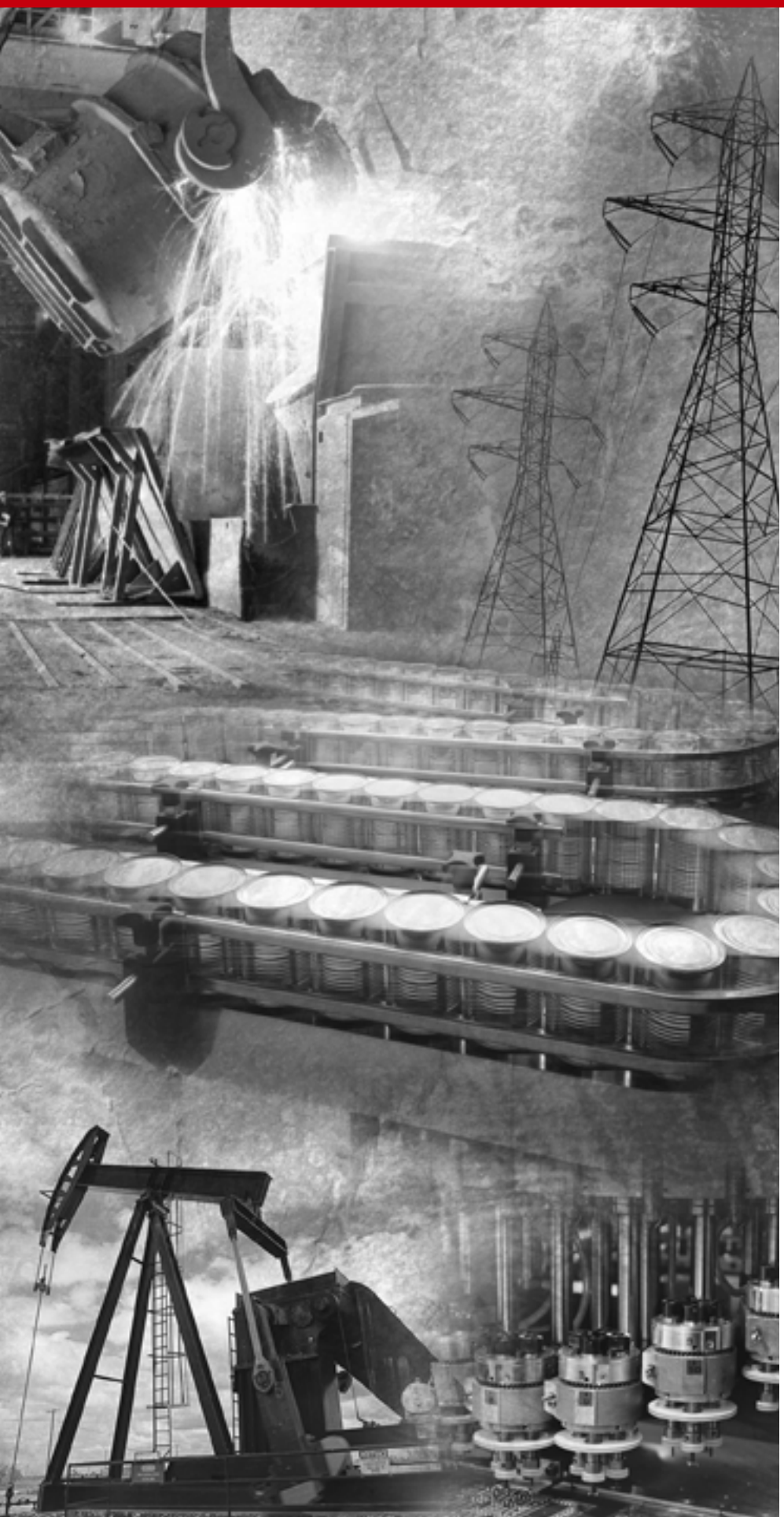

Allen-Bradley

SMC-Flex™

Bulletin 150

User Manual

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.

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.

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.

Notes

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Product Overview

Chapter 2
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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)
  41053-228-01 (108…480 A)
- Selection Guide — Publication 150-SG008_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
- 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 three-phase squirrel-cage motors rated 1…480 A or wye-delta motors rated 1.8…831 A; 200…480V AC or 200…600V AC; 50/60 Hz. Depending upon the catalog number ordered, the controller will accept a control power input of either 100…240V AC or 24V AC/DC. If the control power input option is 100…240V AC, the controller's microprocessor will self-adjust to the input control voltage.

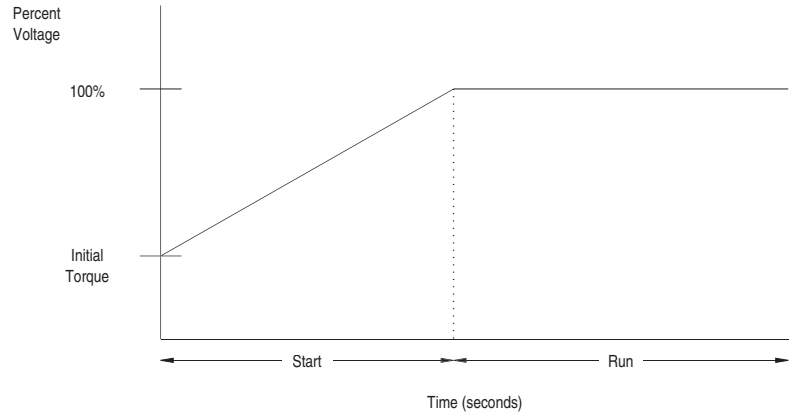
Note that the motor FLA must fall within the range of the SMC-Flex as specified in the selection guide for proper operation.

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

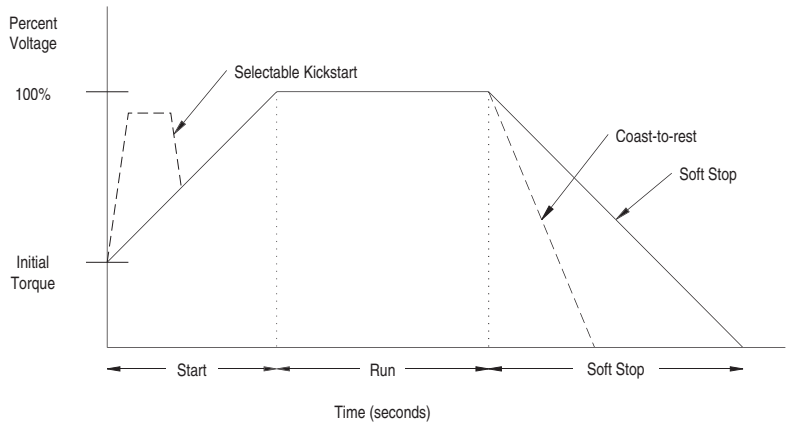


① Kickstart is also available with Soft Start.

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.

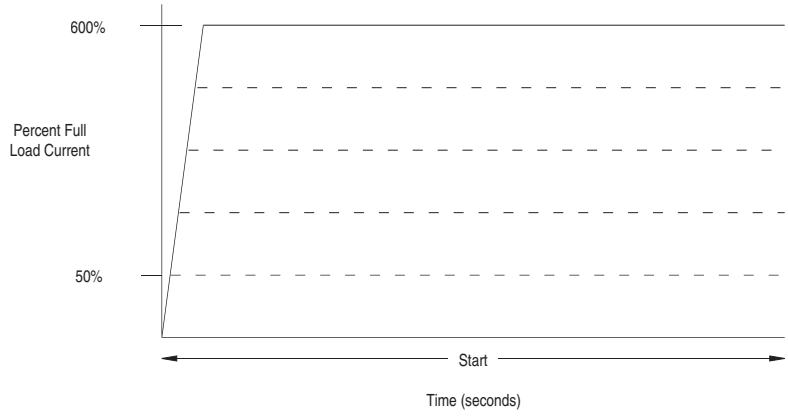
Figure 1.2 Selectable Kickstart



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

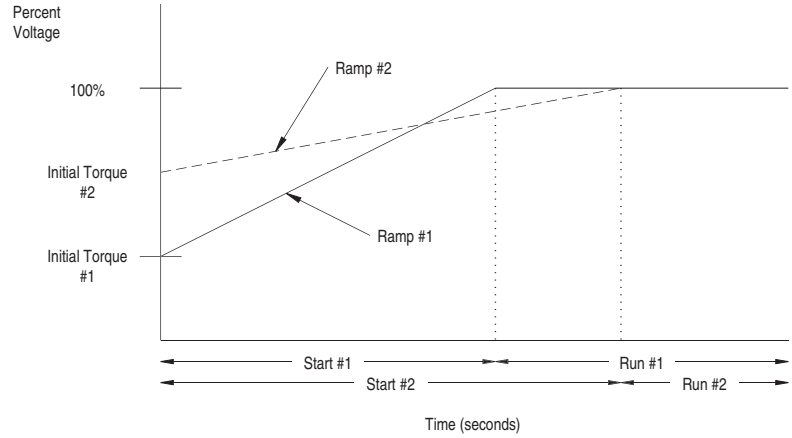


① Kickstart is also available with Current Limit Start.

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 Soft 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

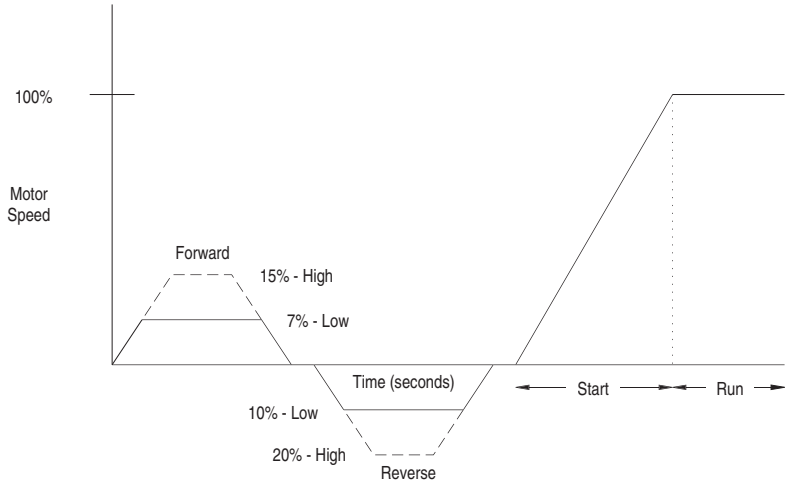
This starting mode is used for applications requiring across-the-line starting. The output voltage to the motor will reach full voltage within 1/4 second.

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

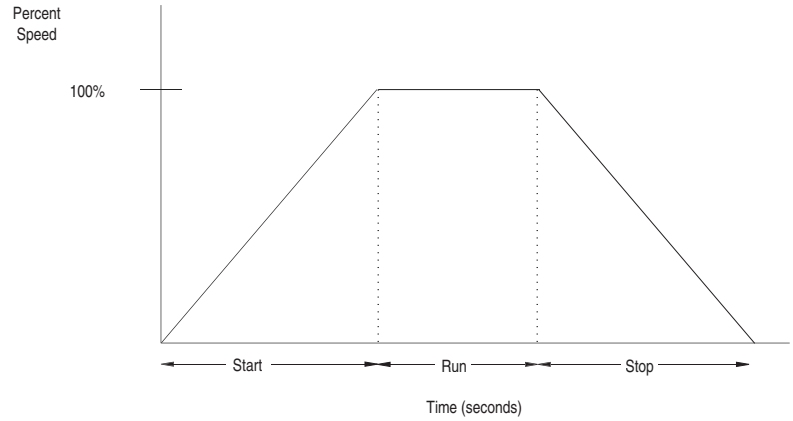


ATTENTION Slow speed running is not intended for continuous operation due to reduced motor cooling.

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

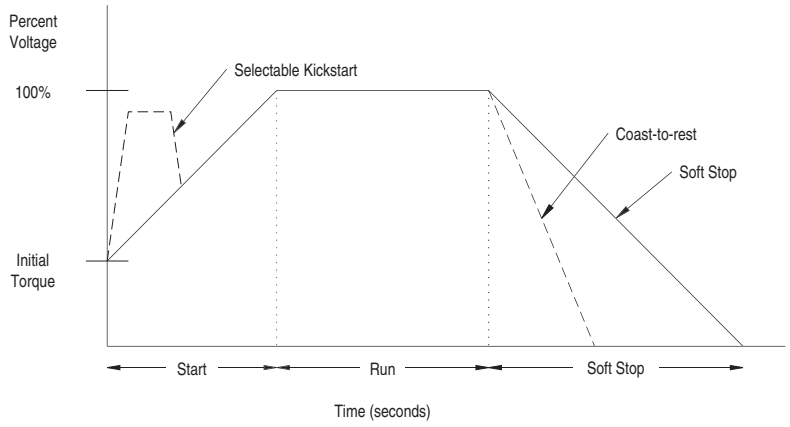
Linear Stop is not intended to be used as an emergency stop. Refer to the applicable standards for emergency stop requirements.

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 coast-to-rest. 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.

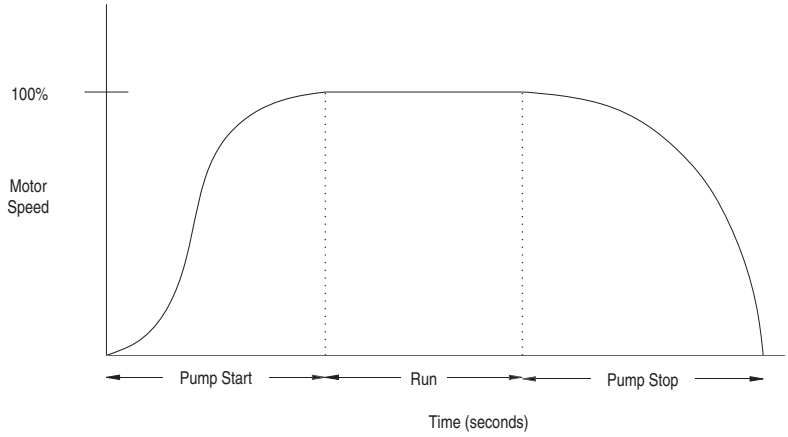
Modes of Operation (Pump Control)

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.

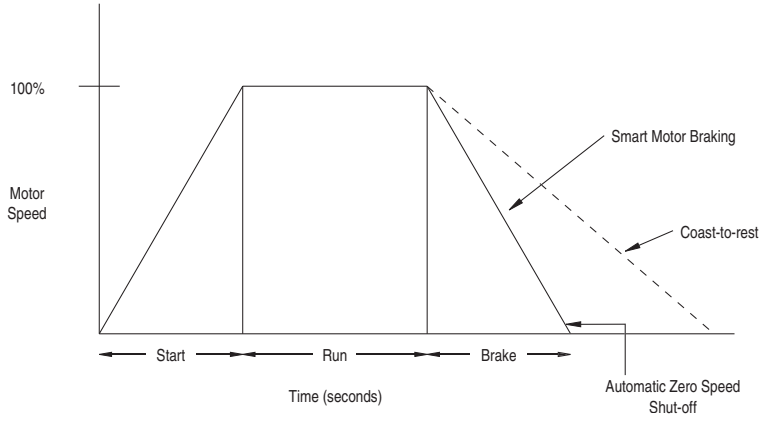
ATTENTION Pump stopping may cause motor heating depending on the mechanical dynamics of the pumping system. Therefore, select the lowest stopping time setting that will satisfactorily stop the pump.

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.

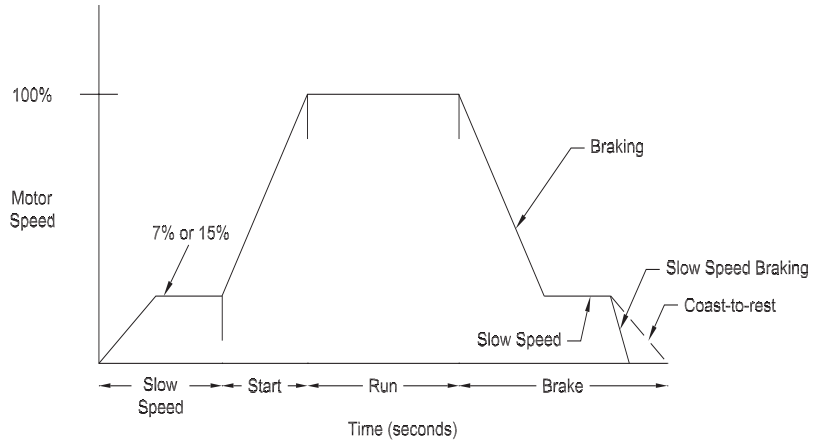
ATTENTION

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



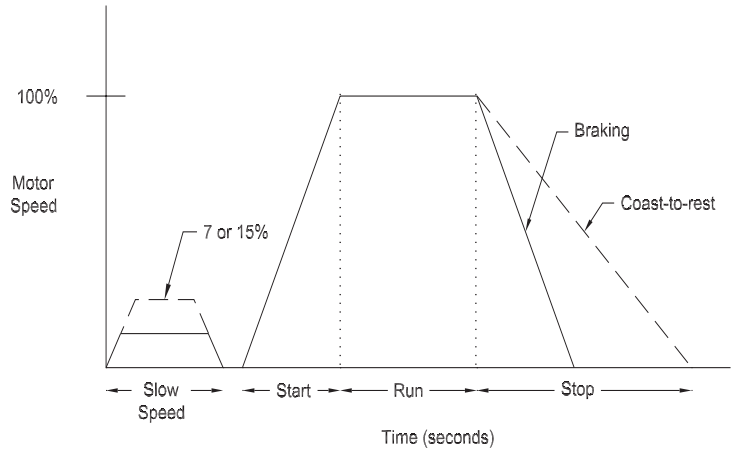
ATTENTION

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…1000 A
Service Factor	0.01…1.99

Notes: (1) The factory default setting for Overload Class, which is "Off," disables overload protection. An overload trip class and the motor's full load current rating must be programmed to enable 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

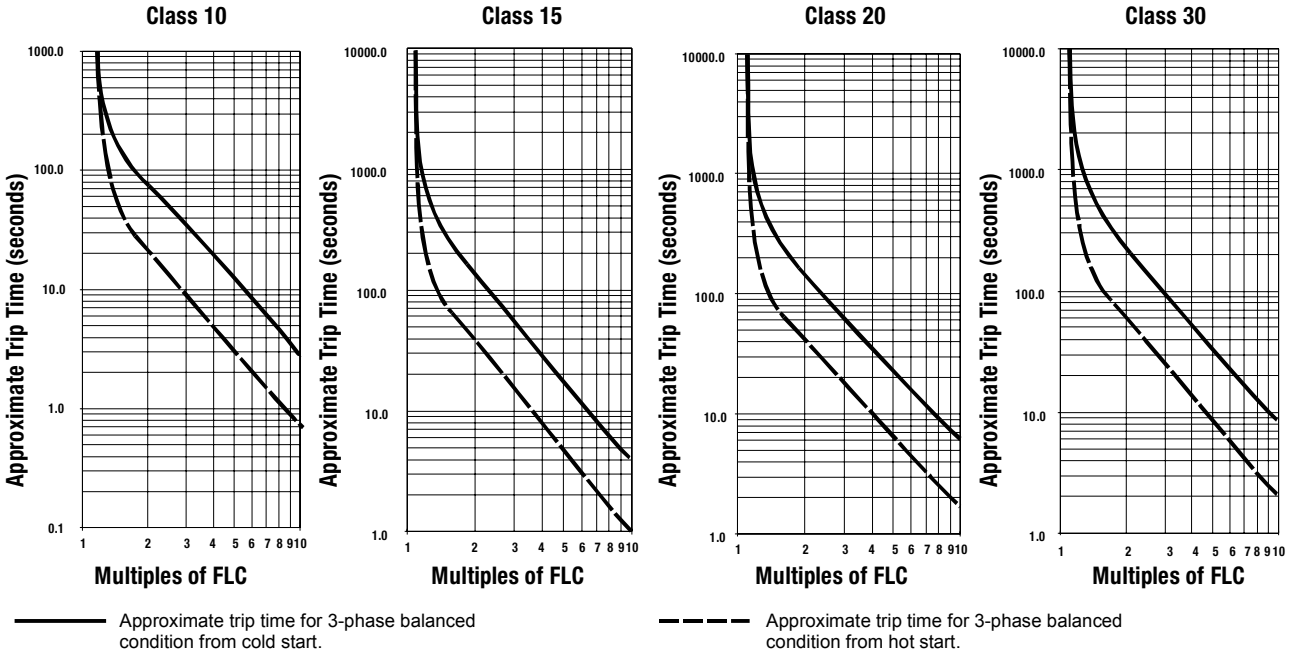
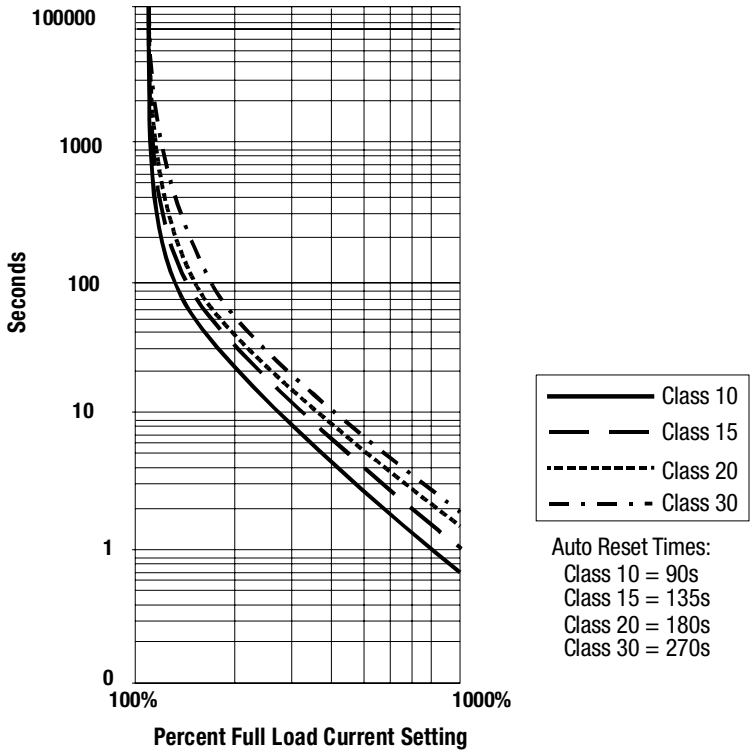


Figure 1.14 Restart Trip Curves after Auto Reset



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.

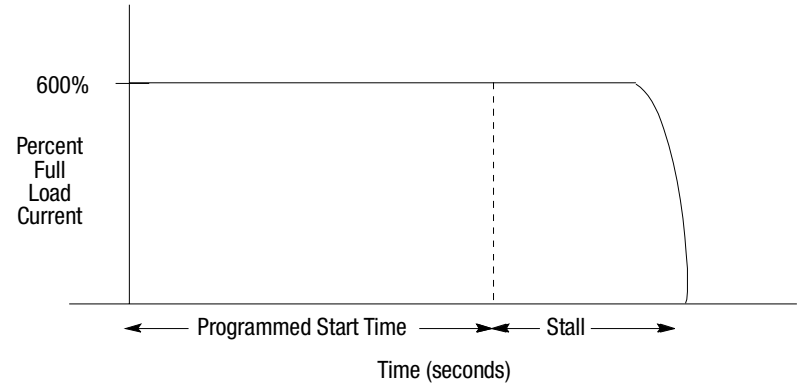
① Undervoltage, overvoltage, and voltage unbalance protection are disabled during braking operation.

Stall Protection and Jam Detection

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

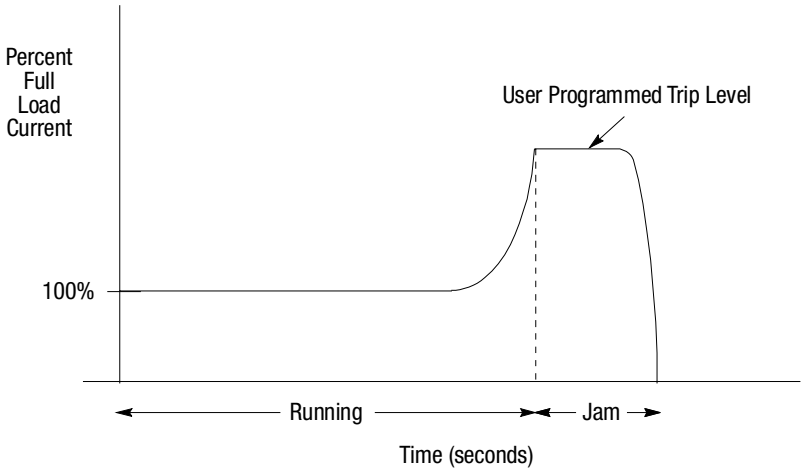
- Stall protection is user-adjustable from 0.0…10.0 seconds (in addition to the ramp time programmed).

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.

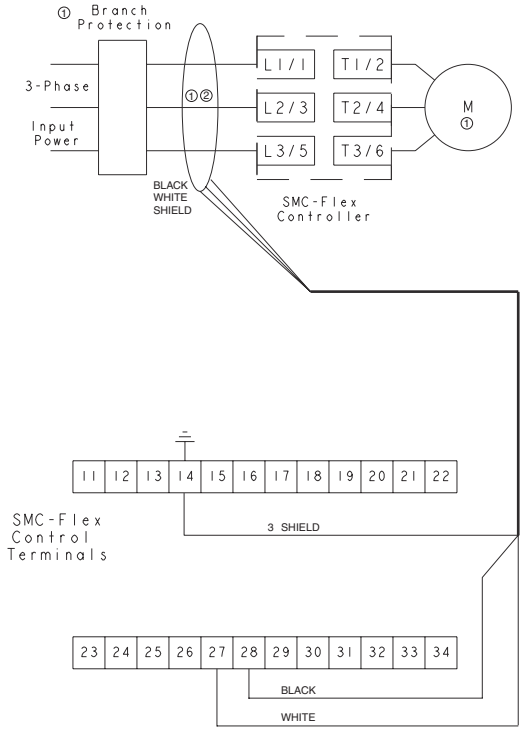
② Unit will self-protect in a jam condition.

