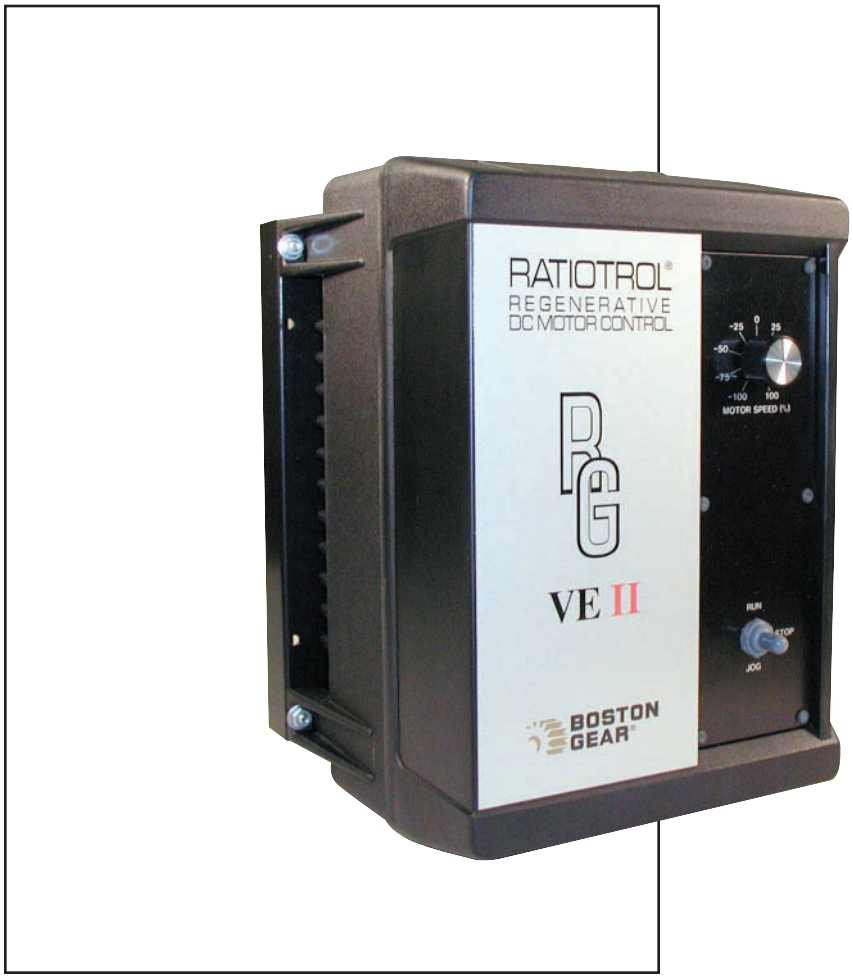
Boston Gear®

Adjustable-Speed Regenerative DC Motor Controllers

Installation and Operation Manual

Doc. No. 64098

RBA-RG
VEA-RG
Series



Boston Gear

An Altra Industrial Motion Company

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WARNING

The Following Safety Precautions Must Be Strictly Adhered To At All Times.

1. **YOU AS THE OWNER OR OPERATOR OF BOSTON GEAR EQUIPMENT HAVE THE RESPONSIBILITY TO HAVE THE USERS OF THIS EQUIPMENT TRAINED IN ITS OPERATIONS AND WARNED OF ANY POTENTIAL HAZARDS OF SERIOUS INJURY.**

2. **THE DRIVE EQUIPMENT SHOULD BE INSTALLED, OPERATED, ADJUSTED, AND SERVICED ONLY BY QUALIFIED PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THE EQUIPMENT AND THE HAZARDS INVOLVED INCLUDING THOSE DESCRIBED BELOW. FAILURE TO OBSERVE THIS PRECAUTION CAN RESULT IN PERSONAL INJURY, LOSS OF LIFE, AND PROPERTY DAMAGE.**

3. **THE NATIONAL ELECTRICAL CODE REQUIRES THAT AN AC LINE FUSED DISCONNECT OR CIRCUIT BREAKER BE PROVIDED IN THE AC INPUT POWER LINES TO THE CONTROLLER. THIS DISCONNECT MUST BE LOCATED WITHIN SIGHT OF THE CONTROLLER. DO NOT OPERATE THE CONTROLLER UNTIL THIS CODE REQUIREMENT HAS BEEN MET.**

4. **THE DRIVE EQUIPMENT IS AT AC LINE VOLTAGE POTENTIAL WHENEVER AC POWER IS CONNECTED TO THE DRIVE EQUIPMENT. CONTACT WITH AN ELECTRICAL CONDUCTOR INSIDE THE DRIVE EQUIPMENT OR AC LINE DISCONNECT CAN CAUSE ELECTRIC SHOCK RESULTING IN PERSONAL INJURY OR LOSS OF LIFE.**

5. **BE SURE ALL AC POWER IS DISCONNECTED FROM THE DRIVE EQUIPMENT BEFORE TOUCHING ANY COMPONENT, WIRING, TERMINAL, OR ELECTRICAL CONNECTION IN THE DRIVE EQUIPMENT.**

6. **ALWAYS WEAR SAFETY GLASSES WHEN WORKING ON THE DRIVE EQUIPMENT.**

7. **DO NOT REMOVE OR INSERT CIRCUIT BOARDS, WIRES, OR CABLES WHILE AC POWER IS APPLIED TO THE DRIVE EQUIPMENT. FAILURE TO OBSERVE THIS PRECAUTION CAN CAUSE DRIVE DAMAGE, PERSONAL INJURY, AND LOSS OF LIFE.**

8. **ALL DRIVE EQUIPMENT ENCLOSURES, MOTOR FRAMES, AND REMOTE OPERATOR STATIONS MUST BE CONNECTED TO AN UNBROKEN COMMON GROUND CONDUCTOR. AN UNBROKEN GROUNDING CONDUCTOR MUST BE RUN FROM THE COMMON GROUND CONDUCTOR TO A GROUNDING ELECTRODE BURIED IN THE EARTH OR ATTACHED TO A PLANT GROUND. REFER TO THE NATIONAL ELECTRICAL CODE AND LOCAL CODES FOR GROUNDING REQUIREMENTS.**

9. **THE ATMOSPHERE SURROUNDING THE DRIVE EQUIPMENT MUST BE FREE OF COMBUSTIVE VAPORS, CHEMICAL FUMES, OIL VAPOR, AND ELECTRICALLY CONDUCTIVE OR CORROSIVE MATERIALS.**

10. **SOME COMPONENTS IN THE CONTROLLER CAN BE SEVERELY DAMAGED BY STATIC ELECTRICITY. THEREFORE, BE SURE YOUR BODY IS FREE OF STATIC ELECTRICITY BY TOUCHING A GROUNDED METAL OBJECT BEFORE TOUCHING INTERNAL COMPONENTS.**

SECTION I

GENERAL INFORMATION

INTRODUCTION

This manual contains installation, operation, and maintenance and repair instructions for Boston Gear Series
RBA-RG/VEA-RG Single-Phase Adjustable-Speed Regenerative DC Motor Controllers. A parts list, list of options, ratings and specifications, and drawings are also included.

GENERAL DESCRIPTION

Series RBA-RG/VEA-RG Controllers statically convert AC line power to regulated DC for adjustable-speed armature control of shunt-wound and permanent-magnet motors.

Applications include those requiring controllable bi-directional torque for overhauling loads, contactor-less reversing, and position control.

Series RBA-RG/VEA-RG Controllers comply with applicable standards established by the National Electrical Code and NEMA for motor and industrial control equipment. The controllers are Underwriters Laboratories Listed.

MODEL TYPES

TABLE 1. SERIES RBA-RG/VEA-RG MODEL MATRIX

MODEL	FUNCTION		CONFIGURATION		OPERATOR CONTROLS		POWER SOURCE[a] & HP RANGE		CONNECTION DIAGRAM FIGURE
	RUN/STOP/ JOG[b]	RUN/STOP/JOG AND DB[c]	OPEN CHASSIS	ENCLOSED	LOCAL INTEGRAL	REMOTE	115V	230V	
RBA2-RG	X		X			X			6, 7, 8, 9, 12
RBA2U-RG		X	X			X			10,11
RBA2B-RG	X			X		X	1/6-1	1/2-2	6, 7, 8, 9, 12
RBA2S-RG	X			X	X				6
RBA2UB-RG		X		X		X			10,11
RBA2US-RG		X		X	X				11
RBA3-RG	X		X			X			6, 7, 8, 9, 12
RBA3U-RG		X	X			X	1/6-1	1/2-3	10, 11
RBA3B-RG	X			X		X			6, 7, 8, 9, 12
RBA3S-RG	X			X	X				6
RBA2C-RG	X		X[d]			X	1/6-1	1/2-2	6, 7, 8, 9, 12
RBA2CU-RG		X	X[d]			X	1/6-1	1/2-2	10, 11
VEA5-RG	X		X			X			6, 7, 8, 9, 12
VEA5U-RG		X	X			X			10, 11
VEA5B-RG	X			X		X	1/6-1	1/2-5	6, 7, 8, 9, 12
VEA5S-RG	X			X	X				6
VEA5UB-RG		X		X		X			10,11
VEA5US-RG		X		X	X				12

a. Controllers are reconnectable
b. No armature contactor
c. Includes an armature contactor
d. Angle bracket chassis

MOTOR SELECTION

Series RBA-RG/VEA-RG Controllers control the operation of general purpose DC motors designed for use with solid-state rectified power supplies. The motor may be shunt-wound, stabilized shunt-wound, or permanent magnet. For maximum efficiency, the motor should be rated for operation from a NEMA Code K power supply.

DESCRIPTION OF OPERATION

Series RBA-RG/VEA-RG Regenerative Controllers, also known as four-quadrant controllers, not only control motor speed and direction of rotation, but also the direction of motor torque.

With reference to Figure 1, when the drive (controller and motor) is operating in Quadrants I and III, motor rotation and torque are in the same direction, and the drive functions as a conventional non-regenerative drive. In Quadrants II and IV, motor torque opposes the direction of motor rotation, which results in controlled braking. The drive can switch rapidly from motoring to braking modes while simultaneously controlling the direction of motor rotation.

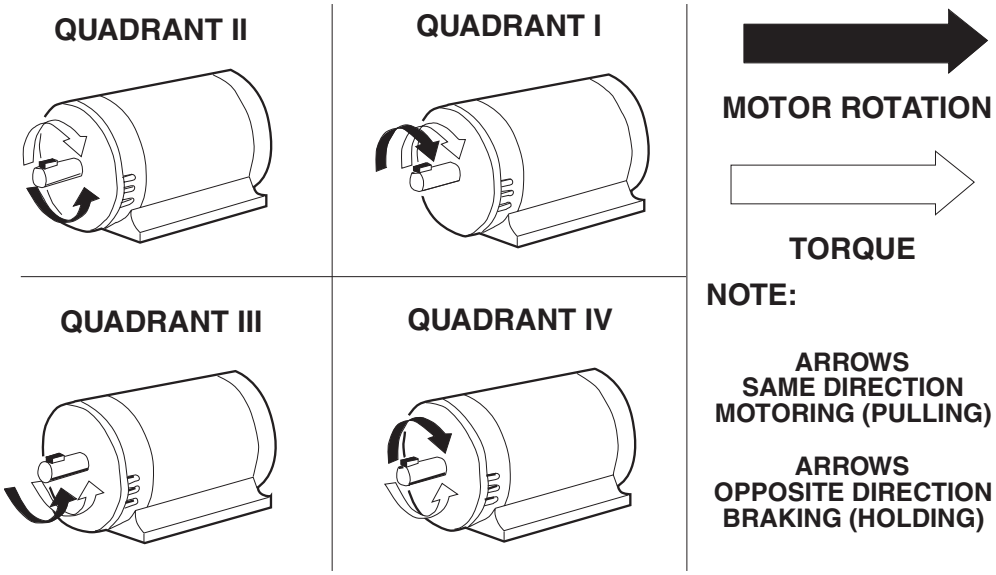

FIGURE 1. FOUR-QUADRANT OPERATION

Under braking conditions, Series RBA-RG/VEA-RG Controllers convert the mechanical energy of the motor and connected load into electrical energy, which is returned (regenerated) to the AC power source.

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 RBA-RG Controllers may be wall-mounted in either a vertical or horizontal position.

  However, if a Model RBA2-RG or RBA3-RG Controller is wall-mounted in a horizontal position, the controller maximum horsepower rating must be derated as shown in Table 2.

TABLE 2. CONTROLLER MAXIMUM HP RATING FOR HORIZONTAL MOUNTING

MODEL	RBA2-RG		RBA3-RG	
Supply Voltage (VAC)	115	230	115	230
Maximum HP Rating	3/4	1-1/2	1	2

Series VEA-RG Controllers rated at 5 HP and all Series RBA2C-RG 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.

