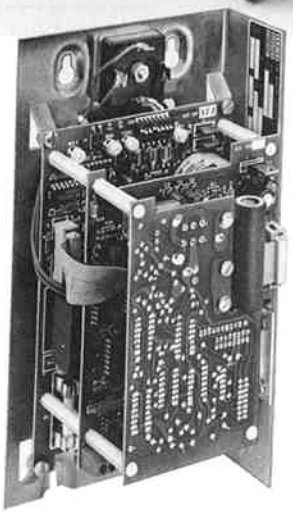
Instructions for Installation and Operation

Type-FPM Controls with Digital Interface Boards



BODINE® ELECTRIC COMPANY

QUALITY IN MOTION®

Manual No. 074 00158 D

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.

TABLE OF CONTENTS

LIST OF FIGURES

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 a Digital 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 horsepowers, 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 Digital Interface Board accepts an external 8-bit digital signal from a personal computer, programmable logic controller, or other digital device and outputs an optically isolated voltage signal to the driver board to control motor speed (direction can also be controlled if the optional Model 890 Electronic Forward-Brake-Reverse (F-B-R) Board is used). Models are also available with integral Analog 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 ± 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 (1 KVA) 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 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 "" symbol in the upper right corner of their nameplates. In addition, most products are CSA certified, identified by a "" 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.

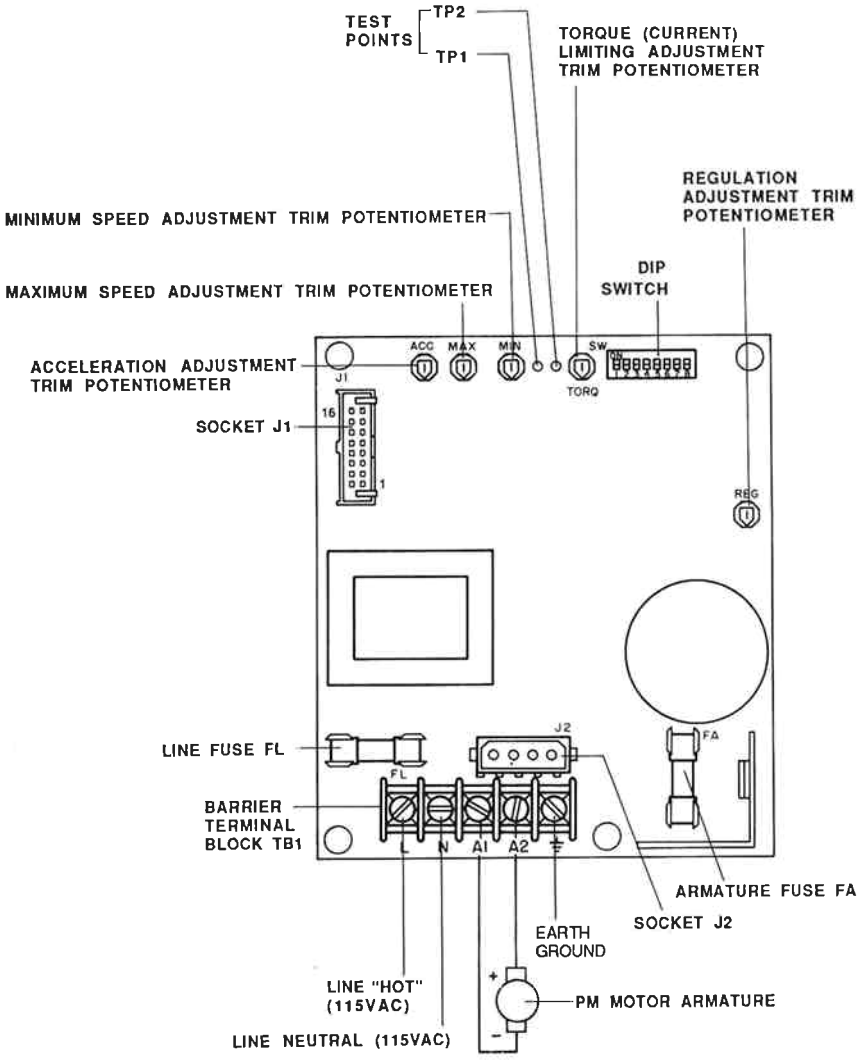


Figure 1
Top View of Driver Board (Models 810 through 818). Driver Boards of Other FPM Models Are Similar.