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 consist of installing a Cat. No. 825-CBCT core balance current transformer for 1…5A core-balanced ground fault protection with the option of enabling Ground Fault Trip, Ground Fault Alarm, or both.

Figure 1.17



① Customer supplied.

② Cat. No. 825-CBCT

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…25 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.

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.

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 0.1…25 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.

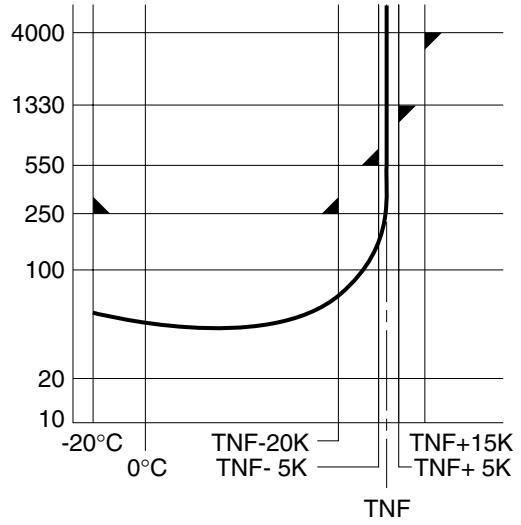
The following table defines the SMC-Flex PTC thermistor input and response ratings:

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:

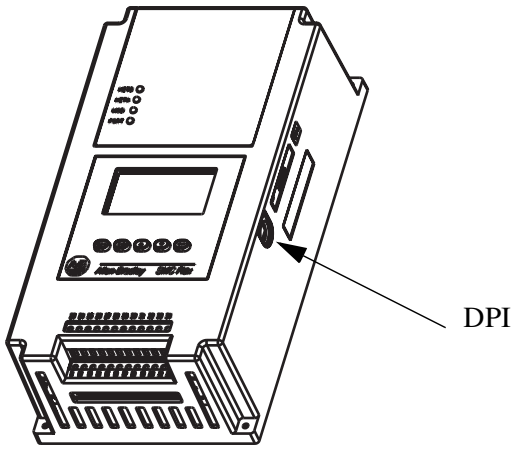
- Three-phase current
- Three-phase voltage
- Power in kW
- Power usage in kWH
- Power factor
- Motor thermal capacity usage
- Elapsed time

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%.

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

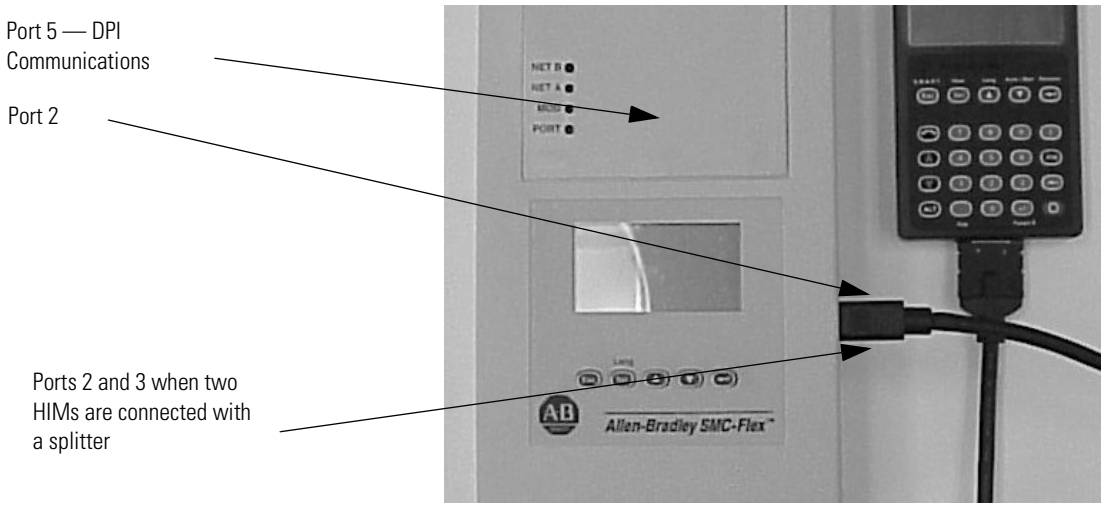


ATTENTION Two peripheral devices can be connected to the DPI. The maximum output current through the DPI is 280 mA.

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:

- The Auxiliary #1 Contact is N.O. programmable for Normal/Up-to-speed/External Bypass.
- The fault Contact is for fault indication and is programmable for N.O./N.C.
- The alarm Contact is for alarm indication and is programmable for N.O./N.C.
- The Auxiliary #2 Contact is for normal indication and is programmable for N.O./N.C.

Figure 1.21 Control Terminals

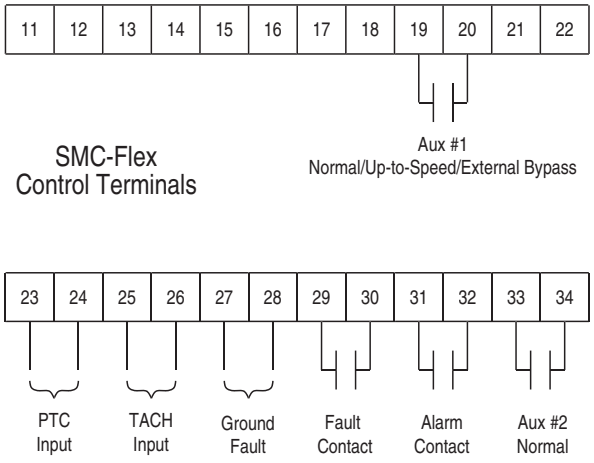


Figure 1.22

Installation

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.

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
Max. Watts	95	95	106	122	155	167	176	200	218	225	245	290

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.**

Enclosures

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)	229 (9)
25	610 (24)	406 (16)	229 (9)
43	610 (24)	406 (16)	229 (9)
60	610 (24)	406 (16)	229 (9)
85	610 (24)	406 (16)	229 (9)
108	762 (30)	610 (24)	305 (12)
135	965 (38)	762 (30)	356 (14)
201	965 (38)	762 (30)	356 (14)
251	1295 (51)	914 (36)	356 (14)
317	1524 (60)	914 (36)	356 (14)
361	2134 (84)	1016 (40)	457 (18)
480	2286 (90)	1778 (70)	508 (20)
Combination Controllers with Fusible Disconnect			
5	610 (24)	406 (16)	229 (9)
25	610 (24)	406 (16)	229 (9)
43	610 (24)	406 (16)	229 (9)
60	610 (24)	406 (16)	229 (9)
85	610 (24)	406 (16)	229 (9)
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	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)
Combination Controllers with Circuit Breaker			
5	610 (24)	406 (16)	229 (9)
25	610 (24)	406 (16)	229 (9)
43	610 (24)	406 (16)	229 (9)
60	610 (24)	406 (16)	229 (9)
85	610 (24)	406 (16)	229 (9)
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)

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

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

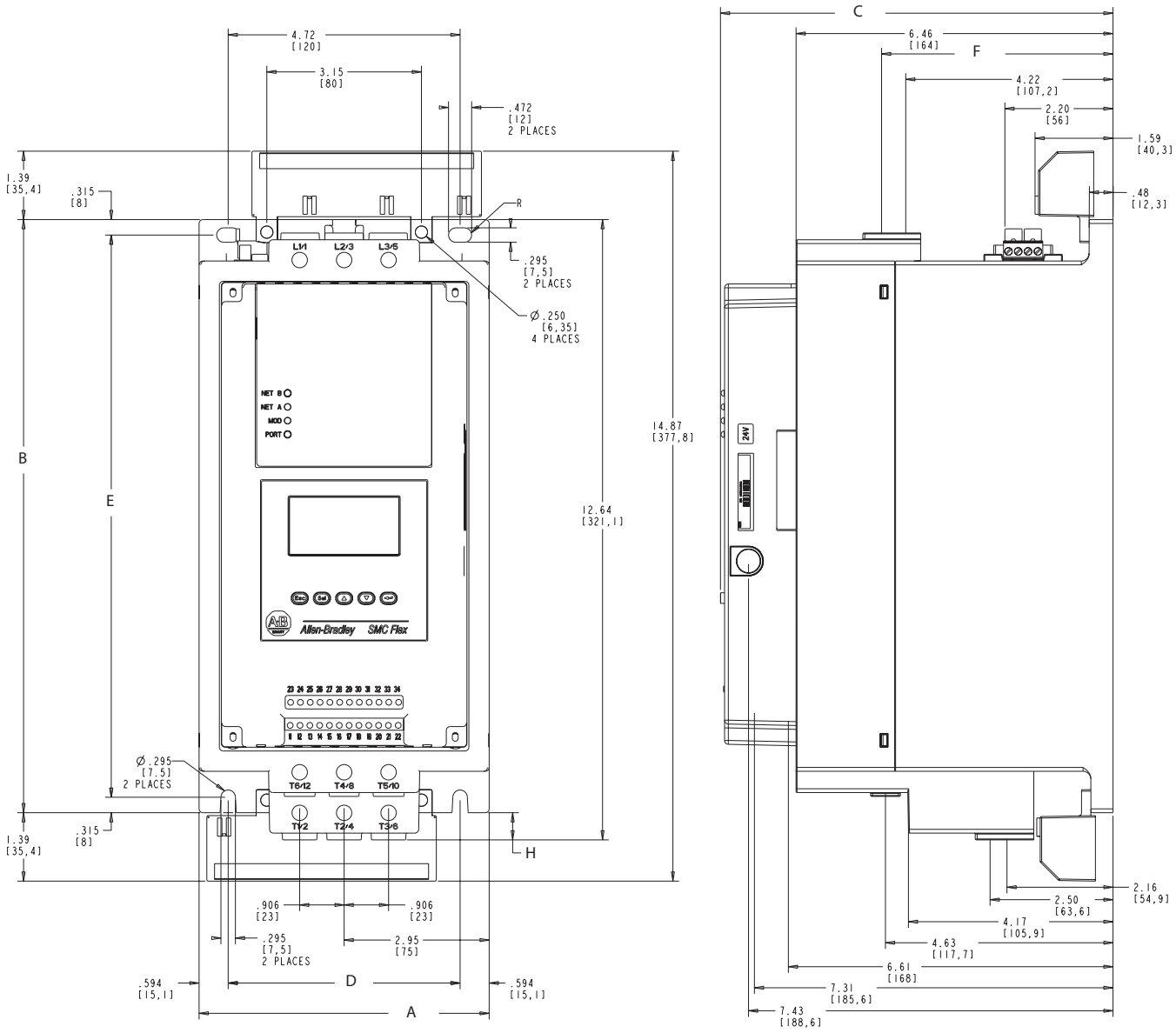
Mounting

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.**

Dimensions

Figure 2.1 shows the SMC-Flex product dimensions for the 5…85 A devices. Figure 2.2 shows the dimensions for 108…251 A devices. Figure 2.3 shows the dimensions for 317…480 A devices.

Figure 2.1 Dimensions: 5…85 A Controllers



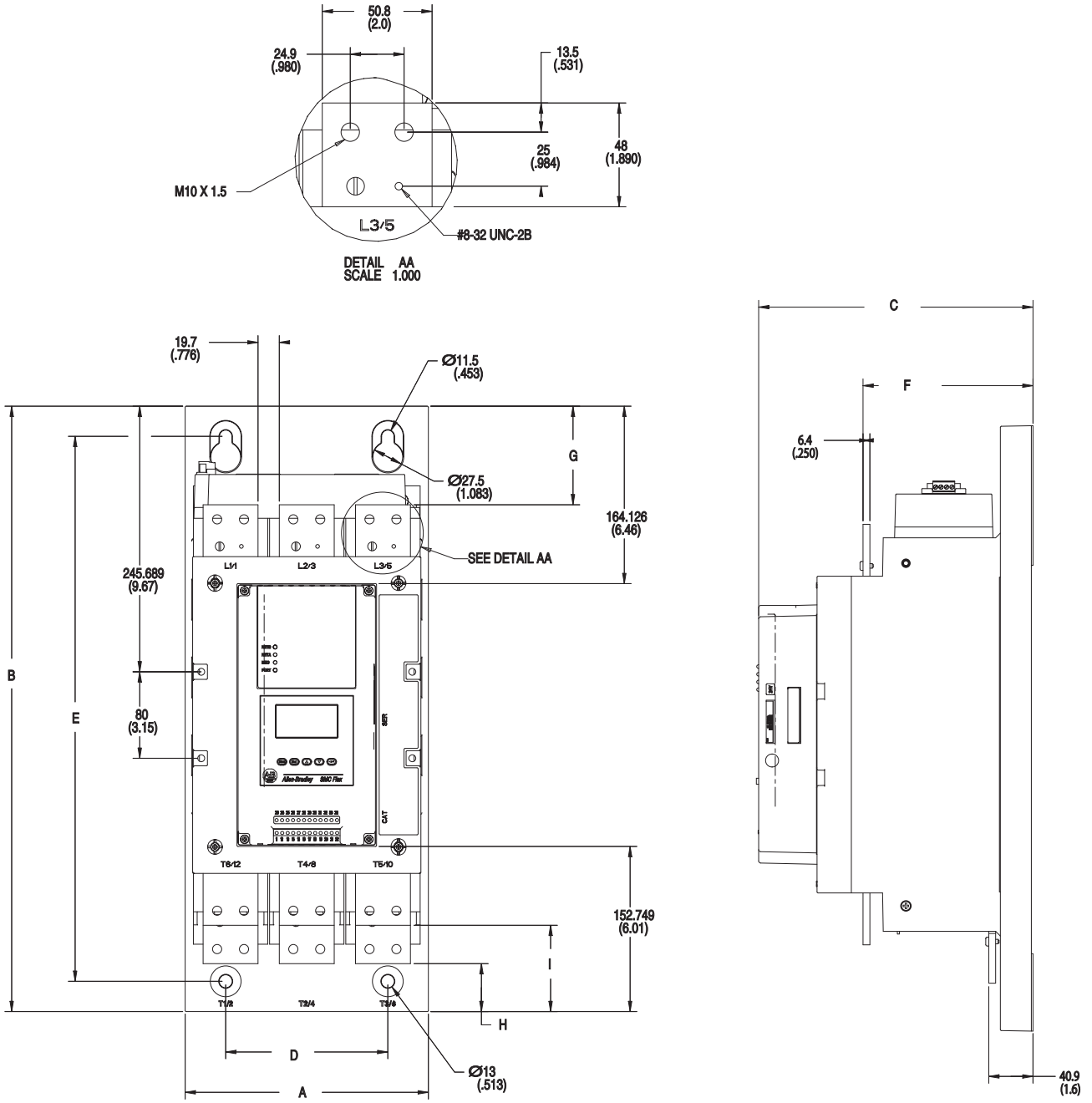
NOTE:
1) DIMENSIONS IN INCHES [MILLIMETERS].

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.

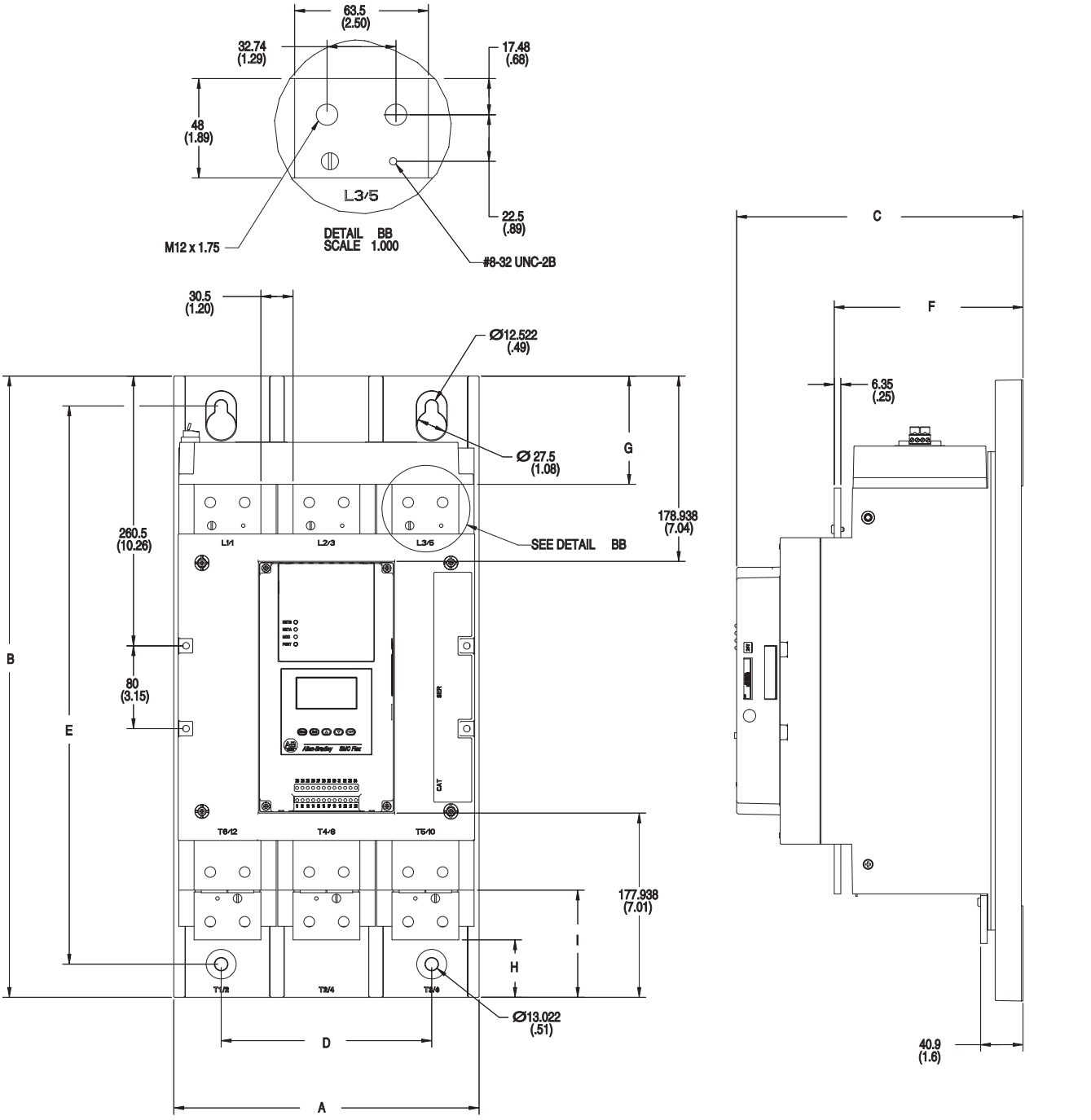
Figure 2.2 Dimensions: 108…251 A Controllers



	Unit	A Width	B Height	C Depth	D	E	F	G	H	I	Approx. Ship. Wt.
108…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 2.3 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.

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…600V — 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 2.4 Typical Wiring Diagram for Power Factor Correction Capacitors

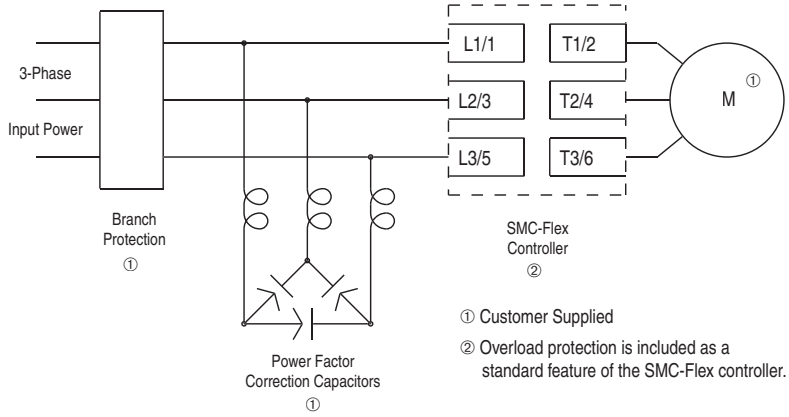
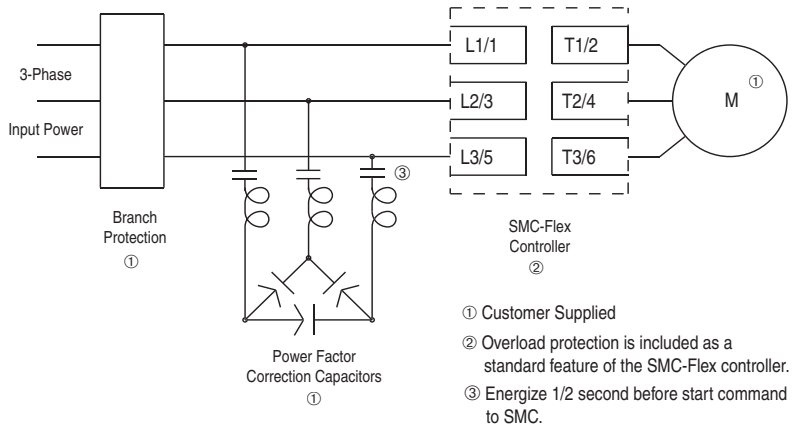


Figure 2.5 Typical Wiring Diagram for Power Factor Correction Capacitors and Contactor



Protective Modules

Protective modules containing metal oxide varistors (MOVs) can be installed on controllers rated 5…480 A 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 3.2. 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 inside-the-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)

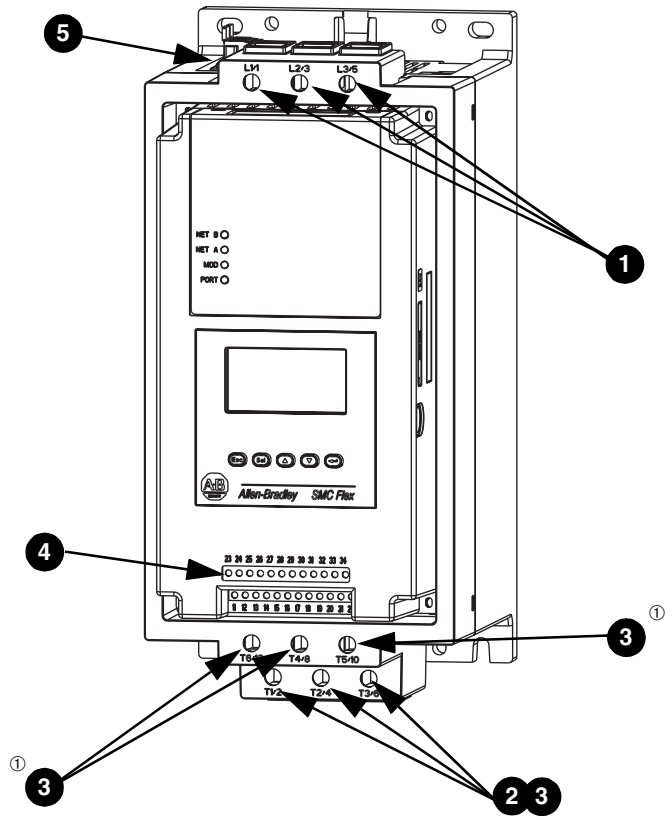


Table 3.A Wiring Terminal Locations

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)

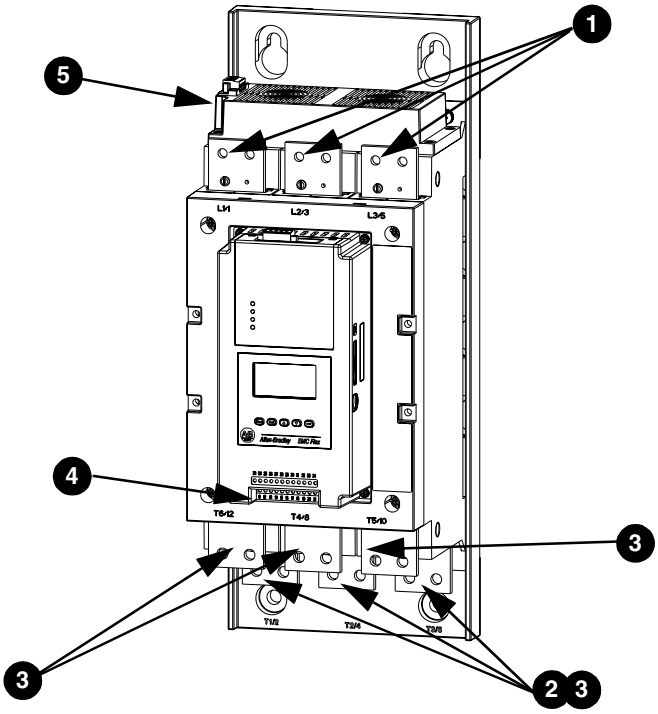


Table 3.A Wiring Terminal Locations

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

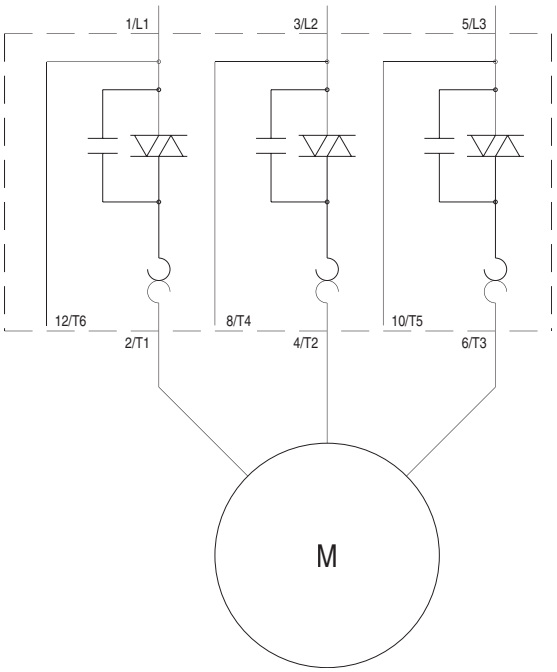
Power Structure

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…480 A units. In the 5…85 A units, these contacts are pulled in, all at once. The SMC-Flex product also has a CT, built in on each phase of the motor to provide current readings.