If a Model RBA3-RG Controller with an enclosure cover is to be wall-mounted, a Boston Gear Spacer Kit (Option SK) must be used between the enclosure mounting feet and the panel to provide adequate cooling. If a Model RBA3-RG Controller is supplied with either a Type “B” or “S” Cover, the spacer kit is provided.

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 VEA5-RG Controller enclosure has Cover Hinges (Option 50), 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 VEA-RG 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 Boston Gear Fan Assembly (Option VFKT). If a Series VEA-RG Controller is supplied with either a Type “B” or “S” Cover, a fan assembly is provided.

- **CONTROLLER CONSTRUCTION -** Enclosed Series RBA-RG/VEA-RG 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 a flexible boot to seal the switch, and a seal for the MOTOR SPEED potentiometer.

  Series RBA2C-RG Controllers are unenclosed open-chassis units with the printed wire board mounted on an aluminum bracket.

  Series RBA-RG/VEA-RG Controller bases are made of die-cast aluminum with a powdered epoxy finish.

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

  Series VEA-RG 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 VEA-RG 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 30) is available for Model VEA5-RG 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 100,000 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 11, page 37.

  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 11 (page 37) 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.

  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. Signal and control wiring may **not** be run in the same conduit with the power wiring, and 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 are 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 3 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 3. RECOMMENDED CONTROL AND SIGNAL WIRING FUSES

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

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

- **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 4. For the location of shunt wires, see Figure 23 (page 47) or Figure 24 (page 48), as applicable.

TABLE 4. HORSEPOWER CALIBRATION

MOTOR CURRENT RATING (AMPS)[a]	REMOVE SHUNT WIRES			NUMBER OF SHUNT WIRES REMAINING
	MODELS RBA2-RG & RBA2C-RG	MODEL RBA3-RG	MODEL VEA5-RG	
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
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 VEA5-RG 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 23 (page 47) or Figure 24 (page 48), 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 23 (page 47) or Figure 24 (page 48), as applicable.

RBA2-RG AND RBA3-RG CONTROLLERS

1. The controller may be surface mounted or panel mounted as shown in Figure 2, page 8. Mount the controller. Mounting dimensions are shown in Figure 3, page 8.

   An enclosed Model RBA3-RG 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 Boston Gear Spacer Kit (Option SK) 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.

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 15 on page 40).

   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 6 through 19). Figures 6 through 12 show connections to user supplied operator controls and Figures 13 through 19 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 25. For the location of DIP Switch S3, see Figure 23 (page 47).

7. Install the controller cover, if used.

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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.

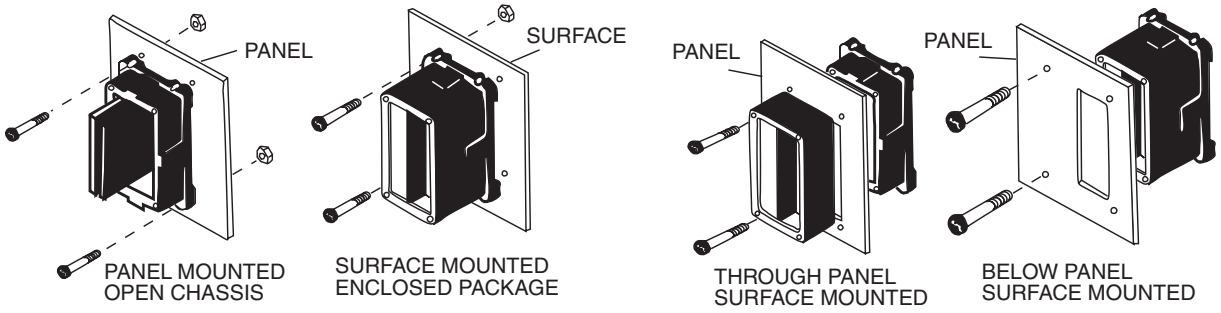

FIGURE 2. CONTROLLER MOUNTING CONFIGURATIONS, RBA2-RG AND RBA3-RG

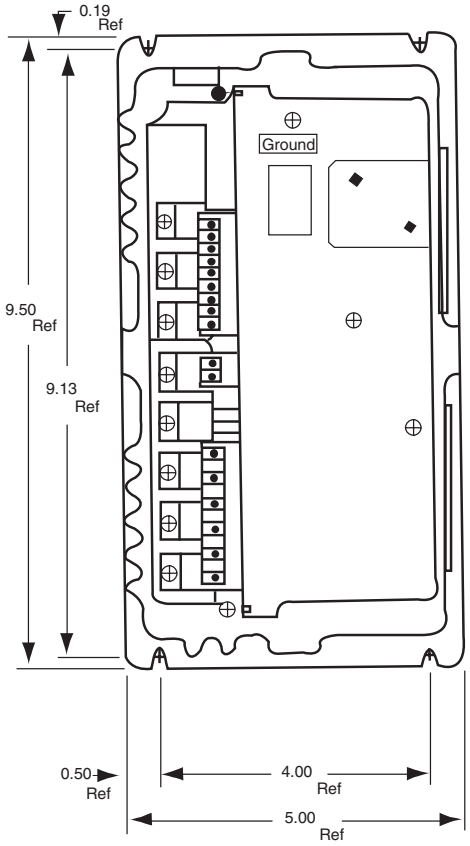

FIGURE 3. CONTROLLER MOUNTING DIMENSIONS, RBA2-RG AND RBA3-RG

RBA2C-RG CONTROLLER

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 4, below.

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 15 on page 40).

   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 6 through 19). Figures 6 through 12 show connections to user supplied operator controls, and Figures 13 through 19 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 25. For the location of DIP Switch S3, see Figure 23 (page 47).

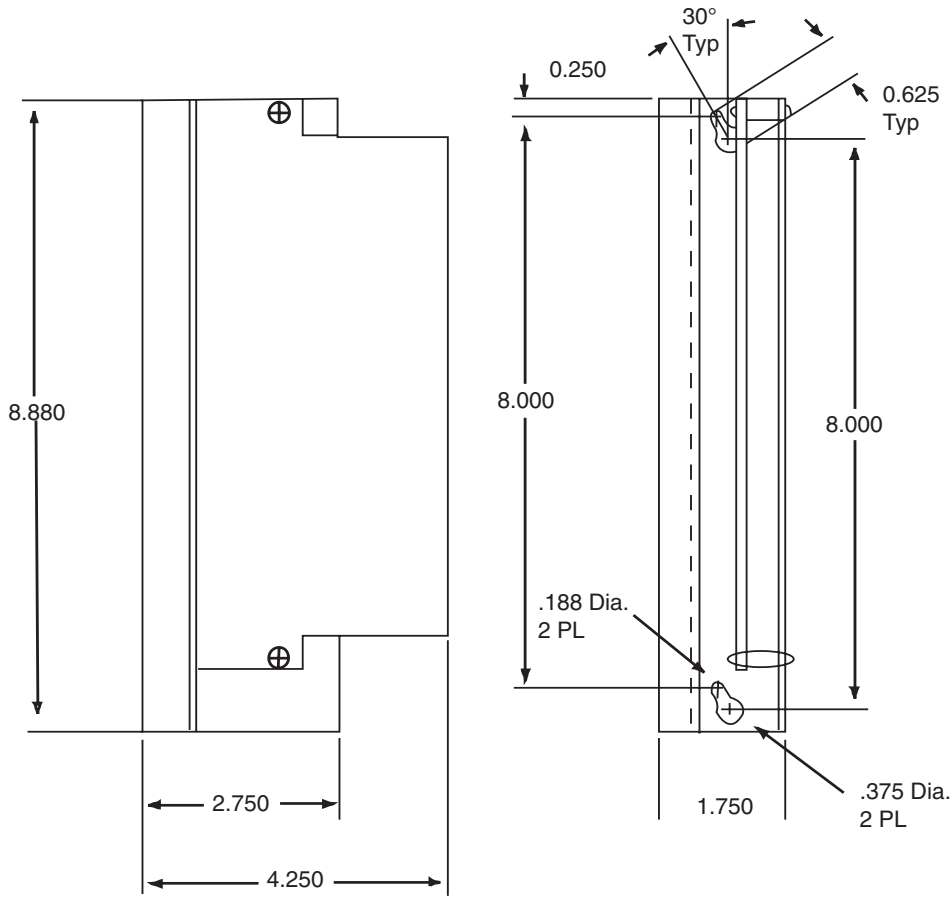

FIGURE 4. CONTROLLER MOUNTING DIMENSIONS, RBA2C-RG

VEA5-RG CONTROLLER

1. Mount the controller. Mounting dimensions are shown in Figure 5, below.

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 15 on page 40).

   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 6 through 19). Figures 6 through 12 show connections to user supplied operator controls, and Figures 13 through 19 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 25. For the location of DIP Switch S3, see Figure 24 (page 48).

