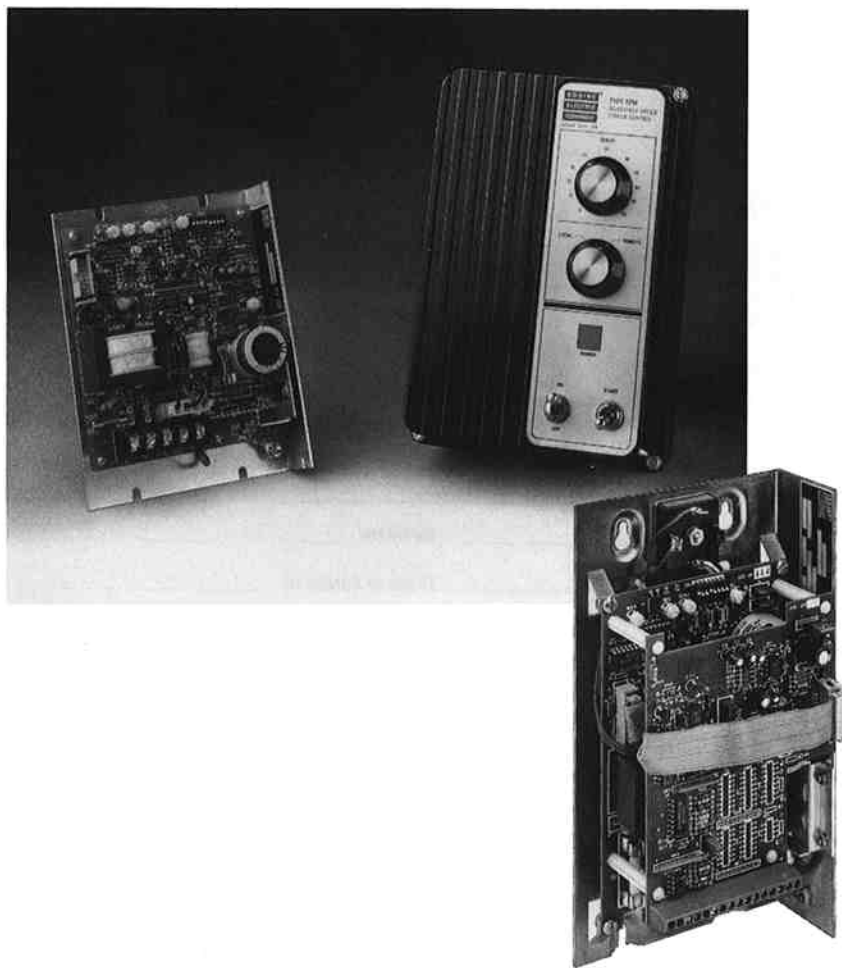

Instructions for Installation and Operation

Type-FPM Controls with

Analog Interface Boards



BODINE®
ELECTRIC
COMPANY

QUALITY
IN
MOTION®

Manual No. 074 00157 E

BODINE LIMITED WARRANTY

The Bodine Electric Company warrants all products it manufactures to be free of defects in workmanship and materials when used under normal operating conditions and when applied in accordance with nameplate specifications. Bodine motors and gearmotors purchased with and used only with appropriately applied Bodine controls are covered by this warranty for a period of 24 months from the date of purchase or 30 months from date of manufacture, whichever comes first. Bodine motors and gearmotors used with non-Bodine controls and Bodine controls used with non-Bodine motors and gearmotors are covered by a 12 month warranty period. The Bodine Electric Company will repair or replace, at its option, any of its products which has been found to be defective and within the warranty period, provided that the product is shipped freight prepaid, with previous authorization, to Bodine or to a Bodine Authorized Service Center. Bodine is not responsible for removal, installation, or any other incidental expenses incurred in shipping the products to or from Bodine. This warranty is in lieu of any other expressed or implied warranty - including, but not limited to, any implied warranties of merchantability and/or fitness for a particular use. Bodine's liability under this warranty shall be limited to repair or replacement of the Bodine product and Bodine shall not be liable, under any circumstances, for any consequential, incidental or indirect damages or expenses associated with the warranted products. Proof of purchase of motor or gearmotor and matching control as a system must be provided with any claim.

All data subject to change without notice.

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CONGRATULATIONS!...and thank you for selecting a **Bodine Type-FPM Adjustable Speed PM Motor Control**. Your new control will provide the same excellent performance and reliability that have been characteristic of Bodine products since 1905. We call it ADE (After Delivery Economies).

Bodine Electric Company takes pride in the quality of its products and in the ultimate satisfaction of its customers. Every effort is made to provide products free of defective design, workmanship, and materials. It will be considered a favor to have cases of unsatisfactory service from Bodine products brought to our attention.

ABOUT THIS MANUAL

This manual contains the basic information needed to operate a Bodine Type-FPM SCR control with Analog Interface Card. It is organized in a systematic, step-by-step fashion so that the system may be set up *safely* in the shortest possible time.

IMPORTANT

Read this manual completely and carefully. Pay special attention to the warnings, precautions, and safety rules listed. Failure to follow the instructions could produce safety hazards to personnel or lead to damage of the control and/or feature boards.

PRODUCT DESCRIPTION

Bodine's versatile Type-FPM SCR controls are intended for use with Bodine's 130VDC Permanent Magnet (PM) 1/50 to 1/3 Hp motors. Each control can cover a range of horsepower, and can be adjusted for use with a particular Bodine motor by simply setting a "DIP switch" and selecting the proper armature fuse (See pages 12 and 13).

The FPM Analog Interface Board accepts an external voltage or current speed input signal from an analog output port of a programmable logic controller or other device and outputs an optically isolated voltage signal to the driver board to control motor speed (direction can also be controlled if the optional Electronic Forward-Brake-Reverse (F-B-R) Board (Model No. 890) is used). Models are also available with integral Digital Interface Boards, or electronic F-B-R Boards.

Type-FPM controls provide pure DC (negligible ripple, Form Factor 1.0) to the motors. Compared to unfiltered 90VDC SCR controls (Form Factor 1.6), Bodine's FPM controls can provide as much as 92% more continuous motor torque output or 46% lower motor operating temperature, longer brush and commutator life, and smoother low-speed motor rotation.

SPECIFICATIONS

INPUT VOLTAGE ¹	115VAC \pm 10% 50/60 Hz SINGLE PHASE
INPUT CURRENT	
Models 810 thru 818	2.9 Amps AC
Models 830 thru 838	4.2 Amps AC
Models 850 thru 858	9.0 Amps AC
ARMATURE VOLTAGE (Nominal)	0-130VDC
ARMATURE CURRENT (Max. Continuous)	
Models 810 thru 819	0.50 Amps DC
Models 830 thru 833	1.25 Amps DC
Models 850 thru 853	2.30 Amps DC
AMBIENT TEMPERATURE (Max.)	
Chassis	0 to 50°C
Encased	0 to 40°C
SPEED REGULATION (Typical)	2%
SPEED RANGE (Typical)	up to 42:1
LINE VOLTAGE COMPENSATION	1.5%
ELECTRONIC F-B-R BOARD	10 reversals per minute MAX. ²
ACCELERATION TIME	0.5 to 10 sec. (adjustable)

Notes:

- ¹ For 220/240VAC single-phase operation, a 2:1 step-down isolation transformer may be used. Signal Transformer Type DU-1 (1KVA) is recommended for Models 850 to 858, and Type DU-1/2 (.5 KVA) for Models 810 to 838.
- ² The number of reversals are limited to 4 max. with model 858 when using motor type 42D7, unless the brake resistor is mounted outside the enclosure