Power Wiring

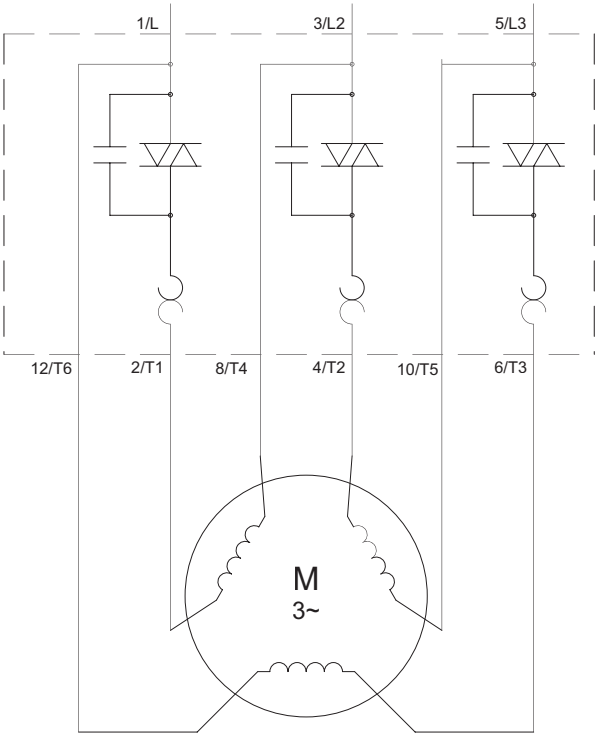
The SMC-Flex can be connected to a Line-controlled motor as shown in Figure 3.3. Current ratings for the motor must be in the range of 1 A…480 A.

Figure 3.3 Line Power Wiring diagram



The SMC-Flex can be connected to a Wye-Delta motor in an inside-the-Delta wiring configuration as shown in Figure 3.4. Current ratings for the motor must be in the range of 1.8…831 A.

Figure 3.4 Delta Power Wiring diagram



Power lugs are available as optional kits. Each kit contains three lugs. The number of terminal lugs required is listed in the table below. Table 3.A also provides the lug wire capacity and the tightening torque requirements.

ATTENTION

Terminal covers are available which can make the product deadfront (IP2X) safe. See Appendix D for the appropriate catalog numbers for ordering.

Table 3.A Lug Wire Capacity and Tightening Torque

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…85 mm^2 (#14…3/0 AWG)	—	—	14.7 N•m (130 lb.-in.)	—
108…135 A (Series 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.)
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.)	45 N•m (400 lb.-in.)

Control Power

Control Voltage

The SMC-Flex controller will accept a control power input of 100...240V AC, (–15/+10%), 1 phase, 50/60 Hz or 24V AC/DC. Refer to the product nameplate to verify the control power input voltage.

Connect control power to the controller at terminals 11 and 12. The control power requirement for the control module is 75 VA. For controllers rated 5…480 A, control power is also required for the heatsink fans as defined in Table 3.C. Depending on the specific application, additional control circuit transformer VA capacity may be required.

Control Wiring

Table 3.B 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.B 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…480 A have heatsink fan(s). Refer to Table 3.C for the control power VA requirements of the heatsink fans.

Fan Terminations

See Figure 3.2 for fan power connection locations.

ATTENTION The fan jumpers have been factory installed for 110/120 VAC input. Refer to Figure 3.5 for 220/240 VAC fan wiring.

Figure 3.5 5…480 A Fan Terminations

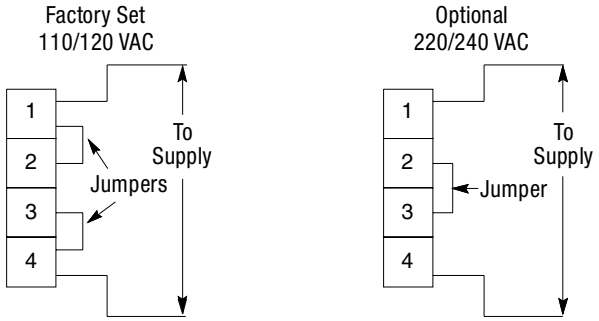


Table 3.C Heatsink Fan Control Power

SMC Rating	Heatsink Fan VA
5…85 A	15
108…480 A	50

Control Terminal Designations

As shown in Figure 3.6, the SMC-Flex controller contains 24 control terminals on the front of the controller.

Figure 3.6 SMC-Flex Controller Control Terminals

Terminal Number	Description
11	Control Power Input ①
12	Control Power Common ①
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	N.O. Aux. Contact #1 (Normal/Up-to-Speed/External Bypass) ①③
20	N.O. Aux. Contact #1 (Normal/Up-to-Speed/External Bypass) ①③
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	Fault Contact (N.O./N.C.) ①
30	Fault Contact (N.O./N.C.) ①
31	Alarm Contact (N.O./N.C.) ①
32	Alarm Contact (N.O./N.C.) ①
33	Aux Contact #2 Normal (N.O./N.C.) ①
34	Aux Contact #2 Normal (N.O./N.C.) ①

① RC Snubbers are required on loads connected to auxiliary.

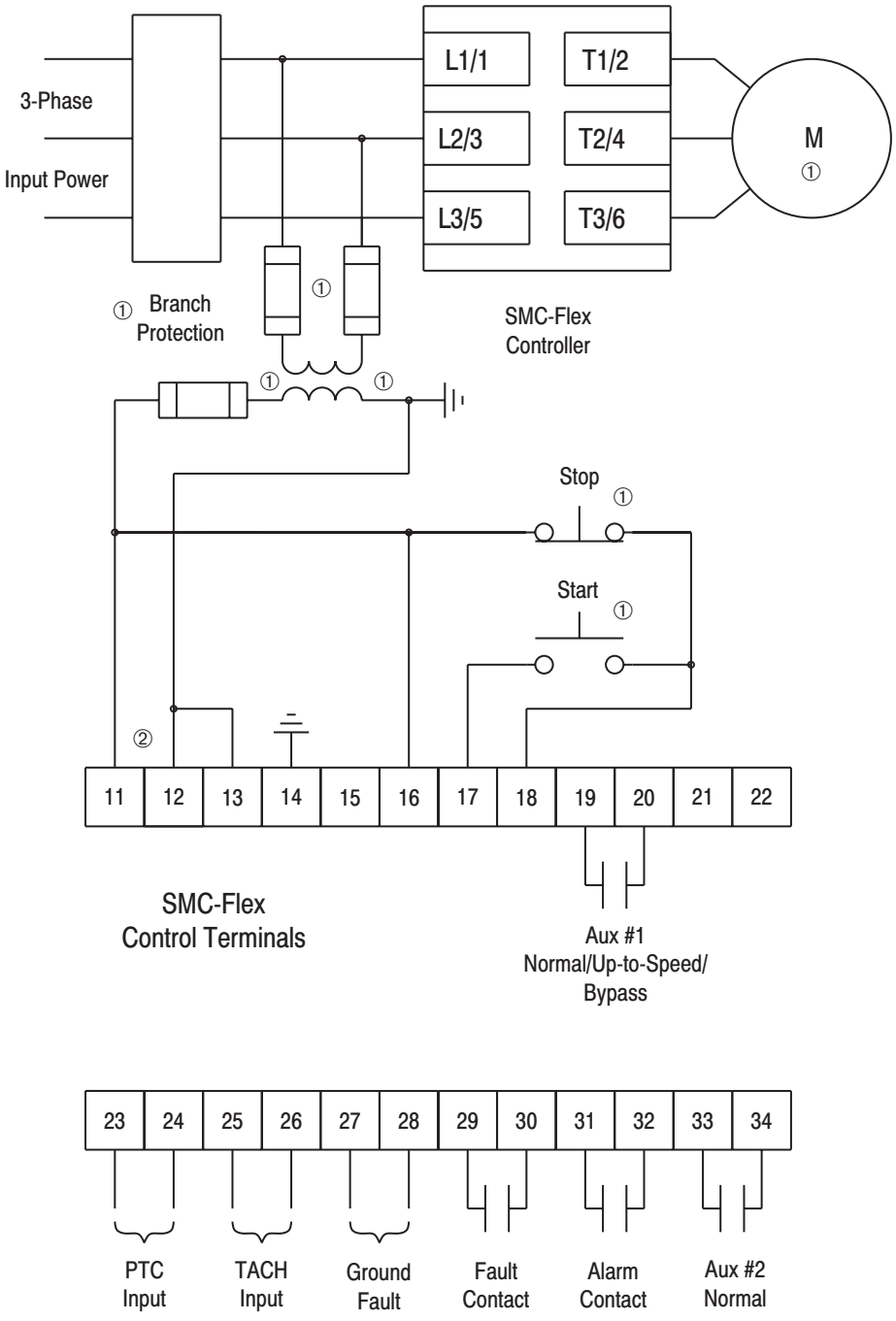
② Do not connect any additional loads to these terminals. These “parasitic” loads may cause problems with operation, which may result in false starting and stopping.

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.

Standard Controller Wiring Diagrams

Figure 3.7 through Figure 3.18 show typical wiring for the SMC-Flex controller.

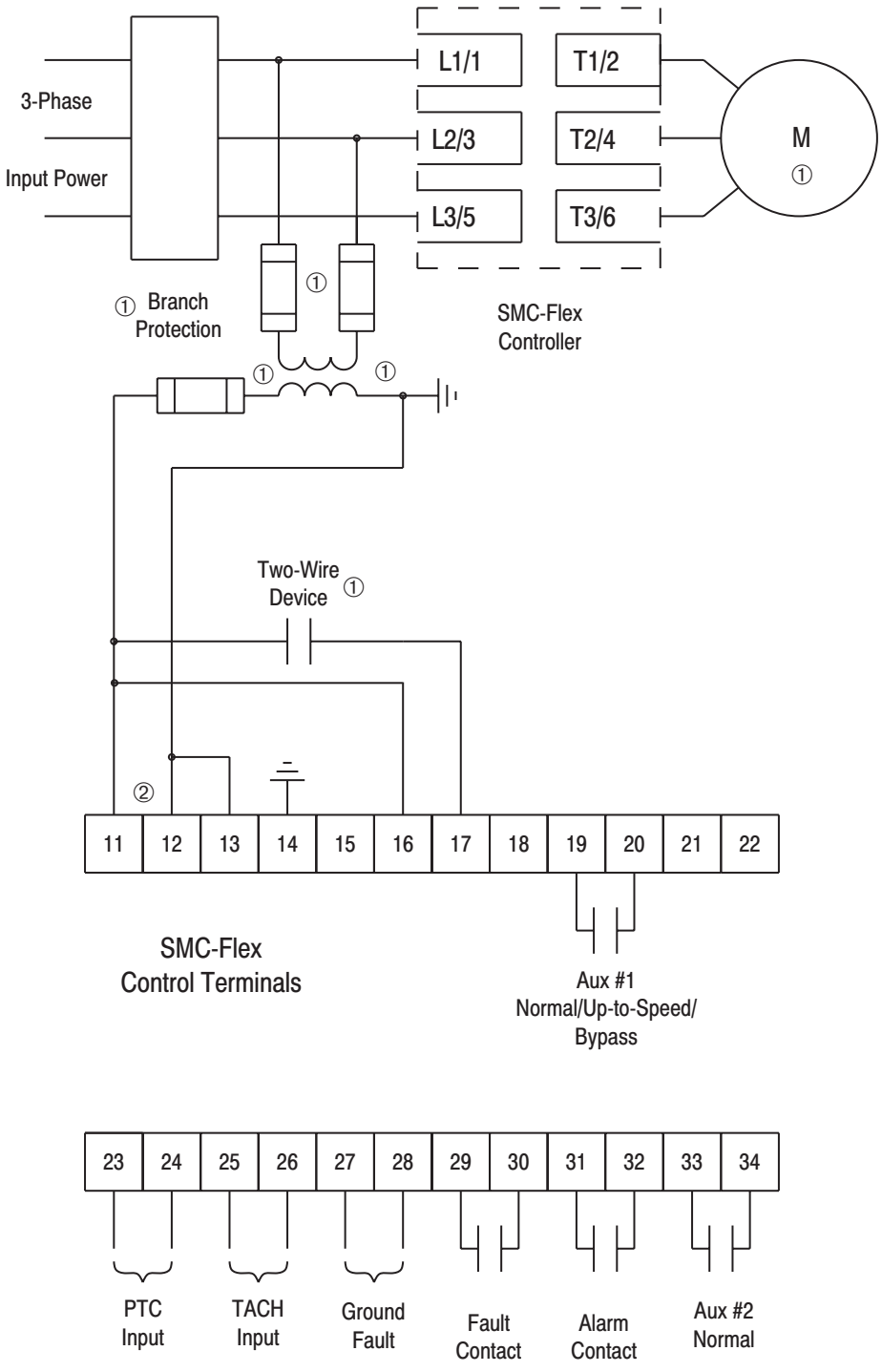
Figure 3.7 Typical Wiring Diagram for Standard Controller



① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage.

Figure 3.8 Typical Wiring Diagram for Two-Wire Control with No Stopping Control (No DPI Control)



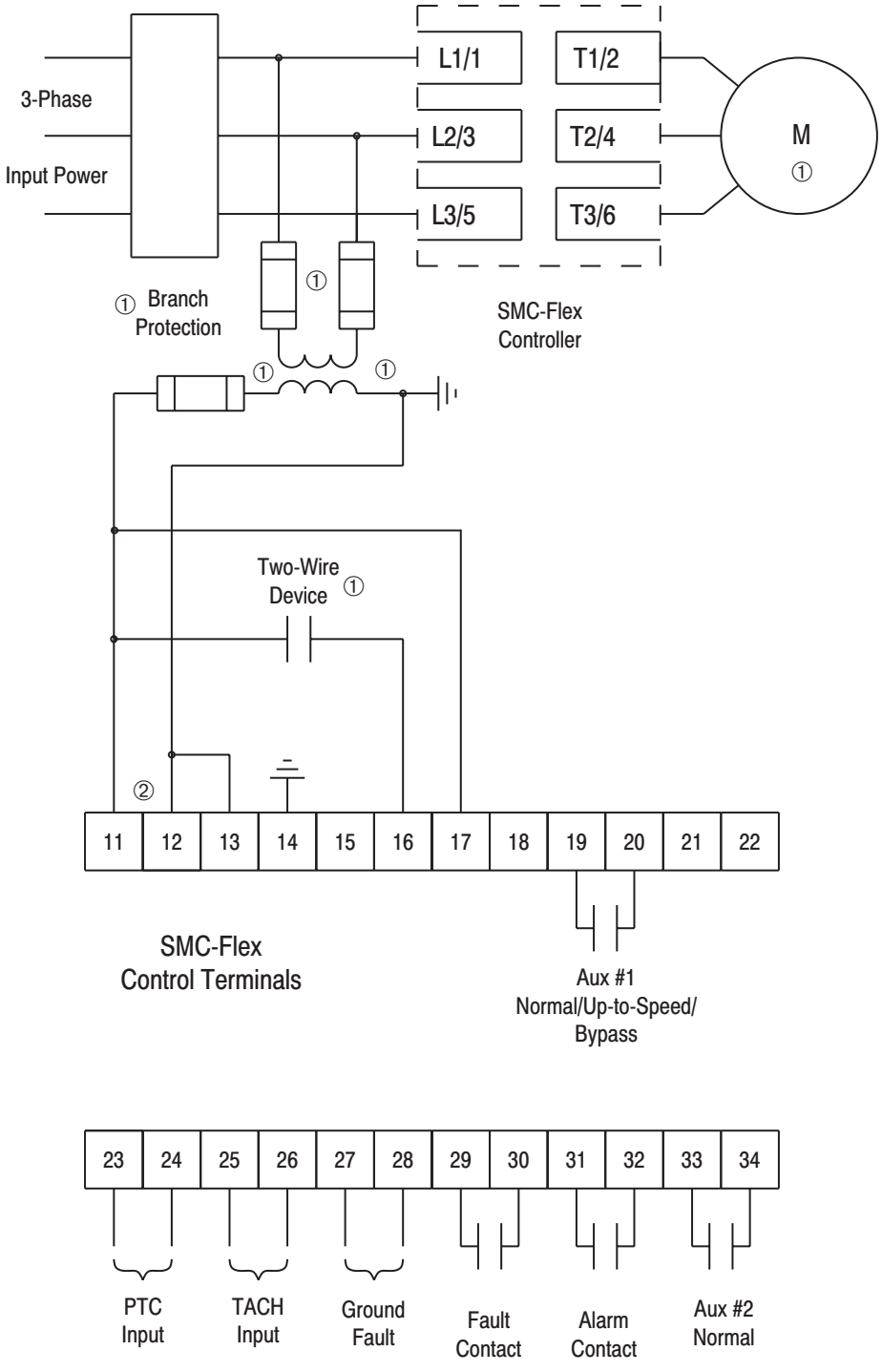
① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage.

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



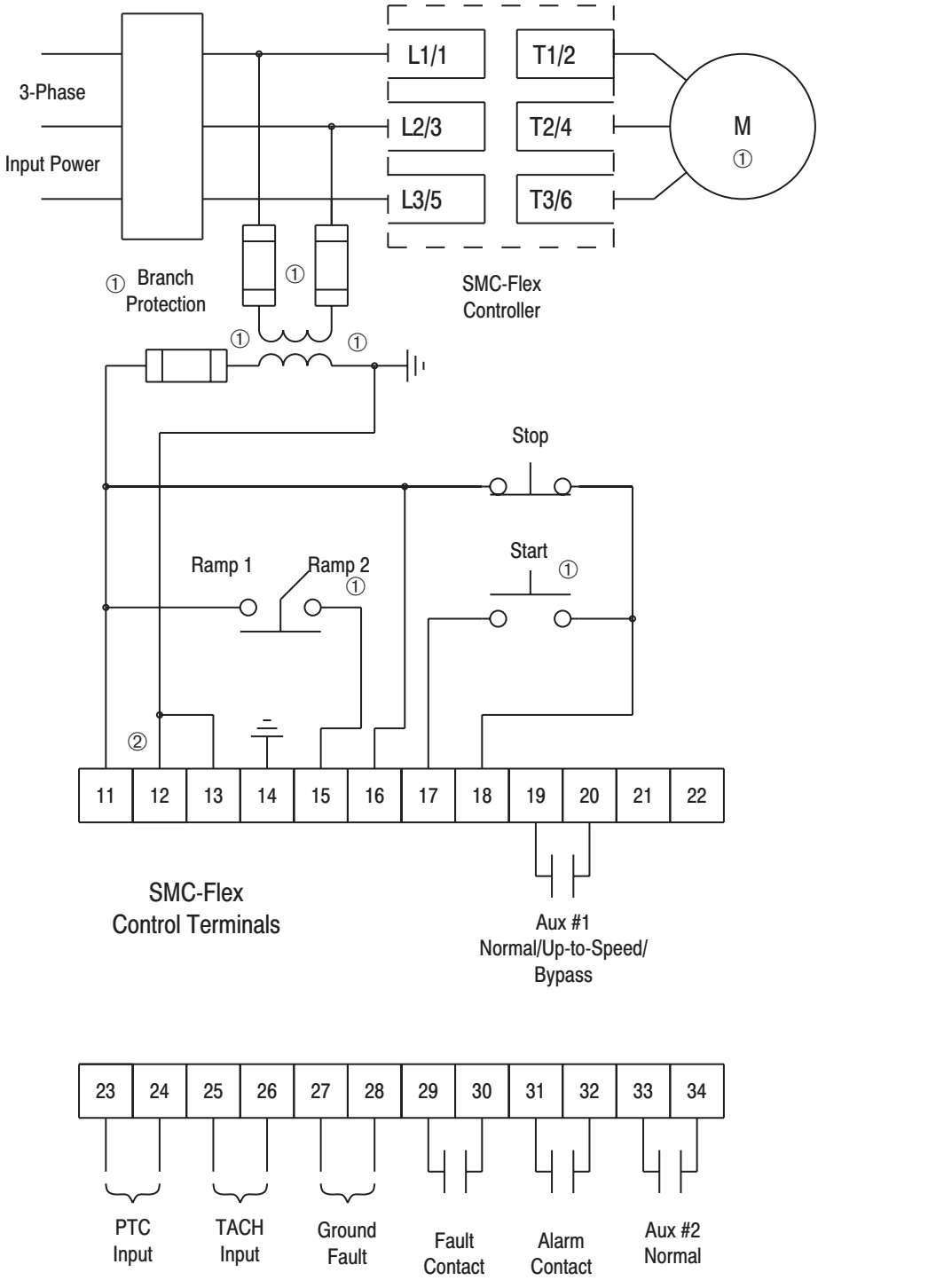
① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage.

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 3.10 Typical Wiring Diagram for Dual Ramp Applications



① Customer supplied.

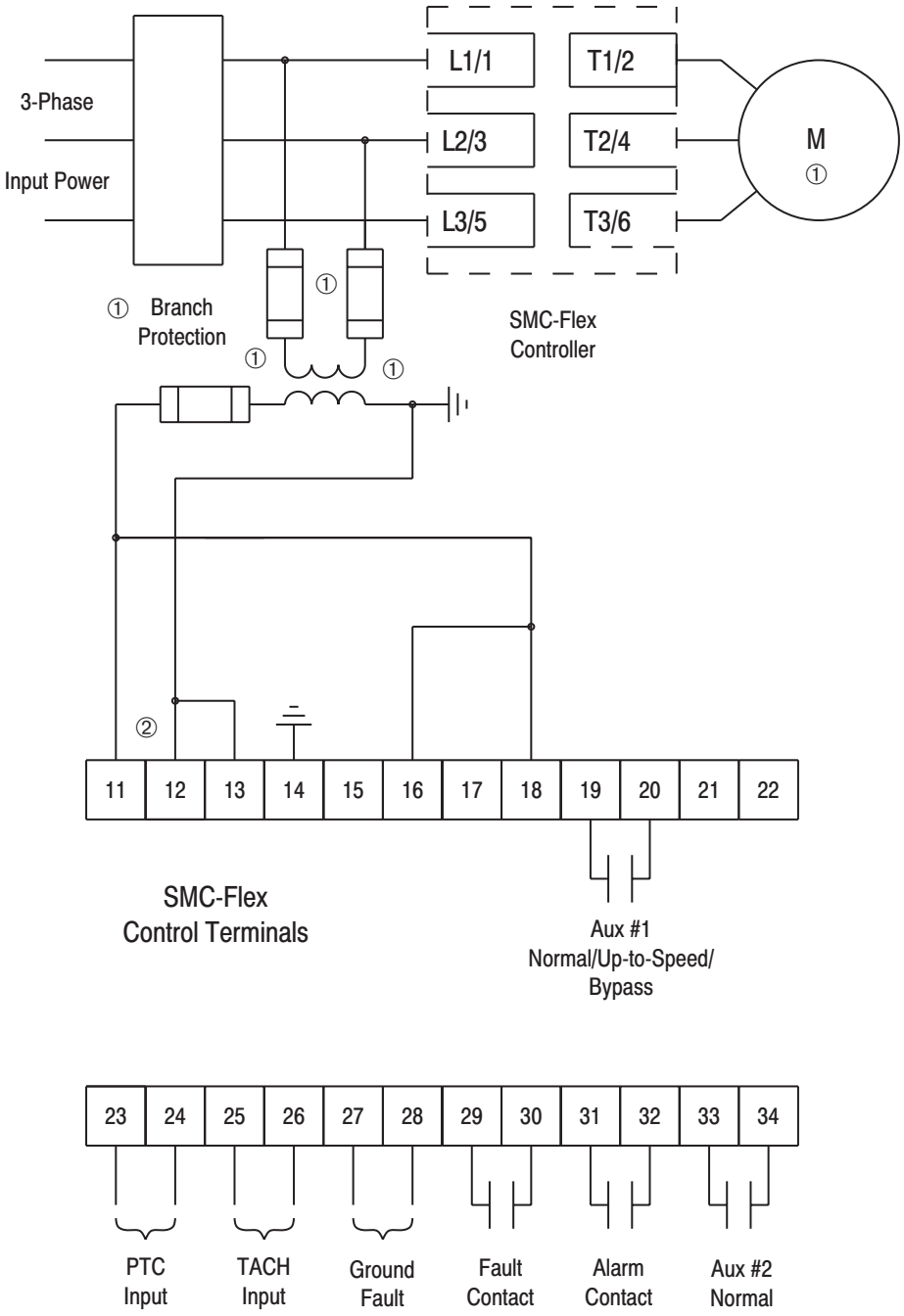
② Refer to the controller nameplate to verify the rating of the control power input voltage.

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

Figure 3.11 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.

