SECTION II

INSTALLATION

Before starting the installation, read this section thoroughly. In addition, a thorough review of the Ratings And Specifications (Section VIII) is recommended. The following installation guidelines should be kept in mind when installing the controller.

INSTALLATION GUIDELINES

- **CONTROLLER MOUNTING -** Series 2230 Controllers may be wall-mounted in either a vertical or horizontal position.

  However, if a Model 2231 or 2232 Controller is wall-mounted in a horizontal position, the controller maximum horsepower rating must be derated as shown in Table 2-1.

TABLE 2-1. CONTROLLER MAXIMUM HP RATING FOR HORIZONTAL MOUNTING

MODEL	2231		2232	
SUPPLY VOLTAGE (VAC)	115	230	115	230
MAXIMUM HP RATING	3/4	1-1/2	1	2

Series 2240 Controllers rated at 5 HP and Model 2235 and 2236 Controllers may only be mounted vertically.

Never mount the controller upside down, immediately beside or above heat generating equipment, directly below water or steam pipes, or on a horizontal surface.

Model 2235 and 2236 Controllers must be mounted in an enclosure to prevent contact with the controller heat sink.

If a Model 2232 Controller with an enclosure cover is to be wall-mounted, a Fincor Spacer Kit (Option 1613) must be used between the enclosure mounting feet and the panel to provide adequate cooling. If a Model 2232 Controller is supplied with either a Type P0 or P1 Cover, the spacer kit is provided.

If a Model 2236 Controller is to be mounted on a metal surface, do not use the spacers supplied with the controller.

The controller must be mounted in a location free of vibration.

Multiple controllers may be mounted side by side, as close to each other as the mounting feet will allow. However, if a Model 2242 Controller enclosure has Cover Hinges (Option 1638), 4 inches (102 mm) clearance must be provided on the hinged side of the enclosure to accommodate the swing of the cover.

The minimum clearance at the top and bottom of the controller may be as narrow as the conduit fittings allow.

- **ATMOSPHERE -** The atmosphere surrounding the controller must be free of combustible vapors, chemical fumes, oil vapor, and electrically conductive or corrosive materials.

  The air surrounding an enclosed controller must not exceed 40 degrees C (104 degrees F), and the air surrounding an open-chassis controller must not exceed 55 degrees C (131 degrees F). Minimum air temperature is 0 degree C (32 degrees F) for enclosed and open-chassis controllers.
  Series 2240 Controllers (except 5 HP enclosed models) require a natural convection flow of air over the pins on the back of the controller to dissipate the heat generated by the controller. Allow 4 inches (102 mm) clearance on all sides from solid objects which block the flow of air to the pins. Enclosed 5 HP models require a Fincor Fan Assembly (Option 1170A). If a Series 2240 Controller is supplied with either a Type P0 or P1 Cover, a fan assembly is provided.

- **CONTROLLER CONSTRUCTION -** Enclosed Series 2230/2240 Controllers are totally enclosed, nonventilated, and comply with NEMA Type 4 and 12 standards. There is an oil resistant synthetic rubber gasket between the cover and base. Those models with integral operator controls include flexible boots to seal the switches, and a seal for the MOTOR SPEED potentiometer.

  Model 2235 and 2236 Controllers are unenclosed open-chassis units with the printed wire board mounted on an aluminum bracket.

  Series 2230/2240 Controller bases are made of die-cast aluminum with a powdered epoxy finish.

  Series 2230 enclosure covers are made of a die-cast aluminum alloy.

  Series 2240 enclosure covers are molded of Noryl®, which is not affected by most water-based solutions, detergents, acids, and bases. However, the cover may be softened by heptane, acetone, and other halogenated and aromatic hydrocarbons, so install Series 2240 Controllers in a location free of these substances.

- **BRANCH CIRCUIT PROTECTION -** The National Electrical Code requires that a two-pole fused disconnect switch or circuit breaker be installed in the AC line supply to the controller. Although an optional two-pole circuit breaker (Option 1010) is available for Model 2242 Controllers, this circuit breaker should not be considered as branch circuit protection. However, the existing branch circuit **may** already provide the required protection. Refer to the National Electrical Code and local codes.

- **LINE SUPPLY -** The controller should **not** be connected to a line supply capable of supplying more than 5,000 amperes short-circuit current. Short-circuit current can be limited by using an input supply transformer of 50 KVA or less, or by using correctly sized current limiting fuses in the supply line ahead of the controller. Do not use a transformer with less than the minimum transformer KVA listed in Table 8-1, page 8-1.

  If rated line voltage is not available, a line transformer will be required. If the line supply comes directly from a transformer, place a circuit breaker or disconnect between the transformer secondary and the controller. If power is switched in the transformer primary, transients may be generated which can damage the controller. See Table 8-1 (page 8-1) for minimum transformer KVA.

  Do not use power factor correction capacitors on the supply line to the controller.

  A 12-joule metal oxide varistor (MOV) is connected across the controller line terminals. If higher energy transients are present on the line supply, additional transient suppression will be required to limit transients to 150% of peak line voltage.

When a 115 VAC line supply is used, connect the white (common) wire to Terminal L2 and connect the remaining (hot) wire to Terminal L1.

- **ISOLATION TRANSFORMER -** While not required, an isolation transformer can provide the following advantages:

  a. Reduce the risk of personal injury if high voltage drive circuits are accidently touched.

  b. Provide a barrier to externally generated AC supply transients. This can prevent controller damage from abnormal line occurrences.

  c. Reduce the potential for damaging current if the motor armature, motor field, or motor wiring become grounded.

- **GROUNDING -** Connect the green or bare (ground) wire of the line supply to the ground screw located near the top conduit entry hole in the controller base. Then ground the controller base by connecting the ground screw to earth ground.

  The motor frame and operator control stations must also be grounded.

  Personal injury or loss of life may occur if the controller, motor, and operator stations are not properly grounded.

- **WIRING PRACTICES -** The power wiring must be sized to comply with the National Electrical Code, CSA, and local codes. Refer to the controller data label for line and motor current ratings.

  All external wiring must be rated 75°C minimum.

  Do not use solid wire.

  Signal and control wiring refers to wiring for potentiometers, tachometer generators, transducers, and operator controls. Power wiring refers to wiring for the AC supply and motor armature and field. Do not run signal and control wiring in the same conduit with the power wiring. Signal and control wiring should be kept separated from power wiring in an enclosure. Low power control wiring (115 VAC) must be kept separated from all other power, control, and signal wiring.

  Multiconductor twisted cable (Alpha 5630B1801 or equal) is recommended for signal and control wiring. Shielded wire is **not** recommended since it may induce electrical noise into the controller, causing erratic controller operation.

  Signal and control wiring is not electrically isolated from the AC power source, thus, this wiring is electrically hot. A ground fault or non-isolated input will cause high currents which will damage the controller, and can cause high voltage electric shock resulting in personal injury or loss of life.

