

General Description

General Description

Introduction

Cutler-Hammer currently produces two motor control center designs; Freedom™ and Advantage®. Each MCC type provides quality group motor control for a wide variety of applications. Freedom MCCs offer the best motor control for traditional electromechanical starter applications. The Advantage motor starter brings solid-state technology to the electromechanical motor starter industry. Each MCC model utilizes the same rugged enclosure and plug-in cell design.

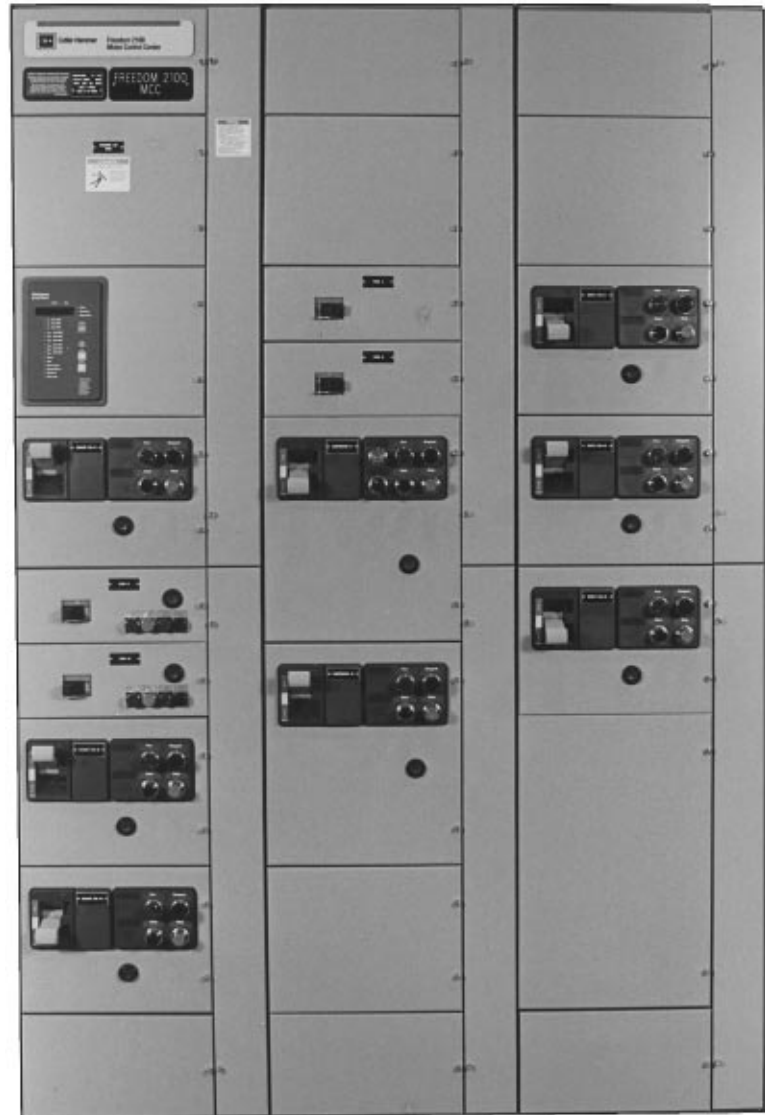
Refer to Table V for feature highlights of each MCC design.

Layout Guide —

Space Requirements

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2100 Series Motor Control Center

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General Description

Features

- UL Label
- 65,000 AIC Ratings
- Series C Circuit Breakers
- 3200A Maximum Horizontal Bus
- Labyrinth Barrier System for Bus
- Pull Apart Latching Terminal Blocks
- Unit Grounding Clip
- Front Only or Front and Rear Unit Mounting
- Solid-State Motor Control

Description

Motor Control Centers (MCC) provide the best method for grouping motor control, associated control and distribution equipment. The Freedom and Advantage 2100 Series Control Centers are specially designed to operate machinery, industrial processes and commercial building systems.

The MCC enclosure consists of a strong and rigid steel channel framework assembled into standardized vertical sections and bolted together to form a complete shipping section of up to 80-inch 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 Cutler-Hammer components with proven safety, quality and reliability. All components are wired in accordance with NEC and UL standards. Specifically designed bus stabs, insertion guides, handle mechanisms and safety interlocks are added to form a standardized plug-in unit which meets the highest safety standards.

Both Freedom and Advantage 2100 Series MCCs may be applied on electrical systems up to 600V, 50 or 60 hertz having available fault currents of up to 100,000A rms. Enclosure designs include NEMA 1A Gasketed, 2, 12 and 3R. An ongoing

temperature and short circuit design test program as required by UL 845 ensures a quality product that meets the latest safety codes.

Replacement MCC Units

In addition to fully assembled, free-standing motor control center line-ups, replacement MCC plug-in units are available for:

- Westinghouse 11-300, built from 1950
- Westinghouse Type W, built from 1965
- Westinghouse FIVE STAR, built from 1975
- Westinghouse SERIES 2100, built since 1986
- Westinghouse Advantage, built since 1991
- Cutler-Hammer 9800, built from 1956
- Cutler-Hammer F10, built from 1972
- Cutler-Hammer Freedom, built since 1988
- Cutler-Hammer Freedom Series 2100, built since 1995

A complete plug-in unit for adding to an existing MCC includes the plug-in unit, hinged door, isolating divider pan, and all necessary installation hardware. Note: mounting hardware for old Cutler-Hammer MCC is sold separately. Since MCC UL 845 standard was established in 1975, most standard replacement plug-in units will have UL labels.

Ordering Information

Replacement plug-in units should be ordered by description indicating:

- Old GO Number/Factory Order Number

Further Information

| 2100 Series MCC | Freedom | Advantage |
|---|--------------|--------------|
| Renewal Parts Data | RPD 8991 | RPD 8991 |
| Renewal Parts Price List | RPPL 8991A | RPPL 8991A |
| Price List | PL.A3.01.P.E | PL.A3.02.P.E |
| Instructions and Installation Manual | IB 8926-1 | IB 8922-1 |
| Cutler-Hammer Product Specification Guide | CSI-#16482 | CSI-#16482 |

- MCC model
- Type of plug-in unit
- Required features
- Circuit breaker or fuse rating
- Schematic reference, if any
- Motor data

Standard Five Star, Series 2100, Freedom Series 2100 and Advantage plug-in units with current Cutler-Hammer components wired to standard schematics can be obtained out of stock from one of seven regional Service Centers. All other units are to be ordered from the MCC assembly plant in Fayetteville, NC.

NEMA Classifications

Class I Control Centers

These are essentially a mechanical grouping of combination motor control, feeder tap and/or other units arranged in a convenient assembly. They include connections from the common horizontal power bus to the units. They do not include interwiring or interlocking between units or to remotely mounted devices, nor do they include control system engineering. Diagrams of the individual units only are supplied.

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

Class II Control Centers

These are basically 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 center will be provided.

General Description

NEMA Classifications, Continued

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 terminal blocks. Combination linestarters are factory wired and assembled in the structure in the most efficient arrangement. Auxiliary devices can be

supplied, but no wiring external to the unit will be furnished. All feeder circuit breaker or fusible disconnect units are in this classification.

Type B essentially duplicates Type A except that all control wires terminate at blocks on the side or near the bottom of each unit. Load terminals are all conveniently located adjacent to the control terminal blocks on size 1s only. Plug-in type terminal

blocks are standard for all control wiring.

Type C utilizes Type B units. Factory wiring of required control wiring and load wiring through sizes 1 and 2 and control wiring only size 3 and larger is extended from the unit terminals to master terminal blocks located at the top or bottom of each vertical compartment.

I. Structure

Construction

The standard vertical structure is 90 inches high and 20 inches wide. Front mounted only structures can be either 16 inches or 21 inches deep. Back-to-back unit mounting is 21 inches deep.

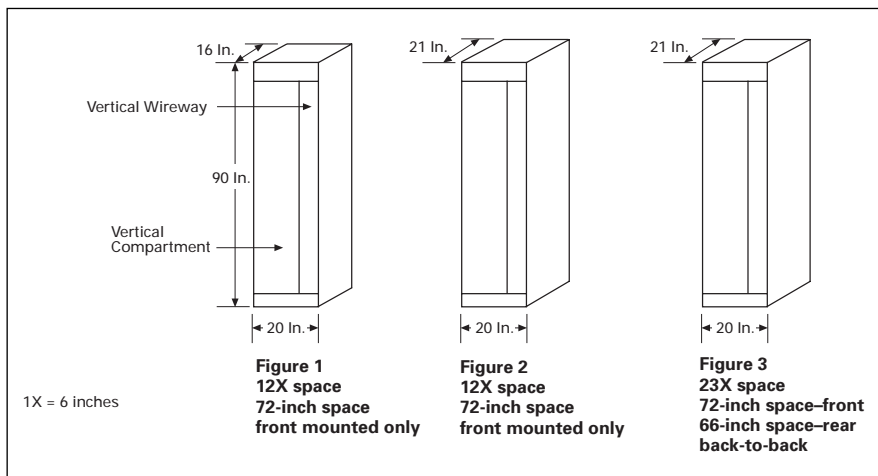
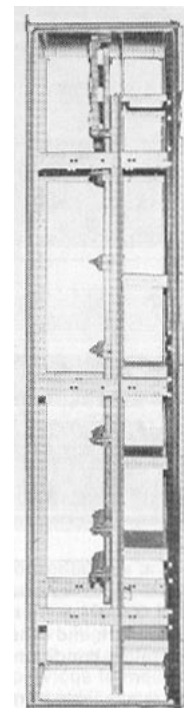
The structure framework is made of 12-gauge formed steel channels. The subframes for the front and rear of each structure are welded. These subframes are then bolted to longitudinal members to form the complete frame which is rigid and self-supporting. Side, back and roof covers of 14-gauge steel are mounted with screw fasteners for quick and easy removal when desired. All doors are 14-gauge steel with a 1/2-inch 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 inches with 9-inch horizontal wireways available at top and bottom for wiring. The balance of vertical compartments, 72 inches, is available for mounting of control units. This space can provide up to twelve 6-inch high (X spaces) or any combination thereof.



Note: In the rear of back-to-back structures, the top horizontal wireway is 15 inches high and the bottom wireway is 9 inches. This means that back-to-back structures have only 66 inches (11X) of usable space in the rear.

Special Structures

In addition to the standard 20-inch wide structure, extra wide structures are available in 4-inch increments up to 40 inches wide. These structures can be supplied with or without 4-5/8-inch wide vertical wireways. They are used for mounting transfer switches, PLC hardware and other special equipment.

General Description

I. Structure, *Continued*

Reduced height structures, in increments of 6 inches (1X), are available for applications with limited access.

Another special structure is a transition section between Type W and the Freedom 2100 Series. This structure is 10 inches 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 grey (Munsel No. 8.3G/6.10/0.54). For improved interior visibility, the interior of the enclosure and plug-in units are painted white (Munsel No. N9.43/0.21B, 0.23).

Enclosures

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

The NEMA Type 2 Drip-proof — Indoor employs a special roof panel with a drip shield and water channels. This prevents liquid from dripping into 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 cut-outs, 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. MCC 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.

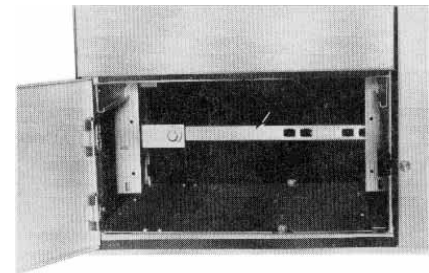
Vertical Wireway

A vertical wireway is provided in each structure. Located on the right side, it extends the full 90-inch height of the structure. The width of the wireway is 4-5/8 inches at the rear of the vertical frame members. Overall depth of the wireway is 8 inches providing a cross-sectional area of nearly 35 square inches to easily accommodate control and load wiring. Supports are provided at suitable intervals to secure all wiring and cables.

The wireway opening is covered by two doors, top and bottom, so that the entire wireway need not be exposed to gain access to one section. The doors swing open 115° and opposite to the unit doors for maximum accessibility. The doors are mounted on concealed removable double-barrel pin hinges for quick detachment and are secured in the closed position by one spring-loaded quarter-turn indicating type fastener.



Top Horizontal Wireway



Bottom Horizontal Wireway

Horizontal Wireways

The top front horizontal wireway is 9 inches high and 8 inches 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 inches high and extends the full depth of the structure. This provides unlimited wiring space. 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 inches high, reducing the bottom wireway height to 3 inches.

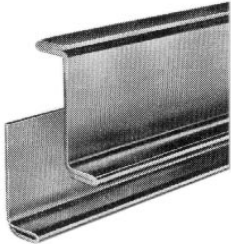
For back-to-back unit mounted, the rear top horizontal wireway is 15 inches high and 5 inches deep. When 2500A or 3200A bus is used, rear top horizontal wireway is 15 inches high and 1 inch deep.

All horizontal wireway openings are covered by doors for increased accessibility. Each door is mounted with removable double-barrel pin hinges to allow quick detachment and securely close with a spring-loaded quarter-turn indicating type fastener.

General Description

II. Bus System

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

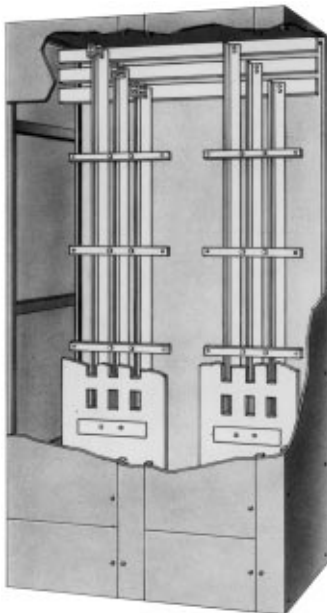


Vertical Bus Configuration

Vertical Bus

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

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

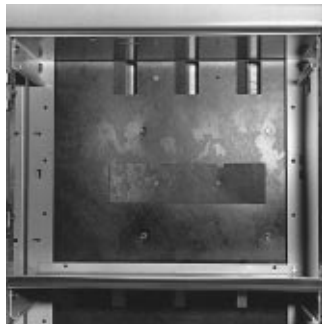


MCC Bus Layout

100,000A 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 300, 600, 800 and 1200A for front mounted only, and 600, 800 and 1200A for back-to-back mounted. **Vertical bus bars are tin-plated copper only.** Vertical bus of the incoming section will match the horizontal bus when applicable.

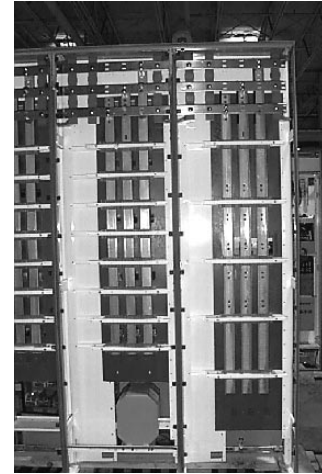
Isolation of the Freedom Series 2100 vertical bus compartment from the unit compartment is accomplished by a full height barrier which is provided as standard. This is a single sheet of glass-reinforced polyester with cutouts to allow the unit stabs to engage the vertical bus. Snap-in covers are available for the cutout openings to provide total isolation during maintenance procedures.



Standard Isolation Barrier

When insulation and isolation of the vertical bus is required, a **labyrinth design barrier** as shown to the right is available. 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. The labyrinth barrier is standard for Advantage MCCs.

An automatic shutter mechanism is optional with the labyrinth barrier to provide complete isolation of the



Standard Isolation Barrier Rear View

vertical bus. The shutter moves automatically to cover the stab openings when a unit is removed. This provides maintenance personnel with maximum protection since 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

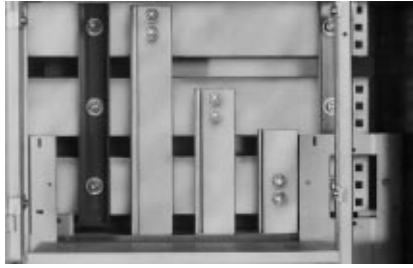
Horizontal Bus

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.



General Description

II. Bus System, *Continued*

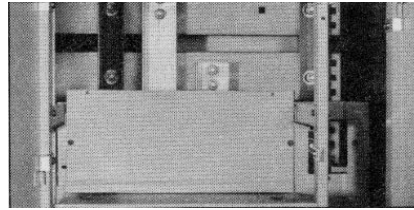


Horizontal Bus

Standard horizontal bus bracing is 65,000A rms symmetrical amperes. Optional bracing is available at 100,000A rms. Bus braces are molded from high strength glass-reinforced polyester material which is non-tracking and impervious to moisture and other adverse atmospheric operating conditions.

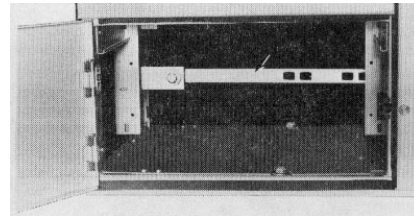
The main horizontal bus is rated at 600A as standard with ratings of 800, 1200, 1400, 1600, 2000, 2500 and 3200A^① optionally available. Tin-plated copper bus bars are supplied as standard. Silver-plated copper is also available.

The horizontal main bus is isolated from the top horizontal wireway compartment by an 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.



Horizontal Bus Barrier

This allows maintenance personnel to make splices and check splice bolt torques from the front of the structure.



Neutral Bus (Bottom)

Neutral Bus

Neutral bus can be supplied one half or fully rated up to 3200A^① maximum. The bus bar is mounted on stand-off insulators across the bottom of each vertical compartment.



Ground Bus (Top)

Ground Bus

Copper ground bus, rated 300A (1/4-inch by 1-inch) 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 inches are not occupied by units or master terminal blocks. A 1/4-inch by 2-inch copper ground bus rated 600A is optional.

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

Captive Splice Plates

Bus splice plates are shipped connected to the horizontal bus of a shipping split. This reduces installation time and ensures that the splice plates are not lost during shipment.



Horizontal Bus Splice Bars

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

General Description

III. Units

General

Motor starter units are combination type employing a linestarter and a disconnect device of proven capability. The disconnect device can be either a circuit breaker or fusible switch. The Cutler-Hammer Type HMCP motor circuit protector breaker is furnished as standard.

All starters through NEMA Size 5 are a drawout design except Size 5 reduced voltage.

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

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

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.

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
- Adjustable Frequency Controllers

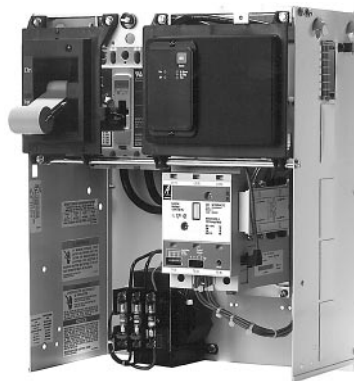
Each starter has, as standard, a stainless steel corrosion-resistant safety ground clip that makes connection before the power stabs engage the vertical bus.



Freedom - FVNR Starter

Units - Freedom

Freedom Series 2100 starter units are equipped with Cutler-Hammer Freedom starters and contactors NEMA size 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 as standard. The overload relay also provides single-phase sensitivity and isolated alarm contact. An insulated hand reset button extends through the compartment door.



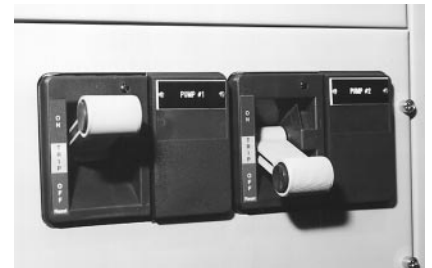
Advantage - FVNR Starter

Units - Advantage

Advantage starter units are equipped with Cutler-Hammer Advantage starters NEMA sizes one through six. Introduced in 1991, the Advantage starter has been successfully applied in the most demanding

industrial applications. Utilizing state-of-the-art microprocessor control, the Advantage starter affords phase unbalance protection, ground fault protection, more accurate motor overload protection, discrete pickup and drop out voltages and inherent coil surge protection. Additionally, motor running data and starter status are available through IMPACC/PowerNet and DeviceNet communications systems.