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.

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.

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 NOTconnect 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
⏚ ..... 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.

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]	235005[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		1, 2, 7	MDA-0.80[2]	ABC-6[2]
	32D4BEPM	1/12	2000	1, 2, 5, 7	326.700[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.

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.

CONNECTING THE DIGITAL 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 Digital Interface Board, the FPM Driver Board or Electronic F-B-R Board, and external control circuitry.

A. Checking the Jumper at J4 (Chassis version only)

Position the control in front of you as shown in **Fig. 4** and locate socket **J4**. **Terminals 1 and 2, terminals 5 and 6** and **terminals 7 and 8** of **J4** should be connected by three **jumpers** (push-on plastic caps, shown in **Fig. 4A**).

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

The 16-position "I/O" terminal block **TB2** on the Digital Board (shown in **Fig. 4**) is used for connecting external inputs and outputs (I/O) to the Digital Board. (Connections between the Digital 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 3A—Digital Interface Board Connected to Driver Board.

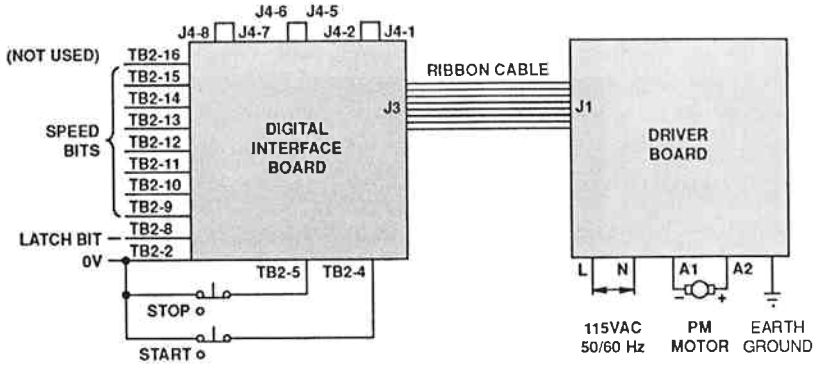


Figure 3B—Digital Interface Board and Electronic F-B-R Board Connected to Driver Board.

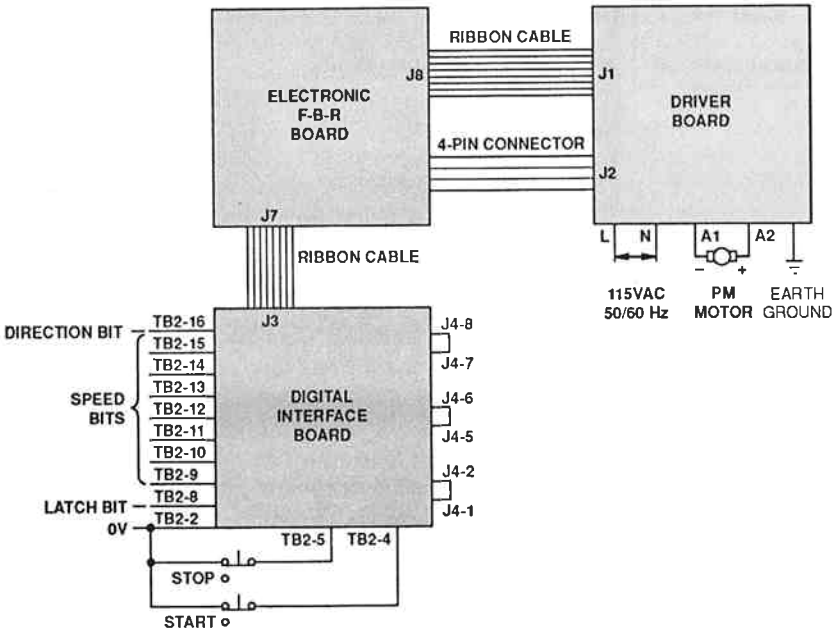


Figure 3
Circuit Connection Diagrams.

