Boston Gear®
Ratiotrol®

DC Motor Speed Control

Installation and Operation

Doc. No. 57762

Beta II Series
Single Phase
1/6-3 HP

Boston Gear

Table of Contents

Table of Contents (continued)

LIST OF TABLES

LIST OF ILLUSTRATIONS

WARNINGS

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, OR 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 BETA II Single-Phase Adjustable-Speed DC Motor Controllers. A parts list, ratings, specifications, and drawings are included.

GENERAL DESCRIPTION

BETA II controllers statically convert AC line power to regulated DC for nonregenerative, adjustable-speed armature control of shunt-wound and permanent-magnet motors.

All 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 (File No. E60207) and CSA approved (File No. LR19781).

Table 1. BETA II MODEL MATRIX

Item Code	Cat. No.	Line Volt.† HP Range		Construction			Function				Operator's Controls		Wiring Diagram Figure #
		115 VAC	230 VAC	Angle Bracket Chassis	Open Chassis	Enclosed	Run/ Stop	Arm. Cont. Run/Stop W/D.B.	Arm. Switch Rev.	Arm. Cont. Rev. W/D.B.	Local (Integral)	Remote	
64801	RBA2	1/6-1	1/2-2		X		X					X	3,5
57854	RBA2C			X			X					X	3,5
57831	RBA2U				X			X				X	5A, 5B
57855	RBA2CU			X				X				X	5A, 5B
64821	RBA2M				X					X		X	6,7
57856	RBA2CM			X						X		X	6,7
64805	RBA2B					X	X					X	3,5
13048	RBA2B-WD					X*	X					X	3,5
57852	RBA2UB					X		X				X	5A, 5B
13050	RBA2UB-WD					X*		X				X	5A, 5B
64855	RBA2MB					X				X		X	6, 7
13100	RBA2MB-WD					X*				X		X	6, 7
64814	RBA2S					X	X				X		3
13102	RBA2S-WD					X*					X		3
64820	RBA2R					X			X		X		4
13104	RBA2R-WD					X*			X		X		4
57853	RBA2US					X		X			X		5A
13106	RBA2US-WD					X*		X			X		5A
64863	RBA2MR					X				X	X		6
13108	RBA2MR-WD					X*				X	X		6
64865	RBA3	1/6-1	1/2-3		X		X					X	3, 5
57889	RBA3U				X			X				X	5A, 5B
64873	RBA3M				X					X		X	6, 7

*Washdown Duty
†Units are Reconnectable

MOTOR SELECTION

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

Section II – Installation

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

INSTALLATION GUIDELINES

1. **CONTROLLER MOUNTING** – The controller may be wall mounted either vertically or horizontally. However, never mount the controller upside down, immediately beside or above heat generating equipment, or directly below water or steam pipes.

   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.

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

2. **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.

3. **CONTROLLER CONSTRUCTION** – The controller base is made of die-cast aluminum with a powdered epoxy finish, and the cover is made of a die-cast aluminum alloy.

   The controller enclosure is totally enclosed, nonventilated, and complies 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.

4. **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 8, page 24.

   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 (page 24) 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 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.

5. I**SOLATION 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 accidentally 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.

6. 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. For angle chassis units, the ground wire connects to one of the mounting bracket screws. Then ground the controller base by connecting the ground screw to the 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.

7. WIRING PRACTICES – The power wiring must be sized to comply with the National Electrical Code, CSA, or 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 potentiometer, tachometers, run / stop pushbuttons, etc. Power wiring refers to AC line input wiring, and motor armature (or stator) and field connections. Signal and control wiring should not be run in the same conduit with power wiring and should be kept separated from power wiring in an enclosure. The exception to this is that 115 VAC control wiring should be considered as low power wiring and kept separate from other control and signal wiring, as well as other power wiring.

Multi-conductor twisted cable (such as 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, and cause erratic operation.

Warning: The signal and control wiring is *not* electrically isolated from the AC power source. This means that these circuits are *electrically hot*. A ground fault or any non-isolated input will cause high currents to flow and will damage the controller. Any operator contact with these circuits will result in high voltage *electric shock*. Operator controls must be rated for at least line voltage application.

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 for recommended fuses. Controllers with integral operator controls do not require operator control fusing.

Two 3/4-14 NPT threaded holes are provided for conduit entry, one each in the top and bottom of the controller. (Base mounted units only).

TABLE 2. RECOMMENDED CONTROL AND SIGNAL WIRING FUSES

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

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 3, page 8. For the location of the shunt wires, refer to Figure 16, page 30.

TABLE 3. HORSEPOWER CALIBRATION

MOTOR CURRENT RATING (AMPS)*	REMOVE SHUNT WIRES		NUMBER OF SHUNT WIRES REMAINING
	RBA2	RBA3	
15.0	NA	NONE	10
13.5	NA	R1	9
12.0	NA	R1 & R2	8
10.5	NONE	R1 – R3	7
9.0	R1	R1 – R4	6
7.5	R1 & R2	R1 – R5	5
6.0	R1 – R3	R1 – R6	4
4.5	R1 – R4	R1 – R7	3
3.0	R1 – R5	R1 – R8	2
1.5	R1 – R6	R1 – R9	1

*Select the motor current rating in the table that is closest to the motor nameplate armature current rating.

5. Check the positions of Jumpers J1* and J2 on the control board. For the locations of J1* and J2, see Figure 16, page 31. For a 230 VAC line supply and a 180V armature motor, Jumper J1* must be in the 230V position, and Jumper J2 must be in the 180V position. For a 115 VAC line supply, J1* must be in the 115V position, and J2 must be in the 90V position. To change the position of J1* or J2, pull the jumper from the control board and then push it onto the appropriate pins on the board.

*For controllers supplied with factory installed contactor or interface board,Jumper J1 has been moved to one of these adjacent option boards. Do not offset the five-position plug with ribbon cable (Connector J1 supplied with option board) at Connector J1 on the control board. The four-position plug (Jumper J1) now located on the option board should be moved for input voltage calibration. Refer to the specific option board instruction for further information. All controls are shipped with Jumper J1 connected for 230VAC.

6. Base mounted controllers may be surface wall mounted or panel wall mounted as shown in Figure 1, page 9. Mount the controller. Mounting dimensions are shown in Figure 2, page 9.

7. For base mounted units, 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.

8. Connect the AC power wiring to Terminals L1, L2, motor armature leads to A1(+) and A2 (-) *or* M1 and M2 *or* A1A and A2A*; ground to ground lug, field leads to F+ and F-. Be sure to observe Installation Guidelines 4 and 7 on pages 6 and 7. If half-wave shunt field voltage is desired, connect motor shunt field leads to Terminals F+ and F/2. (Table 12, page 26).

NOTE: Low inductance motors require a full-wave field to prevent current instability.
* Refer to model matrix on page 5, table 1 referencing proper wiring diagram for specific model.

9. If remote operator control and/or signal wiring is required, connect the controller as shown in the appropriate connection diagram (Figures 3 through 13). Figures 3 through 8 show operator control connections, and Figures 9 through 13 show signal connections.

10. The controller can be programmed for various applications by the removal (clipping with a wire cutter) of wire Jumpers (W1 - W6). For line starting, clip Jumper W1. To use an external Current (Torque) Reference Potentiometer, clip Jumper W6. If jumpers need to be removed, it is noted in the appropriate signal connection diagram (Figures 9 through 13). Refer to Figure 16 (page 31) for the location of Jumpers W1 - W6.

