Installation
&
Operation Manual

SECO® SE 2000 Series DC Motor Controller

1 Through 5 HP
115/230 VAC 1 Phase Input

Seco
AC/DC Drives

TABLE OF CONTENTS

Section		Page
1.0	**GENERAL INFORMATION**	3
1.1	Controller	4
1.2	Specifications	7
2.0	**INSTALLATION**	8
2.1	Power Unit Models	8
2.2	Controller Mounting	9
2.2.1	Ambient Temperature	9
2.2.2	Altitude	9
2.2.3	Air Contaminants	9
2.2.4	Mounting Clearances	17
2.2.5	Mounting Area	17
2.2.6	Ground Conductor	17
2.2.7	Electrical Connections	17
2.3	Installation Wiring	17
2.3.1	Wiring Codes	17
2.3.2	Shielded Cable	17
2.3.3	Motor Shunt Field	17
2.3.4	Permanent Magnet Motors	21
2.3.5	Motor Series Field	21
2.3.6	Motor Thermostat	21
3.0	**OPERATION**	21
3.0.1	Speed Adjust Potentiometer	21
3.0.2	Torque Adjust Potentiometer	21
3.0.3	Start/Stop	21
3.0.4	Jog/Run	21
3.0.5	Forward/Reverse	21
3.1	Initial Settings	21
3.1.1	Line Voltage Selection	22
3.1.2	A.C. Supply	22
3.1.3	Voltage Feedback	22
3.1.4	Current Scaling	22
3.1.5	Speed Feedback Selection	22
3.1.6	Field Failure Circuit	22
3.1.7	Overcurrent Trip Circuit	22
3.1.8	Torque vs. Speed Control	22
3.1.9	Maximum Speed	22
3.1.9.1	Minimum Speed	22
3.1.9.2	Acceleration/Deceleration Times	23
3.1.9.3	IR Compensation	23
3.1.9.4	Jog	23
3.1.9.5	Torque (current limit) and Slope	23
3.2	Indicators	23
4.0	**RELAY CIRCUITS**	24
4.1	Power Unit and Basic On-Off	24
4.2	Run-Brake	24
4.3	Reversing Brake	24
4.4	Jog	24
4.5	Alternative Start/Stop Control Arrangements	24
5.0	**OPTIONS**	33
5.1	General Description	33
5.1.1	Option Description	33
6.0	**START UP PROCEDURES**	34
6.1	Field Excitation	34
6.2	Control Voltage	34
6.3	Motor Rotation and Tachometer Generator Feedback	34
6.4	Speed Setting Adjustment	34
6.5	Loading	34
6.6	Option Installation and Start-Up	35
6.7	**Follower-Process Controller/ DC Voltage**	35
6.7.1	Specifications	35
6.7.2	Input Connections	35
6.7.3	Jumper/Switch Selection	35
6.7.4	Adjustments	35
6.8	**Follower-Pulse Tach Generator**	35
6.8.1	Specifications	35
6.8.2	Input Connections	36
6.8.3	Adjustments	36
6.9	**Controller Deceleration Stop**	36
6.9.1	Specifications	36
6.9.2	Connections	37
6.10	**Fault Module**	37
6.10.1	Specifications	37
6.10.2	Connections	37
6.10.3	Adjustments	37
6.11	**Enhanced Torque Slope**	37
6.11.1	Features	37
6.11.2	Adjustment of SE2000 Drive	37
6.11.3	Adjustment Procedure with Line Speed Signal	38
6.11.4	Adjustment Procedure without Line Speed Signal	38
7.0	**THEORY OF OPERATION**	39
7.1	Drive System	39
7.2	Control Electronics	39
7.3	Basic Block	39
7.3.1	Speed Reference	39
7.3.2	Process Follower Buffer	39
7.3.3	Acceleration/Deceleration	39
7.3.4	Tach Scaling Circuit	39
7.3.5	Armature Voltage Scaling	39
7.3.6	Speed Loop Regulator and IR Comp	39
7.3.7	Current Regulator	39
7.3.8	Firing Circuits	39

Section		Page
8.0	**TROUBLESHOOTING**	45
8.1	Safety Procedures	45
8.2	Recommended Instruments	45
8.3	Troubleshooting Areas	46
8.3.1	Loose Connections	46
8.3.2	Wiring Errors	46
83.3	Incoming AC Line	46
8.3.4	Motor Checks	46
8.4	Checking with External Meter	46
8.4.1	Voltage Checks	47
8.5	Troubleshooting Guide	47
9.0	**REPLACEMENT PARTS**	48

For your safety and for proper operation, please take time to carefully read all instructions before installing and operating this unit.

RECEIPT OF SHIPMENT

All equipment is tested before shipment, and is shipped in good condition. Any damages or shortages evident when the equipment is received must be immediately reported to the commercial carrier who transported the equipment. If required, assistance is available from the nearest Superior Electric Representative. Always refer to Superior Electric order number, model number and serial number when contacting Superior Electric

NOTE: The information contained herein is accurate at the time of publication. Superior Electric reserves the right to make design changes to motor controls described in this manual at any time and without notice.

1.0 GENERAL INFORMATION

This manual outlines installation and operating practices for the SE2000 Series of DC controllers. It also contains a brief description of the product and includes specifications. Before installing or operating the equipment, read and understand this manual. Always observe the following dangers and cautions when operating or working on this equipment.

DANGER

The National Electrical Code (Publication NFPA No. 70) requires that a fused main disconnect switch be installed between the AC line and the drive system or, if used, the power transformer. (Specifically, this includes the Controller.) Serious injury or death may result if a disconnect switch is not provided.

DANGER

The main power feed must be disconnected by a switch before it is safe to work on the SE2000 internal parts. Serious personal injury or death may result if the procedure is not observed.

DANGER

The SE2000 unit is combined with user components to form a drive package. The user is responsible for proper selection of parts and subsequent operation. When a SE2000 Controller is being used, it should be installed, adjusted and serviced only by qualified personnel who are familiar with the operation of all major components in the system. Serious personal injury or death, and/or equipment damage, may result if this procedure is not followed.

1.1 CONTROLLER

Superior Electric's SE2000 series DC motor controllers are designed to control shunt wound and permanent magnet DC motors from 1/4 to 5 HP. Versatile and extremely reliable, the SE2000 is available in several configurations to meet the needs of the most demanding applications.

Design Features

- Full wave power conversion circuit with two SCR's and three diodes providing NEMA Code K, DC armature supply insures optimum motor performance, cooler motor operation and longer life.
- **Circuit Protection**
  Transient voltage protection by MOV. All models except Power Unit have AC line circuit breaker for line protection.
- **Enclosed Unit**
  Dead front and back construction. Hinged cover provides easy access to all components.
- **Isolation**
  Control circuit is isolated from main circuit potential.
- **Tachometer Generator Feedback**
  For improved speed holding, unit will accept feedback from analog tach generator or digital pulse tach generator.
- **Jog**
  Jog at separately adjustable speed standard.

Adjustments

Customer adjustments match control to application.

- **Maximum Speed**
  Limits speed available to operator
- **Minimum Speed**
  Allows minimum motor speed to be set
- **IR Compensation**
  Improves motor speed regulation in armature feedback mode
- **Acceleration**
  Sets time to reach full speed
- **Deceleration**
  Sets time to decelerate to zero speed
- **Torque**
  Sets motor torque available (current limit)
- **Slope**
  Produces increasing torque as speed decreases
- **Jog**
  Sets separate Jog speed
- **Torque and Slope Control**
  Precise setting of motor torque and slope control to give increasing torque/decreasing speed characteristic above fixed torque limit for simple winder applications.
- **Control relay** with three wire Start/Stop circuit. All models have control relay to prevent automatic restart after power outage for increased safety (may be reconnected for line start operation, if required.
- **Field Supply** with Field Loss Circuit standard.
- **Overcurrent Protection**
  Timed overcurrent trip circuit for motor protection.
- **Run-Brake Model**
  Unit includes motor contactor and dynamic braking.
- **Reversing-Brake**
  Reversing model with dynamic braking
- **4-20 mA or 0-10 VDC speed reference.**

Selectable Features

Selected by jumpers which program drives for specific motor or application.

- **AC Supply**
  Selects 115 or 230 VAC
- **DC Armature**
  Selects 90 or 180 VDC
- **Feedback**
  Selects type and feedback value
- **Preset Jog**
  Selects internal or external jog
- **Field Loss**
  Selects for PM or shunt wound type motors
- **Current Scaling**
  Selects appropriate motor amps
- **Acceleration/Deceleration Time**
  Selects range of adjustment control up to 30 seconds
- **Torque or Speed Control**
  Selects mode or either motor speed or motor torque controlled by operator's potentiometer
- **Overcurrent Trip**
  Timed or instantaneous or disabled

MODELS

- **Power Unit Only**

  Consists of control board, SCR power bridge, and terminals.

- **Basic On-Off**

  Power Unit with single pole AC line circuit breaker. Two pole breaker is standard on all 3-5 HP models and all enclosed models.

- **Run-Brake Model**

  Models include motor contactor and dynamic braking.

- **Reversing-Brake**

  Models include forward and reversing contactors with antiplugging and dynamic braking.

OPTIONS

- **2 Pole Circuit Breaker**

  Enables both input lines to be disconnected. Required by some local Electrical Codes (std. on 3 & 5 HP models and on all enclosed units).

- **Enhanced Process Follower**

  Speed control by external signal, 4-20 mA, 10-50 mA, 0-14 VDC, 0-100 VDC

- **Digital Signal Follower**

  Speed control by external digital pulse signal from MTK magnetic pick-up, Hall Effect sensor or encoder.

- **Controlled Deceleration Stop**

  Drive follows deceleration ramp on Stop command. Two stopping modes are available

  Ramp or Dynamic Braking if additional Stop button is used.

- **Fault Module**

  Shuts down drive and provides output signal if Tach Loss, Field Loss or Overcurrent failures occur.

SELECTION CHART

Input Line Voltage	HP	Power Unit Only	BASIC ON-OFF			RUN-BRAKE			REV-BRAKE		
			Chassis	NEMA 4/12 W/O Operators	NEMA 4/12 With Operators	Chassis	NEMA 4/12 W/O Operators	NEMA 4/12 With Operators	Chassis	NEMA 4/12 W/O Operators	NEMA 4/12 With Operators
115VAC 1 Phase 230VAC	1/4-1 1/2-2	SE2002	SE2102	SE2122	SE2132	SE2202	SE2222	SE2232	SE2302	SE2322	SE2342
230VAC 1 Phase	3-5	SE2005	SE2105	SE2125	SE2135	SE2205	SE2225	SE2235	SE2305	SE2325	SE2345

OPTIONS

Description	Factory Installed Model Number Suffix	Field Installed Model Number
2 pole circuit breaker – enables both lines to be disconnected – required by some local electrical codes	-1*	SE2999-1*
Follower-Process Controller/DC Voltage Speed Control by external signal, 4-20 mA, 1-5 mA, 0-14 VDC, 0-100 VDC	-2**	SE2999-2**
Follower-Pulse Tach-Generator-Speed Control by external digital pulse signal from magnetic pick-up Hall Effect sensor or encoder	-3**	SE2999-3**
Controlled Decel Stop-Drive follows deceleration ramp on stop command	-4**	SE2999-4**
Fault module-shuts down drive and provides output signal if tach loss, field loss or overcurrent failure occur	-5**	SE2999-5**
Enhanced Performance Torque-Slope External Control for constant tension centerwind or external torque slope applications	-6**	SE2999-6**

* This option only applies to 2 HP chassis models.

** Any two of these options may be fitted to any unit, except power unt.

Models without local operators are designed to be integrated into a drive system and wired by the user. As such it will be necessary to provide either a number of operator's controls or equivalent relay contacts. The control functions are:

- Speed adjust or torque control potentiometer
- Start pushbutton switch, or relay contact
- Stop pushbutton switch, or relay contact
- Jog switch or relay contacts
- Forward/Reverse pushbutton, switch or relay contacts
- Automatic/manual switch or relay contacts

1.2 SPECIFICATIONS

Performance Characteristics	
Speed Range:	30:1
Speed Regulation (As % of Motor Base Speed) – For 95% Load Change	
Armature Voltage Feedback:	±2%
Tachometer Feedback:	±1/2% (depending on tach generator)
Acceleration/Deceleration	
Range A	by current limit
Range B	3-30 seconds
Range C	0.3-3 seconds
Operating Conditions	
Ambient Temperature –	
Chassis Models:	55°C
Enclosed Models:	40°C
Relative Humidity:	95% Non-Condensing
Altitude:	To 3300 Feet (1000m)
Adjustments	
Current Range (Torque):	25-150%
Maximum Speed:	60-110% of Motor Base Speed
Minimum Speed:	0-30% of Motor Base Speed
IR Compensation:	Improves load regulation in armature feedback mode
Acceleration:	0.3 to 30 Seconds
Deceleration:	0.3 to 30 Seconds
Preset Jog:	0-100% of Motor Base Speed
Torque Slope:	Increasing torque to decreasing speed relationship above a fixed torque limit
Ratings	
Horsepower Range	
115 VAC	1/4 - 1 HP
230 VAC	1/2 - 5 HP
AC Line Input Voltage:	115 or 230 V ±10%
AC Line Frequency:	50/60 Hz ±2 Hz, Single Phase
DC Output Voltage	
115 VAC Supply	
Armature:	0 - 90 VDC
Field:	50/100 VDC
230 VAC Supply	
Armature:	0 - 180 VDC
Field:	100/200 VDC
Service Factor:	1.0
Duty:	Continuous
Max. Load Capacity:	150% for 1 minute
Line Protection:	Circuit Breaker (not Power Unit)
Speed Reference Signal Voltage:	0 - 10 VDC 4 - 20 mA Grounded or Ungrounded
Feedback Signal:	0 -14 VDC from 7V/1000 Tach Generator 0 - 85 VDC from 50V/1000 Tach Generator 60 PPR from MTK Magnetic Pickup

2.0 INSTALLATION

The procedure describes the installation of the SE2000 controller.

CAUTION

In cases where the motor speed controller is integrated into a customer-designed drive system, the buyer is responsible for the correct choice of required associated equipment. Incorrectly specified components may cause improper operation and/or damage to the motor speed controller.

WARNING

Only qualified maintenance personnel should install the controller. They should be familiar with drive systems — including operation — and with the possible hazards resulting from improper installation practices. Serious personal injury and/or equipment damage could result if this warning is not observed.

DANGER

The user is responsible for installation for the entire drive system in accordance with NFPA No. 70; with Electrical Standards for Metalworking Machine Tools, NFPA No. 70; and with all local and national codes which apply. Serious personal injury, death and/or equipment damage could result if this procedure is not followed.

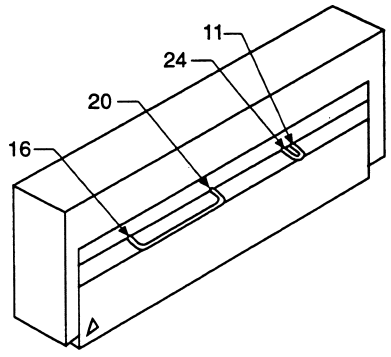


Figure 1

2.1 POWER UNIT MODELS

The Power Unit is intended to replace the Challenger 8500, 8600 and 8800 Power Units. The mounting dimensions are identical to the Challenger Series.

Care should be taken to ensure the correct voltage settings are selected for the SE2000 depending on which Challenger Model is being replaced.

A jumper is installed on SE2002 and SE2005 models to match the characteristics of the Challenger Series of drives.

2.1.1 SE2000 STAND ALONE

If the SE2002 or SE2005 Control is to be used as a stand along unit, remove the jumper that is connected between pins 16 and 20 of connector P1. (Ref. Figure 1)

2.1.2 SE2000 POWER UNIT CONVERSION

If the SE2000 power unit is used on a C8000 series assembly, use the chart below for the proper wire reconnection. The factory installed wire jumper from TB2-1 to TB2-3 must be removed and replaced with a wire from TB2-1 to TB2-6.

From 8500/8600	Model	To SE2002
TB1-1	C8501	TB1-L1
TB1-2	C8601	TB1-L2
TB1-1	C8503	TB1-L1
TB1-2	C8603	TB1-L2
TB1-3		TB1-A1
TB1-4, 5 or 6		TB1-A2
TB2-12*		TB2-13
TB2-13		TB2-4
TB2-18		TB2-11
TB2-19		TB2-10
TB1-1	C8504	TB1-L1
TB1-2	C8604	TB1-L2
TB1-3		TB1-A1
TB1-4, 5 or 6		TB1-A2
TB2-12		TB2-4
TB2-13		TB2-13
TB1-1	C8509	TB1-L1
TB1-2	C8609	TB1-L2
TB1-3		TB1-A1
TB1-4, 5 or 6		TB1-A2
TB2-10*		TB2-17
TB2-12*		TB2-13
TB2-13		TB2-4

(Continued on next page)

From 8300/8800	Model	To SE2005
TB1-1	C8301	TB1A-AC1
TB1-2	C8801	TB1A-AC2
TB1-1	C8303	TB1A-AC1
TB1-2	C8803	TB1A-AC2
TB1-3		TB1A-A1
TB1-4 or 5		TB1A-A2
TB2-12*		TB2-13
TB2-13*		TB2-4
TB2-18		TB2-11
TB2-19		TB2-10
TB1-1	C8304	TB1A-AC1
TB1-2	C8804	TB1A-AC2
TB1-3		TB1A-A1
TB1-4 or 5		TB1A-A2
TB2-12		TB2-4
TB2-13		TB2-13
TB1-1	C8309	TB1A-AC1
TB1-2	C8809	TB1A-AC2
TB1-3		TB1A-A1
TB1-4 or 5		TB1A-A2
TB2-12 Orange		TB2-13
TB2-10 Brown		TB2-17
TB2-12 Red		TB2-4
TB2-13 Green		TB2-13

* Wire extension may be required.

2.2 CONTROLLER MOUNTING

The SE2000 controller must be mounted in a vertical position. This orientation permits the required cooling of the heat sinks.

Drill patterns and dimensions for the SE2000 controller are shown in Figure 2-1. Be certain that the mounting area provides the environmental conditions noted in the following paragraphs.

2.2.1 AMBIENT TEMPERATURE

Ambient temperature should not exceed 40°C for enclosed models or 55°C for chassis mount unit.

2.2.2 ALTITUDE

Altitude should not exceed 1000 meters (3300 feet). Consult factory for de-rating factor for high altitude operation.

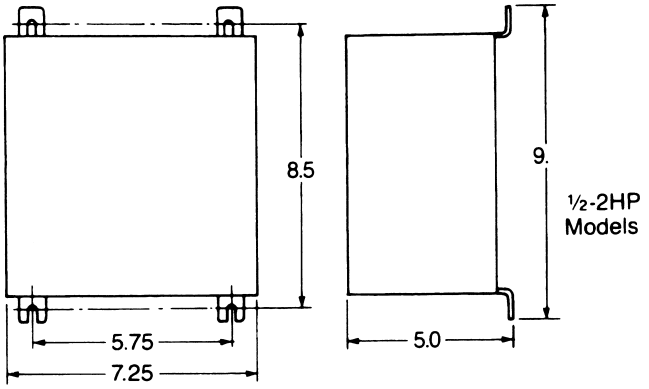
2.2.3 AIR CONTAMINANTS

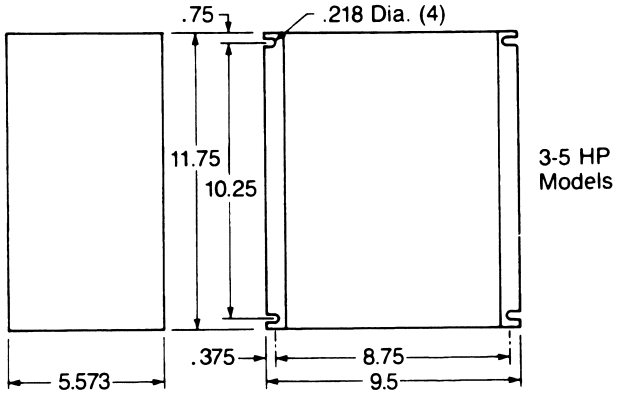
Ambient air should not be contaminated with caustic chemical vapors, excessive dust, dirt, or moisture. If such conditions exist, the proper enclosure and cooling methods recommended for such conditions should be used.