Note: Freedom and Advantage starters passed IEC 947-4 Type II testing with R and J fuses. Additionally, Advantage is Type II listed with Cutler-Hammer HMCPs.



Dual Feeder Tap Unit

Feeder Tap Units

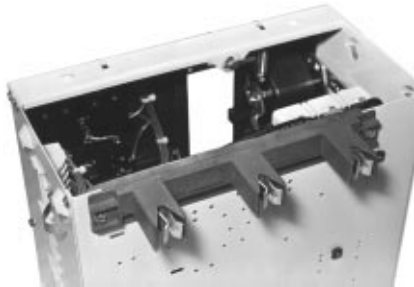
Feeder tap units may contain either circuit breakers or fusible switches. Drawout breaker units include the fixed trip Type HFD, single or dual mounted in ratings through 150A and the interchangeable trip Types HJD and HKD single mounted through 250A and 400A respectively. Larger Series C circuit breakers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

Fusible feeder tap units utilize the Cutler-Hammer Type K visible blade disconnect switch. Fused switches are mounted in drawout units through 400A with 30 and 60A ratings available in dual mountings. Fixed mounted switch ratings of 600A and 800A 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.

General Description

III. Units, *Continued*



Plug-in Unit Bus Stabs

Stab Assembly

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 which 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. Standard power wiring is firmly 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 400A ratings.



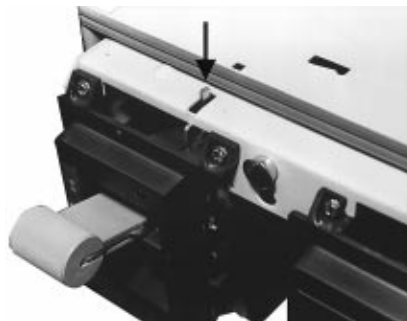
Circuit Breaker Handle Mechanism

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.

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.



Unit Insertion Interlock

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



Padlocking Bar

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 the ON position.

General Description

III. Units, Continued



Standard Device Panel



Advantage Device Panel with ACM and Metering Module

Device Panel

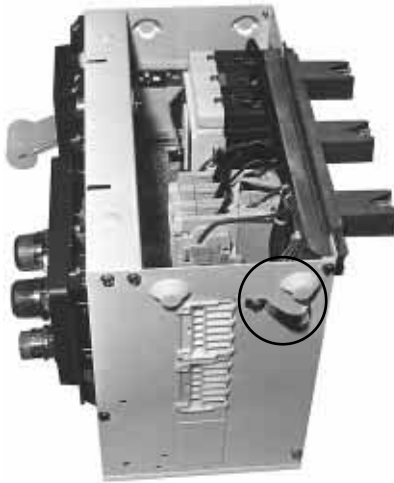
The device panel can accommodate up to six 30 mm Cutler-Hammer 10250T type pilot devices such as oiltight push buttons, indicating lights, selector switches and miniature meters.

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 1/2-inch 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 engraved with 3/16-inch high white lettering on a black background. They are heat and crack resistant to eliminate the need for replacement. Nameplates are mounted with self-tapping screws. Stainless steel screws are available as an option.



Plug-in Unit Wrapper

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 Munsel No. N9.43/0.21B, 0.23 white. This is a highly durable finish, off-white in color to increase visibility within the unit and facilitate wiring and maintenance procedures.

The unit wrapper provides three sides of a rugged steel shell and the mounting base for the unit compartments. The smallest unit measures 13-3/4 inches wide, 8 inches deep and 6 inches high. Units increase in 6-inch increments to a maximum height of 72 inches.

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

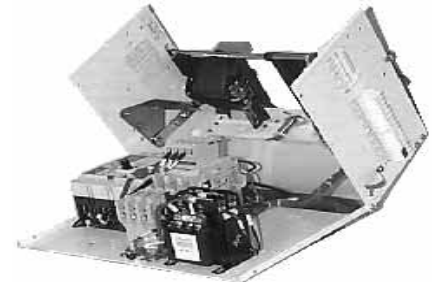
The unit wrapper has four mounting points, two on each side, which support the unit in the structure. They



Unit Wrapper Latch

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.

At the top center of the unit wrapper is a quarter-turn latch which 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.



Plug-in Unit Maintenance

Unit Maintenance

A three-piece 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. The industrial grade Cutler-Hammer MCC terminal block provides solid electrical connections while conserving space and making installation and maintenance easier.

General Description

III. Units, *Continued*

Terminal blocks are mounted in knockouts 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 600V, 30A rated terminal block will accept up to two 12 AWG stripped wires as well as ring or spade wire lugs. All terminal block conductors are fully shielded for added safety and cleanliness.

A 12-inch high (2X-space) starter unit accommodates up to three side-mounted terminal blocks providing a maximum of 21 points. Larger units accommodate two additional seven points terminal blocks for every additional 6 inches (1X-space) of unit height. The 6-inch 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 2100 Series MCCs and 14 AWG wire for

Advantage 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 Cutler-Hammer for terminal block types available and space restrictions.



12-inch Unit Door

Unit Doors

Unit doors are formed of 14-gauge steel with a 1/2-inch 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 ANSI 61.

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

Doors 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.



Spring-Loaded Unit Door 1/4 Turn Latch

Options

Starter and feeder tap units can be modified to meet a variety of specification requirements. Some typical components which can be added include: control power transformers with two primary and one secondary control fuses, control relays, IQ500 (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 do 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 .5, .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, 120/240V, 120/208V or 480V, single- or three-phase.

General Description

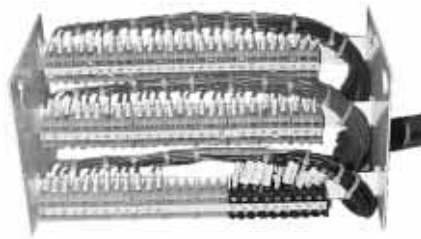
III. Units, Continued

- Current limiting reactors with ohmic values of .01, .015, .02 and .025 and ampere ratings of 600, 800, 1000 and 1200.
- Metering equipment such as the IQ family of solid-state power monitors, voltmeters and ammeters.
- PLC programmable controllers and I/O racks.
- Easy Start family of solid-state reduced voltage starters.
- AF91, SV9000 and AF95 adjustable frequency controllers.
- Size 4, 5 and 6 vacuum starters and contactors.
- Power factor correction capacitors.
- Automatic transfer switches.
- DeviceNet Network
- IMPACC/PowerNet communications

Control and Load Terminations

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.



*Master Terminal Blocks at Bottom
(Class C Wiring)*

For NEMA Type C wiring, control and size 1 and 2 starter 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 inches of unit space must be used. When mounting is made in the rear of back-to-back mounted structures, 6 inches of unit space must be used at the bottom and 12 inches at the top.

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

Incoming Line

Incoming line cables entering the Motor Control Center from either the top or bottom can be easily terminated in 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 4 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 Motor Control Center and bottom entry cables are conveniently terminated near the bottom. Table T shows spacing requirements for various cable configurations. MLO termination for 1600, 2000, 2500 and 3200A^① requires a full vertical section.

Main Disconnects

Incoming cables may also be easily terminated on a main circuit breaker or fused switch. A variety of molded case or encased circuit breakers are available. Tables F and G show spacing requirements for various main devices.

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

General Description

IV. Solid-State Devices

A wide variety of solid-state devices are available for mounting in Motor Control Centers. Solid-state components offer a wide variety of control capability not available with electro-mechanical components. Typical components include:

- Adjustable Frequency Controllers
- Reduced Voltage Solid-State Starters
- Programmable Controllers
- IQ MP3000 Motor Protective Relay
- IQ 500
- IQ 200
- IQ Data
- IQ DP4000
- IQ Analyzer
- IMPACC/PowerNet Communications
- DNet Communications

Both Freedom Series 2100 and Advantage MCCs have standard designs available for the mounting of these and many other solid-state components.

Adjustable Frequency Controllers are available from .5 hp to 300 hp for control of standard ac motors in processes that benefit with 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 available for Volts/Hz, open loop vector and closed loop vector. Standardized mountings are available for Cutler-Hammer AFC controllers. A wide range of AFC features and options are available to meet the requirements of most applications. AFC are available in NEMA 1 and NEMA 12. Operator controls are available using the standard device panel.

Reduced Voltage Solid-State Starters are designed to reduce the inrush current to a motor during starting and limit the amount of

available starting torque, thus extending motor acceleration time. The amount of starting current is field adjustable to match the specific requirements of all applications. In addition to controlling starting current, the RVSS starter has a motor load sensing circuit which will minimize power consumption and act as a line voltage limiter during periods of high line voltage (>480).

Cutler-Hammer EA, ES and EJ SSRV controllers are available with a wide variety of options.



Applications include those which benefit from reduced voltage starting including conveyors, compressors, machine tools, pumps and fans.

Programmable Controllers can be mounted in Freedom Series 2100 and Advantage MCCs in a wide variety of configurations. Popular mounting configurations include small PLCs unit mounted to replace relays, medium sized PLCs with I/O for control of an MCC lineup, and remote I/O drops mounted in an MCC and connected to the main CPU via coaxial cable. Due to the flexibility of PLCs and the wide variety of applications and configurations, the Freedom Series 2100 and Advantage MCCs are designed to meet the mounting requirements of any application.

The **IQ MP3000** Motor Overload Relay is a microprocessor-based relay which provides superior motor protection for critical process

motors. Standard protective features provided in the IQ MP3000 include: I^2t with programmable locked rotor protection, instantaneous overcurrent, ground fault, underload, jam, phase loss/unbalance/reversal, limit starts/hr, alarm and trip modes and capability to utilize RTDs for motor protection. Functions are user programmed via a data entry and display panel mounted in the door of the Freedom Series 2100. Alarm and Trip contacts are provided for remote indication. In addition, the IQ MP3000 will have the capability for remote monitoring via a communications port. The ultimate in motor protection is available in the IQ MP3000 and the 2100 Series MCC.

The **IQ-500** Current-Sensing Motor Overload Relay is a multifunction adjustable (class 5, 10, 20 or 30) motor protective relay with optional communications capabilities for Freedom Series starters. Several functions are incorporated into the base relay as standard:

- Overload (Overcurrent) Protection
- Phase-Unbalance Protection
- Phase-Loss Protection
- Ground-Fault Protection (Class II)

The base relay can serve as the initial building block for a Motor Protection System by adding the IQ500M Special Function Module. The module can address application-related motor load functions with the additional features:

- Underload Protection
- Long Acceleration
- Jam Protection
- Load Control

General Description

IV. Solid-State Devices, Continued



IQ DP4130

Metering

The Cutler-Hammer IQ family of metering and power monitors include:

IQ Data microprocessor-based three-phase power monitor replaces the traditional ammeter, voltmeter and instrument switches.

IQ Generator microprocessor-based three-phase monitor replaces the traditional frequency meter, ammeter, voltmeter, and instrument switches.

IQ 200 includes all of the functions of the IQ-Data plus watt-meter, watt-hour meter, power factor meter, and voltage power sensor. This device is ideal for individual load or machine monitoring.

IQ DP4130 includes all of the functions of the IQ-Generator plus watt-meter, watt-hour meter, power factor meter, and voltage power sensor. This device is ideal for incoming line monitoring.

IQ Analyzer 6030 provides extensive metering, power quality analysis, remote input monitoring, control relaying, analog input/outputs, and is communications capable. A dot matrix, gas plasma display provides the flexibility of exhibiting large characters with high visibility and small characters for detailed descriptions. Refer to PG.17.01.T.E.

These IQ power monitors each contain their own voltage power pack for systems up to 600V. Therefore, separate potential transformers are not required. Either two or three separate current transformers must be used. All IQ power monitors are communications capable.



Central Monitoring Unit

IMPACC/PowerNet Communications

The Advantage MCC is available with the IMPACC/PowerNet communications network. IMPACC/PowerNet network capable devices, such as Advantage starters, the IQ family of metering devices, addressable relays, energy sentinels and many others, can be connected together with one twisted pair IMPACC/PowerNet communications network. Advantage starters may be controlled and monitored from remote locations. Three-phase motor running current, control voltage, elapsed time, start count and overload status information is available on the network. When Advantage starters with WPONI modules are furnished, an internal IMPACC/PowerNet network is wired and extended to terminal blocks. IMPACC/PowerNet network wiring is also provided and wired to a CMU when specified.

Central Monitor Unit (CMU) For Advantage MCCs, a Central Monitor Unit can be installed to provide centralized motor monitoring for an entire MCC. Using an IMPACC/PowerNet communications network, all Advantage starters with WPONI network modules are serially connected to the CMU via one shielded twisted pair network. At the CMU, motor running data as well as start/stop and overload status can be conveniently monitored.

DeviceNet Communications

Advantage MCCs are available with DeviceNet Communications.

DeviceNet is a device level open communication network linking DeviceNet capable control products, such as Advantage Starters, Freedom Series AE19 Starters, Adjustable Frequency Controllers, PanelMate 500 and 1500 Series operator interfaces, DN50 I/O blocks, and the D700 line of Cutler-Hammer iPCs. These products are prewired in the MCC with DeviceNet cable. Available control and monitoring features of the Advantage and Freedom AE19 Starters include:

- On/Off control
- Trip reset
- Trip indication
- Thermal capacity
- Three-phase or average motor current
- Overload alarm

The DeviceNet specification is controlled by the Open Device Vendors Association (ODVA). The DeviceNet system can be controlled from:

- iPC (industrial personal computer) via Cutler-Hammer's NetView™ and NetSolver® Software
- DeviceNet scanner cards designed for leading PLCs.



PanelMate

PanelMate® Series Operator Interfaces

For Cutler-Hammer Freedom and Advantage 2100 Series MCCs, a PanelMate 500 or 1500 can be installed to provide machine or process control. Whether connected to a DeviceNet System or a PLC system, the PanelMate operator interface will provide centralized control and monitoring of the system.

General Description

V. 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.

Seismic Qualification

Seismic testing has been completed on a wide array of products in Freedom and Advantage MCCs. When installation instructions are followed, Freedom and Advantage MCCs can be seismically qualified up to UBC Seismic Zone 4, BOCA and CBC^①. The Freedom and Advan-

tage MCCs are the most tested MCCs available.

Retrofits

Existing installations can many times benefit from some of the "new" technology equipment available in today's MCCs. Cutler-Hammer offers a full range of retrofit capabilities to allow for upgrading of existing MCC lineups. Examples include: vacuum contactors, reduced voltage solid-state starters, IQ DP4000 solid-state metering, IQ 1000 II solid-state overload protection and much more. Starter retrofit kits for selective competitor MCCs are also available. Consult factory for availability.

VI. Technical

Information Required

1. MCC model
2. Quantity
3. Starter sizes and type
 - a. NEMA size (1 through 6)
 - b. Type
 1. HMCP
 2. HMCP with current limiting fuses
 3. Fusible plus clip type
 - c. Short circuit rating
 - d. FVNR, FVR, RVNR, 2-speed 1W, 2-speed 2W
 - e. Motor hp ratings
4. Starter options
 - a. Pushbuttons
 - b. Selector switch
 - c. Lights
 - d. Interlocks
 - e. Relay types and timing ranges
5. Overload relay information
 - a. Heaters/FLA
 - b. Service factor
 - c. Thermal/IQ500/Advantage
6. Unit data
 - a. Service voltage
 - b. Hertz
 - c. Control voltage
 - d. Source of control voltage
7. Enclosure – NEMA type
 - a. 1 Gasketed
 - b. 12
 - c. 3R non-walk-in
 - d. 3R walk-in aisle or tunnel
8. Unit mounting
 - a. Front only
 - b. Back-to-back
9. Incoming line data
 - a. Structure location
 - b. Top or bottom entry/left or right
 - c. Cable size
 - d. Number of cables per phase
 - e. Bus duct entry
10. NEMA class wiring
 - a. IA
 - b. IB
 - c. IC
 - d. IIB
 - e. IIC
11. Bus bracing – Symmetrical Amperes
 - a. 42,000 (option F2100)
 - b. 65,000 (standard)
 - c. 100,000
12. Horizontal bus rating and material
 - a. 600A through 3200A^②
 - b. Copper
13. Copper vertical bus rating
 - a. 300A through 1200A
14. Also include with order:
 - a. Specifications and drawings
 - b. Control diagrams
 - c. Special requirements
15. Nameplate information

^① Contact Cutler-Hammer for availability of seismically qualified MCC.

^② 3200A available in NEMA 1A enclosure and 65°C rise above 40°C ambient only.

Technical Data

Technical Data

Table A – Combination Starters with Series C Motor Circuit Protectors or Molded Case Circuit Breakers

| NEMA Size | Maximum Horsepower | | | | | HMCP Frame ^① | MCCB Frame ^② | Freedom | | Advantage | |
|---|--------------------|------------|------------|-------------------|---------------|-------------------------|-------------------------------|---|--|--|--|
| | | | | | | | | Unit Size | | Unit Size | |
| | | | | | | | | Inches | X Space | Inches | X Space |
| Full Voltage Non-Reversing | | | | | | | | Type F206 | | Type W206 | |
| 1 | 7.5 | 7.5 | 10 | 10 | 10 | 150 | HFD/FDC HFD/FDC | 6 ^① 12 ^⑨ 18 | 1X ^① 2X ^⑨ 3X | 6 ^① 12 ^⑨ 18 | 1X ^① 2X ^⑨ 3X |
| 2 | 10 | 15 | 25 | 25 | 25 | 150 | HFD/FDC HFD/FDC | 12 ^⑨ 18 | 2X ^⑨ 3X | 6 ^① 12 ^⑨ 18 | 1X ^① 2X ^⑨ 3X |
| 3 | 25 | 30 | 50 | 50 | 50 | 150 | HFD/FDC HFD/FDC HFD/FDC | 18 ^⑩ 24 | 3X ^⑩ 4X | 12 ^① 18 ^⑩ 24 | 2X ^① 3X ^⑩ 4X |
| 4 | 40 | 50 | 75 | 100 | 100 | 150 | HFD/FDC HFD/FDC HJD/JDC | 18 ^{②⑩} 24 ^② | 3X ^⑩ 4X | 12 ^② 18 ^{②⑩} 24 ^② | 2X 3X ^⑩ 4X |
| 5 | 50 75 | 60 100 | 100 150 | 125 200 | 150 200 | 250 400 | HJD/JDC HKD/KDC | 36 | 6X | 36 | 6X |
| 6 | 125 150 | 100 200 | 250 300 | 300 350 400 | 400 – – | 600 | HLD/LDC HND | 48 | 8X | 36 | 6X |
| 7 | – | 300 | – | 600 | 600 | 1200 | HND | 54 | 9X | 54 | 9X |
| Full Voltage Non-Reversing – Dual Unit^③ | | | | | | | | Type F246 | | Type W246 | |
| 1 | 7.5 | 7.5 | 10 | 10 | 10 | 150 | HFD/FDC | 18 | 3X | 18 | 3X |
| 2 | 10 | 15 | 25 | 25 | 25 | 150 | HFD/FDC | 18 | 3X | 18 | 3X |
| Full Voltage Reversing | | | | | | | | Type F216 | | Type W216 | |
| 1 | 7.5 | 7.5 | 10 | 10 | 10 | 150 | HFD/FDC | 18 ^⑩ 24 | 3X ^⑩ 4X | 18 ^⑩ 24 | 3X ^⑩ 4X |
| 2 | 10 | 15 | 25 | 25 | 25 | 150 | HFD/FDC | 18 ^⑩ 24 | 3X ^⑩ 4X | 18 ^⑩ 24 | 3X ^⑩ 4X |
| 3 | 25 | 30 | 50 | 50 | 50 | 150 | HFD/FDC | 24 ^④ | 4X | 24 ^④ | 6X |
| 4 | 40 | 50 | 75 | 100 | 100 | 150 | HJD/JDC | 30 ^④ | 5X | 30 ^④ | 5X |
| 5 | 50 75 | 60 100 | 100 150 | 125 200 | 150 200 | 250 400 | HJD/JDC HKD/KDC | 60 | 10X | 60 | 10X |
| 6 | 125 150 | 100 200 | 250 300 | 300 400 | 400 – | 600 | HLD/LDC | 72 ^⑤ | 12X | 72 | 12X |
| Two-Speed One Winding, Constant/Variable Torque | | | | | | | | Type F946 | | Type W946 | |
| 1 | 7.5 | 7.5 | 10 | 10 | 10 | 150 | HFD/FDC | 24 ^⑥ | 4X | 24 ^⑥ | 4X |
| 2 | 10 | 15 | 25 | 25 | 25 | 150 | HFD/FDC | 24 ^⑥ | 4X | 24 ^⑥ | 4X |
| 3 | 25 | 30 | 50 | 50 | 50 | 150 | HJD/JDC | 36 ^{⑥⑦} | 6X | 36 ^⑥ | 6X |
| 4 | 40 | 50 | 75 | 100 | 100 | 150 | HJD/JDC | 36 ^{⑥⑦} | 6X | 36 ^⑥ | 6X |
| 5 | 50 75 | 60 100 | 100 150 | 125 200 | 150 200 | 250 400 | HJD/JDC HKD/KDC | 72 ^⑤ | 12X | 72 ^⑤ | 12X |
| Two-Speed Two Winding, Constant/Variable Torque | | | | | | | | Type F956 | | Type W956 | |
| 1 | 7.5 | 7.5 | 10 | 10 | 10 | 150 | HFD/FDC | 24 | 4X | 24 ^⑥ | 4X |
| 2 | 10 | 15 | 25 | 25 | 25 | 150 | HFD/FDC | 24 | 4X | 24 ^⑥ | 4X |
| 3 | 25 | 30 | 50 | 50 | 50 | 150 | HFD/FDC | 30 | 5X | 30 ^⑥ | 5X |
| 4 | 30 40 | 40 50 | 60 75 | 75 100 | 100 – | 150 250 | HFD/FDC HJD/JDC | 30 30 ^④ | 5X 5X | 30 ^⑥ 30 ^⑥ | 5X 5X |
| 5 | 50 75 | 60 100 | 100 150 | 125 200 | 150 200 | 250 400 | HJD/JDC HKD/KDC | 72 ^⑤ | 12X | 72 ^⑤ | 12X |

