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USER MANUAL FOR SERIES B

SMC™-Flex

BULLETIN 150



ALLEN-BRADLEY • ROCKWELL SOFTWARE • DODGE • RELIANCE ELECTRIC

Rockwell Automation

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

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Throughout this manual we use notes to make you aware of safety considerations:

ATTENTION



Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss

Attention statements help you to:

- identify a hazard
- avoid a hazard
- recognize the consequences

IMPORTANT

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

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European Communities (EC) Directive Compliance

If this product has the CE mark it is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

EMC Directive

This product is tested to meet the Council Directive 89/336/EC Electromagnetic Compatibility (EMC) per EN/IEC 60947-4-2.

This product is intended for use in an industrial environment.

Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage, per EN/IEC 60947-4-2.

This equipment is classified as open equipment and must be mounted in an enclosure during operation to provide safety protection.

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Product Overview

Other Related Documents

- Quick Start — Publication 150-QS001_①-EN-P
- Renewal Part Instructions — 41053-277-01 (5…85 A)
  41053-328-01 (108…135 A)
  41053-228-01 (201…480 A)
  41053-367-01 (625…1250 A)
- Selection Guide — Publication 150-SG009_①-EN-P
- Application Guide — Publication 150-AT002_①-EN-P

Description

The SMC™-Flex controller offers a full range of starting modes as standard:

- Soft Start with Selectable Kickstart
- Current Limit with Selectable Kickstart
- Dual Ramp Start with Selectable Kickstart
- Full Voltage Start
- Preset Slow Speed
- Linear Speed Acceleration with Selectable Kickstart (requires Tach feedback)
- Soft Stop

Other features that offer further user benefit include:

- Expanded protective features
- Metering
- I/O
- Communication capability

Innovative starting and stopping options provide enhanced performance:

- Pump Control
- Braking Control
  - Smart Motor Braking (SMB™)
  - Accu-Stop™
  - Slow Speed with Braking

These modes, features, and options are further described in this chapter.

① Latest revision

Operation

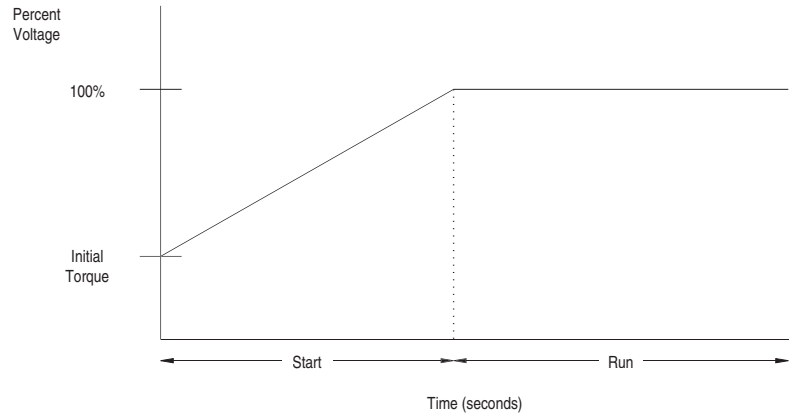
The SMC-Flex controller can operate standard squirrel-cage induction motors rated 1…1250 A or Star-delta (wye-delta) type motors rated 1.8…1600 A; up to 690V AC, 50/60 Hz. Depending upon the controller type ordered, the control power input can range from 100…240V AC to 24V AC/DC. Please verify voltage on product, before applying power.

Modes of Operation (Standard)

Soft Start ①

This mode has the most general application. The motor is given an initial torque setting, which is user-adjustable from 0…90% of locked rotor torque. From the initial torque level, the output voltage to the motor is steplessly increased during the acceleration ramp time. The acceleration ramp time is user-adjustable from 0…30 seconds. If the SMC-Flex controller senses that the motor has reached the up-to-speed condition during the voltage ramp operation, the internal bypass contactor will be pulled in.

Figure 1.1 Soft Start

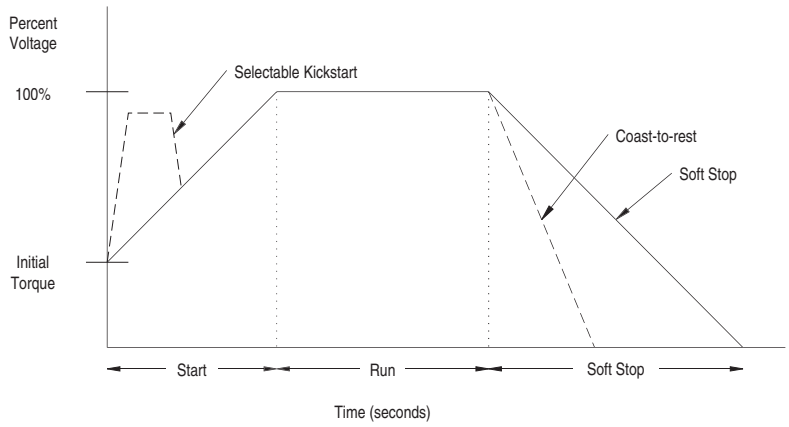


① Kickstart is also available with Soft Start.

Selectable Kickstart

This feature provides a boost at startup to break away loads that require a pulse of high torque to get started. This is intended to provide a pulse of current that is selectable from 0…90% of locked rotor torque. Selectable kickstart is user-adjustable from 0.0…2.0 seconds.

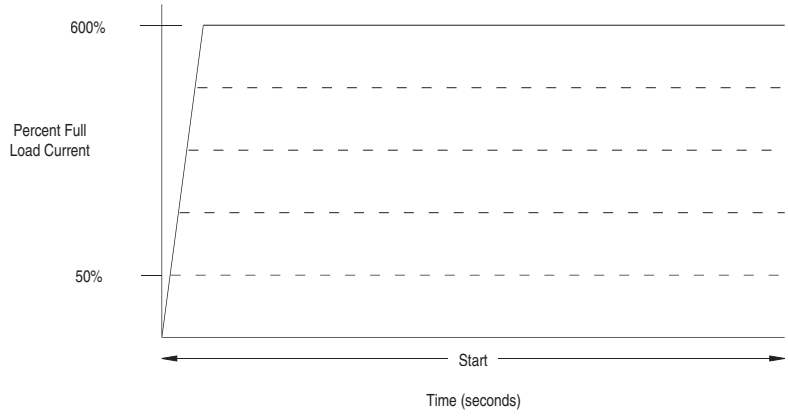
Figure 1.2 Selectable Kickstart



Current Limit Start ①

This starting mode provides a true current limit start; it is used when limiting maximum starting current is necessary. The Current Limit level is user-adjustable from 50…600% of the motor full load ampere rating; and the current limit time is user-adjustable from 0…30 seconds. If the SMC-Flex controller senses that the motor has reached the up-to-speed condition during the current limit starting mode, the internal bypass contactor will be pulled in.

Figure 1.3 Current Limit Start

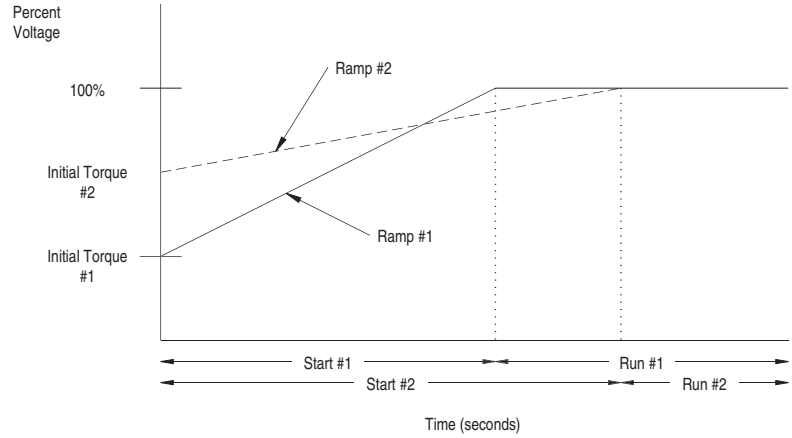


① Kickstart is also available with Current Limit Start.

Dual Ramp Start ①

This starting mode is useful on applications that have varying loads (and therefore varying starting torque requirements). Dual Ramp Start allows the user to select between two separate start profiles with separately adjustable ramp times and initial torque settings.

Figure 1.4 Dual Ramp Start



① Dual Ramp Start is available only with the standard controller.

Full Voltage Start

This starting mode is used for applications requiring across-the-line starting. The output voltage to the motor will reach full voltage within 1/4 second.

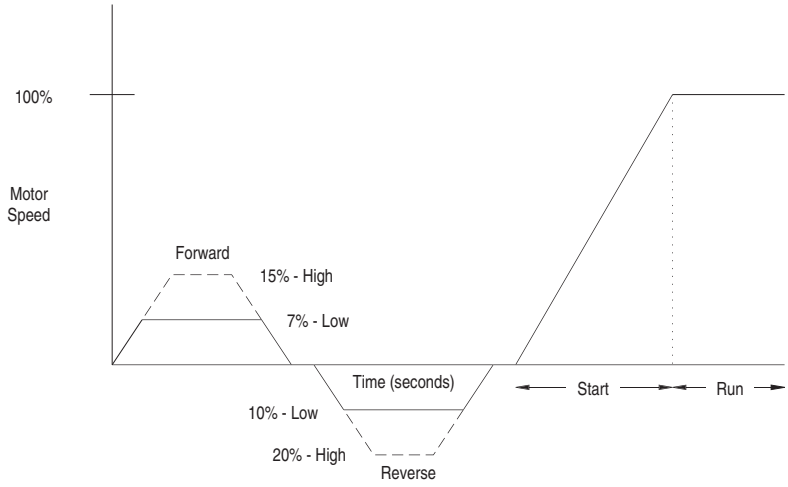
Figure 1.5 Full Voltage Start



Preset Slow Speed

This option can be used in applications that require a slow speed jog for general purpose positioning. Preset Slow Speed provides either 7% of base speed (low) or 15% of base speed (high) settings in the forward direction. Reverse can also be programmed and offers 10% of base speed (low) and 20% of base speed (high) settings.

Figure 1.6 Preset Slow Speed

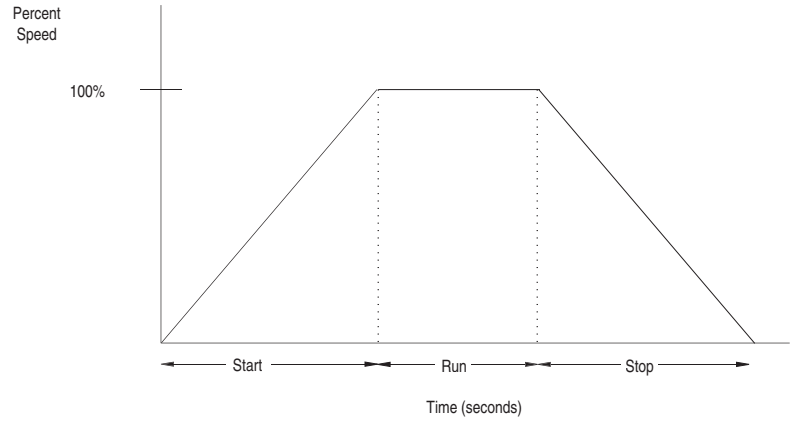


ATTENTION Slow speed running is not intended for continuous operation due to reduced motor cooling.

Linear Speed Acceleration ①

The SMC-Flex has the ability to control the motor speed during starting and stopping maneuvers. A tach input (0…5V DC) is required to perform this start mode. The start time is selectable from 0…30 seconds and determines the time the motor will ramp from 0 speed to full speed. Kickstart is available with this option.

Figure 1.7 Linear Speed Acceleration



① Kickstart is also available with Linear Speed Acceleration.

ATTENTION

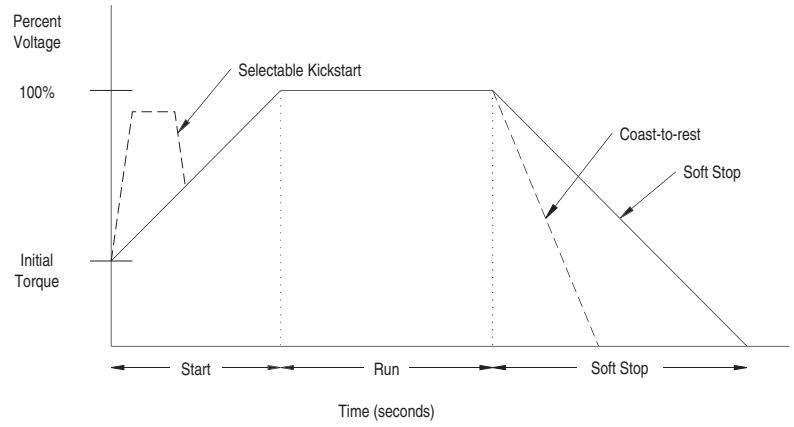
Linear Stop is not intended to be used as an emergency stop. Refer to the applicable standards for emergency stop requirements.

The Linear Stop does not need to be set up even if the linear start has been programmed. The Linear Stop can not brake the motor/load and reduce the stopping time.

Soft Stop

This option can be used in applications that require an extended stop time. The voltage ramp down time is user-adjustable from 0…120 seconds and is adjusted independently from the starting time. The load will stop when the output voltage drops to a point where the load torque is greater than the developed motor torque.

Figure 1.8 Soft Stop



ATTENTION Soft Stop is not intended to be used as an emergency stop. Refer to the applicable standards for emergency stop requirements.

Control Options

The SMC-Flex controller offers the control options described below.

Important: The options listed in this section are mutually exclusive and must be specified when ordering. An existing controller may be upgraded to another control option by replacing the control module. Consult your local Allen-Bradley distributor.

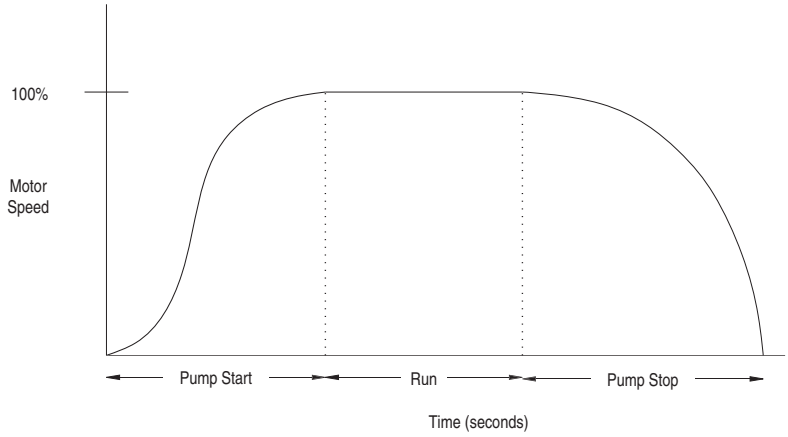
Modes of Operation (Pump Control)

Pump Control Option ①

This option reduces surges during the starting and stopping of a centrifugal pump by smoothly accelerating and decelerating the motor. The microprocessor analyzes the motor variables and generates commands that control the motor and reduce the possibility of surges occurring in the system.

The starting time is programmable from 0…30 seconds, and the stopping time is programmable from 0…120 seconds.

Figure 1.9 Pump Control Option



① Kickstart is also available with Pump Control.

ATTENTION Pump stopping is not intended to be used as an emergency stop. Refer to the applicable standard for emergency stop requirements.

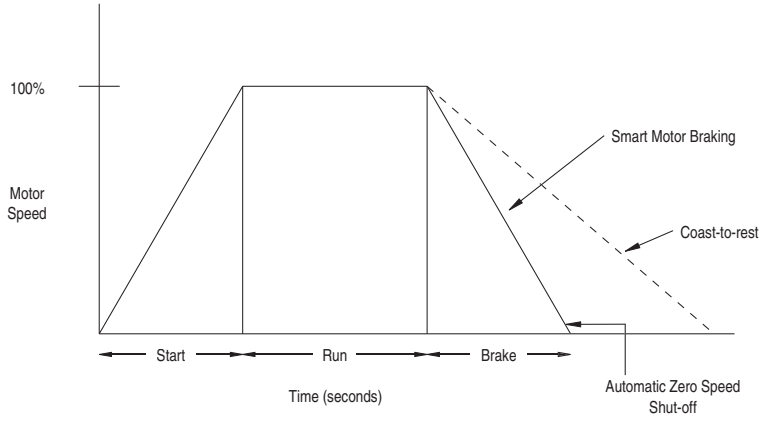
ATTENTION Pump stopping may cause motor heating depending on the mechanical dynamics of the pumping system. Therefore, select the lowest stopping time setting that will satisfactorily stop the pump.

Modes of Operation (Braking Control)

SMB™ Smart Motor Braking Option

This option can be used in applications that require reduced stopping times. The SMC-Flex controller incorporates a microprocessor-based system that applies braking current to a motor without any additional equipment. This option offers a user-adjustable braking current setting from 0% to 400% of the motor's full load current rating. Further, it provides automatic shut-off at zero speed detection.

Figure 1.10 SMB Smart Motor Braking Option



Note: All braking current settings in the range of 1…100% will provide 100% braking current to the motor.

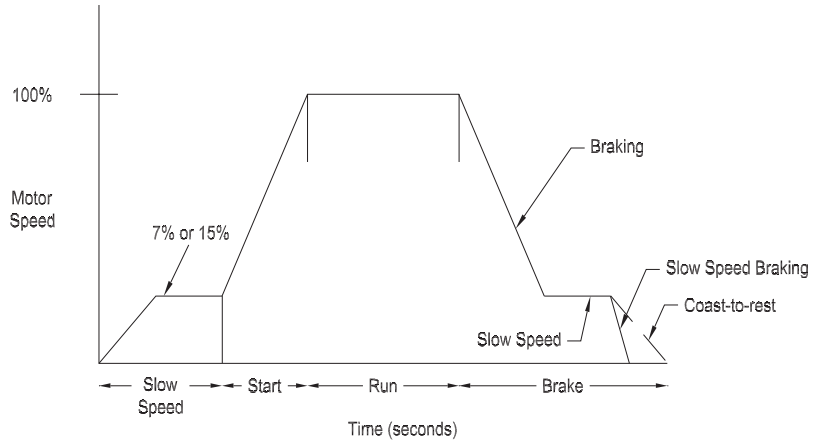
ATTENTION

SMB Smart Motor Braking is not intended to be used as an emergency stop. Refer to applicable standards for emergency stop requirements.

Accu-Stop™ Option

This option combines the benefits of the SMB Smart Motor Braking and Preset Slow Speed options. For general purpose positioning, the Accu-Stop option provides a brake from full speed to the preset slow speed setting, then brakes to stop.

Figure 1.11 Accu-Stop Option



ATTENTION

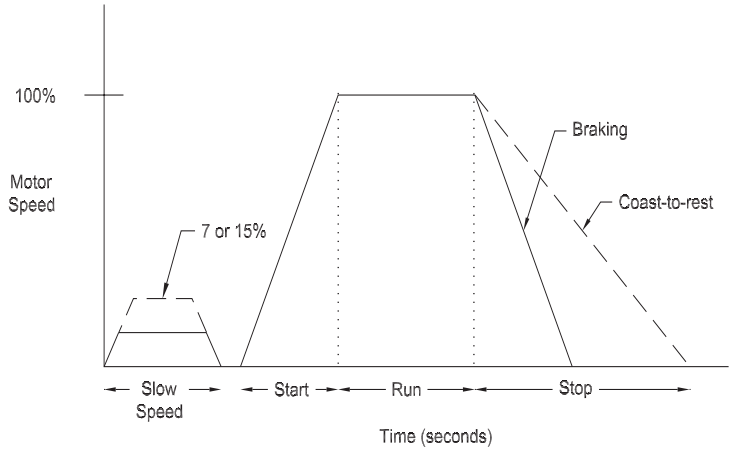


Accu-Stop and Slow Speed with Braking are not intended to be used as an emergency stop. Refer to applicable standards for emergency stop requirements.

Slow Speed with Braking Option

The Slow Speed with Braking option provides a jog speed for process set-up and braking-to-stop at the end of the cycle.

Figure 1.12 Slow Speed with Braking Option



Protection and Diagnostics

The SMC-Flex controller provides the protective and diagnostic features described below.

Overload

The SMC-Flex controller meets applicable requirements as a motor overload protective device. Thermal memory provides added protection and is maintained even when control power is removed. The built-in overload controls the value stored in Parameter 12, Motor Thermal Usage; an Overload Fault will occur when this value reaches 100%. The programming parameters below provide application flexibility and easy setup.

Parameter	Range
Overload Class	Off, 10, 15, 20, 30
Overload Reset	Manual – Auto
Motor FLC	1.0…2200 A
Service Factor	0.01…1.99

Notes: (1) The factory default setting for Overload Class, which is 10, enables overload protection. The motor's full load current rating must be programmed to properly set overload protection.
(2) Automatic reset of an overload fault requires the start input to be cycled in a 2-wire control scheme.

The trip rating is 117% of the programmed FLC.

Figure 1.13 and Figure 1.14 provide the overload trip curves for the available trip classes.

Underload ①

Utilizing the underload protection of the SMC-Flex controller, motor operation can be halted if a sudden drop in current is sensed.

The SMC-Flex controller provides an adjustable underload trip setting from 0…99% of the programmed motor full load current rating. Trip delay time can be adjusted from 0…99 seconds.

① Underload protection is disabled during slow speed and braking operations.

Figure 1.13 Overload Trip Curves

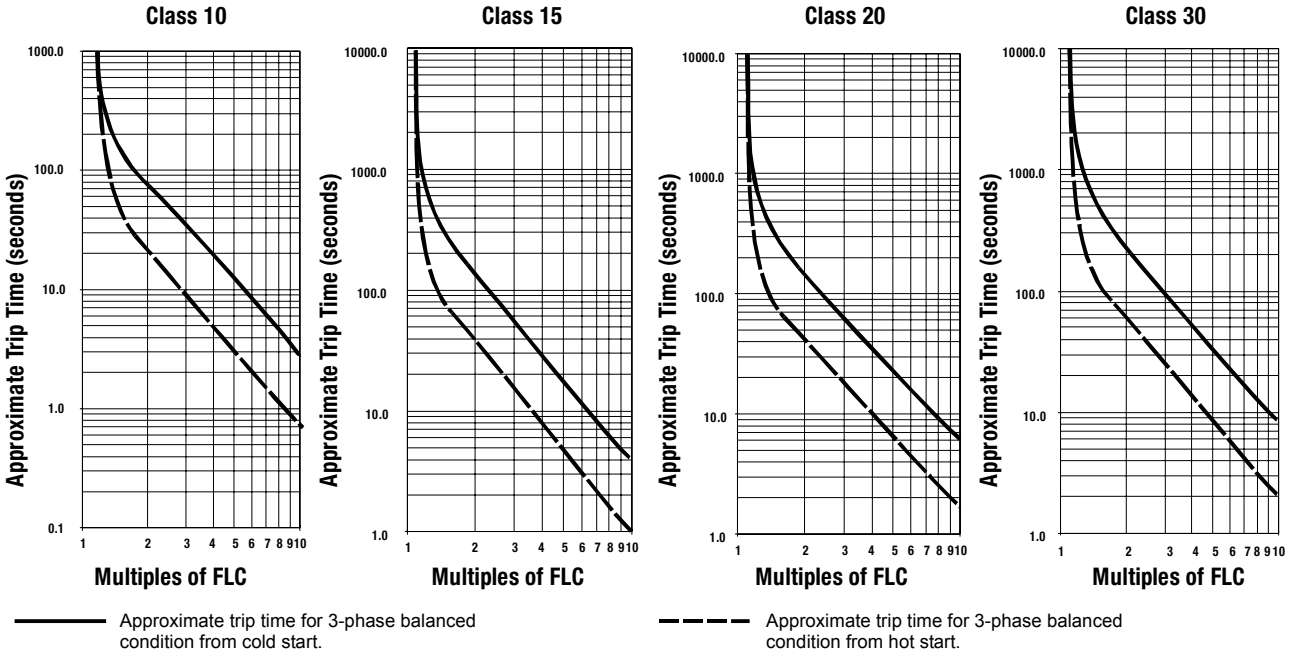
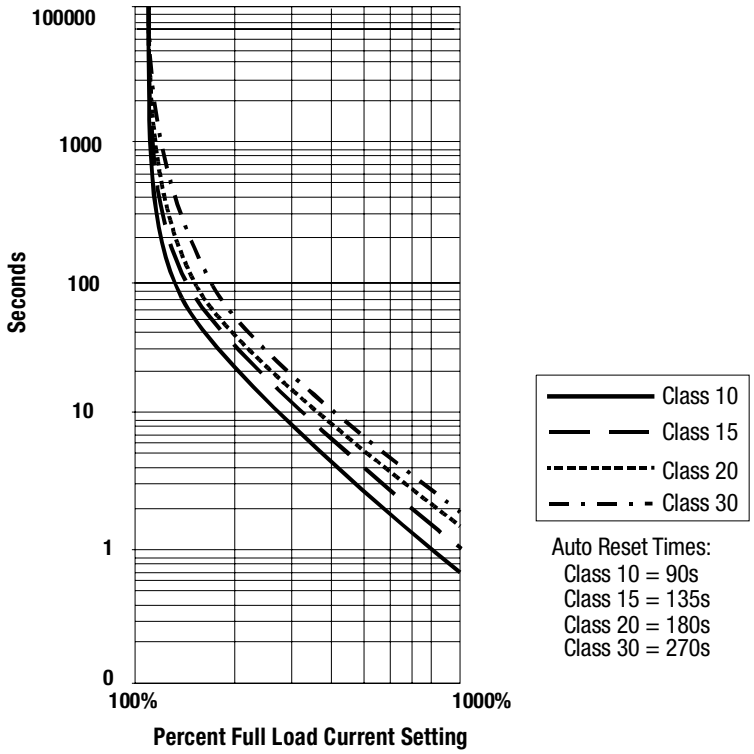


Figure 1.14 Restart Trip Curves after Auto Reset



Undervoltage ①

Utilizing the undervoltage protection of the SMC-Flex, motor operation can be halted if a sudden drop in voltage is detected.

The SMC-Flex controller provides an adjustable undervoltage trip setting from 0…99% of the programmed motor voltage. Trip delay time can be adjusted from 0…99 seconds.

An alarm (pre-fault) indication level can be programmed to indicate the unit is getting close to faulting. The alarm modification information is displayed through the LCD, HIM, Communication (if applicable) and alarm contact closing.

Overvoltage ①

Utilizing the overvoltage protection of the SMC-Flex, motor operation can be halted if a sudden increase in voltage is detected.

The SMC-Flex controller provides an adjustable overvoltage trip setting from 0…199% of the programmed motor voltage. Trip delay time can be adjusted from 0…99 seconds.

An alarm (pre-fault) indication level can be programmed to indicate the unit is getting close to faulting. The alarm modification information is displayed through the LCD, HIM, Communication (if applicable) and alarm contact closing.

Unbalance ①

The SMC-Flex is able to detect an unbalance in line voltages. Motor operation can be halted if the unbalance is greater than the desired range.

The SMC-Flex controller provides an adjustable unbalance setting from 0…25% of the line voltages. Trip delay time can be adjusted from 0…99 seconds.

An alarm (pre-fault) indication level can be programmed to indicate the unit is getting close to faulting. The alarm modification information is displayed through the LCD, HIM, Communication (if applicable) and alarm contact closing.

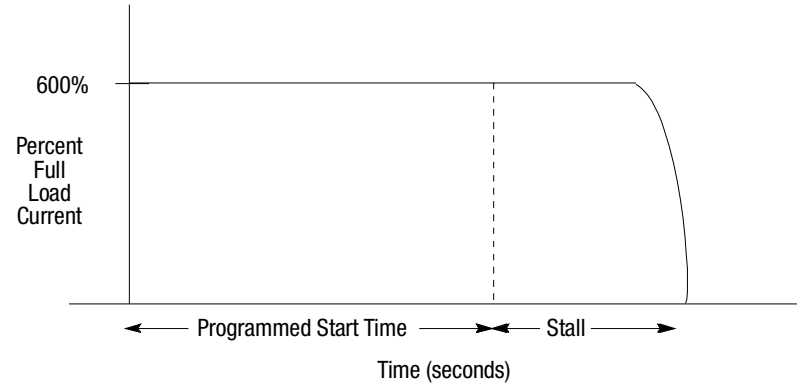
① Undervoltage, overvoltage, and voltage unbalance protection are disabled during braking operation.

Stall Protection and Jam Detection

The SMC-Flex controller provides both stall protection and jam detection for enhanced motor and system protection.

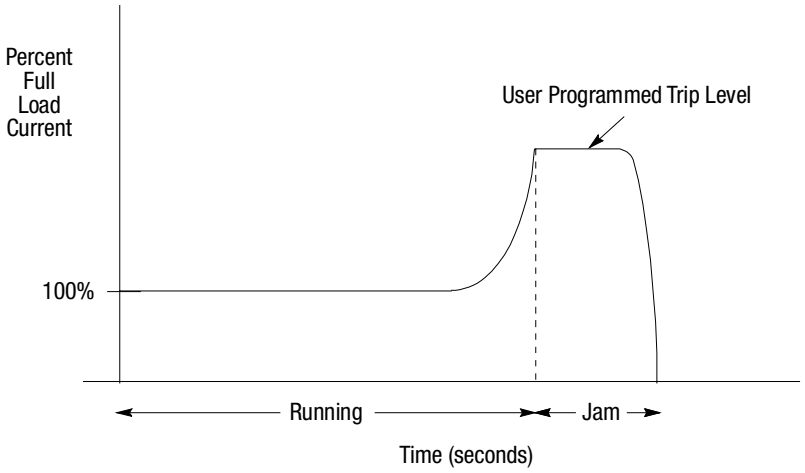
- Stall protection is user-adjustable from 0.0…10.0 seconds (in addition to the ramp time programmed).

Figure 1.15 Stall Protection



- An alarm (pre-fault) indication level can be programmed to indicate the unit is getting close to faulting. The alarm modification information is displayed through the LCD, HIM, Communication (if applicable) and alarm contact closing.
- Jam detection allows the user to determine the jam level (up to 1000% of the motor's FLC rating) and the delay time (up to 99.0 seconds) for application flexibility.

Figure 1.16 Jam Detection ①②



① Jam detection is disabled during slow speed and braking operation.

② Unit will self-protect in a jam condition.

Ground Fault

In isolated or high impedance-grounded systems, core-balanced current sensors are typically used to detect low level ground faults caused by insulation breakdowns or entry of foreign objects. Detection of such ground faults can be used to interrupt the system to prevent further damage, or to alert the appropriate personnel to perform timely maintenance.

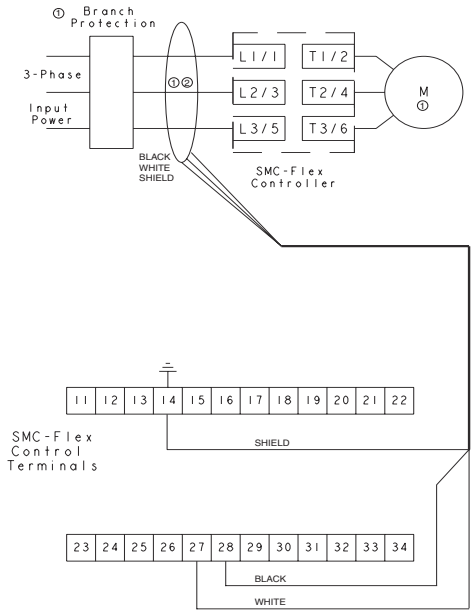
The SMC-Flex's ground fault detection capabilities require the use of external sensor. Installation of this sensor allows the option of enabling Ground Fault Trip, Ground Fault Alarm, or both.

For the 5…480 Amp devices, the recommended sensor is a Cat. No. 825-CBCT core balance current transformer for 1…5 A core-balanced ground fault protection.

For the 625…1250 A devices, the recommended sensor is shown below and provides 5…25 A core-balanced ground fault protection.

- Manufacturer:Flex-Core
- Description:600 Volt Rated Current Transformer
- Catalog Number:126-252
- Ratio:2500:5

Figure 1.17



① Customer supplied.

② Cat. No. 825-CBCT or Flex-Core Cat. No. 126-252

Note: When connecting the ground fault sensors, the secondary of the CT should be shorted until the connection to the Flex control module is completed.

Ground Fault Trip

The SMC-Flex will trip with a ground fault indication if:

- No other fault currently exists
- Ground fault protection is enabled
- *GF Inhibit Time* has expired
- *GF Current* is equal to or greater than the *GF Trip Level* for a time period greater than the *GF Trip Delay*

Parameter 75, *Gnd Flt Inh Time,* allows the installer to inhibit a ground fault trip from occurring during the motor starting sequence and is adjustable from 0…250 seconds.

Parameter 74, *Gnd Flt Delay,* allows the installer to define the time period a ground fault condition must be present before a trip occurs. It is adjustable from 0.1…250 seconds.

Parameter 73, *Gnd Flt Level,* allows the installer to define the ground fault current at which the SMC-Flex will trip. It is adjustable from 1.0…5.0 A or 5.0…25 A, depending on the service size.

Important: The ground fault inhibit timer starts after the maximum phase of load current transitions from 0 A to 30% of the device's minimum *FLA Setting* or the *GF Current* is greater than or equal to 0.5 A. The SMC-Flex does not begin monitoring for a ground fault condition until the *Gnd Flt Inh Time* expires.

Ground Fault Alarm

The SMC-Flex will indicate a Ground Fault Alarm if:

- No warning currently exists
- Ground fault alarm is enabled
- *GF Inhibit Time* has expired
- *GF Current* is equal to or greater than the *Gnd Flt A Lvl*

Parameter 77, *Gnd Flt A Lvl,* allows the installer to define the ground fault current at which the SMC-Flex will indicate a warning. It is adjustable from 1.0…5.0 A or 5.0…25 A, depending on the service size.

Parameter 78, *Gnd Flt A Dly,* allows the installer to define the time period a ground fault alarm condition must be present before a trip occurs. It is adjustable from 0…250 seconds.

Thermistor/PTC Protection

The SMC-Flex provides terminals 23 and 24 for the connection of positive temperature coefficient (PTC) thermistor sensors. PTC sensors are commonly embedded in motor stator windings to monitor the motor winding temperature. When the motor winding temperature reaches the PTC sensor's temperature rating, the PTC sensor's resistance transitions from a low to high value. Since PTC sensors react to actual temperature, enhanced motor protection can be provided to address such conditions as obstructed cooling and high ambient temperatures.

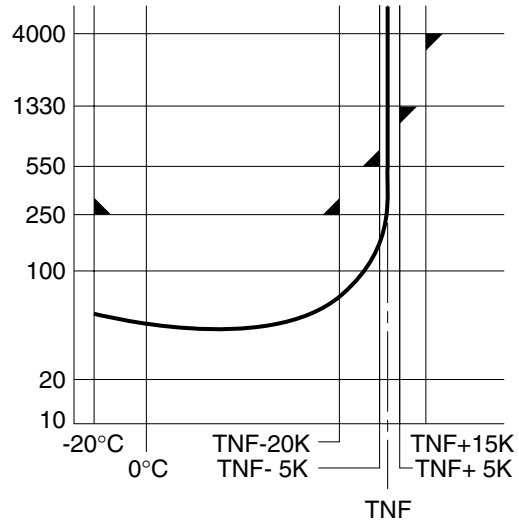
The following table defines the SMC-Flex PTC thermistor input and response ratings:

Table 1.A PTC Input Ratings

Response resistance	3400 Ω ±150 Ω
Reset resistance	1600 Ω ±100 Ω
Short-circuit Trip Resistance	25 Ω ±10 Ω
Maximum Voltage at PTC Terminals (R_{PTC} = 4kΩ)	< 7.5V
Maximum Voltage at PTC Terminals (R_{PTC} = open)	30V
Maximum Number of Sensors	6
Maximum Cold Resistance of PTC Sensor Chain	1500 Ω
Response Time	800 ms

The following figure illustrates the required PTC sensor characteristics, per IEC-34-11-2.

Figure 1.18 PTC Sensor Characteristics per IEC-34-11-2



PTC Trip

The SMC-Flex will trip with a PTC indication if:

- No other fault currently exists
- PTC protection is enabled

- The resistance across terminals 23 and 24 is either greater than the relay's response resistance or less than the short-circuit trip resistance.

Excessive Starts/Hour

The SMC-Flex controller allows the user to program the allowed number of starts per hour (up to 99). This helps eliminate motor stress caused by repeated starting over a short time period.

Overtemperature

The SMC-Flex controller monitors the temperature of the SCRs and Bypass by using internal thermistors. When the power poles' maximum rated temperature is reached, the unit will shut down and restart is inhibited.

An overtemperature condition can indicate inadequate ventilation, high ambient temperature, overloading, or excessive cycling. After the temperature is reduced to allowable levels, the fault can be cleared.

Open Gate

An open gate fault indicates that improper SCR firing, typically caused by an open SCR gate, has been detected on one of the power poles. Before the controller shuts down, it will attempt to start the motor a total of three times.

Line Faults

The SMC-Flex controller continually monitors line conditions for abnormal factors. Pre-start protection includes:

- Line Fault (with phase indication)
  - Line voltage loss
  - Missing load connection
  - Shorted SCR

Running protection includes:

- Line Fault (no phase indication)
  - Line voltage loss
  - Missing load connection

Phase Reversal① protection can be toggled either On or Off.

① Phase Reversal protection is functional only at pre-start.

Metering

Power monitoring parameters include:

- Three-phase current
- Three-phase voltage
- Power in kW
- Power usage in kWH
- Power factor
- Motor thermal capacity usage
- Elapsed time

Notes: (1) Voltage measurement is not available during the braking operation of the SMB Smart Motor Braking, Accu-Stop, and Slow Speed with Braking control options.
(2) The elapsed time and kWH values are automatically saved to memory every 12 hours.
(3) Motor thermal capacity usage is determined by the built-in electronic thermal overload. An overload fault occurs when this value reaches 100%.

I/O

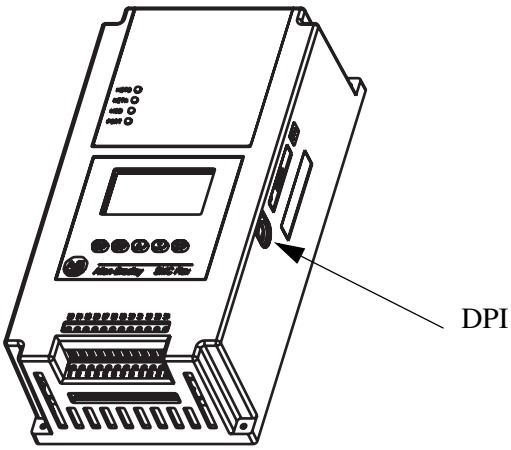
The SMC-Flex has the ability to accept up to two (2) inputs and four (4) outputs controlled over a network. The two inputs are controlled at terminal 16 (Option Input #1), and terminal 15 (Option Input #2). For these two inputs, see Chapter 4 for the parameter settings and see Chapter 7 for the bit identification. By using these two terminals as inputs, the Stop Input will need to be programmed to meet the desired stop functionality.

The four (4) outputs are Aux #1, Aux #2, Aux #3, and Aux #4. All auxiliary contacts are programmable to the function found on page 4-14. If programmed to Network or Network NC, they can be controlled over a Network. Please see Table 7.H that defines the Logic Command Word (Control).

Communication

A serial interface port (DPI) is provided as standard, which allows connection to the Bulletin 20-HIM LCD interface modules.

Figure 1.19 DPI Location

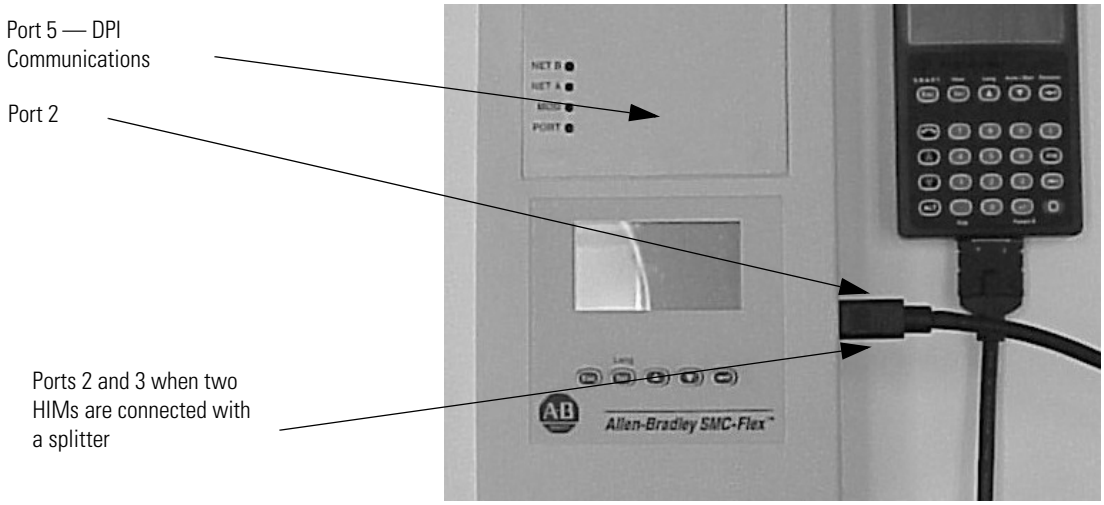


ATTENTION Two peripheral devices can be connected to the DPI. The maximum output current through the DPI is 280 mA.

Programming

Setup is easy with the built-in keypad and three-line, sixteen character backlit LCD. Parameters are organized in a three-level menu structure, using a text format for straightforward programming.