  Since the controller DC circuits are **not** isolated from the AC power source, all external signal and control wiring should be fused for operator and equipment safety. Refer to Table 2-2 (page 2-4) for recommended fuses. Controllers with integral operator controls do not require operator control fusing. However, all operator controls must be rated for at least rated line voltage.

TABLE 2-2. RECOMMENDED CONTROL AND SIGNAL WIRING FUSES

AC POWER SOURCE (VAC)	FUSE RATING	PART NUMBER	
		BUSSMAN	FINCOR
115	1/2A, 250V	ABC-1/2	3002386
230	1/2A, 600V	ATM-1/2	3002413

Two 3/4-14 NPT threaded holes are provided for conduit entry, one each in the top and bottom of the controller base, except for Model 2235 and 2236 Controllers

- **OPTIONS -** This equipment manual is for use with the basic controller. If options are installed in the controller, they will be identified on the controller data label. The instruction sheets supplied with the options should be reviewed before the controller is installed.

INSTALLING THE CONTROLLER

1. Remove the controller front cover (if used) by removing the four cover screws.

2. Check components in the controller for shipping damage. Report shipping damage to the carrier.

3. Check the controller and motor data labels to be sure the units are electrically compatible.

4. Calibrate the controller for the motor being used by removing (clipping with a wire cutter) shunt wires from the controller control board to comply with Table 2-3. For the location of shunt wires, see Figure 9-4 (page 9-5) or Figure 9-5 (page 9-6), as applicable.

TABLE 2-3. HORSEPOWER CALIBRATION

MOTOR CURRENT RATING (AMPS)[a]	REMOVE SHUNT WIRES			NUMBER OF SHUNT WIRES REMAINING
	MODELS 2231 & 2235	MODELS 2232 & 2236	MODEL 2242[b]	
24.0	NA	NA	NONE	16
22.5	NA	NA	R30	15
21.0	NA	NA	R29-R30	14
19.5	NA	NA	R28-R30	13
18.0	NA	NA	R27-R30	12
16.5	NA	NA	R26-R30	11
15.0	NA	NONE	R25-R30	10
13.5	NA	R1	R1, R25-R30	9
12.0	NA	R1-R2	R1-R2, R25-R30	8
10.5	NONE	R1-R3	R1-R3, R25-R30	7
9	R1	R1-R4	R1-R4, R25-R30	6

TABLE 2-3. HORSEPOWER CALIBRATION

MOTOR CURRENT RATING (AMPS)[a]	REMOVE SHUNT WIRES			NUMBER OF SHUNT WIRES REMAINING
	MODELS 2231 & 2235	MODELS 2232 & 2236	MODEL 2242[b]	
7.5	R1-R2	R1-R5	R1-R5, R25-R30	5
6.0	R1-R3	R1-R6	R1-R6, R25-R30	4
4.5	R1-R4	R1-R7	R1-R7, R25-R30	3
3.0	R1-R5	R1-R8	R1-R8, R25-R30	2
1.5	R1-R6	R1-R9	R1-R9, R25-R29	1

a. Select the motor current rating in the table that is closest to the motor nameplate armature current rating.
b. Shunt Wires R25 - R30 are available only in Model 2242 Controllers.

5. Check the positions of Jumpers J1[1], J2, and J3 on the control board. For the locations of J1[1], J2, and J3, see Figure 9-4 (page 9-5) or Figure 9-5 (page 9-6), as applicable. For a 230 VAC line supply and a 180V armature motor, Jumper J1[1] must be in the 230V position, and Jumpers J2 and J3 must both be in the 180V position. For a 115 VAC line supply, J1[1] must be in the 115V position, and J2 and J3 must be in the 90V position.

6. If the controller is to operate from a 50 Hz supply, set Segment 6 of the DIP Switch (S3) to OFF position on the controller control board. For the location of DIP Switch S3, see Figure 9-4 (page 9-5) or Figure 9-5 (page 9-6), as applicable.

MODEL 2231 AND 2232 CONTROLLERS

1. The controller may be surface mounted or panel mounted as shown in Figure 2-1, page 2-6. Mount the controller. Mounting dimensions are shown in Figure 2-2, page 2-7.

   An enclosed Model 2232 Controller should **not** be mounted directly on a panel. A natural convection flow of air is required over the back of the enclosure base. As a result, a Fincor Spacer Kit (Option 1613) is provided which allows the required air flow behind the enclosure. Place one spacer between each enclosure mounting foot and the panel.

2. Conduit entry is made by punching out the knockout at the top or bottom of the controller base. To prevent component damage from knockout fragments, apply masking tape to the inside of the knockout before punching.

1. If the controller is supplied with a factory installed armature contactor board or isolated input board, Jumper J1 will be located on the option board instead of the control board. Do not confuse Jumper J1 with Connector J1. A ribbon cable from the option board connects to Connector J1 on the control board. If the user is to install the option board, be careful not to offset the five-position plug at Connector J1. Refer to the instructions supplied with the specific option board for further instructions.

   All controllers are shipped from the factory with Jumper J1 in the 230V position.

3. Connect the power wiring to Terminals L1, L2, A1 (+) or M1, A2 (-) or M2, F+ and F-. If half-wave shunt field voltage is desired, connect one of the motor shunt field leads to Terminal L1 (see Table 8-5 on page 8-4).

   Note: Low inductance motors require a full-wave field to prevent current instability.

4. If the controller contains any options that require external wiring, follow the wiring instructions in the instruction sheet supplied with the option.

5. If remote operator control wiring and/or signal wiring is required, connect the controller as shown in the appropriate connection diagram (Figures 2-5 through 2-18). Figures 2-5 through 2-11 show connections to user supplied operator controls and Figures 2-12 through 2-18 show signal connections.

6. The controller can be programmed for various applications by using the DIP Switch (S3) on the control board. See Application Programming, page 4-3. For the location of DIP Switch S3, see Figure 9-4 (page 9-5).