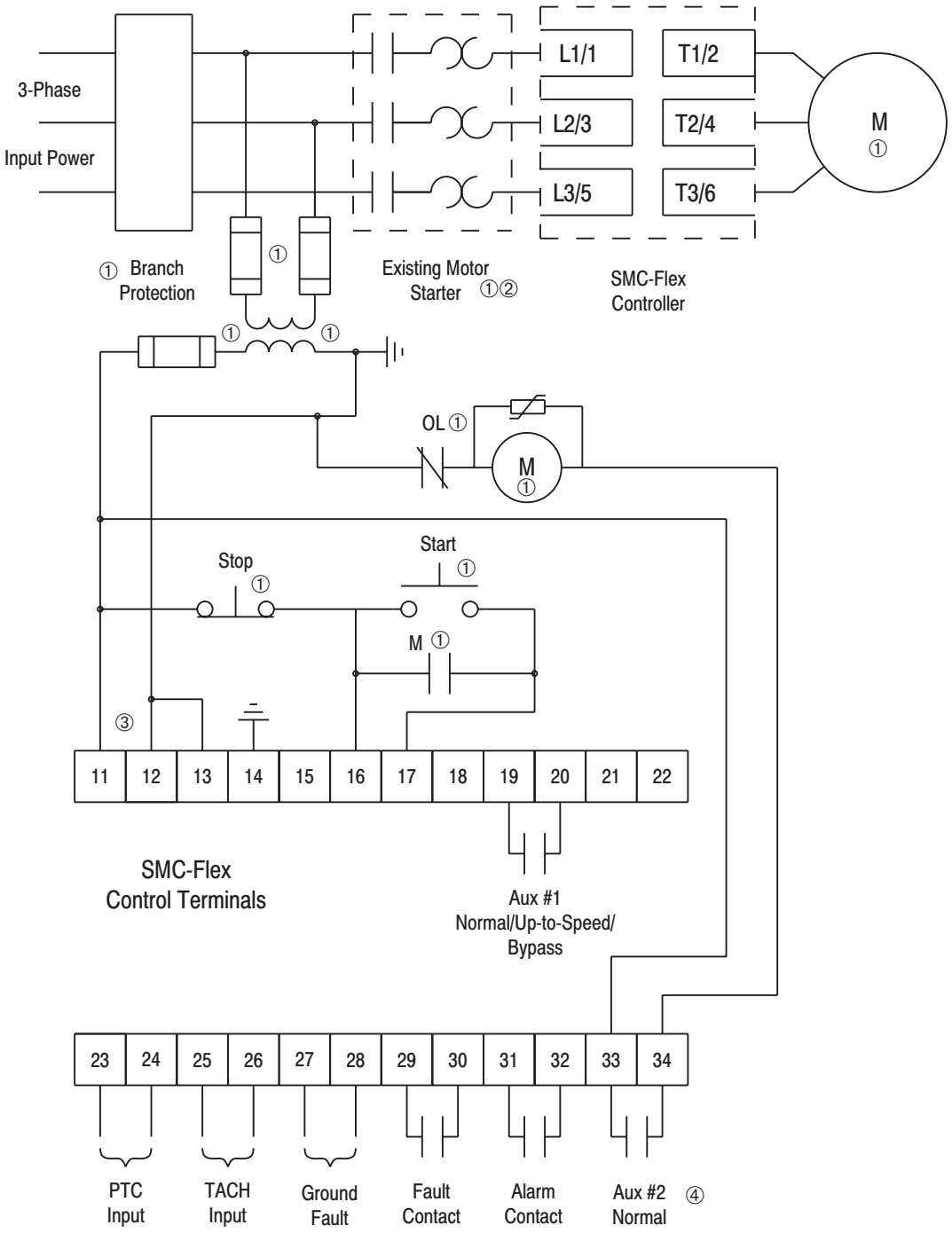
Note: Logic mask must be properly configured, see Chapter 8.



① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage.

Figure 3.12 Typical Wiring Diagram for Retrofit Applications



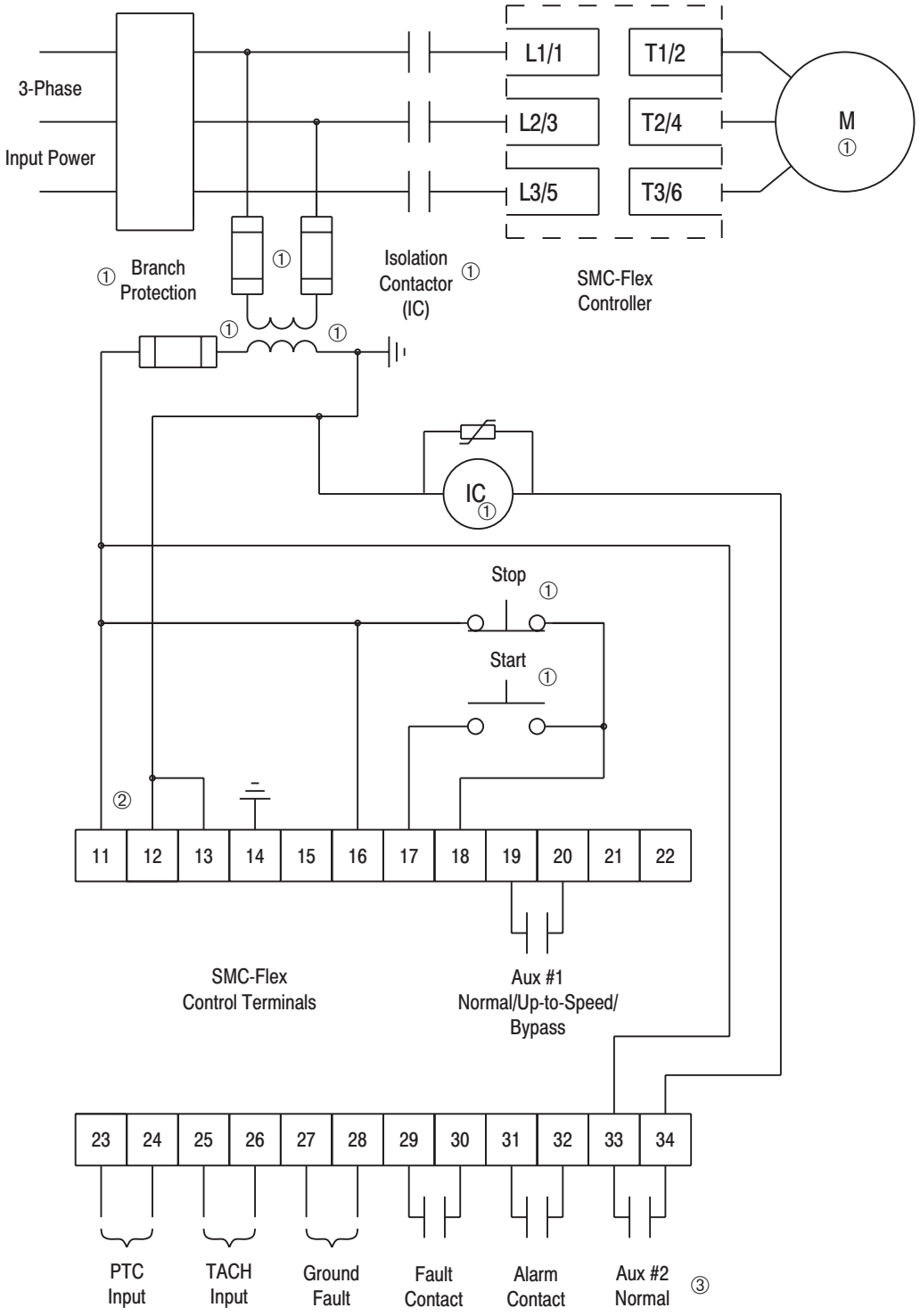
① Customer supplied.

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.

④ Aux #2 should be set for N.O.

Figure 3.13 Typical Wiring Diagram for Isolation Applications (DPI also)

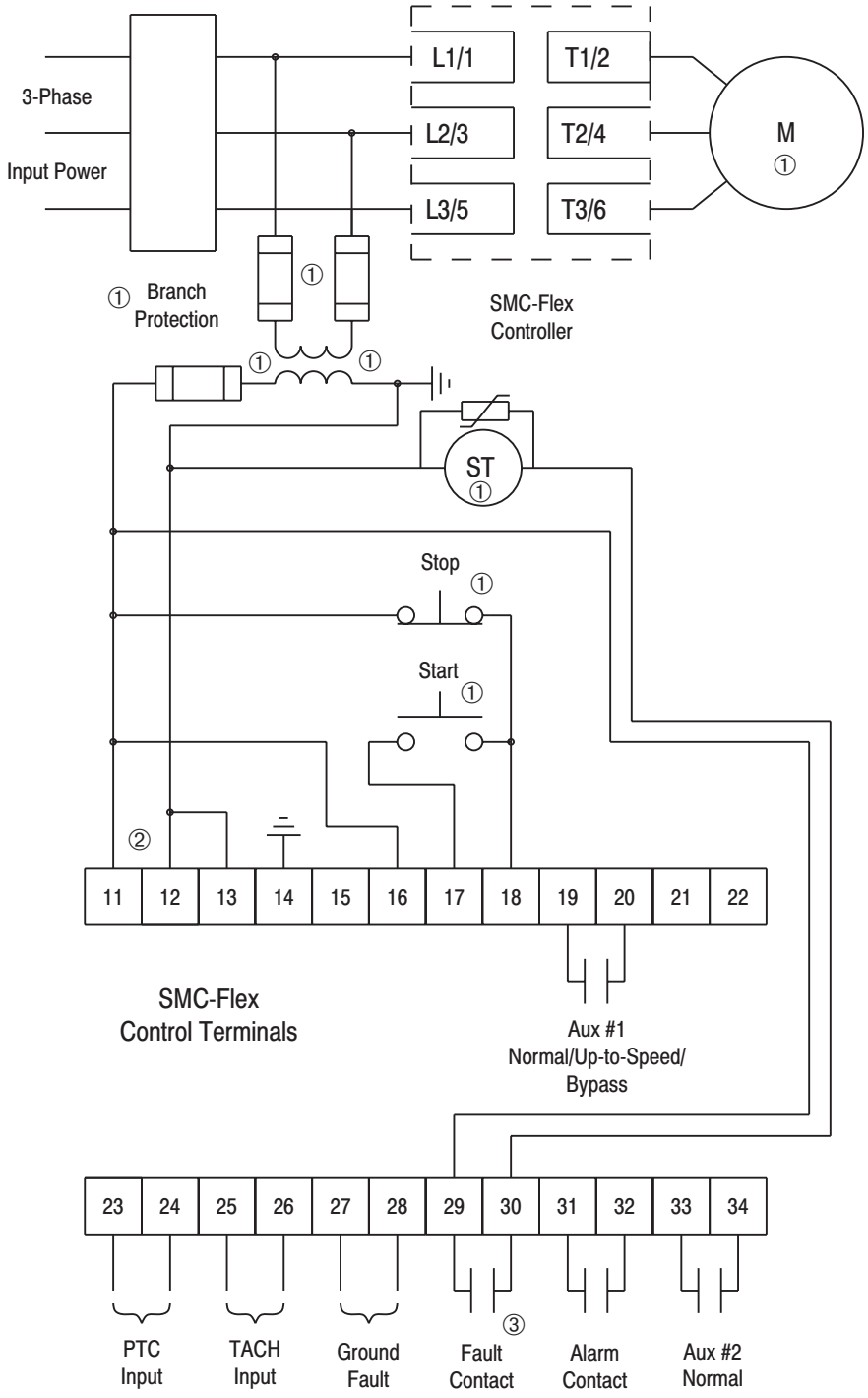


① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage.

③ Aux #2 should be set for N.O..

Figure 3.14 Typical Wiring Diagram for Shunt Trip Applications

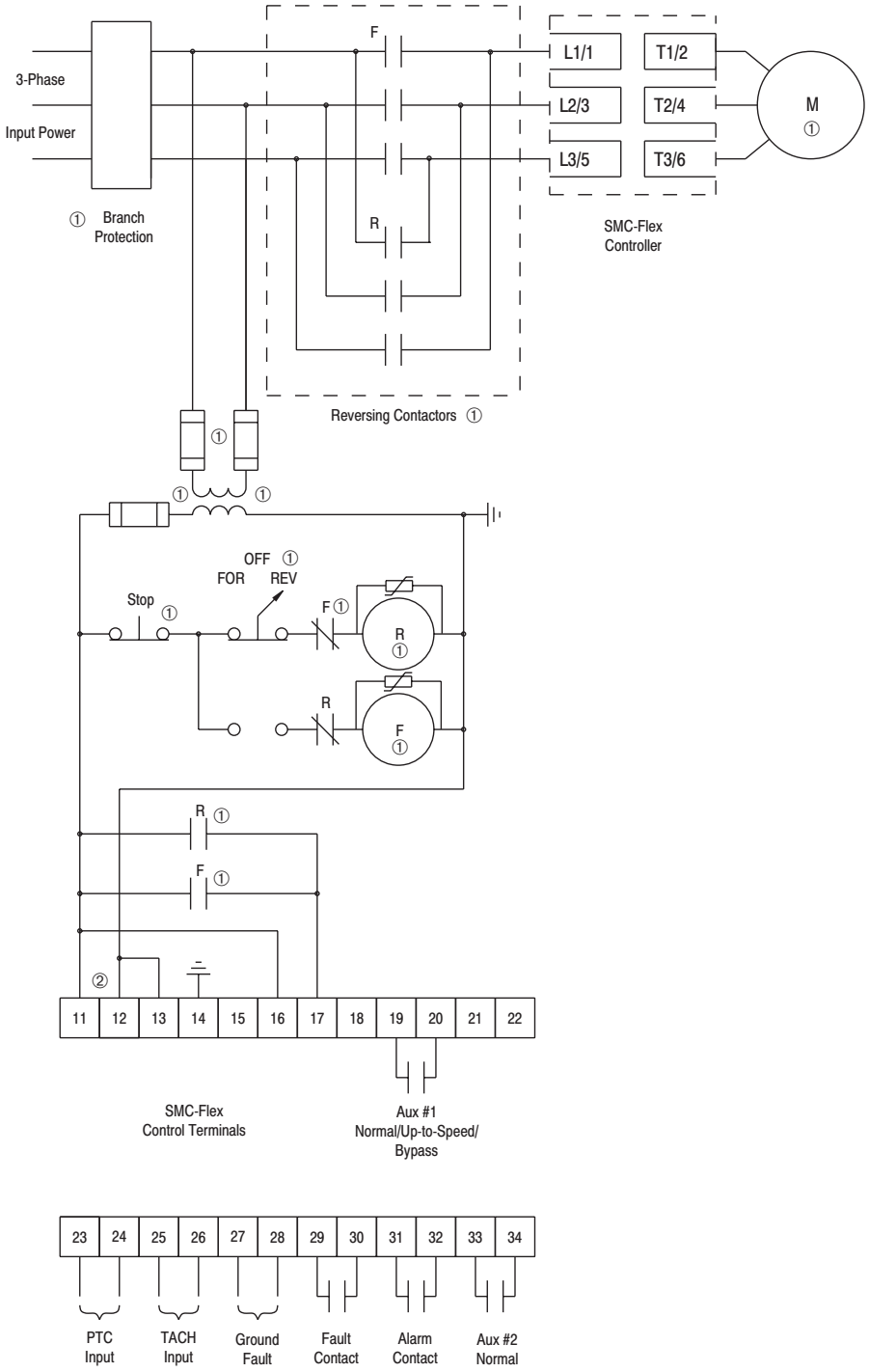


① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage.

③ Fault Contact should be set to N.O.

Figure 3.15 Typical Wiring Diagram for Single-Speed Reversing Applications



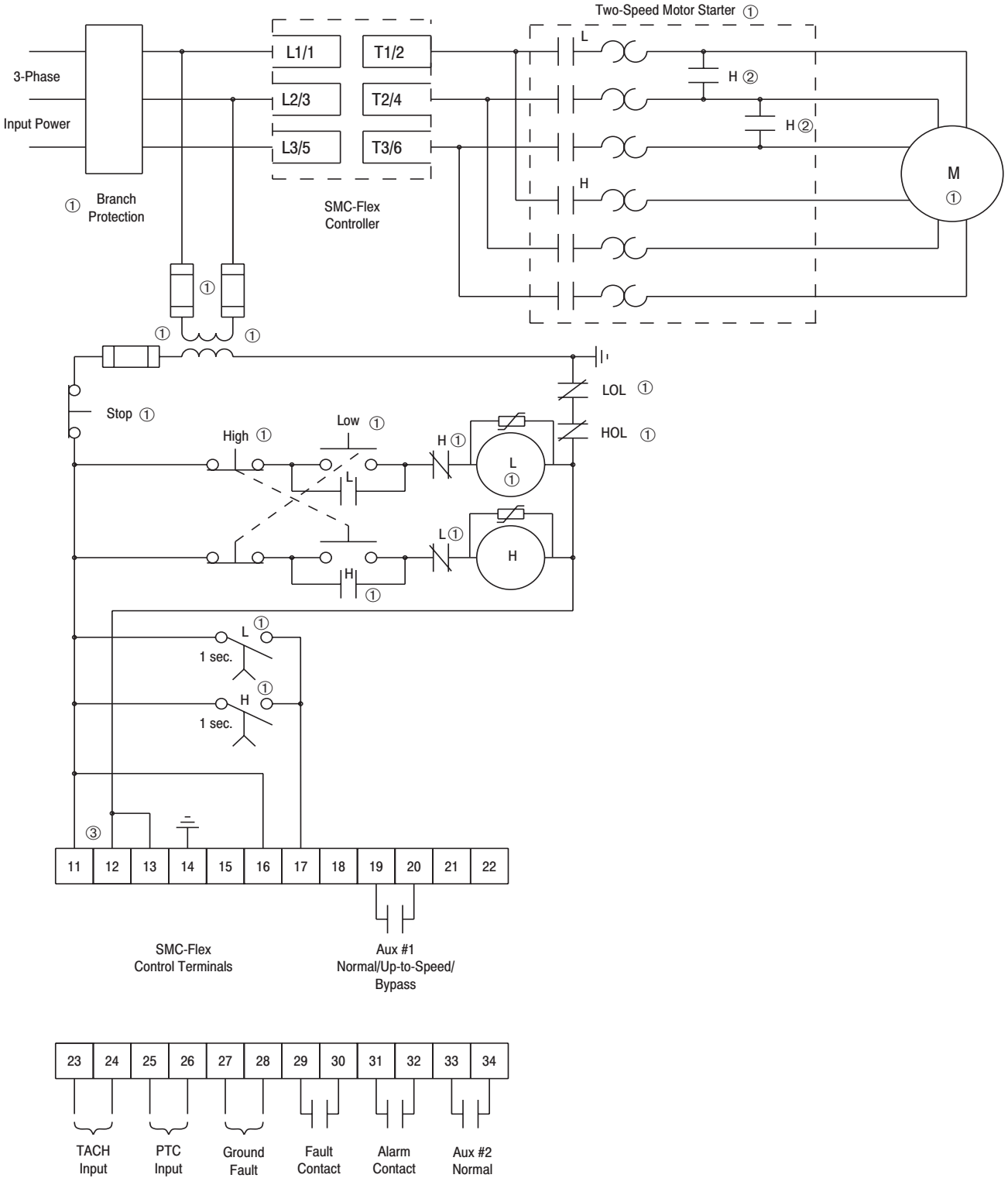
① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input rating.

③ No braking manuever allowed in wiring diagram.

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

Figure 3.16 Typical Wiring Diagram for Two-speed Applications



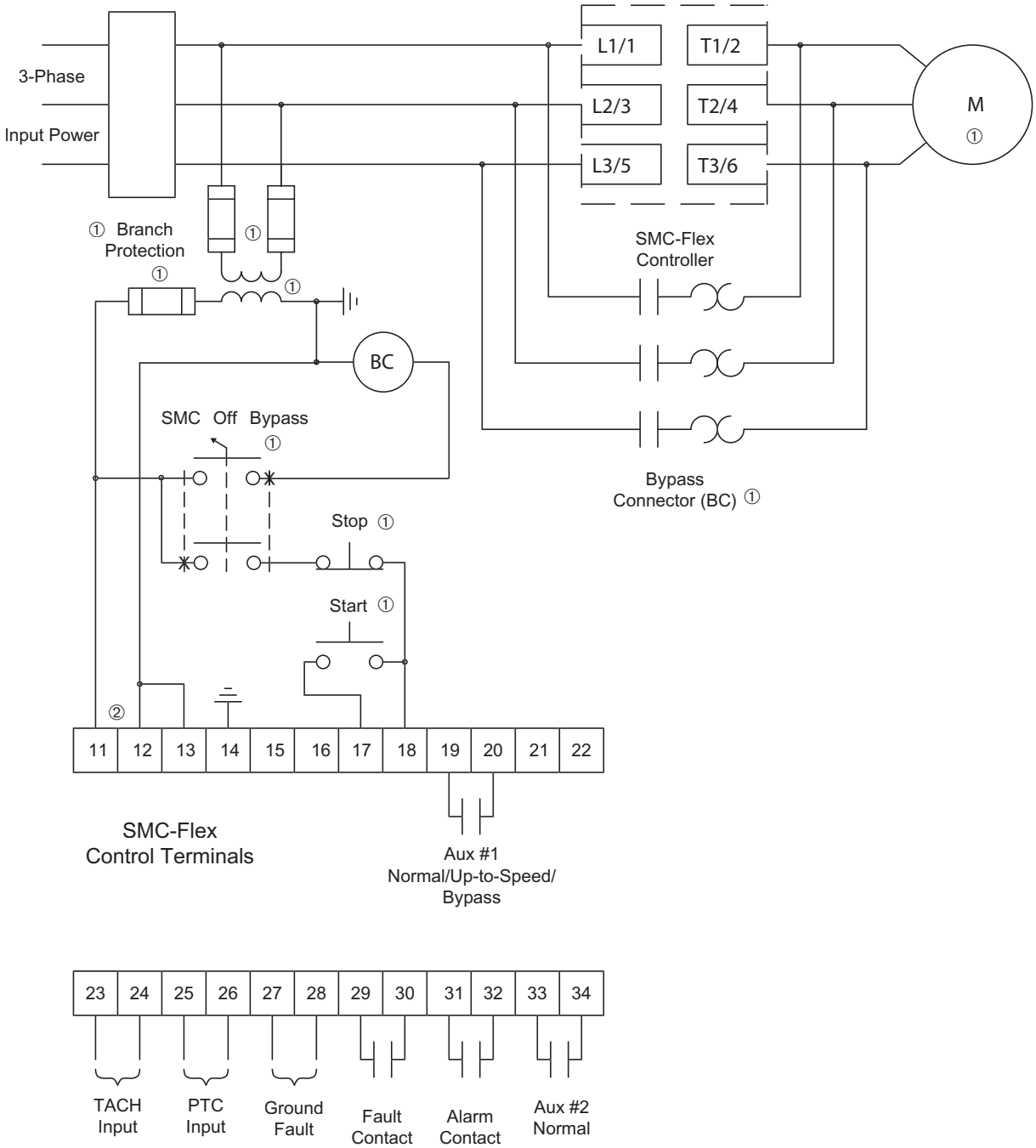
① Customer supplied.

② Two-speed, consequent pole installations.

③ Refer to the controller nameplate to verify the rating of the control power input voltage.

④ Overload must be disabled.

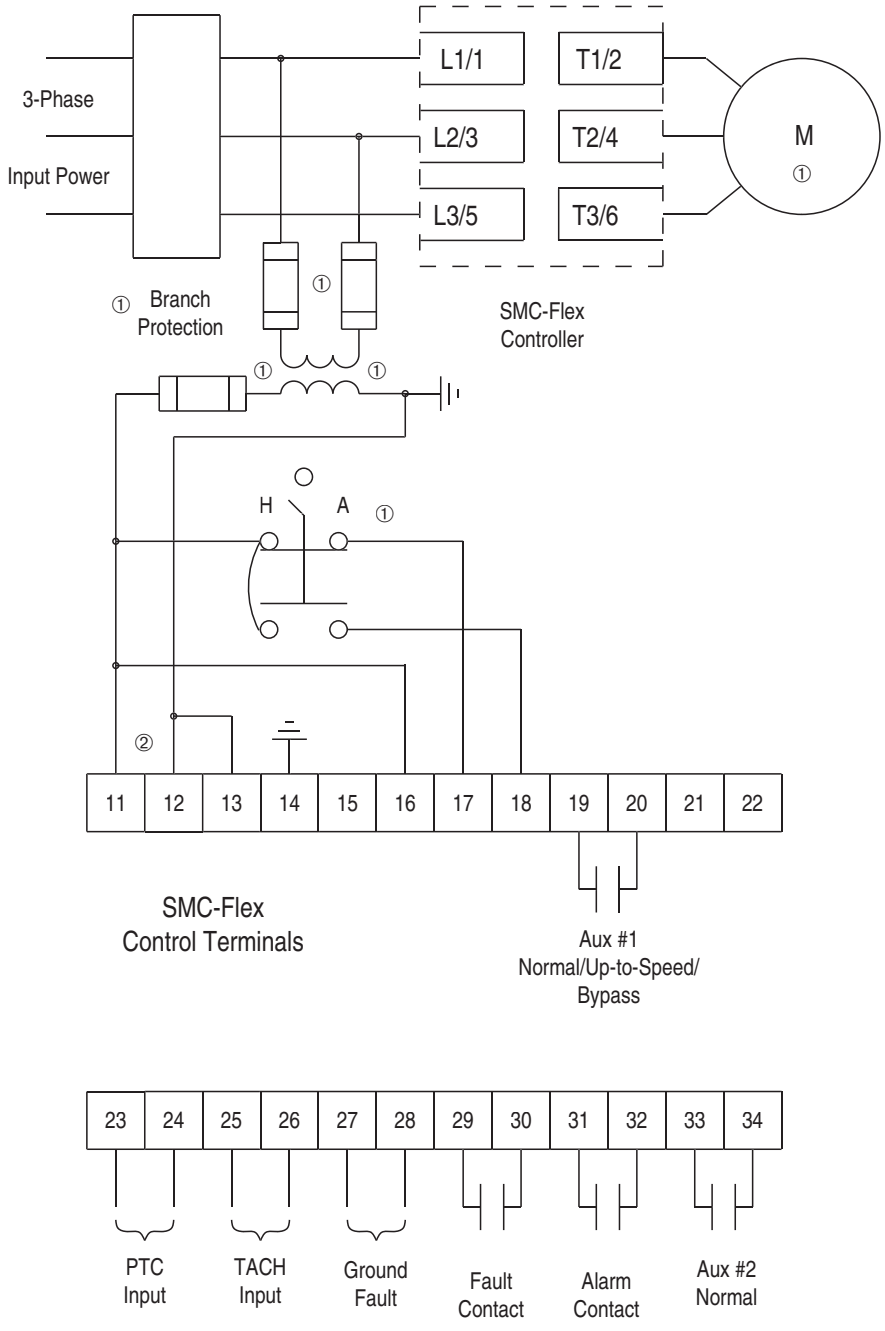
Figure 3.17 Typical Wiring Diagram for SMC-Off-Bypass Control



① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage.

