommend that you use only exclusive 600V, UL Listed, shielded, power limited tray cable (PLTC) rated, Category 5e industrial Ethernet cable.

With this 600V UL Listed industrial Ethernet cable, the EtherNet/IP network and intelligent devices in the IntelliCENTER MCCs have been tested to the most rigorous standards for electrical noise immunity. These test results allow Rockwell Automation to deliver a robust, noise-immune EtherNet/IP architecture within the MCC:

- Surge - Simulates lightening strike
  - $\pm 2$  KV, 40 A surge that is repeatedly applied to the network cable
  - IEC 61000-4-5
- Fast Transient Burst - Simulates industrial noise
  - $\pm 1$  KV high voltage burst applied to the network cable
  - IEC 61000-4-4
- Conducted Immunity - Simulates radio frequency interference
  - 150 kHz...80 MHz interference that is applied to the network cable
  - IEC 61000-4-6
- Electrostatic Discharge Immunity - Simulates static discharge
  - $\pm 8$  KV ESD event at 12 locations on the MCC and network cable
  - IEC 61000-4-2

**Figure 47 - Industrial Ethernet Network Cable**



[Table 12](#) shows the three speeds that the Category 5e cable supports. The higher speed data rates allow more data to be transferred in a shorter period, which can be vital for applications that require short response times.

**Table 12 - Category 5e Copper Cabling**

Speed Rating	Data Speed
10Base-T	10 Mb/s
100BASE-TX	100 Mb/s
1000BASE-T	1 Gb/s

The standard industrial Ethernet cable for all switch-to-IMC device connections within the IntelliCENTER EtherNet/IP MCC is the 600V UL Listed copper Ethernet cable. However, fiber-optic Ethernet cable is sometimes required for switch-to-switch EtherNet/IP connections in certain EtherNet/IP topologies. See the [Device Level Ring \(DLR\)](#) section for more information on when fiber-optic Ethernet cable can be required within an IntelliCENTER EtherNet/IP MCC.

The 600V UL Listed industrial Ethernet cable is also commonly used to connect the IntelliCENTER EtherNet/IP MCC to the plant EtherNet/IP network.

## Maintenance



**ATTENTION:** Only skilled personnel shall oversee the maintenance and service of motor control centers.

De-energize all power sources before any maintenance or service work is performed on columns or units.

For work on energized equipment, follow EN 50110 requirements, and local codes and guidelines.

Replace and secure all barriers, covers, shields and doors, and perform the [Pre-commissioning Checklist on page 79](#) before re-energizing the equipment.

### Establish a Maintenance Program

Establish a periodic maintenance program for MCCs to avoid unnecessary downtime. The frequency of service to the MCC depends on the equipment usage and the operating environment. Inspect MCCs once per year or per an established maintenance program. Use the following suggested maintenance guidelines to establish a maintenance program.



Keep a log of service and maintenance work performed on your MCC. Record the following information.

- Date test and maintenance work are performed
- List of checks and tests performed
- Condition of the equipment
- Any repairs or adjustments that are made to equipment

For maintenance regarding specific components, such as circuit breakers, contactors, AC drives, relays, and meters, reference the specific component instruction manual for each device.

## Suggested Maintenance Guidelines

This table provides some suggested guidelines for maintaining your MCC.

