Motor Control Centers
—Low Voltage

Contents

29

Specifications

See Eaton's *Product Specification Guide*, available on CD or on the Web.

CSI Format:	1995	2010
Freedom	**Section 16482A**	**Section 26 24 19.11**
FlashGard	**Section 16482D**	**Section 26 24 19.13**

Freedom Motor Control Center

Freedom Arc Resistant Motor Control Center

Freedom FlashGard Motor Control Center

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Freedom, Freedom Arc Resistant, Freedom FlashGard® Motor Control Centers

Freedom Motor Control Center

Freedom Arc Resistant Motor Control Center

Freedom FlashGard Motor Control Center

General Description

Overview

Eaton's motor control centers (MCCs) provide a convenient method for grouping motor control, as well as associated distribution equipment. MCCs may be applied on electrical systems up to 600 V, 50 or 60 Hz, having available fault currents of up to 100,000 A rms. Enclosure designs include NEMA® 1 Gasketed as well as NEMA 2, 12, 3R and 3R walk-in. All controllers are assembled with Eaton components of proven safety, quality and reliability. All components are wired in accordance with NEC® and UL® standards. An ongoing temperature and short-circuit design test program, as required by UL 845, ensures a quality product that meets the latest safety codes. Freedom DC motor control centers are available up to 250 Vdc, having available fault currents up to 22,000 A rms. A comprehensive range of communications options are also available, including DeviceNet™, Modbus®, PROFIBUS®, Modbus TCP and EtherNet/IP®.

MCCs provide the best method for grouping motor control as well as associated distribution equipment. Eaton's MCCs are specially designed to operate machinery, industrial processes and commercial building systems. The MCC enclosure consists of a strong and rigid self-supporting steel channel framework assembled into standardized vertical sections and bolted together to form a complete shipping section of up to 80.00 inches (2032.0 mm) maximum, four structures each. Structures include horizontal and vertical bus, insulation and isolation barriers, horizontal and vertical isolated wiring troughs, cable entrance areas, and space for inserting starter and control equipment. All control units, removable or fixed mounted, are assembled with Eaton components of proven safety, quality and reliability. Specifically designed bus stabs, insertion guides, handle mechanisms and safety interlocks are added to form a standardized plug-in unit that meets the highest safety standards.

Market Segments

Eaton's MCCs have been designed to meet the specific needs of several industries including:

- Oil and gas (upstream, downstream and pipeline)
- Water treatment and wastewater
- Commercial construction
- Mining and aggregate
- Utility

Standards and Certifications

- UL 845 Listed
- NEMA ICS 3 Part 1
- NEC section 430 Part H
- Seismic compliance to IBC 2009 and CBC 2010
- ABS certified for non-propulsion loads
- CSA 22.2 No. 0.22-11 Arc Resistant
- Tested to C37.20.7 guidelines

Ratings

- 600 Vac / 250 Vdc
- Maximum 3200 A horizontal bus
- Maximum 1200 A vertical bus
- 42 kA, 65 kA and 100 kA short circuit withstand
- Operating temperature 0 °C (32 °F) to 40 °C (104 °F)
- Storage temperature –40 °C (–40 °F) to 65 °C (149 °F)

Key MCC Features

- Molded-case and air circuit breaker mains
- Bimetallic and solid-state overloads
- IEEE 519 clean power drives
- Adjustable frequency drives (AFD) up to 500 hp
- Reduced voltage soft starts (RVSS) up to 1000 A
- Panelboards/transformers/ATS
- Metering/SPDs/feeder breakers
- MCPs/fused switch disconnects
- 16- and 21-inch deep enclosures
- 21-inch deep back-to-back design
- 1A to 2C wiring capability
- 120 V / 240 V or 480 V coil options as well as 24 Vdc
- Drawout NEMA Size 1 to 5
- Fixed NEMA 6 and higher

Table 29.1-1. Feature Comparison Key

Family	480 V and Lower	600 V	Compact Units	Arc Rating	Smart
Freedom	Yes	Yes	Yes	N/A	Yes
Freedom FlashGard	Yes	Yes	N/A	Preventive	Yes
Freedom Arc Resistant	Yes	Yes	Yes	Type 2	Yes

Freedom

Eaton's Freedom motor control center has been in production since 1994 employing the Freedom NEMA contactor in combination with multiple motor overload styles and either a fused switch or a molded-case breaker disconnect. The Freedom motor control center meets all the above listed standards, ratings and features.

Freedom Arc Resistant

Eaton's Freedom Arc Resistant is the first motor control center to be tested to a North American guideline specifically written for low voltage motor control centers, unlike C37.20.7 that is a guideline for testing metal-enclosed switchgear up to 38 kV. Eaton's Freedom Arc Resistant motor control center is tested in accordance with CSA C22.2 No. 0.22-11 titled "Evaluation methods for arc resistant ratings of enclosed electrical equipment". To meet the CSA guideline (and also the future C37.20.7 guideline) the following must be met.

- Criterion 1: Deformation—Doors, covers and other items must not open. Distortion and bowing of these items is permitted but must not extend to the indicators placed around the enclosure for testing.
- Criterion 2: Fragmentation—Fragmentation of the enclosure must not occur. Small items/parts are permitted to eject as long as their mass is 60 grams or less.
- Criterion 3: Burn-through—Burn-through that causes holes in the enclosure must not occur in the freely accessible enclosure. Based on the results of this test, an Accessibility Type is achieved (Accessibility Type 1 or Type 2).
- Criterion 4: Indicators—Indicators placed around the enclosure for testing must not ignite as a result of escaping gases or particles.
- Criterion 5: Grounding—All grounding connections must remain effective.

Eaton's Freedom Arc Resistant motor control center is a Type 2, 50 ms device limited Arc offering. Device limited means that specific combinations of devices (units and assemblies) are tested so that an Arc rating can be achieved. The combination of devices includes all the standard Freedom devices less a handful, which are covered under the Features section.

The Freedom Arc Resistant motor control center is constructed out of 12-gauge sheet steel instead of the standard 14-gauge including the doors, side and back sheets and the top panels.

The width of the MCC is 8.00 inches (203.2 mm) wider than a standard Freedom MCC with 4.00 inches (101.6 mm) added to the left and to the right of the lineup to allow for gas to expand if an arc occurs. The depth of the Freedom Arc Resistant motor control center is 21.00 inches (533.4 mm) deep and is front mount only. The Freedom Arc Resistant motor control center is 90.00 inches (2286.0 mm) in height and does not come in reduced height. The Freedom Arc Resistant does not need any venting or plenums to vent the gas, allowing the MCC to be mounted up against a wall or a ceiling to be brought down to the top of the MCC.

Arc Resistant Features

To meet the CSA guideline, the following features and devices must be met.

- Main breaker must be NGH or RGH molded-case or MLO fed from NGH or RGH
- Main horizontal bus up to 2500 A
- RVSS to 200 hp and AFDs to 150 hp
- Thermal-magnetic breaker combination starters only
- 65 kAIC bus bracing
- NEMA 1, 2 enclosures
- 21-inch front mount
- Insulated horizontal bus and labyrinth vertical bus
- 80% rated feeder breakers up to 600 A

Freedom FlashGard

Eaton's Freedom FlashGard motor control centers are an industry first in addressing the dangers associated with an arc flash event by minimizing the risk of arc flash exposure. Freedom FlashGard offers features to help prevent injury from electric shock, arc-flash burn and arc-blast impacts and is the first Arc Preventative MCC.

The Freedom FlashGard motor control center uses a "retractable stab" mechanism called RotoTract™ that allows the electrical worker to connect and disconnect line power to the unit from behind a dead front (closed door). Visual indication of the stab position is provided on the unit door on the "Connected" and "Disconnected" positions of RotoTract. Visual indication on the position of the shutters that enclose the stabs is also provided (open shutters indicates that stabs are extended and closed shutters indicate that the stabs are withdrawn). In addition, a number of safety interlocks prevents scenarios where removal or insertion of FlashGard bucket could compromise arc flash safety.

A motorized tool, such as an electric screwdriver with a 3/8-inch (9.5 mm) square bit or standard 3/8-inch (9.5 mm) drive ratchet is required to operate RotoTract's "retractable stab" mechanism. An optional 120 V remote racking accessory with a pendant station is available as to enable the operator to operate the RotoTract from safely behind the arc flash boundary as prescribed by the National Fire Protection Agency (NFPA).

NEMA Classifications (ICS 3, Part 1)

Class I Control Centers

A mechanical grouping of combination motor control, feeder tap and/or other units arranged in a convenient assembly. Connections from the common horizontal power bus to the units are included. Interwiring or interlocking between units or to remotely mounted devices is not included. Only diagrams of the individual units are supplied.

When master terminal blocks are specified, a sketch showing general location of terminals is provided.

Class II Control Centers

The same as Class I, but designed to form a complete control system. They include the necessary electrical interlocking and interwiring between units and interlocking provisions to remotely mounted devices. A suitable diagram illustrating operation of the control associated with the motor control center will be provided.

When master terminal blocks are specified, the terminal arrangement and required wiring connections are shown on the diagram.

NEMA Types of Wiring

Type A includes no unit terminal blocks and no unit-to-unit wiring. Combination line starters power wiring are factory wired and assembled in the structure in the most efficient arrangement. Auxiliary devices can be supplied, wired or unwired as specified. All feeder circuit breaker or fusible disconnect units are in this classification.

Type B duplicates Type A except that all control wires terminate at terminal blocks on the side or near the bottom of each unit. Removable terminal blocks are standard for all control wiring.

Type C-S all factory-supplied control terminals are brought to a master terminal block located in the structure.

Type C-M all factory-supplied control terminals are brought to a master terminal block located in a separate marshaling structure.

Structures

Standard Structure—Side View

Construction

The standard vertical structure is 90.00 inches (2286.0 mm) high and 20.00 inches (508.0 mm) wide. Front-mounted-only structures can be either 16.00 inches (406.4 mm) or 21.00 inches (533.4 mm) deep. Front-to-back unit mounting is 21.00 inches (533.4 mm) deep. Bolted back-to-back can be in 16.00-inch (406.4 mm) or 21.00-inch (533.4 mm) deep structures.

The free-standing structure framework is made of 12-gauge formed steel channels. The subframes for the front and rear of each structure are welded. These subframes are then bolted to longitudinal members to form the complete frame, which is rigid and self-supporting. Side, back and roof covers of 14-gauge steel (except where noted) are mounted with screw fasteners for quick and easy removal. All doors are 14-gauge steel (except where noted) with a 0.50-inch (12.7 mm) flange to provide a rigid, secure closure for all openings. Doors mounted on removable pin hinges are provided on all unit compartments. Vertical wireways, top horizontal wireways and bottom horizontal wireways are standard.

The unit pan forms the top barrier of each unit space. In conjunction with the unit wrapper, this provides isolation between adjacent units and wireways. The guide rails are an integral part of this pan and provide precise alignment of the unit stabs on the vertical bus.

Standard Structure Arrangements

Standard structural height is 90.00 inches (2286.0 mm) with 9.00-inch (228.6 mm) horizontal wireways available at top and bottom for wiring. The balance of vertical compartments, 72.00 inches (1828.8 mm), is available for mounting of control units. This space can provide up to 12 6.00-inch (152.4 mm) high (X spaces) or any combination thereof.

Note: In the rear of common vertical bus front-to-back structures, the top horizontal wireway is 15.00 inches (381.0 mm) high and the bottom wireway is 9.00 inches (228.6 mm). This means that front-to-back structures have only 66.00 inches (1676.4 mm) 11X of usable space in the rear. 72.00-inch (1828.8 mm) 12X of mounting space is available with a 3.00-inch (76.2 mm) bottom wireway. Two front-mounted only structures can be supplied in a front-to-back configuration, allowing 12X rear usable space (depth dimension will increase).

Special Structures

In addition to the standard 20.00-inch (508.0 mm) wide structure, extra wide structures are available in 4.00-inch (101.6 mm) increments up to 40.00 inches (1016.0) wide.

Reduced height structures, in increments of 6.00 inches (152.4 mm) 1X from 90.00 to 54.00 inches (2286.0 to 1371.6 mm), are available for applications with limited access.

Another special structure is a transition section between Type W and the Freedom Series. This structure is 10.00 inches (254.0 mm) wide to provide for horizontal bus splicing.

Paint

All enclosure parts are thoroughly cleaned and given a phosphatizing treatment to inhibit rust and to prime the metal for the finish coating. A 2 mil thick electrostatic powder paint coat is applied to all surfaces. The paint type and process meets UL 1332 for electrical equipment steel enclosures. All exterior enclosure covers and doors are painted ANSI 61 gray (Munsell No. 8.3G/6.10/0.54). For improved interior visibility, the interior of the enclosure and plug-in units are painted white (Munsell No. N9.43/0.21B, 0.23).

Enclosures

The standard enclosure type is NEMA Type 1 Gasketed General Purpose—Indoor. This enclosure is appropriate for installations with normal atmospheric conditions.

The NEMA Type 2 Dripproof—Indoor employs a special roof panel with a drip shield and water channels. This prevents liquid from dripping onto the front of the control center.

The NEMA Type 3R Rainproof and Sleet Resistant—Outdoor consists of a NEMA 1 gasketed enclosure mounted on a special base with an outdoor house erected around and over it. Non-walk-in, walk-in aisle and tunnel types are available.

The NEMA Type 12 Dust-tight and Driptight—Indoor has gasketed material around all doors, door cutouts, cover plates, side, top and back sheets. A gasketed bottom plate is provided with this enclosure. This construction provides maximum protection against airborne matter and dripping liquids.

Indoor enclosures comply with NEC UL 845's "Two Meter Rule" when the bottom of the MCC is at the same level as the operator's platform. MCCs elevated on a raised pad or installed on unembedded channel sills may require operator handle extensions for the uppermost operators. Handle extensions are optionally available and may be installed on-site.

Seismic Qualification

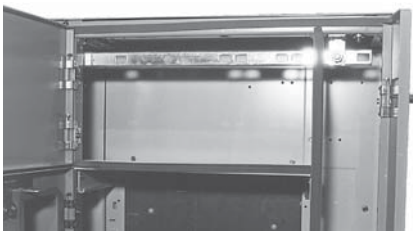
Refer to **Tab 1** for information on seismic qualification for this and other Eaton products.

Vertical Wireway

A vertical wireway is provided in each structure. Located on the right side, it extends the full 90.00-inch (2286.0 mm) height of the structure. The width of the wireway is 4-5/8 inches (117.5 mm) at the rear of the vertical frame members. Overall depth of the wireway is 8.00 inches (203.2 mm) providing a cross-sectional area of nearly 35 square inches (889 square mm) to easily accommodate control and load wiring. Supports are provided at suitable intervals to secure all wiring and cables.

The doors swing open 115° and opposite to the unit doors for maximum accessibility. The doors are mounted on concealed removable pin hinges for quick detachment and are secured in the closed position by spring-loaded quarter-turn indicating type fastener.

Horizontal Wireways



Top Horizontal Wireway

Bottom Horizontal Wireway

The top front horizontal wireway is 9.00 inches (228.6 mm) high and 8.00 inches (203.2 mm) deep in front-mounted only structures and in the front of back-to-back mounted structures. It extends the full width of each structure and is totally isolated from the main horizontal bus. The bottom horizontal wireway is 9.00 inches (228.6 mm) high and extends the full depth of the structure. The entire floor area under the control center is open for unrestricted conduit entry. For top entry, the top wireway can be increased to 15.00 inches (381.0 mm) high, reducing the bottom wireway height to 3.00 inches (76.2 mm).

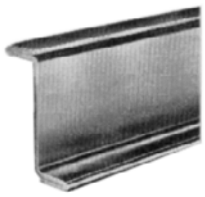
For back-to-back unit mounted, the rear top horizontal wireway is 15.00 inches (381.0 mm) high and 5.00 inches (127.0 mm) deep.

All horizontal wireway openings are covered by doors for increased accessibility. Each door is mounted with removable pin hinges to allow quick detachment.

Bus System

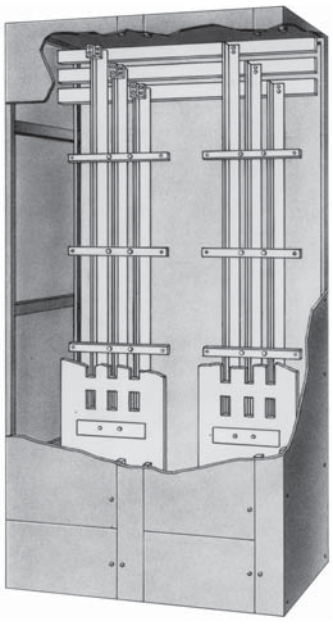
The bus system is designed to efficiently distribute power throughout the MCC and provides inherent mechanical strength in the event of faults.

Vertical Bus



Vertical Bus Configuration

The vertical bus provides three-phase power distribution from the main horizontal bus into the vertical compartments. The bus is a unique angular configuration with a "Z" shape for front-mounted structures and for back-to-back. These shapes have the inherent mechanical strength to withstand fault stresses. They also provide a smooth stabbing surface for unit connection.

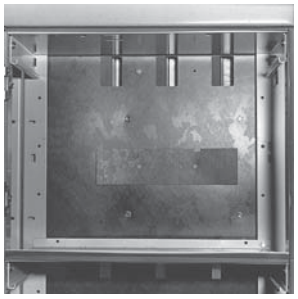


MCC Bus Layout

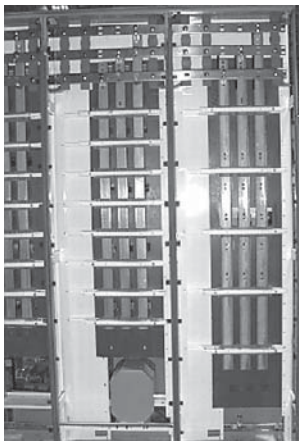
Due to the high-strength capability of the bus bars, bus bracing at 65,000 rms symmetrical amperes is standard. Optional bracing is available at 42,000 and 100,000 A rms. Bus braces are molded from a glass-reinforced polyester material, which is non-tracking and impervious to moisture and other adverse atmospheric operating conditions.

The vertical bus is available in ratings of 600, 800 and 1200 A for front-mounted only, and 600, 800 and 1200 A for back-to-back mounted. **Vertical bus bars are tin-plated copper only.** In addition to tin plating having environmental superiority over silver, its mechanical strength is better able to withstand the stresses of unit insertion and removal on and off the bus. Vertical bus of the incoming section will match the horizontal bus when applicable.

Isolation of the Freedom vertical bus compartment from the unit compartment is accomplished by a full height isolation barrier, which is a single sheet of glass-reinforced polyester with cutouts to allow the unit stabs to engage the vertical bus. Snap-in covers are available for the cutout openings to provide total isolation during maintenance procedures.



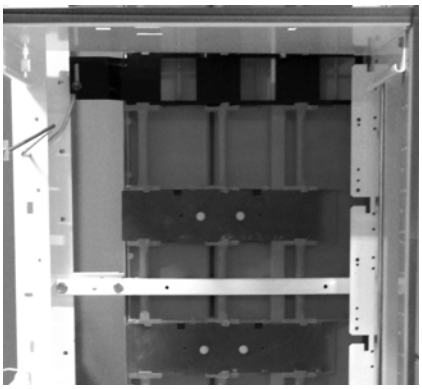
Standard Isolation Barrier



Standard Isolation Barrier Rear View

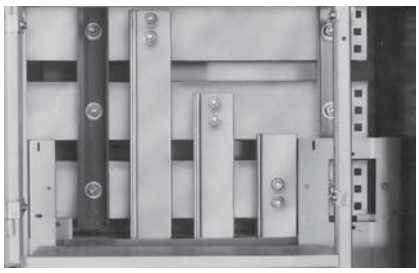
When insulation and isolation of the vertical bus is required, a **labyrinth design barrier**, as shown below, as an option for Freedom and as a standard for Freedom Arc Resistant and Freedom FlashGard. This barrier is molded glass-reinforced polyester and forms a labyrinth around the bus bars to prevent fault propagation. This design provides maximum protection against phase-to-phase insulation breakdown. Thermal efficiency is maintained by a close tolerance fit between the bus bars and the barrier, which minimizes air pockets.

An automatic shutter mechanism is standard with the labyrinth barrier to provide complete isolation of the vertical bus. The shutter moves automatically to cover the stab openings when a unit is removed. This provides maintenance personnel with maximum protection because the vertical bus is never exposed. As the unit is reinserted in the compartment, the shutter moves sideways to uncover the stab openings in the barrier.



Labyrinth Barrier with Automatic Shutter Mechanism

Horizontal Bus



Horizontal Bus

The main horizontal bus provides three-phase power distribution from the incoming line or primary disconnect device to each vertical structure in the motor control center. The bus bars are mounted in a vertical plane, edge to edge. This mounting produces an exceptionally strong assembly, able to withstand high fault current stresses.

The main horizontal bus is rated at 600 A as standard with ratings of 800, 1200, 1600, 2000, 2500 and 3200 A optionally available. Tin-plated copper horizontal bus bars are supplied as standard. Silver-plated copper horizontal bus bars are an option.

Note: 3200 A horizontal bus available in NEMA 1A enclosure only and 65 °C rise above 40 °C ambient only.

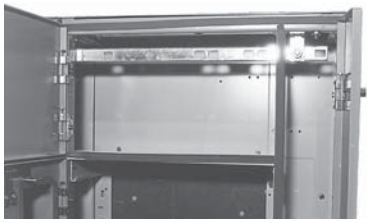
The horizontal main bus is isolated from the top horizontal wireway compartment by a metal isolation barrier. This two-piece steel barrier extends to the full width of each vertical structure. The two-piece design allows access to bus connections without the removal of the entire barrier, for added maintenance convenience. The bus bar layout permits front access to all bus connections. This allows maintenance personnel to make splices and check splice bolt torques from the front of the structure.

Neutral Assemblies

Neutral Bus (Bottom)

For three-phase, four-wire applications, a neutral landing pad is provided as standard. This is a 100% rated neutral. As an option, half or fully rated neutral bus can be supplied in the bottom of the entire MCC.

Ground Bus



Ground Bus (Top)

Copper ground bus, rated 300 A 0.25-inch by 1.00-inch (6.4 mm by 25.4 mm) is supplied as standard. Mounting is across the top of each vertical structure in the horizontal wireway. The bus can also be mounted across the bottom when the bottom 9.00 inches (228.6 mm) are not occupied by units or master terminal blocks. A 0.25-inch by 2.00-inch (6.4 mm by 50.8 mm) optional copper ground bus rated 600 or 800 A is also available.

An optional 300 A vertical tin-plated only copper ground bus is available. Located in the vertical wireway, it provides direct starter unit grounding.

Units

General

Motor starter units are combination type employing a linestarter and a disconnect device of proven capability. The disconnect device can be a High interrupting Motor Circuit Protector (HMCP), Thermal-Magnetic (TM) breaker or fusible switch. Eaton's Type HMCP and HMCPE motor circuit protectors are furnished as standard.

All starters and soft starters through NEMA Size 5 are a drawout design except Size 5 electromechanical reduced voltage. Size 5 optionally can be bolt-in if requested.

All feeder breakers through 400 A are a drawout design.

All dimensions and ratings in the following tables are based on NEMA Design B, 1800 RPM motors.

The HMCP/HMCPE and starter combination has a 65,000 rms symmetrical ampere short-circuit current rating as standard at 480 V. Starter units are available with optional 100,000 A short-circuit current rating. Series C® thermal-magnetic circuit breakers (65 kAIC, or optional 100 kAIC) for starter units are also available.

Freedom, Freedom Arc Resistant and Freedom FlashGard starters meet or exceed IEC 947-4 Type II testing with HMCP, or R and J fuses (Freedom Arc Resistant is HMCP only).

The fusible switch disconnect device is the Type K. It is a quick-make, quick-break, visible blade switch with fuse clips for use with current-limiting or dual element, rejection type, NEMA Class J or R fuses. Rejection fuse clips for Class RK-5 fuses are standard. Fuses are not included as standard.

Both breaker and fuse selection must take into consideration the total short-circuit capacity of the system to which the control center is connected. For a fused switch and starter combination, a 100 kA SCCR at 600 V can be achieved.

Typical starter units available include the following:

- Full voltage, non-reversing
- Full voltage, reversing
- Two-speed, single winding and two winding
- Reduced voltage, autotransformer, closed transition
- Reduced voltage, wye delta
- Reduced voltage, part winding
- Reduced voltage, solid-state (RVSS)
- Adjustable frequency drives (AFD)

Each starter includes a stainless steel corrosion-resistant safety ground clip that makes connection before the power stabs engage the vertical bus.

Units—Freedom and Freedom Arc Resistant

Freedom FVNR Starter

Freedom and Freedom Arc Resistant starter units are equipped with Eaton's Freedom starters and contactors NEMA Sizes 1 through 5. Size 6 and 7 starters are A200 type. These contactors have been successfully applied in thousands of the most demanding industrial applications. Overload protection is provided by a three-pole adjustable ambient compensated, bi-metallic thermal overload relay. The overload relay also provides single-phase sensitivity and isolated alarm contact. As an option, the overload relay can be upgraded to a standard solid-state overload or an advanced solid-state overload as described on **Page 29.1-21**. An insulated hand reset button extends through the compartment door. Additionally, motor running data and starter status/control are available through one of the many industrial standard communication protocols. Freedom Arc Resistant adds line and load shields to the disconnect.

Units—Freedom FlashGard Starter

Freedom FlashGard FVNR Starter

The Freedom FlashGard units are equipped with a "retractable stab" mechanism called RotoTract, that allows the electrical worker to connect and disconnect power to the bucket with the **unit door closed,** thereby minimizing exposure to arc flash. A visual indication is provided on the unit door on the "Connected" and "Disconnected" positions of RotoTract. A visual indication on the position of the shutters that enclose the stabs is also provided (open shutters indicate that stabs are extended and closed shutters indicate that the stabs are withdrawn). A motorized tool such as an electric screwdriver, drill with a 3/8-inch square drill bit or standard 3/8-inch drive ratchet is used to operate RotoTract through its racking tool receiver.

Additional safety features of a FlashGard unit include:

- Unit Latch—When the RotoTract is in "Connected" position, this latch is mechanically interlocked to hook the bucket to the divider pan that separates the bucket from the unit above, thereby preventing physical removal of the bucket when it is connected to 480 V and/or control power. The unit latch also prevents insertion of a bucket with the stabs extended
- RotoTract racking tool receiver shutter—When the breaker is in the "On" position, the shutter for the access hole in the RotoTract (access hole is needed for the motorized tool to retract the stabs) is closed, thereby not allowing the stabs to be retracted when the breaker is energized

Freedom FlashGard starters are equipped with electromechanical starters and contactors NEMA size 1–5.

Units—Adjustable Frequency Drives

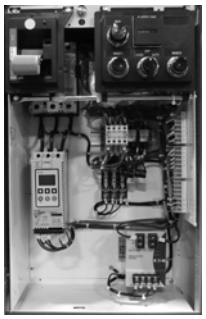
Adjustable Frequency Drive

Adjustable Frequency Drives are available from 0.5–1100 hp for control of standard AC motors in processes that benefit from the ability to change motor speed. Use of Inverter Duty motors is recommended.

Controllers are available to handle constant torque applications, such as conveyors and crushers, and variable torque applications, such as fans and pumps. Control schemes are available for volts/Hz, open loop vector and closed loop vector models. SVX9000 drive units include as standard: line reactors and a door-mounted keypad. Units up to 150 hp VT come standard with a 3% output reactor. MMX drive units do not contain line or load reactors and can be added as an option. All drive structures are bus connected, which allows for expansion of the MCC on both sides of the structure. A wide range of AFD features and options are available to meet the requirements of most applications including IEEE 519 compliant applications. AFDs are available in NEMA 1A gasketed enclosures. AFDs are available in NEMA 3R MCC enclosures from 1–200 hp, constant torque.

29

Units—Solid-State Reduced Voltage Starters (SSRV)



S811+ SSRV

S811+ Solid-State Reduced Voltage (SSRV) starters are designed to reduce the inrush current to a motor during starting and to limit the amount of available starting torque, thus reducing mechanical wear and utility demand requirements. The amount of starting current is field adjustable to match the specific requirements of all applications.

Eaton's S811+ SSRV controllers are available with a wide variety of standard features: kick start, soft stop, phase loss and stall protection. S811+ SSRV starters are 30–70% smaller than competitive designs and contain an integral fully rated bypass relay that almost eliminates heat generation when the motor is at speed.

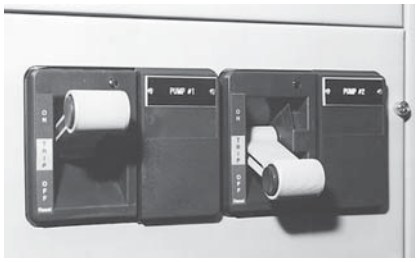
Typical applications include conveyors, compressors, machine tools, pumps and fans.

Units—DC Starters

DC Starter Unit

UL listed DC MCCs use combination circuit breaker DC starters suitable for motor starting duty only. Using Eaton's Type ME DC definite purpose contactors, all DC starters are suitable for up to 250 Vdc and have a 22 kA withstand rating. Class 135 starting resistors for reduced voltage starters are sized for 200% starting current. Typical applications include emergency lube oil pumps, emergency seal oil pumps and emergency turning gear motors.

Freedom and Freedom Arc Resistant Feeder Tap Units



Freedom Dual Feeder Tap Unit

Feeder tap units may contain either circuit breakers or fusible switches; Freedom Arc Resistant only contains circuit breakers. Freedom drawout breaker units include the fixed trip Type HFD, single-or dual-mounted in ratings through 150A and the interchangeable trip Types HJD and HKD single-mounted through 250 A and 400 A respectively. Larger Series C circuit breakers with ratings to 2500 A are fixed-mounted.

Fusible feeder tap units use Eaton's Type K visible blade disconnect switch. Fused switches are mounted in drawout units through 400 A with 30 A and 60 A ratings available in dual mountings. Fixed-mounted switch ratings of 600 A and 800 A are also available.

All switches are supplied with fuse clips for use with current-limiting or dual-element rejection type. Types of fuses include Class J, R or L, which are supplied by "others."

Freedom FlashGard Feeder Tap Units

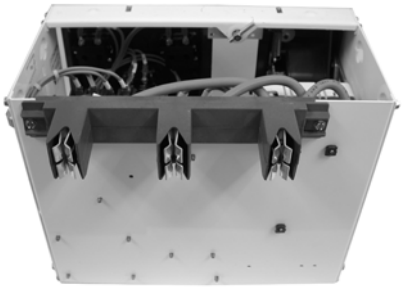
Circuit Breaker Handle Mechanism

Feeder tap units may contain either circuit breakers or fusible switches. Drawout breaker units include the fixed trip Type HFD, single-mounted in ratings through 150 A and the interchangeable trip Type HJD single-mounted through 250 A and Type HKD single-mounted through 400 A. Larger Series C circuit breakers with ratings to 2500 A are fixed-mounted.

Fusible feeder tap units use Eaton's Type K visible blade disconnect switch. Fused switches are mounted in drawout units through 400 A with 30 A and 60 A ratings available in dual mountings. Fixed-mounted switch ratings of 600 A and 800 A are also available.

All switches are supplied with fuse clips for use with current-limiting or dual-element rejection type. Types of fuses include Class J, R or L supplied by "others."

Freedom and Freedom Arc Resistant Stab Assembly



Freedom Plug-in Unit Bus Stabs

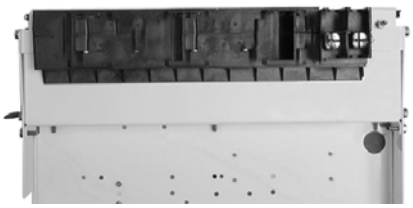
A tin-plated copper alloy stab incorporates the ultimate in mechanical simplicity to provide precise control of contact pressure on the bus. This ensures a positive connection yet permits easy unit insertion and withdrawal. Self-aligning stabs are mounted in a glass-reinforced plastic insulation block that totally shrouds each stab and absolutely ensures positive alignment of the stabs with the vertical bus. The insulation block is also an integral part of the phase-to-phase isolation system. Power wiring is welded to the stabs and is totally contained within the unit enclosure. This means the vertical bus compartment is completely free of wiring for maximum safety and reliability.

Stab assemblies are accurately matched to the electrical requirements of each individual unit and are provided in 60, 150, 300 or 400 A ratings (plug-in through Size 5).

Freedom FlashGard Stab Assembly

Stabs Extended

Stabs Withdrawn



Freedom FlashGard Plug-in Unit Bus Stabs

The Freedom FlashGard MCC uses a "retractable stab" mechanism, called RotoTract, that allows the electrician to connect and disconnect power to the bucket with the unit door closed. A visual indication is provided on the unit door on the "Connected" and "Disconnected" positions of RotoTract. A visual indication on the position of the shutters that enclose the stabs is also provided (open shutters indicate that stabs are extended and closed shutters indicate that the stabs are withdrawn). A motorized tool or standard 3/8-inch (9.5 mm) drive ratchet is used to operate RotoTract's "retractable stab" mechanism. A wired remote racking accessory is also available for operating RotoTract with a pendant station safely beyond the NFPA-prescribed flash protection boundaries.

The stabs are constructed from a tin-plated copper alloy, incorporating the ultimate in mechanical simplicity to provide precise control of contact pressure on the bus. This ensures a positive connection, yet permits easy unit insertion and withdrawal. The stabs are self-aligning and are mounted in a glass-reinforced plastic insulation block, which totally shrouds each stab and ensures positive alignment of the stabs with the vertical bus. The insulation block is also an integral part of the phase–phase isolation system. Power wiring is welded to the stabs and is totally contained within the unit enclosure. The wire is designed for a high level of flexibility to be suitable for RotoTract's retractable stab mechanism.

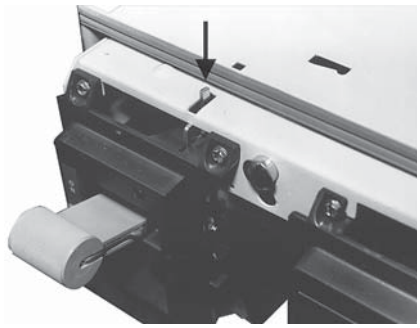
Stab assemblies are accurately matched to the electrical requirements of each individual unit and are provided in 60 A, 150 A, 300 A or 400 A ratings (plug-in through Size 5).

Freedom and Freedom Arc Resistant Handle Mechanism

Circuit Breaker Handle Mechanism

The handle mechanism is designed to provide a high mechanical leverage so that little effort is required to operate any device.

The standard handle mechanism is a vertical motion type device with four positions: ON, OFF, TRIPPED and RESET. Only circuit breaker types have tripped and reset positions. It is securely mounted to the front of the unit and mechanically connected to the breaker or fusible switch, eliminating alignment problems. It provides a positive indication of the breaker or switch position, even with the door open.



Unit Insertion Interlock

The handle and exterior front panel are molded from the same plastic material as the device panel. A textured surface preserves the appearance. The ON position indicator is at the top and is a bright red. The OFF/RESET position is at the bottom and is bright green. The TRIP position, a bright yellow, is in the middle, between the ON and OFF position. All position indicator colors contrast with the black background and are highly visible even at considerable distances. The operating handle is designed for rugged duty and solid operator feel.

Padlocking Bar

The handle mechanism provides several safety features:

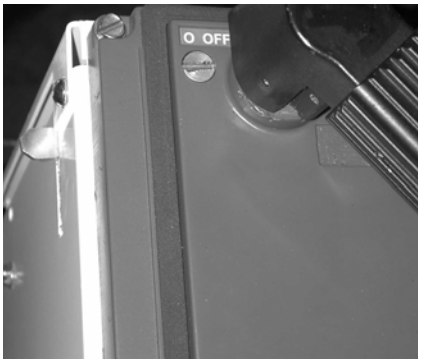
- In the ON position, an interlock prevents the unit door from being opened. A door interlock defeater screw located above the handle is provided to enable authorized maintenance personnel access to the units when required
- With the unit door open and the operating handle in the ON position, an interlock slides into a slot in the divider pan above and prevents removal of the unit. This same interlock prevents insertion of the unit unless the handle mechanism is in the OFF position. The interlock also prevents the operating handle from being turned on with the unit door open
- To ensure that units are not energized accidentally or by unauthorized personnel, the handle mechanism can be padlocked in the OFF position. Sufficient space is available for a maximum of three padlocks. Where critical processes are involved and to prevent unauthorized shutdown, the handle mechanism can be modified to enable padlocking in t he ON position

Freedom FlashGard Handle Mechanism

Circuit Breaker Handle Mechanism

The handle mechanism is designed to provide a high mechanical leverage, so that little effort is required to operate any device.

The standard handle mechanism is a vertical motion type device with four positions: ON, OFF, TRIPPED and RESET. Only circuit breaker types have tripped and reset positions. It is securely mounted to the front of the unit and mechanically connected to the breaker or fusible switch, eliminating alignment problems. It provides a positive indication of the breaker or switch position, even with the door open.



Unit Insertion Interlock

The handle and exterior front panel are molded from the same plastic material as the device panel. A textured surface preserves the appearance. The ON position indicator is at the top and is a bright red. The OFF/RESET position is at the bottom and is bright green.

The TRIP position, a bright yellow, is in the middle, between the ON and OFF position. All position indicator colors contrast with the black background and are highly visible even at considerable distances. The operating handle is designed for rugged duty and solid operator feel.

Padlocking Bar

The handle mechanism for Freedom FlashGard provides several safety features:

- In the ON position, an interlock prevents the unit door from being opened. A door interlock defeater screw located to the right of the handle is provided to enable authorized maintenance personnel access to the units when required
- The unit insertion interlock is located to the left of the operating handle. The interlock must be in the locked position in order to turn the disconnect on. When the interlock is in the locked position, the unit cannot be withdrawn or inserted
- To ensure that units are not energized accidentally or by unauthorized personnel, the handle mechanism can be padlocked in the OFF position. Sufficient space is available for a maximum of three padlocks. Where critical processes are involved and to prevent unauthorized shutdown, the handle mechanism can be modified to enable padlocking in the ON position

Each unit has a safe lock position. This interlock will lock the unit in a position off the 480 V bus and ensure the unit cannot be inserted or withdrawn.