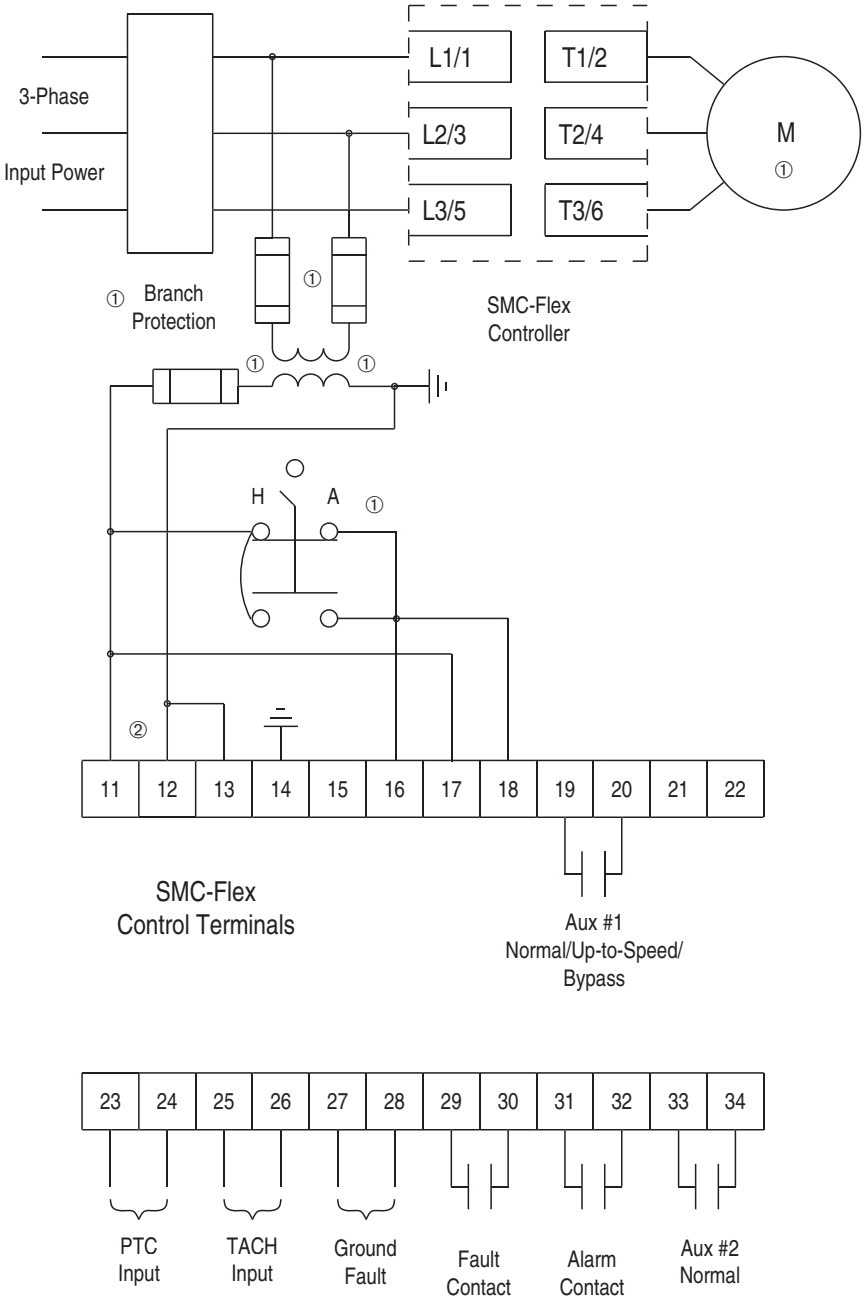
Figure 3.18 Typical Wiring Diagram for Hand-Off-Auto (DPI) Control with no Stopping Control



① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage.

Figure 3.19 Typical Wiring Diagram for Hand-Off-Auto (PLC) Control with Stopping Control



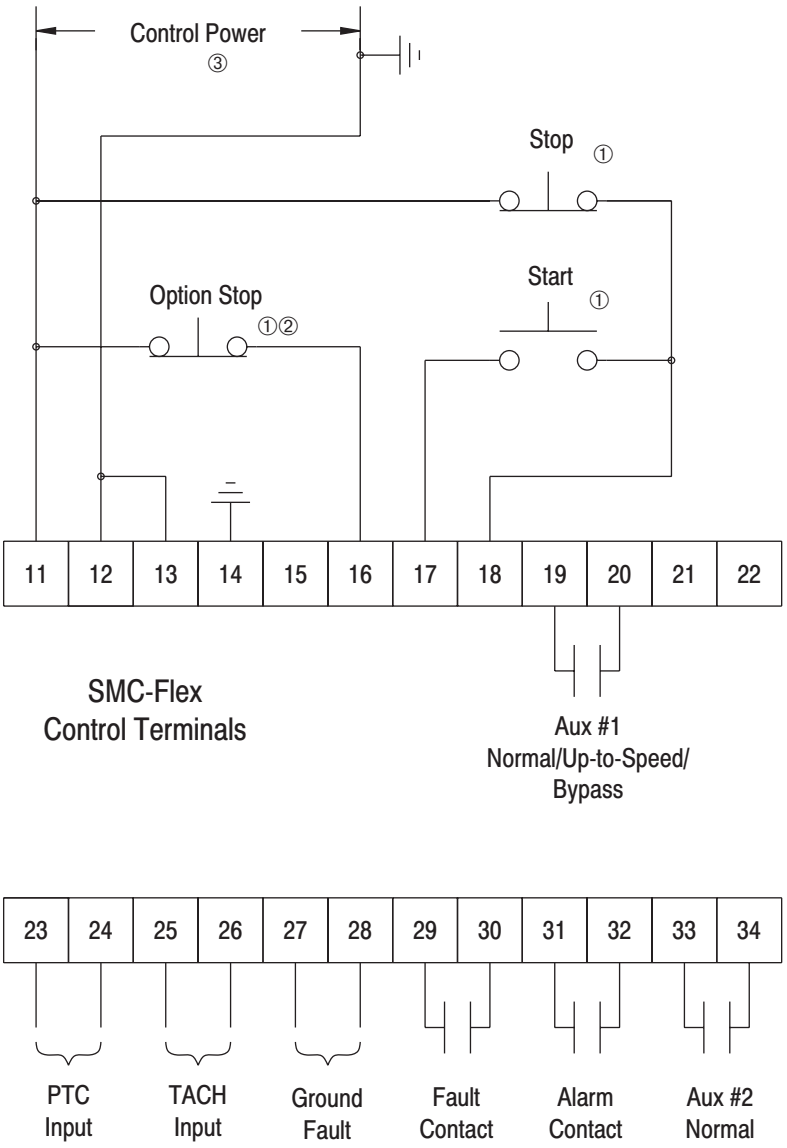
① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage.

Soft Stop, Pump Control, and SMB Smart Motor Braking

Figure 3.20 through Figure 3.23 show the different wiring for the Soft Stop, Pump Control, and SMB Smart Motor Braking options.

Figure 3.20 Typical Wiring Diagram



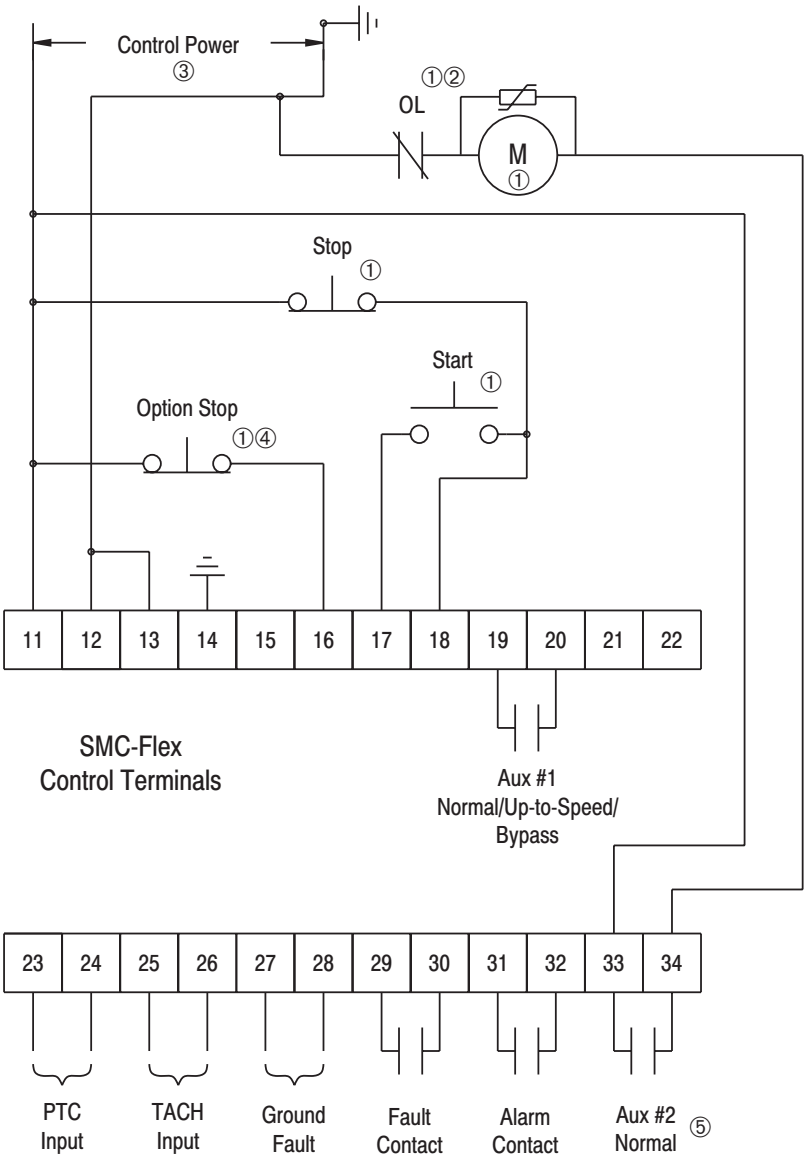
① Customer supplied.

② Soft Stop, Pump Stop, or Brake.

③ Refer to the controller nameplate to verify the rating of the control power input voltage.

Note: Refer to Chapter 3 for typical power circuits.

Figure 3.21 Typical Retrofit Wiring Diagram



① Customer supplied.

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

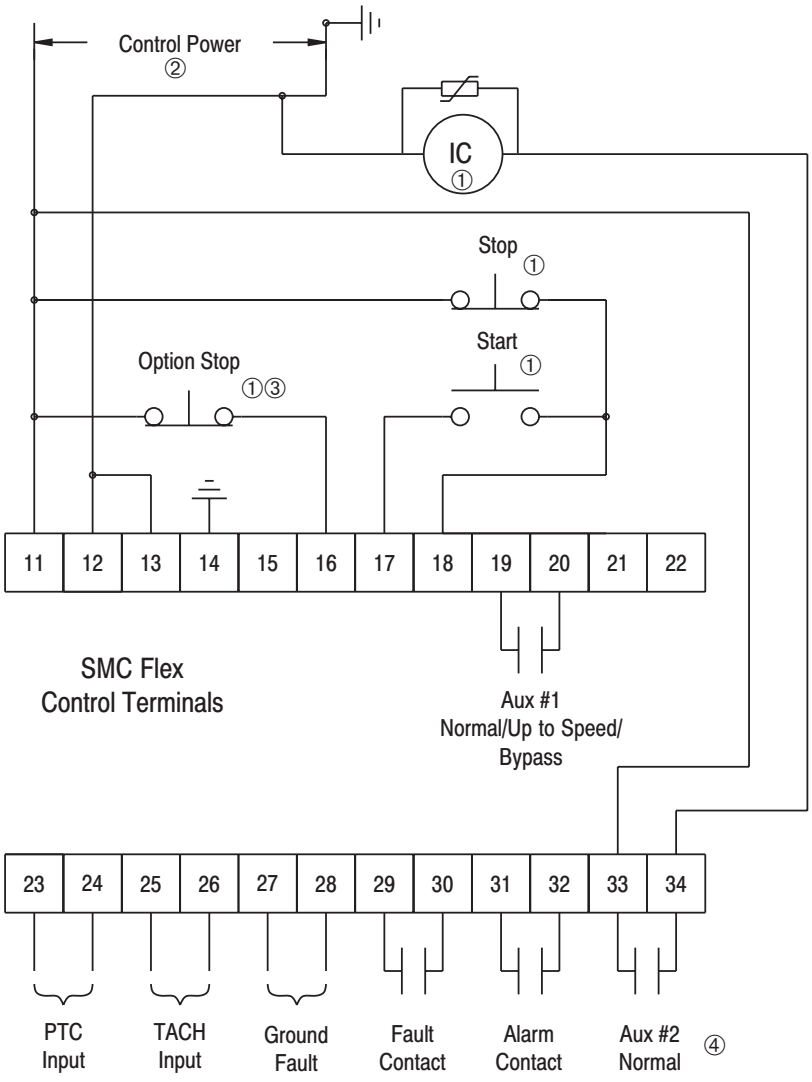
③ Refer to the controller nameplate to verify the rating of the control power input voltage.

④ Soft Stop, Pump Stop, or Brake.

⑤ Aux #2 should be set to N.O.

Note: Refer to Chapter 3 for typical power circuits.

Figure 3.22 Typical Wiring Diagram for Applications Requiring an Isolation Contactor



① Customer supplied.

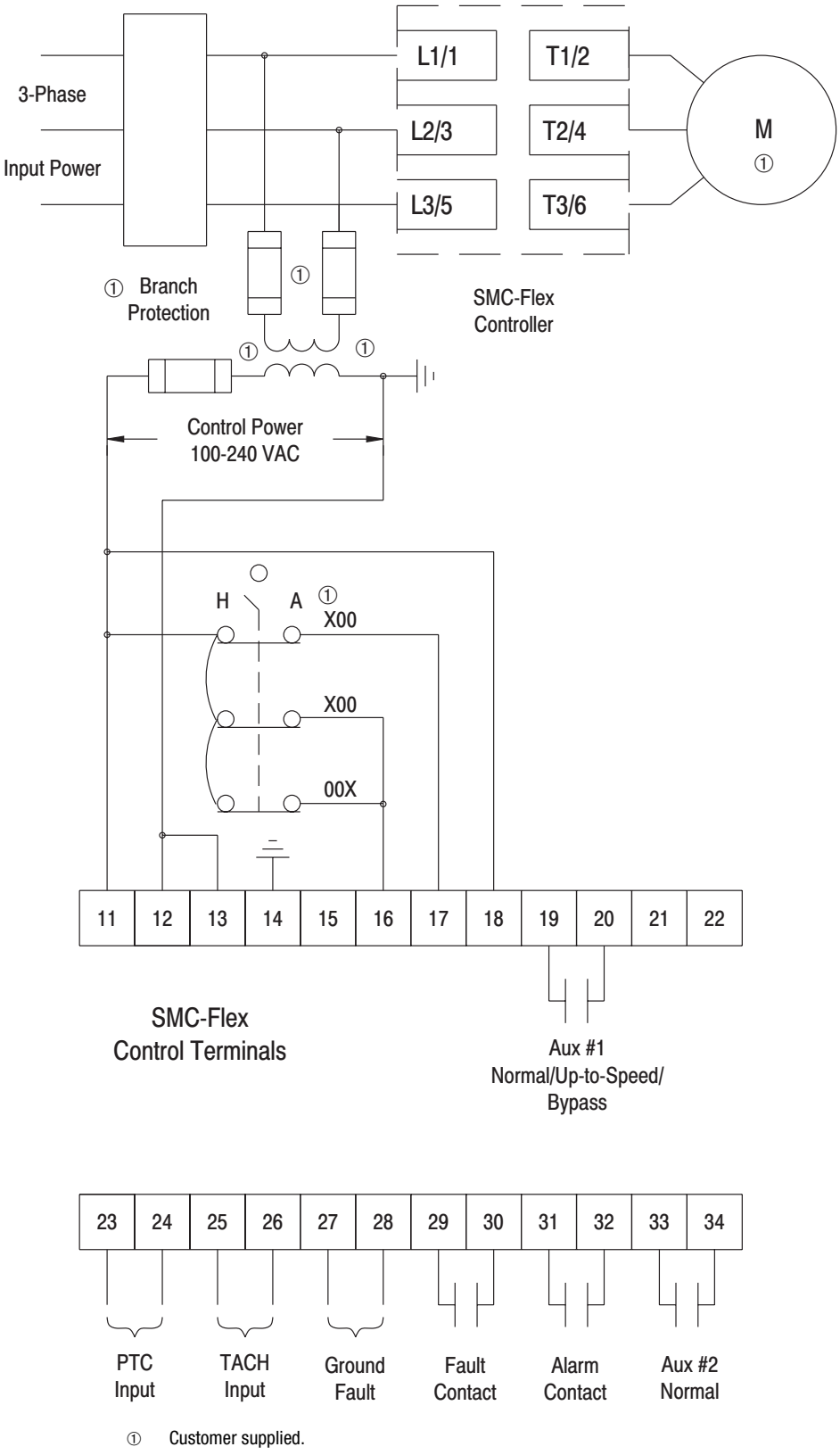
② Refer to the controller nameplate to verify the rating of the control power input voltage.

③ Soft Stop, Pump Stop, or Brake.

④ Aux #2 should be set to N.O.

Note: Refer to Chapter 3 for typical power circuits.

Figure 3.23 Typical Wiring Diagram for Hand-Off-Auto (DPI) Control (Soft Stop, Braking, and Pump Control Only)

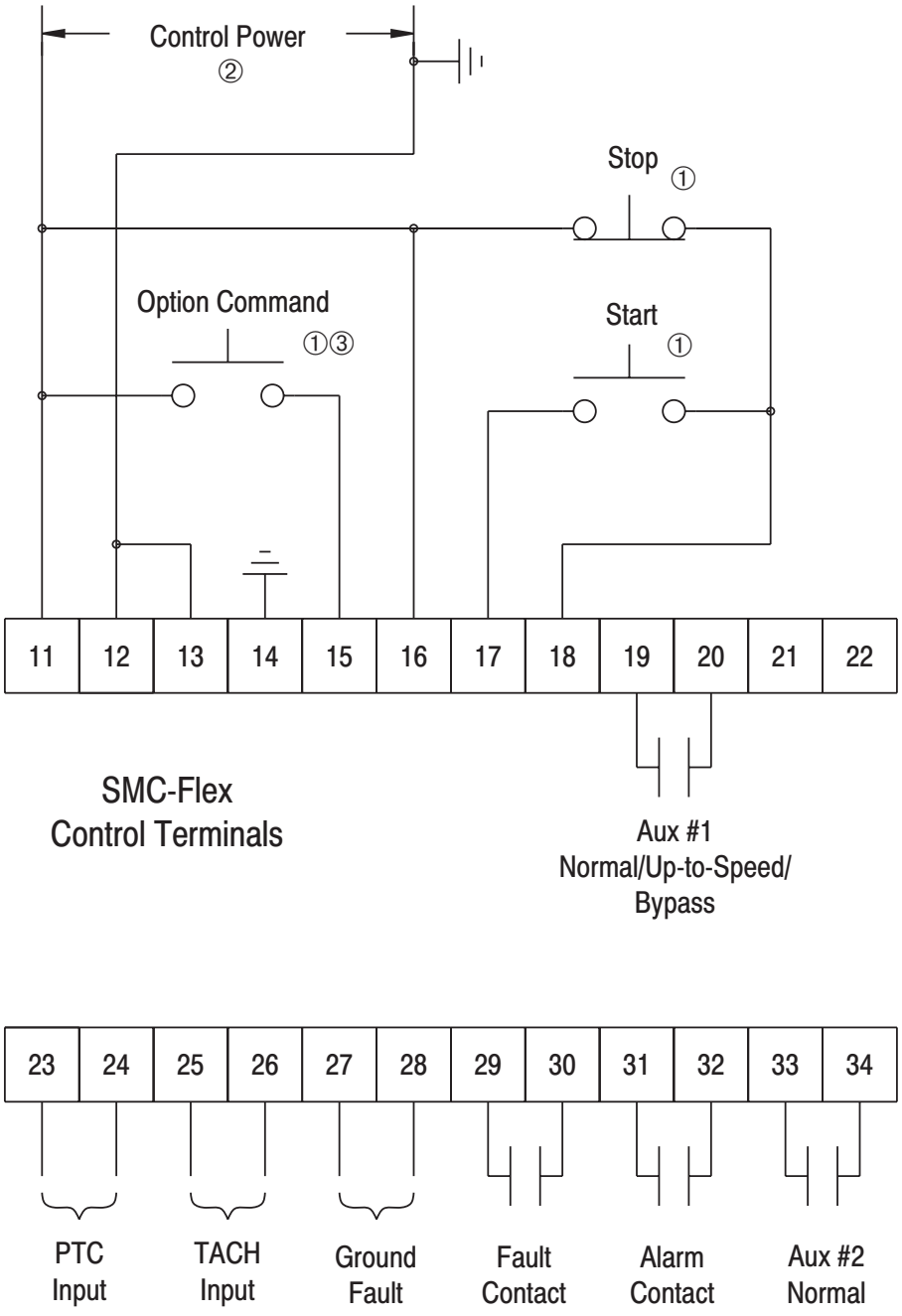


① Customer supplied.

Preset Slow Speed

Figure 3.24 and Figure 3.25 show the different wiring for the Preset Slow Speed.

Figure 3.24 Typical Wiring Diagram for the Preset Slow Speed



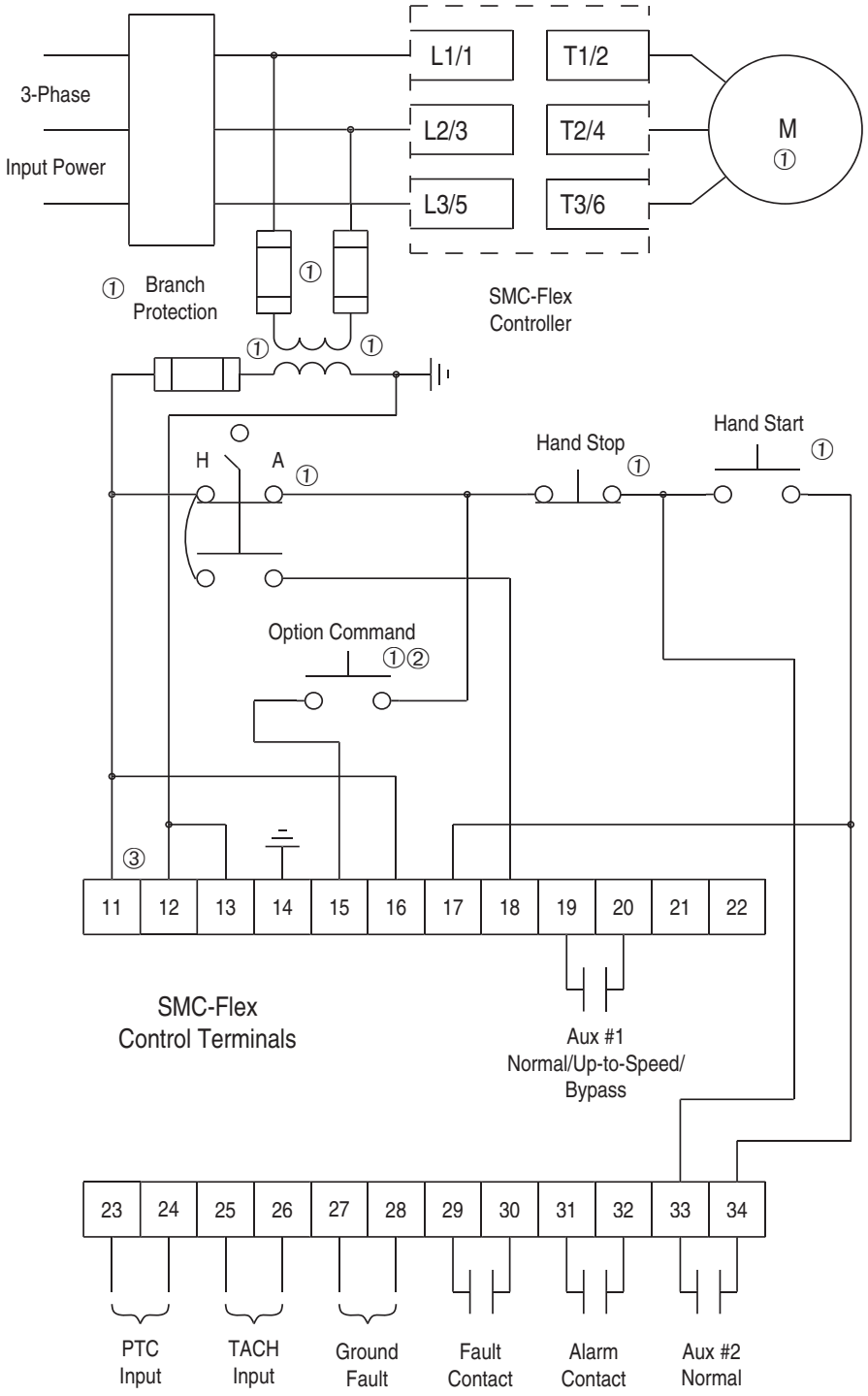
① Customer supplied.