Suggested Maintenance Guidelines	Date	Remarks	Initials
1. Environment <ul style="list-style-type: none"> <li>• Verify operating (ambient) conditions.               <ul style="list-style-type: none"> <li>– Room temperature range: -5...+40 °C<sup>(1)</sup></li> <li>– Noncondensing humidity, max: 95% at 40 °C<sup>(1)</sup></li> </ul> </li> </ul>			
2. Enclosure Exterior <ul style="list-style-type: none"> <li>• Clean surfaces. Retouch painted surfaces if necessary.</li> <li>• Check that door latches are functioning and secure.</li> <li>• Inspect for signs of excessive heat in the following locations:               <ul style="list-style-type: none"> <li>– Doors</li> <li>– Enclosure sides</li> </ul> </li> </ul> <p>If severe corrosion or discoloration is evident, replace the damaged components. <b>Identify the cause of damage and make necessary repairs.</b></p>			
3. Contaminants <div style="display: flex; align-items: flex-start; margin-bottom: 10px;">  <div> <p><b>ATTENTION:</b> For work on energized equipment, follow EN 50110 requirements, and local codes and guidelines.</p> </div> </div> <ul style="list-style-type: none"> <li>• Check for contaminants (moisture, dirt, dust) inside the enclosure. Remove any contaminants and their source.</li> <li>• Check for contaminants in the following locations:               <ul style="list-style-type: none"> <li>– Cable entry and exit points, seams, and openings</li> <li>– Devices (push buttons, relays, and disconnect switches)</li> </ul> </li> </ul> <p><b>Make sure the source or cause of wetness or moisture is identified and removed.</b></p>			
4. Bus System <div style="display: flex; align-items: flex-start; margin-bottom: 10px;">  <div> <p><b>ATTENTION:</b> De-energize all power sources before any maintenance or service work on columns or units is performed.</p> </div> </div> <ul style="list-style-type: none"> <li>• The factory-made power bus connections are tightened by a computer-controlled torquing system. The following connections do not require retorquing:               <ul style="list-style-type: none"> <li>– Vertical to horizontal bus connections</li> <li>– Power conductor to horizontal bus connections</li> </ul>               These factory-made connections do not require servicing for the life of the MCC.             </li> <li>• Check the bus support and insulation for cracks or damage.</li> <li>• Inspect bus splice connections for discoloration.</li> <li>• Verify the integrity of bus splice connections. Retorque connections. See <a href="#">Splice the Power Bus on page 44</a> for recommended torque values.</li> <li>• Use a vacuum or a lint free cloth to clean the bus and supports.</li> <li>• Conduct an electrical insulation resistance test. Record and save the results. <a href="#">See Pre-commissioning Checklist on page 79.</a></li> </ul>			
5. Operating Handles <ul style="list-style-type: none"> <li>• Verify that operator handles move freely (no sticking or binding).</li> <li>• Check function of the operator handles.</li> <li>• Check the defeater mechanisms on operator handles.</li> <li>• Replace broken, deformed, malfunctioning or badly worn parts/assemblies.</li> </ul>			
6. Locking Devices <p>Check locking and interlocking devices for proper working condition. Replace as necessary.</p>			
7. Current Carrying Components <ul style="list-style-type: none"> <li>• Inspect for discoloration, corrosion, wear, excessive heat, and other signs of possible failure.</li> <li>• Current carrying devices can include fuse clips, line, and load terminals.</li> </ul>			
8. Contacts <ul style="list-style-type: none"> <li>• Check for excessive wear and dirt accumulation.               <ul style="list-style-type: none"> <li>– Vacuum or wipe contacts with a soft cloth to remove dirt.</li> </ul> </li> <li>• Replace contacts in complete sets to avoid misalignment and uneven contact pressure.</li> <li>• Discoloration or slight pitting of the contacts is normal.</li> <li>• Do not file contacts or use spray cleaners.</li> </ul>			



Suggested Maintenance Guidelines	Date	Remarks	Initials	
9. Coils	<ul style="list-style-type: none"> <li>• Check contactor and relay coils for signs of overheating (cracking, melting, or burnt insulation).               <ul style="list-style-type: none"> <li>– If signs of overheating are present, replace the coil.</li> </ul> </li> <li>• Correct the overvoltage or undervoltage conditions that caused coil failure.</li> <li>• Clean any residue of melted coil insulation from other parts of the device or replace such parts.</li> </ul>			
10. Terminals	<ul style="list-style-type: none"> <li>• Check for loose wire connections and tighten as necessary.</li> <li>• Check schematics/component documentation for torque values.               <ul style="list-style-type: none"> <li>– Power terminals</li> <li>– Control circuit terminals</li> </ul> </li> <li>• Replace damaged parts or wiring.</li> </ul>			
11. Pilot Lights	Replace damaged lamps and lenses.			
12. Fuses	<ul style="list-style-type: none"> <li>• Check fuses and fuse clips.               <ul style="list-style-type: none"> <li>– When replacing fuses, install the same type and rated fuse that was originally furnished with the MCC.</li> </ul> </li> </ul>			
13. Fans and Cooling Devices	<ul style="list-style-type: none"> <li>• Inspect blowers and fans for operation and damage.               <ul style="list-style-type: none"> <li>– Replace blowers and fans that have bent, chipped, or missing blades, or if the shaft does not turn freely.</li> </ul> </li> <li>• Clean or change air filters for fans.</li> <li>• Clean heat exchanger fins.</li> <li>• Clean ventilation mesh.</li> </ul>			
14. Solid-state Devices	<ul style="list-style-type: none"> <li>• Perform a visual inspection. Components or circuit boards must be replaced if the following are found:               <ul style="list-style-type: none"> <li>– Discoloration</li> <li>– Charred or burned components</li> </ul> </li> <li>• Check printed circuit boards for:               <ul style="list-style-type: none"> <li>– Proper seating in the edge board connectors</li> <li>– Locking tabs in place</li> </ul> </li> </ul>			
15. Unit Stabs	<ul style="list-style-type: none"> <li>• Inspect stabs for wear and corrosion. Replace if necessary.               <ul style="list-style-type: none"> <li>– If the line stab assembly is severely pitted, inspect the vertical bus for wear and pitting. Replace as necessary.</li> </ul> </li> </ul>			
16. Control and Network Plugs	<ul style="list-style-type: none"> <li>• Inspect for bent or damaged pins.               <ul style="list-style-type: none"> <li>– If necessary, clean the contacts.</li> </ul> </li> <li>• Verify that the connector mechanism is functioning properly.</li> </ul>			
17. Withdrawable Units	<ul style="list-style-type: none"> <li>• Remove dust and grease from the guide rail.</li> <li>• Check that the locking mechanism operate freely.</li> <li>• Check for easy movement of withdrawable units within the column.</li> <li>• Test the unit interlock function.</li> </ul>			
18. Disconnect Switch	<ul style="list-style-type: none"> <li>• If a switch that is used frequently becomes difficult to operate or is in a highly corrosive or caustic environment, it can require lubrication.</li> <li>• Generously apply the NO-OX-ID compound (sufficient enough to cover with a noticeable film) to both sides of the movable contact blades and to the adjacent insides stationary contacts and the hinge.</li> </ul>			
19. Final Check	<ul style="list-style-type: none"> <li>• Verify that all withdrawable units are in the correct operating position (Connected, Test, Disconnected, Withdrawn).</li> <li>• Verify that enclosure doors and cable compartment covers have been closed and are secure.</li> <li>• After maintenance or repair is performed, test the control system for proper functioning under controlled conditions.</li> </ul>			

