User Manual

Allen-Bradley

Elevator Panel Solution

Bulletin 150-E

Allen-Bradley • Rockwell Software

Rockwell Automation

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence
	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Introduction

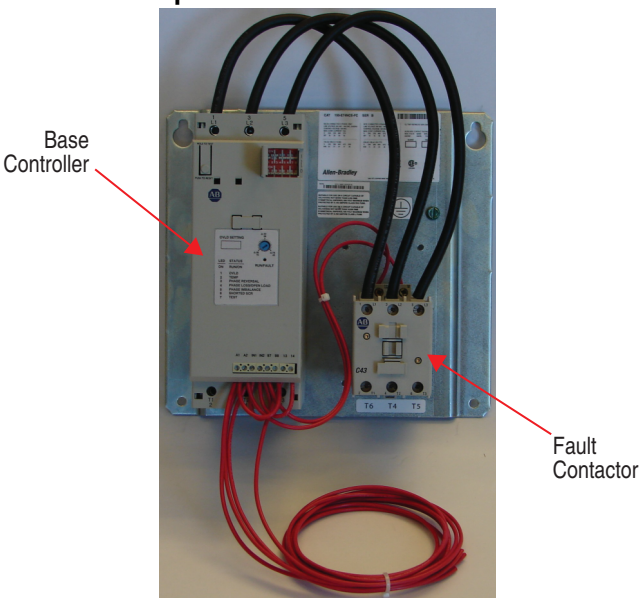
This manual provides and overview of the installation, set-up, and typical operation of the Allen-Bradley hydraulic elevator and escalator starter. This solid-state starter solution is designed to operate 3-phase standard squirrel cage induction motors and can be connected to a 6 or 12 lead Wye-Delta or standard 3 or 9 lead motors. Through the use of LINE or INSIDE-THE-DELTA control, the solid-state solution can provide ultimate control of the motor. The advantages of a solid-state solution include the following:

- Provides smooth motor starting.
- Reduces current surges on weak electrical systems.
- Reduces starting torque of the motor, wich helps to reduce mechanical stress on system components.
- Helps meet both local and regional electrical codes when reduced voltage starting is a requirement.
- Eliminates voltage and current spikes associated with traditional Wye-Delta starters.
- Maximizes the life of the motor with reduced electrical strain.
- Reduces general system maintenance requirements for improved uptime.

Component Overview

The starter is made up of two components, the base controller and a fault contactor.

Figure 1 - Bulletin 150-E Components



Base Controller

The base controller is a standard product that uses a number of intelligent features to provide advanced motor control and simple diagnostics. The base controller consists of the elements necessary to control the motor. These elements include:

- a main micro-processor
- current sensing
- built-in adjustable overload
- solid-state power modules, and
- electro-mechanical bypass contacts.

Through the use of simple DIP switch configuration, the product can be configured for a variety of modes. The default configuration uses the built-in current sensing to limit current to the motor during starting. Once up to speed, the base controller transitions to the run mode by transitioning to internal bypass contactors and changing the state of the auxillary contact. The internal bypass contactor provides decreased heating during run and removes the SCRs from the circuit.

Fault Contactor

The fault contactor is controlled through the fault contact of the controller. When control power is applied to the controller, the normally open fault contact closes and applies control power to the coil of the contactor. The fault contact will open, removing power from the fault contactor, and thus disabling the motor during any one of the following events:

- The power is removed from the controller.
- The motor has developed a problem including overloading due to one of the following:
  - Mechanical or electrical reasons
  - Ground faults or
  - Motor short circuits.
- The starter has detected an internal problem such as a shorted SCR or overtemperature condition.

Function Overview

The Bulletin 150-E elevator panel provides solution to both advanced motor control and simple diagnostics. The following information provides a brief overview of the basic product features.

Motor Control

Current Limit	Through the use of internal current sensors, the SMC™ will regulate the current level applied to the motor over the programmed period of time. This type of motor control produces a slow start and insures that the current does not exceed the programmed level. This is the standard configuration of the device and aligns well with traditional applications.
Soft Start	The voltage is ramped from an initial set point to full voltage over the programmed period of time. This type of motor control produces a smooth start in less time than the current limit setting. However, the current is not restricted.
Soft Stop	The voltage is ramped down from full voltage and applied to the motor over a programmed period of time. The result is a smooth stop.

Diagnostics

Overload	Provides protection of the motor for over current conditions. This feature offers a user-selectable setting called the trip class, which can be used to accommodate different applications and motor types. When the motor draws more than the nominal value of current for a period of time, the device will fault on a motor overload fault.
Over-Temperature	A built-in self-monitoring method for detecting a SCR over-temperature condition. If the internal temperature exceeds a design threshold, the device will fault on a SCR Overtemp fault.
Phase Reversal	The user can select the phase relationship of the incoming power. If this phase relationship changes, the device will fault indicating a problem.
Phase Loss/ Open Load	When any one of the incoming 3 phases are lost, the controller will fault indicating a phase loss condition has occurred.
Phase Imbalance	When enabled, will detect if a phase imbalance condition exists and fault the unit. A phase imbalance is defined as a 65% differential between the highest and lowest phase for more than 3 seconds.
Shorted SCR	Each time the SMC initiates a start, it checks to see if the SCRs are operating correctly. If the controller is unable to properly turn on and off any one of the SCRs, the device will fault on a Shorted SCR fault.

Starter Selection

For 6 or 12 Lead Wye-Delta Wound Motors

The following table lists the catalog numbers that can be used with 6 or 12 lead Wye-Delta motors. For proper operation, the connection should be verified during installation. Sample connection diagrams for INSIDE-THE-DELTA connected motors are included in the Installation and Wiring section found later in this manual.

Table 1 - Cat. Nos. For Use with 6- or 12-Lead Wye-Delta Motors

Hp at Nominal Ratings					Control Voltage Cat. Nos.	
200V	240V	480V	575V	Overload Range ❶	120V	230V
10	10	20	30	10.9…32.9	150-E32NCE-FC	150-E32NCA-FC
15	15	30	40	17…51	150-E51NCE-FC	150-E51NCA-FC
20	20	40	60	21.3…64	150-E64NCE-FC	150-E64NCA-FC
20	25	50	60	24.7…74	150-E74NCE-FC	150-E74NCA-FC
30	40	75	100	34.7…104	150-E104NCE-FC	150-E104NCA-FC
40	50	100	150	49…147	150-E147NCE-FC	150-E147NCA-FC
75	75	150	200	59…234	150-E234NCE-FC	150-E234NCA-FC

❶ Motor FLA must fall within the specified range to operate correctly.

For 3- or 9-Lead Closed Delta-Type Motors

The following table lists the catalog numbers that can be used with 3- or 9-lead closed delta type motors. For proper operation, the connection should be verified during installation. Sample connection diagrams for LINE connected motors are included in the Installation and Wiring section found later in this manual.

Table 2 - Cat. Nos. For Use with 6 or 12 Lead Closed Delta-Type Motors

Hp at Nominal Ratings					Control Voltage Cat. Nos.	
200V	240V	480V	575V	Overload Range ❶	120V	230V
5	5	10	15	6.3…19	150-E32NCE-FC	150-E32NCA-FC
7.5	10	20	25	10…30	150-E51NCE-FC	150-E51NCA-FC
10	10	25	30	12.3…37	150-E64NCE-FC	150-E64NCA-FC
10	15	30	40	14.3…43	150-E74NCE-FC	150-E74NCA-FC
15	20	40	50	20…60	150-E104NCE-FC	150-E104NCA-FC
25	30	60	75	28.3…85	150-E147NCE-FC	150-E147NCA-FC
40	50	100	125	34…135	150-E234NCE-FC	150-E234NCA-FC

❶ Motor FLA must fall within the specified range to operate correctly.