② Refer to the controller nameplate to verify the rating of the control power input voltage

③ Slow Speed.

Note: Refer to Chapter 3 for typical power circuits.

Figure 3.25 Typical Slow Speed Wiring Diagram for Hand-Off-Auto (DPI) Control



① Customer supplied.

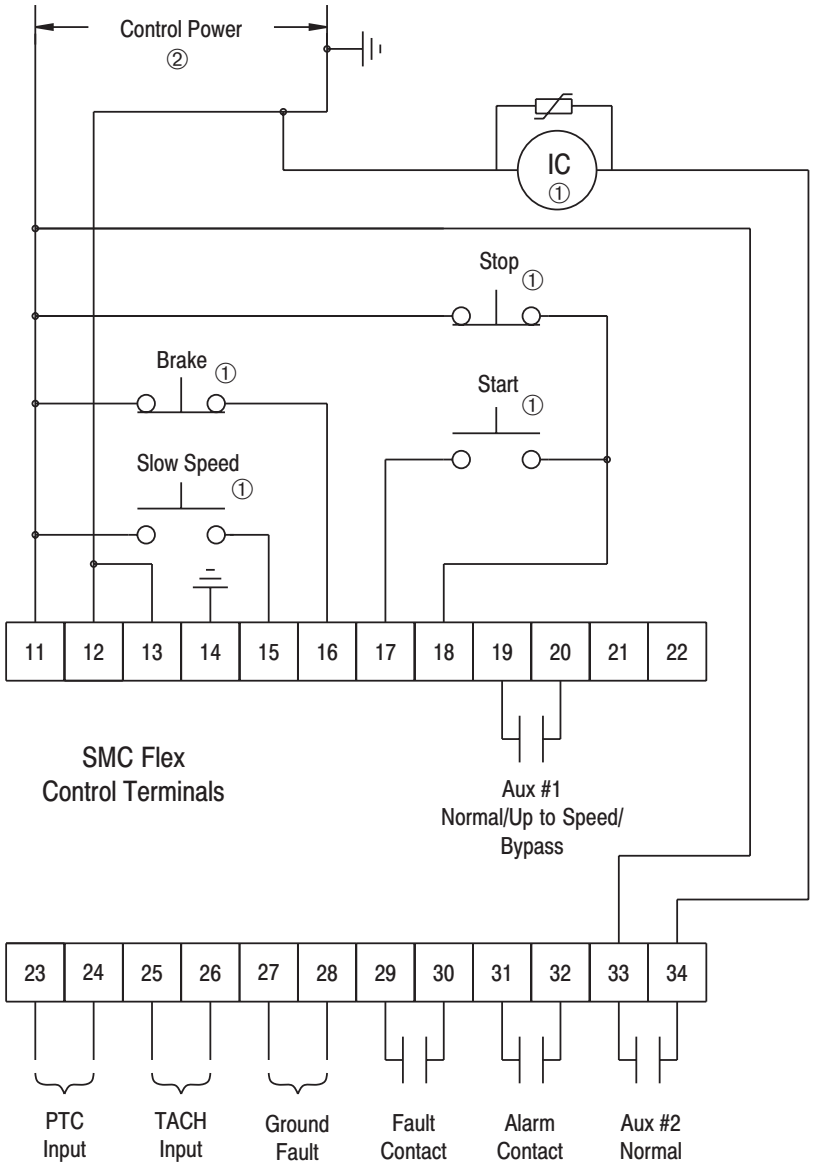
② Slow Speed.

③ Refer to the controller nameplate to verify the rating of the control power input voltage.

Slow Speed with Braking

Figure 3.26 shows the wiring for the Slow Speed with Braking option.

Figure 3.26 Typical Wiring Diagram for the Slow Speed with Braking with an Isolation Contactor



① Customer supplied.

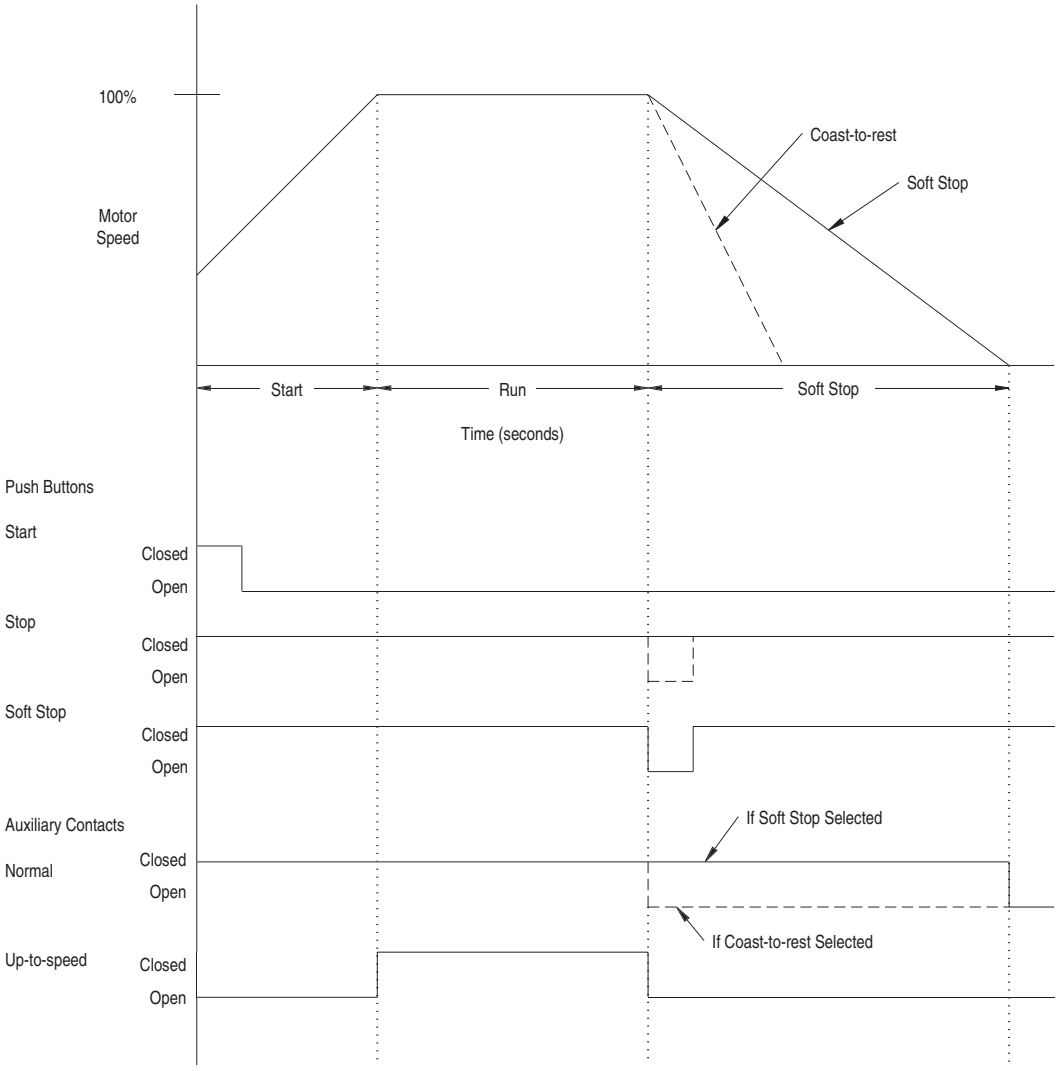
② Refer to the controller nameplate to verify the rating of the control power input voltage.

Note: Refer to Chapter 3 for typical power circuits.

Sequence of Operation

Figure 3.27 through Figure 3.32 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 3.27 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 3.28 Preset Slow Speed Sequence of Operation

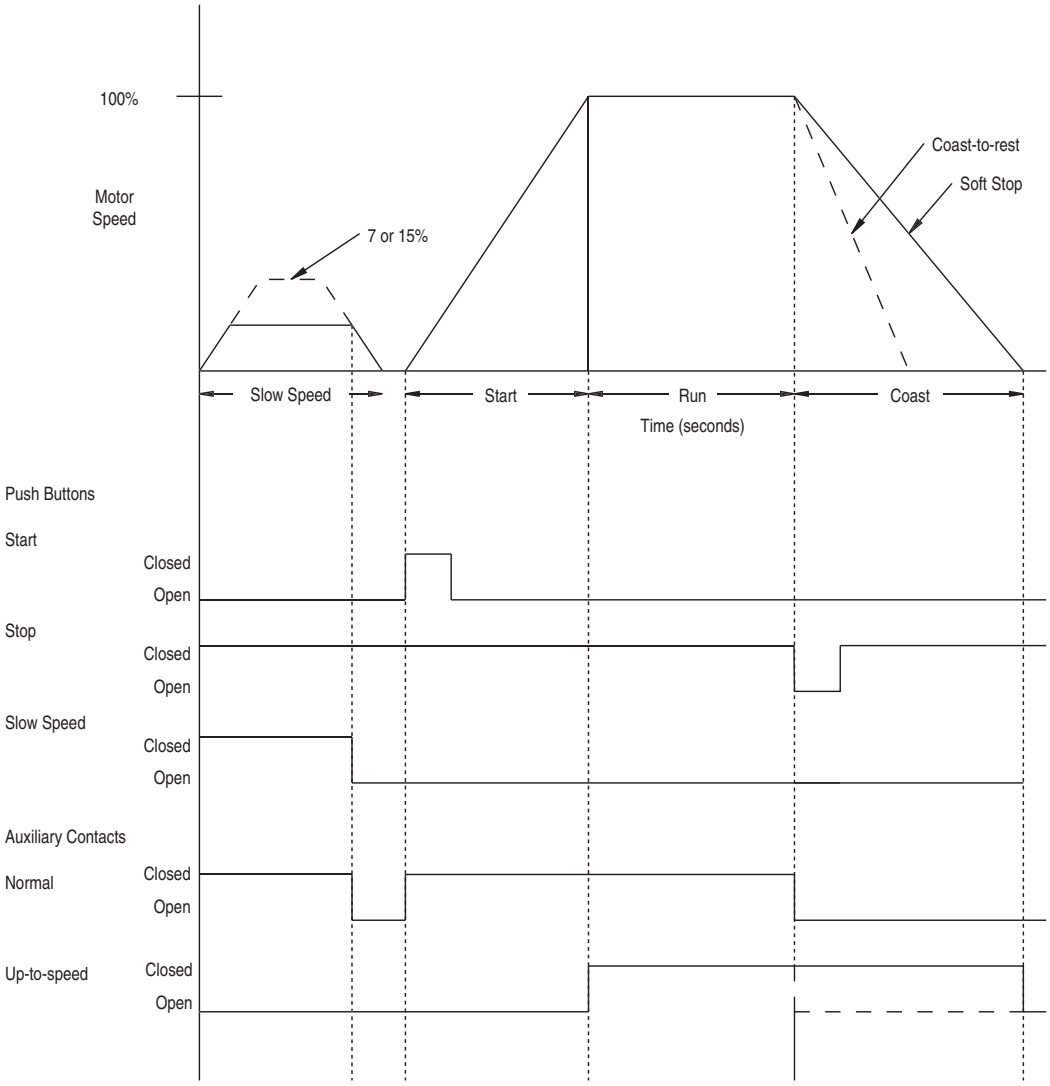
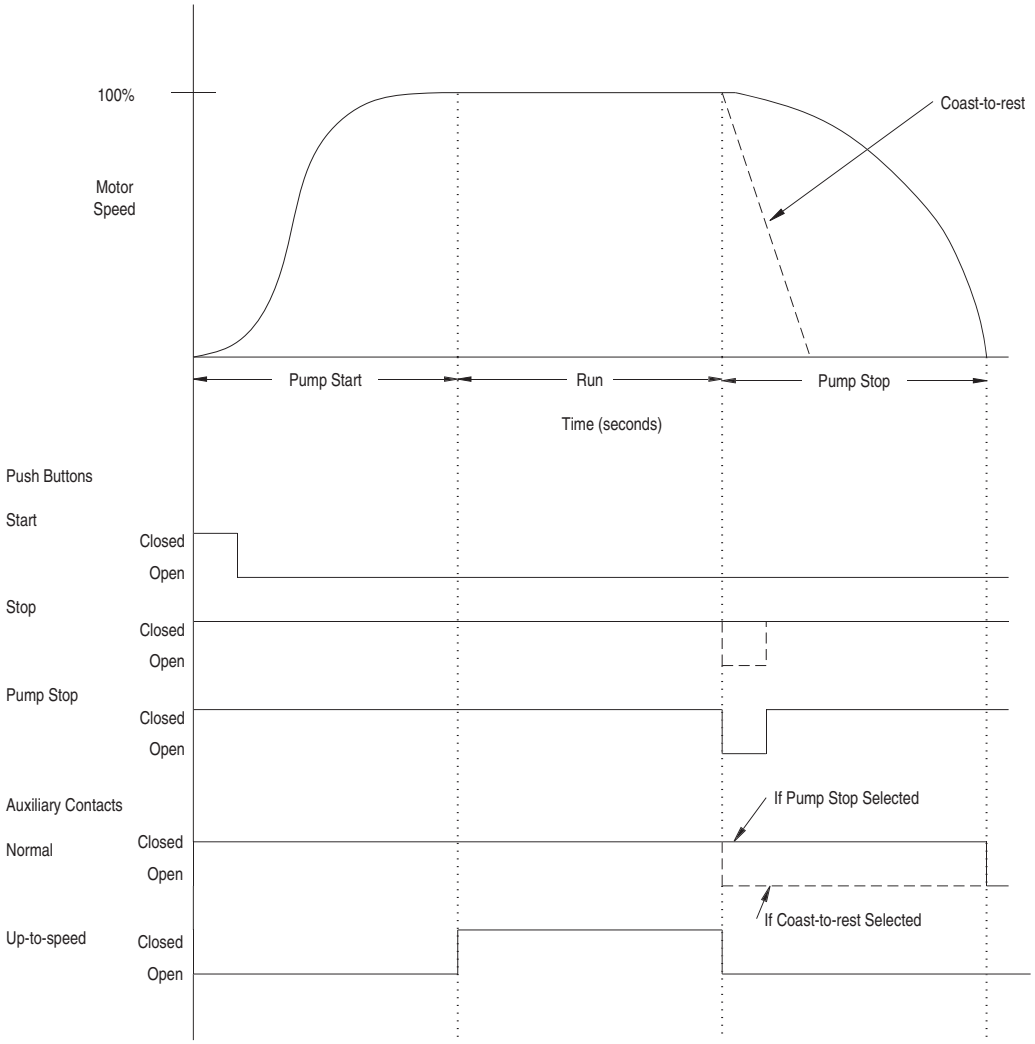


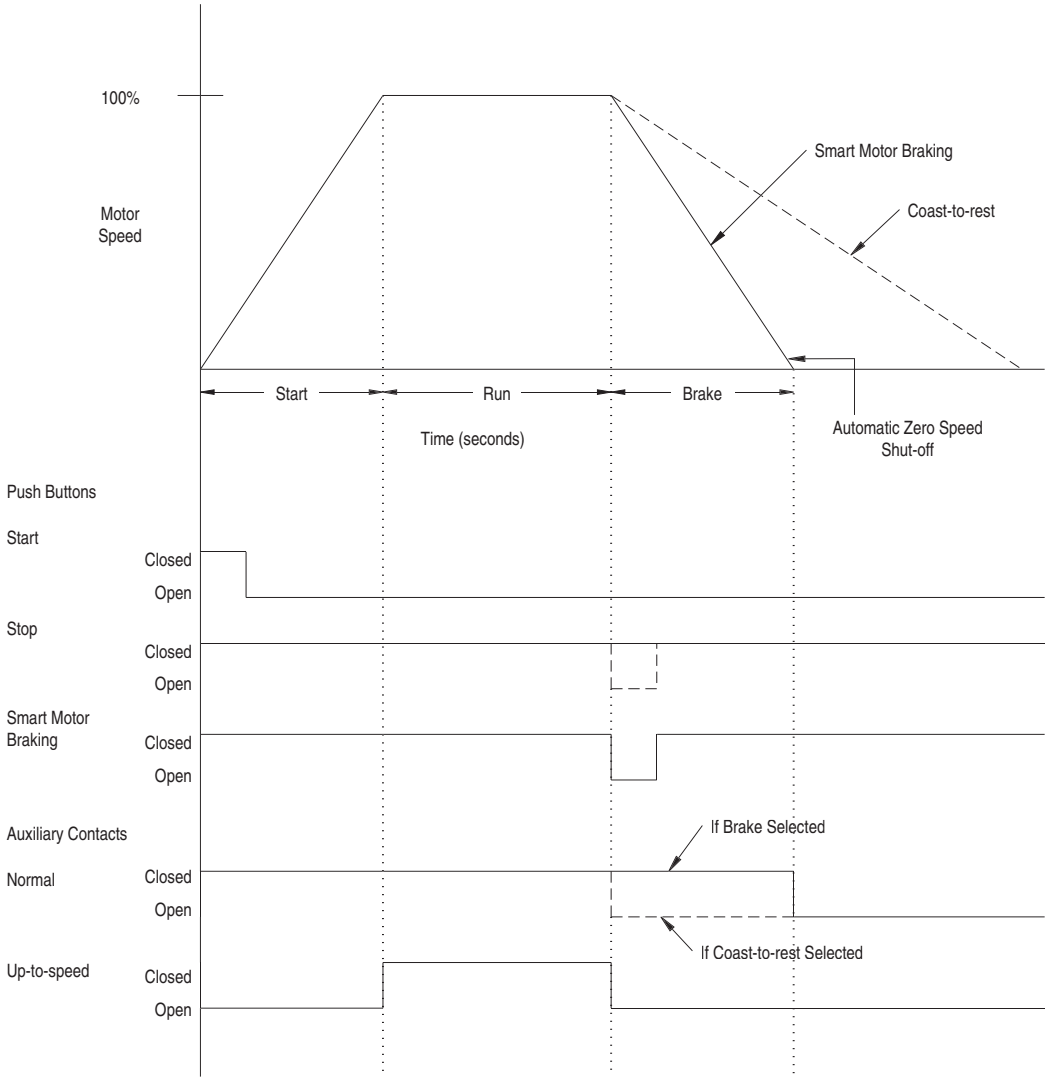
Figure 3.29 Pump Control Sequence of Operation



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.

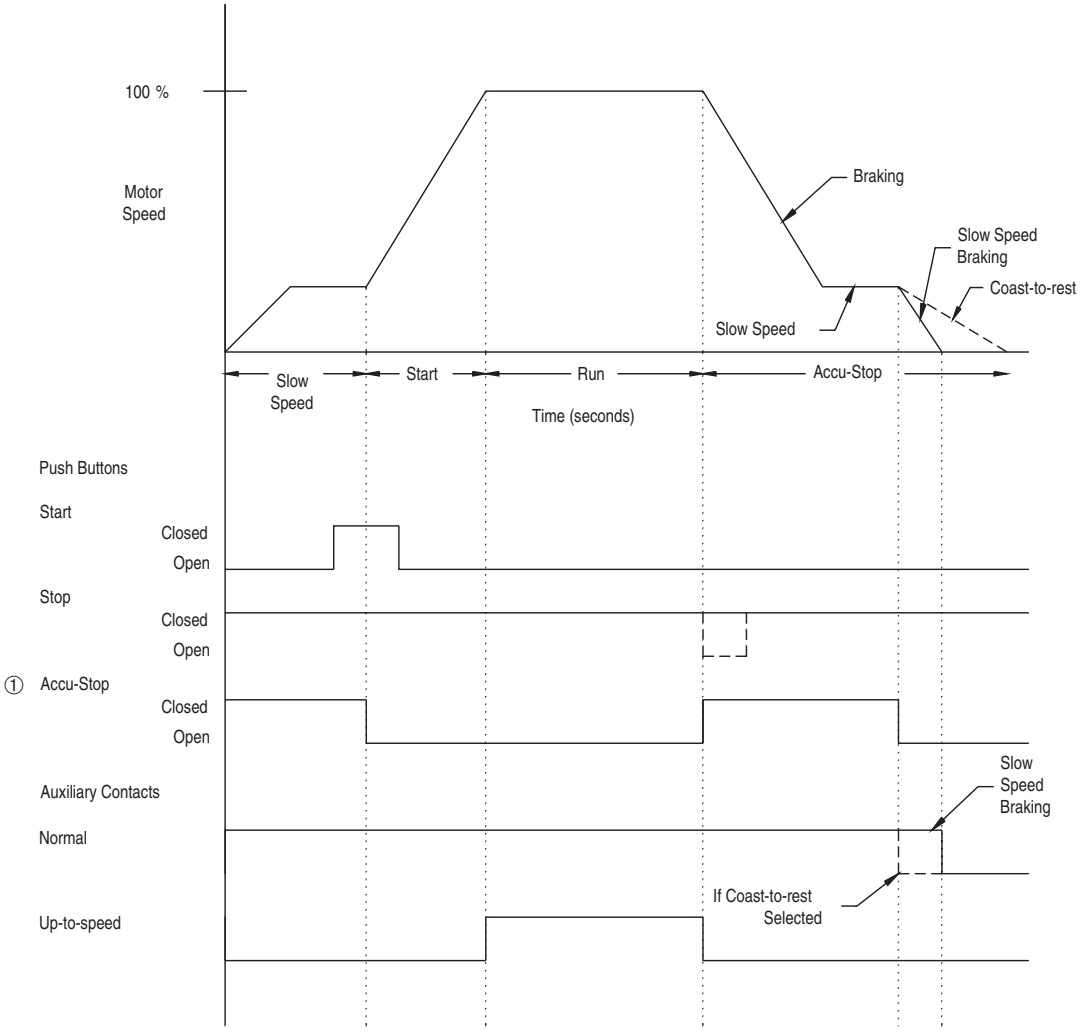
Figure 3.30 SMB Smart Motor Braking Sequence of Operation



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 3.31 Accu-Stop Sequence of Operation

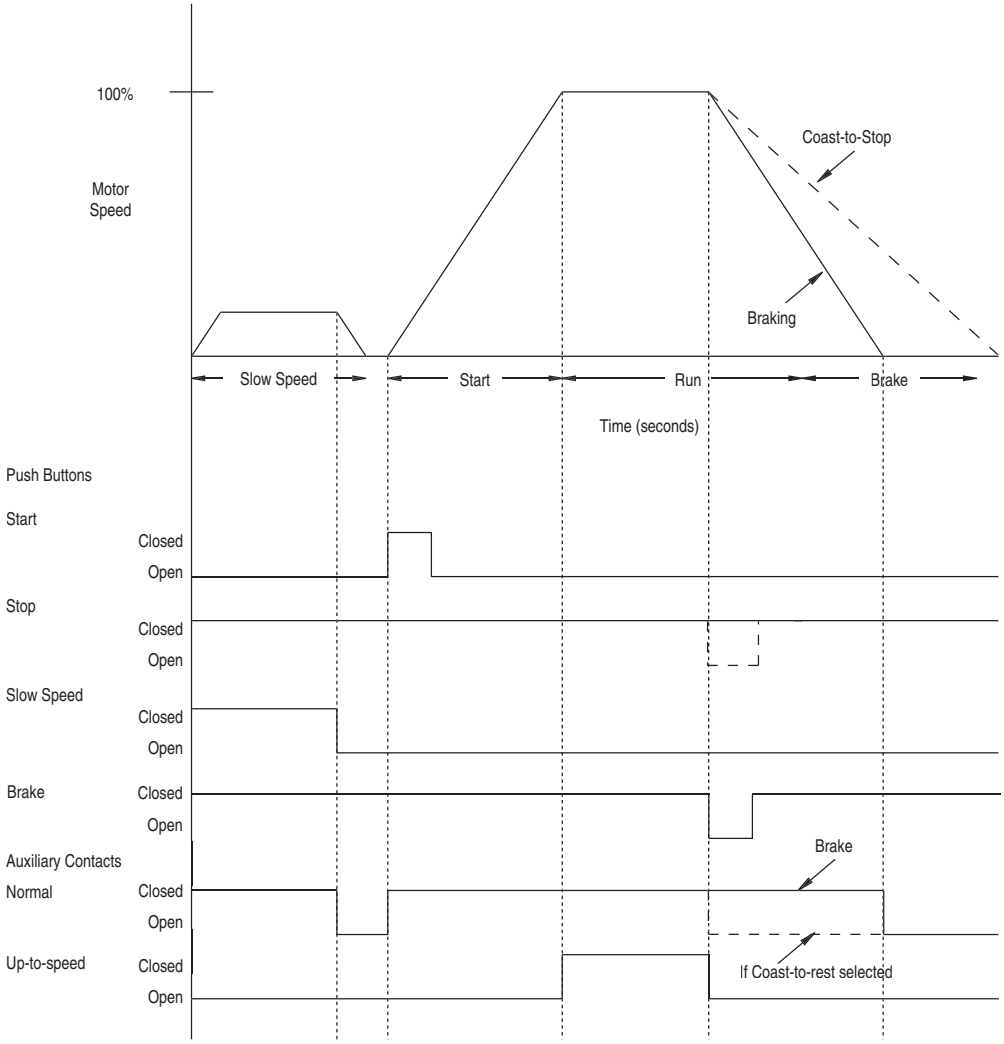


① When Accu-Stop push button is closed, start/stop function is disabled.