11. Replace the controller cover, if required.

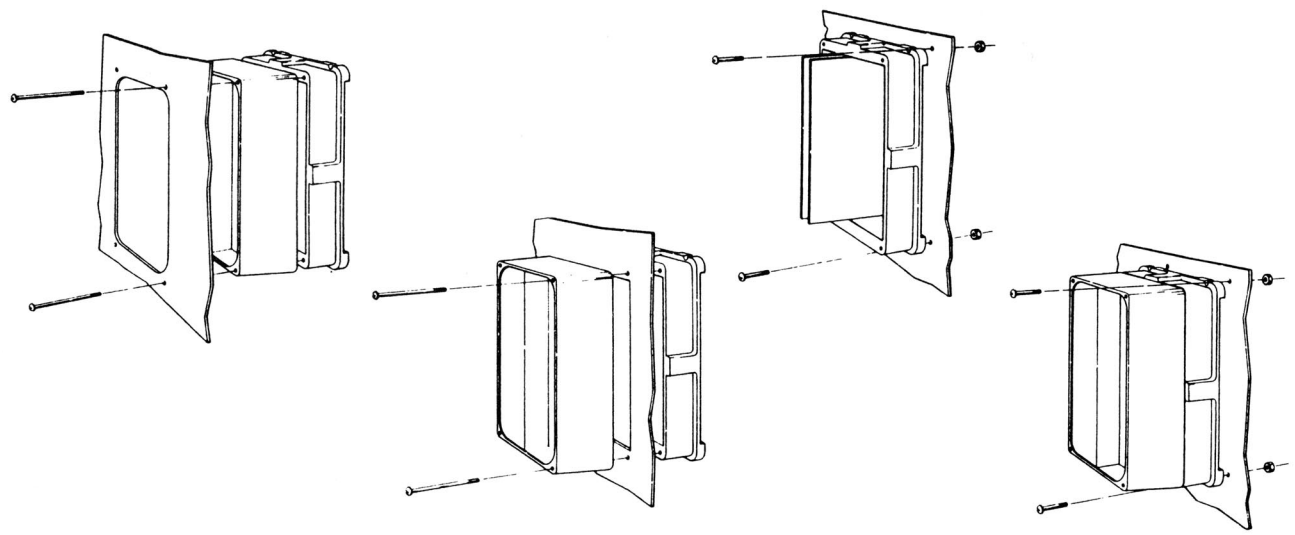
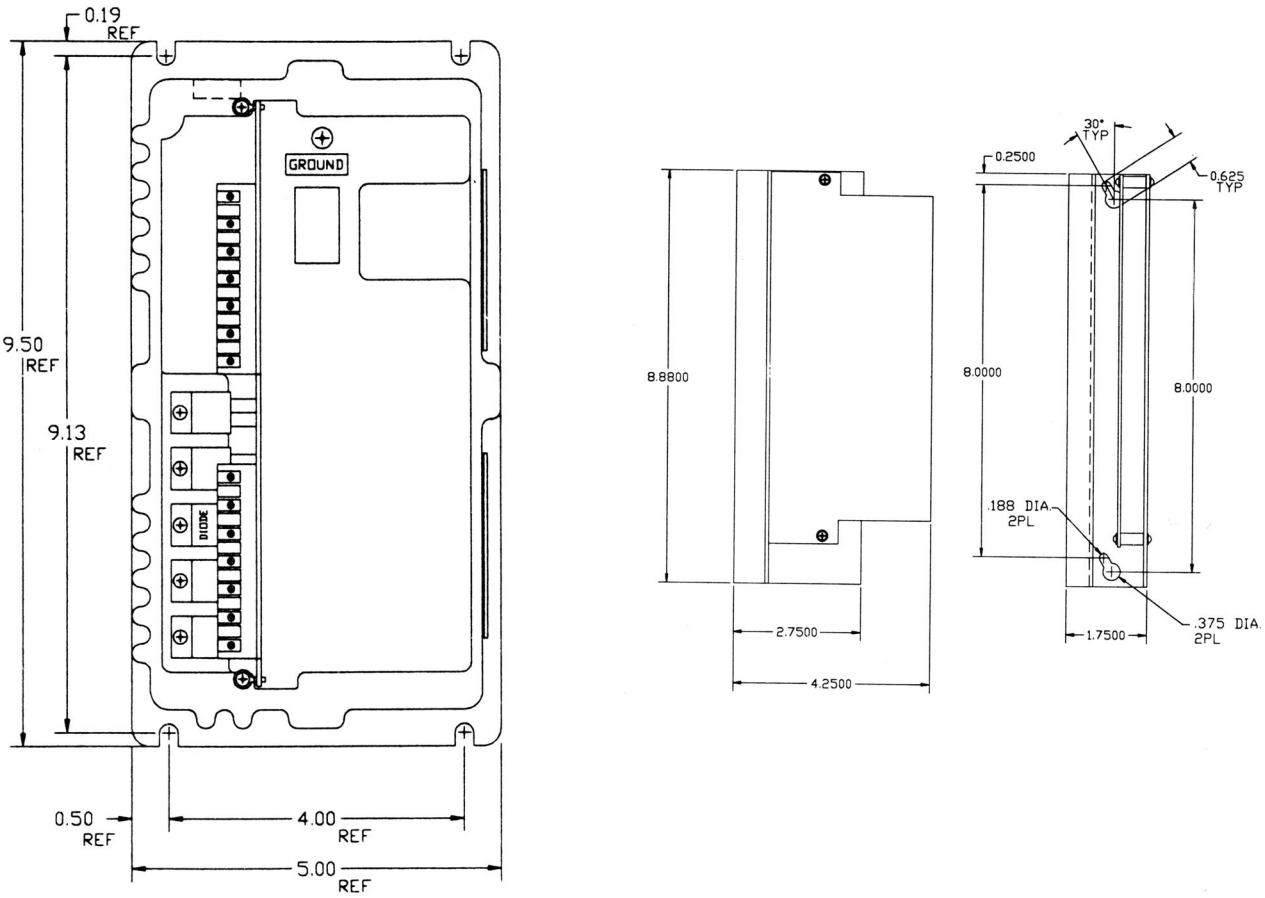