Installation & Wiring

Unpacking

Prior to installation, unpack the starter panel from its packaging and perform a complete visual inspection of the panel. Inspect all components including the controller, wiring, and fault contactor for damage related to shipping and handling. Claims for damage must be made to the carrier as soon as possible after receipt of the shipment.

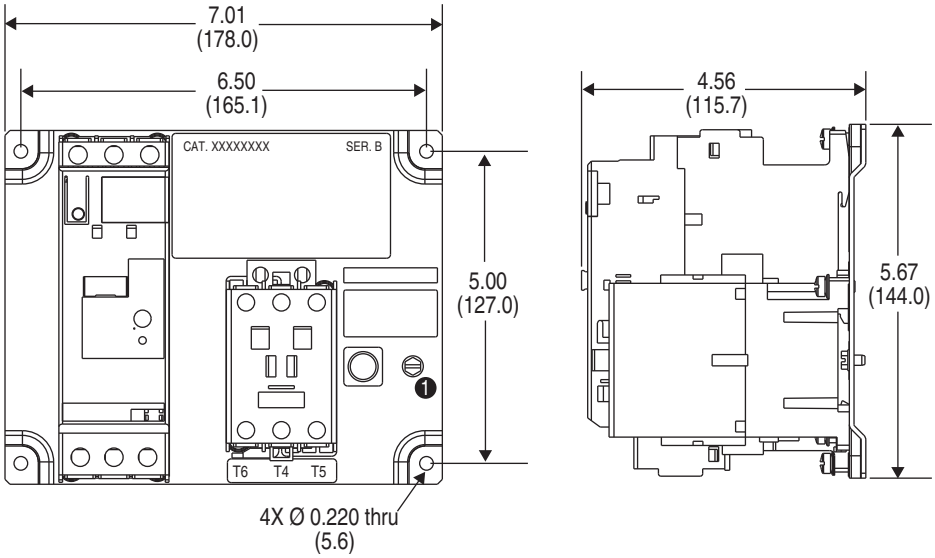
Mounting

The small footprint of the starter panel makes it ideal for mounting in the same space previously occupied by legacy solid state starters and traditional Full Voltage starters. The starter panel does not require mounting requirements beyond the basic footprint of the panel.

The product may incorporate a small cooling fan. There are no additional cooling requirements for the product. However, it is good practice to leave at least 6 inches (15.24 cm) of free space above and below the unit for ideal air flow.

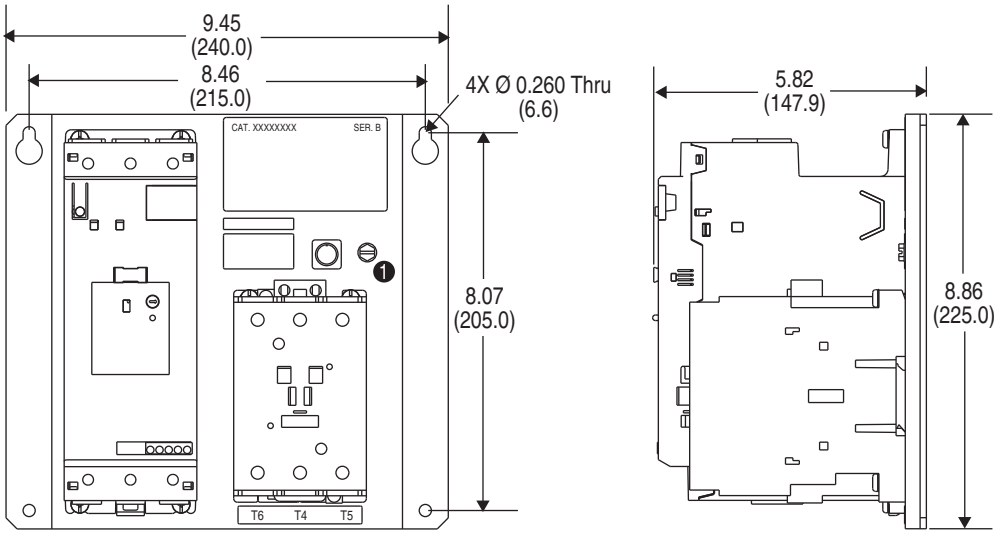
Dimensions

Figure 2 - Panel Dimensions for 32, 51, & 64 A Elevator Panels



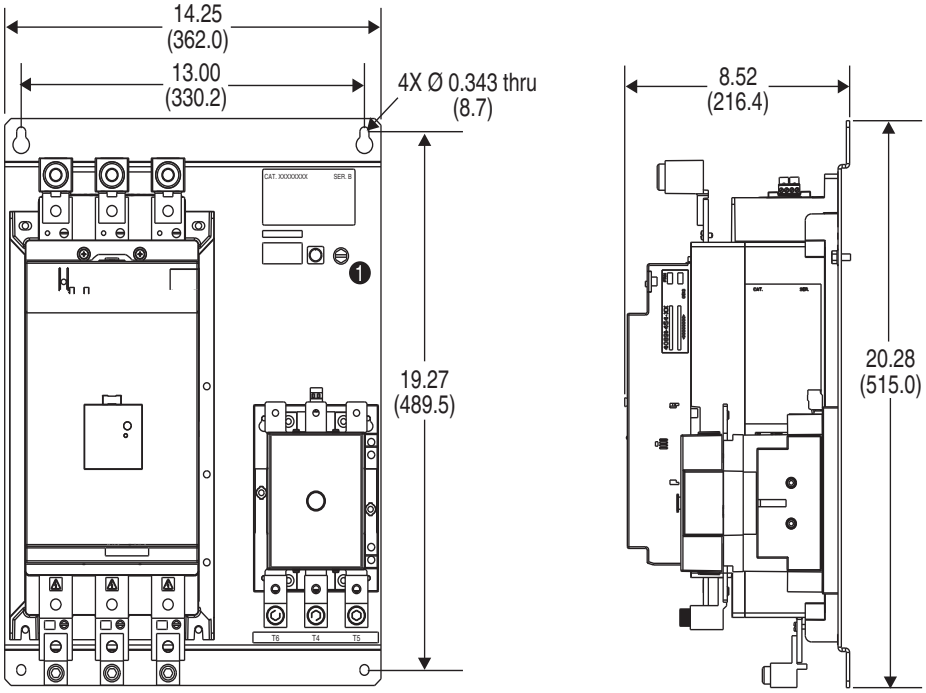
❶ This screw is intended to secure a prepared bonding conductor (e.g., a bonding conductor with a crimped-on lug) **or** a suitable terminal for connection of an unprepared bonding conductor (e.g., a bonding conductor with a stripped wire end). This screw is **not** intended for a direct field wiring connection of an unprepared bonding conductor or equipment grounding conductor.

Figure 3 - Panel Dimensions for 74, 104, & 147 A Elevator Panels



❶ This screw is intended to secure a prepared bonding conductor (e.g., a bonding conductor with a crimped-on lug) **or** a suitable terminal for connection of an unprepared bonding conductor (e.g., a bonding conductor with a stripped wire end). This screw is **not** intended for a direct field wiring connection of an unprepared bonding conductor or equipment grounding conductor.

Figure 4 - Panel Dimensions for 234 A Elevator Panels



❶ This screw is intended to secure a prepared bonding conductor (e.g., a bonding conductor with a crimped-on lug) **or** a suitable terminal for connection of an unprepared bonding conductor (e.g., a bonding conductor with a stripped wire end). This screw is **not** intended for a direct field wiring connection of an unprepared bonding conductor or equipment grounding conductor.

Installation Precautions

The following precautions are provided as guidance for proper installation of this controller. As this product was designed to be used in a variety of applications, not all precautions mentioned are relevant to your particular application. In all cases, the local codes and standards governing this type of product must be observed.

Motor Branch Protection and Disconnecting Means

- The controller featues motor overload protection. However, it does not have means to protect itself from a short circuit condition. Suitable branch circuit protection and coordination must be provided per the NEC, or the equivalent local electrical code.