For HMCP Continuous Ampere Ratings By Motor Hp See Table W Page I2-32

- ① Limited options. Refer to Cutler-Hammer.
- ② Minimum 30-inch space needed with Thermal Magnetic Circuit Breaker.
- ③ Limited options. Two starter units share common door.
- ④ 36-inch space needed for Thermal Magnetic Circuit Breaker.
- ⑤ Requires 28-inch wide structure.
- ⑥ Add 6-inch space for low speed disconnect.
- ⑦ 42-inch space needed with Thermal Magnetic Circuit Breaker. 48-inch space needed with Thermal Magnetic Circuit Breaker.
- ⑧ 12-inch/2X unit is standard.
- ⑨ 18-inch/3X unit is standard.
- ⑩ Standard Combination Starter Units with HMCP Magnetic Only disconnect has short circuit ratings of 65,000 amperes at 480 volts. Optional HMCP combination starter units are available with 100,000 amperes at 480 volts.
- ⑪ Optional Combination Starter Units with Thermal Magnetic breaker disconnects are available with either 65,000 amperes or / 100,000 amperes at 480 volts.

Technical Data

Table A – Combination Starters with Series C Motor Circuit Protectors or Molded Case Circuit Breakers, Continued

| NEMA Size | Maximum Horsepower | | | | | HMCP Frame ^③ | MCCB Frame ^④ | Freedom | | Advantage | |
|--|--------------------|-----|-----|-----|-----|-------------------------|-------------------------------|------------------|---------|------------------|---------|
| | | | | | | | | Unit Size | | Unit Size | |
| | | | | | | | | Inches | X Space | Inches | X Space |
| Reduced Voltage Autotransformer | | | | | | | | Type F606 | | Type W606 | |
| 2 | 10 | 15 | 25 | 25 | 25 | 150 | HFD/FDC | 36 | 6X | 36 | 6X |
| 3 | 25 | 30 | 50 | 50 | 50 | 150 | HFD/FDC | 48 | 8X | 54 | 9X |
| 4 | 30 | 50 | 75 | 100 | 100 | 150 | HJD/JDC | 54 | 9X | 54 | 9X |
| 5 | 50 | 60 | 100 | 125 | 150 | 250 | HJD/JDC HKD/KDC | 72 | 12X | 72 | 12X |
| | 75 | 100 | 150 | 200 | 200 | 400 | | | | | |
| 6 | 150 | 200 | 300 | 400 | 400 | 600 | HLD/LDC | 72 ^① | 12X | 72 ^① | 12X |
| 7 | – | 300 | – | 600 | 600 | 1200 | HND | 72 ^① | 12X | 72 ^① | 12X |
| Reduced Voltage Part Winding | | | | | | | | Type F706 | | Type W706 | |
| 1PW | 10 | 10 | 15 | 15 | 15 | 150 | HFD/FDC | 24 | 4X | 24 ^② | 4X |
| 2PW | 20 | 25 | 40 | 40 | 40 | 150 | HFD/FDC | 24 | 4X | 24 ^② | 4X |
| 3PW | 40 | 50 | 75 | 75 | 75 | 150 | HFD/FDC | 30 | 5X | 30 ^② | 5X |
| 4PW | – | – | – | 100 | 125 | 150 | HFD/FDC HJD/JDC HKD/KDC | 36 ^② | 6X | 36 ^② | 6X |
| | 60 | 60 | 125 | 150 | 150 | 250 | | | | | |
| | 75 | 75 | 150 | – | – | 400 | | | | | |
| 5PW | 100 | 125 | – | 250 | 300 | 400 | HKD/KDC HLD/LDC | 72 ^① | 12X | 72 ^① | 12X |
| | 150 | 150 | 250 | 350 | 350 | 600 | | | | | |
| Reduced Voltage Wye Delta Open Transition | | | | | | | | Type F806 | | Type W806 | |
| 2YD | 20 | 25 | 40 | 40 | 40 | 150 | HFD/FDC | 30 | 5X | 30 | 5X |
| 3YD | 30 | 40 | 75 | 75 | 75 | 150 | HFD/FDC HJD/JDC | 42 | 7X | 42 | 7X |
| | 40 | 50 | – | – | – | 250 | | | | | |
| 4YD | 60 | 75 | 125 | 150 | 150 | 250 | HJD/JDC HKD/KDC | 48 | 8X | 42 | 7X |
| | – | – | 150 | – | – | 400 | | | | | |
| 5YD | 100 | 125 | 200 | 250 | 300 | 400 | HKD/KDC HLD/LDC | 72 ^① | 12X | 72 ^① | 12X |
| | 150 | 150 | 250 | 300 | – | 600 | | | | | |
| Reduced Voltage Wye Delta Closed Transition | | | | | | | | Type F896 | | Type W896 | |
| 2YD | 20 | 25 | 40 | 40 | 40 | 150 | HFD/FDC | 42 | 7X | 42 | 7X |
| 3YD | 40 | 50 | – | – | – | 250 | HFD/FDC | 54 | 9X | 54 | 9X |
| 4YD | 60 | 75 | 125 | 150 | 150 | 250 | HJD/JDC HKD/KDC | 60 | 10X | 60 | 10X |
| | – | – | 150 | – | – | 400 | | | | | |
| 5YD | 100 | 125 | 200 | 250 | 300 | 400 | HKD/KDC HLD/LDC | 72 ^① | 12X | 72 ^① | 12X |
| | 150 | 150 | 250 | 300 | – | 600 | | | | | |

① Requires 21-inch deep, 28-inch wide structure.

② For starting speed disconnect, add 6-inch space.

③ Standard Combination Starter Units with HMCP Magnetic Only disconnect has short circuit ratings of 65,000 amperes at 480 volts. Optional HMCP combination starter units are available with 100,000 amperes at 480 volts.

④ Optional Combination Starter Units with Thermal Magnetic breaker disconnects are available with either 65,000 amperes or / 100,000 amperes at 480 volts.

Technical Data

Table A – Combination Starters with Series C Motor Circuit Protectors or Molded Case Circuit Breakers, *Continued*

| Frame Size | Ampere Rating | Maximum Horsepower | | | | MCCB Frame Size ^③ | Freedom or Advantage | |
|---------------------------------|---------------|--------------------|------|------|------|------------------------------|----------------------|---------|
| | | 208V | 240V | 480V | 600V | | Unit Size | |
| | | | | | | | Inches | X Space |
| SSRV – Easy Start EJ – ③ | | | | | | | Type EJ06 | |
| EJ026 | 26 | 7.5 | 7.5 | 15 | 25 | HFD/HMCP | 24 | 4X |
| EJ052 | 52 | 15 | 15 | 40 | 50 | HFD/HMCP | 24 | 4X |
| EJ075 | 75 | 25 | 25 | 60 | 75 | HFD/HMCP | 24 | 4X |
| EJ130 | 130 | 40 | 50 | 100 | 125 | HFD/HMCP | 36 | 6X |
| EJ130 | 130 | 40 | 50 | 100 | 125 | HJD/HMCP | 42 | 7X |
| EJ190 | 190 | 60 | 75 | 150 | 150 | HJD/HMCP | 72 ^② | 12X |
| EJ270 | 270 | 75 | 100 | 200 | 250 | HKD/HMCP | 72 ^② | 12X |
| EJ390 | 390 | 125 | 150 | 300 | 350 | HLD/HMCP | 72 ^② | 12X |
| SSRV – Easy Start ES – ③ | | | | | | | Type ES06 | |
| ES070 | 70 | 20 | 25 | 50 | 60 | HFD/HMCP | 24 | 4X |
| ES120 | 120 | 40 | 40 | 100 | 100 | HFD/HMCP | 36 | 6X |
| ES120 | 120 | 40 | 40 | 100 | 100 | HJD/HMCP | 42 | 7X |
| ES180 | 180 | 60 | 75 | 150 | 150 | HKD/HMCP | 72 ^② | 12X |
| ES250 | 250 | 75 | 100 | 200 | 250 | HKD/HMCP | 72 ^② | 12X |
| ES560 | 560 | 200 | 200 | 450 | 400 | HLD/HND | 72 ^① | 12X |
| ES750 | 750 | 300 | 300 | 600 | 750 | HND | 72 ^① | 12X |
| SSRV – Easy Start EA – ③ | | | | | | | Type EA06 | |
| EA045 | 45 | 15 | 15 | 30 | 40 | HFD/HMCP | 24 | 4X |
| EA090 | 90 | 30 | 30 | 60 | 75 | HFD/HMCP | 30 | 5X |
| EA135 | 135 | 50 | 50 | 100 | 125 | HJD/HMCP | 36 | 6X |
| EA270 | 270 | 100 | 100 | 200 | 250 | HKD/HMCP | 48 | 8X |
| EA360 | 360 | 125 | 125 | 250 | 350 | HLD/HMCP | 54 | 9X |
| EA540 | 510 | 200 | 200 | 450 | 500 | HLD/HMCP | 60 | 10X |
| EA540 | – | – | – | – | – | HND | 72 | 12X |
| EA760 | 760 | 250 | 300 | 600 | 750 | HND | 72 | 12X |

Type EJ is the standard reduced voltage solid state starter with standard basic available options.

Type ES is the premium reduced voltage solid state starter with full complement of available options.

Type EA combines solid state reduced voltage starting with Advantage starter bypass.

① Requires a 32-inch wide, 21-inch deep structure with 4-inch vertical wireway.
 ② MCC Slim Line design in standard structure.
 ③ Consult Cutler-Hammer for AIC rating at 480V.

Technical Data

Table B – Combination Starters with Fusible Switches

| NEMA Size | Maximum Horsepower | | | | | Switch Rating [Ⓣ] | Freedom | | Advantage | |
|--|--------------------|----------|---------|----------|-----------|-------------------------------|------------------------------------|-----------------------------|----------------------------|-----------------------------|
| | 208V | 240V | 380V | 480V | 600V | | Unit Size | | Unit Size | |
| | | | | | | | Inches | X Space | Inches | X Space |
| Full Voltage Non-Reversing – Fusible | | | | | | | Type F204 | | Type W204 | |
| 1 | 7.5 | 7.5 | 10 | 10 | 10 | 30 | 6 12 [Ⓞ] 18 | 1X 2X [Ⓢ] 3X | 6 12 [Ⓞ] 18 | 1X 2X [Ⓢ] 3X |
| 2 | 10 | 15 | 25 | 25 | 25 | 60 | 12 [Ⓞ] 18 | 2X [Ⓢ] 3X | 12 [Ⓞ] 18 | 2X [Ⓢ] 3X |
| 3 | 25 | 30 | 50 | 50 | 50 | 100 | 24 | 4X | 24 | 4X |
| 4 | 40 | 50 | 75 | 100 | 100 | 200 | 36 | 6X | 36 | 6X |
| 5 | 75 | 100 | 150 | 200 | 200 | 400 [Ⓛ] | 60 | 10X | 54 | 9X |
| 6 | 150 | 200 | 300 | 400 | 400 | 600 | 66 [Ⓜ] 72 [Ⓝ] | 11X 12X | 60 | 10X |
| Full Voltage Reversing – Fusible | | | | | | | Type F214 | | Type W214 | |
| 1 | 7.5 | 7.5 | 10 | 10 | 10 | 30 | 24 | 4X | 24 | 4X |
| 2 | 10 | 15 | 25 | 25 | 25 | 60 | 24 | 4X | 24 | 4X |
| 3 | 25 | 30 | 50 | 50 | 50 | 100 | 30 | 5X | 30 | 5X |
| 4 | 40 | 50 | 75 | 100 | 100 | 200 | 54 | 9X | 48 | 8X |
| 5 | 75 | 100 | 150 | 200 | 200 | 400 | 72 [Ⓞ] | 12X | 72 [Ⓞ] | 12X |
| 6 | 150 | 200 | 300 | 400 | 400 | 600 | 72 [Ⓞ] | 12X | 72 [Ⓞ] | 12X |
| Two-Speed One Winding – Fusible | | | | | | | Type F944 | | Type W944 | |
| 1 | 7.5 | 7.5 | 10 | 10 | 10 | 30 | 24 | 4X | 24 | 4X |
| 2 | 10 | 15 | 25 | 25 | 25 | 60 | 24 | 4X | 24 | 4X |
| 3 | 25 25 | 30 30 | – 50 | 30 50 | 50 50 | 60 100 | 36 | 6X | 36 | 6X |
| 4 | – 40 | – 50 | – 75 | – 100 | 60 100 | 100 200 | 60 | 10X | 54 | 9X |
| 5 | 75 | 100 | 150 | 200 | 200 | 400 | 72 [Ⓞ] | 12X | 72 [Ⓞ] | 12X |
| Two-Speed Two Winding – Fusible | | | | | | | Type F954 | | Type W954 | |
| 1 | 7.5 | 7.5 | 10 | 10 | 10 | 30 | 24 | 4X | 24 | 4X |
| 2 | 10 | 15 | 25 | 25 | 25 | 60 | 30 | 5X | 24 | 4X |
| 3 | 25 | 30 | 50 | 50 | 30 50 | 60 100 | 30 | 5X | 30 | 5X |
| | – 25 | – 30 | – 50 | – 50 | 30 50 | 60 100 | 36 [Ⓟ] | 6X | 36 | 6X |
| 4 | – 40 | – 50 | – 75 | – 100 | 60 100 | 100 200 | 54 [Ⓟ] | 9X | 48 | 8X |
| 5 | 75 | 100 | 150 | 200 | 200 | 400 | 72 [Ⓞ] | 12X | 72 [Ⓞ] | 12X |
| Reduced Voltage Autotransformer – Fusible | | | | | | | Type F604 | | Type W604 | |
| 2 | 10 | 15 | 25 | 25 | 25 | 60 | 36 | 6X | 36 | 6X |
| 3 | 25 | 30 | 50 | 50 | 50 | 100 | 60 | 10X | 54 | 8X |
| 4 | 40 | 50 | 75 | 100 | 100 | 200 | 72 [Ⓡ] | 12X | 72 [Ⓡ] | 12X |
| 5 | 75 | 100 | 150 | 200 | 200 | 400 | 72 [Ⓞ] | 12X | 72 [Ⓞ] | 12X |
| 6 | 150 | 200 | 300 | 400 | 400 | 600 | 72 [Ⓢ] | 12X | 72 [Ⓢ] | 12X |

Ⓛ Certain items in Groups B and C may require additional space. Consult factory.
 Ⓢ For bottom entry of motor cables.
 Ⓝ For top entry of motor cables.

Ⓞ Requires 28-inch wide structure.
 Ⓟ Add 6-inch space for low speed fuses.
 Ⓠ Add 12-inch space for low speed fuses.
 Ⓡ Bottom 24-inch space in rear is unusable.

Ⓢ Requires 28-inch wide and 21-inch deep structure.
 Ⓣ 12-inch/2X unit is standard.
 Ⓤ Combination fused starter units rated 100 kAIC short circuit current.

Technical Data

Table B – Combination Starters with Fusible Switches, *Continued*

| NEMA Size | Maximum Horsepower | | | | | Switch Rating ^① | Freedom | | Advantage | |
|--|--------------------|------------------------|------------------------|------------------------|--------------------------|-------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|
| | 208V | 240V | 380V | 480V | 600V | | Unit Size | | Unit Size | |
| | Inches | X Space | Inches | X Space | Inches | | X Space | | | |
| Reduced Voltage Part Winding – Fusible | | | | | | | Type F704 | | Type W704 | |
| 1PW | 10 | 10 | 15 | 15 | 15 | 60 | 24 | 4X | 24 | 4X |
| 2PW | – 20 | 15 25 | 25 40 | 30 40 | 40 – | 60 100 | 24 24 | 4X 4X | 24 24 | 4X 4X |
| 3PW | – 40 | – 50 | – 75 | 50 75 | 60 75 | 100 200 | 48 48 | 8X 8X | 48 48 | 8X 8X |
| 4PW | 50 75 | – 75 | 100 150 | 100 150 | 150 – | 200 400 | 54 54 | 9X 9X | 48 48 | 8X 8X |
| 5PW | 100 150 | 100 150 | 200 250 | 250 350 | 300 350 | 400 600 | 72 ^② 12X ^② | 12X ^② | 72 ^② 12X ^② | 12X ^② |
| Reduced Voltage Wye Delta Open Transition – Fusible | | | | | | | Type F804 | | Type W804 | |
| 2YD | 15 20 | 15 25 | 30 40 | 40 – | 40 – | 60 100 | 36 | 6X | 36 | 6X |
| 3YD | 25 40 | 30 50 | 50 75 | 60 75 | 75 – | 100 200 | 54 | 9X | 54 | 9X |
| 4YD | 50 60 | 60 75 | 100 150 | 125 150 | 150 – | 200 400 | 72 ^② | 12X ^② | 60 72 ^② | 10X 12X ^② |
| 5YD | 100 150 | 125 150 | 200 250 | 250 300 | 300 – | 400 600 | 72 ^② | 12X ^② | 72 ^② | 12X ^② |
| 6YD | – 250 300 | – 200 250 350 | – 350 400 500 | – 400 500 700 | 350 500 700 700 | 400 600 800 1200 | 72 ^③ | 12X ^③ | 72 ^③ | 12X ^③ |
| Reduced Voltage Wye Delta Closed Transition – Fusible | | | | | | | Type F894 | | Type W894 | |
| 2YD | 15 20 | 15 25 | 30 40 | 40 – | 40 – | 60 100 | 48 | 8X | 48 | 8X |
| 3YD | 25 40 | 30 50 | 50 75 | 60 75 | 75 – | 100 200 | 66 | 11X | 66 | 11X |
| 4YD | 50 60 | 60 75 | 100 150 | 125 150 | 50 – | 200 400 | 72 ^② 72 ^② | 12X ^② 12X ^② | 72 ^② 72 ^② | 12X ^② 12X ^② |
| 5YD | 100 150 | 125 150 | 200 250 | 250 300 | 300 – | 400 600 | 72 ^② | 12X ^② | 72 ^② | 12X ^② |
| 6YD | – 250 300 | – 200 250 350 | – 350 400 500 | – 400 500 700 | 350 500 700 700 | 400 600 800 1200 | 72 ^③ | 12X ^③ | 72 ^③ | 12X ^③ |

① Combination fused starter units rated 100 kAIC short circuit current.
 ② Requires 28-inch wide structure.
 ③ Requires 28-inch wide section (21-inch deep).