7. Install the controller cover, if used.

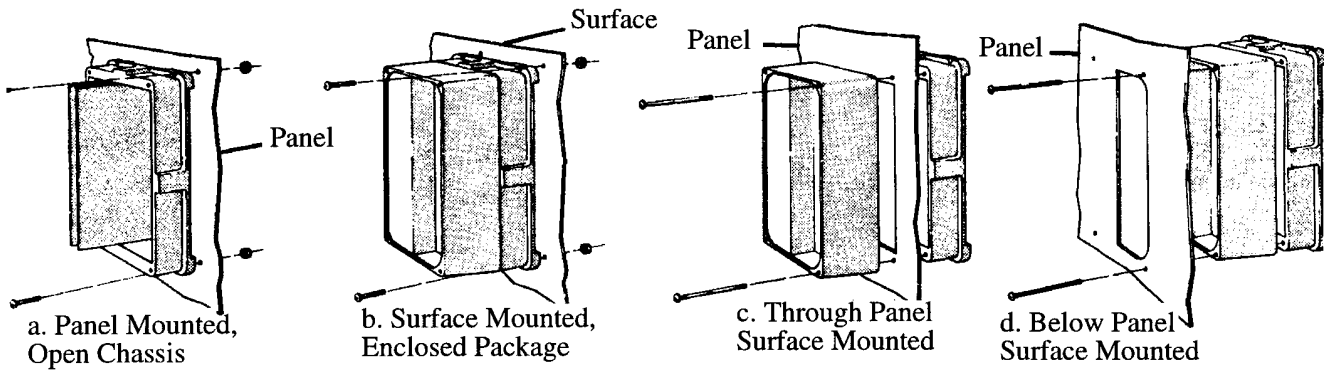

FIGURE 2-1. CONTROLLER MOUNTING CONFIGURATIONS, MODELS 2231 AND 2232

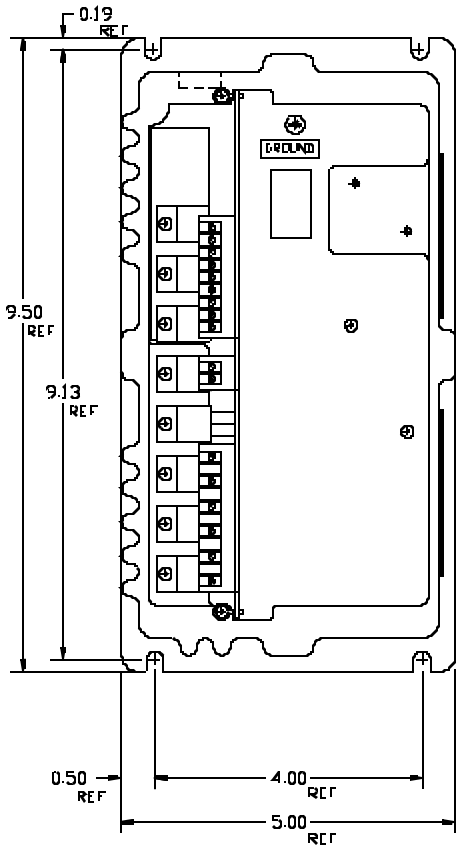

FIGURE 2-2. CONTROLLER MOUNTING DIMENSIONS, MODELS 2231 AND 2232

MODEL 2235 AND 2236 CONTROLLERS

1. Mount the controller on a panel in a vertical position using the two holes in the controller mounting bracket. Mounting dimensions are shown in Figure 2-3, page 2-8.

2. Connect the power wiring to Terminals L1, L2, A1 (+) or M1, A2 (-) or M2, F+ and F-. If half-wave shunt field voltage is desired, connect one of the motor shunt field leads to Terminal L1 (see Table 8-5 on page 8-4).

   Note: Low inductance motors require a full-wave field to prevent current instability.

3. If the controller contains any options that require external wiring, follow the wiring instructions in the instruction sheet supplied with the option.

4. Connect the controller as shown in the appropriate connection diagram (Figures 2-5 through 2-18). Figures 2-5 through 2-11 show connections to user supplied operator controls, and Figures 2-12 through 2-18 show signal connections.

5. The controller can be programmed for various applications by using the DIP Switch (S3) on the control board. See Application Programming, page 4-3. For the location of DIP Switch S3, see Figure 9-4 (page 9-5).

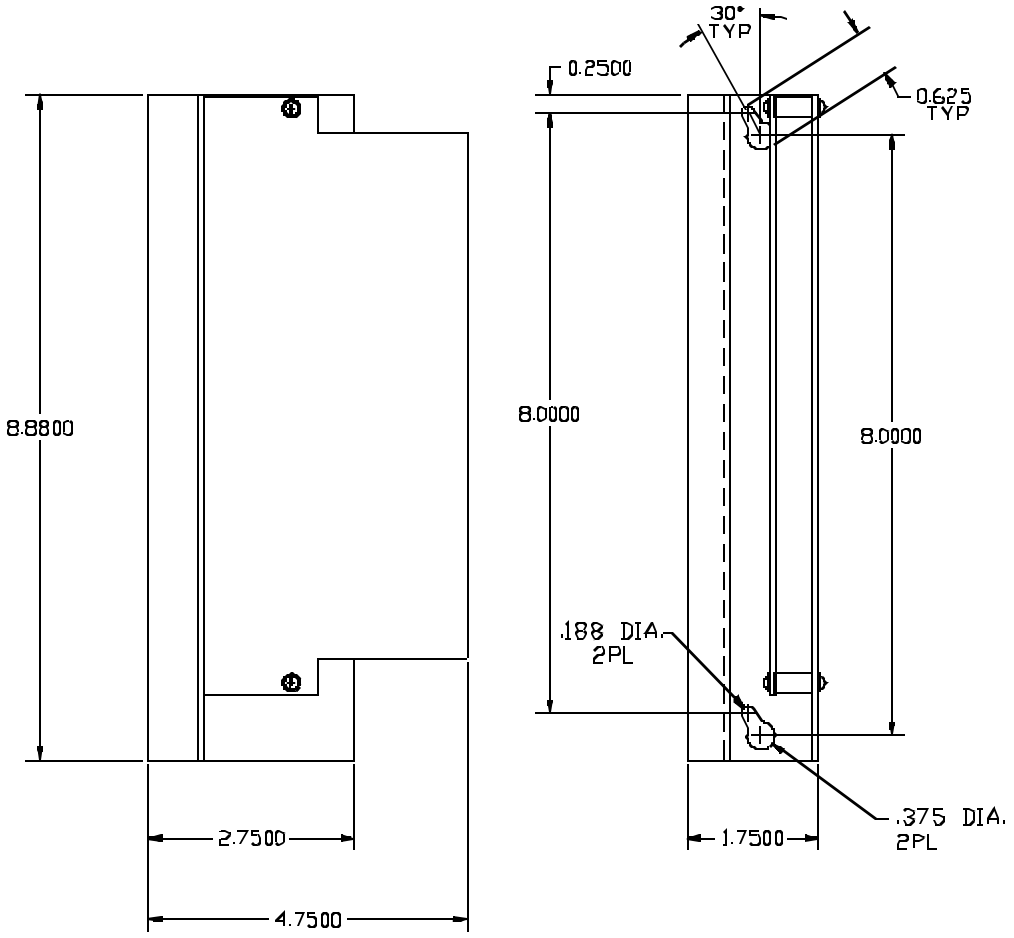

FIGURE 2-3. CONTROLLER MOUNTING DIMENSIONS, MODELS 2235 AND 2236

MODEL 2242 CONTROLLER

1. Mount the controller. Mounting dimensions are shown in Figure 2-4, page 2-9.

2. Install conduit and connect the power wiring to Terminals L1, L2, A1 (+) or M1, A2 (-) or M2, F+ and F-. If half-wave shunt field voltage is desired, connect one of the motor shunt field leads to Terminal L1 (see Table 8-5 on page 8-4).

