

TECHNICAL APPLICATION GUIDE

ReliaGear™ LV MCC

Motor control center



Table of contents

04–05	ReliaGear™ LV MCC motor control center
06–17	Overview
18–37	Structure
38–45	Mains, feeders, incoming lines
46–56	Starters
57–62	Miscellaneous units
63–89	Variable frequency drives
90	Softstarters
90–118	Components
119–140	Application data
141–146	Drawings/tests
147–183	Typical circuits
184–187	Specifications

ReliaGear™ LV MCC

Motor control center

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01 ReliaGear LV MCC

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02 ReliaGear LV MCC

ReliaGear LV MCC has been designed to be safer, smarter and built for sustainability. This motor control center (MCC) provides customers with a centralized safe and flexible way to house motor starters and related control equipment.

ReliaGear LV MCC overview:

- 3P3 W and 3P4 W
- 50 Hz or 60Hz
- 100 kAIC @ 480 V
- 50 kAIC @ 600 V
- Main circuit breaker up to 3200 A
- Main lug only up to 3200 A
- Plug-in branch circuit breakers 3 A-600 A
- VFD's up to 500 Hp
- Soft-starters up to 500 Hp
- Full Voltage Non-Reversing Starters (FVNR) up to size 5
- Full Voltage Reversing Starters (FVR) up to size 5
- NEMA 1, 2, 3R (non-walk in), Type 12 enclosures
- 600 A to 3200 A main horizontal bus
- 300 A, 600 A, 850 A vertical bus
- 150 A vertical ground bus
- Seismic (non-OSHPD) ratings (see page 17)
- Various section depths, widths, and heights available

NOTICE

Notice: Restrictions on ratings may apply based on component selection and application.

ABB's rugged and reliable motor control centers are constructed of standardized heavy gauge vertical sections housing vertical and horizontal buses, wiring channels and compartmented control units. Customers can specify shipping splits up to 60 inches in length, which are bolted together at the customer site to form a single common bus line-up assembly.



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Units are mounted and wired in accordance with the wiring class as specified by the user and can have standard or customized control schemes to meet a variety of applications. The motor control center may be powered by incoming line connection at a single main lug connection point protected by an upstream disconnect or provided with a main protective device within the equipment.

ReliaGear LV MCC will bear UL845 section and unit labels, unless otherwise communicated during contract negotiations.

ReliaGear LV MCC with optional AFM

ReliaGear LV MCC with arc flash mitigation (AFM) units is an offering for customers and specific applications where additional protection of personnel is essential.

The AFM units were designed around lowering the potential for electrical shock hazards in motor control centers using guidelines referenced in IEEE 1683. The AFM unit design may include optional IP20 devices and incidental contact safety barriers in an effort to prevent accidental contact with energized parts during maintenance.

The AFM units are designed to help reduce the likelihood of exposure to electrical shock and the potential of internal arcing faults from occurring during maintenance.

The retractable stab mechanism allows for closed door racking of the unit and helps to provide added protection for personnel. Also available are remote racking devices that enable the user to stand up to 40 feet away from the equipment to retract the unit stabs.

Overview

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03 Roll-formed

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04 Knockouts

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05 Incoming line

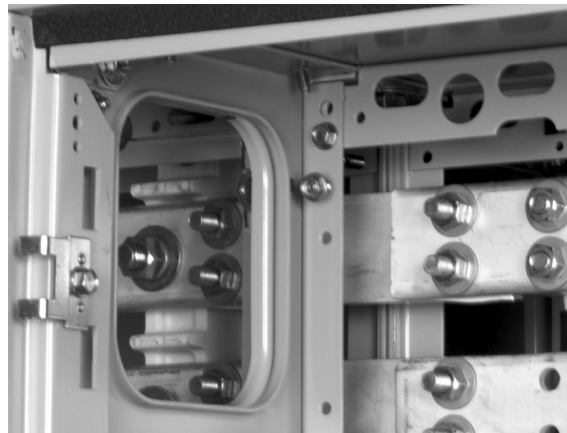
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06 Steel barrier

Product design and features

ReliaGear LV MCC integrates the superior technology available in ABB devices such as the ACS580 variable frequency drive (VFD) and TmaxXT breakers. The mechanical design of ReliaGear LV MCC is optimized for flexibility, personnel and equipment protection, and ease of maintenance and installation. ReliaGear LV MCC features, such as separate wiring troughs, split-type terminal boards, isolated bus, draw-out starter units, new and improved operating handle mechanisms, and provisions for starter interchangeability, are designed for a higher level of reliability, safety and convenience. The AFM unit construction was added in order to provide additional safety features and flexibility for customers. Both standard and AFM units are interchangeable in ReliaGear LV MCC's with use of a small shelf conversion kit.

Enclosure features

These steel-enclosed control centers can be joined together to centralize, protect and control the most complex systems of industrial auxiliary drives, or the simplest of loads such as fan or pump controls. As the need arises, additional sections can be added to an existing lineup in the field, often times without the need for a transition section. A paint finish is applied to all unplated steel parts. The powder coating paint process passes 1000 hours per ASTM117B salt spray tests for all exterior parts and provides lasting protection. Some internal galvanized parts meet 600 hours per ASTM117B.



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All case side wireways are roll-formed to provide a 1/2 inch lip for cross wiring to rest on, thus preventing skinned insulation.



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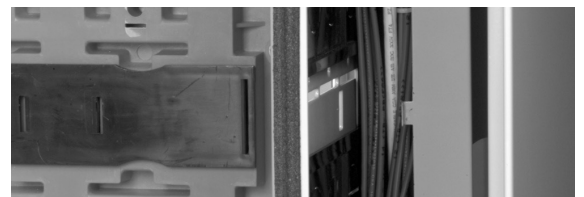
Easily removable plastic knock-outs are provided in the vertical wireway ladder assembly to allow routing of field wiring into units.



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05

An incoming line terminal compartment can be located at the top or bottom of a vertical section to allow cable termination with minimum bending.

The standard 600 A incoming line terminal compartment shown is furnished with mechanical type lugs. Other incoming line terminal compartments are available for main bus ampacities up to 3200 A.



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06

- 07 Splicing
- 08 Main bus barrier
- 09 Infrared scanning

Bus features



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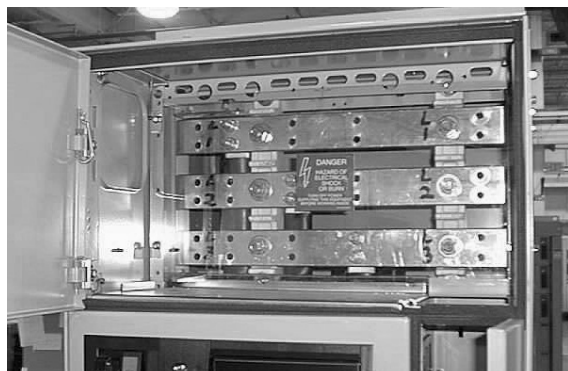
ReliaGear LV MCC can be spliced onto existing 7700 Line, 8000 Line and Spectra MCC for 1200 A (supplied with 2-inch bars) and below without a transition section as long as there is no XT5 or XT7 circuit breaker in the splice-to section, but may require modifications to the existing enclosure. Horizontal bus location in ReliaGear LV MCC matches the existing 2-inch bus location. Main bus amperage 1200A and greater with 4-inch bus bars can be spliced together but requires a transition section. ReliaGear LV MCC can be spliced to any E9000 bus amperage without the need for transition sections, but may require modifications to the existing E9000 enclosure if there is an XT5 or XT7 in the splice-to section. Optional close coupling to ReliaGear SB and ReliaGear LV SG is available through the factory when needed.

Table 1: Bus size by product

Bus Amperage	8000 Line	E9000 Evolution	ReliaGear LV MCC	Bus Splicing Information
600	2"	2"	2"	Yes, must consider door latch & wireway door modifications*
800	2"	2"	2"	Yes, must consider door latch & wireway door modifications*
1200	2"	2"	2"	Yes, must consider door latch & wireway door modifications*
1200	4"	2"	2"	Requires Transition Section between 8000/E9000 and ReliaGear LV MCC
2000	4"	2"	2"	Requires Transition Section between 8000/E9000 and ReliaGear LV MCC
2500	4"	2"	2"	Requires Transition Section between 8000/E9000 and ReliaGear LV MCC
2500	N/A	1.5"	1.5"	Yes, between E9000 & ReliaGear. Must consider door latch & wireway door modifications*
3200	N/A	1.5"	1.5"	Yes, between E9000 & ReliaGear. Must consider door latch & wireway door modifications*

*If the section you are splicing with includes XT5 or XT7, it is required to change the unit door latches, top wireway door latches, and bottom wireway door latches as well as change the vertical wireway door on the adjacent E9000 section. This splice section with XT5 or XT7 can only be spliced to a ≥20" deep E9000 section.

ReliaGear LV MCC features a new door latch that is type tested with the new SACE®Tmax® XT breakers. When splicing ReliaGear LV MCC to other installed MCC equipment, please consult factory to determine if the existing MCC needs to be refreshed with new door latches.



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Clear polycarbonate barriers located in front of the main horizontal bus isolate the bus from the top horizontal wireway for plug-in sections. Maintenance personnel can easily gain entrance to the top horizontal wireway of the control center with reduced hazard of contact with a live bus.



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Infrared viewing windows on the main bus are available when required. Please contact the factory for further information.

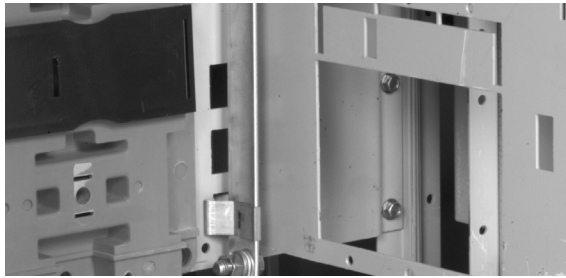
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10 Vertical ground bus and unit ground stab

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11 Insulated and isolated vertical bus

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12 Vertical bus shutters

—
13 Vertical bus shutter

—
14 Doors



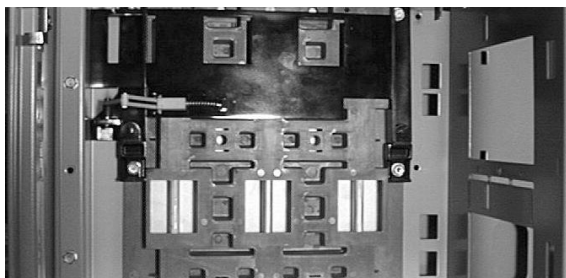
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10

(Optional) Vertical copper ground bus allows direct grounding of unit saddles to the equipment ground bus. A unit ground bus stab engages the vertical ground bus before the unit power stabs engage the vertical bus. A load ground lug is available for customer cable grounding. Termination points are located at the rear of the bucket, next to starter. When AFM units are selected, vertical copper ground bus is mandatory.



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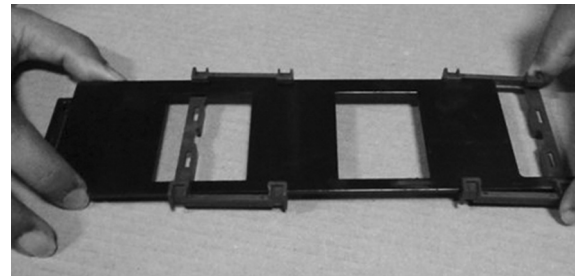
A polyester-reinforced “sandwich” insulates and isolates the vertical bus and helps prevent the spread of faults from starter and feeder units to vertical or horizontal bus. Small stab openings provide access to vertical bus and maintains effective isolation. 65 kA short circuit bracing is standard for ReliaGear LV MCC.



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(Optional) For standard ReliaGear LV MCC’s, a vertical bus shutter mechanism can be supplied which covers the vertical bus stab area when a plug-in starter or feeder is withdrawn. Cap plugs are standard to close unused stab openings.

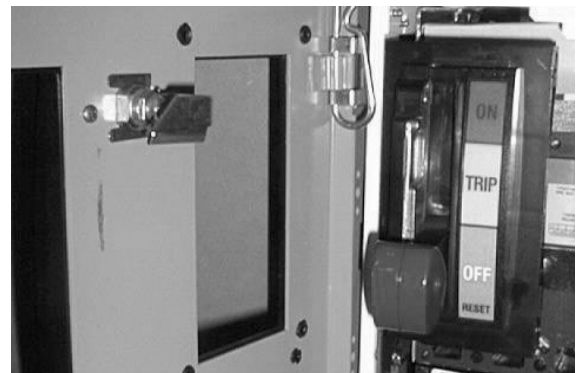
(Standard for AFM) For ReliaGear LV MCC with AFM units, a vertical bus shutter mechanism is supplied as standard. The shutter will be mechanically closed when the stabs are retracted, isolating the bus and preventing contact. When the stab is extended and engaged with the bus, the shutter will open.



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The vertical bus shutter for AFM design is different than the standard ReliaGear LV MCC vertical bus shutter option. The AFM shutter and shutter guide are shown above.

Unit features



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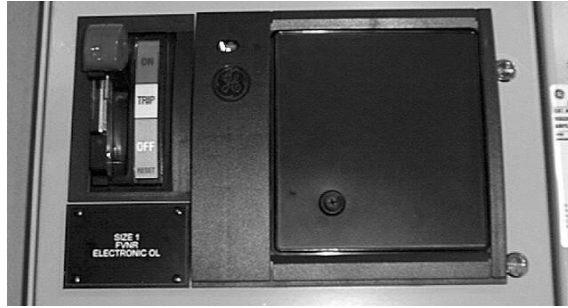
ReliaGear LV MCC, features a new and improved door latch which is 21 times stronger than the previous designs. The unit doors are all mounted on the case feature a removable hinge pin providing easy door removal and accurate alignment. Existing MCCs can be retrofitted with this new latch, when needed, by the ABB Service team.

- 15 Visual indication
- 16 Oversized nameplate
- 17 Device bracket
- 18 Stationary stabs
- 19 Retracted stabs
- 20 Extended stabs



15

AFM doors have a visual stab and shutter indicator feature as well as a remote racking provision.



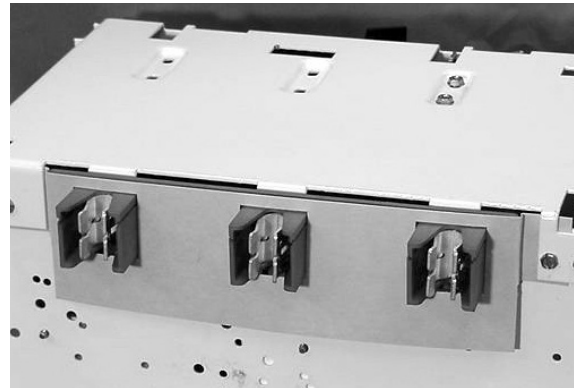
16

Oversized engraved unit nameplates on 12-inch units and larger feature 1 to 9 lines of up to 20 characters 0.18-inch high or 4 lines of up to 10 characters 0.30-inch high. Nameplates use Microsoft® Windows® Arial font. Custom non-English characters are an option.



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Device bracket mounts 30 mm for compact pilot devices and bracket swings open to allow easy access to unit components, wiring and terminal blocks. Fully insulated, this device bracket does not require grounding.



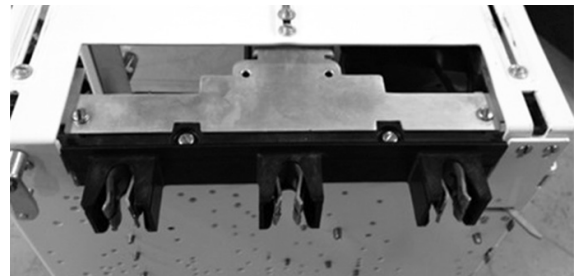
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Combination starter and feeder units of plug-in construction utilize a positive guidance system. Plug-in stabs are rated 250 A and 600 A. The 250 A stab connections shown are made with copper unit power stabs which are under double spring pressure and engage the vertical bus to provide positive contact.



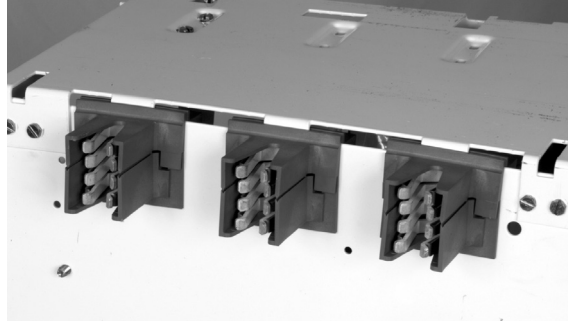
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AFM (optional) unit stabs are retractable while maintaining a closed-door unit. They move in a horizontal motion to engage and disengage from the bus when extended or retracted.



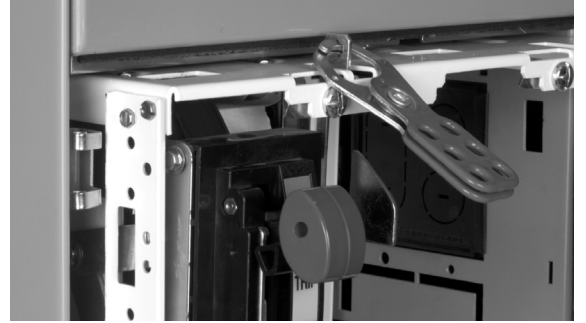
20

- 21 6000 A stab
- 22 Safety interlocks
- 23 Prevent insertion
- 24 Padlocks
- 25 Lifted handle
- 26 6-inch feeder



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The 600 A stab shown above uses a two-step engagement with vertical bus for low insertion/withdrawal force. Line side cables are crimped directly into spring reinforced tin-plated copper stabs. Tapered glass polyester stab mounting base gives positive plug-in alignment with vertical bus.



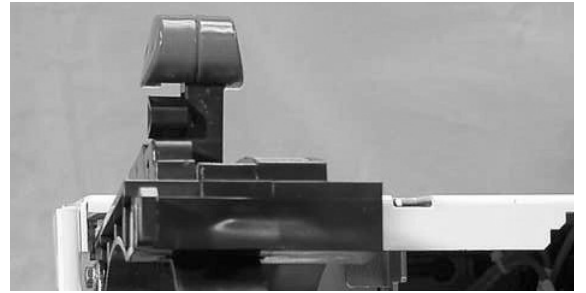
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Units can be withdrawn to a disconnected position and padlocked for maintenance. The vertically mounted integral handle can be locked in the OFF position. Padlock must have maximum of 3/8-inch shackle. If multiple locks are required to support lock-out tag-out, a multi-lock hasp must be used.



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An interlock release system is provided so that if it becomes necessary for maintenance purposes, the disconnect may be closed with the door open. A by-pass is provided to allow opening the door with the disconnect closed.



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Lift up handle design to allow full access to circuit breaker. Position indication ON-TRIP-OFF.



Danger: Only qualified personnel familiar with the equipment should use the interlock release and by-pass features.



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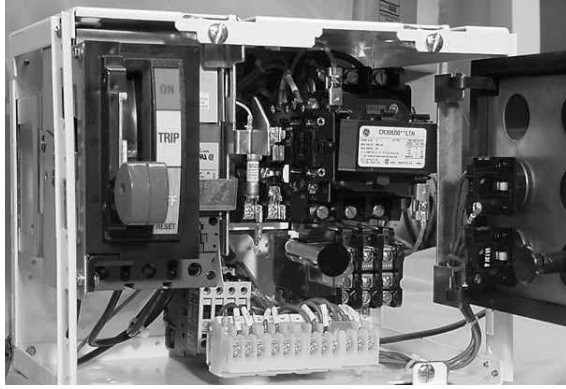
For AFM unit shown above, the padlock provision also serves as a mechanical interlock to prevent the insertion of a unit with the disconnect in the closed/ON position.



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Horizontal handles are standard on 6-inch 125 A and 12-inch 250 A feeder breakers to optimize space. Optional vertical handles are available, but will increase the unit height. Horizontal handles are not available with AFM units.

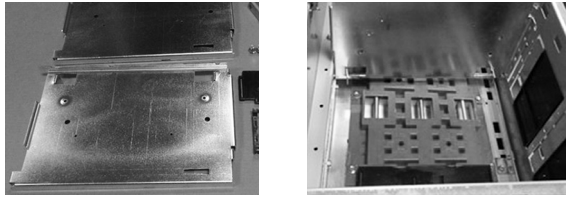
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27 Interchangeable units



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For flexibility, many units can be interchanged. This design allows quick, easy field changes when modifications are desired after installation. Front accessible quarter-turn latches provide for ease of securing and withdrawal of all plug-in units without the use of non-standard tools (flat head screwdriver recommended).

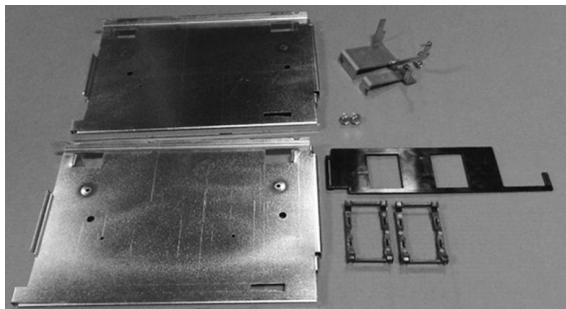
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28 AFM retrofit kit unit shelves



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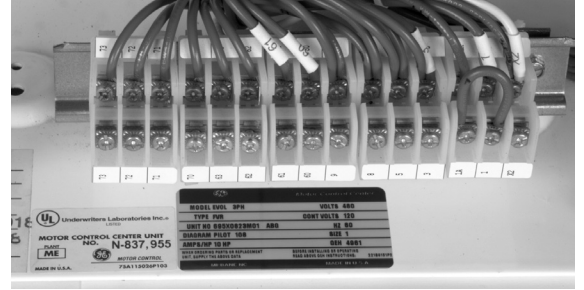
With the AFM unit, a different unit shelf is required to support the movement of the stab assembly while it is being racked in or racked out. When retrofitting an existing ReliaGear LV MCC, a Retrofit Kit will need to be ordered with the AFM Retrofit bucket. The Retrofit Kit will include this AFM shelf.

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29 AFM retrofit shelf kit



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AFM units can be ordered to retrofit existing ReliaGear LV MCC by ordering the AFM Retrofit Kit along with the AFM unit.



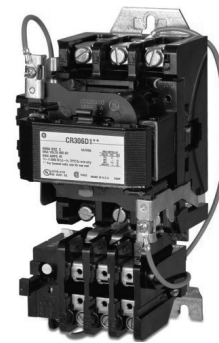
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High density two-piece, pull-apart control terminal boards feature up to 18 points in 12-inch high units. External and internal unit connections are made on opposite sides, allowing the unit to be withdrawn without disconnecting control wiring. Each terminal support the termination of up to two #12 AWG wires with ring, fork, or bare terminations, rated 30 A, 600Vac and are compliant with NEC Article 430.7.



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(Optional) When removing a unit utilizing NEMA Type BT wiring, motor power terminal blocks can be supplied in Size 1 and 2 starters to allow disconnecting motor wires when removing a unit.



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ReliaGear LV MCC units are equipped with the CR305 contactor as standard configuration.

IP20 fuses (optional)

(Optional) IP20 rated fuses are available. Please contact factory.



(Optional) 30 mm Lights and Push buttons are available with optional IP20 accessory. Please contact factory.

Incidental contact barrier features

(Optional) Clear polycarbonate incidental contact barriers are available for CR305 contactor.

**Wire and cable**

Standard control wire size is 14 AWG unless limited by component terminations. Standard control and power wire includes flame-retardant, (VW-1) moisture-heat-and oil-resistant thermoplastic insulation rated 600 V, with stranded copper conductors, types MTW and THW.

Standard colors¹ are:

- Red – AC Control
- Blue – DC Control
- Black – AC/DC Power and CPT primary
- Green – Ground
- White – Neutral

Optional wiring available includes SIS heat-resistant synthetic rubber-covered switchboard wire and XHHW flame-retardant cross-linked synthetic polymer, both rated 600 V with stranded copper conductors, and a VW-1 flame rating (no PVC). Wire is rated 90°C and terminals are rated 75 °C.

NOTICE

Notice: Not all colors are available with optional wiring.

Nameplates

Unit service designation nameplates are furnished when specified. These nameplates can be supplied as blanks suitable for field engraving, or engraved at the factory. The standard unit service designation nameplate is of 2-ply thermoplastic material, black face with white core, 2 5/32 inches x 3 1/2 inches, or 1 inches x 3 inches depending on the unit configuration, fastened with non-corrosive nylon clips. Stainless steel screws are available as an option. Nameplates are engraved with white letters on a black background unless specified otherwise.

NEMA class of diagrams and wiring

Motor control centers are classified by NEMA as follows:

NEMA class I definition

Class I motor control centers consist essentially of a mechanical grouping of combination motor control units, feeder tap units and/or other units arranged in a convenient assembly and connect to the horizontal and vertical common power bus to the units.

This class does not include interwiring or interlocking between units or to remotely mounted devices, nor does it include control system engineering. Diagrams of the individual units only are supplied.

NEMA class II definition

Class II motor control centers consist of a grouping of combination motor control units, feeder tap units and/or other units designed to form a complete control system. They include the necessary electrical interlocking and interwiring between units and interlocking provisions to remotely mounted devices in addition to the connections from the horizontal and vertical common power bus to the units.

The control manufacturer shall provide a suitable diagram to illustrate operation of the control associated with the motor control center.

NEMA class IS and IIS definition

Class IS and IIS motor control centers shall be the same as Class I and II motor control centers except custom drawings shall be provided in lieu of standard drawings.

Examples of custom drawings are:

- Special identifications for electrical devices
- Special terminal numbering designations
- Special sizes of drawings

1. From NEMA standard ICS 18-2001.

The drawings supplied by the manufacturer shall convey the same information as drawings provided with Class I and II motor control centers, additionally modified as specified by the user.

When to specify class I

Specify NEMA Class I control centers for independently operated motors requiring no interlocking or other interconnection between units.

When to specify class II

When factory interconnections are desired to provide such functions as sequencing and other interlocking or interconnection, the motor control centers NEMA Class II.

When to specify class IS and IIS

When custom drawings are desired to show special device identification, special terminal numbering, or special diagram size, etc. the control centers required are Class IS or IIS.

Wiring type

The NEMA classes are sub-divided into A, B and C depending on the type wiring furnished, with type B further having type B-D for customer load wiring direct to the device and B-T for customer wiring to a load TB (size 1 and 2 starters).

NOTICE

Notice: For feeders >12-inches and large starters, customer must wire direct to unit device terminals.

NOTICE

Notice: In addition to NEMA prescribed wiring types, ABB offers a NEMA IA Modified MCC wiring choice (IAM). This type of MCC will be supplied without wiring and without control diagrams. But unlike NEMA "A" type wiring class. ABB can mount low voltage control devices on the pilot device bracket and supply terminal boards for more flexibility to original equipment manufacturers (OEM's).

Table 2: Wiring features by NEMA classification

Type of power or control termination furnished	Class I			Class IS			Class II		Class IIS	
	A	B	C	A	B	C	B	C	B	C
Pull-apart and numbered control terminal boards on unit starter—Sizes 1, 2, 3 and 4	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Stationery and numbered control terminal boards on unit starter – Sizes 5, 6 and 7	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Pull-apart and numbered power terminal boards on unit starter—Sizes 1 and 2. (On Type A wiring: Same type of numbered terminals on starter itself for Sizes 1, 2, 3 and 4)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Numbered terminals on starter itself for power connection with no power terminal boards – Sizes, 5, 6 and 7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Stationery master terminal boards (Top, bottom or rear of section) For control – Sizes 1 thru 5 / For power – sizes 1 thru 3 (ReliaGear Sizes 1 and 2 only)	No	No	Yes	No	No	Yes	No	Yes	No	Yes
Unit terminal boards for feeder tap units and distribution panels	No	No	No	No	No	No	No	No	No	No
Starter-unit-mounted pilot devices internally wired to starter – Sizes 1 thru 7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Terminal board points for remote devices (Excluding extra tie points)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Master terminal-board wiring connections	No	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes
Factory-wired interconnections between units in the same motor control center	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Type of drawings furnished										
Outline and summary sheet (Schedule of units)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unit elementary wiring diagrams showing numbered terminal points (Terminal boards not furnished on Type A)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unit elementary wiring diagrams showing numbered terminal points and interconnections to other units and/or to the first level of remote devices	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Schedule of wires to master terminal blocks	No	No	Yes	No	No	Yes	No	Yes	No	Yes
Custom drawings as specified by user	No	No	No	Yes	Yes	Yes	No	No	Yes	Yes

A computerized manufacturing process necessitates that the ReliaGear Line motor control center standard unit numbering system be followed to identify the section and location of each unit. This is explained in detail in application data (Section J). It greatly simplifies wire tracing of interconnection wires, and is beneficial to the application of programmable control. The Outline and Summary drawing furnished with the equipment cross references the unit numbers and customer unit designations when specified.

Codes and standards

Motor control centers are manufactured to receive the Underwriters Laboratories listing mark under standard UL 845, a tri-national standard including UL/cUL/CSA Canada C22.2 No.254-05. Vertical sections and units which have been listed with UL will bear the UL listing mark.

Upon request, the cUL mark indicates the product has been tested to meet Canadian Standards by the UL organization, in this case CSA C22.2 No. 254-05, which is comparable and valid as CSA certification.

Sections and units which will be shipped with the UL listing mark are identified in the appropriate sections of this publication.

The National Electric Code (NEC) covers installation of electric conductors and equipment for installations identified in the NEC Article 90. The NEC is not intended as a design specification and acceptance of an installed motor control center by a local code authority relies on factors independent of the equipment as shipped from the factory. In general, equipment which bears the UL listing mark can be installed to meet the NEC.

Compliance to NEC is the responsibility of the installer.

Short circuit considerations

All ratings in this publication are RMS symmetrical amperes per UL845.

Environmental considerations

The standard ReliaGear LV MCC is designed for operation in a clean, indoor environment having a 40 °C maximum ambient temperature. The nominal minimum temperature for storage is -40 °C and for operation, -20 °C. Motor control center space heaters are recommended whenever temperature conditions below 0 °C will exist. Where extreme cold temperatures are to be encountered for long periods of time, it is recommended that the motor control center be installed in heated rooms or enclosures. Per clause 7.2.C of UL845, the average value of relative humidity, measured over a period of 24hours, does not exceed 95% non-condensing.

For ambient temperatures above 40 °C, special consideration must be given to the need for ventilation, ambient-compensated breakers and overload relays, special wire insulation and oversized control transformers.

Ambient compensated overloads provide essentially constant trip setting as the control ambient varies. For indoor environments subject to falling liquids, water spray and splashing, NEMA 2 drip proof enclosures are recommended. Space heaters may be desirable to prevent condensation on internal parts.

For outdoor installations, NEMA 3R non-walk-in weatherproof enclosures are required.

Thermostatically controlled space heaters and ambient-compensated breakers and overload relays should be considered for these applications. Provisions for heating and cooling the entire outdoor enclosure are also available.

ReliaGear LV MCC complies with seismic (non-OSHPD) requirements per IEEE-693-2005 and ASCE7-16. It was tested in accordance with 2015-ICC-ES AC156 standard. ReliaGear LV MCC is certified for installation in accordance with Section 1705.13.3 of the California Building Code (CBC-2019) / International Building Code (IBC-2018) per Table 3. Please note the unit exceptions in the table. If these excluded unit types are required, the entire line-up will not be seismic rated. If splicing to existing E9000, the seismic rules for new ReliaGear LV MCC sections will apply to entire line-up.

For dusty atmospheres, see "Structure" section.

The altitude limit for the standard electro-mechanical motor control center design is 6600 feet. Applications above this should be referred by the factory for recommendations. Some components have a lower altitude rating and may reduce the altitude limit of the motor control center.

Fungus-proofing of organic materials is inherent. Keeping equipment dry and above the dew-point is the best way of avoiding fungus-growth, and the use of space heaters is recommended for this purpose. Heaters should be energized if the motor control center is to be stored for any length of time. Where export crating is involved, provisions must be made on the outside of the crate for access to space heaters.

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Table 3: ReliaGear LV MCC seismic ratings

Product	Ampacity	Width	Depth	Height	Weight	Enclosure type	Sds (g)	z/h	Importance factor (Ip)	IEEE-693 seismic level	Notes
ReliaGear LV MCC	600-2500 A	20-36"	20"-42.5"	90-112"	823 lbs max	NEMA 1, 3R	2.24	0	1.5	High	Excludes: ATS, 2500A draw-out PBII, FVR size 5, 2S1W/2S2W size 5, Part winding size 5, Y delta size 5, 1.5kVA & 3kVA CPT's, distribution transformers
ReliaGear LV MCC	600-3200 A	20-36"	20"-42.5"	90-112"	1,835 lbs max	NEMA 1, 3R	1.4	1	1.5	High	Excludes: ATS, 2500A draw-out PBII, FVR size 5, 2S1W/2S2W size 5, Part winding size 5, Y delta size 5, 1.5kVA & 3kVA CPT's, distribution transformers

Structure

Enclosure types

Motor control centers are made up of standardized vertical sections housing vertical and horizontal bus, wiring channels and compartmented control units. Sections may be bolted together to form a single panel assembly powered by line connection at a single point. Normal shipping split is three sections maximum.

NEMA type 1 – gasketed – semi dust-tight, indoor

Intended to cushion doors and mitigate vibration. Standard finish is light-gray ANSI 61 over a phosphate rust inhibitor. All unpainted parts are zinc-plated or galvanized. Enclosures are furnished with bolt-on rear covers. Hinged rear doors are available as an option. Pan-type doors utilize quarter-turn fasteners. Gasketed doors, cover plates, and operating handles are available as an option. Two heavy-duty 3 inches by 1-1/2 inches, 12-gauge floor sills and 1/4 inch structural lifting lugs are included. Open bottom is standard.

NEMA type 2 – drip-proof, indoor

Intended for use indoors to protect the enclosed equipment against falling noncorrosive liquids and falling dirt. Dripshields on top of the motor control center and neoprene closed-cell gasketing afford protection from falling and splashing liquids.

They are not water-tight. Similar to NEMA 12 gasketed construction except with catch pan-type dripshield on top and with open bottom.

Dripshield extends four inches beyond front of motor control center. Standard finish: light gray ANSI 61. Furnished with removable conduit cover plates unless otherwise specified.

NEMA type 3R – rain-proof, outdoor

Intended for use outdoors to protect the enclosed equipment against rain. They are not dust-proof, snow-proof nor sleet proof (ice-proof). Optional lights and receptacles available.

Type 12 – industrial use – dust-tight and drip-tight, indoor

Intended for use indoors to protect the enclosed equipment against fibers, flyings, lint, dust and dirt, light splashing, seepage, dripping and external condensation of noncorrosive liquids.

1HG

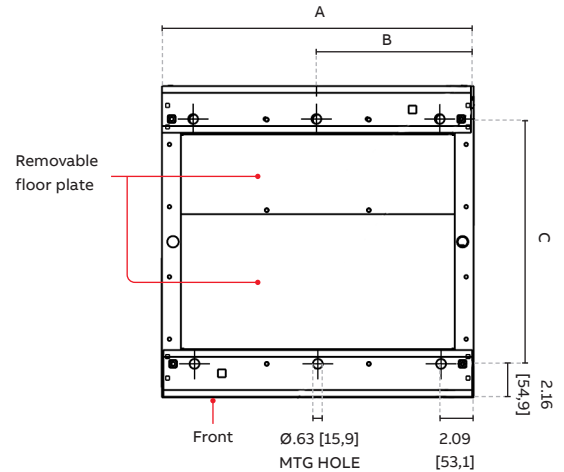
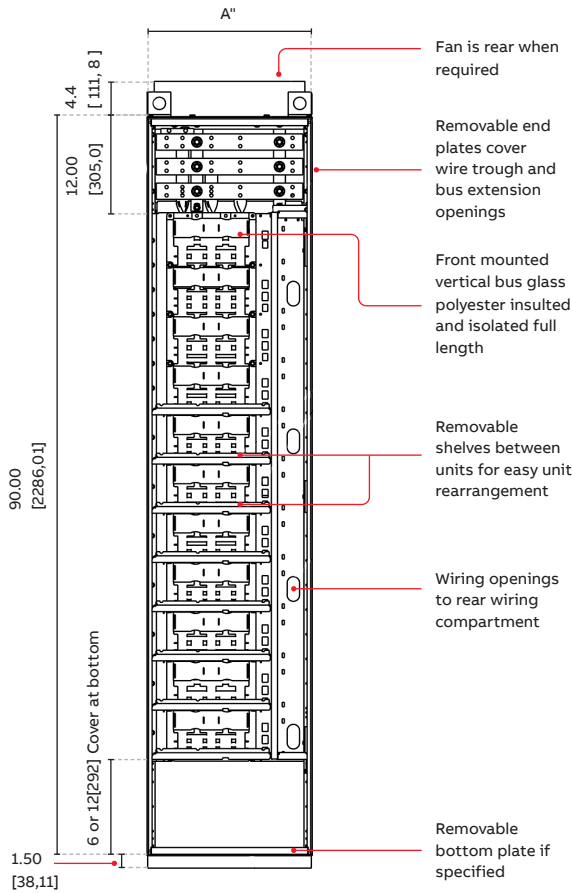
Similar to NEMA 1 gasketed construction except that bottom plates are furnished and all removable plates are gasketed.

Table 4: ReliaGear LV MCC ratings and enclosure types

Construction type	Enclosure type	Description	Voltage	Main bus rating (Amperes) / short circuit (kA)						
				600	800	1200	1600	2000	2500	3200
Standard, non-Arc Resistant	NEMA Type 1	Semi dust-tight, indoor	480	100	100	100	100	100	100	100
	NEMA Type 1HG	Heavy gasketed, indoor		100	100	100	100	100	100	100
	NEMA Type 2	Drip-proof, indoor		100	100	100	100	100	100	100
	NEMA Type 3R	Rain-proof, outdoor		100	100	100	100	100	100	100
	Type 12	Dust-tight, drip-tight, indoor		100	100	100	100	100	100	100
	NEMA Type 1	Semi dust-tight, indoor	600	65	65	65	65	65	65	65
	NEMA Type 1HG	Heavy gasketed, indoor		65	65	65	65	65	65	65
	NEMA Type 2	Drip-proof, indoor		65	65	65	65	65	65	65
	NEMA Type 3R	Rain-proof, outdoor		65	65	65	65	65	65	65
	Type 12	Dust-tight, drip-tight, indoor		65	65	65	65	65	65	65

Indoor enclosures

Front elevation and mounting locations
(13, 20, 22 and 25-inch deep sections)



Bottom view location of mounting holes

NOTICE

Notice: If anchor bolts are to be embedded in the foundation, they must be located according to the drawing furnished by ABB for the specific equipment. Locate one in the center front and one in the center back. Anchor bolts should be 1/2 inch diameter, of Grade 2 steel (minimum) in non-Seismic Locations. Bolts must extend a minimum of 2 11/32 inch above grade to 3/4 inch above the channel sill. If 13 (330.2 mm) deep vertical sections are used, anchor bolts or some form of external bracing is required.

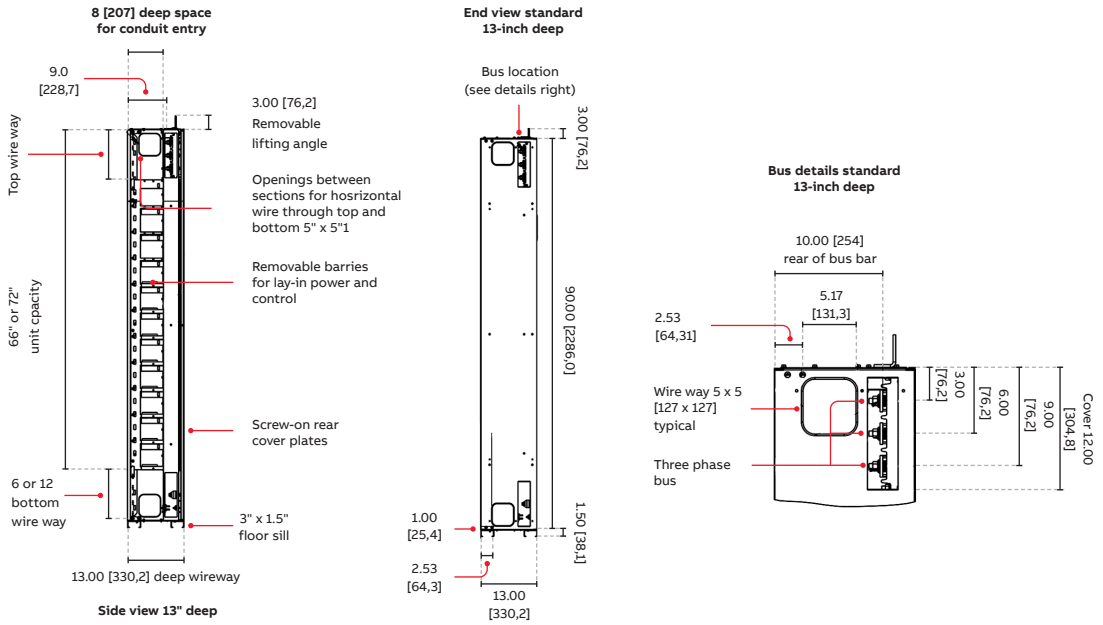
NOTICE

Notice: For seismic applications, use 1/2-inch x 13 TPI, grade 5 bolts, torqued to 50 foot-pounds, located in each of the four corners in each section.

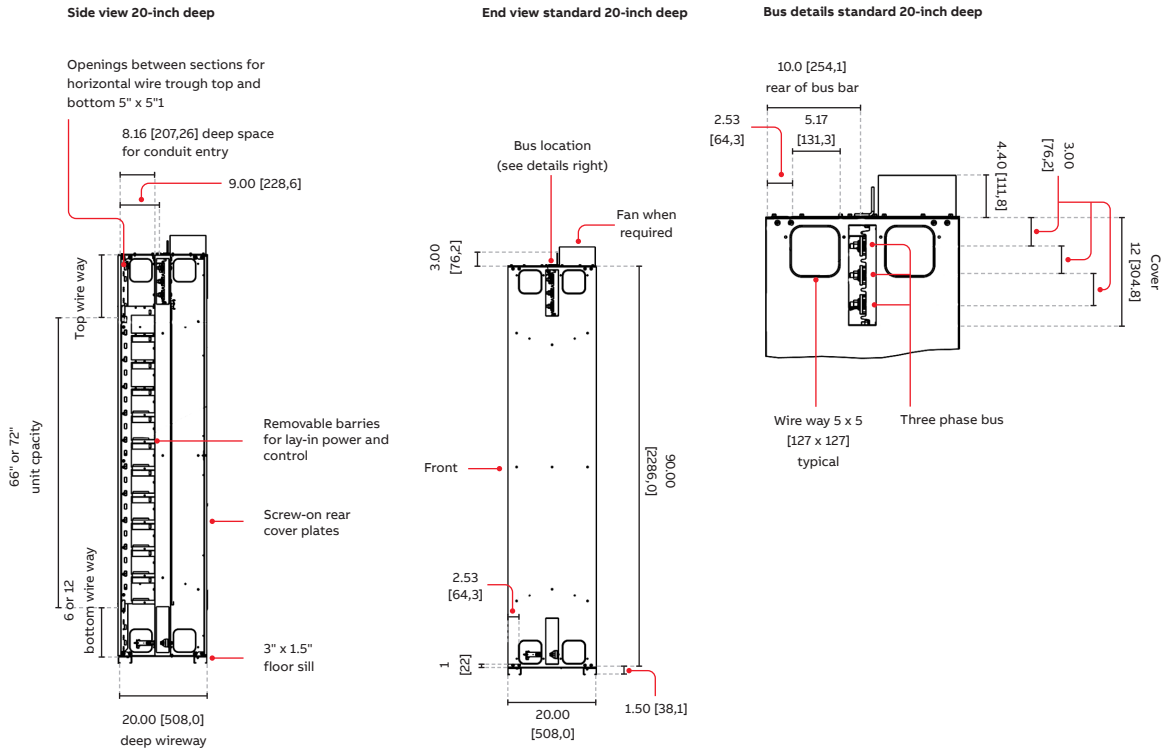
Table 5: Section depth

Ref. dim.	13" deep		20" deep		22" deep		25" deep	
	B	C	B	C	B	C	B	C
20 in.	10.00 in.	8.7 in.	10.00 in.	15.73 in.	10.00"	17.73 in.	10.00 in.	20.68 in.
508.8 mm	254.4 mm	221.7 mm	254.4 mm	399.5 mm	254.4 mm	450.3 mm	254.4 mm	525.3 mm
24 in.	12.00 in.	8.73 in.	12.00 in.	15.73 in.	12.00"	17.73 in.	12.00 in.	20.68 in.
609.6 mm	304.8 mm	221.7 mm	304.8 mm	399.5 mm	304.8 mm	450.3 mm	304.8 mm	525.3 mm
30 in.	15.00 in.	8.73 in.	15.00 in.	15.73 in.	15.00"	17.73 in.	15.00 in.	20.68 in.
762.0 mm	381.0 mm	221.7 mm	381.0 mm	399.5 mm	381.0 mm	450.3 mm	381.0 mm	525.3 mm

Side elevations 13-inch deep section 600 A to 1200 A main bus

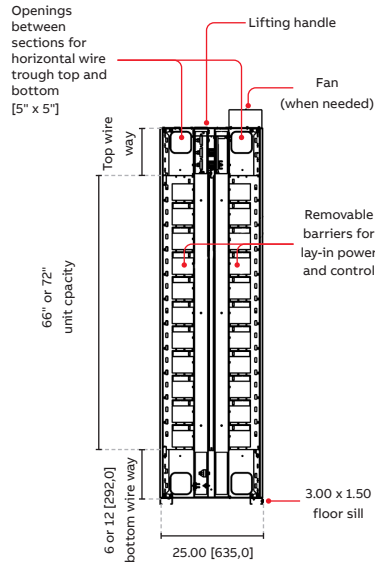


Side elevations 20-inch deep section 600 A to 1200 A main bus

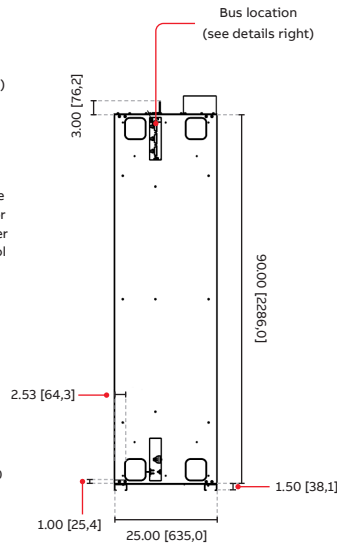


Side elevations 25-inch deep back-to-back section up to 1200 A main bus

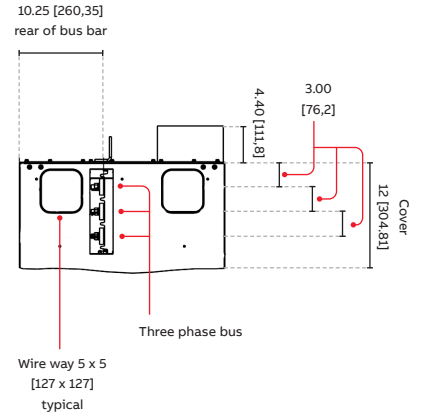
Side view 25-inch deep section



End view standard 25-inch deep

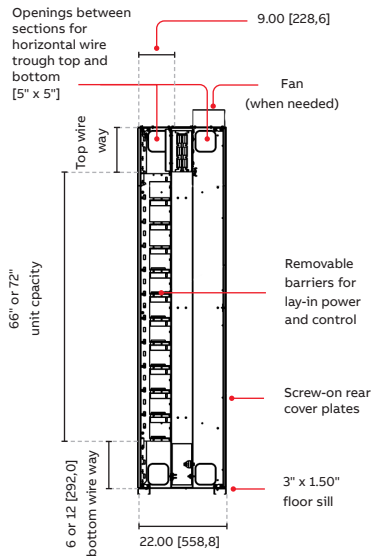


Bus details standard 25-inch deep

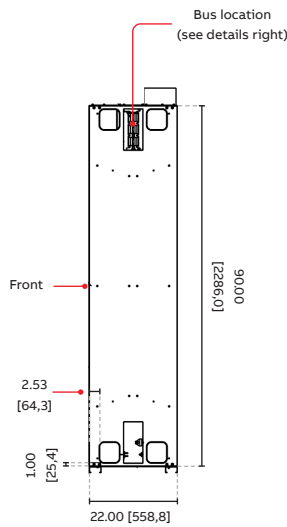


Side elevations 22-inch deep section 1600 A to 2500 A main bus

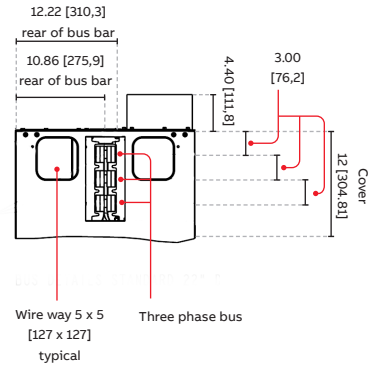
Side view 22-inch deep section



End view standard 22-inch deep

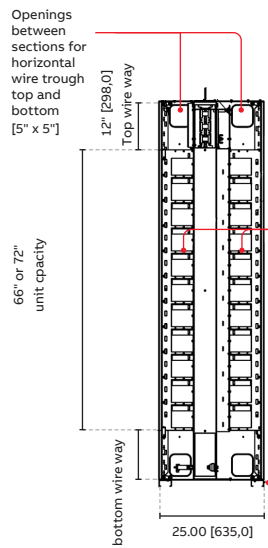


Bus details standard 22-inch deep

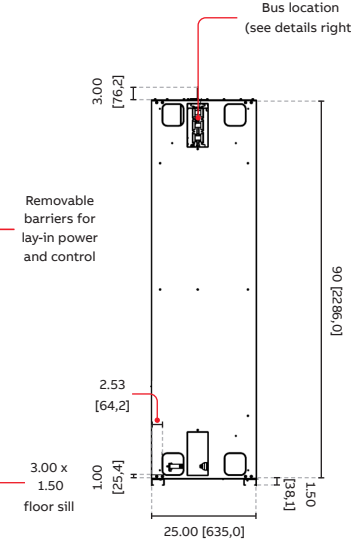


Side elevations 25-inch deep back-to-back section 1600 A to 2500 A main bus

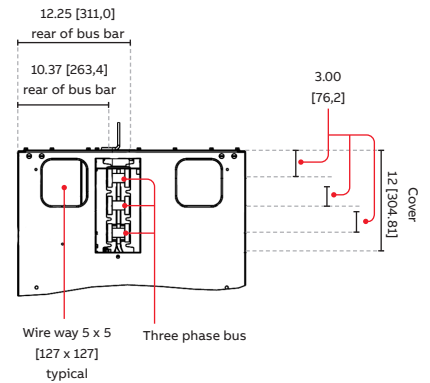
Side view 25-inch deep section



End view standard 25-inch deep

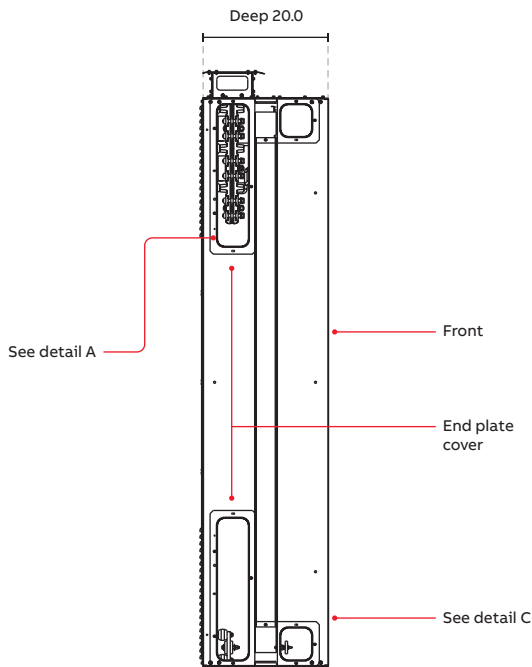


Bus details standard 25-inch deep



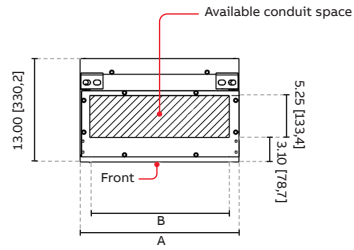
Side elevations 20-inch and 30-inch for 2500 A and 3200 A main bus without fans

SIDE VIEW

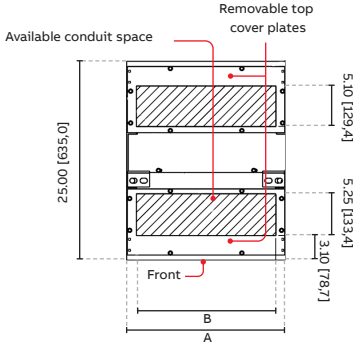
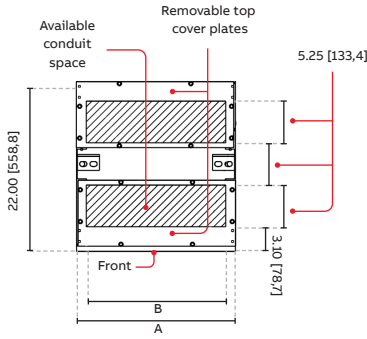
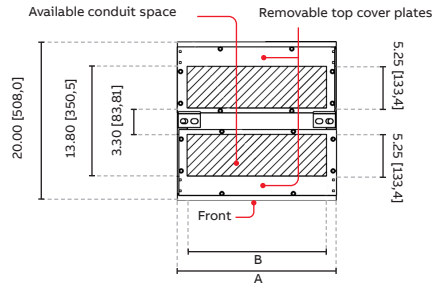


Top conduit entry (13, 20, 22 and 25-inch deep sections)

Top conduit entrance details for std. 13-inch



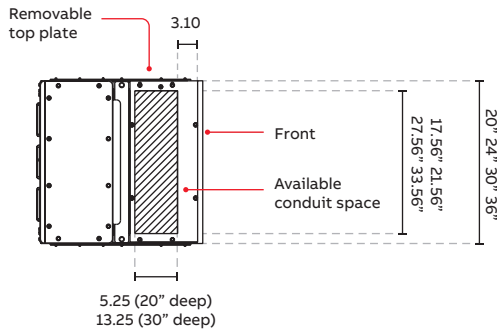
Top conduit entrance details for std. 20-inch



Top conduit entrance details for std. 22-inch

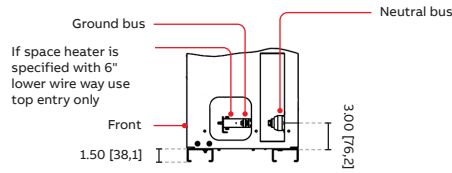
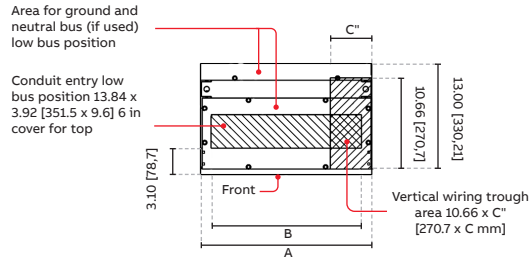
Top conduit entrance details for std. 25-inch

Top conduit entry for 2500 A without fans and 3200 A main bus construction



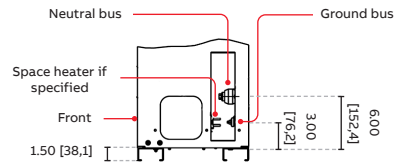
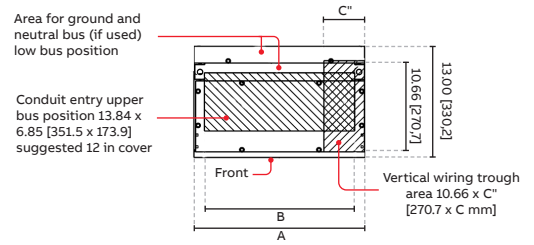
Bottom conduit entry 13-inch deep section

Bottom conduit entrance details for std. 13-inch low bus position



Low bus position of ground and neutral bus (minimum available space for conduit entry) 6-inch [152.4] cover

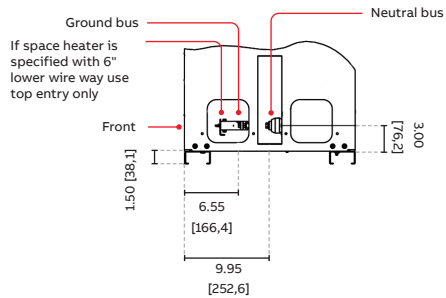
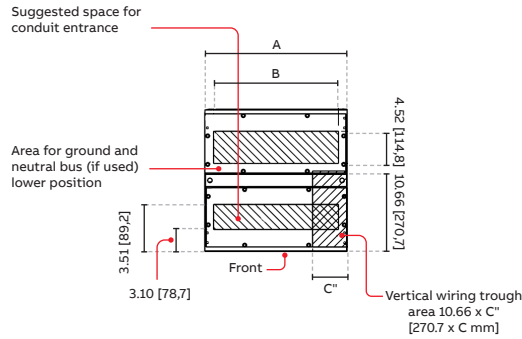
Bottom conduit entrance details for std. 13-inch bus upper position



Standard location of ground and neutral bus with 12-inch [304.8] cover compartment at the bottom of MCC

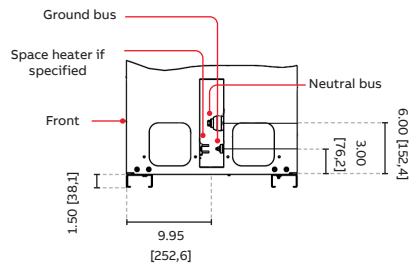
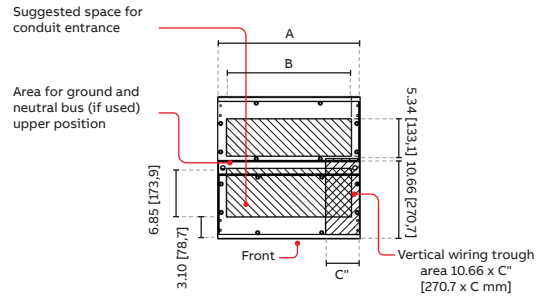
Bottom conduit entry 20-inch deep section

Bottom conduit entrance details for std. 20-inch x 20-inch low bus position, 6-inch bottom cover



Low bus position of ground and neutral bus (minimum available space for conduit entry) 6-inch [152.4] cover

Bottom conduit entrance details for std. 20-inch bus upper position



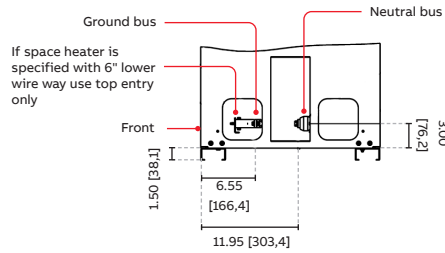
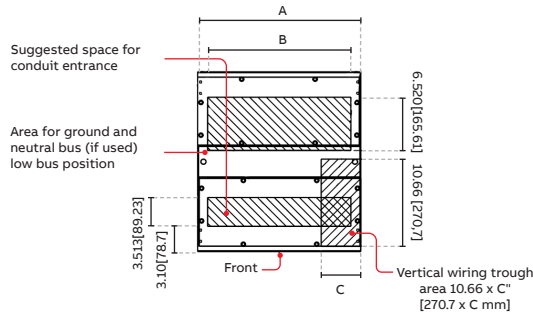
Upper position of ground and neutral bus (maximum available space for conduit entry) 12-inch [304.8 mm] cover

Table 6: Reference dimensions

Ref. dim.	20 in. wide enclosure	24 in. wide enclosure	30 in. wide enclosure
A"	20 in. 508.8 mm	24 in. 609.6 mm	30 in. 762.0 mm
B"	17.56 in. 446.0 mm	21.56 in. 547.6 mm	27.56 in. 700.0 mm
C"	4.85 in. 123.2 mm	8.85 in. 174.2 mm	14.85 in. 377.2 mm

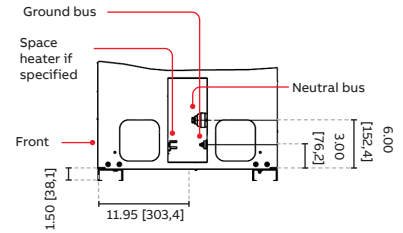
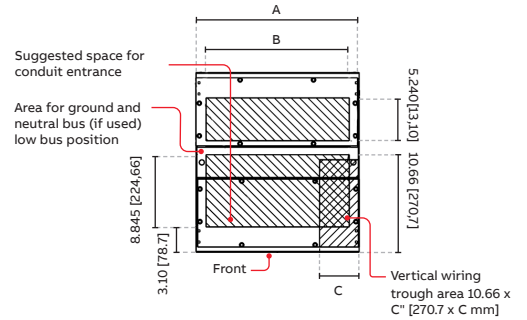
Bottom conduit entry 22-inch deep section

Bottom conduit entrance details for std. 22-inch low bus position 6-inch bottom cover



Low bus position of ground and neutral bus (minimum available space for conduit entry) 6-inch [152,4 mm] cover

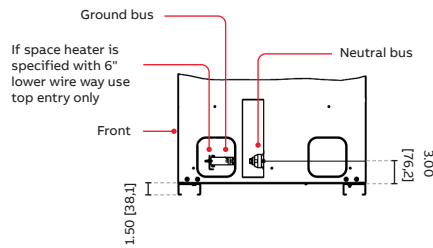
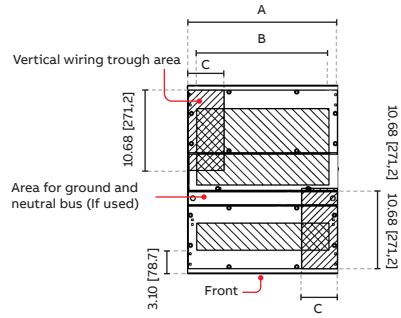
Bottom conduit entrance details for std. 22-inch low bus position 12-inch bottom cover



Upper position for ground and neutral bus (maximum available space for conduit entry) 12-inch [304,8 mm] cover

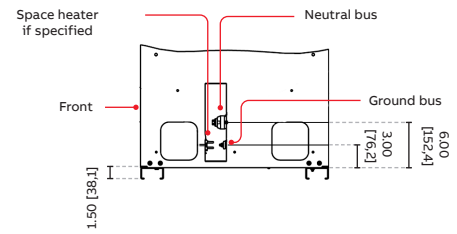
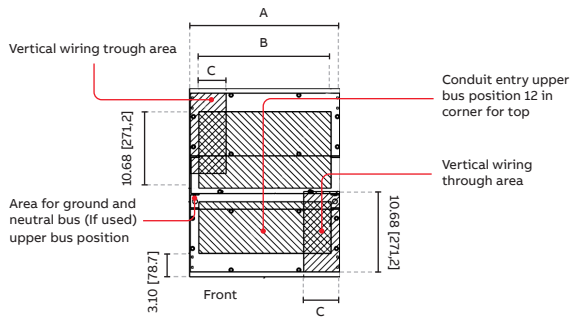
Bottom conduit entry 25" deep section

Bottom conduit entrance details for std. 25-inch low bus position 6-inch bottom cover



Low bus position of ground and neutral bus (minimum available space for conduit entry) 6-inch [152,4 mm] cover

Bottom conduit entrance details for std. 25-inch low bus position 12-inch bottom cover



Upper position for ground and neutral bus (maximum available space for conduit entry) 12-inch [304,8 mm] cover

Bottom conduit entry for 2500 A without fans and 3200 A main bus construction

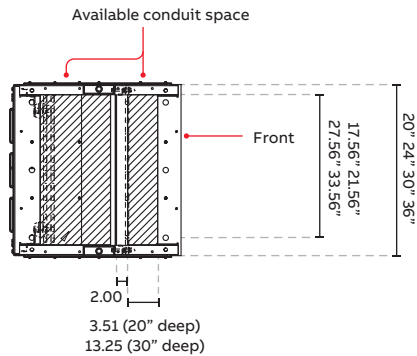
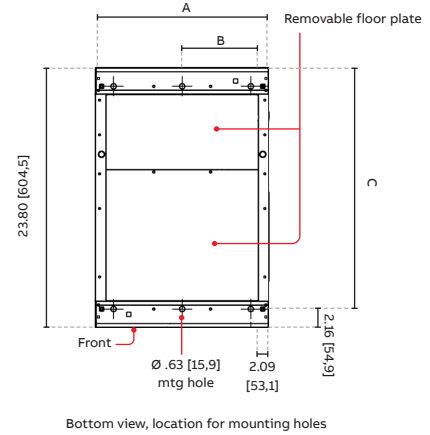
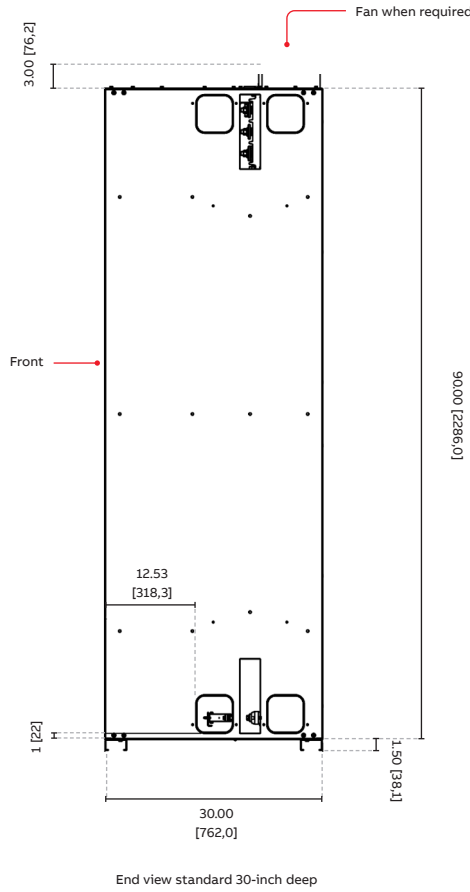


Table 7: Reference dimensions

Ref. dim.	20 in. wide enclosure	24 in. wide enclosure	30 in. wide enclosure
A"	20 in. 508.8 mm	24 in. 609.6 mm	30 in. 762.0 mm
B"	17.56 in. 446.0 mm	21.56 in. 547.6 mm	27.56 in. 700.0 mm
C"	4.85 in. 123.2 mm	8.85 in. 174.2 mm	14.85 in. 377.2 mm

Elevation and mounting 30-inch deep section 600 A to 1200 A main bus



NOTICE

Notice: If anchor bolts are to be embedded in the foundation, they must be located according to the drawing furnished by ABB for the specific equipment. Locate one in the center front and one in the center back. Anchor bolts should be 1/2 inch diameter, of Grade 2 steel (minimum) in non-seismic locations. Bolts must extend a minimum of 2 11/32 inch above grade to 3/4 inch above the channel sill. If 13 (330.2mm) deep verical sections are used, anchor bolts or some form of external bracing is required.