Standard Features Include:

- Industrial Quality Enclosure (Encased Models 815-8, 835-8, 855-8)
- Terminal Block for Easy Electrical Connections
- L-Bracket/Heat Sink for Simplified Mounting
- Inhibit Function Standard on Models 810, 830, and 850
- Adjustable Acceleration
- Temperature Compensation
- Line and Armature Fuses
- Tight Speed Regulation
- Line Voltage Compensation
- Optical Isolation with Interface Boards
- On-board Torque (Current) Limiting, Speed Regulation, and Min/Max Speed Adjustments
- Wall Mounting Provisions for Encased Controls

Optional Features Include:

- Mechanical F-B-R Kits for Chassis Controls Only
- Electronic F-B-R Kit (for Chassis Controls and Encased Models 815, 835, and 855)
- Local/Remote Control Kit (for Chassis Models 811, 812, 831, 832, 851, 852, Standard on Encased Models 816, 817, 836, 837, 856, 857)

SAFETY PRECAUTIONS

The following safety precautions must be observed during all phases of operation, service, and repair of this electronic drive/motor product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture and intended use of the products. Bodine Electric Company assumes no liability for the customer's failure to comply with safety requirements and practices.

Warnings, such as the example below, highlight potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages capable of causing death may be present in the electronic control and motor. Use extreme caution when handling, testing, and adjusting. Properly guard the electronic control and motor to prevent accidental contact by both knowledgeable and unknowledgeable persons.

"The use of electric motors and generators, like that of all other utilization of concentrated power, is potentially hazardous. The degree of hazard can be greatly reduced by proper design, selection, installation, and use, but hazards cannot be completely eliminated. The reduction of hazard is the joint responsibility of the user, the manufacturer of the driven or driving equipment, and the manufacturer of the control or motor or generator." *

Bodine products are designed and manufactured to comply to applicable safety standards and in particular to those issued by ANSI (American National Standards Institute), NEMA (National Electrical Manufacturers Association), U.L. (Underwriters Laboratories, Inc.), and CSA (Canadian Standards Association).

- * Standards Publication No. ANSI C5.1/NEMA MG-2. "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators."

Available from:

National Electrical Manufacturers Association
2101 L Street N.W.
Washington, D.C. 20037, U.S.A.

Most Bodine products are "third party approved" with respect to construction. Type-FPM chassis controls "recognized by U.L., Inc." are designated by having a "UL" symbol in the upper right corner of their nameplates. In addition, most products are CSA certified, identified by a "CSA" symbol. If you need specific information regarding the "third party approval" status of Bodine products, contact the nearest Bodine representative, or the home office.

However, since even well-built apparatus can be installed or operated in a hazardous manner, it is important that safety considerations be observed by the user. With respect to the load and environment, the user must properly select, install, and use the apparatus—for guidance on all three aspects see safety standards publication No. ANSI C5.1/NEMA MG-2 (footnoted on page 6).

WARNING

The chance of explosions, fires, or electric shocks can be reduced through thermal and over-current protection, good maintenance, and proper grounding and enclosure selection. The following safety considerations are not intended to be all-inclusive, and the references mentioned elsewhere in this manual should be consulted.

GROUNDING

Both electronic controls and motors must be securely mounted and adequately grounded. Failure to ground properly may cause serious injury to personnel.

FUSING

Both the control input and output are fused. If fuses must be replaced, they must always conform to the values and ratings specified on the control's nameplate.

LIVE CIRCUITRY

Open-type electronics should be properly guarded or enclosed to prevent accidental human contact with live circuitry. No work should be performed on or close to the control or motor (including brush examination or replacement) while the control is connected to the AC line. If an AC line switch is used, it should be a Double Pole Single Throw (DPST), so that both sides of the AC line can be disconnected.

ENVIRONMENT

Sparking of brushes in commutated DC motors occurs during normal operation. In addition, open controls or controls in ventilated enclosures may emit flame during failure. Bodine's totally enclosed products are not explosion-proof, and Bodine does not offer an explosion-proof motor, gearmotor, or control for hazardous locations (e.g., in an environment of flammable or explosive gas, vapor, or dust). Bodine recommends use of only *approved* explosion-proof products in hazardous locations. Exceptions are allowed by the National Electric Code (NEC), but NEC and NEMA safety standards should be studied thoroughly before exercising this option. Moisture will increase the electrical shock hazard of electrical insulation. Therefore, open-type or unsealed controls not specifically designed for such use, should be protected from and should not come into contact with liquids or moisture.

VENTILATED PRODUCTS

Open, ventilated products are suitable for clean, dry locations where cooling air is not restricted. Do not insert anything into a product's ventilation openings.

SERVICING

Emergency field repairs must be made only by qualified electronic personnel. Repairs made by persons not authorized by the Bodine Electric Company will void the warranty. Normal field repairs must be limited to replacing an entire printed circuit board assembly. Because of the danger of introducing safety hazards, do not install substitute parts or perform any unauthorized modifications to electronic PC boards or motors. Return the electronic control or motor to Bodine Electric Company for servicing to ensure continued compliance with the design precautions against potential fire and/or shock hazards.

This manual does not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance—and no warranty of fitness for purpose is expressed or implied. Should further information be desired or should particular problems arise which are not covered sufficiently for the user's purpose, the matter should be referred to the Bodine Electric Company.

The issuance of this manual does not confer to the recipient any license to manufacture under any patents owned or controlled by the Bodine Electric Company.

PREPARING THE CONTROL

REVIEWING YOUR CONTROL SELECTION

Before proceeding with the installation, review the application to confirm that the proper motor and speed control have been selected. This should be done after reading this manual and all applicable safety standards. If in doubt, contact your Bodine Representative, or the Home Office if there is no Representative in your area. Any selection or application suggestions made by Bodine Electric Company are only to assist the customer—and in all cases, determination of fitness for purpose or use is solely the customer's responsibility.

Unless otherwise agreed to by Bodine Electric Company, all control nameplate ratings are based on the following normal operating conditions:

1. Duty—8 hours per day; 5 days per week, without frequent reversals or starts and stops.
2. Ambient temperature should not exceed 40°C (104°F) for all *encased* controls. The maximum ambient temperature is 50°C (122°F) for chassis controls.
3. Voltage—Within 10% of nameplate rating.
4. Frequency—Within 5% of nameplate rating.
5. Combined variation of voltage and frequency—Within a total of 10% providing frequency variation does not exceed 5%.

Consult Bodine Electric Company if variations from the above conditions are contemplated.

INSPECTING THE CONTROL

Please examine your control (and any option kits, if ordered) carefully for shipping damage. Check to be certain that the control you ordered is the one in front of you. Also check any option kits you received. Any claim(s) for shipping damages should be made to the freight carrier.

INSTALLING THE CONTROL

WARNING

It is the responsibility of the equipment manufacturer or individual installing the apparatus to take diligent care in installing it. The National Electrical Code (NEC), sound local electrical and safety codes, and when applicable, the Occupational Safety and Health Act (OSHA) should be followed when installing the apparatus to reduce hazards to persons and property.

MOUNTING THE CONTROL PROPERLY

The mounting template (provided in the shipping box) can be used to facilitate mounting the control. The control may be mounted in any position. For encased controls, refer to the mounting template for instructions.