Figure 1.20 Built-in Keypad and LCD

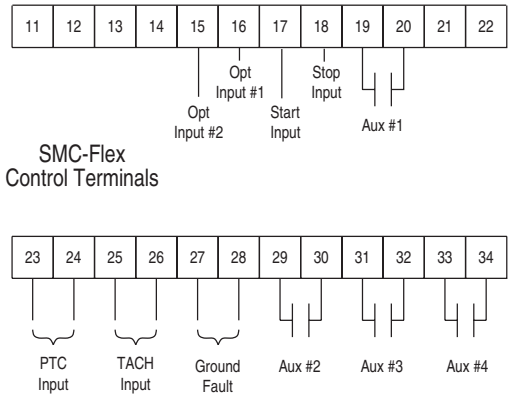


Status Indication

Four programmable hard contact outputs are provided as standard. All auxiliary contacts are programmable for the following states:

- Normal (N.O./N.C.)
- Up-to-Speed (N.O./N.C.)
- Alarm (N.O./N.C.)
- Fault (N.O./N.C.)
- Network Control (N.O./N.C.)
- External Bypass (N.O.)

Figure 1.21 Control Terminals



Network inputs can be obtained through proper programming of Option Input #1 and Option Input #2.

Notes

Installation

Degree of Protection

The SMC-Flex soft starters have an IP00 or IP2X protection rating, depending on the size. Taking into account the ambient conditions, the device must be installed in IP54 (Type 2) switchgear cabinets. Make sure that no dust, liquids, or conductive parts can enter the soft starter. Soft starter operation produces waste heat (heat loss). See Table 2.A or *Specifications* on page A-1, for details.

Receiving

It is the user's responsibility to thoroughly inspect the equipment before accepting the shipment from the freight company. Check the item(s) received against the purchase order. If any items are damaged, it is the responsibility of the user not to accept delivery until the freight agent has noted the damage on the freight bill. Should any concealed damage be found during unpacking, it is again the responsibility of the user to notify the freight agent. The shipping container must be left intact and the freight agent should be requested to make a visual inspection of the equipment.

Unpacking

Remove all packing material, wedges, or braces from within and around the controller.

Inspecting

After unpacking, check the item(s') nameplate catalog number against the purchase order.

Storing

The controller should remain in its shipping container prior to installation. If the equipment is not to be used for a period of time, it must be stored according to the following instructions in order to maintain warranty coverage.

- Store in a clean, dry location.
- Store within an ambient temperature range of –20°C to +75°C (–4°F to +167°F).
- Store within a relative humidity range of 0% to 95%, noncondensing.
- Do not store equipment where it could be exposed to a corrosive atmosphere.
- Do not store equipment in a construction area.

Lifting

For controllers rated 625…1250 A, the device should only be lifted from designated lifting points. The lifting points are designed to accept a ½ -13 threaded hoist ring capable of lifting 2500 pounds. These points are identified in Figure 2.1.

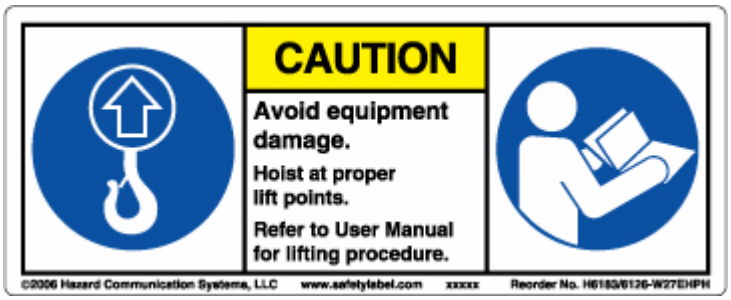
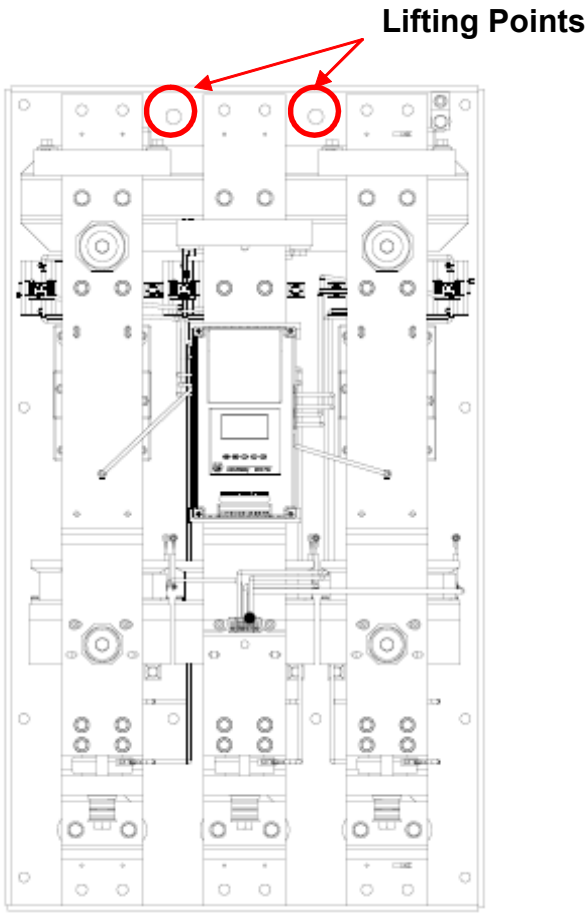


Figure 2.1 Lifting Points



General Precautions

In addition to the precautions listed throughout this manual, the following statements, which are general to the system, must be read and understood.

ATTENTION



The controller contains ESD- (electrostatic discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing, or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, refer to applicable ESD protection handbooks.

ATTENTION



An incorrectly applied or installed controller can damage components or reduce product life. Wiring or application errors, such as undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures, may result in malfunction of the system.

ATTENTION



Only personnel familiar with the controller and associated machinery should plan or implement the installation, start-up, and subsequent maintenance of the system. Failure to do this may result in personal injury and/or equipment damage.

ATTENTION



Hazardous voltages that can cause shock, burn, or death are present on L1, L2, L3, T1, T2, T3, T4, T5, and T6.

Power terminal covers can be installed to prevent inadvertent contact with terminals. Disconnect the main power before servicing the motor controller or associated wiring.

Heat Dissipation

The following table provides the maximum heat dissipation at rated current for the controllers. For currents lower than rated value, heat dissipation will be reduced.

Table 2.A Maximum Heat Dissipation

SMC Rating	5 A	25 A	43 A	60 A	85 A	108 A	135 A	201 A	251 A	317 A	361 A	480 A	625 A	700 A	970 A	1250 A
Max. Watts	70	70	81	97	129	91	104	180	198	225	245	290	446	590	812	1222

Enclosures

The open-style design of the SMC-Flex controller requires that it be installed in an enclosure. **The internal temperature of the enclosure must be kept within the range of 0…50°C.**

For Type 12 (IP54) enclosures, the following guidelines are recommended to limit the maximum controller ambient temperature.

There should be a clearance of at least 15 cm (6 in.) above and below the controller. This area allows air to flow through the heatsink.

Table 2.B Minimum Enclosure Size

Controller Rating (A)	IP65 (Type 4/12)		
	B Height	A Width	C Depth
Non-Combination Controller [mm (in.)]			
5	610 (24)	406 (16)	254 (10)
25	610 (24)	406 (16)	254 (10)
43	610 (24)	406 (16)	254 (10)
60	610 (24)	406 (16)	254 (10)
85	610 (24)	406 (16)	254 (10)
108	762 (30)	610 (24)	305 (12)
135	762 (30)	610 (24)	305 (12)
201	965 (38)	762 (30)	356 (14)
251	965 (38)	762 (30)	356 (14)
317	1295 (51)	914 (36)	356 (14)
361	1295 (51)	914 (36)	356 (14)
480	1295 (51)	914 (36)	356 (14)
625	2286 (90)	762 (30)	508 (20)
780	2286 (90)	762 (30)	508 (20)
970 ③	2286 (90)	762 (30)	508 (20)
1250 ③	2286 (90)	762 (30)	508 (20)
Combination Controllers with Fusible Disconnect			
5	610 (24)	406 (16)	254 (10)
25	610 (24)	406 (16)	254 (10)
43	610 (24)	406 (16)	254 (10)
60	610 (24)	406 (16)	254 (10)
85	610 (24)	406 (16)	254 (10)
108	965 (38)	762 (30)	356 (14)
135	965 (38)	762 (30)	356 (14)
201	965 (38)	762 (30)	356 (14)
251	965 (38)	762 (30)	356 (14)
317	1524 (60)	965 (38)	356 (14)
361	1524 (60)	965 (38)	356 (14)
480 ①	1524 (60)	965 (38)	356 (14)
480 ②	2286 (90)	889 (35)	508 (20)
625	2286 (90)	1387 (55)	508 (20)
780	2286 (90)	1387 (55)	508 (20)
970 ③	2286 (90)	1651 (65)	508 (20)
1250 ③	2286 (90)	1651 (65)	508 (20)
Combination Controllers with Circuit Breaker			
5	610 (24)	406 (16)	254 (10)
25	610 (24)	406 (16)	254 (10)
43	610 (24)	406 (16)	254 (10)
60	610 (24)	406 (16)	254 (10)
85	610 (24)	406 (16)	254 (10)
108	965 (38)	762 (30)	356 (14)
135	965 (38)	762 (30)	356 (14)
201	965 (38)	762 (30)	356 (14)
251	965 (38)	762 (30)	356 (14)
317	1295 (51)	914 (36)	356 (14)
361	1295 (51)	914 (36)	356 (14)
480	1295 (51)	914 (36)	356 (14)
625	2286 (90)	1397 (55)	508 (20)
780	2286 (90)	1397 (55)	508 (20)
970 ③	2286 (90)	1651 (65)	508 (20)
1250 ③	2286 (90)	1651 (65)	508 (20)

① Use this row for 460V -58 and 575V -59.
② Use this row for 460V -59 and 575V -60 and -61.
③ 970…1250 rated devices are only available as Type 1 and require a door-mounted fan, capable of delivering 240 cfm.

Mounting

All units are fan cooled. It is important to locate the controller in a position that allows air to flow vertically through the power module. **The controller must be mounted in a vertical plane and have a minimum of 15 cm (6 in.) free space above and below the controller.**

When drilling or installing near the softstarter, make sure that adequate measures are taken to protect the device from dust and debris. See Figure 2.2.

Figure 2.2 SMC-Flex Mounting Protection

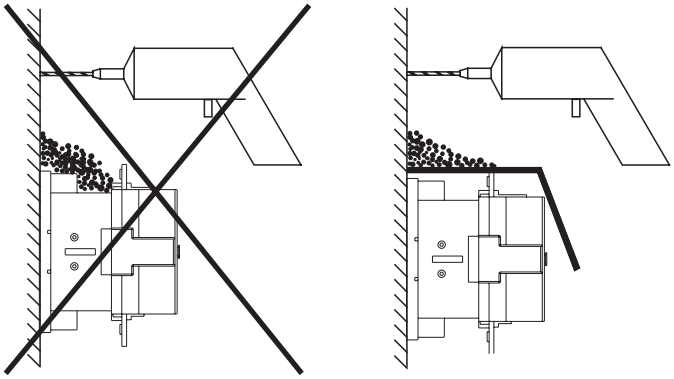
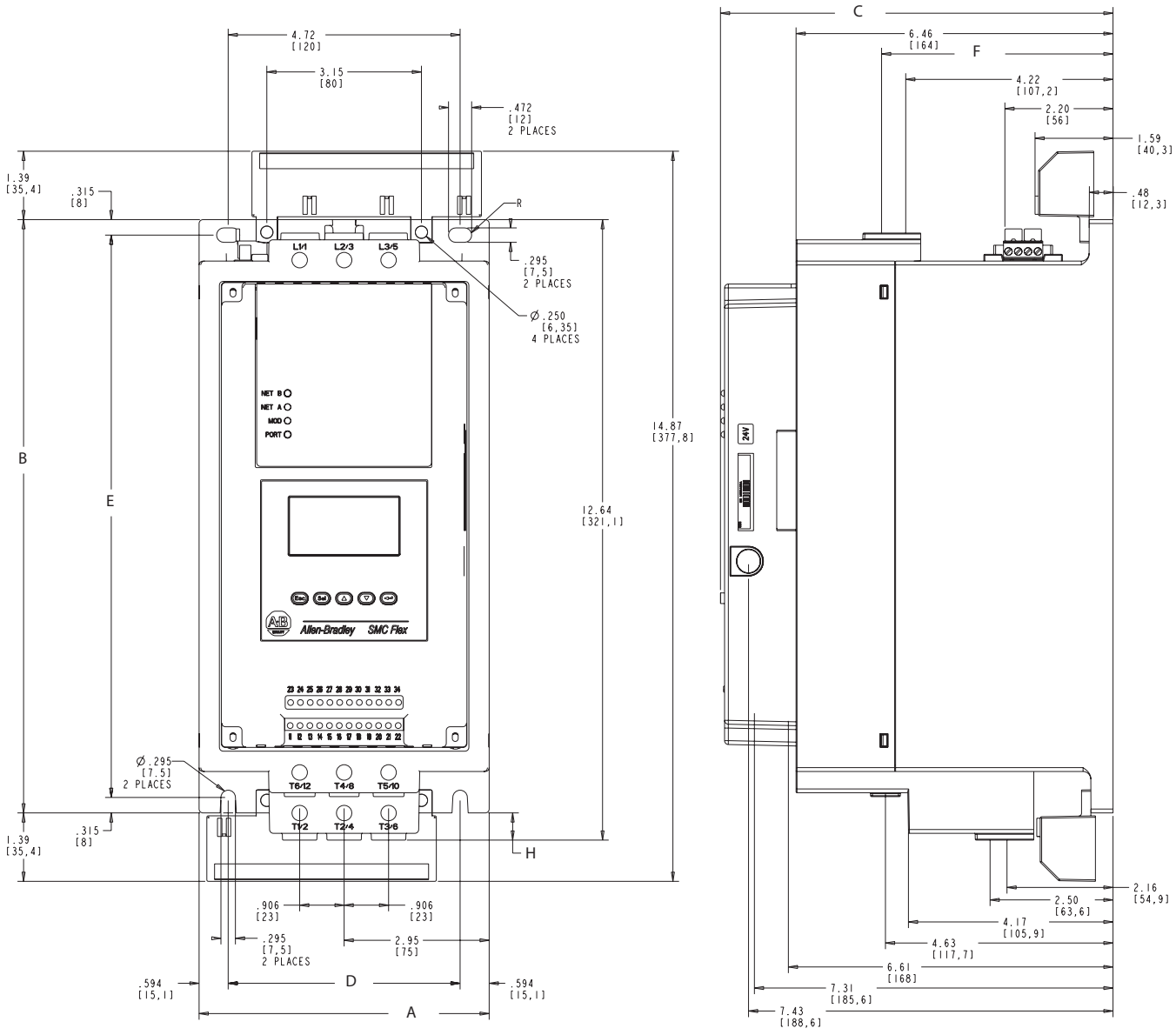


Figure 2.3 Dimensions: 5…85 A Controllers



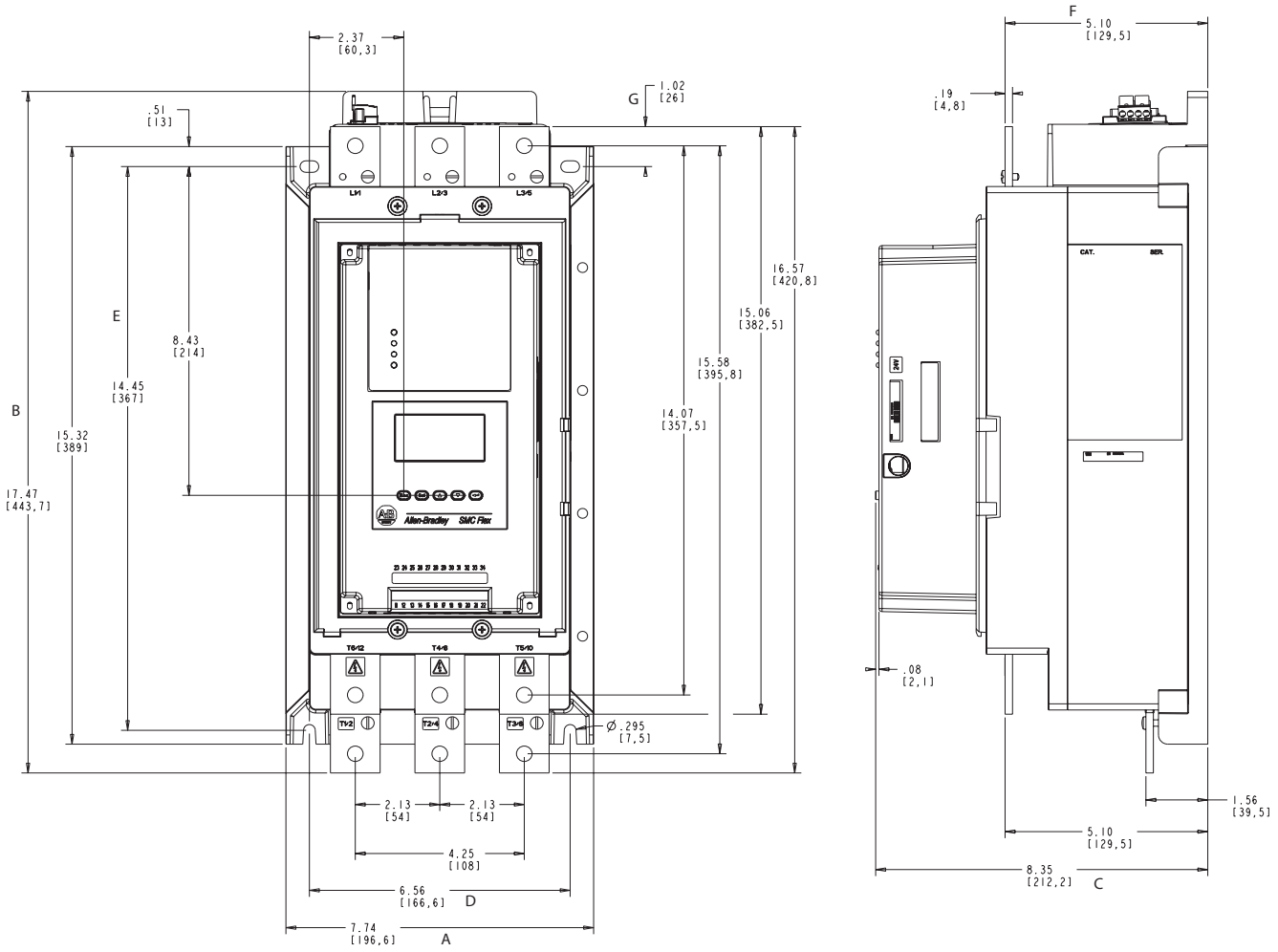
NOTE:
1) DIMENSIONS IN INCHES [MILLIMETERS].

2) DIMENSIONS ARE NOT INTENDED TO BE USED FOR MANUFACTURING PURPOSES.

	Unit	A Width	B Height	C Depth	D	E	F	H	Approx. Ship. Wt.
5…85 A Controller	mm	150.1	307	203.1	120	291	119.8	14.1	5.7 kg
	in.	5.91	12.09	8.00	4.72	11.46	4.72	0.56	12.6 lb.

All dimensions are approximate and are not intended for manufacturing purposes. Consult your local Allen-Bradley distributor for complete dimension drawings.

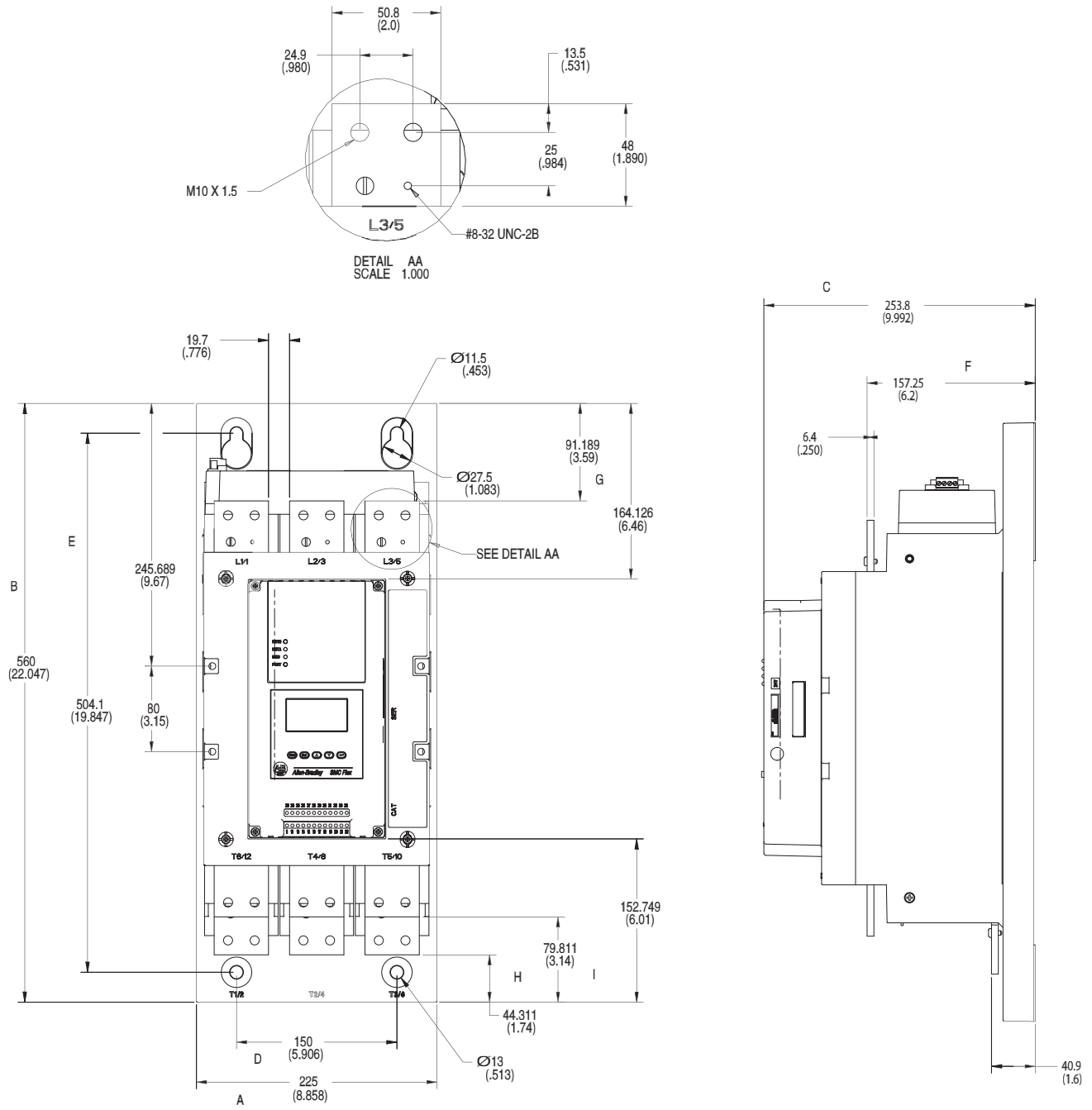
Figure 2.4 Dimensions: 108…135 A Controllers



	Unit	A Width	B Height	C Depth	D	E	F	G	Approx. Ship. Wt.
108…135 A Controller	mm	196.4	443.7	212.2	166.6	367	129.5	26	15 kg
	in.	7.74	17.47	8.35	6.56	14.45	5.10	1.02	33 lb.

All dimensions are approximate and are not intended for manufacturing purposes. Consult your local Allen-Bradley distributor for complete dimension drawings.

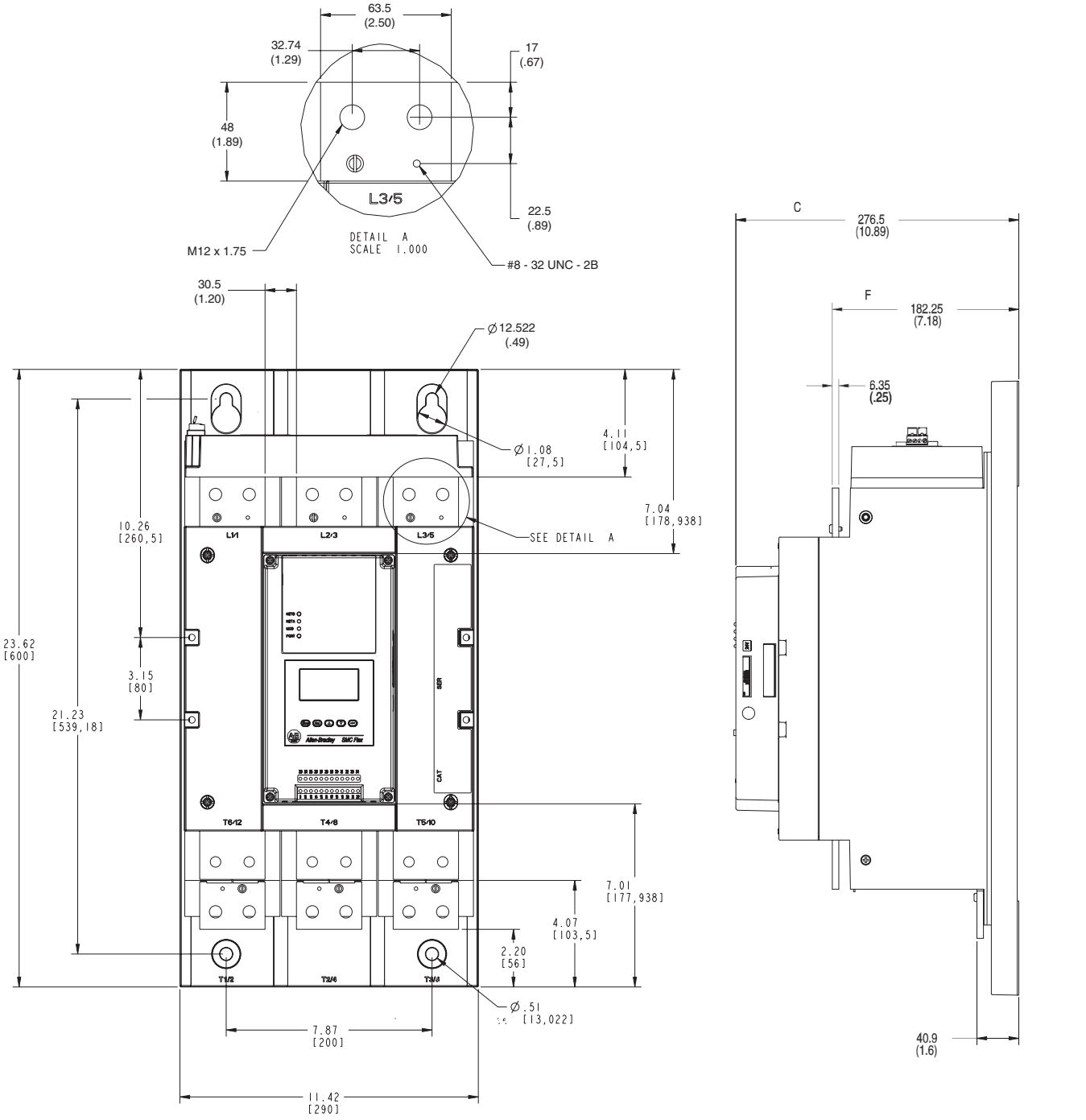
Figure 2.5 Dimensions: 201…251 A Controllers



	Unit	A Width	B Height	C Depth	D	E	F	G	H	I	Approx. Ship. Wt.
201…251 A Controller	mm	225	560	253.8	150	504.1	157.25	91.189	44.311	79.811	30.4 kg
	in.	8.858	22.047	9.992	5.906	19.847	6.2	3.59	1.74	3.14	67 lb.

All dimensions are approximate and are not intended for manufacturing purposes. Consult your local Allen-Bradley distributor for complete dimension drawings.

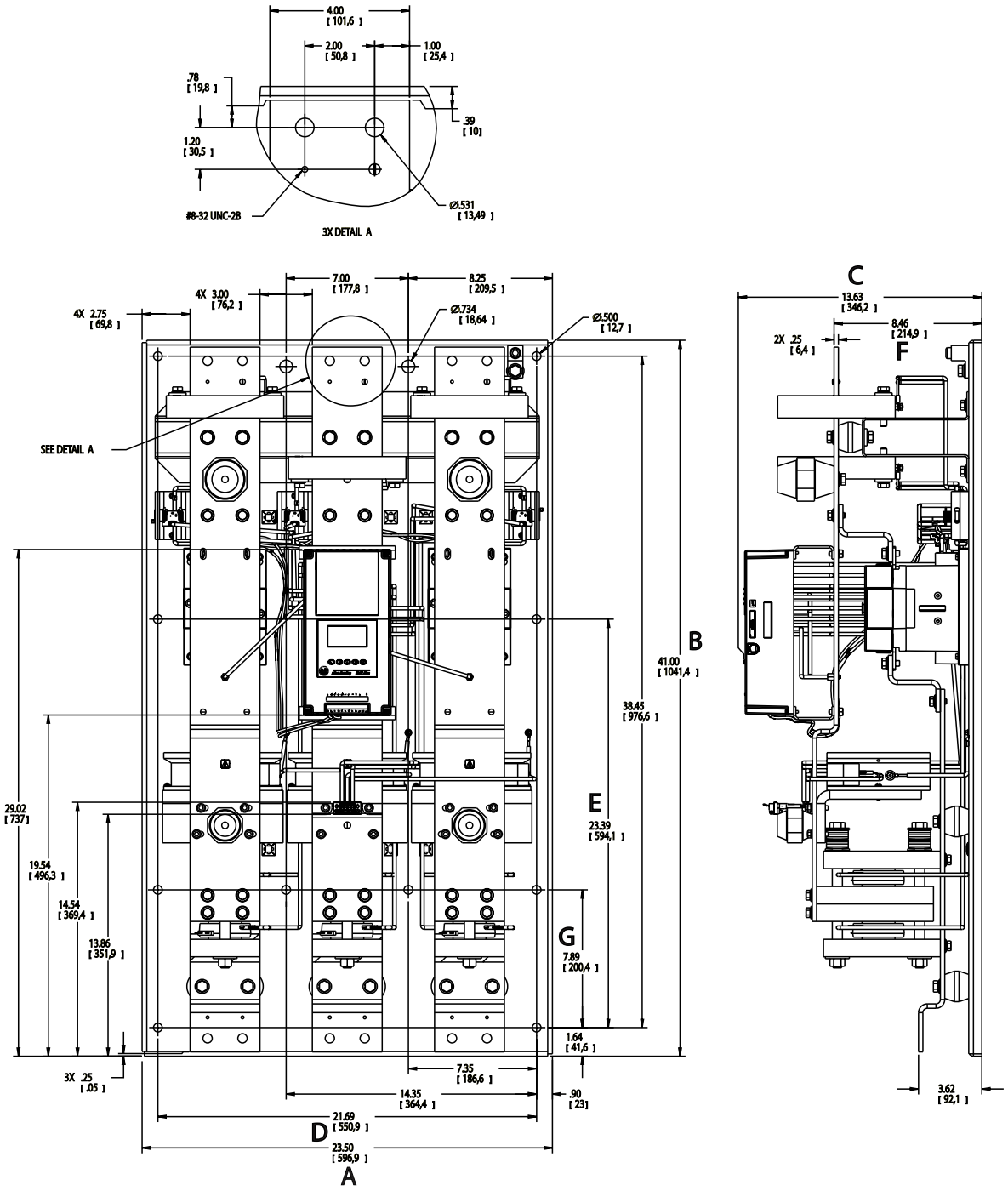
Figure 2.6 Dimensions: 317…480 A Controllers



	Unit	A Width	B Height	C Depth	D	E	F	G	H	I	Approx. Ship. Wt.
317…480 A Controller	mm	290	600	276.5	200	539.18	182.25	104.5	55.5	103.5	45.8 kg
	in.	11.42	23.62	10.89	7.87	21.23	7.18	4.11	2.19	4.07	101 lb.

All dimensions are approximate and are not intended for manufacturing purposes. Consult your local Allen-Bradley distributor for complete dimension drawings.

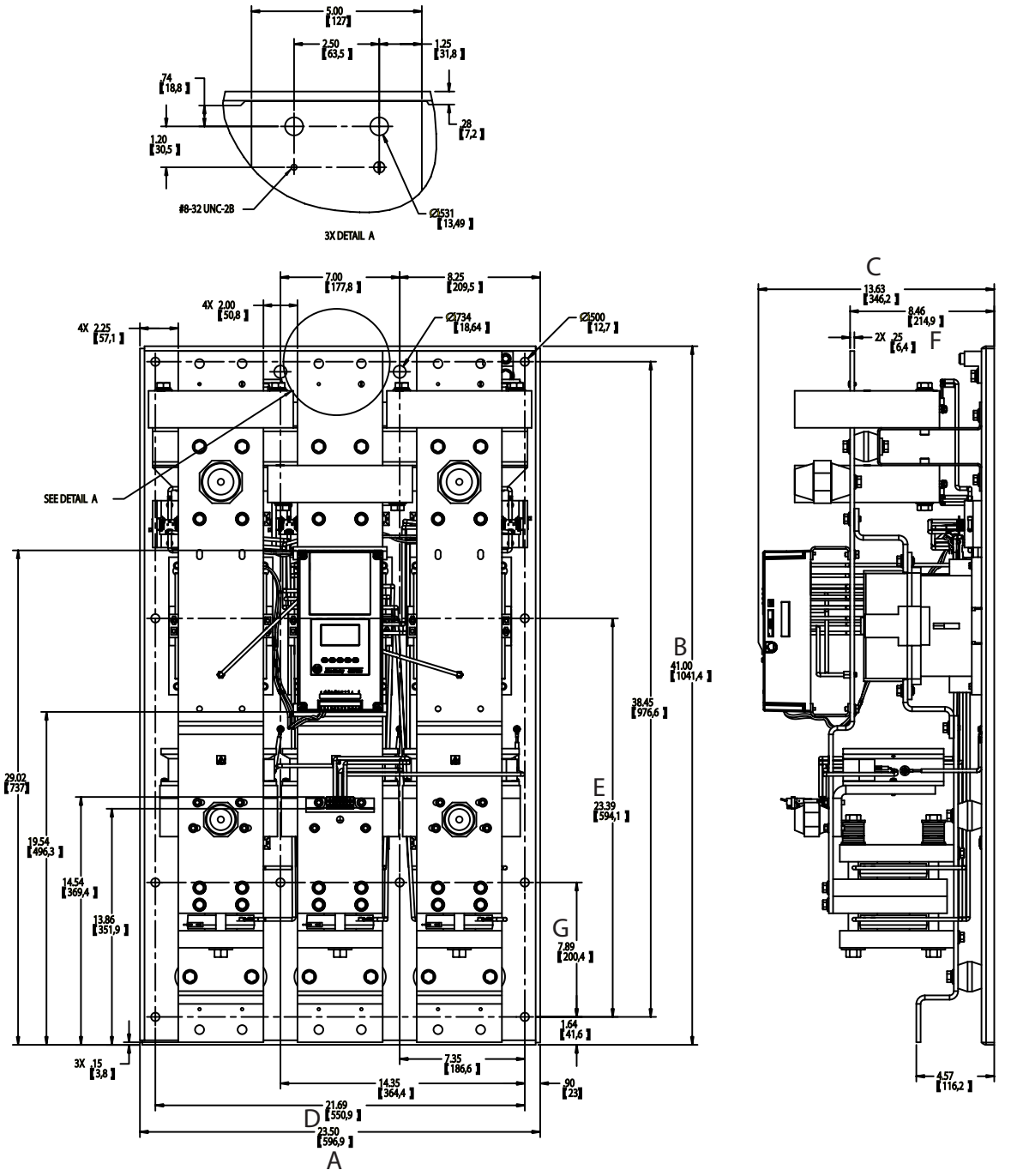
Figure 2.7 Dimensions: 625…780 A Controllers



	Unit	A Width	B Height	C Depth	D	E	F	G	Approx. Ship. Wt.
625…780 A Controller	mm	596.9	1041.4	346.2	550.9	594.1	214.9	200.4	179 kg
	in.	23.5	41.0	13.63	21.69	23.39	8.46	7.89	395 lb.

All dimensions are approximate and are not intended for manufacturing purposes. Consult your local Allen-Bradley distributor for complete dimension drawings.

Figure 2.8 Dimensions: 970…1250 A Controllers



	Unit	A Width	B Height	C Depth	D	E	F	G	Approx. Ship. Wt.
970…1250 A Controller	mm	596.9	1041.4	346.2	550.9	594.1	214.9	200.4	224 kg
	in.	23.5	41.0	13.63	21.69	23.39	8.46	7.89	495 lb.

All dimensions are approximate and are not intended for manufacturing purposes. Consult your local Allen-Bradley distributor for complete dimension drawings.

Power Factor Correction Capacitors

The controller can be installed on a system with power factor correction (PFC) capacitors. The capacitors **must** be located on the line side of the controller. This must be done to prevent damage to the SCRs in the SMC-Flex controller.

When discharged, a capacitor essentially has zero impedance. For switching, sufficient impedance should be connected in series with the capacitor bank to limit the inrush current. One method for limiting the surge current is to add inductance in the capacitor's conductors. This can be accomplished by creating turns or coils in the power connections to the capacitors.

- 250V — 15 cm (6 in.) diameter coil, 6 loops
- 480…690V — 15 cm (6 in.) diameter coil, 8 loops

Take care in mounting the coils so that they are not stacked directly on top of each other; stacking will cause a cancelling effect. Also, mount the coils on insulated supports away from metal parts so they will not act as induction heaters. If an isolation contactor is used, put capacitors in front of contactor.

Note: For further instructions, consult the PFC capacitor vendor.

Figure 2.9 Typical Wiring Diagram for Power Factor Correction Capacitors

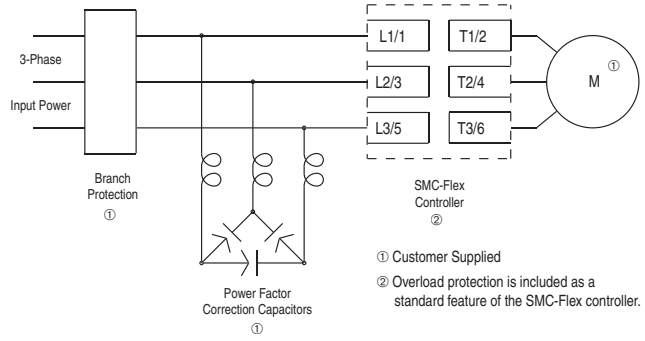
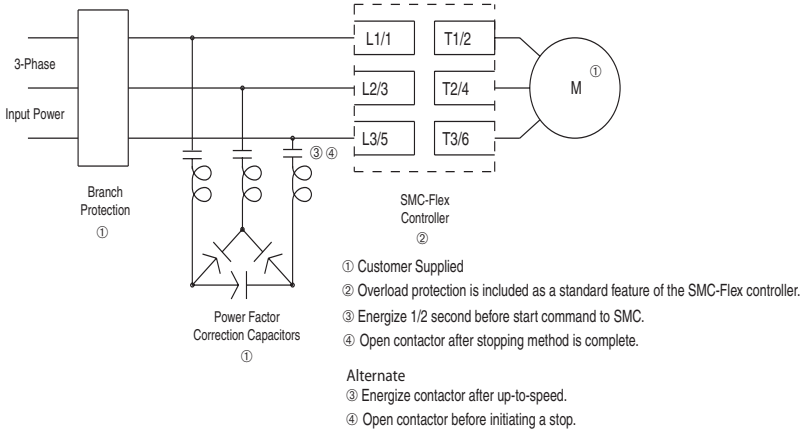


Figure 2.10 Typical Wiring Diagram for Power Factor Correction Capacitors and Contactor



Protective Modules

Protective modules containing metal oxide varistors (MOVs) can be installed on controllers rated 5…1250 A and 200…600V, to protect the power components from electrical transients. The protective modules clip voltage transients generated on the lines to prevent such surges from damaging the SCRs.

ATTENTION



When installing or inspecting the protective module, make sure that the controller has been disconnected from the power source. The protective module should be inspected periodically for damage or discoloration. Replace if necessary.

Motor Overload Protection

Thermal motor overload protection is provided as standard with the SMC-Flex controller. If the overload trip class is less than the acceleration time of the motor, nuisance tripping may occur.

ATTENTION



Overload protection should be properly coordinated with the motor.

Two applications require special consideration: two-speed motors, and multi-motor protection.

Two-speed Motors

The SMC-Flex controller has overload protection available for single speed motors. When the SMC-Flex controller is applied to a two-speed motor, the Overload Class parameter must be programmed to OFF and separate overload relays must be provided for each speed.

Multi-motor Protection

If the SMC-Flex controller is controlling more than one motor, individual overload protection is required for each motor.

Electromagnetic Compatibility (EMC)

ATTENTION



This product has been designed for Class A equipment. Use of the product in domestic environments may cause radio interference, in which case, the installer may need to employ additional mitigation methods.

The following guidelines are provided for EMC installation compliance.

Enclosure

Install the product in a grounded metal enclosure.

Wiring

Wire in an industrial control application can be divided into three groups: power, control, and signal. The following recommendations for physical separation between these groups is provided to reduce the coupling effect.

- Different wire groups should cross at 90° inside an enclosure.
- Minimum spacing between different wire groups in the same tray should be 16 cm (6 in.).
- Wire runs outside an enclosure should be run in conduit or have shielding/armor with equivalent attenuation.
- Different wire groups should be run in separate conduits.
- Minimum spacing between conduits containing different wire groups should be 8 cm (3 in.).
- For additional guidelines, please refer to Wiring and Ground guidelines, publication DRIVES-IN001A-EN-P.