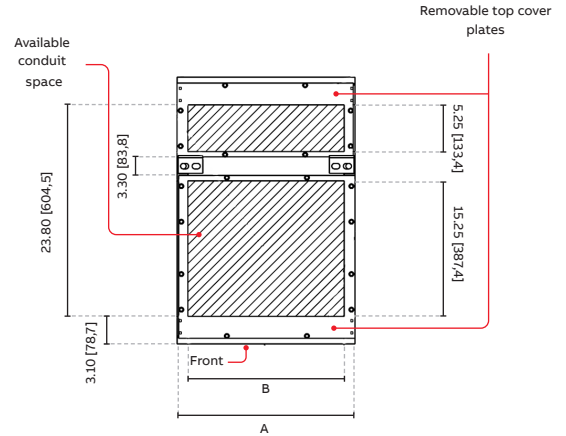
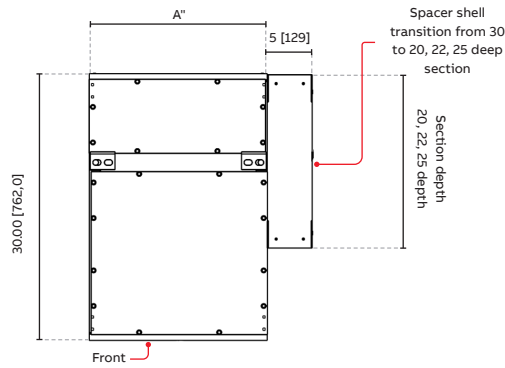
NOTICE

Notice: Seismic CBC testing was performed use 1/2' - 13 Grade 5 bolts, torqued to 50 foot-pounds, located in each of the four corners in each section.

Table 8: Reference dimensions

Ref. dim.	Section depth									
	13 in. deep		20 in. deep		22 in. deep		25 in. deep		30 in. deep	
Width "A"	B	C	B	C	B	C	B	C	B	C
20 in.	10.00 in.	8.73 in.	10.00 in.	15.73 in.	10.00 in.	17.73 in.	10.00 in.	20.68 in.	10.00 in.	25.69 in.
508.8 mm	254.4 mm	221.7 mm	254.4 mm	399.5 mm	254.4 mm	450.3 mm	254.4 mm	525.3 mm	254.4 mm	653.5 mm
24 in.	12.00 in.	8.73 in.	12.00 in.	15.73 in.	12.00 in.	17.73 in.	12.00 in.	20.68 in.	12.00 in.	25.69 in.
609.6 mm	304.8 mm	221.7 mm	304.8 mm	399.5 mm	304.8 mm	450.3 mm	304.8 mm	525.3 mm	304.8 mm	653.5 mm
30 in.	15.00 in.	8.73 in.	15.00 in.	15.73 in.	15.00 in.	17.73 in.	15.00 in.	20.68 in.	15.00 in.	25.69 in.
762.0 mm	381.0 mm	221.7 mm	381.0 mm	399.5 mm	381.0 mm	450.3 mm	381.0 mm	525.3 mm	381.0 mm	653.5 mm

Top conduit entry 30-inch deep section

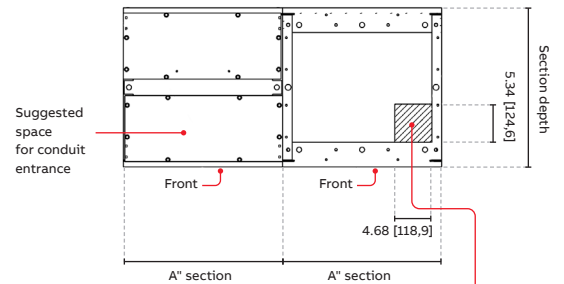
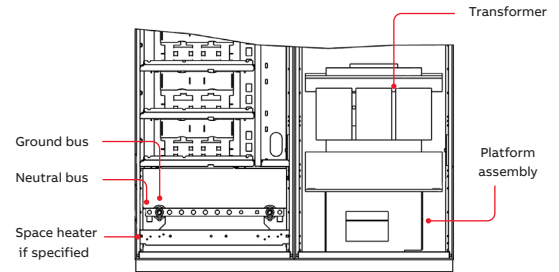
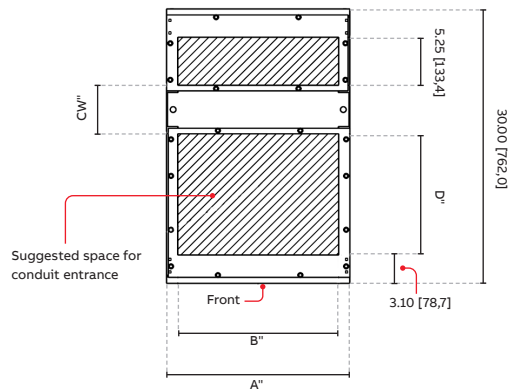


NOTICE

Notice: Spacer shell allows unit doors, in spliced section on the right, to open fully.

Details for auto transformer

Bottom conduit entry 30-inch deep section



If floor plate required, small, removal wireway access plate provided.

Bottom conduit entrance details for transformer cable incoming

Table 9: Reference dimensions

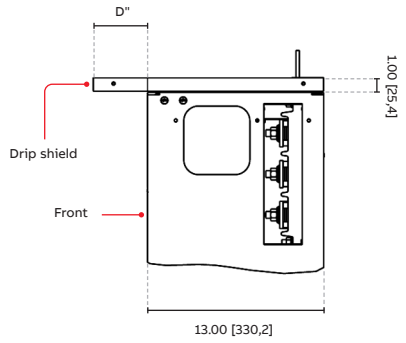
Ref. dim.		30" deep section		
D	A"	20.00"	24.00"	30.00"
	B"	17.56"	21.56"	27.56"
	CW" - 3"			
	600A - 1200A	13.25"	13.25"	13.25"
	CW" - 5"			
	1600A - 2500A	15.25"	15.25"	15.25"

CW - Channel width

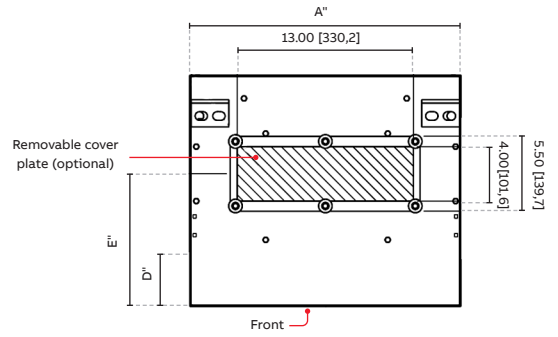
NOTICE

Notice: Transformer platform is 6" from floor recommend that cable entry come from adjoining section.

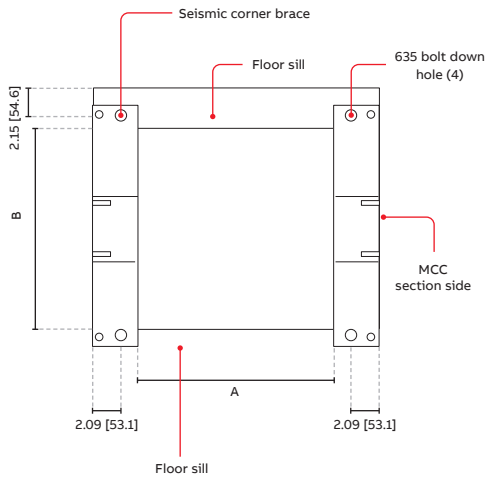
Drip pan — NEMA II 13-inch deep section



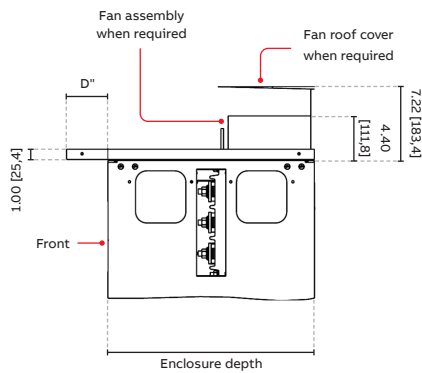
NEMA 11 drip shield end view



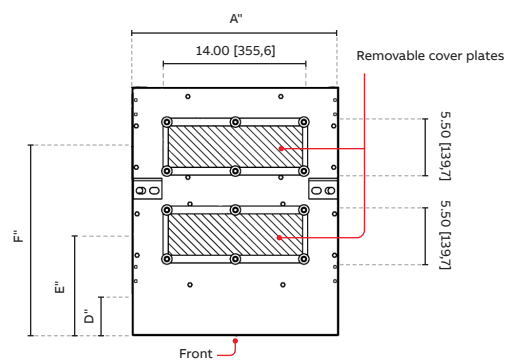
NEMA 11 drip shield top view



Drip pan — NEMA II 20, 22, 30-inch deep sections



NEMA II drip shield end view



NEMA II drip shield top view

Drip pan — NEMA II 25-inch deep section back-to-back

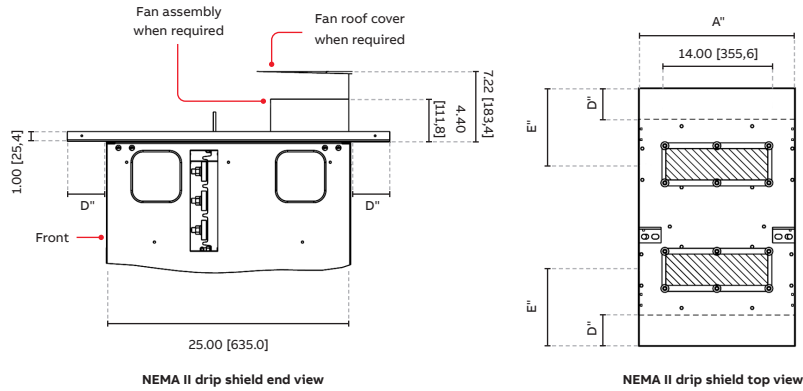
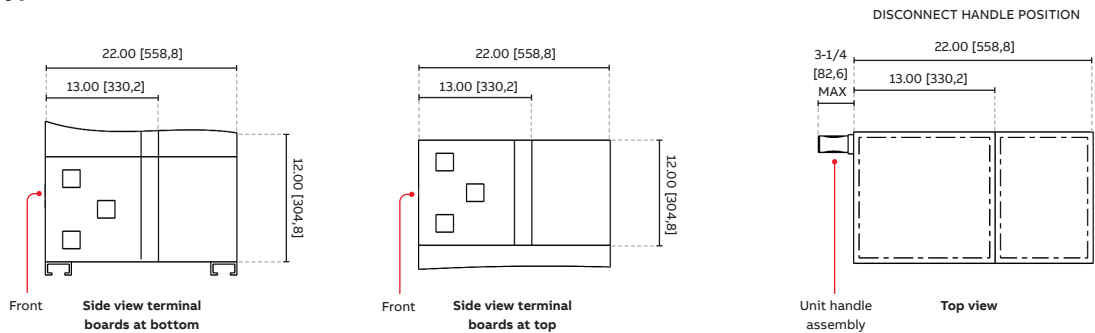


Table 11: Reference dimensions

Ref. dim.	13" deep	20" deep	22" deep	25" deep	30" deep
A"	20.00"	20.00"	20.00"	20.00"	20.00"
D"	4.00"	4.00"	4.00"	4.00"	4.00"
E"	9.75"	9.75"	9.75"	9.76"	9.75"
F"	NA	18.25"	20.25"	NA	28.25"

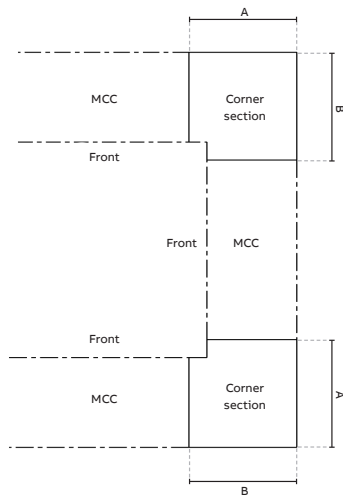
Type C master terminal



NOTICE

Notice: Maxium handle is 6'7", measure from bottom of sill to top of handle

Used for L and U shaped motor control center arrangements



Back-to-back configuration with wrap-around corner section (2" bus only)

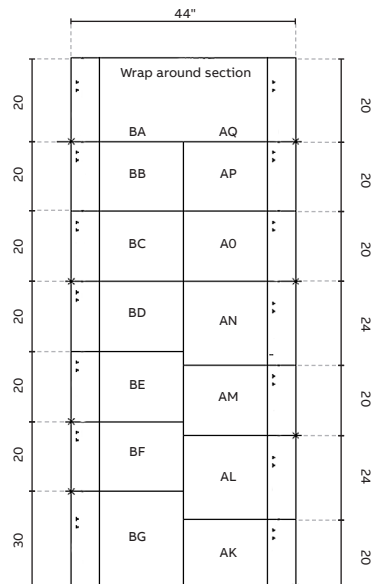


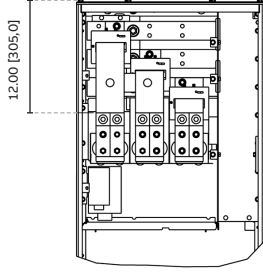
Table 10: Reference dimensions for NEMA 3R

Dimensions (in inches)		
MCC depth	A	B
13	20	17
20	24	24
22	24	26

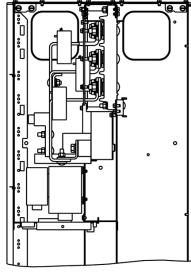
Wrap-around section includes verticals for L01 (AQ) and L02 (BA)

The wrap-around corner section is standard sections which accommodate plug-in units, therefore no space is lost in the transition.

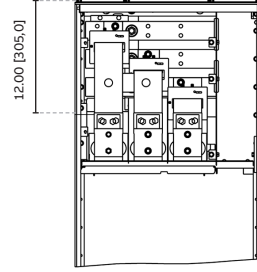
Incoming line terminations



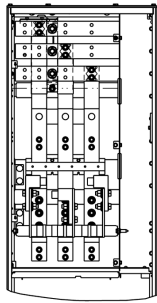
Front elevation
600 Ampere (top)
20" W NEMA lug shown with lightning
arrester and surge suppressor for 24" H



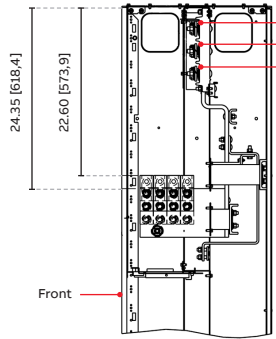
Side view
600 Ampere (top)
20" W



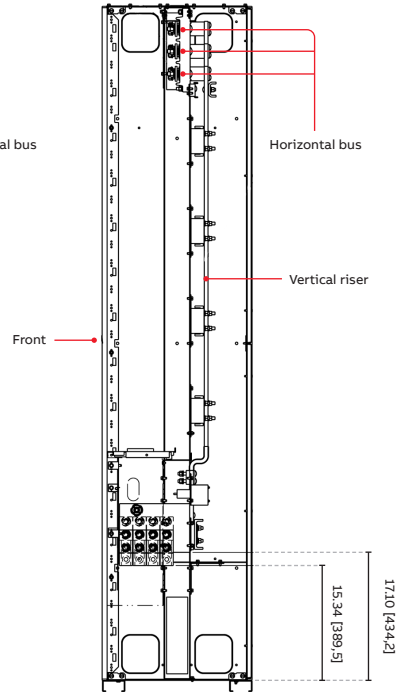
Front elevation
600 Ampere (top)
20" W, std. lug



Front elevation
800/1200 Ampere (top)
20" W, NEMA lug

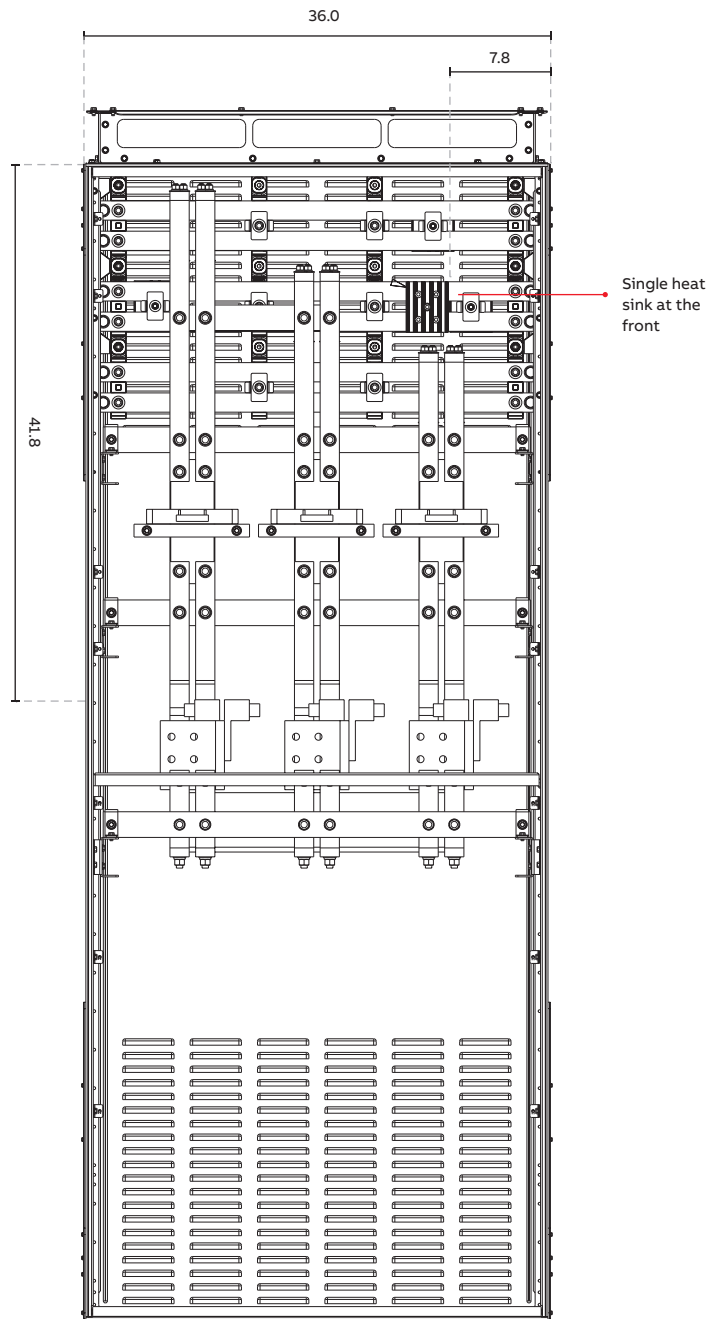


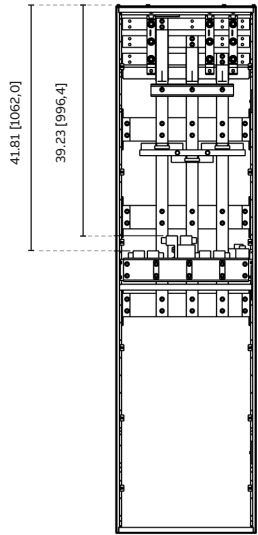
Side view
800/1200 Ampere (top)
20" W, NEMA lug



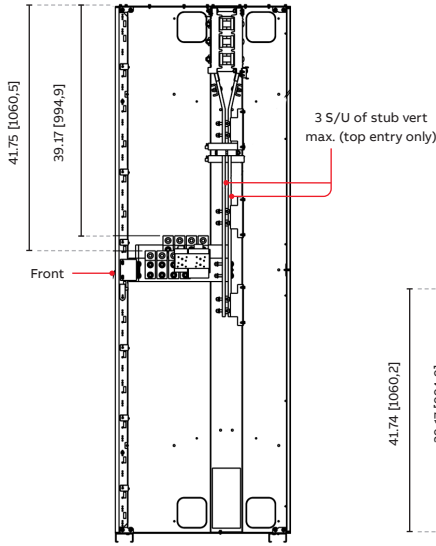
End view
800/1200 Ampere (bottom)
20" W, NEMA lug

Main Incoming line (top feed) for 2500A without fans and 3200A main bus construction

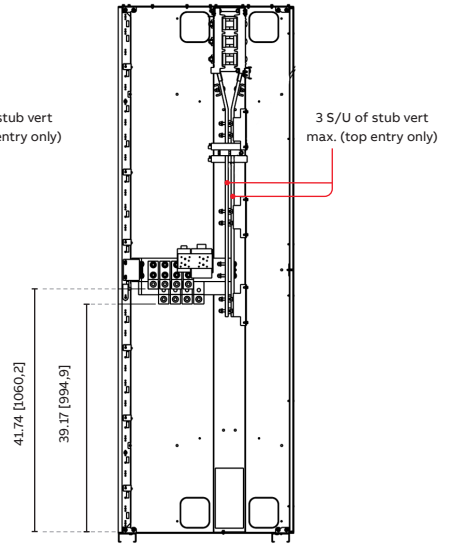




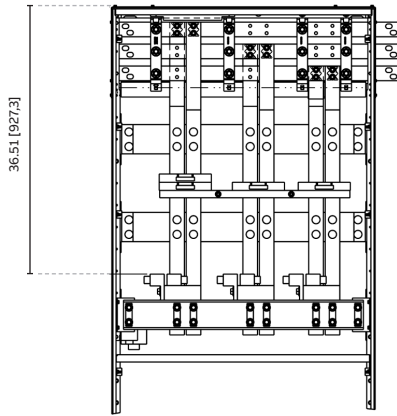
Front elevation
1600/2000 Ampere (top/
bottom)
24" W X 30" D



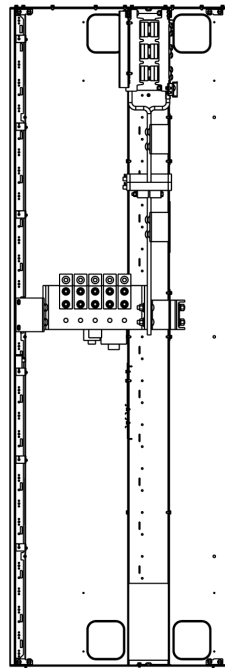
Side view
1600/2000 Ampere (top)
24" W X 30" D



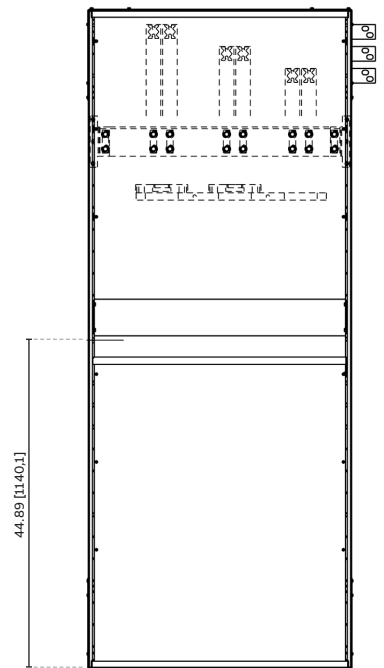
Side view
1600/2000 Ampere (bottom)
24" W X 30" D



Front elevation
2500 Ampere (top)
36" W X 30" D NEMA lug



Side view
2500 Ampere (top)
36" W X 30" D NEMA lug



Front elevation
2500 Ampere (bottom)
36" W X 30" D NEMA lug

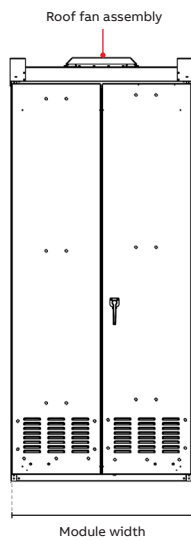
Outdoor enclosures

UL listed type 3R non-walk-in enclosure (standard)

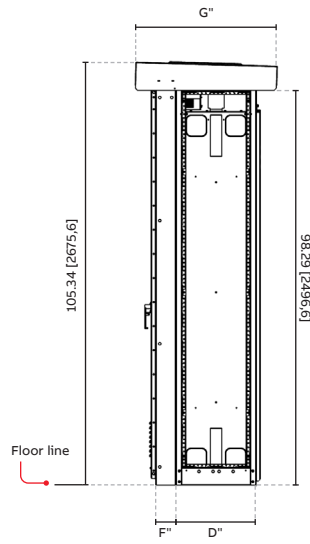
The standard NEMA 3R enclosure consists of a specially constructed MCC section with a mating framework which supports the roof and extended front. The basic design is similar to switchboard construction.

The NEMA 3R enclosure is designed for bottom cable entry and exit.

- Three-point door latch
- 90° door with wind stop
- Reinforced roof
- Crane lifting
- 2° roof pitch
- Shipped via flatbed truck
- 3" floor sills



Elevation NEMA 3R type A



Side view NEMA 3R type A

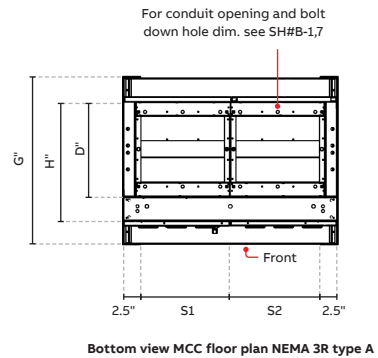
Table 12: Reference dimensions

MCC depth (D)	Front extension (F)	Top cover (G)	(H)
20"	5	35	25
22"	5	37	27
30"	5	45	35

NOTICE

Notice:

1. Doors shown are double door or single door module width less than 45".
2. Nema 3R module may contain 1, 2 or 3 MCC sections, 3 section shipping split limited to (3) 20" wide MCC sections only.
3. When 30" deep sections is used, 20" and 22" deep section enclosure are extended so that they are flush front and rear with the 30" deep enclosure.
4. All dimensions are in inches.



Bottom view MCC floor plan NEMA 3R type A

33 Optional structural type floor sills

Enclosure options

Space heaters

Space heaters are used to prevent moisture condensation on the inside of the motor control center. One heater (62.5 watts at 120 Vac AC) is installed in the bottom of each vertical section. UL requires space heaters be controlled by a thermostat. One thermostat can control up to 23 heaters and is located in the top horizontal wireway.

A terminal board for connecting an external 120 Vac power source is standard. The terminal board is located in the top horizontal wireway adjacent to the thermostat(s).

This is recommended since it permits the space heaters to be energized even when the motor control center itself is deenergized. If export crating is involved, the space heater circuit can be wired to an external plug for energizing the heaters during shipment and storage.

When specified, space heater power can be provided from within the motor control center. Include the required distribution transformer with primary and secondary protection in the motor control center. An enclosed foreign voltage disconnect switch is available as an option.

Bottom plates

Plates bolt on to the bottom of each motor control center section. They may be removed to facilitate installing conduit.

Extended height pull box (top hat)

A pull box can be mounted on top of a vertical section when specified. The standard height is 12 inches; 6-, 18-, and 24-inch heights are also available. Top, front, and end covers are removable for access.

Special transitions to 8000 line and low-voltage switchboards are available upon request. Please consult factory.

Rodent barriers

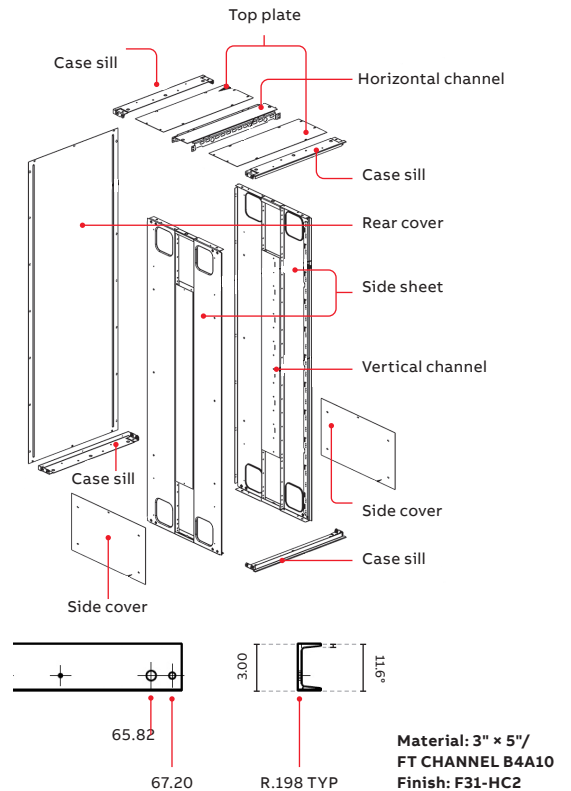
Metal plates bolted to the bottom of each end section to close the opening between the front and rear floor sills. Not required if the floor sills will be removed or imbedded in concrete.

Extra width vertical wireway

24-inch and 30-inch wide sections can be furnished with 8-inch wide vertical wireway and door.

Table 13: Steel thickness

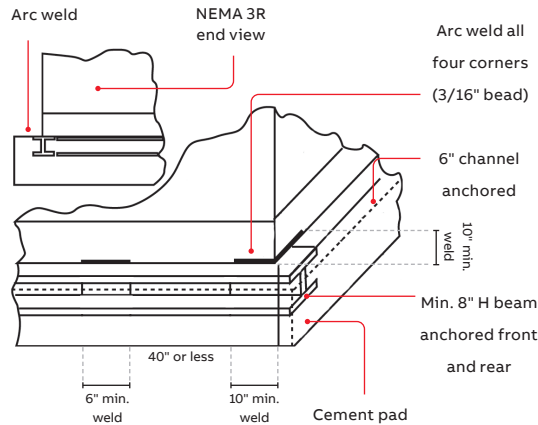
Motor control center construction	Steel thickness
Major structural components side sheets, L-H and R-H	0.075"
Vertical Bus Mounting Channels	0.090"
Case Sills, Front/Rear, Top/Bottom, Top Horizontal Channel	(13 gauge)
Lifting channel (top)	0.187"
Floor sills (optional structural type) see below	0.105" (12 gauge)
Enclosing covers/panels	
Rear covers, 13" and 30" deep	0.075" (14 gauge)
Rear covers, 20" and 22" deep	0.060" (16 gauge)
Endplates	0.060" (16 gauge)
Top conduit covers	0.060"
Bottomplates	0.060"
Vertical wiretrough door	0.060"
Other steel	
Unit barrier shelves	0.063"
Unit cover doors	0.075"
Unit saddles	0.090"



NOTICE

Notice: Bolt down locations for sections with seismic bracing change from center of structure (left to right), to four corners with .635 clearance holes for 1/2-inch bolts.

Mounting requirements for seismic NEMA 3R with optional heavy base



NOTICE

Notice: Arc weld down length of NEMA 3R every 40" or less for 130 mph winds and 2.25G shock (length and depth per outline)

NOTICE

Notice: For all installations, including Seismic Zone 4, testing was performed using 1/2"-13 Grade 5 bolts, torqued to 50 foot-pounds, located in each of the four corners in each section.

Table 14: Typical section weights

Section	Enclosure type	Bus size	Typical weight in pounds (lbs)
90"H x 20"W	Indoor	2"	500
90"H x 24"W	Indoor	2"	600
90"H x 30"W	Indoor	2"	700
90"H x 20"W	Indoor, back-to-back	2"	1000
90"H x 24"W	Indoor, back-to-back	2"	1200
90"H x 30"W	Indoor, back-to-back	2"	1400
90"H x 20"W	Outdoor, NEMA 3R	2"	725
90"H x 20"W	Indoor	1.5"	550
90"H x 24"W	Indoor	1.5"	650
90"H x 30"W	Indoor	1.5"	750

Bus selection

All continuous-current rating selections or recommendations are based on the motor control center being located in a maximum 40 °C (104 °F) ambient. Refer to "Overview" section for other environmental considerations.

Main horizontal bus

The size of motor control center main bus and cables feeding the main bus is based on the current-carrying capacity required for motors plus other connected loads.

The capacity required for motors can be taken as 125 percent of the full-load rating of the largest motor plus 100 percent of the full-load rating of all other motors to be operated at the same time. Modified requirements resulting from duty-cycle or demand factor can be taken into account.

The current-carrying capacity required for other connected loads should be computed on the basis of 100 percent of the sum of individual loads except where a demand factor can properly be applied to reduce this total. Consideration should be given to future requirements.

Vertical bus extensions

Vertical bus will be provided in all sections up to 30-inch wide enclosures. The maximum load on vertical bus should not exceed the factory labeled vertical bus rating. How to calculate the vertical bus loading is as follows: 80 percent of the feeder trip or fuse clip rating, plus 100 percent of the starter full load amps, plus 25 percent of the largest motor full load amps.

This total cannot exceed the vertical bus rating. Tin plated copper vertical bus is standard, with silver plating as an option.

Neutral bus

Neutral lugs will be provided as applicable. Neutral bus is normally sized at 50 percent of the main bus ampacity.

Ground bus

NEC requires a ground bus in multisection motor control centers. 300A copper ground bus will meet minimum size requirements for main busses rated through 2000A.

A clearance hole for 3/8" hardware is provided in each section.

The default for incoming ground termination is (3) #2-1/0 for 300A ground bus and (3) 1/0-500 kcmil for 600A ground bus. Ground bar comes with six pre-drilled holes for ground connectors.

Options

The following UL listed options are available:

- Shutter mechanism for vertical bus stab openings
- Insulated main horizontal bus
- Silver plated horizontal and vertical bus
- Silver plated ground bus

Table 15: Bus systems/selection⁶

MCC Bus	Continuous current ⁵	Material	Short-circuit rating in RMS symmetrical amperes – (kA)		Bus bar size
	Rating amperes		65	100	
Main Horizontal	600	•	•		1/4" x 2"
	800	•	•		3/8" x 2"
	1200	•		•	1/2" x 2"
	1600 ¹	•		•	(2) 1/2" x 2"
	2000 ¹	•		•	(2) 1/2" x 2"
	2500 ^{1 3}	•		•	(2) 1/2" x 2"
	2500/3200	•		•	(6) 3/8" x 1.5"
Vertical	300 ²	•	•		3/8" x 3/4"
	600/700 ⁷ /850	•		•	3/8" x 1 1/2"
Neutral	800	•			
	1200	•			
	1250	•			
	1600	•			(2) 0.5" x 2"
Horizontal ground	300	•			1/4" x 1"
	600	•			1/4" x 2"
	800	•			3/8" x 2"
Vertical ground	150	•			1/8" x 1"

All values shown based on 1200 A/sq.in. density rating. Alternate density ratings are available; if required, consult factory.

1. Requires a 22" deep section

2. Will not exceed 600 A stabs

3. Provided with fans

4. 1200 A horizontal or higher

5. Bus ratings based on UL Temperature Rise testing

6. When greater than 1000 A, a main breaker with service entrance must have a ground fault

7. 700 A vertical bus for 2500 A Type 12 enclosure only

Data subject to change without notice.

Mains, feeders and incoming lines

Mains

General

Main units consist of an externally operable circuit disconnect. Sizes by ampere rating, short-circuit rating, construction type and space units required are given in the accompanying lists. Normally, thermal magnetic circuit breakers or fuses are necessary for main protection. The short-circuit interrupting rating depends on the type disconnect furnished. Select a main unit for which the interrupting rating equals or exceeds the maximum available fault current. For reverse-fed circuit breakers, refer to factory for details.

Utilize ABB's CurvesWeb online tool for all information pertaining to time current curves. The tool can be accessed at <https://partnerhub.connect.abb.com/>. If access to this tool is not available please consult the factory. If any discrepancies are found in the time current curve information from other sources, the ABB's CurvesWeb online tool takes precedence.

Service entrance

UL listed main units containing only circuit breakers or fused switches may be UL classified as suitable for service entrance.

If a single disconnect is furnished as a disconnect for all load circuits the unit will be marked "Main". In order for the units to be classified as suitable for service entrance, the incoming phase conductors must connect directly to the disconnect device line terminals or to a UL listed main line terminal assembly.

A grounding electrode conductor terminal connector sized in accordance with the circuit ampacity is furnished in one section. Three-phase, four-wire systems include a neutral bonding jumper for grounding the neutral conductor during installation. Ground fault protection is required for disconnects 1000 A and above for solidly grounded wye services, where phase-to-ground is more than 150 Vac (NEC 230.95).

Main metering/lugs

Current transformers (CTs) can be provided in the main compartment for use with a metering unit. This option may increase space requirement. If crimp type lugs are required, a bus assembly is fabricated to provide a landing pad for these terminals. This extends the space required for the main and must be factory installed. Size will be the same as NEMA lug option.

Table 16: Fused switch mains - standard selection

Amperes	Interrupting rating RMS amps (in thousands) ⁽¹⁾			Construction		Space units	Notes
	Vac			Stab-in	Bolt-in		
	240	480	600				
High pressure contact (HPC) switch							
800	100	100	100	•		6	(2)
1200	100	100	100	•		6	(2)
1600	100	100	100	•		6	(3)
2500	100	100	100	•		6	(3)

1 With Class J, R and L fuses

2 Requires a 24 inches wide by 20 inches deep section. Full depth of enclosure is required

3 Requires 30 inches wide by 30 inches deep section. Must be NEMA 1 Construction, 80% rated only

4 Class J fuse is 3X

Table 17: Circuit breaker mains - standard selection

Amperes	CB type	IC (kA)			Stab-in	Bolt-in	Space units	Notes	Entry top/ bottom	Notes
		240V	480V	600V						
SACE®Tmax® XT thermal magnetic molded case circuit breaker (80% rated)										
400/600	XT5	65	65	65	•	2.5			T/B	
1200	XT7	65	65	65	•	4	(3)		T/B	
PowerBreak II insulated-case circuit breaker with EntelliGuard G trip unit (100% rated available as option)										
800	SSF/SHF	65	65	42	•	6 (24W)	(1)		T/B	
1200	SSF/SHF	65	65	42	•	6 (24W)	(1)		T/B	
1600	SSF/SHF	65/100	65/100	42/65	•	6 (30W)	(2)		T/B	
2000	SSF/SHF	65/100	65/100	42/65	•	6 (30W)	(2)(4)		T/B	
2500	SSF/SHF	65/100	65/100	42/65	•	6 (36W)	(2)(4)		T/B	
800	SSD	65	65	42	•	6 (30W)	(4)(5)(6)		T/B	
1600	SSD	65	65	42	•	6 (30W)	(2)(4)(5)(6)		T/B	
2000	SSD	65	65	42	•	6 (30W)	(2)(4)(5)(6)		T/B	
SACE Emax 2 air circuit breaker with Ekip trip unit (UL1066; 2500A-3200A main bus only, 100% rated available as option)										
2500	E4.2	65/100	65/100	65/100	•	36W x 30D	(5) (6) (7)		T/B	Design without fan cooling
3200	E4.2	65/100	65/100	65/100	•	36W x 30D	(6) (7)		T/B	Requires 3 inches rear clearance room wall

1. Requires special section 90 inches high, 24 inches wide, 20 inches deep

2. Requires special section 90 inches high, 30 inches wide, 30 inches deep

3. Main breaker must be mounted at top of the section and requires full 20 inches depth of enclosure

4. Requires special section 90 inches high, 30 inches wide, 30 inches deep. When section is on the left, allow for a 5 inches spacer to permit unit doors on the right to open

5. For UL or service entrance labels provide main breaker in switchboard construction

6. 2500 Type 12, 3200 require section 90 inches H, 36 inches W, 30 inches D; Spacer shell (5 inches)

7. 3200 require elevated roof cover (5 inches), not available with NEMA 3R enclosure

Data subject to change without notice

Ground-fault protection of equipment per NEC

Each main or feeder disconnect rated 1000 amperes or more and installed on a solidly grounded wye electrical system of more than 150 Vac to ground, but not exceeding 600 Vac phase-to-phase, will be provided with ground-fault protection of equipment.

Exception No 1: The above is not required if the disconnect is for a continuous industrial process where a non-orderly shutdown will introduce additional or increased hazards.

Exception No 2: The above is not required for fire pumps.

Exception No 3: The above is not required if ground-fault protection is provided ahead of the equipment.

NOTICE

Notice: The above is paraphrased from NEC section 215.10, 215.95 and 240.13.

Feeders

Feeder units consist of an overload and instantaneous protective device.

Select the circuit breaker trip rating based on the feeder circuit continuous current rating in accordance with the NEC. Feeder unit short-circuit interruption ratings must equal or exceed the available short-circuit currents.

Arc flash mitigation (AFM) main and feeder units

The AFM units are designed to help reduce the likelihood of exposure to electrical shock and the potential of internal arcing faults from occurring during maintenance.

The retractable stab mechanism allows for closed-door racking of the unit, providing added protection to the electrical personnel from the dangers of an arc flash occurrence.

Some optional IP20 protection features are available including IP20 control power transformer fuses and pilot devices.

Table 18: Fused switch feeders (HPCII) - standard selection

Amperes	Interrupting rating RMS Amps (in thousands)			Construction	Space units ⁽¹⁾	Notes
	Vac					
	240	480	600	Stab-in	Bolt-in	
800	100	100	100		•	(2)
1200	100	100	100		•	(2)
1600	100	100	100		•	(3)

1. Top/bottom entry
 2. Requires a 24 inches wide by 20 inches deep section. Full depth of enclosure is required
 3. Requires a 30 inches wide by 30 inches deep section. Full depth of enclosure is required

Table 19: Circuit breaker feeders – standard selection

Amperes	Circuit breaker type	IC (kA)				Stab-in	Bolt-on	Space units	Notes	Entry top/bottom
		208V	240V	480V	600V					
125	XT2H	65	65	65		•		0.5	(1)(2)	T/B
125	XT2L	100	100	100		•		0.5	(1)(2)	T/B
125	XT2V				42	•		0.5	(1)(2)	T/B
225	XT4H	65	65	65		•		0.5	(1)(2)	T/B
250	XT4H		65	65		•		1	(1)	T/B
250	XT4L		100	100		•		1	(1)	T/B
250	XT4N	65	65			•		1	(1)	T/B
250	XT4S	100	100			•		1	(1)	T/B
250	XT4V			65	65	•		1	(1)	T/B
Qty 2 - 125	XT2L	100	100	100		•		1	(1)	T/B
Qty 2 - 125	XT2N	65	65			•		1	(1)	T/B
Qty 2 - 125	XT2S	100	100			•		1	(1)	T/B
Qty 2 - 125	XT2V				42	•		1	(1)	T/B
Qty 2 - 250	XT4H		65	65		•		1.5	(1)	T/B
Qty 2 - 250	XT4L		100	100		•		1.5	(1)	T/B
Qty 2 - 250	XT4N	65	65			•		1.5	(1)	T/B
Qty 2 - 250	XT4S	100	100			•		1.5	(1)	T/B
Qty 2 - 250	XT4V			65	65	•		1.5	(1)	T/B
600	XT5H		65	65		•		2	(1)	T/B
600	XT5L		100	65/100	65	•		2	(1)	T/B
600	XT5N	65	65			•		2	(1)	T/B
600	XT5S	100	42/100	42		•		2	(1)	T/B
1200	XT7H	100	65/100	65			•	6.5	(3)	T/B
1200	XT7L		100	65/100	65		•	6.5	(3)	T/B
1200	XT7S	65	65				•	6.5	(3)	T/B
PowerBreak II insulated-case circuit breaker with EntelliGuard G trip unit										
800	SSF/SHF	65		65	42		•	6 (24W)		
1200	SSF/SHF	65		65	42		•	6 (24W)		
1600	SSF/SHF	65/100		65/100	42/65		•	6 (30W)		
2000	SSF/SHF	65/100		65/100	42/65		•	6 (30W)		
2500	SSF/SHF	65/100		65/100	42/65		•	6 (36W)		
800	SSD	65		65	42	•		6 (30W)		
1600	SSD	65		65	42	•		6 (30W)		
2000	SSD	65		65	42	•		6 (30W)		
SACE Emax2 air circuit breaker with Ekip trip unit (UL1066; 2500A-3200A main bus only)										
800	E2.2	65/100		65/100	65/85	D/F		24W x 30D	(3)	T/B
1200	E2.2	65/100		65/100	65/85	D/F		24W x 30D	(3)	T/B
1600	E2.2	65/100		65/100	65/85	D/F		24W x 30D	(3)	T/B
2000	E2.2	65/100		65/100	65/85	D/F		30W x 30D	(3)	T/B
800	E4.2	100		100	100	D/F		24W x 30D	(3)	T/B
1600	E4.2	100		100	100	D/F		24W x 30D	(3)	T/B
2000	E4.2	100		100	100	D/F		30W x 30D	(3)	T/B

1. When the unit is accessorized the unit height and form of connection will vary
2. 6" units are available with horizontal handle
3. Requires full depth of enclosure; (20" deep minimum) and full section height unit

Table 20: AFM circuit breaker feeders – standard selection

Amperes (up to)	Circuit breaker type	Interrupting rating RMS Amps (in thousands)				Construction	Minimum unit size (inches)	Space units
		Volts						
		208	240	480	600	Stab-in		
SACE®Tmax® XT Molded Case Circuit Breaker								
125	XT2H	65	65	65		•	12	
125	XT2L	100	100	100		•	12	
125	XT2V			42	42	•	12	
250	XT4H		65	65		•	12	
250	XT4L		100	100		•	12	
250	XT4N	65	65			•	12	
250	XT4S	100	100			•	12	
250	XT4V			65	65	•	12	

Table 21: Accessories for mains and feeders

Circuit breaker	Accessories				
	Bell alarm	Auxiliary switch	Shunt trip	Undervoltage release	RELT
Power Break II	•	Up to 12	•	•	•
HPC II	•	Up to 12	•	•	•
SACE Emax2 (E2.2/E4.2)	•	Up to 25	•	•	•
SACE®Tmax® XT	• ⁽¹⁾	Up to 3 ⁽²⁾ Up to 4 ⁽³⁾	• ⁽⁴⁾	•	X ⁽⁵⁾

- 1. 250 V AC/DC
- 2. Available in XT2 - XT5
- 3. Available in XT7
- 4. 12-250 V DC 24-500 V AC
- 5. Only offered with XT5 and XT7

Table 22: Terminals for field wiring mains and feeders

Circuit breakers	Lugs per Phase	Cables per lug	Will accept wire	
			AWG/kcmil	Material
XT2	1	1	10 - 1/0	Cu-Al
XT4	1	1	10 - 250	Cu-Al
XT5	1	2	1/0 - 500	Cu-Al
XT7	1	4	350 - 500	Cu-Al

Terminal size	Will accept wire ⁽²⁾	
	AWG/kcmil ⁽¹⁾	Material
Switches		
HPC II switch — 800-1600 A	300-750	Cu
	300-800	Al

- 1. Conductor #1 and smaller may be noted 60/75°C
Conductors #0 and larger must be rated 75°C
- 2. Conductor sizes based on 1/Ph unless otherwise indicated

Accessories for high pressure contact (HPC) switches

- Motor operator mechanism
- Remote close
- Undervoltage release
- Shunt trip with lockout
- Bell alarm—alarm only
- Bell alarm with lockout
- Auxiliary switch module
- Mechanical counter
- Key interlock mounting provision
- Push button cover
- Door interlock
- Blown fuse protector

Key interlocking

Provisions for key interlocking can be provided on all circuit breakers over 250 A. The standard key lock is by Superior Lock Corporation for molded case breakers. Kirk lock is standard for Emax 2. When coordination between molded case breakers and EMax 2 is required, it is recommended to use Kirk key locking for both. The following information is required when lock coordination is to be provided with other up-stream or down-stream devices remote from the motor control center:

PURCHASED BY _____
 ULTIMATE USER _____
 DESTINATION _____
 LOCK MANUFACTURER _____
 LOCK NUMBER _____
 PURCHASE ORDER NUMBER _____

NOTICE **Notice:** Minimum 24 inches high units are required for key interlocking. UL listed option.

Ground fault protection

Two types of UL listed ground fault protection can be provided as an option with feeder and main circuit breakers. A shunt trip device is required in the circuit breaker to trip the breaker if a ground fault should occur. BGFL ground break protective relaying is recommended for main breaker application. Model #252 ground fault relaying is recommended for most feeder applications. See "Components" section for description of both ground fault relay types. A minimum of 12 inches additional space height is required in addition to the standard space height shown for each main feeder unit.

A separate 120 Vac source for the shunt trip circuit will decrease the additional space required. Refer to page 164-165 for application help.

Incoming line terminations

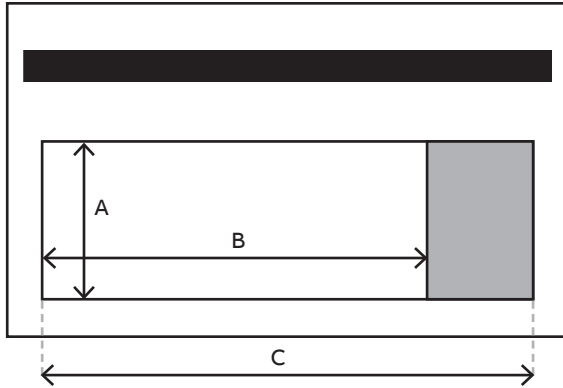
The following cable terminal compartments are commonly specified for use in motor control center construction where the main AC power disconnect is located upstream of the motor control center. For other custom cable termination arrangements contact an ABB sales representative. The number of cables indicated must not be exceeded to maintain the short-circuit rating.

Table 23: Incoming line cable assemblies

Incoming line cable assemblies	MLO space in inches / vertical space available		Cables/lug ⁽³⁾	Cables/phase	Cable range per NEMA bending ⁽⁷⁾	Minimum width and depth	Top feed conduit space top bottom (Figure 1)
	Top	Bottom					
600 A Std. lug ⁽⁴⁾⁽⁵⁾	18/66		2	2	#2-350 kcmil	20"x13"	5"x13.7" A-B
	18/66		3	3	#6-300 kcmil	20"x13"	5"x13.7" A-B
		24/54	2	2	#2-600 kcmil	20"x13"	5"x13.7" A-B
		24/54	3	3	#2-500 kcmil	20"x13"	5"x13.7" A-B
		30/48	1	2	#2-600 kcmil	20"x13"	5"x13.7" A-B
600 A NEMA lug ⁽²⁾	18/66		1	2	#2-350 kcmil	20"x13"	5"x13.7" A-B
		30/48	1	2	#2-600 kcmil	20"x13"	5"x13.7" A-B
800 A/1200 A Std. lug ⁽¹⁾⁽⁴⁾	24/60	24/54	4	4	#2-500 kcmil	20"x13"	5"x13.7" A-B
	24/60	24/54	3	3	#2-600 kcmil	20"x13"	5"x13.7" A-B
	30/54	24/54	4	4	#2-600 kcmil	20"x13"	5"x13.7" A-B
800 A/1200 A NEMA lug		30/48 ⁽⁶⁾	1	4	500-750kcmil	24"x13"	5"x13.7" A-B
	36/58	36/42	1	4	500-1000kcmil	24"x13"	5"x13.7" A-B
1600 A NEMA lug	72/0	72/0	1	8	500-1000kcmil	30"x30"	13"x17.7" A-C
2000 A NEMA lug ⁽²⁾⁽⁴⁾	72/0	72/0	1	8	500-1000kcmil	30"x30"	13"x17.7" A-C
2500 A NEMA lug ⁽²⁾⁽⁴⁾	72/0	72/0	1	10	500-1000kcmil	36"x30"	13"x17.7" A-C
2500 A without fans	72/0	72/0	1	12	500-1000kcmil	36"x30"	13"x27.6" A-C
3200 A	72/0	72/0	1	12	500-1000kcmil	36"x30"	13"x27.6" A-C

1. Space shown above is for 20-inch deep design 800 A to 1200 A MLO
2. Burndy type YA crimp lugs is available as an option. Crimp Lugs require NEMA drilling and NEMA Lug spacing
3. Mechanical compression Cu/Al Lugs furnished for 75°C cable
4. Cu/Al standard. Copper only lugs are available as an option. These may affect number of cables per lug
5. NEMA wire bending rules reduce cable size if entry is from the side
6. 13-inch deep requires full section no vertical bus
7. Lug cable range may be larger than the NEMA bending allows above

34 Figure 1



34

Busway entrances

Motor control centers include provisions for connecting a busway. Busway must be braced for maximum available short circuit current. Minimum enclosure sizes for busway are shown in the adjacent table. Refer to the factory for other type busway. Include busway requisition number when ordering motor control center.

Table 24: Surge Protective Device (SPD)

Tranquell device	Per mode/ phase kA	SCCR (kAIC)	Space unit
ME	65/130	200	2X
ME	80/160	200	2X
HE	125/250	200	2X
HE	150/300	200	2X
HE	200/400	200	2X

Table 25: Spectra series busway

Entry	Pull box	Enclosure size	Max. busway Ampacity			
			Cu		Al	
			Std 1000A/ IN ²	Std 750A/ IN ²	Std 1000A/ IN ²	Std 750A/ IN ²
Top	12"	30"W x 22"D	1600	1500	1350	1000
Bottom		30"W x 22"D	1600	1500	1350	1000
Top	12"	30"W x 22"D	2000	2000	2000	2000
Bottom		30"W x 22"D	2000	2000	2000	2000
Top	12"	36"W x 22"D	2500	2500	2500	2500
Bottom		36"W x 22"D	2500	2500	2500	2500

NOTICE

Notice: Bus bars must be phased front-to-rear in 24 inches width enclosure. Bottom entry requires full section. For busway, refer to factory.

Transitions

Transitions for connecting control centers to transformers, low-voltage switchgear or switchboards are available and generally the same depth as the equipment to which they are to be connected. Appropriate overcurrent protection for the control center must be provided.

Starters

General

Combination motor control starter units consist of an externally operable circuit disconnect and a magnetic starter with an overload relay in the motor lines.

Unit NEMA sizes listed are based on continuous horsepower ratings. The maximum horsepower rating of each NEMA size controller is reduced for long accelerating times and for jogging or plugging duty. Jogging duty is defined as 5 or more contactor openings or closings per minute or over 10 in a 10-minute period. Plugging is rapidly stopping or reversing the motor by reversing the phase sequence of the power supplied to the motor. Refer to the factory anytime accelerating times exceed 10 seconds or jogging or plugging duty is required. Refer to the factory when 'Design E' motors are used, not to be confused with Energy Policy Act (EPAC) motors.

The short-circuit interrupting rating depends on the type of disconnect furnished. Select a starter combination for which the interrupting rating equals or exceeds the maximum available fault current.

Basic combination motor starter units consist of:

1. Externally operable circuit disconnect.
2. Magnetic starter with a thermal-magnetic or electronic overload relay.
3. External overload reset operator.
4. Tapped line voltage, 120 Vac CPT control power or external control power 24 Vdc CPT control power is also available upon request.
5. Pull-apart control terminal boards through NEMA size 5.
6. Pull-apart power terminal boards through NEMA size 2, limited FLA (when BT wiring specified).
7. Extra CPT capacity for operating auxiliary relays and pilot devices (when specified).
8. Plug-in construction through NEMA size 5 (FVNR) starters. Bolt-in construction may require vertical bus modifications.

Basic starter units are provided in tables in this section. Starters are listed by starter function, line voltage, HP, NEMA size, and combination short-circuit rating. Tables in this section also list control power options and other options including any additional space requirements for these options. Typical starter circuits are shown in "Drawings/tests" section. Starters can also be used for lighting or resistive heat loads ("Application data" section).

Arc flash mitigation (AFM) main and starter units

AFM units are a new offering for customers and specific applications where additional protection of personnel is essential. The AFM units were designed around lowering the electrical shock hazards for motor control centers. The AFM unit design includes optional IP20 devices and incidental contact safety barriers in an effort to prevent accidental contact with energized parts during maintenance.

The AFM units are designed to help reduce the likelihood of exposure to electrical shock and the potential of internal arcing faults from occurring during maintenance. The retractable stab mechanism allows for closed-door racking of the unit, providing added protection to the electrical personnel from the dangers of an arc flash occurrence.

A safety interlock prevents customers from opening the unit door and racking out the stab when the unit is energized. The visual indicators on the front of the units provide personnel with a clear view of the status of the stab and vertical bus isolation shutter.

AFM Features:

- Two-position closed-door retractable unit stabs
- Automatic operation vertical bus isolation shutter
- Stab and Shutter position indicators on unit doors
- Padlock for racking screw and stab-breaker interlock
- Optional IP20 safety features and incidental contact barriers
- Stab and Door Interlock: prevents opening the unit door when stab is energized.
- Stab and Unit Interlock: prevents user from taking the unit out when stab is energized, or inserting the unit into the bus when stab is extended
- Racking Screw and Disconnect Interlock: prevents the user from racking the stab in/out of the unit with the disconnect in the "ON" position

For information, please see publication DEA-593.

Selection tables - Circuit breaker type

208 Vac, 60 Hertz – combination motor starters

Table 26: FVNR

NEMA size	Max. Hp	IC (kA)	Frame	Type	Std. Space Unit	Smart Starter Space Unit
1	7.5	65/100	XT2H	Ekip I	0.5	-
1	7.5	65/100	XT2H	Ekip I	1	1
2	10	65/100	XT2H	Mag only	1	1
3	25	65/100	XT2H	Mag only	1.5	1.5
4	40	65/100	XT4H	Mag only	2	2
5	75	65	XT5N	Mag only	3	4
5	75	100	XT5S	Mag only	3	4

Selection tables

Circuit breaker type

Table 27: FVNR AFM

NEMA size	Max. Hp	IC (kA)	Frame	Type	Std. Space Unit	Smart Starter Space Unit
1	7.5	65/100	XT2H	Ekip I	1	1.5
2	10	65/100	XT2H	Mag only	1.5	1.5
3	25	65/100	XT2H	Mag only	2	2
4	40	65/100	XT4H	Mag only	2	2.5
5	75	65	XT5N	Mag only	3.5	-
5	75	100	XT5S	Mag only	3.5	-

Table 28: FVR

NEMA size	Max. Hp	IC (kA)	Frame	Type	Std. Space Unit	Smart Starter Space Unit
1	7.5	65/100	XT2H	Ekip I	1.5	1.5
2	10	65/100	XT2H	Mag only	2	2
3	25	65/100	XT2H	Mag only	3	3
4	40	65/100	XT4H	Mag only	3	3
5	75	65	XT5N	Mag only	4.5	4.5
5	75	100	XT5S	Mag only	4.5	4.5

Table 29: FVR AFM

NEMA size	Max. Hp	IC (kA)	Frame	Type	Std. Space Unit	Smart Starter Space Unit
1	7.5	65/100	XT2H	Ekip I	2	1.5
2	10	65/100	XT2H	Mag only	2	2
3	25	65/100	XT2H	Mag only	3	3
4	40	65/100	XT4H	Mag only	3	3

Table 30: Part winding

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units
1	10	65/100	SEL/SEP	2
2	20	65/100	SEL/SEP	2
3	40	65/100	SFL/SEP	4.5
4	75	100	SGL	5
5				

Table 31: Y-Delta

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units	Notes
2	20	65/100	SEL/SEP	4	
3	40	65/100	SEL/SEP	5	
4	60	100	TGL	5.5	
5	150	100	TGL	5.5	(3)
6	300	100	TGL	5.5	

Table 32: 2S1W, 2S2W

NEMA size	Max. Hp		IC (kA)	Circuit breaker type	Space units	Notes	Rev space units
	Constant variable torque	Constant HP					
4	40	30	25	SFL	4.5		7.5
5	75	60	30	SGL	5		10
6	150	100	65	SGL/SKL	8.5	(3)	
1	7.5	5	65/100	SEL/SEP	2		2.5
2	10	7.5	65/100	SEL/SEP	2		3
3	25	20	65/100	SEL/SEP	4		4.5
4	40	30	65/100	SFL/SFP	4.5		5.5
5	75	60	100	SGL	5.5		10

Table 33: RVAT

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units		Notes
				13" Deep	20" Deep	
4	40	25	SFL	5	4	
5	75	100	SGL		5	
6	150	65	SKL	N/A	12	(1)
2	10	65/100	SEL/SEP	4	4	
3	25	65/100	SEL/SEP	5	4	
4	40	65/100	SEL/SFP	5.5	4.5	
5	75	100	SGL		5	(2)
6	100	65	SKL	N/A	12	(1)

NOTICE

Notice: The space requirements shown in these tables are minimum. Where layout dimensions are critical, refer to factory. One space unit or X unit equals 12 inches of vertical height.

1. Size 6 FVR, RVAT, 2S2W require (2) adjacent 24 inches wide sections, 20 inches deep (2S1W)
2. Refer to factory

Selection tables

Circuit breaker type

230 Vac, 60 Hertz – combination motor starters

Table 34: FVNR

NEMA size	Max. Hp	IC (kA)	Frame	Type	Non-AFM		AFM	
					Std. Space unit	Smart starter space unit	Std. Space unit	Smart starter space unit
1	7.5	65/100	XT2H	Ekip I	0.5	-	-	-
1	7.5	65/100	XT2H	Ekip I	1	1	1	1.5
2	15	65/100	XT2H	Mag only	1	1	1.5	1.5
3	30	65/100	XT2H	Mag only	1.5	1.5	2	2
4	50	65/100	XT4H	Mag only	2	2	2	2.5
5	100	65	XT5N	Mag only	3	4	3.5	-
5	100	100	XT5S	Mag only	3	4	3.5	-

Table 35: FVR

NEMA size	Max. Hp	IC (kA)	Frame	Type	Non-AFM		AFM	
					Std. Space unit	Smart starter space unit	Std. Space unit	Smart starter space unit
1	7.5	65/100	XT2H	Ekip I	1.5	1.5	2	1.5
2	15	65/100	XT2H	Mag only	2	2	2	2
3	30	65/100	XT2H	Mag only	3	3	3	3
4	50	65/100	XT4H	Mag only	3	3	3	3
5	100	65	XT5N	Mag only	4.5	4.5	-	-
5	100	100	XT5S	Mag only	4.5	4.5	-	-

Table 36: Part winding

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units	Notes
1	10	65/100	SEL/SEP	2	
2	25	65/100	SEL/SEP	2	
3	50	65/100	SEL/SEP	4.5	
4	75	100	SGL	5	

Table 37: Y-Delta

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units	Notes
4	75	100	SGL	5.5	⁽¹⁾
2	25	65/100	SEL/SEP	4	
3	50	65/100	SEL/SEP	5	⁽¹⁾
4	75	100	SGL	5.5	⁽¹⁾
5	150	100	SGL	5.5	⁽³⁾

Table 38: 2S1W, 2S2W

NEMA size	Max. Hp		IC (kA)	Circuit breaker type	Space units	Notes	Rev space units
	Constant variable torque	Constant HP					
4	50	40	25	SFL	4.5		5.5
5	100	75	30	SGL	5.5	(2)	10
6	200	150	65	SKL	8.5	(2)	
1	7.5	7.5	65/100	SEL/SEP	2		2.5
2	15	20	65/100	SEL/SEP	2		3
3	30	40	65/100	SEL/SEP	4		4.5
4	50	75	65/100	SFL/SFP	4.5		7.5
5	100	150	100	SGL	5.5	(2)	10

Table 39: RVAT

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units		Notes
				13" Deep	20" Deep	
5	100	100	SGL	N/A	5	
6	200	65	SKL	N/A	12	(2)
2	15	65/100	SEL/SEP	4	4	
3	30	65/100	SEL/SEP	5	4	
4	50	65/100	SFL/SFP	6	4.5	
5	100	100	SGL	N/A	5	

1. Requires 24 inches wide section.
2. Size 6 FVR, RVNR, 2S2W require (2) adjacent 24 inches wide sections, 20 inches deep (2S2W).
3. Refer to factory.
4. A 1/2X compact starter is available.

NOTICE

Notice: The space requirements shown in these tables are minimum. Where layout dimensions are critical, refer to factory. One space unit or X unit equals 12 inches of vertical height.