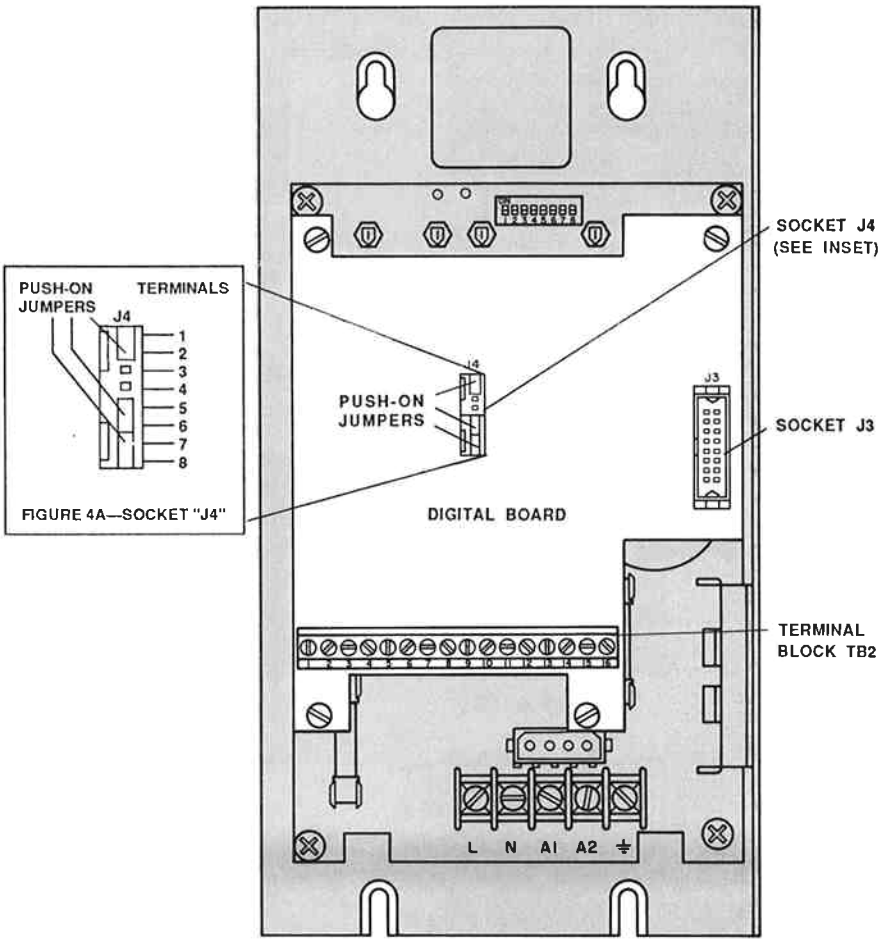
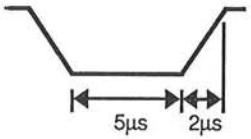


Figure 4
Top View of FPM Models 832 and 852 Showing Details of Digital Interface Board. (The layouts of other models having digital boards are similar.)