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 3.32 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.

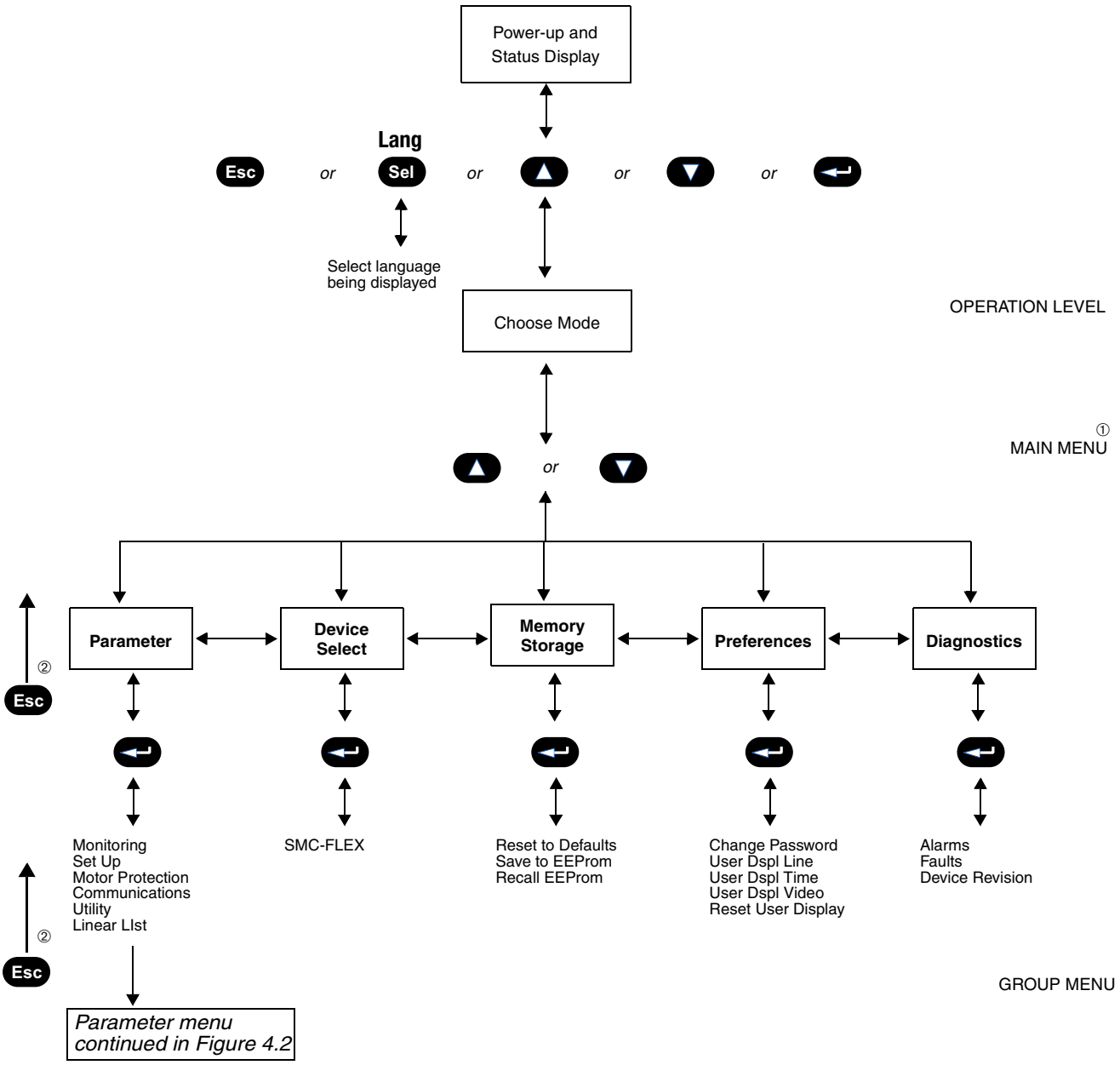
Note: For ease of programming values, after using the Enter key to edit, use the Sel key to jump to the digit that needs to be modified, then use the arrow keys to scroll through the digits.

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.

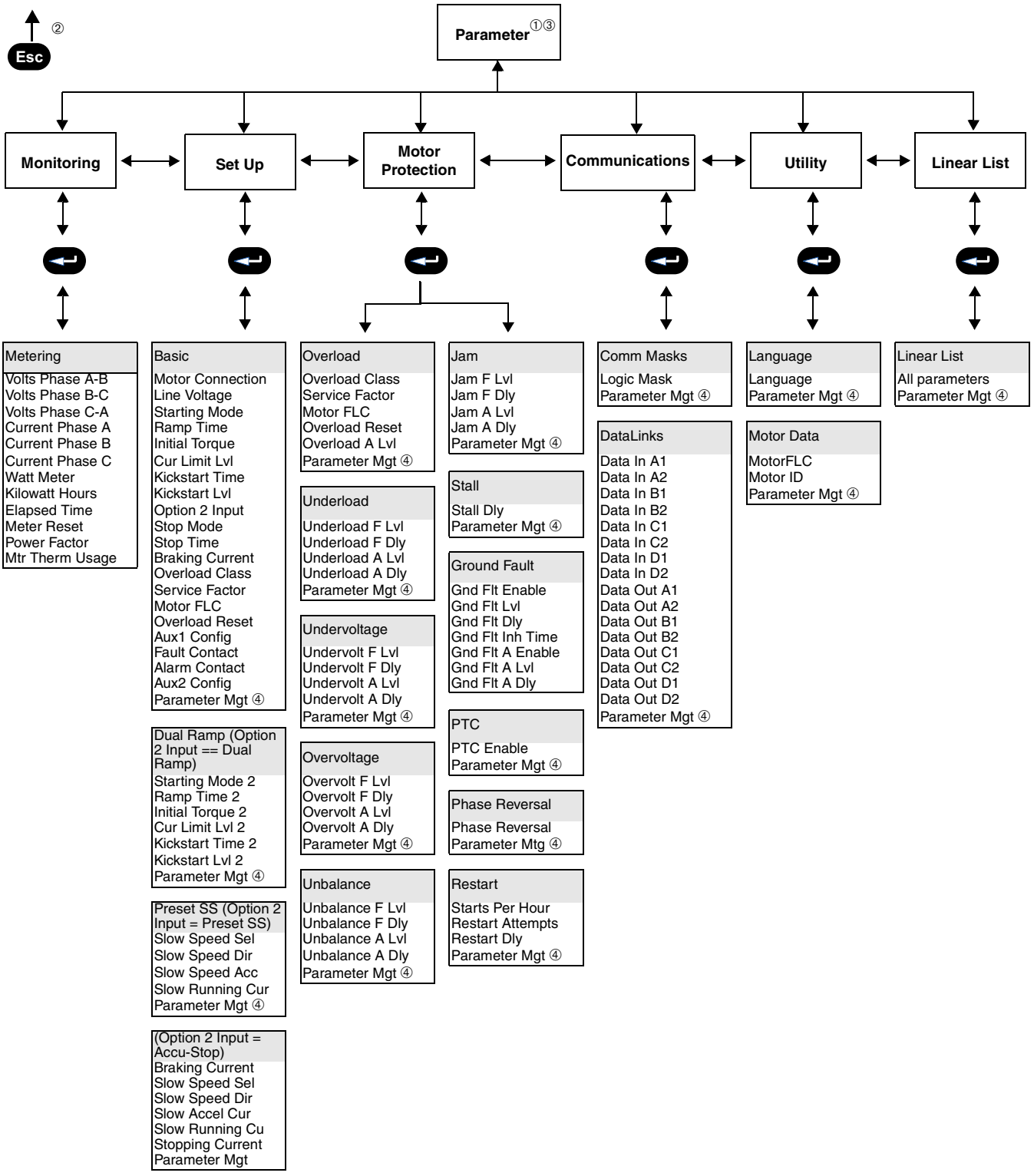
Figure 4.1 Menu Structure Hierarchy



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

② Steps back one level.

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 4-7.

Table 4.A Parameter Linear List

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

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 or login after a password is programmed, 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.①②	↵	Preferences: Change Password User Dspy lines

① After you have changed your password, go to Parameter Management and Save to User Store.

② 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.

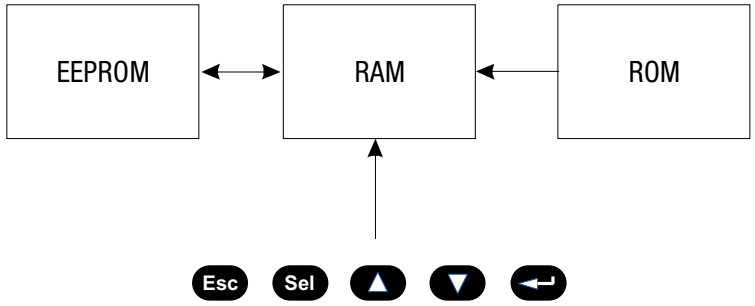
Parameter Management

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. When you modify parameters in the Program mode, the new values are stored in RAM. When power is applied to the controller, parameter values stored in the EEPROM are copied to RAM. **RAM is volatile and the values stored in this area are lost when the controller loses power.**

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.

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.

Using Parameter Management with DPI HIM

Memory Storage and Parameter Management perform the same function of saving programmed settings.

Description	Action	Display
Saving to EEPROM To ensure that the newly modified parameters are not lost if control power is removed from the controller, store the values into EEPROM.		Memory Storage: Save EEPROM Recall EEPROM
Recalling from EEPROM Parameters stored in EEPROM can be manually brought to RAM by directing the controller to recall the values stored in its EEPROM.		Memory Storage: Recall EEPROM Reset to Defaults
Recalling Defaults After parameter values have been modified and saved to EEPROM, factory default settings can still be re-initialized.		Memory Storage: Reset to Defaults Save 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
11. To save modifications to memory, scroll to Parameter Mgmt, press Enter twice and scroll to User Store. Press the Enter key again to save the new settings to EEPROM.	↵ ↵	F G P : P# 115 Parameter Mgmt User Store

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
Option 2 Input Allows the user to select a Dual Ramp or Preset Slow Speed (SS).	Disable, Preset SS, Dual Ramp
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
Aux1 Config N.O. 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, External Bypass
Fault Contact A fault auxiliary contact is provided between terminals 29 and 30. Fault Contact allows the user to program the operation of the contact for a fault condition.	N.O., N.C.
Alarm Contact An alarm contact is provided between terminals 31 and 32. Alarm contact allows the user to program the operation of the contact for an Alarm condition.	N.O., N.C.
Aux2 Config This parameter provides the user with the ability to program the “Normal” state of the second auxiliary contact. This contact is located at terminals 33 and 34.	N.O., N.C.
Parameter Mgmt ③ The newly programmed parameters’ values can be saved to memory, or the factory default parameter values can be recalled.	Ready, User Store, User Recall, 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.

③ The new programmed parameter values will not be stored to the EEPROM without the user’s direction in Parameter Management: User Store.

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. A separate 825-CBCT is required.	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 1-16.

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 Will self-protect.

Motor Information

Overview

The Basic Set Up and Overload programming group allows the user to set parameters indicating to the controller the motor that is connected. It is important to correctly input the data to achieve the best performance from your controller.

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

Motor Data Entry

In the Program mode, enter the correct values into the Overload group:

Parameter	Option	Display
Overload Class ②③ The factory default setting disables overload protection. To enable it, enter the desired trip class in this parameter.	Disable, 10, 15, 20, 30	F G P : P# 44 Overload Class Class ##
Service Factor ②③ Enter the value from the motor's nameplate.	0.01…1.99	F G P : P# 45 Service Factor #.##
Motor FLC ①②③ Enter the value from the motor's nameplate.	1.0…1000 A	F G P : P# 46 Motor FLC ###.# Amps
Overload Reset ②③ Allows the user to select either a manual or auto reset after an overload fault.	Manual, Auto	F G P : P# 47 Overload Reset Manual
Motor Connection ③ Enter the type of motor being connected to the SMC-Flex; Line or Delta	Line, Delta	F G P : P# 15 Motor Connection Line
Line Voltage ①③ Enter the system voltage in this parameter. This **must** be done to ensure optimum motor performance and correct operation of undervoltage and overvoltage protection.	1…10,000V	F G P : P# 16 Line Voltage ### Volt

① Refer to the SMC-Flex controller nameplate for maximum ratings. Exceeding these could result in damage to the controller.

② Found in Overload programming group. Only one location needs to be programmed.

③ Found in Basic Set Up programming group.

Metering

Overview

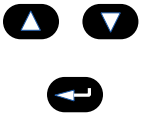
While the SMC-Flex controller operates your motor, it also monitors several different parameters, providing a full function metering① package.

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

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 8-4 for instructions.
(2) The control terminals must be wired according to Figure 3.11 on page 3-12 or Figure 3.18 on page 3-19.

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.

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 8.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

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

Communication Ports

The SMC 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 modules 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 the optional Bulletin 20-HIM LCD human interface modules. Parameters are organized in a three-level menu structure and divided into programming groups.

Keypad Description

The functions of each programming key are described below.

Table 8.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" 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 8.1 shows the connection of the SMC-Flex controller to a human interface module. Table 8.C provides a description of each port.

See Figure 3.11 on page 3-12 for the control wiring diagram that enables start-stop control from a human interface module.

Figure 8.1 SMC-Flex Controller with Human Interface Module

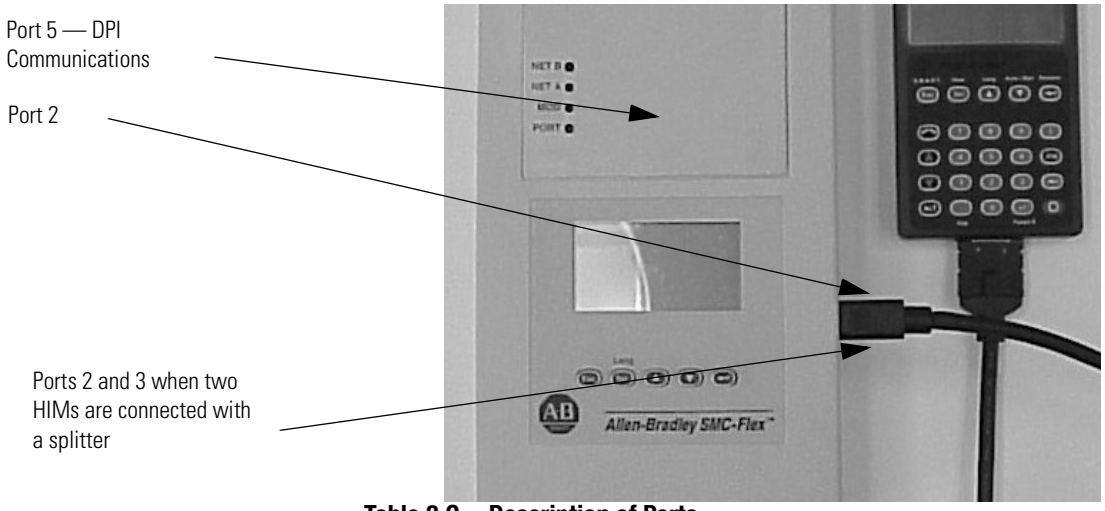


Table 8.C Description of Ports

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

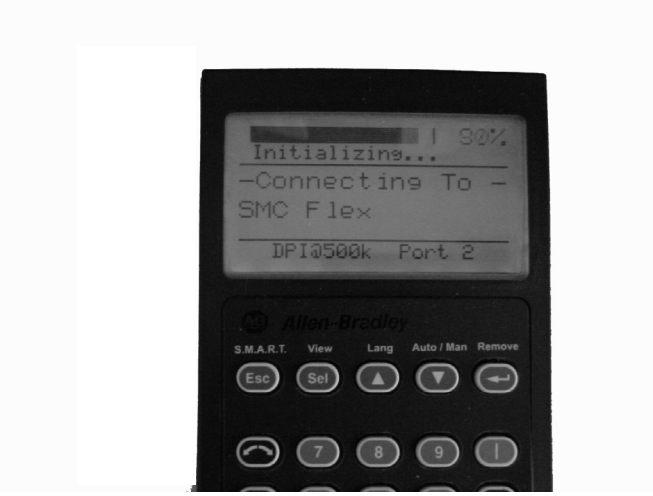
To enable motor control from a connected human interface module, follow the procedure below with the connected human interface module's programming keys.

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:

Series A

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).
5. Go to Parameter Management and save as User Store.

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 8.D Logic Mask Requirements

Mask Code	Description
0	No external DPI devices are enabled

4	Only one HIM on port 2 is enabled
12	Two HIMs are enabled on ports 2 and 3
32	Only the DPI communication cared on port 5 is enabled
36	One 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 is 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) and is arranged according to the following table.

Table 8.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

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 8.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 8-9.

SMC — Flex Bit Identification

Table 8.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 — Bypass Contactor Enabled 0 — Bypass Contactor Disabled
				X												Ready	1 — Ready 0 — Not Ready
—																—	Bits 12…15 — Not Used

Table 8.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…15 — Not Used

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 8.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 8.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 drive 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.

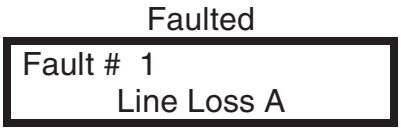
Protection Programming

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 9.1 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 hit 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.

- 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 9.A.

Fault Codes

Table 9.A provides a complete cross-reference of the available fault codes and corresponding fault descriptions.

Table 9.A Fault Code Cross-reference

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

① See Table 9.B for definition.

Fault and Alarm Auxiliary Contact

The fault and alarm auxiliary contacts are located at terminals 29/30 and 31/32 respectively. These contacts can be programmed as either N.O. or N.C. Parameter setup can be found in the Parameter/Motor Protection group when modifying parameters in the Program Mode.

Fault Definitions

Table 9.B shows the fault definitions for the SMC-Flex.

Table 9.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.
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 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 10.1 Troubleshooting Flowchart

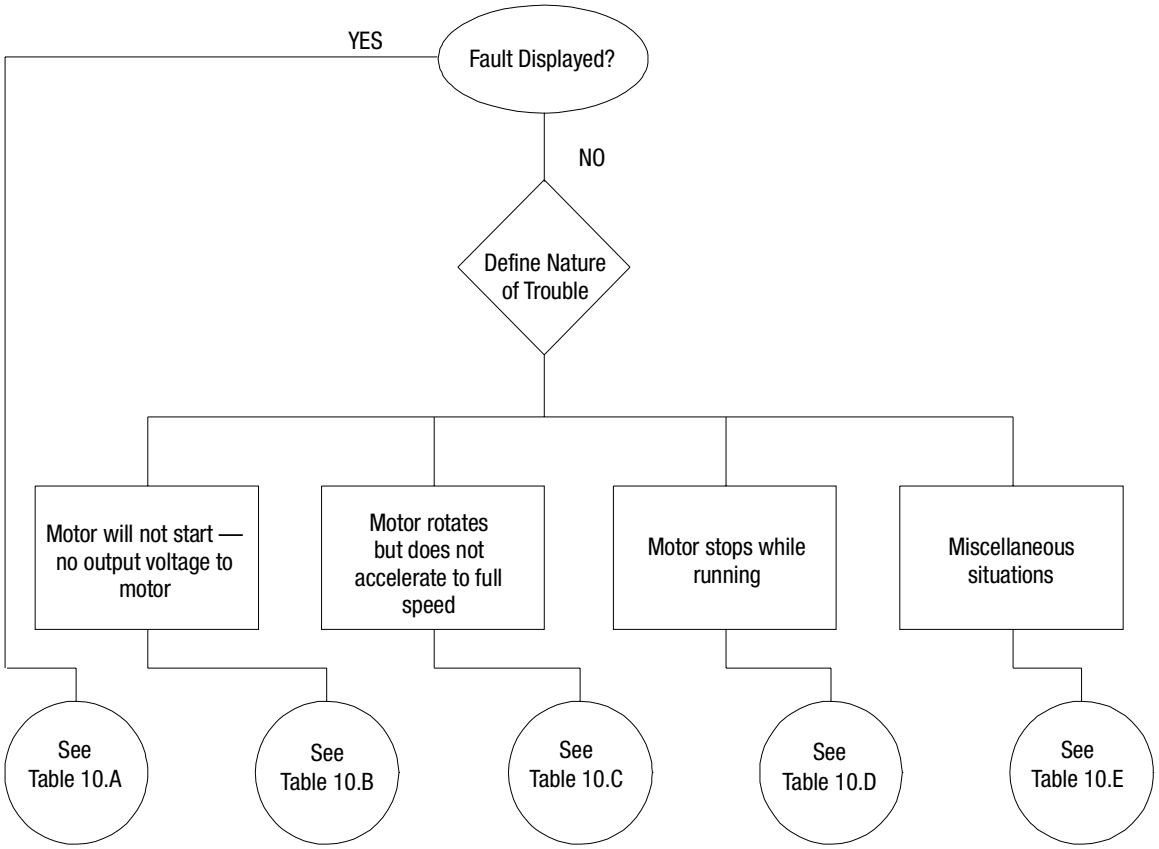


Table 10.A SMC Fault Display Explanation

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 10.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 configuration is 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 and perform a User Store function • Replace control module
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 10.B Motor Will Not Start — No Output Voltage to the Motor

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 • 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 8-4…8-5 to enable control capability • Check control voltage • Replace control module
Starting	• Two or three power phases are missing	• Check power system

Table 10.C Motor Rotates (but does not accelerate to full speed)

Display	Possible Cause	Possible Solutions
Fault displayed	• See fault description	• See Table 10.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 10.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 10.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.

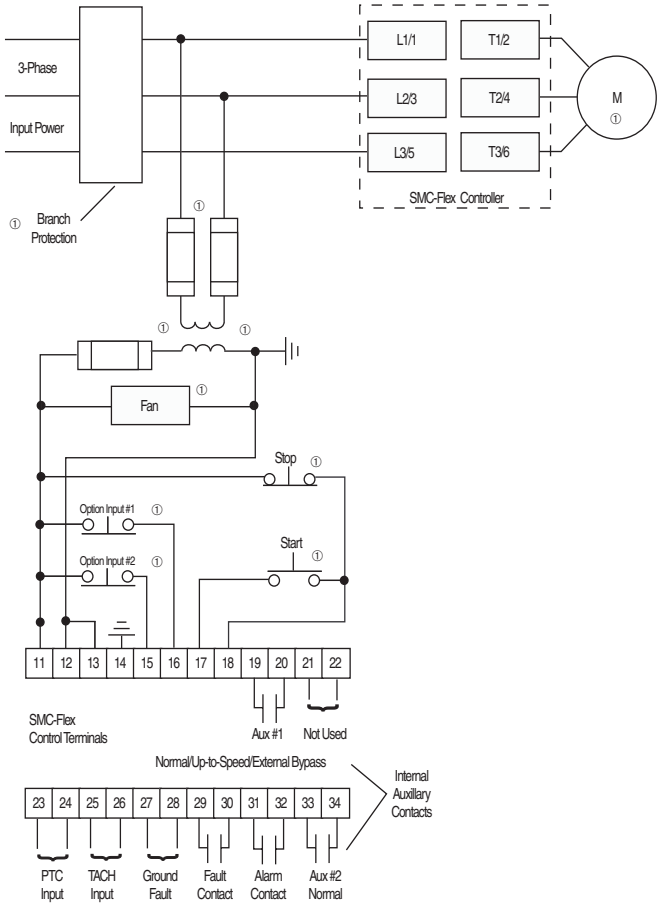
Specifications

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 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		Contact programmable as normal/up-to-speed/external bypass; one programmable for fault, one programmable for alarm, and one programmable for N.O./N.C. normal.
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.

Wiring Diagram

Figure A.1 Wiring Diagram



① Customer supplied.