   Note: Low inductance motors require a full-wave field to prevent current instability.

3. If the controller contains any options that require external wiring, follow the wiring instructions in the instruction sheet supplied with the option.

4. If remote operator control wiring and/or signal wiring is required, connect the controller as shown in the appropriate connection diagram (Figures 2-5 through 2-18). Figures 2-5 through 2-11 show connections to user supplied operator controls, and Figures 2-12 through 2-18 show signal connections.

5. The controller can be programmed for various applications by using the DIP Switch (S3) on the control board. See Application Programming, page 4-3. For the location of DIP Switch S3, see Figure 9-5 (page 9-6).

6. Install the controller cover, if used.

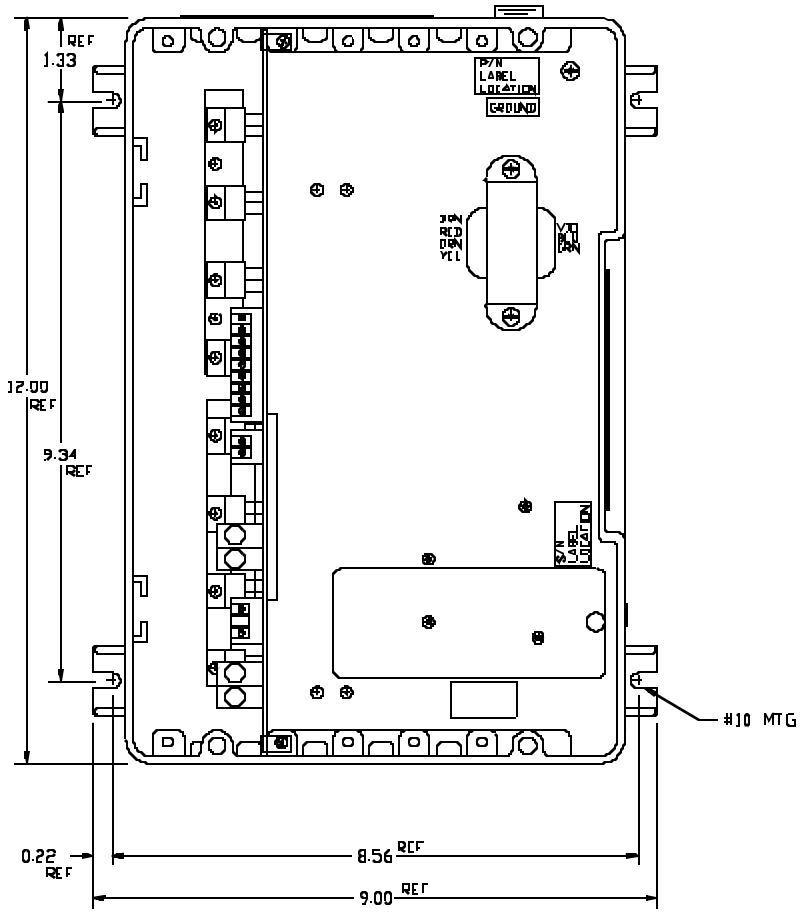

FIGURE 2-4. CONTROLLER MOUNTING DIMENSIONS, MODEL 2242

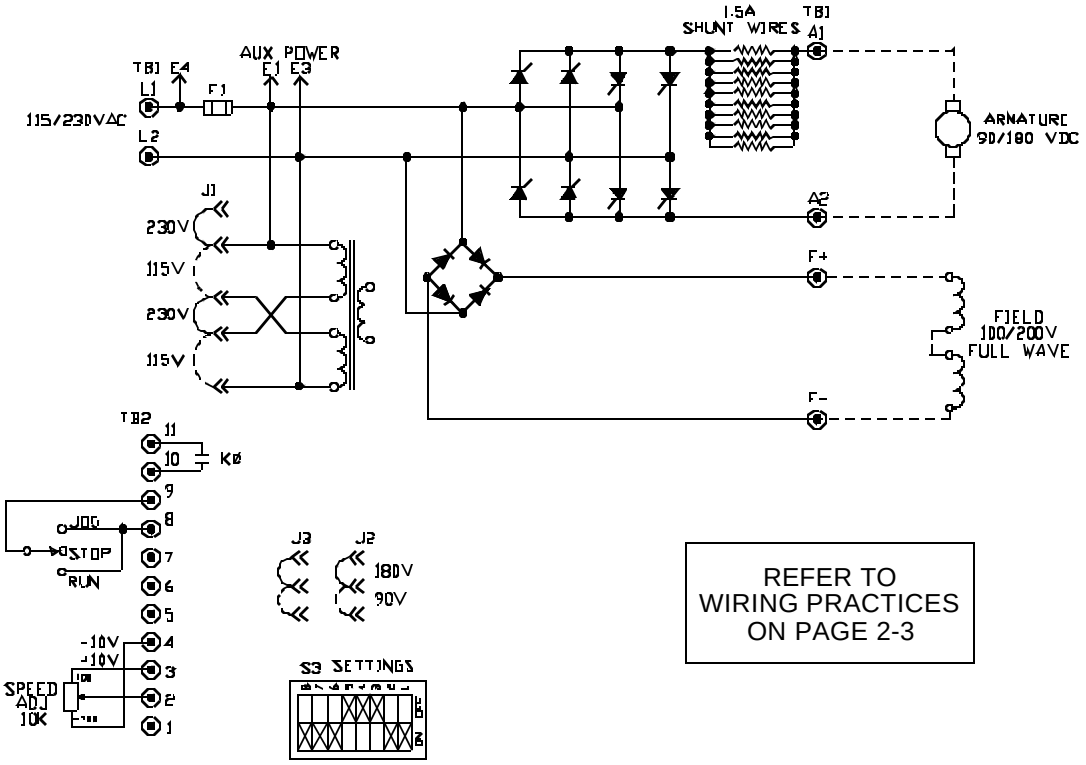