WARNING

User must provide a proper enclosure for chassis type controls. Circuitry is not at ground potential. No work should be performed on or close to the control while it is connected to the AC line.

CONNECTING THE DRIVER BOARD

WARNING

Disconnect the 115VAC power line to the control before making electrical connections or replacing motor brushes. Connection of the power line should be the very last connection made. Please follow the instructions carefully.

NOTE: Any exposed circuit boards should be handled in a static-protected area. The feature boards use CMOS circuitry. Static discharge into the feature boards must be avoided.

All encased controls accept 1/2-inch liquid-tight conduit fittings. For wire sizes and electrical connections refer to the National Electrical Code (NEC)—Article 430—"Motors, Motor Circuits, and Controllers" and/or applicable local area codes. If extension cords are used, they should be kept short for minimum voltage drop and optimum performance. Only copper wire with 60°C rated insulation is recommended. The terminal block will accept leads up to 14 gauge (18 gauge is the smallest recommended size). Please also review the safety notes on pages 6, 7, 8, and 10. The barrier terminal block (TB1) screws should be tightened to 6 lb-in.

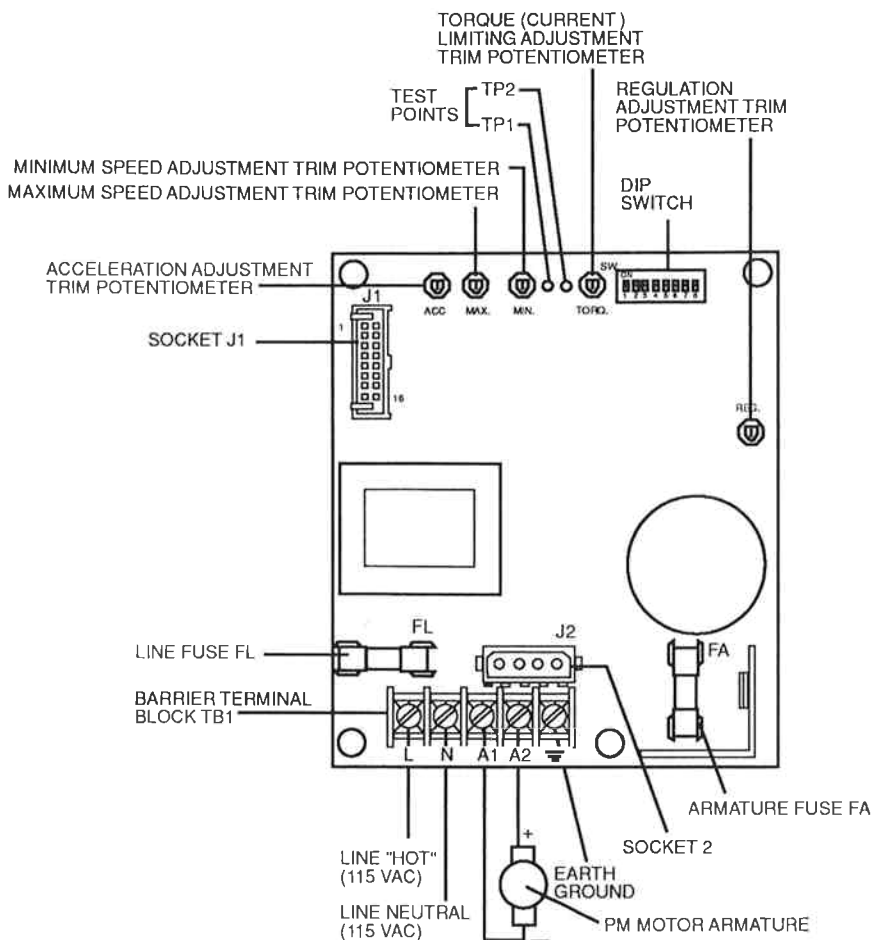


Figure 1

Top View of Driver Board (Models 810 Through 818). Driver Boards of Other FPM Models Are Similar.

The Circuit Connection Diagrams in **Fig. 3** show all electrical control connections.

1. Identify the Driver Board as shown in **Fig. 1**, and identify the fuse-holder labeled "**FA**" (Armature Fuse). Refer to **Fig. 2** (or the label on the side of the Type-FPM control) for the proper fuse rating, and select the fuse with this rating from the bag of fuses provided. Then, install this fuse in fuse-holder "**FA**."
2. The line fuse, labeled "**FL**" in **Fig. 1** and on the driver board, has been installed. Its rating is shown on the control's nameplate should it need to be replaced.
3. Next, locate the "**DIP switch**" on your control's driver board (**Fig. 1**). There are eight switch levers (numbered 1 through 8) on the "**DIP switch**." The "ON" positions for these levers are clearly marked on the "**DIP switch**." **Fig. 2** identifies which of the eight levers should be set in the "ON" position, depending on the control and motor or gearmotor selected. Locate your control and motor type in **Fig. 2** and then set only those levers specified in **Fig. 2** to the "ON" position. Be certain that the remaining levers on the "**DIP switch**" are in the "OFF" position. An insulated alignment tool may be used to adjust the switch settings.

Control Model Number	Motor or Gearmotor Type	HP	Rated Speed (RPM)	DIP Switch Levers in the "On" Position	Arm. Fuse (FA)	Line Fuse (FL)
810 thru 818	24D0BEPM	1/50	2500	2, 4, 5, 6, 7	239.200 ¹	235.005 ¹
	24D1BEPM	1/32		1, 2, 3, 5, 8	239.300 ¹	
	24D2BEPM	1/29				
	24D3BEPM	1/19		1, 2, 3, 4	239.500 ¹	
	24D4BEPM	1/17				
830 thru 838	32D3BEPM	1/12	2000	1, 2, 7	MDA-0.80 ²	ABC-6 ²
	32D4BEPM	1/12		1, 2, 5, 7	326-0.70 ¹	
	32D4BEPM	1/10	2500	1, 2, 4, 5	MDA-1.00 ²	
	32D5BEPM	1/8		1, 2, 5	MDA-1.25 ²	
	42D3BEPM	1/8		1, 2, 5		
	42D4BEPM	1/6	2000	1, 2, 4		
850 thru 858	42D4BEPM	1/6	2500	1, 5	MDA-1.50 ²	ABC-12 ²
	42D5BEPM	1/4		1, 4	MDA-2.00 ²	
	42D7BEPM	0.29	2000	1	313-2.25 ¹	
	42D7BEPM	1/3	2500	1, 2, 8	MDA-2.5	

¹ Littelfuse

² Bussman

Figure 2

FPM Driver Board—Fuse Selection and DIP Switch Settings.

4. Referring to **Fig. 1**, identify the **barrier terminal block (TB1)** on your control's driver board. Connect the ground wire and motor armature wires to the **terminal block**. Finally, attach the 115VAC power line to the **terminal block**. **DO NOT** connect the 115VAC power line to an external power source at this time. (This should always be the very last connection you make.)

Terminal Descriptions:

L Hot side of 115VAC line

N Neutral side of 115VAC line

A1 Negative* motor armature supply voltage

A2 Positive* motor armature supply voltage

\perp Earth ground for control and motor

* In **Fig. 1**, the armature is connected for clockwise (CW) rotation. For counter-clockwise rotation (CCW), simply reverse the connections at **A1** and **A2**. The connections at **A1** and **A2** can be reversed with the Electronic F-B-R Board or mechanical F-B-R switches.