Electrical Ratings

	UL/CSA/NEMA	IEC
Power Circuit		
Rated Operation Voltage	200…480V AC 200…600V AC (–15%, +10%)	200…415V 200…500V
Rated Insulation Voltage	N/A	500V
Rated Impulse Voltage	N/A	6000V
Dielectric Withstand	2200V AC	2500V
Repetitive Peak Inverse Voltage Rating	200…480V AC: 1400V 200…600V AC: 1600V	200…415V: 1400V 200…500V: 1600V
Operating Frequency	50/60 Hz	50/60 Hz
Utilization Category	MG 1	AC-53B:3.0-50:1750
Protection Against Electrical Shock	N/A	IP00 (open device)/ Optional IP20
DV/DT Protection	RC Snubber Network	
Transient Protection	Metal Oxide Varistors: 220 Joules	

		UL/CSA/NEMA		IEC	
Short Circuit Protection					
SCPD Performance		Type 1			
SCPD List		Max. Available Fault	Max. Fuse (A)	Max. Available Fault	Max. Circuit Breaker (A)
Line Device Operational Current Rating (A)	5	10 kA	35	10 kA	35
	25	10 kA	150	10 kA	150
	43	10 kA	300	10 kA	300
	60	10 kA	400	10 kA	300
	85	10 kA	400	10 kA	400
	108	30 kA	400	30 kA	300
	135	30 kA	500	30 kA	400
	201	30 kA	600	30 kA	600
	251	30 kA	700	30 kA	700
	317	42 kA	800	30 kA	800
	361	42 kA	1000	30 kA	1000
	480	42 kA	1200	30 kA	1200
Delta Device Operational Current Rating (A)	8.7	10 kA	35	10 kA	35
	43	10 kA	150	10 kA	150
	74	10 kA	300	10 kA	300
	104	10 kA	400	10 kA	300
	147	10 kA	400	10 kA	400
	187	30 kA	500	30 kA	500
	234	30 kA	700	30 kA	700
	348	30 kA	1000	30 kA	1000
	435	42 kA	1200	30 kA	1200
	549	42 kA	1600	30 kA	1600
	625	42 kA	1600	30 kA	1600
	831	42 kA	1600	30 kA	1600
Control Circuit					
Rated Operational Voltage		100…240V AC 24V AC/24V DC		100…240V 24V ~/24V DC	
Rated Insulation Voltage		N/A		240V	
Rated Impulse Voltage		N/A		3000V	
Dielectric Withstand		1600V AC		2000V	
Operating Frequency		50/60 Hz		50/60 Hz	
Protection Against Electric Shock		N/A		IP20	
Power Requirements					
Control Module		75 VA			
Heatsink Fan(s) (A) ①		50 VA			
Vibration					
Operational		1 G			
Non-Operational		2.5 G			

① For devices rated 5…480 A, heatsink fans can be powered by either 110/120V AC or 220/240V AC.

		UL/CSA/NEMA	IEC
Steady State Heat Dissipation (W)			
Controller Rating (A)	5	95	
	25	95	
	43	106	
	60	122	
	85	155	
	108	167	
	135	176	
	201	200	
	251	218	
	317	225	
	361	245	
	480	290	
Auxiliary Contacts • 19/20 (Normal/Up-to-Speed/External Bypass) • 29/30 (Fault) • 31/32 (Alarm) • 33/34 (Normal)			
Type of Control Circuit		Electromagnetic relay	
Number of Contacts		1	
Type of Contacts		N.O.	
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	

Environmental

Operating Temperature Range	0…50°C (32…122°F) (open) 0…40°C (32…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		1.0 G Peak, 0.15 mm (0.006 in.) displacement
	Non-Operational		2.5 G, 0.38 mm (0.015 in.) displacement
Resistance to Shock	Operational		5.5 G
	Non-Operational		25 G
Construction	Power Poles	5…85 A	Heatsink thyristor modular design
		108…480 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 — 2.5…85 mm^2 (#14…3/0 AWG) Tightening torque — 14.7 N•m (130 lb.-in.) Wire strip length — 18…20 mm (0.22…0.34 in.)
		108…251 A	Two M10 x 1.5 diameter holes per power pole
		317…480 A	Two M12 x 1.5 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	54…108	94…187
		135	68…135	117…234
		201	100…201	174…348
		251	125…251	218…435
		317	158…317	275…549
		361	180…361	313…625
		480	240…480	415…831
	Trip Classes		10, 15, 20, and 30	
	Trip Current Rating		117% of Motor FLC	
	Number of Poles		3	
Approvals	Open Type Controllers		CE Marked Per Low Voltage Directive 73/23/EEC, 93/68/EEC UL Listed (File No. E96956) CSA Certified (Class No. 3211-06)	

Approximate Dimensions and Shipping Weights

Open Type Controllers

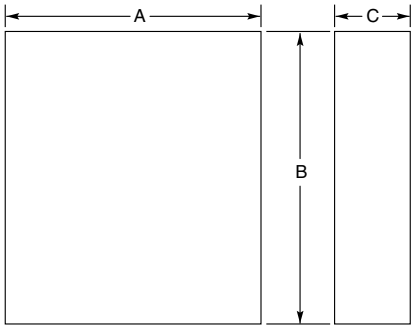
Dimensions are in millimeters (inches). Dimensions are not intended for manufacturing purposes.

Controller Rating (A)	Height	Width	Depth	Weight
5…85	321 (12.6)	150 (5.9)	203 (8.0)	5.7 kg (12.6 lb.)
108…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.)

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)	229 (9)
25	—	610 (24)	406 (16)	229 (9)
43	—	610 (24)	406 (16)	229 (9)
60	—	610 (24)	406 (16)	229 (9)
85	—	610 (24)	406 (16)	229 (9)
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)

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)	229 (9)
25	30 A/J	610 (24)	406 (16)	229 (9)
43	60 A/J	610 (24)	406 (16)	229 (9)
60	100 A/J	610 (24)	406 (16)	229 (9)
85	100 A/J	610 (24)	406 (16)	229 (9)
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)
Combination Controllers with Circuit Breaker				
5	15 A	610 (24)	406 (16)	229 (9)
25	30 A	610 (24)	406 (16)	229 (9)
43	80 A	610 (24)	406 (16)	229 (9)
60	100 A	610 (24)	406 (16)	229 (9)
85	125 A	610 (24)	406 (16)	229 (9)
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)

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

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

Enclosed Type Delta-Connected Controllers

Controller Rating (A)	IP65 (Type 4/12)		
	B Height	A Width	C Depth
Non-Combination Controller			
5	610 (24)	406 (16)	229 (9)
25	610 (24)	406 (16)	229 (9)
43	610 (24)	406 (16)	229 (9)
60	610 (24)	406 (16)	229 (9)
85	610 (24)	406 (16)	229 (9)
108	762 (30)	610 (24)	305 (12)
234	762 (30)	610 (24)	305 (12)
348	965 (38)	762 (30)	356 (14)
435	965 (38)	762 (30)	356 (14)
549	1524 (60)	914 (36)	356 (14)
625	1524 (60)	914 (36)	356 (14)
831	2286 (90)	635 (25)	508 (20)

Notes

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	V			
Metering	Volts Phase B-C	2	V			
Metering	Volts Phase C-A	3	V			
Metering	Current Phase A	4	A			
Metering	Current Phase B	5	A			
Metering	Current Phase C	6	A			
Metering	Watt Meter	7	KW/MW			
Metering	Kilowatt Hours	8	KWH/MWH			
Metering	Elapsed Time	9	Hours			
Metering	Meter Reset	10		Ready ETM Reset KWH Reset	Ready	
Metering	Power Factor	11		0.00…0.99		
Metering	Mtr Therm Usage	12	%	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	V	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	SEC	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	Torque Limit	21	%LRT	0…100	90	
Basic Set Up	Kickstart Time	22	SEC	0.0…2.0	0.0	
Basic Set Up	Kickstart Level	23	%LRT	0…90	0	
Basic Set Up	Option 2 Input	24		Disable Dual Ramp Preset SS	Disable	
Dual Ramp	Starting Mode 2	25		Full Voltage Current Limit Soft Start Linear Speed	Soft Start	
Dual Ramp	Ramp Time 2	26	SEC	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	Torque Limit 2	29	%LRT	0…100	90	

Table B.1 Parameter List (Continued)

Group	Parameter Description	Parameter Number	Units	Min./ Max.	Default Settings	User Settings
Dual Ramp	Kickstart Time 2	30	SEC	0.0…2.0	0.0	
Dual Ramp	Kickstart Level2	31	%LRT	0…90	0	
Basic Set Up	Stop Mode	32		Disable Soft Stop Linear Speed SMB Accu-Stop	Disable	
Basic Set Up	Stop Time	33	SEC	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	Disable	
Basic Set Up/ Overload	Service Factor	45		0.01…1.99	1.15	
Basic Set Up/ Overload	Motor FLC	46	A	1.0…1000.0	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	SEC	0…99	0	
Underload	Underload A Lvl	53	%FLC	0…99	0	
Underload	Underload A Dly	54	SEC	0…99	0	
Undervoltage	Undervolt F Lvl	55	%V	0…99	0	
Undervoltage	Undervolt F Dly	56	SEC	0…99	0	
Undervoltage	Undervolt A Lvl	57	%V	0…99	0	
Undervoltage	Undervolt A Dly	58	SEC	0…99	0	
Overvoltage	Overvolt F Lvl	59	%V	0…199	0	
Overvoltage	Overvolt F Dly	60	SEC	0…99	0	
Overvoltage	Overvolt A Lvl	61	%V	0…199	0	
Overvoltage	Overvolt A Dly	62	SEC	0…99	0	
Unbalance	Unbalance F Lvl	63	%	0…25	0	
Unbalance	Unbalance F Dly	64	SEC	0…99	0	
Unbalance	Unbalance A Lvl	65	%	0…25	0	
Unbalance	Unbalance A Dly	66	SEC	0…99	0	
Jam	Jam F Lvl	67	%FLC	0…1000	0	
Jam	Jam F Dly	68	SEC	0…99	0	
Jam	Jam A Lvl	69	%FLC	0…1000	0	
Jam	Jam A Dly	70	SEC	0…99	0	

Table B.1 Parameter List (Continued)

Group	Parameter Description	Parameter Number	Units	Min./ Max.	Default Settings	User Settings
Stall	Stall Delay	71	SEC	0.0…10.0	0	
Ground Fault	Gnd Flt Enable	72		Disable Enable	Disable	
Ground Fault	Gnd Flt Level	73	A	1.0…5.0	2.5	
Ground Fault	Gnd Flt Delay	74	SEC	0.1…250.0	0.5	
Ground Fault	Gnd Flt Inh Time	75	SEC	2…25	10	
Ground Fault	Gnd Flt A Enable	76		Disable Enable	Disable	
Ground Fault	Gnd Flt A Lvl	77	A	1.0…5.0	2.0	
Ground Fault	Gnd Flt A Dly	78	SEC	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	2	
Restart	Restart Delay	83	SEC	0…60	0	
Comm Masks	Logic Mask	87		8-bit binary		
DataLinks	Data In A1	88				
DataLinks	Data In A2	89				
DataLinks	Data In B1	90				
DataLinks	Data In B2	91				
DataLinks	Data In C1	92				
DataLinks	Data In C2	93				
DataLinks	Data In D1	94				
DataLinks	Data In D2	95				
DataLinks	Data Out A1	96				
DataLinks	Data Out A2	97				
DataLinks	Data Out B1	98				
DataLinks	Data Out B2	99				
DataLinks	Data Out C1	100				
DataLinks	Data Out C2	101				
DataLinks	Data Out D1	102				
DataLinks	Data Out D2	103				
Motor Data	Motor ID	104		0…65535	0	
Motor Data	CT Ratio	105		1…1500		
Motor Data	MV Ratio	106		1…10000		
Basic Set Up	Aux1 Config	107		Normal Up To Speed External Bypass	Normal	
Basic Set Up	Fault Contact	108		NO NC	NO	
Basic Set Up	Alarm Contact	109		NO NC	NO	

Table B.1 Parameter List (Continued)

Group	Parameter Description	Parameter Number	Units	Min./ Max.	Default Settings	User Settings
Basic Set Up	Aux2 Config	110		NO NC	NO	
Language	Language	111		English French Spanish German Portuguese Mandarin	English	
All	Parameter Mgmt	115		Ready User Recall User Store Factory Default	Ready	
Basic Set Up	Backspin Timer	116	SEC	0…999	0	

Renewal Parts

Description		SMC Rating	Input Control Voltage	Part No. ①
Control Modules	Standard	All	120…240V AC	41391-454-01-S1FX
	Pump Control	All		41391-454-01-B1FX
	Braking Control	5…85 A		41391-454-01-D1AX
		108…251 A		41391-454-01-D1BX
		317…480 A		41391-454-01-D1CX
	Standard	All	24V AC/DC	41391-454-02-S2FX
	Pump Control	All		41391-454-02-B2FX
	Braking Control	5…85 A		41391-454-02-D2AX
		108…251 A		41391-454-02-D2BX
		317…480 A		41391-454-02-D2CX
Description		**SMC Rating**	**Line Voltage**	**Part No. ①**
Power Poles		5 A	200…480V	150-FPP5B ②③
		25 A	200…480V	150-FPP25B ②③
		43 A	200…480V	150-FPP43B ②③
		60 A	200…480V	150-FPP60B ②③
		85 A	200…480V	150-FPP85B ②③
		108 A	200…480V	41391-800-01 ④
		135 A	200…480V	41391-800-03 ④
		201 A	200…480V	41391-800-05 ④
		251 A	200…480V	41391-800-07 ④
		317 A	200…480V	41391-800-09 ④
		361 A	200…480V	41391-800-11 ④
		480 A	200…480V	41391-800-13 ④
		5 A	200…600V	150-FPP5C ②③
		25 A	200…600V	150-FPP25C ②③
		43 A	200…600V	150-FPP43C ②③
		60 A	200…600V	150-FPP60C ②③
		85 A	200…600V	150-FPP85C ②③
		108 A	200…600V	41391-800-02 ④
		135 A	200…600V	41391-800-04 ④
		201 A	200…600V	41391-800-06 ④
		251 A	200…600V	41391-800-08 ④
		317 A	200…600V	41391-800-10 ④
		361 A	200…600V	41391-800-12 ④
		480 A	200…600V	41391-800-14 ④
Heatsink Fans		5…85 A	All	41391-801-03 ②
		108…251 A	All	41391-801-01
		317…480 A	All	41391-801-02
Base Plate		108…251 A	All	41391-803-01
		317…480 A	All	41391-803-02

① One piece provided per part number.

② 5…85 A power pole structure does not include heatsink fan.

③ Three-phase power pole structure provided per part no.

④ One-phase power pole provided per part no.

Accessories

Description	Description/Used With	Cat. No.
Protective Modules	5…85 A, 480V	150-F84
	108…480 A, 480V	150-F84L
	5…85 A, 600V	150-F86
	108…480 A, 600V	150-F86L
Terminal Lugs	108…251 A	199-LF1
	317…480 A	199-LG1
IEC Terminal Covers	108…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	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

① Requires a 20-HIM-H10 cable.

Renewal Part Cross Reference

	Description	SMC Rating	Line Voltage	Input Voltage	Orderable Allen-Bradley Renewal Part No.	Control Module Internal Cat. No. Label ①
Control Module	Standard	All	—	100…240V	41391-454-01-S1FX	150-FS1FX
		All	—	24V	41391-454-02-S2FX	150-FS2FX
	Pump Control	All	—	100…240V	41391-454-01-B1FX	150-FB1FX
		All	—	24V	41391-454-02-B2FX	150-FB2FX
	Brake Control	5…85 A	—	100…240V	41391-454-01-D1AX	150-FD1AX
		5…85 A	—	24V	41391-454-02-D2AX	150-FD2AX
		108…251 A	—	100…240V	41391-454-01-D1BX	150-FD1BX
		108…251 A	—	24V	41391-454-02-D2BX	150-FD2BX
		317…480 A	—	100…240V	41391-454-01-D1CX	150-FD1CX
		317…480 A	—	24V	41391-454-02-D2CX	150-FD2CX

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	A	150-FS1FX	150-FPP5B
			25	150-F25NBD	A	150-FS1FX	150-FPP25B
			43	150-F43NBD	A	150-FS1FX	150-FPP43B
			60	150-F60NBD	A	150-FS1FX	150-FPP60B
			85	150-F85NBD	A	150-FS1FX	150-FPP85B
		200…600V AC	5	150-F5NCD	A	150-FS1FX	150-FPP5C
			25	150-F25NCD	A	150-FS1FX	150-FPP25C
			43	150-F43NCD	A	150-FS1FX	150-FPP43C
			60	150-F60NCD	A	150-FS1FX	150-FPP60C
			85	150-F85NCD	A	150-FS1FX	150-FPP85C
	24V AC/DC	200…480V AC	5	150-F5NBR	A	150-FS2FX	150-FPP5B
			25	150-F25NBR	A	150-FS2FX	150-FPP25B
			43	150-F43NBR	A	150-FS2FX	150-FPP43B
			60	150-F60NBR	A	150-FS2FX	150-FPP60B
			85	150-F85NBR	A	150-FS2FX	150-FPP85B
		200…600V AC	5	150-F5NCR	A	150-FS2FX	150-FPP5C
			25	150-F25NCR	A	150-FS2FX	150-FPP25C
			43	150-F43NCR	A	150-FS2FX	150-FPP43C
			60	150-F60NCR	A	150-FS2FX	150-FPP60C
			85	150-F85NCR	A	150-FS2FX	150-FPP85C

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	A	150-FB1FX	150-FPP5B
			25	150-F25NBDB	A	150-FB1FX	150-FPP25B
			43	150-F43NBDB	A	150-FB1FX	150-FPP43B
			60	150-F60NBDB	A	150-FB1FX	150-FPP60B
			85	150-F85NBDB	A	150-FB1FX	150-FPP85B
		200…600V AC	5	150-F5NCDB	A	150-FB1FX	150-FPP5C
			25	150-F25NCDB	A	150-FB1FX	150-FPP25C
			43	150-F43NCDB	A	150-FB1FX	150-FPP43C
			60	150-F60NCDB	A	150-FB1FX	150-FPP60C
			85	150-F85NCDB	A	150-FB1FX	150-FPP85C
	24V AC/DC	200…480V AC	5	150-F5NBRB	A	150-FB2FX	150-FPP5B
			25	150-F25NBRB	A	150-FB2FX	150-FPP25B
			43	150-F43NBRB	A	150-FB2FX	150-FPP43B
			60	150-F60NBRB	A	150-FB2FX	150-FPP60B
			85	150-F85NBRB	A	150-FB2FX	150-FPP85B
		200…600V AC	5	150-F5NCRB	A	150-FB2FX	150-FPP5C
			25	150-F25NCRB	A	150-FB2FX	150-FPP25C
			43	150-F43NCRB	A	150-FB2FX	150-FPP43C
			60	150-F60NCRB	A	150-FB2FX	150-FPP60C
			85	150-F85NCRB	A	150-FB2FX	150-FPP85C
Braking Control	100…240V	200…480V AC	5	150-F5NBDD	A	150-FD1AX	150-FPP5B
			25	150-F25NBDD	A	150-FD1AX	150-FPP25B
			43	150-F43NBDD	A	150-FD1AX	150-FPP43B
			60	150-F60NBDD	A	150-FD1AX	150-FPP60B
			85	150-F85NBDD	A	150-FD1AX	150-FPP85B
		200…600V AC	5	150-F5NCDD	A	150-FD1AX	150-FPP5C
			25	150-F25NCDD	A	150-FD1AX	150-FPP25C
			43	150-F43NCDD	A	150-FD1AX	150-FPP43C
			60	150-F60NCDD	A	150-FD1AX	150-FPP60C
			85	150-F85NCDD	A	150-FD1AX	150-FPP85C
	24V AC/DC	200…480V AC	5	150-F5NBRD	A	150-FD2AX	150-FPP5B
			25	150-F25NBRD	A	150-FD2AX	150-FPP25B
			43	150-F43NBRD	A	150-FD2AX	150-FPP43B
			60	150-F60NBRD	A	150-FD2AX	150-FPP60B
			85	150-F85NBRD	A	150-FD2AX	150-FPP85B
		200…600V AC	5	150-F5NCRD	A	150-FD2AX	150-FPP5C
			25	150-F25NCRD	A	150-FD2AX	150-FPP25C
			43	150-F43NCRD	A	150-FD2AX	150-FPP43C
			60	150-F60NCRD	A	150-FD2AX	150-FPP60C
			85	150-F85NCRD	A	150-FD2AX	150-FPP85C

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.

AC — Alternating current.

AC Contactor — An alternating current (AC) contactor is designed for the specific purpose of establishing or interrupting an AC power circuit.

Ambient Temperature — Ambient temperature is the temperature of air, water, or a surrounding medium where equipment is operated or stored.

American Wire Gauge (AWG) — A standard system used for designing the size of electrical conductors. Gauge numbers have an inverse relationship to size; larger numbers have a smaller cross sectional area. However, a single-strand conductor has a larger cross-sectional area than a multi-strand conductor of the same gauge so that they have the same current-carrying specification.

Block Transfer — Block Transfer is the method used by a PLC™ to transfer data that does not require continuous updates. To perform this function, the module provides a status word to the PLC during normal discrete transfer scan. This status word occupies the first module group in the PLC I/O image table for the designated rack. The status word is then used by the PLC program to control the BTW and BTR functions of the PLC.

BTR — A PLC Block Transfer Read instruction.

BTW — A PLC Block Transfer Write instruction.

Buffer

1. In software terms, a register or group of registers used for temporary storage of data to compensate for transmission rate differences between the transmitter and receiving device.
2. In hardware terms, an isolating circuit used to avoid the reaction of one circuit with another.

Contactor, Reversing — A method of reversing motor rotation by the use of two separate contactors, one of which produces rotation in one direction and the other produces rotation in the opposite direction. The contactors are electrically (and mechanically) interlocked so that both cannot be energized at the same time.

COP — This instruction copies data from one location into another. It uses no status bits. If you need an enable bit, program a parallel output using a storage address.

Cursor — The intensified or blinking element in a video display. A means for indication where data entry or editing occurs.

Cycle

1. A sequence of operations that is repeated regularly.
2. The time it takes for one sequence of operations to occur.

DH-485 Link Data Highway 485 link. An Allen-Bradley token-passing baseband link for a local area network based on the RS-485 standard.

Disable To inhibit logic from being activated.

Duty Cycle The relationship between the operating and rest times or repeatable operation at different loads.

Enable To allow an action or acceptance of data by applying an appropriate signal to the appropriate input.

Fault Any malfunction that interferes with normal system operation.

G File G File configuration is based on the devices that you have on the RIO link. G File configuration consists of setting logical device starting addresses and the logical device image size of each physical device/adapter with which the scanner communicates.

Gate The control element of an SCR (silicon controlled rectifier) commonly referred to as a thyristor. When a small positive voltage is applied to the gate momentarily, the SCR will conduct current (when the anode is positive with respect to the cathode of the SCR). Current conduction will continue even after the gate signal is removed.

Jogging Jogging is a means of accomplishing momentary motor movement by repetitive closure of a circuit using a single push button or contact element.

Jumper A short conductor with which you connect two points.

LCD Liquid crystal display, which is a reflective visual readout device commonly used in digital watches and laptop computers.

Locked Rotor Torque The minimum torque that a motor will develop at rest for all angular positions of the rotor (with rated voltage applied at rated frequency).

Mode A selected method of operation. Example: run, test, or program.

Normally Closed Contacts A set of contacts on a relay or switch that are closed when the relay is de-energized or the switch is de-activated. They are open when the relay is energized or the switch is activated.

Normally Open Contacts A set of contacts on a relay or switch that are open when the relay is de-energized or the switch is de-activated. They are closed when the relay is energized or the switch is activated.

PLC® Controller

1. An Allen-Bradley programmable controller.
2. An Allen-Bradley programmable controller with a name that includes the letters PLC. See *Programmable Controller*.

Port	On a communication link, the logic circuitry or software at a station that determines its communication parameters for a particular communication channel.
Power Factor	A measurement of the time phase difference between the voltage and current in an AC circuit. It is represented by the cosine of the angle of this phase difference. Power factor is the ratio of Real Power (kW) to total kVA or the ratio of actual power (W) to apparent power (volt-amperes).
Preset Speed	Preset speed refers to one or more fixed speeds at which the drive will operate.
Programmable Controller	A solid-state system that has a user-programmable memory for storage of instructions to implement specific functions such as I/O control, logic, timing, counting, report generation, communication, arithmetic, and data file manipulation. A controller consists of a central processor, input/output interface, and memory. A controller is designed as an industrial control system.
Protocol	A set of conventions governing the format and timing of data between communication devices.
Remote I/O	I/O connected to a processor across a serial link. With a serial link, remote I/O can be located long distances from the processor.
RS-232-C	An EIA standard that specifies electrical, mechanical, and functional characteristics for serial binary communication circuits in a point-to-point link.
RS-422	An EIA standard that specifies electrical characteristics of balanced-voltage digital interface circuits in a point-to-point link.
RS-485	An EIA standard that specifies electrical characteristics of balanced-voltage digital interface circuits in a multi-point link.
Scrolling	The vertical movement of data on a display screen caused by the dropping of one line of displayed data for each new line added at the opposite end.
Serial	Pertaining to time-sequential transmission of, storage of, or logic operations on data, using the same facilities for successive parts.
Service Factor (S-F)	When used on a motor nameplate, a number which indicates how much above the nameplate rating a motor can be loaded without causing serious degradation (i.e., a motor with 1.15 S-F can produce 15% greater torque than one with 1.0 S-F) to adjust measured loads in an attempt to compensate for conditions which are difficult to measure or define.
Silicon Controlled Rectifier (SCR)	A solid-state switch, sometimes referred to as a thyristor. The SCR has an anode, cathode and control element called the gate. The device provides controlled rectification since it can be turned on at will. The SCR can rapidly switch large currents at high voltages. They are small in size and low in weight.
SLC™ Controller	An Allen-Bradley programmable controller with a name that includes the letters SLC. See *Programmable Controller*.

Status	The condition at a particular time of any numerous entities within a system. These conditions may be represented by values in a status line.
Surge Protection	The process of absorbing and clipping voltage transients on an incoming AC line or control circuit. MOVs (Metal Oxide Varistors) and specially designed R-C networks are usually used to accomplish this.
Toggle	To switch alternately between two possible selections.
Transient	A momentary deviation in an electrical or mechanical system.
UL	Underwriters Laboratories (a third-party safety certification agency).

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