6. Install the controller cover, if used.

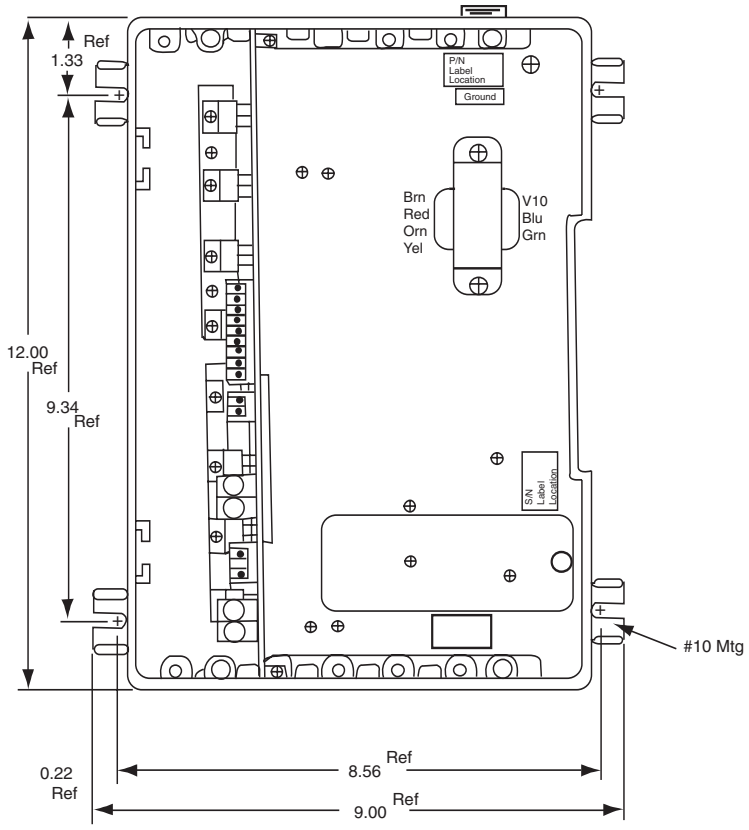

FIGURE 5. CONTROLLER MOUNTING DIMENSIONS, VEA5-RG

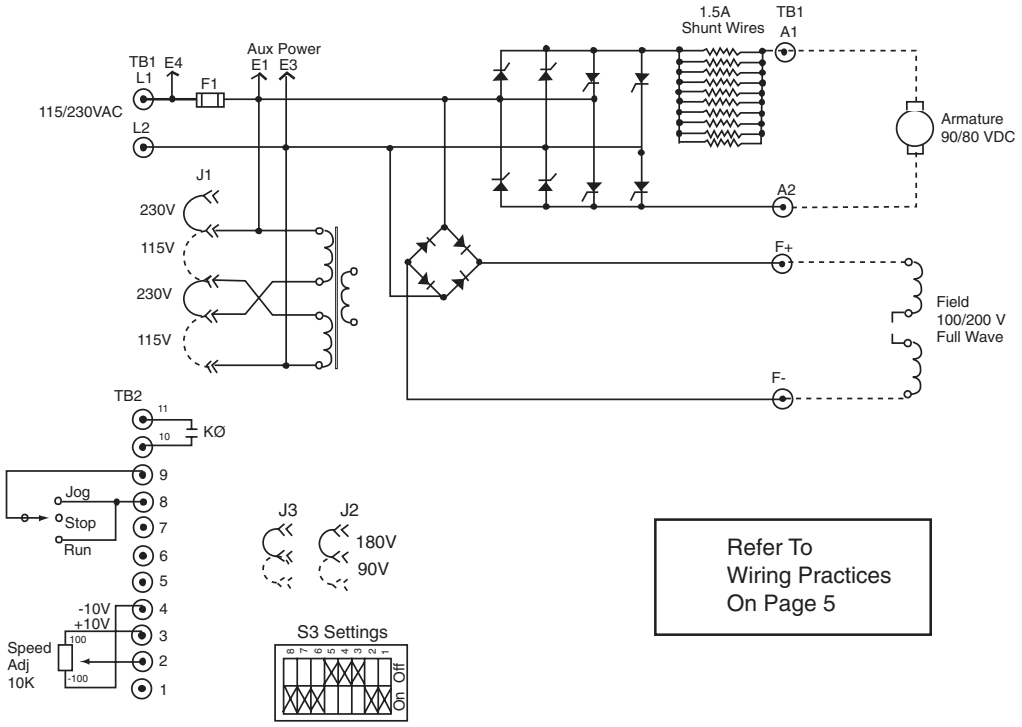

FIGURE 6. LOGIC CONNECTION DIAGRAM USING RUN/STOP/JOG SWITCH

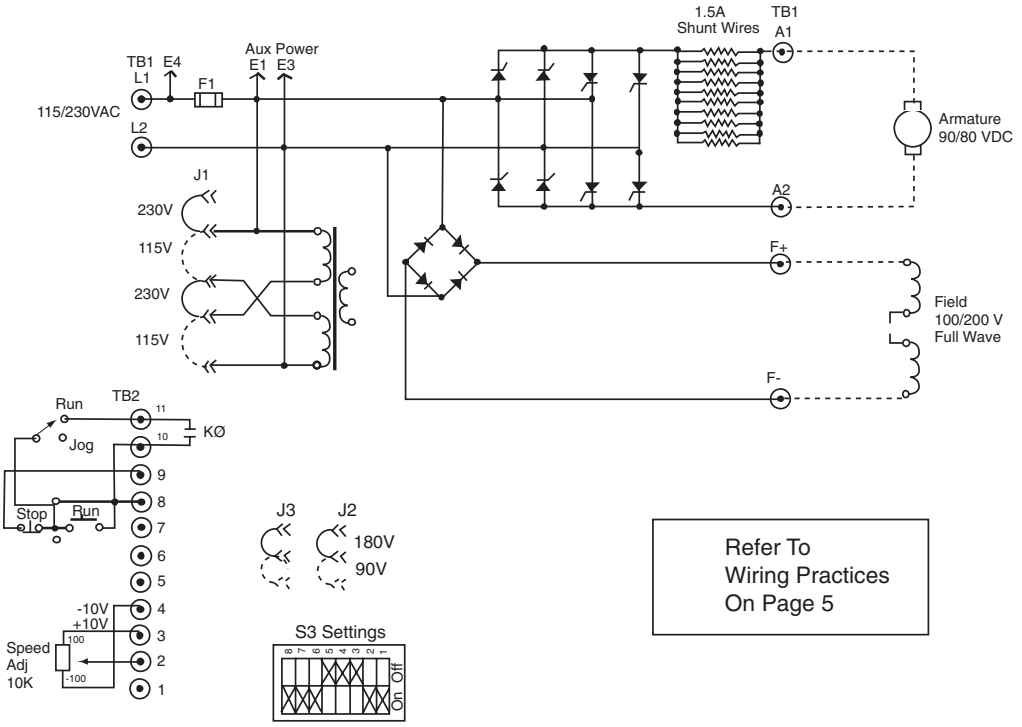

FIGURE 7. LOGIC CONNECTION DIAGRAM USING RUN-STOP PUSHBUTTONS AND RUN/JOG SWITCH

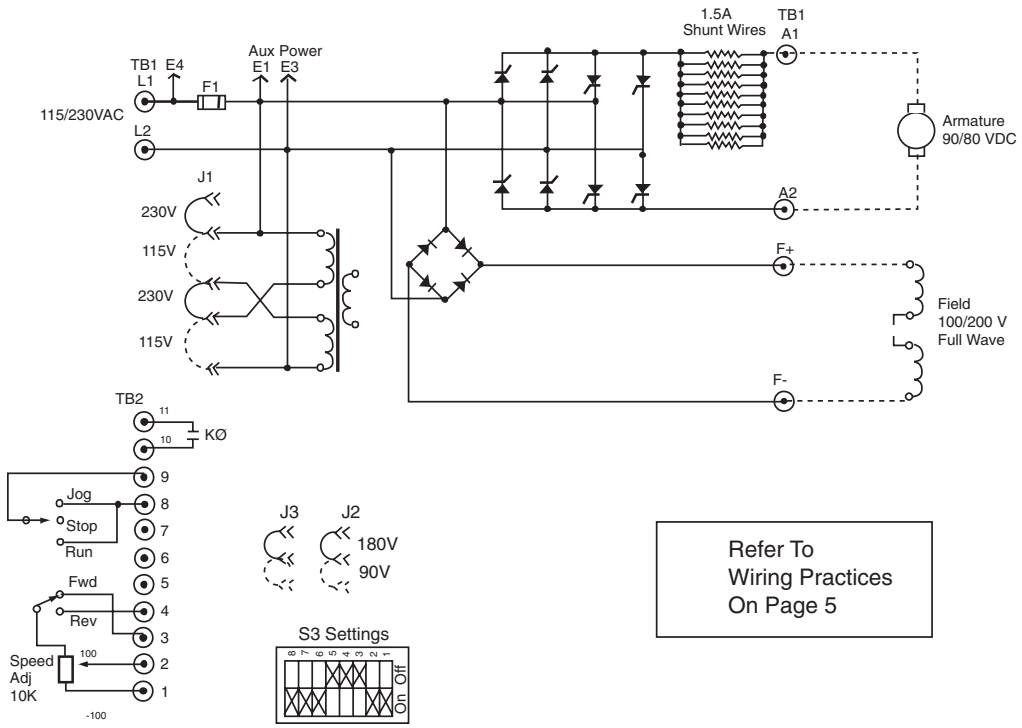

FIGURE 8. LOGIC CONNECTION DIAGRAM USING RUN/STOP/JOG AND FWD/REV SWITCHES

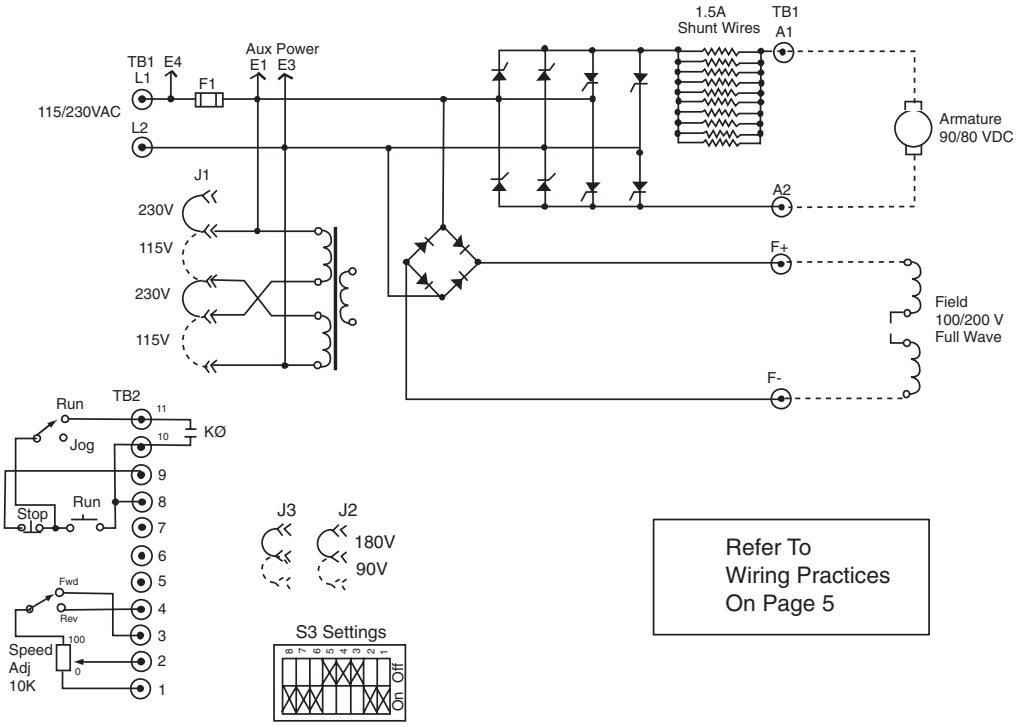

FIGURE 9. LOGIC CONNECTION DIAGRAM USING RUN-STOP PUSHBUTTONS AND

RUN/JOG AND FWD/REV SWITCHES

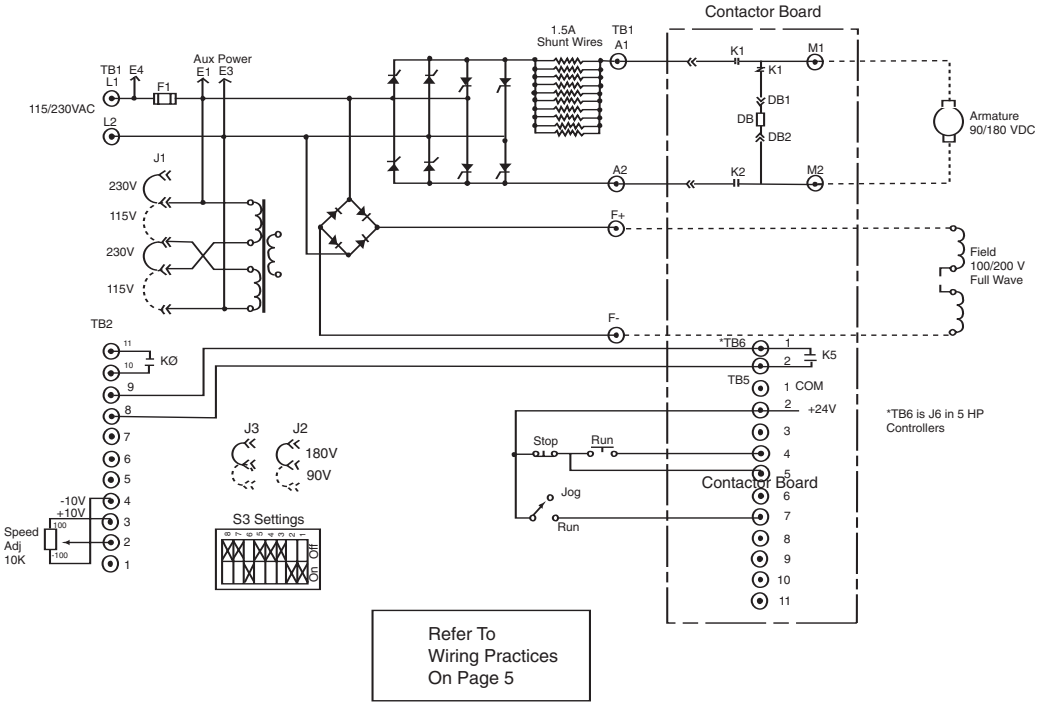

FIGURE 10. LOGIC CONNECTION DIAGRAM WITH ARMATURE CONTACTOR BOARD USING RUN-STOP PUSHBUTTONS AND RUN/JOG SWITCH

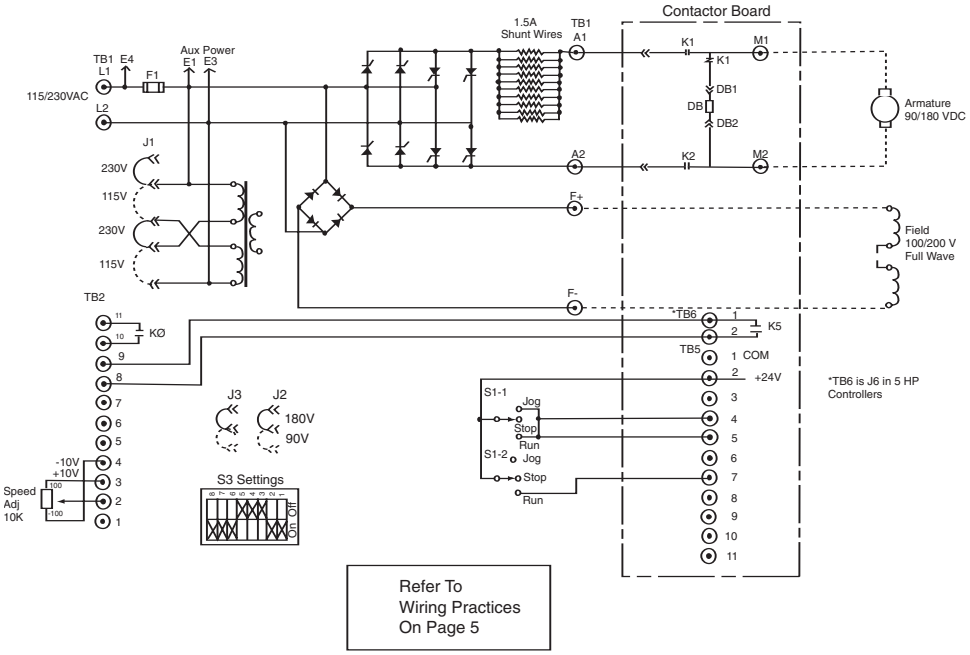

FIGURE 11. LOGIC CONNECTION DIAGRAM WITH ARMATURE CONTACTOR BOARD USING RUN/STOP/JOG SWITCHES

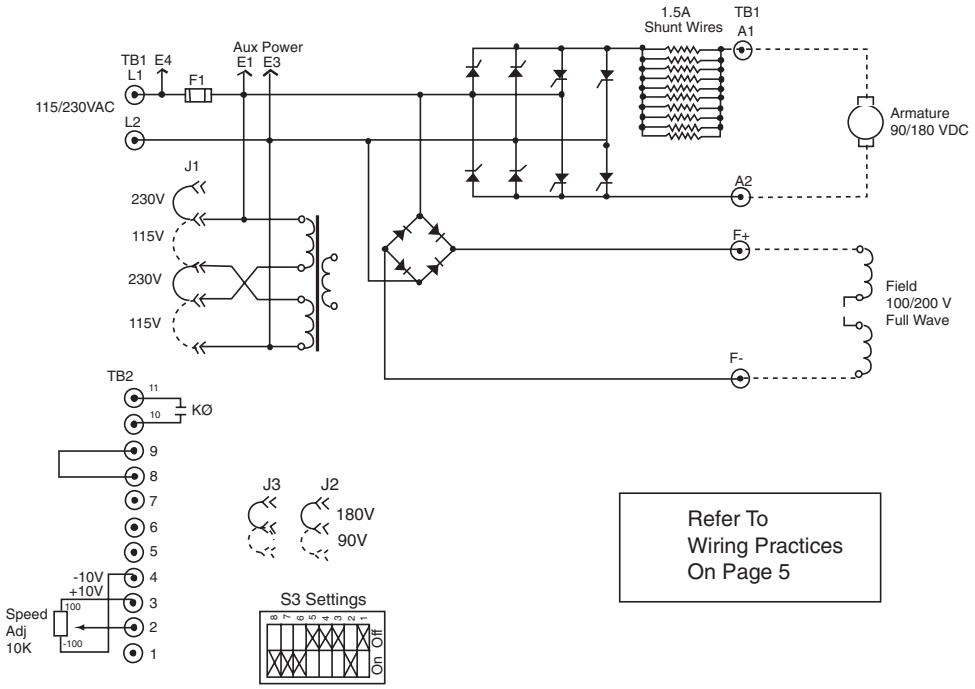

FIGURE 12. LOGIC CONNECTION DIAGRAM, LINE STARTING WITH MOTOR SPEED POTENTIOMETER

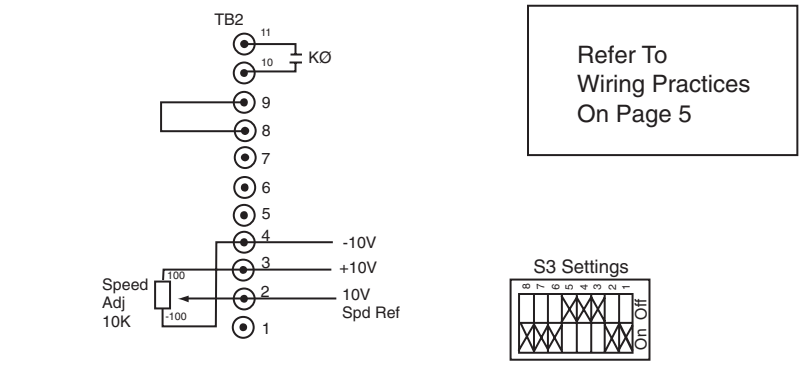

FIGURE 13. SIGNAL CONNECTION DIAGRAM USING A MOTOR SPEED

POTENTIOMETER FOR BIDIRECTIONAL CONTROL

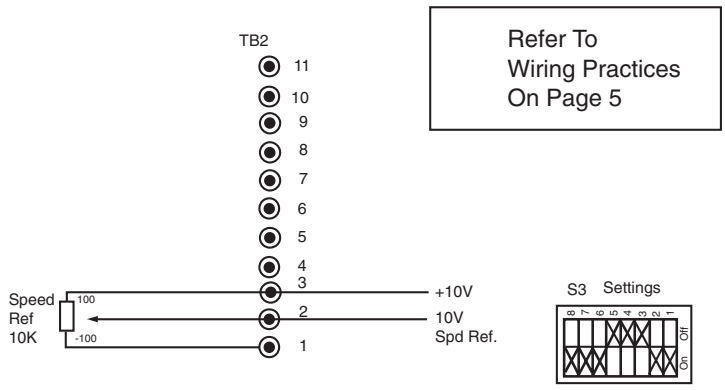

FIGURE 14. SIGNAL CONNECTION DIAGRAM USING A MOTOR SPEED POTENTIOMETER FOR UNIDIRECTIONAL CONTROL

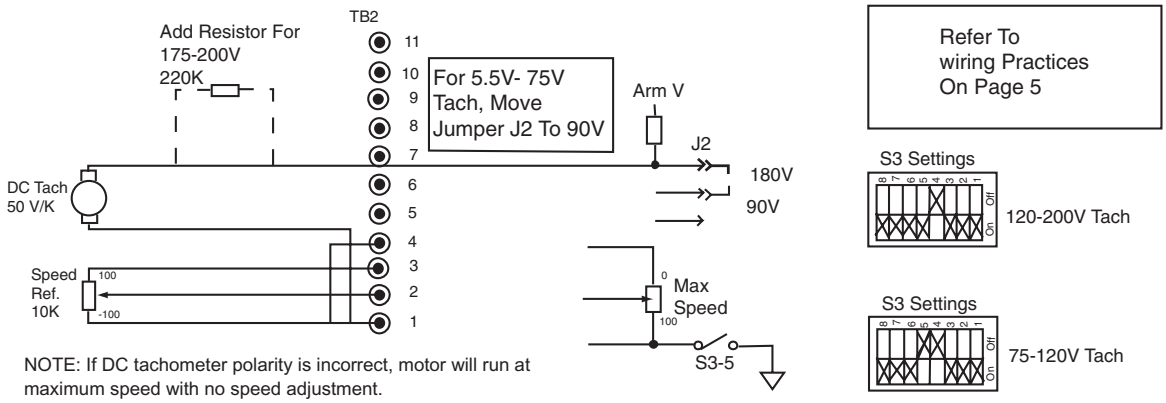

FIGURE 15. SIGNAL CONNECTION DIAGRAM, TACHOMETER FEEDBACK USING A DC TACHOMETER GENERATOR

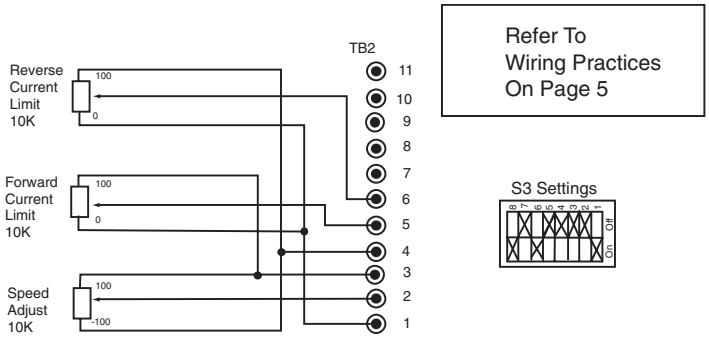

FIGURE 16. SIGNAL CONNECTION DIAGRAM USING EXTERNAL CURRENT LIMIT AND MOTOR SPEED POTENTIOMETERS

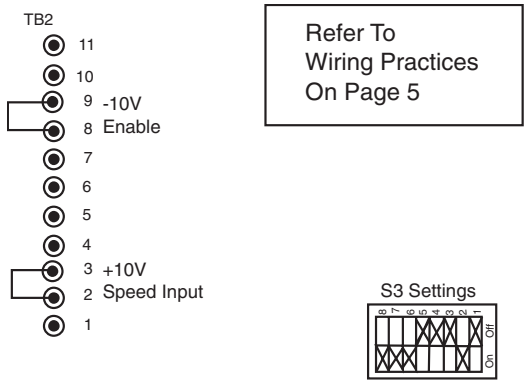

FIGURE 17. SIGNAL CONNECTION DIAGRAM, LINE STARTING WITHOUT A MOTOR SPEED POTENTIOMETER

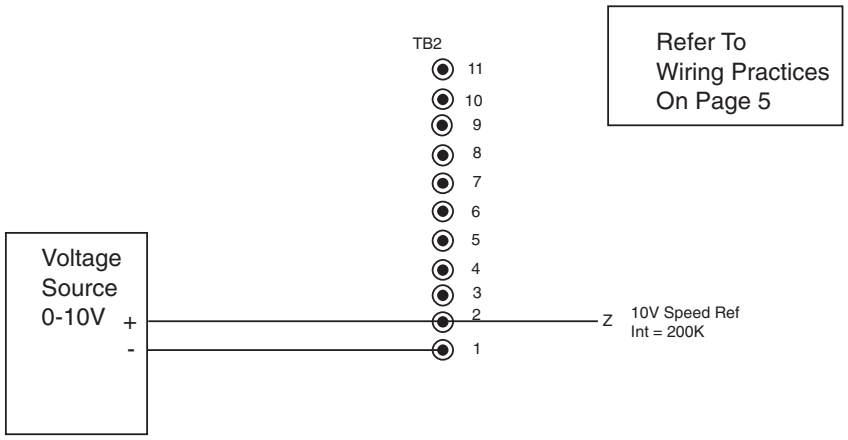

FIGURE 18. SIGNAL CONNECTION DIAGRAM USING 0 - 10 VDC EXTERNAL SPEED REFERENCE SIGNAL

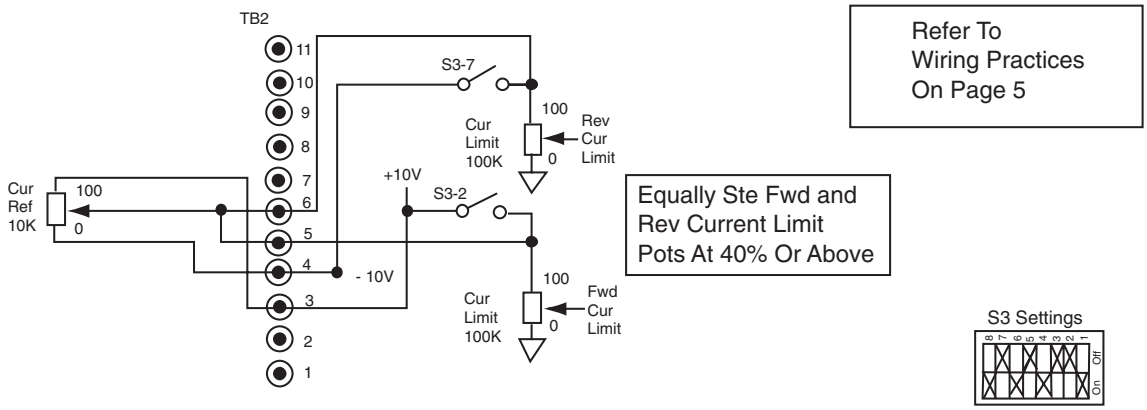

FIGURE 19. SIGNAL CONNECTION DIAGRAM USING AN EXTERNAL CURRENT (TORQUE) REFERENCE POTENTIOMETER

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 6 and 7.