FIGURE 1. BASE MOUNTED CONTROLLER MOUNTING CONFIGURATIONS



BASE MOUNTED UNIT **ANGLE BRACKET CHASSIS UNIT**

FIGURE 2. CONTROLLER MOUNTING DIMENSIONS

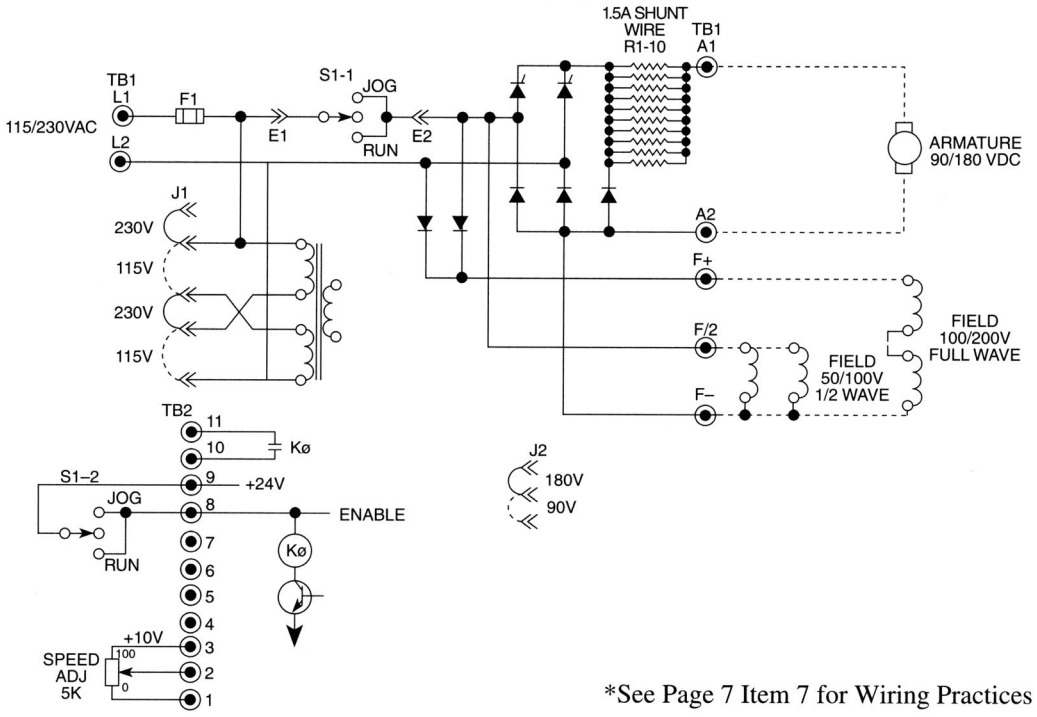


FIGURE 3. LOGIC CONNECTION DIAGRAM, RUN-STOP-JOG SWITCH, 1/6 - 2 HP

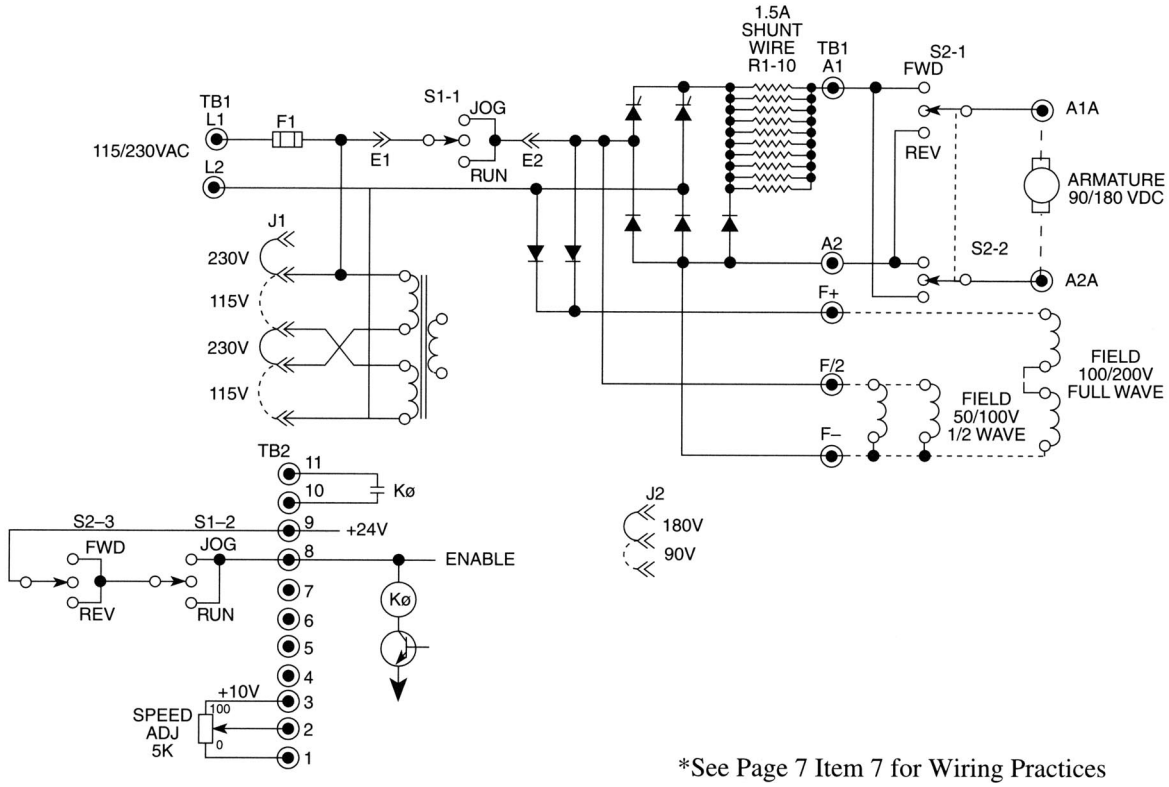


FIGURE 4. LOGIC CONNECTION DIAGRAM, FORWARD-REVERSE SWITCH AND RUN-STOP-JOG SWITCH, 1/6 - 2 HP

FIGURE 5.
LOGIC CONNECTION DIAGRAM, RUN-STOP PUSHBUTTONS AND RUN-JOG SWITCH, 1/6 - 3 HP

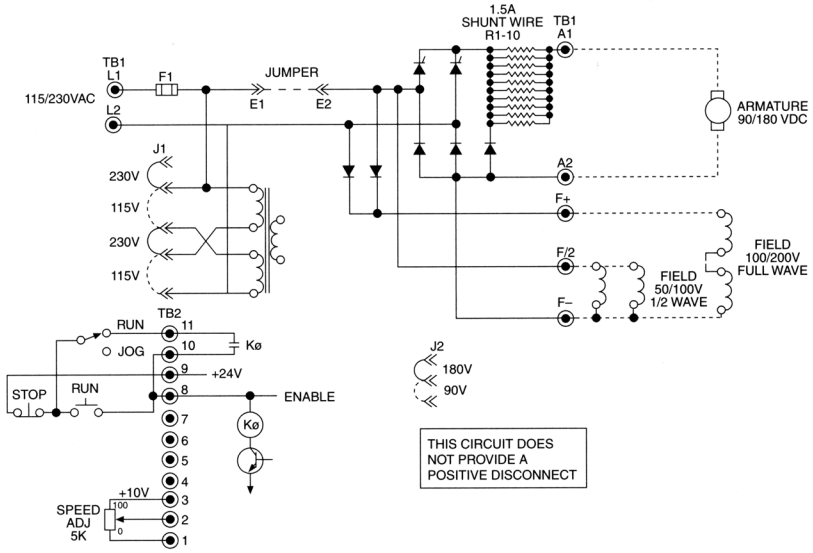


FIGURE 5A.
LOGIC CONNECTION DIAGRAM, WITH UNIDIRECTIONAL ARMATURE CONTACTOR USING RUN-STOP-JOG SWITCH, 1/6-3 HP

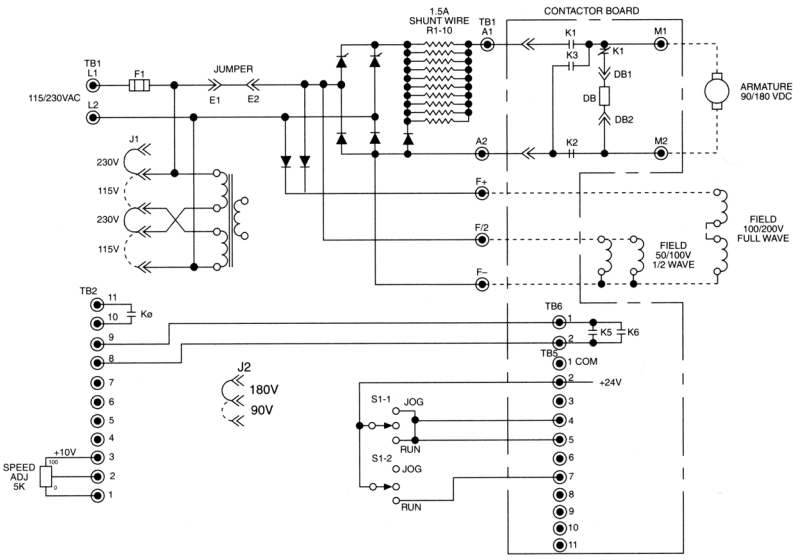


FIGURE 5B.
LOGIC CONNECTION DIAGRAM, WITH UNIDIRECTIONAL ARMATURE CONTACTOR USING RUN-STOP PUSHBUTTONS & RUN-JOG SWITCH, 1/6-3 HP