SE2000 Chassis

Basis ON-Off or Run Brake Models

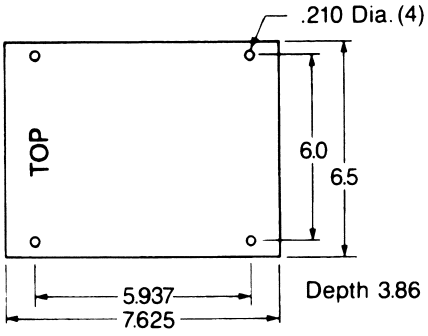
Reversing Brake Models



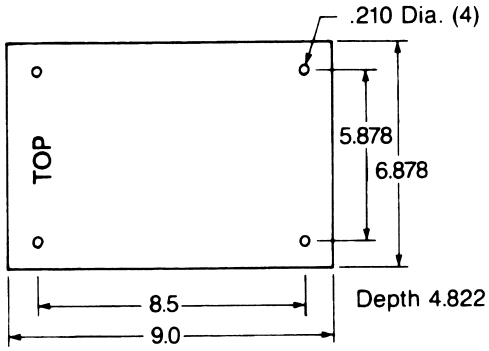


SE2000 Power Unit

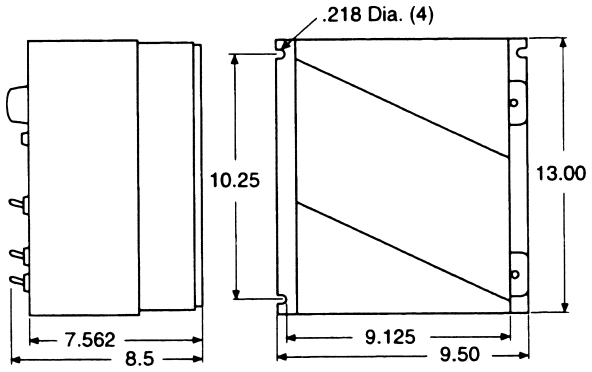
½-2 HP Models

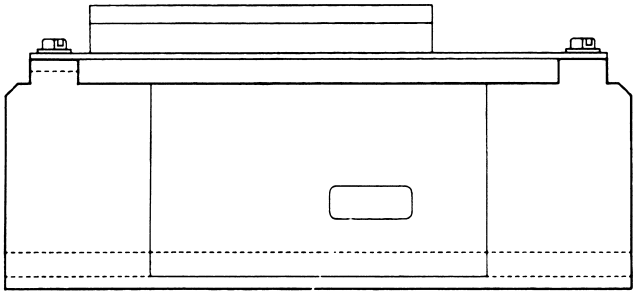


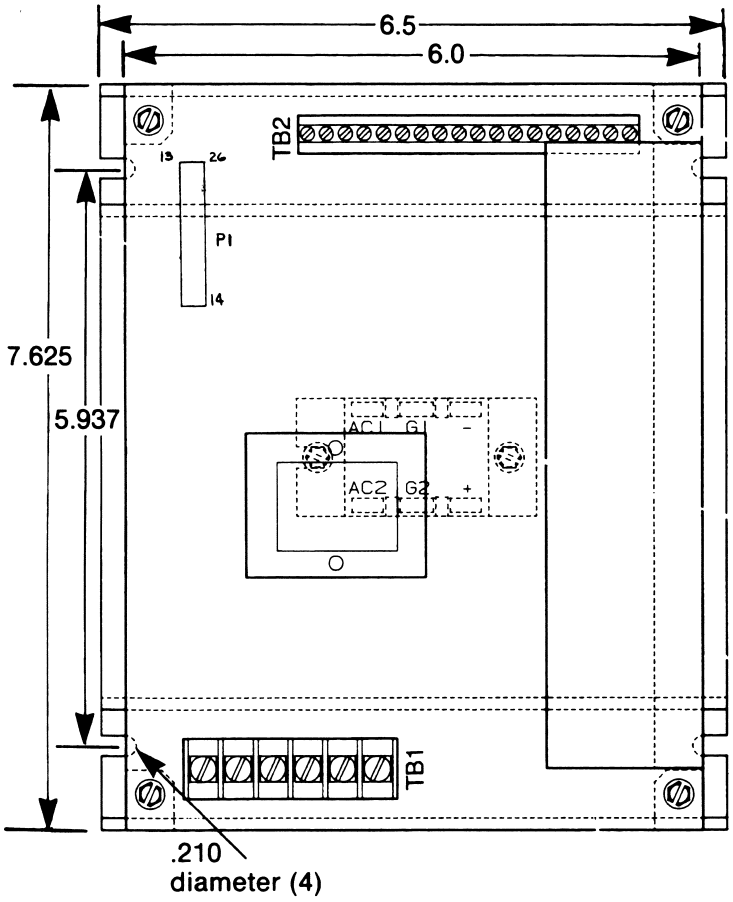
3-5 HP Models

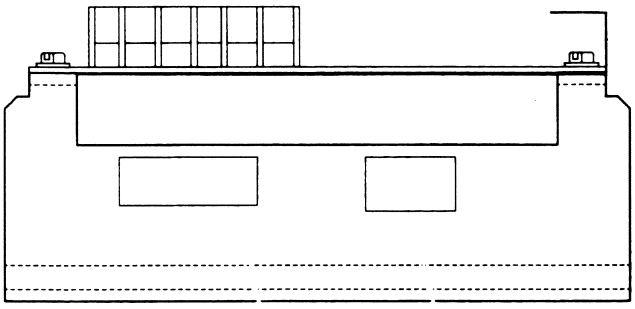


Enclosed Unit - All Models



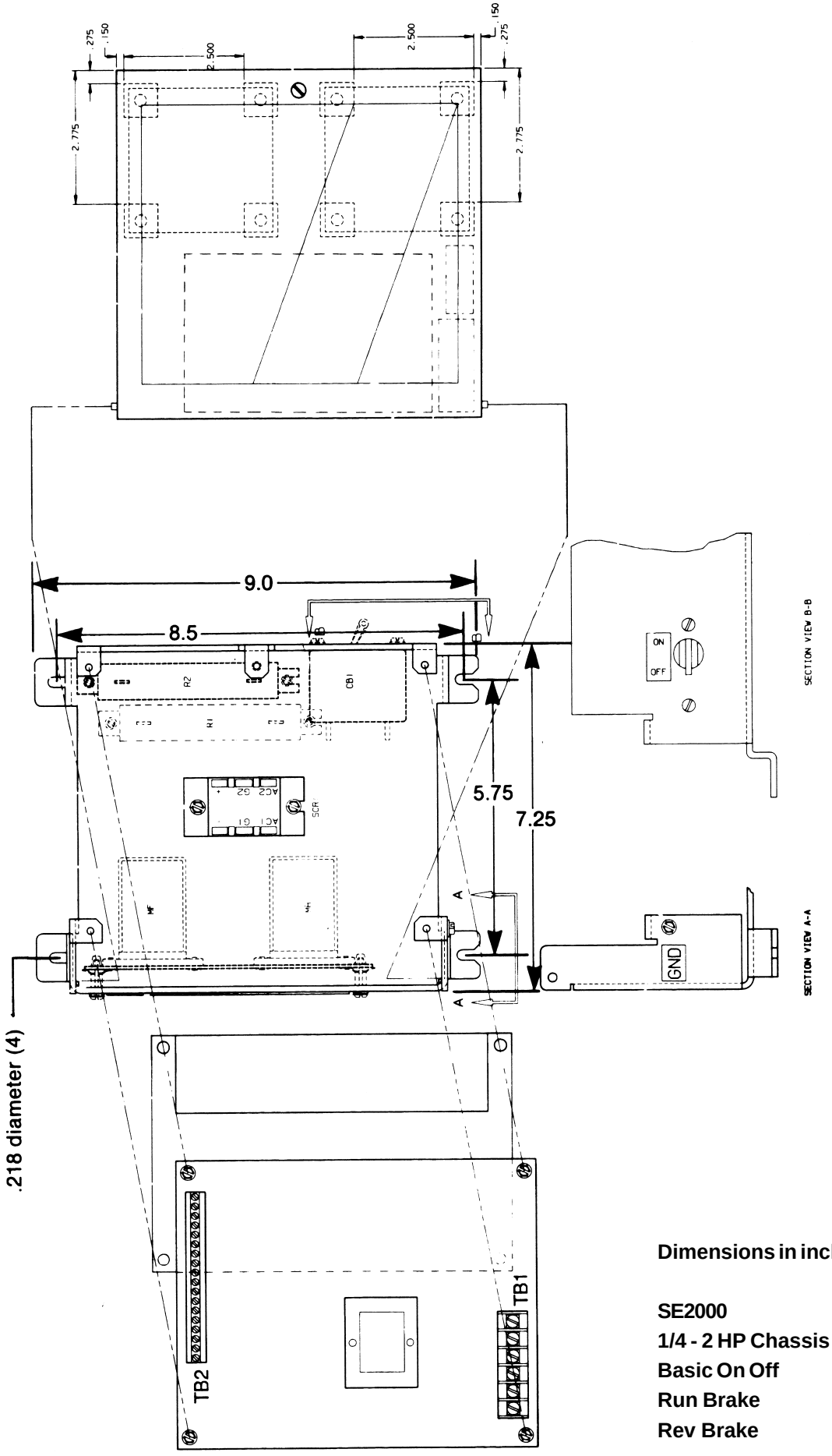






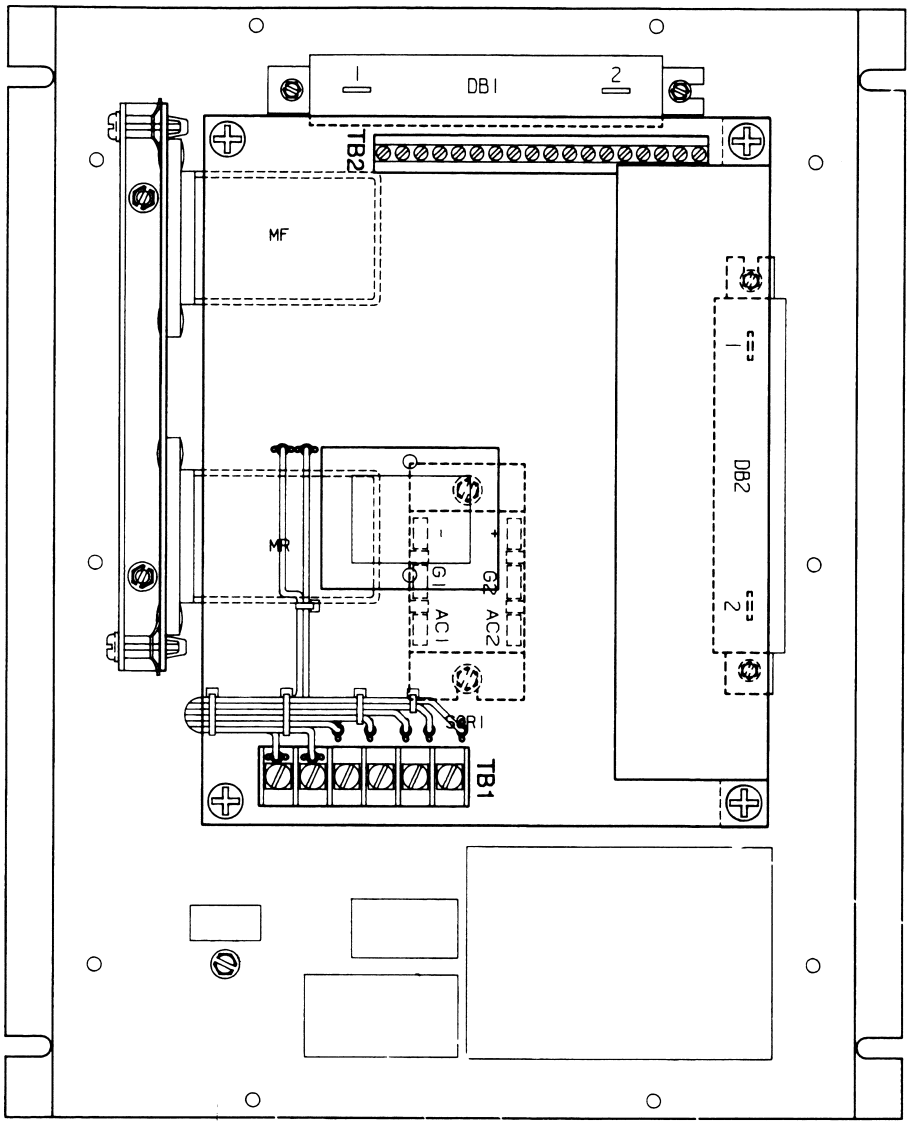
Dimensions in inches

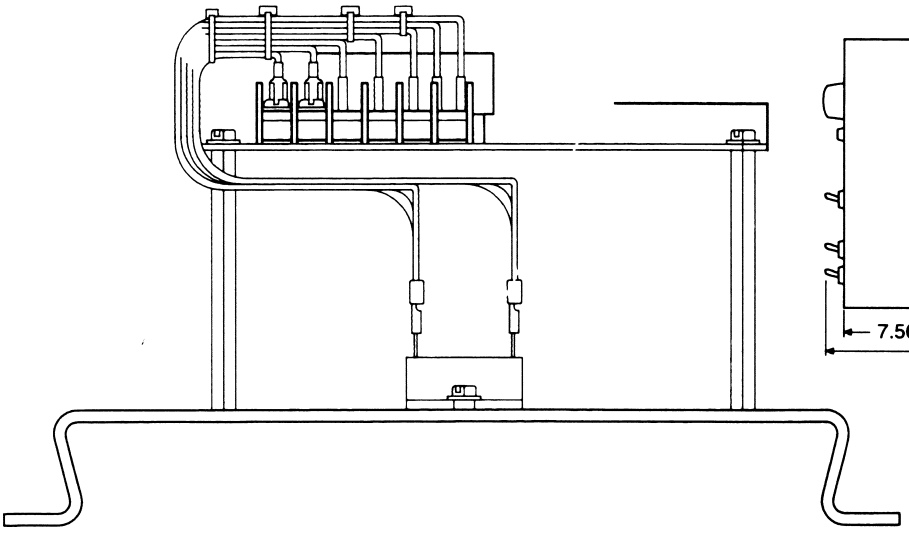
SE2000
1/4 - 2 HP Power Unit Layout



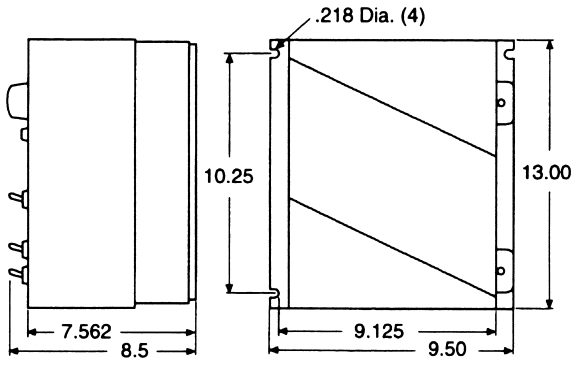
Dimensions in inches

SE2000
1/4 - 2 HP Chassis Layout
Basic On Off
Run Brake
Rev Brake

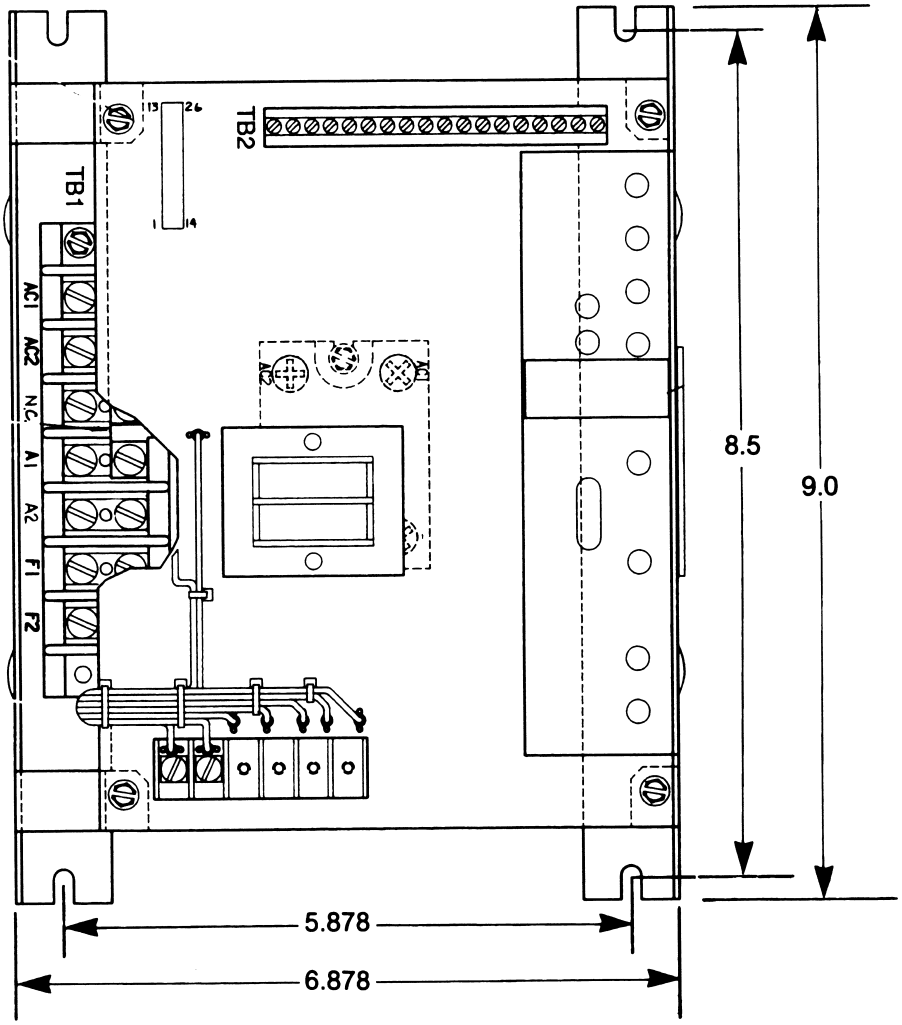


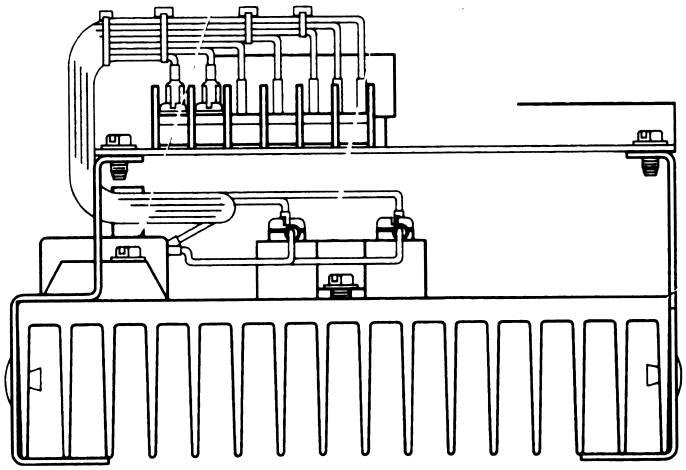


Enclosed Unit—All Models



SE2000
1/4 - 2 HP Enclosed Layout
Basic On Off
Run Brake
Rev Brake

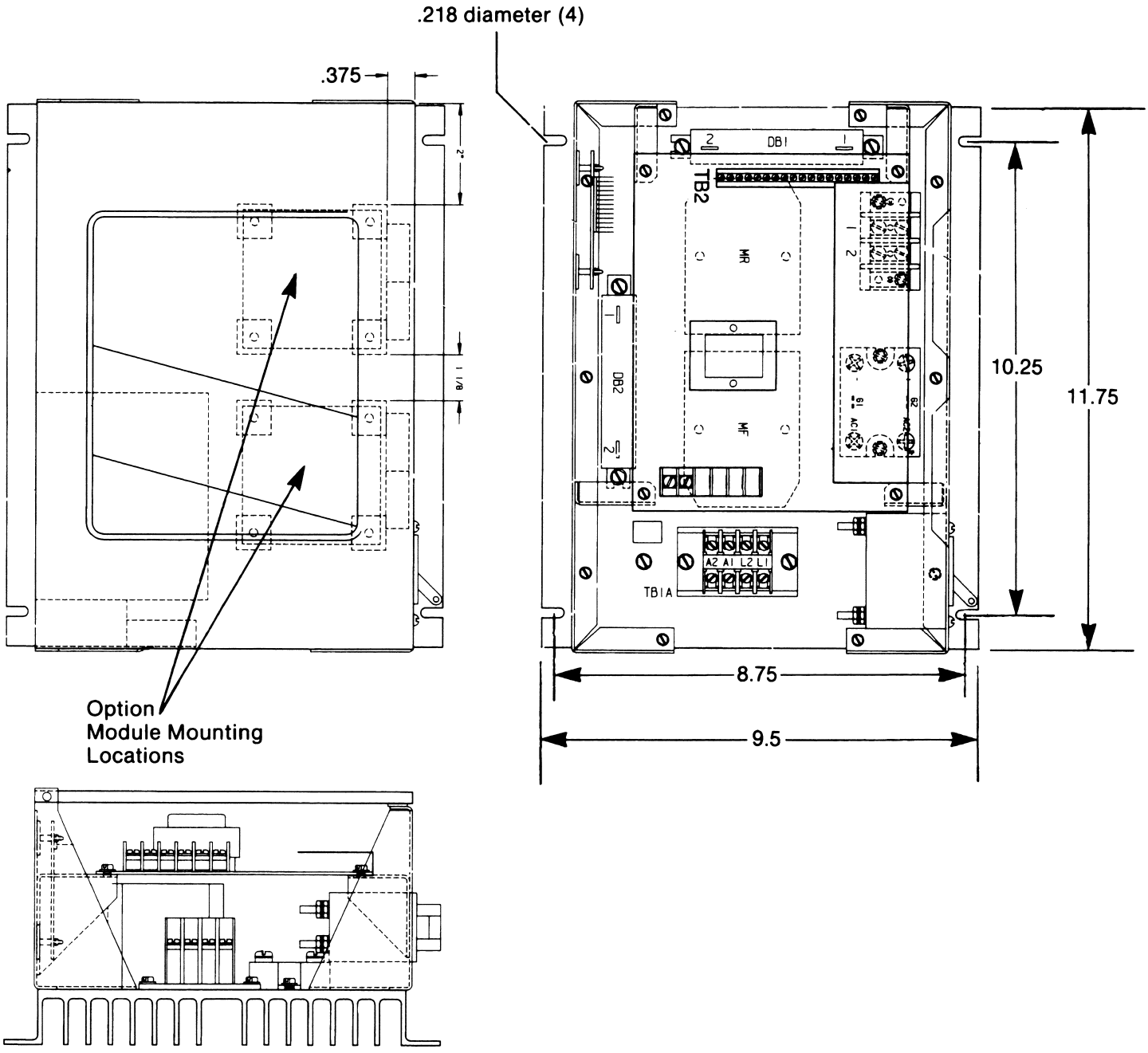




SE2000

3-5 HP Power Unit Layout

Dimensions in Inches



SE2000

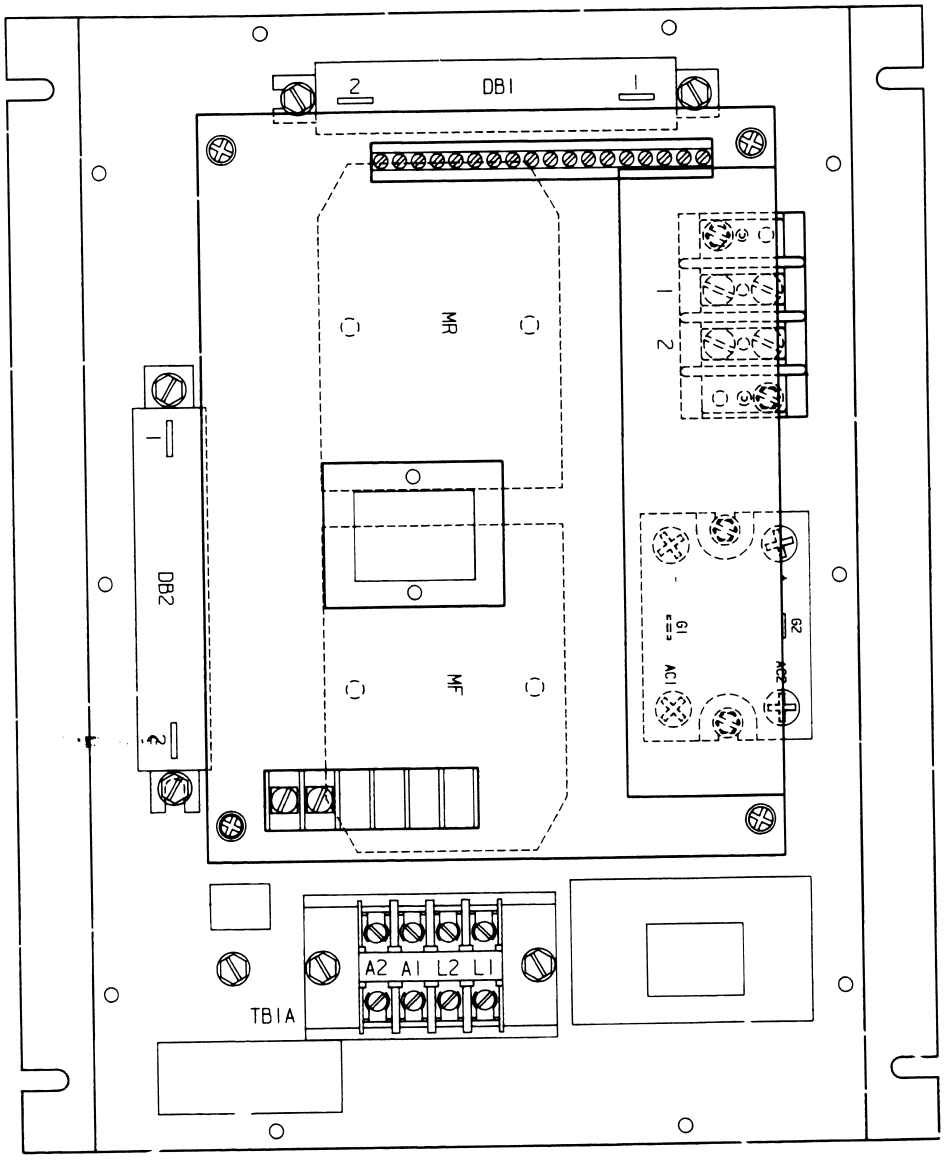
3-5 HP Chassis Layout

Basic On Off

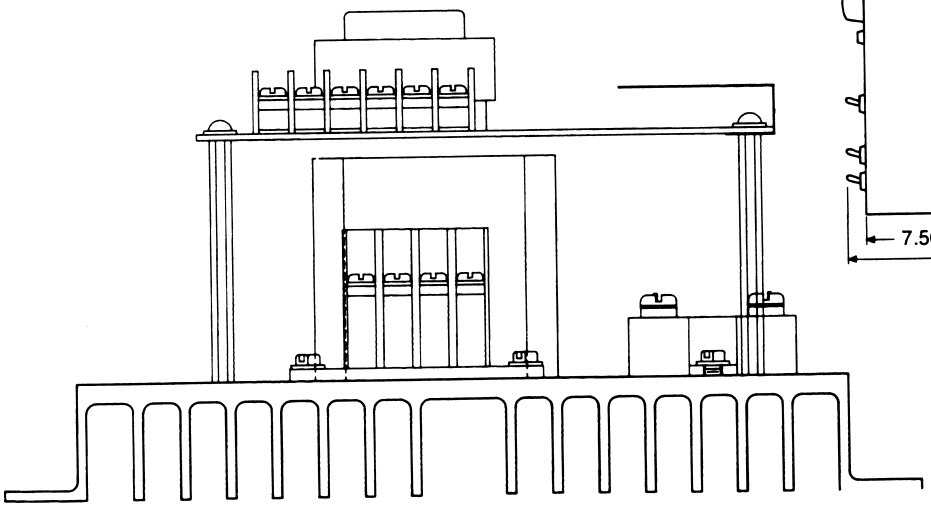
Run Brake

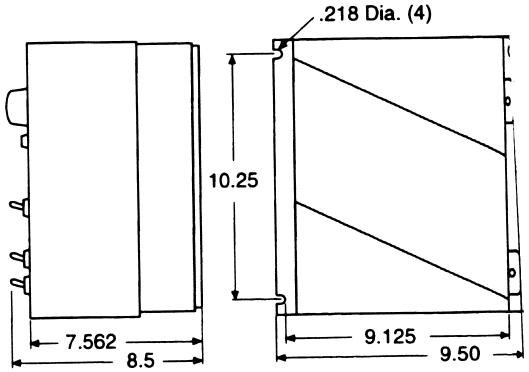
Rev Brake

Dimensions in inches



Enclosed Unit—All Models





SE2000
3-5 HP Enclosed Layout
Basic On Off
Run Brake
Rev Brake

Dimensions in inches

2.2.4 MOUNTING CLEARANCES

Adequate clearance should be allowed for easy access to terminals and adjustments and to facilitate inspection and maintenance.

2.2.5 MOUNTING AREA

Mounting area should be free of vibration and have sufficient clear air circulation.

2.2.6 GROUND CONDUCTOR

An equipment ground conductor (that is, ground wire) must be connected to the controller mounting panel. This conductor must run unbroken to a drive system wire connection point — or ground bus or grounding terminal block, as local usage determines. (See Figure 2-2) Separate equipment grounding conductors from other major components in the system must also be run unbroken to a central connection point. These components include:

- Motor
- Isolation transformer case, if used
- Operator control panel and enclosure, if used.

2.2.7 ELECTRICAL CONNECTIONS

When connecting the equipment grounding conductor to the SE2000 controller mounting panel, permanently connect it to the grounding terminal provided.

2.3 INSTALLATION WIRING

Be sure that the AC power supplied is the voltage and frequency called for on the controller nameplate. Also be sure that the power line is capable of supplying the KVA rating indicated on Table 2 without voltage reduction. Improper voltage may damage the equipment and insufficient current will cause erratic operation of the drive. Typical connection diagrams are shown in Figure 2-2.

On enclosed units, install conduit fittings that maintain the NEMA integrity of the enclosure.

2.3.1 WIRING CODES

All interconnection wiring should be installed in conformance with the National Electrical Code published by the National Fire Protection Association as well as any other applicable local codes.

2.3.2 SHIELDED CABLE

Shielded cable is required for the tachometer generator, speed potentiometer, and all low-level signal circuits to eliminate the possibility of electrical interference. Connect the shield to chassis ground at the controller end of the cable only.

CAUTION

Follow the installation wiring diagram provided in Figures 4-1 to 9. When connecting the motor, pay particular attention to the marking on the motor leads. It is possible to damage the Controller and motor if incorrect connections are made.

2.3.3 MOTOR SHUNT FIELD

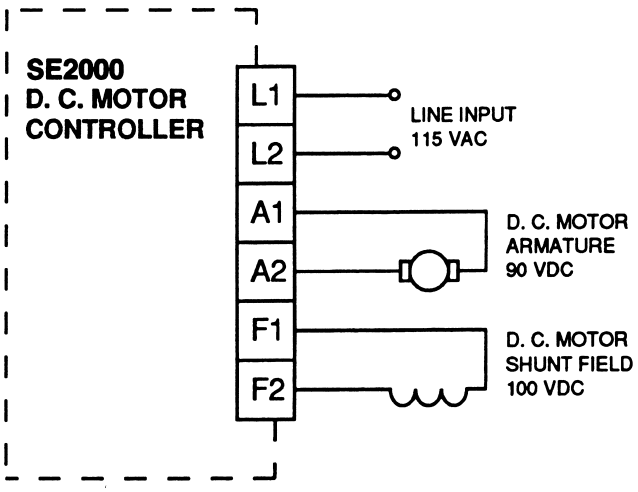
SE2000 controllers have a standard field voltage supply as follows:

115 VAC Controller 50/100 VDC Shunt Field Supply