Electrical Noise Suppression

- Electrical noise can be generated from various sources connected to the same power as the controller. Sources of noise include: inductive loads (i.e. relays and solenoids), large motors and machinery, Variable Frequency Drives, and other high frequency devices (i.e. welders).
- Electrical noise can enter the product through power and control wiring and cause damage to solid-state components.
- Mitigation of electrical noise can be accomplished through the following methods:
  - Proper wiring practices including grounding, use of shielded cable where appropriate, and separation of power, control, and signaling wires.
  - Use of surge suppression devices on inductive loads.
  - Use of isolation transformers for high frequency generators.

Power Factor Correction Capacitors (PFCC).

- PFCCs must always be used on the line side of the controller. Use of PFCCs on the output side of the controller will damage the starter.

Terminal Torque Specifications

Table 3 - Controller Information

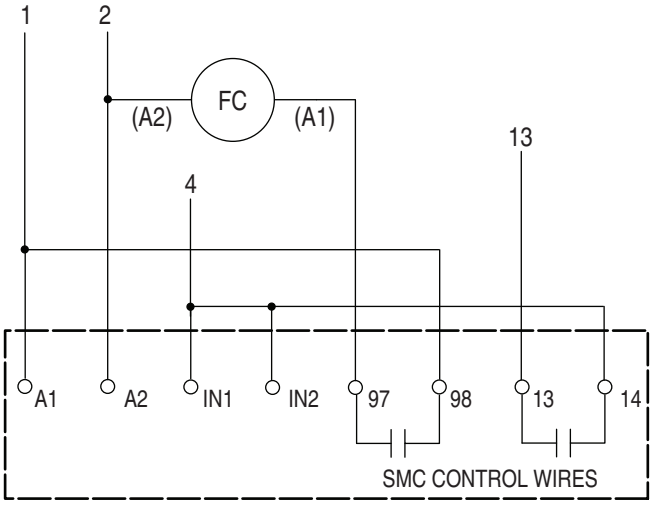
Controller Size	Units	Power Terminals		
		Line	**Load**	**Control**
32/51/64	Wire size	14…4 AWG (2.5…25 mm^2)	14…6 AWG (2.5…16 mm^2)	24…14 AWG (0.2…2.5 mm^2)
	Torque	20…25 lb-in. (2.3…2.8 Nm)	20…22.5 lb-in. (2.3…2.6 Nm)	4.4…8 lb-in. (0.5…0.9 Nm)
74/104/147	Wire size	14…3/0 AWG (2.5…95 mm^2)	14…1 AWG (2.5…50 mm^2)	24…14 AWG (0.2…2.5 mm^2)
	Torque	100…110 lb-in. (11.3…12.4 Nm)	100…110 lb-in. (11.3…12.4 Nm)	4.4…8 lb-in. (0.5…0.9 Nm)
234	Wire size	6…250 AWG (16…120 mm^2)	6…250 AWG (16…120 mm^2)	24…14 AWG (0.2…2.5 mm^2)
	Torque	275 lb-in. (31 Nm)	275 lb-in. (31 Nm)	4.4…8 lb-in. (0.5…0.9 Nm)

Table 4 - Fault Contactor Information

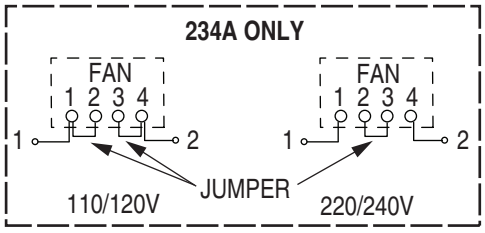
Controller Size	Units	Power Terminals		
		Line	**Load**	**Control**
32/51/64	Wire size	14…6 AWG (2.5…16 mm^2)	14…6 AWG (2.5…16 mm^2)	16…12 AWG (1…4 mm^2)
	Torque	13…31 lb-in. (2.3…3.5 Nm)	13…31 lb-in. (2.3…3.5 Nm)	8.9…13 lb-in. (1…1.5 Nm)
74/104/147	Wire size	14…2 AWG (2.5…35 mm^2)	14…2 AWG (2.5…35 mm^2)	16…12 AWG (1…4 mm^2)
	Torque	31…52 lb-in. (3.5…6 Nm)	31…52 lb-in. (3.5…6 Nm)	8.9…13 lb-in. (1…1.5 Nm)
234	Wire size	6…300 AWG (16…150 mm^2)	6…300 AWG (16…150 mm^2)	2x 16…12 AWG (2x 1…4 mm^2)
	Torque	250 lb-in. (28 Nm)	250 lb-in. (28 Nm)	12…20 lb-in. (1.4…2.3 Nm)

Delta Connection

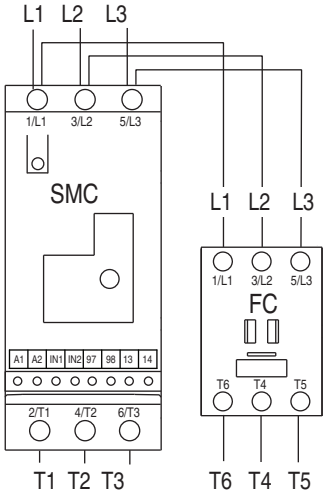
Figure 5 - Diagram, Power, & Motor Wiring



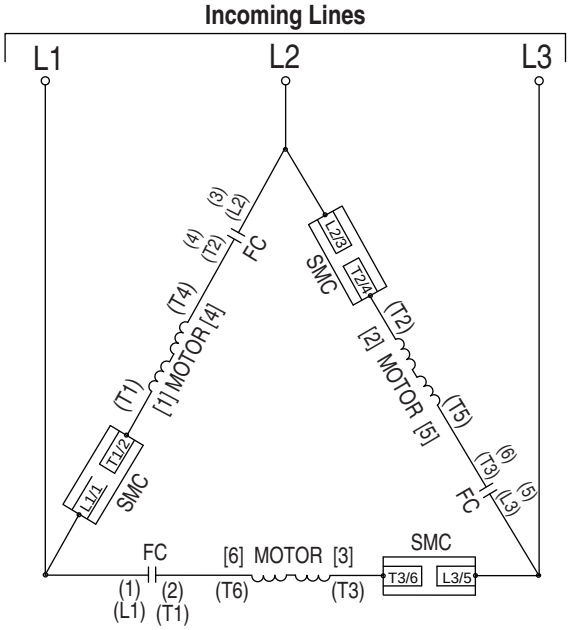
1 — Contol Power (L1)
2 — Contol Common (L2)
4 — Start Enable
13 — Up-To-Speed Indication