Technical Data

Table B – Combination Starters with Fusible Switches, Continued

| Frame Size | Ampere Rating | Maximum Horsepower | | | | Switch Rating ^① | Fuse Clip | Freedom or Advantage | |
|--|---------------|--------------------|------|------|------|----------------------------|--------------|----------------------|---------|
| | | 208V | 240V | 480V | 600V | | | Unit Size | |
| | | | | | | | | Inches | X Space |
| SSRV – Easy Start EJ – Fusible Switch | | | | | | | | EJ04 | |
| EJ026 | 26 | 7.5 | 7.5 | 15 | 25 | 100 | 60/100 | 30 | 5X |
| EJ052 | 52 | 15 | 15 | 40 | 50 | 100 | 60/100 | 30 | 5X |
| EJ075 | 75 | 25 | 25 | 60 | 75 | 100 | 60/100 | 60 | 10X |
| EJ130 | 130 | 40 | 50 | 100 | 125 | 200 | 200/400 | 72 ^① | 12X |
| EJ270 | 270 | 75 | 100 | 200 | 250 | 400 | 200/400/600 | 72 ^① | 12X |
| EJ390 | 390 | 125 | 150 | 300 | 350 | 600 | 400/600/800 | 72 ^① | 12X |
| SSRV – Easy Start ES – Fusible Switch | | | | | | | | ES04 | |
| ES070 | 70 | 20 | 25 | 50 | 60 | 100 | 60/100 | 30 | 5X |
| ES120 | 120 | 40 | 40 | 100 | 100 | 200 | 200/400 | 60 | 10X |
| ES250 | 250 | 75 | 100 | 200 | 250 | 400 | 200/400/600 | 72 ^① | 12X |
| ES560 | 560 | 200 | 200 | 450 | 400 | 600 | 400/600/800 | 72 ^① | 12X |
| ES750 | 750 | 300 | 300 | 600 | 750 | 800 | 600/800/1200 | 72 ^② | 12X |
| SSRV – Easy Start EA – Fusible Switch | | | | | | | | EA04 | |
| EA045 | 45 | 15 | 15 | 30 | 40 | 100 | 60/100 | 36 | 6X |
| EA090 | 90 | 30 | 30 | 60 | 75 | 100 | 60/100 | 48 | 8X |
| EA135 | 135 | 50 | 50 | 100 | 125 | 200 | 200/400 | 54 | 9X |
| EA270 | 270 | 100 | 100 | 200 | 250 | 400 | 200/400/600 | 72 | 12X |
| EA360 | 360 | 125 | 125 | 250 | 350 | 600 | 400/600/800 | 72 | 12X |
| EA540 | 510 | 200 | 200 | 450 | 500 | 800 | 600/800/1200 | 72 ^① | 12X |
| EA760 | 760 | 250 | 300 | 600 | 750 | 800 | 600/800/1200 | 72 ^① | 12X |

^① Requires 32-inch wide structure with 4-inch vertical wireway, 21 inches deep.

^② Requires 36-inch wide structure with 4-inch vertical wireway, 21 inches deep.

Technical Data

Table C – AF91 Adjustable Frequency Drives

Maximum motor lead length is 500 feet. Drives are dual rated CT and VT with 150%. Overload for 1 minute. Standard unit includes disconnect,

1% line reactor^⑤, 50VA CPT, a 1.5% output reactor, and provisions for a control relay. Output reactor is not required if using an inverter duty motor.

| Maximum Hp | Maximum Amperes | CB Type | Standard Unit Space | | Typical Option Space | | Maximum Option Space | |
|------------|-----------------|---------|---------------------|---------|----------------------|---------|----------------------|---------|
| | | | Inches | X Space | Inches | X Space | Inches | X Space |

460V Application (+/- 10%)

| | | | | | | | | |
|----|-----|--------------|----|---|----|---|----|---|
| .5 | 1.5 | HMCP or MCCB | 18 | 3 | 30 | 5 | 42 | 7 |
| 1 | 2.5 | | 18 | 3 | 30 | 5 | 42 | 7 |
| 2 | 3.8 | | 18 | 3 | 30 | 5 | 42 | 7 |
| 3 | 5.5 | | 18 | 3 | 30 | 5 | 42 | 7 |
| 5 | 8.6 | | 18 | 3 | 30 | 5 | 42 | 7 |

208/240V Application

| | | | | | | | | |
|-----|------|--------------|----|---|----|---|----|---|
| .25 | 1.4 | HMCP or MCCB | 18 | 3 | 30 | 5 | 42 | 7 |
| .5 | 2.6 | | 18 | 3 | 30 | 5 | 42 | 7 |
| 1 | 4 | | 18 | 3 | 30 | 5 | 42 | 7 |
| 2 | 7.1 | | 18 | 3 | 30 | 5 | 42 | 7 |
| 3 | 10 | | 18 | 3 | 30 | 5 | 42 | 7 |
| 5 | 15.9 | | 18 | 3 | 30 | 5 | 42 | 7 |

AF91 Options

| Description | Units with Space |
|------------------------------------|------------------|
| Viewing window | ①② |
| Output contactor | ②③ |
| Manual 3 contactor bypass | ③④ |
| 3 or 5% line reactors ^⑤ | ②③ |
| Door mounted keypad | ①②③ |
| Door mounted display | ③ |
| Oversized CPT | ②③ |
| Fusible Disconnect | ②③ |
| Line fuses | ③④ |
| Dual Overloads | ②③ |
| EMI Filter | ③ |
| 1 Control Relay | ①②③ |
| 2 Control Relays | ②③ |
| 3 Control Relays | ③ |

- All AFP91 units are Plug-in for 20-inch wide structures.
- Maximum motor lead length is 500 feet.
- Firmly connect each drive chassis to an earthed ground. Grounding conduit does not provide adequate grounding.
- Use separate conduit for output power conductors and digital and analog control signals. Within the MCC, care should be taken in routing power and control wiring.

① Standard unit.
 ② Typical option unit.
 ③ Maximum option unit.
 ④ Only one of these options can fit in the typical option unit.
 ⑤ 3% line reactors should be used where Power Factor Correction Capacitors are an integral part of the MCC Line Power.

Technical Data

Table D – SV9000 Adjustable Frequency Drives

SV9000 drives are available in plug-in buckets up to 30 Hp CT, and in non-plug-in units up to 200 Hp CT.

All standard units include a disconnect, an ac choke, output reactor, and a door mounted keypad. The SV9000 comes standard as a Sensorless Vector or V/Hz drive; an option

board can be added to make the SV9000 a Close Loop Vector Drive.

SV9000 Plug-in Drive Units^①

| Amperes CT | Nominal Hp CT (kW) | Amperes VT | Nominal Hp VT (kW) | CB Type ^② | Standard Unit Space (inches) | Standard Unit Space (X) | Drive with Typical Options Space (inches) | Typical Option Unit Space (X) | Drive with Maximum Options Space (inches) | Maximum Option Unit Space (X) |
|-------------|--------------------|------------|--------------------|----------------------|------------------------------|-------------------------|---|-------------------------------|---|-------------------------------|
| 230V | | | | | | | | | | |
| 3.6 | 0.75 | 4.7 | 1 | HMCP or MCCB | 18 | 3 | 24 | 4 | 30 | 5 |
| 4.7 | 1 | 5.6 | 1.5 | | 18 | 3 | 24 | 4 | 30 | 5 |
| 5.6 | 1.5 | 7 | 2 | | 18 | 3 | 24 | 4 | 30 | 5 |
| 7 | 2 | 10 | 3 | | 18 | 3 | 24 | 4 | 30 | 5 |
| 10 | 3 | – | – | | 24 | 4 | 30 | 5 | 36 | 6 |
| – | – | 16 | 5 | | 24 | 4 | 30 | 5 | 36 | 6 |
| 16 | 5 | 22 | 7.5 | | 24 | 4 | 30 | 5 | 36 | 6 |
| 22 | 7.5 | 30 | 10 | | 24 | 4 | 30 | 5 | 36 | 6 |
| 30 | 10 | 43 | 15 | | 36 | 6 | 42 | 7 | 48 | 8 |
| 43 | 15 | 57 | 20 | | 36 | 6 | 42 | 7 | 48 | 8 |
| 57 | 20 | 60 | 25 | 36 | 6 | 42 | 7 | 48 | 8 | |

380-440V

| | | | | | | | | | | |
|-----|--------|-----|--------|--------------------|----|----|----|----|----|---|
| 2.5 | (0.75) | 3.5 | (1.1) | HMCP or MCCB | 18 | 3 | 24 | 4 | 30 | 5 |
| 3.5 | (1.1) | 4.5 | (1.5) | | 18 | 3 | 24 | 4 | 30 | 5 |
| 4.5 | (1.5) | 6.5 | (2.2) | | 18 | 3 | 24 | 4 | 30 | 5 |
| 6.5 | (2.2) | – | – | | 18 | 3 | 24 | 4 | 30 | 5 |
| – | – | 10 | (4) | | 18 | 3 | 24 | 4 | 30 | 5 |
| 10 | (4) | 13 | (5.5) | | 24 | 4 | 30 | 5 | 36 | 6 |
| 13 | (5.5) | 18 | (7.5) | | 24 | 4 | 30 | 5 | 36 | 6 |
| 18 | (7.5) | 24 | (11) | | 24 | 4 | 30 | 5 | 36 | 6 |
| 24 | (11) | 32 | (15) | | 24 | 4 | 30 | 5 | 36 | 6 |
| 32 | (15) | 42 | (18.5) | | 36 | 6 | 42 | 7 | 48 | 8 |
| 42 | (18.5) | 48 | (22) | 36 | 6 | 42 | 7 | 48 | 8 | |
| 48 | (22) | 60 | (30) | 36 | 6 | 42 | 7 | 48 | 8 | |

440-500V

| | | | | | | | | | | |
|-----|-----|-----|-----|--------------------|----|----|----|----|----|---|
| 2.5 | 1 | 3 | 1.5 | HMCP or MCCB | 18 | 3 | 24 | 4 | 30 | 5 |
| 3 | 1.5 | 3.5 | 2 | | 18 | 3 | 24 | 4 | 30 | 5 |
| 3.5 | 2 | 5 | 3 | | 18 | 3 | 24 | 4 | 30 | 5 |
| 5 | 3 | – | – | | 18 | 3 | 24 | 4 | 30 | 5 |
| 6 | – | 8 | 5 | | 18 | 3 | 24 | 4 | 30 | 5 |
| 8 | 5 | 11 | 7.5 | | 24 | 4 | 30 | 5 | 36 | 6 |
| 11 | 7.5 | 15 | 10 | | 24 | 4 | 30 | 5 | 36 | 6 |
| 15 | 10 | 21 | 15 | | 24 | 4 | 30 | 5 | 36 | 6 |
| 21 | 15 | 27 | 20 | | 24 | 4 | 30 | 5 | 36 | 6 |
| 27 | 20 | 34 | 25 | | 36 | 6 | 42 | 7 | 48 | 8 |
| 34 | 25 | 40 | 30 | 36 | 6 | 42 | 7 | 48 | 8 | |
| 40 | 30 | 52 | 40 | 36 | 6 | 42 | 7 | 48 | 8 | |

SV9000 Options

| | |
|--|-------|
| Output Contactor | ④ ⑤ |
| Line Fuses | ④ ⑤ |
| Fusible Disconnect | ④ ⑤ |
| Manual 3 Contactor Bypass | ⑤ ⑥ |
| Automatic 3 Contactor Bypass | ⑤ |
| Control Relay | ④ ⑤ |
| Extra VA CPT | ④ ⑤ |
| Dual Overload Relays | ④ ⑤ |
| Graphical Keypad | ③ ④ ⑤ |
| Dynamic Braking Resistors ^⑦ | ③ ④ ⑤ |
| I/O or Communication Board | ⑤ ⑥ |
| Closed Loop Encoder Board | ③ ④ ⑤ |
| Output Filter 1500V/microsecond | ⑤ ⑥ |

- All units have built-in Ac chokes.
- Motor lead length.
- 1.1 kW, 2 Hp and above 100 feet without output filter, maximum 656 feet (200m).
- .75 kW, 1.5 Hp 50 feet without output filter, maximum 328 feet (100m).
- .55 kW, 1 Hp maximum motor lead length is 165 feet (50m).

① Drive units fit into a standard 20-inch wide MCC structure. All plug-in units have a built-in RFI filter, and a Dynamic Breaker Circuit.
 ② For fusible disconnect use typical option unit.
 ③ All options will fit in the Standard unit.
 ④ All options will fit in the Typical option unit.
 ⑤ All options will fit in the Maximum option unit.
 ⑥ One of these options will fit in a typical option unit. If more than one of these options are required use Maximum option unit.
 ⑦ Resistors are to be mounted by customer. Terminals will be provided in upper wireway.

Technical Data

Table D: SV9000 Non-Plug-in Drive Units (Continued)

| Amperes CT | Nominal Hp CT (kW) | Amperes VT | Nominal Hp VT (kW) | CB Type ^① | Standard Unit Space (inches) | Standard Unit Space (X) | Drive with Options Space (inches) | Drive Options Space (X) |
|------------|--------------------|------------|--------------------|----------------------|------------------------------|-------------------------|-----------------------------------|-------------------------|
|------------|--------------------|------------|--------------------|----------------------|------------------------------|-------------------------|-----------------------------------|-------------------------|

230V

| | | | | | | | | |
|-----|----|-----|-----|--------------------|-----------------|----|-----------------|----|
| 70 | 25 | 83 | 30 | HMCP or MCCB | 48 | 8 | 72 | 12 |
| 83 | 30 | 113 | 40 | | 48 | 8 | 72 | 12 |
| 113 | 40 | 139 | 50 | | 72 | 12 | 72 ^② | 12 |
| 139 | 50 | 165 | 60 | | 72 | 12 | 72 ^② | 12 |
| 165 | 60 | 200 | 75 | | 72 | 12 | 72 ^② | 12 |
| 200 | 75 | 264 | 100 | | 72 ^③ | 12 | 72 ^② | 12 |

380-440V, 50/60 Hz

| | | | | | | | | |
|-----|-------|-----|-------|--------------------|-----------------|----|-----------------|----|
| 60 | (30) | 75 | (37) | HMCP or MCCB | 48 | 8 | 72 | 12 |
| 75 | (37) | 90 | (45) | | 48 | 8 | 72 | 12 |
| 90 | (45) | 110 | (55) | | 48 | 8 | 72 | 12 |
| 110 | (55) | 150 | (75) | | 72 | 12 | 72 ^② | 12 |
| 150 | (75) | 180 | (90) | | 72 | 12 | 72 ^② | 12 |
| 180 | (90) | 210 | (110) | | 72 | 12 | 72 ^② | 12 |
| 210 | (110) | — | (132) | | 72 ^③ | 12 | 72 ^② | 12 |
| 270 | (132) | 325 | (160) | | 72 ^③ | 12 | 72 ^② | 12 |
| 325 | (160) | 410 | (200) | | 72 ^③ | 12 | 72 ^② | 12 |
| 410 | (200) | 510 | (250) | | 72 ^② | 12 | ④ | |
| 510 | (250) | 580 | -315 | | 72 ^② | 12 | 72 ^④ | 12 |

440-500V, 50/60 Hz

| | | | | | | | | |
|-----|-----|-----|-----|--------------------|-----------------|----|-----------------|----|
| 52 | 40 | 65 | 50 | HMCP or MCCB | 48 | 8 | 72 | 12 |
| 65 | 50 | 77 | 60 | | 48 | 8 | 72 | 12 |
| 77 | 60 | 96 | 75 | | 48 | 8 | 72 | 12 |
| 96 | 75 | 125 | 100 | | 72 | 12 | 72 ^③ | 12 |
| 125 | 100 | 160 | 125 | | 72 | 12 | 72 ^③ | 12 |
| 160 | 125 | 180 | 150 | | 72 | 12 | 72 ^③ | 12 |
| 180 | 150 | — | — | | 72 ^③ | 12 | 72 ^② | 12 |
| 220 | — | 260 | 200 | | 72 ^③ | 12 | 72 ^② | 12 |
| 260 | 200 | 320 | 250 | | 72 ^③ | 12 | 72 ^② | 12 |
| 320 | 250 | 400 | 400 | | 72 ^② | 12 | ④ | |
| 400 | 300 | 460 | 400 | | 72 ^② | 12 | ④ | |

525-690V, 50/60 Hz

| | | | | | | | | |
|-----|-----|-----|-----|--------------------|-----------------|----|-----------------|----|
| 4.5 | 3 | — | — | HMCP or MCCB | 36 | 6 | 72 | 12 |
| — | — | 7.5 | 5 | | 36 | 6 | 72 | 12 |
| 7.5 | 5 | 10 | 7.5 | | 36 | 6 | 72 | 12 |
| 10 | 7.5 | 14 | 10 | | 36 | 6 | 72 | 12 |
| 14 | 10 | 19 | 15 | | 36 | 6 | 72 | 12 |
| 19 | 15 | 23 | 20 | | 36 | 6 | 72 | 12 |
| 23 | 20 | 26 | 25 | | 36 | 6 | 72 | 12 |
| 26 | 25 | 35 | 30 | | 36 | 6 | 72 | 12 |
| 35 | 30 | 42 | 40 | | 48 | 8 | 72 | 12 |
| 42 | 40 | 52 | 50 | | 48 | 8 | 72 | 12 |
| 52 | 50 | 62 | 60 | | 48 | 8 | 72 | 12 |
| 62 | 60 | 85 | 75 | | 48 | 8 | 72 | 12 |
| 85 | 75 | 100 | 100 | | 48 | 8 | 72 | 12 |
| 100 | 100 | 122 | 125 | | 72 ^③ | 12 | 72 ^② | 12 |
| 122 | 125 | 145 | 150 | | 72 ^③ | 12 | 72 ^② | 12 |
| 145 | 150 | — | — | | 72 ^③ | 12 | 72 ^② | 12 |
| 185 | — | 222 | 200 | | 72 ^② | 12 | ④ | |
| 222 | 200 | 287 | 250 | | 72 ^② | 12 | ④ | |

SV9000 Options

| | |
|--|-----|
| Output Contactor | ⑤ ⑥ |
| Line Fuses | ⑤ ⑦ |
| Fusible Disconnect | ⑦ |
| Manual 3 Contactor Bypass | ⑦ |
| Automatic 3 Contactor Bypass | ⑦ |
| Control Relay | ⑤ ⑦ |
| Extra VA CPT | ⑤ ⑦ |
| Dual Overload Relays | ⑤ ⑦ |
| Graphical Keypad | ⑤ ⑦ |
| Dynamic Braking Resistors ^⑧ | ⑤ ⑦ |
| I/O or Communication Board | ⑤ ⑦ |
| Closed Loop Encoder Board | ⑤ ⑦ |
| Output Filter 1500V/microsecond | ⑤ ⑦ |

- All units have built-in Ac chokes.
- Motor lead length.
- 1.1 kW, 2 Hp and above 100 feet W/O output filter, maximum 656 feet (200m).
- .75 kW, 1.5 Hp 50 feet W/O output filter, maximum 328 feet (100m).
- .55 kW, 1 Hp maximum motor lead length is 165 feet (50m).

① Drives with fusible disconnects require drive with option space. Contact factory for NEMA 12.
 ② 36-inch wide enclosure with bolt-in panel.
 ③ 28-inch wide enclosure with bolt-in panel.
 ④ Options in an additional 20-inch structure.
 ⑤ All options will fit in the Standard unit.
 ⑥ All options will fit in the Option unit.
 ⑦ Available in standard unit if output reactor is not required.
 ⑧ Resistors are to be mounted by customer. Terminals will be provided in upper wireway.