(1) The average temperature over a 24-hour period must not exceed 35 °C (95 °F).

## Maintenance after Fault Condition



**ATTENTION:** Make sure that the MCC remote power sources are disconnected and that the respective disconnects are locked in the OFF/O position.

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The opening of the short circuit protective device (such as fuses or circuit breakers) in a properly coordinated motor branch circuit is an indication of a fault condition in excess of operating overload and must be corrected.

Fault conditions can damage control equipment. When a fault occurs, follow this procedure:

1. De-energize the MCC.
2. Investigate the cause of the fault and inspect all equipment thoroughly per IEC Standards publication; see IEC 61439-1, Chapter 6.2.2.
3. Make necessary repairs to units, components, and structures as required.
4. Be sure that replacement parts are suitably rated for the application.

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**IMPORTANT** An insulation resistance test can be required. See [Chapter 7](#) for testing information.

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## Low Voltage Motor Control Center Security

The architecture with FLEXLINE™ 3500 Low Voltage Motor Control Centers (LVMCCs) supports IEC-62443-3-3 SL 1 security requirements. To help meet these requirements, reference these publications.

For This Information	See the Following Publications
Network architecture recommendations	Converged Plantwide Ethernet (CPwE) Design and Implementation Guide, publication <a href="#">ENET-TD001</a>
Windows infrastructure recommendations How to configure and use these Rockwell Automation products: <ul style="list-style-type: none"> <li>• FactoryTalk® Directory</li> <li>• FactoryTalk Activation Manager</li> <li>• FactoryTalk Security</li> <li>• FactoryTalk AssetCentre</li> </ul>	Security Configuration User Manual, publication <a href="#">SECURE-UM001</a>
How to configure and implement CIP Security™	CIP Security with Rockwell Automation Products Application Technique, publication <a href="#">SECURE-AT001</a>
System Security Concepts	System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a>
Overview of the PlantPax® responses for the IEC-62443-3-3 SL1 requirements	Securing your PlantPax system in The Connected Enterprise, publication <a href="#">PROCES-WP024</a>
System Feature Checklist to meet IEC-62443-3-3 SL1 requirements when using a PlantPax architecture	<ul style="list-style-type: none"> <li>• PlantPax Distributed Control System Configuration and Implementation User Manual, publication <a href="#">PROCES-UM100</a></li> <li>• PlantPax Security Certification-Appendix A of publication <a href="#">PROCES-UM100</a></li> </ul>

### LVMCC Security Architectures

An LVMCC is a collection of intelligent and non-intelligent devices. Proper management of the physical and network access to these devices are key to manage the integrity of the devices and system.

This section covers two possible architectures to implement an IEC-62443-3-3 SL 1 system that includes one or multiple LVMCCs.