	Terminal (TB 2)	Description (See Figure 4)
	1 (OUTPUT)	Internal -12VDC, 10mA max. current source, isolated from line (normally not used)
	2	Signal common (0VDC) which can be used for all input signals (isolated from line)
	3 (OUTPUT)	Internal +12VDC, 10mA max. current source, isolated from line (normally not used)
*	4 (INPUT)	START—turns on (enables) power to the motor (normally at +5VDC). This terminal is normally tied to 0VDC (TB2-2). 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.
*	5 (INPUT)	STOP—turns off power to motor (normally at +5VDC) This terminal must be tied to 0VDC (TB2-2). The motor will STOP if the connection is opened momentarily. If the optional Electronic F-B-R Board is used, dynamic braking will be activated.
	6-7	NOT USED
*	8 (INPUT)	INPUT LATCH ENABLE LINE—captures speed data (and direction data, if the optional Electronic F-B-R Board is used) from TB2-9 through TB2-16. *When this line is momentarily low,* data on TB2-9 to TB2-16 are captured (latched) and the motor rotates according to the data. *When it is held high,* data on TB2-9 through TB2-16 are ignored. *When it is held low,* the motor responds directly to changes in the data on TB2-9 to TB2-16. The minimum width of the "low" pulse is 5 µS, and its maximum rise time is 2 µS. Data on TB2-9 through TB2-16 should be held stable at least 1 µS after the signal on TB2-8 goes high (to ensure the input signal is captured).  Latch Enable Pulse
*	9	BIT 0 (Least significant bit)
*	10-14 (INPUTS)	SPEED CONTROL BITS
*	15	BIT 6 (Most significant bit)
*	16 (INPUT)	DIRECTION CONTROL BIT (Used only with the F-B-R Board). A logic "1" causes clockwise rotation. A logic "0" causes counterclockwise rotation.

8-Bit Parallel Input

* **NOTE:** These terminals are connected through internal 10K ohm 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. Making Connections to the I/O Terminal Block (TB2)

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

C.1. 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. Instructions follow.

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 latched binary data.

Connect a "normally closed momentary contact" switch between **terminals TB2-2 and TB2-4** on the digital interface board (see **Figures 4 and 5**). This is the **"START"** switch. Next, connect a "normally closed momentary contact" switch between **TB2-2 and 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 0.06 mA.

WARNING

For a short power interrupt, the binary input data on TB2-9 to TB2-16 during the interrupt will be captured if a latch pulse appears on TB2-8 and the motor will respond to this speed data (and direction data, if the Electronic F-B-R Board is used). If this presents a safety hazard, the user should provide proper safety devices or assure that his hardware/software does not develop a false latch signal during short power line interrupts. Normally, the PC or PLC will maintain valid data for a short time period or will require more than a few seconds to restart. Under these circumstances no operational problems should exist. (The motor will operate as programmed or intended.)

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 latched binary data until the switch is released. Releasing the "Jog" 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 latched binary data.

Connect a "single pole double throw (momentary-off-on)" toggle switch between **terminals TB2-2 and TB2-5** on the digital board and leave **TB2-4** unconnected (**Fig. 6**). This is the **"Jog-Off-Run"** switch.

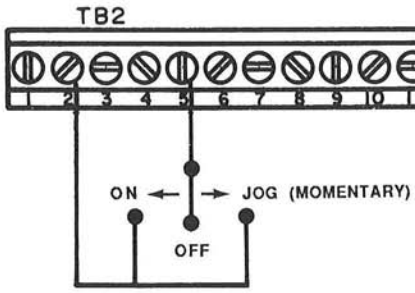


Figure 6
Wiring a "JOG-OFF-RUN" Switch.

WARNING

If the **"Jog-Off-Run"** toggle switch is in the **"Run"** position before power up or after a power interrupt, the binary input data on **TB2-9** through **TB2-16** will be latched, and the motor will **immediately** respond to this speed data (and direction data, if an optional Electronic F-B-R card is used) 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 a Digital Interface Board, connect terminal **TB2-2** to terminal **TB2-5** on the Digital Interface Board and leave **TB2-4** unconnected. The motor will run at a speed corresponding to the latched binary input data.