Speed Regulation is adversely affected by the length of the leads from terminals **A1** and **A2** to the motor. Lead lengths of 25 feet or more can produce measurable degradation, especially at lower armature speeds. Shorter leads and heavier guage wire will improve speed regulation.

WARNING

The control and motor must be securely and adequately grounded, as shown in *Fig. 1*. Failure to ground properly may result in serious injury.

Figure 3A—Analog Interface Board Connected to Driver Board.

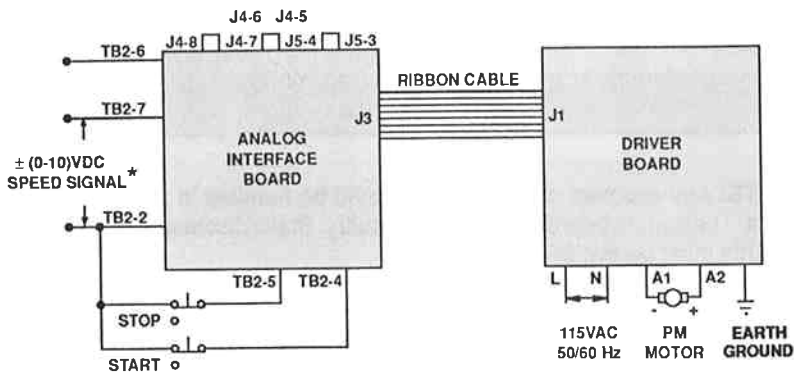


Figure 3B—Analog Interface Board and Electronic F-B-R Board Connected to Driver Board.

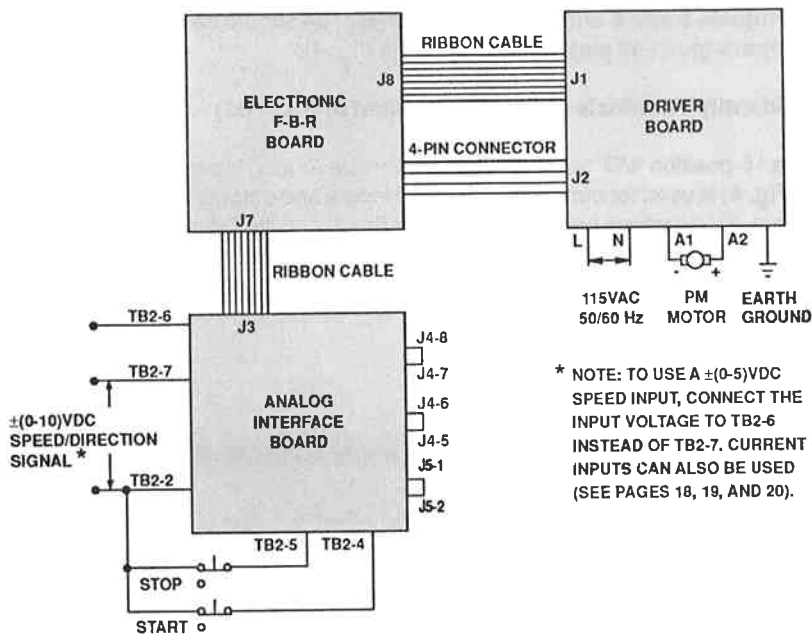


Figure 3
Circuit Connection Diagrams.

CONNECTING THE ANALOG BOARD

WARNING

Disconnect the motor armature leads and the 115VAC power line to the control before making electrical connections or replacing motor brushes.

NOTE: Any exposed circuit boards should be handled in a static-protected area. The feature boards use CMOS circuitry. Static discharge into the feature boards must be avoided.

The Circuit Connection Diagrams in **Fig. 3** show the electrical connections between the Analog Interface Board, the FPM Driver Board or Electronic F-B-R Board, and external control circuitry.

A. Checking the Jumper at J4

Position the control in front of you as shown in **Fig. 4** and locate socket **J4**. **Terminals 5 and 6** and **terminals 7 and 8** of **J4** should be connected by two **jumper**s (push-on plastic caps, shown in **Fig. 4**).

B. Identify Terminals on the I/O Terminal Block (TB2)

The 16-position "I/O" terminal block **TB2** on the Analog Interface Board (shown in **Fig. 4**) is used for connecting external inputs and outputs (I/O) to the Analog Board. (Connections between the Analog Board and the Driver Board and/or the Electronic F-B-R Board are **not** made on **TB2**.) The terminals are numbered 1 through 16 on the I/O terminal block, and the function of each "I/O" is described in **Fig. 5**.

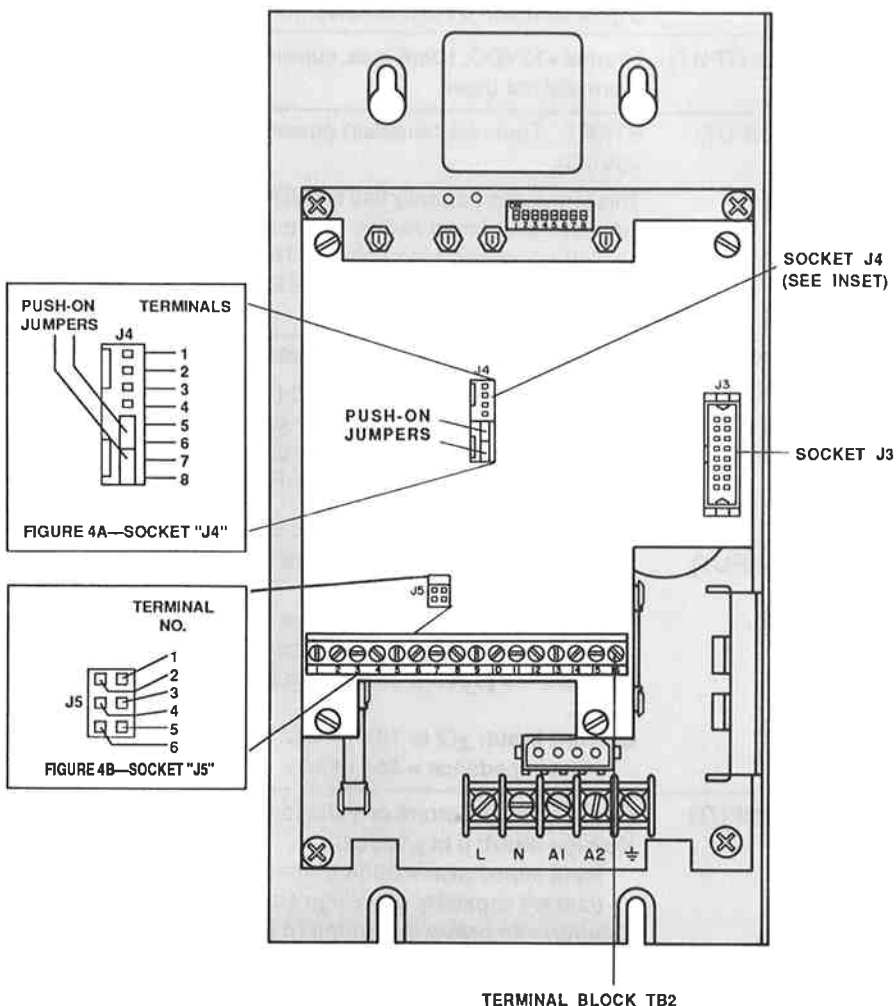


Figure 4
Top View of Model 831 or 851 Showing Details of the Analog Interface Board. (The layouts of other models having Analog Boards are similar.)