Freedom FlashGard Unit Wrapper Side Latch

Device Panel

Standard Device Panel

The device panel can accommodate up to six 1-3/16-inch (30.2 mm) Eaton's 10250T type pilot devices such as oiltight pushbuttons, indicating lights, selector switches and miniature meters.

Molded into the panel is a knockout for each device location. This facilitates the future addition of devices to the panel.

The device panel is hinged on a horizontal pivot tube extending across the front of the unit. With the unit door open, loosening two captive retaining screws at the top of the panel and sliding it 0.50-inch (12.7 mm) left, permits it to swing down. This provides ready access to the rear of the panel and increased accessibility to the unit interior.

Nameplates

Unit nameplates are 1.00 x 2.50 inches (25.4 x 63.5 mm) and engraved with 3/16-inch (4.8 mm) high white lettering on a black background (black lettering on a white background optional). They are heat- and crack-resistant to eliminate the need for replacement. Nameplates are mounted with stainless steel self-tapping screws.

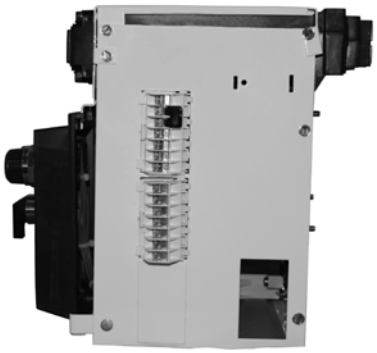
Freedom FlashGard Unit Wrapper

The unit wrapper is fabricated of 14-gauge steel. After fabrication, it is cleaned and given a rust inhibiting phosphatizing treatment. The finish on a unit wrapper is a baked Munsell No. N9.43/0.21B, 0.23 white. This is highly durable finish, gloss-white in color to increase visibility within the unit and to facilitate wiring and maintenance procedures.

The unit wrapper consists of a three-sided rugged steel shell including the mounting base for the unit components. The smallest unit measures 13-3/4 inches (349.3 mm) wide, 8.00 inches (203.2 mm) deep and 6.00 inches (152.4 mm) high. Units increase in 6.00-inch (152.4 mm) increments to a maximum height of 72.00 inches (1828.8 mm).

The unit wrapper is designed to provide ample space for cable entry from the wireway to the unit.

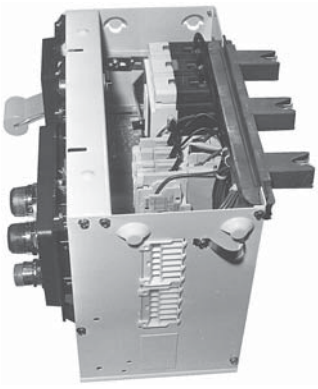
The unit wrapper has four mounting points, two on each side, which support the unit in the structure. They engage guide rails located near the top of each unit space. This mounting point guide rail system produces minimum friction and allows units to be inserted and withdrawn easily. The guide rails also give precise alignment to the unit for accurate stabbing on the vertical bus.



Freedom FlashGard Plug-in Unit Wrapper

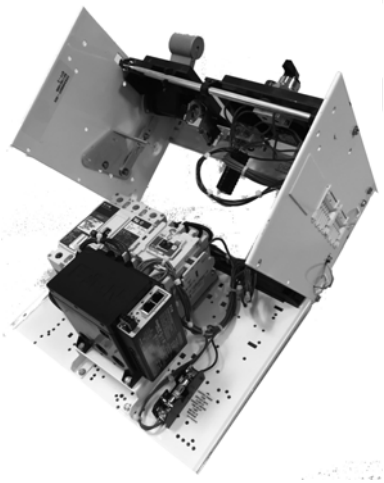
Freedom and Freedom Arc Resistant Unit Wrapper

The FlashGard unit wrapper is equipped with a quarter-turn side wrapper latch that securely holds the unit in the compartment. The latch can only be engaged when the stabs are fully mated with the vertical bus. Upon release of the latch, the unit can be partially withdrawn such that the stabs disengage from the vertical bus. In this position, the latch can be re-engaged to prevent the unit from being returned to the fully stabbed position or from being removed from the structure. The latch can be padlocked in this position to ensure that the stabs remain disengaged during maintenance.



Freedom Plug-in Unit Wrapper

Unit Maintenance



Plug-in Unit Maintenance

The Freedom three-piece (clam shell) unit wrapper design facilitates easy work bench maintenance. When removed from the MCC, the unit top/side barrier assembly can easily be swiveled up and back for complete access to components and wiring.

Terminal Blocks

A side-mounted, seven-circuit, latching pull-apart terminal block is standard on units with NEMA Type B or C wiring. This industrial-grade Eaton MCC terminal block provides solid electrical connections while conserving space and making installation and maintenance easier.

Terminal blocks are mounted in knock-outs on the vertical wireway side of the unit housing affording greater access to the unit compartment and interior components. The two-piece terminal block snap-locks together to ensure permanent circuit continuity. To aid installation and wiring checks, the terminal marking strips for both sides of the terminal block are fully visible from the front of the starter compartment.

Side Mounted—Latched Pull-Apart Terminal Block

Heavy-duty saddle wire terminals are of the resilient collar design, which eliminates loose connections caused by expansion and contracting of the conductor as the current is switched on and off. This unique design maintains constant pressure as the wire expands and contracts. This 600 V, 30 A rated terminal block will accept 12 AWG stripped wires, as well as 14 AWG ring or spade wire lugs. All terminal block conductors are fully shielded for added safety and cleanliness.

A 12.00-inch (304.8 mm) high (2X space) starter unit accommodates up to three side-mounted terminal blocks providing a maximum of 21 points. Larger units accommodate two additional 7-point terminal blocks for every additional 6.00 inches (152.4 mm) 1X space of unit height. The 6.00-inch (152.4 mm) compact starter unit uses a 9-point pull-apart terminal block, which is installed along the top front of the starter unit.

Control wiring within each starter compartment consists of 16 AWG control wire for Freedom FlashGard MCCs and 2100 Series MCCs. Rated 105 °C, the flame-retardant, thermoplastic insulated wire is red. Power wiring is black and sized to carry the maximum full load current of the starter unit.

Front-Rail-Mounted Terminal Blocks

For special applications, other types of rail-mounted terminal blocks are also available. They are installed horizontally at the bottom front of the starter unit. Refer to Eaton for terminal block types available and space restrictions.

Unit Doors

Unit doors are formed of 14-gauge steel with a 0.50-inch (12.7 mm) flange on all four sides. The flange adds rigidity to the door and provides a surface to contain door gasketing. Cutouts are made in the door as required to accommodate the operating handle and device panel. The doors are cleaned, phosphatized and given a finish of gray, baked-on enamel ANSI 61 (Munsell No. N9.43/0.21B, 0.23).

The doors will open 115° opposite to the wireway doors permitting optimum access to the unit compartment. The doors are mounted on removable concealed pin hinges. This permits quick removal of any door in a vertical structure without disturbing adjacent doors.

Doors 2X and larger are held closed with a minimum of two quarter-turn indicating-type fasteners. They securely hold the door in the closed position, yet allow quick and easy access to the unit when required. The fasteners provide a visual indication of the latched position. The head slot of the fastener is designed to prevent screwdriver slippage.

Freedom 12.00-Inch (304.8 mm) Unit Door

Freedom FlashGard 12.00-Inch (304.8 mm) Unit Door

Spring-Loaded Unit Door Quarter-Turn Latch

29

Options

Eaton's starter and feeder tap units can be modified to meet a variety of specification requirements. Some typical components that can be added include: control power transformers with two primary and one secondary control fuses, control relays, solid-state overload relays, ground fault relays, current transformers, extra electrical interlocks, pushbuttons, selector switches, indicating lights, circuit breaker shunt trip or undervoltage release and auxiliary switches. In most cases, one of these modifications does not increase starter unit size.

Additional Equipment

In addition to motor starter and feeder units, additional equipment can be supplied including the following:

- Single-phase dry-type distribution transformers in ratings of 0.5, 0.75, 1, 1.5, 2, 3, 5, 7.5, 10, 15, 20, 25, 30 and 45 kVA
- Three-phase dry-type distribution transformers in ratings of 9, 15, 25, 30 and 45 kVA
- Lighting panelboards with up to 42 circuits with either plug-in branch breakers or bolt-on branch breakers, 120/240 V, 120/208 V or 480 V, single- or three-phase
- Metering equipment including the IQ family of solid-state power monitors, voltmeters and ammeters
- PLC and DCS I/O racks
- S811+ family of solid-state reduced voltage starters
- SVX9000 and MMX adjustable-frequency controllers
- Active harmonic correction units
- Surge protective device (SPD) units
- Size 4, 5 and 6 vacuum starters and contactors
- Power factor correction capacitors
- Automatic transfer switches
- DeviceNet, Modbus, PROFIBUS, Modbus TCP, EtherNet/IP Communications
- Power Xpert® communications
- Industrial Operator Interface
- Industrial PLCs and PCs

Control and Load Terminations

Master Terminal Blocks at Bottom (Class C Wiring)

For NEMA Type A wiring, each unit is assembled and devices interwired. Terminal blocks are not supplied and control and load wiring is internal to the unit.

For NEMA Type B wiring, control wires are terminated at blocks within the unit. Refer to the discussion of units for types of terminal blocks available.

For NEMA Type C-S wiring, control and load wires are extended from the unit terminal blocks to master terminal blocks located at the top or bottom of each vertical structure.

The mounting location of the master terminal block in front-mounted only structures is in the existing horizontal wireway space at the top or at the bottom as shown above. When mounting is made in an incoming line section, 12.00 inches (304.8 mm) of unit space must be used. When mounting is made in the rear of back-to-back mounted structures, 6.00 inches (152.4 mm) of unit space must be used at the bottom and 12.00 inches (304.8 mm) used at the top.

Master terminal blocks are rack-mounted to permit removal of entire assembly for ease of wiring during installation and maintenance.

For NEMA Type C-M wiring, control and load wires are extended from the unit terminal blocks to master terminal blocks located in a separate marshaling structure.

Incoming Line

Incoming line cables entering the MCC from either the top or bottom can be easily terminated onto main lugs or connected to a main disconnect. All incoming line sections comply with NEC wiring bending requirements as adopted by UL.

Main Lugs Only (MLO)

Up to 1200A rated horizontal bus, cables, up to four per phase, are terminated on crimp or screw lugs mounted on adapters solidly bolted to fully rated vertical bus. Top entry cables are terminated at the top of the MCC and bottom entry cables are conveniently terminated near the bottom. **Table 29.2-4** shows spacing requirements for various cable configurations. MLO termination for 1600, 2000, 2500 and 3200 A requires a full vertical section.

Note: 3200 A main lugs only available in NEMA 1 enclosure only and 65 °C rise above 40 °C ambient only.

Main Disconnects

Incoming cables may also be easily terminated on a main circuit breaker or fused switch. A variety of main circuit breakers are available. **Tables 29.3-17** through **29.3-22** show spacing requirements for various main devices.

Metering

IQ 250/260 Electronic Power Meter

IQ 100 series meters are microprocessor-based three-phase power monitors that replace the traditional ammeter, voltmeter and instrument switches. The meters display phase currents, voltage, L-L, L-N, power-real and reactive apparent, power factor, frequency, energy (watthours, VAR-hours and VA-hours) at 0.5% accuracy. Options include Modbus RTU, Modbus TCP and KYZ outputs.

IQ 200 series meters are microprocessor-based three-phase power monitors that replace the traditional ammeter, voltmeter and instrument switches. The meters display phase currents, voltage, L-L, L-N, power-real and reactive apparent, power factor, frequency, energy (watthours, VAR-hours and VA-hours) at 0.1% accuracy. Advanced versions also display THD readings for voltage and current as well as discrete inputs and outputs that are ideal for incoming line metering.

Power Xpert 2000 series meters include all the features of the IQ 200 series meters with an added communication port supporting Web services, Ethernet industrial communications including Modbus TCP and BACnet/IP as well as DNP 3.0. All Power Xpert meters support field upgradable firmware.

IQ Analyzer provides extensive metering, power quality analysis, remote input monitoring, control relaying, analog input/outputs and is communications capable. A display provides the flexibility of exhibiting large characters with high visibility and small characters for detailed descriptions. These IQ power monitors each contain their own voltage power pack for systems up to 600 V. Therefore, separate potential transformers are not required. Either two or three separate current transformers must be used. All IQ power monitors are communications capable. Refer to **Tab 3** for further details.

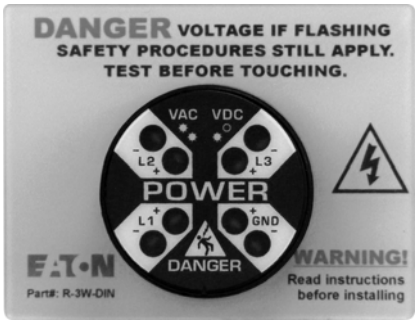
Power Xpert 4000/6000/8000 meters are available with communication features for power management and system software integration in addition to a Web interface. Customers and facility personnel can view the metering data using a standard PC Web browser. The new platform offers advanced functionality like transient capture, high sampling rate, open communications, Web server gateway, field-upgradable firmware, expandable memory and optional I/O.

FlashGard Remote Racking Accessory

Remote Racking Accessory

- Performs RotoTract racking safely behind NFPA Arc Flash boundaries
- 120 Vac motor driven
- Mounts to RotoTract mechanism
- Wired pendant station for "rack-in"/"rack-out" operation
- Momentary jog
- Mounting offset bracket to clear device panel

Voltage Presence Indicator (VoltageVision™)



Voltage Presence Indicator (VoltageVision)

- Hardwired voltage detector connected to load side of disconnect
- Enables operator to "pre-verify" voltage presence with unit door closed
- Installable in a 30 mm pilot device knockout
- Dual redundant circuitry for reliability
- Phase insensitive

Automatic Insulation Tester (Motorguard™)

Automatic Insulation Tester (Motorguard)

- "Meggers" equipment motor insulation to continuously monitor integrity of insulation for the period that the equipment is de-energized
- Applies 500 Vdc potential at current-limited, operator-safe maximum amperage of 200 microamperes
- Alarms upon detection of a threshold leakage to ground current
- Visual alarm indication and lockout; Form C contact available for remote alarm status

FlashGard Padlock Accessory

FlashGard Padlock Accessory

- Locks out RotoTract operation during maintenance
- Allows operation of FlashGard units by authorized personnel only
- Provided as standard on NEMA 12 FlashGard MCCs (prevents dust entry into RotoTract access port)
- Heavy-gauge steel construction

Surge Protective Device—SPD

SPD (Surge Protective Device) with Circuit Breaker Disconnect

SPD Series units feature advanced thermodynamic fusing technology and are available in 18.00 inch (457.2 mm) space factors. All units (100–400 kA) meet UL 1449, 3rd Edition. Internal fuse protection is up to 200 kAIC.

Standard MCC offering includes Monitoring Display with dual-colored status LEDs. Optional surge counter, Form C alarm contacts and audible alarm enable/disable are also available.

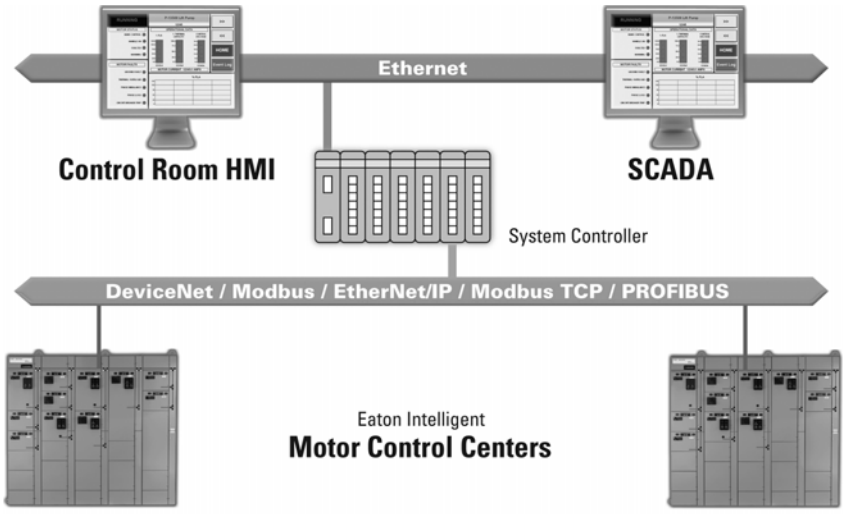
Communications

Eaton's motor control centers offer the industry's most comprehensive communications solutions in motor control providing seamless communicating on all major industry standard field busses. Available with communications to fit new and existing applications, Eaton's motor control centers are custom-made assemblies of conveniently grouped control equipment primarily used for control of motors and power distribution.

Eaton motor control centers not only are capable of communicating to the industry standard protocols, they also have the ability to serve up Web pages, so any Web client can monitor and manage the MCC from any location accessible to the LAN. Ordering the MCC with the Power Xpert® Gateway provides the ability to communicate information to the Web as well as provides a seamless interface between the low voltage, medium voltage and all meters.

MCC Motor Control Communication Choices

Table 29.1-2 is used to assist the user in how each of the smart devices communicates within the MCC. All MCC communication solutions provide for a single node per unit configuration, eliminating any single point of failure within the MCC. All networks are industry accepted industrial networks and allow for configuration, monitoring and control of the end node. A node is defined as a starter, drive, soft start, breaker, meter or other control device on the network.



Eaton's Motor Control Centers

Table 29.1-2. Network Matrix

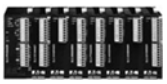
Network Protocol	EtherNet/IP	Modbus TCP	DeviceNet	PROFIBUS DP	Modbus RTU
Physical layer	Ethernet	Ethernet	Serial	Serial	Serial
Node count	Greater than 250, scanner limited	Greater than 250, scanner limited	63 devices per network	32 devices per segment, 127 using repeaters	32 devices per segment, 254 using repeaters
Speed (baud)	10/100 meg	10/100 meg	125/250/500 K	500 K to 12 meg	Default 9600
C306 starter (AC)	C441U	C441U	C441K	C441S	C441N
C440 starter (AC)	C441U	C441U	C441K	C441S	C441N
C441 starter (AC)	C441R	C441R	C441K	C441S	C441N
S811+ (AC)	C441U	C441U	C441KS	C441SS	Onboard
Feeder tap	C441U	C441U	C441K	C441S	C441N
Remote IO (4 in 2 out)	C441U	C441U	C441K	C441S	C441N
PXM series meters	Gateway	Onboard	Gateway	Gateway	Onboard
IQ series meters	Gateway	Gateway/ optional onboard	Gateway	Gateway	Onboard
MP series relays	MPONI + gateway	MPONI + gateway	MPONI + gateway	MPONI + gateway	MPONI

Note: All MCCs are Power Xpert capable with the PXG gateway communicating to each bucket.

Data Parameters

To simplify system design and wiring schemes, regardless of the industrial network selected and the MCC family selected, the nodes will be the same. Depending on the type of smart device chosen, there will be varying types of data and control capability associated with it. Each of the Eaton devices has a rich set of monitored data associated with it; consulting the user manual may be needed to determine all available data/parameters.

Table 29.1-3. Data Parameters

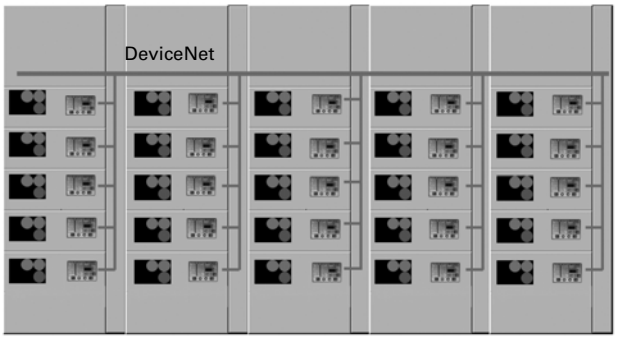
Description	Data	Graphic
S811+ Soft Starts DeviceNet Modbus Modbus TCP PROFIBUS EtherNet/IP	Line current (scaled/float) Average current (scaled/float) Power pole temperatures % FLA (Running current/FLA setting) Thermal capacity Fault/warning codes Field wiring status Handle position/breaker status Ground fault current Fault history Status (Run/Fault/Warn/Control/Aux...)	
SVX/DG1/MMX AFDs DeviceNet Modbus Modbus TCP PROFIBUS EtherNet/IP	Speed (Hz) Speed (rpm) Torque Current Voltage DC bus voltage temperature Status (Run/Fault/Warn...) Faults More—refer to manual	
C441 IO DeviceNet PROFIBUS Modbus Modbus TCP EtherNet/IP	Four AC inputs (DC is in an option) (Running/Faulted/Breaker status, user denied) Two B300 relay outputs (Run)	
C440 SSOL DeviceNet PROFIBUS Modbus Modbus TCP EtherNet/IP	Line currents % thermal remaining Faults Ground current Status (Run/Fault/input/output…) More—refer to manual	
C441 SSOL DeviceNet PROFIBUS Modbus Modbus TCP EtherNet/IP	Line currents % thermal remaining % current unbalance Line voltages % voltage unbalance Faults kW Status (Run/Fault/input/output…) More—refer to manual	
MP-3000 MP-4000 DeviceNet PROFIBUS Modbus Modbus TCP EtherNet/IP	Currents Voltages Power Energy Much more—refer to manual	
PXM Meters	Currents Voltages Power Energy Much more—refer to manual	
Power Xpert Gateway to PowerNet	Data depends on target device Trending Logging Fault indication and more	
Power Xpert Smart Gear	Online diagnostics, troubleshooting, documentation and monitoring software solution.	
Logic Control	In a single unit, a PLC is provided for local control of the MCC components.	

29

DeviceNet

DeviceNet is an industry standard field bus governed by ODVA and is supported by most major vendors of PLC and DSCs. DeviceNet, like most major field buses, provides simplified control, increased diagnostics, reduced wiring and data richness of the motor control centers. The Eaton DeviceNet MCC solution provides users with significantly reduced installation time and increased uptime through the integration of intelligent devices and advanced software tools. Control products include: ODVA compliant motor starters, variable speed drives, operator interface, line metering and block I/O.

DeviceNet in an MCC



DeviceNet

Eaton's MCC use either a direct connect I/O block or direct connect advanced solid-state overload relay to connect to DeviceNet. The topology is a trunk drop configuration where the trunk runs along the top of the MCC and each device is connected to DeviceNet via a drop cable running through the vertical wireway.

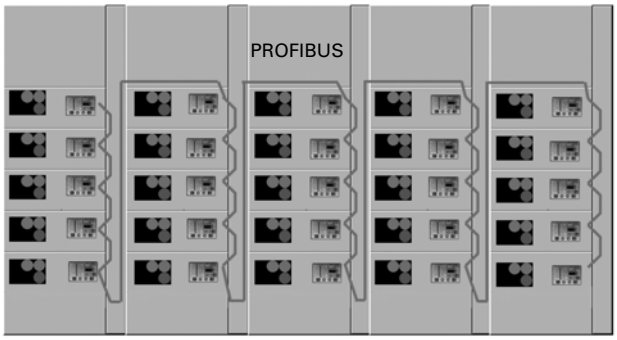
About DeviceNet

Learn more about DeviceNet by visiting the Open DeviceNet Vendor Association at odva.org.

PROFIBUS DP

PROFIBUS DP is an industry standard field bus governed by the PROFIBUS Trade Organization and is supported by most major vendors of PLC and DSCs. PROFIBUS, like most major field buses, provides simplified control, increased diagnostics, reduced wiring and data richness of the motor control centers. The Eaton PROFIBUS MCC solution provides users with significantly reduced installation time and increased uptime through the integration of intelligent devices and advanced software tools. Control products include: motor starters, variable speed drives, operator interface and block I/O.

PROFIBUS DP MCC



PROFIBUS DP

Eaton's MCC use either a direct connect I/O block or direct connect advanced solid-state overload relay to connect to the PROFIBUS. The topology for PROFIBUS is daisy chain and each device in the MCC will be daisy-chained together to meet the PROFIBUS specification.

About PROFIBUS

Learn more about PROFIBUS by visiting the PROFIBUS Trade Organization Association at profibus.com.

Ethernet

There are two supported protocols on Ethernet for the Eaton MCC offering—EtherNet/IP (ODVA) and Modbus TCP (Modbus IDA), which are both industry standard field buses and supported by most major vendors of PLCs and DSCs. Ethernet, like most major field buses, provides simplified control, increased diagnostics, reduced wiring and data richness of the motor control centers. Another added benefit of Ethernet is that a PC can connect directly to the control system and monitor the MCC from any location where remote access is permitted. The Eaton Ethernet MCC solution provides users with significantly reduced installation time and increased uptime through the integration of intelligent devices and advanced software tools. Many of the Eaton control products such as the across-the-line starters, DG1 AFDs and S811+ communicate on Modbus TCP and EtherNet/IP at the same time, allowing for a more flexible control and monitoring solution.

Understanding Ethernet

Ethernet can be a very misunderstood word and confusing to someone who is trying to build a control or monitoring system and doesn't have much experience specifying this type of communication. To help bring some clarity to how to specify Ethernet, this simple example is going to use an analogy that most of us are very familiar with. When you are at home and pick up the phone to call a friend or neighbor, your conversation is transmitted across a land line (wire) that can be compared to Ethernet. In this example, both the land line and the Ethernet are the physical medias in which the communication is transmitted. When you call your friends to communicate to them, you need to talk in a language that is understood by each other; this language is called the protocol, which is no different than Ethernet, for the devices to communicate to each other they need to support the same language or protocol. Modbus TCP and EtherNet/IP are two widely supported protocols for Ethernet. Modbus TCP is a standard founded by Modbus IDA and natively supported by many major PLC and DCS vendors.

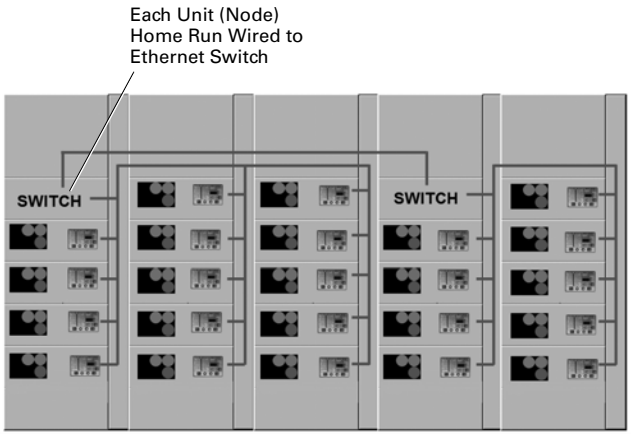
EtherNet/IP is another standard that is founded by ODVA and supported primarily by AB and other third-party vendors for use in PLC and DCS applications. Now let's add another twist to the example, let's say that you and a friend are talking in one protocol and then you conference in two friends that talk another protocol. Using the same physical media, the four of you can all communicate to each other using multiple protocols. This is no different than Ethernet where the physical media supports both Modbus TCP and EtherNet/IP (and others) on the same physical media at the same time.

In the Eaton MCC when Ethernet is applied, there is a switch in each shipping split and all the Ethernet devices for that split are then home run wired back to that switch. There will be at least one customer connection per switch to make local connections or to connect to the control system. Over this Ethernet connection, not only can control and monitoring be performed, but also configuration of the end devices, allowing for easy access for maintenance personnel to the equipment once they gain access to the Ethernet system.

There are two switch choices for the Eaton MCC: an unmanaged switch (which is typical for Modbus TCP) and a managed switch (which is required for EtherNet/IP). The managed switches can be connected in a redundant ring network and only 600 V CAT 5 shielded Ethernet cable is used when connecting the devices to the switch and the switches together.

For more information or clarity on the supported Ethernet protocols and the products that support Ethernet, please call 877-ETN-CARE (877-386-2273) option 2.

EtherNet/IP and Modbus TCP in a MCC



Modbus TCP and EtherNet/IP

About Ethernet

Learn more about EtherNet/IP by visiting the ODVA website at odva.org. Learn more about Modbus TCP by visiting the Modbus IDA website at modbus.org.

Web-Enabled MCC

The Power Xpert Gateway provides Web-enabled, real-time monitoring of electrical distribution and control equipment. The Power Xpert Gateway makes integrating power equipment (up to 96 devices) onto an Ethernet network fast and easy. The PXG is installed in a motor control center, low/medium voltage switchgear or switchboard to consolidate data available from components such as breakers, meters, motor controllers and protective relays. Through standard onboard Web pages, Power Xpert Software or third-party software, the PXG allows you to closely monitor the performance of your power infrastructure with easily accessed, real-time, Web-enabled data. In addition to Web-enabling the components in the MCC, the PXG also makes all the data available to upper level PLC, SCADA, and BMS type systems over Modbus TCP, SNMP and BACnet/IP protocols.

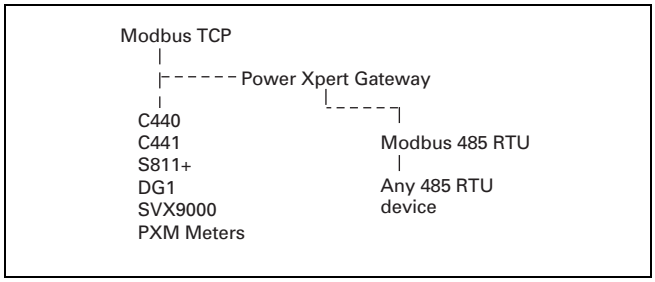
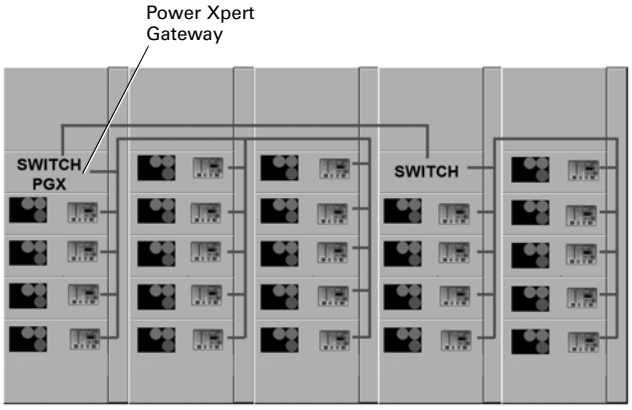


Figure 29.1-1. MCC Configuration—Modbus TCP

Figure 29.1-1 through 29.1-6 represent typical Eaton communications equipment found in MCCs. For more available equipment and configurations, please contact your local Eaton representative.



Power Xpert Architecture in an MCC

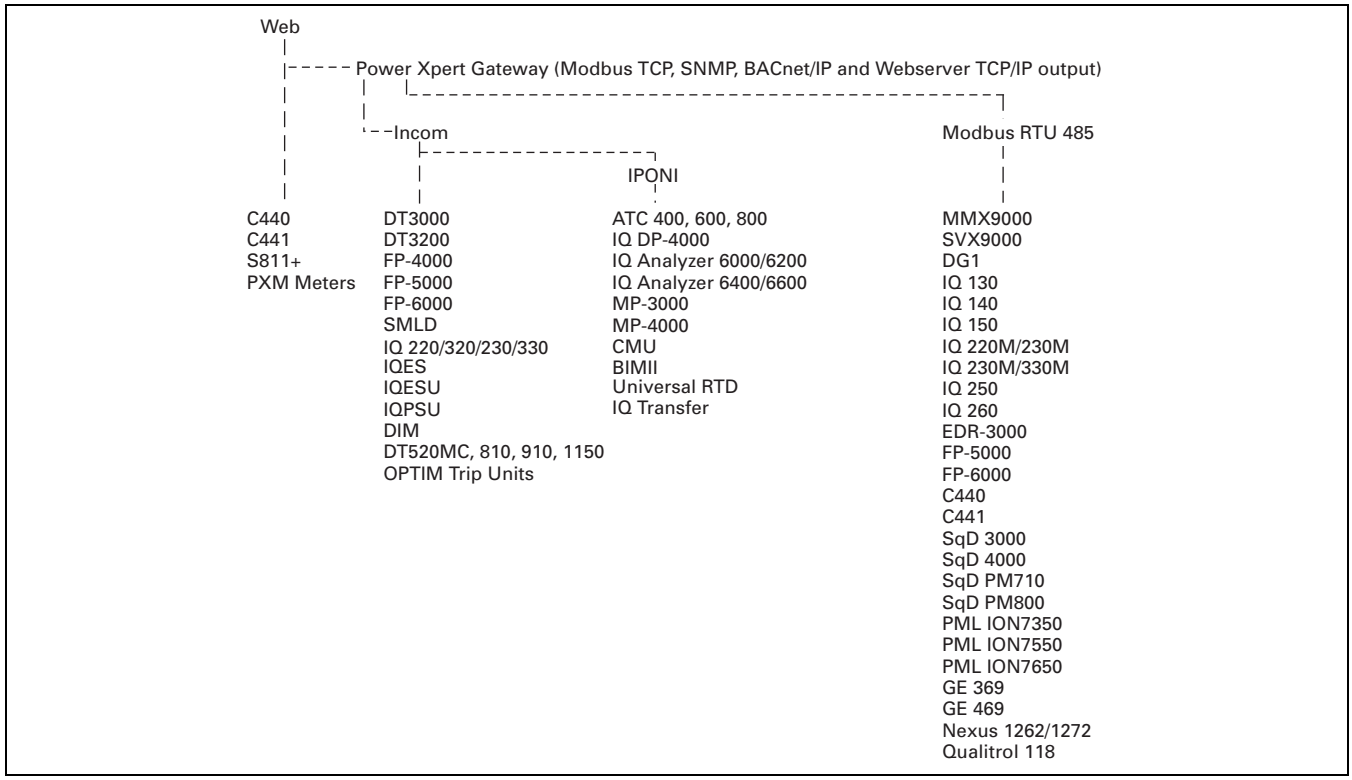


Figure 29.1-2. MCC Configuration—Web-Enabled

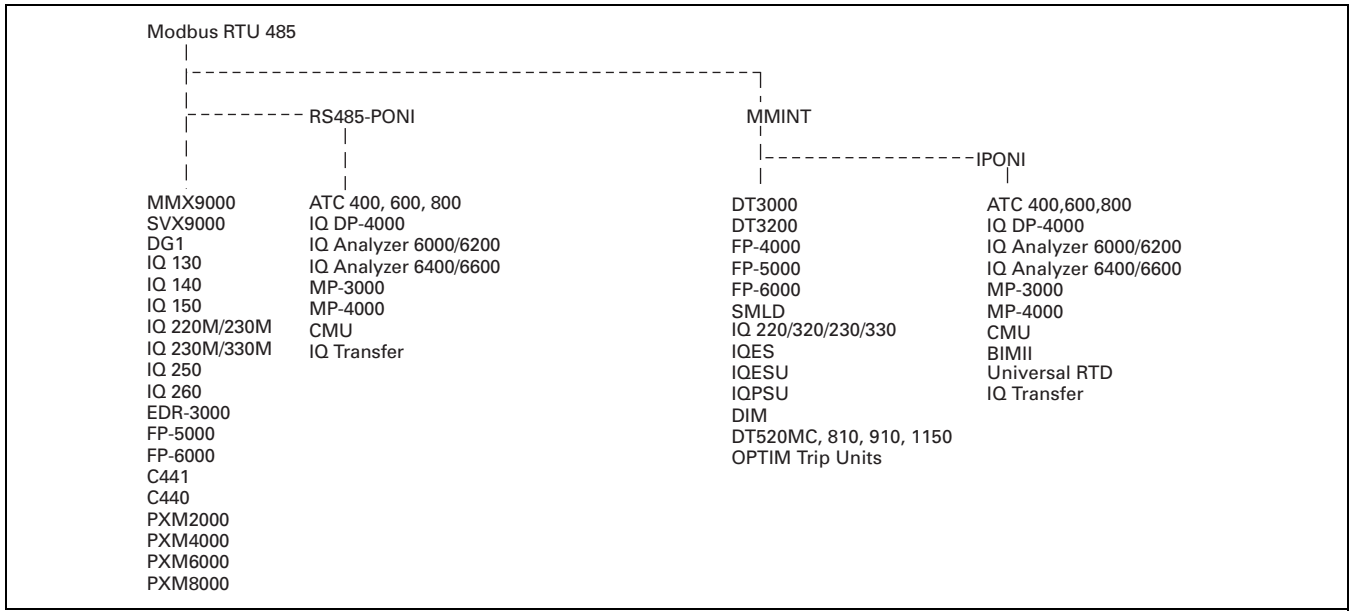


Figure 29.1-3. MCC Configuration—Modbus 485 RTU

Power Xpert Smart Gear

Eaton's Power Xpert Smart Gear interface adds one more layer of safety and diagnosis to any of the Eaton MCC products. The Power Xpert Smart Gear passively attaches (can be removed from the network or unplugged without affecting the MCC communications) to the MCC Ethernet network and performs a variety of functions including monitoring, documentation, Maintenance Minder and alarms. The Power Xpert Smart Gear comes factory configured on a 15.00 inch (381.0 mm) screen. The software is written such that the application can be easily modified or changed by the user to fit expansion or reconfiguration of the MCC by any end user without any software or service contracts.