230 VAC Controller 100/200 VDC Shunt Field Supply

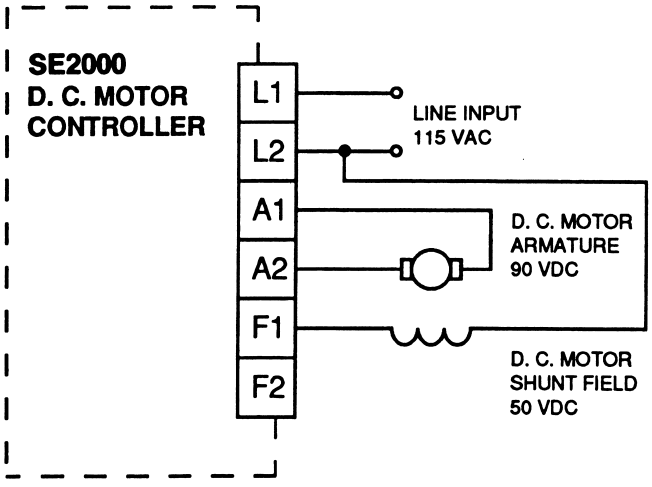
Some motors are furnished with dual voltage fields. If so, they will have 4 field leads marked F1, F2, F3 (F11), and F4 (or F22). In such instances, check the motor nameplate for the field voltages and connect the motor leads for the field voltage supplied by the drive. See Figure 2-3 for various ways to connect the field supply to wound field motors.

TABLE 2

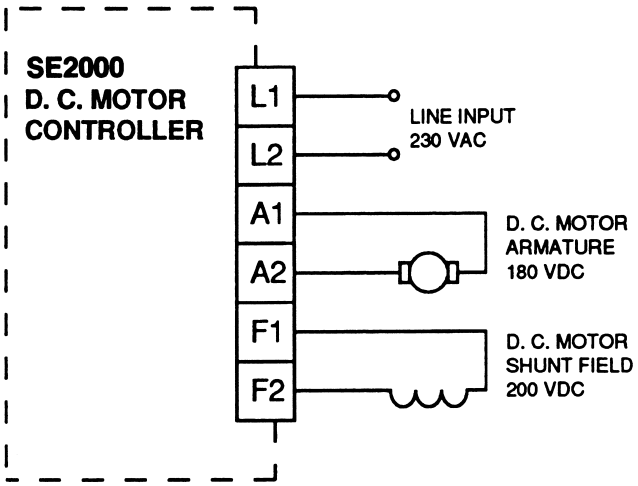
Motor HP	Motor Voltage (V dc)	Typical Armature Current (A dc)	Line Current (Arms)	Recommended Transformer Rating KVA
1/4	90	3.0	5	1/2
1/2	90	5.5	9	1
1/2	180	2.8	5	1
3/4	90	8.4	13	1.5
3/4	180	4.0	7	1.5
1	90	10.7	16	2
1	180	5.3	8	2
1 1/2	180	7.7	12	3
2	180	9.5	14	5
3	180	14.5	21	7.5
5	180	23.4	34	10



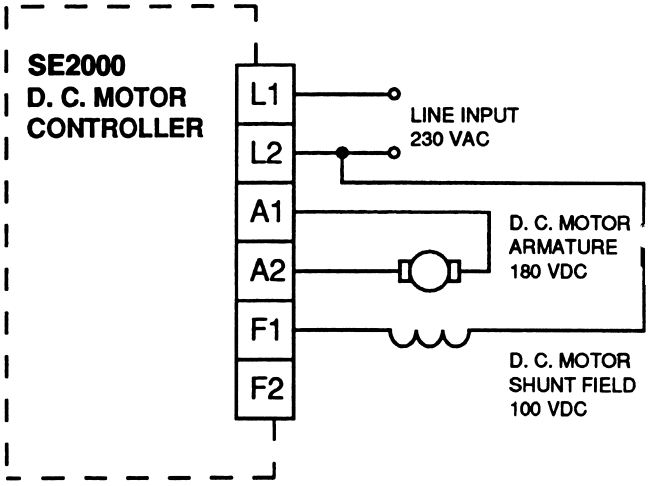
CONNECTIONS FOR A D. C. MOTOR WITH A 90 VDC ARMATURE AND 100 VDC SHUNT FIELD.



CONNECTIONS FOR A D. C. MOTOR WITH A 90 VDC ARMATURE AND 50 VDC SHUNT FIELD.



CONNECTIONS FOR A D. C. MOTOR WITH A 180 VDC ARMATURE AND 200 VDC SHUNT FIELD.



CONNECTIONS FOR A D. C. MOTOR WITH A 180 VDC ARMATURE AND 100 VDC SHUNT FIELD.

Figure 2-3 Shunt Field Connections for D.C. Motors

TABLE 3

PROGRAMMING JUMPERS/SWITCHES/ADJUSTMENT POTENTIOMETERS

Location	Function		Position
JUMPERS			
J1	90V Armature		90
	*180V Armature		180
J2 - J3	115V Input		Refer to Text
	*230V Input		
J4	.3 - 3 Seconds Acceleration/Deceleration Range		C
	*3 - 30 Seconds Acceleration/Deceleration Range		B
	Current Limit Acceleration		A
J5	*Internal Jog Reference		A
	External Jog Reference		B
J6	SE2005 Current Range	SE2002 Current Range	
	*25	*10	E
	15	6	D
	10	4	C
	7.5	3	B
	5	2	A
J7	*Timed Overcurrent Trip		A
	Instantaneous Overcurrent Trip		B
	Disable Overcurrent Trip		C
J8	*Field Loss Enable (Shunt Motors)		SH
	Field Loss Disable (PM Motors)		PM
J9	*Armature Voltage Feedback		A
	7V/1000 RPM Tachometer		B
	50V/1000 RPM Tachometer		C
	1800 PPS Pulse Tachometer		D
	3600 PPS Pulse Tachometer		E
SWITCHES			
SW1	Torque or speed* control provides operation of controller in either the torque or speed mode		
ADJUSTMENT POTENTIOMETERS			
R98	*Acceleration	R107	*IR Compensation
R99	*Deceleration	R112	*Maximum Speed
R100	*Jog	R116	*Torque
R101	*Minimum Speed	R117	*Slope

* Indicates factory setting

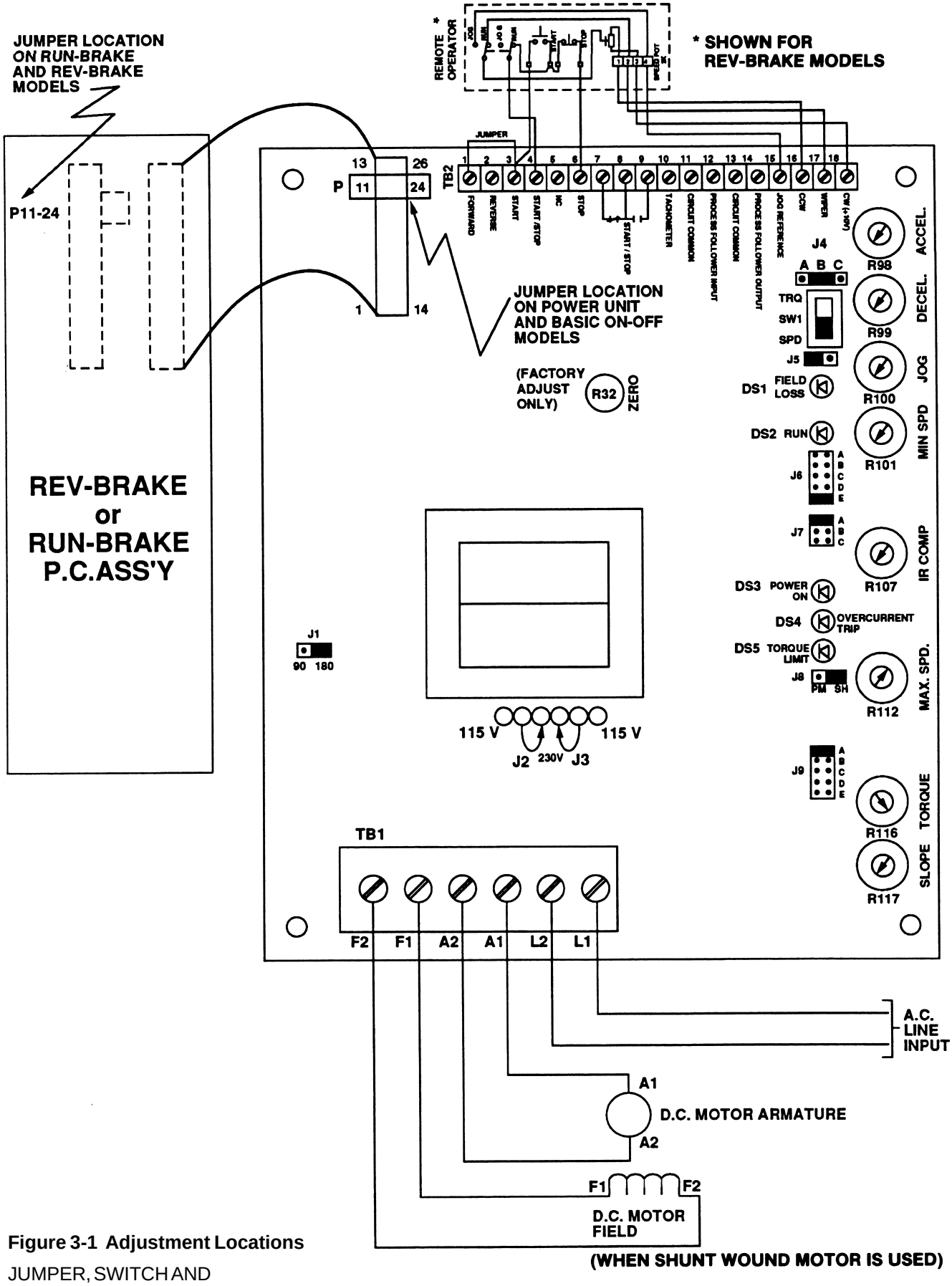


Figure 3-1 Adjustment Locations

JUMPER, SWITCH AND ADJUSTMENT POTENTIOMETERS SHOWING FACTORY SETTINGS

2.3.4 PERMANENT MAGNET MOTORS

If the SE2000 is to be used with a permanent magnet motor, no connection is required to the field terminals. However, the field loss circuit must be disabled by means of J8 (see section 3.1.6).

2.3.5 MOTOR SERIES FIELD

If the motor has other leads marked S1 and S2 (series stabilizing field), ensure these are connected as recommended by the motor manufacturer.

2.3.6 MOTOR THERMOSTAT

If the motor has additional leads labeled P1 and P2 (motor thermal switch) identified on SECO's drawings as MOT, connect these wires in series with the STOP pushbutton. Terminal TB1-5 provides a convenient connection point for this purpose. See Figures 4-6 to 4-9.

3.0 OPERATION

3.0.1 SPEED MODE

A speed potentiometer varies motor speed by controlling applied armature voltage. Clockwise rotation of the Reference Potentiometer increases motor speed. A 4-20 mA or 0-10V signal may be used instead of the potentiometer by using the process signal buffer. See Figures 4-1 to 9 for connection details.

3.0.2 TORQUE MODE

The speed potentiometer can be used to control motor torque instead of speed by changing the position of SW1 to the torque mode. The SE2000 controls motor torque by controlling the DC current in the motor armature. Clockwise rotation of the reference potentiometer increases motor torque.