Additional Requirements

- If linear acceleration is used, a separate conduit or wire way should be used for the tachometer leads.
- Wire earth ground to control terminal 14.
- Use shielded wire for PTC, Tachometer, and ground fault input.
- Terminate shielded wires to terminal 14.
- Ground fault CT must be inside or within 3 m of metal enclosure.

To meet product susceptibility requirements, ferrite cores need to be added to the communication lines. When using an external HIM (or DPI interface), a core should be added to the HIM cable near the SMC-Flex control module. The recommended core is Fair-Rite no. 0431167281 or equivalent. When using a DeviceNet circuit, two cores need to be added to the DeviceNet cable near the SMC-Flex control module. The recommended cores are TDK ZCAT2023 0930H and TDK ZCAT2035 0930 or equivalent. All cores specified are the split type cores and can be added to existing connections.

Wiring

Terminal Locations

The SMC-Flex controller wiring terminal locations are shown in Figure 3.1 and Figure 3.2. Make wiring connections as indicated in the typical connection diagrams. Incoming three-phase power connections are made to terminals L1/1, L2/3, and L3/5. Load connections to Line motors are made to T1/2, T2/4, and T3/6, while load connections to Wye-Delta motors are made to T1/2, T2/4, T3/6, T4/8, T5/10, and T6/12.

Figure 3.1 Wiring Terminal Locations (5…85 A)

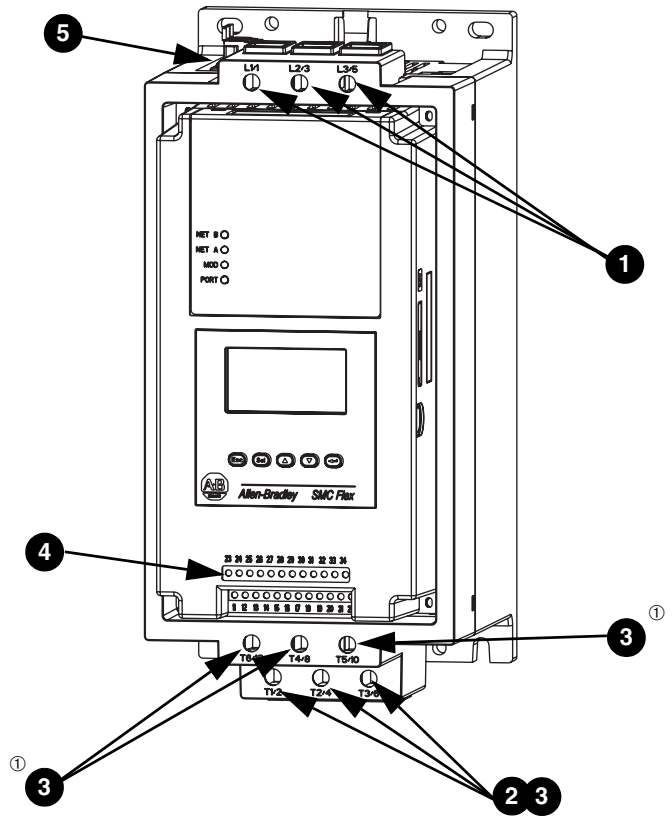


Table 3.A Wiring Terminal Locations

1	Incoming Line Termination
2	Line Motor Connections
3	Delta Motor Connections
4	Control Terminations
5	Fan Terminations

① IP20 protective covers on Delta termination must be removed when connecting in a Delta configuration.

Figure 3.2 Wiring Terminal Locations (108…480 A)

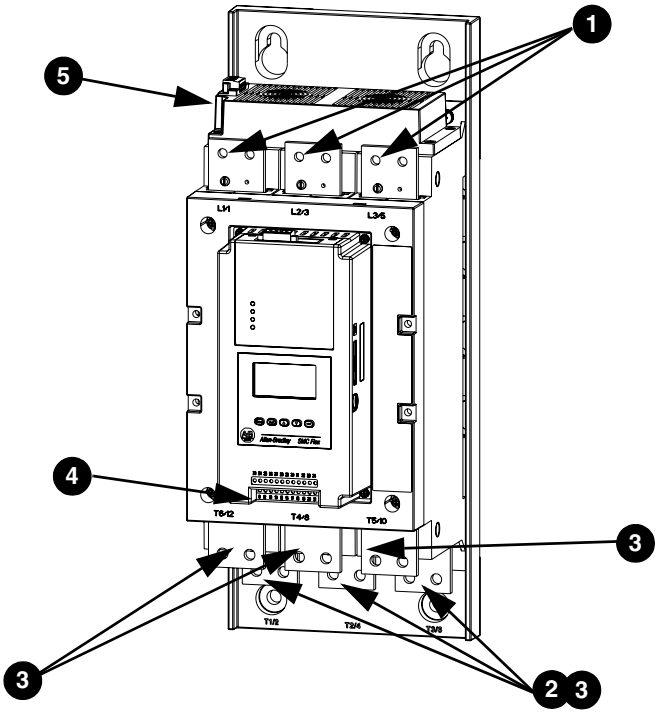


Table 3.A Wiring Terminal Locations

1	Incoming Line Termination
2	Line Motor Connections
3	Delta Motor Connections
4	Control Terminations
5	Fan Terminations

Figure 3.3 Wiring Terminal Locations (625…1250 A)

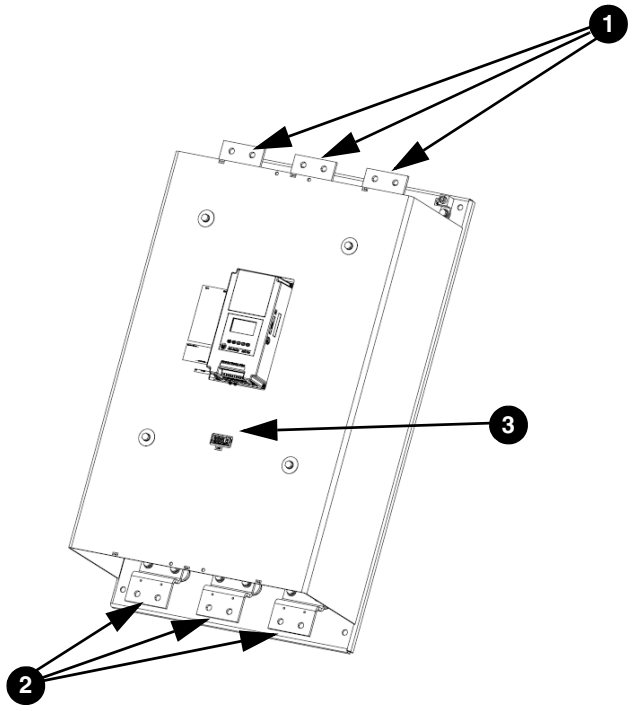


Table 3.B Wiring Terminal Locations

1	Incoming Line Terminations
2	Line Motor Connections
3	Terminal Block CP1 - Common Control Power Connections (Fans, Contactors, and Control Modules)

Power Structure

The SMC-Flex product has an integrated mechanical run contactor on each phase of the motor to minimize heat generation during run time. These contacts are pulled in sequentially in the 108…1250 A units. In the 5…85 A units, these contacts are pulled in, all at once. The SMC-Flex product also has a Current Transformer (CT), built in on each phase of the motor to provide current readings.

Power Wiring

Refer to the product nameplate or User Manual for power lug termination information including:

- Lug wire capacity
- Tightening torque requirements
- Lug kit catalog numbers (108…1250 A)

ATTENTION

Failure of solid state power switching components can cause overheating due to a single-phase condition in the motor. To prevent injury or equipment damage, the following is recommended:

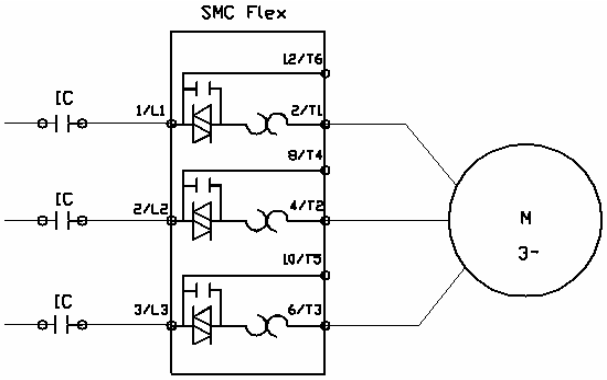
Use of an isolation contactor or shunt trip type circuit breaker on the line side of the SMC. This device should be capable of interrupting the motor's lock rotor current.

Connection of this isolation device to an auxiliary contact on the SMC-Flex. The auxiliary contact should be programmed for the "normal" condition. See Chapter 4 for additional information on programming.

Line Connected

The SMC-Flex by default is programmed to be connected to a line controlled motor as shown in Figure 3.4. These motors typically have 3 leads and must be rated between 1…1250 amps. An optional isolation contactor can be added to the circuit to provide galvanic isolation of the motor and final electro-mechanical removal of power.

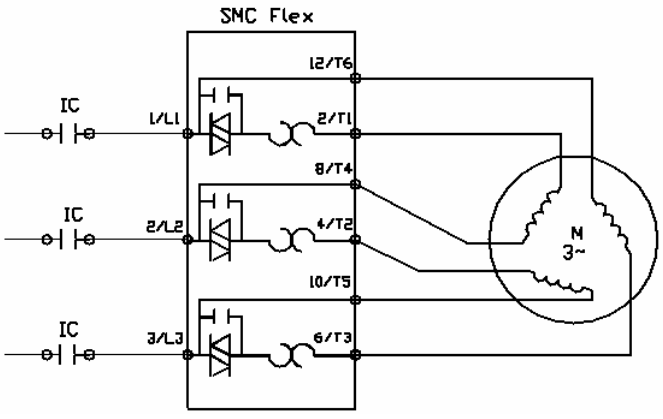
Figure 3.4



Delta Connected

The SMC Flex can be programmed and connected to a delta controlled motor as shown in Figure 3.5. These motors typically have 6 or 12 leads and must be rated between 1.8…1600 amps. It is recommended that an isolation contactor be added to the circuit to provide galvanic isolation of the motor and final electro-mechanical removal of power.

Figure 3.5



Power Lugs

Power lugs are required for devices rated 108..1250 A. In some cases these lugs are sold in kits. Each kit contains three lugs. The number and type of lugs required is listed in the following tables.

Table 3.C lists the recommended lugs for the SMC when configured as a line connection. Table 3.D lists the recommended lugs when using the SMC Flex with a delta connection. Note that devices rated 625…1250 A require the use of a power distribution block when used with a delta connection.

ATTENTION



Terminal covers are available for units rated 108…480 A which can make the product deadfront (IP2X) safe. See Appendix D for the appropriate catalog numbers for ordering.

Table 3.C SMC-Flex 5…1250 A, Line Connection Lug Information

SMC Rating	Lug Kit Cat. No.	Wire Strip Length	Conductor Range	Max. No. Lugs/Pole		Tightening Torque	
				Line Side	Load Side	Wire — Lug	Lug — Busbar
5…85 A	—	18…20 mm	2.5…95 mm^2 (#14…3/0 AWG)	—	—	11.3 N•m (100 lb.-in.)	—
108…135 A	199-LF1	18…20 mm	16…120 mm^2 (#6…250 MCM)	3	3	31 N•m (275 lb.-in.)	23 N•m (200 lb.-in.)
201…251 A	199-LF1	18…20 mm	16…120 mm^2 (#6…250 MCM)	6	6	31 N•m (275 lb.-in.)	23 N•m (200 lb.-in.)
317…480 A	199-LG1	18…25 mm	25…240 mm^2 (#4…500 MCM)	6	6	42 N•m (375 lb.-in.)	28 N•m (250 lb.-in.)
625…780 A	100-DL630	32 mm / 64 mm	70…240 mm^2 (2/0…500 MCM)	2	2	45 N•m (400 lb.-in.)	68 N•m (600 lb.-in.)
970 A	100-DL860	26 mm / 48 mm	120…240 mm^2 (4/0…500 MCM)	1	1	45 N•m (400 lb.-in.)	68 N•m (600 lb.-in.)
1250 A ①	100-DL630	32 mm / 64 mm	70…240 mm^2 (2/0…500 MCM)	1	1	45 N•m (400 lb.-in.)	68 N•m (600 lb.-in.)
	100-DL860	26 mm / 48 mm	120…240 mm^2 (4/0…500 MCM)	1	1		

① The 1250 A device requires one (1) each of the 100-DL630 and 100-DL860.

Table 3.D SMC-Flex 108…1250 A, Delta Connection Lug Information (for Inside-the-Delta applications)

SMC Rating	Suggested Lug Cat. No.	Conductor Range	Max. No. Lugs/ Pole	Tightening Torque	
			Line Side ②	Wire — Lug	Lug — Busbar
108…135 A	1494R-N15	25…240 mm^2 (#4…500 MCM)	1	42 N•m (375 lb.-in.)	23 N•m (200 lb.-in.)
201…251 A	1494R-N14	50…120 mm^2 (1/0…250 MCM)	2	31 N•m (275 lb.-in.)	23 N•m (200 lb.-in.)
317…480 A	150-LG5MC	95…240 mm^2 (3/0…500 MCM)	1	33.9 N•m (300 lb.-in.)	28 N•m (250 lb.-in.)
625…780 A ①	—	25…240 mm^2 (#4…500 MCM)	2	42 N•m (375 lb.-in.)	N/A
970…1250 A ①	—	25…240 mm^2 (#4…500 MCM)	4	42 N•m (375 lb.-in.)	N/A

① For 625…1250 A inside-the-delta connections, terminal blocks are reccommended for line side connections. Recommended terminal blocks are as follows:
- Cooper Bussmann Part# 16504-2 (625…780 A: 1 per phase, 970…1250 A: 2 per phase)

② Load side lug information for inside-the-delta applications is contained in Table 3.C.

Control Power

Control Wiring

Refer to the product nameplate for control terminal wire capacity and tightening torque requirements. Each control terminal will accept a maximum of two wires. Refer to the product nameplate prior to applying control power. Depending on the specific application, additional control circuit transformer VA capacity may be required.

Controllers rated 5…480 A

The SMC-Flex controllers rated 5…480 A accept control power input of 100…240V AC or 24V AC/DC, (+10/–15%) single-phase, 50/60 Hz. A control power source of 125 VA is required. The control power requirement for the control module is 75 VA. The control power requirement for the fans is 20 or 50 VA. The control module and fans are separately wired. The control module requirements are shown in Table 3.E. The fans require additional power as defined in Table 3.G.

Table 3.E Control Module Requirements

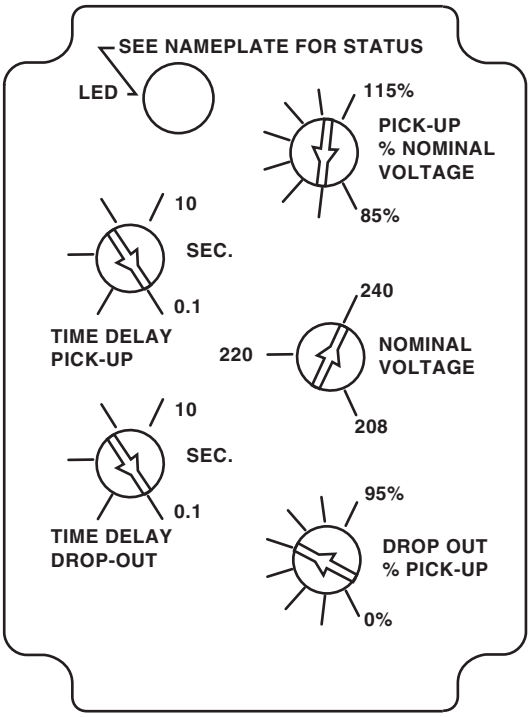
120…240V AC	Transformer	75 VA
24V AC	Transformer	130 VA
24V DC	Inrush Current	5 A
	Inrush Time	250 ms
	Transient Watts	60 W
	Transient Time	500 ms
	Steady State Watts	24 W
	Minimum Allen-Bradley Power Supply	1606-XLP50E

Controllers rated 625…1250 A

For controllers rated 625…1250 A, common control is required for proper operation. Control power is connected to the product through terminal block CP1, at terminals 1 and 4. This single connection point feeds the control module, contactors, and fans. Control power must be supplied as 110/120 VAC or 230/240 VAC, 50/60 Hz only. A control power source of at least 800 VA is required. The control power requirements include the control module (75 VA), bypass contactors (526 VA max), and fan power (150 VA).

Depending on the specific application, additional control circuit transformer VA capacity may be required.

Figure 3.6 230V Control Undervoltage Relay Settings for 625…1250 A Devices



GENERAL NOTES:
1. SET ALL RELAY POTENTIOMETERS PER ILLUSTRATION.

Figure 3.7 Internal Wiring and 230V Control Undervoltage Relay Connection Diagram for 625…1250 A Devices

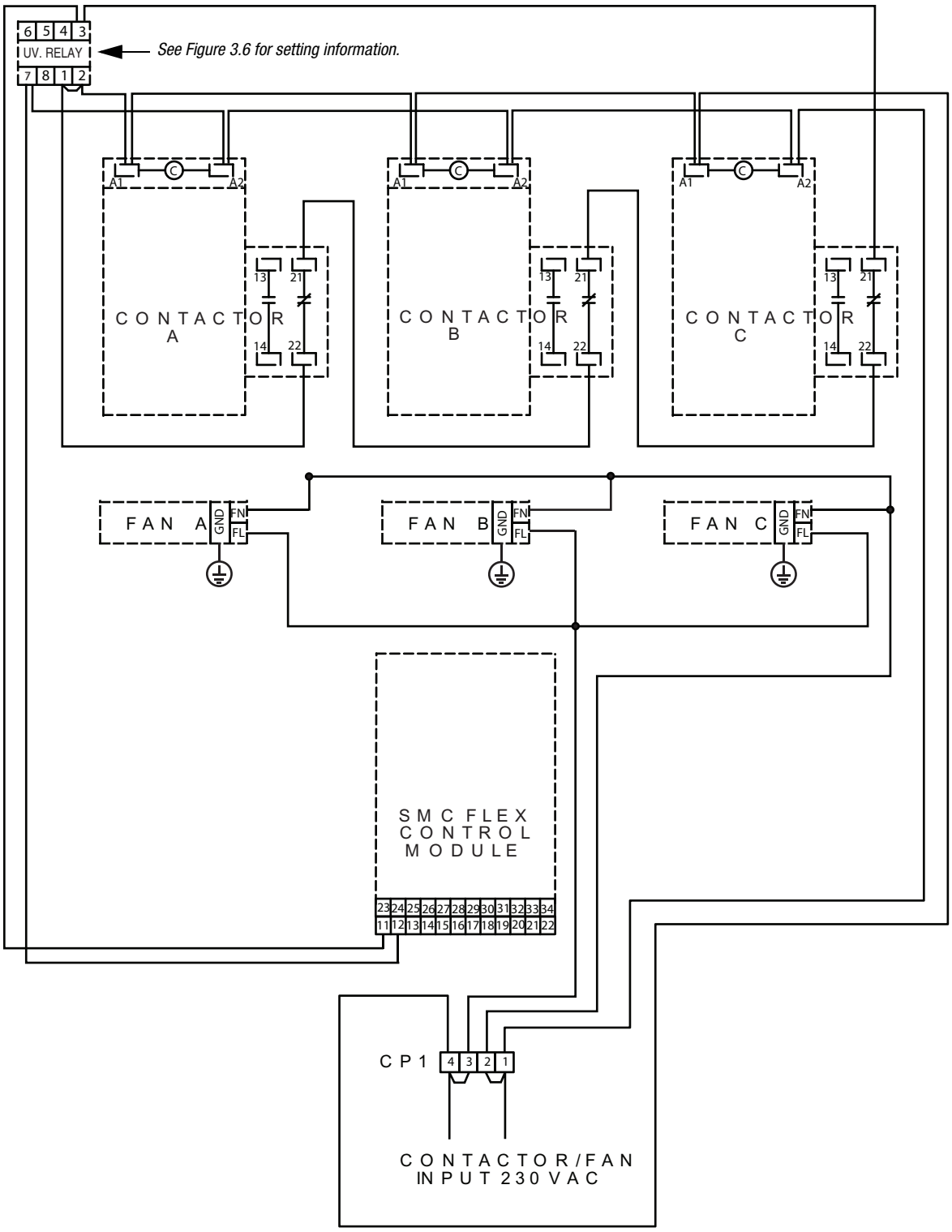
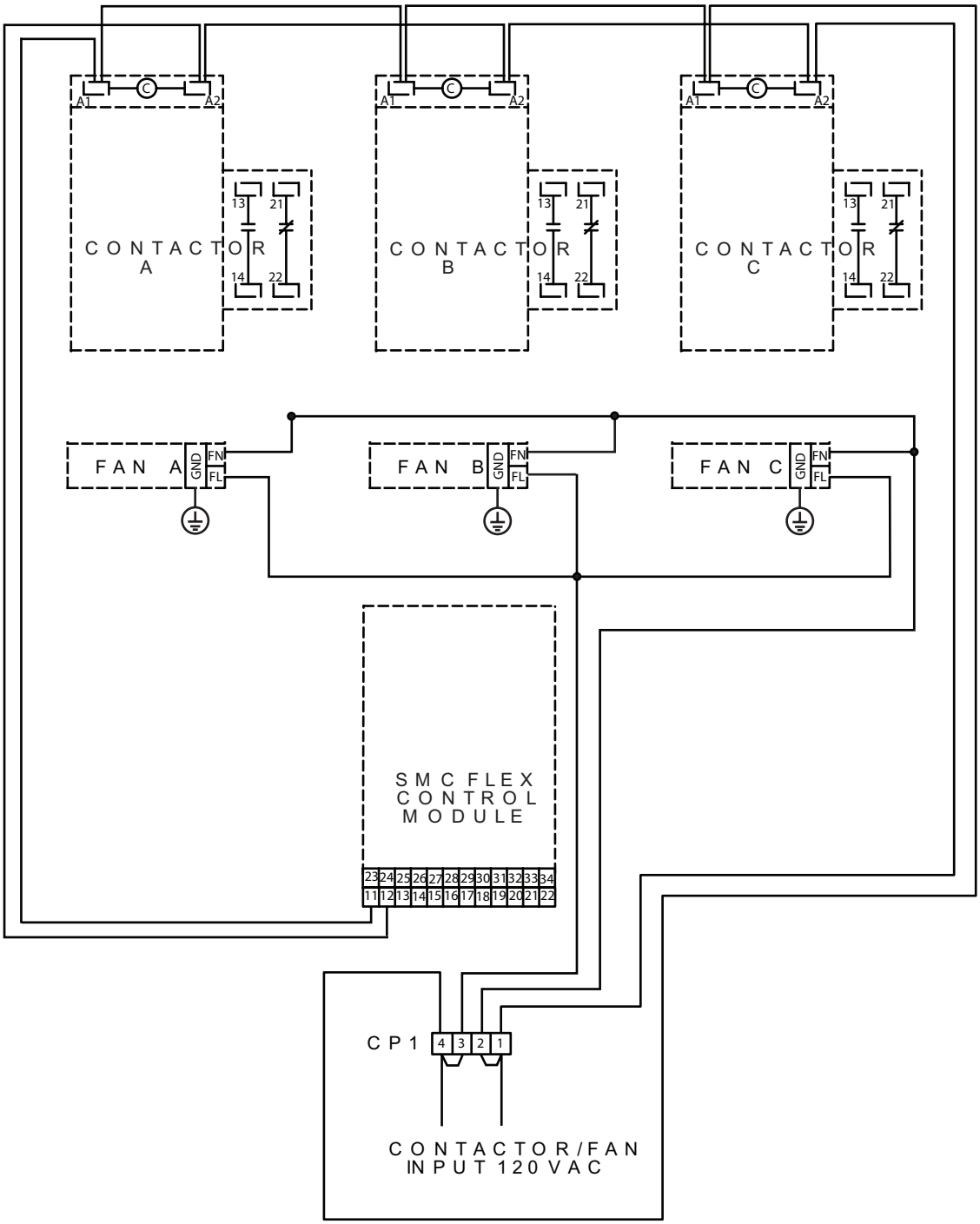


Figure 3.8 Internal Wiring and 120V Control Connection Diagram for 625…1250 A Devices



Control Wire Specifications

Table 3.F provides the control terminal wire capacity, the tightening torque requirements, and the wire strip length. Each control terminal will accept a maximum of two wires.

Table 3.F Control Wiring and Tightening Torque

Wire Size	Torque	Wire Strip Length
0.75…2.5 mm^2 (#18…14 AWG)	0.6 N•m (5 lb.-in.)	5.6…8.6 mm (0.22…0.34 in.)

Fan Power

Controllers rated 5…1250 A have heatsink fan(s). Refer to Table 3.G for the control power VA requirements of the heatsink fans.

Fan Terminations

See Figure 3.1, Figure 3.2, and Figure 3.3 for fan power connection locations.

ATTENTION



The fan jumpers have been factory installed for 110/120V AC input. Refer to Figure 3.9 for 220/240V AC fan wiring (5…480A devices only).

Figure 3.9 Power Terminations

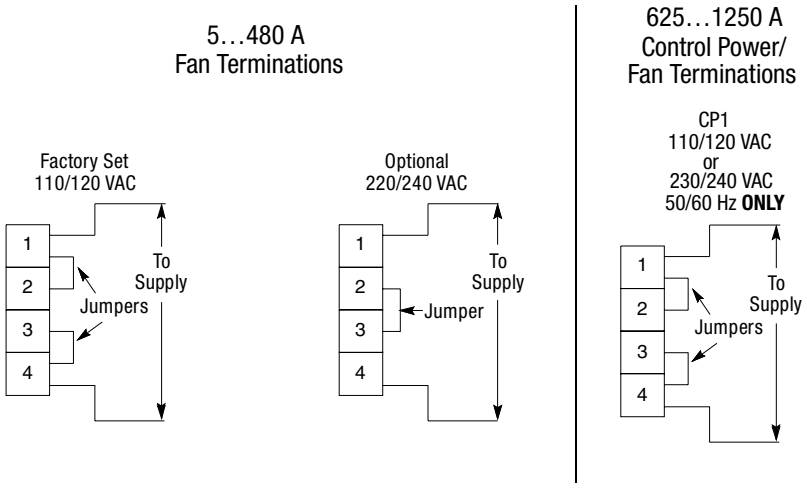


Table 3.G Heatsink Fan Control Power

SMC Rating	Heatsink Fan VA
5…135 A	20
201…251 A	40
317…480 A	60
625…780 A	150 ①
970…1250 A	150 ①

① Internally wired.

Control Terminal Designations

As shown in Figure 3.10, the SMC-Flex controller contains 24 control terminals on the front of the controller.

Figure 3.10 SMC-Flex Controller Control Terminals



Terminal Number	Description
11	Control Power Input ①④
12	Control Power Common ①④
13	Controller Enable Input ②
14	Control Module Ground
15	Option Input #2 ①②
16	Option Input #1 ①②
17	Start Input ①②
18	Stop Input ①②
19	Aux. Contact #1①③
20	Aux. Contact #1①③
21	Not Used
22	Not Used

Terminal Number	Description
23	PTC Input ②
24	PTC Input ②
25	Tach Input
26	Tach Input
27	Ground Fault Transformer Input ②
28	Ground Fault Transformer Input ②
29	Aux. Contact #2①③
30	Aux. Contact #2①③
31	Aux. Contact #3①③
32	Aux. Contact #3①③
33	Aux. Contact #4①③
34	Aux. Contact #4①③

① RC Snubbers are required on loads connected to auxiliary.

② Do not connect any additional loads to these terminals. These "parasitic" loads may cause problems with operation, which may result in false starting and stopping.

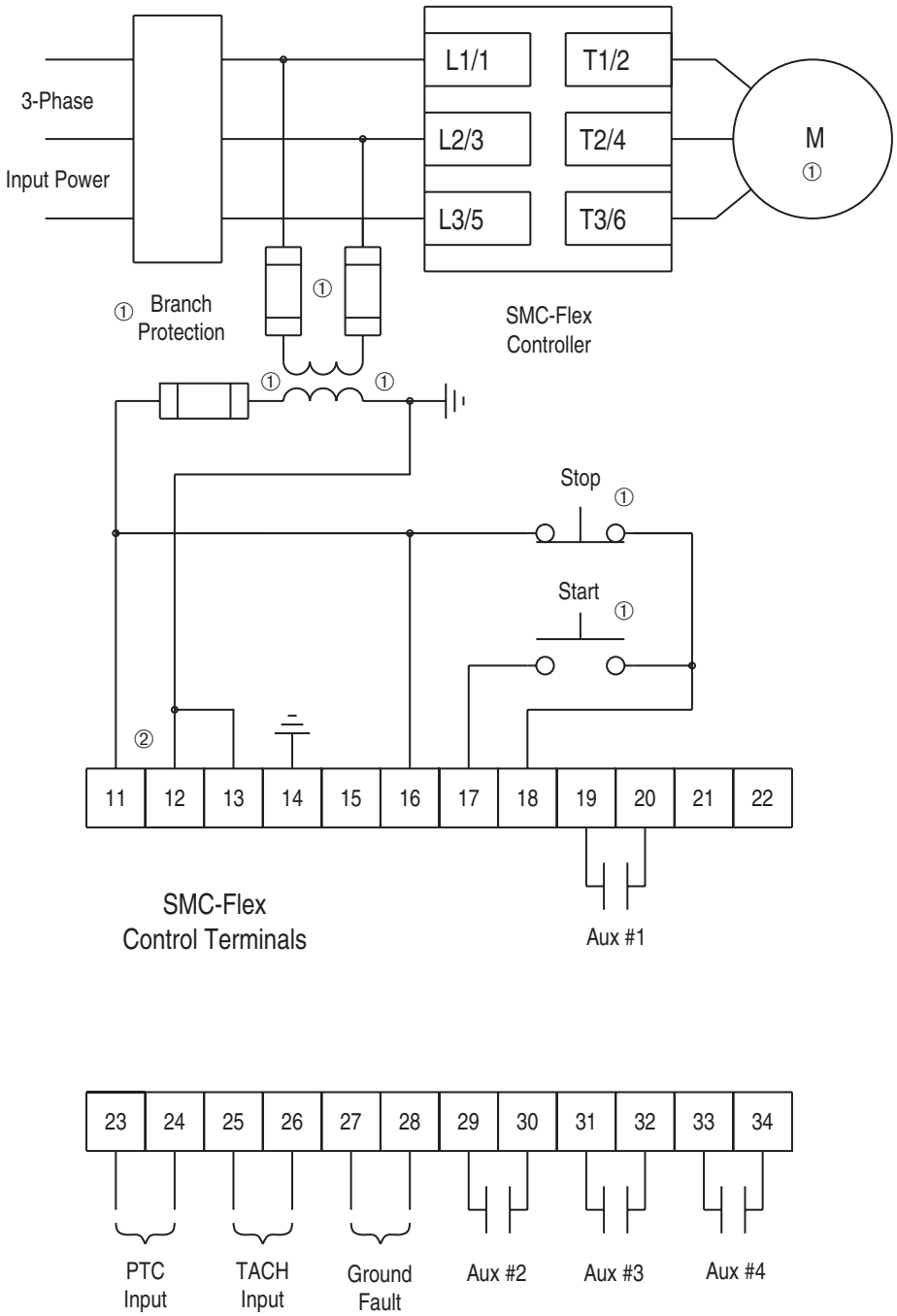
③ External Bypass operates an external contactor and overload relay once the motor reaches full speed. The SMC-FLEX overload functionality, diagnostics and metering are disabled when the external bypass is activated. Proper sizing of the contactor and overload is required.

④ Control power on units rated 625…1250 A is pre-wired internally, from terminal block CP1.

Standard Controller Wiring Diagrams

Figure 3.11 through Figure 3.22 show typical wiring for the SMC-Flex controller.

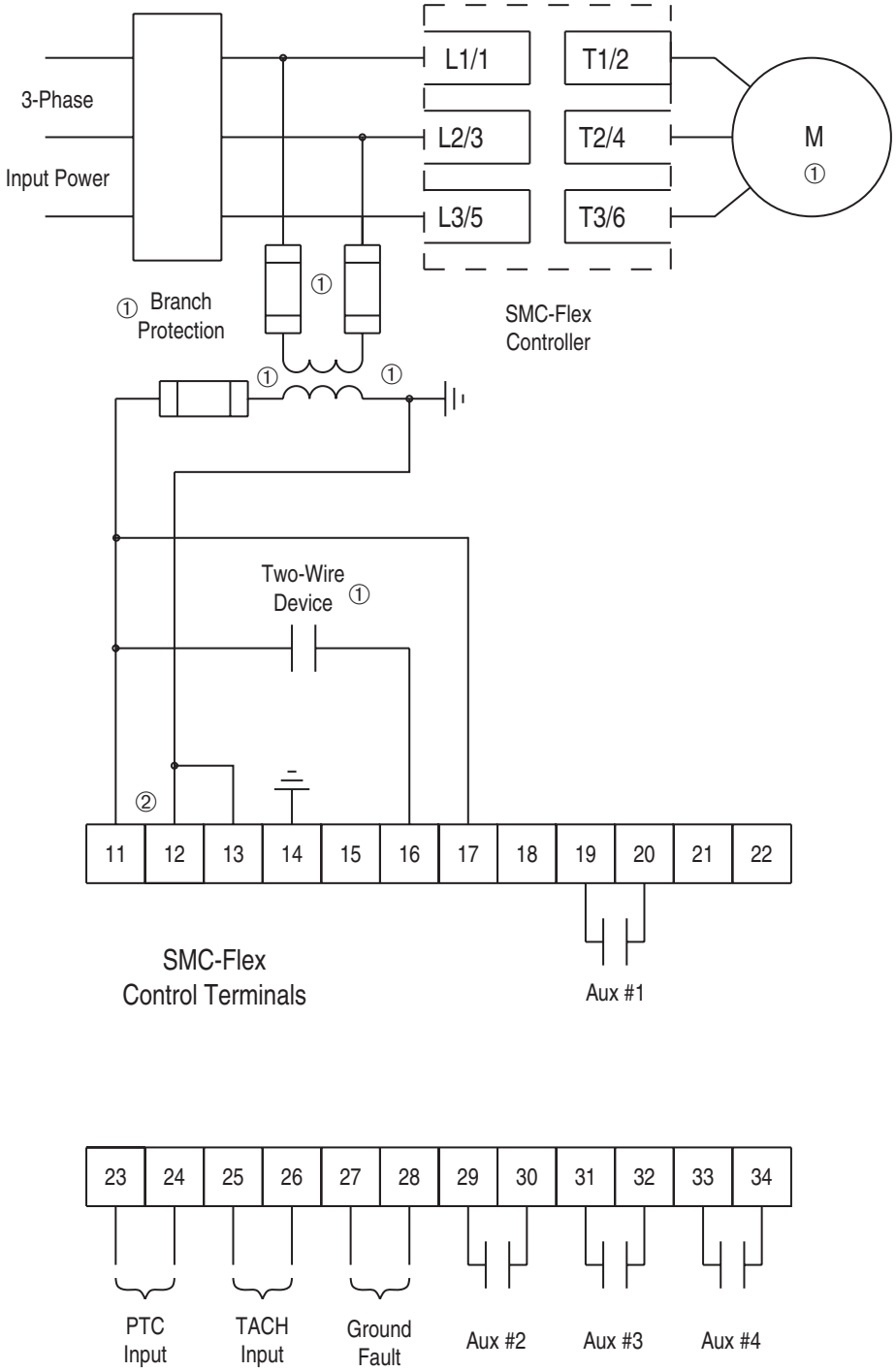
Figure 3.11 Typical Wiring Diagram for Standard Controller



① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

Figure 3.12 Typical Wiring Diagram for Two-Wire Control with Stopping Control (No DPI Control)



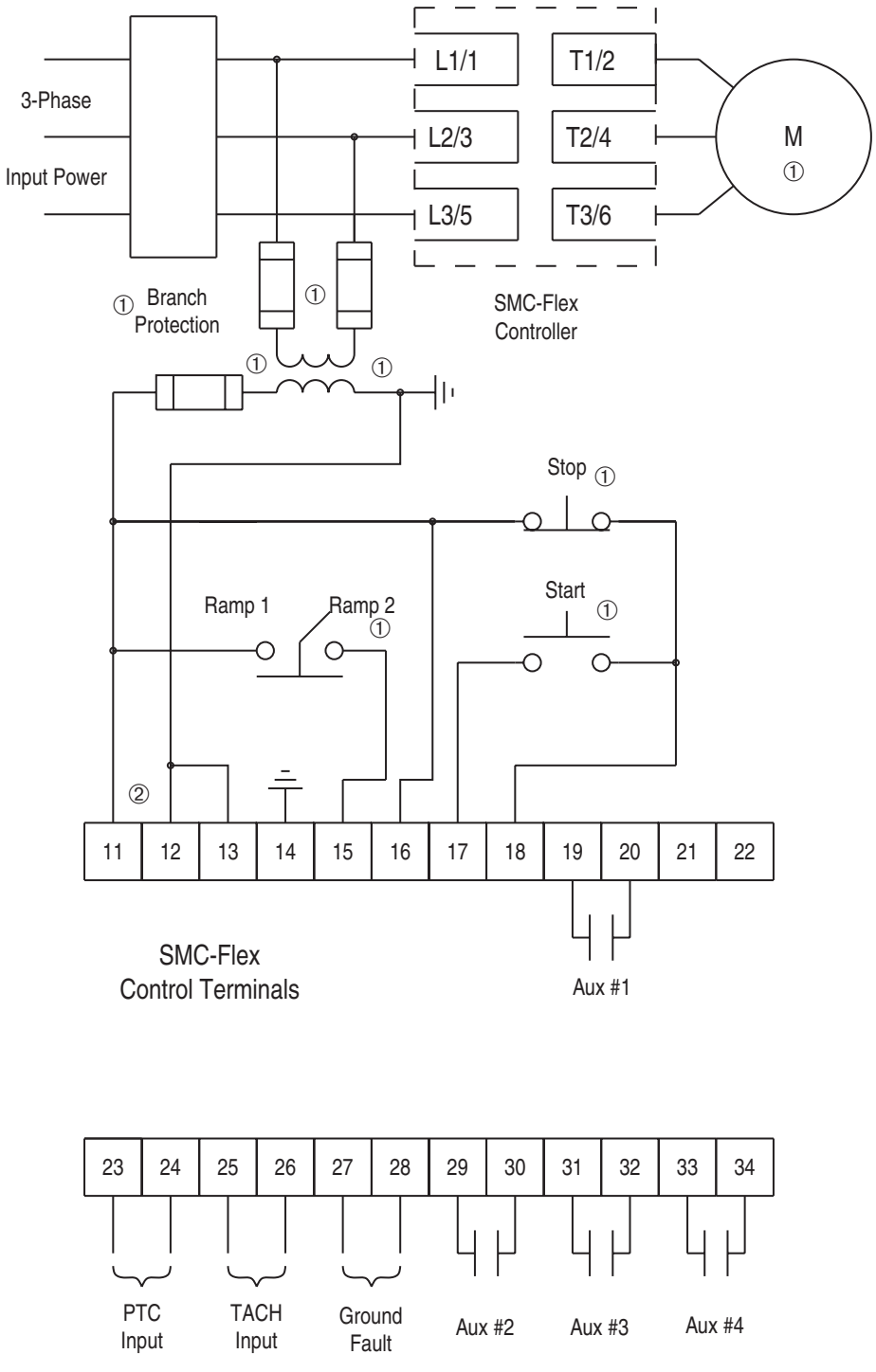
① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

Notes: (1) Programmable controller interfacing in this diagram refers to hard-wiring between the PLC's output contacts and the SMC-Flex controller's control terminals.

(2) The OFF state leakage current for a solid-state device must be less than 6 mA.

Figure 3.13 Typical Wiring Diagram for Dual Ramp Applications



① Customer supplied.