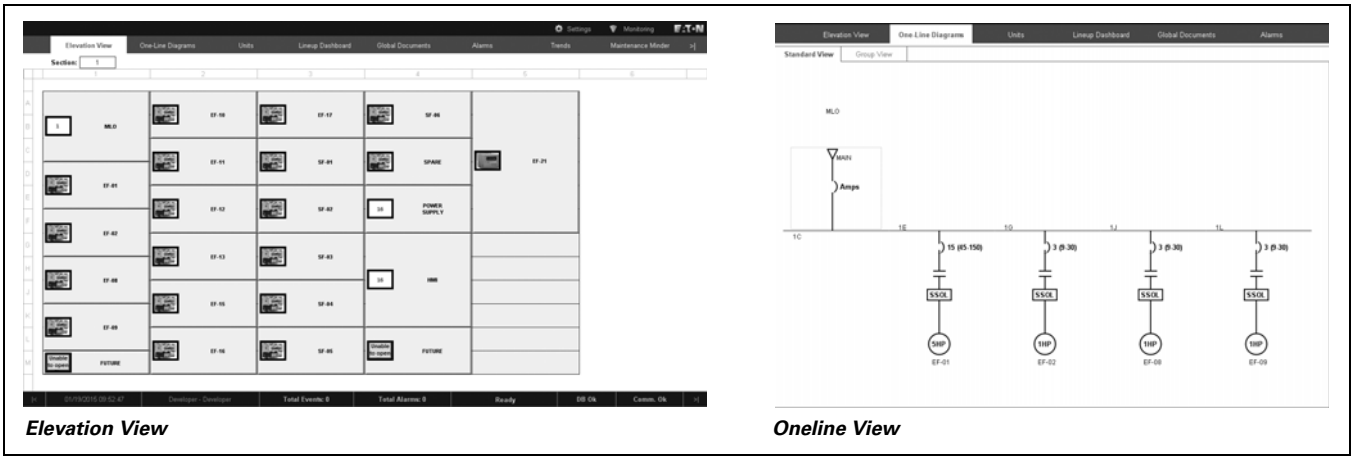
The Power Xpert Smart Gear views feature provides multiple ways to look at the loads within the MCC. The views contain an elevation of the MCC, a one-line view and the grouped one-line. The default elevation will display the MCC as seen from the front, with each load identified and in a space that is representative of the space it occupies in the MCC by section and location. By selecting a unit, a detailed view of the unit will appear, which contains a trend along with the analog and discrete status of the device. Fault information for the individual units are easily seen from this view.

There is also a one-line that will represent a flat view of the MCC by power flow. Lastly the user has an option of grouping loads together to form several grouped one-lines that can be 3 layers deep, which can be used to group loads of a similar process for example. From the one-line, devices that are faulted are easily seen and by selecting a device, a favorites parameter list for that device is displayed.

The documentation view is an easy way to centralize user manuals, troubleshooting tips, spare parts and electrical drawings into one location per load. This information will be factory loaded and the user can choose to easily add or remove documents in the field. Having all the wiring diagrams in one location on a large screen makes troubleshooting easy as drawings will never get lost or be unreadable.

Maintenance Minder is used to keep track of routine and scheduled maintenance needed for all the devices in the MCC. This will let the user know when a breaker needs to be tripped per PM, how many cycles a contactor has used and when to order new contacts, and other preventive maintenance functions.

The alarm view will show all alarms and user-defined events that occur. From this view, the user can acknowledge and also Prado the alarms or events to assist in troubleshooting and operating the equipment more efficiently.



Elevation View *Oneline View*

Figure 29.1-4. Power Xpert Smart Gear

PLCs

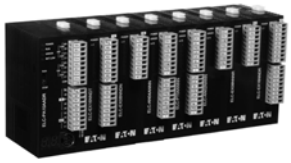
Programmable controllers can be mounted in all styles of the Eaton MCCs in a wide variety of configurations. Popular mounting configurations include small PLCs (EZ) unit mounted to replace relays and timers, medium-sized PLCs with I/O for control of an MCC lineup and also fieldbus mastering capabilities to control over DeviceNet, Modbus or Modbus TCP. Due to the flexibility of PLCs and the wide variety of applications and configurations, the Eaton MCC is designed to meet the mounting requirements of most applications to control not only the MCC but also auxiliary equipment not in the MCC.

EZ PLC

EZ PLC

The EZ PLC is a timer and relay replacer capable of being mounted directly inside the MCC bucket and controlling starters or other types of process equipment. This small PLC comes in styles that have AC or DC I/O and analog I/O, and also the ability to expand the I/O for larger I/O counts. From the face of the EZ, a user can change set points and count values or other program values to easily manipulate the process it is controlling.

ELC PLC



ELC PLC

Flexibility—Handle I/O counts from 10 I/O up to 256 I/O using a single controller. ELCs eliminate the process of counting I/O and deciding which controller to use, as modules can easily be added and removed as needed. ELC modules come in many flavors of I/O from modules containing 4 in/4 out to modules containing 8 in/8 out. ELC controllers and modules mount to a DIN rail, and the modules are added by simply snapping them into the mating connectors and closing the attached locks.

Large PLC Features—Include the feature set of larger PLCs such as multiple communication ports, remote I/O, data storage, high-speed counters, high-speed pulse outputs, interrupts, timer resolution to 1 ms, PID, plus much more. The ELC also has mastering capabilities to control DeviceNet, Modbus and Modbus TCP slaves over an industrial network.

Power of One—Regardless of the level of integration needed, Eaton MCCs provide an easy and comprehensive solution to be part of a larger system or be the entire system all by itself. The Power Xpert gateway allows for seamless integration into the Power Xpert architecture, linking switchgear, meters and medium voltage assemblies. When the MCC is the control, integrating the ELC with one of the Eaton operator interface units and communicating to starters, drives, soft starts, meters and feeder breakers is integrated into a clean, easy-to-use solution.

Monitoring and Configuration Tools

For all the advanced MCC choices, a tool is available to allow for configuration and monitoring of the MCC and its devices. The complimentary tool located at www.eaton.com is called CH Studio, and is a Windows-based configuration and monitoring package.

CH Studio allows the user to custom configure I/O data for the starters and drives, to verify loads and configuration parameters, and to view the faults and operation status of the end devices. In addition to this, CH Studio is also able to print out a detailed report for the system programmer to use with designing their program. To get an early start on the system design, CH Studio provided the ability to create the system offline and then synchronize the offline settings to the online system once the MCC arrives.

Clean Control Center with Active Harmonic Control—Typical Layout

The layout to the right is a typical arrangement for Eaton's Clean Control Center including harmonic correction units for nonlinear loads such as AC Variable Frequency Drives. The horizontal bus of the Clean Control Center is virtually free of harmonic current content at the point where the harmonic correction unit connects to the bus. From this point to the connection at the utility bus, the Clean Control Center complies with the most stringent requirements of IEEE® 519 and provides a clean waveform to the upstream distribution system. Harmonic correction may be applied to loads fed directly from the MCC (e.g., MCC mounted AC drives) or loads fed indirectly from the MCC (e.g., MCC mounted circuit breakers feeding remote drives). Multiple correction units may be used to achieve the level of harmonic correction as required by the amount of nonlinear loads within the MCC lineup.

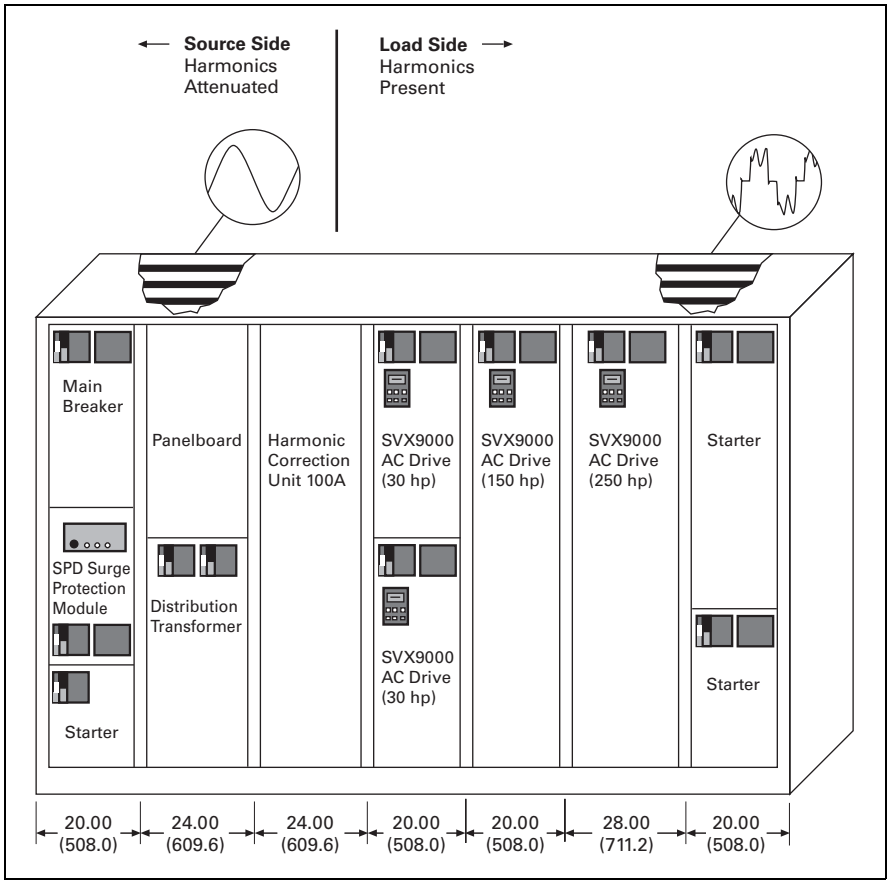


Figure 29.1-5. Clean Control Center with Active Harmonic Control—Dimensions in Inches (mm)

Note: As seen by the upstream electrical system—compliance to the most stringent standards of IEEE 519 is ensured.

Harmonic Correction

The Clean Control Center uses a harmonic correction unit to provide harmonic cancellation directly on the motor control center horizontal bus. The harmonic correction unit senses the load current and injects into the AC lines a synthesized waveform that is inverted compared to the remaining signal. The result is a clean waveform as seen by the upstream electrical system. Single or multiple harmonic correction units may be applied within a Clean Control Center providing an economical solution to excessive harmonics due to AC drives or other nonlinear loads. Use of the Clean Control Center will provide compliance to the most stringent 5% Total Demand Distortion (TDD) requirements of IEEE 519. Clean Control Center assemblies include a 24.00-inch (609.6 mm) wide MCC structure, active harmonic correction unit, current transformers and a door-mounted digital interface panel.

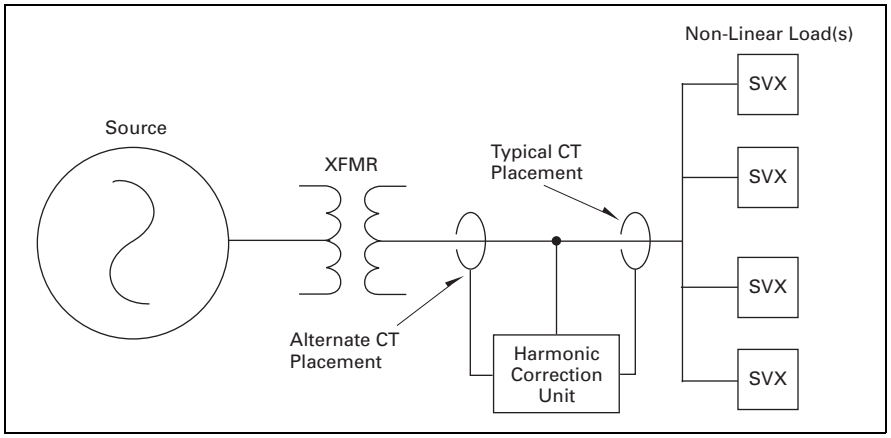
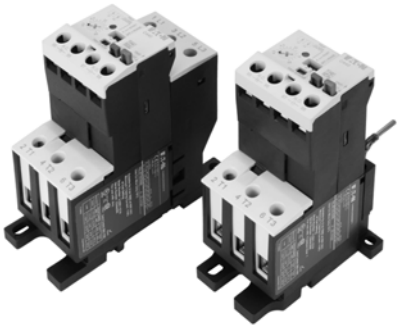


Figure 29.1-6. Clean Control Center Installation Diagram

Solid-State Motor Protection



C440/XT Electronic Overload Relay

Eaton's C440 and C441 solid-state overload relay offers improved motor protection due to high repeat accuracy and fast reaction times to phase failures. The state-of-the-art microelectronics design permits the choice of relays with different trip classes (Class 5, 10, 20, 30) to accommodate motors with a variety of application needs.

The C440 solid-state overloads are available on all Freedom starter sizes. (Size 5 and up use CTs with the overload relay.) Key features include:

- Phase loss
- Phase imbalance
- Wide adjustment range
- Low energy usage
- Reduced heat

With the simple addition of a communication module, the C440 is capable of communicating to one of the following industrial field busses: DeviceNet, Modbus RTU, PROFIBUS, EtherNet/IP or Modbus TCP.

C441 Overload Relays

The C441 Motor Insight® is a microprocessor-based solid-state overload relay providing superior motor protection, communications and motor monitoring features. This overload provides the standard set of protections that includes I^2t, jam, stall and phase protections. The C441 also provides ground fault, phase reversal, voltage unbalance, programmable trip class, trip history, thermal capacity, power factor and voltage, current and power monitoring. With the simple addition of a communication module, the C441 is capable of communicating to one of the following industrial field busses: DeviceNet, Modbus RTU, PROFIBUS, EtherNet/IP or Modbus TCP.

Key features of C441 Motor Insight communicating overloads include:

- DeviceNet, Modbus, PROFIBUS and Ethernet communication options
- Three-phase voltage monitoring
- Three-phase current monitoring
- kWh usage indication
- Motor power factor indication
- Last four faults history
- Optional remote mounted display
- I/O communication adapter with four inputs and two outputs
- Programmable set points, including:
  - Low voltage set point
  - High voltage set point
  - Voltage unbalance set point
  - CT multiplier/ratio settings
  - Overcurrent set point
  - Current unbalance trip point
  - Trip Class (5, 10, 15, 20, 30, and/or Jam)
  - Rapid cycle timer
  - Restart delay timer
  - Underload restart delay timer
  - Number of restarts after faults (Manual/Auto)
  - Undercurrent trip delay
  - Ground fault trip set point

EMR 3000 Relay

The EMR 3000 motor overcurrent relay is a microprocessor-based relay that provides superior motor protection for critical process motors. Standard protective features provided in the EMR 3000 include: I^2t, programmable locked rotor protection, instantaneous overcurrent, ground fault, under load, jam, phase loss/unbalance/reversal, limit starts per hour, alarm and trip modes, and the capability to use motor RTD for motor protection. Functions are user programmable via local or remote data entry and display panel mounted in the door of the MCC. For further details, refer to **Tab 4**.

EMR 4000 Relay

The EMR 4000 motor overload relay provides a higher level in motor protection. In addition to all the protective features included in the EMR 3000, the EMR 4000 also includes voltage-based protection/metering as well: undervoltage, negative sequence, power factor, overvoltage, over/under frequency and forward/reverse power. For further details, refer to **Tab 4**.

Additional Services

Startup Assistance

To ensure complete customer satisfaction and to expedite equipment startup for motor control centers, this service provides a factory-trained representative at the job site during equipment energization. This service is provided on a fixed price basis. In addition to factory directed startup, the standard equipment warranty is extended for a period of 24 months. This service is especially beneficial when solid-state equipment is incorporated within the MCC due to the flexibility in adjusting solid-state equipment for each application.

Maintenance and Operational Training

A full range of training and operational training programs are available for all types of MCC-mounted equipment. In addition, preventative maintenance programs are available to ensure years of trouble-free operation.

Retrofits

Existing installations can many times benefit from some of the "new" technology equipment available in today's MCCs. Eaton offers a full range of retrofit capabilities to upgrade existing MCC lineups. Examples include: vacuum contactors, reduced voltage solid-state starters, solid-state metering and solid-state overload protection. Starter retrofit kits for selective competitor MCCs are also available. Consult factory for availability.

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Standard Structures and Structure Options

The standard Freedom, Freedom Arc and Freedom FlashGard structure is NEMA 1, gasketed, 90.00 inches (2286.0 mm) high, 20.00 inches (508.0 mm) wide with a depth as shown in **Figure 29.2-1**. Each standard structure has a 9.00-inch (228.6 mm) high horizontal wireway at the top and at the bottom and a 4.00-inch (101.6 mm) wide full height vertical wireway at the right. All wireway doors are hinged and secured with 1/4-turn latches. The standard busing is 600 A, UL rated, copper horizontal bus and 300 A, UL rated, copper vertical bus braced for 65,000 symmetrical amperes. Many other bus sizes and types are available. Also included as standard is a vertical bus isolation barrier.

Table 29.2-1. Standard Structures and Structure Options—Dimensions in Inches (mm) ①

Description	
Standard Structures	
16.00 (406.4) deep structure ②	Structure 1
21.00 (533.4) deep structure	
Front mounting only	Structure 2
Front and rear mounting ②	Structure 3
4.00 (101.6) of additional structure width, 32.00 (812.8) maximum ②	
8.00 (203.2) vertical wireway in lieu of standard 4.00-inch (101.6)	
Special Structures	
Single corner section for "L" configuration of MCC	
Transition section ②	
Series 2100 to Type W	
10.00 (254.0) wide—front aligned	
Plug-in blank relay mounting space, per 6-inch	Any 6.00 (152.4) height
Fixed-mounted relay back pan, full depth of structure	
20.00 (508.0) structure with wireway	13.00 (330.2) with usable panel
24.00 (609.6) structure with wireway	17.00 (431.8) with usable panel
28.00 (711.2) structure with wireway	21.00 (533.4) with usable panel
20.00 (508.0) structure without wireway	17.00 (431.8) with usable panel
24.00 (609.6) structure without wireway	21.00 (533.4) with usable panel
28.00 (711.2) structure without wireway	25.00 (635.0) with usable panel
32.00 (812.8) with double door ②	
36.00 (914.4) with double door ②	
40.00 (1016.0) with double door ②	
Relay Structures	
(per complete structure with full fixed mounting back pan)	
20.00 (508.0) structure with wireway	Complete section
24.00 (609.6) structure with wireway	Complete section
28.00 (711.2) structure with wireway	Complete section
20.00 (508.0) structure without wireway	Complete section
24.00 (609.6) structure without wireway	Complete section
28.00 (711.2) structure without wireway	Complete section
Plexiglass see-through door insert for PLC structure	6.00 (152.4) increments
19.00 (482.6) instrumentation mounting racks installed in relay structure	Consult Eaton

① This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.

② Not available in Freedom Arc.

Table 29.2-2. Structure Modifications—Dimensions in Inches (mm) ③

Channel floor sills: 11-gauge, 1.00 x 3.00 (25.4 x 76.2)
NEMA 1 gasket
NEMA 12 dust-proof, includes bottom plate ④
Bottom plate for NEMA 1 gasketed enclosure
150-watt space heater, per structure
Thermostat for space heater control
Pullbox kit for cable and wiring to be field mounted on top structure ④
12.00 (304.8) high
18.00 (457.2) high
24.00 (609.6) high
Rear hinged structure door, 72.00 (1828.8) high ④
NEMA 2 drip shield on top of MCC ④
NEMA 3R non-walk-in—front-mounted, back-to-back ④
NEMA 3R walk-in aisle-front mounted ④
NEMA 3R walk-in tunnel type ④
NEMA 4X—consult factory ④
Special reduced height structures ④
Seismic certification (earthquake qualification)
UL handle extension ⑤

③ This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.

④ Not available in Freedom Arc.

⑤ The standard Freedom, Freedom Arc and Freedom FlashGard Series structure is designed to comply with the UL 2-meter requirement. Disconnect operating handle is not more than 2 meters [78.00 inches (1981.2 mm)] above the bottom of the MCC. Motor control centers elevated on a raised pad or installed on unembedded channel sills may require operator handle extensions for the uppermost operators. UL handle extension optionally available when required.

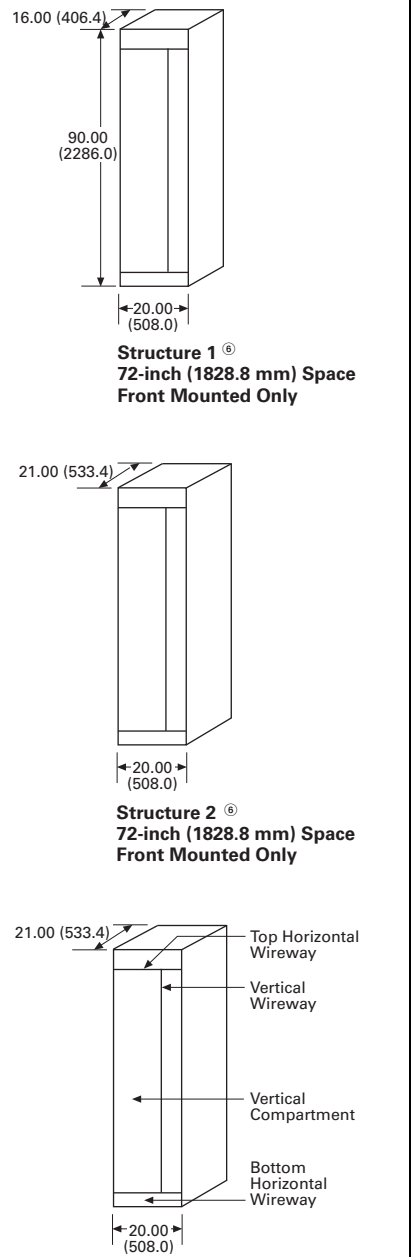


Figure 29.2-1. Structure—Dimensions in Inches (mm)

⑥ The standard Freedom Series structure is designed to comply with the UL 2-meter requirement. Disconnect operating handle is not more than 2 meters [78.00 inches (1981.2 mm)] above the bottom of the MCC. Motor control centers elevated on a raised pad or installed on unembedded channel sills may require operator handle extensions for the uppermost operators. UL handle extension optionally available when required.

29

Table 29.2-3. Bus Modifications—Dimensions in Inches (mm) ①

Eaton's Freedom Series MCCs bear the UL label. Service entrance labeling is available.

Description			
Main Bus, Per Vertical Structure			**Cu—Tin-Plated (Standard)**
Copper Horizontal Bus Ratings Tin-Plated	**50 °C**	**65 °C**	
600 A Size	0.25 x 2.00 (6.4 x 50.8)–Bars/Phase 1	0.25 x 2.00 (6.4 x 50.8)–Bars/Phase 1	—
800 A Size	0.25 x 3.00 (6.4 x 76.2)–Bars/Phase 1	0.25 x 2.00 (6.4 x 50.8)–Bars/Phase 1	—
1200 A Size	0.25 x 2.50 (6.4 x 63.5)–Bars/Phase 2	0.25 x 3.00 (6.4 x 76.2)–Bars/Phase 1	—
1600 A Size	0.25 x 3.00 (6.4 x 76.2)–Bars/Phase 4	0.25 x 3.00 (6.4 x 76.2)–Bars/Phase 2	21.00 (533.4) deep ③
2000 A Size	0.25 x 2.50 (6.4 x 63.5)–Bars/Phase 6	0.25 x 2.50 (6.4 x 63.5)–Bars/Phase 4	21.00 (533.4) deep ③
2500 A Size	0.25 x 3.00 (6.4 x 76.2)–Bars/Phase 8 ②	0.25 x 3.00 (6.4 x 76.2)–Bars/Phase 6	21.00 (533.4) deep ④
3200 A Size ②	N/A	0.25 x 3.00 (6.4 x 76.2)–Bars/Phase 8	21.00 (533.4) deep ④⑤
Silver-plated bus main horizontal bus			Optional
Insulated main horizontal bus, per vertical structure (taping)			Optional
Vertical bus, per vertical structure: 300 A—copper (tin-plated)			Standard ⑥
Increased bus capacity: rated at 600 A (front-mounted only)			Cu only
Rated at 600 A (back-to-back)—copper			Standard
Rated at 800 A (back-to-back and front)			Cu only
Rated at 1200 A			Cu only
Increased mechanical bus bracing, per vertical structure:			
42,000 A rms symmetrical short-circuit current			Optional
65,000 A rms symmetrical short-circuit current			Standard
100,000 A rms symmetrical short-circuit current ②			Optional
Vertical bus isolation barrier, per vertical structure			Standard
Labyrinth design insulation-isolation vertical bus barrier			Optional Freedom
Ground bus, 300 A standard, per vertical structure			Standard Cu
Increased capacity ground bus only, 600 A, 1/4- x 2.00-inch (6.4 x 50.8 mm), per vertical structure			Standard Cu
FlashGard plug-in grounding system, includes 300 A vertical ground bus and unit grounding clips, per vertical structure			Cu
Neutral bus, ungrounded for three-phase, four-wire power, per vertical structure ⑦			Cu
Splice plates			—

① This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.
② Not available in Freedom Arc.
③ Requires 21.00-inch (533.4 mm) deep structure.
④ Requires 21.00-inch (533.4 mm) deep structure. Not available in back-to-back structure.
⑤ Contact Eaton for 3200 A dimensions.
⑥ Vertical bus and unit stabs are tin-plated copper only.
⑦ Neutral is half-rating of horizontal bus.

Table 29.2-4. Main Lugs Only—Mechanical Lug Compartment (Three-Phase, Three- or Four-wire)—Dimensions in Inches (mm) ⑧

Provisions for terminating incoming line cables directly onto the MCC bus system. Up to 1200 A, all lug landings are bolted to a fully rated vertical bus in that section. MLO sections must be put at the top for top entry cables and at the bottom for bottom entry cables. For smaller cable sizes, cable lugs may also be extended into an optional top hat as shown in this table.

Maximum Cable Size (kcmil)	Bus Rating (Amperes)	Maximum Cables per Phase	Cable Entry (Top or Bottom)	Lug Type	Unit Space	X Space ⑨	Enclosure Width
350	600	2	—	Screw Crimp	12.00 (304.8) 18.00 (457.2)	2X 3X	20.00 (508.0)
		4	Top Bottom	Screw Screw Crimp	18.00 (457.2) 24.00 (609.6) 36.00 (914.4)	3X 4X 6X	
			18.00-inch (457.2 mm) top hat	Either	—	—	
600	800	2	—	Screw Crimp	18.00 (457.2) 24.00 (609.6)	3X 4X	
		4	—	Screw Crimp	24.00 (609.6) 36.00 (914.4)	4X 6X	
			18.00-inch (457.2 mm) top hat	Either	—	—	
750	1000	2 2 4 4	—	Screw Crimp Screw Crimp	24.00 (609.6) 36.00 (914.4) 36.00 (914.4) 48.00 (1219.2)	4X 6X 6X 8X	
1000	1200	2	—	Screw Crimp	30.00 (762.0) 36.00 (914.4)	5X 6X	
1000	1600	8	—	Screw Crimp	72.00 (1828.8) ⑩ 72.00 (1828.8) ⑩	12X 12X	
1000	2500	8	—	Screw Crimp	72.00 (1828.8) ⑩ 72.00 (1828.8) ⑩	12X 12X	
	3200	—	—	Screw Crimp	72.00 (1828.8) ⑩ 72.00 (1828.8) ⑩	12X 12X	

⑧ This table is common for the Freedom and Freedom FlashGard. Freedom Arc Resistant does not contain an MLO option.
⑨ Requires 6.00-inch (152.4 mm) = (1X) unit space.
⑩ Lug landings require the complete vertical section. The rear is unusable.

Bus Duct Entry Sandwich Type to Horizontal Bus or Main Disconnect—Pull Box

Pull box and pre-fabricated bus connectors are supplied to match the sandwich type bus duct end flange. Bus duct is assumed to enter the top. Bus duct type and orientation to the MCC must be provided.

Table 29.2-5. Bus Duct Entry to Horizontal Bus or Main Disconnect—Pull Box—Dimensions in Inches (mm) ①

Horizontal Bus Rating (Amperes)	Pull Box Height
600–1600	18.00 (457.2)
2000–2500 ②	24.00 (609.6)

① This table is common for both Freedom and Freedom FlashGard MCCs; Freedom Arc does not have this option.
② Contact Eaton for 3200 A dimensions.

Note: Consult factory for non-segregated bus requirements.

Table 29.2-6. Typical Heat Loss Data ③

Description	Current (A)	Loss (W)
Vertical Sections Horizontal Bus and Ampacity	**600**	**200**
	800	**300**
	1200	**500**
	1600	**700**
	2000	**1000**
	2500	**1400**
	3200	**2050**

Space Heaters	Loss (W)
Space heaters	500

	Loss (W)	
Starters	C306	C440/C441
FVNR size 1	40	30
FVNR size 2	60	50
FVNR size 3	100	90
FVNR size 4	130	120
FVNR size 5	230	220
FNVR size 6	400	390

AFDs			
SVX	DG1	hp (VT)	Loss (W)
FR4	FR1	7.5	140
FR5	FR2	20	400
FR6	FR3	40	800
FR7	FR4	75	1400
FR8	FR4	150	2800
FR9	—	250	4000
FR10	—	400	6250

Power Breakers	Amps	Loss (W)
MDN-608 (Fixed)	800	45
MDN-612 (Fixed)	1200	110
MDN-616 (Fixed)	1600	180
MDS-C08 (Drawout)	800	60
MDS-C16 (Drawout)	1600	240
MDS-C20 (Drawout)	2000	380
MDS-C32 (Drawout)	3200	800

Series C Molded Case Breakers	Amps	Loss (W)
FD	150	60
KD	400	175
LD	600	225
ND	800	87
ND	1200	210
RK	1600	220
RD	2000	270
RD	2500	400

Series G Molded Case Breakers	Amps	Loss (W)
EG	125	50
JG	250	75
LG	600	225
NG	800	87
NG	1200	210
RG	1600	220
RG	2000	270
RG	2500	400

③ The starters are using the C306 bi-metal overload relay.

29

Table 29.2-7. Typical Weights in lbs (kg) ①

Description	Weight
16.00-inch (406.4 mm) deep x 20.00-inch (508.0 mm) wide structure ②	200 (91)
21.00-inch (533.4 mm) deep x 20.00-inch (508.0 mm) wide structure ②	260 (118)
Adder for Horizontal Bus	
800 A	10 (5)
1000 A	15 (7)
1200 A	18 (8)
1600 A	24 (11)
2000 A	30 (14)
2500 A	38 (17)
3200 A	49 (22)
Adder for Vertical Bus	
600 A	30 (14)
800 A	40 (18)
1200 A	60 (27)
Adder for Units Freedom—Inches (mm)	
12.00 (304.8)	25 (11.4)
18.00 (457.2)	40 (18)
24.00 (609.6)	63 (29)
30.00 (762.0)	77 (35)
36.00 (914.4)	100 (45)

① Example: 21.00 inches deep NEMA 1, 2000 A horizontal bus, 600 A vertical bus, two Size 1 starters, one Size 3 starter. 260 + 30 + 30 + (2 x 25) + 40 = 410 lbs

② Weight for NEMA 1 structure with 600 A horizontal and 300 A vertical bus.

Table 29.2-8. Control Power Transformer Data ③

All control power transformers are encapsulated and will deliver rated secondary voltage at full load. Two primary and one secondary fuses are furnished as standard.

NEMA Size Starter	Starter Type	Freedom	
		Standard VA Rating	Maximum ④ VA Rating
Size 1	Full voltage non-reversing and reversing	100	150
Size 1 ⑤		100	100
Size 2		100	150
Size 2 ⑤		N/A	N/A
Size 3		150	250
Size 4		200	250
Size 5		200	350
Size 6		150	250
Size 2	Autotransformer	100	150
Size 3		150	250
Size 4		200	250
Size 5		250	350
Size 6		200	350
Size 1	Two-speed One winding	100	200
Size 2		100	200
Size 3		200	250
Size 4		350	500
Size 5		350	500
Size 6		200	350
Size 1	Two-speed Two winding	100	150
Size 2		100	150
Size 3		150	250
Size 4		200	250
Size 5		200	250
Size 6		200	350
Size 1	Part winding	150	150
Size 2		150	150
Size 3		200	250
Size 4		350	500
Size 5		350	500
Size 6		200	350
Size 2	Wye delta (open or closed transition)	200	200
Size 3		350	200
Size 4		350	500
Size 5		200	500
Size 6		200	350

③ This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.

④ Maximum size without increasing starter space.

⑤ 6.00-inch (152.4 mm) unit.

Motor Protection

In line with 2005 NEC 430.6(A) circuit breaker, HMCP and fuse rating selections are based on full load currents for induction motors running at speeds normal for belted motors and motors with normal torque characteristics using data taken from NEC Table 130.250 (three-phase). Actual motor nameplate ratings shall be used for selecting motor running overload protection. Motors built special for low speeds, high torque characteristics, special starting conditions and applications will require other considerations as defined in the application section of the NEC.

These additional considerations may require the use of a higher rated HMCP, or at least one with higher magnetic pickup settings.

Circuit breaker, HMCP and fuse ampere rating selections are in line with maximum rules given in NEC 430.52 and Table 430.250. Based on known characteristics of Eaton type breakers, specific units are recommended. The current ratings are no more than the maximum limits set by the NEC rules for motors with code letters F to V or without code letters. Motors with lower code letters will require further considerations.

In general, these selections were based on:

1. Ambient—Outside enclosure not more than 40 °C (104 °F).
2. Motor starting—Infrequent starting, stopping or reversing.
3. Motor accelerating time—10 seconds or less.
4. Locked rotor—Maximum 6 times motor FLA.

Type HMCP motor circuit protector may not set at more than 1300% of the motor full-load current to comply with NEC 430.52. (Except for NEMA Design B energy high-efficiency motors which can be set up to 1700%.)

Circuit breaker selections are based on types with standard interrupting ratings. Higher interrupting rating types may be required to satisfy specific system application requirements.

For motor full load currents of 208 and 200 volts, increase the corresponding 230-volt motor values by 10 and 15% respectively.

Table 29.2-9. Motor Circuit Protector (MCP), Circuit Breaker and Fusible Switch Selection Guide

Horsepower	Full Load Amperes (NEC) FLA	Fuse Size NEC 430.52 Maximum Amperes		Circuit Breaker			
				Circuit Breaker		Motor Circuit Protector Type HMCP	
		Time Delay	Non-Time Delay	Amperes	Type	Amperes	Adj. Range
230 Volts, Three-Phase							
1	3.6	10	15	15	HFD	7	21–70
1-1/2	5.2	10	20	15	HFD	15	45–150
2	6.8	15	25	15	HFD	15	45–150
3	9.6	20	30	20	HFD	30	90–300
5	15.2	30	50	30	HFD	30	90–300
7-1/2	22	40	70	50	HFD	50	150–500
10	28	50	90	60	HFD	50	150–500
15	42	80	150	90	HFD	100	300–1000
20	54	100	175	100	HFD	100	300–1000
25	68	125	225	125	HFD	150	450–1500
30	80	150	250	150	HFD	150	450–1500
40	104	200	350	150	HFD	150	750–2500
50	130	250	400	200	HFD	150	750–2500
60	154	300	500	225	HFD	250	1250–2500
75	192	350	600	300	HKD	400	2000–4000
100	248	450	800	400	HKD	400	2000–4000
125	312	600	1000	500	HLD	600	1800–6000
150	360	700	1200	600	HLD	600	1800–6000
200	480	1000	1600	700	HND	600	1800–6000
460 Volts, Three-Phase							
1	1.8	6	6	15	HFD	7	21–70
1-1/2	2.6	6	10	15	HFD	7	21–70
2	3.4	6	15	15	HFD	7	21–70
3	4.8	10	15	15	HFD	15	45–150
15	7.6	15	25	15	HFD	15	45–150
7-1/2	11	20	35	25	HFD	30	90–300
10	14	25	45	35	HFD	30	90–300
15	21	40	70	45	HFD	50	150–500
20	27	50	90	50	HFD	50	150–500
25	34	60	110	70	HFD	70	210–700
30	40	70	125	70	HFD	100	300–1000
40	52	100	175	100	HFD	100	300–1000
50	65	125	200	110	HFD	150	450–1500
60	77	150	150	125	HFD	150	750–2500
75	96	175	300	150	HJD	150	750–2500
100	124	225	400	175	HJD	150	750–2500
125	156	300	500	225	HKD	400	2000–4000
150	180	350	600	250	HJD	400	2000–4000
200	240	450	800	350	L600	600	1800–6000
575 Volts, Three-Phase							
1	1.4	3	6	15	HFD	3	9–30
1-1/2	2.1	6	10	15	HFD	7	21–70
2	2.7	6	10	15	HFD	7	21–70
3	3.9	10	15	15	HFD	7	21–70
15	6.1	15	20	15	HFD	15	45–150
7-1/2	9	20	30	20	HFD	30	90–300
10	11	20	35	25	HFD	30	90–300
15	17	30	60	40	HFD	30	90–300
20	22	40	70	50	HFD	50	150–500
25	27	50	90	60	HFD	50	150–500
30	32	60	100	60	HFD	70	210–500
40	41	80	125	80	HFD	100	300–1000
50	52	100	175	100	HFD	100	300–1000
60	62	110	200	125	HFD	150	750–2500
75	77	150	250	150	HFD	150	750–2500
100	99	175	300	175	HJD	150	750–2500
125	125	225	400	200	HJD	250	1250–2500
150	144	300	450	225	HJD	250	1250–2500
200	192	350	600	300	HKD	400	2000–4000

29

Table 29.2-10. Starter Sizes Selection Guide ①

Squirrel-Cage Motor Horsepower	230 V, Three-Phase			460 V, Three-Phase			575 V, Three-Phase		
	Control Center Starter NEMA Size	Full Load ② Current Amperes	Wire Size ③ at 75 °C Max. at 40 °C Amb.	Control Center Starter NEMA Size	Full Load ② Current Amperes	Wire Size ③ at 75 °C Max. at 40 °C Amb.	Control Center Starter NEMA Size	Full Load ② Current Amperes	Wire Size ③ at 75 °C Max. at 40 °C Amb.
1/2	1	2.2	14	1	1.1	14	1	0.9	14
3/4	1	3.2	14	1	1.6	14	1	1.3	14
1	1	4.2	14	1	2.1	14	1	1.7	14
1-1/2	1	6.0	14	1	3.0	14	1	2.4	14
2	1	6.8	14	1	3.4	14	1	2.7	14
3	1	9.6	14	1	4.8	14	1	3.9	14
5	1	15.2	12	1	7.6	14	1	6.1	14
7-1/2	1	22	10	1	11	14	1	9	14
10	2	28	10	1	14	14	1	11	14
15	2	42	8	2	21	10	2	17	12
20	3	54	6	2	27	10	2	22	10
25	3	68	4	2	34	8	2	27	10
30	3	80	3	3	40	8	3	32	8
40	4	104	1	3	52	6	3	41	8
50	4	130	1/0	3	65	4	3	52	6
60	5	154	3/0	4	77	3	4	62	4
75	5	192	4/0	4	96	2	4	77	3
100	5	248	300 kcmil	4	124	1/0	4	99	2
125	6	312	500 kcmil	5	156	3/0	5	125	1/0
150	6	360	2–4/0	5	180	4/0	5	144	2/0
200	6	480	2–300 kcmil	5	240	300 kcmil	5	192	4/0
250 ④	—	—	—	6	302	500 kcmil	6	242	300 kcmil
300 ④	—	—	—	6	361	2–4/0	6	289	400 kcmil

① This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.