WARNING
Line voltage is connected to the control when it is in the STOP position. Disconnect line voltage from the control before attempting to wire or service the control.

3.0.3 START/STOP

A start relay is included in each SE2000 control. When this relay is energized, the DC motor controller provides an output to drive the DC motor. For models without local operator control, the user provides the devices that energize and de-energize the relay. Figure 4-2 shows the connection for a 2-wire startstop circuit. In models with operators controls, the drive is started by pressing the Start button.

3.0.4 JOG/RUN

The SE2000 will Jog at a separately adjustable speed if the output from the Jog potentiometer R118 at TB2-15 is connected to the Speed reference input at TB1-17 and the Start relay hold-in circuit is disabled. In enclosed units with operators, the motor will Jog if the Jog button is pressed and either the Start Forward or Start Reverse button is held in. The releasing the Start button will cause the motor to stop.

3.0.5 FORWARD-REVERSE

Reversing-Brake models of the SE2000 are arranged to drive the motor in either the Forward or Reverse direction of rotation. The correct direction of rotation must be selected by either a selector switch or by providing two pushbuttons. Figures 4-1, 4-4, 4-5, 4-6, 4-9 show three different ways of obtaining motor reversal. For enclosed units with operator controls mounted, the Start/Forward and Start/Reverse pushbuttons are provided.

3.1 INITIAL SETTINGS FOR JUMPERS, SWITCHES AND POTENTIOMETERS

The following procedure should be followed to check if jumper connections have been made correctly and that potentiometers are adjusted correctly.

All controllers have been tested at the factory under actual motor load. Factory settings for potentiometers are indicated in the procedure.

See Figure 3-1 for location of jumpers and potentiometers. Table 3 contains a summary of the position of programming jumpers.

Potentiometer settings should be checked before AC power is applied. The factory settings indicated are set when the controller is tested with a motor load. During start-up it may be necessary to modify them for a specific drive application. Generally clockwise (CW) rotation of a potentiometer increases a setting and counterclockwise (CCW) rotation decreases the setting.

3.1.1 LINE VOLTAGE SELECTION

SE2000 Series controllers are suitable for operation on either 115 or 230 VAC single phase, 50/60 Hz supply.

3.1.2 AC SUPPLY

Jumpers J2 and J3 should be in the 230V position for 230 VAC operation or in the 115V position for 115 VAC operation.

3.1.3 VOLTAGE FEEDBACK

Jumper J1 should be in the 180V position for 230 VAC operation or in the 90V position for 115 VAC operation.

3.1.4 CURRENT SCALING

The factory setting for the controller has been made for the maximum current and horsepower rating shown on the nameplate. Connections may be made for a lower maximum current rating by connecting Jumper J6 to match the current rating of the motor to be used as follows:

Position of Jumper J6	Nominal Current in Amps (SE2002)	Nominal Current in Amps (SE2005)
A	2	5
B	3	7.5
C	4	10
D	6	15
E	10	25

3.1.5 SPEED FEEDBACK SELECTION

The SE2000 can accommodate several different speed feedback signals. These feedback signals include: armature voltage feedback, 7V/1000 RPM analog tachometer, 50V/1000 RPM analog tachometer, 1800 pps digital tachometer (magnetic pickup) and 3600 pps digital tachometer. The following chart shows the proper position of J9 for a particular feedback mode.

Type of Feedback	Jumper J9 Position
Armature Voltage	A
7V/1000 RPM Analog Tachometer	B
50V/1000 RPM Analog Tachometer	C
*1800 pps Digital Tachometer	D
**3600 pps Digital Tachometer	E

*1800 pps range – used with 60 tooth gear and 1750 RPM motor or 30 tooth gear and 3500 RPM motor.

**3600 pps range – used with 60 tooth gear and 3500 RPM motor or 120 tooth gear and 1750 RPM motor.

Terminals 10 and 11 of TB2 serve as connector points for either an analog tachometer or a digital tach. Either polarity on the tachometer inputs can be used. See Figures 4-1 to 4-9.

3.1.6 FIELD FAILURE CIRCUIT

The SE2000 includes a circuit to monitor current in the field winding of a shunt wound DC motor. If field current is not present the drive is disabled. When the SE2000 is used with permanent magnet motors, the Field Failure circuit must be disabled by changing the position of Jumper J8 to PM. See Figure 3-1.

3.1.7 OVERCURRENT TRIP CIRCUIT

The SE2000 contains an Over Current Trip Circuit that indicates and trips the drive when the drive has been in current limit for a specified time. This time can be selected by Jumper J7 as follows:

J7 Position	Approximate Time
A	1.0 minutes
B	1.0 seconds
C	Disabled

To reset the over current circuit, operate stop circuit, remove overload and restart the drive.

3.1.8 TORQUE OR SPEED CONTROL

The factory setting for the SE2000 controller is for speed control. Should the application require operation in the torque control mode, SW1 must be switched to the torque position. In this mode the motor torque will be set by the control potentiometer. The motor will run at whatever speed the load requires up to the motor Maximum Speed which may be adjusted by Max Speed potentiometer (R112).

3.1.9 MAXIMUM SPEED

The factory setting is at 100% of rated speed. Motor speed can be adjusted to between 60% and 110% of rated speed by adjusting R112 potentiometer, MAX SPEED.

3.1.9.1 MINIMUM SPEED

The potentiometer sets the minimum motor speed available when the operator's SPEED ADJUST potentiometer is a zero. The factory setting of full CCW allows the operator to control motor speed down to zero speed. The minimum speed may be increased to 30% of BASE SPEED by turning potentiometer R101, MIN SPEED, clockwise.

3.1.9.2 ACCELERATION/DECELERATION TIMES

Acceleration and deceleration times are independently adjustable by means of potentiometers R98 Accel and R99 Decel respectively. Two ranges of adjustment are available depending on the position of Jumper J4.

When J4 is in the C position, the range of adjustment of Acceleration and Deceleration is 0.3 to 3 seconds. When J4 is in the B position, the range of adjustment is 3 to 30 seconds. Position A disables the Accel/Decel controls and acceleration is dependent on torque setting and load inertia. Deceleration is dependent on machine coast-to-rest time. A fully clockwise adjustment of R98 Accel or R99 Decel potentiometers corresponds to a maximum ramp time within the selected range.

3.1.9.3 IR COMPENSATION

This control provides a means of improving motor speed regulation in the armature feedback mode. The factory setting of full CCW provides no compensation. To compensate for motor IR losses, run the motor at the required speed with no motor load, then increase the load to maximum and adjust R107, IR COMP, to obtain the same motor speed as with no load.

CAUTION
Excessive IR Compensation can cause instability.

NOTE: When Tach-Feedback is used, R107 should be turned fully CCW.

3.1.9.4 JOG

Preset Jog speed may be set by adjusting R100, Jog potentiometer. Jumper J5 must be in the A position. The maximum adjustment for R100 is 100% of base motor speed. Jog speed may be set by an external Jog potentiometer (such as that fitted to Remote Operator's Control Station R8005 RJ.) To enable the external Jog speed potentiometer to be used, Jumper J5 must be placed in position B. See Figure 3-1. For connection diagram, see Figures 4-6 to 4-9.

3.1.9.5 TORQUE (CURRENT LIMIT) AND SLOPE

The factory setting for R116 Torque represents a current limit setting of approximately 150% of the selected current range. It is possible to adjust the Torque Limit of the controller from 25% to 150% of the selected current range by adjusting R116 TORQUE potentiometer. The SLOPE R117 potentiometer is used in conjunction with the TORQUE potentiometer R116 to provide an increasing torque – decreasing speed characteristic (tapered current limit) above a fixed torque limit. Adjustment of R117 changes the slope of this characteristic. Normal setting is at minimum. See Figure 3-2. Adjusting the TORQUE setting CCW moves the entire curve. Adjusting the SLOPE setting changes the stall point only.

3.2 INDICATORS

The SE2000 power modules contain 5 LED type indicators. See Figure 3-1 for location:

DS1	Field Loss	DS4	Over Current Trip
DS2	Run	DS5	Torque Limit
DS3	Power On		

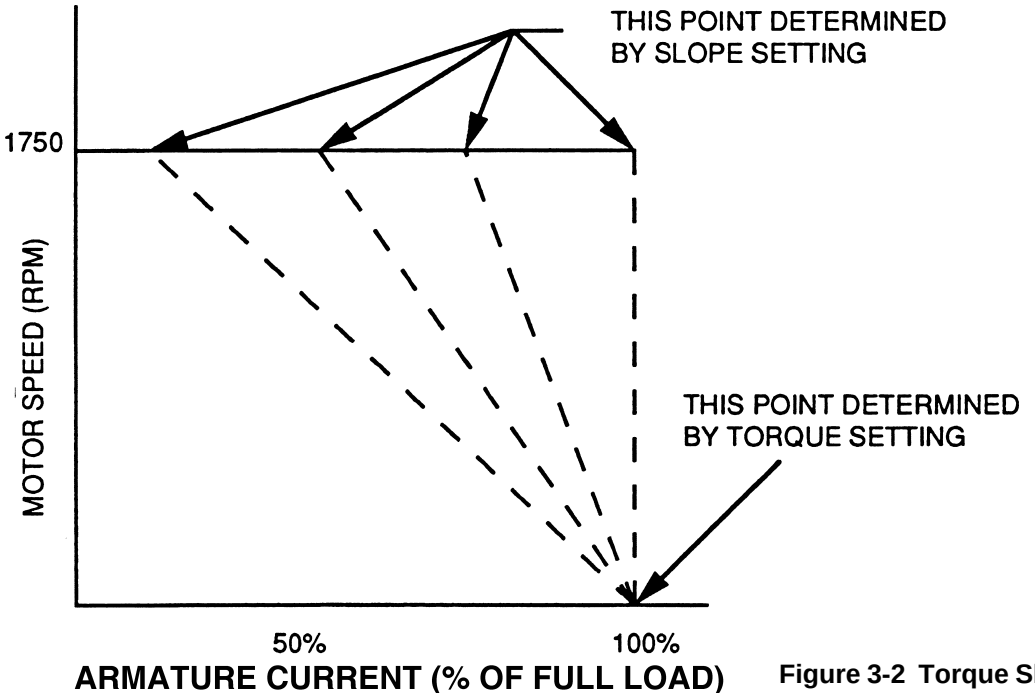


Figure 3-2 Torque Slope Characteristics

4.0 RELAY CIRCUITS

4.1 POWER UNIT AND BASIC ON-OFF

A Start-Stop relay K1 is mounted on the main control board. K1 has a 24 VDC coil and when energized one set of contacts is used on the latching circuit and a set of form C contacts is available for customer use. When the relay coil is not energized, the acceleration/deceleration circuit is clamped at zero and the SCR firing circuit is inhibited. When the relay coil is energized the power unit is turned on.

4.2 RUN-BRAKE

In the Run-Brake version of the SE2000 when relay K1 on the main control board is energized contactor MF is energized and this connects the output of the SCR bridge to terminals A-1 and A-2 and hence to the motor armature. When contactor MF is de-energized, a dynamic braking resistor is connected across the motor armature providing a path for dynamic braking current.

4.3 REVERSING BRAKE

In the Reversing-Brake version of the SE2000 controller, the Forward-Reverse switch selects which contactor MF or MR is energized when the Start button is pressed and K1 is energized.

4.4 JOG

Jog, at separately adjustable speed, is available on all versions of the SE2000 when the JOG speed reference voltage on TB1-15 is connected to the drive input reference terminal TB1-17 and the hold-in circuit on relay K1 is disabled. See Figure 3-1 for connection diagram.

4.5 ALTERNATIVE START-STOP CONTROL ARRANGEMENTS

The SE2000 units may be used with a wide variety of control schemes. Some possible ways to start and stop the controller are shown in Figures 4-1 through 4-9.

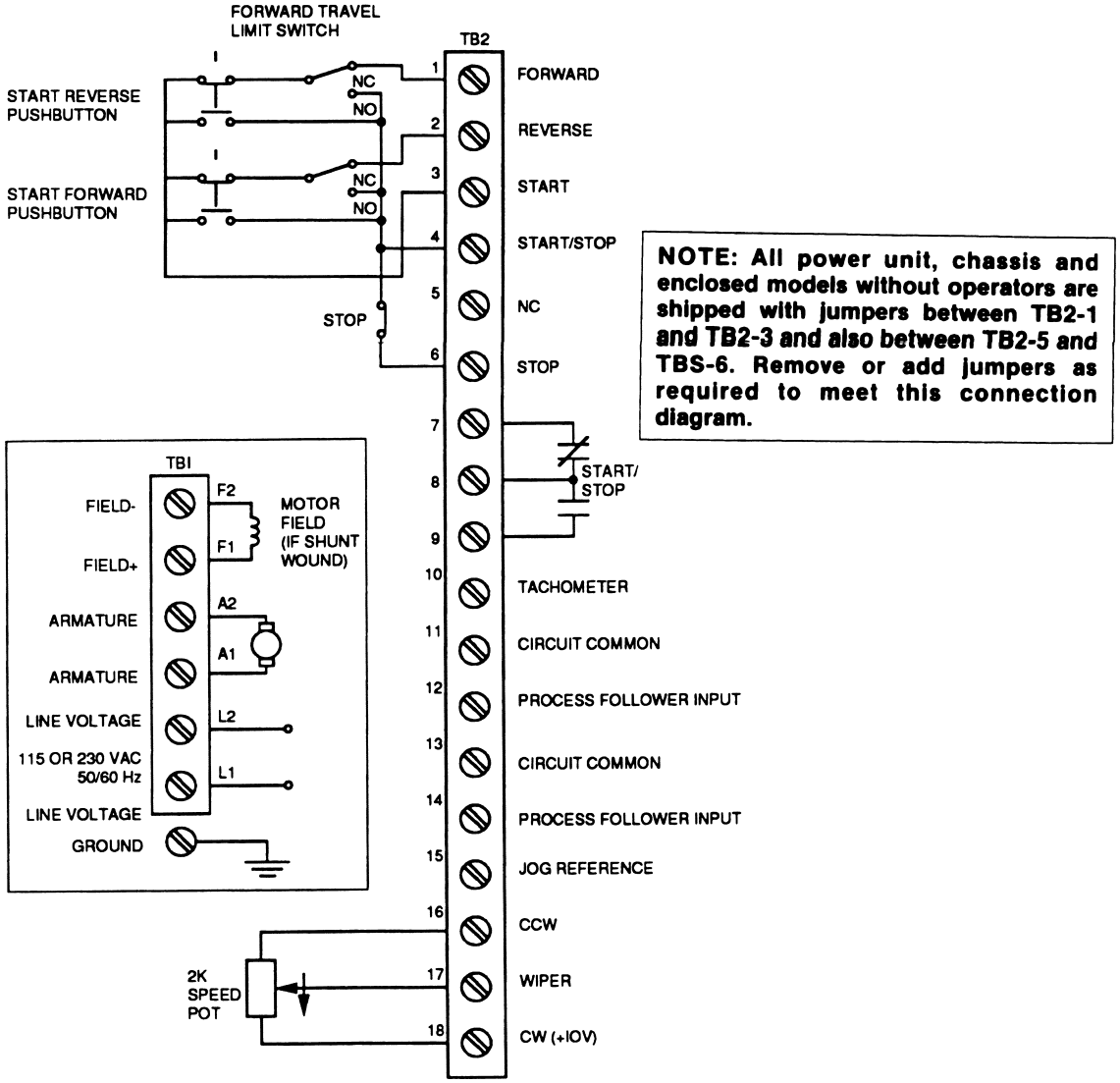
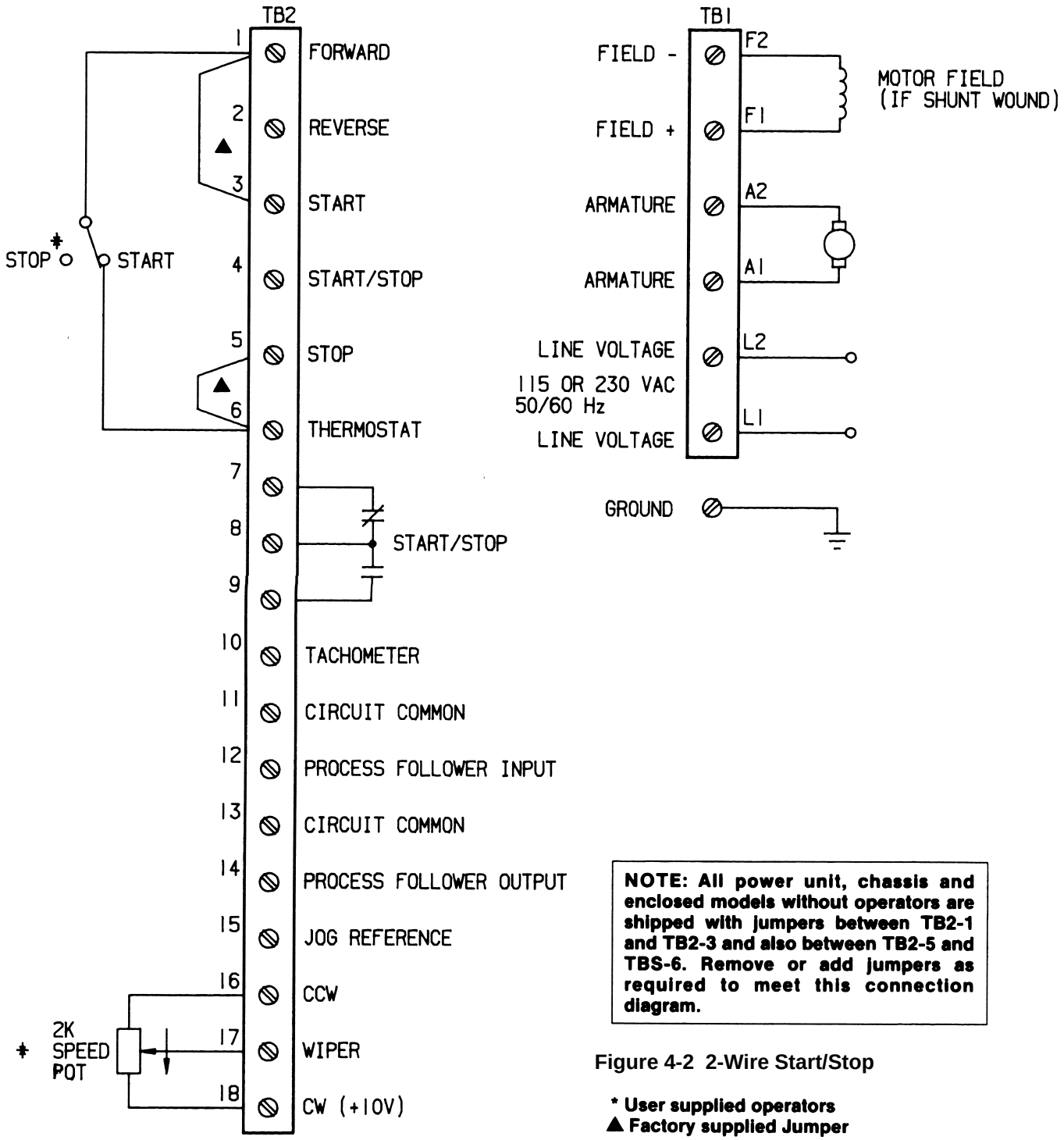


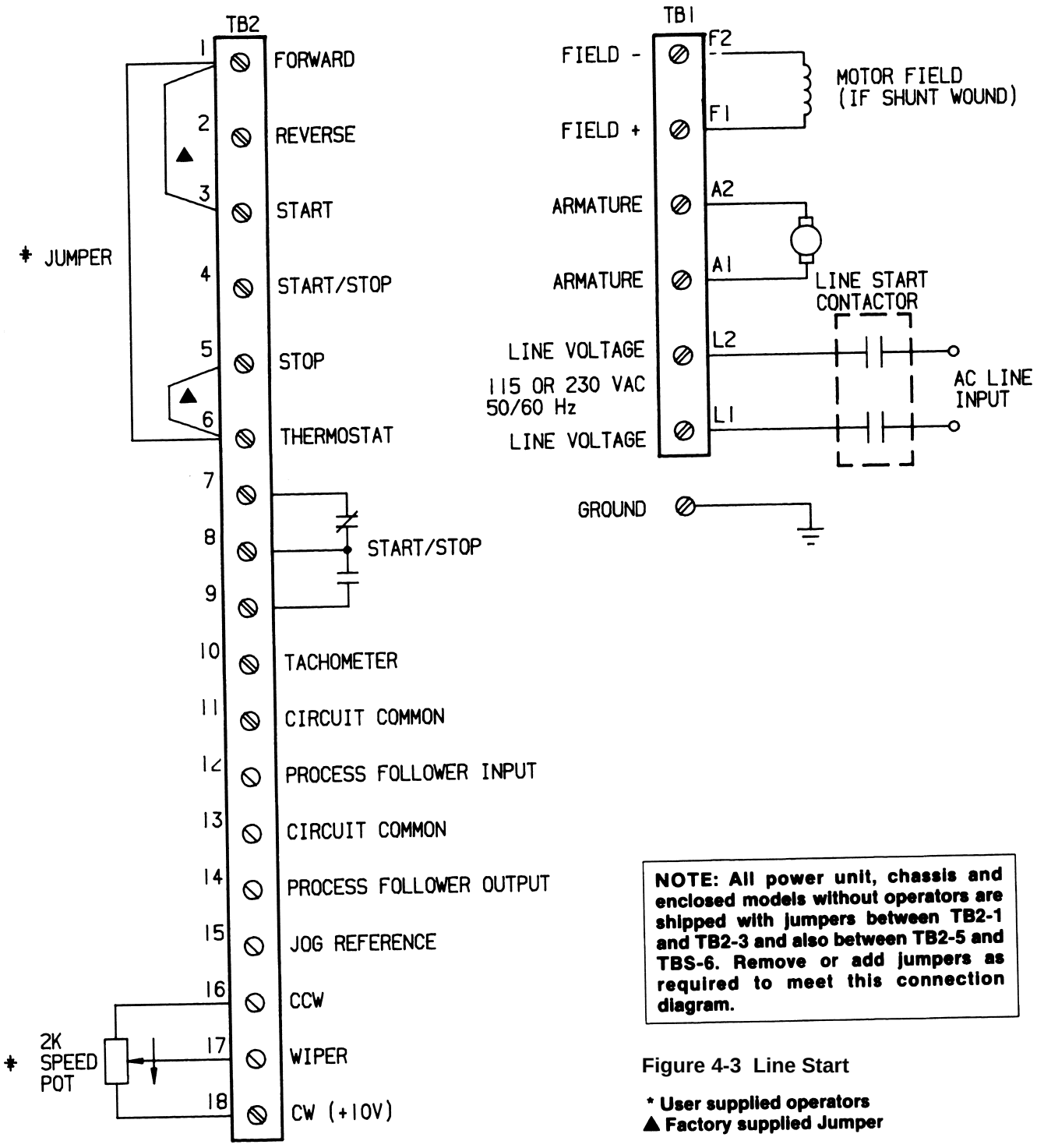
Figure 4-1 Reversing Using Limit Switches



NOTE: All power unit, chassis and enclosed models without operators are shipped with jumpers between TB2-1 and TB2-3 and also between TB2-5 and TBS-6. Remove or add jumpers as required to meet this connection diagram.