Selection tables

Circuit breaker type

480 Vac, 60 Hertz – combination motor starters

Table 40: FVNR 480V

NEMA size	Max. Hp	IC (kA)	Frame	Type	Non-AFM		AFM	
					Std. Space unit	Smart starter space unit	Std. Space unit	Smart starter space unit
1	10	65	XT2H	Ekip I	0.5	-	-	-
1	10	100	XT2L	Ekip I	0.5	-	-	-
1	10	65	XT2H	Ekip I	1	1	1	1.5
1	10	100	XT2L	Ekip I	1	1	1	1.5
2	25	65	XT2H	Mag only	1	1	1.5	1.5
2	25	100	XT2L	Mag only	1	1	1.5	1.5
3	50	65	XT2H	Mag only	1.5	1.5	2	2
3	50	100	XT2L	Mag only	1.5	1.5	2	2
4	100	65	XT4H	Mag only	2	2	2	2.5
4	100	100	XT4L	Mag only	2	2	2	2.5
5	200	65	XT5H	Mag only	3	4	3.5	-
5	200	100	XT5L	Mag only	3	4	3.5	-

Table 41: FVR 480V

NEMA size	Max. Hp	IC (kA)	Frame	Type	Non-AFM		AFM	
					Std. Space unit	Smart starter space unit	Std. Space unit	Smart starter space unit
1	10	65	XT2H	Ekip I	1.5	1.5	2	1.5
1	10	100	XT2L	Ekip I	1.5	1.5	2	1.5
2	25	65	XT2H	Mag only	2	2	2	2
2	25	100	XT2L	Mag only	2	2	2	2
3	50	65	XT2H	Mag only	3	3	3	3
3	50	100	XT2L	Mag only	3	3	3	3
4	100	65	XT4H	Mag only	3	3	3	3
4	100	100	XT4L	Mag only	3	3	3	3
5	200	65	XT5H	Mag only	4.5	4.5	-	-
5	200	100	XT5L	Mag only	4.5	4.5	-	-
5	200	50	XT5S	Mag only	4.5	4.5	-	-

Table 42: Part winding

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units	Notes
4	150	10	SGL	4.5	
5					(4)
1	15	65/100	SEL/SEP	2	
2	40	65/100	SEL/SEP	2	
3	75	65/100	SEL/SEP	4.5	
4	150	100	SGL	5	
5					(4)

Table 43: Y-Delta, OT

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units	Notes
2	40	25/65	SE	3	
3	75	25/65	SGL	3.5	(1)
4	150	65	SGL	4.5	(1)
5	300	65	SGL	5	

Table 44: 2S1W, 2S2W

NEMA size	Max. Hp		IC (kA)	Circuit breaker type	Space units	Notes	Rev space units
	Constant variable torque	Constant HP					
4	100	75	25	SFL	4.5		5.5
5	200	150	30	TJC	6	(1)(2)	10
6	400	300	65	SKL	12	(2)	
1	10	7.5	65/100	SEL/SEP	1.5		2.5
2	25	20	65/100	SEL/SEP	2		3
3	50	40	65/100	SEL/SEP	4		4.5
4	100	75	65/100	SFL/SFP	4.5		7.5
5	200	150	100	SGL	6	(1)(2)	10

Table 45: RVAT

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units		Notes
				13" deep	20" deep	
5	200	100	SGL		5	(3)
6	400	65	SKL	N/A	12	(2)
2	25	65/100	SEL/SEP	4	4	
3	50	65/100	SEL/SEP	5	4	
4	100	65/100	SEL/SEP	6	4.5	
5	200	100	SGL	N/A	5	(3)

- Requires 24 inches wide section.
- Size 6 FVR, RVAT, 2S2W require (2) adjacent 24 inches wide sections, 20 inches deep (2S1W not available).
- Size 5 RVAT cannot be mounted in 13 inches deep enclosure.
- Refer to factory.
- A 1/2X compact starter is available.

NOTICE

Notice: The space requirements shown in these tables are minimum. Where layout dimensions are critical, refer to factory. One space unit or X unit equals 12 inches of vertical height.

Selection tables
Circuit breaker type

600 Vac, 60 Hertz – combination motor starters

Table 46: FVNR

NEMA size	Max. Hp	IC (kA)	Frame	Type	Non-AFM		AFM	
					Std. Space unit	Smart starter space unit	Std. Space unit	Smart starter space unit
1	5	42	XT2V	Ekip I	0.5	-	-	-
1	5	42	XT2	Ekip I	0.5	N/A	N/A	N/A
1	10	50	XT4L	Ekip I	1	1.5	1	1.5
2	25	50	XT4L	Ekip I	1	1.5	1.5	1.5
3	50	50	XT4L	Mag only	1.5	1.5	2	2
4	100	50	XT4L	Mag only	2	2	2	2.5
5	200	65	XT5L	Mag only	3	4	3.5	-

Table 47: FVR

NEMA size	Max. Hp	IC (kA)	Frame	Type	Non-AFM		AFM	
					Std. Space unit	Smart starter space unit	Std. Space unit	Smart starter space unit
1	10	50	XT4L	Ekip I	1.5	1.5	2	1.5
2	25	50	XT4L	Ekip I	2	2	2	2
3	50	50	XT4L	Mag only	3	3	3	3
4	100	50	XT4L	Mag only	3	3	3	3
5	200	65	XT5L	Mag only	4.5	4.5	-	-

Table 48: Part winding

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units	Notes
1	15	25	SEL	2	
2	40	25	SEL	2	
3	75	25	SEL	4.5	
4	150	10	SGL	5	
4	150	42	SGL	5	

Table 49: Y-Delta, OT

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units	Notes
2	40	25	SEL	3	
3	75	25	SEL	3.5	(1)
4	100	25	SEL	4.5	(1)
4	150	100	SGL	5	(1)
4	150	42	SGL	5	(1)

Table 50: 2S1W, 2S2W

NEMA size	Max. Hp		IC (kA)	Circuit breaker type	Space units	Notes	Rev Space units
	Constant variable torque	Constant HP					
1	10	7.5	25	SEL	2		2.5
2	25	20	25	SEL	2		3
3	50	40	25	SEL	4		4.5
4	100	75	25	SFL	5		7.5
5	200	150	22	SGL	5.5	⁽¹⁾ ⁽²⁾	10
6	400	300	42	SKL	8.5	⁽²⁾	

Table 51: RVAT

NEMA size	Max. Hp	IC (kA)	Circuit breaker type	Space units		Notes
				13" Deep	20" Deep	
2	25	25	SEL	4	4	
3	50	25	SEL	5	4	
4	100	25	SFL	6	4.5	
5	200	65	SGL	5	4.5	
6	400	42	SKL	N/A	12	⁽²⁾
5	200	100	SGL	N/A	5	
6	400	42	SKL	N/A	11	⁽²⁾

1. Requires 24 inches wide section
2. Size 6 FVR, RVAT, 2S2W require (2) adjacent 20 and 24 inches wide sections, 20 inches deep (2S1W)
3. Refer to factory

NOTICE

Notice: The space requirements shown in these tables are minimum. Where layout dimensions are critical, refer to factory. One space unit or X unit equals 12 inches of vertical height.

Table 52: Starter options

Option	Function	Additional space required
Control transformer	Provides control power. See "Control Transformer" for details	—
CPT primary fuses	Class CC fuse wired in each ungrounded transformer primary conductor	—
CPT secondary fuse	One midget fuse (typical Gould Ferraz type TRM) wired in ungrounded Control Power Conductor	—
Control power fuse	One Class CC fuse wired in each ungrounded control power conductor. Use when control power source is remote from unit	—
Starter overload protection	For more information see "Application data" section	—
Pilot lights	30mm type	—
Full voltage	Red—ON FAST, FWD, UP Amber—DOWN, REV, SLOW Green—STOPPED, READY	—
Transformer	30mm with 6V lamp (See full voltage lights for lens colors)	—
LED	30mm Type transformer type with 6V LED Lamp	—
Push-to-test	30mm, Full-voltage transformer type, or LED (See full-voltage lights for lens colors)	—
Push buttons	30mm momentary type-use	—
Start-stop	with FVNR starters with 3-wire control	—
Stop	30mm momentary type-provides stop function at MCC with 3-wire control	—
Stop	30mm maintained type-provides stop function at MCC with 2/3 wire control. Can be furnished with mushroom head and provision for locking open	—
Fwd, Rev, Stop	30mm momentary type-use with FVR starters	—
Fast, Slow, Stop	30mm momentary type-use with 2-speed starters	—

Table 52: Starter options (continued)

Option	Function	Additional space required
Selector switches	30 mm maintained type—use as permissive start with 2 or 3 on-off wire control	—
Hand-off-auto	30 mm maintained type—use to select auto or manual start with 2-wire control	—
Fast-slow-off-auto	30 mm maintained type—use with 2-speed starters	—
Fixed control TB	Stationery control terminal boards in place of split type terminal boards	—
Power TB	Split type terminal blocks on NEMA size 1 and 2	—
Control disconnect	High density pull-apart TB will provide foreign voltage isolation without disengaging the unit vertical bus stabs	—
Control relay	Rated 600 V, with 10 A contacts. Relays are available with normally open and normally closed non-convertible contacts. Up to four additional contact blocks can be added to basic 4 pole relay. Size 1 and Size 2 FVNR starters require an additional half-space unit for three to four relays. Two relays can be added with no increase in Space units	Yes
Timing relays pneumatic	.3 to 3 seconds or 10 to 180 seconds timing range. 10 A contacts. 4 INST and 2 TD interlocks (NO and NC)	Yes
Timing relays electronic	Time-delay on energization/de-energization double pole, double throw contacts rated 600 V, 10 A. Timing ranges 1-10 or 10-300 seconds	—

NOTICE

Notice: Please note that if multiple options are selected, there may be sizing impact due to the combination of additional options.

Table 52: Starter options (continued)

Option	Function	Additional space required
Motor driven	Used for long timing periods. Specify timing range	1/2X
Accelerating relay	Timing relay for multi-speed motors to provide definite accelerating time for each speed above first speed. Time interval is adjustable .3 to 30 seconds. Alternate Electronic Timer	
Decelerating relay	Timing relay allows time for motor to coast stop before permitting restart or coast to a lower speed on multi-speed motors before initiating slow speed operation (2-speed motors). Time interval is adjustable .3 to 30 seconds. Alternate Electronic Timer	
Compelling relays	On multi-speed starters, requires the controller to progress in sequence from low to high speed. One relay is required for each speed over one. Alternate Electronic Timer	
Latch relay	Once relay closes, mechanical latch holds relay closed until electrically reset	
Fused switch auxiliary interlock	2-10A auxiliary interlocks operated by disconnect operator Max. (2NO, or 1NO and 1NC)	—
Q (open/closed)	Status of CB power contacts	
SY (Trip)	Signals that the CB is opening due to the intervention of the trip unit	
S51 (Trip Unit Tripping)	Indicates that one of the protection functions of the electronic or thermal-magnetic trip unit has tripped	
YO/YU (Tripping)	Indicates that the under voltage or shunt opening release has been activated	
Key interlock above 250A	Added to disconnect operating handle to require a predetermined system operating sequence. Specify operating sequence	—
Ground fault	Zero sequence sensing Ground Fault Relay for equipment protection for NEMA size 2-5 starters	Yes

Table 52: Starter options (continued)

Option	Function	Additional space required
Current transformer	Donut type CT located in one motor phase conductor for purchasers use (Also used for door mounted Ammeter)	Yes
Amp transducer ammeter	Integrated CT/Current transducer with 4-20 MA output. (Requires 120V Power). AC panel-type, single current transformer operated five-ampere movement. Scale selected based on 125% motor full-load amperes	Yes
Elapsed time meter	Mounts on pushbutton bracket. Meter Visible from front of MCC	
Phase loss/unbalance voltage sensing	APVR used primarily to sense phase loss, unbalance, or reversal, has time delay under-voltage	—
Motor winding heater	The motor winding heater is designed for use with 3-phase ac motors to guard against damage caused by condensation buildup on motor windings which can occur in high humidity environments during motor idle periods. Refer to application data in "Components" section (1X-size 5)	1/2X
Coil suppressor 120V	Surge suppressors reduce undesirable transients in control circuits by absorbing voltage transients generated by operating coils	
Door diagram	Circuit diagram mounted on back of unit door	—
Wire markers	Permanent wire number identification on each control wire. Tube type standard, heat shrink optional	—
Provision for PFC capacitor	Terminals located between contactor and OL relay	

Product information

Undervoltage protection

Standard starters drop out when line voltage drops below approximately 65 percent rated volts and can be reclosed when voltage returns to 85 percent rated volts. Where momentary contact devices are used in standard three-wire control circuits, the starter will not reclose on momentary loss of voltage until the START button is pushed, thus inherently providing undervoltage protection.

If a maintained contact device, such as a float switch, is used to start the motor, the starter will close automatically upon restoration of control voltage. In some cases, this may not be desirable for safety reasons, and a reset pushbutton and auxiliary relay should be specified to provide undervoltage protection.

Overload relays

Standard relays are three-leg block bimetallic type with adjustment from 90 to 110 percent of the heater rating. A single calibration adjusts all three legs. A single reset button mounted on the starter door permits external reset. Ambient-compensated relays are available for ambients from -30 °C to +80 °C and have adjustment from 90 to 110 percent of normal rating. Improved protection is provided when the motor is in a relatively constant ambient but control is subject to varying ambient. Relays are interchangeable with standard type.

Optional electronic overload relay and Motor management relays

Electronic overload relays and electronic overload relays with basic communication functions are available (see page H-12). Advanced motor management relays are also available (see components section for more information).

Control circuit protection

Motor control circuits tapped from the load side of the starter unit disconnect, such as line-to-line control and line-to-neutral control are protected by listed, branch circuit rated fuses in each ungrounded conductor. UL requires rejection type fuses for equipment rated above 10kA short-circuit rating. 6 A, 600 volt Class CC fuses are furnished as standard. Motor control circuit transformers are protected with a fuse in each ungrounded secondary conductor. Secondary fuses are UL Recognized supplementary fuses size per Article 450 of the NEC (20 A maximum).

UL required primary transformer protection in accordance with NEC Article 430.72(c) and Article 450 fuses are furnished in each ungrounded primary conductor. Motor control circuit power, other than power tapped from the load side of the starter unit disconnect, should be protected against overcurrent. The protective device may be located at the source or by the optional fuse(s) located in each unit. Normally, one (Class CC) fuse in the ungrounded conductor will provide the needed protection. Where wiring external to the motor control center is indicated, No. 14 AWG copper will be assumed as the minimum conductor size unless otherwise specified.

Long control circuits

On exceedingly long control circuits two problems may occur – (1) starter will not close due to line voltage drop and (2) starter may not open due to capacitive coupling. Table below gives the one-way distances (in feet) from the starter to the pushbutton along the route of the control cable. This table is for 120 volt coils and allows for a maximum voltage variation of 10 percent. The distances are given for #14 and #12 AWG control wire.

Table 53: Long control circuits

NEMA size	Distance in feet with #14 wire	Distance in feet with #12 wire
1	1300	2070
2	460	730
3	320	510
4	250	395
1-6 ⁽¹⁾	5000	6000

1. Distance based on using an interposing relay, type C2000

Separate source control circuits

A separate control bus is available as an option. This bus can be fed from a separate external source, or from within the motor control center by a separate distribution transformer or distribution panel. A normally open auxiliary contact should be specified on each unit disconnect to open the control bus circuit when the unit disconnect is opened. Unit control circuit fusing should also be added.

In lieu of the auxiliary disconnect contact, pull-apart terminal boards may be specified to provide control voltage isolation for individual starters.

Pilot devices

Pushbuttons, selector switches, pilot lights, etc., are single-unit, heavy-duty oil-tight type mounted on the starter unit door.

Auxiliary contact ratings

Table 54: NEMA size 1-6

AC Vac	Amperes		
	Continuous	Make	Break
115	10	60	6.0
230	10	30	3.0
460	10	15	1.5
575	10	12	1.2
DC Vac			
125	10	—	1.1
250	10	—	0.5

Starter auxiliary contacts (option)

Auxiliary contacts rated 10 amperes, 600 volts are available, either normally open or closed (non-convertible). Quantities of contacts shown are maximum available and include starter requirements for cross-electrical interlocking and holding circuits. If more contacts are required than shown, a relay must be added.

Table 55: Optional starter aux contacts

Starter type	Total control contacts available (includes contacts required in basic control circuit for seal-in, cross interlocking, etc.)					
	NEMA size Starter					
	1	2	3	4	5	6
Full-voltage, nonreversing (FVNR)	5	6 ⁽²⁾	6	6	6	6
Full voltage, reversing (FVR)						
Forward contactor	4	4	4	4	4	4
Reverse contactor	4	4	4	4	4	4
Two-speed, one winding (251W) ¹						
Low-speed contactor	4	4	4	4	4	5
High-speed contactor	3	4	4	4	4	5
Two-speed, two winding (252W)						
Low-speed contactor	4	4	4	4	4	5
High-speed contactor	4	4	4	4	4	5
Part winding						
Run contactor	5	6	6	6	6	6
Autotransformer, reduced-voltage						
Run contactor		6	6	6	6	6

Control terminals

The table below lists the maximum number of high density control terminals available on standard heights units. See standard diagrams in "Typical circuits" section for number of control terminals required for standard starters. Note that the total number of control points are in addition to T1, T2 and T3 power terminal points.

Table 56: Control terminals

Starter function	Size 1 CB	Size 2 CB	Size 3 CB	Size 4 CB	Size 5 CB
FVNR	18	18	18	36	18
FVR	18	18	18	18	18
2S1W	24	36	48	48	48
2S2W	24	36	48	48	48

CB = Circuit breaker.

Control transformers

Power is tapped from the load side of the starter unit disconnect and the transformer provides 120 volt power. Two 600 volt primary fuses, plus one 250 volt secondary fuse in the ungrounded conductor is standard.

Standard control power transformer ratings are adequate to handle the starter-coil current and three pilot lights. If additional burdens are expected, larger transformers should be specified.

Table 57: CPTs

Starter Size	CPT Std. VA	CPT Max. VA
	60 Hz	60 Hz
Size 1	60	300
Size 2	150	300
Size 3	250	300
Size 4	250	300
Size 5	100	500

Table 58: Coil characteristics

Size	Type	Inrush VA	Sealed VA
Size 1	FVNR, FVR	151	23
Size 2	FVNR, FVR	528	60
Size 3	FVNR, FVR	1152	83
Size 4	FVNR, FVR	1248	87
Size 5	FVNR, FVR	2580	191
Size 2	2S1W	576	75
Size 3	2S1W	1248	87
Size 4	2S1W	1336	95
Relay for size 3 and 4	RVAT	55	9
Relay for size 5	FVNR, FVR	55	9
Relay for FVNR size 5 and 6		55	9

Table 59: 300 line standard coil data

Size	Coil	Amps 120V	Amps 480V	VA	Watts	Vars	PF	% Vac			Millisec
								P/U	D/O	P/U	D/O
1	Inrush	1.26	.33	151	69.5	134	.46	85	63	15 to 30	7 to 15
	Holding	.2	.55	24	6	23	.25				
2	Inrush	4.4	1.2	528	169	500	.32	85	68	20 to 40	7 to 15
	Holding	.5	.14	60	12.9	57.9	.26				
3	Inrush	9.6	2.6	1152	230	1129	.20	85	65	20 to 45	7 to 15
	Holding	.69	.18	83	18.4	81.5	.19				
4	Inrush	10.4	2.8	1248	262	1220	.21	85	65	20 to 45	7 to 15
	Holding	.73	.2	87	18.8	84.8	.22				
5	Inrush	21.5	5.7	2580	464	2538	.18	85	65	30 to 50	15 to 25
	Holding	1.6	.42	191	38.8	185	.25				
6	Inrush	28.1	7.6	3360	608	3325	.18	85	65	30 to 50	15 to 25
	Holding	2.1	.58	255	44	246	.25				

1. For constant- or variable-torque motors
2. Limit 4 with APVR relay
3. Refer to Company for part-winding and Y-delta starters
4. Starter coils operated at line voltage. Starters operated by control relay in 120 Vac control circuit. Class CC fuses are provided for starter coil circuit
5. Without increasing standard unit space requirements for size 1 to 4, over size CPT in size 5 will add 6 inches
6. 1/2X FVNR uses a 100VA CPT

Thermal magnetic circuit breaker substitution

Substituting a thermal-magnetic circuit breaker in place of a Mag-Break® circuit breaker may require increasing the circuit breaker trip rating to avoid tripping on starting. See "Application data" section for recommended thermal-magnetic circuit breaker trip ratings.

Table 60: Terminals for field wiring

Description	Will accept wire ⁽¹⁾	
	AWG/MCM	Material
Starterload terminals		
Size 1 Starter	14-8	Cu
Size 2 Starter	14-4	Cu
Size 3 Starter	8-1/0	Cu
Size 4 Starter	4-3/0	Cu
Size 5 Starter	(2) 2/0-400	Cu
Control terminal boards		
Hi density pull-apart	(2) 12 Max.	Cu
Power terminal boards		
50 Amp size 1 and 2 type C wiring	14-6 ⁽²⁾	Cu

1. Conductors #1 and smaller may be rated 60/75°C. Conductors #1/0 and larger must be rated 75°C. Conductors wired directly to OL device terminals must be rated 75°C Cu
2. #6 only with ring terminal

Miscellaneous units

Operator and metering panels

Unit spaces can be used to provide metering and/or operator's panels in the motor control center itself. Arrangement and dimensions will vary depending on the quantity and type of the devices required. Normally, fuse blocks, terminal blocks (T.B.s), current and potential transformers, etc., can be mounted on a base within the unit space.

Meters, pilot lights, pushbuttons, switches, etc., can be mounted on the door. Suitable locations and adequate space should be provided so that wiring is simplified and there is no interference between door and base mounted components.

The following devices are often specified:

- Pushbuttons, selector switches, pilot lights;
- Ammeters, voltmeters and other instruments (switchboard type);
- Instrument and transfer switches;
- Electronic power meter;
- Control relays;
- Timing relays (pneumatic, motor-operated or electronic);
- Protection relays;
- Alternator relays.

These panels will be UL labeled providing all the components are UL listed for use in motor control centers.

Relay panels

Relay panels can be furnished from 1 space unit to 6 Space units with full width doors. The amount of vertical space required is generally determined by the number of terminal board points required or relay type used; when in doubt allow for a double vertical row of terminal boards.

These panels will be UL labeled providing all the components are UL listed for use in motor control centers.

Alternator relay panels

Consists of two motor alternator circuit using two control relays and a latching relay. Requires minimum 1 space unit height.

Mounting plates

Blank plates are available for customer use when field mounting a PLC and/or relays. All plates come with mounting screws and door. Full height dish plates come with top horizontal bus barrier.

Table 61: Sizing chart

Space units	Single vertical row of T.B.s				Double vertical row of T.B.s		
	Maximum no. of T.B. points	Horizontal width for component mounting	Maximum no. of std. 4-pole relays	Maximum no. of T.B. points	Horizontal width for component mounting	Maximum no. of std. 4-pole relays	
							Section width 20"W
1	12	11 1/2"	6	24	6"	3	
1 1/2	24	11 1/2"	12	48	6"	6	
2	30	11 1/2"	18	60	6"	9	
2 1/2	42	11 1/2"	24	84	6"	12	
3	48	11 1/2"	36	96	6"	18	
3 1/2	60	11 1/2"	42	120	6"	21	
4	72	11 1/2"	48	144	6"	24	
4 1/2	78	11 1/2"	54	156	6"	27	
5	90	11 1/2"	60	180	6"	30	
5 1/2	96	11 1/2"	66	192	6"	33	
6	108	11 1/2"	72	216	6"	36	

T.B.s or relays for size estimating only.

Table 62: Mounting plates

Description	Min. enclosure depth (inches)	Mounting plate dimensions (inches)		Part number		
		Width	Height			
Over vertical bus, 9.5" from door	13	15	12	110C1040MDG1		
			18	110C1040MDG2		
			24	110C1040MDG3		
			30	110C1040MDG4		
			36	110C1040MDG5		
			42	110C1040MDG6		
			48	110C1040MDG7		
	20	20	12	110C1040MDG8		
			18	110C1040MDG9		
			24	110C1040MDG10		
			30	110C1040MDG11		
			36	110C1040MDG12		
			42	110C1040MDG13		
			48	110C1040MDG14		
			54	110C1040MDG15		
			60	110C1040MDG16		
			66	110C1040MDG17		
			72	110C1040MDG18		
			24	24	12	110C1040MDG19
					18	110C1040MDG20
24	110C1040MDG21					
30	110C1040MDG22					
36	110C1040MDG23					
42	110C1040MDG24					
48	110C1040MDG25					
54	110C1040MDG26					
60	110C1040MDG27					
66	110C1040MDG28					
30	30	12	110C1040MDG29			
		18	110C1040MDG30			
		24	110C1040MDG31			
		30	110C1040MDG32			
		36	110C1040MDG33			
		42	110C1040MDG34			
		48	110C1040MDG35			
		54	110C1040MDG36			
		60	110C1040MDG37			
		66	110C1040MDG38			
		72	110C1040MDG39			
		Dished mounting plate, No bus, 13.5" from door	20	20	12	110C1040MDG40
18	110C1040MDG41					
24	110C1040MDG42					
30	110C1040MDG43					
36	110C1040MDG44					
42	110C1040MDG45					
48	110C1040MDG46					
54	110C1040MDG47					
60	110C1040MDG48					
66	110C1040MDG49					
72	110C1040MDG50					
72	110C1040MDG51					

Table 62: Mounting plates (continued)

Description	Min. enclosure depth (inches)	Mounting plate dimensions (inches)		Part number		
		Width	Height			
Dished mounting plate, no bus, 13.5" from door	20	24	12	110C1040MDG52		
			18	110C1040MDG53		
			24	110C1040MDG54		
			30	110C1040MDG55		
			36	110C1040MDG56		
			42	110C1040MDG57		
			48	110C1040MDG58		
			54	110C1040MDG59		
			60	110C1040MDG60		
			66	110C1040MDG61		
			72	110C1040MDG62		
			30	30	12	110C1040MDG63
					18	110C1040MDG64
					24	110C1040MDG65
					30	110C1040MDG66
					36	110C1040MDG67
					42	110C1040MDG68
Dished Mounting Plate, no Bus, 15.5" from door	20	20	48	110C1040MDG69		
			54	110C1040MDG70		
			60	110C1040MDG71		
			66	110C1040MDG72		
			72	110C1040MDG73		
			12	110C1040MDG74		
			18	110C1040MDG75		
			24	110C1040MDG76		
			30	110C1040MDG77		
			36	110C1040MDG78		
24	24	42	110C1040MDG79			
		48	110C1040MDG80			
		54	110C1040MDG81			
		60	110C1040MDG82			
		66	110C1040MDG83			
		72	110C1040MDG84			
		12	110C1040MDG85			
		18	110C1040MDG86			
		24	110C1040MDG87			
		30	110C1040MDG88			
		36	110C1040MDG89			
		42	110C1040MDG90			
48	110C1040MDG91					
54	110C1040MDG92					
60	110C1040MDG93					
66	110C1040MDG94					
72	110C1040MDG95					

Table 62: Mounting plates (continued)

Description	Min. enclosure depth (inches)	Mounting plate dimensions (inches)		Part number
		Width	Height	
Dished mounting plate, no bus, 15.5" from door	20	30	12	110C1040MDG96
			18	110C1040MDG97
			24	110C1040MDG98
			30	110C1040MDG99
			36	110C1040MDG100
			42	110C1040MDG101
			48	110C1040MDG102
			54	110C1040MDG103
			60	110C1040MDG104
			66	110C1040MDG105
Dished mounting plate, no bus, 17.5" from door	20	20	12	110C1040MDG107
			18	110C1040MDG108
			24	110C1040MDG109
			30	110C1040MDG110
			36	110C1040MDG111
			42	110C1040MDG112
			48	110C1040MDG113
			54	110C1040MDG114
			60	110C1040MDG115
			66	110C1040MDG116
			72	110C1040MDG106
			12	110C1040MDG117
			18	110C1040MDG118
			24	110C1040MDG119
			30	110C1040MDG120
			36	110C1040MDG121
			42	110C1040MDG122
			48	110C1040MDG123
			54	110C1040MDG124
			60	110C1040MDG125
		24	66	110C1040MDG126
			72	110C1040MDG127
			12	110C1040MDG128
			18	110C1040MDG129
			24	110C1040MDG130
			30	110C1040MDG131
			36	110C1040MDG132
			42	110C1040MDG133
			48	110C1040MDG134
			54	110C1040MDG135
		30	60	110C1040MDG136
			66	110C1040MDG137
			72	110C1040MDG138
			12	110C1040MDG139
			18	110C1040MDG140
			24	110C1040MDG141
			30	110C1040MDG142
			36	110C1040MDG143
			42	110C1040MDG144
			48	110C1040MDG145
Dished mounting plate, no bus, 18.5" from door	20	20	54	110C1040MDG146
			60	110C1040MDG147
			66	110C1040MDG148
			72	110C1040MDG149
			12	110C1040MDG150
			18	110C1040MDG151
			24	110C1040MDG152
			30	110C1040MDG153
			36	110C1040MDG154
			42	110C1040MDG155
			48	110C1040MDG156
			54	110C1040MDG157
			60	110C1040MDG158
			66	110C1040MDG159
			72	110C1040MDG160
			12	110C1040MDG161
			18	110C1040MDG162
			24	110C1040MDG163
			30	110C1040MDG164
			36	110C1040MDG165
		30	42	110C1040MDG166
			48	110C1040MDG167
			54	110C1040MDG168
			60	110C1040MDG169
			66	110C1040MDG170
			72	110C1040MDG171
			12	110C1040MDG172
			18	110C1040MDG173
			24	110C1040MDG174
			30	110C1040MDG175
36	110C1040MDG176			
			42	110C1040MDG177
			48	110C1040MDG178
			54	110C1040MDG179
			60	110C1040MDG180
			66	110C1040MDG181
			72	110C1040MDG182
			12	110C1040MDG183
			18	110C1040MDG184
			24	110C1040MDG185
			30	110C1040MDG186
36	110C1040MDG187			
			42	110C1040MDG188
			48	110C1040MDG189
			54	110C1040MDG190
			60	110C1040MDG191
			66	110C1040MDG192
			72	110C1040MDG193
			12	110C1040MDG194
			18	110C1040MDG195
			24	110C1040MDG196
			30	110C1040MDG197
		24	36	110C1040MDG198
			42	110C1040MDG199
			48	110C1040MDG200
			54	110C1040MDG201
			60	110C1040MDG202
			66	110C1040MDG203
			72	110C1040MDG204
			12	110C1040MDG205
			18	110C1040MDG206
			24	110C1040MDG207
Dished mounting plate, no bus, 21" from door	22	20	30	110C1040MDG208
			36	110C1040MDG209
			42	110C1040MDG210
			48	110C1040MDG211
			54	110C1040MDG212
			60	110C1040MDG213
			66	110C1040MDG214
			72	110C1040MDG215
			12	110C1040MDG216
			18	110C1040MDG217
			24	110C1040MDG218
			30	110C1040MDG219
			36	110C1040MDG220
			42	110C1040MDG221
			48	110C1040MDG222
			54	110C1040MDG223
			60	110C1040MDG224
			66	110C1040MDG225
			72	110C1040MDG226
			12	110C1040MDG227
		24	18	110C1040MDG228
			24	110C1040MDG229
			30	110C1040MDG230
			36	110C1040MDG231
			42	110C1040MDG232
			48	110C1040MDG233
			54	110C1040MDG234
			60	110C1040MDG235
			66	110C1040MDG236
			72	110C1040MDG237
			12	110C1040MDG238
			18	110C1040MDG239
			24	110C1040MDG240
			30	110C1040MDG241
			36	110C1040MDG242
			42	110C1040MDG243
			48	110C1040MDG244
			54	110C1040MDG245
			60	110C1040MDG246
			66	110C1040MDG247
			72	110C1040MDG248
			12	110C1040MDG249
			18	110C1040MDG250
			24	110C1040MDG251
			30	110C1040MDG252
			36	110C1040MDG253
			42	110C1040MDG254
			48	110C1040MDG255
			54	110C1040MDG256
			60	110C1040MDG257
			66	110C1040MDG258
			72	110C1040MDG259
			12	110C1040MDG260
			18	110C1040MDG261
			24	110C1040MDG262
			30	110C1040MDG263
			36	110C1040MDG264
			42	110C1040MDG265
			48	110C1040MDG266
			54	110C1040MDG267
			60	110C1040MDG268
			66	110C1040MDG269
			72	110C1040MDG270
			12	110C1040MDG271
			18	110C1040MDG272
			24	110C1040MDG273
			30	110C1040MDG274
			36	110C1040MDG275
			42	110C1040MDG276
			48	110C1040MDG277
			54	110C1040MDG278
			60	110C1040MDG279
			66	110C1040MDG280
			72	110C1040MDG281
			12	110C1040MDG282
			18	110C1040MDG283
			24	110C1040MDG284
			30	110C1040MDG285
			36	110C1040MDG286
			42	110C1040MDG287
			48	110C1040MDG288
			54	110C1040MDG289
			60	110C1040MDG290
			66	110C1040MDG291
			72	110C1040MDG292
			12	110C1040MDG293
			18	110C1040MDG294
			24	110C1040MDG295
			30	110C1040MDG296
			36	110C1040MDG297
			42	110C1040MDG298
			48	110C1040MDG299
			54	110C1040MDG300
			60	110C1040MDG301
			66	110C1040MDG302
			72	110C1040MDG303
			12	110C1040MDG304
			18	110C1040MDG305
			24	110C1040MDG306
			30	110C1040MDG307
			36	110C1040MDG308
			42	110C1040MDG309
			48	110C1040MDG310
			54	110C1040MDG311
			60	110C1040MDG312
			66	110C1040MDG313
			72	110C1040MDG314
			12	110C1040MDG315
			18	110C1040MDG316
			24	110C1040MDG317
			30	110C1040MDG318
			36	110C1040MDG319
			42	110C1040MDG320
			48	110C1040MDG321
			54	110C1040MDG322
			60	110C1040MDG323
			66	110C1040MDG324
			72	110C1040MDG325
			12	110C1040MDG326
			18	110C1040MDG327
			24	110C1040MDG328
			30	110C1040MDG329
			36	110C1040MDG330
			42	110C1040MDG331
			48	110C1040MDG332
			54	110C1040MDG333
			60	110C1040MDG334
			66	110C1040MDG335
			72	110C1040MDG336
			12	110C1040MDG337
			18	110C1040MDG338
			24	110C1040MDG339
			30	110C1040MDG340
			36	110C1040MDG341
			42	110C1040MDG342
			48	110C1040MDG343
			54	110C1040MDG344
			60	110C1040MDG345
			66	110C1040MDG346
			72	110C1040MDG347
			12	110C1040MDG348
			18	110C1040MDG349
			24	110C1040MDG350
			30	110C1040MDG351
			36	110C1040MDG352
			42	110C1040MDG353
			48	110C1040MDG354
			54	110C1040MDG355
			60	110C1040MDG356
			66	110C1040MDG357
			72	110C1040MDG358
			12	110C1040MDG359
			18	110C1040MDG360
			24	110C1040MDG361
			30	110C1040MDG362
			36	110C1040MDG363
			42	110C1040MDG364
			48	110C1040MDG365
			54	110C1040MDG366
			60	110C1040MDG367
			66	110C1040MDG368
			72	110C1040MDG369
			12	110C1040MDG370
			18	110C1040MDG371
			24	110C1040MDG372
			30	110C1040MDG373
			36	110C1040MDG374
			42	110C1040MDG375
			48	110C1040MDG376
			54	110C1040MDG377
			60	110C1040MDG378
			66	110C1040MDG379
			72	110C1040MDG380
			12	110C1040MDG381
			18	110C1040MDG382
			24	110C1040MDG383
			30	110C1040MDG384
			36	110C1040MDG385
			42	110C1040MDG386
			48	110C1040MDG387
			54	110C1040MDG388
			60	110C1040MDG389
			66	110C1040MDG390
			72	110C1040MDG391
			12	110C1040MDG392
			18	110C1040MDG393
			24	110C1040MDG394
			30	110C1040MDG395
			36	110C1040MDG396
			42	110C1040MDG397
			48	110C1040MDG398
			54	110C1040MDG399
			60	110C1040MDG400
			66	110C1040MDG401
			72	110C1040MDG402
			12	110C1040MDG403
			18	110C1040MDG404
			24	110C1040MDG405
			30	110C1040MDG406
			36	110C1040MDG407
			42	110C1040MDG408
			48	110C1040MDG409
			54	110C1040MDG410
			60	110C1040MDG411
			66	110C1040MDG412
			72	110C1040MDG413
			12	110C1040MDG414
			18	110C1040MDG415
			24	110C1040MDG416
			30	110C1040MDG417
			36	110C1040MDG418
			42	110C1040MDG419
			48	110C1040MDG420
			54	110C1040MDG421
			60	110C1040MDG422
			66	1

Lighting and distribution panelboards

The following panelboards are available for mounting in motor control centers. Type RL and RQ Panelboards with main circuit breakers are normally provided. Type RE and RD panels require a feeder unit for the main circuit breaker, which then feeds the M.L.O. panel.

Table 63: Lighting panelboards

Panel type	System voltage (max.)	Branch			Interrupting rating rms symmetrical Amps (in thousands)		
		Type	Poles (1)	Poles Ampere Rating			
ReliaGear Type RL	120/240 Vac	THQL	1	15-70	10		
		THQL	2	15-100	10		
		THHQL	1	15-70	22		
		THHQL	2	15-125	22		
		TXQL	1.2	15-30	65		
	240 Vac	THQL	2.3	15-100	10		
		THHQL	2.3	15-100	22		
		THQL	3	15-30	65		
		ReliaGear Type RQ	120/240 Vac	THQB-GF	1.2	15-30	10
				THQB	1	15-70	10
THQB	2			15-100	10		
THHQB-GF	1			15-30	22		
THHQB	1			15-70	22		
240 Vac	THHQB		2	15-100	22		
	TXQB		1.2	15-30	65		
	THQB		1.2	15-100	10		
	THHQB		2.3	15-100	22		
	TXQB		3	15-30	65		
ReliaGear Type RE	120 Vac	TEY	1	15-100	65		
	240 Vac	TEY	2.3	15-100	65		
	277 Vac	TEY	1	15-100	14		
	480/277 Vac Max.	TEY	2.3	15-100	14		
ReliaGear Type RD	277 Vac	TED	1	15-100	14		
		TED4	1	15-50	14		
		THED	1	15-30	65		
	480 Vac	TED4	2	15-100	14		
		TED4,6	3	15-150	14		
		THED4	2	15-100	25		
		THED4	3	110-150	25		
		THED6	3	15-150	25		
	600 Vac	TED6	3	15-150	14		
		THED6	3	15-150	18		

1. Two-pole THED breakers require a 3-pole space
 2. Equipment rating is equal to the lowest interrupting rating of any circuit breaker installed
 3. One space unit (X) equals 12" vertical height. M.L.O. panel does not include feeder space requirements (see pg. C4)

NOTICE

Notice:

- Branch devices are plug-in for Type RL and bolt-on for RQ, RE and RD panelboards. Maximum of 42 circuits per panel.
- Ground fault CB not available in RL panels.
- Lighting panel main bus is rated 1000 amps per square inch, alternate 800 amps per square inch is available.

NOTICE

Notice:

65 kAIC rating for panels is obtained through series rating. For all panels fed from MCC bus, add feeder unit to feed panel.

Table 64: MCC space units

Number of circuits	Panel main bus rating (Amps)	Space units ⁽³⁾	
		RL, RQ	RE
12	100	2	2
12	225	2 1/2	2
18	100	2 1/2	2 1/2
18	225	2 1/2	2 1/2
24	225	2 1/2	2 1/2
24	400	4 1/2	3 1/2
30	225	3	3
30	400	4 1/2	3 1/2
36	225	3 1/2	3
36	400	5	4
42	225	3 1/2	3 1/2
42	400	5	4

Table 65: RD

Number of circuits	Panel main bus rating (Amps)	Space units ⁽³⁾	
		RL, RQ	RE
12	100	2 1/2	
12	225	3	
18	100	3	
18	225	3 1/2	
24	100	3	
24	225	3 1/2	
30	100	3 1/2	
30	225	4	
36	100	4	
36	225	4 1/2	
42	100	4	
42	400	1/2	

The unit rating is the same as the lighting panel rating when:

- A. The lighting panel is mounted as a separate motor control center unit but not connected to any power source within the motor control center. This does not reduce or affect motor control center short-circuit rating. The lighting/distribution panel must have a main breaker.
- B. The lighting panel is mounted as a separate motor control center unit and factory connected directly (with no intermediate transformer) to motor control center bus through a feeder. The panel series rating must equal or exceed motor control center short-circuit rating.
- C. The lighting panel is mounted as a separate motor control center unit and factory connected to a transformer unit in the motor control center. This does not reduce or affect motor control center short-circuit rating.

Distribution transformers

General

Open, dry-type transformers with primary thermal-magnetic circuit breaker with NEMA Class R (dual element) fuses are available in motor control center construction.

The accompanying tables give both single- and three-phase transformers normally mounted in motor control centers for use in supplying separate-source control circuits, panelboards and power external to the motor control center.

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Table 67: Primary protection only

Primary Current	Primary protection rating
9 amps or more	125% or next higher standard rating per NEC Sect. 240-6
2 amps to 9 amps	167% maximum
Less than 2 amps	300% maximum

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Table 68: Primary and secondary protection

Secondary current	Primary protection rating	Secondary protection rating
9 amps or more	250% maximum	125% or next higher standard rating
Less than 9 amps	250% maximum	167% maximum

Space units shown include space necessary for the primary disconnect. One space unit equals 12 inches of vertical height. If transformers with taps are required, refer to the factory. Primary disconnects stab into the vertical bus. Transformer secondary conductors are wired to a terminal board in the unit. One leg of 120 Vac secondaries, the center point of 120/240 Vac secondaries, and the Y-point of 3-phase secondaries are grounded unless otherwise specified. NEC Article 450-3 covers transformer protection, other than motor control circuit transformers or special applications.

The general requirements are:

- The degree of protection required depends on the specific application.
- Select a transformer protective device which provides the required protection.
- Secondary protection in each ungrounded conductor can be provided if specified.

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Table 66: Three-phase transformers (Delta-Y, no Taps⁽⁶⁾)

KVA	Fused switch-100kAIC					Circuit breaker					
	Switch size	Fuse Amps ⁽⁴⁾	Space unit	UL listed (X)	Notes	IC rating (kA)		CB trip	Space unit ⁽⁵⁾	UL listed (X)	Notes
						65	100				
380-120/208 Vac, 50 Hertz											
9	30	17.5	3	•		SEL	SEP	30	3		
30	60	60	6	•	⁽¹⁾ (⁶)	SEL	SEP	70	4	•	⁽¹⁾ (⁶)
45	200	90	6	•	⁽⁶⁾	SEL	SEP	150	4.5	•	⁽⁶⁾
480-120/208 Vac, 60 Hertz											
9	30	15	3	•		SEL	SEP	20	3	•	
15	30	25	4	•		SEL	SEP	30	3.5	•	
30	60	45	4	•	⁽¹⁾ (⁶)	SEL	SEP	70	3.5	•	⁽¹⁾ (⁶)
45	100	70	4	•	⁽⁶⁾	SEL	SEP	125	3.5	•	⁽¹⁾ (⁶)
600-120/208 Vac, 60 Hertz											
9	30	12	3	•			SELL	20	3.5	•	
30	60	40	4	•	⁽¹⁾ (⁶)		SELL	70	3.5	•	⁽¹⁾ (⁶)

1. Requires full depth of motor control center
 2. Requires 24" wide enclosure
 3. Sized for primary protection only (Dual element fuses)
 4. Sized for primary and secondary protection

5. Add 6" for Taps
 6. Requires 30" wide enclosure

NOTICE

Notice:

- 15-45KVA transformers are TP-1 rated per NEMA Standard TP-1-2016
- Low temperature rise and/or copper windings are available. Refer to factory

Distribution transformers

Table 69: Single-phase transformers

KVA	Fused switch-100kAIC				Notes	Circuit breaker					
	Switch size	Fuse Amps ⁽⁴⁾	Space unit	UL listed (X)		IC rating (kA)		CB trip ⁽⁵⁾	Space unit	UL listed (X)	Notes
						65	100				
240-120/240 Vac, 60 Hertz											
3	30	15	1.5	•		SEL	SEP	30	1.5	•	
5	30	30	2	•		SEL		40	2	•	
10	60	60	2	•	⁽¹⁾	SEL		70	2	• ⁽¹⁾	
15	200	80	4	•	⁽¹⁾⁽⁶⁾	SEL	SEP	150	3.5	• ⁽¹⁾⁽⁶⁾	
25	200	150	4	•	⁽¹⁾⁽⁶⁾	SEL	SEP	225	3	• ⁽¹⁾⁽⁶⁾	
37.5	200	200	6	•	⁽¹⁾⁽⁷⁾	SEL	SEP	225	4	• ⁽¹⁾⁽⁷⁾	
380-120/240 Vac, 50 Hertz											
3	30	12	1.5	•		SEL		15	1.5	•	
10	60	35	2	•	⁽¹⁾	SEL		50	2	• ⁽¹⁾	
15	60	50	3	•	⁽¹⁾⁽⁶⁾	SEL		90	2.5	• ⁽¹⁾⁽⁶⁾	
25	100	90	3	•	⁽³⁾	SEL	SEP	150	2.5	• ⁽³⁾	
37.5	200	125	4	•	⁽⁶⁾⁽⁷⁾	SEL	SEP	125	4	• ⁽⁶⁾⁽⁷⁾	
480-120/240 Vac, 60 Hertz											
0.50	30	2.8	1	•		SEL			1		
1	30	3.5	1	•		SEL			1		
3	30	10	1.5	•		SEL		15	1.5	•	
5	30	12	2	•		SEL		20	2	•	
10	30	25	2	•	⁽¹⁾	SEL		40	2	• ⁽¹⁾	
15	60	40	3	•	⁽¹⁾⁽⁶⁾	SEL		50	2.5	• ⁽¹⁾⁽⁶⁾	
25	100	70	3	•	⁽³⁾	SEL	SEP	125	2.5	• ⁽³⁾	
37.5	100	100	4	•	⁽⁶⁾⁽⁷⁾	SEL	SEP	125	3.5	• ⁽⁶⁾⁽⁷⁾	
600-120/240 Vac, 60 Hertz											
10	30	20	2	•	⁽¹⁾		SELL	40	2	• ⁽¹⁾	
15	60	35	3	•	⁽¹⁾⁽⁶⁾			50	2.5	• ⁽¹⁾⁽⁶⁾	
25	60	60	3	•	⁽³⁾			100	2.5	• ⁽³⁾	
37.5	100	80	4	•	⁽⁶⁾⁽⁷⁾			90	3.5	• ⁽⁶⁾⁽⁷⁾	

1. Requires full depth of motor control center
2. Requires 24" wide enclosure
3. Requires 20" deep enclosure 24" wide
4. Sized for primary protection only (Dual element fuses)
5. Sized for primary and secondary protection
6. Add 6" for Taps
7. Requires 30" wide enclosure

NOTICE

Notice:

- 15-45KVA transformers are TP-1 rated per NEMA Standard TP-1-1996
- Low temperature rise and/or copper windings are available. Refer to factory

Variable frequency drives

Low voltage AC drives

General application notes

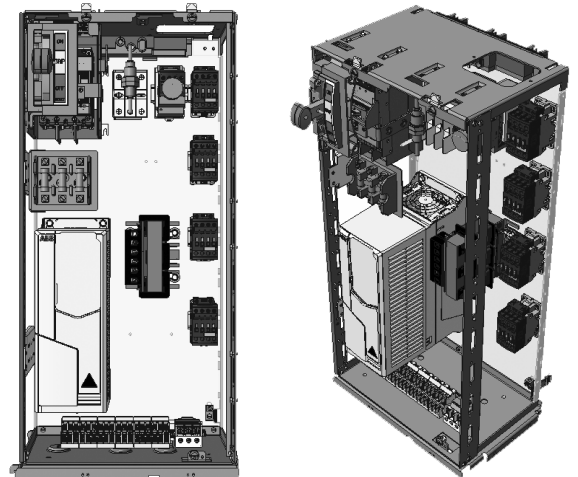
As a vehicle for controlling multiple motor functions, the Motor Control Center has become the logical place to mount variable speed drives.

A drive must have ventilation. The basic power switching components are transistors, which are mounted on finned heat sinks. Although the drive may be operating at 98% or greater efficiency, the 2% (\pm) normal heat loss cannot be enclosed in the MCC without exceeding the safe operating temperature (50 °C). For mounting inside MCC construction, venting and fans are added to the drive assembly to actively remove heat from the enclosure and keep the ambient temperatures within the UL845 guidelines and to maintain reliability and uptime.

A drive is electronically controlled. The new generation of Pulse Width Modulated (PWM) output drives are all microprocessor based. Although well shielded from stray noise, they require careful wire routing, and in some cases shielded wire runs to avoid “nuisance” problems. When mounted inside MCC’s, control wires will be run separate from power leads. If they must cross, the factory will try to keep them at right angles to minimize the induced electric fields (noise).

Both load filters and additional line reactors are available inside the ReliaGear LV MCC to mitigate harmonics produced by the drives. To size your MCC with the proper harmonic filtering for your drives, a system harmonic study is required. When system study is performed properly by a customer, the MCC and drive combination will successfully meet the requirements of IEEE 519.

A drive can provide significant energy savings. When a fan or pump is utilized on a system with variable flow rates, whether measured in gallons per minute or cubic feet of cooling air per minute, a variable speed drive is the most efficient means of control. Since a variable torque load requires significantly less energy when operated at lower speed, the energy savings can be in the 25 to 50% range when compared to a full voltage motor using dampers or valving to reduce its output. (The amount of savings depends, of course, on the amount of time the motor can be used at the reduced speed.) It will also lower demand charges due to reduced motor starting current.



Line reactor (LR)

Line Reactors are electrical components that help to protect 6-pulse rectifiers and power conversion devices such as variable frequency drives (VFDs). When used in conjunction with a VFD, a line reactor can help to reduce harmonics and protect the drive from harmful voltage spikes.

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35 Line reactor

—
36 Load filter

—
37 AF Contactor + EF OL

—
38 NF Control relay

The addition of a 3% or 5% Line Reactor will reduce harmonic content, which reduces the total RMS current, thereby improving the total power factor.

- Nuisance tripping is less common
- Drive uptime is increased
- Power factor is improved
- Limits expensive down-time
- Increases life of drive
- Protects sensitive equipment
- Option for 3% or 5%



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35

Load filter (LF)

Load filter provides motor protection by limiting voltage spikes to below 1,000 V for applications with leads lengths greater than 100 ft.

- Greatly extends the life of the motor and cable
 - Up to 30% reduction in common mode current
 - dV/dt solution for leads less than 1,000 ft.
- Available for all drives in ReliaGear LV MCC except 500HP Heavy Duty applications



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The Reliagear LV MCC VFD units are equipped with AF Contactors, EF Electronic Overload and NF Control Relays. These devices (AF, EF and NF) are utilized in both standard stationary and arc flash mitigation retractable stab units.



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38

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39 Mounted
drives - ACS580

—
40 Drive modules
- ACS580

ACS580 drives

The ACS580 is an all-compatible general-purpose drive, offered in a range of Mounted Drives as well as Drive Modules. Based on the technology of this family of drives, it is simple to program, install and operate and makes controlling processes easy and efficient. All the ACS580 all compatible drives share the same architecture; software platform, tools, user interfaces and options within the ACS580 drive portfolio.

One product with many applications, the ACS580 drives include all the essential components for typical industry applications, with a scalable offering with ratings as shown in ACS580 Ratings table. The drive is ready to control compressors, conveyors, mixers, pumps and fans, as well as many other variable and constant torque applications.

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Table 70: ACS580 Ratings

Voltage	Horsepower (min)	Horsepower (max)	Duty
208V (3phase)	0.5	500	Normal
208V (3phase)	0.33	500	Heavy
480V (3phase)	0.5	500	Normal
480V (3phase)	0.33	500	Heavy
600V (3phase)	0.5	200	Normal
600V (3phase)	0.33	200	Heavy

Easier than ever before, the ACS580 drives have all the essential features built-in reducing the commissioning and setup time. The assistant control panel is standard in ACS580 drives, and users can upgrade to an optional Bluetooth control panel for wireless commissioning and monitoring. Primary settings and control macros help in the quick product setup. The compact design makes handling the units easy.

The ACS580 is manufactured in frames (frame sizes) R1 to R11, that refer to their maximum HP rating and physical size.

- Mounted Drives: R1 to R9
- Drive Modules: R10 and R11

The frame is marked on the type designation label attached to the drive.

Typical applications

ACS580 drives improve process performance, increase productivity and ensure machine and personnel safety.

- Food and beverage: Blowers, centrifuges, compressors, conveyors, fans, mills, pumps, separators, mixers, dryers, pelletizers
- Material handling: Conveyors
- Printing: Compressors, pressers, winders
- Rubber and plastics: Extruders, injection molding machines, pumps
- Textile: Bleaching machines, compressors, conveyors, drum washers, extruders, fans, jet dyeing machines, pumps, stenter machines, stretchers, winders
- Sawmill: Chippers, conveyors, feeders, dryers, pickers, drying kilns
- Water handling: Compressors, pump stations
- Agriculture: Fans, irrigators, pumps, sorters
- Automotive: Conveyors, fans, pumps



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Table 71: ACS580 standard features and specifications

Choke and EMC	Swinging choke technology to mitigate harmonics Fulfills standard the EN61000-3-12 standard EMC C2 filter allows installation in first environment
Scalar and vector control for process control	Scalar control for effortless process control. Vector control for accurate and energy-efficient speed and torque control in demanding applications. Support for induction, permanent magnet and synchronous reluctance motors (SynRM)
Extensive I/O connections	The ACS580 features extensive I/O connections for flexible configuration in various applications Colored terminals for easy configuration
Assistant control panel and primary settings	The ACS-AP-S assistant control panel speaks 16 different languages USB interface for PC and tool connection Help button for problem-solving
Integrated safe torque off (STO)	Safe torque off for implementing safe machinery SIL 3, PL e
Brake chopper	The brake chopper is built-in as standard for ACS580 frames up to R3. Braking control is integrated into ACS580 drives. For drives larger than R3 frame, additional space will be required to accommodate brake chopper feature
Performance	Suitable for constant and variable torque applications

Efficiency

Approximately 98% at nominal power level

Table 72: ACS580 standard Features and specifications

Internal Fans	For fans replacement recommendations in average operation condition please refer to Hardware Manual 3AXD50000044794
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Table 73: ACS580 standard features and specifications

Ambient temperature	
Operation area	ACS580-01: -15 to +50 °C. No frost allowed; R1 to R9 from +40 to +50 °C with derating ACS580-04: -15 to +55 °C. No frost allowed; R10 to R11 from +40 to +55 °C with derating
Cooling method	Dry clean air
Air-cooled	
Altitude	
0 to 1,000 m	Without derating
1,000 to 4,000 m	With derating of 1%/100 m
Relative humidity	5 to 95%, no condensation allowed
Degree of protection	ACS580-01 (Frames R1 to R9): IP21 ACS580-04 (frames R10 to R11): IP00
Functional safety	Safe torque off (STO according EN 61800-5-2) IEC 61508 ed2: SIL 3. IEC 61511: SIL 3. IEC 62061: SIL CL 3. EN ISO 13849-1: PL e Do not install in locations where product could be exposed to corrosive dust, corrosive gas, inflammable gas, oil mist, vapor, water drops or direct sunlight. There must be no salt in the atmosphere. Condensation must not be caused by sudden changes in temperature. No conductive dust allowed

Table 74: ACS580 standard features and specifications

Contamination levels	Do not install in locations where product could be exposed to corrosive dust, corrosive gas, inflammable gas, oil mist, vapor, water drops or direct sunlight. There must be no salt in the atmosphere. Condensation must not be caused by sudden changes in temperature. No conductive dust allowed
Storage	IEC 60721-3-1. Class 1C2 (chemical gases). Class 1S2 (solid particles)*
Operation	IEC 60721-3-3. Class 3C2 (chemical gases). Class 3S2 (solid particles)*
Transportation	IEC 60721-3-2. Class 2C2 (chemical gases). Class 2S2 (solid particles)*

*C= chemically active substances
S= mechanically active substances

Table 75: ACS580 standard features and specifications

Voltage (U1)	ACS580-01-xxxx-2 drives: Input voltage range 3~ 200...240 V AC +10%... -15%
	ACS580-01-xxxx-4 drives: Input voltage range 3~ 380...480 V AC +10%... -15%
	ACS580-01-xxxx-6 drives: Input voltage range 3~ 575...600 V AC +10%... -15%
Network type	Public low voltage networks. Symmetrically grounded TN-S system, IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems
Short-circuit current protection (UL 508C, UL 61800-5-1)	The drives offering in ReliaGear LV MCC complies with the corresponding short-circuit protection standards UL508C and UL 61800-5-1. Please see tables in following pages for details regarding specific ratings
Frequency (f₁)	47 to 63 Hz. This is indicated in the type designation label as typical input frequency level f ₁ (50/60 Hz)
Imbalance	Max. ± 3% of nominal phase to phase input voltage
Fundamental power factor (cos phi₁)	0.98 (at nominal load)

Table 76: ACS580 standard features and specifications

Motor types	Asynchronous AC induction motors, permanent magnet motors and synchronous reluctance motors (SynRM)
Short-circuit current protection (UL 508C)	The drive provides solid state short circuit protection for the motor connection per UL 61800-5-1 and UL 508C
Frequency (f₂)	0...500 Hz. This is indicated in the type designation label as output frequency level f ₁ (0...500 Hz)
Frequency resolution	0.01 Hz

Table 77: ACS580 standard features and specifications

External power supply	Maximum power: Frames R1...R5: 25 W, 1.04 A at 24 V AC/DC ±10% with an option module Frames R6...R9: 36 W, 1.50 A at 24 V AC/DC ±10% as standard Supplied from an external power supply through option module CMOD-01 or CMOD-02 with frames R1...R5. With frames R6...R9 no options are needed. Terminal size: Frames R1...R5: 0.2...2.5 mm ² (24...14 AWG); Frames R6...R9: 0.14...2.5 mm ² (26...14 AWG)
+24 V DC output (Term. 10)	Total load capacity of this outputs is 6.0 W (250 mA / 24 V) minus the power taken by the option modules installed on the board. Terminal size: Frames R1...R5: 0.2...2.5 mm ² (24...14 AWG); Frames R6...R9: 0.14...2.5 mm ² (26...14 AWG)
Digital inputs DI1...DI6 (Term. 13...18)	Input type: NPN/PNP Terminal size: Frames R1...R5: 0.14...1.5 mm ² (26...16 AWG); Frames R6...R9: 0.14...2.5 mm ² (26...14 AWG) DI1...DI5 (Term.13...17); 12/24 V DC logic levels: "0" < 4 V, "1" > 8 V, 10 to 24 V AC; Rin: 3 kohm Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling DI5 (Term.17) Can be used as a digital or frequency input. 12/24 V DC logic levels: "0" < 3 V, "1" > 8 V, 10 to 24 V AC; Rin: 3 kohm Max. frequency 16 kHz Symmetrical signal (duty cycle D = 0.50); DI6 (Term. 18) Can be used as a digital or PTC input. Digital input mode 12/24 V DC logic levels: "0" < 4 V, "1" > 8 V; Rin: 3 kohm Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling Note: DI6 is not supported in the NPN configuration. PTC mode – PTC thermistor can be connected between DI6 and +24VDC: < 1.5 kohm = '1' (low temperature), > 4 kohm = '0' (high temperature), open circuit = '0' (high temperature). DI6 is not a reinforced/double insulated input. Connecting the motor PTC sensor to this input requires usage of a reinforced/double insulated PTC sensor inside the motor
Relay outputs RO1...RO3 (Term. 19...27)	250 V AC / 30 V DC, 2 A; Terminal size: Frames R1...R5: 0.14...1.5 mm ² ; Frames R6...R9: 0.14...2.5 mm ²

Table 78: ACS580 Standard Features and specifications

Analog inputs AI1 and AI2 (Term. 2 and 5)	Current/voltage input mode selected with a parameter. Current input: 0(4)...20 mA, Rin: 100 ohm Voltage input: 0(2)...10 V, Rin: > 200 kohm Terminal size: Frames R1...R5: 0.14...1.5 mm ² ; Frames R6...R9: 0.14...2.5 mm ² Inaccuracy: typical ±1%, max. ±1.5% of full scale
Analog outputs AO1 and AO2 (Term. 7 and 8)	Current/voltage input mode selected with a parameter. Current output: 0...20 mA, Rload: < 500 ohm Voltage output: 0...10 V, Rload: > 100 kohm (AO1 only) Terminal size: Frames R1...R5: 0.14...1.5 mm ² ; Frames R6...R9: 0.14...2.5 mm ² Inaccuracy: ±1% of full scale (in voltage and current modes)
Reference voltage output for analog inputs +10V DC (Term. 4)	Max. 20 mA output Inaccuracy: ±1%
Embedded fieldbus (Term. 29...31)	Connector pitch 5 mm, wire size 2.5 mm ² Physical layer: EIA-485 Cable type: Shielded twisted pair cable with twisted pair for data and a wire or pair for signal ground, nominal impedance 100...165 ohms, for example Belden 9842 Baud rate: 4.8...115.2 kbit/s Termination by switch
Safe torque off (STO) inputs IN1 and IN2 (Term. 37 and 38)	24 V DC logic levels: "0" < 5 V, "1" > 13 V Rin: 2.47 kohm Terminal size: Frames R1...R5: 0.14...1.5 mm ² ; Frames R6...R9: 0.14...2.5 mm ²
STO cable	Maximum cable length 300 m (984 ft) between activation switch (K) and drive control board.
Control panel - drive and drive - drive connection (panel bus)	EIA-485, male RJ-45 connector, unshielded or shielded twisted pair cable, type CAT 5e or better, max. total cable length of the panel bus 100 m (in single or multiple cables)
Control panel - PC connection	USB Type Mini-B, max. cable length 3 m

Isolation areas, R1...R5

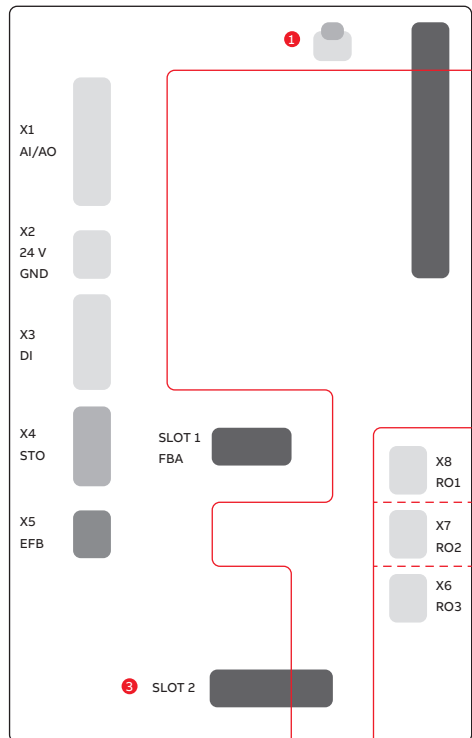


Table 79: Key

Symbol	Description
①	Panel port
②	Power unit connection
③	I/O extension
—	Reinforced insulation (IEC/EN 61800-5-1:2007)
- - -	Functional insulation (IEC/EN 61800-5-1:2007)

Below altitudes 4000 m (13123 ft)

The terminal on the control board fulfills the Protective Extra Low Voltage (PELV) requirements (EN 50178): There is adequate insulation between the user terminals which only accept ELV voltages and terminals that accept higher voltages (relay outputs).

Isolation areas, R6...R9

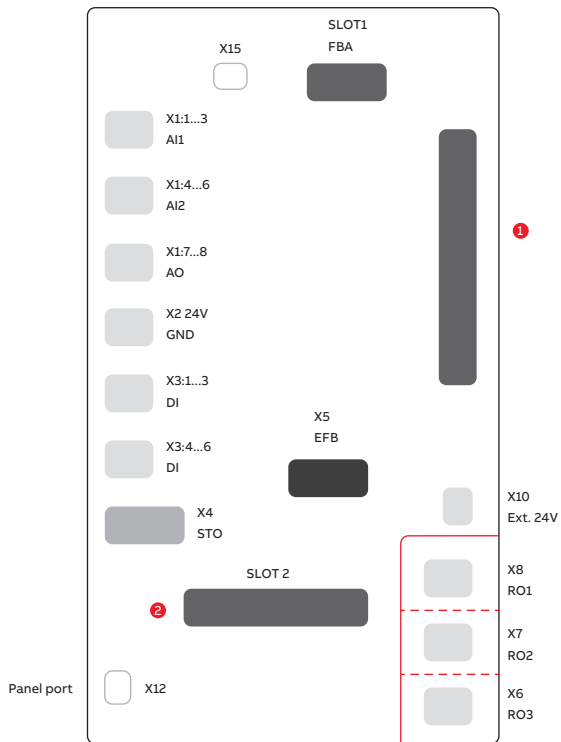


Table 80: Key

Symbol	Description
①	Power unit connection
②	I/O extension
—	Reinforced insulation (IEC/EN 61800-5-1:2007)
- - - - -	Functional insulation (IEC/EN 61800-5-1:2007)

Below altitudes 4000m (13123 ft)

The terminals on the control board fulfill the Protective Extra Low Voltage (PELV) requirements (EN 50178): There is reinforced insulation between the user terminals which only accept ELV voltages and terminals that accept higher voltages (relay outputs).