WARNING

With this option, during power up or after power interrupt, the binary input data on **TB2-9** through **TB2-16** will be latched and the motor will immediately respond to this speed data (and direction data, if an optional Electronic F-B-R board is used). This option should not be used if an unexpected startup presents a safety hazard.

C.2. Connecting the Digital Inputs

Your FPM control with the Digital Interface Board is preset to operate at 5V TTL logic levels. (If CMOS logic levels are desired, please consult Bodine Electric Company.)

Fig. 7 describes the voltage levels that correspond to logic "0" and logic "1." It also shows that when terminals **TB2-9 through TB2-16** are pulled "low", they are "activated" (the inputs are inverted internally).

Input State	Input Voltage
	+5V TTL
Activated, Logic "0"	0.0 - 0.8VDC
Deactivated, Logic "1"	2.0 - 5.5VDC

Figure 7
Voltage Levels Used on Logic Inputs to TB2.

To take advantage of the digital speed control capability of your control, **connect TB2-2 to Signal Common of your programmable controller, personal computer, other control circuitry.** Then connect terminals **TB2-8 through TB2-16** on the Digital Interface Board to the parallel I/O port of a personal computer, I/O module of a programmable controller, or other digital parallel port. Refer to the manuals provided with these devices for installation and operation instructions.

The sinking current for **TB2-8 through TB2-16** (current required to pull the terminals to 0VDC) is 0.6 mA.

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.

Logic Levels							Resulting Speed	
TB2 -15	TB2 -14	TB2 -13	TB2 -12	TB2 -11	TB2 -10	TB2 -9	2500RPM Rated Motor	2000RPM Rated Motor
							0	0
						X	20	16
					X		39	31
					X	X	59	47
				X			79	63
				X		X	98	79
				X	X		118	94
				X	X	X	138	110
			X				157	126
			X			X	177	142
			X		X		197	157
			X		X	X	217	173
			X	X			236	189
			X	X		X	256	205
			X	X	X		276	220
			X	X	X	X	295	236
		X					315	252
		X				X	335	268
		X			X		354	283
		X			X	X	374	299
		X		X			394	315
		X		X		X	413	331
		X		X	X		433	346
		X		X	X	X	453	362
		X	X				472	378
		X	X			X	492	394
		X	X		X		512	409
		X	X		X	X	531	425
		X	X	X			551	441
		X	X	X		X	571	457
		X	X	X	X		591	472
		X	X	X	X	X	610	488
	X						630	504
	X					X	650	520
	X				X		669	535
	X				X	X	688	551
	X			X			709	567
	X			X		X	728	583
	X			X	X		748	598
	X			X	X	X	768	614
	X		X				787	630
	X		X			X	807	646
	X		X		X		827	661

Logic Levels							Resulting Speed	
TB2 -15	TB2 -14	TB2 -13	TB2 -12	TB2 -11	TB2 -10	TB2 -9	2500RPM Rated Motor	2000RPM Rated Motor
	X		X		X	X	846	677
	X		X	X			866	693
	X		X	X		X	886	709
	X		X	X	X		906	724
	X		X	X	X	X	925	740
	X	X					945	756
	X	X				X	965	772
	X	X			X		984	787
	X	X			X	X	1004	803
	X	X		X			1024	819
	X	X		X		X	1043	835
	X	X		X	X		1063	850
	X	X	X				1083	866
	X	X	X			X	1102	882
	X	X	X		X		1122	898
	X	X	X	X			1142	913
	X	X	X		X	X	1161	929
	X	X	X	X			1181	945
	X	X	X	X		X	1201	961
	X	X	X	X	X		1220	976
	X	X	X	X	X	X	1240	992
X		X	X	X			1260	1008
X		X	X	X		X	1280	1024
X		X	X	X	X		1299	1039
	X	X	X	X	X	X	1319	1055
	X	X	X	X			1339	1071
	X	X	X		X	X	1358	1087
	X	X	X		X		1378	1102
	X	X	X	X	X	X	1398	1118
	X	X	X	X			1417	1134
	X	X	X	X		X	1437	1150
	X	X	X	X	X		1457	1165
	X	X	X		X	X	1476	1181
	X	X	X				1496	1197
	X	X	X			X	1516	1213
	X	X	X		X		1535	1228
	X	X	X	X	X	X	1555	1244
	X	X	X	X			1575	1260
	X	X	X	X		X	1594	1276
	X	X	X	X	X		1614	1291
	X	X	X		X	X	1634	1307
	X	X	X				1654	1323
	X	X	X	X		X	1673	1339