ISA-99/IEC 62443 is based on seven foundational requirements that cover a defense in depth approach that is suited for an Industrial Automation Control System (IACS). These foundational requirements are:

- FR1: Identification and authentication control (IAC)
- FR2: Use control (UC)
- FR3: System integrity (SI)
- FR4: Data confidentiality (DC)
- FR5: Restricted data flow (RDF)
- FR6: Timely response to events (TRE)
- FR7: Resource availability (RA)

### Trusted Zones

ISA-99/IEC 62443-3-3 SL1 requires the capability to separate trusted and untrusted zones. You can use a standard firewall implementation to separate trusted traffic and untrusted traffic. Standard implementation creates two basic security zones, which are known as inside and outside. The inside, or trusted zone, is also referred to as the private zone. The outside, or untrusted zone, is also known as the public zone. The public zone is outside the control of an organization and can be thought of as simply the public Internet.

## LVMCC As a Secure Control System

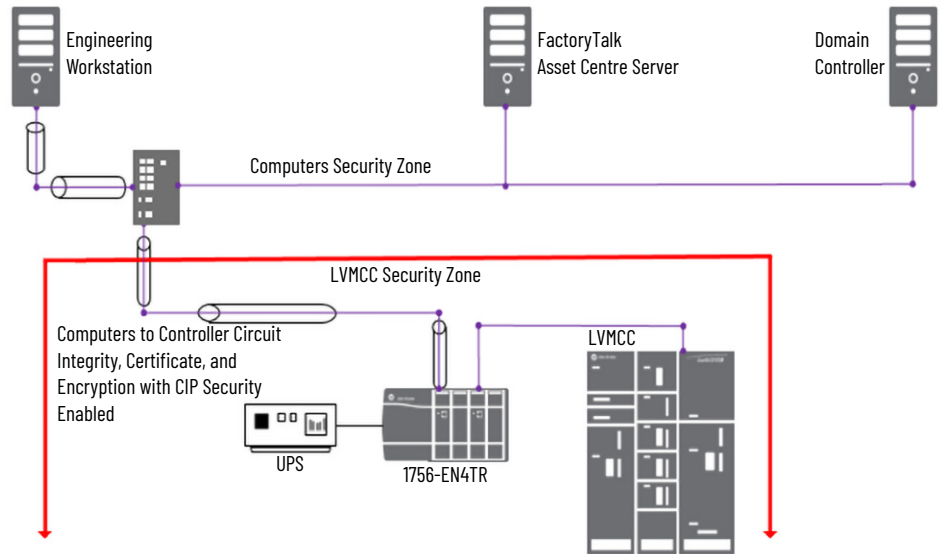
The first architecture considers placing the LVMCC in a separate and distinct security zone. The LVMCC is considered a secure control system; for an example, see [Figure 48 on page 92](#). It is a smaller system where the Engineering Station is outside of the trusted boundary of the system and, therefore, it is an external access to the system. This approach is scalable, since you can start small and then expand the system.

A 1756-EN4TR module provides a CIP Security firewall to access devices over the network. The ControlLogix® backplane act as a firewall that blocks all non-EtherNet/IP™ traffic. There is a security conduit between the engineering workstation and the 1756-EN4TR module. The Engineering Station uses Studio 5000® AOP to configure the devices over the network. The 1756-EN4TR, engineering workstation, Studio 5000 AOP, FactoryTalk Security, FactoryTalk Asset Centre, and Domain Controller are compensating countermeasures to the LVMCC as a system.

The trusted boundary defines the limit of the IACS security zone. The following conduits cross the trusted boundary:

- Input power to the LVMCC
- Input control power to the UPS
- Communication cables
- Control wiring
- Motor cable output