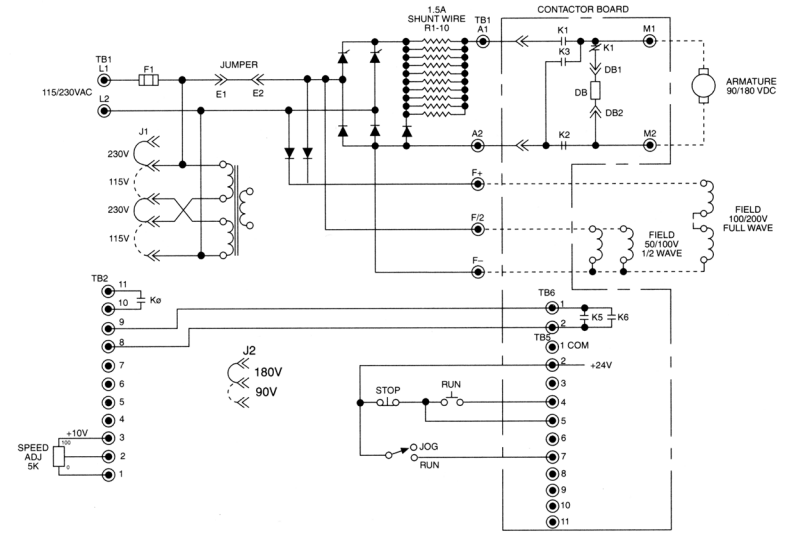


FIGURE 6.
LOGIC CONNECTION DIAGRAM, WITH ARMATURE CONTACTOR REVERSING USING SWITCHES, 1/6 - 3 HP

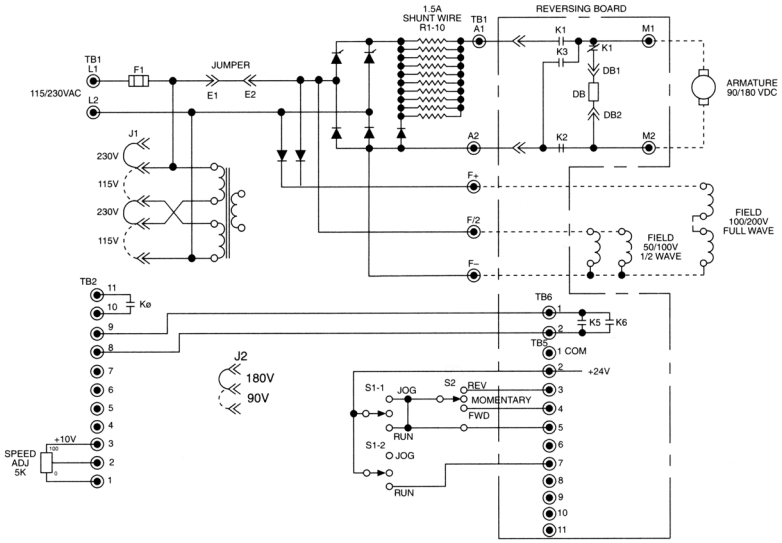


FIGURE 7.
LOGIC CONNECTION DIAGRAM, WITH ARMATURE CONTACTOR REVERSING USING PUSHBUTTONS AND RUN-JOG SWITCH, 1/6 - 3 HP

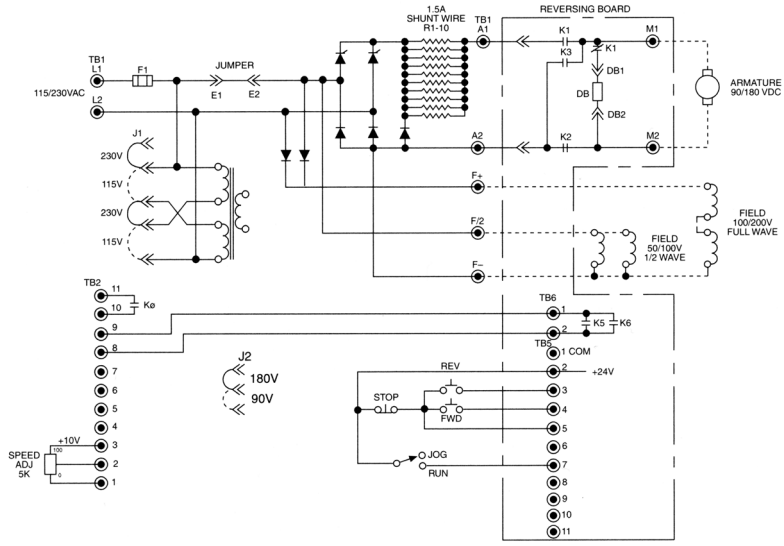
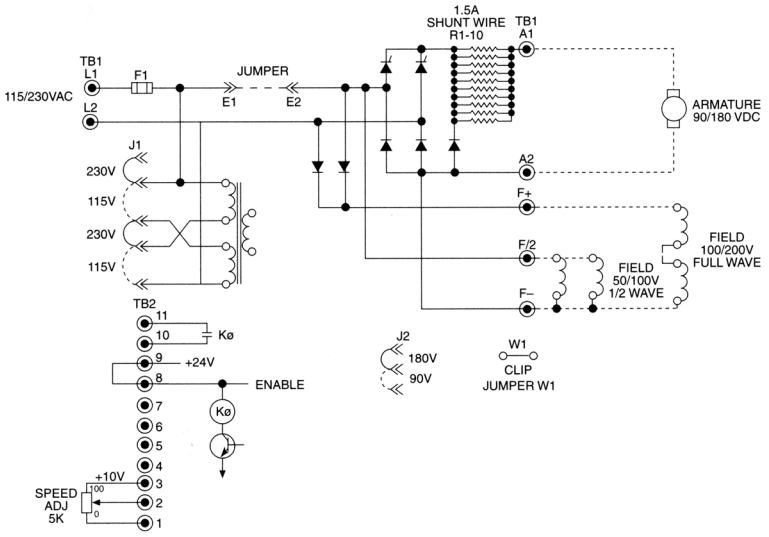


FIGURE 8.
LOGIC CONNECTION DIAGRAM, LINE STARTING WITH MOTOR SPEED POTENTIOMETER, 1/6 - 3 HP



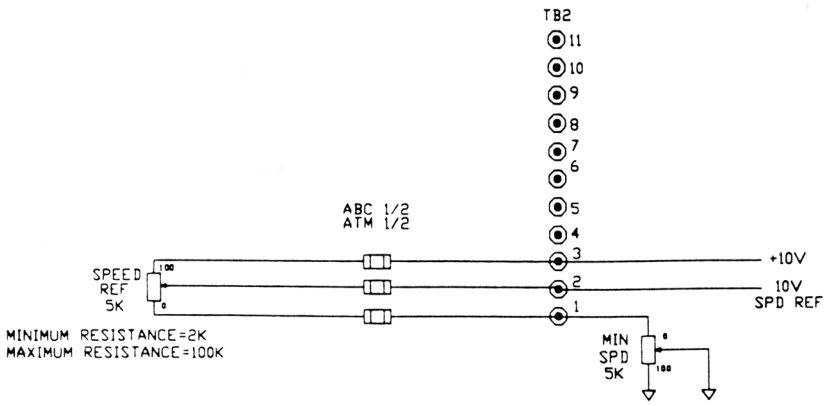


FIGURE 9. SIGNAL CONNECTION DIAGRAM, MOTOR SPEED POTENTIOMETER

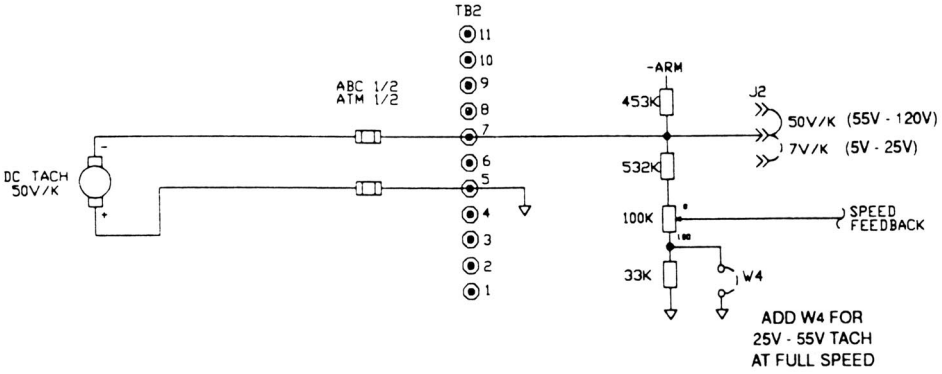


FIGURE 10. SIGNAL CONNECTION DIAGRAM, TACHOMETER FEEDBACK

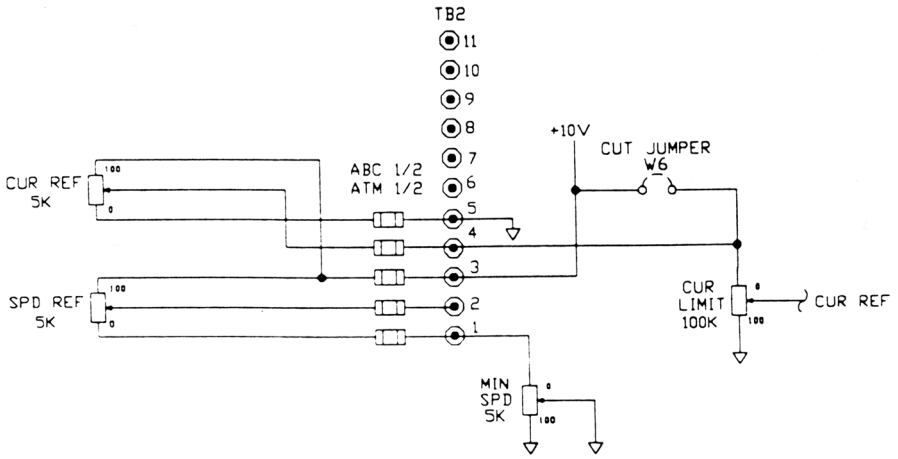


FIGURE 11. SIGNAL CONNECTION DIAGRAM, CURRENT (TORQUE) REFERENCE POTENTIOMETER

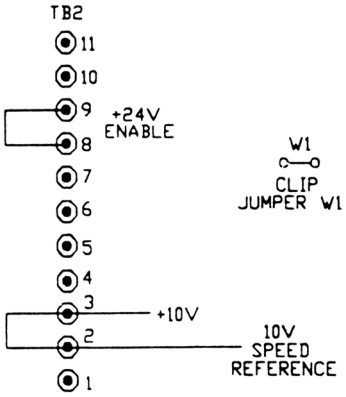


FIGURE 12. SIGNAL CONNECTION DIAGRAM, LINE STARTING WITHOUT A MOTOR SPEED POTENTIOMETER

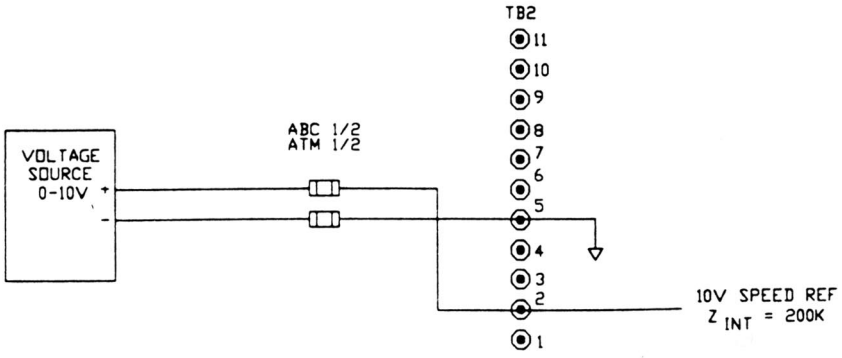


FIGURE 13. SIGNAL CONNECTION DIAGRAM, EXTERNAL 0 - 10 VDC SPEED REFERENCE SIGNAL

INITIAL STARTUP

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

2. Be sure all wiring is correct and all connections are tightened securely.

3. Be sure the controller is calibrated correctly. See steps 4 and 5 under "Installing The Controller" on pages 7 and 8.

4. Be sure the AC line voltage to the controller agrees with the controller nameplate.

5. The potentiometers in the controller are factory adjusted as shown in Table 4. These settings will provide satisfactory operation for most applications. If different settings are required, refer to "Adjustment Instructions" starting on page 18.

TABLE 4. INITIAL POTENTIOMETER SETTINGS

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

6. Replace the controller cover, if used, and secure it with four cover screws.

7. Switch on the AC power to the controller.

8. Check motor rotation, as follows:

a. If a MOTOR SPEED potentiometer is used, turn it fully counterclockwise. 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, disconnect the AC power to the control, and then interchange the motor armature leads at the motor connection box or at the controller terminal board.

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

Section III – Operation

POWER ON/OFF

The controller energizes when the AC voltage is supplied to the controller.

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: The line starting feature is not recommended for use on equipment where personnel have direct access to operating machinery. Personal injury or loss of life could occur due to the instantaneous starting of the motor without warning when AC power is restored.

NOTE: Whenever the AC supply voltage is applied to the controller, the motor shunt field is energized with rated voltage, and potentially hazardous voltage is present at the motor armature terminals. **These voltages can cause electric shock resulting is personal injury or loss of life.**

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, 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 are connected across the motor armature.

The dynamic braking resistors provide initial braking torque and stops per minute as shown in Table 5.