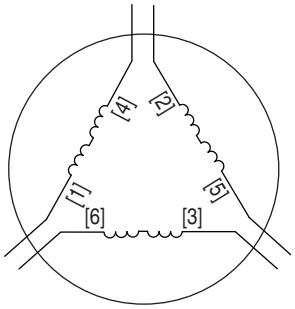


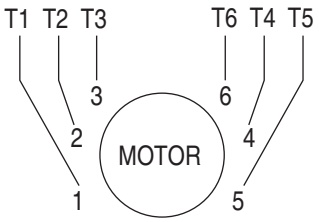
Incoming Line Connections



Incoming Lines

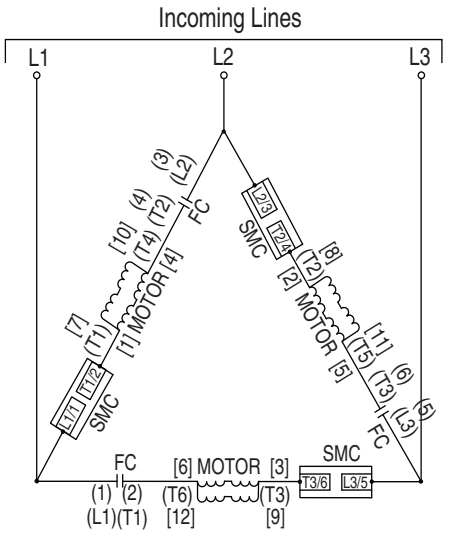


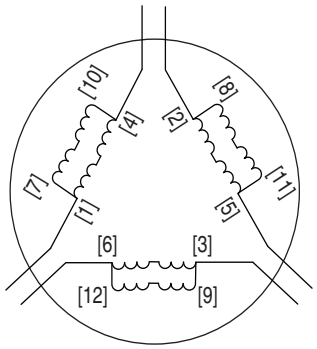


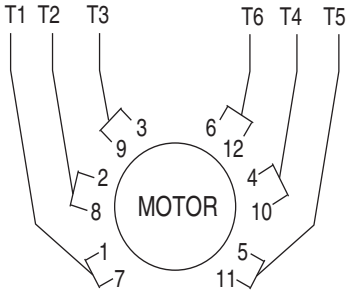


6 LEAD MOTOR CONNECTIONS							
STARTER TERMINALS	T1	T2	T3	T6	T4	T5	JUMPER
MOTOR TERMINALS	1	2	3	6	4	5	N/A

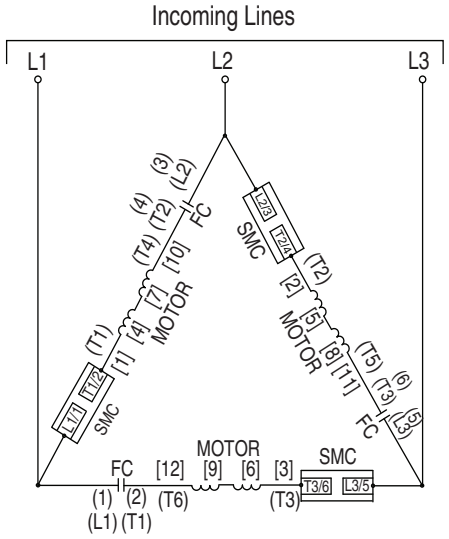
Delta Connection (continued)

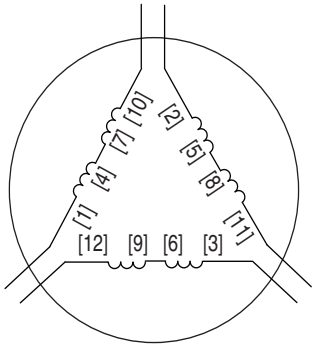


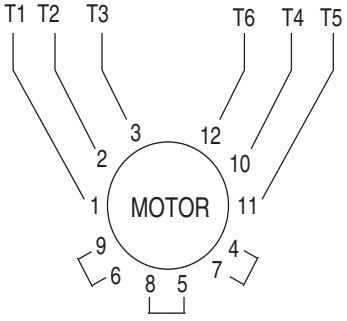




12 LEAD 230V LOW VOLTAGE MOTOR CONNECTIONS							
STARTER TERMINALS	T1	T2	T3	T6	T4	T5	JUMPER
MOTOR TERMINALS	1&7	2&8	3&9	6&12	4&10	5&11	N/A



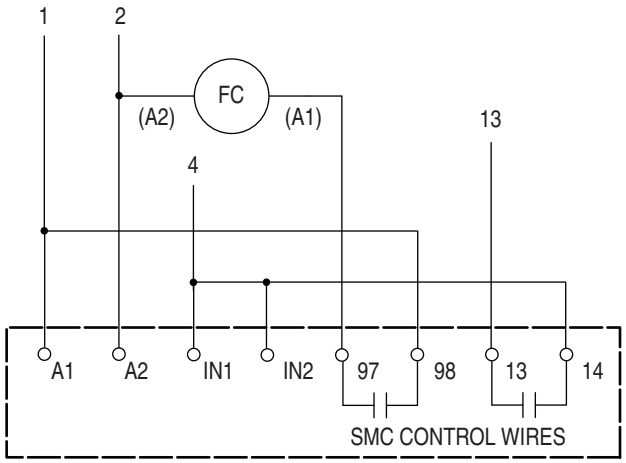




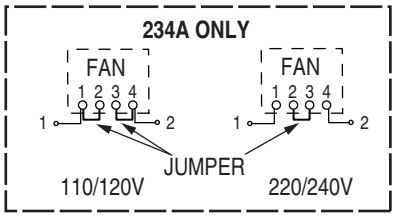
12 LEAD 460V HIGH VOLTAGE MOTOR CONNECTIONS							
STARTER TERMINALS	T1	T2	T3	T6	T4	T5	JUMPER
MOTOR TERMINALS	1	2	3	12	10	11	4&7 5&8 6&9

Line Connection

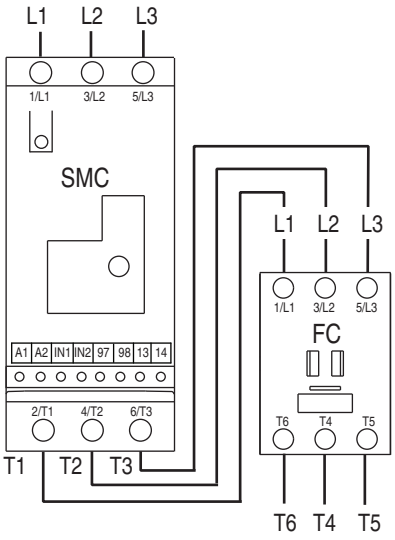
Figure 6 - Diagram, Power, & Motor Wiring

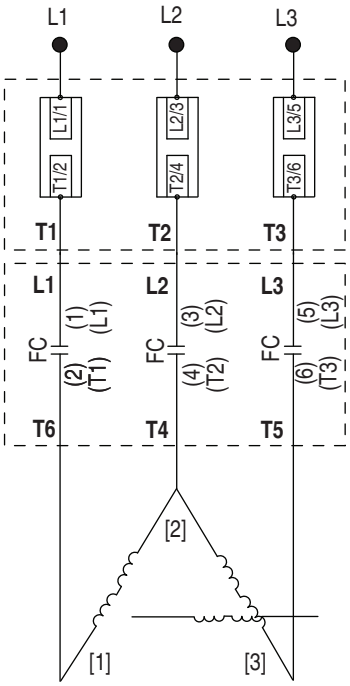


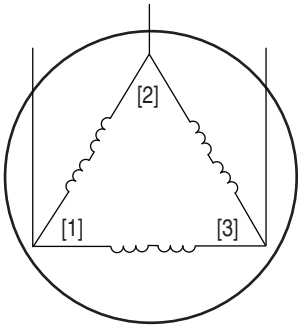
1 — Contol Power (L1)
2 — Contol Common (L2)
4 — Start Enable
13 — Up-To-Speed Indication