Technical Data

Table E – AF95 Adjustable Frequency Drive Controllers

AF95 drives installed in standard 20-inch wide sections (15–100) hp will include a vertical wireway. Included in the standard space is the disconnect, 1% line reactor and provision for CPT and control relay. In the “Drive with Options” space, space is allowed for all of the options in the options list.

| Maximum Hp | Maximum Amperes | CB Type ⑤ | Standard Unit Space | | Space with Options | | |
|------------|-----------------|-----------|---------------------|---------|--------------------|---------|----------------|
| | | | Inches | X Space | Inches | X Space | Width (Inches) |

208V Application

| Maximum Hp | Maximum Amperes | CB Type ⑤ | Standard Unit Space Inches | X Space | Space with Options Inches | X Space | Width (Inches) |
|------------|-----------------|--------------|----------------------------|---------|---------------------------|---------|----------------|
| 15 | 49 | HMCP or MCCB | 60 | 10X | 72 | 12x | 36 |
| 20 | 63 | | 60 | 10X | 72 | 12x | 36 |
| 25 | 79 | | 72 | 12X | 72 | 12x | 36 |
| 30 | 93 | | 72 | 12X | 72 | 12x | 36 |
| 40 | 120 | | 72 | 12X | 72 | 12x | 36 |

240V Application

| Maximum Hp | Maximum Amperes | CB Type ⑤ | Standard Unit Space Inches | X Space | Space with Options Inches | X Space | Width (Inches) |
|------------|-----------------|--------------|----------------------------|---------|---------------------------|---------|----------------|
| 15 | 44 | HMCP or MCCB | 36 | 6X | 72 | 12x | 20 |
| 20 | 57 | | 60 | 10X | 72 | 12x | 36 |
| 25 | 71 | | 60 | 10X | 72 | 12x | 36 |
| 30 | 84 | | 72 | 12X | 72 | 12x | 36 |
| 40 | 109 | | 72 | 12X | 72 | 12x | 36 |
| 50 | 137 | | 72 | 12X | 72 | 12x | 36 |

380V Application

| Maximum Hp | Maximum Amperes | CB Type ⑤ | Standard Unit Space Inches | X Space | Space with Options Inches | X Space | Width (Inches) |
|------------|-----------------|--------------|----------------------------|---------|---------------------------|---------|----------------|
| 15 | 23 | HMCP or MCCB | 36 | 6X | 72 | 12x | 20 |
| 20 | 31 | | 36 | 6X | 72 | 12x | 20 |
| 25 | 39 | | 36 | 6X | 72 | 12x | 20 |
| 30 | 46 | | 36 | 6X | 72 | 12x | 20 |
| 35 | 55 | | 60 | 10X | 72 | 12x | 36 |
| 45(VT) | 66 | | 60 | 10X | 72 | 12x | 36 |
| 50 (CT) | 72 | | 60 | 10X | 72 | 12x | 36 |
| 54 | 83 | | 72 | 12X | 72 | 12x | 36 |
| 75(VT) | 100 | | 72 | 12X | 72 | 12x | 36 |
| 75(CT) | 105 | | 72 | 12X | 72 | 12x | 36 |
| 85(VT) | 117 | | 72 | 12X | 72 | 12x | 36 |

415V Application

| Maximum Hp | Maximum Amperes | CB Type ⑤ | Standard Unit Space Inches | X Space | Space with Options Inches | X Space | Width (Inches) |
|------------|-----------------|--------------|----------------------------|---------|---------------------------|---------|----------------|
| 15 | 22 | HMCP or MCCB | 36 | 6X | 72 | 12x | 20 |
| 20 | 29 | | 36 | 6X | 72 | 12x | 20 |
| 25 | 37 | | 36 | 6X | 72 | 12x | 20 |
| 35 (VT) | 49 | | 36 | 6X | 72 | 12x | 20 |
| 30 (CT) | 42 | | 36 | 6X | 72 | 12x | 20 |
| 40 | 58 | | 60 | 10X | 72 | 12x | 36 |
| 50 | 66 | | 60 | 10X | 72 | 12x | 36 |
| 60 | 84 | | 72 | 12X | 72 | 12x | 36 |
| 75 (VT) | 100 | | 72 | 12X | 72 | 12x | 36 |
| 75 (CT) | 105 | | 72 | 12X | 72 | 12x | 36 |
| 85 (VT) | 115 | | 72 | 12X | 72 | 12x | 36 |

- ① Will fit in standard enclosure size for 125–300 hp.
- ② Requires additional 12x20-inch wide structure – for 125–300 hp.
- ③ 5% input line reactor not available on 250–300 hp.
- ④ 1000 V/μs only on 250–300 hp.
- ⑤ Contact factory for fusible disconnect.
- ⑥ 2500A maximum horizontal bus rating.
- ⑦ 20-inch wide.
- ⑧ 36-inch wide.
- ⑨ 40-inch wide.

| Maximum Hp | Maximum Amperes | CB Type ⑤ | Standard Unit Space | | Space with Options | |
|------------|-----------------|-----------|---------------------|---------|--------------------|---------|
| | | | Inches | X Space | Inches | X Space |

480V Application

| Maximum Hp | Maximum Amperes | CB Type ⑤ | Standard Unit Space Inches | X Space | Space with Options Inches | X Space | Width (Inches) |
|------------|-----------------|--------------|----------------------------|---------|--|---------|----------------|
| 15 | 22 | HMCP or MCCB | 36 | 6X | 72⑦ | 12X⑦ | 36 |
| 20 | 28 | | 36 | 6X | 72⑦ | 12X⑦ | 36 |
| 25 | 36 | | 36 | 6X | 72⑦ | 12X⑦ | 36 |
| 30 | 42 | | 36 | 6X | 72⑦ | 12X⑦ | 36 |
| 40 | 55 | | 60 | 10X | 72⑧ | 12X⑧ | 36 |
| 50 | 68 | | 60 | 10X | 72⑧ | 12X⑧ | 36 |
| 60 | 81 | | 72 | 12X | 72⑧ | 12X⑧ | 36 |
| 75 | 101 | | 72 | 12X | 72⑧ | 12X⑧ | 36 |
| 100 | 130 | | 72 | 12X | 72⑧ | 12X⑧ | 36 |
| 125⑥ | 164 | | 72⑨ | 12X⑨ | See Notes in Option List on page 12-23 | | |
| 150⑥ | 189 | | 72⑨ | 12X⑨ | | | |
| 200⑥ | 252 | | 72⑨ | 12X⑨ | | | |
| 250 (VT) | 300 | 72⑨ | 12X⑨ | | | | |
| 300 (VT) | 380 | 72⑨ | 12X⑨ | | | | |

575V Application

| Maximum Hp | Maximum Amperes | CB Type ⑤ | Standard Unit Space Inches | X Space | Space with Options Inches | X Space | Width (Inches) |
|------------|-----------------|--------------|----------------------------|---------|---------------------------|---------|----------------|
| 15 | 18 | HMCP or MCCB | 36 | 6X | 72⑦ | 12X⑦ | 36 |
| 20 | 23 | | 36 | 6X | 72⑦ | 12X⑦ | 36 |
| 25 | 29 | | 36 | 6X | 72⑦ | 12X⑦ | 36 |
| 30 | 34 | | 36 | 6X | 72⑦ | 12X⑦ | 36 |
| 40 | 44 | | 60 | 10X | 72⑧ | 12X⑧ | 36 |
| 50 | 55 | | 60 | 10X | 72⑧ | 12X⑧ | 36 |
| 60 | 65 | | 72 | 12X | 72⑧ | 12X⑧ | 36 |
| 75 (VT) | 77 | | 72 | 12X | 72⑧ | 12X⑧ | 36 |

■ **AF95:** The AF95 utilizes the patented MotoRx™ dV/dt output filter as an option. The 1500 V/μs is recommended for use with standard motors on cable runs of 100 to 300 feet. The 1000 V/μs is recommended for use with standard motors on cable runs of 300 to 500 feet.

Note: The type of motors and multiple motor applications affect the output filtering required. Consult Cutler-Hammer for application details.

AF95 Drive Options

| |
|--|
| Output Contactor① |
| HOA 3 Contactor Bypass② |
| EA Bypass Starter (Electrically Interlocked Only)② |
| Input Line Fuses① |
| EMI Filter② |
| 3% or 5% Input Line Reactor①③ |
| 1000 – 1500 V/μs DVDVT Output Filters①④ |
| Dual Overload Relays② |

For NEMA 12 refer to Cutler-Hammer.

Technical Data

Table F— Incoming Line and Feeder Circuit Breakers ①

Frames reflect standard Series C circuit breakers. Unit spacings shown include sufficient space to terminate cables on any standard breaker lug. If cable sizes exceed those listed, add 12-inch space for lug adapters.

Molded Case Series C Circuit Breakers

| Maximum Amperes | Circuit Breaker Frame | Interrupting Ratings (kAIC) | | | Enclosure Width | Main Unit Size | | Feeder Unit Size | | Maximum Cable Size See circuit breaker terminal data for variations. | |
|-----------------|-----------------------|-----------------------------|------|------|-----------------------|----------------|---------|------------------|-------------------------|---|-------------------------|
| | | 240V | 480V | 600V | | Inches | X Space | Inches | X Space | | |
| 100 | HFD | 100 | 65 | 25 | Standard 20 Inches | 12 | 2X | 6 | 1X | 4/0 (1 per Phase) | |
| | FDC | 100 | 100 | 35 | | | | 12 | 2X | | |
| 150 | HFD | 100 | 65 | 25 | | | | 12 | 2X | | |
| | FDC | 100 | 100 | 35 | | | | 12 | 2X | | |
| 225 | HFD | 100 | 65 | 25 | | 18 | 3X | | | | |
| 250A | HJD | 100 | 65 | 25 | | 30 | 5X | 18 | 3X | | 350 kcmil (1 per Phase) |
| | JDC | 100 | 100 | 35 | | | | | | | |
| 400A | HKD | 100 | 65 | 35 | | 30 | 5X | 24 | 4X | | 250 kcmil (2 per Phase) |
| | KDC | 100 | 100 | 50 | | | | | | | |
| 600A | HLD | 100 | 65 | 35 | | 30 | 5X | 30 | 5X | | 500 kcmil (2 per Phase) |
| | LDC | 100 | 100 | 50 | 24 | 4X | 24 | 4X | | | |
| 800A | HND | 100 | 65 | 35 | 42 | 7X | 42 | 7X | 750 kcmil (3 per Phase) | | |
| | NDC | 100 | 100 | 50 | | | | | | | |
| 1200A | HND | 100 | 65 | 35 | 42 | 7X | 42 | 7X | 750 kcmil (3 per Phase) | | |
| | NDC | 100 | 100 | 50 | | | | | | | |
| 2000A | RD | 100 | 65 | 50 | 72① | 12X | 72 | 12X | 750 kcmil (6 per Phase) | | |
| 2500A | RD | 100 | 65 | 50 | 24 Inches | 72① | 12X | | | | |

Main Circuit Breakers – Insulated Case Type SPB Stored Energy or Magnum DS Air Circuit Breaker, Manually or Electrically Operated

| Frame Size | CB Type | Interrupting Capacity (kAIC) | Mounting | Enclosure Width | Main Unit Size | | Feeder Unit Size | | Maximum Cable Size See circuit breaker terminal data for variations. |
|------------|-------------|------------------------------|----------------|-----------------|----------------|---------|------------------|---------|---|
| | | | | | Inches | X Space | Inches | X Space | |
| 800A | SPB/ MDS | 100 kA | Fixed Drawout② | 20 20 | 72 | 12X | N/A | | 750 kcmil (6 per Phase) |
| 1600A | | | Fixed Drawout② | 20 20 | | | | | |
| 2000A | | | Fixed Drawout② | 20 24 | | | | | |
| 3200A④ | | | Fixed Drawout② | 20 24 | | | | | |

Dual Feeder Units – Molded Case Series C Circuit Breakers

| Maximum Amperes | Circuit Breaker Frame | Interrupting Ratings (kAIC) | | | Enclosure Width | Main Unit | | Feeder Unit Size | | Maximum Cable Size |
|-----------------|-----------------------|-----------------------------|------|------|-----------------------|-----------|---------|------------------|---------|-------------------------------------|
| | | 240V | 480V | 600V | | Inches | X Space | Inches | X Space | |
| 50/50 | HFD | 100 | 65 | 25 | Standard 20 Inches | N/A | | 12 | 2X | See above breaker frame information |
| | FDC | 200 | 100 | 35 | | | | 12 | 2X | |
| 50/100 | HFD | 100 | 65 | 25 | | | | 12 | 2X | |
| | FDC | 200 | 100 | 35 | | | | | | |
| 100/100 | HFD | 100 | 65 | 25 | | | | 12 | 2X | |
| | FDC | 200 | 100 | 35 | | | | | | |
| 100/100 | HFD | 100 | 65 | 25 | | | | 12 | 2X | |
| | FDC | 200 | 100 | 35 | | | | | | |
| 150/150 | HFD | 100 | 65 | 25 | | | | 12 | 2X | |
| | FDC | 200 | 100 | 35 | | | | | | |

① The main breaker requires the complete vertical section. The rear is unusable.
② Drawout circuit breakers require a 42-inch deep structure.

③ All breakers 600A and over are supplied with Digitrip.
④ SPB 3000A Maximum.

Technical Data

Table G – Incoming Line and Feeder Fusible Switches
3-Pole – 250V or 600V AC. Fuses not included.

| Switch Rating ^① | Fuse Clip Size Amperes ^⑥ | Unit Space | | | |
|----------------------------|--|-----------------|-----------------|-----------------|-----------------|
| | | Incoming Line | | Feeder | |
| | | Inches | X Space | Inches | X Space |
| 30 | 30 | 18 | 3X | 12 | 2X |
| 60 | 60 | 18 | 3X | 12 | 2X |
| 30/30 Dual | 30/30 Dual | | | 12 | 2X |
| 30/60 Dual | 30/60 Dual | | | 12 | 2X |
| 60/60 Dual | 60/60 Dual | | | 12 | 2X |
| 100 | 100 | 18 | 3X | 18 | 3X |
| 200 | 200 | 30 | 5X | 30 | 5X |
| 400 | 400 | 48 | 8X | 42 | 7X |
| 600 | 600 | 54 ^② | 9X ^② | 48 | 8X |
| 800 | 800 | 48 ^④ | 8X ^④ | 48 ^⑤ | 8X ^⑤ |
| 1200 ^⑦ | 1200 | 60 | 10X | 60 | 10X |

Table H – Lighting Panelboards
120/240V or 120/208V Lighting Panelboards Type – PL1A

Fixed mounted, main lug only panelboards can be either 120/240V, 1-phase 3-wire; 208Y/120V, 3-phase, 4-wire.

| Number of Circuits | Chassis Rating | | Unit Space | |
|--------------------|----------------|----------------|----------------|----------------|
| | 1-Phase 3-Wire | 3-Phase 4-Wire | 1-Phase 3-Wire | 3-Phase 4-Wire |
| 18 | 225A | 100A | 24 – 4X | 24 – 4X |
| 30 | 225A | 100A | 30 – 5X | 30 – 5X |
| 42 | 225A | 225A | 36 – 6X | 36 – 6X |

Note 1: For MCB, back feed panelboard branch circuit breaker, or select separate feeder unit.
Note 2: Bolt-on 1-, 2-, 3-pole breakers only.

277/480V or 480/600V Lighting Panelboards Type – PRL3A

Fixed mounted, main lug only panelboards can be either 480V or 600V, 3-phase, 3-wire or 480Y/277V, 3-phase, 4-wire. Mounted in bottom portion of structure.

| Number of Circuits | Chassis Rating | Unit Space | |
|--------------------|----------------|----------------|----------------|
| | | 3-Phase 3-Wire | 3-Phase 4-Wire |
| 14 | 100A | | 36 – 6X |
| 18 | 250A | 36 – 6X | |
| 24 | 100A | 36 – 6X | |
| 26 | 250A | | 48 – 8X |
| 32 | 100A | | 48 – 8X |
| 36 | 250A | 48 – 8X | |
| 42 | 100A | 48 – 8X | 60 – 10X |
| 42 | 250A | 60 – 10X | 60 – 10X |
| 12 | 400/600A | 36 – 6X | |
| 14 | 400/600A | | 48 – 8X |
| 30 | 400/600A | 48 – 8X | 60 – 10X |
| 42 | 400/600A | 60 – 10X | 72 – 12X |

Note 1: For MCB, back feed panelboard branch circuit breaker, or select separate feeder unit.
Note 2: Either plug-in or bolt-on 1-, 2-, 3-pole breakers only.

Lighting Panelboard Circuit Breakers

Cutler-Hammer circuit breakers can be either plug-in or bolt-on, 1-, 2- or 3-pole through 240V. 600V maximum 1-, 2- or 3-pole circuit breakers are bolt-on.

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

Table I: Automatic Transfer Switches

| Ampere Rating | Switch Type | Interrupting Rating | Unit Width | Unit Space |
|---------------|---------------------|---------------------|----------------------|------------------|
| 100A | Cutler-Hammer ATVS | 65 kA | 20-inch ^③ | 72 inches or 12X |
| 150A | Cutler-Hammer ATVS | 65 kA | | |
| 250A | Cutler-Hammer ATVS | 65 kA | 24-inch ^③ | |
| 400A | Cutler-Hammer ATVS | 35 kA | | |
| 600A | Cutler-Hammer ATVS | 35 kA | | |
| 800A | Cutler-Hammer ATVS | 50 kA | | |
| 1000A | Cutler-Hammer ATVS | 50 kA | | |
| 1000A | Cutler-Hammer ATSRM | 100 kA | 44-inch ^③ | |
| 1200A | Cutler-Hammer ATSRM | 100 kA | | |
| 1600A | Cutler-Hammer ATSRM | 100 kA | | |
| 2000A | Cutler-Hammer ATSRM | 100 kA | | |
| 100A | ASCO Type 940 | 65 kA | 20-inch ^③ | 72 inches or 12X |
| 150A | ASCO Type 940 | 65 kA | | |
| 260A | ASCO Type 940 | 65 kA | 28-inch ^③ | |
| 400A | ASCO Type 940 | 35 kA | | |
| 600A | ASCO Type 940 | 35 kA | 36-inch ^③ | |
| 800A | ASCO Type 940 | 50 kA | | |
| 1000A | ASCO Type 940 | 50 kA | 40-inch ^③ | |
| 1200A | ASCO Type 940 | 100 kA | | |

① Suitable for 100,000A interrupting if Class RK fuses are used.
 ② For bottom cable entry, add 6 inches or 1X space.
 ③ Requires 21-inch deep structure.
 ④ For bottom entry, add 12 inches or 2X space.
 ⑤ For top entry, add 6 inches or 1X space.
 ⑥ Type of SW K-SW 30–800A.
 ⑦ High magnetic molded case switch.