**Figure 48 - LVMCC Security Zone In A Secure Control System**



## The LVMCC as Part of a Security Zone in a Larger PlantPax Distributed Control System

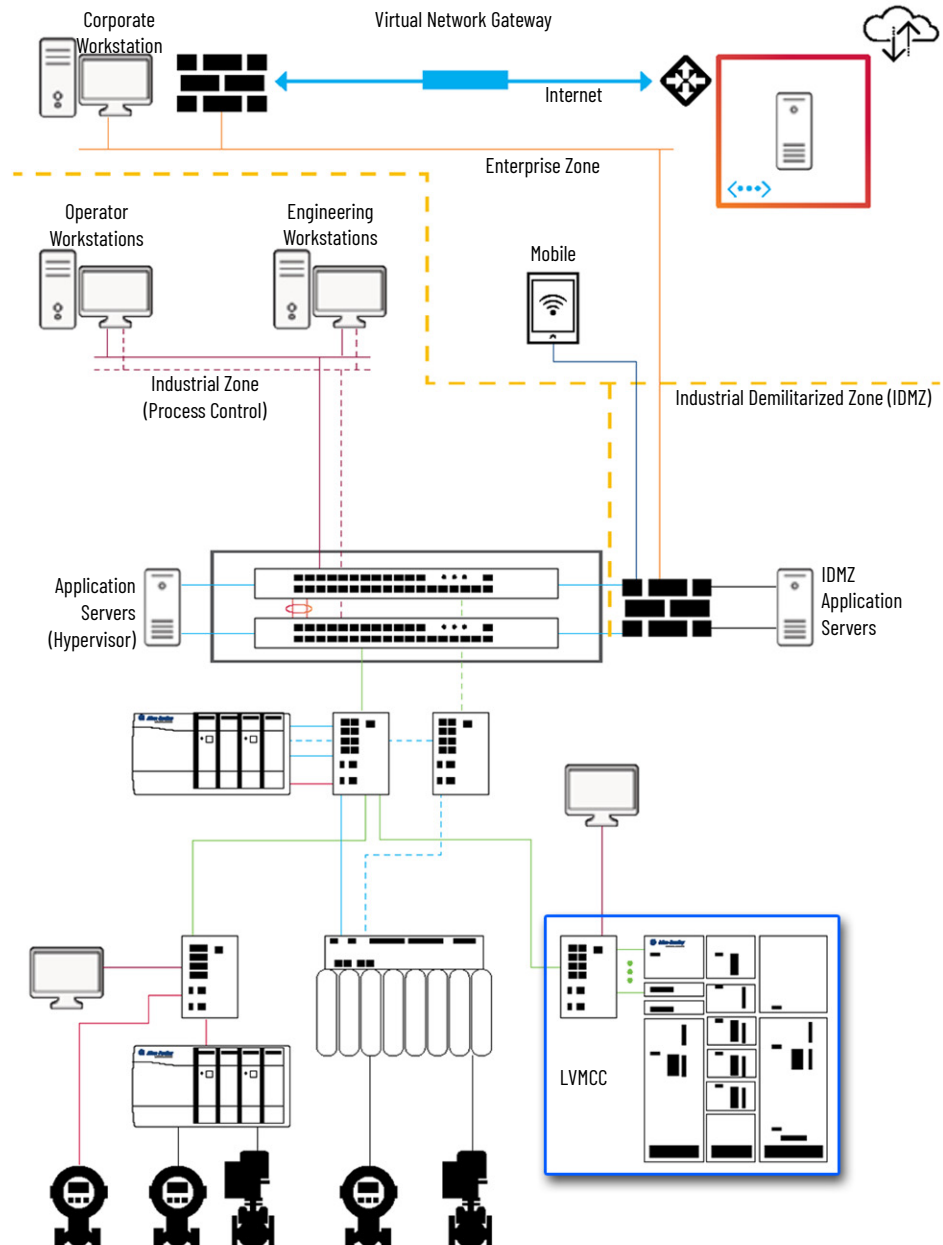
The second architecture considers the LVMCC as part of a security zone that includes other components of the process control. The LVMCC and its devices are considered components of a larger PlantPax industrial zone; for an example, see [Figure 49 on page 93](#).

PlantPax SL1 IEC 62443-3-3 certified architecture provides a standard, prescriptive reference design.

In situations where untrusted networks are part of the system, PlantPax creates a zone boundary by implementing industrial-level firewalls. Wireless and external communication connections are monitored and controlled through the industrial demilitarized zone (IDMZ) firewall.

Appendix A of the publication [PROCES-UM100](#), PlantPAx Distributed Control System Configuration and Implementation User Manual, provides guidelines and checklists for a collective strategy to meet the ISA-99/IEC 62443-3-3 SL1 requirements in a conformant PlantPAx system.

**Figure 49 - LVMCC Security Zone In a Larger PlantPAx Distributed Control System**



## System Security Features

If your LVMCC is used as a Secure Control System architecture, then use the following checklists to secure your system.

If your LVMCC is part of a security zone in a larger PlantPAx distributed control system, then use the checklist available in Appendix A of the PlantPAx Distributed Control System Configuration and Implementation User Manual, publication [PROCES-UM100](#).

Identify and authenticate all users.