FIGURE 2-5. LOGIC CONNECTION DIAGRAM USING RUN/STOP/JOG SWITCH

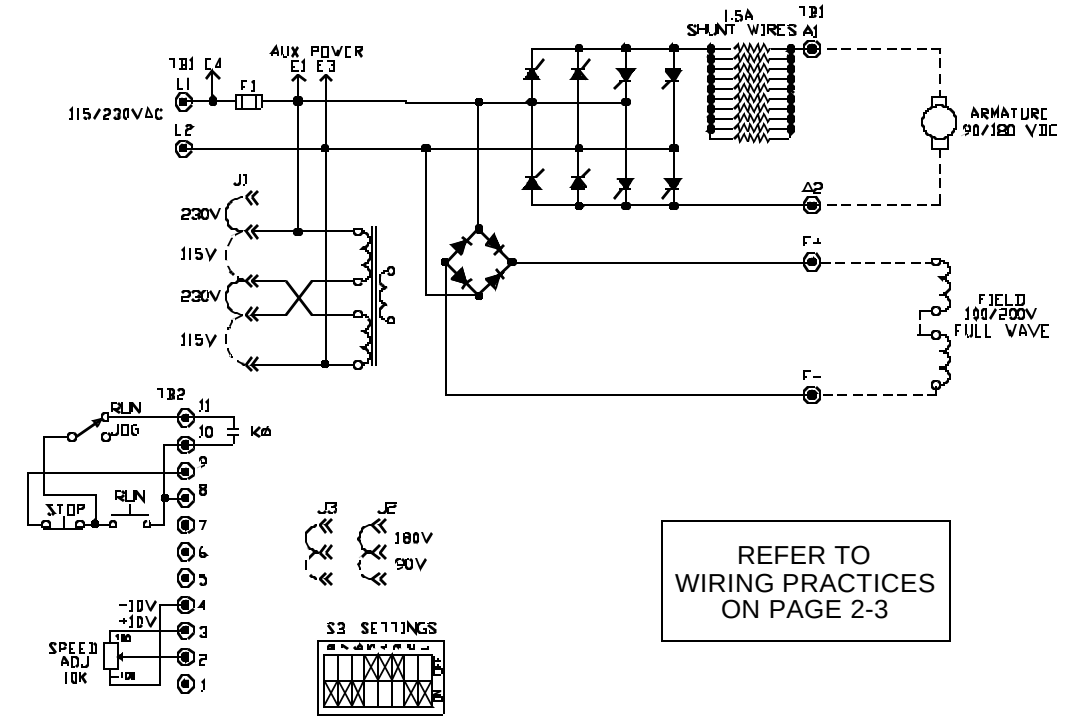

FIGURE 2-6. LOGIC CONNECTION DIAGRAM USING RUN-STOP PUSHBUTTONS AND RUN/JOG SWITCH

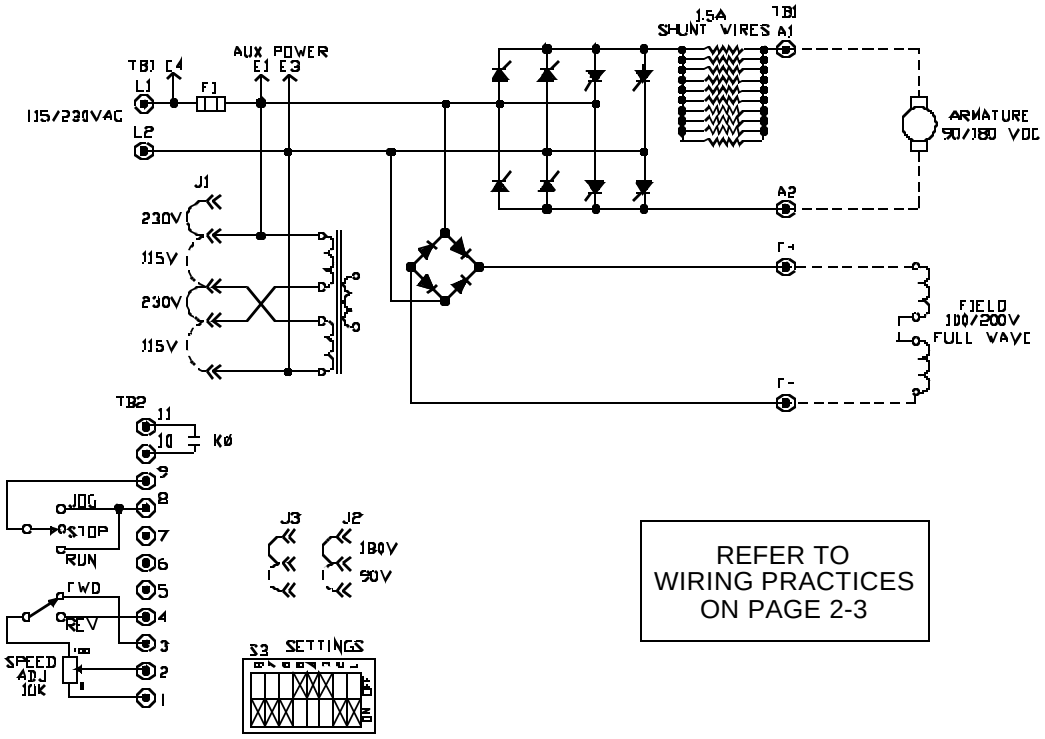

FIGURE 2-7. LOGIC CONNECTION DIAGRAM USING RUN/STOP/JOG AND FWD/REV SWITCHES

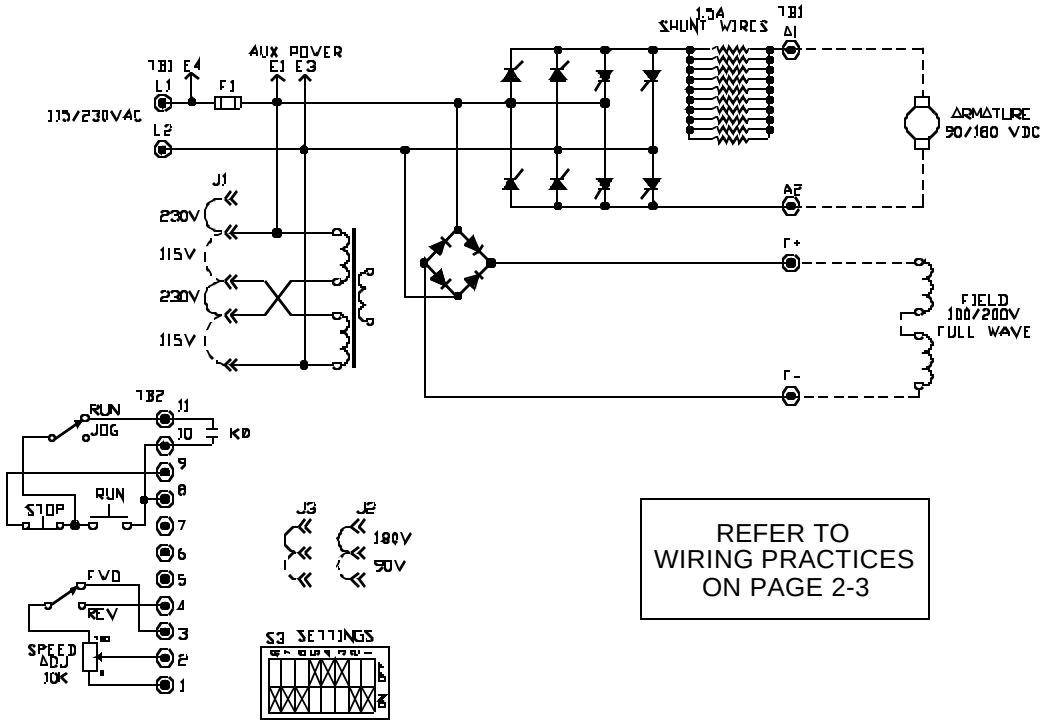

FIGURE 2-8. LOGIC CONNECTION DIAGRAM USING RUN-STOP PUSHBUTTONS AND RUN/JOG AND FWD/REV SWITCHES

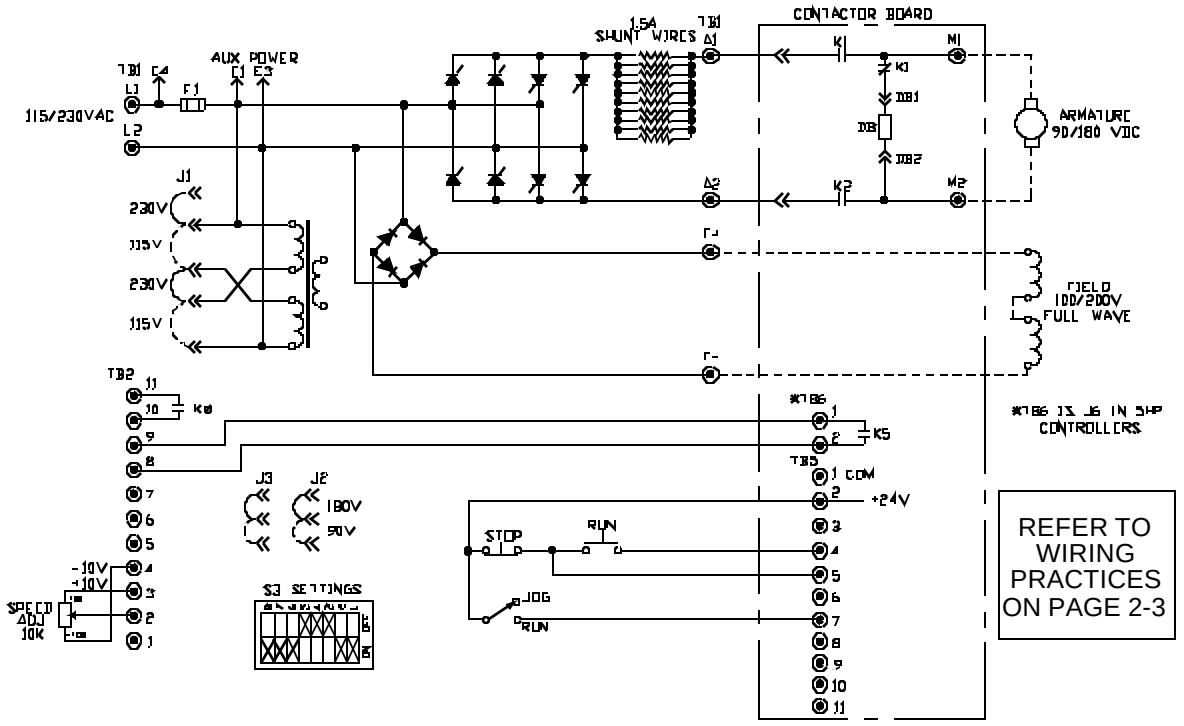

FIGURE 2-9. LOGIC CONNECTION DIAGRAM WITH ARMATURE CONTACTOR BOARD USING RUN-STOP PUSHBUTTONS AND RUN/JOG SWITCH

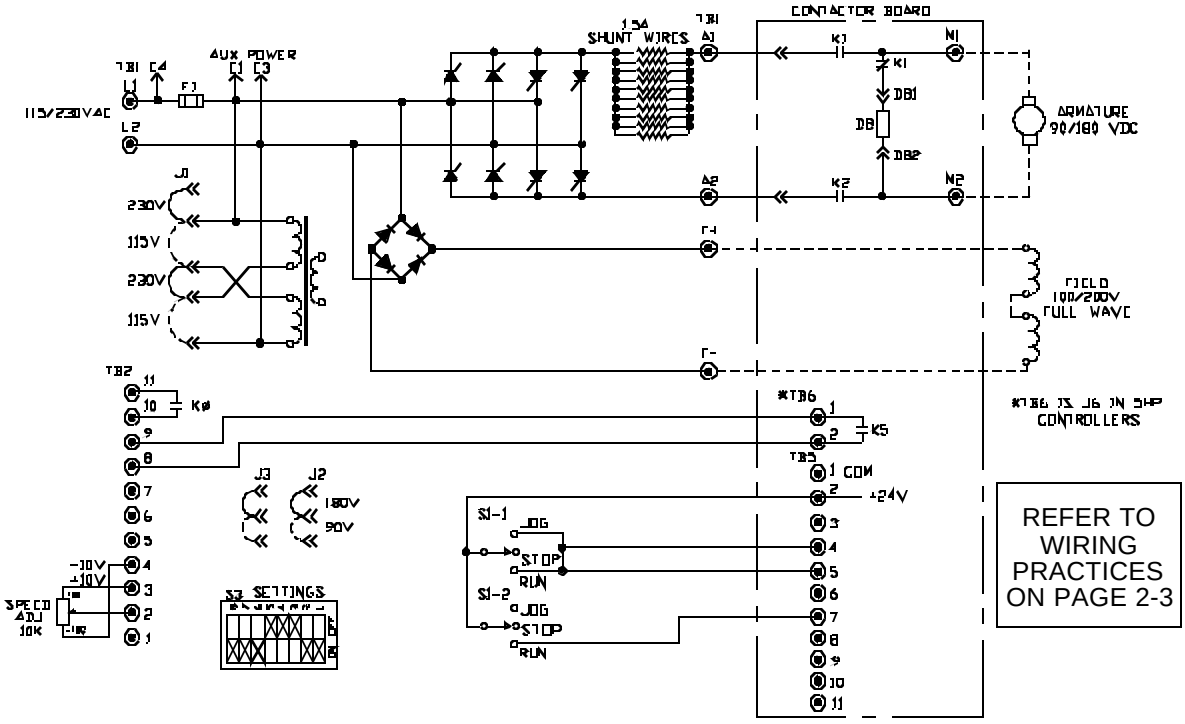

FIGURE 2-10. LOGIC CONNECTION DIAGRAM WITH ARMATURE CONTACTOR BOARD USING RUN/ STOP/JOG SWITCHES

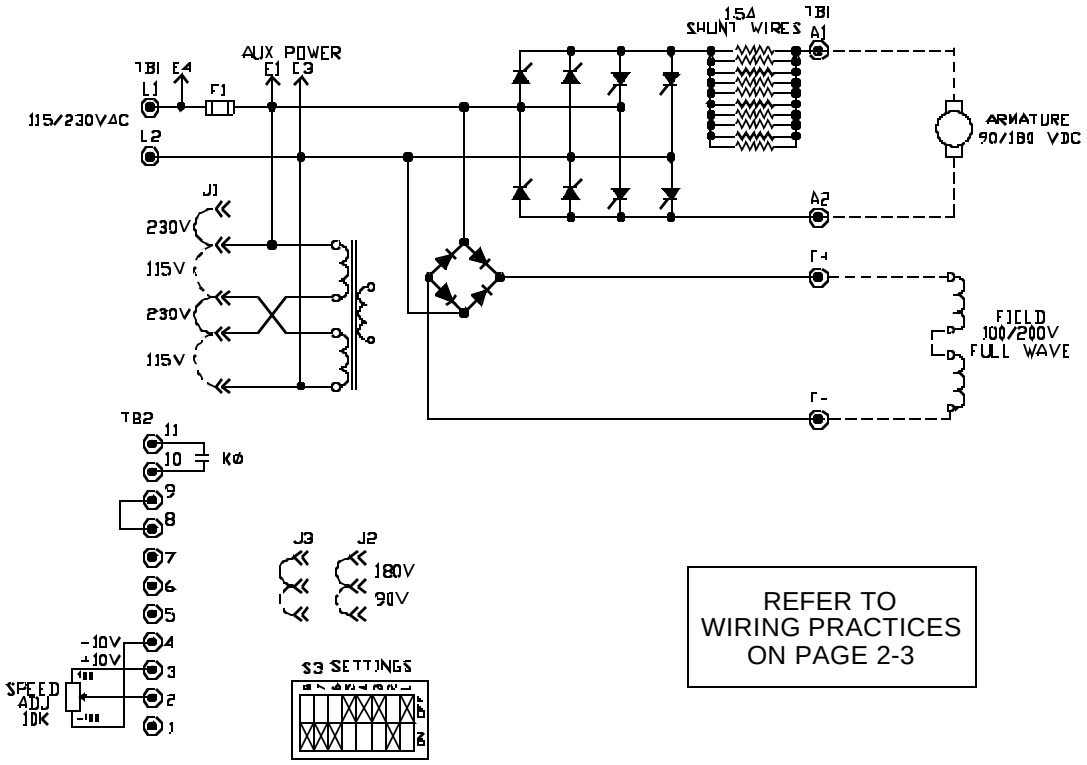

FIGURE 2-11. LOGIC CONNECTION DIAGRAM, LINE STARTING WITH MOTOR SPEED POTENTIOMETER

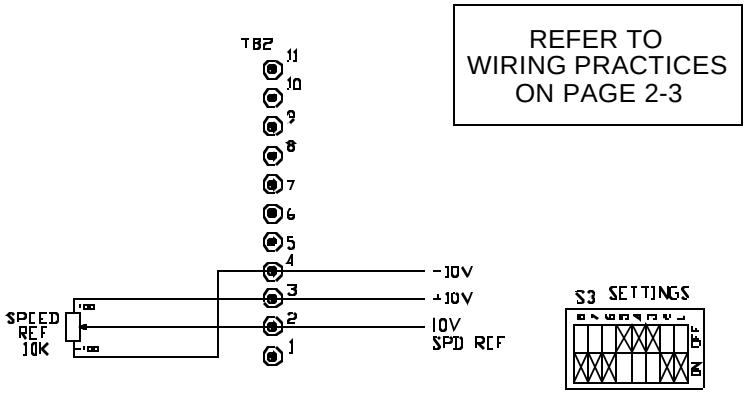