② Information is based on Table 430.150 of NEC (1999).

③ Information is based on use of copper conductors—Table 310.16 and Tables 1, 4 and 5, Ch. 9 of NEC. If aluminum conductors are used refer to Table 310.16 of NEC (1999).

④ Not available in Freedom Arc.

29

Dimensions in Inches (mm)

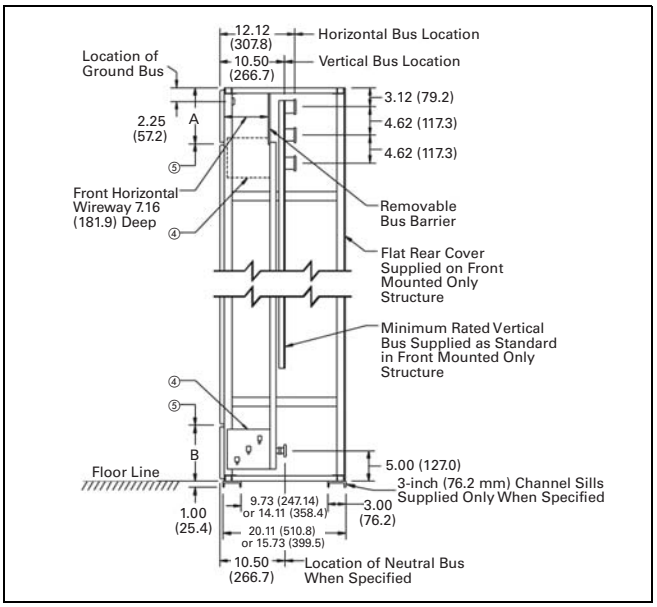


Figure 29.2-2. Side View A—Front Mounted Only

⑤ Master terminal block assembly furnished for Type C wiring only. When location not specified, MTB supplied at the bottom.

⑥ Standard structure arrangement in front
Without MTB; A and B = 9.00 inches (228.6 mm)
With MTB at bottom; A and B = 9.00 inches (228.6 mm)
With MTB at top; A = 15.00 inches (381.0 mm),
B = 3.00 inches (76.2 mm)

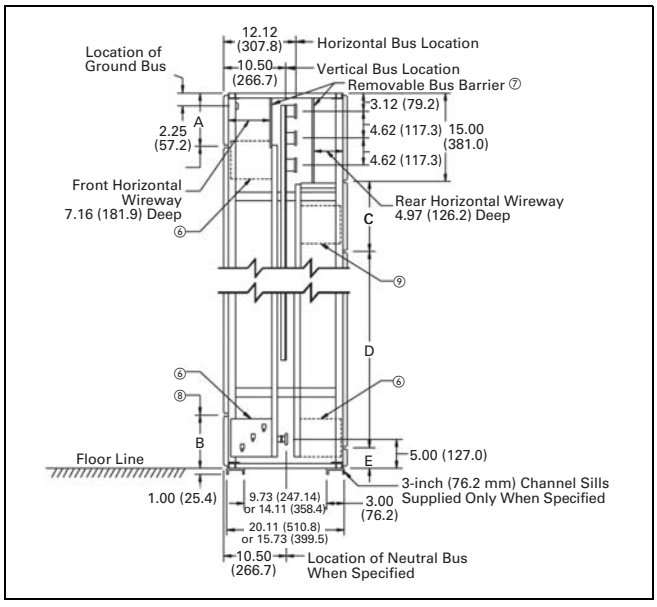


Figure 29.2-3. Side View B—Front and Rear Mounted

⑦ Master terminal block assembly furnished for Type C wiring only. When location not specified, MTB supplied at the bottom.

⑧ Rear horizontal bus barrier not supplied with front mounted only structure.

⑨ Standard structure arrangement in front
Without MTB; A and B = 9.00 inches (228.6 mm)
With MTB at bottom; A and B = 9.00 inches (228.6 mm)
With MTB at top; A = 15.00 inches (381.0 mm), B = 3.00 inches (76.2 mm)

⑩ Standard structure arrangement in rear
Without MTB; C = 9.00 inches (228.6 mm),
D = 72.00 inches (1828.8 mm), E = 3.00 inches (76.2 mm)
With MTB at bottom; C = 0, D = 66.00 inches (1676.4 mm),
E = 9.00 inches (228.6 mm)
With MTB at top; C = 12.00 inches (304.8 mm),
D = 60.00 inches (1524.0 mm), E = 3.00 inches (76.2 mm)

Not to be used for construction purposes unless approved.

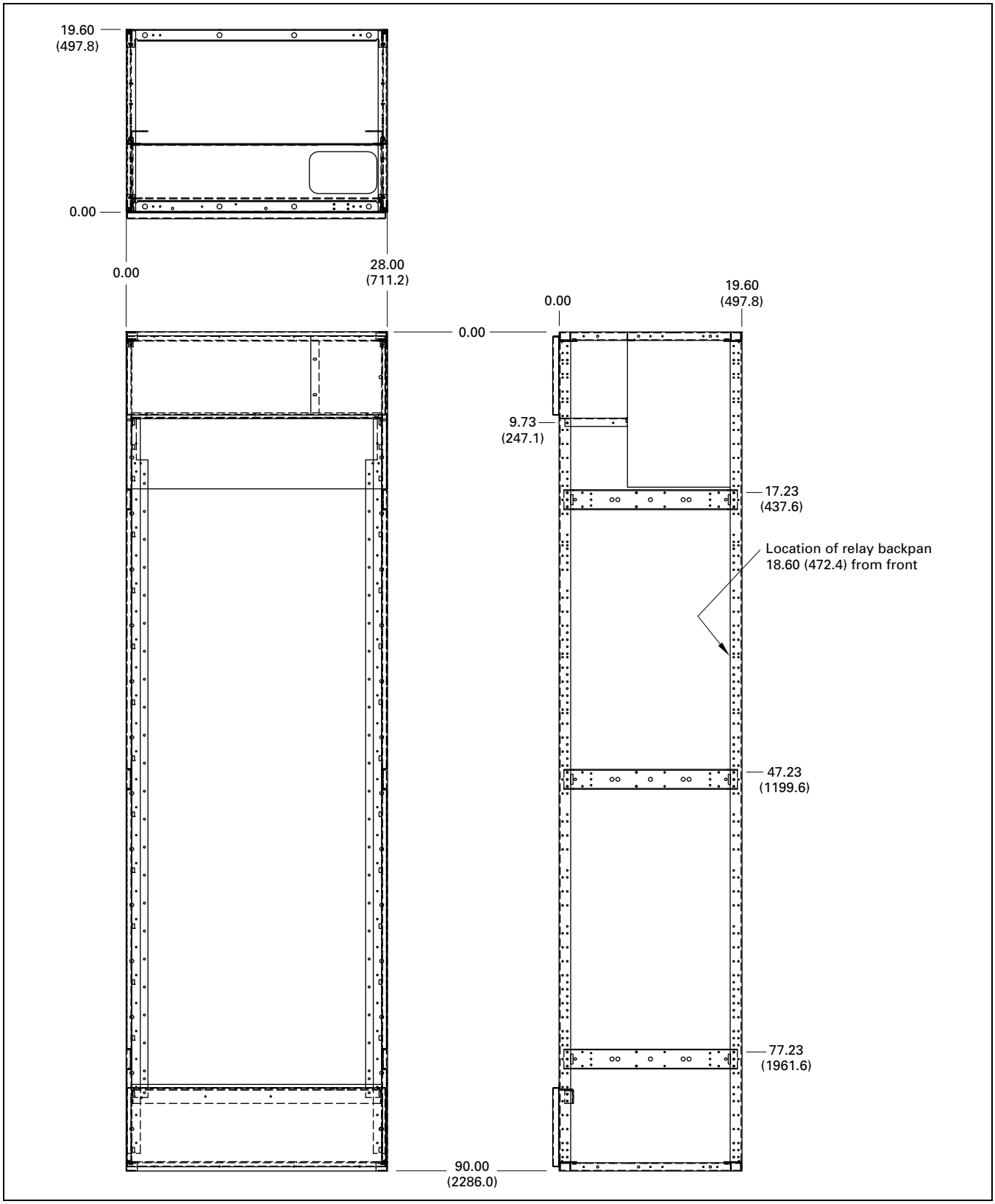


Figure 29.2-4. Relay Structure (28.00 inches [711.2 mm] wide and 20.00 inches [508.0 mm] deep shown)

Dimensions in Inches (mm)

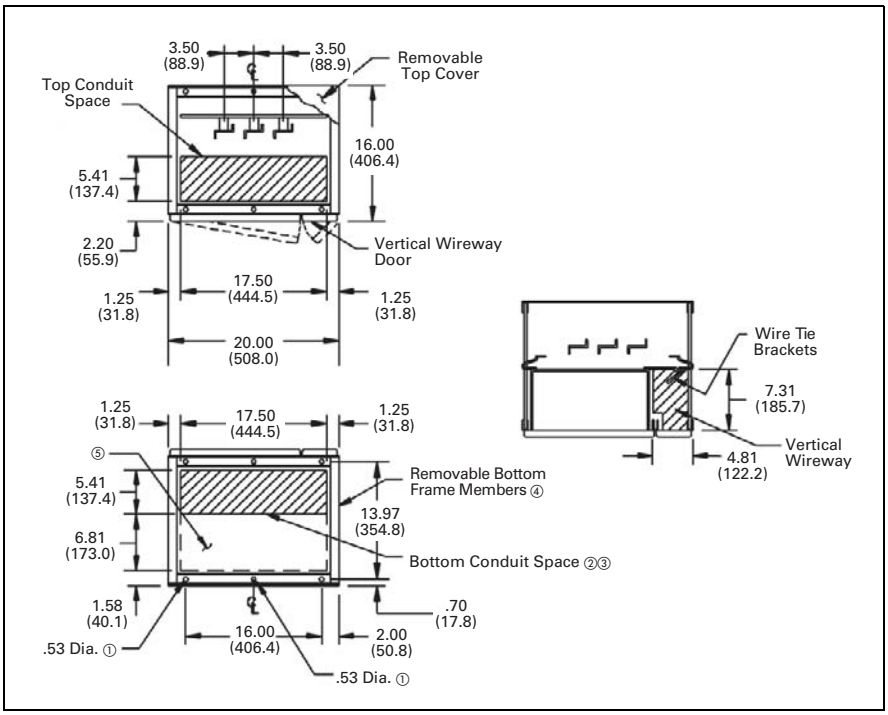


Figure 29.2-5. 20.00 Inches (508.0 mm) Wide, 16.00 Inches (406.4 mm)—Deep-Front Mounted Only (FMO)

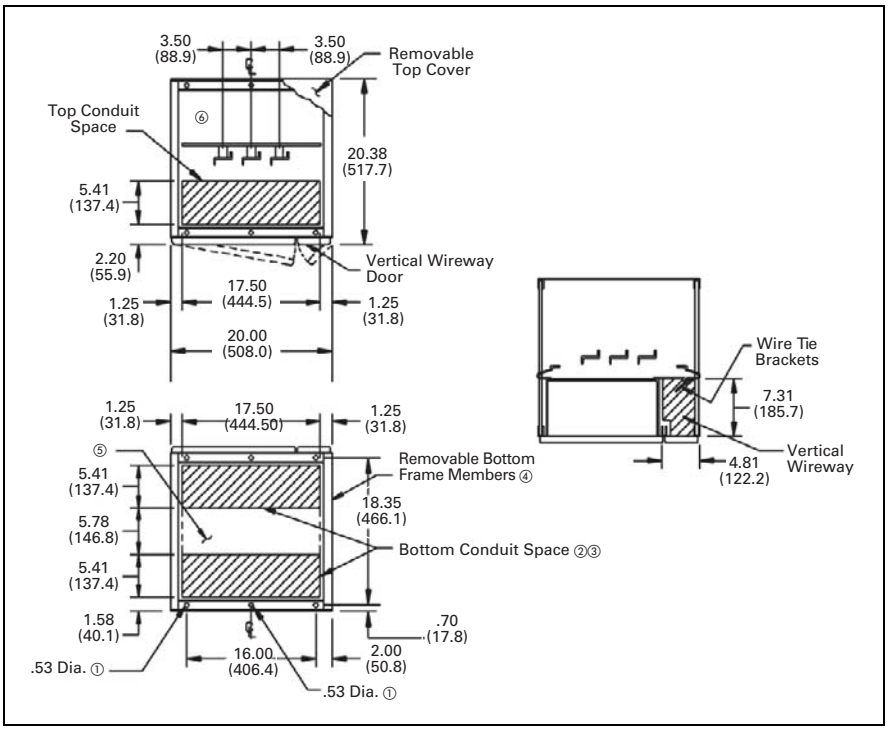


Figure 29.2-6. 20.00 Inches (508.0 mm) Wide, 21.00 Inches (533.4 mm)—Deep-Front Mounted Only (FMO)

① Minimum length of anchor bolt 2.00 inches (50.8 mm) 0.36 inches (9.1 mm)—16 recommended.
② Recommended maximum conduit height above floor line 3.50 inches (88.9 mm).
③ Maximum conduit space with channel sills 17.50 x 9.73 inches (444.5 x 247.1 mm).
④ For multiple structure assemblies. Either one or both of these members are removed to provide maximum unrestricted conduit space at bottom. Not to be removed for seismic.
⑤ This conduit space not recommended when neutral bus required. Otherwise available.
⑥ Top rear conduit space not recommended for conduit entry in FMO structure.

See Side View A **Page 29.2-6** for vertical dimensions.

Not to be used for construction purposes unless approved.

Dimensions in Inches (mm)

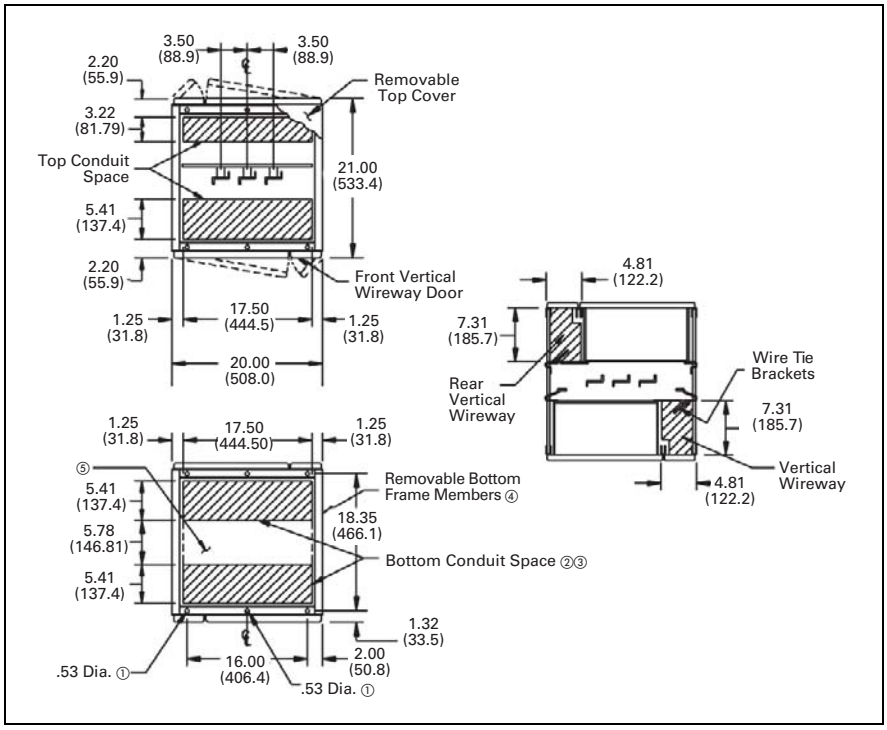


Figure 29.2-7. 20.00 Inches (508.0 mm) Wide, 21.00 Inches (533.4 mm) Deep—Front- and Rear-Mounted

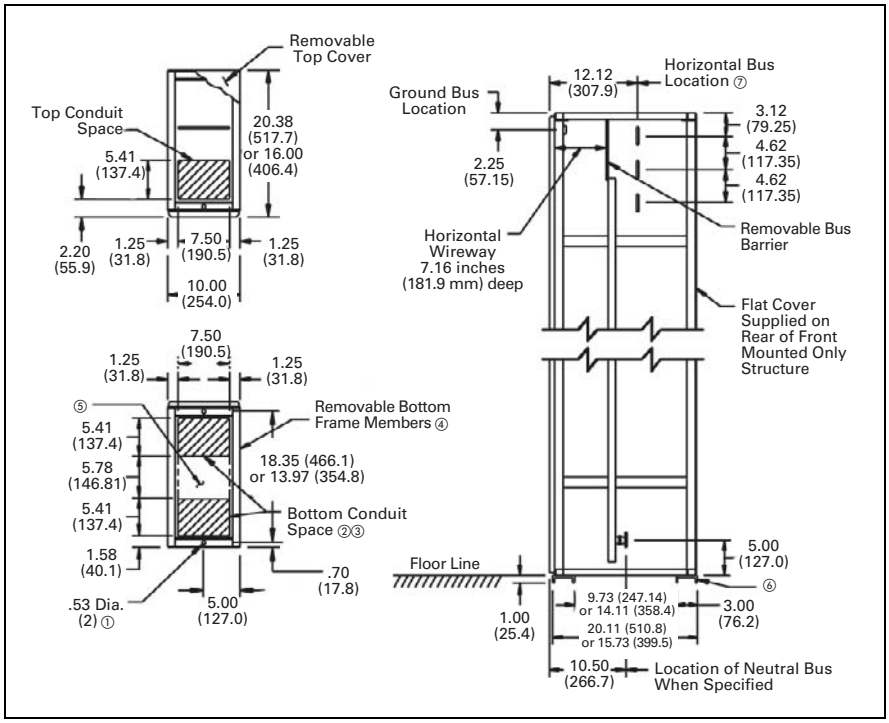


Figure 29.2-8. 10.00 Inches (254.0 mm) Wide, 16.00 or 21.00 Inches (406.4 or 533.4 mm) Deep—Transition Structure

① Minimum length of anchor bolt 2.00 inches (50.8 mm) 0.36 inches (9.1 mm)—16 recommended.
② Recommended maximum conduit height above floor line 3.50 inches (88.9 mm).
③ Maximum conduit space with channel sills 17.50 x 14.11 (444.5 x 358.4) in 21.00-inch (533.4 mm) deep structure. 7.50 x 9.73 inches (190.5 x 247.1 mm) in 16.00-inch (406.4 mm) deep structure.
④ For multiple structure assemblies. Either one or both of these members are removed to provide maximum unrestricted conduit space at bottom. Not to be removed for Seismic.
⑤ This conduit space not recommended when neutral bus required. Otherwise available.
⑥ Channel sills supplied only when specified. For seismic loads, channel sills if required must be embedded so top of channel sill is still at floor level.

See Side View B **Page 29.2-6** for vertical dimensions.

Not to be used for construction purposes unless approved.

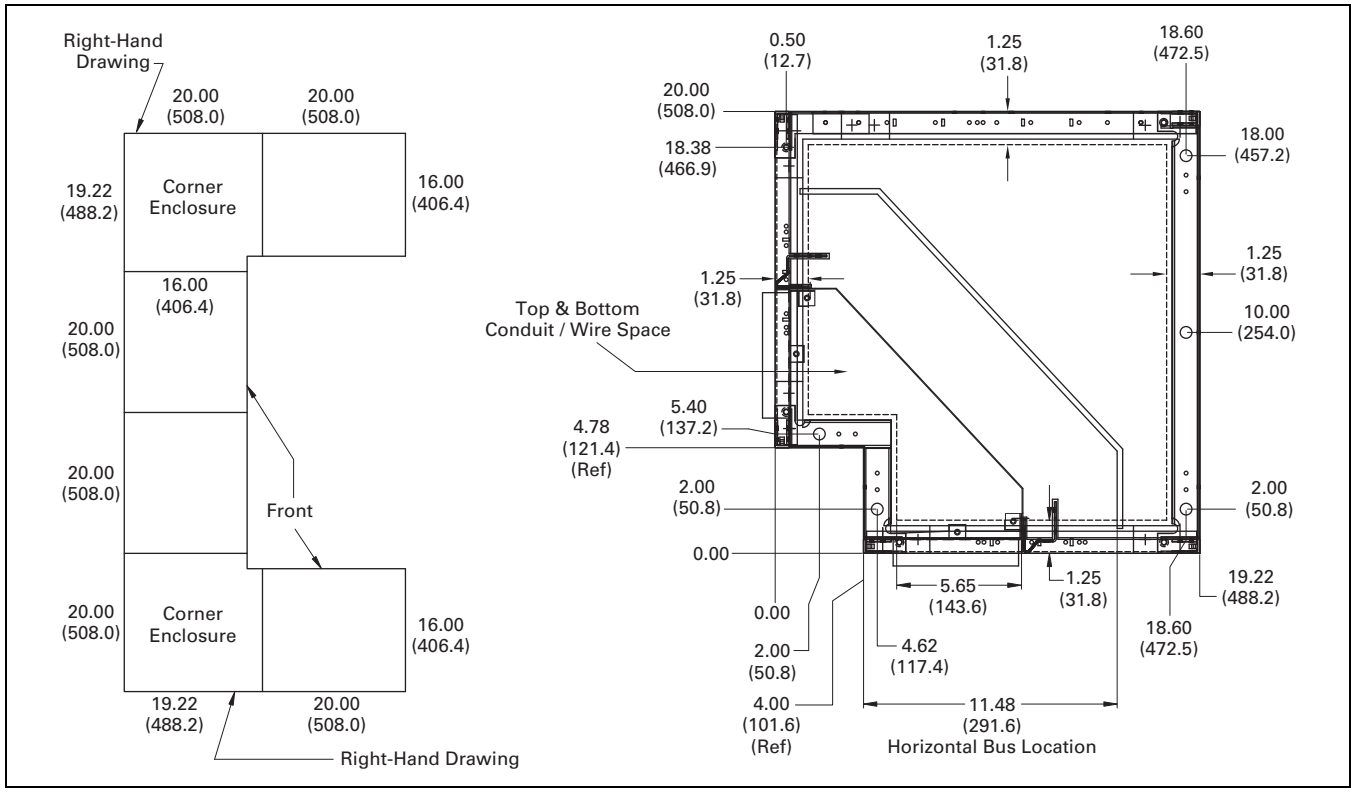


Figure 29.2-9. 16.00-Inch (406.4 mm) Deep—Front-Mounted Corner Structure (inside corner shown; consult factory for outside corner option)

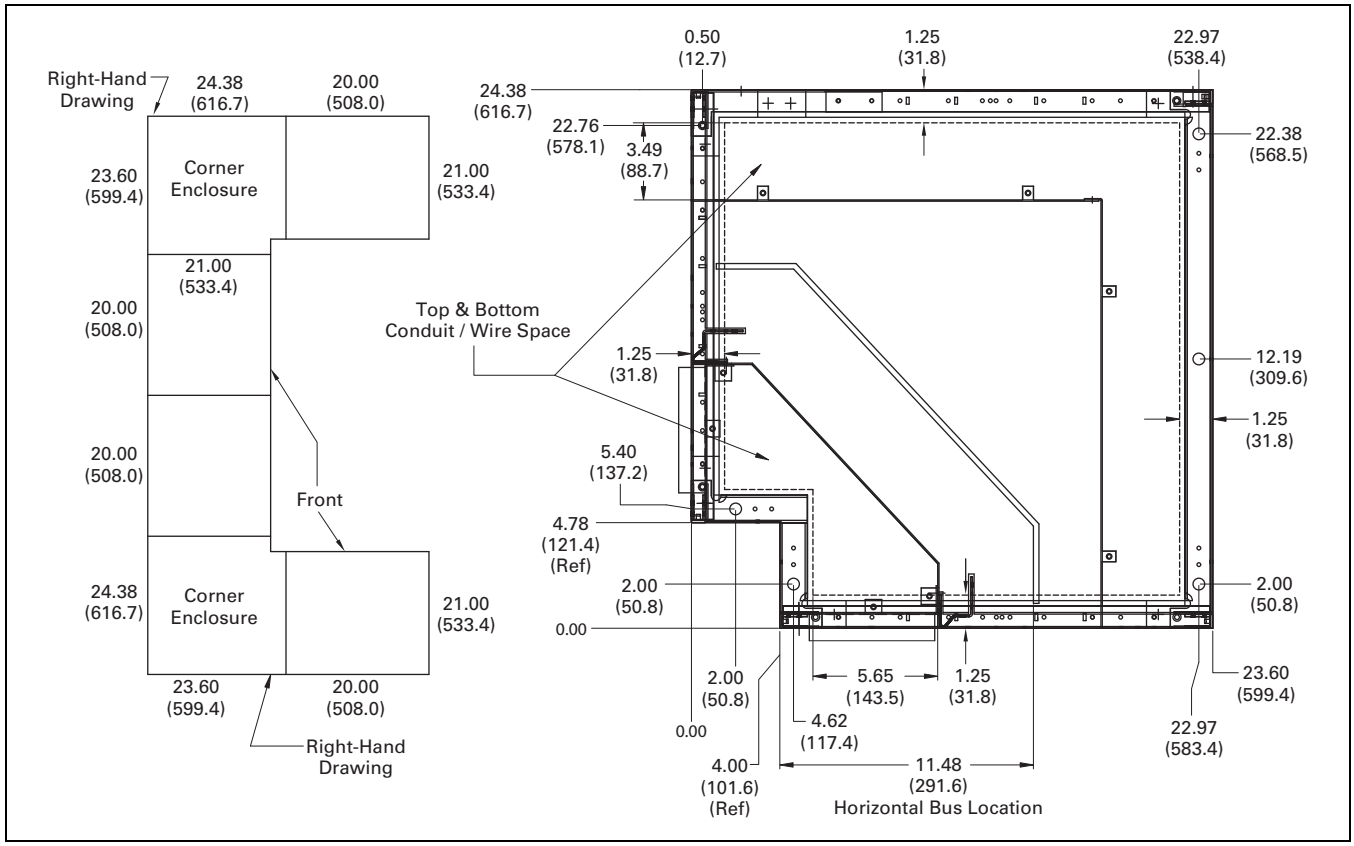


Figure 29.2-10. 21.00-Inch (533.4 mm) Deep—Front- and Rear-Mounted Corner Structure

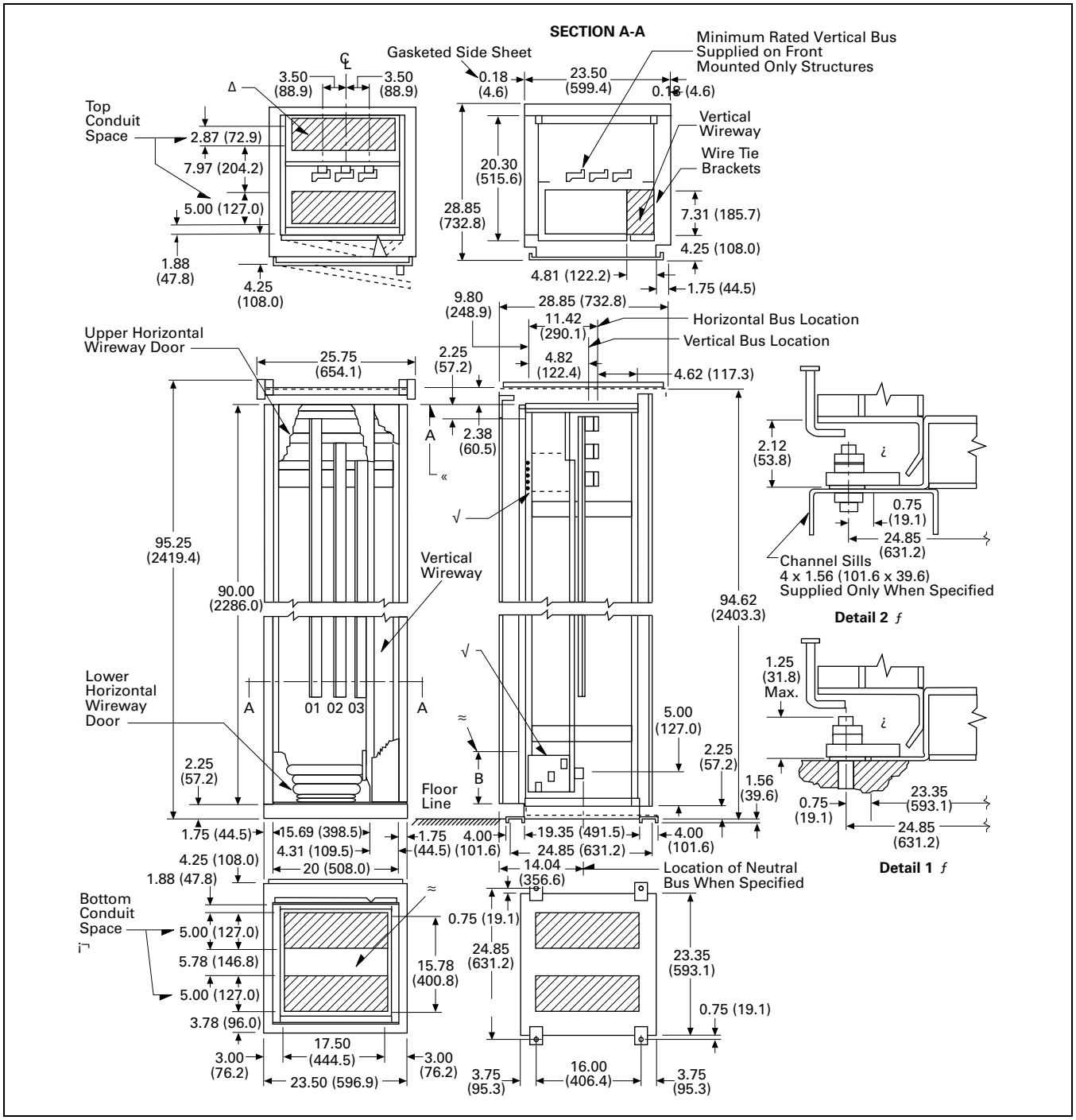


Figure 29.2-11. Freedom and Freedom FlashGard Motor Control Center Outline and Floor Plan NEMA 3R 28.85-Inch (732.8 mm) Deep Structure—Dimensions in Inches (mm)

① Minimum length of anchor bolt 2.00 inches (50.8 mm). 38.00 (9.7 mm)—16 recommended.
② Recommended maximum conduit height above floor line 3.50 inches (88.9 mm).
③ Maximum conduit space with channel sills 15.78 x 16.6 inches (400.8 x 421.6 mm).
④ Master terminal block assembly furnished for type "C" wiring only. When location not specified MTB supplied at the bottom.
⑤ Recommended standard anchor bolting for Detail 1. When channel sills are used, see Detail 2.
⑥ This conduit space is not recommended when neutral bus is required. Otherwise available.
⑦ Top rear conduit space is not recommended for conduit entry in front mounted only structure.
⑧ Standard structure arrangement (in front) without master terminal block, A and B—9.00 inches (228.6 mm). With master terminal block at bottom, A and B—9.00 inches (228.6 mm). With master terminal block at top: A—15.00 inches (381.0 mm), B—3.00 inches (76.2 mm).

Note: Rear horizontal bus barrier is not supplied with front-mounted only structure.

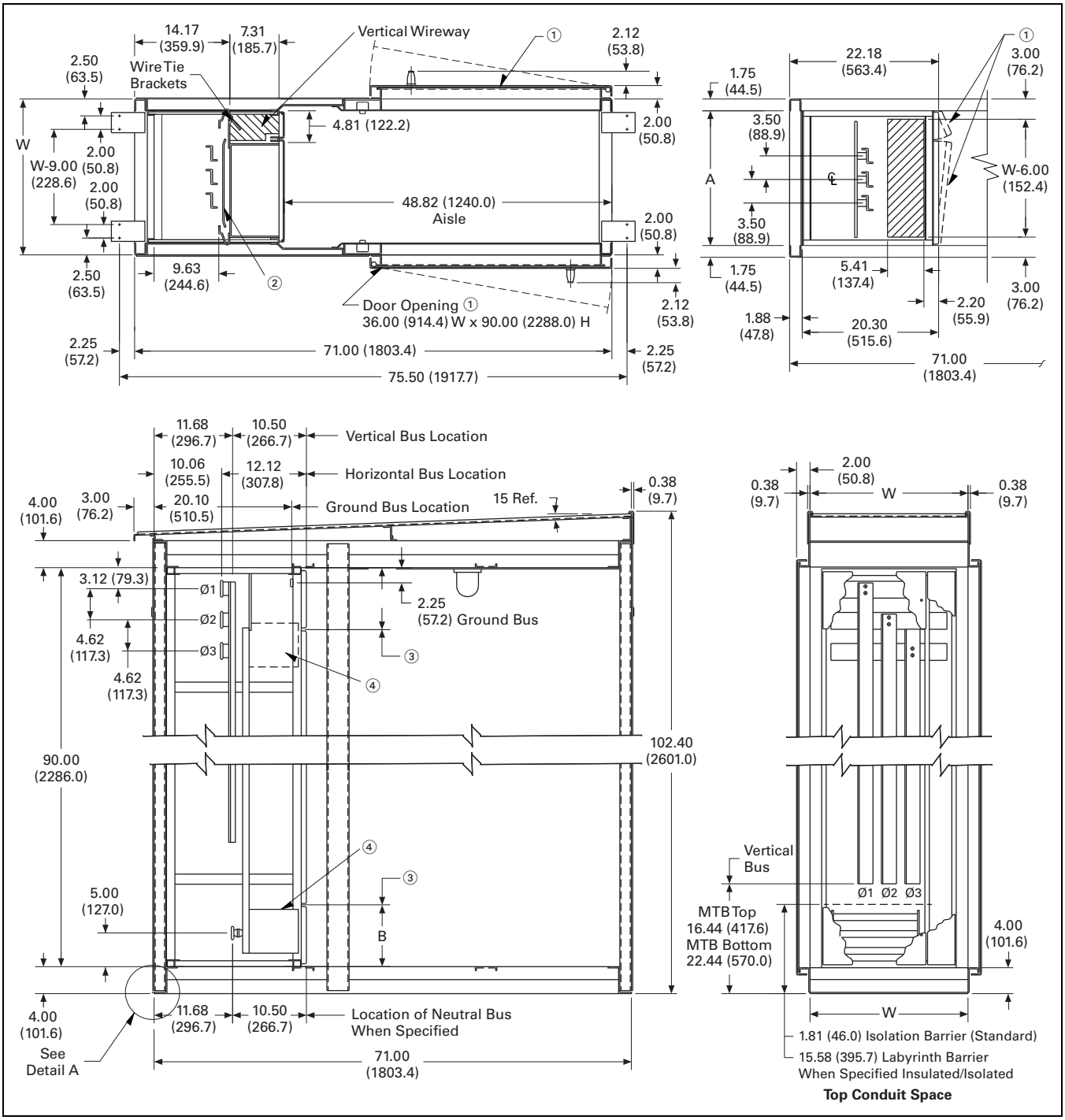
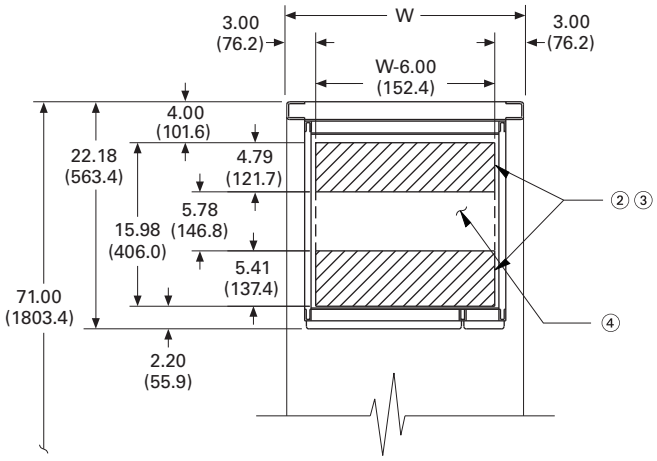


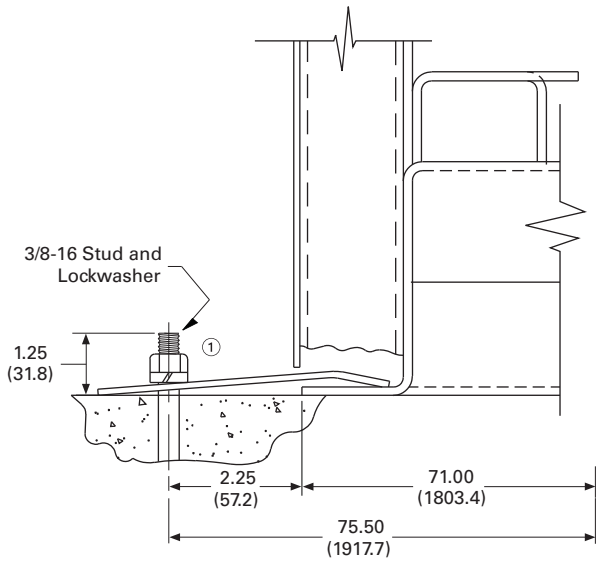
Figure 29.2-12. Freedom and Freedom FlashGard NEMA 3R Walk-In Aisle Structures—Dimensions in Inches (mm)

① All doors open minimum of 105°.
② Rear vertical bus barrier not supplied with front-mounted only structure.
③ Standard structure arrangement (in front) without master terminal block, A and B—9.00 inches (228.6 mm). With master terminal block at bottom, A and B—9.00 inches (228.6 mm). With master terminal block at top: A—15.00 inches (381.0 mm), B—3.00 inches (76.2 mm).
④ Master terminal block assembly furnished for type "C" wiring only. When location is not specified MTB is supplied at the bottom.