Figure 4-2 2-Wire Start/Stop

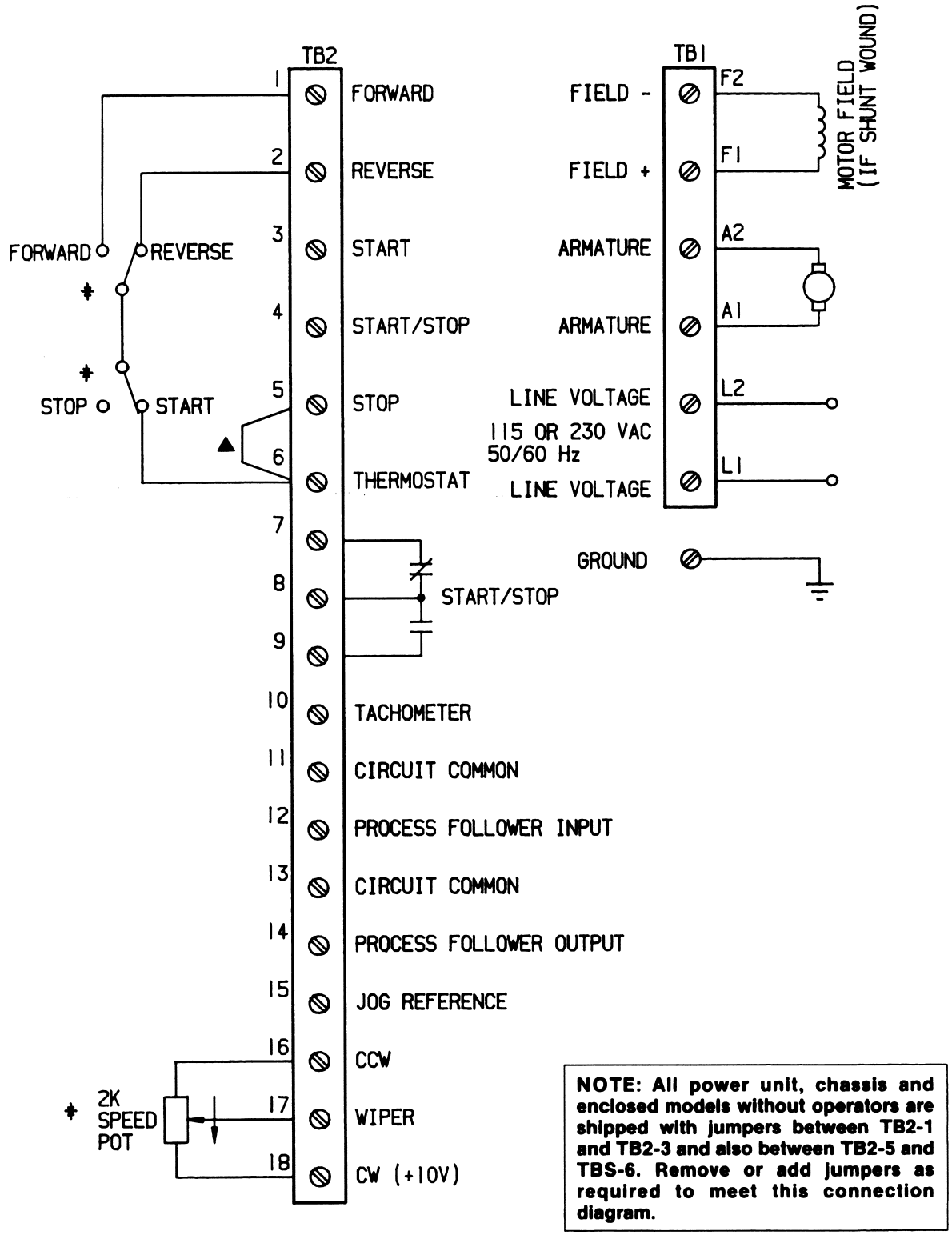
*** User supplied operators**
▲ Factory supplied Jumper



NOTE: All power unit, chassis and enclosed models without operators are shipped with jumpers between TB2-1 and TB2-3 and also between TB2-5 and TBS-6. Remove or add jumpers as required to meet this connection diagram.

Figure 4-3 Line Start

*** User supplied operators**
▲ Factory supplied Jumper



NOTE: All power unit, chassis and enclosed models without operators are shipped with jumpers between TB2-1 and TB2-3 and also between TB2-5 and TBS-6. Remove or add jumpers as required to meet this connection diagram.

Figure 4-4 2-Wire Start/Stop with Memory Reversing

*** User Supplied operators**

s Factory Supplied Jumper

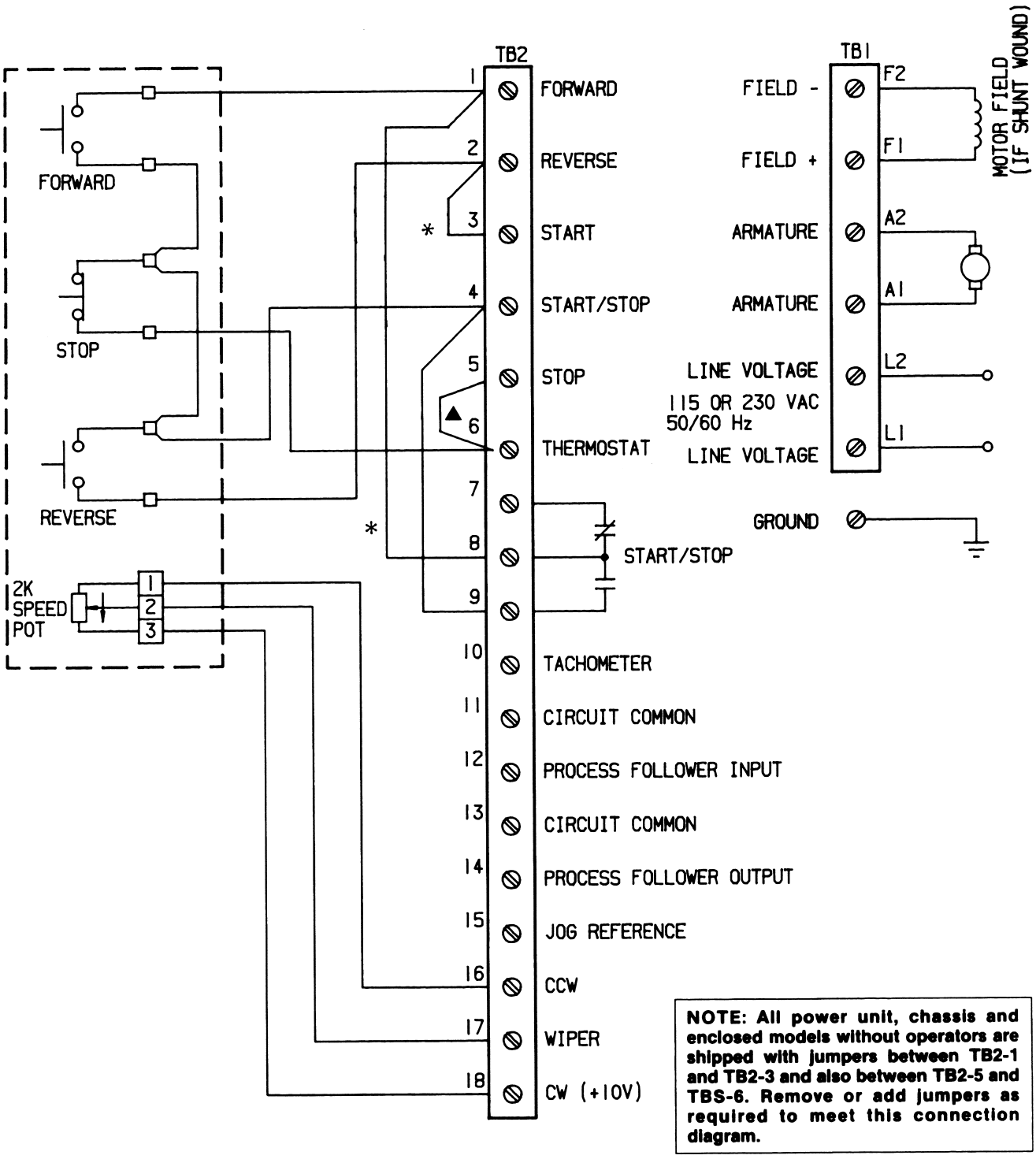


Figure 4-5 Reversing-Brake with R8006 Remote Operator Station

*** User Supplied operators**

s Factory Supplied Jumper

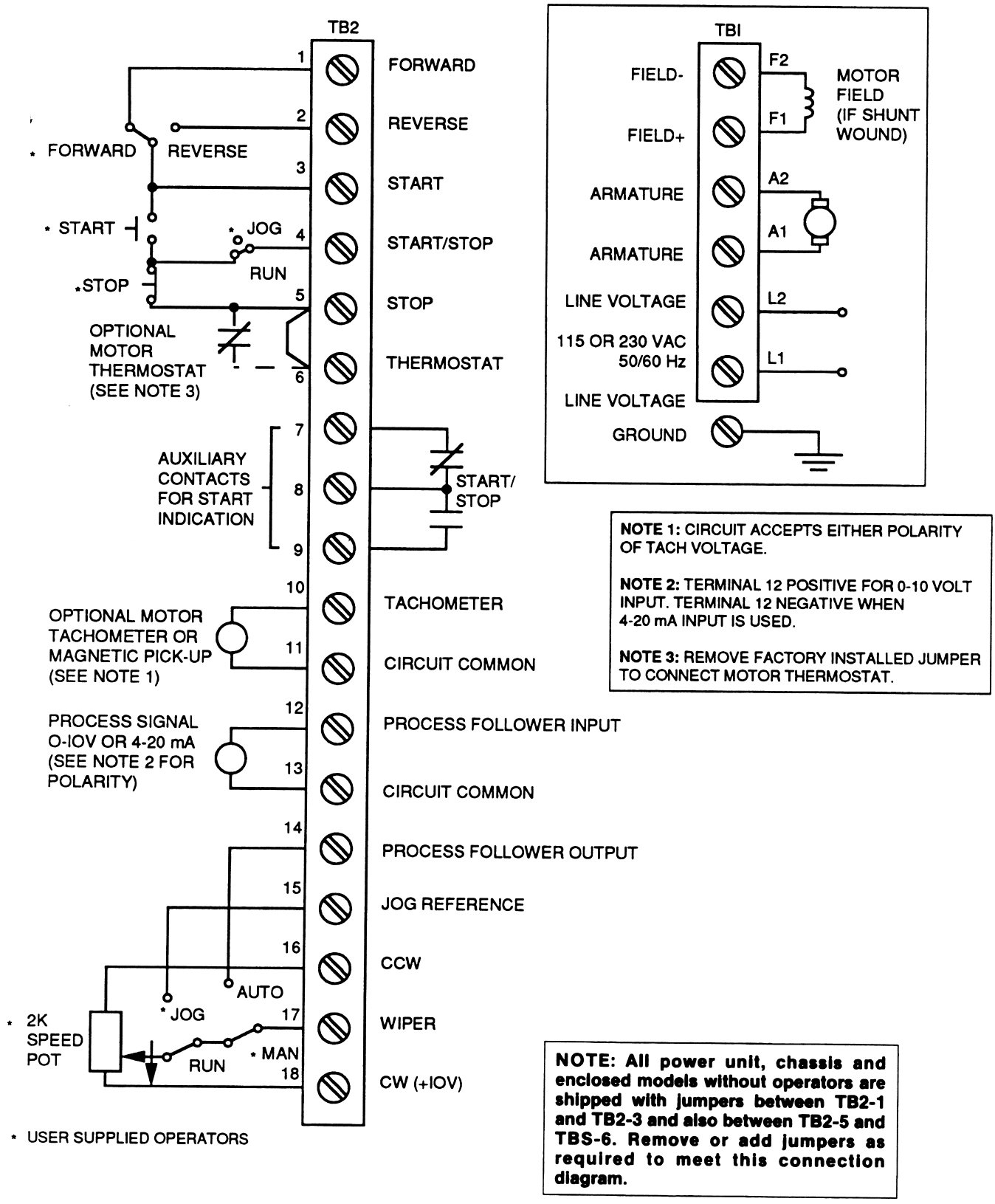


Figure 4-6
SE2000
Operator Connections for all
Chassis or ENclosed (w/o operator)
Rev-Brake Models

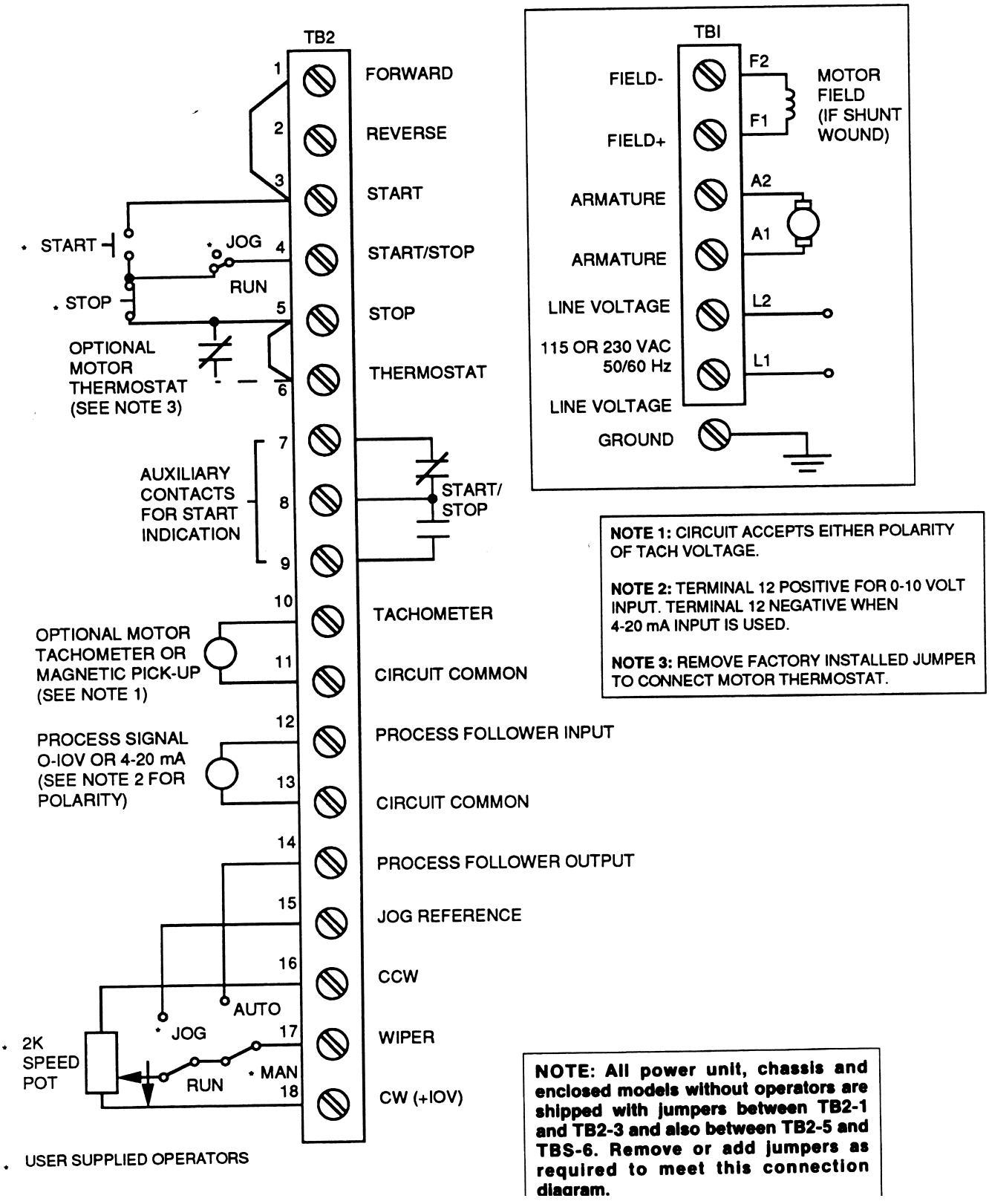


Figure 4-7
SE2000
Operator Connections for
Chassis, Power Unit or ENclosed (w/o operators)
Basic On-Off or Run-Brake Models