Terminal (TB2-)	Description
1 (OUTPUT)	Internal -12VDC, 10mA max. current source, isolated from line (normally not used)
2	Signal common 0VDC, isolated from line
3 (OUTPUT)	Internal +12VDC, 10mA max. current source, isolated from line (normally not used)
* 4 (INPUT)	<p>START...Turns on (enables) power to the motor (normally at +5VDC)</p> <p>This terminal is normally tied to 0VDC (TB2-2) using a momentary normally closed switch. The motor will START if the connection is opened momentarily. The STOP terminal (TB2-5) must also be tied to (TB2-2) or START will not work and the motor will remain motionless.</p>
* 5 (INPUT)	<p>STOP...Turns off power to the motor (normally at +5VDC)</p> <p>This terminal must be tied to 0VDC (TB2-2). This is normally accomplished through a "normally closed momentary contact switch." The motor will stop if this connection is opened. If the electronic F-B-R (Forward-Brake-Reverse) Board is used dynamic braking will be activated.</p>
6 (INPUT)	<p>Speed Control Current or Voltage Input</p> <p>Voltage Input: 0 to ± 5VDC Input impedance = 100K ohms (current capability of voltage source: 5 μA minimum)</p> <p>Caution—to prevent damage to the control do not exceed 6VDC.</p> <p>Current input: $\pm(2$ to 10) mA DC Input impedance = 250 ohms</p>
7 (INPUT)	<p>Speed Control Current or Voltage Input</p> <p>Voltage Input: 0 to ± 10VDC Input impedance = 200K ohms (current capability of voltage source: 5 μA minimum)</p> <p>Caution—to prevent damage to the control do not exceed 12VDC.</p> <p>Current Input: $\pm(4$ to 20) mA DC Input impedance = 500 ohms</p>
8 through 16	NOT USED

* **Note:** These terminals are connected to internal 10K Ω pull up resistors to a 5.1VDC source. They are high (+5VDC) when they are not connected to external circuitry.

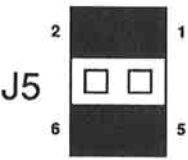
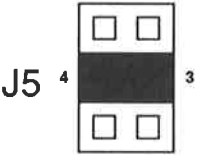
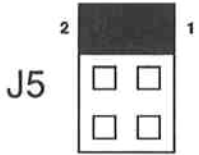
Figure 5

Description of Terminals on Terminal Block TB2.

C. Selecting a Current or Voltage Speed Control Input

- 1. Decide whether you will control speed by inputting a variable voltage or current signal to **TB2-6** or **TB2-7** (**Fig. 5**), and whether you will use an optional electronic Forward-Brake-Reverse (F-B-R) Board to control the direction of rotation.
- 2. Locate connector **J5** on the Analog Interface Board shown in **Fig. 4**.
- 3. To select current or voltage inputs and reversing or no reversing, attach the push-on plastic cap jumpers provided with your FPM control to **J5** as shown in **Fig. 6** and as described below.
 - A. To use **current inputs**, place a jumper across terminals **1** and **2** of socket **J5**, and place a second jumper across terminals **5** and **6** of **J5**.
 - B. To use **voltage inputs** without reversing (without the Model 890 Electronic F-B-R Board), place a jumper across terminals **3** and **4** of **J5**.
 - C. To use **voltage inputs** with reversing (with the Model 890 Electronic F-B-R Board), place a jumper across terminals **1** and **2** of **J5**.

Note: An additional jumper is available on J4 connector at pin 1 and 2.

Figure 6 Jumper Connections at Socket J5		
Current Input	Voltage Input	
With or Without Optional F-B-R Board*	Without Optional F-B-R Board	With Optional F-B-R Board*
		

* Model No. 890 Electronic Forward-Brake-Reverse Kit required.

D. Making Connections to the I/O Terminal Block (TB2)

The Analog Interface Board's I/O Terminal block TB2 will accept a maximum of 16 gauge wire. A minimum of 22 gauge wire is recommended.

D. 1. Connecting the Analog Speed Control Inputs

A Bodine FPM adjustable speed control with an Analog Interface Board accepts both variable DC voltages and currents as speed control inputs. The Analog Interface Board has two speed control inputs, **TB2-6** and **TB2-7** (See **Fig. 5**). The speed control input is connected to terminal **TB2-6** when the input signal is 0 to $\pm 5\text{VDC}$ or $\pm(2 \text{ to } 10) \text{ mA DC}$, and it is connected to terminal **TB2-7** when the input signal is 0 to $\pm 10\text{VDC}$ or $\pm(4 \text{ to } 20) \text{ mA DC}$.

To Control the Motor Using an Adjustable DC Input Voltage (V_{in}):

1. Connect the signal common (low) side of the input voltage source to terminal **TB2-2**.
2. If the maximum value of the input voltage V_{in} is $\pm 5\text{V}$, connect the other (high) side of the input voltage source to I/O terminal **TB2-6**. If the maximum value of V_{in} is $\pm 10\text{V}$, connect the high side to **TB2-7**.

To Control the Motor Using an Adjustable DC Input Current (I_{in}):

1. Connect the signal common (low) side of input current source to terminal **TB2-2**.
2. If the maximum value of the input current I_{in} is $\pm 10\text{mA}$, connect the other (high) side of the input current source to **TB2-6**. If the maximum value of I_{in} is $\pm 20\text{mA}$, connect the high side to **TB2-7**.

D. 2. Wiring the "START" and "STOP" Terminals

The "START" and "STOP" terminals can be wired to provide either "START" and "STOP" switches or a "Jog-Off-Run" switch. It is also possible to wire these terminals without switches.

To Wire a "STOP" Switch and a "START" Switch (Recommended):

The addition of STOP and START switches will prevent unexpected or immediate restart after a power failure (a short power interrupt). The START button must be pushed in order to restart the motor. The motor will then run in accordance with the speed input signal applied to **TB2-6** or **TB2-7**.

Connect a "normally closed momentary contact" switch between terminals **TB2-2** (signal common) and **TB2-4** (the START input) on the Analog Interface Board (see **Figures 4 and 5**). This is the "START" switch. Next, connect a "normally closed momentary contact" switch between **TB2-2** and the STOP input **TB2-5** (see **Figures 4 and 5**). This is the "STOP" switch.

The sinking current for **TB2-4** and **TB2-5** (current required to pull the terminals to 0VDC) is 0.06mA.

WARNING

After a short power interrupt, the motor (if it was previously energized) will resume rotating in accordance with the speed input signal applied to **TB2-6** or **TB2-7**. If this presents a safety hazard, the user should provide proper safety devices.

To Wire a "JOG-OFF-RUN" Switch (Not Recommended Without Proper Safety Precautions):

Holding the "Jog-Off-Run" toggle switch in the "Jog" (momentary) position will cause the motor to run in accordance with the speed input signal applied to either **TB2-6** or **TB2-7** until the switch is released. Releasing the switch will cause the motor to stop. If the "Jog-Off-Run" toggle switch is set in the "Run" position, the motor will run continuously in accordance with the speed input signal.

Connect a "single pole double throw (momentary-off-on)" toggle switch between terminals **TB2-2** (signal common) and **TB2-5** (stop) on the analog board and leave **TB2-4** unconnected (Fig. 7). This is the "Jog-Off-Run" switch.