Note: Minimum rated vertical bus supplied as standard. Rear conduit space not recommended for conduit entry in front mounted only structure. Top rear conduit space not recommended for conduit entry in front mounted only structure.



Bottom Conduit Space



Tie Down—Detail A

Figure 29.2-13. Freedom and Freedom FlashGard NEMA 3R Walk-In Aisle Structures—Dimensions in Inches (mm)

① Minimum length of anchor bolt above grade 1.25 (31.75) (0.38-16 grade 5 torqued at 31 lb ft (43.4 Nm).
② Recommended maximum conduit height above floor line 5.50 inches (139.7 mm).
③ Maximum conduit space B.
④ This conduit space not recommended when a neutral bus is required. The space is otherwise available.

Table 29.2-11. Dimensions in Inches (mm)

Outdoor Structure Width (W)	Indoor Structure Width (A)	Maximum Conduit Space (B)
23.50 (596.9) 27.50 (698.5)	20.00 (508.0) 24.00 (609.6)	17.50 x 15.98 (444.5 x 405.9) 21.50 x 15.98 (546.1 x 405.9)
31.50 (800.1) 35.50 (901.7)	28.00 (711.2) 32.00 (812.8)	25.50 x 15.98 (647.7 x 405.9) 29.50 x 15.98 (749.3 x 405.9)

Metering and Bus Protection

Table 29.2-12. Incoming Line Metering and Bus Protection ⑤

Type	Description	Unit Space Inches (mm) ⑥
Switchboard meters ⑦ 1% accuracy	Ammeter Ammeter with switch Voltmeter Voltmeter with switch	12.00 (304.8) or 2X
	AM/VM AM/VM with switches	
Instrument Transformers	600/800A CT 1000A CT 2000A CT 2500A CT	Consult Eaton
	480/120 PT	6.00 (152.4) or 1X
Signal transducers	Current (add CT) single-phase Voltage (add PT) Watt (add CT and PT) single-phase	6.00 (152.4) or 1X
Voltage Protection		
SPD (see **Table 29.2-20** on **Page 29.2-15**) Ground detection lights—three-phase underground systems System voltage monitor		18.00 (457.2) or 3X ⑧
Lightning arrester and surge capacitor		6.00 (152.4) or 1X
Ground Fault Sensing C-HRG "Safe Ground" High Resistance Ground System		
Current Voltage	Requires 21.00-inch (533.4 mm) deep, 20.00-inch (508.0 mm) wide structure without a vertical wireway.	72.00 (1828.8) or 12X

⑤ This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.
⑥ Two electronic meters will fit in a single 12.00-inch (304.8 mm) (2X) unit.
⑦ Ammeters require two CTs for three-phase/three-wire systems, and three CTs for three-phase/four-wire systems. Voltmeters require two PTs for three-phase/three-wire systems, and three PTs for three-phase/four-wire systems.
⑧ Without disconnect 12.00 inches (304.8 mm) or 2X.

Harmonic Correction

Table 29.2-13. Clean Control Center ①

Eaton's Clean Control Center is an integrated power correction system that provides harmonic correction directly on the MCC horizontal bus. The harmonic correction unit senses the load current and dynamically injects into the horizontal bus a synthesized waveform that cancels harmonic content from nonlinear loads such as AC drives. The result is a clean waveform. Clean Control Centers are UL 845 listed.

Harmonic Current (Amperes)	Input Voltage	Disconnect Type	Standard Unit Space ② Inches (mm)	Standard Unit Space (X)
50 A active harmonic filter ③	Up to 480V	Molded-case switch	72.00 H x 20.00 W (1828.8 H x 508.0 W)	12X
100 A active harmonic filter ③	Up to 480V	Molded-case switch	72.00 H x 20.00 W (1828.8 H x 508.0 W)	12X

① This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.

② Clean Control Center model includes 24.00-inch (609.6 mm) wide MCE structure, current transformers and door-mounted digital interface panel.

③ Multiple units can be applied in parallel for additional harmonic correction.

29

Panelboards

Table 29.2-14. Lighting Panelboards
120/240 V or 120/208 V Lighting Panelboards Type—PL1A ④

Fixed mounted, main lug only panelboards can be either 120/240 V, single-phase, three-wire; 208Y / 120 V, three-phase, four-wire.

Number of Circuits	Chassis Rating (Amperes)		Unit Space Inches (mm)	
	Single-Phase Three-Wire	Three-Phase Four-Wire	Single-Phase Three-Wire	Three-Phase Four-Wire
18	225	100	24.00 (609.6) or 4X	24.00 (609.6) or 4X
30	225	100	30.00 (762.0) or 5X	30.00 (762.0) or 5X
42	225	225	36.00 (914.4) or 6X	36.00 (914.4) or 6X

④ This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.

Note: For MCB, back-feed panelboard branch circuit breaker, or select separate feeder unit.
Note: Bolt-on single-, two-, three-pole breakers only.

Table 29.2-15. 277/480 V or 480/600 V Lighting Panelboards Type —PRL3A ⑤

Fixed mounted, main lug only panelboards can be either 480 or 600 V, three-phase, three-wire or 480Y / 277 V, three-phase, four-wire. Mounted in bottom portion of structure.

Number of Circuits	Chassis Rating (Amperes)	Unit Space Inches (mm)	
		Three-Phase Three-Wire	Three-Phase Four-Wire
14	100	—	36.00 (914.4) or 6X
18	250	36.00 (914.4) or 6X	—
24	100	36.00 (914.4) or 6X	—
26	250	—	48.00 (1219.2) or 8X
32	100	—	48.00 (1219.2) or 8X
36	250	48.00 (1219.2) or 8X	—
42	100	48.00 (1219.2) or 8X	60.00 (1524.0) or 10X
42	250	60.00 (1524.0) or 10X	60.00 (1524.0) or 10X
12	400/600	36.00 (914.4) or 6X	—
14	400/600	—	48.00 (1219.2) or 8X
30	400/600	48.00 (1219.2) or 8X	60.00 (1524.0) or 10X
42	400/600	60.00 (1524.0) or 10X	72.00 (1828.8) or 12X

⑤ This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.

Note: For MCB, back-feed panelboard branch circuit breaker, or select separate feeder unit.
Note: Either plug-in or bolt-on single-, two-, three-pole breakers only.

Table 29.2-16. Lighting Panelboard Circuit Breakers ⑥

Eaton's circuit breakers can be either plug-in or bolt-on, single-, two- or three-pole through 240 V. 600 V maximum single-, two- or three-pole circuit breakers are bolt-on.

Poles	Maximum Voltage	Plug-in	Bolt-on	Ampere Interrupting Capacity
1/2/3	240	HQP	BAB	10,000
1/2/3	240	QPHW	QBHW	22,000
1/2/3	600	—	EHD	14,000
1/2/3	600	—	HFD	65,000

⑥ This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.

Automatic Transfer Switches

Table 29.2-17. Automatic Transfer Switches—Dimensions in Inches (mm) ⑦

Ampere Rating	Switch Type ⑧	Interrupting Rating (kA)	Unit Width	Unit Space
100 ⑨	Eaton MTVX, NTVS	65	20.00 (508.0) ⑨	36.00 (914.4) or 6X
150 ⑨	Eaton MTVX, NTVS	65		
100	Eaton ATVI	65		48.00 (1219.2) or 8X
150	Eaton ATVI	65		
225	Eaton ATVI	65		72.00 (1828.8) or 12X
300	Eaton ATVI	65		
400	Eaton ATVI	65		
600	Eaton ATVI	50	24.00 (609.6) ⑨	72.00 (1828.8) or 12X
800	Eaton ATVI	50		
1000	Eaton ATVI	50		
1000	Eaton ATVISP	100	44.00 (1117.6) ⑩	72.00 (1828.8) or 12X
1200	Eaton ATVISP	100		
1600	Eaton ATVISP	100		
2000	Eaton ATVISP	100		
100	ASCO Type 7000	65	20.00 (508.0) ⑩	72.00 (1828.8) or 12X
150	ASCO Type 7000	65		
260	ASCO Type 7000	65	28.00 (711.2) ⑩	
400	ASCO Type 7000	35		
600	ASCO Type 7000	35	36.00 (914.4) ⑩	
800	ASCO Type 7000	50		
1000	ASCO Type 7000	50	40.00 (1016.0) ⑩	
1200	ASCO Type 7000	100		

⑦ This table is common for both Freedom and Freedom FlashGard MCCs; not available in Freedom Arc.

⑧ ATVI designs include ATC controller door mounted microprocessor-based monitoring device for use in open transition transfer switches where rapid, reliable restoration of power in outage situations is essential. The ATC controller is a microprocessor-based logic controller to be used with Eaton transfer switches. This device provides the operator with an at-a-glance overview of switch status and parameters, as well as key diagnostic data. Real-time values for volts and frequency can be viewed via the front panel LED display, along with an indication of the power source currently in use. The ATC controller continuously monitors either single-phase or three-phase voltages for Source 1, Source 2 and the Load. Depending on the application, the user can customize the ATC controller to meet specific application need.

⑨ Manually operated switch: MTVX = Single handle manual operation. NTVS = Electrically operated non-automatic.

⑩ Requires 42.00-inch (1066.8 mm) deep structure.

Dry-Type Transformers

Table 29.2-18. Dry-Type Distribution Transformers ①

- Transformer 1.0–2.0 kVA will include a circuit breaker and fuses in a standard 2X unit
- Transformers 3.0 kVA and above have taps and electrostatic shields as standard
- Transformers 3.0 kVA and above will include the primary and secondary circuit breakers housed behind a single door

kVA Rating	Unit Space	Primary Breaker (Included in Space Factor)		Secondary Breaker ② (Included in Space Factor)
		230 V	480 V	
Single-Phase				
0.5	2X	15	15	—
0.75	2X	15	15	—
1	2X	15	15	—
1.5	2X	15	15	—
2	2X	15	15	—
3	4X	15	15	20
5	4X	15	15	30
7.5	4X	20	20	40
10	4X	25	30	60
15	5X	40	40	90
20	5X	50	60	125
25	5X	60	70	150
30	6X	70	80	175
45	7X	100	125	250
Three-Phase				
9	5X	15	15	40
15	5X	20	25	60
25	6X	40	40	90
30	6X	40	50	125
45	6X	60	70	175

① This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.

② Transformers feeding an MCC mounted panelboard require a secondary breaker or main breaker in panelboard.

Power Factor Correction Capacitors

Table 29.2-19. Power Factor Correction Capacitors ③

PF capacitors are electrolytic type and are optionally available with external line fuses and blown fuse indicators. Capacitors' sizes must be specified by the customer.

Caution: Capacitors on the main bus of the MCC may affect solid-state equipment. Please consult factory.

kVAR Rating	208 V Unit Space		240 V Unit Space		600 V Unit Space	
	Inches (mm)	X Space	Inches (mm)	X Space	Inches (mm)	X Space
2	12.00 (304.8)	2X	12.00 (304.8)	2X	12.00 (304.8)	2X
3	12.00 (304.8)	2X	12.00 (304.8)	2X	12.00 (304.8)	2X
4	12.00 (304.8)	2X	12.00 (304.8)	2X	12.00 (304.8)	2X
5	12.00 (304.8)	2X	12.00 (304.8)	2X	12.00 (304.8)	2X
7.5	12.00 (304.8)	2X	12.00 (304.8)	2X	12.00 (304.8)	2X
10	12.00 (304.8)	2X	12.00 (304.8)	2X	12.00 (304.8)	2X
15	12.00 (304.8)	2X	12.00 (304.8)	2X	12.00 (304.8)	2X
20	24.00 (609.6)	4X	12.00 (304.8)	2X	12.00 (304.8)	2X
22.5	24.00 (609.6)	4X	12.00 (304.8)	2X	12.00 (304.8)	2X
25	—	—	24.00 (609.6)	4X	12.00 (304.8)	2X
30	—	—	24.00 (609.6)	4X	12.00 (304.8)	2X
40	—	—	—	—	12.00 (304.8)	2X
50	—	—	—	—	24.00 (609.6)	4X
60	—	—	—	—	24.00 (609.6)	4X
75	—	—	—	—	24.00 (609.6)	4X
90	—	—	—	—	24.00 (609.6)	4X
100	—	—	—	—	36.00 (914.4)	6X
120	—	—	—	—	36.00 (914.4)	6X

③ This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.

Surge Protective Devices

Table 29.2-20. SPD (Surge Protective Device) with Circuit Breaker Disconnect ④

Includes SuperVisor Monitoring Display with power quality meter for volts, sag, swell, outage, transient counter, Form C contact, alarm enable and disable, and circuit breaker disconnect.

Description	Unit Space ⑤	
	Inches (mm)	X Space
Surge Current Per Phase		
100 kA SPD-100	18.00 (457.2)	3X
120 kA SPD-120 (recommended branch unit)	18.00 (457.2)	3X
160 kA SPD-160	18.00 (457.2)	3X
200 kA SPD-200	18.00 (457.2)	3X
250 kA SPD-250 (recommended service entrance)	18.00 (457.2)	3X
300 kA SPD-300	18.00 (457.2)	3X
400 kA SPD-400	18.00 (457.2)	3X

④ This table is common for Freedom, Freedom Arc and Freedom FlashGard MCCs.

⑤ Also available in 12.00-inch (304.8 mm) unit (2X) without circuit breaker disconnect.

Note: Specify three-phase delta or three-phase wye.

Option Groups for AC Combination Starters, AFDs

Note: Option groups are common to both Freedom and Freedom FlashGard MCCs.

Option Group A

Table 29.2-21. Wiring Class

Description
NEMA Class IA ⑥ NEMA Class IC
NEMA Class IIB NEMA Class IIC NEMA Class IS (includes 1B wiring and 2B schematics)

⑥ Control terminal blocks and device panels not included with NEMA 1A wiring.

Table 29.2-22. 100 kA Circuit Breaker Starter Interrupting Capacity

Starter Type	Voltage
Starters with HMCPs	480
Starters with thermal-magnetic circuit breakers	480
Starters with HMCPs	600 ⑦
Starters with thermal-magnetic circuit breakers	600 ⑦

⑦ Current limiter attachments are used. Add 6.00 inches (152.4 mm) to all size 3 and 4 starters.

Table 29.2-23. Control Circuit Transformers—Typical Sizing ⑧

Starter Size
1, 2 (100 VA)—includes extra 50 VA 3, 4 (150 VA)—includes extra 50 VA 5, 6 (250 VA)—includes extra 50 VA
Extra 50 VA, size 1, 2 Extra 100 VA, size 3, 4 Extra 150 VA, size 5, 6

⑧ Refer to **Table 29.2-6** for actual ratings.

Note: Price includes one secondary and two primary fuses.

29

Table 29.2-24. Control Circuit Fusing

Description
Control fuse and auxiliary switch Control fuse Blown fuse indicator

Note: Required in accordance with NEC for all starter units with control wiring external to the MCC. See NEC, General for exceptions.

Table 29.2-25. Motor Starter Auxiliary Contacts

Description	
1NO or 1NC (sizes 1–4) 1NO or 1NC (sizes 5–6)	Maximum of eight on each contactor ① Maximum of four on each contactor

① Maximum of four per contactor on multi-contactor starters and 6.00-inch (152.4 mm) units.

Table 29.2-26. Interlock for Switch or Breaker Operator

Description
1NO–1NC 2NO–2NC

Note: For use when control circuit is fed from an external source.

Table 29.2-27. Internal Circuit Breaker Options

Description
Alarm contact Auxiliary 1NO–1NC Auxiliary 2NO–2NC 120 V shunt trip 50 °C (thermal-magnetic)

Table 29.2-28. Terminal Blocks

Description	
7 Terminal Side mounted ② (Will accept stripped wire or ring/spade wire lug–12 AWG bare/14 AWG ring/spade)	
Front rail–pressure connector Front rail–pull apart Front rail–utility/accepts ring wire lug.	Additional 6.00-inch (152.4 mm) space required for Freedom starters sizes 1–4

② Use Burndy YAEV10-L36 for #10 AWG compression termination.

Table 29.2-29. Control Wire Options

Description
#16 AWG (standard) #14 AWG Wire markers
Spade wire terminals Ring wire terminals ③ Wiring to common CPT
SIS power wire–substitution SIS control wire–substitution Starter Class 2 interwiring/per wire

③ Freedom Starter control terminals only available with spade wire terminals.

Table 29.2-30. Miscellaneous Options

Description
Mini ammeter and CT ④ Mini voltmeter Mini elapsed time meter
Panel elapsed time meter ⑤ Operations counter Wiring diagram on door Coil surge suppressor
CT for remote metering (requires additional 6.00-inch (152.4 mm) space) Heater packs installed Device labels Blank device panels

④ May add 6.00 inches (152.4 mm) to unit size. Consult factory.

⑤ May add 6.00 inches (152.4 mm). Consult factory.

Table 29.2-31. Vacuum Contactors in Lieu of Air Break

Starter Type	
FVNR FVR, 2S2W, PW RVAT, 2S1W, YD-Open YD-Closed	Available sizes 4–6

Table 29.2-32. Ground Fault Protection—Instantaneous or Adjustable

Description	
D64 relay (with zero sequence CT)	Requires additional 6.00-inch (152.4 mm) space

Note: Option groups are common to both Freedom and Freedom FlashGard MCCs.

Table 29.2-33. Power Fuses—R, J Type

Ampere Rating	
30 60 100	Optional Optional Optional
200 400 600	Optional Optional Optional

Table 29.2-34. Power Factor Capacitor Options

Description
Blown power fuse indicator (set of three—one per phase)

Table 29.2-35. Current Limiter Attachment for HMCP

Description	
Size 1–2 Size 3 Size 4	— Requires additional 6.00-inch (152.4 mm) space Requires additional 6.00-inch (152.4 mm) space

Option Group B

Devices may require extra unit space.

Table 29.2-36. Timing Relays

Type of Relay	Mounting
Solid-state timer Pneumatic—AGASTAT	Panel Panel on or off delay
24-hour motor timer 7-day timer Repeat cycle timer	Panel Panel Door or panel

Table 29.2-37. Control Relays

Number of Poles	Type
Two-pole Four-pole	General purpose Type D7 socket relay N300 fixed contacts
Two-pole Four-pole Six-pole Eight-pole Ten-pole	Type AR machine tool relays N600 convertible contacts
Two-pole Three-pole Four-pole Six-pole ① Eight-pole ①	Type M—D26 relays N600 convertible contacts

① The six- and eight-pole units can be provided with four additional non-convertible NO contacts.

Table 29.2-38. Alternators

Description	
Two-circuit alternator Three-circuit alternator	Panel (additional 6.00-inch (152.4 mm) space required on size 1s and size 2s)

Option Group C

Devices may require extra unit space.

Table 29.2-39. Monitoring Relays

Type of Relay		
D60LA current sensing voltage transducer	— Price includes 1 PT	Additional 6.00-inch (152.4 mm) space required
AC current sensors with CTs ②	0–5 thru 0–100A 0–50 thru 0–300A 0–300 thru 0–600A	
AC current transducer, 4–20 mA, self-powered with CTs ③	All Ratings	
Phase monitoring relay—three-phase Watt transducer, 4–20 mA, self-powered CTs ③		

② Loop-powered devices—requires 24 Vdc power source, which is typically provided in the PLC.

③ Does not require separate 24 Vdc power source. Suitable for powering analog meters.

Table 29.2-40. Extra Bi-Metallic Overload Relay—Type C306

Description
Size 1—32A overload relay Size 2—75A overload relay Size 3—100A overload relay Size 4—144A overload relay

Option Group D

Devices may require extra unit space.

Table 29.2-41. Solid-State Overload Relays

Description
C440 solid-state overload with ground fault protection ④ C441 Motor Insight MP-3000 motor protector MP-3000 RTD module

④ Size 4 starters require an additional 6.00-inch (152.4 mm) (1X) space when used with solid-state overloads.

Note: Option groups are common to Freedom, Freedom Arc and Freedom FlashGard MCCs.

Option Group E

Table 29.2-42. Oiltight Pushbuttons, Lights, Selector Switches

Device	Device Type
Pushbuttons 1 unit 2 unit 3 unit	10250T ⑤⑥
Selector switches 2 position 3 position 4 position Key operated adder	
Pilot lights Standard transformer 6V bulb Standard transformer LED bulb Push to test transformer 6V bulb Push to test LED bulb	
Pushbuttons 1 unit 2 unit 3 unit	E30 ⑤⑥
Selector switches 2 position 3 position 4 position Key operated adder	
Pilot lights Standard transformer 6V bulb Standard transformer LED bulb Push to test Transformer 6V bulb Push to test LED bulb	

⑤ Maximum two devices per starter in dual units.

⑥ Maximum of six devices without increasing compartment space.

29

Option Group F

Options for 6.00-Inch (152.4 mm) Starter Units

- Control terminal blocks are 300 V rated and are limited to 12 points maximum
- Standard VA control transformer only

Table 29.2-43. Oiltight Pushbuttons, Lights, Selector Switches

Device	Device Type
Pushbuttons 1 unit 2 unit 3 unit	E22 ①
Selector switches 2 position 3 position 4 position Key operated adder	
Pilot lights Standard transformer 6V bulb Standard transformer LED bulb Push to test transformer 6V bulb Push to test LED bulb	

① On 6.00-inch (152.4 mm) starter units, pilot devices are limited to three E22 devices.

Option Group G

Table 29.2-44. Remote Racking System

Description
Wired remote racking system for FlashGard MCC units

Table 29.2-45. FlashGard Locking Accessory

Description
Locking accessory for FlashGard MCC

Option Group I

Optional Safety Accessories

Table 29.2-46. Automatic Insulation Tester

Description
Automatic insulation tester
Automatic insulation tester with megohm meter (mounted in unit door)

Table 29.2-47. Voltage Presence Indicator (VoltageVision)

Description
Voltage presence indicator (mounted on unit door)

Freedom

Freedom Motor Control Center

General Description

Eaton's Freedom MCC has been in production since 1994, employing the Freedom NEMA contactor in combination with multiple motor overload styles and either a fused switch or a molded-case circuit breaker disconnect. The Freedom meets all the above listed standards, ratings and features.

Quick Reference Layout Guide Index

Technical Data

Table 29.3-1. Short-Circuit Ratings for Motor Control (480 V)

Short-Circuit Protective Device	Combination Starter FV and RV (kA)	Solid-State Reduced Voltage (kA)	Adjustable Frequency Drives (kA)
HMCP motor circuit protector (standard rating) HMCP motor circuit protector (optional rating)	65 100	65 100	65 100
MCCB molded-case circuit breaker (standard rating) MCCB molded-case circuit breaker (optional rating) Fusible switch	65 100 100	65 — 100	65 100 100

Table 29.3-2. Combination Starters with Series C Motor Circuit Protectors or Molded-Case Circuit Breakers

Motor circuit protector ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

NEMA Size	Maximum Horsepower					HMCP/HMCPE Frame ①②	MCCB Frame ③	Freedom Unit Size	
	208 V	240 V	380 V	480 V	600 V			Inches (mm)	X Space
Full Voltage Non-Reversing								**Type F206**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	6.00 (152.4) ④ 12.00 (304.8) ⑤ 18.00 (457.2)	1X ④ 2X ⑤ 3X
2	10	15	25	25	25	125 150	E HFD/FDC	6.00 (152.4) ④ 12.00 (304.8) ⑤ 18.00 (457.2)	1X ④ 2X ⑤ 3X
3	25	30	50	50	50	125 150	E HFD/FDC	12.00 (304.8) ④ 18.00 (457.2) ⑥ 24.00 (609.6)	2X ④ 3X ⑥ 4X
4	40	50	75	100	100	150	HFD/FDC HJD/JDC	12.00 (304.8) ⑦ 18.00 (457.2) ⑥⑦ 24.00 (609.6) ⑦	2X 3X ⑥ 4X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	36.00 (914.4)	6X
6 ⑧	25 150	100 200	250 300	300 350 400	400 — —	600 1200	HLD/LDC ⑧ HND	42.00 (1066.8) 60.00 (1524.0)	7X ⑨ 10X
7	—	300	—	600	600	1200	HND	72.00 (1828.8) ⑩	12X
Full Voltage Reversing								**Type F216**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	18.00 (457.2) ⑥ 24.00 (609.6)	3X ⑥ 4X
2	10	15	25	25	25	125 150	E HFD/FDC	18.00 (457.2) ⑥ 24.00 (609.6)	3X ⑥ 4X
3	25	30	50	50	50	125/150	HFD/FDC/E	24.00 (609.6) ⑪	6X
4	40	50	75	100	100	150	HJD/JDC	30.00 (762.0) ⑪	5X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	60.00 (1524.0)	10X
6	125 150	100 200	250 300	300 400	400 —	600 1200	HLD/LDC HND	72.00 (1828.8) 72.00 (1828.8) ⑧	12X 12X ⑧

① Standard combination starter units with HMCP/HMCPE magnetic only disconnect have short-circuit ratings of 65,000 A at 480 V. Optional HMCP/HMCPE combination starter units are available with 100,000 A at 480 V.
② E-Frame motor circuit protection available for size 1–3 starters only.
③ Optional combination starter units with thermal-magnetic breaker disconnects are available with either 65,000 or 100,000 A at 480 V.
④ Maximum of (three) pilot devices, (two) auxiliary contacts 100 VA CPT maximum. Standard lugs only.
⑤ 12.00-inch (304.8 mm)/2X unit is standard.
⑥ 18.00-inch (457.2 mm)/3X unit is standard.
⑦ Minimum 30.00-inch (762.0 mm) space needed with thermal-magnetic circuit breaker.
⑧ 1200 A HMCP frame available in 11X 66.00-inch (1676.4 mm).
⑨ For top entry, 8X space required.
⑩ Requires 28.00-inch (711.2 mm) wide structure.
⑪ 30.00-inch (762.0 mm) space needed for thermal-magnetic circuit breaker.

Table 29.3-2. Combination Starters with Series C Motor Circuit Protectors or Molded-Case Circuit Breakers (Continued)
Motor circuit protector ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

NEMA Size	Maximum Horsepower					HMCP Frame ①②	MCCB Frame ②③	Freedom	
								Unit Size	
	208 V	240 V	380 V	480 V	600 V			Inches (mm)	X Space
Two-Speed One Winding, Constant/Variable Torque								**Type F946**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	24.00 (609.6) ④	4X
2	10	15	25	25	25	125 150	E HFD/FDC	24.00 (609.6) ④	4X
3	25	30	50	50	50	125 150	E HJD/JDC	36.00 (914.4) ④⑤	6X
4	40	50	75	100	100	150 250	HFD/FDC HJD/JDC	36.00 (914.4) ④⑤	6X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72.00 (1828.8) ⑥	12X
Two-Speed Two Winding, Constant/Variable Torque								**Type F956**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	24.00 (609.6) ④	4X
2	10	15	25	25	25	125 150	E HFD/FDC	24.00 (609.6) ④	4X
3	25	30	50	50	50	125 150	E HFD/FDC	30.00 (762.0) ④	5X
4	30 40	40 50	60 75	75 100	100 —	150 250	HFD/FDC HJD/JDC	30.00 (762.0) ④ 30.00 (762.0) ④	5X 5X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72.00 (1828.8) ⑥	12X
Reduced Voltage Autotransformer								**Type F606**	
2	10	15	25	25	25	150	HFD/FDC	36.00 (914.4)	6X
3	25	30	50	50	50	150	HFD/FDC	54.00 (1371.6)	9X
4	30	50	75	100	100	150	HJD/JDC	54.00 (1371.6)	9X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72.00 (1828.8)	12X
6	150	200	300	400	400	600	HLD/LDC	72.00 (1828.8) ⑦	12X
7	—	300	—	600	600	1200	HND	72.00 (1828.8) ⑦	12X
Reduced Voltage Part Winding								**Type F706**	
1PW	10	10	15	15	15	150	HFD/FDC	24.00 (609.6) ⑧	4X
2PW	20	25	40	40	40	150	HFD/FDC	24.00 (609.6) ⑧	4X
3PW	40	50	75	75	75	150	HFD/FDC	30.00 (762.0) ⑧	5X
4PW	— 60 75	— 60 75	— 125 150	100 150 —	125 150 —	150 250 400	HFD/FDC HJD/JDC HKD/KDC	36.00 (914.4) ⑧	6X
5PW	100 150	125 150	— 250	250 350	300 350	400 600	HKD/KDC HLD/LDC	72.00 (1828.8) ⑦	12X

① Standard combination starter units with HMCP/HMCPE Magnetic Only disconnect have short-circuit ratings of 65,000 A at 480 V. Optional HMCP/HMCPE combination starter units are available with 100,000 A at 480 V.
② E-Frame motor circuit protector available through size 3 starter only.
③ Optional combination starter units with thermal-magnetic breaker disconnects are available with either 65,000 or 100,000 A at 480 V.
④ Add 6.00-inch (152.4 mm) space for low speed disconnect.
⑤ 42.00-inch (1066.8 mm) space needed with Thermal-magnetic circuit breaker. 48.00-inch (1219.2 mm) space needed with thermal-magnetic circuit breaker.
⑥ Requires 28.00-inch (711.2 mm) wide structure.
⑦ Requires 21.00-inch (533.4 mm) deep, 28.00-inch (711.2 mm) wide structure.
⑧ For starting speed disconnect, add 6.00-inch (152.4 mm) space.

Table 29.3-2. Combination Starters with Series C Motor Circuit Protectors or Molded-Case Circuit Breakers (Continued)
Motor circuit protector ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

NEMA Size	Maximum Horsepower					HMCP Frame ①②	MCCB Frame ②③	Freedom Unit Size	
	208 V	240 V	380 V	480 V	600 V			Inches (mm)	X Space
Reduced Voltage Wye Delta Open Transition ④								**Type F806**	
2YD	20	25	40	40	40	150	HFD/FDC	30.00 (762.0)	5X
3YD	30 40	40 50	75 —	75 —	5 —	150 250	HFD/FDC HJD/JDC	42.00 (1066.8)	7X
4YD	60 —	75 —	125 150	150 —	150 —	250 400	HJD/JDC HKD/KDC	42.00 (1066.8)	7X
5YD	100 150	125 150	200 250	250 300	300 —	400 600	HKD/KDC HLD/LDC	72.00 (1828.8) ④	12X
Reduced Voltage Wye Delta Closed Transition ④								**Type F896**	
2YD	20	25	40	40	40	150	HFD/FDC	42.00 (1066.8)	7X
3YD	40	50	—	—	—	250	HFD/FDC	54.00 (1371.6)	9X
4YD	60 —	75 —	125 150	150 —	150 —	250 400	HJD/JDC HKD/KDC	60.00 (1524.0)	10X
5YD	100 150	125 150	200 250	250 300	300 —	400 600	HKD/KDC HLD/LDC	72.00 (1828.8) ④	12X

① Standard combination starter units with HMCP/HMCPE magnetic only disconnect have short-circuit ratings of 65,000 A at 480 V. Optional HMCP/HMCPE combination starter units are available with 100,000 A at 480 V.
② E-Frame motor circuit protector available through size 3 starter only.
③ Optional combination starter units with thermal-magnetic breaker disconnects are available with either 65,000 or 100,000 A at 480 V.
④ Requires 21.00-inch (533.4 mm) deep, 28.00-inch (711.2 mm) wide structure.

S811+ Solid-State Reduced Voltage Starter

Eaton's S811+ solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The S811+ solid-state starter has five 24 Vdc inputs and two relay outputs. S811+ soft start units include a disconnect, starter, 24 Vdc power supply and 100 VA CPT.

Motor Service Factor (SF) Effect on S811+ Starter Selection

- A 1.0 service factor motor may draw up to 1.00 x full load amperes
- A 1.15 service factor motor may draw up to 1.15 x full load amperes (15% more current). This chart is based off of a 1.15 SF motor selection
- S811+ starters are current rated devices. In some cases, a larger S811+ SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below

Table 29.3-3. Standard-Duty and Severe-Duty Ratings ①

S811+ Amperage	S811+ Frame	208 V				230 V				380 V				460 V				575 V				Inches (mm)	X Space
		hp	HMCP	T.M.	Fuse	hp	HMCP	T.M	Fuse	hp	HMCP	T.M.	Fuse	hp	HMCP	T.M.	Fuse	hp	HMCP	T.M.	Fuse		
Standard Duty																							
37	65	10	50	70	30/60	10	50	70	30/60	15	50	70	30/60	20	50	70	30/60	30	50	80	30/60	18 (457.2)	3X
66	65	15	100	125	100	20	100	125	100	30	100	150	100	40	100	150	100	50	100	150	100	18 (457.2)	3X
105	110	30	150	225	200	30	150	200	200	45	150	150	200	60	150	150	200	75	150	200	200	18 (457.2)	3X
135	110	40	150	225	200	40	150	250	200	55	150	250	200	75	150	250	200	100	150	250	200	18 (457.2)	3X
180	200	50	250	400	400	60	250	350	400	75	250	350	400	125	250	400	400	150	250	350	400	36 (914.4)	6X
240	200	60	250	400	400	75	250	450	400	110	400	500	400	150	400	500	400	200	250	450	400	36 (914.4)	6X
304	200	75	400	600	400	100	400	600	600	132	400	600	600	200	400	600	600	250	400	600	600	36 (914.4)	6X
360	290	100	400	700	600	125	400	800	600	160	600	800	600	—	—	—	—	300	400	800	600	54 (1371.6)	9X
420	290	125	600	900	600	—	—	—	—	200	600	1000	800	300	600	1000	800	350	600	900	600	54 (1371.6)	9X
500	290	—	—	—	—	150	600	1000	800	250	600	1000	800	350	600	1000	800	450	600	1000	800	54 (1371.6)	9X
650	290	200	1200	1200	1200	200	1200	1200	800	315	1200	1200	1200	450	1200	1200	1200	600	1200	1200	1200	72 (1828.8)	12X
720	290	—	—	—	—	250	1200	1200	1200	—	—	—	—	500	1200	1200	1200	—	—	—	—	72 (1828.8)	12X
850	290	—	—	—	—	300	1200	1200	1200	375	1200	1200	1200	600	1200	2000	1200	700	1200	1200	1200	72 (1828.8)	12X
1000	290	—	—	—	—	350	2000	2000	1200	500	2000	2000	1200	700	2000	2000	1200	900	2000	2000	1200	72 (1828.8)	12X
Severe Duty																							
22	65	5	—	70	40	5	—	70	35	7.5	—	60	35	10	—	60	35	15	—	70	40	18 (457.2)	3X
42	65	10	—	125	70	10	—	125	70	18.5	—	150	90	25	—	150	80	30	—	125	80	18 (457.2)	3X
65	110	15	—	200	110	20	—	200	125	22	—	150	100	40	—	150	125	50	—	200	125	18 (457.2)	3X
80	110	20	—	225	150	25	—	300	175	37	—	300	175	50	—	250	150	60	—	250	150	18 (457.2)	3X
115	200	30	—	300	225	30	—	350	200	55	—	300	250	75	—	300	225	100	—	300	250	36 (914.4)	6X
150	200	40	—	350	250	50	—	400	300	—	—	—	—	100	—	400	300	125	—	400	300	36 (914.4)	6X
192	200	50	—	400	350	60	—	500	350	90	—	500	400	125	—	500	400	150	—	400	350	36 (914.4)	6X
240	290	60	—	500	400	—	—	—	—	110	—	600	500	150	—	600	450	—	—	—	—	54 (1371.6)	9X
305	290	75	—	700	500	100	—	800	600	132	—	800	600	200	—	800	600	250	—	800	600	54 (1371.6)	9X
365	290	100	—	900	700	125	—	1000	800	160	—	900	700	250	—	1000	700	300	—	900	700	72 (1828.8)	12X
420	290	125	—	1000	800	—	—	—	—	200	—	1200	800	300	—	1200	800	350	—	1000	800	72 (1828.8)	12X
480	290	—	—	—	—	150	—	1200	800	220	—	1200	1000	350	—	1200	1000	450	—	1200	1000	72 (1828.8)	12X
525	290	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72 (1828.8)	12X
600	290	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72 (1828.8)	12X

① Standard-duty ratings reflect the maximum starting duty that these units are designed to supply.

Table 29.3-4. Option Sizing—Dimensions in Inches (mm)

S811+ Width (mm)	Disconnect Type	Starter Size	Option Unit Size ②	Structure Width
Isolating Contactor				
65	HMCP, MCCB	1, 2, 3	30.00 (762.0)	20.00 (508.0)
110	HMCP, MCCB	3, 4	36.00 (914.4)	20.00 (508.0)
110	HMCP, MCCB	5	54.00 (1371.6)	20.00 (508.0)
200	HMCP, MCCB	5,6	72.00 (1828.8)	20.00 (508.0)
290	HMCP, MCCB	6	72.00 (1828.8)	32.00 (812.8)
290	HMCP, MCCB	7	72.00 (1828.8)	48.00 (1219.2)
Bypass Starter				
65	HMCP, MCCB	1, 2, 3	30.00 (762.0)	20.00 (508.0)
110	HMCP, MCCB	3, 4	36.00 (914.4)	20.00 (508.0)
110	HMCP, MCCB	5	54.00 (1371.6)	20.00 (508.0)
200	HMCP, MCCB	5, 6	72.00 (1828.8)	24.00 (609.6)
290	HMCP, MCCB	6	72.00 (1828.8)	32.00 (812.8)
290	HMCP, MCCB	7	72.00 (1828.8)	48.00 (1219.2)

② Option fits in standard unit space.

Table 29.3-5. Control Options

Extra 50 VA Control Power Transformer ③④
24 Vdc Control ③
Line or Load MOV Protection ③
Pump Control Option ③

③ Option fits in standard unit space.