Table 13 - Requirements for Identification and Access Control

Add Check Mark When Completed	Product	Required to Meet IEC- 62443-3-3 SL 1	Details
	Windows infrastructure	Yes	Configure and use the following: <ul style="list-style-type: none"> <li>• Create Active Directory groups and unique users.</li> <li>• Password strength and recommendations</li> <li>• Enable system notifications.</li> <li>• No wireless access</li> </ul> For more information, see: <ul style="list-style-type: none"> <li>• Configure System Security Features User Manual, publication <a href="#">SECURE-UM001</a></li> <li>• System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a></li> </ul>
	Windows domain	Yes	Configure the domain controller. Configure all operating system clients as domain members. For more information, see: <ul style="list-style-type: none"> <li>• Configure System Security Features User Manual, publication <a href="#">SECURE-UM001</a></li> <li>• System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a></li> </ul>
	FactoryTalk Directory software FactoryTalk Security software	Yes	Configure appropriate: <ul style="list-style-type: none"> <li>• Users, groups, roles</li> <li>• Policies</li> </ul> For more information, see Configure System Security Features User Manual, publication <a href="#">SECURE-UM001</a>
	Physical access controls	Yes	Place the LVMCC in a room with proper access control and/or install and configure the following: <ul style="list-style-type: none"> <li>• Locking latches; for more information, see <a href="#">Chapter 5 on page 55</a>.</li> </ul>

Enforce the assigned privileges of the authenticated user.

Table 14 - Requirements for Use Control

Add Check Mark When Completed	Product	Required to Meet IEC- 62443-3-3 SL 1	Details
	Windows infrastructure	Yes	Configure and use the following: <ul style="list-style-type: none"> <li>• Session lock</li> <li>• Disable Remote Desktop Services</li> <li>• Interactive login policy</li> <li>• Notifications for unsuccessful login attempts</li> <li>• Windows application blocker</li> </ul> For more information, see: <ul style="list-style-type: none"> <li>• Configure System Security Features User Manual, publication <a href="#">SECURE-UM001</a></li> <li>• System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a></li> </ul>
	FactoryTalk Directory software FactoryTalk Security software	Yes	Configure appropriate: <ul style="list-style-type: none"> <li>• Users, groups, roles</li> <li>• Policies</li> </ul> For more information, see Configure System Security Features User Manual, publication <a href="#">SECURE-UM001</a> .
	FactoryTalk AssetCentre software	Yes	Configure and use the following: <ul style="list-style-type: none"> <li>• Auditable events</li> <li>• Audit storage capacity</li> <li>• Diagnostics and health log</li> <li>• Time stamps</li> </ul> For more information, see Configure System Security Features User Manual, publication <a href="#">SECURE-UM001</a> .
	Physical access controls	Optional	Place the LVMCC in a room with proper access control and/or install and configure the following: <ul style="list-style-type: none"> <li>• Locking latches; for more information, see <a href="#">Chapter 5 on page 55</a>.</li> </ul> These components that are built in a system help provide access authorization to energized equipment based on proper electrical training.

Confirm the integrity of the system to help prevent unauthorized manipulation.

**Table 15 - Requirements for System Integrity**

Add Check Mark When Completed	Product	Required to Meet IEC- 62443-3-3 SL 1	Details
	Windows infrastructure	Yes	Configure and use the Active Directory and domain structure to handle authorization. For more information, see System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a> .
	Antivirus software	Yes	Use antivirus and anti-malware software to harden workstations. For more information, see System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a> .
	CIP Security	Yes	Use FactoryTalk Policy Manager software to define communication between zones. Engineering Station is in the untrusted zone and 1756-EN4Tx is in the trusted zone. For more information, see CIP Security with Rockwell Automation Products Application Technique, publication <a href="#">SECURE-AT001</a> .
	FactoryTalk AssetCentre software	Yes	Configure and use the following: <ul style="list-style-type: none"> <li>• Change detection and reporting</li> <li>• Scheduled backups</li> </ul> For more information, see: <ul style="list-style-type: none"> <li>• Configure System Security Features User Manual, publication <a href="#">SECURE-UM001</a></li> <li>• System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a></li> </ul>

Confirm the confidentiality of communication and data to help prevent unauthorized disclosure.

**Table 16 - Requirements for Data Confidentiality**

Add Check Mark When Completed	Product	Required to Meet IEC- 62443-3-3 SL 1	Details
	CIP Security	Yes	Use FactoryTalk Policy Manager software to define conduit from Engineering Station in the untrusted zone to the 1756-EN4Tx is in the trusted zone. For more information, see CIP Security with Rockwell Automation Products Application Technique, publication <a href="#">SECURE-UM001</a> .
	CIP Security Cryptography	Recommended	Use FactoryTalk Policy Manager to enable CIP Security Cryptography. For more information, see CIP Security with Rockwell Automation Products Application Technique, publication <a href="#">SECURE-AT001</a> .
	Physical access controls	Yes	Install and configure the following: <ul style="list-style-type: none"> <li>• Electrical requirements - Emergency power requirements (UPS) to help avoid the boot up of the firewall components (ControlLogix rack) that increases surface attack. For more information, see <a href="#">Electrical Requirements on page 97</a>.</li> <li>• Emergency power requirements (UPS) to help avoid the loss of physical access control access essential function. For more information, see <a href="#">Electrical Requirements on page 97</a>.</li> </ul>
	Disable devices webpages	Recommended	Install and configure the following: <ul style="list-style-type: none"> <li>• Disable webpages - Webpages for diagnostics are read-only and enabled by default. Disable the webpages if required by the system design, threat model, or risk assessment. For more information, see <a href="#">Disable Webpages on page 97</a>.</li> </ul>

Segment the control system via zones and conduits to limit the unnecessary flow of data.