TABLE 5. DYNAMIC BRAKING CHARACTERISTICS*

COMPONENT	MODEL	RATED VOLTAGE	RATED HORSEPOWER								
			1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3
BRAKING TORQUE (%)	RBA2M	115V	180	129	103	66	44	34	-	-	-
		230V	-	-	-	278	190	130	88	62	-
	RBA3M	115V	300	215	170	110	75	60	-	-	-
		230V	-	-	-	400	320	220	145	105	85
STOPS PER MINUTE	RBA2M	115V	15	12	11	8	6	2	-	-	-
		230V	-	-	-	8	6	1	1	1	-
	RBA3M	115V	9	6	5	5	4	4	-	-	-
		230V	-	-	-	5	4	4	3	3	2

*High Intertia Loads may extend braking time and cause overheating of the dynamic braking resistors.

An antiplug feature, present in the armature contactor board, prevents restarting the motor before the motor has braked to a stop.

JOG

If 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.

NOTE: This control jogs at run speed.

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.

Maximum speed and minimum speed are preset by the MAX SPD and MIN SPD potentiometers, respectively, located on the control board.

REVERSE

To reverse motor rotation on controllers with reversing capabilities, initiate a STOP function and then initiate a reversing command. The motor will then accelerate to the setting of the MOTOR SPEED potentiometer or external speed reference signal, as applicable. Forward and reverse speed ranges are identical.

If a FWD-REV switch is used, it must have a center position interlock, which requires a momentary relaxation of pressure before the opposite position can be engaged. The center position causes a STOP command and allows time for the motor to stop before a REVERSE command is initiated. If a REVERSE command is initiated while the motor is rotating, motor and controller damage may occur.

Armature contactor reversing incorporates an anti-plug feature which requires that the motor be stopped before it can be reversed.

INOPERATIVE MOTOR

If the motor stops and/or won’t start, disconnect the AC Power to the controller, remove the controller cover (if used), and check the AC line fuse on the controller control board. For the location of the fuse, see Figure 16, page 30. If the fuse is blown, refer to the Troubleshooting Table (Table 6), pages 20 - 22.

Section IV – Maintenance and Repair

GENERAL

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

2. Periodically disconnect the AC line 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.

ADJUSTMENT INSTRUCTIONS

NOTE: Use an insulated screwdriver for internal adjustments below.

ACCELERATION

1. Set the MOTOR SPEED potentiometer at 100% or 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 (40 seconds).

4. The acceleration time may be extended by the addition of a capacitor to the control board (contact factory for instructions).

DECELERATION

1. With the motor running at maximum speed, quickly reset the MOTOR SPEED to zero, 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 (40 seconds).

3. The deceleration time may be extended by the addition of a capacitor to the control board (contact factory for instructions).

IR COMPENSATION

IR compensation is used only when the controller is programmed for armature feedback. The IR/COMP potentiometer is factory set at zero (full counterclockwise rotation) for satisfactory operation with most motors. If improved speed regulation is desired, readjust IR compensation as follows:

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

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

MAXIMUM SPEED

The MAX SPD potentiometer is factory set to provide 90 VDC armature voltage with a 115 VAC line, or 180 VDC armature voltage with a 230 VAC line.

To readjust maximum speed, run the motor at maximum speed and adjust the MAX SPD potentiometer for the desired maximum speed.

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

MINIMUM SPEED

1. Turn the MIN SPD potentiometer fully counterclockwise (0%) for zero speed.

2. Set the MOTOR SPEED potentiometer at 0% or the external speed reference signal at minimum, as applicable.

3. Initiate a RUN command and adjust the MIN SPD potentiometer for the desired minimum speed (adjustable from 0 to 40% of motor base speed).

CURRENT LIMIT

1. Turn the CUR LMT potentiometer fully clockwise (100%) to limit motor armature current to 150% of rated.

2. Turn the CUR LMT potentiometer counterclockwise to reduce maximum motor armature current.

NOTE: An external 5K ohm Current (Torque) Reference potentiometer can be used as shown in Figure 11 on page 13. Jumper W6 must be removed from the controller control board if an external Current (Torque) Reference potentiometer is desired.

TROUBLESHOOTING

The following table is provided as a guide to common problems that may occur with a DC motor controller and the corrective action that may resolve that problem.

TABLE 6. TROUBLESHOOTING

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Motor won't start (See "Inoperative Motor" page 17.)	AC line open	Be sure rated AC line voltage is applied to the controller
	Operator controls inoperative or connected incorrectly	Repair accordingly.
	Open circuit between Connectors E1 and E2.	A wire jumper or switch must connect E1 to E2.
	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 8 under, "Installing The Controller."
	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	Turn the ACCEL and CUR LIM potentiometers fully clockwise (100%).
	Open shunt field winding or wiring to the motor shunt field, causing loss of torque (1)	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.
2. Controller line 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.
	SCR 1 and SCR 2 shorted	Replace shorted SCR's or the control board.
	Bridge diode D2 or D3 shorted	Replace shorted diode or the control board.
	Varistor RV1 shorted	Replace RV1 or the control board.
	Shunt field diode D4 or D5 shorted (1)	Replace shorted diode or the control board.
	Motor shunt field shorted or grounded (1)	Repair or replace the motor.
	Control board failure	Replace the control board.
3. Controller line fuse blows when a START command is initiated	One or more SCR's or Diode D1 shorted	Replace shorted devices or the control board.
	Motor shorted or grounded	Repair or replace the motor.
	Control board failure causing SCR's to turn-on fully	Replace the control board.

(continued)

TROUBLESHOOTING

TABLE 6. TROUBLESHOOTING (continued)

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
4. Controller line fuse blows while the motor is running	Motor overloaded	Check shunt field current (1). 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.
	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 or Diode D1 breaking down (shorting intermittently)	Replace shorted devices or the control board.
	Control board failure causing SCR false firing or misfiring	Replace the control board.
5. Minimum speed excessive	Minimum speed not adjusted correctly	Turn the MIN SPD potentiometer counterclockwise.
	Motor armature grounded	Correct ground fault.
	Control board failure	Replace the control board.
6. Maximum speed excessive	Maximum speed set too high	Turn the MAX SPD potentiometer counterclockwise.
	Controller not calibrated correctly	Refer to Steps 4 and 5 on page 7 & 8.
	Open shunt field winding or wiring to the motor shunt field (1)	Check the motor shunt field and associated circuitry for a loose connection or a broken wire. Repair accordingly.
	Motor field demagnetized (2)	Replace the motor.
7. 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 (1). 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 CUR LMT potentiometer clockwise.
	Wrong shunt wires removed	See Step 4 (page 7) and Table 3 (page 8)
	Motor field demagnetized (2)	Replace the motor.
	Control board failure	Replace the control board.

(continued)

TROUBLESHOOTING

TABLE 6. TROUBLESHOOTING (continued)

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
8. 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, incorrect, or grounded	Check all terminals, connections, and wiring between the line, operator controls, controller, and motor.
	Oscillating load connected to the motor	Stabilize the load. Turning the IR/COMP potentiometer counterclockwise may minimize oscillation.
	Voltage selection jumpers J1 and J2 in wrong position	See Step 5 on page 8 under, "Installing The Controller."
	IR compensation not adjusted correctly	See the IR Compensation adjustment instructions on page 18.
	Maximum speed not adjusted correctly	See the Maximum Speed adjustment instructions on page 19.
	Motor faulty	Check motor brushes. Replace if needed. Repair or replace the motor.
	Tachometer generator or coupling faulty (if used)	Repair accordingly.
9. Line and motor armature current excessive	Motor overloaded	Check shunt field current (1). 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.
10. Shunt field current too low (1)	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 12, page 26.
	Diode D2, D3, D4 or D5 failure	Replace faulty diode or the control board.
11. Shunt field current too high (1)	Shunt field connected for incorrect voltage	Check motor rating and refer to Table 12, page 26.
	Shunt field windings shorted	Measure the shunt field resistance and compare with the motor rating. Repair or replace the motor.
12. Motor thermal guard tripped (if used)	Ventilation insufficient	Free the motor intake and exhaust screens from dirt, dust, and debris.
	Excessive motor load at low speed	Reduce the load or increase the speed.
	Line and motor armature current excessive	See Indication 9.
	Motor overheating from friction	Check for misalignment. Realign the motor.
	Shorted motor windings or faulty bearings	Repair or replace the motor.

(1) Does not apply to permanent-magnet motors. (2) Does not apply to shunt-wound motors.