NOTICE**Notice:**

- There is functional insulation between the individual relay outputs
- There is reinforced insulation on the power unit

Table 81: R10 and R11

Control connection data	
External power supply Term. 40, 41	Maximum power: 36 W, 1.50 A at 24 V AC/DC ±10% as standard Terminal size: 0.14...2.5 mm ²
+24 V DC output (Term. 10)	Total load capacity of this output is 6.0 W (250 mA / 24 V) minus the power taken by the option modules installed on the board. Terminal size: 0.14...2.5 mm ²
Digital inputs DI1...DI6 (Term. 13...18)	Input type: NPN/PNP Terminal size: 0.14...2.5 mm ² DI1...DI5 (Term.13...17) 12/24 V DC logic levels: "0" < 4 V, "1" > 8 V Rin: 3 kohm Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling DI5 (Term.17) Can be used as a digital or frequency input. 12/24 V DC logic levels: "0" < 3 V, "1" > 8 V Rin: 3 kohm Max. frequency 16 kHz Symmetrical signal (duty cycle D = 0.50) DI6 (Term.18) Can be used as a digital or PTC input. Digital input mode. 12/24 V DC logic levels: "0" < 4 V, "1" > 8 V Rin: 3 kohm Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling Note: DI6 is not supported in the NPN configuration. PTC mode – PTC thermistor can be connected between DI6 and +24VDC: < 1.5 kohm = '1' (low temperature), > 4 kohm = '0' (high temperature), open circuit = '0' (high temperature). DI6 is not a reinforced/double insulated input. Connecting the motor PTC sensor to this input requires usage of a reinforced/double insulated PTC sensor inside the motor
Relay outputs RO1...RO3 (Term. 19...27)	250 V AC / 30 V DC, 2 A Terminal size: 0.14...2.5 mm ²
Analog inputs AI1 and AI2 (Term. 2 and 5)	Current/voltage input mode selected with a parameter Current input: 0(4)...20 mA, Rin: 100 ohm Voltage input: 0(2)...10 V, Rin: > 200 kohm Terminal size: 0.14...2.5 mm ² Inaccuracy: typical ±1%, max. ±1.5% of full scale
Analog outputs AO1 and AO2 (Term. 7 and 8)	Current/voltage output mode for AO1 selected with a parameter Current output: 0...20 mA, Rload: < 500 ohm Voltage output: 0...10 V, Rload: > 100 kohm (AO1 only) Terminal size: 0.14...2.5 mm ² Inaccuracy: ±1% of full scale (in voltage and current modes)
Reference voltage output for analog inputs +10V DC (Term. 4)	Max. 20 mA output Inaccuracy: ±1%
Safe torque off (STO) inputs IN1 and IN2 (Term. 37 and 38)	24 V DC logic levels: "0" < 5 V, "1" > 13 V Rin: 2.47 kohm Terminal size: 0.14...2.5 mm ²
STO cable	Maximum cable length 300 m (984 ft) between activation switch (K) and drive control board
Control panel - drive connection	EIA-485, male RJ-45 connector, max. cable length 100 m
Control panel - PC connection	USB Type Mini-B, max. cable length 2 m

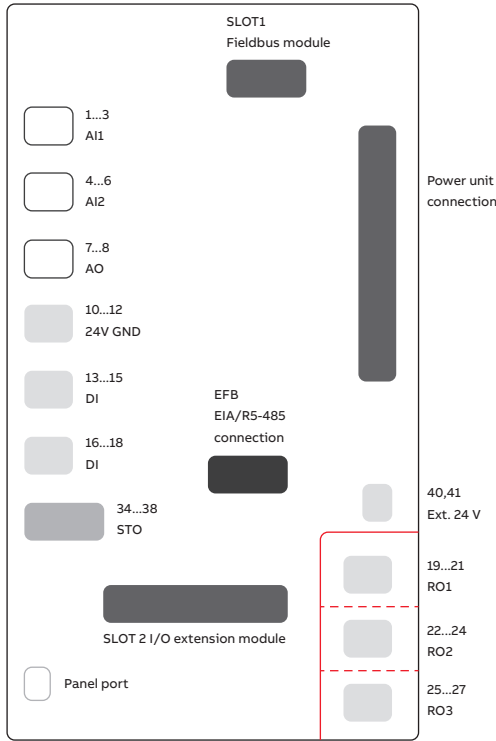


Table 83: Control panel key

Symbol	Description
	Reinforced insulation (IEC/EN 61800-5-1:2007)
	Functional insulation (IEC/EN 61800-5-1:2007)

The terminals on the control board fulfill the Protective Extra Low Voltage (PELV) requirements (EN 50178): There is reinforced insulation between the user terminals which only accept ELV voltages and terminals that accept higher voltages (relay outputs).

NOTICE

Notice:

- There is functional insulation between the individual relay outputs.
- There is reinforced insulation on the power unit.

Table 82: Control panel

Assistant Control Panel

Set up the drive using the assistant control panel delivered as standard with all ACS580 drives. There is no need to know any drive parameters, as the control panel helps to set up the essential settings quickly and get the drive into action.

Drive setup with the primary settings menu including embedded assistants Process monitoring with one glance at the control panel's editable home view showing you the status of the drive and process Drive maintenance with the help function providing context-sensitive guidance and troubleshooting instructions Drive diagnostics under the diagnostics menu informing the user of the root cause

Bluetooth Panel

The optional Bluetooth panel enables connection with the Drivetune mobile app. The app is available for free on the Google Play and the Apple App store. Some of the Drivetune features are: commissioning, troubleshooting, monitoring and controlling the drive. Drivetune also has full parameter access

Connectivity options

The ACS580 general purpose drives are compatible with a wide range of fieldbus protocols.

The drive comes with Modbus RTU fieldbus interface as standard.

Fieldbus communication reduces wiring costs when compared to traditional hardwired input/output connections.

Table 84: VFD communication modules

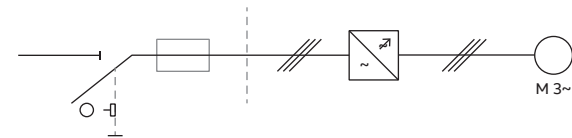
Fieldbus adapters	
	DeviceNet™
	PROFIBUS DP
	CANopen®
	Modbus RTU
	ControlNet
	EtherCAT®
	POWERLINK
	EtherNet/IP™, Modbus TCP, PROFINET IO
	Two port EtherNet/IP™, Modbus TCP, PROFINET IO

ACS580 Product compliance

- CE
- Low Voltage Directive 2006/95/EC, EN 61800-5-1: 2007
- Machinery Directive 2006/42/EC, EN 61800-5-2: 2007
- EMC Directive 2004/108/EC, EN 61800-3: 2004 + A1: 2012
- RoHS directive 2011/65/EU
- Quality assurance system ISO 9001 and Environmental system
- ISO 14001
- Waste electrical and electronic equipment directive
- (WEEE) 2002/96/EC
- RoHS directive 2011/65/EU
- UL, EAC, RCM, UL, cUL

Drive protection

Protect the drive and input cable with fuses as follows:



41

The fuses will protect the input cable in short-circuit situations, restrict drive damage and prevent damage to adjoining equipment in case of a short-circuit inside the drive.

UL fuses are used for branch circuit protection in addition to a molded case circuit breaker. A list of fuses for each VFD frame size is shown in the table below.

NOTICE

Notice:

- Fuses are included in the standard design of each VFD unit
- Fuses with higher current rating than specified below must not be used
- Fuses with lower current rating than specified below may be used if they are of the same class and voltage rating. It is the user's responsibility to verify that lower current rated fuses are compliant with local regulations and appropriate for the application

Table 85: VFD ratings by duty

Voltage	VFD frame	Normal duty	Heavy duty	Fuses
380/415	R1	0.5 - 5	0.5 - 3	JJS - 3 JJS - 6 JJS - 15
	R2	7.5 - 10	5 - 7.5	JJS - 30
	R3	15 - 25	10 - 20	JJS - 40 JJS - 60
	R4	30 - 40	25 - 30	JJS - 80 JJS - 100
	R5	50	40	JJS - 150
	R6	60	50	JJS - 200
	R7	75 - 100	60 - 75	JJS - 225 JJS - 300
	R8	125 - 150	100 - 125	JJS - 350 JJS - 400
	R9	200 - 250	150 - 200	JJS - 500 JJS - 600
	R10	300 - 350	250 - 300	JJS - 600 KTU - 800

Voltage	VFD frame	Normal duty	Heavy duty	Fuses
440/480	R1	0.5 - 7.5	0.5 - 5	JJS - 3 JJS - 6 JJS - 15
	R2	10 - 15	7.5 - 10	JJS - 30
	R3	20 - 30	15 - 25	JJS - 40 JJS - 60
	R4	40 - 50	30 - 40	JJS - 80 JJS - 100
	R5	60 - 75	50 - 60	JJS - 110 JJS - 150
	R6	100	75	JJS - 200
	R7	125 - 150	100 - 125	JJS - 225 JJS - 300
	R8	200	150	JJS - 350
	R9	250 - 350	200 - 300	JJS - 500 JJS - 600
	R10	400 - 500	300 - 400	JJS - 600 KTU - 800
	R11	-	500	KTU - 900

Voltage	VFD frame	Normal duty	Heavy duty	Fuses
575/600	R2	0.50 - 15	0.5 - 10	JJS - 3 JJS - 6 JJS - 15 JJS - 30
	R3	20 - 30	15 - 25	JJS - 40
	R5	40 - 75	30 - 60	JJS - 100
	R7	100 - 125	75 - 100	JJS - 150 JJS - 200
	R8	150	125	JJS - 250
	R9	200	150	JJS - 300

VFD ACS580 Units Space Height and Features

For each below VFD Frame table, exist Features and SCCR values in common:

Table 86: VFD options

Features		
NONE (VFD only)	LR	LR + LF
ISOLATION	ISO + LR	ISO + LR + LF
BYPASS	BYP + LR	BYP + LR + LF
BYP and ISO	BYP and ISO + LR	BYP and ISO + LR + LF

SCCR	
600 V @ 65 kA	
480 V @ 100 kA	

LR: Line Reactor
 LF: Load Filter
 ISO: With Isolation Contactor
 BP: With Bypass Contactors (and Overload Relay)

Isolation (ISO)

The isolation contactor between the Circuit Breaker and Drive is used to isolate the drive from the power source when the drive is at fault or if maintenance is required.

Bypass (BP)

When a bypassing is required, employ mechanically and/or electrically interlocked contactors between the motor and the drive and between the motor and the power line. Interlocking ensures the contactors cannot be closed simultaneously. The bypass connection cannot be used with permanent magnet motors or synchronous reluctance motors.

NOTICE

Notice: Bypass option not available for R11 (all ratings). R9 bypass option only available at 600 V.

Table 87: VFD ACS580 units space height, 42 and 65 kA type 1

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
VFD only	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5				
	X	20/15	20/15	25/20	30/25	-	XT2	15	3				
	X	-	-	-	-	30/25	XT4	15	3				
	X	30/25	30/25	50/40	50/40	-	XT2	15	3.5				
	X	40/30	40/30	40/30	75/60	75/60	XT4	15	3.5				
		50/40	50/40	60/50	100/75	-	XT4	20	5.5				
		60/50	60/50	100/75	-	200/150	XT4	24	5.5				
		-	-	250/200	350/300	-	XT5	24	6.5				
	-	-	350/300	500/500	-	XT7	24	5.5	30	6.5			

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
LR	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5				
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3				
	X	-	-	-	-	15/10	XT4	15	3				
	X	20/15	20/15	25/20	30/25	-	XT2	15	3.5				
	X	-	-	-	-	30/25	XT4	15	3.5				
	X	25/20	25/20	-	50/40	-	XT2	15	4				
	X	-	-	40/30	-	-	XT4	15	4				
		30/25	30/25	50/40	-	-	XT2	20	5				
		40/30	40/30	-	75/60	75/60	XT4	20	5				
		50/40	50/40	60/50	100/75	-	XT4	20	6.5				
		60/50	60/50	100/75	-	200/150	XT4	24	6.5				
		-	-	150/125	200/150	-	XT5	20	5	24	4.5		
		-	-	250/200	350/300	-	XT5	20	5.5	24	4.5		
		-	-	350/300	500/500	-	XT7	24	6.5	30	6.5		

Table 88: VFD ACS580 units space height, 42 and 65 kA type 1

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
LR + LF	X	5/3	5/3	5/3	7.5 / 5	-	XT2	15	3					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5					
	X	-	-	-	-	15/10	XT4	15	3.5					
			20/15	20/15	25/20	30/25	-	XT2	20	5				
			-	-	-	-	30/25	XT4	20	5				
			25/20	25/20	-	50/40	-	XT2	20	5.5				
			-	-	40/30	-	-	XT4	20	5.5				
			30/25	30/25	50/40	-	-	XT2	20	6.5				
			40/30	40/30	-	75/60	75/60	XT4	20	6.5				
			-	-	150/125	200/150	-	XT5	20	5	24	5		
			-	-	250/200	350/300	-	XT5	20	5.5	30	5		
			50/40	50/40	60/50	100/75	-	XT4	20	6.5	20	2.5		
			60/50	60/50	100/75	-	200/150	XT4	24	6.5	20	2.5		
		-	-	350/300	500/400	-	XT7	24	6.5	30	6.5	30	2	

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
ISO	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3					
	X	-	-	-	-	15/10	XT4	15	3					
	X	20/15	20/15	25/20	30/25	-	XT2	15	3.5					
	X	-	-	-	-	30/25	XT4	15	3.5					
	X	25/20	25/20	-	50/40	-	XT2	15	4					
	X	-	-	40/30	-	-	XT4	15	4					
			30/25	30/25	50/40	-	-	XT2	20	5.5				
			40/30	40/30	-	75/60	75/60	XT4	20	5.5				
			60/50	60/50	100/75	100/75	200/150	XT4	24	6.5				
			-	-	250/200	350/300	-	XT5	20	6.5	24	4.5		
			-	-	350/300	500/500	-	XT7	24	6.5	30	6.5		

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
ISO+LR	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3					
	X	-	-	-	-	15/10	XT4	15	3					
	X	20/15	20/15	25/20	30/25	-	XT2	15	3.5					
	X	-	-	-	-	30/25	XT4	15	3.5					
	X	25/20	25/20	-	50/40	-	XT2	15	4					
	X	-	-	40/30	-	-	XT4	15	4					
			30/25	30/25	50/40	-	-	XT2	20	5.5				
			40/30	40/30	-	75/60	75/60	XT4	20	5.5				
			60/50	60/50	100/75	100/75	200/150	XT4	24	6.5				
			-	-	250/200	350/300	-	XT5	20	6.5	24	4.5		
			-	-	350/300	500/500	-	XT7	24	6.5	30	6.5		

*42kA only

Table 88: VFD ACS580 units space height, 42 and 65 kA type 1 (continued)

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
ISO+LR+LF	X	5/3	5/3	5/3	7.5/5	-	XT2	15	3					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5					
	X	-	-	-	-	15/10	XT4	15	3.5					
			20/15	20/15	25/20	30/25	-	XT2	20	5.5				
			-	-	-	-	30/25	XT4	20	5.5				
			30/25	30/25	50/40	50/40	-	XT2	20	6.5				
			40/30	40/30	40/30	75/60	75/60	XT4	20	6.5				
			-	-	150/125	200/150	-	XT5	20	6.5	24	5		
			-	-	250/200	350/300	-	XT5	20	6.5	30	5		
			60/50	60/50	100/75	100/75	200/150	XT4	24	6.5	20	2.5		
			-	-	350/300	500/400	-	XT7	24	6.5	30	6.5	30	2

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
BYPASS	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3					
	X	-	-	-	-	-	XT4	15	3					
	X	20/15	20/15	25/20	30/25	-	XT2	15	3.5					
	X	-	-	-	-	-	XT4	15	3.5					
	X	25/20	25/20	-	50/40	-	XT2	15	4					
	X	-	-	40/30	-	-	XT4	15	4					
			30/25	30/25	50/40	-	-	XT2	20	5.5				
			40/30	40/30	-	75/60	75/60	XT4	20	5.5				
			-	-	150/125	200/150	-	XT5	20	4	24	6.5		
			50/40	50/40	60/50	100/75	-	XT4	20	5.5	20	3.5		
			60/50	60/50	100/75	-	200/150*	XT4	24	5.5	20	3.5		
			-	-	300/250	400/300	-	XT7	24	5.5	30	6.5	30	5.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
BYPASS + LR	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3					
	X	-	-	-	-	-	XT4	15	3					
	X	20/15	20/15	25/20	30/25	-	XT2	15	4					
	X	-	-	-	-	-	XT4	15	4					
			25/20	25/20	-	50/40	-	XT2	20	5.5				
			-	-	40/30	-	-	XT4	20	5.5				
			30/25	30/25	50/40	-	-	XT2	20	6.5				
			40/30	40/30	-	75/60	75/60	XT4	20	6.5				
			-	-	150/125	200/150	-	XT5	20	5	24	6.5		
			50/40	50/40	60/50	100/75	-	XT4	20	6.5	20	3.5		
			60/50	60/50	100/75	-	200/150*	XT4	24	6.5	20	3.5		
			-	-	300/250	400/300	-	XT7	24	6.5	30	6.5	30	5.5

*42kA only

Table 88: VFD ACS580 units space height, 42 and 65 kA type 1 (continued)

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
BYPASS + LR + LF	X	5/3	5/3	5/3	7.5/5	-	XT2	15	3					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5					
	X	-	-	-	-	-	XT4	15	3.5					
			20/15	20/15	25/20	30/25	-	XT2	20	5.5				
			-	-	-	-	-	XT4	20	5.5				
			25/20	25/20	-	50/40	-	XT2	20	6.5				
			-	-	40/30	-	-	XT4	20	6.5				
			30/25	30/25	50/40	-	-	XT2	24	6.5				
			40/30	40/30	-	75/60	75/60	XT4	24	6.5				
			-	-	150/125	200/150	-	XT5	20	5	30	6.5		
			50/40	50/40	60/50	100/75	-	XT4	20	6.5	20	5		
			60/50	60/50	100/75	-	200/150*	XT4	24	6.5	20	5		
		-	-	300/250	400/300	-	XT7	24	6.5	30	6.5	36	6.5	

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
BYP and ISO	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3					
	X	-	-	-	-	-	XT4	15	3					
	X	20/15	20/15	25/20	30/25	-	XT2	15	4					
	X	-	-	-	-	-	XT4	15	4					
			30/25	30/25	50/40	50/40	-	XT2	20	5.5				
			40/30	40/30	40/30	75/60	75/60	XT4	20	5.5				
			-	-	150/125	200/150	-	XT5	20	5	24	6.5		
			50/40	50/40	60/50	100/75	-	XT4	20	6.5	20	3.5		
			60/50	60/50	100/75	-	200/150*	XT4	24	6.5	20	3.5		
			-	-	300/250	400/300	-	XT7	24	5.5	30	6.5	30	5.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
BYP and ISO + LR	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3					
	X	-	-	-	-	-	XT4	15	3					
			20/15	20/15	25/20	30/25	-	XT2	20	5.5				
			-	-	-	-	-	XT4	20	5.5				
			25/20	25/20	-	50/40	-	XT2	20	6.5				
			-	-	40/30	-	-	XT4	20	6.5				
			30/25	30/25	50/40	-	-	XT2	24	6.5				
			40/30	40/30	-	75/60	75/60	XT4	24	6.5				
			-	-	150/125	200/150	-	XT5	20	6.5	24	6.5		
			60/50	60/50	100/75	100/75	200/150*	XT4	24	6.5	20	3.5		
			-	-	300/250	-	-	XT7	24	6.5	30	6.5	30	5.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
BYP and ISO + LR + LF	X	5/3	5/3	5/3	7.5/5	-	XT2	15	3					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5					
	X	-	-	-	-	-	XT4	15	3.5					
			25/20	25/20	25/20	50/40	-	XT2	20	6.5				
			-	-	-	-	-	XT4	20	6.5				
			30/25	30/25	50/40	-	-	XT2	24	6.5				
			40/30	40/30	-	75/60	75/60	XT4	24	6.5				
			60/50	60/50	100/75	100/75	200/150*	XT4	24	6.5	20	5		
			-	-	300/250	-	-	XT7	24	6.5	30	6.5	36	6.5

*42kA only

Table 89: VFD ACS580 units space height, 42 and 65 kA type 12

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
VFD only	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
	X	-	-	-	-	15/10	XT4	15	3.5				
		30/25	30/25	50/40	50/40	-	XT2	20	5				
		40/30	40/30	40/30	75/60	75/60	XT4	20	5				
		-	-	-	-	200/150	XT4	30	5.5				
		60/50	60/50	100/75	100/75	150/125	XT4	24	6.5				
		75/60	75/60	150/125	200/150	-	XT5	24	6.5				
		-	-	250/200	350/300	-	XT5	30	6.5				
		-	-	350/300	500/500	-	XT7	24	5.5	30	7.5		

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
LR	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
	X	-	-	-	-	15/10	XT4	15	3.5				
		25/20	25/20	20/15	50/40	-	XT2	20	5				
		-	-	40/30	-	30/25	XT4	20	5				
		30/25	30/25	50/40	-	-	XT2	20	5.5				
		40/30	40/30	-	75/60	75/60	XT4	20	5.5				
		60/50	60/50	100/75	100/75	150/125	XT4	24	6.5	24	5		
		-	-	-	-	200/150	XT4	30	6.5	30	5		
		75/60	75/60	150/125	200/150	-	XT5	20	4	30	7.5		
		-	-	250/200	350/300	-	XT5	20	4				

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
LR + LF	X	5/3	5/3	5/3	7.5/5	-	XT2	15	3.5				
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	4				
	X	-	-	-	-	15/10	XT4	15	4				
		20/15	20/15	25/20	30/25	-	XT2	20	5.5				
		-	-	-	-	30/25	XT4	20	5.5				
		30/25	30/25	50/40	50/40	-	XT2	20	6.5				
		40/30	40/30	40/30	75/60	75/60	XT4	20	6.5				
		75/60	75/60	150/125	200/150	-	XT5	20	4	24	6.5		
		-	-	250/200	350/300	-	XT5	20	4	30	6.5		
		60/50	60/50	100/75	100/75	150/125	XT4	24	6.5	20	2.5		

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
ISO	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
	X	-	-	-	-	15/10	XT4	15	3.5				
		30/25	30/25	50/40	50/40	-	XT2	20	5				
		40/30	40/30	40/30	75/60	75/60	XT4	20	5				
		60/50	60/50	100/75	100/75	150/125	XT4	24	6.5				
		-	-	-	-	200/150	XT4	30	6.5				
		75/60	75/60	150/100	200/150	-	XT5	20	4	24	5		
		-	-	250/200	350/300	-	XT5	20	4	30	5		
		-	-	350/300	500/500	-	XT7	24	5.5	30	7.5		

Table 89: VFD ACS580 units space height, 42 and 65 kA type 12 (continued)

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
ISO + LR	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
	X	-	-	-	-	15/10	XT4	15	3.5				
	X	25/20	25/20	25/20	50/40	-	XT2	20	5				
		-	-	40/30	-	30/25	XT4	20	5				
		30/25	30/25	50/40	-	-	XT2	20	5.5				
		40/30	40/30	-	75/60	75/60	XT4	20	5.5				
		60/50	60/50	100/75	100/75	150/125	XT4	24	6.5				
		-	-	-	-	200/150	XT4	30	6.5	24	5		
		75/60	75/60	150/125	200/150	-	XT5	20	5	30	5		
		-	-	250/200	350/300	-	XT5	20	5.5	30	7.5		
		-	-	350/300	500/500	-	XT7	24	6.5				
		-	-	350/300	500/400	-	XT7	24	6.5				

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
ISO + LR + LF	X	5/3	5/3	5/3	7.5/5	-	XT2	15	3.5				
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	4				
	X	-	-	-	-	15/10	XT4	15	4				
		20/15	20/15	25/20	30/25	-	XT2	20	5.5				
		-	-	-	-	30/25	XT4	20	5.5				
		30/25	30/25	50/40	50/40	-	XT2	20	6.5				
		40/30	40/30	40/30	75/60	75/60	XT4	20	6.5				
		75/60	75/60	150/125	200/150	-	XT5	20	5	24	6.5		
		-	-	250/200	350/300	-	XT5	20	5.5	30	6.5		
		60/50	60/50	100/75	100/75	150/125	XT4	24	6.5	20	2.5		
		-	-	-	-	200/150	XT4	30	6.5	20	2.5		
		-	-	350/300	500/400	-	XT7	24	6.5	30	7.5	30	2

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYPASS	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
	X	-	-	-	-	-	XT4	15	3.5				
		25/20	25/20	25/20	50/40	-	XT2	20	5				
		-	-	-	-	-	XT4	20	5				
		30/25	30/25	50/40	-	-	XT2	20	5.5				
		40/30	40/30	-	75/60	75/60	XT4	20	5.5				
		75/60	75/60	150/125	200/150	-	XT5	20	4	24	6.5		
		-	-	-	-	200/150*	XT4	30	5.5	20	3.5		
		60/50	60/50	100/75	100/75	150/125*	XT4	24	6.5	20	3.5		
		-	-	300/250	400/300	-	XT7	24	5.5	30	7.5	30	5.5

*42kA only

Table 89: VFD ACS580 units space height, 42 and 65 kA type 12 (continued)

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYPASS + LR	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
	X	-	-	-	-	-	XT4	15	3.5				
		20/15	20/15	25/20	30/25	-	XT2	20	5.5				
		-	-	-	-	-	XT4	20	5.5				
		30/25	30/25	50/40	50/40	-	XT2	20	6.5				
		40/30	40/30	40/30	75/60	75/60	XT4	20	6.5				
		75/60	75/60	150/125	200/150	-	XT5	20	4	24	6.5		
		60/50	60/50	100/75	100/75	150/125*	XT4	24	6.5	20	3.5		
		-	-	-	-	200/150*	XT4	30	6.5	20	3.5		
		-	-	300/250	400/300	-	XT7	24	6.5	30	7.5	30	5.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYPASS + LR + LF	X	5/3	5/3	5/3	7.5/5	-	XT2	15	3.5				
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	4				
	X	-	-	-	-	-	XT4	15	4				
		25/20	25/20	25/20	50/40	-	XT2	20	6.5				
		-	-	-	-	-	XT4	20	6.5				
		30/25	30/25	50/40	-	-	XT2	24	6.5				
		40/30	40/30	-	75/60	75/60	XT4	24	6.5				
		75/60	75/60	150/125	200/150	-	XT5	20	5	30	6.5		
		60/50	60/50	100/75	100/75	150/125*	XT4	24	6.5	20	5		
		-	-	-	-	200/150*	XT4	30	6.5	20	5		
	-	-	300/250	400/300	-	XT7	24	6.5	30	7.5	36	6.5	

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYP and ISO	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
	X	-	-	-	-	-	XT4	15	3.5				
		30/25	30/25	50/40	50/40	-	XT2	20	5.5				
		40/30	40/30	40/30	75/60	75/60	XT4	20	5.5				
		75/60	75/60	150/125	200/150	-	XT5	20	5	24	6.5		
		60/50	60/50	100/75	100/75	150/125*	XT4	24	6.5	20	3.5		
		-	-	-	-	200/150*	XT4	30	6.5	20	3.5		
		-	-	300/250	400/300	-	XT7	24	5.5	30	7.5	30	5.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYP and +LR	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
	X	-	-	-	-	-	XT4	15	3.5				
		20/15	20/15	25/20	30/25	-	XT2	20	5.5				
		-	-	-	-	-	XT4	20	5.5				
		25/20	25/20	-	50/40	-	XT2	20	6.5				
		-	-	40/30	-	-	XT4	20	6.5				
		30/25	30/25	50/40	-	-	XT2	24	6.5				
		40/30	40/30	-	75/60	75/60	XT4	24	6.5	24	6.5		
		75/60	75/60	150/125	200/150	-	XT5	20	5	20	3.5		
		60/50	60/50	100/75	100/75	150/125*	XT4	24	6.5	20	3.5		
	-	-	-	-	200/150*	XT4	30	6.5	30	7.5	30	5.5	
	-	-	300/250	-	-	XT7	24	6.5					

*42kA only

Table 89: VFD ACS580 units space height, 42 and 65 kA type 12 (continued)

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
BYP and ISO + LR + LF	X	5/3	5/3	5/3	7.5/5	-	XT2	15	3.5					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	4					
	X	-	-	-	-	-	XT4	15	4					
			25/20	25/20	25/20	50/40	-	XT2	20	6.5				
			-	-	-	-	-	XT4	20	6.5				
			30/25	30/25	50/40	-	-	XT2	24	6.5				
			40/30	40/30	-	75/60	75/60	XT4	24	6.5				
			75/60	75/60	-	-	-	XT5	20	6.5	30	6.5		
			60/50	60/50	100/75	100/75	150/125*	XT4	24	6.5	20	5		
			-	-	300/250	-	200/150*	XT4	30	6.5	20	5		
		-	-	300/250	-	-	XT7	24	6.5	30	7.5	36	6.5	

*42kA only

Table 90: VFD ACS580 units space height, 100 kA type 1

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
VFD only	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5					
	X	20/15	20/15	25/20	30/25	-	XT2	15	3					
	X	30/25	30/25	50/40	50/40	-	XT2	15	3.5					
	X	40/30	40/30	-	75/60	-	XT4	15	3.5					
			50/40	50/40	60/50	100/75	-	XT4	20	5.5				
			60/50	60/50	100/75	-	-	XT4	24	5.5				
			-	-	250/200	350/300	-	XT5	24	6.5				
			-	-	350/300	-/500	-	XT7	24	5.5	30	6.5		

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
LR	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3					
	X	20/15	20/15	25/20	30/25	-	XT2	15	3.5					
	X	25/20	25/20	40/30	50/40	-	XT2	15	4					
			30/25	30/25	50/40	-	-	XT2	20	5				
			40/30	40/30	-	75/60	-	XT4	20	5				
			50/40	50/40	60/50	100/75	-	XT4	20	6.5				
			60/50	60/50	100/75	-	-	XT4	24	6.5				
			-	-	150/125	200/150	-	XT5	20	5	24	4.5		
			-	-	250/200	350/300	-	XT5	20	5.5	24	4.5		
		-	-	350/300	-/500	-	XT7	24	6.5	30	6.5			

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
LR + LF	X	5/3	5/3	5/3	7.5/5	-	XT2	15	3					
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5					
			20/15	20/15	25/20	30/25	-	XT2	20	5				
			25/20	25/20	40/30	50/40	-	XT2	20	5.5				
			30/25	30/25	50/40	-	-	XT2	20	6.5				
			40/30	40/30	-	75/60	-	XT4	20	6.5				
			-	-	150/125	200/150	-	XT5	20	5	24	5		
			-	-	250/200	350/300	-	XT5	20	5.5	30	5		
			50/40	50/40	60/50	100/75	-	XT4	20	6.5	20	2.5		
			60/50	60/50	100/75	-	-	XT4	24	6.5	20	2.5		
		-	-	350/300	500/400	-	XT7	24	6.5	30	6.5	30	2	

Table 90: VFD ACS580 units space height, 100 kA type 1 (continued)

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
ISO	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5				
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3				
	X	20/15	20/15	25/20	30/25	-	XT2	15	3.5				
	X	30/25	30/25	50/40	50/40	-	XT2	15	4				
	X	40/30	40/30	-	75/60	-	XT4	15	4				
		50/40	50/40	60/50	100/75	-	XT4	20	6.5				
		60/50	60/50	100/75	-	-	XT4	24	6.5				
		-	-	250/200	350/300	-	XT5	20	5	24	4.5		
	-	-	350/300	-/500	-	XT7	24	5.5	30	6.5			

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
ISO + LR	X	5/3	5/3	5/3	7.5/5	-	XT2	15	2.5				
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3				
	X	20/15	20/15	25/20	30/25	-	XT2	15	3.5				
	X	25/20	25/20	40/30	50/40	-	XT2	15	4				
		30/25	30/25	50/40	-	-	XT2	20	5.5				
		40/30	40/30	-	75/60	-	XT4	20	5.5				
		60/50	60/50	100/75	100/75	-	XT4	24	6.5				
		-	-	250/200	350/300	-	XT5	20	6.5	24	4.5		
	-	-	350/300	-/500	-	XT7	24	6.5	30	6.5			

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
ISO + LR + LF	X	5/3	5/3	5/3	7.5/5	-	XT2	15	3				
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
		20/15	20/15	25/20	30/25	-	XT2	20	5.5				
		30/25	30/25	50/40	50/40	-	XT2	20	6.5				
		40/30	40/30	-	75/60	-	XT4	20	6.5				
		-	-	150/125	200/150	-	XT5	20	6.5	24	5		
		-	-	250/200	350/300	-	XT5	20	6.5	30	5		
		60/50	60/50	100/75	100/75	-	XT4	24	6.5	20	2.5		
	-	-	350/300	500/400	-	XT7	24	6.5	30	6.5	30	2	

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYPASS		30/25	30/25	-	-	-	XT2	20	5.5				
		40/30	40/30	-	75/60	-	XT4	20	5.5				
		-	-	150/125	200/150	-	XT5	20	4	24	6.5		
		50/40	50/40	60/50	100/75	-	XT4	20	5.5	20	3.5		
		60/50	60/50	100/75	-	-	XT4	24	5.5	20	3.5		
		-	-	300/250	400/300	-	XT7	24	5.5	30	6.5	30	5.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYPASS + LR		30/25	30/25	-	-	-	XT2	20	6.5				
		40/30	40/30	-	75/60	-	XT4	20	6.5				
		-	-	150/125	200/150	-	XT5	20	5	24	6.5		
		50/40	50/40	60/50	100/75	-	XT4	20	6.5	20	3.5		
		60/50	60/50	100/75	-	-	XT4	24	6.5	20	3.5		
		-	-	300/250	400/300	-	XT7	24	6.5	30	6.5	30	5.5

Table 90: VFD ACS580 units space height, 100 kA type 1 (continued)

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYPASS + LR + LF		30/25	30/25	-	-	-	XT2	24	6.5				
		40/30	40/30	-	75/60	-	XT4	24	6.5				
		-	-	150/125	200/150	-	XT5	20	5	30	6.5		
		50/40	50/40	60/50	100/75	-	XT4	20	6.5	20	5		
		60/50	60/50	100/75	-	-	XT4	24	6.5	20	5		
		-	-	300/250	400/300	-	XT7	24	6.5	30	6.5	36	6.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYP and ISO		30/25	30/25	-	-	-	XT2	20	5.5				
		40/30	40/30	-	75/60	-	XT4	20	5.5				
		-	-	150/125	200/150	-	XT5	20	5	24	6.5		
		50/40	50/40	60/50	100/75	-	XT4	20	6.5	20	3.5		
		60/50	60/50	100/75	-	-	XT4	24	6.5	20	3.5		
		-	-	300/250	400/300	-	XT7	24	5.5	30	6.5	30	5.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYP and ISO + LR		30/25	30/25	-	-	-	XT2	24	6.5				
		40/30	40/30	-	75/60	-	XT4	24	6.5				
		-	-	150/125	200/150	-	XT5	20	6.5	24	6.5		
		60/50	60/50	100/75	100/75	-	XT4	24	6.5	20	3.5		
		-	-	300/250	-	-	XT7	24	6.5	30	6.5	30	5.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYP and ISO + LR + LF		30/25	30/25	-	-	-	XT2	24	6.5				
		40/30	40/30	-	75/60	-	XT4	24	6.5				
		60/50	60/50	100/75	100/75	-	XT4	24	6.5	20	5		
		-	-	300/250	-	-	XT7	24	6.5	30	6.5	36	6.5

Table 91: VFD ACS580 space height, 100 kA type 12

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
VFD only	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
		30/25	30/25	-	50/40	-	XT2	20	5				
		40/30	40/30	-	75/60	-	XT4	20	5				
		60/50	60/50	100/75	100/75	-	XT4	24	6.5				
		75/60	75/60	150/125	200/150	-	XT5	24	6.5				
		-	-	250/200	350/300	-	XT5	30	6.5				
		-	-	350/300	-/500	-	XT7	24	5.5	30	7.5		

Table 91: VFD ACS580 space height, 100 kA type 12 (continued)

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
LR	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
		25/20	25/20	40/30	50/40	-	XT2	20	5				
		30/25	30/25	50/40	-	-	XT2	20	5.5				
		40/30	40/30	-	75/60	-	XT4	20	5.5				
		60/50	60/50	100/75	100/75	-	XT4	20	6.5				
		75/60	75/60	150/200	200/150	-	XT5	20	4	24	5		
		-	-	-	350/300	-	XT5	20	4	30	5		
		-	-	350/300	-/500	-	XT7	24	6.5	30	7.5		

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3		
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height	
LR + LF	X	5/3	5/3	5/3	7.5/5	-	XT2	15	3.5					
		10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	4					
		20/15	20/15	25/20	30/25	-	XT2	20	5.5					
	-	-	30/25	30/25	50/40	50/40	-	XT2	20	6.5				
			40/30	40/30	-	75/60	-	XT4	20	6.5	24	6.5		
			75/60	75/60	150/125	200/150	-	XT5	20	4	30	6.5		
			-	-	250/200	350/300	-	XT5	20	4	20	2.5		
			60/50	60/50	100/75	100/75	-	XT4	24	6.5	30	7.5	30	2
			-	-	350/300	500/400	-	XT7	24	6.5				

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
ISO	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
		30/25	30/25	50/40	50/40	-	XT2	20	5				
		40/30	40/30	-	75/60	-	XT4	20	5				
		60/50	60/50	100/75	100/75	-	XT4	24	6.5				
		75/60	75/60	150/125	200/150	-	XT5	20	4	24	5		
		-	-	250/200	350/300	-	XT5	20	4	30	5		
		-	-	350/300	-/500	-	XT7	24	5.5	30	7.5		

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
ISO + LR	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	3.5				
		25/20	25/20	40/30	50/40	-	XT2	20	5				
		30/25	30/25	50/40	-	-	XT2	20	5.5				
		40/30	40/30	-	75/60	-	XT4	20	5.5				
		60/50	60/50	100/75	100/75	-	XT4	24	6.5				
		75/60	75/60	150/125	200/150	-	XT5	20	5	24	5		
		-	-	250/200	350/300	-	XT5	20	5.5	30	5		
		-	-	350/300	-/500	-	XT5	24	6.5	30	7.5		

Table 91: VFD ACS580 space height, 100 kA type 12 (continued)

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
ISO + LR + LF	X	5/3	5/3	5/3	7.5/5	-	XT2	15	3.5				
	X	10/7.5	10/7.5	10/7.5	15/10	-	XT2	15	4				
		20/15	20/15	25/20	30/25	-	XT2	20	5.5				
		30/25	30/25	50/40	50/40	-	XT2	20	6.5				
		40/30	40/30	-	75/60	-	XT4	20	6.5				
		75/60	75/60	150/125	200/150	-	XT5	20	5	24	6.5		
		-	-	250/200	350/300	-	XT5	20	5.5	30	6.5		
		60/50	60/50	100/75	100/75	-	XT4	24	6.5	20	2.5		
	-	-	350/300	500/400	-	XT7	24	6.5	30	7.5	30	2	

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYPASS		40/30	40/30	-	75/60	-	XT4	20	5.5				
		75/60	75/60	150/125	200/150	-	XT5	20	4	24	6.5		
		60/50	60/50	100/75	100/75	-	XT4	24	6.5	20	3.5		
		-	-	300/250	400/300	-	XT7	24	5.5	30	7.5	30	5.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYPASS + LR		30/25	30/25	-	-	-	XT2	20	6.5				
		40/30	40/30	-	75/60	-	XT4	20	6.5				
		75/60	75/60	150/125	200/150	-	XT5	20	4	24	6.5		
		60/50	60/50	100/75	100/75	-	XT4	24	6.5	20	4		
		-	-	300/250	400/300	-	XT7	24	6.5	30	8	30	5.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYPASS + LR + LF		30/25	30/25	-	-	-	XT2	24	6.5				
		40/30	40/30	-	75/60	-	XT4	24	6.5				
		75/60	75/60	150/125	200/150	-	XT5	20	5	30	6.5		
		60/50	60/50	100/75	100/75	-	XT4	24	6.5	20	5		
		-	-	300/250	400/300	-	XT7	24	6.5	30	7.5	36	6.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYP and ISO		30/25	30/25	-	-	-	XT2	20	5.5				
		40/30	40/30	-	75/60	-	XT4	20	5.5				
		75/60	75/60	150/125	200/150	-	XT5	20	5	24	6.5		
		60/50	60/50	100/75	100/75	-	XT4	24	6.5	20	3.5		
		-	-	300/250	400/300	-	XT7	24	5.5	30	7.5	30	5.5

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYP and ISO + LR		30/25	30/25	-	-	-	XT2	24	6.5				
		40/30	40/30	-	75/60	-	XT4	24	6.5				
		75/60	75/60	150/125	200/150	-	XT5	20	5	24	6.5		
		60/50	60/50	100/75	100/75	-	XT4	24	6.5	20	3.5		
		-	-	300/250	-	-	XT7	24	6.5	30	7.5	30	5.5

Table 91: VFD ACS580 space height, 100 kA type 12 (continued)

Function	Plug in	Max HP LD/HD @					Disc	Section 1		Section 2		Section 3	
		208V	230/240V	380/415V	440/480V	575/600V		Width	x height	width	x height	width	x height
BYP and ISO + LR + LF		30/25	30/25	-			XT2	24	6.5				
		40/30	40/30	-	75/60	-	XT4	24	6.5				
		75/60	75/60	-	-	-	XT5	20	6.5	30	6.5		
		60/50	60/50	100/75	100/75	-	XT4	24	6.5	20	5		
		-	-	300/250	-	-	XT7	24	6.5	30	7.5	36	6.5

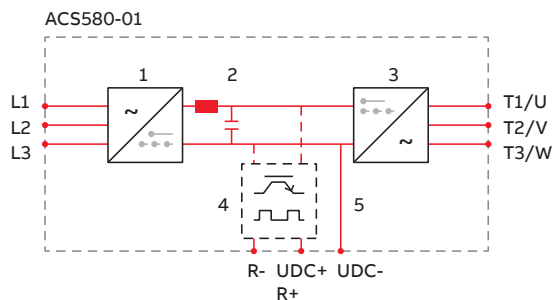
¹ LD: Light Duty / HD: Heavy Duty

² All space height is based on all main bus sizes (X = 12 in) For units with 2 or 3 sections, the order of unit installation must be respected as in tables (from left to right) and always at bottom of section

Operation principle R1 to R9

The ACS580-01 is a drive for controlling asynchronous AC induction motors, permanent magnet motors and synchronous reluctance motors (SynRM).

The figure below shows the simplified main circuit diagram of the drive.

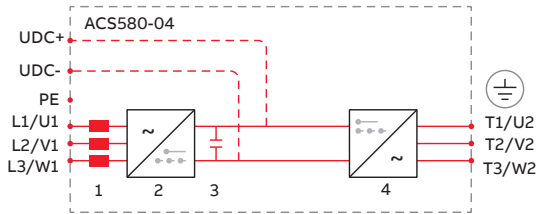


1. Rectifier. Converts alternating current and voltage to direct current and voltage.
2. DC link. DC circuit between rectifier and inverter.
3. Inverter. Converts direct current and voltage to alternating current and voltage.
4. Built-in brake chopper (R-, R+) in frames R1...R3. Conducts the surplus energy from the intermediate DC circuit of the drive to the brake resistor when necessary. The chopper operates when the DC link voltage exceeds a certain maximum limit. The voltage rise is typically caused by deceleration (braking) of a high inertia motor. The user obtains and installs the brake resistor when needed.
5. DC connection (UDC+, UDC-), for an external brake chopper in frames R4...R9.

* For further information about this topic, please refer to Hardware Manual 3AXD50000044794

Operation principle R10 and R11

The ACS580-04 is a drive module for controlling AC induction motors, synchronous reluctance motors and synchronous permanent magnet motors in open loop control. The main circuit of the drive module is shown below.



1. AC choke.
2. Rectifier.
3. Inverter. Converts alternating current and voltage to direct current and voltage.
4. DC link. DC circuit between rectifier and inverter.
5. Inverter. Converts direct current and voltage to alternating current and voltage.

* For further information about this topic, please refer to Hardware Manual 3AXD50000044794

VFD unit configurations

Following are the standard configurations and their single-line diagrams.

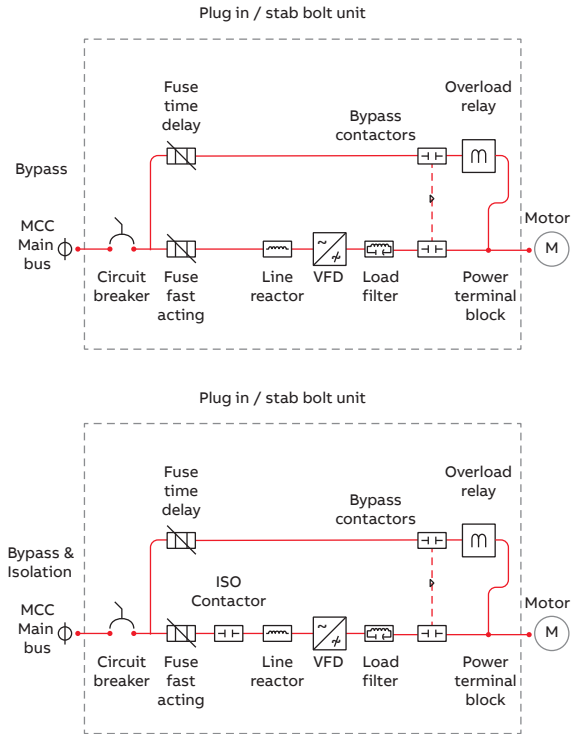
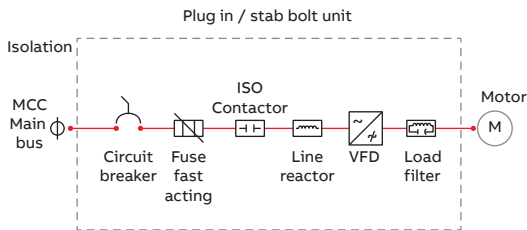
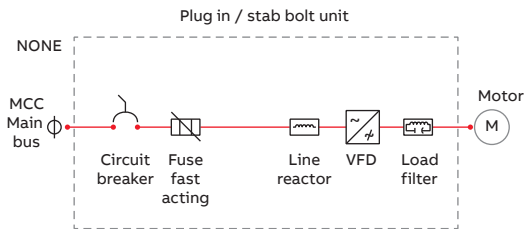


Table 92: VFD options

	Drive fuses will be used to maintain the drive UL listing
Fuses	R1 to R11 use fast acting fuses to protect the drive
	R10 (BP feature) uses fast acting fuses to protect the drive and time delay fuses to protect BP branch
Line reactor and load filter	Optional features (LR and LF could be or not, depending on customer requirement)
	LF available with LR only

Harmonic filters

Poor power quality can be a result of variable frequency drives or other types of non-linear loads using a power conversion process that causes current and voltage distortion. This resulting distortion is known as harmonics.

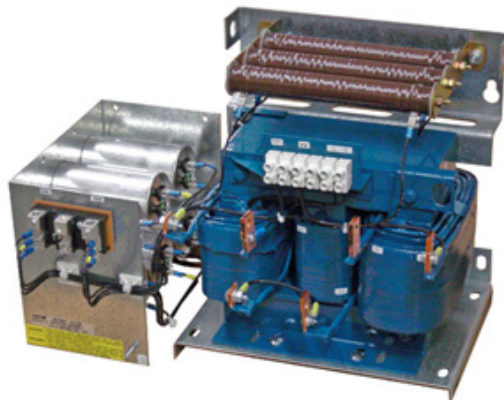
Issues caused by harmonics may include:

- Transformer and distribution equipment overheating
- Random breaker tripping
- Sensitive equipment failure
- Poor power factor

The MCC has the option to include (PHF) Passive Harmonic Filters to meet IEEE 519 requirements.

Most traditional filters work fine at 100% power load, but severely underperform at lower loads. PHF is different, because virtually eliminates harmonic distortion by adapting to varying power loads. It delivers better THID (Total Harmonic Current Distortion) performance, increases energy efficiency, and allows you to meet IEEE-519 requirements. Its design generates less heat and is easy to install and maintain. With PHF power quality, energy efficiency and reduced downtime are easy to achieve. Improve three-phase power quality and reduce downtime with the adaptive passive technology:

- Adapts to varying power loads
- Best performance in the industry
- Extends the service life of electrical equipment
- Generator compatible



Harmonic derating

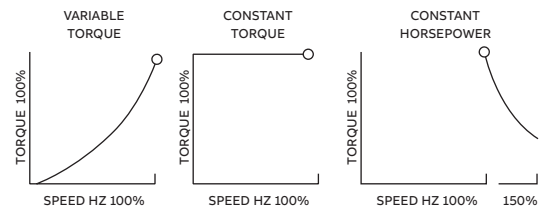
Motors that works with PWM (Pulse Width Modulation) signals from Drives are subject to harmonics. Depending on the modulation of PWM, switching frequency and other characteristics from Drive, motors may present increase losses and temperature, increased levels of vibrations, noise and efficiency losses.

Some motors are designed specifically for high efficiency with improved thermal characteristics; they may be applied at nameplate rating for variable torque duty, such as centrifugal fans and pumps, for 4 and 6 pole ratings. Standard AC motors designed for 60 Hertz operation should be derated 10% for variable torque duty.

How to select drives

Types of load

In selecting inverters, load patterns of machines should be known in advance. Generally, loads can be categorized into the three types shown below. Estimate or obtain the point marked O as indicated. This defines maximum torque and the maximum or minimum speed requirement of the driven equipment. Calculate the required motor hp by substituting the maximum torque and rated motor base speed in equation ⁽¹⁾.



$$^{(1)} Hp = \frac{t \times n}{5250}$$

Hp = required hp

T = torque in lb./Ft.

N = speed in rpm

Select the proper motor using the data from motor application brochures, identify the motor full load current and select the inverter which meets or exceeds the motor full load current requirements.

Motor speed range

Motor synchronous speed is determined by the following equation:

$$\text{Sync. motor speed} = \frac{\text{Frequency} \times 120 \times \text{applied}}{\text{Number of motor poles}}$$

Induction motors operate at a somewhat slower speed than synchronous speed due to slip, which is generally 2-3 percent of synchronous speed.

If the application requirements call for higher or lower speeds than can be obtained by using standard motors following these application guidelines, gear increasers or reducers should be considered.

Multi motor drives

In certain applications, multiple motors can be driven simultaneously by one drive unit. In order to select the proper inverter, total the individual motor full load currents and add 20% (to adjust a small leakage by inductance). Select the inverter than can deliver the total current calculated. Each motor will require individual overload relays, when switched independently rtf.

Acceleration time

Acceleration time is programmable. If the programmed setting calls for a faster acceleration than the drive system is capable of, the unit may trip due to an overcurrent condition. Therefore, the actual time to accelerate the driven load should be calculated using the following equation and the acceleration time setting should be adjusted accordingly.

$$TA = \frac{(Wk^2 \times \Delta N)}{308 (T \times 1.2)}$$

Where:

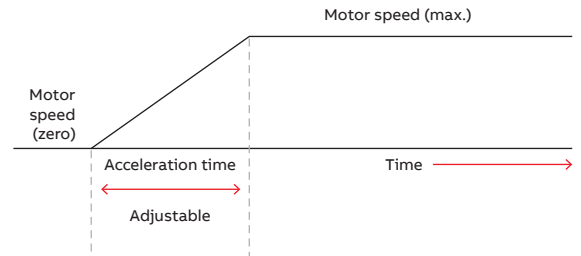
Ta = time to accelerate the driven load (in seconds).

Δn = change in speed (in rpm)

Wk² = the total system inertia reflected to the motor shaft. Includes motor, machine gears (in ft./Lbs.²)

T = motor full load torque (lb./Ft.)

When using a drive in a conventional constant speed machine application where a full voltage starter has been used, the acceleration time should be set longer than the original machine. This is because the maximum allowable current that the acs580 drive can deliver is 110/150% (light duty/heavy duty) of rated current, while full voltage starters deliver 600-800 percent. This means that the drive delivers a “soft start” and thus reduces starting torque over that of a full voltage starter, which naturally yields a longer acceleration time.



Deceleration time

Deceleration time is programmable. If the programmed setting calls for faster deceleration than the drive system is capable of, the unit may trip due to an overvoltage or overcurrent condition. Therefore, the actual time required to decelerate the driven load should be calculated using the following equation and the deceleration time setting should be adjusted accordingly.

$$TD = \frac{(Wk^2 \times \Delta N)}{308 (T \times 1.2)}$$

Where: td = time to decelerate the driven load (in seconds).

Δn = change in speed (in rpm)

Wk² = the total system inertia reflected to the motor shaft. Includes motor, machine gears (in ft./Lbs.²)

T = motor full load torque (lb./Ft.)

If faster deceleration is required, refer to ABB technical assistance.

Cable and motor considerations for ACS580

In recent years, a primary concern has been for wiring between adjustable speed drives and motors. This is because voltage spiking, seen at the motor terminals at the switching frequency can cause damage to the motor insulation. This spiking depends on several factors such as drive input voltage level, drive output wave-form dv/dt, length of the cabling from the drive to the motor and characteristics of the cabling used, etc. In addition, there are secondary effects related to drive/motor wiring that impact performance such as parasitic capacitance.

Drive input voltage, motor insulation and cable length are beyond the scope of the drive design. The following guidelines were compiled for your convenience.

System filtering

The use of a properly sized filter can reduce the voltage peaks and rise times seen at the motor. The filter must be properly sized and located. If the filtering is done with reactors it must be placed close to the motor terminals. If the filtering is with Irc (inductance, resistance and capacitance) it must be placed at the output terminals of the drive.

Estimating cable length restrictions

Below table provides estimates for the maximum motor cable lengths that should be observed to minimize the risk of motor insulation damage due to voltage stress. Cable lengths are listed for various levels of peak voltage withstand capability with and without dv/dt filters.

The listed peak voltage withstand capabilities are peak voltages that motors must withstand at a rise time of 0.1M and a 3 khz switching frequency. The motor insulation must withstand these peak voltages continuously for a normal operating lifetime. The 1000v capability level is the minimum that should be considered for use with an adjustable frequency drive application. If a motor with a lower capability level is connected to a pwm drive, only a limited service life can be expected. When new, many good quality standard motors have a peak voltage withstand capability of 1200v to 1300v. ABB can provide inverter duty motors that can withstand 1600v peaks with the waveform characteristics encountered with ABB drives.

Table 93: Maximum motor cable length recommendation

	1000 V peak				480 V motors		600 V motors	
	Widthstand		Widthstand		1600 V peak		1600 V peak	
	Output reactor	dv/dt filter	Output reactor	dv/dt filter	Output reactor	dv/dt filter	Output reactor	dv/dt filter
	Up to 60 HP	>25 ft.	>200 ft.	>40 ft.	>200 ft.	>375 ft.	>600 ft.	Any length
60 - 150 HP	>40 ft.	>200 ft.	>150 ft.	>200 ft.	>375 ft.	>600 ft.	Any length	
Over 150 HP	>40 ft.	>200 ft.	>250 ft.	>200 ft.	>375 ft.	>600 ft.	Any length	

Cable length estimates are based only on peak voltage considerations. Refer to the drive instruction material for other restrictions that may apply to specific AC drive models

Cable length estimates are based on operation at the nominal 480V line voltage. Reduced cable lengths apply to installations that experience sustained operation at high line voltages

Cable length estimates apply to motors that are not subjected to abnormal thermal and environmental stresses. Refer to the application, installation and operating guidelines provided by the motor manufacturer

Data for motors rated to withstand 1600V peaks applies to inverter duty motors furnished by ABB

Softstarters

PSTx softstarter

An ABB PSTx softstarter offers value by securing motor reliability, improving installation efficiency and increasing application productivity.

Complete motor protection

The PSTX offers complete motor protection in only one unit and is able to handle both load and network irregularities. Temperature control, ground fault protection and over/under voltage protection help to keep your motor safer than ever. PSTX also offers three types of current limit: standard, dual and ramp. This gives you full control of your motor during start and allows you to use your motor in weaker networks.

Built-in bypass saves time and energy

When reaching full speed, the PSTX will activate its bypass. This saves energy while reducing the softstarter's heat generation. On the PSTX, the bypass is built-in and verified by ABB, saving you time during installation and space in your panel.

Complete control of pumps

Time to maximize your processes to their full potential. The PSTX features many application enhancing features, including torque control: the most efficient way to start and stop pumps. The pump cleaning feature can reverse pump flow and clean out pipes, securing uptime of your pump system.

Feature list

- Rated operational current: 9 to 590 A
- Three-phase controlled
- Operational voltage: 208 – 600 VAC
- Wide rated control supply voltage: 100 – 250 V, 50/60 Hz (inside-delta: 2160 A)
- Detachable keypad rated IP66 & UL Type 1 & Type 12
- Graphical display with 17 languages for easy setup and operation
- Built-in bypass for energy saving and easy installation
- Built-in Modbus RTU for monitoring and control
- Support for all major communication protocols (DeviceNet, Profibus, Modbus TCP/IP, and Ethernet IP)
- Analog output for measurement of current, voltage, power factor etc.
 - External ground fault using ITI GFM 252 relay

NOTICE

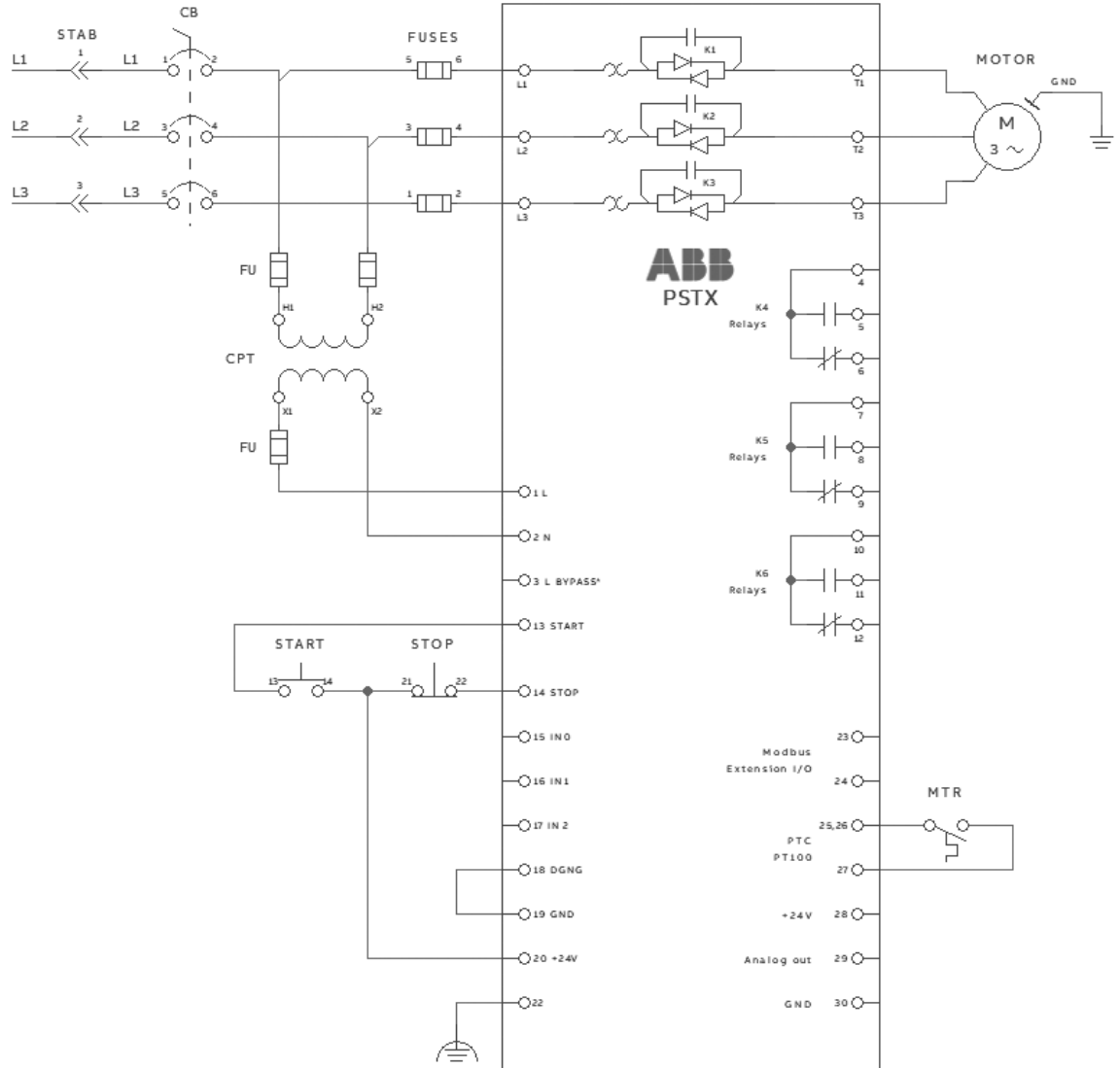
Notice: CEM11 is not used in LV MCC construction.



Technical data and functions

Please refer to PSTx landing page for further technical data.

PSTX30 ... PSTX570 UL circuit diagram



Isolation (ISO)

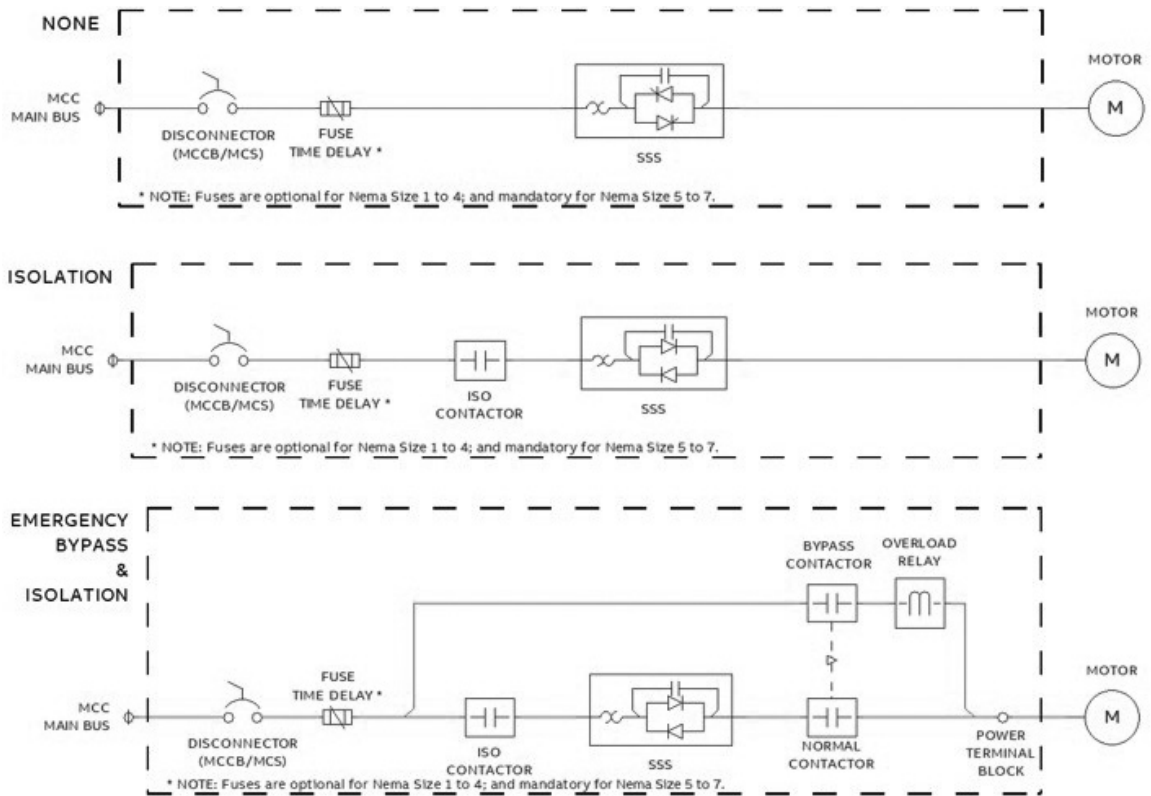
The isolation contactor between the Circuit Breaker and Softstarter is used to isolate the softstarter from the power source when the softstarter is at fault or if maintenance is required.

PSTx Softstarter Unit Configurations

Following are the standard configurations and their single-line diagrams.

Emergency Bypass & Isolation (E-BP & ISO)

When bypassing is required, employ mechanically and/or electrically interlocked contactors to ensure they cannot be closed simultaneously. This feature is used for non-stopping the starter function of the unit, but instead of using the softstarter will be use an alternate emergency bypass line to continue working.