**Table 17 - Requirements for Restricted Data Flow**

Add Check Mark When Completed	Product	Required to Meet IEC- 62443-3-3 SL 1	Details
	CIP Security	Yes	Use FactoryTalk Policy Manager software to define conduit from Engineering Station in the untrusted zone to the 1756-EN4Tx in the trusted zone. For more information, see: <ul style="list-style-type: none"> <li>CIP Security with Rockwell Automation Products Application Technique, publication <a href="#">SECURE-AT001</a></li> <li>EtherNet/IP Network Devices User Manual, publication <a href="#">ENET-UM006</a></li> </ul>
	ControlLogix rack with 1756-EN4Tx and a second EtherNet/IP communication module	Yes	Install the 1756-EN4Tx in the ControlLogix rack to communicate with Engineering Station and a second EtherNet/IP module to communicate with the LVMCC devices. The ControlLogix rack blocks all non-EtherNet/IP traffic. For more information, see EtherNet/IP Network Devices User Manual, publication <a href="#">ENET-UM006</a> .
	Managed switches	Optional	Stratix® switches inside MCCs come factory configured. You can choose to enable the Smartport for automation device implements MAC address-based port security. For more information, see Stratix 5200 and Stratix 5800 Managed Switches User Manual, publication <a href="#">1783-UM012</a> .

Respond to security violations and take timely corrective action.

**Table 18 - Requirements for Timely Response to Events**

Add Check Mark When Completed	Product	Required to Meet IEC- 62443-3-3 SL 1	Details
	FactoryTalk AssetCentre software	Yes	Configure and use the following: <ul style="list-style-type: none"> <li>Audit log accessibility</li> <li>Continuous monitoring</li> </ul> For more information, see: <ul style="list-style-type: none"> <li>Configure System Security Features User Manual, publication <a href="#">SECURE-UM001</a></li> <li>System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a></li> </ul>
	Individual products in the system	Yes	Protect the internally stored audit logs in individual products in the system. Configure the FactoryTalk AssetCentre audit log to collect these individual audit logs. For more information, see the user documentation for the individual products.

Confirm the availability of the system against the degradation or denial of essential services.

**Table 19 - Requirements for Resource Availability**

Add Check Mark When Completed	Product	Required to Meet IEC- 62443-3-3 SL 1	Details
	Windows infrastructure	Yes	Configure the operating system to prioritize control system functionality over antivirus checks and patching. Download software patches from trusted sources. For more information, see: <ul style="list-style-type: none"> <li>System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a></li> <li>Ethernet (CPwE) Design and Implementation Guide, publication <a href="#">ENET-TD001</a></li> </ul>
	FactoryTalk AssetCentre software	Yes	Configure and use the following: <ul style="list-style-type: none"> <li>Asset inventory</li> <li>Control system backup</li> <li>Disaster recovery</li> </ul> For more information, see Configure System Security Features User Manual, publication <a href="#">SECURE-UM001</a> .
	UPS	Yes	Provide your own UPS with separate battery unit and redundant supplies. Size the UPS so that it correctly supports the system and provides enough power to properly shut down servers and workstations, ControlLogix rack, and LVMCC access control system if used.



## Wireless Interfaces

To maintain the IEC-62443-3-3 SL 1 certification described in this appendix, wireless interfaces, such as Bluetooth, should be disabled in the firmware. If the wireless interface cannot be disabled, the wireless interfaces should be turned off, with the means to turn them on protected by physical barriers and passwords/passcodes.

If a wireless interface needs to be used, it should be enabled only as long as necessary to complete the required tasks and then be disabled again or turned back off.

Consult the instruction manuals for the components which have wireless interfaces for additional information regarding security. It is possible that only the component manufacturer or their field service personnel have the ability to disable the wireless interface and it will be necessary to work with the component manufacturer to have the wireless interface disabled.

## Disable Webpages

Devices within the LVMCC with EtherNet/IP connectivity support embedded web servers.