Technical Data

Table J – Dry-Type Distribution Transformers

- Transformer 1.0 – 2.0 kVA will include a CB and fuses in a standard 2X unit.
- Transformers 3.0 kVA and above have taps and electro-static 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 (included in space factor) |
|------------|------------|--|------|--|
| | | 230V | 480V | |

Single-Phase

| Rating | Unit Space | 230V | 480V | Secondary Breaker |
|--------|------------|------|------|-------------------|
| 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

| Rating | Unit Space | 230V | 480V | Secondary Breaker |
|--------|------------|------|------|-------------------|
| 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 |

Table K – Power Factor Correction Capacitors

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 | 208V Unit Space | 240V Unit Space | 600V Unit Space |
|-------------|-----------------|-----------------|-----------------|
| 2 | 12 – 2X | 12 – 2X | 12 – 2X |
| 3 | 12 – 2X | 12 – 2X | 12 – 2X |
| 4 | 12 – 2X | 12 – 2X | 12 – 2X |
| 5 | 12 – 2X | 12 – 2X | 12 – 2X |
| 7.5 | 12 – 2X | 12 – 2X | 12 – 2X |
| 10 | 12 – 2X | 12 – 2X | 12 – 2X |
| 15 | 12 – 2X | 12 – 2X | 12 – 2X |
| 20 | 24 – 4X | 12 – 2X | 12 – 2X |
| 22.5 | 24 – 4X | 12 – 2X | 12 – 2X |
| 25 | | 24 – 4X | 12 – 2X |
| 30 | | 24 – 4X | 12 – 2X |
| 40 | | | 12 – 2X |
| 50 | | | 24 – 4X |
| 60 | | | 24 – 4X |
| 75 | | | 24 – 4X |
| 90 | | | 24 – 4X |
| 100 | | | 36 – 6X |
| 120 | | | 36 – 6X |

Table L – Current Limiting Reactors

Structures contain 3 single-phase 60 Hz reactors which limit available short-circuit current from 100,000 rms amperes to 14,000 rms amperes. Reactors available with ohmic values of .01, .015, .02 and .025.

| Amps | Unit Space | Mounting |
|------|------------------|-----------------------|
| 600 | 72 inches or 12X | 21-inch D x 20-inch W |
| 800 | 72 inches or 12X | 21-inch D x 20-inch W |
| 1000 | 72 inches or 12X | 26-inch D x 28-inch W |
| 1200 | 72 inches or 12X | 26-inch D x 28-inch W |

Table M – TVSS (Clipper Power System) ①

Includes TRI-Monitor™ diagnostic and alarm system with LED status on each phase.

| Description | Unit Space | |
|-------------|------------|---------|
| | Inches | X Space |

Surge Current Per Phase

| Surge Current | Unit Space | X Space |
|--|------------|---------|
| 100KA CPS-B | 12 | 2X |
| 120KA CPS-S (Reconnected Branch Entrance) | 12 | 2X |
| 160KA CPS-S2 | 12 | 2X |
| 200KA CPS-S3 | 12 | 2X |
| 250KA CPS-H (Recommended Service Entrance) | 12 | 2X |
| 300KA CSP-H2 | 12 | 2X |
| 400KA CPS-M | 12 | 2X |

Options

| Description | Inches | X Space |
|--|--------|---------|
| Disconnect Switch | 6 | 1X |
| Form C relay contact for remote indication and push to test PB | 0 | 0 |
| Form C relay, PB, plus surge counter and audible alarm | 0 | 0 |

Table N – DeviceNet Communications

DeviceNet is pre-wired through the MCC. Trunk cable is provided in the horizontal wireway. A tee is provided for each drop in the vertical wireway. Units are daisy chained in each vertical section. Terminating resistors are provided at each end of the trunk cable.

Product Information

| Part Number | Description | Space Requirements |
|----------------|--|---------------------|
| WPNIDNA | DeviceNet interface for ADVANTAGE Starter | No additional space |
| C395DNA | DeviceNet interface for Freedom AE19 Starter | No additional space |
| PanelMate 1500 | Operator interface for DeviceNet System | 12-inch/2X |
| DN50 | DeviceNet I/O module | 12-inch/2X min. |

① Specify 3-phase Delta or 3-phase Wye.

Technical Data

Table O – Earth Leakage Breakers

Earth Leakage Breakers offer Class 1 ground fault protection down to the 30 mA level.

- Ground fault pickup setting is adjustable from .03 to 30A in eight steps.
- Ground fault time delay setting is adjustable from instantaneous to 2.0 seconds in six steps.

Standard Features

- Built-in push to trip for functional testing.
- Tripped window indicates red for ground fault trip.
- Alarm contact for remote indication of trip.

| Frame | HMCP or Thermal Magnetic | Additional Space Required |
|-------|--------------------------|---------------------------|
| F | Yes | ④ |
| J | Yes | ④ |
| K | Yes | ④ |

Table P – Incoming Line Metering and Bus Protection

| Type | Description | Unit Space |
|------------------------------------|--|--------------------------|
| Electronic Metering① | IQ Analyzer 6030 | 12 inches or 2X |
| | IQ DP4130 | |
| | IQ Generator | |
| | IQ Data | |
| Switchboard Meters② 1% Accuracy | Ammeter | 12 inches or 2X |
| | Ammeter with Switch | |
| | Voltmeter | |
| | Voltmeter with Switch | |
| | AM/VM | |
| Instrument Transformers | 600/800A CT | Consult Cutler-Hammer |
| | 1000A CT | |
| | 2000A CT | |
| | 2500A CT | |
| | 480/120 PT | |
| Signal Transducers | Current (Add CT) 1ø Voltage (Add PT) Watt (Add CT and PT) 1ø | 6 inches or 1X |

| Voltage Protection | Unit Space |
|---|-----------------|
| TVSS with Disconnect③ | 18 inches or 3X |
| Ground Detection Lights – 3-Phase Underground Systems | 6 inches or 1X |
| System Voltage Monitor | |
| Lightning Arrester and Surge Capacitor | |

| Ground Fault Sensing C-HRG "Safe Ground" High Resistance Ground System | Unit Space |
|--|---|
| Current | Requires 21-inch deep, 20-inch wide structure without a vertical wireway. |
| Voltage | |
| | 72 inches or 12X |

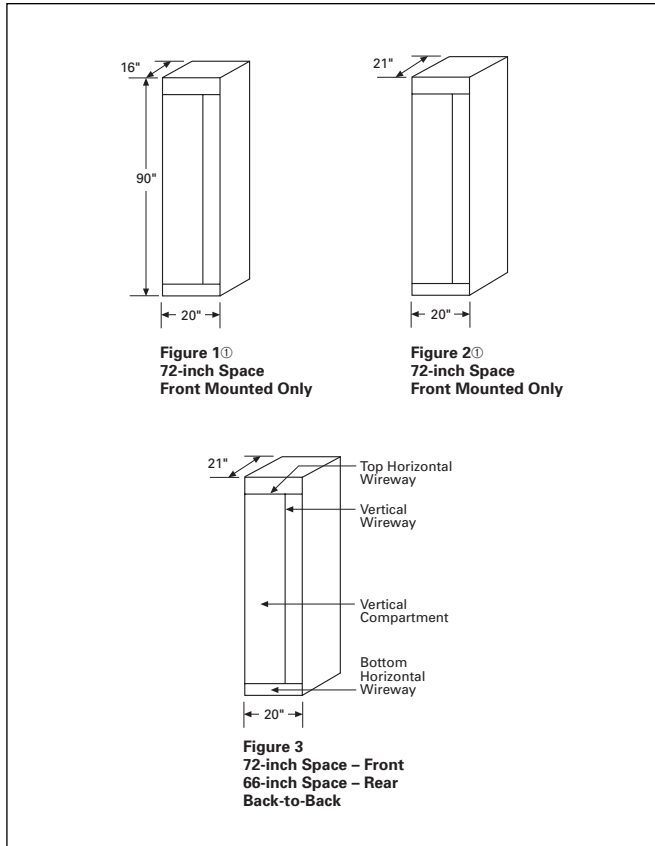
① 3-phase/3-wire systems require 2 CTs.
3-phase/4-wire systems require 3 CTs.
② Ammeters require 2 CTs for 3-phase/3-wire systems, and 3 CTs for 3-phase/4-wire systems. Voltmeters require 2 PTs for 3-phase/3-wire systems, and 3-PTs for 3-phase/4-wire systems.
③ Without disconnect 12 inches or 2X.
④ Add 6-inch for Size 1-5 units.

Technical Data

Table Q – Standard Structures and Structure Options

The Standard Freedom or Advantage 2100 Series MCC structure is NEMA 1, gasketed, 90-inch high, 20-inch wide with a depth as shown on Figs. 1-3 below. Each standard structure has a 9-inch high horizontal wireway at the top and at the bottom and a 4-inch wide full height vertical wireway at the right. All wireway doors are hinged and

secured with 1/4-turn latches. The standard busing is 600A, UL rated, aluminum horizontal bus and 300A, 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 bar-



| Description | |
|---|---------------------------------|
| Standard Structures | |
| 16-inch deep structure | Figure 1 |
| 21-inch deep structure | |
| Front mounting only | Figure 2 |
| Front and rear mounting | Figure 3 |
| 4 inches of additional structure width (32-inch max.) | |
| 8-inch vertical wireway in lieu of standard 4-inch | |
| Special Structures | |
| Single corner section for "L" configuration of MCC | |
| Transition section | |
| Series 2100 to Type W | |
| (10-inch wide – front aligned) | |
| Plug-in blank relay mounting space, per 6-inch | Any 6-inch height |
| Fixed-mounted relay back pan, full depth of structure | |
| 20-inch structure with wireway, 13-inch with usable panel | |
| 24-inch structure with wireway, 17-inch with usable panel | |
| 28-inch structure with wireway, 21-inch with usable panel | |
| 20-inch structure without wireway, 17-inch with usable panel | |
| 24-inch structure without wireway, 21-inch with usable panel | |
| 28-inch structure without wireway, 25-inch with usable panel | |
| 32-inch with double door | |
| 36-inch with double door | |
| 40-inch with double door | |
| Programmable controller mounting structure (per complete structure with full fixed mounting back pan) | |
| 20-inch structure with wireway | Complete section |
| 24-inch structure with wireway | Complete section |
| 28-inch structure with wireway | Complete section |
| 20-inch structure without wireway | Complete section |
| 24-inch structure without wireway | Complete section |
| 28-inch structure without wireway | Complete section |
| Plexiglass see-through door insert for PLC structure | 6-inch increments |
| 19-inch instrumentation mounting racks installed in PLC structure | Consult Cutler-Hammer |

Table R: Structure Modifications

| | |
|---|---|
| Channel floor sills (11-gauge, 1-inch x 3-inch) | Rear hinged structure door (72 inches high) |
| NEMA 1 gasketed (included with UL) | NEMA 2 drip shield on top of MCC |
| NEMA 12 dust-proof, includes bottom plate | NEMA 3R non-walk-in |
| Bottom plate for NEMA 1 gasketed enclosure | Front-mounted |
| 150-watt space heater, per structure | Back-to-back |
| Thermostat for space heater control | NEMA 3R walk-in aisle-front mounted |
| Pullbox kit for cable and wiring to be field mounted on top structure | NEMA 3R walk-in tunnel type |
| 12 inches high | Special reduced height structures |
| 18 inches high | Seismic certification (earthquake qualification), consult factory |
| 24 inches high | UL Handle Extension |

① The standard Freedom Series 2100 and Advantage structure is designed to comply with the UL 2-meter requirement. Disconnect operating handle is not more than 2 meters (78 inches) 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.

Technical Data

Table S – Bus Modifications

Freedom and Advantage 2100 Series MCCs bear the UL label. Service entrance labeling is available.

| Description | | | | Cu – Tin-Plated (Standard) |
|--|---------------------------|---------------------------|--|----------------------------|
| Main Bus, Per Vertical Structure | | | | |
| Copper Horizontal Bus Ratings Tin-Plated | 50°C | 65°C | | |
| 600A Size | .25 x 2.00 – Bars/Phase 1 | .25 x 2.00 – Bars/Phase 1 | | |
| 800A Size | .25 x 3.00 – Bars/Phase 1 | .25 x 2.00 – Bars/Phase 1 | | |
| 1200A Size | .25 x 2.50 – Bars/Phase 2 | .25 x 3.00 – Bars/Phase 1 | | |
| 1600A Size | .25 x 3.00 – Bars/Phase 4 | .25 x 3.00 – Bars/Phase 2 | | 21-inch Deep ^① |
| 2000A Size | .25 x 2.50 – Bars/Phase 6 | .25 x 2.50 – Bars/Phase 4 | | 21-inch Deep ^① |
| 2500A Size | .25 x 3.00 – Bars/Phase 8 | .25 x 3.00 – Bars/Phase 6 | | 21-inch Deep ^② |
| 3200A Size | N/A | .25 x 3.00 – Bars/Phase 8 | | 21-inch Deep ^{②⑥} |
| Silver-Plated Bus | | | | Optional |
| Insulated main horizontal bus, per vertical structure (taping) | | | | Optional |
| Vertical bus, per vertical structure: 300A — copper (tin-plated) | | | | Standard ^③ |
| Increased bus capacity: Rated at 600A (Front mounted only) | | | | Cu Only |
| Rated at 600A (Back-to-back) – copper | | | | Standard |
| Rated at 800A (Back-to-back and front) | | | | Cu Only |
| Rated at 1200A | | | | Cu Only |
| Increased mechanical bus bracing, per vertical structure: | | | | |
| 42,000A rms symmetrical short-circuit current | | | | Optional |
| 65,000A rms symmetrical short-circuit current | | | | Standard |
| 100,000A rms symmetrical short-circuit current | | | | Optional |
| Vertical Bus isolation barrier, per vertical structure | | | | Standard |
| Labyrinth design insulation-isolation vertical bus barrier | | | | Optional Freedom |
| Ground bus, 300A standard, per vertical structure | | | | Standard Cu |
| Increased capacity ground bus only, 600A, 1/4- x 2-Inch, per vertical structure | | | | Standard Cu |
| Plug-in Grounding System, includes 300A vertical ground bus and unit grounding clips, per vertical structure | | | | Cu |
| Neutral bus, ungrounded for three-phase, four-wire power, per vertical structure ^④ | | | | Cu |
| Splice plates | | | | |

Table T – Main Lugs Only

Mechanical Lug Compartment (3-Phase, 3- or 4-wire)

Provisions for terminating incoming line cables directly onto the MCC bus system. Up to 1200A, 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 | Maximum Cables per Phase | Cable Entry (Top or Bottom) | Lug Type | Unit Space | X Space | Enclosure Width |
|----------------------------|------------|--------------------------|-----------------------------|----------|-----------------|-----------------|-----------------|
| 350 | 600A | 2 | | Screw | 12 | 2X | 20 Inches |
| | | | | Crimp | 18 | 3X | |
| | | 4 | Top | Screw | 18 | 3X | |
| | | | | Screw | 24 | 4X | |
| | | | Bottom | Crimp | 36 | 6X | |
| 18-inch Top Hat | Either | 0 | – | | | | |
| 600 | 800A | 2 | | Screw | 18 | 3X | |
| | | | | Crimp | 24 | 4X | |
| | | 4 | | Screw | 24 | 4X | |
| | | | | Crimp | 36 | 6X | |
| | | | 18-inch Top Hat | Either | 0 | – | |
| 750 | 1000A | 2 | | Screw | 24 | 4X | |
| | | | | Crimp | 36 | 6X | |
| | | 4 | | Screw | 36 | 6X | |
| | | | | Crimp | 48 | 8X | |
| | | | | | | | |
| 1000 | 1200A | 2 | | Screw | 30 | 5X | |
| | | | | Crimp | 36 | 6X | |
| 1000 | 2500A | 8 | | Screw | 72 ^⑤ | 12X | |
| | | | | Crimp | 72 ^⑤ | 12X | |
| | 3200A | | | | Screw | 72 ^⑤ | 12X |
| | | | | | Crimp | 72 ^⑤ | 12X |

Bus Duct Entry to Horizontal Bus or Main Disconnect – Pull Box

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

| Horizontal Bus Bus Rating | Pull Box Height |
|----------------------------|-----------------|
| 600A - 1600A | 18 inches |
| 2000A - 2500A ^⑥ | 24 inches |

- ① Requires 21-inch deep structure.
- ② Requires 21-inch deep structure. Not available in back-to-back structure.
- ③ Vertical bus and unit stabs are tin-plated copper only.
- ④ Neutral is half-rating of horizontal bus.
- ⑤ Lug landings require the complete vertical section. The rear is unusable.
- ⑥ Contact Cutler-Hammer for 3200A dimensions.

Technical Data

Table U – Control Power Transformer Data

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 | | Advantage | |
|--------------------|--|--------------------|--------------------------------|--------------------|--------------------------------|
| | | Standard VA Rating | Maximum ^① VA Rating | Standard VA Rating | Maximum ^① VA Rating |
| Size 1 | Full Voltage Non-Reversing and Reversing | 100 VA | 150 VA | 100 VA | 150 VA |
| Size 1–6-inch Unit | | 100 VA | 100 VA | 100 VA | 100 VA |
| Size 2 | | 100 VA | 150 VA | 100 VA | 150 VA |
| Size 2–6-inch Unit | | NA | NA | 100 VA | 100 VA |
| Size 3 | | 150 VA | 250 VA | 150 VA | 250 VA |
| Size 4 | | 200 VA | 250 VA | 150 VA | 250 VA |
| Size 5 | Autotransformer | 200 VA | 350 VA | 300 VA | 350 VA |
| Size 6 | | 150 VA | 250 VA | 300 VA | 350 VA |
| Size 2 | | 100 VA | 150 VA | 150 VA | 250 VA |
| Size 3 | | 150 VA | 250 VA | 150 VA | 250 VA |
| Size 4 | | 200 VA | 250 VA | 150 VA | 250 VA |
| Size 5 | | 200 VA | 250 VA | 500 VA | 500 VA |
| Size 6 | 200 VA | 350 VA | 500 VA | 500 VA | |
| Size 1 | Two-Speed One Winding | 100 VA | 200 VA | 200 VA | 250 VA |
| Size 2 | | 100 VA | 200 VA | 200 VA | 250 VA |
| Size 3 | | 200 VA | 250 VA | 200 VA | 250 VA |
| Size 4 | | 350 VA | 500 VA | 200 VA | 250 VA |
| Size 5 | | 350 VA | 500 VA | 500 VA | 500 VA |
| Size 6 | | 200 VA | 350 VA | 500 VA | 500 VA |
| Size 1 | Two-Speed Two Winding | 100 VA | 150 VA | 100 VA | 250 VA |
| Size 2 | | 100 VA | 150 VA | 100 VA | 250 VA |
| Size 3 | | 150 VA | 250 VA | 150 VA | 250 VA |
| Size 4 | | 200 VA | 250 VA | 150 VA | 250 VA |
| Size 5 | | 200 VA | 250 VA | 300 VA | 350 VA |
| Size 6 | | 200 VA | 350 VA | 300 VA | 350 VA |
| Size 1 | Part Winding | 150 VA | 150 VA | 200 VA | 250 VA |
| Size 2 | | 150 VA | 150 VA | 200 VA | 250 VA |
| Size 3 | | 200 VA | 250 VA | 200 VA | 250 VA |
| Size 4 | | 350 VA | 500 VA | 200 VA | 250 VA |
| Size 5 | | 350 VA | 500 VA | 200 VA | 250 VA |
| Size 6 | | 200 VA | 350 VA | 500 VA | 500 VA |
| Size 2 | Wye Delta (Open or Closed Transition) | 200 VA | 200 VA | 200 VA | 250 VA |
| Size 3 | | 350 VA | 200 VA | 200 VA | 250 VA |
| Size 4 | | 350 VA | 500 VA | 200 VA | 250 VA |
| Size 5 | | 200 VA | 500 VA | 500 VA | 500 VA |
| Size 6 | | 200 VA | 350 VA | 500 VA | 500 VA |

Table V: Freedom and Advantage MCC Ratings and Highlights

| Feature | Freedom | Advantage |
|-----------------------------------|---|--|
| Vertical Bus Barrier | Flat Glastic, Labyrinth Available | Labyrinth |
| Communications From Starter Units | IQ500 via IMPACC/PowerNet, C395 via DeviceNet IQMP3000 via IMPACC/PowerNet | Advantage WPONI or CMU via IMPACC/PowerNet WPONIDNA via DeviceNet |
| Bus Bracing | 65 kA Standard 42 kA or 100 kA Available | 65 kA Standard 100 kA Available |
| Control Wire | #16 Standard | #14 Standard |
| Horizontal Bus Material | Copper | Copper |
| Pilot Devices | 10250T | ACM or 10250T |
| 6-Inch Starter Compartment | F206 Size 1 | W206 Sizes 1 and 2 |
| FVNR Sizes 3 and 4 | 18-Inch High Compartment | 12- or 18-Inch Compartment |
| FVNR Size 6 | 54-Inch High Compartment | 36-Inch High Compartment |

① Maximum size without increasing starter space.