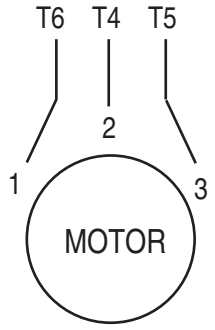


Incoming Line Connections



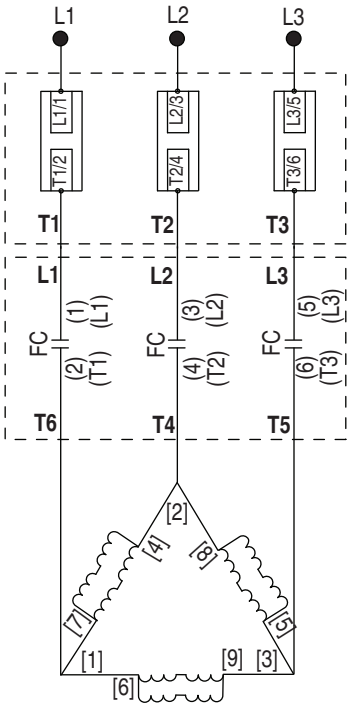


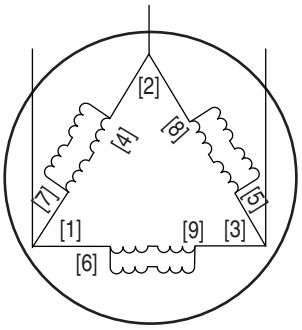


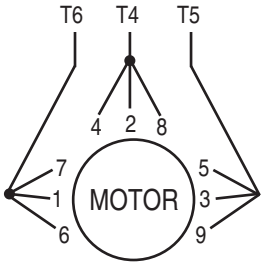


3 LEAD MOTOR CONNECTIONS				
STARTER TERMINALS	T6	T4	T5	JUMPER
MOTOR TERMINALS	1	2	3	N/A

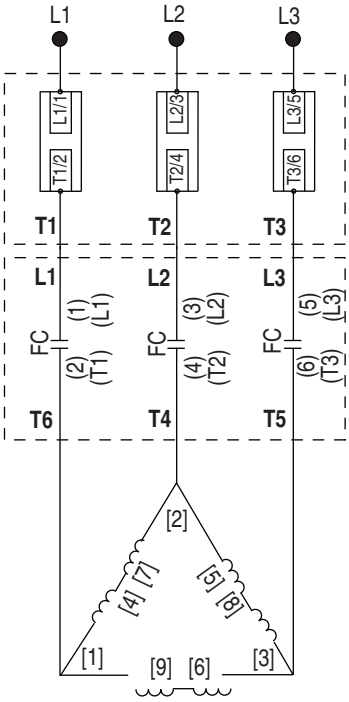
Line Connection (continued)

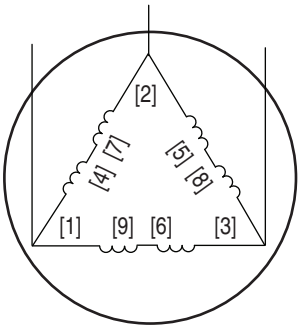


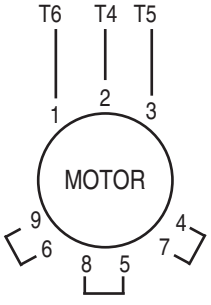




9 LEAD 230V LOW VOLTAGE MOTOR CONNECTIONS				
STARTER TERMINALS	T6	T4	T5	JUMPER
MOTOR TERMINALS	1, 6, 7	2, 4, 8	3, 5, 9	N/A