Devices	Embedded Web Server
E300 EtherNet/IP communication module	The web server is disabled by default. For more information, see E300™ Electronic Overload Relay User Manual, publication <a href="#">193-UM015</a> .
1756-EN4TR EtherNet/IP communication module	The web server is enabled by default For more information, see ControlLogix EtherNet/IP Network Devices, publication <a href="#">1756-UM004</a> .
Stratix switch	The web server is enabled by default. For more information, see Stratix Managed Switches User Manual, publication <a href="#">1783-UM007</a> .

Before you disable the web server for a device:

- Save the configuration file
- Schedule disaster recovery in a FactoryTalk AssetCentre project
- Disable the embedded web server

## Electrical Requirements

The secure LVMCC provides the following features to meet electrical requirements for resource availability.

The power supply unit has an input for an alternative control power source so that the 24V DC is available to the LVMCC devices or only to the LVMCC access control system components, even if the main control power source is lost.

The power supply unit has an input for an alternative control power source so that the 24V DC is available to the LVMCC devices even if the main control power source is lost.

The redundant power supply unit has two 24V DC power supplies in parallel fed from two different 110...240V AC power control sources. Each 24V DC power supply can feed the circuit without the help of the other 24V DC power supply.

## Products in the Security Architecture

Element	Required Components (Minimum Version)
Domain controller	<ul style="list-style-type: none"> <li>• Microsoft Windows® Server 2016 - Version 1607 (OS Build 14393.1884)</li> <li>• Active Directory</li> </ul>
Engineering workstation	<ul style="list-style-type: none"> <li>• Microsoft Windows 10 - Version 1809</li> <li>• Studio 5000 Logix Designer - Version 32.00.00 (CPR 9 SR 11)</li> <li>• FactoryTalk Asset Centre Client - Version 9.00.00.231</li> <li>• FactoryTalk Asset Centre Agent - Version 9.00.00.231</li> <li>• ControlFLASH™ - Version 15.01.00</li> <li>• FactoryTalk Services Platform - Version 6.11.00 (CPR 9 SR 11.1)                             <ul style="list-style-type: none"> <li>- FactoryTalk Alarms and Events</li> <li>- FactoryTalk Diagnostics</li> <li>- FactoryTalk Security</li> <li>- FactoryTalk Directory</li> <li>- FactoryTalk Linx</li> <li>- FactoryTalk Policy Manager</li> <li>- FactoryTalk System Services</li> </ul> </li> </ul>
FactoryTalk AssetCentre server	<ul style="list-style-type: none"> <li>• Windows Server 2016 - Version 1607 (OS Build 14393.1884)</li> <li>• Microsoft SQL Server 2016 - Version 13.0.5292.0 (X64)</li> <li>• Microsoft SQL Server Management Studio - Version 17.9.1</li> <li>• FactoryTalk Asset Centre Server - Version 9.00.00.231</li> <li>• FactoryTalk Asset Centre Agent - Version 9.00.00.231</li> <li>• FactoryTalk Services Platform - Version 6.11.00 (CPR 9 SR 11.1)                             <ul style="list-style-type: none"> <li>- FactoryTalk Alarms and Events</li> <li>- FactoryTalk Diagnostics</li> <li>- FactoryTalk Security</li> <li>- FactoryTalk Directory</li> <li>- FactoryTalk Linx</li> <li>- FactoryTalk Policy Manager</li> <li>- FactoryTalk System Services</li> </ul> </li> </ul>
LVMCC security zone	<ul style="list-style-type: none"> <li>• 1756-EN4TR EtherNet/IP communication adapter with CIP Security</li> <li>• 1756-EN2TR EtherNet/IP communication adapter</li> <li>• 1756 ControlLogix rack</li> <li>• 1756 ControlLogix power supply</li> <li>• UPS power supply</li> </ul>



# Rockwell Automation Support

Use these resources to access support information.

<b>Technical Support Center</b>	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	<a href="http://rok.auto/support">rok.auto/support</a>
<b>Local Technical Support Phone Numbers</b>	Locate the telephone number for your country.	<a href="http://rok.auto/phonesupport">rok.auto/phonesupport</a>
<b>Technical Documentation Center</b>	Quickly access and download technical specifications, installation instructions, and user manuals.	<a href="http://rok.auto/techdocs">rok.auto/techdocs</a>
<b>Literature Library</b>	Find installation instructions, manuals, brochures, and technical data publications.	<a href="http://rok.auto/literature">rok.auto/literature</a>
<b>Product Compatibility and Download Center (PCDC)</b>	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	<a href="http://rok.auto/pcdc">rok.auto/pcdc</a>

## Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at [rok.auto/docfeedback](http://rok.auto/docfeedback).

## Waste Electrical and Electronic Equipment (WEEE)



At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at [rok.auto/pec](http://rok.auto/pec).

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