④ Option adds 6.00 inches (152.4 mm) (1X) to 37 and 66 A units.

Table 29.3-6. FLA Ratings

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
Standard Duty			
300%	30 seconds	3	Soft start
500%	10 seconds	3	Full voltage
350%	20 seconds	3	Wye delta
480%	20 seconds	2	80% RVAT
390%	20 seconds	3	65% RVAT
300%	20 seconds	4	50% RVAT
Severe Duty			
450%	30 seconds	4	Soft start
500%	10 seconds	10	Full voltage
350%	65 seconds	3	Wye delta
480%	25 seconds	4	80% RVAT
390%	40 seconds	4	65% RVAT
300%	60 seconds	4	50% RVAT

All of Eaton's combination starters are available with Class R or J fuse clips for all voltages. If 100 kA SCR is required at 575 V and 600 V, fuses must be used where current limiting options are not available in combination with breakers. When selecting fuse switches, the fuses are not supplied by default. Fuses may be selected as follows:

- RK5: 1.25x FLC
- RK1: 1.3x FLC
- Class J: 1.5x FLC

Table 29.3-7. Combination Starters with Fusible Switches—Dimensions in Inches (mm)

NEMA Size	Maximum Horsepower					Switch Rating ①	Freedom Unit Size	
	208 V	240 V	380 V	480 V	600 V		Inches (mm)	X Space
Full Voltage Non-Reversing—Fusible							**Type F204**	
1	7.5	7.5	10	10	10	30	12.00 (304.8)	2X
2	10	15	25	25	25	60	12.00 (304.8)	2X
3	25	30	50	50	50	60/100	24.00 (609.6)	4X
4	40	50	75	100	100	100/200	36.00 (914.4)	6X
5	75	100	150	200	200	400 ②	54.00 (1371.6)	9X
6 ②	150	200	300	400	400	600	66.00 (1676.4) 72.00 (1828.8)	11X 12X
Full Voltage Reversing—Fusible							**Type F214**	
1	7.5	7.5	10	10	10	30	18.00 (457.2)	3X
2	10	15	25	25	25	60	18.00 (457.2)	3X
3	25	30	50	50	50	100/200	30.00 (762.0)	5X
4	40	50	75	100	100	200	40.00 (1016.0)	8X
5	75	100	150	200	200	400	72.00 (1828.8)	12X
6	150	200	300	400	400	600	72.00 (1828.8)	12X
Two-Speed One Winding—Fusible							**Type F944**	
1	7.5	7.5	10	10	10	30	24.00 (609.6)	4X
2	10	15	25	25	25	60	24.00 (609.6)	4X
3	25 25	30 30	— 50	30 50	50 50	60 100	36.00 (914.4)	6X
4	— 40	— 50	— 75	— 100	60 100	100 200	60.00 (1524.0)	10X
5	75	100	150	200	200	400	72.00 (1828.8)	12X
Two-Speed Two Winding—Fusible							**Type F954**	
1	7.5	7.5	10	10	10	30	24.00 (609.6)	4X
2	10	15	25	25	25	60	24.00 (609.6)	4X
3	— 25	— 30	— 50	— 50	30 50	60 100	30.00 (762.0)	5X
4	— 40	— 50	— 75	— 100	60 100	100 200	60.00 (1524.6)	10X
5	75	100	150	200	200	400	72.00 (1828.8)	12X
Reduced Voltage Autotransformer—Fusible							**Type F604**	
2	10	15	25	25	25	60	36.00 (914.4)	6X
3	25	30	50	50	50	100	54.00 (1371.6)	9X
4	40	50	75	100	100	200	72.00 (1828.8)	12X
5	75	100	150	200	200	400	72.00 (1828.8)	12X
6	150	200	300	400	400	600	72.00 (1828.8)	12X

① Combination fused starter units rated 100 kAIC short-circuit current.
② Certain items in unit option Groups B and C may require additional space. See **Page 29.2-17.**

Table 29.3-7. Combination Starters with Fusible Switches—Dimensions in Inches (mm) (Continued)

NEMA Size	Maximum Horsepower					Switch Rating ①	Freedom Unit Size	
	208 V	240 V	380 V	480 V	600 V		Inches (mm)	X Space
Reduced Voltage Part Winding—Fusible							**Type F704**	
1PW	10	10	15	15	15	60	36.00 (914.4)	6X
2PW	— 20	15 25	25 40	30 40	40 —	60 100	36.00 (914.4) 36.00 (914.4)	6X 6X
3PW	— 40	— 50	— 75	50 75	60 75	100 200	40.00 (1016.0) 40.00 (1016.0)	8X 8X
4PW	50 75	— 75	100 150	100 150	150 —	200 400	60.00 (1524.0) 60.00 (1524.0)	10X 10X
5PW	100 150	100 150	200 250	250 350	300 350	400 600	72.00 (1828.8) ②	12X ②
Reduced Voltage Wye Delta Open Transition—Fusible							**Type F804**	
2YD	15 20	15 25	30 40	40 —	40 —	60 100	30.00 (762.0)	5X
3YD	25 40	30 50	50 75	60 75	75 —	100 200	54.00 (1371.6)	9X
4YD	50 60	60 75	100 150	125 150	150 —	200 400	72.00 (1828.8) ②	12X ②
5YD	100 150	125 150	200 250	250 300	300 —	400 600	72.00 (1828.8) ②	12X ②
6YD	— — 250 300	— 200 250 350	— 350 400 500	— 400 500 700	350 500 700 700	400 600 800 1200	72.00 (1828.8) ③	12X ③
Reduced Voltage Wye Delta Closed Transition—Fusible							**Type F894**	
2YD	15 20	15 25	30 40	40 —	40 —	60 100	42.00 (1066.8)	7X
3YD	25 40	30 50	50 75	60 75	75 —	100 200	66.00 (1676.4)	11X
4YD	50 60	60 75	100 150	125 150	50 —	200 400	72.00 (1828.8) ② 72.00 (1828.8) ②	12X ② 12X ②
5YD	100 150	125 150	200 250	250 300	300 —	400 600	72.00 (1828.8) ②	12X ②
6YD	— — 250 300	— 200 250 350	— 350 400 500	— 400 500 700	350 500 700 700	400 600 800 1200	72.00 (1828.8) ③	12X ③

① Combination fused starter units rated 100 kAIC short-circuit current.
② Requires 28.00-inch (711.2 mm) wide structure.
③ Requires 28.00-inch (711.2 mm) wide and 21.00-inch (533.4 mm) deep section.

29

S811+ Solid-State Reduced Voltage Starter—Fusible Switch

Eaton's S811+ solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The S811+ solid-state starter has five 24 Vdc inputs and two relay outputs. S811+ soft start units include a disconnect, a starter, 24 Vdc power supply and 100 VA CPT.

Motor Service Factor (SF) Effect on S811+ Starter Selection

- A 1.0 service factor motor may draw up to 1.00 x full load amperes
- A 1.15 service factor motor may draw up to 1.15 x full load amperes (15% more current). This chart is based off of a 1.15 SF motor selection.
- S811+ starters are current rated devices. In some cases, a larger S811+ SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below

Table 29.3-8. Standard-Duty and Severe-Duty Ratings—Fusible

S811+ Amperage	S811+ Frame	208 V				230 V				380 V				460 V				575 V				Inches (mm)	X Space
		hp	HMCP	T.M.	Fuse	hp	HMCP	T.M	Fuse	hp	HMCP	T.M.	Fuse	hp	HMCP	T.M.	Fuse	hp	HMCP	T.M.	Fuse		
Standard Duty																							
37	65	10	50	70	30/60	10	50	70	30/60	15	50	70	30/60	20	50	70	30/60	30	50	80	30/60	18 (457.2)	3X
66	65	15	100	125	100	20	100	125	100	30	100	150	100	40	100	150	100	50	100	150	100	18 (457.2)	3X
105	110	30	150	225	200	30	150	200	200	45	150	150	200	60	150	150	200	75	150	200	200	18 (457.2)	3X
135	110	40	150	225	200	40	150	250	200	55	150	250	200	75	150	250	200	100	150	250	200	18 (457.2)	3X
180	200	50	250	400	400	60	250	350	400	75	250	350	400	125	250	400	400	150	250	350	400	36 (914.4)	6X
240	200	60	250	400	400	75	250	450	400	110	400	500	400	150	400	500	400	200	250	450	400	36 (914.4)	6X
304	200	75	400	600	400	100	400	600	600	132	400	600	600	200	400	600	600	250	400	600	600	36 (914.4)	6X
360	290	100	400	700	600	125	400	800	600	160	600	800	600	—	—	—	—	300	400	800	600	54 (1371.6)	9X
420	290	125	600	900	600	—	—	—	—	200	600	1000	800	300	600	1000	800	350	600	900	600	54 (1371.6)	9X
500	290	—	—	—	—	150	600	1000	800	250	600	1000	800	350	600	1000	800	450	600	1000	800	54 (1371.6)	9X
650	290	200	1200	1200	1200	200	1200	1200	800	315	1200	1200	1200	450	1200	1200	1200	600	1200	1200	1200	72 (1828.8)	12X
720	290	—	—	—	—	250	1200	1200	1200	—	—	—	—	500	1200	1200	1200	—	—	—	—	72 (1828.8)	12X
850	290	—	—	—	—	300	1200	1200	1200	375	1200	1200	1200	600	1200	2000	1200	700	1200	1200	1200	72 (1828.8)	12X
1000	290	—	—	—	—	350	2000	2000	1200	500	2000	2000	1200	700	2000	2000	1200	900	2000	2000	1200	72 (1828.8)	12X
Severe Duty																							
22	65	5	—	70	40	5	—	70	35	7.5	—	60	35	10	—	60	35	15	—	70	40	18 (457.2)	3X
42	65	10	—	125	70	10	—	125	70	18.5	—	150	90	25	—	150	80	30	—	125	80	18 (457.2)	3X
65	110	15	—	200	110	20	—	200	125	22	—	150	100	40	—	150	125	50	—	200	125	18 (457.2)	3X
80	110	20	—	225	150	25	—	300	175	37	—	300	175	50	—	250	150	60	—	250	150	18 (457.2)	3X
115	200	30	—	300	225	30	—	350	200	55	—	300	250	75	—	300	225	100	—	300	250	36 (914.4)	6X
150	200	40	—	350	250	50	—	400	300	—	—	—	—	100	—	400	300	125	—	400	300	36 (914.4)	6X
192	200	50	—	400	350	60	—	500	350	90	—	500	400	125	—	500	400	150	—	400	350	36 (914.4)	6X
240	290	60	—	500	400	—	—	—	—	110	—	600	500	150	—	600	450	—	—	—	—	54 (1371.6)	9X
305	290	75	—	700	500	100	—	800	600	132	—	800	600	200	—	800	600	250	—	800	600	54 (1371.6)	9X
365	290	100	—	900	700	125	—	1000	800	160	—	900	700	250	—	1000	700	300	—	900	700	72 (1828.8)	12X
420	290	125	—	1000	800	—	—	—	—	200	—	1200	800	300	—	1200	800	350	—	1000	800	72 (1828.8)	12X
480	290	—	—	—	—	150	—	1200	800	220	—	1200	1000	350	—	1200	1000	450	—	1200	1000	72 (1828.8)	12X
525	290	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72 (1828.8)	12X
600	290	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72 (1828.8)	12X

Table 29.3-9. Control Options

Extra 50 VA Control Power Transformer ①
24 Vdc Control ①
Line or Load MOV Protection ①
Pump Control Option ①

① Option fits in standard unit space.

Table 29.3-10. Option Sizing for Isolating Contactor and Bypass Starter

S811+ Width (mm)	Fused Switch Type (Amperes)	Starter Size	Option Unit Size Inches (mm)	FlashGard Unit Size Inches (mm)	Structure Width Inches (mm)
65	30/60/100	1, 2, 3	36.00 (914.4)	36.00 (914.4)	20.00 (508.0)
110	100	3	42.00 (1066.8)	42.00 (1066.8)	20.00 (508.0)
110	200	4	54.00 (1371.6)	54.00 (1371.6)	20.00 (508.0)
200	400/800	5, 6	72.00 (1828.8)	72.00 (1828.8)	32.00 (812.8)
290	600/800	6	72.00 (1828.8)	72.00 (1828.8)	36.00 (914.4)
290	800/1200	7	72.00 (1828.8)	72.00 (1828.8)	64.00 (1625.6)

Table 29.3-11. FLA Ratings

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
Standard Duty			
300%	30 Seconds	3	Soft start
500%	10 Seconds	3	Full voltage
350%	20 Seconds	3	Wye delta
480%	20 Seconds	2	80% RVAT
390%	20 Seconds	3	65% RVAT
300%	20 Seconds	4	50% RVAT
Severe Duty			
450%	30 seconds	4	Soft start
500%	10 seconds	10	Full voltage
350%	65 seconds	3	Wye delta
480%	25 seconds	4	80% RVAT
390%	40 seconds	4	65% RVAT
300%	60 seconds	4	50% RVAT

SVX9000 Adjustable Frequency Drive Units

All Eaton's standard units include a disconnect, an AC choke, an output reactor and a door-mounted keypad. All plug-in units have a built-in dynamic braking circuit through the FR5 frame size. Drive units that require door-mounted fans also include a CPT.

Note: Output reactor not included on 240 V units.

CT (I_H): High overload drives are capable of producing 200% starting torque for 10 seconds and are rated 150% overload for one minute. Essentially a constant torque drive.

VT (I_L): Low overload drives are capable of producing 200% starting torque for 10 seconds and are rated 110% overload for one minute. Essentially a variable torque drive.

Table 29.3-12. SVX9000 Adjustable Frequency Drives—Dimensions in Inches (mm)

AFD Frame	Unit	Nominal hp	(VT) I_L Amperes	(CT) I_H Amperes	Branch Protection			Min			Typical			Maximum		
					HMCP	T.M.	K-SW	Height	(X)	Width	Height	(X)	Width	Height	(X)	Width
200–240 V																
FR4	Drawout	0.75	3.7	3.7	7	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		1.0	4.8	4.8	15	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		1.5	6.6	6.6	15	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		2.0	7.8	7.8	15	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		3.0	11.0	—	15	25	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		3.0	—	11.0	15	25	30	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
FR5	Drawout	5.0	17.5	17.5	30	40	30	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		7.5	25.0	25.0	50	50	60	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		10.0	31.0	—	50	70	60	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	X6	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
FR6	Drawout	10.0	31.0	31.0	50	60	60	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		15.0	48.0	48.0	100	100	100	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		20.0	61.0	—	100	125	100	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
FR7	Fixed	20.0	—	61.0	100	125	100	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		25.0	75.0	75.0	100	175	200	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		30.0	88.0	88.0	100	220	200	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		35.0	114.0	—	150	285	200	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
380–500 V																
FR4	Drawout	1.0	2.2	2.2	7	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		1.5	3.3	3.3	7	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		2.0	4.3	4.3	7	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		3.0	5.6	5.6	15	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		5.0	7.6	—	15	25	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		5.0	—	7.6	15	25	30	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		7.5	12.0	—	30	25	30	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
FR5	Drawout	7.5	—	12.0	30	25	30	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		10.0	16.0	16.0	30	35	30	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		15.0	23.0	23.0	30	50	60	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		20.0	31.0	—	50	60	60	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
FR6	Drawout	20.0	—	31.0	50	60	60	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		25.0	38.0	38.0	50	80	60	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		30.0	46.0	46.0	100	100	80	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		40.0	61.0	—	100	125	100	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
FR7	Fixed	40.0	—	61.0	100	125	100	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		50.0	72.0	72.0	100	150	100	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		60.0	87.0	87.0	100	175	100	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		75.0	105.0	—	150	225	175	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
FR8	Fixed	75.0	—	105.0	150	225	175	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	32.0 (812.8)
		100.0	140.0	140.0	150	300	200	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	32.0 (812.8)
		125.0	170.0	170.0	250	400	250	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	32.0 (812.8)
		150.0	205.0	—	400	500	350	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	32.0 (812.8)
FR9	Fixed	150.0	—	205.0	400	500	350	72.0 (1828.8)	12X	28.0 (711.2)	—	—	—	72.0 (1828.8)	12X	40.0 (1016.0)
		200.0	261.0	261.0	400	600	450	72.0 (1828.8)	12X	28.0 (711.2)	—	—	—	72.0 (1828.8)	12X	40.0 (1016.0)
		250.0 ①	300.0	—	400	700	500	72.0 (1828.8)	12X	28.0 (711.2)	—	—	—	72.0 (1828.8)	12X	40.0 (1016.0)
FR10	Fixed	250.0	—	300.0	400	700	500	72.0 (1828.8)	12X	64.0 (1625.6)	—	—	—	72.0 (1828.8)	12X	80.0 (2032.0)
		300.0	385.0	385.0	600	800	600	72.0 (1828.8)	12X	64.0 (1625.6)	—	—	—	72.0 (1828.8)	12X	80.0 (2032.0)
		350.0	460.0	460.0	600	1000	800	72.0 (1828.8)	12X	64.0 (1625.6)	—	—	—	72.0 (1828.8)	12X	80.0 (2032.0)
		400.0	520.0	—	1200	1200	800	72.0 (1828.8)	12X	64.0 (1625.6)	—	—	—	72.0 (1828.8)	12X	80.0 (2032.0)
FR11	Fixed	400.0	—	590.0	1200	1200	1000	72.0 (1828.8)	12X	80.0 (2032.0)	—	—	—	—	—	—
		500.0	650.0	650.0	1200	1500	1000	72.0 (1828.8)	12X	80.0 (2032.0)	—	—	—	—	—	—
		550.0	730.0	730.0	1200	1600	1200	72.0 (1828.8)	12X	80.0 (2032.0)	—	—	—	—	—	—
FR12	Fixed	600.0	—	820.0	1200	1600	1200	72.0 (1828.8)	12X	128.0 (3251.2)	—	—	—	—	—	—

① If a 250 hp 40 °C rating is required, then up-size to the FR10. This FR9 sizing is only valid at 30 °C ambient.

Note: FR9 and larger AFD units require a 21.00 inch (533.4 mm) deep enclosure. FR11 and FR12 are non UL designs; consult factory for specific application. In drawout, minimum does not contain an operator panel, typical contains a device panel and room for timers and relays, maximum makes provisions for isolation contactors and bypass. In fixed, minimum contains a device panel and room for timers and relays, maximum makes provisions for isolation contactors and bypass. Consult factory for NEMA 3R sizing.

Table 29.3-13. Adjustable Frequency Drives Passive Filters Addition

Hp (Maximum)	SVX Drive (Amperes)	Passive Input (Amperes)	Height	Unit Space (X)
1	2.2	6	36.0 (914.4)	6X
1.5	3.3	6	36.0 (914.4)	6X
3	5.6	6	36.0 (914.4)	6X
5	7.6	8	36.0 (914.4)	6X
7.5	12	14	36.0 (914.4)	6X
10	16	21	36.0 (914.4)	6X
15	23	27	36.0 (914.4)	6X
20	31	34	36.0 (914.4)	6X
25	38	44	36.0 (914.4)	6X
30	46	52	48.0 (1219.2)	8X
40	61	66	48.0 (1219.2)	8X
50	72	83	48.0 (1219.2)	8X
60	87	103	48.0 (1219.2)	8X
75	105	128	60.0 (1524.0)	10X
100	140	165	60.0 (1524.0)	10X
125	170	208	60.0 (1524.0)	10X
150	205	208	60.0 (1524.0)	10X
200	261	320	72.0 (1828.8)	12X

Note: Passive filters are a separate unit located next to the connected AFD. Passive filters can reduce THD of the connected AFD to 8% or less. Passive filters are not interlocked to the AFD compartment.

Table 29.3-14. SVX9000 Adjustable Frequency Drives in NEMA 3R MCCs —Dimensions in Inches (mm) ①

I_H Amperes	Nominal hp I_H ②	I_L Amperes	Nominal hp I_L	CB Type ③		Unit Space (Typ./Max)	
				HMCP	MCCB	Dim.	(X)
380–500 V							
2.2	1.0	3.3	1.5	7	15	30.00 (762.0)	5X
3.3	1.5	4.3	2.0	7	15	30.00 (762.0)	5X
4.3	2.0	5.6	3.0	7	15	30.00 (762.0)	5X
5.6	3.0	7.6	5.0	15	15	30.00 (762.0)	5X
7.6	5.0	12.0	7.5	15	15	30.00 (762.0)	5X
12.0	7.5	16.0	10.0	30	25	72.00 (1828.8)	12X
16.0	10.0	23.0	15.0	30	35	72.00 (1828.8)	12X
23.0	15.0	31.0	20.0	30	50	72.00 (1828.8)	12X
31.0	20.0	38.0	25.0	50	60	72.00 (1828.8)	12X
38.0	25.0	46.0	30.0	50	80	72.00 (1828.8)	12X
46.0	30.0	61.0	40.0	100	100	72.00 (1828.8)	12X

① This table is common for both Freedom and Freedom FlashGard MCC.
② A separate CPT bucket is provided for all AFDs (1–5 hp) listed in the table.
③ For fusible disconnect, use typical option unit.

Note: Drive units fit into a standard 20.00-inch (508.0 mm) wide structure.

Table 29.3-15. Options

Plug-in Options	
Option Boards ④	
I/O Expander	⑤
Encoder Expander	⑤
Interbus S Communications	⑤
Modbus Communications	⑤
PROFIBUS DP Communications	⑤
LonWorks Communications	⑤
Can Open (Slave) Communications	⑤
DeviceNet Communications	⑥
Johnson Controls N2 Communications	⑤
PROFIBUS DP (D9 Connector)	⑤
EtherNet/IP Communications	⑤
Modbus TCP Communications	⑤
Modbus (D9 Connector)	⑤
Plug-in Control Relays	
One relay	⑦
Two relays	⑦
Three relays	⑧
Other Options	
Automatic bypass circuit	⑨
Bypass drive test switch	⑨
Seven relay 120V control with CPT	⑦
Isolated signal processor	⑤
3–15 PSIG interface	⑤
Dynamic breaking resistors	⑩
Graphics keypad	⑥
Line fuses	⑤⑦
RFI filter	⑥
Deduct to remove output filter	⑪
V1K 2000 ft (610m) Dv/Dt filter	⑧
Output contactor	⑤
Dual overloads	⑤⑧
Three contactor bypass	⑤⑧

④ Up to five option boards may be selected. Please see **Tab 31** for detailed information.
⑤ All options will fit in typical and maximum option unit.
⑥ This option will fit in all units.
⑦ One of these options will fit in 5–30 hp CT at 480 V frame standard units, 1–30 hp CT at 480 V typical and maximum option units.
⑧ All options will fit in maximum option unit.
⑨ Use with bypass option.
⑩ DB resistors are to be mounted by the customer external to the MCC.
⑪ Not available for 240V units.

Note: Output reactor or Dv/Dt filter not required for motor lead lengths shorter than 100 feet (30.4 m)—30 feet (9.1 m) for 2 hp and below).

Note: Maximum motor lead length is 160 feet (48.8 m) for 1.5 hp and below, 330 feet (100.6 m) for 2 hp and 400 feet (121.9 m) for 3 hp and larger when using a standard output reactor.

Note: Motor lead lengths up to 2000 feet (609.6 m) can be achieved by using a Dv/Dt filter.

CPX9000 Clean Power Drives 1–500 hp at 480V

Eaton's CPX9000 Clean Power Drives use advanced 18-pulse, clean-power technology that significantly reduces line harmonics at the drive input terminals, resulting in one of the purest sinusoidal waveforms.

I_H (CT): High overload drives are capable of producing 200% starting torque for 10 seconds and are rated 150% overload for one minute. Essentially a constant torque drive.

I_L (VT): Low overload drives are capable of producing 200% starting torque for 10 seconds and are rated 110% overload for one minute. Essentially a variable torque drive.

Table 29.3-16. CPX9000 Low Overload Clean Power Drives, Thermal-Magnetic Breaker and Motor Circuit Protector (MCP) Disconnect —Dimensions in Inches (mm)

Low Overload Drive ①		High Overload Drive ①		CB Type ②		Standard Unit Space Dimensions Inches (mm) ③			
I_L Amperes	Nominal hp I_L	I_H Amperes	Nominal hp I_H	HMCP	MCCB	Width	Height	Depth	(X)
34	25 ④	27	20 ④	50	80	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
40	30 ④	34	25 ④	100	100	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
52	40 ④	40	30 ④	100	125	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
65	50 ④	52	40 ④	100	150	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
77	60 ④	65	50 ④	100	175	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
96	75 ④	77	60 ④	150	225	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
124	100 ④	96	75 ④	150	300	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
156	125 ④	124	100 ④	250	400	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
180	150 ④	156	125 ④	400	400	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
240	200	180	150	600	600	60.00 (1524.0)	90.00 (2286.0)	21.00 (533.4)	12X
302	250	240	200	600	600	60.00 (1524.0)	90.00 (2286.0)	21.00 (533.4)	12X
361	300 ⑤	302	250 ⑤	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
414	350 ⑤	361	300 ⑤	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
477	400 ⑤	414	350 ⑤	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
515	450 ⑤	477	400 ⑤	1200	1200	106.00 (2692.4)	90.00 (2286.0)	28.00 (711.2)	12X
590	500 ⑤	515	450 ⑤	1200	1200	106.00 (2692.4)	90.00 (2286.0)	28.00 (711.2)	12X

① The CPX9000 drive uses the term Low Overload (I_L) in place of the term "Variable Torque" and High Overload (I_H) in place of the term "Constant Torque."
② CPX9000 Drives in MCCs are available in thermal-magnetic breaker, motor circuit protector and fused disconnect configurations.
③ A minimum clearance of 4.00 inches (101.6 mm) should be provided at the back of CPX9000 Drive MCC section for ventilation.
④ Add 32.00 inches (812.8 mm) of width for bypass.
⑤ Required transformer section is 28.00 (711.2) deep. CPX and bypass is 21.00 (533.4) deep.

Table 29.3-17. CPX9000 Low Overload Clean Power Drives, Fusible Switch Disconnect—Dimensions in Inches (mm)

Low Overload Drive ⑥		High Overload Drive ⑥		Fuse Switch		Standard Unit Space Dimensions Inches (mm) ⑦			
I_L Amperes	Nominal hp I_L	I_H Amperes	Nominal hp I_H	Fuse	Switch	Width	Height	Depth	(X)
34	25 ⑧	27	20 ⑧	50	60	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
40	30 ⑧	34	25 ⑧	60	60	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
52	40 ⑧	40	30 ⑧	80	100	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
65	50 ⑧	52	40 ⑧	100	100	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
77	60 ⑧	65	50 ⑧	100	100	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
96	75 ⑧	77	60 ⑧	100	100	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
124	100 ⑧	96	75 ⑧	175	200	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
156	125 ⑧	124	100 ⑧	200	200	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
180	150 ⑧	156	125 ⑧	250	400	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
240	200	180	150	350	600	60.00 (1524.0)	90.00 (2286.0)	21.00 (533.4)	12X
302	250	240	200	450	600	60.00 (1524.0)	90.00 (2286.0)	21.00 (533.4)	12X
361	300 ⑨	302	250 ⑨	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
414	350 ⑨	361	300 ⑨	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
477	400 ⑨	414	350 ⑨	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
515	450 ⑨	477	400 ⑨	800	1200	106.00 (2692.4)	90.00 (2286.0)	28.00 (711.2)	12X
590	500 ⑨	515	450 ⑨	800	1200	106.00 (2692.4)	90.00 (2286.0)	28.00 (711.2)	12X

⑥ The CPX9000 product uses the term Low Overload (I_L) in place of the term "Variable Torque" and High Overload (I_H) in place of the term "Constant Torque."
⑦ A minimum clearance of 4.00 inches (101.6 mm) should be provided at the back of CPX9000 Drive MCC section for ventilation.
⑧ Add 32.00 inches (812.8 mm) of width for bypass.
⑨ Required transformer section is 28.00 (711.2) deep. CPX and bypass is 21.00 (533.4) deep.

Table 29.3-18. Main Incoming Line and Feeder Circuit Breakers—Molded-Case Circuit Breakers—Dimensions in Inches (mm)

Frames reflect standard circuit breakers. Unit spacings shown include sufficient space to terminate cables on any standard breaker lug. If cable sizes exceed those listed, add 12.00-inch (304.8 mm) space for lug adapters.

Frame Size (Amperes)	Circuit Breaker Frame	Interrupting Capacity (kAIC)			Main Unit Size		Feeder Unit Size		Maximum Cable Size ①
		240 V	480 V	575 V	Inches (mm)	X Space	Inches (mm)	X Space	
125 150	E125H HFD	100 100	65 65	25 25	12.00 (304.8) 18.00 (457.2)	2X 3X	12.00 (304.8) 12.00 (304.8)	1X ⑦ or 2X 2X	4/0 (one per phase) 4/0 (one per phase)
150 225	FDC HFD	100 100	100 65	35 25	18.00 (457.2) 18.00 (457.2)	3X 3X	12.00 (304.8) 18.00 (457.2)	2X 3X	4/0 (one per phase) 4/0 (one per phase)
225	J250 FDC	100 100	100 100	25 35	18.00 (457.2)	3X	18.00 (457.2)	1X ⑦ or 3X	4/0 (one per phase)
250	J250 JDC	100 100	65 100	25 35	24.00 (609.6) 30.00 (762.0)	4X 5X	18.00 (457.2)	3X	350 kcmil (one per phase)
400	HKD KDC	100 100	65 100	35 50	30.00 (762.0)	5X	30.00 (762.0)	4X	250 kcmil (two per phase) or 500 kcmil (one per phase)
	CHKD ② CKDC ②	100 100	65 100	35 50	30.00 (762.0)	5X	30.00 (762.0)	5X	
600	HLD LDC	100 100	65 100	35 50	24.00 (609.6)	4X	30.00 (762.0)	5X	500 kcmil (two per phase)
	CHLD ②③ CLDC ②③	100 100	65 100	35 50		4X	24.00 (609.6)	4X	
800	NGC	100	100	50	42.00 (1066.8)	7X	42.00 (1066.8)	7X	750 kcmil (three per phase)
	NGH-C ② NGC-C ②	100 100	65 100	35 50	72.00 (1828.8)	12X	72.00 (1828.8)	12X	
1200	NGH ④ NGC ④	100 100	65 100	35 50	42.00 (1066.8)	7X	42.00 (1066.8)	7X	750 kcmil (three per phase)
	NGH-C ②③ NGC-C ②③	100 100	65 100	35 50	72.00 (1828.8)	12X	72.00 (1828.8)	12X	
2000	RGH ④ RGC ③ RGH-C ② RGC-C ②	100 100 100 100	65 100 65 100	50 65 50 65	72.00 (1828.8) ⑤	12X	72.00 (1828.8)	12X	750 kcmil (six per phase)
2500	RGH RGC	100 100	65 65	50 50	72.00 (1828.8) ⑤⑥	12X	72.00 (1828.8)	12X	750 kcmil (six per phase)

① See circuit breaker terminal data for variations.
② Digitrip 310+ LS is required and included in the price.
③ NEMA 1 gasketed only.
④ Digitrip 310+ LS is standard and included in the pricing.
⑤ The main breaker requires the complete vertical section. The rear is unusable.
⑥ 24.00-inch (609.6 mm) wide.
⑦ Compact feeder units.

Table 29.3-19. Main Circuit Breakers—Magnum DS Air Circuit Breakers Manually or Electrically Operated —Fixed Mounted—Dimensions in Inches (mm)

Frame Size Amperes	Circuit Breaker Type	Interrupting Capacity (kAIC)			Unit Size	Enclosure Width	Enclosure Depth
		240 V	480 V	575 V			
800	MDS-608 MDS-C08	65 100	65 100	65 100	72.00 (1828.8)	24.00 (609.6)	21.00 (533.4)
1600	MDS-616 MDS-C16	65 100	65 100	65 100			
2000	MDS-620 MDS-C20	65 100	65 100	65 100			

Note: A 4.00-inch (101.6 mm) filler section must be added between the main and the rest of the MCC to allow for door opening.

Table 29.3-20. Main Circuit Breakers —Magnum DS Air Circuit Breakers, Manually or Electrically Operated —Drawout Mounted—Dimensions in Inches (mm)

Frame Size (Amperes)	Circuit Breaker Type	Interrupting Capacity (kAIC)			Unit Size	Enclosure Width	Enclosure Depth
		240 V	480 V	575 V			
800	MDS-608 MDS-C08	65 100	65 100	65 100	72.00 (1828.8)	24.00 (609.6) ①	42.00 (1066.8) ②
1600	MDS-616 MDS-C16	65 100	65 100	65 100			
2000	MDS-620 MDS-C20	65 100	65 100	65 100			
3200	MDS-632 MDS-C32	65 100	65 100	65 100			

① A 4.00-inch (101.6 mm) filler section must be added between the main and the rest of the MCC to allow for door opening.
② Structure is rear aligned.

Table 29.3-21. Digitrip Units

Type		Unit Space Inches (mm)
RMS 310–1150	Refer to **Page 21.4-10** for more details.	—
Options		
Tie breaker ③ Electrically operated		72.00 (1828.8) or 12X —
Accessories		
UV release-instantaneous Shunt trip (standard on electrically operated breakers) Key interlock on breaker		— — —
Auxiliary switch (3A/3B) Cell position switch Operations counter		— — —
Auxiliary power module (to test Digitrip) Portable lift truck Manual close pushbutton cover		— — —

③ Tie breaker adds an additional 20.00-inch (508.0 mm) wide bus transition section. Also two 4.00-inch (101.6 mm) filler sections will be added to the MCC if the tie breaker is located in the center of the MCC lineup. If the tie breaker is located between the two main structures, the two 4.00-inch (101.6 mm) fillers are not needed.

Table 29.3-22. Main-Tie-Main Auto Throw-Over Options

Option	Description
AT200	Standard PLC-based control scheme. No operator interface (PanelMate) provided. Sequence of operations and external controls are pre-defined and not subject to customer modifications. Type of voltage sensing device must be chosen. If closed-transition operation is required, a sync-check relay (device 25) must be used.
AT300	Same as AT200, except includes operator interface (PanelMate). ④
AT300X	Same as AT200, except customer modifications are acceptable. This is the proper choice for PLC-based systems with special sequences, more than main-tie-main configurations, and/or where special PanelMate page layouts are required.
AT300IQ	Standard Automatic Transfer Control (ATC) controller-based control scheme for main-main configurations. Either or both sources may be generators. Includes manual-auto operation, and generator control switch. If closed-transition operation is required, a sync-check relay (device 25) must be used.

④ Operator interface page layouts are pre-defined and not subject to customer modifications.

Table 29.3-23. Freedom Main Incoming Line and Feeder Fusible Switches—Dimensions in Inches (mm)

Three-pole—250 V or 600 Vac. Fuses not included.

Switch Rating ⑤ Amps ⑥	Fuse Clip Size Amps	Unit Space			
		Incoming Line		Feeder	
		Inches (mm)	X Space	Inches (mm)	X Space
30	30	18.00 (457.2)	3X	12.00 (304.8)	2X
60	60	18.00 (457.2)	3X	12.00 (304.8)	2X
30/30 Dual	30/30 Dual	—	—	12.00 (304.8)	2X
30/60 Dual	30/60 Dual	—	—	12.00 (304.8)	2X
60/60 Dual	60/60 Dual	—	—	12.00 (304.8)	2X
100	100	18.00 (457.2)	3X	18.00 (457.2)	3X
200	200	30.00 (762.0)	5X	30.00 (762.0)	5X
400	400	48.00 (1219.2)	8X	42.00 (1066.8)	7X
600	600	54.00 (1371.8) ⑧	9X ⑧	48.00 (1219.2)	8X
800	800	48.00 (1219.2) ⑨	8X ⑨	48.00 (1219.2) ⑩	8X ⑩
1200 ⑦	1200	60.00 (1524.0)	10X	60.00 (1524.0)	10X

⑤ Suitable for 100,000 A interrupting if Class RK fuses are used.
⑥ Type of SW K-SW 30–800 A.
⑦ High magnetic molded-case switch.
⑧ For bottom cable entry, add 6.00 inches (152.4 mm) or 1X space.
⑨ For bottom entry, add 12.00 inches (304.8 mm) or 2X space.
⑩ For top entry, add 6.00 inches (152.4 mm) or 1X space.

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Freedom Arc Resistant

Freedom Arc Resistant Motor Control Center

General Description

Eaton's Freedom Arc Resistant motor control center is the first MCC to be tested to a North American guideline specifically written for low voltage MCCs, unlike C37.20.7 that is a guideline for testing metal-enclosed switchgear up to 38 kV. Eaton's Freedom Arc Resistant motor control center is tested in accordance with CSA C22.2 No. 0.22-11 titled "Evaluation methods for arc resistant ratings of enclosed electrical equipment".