FIGURE 2-12. SIGNAL CONNECTION DIAGRAM USING A MOTOR SPEED POTENTIOMETER FOR BIDIRECTIONAL CONTROL

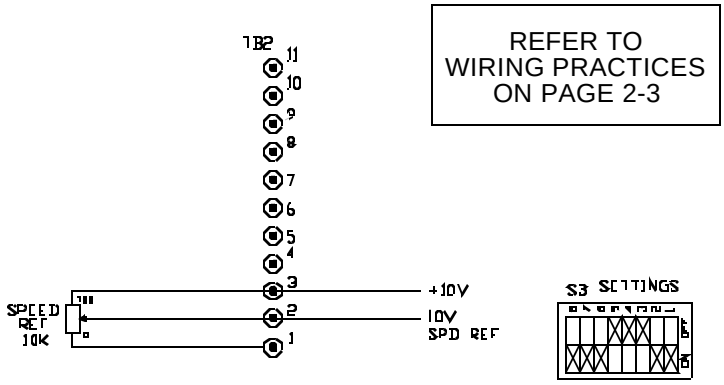

FIGURE 2-13. SIGNAL CONNECTION DIAGRAM USING A MOTOR SPEED POTENTIOMETER FOR UNIDIRECTIONAL CONTROL

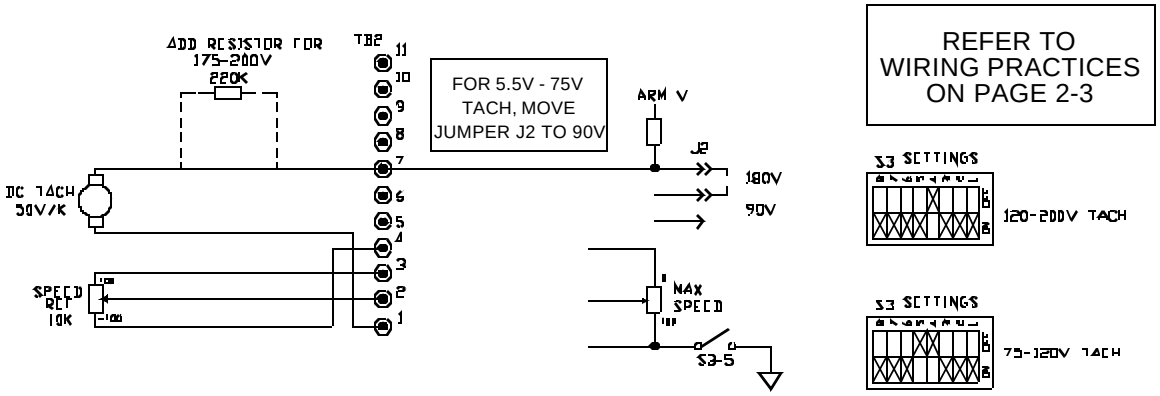

FIGURE 2-14. SIGNAL CONNECTION DIAGRAM, TACHOMETER FEEDBACK USING A DC TACHOMETER GENERATOR

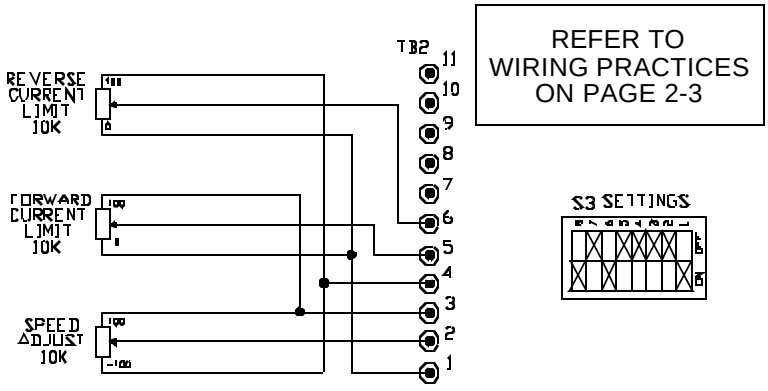

FIGURE 2-15. SIGNAL CONNECTION DIAGRAM USING EXTERNAL CURRENT LIMIT AND MOTOR SPEED POTENTIOMETERS

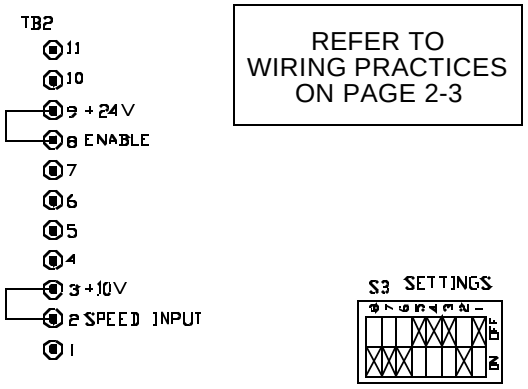

FIGURE 2-16. SIGNAL CONNECTION DIAGRAM, LINE STARTING WITHOUT A MOTOR SPEED POTENTIOMETER

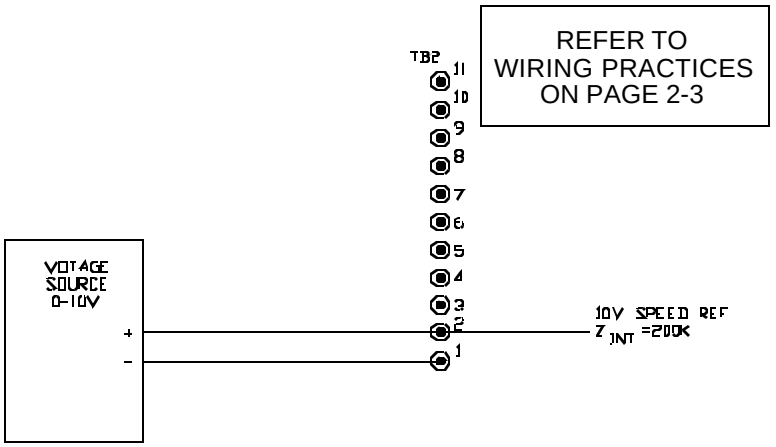

FIGURE 2-17. SIGNAL CONNECTION DIAGRAM USING 0 - 10 VDC EXTERNAL SPEED REFERENCE SIGNAL

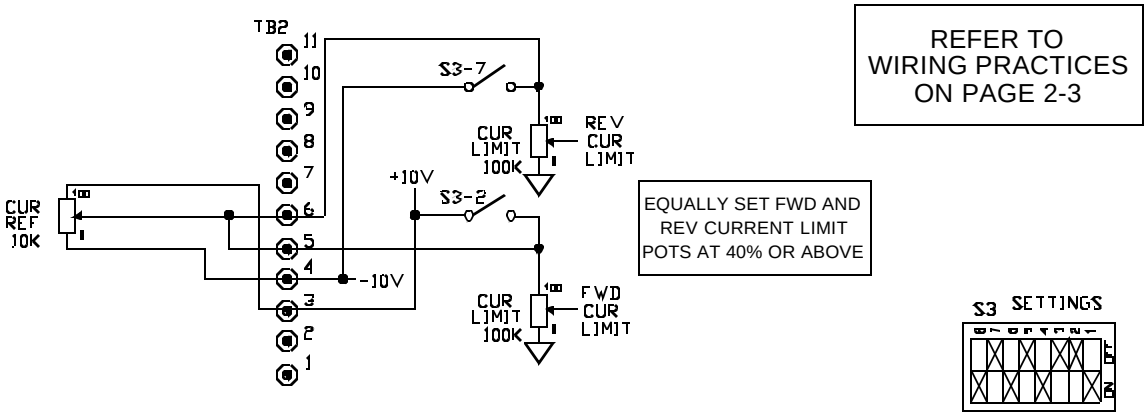

FIGURE 2-18. SIGNAL CONNECTION DIAGRAM USING AN EXTERNAL CURRENT (TORQUE) REFERENCE POTENTIOMETER

INITIAL STARTUP

1. Open the controller cover (if used) by removing the four cover screws.