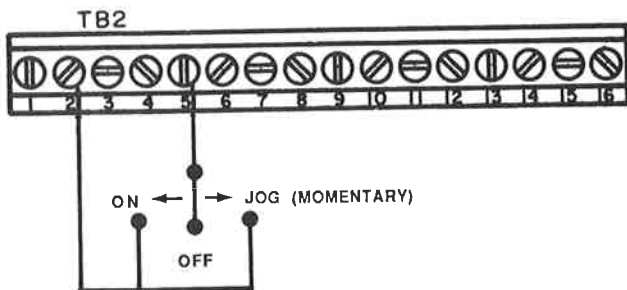


Figure 7
Wiring a "JOG-OFF-RUN" Switch.

WARNING

If the "Jog-Off-Run" toggle switch is in the "Run" position before power up or after a power interrupt, the motor will **immediately** respond to the speed input signal applied to **TB2-6** or **TB2-7** upon power up. This option is not to be used if this condition presents a safety hazard unless the user provides proper safety devices.

To Wire a Permanently Enabled Drive (Without START and STOP Switches) (Not Recommended):

To "permanently enable" an FPM control with Analog Interface Board, connect terminal **TB2-2** to terminal **TB2-5** on the Analog Interface Board and leave **TB2-4** unconnected. The motor will run at a speed corresponding to the speed input signal applied to **TB2-6** or **TB2-7**.

WARNING

With this option, during power up or after power interrupt, the motor will **immediately** respond to the speed input signal applied to **TB2-6** or **TB2-7**. This option should not be used if an unexpected startup presents a safety hazard.

CONNECTING AN F-B-R KIT

If you have purchased a separate electronic Forward-Brake-Reverse Kit (Model 890) or a mechanical F-B-R Kit (Model 891, 892, or 894) read the installation instructions provided with the Kit. Then proceed to: "**OPERATING THE CONTROL**".

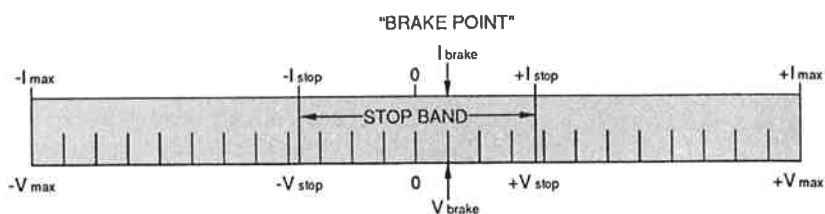
OPERATING THE CONTROL

WARNING

The chance of explosions, fires, or electric shocks can be reduced through thermal and over-current protection, good maintenance, and proper grounding and enclosure selection. The safety considerations mentioned in "SAFETY PRECAUTIONS" and "INSTALLING THE CONTROL" should be consulted.

SAFETY PRECAUTIONS

1. Before starting the control, check all fuses and connections.
2. Proper consideration should be given to all rotating members. Before starting, be sure keys, pulleys, etc. are securely fastened. *Proper guards should be provided to prevent hazards to personnel while the equipment is rotating.*
3. Other mechanical considerations include proper mounting and alignment of products, and safe loads on shafts and gears. Do not depend upon gear friction to hold loads.
4. The motor or gearmotor should be securely mounted (because of possible reaction torque). Test the motor/gearmotor unloaded to be certain that proper connections have been made.
5. If the motor/gearmotor does not start promptly and run smoothly, disconnect the AC power to the control. Double check all wiring, and refer to "TROUBLESHOOTING" on page 33.
6. If the problem persists, contact your source of purchase or a Bodine Authorized Service Center and describe the problem in detail. Include all the nameplate data. Do not disassemble the product unless authorized by Bodine. Removing screws voids the Warranty.



	Current Input (DCmA)			Voltage Input (DC Volts)				
	With or Without Optional F-B-R Board*			With Optional F-B-R Board*		Without Opt. F-B-R Board		
Input Terminal	I_{brake}^*	I_{slop}	I_{max}	V_{brake}^*	V_{slop}	V_{max}	V_{slop}	V_{max}
TB2-6	1.6	2	10	0.4	1	5	0.4	5
TB2-7	3.2	4	20	0.8	2	10	0.8	10

* Model No. 890 Electronic Forward-Brake-Reverse Kit required.

Figure 8
The STOP BAND.

DESCRIPTION OF OPERATION

Description of "STOP BAND":

The Analog Interface Board has a **"STOP BAND"** (zero speed zone). If the magnitude of the input signal lies within this **"STOP BAND"**, the motor will not rotate. The **"STOP BAND"** is required for proper operation of the optional electronic F-B-R Board, and cannot be eliminated by adjusting the **MIN** trim potentiometer on the driver board. The **"STOP BAND"** is illustrated in Fig. 8.

Without an Electronic Forward-Brake-Reverse (F-B-R) Board, a positive or negative speed signal outside the **"STOP BAND"** (zero speed zone) will cause the motor armature to rotate clockwise, provided the motor armature leads are wired according to instructions. Outside the **"STOP BAND"**, speed will be directly proportional to the applied signal. **If an Electronic F-B-R Board (Model 890) is used**, positive speed signals produce counterclockwise rotation, and negative signals produce clockwise rotation.

Description of "BRAKE POINT":

The **BRAKE POINT** (Fig. 8) is of concern only when the optional **Electronic F-B-R Board (Model No. 890)** is used. If you are not planning to use the **Electronic F-B-R Board**, you may skip this section.

Note that the **"BRAKE POINT"** (the voltage or current level at which **dynamic braking** will be activated, if the optional **Electronic F-B-R Board** is used) lies with the **"STOP BAND"**.

To stop the motor with dynamic braking, do one of the following:

1. For a positive speed input voltage (V_{in}), lower V_{in} until it is between V_{brake} and $-V_{stop}$.
2. For a negative speed input voltage, increase V_{in} until it is between V_{brake} and $+V_{stop}$.
3. For a positive speed input current (I_{in}), lower I_{in} until it is between I_{brake} and $-I_{stop}$.
4. For a negative speed input current, increase I_{in} until it is between I_{brake} and $+I_{stop}$.

To stop the motor without dynamic braking, do one of the following:

1. For a positive speed input voltage (V_{in}), lower V_{in} until it is between V_{brake} and $+V_{stop}$.
2. For a negative speed input voltage, increase V_{in} until it is between V_{brake} and $-V_{stop}$.
3. For a positive speed input current (I_{in}), lower I_{in} until it is between I_{brake} and $+I_{stop}$.
4. For a negative speed input current, increase I_{in} until it is between I_{brake} and $-I_{stop}$.

OPERATING THE MOTOR AND CONTROL

WARNING

Check to verify that the 115VAC line power to the driver is switched off before starting.

The following procedure assumes that the motor attached to the FPM control is operating under no-load conditions and that STOP and START switches are used.