PSTX Units Space Height and Features

For each below softstarter Nema Size table, exist
Features and SCCR values in common:

Table 94: SSS PSTX Units Space Height, 65 kA Type 1/12

	Function	Plug In	Max HP @					Disc	Section 1		Section 2	
			208V	230/240V	380/415V	440/480V	575/600V		Width	x Height Min	Width	x Height
Without Fusible	SSS only	•	10	10	20	25	30	XT4	15	2		
		•	20	20	40	50	50	XT4	15	2.5		
		•	40	40	57	100	100	XT4	15	3		
With Fusible	SSS only	•	10	10	20	25	30	XT4	15	2		
		•	20	20	40	50	50	XT4	15	2.5		
		•	40	40	75	100	100	XT4	15	4		
		•	75	75	150	200	200	XT5	20	4		
		•	100	100	300	500	500	XT7	24	7.5		
Without Fusible	SSS + isolation contactor	•	10	10	20	25	30	XT4	15	2		
		•	20	20	40	50	50	XT4	15	2.5		
		•	40	40	75	100	100	XT4	20	3		
With Fusible	SSS + isolation contactor	•	10	10	20	25	30	XT4	15	2		
		•	20	20	40	50	50	XT4	15	3		
		•	40	40	75	100	100	XT4	20	3.5		
		•	75	75	150	200	200	XT5	20	4.5		
		•	100	100	300	500	500	XT7	30	7.5		
Without Fusible	SSS + emergency bypass and isolation contactor	•	10	10	20	25	-	XT4	15	2.5		
		•	20	20	40	50	-	XT4	15	3		
		•	40	40	75	100	100	XT4	20	4		
		•	-	-	-	-	-	XT4	20	4.5		
With Fusible	SSS + emergency bypass and isolation contactor	•	5	7.5	10	15	15	XT4	15	2.5		
		•	10	20	25	30	30	XT4	15	3		
		•	20	40	50	50	50	XT4	15	3.5		
		•	40	40	75	100	100	XT4	20	4.5	-	-
		•	75	75	150	200	200	XT5	20	3	20	4

Table 95: SSS PSTX Units Space Height, 100 kA Type 1/12

	Function	Plug In	Max HP @				Disc	Section 1		Section 2		
			208V	230/240V	380/415V	440/480V		575/600V	Width	x Height Min	Width	x Height
Without Fusible	SSS only	•	10	10	20	25	-	XT4	15	2		
		•	20	20	40	50	-	XT4	15	2.5		
		•	40	40	75	100	-	XT4	15	3		
With Fusible	SSS only	•	10	10	20	25	-	XT4	15	2		
		•	20	20	40	50	-	XT4	15	2.5		
		•	40	40	75	100	-	XT4	15	4		
		•	75	75	150	200	-	XT5	20	4		
		•	100	100	300	500	-	XT7	24	7.5		
Without Fusible	SSS + isolation contactor	•	10	10	20	25	-	XT4	15	2		
		•	20	20	40	50	-	XT4	15	2.5		
		•	40	40	75	100	-	XT4	20	3		
With Fusible	SSS + isolation contactor	•	10	10	20	25	-	XT4	15	2		
		•	20	20	40	50	-	XT4	15	3		
		•	40	40	75	100	-	XT4	20	3.5		
		•	75	75	150	200	-	XT5	20	4.5		
		•	100	100	300	500	-	XT7	30	7.5		
Without Fusible	SSS + emergency bypass	•	10	10	20	25	-	XT4	15	2.5		
		•	20	20	40	50	-	XT4	15	3		
		•	40	40	75	100	-	XT4	20	4		
With Fusible	SSS + emergency bypass and isolation contactor	•	5	5	7.5	10	-	XT4	15	2.5		
		•	10	10	20	25	-	XT4	15	3		
		•	20	20	40	50	-	XT4	15	3.5		
		•	40	40	75	100	-	XT4	20	4.5		
		•	75	75	150	200	-	XT5	20	3	20	4

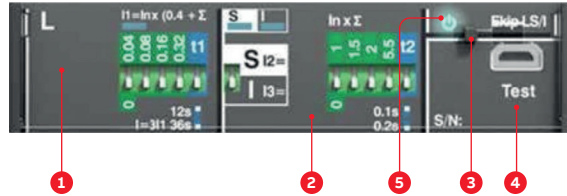
NOTICE Notice: Only Plug In units may be AFM (Arc Flash Mitigation). The sizes of units Non-AFM vs AFM are the same.

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43 Ekip DIP trip unit features

Ekip DIP

The first level of electronic trip units, Ekip DIP trip units, are based on microprocessor technologies and guarantee high reliability, protection, adjustability and coordination.

They provide protection against overloads, selective short circuits, short circuits and ground faults. The power required for their operation is provided directly from the current sensors.



- ① Overload-protection setting
- ② DIP switches for short-circuit and time-delayed short-circuit
- ③ Slot for lead seal
- ④ Test connector
- ⑤ Power-on LED

—
43

DIP switches

The DIP switches on the front of the trip unit allow manual settings when the trip unit is off.

LEDs

The LEDs on the front indicate the status of the release (on/off) and provide information about the protection tripped when the Ekip TT accessory is connected.

Table 101: Ekip DIP features

Field of application	Trip unit	L – overload protection		S – selective short-circuit protection		I – short-circuit protection	
		Current threshold	Trip time	Current threshold	Trip time	Current threshold	Trip time
Power distribution protection	Ekip DIP	LSI	Adjustable	Adjustable	Adjustable	Adjustable	Fixed
		LSIG	Adjustable	Adjustable	Adjustable	Adjustable	Fixed

Table 102:

In [A]	10	25	40	60	100	125	150	225	250	300	400	600	800	1000	1200
XT2	•	•		•	•	•									
XT4			•	•	•		•	•	•						
XT5									•	•	•	•			
XT7													•	•	•

Front connector

The connector on the front of the unit allows the connection of:

- Ekip TT for trip testing, LED-test and signalling of the most recent trip
- Ekip TandP for connection to a laptop with the Ekip Connect program (thus measurement reading, as well as trip and protection function tests, are made available to the user)

Table 100: Characteristics of electronic Ekip DIP trip units

Operating temperature	-25°C to +70°C
Relative humidity	98%
Self-supplied	0.2xIn (single phase)*
Auxiliary supply (where applicable)	24 V DC ± 20%
Operating frequency	45 to 66 Hz
Electromagnetic compatibility	IEC 60947-2 Annex F

*For 10 A: 0.4 in

Thermal memory

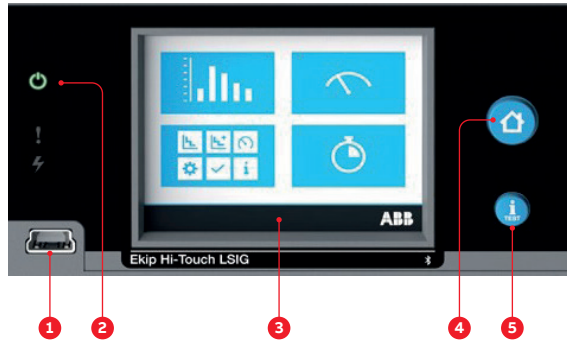
All the Ekip DIP trip units include a thermal memory function. The trip unit records the trips that have occurred in the last few minutes. Since the trip causes overheating, to protect the cables and let them cool down, the trip unit imposes a shorter delay-tripping time in case of a fault.

Thus, the system is protected against damage due to cumulative overheating. This can be disabled if needed by using the Ekip TandP.

—
44 Ekip Touch/Hi-Touch
trip unit features

Ekip Touch/Hi-Touch

Ekip Touch/Hi-Touch trip units provide a wide series of protections and high accuracy measurements of all electrical parameters. They are intended to integrate perfectly with most common automation and supervision systems.



- 1 Power-on LED; pre-alarm LED; alarm LED
- 2 Test and programming connector
- 3 Display
- 4 Home pushbutton to return to homepage
- 5 Pushbutton for testing and tripping information

—
44

Table 103: Ekip Touch/Hi-Touch features

Trip unit	Current measurement and protection	Voltage, power, energy measurements	Voltage, power, energy protections	Embedded functions*
Ekip Touch LSI	•	◦	◦	◦
Ekip Touch LSIG	•	◦	◦	◦
Ekip Hi-Touch LSI	•	•	•	•
Ekip Hi-Touch LSIG	•	•	•	•

• Default available

◦ Additional features

* Please refer to the SACE®Tmax® XT catalog 1SXU210248C0201 for more details

Table 104: XT5 & XT7 with Ekip Touch/Hi-Touch Ratings

In [A]	40	60	100	125	150	225	250	300	400	600	800	1000	1200
XT5							•	•	•	•			
XT7										•	•	•	•

NOTICE

NOTICE: Some motor starters may utilize the previous generation Spectra circuit breakers for a period of time. Please reference DET-291 for the application data if the specific project utilizes Spectra breakers.

Communication and connectivity

The Ekip Touch/Hi-Touch trip units integrate perfectly into most common automation and energy management systems to improve productivity and energy consumption and for remote control. The circuit breakers can be equipped with communication modules for Modbus, Profibus and DeviceNet™ protocols, as well as Modbus TCP, Profinet and EtherNet/IP™. The modules can be easily installed even at a later date.

The integrated display makes interaction with the Ekip Touch/Hi-Touch an easy and intuitive experience for the user, and the embedded Bluetooth functionality allows fast interaction via EPiC (electrification products intuitive configurator), the new mobile application to configure and check the status of ABB low-voltage circuit breakers.

High pressure contact (HPC) switches

The new generation HPC switch is based on the time-proven platform of the Power Break II circuit breaker. Now, it's ArcWatch-enabled to provide a better Arc Flash hazard mitigation solution. The new generation HPC builds on the abilities of the original HPC by utilizing the features of the Power Break II (PBII) circuit breaker. In addition, HPC utilizes the EntelliGuard control unit which incorporates many of the features of the EntelliGuard Trip Unit for circuit breakers.

The HPC switch is available in frame ratings of 800, 1200, 1600, 2000 and 2500, both top and bottom feed, with IC ratings to 200kA with the appropriate UL Class L fuses. The new generation HPC switch is available for new installations and for retrofit, to replace the older HPC. By retrofitting with the new generation HPC switch, remote operation of the switch through the motor operators, shunt trips with lockouts, RELT and the Adjustable IOC for continuous reduced incident energy can be added in the same footprint as that of the older existing switch.

Features and benefits

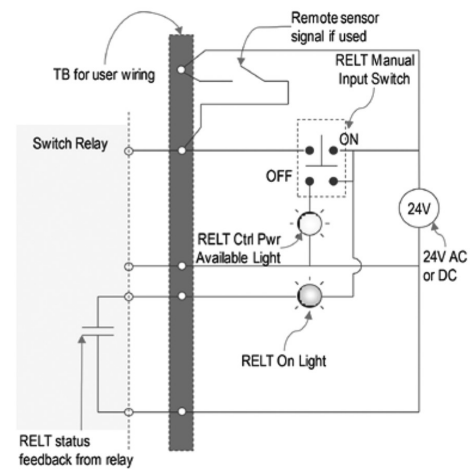
- Top or Bottom Feed
 - 800-4000 Amperes 600 Volts ac Max
- High Durability–Safety of Operation
 - High-dielectric strength, glass reinforced insulating case
- High Interrupting Capability
 - Arc chute of unique construction suppresses arcs and cools gases rapidly, providing quick arc interruption and extended switch life
- High Transient Voltage Withstand Capability
 - Interphase partitions mesh with switch cover to completely isolate each pole
- Extended Switch Life
 - Preloaded constant pressure pivot eliminates braid whip and fraying on high short-circuit currents and repeated operations
- Positive “ON-OFF” Indication
 - Green (OFF), Red (ON), eliminates any question about the position of the switch contacts
- Easy Operation Quick Make
- Emergency Open–Quick Break
 - Finger-tip “OFF” button instantly opens the switch contacts
- Fuse Mounting Bolts with Captive Washers for Ease of Mounting Fuses
- Padlocking Provisions Standard



In addition, the HPC utilizes the EntelliGuard control unit which incorporates many of the features of the EntelliGuard Trip Unit for circuit breakers:

- Built-in metering, waveform capture and Modbus communications
- Ground fault protection or alarm, optional GF disable
- WFR Adjustable Selective Instantaneous protection
- RELT Alternate Adjustable fast instantaneous setting, remote operable and with positive status feedback
- Zone-Selective operation for GF that works with all circuit breaker trip platforms and includes four different GF curve shapes
- Instantaneous Zone-Selective operation that works with upstream EntelliGuard Trip Units and EntelliGuard control units

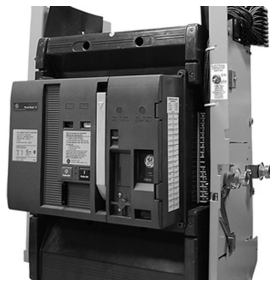
RELT Control Schematic



Power Break II insulated case circuit breakers

General description

Power Break II insulated case circuit breakers offer the rugged, reliable type of system protection critical for heavy-duty applications. In ReliaGear LV MCC, Power Break II circuit breakers are rated up to 100,000 A RMS symmetrical interrupting capacity without fuses or current limiters. In ReliaGear LV MCC, the Power Break II design consists of 800, 1600A*, 2000A*, and 2500A* Amp frame sizes.



Power Break II is a versatile breaker, designed for a wide variety of applications with features such as temperature insensitive trip units, push-to-open and -close buttons, standard padlocking provision, maximum three-cycle closing time, field installable rating plugs to change ampere ratings, UL listing, plug in field installable accessories, and easy-to-operate two stage pumphandle, stored-energy operating mechanism capable of change after close.

EntelliGuard TU trip unit

EntelliGuard TU is the trip unit with the built-in flexibility required to match your system's needs, whether for optimum safety, optimum system reliability or both at the same time. The EntelliGuard TU trip unit provides the industry's most advanced instantaneous protection without compromising system selectivity.



Standard features for exceptional flexibility

- Highly flexible time current settings
 - up to 22 Long Time Delays
 - up to 22 (fuse shaped) Long Time
 - up to 14 Short Time Delay bands
 - 3 Short Time slopes (I²T)
- Selective Instantaneous algorithm (WFR)
- Ammeter
- Large backlit LCD screen
- Breaker status indication
- Universal rating plugs – less plug inventory
- Status and event log (10 Events)
- Date and time event stamping
- LED health status indicator
- Free set-up software
- Discrete I/O
- Thermal memory, battery back-up
- Common interface across all versions
- Mechanism self-timing

Optional full-function metering

- Current (Amps, kAmps)
- Voltage (Ph-Ph, Ph-N)
- Energy (kWh, MWh, GWh)
- Real power (kW, MW)
- Total power (kVA, MVA)
- Frequency (Hz)
- Demand (avg. kW, MW) and peak demand

Options

- Internal/external ground fault trip or alarm with 4 curves to select from (I²T, I⁴T, special selective GF curve, and definite time slope)
- Switchable ground fault trip / alarm (now password protected and UL Listed)
- Modbus RTU communications (Profibus also available for EntelliGuard G)
- Waveform capture for harmonic analysis
- Full-function metering
- Protective relaying (see list of functions below)
- Zone-Selective-Interlocking for GF, ST, Instantaneous (I-ZSI)
- Threshold Zone-Selective-Interlocking for ST and Instantaneous (T-ZSI)
- Built-in Zone-Selective-Interlocking test capability
- RELT – Reduce Energy Let Through
- RELT and ground fault alarm harness kits
- Test Set GTUTK20
- Digital Test Kit Software, available December 2013

Optional protective relaying functions

- Undervoltage
- Overvoltage
- Voltage unbalance
- Current unbalance
- Power reversal
- Power direction setup

1. Some options require 24VDC additional hardware to enable Metering, Relaying, RELT, ZSI, Modbus to be added to the breaker, equipment cubicle and equipment sections.

* 1600A, 2000A, 2500A PowerBreak II circuit breakers are 100% rated in the LV MCC construction. 800A PowerBreak II circuit breakers are 80% rated

Ground fault current detection systems

Model BGFL (Relay)

Trip Currents 5-60, 30-360, or 100-1200A

Description

These Class 1 Model BGFL ground fault relays and sensors form a system for detecting a ground fault current on a ground ac power system. When a ground fault exceeds a pre-selected current level and time delay setting, the relay initiates a trip signal for a shunt trip disconnect device to open and clear the fault. This BGFL system provides protection for electrical equipment, not for personnel.

Operating range: Trip currents of 5-60, 30-360, or 100-1200A. Time delay from 0.10 to 1 second (adjustable).

Input power: 2 VA plus shunt coil requirements. Rated @ 120 Vac.

Input withstand: 200,000 A RMS for 3 cycles, 50/60 Hz.

Nominal input voltage: 120 Vac ac, 125 Vac dc, 24 Vac dc, 48 Vac dc.

Frequency: 50/60 Hz.

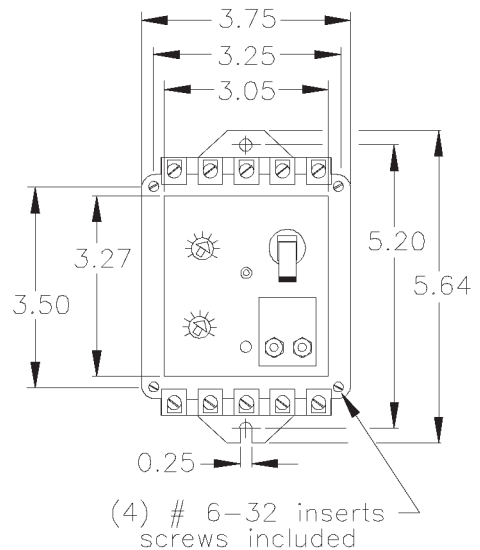
Ambient temperature range: -30°C to +60°C
Only for use with GFL sensors.

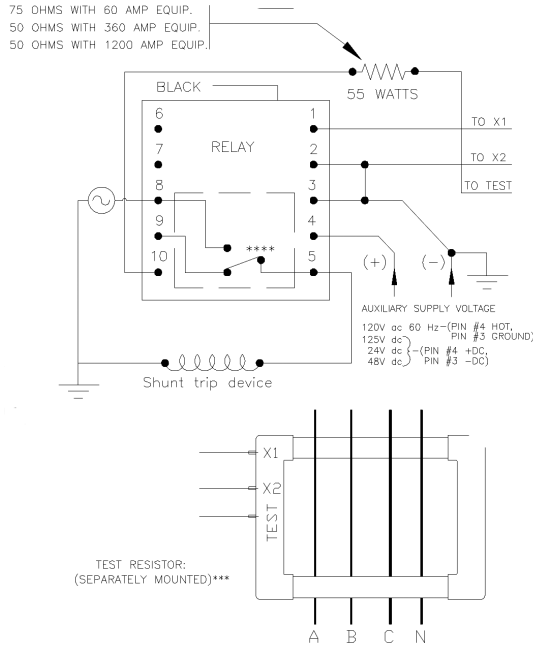
Approximate weight 1.5 lbs.

- Meets NEC service entrance equipment standards
- Available in three basic styles: Standard, Form C or Zone Interlocking for coordination of single or multiple ground fault devices in system
- Integral test panel with Push To Test and Shunt Trip Bypass pushing for ease in proper operational testing of the system, with or without tripping the protective device
- Power On LED indicator in cover
- Positive visual trip indicator, manual reset
- Infinitely adjustable Time Delay
- Discrete current threshold adjustment
- Panel or door mounting
- Rear terminal kit and clear plastic cover standard with door mounting
- Electromechanical relay output, positive ON and OFF
- Operates with molded case and power circuit breakers, bolted pressure switches, fusible disconnect switches

Table 105: Contact rating

Device input power	Inrush	Cont.
120 VAC AC	10A	3A
125 VAC DC	1A	1A
48 VAC DC	4A	4A
24 VAC DC	8A	8A





NOTICE

Notice: Mounting provision on rectangular GFL sensors with 11.1 inches and 13.2 inches widths.

Ground fault current detection systems

Model GFM relay
2.0 to 65 Amp trip currents

Description

These Class 1 Model GFM Ground Fault protection systems are designed to minimize damage or loss to equipment caused by destructive arcing ground faults. This GFM system is designed for all polyphase applications and is ideally suited for motor control, motor control centers, and medium voltage starters. Systems can be wye or delta, grounded or resistance grounded. When the ground fault current exceeds a preselected condition (current and time settings) the relay trips. The relay contacts can be connected in the control circuit of a motor starter, to the shunt trip of a circuit breaker or similar disconnecting or alarm devices. The system has an inverse time characteristic to prevent nuisance tripping. The relay tripping current value is field adjustable over the trip current range of the sensor. The adjustable trip time delay relay is field settable up to 36 cycles.

Operating range: Trip currents from 2.0-65A. Time delay from instantaneous to 36 cycles.

Input power: Self-powered

Frequency: 50/60 Hz.

Ambient temperature range: -30°C to +60°C
Only for use with GFL sensors.

Operation

- Positive condition indication
- Normal (Reset) - Green (“ON”)
- Tripped - Red (“OFF”)
- Manual Reset

Table 106: Ground Fault Modules

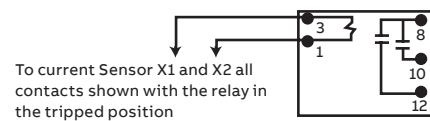
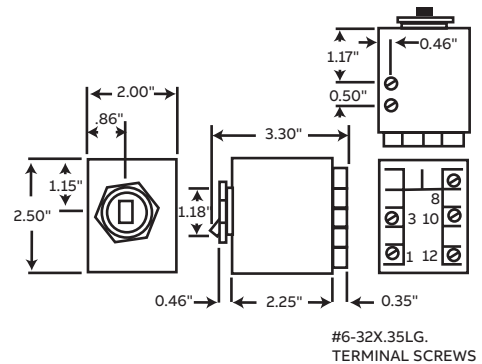
Model number	Trip ⁽¹⁾ Current
GFM 156	3.8 to 18
Model number	Trip ⁽¹⁾ Current
GFM 3P208	5 to 20

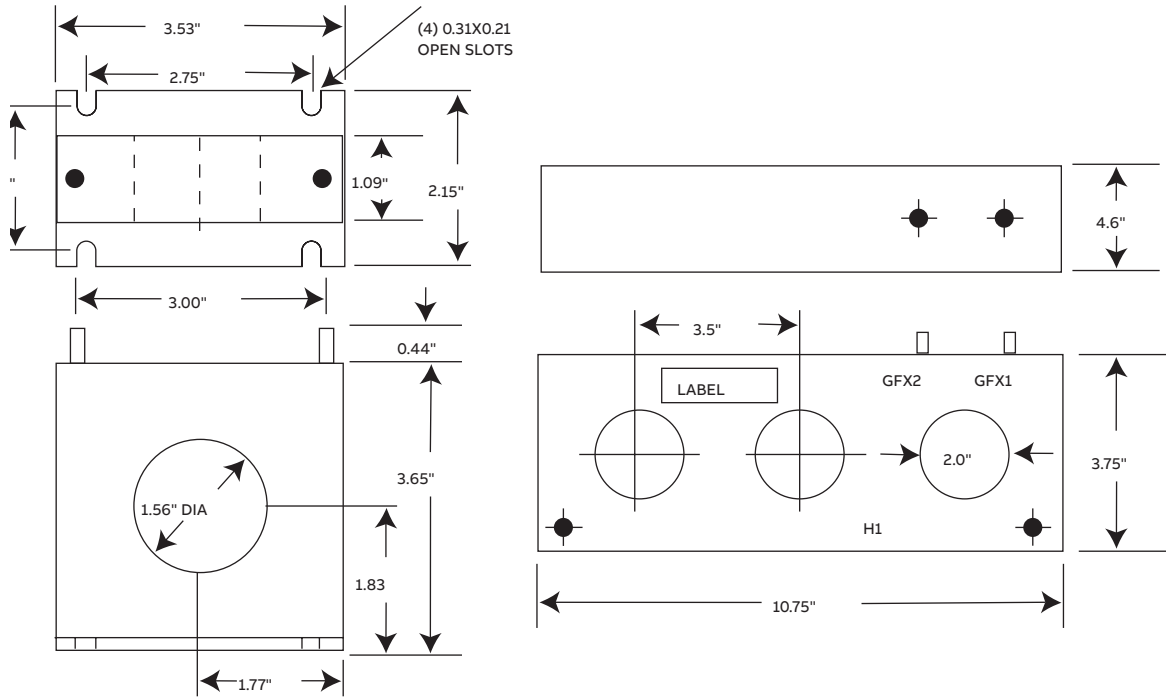
1. Trip current tolerance is ± 15 percent.



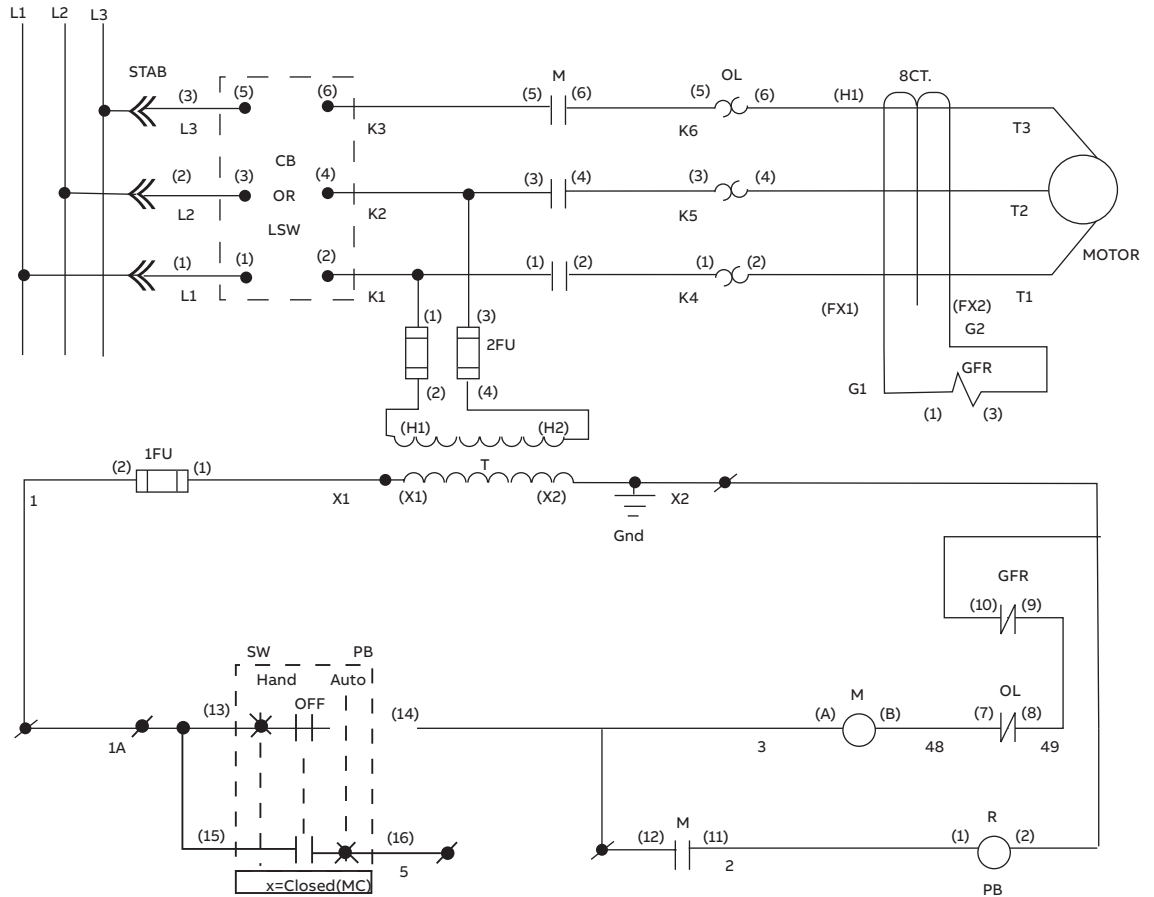
Model GFM-252 and 262

Contacts rated 10 Amps continuous, 23 Amps inrush, 120 Vac AC.





Typical circuit

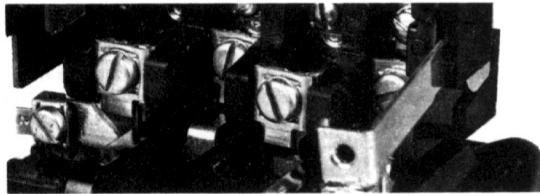


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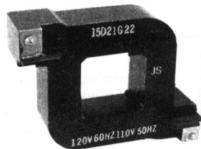
300-line motor starters

The 300-line starter is a full-voltage, magnetic motor starter with encapsulated coil and three-leg block overload relay with visual trip indicator, manual reset and manual weld check. It incorporates all the features and benefits most asked for by users and has received standard specification approval by many major manufacturers. In addition to the basic non-reversing form, the 300-Line is available in reversing, two-speed and combination forms in NEMA sizes 00-5.

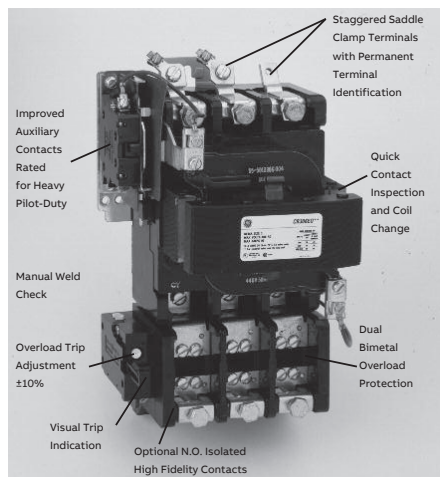
The 300-Line’s toolless contactor disassembly allows quick access for inspection and maintenance. Simply release two coil retainers and pull the spring clip from the “I” magnet to gain access to the magnet, coil and contacts. No need to remove any wiring.



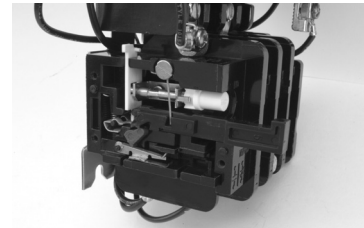
Optional terminals can be provided to permit the easy connection of power factor correction capacitors for energy conservation.



The molded coil is impervious to moisture, dirt and oil. It is highly resistant to mechanical damage and high-humidity failure. Retaining clips engage detents encapsulated in the coil to hold it securely in place.

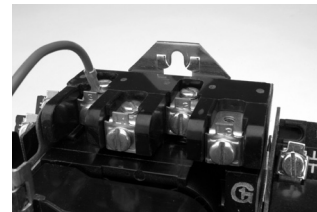


300-line motor starters



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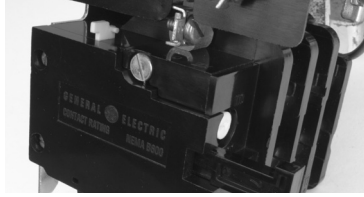
Where it’s essential to monitor performance or diagnose faults, a 300-Line starter may be ordered with an additional isolated, highfidelity, normally-open contact on the overload relay. This contact may be used for direct input to a programmable controller or direct interface with a computer.



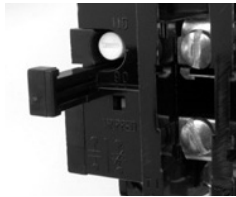
All line and load terminals on NEMA size 00, 0 and 1 starters have saddle clamps to accommodate all types of terminations– ring, spade and stripped-wire. Terminal numbering is permanently stamped, and terminals are staggered to help prevent shorting. NEMA size 2, 3 and 4 starters are also available with provision for ring terminations with staggered terminals. Size 5 starters are available with provision for ring terminations. In-line terminals for spade and stripped-wire connections are standard.



On NEMA size 1 starters and larger, contact tips are weld-resistant with cool operation and extended life. The contacts have a wedgeshaped configuration for positive make with minimum bounce. They can be easily changed from normally open to normally closed without additional parts on Sizes 0 and 1. Magnet provides long life and is specially treated to resist rust.

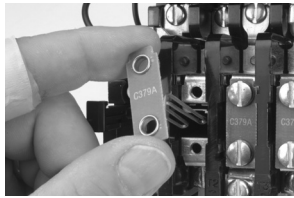


The overload relay can be manually tripped deliberately as a convenient way to check against contact welding. Depressing the manual weld check arm trips the relay. Then a welded contact can be detected with a simple continuity check.



Overriding is eliminated because overload reset occurs only when the reset arm is released on the standard manual-reset form.

A bright yellow visual trip indicator tells operators at a glance if the overload has tripped. An optional automatic-reset overload relay is available for special applications upon request.



Overload relay heaters are completely interchangeable with heaters for 200- and 100-Line starters, eliminating the need to stock different heaters.

Relay trip points are factory calibrated at given currents for high accuracy. For added flexibility, the trip current of the relay is adjustable ± 10 percent to allow tuning the protection to any given motor and to eliminate nuisance tripping. A single calibration adjusts all three legs. The overload relay is available in standard or ambient-compensated forms.

Each auxiliary contact is rated 10 A AC, continuous current (NEMA A600), and is suitable for either right or left side mounting. All necessary parts are supplied in the modification kit for easy installation. An insulating shield is also provided for use between each auxiliary contact unit and the starter.

Auxiliary contact kits offered include one with a basic contact block and one with an adder block. The basic block is supplied with either a single circuit (one normally open contact or one normally closed contact) or a double circuit (one normally open and one normally closed contact). The adder block must be used in conjunction with a basic block. It may be ordered with either one normally open or one normally closed contact.

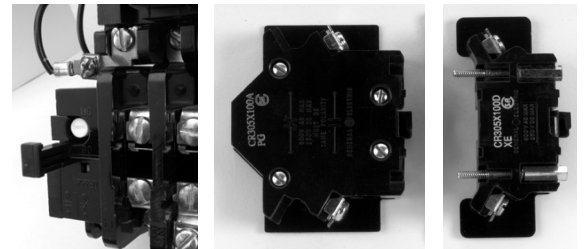


Table 107: Overload relays

	CR324 thermal bimetallic overload relay	CR324X electronic overload relay	UMC100.3 motor controller	MM200 motor controller	MM300 motor controller
Description	The CR324 thermal bimetallic overload relays use interchangeable match overload relays to motor amps. A ±10 trip adjustment dial is used to fine tune the motor overload relays. Overload relay features include trip test , manual reset on upstroke, weld check visible trip indicator and an optional normally-open signal contact	The CR324X is an electronic alternative to the CR324 bimetallic overload relay. The CR324X eliminates the need for heater elements, providing a broader amperage adjustment range. Provisions for increased diagnostic capabilities permit automation control via auxiliary contacts and remote reset open collector. Mounting dimensions are identical to the CR324 thermal overload relay and permit fast, simple field upgrades	The Universal Motor Controller UMC100.3 delivers all the reliability and protection you expect while driving an intelligent data hub for predictive applications, maintenance and asset management. Outstanding user experience for smooth running of your operations, paired with unrivalled communication options, simple configuration and market leading software	The MM200 integrates protection, control and multiple communication protocols in a rugged compact device for low voltage motor applications. Easily integrated into new and existing control system architectures, the MM200 provides comprehensive low voltage motor protection and all types of motor protection applications	The MM300 integrates protection, control, automation, metering, diagnostics and multiple communication protocols in a rugged compact device for low voltage motor applications. Designed for motor control centers, the MM300 delivers superior protection and control to extend equipment life and maximize process uptime
Type	Thermal bimetallic	Electronic	Electronic	Electronic	Electronic
Protection class	20	10, 20, 30 (selectable)	5, 10, 20, 30, 40 (selectable)	10, 15, 20, 30 (selectable)	10, 15, 20, 30 (selectable)
Ambient compensation	Optional	Ambient insensitive	N/A	Yes*	Yes*
Phase loss protection	No	Yes	Yes	Yes	Yes
Phase unbalance	No	No	Yes	Yes	Yes
Ground fault	No	No	Yes	Yes	Yes
Self powered	Yes	Yes	No (power from starter CPT)	No (power from starter CPT)	No (power from starter CPT)
Accuracy	±5%	±2%	3%	2%	2%
Repeatability	±3%	±2%	-	-	-
Fla adj. range	Up to 135A	"0.4-540 A Depending on relay chosen"	"0.24-63A for base relay 60-850A with external CT's"	5 to 1000 FLA in steps of 1A**	5 to 1000 FLA in steps of 1A***
Reset mode	Manual (auto optional)	Manual	Manual and Automatic	Manual and Automatic	Manual and Automatic
Trip test	Yes	Yes	No	Manual and Automatic	Manual and Automatic
Trip indication	Yes	Yes	LED/User Interface/ SCADA	LED/User Interface/ SCADA	LED/User Interface/ SCADA
Operating temp. range	0° to 55°C	-20° to 70°C	0...+60 °C	-20°C to +60°C	-20°C to +60°C **
Communications	No	No	"-Modbus RTU -Profibus -DeviceNet -Modbus TCP -EtherNet IP -ProfiNet"	"-Modbus RTU -Modbus RTU + Profibus DP -Modbus RTU + DeviceNet"	"-Modbus RTU -Modbus RTU + Modbus TCP + Profibus DP -Modbus RTU + Modbus TCP + DeviceNet"

Table 107: Overload relays (continued)

	CR324 thermal bimetallic overload relay	CR324X electronic overload relay	UMC100.3 motor controller	MM200 motor controller	MM300 motor controller
Addressable	No	No	Yes	Yes	Yes
Heater Required	Yes	No	No	No	No
PFC Terminals	Yes (optional through NEMA Size 2)	Yes (optional through NEMA Size 2)	No	No	No
PLC Compatible Contacts	No	Yes	Yes	Yes	Yes
Aux. Contacts	NC (NO optional)	NO and NC		2 NO, 1 C FORM	2 NO STANDARD, ADD ON AVAILABLE
Inputs/Outputs			6 inputs / 3 outputs		
Mount	Designed to mount directly to CR305 contactor or panel mount.	Designed to mount directly to CR305 contactor or panel mount.	Din-Rail Panel Mount	Din-Rail Panel Mount	Din-Rail Panel Mount
Reference Publication	Control Catalog Section 1	DEP-015	-2CDC135011B0203	"-090824 - V17 -GEK-113400E -1601-9034-A6"	"-131111 - V21 -GEK-113022J -1601-9023-AA"
Notes			Internal CT's up to 63A, external CT's required >63A **1-10 turns are available to accommodate CT turns lower than 5A "	**When ordered with RTD Module	**When ordered with RTD Module ** based on 1" around base unit ***1-10 turns are available to accommodate CT turns lower than 5A"

This table reflects standard offering of overload relays; however, other overload relays can be included if needed. If you have other overload relays you wish to add to your MCC, please contact the factory for assistance

ASTATs and VFDs utilize integral overload protection algorithms. External overload relays are only used with ASTATs and VFDs to support the motor control in a bypass configuration

30 mm pilot devices

Description

Newly-designed nameplates with chrome-plated octagonal rings project an attractive, quality appearance. Positive feel selector switches give a quality touch in all illuminated, solid color, spring return, and maintained units.

Standard and illuminated push buttons and selector switches are available. Both push button and selector switches are available with key or for conventional operation. The 30 mm push-button line also includes press-to-test and standard indicating lights, mushroom-head, joy stick, push-pull and push-push operators.

Application

Especially adapted to machine-tool service or any application where oil or coolant is present. The convenient one-hole mounting makes this line suitable for general purpose use in equipment of all kinds where panel mounting is possible. This line is ideal for applications where oil tightness, watertightness and long life are essential.

All units are suitable for use in Type 1, 3R, and 12 environments when mounted in enclosures rated for those same applications.

Features

- Ease of assembly—One screw contact block mounting. Octagonal ring provides ease in front panel mounting and enclosure applications.
- Greater torque—Due to the eight-sided ring design, greater torque can be developed during assembly and installation to provide oil tightness.
- Stocking inventories reduced—Forms may be furnished as complete units or as components, allowing building block construction from a minimum of stock.
- Color Coded—Colored knobs and caps are available in kit forms for easy field conversion.

30 mm pilot lights

Pilot lights match appearance of switches above. Standard applications use full voltage or transformer type lights. Optional nameplates match those used with switches, neon lights are available (with limited lens colors).

Table 108:

Type	STD	Push-to-test	Bulb	Color
Full voltage (120 VAC)	•	•	#120PSB	Red
				Green
Transformer (6 VAC secondary)	•	•	#755	Amber
				Blue
				White
				Clear
Neon	•	N/A	Neon	Red
				White
				Amber
				Clear
LED (transformer type only)	•	•	LED (6 Volt)	Red
				Green
				Blue
				Amber
				Amber



Contact ratings

Table 109: AC ratings, NEMA A600 heavy pilot duty

Max. Ac	Continuous current Amps	AC Voltamperes @ 60/50 Hz ²	
		Make	Break
600	10	7200	720

Table 111: DC ratings, NEMA P600

Max. Make or break amps		
125 V	250 V	600 V
1.1	0.55	0.2

1. Maximum make and break currents are 60 and 6 amperes respectively for voltages of 120 and below.

Solid-state motor winding heater

Description

The motor winding heater is designed for use with 3-phase ac motors to guard against damage caused by condensation build-up on motor windings, which can occur in high-humidity environments during motor idle periods. With the heater connected as indicated in the connection diagram, and the motor not running, an SCR controlled current flows in the motor windings, producing enough heat to maintain the temperature inside the motor above the ambient temperature. The motor winding heater is automatically energized after the starter contacts (M) open, and de-energized when the starter contacts close. Fuses are included for SCR overcurrent protection and protection for wiring.

If desired, a pilot light can be connected as shown (“Fuse Condition Indicator”) to visually monitor the condition of the fuses. With the starter contacts open, the light will be On if current paths through FU1 and FU2 are complete. The pilot light should have a line voltage rating.

Specifications

Output Voltage Regulation: Voltage applied to motor winding will vary +2% maximum for line voltage variations of +10%, -15%.

Operating Temperature Range: -20°C to +50°C.

Fusing: FU1–Fast-acting semiconductor fuse for SCR overcurrent protection. FU2–Class RK-5 rejection type fuse with time delay for wiring protection.

Additional SCR Protection: Metal oxide varistor protects against voltage surges. RC snubber circuit limits rate of change of circuit voltage.

Table 110: Motor HP range

Motor voltage +10%, -15%, 3-Phase 60 Hz	Motor horsepower range
230/460V	15-400 Hp
575V	25-400 Hp

Heater is UL Listed in MCC Construction

REM 6010 automation power meter

BACnet/IP communications and energy measurement.

Overview

The REM 6010 is an industry leading revenue grade power meter with native BACnet/IP communications. This meter is designed to integrate seamlessly into existing and new building management systems using the popular BACnet protocol. The meter allows users to gather data on voltage, current, power and energy usage throughout a facility.

Designed to be the perfect device for environmental initiatives, LEED certified projects and smart energy projects, the EPM 6010 provides superior metrology, and revenue testable 0.2% energy accuracy. The meter is in compliance with ANSI and IEC accuracy standards, has advanced DSP technology, samples at high rates, and has 24 bit A/D conversion to measure and analyze power accurately and reliably.

Applications

- LEED projects
- Smart buildings
- Commercial energy management
- HVAC efficiency monitoring
- Building management systems

Key benefits

- Rapid integration into BACnet management systems
- High accuracy multifunction power meter, 0.2% class revenue certifiable energy and demand metering
- Ultra compact and easy to install, fits both ANSI and DIN cutouts
- EnerVista software makes metered data and power quality status easily accessible
- User programmable for different system voltages and current measurements
- Standard Modbus and TCP communications
- Easy to read, large 3 line .56 inches bright LED display for better visibility and longer life

**Features****Measuring and Metering**

- High accuracy multifunction power meter, 0.2% class revenue certifiable energy and demand metering
- Samples at 400+ times per cycle and has 24 bit A/D conversion to measure accurately and reliably
- Meets ANSI C12.20 (0.2%) and IEC 687 (0.2%) accuracy classes
- Total harmonic distortion (%THD)
- Load percentage graphical bar for instant load visualization
- True RMS multifunction measurements including voltage, current, power, frequency and energy

Communications

- BACnet/IP 100BaseT Ethernet protocol
- 40 pre-defined BACnet objects facilitate rapid integration
- Embedded web-server, allows BACnet/IP interface to be remotely configured and BACnet objects can be remotely viewed over the internet with a web browser
- Standard Modbus TCP communications can be used to poll the EPM 6010 while BACnet/IP interface is being used

For more information on EPM 6010, please see <https://www.gedigitalenergy.com/multilin/catalog/epm6010.htm>

REM 7000 power meter

Power quality and energy cost measurement

Overview

The REM 7000 meter provides revenue class (0.2%) three phase power metering with optional Ethernet, relay, status, and analog output communication modules. This flexible meter can be used for a wide range of high accuracy applications including disturbance recording and power quality studies.

EPM 7000 can easily be mounted in a panel for generator monitoring, substation automation, power quality studies, data recording and more. The meter can also provide data to RTUs, PLCs and other control devices.

The REM 7000 is a highly accurate meter providing 0.1% accuracy for Voltage and Current. The unit's real-time clock provides time stamping of all logs as they are created. Up to 4 MB of data can be logged for analysis of historical trends, limit alarms, I/O changes power quality recording and sequence of events.

Applications

- Four quadrant energy and power monitoring of distribution feeders, transformers, reactors and generators
- Power monitoring of LV and MV industrial power control centers and motor control centers.
- Energy monitoring of commercial and distribution utilities

Key benefits

- Four Quadrant Energy and Power Measurement, complying with ANSI C12.20 (0.2% Accuracy)
- Analyze power quality over long periods of time to improve network reliability through high resolution event and disturbance recording
- Ideal for monitoring industrial power centers, data centers and hospitals due to high accuracy disturbance recording (up to 512 samples/cycle)
- Retrieve archived data, capture past events and analyze disturbances through high resolution data recording (up to 4MB of data logging)
- Flexible communication options provide easy to access meter values, simplified configuration and seamless integration into new or existing automation systems



Features

Metering

- Meets ANSI C 12.20 and IEC 687 (0.2%) accuracy
- Ia Ib Ic In
- Va Vb Vc Vab Vbc Vca
- Hz W VAR VA
- Wh VARh VAh
- Demand: W VAR VA
- Power factor
- Voltage and current angles
- Load bar

Power quality

- Harmonics to the 40th order
- Total harmonic distortion
- Disturbance recording and waveform capture
- Sag and swell

Data logging

- Up to 4 MB memory
- Disturbance recording
- Power quality studies
- Load studies

Communications

- Standard RS485 Modbus (DNP 3.0 and Modbus RTU or ASCII)
- Optional Ethernet 100BaseT
- IrDA port
- Intuitive faceplate programming

Software

- Embedded web server
- Communicator

For more information on EPM 7000, please see <https://www.gedigitalenergy.com/multilin/catalog/epm7000.htm>

PQM II power quality meter

Power quality and energy cost management

Overview

Multilin has set a new standard in metering technology with the introduction of the PQM II. This meter, designed on the latest industry specifications, provides accurate and reliable three-phase power metering with an optional Ethernet and fiber communications module in a small and modern package. The PQM II can be used for a variety of applications including metering of distribution feeders, transformers, generators and motors.

Applications

- Metering of distribution feeders, transformers, generators, capacitor banks and motors
- Medium and low voltage systems
- Commercial, industrial, utility
- Flexible control for demand load shedding, power factor, etc.

Key benefits

- Power quality metering with waveform capture and historical data logging
- Easy to program and use with keypad and large illuminated 40 character display
- Multiple communication ports for integration with DCS and SCADA systems
- Supports DNP 3.0 and Modbus protocols
- Digital and analog I/Os for control and alarms
- Voltage disturbance recording capability for electrical sag and swell events



Features

Monitoring and metering

- Ia Ib Ic In
- Va Vb Vc Vab Vbc Vca
- V I unbalance
- True PF crest and K factor
- Hz W var VA
- Wh varh VAh W cost
- Demand: A W var VA
- Harmonic analysis through 63rd with THD and TIF
- Event recorder - 150 events
- Waveform capture
- Data logger -98,000 events
- Voltage Disturbance Recorder (VDR) -500 events

Communications

- Front RS232 serial port (1,200 to 19,200 bps)
- Two rear RS485 serial ports with ModBus and DNP 3.0 protocol
- Ethernet connectivity provided by MultiNet
- EnerVista software is provided for setup and monitoring functions
- External dial-in modem capabilities

Protection and control

- Load shedding
- Power factor control
- Pulse input totalizing

For more information on PQM II, please see <https://www.gedigitalenergy.com/multilin/catalog/pqmil.htm>

Three-phase voltage monitors

Model SPVRB

General

UL Listed file No. E103039 The model SPVRB Voltage Sensing Relay is designed to protect against single phase, phase loss, phase unbalance, and phase reversal in a power system. The output contacts change their normal state only when a single phase, phase loss, phase unbalance, or phase reversal occurs for longer than the preset trip delay. A total power loss or de-energization of the SPVRB relay will not change the output contacts position. Recommended for manual reset switches and breaker applications. The SPVRB is suitable for loss of phase with motor loads.

Features

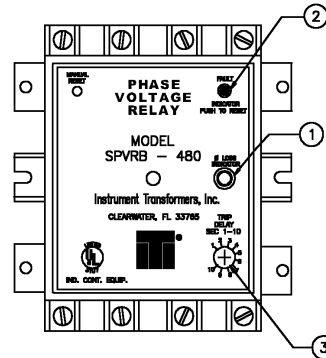
- Phase unbalance: 8%
- Adjustable trip delay: 1 to 10 seconds after failure occurs, prevents nuisance operations
- Output relay: normally de-energized, form C contacts for easy circuit configuration
- Electro-mechanical indicator: retains memory of fault until manually reset
- Door or panel mounting
- Status indicator: bi-colored LED
 - Green: output relay de-energized (normal condition)
 - Red: output relay energized (fault condition)
 - Dark: output relay de-energized (input power off)
- Single phase, phase reversal, phase unbalance and phase loss protection: operates the output relay after a preselected time
- Automatic or manual mode
 - Automatic mode: upon removal of fault conditions, relay automatically resets to normal
 - Manual mode: upon removal of fault conditions, relay resets to normal after local or remote reset button has been pressed

SPVRB — XXX

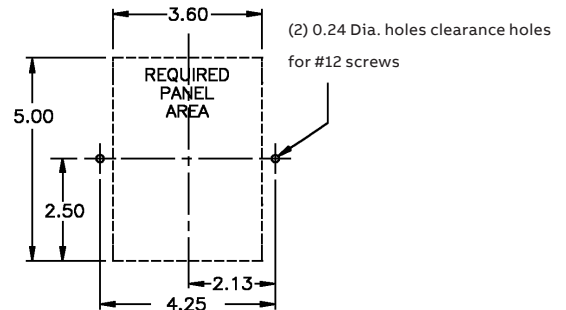
Input voltage: 120/208/240/480 or 575 Vac, (60 Hz) 380 or 415 Vac, (50 Hz)

Table 111: Available models

Model No.	Nominal Vac	Hz
SPVRB-120	120	60
SPVRB-208	208	60
SPVRB-480	480	60
SPVRB-575	575	60
SPVRB-380	380	50
SPVRB-415	415	50



- 1 Bi-Colored LED Indicator
- Power system condition normal (Green), trip (Red)
- 2 Electromechanical diagnostic indicator
- Phase loss
- 3 Adjustable system delay
- Phase loss
 - Phase unbalance
 - Single phase
 - Phase reversal
 - Under and over voltage



Panel mounting layout

Table 112: Output contact ratings

Voltage	Continuous	HP
120 Vac	10 A	1/3
240 Vac	10 A	1/2
600 Vac	3 A	1/2

10 A, 28 Vdc/120 Vac/240 Vac, 80% pf
 3 A, 480 Vac/600 Vac, 80% pf

High-resistance ground

Equipment overview

High Resistance Grounding Equipment coordinates the use of resistors and control devices, creating a high-resistance ground for a power system. The grounding equipment has the following features:

- **Over-voltage reduction:** Reduces the transient over voltages that can occur during arcing faults
- **Fault detection:** Gives immediate warning when the first ground fault occurs
- **Fault tracking:** Helps locate the fault by producing a tracer signal of current pulses easily distinguishable from background noise
- **Operation protection:** Enables the system to continue operation with a single line-to ground fault present

Operational description – low-voltage systems (600v max)

Typical circuit used in low-voltage is shown on page L22.

When a ground fault occurs, the resistor acts to limit the ground current to a pre-determined low value. Taps are provided on the resistor to adjust the fault current. The voltage appearing across the resistor or the amperage through the resistor is sensed by the PulserPlus Pro Controller. A variable time delay is entered via the operator’s panel. When the time delay expires, the red Ground Fault indicator light will illuminate. Auxiliary contacts are provided in case a remote indication of the fault is needed or desired. The red light will stay illuminated until the ground fault is removed and the system is reset. Optionally, the PulserPlus Pro can be set for auto-reset. In addition, an audible alarm will sound when the ground fault occurs. This alarm can be silenced from the operator’s panel.

Features

- Undervoltage and undercurrent detection and alarm
- Adjustable pulser from 10 to 50 per minute for custom setup
- Adjustable trip delay to avoid nuisance downtime
- Alarm contacts for remote monitoring of ground fault, high harmonics and loss of ground
- High harmonic filtering and detection
- Third harmonics generator winding protection
- Remote operation and monitoring via RS232, Modbus or Ethernet communication

Line and control connections

The line connections are made to the main bus. The control power and auxiliary device connections are made to the terminal blocks rated 30 A, 600 Vac. Refer to the specific diagrams furnished with the equipment for location detail. Setup information is through the operator’s panel.

Where to use

The function of high-resistance grounding equipment is:

1. To provide a ground for neutral of an ungrounded three-phase power system, utilizing the high-resistance method. Using this equipment allows the system to operate basically as an ungrounded system. The equipment is designed to eliminate the danger of high-transient overvoltages during certain types of ground faults.

NOTICE

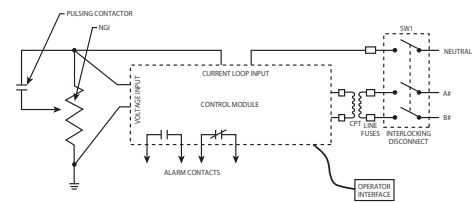
Notice: The use of high-resistance grounding on 600 Vac maximum systems precludes line-to-neutral loading.

2. To provide an immediate warning when the first ground fault occurs through an alarm system.
3. To provide a method for quickly locating and removing the fault before another fault develops on another phase, thereby preventing circuit outages due to double line-to-ground faults. This is done by using the pulsing ground current feature and portable detector.

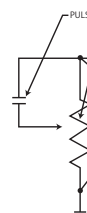
Table 113: Approximate dimensions and weights

Equipment enclosure type	W x D x H (inches)	With pulser in pounds		Without pulser in pounds	
		Wye	Delta	Wye	Delta
NEMA 1	20 x 20 x 90	600	700	575	675

600 Vac maximum Wye system



600 Vac maximum Delta system



MM200 motor management system

Low voltage motor protection and control

Overview

The MM200 meter integrates protection, control and multiple communication protocols in a rugged compact device for low voltage motor applications. Easily integrated into new and existing control system architectures, the MM200 provides comprehensive low voltage motor protection and communications for all types of motor protection applications.

Applications

- Low Voltage Three-Phase AC Motors
- MCC and standalone Panel Mount Applications
- IEC NEMA Motor Control Center (MCCs)
- Process control applications
- System architecture requiring multiple simultaneous communications
- FVNR, FVR, two speed

Key benefits

- Flexible Protection, Control, and Communication options to suit Low Voltage Motor applications
- Small footprint designed specifically for IEC and NEMA MCC applications
- Integrated pushbuttons and LED indicators reduce external wiring
- Flexible DIN rail mounting
- Multiple communication protocols allows simple integration into monitoring and control systems
- Optional control panel provides local control



Features

Protection and control

- Motor thermal model
- Undercurrent
- Current unbalance
- Acceleration time
- Sensitive ground fault
- Built-in starter logic
- FVNR, FVR, two-speed
- Auto / manual control
- Configurable inputs
- Power fail restart

Metering and monitoring

- Current, motor loads, thermal capacity
- Motor running time, cause of trip, total number of trips
- 1A / 5A combined CT inputs

Communications

- Networking through RS485
- Multiple protocols - Modbus RTU ODVA Compliant DeviceNet Internally powered Profibus
- Simultaneous communications

User interface

- Optional control panel with control push buttons and LED status indicators
- Includes EnerVista MM200 setup software for simple programming and retrieval of system or trip information

EnerVista software

- State of the art software for configuration and commissioning Multilin products
- Graphical logic designer and logic monitor to simplify designing and testing procedures
- Document and software archiving toolset to ensure reference material and device utilities are up-to-date

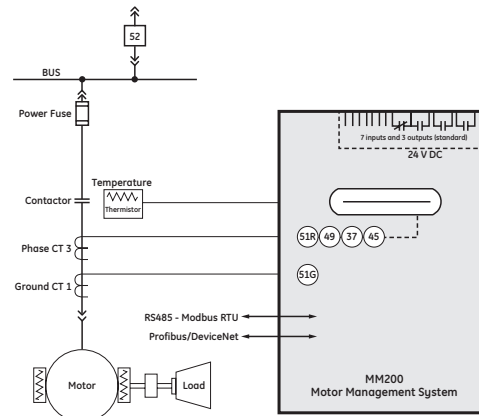
For more information on MM200, please see <https://www.gegridsolutions.com/multilin/catalog/mm200.htm>

MM200 motor management system

Functional block diagram

Table 114: ANSI device numbers and functions

Device No.	Function
37	Undercurrent
46	Current unbalance
49	Thermal overload
50G	Ground instantaneous overcurrent
51R	Locked/Stalled rotor, mechanical jam



MM200 motor management system

User interface

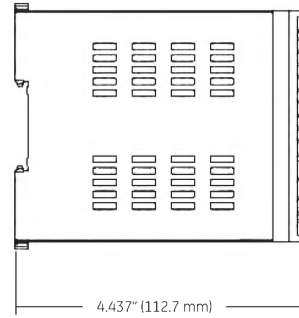
- Front panel controls**
- Integrated device controls

- 12 LED indicators**
- Motor status
 - Alarm indication and trip
 - Communication status
 - Additional user LEDs
 - Auto/manual
 - % motor load

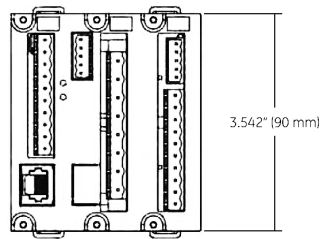


Dimensions

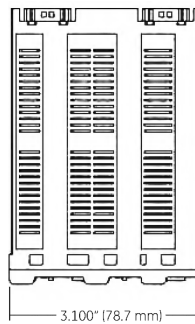
Side view



Front view



Top view



Optional Fieldbus Protocols
(ProfiBus or DeviceNet)

Power supply and digital inputs

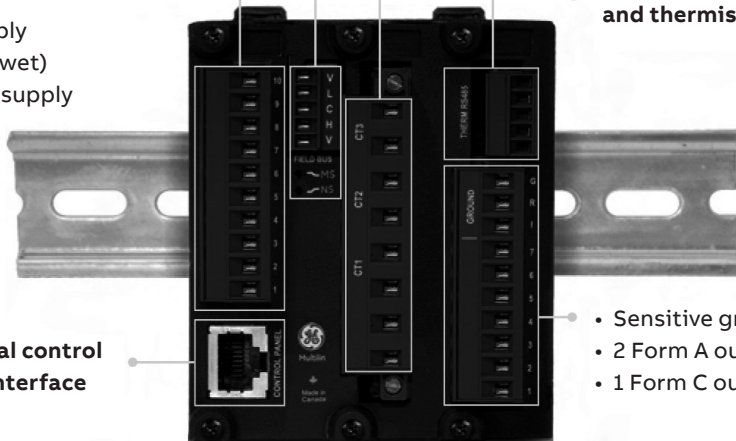
- 24 VDC Power supply
- 7 x 24 VDC inputs (wet)
- 60-300VAC power supply
- 6x AC inputs

3 Phase CT inputs

RS485 Communications and thermistor input

Optional control panel interface

- Sensitive ground fault
- 2 Form A outputs (5 Amps)
- 1 Form C outputs (5 Amps)



MM300 motor management system

Integrated automation and protection for low voltage motors

Overview

The MM300 meter integrates protection, control, automation, metering, diagnostics and multiple communication protocols in a rugged compact device for low voltage motor applications. Designed for Motor Control Centers, the MM300 delivers superior protection and control to extend equipment life and maximize process uptime.

Applications

- Low Voltage three-phase AC motors
- MCC or stand alone panel mount applications
- Reversing and reduced voltage applications
- Motor applications requiring advanced automation or control such as conveyor systems or well recovery pumps
- IEC or NEMA class motors

Key benefits

- Full-featured protection for low voltage AC motors
- Advanced automation capabilities for providing customized protection and integrated process control
- Advanced FlexLogic reduces requirement for local PLC's
- Reduced installation space requirements through integration of multiple devices including protection, control functions, pushbuttons, status LEDs and communication interfaces
- Application flexibility with multiple I/O options and programmable logic options (FlexLogic)
- Enhanced troubleshooting tools including sequence of event records and waveform capture
- Powerful communications including Serial, Ethernet, Profibus, and DeviceNet protocols
- Small form factor and remote display options designed to fit in MCC buckets

Features

Protection and control

- Enhanced thermal modeling
- Mechanical jam / stalled rotor
- Undercurrent
- Underpower
- Acceleration time
- Current unbalance
- Ground fault
- Sensitive ground fault
- Phase overvoltage / undervoltage
- Auxiliary undervoltage

- Phase reversal
- VT fuse failure
- Thermistor
- RTD overtemperature

Automation

- Programmable FlexLogic option
- Starter control
- Process interlocks
- Programmable inputs and outputs
- Undervoltage auto-restart

Metering and monitoring

- Metering — current, voltage, power, energy, frequency, RTD, thermistor
- Oscillography — analog values at 32 samples/cycle and digital states
- Event recorder — up to 256 time tagged events with 1ms re
- Advanced device health diagnostics

Communications

- Networking interfaces — two wire RS485, RJ45 Ethernet
- Multiple protocols (Modbus RTU , Modbus TCP/IP, Internally Powered Profibus, ODVA Compliant DeviceNet)
- Programming ports - USB, RS485
- Network time protocol (when ordered with Ethernet)



User interface

- Control panel with 12 status LED's, motor control and function keys
- Color HMI display featuring a full color graphical display, motor and system status LED's, USB programming port and motor control keys

EnerVista software

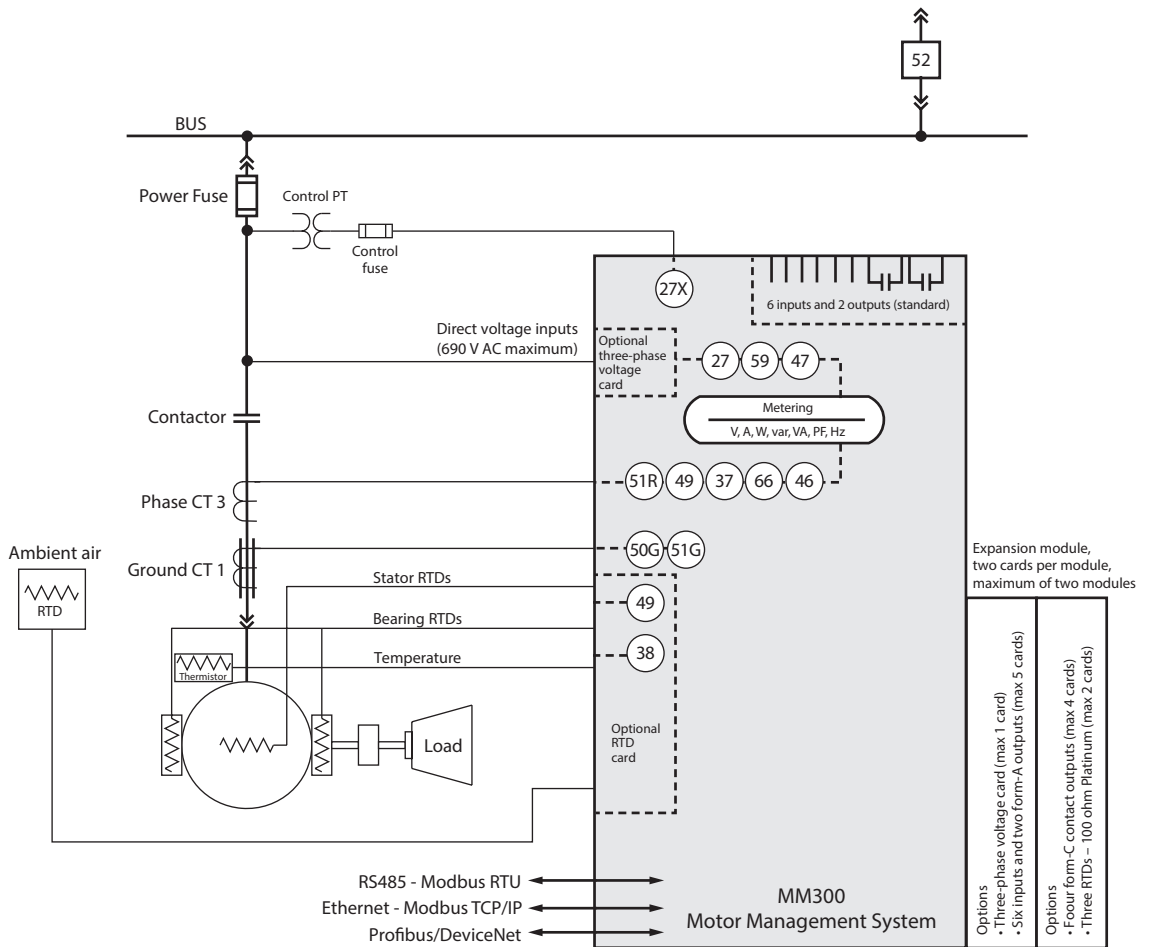
- State of the art software for configuration and commissioning Multilin products
- Graphical logic designer and logic monitor to simplify designing and testing procedures
- Document and software archiving toolset to ensure reference material and device utilities are up-to-date

For more information on MM300, please see <https://www.gegridsolutions.com/multilin/catalog/mm300.htm>

MM300 motor management system

Table 115: Functional block diagram - ANSI device numbers and functions

Device No.	Function
27AUX	Undervoltage - auxiliary input
27	Undervoltage - three phase
37	Undercurrent/Underpower
38	Bearing temperature RTD
46	Current unbalance
47	Voltage phase reversal
49	Thermal overload
50G	Ground instantaneous overcurrent
51G	Ground time overcurrent
51R	Locked/stalled rotor/mechanical jam
59	Overvoltage - three phase
66	Starts/hour and time between starts



MM300 motor management system

User interface

Graphical interface

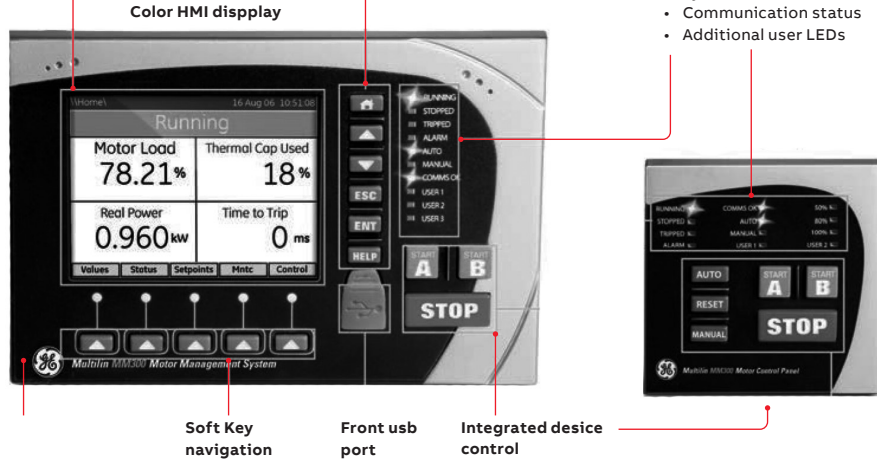
- Easy to use
- Wide viewing angle

Navigation keys

- View actual values and status
- View and modify settings

LED indicator

- Motor status
- Alarm indication
- System status
- Communication status
- Additional user LEDs



RS485 communications and thermistor Input

Profibus or DeviceNet
Optional fieldbus protocols

Switched power supply
Allows AC or DC control voltage

Optional TCP/IP Ethernet

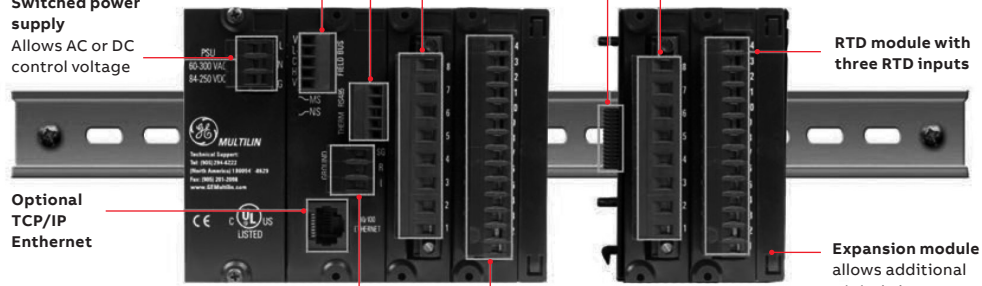
3 Phase + residual ground CT inputs

Expansion module
to base unit with a single connector

Optional 3 phase voltage module

RTD module with three RTD inputs

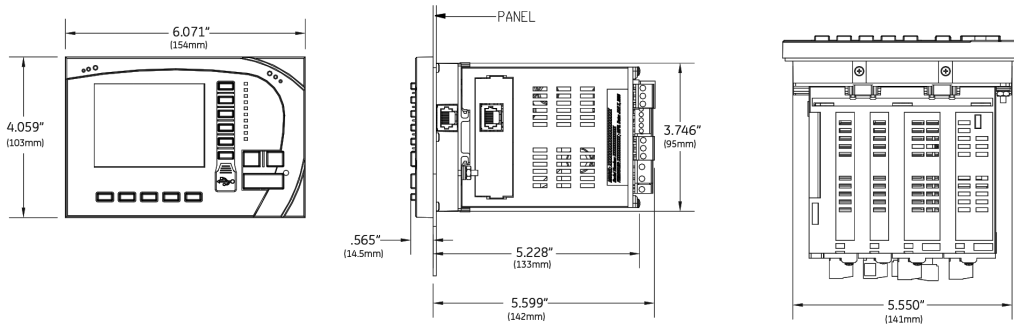
Expansion module
allows additional Digital I/O, RTD or voltage inputs



Core balance ground CT Input

- I/O card includes:**
- 2 contractor outputs (from A)
 - 6 programmable inputs
 - Single phase VT input (60-300Vac)

Dimensions



Application data

Approximate motor full-load current ratings
Full-Load Current for EPAC Compliant Motors.