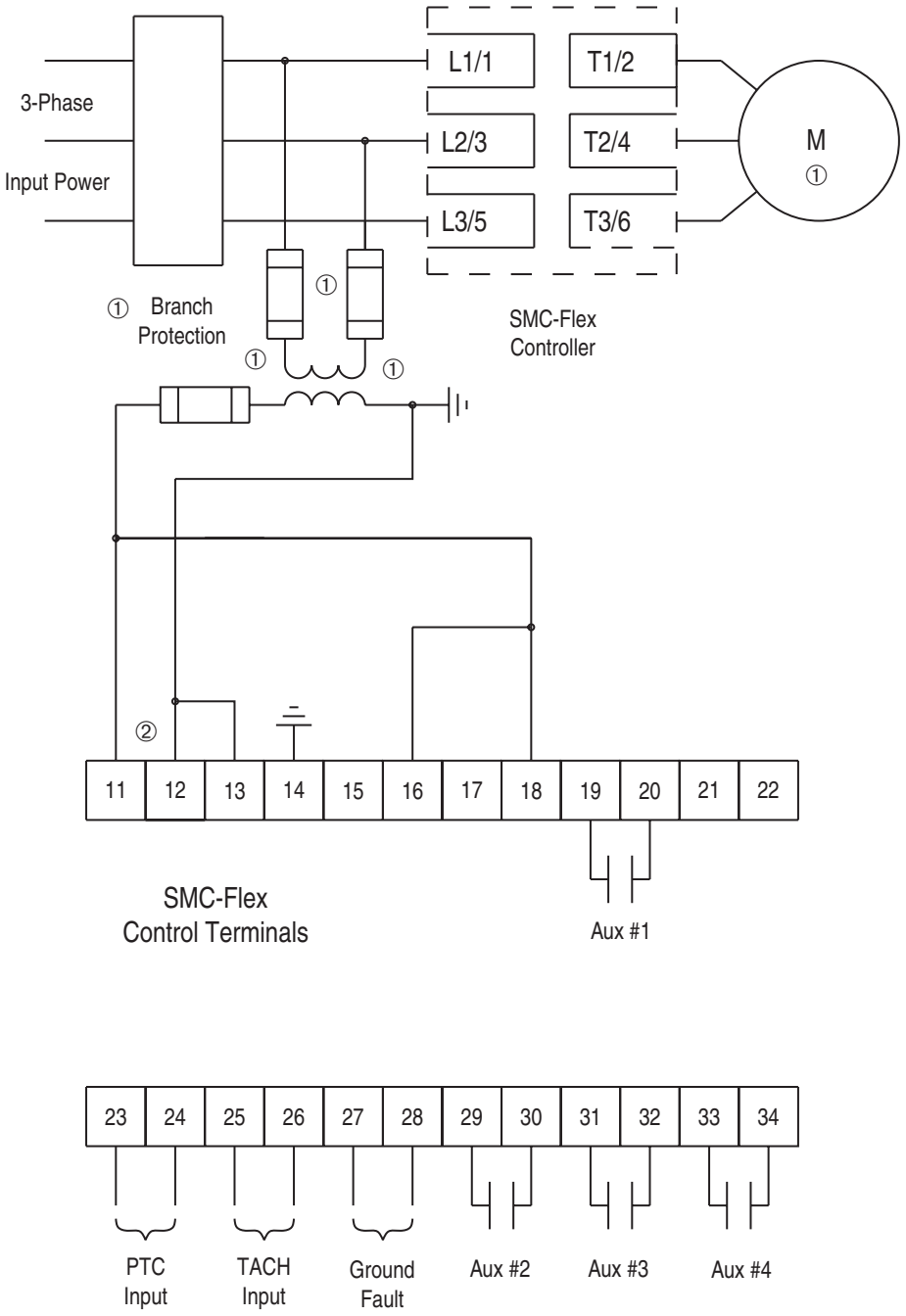
② Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

Note: The Dual Ramp feature is available only with the standard control version.

Figure 3.14 Typical Wiring Diagram for Start-Stop Control via DPI Communications

Note: Use this wiring diagram when start-stop will come from either a Bulletin 20-HIM LCD interface module or a Bulletin 20-COMM communication module connected to the SMC-Flex.

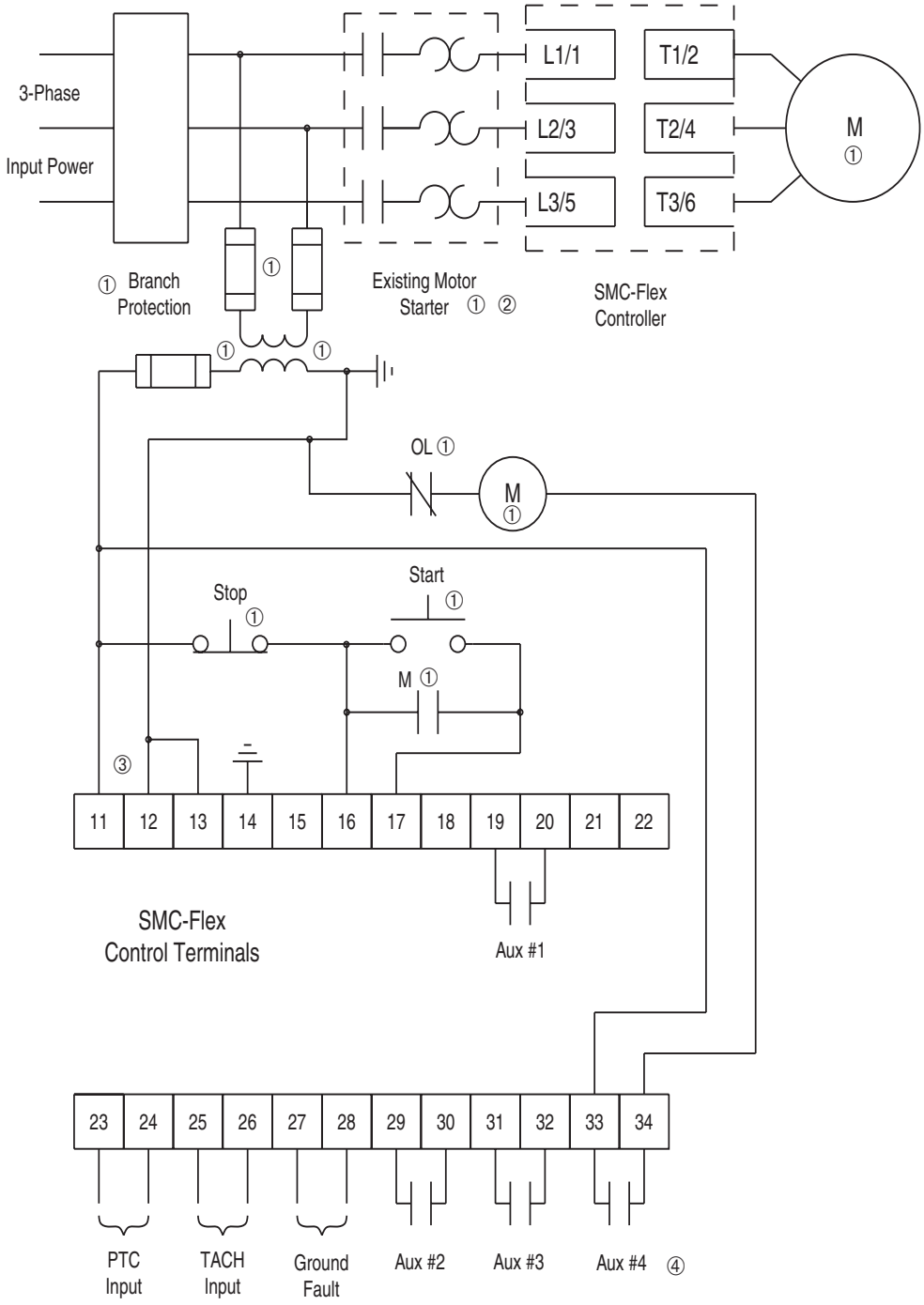
Note: Logic mask must be properly configured, see Chapter 8.



① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

Figure 3.15 Typical Wiring Diagram for Retrofit Applications



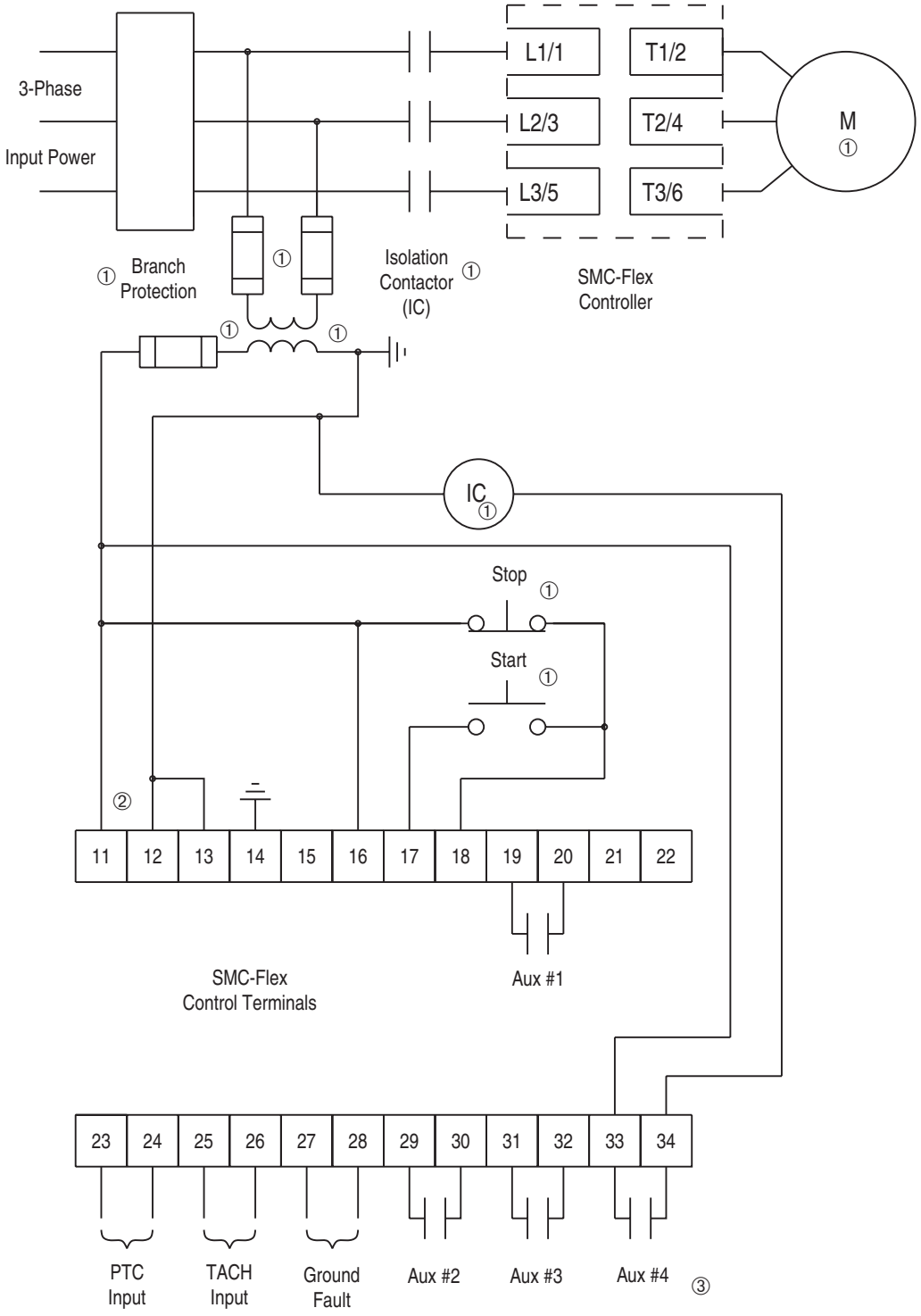
① Customer supplied.

② Overload protection should be disabled in the SMC-Flex controller.

③ Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

④ Aux #4 should be set for normal operation

Figure 3.16 Typical Wiring Diagram for Isolation Applications (DPI also)

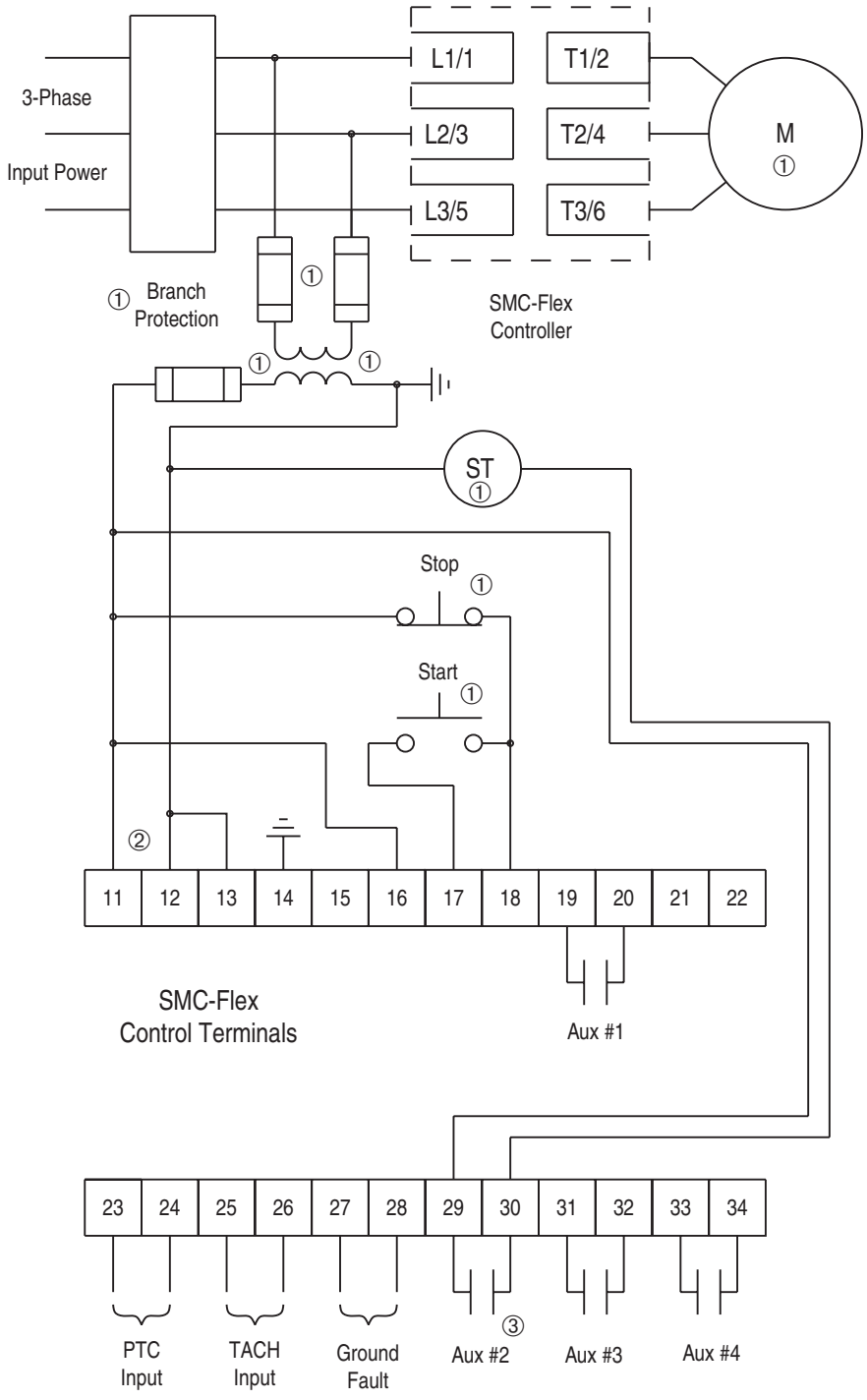


① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

③ Aux #4 should be set for normal operation.

Figure 3.17 Typical Wiring Diagram for Shunt Trip Applications

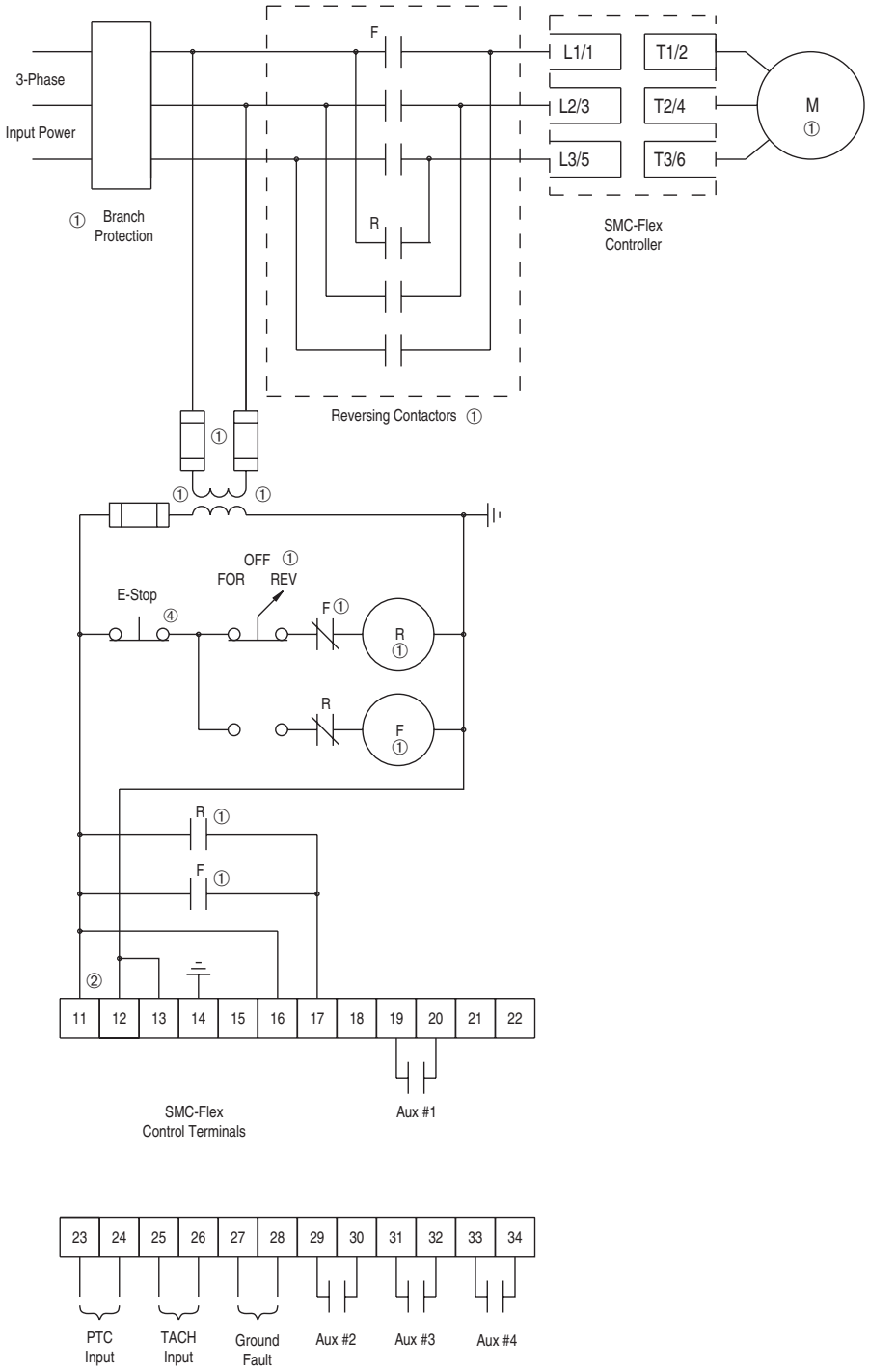


① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

③ Aux #2 should be set to fault operation.

Figure 3.18 Typical Wiring Diagram for Single-Speed Reversing Applications



① Customer supplied.

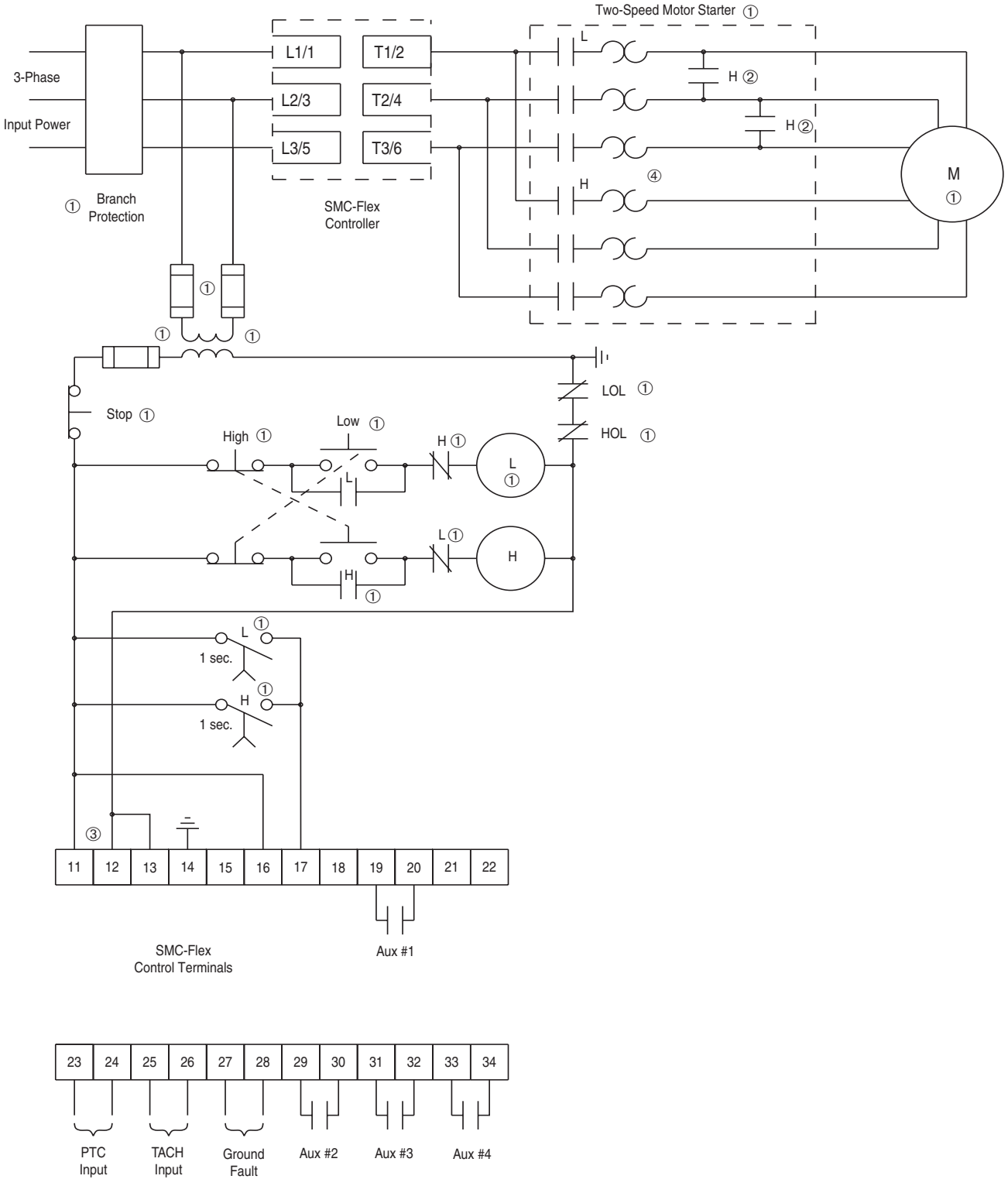
② Refer to the controller nameplate to verify the rating of the control power input rating. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

③ No braking manuever allowed in wiring diagram.

④ Maintained pushbutton.

Notes: (1) Minimum transition time for reversing direction is 1/2 second.
(2) Phase Reversal protection **must** be disabled in reversing applications.

Figure 3.19 Typical Wiring Diagram for Two-speed Applications



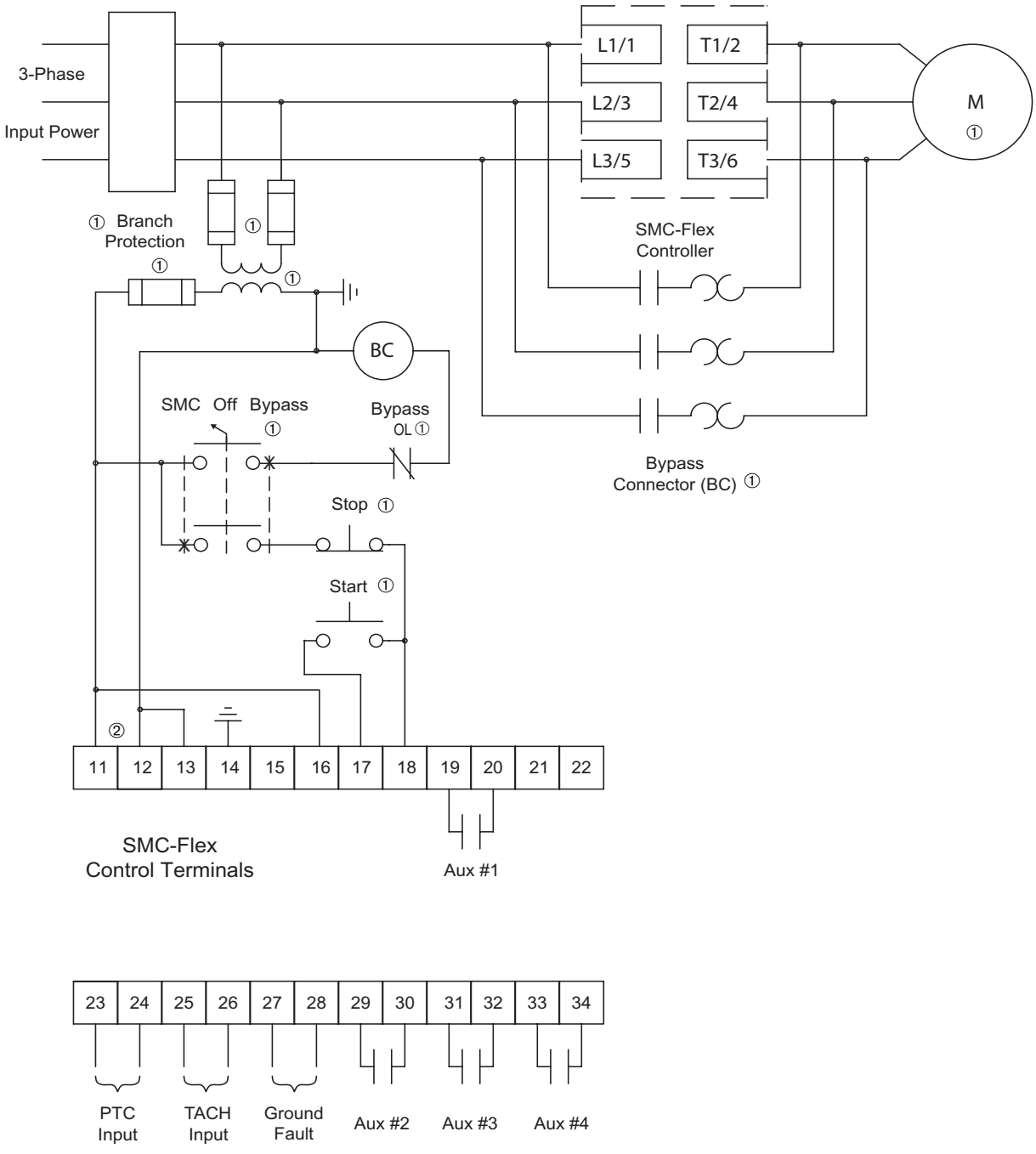
① Customer supplied.

② Two-speed, consequent pole installations.

③ Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

④ Overload must be disabled in SMC-Flex.

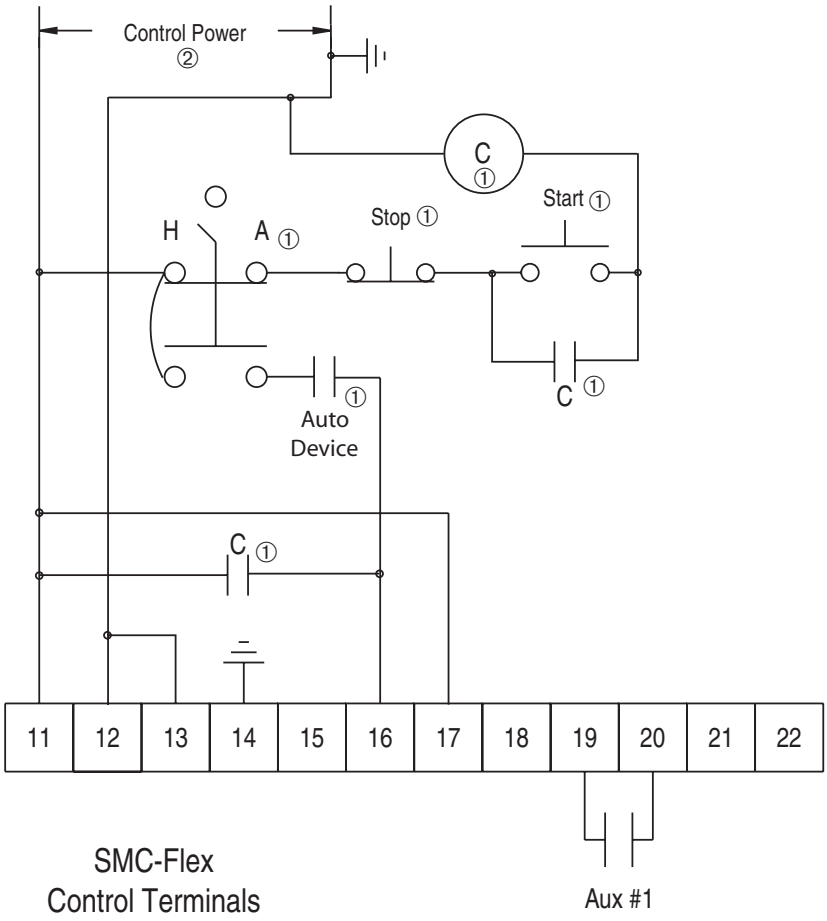
Figure 3.20 Typical Wiring Diagram for SMC-Off-Bypass Control

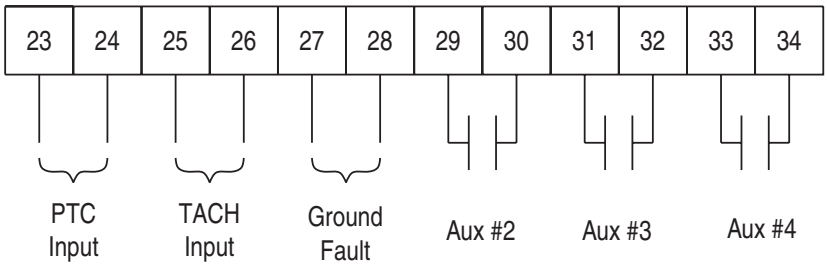


① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

Figure 3.21 Typical Wiring Diagram for Hand-Off-Auto Control with Stop Option and Start/Stop Push Buttons





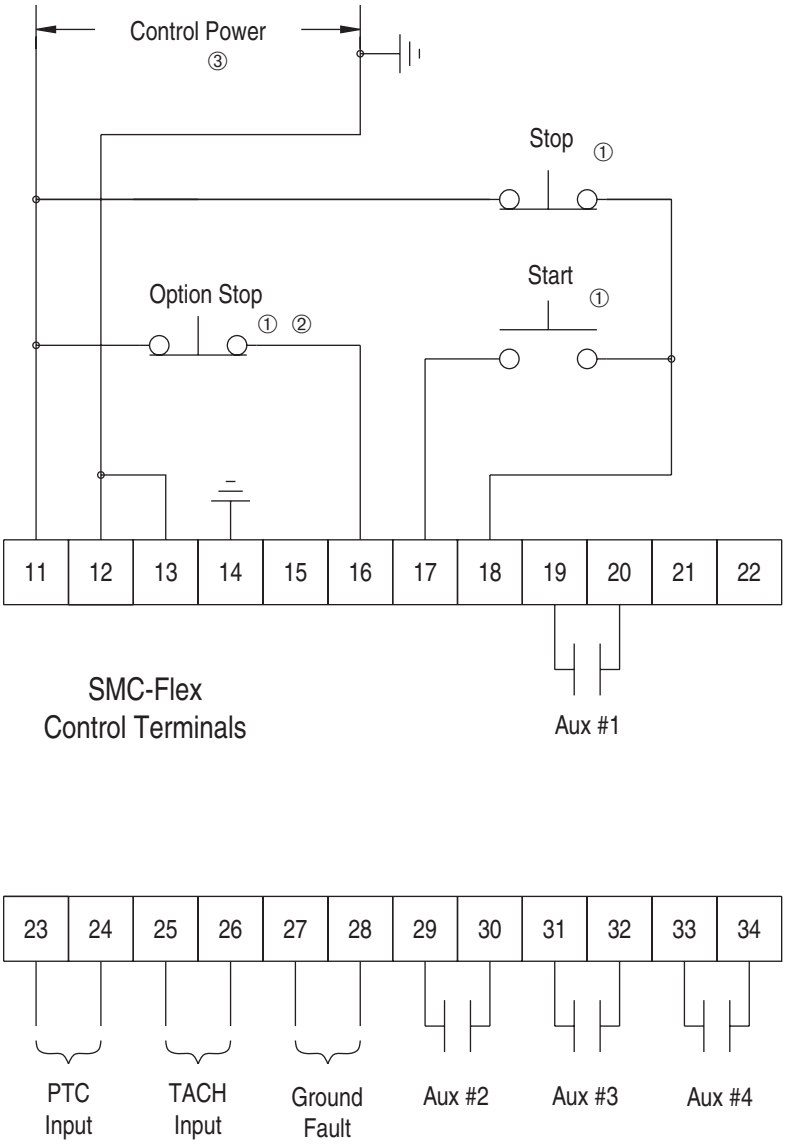
① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

Soft Stop, Pump Control, and SMB Smart Motor Braking

Figure 3.22 through Figure 3.25 show the different wiring for the Soft Stop, Pump Control, and SMB Smart Motor Braking options.

Figure 3.22 Typical Wiring Diagram



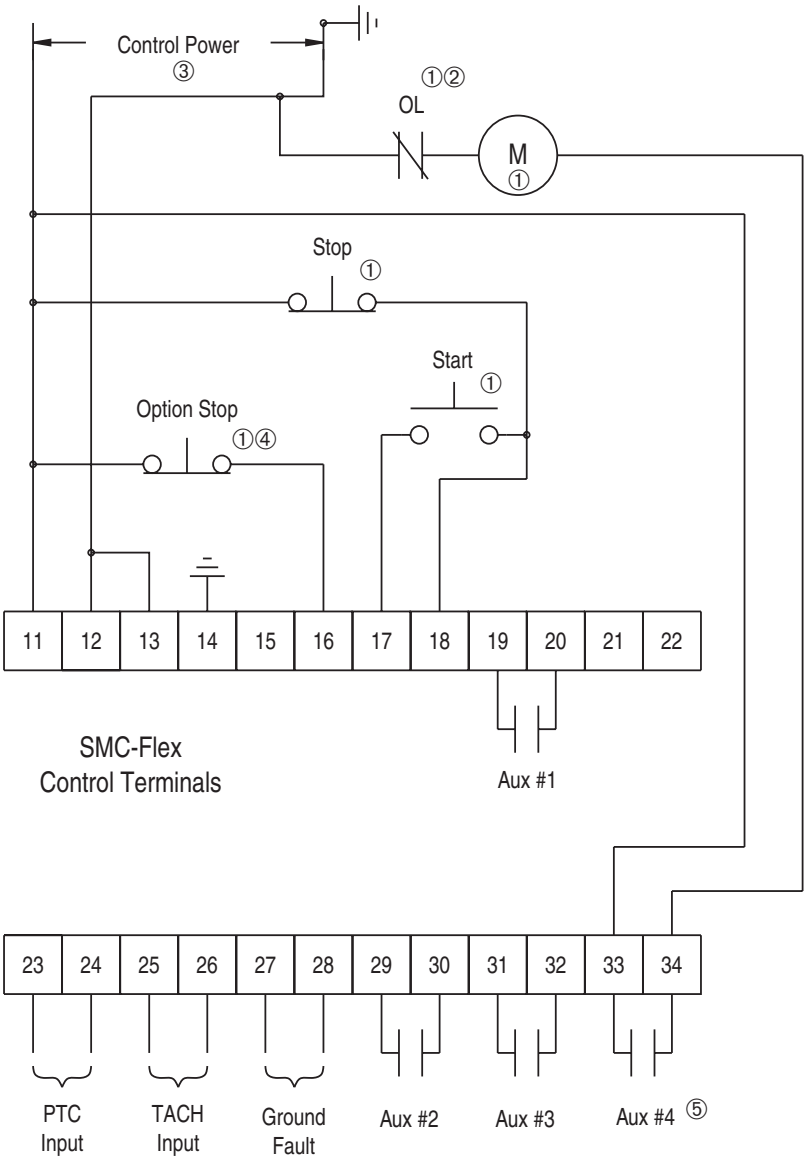
① Customer supplied.

② Soft Stop, Pump Stop, or Brake.

③ Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

Note: Refer to Chapter 3 for typical power circuits.

Figure 3.23 Typical Retrofit Wiring Diagram



① Customer supplied.

② Overload protection should be disabled in the SMC-Flex controller.

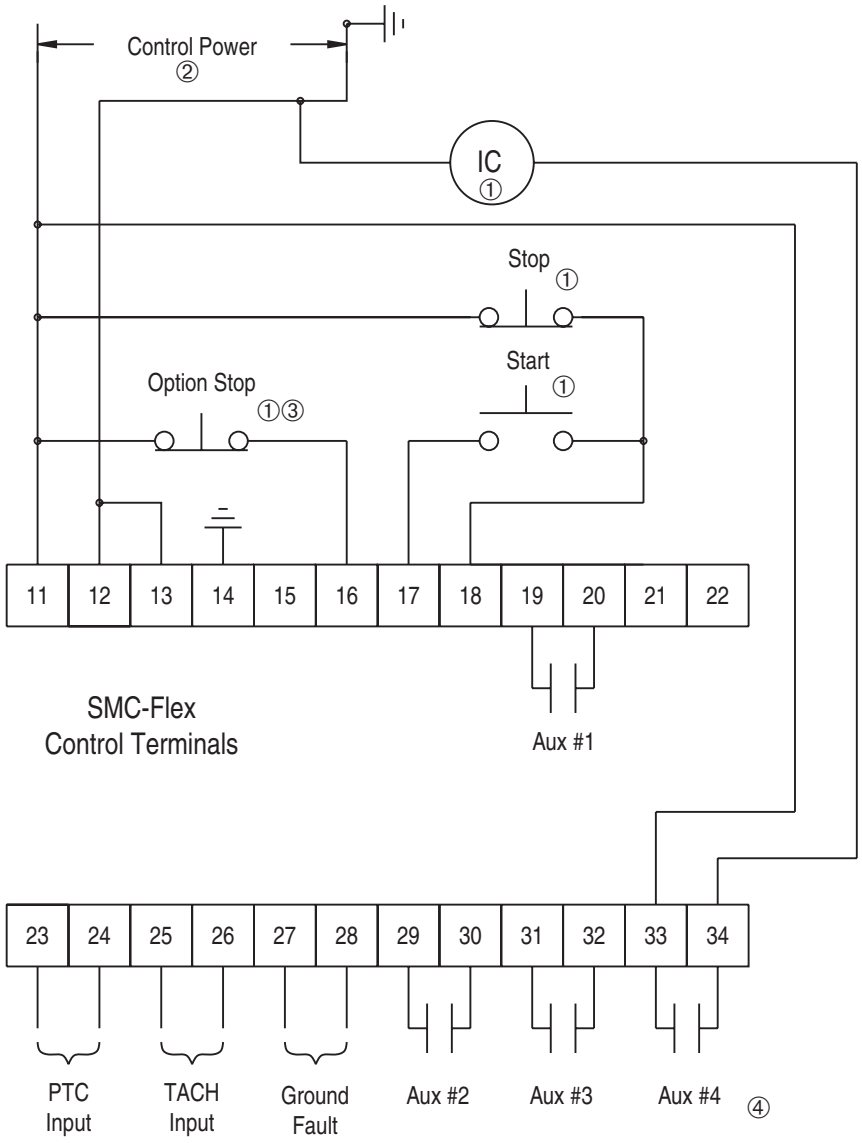
③ Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

④ Soft Stop, Pump Stop, or Brake.

⑤ Aux #4 should be set to normal operation.

Note: Refer to Chapter 3 for typical power circuits.

Figure 3.24 Typical Wiring Diagram for Applications Requiring an Isolation Contactor



① Customer supplied.

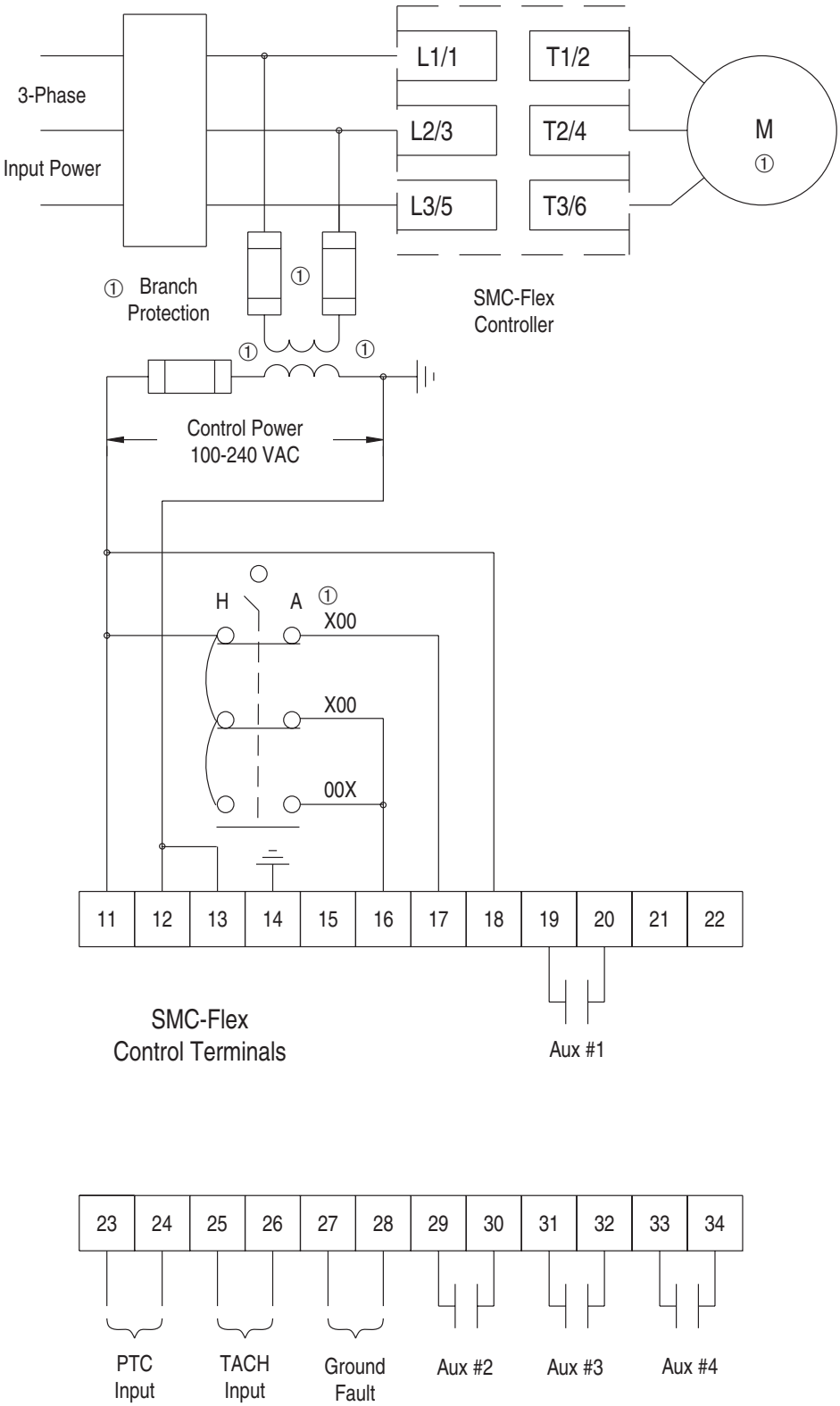
② Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

③ Soft Stop, Pump Stop, or Brake.