1. Set the input speed control voltage signal or current signal to ZERO. If an optional mechanical Forward-Brake-Reverse switch is used, set it at the BRAKE position. (Mechanical and electronic Forward-Brake-Reverse kits are sold separately.)
2. Connect the 115VAC power line attached to terminal block **TB1** on the driver board (**Fig. 1**) to the external power source. Then turn ON the 115VAC line power to the control.
3. If an optional F-B-R switch is used, set it to FORWARD or REVERSE.
4. Push the "**START**" pushbutton or switch. The motor should remain motionless.
5. Increase the magnitude of the speed control voltage or current input until rotation occurs. Then adjust the input to achieve the desired speed. If the optional Electronic F-B-R Board is used the shaft should rotate counterclockwise. If the F-B-R Board is not used the shaft normally will rotate clockwise. For more information on controlling the direction refer to "*Reversing Motor Shaft Rotation*" on page 28.
6. If the motor shaft does not rotate, turn 115VAC line power off and check all connections and fuses **FA** and **FL** (**Fig. 1**). If a fuse is blown and the motor is not locked or stalled (overloaded), **DO NOT REPLACE THE FUSE—THE CONTROL MAY BE DAMAGED**. Refer to "*TROUBLESHOOTING*" (page 33) and follow instructions. If the motor is overloaded, reduce the load and replace blown fuses with those of the proper type and rating as specified on the control's nameplate.
7. If the motor shaft rotates opposite to the direction desired, first disconnect 115VAC line power to the driver. Then reverse connections to **terminals A1 and A2** on the terminal block **TB1** on the driver board (**Fig. 1**).

B. Reversing Motor Shaft Rotation *

The motor attached to your FPM control may be reversed manually or electronically if an **Electronic Forward-Brake-Reverse (F-B-R) Board** is used. Manual reversing can be added by using a **Mechanical F-B-R Switch Kit**.

Electronic Reversing: *

To reverse rotation electronically, an **Electronic F-B-R Kit (Model 890)** can be used. A negative speed input signal to **TB2-6** or **TB2-7** will cause clockwise rotation, and a positive signal will cause counterclockwise rotation.

Alternatively, direction can be changed with the **Electronic F-B-R Board** by removing the jumper connecting terminals **7** and **8** of **J4** on the Analog Interface Board. As long as terminal **8** is left unconnected (allowed to float at 12VDC) rotation will be counterclockwise—independent of the polarity of the speed input signal. Clockwise rotation will occur only when terminal **8** is brought (low) to signal common potential. Order the **Local/Remote Control Kit (Model 893)** for the necessary connector and additional instructions.

Manual Reversing: *

To reverse rotation manually, a **Mechanical F-B-R Switch Kit (Model 891, 892, or 894)** may be used. The switch reverses rotation by interchanging the motor armature lead connections to the control.

The **Local/Remote Control Kit (Model 893)** can be used with the **Electronic F-B-R Board (Model 890)** to allow manual braking and reversing. The kit provides instructions with the necessary wired connector and switches to allow complete manual override of the Analog Interface Board's speed and direction control.

* Model 890 can only be added to chassis versions at this time. Consult factory for use with encased models.

A. Stopping Motor Shaft Rotation *

The motor attached to your FPM control may be stopped *manually* by actuating a switch, or electronically using a speed input signal.

WARNING

ALWAYS turn off 115VAC line power to the control to keep the motor from rotating when safety is a concern—such as when working on the driven equipment or when changing brushes in the motor. **NEVER** rely only on the electronic means of stopping the driven motor.

Electronically Stopping the Motor: *

*To electronically stop motor shaft rotation, reduce the magnitude of the speed input signal at **TB2-6** or **TB2-7** until it is within the "STOP BAND" (zero speed zone). The motor will then coast to a stop.*

*To stop the motor with dynamic braking, an **electronic Forward-Brake-Reverse (F-B-R) Board (Model 890)** should be used. Dynamic braking may then be activated by pushing the stop button or adjusting the voltage or current input signal to cross the "BRAKE POINT" (see pages 24 and 25).*

Manually Stopping the Motor: *

To manually stop motor shaft rotation, push the "STOP" pushbutton or toggle switch, if one is used (switch installation instructions are given on page 21 of this manual). The motor should stop. **If an electronic Forward-Brake-Reverse (F-B-R) board (Model 890) is used, *dynamic braking will be activated.*** Otherwise the motor will coast to a stop. Pushing "START" should restart the motor. However, if the "STOP" button is simultaneously depressed (terminal **TB2-5** is not brought to signal common potential) the motor will not restart.

* Model 890 can only be added to chassis versions at this time. Consult factory for use with encased models.

B. Reversing Motor Shaft Rotation *

The motor attached to your FPM control may be reversed manually or electronically if an **Electronic Forward-Brake-Reverse (F-B-R) Board** is used. Manual reversing can be added by using a **Mechanical F-B-R Switch Kit**.

Electronic Reversing: *

To reverse rotation electronically, an **Electronic F-B-R Kit (Model 890)** can be used. A negative speed input signal to **TB2-6** or **TB2-7** will cause clockwise rotation, and a positive signal will cause counterclockwise rotation.

Alternatively, direction can be changed with the **Electronic F-B-R Board** by removing the jumper connecting terminals **7** and **8** of **J4** on the Analog Interface Board. As long as terminal **8** is left unconnected (allowed to float at 12VDC) rotation will be counterclockwise—independent of the polarity of the speed input signal. Clockwise rotation will occur only when terminal **8** is brought (low) to signal common potential. Order the **Local/Remote Control Kit (Model 893)** for the necessary connector and additional instructions.

Manual Reversing: *

To reverse rotation manually, a **Mechanical F-B-R Switch Kit (Model 891, 892, or 894)** may be used. The switch reverses rotation by interchanging the motor armature lead connections to the control.

The **Local/Remote Control Kit (Model 893)** can be used with the **Electronic F-B-R Board (Model 890)** to allow manual braking and reversing. The kit provides instructions with the necessary wired connector and switches to allow complete manual override of the Analog Interface Board's speed and direction control.

* Model 890 can only be added to chassis versions at this time. Consult factory for use with encased models.

MAKING INTERNAL ADJUSTMENTS

Your control has been factory-adjusted and normally does not require readjustment. If you do not need to readjust the control, proceed to "TROUBLESHOOTING."

WARNING

Use only a non-metallic or insulated adjustment tool (such as a TV alignment tool) for internal adjustments. Circuit components are not at ground potential and accidental short circuiting and shock hazard may occur with conducting tools. Adjustment should be made *only* by qualified service personnel.

MINIMUM AND MAXIMUM SPEED ADJUSTMENT

The "MIN" and "MAX" trim potentiometers (Fig. 1) have already been adjusted so that the lowest speed pot setting corresponds to 0 RPM and the highest setting corresponds to motor nameplate speed (2500 or 2000 RPM). ***The MIN and MAX trim pots should not be re-adjusted.*** If the MIN and MAX pots are turned away from their factory-set positions, the voltage and current values in the "STOP BAND" specified in Fig. 8 will no longer be valid.

To decrease the maximum speed: turn the MAX trim potentiometer counterclockwise. This adjustment will not affect the factory-set minimum speed of 0 RPM.

To increase the minimum speed: turn the MIN trim potentiometer counterclockwise. This adjustment will increase the maximum speed beyond nameplate speed (2500 or 2000 RPM). The MAX trim potentiometer will need to be readjusted.

To allow motor operation at very low speeds: turn the MIN potentiometer *slightly* counterclockwise. If the motor will not stop with the speed input signal or speed potentiometer at zero, turn the MIN potentiometer clockwise until the motor stops.

WARNING

To avoid damage to the control or motor, and to assure the best high speed motor performance possible, the maximum armature speed should not exceed the rated nameplate speed of the motor.

Adjustment of the "MIN" and "MAX" trim potentiometers may have to be repeated several times to arrive at the desired speeds.