Quick Reference Layout Guide Index

Technical Data

Table 29.4-1. Short-Circuit Ratings for Motor Control (480 V)

Short-Circuit Protective Device	Combination Starter FV and RV (kA)	Solid-State Reduced Voltage (kA)	Adjustable Frequency Drives (kA)
HMCP motor circuit protector (standard rating) HMCP motor circuit protector (optional rating)	65 100	65 100	65 100
MCCB molded-case circuit breaker (standard rating) MCCB molded-case circuit breaker (optional rating) Fusible switch	65 100 100	65 — 100	65 100 100

Table 29.4-2. Combination Starters with Series C Motor Circuit Protectors or Molded-Case Circuit Breakers

Motor circuit protector ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

NEMA Size	Maximum Horsepower					HMCP/HMCPE Frame ①②	MCCB Frame ③	Freedom Arc Resistant Unit Size	
	208 V	240 V	380 V	480 V	600 V			Inches (mm)	X Space
Full Voltage Non-Reversing								**Type F206**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	6.00 (152.4) ④ 12.00 (304.8) ⑤ 18.00 (457.2)	1X ④ 2X ⑤ 3X
2	10	15	25	25	25	125 150	E HFD/FDC	6.00 (152.4) ④ 12.00 (304.8) ⑤ 18.00 (457.2)	1X ④ 2X ⑤ 3X
3	25	30	50	50	50	125 150	E HFD/FDC	12.00 (304.8) ④ 18.00 (457.2) ⑥ 24.00 (609.6)	2X ④ 3X ⑥ 4X
4	40	50	75	100	100	150	HFD/FDC HJD/JDC	12.00 (304.8) ⑦ 18.00 (457.2) ⑥⑦ 24.00 (609.6) ⑦	2X 3X ⑥ 4X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	36.00 (914.4)	6X
Full Voltage Reversing								**Type F216**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	18.00 (457.2) ⑥ 24.00 (609.6)	3X ⑥ 4X
2	10	15	25	25	25	125 150	E HFD/FDC	18.00 (457.2) ⑥ 24.00 (609.6)	3X ⑥ 4X
3	25	30	50	50	50	125/150	HFD/FDC/E	24.00 (609.6) ⑧	6X
4	40	50	75	100	100	150	HJD/JDC	30.00 (762.0) ⑧	5X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	60.00 (1524.0)	10X

① Standard combination starter units with HMCP/HMCPE magnetic only disconnect have short-circuit ratings of 65,000 A at 480 V. Optional HMCP/HMCPE combination starter units are available with 100,000 A at 480 V.
② E-Frame motor circuit protection available for size 1–3 starters only.
③ Optional combination starter units with thermal-magnetic breaker disconnects are available with either 65,000 or 100,000 A at 480 V.
④ Maximum of (three) pilot devices, (two) auxiliary contacts 100 VA CPT maximum. Standard lugs only.
⑤ 1200 A HMCP frame available in 11X 66.00-inch (1676.4 mm).
⑥ For top entry, 8X space required.
⑦ Requires 28.00-inch (711.2 mm) wide structure.
⑧ 30.00-inch (762.0 mm) space needed for thermal-magnetic circuit breaker.

Table 29.4-2. Combination Starters with Series C Motor Circuit Protectors or Molded-Case Circuit Breakers (Continued)
Motor circuit protector ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

NEMA Size	Maximum Horsepower					HMCP Frame ①②	MCCB Frame ②③	Freedom Arc Resistant Unit Size	
	208 V	240 V	380 V	480 V	600 V			Inches (mm)	X Space
Two-Speed One Winding, Constant/Variable Torque								**Type F946**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	24.00 (609.6) ④	4X
2	10	15	25	25	25	125 150	E HFD/FDC	24.00 (609.6) ④	4X
3	25	30	50	50	50	125 150	E HJD/JDC	36.00 (914.4) ④⑤	6X
4	40	50	75	100	100	150 250	HFD/FDC HJD/JDC	36.00 (914.4) ④⑤	6X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72.00 (1828.8) ⑥	12X
Two-Speed Two Winding, Constant/Variable Torque								**Type F956**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	24.00 (609.6) ④	4X
2	10	15	25	25	25	125 150	E HFD/FDC	24.00 (609.6) ④	4X
3	25	30	50	50	50	125 150	E HFD/FDC	30.00 (762.0) ④	5X
4	30 40	40 50	60 75	75 100	100 —	150 250	HFD/FDC HJD/JDC	30.00 (762.0) ④ 30.00 (762.0) ④	5X 5X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72.00 (1828.8) ⑥	12X
Reduced Voltage Autotransformer								**Type F606**	
2	10	15	25	25	25	150	HFD/FDC	36.00 (914.4)	6X
3	25	30	50	50	50	150	HFD/FDC	54.00 (1371.6)	9X
4	30	50	75	100	100	150	HJD/JDC	54.00 (1371.6)	9X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72.00 (1828.8)	12X
Reduced Voltage Part Winding								**Type F706**	
1PW	10	10	15	15	15	150	HFD/FDC	24.00 (609.6) ⑧	4X
2PW	20	25	40	40	40	150	HFD/FDC	24.00 (609.6) ⑧	4X
3PW	40	50	75	75	75	150	HFD/FDC	30.00 (762.0) ⑧	5X
4PW	— 60 75	— 60 75	— 125 150	100 150 —	125 150 —	150 250 400	HFD/FDC HJD/JDC HKD/KDC	36.00 (914.4) ⑧	6X
5PW	100 150	125 150	— 250	250 350	300 350	400 600	HKD/KDC HLD/LDC	72.00 (1828.8) ⑦	12X

① Standard combination starter units with HMCP/HMCPE Magnetic Only disconnect have short-circuit ratings of 65,00 0A at 480 V. Optional HMCP/HMCPE combination starter units are available with 100,000 A at 480 V.
② E-Frame motor circuit protector available through size 3 starter only.
③ Optional combination starter units with thermal-magnetic breaker disconnects are available with either 65,000 or 100,000 A at 480 V.
④ Add 6.00-inch (152.4 mm) space for low speed disconnect.
⑤ 42.00-inch (1066.8 mm) space needed with Thermal-magnetic circuit breaker. 48.00-inch (1219.2 mm) space needed with thermal-magnetic circuit breaker.
⑥ Requires 28.00-inch (711.2 mm) wide structure.
⑦ Requires 21.00-inch (533.4 mm) deep, 28.00-inch (711.2 mm) wide structure.
⑧ For starting speed disconnect, add 6.00-inch (152.4 mm) space.

Table 29.4-2. Combination Starters with Series C Motor Circuit Protectors or Molded-Case Circuit Breakers (Continued)
Motor circuit protector ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

NEMA Size	Maximum Horsepower					HMCP Frame ①②	MCCB Frame ②③	Freedom Arc Resistant	
								Unit Size	
	208 V	240 V	380 V	480 V	600 V			Inches (mm)	X Space
Reduced Voltage Wye Delta Open Transition ④								**Type F806**	
2YD	20	25	40	40	40	150	HFD/FDC	30.00 (762.0)	5X
3YD	30 40	40 50	75 —	75 —	5 —	150 250	HFD/FDC HJD/JDC	42.00 (1066.8)	7X
4YD	60 —	75 —	125 150	150 —	150 —	250 400	HJD/JDC HKD/KDC	42.00 (1066.8)	7X
5YD	100 150	125 150	200 250	250 300	300 —	400 600	HKD/KDC HLD/LDC	72.00 (1828.8) ④	12X
Reduced Voltage Wye Delta Closed Transition ④								**Type F896**	
2YD	20	25	40	40	40	150	HFD/FDC	42.00 (1066.8)	7X
3YD	40	50	—	—	—	250	HFD/FDC	54.00 (1371.6)	9X
4YD	60 —	75 —	125 150	150 —	150 —	250 400	HJD/JDC HKD/KDC	60.00 (1524.0)	10X
5YD	100 150	125 150	200 250	250 300	300 —	400 600	HKD/KDC HLD/LDC	72.00 (1828.8) ④	12X

① Standard combination starter units with HMCP/HMCPE magnetic only disconnect have short-circuit ratings of 65,000 A at 480 V. Optional HMCP/HMCPE combination starter units are available with 100,000 A at 480 V.
② E-Frame motor circuit protector available through size 3 starter only.
③ Optional combination starter units with thermal-magnetic breaker disconnects are available with either 65,000 or 100,000 A at 480 V.
④ Requires 21.00-inch (533.4 mm) deep, 28.00-inch (711.2 mm) wide structure.

S811+ Solid-State Reduced Voltage Starter

Eaton's S811+ solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The S811+ solid-state starter has five 24 Vdc inputs and two relay outputs. S811+ soft start units include a disconnect, starter, 24 Vdc power supply and 100 VA CPT.

Motor Service Factor (SF) Effect on S811+ Starter Selection

- A 1.0 service factor motor may draw up to 1.00 x full load amperes
- A 1.15 service factor motor may draw up to 1.15 x full load amperes (15% more current). This chart is based off of a 1.15 SF motor selection
- S811+ starters are current rated devices. In some cases, a larger S811+ SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below

Table 29.4-3. Standard-Duty and Severe-Duty Ratings ①

S811+ Amperage	S811+ Frame	208 V			230 V			380 V			460 V			575 V			Inches (mm)	X Space
		hp	HMCP	T.M.	hp	HMCP	T.M.	hp	HMCP	T.M.	hp	HMCP	T.M.	hp	HMCP	T.M.		
37 66	65 65	10 15	50 100	70 125	10 20	50 100	70 125	15 100	50 50	70 150	20 40	50 100	70 150	30 50	50 100	80 150	18.00 (457.2)	3X
105 135	110 110	30 40	150 150	225 225	30 40	150 150	200 250	150 150	75 100	150 250	60 75	150 150	150 250	75 100	150 150	200 250	18.00 (457.2)	3X
180 240 304	200 200 200	50 60 75	250 250 400	400 400 600	60 75 100	250 250 400	350 450 600	250 110 132	150 200 250	350 500 600	125 150 200	250 400 400	400 500 600	150 200 250	250 250 400	350 400 600	36.00 (914.4)	6X
Severe Duty																		
22 42	65 65	5 10	— —	70 125	5 10	— —	70 125	7.5 18.5	— —	60 150	10 25	— —	60 150	15 30	— —	70 125	18.00 (457.2)	3X
65 80	110 110	15 20	— —	200 225	20 25	— —	200 300	22 37	— —	150 300	40 50	— —	150 250	50 60	— —	200 250	18.00 (457.2)	3X
115 150 192	200 200 200	30 40 50	— — —	300 350 400	30 50 60	— — —	350 400 500	55 — 90	— — —	300 — 500	75 100 125	— — —	300 400 500	100 125 150	— — —	300 400 400	36.00 (914.4)	6X

① Standard-duty ratings reflect the maximum starting duty that these units are designed to supply.

Table 29.4-4. Option Sizing—Dimensions in Inches (mm)

S811+ Width (mm)	Disconnect Type	Starter Size	Option Unit Size ②	Structure Width
Isolating Contactor				
65 110 110	HMCP, MCCB HMCP, MCCB HMCP, MCCB	1, 2, 3 3, 4 5	30.00 (762.0) 36.00 (914.4) 54.00 (1371.6)	20.00 (508.0) 20.00 (508.0) 20.00 (508.0)
200 290 290	HMCP, MCCB HMCP, MCCB HMCP, MCCB	5,6 6 7	72.00 (1828.8) ③ 72.00 (1828.8) ③ 72.00 (1828.8) ③	20.00 (508.0) 32.00 (812.8) 48.00 (1219.2)
Bypass Starter				
65 110 110 200	HMCP, MCCB HMCP, MCCB HMCP, MCCB HMCP, MCCB	1, 2, 3 3, 4 5 5, 6	30.00 (762.0) 36.00 (914.4) 54.00 (1371.6) 72.00 (1828.8) ③	20.00 (508.0) 20.00 (508.0) 20.00 (508.0) 24.00 (609.6)

② Option fits in standard unit space.
③ Fixed assemblies, no RotoTract.

Table 29.4-5. Control Options

Extra 50 VA Control Power Transformer ④⑤
24 Vdc Control ④
Line or Load MOV Protection ④
Pump Control Option ④

④ Option fits in standard unit space.
⑤ Option adds 6.00 inches (152.4 mm) (1X) to 37 and 66 A units.

Table 29.4-6. FLA Ratings

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
Standard Duty			
300% 500% 350%	30 seconds 10 seconds 20 seconds	3 3 3	Soft start Full voltage Wye delta
480% 390% 300%	20 seconds 20 seconds 20 seconds	2 3 4	80% RVAT 65% RVAT 50% RVAT
Severe Duty			
450% 500% 350%	30 seconds 10 seconds 65 seconds	4 10 3	Soft start Full voltage Wye delta
480% 390% 300%	25 seconds 40 seconds 60 seconds	4 4 4	80% RVAT 65% RVAT 50% RVAT

29

SVX9000 Adjustable Frequency Drive Units

All Eaton's standard units include a disconnect, an AC choke, an output reactor and a door-mounted keypad. All plug-in units have a built-in dynamic braking circuit through the FR5 frame size. Drive units that require door-mounted fans also include a CPT.

Note: Output reactor not included on 240 V units.

CT (I_H): High overload drives are capable of producing 200% starting torque for 10 seconds and are rated 150% overload for one minute. Essentially a constant torque drive.

VT (I_L): Low overload drives are capable of producing 200% starting torque for 10 seconds and are rated 110% overload for one minute.Essentially a variable torque drive.

Table 29.4-7. SVX9000 Adjustable Frequency Drives —Dimensions in Inches (mm)

AFD Frame	Unit	Nominal hp	(VT) I_L Amperes	(CT) I_H Amperes	Branch Protection		Minimum			Typical			Maximum		
					HMCP	T.M.	Height	(X)	Width	Height	(X)	Width	Height	(X)	Width
200–240 V															
FR4	Drawout	0.75	3.7	3.7	7	15	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		1.0	4.8	4.8	15	15	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		1.5	6.6	6.6	15	15	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		2.0	7.8	7.8	15	15	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		3.0	11.0	—	15	25	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		3.0	—	11.0	15	25	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
FR5	Drawout	5.0	17.5	17.5	30	40	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		7.5	25.0	25.0	50	50	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		10.0	31.0	—	50	70	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
FR6	Drawout	10.0	31.0	31.0	50	60	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		15.0	48.0	48.0	100	100	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		20.0	61.0	—	100	125	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
FR7	Fixed	20.0	—	61.0	100	125	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		25.0	75.0	75.0	100	175	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		30.0	88.0	88.0	100	220	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		35.0	114.0	—	150	285	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
380–500 V															
FR4	Drawout	1.0	2.2	2.2	7	15	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		1.5	3.3	3.3	7	15	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		2.0	4.3	4.3	7	15	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		3.0	5.6	5.6	15	15	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		5.0	7.6	—	15	25	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		5.0	—	7.6	15	25	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		7.5	12.0	—	30	25	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
FR5	Drawout	7.5	—	12.0	30	25	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		10.0	16.0	16.0	30	35	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		15.0	23.0	23.0	30	50	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		20.0	31.0	—	50	60	24.0 (609.6)	4X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
FR6	Drawout	20.0	—	31.0	50	60	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		25.0	38.0	38.0	50	80	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		30.0	46.0	46.0	100	100	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		40.0	61.0	—	100	125	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
FR7	Fixed	40.0	—	61.0	100	125	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		50.0	72.0	72.0	100	150	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		60.0	87.0	87.0	100	175	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		75.0	105.0	—	150	225	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
FR8	Fixed	75.0	—	105.0	150	225	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	—	—	—
		100.0	140.0	140.0	150	300	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	—	—	—
		125.0	170.0	170.0	250	400	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	—	—	—
		150.0	205.0	—	400	500	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	—	—	—

Note: In drawout, minimum does not contain an operator panel, typical contains a device panel and room for timers and relays, maximum makes provisions for isolation contactors and bypass. In fixed, minimum contains a device panel and room for timers and relays, maximum makes provisions for isolation contactors and bypass.

Table 29.4-8. Adjustable Frequency Drives Passive Filters Addition

Hp (Maximum)	SVX Drive (Amperes)	Passive Input (Amperes)	Height	Unit Space (X)
1	2.2	6	36.0 (914.4)	6X
1.5	3.3	6	36.0 (914.4)	6X
3	5.6	6	36.0 (914.4)	6X
5	7.6	8	36.0 (914.4)	6X
7.5	12	14	36.0 (914.4)	6X
10	16	21	36.0 (914.4)	6X
15	23	27	36.0 (914.4)	6X
20	31	34	36.0 (914.4)	6X
25	38	44	36.0 (914.4)	6X
30	46	52	48.0 (1219.2)	8X
40	61	66	48.0 (1219.2)	8X
50	72	83	48.0 (1219.2)	8X
60	87	103	48.0 (1219.2)	8X
75	105	128	60.0 (1524.0)	10X
100	140	165	60.0 (1524.0)	10X
125	170	208	60.0 (1524.0)	10X
150	205	208	60.0 (1524.0)	10X

Note: Passive filters are a separate unit located next to the connected AFD. Passive filters can reduce THD of the connected AFD to 8% or less.

Table 29.4-9. Options

Plug-in Options	
Option Boards ①	
I/O Expander	②
Encoder Expander	②
Interbus S Communications	②
Modbus Communications	②
PROFIBUS DP Communications	②
LonWorks Communications	②
Can Open (Slave) Communications	②
DeviceNet Communications	③
Johnson Controls N2 Communications	②
PROFIBUS DP (D9 Connector)	②
EtherNet/IP Communications	②
Modbus TCP Communications	②
Modbus (D9 Connector)	②
Plug-in Control Relays	
One relay	④
Two relays	④
Three relays	⑤
Other Options	
Automatic bypass circuit	⑥
Bypass drive test switch	⑥
Seven relay 120V control with CPT	④
Isolated signal processor	②
3–15 PSIG interface	②
Dynamic breaking resistors	⑦
Graphics keypad	③
Line fuses	②④
RFI filter	③
Deduct to remove output filter	⑧
V1K 2000 ft (610 m) Dv/Dt filter	⑤
Output contactor	②
Dual overloads	②⑤
Three contactor bypass	②⑤

① Up to five option boards may be selected. Please see **Tab 31** for detailed information.
② All options will fit in typical and maximum option unit.
③ This option will fit in all units.
④ One of these options will fit in 5–30 hp CT at 480 V frame standard units, 1–30 hp CT at 480 V typical and maximum option units.
⑤ All options will fit in maximum option unit.
⑥ Use with bypass option.
⑦ DB resistors are to be mounted by the customer external to the MCC.
⑧ Not available for 240 V units.

Note: Output reactor or Dv/Dt filter not required for motor lead lengths shorter than 100 feet (30.4 m)—30 feet (9.1 m) for 2 hp and below).

Note: Maximum motor lead length is 160 feet (48.8 m) for 1.5 hp and below, 330 feet (100.6 m) for 2 hp and 400 feet (121.9 m) for 3 hp and larger when using a standard output reactor.

Note: Motor lead lengths up to 2000 feet (609.6 m) can be achieved by using a Dv/Dt filter.

29

Table 29.4-10. Main Incoming Line and Feeder Circuit Breakers—Molded-Case Circuit Breakers—Dimensions in Inches (mm)

Frames reflect standard circuit breakers. Unit spacings shown include sufficient space to terminate cables on any standard breaker lug. If cable sizes exceed those listed, add 12.00-inch (304.8 mm) space for lug adapters.

Frame Size (Amperes)	Circuit Breaker Frame	Interrupting Capacity (kAIC)			Main Incoming Size		Feeder Unit Size		Maximum Cable Size ①
		240 V	480 V	575 V	Inches (mm)	X Space	Inches (mm)	X Space	
125	E125H	65	65	25	12.00 (3048.8)	2X	12.00 (304.8)	1X ② or 2X	4/0 (one per phase)
150	HFD	65	65	25	18.00 (457.2)	3X	12.00 (304.8)	2X	4/0 (one per phase)
225	HFD	65	65	25	18.00 (457.2)	3X	18.00 (457.2)	3X	4/0 (one per phase)
225	J250	65	65	25	24.00 (609.6)	4X	18.00 (457.2)	1X ② or 3X	4/0 (one per phase)
250	J250	65 65	65 65	25 35	30.00 (762.0) 30.00 (762.0)	5X 5X	18.00 (457.2)	3X	350 kcmil (one per phase)
400	HKD	65	65	35	30.00 (762.0)	5X	30.00 (762.0)	4X	250 kcmil (two per phase) or 500 kcmil (one per phase)
600	HLD	65	65	35	72.00 (1828.8)	12X	30.00 (762.0)	5X	500 kcmil (two per phase)
800	NGH ③	65	65	50	72.00 (1828.8)	12X	42.00 (1066.8)	12X	750 kcmil (three per phase)
1200	NGH ③	65	65	35	72.00 (1828.8)	12X	42.00 (1066.8)	12X	750 kcmil (three per phase)
2000	RGH ③	65	65	50	72.00 (1828.8)	12X	72.00 (1828.8) ④	12X	750 kcmil (six per phase)
2500	RGH ③	65	65	50	72.00 (1828.8)	12X	72.00 (1828.8) ④⑤	12X	750 kcmil (six per phase)

29

① See circuit breaker terminal data for variations.
② Compact feeder units.
③ Digitrip 310+ LS is standard and included in the pricing.
④ The main breaker requires the complete vertical section. The rear is unusable.
⑤ 24.00-inch (609.6 mm) wide.

Freedom FlashGard

Freedom FlashGard Motor Control Center

General Description

Eaton's Freedom FlashGard MCCs are an industry first in addressing the dangers associated with an arc flash event by minimizing the risk of arc flash exposure. Freedom FlashGard offers features to help prevent injury from electric shock, arc-flash burn and arc-blast impacts, and is the first arc preventative MCC.

Quick Reference Layout Guide Index

The FlashGard motor control center uses a patented technology for arc flash prevention called the RotoTract, which allows the user to retract the stabs from the bus from behind a deadfront. The RotoTract is described more in section 29.1-8 under the Freedom FlashGard Stab Assembly heading. The RotoTract is a movable stab that can be installed on any MCC unit 20.00 inches wide and less than 400 A of ampacity and is a drawout unit. Fixed units do not have the RotoTract nor do units wider than 20.00 inches.

Technical Data

Table 29.5-1. Short-Circuit Ratings for Motor Control (480 V)

Short-Circuit Protective Device	Combination Starter FV and RV (kA)	Solid-State Reduced Voltage (kA)	Adjustable Frequency Drives (kA)
HMCP motor circuit protector (standard rating) HMCP motor circuit protector (optional rating)	65 100	65 100	65 100
MCCB molded-case circuit breaker (standard rating) MCCB molded-case circuit breaker (optional rating) Fusible switch	65 100 100	65 — 100	65 100 100

Table 29.5-2. Combination Starters with Series C Motor Circuit Protectors or Molded-Case Circuit Breakers

Motor circuit protector ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

29

NEMA Size	Maximum Horsepower					HMCP/HMCPE Frame ①②	MCCB Frame ③	Freedom FlashGard Unit Size	
	208 V	240 V	380 V	480 V	600 V			Inches (mm)	X Space
Full Voltage Non-Reversing								**Type F206**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	12.00 (304.8) ④ 18.00 (457.2)	2X ④ 3X
2	10	15	25	25	25	125 150	E HFD/FDC	12.00 (304.8) ④ 18.00 (457.2)	2X ④ 3X
3	25	30	50	50	50	125 150	E HFD/FDC	18.00 (457.2) ⑤ 24.00 (609.6)	3X ⑤ 4X
4	40	50	75	100	100	150	HFD/FDC HJD/JDC	24.00 (609.6) ⑥ 30.00 (762.0) ⑦	4X ⑥⑧ 5X ⑨
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	36.00 (914.4) 42.00 (1066.8)	6X 7X
6 ⑦	25 150	100 200	250 300	300 350 400	400 — —	600 1200	HLD/LDC ⑩ HND	48.00 (1219.2) 72.00 (1828.8) ⑫	8X 12X
7 ⑦	—	300	—	600	600	1200	HND	72.00 (1828.8) ⑫	12X
Full Voltage Reversing								**Type F216**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	24.00 (609.6) ⑤ 24.00 (609.6)	4X ⑤ 4X
2	10	15	25	25	25	125 150	E HFD/FDC	24.00 (609.6) ⑤ 24.00 (609.6)	4X ⑤ 4X
3	25	30	50	50	50	125/150	HFD/FDC/E	24.00 (609.6) ⑬	4X
4	40	50	75	100	100	150	HJD/JDC	36.00 (914.4) ⑬	6X ⑧⑭
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	66.00 (1676.4)	11X
6 ⑦	125 150	100 200	250 300	300 400	400 —	600 1200	HLD/LDC HND	72.00 (1828.8) ⑫ 72.00 (1828.8) ⑮	12X 12X ⑮

① Standard combination starter units with HMCP/HMCPE magnetic only disconnect have short-circuit ratings of 65,000 A at 480 V. Optional HMCP/HMCPE combination starter units are available with 100,000 A at 480 V.
② E-Frame motor circuit protection available for size 1–3 starters only.
③ Optional combination starter units with thermal-magnetic breaker disconnects are available with either 65,000 or 100,000 A at 480 V.
④ 12.00-inch (304.8 mm)/2X unit is standard.
⑤ 18.00-inch (457.2 mm)/3X unit is standard.
⑥ Minimum 30.00-inch (762.0 mm) space needed with thermal-magnetic circuit breaker.
⑦ Fixed assemblies, no RotoTract.
⑧ 1X additional space required with solid-state overloads.
⑨ 1X additional space with advanced solid-state overload.
⑩ 1200 A HMCP frame available in 11X 66.00-inch (1676.4 mm).
⑪ For top entry, 8X space required.
⑫ Requires 28.00-inch (711.2 mm) wide structure.
⑬ 30.00-inch (762.0 mm) space needed for thermal-magnetic circuit breaker.
⑭ 7X with solid-state overloads.
⑮ Requires 36.00-inch (914.4 mm) wide structure.

Table 29.5-2. Combination Starters with Series C Motor Circuit Protectors or Molded-Case Circuit Breakers (Continued)
Motor circuit protector ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

NEMA Size	Maximum Horsepower					HMCP Frame ①②	MCCB Frame ②③	Freedom FlashGard Unit Size	
	208 V	240 V	380 V	480 V	600 V			Inches (mm)	X Space
Two-Speed One Winding, Constant/Variable Torque								**Type F946**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	24 (609.6) ④	4X 4X
2	10	15	25	25	25	125 150	E HFD/FDC	24 (609.6) ④ 30 (762.0)	4X 5X
3	25	30	50	50	50	125 150	E HJD/JDC	36 (914.4) ④⑤	6X
4	40	50	75	100	100	150 250	HFD/FDC HJD/JDC	42 (1066.8) ④⑤	7X
5 ⑥	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72 (1828.8) ⑦	12X
Two-Speed Two Winding, Constant/Variable Torque								**Type F956**	
1	7.5	7.5	10	10	10	125 150	E HFD/FDC	24.00 (609.6)	4X
2	10	15	25	25	25	125 150	E HFD/FDC	24.00 (609.6)	4X
3	25	30	50	50	50	125 150	E HFD/FDC	30.00 (762.0)	5X
4	30 40	40 50	60 75	75 100	100 —	150 250	HFD/FDC HJD/JDC	42.00 (1066.8) 42.00 (1066.8) ⑧	7X ⑨ 7X ⑨
5 ⑥	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72.00 (1828.8) ⑦	12X
Reduced Voltage Autotransformer ⑥								**Type F606**	
2	10	15	25	25	25	150	HFD/FDC	36.00 (914.4)	7X
3	25	30	50	50	50	150	HFD/FDC	48.00 (1219.2)	9X
4	30	50	75	100	100	150	HJD/JDC	54.00 (1371.6)	10X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	72.00 (1828.8)	12X
6	150	200	300	400	400	600	HLD/LDC	72.00 (1828.8) ⑩	12X
7	—	300	—	600	600	1200	HND	72.00 (1828.8) ⑩	12X
Reduced Voltage Part Winding ⑥								**Type F706**	
1PW	10	10	15	15	15	150	HFD/FDC	24.00 (609.6)	5X
2PW	20	25	40	40	40	150	HFD/FDC	24.00 (609.6)	5X
3PW	40	50	75	75	75	150	HFD/FDC	30.00 (762.0)	6X
4PW	— 60 75	— 60 75	— 125 150	100 150 —	125 150 —	150 250 400	HFD/FDC HJD/JDC HKD/KDC	36.00 (914.4) ⑪	7X
5PW	100 150	125 150	— 250	250 350	300 350	400 600	HKD/KDC HLD/LDC	72.00 (1828.8) ⑩	12X

① Standard combination starter units with HMCP/HMCPE Magnetic Only disconnect have short-circuit ratings of 65,000 A at 480 V. Optional HMCP/HMCPE combination starter units are available with 100,000 A at 480 V.
② E-Frame motor circuit protector available through size 3 starter only.
③ Optional combination starter units with thermal-magnetic breaker disconnects are available with either 65,000 or 100,000 A at 480 V.
④ Add 6.00-inch (152.4 mm) space for low speed disconnect.
⑤ 42.00-inch (1066.8 mm) space needed with Thermal-magnetic circuit breaker. 48.00-inch (1219.2 mm) space needed with thermal-magnetic circuit breaker.
⑥ Fixed assemblies not available with RotoTract.
⑦ Requires 28.00-inch (711.2 mm) wide structure.
⑧ 36.00-inch (914.4 mm) space needed for thermal-magnetic circuit breaker.
⑨ 1X additional space required with standard SSOL and 2X additional space required with advanced SSOL.
⑩ Requires 21.00-inch (533.4 mm) deep, 28.00-inch (711.2 mm) wide structure.
⑪ For starting speed disconnect, add 6.00-inch (152.4 mm) space.

Table 29.5-2. Combination Starters with Series C Motor Circuit Protectors or Molded-Case Circuit Breakers (Continued)
Motor circuit protector ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

NEMA Size	Maximum Horsepower					HMCP Frame ①②	MCCB Frame ②③	Freedom FlashGard Unit Size	
	208 V	240 V	380 V	480 V	600 V			Inches (mm)	X Space
Reduced Voltage Wye Delta Open Transition ④								**Type F806**	
2YD	20	25	40	40	40	150	HFD/FDC	30.00 (762.0)	6X
3YD	30 40	40 50	75 —	75 —	5 —	150 250	HFD/FDC HJD/JDC	42.00 (1066.8)	8X
4YD	60 —	75 —	125 150	150 —	150 —	250 400	HJD/JDC HKD/KDC	48.00 (1219.2)	9X
5YD	100 150	125 150	200 250	250 300	300 —	400 600	HKD/KDC HLD/LDC	72.00 (1828.8) ⑤	12X
Reduced Voltage Wye Delta Closed Transition ④								**Type F896**	
2YD	20	25	40	40	40	150	HFD/FDC	42.00 (1066.8)	8X
3YD	40	50	—	—	—	250	HFD/FDC	54.00 (1371.6)	10X
4YD	60 —	75 —	125 150	150 —	150 —	250 400	HJD/JDC HKD/KDC	60.00 (1524.0)	11X
5YD	100 150	125 150	200 250	250 300	300 —	400 600	HKD/KDC HLD/LDC	72.00 (1828.8) ⑤	12X

① Standard combination starter units with HMCP/HMCPE magnetic only disconnect have short-circuit ratings of 65,000 A at 480 V. Optional HMCP/HMCPE combination starter units are available with 100,000 A at 480 V.
② E-Frame motor circuit protector available through size 3 starter only.
③ Optional combination starter units with thermal-magnetic breaker disconnects are available with either 65,000 or 100,000 A at 480 V.
④ Fixed assemblies not available with RotoTract.
⑤ Requires 21.00-inch (533.4 mm) deep, 28.00-inch (711.2 mm) wide structure.

S811+ Solid-State Reduced Voltage Starter

Eaton's S811+ solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The S811+ solid-state starter has five 24 Vdc inputs and two relay outputs. S811+ soft start units include a disconnect, starter, 24 Vdc power supply and 100 VA CPT.

Motor Service Factor (SF) Effect on S811+ Starter Selection

- A 1.0 service factor motor may draw up to 1.00 x full load amperes
- A 1.15 service factor motor may draw up to 1.15 x full load amperes (15% more current). This chart is based off of a 1.15 SF motor selection
- S811+ starters are current rated devices. In some cases, a larger S811+ SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below

Table 29.5-3. Standard-Duty and Severe-Duty Ratings ①

S811+ Amperage	S811+ Frame	208 V				230 V				380 V				460 V				575 V				Inches (mm)	X Space
		hp	HMCP	T.M.	Fuse	hp	HMCP	T.M	Fuse	hp	HMCP	T.M.	Fuse	hp	HMCP	T.M.	Fuse	hp	HMCP	T.M.	Fuse		
Standard Duty																							
37	65	10	50	70	30/60	10	50	70	30/60	15	50	70	30/60	20	50	70	30/60	30	50	80	30/60	18 (457.2)	3X
66	65	15	100	125	100	20	100	125	100	30	100	150	100	40	100	150	100	50	100	150	100	18 (457.2)	3X
105	110	30	150	225	200	30	150	200	200	45	150	150	200	60	150	150	200	75	150	200	200	24 (609.6)	4X
135	110	40	150	225	200	40	150	250	200	55	150	250	200	75	1 50	250	200	100	150	250	200	24 (609.6)	4X
180	200	50	250	400	400	60	250	350	400	75	250	350	400	125	250	400	400	150	250	350	400	42 (1066.8)	7X
240	200	60	250	400	400	75	250	450	400	110	400	500	400	150	400	500	400	200	250	450	400	42 (1066.8)	7X
304	200	75	400	600	400	100	400	600	600	132	400	600	600	200	400	600	600	250	400	600	600	42 (1066.8)	7X
360	290	100	400	700	600	125	400	800	600	160	600	800	600	—	—	—	—	300	400	800	600	54 (1371.6)	9X
420	290	125	600	900	600	—	—	—	—	200	600	1000	800	300	600	1000	800	350	600	900	600	54 (1371.6)	9X
500	290	—	—	—	—	150	600	1000	800	250	600	1000	800	350	600	1000	800	450	600	1000	800	54 (1371.6)	9X
650	290	200	1200	1200	1200	200	1200	1200	800	315	1200	1200	1200	450	1200	1200	1200	600	1200	1200	1200	72 (1828.8)	12X
720	290	—	—	—	—	250	1200	1200	1200	—	—	—	—	500	1200	1200	1200	—	—	—	—	72 (1828.8)	12X
850	290	—	—	—	—	300	1200	1200	1200	375	1200	1200	1200	600	1200	2000	1200	700	1200	1200	1200	72 (1828.8)	12X
1000	290	—	—	—	—	350	2000	2000	1200	500	2000	2000	1200	700	2000	2000	1200	900	2000	2000	1200	72 (1828.8)	12X
Severe Duty																							
22	65	5	—	70	40	5	—	70	35	7.5	—	60	35	10	—	60	35	15	—	70	40	18 (457.2)	3X
42	65	10	—	125	70	10	—	125	70	18.5	—	150	90	25	—	150	80	30	—	125	80	18 (457.2)	3X
65	110	15	—	200	110	20	—	200	125	22	—	150	100	40	—	150	125	50	—	200	125	24 (609.6)	4X
80	110	20	—	225	150	25	—	300	175	37	—	300	175	50	—	250	150	60	—	250	150	24 (609.6)	4X
115	200	30	—	300	225	30	—	350	200	55	—	300	250	75	—	300	225	100	—	300	250	42 (1066.8)	7X
150	200	40	—	350	250	50	—	400	300	—	—	—	—	100	—	400	300	125	—	400	300	42 (1066.8)	7X
192	200	50	—	400	350	60	—	500	350	90	—	500	400	125	—	500	400	150	—	400	350	42 (1066.8)	7X
240	290	60	—	500	400	---	—	—	—	110	—	600	500	150	—	600	450	---	—	—	---	54 (1371.6)	9X
305	290	75	—	700	500	100	—	800	600	132	—	800	600	200	—	800	600	250	—	800	600	54 (1371.6)	9X
365	290	100	—	900	700	125	—	1000	800	160	—	900	700	250	—	1000	700	300	—	900	700	72 (1828.8)	12X
420	290	125	—	1000	800	—	—	—	—	200	—	1200	800	300	—	1200	800	350	—	1000	800	72 (1828.8)	12X
480	290	---	—	—	—	150	—	1200	800	220	—	1200	1000	350	—	1200	1000	450	—	1200	1000	72 (1828.8)	12X
525	290	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72 (1828.8)	12X
600	290	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72 (1828.8)	12X

① Standard-duty ratings reflect the maximum starting duty that these units are designed to supply.

Table 29.5-4. Option Sizing—Dimensions in Inches (mm)

S811+ Width (mm)	Disconnect Type	Starter Size	Option Unit Size ②	Structure Width
Isolating Contactor				
65	HMCP, MCCB	1, 2, 3	30.00 (762.0)	20.00 (508.0)
110	HMCP, MCCB	3, 4	36.00 (914.4)	20.00 (508.0)
110	HMCP, MCCB	5	54.00 (1371.6)	20.00 (508.0)
200	HMCP, MCCB	5,6	72.00 (1828.8) ③	20.00 (508.0)
290	HMCP, MCCB	6	72.00 (1828.8) ③	32.00 (812.8)
290	HMCP, MCCB	7	72.00 (1828.8) ③	48.00 (1219.2)
Bypass Starter				
65	HMCP, MCCB	1, 2, 3	30.00 (762.0)	20.00 (508.0)
110	HMCP, MCCB	3, 4	36.00 (914.4)	20.00 (508.0)
110	HMCP, MCCB	5	54.00 (1371.6)	20.00 (508.0)
200	HMCP, MCCB	5, 6	72.00 (1828.8) ③	24.00 (609.6)
290	HMCP, MCCB	6	72.00 (1828.8) ③	32.00 (812.8)
290	HMCP, MCCB	7	72.00 (1828.8) ③	48.00 (1219.2)

② Option fits in standard unit space.
③ Fixed assemblies, no RotoTract.

Table 29.5-5. Control Options

Extra 50 VA Control Power Transformer ④⑤
24 Vdc Control ④
Line or Load MOV Protection ④
Pump Control Option ④

④ Option fits in standard unit space.
⑤ Option adds 6.00 inches (152.4 mm) (1X) to 37 and 66 A units.