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 5. These settings will provide satisfactory operation for most applications. If different settings are required, refer to "Adjustment Instructions" starting on page 23.

TABLE 5. 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.

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SECTION III

OPERATION

POWER ON/OFF

To energize the drive, turn-on the AC supply voltage to the controller. When this occurs, the motor shunt field energizes with rated field voltage, and potentially hazardous voltage is present at the motor armature terminals. **These voltages can cause electric shock resulting in personal injury or loss of life.**

If the AC supply is interrupted, and the controller is **not** set up for line starting, the motor will not restart when the AC supply is restored until the controller is reset by initiating a Stop command and then a Start command. If the controller is set up for line starting, and the AC supply is interrupted, the motor will restart when the AC supply is restored.

CAUTION

LINE STARTING IS NOT RECOMMENDED FOR APPLICATIONS WHERE PERSONNEL MAY BE EXPOSED TO THE MOTOR AND CONNECTED DRIVE EQUIPMENT. PERSONAL INJURY OR LOSS OF LIFE CAN OCCUR DUE TO THE MOTOR STARTING UNEXPECTEDLY WITHOUT WARNING.

RUN

If a RUN/STOP/JOG switch is used, place the switch in RUN position. Otherwise, initiate a Run command. A Run command will accelerate the motor to the setting of the MOTOR SPEED potentiometer or external speed reference signal, as applicable. The rate of acceleration is preset by the ACCEL potentiometer on the controller control board.

STOP

If a RUN/STOP/JOG switch is used, place the switch in STOP position. Otherwise, initiate a Stop command. A Stop command will stop the motor at a rate proportional to the stopping rate of the motor load.

If the controller has dynamic braking, on units with a “U” suffix in catalog numbers, the motor stopping time will be reduced. Dynamic braking provides exponential rate braking of the motor armature, which occurs when the circuit is opened between the controller and the motor armature, and one or more resistors connect across the motor armature.