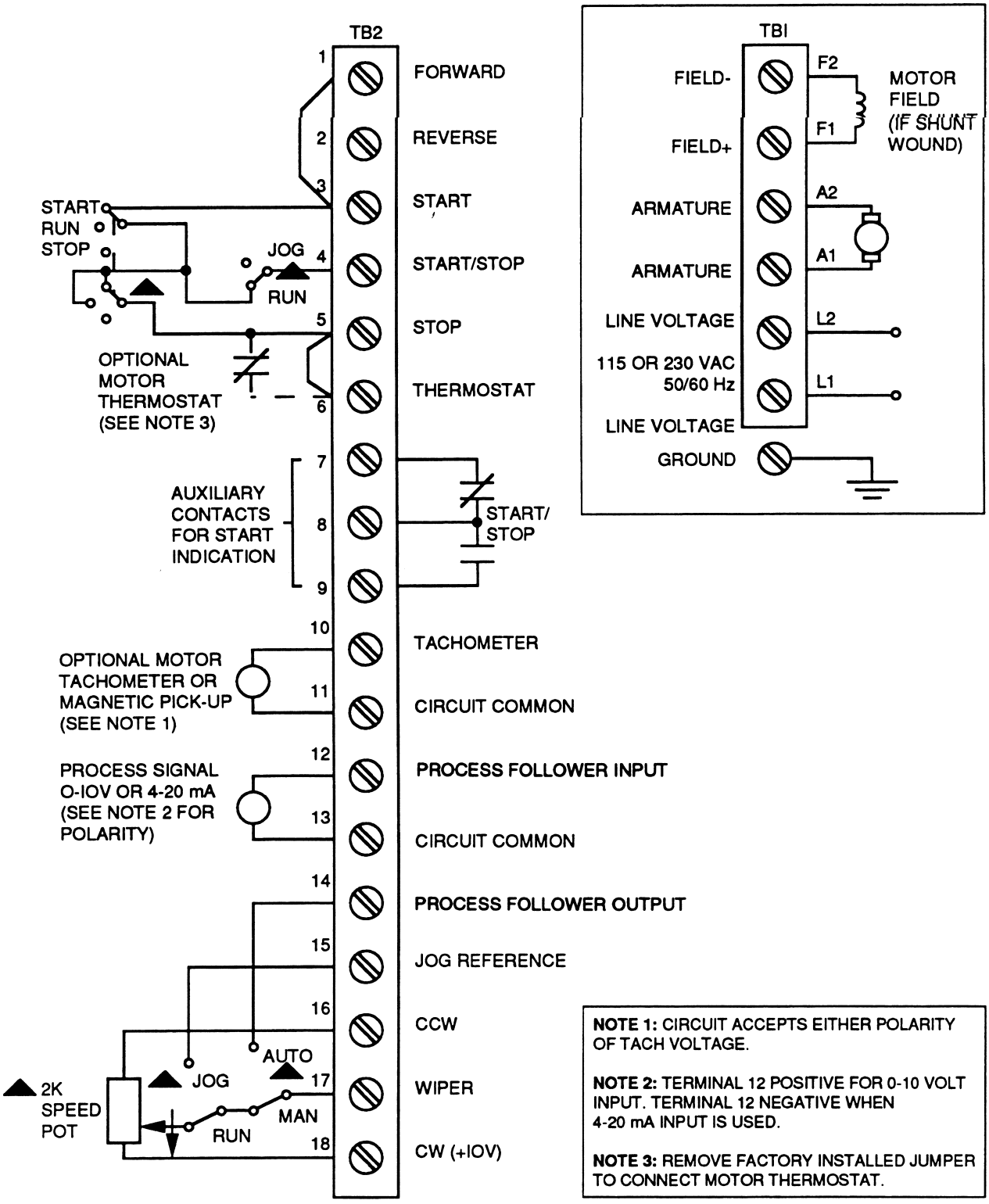
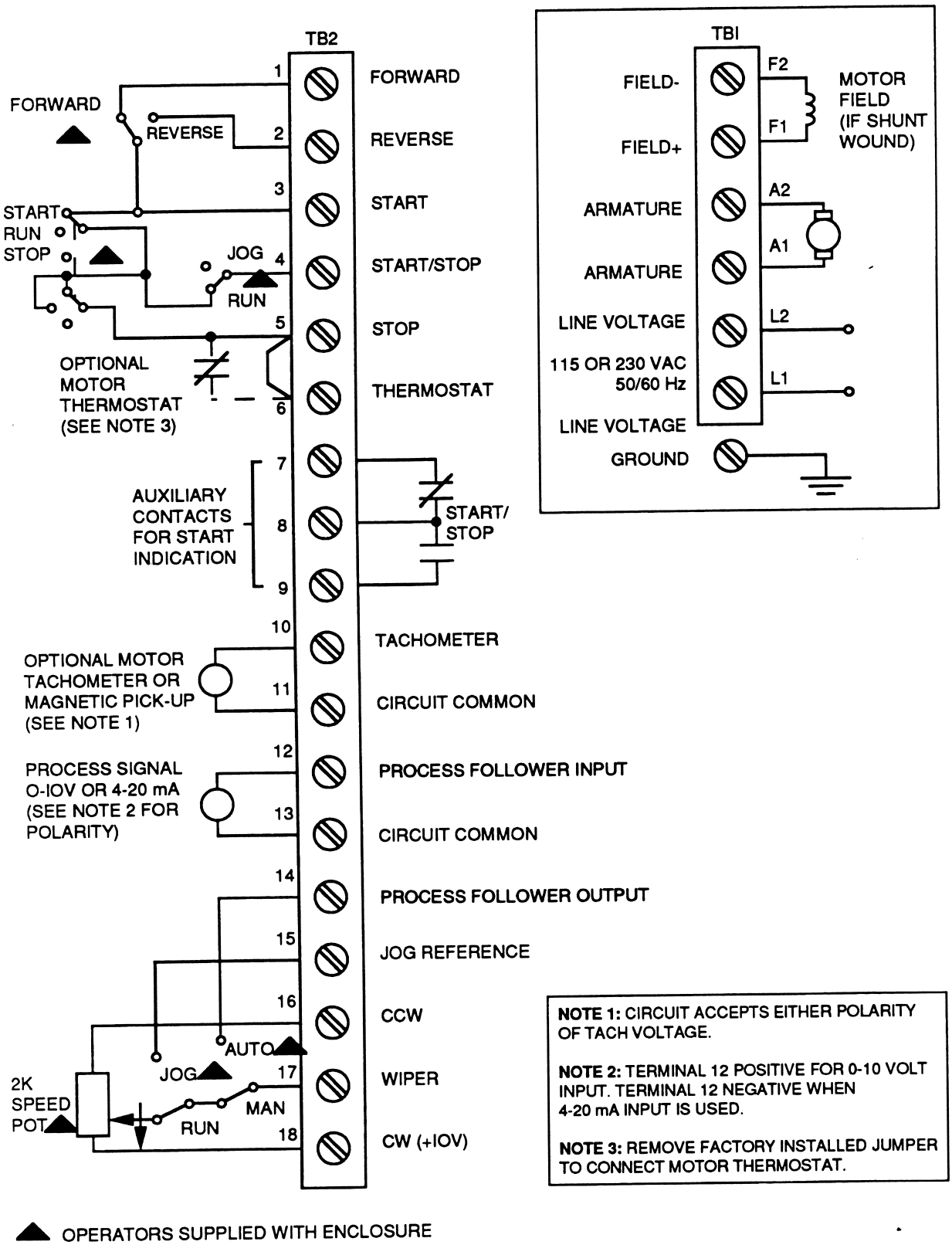


Figure 4-8
SE2000
Operator Connections for
ENclosed (with operators)
Basic On-Off
Run-Brake Models



NOTE 1: CIRCUIT ACCEPTS EITHER POLARITY OF TACH VOLTAGE.

NOTE 2: TERMINAL 12 POSITIVE FOR 0-10 VOLT INPUT. TERMINAL 12 NEGATIVE WHEN 4-20 mA INPUT IS USED.

NOTE 3: REMOVE FACTORY INSTALLED JUMPER TO CONNECT MOTOR THERMOSTAT.

Figure 4-9
SE2000
Operator Connections for
ENclosed (with operators)
Run-Brake Models

5.0 OPTIONS

5.1 GENERAL DESCRIPTION

The SE2000 Series has been designed for maximum flexibility and utility to fit the precise requirements of each specific application. To achieve this goal several options have been designed to enhance the standard SE2000 features and allow each user to purchase a system with only those features required by their application. These optional features can be included when the SE2000 is purchased or can be added later as an easily installed field modification.

5.1.1

Option Description	Factory Installed Model Number Suffix	Field Installed Model Number
2 pole circuit breaker Enables both input lines to be disconnected. Required by some local electrical codes. Standard on 3 and 5 HP models.	-1	SE2999-1*
Follower-Process Controller/DC Voltage or Current (see 6.7) Allows speed control by an external signal, direct or indirect modes. 4-20 mA, 10-50 mA, 0-10 VDC, 0-14 VDC, 0-100 VDC. (Standard model allows 0-10 VDC or 4-20 mA input signal)	-2	SE2999-2**
Follower-Pulse Tach-Generator (see 6.8) Speed Control by external digital pulse signal from magnetic pick-up, Hall Effect sensor, or encoder	-3	SE2000-3**
Controlled Deceleration Stop (see 6.9) Stop command input that provides deceleration ramp to zero speed	-4	SE2999-4*
Fault Module (see 6.10) If tach loss, field loss or overcurrent trip occurs, the fault module will shut down the drive and through the fault indication relay, provide a form C contact to interface with the user's system.	-5	SE2999-5*
Enhanced Torque Slope (see 6.11) Allows for external Torque and Slope pots. Line speed input to maintain tension at different line speeds for winder applications.	-6	SE2999-6**

* This option can be added to all SE2002 chassis except power unit. It is standard on enclosed models.

** A maximum of two of these options may be installed on any unit (except power units).

6.0 START UP PROCEDURES

The following procedures verify that the motor field excitation, AC control voltage, reference voltage, and motor current are within tolerance and that direction of motor rotation is correct.

6.1 FIELD EXCITATION (Shunt Wound Motors only)

a) Before applying AC power, disconnect armature lead A1 and insulate safely.

b) Apply AC power and verify that one of the following voltages exists across the F1, F2 terminals of the motor:

50V or 100V, on a 115 VAC drive
100V or 200V, on a 230 VAC drive

6.2 CONTROL VOLTAGE

a) With a VOM, verify that a voltage of +10 VDC exists across terminals 18 - 16 on the control board.

b) Verify proper operation of all pilot lights, relays, limit switches, etc., as required in the particular installation.

On completion of this phase of the start-up procedure, turn off the AC power, reconnect the motor armature lead to terminal A1. Set the drive for armature voltage feedback by moving Jumper J9 to the armature voltage position A (1-6). This will permit verification of direction of motor rotation and correct tachometer voltage. All drives should be started up in this mode, regardless of the final mode of feedback control.

6.3 MOTOR ROTATION

Follow this procedure only after the operation of all relays, pushbutton switches, etc., has been verified. (See paragraph 6.2) NOTE: Disconnect motor from driven machine for these tests, especially if the machinery can be damaged by reverse rotation.

a) Set the speed command to zero speed and apply AC power.

b) Depress the START pushbutton or activate the start command circuit.

c) Slowly rotate the speed adjusting potentiometer and note rotation of the motor. If the motor direction of rotation is incorrect, turn off AC power, interchange motor armature leads A1 and A2 at the controller terminals.

Tachometer Generator Feedback only:

If tachometer feedback is to be used, restart the drive and measure the voltage at the tachometer terminals.

1. With the motor running at approximately 20% of rated speed, the voltage on the terminals of a 7VDC/1000 RPM tach-generator would be approximately 2 VDC. The voltage on the terminals of a 50VDC/1000 RPM tach generator should be approximately 14 VDC.
2. Move Jumper J9 to the correct position
   - For 7 VDC/1000 RPM Tach: J9 in B position
   - For 50 VDC/1000 RPM Tach: J9 in C position
   - For 1800 pps Pulse Tach: J9 in D position
   - For 3600 pps Pulse Tach: J9 in E position
3. Connect tach generator wires to TB1-10, 11. Polarity is not important.
4. Reapply AC power to the controller.
5. Restart the drive/motor.

6.4 SPEED SETTING ADJUSTMENT

Turn on AC power, enable drive, operate start circuit, slowly turn Set Speed potentiometer fully clockwise. Check to verify that motor speed is 100% of nameplace rating. Adjust Max Speed control as required.

6.5 LOADING

This is to verify that the horsepower requirements of the drive load are within the power rating of the Drive Package. Since the armature current is directly proportional to motor torque, excessive armature current indicates a motor load which is too high.

a) With AC power removed, insert DC ammeter in series with either motor armature lead. The capacity of the meter should be of a high enough rating for the possible current. See Table 4.

b) Reapply AC power and start the system.

c) Measure armature current under all conditions of operation. Verify that full load current never exceeds the motor nameplate rating or controller rating, on a continuous basis.

Table 4. DC Motor Armature Amps (Nominal Full Load)

HP	90 VDC Armature Amps	180 VDC Armature Amps
1/4	2.5	1.2
1/2	5	2.5
3/4	7.5	3.7
1	10	5
1 1/2	—	7.5
2	—	10
3	—	15
5	—	25

6.6 OPTION INSTALLATION AND START-UP

The options for the SE2000 can be built in at the factory when purchased or added as a field-installed option. Mounting instructions will be included when shipped.

The option boards are connected to the SE2000 control board via ribbon cable. The option board, if only one option is used, or the second option board, if two are used, must have a jumper located on P2 Position 11-24. This closes the circuit for the run-stop logic.

6.7 FOLLOWER-PROCESS CONTROLLER; DC VOLTAGE — OR CURRENT (-2/SE2999-2) (See Figure 6-1)

6.7.1 SPECIFICATIONS

1. Input Signal:

   0-10 VDC DC, 4-20 mA DC input impedance 50 ohm
   0-14 VDC DC, 10-50 mA DC input impedance 20 ohm, 0-100 VDC

2. Output Signal: 0-10 VDC

6.7.2 INPUT CONNECTIONS

Connect input reference to TB5 with polarity as shown. Minimum voltage or current to TB5-1 and maximum voltage or current to TB5-2.

6.7.3 JUMPER/SWITCH SELECTION

1. Select correct switch position of SW2 for the input signal being used. All other switches must be in the OFF position.

Input Signal	SW2 Switch Selection
0-100 VDC	Positions 1 & 2 ON
0-14 VDC	Positions 3 & 4 ON
0-10 VDC	Positions 5 & 6 ON
10-50 mA	Positions 7, 8 & 9 ON
4-20 mA	Positions 7, 8 & 10 ON

2. Jumper J10, Inverse/Direct Mode

   This feature allows either Direct or Inverse operation. In Direct mode the minimum voltage or current input produces the minimum motor speed. Maximum voltage or current input, will provide maximum motor speed. In Inverse mode, minimum input reference produces maximum output speed and maximum input produces minimum output speed.

		Drive Operation	
Mode	Jumper Position	Input Signal	Motor RPM
Direct	B	0 VDC	0 RPM
		10 VDC	1750 RPM
Inverse	A	0 VDC	1750 RPM
		10 VDC	0 RPM

6.7.4 ADJUSTMENTS

Internal adjustments must be made regardless of which mode is to be used.

1. Place J10 in the B (Direct) position.
2. Turn Gain Pot, R3, Full CW.
3. With minimum input applied to TB5, use either of the following methods to set Zero. Turn the Zero pot R4, full CCW. Slowly turn the Zero pot, R4, CW until the Zero LED, DS7, turn off. As an alternative adjustment procedure, measure the voltage at TB2-14 to TB2-13 on the main drive control board and adjust Zero pot, R4, for zero output voltage (+10mV to +50mV).
4. Apply maximum reference signal to TB5, and slowly turn the Gain pot, R3, CCW until the Span LED, DS6, turns off. As an alternative method, measure voltage at TB2-14 to TB2-13 and adjust the Gain Pot, R3, for +9 VDC output. If operating in the direct mode, adjustments are complete; if operating in the inverse mode, complete steps 5-6.
5. Put Jumper J10, in Position A.
6. Apply max reference input. If the Zero LED, DS7, is off, turn the Zero pot, CCW until the LED turns on. Turn the Zero pot R4, CW until the Zero LED DS7, turns off. If using the voltage adjust method, adjust the Zero pot, R4, for zero output voltage (+10mV to +50mV) at TB2-14 to TB2-13.

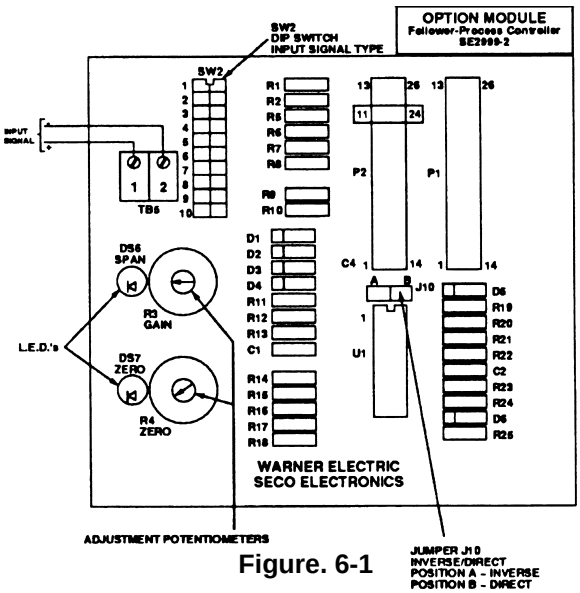


Figure. 6-1

6.8 FOLLOWER - PULSE TACH GENERATOR (-3/SE2999-3) See Figure 6-2

6.8.1 SPECIFICATIONS

1. Input Signal:

   Designed primarily for 60 pulse per revolution magnetic pulse tachometers. (MTK series.) Minimum and maximum frequency range for full voltage output is 1200 Hz to 4000 Hz. Minimum to maximum voltage

input range is 0.1V to 100V. In addition to magnetic pulse tachometers, encoders and Hall Effect devices can be used.

2. Output Signal: 0 to 10 VDC

6.8.2 INPUT CONNECTIONS

Magnetic Pulse Tachometer

TB6 Position 2 - Feedback Signal Input
Position 3 - Common

Hall Effect Devices, Encoders

TB6 Position 1 - Voltage Source (+5 - +12V) @ 20 mA
Position 2 - Feedback Signal Input
Position 3 - Common

6.8.3 ADJUSTMENTS

1. For devices requiring a voltage source, such as encoders and Hall Effect devices, the option board provides an adjustable 5-12 VDC output voltage with a maximum current output of 20 mA. To adjust the voltage amplitude, measure the voltage between TB6-1 with respect to TB6-3 and adjust Voltage Adjust pot, R11, to the voltage level required. Turn the Voltage Adjust pot, R11, CW to increase the voltage level.
2. Turn Gain Pot, R12, full CW.
3. Turn the Zero pot, R10, full CCW with minimum input applied to TB6. Turn the Zero pot, R10, CW until the Zero LED, DS8, turns off. As an alternative method, measure the voltage at TB2-14 to TB2-13 on the main drive control board. Adjust the Zero pot, R10, for zero output voltage (+10mV to +50mV).
4. Apply maximum reference signal (1200-3600 Hz), and while measuring the voltage at TB2-14 to TB2-13, adjust the Gain pot, R12, for +9 VDC output.

6.9 CONTROLLED DECELERATION STOP (-4/SE2999-4) See Figure 6-3

6.9.1 SPECIFICATIONS

The Controlled Deceleration Stop option expands the selection of stopping modes for the SE2000 by using two stop pushbuttons. To help understand the difference between the standard model and this option, refer to the following information.

Stopping Mode When Stop is Activated

Drive Model	Standard Model	Standard Model with Option	
–		Stop Input 1	Stop Input 2
Power Unit On-Off	Coast-to Rest	Coast-to-Rest	Linear Decel (Set by Decel Pot)
Run-Brake Reversing-Brake	Dynamic Braking	Dynamic Braking	Linear Decel (Set by Decel Pot)

Without the Controlled Deceleration Stop option, a linear deceleration rate, as set by the deceleration pot, is achieved only by reducing the reference input to a lower level.

As in all non-regenerative DC motor controllers, the minimum adjustable deceleration time is the coast-to-rest time. The deceleration adjustment allows you to extend the time the motor takes to reach a slower speed or stop.

If the Stop Input 1 was initiated during the linear deceleration, as initiated by Stop Input 1, the coast-to-rest or dynamic braking mode would override the deceleration ramp and become the method of stopping the motor.

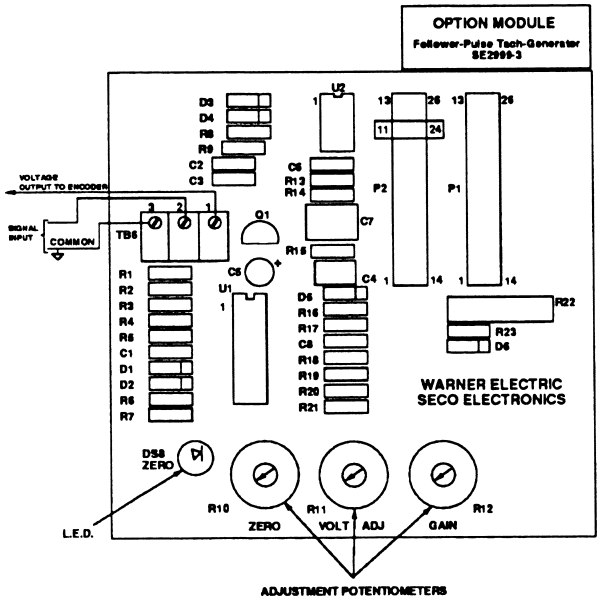


Figure. 6-2

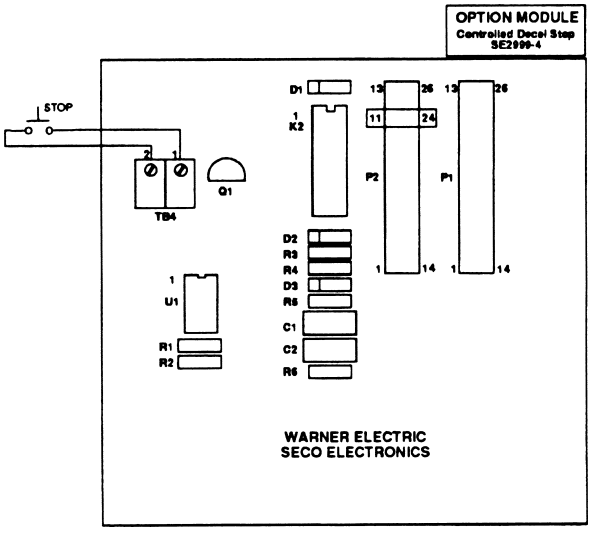


Figure. 6-3

6.9.2 CONNECTION

A normally-open momentary contact Stop pushbutton or contact is connected to TB4, positions 1 and 2.

6.10 FAULT MODULE (-5/SE2999-5) See Figure 6-4

6.10.1 SPECIFICATIONS

The Fault Module includes three types of drive fault detection protection.

Overcurrent — Inverse Time Overcurrent

Field Loss — Detects Loss of Field Current

Tach Loss — Detects Loss of Tach Feedback

Fault Trip Indication — LED Indicators/Trip Relay

Overcurrent Trip LED

Field Loss LED

Tach Loss LED

Fault Indication — Form C Relay Contacts, relay picked up during a fault

Once a fault trip has occurred, the drive will be inhibited and the motor will coast-to-rest. The specific Fault LED and Fault Indication Relay will be maintained until the STOP input is given or AC power is disconnected.

6.10.2 CONNECTIONS

The Fault Indication Relay, K3, is accessible via TB7, Terminals 1, 2, and 3.

TB7 1 N.O.
2 COM
3 N.C.

6.10.3 ADJUSTMENTS

There are no customer adjustments required. Pot R5, is a factory bias adjustment that does not need further adjustment.