Average expected values
For three-phase, 60 Hertz, Type KE (NEMA Design B) dripproof, normal starting torque, continuous 40°C ambient (1.15 service factor) horizontal induction motors.

NOTICE **NOTICE:** These values are for reference only and you should check your specific motor. Please refer to your specific ABB generated quotation for specific FLA values.

Table 116: Average expected values of full-load currents

Motor HP	Synchronous speed, RPM	Average expected values of full-load currents			
		200V	230V	460V	575V
1/4 ¹	1800	1.6	1.4	0.70	0.56
	1200	1.7	1.5	0.75	0.60
1/2 ¹	3600	2.0	1.7	0.85	0.68
	1800	1.7	1.5	0.75	0.60
	1200	2.0	1.7	0.85	0.68
	3600	2.0	1.8	0.88	0.70
1/2	1800	2.3	2.0	1.0	0.80
	1200	2.3	2.0	1.0	0.80
	900	3.2	2.8	1.4	1.4
	3600	2.8	2.4	1.2	0.96
3/4	1800	3.2	2.8	1.4	1.1
	1200	3.7	3.2	1.6	1.3
	900	4.4	3.8	1.9	1.5
	3600	3.7	3.2	1.6	1.3
1	1800	4.1	2.2	1.6	1.4
	1200	4.4	4.6	2.3	1.5
	900	5.5	4.8	2.4	1.9
	3600	5.3	4.8	2.4	1.8
1 1/2	1800	6.0	4.4	2.2	2.1
	1200	6.0	4.6	2.3	2.1
	900	7.1	6.2	3.1	2.5
	3600	6.9	6.0	3.0	2.4
2	1800	7.1	5.8	2.9	2.5
	1200	7.6	6.2	3.1	2.6
	900	10.6	9.2	4.6	3.7

Table 116: Average expected values of full-load currents (Continued)

Motor HP	Synchronous speed, RPM	Average expected values of full-load currents			
		200V	230V	460V	575V
3	3600	9.4	8.0	4.0	3.3
	1800	9.9	7.9	3.9	3.4
	1200	12.0	8.6	4.3	4.2
	900	15.4	13.4	6.7	5.4
5	3600	15.4	12.2	6.1	5.4
	1800	14.4	12.6	6.3	5.7
	1200	19.3	14.0	7.0	6.7
	900	19.8	17.2	8.6	6.9
7 1/2	3600	21.4	18.0	9.0	7.5
	1800	23.7	18.0	9.3	8.2
	1200	26.0	19.8	9.9	9.0
	900	28.5	24.0	12.4	9.9
10	3600	27.4	24.0	12.0	9.5
	1800	27.0	23.8	11.9	10.9
	1200	32.7	25.8	12.9	11.4
	900	33.1	28.8	14.4	11.5
15	3600	42.6	36.0	18.0	14.8
	1800	40.3	35.0	17.6	16.2
	1200	45.1	33.0	19.1	15.7
	900	47.6	41.4	20.7	16.6
20	3600	62.3	45.4	22.7	21.7
	1800	53.2	46.2	23.1	20.6
	1200	56.6	50.0	25.0	19.7
	900	63.9	55.6	27.8	22.2

Table 116: Average expected values of full-load currents (Continued)

Motor HP	Synchronous speed, RPM	Average expected values of full-load currents			
		200V	230V	460V	575V
25	3600	72.0	56.0	28.0	25.0
	1800	71.3	60.0	30.0	24.8
	1200	73.8	63.2	31.6	25.7
	900	82.6	71.8	35.9	28.7
30	3600	85.6	67.8	33.9	29.8
	1800	81.7	71.2	35.6	29.9
	1200	88.6	73.8	36.9	30.8
	900	92.2	80.2	40.1	32.1
40	3600	101	89.0	44.6	39.2
	1800	112	97.8	48.9	40.3
	1200	114	99.6	48.5	39.8
	900	122	105.8	52.9	42.3
50	3600	140	129	64.5	48.9
	1800	142	122	61.1	49.4
	1200	144	125.2	61.0	50.1
	900	159	138.2	69.1	55.3
60	3600	163	145.6	72.8	56.6
	1800	172	147.4	73.7	59.9
	1200	172	149.2	69.8	59.7
	900	176	153.4	76.7	61.4

NOTICE

Notice: The listed data is based on approximate full-load current ratings of standard, open, 1.15 service factor, continuous rated General Electric motors. Full-load current ratings of similar motors of other manufacturers may vary considerably. Therefore, whenever possible use actual full-load current rating given on motor nameplate. Contact motor manufacturer for full-load currents of single-phase and DC motors.

Table 116: Average expected values of full-load currents (Continued)

Motor HP	Synchronous speed, RPM	Average expected values of full-load currents			
		200V	230V	460V	575V
75	3600	206	181	90.5	71.5
	1800	207	180.0	91.6	72.0
	1200	206	719.2	86.7	71.7
	900	221	191.8	95.9	76.7
100	3600	262	238	119	91.2
	1800	281	232	116	97.7
	1200	283	246	118	98.4
	900	296	258	129	103
125	3600	338	290	139	116
	1800	340	296	143	118
	1200	352	306	149	122
	900	370	322	161	129
150	3600	398	346	164	138
	1800	412	348	169	143
	1200	419	364	177	146
	900	435	378	189	151
200	3600		446	217	178
	1800		468	226	187
	1200		482	239	193
250	3600		574	287	230
	1800		590	295	236
	1200		594	297	238
300	3600		676	338	270
	1800		686	340	274
350	3600		774	387	310
	1800		792	396	317
400	3600		890	445	356

1. Open, Type K, general purpose, NEMA SF, solid base, rolled-steel-shell, induction motors

Breaker trip set positions

The greatest degree of protection is provided when the magnetic trip setting is just above the motor starting inrush current.

It is therefore recommended that the magnetic trip position be adjusted to a setting one position higher than the setting that carries the motor starting current. For recommended continuous-current ratings, see overload heater tables.

Table 117: SACE® Tmax® XT circuit breaker current ratings

Circuit breaker	Trip unit	In (A)	L-overload			I-short circuit		
			I1 (A)			I3 (A)		
			Min	Med	Max	Min	Med	Max
XT2	Ekip I	3	Refer to below chart for Ekip I					
		7						
		15						
		30						
	MA	7				28	53	77
		50				150	350	550
		70				210	490	770
		80				240	560	880
		100				300	700	1100
		125				625	938	1250
XT4	MA	25				75	175	275
		50				150	350	550
		80				400	600	800
		100				500	750	1000
		110				550	825	1100
		125				625	938	1250
		150				750	1125	1500
		175				875	1313	1750
		200				1000	1500	2000
		225				1125	1688	2250
250				1250	1875	2500		
XT5	MA	300				2100	3000	3900
		400				2800	4000	5200
		500				3500	5000	6500

Table 118: EKIP I settings:

ABB code	Protection function	Threshold	Trip time	Trip curve
I	Short-circuit	I3 = Off – 1 – 1.5 – 2 – 2.5 – 3 – 3.5 – 4.5 – 5.5 – 6.5 – 7 – 7.5 – 8 – 8.5 – 9 – 10 x In	t3 ≤ 15ms for XT2-XT4 t3 ≤ 20ms for XT5-XT6 t3 ≤ 30ms for XT7"	t=k

Overload heater tables

Heaters for thermal-mag controllers

For continuous rated motors with a service factor of 1.15 to 1.25, select heaters from the heater table. For continuous rated motors with a service factor of 1.0, multiply the motor full-load current by 0.9 and use this value to select heaters. Overload relay tripping current in 40°C ambient is the minimum value of full load current multiplied by 1.25. Provide short circuit protection in accordance with the National Electrical Code.



WARNING

Warning: Opening of the circuit breaker may be an indication that a fault current has been interrupted. To provide continued protection against fire or shock hazard, all current-carrying parts and other components of the motor controller should be examined and replaced if damaged. If heater burnout occurs, the complete overload relay must be replaced.

Table 120: Size 0 and 1 (standard and ambient comp.)

Motor full-load Amps 3-Ph, 3 Heater	Heater number CR 123	Motor full-load Amps 3-Ph, 3 Heater	Heater number CR 123
.41-.45	C054A	4.96-5.49	C592A
.46-.49	C060A	5.50-5.91	C630A
.50-.53	C066A	5.92-6.47	C695A
.54-.59	C071A	6.48-7.20	C778A
.60-.65	C078A	7.21-8.22	C867A
.66-.76	C087A	8.23-8.72	C955A
.77-.84	C097A	8.73-9.67	C104B
.85-.93	C109A	9.68-10.4	C113B
.94-1.04	C118A	10.5-11.0	C125B
1.05-1.15	C131A	11.1-12.4	C137B
1.16-1.27	C148A	12.5-13.2	C151B
1.28-1.39	C163A	13.3-15.4	C163B
1.40-1.55	C184A	15.5-17.1	C180B
1.56-1.73	C196A	17.2-18.0	C198B
1.74-1.89	C220A		Size 1
1.90-2.05	C239A		
2.06-2.28	C268A	17.2-18.1	C198B
2.29-2.47	C301A	18.2-20.0	C214B
2.48-2.79	C326A	20.1-21.5	C228B
2.80-3.31	C356A	21.6-22.5	C250B
3.32-3.70	C379A	22.6-23.9	C273B
3.71-4.06	C419A	24.0-26.3	C303B
4.07-4.47	C466A	26.4-27.0	C330B
4.48-4.95	C526A		

Table 121: Size 2 (standard and ambient comp.)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123
5.48-5.85	C630A	16.8-17.9	C180B
5.85-6.47	C695A	18.0-18.7	C198B
6.48-7.35	C778A	18.8-20.4	C214B
7.36-8.06	C867A	20.5-22.7	C228B
8.07-9.03	C955A	22.8-24.7	C250B
9.04-9.61	C104B	24.8-26.3	C273B
9.62-10.5	C113B	26.4-29.5	C303B
10.6-11.6	C125B	29.6-32.5	C330B
11.7-12.5	C137B	32.6-36.7	C366B
12.6-13.6	C151B	36.8-41.9	C400B
13.7-16.7	C163B	42.0-43.2	C440B
		43.3-45.0	C460B

Table 122: Size 3 (standard and ambient comp.)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123
19.0-19.3	F233B	17.8-18.4	F233B
19.4-22.1	F243B	18.5-21.1	F243B
22.2-23.4	F270B	21.2-22.1	F270B
23.5-27.0	F300B	22.2-26.1	F300B
27.1-29.1	F327B	26.2-28.0	F327B
29.2-31.8	F357B	28.1-31.3	F357B
31.9-33.9	F395B	31.4-33.3	F395B
34.0-37.6	F430B	33.4-34.3	F430B
37.7-41.9	F487B	34.4-40.9	F487B
42.0-47.7	F567B	41.0-44.7	F567B
47.8-52.1	F614B	44.8-51.0	F614B
52.2-55.8	F658B	51.1-52.0	F658B
55.9-59.7	F719B	52.1-55.4	F719B
59.8-68.1	F772B	55.5-63.3	F772B
68.2-71.5	F848B	63.4-66.1	F848B
71.6-78.2	F914B	66.2-73.5	F914B
78.3-87.5	F104C	73.6-82.2	F104C
87.6-90.0	F114C	82.3-90.0	F114C

Table 123: Size 4 (standard and ambient comp.)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123
27.1-32.2	F357B	28.8-32.0	F357B
32.3-34.0	F395B	32.1-34.2	F395B
34.1-36.8	F430B	34.3-36.7	F430B
36.9-44.6	F487B	36.8-43.9	F487B
44.7-48.4	F567B	44.0-46.6	F567B
48.5-53.9	F614B	46.7-52.6	F614B
54.0-57.4	F658B	52.7-55.6	F658B
57.5-60.0	F719B	55.7-58.7	F719B
60.1-69.5	F772B	58.8-67.1	F772B
69.6-71.7	F848B	67.2-70.6	F848B
71.8-79.9	F914B	70.7-76.3	F914B
80.0-92.3	F104C	76.4-88.7	F104C
92.4-97.0	F114C	88.8-93.4	F114C
97.1-108	F118C	93.5-105	F118C
109-118	F133C	106-114	F133C
119-131	F149C	115-128	F149C
132-135	F161C	129-131	F161C
		132-135	F174C

Table 124: Size 5 (standard and ambient comp.)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123
109-118	C592A	185-200	C104B
119-128	C630A	201-221	C113B
129-138	C695A	222-237	C125B
139-155	C778A	238-262	C137B
156-168	C867A	263-270	C151B
169-184	C955A		

Overload heater tables

Heaters for mag controllers

The Mag-Break protector is factory adjusted to the minimum trip setting.



WARNING

Warning: To maintain overload, short circuit, and ground fault protection, use the following instructions to select heaters and to adjust the Mag-Break trip setting.

For continuous rated motors with a service factor of 1.15 to 1.25, select heaters from the heater table. For continuous rated motors with a service factor of 1.0, multiply motor fullload current by 0.9 and use this value to select heaters.

Use the heater table to verify that the Mag-Break and current limiter rating is correct for the motor full-load current. Then set the Mag-Break trip setting to the recommended value.

If the Mag-Break trips when starting the motor, increase trip setting one step at a time until the motor can be consistently started.

Do not exceed the maximum trip setting shown in the heater table.

Overload relay tripping current in 40°C ambient is the minimum value of heater full-load current multiplied by 1.25.



WARNING

Warning: Overload relays with automatic reset may automatically start a motor connected to a 2-wire control circuit. When automatic restarting is not desired, use a 3-wire control circuit.



WARNING

Warning: Tripping of the Mag-Break may be an indication that a fault current has been interrupted. To provide continued protection against fire or shock hazard, all current-carrying parts and other components of the motor controller should be examined and be replaced if damaged. If heater burnout occurs, the complete overload relay must be replaced.

Table 125: Size 0 and 1 (standard)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	XTmax	In	Mag-break trip setting*	
				Rec.	Max.
1.03-1.10	C131A	XT2 EKIP I / LSI	10	10	15
1.24-1.38	C163A	XT2 EKIP I / LSI	10	10	15
1.50-1.67	C196A	XT2 EKIP I / LSI	10	10	20
1.80-1.98	C239A	XT2 EKIP I / LSI	10	15	25
1.99-2.24	C268A	XT2 MA	7	28	28
1.99-2.24	C268A	XT2 EKIP I / LSI	10	15	25
2.25-2.43	C301A	XT2 MA	7	28	28
2.25-2.43	C301A	XT2 EKIP I / LSI	10	15	30
2.25-2.43	C301A	XT4 EKIP I / LSI	40	40	40
2.44-2.75	C326A	XT2 MA	7	28	53
2.44-2.75	C326A	XT2 EKIP I / LSI	10	25	35
2.44-2.75	C326A	XT4 EKIP I / LSI	40	40	40
2.76-3.25	C356A	XT2 MA	7	28	53
2.76-3.25	C356A	XT2 EKIP I / LSI	10	25	45
3.26-3.43	C379A	XT2 MA	7	28	53
3.26-3.43	C379A	XT2 EKIP I / LSI	10	25	45
3.44-4.03	C419A	XT2 MA	7	28	53
3.44-4.03	C419A	XT2 EKIP I / LSI	10	30	45
3.44-4.03	C419A	XT4 EKIP I / LSI	40	40	40
4.04-4.43	C466A	XT2 TMF	15	-	400
4.04-4.43	C466A	XT2 MA	7	28	77
4.04-4.43	C466A	XT2 EKIP I / LSI	10	30	60
4.44-4.94	C526A	XT2 MA	7	53	77
4.44-4.94	C526A	XT2 EKIP I / LSI	10	35	60
4.44-4.94	C526A	XT4 EKIP I / LSI	40	40	60
5.78-6.35	C695A	XT2 TMF	15	-	400
5.78-6.35	C695A	XT2 EKIP I / LSI	10	45	70
5.78-6.35	C695A	XT4 EKIP I / LSI	40	60	80
6.36-6.92	C778A	XT2 TMF	15	-	400
6.36-6.92	C778A	XT2 EKIP I / LSI	25	50	87.5
6.93-7.99	C867A	XT2 TMF	15	-	400
6.93-7.99	C867A	XT2 EKIP I / LSI	25	62.5	87.5
8.48-9.19	C104B	XT4 TMF	25	-	500
8.48-9.19	C104B	XT4 EKIP I / LSI	40	80	120
9.20-10.0	C113B	XT2 TMF	25	-	400
9.20-10.0	C113B	XT2 EKIP I / LSI	25	75	125
10.8-12.0	C137B	XT2 TMF	25	-	400
10.8-12.0	C137B	XT4 TMF	25	-	500
10.8-12.0	C137B	XT2 EKIP I / LSI	25	75	150
10.8-12.0	C137B	XT4 EKIP I / LSI	40	80	160
13.0-15.1	C163B	XT2 TMF	25	-	400
13.0-15.1	C163B	XT2 EKIP I / LSI	25	125	200
15.2-16.3	C180B	XT2 TMF	25	-	400
15.2-16.3	C180B	XT2 EKIP I / LSI	25	125	200
16.4-17.9	C198B	XT2 TMF	25	-	400
16.4-17.9	C198B	XT2 EKIP I / LSI	25	125	250

* Instantaneous trip current corresponding to the adjust breaker trip unit for I3

Table 126: Size 1 (standard)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	XTmax	In	Mag-break trip setting*	
				Rec.	Max.
18.0-19.7	C214B	XT2 TMF	25	-	500
18.0-19.7	C214B	XT2 EKIP I / LSI	25	150	250
21.3-22.3	C250B	XT2 TMF	50	-	500
21.3-22.3	C250B	XT2 EKIP I / LSI	60	150	330
23.6-25.5	C303B	XT2 TMF	50	-	500
23.6-25.5	C303B	XT2 EKIP I / LSI	60	150	300

* Instantaneous trip current corresponding to the adjust breaker trip unit for I3

Table 127: Size 0 and 1 (Ambient Comp.)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	XTmax	In	Mag-break trip setting*	
				Rec.	Max.
1.05-1.15	C131A	XT2 EKIP I / LSI	10	10	15
1.28-1.39	C163A	XT2 EKIP I / LSI	10	10	15
1.56-1.73	C196A	XT2 EKIP I / LSI	10	15	20
1.90-2.05	C239A	XT2 EKIP I / LSI	10	15	25
2.06-2.28	C268A	XT2 MA	7	23	23
2.06-2.28	C268A	XT2 EKIP I / LSI	10	15	25
2.29-2.47	C301A	XT2 MA	7	23	33
2.29-2.47	C301A	XT2 EKIP I / LSI	10	15	30
2.48-2.79	C326A	XT2 MA	7	28	53
2.48-2.79	C326A	XT2 EKIP I / LSI	10	25	35
2.48-2.79	C326A	XT4 EKIP I / LSI	40	40	40
2.80-3.31	C356A	XT2 MA	7	28	53
2.80-3.31	C356A	XT2 EKIP I / LSI	10	25	45
3.32-3.70	C379A	XT2 MA	7	28	53
3.32-3.70	C379A	XT2 EKIP I / LSI	10	30	45
3.71-4.06	C419A	XT2 MA	7	28	53
3.71-4.06	C419A	XT2 EKIP I / LSI	10	30	45
3.71-4.06	C419A	XT4 EKIP I / LSI	40	40	40
4.07-4.47	C466A	XT2 TMF	15	-	500
4.07-4.47	C466A	XT2 MA	7	28	77
4.07-4.47	C466A	XT2 EKIP I / LSI	10	30	55
4.48-4.95	C526A	XT2 TMF	15	-	500
4.48-4.95	C526A	XT2 MA	7	53	77
4.48-4.95	C526A	XT2 EKIP I / LSI	10	35	55
5.92-6.47	C695A	XT2 TMF	15	-	500
5.92-6.47	C695A	XT2 EKIP I / LSI	10	45	70
5.92-6.47	C695A	XT4 EKIP I / LSI	40	40	80
6.48-7.20	C778A	XT2 TMF	15	-	500
6.48-7.20	C778A	XT2 EKIP I / LSI	25	50	87.5
7.21-8.22	C867A	XT2 TMF	15	-	500
7.21-8.22	C867A	XT2 EKIP I / LSI	25	50	87.5
8.73-9.67	C104B	XT4 TMF	25	-	400
8.73-9.67	C104B	XT4 EKIP I / LSI	40	80	120
9.68-10.4	C113B	XT2 TMF	25	-	500
9.68-10.4	C113B	XT2 EKIP I / LSI	25	62.5	125
11.1-12.4	C137B	XT2 TMF	25	-	500
11.1-12.4	C137B	XT4 TMF	25	-	400
11.1-12.4	C137B	XT2 EKIP I / LSI	25	62.5	150
11.1-12.4	C137B	XT4 EKIP I / LSI	40	60	160
13.3-15.4	C163B	XT2 TMF	25	-	500
13.3-15.4	C163B	XT2 EKIP I / LSI	25	125	200
15.5-17.1	C180B	XT2 TMF	25	-	500
15.5-17.1	C180B	XT2 EKIP I / LSI	25	125	200

* Instantaneous trip current corresponding to the adjust breaker trip unit for I3

Table 128: Size 1 (Ambient Comp.)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	XTmax	In	Mag-break trip setting*	
				Rec.	Max.
17.2-18.1	C198B	XT2 TMF	25	-	400
17.2-18.1	C198B	XT2 EKIP I / LSI	25	125	250
18.2-20.0	C214B	XT2 TMF	25	-	400
18.2-20.0	C214B	XT2 EKIP I / LSI	25	150	250
21.6-22.5	C250B	XT2 TMF	50	-	500
21.6-22.5	C250B	XT2 EKIP I / LSI	60	150	330
24.0-26.0	C303B	XT2 TMF	50	-	500
24.0-26.0	C303B	XT2 EKIP I / LSI	60	180	300

* Instantaneous trip current corresponding to the adjust breaker trip unit for I3

Table 129: Size 2 (Standard)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	XTmax	Mag-break trip setting*		
			In	Rec.	Max.
16.9-18.0	C198B	XT4 TMF	50	-	500
16.9-18.0	C198B	XT4 EKIP I / LSI	60	120	270
19.8-21.6	C228B	XT2 TMF	50	-	500
19.8-21.6	C228B	XT2 MA	50	150	350
19.8-21.6	C228B	XT2 EKIP LSI	60	150	240
21.7-23.9	C250B	XT4 TMF	50	-	500
21.7-23.9	C250B	XT4 EKIP I / LSI	60	150	300
25.6-28.2	C303B	XT2 TMF	50	-	500
25.6-28.2	C303B	XT4 TMF	50	-	500
25.6-28.2	C303B	XT2 MA	50	150	350
25.6-28.2	C303B	XT2 EKIP LSI	60	180	390
25.6-28.2	C303B	XT4 EKIP I / LSI	60	180	390
31.7-34.7	C366B	XT2 TMF	50	-	500
31.7-34.7	C366B	XT2 MA	50	350	550
31.7-34.7	C366B	XT2 EKIP LSI	60	240	510
40.7-43.4	C460B	XT2 TMF	60	-	600
40.7-43.4	C460B	XT2 MA	70	490	770
40.7-43.4	C460B	XT2 EKIP LSI	60	300	600

* Instantaneous trip current corresponding to the adjust breaker trip unit for I3

Table 130: Size 2 (Ambient Comp.)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	XTmax	Mag-break trip setting*		
			In	Rec.	Max.
18.0-18.7	C198B	XT4 TMF	50	-	500
18.0-18.7	C198B	XT4 EKIP I / LSI	60	120	270
20.5-22.7	C228B	XT2 TMF	50	-	500
20.5-22.7	C228B	XT2 MA	50	150	350
20.5-22.7	C228B	XT2 EKIP LSI	60	150	330
22.8-24.7	C250B	XT4 TMF	50	-	500
22.8-24.7	C250B	XT4 EKIP I / LSI	60	150	300
26.4-29.5	C303B	XT2 TMF	50	-	500
26.4-29.5	C303B	XT4 TMF	50	-	500
26.4-29.5	C303B	XT2 MA	50	150	350
26.4-29.5	C303B	XT2 EKIP LSI	60	180	390
26.4-29.5	C303B	XT4 EKIP I / LSI	60	180	390
32.6-36.7	C366B	XT2 TMF	50	-	500
32.6-36.7	C366B	XT2 MA	50	350	550
32.6-36.7	C366B	XT2 EKIP LSI	60	240	510
43.3-43.4	C460B	XT2 TMF	60	-	600
43.3-43.4	C460B	XT2 MA	70	210	770
43.3-43.4	C460B	XT2 EKIP LSI	60	300	600

* Instantaneous trip current corresponding to the adjust breaker trip unit for I3

Table 131: Size 3 (standard and ambient comp.)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	XTmax	Mag-break trip setting*		
			In	Rec.	Max.
31.4-33.3	F395B	XT4 TMF	50	-	500
31.4-33.3	F395B	XT4 MA	50	350	550
31.4-33.3	F395B	XT4 EKIP LSI	60	240	390
34.4-40.9	F487B	XT2 TMF	60	-	600
34.4-40.9	F487B	XT2 MA	70	210	770
34.4-40.9	F487B	XT2 EKIP LSI	60	270	540
41.0-44.7	F567B	XT2 TMF	60	-	600
41.0-44.7	F567B	XT2 MA	70	490	770
41.0-44.7	F567B	XT2 EKIP LSI	60	330	540
41.0-44.7	F567B	XT4 TMF	60	-	600
41.0-44.7	F567B	XT4 MA	80	560	560
41.0-44.7	F567B	XT4 EKIP LSI	60	330	540
44.8-51.0	F614B	XT2 TMA	90	450	675
44.8-51.0	F614B	XT2 MA	70	490	770
44.8-51.0	F614B	XT2 MA	100	300	700
44.8-51.0	F614B	XT2 EKIP LSI	100	300	600
51.1-52.0	F658B	XT2 TMA	90	450	675
51.1-52.0	F658B	XT2 MA	100	300	700
51.1-52.0	F658B	XT2 EKIP LSI	100	300	600
51.1-52.0	F658B	XT4 TMA	90	450	675
51.1-52.0	F658B	XT4 MA	100	300	700
51.1-52.0	F658B	XT4 EKIP LSI	100	300	300
52.1-55.4	F719B	XT2 TMA	90	450	900
52.1-55.4	F719B	XT2 MA	70	490	770
52.1-55.4	F719B	XT2 EKIP LSI	100	400	800
55.5-63.3	F772B	XT2 TMA	90	450	900
55.5-63.3	F772B	XT2 MA	80	560	880
55.5-63.3	F772B	XT2 EKIP LSI	100	500	800
63.4-66.1	F848B	XT2 TMA	100	500	750
63.4-66.1	F848B	XT2 MA	100	700	700
63.4-66.1	F848B	XT2 EKIP LSI	100	500	800
66.2-73.5	F914B	XT2 TMA	100	500	1000
66.2-73.5	F914B	XT2 MA	100	700	1100
66.2-73.5	F914B	XT2 EKIP LSI	100	500	1000
73.6-82.2	F104C	XT2 TMA	125	325	937
73.6-82.2	F104C	XT2 MA	100	700	700
73.6-82.2	F104C	XT2 EKIP LSI	100	500	750

* Instantaneous trip current corresponding to the adjust breaker trip unit for I3

Table 132: Size 4 (standard)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	XTmax	Mag-break trip setting*		
			In	Rec.	Max.
58.8-67.1	F772B	XT4 TMA	100	500	750
58.8-67.1	F772B	XT4 MA	100	500	750
58.8-67.1	F772B	XT4 EKIP LSI	100	500	800
76.4-88.7	F104C	XT4 TMA	125	625	1250
76.4-88.7	F104C	XT4 MA	125	625	1250
76.4-88.7	F104C	XT4 EKIP LSI	150	600	1200
88.8-93.4	F114C	XT4 TMA	125	938	1250
88.8-93.4	F114C	XT4 MA	125	938	1250
88.8-93.4	F114C	XT4 EKIP LSI	150	750	1200
93.5-102.0	F118C	XT4 TMA	150	750	1125
93.5-102.0	F118C	XT4 MA	150	750	1125
93.5-102.0	F118C	XT4 EKIP LSI	150	750	1200
103.0-110.0	F133C	XT4 TMA	150	750	1125
103.0-110.0	F133C	XT4 MA	150	750	1125
103.0-110.0	F133C	XT4 MA	175	875	1313
103.0-110.0	F133C	XT4 EKIP LSI	150	750	1200
111.0-122.0	F149C	XT4 TMA	175	875	1750
111.0-122.0	F149C	XT4 MA	175	875	1313
111.0-122.0	F149C	XT4 EKIP LSI	225	900	1575
123.0-131.0	F161C	XT4 TMA	175	875	1750
123.0-131.0	F161C	XT4 MA	175	875	1313
123.0-131.0	F161C	XT4 EKIP LSI	225	900	1575

* Instantaneous trip current corresponding to the adjust breaker trip unit for I3

Table 133: Size 4 (ambient comp.)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	XTmax	In	Mag-break trip setting*	
				Rec.	Max.
58.8-67.1	F772B	XT4 TMA	100	500	750
58.8-67.1	F772B	XT4 MA	100	500	750
58.8-67.1	F772B	XT4 EKIP LSI	100	500	800
76.4-88.7	F104C	XT4 TMA	125	625	1250
76.4-88.7	F104C	XT4 MA	125	625	1250
76.4-88.7	F104C	XT4 EKIP LSI	150	600	1200
88.8-93.4	F114C	XT4 TMA	125	938	1250
88.8-93.4	F114C	XT4 MA	125	938	1250
88.8-93.4	F114C	XT4 EKIP LSI	150	750	1200
93.5-105.0	F118C	XT4 TMA	150	750	1125
93.5-105.0	F118C	XT4 MA	150	750	1125
93.5-105.0	F118C	XT4 EKIP LSI	150	750	1200
106.0-114.0	F133C	XT4 TMA	150	750	1125
106.0-114.0	F133C	XT4 MA	150	750	1125
106.0-114.0	F133C	XT4 MA	175	875	1313
106.0-114.0	F133C	XT4 EKIP LSI	150	750	1200
115.0-128.0	F149C	XT4 TMA	175	875	1750
115.0-128.0	F149C	XT4 MA	175	875	1313
115.0-128.0	F149C	XT4 EKIP LSI	225	900	1575
129.0-130.0	F161C	XT4 TMA	175	875	1750
129.0-130.0	F161C	XT4 MA	175	875	1750
129.0-130.0	F161C	XT4 EKIP LSI	225	900	1575

* Instantaneous trip current corresponding to the adjust breaker trip unit for I3

Table 134: Size 4 (standard)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	SF rating plug	Mag-break trip setting	
			Rec.	Max.
28.8-32.0	F357B	70	2	4
32.1-34.2	F395B	70	2	4
34.3-36.7	F430B	70	2	5
36.8-43.9	F487B	70	2	5
44.0-46.6	F567B	70	3	5
46.7-52.6	F614B	100	2	4
52.7-55.6	F658B	100	2	4
55.7-58.7	F719B	100	2	5
58.8-67.1	F772B	150	LO	4
67.2-70.6	F848B	150	LO	4
70.7-76.3	F914B	150	2	4
76.4-88.7	F104C	200	LO	4
88.8-93.4	F114C	200	LO	4
93.5-102.0	F118C	200	LO	5
103.0-110.0	F133C	200	2	6
111.0-122.0	F149C	200	2	6
123.0-131.0	F161C	200	2	6

Table 135: Size 4 (ambient comp.)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	SF rating plug	Mag-break trip setting	
			Rec.	Max.
28.8-32.0	F357B	70	2	4
32.1-34.2	F395B	70	3	4
34.3-36.7	F430B	70	3	5
36.8-43.8	F487B	70	3	5
43.9-46.6	F567B	70	3	5
46.7-52.6	F614B	100	2	4
52.7-55.6	F658B	100	2	4
55.7-58.7	F719B	100	2	5
58.8-67.1	F772B	150	LO	4
67.2-70.6	F848B	150	LO	4
70.7-76.3	F914B	150	2	4
76.4-88.7	F104C	200	LO	4
88.8-93.4	F114C	200	LO	4
93.5-105.0	F118C	200	LO	5
106.0-114.0	F133C	200	2	6
115.0-128.0	F149C	200	2	6
129.0-130.0	F161C	200	2	6

Table 136: Size 5 – 300:15 CT (standard and ambient comp.)

Motor full-load Amps 3-Ph, 3 heater	Heater number CR 123	XTmax	In	Mag-break trip setting*	
				Rec.	Max.
116-125	C630A	XT5 TMA	300	1500	1500
116-125	C630A	XT5 MA	300	2100	2100
116-125	C630A	XT5 EKIP LSI	300	750	1500
136-151	C778A	XT5 TMA	300	1500	2250
136-151	C778A	XT5 MA	300	2100	2100
136-151	C778A	XT5 EKIP LSI	300	1050	1950
152-164	C867A	XT5 TMA	300	1500	2250
152-164	C867A	XT5 MA	300	2100	2100
152-164	C867A	XT5 EKIP LSI	300	1200	1800
165-179	C955A	XT5 TMA	300	1500	2250
165-179	C955A	XT5 MA	300	2100	3000
165-179	C955A	XT5 EKIP LSI	300	1200	2400
180-195	C104B	XT5 TMA	300	1500	2250
180-195	C104B	XT5 MA	300	2100	2100
180-195	C104B	XT5 EKIP LSI	300	1350	2100
196-215	C113B	XT5 TMA	300	1500	3000
196-215	C113B	XT5 MA	300	2100	3000
196-215	C113B	XT5 EKIP LSI	300	1350	2700
216-231	C125B	XT5 TMA	300	1500	3000
216-231	C125B	XT5 MA	300	2100	3000
216-231	C125B	XT5 EKIP LSI	300	1350	2400
232-255	C137B	XT5 MA	300	2100	3000

* Instantaneous trip current corresponding to the adjust breaker trip unit for I3

Overload heater tables

Electronic overloads for circuit breaker controllers

Tripping current is 120% of Dial setting. Motors with 1.15-1.25 service factor, set dial to motor FLA
Motors with 1.0 service factor, set dial to 0.9 motor FLA.

Table 137: Electronic overloads for circuit breaker controllers

NEMA size	FLA range in Amps	Catalog number	Breaker frame and type
1	0.8 to 1.7	CR324CXD	E Mag. and Thermal Mag.
1	1.8 to 3.4	CR324CXE	E Mag. and Thermal Mag.
1	3.2 to 6.8	CR324CXF	E Mag. and Thermal Mag.
1	6.5 to 13.5	CR324CXG	E Mag. and Thermal Mag.
1	13 to 27	CR324CXH	E Mag. and Thermal Mag.
2	6.5 to 13.5	CR324DXG	E Mag. and Thermal Mag.
2	13 to 27	CR324DXH	E Mag. and Thermal Mag.
2	25 to 50	CR324DXJ	E Mag. and Thermal Mag.
3	17 to 35	CR324FXK	E Mag. and Thermal Mag.
3	35 to 70	CR324FXL	E Mag. and Thermal Mag.
3	65 to 135	CR324FXM	E Mag. and Thermal Mag.
4	17 to 35	CR324FXK	E,FandG Mag. and Thermal Mag.
4	35 to 70	CR324FXL	E,FandG Mag. and Thermal Mag.
4	65 to 135	CR324FXM	E,FandG Mag. and Thermal Mag.
5 ¹	35 to 70	CR324GXN	E Mag. and Thermal Mag.
5 ¹	65 to 135	CR324GXP	E Mag. and Thermal Mag.
5 ¹	130 to 270	CR324GXQ	E Mag. and Thermal Mag.

1. 300:15 CT's

Table 138: Control transformer fusing

XFMR VA	600, 750 and 1000VA Type ATMR or Equivalent							Secondary Volts 250V Type TRM or Equivalent
	200-230V 60HZ	240V 60HZ	380-400V 50HZ	416V 50HZ	440-480V 60HZ	575-600V 60HZ	110-120V 50HZ	220-240V 50HZ
60	1	1	3/4	6/10	1/2	1/2	6/10	3/10
75	1-1/2	1-1/2	8/10	8/10	3/4	6/10	8/10	1/2
100	2	2	1-1/4	1	1	3/4	1	6/10
150	3-1/2	3	1-1/2	1-1/2	1-1/2	1-1/4	1-6/10	8/10
200	4	4	2	2	2	1-1/2	2	1
250	5	5	2	2	2	2	2-8/10	1-1/2
300	6	6	3-1/2	3-1/2	2	2	3-2/10	1-6/10
500	6	6	6	6	5	4	5	2-8/10

Table 139: Control fusing for non-CPT applications

Type control	Fuse Amps (class CC)
Line to line	10
Line to neutral	10
Common control	6
Separate source	6

Table 140: Typical CPT ratings

VA	Typical CPT ratings (480V/120V Shown)		
	%R	%X	Open circuit secondary Volts
60	9.05	1.03	131.9
100	6.39	1.18	129.4
150	5.02	1.01	127.3
200	5.09	1.06	126.2
250	6.81	.88	127.8
300	5.15	.73	126.4
500	5.84	1.45	128.7
750			
1000			

Heat loss considerations

In determining the heat loss of a motor control center for air conditioning requirements, 250 watts per foot of lineup is a reasonable assumption.

Actual heat loss will vary due to section loading and diversity factors. A typical motor control center may operate normally at 60 percent of maximum possible loading.

Fully rated circuit breaker starters with CPT's, approximate losses are:

- Size 1– 27 Watts
- Size 2– 57 Watts
- Size 3–130 Watts
- Size 4–200 Watts
- Size 5–300 Watts

Heat losses for feeders and mains vary depending on frame size, loading and type of trip with electronic trips having lower losses. The following table provides a general guide for estimating losses assuming 80 percent loading. For critical applications refer to the Company.

Table 141: Heat loss

	In (A)	XT2 (w/pole)	XT4 (w/pole)	XT5 (w/pole)
	15	-	-	-
	20	-	-	-
	25	-	2.7	-
	30	-	3.9	-
	35	-	4.4	-
	40	-	4.5	-
	45	-	-	-
	50	-	4.7	-
	60	3.9	4.8	-
	70	3.7	5.4	-
	80	4.8	5.5	-
Thermomagnetic trip units: TMF, TMA	90	4.5	6	-
	100	5.6	6.2	-
	110	5.8	6.7	-
	125	6.6	7.4	-
	150	6.9	7.8	-
	160	7.9	8.9	-
	175	10.1	9.1	-
	200	13.2	11.9	-
	225	14.4	13.3	-
	250	-	16.4	-
	300	-	-	15.4
	400	-	-	24.1
	500	-	-	33.5
	600	-	-	46

Table 141: Heat loss (Continued)

	In (A)	XT2 (w/pole)	XT4 (w/pole)	XT5 (w/pole)
	10	0.1	-	-
	25	0.8	-	-
	40	0.7	0.6	-
	60	1.5	1.3	-
	100	4.2	3.5	-
Electronic trip units: Ekip Dip, Ekip touch	125	6.6	-	-
	150	-	7.8	-
	200	-	10.5	-
	225	-	13.3	-
	250	-	16.4	8
	300	-	-	10.8
	400	-	-	19
	600	-	-	43
	3	3.7	-	-
	7	9.3	-	-
	15	6.4	-	-
	25	-	2.6	-
	30	3.8	-	-
	50	5	6.8	-
	70	5.5	-	-
	80	6.8	5.5	-
Magnetic only trip units: MA	100	8.1	6.2	-
	110	-	6.7	-
	125	14	7.4	-
	150	-	7.8	-
	175	-	9.1	-
	200	-	11.9	-
	225	-	13.3	-
	250	-	16.4	-
	300	-	15.4	15.4
	400	-	24.1	24.1
	500	-	33.5	33.5

Typical losses for transformers:

- 1kVA, 1-Ph 75 Watts
- 5 kVA, 1-Ph 190 Watts
- 9 kVA, 3-Ph 295 Watts
- 15 kVA, 3-Ph 460 Watts
- 30 kVA, 3-Ph 1000 Watts

Horizontal and vertical bus losses, when loaded to capacity are approximately 100 watts per section.

Soft Starters or VFDs will typically generate 3 watts per ampere of load during operation.

Motor Loads

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Table 142: NEMA contactor ratings

Description	Normal starting duty HP/ KW rating by NEMA size						
	1	2	3	4	5	6	
Single phase	115V	2	3	7.5			
	230V	3	7.5	15			
Three phase	200V	7.5/ 5.5	10/ 7.5	25/ 18.5	40/ 30	75/ 55	150/ 110
	230V	7.5/ 5.5	15/ 11	30/ 22	50/ 37	100/ 75	200/ 150
	380/ 415V	10/ 7.5	25/ 18.5	50/ 37	75/ 55	150/ 110	300/ 260
	460V	10/ 7.5	25/ 18.5	50/ 37	100/ 75	200/ 150	400/ 260
	575V	10/ 7.5	25/ 18.5	50/ 37	100/ 75	200/ 150	400/ 260

Non-Motor Loads

When selecting contactors for non-motor loads, the following load characteristics should be considered:

1. Voltage and maximum continuous current.
2. Maximum peak inrush current and duration.
3. RMS current and duration of maximum current on cyclic loads.
4. Frequency of operation.
5. Maximum interrupting current, voltage, power factor and wave form.
6. Available short-circuit current.

Non-motor load ratings are based on the use of two poles to control single-phase loads and three poles to control three-phase loads.

Capacitor switching, requires special considerations. A discharged capacitor acts essentially like a short circuit, and the inrush current is limited by the impedance connected in series with the capacitor which includes connecting cables. Therefore, the maximum capacitance which can be switched by a contactor will increase with higher series impedance. Switching more than one capacitor or capacitor bank in close electrical proximity to each other should be avoided as the energized capacitor bank can increase the inrush current to the second bank when it is energized. Reactors or resistors may be required between the two capacitor banks to limit inrush currents.

NEMA Standards require shunt capacitors to operate satisfactorily at 135 percent of rated KVAR due to manufacturing tolerances and other variations. The higher inrush and steady state currents associated with these capacitors should be taken into consideration.

NEMA Publication ICS2-210 covers non-motor loads.

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Table 143: NEMA contactor ratings

Size of contactor	Cont. Amps	Max. inrush current (Amps Peak)	Tungsten lamps ⁽¹⁾	Resistive loads ⁽²⁾	Transformer primary switching (kVA)															
					Transformers having inrush currents of not more than 20 times FLA						Transformers having inrush currents of over 20 through 40 times FLA									
					Single-phase Vac			Three-phase Vac			Single-phase Vac			Three-phase Vac						
					120	240	480	600	208	240	480	600	120	240	480	600	208	240	480	600
0	18	140	10	18	0.6	1.2	2.4	3	1.8	2.1	4.2	5.2	0.3	0.6	1.2	1.5	0.9	1.0	2.1	2.6
1	27	288	15	27	1.2	2.4	4.9	6.2	3.6	4.3	8.5	11	0.6	1.2	2.5	3.1	1.8	2.1	4.3	5.3
2	45	483	30	45	2.1	4.1	8.3	10	6.3	7.2	14	18	1.0	2.1	4.2	5.2	3.1	3.6	7.2	8.9
3	90	947	60	90	4.1	8.1	16	20	12	14	28	35	2.0	4.1	8.1	10	6.1	7.0	14	18
4	135	1581	120	135	6.8	14	27	34	20	23	47	59	3.4	6.8	14	17	10	12	23	29
5	270	3163	240	270	14	27	54	68	41	47	94	117	6.8	14	27	34	20	24	47	59

1. 300-Vac maximum, Tungsten lamp loads include infrared lamps having Tungsten filaments.
 2. Resistive loads include electric discharge lamps such as fluorescent, mercury, vapor, etc.

Non-motor loads

Table 144: NEMA contactor ratings for single capacitor or capacitor bank switching

Size of controller	Continuous ratings rms amperes	Three-phase rating of capacitor					
		Maximum size of three-phase capacitor in kVAR or available current in Amperes RMS sym.					
		3000	5000	10.000	14.000	18.000	22.000
At 230 Vac, 60 Hertz							
2	45	12	8	4	3	2	2
3	90	27	27	15	11	9	7
4	135	40	40	40	30	24	20
5	270	80	80	80	80	80	75
At 460 Vac, 60 Hertz							
2	45	25	16	8	6	4	4
3	90	53	53	31	23	18	15
4	135	80	80	80	61	49	41
5	270	160	160	160	160	160	149
At 575 Vac, 60 Hertz							
2	45	31	20	10	7	6	5
3	90	67	67	39	29	23	19
4	135	100	100	100	77	61	51
5	270	200	200	200	200	200	189

Disconnect minimums: thermal magnetic breakers rated 135%, fused switch rated 165%.

Table 145: NEMA contactor for heating loads

NEMA size	Continuous current rating amps	Maximum kW ratings ⁽²⁾							
		575 Vac		460 Vac		230 Vac		115 Vac	
		2-Pole 1-Ph	3-Pole 3-Ph	2-Pole 1-Ph	3-Pole 3-Ph	2-Pole 1-Ph	3-Pole 3-Ph	2-Pole 1-Ph	3-Pole 3-Ph
00	9	5	9	4	7	2	3.5	1	1.75
0	18	10	18	8	14	4	7	2	3.5
1	27	15	25	12	20	6	10	3	5
2	45	24	43	20	34	10	17	5	8.5
3	90	50	86	40	68	20	34	10	17
4	135	75	130	60	105	30	52	15	26
5	270	150	260	120	210	60	105	30	52

- 1. Available at capacitor terminals
- 2. Applicable only to resistive loads having inrush currents not exceeding 1.5 times the continuous current rating
- 3. Spectra CB will permit deletion of overload heaters for these loads

Application of starters for heating and lighting loads

- 1. No Tungsten lamp loads, No transformer loads.
- 2. Contactor loading must meet table above.
- 3. Overload heaters may be sized for maximum³.
- 4. Disconnect must be thermal magnetic or fused switch rated per NEC @ 125% of load amps.

Publication references

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Table 146: Construction equipment and components

Publication	Description
BuyLog	https://electrification.us.abb.com/buylog
Molded case circuit breakers	
1SXU210248C0201	SACE®Tmax® XT UL/CSA Catalog
Power break insulated case circuit breakers	
GET-8052	Selection and Application
GEZ-7001	Time-Current Curves
Disconnect switches	
GET-6205	Type HPC High-Pressure Contact Switches, Technical
GEZ-7003	Type HPC Time-Current Curves
Ground fault protective products	
GET-2964	Ground Break Systems
GEZ-7003	Ground Break Time-Current Curves
Panelboards	
GET-6592	“A” series Tech. Specifications
GEA-11316	A Series

Installation manuals

Additional technical information, instructions and installation manuals can be found in the following documents:

- 1SDH000722R0001 – SACE Tmax XT – Installation Instructions XT4
- 1SDH002011A1002 – SACE Tmax XT – Installation Instructions XT5
- 1SDH002013A1001 – SACE Tmax XT7 – XT7M – Installation Instructions XT7-XT7M
- 1SDH001821A1002 – SACE Tmax XT7 - User manual for use and maintenance of Ekip Touch Trip units for Tmax XT7 low-voltage molded-case circuit breakers
- 1SDH002039A1002 – SACE Tmax XT - Operation

and maintenance manual for Ekip Touch Trip Units

- 1SDH002031A1002 – Tmax XT2 - XT4 - User manual for use and maintenance of Ekip Touch Trip units for Tmax XT2 - XT4 low-voltage molded-case circuit breakers
- 1SDH000722R0003 – SACE Tmax XT UL – Installation instructions XT4 UL
- SACE Tmax XT UL/CSA – Low voltage molded case circuit breakers UL489 and CSA CS22.2 Standards for the NEMA market
- 1SDH001000R0524 – Ekip Signalling 2K - E1.2-E2.2-E4.2-E6.2-XT2-XT4-XT5-XT7-XT7M

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Table 147: Legacy motor control center equipment

Publication	Description
Spectra series and 8000-line MCC	
DET-291	E9000 Evolution Series Application Guide
DEA-036	Spectra Series Product Brochure
GEF-4628	8000-Line Renewal Parts Bulletin
GEH-4961	Installation and Maintenance (Instructions)

1. For more information visit our website at www.gefanuc.com/default2.htm

Time current curves:

Utilize ABB's CurvesWeb online tool for all information pertaining to time current curves. The tool can be accessed at <https://partnerhub.connect.abb.com/>. If access to this tool is not available please consult the factory. If any discrepancies are found in the time current curve information from other sources, the ABB's CurvesWeb online tool takes precedence.

Table 148: General purpose controls

Publication	Description
Control catalog	https://electrification.us.abb.com/control-catalog
Magnetic motor starters	
GEA-10928	300-Line magnetic motor starters, descriptive
GEH-5190	300-Line Instructions, NEMA size 1, FVNR
GEH-4774	300-Line Instructions, NEMA size 2, FVNR
GEH-4806	300-Line Instructions, NEMA size 3, FVNR
GEH-4807	300-Line Instructions, NEMA size 4, FVNR
GEH-4869	300-Line Instructions, NEMA size 5, FVNR
GEH-5198	300-Line Instructions, NEMA size 6, FVNR
GEH-5190	300-Line Instructions, NEMA size 1, FVR and 2-Speed
GEH-4775	300-Line Instructions, NEMA size 2, FVR and 2-Speed
GEH-4806	300-Line Instructions, NEMA size 3, FVR and 2-Speed
GEH-4807	300-Line Instructions, NEMA size 4, FVR and 2-Speed
GEH-4839	300-Line Instructions, NEMA size 5, FVR and 2-Speed
Pilot devices	
1SXU910001C0201	
Relays and timers	
GEA-10639	
GEH-4115	
GEH-4120	
GEH-4147	
GEH-4139	
GEH-6435	
DET-069	
Variable frequency drives	
3AXD50000044794	
3AXD50000015497	
Softstarters	
1SFC132012C0201	

Electrical data

Motor horsepower output may also be calculated as follows:

$$HP = \frac{V \times A \times Pf \times EFF}{746}$$

Rules of thumb (approximation)

At 1800 RPM, a motor develops a 3 lb. – ft. per HP.
 At 1200 RPM, a motor develops 4.5 lb – ft. per HP.
 At 460 volts, a 3-phase motor draws 1.25 amp per HP. At 230 volts, a 3-phase motor draws 2.5 amp per HP.

Table 149: Conversion formulas

To find	Alternating current three-phase
Amperes when Horsepower is known	$\frac{HP \times 746}{1.73 \times V \times Eff \times pf}$
Amperes when Kilowatts is known	$\frac{Kw \times 1000}{1.73 \times V \times pf}$
Amperes when Kva is known	$\frac{Kva \times 1000}{1.73 \times V}$
Kilowatts	$\frac{1.73 \times A \times V \times pf}{1000}$
Kva	$\frac{1.73 \times A \times V}{1000}$
Horsepower - (Output)	$\frac{1.73 \times A \times V \times Eff \times pf}{746}$
KW (alternating current) = KVA x Power Factor	
KW (direct current) = V x A x .001	
KWH = KW x Hours	
HP = $\frac{KW}{\text{Motor Efficiency}}$	

Values Ohms Law

V=Volts	I=E/R
A or I = Amperes (amps)	R=E/I
Work/P = Watts/Power	E=IXR
KW=Kilowatts	P=IXE
KwH=Kilowatt Hours	P=IXIXR
KVA=Kilovolt Amperes	
Pf=Power Factor, Table	
Ph= Phase Factor, Table	

kVAR calculation when motor operating characteristics are known

If motor HP, full-load power factor (PF) and efficiency (eff) are known, its easy to calculate the correct kVAR necessary to improve PF to any value.

Example: 75HP, 3600 RPN, NEMA B motor with full-load PF of 87% and eff. of 92% corrected to 95%PF

Original PF = .87 Cos: Tan: = .567
 Desired PF = .95 = Cos: Tan: = .329
 Difference = .238

$$KW = \frac{HP \times 746}{Eff.} \text{ or } \frac{75 \times 746}{.902} = 62$$

$$.238 \times 62 = 14.8 \text{ kVAR (use 15 kVAR)}$$

Defining the load

Rotating motion horsepower

$$HP = \frac{T \times N}{5250}$$

Where: T = Torque (lb-ft)

N = Speed (RPM)

$$HP = \frac{T \times N}{63.000}$$

Where: T = Torque (lb-in)

N = Speed (RPM)

Accelerating torque/force

$$T_A = \frac{WK^2 \times N}{308t}$$

Where: T_A = Accelerating torque (lb ft)
 WK² = Total system inertia that must be accelerated.
 This includes motor rotor, speed reducer (if used), and load. (lb-ft²)

Torque

$$T = F \times R$$

Where: T = Torque (lb-ft)
 F = Force (lb)
 R = Radius (ft)

WK² – reflected

$$\text{Reflected WK}^2 = \frac{\text{WK}^2 \text{ of Load}}{(\text{Reduction Ratio})^2}$$

This is for either belt or gear reductions.

FPM to RPM

$$RPM = \frac{FPM}{.262 \times (\text{diameter in inches})}$$

Linear motion

$$HP = \frac{F \times V}{33.000}$$

Where: F = Force or Tension (lb)
 V = Velocity (FPM)

$$HP = \frac{F \times V}{396.000}$$

Where: F = Force or Tension (lb)

V = Velocity (in/min)

$$F_A = \frac{W \times V}{1933t}$$

Where: F_A = Accelerating Force (lb-ft)
 W = Weight (lb)
 V = Change in velocity (FPM)
 t = Time (sec.)

Electrical data

Centrifugal loads

Flow rate:
$$\begin{aligned} \text{Flow}_1 &= \left(\frac{\text{RPM}_1}{\text{RPM}_2} \right) \\ \text{Flow}_2 &= \left(\frac{\text{RPM}_2}{\text{RPM}_1} \right) \end{aligned}$$

Torque:
$$\begin{aligned} \text{Torque}_1 &= \left(\frac{\text{RPM}_1}{\text{RPM}_2} \right) \\ \text{Torque}_2 &= \left(\frac{\text{RPM}_2}{\text{RPM}_1} \right) \end{aligned}$$

Pressure:
$$\begin{aligned} \text{Pres}_1 &= \left(\frac{\text{RPM}_1}{\text{RPM}_2} \right)^2 \\ \text{Pres}_2 &= \left(\frac{\text{RPM}_2}{\text{RPM}_1} \right)^2 \end{aligned}$$

Horsepower:
$$\begin{aligned} \text{BHP}_1 &= \text{RPM}_1^3 \\ \text{BHP}_2 &= \text{RPM}_2^3 \end{aligned}$$

Fans and blowers:
$$\text{BHP} = \frac{\text{CFM} \times \text{PSF}}{3300 \times (\text{fan efficiency})}$$

$$\text{BH} = \frac{\text{CFM} \times \text{PIW}}{6350 \times (\text{fan efficiency})}$$

$$\text{BHP} = \frac{\text{CFM} \times \text{PSI}}{229 \times (\text{fan efficiency}) \times \text{GPM} \times \text{TH} \times (\text{specific gravity})}$$

Pumps:
$$\text{BHP} = \frac{(\text{specific gravity})}{3960 \times (\text{pump efficiency})}$$

$$\text{BHP} = \frac{\text{GPM} \times \text{PSI} \times (\text{specific gravity})}{1713 \times (\text{pump efficiency})}$$

Where:
 BHP = Brake horsepower
 PSF = Pounds per square foot
 PIW = Pressure in inches of water guage
 PSI = Pounds per square inch
 GPM = Gallons per minute
 TH = Total head (including friction)

Other useful formulas

Gear ratio - most favorable

$$\text{GR} = \frac{WK^2 + Tf^2 + Tf}{WK M^2 T_M^2 T_M}$$

Where: $WK^2 = WK^2$ of the load
 $WK_M^2 = WK^2$ of the motor
 Tf = Friction torque of the laod
 $T_M =$ Average motor torque during acceleration

If friction torque is low compared to accelerating torque this can be reduced to:

$$\text{GR} = \sqrt{\frac{WK^2}{WK^2}}$$

Duty cycle calculations

$$\text{HP}_{\text{RMS}} = \sqrt{\frac{\text{HP}_1^2 t_1 + \text{HP}_2^2 t_2 + \text{HP}_3^2 t_3 + \text{etc}}{t_1 + t_2 + t_3 + \text{etc}}}$$

Drawings/tests

MCC unit numbering system

The Engineering Documentation System will accept a 3-character unit address designation consisting of a combination of letters and/or numbers (such as: 12J, ABC, A1D, 2AD, etc.). The recommended unit addressing system is illustrated and described in the following paragraphs.

NOTICE **Notice:** Should customer's (3-character maximum) unit numbering system differ from the following unit addressing system, then both can appear when requested on the CAD-generated motor control center unit summary drawings issued from the factory.

Benefits

When ordering NEMA Class I or II motor control centers where factory interconnections are required, this system produces a uniform numbering format for engineering documentation. The unit numbering system produces a unique unit address designation. When wiremarkers are specified, it ensures consistency and ease of wire tracing/troubleshooting between factory-wired units and other devices within the motor control center lineup such as programmable control I/O racks.

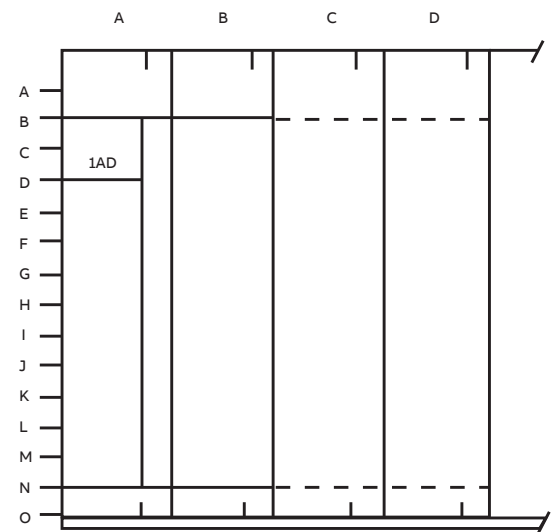
General

Typical 3-Character designation **1 A D**
 Motor control center number/character
 Vertical section number/character
 Unit location (line number/character)

NOTICE **Notice:** The motor control center number/character assignment may be a number (1, 2, 3, 4, etc.) provided the number of MCC lineups on an order does not exceed 9. If 10 or greater, then the motor control center character should be a letter of the alphabet (A, B, C, D, etc.). Likewise, the vertical section character should be an alphabetic entry for lineups exceeding 9 sections.

The outline summary drawing furnished with the equipment cross-references the unit location and the service designation specified for each unit.

Motor control center no. 1



Number the front view arrangement from left-to-right 1, 2, 3 ... or A, B, C ... Line off the space required for the top and bottom horizontal wireways. Then line off the interconnecting vertical wireway in each vertical section. Note that some units (including large starters, transformers, panelboards, etc.) may require full width of section and that no separate vertical wireway door will be adjacent to these units.

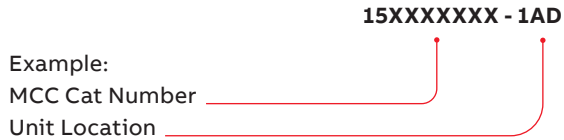
Example:

Assume that the top horizontal wireway is to be 12 inches high. In the first section a full-voltage non-reversing NEMA size 1 combination starter is to be installed in the first available position below the top horizontal wireway. Assuming conventional unit sizing (FVNR-1 equals 1X or 12-inch unit height), the unit location assignment becomes: 1 A D

1 A D
 Motor control center
 Vertical section
 Unit location

—
46 Figure 2

Continue lining off the unit space requirements for various units and future spaces as required until the lineup is complete and all spaces have been addressed. Notice that every unit location has a unique unit location designation. This unit designation will not be repeated again within the order. Since every motor control center lineup also has a unique panel catalog number, then the unit nameplate and catalog number will never be duplicated.



A reminder about future spaces: If a 2X future space is to be arranged into two 1X compartments, then the outline sketch must be lined off into 1X compartments with individual unit addresses. This will ensure that the necessary unit doors A B C D and shelves will be provided by the factory.

MCC unit numbering system

CAD documentation system permits the engineer to perform virtually all design functions without the need of traditional drafting tools and associated equipment.

This computer-based system is used to translate equipment functional requirements into detailed equipment designs and material lists. These computerized drawings are used in the manufacturing process to increase product assembly accuracy, repeatability and consistency. Standardization of production procedures and methods has been improved such that given devices are consistently located in the same position on or within the equipment. Unit wiring is handled in the same manner, resulting in improved wiring accuracy and productivity. The following drawing elements are included in the standard documentation package.

- 1) Lead Sheet Figure 1
- 2) Outline Figure 2
- 3) Summary Tables Figure 3
- 4) Unit Elementaries Drawings/tests section

1. Lead Sheet – Contains special Customer notes and manufacturing or test instructions.
2. Outline – Presents front view plan drawings showing the physical arrangement of units and associated equipment within the motor control center lineup.
3. Summary Tables – Provides all necessary functional detail of each unit including nameplate inscriptions.