The dynamic braking resistors provide initial braking torque as shown in Table 6.

TABLE 6. DYNAMIC BRAKING CHARACTERISTICS[a]

COMPONENT	MODEL	RATED VOLTAGE	RATED HORSEPOWER									
			1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3	5
BRAKING TORQUE (%)	RBA2-RG & RBA2C-RG	115V	180	129	103	66	44	34	NA	NA	NA	NA
		230V	NA	NA	NA	278	200	138	93	66	NA	NA
	RBA3-RG	115V	300	214	171	111	74	57	NA	NA	NA	NA
		230V	NA	NA	NA	462	316	218	146	103	79	NA
	VEA5-RG	115V	600	429	343	222	148	114	NA	NA	NA	NA
		230V	NA	NA	NA	923	632	436	293	207	159	96
STOPS PER MINUTE	RBA2-RG RBA2C-RG	115V	15	12	11	8	6	2	NA	NA	NA	NA
		230V	NA	NA	NA	8	6	1	1	1	NA	NA
	RBA3-RG	115V	9	6	5	5	4	4	NA	NA	NA	NA
		230V	NA	NA	NA	5	4	4	3	3	2	NA
	VEA5-RG	115V	15	12	10	10	7	7	NA	NA	NA	NA
		230V	NA	NA	NA	10	7	7	5	5	3	2

A. HIGH INERTIA LOADS MAY EXTEND BRAKING TIME AND CAUSE THE WATTAGE RATING OF THE DYNAMIC BRAKING RESISTORS TO BE EXCEEDED.

An antiplug feature is included with dynamic braking. This feature prevents restarting the motor before the motor has braked to a stop.

JOG

When a RUN/STOP/JOG switch is used, place the switch in JOG position. Otherwise initiate a Jog command. Jog is momentary, causing motor rotation only while the switch is held in JOG position or while a Jog command is active. Release the switch to stop the motor.

Jog speed is directly proportional to the setting of the MOTOR SPEED potentiometer.

SPEED CONTROL

Motor speed is directly proportional to the setting of the MOTOR SPEED potentiometer or the magnitude of an external speed reference signal, as applicable. This potentiometer or the speed reference signal may be adjusted while the motor is running or may be preset before the motor is started.

The rates of acceleration and deceleration are preset by the ACCEL and DECEL potentiometers, respectively, located on the controller control board.

NOTE: When a positive speed reference is supplied to terminal TB2-2, the ACCEL and DECEL potentiometer function as labeled. When a negative speed reference is supplied, the ACCEL and DECEL potentiometer functions are reversed. Option 17 allows four-quadrant acceleration/deceleration.

Maximum speed is preset by the MAX SPD potentiometer, located on the control board.

REVERSE

When a bidirectional (zero center) MOTOR SPEED potentiometer is used, turning it in one direction past zero rotates the motor in a particular rotating direction at a speed directly proportional to the potentiometer setting. Turning the potentiometer in the opposite direction past zero rotates the motor in the opposite direction at a speed directly proportional to the potentiometer setting. If the motor is running when the potentiometer is turned in the opposite direction, the motor will first brake to a stop by means of regenerative braking before reversing rotation. When the potentiometer is in center (zero) position, motor speed is zero.

The rates of acceleration and deceleration (braking) are preset by the ACCEL and DECEL potentiometers, respectively, located on the controller control board.

Maximum speed is preset by the MAX SPD potentiometer, located on the control board. Forward and reverse maximum speeds are identical.

INOPERATIVE MOTOR

If the motor stops and/or won't start, turn-off the AC supply to the controller, remove the controller cover (if used), and check the AC line fuse(s) on the controller control board. For the location of the fuse(s), see Figure 23 (page 47) or Figure 24 (page 48), as applicable. If a fuse is blown, refer to the Troubleshooting Table (Table 8).

NOTE: An LED glows red on the controller control board when motor armature current is being limited by the controller current limit circuit. This LED glows green when armature current is not being limited.

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SECTION IV

ADJUSTMENT INSTRUCTIONS

ACCELERATION

1. Set the MOTOR SPEED potentiometer at 100% or set the external speed reference signal at maximum, as applicable.

2. Initiate a Run command and observe the time required for the motor to reach maximum speed.

3. Adjust the ACCEL potentiometer for the desired rate. Full clockwise rotation is the fastest acceleration (0.2 second), and full counterclockwise rotation is the slowest acceleration (30 seconds).

4. The ACCEL Pot will function as labeled when a positive speed pot reference (0 to +10 VDC) is supplied to terminal TB2-2. When a negative signal (0 to –10 VDC) is supplied to this terminal, this pot will function as a DECEL pot.

DECELERATION

1. With the motor running at maximum speed, quickly reset the MOTOR SPEED potentiometer to zero, or quickly decrease the speed reference signal to minimum, as applicable, and observe the time required for the motor to reach minimum speed.

2. Adjust the DECEL potentiometer for the desired rate. Full clockwise rotation is the fastest deceleration (0.2 second), and full counterclockwise rotation is the slowest deceleration (30 seconds).

3. The DECEL Pot will function as labeled when a positive speed pot reference (0 to +10 VDC) is supplied to terminal TB2-2. When a negative signal (0 to –10 VDC) is supplied to this terminal, this pot will function as an ACCEL pot.

IR COMPENSATION

IR compensation is recommended when the controller is using armature feedback. When tachometer feedback is used, the IR compensation potentiometer must be set at zero (full counterclockwise rotation).

The IR COMP potentiometer is factory set at zero for satisfactory operation with most motors. If improved speed regulation is desired, readjust IR compensation as follows:

1. Be sure DIP Switch S3 is set correctly. See Table 7, page 24.

2. Be sure Jumpers J1, J2, and J3 are in the correct positions. See step 5 on page 6.

3. If the motor is shunt-wound, run it at rated base speed. If the motor is a permanent-magnet type, run it about 1/3 speed.

4. Turn the IR COMP potentiometer clockwise slowly until the motor speed becomes unstable. Then turn the potentiometer counterclockwise until motor speed stabilizes.

MAXIMUM SPEED (ARMATURE FEEDBACK)

The MAX SPD potentiometer adjusts maximum speed by setting maximum armature voltage. The voltage range is from 50% to 100% of rated armature voltage.

1. Be sure DIP Switch S3 is set correctly. See Table 7, page 26.
2. Be sure Jumpers J1, J2, and J3 are in the correct positions. See step 5 on page 7.
3. Initiate a Run command.
4. Turn the MOTOR SPEED potentiometer to 100% or increase the external speed reference signal to maximum, as applicable.
5. Adjust the MAX SPD potentiometer as required to attain 90 VDC armature voltage with a 115 VAC line, or 180 VDC armature voltage with a 230 VAC line, as applicable.

   NOTE: If the MAX SPD potentiometer is turned too far counterclockwise, speed instability may occur.

MAXIMUM SPEED (TACHOMETER FEEDBACK)

1. Set Jumper J2 and Segment 5 of DIP Switch S3 as shown in the following table.

JUMPER J2 POSITION	SWITCH S3-5 POSITION	TACHOMETER VOLTAGE RANGE @ 1750 RPM	TYPICAL TACHOMETER VOLTS/1000 RPM
90V	OFF	5.5 - 15 VDC	7 VDC
180V	OFF	75 - 120 VDC	50 VDC
90V	ON	15 - 75 VDC	35 VDC
180V	ON	120 - 200 VDC	100 VDC

2. Turn the IR COMP potentiometer fully counterclockwise (0%).
3. Initiate a Run command.
4. Turn the MOTOR SPEED potentiometer to 100% or increase the external speed reference signal to maximum, as applicable.
5. Adjust the MAX SPD potentiometer as required for the motor to run at rated base speed.

   NOTE: If DC tach polarity is wrong, the motor will run at maximum speed with no speed adjustment. When a positive DC signal is supplied to the speed reference (Terminal TB2-2), the negative DC tach signal lead should be connected to TB2-7.

CURRENT LIMIT

1. Turn the FWD CUR LMT and REV CUR LMT potentiometers fully clockwise (100%) to limit motor armature current at 150% of rated.

2. Turn the FWD CUR LMT and REV CUR LMT potentiometers counterclockwise as required to reduce maximum motor armature current.

   NOTES: a. An LED glows red on the controller control board when motor armature current is being limited.

   b. External 10K ohm Current (Torque) Limit potentiometers can be used as shown in Figure 15 on page 14. If an external Forward Current (Torque) Limit potentiometer is desired, Segment 2 of DIP Switch S3 must be in OFF (Open) position. If an external Reverse Current (Torque) Limit potentiometer is desired, Segment 7 of DIP Switch S3 must be in OFF (Open) position.

DEAD BAND

If motor creeping is a problem when the speed reference signal is set at zero, a dead band can be enabled which allows a 2% range around zero through which the speed reference can be varied without initiating a motor response. To enable the dead band, set Segment 3 of DIP Switch S3 to ON (Closed) position.

APPLICATION PROGRAMMING

An 8-position DIP Switch (S3), located on the control board, can be used to program the controller for various applications and operations as shown in Table 7, page 26.

TABLE 7. DIP SWITCH S3 SETTINGS

S3	SEGMENT POSITION		DESCRIPTION
	ON (CLOSED)	OFF (OPEN)	
1	**X**[a]		Prevents the drive from restarting automatically after an AC power interruption.
		X	Enables line starting. Allows the drive to start automatically when AC power is applied to the controller. Terminals TB2-8 and TB2-9 must be jumpered to activate this function. For connection diagrams see Figure 12 (Page 14) and Figure 17 (page 16)
2	**X**[a]		Enables the internal forward current limit, adjustable with the FWD CUR LMT potentiometer.
		X	Allows the use of an external Forward Current Limit potentiometer. The internal FWD CUR LMT potentiometer is then used to scale the external potentiometer. For a connection diagram, see Figure 16, page 15.
3	X		Enables a dead band of 2% around zero to prevent motor creeping. This may be required for tachometer feedback.
		X[a]	Disables dead band.
4	X		Enables the torque mode which allows the drive to operate as a current regulator instead of a speed regulator. S3-2 and S3-7 must be set to OFF (Open) position to activate this function, and the internal FWD and REV CUR LMT potentiometers must be set at the same positions and above 40%. For a connection diagram, see Figure 19, page 16.
		X[a]	Enables the speed mode and disables the torque mode.
5	X		Allows the use of a tachometer generator with a non-standard output (15 - 75 VDC or 120 - 200 VDC @ 1750 RPM) for tachometer feedback.[b]
		X[a]	Allows the use of armature voltage feedback, or a tachometer generator with a standard output (5.5V - 15V or 75V - 120V @ 1750 RPM) for tachometer feedback[b].
6	**X**[a]		Sets the controller to operate fro a 60 Hz supply.
		X	Sets the controller to operate from a 50 Hz supply.
7	**X**[a]		Enables the internal reverse current limit, adjustable with the REV CUR LMT potentiometer.
		X	Allows the use of an external Reverse Current Limit potentiometer. The internal REV CUR LMT potentiometer is then used to scale the external potentiometer. For a connection diagram, see Figure 16, page 15.
8	**X**[a]		Reserved for future use. **S3-8 must remain in ON position.**
		X	Reserved for future use. **Do not use this position.**

a. Factory preset position.

b. See Maximum Speed adjustment instructions, page 24.

SECTION V

MAINTENANCE AND REPAIR

GENERAL

1. Keep the controller dry and free of dust, dirt, and debris. No parts require periodic replacement.

2. Periodically turn-off the AC line supply to the controller and check all wire terminations to be sure they are tight.

3. Visually check components for damage due to overheating or breakage. All damaged and/or faulty components must be replaced for satisfactory operation.

4. Maintain the motor according to maintenance instructions supplied by the motor manufacturer.

TROUBLESHOOTING

The following table (Table 8) is a general guide for locating and correcting common problems that may occur with a DC drive. Table 8 is not intended to cover every contingency. The corrective actions are presented in a logical order. When a corrective action has been completed and the problem still exists, proceed to the next possible cause.

TABLE 8. TROUBLESHOOTING

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Motor won't start (See "Inoperative Motor," Page 19.)	AC line open	Be sure rated AC line voltage is applied to the controller.
	Operator controls inoperative or connected incorrectly.	Repair accordingly.
	Controller not reset	Initiate a Stop command and then a Start command.
	Line Voltage Selection Jumper J1 in wrong position	See Step 5 on page 6.
	Controller not enabled	Be sure +24 VDC is applied to Terminal TB2-8.
	Loss of speed reference signal	Check for 0 - ± 10 VDC, speed reference signal
	Controller not adjusted correctly	See Adjustment Instructions, Section IV.
	DIP Switch S3 not set correctly	See Table 7, page 26
	Current limit set too low	Turn the FWD CUR LMT and REV CUR LMT potentiometers clockwise.
	Open shunt field winding or wiring to the motor shunt field, causing loss of torque[a]	Check the motor shunt field and associated circuitry for a loose connection or a broken wire. Repair accordingly.
	Motor failure	Repair or replace the motor.
	Control board failure	Replace the control board.