④ Aux #4 should be set to normal operation.

Note: Refer to Chapter 3 for typical power circuits.

Figure 3.25 Typical Wiring Diagram for Hand-Off-Auto (DPI) Control (Soft Stop, Braking, and Pump Control Only)

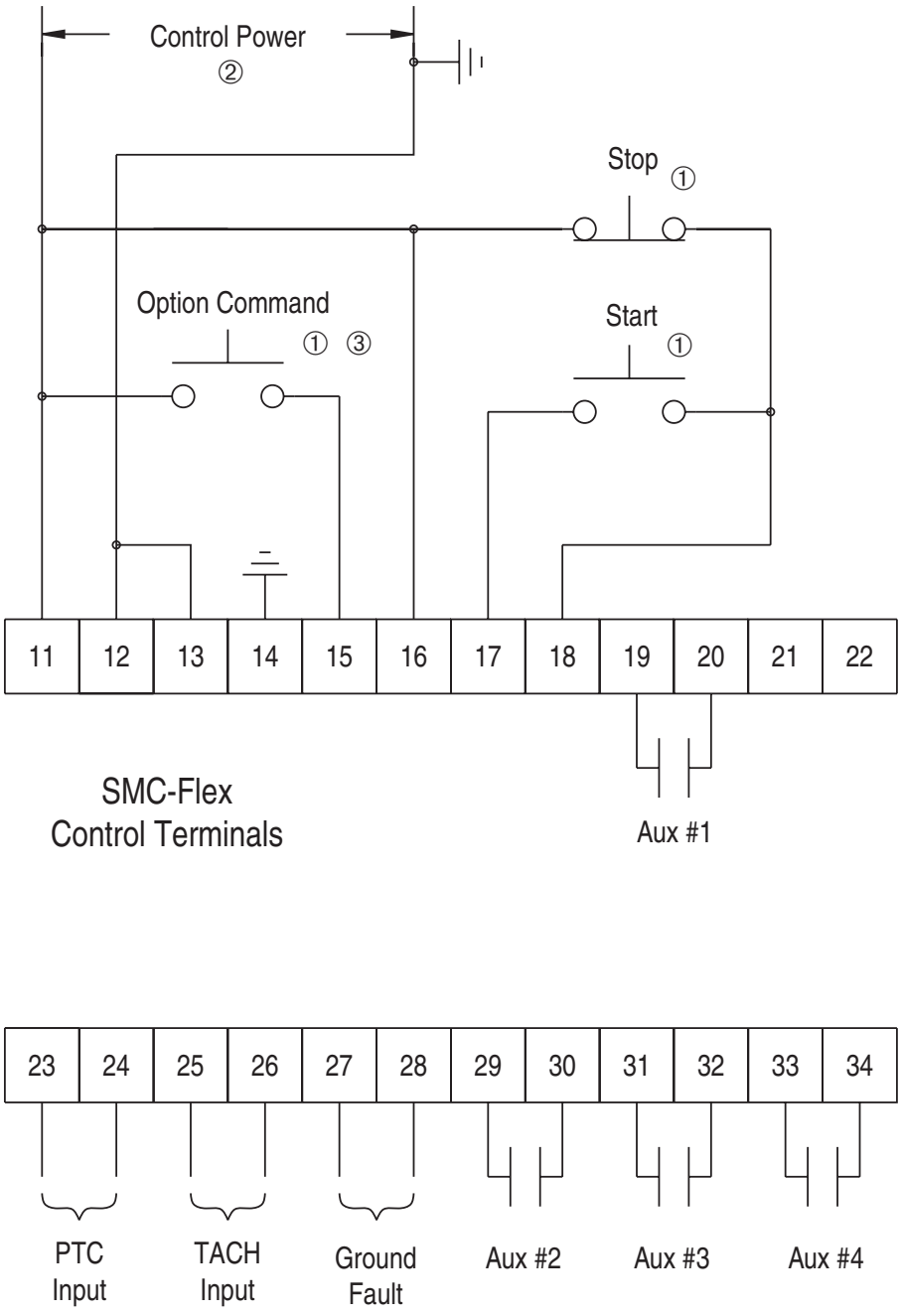


① Customer supplied.

Preset Slow Speed

Figure 3.26 and Figure 3.27 show the different wiring for the Preset Slow Speed.

Figure 3.26 Typical Wiring Diagram for the Preset Slow Speed



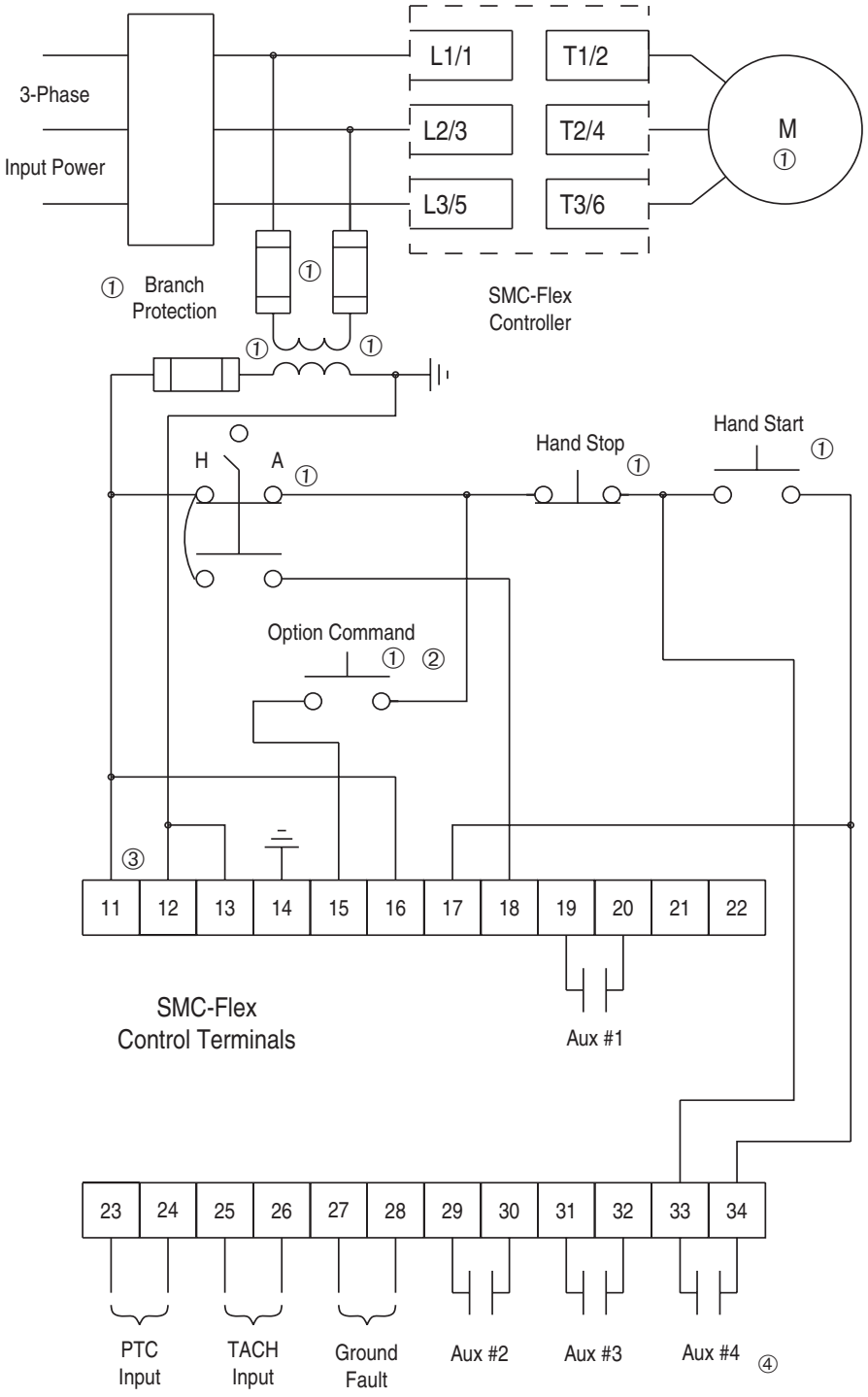
① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

③ Slow Speed.

Note: Refer to Chapter 3 for typical power circuits.

Figure 3.27 Typical Slow Speed Wiring Diagram for Hand-Off-Auto (DPI) Control



① Customer supplied.

② Slow Speed.

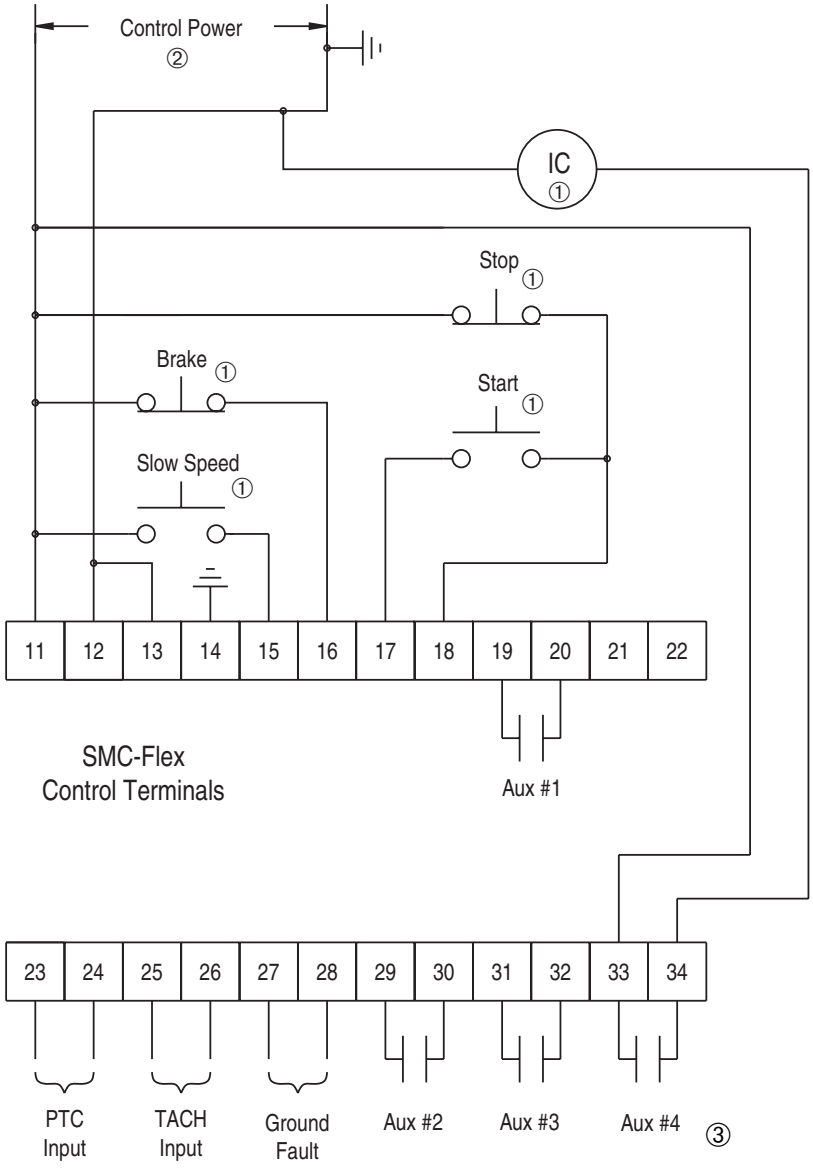
③ Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

④ Aux #4 should be set to normal operation.

Slow Speed with Braking

Figure 3.28 shows the wiring for the Slow Speed with Braking option.

Figure 3.28 Typical Wiring Diagram for the Slow Speed with Braking with an Isolation Contactor



① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage. For units rated 625…1250 A, terminals 11 & 12 are factory pre-wired from terminal block CP1 - terminals 1 & 4.

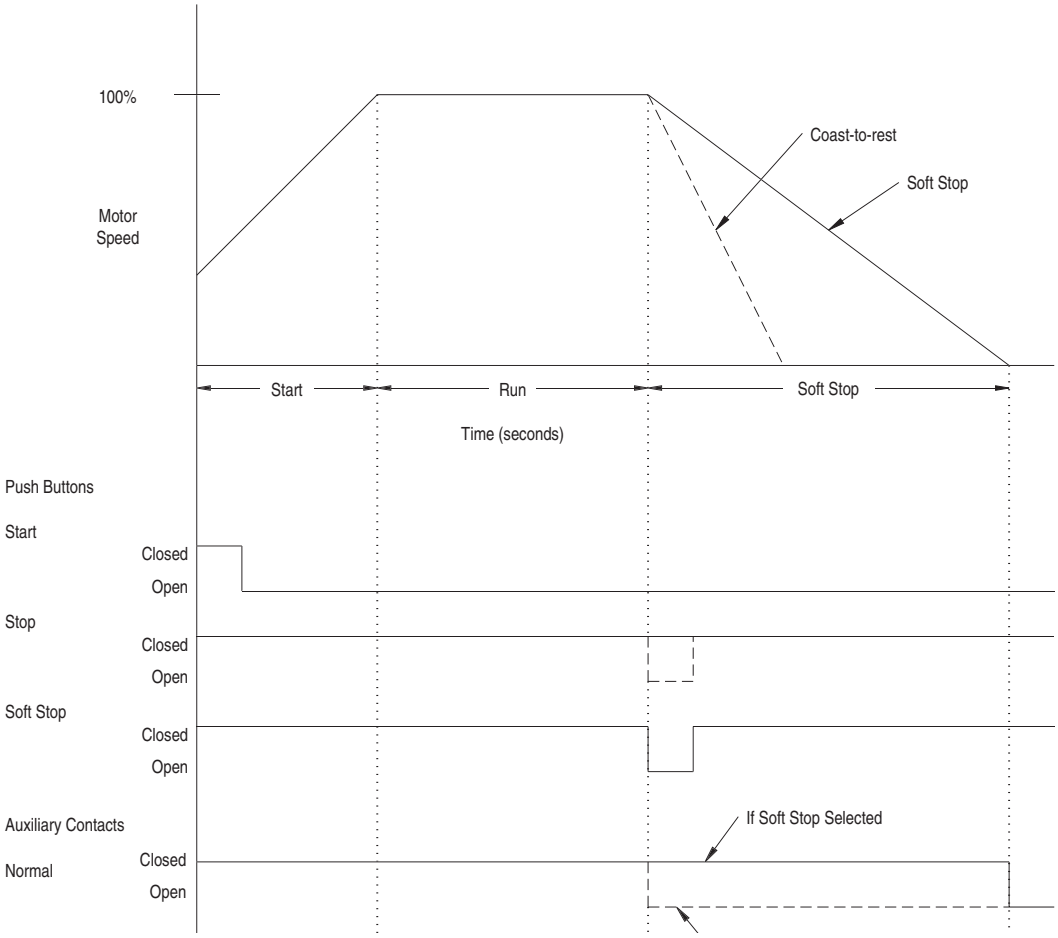
③ Aux #4 should be set to normal operation.

Note: Refer to Chapter 3 for typical power circuits.

Sequence of Operation

Figure 3.29 through Figure 3.34 show the different operation sequences for the Soft Stop, Preset Slow Speed, Pump Control, SMB Smart Motor Braking, Accu-Stop, and Slow Speed with Braking options.

Figure 3.29 Soft Stop Sequence of Operation



ATTENTION

The user is responsible for determining which stopping mode is best suited to the application and will meet applicable standards for operator safety on a particular machine.

Figure 3.30 Preset Slow Speed Sequence of Operation

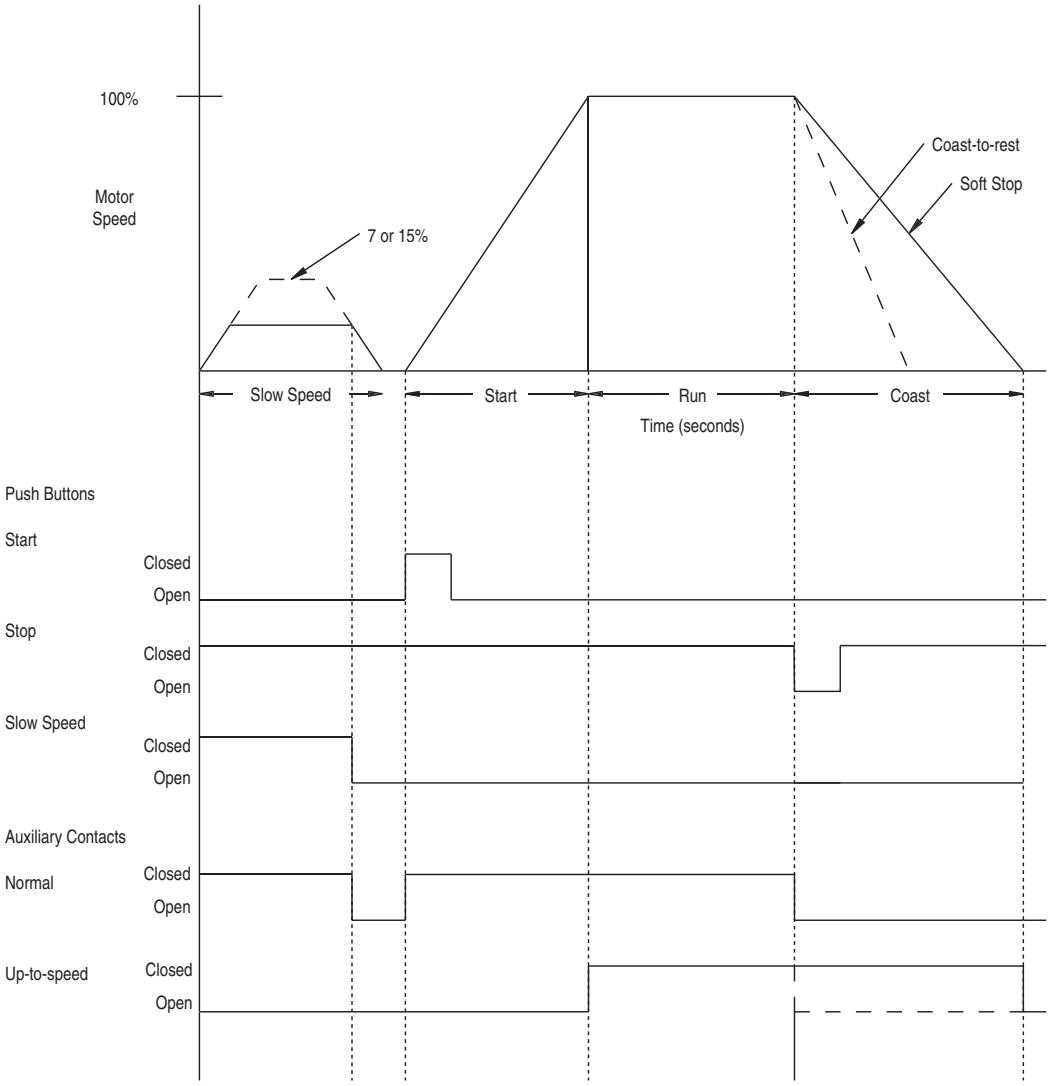
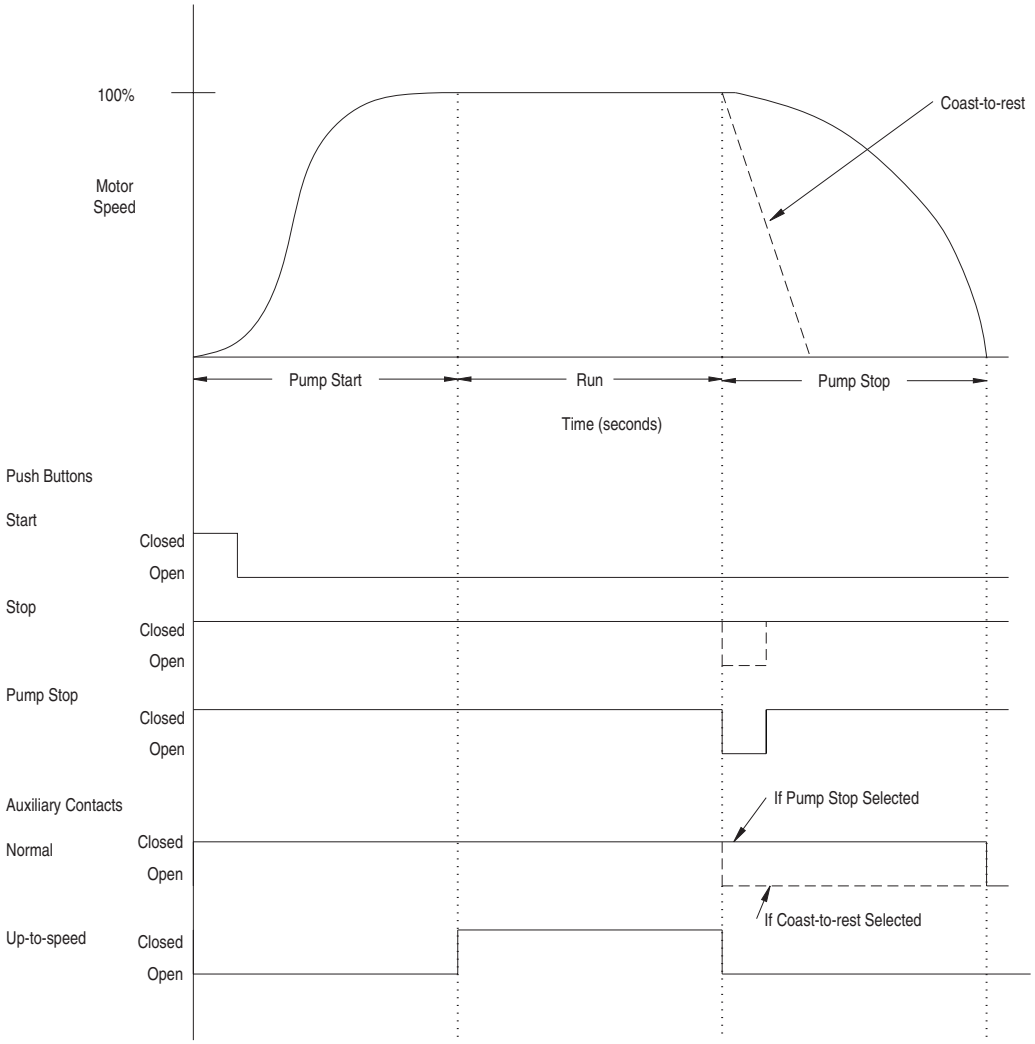


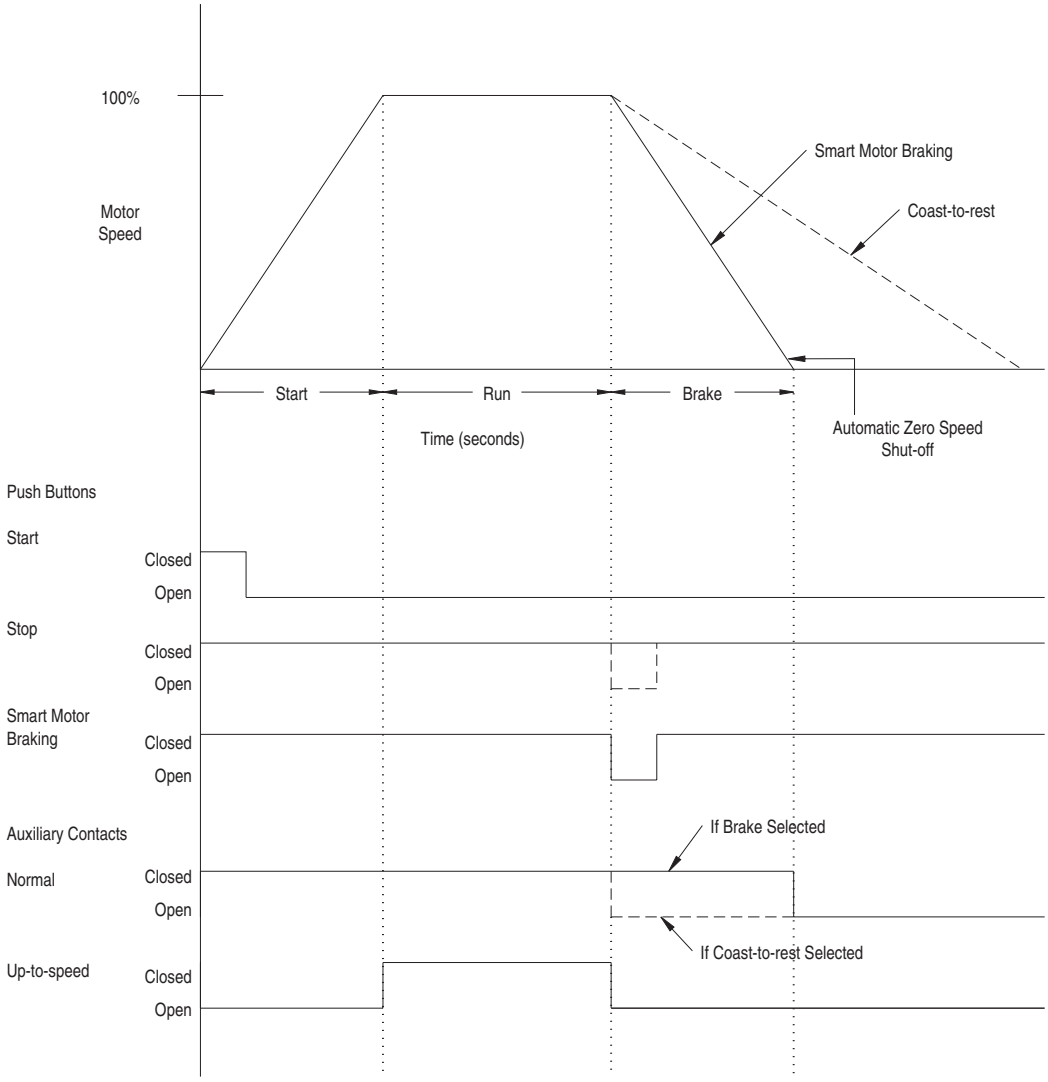
Figure 3.31 Pump Control Sequence of Operation



ATTENTION

The user is responsible for determining which stopping mode is best suited to the application and will meet applicable standards for operator safety on a particular machine.

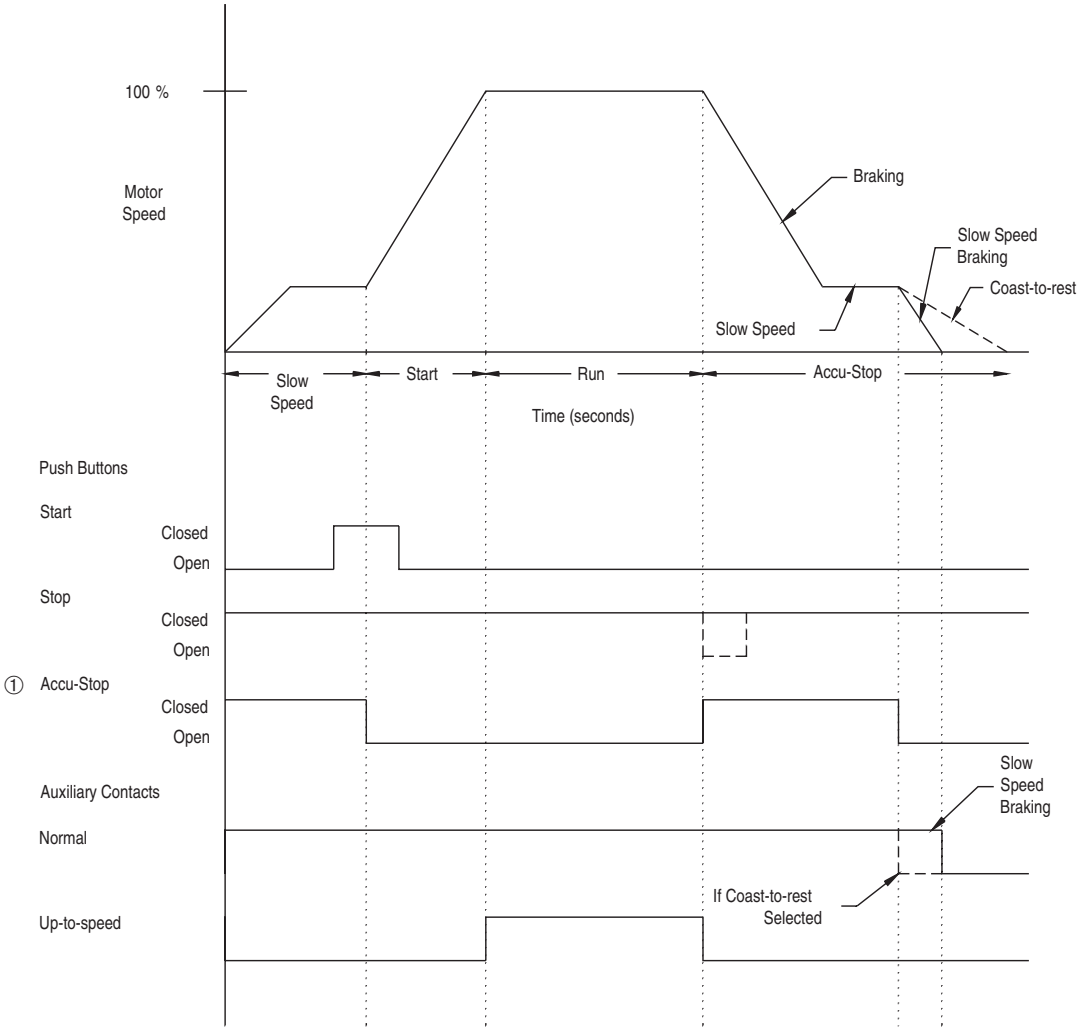
Figure 3.32 SMB Smart Motor Braking Sequence of Operation



ATTENTION

The user is responsible for determining which stopping mode is best suited to the application and will meet applicable standards for operator safety on a particular machine.

Figure 3.33 Accu-Stop Sequence of Operation

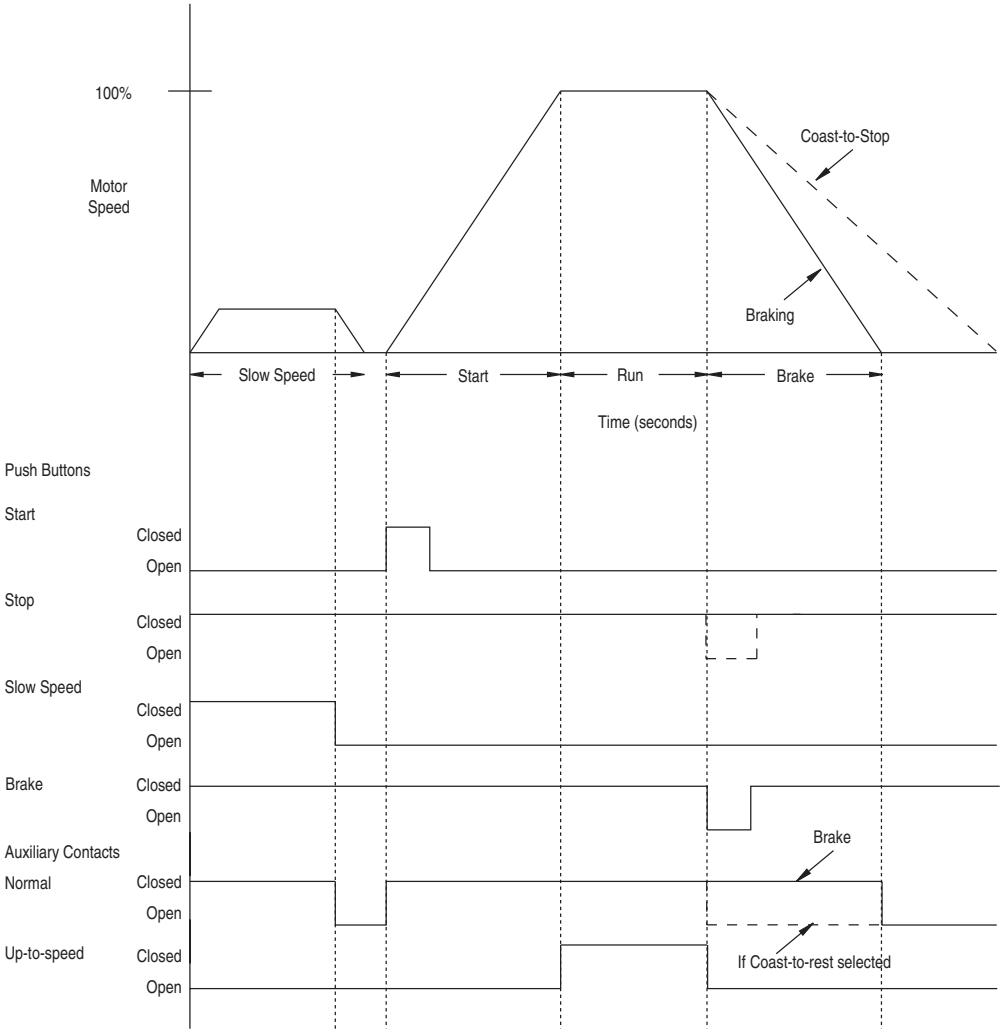


① When Accu-Stop push button is closed, start/stop function is disabled.

ATTENTION

The user is responsible for determining which stopping mode is best suited to the application and will meet applicable standards for operator safety on a particular machine.

Figure 3.34 Slow Speed with Braking Sequence of Operation



ATTENTION

The user is responsible for determining which stopping mode is best suited to the application and will meet applicable standards for operator safety on a particular machine.

Notes

Programming

Overview

This chapter provides a basic understanding of the programming keypad built into the SMC-Flex controller. This chapter also describes programming the controller by modifying the parameters.

Keypad Description

The keys found on the front of the SMC-Flex controller are described below.

Esc	Escape	Exit a menu, cancel a change to a parameter value, or acknowledge a fault/alarm.
Lang Sel	Select	Select a digit, select a bit, or enter edit mode in a parameter screen. Will get to menu to change the language being displayed.
▲ ▼	Up/Down Arrows	Scroll through options increase/decrease a value, or toggle a bit.
↵	Enter	Enter a menu, enter edit mode in a parameter screen, or save a change to a parameter value.

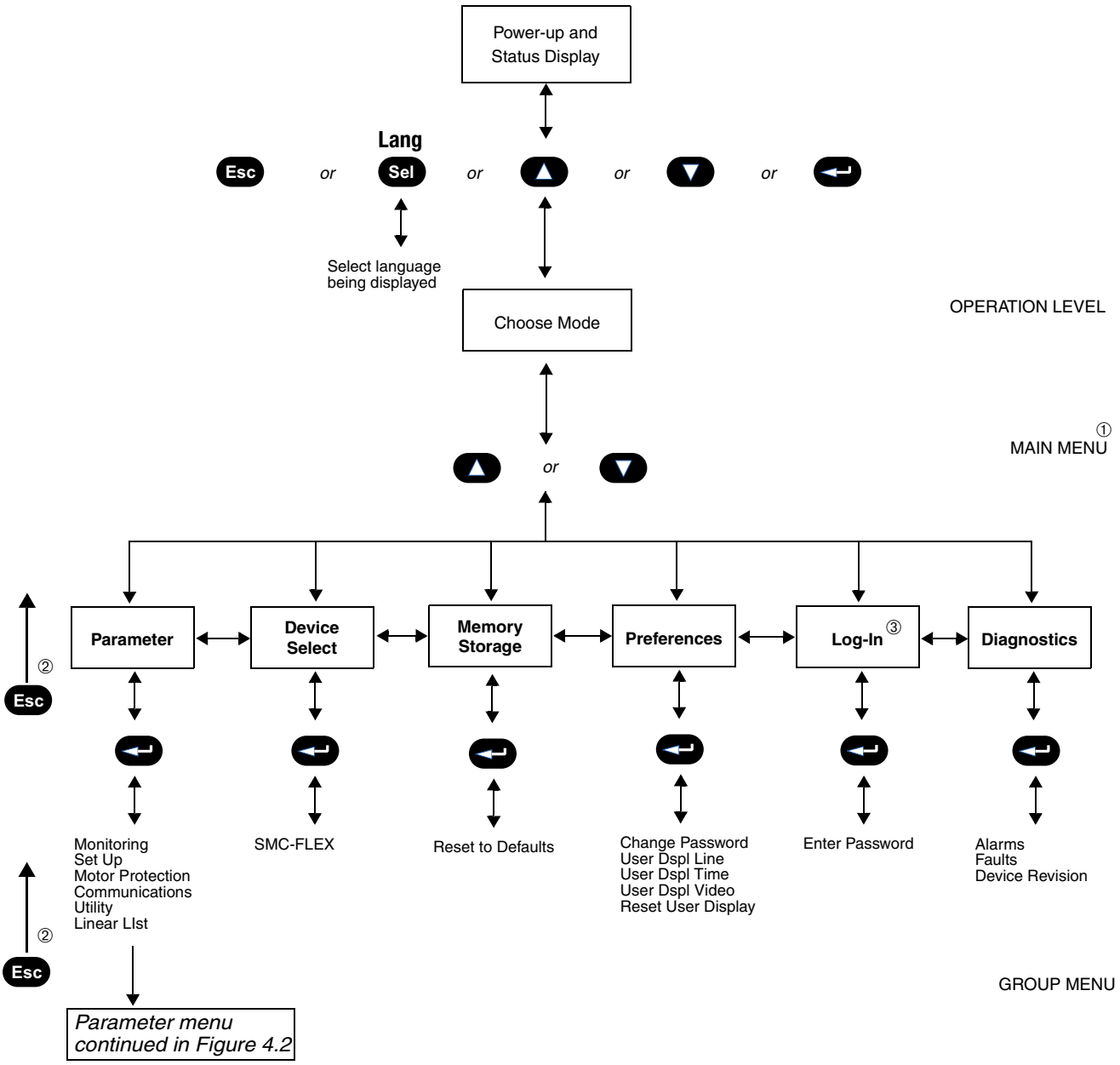
Note: For ease of programming values, after using the Enter key to edit, use the Sel key to jump to the digit that needs to be modified, then use the arrow keys to scroll through the digits.

Programming Menu

Parameters are organized in a three-level menu structure for straightforward programming. Figure 4.1 details the programming menu structure and the three-level hierarchy.

In order to change parameters, the controller must be in the STOP mode, and the control voltage must be present.

Figure 4.1 Menu Structure Hierarchy

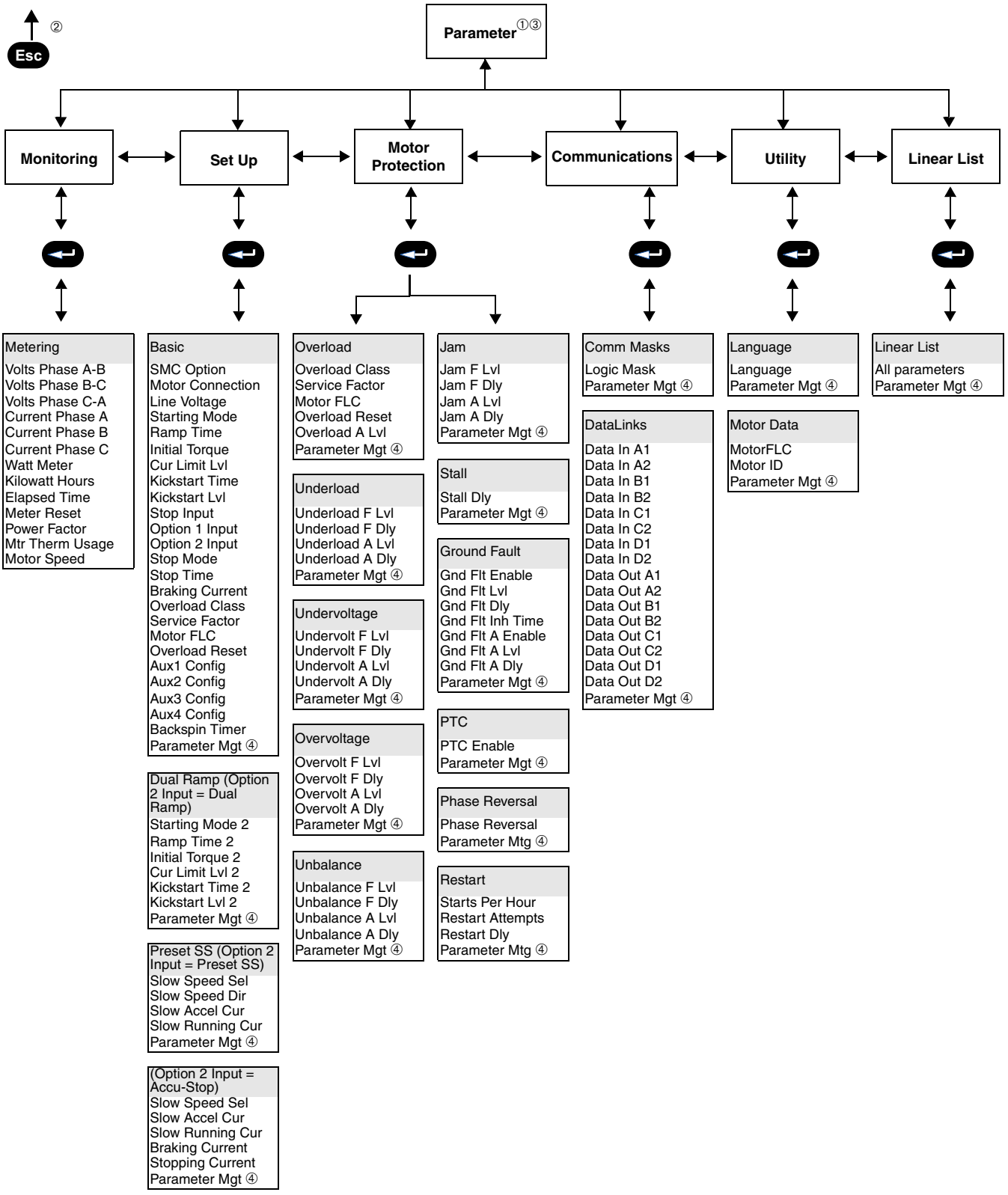


① The SMC-Flex controller does not support EEPROM, Link, Process, or Start-up modes.