UL	UL	< UL	INLINE UL 600
FVNR 1	FVNR 1.5	FDRCB/ACC	ADC
AAD	ABD	FDRCB/ACD	SPACE ADD
FVNR 1.5	FVNR 1.5	FDRCB/ACE	SPACE
AAF	ABF	FDRCB/ACF	ADF
FVNR 1.5	FVNR 1.5	FDRCB/ACG	SPACE
AAH	ABH	FDRCB/ACH	ADH
FVNR 1.5	FVNR 1	FDRCB/ACI	FDRCB/ADI
AAJ	ABJ	FDRCB/ACJ	FDRCB/ADJ
FVNR 1.5	FVNR 1	FDRCB/ACK	SPACE
AAL	ABL	FDRCB/ACL	ADL
FVNR 1.5	FVNR 1	FDRCB/ACM	SPACE
AAN	ABN	FDRCB/ACN	ADN
001		002	
1	2	3	4
FRONT_20X20	FRONT_20X20	FRONT_20X20	FRONT_20X20
300	300	300	600/300

FRONT VIEW

SECT. HEIGHT 90 INCHES

UL SECT. NO.
X=SHIPPING LENGTH
>=SPLICE

MOD SHEET
SECT. WXD
VERT. BUS A

47 Figure 3

UNIT SUMMARY EVOLUTION SERIES MCC

REQ. NO. ENG. NAME JBC
 PANEL CAT. NO. ISSUED 01/16/1996 REV.
 FRONT REV NO. 0

ABB
 MEBANE, NC USA

DWG. FOR INSTALLATION
 DWG. NO. SH F01A
 CONT. ON SH F01B

UNIT LOC	UNIT MOD SH	CUST UNIT NO	CAT# 273A7916P3FC NAMEPLATE	ELEM	CONN.	D R W S I Z E FUNCTION	S I Z E	HP KW K-KW	FLA	RPM	SF	OL HEATER CR123	OL RELAY TYPE	CB SW	TRIP FUSE/ CLIP	FUSES BY	TOTAL AUX JNLK	NOT LABELED			SC MARKER	CPT VA	CATALOG NUMBER
																		UL LABEL	CSA LABEL	UL LABEL			
AAD			6-MILL FEED END JACKING PUMP	100	200A	FVNR	1	1	1.8	1000	1.150	C220A	AMBIENT	SELI	3		3	0	UL		157	150	IA52-102437
RED RUN PTT LT																							
AAF			6-MILL FEED END JACKING PUMP	100	200A	FVNR	1	1.5	2.4	1000	1.150	C301A	AMBIENT	SELI	3		3	0	UL		157	150	IA52-102438
RED RUN PTT LT																							
AAH			6-MILL FEED END FILTRATION PUMP	100	200A	FVNR	1	1.5	2.4	1000	1.150	C301A	AMBIENT	SELI	3		3	0	UL		157	150	IA52-102438
RED RUN PTT LT																							
AAJ			6-MILL DISCHARGE END JACKING PUMP	100	200A	FVNR	1	1.5	2.4	1000	1.150	C301A	AMBIENT	SELI	3		3	0	UL		157	150	IA52-102438
RED RUN PTT LT																							
AAL			6-MILL DISCHARGE END EXT. LUBE PUMP	100	200A	FVNR	1	1.5	2.4	1000	1.150	C301A	AMBIENT	SELI	3		3	0	UL		157	150	IA52-102439
RED RUN PTT LT																							
AAN			6-MILL DISCHARGE END FILTRATION PUMP	100	200A	FVNR	1	1.5	2.4	1000	1.150	C301A	AMBIENT	SELI	3		3	0	UL		157	150	IA52-102439
RED RUN PTT LT																							
ABD			7-MILL FEED END JACKING PUMP	100	200A	FVNR	1	1.5	2.4	1000	1.150	C301A	AMBIENT	SELI	3		3	0	UL		157	150	IA52-102438
RED RUN PTT LT																							
ABF			7-MILL FEED END EXT. LUBE PUMP	100	200A	FVNR	1	1.5	2.4	1000	1.150	C301A	AMBIENT	SELI	3		3	0	UL		157	150	IA52-102438
RED RUN PTT LT																							
ABH			7-MILL FEED END FILTRATION PUMP	100	200A	FVNR	1	1.5	2.4	1000	1.150	C301A	AMBIENT	SELI	3		3	0	UL		157	150	IA52-102438
RED RUN PTT LT																							
ABJ			7-MILL DISCHARGE END JACKING PUMP	100	200A	FVNR	1	1	1.8	1000	1.150	C220A	AMBIENT	SELI	3		3	0	UL		157	150	IA52-102437
RED RUN PTT LT																							

Paint finish

Indoor equipment

The standard paint system consists of the following two processes.

Phase I – cleaning

In a 7-stage spray washer, steel parts are cleaned and sprayed in the controlled cleaning solutions.

—
Table 150: 7-stage spray process

Stage	Temperature	Chemical solution(s)
1–Cleaning	115-120°	Ferro clean
2–Rinse	105-118°	None
3–Iron phosphate	90-105°	Secure low foam
4–Rinse	Ambient	None
5–Non chrome sealer	Ambient	Non chrome final seal
6–Rinse	Ambient	None
7–Deionized rinse	Ambient	None

Cleaned steel parts enter a drying oven at 300-350°F. The preceding operating parameters have been determined to produce an Iron Phosphate coating of a minimum of 150 milligrams per square foot to meet MIL Spec. TT-C-490.

Phase II – painting by electro-static powder process

Primed metal parts are electrostatically coated with a powder paint consisting of the following: 670-011 ANSI-61 Polyester Paint (Light Gray)

Metal parts will enter drying oven at 375-400°F and remain for 20 minutes. The standard color is ANSI-61 light gray with a gloss of 60±5, and a thickness of 1.5 mils. This system will withstand a minimum of 1000 hour humidity test and 1000 hours salt spray tests per ASTM117B. Some internal galvanized parts meet 600 hours per ASTM117B.

Packaging and storage

Domestic packaging

Normally a motor control center Lineup is shipped in groups of three vertical sections for ease of handling. Each shipping split is mounted on a hardwood skid to facilitate moving by rollers or fork-lift truck. Lifting eyes are also provided for moving by crane. Shipping blocks are placed on the face of the sections to protect handles and devices. The shipping splits are wrapped in clear stretch polyfilm to protect the equipment from the usual dust and dirt encountered during shipment. Necessary bus splice bars are included for connecting the shipping splits together.

Export crating

The sections are bolted to a skid with a solid floor. The equipment is then enclosed in a 3/8" plywood crate with 2 x 4 reinforcing at the top and corners. Three 1 1/4" steel bands are placed horizontally around the crate for additional reinforcing.

All equipment should be protected against moisture and temperature extremes during shipment and storage. See Environmental Considerations in "Overview" section. For prolonged shipping periods where export crating is involved, it is recommended the equipment space heaters (when specified) be wired for connecting to an external power source while in transit, to minimize condensation.

Storage

If it is necessary to store the equipment for any length of time, the following precautions should be taken:

1. Uncrate equipment.
2. Store in a clean, dry area at moderate temperature. Cover with a suitable canvas or heavy-duty plastic cover to prevent entrance of foreign material.
3. If equipment must be stored in cool or damp areas, not only should the equipment be completely covered, but heat should be provided to prevent condensation of moisture in the equipment. Energize space heaters (if furnished in the equipment) or place a standard 120-volt lamp rated 75 watts inside the bottom of each vertical section.

Standard commercial tests and inspection

General

The following summary description defines the standard factory tests and inspections performed during manufacture. All motor control center equipment is tested and inspected for conformance with NEMA ICS 18-2001. Production tests and inspections encompass the verification of physical configuration of assembly and workmanship, the mechanical adjustments of parts and components, and the sequencing and functional operations of the control systems. These tests and inspections are performed on manufactured products to verify conformance of the equipment to a previously qualified design. The tests do not include type testing or other destructive tests on equipment to be shipped to a customer. Any additional factory tests beyond those listed in the following paragraphs must be referred to Mebane to verify availability of test facilities and qualified manpower. Additional testing beyond the scope of the following standard commercial tests will affect normal shipment schedules.

Production tests

The following list of inspection activities shall be performed to assure proper and correct materials, workmanship and for any damage conditions in accordance with the manufacturing documentation and drawings:

- Components, parts and material
- Physical condition of components, parts, wire insulation
- Location and orientation of components and parts
- Finish—plating—painting
- Wire/cable type, size, insulating and clamping support
- Wire terminations, insulation removal and crimping of terminals
- Tightness of electrical connections and torque of bus bar bolts
- Wire markers and terminal markers (where specified)
- Labeling of components, parts, etc.
- Tightness torque of assembly bolts and hardware
- Welds (spot only)
- Mechanical clearance
- Electrical clearance (potential hazards)

Mechanical operations test

Mechanical operating tests shall be performed to insure proper functioning of operating mechanisms and interchangeability.

- a. The operation of shutters, mechanical interlocks, circuitbreaker-door interlocks, operating handles, trip mechanisms, solenoid armature travels, contact wipes, electromechanical interlocks, physical clearances for mechanical and electrical isolation including any additional mechanically related operating functions shall be verified.
- b. The interchangeability of removable units designed to be interchangeable shall be verified as well as the rejection functions of non-interchangeable units.

Continuity tests – control wiring and power cables

The correctness of the individual circuit wiring contained in each assembly and the assembly wiring interfaces shall be verified as in accordance with the connection diagram, wiring table, or elementary drawing. The continuity of each circuit shall be checked.

Functional operations test

All equipments shall be subjected to an operational test. The test shall verify the functional operation of the control and power circuits and related components, devices and subassemblies- modules under simulated operating conditions (excluding loading of the power circuits).

Devices

All devices, including subassemblies-modules, shall be operated, set and checked for their functional characteristics in accordance with the instructions for each and any additional characteristics peculiar to a device:

- Pick-up
- Drop-out
- Contact wipe
- Amperes
- In-rush current
- Time-delay

48 Example of standard test report available on request for a nominal charge

Contactors must pick-up and hold-in at or below the following percentage or rated coil voltage:

Table 151: Contactor pick-up

Device type	Voltage source	Pick-up (percentage)
DC	DC	63
AC	AC	85 ⁽¹⁾
DC	AC with rectifier	70 with holding resistor
DC	AC with rectifier	75 with holding and pick-up resistor

1. If a control power transformer is used, apply 90 percent voltage to primary of transformer.

Sequence and timing circuits

Assemblies and systems involving sequential operation of devices and time delays shall be tested to assure that the devices in the sequence function properly and in the order intended.

Polarity – phase-sensitive circuits

The polarity of direct-current circuits and phase connections of alternating-current circuits shall be verified by application of power and measurement of the relative polarities and phase sequence.

Grounding

The grounding circuits and buses shall be verified.

Standard commercial tests and inspection

High Potential – Insulation Tests

Control wiring insulation tests

A dielectric test (hi-pot) shall be performed on circuit wiring to confirm the insulation resistance to withstand breakdown to a selected test voltage. The test voltage – amplitude and waveshape, method of application and duration of time applied – shall be specified in NEMA ICS 18-2001.

Power cable insulation and isolation test

Power cables and buses shall be tested, phase-to-phase and phase-to-ground for insulation breakdown resistance and circuit isolation as specified in NEMA ICS 18-2001.

NOTICE

Notice: These test conditions are as specified for newly constructed equipment and performed in a clean, temperature- and humidity-controlled factory environment.

The test voltages include the standard test voltage (two times rated plus 1000), times 120 percent (for one-second application).

Table 152: Test Voltage

Rated circuit voltage AC or DC	High potential test voltage	Duration of test
120	1500	1 second
240	1800	1 second
480/600	2700	1 second

The frequency of the test voltage shall not be less than the rated frequency of the equipment tested and shall be essentially sinusoidal in wave shape.

NOTICE

Notice: Consideration shall be made for low-voltage devices, semiconductors, meters, instruments, transformers, grounding circuits, etc., in preparation for the dielectric tests.

Option – insulation resistance (megger) tests

Insulation resistance tests measure the amount of circuit resistance to current leakage. This test is performed when this resistance measurement is desired and so specified. A nominal charge will be assessed.

The test voltage and minimum insulation resistance shall be selected as specified by the contract. Standard test values are:

- a. 500 volts DC with 10 megohms minimum
- b. 1000 volts DC with 1 megohm minimum

ABB Monterrey Motor Control Center Quality
MCC Certified Test Report

ABB ELECTRICAL CONTROL SYSTEMS S DE RL DE CV
 Camino a Ojo de Agua 203, CP 86600
 Apodaca, Nuevo León, Mexico

Customer: Customer's Job Name PO: 012345678
 Requirement: 987654321 Tag Customer's Tag
 Sales Order: 150234567 Item: ID
 Wiring Diagram: 3778456

The above equipment has been passed the below listed manufacturer's tests and conforms to the latest applicable ANSI, NEMA and IEEE standards and special contractual requirements.

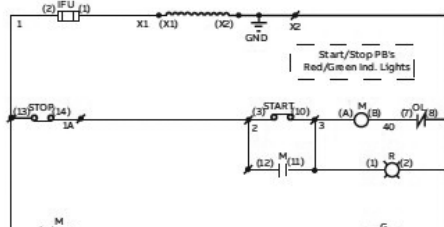
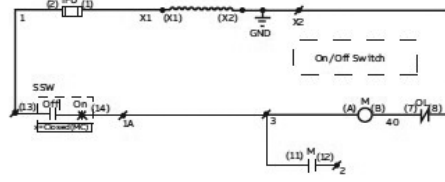
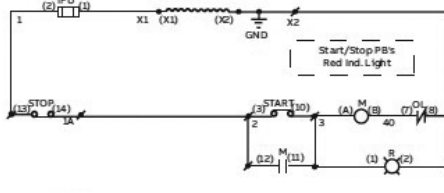
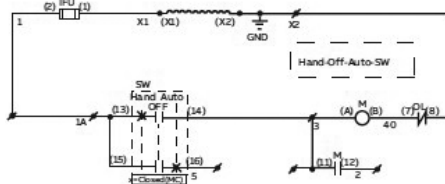
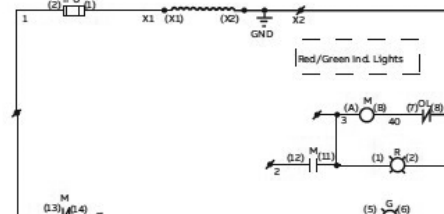
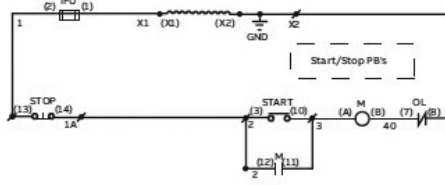
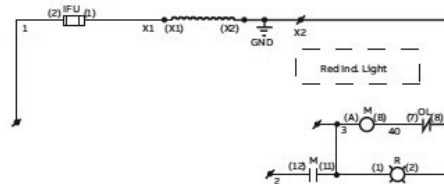
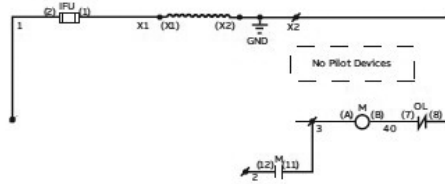
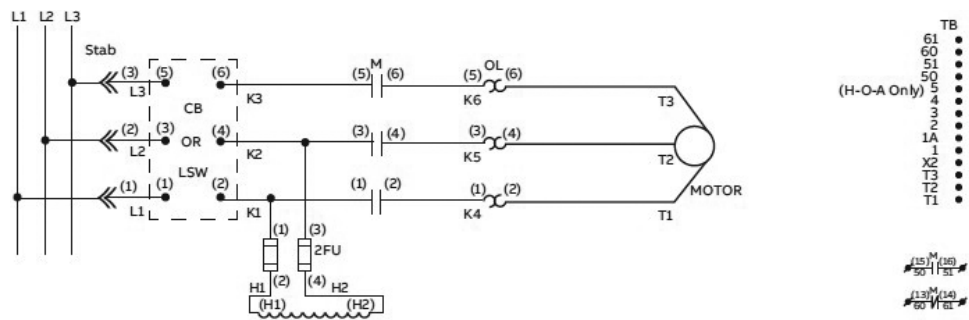
	QUALITY
1. WIRE CHECK Power Circuit Control Circuit.	PASS
2. AC DEVICES Pickup and Noise Tested at 85 % Voltage. 100 % of Rated Voltage with CPT.	PASS
3. DC DEVICES Pickup and Noise Tested at N/A % Voltage. Overvoltage set at N/A Volts. DC Test when requested by engineering order.	N/A
4. SEQUENCE OPERATION At Rated Voltage.	PASS
5. HIGH POTENTIAL TEST (HSPT) Power Circuit 2700 Volts for 1 Sec. Control Circuit N/A Volts for 1 Sec. Circuit Test includes On/Off and Components. When apply, to Control Circuits dual Electronic Protection.	PASS
6. INSULATION RESISTANCE (MEGGER) When Apply Phases to Ground, Phases to Phases. Voltage 500/1000V DC according to the order.	N/A
7. VISUAL INSPECTION Appearance, Workmanship, Components assembly, Mechanical Fabrication, Electrical Clearances and Mechanical Operations.	PASS
8. OTHERS	N/A

Acknowledgment of final inspection and operation of unit listed per this final test report:
 Quality Assurance Representative: Gabriel Martinez Date: January 1, 2020

Typical circuits

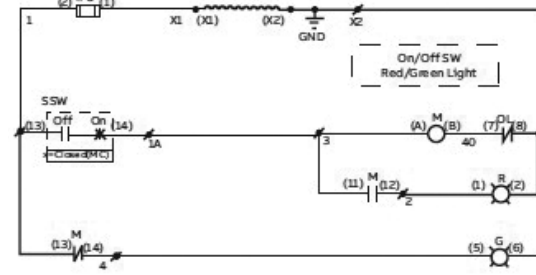
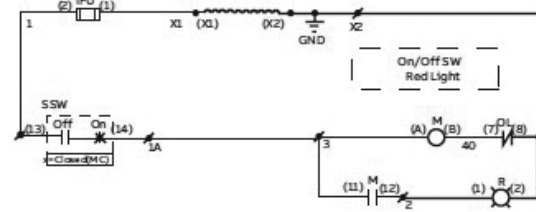
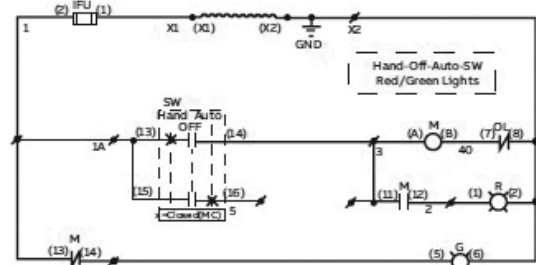
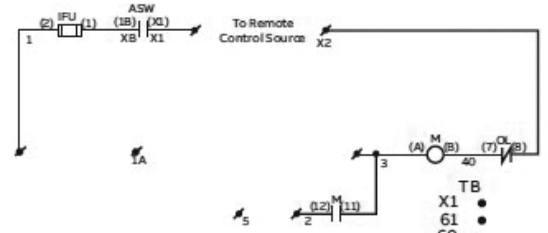
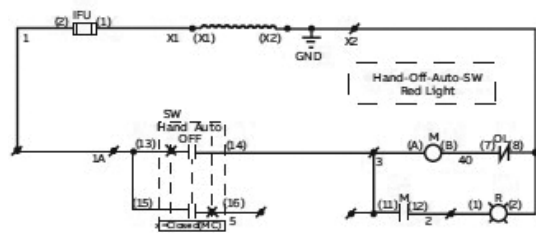
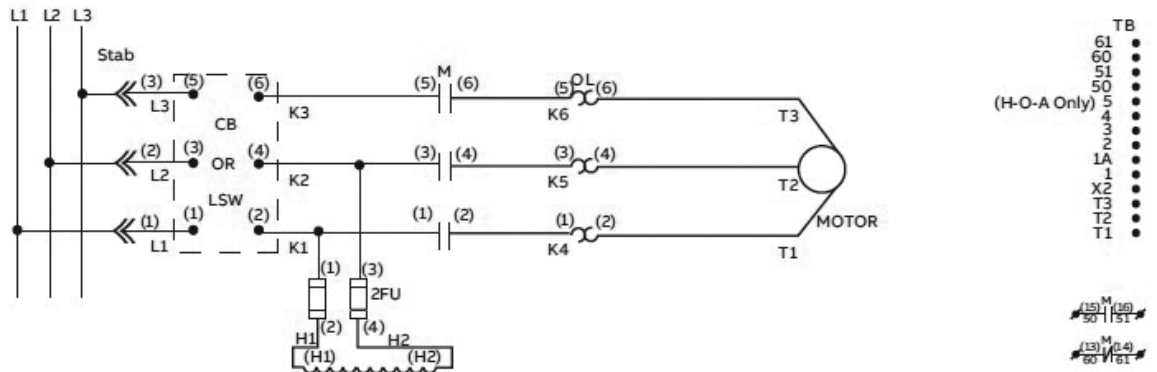
FVNR size 1-4

Typical circuit diagrams



FVNR size 1-4

Typical circuit diagrams

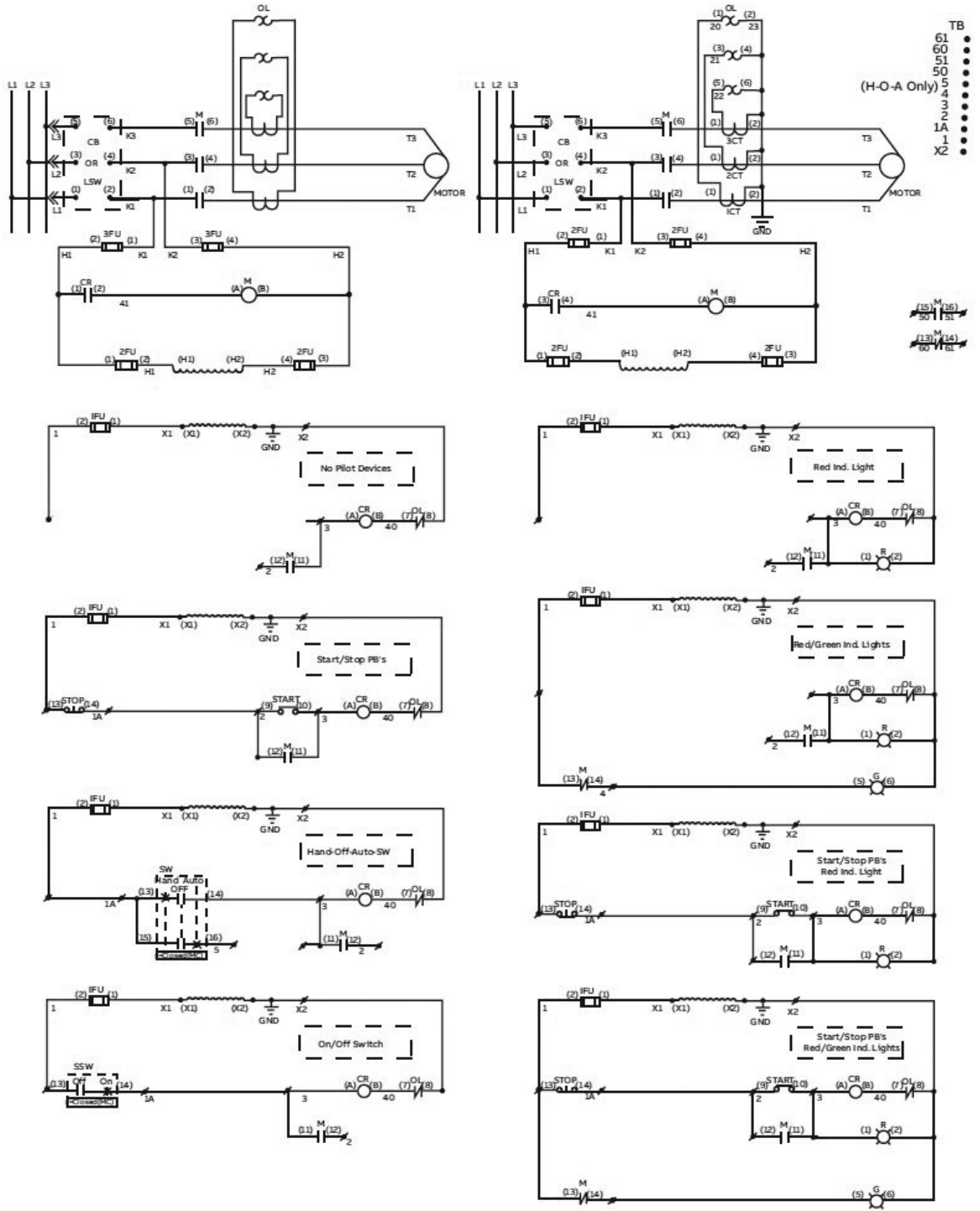


- TB
- 61 ●
- 60 ●
- 51 ●
- 50 ●
- (H-O-A Only) 5 ●
- 4 ●
- 3 ●
- 2 ●
- 1A ●
- 1 ●
- X2 ●
- T3 ●
- T2 ●
- T1 ●

- TB
- X1 ●
- 61 ●
- 60 ●
- 51 ●
- 50 ●
- 5 ●
- 4 ●
- 3 ●
- 2 ●
- 1A ●
- 1 ●
- X2 ●

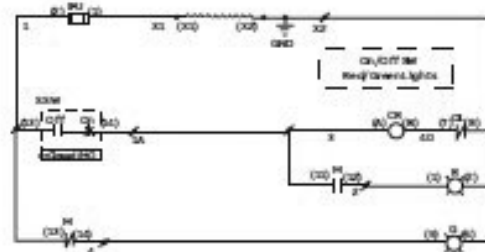
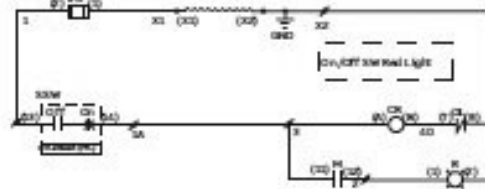
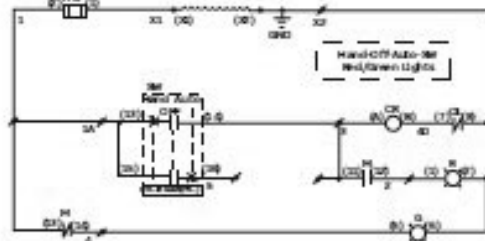
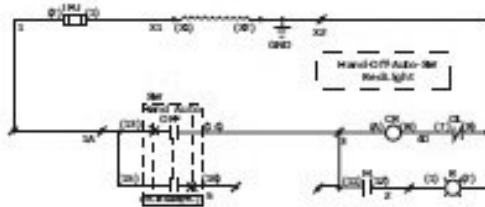
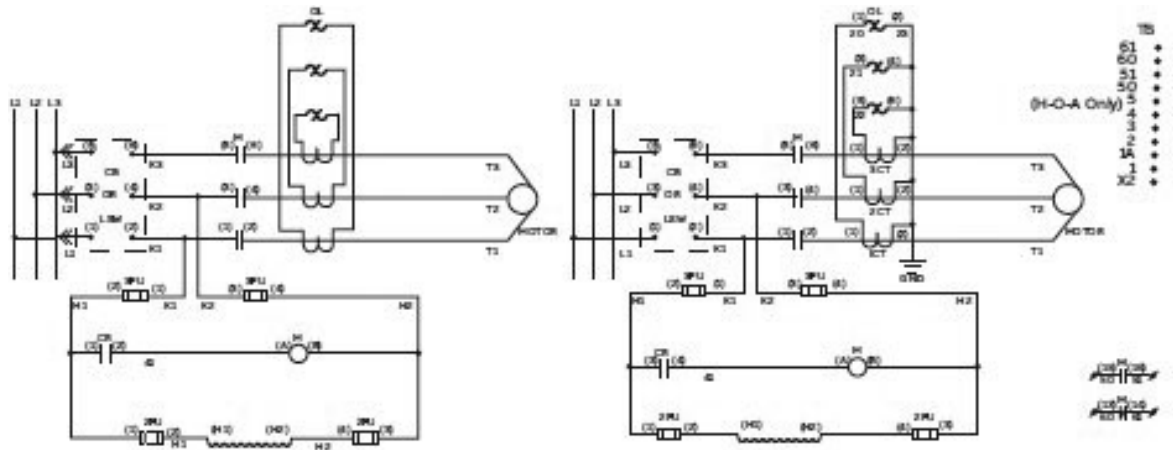
FVNR size 5-6

Typical circuit diagrams
S-5



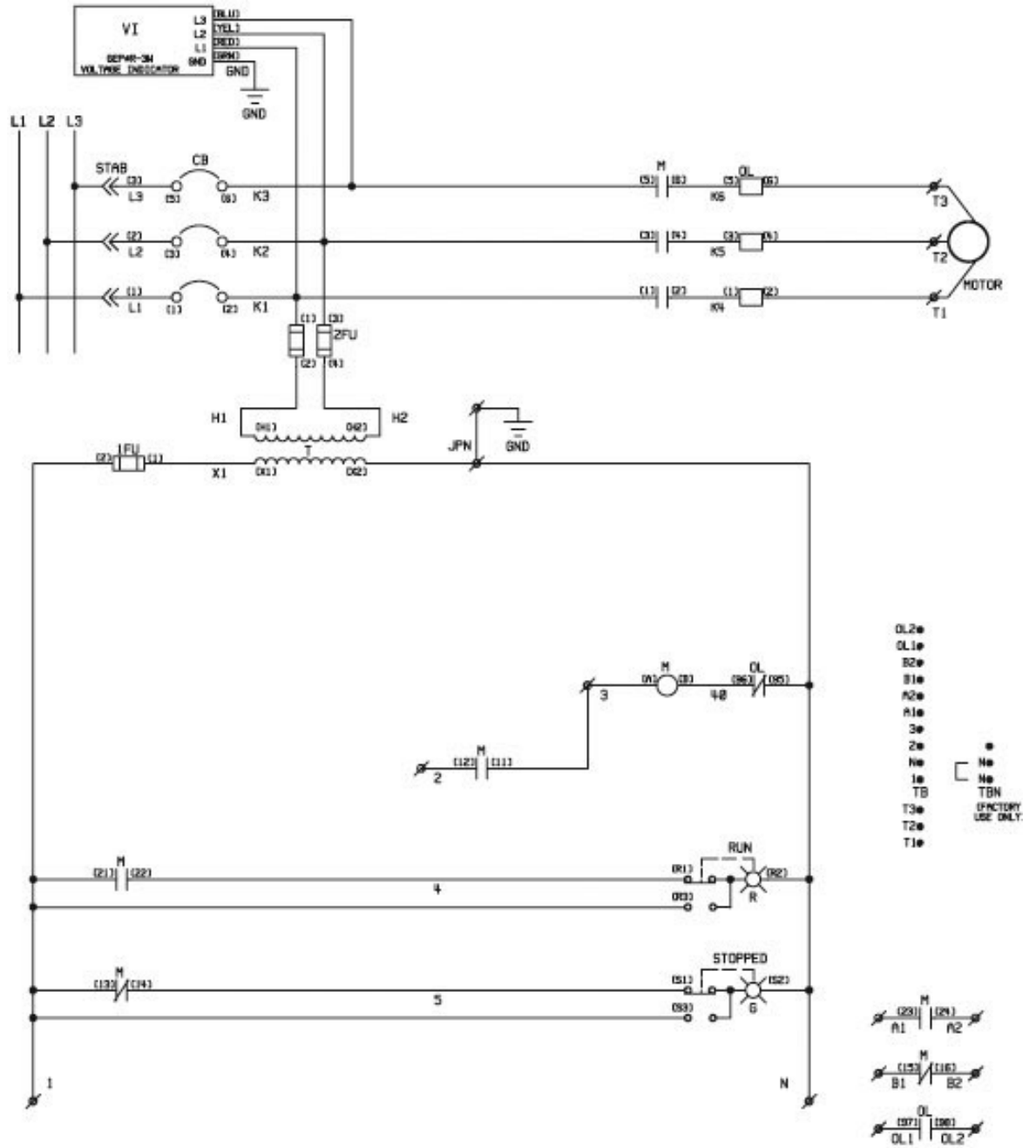
FVNR size 5-6

Typical circuit diagrams
S-5



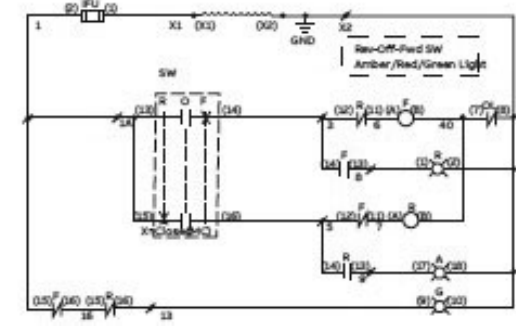
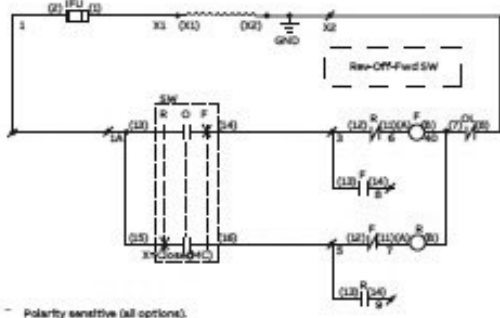
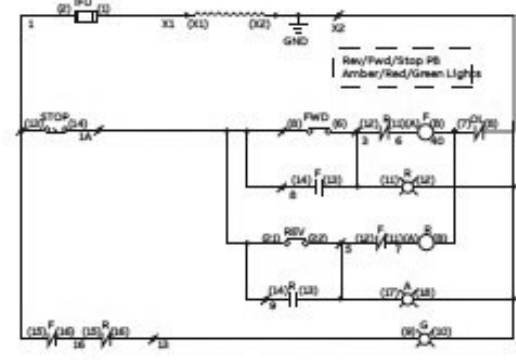
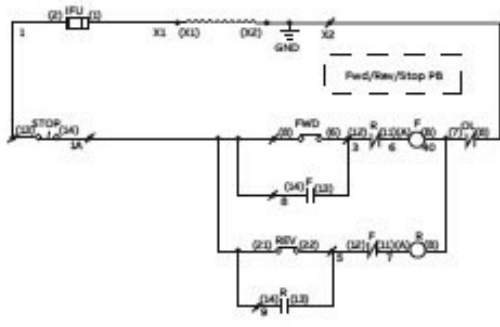
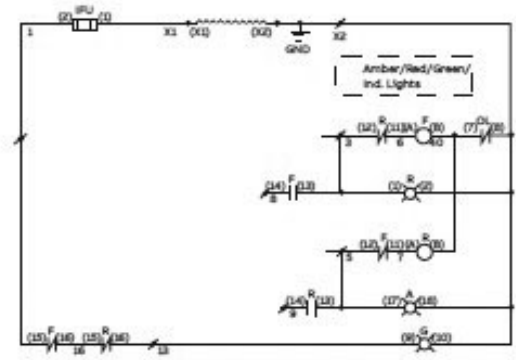
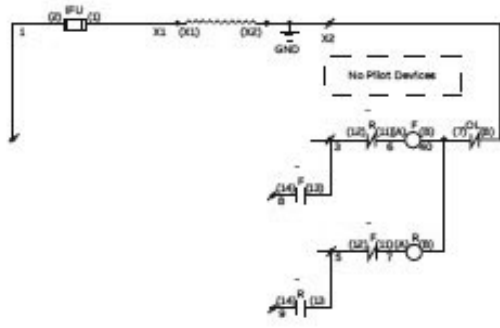
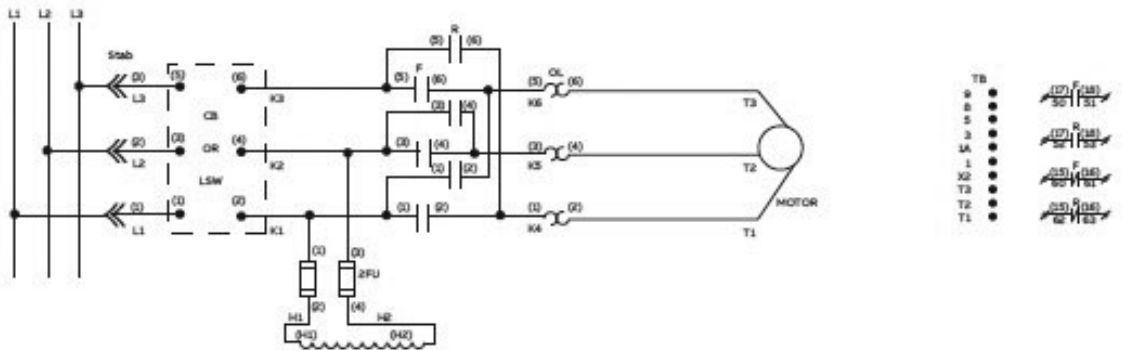
FVNR with voltage indicator module

Typical circuit diagrams



FVR size 1-4

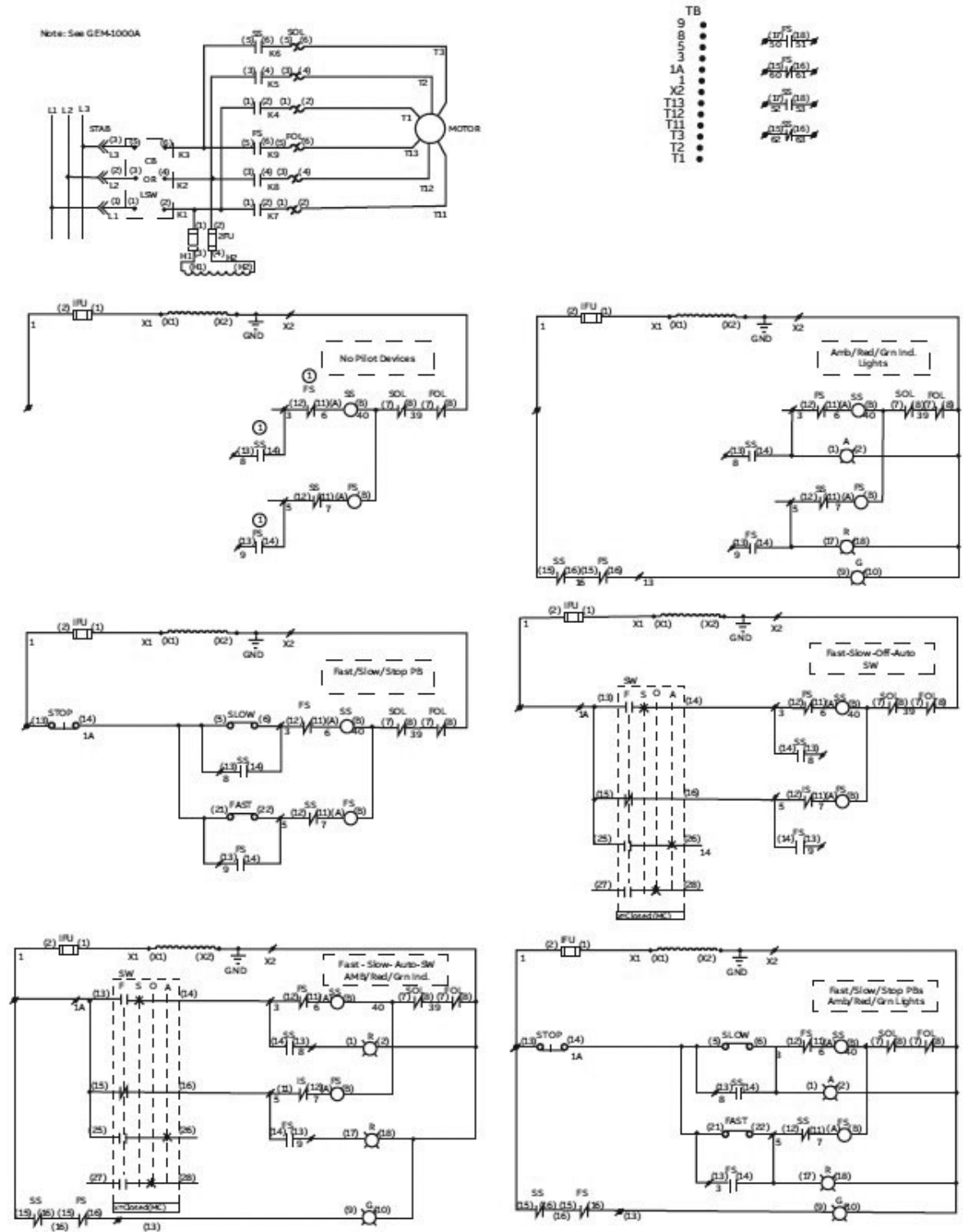
Typical circuit diagrams



~ Polarity sensitive (all options).

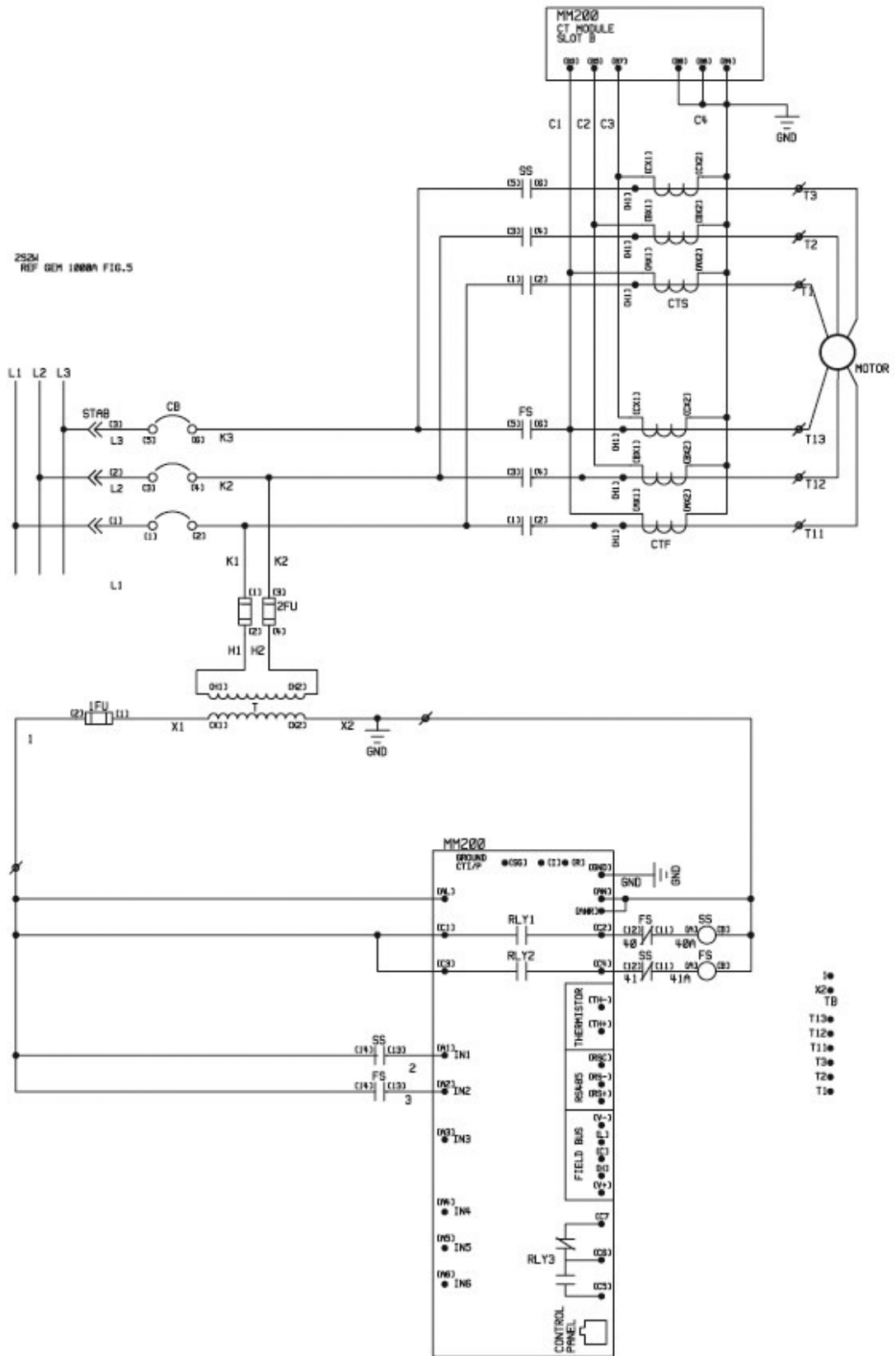
2S2W-C.T., V.T., C.H. Size 1-4

Typical circuit diagrams



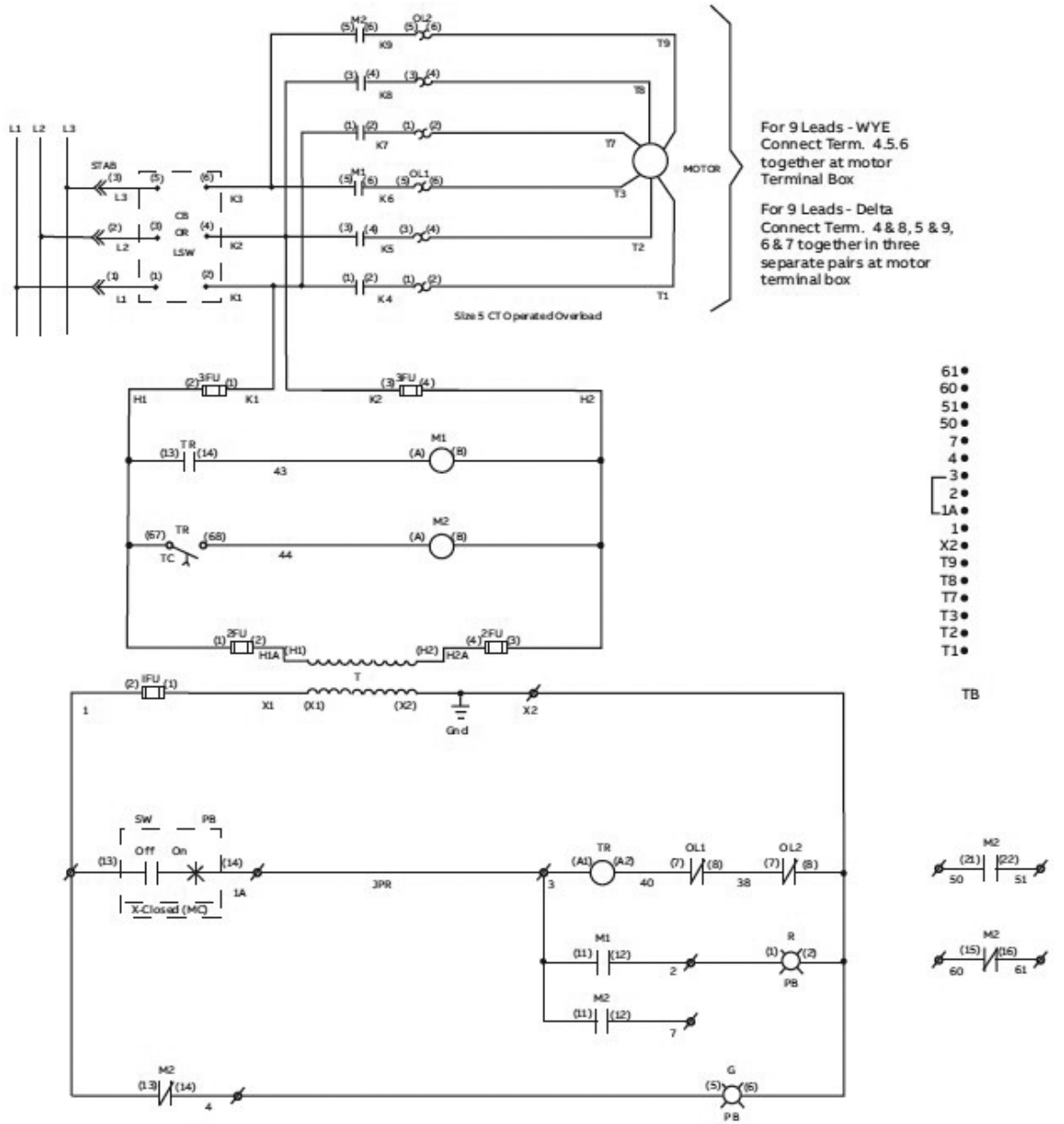
2S2W with MM200

Typical circuit diagrams



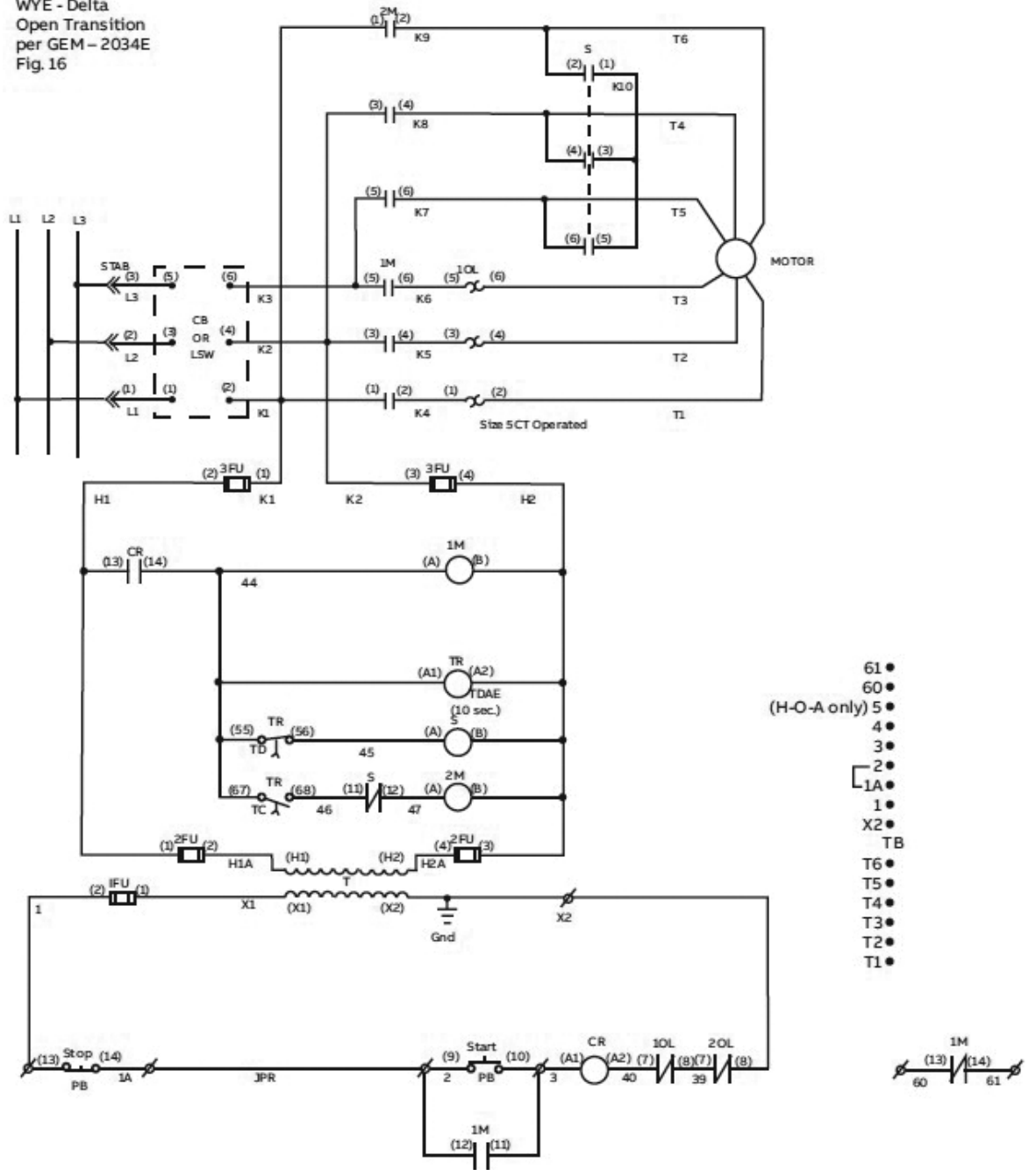
2S-PW size 1-5

Typical circuit diagrams

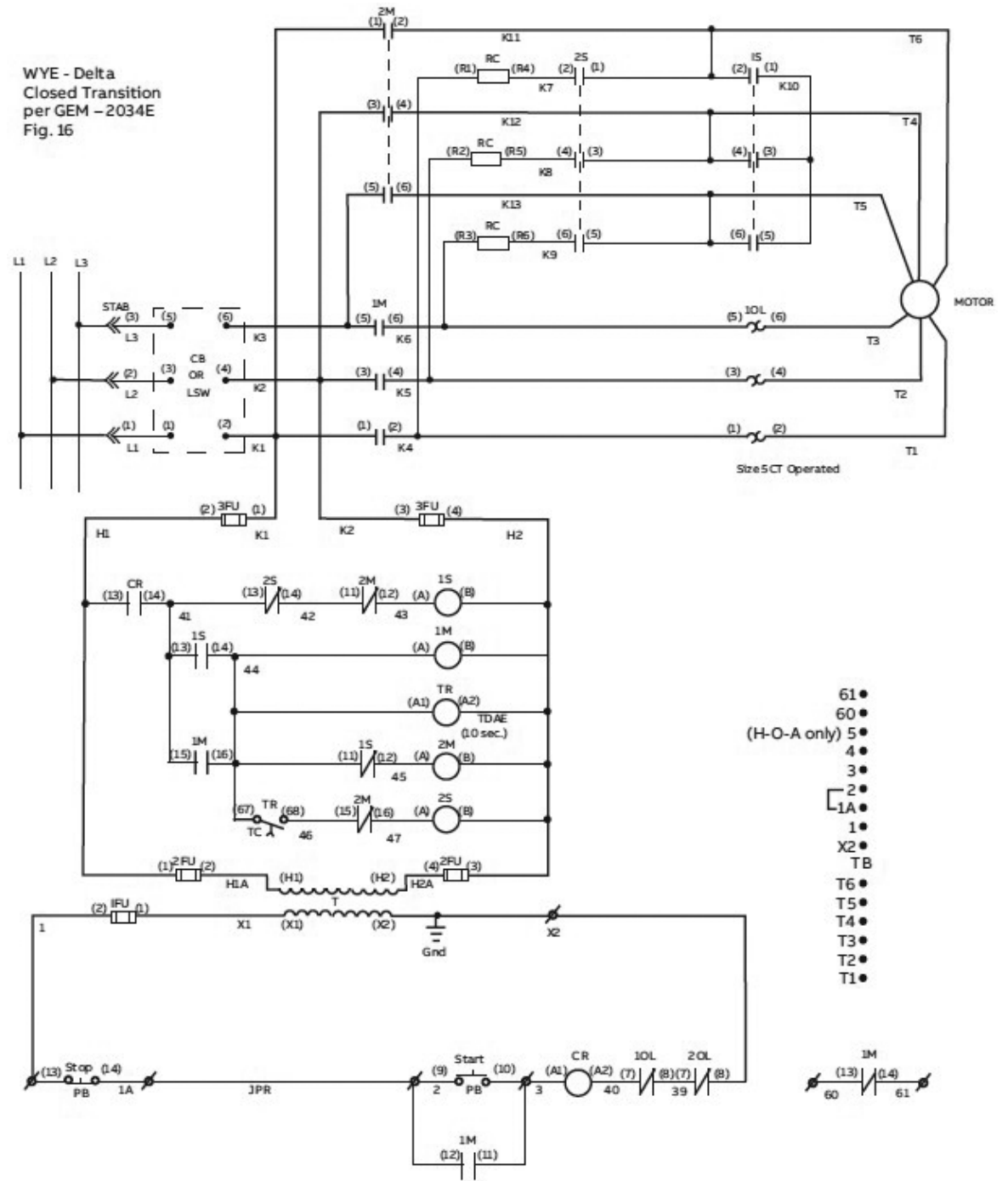


Wye-Delta open transition

WYE - Delta
Open Transition
per GEM - 2034E
Fig. 16



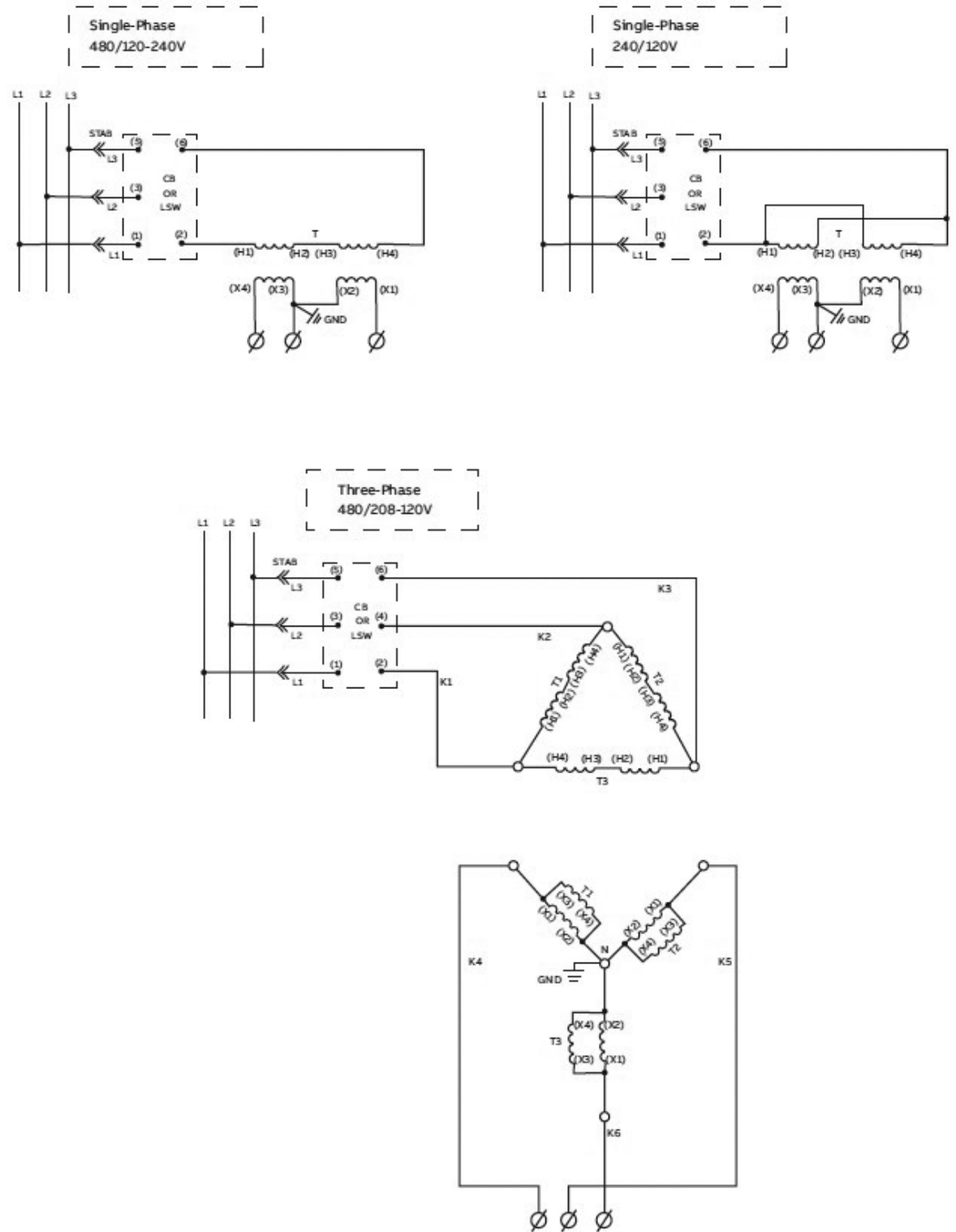
Wye-Delta closed transition



Note: Control circuit options similar to the FVNR size 5

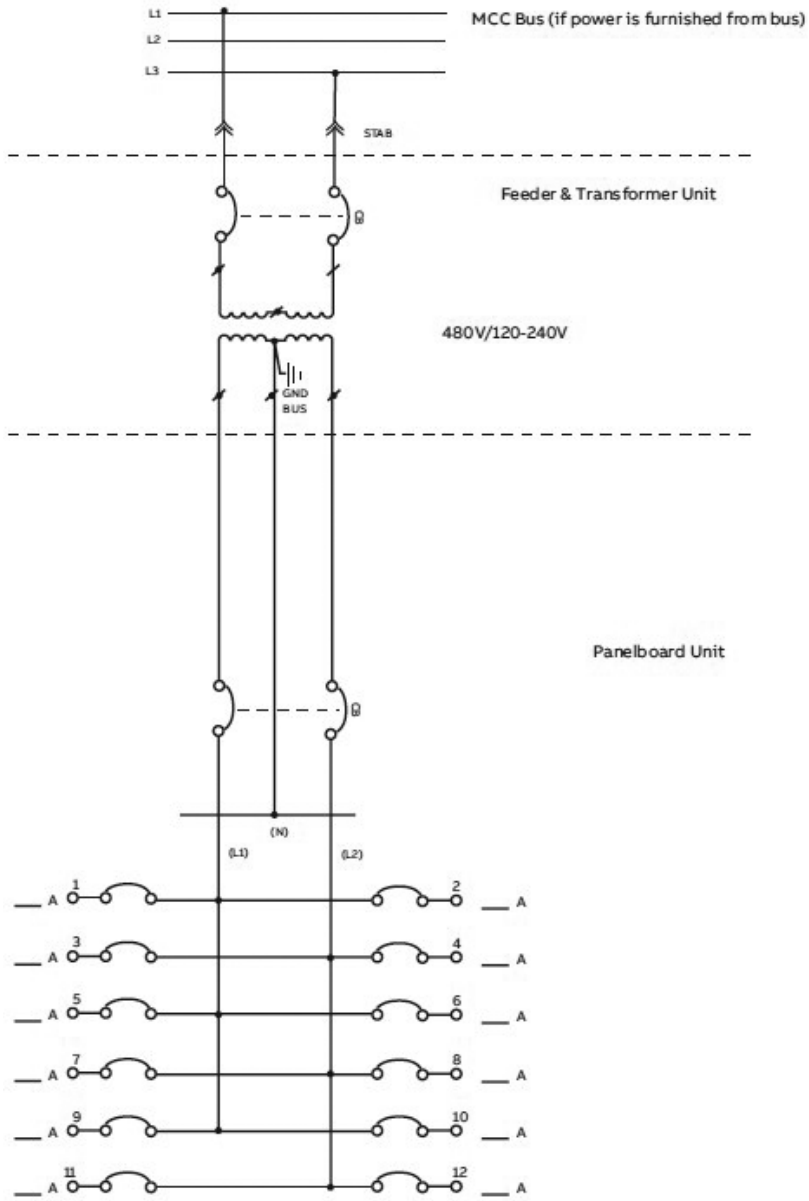
Distribution transformers

Typical circuit diagrams



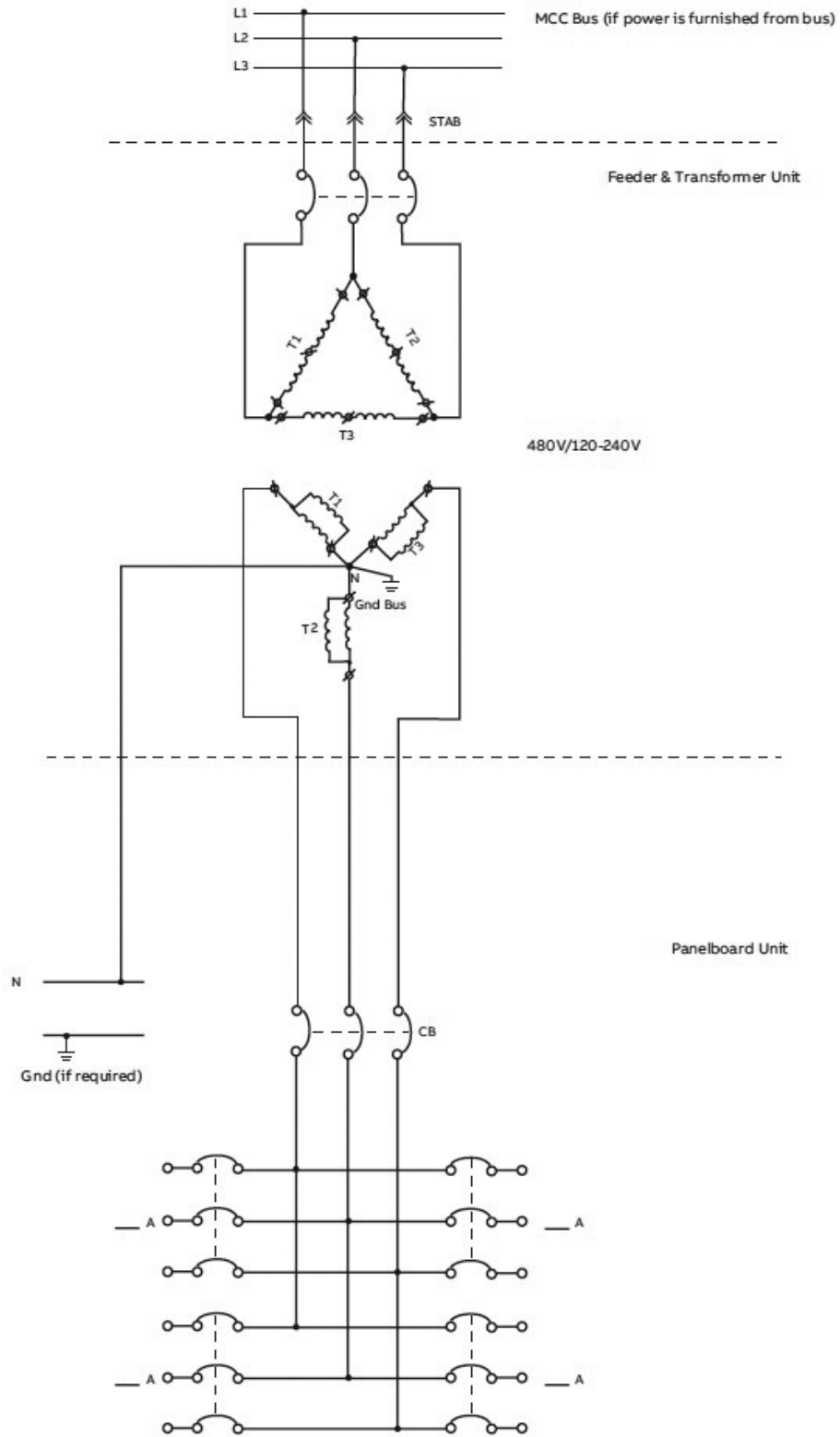
Single-phase panelboard

Typical circuit diagrams



Three-phase panelboard

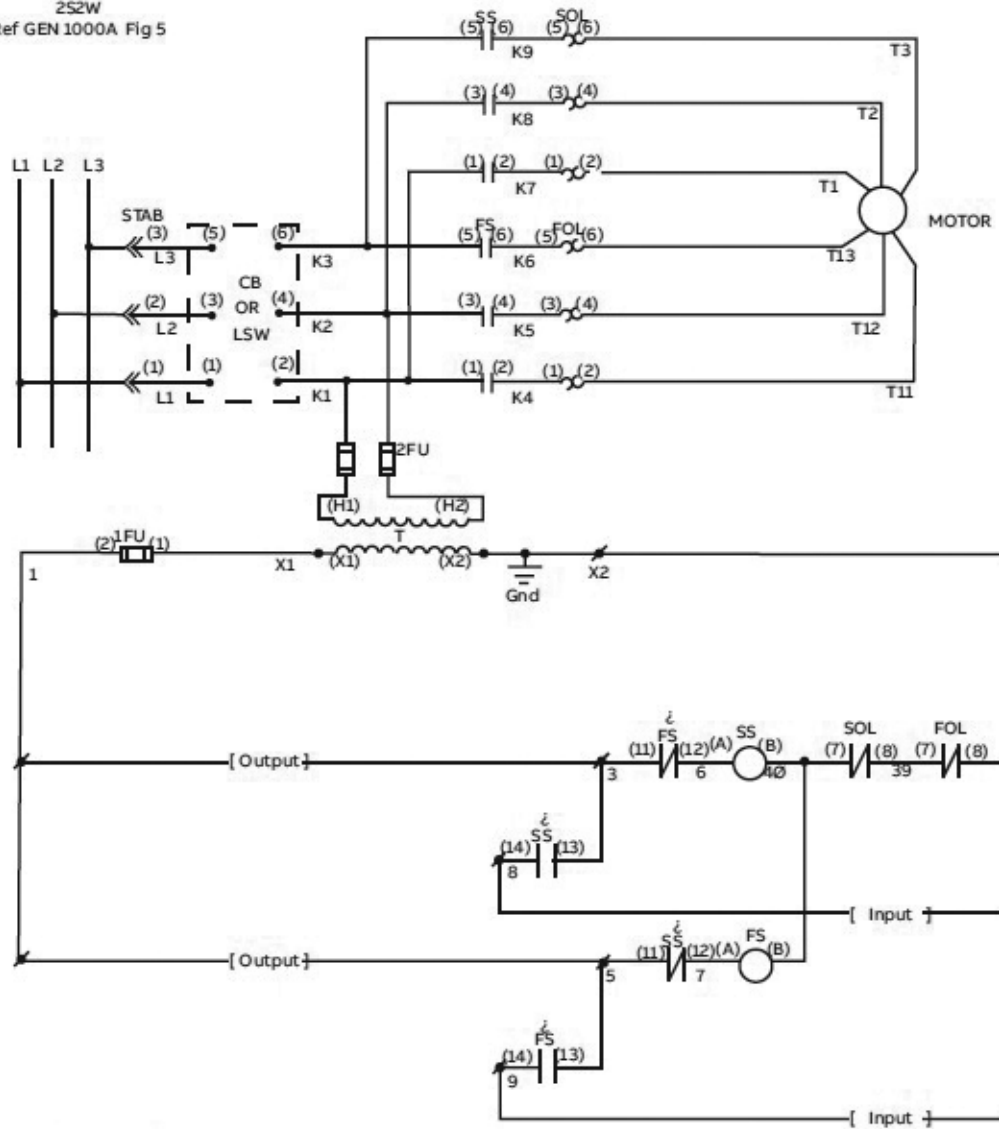
Typical circuit diagrams



2S2W with PLC

Typical circuit diagrams

2S2W
Ref GEN 1000A Fig 5

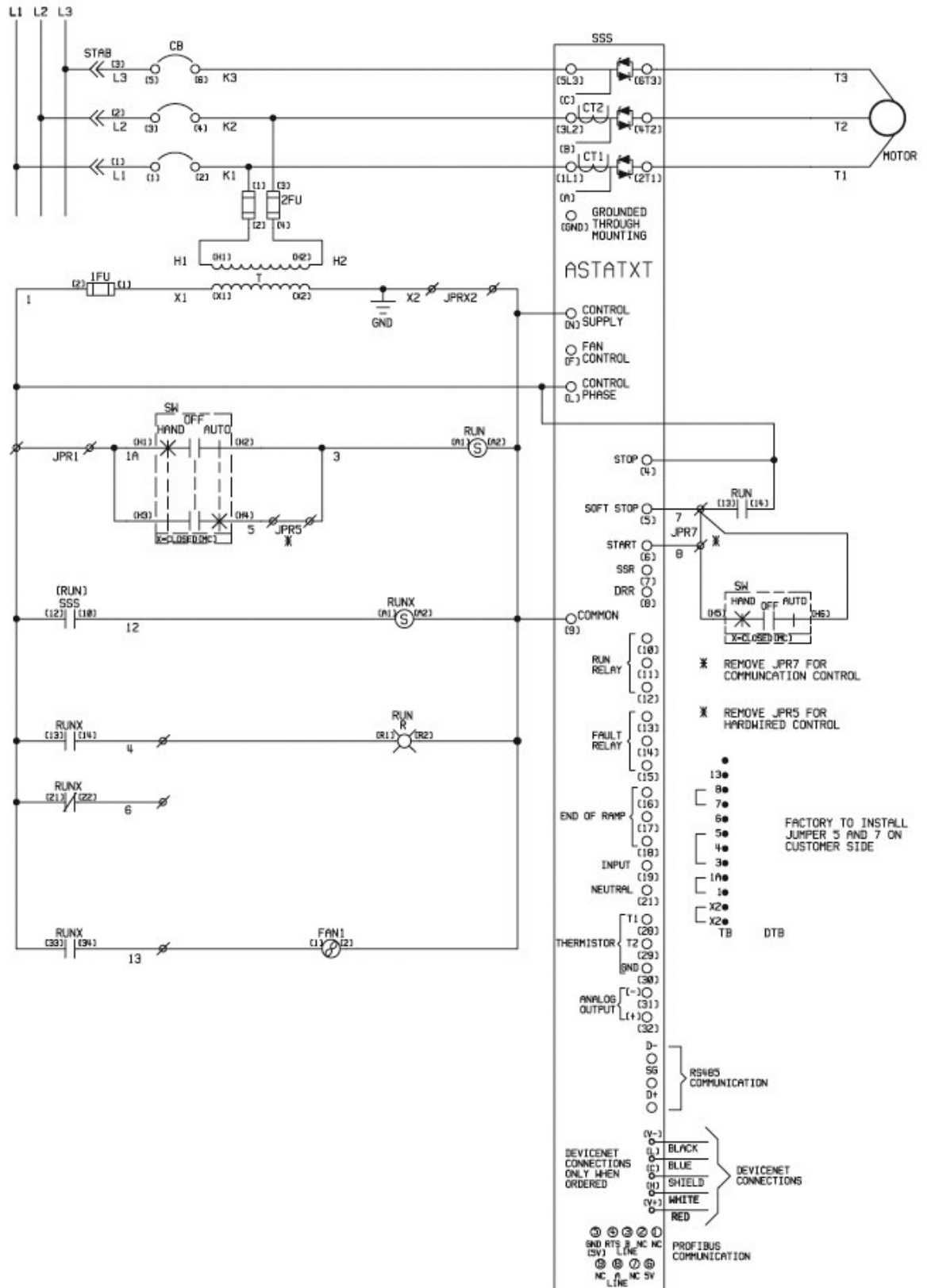


- TB ●
- 9 ●
- 8 ●
- 5 ●
- 3 ●
- 1 ●
- X2 ●
- T13 ●
- T12 ●
- T11 ●
- T3 ●
- T2 ●
- T1 ●

Polarity sensitive.