Control Model Number	Motor or Gearmotor Type	HP	Rated Speed (RPM)	Voltage Across A1 and A2 (Adjust "Reg" Pot)	Voltage Across TP1 and TP2 (Adjust "Max" Pot)
810 thru 818	24D0BEPM	1/50	2500	104VDC	2.3VDC
	24D1BEPM	1/32		112VDC	2.5VDC
	24D2BEPM	1/29		111.6VDC	2.6VDC
	24D3BEPM	1/19		113.8VDC	
	24D4BEPM	1/17		114.5VDC	2.8VDC
830 thru 838	32D3BEPM	1/12	2000	116VDC	2.3VDC
	32D4BEPM	1/12			
	32D4BEPM	1/10	2500	120VDC	
	32D5BEPM	1/8			
	42D3BEPM	1/8		123VDC	
	42D4BEPM	1/6	2000		
850 thru 858	42D4BEPM	1/6	2500	123VDC	2.2VDC
	42D5BEPM	1/4			
	42D7BEPM	0.29	2000		
	42D7BEPM	1/3	2500	128VDC	

Figure 9
Table for Regulation Adjustment.

TORQUE (CURRENT) LIMITING ADJUSTMENT

The "**TORQ**" trim potentiometer (Fig. 1) has already been adjusted so that the motor will never see more than 225 to 250 percent of its rated current input. To further reduce the maximum current available to the motor and limit the maximum torque output (optional):

- a) Record the factory-set position of the **TORQ** trim potentiometer.
- b) With the motor loaded, turn the **TORQ** trim potentiometer counterclockwise until the motor slows down.
- c) Turn the **TORQ** potentiometer back clockwise until motor drives the load, but no farther than its original factory-set position.

WARNING

Avoid turning the "**TORQ**" trim potentiometer clockwise. An increase in the maximum current output could damage the control, the motor, gearing if present, or the equipment driven by the motor/control system.

If for any reason the **TORQ** trim potentiometer has been turned out of adjustment, and you wish to return the **TORQ** potentiometer to its factory setting, return the control to Bodine Electric. This adjustment is inherently dangerous, since it could result in damage to the output shaft and/or gearing.

SPEED REGULATION ADJUSTMENT

Speed regulation has been factory-adjusted for your motor. It is a very critical adjustment which can affect the control's stability and the **MIN** and **MAX** trim potentiometer settings. Consequently, the **REG** trim potentiometer (Fig. 1) should not be readjusted. If for any reason the **REG** trim pot has been turned out of adjustment, use the following procedure to arrive at the proper setting:

1. Turn the 115VAC power off to the control.
2. Connect an external speed control signal.
3. Check for proper DIP switch settings as shown in Fig. 2. The proper motor, as specified on the control nameplate, must be connected to the control with no load.
4. Supply power to the control (*exactly* 115VAC).
5. Turn the **MIN** trim potentiometer fully clockwise. (This gives zero no-load speed at the "zero" external speed input level.)

6. Increase the speed control signal to the maximum value allowed.
7. Locate test points **TP1** and **TP2** at the top of the Driver Board (**Fig. 1**). Attach a voltmeter (min. 1 Meg Ω input impedance) across these terminals and read the DC voltage. Adjust the **MAX** trim potentiometer to arrive at the voltage specified in **Fig. 9**.
8. Locate terminals **A1** and **A2** on the driver board **terminal block** (**Fig. 1**). Measure the DC voltage across these terminals. Adjust the **REG** trim potentiometer to arrive at the voltage specified in **Fig. 9**.

ACCELERATION AND DECELERATION ADJUSTMENT

Some FPM models may not have this adjustment. Check your control's driver board.

The **ACCEL** trim potentiometer (**Fig. 1**) controls the speed input response time, thus influencing the motor's acceleration and deceleration time. The **ACCEL** trim pot will have an effect when a speed signal is reduced or increased. When braking or reversing direction with the electronic F-B-R Board, the deceleration time will be determined primarily by the braking resistor value. Although the **ACCEL** pot will control acceleration and deceleration, deceleration is also influenced by motor speed and system inertia, which will vary with the application.

To decrease acceleration time: turn the **ACCEL** trim potentiometer clockwise. The minimum acceleration time, with the pot fully clockwise, is approximately 0.5 seconds.

To increase acceleration time: turn the **ACCEL** trim potentiometer counterclockwise. The maximum acceleration time, with the pot fully counterclockwise, is approximately 10 seconds.

TROUBLESHOOTING

WARNING

Disconnect the control from the power source before working on the control, motor, or driven equipment.

Your control should not require maintenance under normal conditions. If you encounter a problem, follow the advice contained in this section. If the problem persists, contact your source of purchase or a Bodine Authorized Service Center and describe the problem in detail. Include all the nameplate data. Do not disassemble the product unless authorized by Bodine Electric Company. Performing repairs not authorized by Bodine Electric Company or removing screws will void the Warranty. Read all applicable instruction literature provided with your control and accessories, and double-check your wiring. Verify that proper input signals have been applied to the input terminals of the Analog Board.

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
CONTROL BLOWS LINE FUSE "FL"	Shorted SCR, Power Bridge	Replace the PC board or Varistor (V1) or power bridge.
	Control or Motor Shorted to Earth Ground	Check for shorts and repair as required.
MOTOR WILL NOT START	Blown Line Fuse (FL) or Armature Fuse (FA)	Replace fuse. Refer to Fig. 2 for recommended fuse value.
	J2 Jumper Assembly is missing on the driver	Install the jumper assembly, see Fig. 1.
	SCR Inhibit Function is activated	Check to be sure that PIN 11 of J1 on driver board is 2.7 VDC above PIN 7 (0 VDC), see Fig. 1.
	Analog Interface Board inhibit latch is set	Check to be sure that terminal 5 of TB2 on analog board is normally under 2VDC.
	Defective Motor or Worn Brushes	Repair or replace motor.

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
MOTOR WILL NOT COME UP TO SPEED	Maximum speed adjustment is set too low	Turn the MAX. trim pot (R10) CW to increase speed, refer to "Minimum and Maximum Speed Adjustment" page 29.
	Motor Overloaded	Re-examine the load parameters.
	Regulation is set too low	Check the DIP switch settings (Fig. 2) and refer to "Speed Regulation Adjustment", page 32.
	Defective component on the driver board	Contact Distributor or Bodine for assistance.
	Torque adjustment is set too low	Contact Distributor or Bodine for assistance.
MOTOR SPEED IS UNSTABLE OR PULSATES	Regulation is set too high	Check the DIP switch settings (Fig. 2) and refer to "Speed Regulation Adjustment" page 32.
	Wrong settings on the Analog Interface Board	Review pages 16-22.
	Defective Motor	Repair or replace motor.
MOTOR WILL NOT MAINTAIN SPEED UNDER LOAD	Regulation is set too low	Check the DIP switch settings (Fig. 2) and refer to "Speed Regulation Adjustment" page 32.
	Torque adjustment is set too low	Contact Distributor or Bodine for assistance.
	Motor Overloaded	Re-examine the load parameters. Armature current should not exceed motor's nameplate current.

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
MOTOR WILL NOT STOP WITH SPEED INPUT SET TO ZERO	Minimum speed adjustment is set too high	Turn the MIN pot (R15) CW until motor stops.
	Defective Interface Board	Replace the Interface Board.
NO SPEED ADJUSTMENT	Defective Interface Board	Replace the Interface Board.
	No connection to PIN 10 on J1 of the driver	Check connections to J1. Refer to Fig. 1.
	Wrong settings on Analog Board	Review pages 16-22.



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