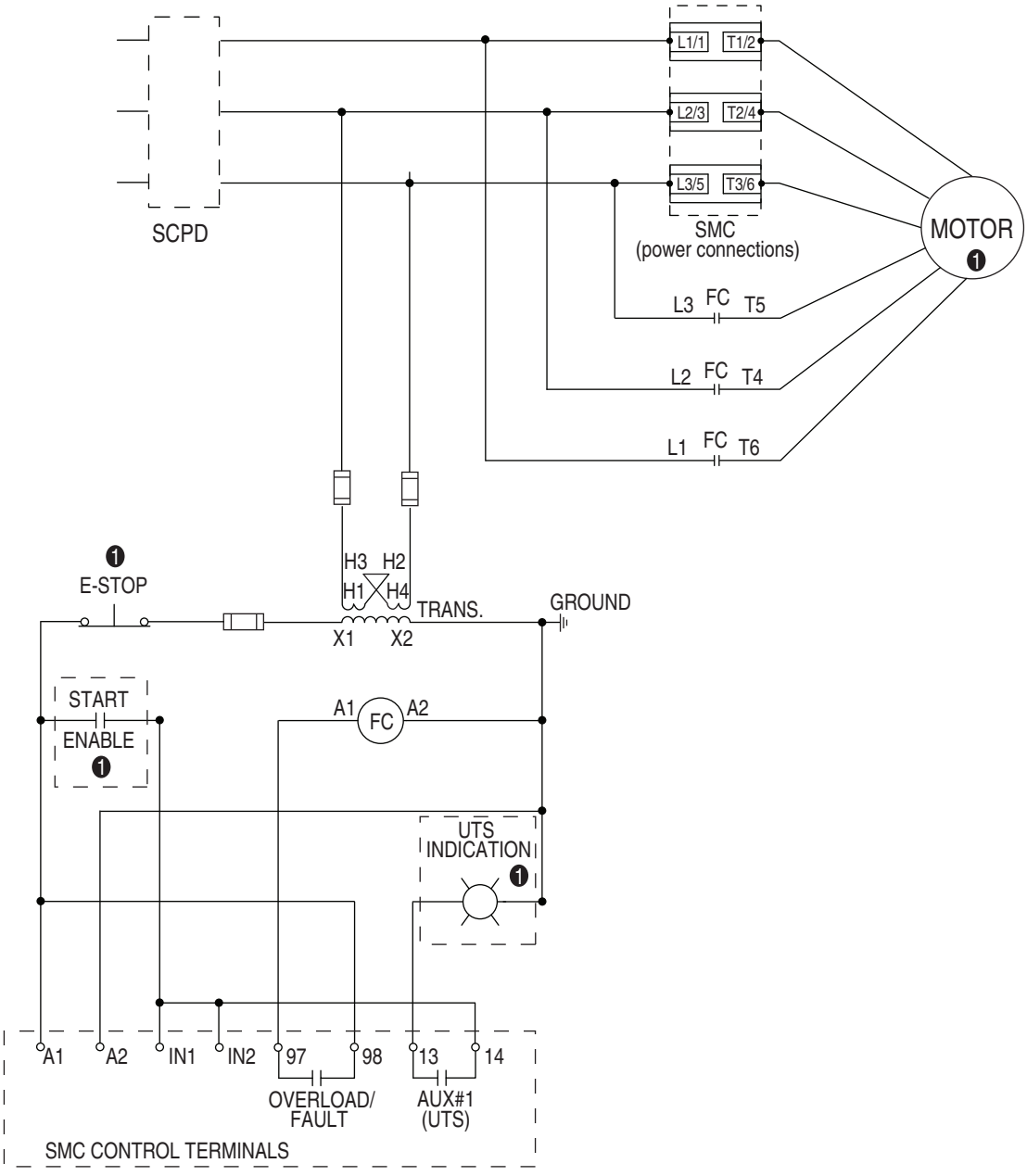




9 LEAD 460V HIGH VOLTAGE MOTOR CONNECTIONS				
STARTER TERMINALS	T6	T4	T5	JUMPER
MOTOR TERMINALS	1	2	3	4&7 5&8 6&9

Delta-Connected Controller

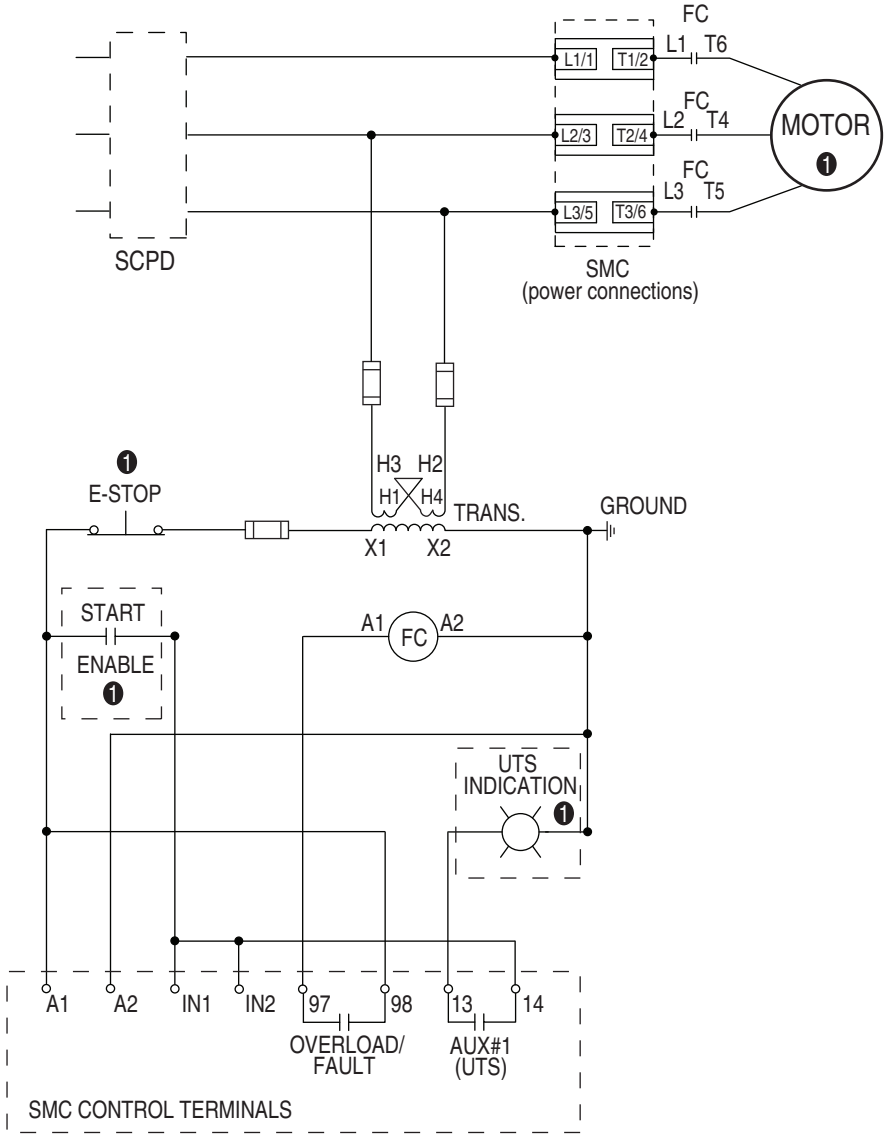
Figure 7 - Typical Control Wiring



❶ Customer supplied

Line-Connected Controller

Figure 8 - Typical Control Wiring



1 Customer supplied.

Programming

DIP Switch Settings

The 150-E elevator controller is programmed through DIP switches located on the front of the controller. All functionality is defined by these settings. The following tables define the settings available within the SMC™ controller. Default settings are indicated by the shaded areas.

Table 5 - Start Time

Settings (seconds)	Switch #1	Switch #2	This defines the time the controller will ramp or limit current to the motor. The controller can determine when the motor is up-to-speed (UTS), therefore it may transition to bypass before this time expires. If the motor does not reach speed before the time expires, the controller will continue under SCR control and not close the bypass contactor.
2	OFF	OFF	
5	ON	OFF	
10	OFF	ON	
15	ON	ON	

Table 6 - Start Mode

Mode Setting	Switch #3	In Current Limit mode, a set level of current is applied to the motor over the start time. In Soft Start mode, the device will ramp the torque from the initial level to 100% over the start time.
Current Limit	OFF	
Soft Start	ON	

Table 7 - Current Limit/Initial Torque Level

% FLA/ % Torque	Switch #4	Switch #5	The level indicated by this programming applies an initial level of current or torque to the motor for the start time. For example, if switch #3 is set to OFF, the device will perform a current limit start at the level indicated by these switches.
150%/15%	OFF	OFF	
250%/25%	ON	OFF	
350%/35%	OFF	ON	
450%/65%	ON	ON	

Table 8 - Soft Stop Time

Settings (seconds)	Switch #6	Switch #7	Soft Stop reduces the voltage applied to the motor over the programmed period of time. The soft stop is complete when the soft stop timer has expired or the current measured drops below 50% of the FLA setting.
OFF	OFF	OFF	
1x start time	ON	OFF	
2x start time	OFF	ON	
3x start time	ON	ON	

Table 9 - Phase Rotation

Setting	Switch #9	
ABC rotation	OFF	The allowable phase rotation of the motor is defined by this switch.
CBA rotation	ON	

Table 10 - Phase Imbalance

Setting	Switch #10	
Enabled	OFF	The controller has the ability to monitor for imbalance between phase currents. This protection feature can be user-disabled.
Disabled	ON	

Table 11 - Overload Trip Class

Setting	Switch #11	Switch #12	
OFF	OFF	OFF	The controller incorporates, as standard, electronic overload protection. This motor overload protection is accomplished electronically with the use of internal current transformers on each of the three phases. The controller's overload protection is programmable, providing the user with flexibility.
10	ON	OFF	
15	OFF	ON	
20	ON	ON	

Table 12 - Overload Reset

Setting	Switch #13	
Manual	OFF	In manual reset mode, the fault can only be reset by pushing the 'Push to Reset' button on the front of the controller. In auto reset mode, the unit will automatically reset when the unit determines the motor has cooled to 75% of its thermal capacity.
Auto	ON	

Table 13 - Aux #1 Setting

Setting	Switch #14	
Normal	OFF	The operation defines the operation of the Auxiliary contacts. Normal mode means that the contact will change state immediately when a start/run command is given. Up-to-Speed mode means that the contact will change state only when the controller is in bypass. Aux#2, when added, will operate opposite of this programming.
Up-to-Speed	ON	

Table 14 - Motor Connection Type

Setting	Switch #15	
Delta	OFF	In DELTA connection mode, the device is designed to control a 6 or 12 lead motor. In LINE connection mode, the device is designed to control a 3 or 9 lead motor.
Line	ON	

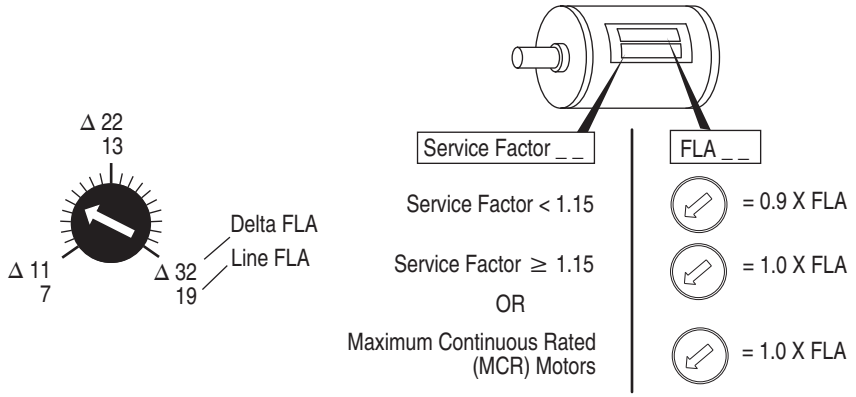
Table 15 - Stop Delay

Setting(seconds)	Switch #16	
0.0	OFF	When the delay is programmed, the motor will continue to run for the programmed period of time after the run command is removed from the controller.
0.75	ON	

Motor FLA Requirements

The front of the SMC controller contains a dial which is used for setting the actual FLA of the motor. The label is designed to accommodate motors connected in the LINE or DELTA mode. To determine the proper setting, look at the motor's nameplate and set the dial accordingly. The dial setting can be modified depending on the service factor of the motor.