Section V – Parts List

TABLE 7. PARTS LIST, BETA II CONTROLLERS

PART	RATING	BOSTON PART NUMBER	
		RB2	RB3
Control Board	12J, 275	64966	64967
Diode D1, D2, & D3	15A, 600V	64989	N/A
	24A, 600V	N/A	64990
Fuse, Line	30A,600V (ATM-30)	64991	64991
SCR1 & SCR2	15A, 600V	64993	N/A
	55A, 800V	N/A	64994
Run Speed or Current Reference Potentiometer	5 KΩ, 1/2 W	60246	60246
Speed or Current Potentiometer Knob	N/A	60245	60245
Run-Stop-Jog Switch	N/A	50457	50457
FWD-REV Switch (RBA2MR)	N/A	67479	67479
FWD-REV Switch (RBA2R)	N/A	67478	N/A
Reversing Board (“M” Suffix)	N/A	64908	64905
Unidirectional Board (“U” Suffix)	N/A	57890	57891

Section VI – Ratings and Specifications

RATINGS

1. Duty ..... Continuous

2. Horsepower Range ..... 1/6 - 3 HP (See Table 1, Page 5)

3. Line Fuse Interrupting Capacity ..... 100,000 Amperes

4. Line Power ..... 115V Or 230V, Single-Phase, 50 Or 60 Hz

5. Motor Speed Potentiometer ..... 5K Ohms, 1/2W

6. Overload Capacity, Armature Circuit ..... 150% For 1 Minute

7. Service Factor 1.0

TABLE 8. TYPICAL APPLICATION DATA

COMPONENT			RATINGS								
RATED HORSEPOWER (HP)			**1/6**	**1/4**	**1/3**	**1/2**	**3/4**	**1**	**1-1/2**	**2**	**3**
RATED KILOWATTS(kW)			**0.124**	**0.187**	**0.249**	**0.373**	**0.560**	**0.746**	**1.120**	**1.492**	**2.238**
1-PHASE AC INPUT (FULL-LOAD)	Line Amps	115V Unit	3.9	5.0	6.0	8.7	12.4	15.8	-	-	-
		230V Unit	-	-	-	4.2	5.9	8.8	12.6	15.8	22.0
	KVA		0.48	0.58	0.71	1.00	1.40	2.00	3.00	4.00	5.00
DC OUTPUT (FULL-LOAD)	Motor Armature Amps	90V	2.0	2.8	3.5	5.4	8.1	10.5	-	-	-
		180V	-	-	-	2.6	3.8	5.5	8.2	11.6	15.1
	Motor Field Amps (Maximum)	RBA2 Series	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-
		RBA3 Series	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
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
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

TABLE 9. OPERATING VOLTAGES AND SIGNALS

POWER SOURCE (Single-phase)	OUTPUT VDC		SPEED REFERENCE SIGNAL*	MAGNETIC CONTROL VOLTAGE	TACHOMETER FEEDBACK VOLTAGE**
	Armature	Field			
115V, 50 or 60 Hz	0-90	50/100	0-10 VDC	24 VDC	5-120 VDC
230V, 50 or 60 Hz	0-180	100/200			

* Speed reference signal must be ungrounded

**At maximum motor speed

RATINGS (continued)

TABLE 10. CONTROLLER WEIGHTS

Controller Model	Weight – LBS (KG)
RBA2C	0.9 (0.41)
RBA2CU, RBA2CM	1.7 (0.77)
RBA2, RBA3	3.25 (1.48)
RBA2U, RBA2M RBA3U, RBA3M	3.8 (1.75)
RBA2B, RBA2B-WD RBA2S, RBA2S-WD RBA2R, RBA2R-WD	5.5 (2.50)
RBA2UB, RBA2UB-WD RBA2US, RBA2US-WD RBA2MB, RBA2MB-WD RBA2MR, RBA2MR-WD	6.05 (2.74)

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 Speed Range ..... 0 to Motor Base Speed

2. Efficiency (Rated Speed/Rated Load)

a. Controller Only 98%

b. Controller With Motor, Typical 85%

3. Speed Regulation ..... Regulation percentages are of motor base speed under steady-state conditions.

TABLE 11. SPEED REGULATION CHARACTERISTICS

Regulation Method	Variable				
	Load Change (95%)	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
Optional Speed (Tach) Feedback*	0.5%	±1%	0.2%	±2%	200:1

*Unidirectional models only.

ADJUSTMENTS

1. Acceleration, Linear ..... 0.2 - 40 Seconds
2. Deceleration, Linear ..... 0.2 - 40 Seconds
3. IR (Load) Compensation..... 0 To 10% Boost
4. Jog Speed..... 0 - 100% Of Motor Base Speed
5. Maximum Speed..... 50% - 100% Of Motor Base Speed
6. Minimum Speed ..... 0 - 40% Of Motor Base Speed
7. Torque (Current) Limit..... 0 - 150% Of Full-Load Torque

SPECIFICATIONS

1. **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.
2. **AUXILIARY CONTACT –** A normally-open Form A relay contact, rated 5 ampere @ 115 VAC and 30 VDC, is available for external use. The relay energizes when a RUN command is initiated, and de-energizes when a Normal STOP command is initiated, the overload monitor trips, or the anti-restart circuit is activated.
3. **FIELD SUPPLY –** A half-wave or full-wave shunt field supply is available as shown in Table 12.

TABLE 12. SHUNT FIELD DATA

Controller Rating (VAC)	Shunt Field Voltage (VDC)		Motor Shunt Field Lead Connections	
	Half-Wave	Full-Wave*	F1	F2
115	50		F+	F/2
		100	F+	F-
230	100		F+	F/2
		200	F+	F-

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

4. **MOTOR CONTACTOR –** Controller model numbers with an ‘M’ or ‘U’ in the suffix, e.g., RBA2MR, RBA3U, 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.
5. **POWER CONVERSION –** The DC power bridge consists of two SCR’s, two diodes, and a freewheeling diode. Each device is rated at least 600 PIV. The controller base forms an integral heat sink, with the power devices electrically isolated from the base.
6. **SELECTABLE CAPABILITIES –** Wire jumpers allow the user to select various modes of operation, as follows:
   a. LINE STARTING - By clipping Jumper W1, the ‘anti-restart’ feature will be disabled, and the controller may be started and stopped with an external AC line contactor. However, a wire jumper must be connected between TB2-8 and TB2-9. If full speed operation is desired, connect another wire jumper between TB2-2 and TB2-3.

b. TACHOMETER FEEDBACK - To use tachometer feedback with armature feedback backup, connect the tachometer generator signal to TB2-7 (-) and TB2-5 (+), and select the tachometer generator voltage at maximum motor speed by using Jumpers J2 and W4, as follows:

TABLE 13. TACHOMETER FEEDBACK VOLTAGE SELECTION

TACH VOLTAGE AT MAX. MOTOR SPEED	JUMPER J2	JUMPER W4
5 - 25VDC	90V (Down)	Out
25 - 55VDC	90V (Down)	In
55 - 120VDC	180V (Up)	Out

If rectifier is used to rectify the polarity of a DC tachometer generator, e.g., a reversing application, or to rectify an AC tachometer generator, a 15K ohm, 1 watt load resistor must be connected across the output of the rectifier. Since armature feedback backup only occurs when the tachometer circuit opens, the rectifier and resistor should be installed at the tachometer generator (not at the controller), thereby enabling the controller to detect open wiring between the tachometer generator and the controller. See Figure 10, page 13. Adjustment of maximum speed in the tachometer feedback mode is done with the maximum speed pot (R15) on the control board.

c. TORQUE REGULATOR - The controller will function as a torque regulator when Jumper W6 is clipped. This allows an external potentiometer to set maximum motor torque (0 - 150% of rated). See Figure 11, page 13.

7. 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.