Technical Data

Motor Protection

In line with 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 shown taken from NEC table 430-150 (3-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.

Circuit breaker, HMCP and fuse ampere rating selections are in line with maximum rules given in NEC 430-52 and table 430-152. Based on known characteristics of Cutler-Hammer 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.
5. Type HMCP motor circuit protector may not set at more than 1300% of the motor full-load current, to comply with the NEC, Sec. 430-52. (Except for new E rated motor 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 percent respectively.

- ① These recommendations are based on previous code interpretations. See the current NEC for exact up-to-date information.
- ② Consult fuse manufacturer's catalog for smaller fuse ratings.
- ③ Types are for minimum interrupting capacity breakers. Ensure that the fault duty does not exceed breakers I.C.

Table W – Motor Circuit Protector (MCP), Circuit Breaker and Fusible Switch Selection Guide

| Hp | Full Load Amperes (NEC) FLA | Fuse Size NEC 430-152 Maximum Amperes | | Recommended Cutler-Hammer | | | |
|---------------------------|-----------------------------|---------------------------------------|----------------|---------------------------|------|-----------------------------------|------------|
| | | Time Delay | Non-Time Delay | Circuit Breaker | | Motor Circuit Protector Type HMCP | |
| | | | | Amperes | Type | Amperes | Adj. Range |
| 230 Volts, 3-Phase | | | | | | | |
| 1 | 3.6 | 10 | 15 | 15 | HFD | 7 | 21-70 |
| 1-1/2 | 5.2 | 10 | 20 | 15 | HFD | 7 | 21-70 |
| 2 | 6.8 | 15 | 25 | 15 | HFD | 15 | 45-150 |
| 3 | 9.6 | 20 | 30 | 20 | HFD | 15 | 45-150 |
| 5 | 15.2 | 30 | 50 | 30 | HFD | 30 | 90-300 |
| 7-1/2 | 22 | 40 | 70 | 50 | HFD | 30 | 90-300 |
| 10 | 28 | 50 | 90 | 60 | HFD | 50 | 150-500 |
| 15 | 42 | 80 | 150 | 90 | HFD | 70 | 210-700 |
| 20 | 54 | 100 | 175 | 100 | HFD | 100 | 300-1000 |
| 25 | 68 | 125 | 225 | 125 | HFD | 100 | 300-1000 |
| 30 | 80 | 150 | 250 | 150 | HFD | 150 | 450-1500 |
| 40 | 104 | 200 | 350 | 150 | HFD | 150 | 450-1500 |
| 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 | 600 | 1800-6000 |
| 125 | 312 | 600 | 1000 | 500 | HLD | 600 | 1800-6000 |
| 150 | 360 | 700 | 1200 | 600 | HLD | — | — |
| 200 | 480 | 1000 | 1600 | 700 | HND | — | — |
| 460 Volts, 3-Phase | | | | | | | |
| 1 | 1.8 | 6 | 6 | 15 | HFD | 3 | 9-30 |
| 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 | 7 | 21-70 |
| 5 | 7.6 | 15 | 25 | 15 | HFD | 15 | 45-150 |
| 7-1/2 | 11 | 20 | 35 | 25 | HFD | 15 | 45-150 |
| 10 | 14 | 25 | 45 | 35 | HFD | 30 | 90-300 |
| 15 | 21 | 40 | 70 | 45 | HFD | 30 | 90-300 |
| 20 | 27 | 50 | 90 | 50 | HFD | 50 | 150-500 |
| 25 | 34 | 60 | 110 | 70 | HFD | 50 | 150-500 |
| 30 | 40 | 70 | 125 | 70 | HFD | 70 | 210-700 |
| 40 | 52 | 100 | 175 | 100 | HFD | 100 | 300-1000 |
| 50 | 65 | 125 | 200 | 110 | HFD | 100 | 300-1000 |
| 60 | 77 | 150 | 150 | 250 | HFD | 150 | 450-1500 |
| 75 | 96 | 175 | 300 | 150 | HJD | 150 | 450-1500 |
| 100 | 124 | 225 | 400 | 175 | HJD | 150 | 750-2500 |
| 125 | 156 | 300 | 500 | 225 | HJD | 250 | 1250-2500 |
| 150 | 180 | 350 | 600 | 250 | HJD | 250 | 1250-2500 |
| 200 | 240 | 450 | 800 | 350 | HKD | 400 | 2000-4000 |
| 575 Volts, 3-Phase | | | | | | | |
| 1 | 1.4 | 3 | 6 | 15 | HFD | 3 | 9-30 |
| 1-1/2 | 2.1 | 6 | 10 | 15 | HFD | 3 | 9-30 |
| 2 | 2.7 | 6 | 10 | 15 | HFD | 7 | 21-70 |
| 3 | 3.9 | 10 | 15 | 15 | HFD | 7 | 21-70 |
| 5 | 6.1 | 15 | 20 | 15 | HFD | 15 | 45-150 |
| 7-1/2 | 9 | 20 | 30 | 20 | HFD | 15 | 45-150 |
| 10 | 11 | 20 | 35 | 25 | HFD | 15 | 45-150 |
| 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 | 50 | 150-500 |
| 40 | 41 | 80 | 125 | 80 | HFD | 70 | 210-700 |
| 50 | 52 | 100 | 175 | 100 | HFD | 100 | 300-1000 |
| 60 | 62 | 110 | 200 | 125 | HFD | 100 | 300-1000 |
| 75 | 77 | 150 | 250 | 150 | HFD | 150 | 450-1500 |
| 100 | 99 | 175 | 300 | 175 | HJD | 150 | 450-1500 |
| 125 | 125 | 225 | 400 | 200 | HJD | 250 | 875-1750 |
| 150 | 144 | 300 | 450 | 225 | HJD | 250 | 1250-2500 |
| 200 | 192 | 350 | 600 | 300 | HKD | 400 | 2000-4000 |

Technical Data/Dimensions

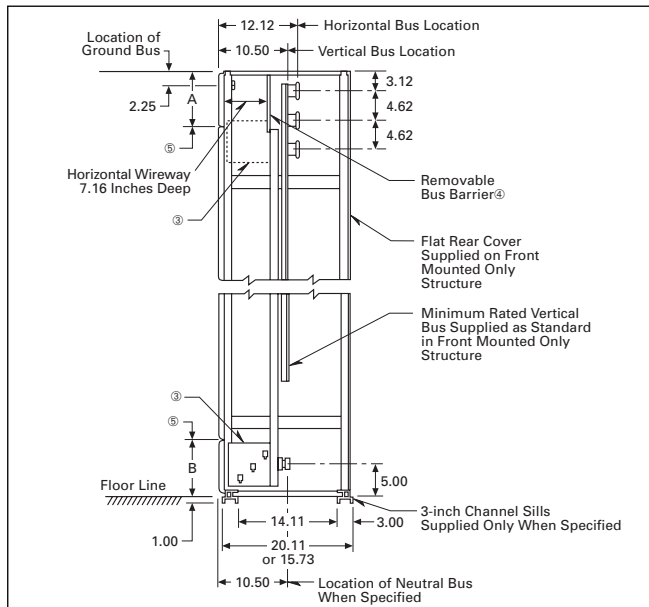
Table X: Starter Sizes Selection Guide

| Squirrel-Cage Motor Horsepower | 230V, 3-Phase | | | 460V, 3-Phase | | | 575V, 3-Phase | | |
|--------------------------------|----------------------------------|--|--|----------------------------------|--|--|----------------------------------|--|--|
| | Control Center Starter NEMA Size | Full ^① Load Current Amperes | Wire ^② Size at 75°C Max. at 40°C Amb. | Control Center Starter NEMA Size | Full ^① Load Current Amperes | Wire ^② Size at 75°C Max. at 40°C Amb. | Control Center Starter NEMA Size | Full ^① Load Current Amperes | Wire ^② Size at 75°C Max. at 40°C Amb. |
| 1/2 | 1 | 2.2 | 14 | 1 | 1.1 | 14 | 1 | .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 | — | — | — | 6 | 302 | 500 kcmil | 6 | 242 | 300 kcmil |
| 300 | — | — | — | 6 | 361 | 2-4/0 | 6 | 289 | 400 kcmil |

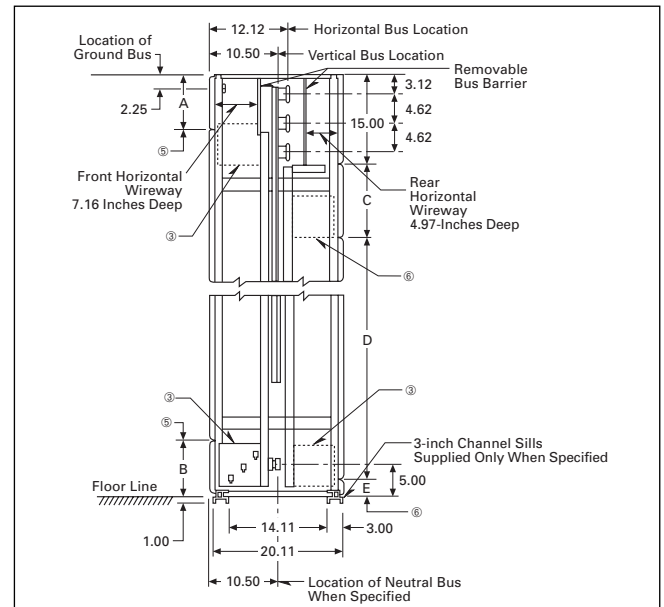
Dimensions, Inches (mm)

Not to be used for construction purposes unless approved.

HP Layout Dimensions Side View A – Front Mounted Only



Side View B – Front and Rear Mounted



- ① Information is based on Table 430-150 of NEC (1996).
- ② 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 (1996).
- ③ Master terminal block assembly furnished for Type C wiring only. When location not specified, MTB supplied at the bottom.
- ④ Rear horizontal bus barrier not supplied with front mounted only structure.

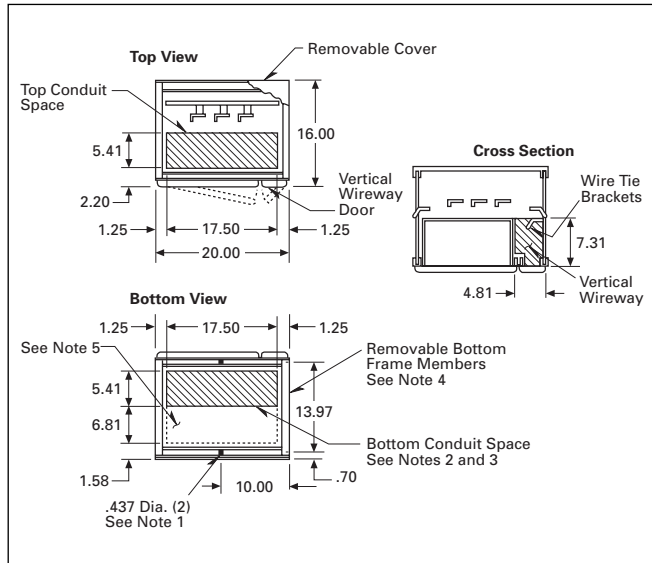
- ⑤ Standard structure arrangement in front
Without MTB; A & B = 9 (228.6)
With MTB at bottom; A & B = 9 (228.6)
With MTB at top; A = 15 (381), B = 3 (76.2)
- ⑥ Standard structure arrangement in rear
Without MTB; C = 9 (228.6), D = 72 (1828.8), E = 3 (76.2)
With MTB at bottom; C = 0, D = 66 (1676.4), E = 9 (228.6)
With MTB at top; C = 12 (304.8), D = 60 (1524), E = 3 (76.2)

Dimensions

Dimensions, Inches (mm)

Not be used for construction purposes unless approved.

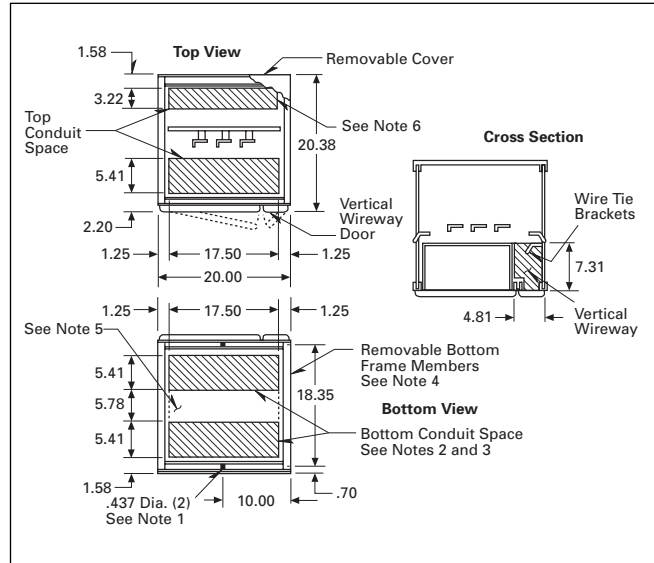
20 Inches (508 mm) Wide, 16 Inches (406.4 mm) Deep-Front Mounted Only (FMO)



1. Minimum length of anchor bolt 2 (50.8) (.36-16 recommended).
2. Recommended maximum conduit height above floor line 3.5 (88.9).
3. Maximum conduit space with channel sills 17.5 x 9.73 (444.5 x 247.1).
4. For multiple structure assemblies either one or both of these members are removed to provide maximum unrestricted conduit space at bottom.
5. This conduit space not recommended when neutral bus required. Otherwise available.

See Side View A page I2-31 for vertical dimensions.

20 Inches (508 mm) Wide, 21 Inches (533.4 mm) Deep-Front Mounted Only (FMO)



1. Minimum length of anchor bolt 2 (50.8) (.36-16 recommended).
2. Recommended maximum conduit height above floor line 3.5 (88.9).
3. Maximum conduit space with channel sills 17.5 x 14.11 (444.5 x 358.4).
4. For multiple structure assemblies either one or both of these members are removed to provide maximum unrestricted conduit space at bottom.
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.

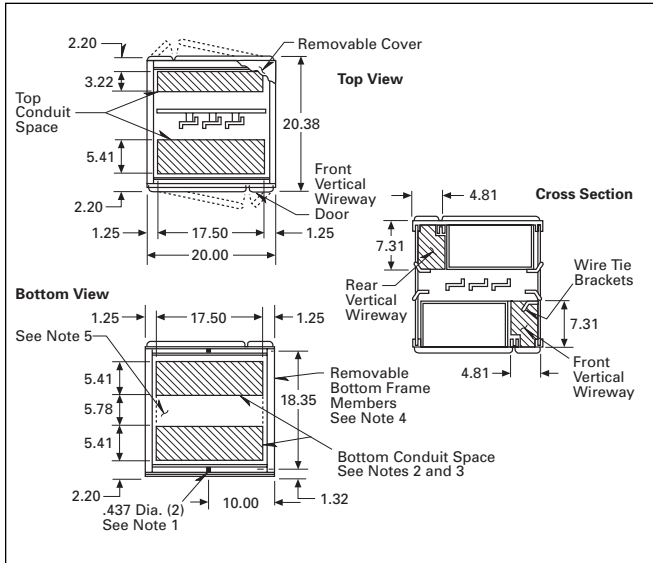
See Side View A page I2-31 for vertical dimensions.

Dimensions

Dimensions, Inches (mm)

Not be used for construction purposes unless approved.

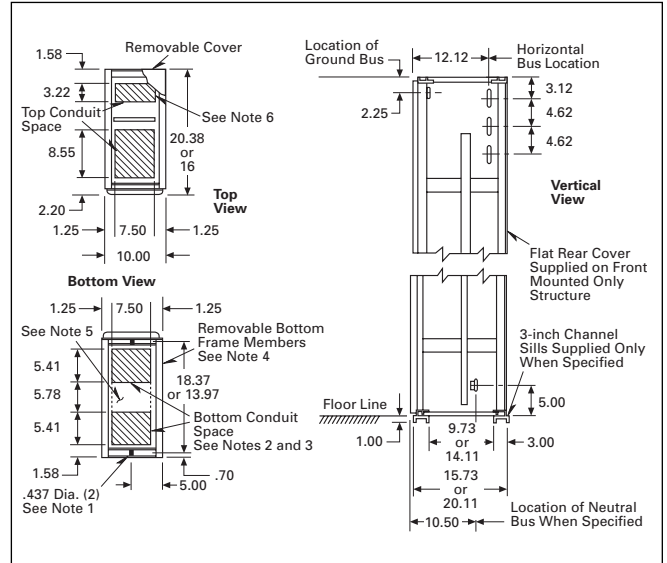
20 Inches (508 mm) Wide, 21 Inches (533.4 mm) Deep-Front and Rear Mounted



1. Minimum length of anchor bolt 2 (50.8) (.36-16 recommended).
2. Recommended maximum conduit height above floor line 3.5 (88.9).
3. Maximum conduit space with channel sills 17.5 x 14.11 (444.5 x 358.4).
4. For multiple structure assemblies either one or both of these members are removed to provide maximum unrestricted conduit space at bottom.
5. This conduit space not recommended when neutral bus required. Otherwise available.

See Side View B page I2-31 for vertical dimensions.

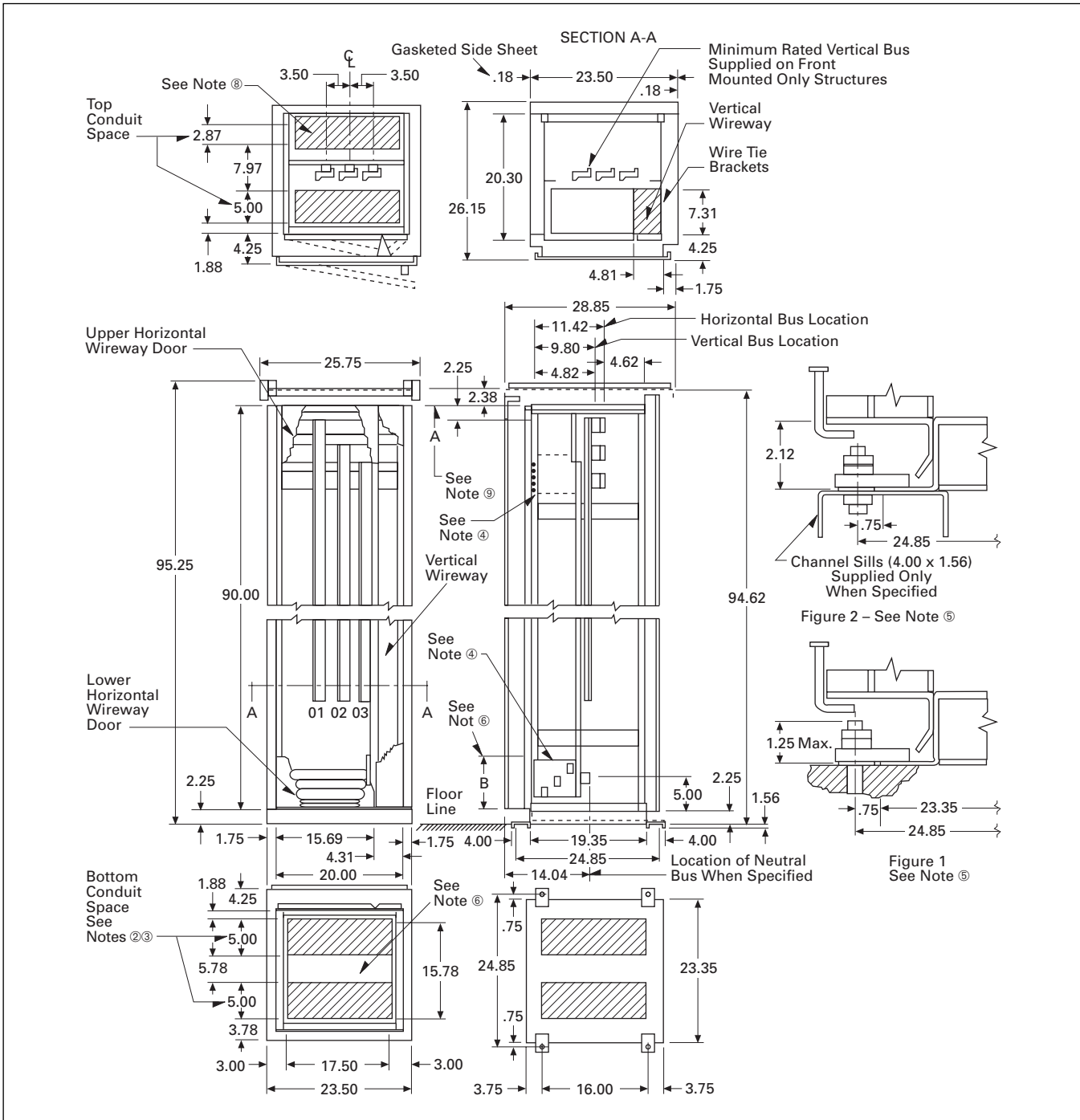
10 Inches (254 mm) Wide, 16 or 21 Inches (406.4 or 533.4 mm) Deep — Transition Structure



1. Minimum length of anchor bolt 2 (50.8) (.36-16 recommended).
2. Recommended maximum conduit height above floor line 3.5 (88.9).
3. Maximum conduit space with channel sills 17.5 x 14.11 (444.5 x 358.4) in 21-inch deep structure. 7.5 x 9.73 (190.5 x 247.1) in 16-inch deep structure.
4. For multiple structure assemblies either one or both of these members are removed to provide maximum unrestricted conduit space at bottom.
5. This conduit space not recommended when neutral bus required. Otherwise available.
6. Top rear conduit space not recommended for conduit entry in 21-inch deep FMO structure. Space not available in 16-inch deep structure.