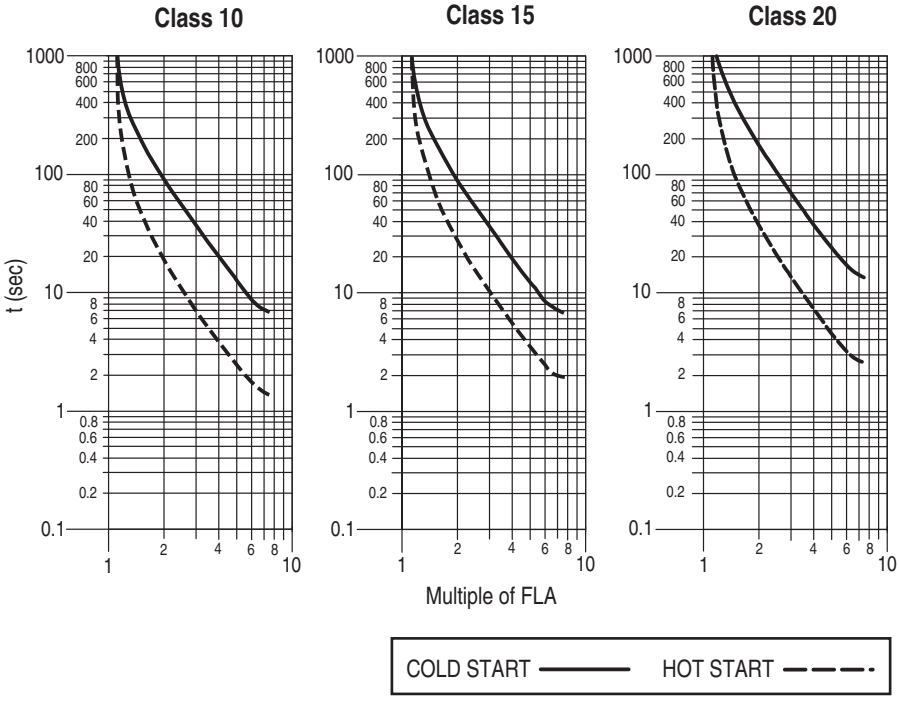
Figure 9 - FLA Setting of Motor



Motor Overload Trip Curves

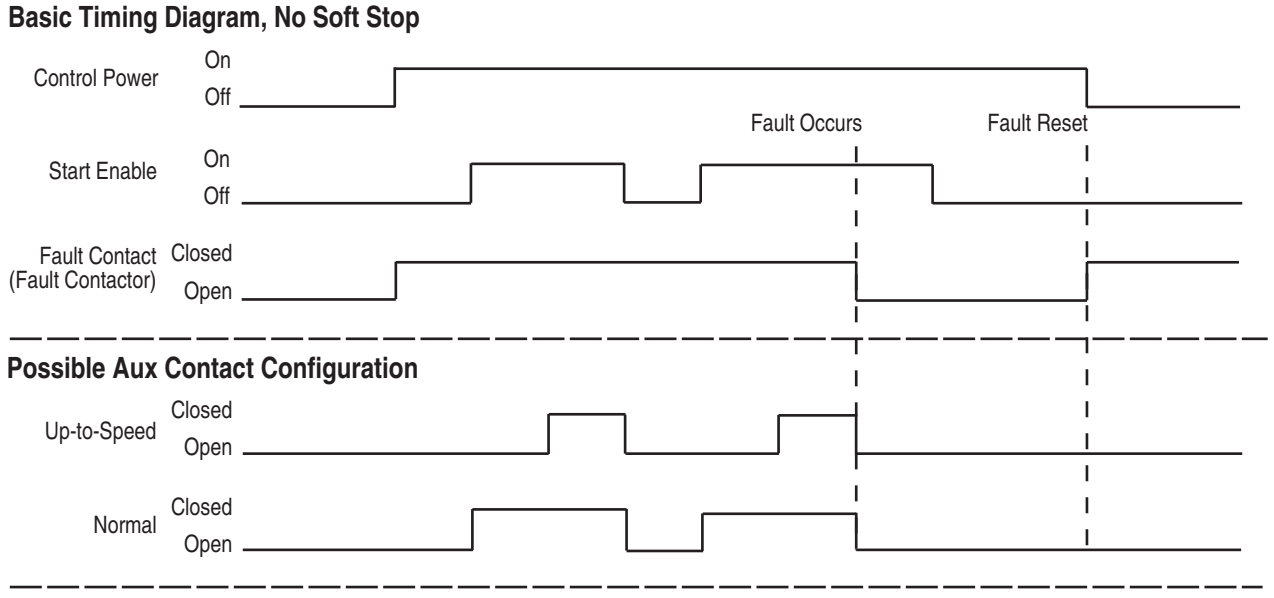
The trip class should be set according to the motor's maximum permissible locked rotor time or the general thermal capabilities. Consult the motor manufacturer for recommendations on setting the trip class.

Figure 10 - Trip Class



Input & Output Timing

Figure 11 - Input & Output Timing



Troubleshooting

Introduction

The following topics are designed to assist in the troubleshooting and maintenance of the SMC™ controller. The items mentioned in this section are not intended to be all-inclusive and it is expected that these items should be used as reference only.

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 (i.e., 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.

SHOCK HAZARD:
Hazardous voltage is present in the motor circuit even when the 150-E controller is off. To avoid shock hazard, disconnect the 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).

Diagnostics Indication

The LED on the front of the product provides limited status information regarding the condition of the controller. The conditions are as follows:

- LED Off — No control power or start command given.
- LED On — The device is active with starting, running, or stopping.
- LED Flashes — A fault has been experienced. Refer to table below for additional explanation.

Table 16 - LED Fault Indication & Diagnostics

Flashes	Fault Type	Possible Fault Explanations	Possible Solutions
1	Overload	• Motor overload condition present. • FLA dial adjustment is not matched to motor type.	• Check for motor overload condition. • Verify actual motor current does not exceed FLA. • Verify/reset the FLA dial adjustment. • Program/modify the Overload setting for load or duty cycle required.
2	Over-Temperature	• Controller ventilation blocked. • Controller duty cycle exceeded. • Cooling fan not working. • Ambient temperature exceeded. • Failed control module. • Over-current condition with Overload disabled.	• Check for proper ventilation. • Verify duty cycle. • Connect or replace cooling fan. • Wait for controller to cool or provide external coolin. • Replace control module.
3	Phase Reversal	• Incoming supply voltage is not the expected sequence.	• Check power wiring. • Adjust dip switch #9 for desired sequence.
4	Phase Loss/ Open Load	• Missing Supply Phase. • Missing or unable to detect motor connection.	• Check for open line (i.e. open fuse). • Check for incorrect wiring to load. • Verify proper operation of the fault contactor. • Verify connection type to motor (LINE or DELTA). • Ensure product is sized correctly for motor.
5	Phase Imbalance	• Unbalanced Phase Currents (> 65% differential). • Incoming line voltage problem.	• Check motor current in each phase to verify imbalance. Motor current imbalance can indicate potential motor problem.
6	Shorted SCR	• Shorted SCR. • Welded or latched bypass contactor.	• Verify connection type (LINE or DELTA) and verify setting. • Perform continuity check across power poles (L1 – T1, L2 – T2, L3 – T3). Measurements should exceed 10 k ohms. For best results, remove line and load motor connections. • Cycle power to device and attempt to restart. If fault persists, replace device.
7	Test	• Intended operation.	• Reset fault.
12	Check Sum	• Internal software corruption.	• Replace device.

Troubleshooting Steps

Table 17 - Troubleshooting Steps

Control	Device Status	Solution
Prestart - no start command given but device is faulted.	LED Flashing	• Reset fault. • Allow device to cool (overload or SCR over temp). Reset fault. • Cycle power to device.
Motor fails to start after start command given.	LED Off	• Check control power. • Check control circuit connections.
	LED ON	• Verify proper operation of fault contactor or isolation devices. • Check connections to the motor. • Verify line power and frequency are within specifications.
	LED Flashing	• Reference the LED Fault Indication & Diagnostics Table for information related to specific fault codes.
Motor attempts to start after start command is given, but fails to reach an up-to-speed condition.	LED ON	• Verify proper operation of the fault contactor or isolation devices. • Verify line power and frequency are within specifications. • Try increasing the initial torque or current limit setting.
	LED Flashing	• Reference the LED Fault Indication & Diagnostics Table for information related to specific fault codes.
Motor stops abruptly and fails to restart.	LED Off	• Check for a blown fuse or tripped circuit breaker. • Ensure the control power and start command are present. • Verify proper operation of the fault contactor or isolation devices.
	LED ON	• Verify proper operation of the fault contactor or isolation devices.
	LED Flashing	• Reference the LED Fault Indication & Diagnostics Table for information related to specific fault codes.
Fault contactor fails to close when power is applied.	All Conditions	• Verify wiring to the coil. The contactor should close when power is applied to the controller. • Verify voltage across the coil (A1 to A2). • Check the resistance of the coil. Replace, if measured open. • Verify internal contact of the controller (terminals 97/98) are properly changing state. Replace the controller if the contact does not operate correctly.