Section VII – Drawings

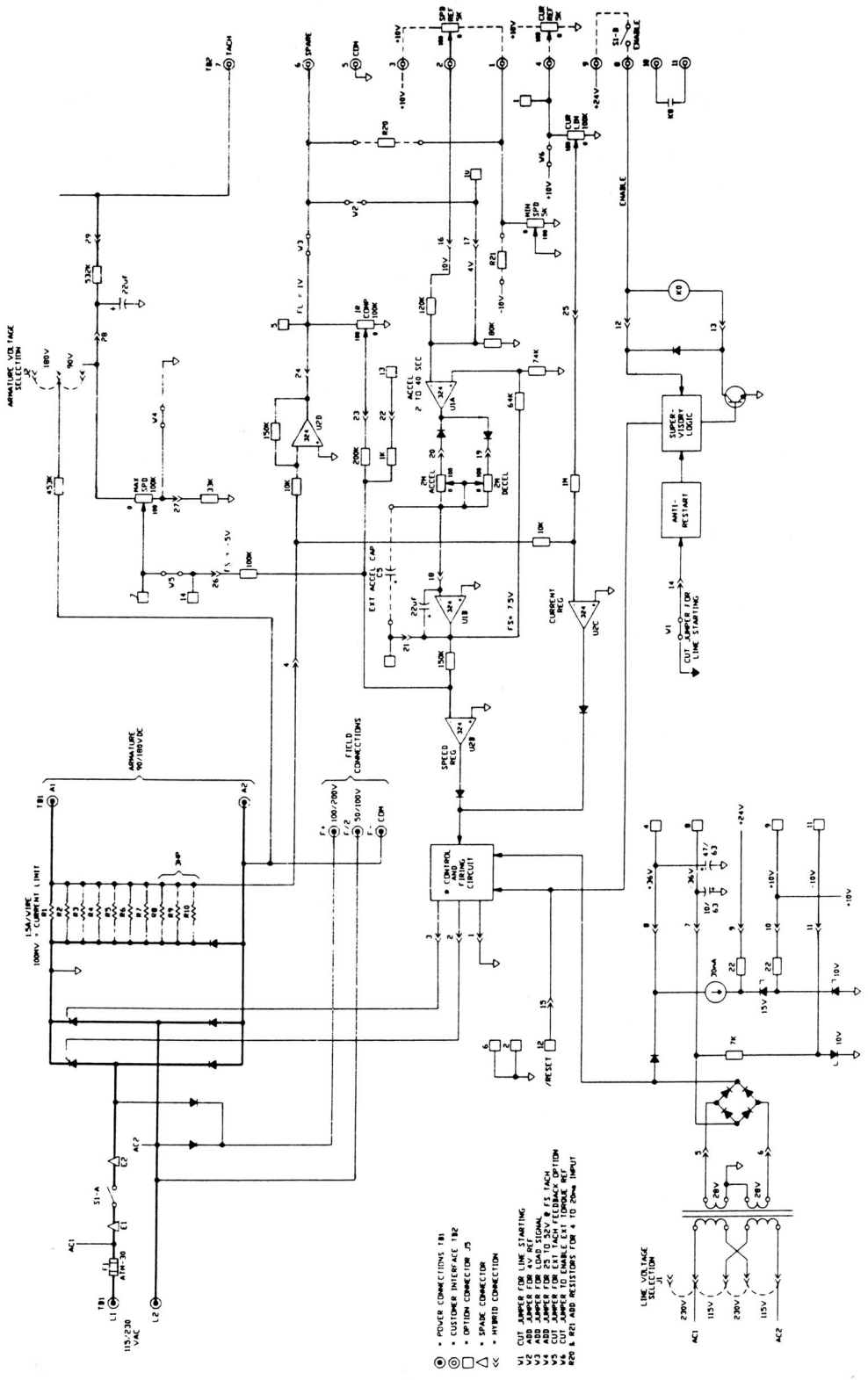


FIGURE 14. FUNCTIONAL SCHEMATIC, BETA II

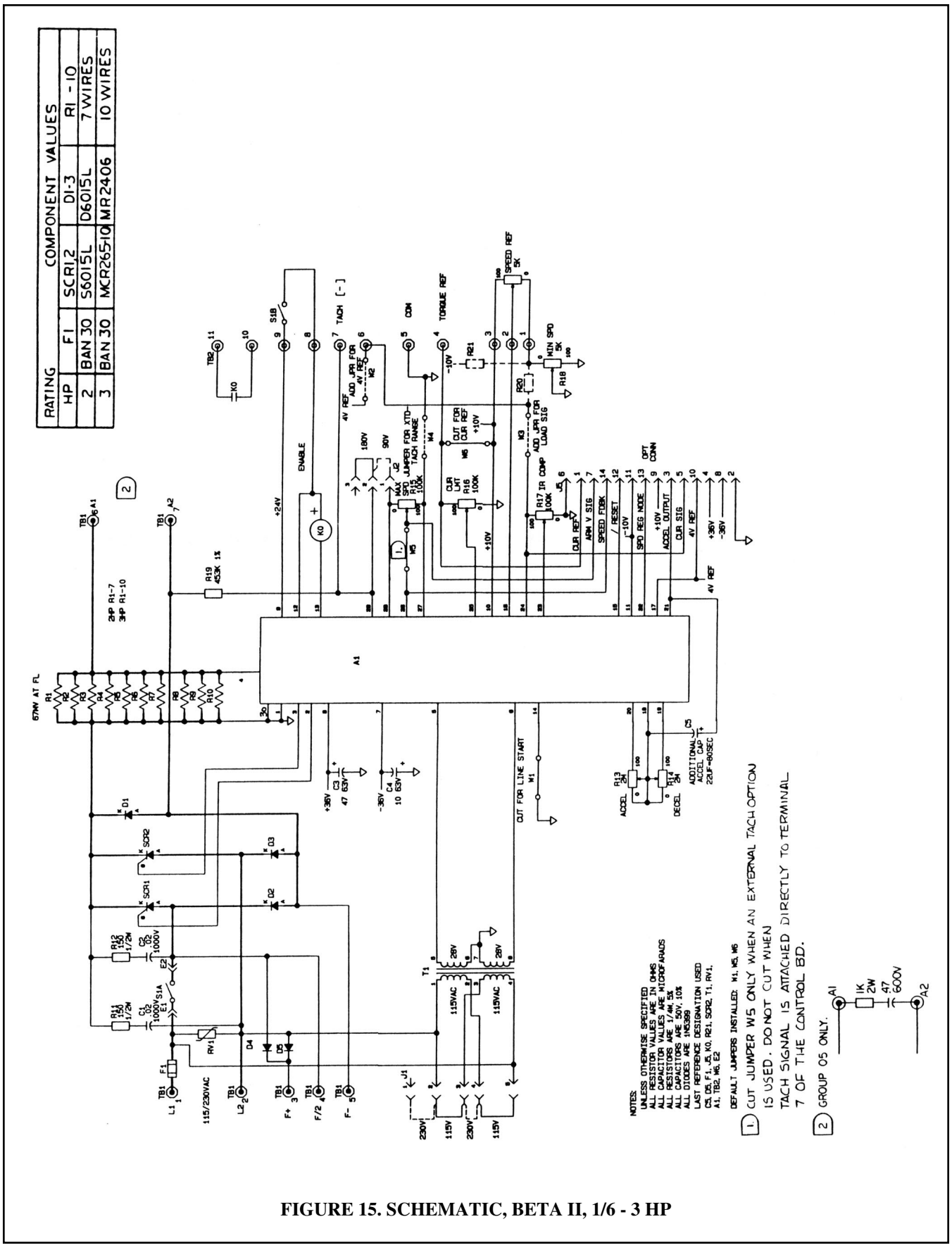


FIGURE 15. SCHEMATIC, BETA II, 1/6 - 3 HP

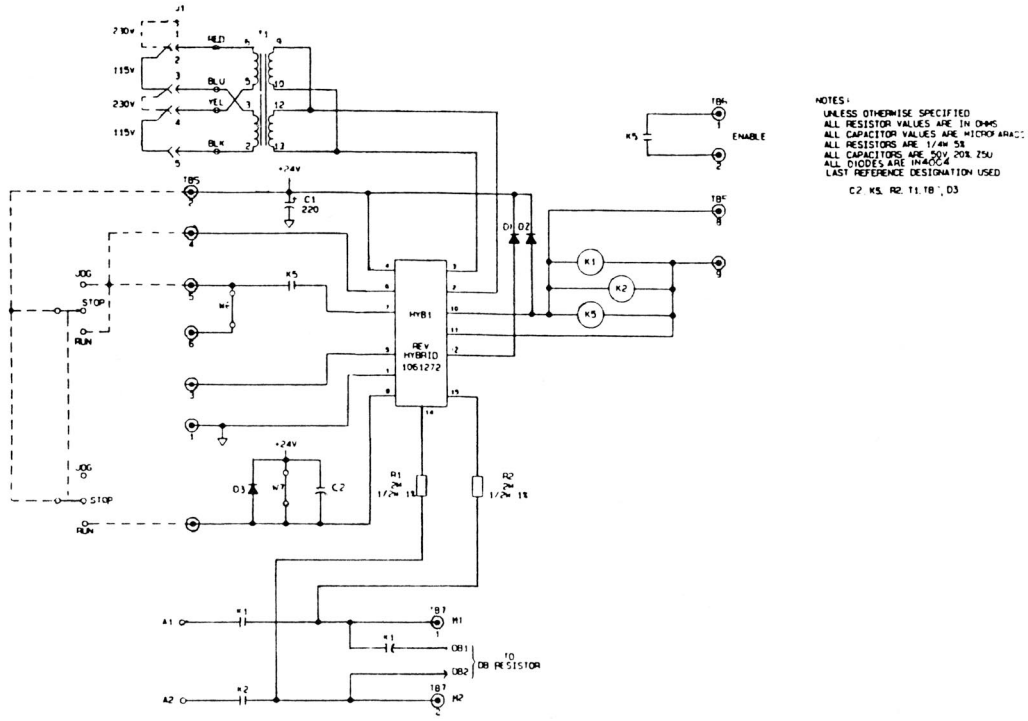


FIGURE 15A. SCHEMATIC, UNIDIRECTIONAL ARMATURE CONTACTOR BOARD

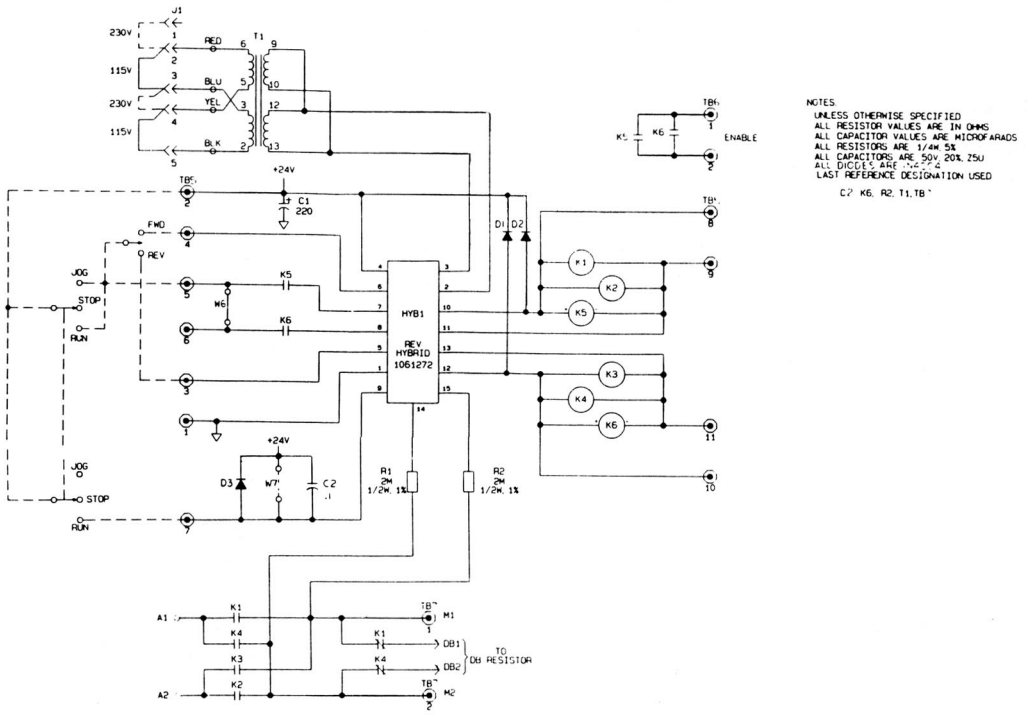