Notes:

1) To calculate speed (RPM) for a maximum speed other than 2500 RPM,
   a) Invert the logic values in the table above and convert to a decimal number "D".
   b) Then: Speed (RPM) = $\frac{D \times (\text{Maximum Speed})}{127}$

2) To calculate speed (RPM) for a gearmotor, divide the speeds in the table above by the gear ratio. For example, if the speed from the chart above is 60 RPM and you wish to use a 6 to 1 gearhead, the speed of the gearmotor's output shaft would be: $\frac{60}{6} = 10$ RPM

Figure 8
Translating the Speed Input Logic Levels to Actual Speed in RPM.

Logic Levels							Resulting Speed	
TB2 -15	TB2 -14	TB2 -13	TB2 -12	TB2 -11	TB2 -10	TB2 -9	2500RPM Rated Motor	2000RPM Rated Motor
X		X		X	X		1693	1354
X		X		X	X	X	1713	1370
X		X	X				1732	1386
X		X	X			X	1752	1402
X		X	X		X		1772	1417
X		X	X		X	X	1791	1433
X		X	X	X			1811	1449
X		X	X	X		X	1831	1465
X		X	X	X	X		1850	1480
X		X	X	X	X	X	1870	1496
X	X						1890	1512
X	X					X	1909	1528
X	X				X		1929	1543
X	X				X	X	1949	1559
X	X			X			1969	1575
X	X			X		X	1988	1591
X	X			X	X		2008	1606
X	X			X	X	X	2028	1622
X	X		X				2047	1638
X	X		X			X	2067	1654
X	X		X		X		2087	1669
X	X		X		X	X	2106	1685
X	X		X	X			2126	1700
X	X		X	X		X	2146	1717
X	X		X	X	X		2165	1732
X	X		X	X	X	X	2185	1748
X	X	X					2205	1764
X	X	X				X	2224	1780
X	X	X			X		2244	1795
X	X	X			X	X	2264	1811
X	X	X		X			2283	1827
X	X	X		X		X	2303	1843
X	X	X		X	X		2323	1858
X	X	X		X	X	X	2343	1874
X	X	X	X				2362	1890
X	X	X	X			X	2382	1906
X	X	X	X		X		2402	1921
X	X	X	X		X	X	2421	1937
X	X	X	X	X			2441	1953
X	X	X	X	X		X	2461	1969
X	X	X	X	X	X		2480	1984
X	X	X	X	X	X	X	2500	2000

3) To achieve the speed desired, refer to the chart above and pull each terminal designated with an "X" low. For example, pulling only terminal TB2-15 low will produce 1260 RPM for 2500 RPM motors (1008 RPM for 2000 RPM Motors).

Figure 8 (cont'd)

DESCRIPTION OF OPERATION

Orient the control as shown in **Fig. 4** and locate the 16-position **terminal block TB2.**

Figures 8 and 9 show the logic levels that must be applied to **TB2-9** through **TB2-15** to produce a desired speed. The motor's rated speed is either 2000 or 2500 RPM, as shown on the motor's nameplate. The 7 logic lines allow 127 increments in speed from 0 RPM to the rated maximum. The minimum and maximum speeds can be adjusted using the **MIN** and **MAX** trim potentiometers (see *"Minimum and Maximum Speed Adjustment"* on page 28).