Repair Parts

Table 18 - Repair Parts

Panel	Controller		Contactor	Fans	Contactor Coil
150-E32NCE-FC	150-E32NCD		100-C37D00	(optional) 150-CF64	TC473
150-E51NCE-FC	150-E51NCD		100-C37D00		
150-E64NCE-FC	150-E64NCD		100-C37D00		
150-E74NCE-FC	150-E74NCD		100-C43D00	150-CF147	TD473
150-E104NCE-FC	150-E104NCD		100-C60D00		TE473
150-E147NCE-FC	150-E147NCD		100-C85D00		TE473
150-E234NCE-FC	Complete Device	150-E234NCD	100-D180ED00	41391-801-03	TGE865
	Control Module	150-ES1BX			
	Power Pole	150-FPP135C			
150-E32NCA-FC	150-E32NCD		100-C37KA00	(optional) 150-CF64	TC858
150-E51NCA-FC	150-E51NCD		100-C37KA00		
150-E64NCA-FC	150-E64NCD		100-C37KA00		
150-E74NCA-FC	150-E74NCD		100-C43KA00	150-CF147	TD858
150-E104NCA-FC	150-E104NCD		100-C60KA00		TE858
150-E147NCA-FC	150-E147NCD		100-C85KA00		TE858
150-E234NCA-FC	Complete Device	150-E234NCD	100-D180EA00	41391-801-03	TGE866
	Control Module	150-ES1BX			
	Power Pole	150-FPP135C			

Specifications

Electrical

Table 19 - Power Circuit

		UL/cUL/CSA	IEC
Rated Operational Voltage		200…600V AC	200…500V~
Rated Insulation Voltage		600V AC	500V~
Di-electric Withstand		2200V AC	2500V~
Repetitive Peak		200…600V AC: 1600	500V~: 1600
Rated Impulse Voltage		6 kV	
Overvoltage Category		III	
Number of Poles		Equipment designed for 3-phase only	
Operating Frequency		50/60 Hz	
Controller Utilization Category		32/52/64	AC-53b: 3.5-15:3585
		74/104/147	AC-53b: 4.5-30:1770
		234	AC-53b: 3.5-30:1770
Overlad Current Range (Amps)		**Line**	**Delta**
	32	6.3...19	10.9...32.9
	51	10...30	17...51
	64	12.3...37	21.3...64
	74	14.3...43	24.7...74
	104	20...60	34.7...104
	147	28.3...85	49...147
	234	34...135	59...234

Table 20 - Control Circuit

	UL/cUL/CSA	IEC
Rated Operational Voltage	100...120V AC, 200...240V AC	120~, 240~
Rated Insulation Voltage	—	300V~
Di-electric Withstand	—	3000V
Rated Impulse Voltage	3 kV	
Operating Frequency	50/60 Hz	
Control Power Requirements	32/52/64	215 mA @ 120 V AC , 180 mA @ 240 V AC
	74/104/147	200 mA @ 120 V AC , 100 mA @ 240 V AC
	234	200 mA @ 120 V AC , 120 mA @ 240 V AC
Fan Power Requrements	32/52/64	—
	74/104/147	—
	234	20VA

Table 21 - Short Circuit Capabilities

Short Circuit Performance	**Type 1**	
Device Current Rating	**Maximum Fuse Size & Type**	**Maximum Available Fault Rating**
32	70 A - RK5	5 kA
	125 A - K5	5 kA
51	125 A - RK5	5 kA
	200 A - K5	10 kA
64	125 A - RK5	5 kA
	200 A - K5	10 kA
74	150 A - RK5	5 kA
	250 A - J	10 kA
104	200 A - RK5	5 kA
	400 A - J	10 kA
147	250 A - RK5	10 kA
	400 A - J	10 kA
234	400 A - RK5	10 kA
	450 A - K5	10 kA

Table 22 - Auxillary Contacts (Fault & Aux #1)

	UL/cUL/CSA	IEC
Rated Operational Voltage	250V AC/30V DC	250V~ / 30V DC
Rated Insulation Voltage	250V	250V~
Di-electric Withstand	—	4 kV
Rated Impulse Voltage	1500 V AC	2000V-
Operating Frequency	50/60 Hz	
Utilization Category	D300	AC-15/DC
Control Circuit Type	Electro-magnetic Relay	
Number of Contacts	1	
Contact Type	Normally Open (N.O.)	
Current Type	AC/DC	
Rated Operational Current (max)	0.6 A @ 120 V~ and 0.3 A @ 240V~	
Conventional Thermal Current (Ith)	1 A	
Make/Break VA	432/72	

Mechanical

Table 23 - Mechanical

Resistance to Vibration	Operational	1.0 G Peak, 0.15 mm (0.006 in) displacment
	Non-Operational	2.5 G Peak, 0.38 mm (0.015 in) displacment
Resistance to Shock	Operational	15 G
	Non-Operational	5.5 G

Environmental

Table 24 - Environmental

Operating Temperature	0…50 °C (32…122 °F) Open
	0…40 °C (32…104 °F) Enclosed
Altitude	2000 m (6560 ft)
Humidity	5…95% (non-condensing)
Pollution Degree	2

Dimensions & Shipping Weights

Figure 12 - Dimensions

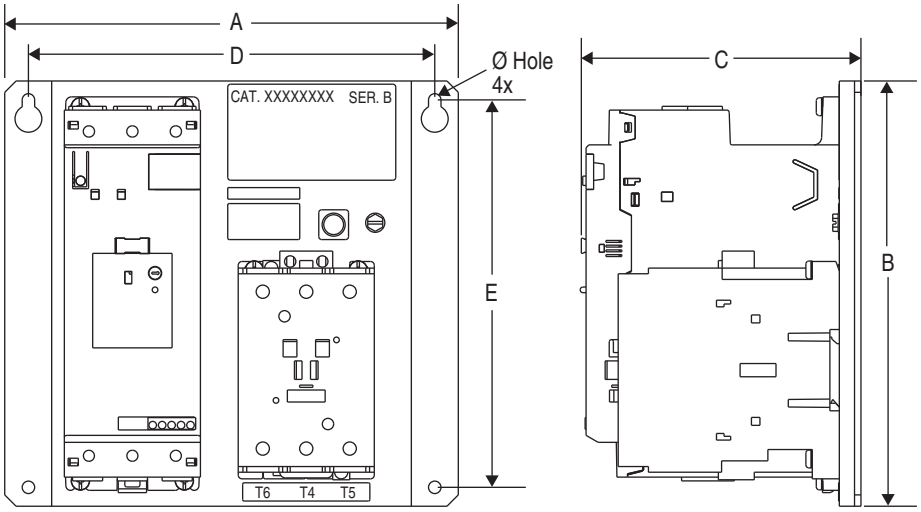


Table 25 - Dimensions & Shipping Weights

	Controller Size		
	32/52/64	**74/104/147**	**234**
A (Width)	178 (7.01)	240 (9.45)	362 (14.25)
B (Height)	144 (5.67)	225 (8.86)	515 (20.28)
C (Depth)	115.7 (4.56)	147.9 (5.82)	216.4 (8.52)
D	165.1 (6.5)	215 (8.46)	330.2 (13.0)
E	127 (5)	205 (8.07)	489.5 (19.27)
4X Ø (Hole Dimensions)	5.6 (0.22)	6.6 (0.26)	8.7 (0.343)
Approximate Weight	4 lbs (2 kg)	14 lbs (6 kg)	51 lbs (23 kg)
NOTE: Dimensions are in millimeters followed by inches unless otherwise specified.			

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