2. Be familiar with all options installed in the controller by reviewing the instruction sheets supplied with the options.

3. Be sure all wiring is correct and all wiring terminations are tightened securely.

4. Be sure the controller is calibrated correctly. See steps 4, 5 and 6 on pages 2-4 and 2-5.

5. Be sure the AC supply voltage to the controller agrees with the controller data label.

6. The potentiometers in the controller are factory adjusted as shown in Table 2-4. These settings will provide satisfactory operation for most applications. If different settings are required, refer to "Adjustment Instructions" starting on page 4-1.

TABLE 2-4. INITIAL POTENTIOMETER SETTINGS

POTENTIOMETER	SETTING	DESCRIPTION
MAX SPD	3/4 Turn Clockwise	100% Speed
IR COMP	Fully Counterclockwise (0%)	0% Boost
CUR LMT FWD	Fully Clockwise (100%)	150% Load
CUR LMT REV	Fully Clockwise (100%)	150% Load
ACCEL	2/3 Turn Clockwise	10 Seconds
DECEL	2/3 Turn Clockwise	10 Seconds

7. If the controller has a cover, place it on the controller and secure it with the four cover screws.

8. Turn-on the AC supply voltage to the controller.

9. Check motor rotation, as follows:

   a. If a MOTOR SPEED potentiometer is used, turn it to zero on its dial. If an external signal is used for the speed reference, set it at minimum.

   b. If a RUN/STOP/JOG switch is used, place it in RUN position. Otherwise, initiate a Run command.

   c. Turn the MOTOR SPEED potentiometer clockwise or increase the speed reference signal, as applicable. To stop the motor, place the switch in STOP position or initiate a Stop command, as applicable.

   If the motor rotates in the wrong direction, turn-off the AC supply to the controller, and then interchange the motor armature leads at the motor connection box or at the controller terminal board.

10. Refer to Section III, "Operation" for operating instructions.