② Steps back one level.

③ Only displayed if a password other than "0" is entered.

Figure 4.2 Parameter Menu Structure



① Depending upon SMC option selected, some parameters may not appear in product display.

② Steps back one level.

③ For further information on parameters, see Appendix B.

④ For further information on parameter management, see page 4-6.

Table 4.A Parameter Linear List

Parameter No.	Description	Parameter No.	Description	Parameter No.	Description
1	Volts Phase A-B	46	Motor FLC	91	Data In B2
2	Volts Phase B-C	47	Overload Reset	92	Data In C1
3	Volts Phase C-A	48	Factory Use	93	Data In C2
4	Current Phase A	49	Factory Use	94	Data In D1
5	Current Phase B	50	Overload A Lvl	95	Data In D2
6	Current Phase C	51	Underload F Lvl	96	Data Out A1
7	Watt Meter	52	Underload F Dly	97	Data Out A2
8	Kilowatt Hours	53	Underload A Lvl	98	Data Out B1
9	Elapsed Time	54	Underload A Dly	99	Data Out B2
10	Meter Reset	55	Undervolt F Lvl	100	Data Out C1
11	Power Factor	56	Undervolt F Dly	101	Data Out C2
12	Mtr Therm Usage	57	Undervolt A Lvl	102	Data Out D1
13	Motor Speed	58	Undervolt A Dly	103	Data Out D2
14	SMC Option	59	Overvolt F Lvl	104	Motor ID
15	Motor Connection	60	Overvolt F Dly	105	CT Ratio
16	Line Voltage	61	Overvolt A Lvl	106	MV Ratio
17	Starting Mode	62	Overvolt A Dly	107	Aux1 Config
18	Ramp Time	63	Unbalance F Lvl	108	Aux3 Config
19	Initial Torque	64	Unbalance F Dly	109	Aux4 Config
20	Cur Limit Level	65	Unbalance A Lvl	110	Aux2 Config
21	Reserved	66	Unbalance A Dly	111	Language
22	Kickstart Time	67	Jam F Lvl	112	Factory Use
23	Kickstart Level	68	Jam F Dly	113	Factory Use
24	Option 2 Input	69	Jam A Lvl	114	Factory Use
25	Starting Mode 2	70	Jam A Dly	115	Parameter Mgmt
26	Ramp Time 2	71	Stall Delay	116	Backspin Timer
27	Initial Torque 2	72	Gnd Flt Enable	117	Factory Use
28	Cur Limit Level 2	73	Gnd Flt Level	118	Factory Use
29	Reserved	74	Gnd Flt Delay	119	Factory Use
30	Kickstart Time 2	75	Gnd Flt Inh Time	120	Factory Use
31	Kickstart Level2	76	Gnd Flt A Enable	121	Factory Use
32	Stop Mode	77	Gnd Flt A Lvl	122	Factory Use
33	Stop Time	78	Gnd Flt A Dly	123	Factory Use
34	Factory Use	79	PTC Enable	124	Fault 1
35	Braking Current	80	Phase Reversal	125	Fault 2
36	Factory Use	81	Starts Per Hour	126	Fault 3
37	Factory Use	82	Restart Attempts	127	Fault 4
38	Factory Use	83	Restart Delay	128	Fault 5
39	Slow Speed Sel	84	Factory Use	129	Factory Use
40	Slow Speed Dir	85	Factory Use	130	Factory Use
41	Slow Accel Cur	86	Factory Use	131	Factory Use
42	Slow Running Cur	87	Logic Mask	132	Option 1 Input
43	Stopping Current	88	Data In A1	133	Stop Input
44	Overload Class	89	Data In A2	134	Factory Use
45	Service Factor	90	Data In B1		

Password

The SMC-Flex controller allows the user to limit access to the programming system through password protection. This feature is disabled with a factory-set default of 0. To modify the password, complete the procedure below.

Description	Action	Display
—	—	0.0 Amps 0 Volt 0 %MTU
1. Press the ESC key to go from the status display to the Main menu.	Esc	Main Menu Diagnostics Parameter
2. Scroll with the Up/Down keys until the Preferences option is highlighted.	▲ ▼	Main Menu Preferences Diagnostics
3. Press the Enter key to access the Preferences menu.	↵	Preferences: Change Password User Dspy lines
4. Scroll with the Up/Down keys until the Change Password option is highlighted.	▲ ▼	Preferences: Change Password User Dspy lines
5. Press the Enter key.	↵	
6. Press the Up/Down keys to enter the desired number. If you are modifying the password, make a note of it as displayed. Use the Sel key to highlight a single digit.	▲ ▼	Prefs: Password New Code: 83 Verify: 83
7. Verification of the new password is required. Press the Enter key.	↵	
8. Press the Enter key after you have completed modifying the password. ①	↵	Preferences: Change Password User Dspy lines

① To complete the programming process, re-enter the Main Menu mode to log out. This will eliminate unauthorized access to the programming system.

Note: If you lose or forget the password, contact your local Allen-Bradley distributor.

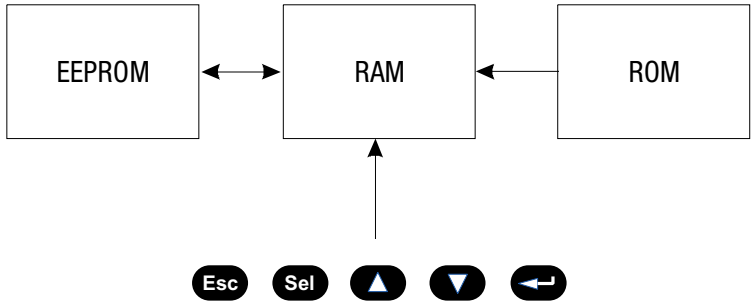
Parameter Management

Before you begin programming, it's important to understand how the controller memory is:

- structured within the SMC-Flex controller
- used on power-up and during normal operation

Refer to Figure 4.3 and the explanations below.

Figure 4.3 Memory Block Diagram



Random Access Memory (RAM)

This is the work area of the controller after it is powered up. The SMC-Flex uses an Auto Store feature when programming parameters. When parameters are modified in the program mode, the new values are stored immediately in RAM and then in EEPROM, once the enter key has been pressed. If control power is lost prior to the enter key being pressed, these values will be lost. When the device first powers up, the values from the EEPROM area of memory are copied into RAM.

Read-only Memory (ROM)

The SMC-Flex controller comes with factory default parameter values. These settings are stored in non-volatile ROM and are displayed the first time you enter the Program mode. At any time you can restore defaults by accessing the memory storage menu.

Description	Action	Display
Recalling Defaults After parameter values have been modified, factory default settings can still be re-initialized.		Memory Storage: Reset to Defaults

Electrically Erasable Programmable Read-only Memory (EEPROM)

The SMC-Flex controller provides a non-volatile area for storing user-modified parameter values in the EEPROM.

Parameter Modification

All parameters are modified using the same method. The basic steps to performing parameter modification are described below.

Notes: (1) Parameter values modified while the motor is operating are not valid until the next time that operation occurs.
(2) If the password is set, parameters cannot be adjusted without logging in.
(3) Use the Sel key to highlight a single digit.

Description	Action	Display ②
—	—	0.0 Amps 0 Volt 0 %MTU
1. Press the ESC key to go from the status display to the Main menu.	Esc	—
2. Scroll with the Up/Down keys until the Parameter option is highlighted.	▲ ▼	Main Menu Parameter Memory Storage
3. Press the Enter key to access the Parameter menu.	↵	F G P : File Monitoring Set Up
4. Scroll with the Up/Down keys until the option you want to use (Monitoring, Motor Protection, etc.) is highlighted. For this example, Set Up will be used.	▲ ▼	F G P : File Set Up Motor Protection
5. Press Enter to select the Set Up group.	↵	—
6. Scroll to Basic Set Up and press Enter. ①	▲ ▼ ↵	F G P : Group Basic Set Up
7. Scroll to the Starting Mode parameter by using the Up/Down keys, and press Enter.	▲ ▼ ↵	F G P : Parameter Starting Mode Ramp Time
8. Press Enter to select the option. Scroll to the option of your choice by using the Up/Down keys. For this example, we will choose Current Limit.	▲ ▼ ↵	F G P : P# 17 Starting Mode Current Lim
9. Press the Enter key to accept the new setting.	↵	—
10. Scroll to the next parameter by using the Down key. Continue the process until all desired settings are entered.	▼	F G P : P# 18 Ramp Time 10 Secs

① The SMC Option advises the user if any control option (i.e., Pump Control) is resident. This parameter is factory set and cannot be modified by the user.

② The display will indicate that the second line is now active by highlighting the first character. If the LCD display does not provide a highlighted cursor, then the controller is in the Display mode.

Soft Start

The following parameters are specifically used to adjust the voltage ramp supplied to the motor.

Parameter	Option
Starting Mode This must be programmed for Soft Start.	Soft Start
Ramp Time ① This programs the time period that the controller will ramp the output voltage up to full voltage from the Initial Torque level programmed.	0…30 s
Initial Torque The initial reduced output voltage level for the voltage ramp to the motor is established and adjusted with this parameter.	0…90% locked rotor torque
Kickstart Time A boost of current is provided to the motor for the programmed time period.	0.0…2.0 s
Kickstart Level Adjusts the amount of current applied to the motor during the kickstart time.	0…90% locked rotor torque

① If the controller senses that the motor has reached full speed before completing the Soft Start, it will automatically switch to providing full voltage to the motor.

Current Limit Start

To apply a current limit start to the motor, the following parameters are provided for user adjustment:

Parameter	Option
Starting Mode This must be programmed for Current Limit.	**Current Limi**t
Ramp Time ① This programs the time period that the controller will hold the fixed, reduced output voltage before switching to full voltage.	0…30 s
Current Limit Level This parameter provides adjustability for the reduced output voltage level provided to the motor.	50…600% full load current
Kickstart Time A boost of current is provided to the motor for the programmed time period.	0.0…2.0 s
Kickstart Level Adjusts the amount of current applied to the motor during the kickstart time.	0…90% locked rotor torque

① If the controller senses that the motor has reached full speed before completing the current limit start, it will automatically switch to providing full voltage to the motor.

Dual Ramp Start

The SMC-Flex controller provides the user with the ability to select between two Start settings. The parameters below are available in the Set Up programming mode. To obtain Dual Ramp control, Ramp #1 is located in the Basic Set Up and Ramp #2 is located in the Option 2 Input (Dual Ramp).

Parameter	Option
Set Up The user must select the Set Up programming mode to obtain access to the Dual Ramp parameters.	—
Basic Set Up/Starting Mode Set Up as stated in previous pages.	—
Option 2 Input (Dual Ramp) ① This allows the user the option to choose between two Soft Start profiles defined by: 1. Start Mode/Ramp Time/Initial Torque and 2. Start Mode 2/Ramp Time 2/Initial Torque 2. When this feature is turned on, the ramp time/initial torque combination is determined by a hard contact input to terminal 15. When this input signal is low, ramp time/initial torque are selected. When this input is high, ramp time 2/initial torque 2 are selected. Once the Option 2 Input has been set to Dual Ramp, you must ESC back to the Parameter (File) menu. Re-enter into the Set Up menu to show both Basic Set Up and Dual Ramp.	—
Basic Set Up/Start Mode ② This selects the start mode for option #1.	—
Basic Set Up/Ramp Time This programs the time period during which the controller will ramp the output voltage up to full voltage for the first Start setup.	0…30 s
Basic Set Up/Initial Torque This parameter establishes and adjusts the initial reduced output voltage level for the first Soft Start setup.	0…90% locked rotor torque
Dual Ramp/Start Mode 2 ② This selects the start mode for option #2.	—
Dual Ramp/Ramp Time 2 This programs the time period during which the controller will ramp the output voltage up to full voltage for the second Start setup.	0…30 s
Dual Ramp/Initial Torque 2 The initial reduced output voltage level for the second Start setup is established and adjusted with this parameter.	0…90% locked rotor torque

① The Dual Ramp feaure is available on the standard controller.

② Kickstart can be programmed for both start modes.

Full Voltage Start

The SMC-Flex controller may be programmed to provide a full voltage start (output voltage to the motor reaches full voltage within 1/4 second) with the following programming:

Parameter	Option
Starting Mode This **must** be programmed for Full Voltage.	Full Voltage

Linear Speed

The SMC-Flex provides the user the ability to control the motor speed during starting and stopping maneuvers. A tach input is required as specified in *Linear Speed Acceleration* on page 1-6.

Parameter	Option
Starting Mode This **must** be programmed for Linear Speed.	Linear Speed
Ramp Time This programs the time period that the controller will ramp from 0 speed to full speed.	0…30 s
Kickstart Time A boost of current is provided to the motor for the programmed time period.	0.0…2.2 s
Kickstart Level Adjusts the amount of current applied to the motor during the kickstart time.	0…90% locked rotor torque

Programming Parameters

The following table provides the option-specific parameters that are provided with each control option. These parameters are in addition to those already discussed in the Basic Set Up and Metering groups. Diagrams supporting the options described below are shown later in this chapter.

Option	Parameter	Range
Standard		
Soft Stop	**SMC Option** This parameter identifies the type of control present and is not user programmable.	Standard
	Soft Stop Time Allows the user to set the time period for the soft stopping function.	0…120 s
Preset Slow Speed	**SMC Option** This parameter identifies the type of control present and is not user programmable.	Standard
	Slow Speed Select Allows the user to program the slow speed that best fits the application.	Low: 7% – forward, 10% – reverse High: 15% – forward, 20% – reverse
	Slow Speed Direction This parameter programs the slow speed motor rotational direction.	Forward, Reverse
	Slow Accel Current Allows the user to program the required current to accelerate the motor to slow speed operation.	0…450% of full load current
	Slow Running Current Allows the user to program the required current to operate the motor at the slow speed setting.	0…450% of full load current

Option	Parameter	Range
Pump Control		
Pump Control	**SMC Option** This parameter identifies the type of control present and is not user programmable.	Pump Control
	Pump Stop Time Allows the user to set the time period for the pump stopping function.	0…120 s
	Starting Mode Allows the user to program the SMC-Flex controller for the type of starting that best fits the application.	Pump Start, Soft Start, Current Limit Start
Braking Control		
SMB Smart Motor Braking	**SMC Option** This parameter identifies the type of control present and is not user programmable.	Braking Control
	Braking Current ① Allows the user to program the intensity of the braking current applied to the motor.	0…400% of full load current
Accu-Stop	**SMC Option** This parameter identifies the type of control present and is not user programmable.	Braking Control
	Slow Speed Select Allows the user to program the slow speed that best fits the application.	Low:7% High:15%
	Slow Accel Current Allows the user to program the required current to accelerate the motor to slow speed operation.	0…450% of full load current
	Slow Running Current Allows the user to program the required current to operate the motor at the slow speed setting.	0…450% of full load current
	Braking Current ① Allows the user to program the intensity of the braking current applied to the motor.	0…400% of full load current
	Stopping Current ① Allows the user to program the intensity of the braking current applied to the motor from slow speed operation.	0…400% of full load current

Option	Parameter	Range
Slow Speed with Braking	**SMC Option** This parameter identifies the type of control present and is not user programmable.	Braking Control
	Slow Speed Select Allows the user to program the slow speed that best fits the application.	Low:7% High:15%
	Slow Accel Current Allows the user to program the required current to accelerate the motor to slow speed operation.	0…450% of full load current
	Slow Running Current Allows the user to program the required current to operate the motor at the slow speed setting.	0…450% of full load current
	Braking Current ① Allows the user to program the intensity of the braking current applied to the motor.	0…400% of full load current

① All braking/stopping current settings in the range of 1…100% will provide 100% braking current to the motor.

Basic Set Up

The Basic Set Up programming group provides a limited parameter set, allowing quick start-up with minimal adjustment. If the user is planning to implement some of the advanced features (e.g., Dual Ramp, or Preset Slow Speed), then the Setup programming group should be selected. It provides all the Basic Set Up parameter set plus the advanced set.

Parameter	Option
SMC Option Displays the type of controller. This is factory set and not adjustable.	Standard
Motor Connection Displays the motor type to which the device is being connected.	Line or Delta
Line Voltage Displays the system line voltage to which the unit is connected.	
Starting Mode Allows the user to program the SMC-Flex controller for the type of starting that best fits the application.	Soft Start, Current Limit, Full Voltage, Linear Speed
Ramp Time This sets the time period during which the controller will ramp the output voltage.	0…30 s
Initial Torque ① The initial reduced voltage output level for the voltage ramp is established and adjusted with this parameter.	0…90% of locked rotor torque
Current Limit Level ② The current limit level that is applied for the Ramp Time selected.	50…600% FLC
Kickstart Time A boost current is provided to the motor for the programmed time period.	0.0…2.0 s
Kickstart Level Adjusts the amount of current applied to the motor during kickstart.	0…90% of locked rotor torque
Stop Input Allows the user to select the operation of terminal 18, Stop Input.	Coast, Stop Option
Option 1 Input Allows the user to select the operation of terminal 16, Option Input #1.	Disable, Coast, Stop Option, Fault, Fault NC, Network
Option 2 Input Allows the user to select the operation of terminal 15, Option Input #2.	Disable, Slow Speed, Dual Ramp, Fault, Fault NC, Network, Clear Fault
Stop Mode Allows the user to program the SMC-Flex controller for the type of stopping that best fits the application.	Disable, Soft Stop, Linear Speed
Stop Time This sets the time period which the controller will ramp the voltage during a stopping maneuver.	0.0…120 s
Overload Class	Disable, 10, 15, 20, 30
Service Factor	0.01…1.99
Motor FLC	1.0…2200
OL Reset	Auto, Manual
Aux1 Config Contact is provided as standard with the SMC-Flex controller. This contact is located at terminals 19 and 20. Aux Contacts 1 allows the user to configure the operation of the contacts.	Normal, Up-to-speed, Fault, Alarm, Network Control, External Bypass: (N.O./N.C.)
Aux2 Config Contact is provided as standard with the SMC-Flex controller. This contact is located at terminals 29 and 30. Aux Contacts 2 allows the user to configure the operation of the contacts.	Normal, Up-to-speed, Fault, Alarm, Network Control, External Bypass: (N.O./N.C.)
Aux3 Config Contact is provided as standard with the SMC-Flex controller. This contact is located at terminals 31 and 32. Aux Contacts 3 allows the user to configure the operation of the contacts.	Normal, Up-to-speed, Fault, Alarm, Network Control, External Bypass: (N.O./N.C.)
Aux4 Config Contact is provided as standard with the SMC-Flex controller. This contact is located at terminals 33 and 34. Aux Contacts 4 allows the user to configure the operation of the contacts.	Normal, Up-to-speed, Fault, Alarm, Network Control, External Bypass: (N.O./N.C.)
Parameter Mgmt Recall of factory default parameter values.	Ready, Load Default

① Starting Mode must be programmed to Soft Start to obtain access to the Initial Torque parameter.

② Starting Mode must be programmed to Current Limit to obtain access to the Current Limit Level parameter.

ATTENTION For overload protection, it is critical that the data be entered as it appears on the motor nameplate.



Motor Protection

While the Basic Set Up group allows the user to get started with a minimum number of parameters to modify, the Motor Protection group allows full access to the SMC-Flex controller's powerful parameter set. Following is a listing of the additional setup parameters provided.

Note: The majority of parameters have a Fault and an Alarm setting.

Parameter	Option
Overload Allows the user to select the operation of the overload:	Trip Class, Service Factor, Motor FLC, Overload Reset, Overload Alarm Level
Underload ② Determines the trip level as a percentage of the motor's FLA, and the delay period.	Underload Fault Level, Underload Fault Delay, Underload Alarm Level, Underload Alarm Delay
Undervoltage ① Determines the trip level as a percentage of the line voltage and the delay period.	Undervoltage Fault Level, Undervoltage Fault Delay, Undervoltage Alarm Level, Undervoltage Alarm Delay
Overvoltage ① Determines the trip level as a percentage of line voltage and delay period.	Overvoltage Fault Level, Overvoltage Fault Delay, Overvoltage Alarm Level, Overvoltage Alarm Delay
Unbalance ① Allows the user to set the current unbalance trip level and delay period.	Unbalance Fault Level, Unbalance Fault Delay, Unbalance Alarm Level, Unbalance Alarm Delay
Jam ② Determines the trip level as a percentage of motor full load current and delay period.	Jam Fault Level, Jam Fault Delay, Jam Alarm Level, Jam Alarm Delay
Stall Allows the user to set the stall delay time.	Stall Delay
Ground Fault ③ Allows the user to enable the ground fault level in amps, delay time, and inhibit time.	Ground Fault Enable, Ground Fault Level, Ground Fault Delay, Ground Fault Inhibit Time, Ground Fault Alarm Enable, Ground Fault Alarm Level, Ground Fault Alarm Delay
Motor PTC ④ Allows the user to connect a PTC to the SMC and enable a fault when it becomes active.	PTC Enable
Phase Reversal Determines the proper orientation of line connections to the SMC. If Enabled and phases are out of sequence, a fault will be indicated.	Phase Reversal
Restarts Allows the user to determine the maximum number of restarts per hour the unit can experience, and delay time between consecutive starts.	Restarts Per Hour, Restart Attempts, Restart Delay

① The delay time must be set to a value greater than zero when Undervoltage, Overvoltage, and Unbalance are enabled.

② For Jam and Underload detection to function, the Motor FLC must be programmed in the Motor Protection group. See Chapter 5 for instructions.

③ See details in *Ground Fault* on page 1-15.

④ See details in *Thermistor/PTC Protection* on page 1-17.

Example Settings

Undervoltage ①

With Line Voltage programmed for 480V and the Undervoltage level programmed for 80%, the trip value is 384V.

Overvoltage ①

With Line Voltage programmed for 240V and the Overvoltage level programmed for 115%, the trip value is 276V.

Jam ②③

With Motor FLC programmed for 150 A and the Jam level programmed for 400%, the trip value is 600 A.

Underload ②

With Motor FLC programmed for 90 A and the Underload level programmed for 60%, the trip value is 54 A.

① The average value of the three phase-to-phase voltages is utilized.

② The largest value of the three phase currents is utilized.

③ The SMC-Flex will self-protect.

Metering

Overview

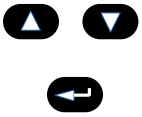
While the SMC-Flex controller operates your motor, it also monitors several different parameters, providing a full function metering① package.

Viewing Metering Data

To access the metering information, follow the procedure below.

Description	Action	Display
—	—	##.# Amps ### Volt ## %MTU
1. Press any of the following keys to access the Main Menu.	Esc ▲ ▼ ↵	Main Menu Parameter Memory Storage
2. Scroll with the Up/Down keys until the Parameter option is shown.	▲ ▼	Main Menu Parameter Memory Storage
3. Press the Enter key to select the Parameter option.	↵	—
4. Scroll with the Up/Down keys until the Monitoring option is displayed.	▲ ▼	F G P : File Monitoring Set Up
5. Press the Enter key to access the Monitoring group.	↵	—
6. Press the Enter key to access the Metering group.	↵	F G P : Group Metering

① Refer to *Metering* on page 1-19 or Figure 4.2 on page 4-3 for details on the metering functions.

Description	Action	Display
7. Scroll through the Metering parameters with the Up/Down keys to access the desired information. Press the Enter key to view that parameter.		F G P: P# 1 Volts Phase A-B ### Volt F G P: P# 2 Volts Phase B-C ### Volt F G P: P# 3 Volts Phase C-A ### Volt F G P: P# 4 Current Phase A ##.# Amps F G P: P# 5 Current Phase B ##.# Amps F G P: P# 6 Current Phase C ##.# Amps F G P: P# 7 Watt Meter ##.# KW F G P: P# 8 Kilowatt Hours ##.# KWH F G P: P# 9 Elapsed Time ##.# Hour F G P: P# 10 Meter Reset No F G P: P# 11 Power Factor ##.# F G P: P# 12 Mtr Therm Usage ## %MTU

The metering values that are displayed on the SMC-Flex can be modified to show your desired values by accessing Main Menu / Preferences.

Optional HIM Operation

Overview

The SMC-Flex controller offers a variety of unique control options that provide enhanced motor starting and stopping capabilities. (See chapter 1 for brief descriptions of each option.)

Note: Only one option can reside in a controller.

Human Interface Module

The control buttons available with the Bulletin 20-HIM LCD Human interface modules are compatible with the SMC-Flex controller's control options. The following table details the functionality of each button with regards to each option.

Notes: (1) The logic mask port must be enabled prior to initiating control commands to the SMC-Flex controller. Refer to *HIM Control Enable* on page 7-4 for instructions.
(2) The control terminals must be wired according to Figure 3.14 on page 3-15 or Figure 3.25 on page 3-26.

Option	Action	Operation
Standard		
Soft Stop Current Limit Full Voltage Linear Speed	I	The green start button, when pressed, will commence motor acceleration to full speed.
	O	The red stop button, when pressed, will provide a coast stop, and/or reset a fault.
	Jog	The jog button, when pressed, will initiate the programmed maneuver.
Preset Slow Speed	I	The green start button, when pressed, will commence motor acceleration to full speed.
	O	The red stop button, when pressed, will provide a coast stop and/or reset a fault.
	Jog	The jog button is not active for Preset Slow Speed. * Slow Speed cannot be operated via the HIM.

Option	Action	Operation
Pump Control		
Pump Control	I	The green start button, when pressed, will commence motor acceleration to full speed.
	O	The red stop button, when pressed, will provide a coast stop, and/or reset a fault.
	Jog	The jog button, when pressed, will initiate a pump stop maneuver.
Braking Control		
Smart Motor Braking	I	The green start button, when pressed, will commence motor acceleration to full speed.
	O	The red stop button, when pressed, will provide a coast stop, and/or reset a fault.
	Jog	The jog button, when pressed, will initiate a brake stop.
Accu-Stop	I	The green start button, when pressed, will commence motor acceleration to full speed.
	O	The red stop button, when pressed, will provide a coast stop, and/or reset a fault.
	Jog	With a “stopped” status, the jog button, when pressed, will initiate slow speed motor operation. From an “at speed” condition, the jog button, when pressed, will initiate braking to slow speed operation. The controller will maintain slow speed operation as long as the jog button is pressed.
Slow Speed with Braking	I	The green start button, when pressed, will commence motor acceleration to full speed.
	O	The red stop button, when pressed, will provide a coast stop, and/or reset a fault.
	Jog	The jog button will initiate a brake stop. * Slow Speed cannot be operated via the HIM.

ATTENTION



The Bulletin 20-HIM LCD Human interface module’s stop push button is not intended to be used as an emergency stop. Refer to applicable standards for emergency stop requirements.

Communications

Overview

The SMC-Flex provides advanced communications capabilities that allow it to be started and stopped from multiple sources as well as provide diagnostic information through the use of communication interfaces. The SMC-Flex uses the DPI method of communication, therefore all standard DPI communication interfaces used by other devices (i.e., PowerFlex™ Drives) can be used in the SMC-Flex. ScanPort devices are not supported by the SMC-Flex.

Standard DPI communications cards are available for various protocols including DeviceNet, ControlNet, Remote I/O, ModBus™, and Profibus® DP. Other modules may be available in the future. For specific programming examples, configuration, or programming information, refer to the user manual for the communication interface being used. A list of available interfaces is located below.

Table 7.A

Protocol Type	Cat. No.	User Manual
DeviceNet	20-COMM-D	20COMM-UM002❶-EN-P
ControlNet	20-COMM-C	20COMM-UM003❶-EN-P
Remote I/O	20-COMM-R	20COMM-UM004❶-EN-P
Profibus®	20-COMM-P	20COMM-UM006❶-EN-P
RS-485	20-COMM-S	20COMM-UM005❶-EN-P
InterBus	20-COMM-I	20COMM-UM007❶-EN-P
EtherNet/IP	20-COMM-E	20COMM-UM010❶-EN-P
RS485 HVAC	20-COMM-H	20COMM-UM009❶-EN-P
ControlNet (Fiber)	20-COMM-Q	20COMM-UM003❶-EN-P

❶ Denotes revision level of user manual. Example: Publication 20COMM-UM002**C**-EN-P is at revision C.

Communication Ports

The SMC-Flex supports three DPI ports for communication. Ports 2 and 3 are supported through the serial connection on the side of the device and are typically used to interface with a Human Interface Module (HIM). Port 2 is the default connection with port 3 available by installing a splitter on port 2. Port 5 is supported by connecting one of the communication cards listed above to the internal DPI comm card connection.

Human Interface Module

The SMC-FLEX controller can be programmed with the built-in keypad and LCD display or with our optional Bulletin 20-HIM LCD human interface modules. Parameters are organized in a three-level menu structure and divided into programming groups.

Note: Node addressing of the DPI communication card can be programmed via software or a hand-held DPI HIM. The on-board HIM cannot be used to address the communication card.

Keypad Description

The functions of each programming key are described below.

Table 7.B Keypad Descriptions

Esc	**Escape**	Exit a menu, cancel a change to a parameter value, or acknowledge a fault/alarm.
Sel	**Select**	Select a digit, select a bit, or enter edit mode in a parameter screen.
▲ ▼	**Up/Down Arrows**	Scroll through options increase/decrease a value, or toggle a bit.
↵	**Enter**	Enter a menu, enter edit mode in a parameter screen, or save a change to a parameter value.

Note: If a human interface module is disconnected from the SMC-Flex controller while the Logic Mask is set to 1, a “Coms Loss” fault will occur.

Note: For ease of programming values, after using the Enter key to edit, use the Sel key to jump to the digit that needs to be modified, then use the arrow keys to scroll through the digits.

The Bulletin 20-HIM LCD interface modules may be used to program and control the SMC-Flex controller. The human interface modules have two sections: a display panel and a control panel. The display panel duplicates the 3-line, 16-character backlit LCD display and programming keypad found on front of the SMC-Flex controller. Refer to Chapter 4 for a description of the programming keys; refer to Appendix D for a listing of human interface module catalog numbers that are compatible with the controller.

Note: Bulletin 20-HIM Rev3.002 or later must be utilized with the SMC-Flex.

Note: Extension cables are available up to a maximum of 10 m in total length.

Note: A maximum of two HIM modules can be installed.

The control panel provides the operator interface to the controller.



Start
The green start button, when pressed, will begin motor operation. (Proper setup of the HIM port is required.)



Stop
The red stop button, when pressed, will halt motor operation and/or reset a fault.



Jog
The jog button is active only when a control option is present. Pressing the jog button will initiate the option maneuver (for example: Pump Stop).

ATTENTION



The Bulletin 20-HIM interface module's stop push button is not intended to be used as an emergency stop. Refer to the applicable standards for emergency stop requirements.

ATTENTION



The external HIM has a similar programming operation to the built-in programmer, but note that differences do exist.

All other controls available with the various human interface modules are non-functional with the SMC-Flex controller.

Connecting the Human Interface Module to the Controller

Figure 7.1 shows the connection of the SMC-Flex controller to a human interface module. Table 7.C provides a description of each port.

Note: The SMC-Flex only supports the use of DPI communication modules and DPI HIM LCD Modules. Scanport devices are not supported by the SMC-Flex.

See Figure 3.14 on page 3-15 for the control wiring diagram that enables start-stop control from a human interface module.

Figure 7.1 SMC-Flex Controller with Human Interface Module

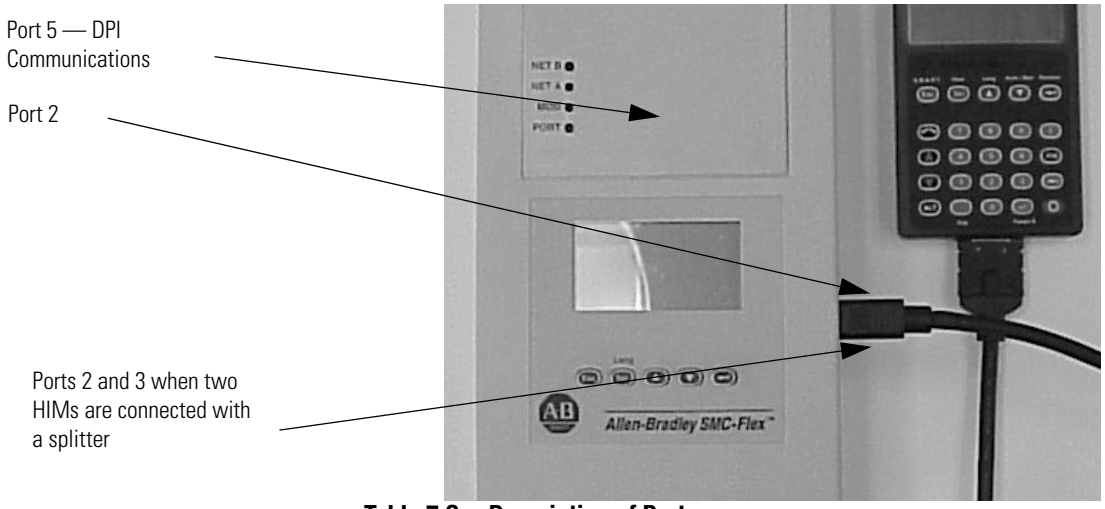


Table 7.C Description of Ports

Port #	Description
1	Unused — not available for use
2	First 20-HIM connected to SMC-Flex
3	Second 20-HIM connected to SMC-Flex
5	DPI Communication Board port

HIM Control Enable

To enable motor control from a connected human interface module, follow the procedure below with the connected human interface module's programming keys.

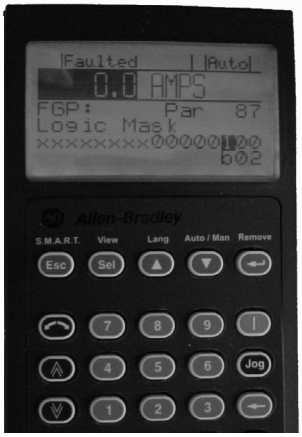
The Bulletin 20-HIM LCD human interface modules with control panels can start and stop the SMC-FLEX controller. However, the factory default settings disable control commands other than Stop through the serial communication port.

To enable motor control from a connected human interface module or communication module, you must take the following programming steps:

1. Disconnect the HIM and allow to power down.
2. Reconnect the HIM. On Initializing screen, the bottom right corner of LCD shows Port X. Note this port number.



3. Go to Logic Mask, found as follows:
Main Menu: Parameter/Communications/Comm Mask/Logic Mask



4. Set b0X equal to 1 (where X is the port number noted in step 2).

Important: The Logic Mask must be set to 0 prior to disconnecting a human interface module from the SMC-FLEX controller. If not, the unit will fault on a “Coms Loss”.

If enabling control from the built-in SMC-Flex programmer, the Logic Mask must be set as follows:

Table 7.D Logic Mask Requirements

Mask Code	Description
0	No external DPI devices are enabled
4	Only HIM on port 2 is enabled
12	Two HIMs are enabled on ports 2 and 3
32	Only the DPI communication card on port 5 is enabled
36	HIM on port 2 and the DPI communication card on port 5 in enabled
44	Two HIMs on ports 2 and 3 and the DPI communication card on port 5 is enabled

Control Enable

The Logic Mask parameter (Parameter 87) allows the user to configure whether a communication device (HIM or network connection) can perform control commands such as starting. Each communication port can be enabled or disabled as required. When a given device is enabled through the logic mask that device is allowed to execute control commands. In addition, disconnecting any device with the logic mask enabled will result in a communication fault unless the communication fault is disabled. When a given device is disabled through the logic mask that device cannot execute control commands, but can still be used for monitoring. A device that is disabled through the logic mask can be disconnected without causing a fault.

IMPORTANT Stop commands override all start commands and can be initiated from the hardwired inputs or any port regardless of the logic mask.

Loss of Communication and Network Faults

The loss of communication fault will follow the functionality as defined in the DPI specification. There will be separate faults for each device. Since three DPI ports are supported there will be three faults that can be generated.

DPI provides a separate network fault for each port. This fault can be generated directly by the peripheral and is separate from the Communications Loss fault (which is actually generated by the SMC-Flex itself).

SMC-Flex Specific Information

The SMC-Flex can be used with all LCD applicable DPI interface. Regardless of the type of interface being used, the information below can be used to configure the rest of the system.

Default Input/Output Configuration

The default configuration for I/O is 4 bytes in and 4 bytes out (TX = 4 bytes, RX = 4 bytes). The total size may very when used with a communication card. The default configuration is arranged according to the following table.

Table 7.E

	Produced Data (Status)	Consumed Data (Control)
Word 0	Logic Status	Logic Command
Word 1	Feedback ❶	Reference ❷

❶ The feedback word is always Current in Phase A

❷ The reference word is not used with the SMC-Flex, however the space must be reseverd

Note: The total size produced or consumed may vary, depending on the communication card being used. For more information, refer to the User Manual for the communication card.

Variable Input/Output Configuration

The SMC-Flex supports 16-bit DataLinks. Therefore, the device can be configured to return additional information. The I/O message size depends on how many DataLinks are enabled. The following table summarizes the I/O data sizes.

Table 7.F

Rx Size	Tx Size	Logic Status/ Command (16-bit)	Reference/ FeedBack (16-bit)	DataLinks			
				A	B	C	D
4	4	x	x				
8	8	x	x	x			
12	12	x	x	x	x		
16	16	x	x	x	x	x	
20	20	x	x	x	x	x	x

To configure DataLinks, refer to *Configuring DataLinks* on page 7-10.

SMC — Flex Bit Identification

Table 7.G Logic Status Word

Bit #																Status	Description
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
															X	Enabled	1 — Control Power Applied 0 — No Control Power
														X		Running	1 — Power Applied to Motor 0 — Power **not** Applied to Motor
													X			Phasing	1 — ABC Phasing 0 — CBA Phasing
												X				Phasing Active	1 — 3-phase is valid 0 — No valid 3-phase detected
											X					Starting (Accel)	1 — Performing a Start Maneuver 0 — Not Performing a Start Maneuver
										X						Stopping (Decel)	1 — Performing a Stop Maneuver 0 — Not Performing a Stop Maneuver
									X							Alarm	1 — Alarm Present 0 — No Alarm Present
								X								Fault	1 — Fault Condition Exists 0 — No Fault Condition
							X									At Speed	1 — Full Voltage Applied 0 — Not Full Voltage Applied
						X										Start/ Isolation	1 — Start/Isolation Contactor Enabled 0 — Start/Isolation Contactor Disabled
					X											Bypass	1 — External Bypass Contactor Enabled 0 — External Bypass Contactor Disabled
				X												Ready	1 — Ready 0 — Not Ready
			X													Option 1 Input	1 — Input Active 0 — Input Inactive
		X														Option 2 Input	1 — Input Active 0 — Input Inactive
—																—	Bits 14 and 15 — Not Used

Table 7.H Logic Command Word (Control)

Bit #																Status	Description
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
															X	Stop	1 — Stop/Inhibit 0 — No Action
														X		Start	1 — Start 0 — No Action
													X			Option #1 Input	1 — Stop Maneuver/Inhibit 0 — No Action
												X				Clear Faults	1 — Clear Faults 0 — No Action
											X					Option #2 Input	1 — Perform Option 2 function 0 — No Action
—																—	Bits 5…10 — Not Used
				X												Aux Enable	1 — Use Aux 1…Aux 4 0 — Ignore Aux 1…Aux 4
			X													Aux 1	1 — Aux 1 Active 0 — Aux 1 Inactive
		X														Aux 2	1 — Aux 2 Active 0 — Aux 2 Inactive
	X															Aux 3	1 — Aux 3 Active 0 — Aux 3 Inactive
X																Aux 4	1 — Aux 4 Active 0 — Aux 4 Inactive

Reference/Feedback

The SMC-Flex does not offer the analog **Reference** feature. The analog **Feedback** feature is supported and will provide Parameter 1, Current in Phase A, automatically as the feedback word.

Parameter Information

A complete listing of the SMC-Flex parameters is located in Appendix B.

Scale Factors for PLC Communication

The parameter values stored and produced by the SMC-Flex through communication are unscaled numbers. When reading or writing values from a PLC image table, it is important to apply the proper scaling factor, which is based on the number of decimal places.

Read Example

Parameter 11; Power Factor — The stored value is 85. Since this value has two decimal places, the value should be divided by 100. The correctly read value is 0.85.