Fig. 9 also shows how **TB2-16** may reverse rotation (on controls equipped with the optional Electronic F-B-R Board). When terminal **TB2-16** is high (Logic "1"), clockwise rotation is selected. When **TB2-16** is low (Logic "0"), counter-clockwise rotation is selected.

Note that when terminals **TB2-9 through TB2-16** are "low" they are "active" (these inputs are inverted internally).

Logic Level of Terminals on I/O Terminal Block TB2								Interpreted	Dec-	Example: Resulting Speed, Direction
16	15	14	13	12	11	10	9	Binary Value	imal	for a 2500 RPM motor
1	1	1	1	1	1	1	1	0000000	0	0 RPM (STOP)
0	1	1	1	0	0	1	0	0001101	13	2500X13/127=256 RPM,CCW
0	1	1	0	0	1	1	0	0011001	25	2500X25/127=492 RPM,CCW
1	1	0	0	0	0	1	1	0111100	60	2500X60/127=1181 RPM, CW
1	0	1	0	1	0	1	0	1010101	85	2500X85/127=1673 RPM, CW
0	0	0	0	0	0	0	0	1111111	127	2500 RPM (Max. speed),CCW

Figure 9
Inputs Required to Select Speed and Direction.

To "capture" or "latch" the data on terminals **TB2-9** to **TB2-16**, **TB2-8** should either receive a "low" pulse (⊔), or be tied to signal common (**TB2-2**). The minimum width of the "low" pulse must be 5 µs, and its maximum rise time must be 2 µs. To successfully capture the input, data on **TB2-9** to **TB2-16** must be held stable at least 1 µs after the low pulse on **TB2-8** goes high.

The driver board has a "**STOP BAND**" to ensure a positive stop with a zero speed input. This "input voltage offset" produces speeds offset from the values listed in **Figures 6 and 7**. The "**STOP BAND**" also may prevent the motor from responding to speed commands in the low end of a motor's speed range. If you want the motor to respond to data on **TB2-9 to TB2-16** exactly as depicted in **Figures 6 and 7**, or if you want the motor to operate at very low speeds near the bottom of its operating speed range, you may need to eliminate the "**STOP BAND**." Instructions for doing so are given on page 30.

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.

1. Set the speed control inputs on I/O terminals **TB2-9** through **TB2-15** and the latching enable input (**TB2-8**) to logic level 1 (high), as shown in the first line in **Fig. 9**.

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. Pull the enable input at terminal **TB2-8** momentarily low. The motor should remain motionless. You have just executed a 0 RPM (STOP) command. For more information on stopping the motor refer to "Stopping Motor Shaft Rotation" on page 26.

NOTE: *When the signal on terminal **TB2-8** goes low momentarily*, data on **TB2-9** through **TB2-16** are captured (latched) and the motor rotates in accordance with these data. *When the input to **TB2-8** is held high*, the motor's speed and direction of rotation will remain the same until another low pulse on **TB2-8** loads new information from **TB2-9** through **TB2-16**. *When the input to **TB2-8** is held low*, the motor's speed (and direction, if the Model 890 F-B-R Board is used) change as the data on terminals **TB2-9** to **TB2-16** change.

> ***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.

4. Push the **"START"** pushbutton or switch, if one is used. The motor should remain motionless.

5. Set the inputs on terminals **TB2-9** through **TB2-16** to the logic levels shown in the second line in **Fig. 9**. Then bring the enable input at **TB2-8** momentarily low (read the notes at the bottom of **Fig. 9**). The motor's shaft should then accelerate to the speed selected. 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 27.

NOTE: If the motor shaft does not rotate, 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"* on 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.

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 terminal block **TB1** on the driver board (**Fig. 1**).