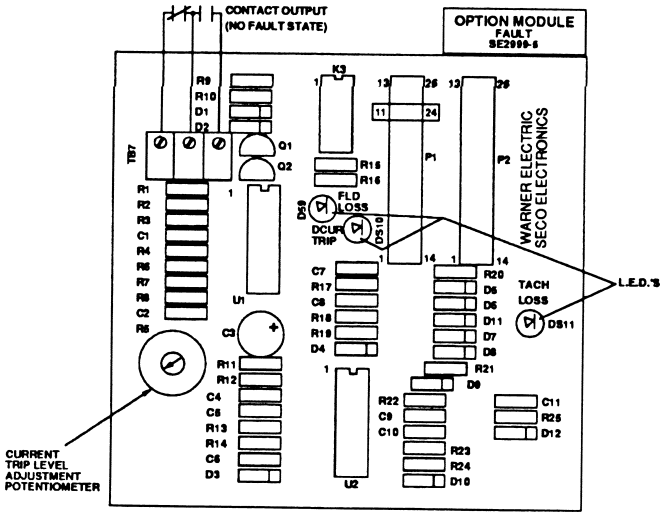


Figure. 6-4

6.11 ENHANCED TORQUE SLOPE (-6/SE2999-6)

6.11.1 FEATURES

1. Terminal connections for external torque and slope pots for centerwind tension control.
2. Torque- slope adjustment independent of line speed (over 10:1 range) when 0-10 VDC line speed signal is available.
3. Internal alternate torque adjustment; selected by contact closure.
4. Internal stop torque adjustment (0 to 100 %) is enabled below pre-set speed (adjustable 0 to 10%) (indicated by LED).
5. Slope function produces non-linear winder speed/ motor torque curve required for constant tension (see Fig. 6.5).
6. Simple set-up: LED's eliminate need for meter.

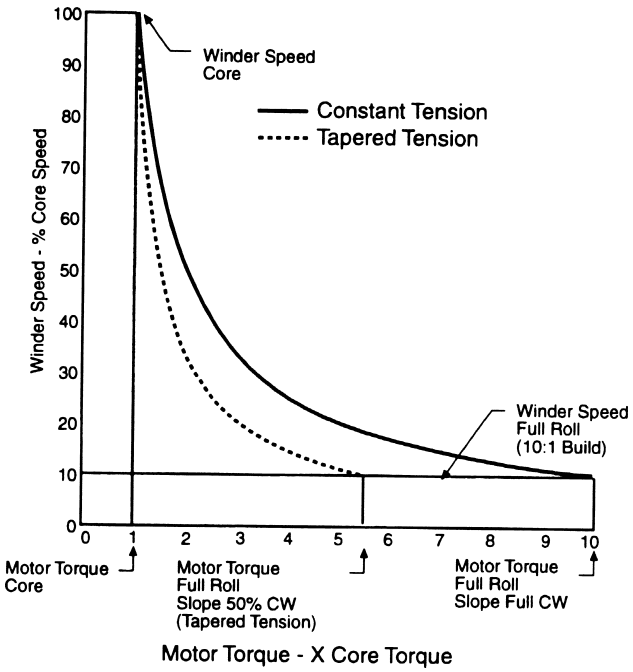


Figure. 6-5
Winder Speed vs Motor Torque

6.11.2 ADJUSTMENT OF SE2000 DRIVE:

1. Set switch S1 for Speed Control Mode. A speed reference voltage is required at TB2-17 for proper operation. For most applications, TB2-18 should be connected to TB2-17 to provide a 10VDC reference voltage (no connection is required to TB2-16). The maximum (no load) winder speed can then be set by R112, maximum speed.
2. R116, Torque, and R117, Slope, should remain in the factory set positions (reference Fig. 3-1).

6.11.3 ADJUSTMENT PROCEDURE WITH LINE SPEED SIGNAL:

1. Refer to FIG. 6.6 for location of adjustments. Set IR, LS, ST, WK^2 and AT pots CCW. Also set external TORQUE and SLOPE CCW. Place J1 in the LS position if a LINE SPEED signal is to be used. If a LINE SPEED signal is not available, see section 6.11.4.
2. With line at STOP and empty roll in place, STOP TORQUE LED should be ON (SL is factory set for 5% of full speed - range is from 0 to 10%). Adjust ST CW for desired Stop Tension.
3. With stop tension applied, adjust IR until NULL LED's are balanced (both ON) (SLOPE LED should be off).
4. START line slowly; as speed reaches 5%, the STOP TORQUE LED will turn OFF. Adjust TORQUE CW to obtain desired core tension. Increase line speed to max; trim TORQUE if necessary.
5. At max. line speed, adjust LS for balanced NULL LED's (SLOPE LED should be OFF).
6. As roll builds, adjust SLOPE CW to maintain desired tension. The Slope function is active when the SLOPE LED is ON in addition to both NULL LED's. For constant tension, adjust SLOPE full CW; for taper tension, adjust SLOPE less than full CW (see FIG. 1). If LINE SPEED is changed, the system remains calibrated and does not require re-adjustment.
7. If an alternate pre-set TORQUE setting is required, a contact closure on TB8 pins 9 & 10 will enable the ALT TORQUE pot. The SLOPE function does not require re-adjustment.
8. Adjust WK^2 COMP CW to compensate for roll inertia by increasing motor torque during acceleration and decreasing torque during deceleration.

6.11.4 Adjustment Procedure Without Line Speed Signal:

1. Refer to FIG. 6.6 for location of adjustments. Set IR, LS, SL, ST, WK^2 and AT pots CCW. Also set external TORQUE and SLOPE CCW. Place J1 in the LS position if a LINE SPEED signal is not to be used. (With J1 in the $\overline{LS}$ position, winder torque will vary with the line speed).
2. Without a LINE SPEED signal, the SL and ST pots and the STOP TORQUE LED are not used. With line at STOP and an empty roll in place, adjust external TORQUE pot CW for desired Stop Tension.
3. With stop tension applied, adjust IR until NULL LED's are balanced (both ON) (SLOPE LED should be off).
4. START line slowly; adjust TORQUE to maintain desired core tension. Increase line speed to max; trim TORQUE if necessary.
5. At max. line speed, adjust LS for balanced NULL LED's (SLOPE LED should be OFF).
6. As roll builds, adjust SLOPE CW to maintain desired tension. The Slope function is active when the SLOPE LED is ON in addition to both NULL LED's. For constant tension, adjust SLOPE full CW; for taper tension, adjust SLOPE less than full CW (see FIG. 1). If LINE SPEED is changed, repeat steps 4 through 6 to calibrate torque and slope for new speed.
7. If an alternate pre-set TORQUE setting is required, a contact closure on TB8 pins 9 & 10 will enable the ALT TORQUE pot. The SLOPE function does not require re-adjustment.
8. WK^2 COMP is not used without a LINE SPEED signal.

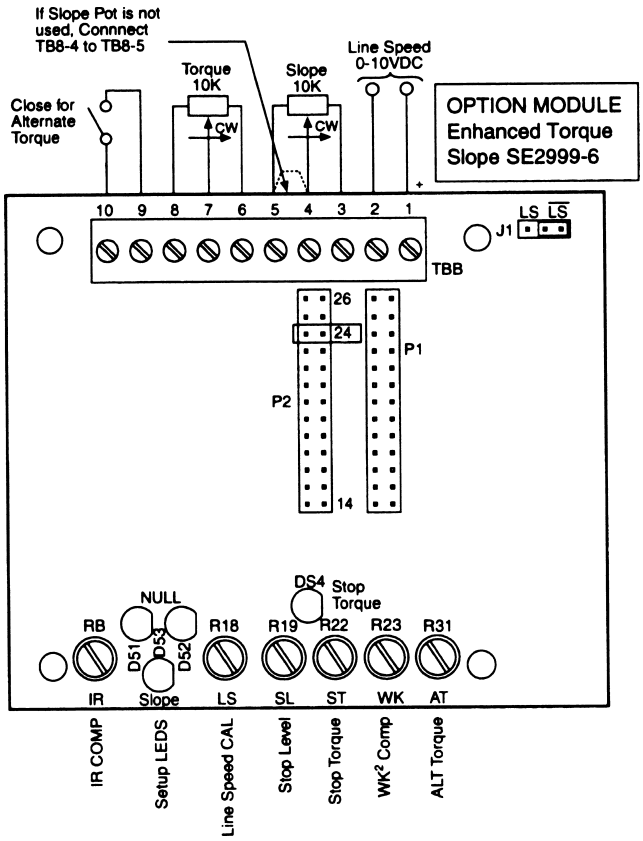


Figure. 6-6

Adjustments and Connections

7.0 THEORY OF OPERATION

This chapter describes the operating theory of the SE2000 DC motor controller.

7.1 DRIVE SYSTEM

The SE2000 drive system is designed to produce an accurately controlled DC motor speed in response to a reference voltage input. The accuracy of commanded speed and speed regulation are determined by feedback loops contained within the drive system.

7.2 CONTROL ELECTRONICS

The control electronics printed circuit card contains the low voltage power circuit, current loop amplifier, speed amplifier, and gate drive circuits.

7.3 BASIC BLOCK DIAGRAM

The basic block diagram for the SE2000 controller (Figure 7-1) shows the relationships between the power convertor, control electronics, operators controls, and motor and tachometer generator. A brief description of each circuit function follows.

7.3.1 SPEED REFERENCE

The speed reference circuit provides a voltage source for the operator speed potentiometer. The SPEED signal for the DC motor controller may be obtained from the wiper of the operators speed control potentiometer, from the wiper of the JOG potentiometer, (TB2-15) or from the PROCESS FOLLOWER buffer (TB2-14). Each of these signals is 0-10V and will provide the input to the Accel/Decel circuit.

7.3.2 PROCESS FOLLOWER BUFFER

The process follower buffer takes a signal from a PROCESS controller that may be either 4-20mA or 0-10V grounded or ungrounded and converts it to a 0-10V signal used as the speed reference voltage for the SE2000.

7.3.3 ACCELERATION/DECELERATION CIRCUIT

The acceleration/deceleration circuit provides a controlled and independently adjustable linear rate of acceleration and deceleration to, or from, operating speed. Adjustment of the time to reach full speed can be made in the range of 0.3 seconds to 3 seconds, or 3 to 30 seconds. The effective range of adjustment is selected by connecting Jumper J4 as described in paragraph 3.1.9.3.

7.3.4 TACH SCALING CIRCUIT

The tach generator scaling circuit takes the voltage from a DC tach generator or Digital Pulse tach generator and conditions it to the correct value for the speed control amplifier. The correct selection is made as follows:

Tach Voltage at 1750 RPM	Jumper	
12.25 VDC (7 VDC/1000 RPM)	B	7V
87.5 VDC (50 VDC/1000 RPM)	C	50V
1800 pps (60T gear)	D	1800 pps
3600 pps (120T gear)	E	3600 pps

1) The correct top speed for a particular combination of tach generator and motor is set using the Max. Speed pot. Note: The tachometer circuit must be physically selected by placing Jumper J9 in the correct position.
2) The circuit is not polarity sensitive and any tach generator polarity is acceptable.

7.3.5 ARMATURE VOLTAGE SCALING

The armature voltage scaling and buffer circuit provide a scaled voltage proportional to the motor's armature voltage for those drive systems which do not use tachometer generator feedback. Note that to select armature voltage feedback, Jumper J9 must be in the A (1-6) position.

7.3.6 SPEED LOOP REGULATOR AND IR COMP

The speed loop amplifier sums the speed command signal (from the acceleration control circuit) and the speed feedback signal (either tachometer or armature voltage). The resulting voltage is amplified and modified and provides the input to the current regulator.

When armature voltage feedback is used, speed errors caused by armature circuit resistance are compensated by the IR compensation circuit. A voltage proportional to armature current is summed with the speed reference voltage input to the speed regulator. This compensation voltage causes the voltage applied to the motor armature to be increased up to 5% of rated armature voltage and will compensate for the IR drop in the armature caused by load current.

The speed regulator output voltage is limited by the Torque Limit Circuit. This amplifier sets the maximum value of the current allowed to flow in the motor armature during motoring. The Torque amplifier output is controlled by the TORQUE and TORQUE SLOPE potentiometers. The Torque potentiometer sets the actual value of the maximum current allowed to flow in the motor armature at full speed. This control is sometimes called the Current Limit.

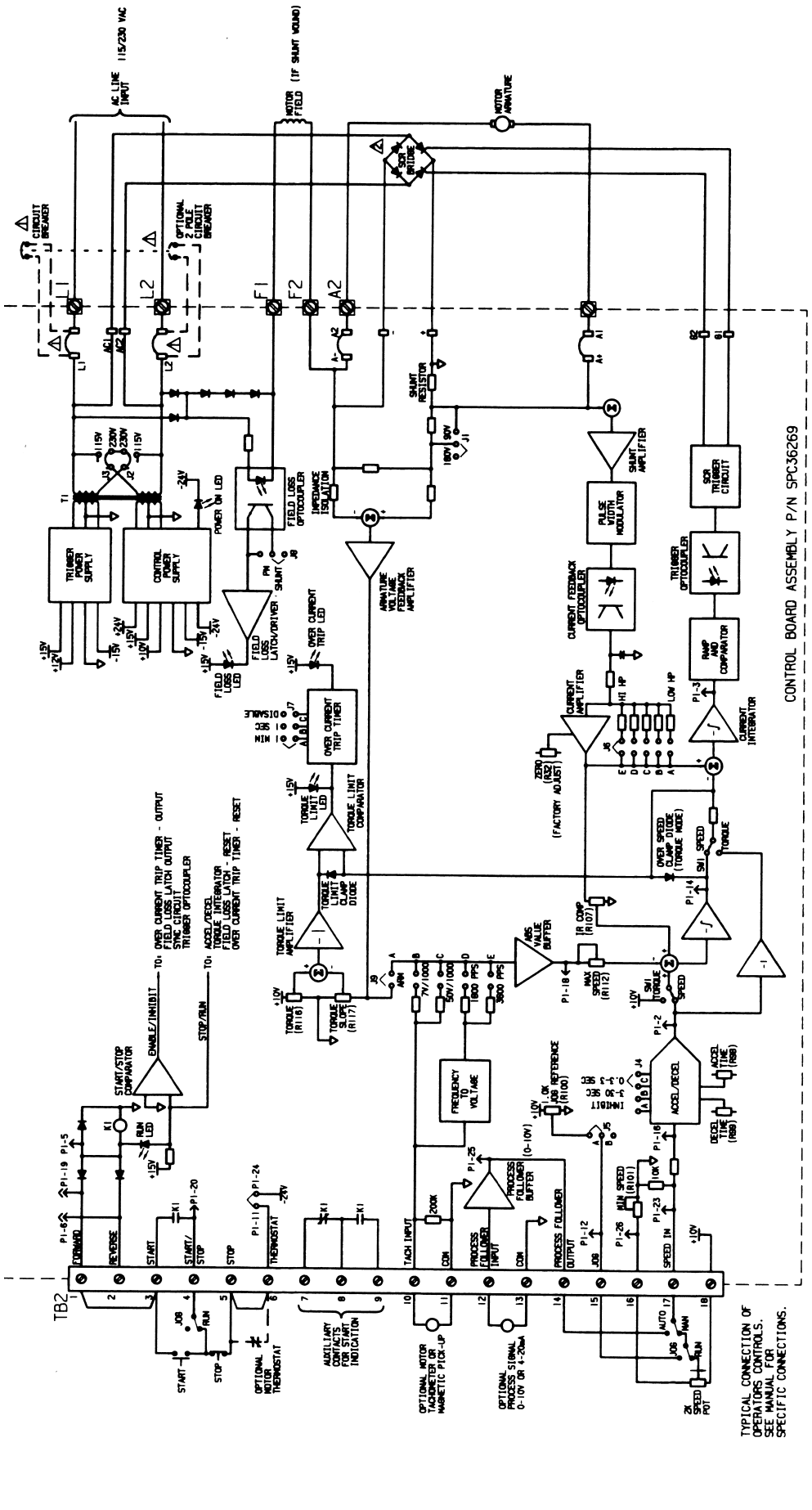
The TORQUE SLOPE potentiometer sets the characteristic of the Torque Limit Circuit so that as motor speed decreases the current available increases. This characteristic is used in simple winder circuits. (See 3.1.9.5 for further details.)

7.3.7 CURRENT REGULATOR

The current regulator sums the current command signal from the Speed Loop controller with the current feedback signal from the Current Feedback Amplifier. The output signal is amplified and stabilized and sent to the Firing Circuits.

7.3.8 FIRING CIRCUITS

The Firing Circuit provides the firing pulses which are fed to the gates of the SCRs to turn on the SCRs and produce output power. They produce correctly phased firing pulses controlled by the current regulator signal. Electrical isolation between the SCRs and the Firing Circuit is provided by opto couplers.



TBI ON CONTROL BOARD

QUICK CONNECT TERMINAL ON CONTROL BOARD.

NOTES:

1. POWER UNIT HAS JUMPERS AS SHOWN. BASIC ON/OFF MODELS HAVE L- OR 2-POLE CIRCUIT BREAKER IN CHASSIS VERSIONS; 2-POLE CIRCUIT BREAKER ONLY IN ENCLOSED VERSIONS.
2. MOUNTED ON DRIVE CHASSIS.