FIGURE 15B. SCHEMATIC, REVERSING ARMATURE CONTACTOR BOARD

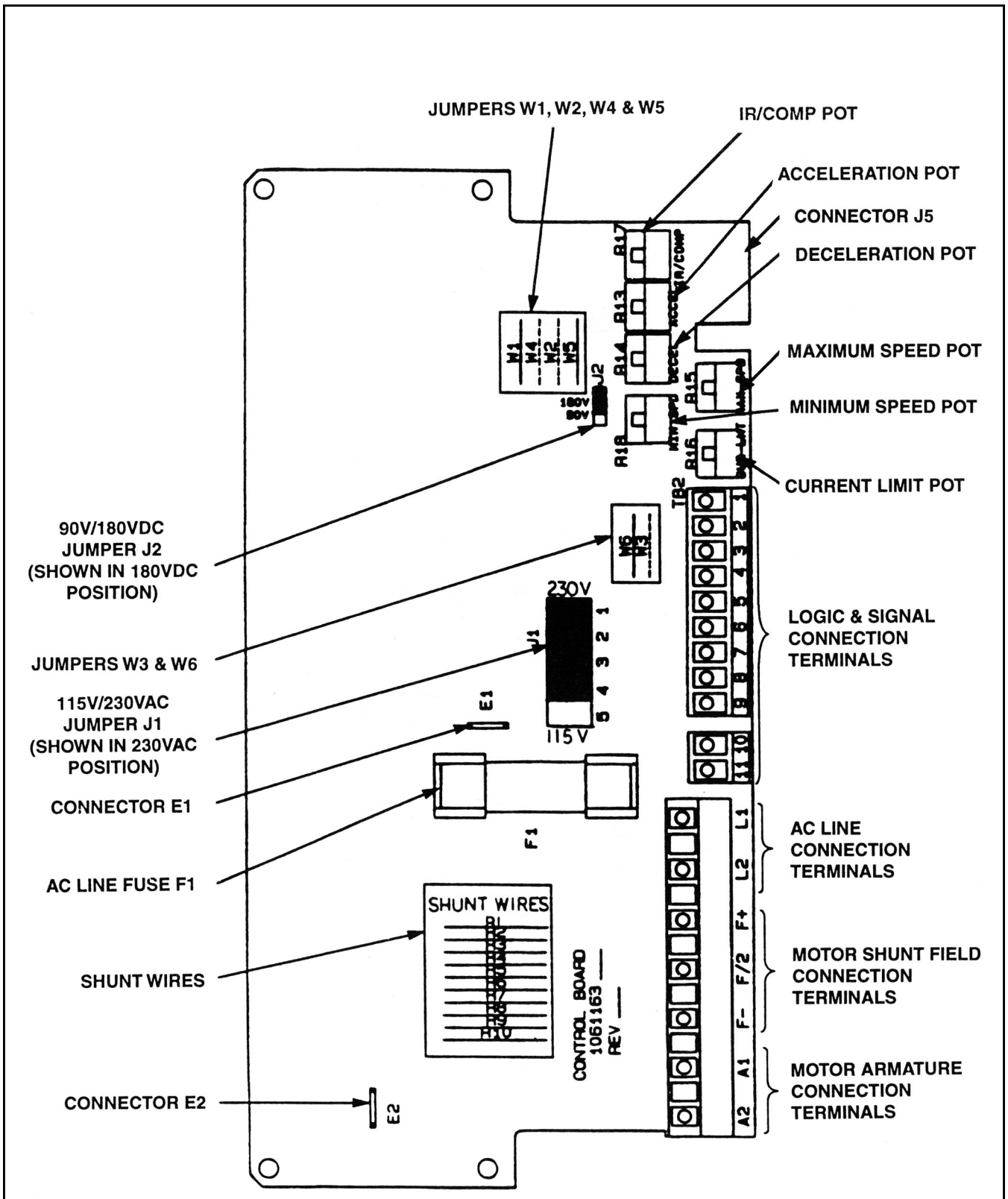


FIGURE 16. BETA II CONTROL BOARD, 1/6 - 3 HP

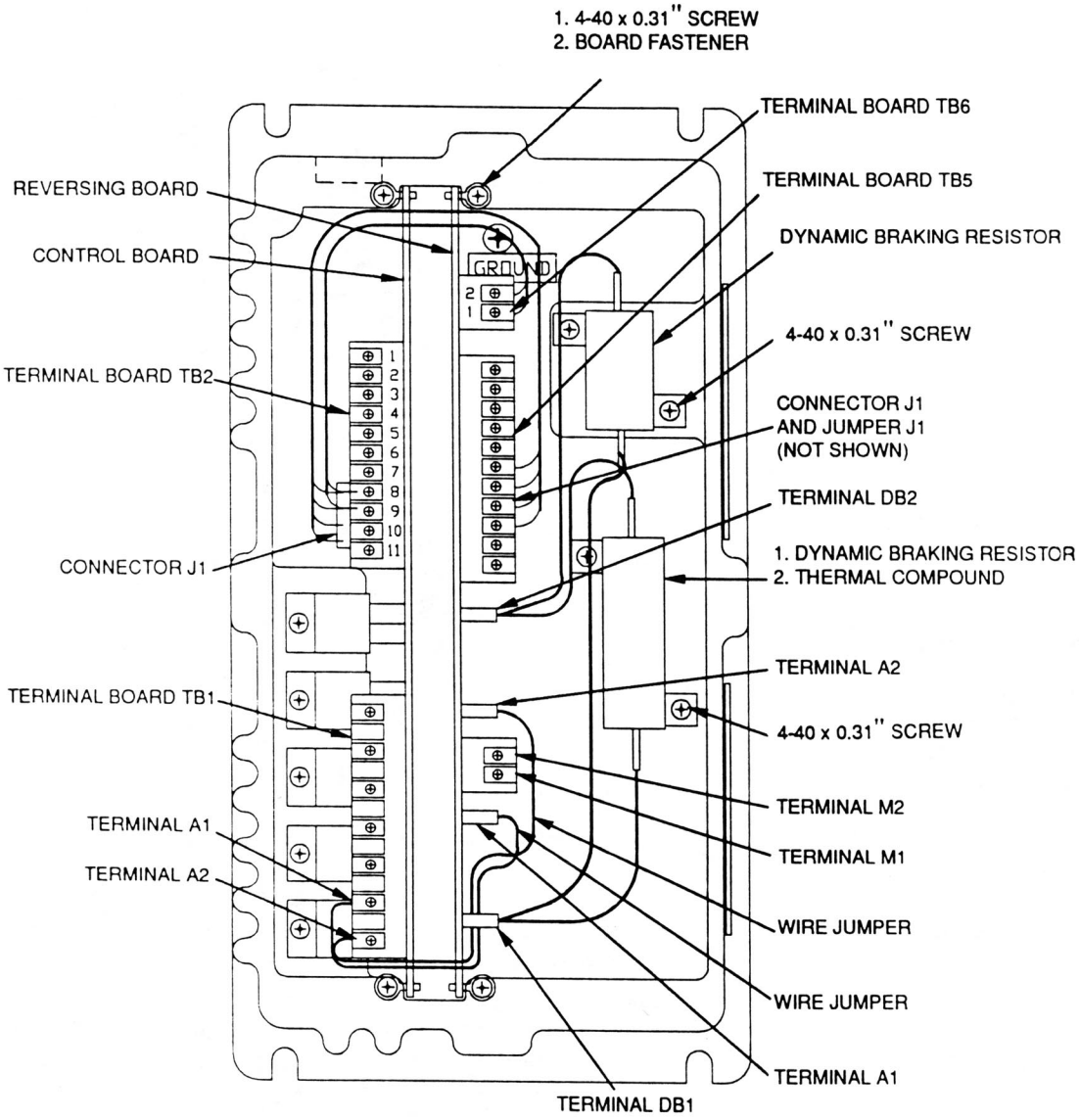


FIGURE 17. BOARD LAYOUT DRAWING

(57762)
Printed in U.S.A.

Boston Gear
14 Hayward Street
Quincy, MA 02171
tel 617.328.3300
fax 617.479.6238
www.bostongear.com