Write Example

Parameter 46; Motor FLC — The value which is to be written to the SMC is 75 A. Since this value has one decimal place, the value should be multiplied by 10. The correctly written value is 750.

Display Text Unit Equivalents

Some parameters have text descriptions when viewed from a HIM or through a communication software program such as RSNetworx™. When receiving or sending information from a PLC each text description has a numerical equivalent. Table 7.I has an example of Parameter 44, Overload Class, and the appropriate relationship between the text descriptor and the equivalent value. This relationship is identical for other similar parameters located in Appendix B.

Table 7.I

Text Descriptor	Numerical Equivalent
Disabled	0
Class 10	1
Class 15	2
Class 20	3
Class 30	4

Configuring DataLinks

DataLinks are supported in the SMC-Flex. A DataLink is a mechanism used by most drives to transfer data to and from the controller without using an Explicit Message. The SMC-Flex supports 16-bit DataLinks, therefore the device can be configured to return up to four additional pieces of information without the need for an explicit message.

Rules for Using DataLinks

- Each set of DataLink parameters in an SMC-Flex can be used by only one adapter. If more than one adapter is connected, multiple adapters must not try to use the same DataLink.
- Parameter settings in the SMC determine the data passed through the DataLink mechanism.
- When you use a DataLink to change a value, the value is not written to the Non-Volatile Storage (NVS). The value is stored in volatile memory and lost when the SMC-Flex loses power.

Parameters 88…103 are used to configure the DataLinks. For additional information regarding DataLinks, refer to the user manual for the communication interface being used.

Note: Node addressing of the DPI communication card can be programmed via software or a hand-held DPI HIM. The on-board HIM cannot be used to address the communication card.

Updating Firmware

The latest version of firmware and instructions for the SMC-Flex can be obtained from www.ab.com.

Diagnostics

Overview

This chapter describes the fault diagnostics of the SMC-Flex controller. Further, this section describes the conditions that cause various faults to occur.

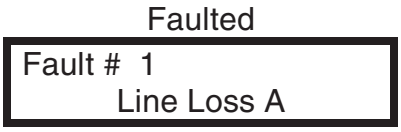
Protection Programming

Many of the protective features available with the SMC-Flex controller can be enabled and adjusted through the programming parameters provided. For further details on programming, refer to the Motor Protection section in Chapter 4, *Programming*.

Fault Display

The SMC-Flex controller comes equipped with a built-in three-line, 16-character LCD. The LCD displays the unit has faulted on the first line, the fault number on the second line, and the fault code on the third line.

Figure 8.1 Fault Display



Note: The fault display will remain active as long as control power is applied. If control power is cycled, the fault will be cleared, the controller will re-initialize, and the display will show a status of “Stopped.”

Note: You can press Esc to get to another programming/diagnostic list, but the SMC-Flex will still be in a faulted state.

Important: Resetting a fault will not correct the cause of the fault condition. Corrective action must be taken before resetting the fault.

Clear Fault

You can clear a fault using any of several methods:

- Program the SMC-Flex controller for a Clear Fault, which can be found in Main Menu/Diagnostics/Faults.
- If a human interface module is connected to the controller, press the Stop button.

Note: A stop signal from HIM will always stop the motor and clear the fault regardless of Logic Mask.

- If a RESET push button is present, the N.O. push button auxiliary contact can be connected to Option Input #2 (terminal 15). Option Input #2 must be programmed for Clear Fault.
- Cycle control power to the SMC-Flex controller.

Important: An overload fault cannot be reset until the Motor Thermal Usage, parameter 12, value is below 75%. See *Protection and Diagnostics* on page 1-11 for further details.

Fault Buffer

The SMC-Flex controller stores in memory the five most recent faults. Display the fault buffer by selecting the View Faults Queue and scrolling through the fault buffer parameters. The information is stored as fault codes and fault descriptions. A fault code cross-reference is provided in Table 8.A.

Fault Codes

Table 8.A provides a complete cross-reference of the available fault codes and corresponding fault descriptions.

Table 8.A Fault Code Cross-reference

Fault	Code	Fault	Code
Line Loss A	1	Stall	25
Line Loss B	2	Phase Reversal	26
Line Loss C	3	Coms Loss P2	27
Shorted SCR A	4	Coms Loss P3	28
Shorted SCR B	5	Coms Loss P5	29
Shorted SCR C	6	Network P2	30
Open Gate A	7	Network P3	31
Open Gate B	8	Network P5	32
Open Gate C	9	Ground Fault	33
PTC Pwr Pole	10	Excess Starts	34
SCR Overtemp	11	Power Loss A	35
Motor PTC	12	Power Loss B	36
Open Bypass A	13	Power Loss C	37
Open Bypass B	14	Hall ID	38
Open Bypass C	15	NVS Error	39
No Load A	16	No Load	40
No Load B	17	Line Loss A	41 ①
No Load C	18	Line Loss B	42 ①
Line Unbalance	19	Line Loss C	43 ①
Overvoltage	20	V24 Loss	45
Undervoltage	21	V Control Loss	46
Overload	22	Input 1	48
Underload	23	Input 2	49
Jam	24	System Faults	128…209

① See Table 8.B for definition.

Fault and Alarm Auxiliary Indication for Fault or Alarm

Auxiliary contacts can be programmed for Fault or Alarm, N.O. or N.C. indication. Parameter setup can be found in the Parameter/Motor Protection group when modifying parameters in the Program Mode.

Fault Definitions

Table 8.B shows the fault definitions for the SMC-Flex.

Table 8.B Fault Definitions

Fault	Description
Line Loss F1, F2, F3	The SMC-Flex can determine if a line connection has been lost, and will indicate this accordingly.
Shorted SCR	Shorted SCRs will be detected and starting will be prohibited by the SMC-Flex.
Open Gate	Open gate indicates that an abnormal condition that causes faulty firing (e.g., open SCR gate) has been sensed during the start sequence. The SMC-Flex controller will attempt to start the motor a total of three times before the controller shuts down.
Power Pole PTC and SCR Overtemperature	The power pole temperature in each phase is monitored. If the temperature rises above the predetermined level, the unit will fault to protect the power pole. A reset can be performed once the temperature falls below this level.
Motor PTC	A motor PTC can be connected to terminals 23 and 24. If the PTC parameter is enabled and the PTC trips, the SMC-Flex will trip and indicate a Motor PTC fault.
Open Bypass	Power pole bypass contacts are monitored for proper operation. In the event that a contact closure is not sensed, the SMC-Flex will indicate an Open Bypass fault.
No Load	The SMC-Flex can determine if a load connection has been lost, and No Load fault will be indicated.
Line Unbalance ①	Voltage unbalance is detected by monitoring the three phase supply voltages. The formula used to calculate the percentage voltage unbalance is as follows: $V_u = 100 (V_d / V_a)$ V_u: Percent voltage unbalance V_d: Maximum voltage deviation from the average voltage V_a: Average voltage The controller will shut down when the calculated voltage unbalance reaches the user-programmed trip percentages.
Overvoltage and Undervoltage Protection ①	Overvoltage and undervoltage protection are user-defined as a percentage of the programmed line voltage. The SMC-Flex controller continuously monitors the three supply phases. The calculated average is then compared to the programmed trip level.
Underload ②	Underload protection is available for undercurrent monitoring. The controller will shut down when the motor current drops below the trip level. This trip level, a percentage of the motor's full load current rating, can be programmed.
Overload Protection	Overload protection is enabled in the Motor Protection group by programming the: • Overload class • Overload reset • Motor FLC • Service factor • Refer to Chapter 5 for more information on Motor Protection.
Phase Reversal	Phase reversal is indicated when the incoming power to the SMC-Flex controller is in any sequence other than ABC. This pre-start protective feature can be disabled.
Coms Loss	The SMC-Flex controller disables control through the DPI communication port as the factory default. To enable control, the Logic Mask found in the Communication programming group must be set to "4." If a Bulletin 20-HIM LCD Human interface module is disconnected from the SMC-Flex controller when control is enabled, a Comm Fault will occur. Other settings could also cause this fault, see Table 7.D.
Network	Network faults are faults generated on the network external to the SMC-Flex, and are annunciated on the LCD display.
Ground Fault	Ground faults are based on feedback from the user supplied 825 CT (5…480 A devices only) detecting ground fault currents. Ground fault parameters of level and time delay must be programmed for proper operation.
Excess Starts/Hour	Excess starts/hour is displayed when the number of starts in a one hour period exceeds the value programmed.
Power Loss	Power loss indicates that an input power phase is not present. The controller's LCD display will identify the missing phase. If all three phases are absent when a start command is issued, the LCD will display "Starting" without motor rotation.
Line Loss F41, F42, F43	During expected SCR gate periods, the power pole voltage and currents are monitored. If the SCR conduction is discontinuous, a fault is indicated.

① Phase loss, overvoltage, and undervoltage protection are disabled during braking operation.

② Jam detection and underload protection are disabled during slow speed and braking operation.

Troubleshooting

Introduction

For safety of maintenance personnel as well as others who might be exposed to electrical hazards associated with maintenance activities, follow the local safety related work practices (for example, the NFPA 70E, Part II in the United States). Maintenance personnel must be trained in the safety practices, procedures, and requirements that pertain to their respective job assignments.

ATTENTION



Hazardous voltage is present in the motor circuit even when the SMC-Flex controller is off. To avoid shock hazard, disconnect main power before working on the controller, motor, and control devices such as Start-Stop push buttons. Procedures that require parts of the equipment to be energized during troubleshooting, testing, etc., must be performed by properly qualified personnel, using appropriate local safety work practices and precautionary measures.

ATTENTION



Disconnect the controller from the motor before measuring insulation resistance (IR) of the motor windings. Voltages used for insulation resistance testing can cause SCR failure. Do not make any measurements on the controller with an IR tester (megger).

Note: The time it takes for the motor to come up to speed may be more or less than the time programmed, depending on the frictional and inertial characteristics of the connected load.

Note: Depending on the application, the Braking options (SMB Motor Braking, Accu-Stop, and Slow Speed) may cause some vibration or noise during the stopping cycle. This may be minimized by lowering the braking current adjustment. If this is a concern in your application, please consult the factory before implementing these options.

The following flowchart is provided to aid in quick troubleshooting.

Figure 9.1 Troubleshooting Flowchart

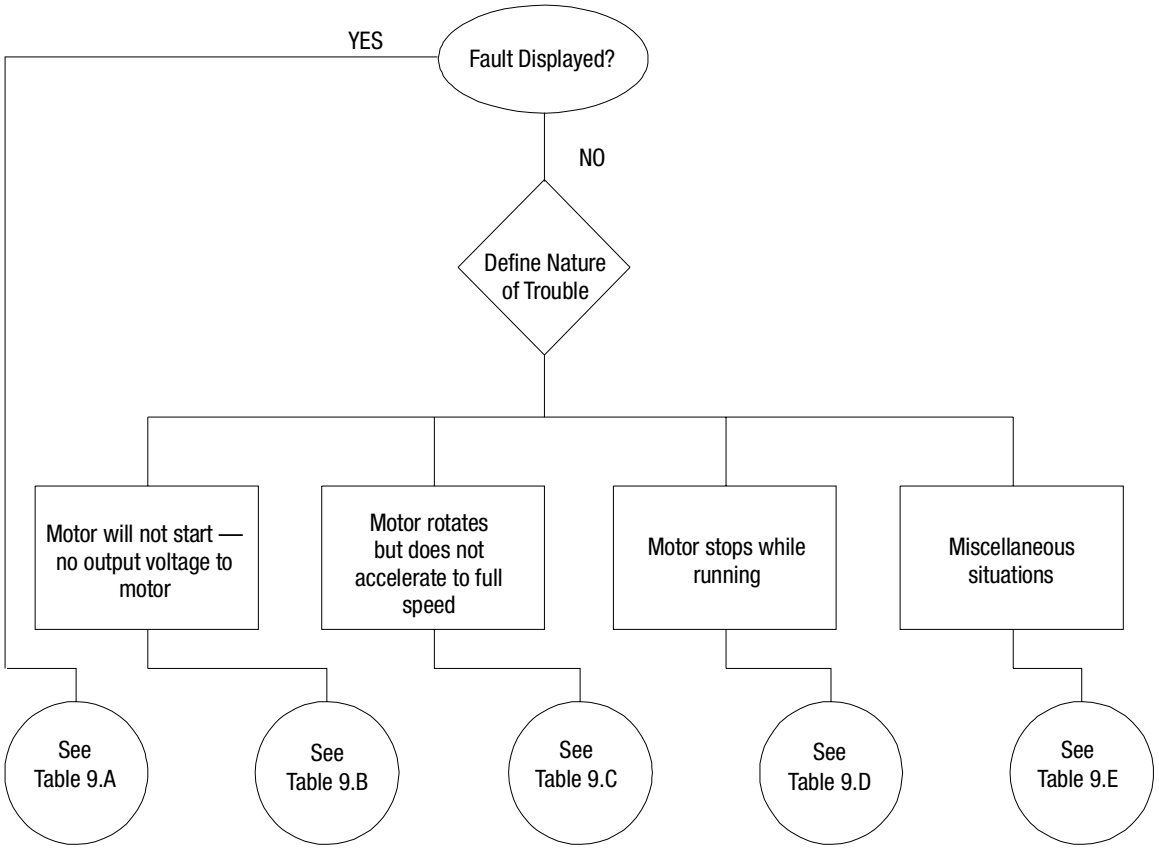


Table 9.A SMC Fault Display Explanation

Display	Fault Code	Possible Causes	Possible Solutions
Line Loss ① (with phase indication)	1, 2, 3	• Missing supply phase • Motor not connected properly	• Check for open line (i.e., blown fuse) • Check for open load lead • Consult the factory
Shorted SCR	4, 5, & 6	• Shorted Power Module	• Check for shorted SCR, replace power module if necessary
Open Gate (with phase indication)	7, 8, & 9	• Open gate circuitry • Loose gate lead	• Perform resistance check; replace power module if necessary • Check gate lead connections to the control module
PTC Power Pole SCR Overtemp	10 & 11	• Controller ventilation blocked • Controller duty cycle exceeded • Fan failure • Ambient temperature limit exceeded • Failed thermistor • Failed control module	• Check for proper ventilation • Check application duty cycle • Replace fan • Wait for controller to cool or provide external cooling • Replace power module • Replace control module
Motor PTC	12	• Motor ventilation blocked • Motor duty cycle exceeded • PTC open or shorted	• Check for proper ventilation • Check application duty cycle • Wait for motor to cool or provide external cooling • Check resistance of PTC

Table 9.A SMC Fault Display Explanation (Continued)

Display	Fault Code	Possible Causes	Possible Solutions
Open Bypass	13, 14, & 15	• Control voltage is low • Inoperable power module bypass	• Check control voltage power supply • Replace power module • Check control module TB2…TB4 and TB5…TB7 for secureness • Check Aux 1, 2, 3, 4 configurations are not set to External Bypass
No Load	16, 17, 18, & 40	• Loss of load side power wiring	• Check all load side power connections and motor windings
Line Unbalance	19	• Supply unbalance is greater than the user-programmed value • The delay time is too short for the application	• Check power system and correct if necessary • Extend the delay time to match the application requirements
Overvoltage	20	• Supply voltage is greater than user-programmed value	• Check power system and correct if necessary • Correct the user-programmed value
Undervoltage	21	• Supply voltage is less than user-programmed value • The delay time is too short for the application	• Check power system and correct if necessary • Correct the user-programmed value • Extend the delay time to match the application requirements
Overload	22	• Motor overloaded • Overload parameters are not matched to the motor	• Check motor overload condition • Check programmed values for overload class and motor FLC
Underload	23	• Broken motor shaft • Broken belts, toolbits, etc. • Pump cavitation	• Repair or replace motor • Check machine • Check pump system
Jam	24	• Motor current has exceeded the user programmed jam level.	• Correct source of jam • Check programmed time value
Stall	25	• Motor has not reached full speed by the end of the programmed ramp time	• Correct source of stall
Phase Reversal	26	• Incoming supply voltage is not in the expected ABC sequence	• Check power wiring
Coms Loss	27, 28, & 29	• Communication disconnection at the serial port	• Check for a communication cable disconnection to the SMC-Flex controller
Network	30, 31, & 32	• DPI network loss	• Reconnect for each DPI connected device
Ground Fault	33	• Ground fault current level has exceeded programmed value	• Check power system and motor; correct if necessary • Check programmed ground fault levels to match application requirements
Excess Starts/Hr.	34	• Number of starts in a one hour period has exceeded the value programmed	• Wait an appropriate amount of time to restart • Turn off the Starts/Hr. feature
Power Loss ① (with phase indication)	35, 36, & 37	• Missing supply phase (as indicated)	• Check for open line (i.e., blown line fuse)
Hall ID	38	• Incorrect power module has been installed	• Check power module and replace
NVS Error	39	• Data entry error	• Check user data • Replace control module • Reset default values
Line Loss	41, 42, 43	• Line distortion • High impedance connection	• Check supply voltage for capability to start/stop motor • Check for loose connections on line side or motor side of power wires

① Prestart fault indication.

Table 9.B Motor Will Not Start — No Output Voltage to the Motor

Display	Possible Cause	Possible Solutions
Fault displayed	• See fault description	• See Table 9.A addressing fault conditions
Display is blank	• Control voltage is absent • Failed control module	• Check control wiring and correct if necessary • Replace control module • Cycle control power
Stopped 0.0 Amps	• Pilot devices • SMC Enable input is open at terminal 13 • Input terminals are not wired correctly • Start-Stop control has not been enabled for the human interface module • Control voltage • Failed control module	• Check wiring • Check wiring • Check wiring • Follow the instructions on page 7-4…7-6 to enable control capability • Check control voltage • Replace control module
Starting	• Two or three power phases are missing	• Check power system

Table 9.C Motor Rotates (but does not accelerate to full speed)

Display	Possible Cause	Possible Solutions
Fault displayed	• See fault description	• See Table 9.A addressing fault conditions
Starting	• Mechanical problems • Inadequate Current Limit setting • Failed control module	• Check for binding or external loading and correct • Check motor • Adjust the Current Limit Level to a higher setting • Replace control module

Table 9.D Motor Stops While Running

Display	Possible Cause	Possible Solutions
Fault displayed	• See fault description	• See Table 10.A addressing fault conditions
Display is blank	• Control voltage is absent • Failed control module	• Check control wiring and correct if necessary • Replace control module
Stopped 0.0 Amps	• Pilot devices • Failed control module	• Check control wiring and correct if necessary • Replace control module
Starting	• Two or three power phases are missing • Failed control module	• Check power system • Replace control module

Table 9.E Miscellaneous Situations

Situation	Possible Cause	Possible Solutions
Motor current and voltage fluctuates with steady load	• Motor • Erratic Load	• Verify type of motor as a standard squirrel cage induction motor • Check load conditions
Erratic operation	• Loose connections	• Shut off **all** power to controller and check for loose connections
Accelerates too fast	• Starting time • Initial torque • Current limit setting • Kickstart	• Increase starting time • Lower initial torque setting • Decrease current limit setting • Lower kickstart time or turn off
Accelerates too slow	• Starting time • Initial torque • Current limit setting • Kickstart	• Decrease starting time • Increase initial torque setting • Increase current limit setting • Increase kickstart time or turn off
Fan does not operate	• Wiring • Failed fan(s)	• Check wiring and correct if necessary • Replace fan module
Motor stops too quickly with Soft Stop option	• Time setting	• Verify the programmed stopping time and correct if necessary
Motor stops too slowly with Soft Stop option	• Stopping time setting • Misapplication	• Verify the programmed stopping time and correct if necessary • The Soft Stop option is intended to **extend** the stopping time for loads that stop suddenly when power is removed from the motor.
Fluid surges with pumps still occur with the Soft Stop option	• Misapplication	• Soft Stop ramps voltage down over a set period of time. In the case of pumps, the voltage may drop too rapidly to prevent surges. A closed loop system such as Pump Control would be more appropriately suited. • Refer to Publication 150-911
Motor overheats	• Duty cycle	• Preset Slow Speed and Accu-Stop options: Extended operation at slow speeds reduces motor cooling efficiency. Consult motor manufacturer for motor limitations. • Smart Motor Braking option: Check duty cycle. Consult motor manufacturer for motor limitations.
Motor short circuit	• Winding fault	• Identify fault and correct. • Check for shorted SCR; replace if necessary. • Ensure power terminals are secure.

Power Module Check

If a power module needs to be checked, use the applicable procedure that follows.

ATTENTION



To avoid shock hazard, disconnect main power before working on the controller, motor, or control devices such as Start/Stop push buttons.

ATTENTION



Make sure that wires are properly marked and programmed parameter values are recorded.

Shorted SCR Test

1. Using an ohmmeter, measure the resistance between the line and load terminals of each phase on the controller. (L1-T1, L2-T2, & L3-T3)

The resistance should be greater than 10,000 ohms.

Specifications

Functional Design Specifications

Standard Features		
Installation	Power Wiring	Standard squirrel-cage induction motor or a Wye-Delta, six-lead motor.
	Control Wiring	2- and 3-wire control for a wide variety of applications.
Setup	Keypad	Front keypad and backlit LCD display.
	Software	Parameter values can be downloaded to the SMC-Flex Controller with DriveTools programming software and the Cat. No. 20-COMM… DPI communication module.
Communications		One DPI provided for connection to optional human interface and communication modules.
Starting and Stopping Modes		• Soft Start • Current Limit Start • Dual Ramp • Full Voltage • Linear Speed Acceleration • Preset Slow Speed • Soft Stop
Protection and Diagnostics		Power loss, line fault, voltage unbalance, excessive starts/hour, phase reversal, undervoltage, overvoltage, controller temp, stall, jam, open gate, overload, underload, communication fault.
Metering		A, V, kW, kWH, elapsed time, power factor, motor thermal capacity usage.
Alarm Contact		Overload, underload, undervoltage, overvoltage, unbalance, jam, stall, and ground fault
Status Indication		Stopped, starting, stopping, at speed, alarm, and fault.
Auxiliary Contacts		Four fully programmable contacts as normal/up-to-speed/external bypass/fault/alarm/ network; (N.O./N.C.)
Optional Features		
Pump Control		Helps reduce fluid surges in centrifugal pumping systems during starting and stopping period. Starting time is adjustable from 0…30 seconds. Stopping time is adjustable from 0…120 seconds.
Braking Control	SMB Smart Motor Braking	Provides motor braking without additional equipment for applications that require the motor to stop quickly. Braking current is adjustable from 0…400% of the motor's full load current rating.
	Accu-Stop	Provides controlled position stopping. During stopping, braking torque is applied to the motor until it reaches preset slow speed (7% or 15% of rated speed) and holds the motor at this speed until a stop command is given. Braking torque is then applied until the motor reaches zero speed. Braking current is programmable from 0…450% of full load current.
	Slow Speed with Braking	Used on applications that require slow speed (in the forward direction) for positioning or alignment and also require braking control to stop.

Electrical Ratings

	Device Rating	UL/CSA/NEMA	IEC
Power Circuit			
Rated Operation Voltage	480V	200…480V AC (–15%, +10%)	200…415V
	600V	200…600V AC (–15%, +10%)	200…500V
	690V	230…600V AC (–15%, +10%)	230…690V/Y
Rated Insulation Voltage	480V	N/A	500V
	600V		500V
	690V		690V
Rated Impulse Voltage	480V	N/A	6000V
	600V		
	690V		
Dielectric Withstand	480V	2200V AC	2500V
	600V		
	690V		
Repetitive Peak Inverse Voltage Rating	480V	1400V	1400V
	600V	1600V	1600V
	690V	1800V	1800V
Operating Frequency	All	50/60 Hz	50/60 Hz
Utilization Category	5…480 A	MG 1	AC-53B: 3.0-50:1750
	625…1250 A	MG 1	AC-53B: 3.0-50:3550
Protection Against Electrical Shock	5…85 A	N/A	IP20
	108…480 A	N/A	IP2X (with terminal covers)
	625…1250 A	N/A	IP00 (open Device)
DV/DT Protection	480V & 600V	RC Snubber Network	
	690V	None	
Transient Protection	480V & 600V	Metal Oxide Varistors: 220 Joules	
	690V	None	
Control Circuit			
Rated Operation Voltage ①	5…480 A	100…240V AC or 24V AC/DC	
	625…1250 A	110/120V AC and 230/240V AC	
Rated Insulation Voltage	All	N/A	240V
Rated Impulse Voltage	All	N/A	3000V
Dielectric Withstand	All	1600V AC	2000V
AC Operating Frequency	All	50/60 Hz	
Logic input on-state voltage minimum		85V AC, 19.2V DC / 20.4V AC	
Logic input on-state current		20 mA @120V AC/ 40 mA @ 240V AC, 7.6 mA @ 24V AC/DC	
Logic input off-state voltage maximum		50V AC, 10V DC / 12V AC	
Logic input off-state current @ input off-state voltage		<10 mA AC, <3 mA DC	

① 690V power is only available with 100…240V control.

Short Circuit Protection

SCCR Performance 200…600V		Type 1					
SCCR List ①		Max. Std. Available Fault	Max. Std. Fuse (A) ②	Max. Std. Available Fault	Max. Circuit Breaker (A)	Max. High Fault	Max. Fuse (A) ③
Line Device Operational Current Rating (A)	5	10 kA	20	10 kA	20	70 kA	10
	25	10 kA	100	10 kA	100	70 kA	50
	43	10 kA	150	10 kA	150	70 kA	90
	60	10 kA	225	10 kA	225	70 kA	125
	85	10 kA	300	10 kA	300	70 kA	175
	108	18 kA	400	18 kA	300	70 kA	200
	135	18 kA	500	18 kA	400	70 kA	225
	201	30 kA	600	30 kA	600	70 kA	350
	251	30 kA	700	30 kA	700	70 kA	400
	317	42 kA	800	30 kA	800	69 kA	500
	361	42 kA	1000	30 kA	1000	69 kA	600
	480	42 kA	1200	30 kA	1200	69 kA	800
	625	42 kA	1600	42 kA	1600	74 kA	1600
	780	42 kA	1600	42 kA	2000	74 kA	1600
	970	85 kA	2500	85 kA	2500	85 kA	2500
	1250	85 kA	3000	85 kA	3200	85 kA	3000
Delta Device Operational Current Rating (A)	8.7	10 kA	35	10 kA	35	70 kA	17.5
	43	10 kA	150	10 kA	150	70 kA	90
	74	10 kA	300	10 kA	300	70 kA	150
	104	10 kA	400	10 kA	300	70 kA	200
	147	10 kA	400	10 kA	400	70 kA	200
	187	18 kA	500	18 kA	500	70 kA	300
	234	18 kA	700	18 kA	700	70 kA	400
	348	30 kA	1000	30 kA	1000	70 kA	600
	435	42 kA	1200	30 kA	1200	70 kA	800
	549	42 kA	1600	30 kA	1600	69 kA	1000
	625	42 kA	1600	30 kA	1600	69 kA	1200
	831	42 kA	1600	30 kA	1600	69 kA	1600
	850	42 kA	1600	42 kA	2000	74 kA	1600
	900	42kA	1600	42 kA	2000	74 kA	1600
	1200	85 kA	3000	85 kA	3200	85 kA	3000
	1600	85 kA	3000	85 kA	3200	85 kA	3000

SCCR Performance 690V ④		Type 1		
SCCR List ①		Max. Std. Available Fault	Max. Ampere Tested — North American Style	Max. Ampere Tested — European Style
Maximum FLC	108	70 kA	A070URD33xxx500	6,9 gRB 73xxx400 6,6URD33xxx500
	135	70 kA	A070URD33xxx500	6,9 gRB 73xxx400 6,6URD33xxx500
	201	70 kA	A070URD33xxx700	6,9 gRB 73xxx630 6,6URD33xxx700
	251	70 kA	A070URD33xxx700	6,9 gRB 73xxx630 6,6URD33xxx700
	317	70 kA	A070URD33xxx900	6,9 gRB 73xxx800 6,6URD33xxx900
	361	70 kA	A070URD33xxx900	6,9 gRB 73xxx800 6,6URD33xxx900
	480	70 kA	A070D33xxx1250 A100URD73xxx1250	9 URD 73xxx1250 6,6URD33xxx1250
	625	70 kA	A070URD33xxx1400	6,6URD33xxx1400
	780	70 kA	A070URD33xxx1400	6,6URD33xxx1400
	970	85 kA	2 fuses in parallel A070URD33xxx1250	2 fuses in parallel 6,6URD33xxx1250
	1250	85 kA	2 fuses in parallel A070URD33xxx1250	2 fuses in parallel 6,6URD33xxx1250

① Consult local codes for proper sizing of short circuit protection.

② Non-time delay fuses: Class K5 or L- 5…480 (8.7…831) A devices, Class L - 625…1250 (850…1600) A devices.

③ High capacity fault rating when used with time delay class CC, J, L fuses.

④ Fuse types — Ferraz Shawmut, equivalent fuses (Ip and I^2T) can be used. "xxx" represents the blade nomenclature. The suggested fuse selection is based on 300% FLC for 50 seconds.

Power Requirements			
Control Module, 1…480 A	120…240V AC	Transformer	75 VA
	24V AC	Transformer	130 VA
	24V DC	Inrush Current	5 A
		Inrush Time	250 ms
		Transient Watts	60 W
		Transient Time	500 ms
		Steady State Watts	24 W
		Minimum Allen-Bradley Power Supply	1606-XLP50E
Control Module, 625…1250 A		751 VA	
Heatsink Fan(s) (A) ①		5…135 A, 20 VA 201…251 A, 40 VA 317…480 A, 60 VA 625…1250 A, 150 VA	

Steady State Heat Dissipation with Control and Fan Power(W)	
Controller Rating (A)	
5	70
25	70
43	81
60	97
85	129
108	91
135	104
201	180
251	198
317	225
361	245
480	290
625	446
780	590
970	812
1250	1222

Auxiliary Contacts

- 19/20 Aux #1
- 29/30 Aux #2
- 31/32 Aux #3
- 33/34 Aux #4

Type of Control Circuit	Electromagnetic relay
Number of Contacts	1
Type of Contacts	programmable N.O./N.C.
Type of Current	AC
Rated Operational Current	3 A @ 120V AC, 1.5 A @ 240V AC
Conventional Thermal Current I_{th}	5 A
Make/Break VA	3600/360
Utilization Category	AC-15
PTC Input Ratings	
Response Resistance	3400 Ω ±150 Ω
Reset Resistance	1600 Ω ±100 Ω
Short-Circuit Trip Resistance	25 Ω ±10 Ω
Max. Voltage at PTC Terminals (R_{PTC} = 4 k)	< 7.5V
Max. Voltage at PTC Terminals (R_{PTC} = open)	30V
Max. No. of Sensors	6
Max. Cold Resistance of PTC Sensor Chain	1500 Ω
Response Time	800 ms
Tach Input	0…5V DC. 4.5V DC = 100% Speed

① For devices rated 5…480 A, heatsink fans can be powered by either 110/120V AC or 220/240V AC. For devices rated 625…1250 A, heatsink fan power is sourced internally, based on supplied power.

Environmental

Operating Temperature Range	-5…50°C (23…122°F) (open) -5…40°C (23…104°F) (enclosed)
Storage and Transportation Temperature Range	–20…+75°C
Altitude	2000 m (6560 ft)
Humidity	5…95% (non-condensing)
Pollution Degree	2

Mechanical

Resistance to Vibration	Operational	All	1.0 G Peak, 0.15 mm (0.006 in.) displacement
	Non-Operational	5…480 A	2.5 G, 0.38 mm (0.015 in.) displacement
		625…1250 A	1.0 G Peak, 0.15 mm (0.006 in.) displacement
Resistance to Shock	Operational	5…85 A	15 G
		108…480 A	5.5 G
		625…1250 A	4 G
	Non-Operational	5…85 A	30 G
		108…480 A	25 G
		625…1250 A	12 G
Construction	Power Poles	5…85 A	Heatsink thyristor modular design
		108…1250 A	Heatsink hockey puck thyristor modular design
	Control Modules		Thermoset and Thermoplastic Moldings
	Metal Parts		Plated Brass, Copper, or Painted Steel
Terminals	Power Terminals	5…85 A	Cable size — Line Upper — 2.5…95 mm2 (14…3/0 AWG) Line Lower — 0.8…2.5 mm2 (18…14 AWG) Load Upper — 2.5…50 mm2 (14…1 AWG) Load Lower — 0.8…2.5 mm2 (18…14 AWG) Tightening torque — 14.7 N•m (130 lb.-in.) Wire strip length — 18…20 mm (0.22…0.34 in.)
		108…135 A	One M10 x 1.5 diameter hole per power pole
		201…251 A	Two M10 x 1.5 diameter holes per power pole
		317…480 A	Two M12 x 1.75 diameter holes per power pole
		625…1250 A	Two 13.5 mm (0.53 in.) diameter holes per power pole
	Power Terminal Markings		NEMA, CENELEC EN50 012
	Control Terminals		M 3 screw clamp: clamping yoke connection

Other

EMC Emission Levels	Conducted Radio Frequency Emissions		Class A	
	Radiated Emissions		Class A	
EMC Immunity Levels	Electrostatic Discharge		8 kV Air Discharge	
	Radio Frequency Electromagnetic Field		Per EN/IEC 60947-4-2	
	Fast Transient		Per EN/IEC 60947-4-2	
	Surge Transient		Per EN/IEC 60947-4-2	
Overload Characteristics	Current Range		Line	Delta
		5	1…5	1.7…9
		25	5…25	8.6…43
		43	8.6…43	14.8…75
		60	12…60	20.8…104
		85	17…85	29.4…147
		108	27…108	47…187
		135	34…135	59…234
		201	67…201	116…348
		251	84…251	145…435
		317	106…317	183…549
		361	120…361	208…625
		480	160…480	277…831
		625	208…625	283…850
		780	260…780	300…900
		970	323…970	400…1200
		1250	416…1250	533…1600
	Trip Classes		10, 15, 20, and 30	
	Trip Current Rating		117% of Motor FLC	
	Number of Poles		3	
Certifications	Open Type Controllers		CE Marked Per Low Voltage Directive 73/23/EEC, 93/68/EEC UL Listed (File No. E96956)	

Approximate Dimensions and Shipping Weights

Open Type Controllers

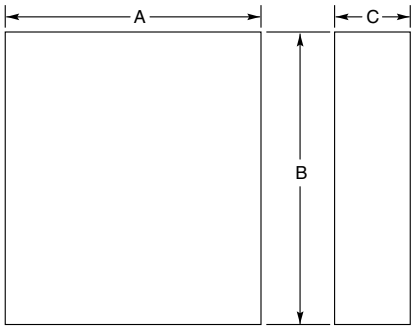
Dimensions are in millimeters (inches). Dimensions are not intended for manufacturing purposes.

Controller Rating (A)	Height	Width	Depth	Approximate Shipping Weight
5…85	321 (12.6)	150 (5.9)	203 (8.0)	5.7 kg (12.6 lb.)
108…135	443.7 (17.47)	196.4 (7.74)	205.2 (8.08)	15.0 kg (33 lb.)
201…251	560 (22.05)	225 (8.86)	253.8 (9.99)	30.4 kg (67 lb.)
317…480	600 (23.62)	290 (11.42)	276.5 (10.89)	45.8 kg (101 lb.)
625…780	1041.1 (41.0)	596.9 (23.5)	346.2 (13.63)	179 kg (395 lb.)
970…1250	1041.1 (41.0)	596.9 (23.5)	346.2 (13.63)	224 kg (495 lb.)

Enclosed Type Line-Connected Controllers

Factory-installed options may affect enclosure size requirements.

Exact dimensions can be obtained after order entry. Consult your local Allen-Bradley distributor.



Controller Rating (A)	IP65 (Type 4/12)			
	Disconnect Rating (A)	B Height	A Width	C Depth
Non-Combination Controller				
5	—	610 (24)	406 (16)	254 (10)
25	—	610 (24)	406 (16)	254 (10)
43	—	610 (24)	406 (16)	254 (10)
60	—	610 (24)	406 (16)	254 (10)
85	—	610 (24)	406 (16)	254 (10)
108	—	762 (30)	610 (24)	305 (12)
135	—	762 (30)	610 (24)	305 (12)
201	—	965 (38)	762 (30)	356 (14)
251	—	965 (38)	762 (30)	356 (14)
317	—	1295 (51)	914 (36)	356 (14)
361	—	1295 (51)	914 (36)	356 (14)
480	—	1295 (51)	914 (36)	356 (14)
625	—	2286 (90)	762 (30)	508 (20)
780	—	2286 (90)	762 (30)	508 (20)
970 ①	—	2286 (90)	762 (30)	508 (20)
1250 ①	—	2286 (90)	762 (30)	508 (20)

① 970…1250 rated devices are only available as Type 1and require a door-mounted fan, capable of delivering 240 cfm.

Enclosed Type Line-Connected Controllers, Continued

Controller Rating (A)	IP65 (Type 4/12)			
	Disconnect Rating (A)	B Height	A Width	C Depth
Combination Controllers with Fusible Disconnect				
5	30 A/J	610 (24)	406 (16)	254 (10)
25	30 A/J	610 (24)	406 (16)	254 (10)
43	60 A/J	610 (24)	406 (16)	254 (10)
60	100 A/J	610 (24)	406 (16)	254 (10)
85	100 A/J	610 (24)	406 (16)	254 (10)
108	200 A/J	965 (38)	762 (30)	356 (14)
135	200 A/J	965 (38)	762 (30)	356 (14)
201	400 A/J	965 (38)	762 (30)	356 (14)
251	400 A/J	965 (38)	762 (30)	356 (14)
317	600 A/J	1524 (60)	965 (38)	356 (14)
361	600 A/J	1524 (60)	965 (38)	356 (14)
480 ①	600 A/J	1524 (60)	965 (38)	356 (14)
480 ②	800 A/J	2286 (90)	508 (20)	508 (20)
625	—	2286 (90)	1387 (55)	508 (20)
780	—	2286 (90)	1387 (55)	508 (20)
970 ③	—	2286 (90)	1651 (65)	508 (20)
1250 ③	—	2286 (90)	1651 (65)	508 (20)
Combination Controllers with Circuit Breaker				
5	15 A	610 (24)	406 (16)	254 (10)
25	30 A	610 (24)	406 (16)	254 (10)
43	80 A	610 (24)	406 (16)	254 (10)
60	100 A	610 (24)	406 (16)	254 (10)
85	125 A	610 (24)	406 (16)	254 (10)
108	175 A/175 A Plug	965 (38)	762 (30)	356 (14)
135	225 A/225 A Plug	965 (38)	762 (30)	356 (14)
201	300 A/300 A Plug	965 (38)	762 (30)	356 (14)
251	400 A/400 A Plug	965 (38)	762 (30)	356 (14)
317	600 A/600 A Plug	1295 (51)	914 (36)	356 (14)
361	600 A/600 A Plug	1295 (51)	914 (36)	356 (14)
480	800 A/800 A Plug	1295 (51)	914 (36)	356 (14)
625	—	2286 (90)	1397 (55)	508 (20)
780	—	2286 (90)	1397 (55)	508 (20)
970 ③	—	2286 (90)	1651 (65)	508 (20)
1250 ③	—	2286 (90)	1651 (65)	508 (20)

① Use this row for 460V -58 and 575V -59.

② Use this row for 460V -59 and 575V -60 and -61.

③ 970…1250 rated devices are only available as Type 1 and require a door-mounted fan, capable of delivering 240 cfm.