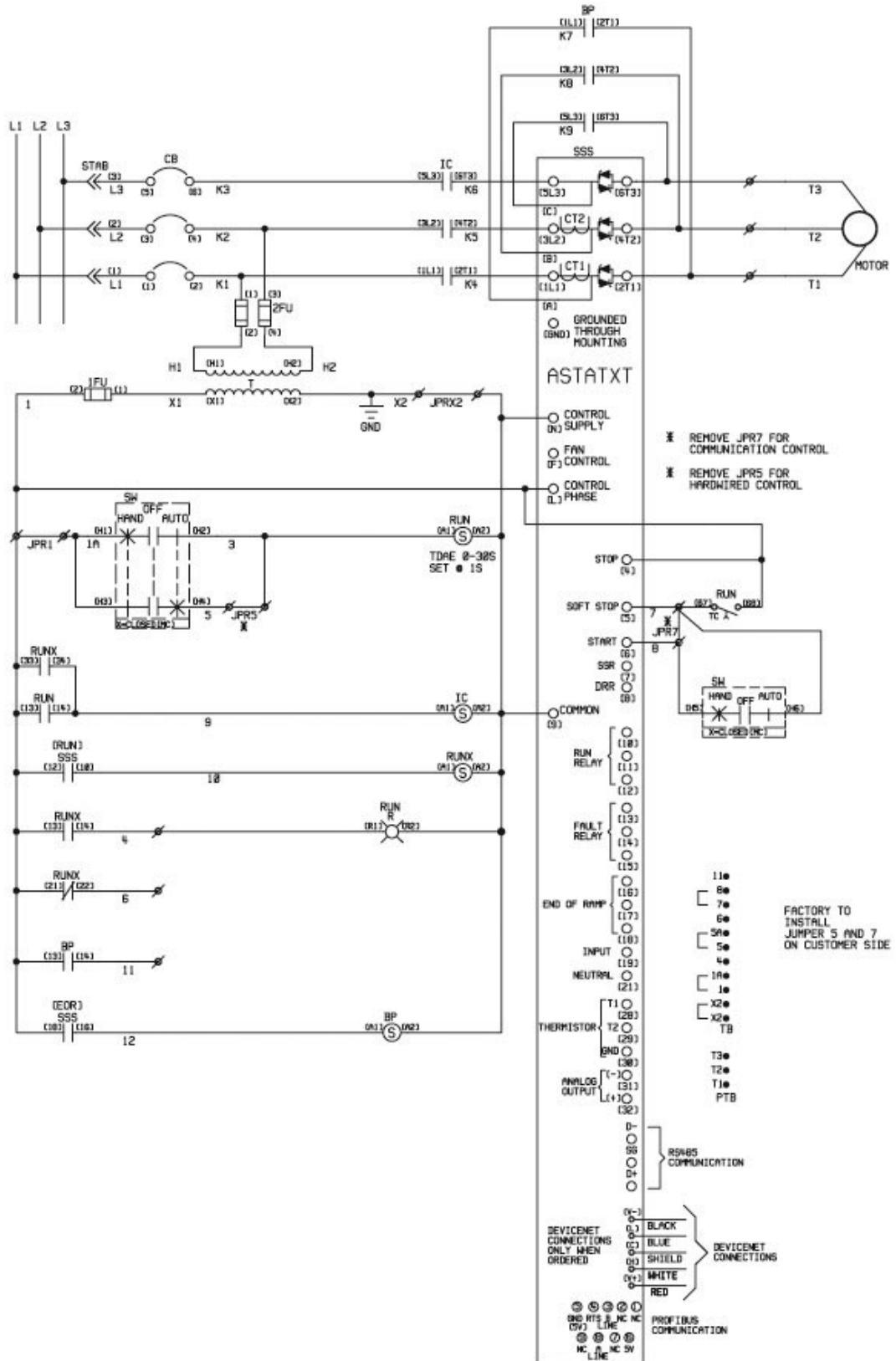
ASTAT XT

Typical circuit diagrams



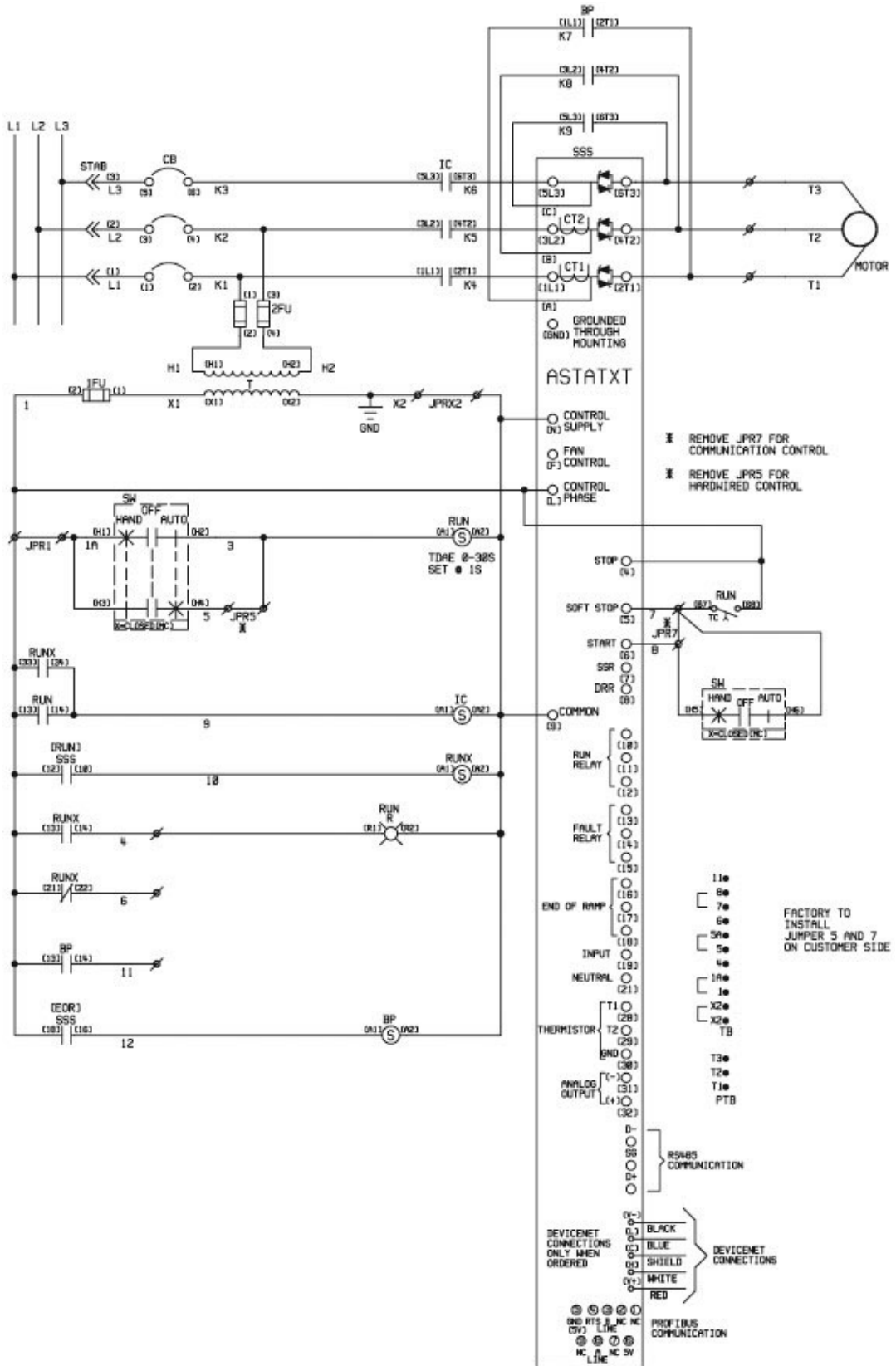
ASTAT XT isolation bypass

Typical circuit diagrams



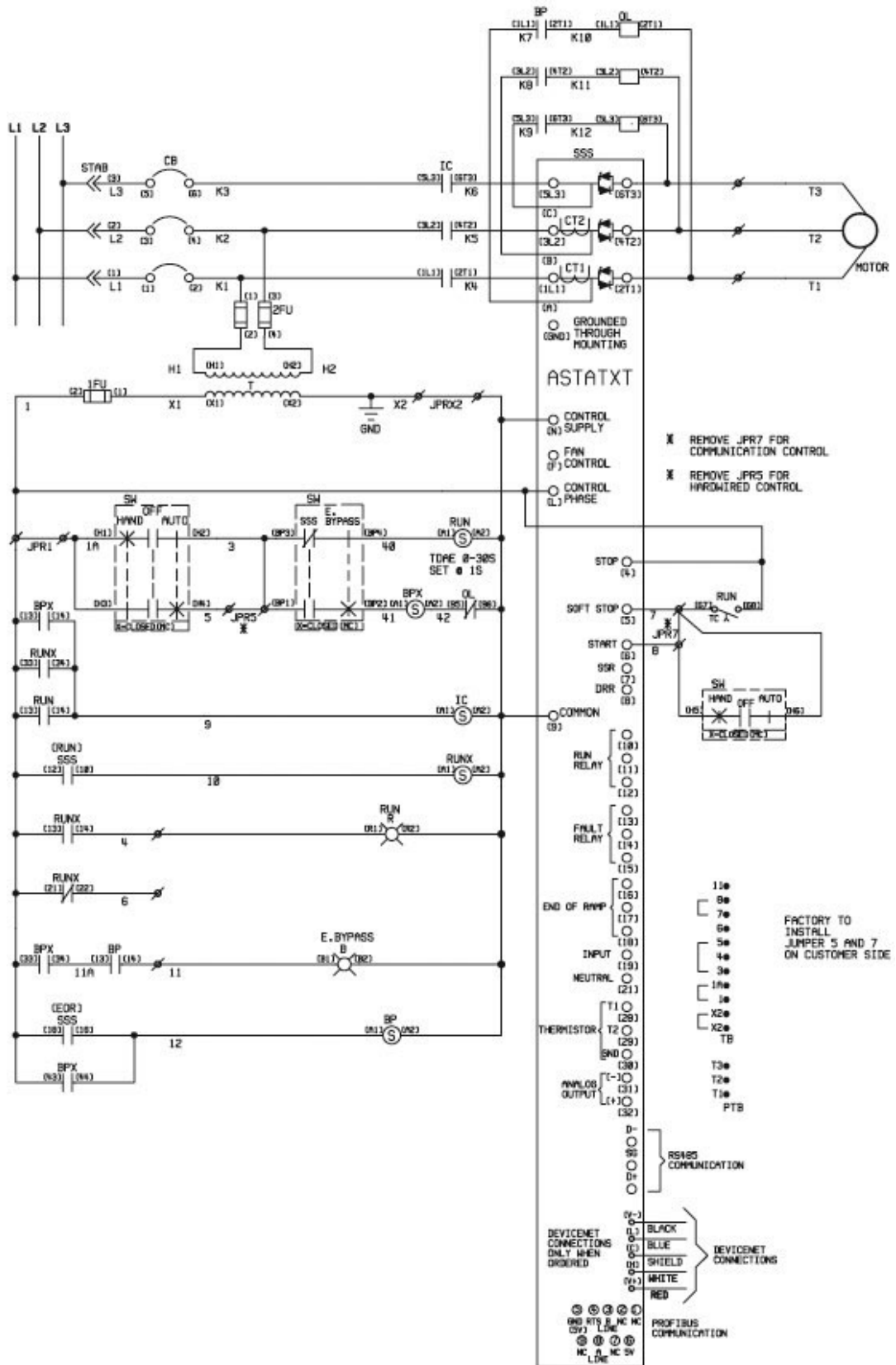
ASTAT XT bypass emergency bypass

Typical circuit diagrams



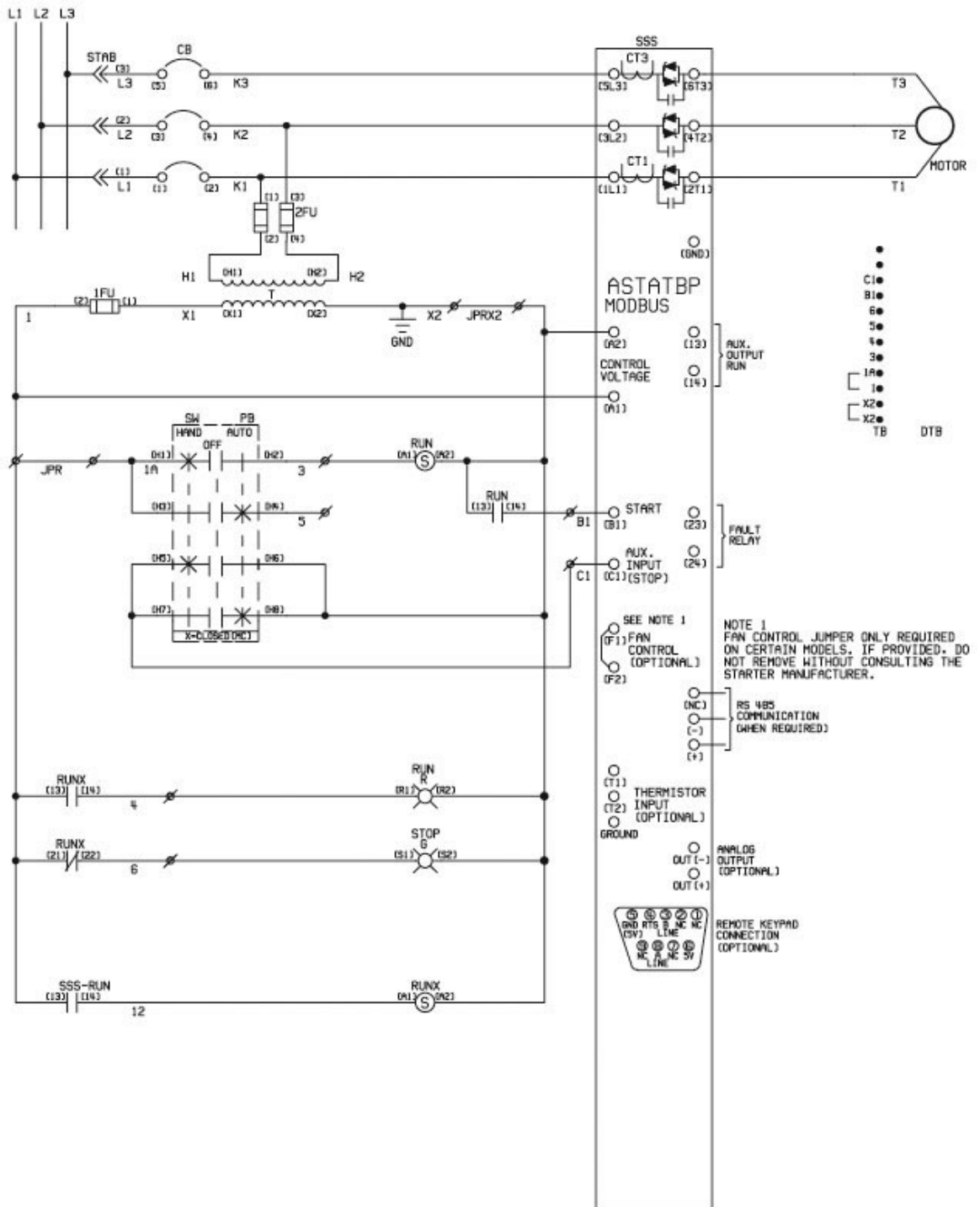
ASTAT XT isolation bypass emergency bypass

Typical circuit diagrams

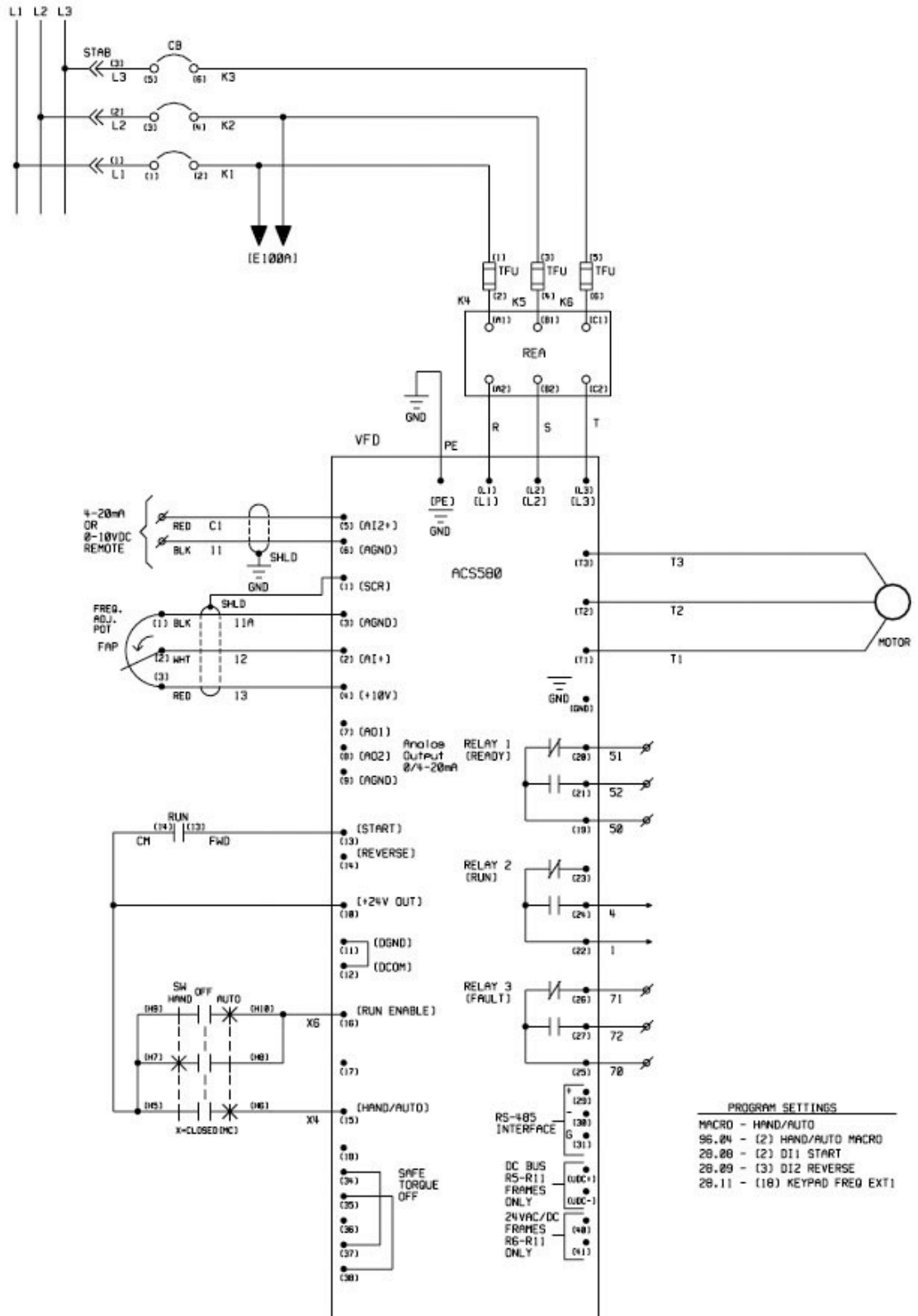


ASTAT BP

Typical circuit diagrams



ACS580 variable frequency drive (1 of 2)

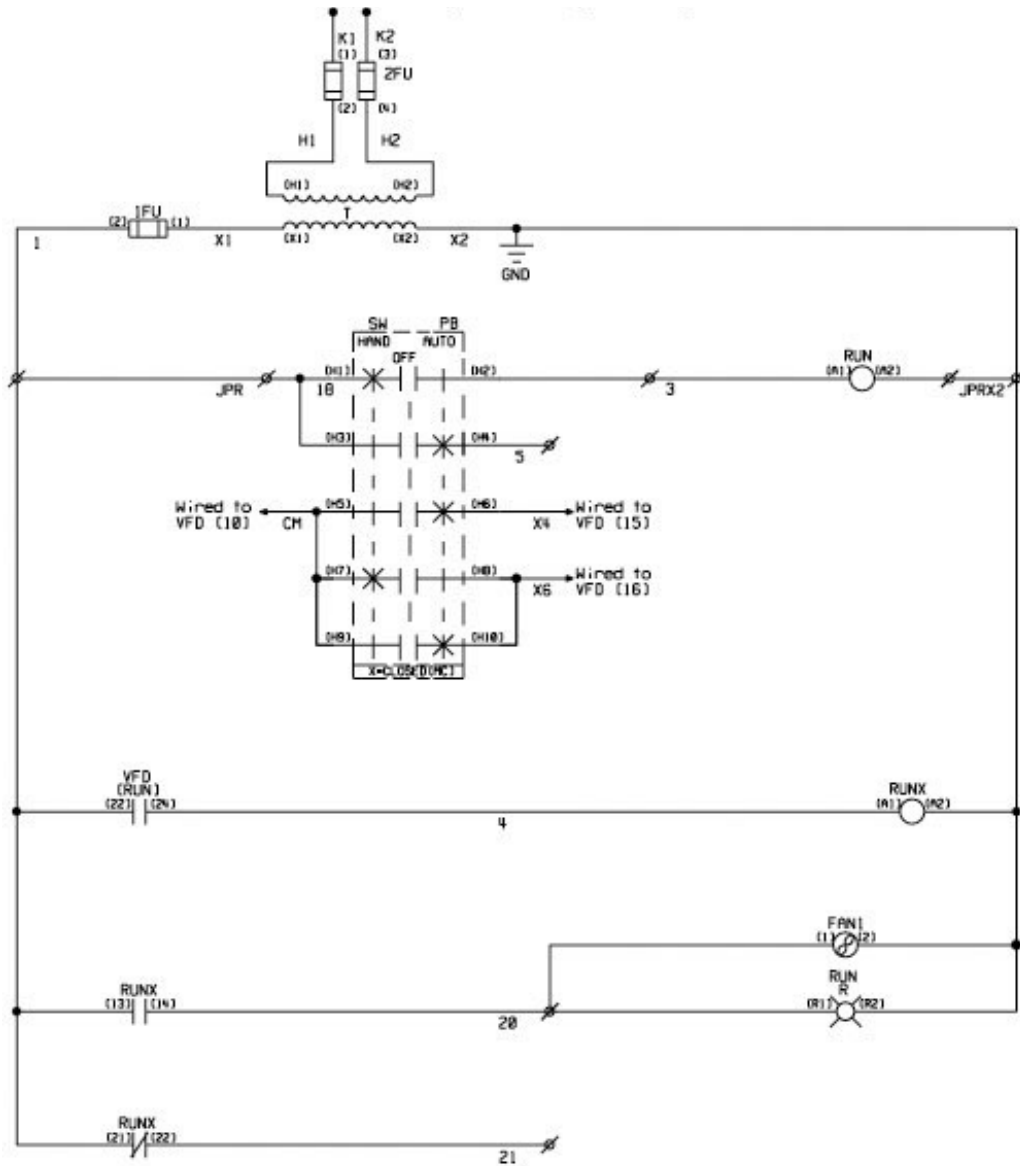


PROGRAM SETTINGS

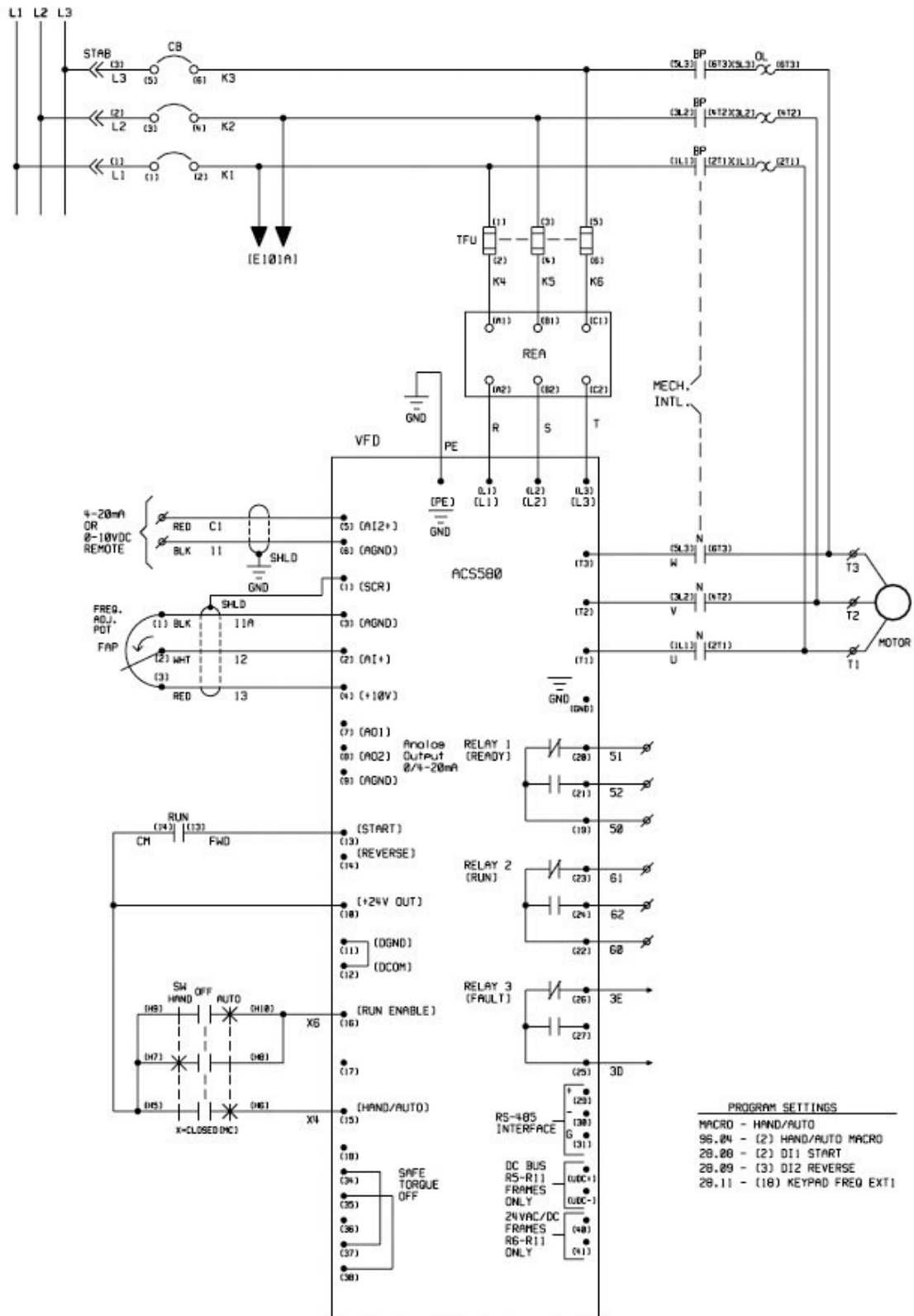
MACRO	-	HAND/AUTO
96.04	-	(2) HAND/AUTO MACRO
26.08	-	(2) DI1 START
26.09	-	(3) DI2 REVERSE
26.11	-	(18) KEYPAD FREQ EXT1

REFER TO MANUAL FOR EMC & VAR GROUNDING

ACS580 variable frequency drive (2 of 2)

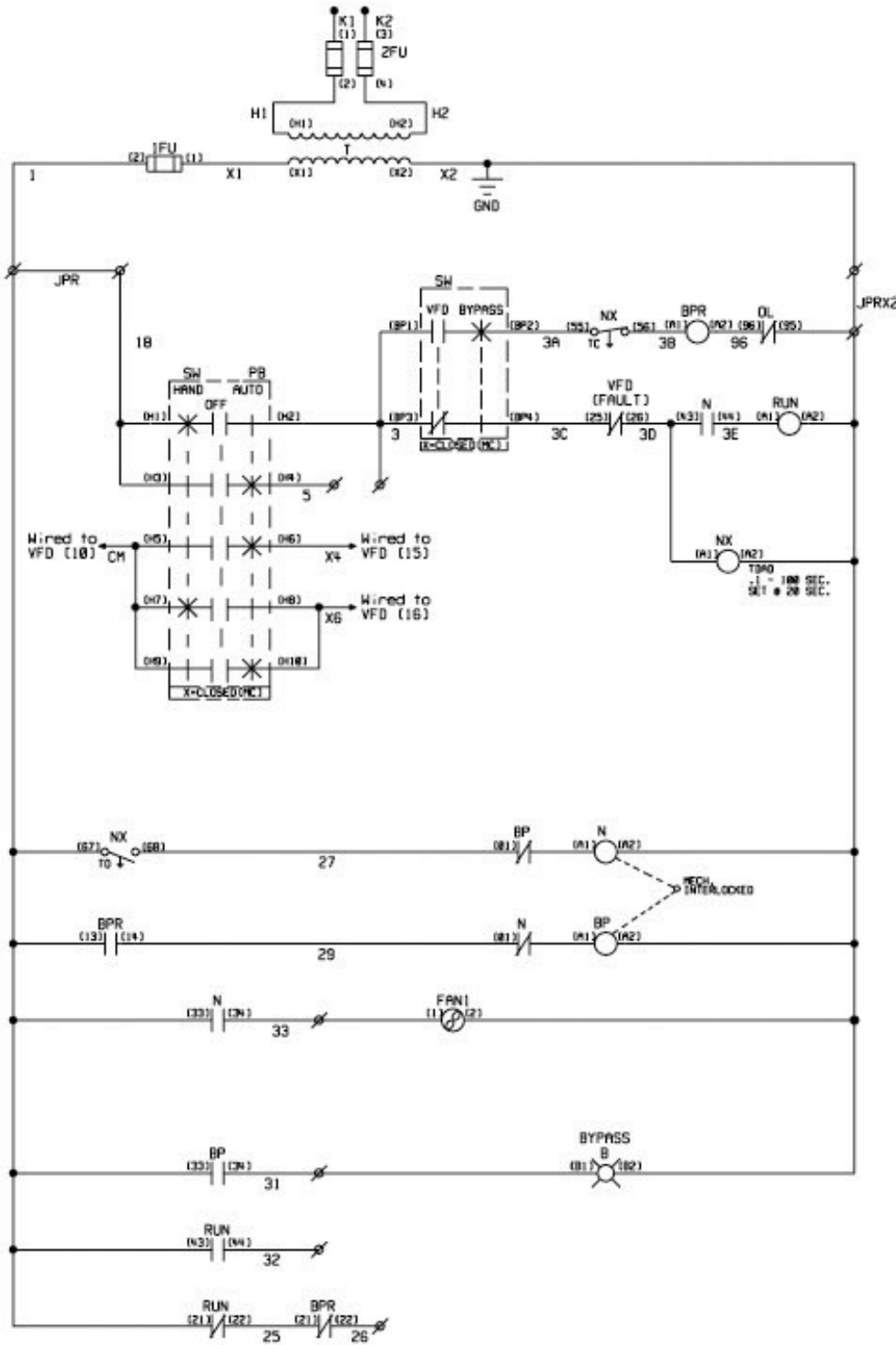


ACS580 variable frequency drive with bypass (1 of 2)



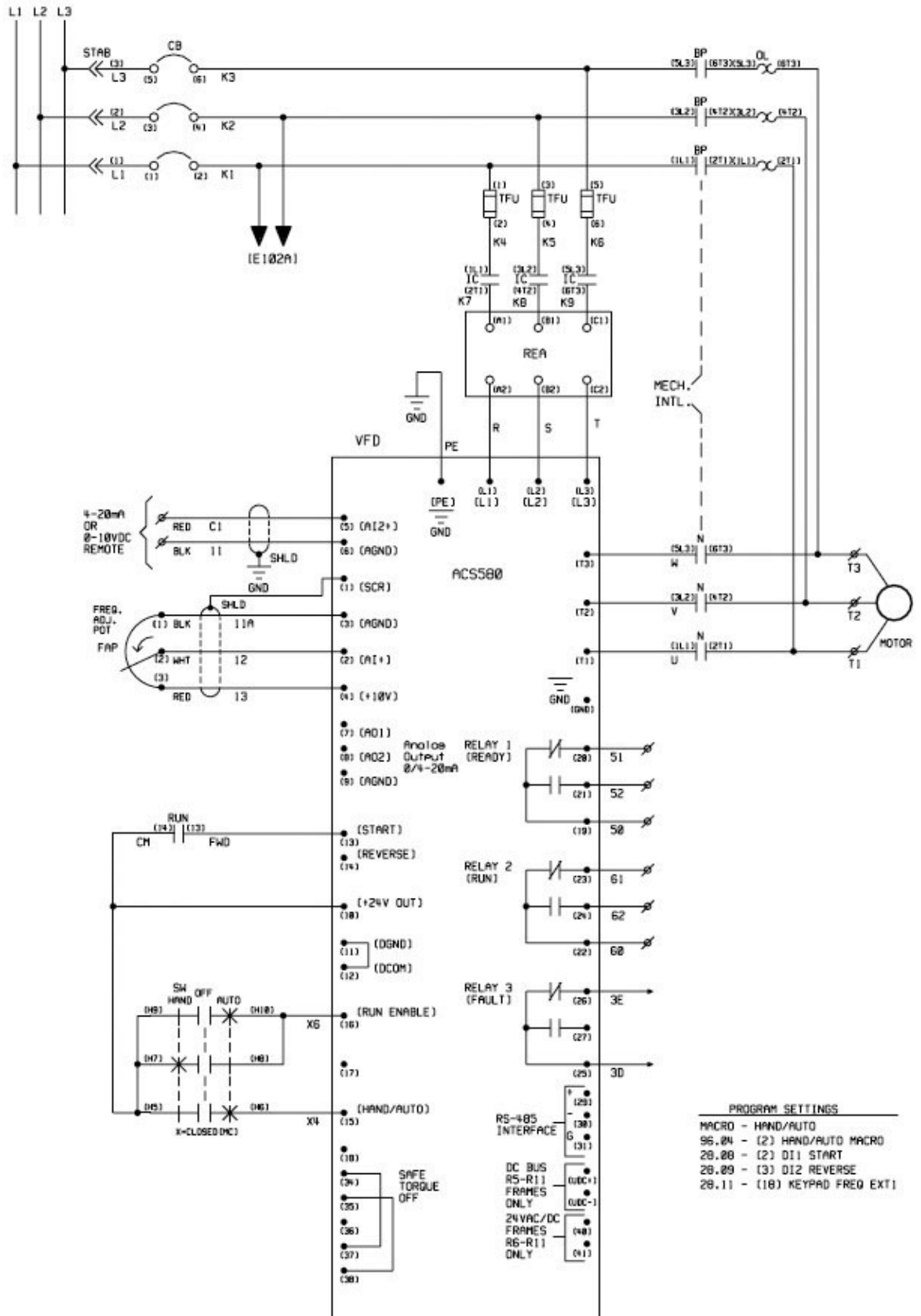
REFER TO MANUAL FOR EMC & VAR GROUNDING

ACS580 variable frequency drive with bypass (2 of 2)



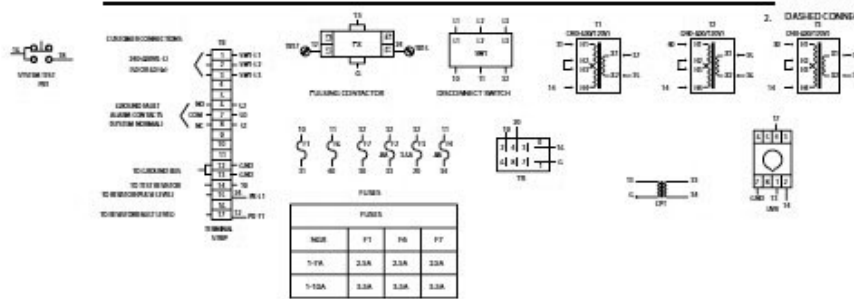
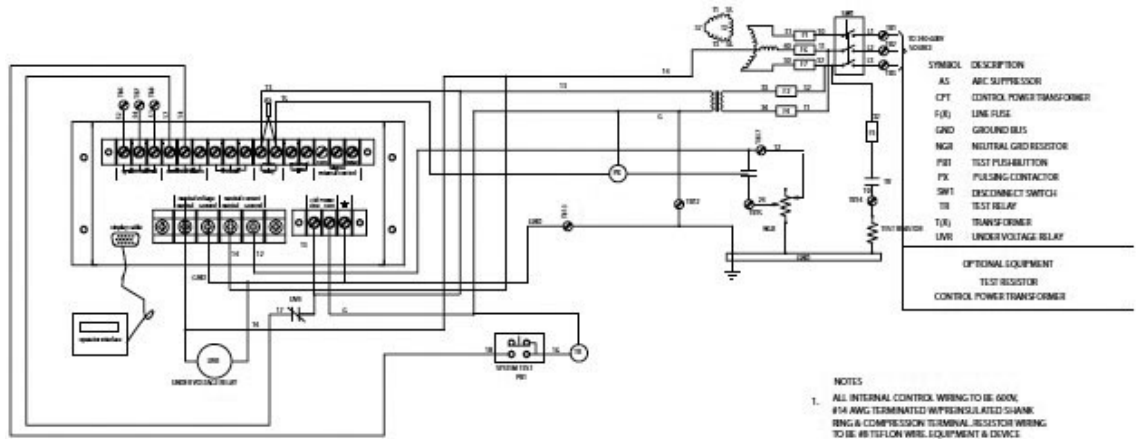
- 62●
- 61●
- 60●
- 52●
- 51●
- 50●
- 33●
- 32●
- 31●
- 26●
- 18●
- 5●
- 3●
- 1●
- X2●
- 11●
- C1●
- TB
- T3●
- T2●
- T1●
- PTB

ACS580 variable frequency drive with isolation & bypass (1 of 2)

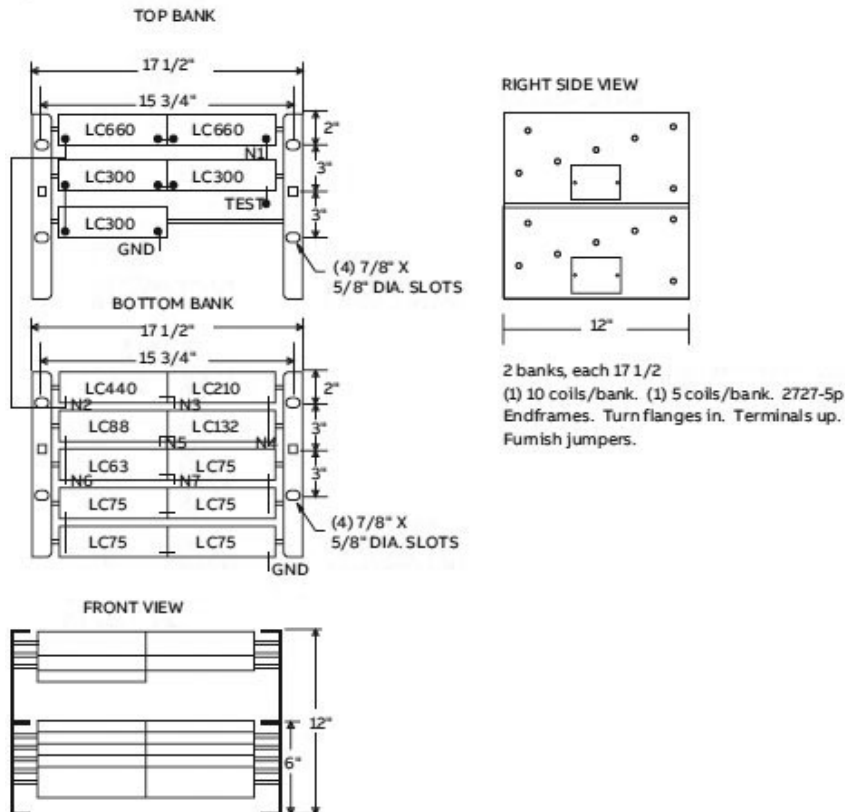


High-resistance ground

Typical circuit diagrams

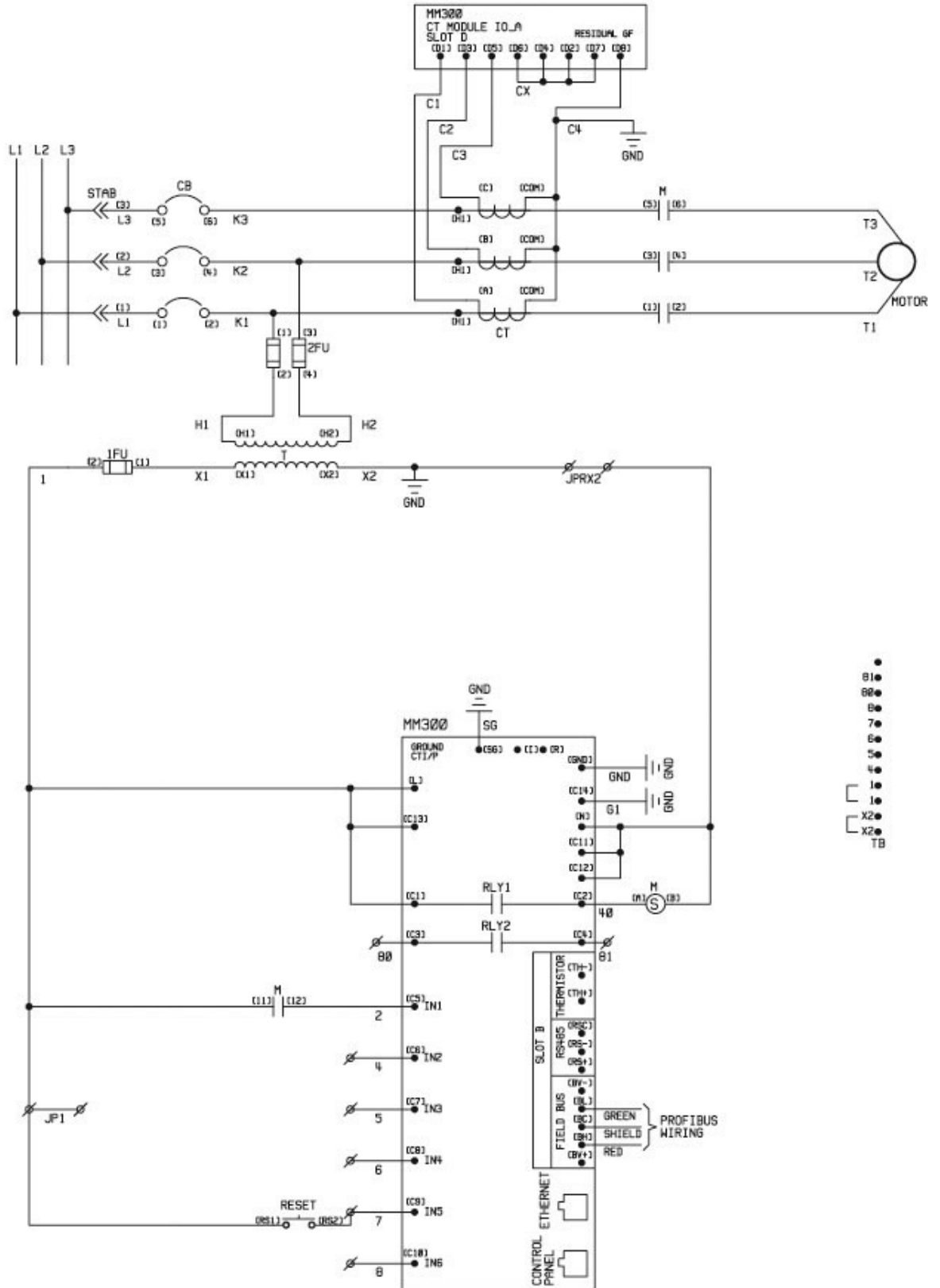


Top view

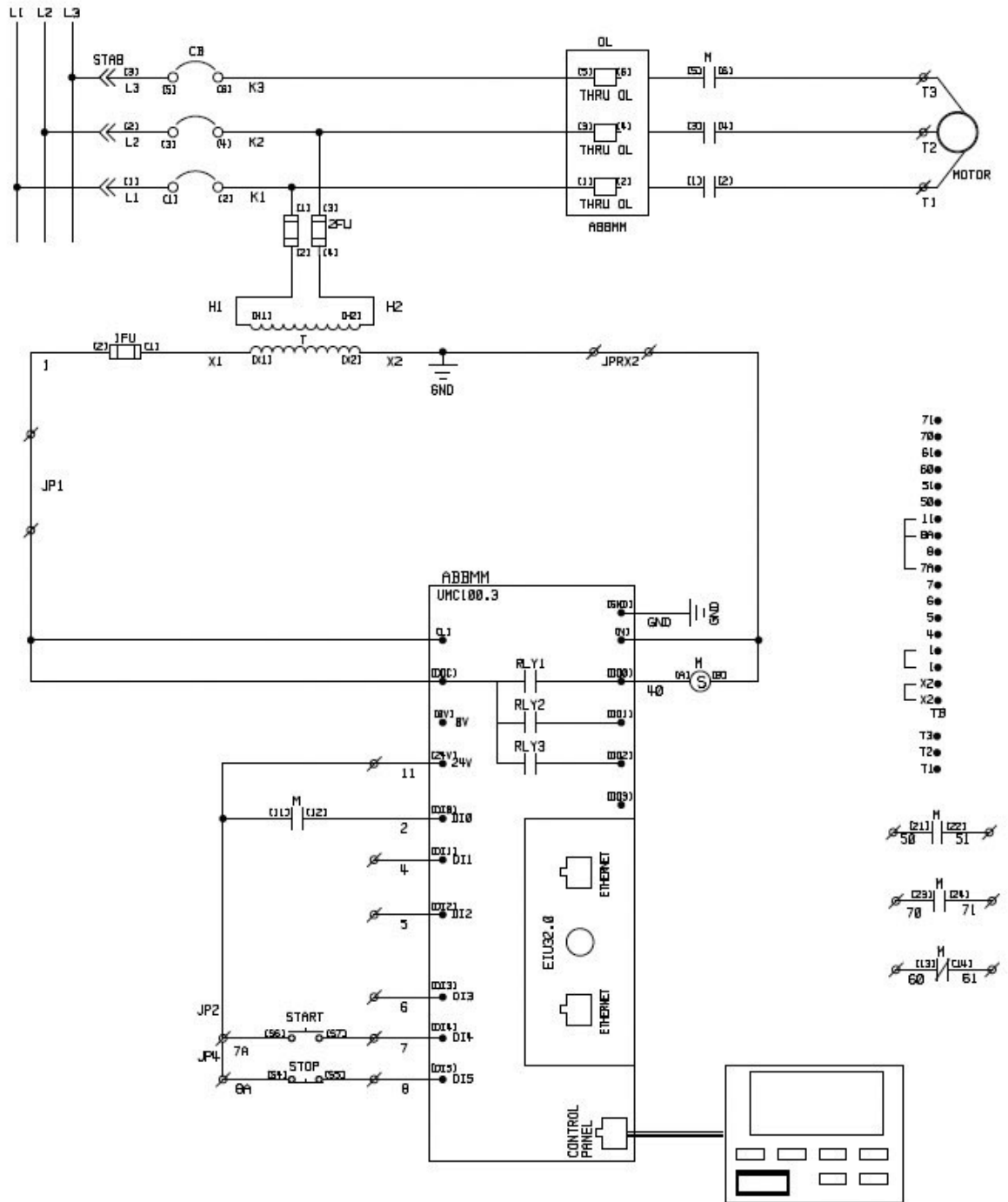


FVNR with MM300

Typical circuit diagrams



FVNR with UMC100.3 (start/stop)



Specifications

Specification for motor control centers 600 Vac and below

1.0 General

This specification covers low voltage motor control centers with combination starter units.

1.1 Standards

The motor control centers shall be manufactured and tested in accordance with NEMA ICS 2-3 and UL Standard 845. Vertical sections and individual units shall be UL Labeled where possible.

1.2 Service

Each motor control center shall be suitable for use on a _____ Vac, three phase, _____ wire, _____ Hertz power system having a short circuit availability of _____ A RMS symmetrical.

1.3 Wiring

Wiring shall be NEMA Class [I] [II], Type [A] [BD] [BT] [C]. Where Type C wiring is required, the master terminal blocks shall be located at the [top] [bottom] of the vertical section. Combination starter units shall be wired out to split type terminal blocks for easy removal of the starter unit without disturbing either factory or field installed wiring. All control terminal boards shall be accessible from the front.

2.0 Construction

Indoor enclosures shall be NEMA Type [1- Gasketed] [2] [12]. Indoor enclosures shall be suitable for front mounting. Outdoor enclosures when specified, shall be NEMA [3R Non-Walk-In].

The motor control center shall be seismic (non-OSHPD) rated in accordance with Section 1705.13.3 of the CBC 2019/ IBC 2018 and tested in accordance with 2015-ICC-ES AC156 Standards. The motor control center shall comply with seismic requirements per IEEE-693-2003 and ASCE7-16.

Each motor control center shall consist of the required number of vertical sections of heavy gauge sheet steel bolted together to form a rigid self-supporting assembly. A removable lifting angle shall be mounted to the motor control center at the top.

Removable bottom channel sills shall be mounted front and rear of the vertical sections and shall extend the width of the lineup. Motor control center vertical sections shall be nominally 90-inch high and 20-inch deep. Alternate section widths shall be 24-inches or 30-inches wide when required.

2.1 Horizontal wireway

Each vertical section shall contain a minimum 12-inch high top horizontal wireway and a 6-inch bottom wireway. When loads exit the bottom a 12-inch bottom wireway shall be provided. The horizontal wireway shall be covered by a removable hinged door.

2.2 Vertical wiring trough

A separate vertical wiring trough shall be furnished in each vertical section adjacent to plug-in unit. The wire trough shall permit the installation of field wiring and shall isolate this wiring from the adjacent unit. No terminal blocks shall be located in the vertical wireway. Cable tie supports shall be furnished in the vertical wireway to hold cable and wiring in place. The vertical wiring trough shall be covered by a removable hinged door. [A low-level signal raceway shall be provided.]

3.0 Incoming power/Main protective device

Incoming power to the motor control center shall be [cable] [bus duct]. [Incoming power cables shall enter the [top] [bottom] of the motor control center.] [Incoming cables shall be of the size and number shown on the plans.] [Incoming bus duct shall enter the top of the motor control center and shall have a current rating as shown on the plans.] The motor control center main protective device shall be a [molded case circuit breaker] [insulated case circuit breaker] [air circuit breaker]. The main device shall be of the ampere rating shown on the plans and shall have an interrupting rating equal to or greater than the available short circuit current.

4.0 Bus System

4.1 Main horizontal bus

Power shall be distributed by means of a continuous horizontal bus with a current rating of [600] [800] [1200] [1600] [2000] [2500] [3200] amperes. The main bus shall be [tin-plated] [standard silver-plated] [heavy silverplated] copper. The main bus shall be braced for [65,000][100,000] amperes RMS symmetrical. The main bus shall be isolated by barriers from wire troughs, starters, and other areas. There shall be double bolt connections on main bus joints and splice connections. Main bus splicing between shipping splits shall be accomplished from the [front up to and including 2500A] [rear for 2500A and 3200A] with no structural disassembly. The main bus shall be fully rated and arranged for future extension.

4.2 Vertical bus

The vertical bus in each section shall be rated [300] [600] [850]*amperes and shall be [tin-plated] [silver-plated]. *(1200A Main bus or greater)

The vertical bus shall be braced for [65KAIC] [100KAIC]. The vertical bus shall have a flame-retardant polyester-glass insulation / isolation system. This system shall insulate the vertical bus front and rear. In addition, the barrier shall isolate each phase bus. Openings in the vertical bus insulation/isolation system shall permit the entry of unit stabs. Unused openings shall have plugs or covers to prevent the entry of foreign objects. [The openings in the vertical bus used for starter connections shall be covered by an automatic shutter mechanism. The shutters shall automatically cover the openings when the starter is removed].The vertical bus bracing AIC rating shall be the same as the main horizontal bus.

4.3 Ground Bus

A copper ground bus shall extend the full width of the motor control center. The ground bus shall be rated [300] [600] amperes.

The ground bus shall be drilled and lugs furnished as specified. [There shall be a vertical copper ground bus in each section. This ground bus shall be accessible to a bus stab mounted in the unit compartment area and arranged so that the unit ground stab engages before the power stabs engage the vertical bus]. [A motor load ground lug shall be mounted in the unit and used for terminating the ground of multi-conductor cables.]

4.4 Neutral bus

A neutral bus shall be furnished when shown on the plans. The neutral bus shall be [300] [600] [800] [1000] [1200] [1250] [1600]. The neutral bus shall [be in the incoming section only] [extend the full-width] of the motor control center. When a neutral bus is specified, bottom plates shall be furnished. Lugs of the proper ampacity shall be furnished.

5.0 Units

Combination motor controller and feeder units shall employ [molded case circuit breakers] for branch circuit protection. Circuit breaker disconnects for combination motor starters shall be [thermalmagnetic] [magnetic only].

All combination starter and feeder units of plug-in construction shall utilize a positive guidance system to insure positive connection of the unit stabs to the section vertical bus. Insertion and removal of each unit shall not require the use of special tools. Unit shelves shall be of a lift out design. Connection from the power stabs to the unit disconnect shall be a direct connection. Each circuit breaker starter unit size 1 through size 5 shall be of plug-in construction. Each circuit breaker feeder 600A or less shall be plug-in.

Each unit compartment shall be equipped with a flange-formed pan type door. The door shall be mounted on the vertical section with removable hinges.

Each unit shall be equipped with an operating handle. The handle shall be connected to the disconnect operator using a direct drive and requiring no adjustment of linkage. The handle shall be mechanically interlocked with the door, preventing door opening with disconnect closed.

The interlock shall also prevent disconnect being closed with the door open and prevent the unit from being removed or installed with disconnect ON. The interlock shall be capable of being defeated, allowing the door to be opened with disconnect closed or disconnect closed with the door open.

The unit handle shall have provision for padlocking in the off position. On circuit breaker units the handle shall have a “tripped” position in addition to OFF/ON.

Each unit shall be capable of being padlocked in a partially withdrawn position. In this position, the unit power stabs are disengaged from the vertical bus and no power can enter the unit.

Combination starter units specified with Type B or C wiring shall be supplied with split-type terminal blocks. These terminal blocks shall be mounted in front of the unit and shall allow the removal of the unit without disconnecting any of the control wiring. Combination starter units up to size 5 shall be plug-in construction and shall be capable of being removed without disconnecting any control leads from their terminal blocks.

Overload relays shall be:

- {select one}
- [Bimetallic, ambient compensated]
- [Bimetallic, non-ambient compensated]
- [Solid-state, ambient insensitive, self powered, adjustable FLA, adjustable phase unbalance, phase loss protection, and selectable overload class (10, 20, 30) with 2% accuracy and repeatability, built-in thermal memory to prevent hot motor starts, isolated 1NO and 1 NC auxiliary contacts]
- [Advanced microprocessor based motor protection, Dip switch selectable Phase loss protection/Phase Unbalance, adjustable FLA, Selectable overload class (10, 20, 30)]
- [Ground fault protection]

Provisions to Communicate over the following Protocol: [DeviceNet] [Modbus RTU] [Profibus] [Modbus TCP/IP] [Ethernet IP]

The following minimum information shall be available over the Network.

- Metering (Average Phase Current in Amps, Control Voltage, Motor Run Time)
- Starter Status and Configuration Notification (Run, Overload, Ground Fault, Phase Unbalance, Commanded Trip, Class setting)
- Information (Voltage, Internal failure, 100% Motor Load Warning)
- Remote Control (On, Off, Trip, Reset)

[Provide a Display Module for accessing at the unit all Network data] [Door mounted] [Hand held using phone jack on the door].

Control power for starter units shall be from:

{select one}

[Individual control power transformers furnished in each starter unit. One secondary lead shall be furnished with a fuse and the other lead shall be grounded. Control power primary fuses are required].

[Line voltage. Control circuits on all starter units with line voltage control power shall be provided with current limiting fuses mounted in both legs of the control circuit].

[Separate source (common control)] Two wired terminal points shall be provided. One leg shall be wired through a normally open auxiliary contact in each disconnect and a control power fuse rated 1 amp shall be provided.]

Starter units shall be provided with the following auxiliary devices:

- [auxiliary starter interlocks, _____ N/O, _____ N/C].
- [control / timing relays (as shown on the drawings)]
- [door mounted pilot devices: Start-stop pushbutton, H-O-A selector switch, Indicating lights (quantity and color)].

Miscellaneous units

The following units shall be included in the motor control center(s) as indicated on the drawings:

- [Lighting and Power transformers]
- [Lighting panelboards]
- [Power metering and associated instrument transformers, where required]
- [Reduced Voltage Solid State or Softstarter]
- [Variable Frequency Drives]
- [PLC's]



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