Table 29.5-6. FLA Ratings

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
Standard Duty			
300%	30 seconds	3	Soft start
500%	10 seconds	3	Full voltage
350%	20 seconds	3	Wye delta
480%	20 seconds	2	80% RVAT
390%	20 seconds	3	65% RVAT
300%	20 seconds	4	50% RVAT
Severe Duty			
450%	30 seconds	4	Soft start
500%	10 seconds	10	Full voltage
350%	65 seconds	3	Wye delta
480%	25 seconds	4	80% RVAT
390%	40 seconds	4	65% RVAT
300%	60 seconds	4	50% RVAT

All of Eaton's combination starters are available with Class R or J fuse clips for all voltages. If 100 kA SCR is required at 575 V and 600 V, fuses must be used where current limiting options are not available in combination with breakers. When selecting fuse switches, the fuses are not supplied by default. Fuses may be selected as follows:

- RK5: 1.25x FLC
- RK1: 1.3x FLC
- Class J: 1.5x FLC

Table 29.5-7. Combination Starters with Fusible Switches—Dimensions in Inches (mm)

NEMA Size	Maximum Horsepower					Switch Rating ①	Freedom FlashGard Unit Size	
	208 V	240 V	380 V	480 V	600 V		Inches (mm)	X Space
Full Voltage Non-Reversing—Fusible							**Type F204**	
1	7.5	7.5	10	10	10	30	18.00 (457.2)	3X
2	10	15	25	25	25	60	18.00 (457.2)	3X
3	25	30	50	50	50	60/100	24.00 (609.6)	4X
4	40	50	75	100	100	100/200	36.00 (914.4)	6X ②
5	75	100	150	200	200	400 ③	60.00 (1524.0)	10X
6 ④	150	200	300	400	400	600	66.00 (1676.4) ⑤ 72.00 (1828.8) ⑥	11X 12X
Full Voltage Reversing—Fusible							**Type F214**	
1	7.5	7.5	10	10	10	30	24.00 (609.6)	4X
2	10	15	25	25	25	60	24.00 (609.6)	4X
3	25	30	50	50	50	100/200	30.00 (762.0)	5X
4	40	50	75	100	100	200	54.00 (1371.6)	9X
5 ④	75	100	150	200	200	400	72.00 (1828.8) ⑦	12X
6 ④	150	200	300	400	400	600	72.00 (1828.8) ⑦	12X
Two-Speed One Winding—Fusible							**Type F944**	
1	7.5	7.5	10	10	10	30	24.00 (609.6)	4X
2	10	15	25	25	25	60	30.00 (762.0)	5X
3	25 25	30 30	— 50	30 50	50 50	60 100	36.00 (914.4)	6X
4	— 40	— 50	— 75	— 100	60 100	100 200	60.00 (1524.0)	10X
5 ④	75	100	150	200	200	400	72.00 (1828.8) ⑦	12X
Two-Speed Two Winding—Fusible							**Type F954**	
1	7.5	7.5	10	10	10	30	24.00 (609.6)	4X
2	10	15	25	25	25	60	30.00 (762.0)	5X
3	— 25	— 30	— 50	— 50	30 50	60 100	36.00 (914.4)	6X
4	— 40	— 50	— 75	— 100	60 100	100 200	54.00 (1371.6) ⑧	10X
5 ④	75	100	150	200	200	400	72.00 (1828.8) ⑦	12X
Reduced Voltage Autotransformer—Fusible ④							**Type F604**	
2	10	15	25	25	25	60	36.00 (914.4)	7X
3	25	30	50	50	50	100	60.00 (1524.0)	10X
4	40	50	75	100	100	200	72.00 (1828.8) ⑨	12X
5	75	100	150	200	200	400	72.00 (1828.8) ⑦	12X
6	150	200	300	400	400	600	72.00 (1828.8) ⑩	12X

① Combination fused starter units rated 100 kAIC short-circuit current.
② 7X (42.00-inch [1066.8 mm]) unit size with solid-state overloads.
③ Certain items in unit option Groups B and C may require additional space. See **Page 29.3-8.**
④ Fixed assemblies, no RotoTract.
⑤ For bottom entry of motor cables.
⑥ For top entry of motor cables.
⑦ Requires 28.00-inch (711.2 mm) wide structure.
⑧ Add 12.00-inch (304.8 mm) space for low speed fuses.
⑨ Bottom 24.00-inch (609.6 mm) space in rear is unusable.
⑩ Requires 28.00-inch (711.2 mm) wide and 21.00-inch (533.4 mm) deep structure.

Table 29.5-7. Combination Starters with Fusible Switches (Continued)

NEMA Size	Maximum Horsepower					Switch Rating ①	Freedom FlashGard Unit Size	
	208 V	240 V	380 V	480 V	600 V		Inches (mm)	X Space
Reduced Voltage Part Winding—Fusible							**Type F704**	
1PW	10	10	15	15	15	60	24.00 (609.6)	5X
2PW	— 20	15 25	25 40	30 40	40 —	60 100	24.00 (609.6) 24.00 (609.6)	5X 5X
3PW	— 40	— 50	— 75	50 75	60 75	100 200	48.00 (1219.2) 48.00 (1219.2)	9X 9X
4PW ②	50 75	— 75	100 150	100 150	150 —	200 400	54.00 (1371.6) 54.00 (1371.6)	10X 10X
5PW ②	100 150	100 150	200 250	250 350	300 350	400 600	72.00 (1828.8) ③	12X ③
Reduced Voltage Wye Delta Open Transition—Fusible							**Type F804**	
2YD	15 20	15 25	30 40	40 —	40 —	60 100	36.00 (914.4)	6X
3YD	25 40	30 50	50 75	60 75	75 —	100 200	54.00 (1371.6)	9X
4YD ②	50 60	60 75	100 150	125 150	150 —	200 400	72.00 (1828.8) ③	12X ③
5YD ②	100 150	125 150	200 250	250 300	300 —	400 600	72.00 (1828.8) ③	12X ③
6YD ②	— — 250 300	— 200 250 350	— 350 400 500	— 400 500 700	350 500 700 700	400 600 800 1200	72.00 (1828.8) ④	12X ④
Reduced Voltage Wye Delta Closed Transition—Fusible ②							**Type F894**	
2YD	15 20	15 25	30 40	40 —	40 —	60 100	48.00 (1219.2)	8X
3YD	25 40	30 50	50 75	60 75	75 —	100 200	66.00 (1676.4)	12X
4YD	50 60	60 75	100 150	125 150	50 —	200 400	72.00 (1828.8) ③ 72.00 (1828.8) ③	12X ③ 12X ③
5YD	100 150	125 150	200 250	250 300	300 —	400 600	72.00 (1828.8) ③	12X ③
6YD	— — 250 300	— 200 250 350	— 350 400 500	— 400 500 700	350 500 700 700	400 600 800 1200	72.00 (1828.8) ④	12X ④

① Combination fused starter units rated 100 kAIC short-circuit current.
② Fixed assemblies, no RotoTract.
③ Requires 28.00-inch (711.2 mm) wide structure.
④ Requires 28.00-inch (711.2 mm) wide and 21.00-inch (533.4 mm) deep section.

29

S811+ Solid-State Reduced Voltage Starter—Fusible Switch

Eaton's S811+ solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The S811+ solid-state starter has five 24 Vdc inputs and two relay outputs. S811+ soft start units include a disconnect, a starter, 24 Vdc power supply and 100 VA CPT.

Motor Service Factor (SF) Effect on S811+ Starter Selection

- A 1.0 service factor motor may draw up to 1.00 x full load amperes
- A 1.15 service factor motor may draw up to 1.15 x full load amperes (15% more current). This chart is based off of a 1.15 SF motor selection
- S811+ starters are current rated devices. In some cases, a larger S811+ SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below

Table 29.5-8. Standard-Duty and Severe-Duty Ratings—Fusible ①

S811+ Amperage	S811+ Frame	208 V				230 V				380 V				460 V				575 V				Inches (mm)	X Space
		hp	HMCP	T.M.	Fuse	hp	HMCP	T.M	Fuse	hp	HMCP	T.M.	Fuse	hp	HMCP	T.M.	Fuse	hp	HMCP	T.M.	Fuse		
Standard Duty																							
37	65	10	50	70	30/60	10	50	70	30/60	15	50	70	30/60	20	50	70	30/60	30	50	80	30/60	18 (457.2)	3X
66	65	15	100	125	100	20	100	125	100	30	100	150	100	40	100	150	100	50	100	150	100	18 (457.2)	3X
105	110	30	150	225	200	30	150	200	200	45	150	150	200	60	150	150	200	75	150	200	200	24 (609.6)	4X
135	110	40	150	225	200	40	150	250	200	55	150	250	200	75	1 50	250	200	100	150	250	200	24 (609.6)	4X
180	200	50	250	400	400	60	250	350	400	75	250	350	400	125	250	400	400	150	250	350	400	42 (1066.8)	7X
240	200	60	250	400	400	75	250	450	400	110	400	500	400	150	400	500	400	200	250	450	400	42 (1066.8)	7X
304 ②	200	75	400	600	400	100	400	600	600	132	400	600	600	200	400	600	600	250	400	600	600	42 (1066.8)	7X
360 ②	290	100	400	700	600	125	400	800	600	160	600	800	600	—	—	—	—	300	400	800	600	54 (1371.6)	9X
420 ②	290	125	600	900	600	—	—	—	—	200	600	1000	800	300	600	1000	800	350	600	900	600	54 (1371.6)	9X
500 ②	290	—	—	—	—	150	600	1000	800	250	600	1000	800	350	600	1000	800	450	600	1000	800	54 (1371.6)	9X
650 ②	290	200	1200	1200	1200	200	1200	1200	800	315	1200	1200	1200	450	1200	1200	1200	600	1200	1200	1200	72 (1828.8)	12X
720 ②	290	—	—	—	—	250	1200	1200	1200	—	—	—	—	500	1200	1200	1200	—	—	—	—	72 (1828.8)	12X
850 ②	290	—	—	—	—	300	1200	1200	1200	375	1200	1200	1200	600	1200	2000	1200	700	1200	1200	1200	72 (1828.8)	12X
1000 ②	290	—	—	—	—	350	2000	2000	1200	500	2000	2000	1200	700	2000	2000	1200	900	2000	2000	1200	72 (1828.8)	12X
Severe Duty																							
22	65	5	—	70	40	5	—	70	35	7.5	—	60	35	10	—	60	35	15	—	70	40	18 (457.2)	3X
42	65	10	—	125	70	10	—	125	70	18.5	—	150	90	25	—	150	80	30	—	125	80	18 (457.2)	3X
65	110	15	—	200	110	20	—	200	125	22	—	150	100	40	—	150	125	50	—	200	125	24 (609.6)	4X
80	110	20	—	225	150	25	—	300	175	37	—	300	175	50	—	250	150	60	—	250	150	24 (609.6)	4X
115	200	30	—	300	225	30	—	350	200	55	—	300	250	75	—	300	225	100	—	300	250	42 (1066.8)	7X
150	200	40	—	350	250	50	—	400	300	—	—	—	—	100	—	400	300	125	—	400	300	42 (1066.8)	7X
192 ②	200	50	—	400	350	60	—	500	350	90	—	500	400	125	—	500	400	150	—	400	350	42 (1066.8)	7X
240 ②	290	60	—	500	400	---	—	—	—	110	—	600	500	150	—	600	450	---	—	—	---	54 (1371.6)	9X
305 ②	290	75	—	700	500	100	—	800	600	132	—	800	600	200	—	800	600	250	—	800	600	54 (1371.6)	9X
365 ②	290	100	—	900	700	125	—	1000	800	160	—	900	700	250	—	1000	700	300	—	900	700	72 (1828.8)	12X
420 ②	290	125	—	1000	800	—	—	—	—	200	—	1200	800	300	—	1200	800	350	—	1000	800	72 (1828.8)	12X
480 ②	290	---	—	—	—	150	—	1200	800	220	—	1200	1000	350	—	1200	1000	450	—	1200	1000	72 (1828.8)	12X
525 ②	290	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72 (1828.8)	12X
600 ②	290	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72 (1828.8)	12X

① Option adds 6.00 inches (152.4 mm) (1X) to 37 and 66 A units.

② Fixed assemblies, no RotoTract.

Table 29.5-9. Control Options

Extra 50 VA Control Power Transformer ③
24 Vdc Control ③
Line or Load MOV Protection ③
Pump Control Option ③

③ Option fits in standard unit space.

Table 29.5-10. Option Sizing for Isolating Contactor and Bypass Starter

S811+ Width (mm)	Fused Switch Type (Amperes)	Starter Size	Option Unit Size Inches (mm)	FlashGard Unit Size Inches (mm)	Structure Width Inches (mm)
65	30/60/100	1, 2, 3	36.00 (914.4)	36.00 (914.4)	20.00 (508.0)
110	100	3	42.00 (1066.8)	42.00 (1066.8)	20.00 (508.0)
110	200	4	54.00 (1371.6)	54.00 (1371.6)	20.00 (508.0)
200 ④	400/800	5, 6	72.00 (1828.8)	72.00 (1828.8)	32.00 (812.8)
290 ④	600/800	6	72.00 (1828.8)	72.00 (1828.8)	36.00 (914.4)
290 ④	800/1200	7	72.00 (1828.8)	72.00 (1828.8)	64.00 (1625.6)

④ Fixed assemblies, no RotoTract.

Table 29.5-11. FLA Ratings

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
Standard Duty			
300%	30 Seconds	3	Soft start
500%	10 Seconds	3	Full voltage
350%	20 Seconds	3	Wye delta
480%	20 Seconds	2	80% RVAT
390%	20 Seconds	3	65% RVAT
300%	20 Seconds	4	50% RVAT
Severe Duty			
450%	30 seconds	4	Soft start
500%	10 seconds	10	Full voltage
350%	65 seconds	3	Wye delta
480%	25 seconds	4	80% RVAT
390%	40 seconds	4	65% RVAT
300%	60 seconds	4	50% RVAT

SVX9000 Adjustable Frequency Drive Units

All Eaton's standard units include a disconnect, an AC choke, an output reactor and a door-mounted keypad. All plug-in units have a built-in dynamic braking circuit through the FR5 frame size. Drive units that require door-mounted fans also include a CPT.

Note: Output reactor not included on 240 V units.

CT (I_H): High overload drives are capable of producing 200% starting torque for 10 seconds and are rated 150% overload for one minute. Essentially a constant torque drive.

VT (I_L): Low overload drives are capable of producing 200% starting torque for 10 seconds and are rated 110% overload for one minute.Essentially a variable torque drive.

Table 29.5-12. Freedom SVX9000 Adjustable Frequency Drives—Dimensions in Inches (mm)

AFD Frame	Unit	Nominal hp	(VT) I_L Amperes	(CT) I_H Amperes	Branch Protection HMCP	T.M.	K-SW	Minimum Height	(X)	Width	Typical Height	(X)	Width	Maximum Height	(X)	Width
200–240 V																
FR4	Drawout	0.75	3.7	3.7	7	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		1.0	4.8	4.8	15	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		1.5	6.6	6.6	15	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		2.0	7.8	7.8	15	15	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		3.0	11.0	—	15	25	30	18.0 (457.2)	3X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)
		3.0	—	11.0	15	25	30	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
FR5	Drawout	5.0	17.5	17.5	30	40	30	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		7.5	25.0	25.0	50	50	60	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		10.0	31.0	—	50	70	60	30.0 (762.0)	5X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
FR6	Drawout	10.0	31.0	31.0	50	60	60	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		15.0	48.0	48.0	100	100	100	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		20.0	61.0	—	100	125	100	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
FR7	Fixed	20.0	—	61.0	100	125	100	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		25.0	75.0	75.0	100	175	200	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		30.0	88.0	88.0	100	220	200	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		35.0	114.0	—	150	285	200	54.0 (8229.6)	9X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
380–500 V																
FR4	Drawout	1.0	2.2	2.2	7	15	30	30.0 (762.0)	5X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		1.5	3.3	3.3	7	15	30	30.0 (762.0)	5X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		2.0	4.3	4.3	7	15	30	30.0 (762.0)	5X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		3.0	5.6	5.6	15	15	30	30.0 (762.0)	5X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		5.0	7.6	—	15	25	30	30.0 (762.0)	5X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		5.0	—	7.6	15	25	30	30.0 (762.0)	5X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
		7.5	12.0	—	30	25	30	30.0 (762.0)	5X	20.0 (508.0)	30.0 (762.0)	5X	20.0 (508.0)	42.0 (1066.8)	7X	20.2 (508.0)
FR5	Drawout	7.5	—	12.0	30	25	30	36.0 (914.4)	6X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	48.0 (1219.2)	8X	20.2 (508.0)
		10.0	16.0	16.0	30	35	30	36.0 (914.4)	6X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	48.0 (1219.2)	8X	20.2 (508.0)
		15.0	23.0	23.0	30	50	60	36.0 (914.4)	6X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	48.0 (1219.2)	8X	20.2 (508.0)
		20.0	31.0	—	50	60	60	36.0 (914.4)	6X	20.0 (508.0)	36.0 (914.4)	6X	20.0 (508.0)	48.0 (1219.2)	8X	20.2 (508.0)
FR6	Drawout	20.0	—	31.0	50	60	60	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		25.0	38.0	38.0	50	80	60	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		30.0	46.0	46.0	100	100	80	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
		40.0	61.0	—	100	125	100	42.0 (1066.8)	7X	20.2 (508.0)	54.0 (8229.6)	9X	20.0 (508.0)	60.0 (2362.2)	10X	20.0 (508.0)
FR7	Fixed	40.0	—	61.0	100	125	100	60.0 (2362.2)	10X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		50.0	72.0	72.0	100	150	100	60.0 (2362.2)	10X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		60.0	87.0	87.0	100	175	100	60.0 (2362.2)	10X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
		75.0	105.0	—	150	225	175	60.0 (2362.2)	10X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	20.0 (508.0)
FR8	Fixed	75.0	—	105.0	150	225	175	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	32.0 (812.8)
		100.0	140.0	140.0	150	300	200	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	32.0 (812.8)
		125.0	170.0	170.0	250	400	250	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	32.0 (812.8)
		150.0	205.0	—	400	500	3 50	72.0 (1828.8)	12X	20.0 (508.0)	—	—	—	72.0 (1828.8)	12X	32.0 (812.8)
FR9	Fixed	150.0	—	205.0	400	500	350	72.0 (1828.8)	12X	28.0 (711.2)	—	—	—	72.0 (1828.8)	12X	40.0 (1016.0)
		200.0	261.0	261.0	400	600	450	72.0 (1828.8)	12X	28.0 (711.2)	—	—	—	72.0 (1828.8)	12X	40.0 (1016.0)
		250.0 ①	300.0	—	400	700	500	72.0 (1828.8)	12X	28.0 (711.2)	—	—	—	72.0 (1828.8)	12X	40.0 (1016.0)
FR10	Fixed	250.0	—	300.0	400	700	500	72.0 (1828.8)	12X	64.0 (1625.6)	—	—	—	72.0 (1828.8)	12X	80.0 (2032.0)
		300.0	385.0	385.0	600	800	600	72.0 (1828.8)	12X	64.0 (1625.6)	—	—	—	72.0 (1828.8)	12X	80.0 (2032.0)
		350.0	460.0	460.0	600	1000	800	72.0 (1828.8)	12X	64.0 (1625.6)	—	—	—	72.0 (1828.8)	12X	80.0 (2032.0)
		400.0	520.0	—	1200	1200	800	72.0 (1828.8)	12X	64.0 (1625.6)	—	—	—	72.0 (1828.8)	12X	80.0 (2032.0)
FR11	Fixed	400.0	—	590.0	1200	1200	1000	72.0 (1828.8)	12X	80.0 (2032.0)	—	—	—	—	—	—
		500.0	650.0	650.0	1200	1500	1000	72.0 (1828.8)	12X	80.0 (2032.0)	—	—	—	—	—	—
		550.0	730.0	730.0	1200	1600	1200	72.0 (1828.8)	12X	80.0 (2032.0)	—	—	—	—	—	—
FR12	Fixed	600.0	—	820.0	1200	1600	1200	72.0 (1828.8)	12X	128.0 (3251.2)	—	—	—	—	—	—

① If a 250 hp 40 °C rating is required, then up-size to the FR10. This FR9 sizing is only valid at 30 °C ambient.

Note: FR9 and larger AFD units require a 21.00-inch (533.4 mm) deep enclosure. FR11 and FR12 are non UL designs; consult factory for specific application. These tables are sized using the Motor Load Block up to 180 A; units without Motor Load Block may be smaller. In drawout, minimum does not contain an operator panel, typical contains a device panel and room for timers and relays, maximum makes provisions for isolation contactors and bypass. In fixed, minimum contains a device panel and room for timers and relays, maximum makes provisions for isolation contactors and bypass. Consult factory for NEMA 3R sizing.

Table 29.5-13. Adjustable Frequency Drives Passive Filters Addition

Hp (Maximum)	SVX Drive (Amperes)	Passive Input (Amperes)	Height	(X)
1	2.2	6	36.0 (914.4)	6X
1.5	3.3	6	36.0 (914.4)	6X
3	5.6	6	36.0 (914.4)	6X
5	7.6	8	36.0 (914.4)	6X
7.5	12	14	36.0 (914.4)	6X
10	16	21	36.0 (914.4)	6X
15	23	27	36.0 (914.4)	6X
20	31	34	36.0 (914.4)	6X
25	38	44	36.0 (914.4)	6X
30	46	52	48.0 (1219.2)	8X
40	61	66	48.0 (1219.2)	8X
50	72	83	48.0 (1219.2)	8X
60	87	103	48.0 (1219.2)	8X
75	105	128	60.0 (1524.0)	10X
100	140	165	60.0 (1524.0)	10X
125	170	208	60.0 (1524.0)	10X
150	205	208	60.0 (1524.0)	10X
200	261	320	72.0 (1828.8)	12X

Note: Passive filters are a separate unit located next to the connected AFD. Passive filters can reduce THD of the connected AFD to 8% or less.

29

Table 29.5-14. SVX9000 Adjustable Frequency Drives in NEMA 3R MCCs —Dimensions in Inches (mm) ①

I_H Amperes	Nominal hp I_H ②	I_L Amperes	Nominal hp I_L	CB Type ③		Unit Space (Typ./Max)	
				HMCP	MCCB	Dim.	(X)
380–500 V							
2.2	1.0	3.3	1.5	7	15	30.00 (762.0)	5X
3.3	1.5	4.3	2.0	7	15	30.00 (762.0)	5X
4.3	2.0	5.6	3.0	7	15	30.00 (762.0)	5X
5.6	3.0	7.6	5.0	15	15	30.00 (762.0)	5X
7.6	5.0	12.0	7.5	15	15	30.00 (762.0)	5X
12.0	7.5	16.0	10.0	30	25	72.00 (1828.8)	12X
16.0	10.0	23.0	15.0	30	35	72.00 (1828.8)	12X
23.0	15.0	31.0	20.0	30	50	72.00 (1828.8)	12X
31.0	20.0	38.0	25.0	50	60	72.00 (1828.8)	12X
38.0	25.0	46.0	30.0	50	80	72.00 (1828.8)	12X
46.0	30.0	61.0	40.0	100	100	72.00 (1828.8)	12X

① This table is common for both Freedom and Freedom FlashGard MCC.
② A separate CPT bucket is provided for all AFDs (1–5 hp) listed in the table.
③ For fusible disconnect, use typical option unit.

Note: Drive units fit into a standard 20.00-inch (508.0 mm) wide structure.

Table 29.5-15. Options

Plug-in Options	
Option Boards ④	
I/O Expander	⑤
Encoder Expander	⑤
Interbus S Communications	⑤
Modbus Communications	⑤
PROFIBUS DP Communications	⑤
LonWorks Communications	⑤
Can Open (Slave) Communications	⑤
DeviceNet Communications	⑥
Johnson Controls N2 Communications	⑤
PROFIBUS DP (D9 Connector)	⑤
EtherNet/IP Communications	⑤
Modbus TCP Communications	⑤
Modbus (D9 Connector)	⑤
Plug-in Control Relays	
One relay	⑦
Two relays	⑦
Three relays	⑧
Other Options	
Automatic bypass circuit	⑨
Bypass drive test switch	⑨
Seven relay 120V control with CPT	⑦
Isolated signal processor	⑤
3–15 PSIG interface	⑤
Dynamic breaking resistors	⑩
Graphics keypad	⑥
Line fuses	⑤⑦
RFI filter	⑥
Deduct to remove output filter	⑪
V1K 2000 ft (610m) Dv/Dt filter	⑧
Output contactor	⑤
Dual overloads	⑤⑧
Three contactor bypass	⑤⑧

④ Up to five option boards may be selected. Please see **Tab 31** for detailed information.
⑤ All options will fit in typical and maximum option unit.
⑥ This option will fit in all units.
⑦ One of these options will fit in 5–30 hp CT at 480 V frame standard units, 1–30 hp CT at 480 V typical and maximum option units.
⑧ All options will fit in maximum option unit.
⑨ Use with bypass option.
⑩ DB resistors are to be mounted by the customer external to the MCC.
⑪ Not available for 240 V units.

Note: Output reactor or Dv/Dt filter not required for motor lead lengths shorter than 100 feet (30.4 m)—30 feet (9.1 m) for 2 hp and below).

Note: Maximum motor lead length is 160 feet (48.8 m) for 1.5 hp and below, 330 feet (100.6 m) for 2 hp and 400 feet (121.9 m) for 3 hp and larger when using a standard output reactor.

Note: Motor lead lengths up to 2000 feet (609.6 m) can be achieved by using a Dv/Dt filter.

CPX9000 Clean Power Drives
1–500 hp at 480 V

Eaton's CPX9000 Clean Power Drives use advanced 18-pulse, clean-power technology that significantly reduces line harmonics at the drive input terminals, resulting in one of the purest sinusoidal waveforms.

I_H (CT): High overload drives are capable of producing 200% starting torque for 10 seconds and are rated 150% overload for one minute. Essentially a constant torque drive.

I_L (VT): Low overload drives are capable of producing 200% starting torque for 10 seconds and are rated 110% overload for one minute. Essentially a variable torque drive.

Table 29.5-16. CPX9000 Low Overload Clean Power Drives, Thermal-Magnetic Breaker and Motor Circuit Protector (MCP) Disconnect —Dimensions in Inches (mm)

Low Overload Drive ①		High Overload Drive ①		CB Type ②		Standard Unit Space Dimensions Inches (mm) ③			
I_L Amperes	Nominal hp I_L	I_H Amperes	Nominal hp I_H	HMCP	MCCB	Width	Height	Depth	(X)
34	25 ④	27	20 ④	50	80	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
40	30 ④	34	25 ④	100	100	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
52	40 ④	40	30 ④	100	125	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
65	50 ④	52	40 ④	100	150	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
77	60 ④	65	50 ④	100	175	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
96	75 ④	77	60 ④	150	225	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
124	100 ④	96	75 ④	150	300	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
156	125 ④	124	100 ④	250	400	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
180	150 ④	156	125 ④	400	400	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
240	200	180	150	600	600	60.00 (1524.0)	90.00 (2286.0)	21.00 (533.4)	12X
302	250	240	200	600	600	60.00 (1524.0)	90.00 (2286.0)	21.00 (533.4)	12X
361	300 ⑤	302	250 ⑤	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
414	350 ⑤	361	300 ⑤	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
477	400 ⑤	414	350 ⑤	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
515	450 ⑤	477	400 ⑤	1200	1200	106.00 (2692.4)	90.00 (2286.0)	28.00 (711.2)	12X
590	500 ⑤	515	450 ⑤	1200	1200	106.00 (2692.4)	90.00 (2286.0)	28.00 (711.2)	12X

① The CPX9000 drive uses the term Low Overload (I_L) in place of the term "Variable Torque" and High Overload (I_H) in place of the term "Constant Torque."
② CPX9000 Drives in MCCs are available in thermal-magnetic breaker, motor circuit protector and fused disconnect configurations.
③ A minimum clearance of 4.00 inches (101.6 mm) should be provided at the back of CPX9000 Drive MCC section for ventilation.
④ Add 32.00 inches (812.8 mm) of width for bypass.
⑤ Required transformer section is 28.00 (711.2) inches deep; CPX and bypass is 21.00 (533.4) inches deep.

Table 29.5-17. CPX9000 Low Overload Clean Power Drives, Fusible Switch Disconnect—Dimensions in Inches (mm)

Low Overload Drive ⑥		High Overload Drive ⑥		Fuse Switch		Standard Unit Space Dimensions Inches (mm) ⑦			
I_L Amperes	Nominal hp I_L	I_H Amperes	Nominal hp I_H	Fuse	Switch	Width	Height	Depth	(X)
34	25 ⑧	27	20 ⑧	50	60	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
40	30 ⑧	34	25 ⑧	60	60	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
52	40 ⑧	40	30 ⑧	80	100	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
65	50 ⑧	52	40 ⑧	100	100	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
77	60 ⑧	65	50 ⑧	100	100	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
96	75 ⑧	77	60 ⑧	100	100	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
124	100 ⑧	96	75 ⑧	175	200	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
156	125 ⑧	124	100 ⑧	200	200	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
180	150 ⑧	156	125 ⑧	250	400	40.00 (1016.0)	90.00 (2286.0)	21.00 (533.4)	12X
240	200	180	150	350	600	60.00 (1524.0)	90.00 (2286.0)	21.00 (533.4)	12X
302	250	240	200	450	600	60.00 (1524.0)	90.00 (2286.0)	21.00 (533.4)	12X
361	300 ⑨	302	250 ⑨	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
414	350 ⑨	361	300 ⑨	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
477	400 ⑨	414	350 ⑨	600	600	68.00 (1727.2)	90.00 (2286.0)	28.00 (711.2)	12X
515	450 ⑨	477	400 ⑨	800	1200	106.00 (2692.4)	90.00 (2286.0)	28.00 (711.2)	12X
590	500 ⑨	515	450 ⑨	800	1200	106.00 (2692.4)	90.00 (2286.0)	28.00 (711.2)	12X

⑥ The CPX9000 product uses the term Low Overload (I_L) in place of the term "Variable Torque" and High Overload (I_H) in place of the term "Constant Torque."
⑦ A minimum clearance of 4.00 inches (101.6 mm) should be provided at the back of CPX9000 Drive MCC section for ventilation.
⑧ Add 32.00 inches (812.8 mm) of width for bypass.
⑨ Required transformer section is 28.00 (711.2) inches deep; CPX and bypass is 21.00 (533.4) inches deep.

Table 29.5-18. Main Incoming Line and Feeder Circuit Breakers—Molded-Case Circuit Breakers—Dimensions in Inches (mm)

Frames reflect standard circuit breakers. Unit spacings shown include sufficient space to terminate cables on any standard breaker lug. If cable sizes exceed those listed, add 12.00-inch (304.8 mm) space for lug adapters.

Frame Size (Amperes)	Circuit Breaker Frame	Interrupting Capacity (kAIC)			Main Unit Size		Feeder Unit Size		Maximum Cable Size ①
		240 V	480 V	575 V	Inches (mm)	X Space	Inches (mm)	X Space	
125 150	E125H ② HFD	100 100	65 65	25 25	12.00 (304.8) 18.00 (457.2)	2X 3X	12.00 (304.8) 12.00 (304.8)	2X 2X	4/0 (one per phase) 4/0 (one per phase)
150 225	FDC HFD	100 100	100 65	35 25	18.00 (457.2) 18.00 (457.2)	3X 3X	12.00 (304.8) 18.00 (457.2)	2X 3X	4/0 (one per phase) 4/0 (one per phase)
225	J250 FDC	100 100	100 100	25 35	18.00 (457.2)	3X	18.00 (457.2)	3X	4/0 (one per phase)
250	J250 JDC	100 100	65 100	25 35	24.00 (609.6) 30.00 (762.0)	4X 5X	18.00 (457.2)	3X	350 kcmil (one per phase)
400	HKD KDC	100 100	65 100	35 50	30.00 (762.0)	5X	30.00 (762.0)	4X	250 kcmil (two per phase) or 500 kcmil (one per phase)
	CHKD ③ CKDC ③	100 100	65 100	35 50	30.00 (762.0)	5X	30.00 (762.0)	5X	
600	HLD LDC	100 100	65 100	35 50	24.00 (609.6)	4X	30.00 (762.0)	5X	500 kcmil (two per phase)
	CHLD ③④ CLDC ③④	100 100	65 100	35 50		4X	24.00 (609.6)	4X	
800	NGC	100	100	50	42.00 (1066.8)	7X	42.00 (1066.8)	7X	750 kcmil (three per phase)
	NGH-C ③ NGC-C ③	100 100	65 100	35 50	72.00 (1828.8)	12X	72.00 (1828.8)	12X	
1200	NGH ⑤ NGC ⑤	100 100	65 100	35 50	42.00 (1066.8)	7X	42.00 (1066.8)	7X	750 kcmil (three per phase)
	NGH-C ③④ NGC-C ③④	100 100	65 100	35 50	72.00 (1828.8)	12X	72.00 (1828.8)	12X	
2000	RGH ⑤ RGC ④ RGH-C ③ RGC-C ③	100 100 100 100	65 100 65 100	50 65 50 65	72.00 (1828.8) ⑥	12X	72.00 (1828.8)	12X	750 kcmil (six per phase)
2500	RGH RGC	100 100	65 65	50 50	72.00 (1828.8) ⑥⑦	12X	72.00 (1828.8)	12X	750 kcmil (six per phase)

① See circuit breaker terminal data for variations.
② Compact feeder units.
③ Digitrip 310+ LS is required and included in the price.
④ NEMA 1 gasketed only.
⑤ Digitrip 310+ LS is standard and included in the pricing.
⑥ The main breaker requires the complete vertical section. The rear is unusable.
⑦ 24.00 inches (609.6 mm) wide.

Note: RotoTract standard on all feeder taps 400 A and lower and not available on any main devices.

Table 29.5-19. Main Circuit Breakers—Magnum DS Air Circuit Breakers, Manually or Electrically Operated—Fixed Mounted—Dimensions in Inches (mm)

Frame Size Amperes	Circuit Breaker Type	Interrupting Capacity (kAIC)			Unit Size	Enclosure Width	Enclosure Depth
		240 V	480 V	575 V			
800	MDS-608 MDS-C08	65 100	65 100	65 100	72.00 (1828.8)	24.00 (609.6)	21.00 (533.4)
1600	MDS-616 MDS-C16	65 100	65 100	65 100			
2000	MDS-620 MDS-C20	65 100	65 100	65 100			

Note: A 4.00-inch (101.6 mm) filler section must be added between the main and the rest of the MCC to allow for door opening.

Table 29.5-20. Main Circuit Breakers —Magnum DS Air Circuit Breakers, Manually or Electrically Operated —Drawout Mounted—Dimensions in Inches (mm) ①

Frame Size (Amperes)	Circuit Breaker Type	Interrupting Capacity (kAIC)			Unit Size	Enclosure Width	Enclosure Depth
		240 V	480 V	575 V			
800	MDS-608 MDS-C08	65 100	65 100	65 100	72.00 (1828.8)	24.00 (609.6) ②	42.00 (1066.8) ③
1600	MDS-616 MDS-C16	65 100	65 100	65 100			
2000	MDS-620 MDS-C20	65 100	65 100	65 100			
3200	MDS-632 MDS-C32	65 100	65 100	65 100			

① This table is common for both Freedom and Freedom FlashGard MCCs.
② A 4.00-inch (101.6 mm) filler section must be added between the main and the rest of the MCC to allow for door opening.
③ Structure is rear aligned.

Table 29.5-21. Digitrip Units

Type		Unit Space Inches (mm)
RMS 310–1150	Refer to **Page 21.4-10** for more details.	—
Options		
Tie breaker ④ Electrically operated		72.00 (1828.8) or 12X —
Accessories		
UV release-instantaneous Shunt trip (standard on electrically operated breakers) Key interlock on breaker		— — —
Auxiliary switch (3A/3B) Cell position switch Operations counter		— — —
Auxiliary power module (to test Digitrip) Portable lift truck Manual close pushbutton cover		— — —

④ Tie breaker adds an additional 20.00-inch (508.0 mm) wide bus transition section. Also two 4.00-inch (101.6 mm) filler sections will be added to the MCC if the tie breaker is located in the center of the MCC lineup. If the tie breaker is located between the two main structures, the two 4.00-inch (101.6 mm) fillers are not needed.

Table 29.5-22. Main-Tie-Main Auto Throw-Over Options

Option	Description
AT200	Standard PLC-based control scheme. No operator interface (PanelMate) provided. Sequence of operations and external controls are pre-defined and not subject to customer modifications. Type of voltage sensing device must be chosen. If closed-transition operation is required, a sync-check relay (device 25) must be used.
AT300	Same as AT200, except includes operator interface (PanelMate). ⑤
AT300X	Same as AT200, except customer modifications are acceptable. This is the proper choice for PLC-based systems with special sequences, more than main-tie-main configurations, and/or where special PanelMate page layouts are required.
AT300IQ	Standard Automatic Transfer Control (ATC) controller-based control scheme for main-main configurations. Either or both sources may be generators. Includes manual-auto operation, and generator control switch. If closed-transition operation is required, a sync-check relay (device 25) must be used.

⑤ Operator interface page layouts are pre-defined and not subject to customer modifications.

Table 29.5-23. Freedom FlashGard Main Incoming Line and Feeder Fusible Switches—Dimensions in Inches (mm)

Three-pole—250 or 600 Vac. Fuses not included.

Switch Rating ⑥ Amps ⑦	Fuse Clip Size Amps	Unit Space			
		Incoming Line		Feeder	
		Inches (mm)	X Space	Inches (mm)	X Space
30 60	30 60	18.00 (457.2) 18.00 (457.2)	3X 3X	12.00 (304.8) 12.00 (304.8)	3X 3X
100 200 400	100 200 400	18.00 (457.2) 30.00 (762.0) 48.00 (1219.2)	3X 5X 8X	24.00 (609.6) 36.00 (914.4) 42.00 (1066.8)	3X 5X 7X
600 800 1200 ⑧	600 800 1200	54.00 (1371.8) ⑨⑩ 48.00 (1219.2) ⑩⑪ 60.00 (1524.0) ⑩	9X ⑨⑩ 8X ⑩⑪ 10X ⑩	48.00 (1219.2) ⑩ 48.00 (1219.2) ⑩⑫ 60.00 (1524.0) ⑩	8X ⑩ 8X ⑩⑫ 10X ⑩

⑥ Suitable for 100,000 A interrupting if Class RK fuses are used.
⑦ Type of SW K-SW 30–800 A.
⑧ High magnetic molded-case switch.
⑨ For bottom cable entry, add 6.00 inches (152.4 mm) or 1X space.
⑩ Fixed assemblies, no RotoTract.
⑪ For bottom entry, add 12.00 inches (304.8 mm) or 2X space.
⑫ For top entry, add 6.00 inches (152.4 mm) or 1X space.

29

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