Continued on next page

TABLE 8. TROUBLESHOOTING

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
2. Controller fuse blows when AC line power is applied to the controller	Wiring faulty or incorrect	Check all external wiring terminating in the controller. Correct accordingly.
	Circuit, component, or wiring grounded.	Remove ground fault.
	Two or more SCR's shorted	Replace shorted SCR's or the control board.
	Varistor RV1 shorted	Replace RV1 or the control board.
	Shunt Field Bridge BR1 shorted[a]	Replace BR1 or the control board.
	Motor shunt field shorted or grounded[a]	Repair or replace the motor.
	Control board failure	Replace the control board
3. Controller fuse blows when a Start command is initiated.	Motor shorted or grounded	Repair or replace the motor.
	Control board failure causing SCR's to turn-on fully	Replace the control board.
	One SCR shorted	Replace shorted SCR.
4. Controller fuse blows while the motor is running	Motor Overloaded	Check shunt field current.[a] Low shunt field current causes excessive armature current. If field current is adequate, check for a mechanical overload. If the unloaded motor shaft does not rotate freely, check motor bearings. Also check for a shorted motor armature. Motor overload can also be caused by incorrect gear rating. Correct accordingly.
	Loose or corroded connection. Wiring faulty, incorrect, or grounded.	Check all terminals, connections, and wiring between the line, controller, and motor.
	Motor shorted or grounded	Repair or replace the motor.
	One or more SCR's breaking down (shorting intermittently)	Replace shorted SCR or the control board.
	Control board failure causing SCR false firing or misfiring	Replace the control board.

Continued on next page

TABLE 8. TROUBLESHOOTING

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
5. Maximum speed excessive	Maximum speed set too high	Turn the MAX SPD potentiometer clockwise
	Controller not calibrated correctly	Refer to Steps 4 and 5 on pages 6 and 7.
	Open shunt field winding or wiring to the motor shunt field[a]	Check the motor shunt field and associated circuitry for a loose connection or a broken wire. Repair accordingly.
	Motor field demagnetized[b]	Replace the motor.
	Tachometer generator faulty or connected incorrectly.	Repair accordingly.
6. Motor won't reach top speed	Low line voltage	Check for rated line voltage, ±10%, on the controller line terminals.
	Motor overloaded	Check shunt field current.[a] Low shunt field current causes excessive armature current. If field current is adequate, check for a mechanical overload. If the unloaded motor shaft does not rotate freely, check motor bearings. Also check for a shorted motor armature. Motor overload can also be caused by incorrect gear ratio. Correct accordingly.
	Maximum speed set too low	Turn the MAX SPD potentiometer clockwise.
	Current limit set too low	Turn the FWD and REV CUR LMT potentiometers clockwise.
	Wrong shunt wires removed	See Step 4 and Table 4, page 6.
	Motor field demagnetized[b]	Replace the motor.
	Control board failure	Replace the control board.
	Tachometer generator faulty or open tachometer wiring.	Repair accordingly.

Continued on next page

TABLE 8. TROUBLESHOOTING

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
7. Unstable speed	AC line voltage fluctuating	Observe line voltage with a voltmeter or oscilloscope. If fluctuations occur, correct condition accordingly.
	Loose or corroded connection. Wiring faulty, incorrrect, or grounded	Check all terrminals, connections, and wiring betwen the line, operator controls, controller, and motor.
	Oscillating load connected to the motor	Stabliize the load. Turning the IR COMP potentiometer counterclockwise may minimize oscillations.
	Voltage Selection Jumpers J1, J2, J3 in wrong position	See Step 5 on page 7.
	IR compensation not adjusted correctly	See the IR Compensation adjustment instructions on page 23.
	Maximum speed not adjusted correctly	See the Maximum Speed adjustment instructions on page 24.
	Motor faulty	Check motor brushes. Replace if needed. Repair or replace the motor.
	Tachometer generator or coupling faulty, (if used)	Repair accordingly.
8. Line and motor armature current excessive	Motor overloaded	Check shunt field current.[a] Low shunt field current causes excessive armature current. If field current is adequate, check for a mechanical overload. If the unloaded motor shaft does not rotate freely, check motor bearings. Also check for a shorted motor armature. Motor overload can also be caused by incorrect gear ratio. Correct accordingly.
9. Shunt field current[a] too low	Open shunt field winding or wiring to the motor shunt field	Check the motor shunt field and associated circuitry for a loose connection or a broken wire. Repair accordingly.
	Shunt field connected for incorrect voltage	Check motor rating and refer to Table 15, page 40.
	Shunt Field Bridge BR1 failure	Replace BR1 or the control board.

Continued on next page

TABLE 8. TROUBLESHOOTING

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
10. Shunt field current[a] too high	Shunt field connected for incorrect voltage	Check motor rating and refer to Table 15, page 40.
	Shunt field windings shorted	Measure the shunt field resistance and compare with the motor rating. Repair or replace the motor.
11. Motor thermal guard tripped (if used)	Ventilation insufficient	Remove dirt, dust, and debris from the motor intake and exhaust screens
	Excessive motor load at low speed	Reduce the load or increase the speed.
	Line and motor armature current excessive	See Indication 8.
	Motor overheating from friction	Check for misalignment. Realign the motor.
	Shorted motor windings or faulty bearings.	Repair or replace the motor.

a. Does not apply to permanent-magnet motors.

b. Does not apply to shunt-wound motors.

SECTION VI

OPTIONS

Options are available for Series RBA-RG/VEA-RG Controllers which increase the functional use of the basic controller. Table 9 (page 34) lists all available options.

Options can be added to the basic controller at any time. Each option consists of all required components, mounting hardware, and instruction sheet.

TABLE 9. ALLOWABLE OPTION COMBINATIONS

OPTION TYPE	OPTION NUMBER	OPTION CODE[a]	OPTION
Enclosure Options — Choice of any or all within this group. May be combined with options from any other groups.	VFKT	XK	Fan Assembly (5 HP Units Only) (Required When Enclosed Model VEA5-RG Is Operated At 5 HP Rating)
Options Used To Convert Open Chassis Units Into Enclosed Package Controllers — Choice of one within this group. May be combined with options from any other groups.	50	XK	Hinge, Enclosure Cover
	SK	XK	Spacer Kit For Model RBA3-RG Enclosed Controllers
Power Options	30	XK	Circuit Breaker — Two Pole (Model VEA5-RG Only)
Input Signal Options — Choice of one within this group.	17	XK, P	Four-Quadrant Acceleration/Deceleration
	25	XK	Isolated Input
	RI	XK	Limit Switch Reversing
Feedback Options — Choice of one within this group.	18A	XK	Torque Taper
	22B/24B	XK	Pulse Tachometer Feedback/Follower
External Options — Choice of any or all within this group	21	K	Motor Speed Potentiometer, One-Turn
	21A	K	Motor Speed Potentiometer, Ten-Turn With Analog Dial
	21B	K	Motor Speed Potentiometer, Ten-Turn With Digital Dial
	IA	K	Card Guide
	SK	K	Spacer Kit (Model RBA3-RG Only)
	SKO	XK	Spacer Kit For Mounting Options On Model RBA2C-RG Bracket

a. XK = Factory Installed Or Field Kit
K = Field Kit
P = Plug-In Option

SECTION VII

PARTS LIST

TABLE 10. PARTS LIST, SERIES RBA-RG/VEA-RG CONTROLLERS

PART	RATING	BOSTON GEAR PART NUMBER		
		MODELS RBA2-RG & RBA2C-RG	MODEL RBA3-RG	MODEL VEA5-RG
Control Board	NA	64093	64094	64095
Fuse, Line	20A, 700V (A070GRB20T13)	64096	NA	NA
	30A, 700V (A070GRB30T13)	NA	64097	(2) 64097
SCR	15A, 600V	64993	NA	NA
	55A, 800V	NA	64994	NA
	65A, 600V	NA	NA	64995

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SECTION VIII

RATINGS AND SPECIFICATIONS

RATINGS

1. Current/Torque Reference Potentiometer . . . . . 10K Ohms, 1/2W
2. Duty . . . . . Continuous
3. Horsepower Range . . . . . 1/6 - 5 HP (See Table 1, Page 1)
4. Line Fuse Interrupting Capacity . . . . . 100,000 Amperes
5. Line Power . . . . . 115V Or 230V, Single-Phase, 50 Or 60 Hz
6. Motor Speed Potentiometer . . . . . 10K Ohms, 1/2W
7. Reference Power Supply (Non-isolated) . . . . . ±10 VDC
8. Service Factor 1.0

TABLE 11. TYPICAL APPLICATION DATA

COMPONENT			RATINGS									
RATED HORSEPOWER (HP)			**1/6**	**1/4**	**1/3**	**1/2**	**3/4**	**1**	**1-1/2**	**2**	**3**	**5**
RATED KILOWATTS (KW)			**0.124**	**0.187**	**0.249**	**0.373**	**0.560**	**0.746**	**1.120**	**1.492**	**2.238**	**3.730**
1 PHASE AC INPUT (FULL-LOAD)	Line Amps	115V Unit	3.9	5.0	6.0	8.7	12.4	15.8	NA	NA	NA	NA
		230V Unit	NA	NA	NA	4.2	5.9	8.8	12.6	15.8	22.0	32.0
	KVA		0.48	0.58	0.71	1.00	1.40	2.00	3.00	4.00	5.00	8.00
DC OUTPUT (FULL-LOAD)	Motor Armature Amps	90V	2.0	2.8	3.5	5.4	8.1	10.5	NA	NA	NA	NA
		180V	NA	NA	NA	2.6	3.8	5.5	8.2	11.6	15.1	25.0
	Motor Field Amps (Maximum)	Series RBA-RG	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	NA
		Model VEA5-RG	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
FULL-LOAD TORQUE (lb-ft.) with 1750 RPM Base Speed Motors			0.5	0.75	1.0	1.5	2.2	3.0	4.5	6.0	9.0	15.0
MINIMUM TRANSFORMER KVA FOR VOLTAGE MATCHING OR ISOLATION			0.5	0.75	0.75	1.0	1.5	2.0	3.0	5.0	7.5	10.0

TABLE 12. OPERATING VOLTAGES AND SIGNALS

POWER SOURCE (SINGLE-PHASE)	OUTPUT VDC		SPEED REFERENCE SIGNAL[a]	MAGNETIC CONTROL VOLTAGE	TACHOMETER GENERATOR VOLTAGE
	ARMATURE	FIELD			
115V, 50 or 60 Hz	0-90	50/100	0 – ± 10 VDC	24 VDC	5.5 – 200 VDC
230V, 50 or 60 Hz	0-180	100/200			

a. Speed reference signal must be ungrounded.

TABLE 13. CONTROLLER WEIGHTS

CONTROLLER MODEL	WEIGHT - LBS (KG)		
RATED HORSEPOWER (HP)	1/6-2	3	5
RBA2-RG	7.70 (3.49)	NA	NA
RBA2U-RG	8.50 (3.86)	NA	NA
RBA2B-RG, RBA2S-RG	11.60 (5.26)	NA	NA
RBA2UB-RG, RBA2US-RG	12.40 (5.62)	NA	NA
RBA3-RG	7.70 (3.49)		NA
RBA3U-RG	8.50 (3.86)		NA
RBA3B-RG, RBA3S-RG	11.60 (5.26)		NA
RBA2C-RG	2.0 (0.91)	NA	NA
RBA2CU-RG	2.25 (1.02)	NA	NA
VEA5-RG	8.20 (3.72)		8.60 (3.90)
VEA5U-RG	8.90 (4.04)		9.30 (4.22)
VEA5B-RG, VEA5S-RG	12.10 (5.49)		12.50 (5.67)
VEA5UB-RG, VEA5US-RG	12.80 (5.81)		13.20 (5.99)

OPERATING CONDITIONS

1. Altitude, Standard . . . . . 1000 Meters (3300 Feet) Maximum[1]
2. Ambient Temperature[2] . . . . . 0 - 40°C (32°F - 104°F)
3. Line Frequency Variation . . . . . ± 2 Hz Of Rated
4. Line Voltage Variation . . . . . ± 10% Of Rated
5. Relative Humidity . . . . . 95% Noncondensing

1. Controller can be derated by 1% per 100 meters to operate at higher altitudes.
2. 55°C (131°F) maximum in enclosed areas where open-chassis controllers are mounted.