Dimensions

Freedom Series 2100 Motor Control Center Outline and Floor Plan – NEMA 3R 20-inch Deep Structure



- ① Minimum length of anchor bolt 2 inches. (38-16 recommended).
- ② Recommended maximum conduit height above floor line 3.50 inches.
- ③ Maximum conduit space with channel sills 15.78 x 16.60 inches.
- 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 Figure 1. When channel sills are used see Figure 2.
- ⑥ This conduit space not recommended when neutral bus required. Otherwise available.
- ⑦ Rear horizontal bus barrier not supplied with front mounted only structure.
- ⑧ Top rear conduit space not recommended for conduit entry in front mounted only structure.

- ⑨ Standard structure arrangement (In front)
Without master terminal block, A and B – 9 inches
With master terminal block at bottom, A and B – 9 inches
With master terminal block at top: A – 15 inches, B – 3 inches.

Typical Specifications

Typical Specifications

Ratings

- A. The Motor Control Center(s) shall be 600-volt class suitable for operation on a three-phase, 60-hertz system. The system operating voltage and number of wires shall be as indicated on the drawings.

Construction

- A. Motor Control Center(s) shall be Cutler-Hammer type [Freedom Series 2100] [Advantage] design.
- B. Structures shall be totally enclosed deadfront, free-standing assemblies. They shall be 90 inches high and [16 inches] [21 inches] deep for front-mounted units. Structures shall contain a horizontal wireway at the top, isolated from the horizontal bus and shall be readily accessible through a hinged cover. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.
- C. Compartments for mounting control units shall be incrementally arranged such that not more than [six (6) 2X size 1 starters for front-mounted only] [eleven (11) 2X size 1 starters for back-to-back] can be mounted within each vertical structure. Guide rails shall be provided.
- D. A vertical wireway with minimum of 35 square inches of cross sectional area shall be adjacent to each vertical unit and shall be covered by a hinged door. Wireways shall contain steel rod cable supports.
- E. All full voltage starter units through NEMA Size 5 shall be of the drawout type. Drawout provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Drawout units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend into the bus compart-

ment. Interior of all units shall be painted white for increased visibility. Units shall be equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 600 volts. Knockouts shall be provided for the addition of future terminal blocks. In addition, a master terminal block, when Type C wiring is specified, shall be drawout and shall be located in the top or bottom wireway, readily accessible through a hinged cover. All control wire to be [14 gauge] [16 gauge] minimum.

- F. All drawout units shall be secured by a spring-loaded quarter turn indicating type fastening device located at the top front of the unit. Each unit compartment shall be provided with an individual front door.
- G. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access unless the disconnect is in the OFF position. A defaeter shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. A second interlock shall be provided to prevent removal or re-insertion of the unit while in the ON position. Padlocking facilities shall be provided to positively lock the disconnect in the OFF position with from one (1) to three (3) padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.

Bus

- A. Each structure shall contain a main horizontal [copper tin-plated] [copper silver-plated] bus, with minimum ampacity of 600 amperes or rated [800] [1200] [1400] [1600] [2000] [2500] [3200] amperes as shown on the drawings. The horizontal bus

shall be rated at 65 [50 optional except 3200A] degrees C temperature rise over a 40 degree C ambient in compliance with UL standards. Vertical busses feeding unit compartments shall be copper and shall be securely bolted to the horizontal main bus. All joints shall be front accessible for ease of maintenance. The vertical bus shall have a minimum rating of 300 amperes for front mounted units and 600 amperes for back-to-back mounted units or fully rated [600] [800] [1200] amperes.

- B. The vertical bus shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical busses to prevent any fault generated gases to pass from one phase to another. The vertical bus shall include a shutter mechanism to provide complete isolation of the vertical bus when a unit is removed.

– OR –

- B. Isolation of the vertical bus compartment from the unit compartment shall be by means of a full height insulating barrier. This barrier shall be a single sheet of glass reinforced polyester with cutouts to allow the unit stabs to engage the vertical bus. Provide snap-in covers for all unused openings.
- C. Busses shall be braced for [65,000] [100,000] amperes RMS symmetrical.

Wiring/Terminations

- A. Wiring shall be NEMA Class [I] [II], Type [A] [B] [C].

Motor Controllers

Two types of combination motor starters are outlined below. Select one of the paragraphs A. The first paragraph is for circuit breaker type combination starters; the second paragraph is for fusible type starters combination starters. Select one of the of paragraphs B. The first paragraph is for Advantage Microprocessor Motor Starters; the second

Typical Specifications

paragraph is for Freedom Series Electromechanical Motor Starters.

A. Combination starter units shall be full-voltage non-reversing, unless otherwise shown, and shall utilize Cutler-Hammer type HMCP Motor Circuit Protectors.

1. Each combination unit shall be rated [65,000] [100,000] AIC symmetrical at 480V. The HMCP shall provide adjustable magnetic protection and be provided with pin insert to stop magnetic adjustment at 1300% motor nameplate full load current to comply with NEC requirements. All HMCP combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button on the HMCP. Type HMCP motor circuit protectors shall include transient override feature for motor inrush current. [HMCP shall be used to provide IEC 947-4 Type 2 coordination to 100,000 amps.]

– OR –

A. Combination starter units shall be full-voltage non-reversing, unless shown otherwise utilizing fusible switches.

1. Fusible switches shall be quick-make, quick-break and shall accept class R dimension fuses and the combination shall safely interrupt 100,000 amperes. Fusible combination starters shall provide IEC 947-4 Type 2 coordination to 100,000 amps.

B. Motor starters shall be Cutler-Hammer type Advantage, electrically operated, electrically held, three-pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight (8) NO or eight (8) NC auxiliary contacts. The overload protection shall consist of one (1) current sensor located in each phase monitored by the micro-

processor that yields a time-current curve closely paralleling that of motor heating damage boundary, accurate to 2%. Running overload protection shall be DIP switch selectable for the specific motor full load amperes within the starter range. Provide DIP switch selectable overload trip class of 10, 20 and 30.

1. Motor starters shall monitor current in each phase to provide phase loss and phase unbalance protection, such that if the unbalance on any of two phases is greater than 30% of the DIP switch selected trip rating, a phase loss/unbalance trip occurs. Provide phase loss/unbalance protection which requires no time delay for reset.
2. Motor starters shall provide ground fault protection. Ground fault protection shall be set at 20% of maximum continuous ampere rating and have a start delay of 20 seconds, and a run delay of 1 second to prevent nuisance trip on starting.
3. Microprocessor shall measure control circuit voltage and prevent closing of the coil on low-voltage (78 volts AC) and/or high-voltage (135 volts AC) conditions which are outside of the coil ratings.
4. Microprocessor shall apply voltage to the coil such that a guaranteed maximum of two (2) milliseconds of main contact bounce occurs on contactor closure.
5. Microprocessor shall continuously measure coil circuit voltage and current so as to maintain constant coil power at a level to maintain main contact closure and minimize coil power consumption.
6. Provide Control Modules to perform the indicated input/output control functions shown on the drawings. Mod-

ule to incorporate faceplates having membrane type push-buttons and LEDs. All push-button and LED functions to be furnished with clearly written identification. Modules to be provided with the ability to replace conventional start, stop, hand, auto, and control functions, and when utilized in starter applications, overload reset function. Modules to be provided with the ability to replace conventional indicating light status of run, off, selector switch pushbutton position, and when utilized in starter applications, overload alarm and overload trip.

7. Provide, where indicated on the drawings, a Metering Module capable of displaying control voltage, status and where utilized on starter applications, cause of trip, current at time of trip and current in each phase.
8. [Provide] [Make provisions for] an addressable communication card capable of transmitting all data over a compatible two-wire local area network to a central personal computer for storage and/or printout. The network shall also be capable of transmitting data in RS232c format via a translator module.
 - a. ON-OFF reset control functions
 - b. Status (ON, OFF, TRIPPED, NO RESPONSE)
 - c. Current in each phase
 - d. Percent phase unbalance
 - e. Control voltage
 - f. Overload protection settings
 - g. Cause of trip
 - h. Trip current magnitude

– OR –

B. Motor starters shall be Cutler-Hammer type Freedom Series electrically operated, electrically held, three-pole assemblies with

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arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight (8) NO or eight (8) NC auxiliary contacts. The overload relay assembly shall be of the thermal bimetallic ambient compensated type. Overload relays shall be reset from outside the enclosure by means of an insulated button. The overload relay shall have a built-in push-to-test button, electrically isolated NO-NC contacts and single phase sensitivity.

- C. Each starter shall be equipped with a fused control power transformer, two (2) indicating lights, HOA selector switch, and two (2) NO contacts, unless otherwise scheduled on the drawings. Device panel to have space to accommodate six (6) oil-tight pilot-control devices or indicating ammeters, voltmeters, or elapsed time meters.
- D. Solid-state reduced-voltage starters, Cutler-Hammer type [EJ] [ES] [EA] shall be provided where shown on the contract drawings. The solid-state reduced-voltage starter shall be UL and CSA listed in the motor control center, and consist of an SCR based power section, logic board and paralleling bypass contactor/starter. The paralleling bypass contactor shall be energized when the motor reaches full speed.

For more detailed specification information refer to section J4.

- E. Adjustable Frequency controllers shall be provided where scheduled. Controllers shall be Cutler-Hammer type AF91 and/or SV9000 for variable torque loads unless otherwise indicated on the drawings. Controllers for constant torque loads shall be rated a minimum of 150% over-current for one (1) minute. All controllers shall be combination type and shall include options as specified.

For more detailed specification information refer to section J5.

F. Advantage Central Monitoring Unit (CMU)

1. Where shown on the drawing, provide a Cutler-Hammer type Advantage Central Monitoring Unit (CMU) or approved equal. The CMU shall be a microprocessor-based, self-contained device (NEMA 3R/12 faceplate) suitable for door mounting and shall perform the following listed functions. Each assembly shall have provisions for a communications module to provide for remote computer monitoring up to 10,000 feet.
2. Monitoring and display parameters of up to 99 Cutler-Hammer type Advantage starters or contactors equipped with product operated network interface card (PONI), or Cutler-Hammer type IQ 500 solid-state overload relays. Communications over the local area network shall be 9,600 baud. Parameters locally displayed at the CMU for each starter and overload relay shall also be capable of being communicated via twisted pair to a remote personal computer. Information displayed at the CMU shall include the following:
 - a. Status – ON, OFF, TRIPPED, NO RESPONSE
 - b. Standard address
 - c. Three-phase current
 - d. Control voltage
 - e. Overload condition (alarm)
 - f. Cause of device trip
 - g. Operations count
 - h. Run time
 - i. Set points
 - j. Starter description and identification.

3. When used with the remote communications option, the CMU shall pass data to a computer from Advantage starters, contactors and overload relays (IQ 500). The master or the host network's baud rate (speed of upper network passing data to a computer) shall be independent of the CMU's subnetwork baud rate. The master or host network's baud rate shall be established via the PONI communications module while the CMU's subnetwork baud rate shall be switch selectable on the rear of the CMU.
4. The program directing the functions of the CMU shall be permanently stored in the CMU. There shall be no need to reload data after AC power loss.
5. The addresses, types of devices and descriptions shall be stored in memory during the learn mode and shall also be retained throughout a power loss. Unless there has been a change, it shall not be necessary to re-enter the learn mode after a power loss.
6. CMU shall have an 8-digit alphanumeric display to monitor active data, trip data or set points which are available from the individual Motor Control devices. CMU shall have three (3) LEDs to indicate which group of data is being displayed, as selected through membrane-type alphanumeric pushbuttons by the user. CMU shall have a 2-digit alphanumeric display to indicate the address of the control device for which data is being displayed. CMU shall have membrane type pushbuttons to allow the user to step up or down to select the control device to be displayed. CMU shall have two (2) additional

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LEDs at the top of the CMU to indicate that the CMU is operational and when there is an "alarm" status on one of the motor control devices. CMU shall have an "acknowledge/reset" membrane-type push-button to permit the user to reset the CMU following a motor control device trip.

7. The CMU shall be operated from 120-volt, single-phase input.
8. The CMU shall have a "Help" button function, which shall scroll English explanations in the alphanumeric window for any condition or abbreviations.
9. [Provide] [Make provisions for] an addressable communication card capable of transmitting all data, including trip data over a compatible two-wire, local area network to a central personal computer for storage and or printout. Provide data and time-stamping for all starter/contacter operations. Reprogramming of the CMU shall not be required when adding a communication module. The network shall also be capable of transmitting data in RS232c format via a translator module.

Overcurrent Devices

A. Circuit Breakers

1. Individual feeder breakers shall have a minimum interrupting capacity of ____ [65] [100] kAIC at rated voltage or as scheduled on the drawings.

B. Fusible Switches

1. Individual feeder switches shall be quick-make, quick-break gang-operated type utilizing class R fuse clips. The fused switch shall be rated 100 kAIC at rated voltage.

Miscellaneous Devices

Incoming Feeder Terminations and Device

- A. Incoming [cable] [busway] shall terminate within the control center on a [main lug] [main breaker] termination point. Main lug terminations shall have adequate dedicated space for the type and size of cable used and the lugs shall be [standard mechanical screw] [compression-type] with antiturn feature. Main breakers shall be provided as indicated on the drawings and shall be [molded case] [insulated case, stored energy device].

Customer Metering

- A. Where indicated on the drawings, provide a separate customer metering compartment with front hinged door. Include the associated instrument transformers.
- B. Current transformers, where shown on the drawings or elsewhere specified, shall be wired to shorting-type terminal blocks.
- C. [Potential transformers including primary and secondary fuses with disconnecting means] [Fused potential taps as the potential source] for metering as shown on the drawings.

Select devices as required for item D.

D. Microprocessor-Based Metering System

IQ Analyzer

IQ DP-4000

IQ-200

IQ Data

Refer to section B-1 for more information on metering device.

Enclosures

- A. The type of enclosure shall be in accordance with NEMA standards for [type 1A with gasketed doors] [type 12 dust-tight and drip-proof] [type 3R non-walk-in] [type 3R walk-in]. All enclosing sheet steel, wireways and unit doors shall be gasketed.

Nameplates

- A. Each unit will have 1.0 x 2.5-inch engraved nameplate. The lettering shall be white 3/16-inch high, on a black background.

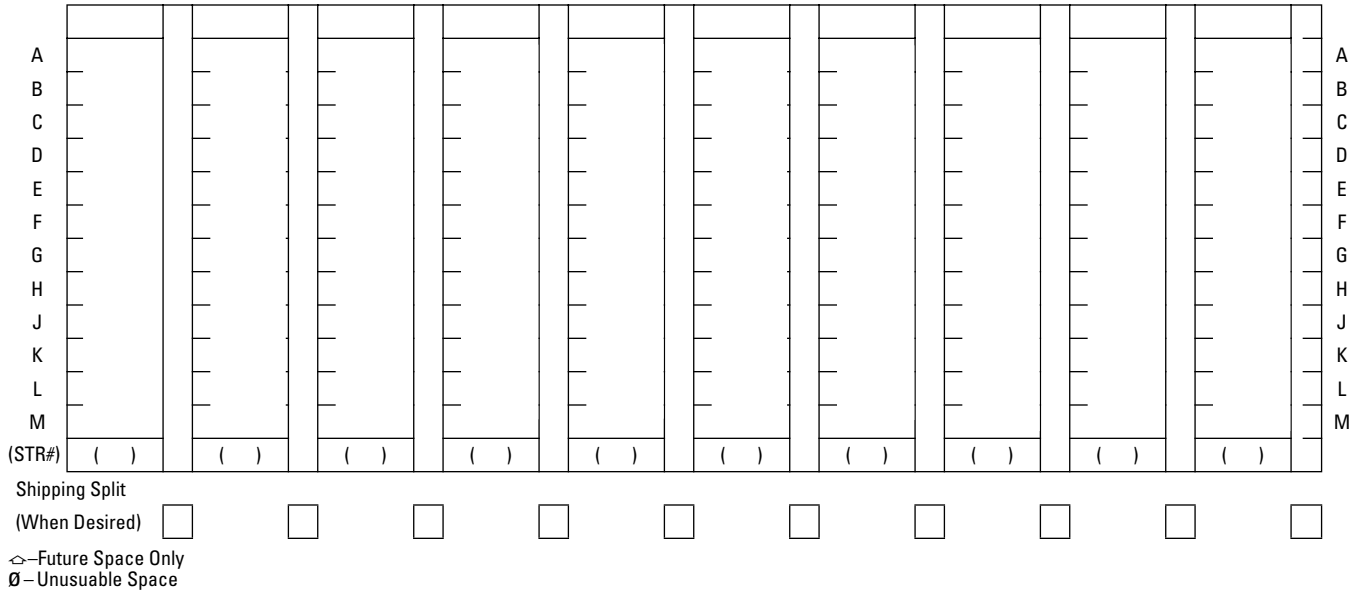
Finish

- A. The control center shall be given a phosphatizing pretreatment. The paint finish shall be an anionic, thermoset acrylic. Manufacturer's standard color shall be used.
- B. The control center finish shall pass 600 hours of corrosion resistance testing per ASTM B 117.

For a complete product specification in CSI format, see **Cutler-Hammer Product Specification Guide**, section 16482.

Arrangement of Structures (Numbered from Left to Right)

Typical Dimensions: Indoor – 20-inch W, 90-inch H; Outdoor 23.5-inch W, 95.25-inch H



| Unit No. | Starter Class or Description | Size | HMC Feeder Breaker or Switch Amperes | H.P. | Extra Intlks. | | Control Devices | | | | | | | | | | | | | | Nameplate Identifications | |
|----------|------------------------------|------|--------------------------------------|------|---------------|--|-----------------|--------------|----------------|-------------------|--------|-------------|---------------|-----------------|----------------------|-------------------|--------------|------------------|--------------|---------|---------------------------|-----------------|
| | | | | | | | Pushbutton | | | Selector Switches | | | Ind. Lights | | | | Meters | | | | | |
| | | | | | | | Start-Stop | Fwd-Rev-Stop | Fast-Slow-Stop | Hand-Off-Auto | On-Off | Fwd-Off-Rev | Fast-Off-Slow | Green (Stopped) | Red (Run, Fwd, Fast) | Amber (Rev, Slow) | Push-To-Test | Transformer Type | Elapsed Time | Ammeter | | Extra VA on CPT |
| NO | NC | | | | | | | | | | | | | | | | | | | | | |
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