6. Now set the inputs on terminals **TB2-9** through **TB2-16** to the values shown on the next line in **Fig. 9**. Then bring **TB2-8** momentarily low. Repeat this step for each of the values given in the table. When the direction input on **TB2-16** is unchanged, the motor will not reverse. However, if the optional **Model 890 Electronic F-B-R Board** is used **and** the direction input at **TB2-8** is changed, the motor should decelerate, dynamically brake, reverse rotation, and accelerate to the new speed.

A. Stopping Motor Shaft Rotation

The motor attached to your FPM control may be stopped manually by actuating a switch, or electronically by feeding a "zero speed" command to terminals **TB2-8** through **TB2-15**.

> ***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, set the speed control inputs at terminals **TB2-9** through **TB2-15** to logic level 1 (high) and apply a low pulse to input terminal **TB2-8**. 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.

*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 18). 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.

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 **Model 893 Local/Remote Control Kit**, or by using a **Mechanical F-B-R Kit**.

*Electronic Reversing: **

To reverse rotation electronically, an **Electronic F-B-R Kit (Model 890)** can be used. A logic "0" applied to terminal **TB2-16** followed by a low pulse on **TB2-8** will cause the motor to decelerate, dynamically brake, then accelerate to the selected speed with counterclockwise rotation. A logic "1" causes clockwise rotation if the motor is connected properly (**Fig. 1**).

*Manual Reversing: **

To reverse rotation manually, a **Mechanical F-B-R 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 Digital 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).

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 minmum 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		116VDC	2.3VDC
	32D4BEPM	1/12	2000		
	32D4BEPM	1/10	2500		
	32D5BEPM	1/8		120VDC	
	42D3BEPM	1/8		123VDC	
	42D4BEPM	1/6	2000		
850 thru 858	42D4BEPM	1/6	2500		2.2VDC
	42D5BEPM	1/4			
	42D7BEPM	0.29	2000		
	42D7BEPM	1/3	2500	128VDC	

Figure 10
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 the motor drives the load, **but no farther than its original factory-set position.**

ELIMINATING THE STOP BAND

The data on terminals **TB2-9 to TB2-16** are converted to a voltage signal by the digital board. This signal is then sent to the driver board, which has a factory-set **"STOP BAND"** or "zero speed range" (an input voltage offset). The **"STOP BAND"** may include a narrow range of voltages that specifies speeds within the low end of a motor's speed range. Speed commands producing an input voltage that lies within the **"STOP BAND"** will not effect rotation. Hence, the motor may remain motionless when **TB2-9 to TB2-16** specify a speed near the bottom of the motor's speed range. For applications that require motor operation at low speeds under 100 RPM, or near the lower limit of a motor or gearmotor's speed range, the **"STOP BAND"** may be eliminated by following the directions below.

To eliminate the "STOP BAND" (optional):

a) Remove the jumper connecting terminals **1 and 2** of **J4** on the interface board (**Fig. 4**). For encased controls, place the Local/Remote switch in "Local" position with local speed pot set at "0" speed position.
b) Slowly turn the **MIN** potentiometer on the driver board (**Fig. 1**) counterclockwise until the motor shaft barely rotates.
c) Slowly turn the **MIN** potentiometer clockwise until the shaft comes to a stop.
d) Replace the jumper connecting terminals **1 and 2** of **J4**. For encased controls, return Local/Remote switch to remote position.

NOTE: The purpose of the jumper connecting terminals **1 and 2** of **J4** is to inhibit the SCRs from firing when the speed input is zero. Otherwise, the shaft might start to rotate very slowly, due to thermal effects in the control and motor.

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.

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. 10**.

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. 10.**

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 instructions 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 Digital 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 2.7VDC above PIN 7 (0VDC), see Fig. 1.
	Digital Interface Board inhibit latch is set	Check to be sure that terminal 5 of TB2 on digital 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 28.
	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.
	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 digital board	Review pages 10-20.

VOID

INFORMATION ONLY

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QUALITY IN MOTION

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