PERFORMANCE CHARACTERISTICS

1. Controlled Bandwidth (Speed Of Response) . . . . . 5 Hz
2. Controlled Speed Range . . . . . 0 To Motor Base Speed
3. Current Ripple Frequency . . . . . 120 Hz (60 Hz); 100 Hz (50 Hz)
4. Efficiency (Rated Speed/Rated Load)
   a. Controller Only. 98%
   b. Controller With Motor, Typical 85%
5. Speed Regulation . Regulation percentages are of motor base speed under steady-state conditions

TABLE 14. SPEED REGULATION CHARACTERISTICS

REGULATION METHOD	LOAD CHANGE (95%)	VARIABLE			
		LINE VOLTAGE (±10%)	FIELD HEATING (COLD/NORMAL)	TEMPERATURE (±10°C)	SPEED RANGE
Standard Voltage Feedback with IR Compensation	2%	±1%	5-12%	±2%	50:1
Tachometer Feedback with 5PY DC Tachometer	0.5%	±1%	0.2%	±2%	200:1

ADJUSTMENTS

1. Acceleration, Linear . . . . . 0.2 - 30 Seconds
2. Dead Band . . . . . ± 2 Hz (Enable) Or 0 (Disable)
3. Deceleration, Linear . . . . . 0.2 - 30 Seconds
4. Forward Torque (Current) Limit . . . . . 10 - 150% Of Full-Load Torque
5. IR (Load) Compensation . . . . . 0 - 10% Boost
6. Jog Speed . . . . . 0 - 100% Of Motor Base Speed
7. Maximum Speed. . . . . 50% - 100% Of Motor Base Speed
8. Reverse Torque (Current) Limit . . . . . 10 - 150% Of Full-Load Torque

SPECIFICATIONS

- **AC LINE PROTECTION -** A 100,000 ampere interrupting capacity AC line fuse provides instantaneous protection from peak loads and fault currents. This line fuse is located inside the controller. A molded-case, magnetic-trip circuit breaker (Option 30) is available for Model VEA5-RG Controllers, which provides a manual disconnection to the controller, and also provides automatic instantaneous trip protection from a peak load.

- **AUXILIARY CONTACT -** A normally-open Form A relay contact, rated 5 ampere @115 VAC and 30 VDC, is available for external use at Terminals TB2-10 and TB2-11. The relay energizes when a Run command is initiated, and de-energizes when a Normal Stop command is initiated or the anti-restart circuit is activated.

- **CONTROL VOLTAGE -** A transformer coupled 24 VDC power supply provides non-isolated control power for all magnetic control logic and operator controls.

- **CURRENT LIMIT CONTROL -** A DIP Switch (S3) allows the forward and reverse current limit circuits to be controlled by internal or external forward and reverse current limit potentiometers. See S3 Segment 2 (Forward) and 7 (Reverse) in Table 7, page 26.

- **DEAD BAND -** A DIP Switch (S3) enables a 2% dead band around zero reference to prevent motor creeping. See S3 Segment 3 in Table 7, page 26.

- **DIP SWITCH SETTINGS -** An 8-position DIP Switch (S3) is used to program the controller for various applications and operations as shown in Table 7, page 26.

- **FEEDBACK -** Two modes of analog feedback are provided, as follows. See Table 14 (page 39) for speed regulation characteristics.

  a. **Armature Feedback -** Counter EMF voltage feedback with IR compensation, adjustable for individual motor characteristics.

  b. **DC Tachometer Feedback -** The controller provides voltage scaling, and terminals for accepting the output of a DC tachometer generator, mechanically coupled to the drive motor armature. The controller will automatically transfer to armature feedback if the tachometer signal is lost. Tachometer generators with an output of 5.5 VDC to 200 VDC at 1750 RPM may be used.

- **FIELD SUPPLY -** A half-wave or full-wave shunt field supply is available as shown in Table 15.

TABLE 15. SHUNT FIELD DATA

CONTROLLER RATING (VAC)	SHUNT FIELD VOLTAGE (VDC)		MOTOR SHUNT FIELD LEAD CONNECTIONS	
	HALF-WAVE	FULL-WAVE[a]	F1	F1
115	50		L1	F–
		100	F+	F–
230	100		L1	F–
		200	F+	F–

a. Low inductance motors requires a full-wave field to prevent current instability.

- **LINE STARTING -** Allows the drive to start automatically when AC power is applied to the controller, and stop when power is removed. A DIP Switch (S3) disables the no-restart-on-power-failure feature and enables line starting. See S3 Segment 1 in Table 7, page 26.

- **MOTOR CONTACTOR -** Controller model numbers with an 'U' suffix, e.g., RBA2U-RG, VEA5UB-RG, have a DC magnetic armature contactor, which disconnects both motor armature leads from the controller. An antiplug circuit ensures that the contactor does not make or break DC.

- **POWER CONVERSION -** The DC power bridge is a dual full-wave converter of two back-to-back bridges of four SCR's each. Each SCR is rated at least 600 PIV. The controller base forms an integral heat sink, with the power devices electrically isolated from the base.

- **STATUS INDICATOR -** A bicolor LED glows red when motor armature current is being limited by the controller current limit, and glows green when armature current is not being limited.

- **TACHOMETER VOLTAGE SELECTION -** A DIP Switch (S3) allows the use of a standard or nonstandard voltage DC tachometer generator for feedback. See S3 Segment 5 in Table 7, page 26.

- **TORQUE REGULATOR -** A DIP Switch (S3) enables the controller to function as a torque regulator instead of a speed regulator. This allows the use of external Forward and Reverse potentiometers to set motor torque (0 - 150% of rated). When the Torque mode is selected, motor speed will seek a level from 0 to 100% of rated depending on the application load torque. See S3 Segment 4 in Table 7, page 26.

- **VOLTAGE TRANSIENT PROTECTION -** A metal oxide suppressor (varistor) across the AC line is combined with RC snubbers across the power bridge to limit potentially damaging high voltage spikes from the AC power source.

- **50/60 HERTZ OPERATION -** A DIP Switch (S3) enables the controller to operate from either a 50 Hertz or 60 Hertz power source. See S3 Segment 6 in Table 7, page 26.

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SECTION IX

DRAWINGS

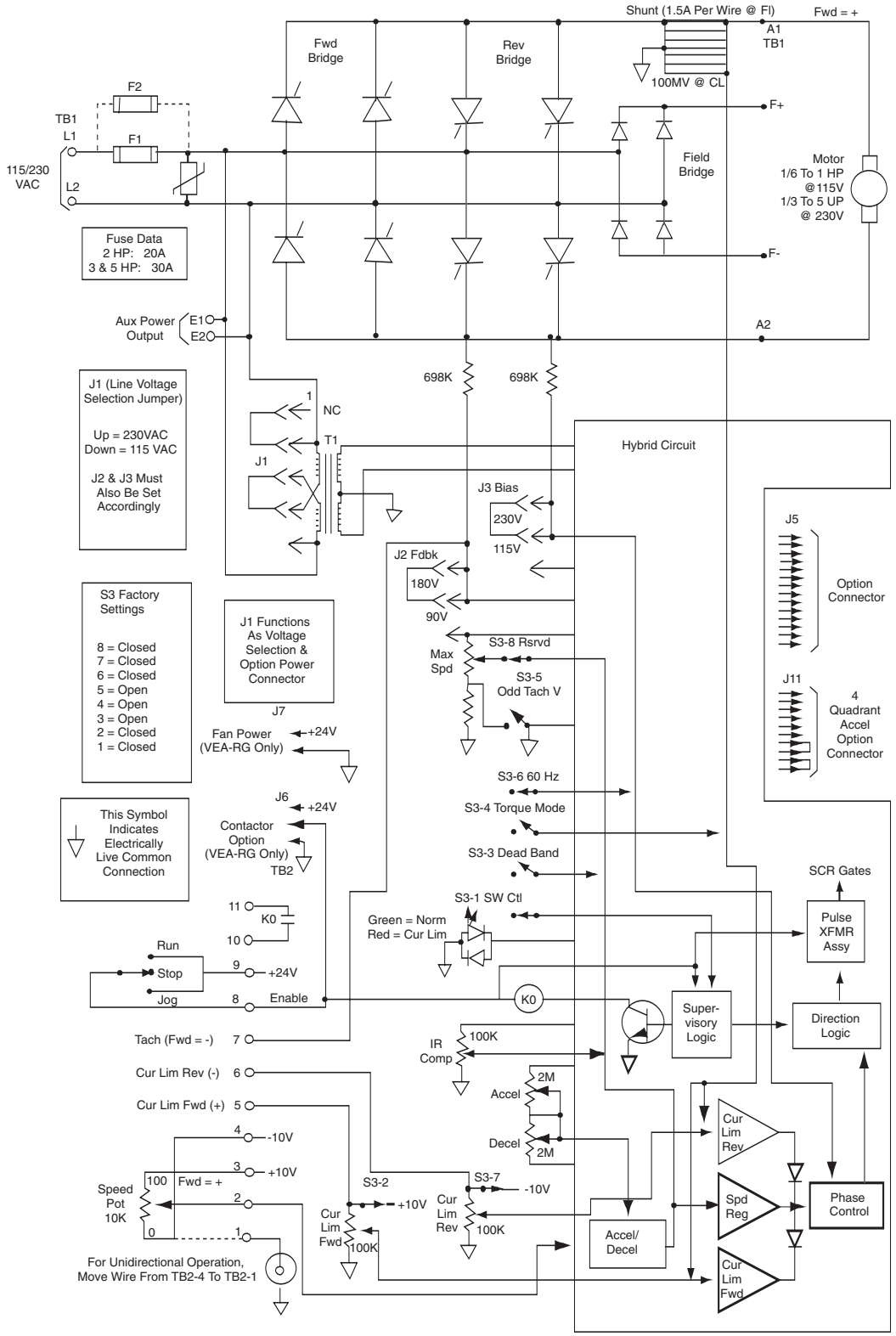
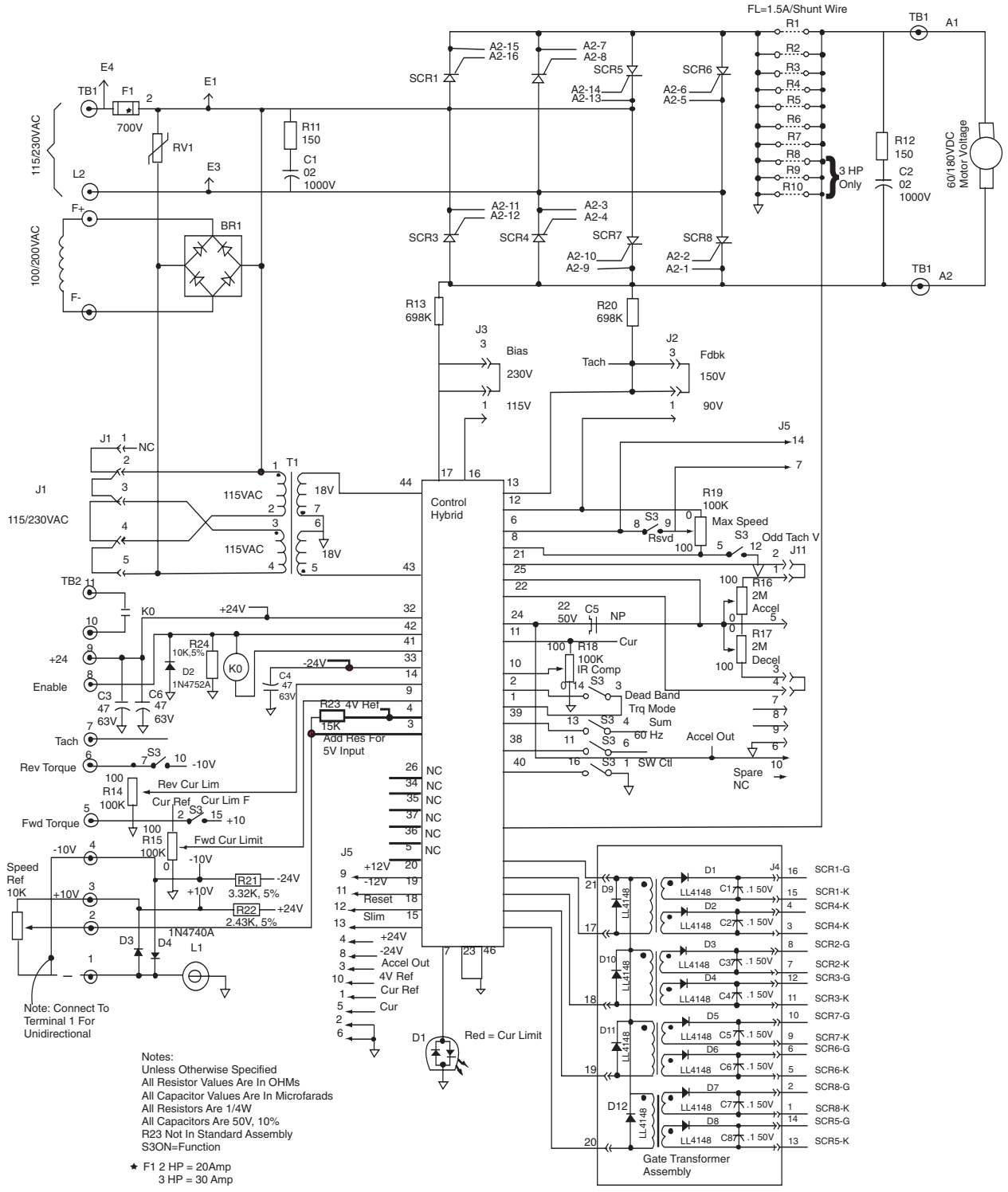