Figure 7-1

SE2000
¼ - 2 HP
Basic On-Off
or
Power Unit

Models
SE2002
SE2122
SE2132

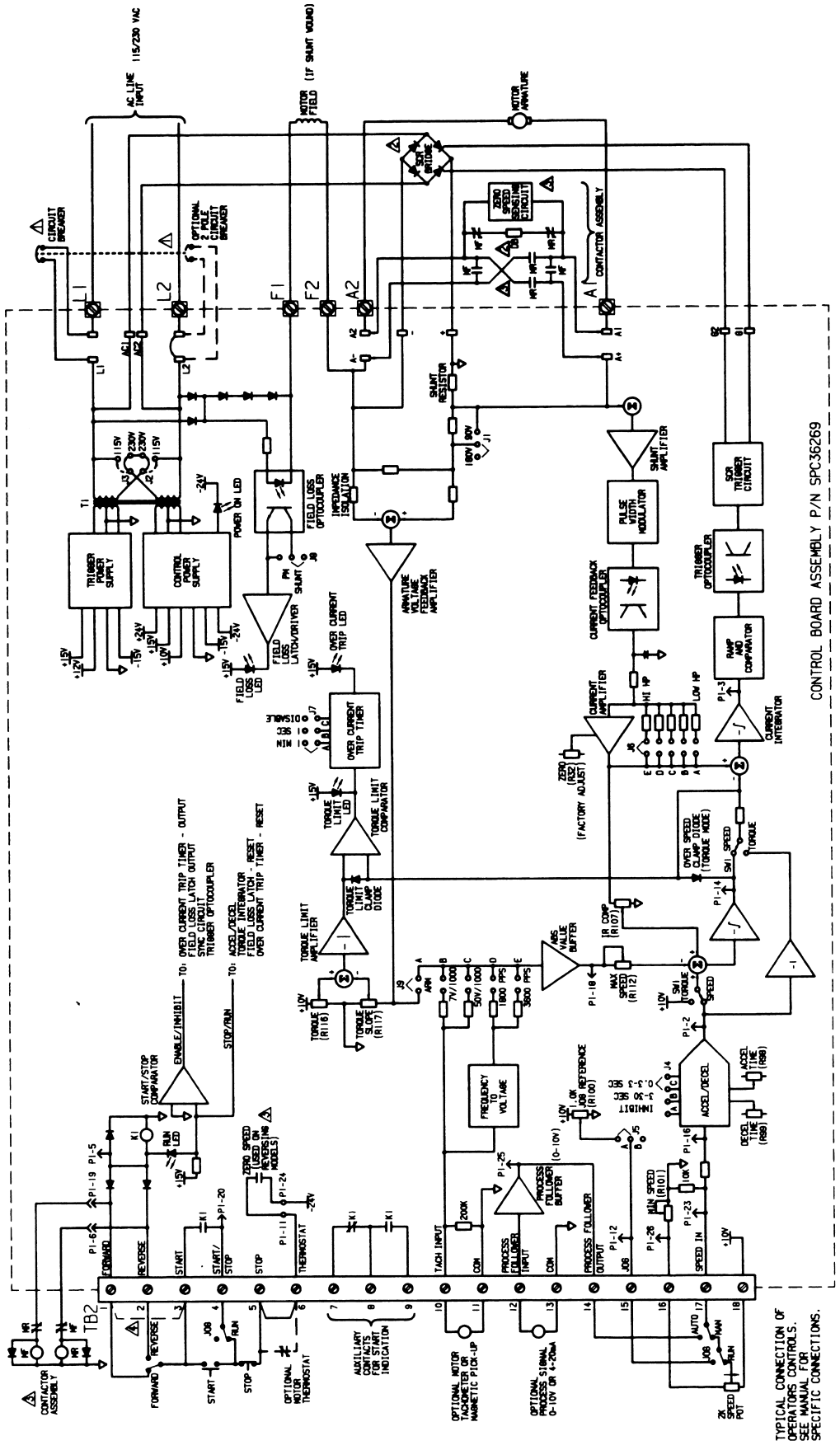


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Figure 7-2

SE2000
¼ - 2 HP
Rev-Brake
or
Run-Brake

Models
SE2202
SE2222
SE2232
SE2302
SE2322
SE2342

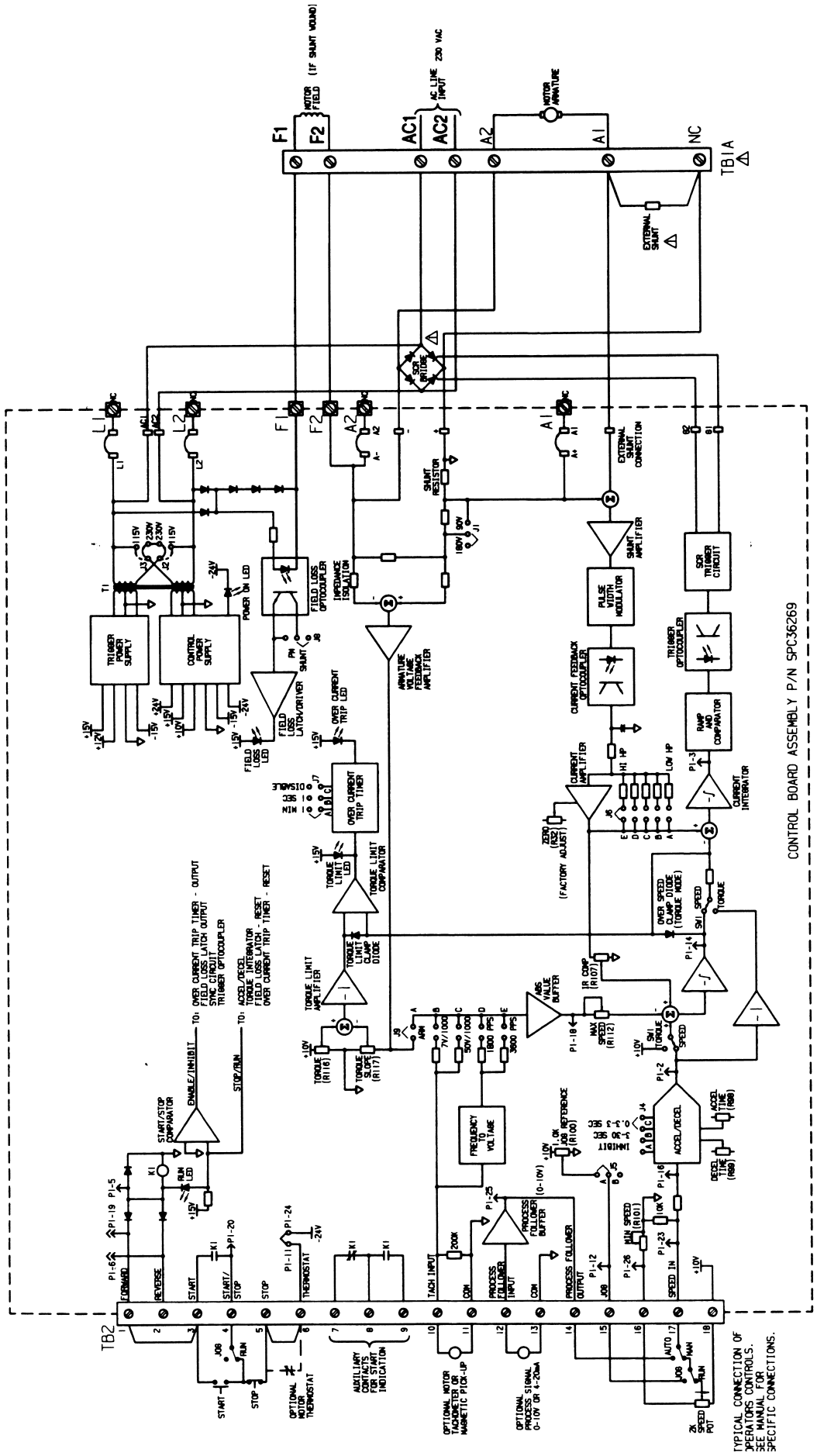

Figure 7-3

SE2000
3 - 5 HP
Power Unit

Model
SE2005

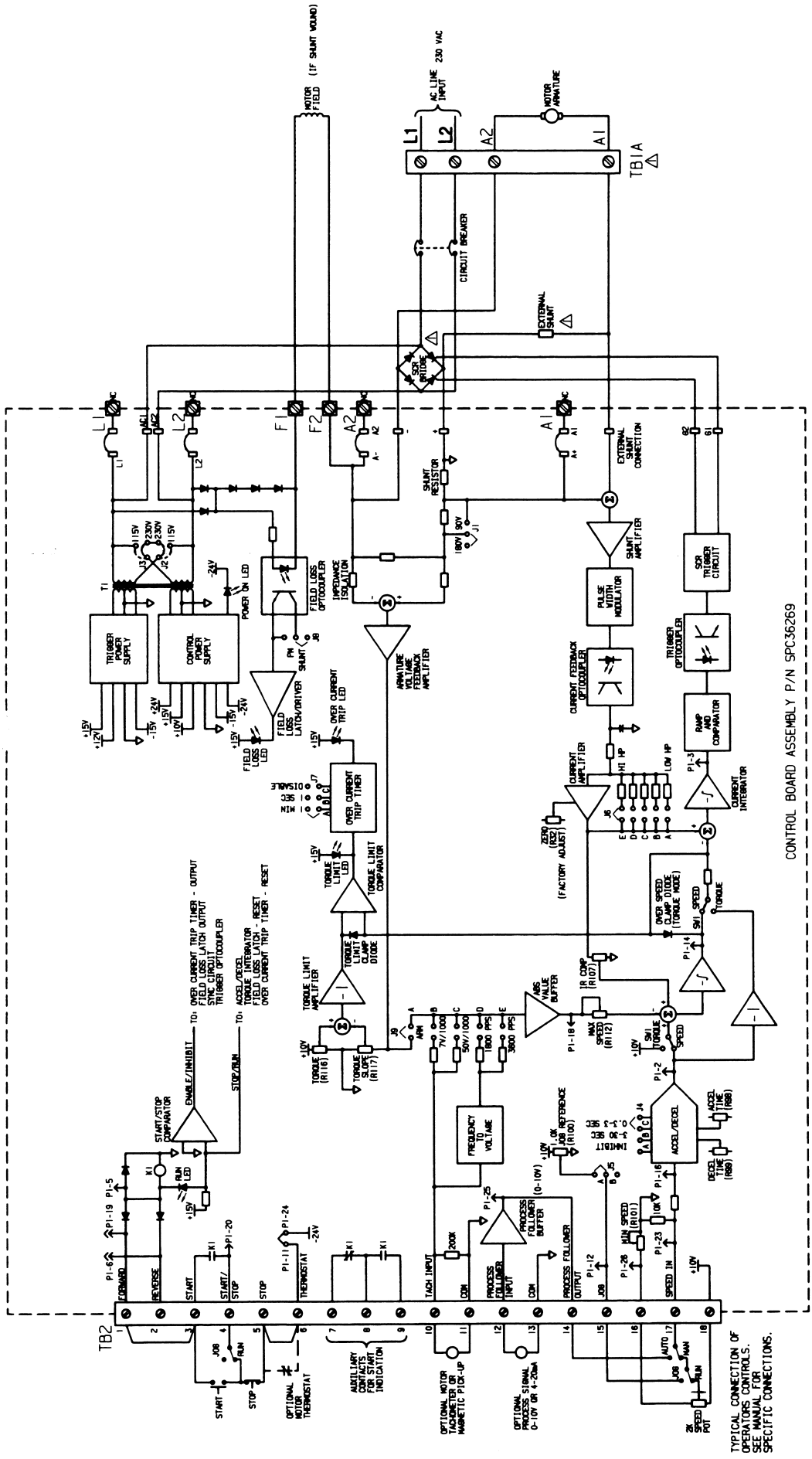

Figure 7-4

SE2000
3 - 5 HP
Basic On-Off

Models
SE2125
SE2135

▨ TB1 ON CONTROL BOARD.
□ QUICK CONNECT TERMINAL ON CONTROL BOARD.

NOTES:
△ LOCATED ON DRIVE CHASSIS.

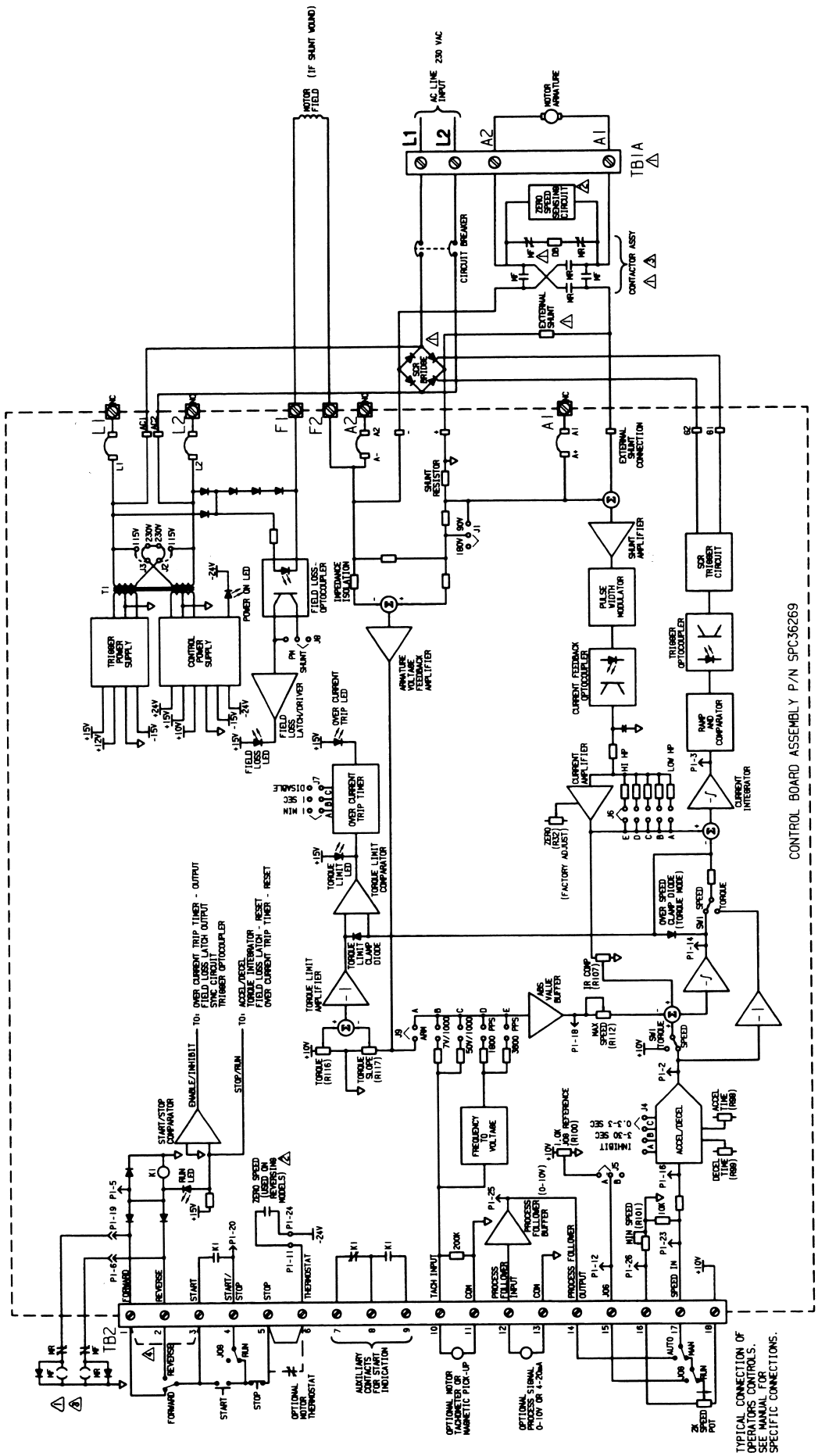

Figure 7-5

SE2000
3 - 5 HP
Rev-Brake
or
Run-Brake

Models
SE2005
SE2225
SE2245
SE2305
SE2325
SE2345

8.0 TROUBLESHOOTING

This chapter contains troubleshooting information for the SE2000 packaged controller. The organization of the chapter is as follows:

- Safety procedures (Paragraph 8.1)
- Recommended instruments (Paragraph 8.2)
- General troubleshooting areas (Paragraph 8.3)
- Checking with external meter (Paragraph 8.4)
- Symptoms, probable cause (Paragraph 8.5)

DANGER

The SE2000 Controller should be installed, adjusted and serviced by qualified electrical maintenance personnel familiar with the construction and operation of the equipment and potential hazards. Failure to follow this procedure may cause serious personal injury, death and/or equipment damage.

DANGER

Dangerous high voltages are present in the SE2000 Controller when incoming AC line power is connected. Make all changes to the equipment with the main machine disconnect locked in the OFF position. Failure to follow this procedure may cause serious personal injury, death and/or equipment damage.

8.1 SAFETY PROCEDURES

Certian basic safety procedures must always be practiced with troubleshooting this equipment.

DANGER

Observe the safety procedures listed here, NEC recommendations, local practices and plant rules when working on the SE2000 equipment. Failure to follow these procedures may cause serious personal injury, death, and/or equipment damage.

Do not assume the procedures listed here form a complete safety list. They are only a basic starting point.

- Always use appropriate high-voltage safety techniques when working on the equipment.
- Visually check for possible short circuits before applying power. Accidental shorts may result in extremely high current. They may also cause serious personal injury and even death.
- Use padlocks to ensure that power remains off at the main machine disconnect switch.
- Use personal safety equipment. Wear safety clothing, eye protection, rubber soled shoes (without nails).
- Keep one hand in a pocket when servicing live equipment and avoid bracing your self on the unit.

8.2 RECOMMENDED INSTRUMENTS

The following instruments are recommended for troubleshooting:

- VOM; choose a Simpson VOM 260, Triplett 630, or an equivalent meter with a minimum sensitivity of 20,000 ohms/volt.
- DC ammeter; choose a unit capable of measuring at least 150% of motor armature current, as indicated on the motor nameplate.
- Oscilloscope; choose an isolated type scope.

DANGER

Always exercise great care when using a non-insulated type of oscilloscope. In such designs, one of the leads may be connected to the metal case. This lead should not be connected to an ungrounded part of the SE2000 Controller or drive system unless the scope is isolated from ground. Also, in this circumstance, consider the metal case as a live high-voltage conductor. Serious personal injury, death and/or equipment damage can result if this procedure is not followed.

8.3 TROUBLESHOOTING AREAS

General troubleshooting areas that can be categorized into the following groups:

- Loose connections
- Wiring errors
- Incoming AC line problems – motor problems
- Controller malfunctions

8.3.1 LOOSE CONNECTIONS

Some industrial applications generate vibrations which eventually cause connections to become loose. With power removed at the main machine disconnect switch, check and tighten all electrical connections, such as mounting screws or terminal board screws. Also, be sure that all relays and fuses are properly seated in their respective sockets and brackets.

8.3.2 WIRING ERRORS

The most common problem in a DC drive's operation is incorrect wiring within a system. Before doing tests or replacements, spend some time examining the wiring. (Keep in mind that a loose or grounded wire can occur in a drive that had previously been operating correctly.)

8.3.3 INCOMING AC LINE

The following are typical problems located in the incoming AC line:

- AC line voltage is not within +10% to -10% range of the nameplate rating of the drive.
- AC line voltage is incorrectly matched for the specific drive.

8.3.4 MOTOR CHECKS

DANGER
Do not use a Megger to check for grounds unless the motor wiring to the Controller is completely disconnected. Damage to the circuitry will result if this procedure is not followed.

- Field. Check the field windings for open or short circuits.
- Armature. Check continuity through the armature and brushes. Use the A1/A2 conductors at the Controller terminals.
- Brushes. When replacing worn brushes, use parts identical to the original equipment. Excessively worn brushes cause a loss of spring tension and subsequent malfunction.
- Commutator. Inspect the condition of the commutator. A shiny and light brown surface generally indicates good condition. If oil, grease or other foreign matter is noted, clean thoroughly. Brush carbon is to be removed with a commutator stone. **Do not** use any other type of abrasive.
- Bearings and gear box. Inspect these two areas for proper lubricant levels. (Refer to the manufacturer's recommendations for type and frequency.)
- Techometer. Inspect this unit's mounting bolts for firmness. Inspect the coupling for cracks or excessive wear due to improper alignment and/or excessive motor shaft end play.

8.4 CHECKING WITH AN EXTERNAL METER

The SE2000 circuits may be checked with a VOM. Use a meter of the specified type as described in 8-2.

Check the AC power line voltage with an accurate voltmeter to make sure it is not more than 10% below the nominal AC line voltage or more than 10% above nominal AC line voltage.

Nominal Line Voltage	5% Low Line	10% High Line
115 VAC	103 VAC	126 VAC
230 VAC	207 VAC	253 VAC

If the controller is still thought to be defective after the above checks, the controller may be tested by following the procedures outlined below.

DANGER
During the following tests, frequent application and removal of the AC input voltage is required. It is essential that the troubleshooter has sufficient knowledge to do so at appropriate times.

8.4.1 VOLTAGE CHECK

Using a VOM, check the voltages listed in Table 5. Take great care when connecting a meter to the points described to avoid short circuiting adjacent terminals.

Table 5

Location	Function	Voltage	
		115 VAC	230 VAC
Power			
L1-L2	AC Line Input	103-126 VAC	207-253 VAC
A1-A2	Armature Output	0 to 90 VDC	0 to 180 VDC
F1-F2	Field Output	85 to 110 VDC	190 to 220 VDC
Control			
TB2 18-11	+10 VDC Supply	+8.2 to +10 VDC	
TB2 17-13	Reference Input	0 to +10 VDC	
TB2 6-11	-24 VDC Supply	-21 to -26 VDC	
TB2 1-11	START Signal	-21 to -28 VDC, START	
or			
TB2 2-11		0 VDC, STOP	

8.5 TROUBLESHOOTING GUIDE

Symptom	Possible Cause	Solution
Motor will not run. (No armature voltage)	Control not started.	Check for -24 VDC at TB 2-6 and TB2-11.
	No reference signal.	Check for Reference Voltage TB 2-17. Check for correct line voltage set up (J2, J3). Reset circuit breaker.
	Circuit breaker tripped.	Check for motor defect, wiring problem, defective SCR module or control circuit.
Motor will not run. (Armature voltage present)	Motor overloaded. Torque setting too low.	Check for overload. Check for proper current range selection and adjustment level.
Motor "runs away" (No speed control)	Tach Feedback mode.	Use armature voltage if no tach (J9). If tach used, check range (J9).
	Control in TORQUE mode, not SPEED mode.	Check set up (SW1)
Motor will not reach desired operating speed.	Motor overloaded. Torque too low. Incorrect armature voltage. MAX SPEED setting incorrect. Incorrect Tach Range. Improper Follower Signal.	Check armature current. Check Current Range (J6). Check Voltage Range (J1). Check adjustment. Check Set Up (J9). Check and adjust signal.
Motor speed unstable.	Load unstable. IR COMP set too high. (in Armature Voltage Feedback mode).	Check load. Re-adjust IR COMP R

9.0 REPLACEMENT PARTS

It is intended that the SE2000 should be serviced by replacing major subassemblies. The Replacement Parts List lists all of the subassemblies required to service SE2000 drives. It is recommended that users keep these parts readily available to support the drive's critical applications.

Replacement parts are readily available from Authorized Service Centers and the Factory.

Table 6 Replacement Parts List

	Part Number	
Description	**1/4-2 HP Models**	**3-5 HP Models**
Control Board Assembly* ●▲◆■ ❍	SPC36269	SPC36269
SCR Module ●▲◆■ ❍	ATY4001-03	ATY4008-00
Circuit Breaker ▲◆■ ❍	Chassis ASW4045-00 (Single Pole) ASW4045-01 (Double Pole) Enclosed ASW4046-03 (Double Pole)	ASW4051-00 (Double Pole) (All models)
Motor Contactor Card ▲	SPB36401-00	SPB36429-00
Reversing Contactor Card ■	SPB36401-01	SPB36429-01
Motor Contactor(s) ◆	On card	ARE3001-05
Dynamic Braking Resistor ◆■	PRE2025-01	PRE2025-00
Power On Lamp Bulb ❍	ALI1025-00	ALI1025-00
Rubber Boot Kit ❍	HMI1026-03	HMI1026-03
Water Tight Nut ❍	HMI1012-00	HMI1012-00
Toggle Switch Boot ❍	HMI1103-00	HMI1103-00
Switch Auto/Man ❍	ASW1079-00	ASW1079-00
Switch Forward/Rev ❍	ASW1040-00	ASW1040-00
Switch Run/Jog ❍	ASW1040-00	ASW1040-00
Potentiometer ❍	APT2026-00	APT2026-00

Product Type Code
- ● Power Unit
- ▲ Basic On-Off
- ◆ RUN-BRAKE
- ■ REV-BRAKE
- ❍ Enclosed

*Note: When replacing the control board assembly, it is essential that all of the set-up jumpers on the new board are identical with those on the board being replaced. It may also be necessary to adjust the potentiometers on the new board for correct operation. See Section 3.0 of this manual.

Seco AC/DC Drives

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