Parameter Information

Table B.1 Parameter List

Group	Parameter Description	Parameter Number	Units	Min./ Max.	Default Settings	User Settings
Metering	Volts Phase A-B	1	Volt			
Metering	Volts Phase B-C	2	Volt			
Metering	Volts Phase C-A	3	Volt			
Metering	Current Phase A	4	Amps			
Metering	Current Phase B	5	Amps			
Metering	Current Phase C	6	Amps			
Metering	Watt Meter	7	KW/MW			
Metering	Kilowatt Hours	8	KWH/MWH			
Metering	Elapsed Time	9	Hours			
Metering	Meter Reset	10		NO ETM Reset KWH Reset	NO	
Metering	Power Factor	11		0.00…0.99		
Metering	Mtr Therm Usage	12	%MTU	0…100		
Metering	Motor Speed	13	%	0…100		
Basic Set Up	SMC Option	14		Standard Brake Pump Control		
Basic Set Up	Motor Connection	15		Line/Delta	Line	
Basic Set Up	Line Voltage	16	Volt	0…10000	480	
Basic Set Up	Starting Mode	17		Full Voltage Current Limit Soft Start Linear Speed Pump Start	Soft Start	
Basic Set Up	Ramp Time	18	Secs	0…30	10	
Basic Set Up	Initial Torque	19	%LRT	0…90	70	
Basic Set Up	Cur Limit Level	20	%FLC	50…600	350	
Basic Set Up	Kickstart Time	22	Secs	0.0…2.0	0.0	
Basic Set Up	Kickstart Level	23	%LRT	0…90	0	
Basic Set Up	Option Input 2	24		Disable Preset Slow Speed Dual Ramp Fault Fault NC Network Clear Fault	Disable	
Dual Ramp	Starting Mode 2	25		Full Voltage Current Limit Soft Start Linear Speed Pump Start	Soft Start	

Table B.1 Parameter List (Continued)

Group	Parameter Description	Parameter Number	Units	Min./ Max.	Default Settings	User Settings
Dual Ramp	Ramp Time 2	26	Secs	0…30	10	
Dual Ramp	Initial Torque 2	27	%LRT	0…90	70	
Dual Ramp	Cur Limit Level 2	28	%FLC	50…600	350	
Dual Ramp	Kickstart Time 2	30	Secs	0.0…2.0	0.0	
Dual Ramp	Kickstart Level2	31	%LRT	0…90	0	
Basic Set Up	Stop Mode	32		Soft Stop Linear Speed SMB Accu-Stop	Soft Stop	
Basic Set Up	Stop Time	33	Secs	0…120	0	
Basic Set Up/ Accu-Stop	Braking Current	35	%FLC	0…400	0	
Preset SS/ Accu-Stop	Slow Speed Sel	39		SS Low SS High	SS High	
Preset SS/ Accu-Stop	Slow Speed Dir	40		SS FWD SS REV	SS FWD	
Preset SS/ Accu-Stop	Slow Accel Cur	41	%FLC	0…450	0	
Preset SS/ Accu-Stop	Slow Running Cur	42	%FLC	0…450	0	
Accu-Stop	Stopping Current	43	%FLC	0…400	0	
Basic Set Up/ Overload	Overload Class	44		Disable Class 10 Class 15 Class 20 Class 30	Class 10	
Basic Set Up/ Overload	Service Factor	45		0.01…1.99	1.15	
Basic Set Up/ Overload	Motor FLC	46	Amps	1.0…2200.0 ①	1.0	
Basic Set Up/ Overload	Overload Reset	47		Manual Auto	Manual	
Overload	Overload A Lvl	50	%MTU	0…100	0	
Underload	Underload F Lvl	51	%FLC	0…99	0	
Underload	Underload F Dly	52	Secs	0…99	0	
Underload	Underload A Lvl	53	%FLC	0…99	0	
Underload	Underload A Dly	54	Secs	0…99	0	
Undervoltage	Undervolt F Lvl	55	%V	0…99	0	
Undervoltage	Undervolt F Dly	56	Secs	0…99	0	
Undervoltage	Undervolt A Lvl	57	%V	0…99	0	
Undervoltage	Undervolt A Dly	58	Secs	0…99	0	
Overvoltage	Overvolt F Lvl	59	%V	0…199	0	
Overvoltage	Overvolt F Dly	60	Secs	0…99	0	
Overvoltage	Overvolt A Lvl	61	%V	0…199	0	
Overvoltage	Overvolt A Dly	62	Secs	0…99	0	
Unbalance	Unbalance F Lvl	63	%V	0…25	0	
Unbalance	Unbalance F Dly	64	Secs	0…99	0	
Unbalance	Unbalance A Lvl	65	%V	0…25	0	
Unbalance	Unbalance A Dly	66	Secs	0…99	0	
Jam	Jam F Lvl	67	%FLC	0…1000	0	
Jam	Jam F Dly	68	Secs	0…99	0	

① Devices rated 625…1250 Amps, are only programmable to the whole digit ampere. There are no decimal points for any current based parameters.

Table B.1 Parameter List (Continued)

Group	Parameter Description	Parameter Number	Units	Min./ Max.	Default Settings	User Settings
Jam	Jam A Lvl	69	%FLC	0…1000	0	
Jam	Jam A Dly	70	Secs	0…99	0	
Stall	Stall Delay	71	Secs	0.0…10.0	0	
Ground Fault	Gnd Flt Enable	72		Disable Enable	Disable	
Ground Fault ②	Gnd Flt Level	73	Amps	1.0…5.0 ②	2.5 ②	
Ground Fault	Gnd Flt Delay	74	Secs	0.1…250.0	0.5	
Ground Fault	Gnd Flt Inh Time	75	Secs	0…250	10	
Ground Fault	Gnd Flt A Enable	76		Disable Enable	Disable	
Ground Fault ②	Gnd Flt A Lvl	77	Amps	1.0…5.0 ②	2.0 ②	
Ground Fault	Gnd Flt A Dly	78	Secs	0…250	10	
PTC	PTC Enable	79		Disable Enable	Disable	
Phase Reversal	Phase Reversal	80		Disable Enable	Disable	
Restart	Starts Per Hour	81		0…99		
Restart	Restart Attempts	82		0…5	0	
Restart	Restart Delay	83	Secs	0…60	0	
Comm Masks	Logic Mask	87		8-bit binary	0	
DataLinks	Data In A1	88			0	
DataLinks	Data In A2	89			0	
DataLinks	Data In B1	90			0	
DataLinks	Data In B2	91			0	
DataLinks	Data In C1	92			0	
DataLinks	Data In C2	93			0	
DataLinks	Data In D1	94			0	
DataLinks	Data In D2	95			0	
DataLinks	Data Out A1	96			0	
DataLinks	Data Out A2	97			0	
DataLinks	Data Out B1	98			0	
DataLinks	Data Out B2	99			0	
DataLinks	Data Out C1	100			0	
DataLinks	Data Out C2	101			0	
DataLinks	Data Out D1	102			0	
DataLinks	Data Out D2	103			0	
Motor Data	Motor ID	104		0…65535	0	
Motor Data	CT Ratio	105		1…1500		
Motor Data	MV Ratio	106		1…10000		

② The 625, 780, 970, and 1250 A units the min./max. is 5.0.…25 and the default value is 5.0 Amps.

Table B.1 Parameter List (Continued)

Group	Parameter Description	Parameter Number	Units	Min./ Max.	Default Settings	User Settings
Basic Set Up	Aux1 Config	107		Normal Normal NC Up To Speed Up To Speed NC Fault Fault NC Alarm Alarm NC Network Network NC External Bypass	Normal	
Basic Set Up	Aux3 Config	108		Normal Normal NC Up To Speed Up To Speed NC Fault Fault NC Alarm Alarm NC Network Network NC External Bypass	Alarm	
Basic Set Up	Aux4 Config	109		Normal Normal NC Up To Speed Up To Speed NC Fault Fault NC Alarm Alarm NC Network Network NC External Bypass	Normal	
Basic Set Up	Aux2 Config	110		Normal Normal NC Up To Speed Up To Speed NC Fault Fault NC Alarm Alarm NC Network Network NC External Bypass	Fault	
Language	Language	111		English French Spanish German Portuguese Mandarin	English	
All	Parameter Mgmt	115		Ready Load Default	Ready	
Basic Set Up	Backspin Timer	116	Secs	0…999	0	

Table B.1 Parameter List (Continued)

Group	Parameter Description	Parameter Number	Units	Min./ Max.	Default Settings	User Settings
Linear List	Fault 1	124		0…255		
Linear List	Fault 2	125		0…255		
Linear List	Fault 3	126		0…255		
Linear List	Fault 4	127		0…255		
Linear List	Fault 5	128		0…255		
Basic Set Up	Option Input 1	132		Disable Coast Stop Option Fault Fault NC Network	Stop Option	
Basic Set Up	Stop Input	133		Coast Stop Option	Coast	

Notes

Renewal Parts

Description		SMC Rating	Part No. ①		
			For units rated 200…600V AC		For units rated 690V AC
			100…240V AC	24V AC/DC	100…240V AC
Control Modules	Standard	All	41391-454-01-S1FX	41391-454-02-S2FX	41391-454-05-S1FZ
	Pump	All	41391-454-01-B1FX	41391-454-02-B2FX	41391-454-05-B1FZ
	Braking	5…85 A	41391-454-01-D1AX	41391-454-02-D2AX	41391-454-05-D1AZ
		108…251 A	41391-454-01-D1BX	41391-454-02-D2BX	41391-454-05-D1BZ
		317…480 A	41391-454-01-D1CX	41391-454-02-D2CX	41391-454-05-D1CZ
		625…780 A	41391-454-01-D1DX	N/A	41391-454-05-D1DZ
		970…1250 A	41391-454-01-D1EX	N/A	41391-454-05-D1EZ

Description	SMC Rating	Series	Part No. ①		
			Line Voltage		
			200…480V	200…600V	230…690V
Power Poles	5 A	B	150-FPP5B ②	150-FPP5C ②	N/A
	25 A	B	150-FPP25B ②	150-FPP25C ②	N/A
	43 A	B	150-FPP43B ②	150-FPP43C ②	N/A
	60 A	B	150-FPP60B ②	150-FPP60C ②	N/A
	85 A	B	150-FPP85B ②	150-FPP85C ②	N/A
	108 A	A	41391-800-01 ③	41391-800-02 ③	N/A
	135 A	A	41391-800-03 ③	41391-800-04 ③	N/A
	108 A	B	150-FPP108B ②	150-FPP108C ②	150-FPP108Z ②
	135 A	B	150-FPP135B ②	150-FPP135C ②	150-FPP135Z ②
	201 A	B	150-FPP201B ③	150-FPP201C ③	150-FPP201Z ③
	251 A	B	150-FPP251B ③	150-FPP251C ③	150-FPP251Z ③
	317 A	B	150-FPP317B ③	150-FPP317C ③	150-FPP317Z ③
	361 A	B	150-FPP361B ③	150-FPP361C ③	150-FPP361Z ③
	480 A	B	150-FPP480B ③	150-FPP480C ③	150-FPP480Z ③
	625 A	B	150-FPP625B ③	150-FPP625C ③	150-FPP625Z ③
	780 A	B	150-FPP780B ③	150-FPP780C ③	150-FPP780Z ③
	970 A	B	150-FPP970B ③	150-FPP970C ③	150-FPP970Z ③
	1250 A	B	150-FPP1250B ③	150-FPP1250C ③	150-FPP1250Z ③
Heatsink Fans	5…85 A	B	41391-801-03		
	108…135 A	B	41391-801-03		
	201…251 A	B	41391-801-01		
	317…480 A	B	41391-801-02		
110/120V AC Control Power	625…1250 A	B	41391-801-04		
230/240V AC Control Power	625…1250 A	B	41391-801-05		
Base Plate	201…251 A	B	41391-803-01		
	317…480 A	B	41391-803-02		
By-Pass Contactor 110/120V AC Control Power	625…780 A	B	100-D180ED11 ④		
	970…1250 A	B	100-D420ED11 ④		
By-Pass Contactor 230/240V AC Control Power	625…780 A	B	100-D180EA11 ④		
	970…1250 A	B	100-D420EA11 ④		

① One piece provided per part number.
② Three-phase power pole structure provided per part no.
③ One-phase power pole provided per part no.
④ See Appendix D for special installation instructions.

Notes:

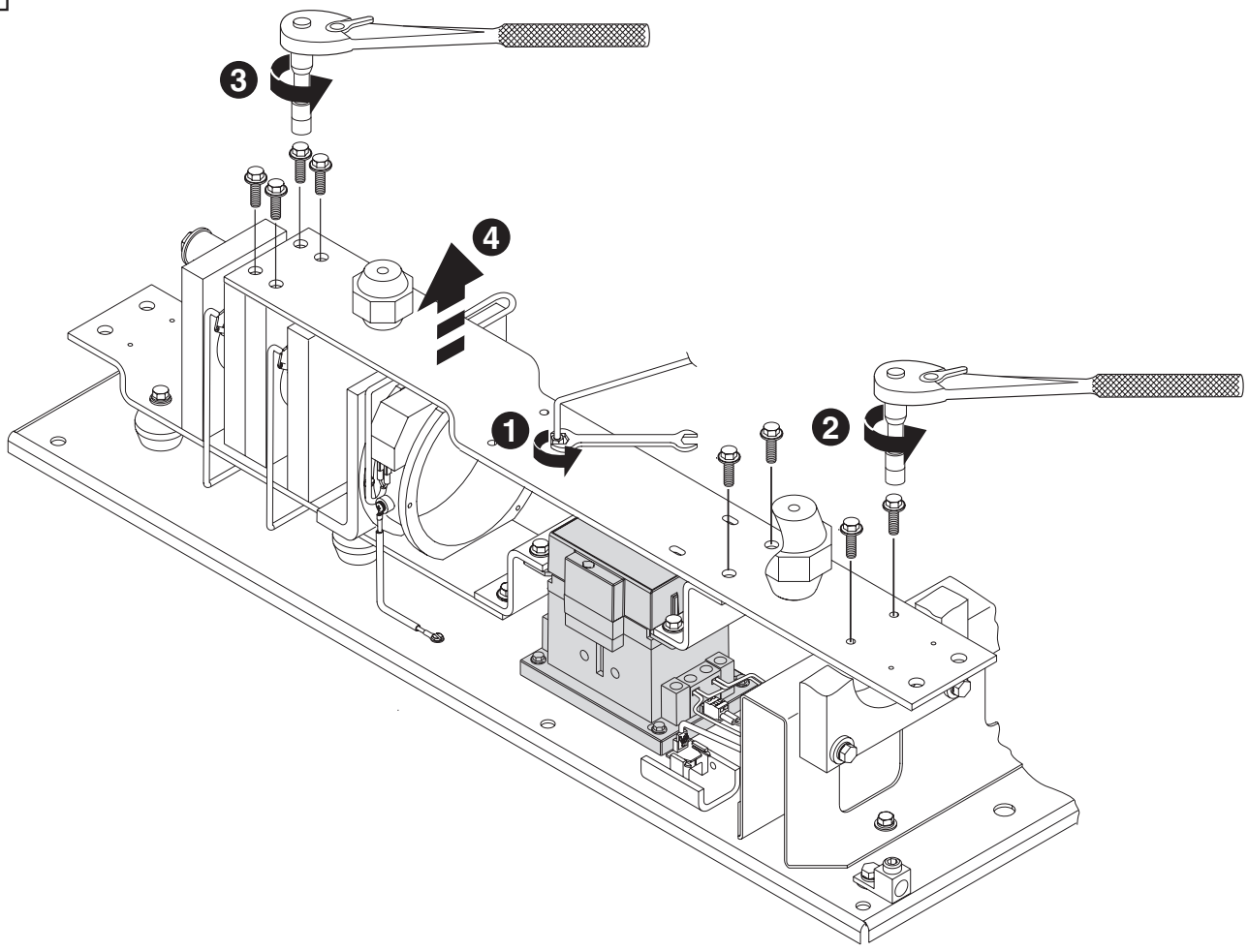
Contactor Replacement Installation Instructions for 625…1250 A units

ATTENTION

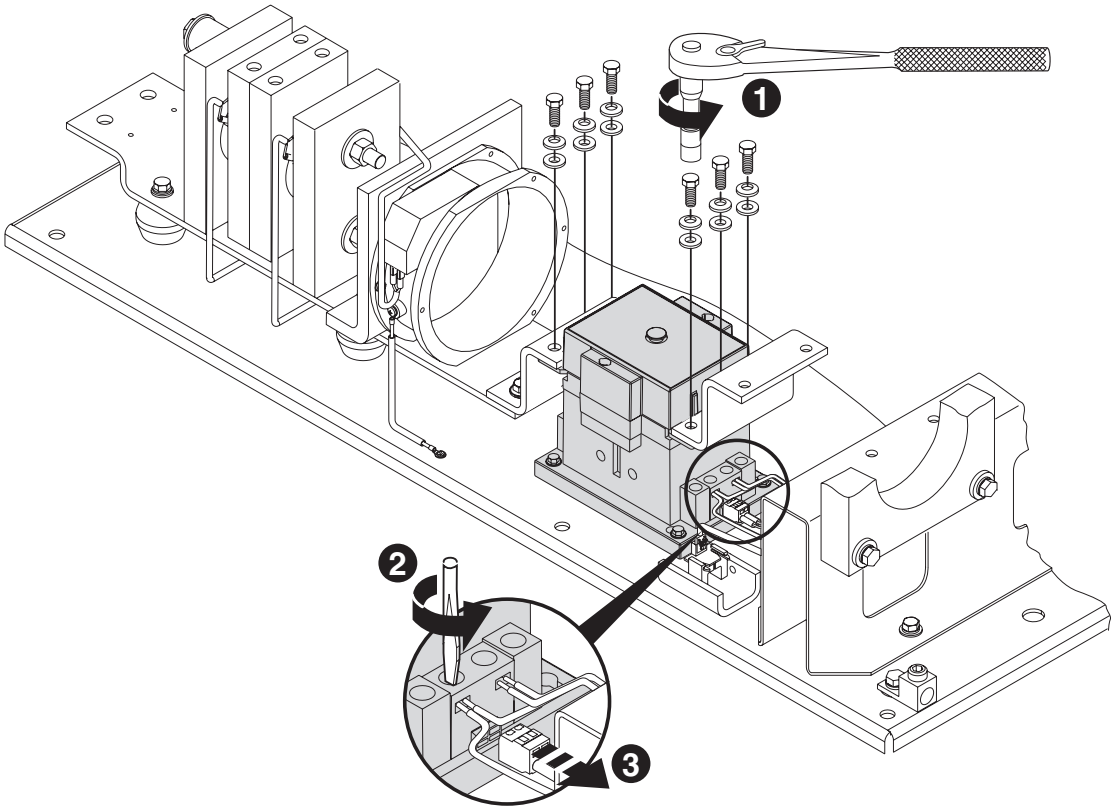
Remove all power to the unit, before proceeding with replacement procedures.

Prior to beginning the following steps, the front cover must be removed:

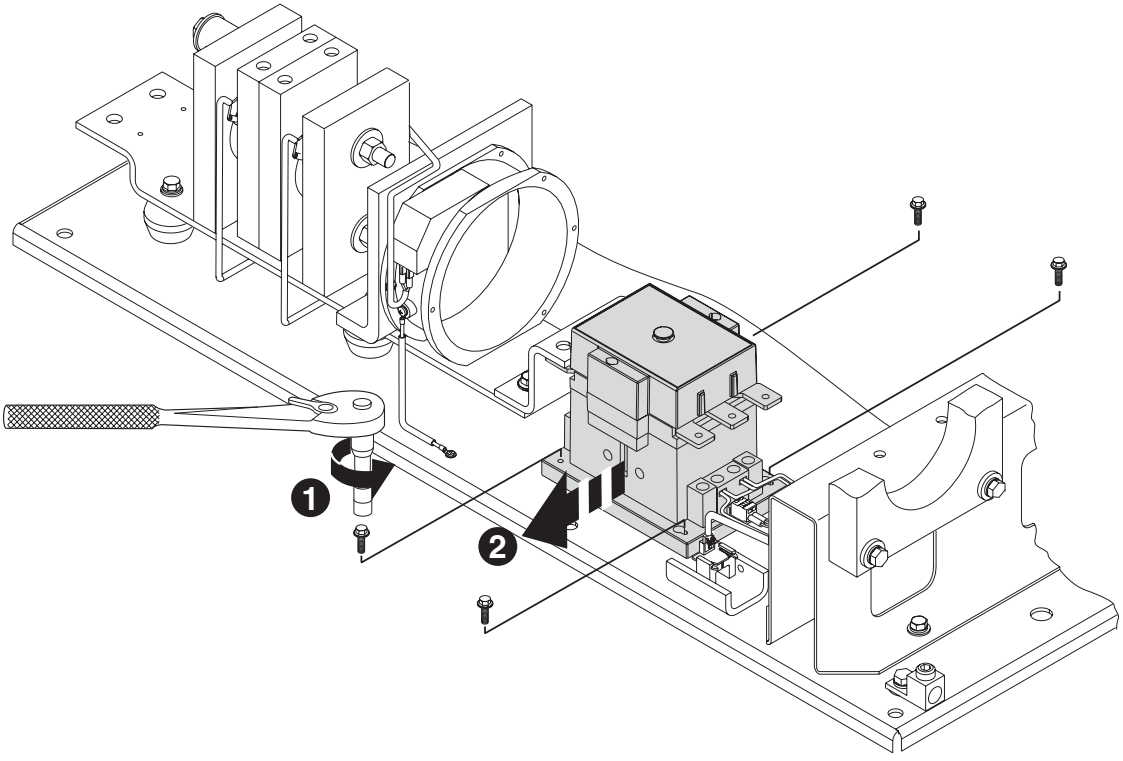
1 **Note: Cover is removed**

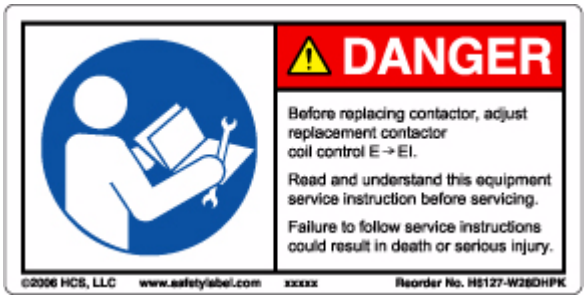


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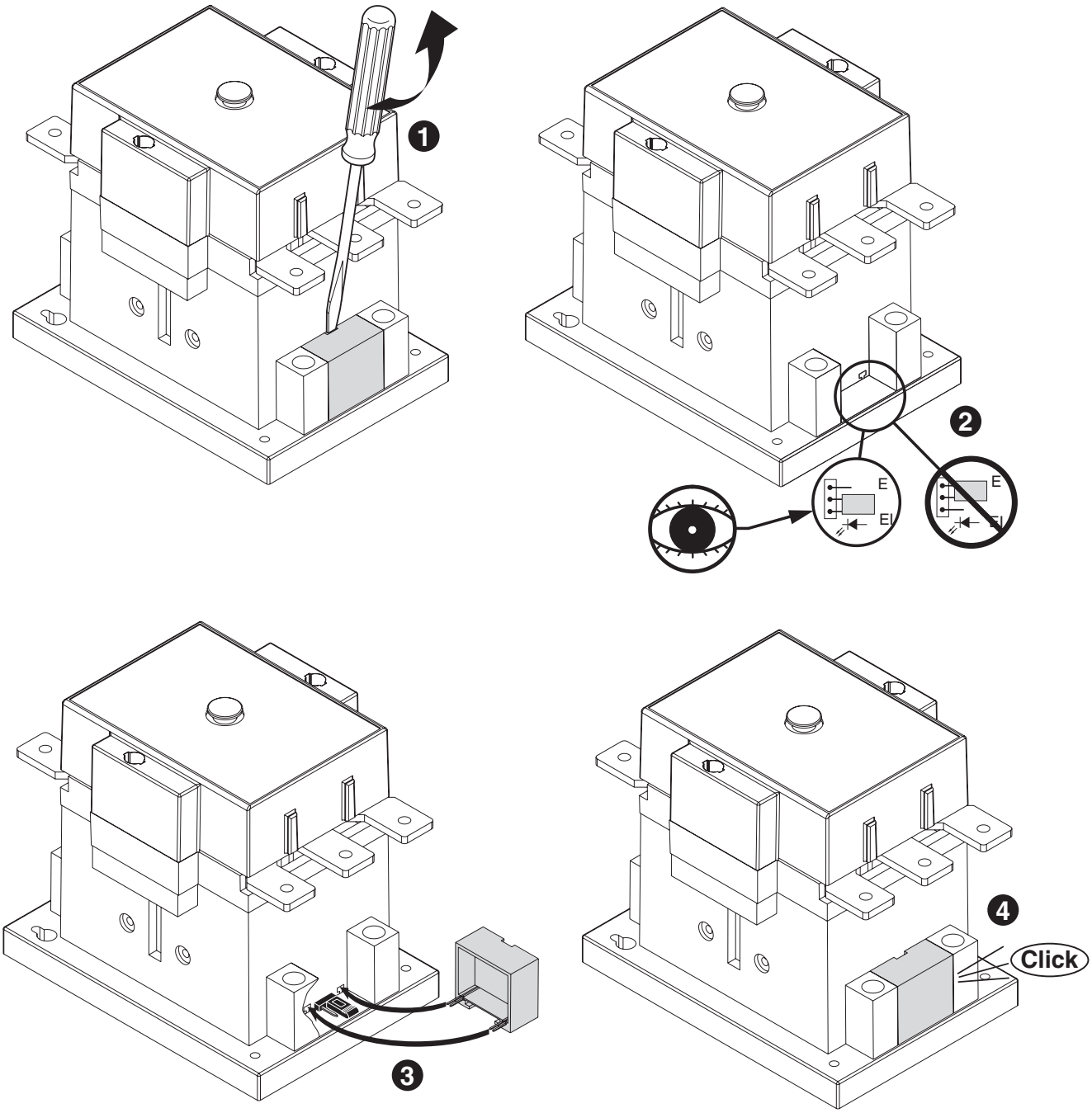


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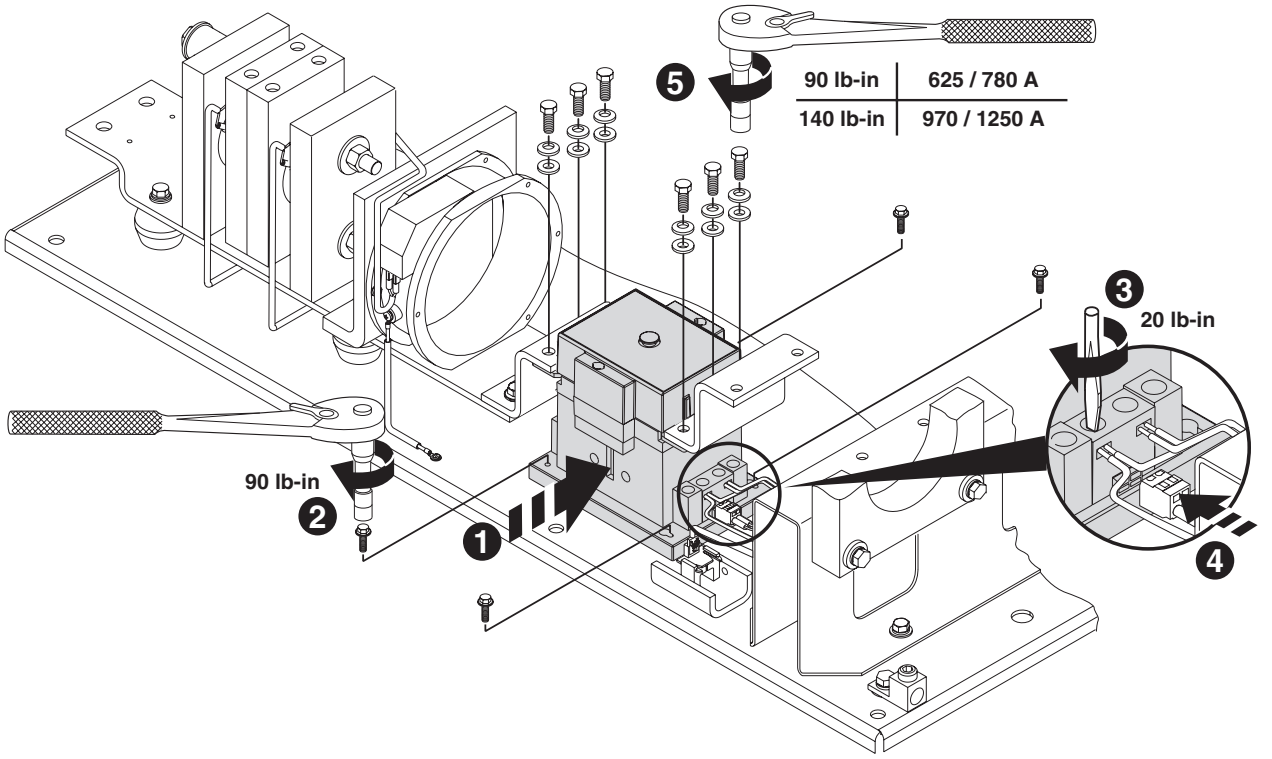



DANGER
Before replacing contactor, adjust replacement contactor coil control E→EI.
Read and understand this equipment service instruction before servicing.
Failure to follow service instructions could result in death or serious injury.
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Reorder No. HS127-W2BDHPK

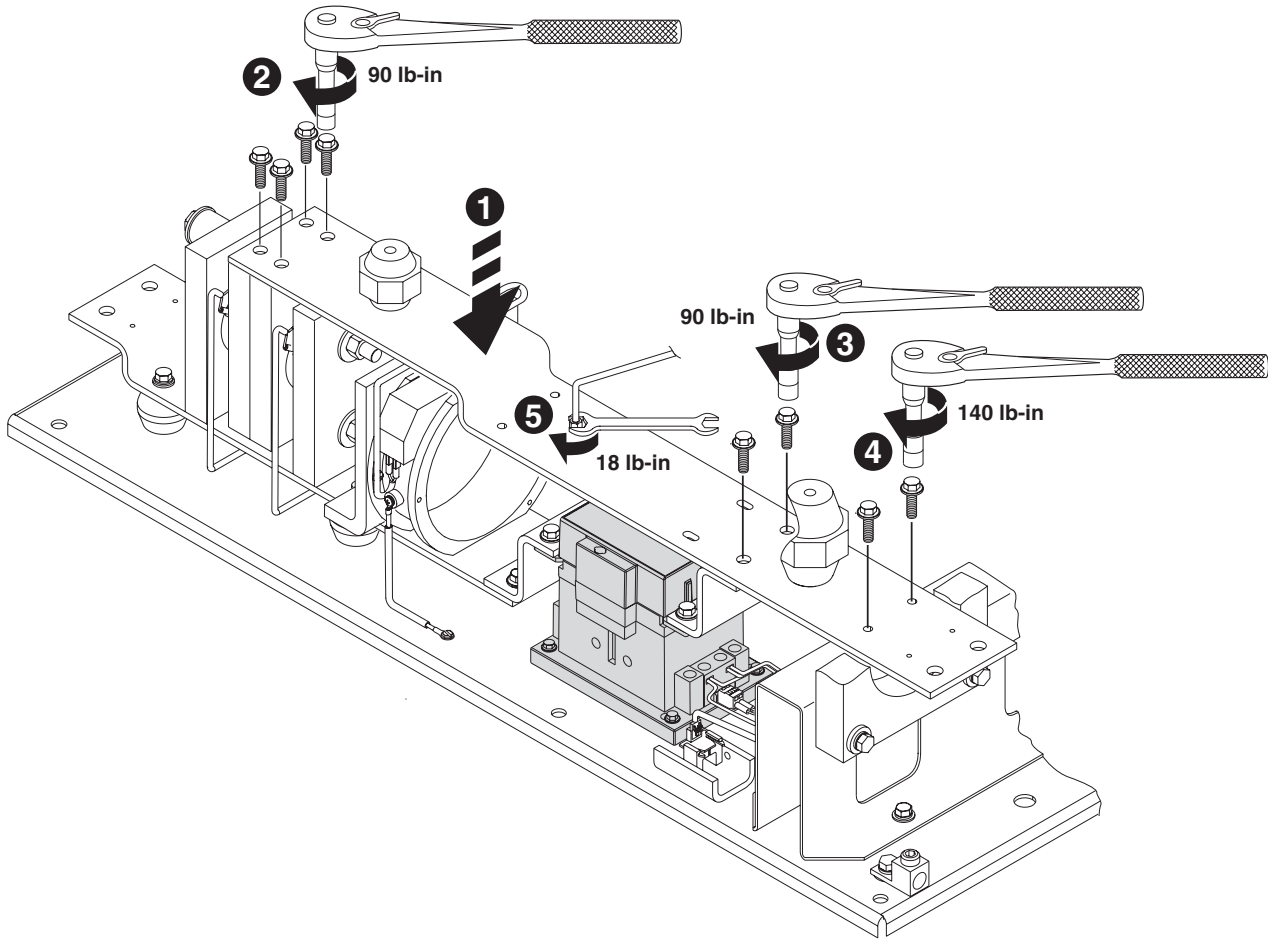
4


1
2
E
EI
E
EI
3
4
Click

5


5
90 lb-in
140 lb-in
625 / 780 A
970 / 1250 A
3
20 lb-in
90 lb-in
2
1
4

6


2
90 lb-in
1
90 lb-in
3
5
18 lb-in
140 lb-in
4

Accessories

Description	Description/Used With	Cat. No.
Protective Modules	5…85 A, 480V	150-F84
	108…1250 A, 480V	150-F84L
	5…85 A, 600V	150-F86
	108…1250 A, 600V	150-F86L
Terminal Lugs	108…251 A	199-LF1
	317…480 A	199-LG1
	625…1250 A	100-DL630 100-DL860
IEC Terminal Covers	108…135 A	150-TC1
	201…251 A	150-TC2
	317…480 A	150-TC3
HIM	Hand-Held ①	20-HIM-A2
		20-HIM-A3
		20-HIM-A4
		20-HIM-A5
	Door-Mounted (includes cable)	20-HIM-C3
		20-HIM-C3S
		20-HIM-C5
		20-HIM-C5S
	Extension Cables	1202-H03 1202-H10 1202-H30 1202-H90
	Splitter Cable	1203-S03
Communication Modules	DeviceNet	20-COMM-D
	ControlNet	20-COMM-C
	Remote I/O	20-COMM-R
	Profibus	20-COMM-P
	RS 485	20-COMM-S
	InterBus	20-COMM-I
	EtherNet	20-COMM-E
	RS 485 HVAC	20-COMM-H
	ControlNet (Fiber)	20-COMM-Q

① Requires a 20-HIM-H10 cable.

Notes:

Renewal Part Cross Reference

Description	Controller Type	SMC Rating	Line Voltage	Control Input Voltage	Orderable Renewal Part No.	Control Module Internal Cat. No. Label ①
Control Module	Standard	All	200…600V	100…240V	41391-454-01-S1FX	150-FS1FX
				24V AC/DC	41391-454-02-S2FX	150-FS2FX
			690V	110/120V	41391-454-05-S1FZ	150-FS1FZ
				230/240V		
	Pump	All	200…600V	100…240V	41391-454-01-B1FX	150-FB1FX
				24V AC/DC	41391-454-02-B2FX	150-FB2FX
			690V	110/120V	41391-454-05-B1FZ	150-FB1FZ
				230/240V		
	Braking	5…85 A	200…600V	100…240V	41391-454-01-D1AX	150-FD1AX
				24V AC/DC	41391-454-02-D2AX	150-FD2AX
			690V	110/120V	41391-454-05-D1AZ	150-FD1AZ
				230/240V		
		108…251 A	200…600V	100…240V	41391-454-01-D1BX	150-FD1BX
				24V AC/DC	41391-454-02-D2BX	150-FD2BX
			690V	110/120V	41391-454-05-D1BZ	150-FD1BZ
				230/240V		
		317…480 A	200…600V	100…240V	41391-454-01-D1CX	150-FD1CX
				24V AC/DC	41391-454-02-D2CX	150-FD2CX
			690V	110/120V	41391-454-05-D1CZ	150-FD1CZ
				230/240V		
		625…780 A	200…600V	110/120V	41391-454-02-D1DX	150-FD1DX
				230/240V		
			690V	110/120V	41391-454-05-D1DZ	150-FD1DZ
				230/240V		
		970…1250 A	200…600V	110/120V	41391-454-02-D1EX	150-FD1EX
				230/240V		
			690V	110/120V	41391-454-05-D1EZ	150-FD1EZ
				230/240V		

Control Type	Control Voltage	Line Voltage	Amperes	Originally Ordered AB Cat. No.	Series	Internal Control Module Label ①	Orderable Power Poles
Standard	100…240V	200…480V AC	5	150-F5NBD	B	150-FS1FX	150-FPP5B
			25	150-F25NBD	B	150-FS1FX	150-FPP25B
			43	150-F43NBD	B	150-FS1FX	150-FPP43B
			60	150-F60NBD	B	150-FS1FX	150-FPP60B
			85	150-F85NBD	B	150-FS1FX	150-FPP85B
			108	150-F108NBD	B	150-FS1FX	150-FPP108B
			135	150-F135NBD	B	150-FS1FX	150-FPP135B
		200…600V AC	5	150-F5NCD	B	150-FS1FX	150-FPP5C
			25	150-F25NCD	B	150-FS1FX	150-FPP25C
			43	150-F43NCD	B	150-FS1FX	150-FPP43C
			60	150-F60NCD	B	150-FS1FX	150-FPP60C
			85	150-F85NCD	B	150-FS1FX	150-FPP85C
			108	150-F108NCD	B	150-FS1FX	150-FPP108C
			135	150-F135NCD	B	150-FS1FX	150-FPP135C
	24V AC/DC	200…480V AC	5	150-F5NBR	B	150-FS2FX	150-FPP5B
			25	150-F25NBR	B	150-FS2FX	150-FPP25B
			43	150-F43NBR	B	150-FS2FX	150-FPP43B
			60	150-F60NBR	B	150-FS2FX	150-FPP60B
			85	150-F85NBR	B	150-FS2FX	150-FPP85B
			108	150-F108NBR	B	150-FS2FX	150-FPP108B
			135	150-F135NBR	B	150-FS2FX	150-FPP135B
		200…600V AC	5	150-F5NCR	B	150-FS2FX	150-FPP5C
			25	150-F25NCR	B	150-FS2FX	150-FPP25C
			43	150-F43NCR	B	150-FS2FX	150-FPP43C
			60	150-F60NCR	B	150-FS2FX	150-FPP60C
			85	150-F85NCR	B	150-FS2FX	150-FPP85C
			108	150-F108NCR	B	150-FS2FX	150-FPP108C
			135	150-F135NCR	B	150-FS2FX	150-FPP135C

① These are not orderable cat. nos. If a control module needs to be ordered, reference the control module renewal part no. found in Appendix C.

Control Type	Control Voltage	Line Voltage	Amperes	Originally Ordered AB Cat. No.	Series	Internal Control Module Label ①	Orderable Power Poles
Pump Control	100…240V	200…480V AC	5	150-F5NBDB	B	150-FB1FX	150-FPP5B
			25	150-F25NBDB	B	150-FB1FX	150-FPP25B
			43	150-F43NBDB	B	150-FB1FX	150-FPP43B
			60	150-F60NBDB	B	150-FB1FX	150-FPP60B
			85	150-F85NBDB	B	150-FB1FX	150-FPP85B
			108	150-F108NBDB	B	150-FB1FX	150-FPP108B
			135	150-F135NBDB	B	150-FB1FX	150-FPP135B
		200…600V AC	5	150-F5NCDB	B	150-FB1FX	150-FPP5C
			25	150-F25NCDB	B	150-FB1FX	150-FPP25C
			43	150-F43NCDB	B	150-FB1FX	150-FPP43C
			60	150-F60NCDB	B	150-FB1FX	150-FPP60C
			85	150-F85NCDB	B	150-FB1FX	150-FPP85C
			108	150-F108NCDB	B	150-FB1FX	150-FPP108C
			135	150-F135NCDB	B	150-FB1FX	150-FPP135C
	24V AC/DC	200…480V AC	5	150-F5NBRB	B	150-FB2FX	150-FPP5B
			25	150-F25NBRB	B	150-FB2FX	150-FPP25B
			43	150-F43NBRB	B	150-FB2FX	150-FPP43B
			60	150-F60NBRB	B	150-FB2FX	150-FPP60B
			85	150-F85NBRB	B	150-FB2FX	150-FPP85B
			108	150-F108NBRB	B	150-FB2FX	150-FPP108B
			135	150-F135NBRB	B	150-FB2FX	150-FPP135B
		200…600V AC	5	150-F5NCRB	B	150-FB2FX	150-FPP5C
			25	150-F25NCRB	B	150-FB2FX	150-FPP25C
			43	150-F43NCRB	B	150-FB2FX	150-FPP43C
			60	150-F60NCRB	B	150-FB2FX	150-FPP60C
			85	150-F85NCRB	B	150-FB2FX	150-FPP85C
			108	150-F108NCRB	B	150-FB2FX	150-FPP108C
			135	150-F135NCRB	B	150-FB2FX	150-FPP135C

① These are not orderable cat. nos. If a control module needs to be ordered, reference the control module renewal part no. found in Appendix C.

Control Type	Control Voltage	Line Voltage	Amperes	Originally Ordered AB Cat. No.	Series	Internal Control Module Label ①	Orderable Power Poles
Braking Control	100…240V	200…480V AC	5	150-F5NBDD	B	150-FD1AX	150-FPP5B
			25	150-F25NBDD	B	150-FD1AX	150-FPP25B
			43	150-F43NBDD	B	150-FD1AX	150-FPP43B
			60	150-F60NBDD	B	150-FD1AX	150-FPP60B
			85	150-F85NBDD	B	150-FD1AX	150-FPP85B
			108	150-F108NBDD	B	150-FD1BX	150-FPP108B
			135	150-F135NBDD	B	150-FD1BX	150-FPP135B
		200…600V AC	5	150-F5NCDD	B	150-FD1AX	150-FPP5C
			25	150-F25NCDD	B	150-FD1AX	150-FPP25C
			43	150-F43NCDD	B	150-FD1AX	150-FPP43C
			60	150-F60NCDD	B	150-FD1AX	150-FPP60C
			85	150-F85NCDD	B	150-FD1AX	150-FPP85C
			108	150-F108NCDD	B	150-FD1BX	150-FPP108C
			135	150-F135NCDD	B	150-FD1BX	150-FPP135C
	24V AC/DC	200…480V AC	5	150-F5NBRD	B	150-FD2AX	150-FPP5B
			25	150-F25NBRD	B	150-FD2AX	150-FPP25B
			43	150-F43NBRD	B	150-FD2AX	150-FPP43B
			60	150-F60NBRD	B	150-FD2AX	150-FPP60B
			85	150-F85NBRD	B	150-FD2AX	150-FPP85B
			108	150-F108NBRD	B	150-FD2BX	150-FPP108B
			135	150-F135NBRD	B	150-FD2BX	150-FPP135B
		200…600V AC	5	150-F5NCRD	B	150-FD2AX	150-FPP5C
			25	150-F25NCRD	B	150-FD2AX	150-FPP25C
			43	150-F43NCRD	B	150-FD2AX	150-FPP43C
			60	150-F60NCRD	B	150-FD2AX	150-FPP60C
			85	150-F85NCRD	B	150-FD2AX	150-FPP85C
			108	150-F108NCRD	B	150-FD2BX	150-FPP108C
			135	150-F135NCRD	B	150-FD2BX	150-FPP135C

① These are not orderable cat. nos. If a control module needs to be ordered, reference the control module renewal part no. found in Appendix C.

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Publication 150-UM008G-EN-P — November, 2006 PN 40055-218-01 (7)
Superecedes Publication 150-UM008F-EN-P — July, 2006
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