FIGURE 20. FUNCTIONAL SCHEMATIC, SERIES RBA-RG/VEA-RG CONTROLLERS



Notes:
Unless Otherwise Specified
All Resistor Values Are In OHMs
All Capacitor Values Are In Microfarads
All Resistors Are 1/4W
All Capacitors Are 50V, 10%
R23 Not In Standard Assembly
S3ON=Function

★ F1 2 HP = 20Amp
3 HP = 30 Amp

FIGURE 21. SCHEMATIC, MODEL RBA-RG CONTROLLERS

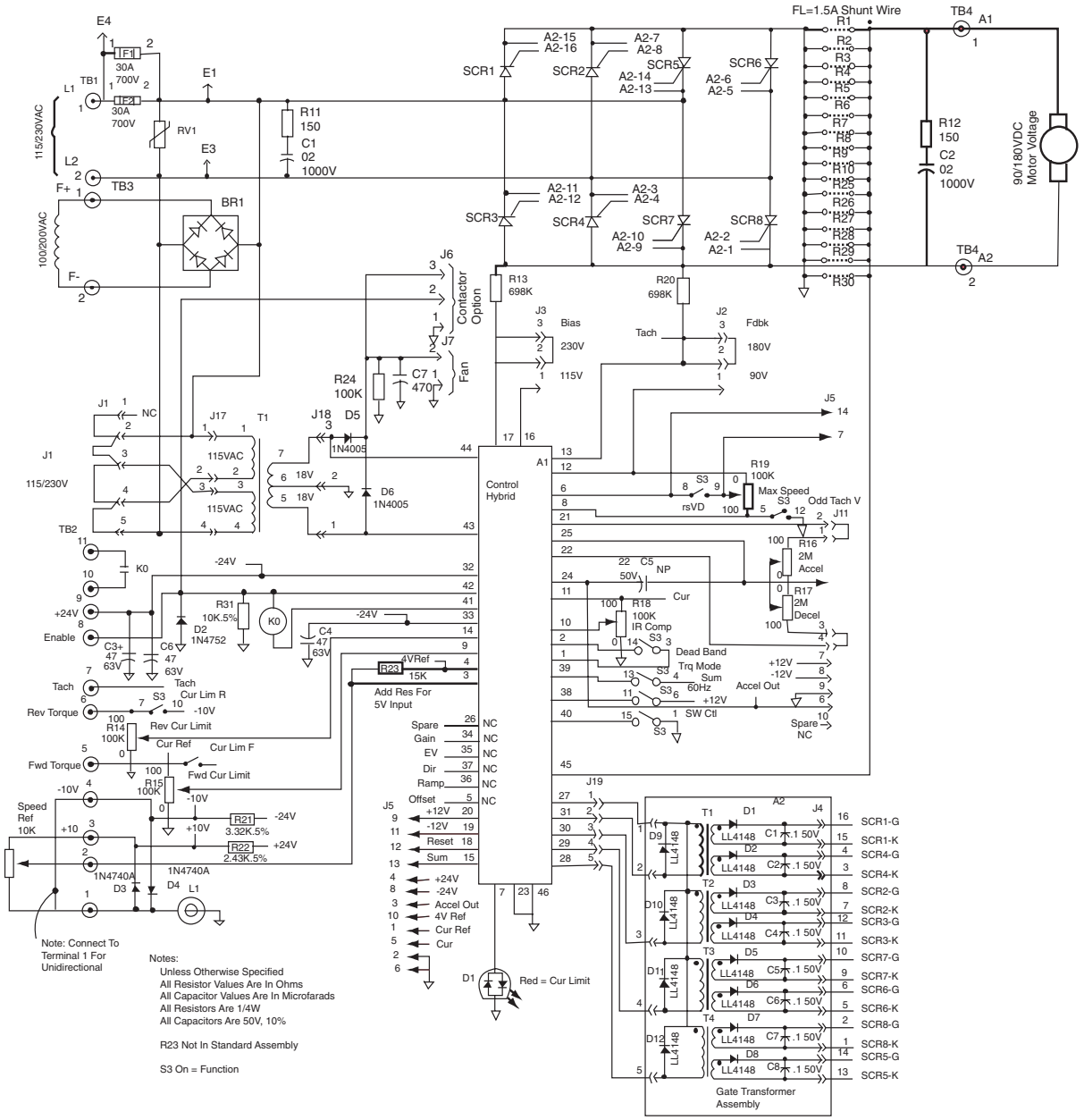


FIGURE 22. SCHEMATIC, MODEL VEA-RG CONTROLLERS

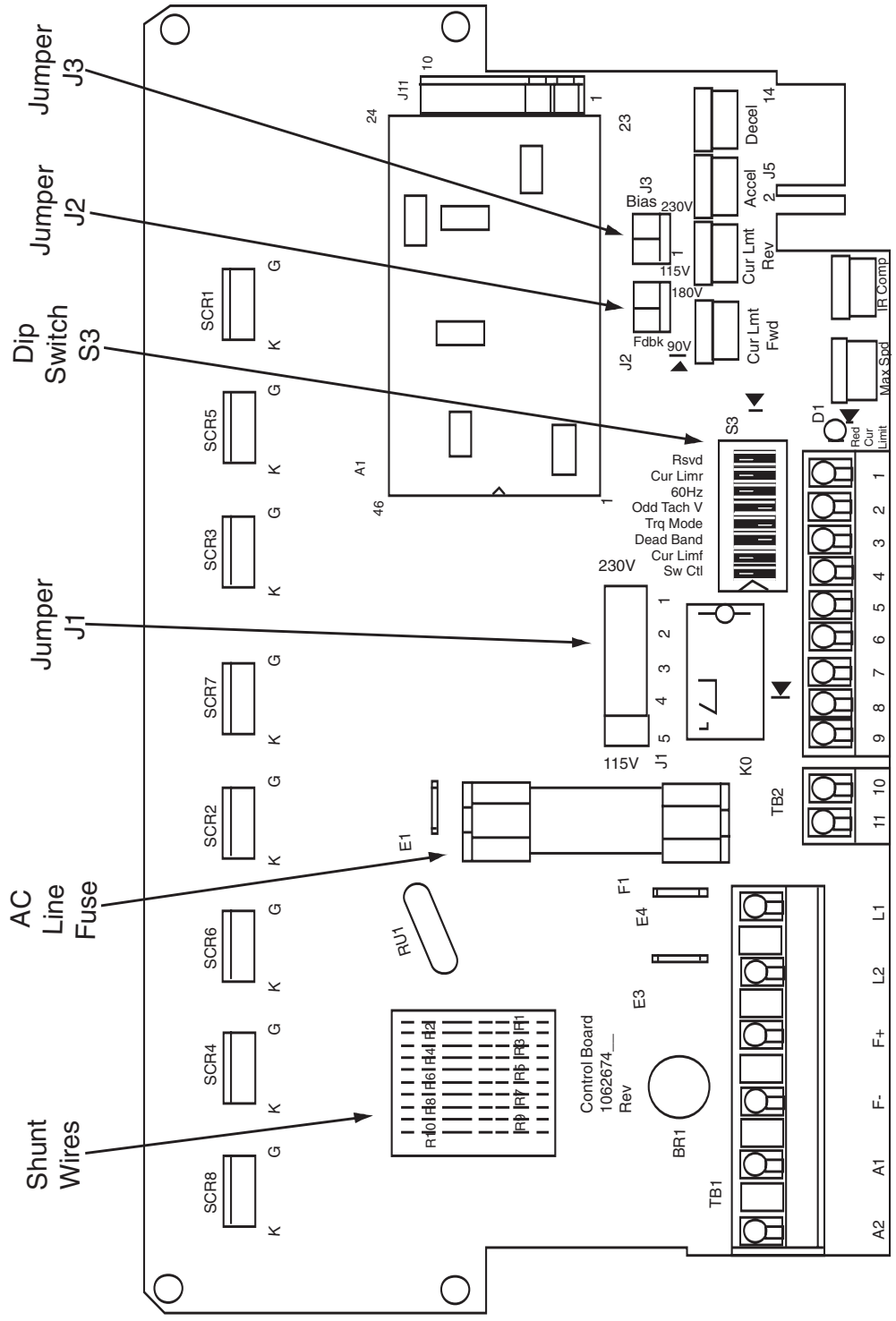


FIGURE 23. CONTROL BOARD FOR RBA-RG CONTROLLERS

NOTE: Not all components are shown.

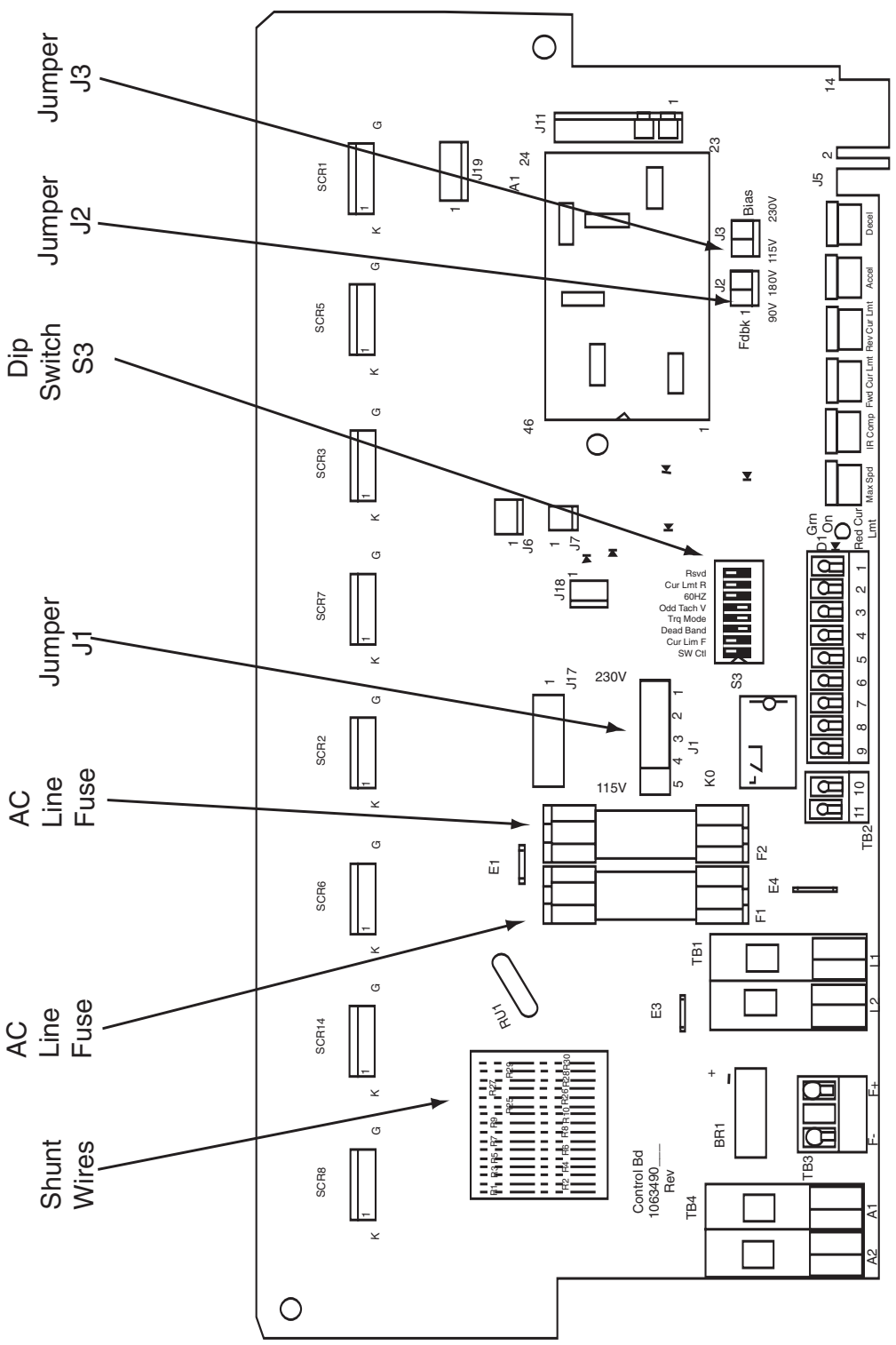


FIGURE 24. CONTROL BOARD FOR VEA-RG CONTROLLERS

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Callouts

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FAN POWER
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CONTACTOR
OPTION
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