

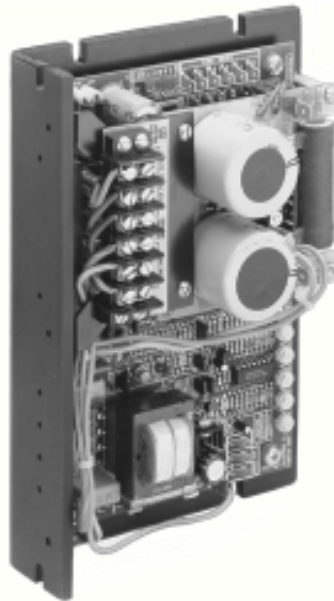


# **CONTINUOUS BELT FURNACE DRIVE MOTOR & CONTROL**

**BODINE TYPE ABL FILTERED SCR BRUSHLESS DC MOTOR CONTROL**

## *Operation and Troubleshooting*

*Version 1.0*



Model 3911C

### **Supplemental Reference to the IR Furnace Equipment Owner's Manual**

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# **Bodine Type ABL Filtered SCR Brushless DC Motor Control**

Operation and Troubleshooting Manual

Supplemental Reference

Version 1.0

Part No. 675-110001-01 CD

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# SAFETY

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*Read this manual completely and carefully. Pay special attention to all warnings, cautions, and safety rules. Failure to follow the instructions could produce safety hazards which could injure personnel or damage the control, motor, or other equipment. If you have any doubts about how to connect the control or motor, refer to the detailed sections of this manual.*

## **IMPORTANT SAFETY PRECAUTIONS**

The following safety precautions must be observed during all phases of installation, operation, service, and repair of this motor control 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. FurnacePros assumes no liability for the customer's failure to comply with safety requirements and practices.

The use of electric motors and generators is potentially hazardous like that of any electrical-mechanical device. The degree of hazard can be greatly reduced by proper design, selection, installation, and use but all hazards cannot be completely eliminated. The reduction of hazards is a joint responsibility between the user, the manufacturer of the driven or driving equipment and the manufacturer of the control or motor.

**Warnings** (such as the example below) highlight procedures which present potential danger to people. **Cautions** highlight possible danger to equipment. Both are used throughout this manual. Warnings and Cautions must always be followed.

### **WARNING**

*Dangerous voltages may be present in the electronic control and motor. These voltages could cause serious injury or death. Use extreme caution during handling, testing, and adjusting. Properly guard the electronic control and motor to prevent accidental contact by all persons.*

*The chance of explosions, fires, or electric shocks can be reduced with thermal and over-current protection, proper grounding, enclosure selection, and good maintenance. The following safety considerations are not intended to be all-inclusive. Specific references throughout this manual should also be consulted.*

### **CAUTION**

*These controls are designed to provide optimum performance when used with Bodine Electric Company motors. They should not be used with other manufacturer's motors without first contacting the Bodine Electric Company. Failure to contact Bodine in advance could cause damage to the control or the motor.*

## **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 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 are disconnected.

## **Environment**

Open controls or controls in ventilated enclosures may emit flame during failure. Bodine's totally enclosed products are not explosion-proof and are not suitable for hazardous locations (e.g., in an environment of flammable or explosive gas, vapor, or dust). Only use 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.

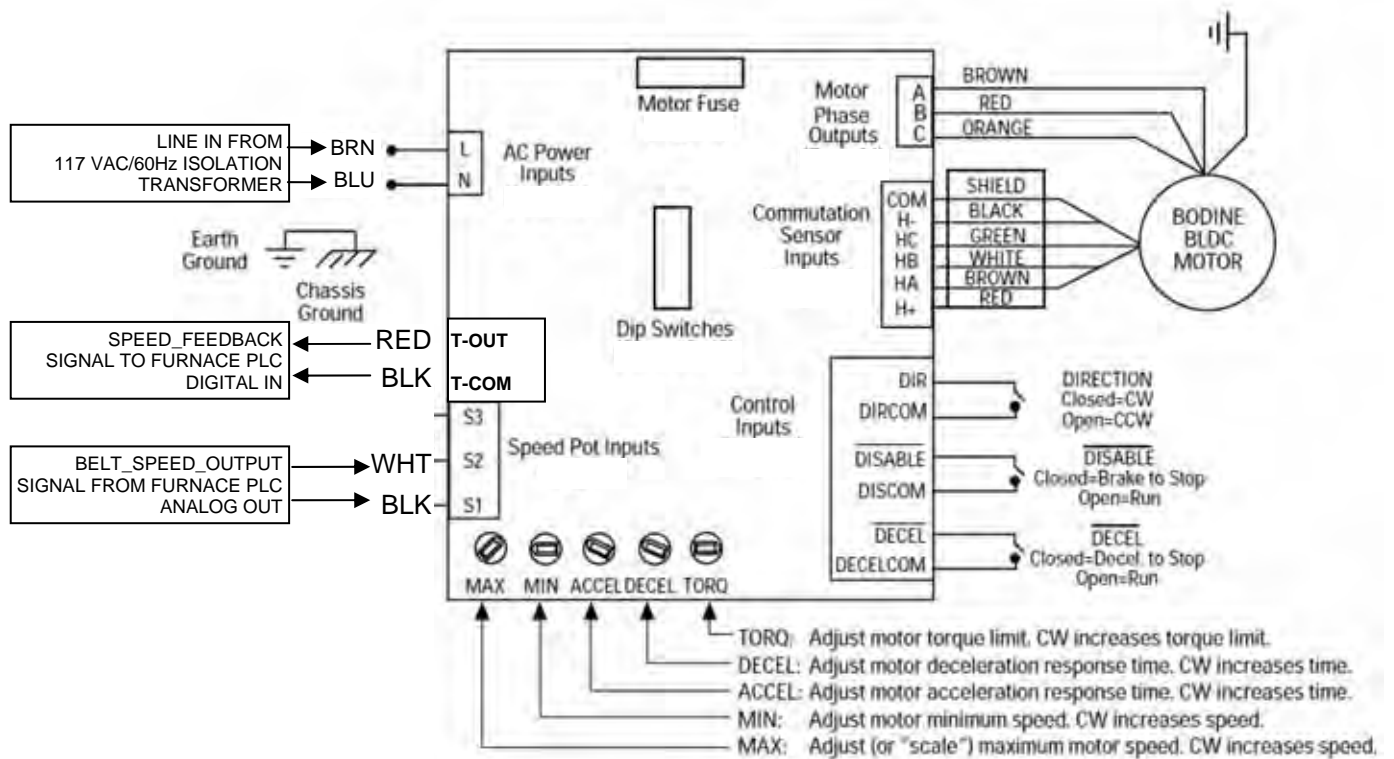
Moisture increases the electrical shock hazard of electrical insulation. Therefore, open-type or unsealed controls not specifically designed for such use, should be protected from contact with liquids or moisture.

## **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.

# SPECIFICATIONS

- Input Voltage:** ..... 115 VAC  $\pm$  10%, 50/60 Hz (Single Phase)
- Input Current:** ..... 12 A rms maximum
- Output Voltage:** ..... 0 to 130 VDC
- Ambient Temperature:** ..... 0 to 50 C
- Motor Hp Range:** ..... Up to 3/8 hp
- Speed Range:** ..... Up to 30:1
- Speed Regulation:** ..... Less than 1% of rated (Typical)
- Line Voltage Compensation:** ..... Negligible speed change with changes in line voltage
- Acceleration Time Range:** ..... 0.2 to 10 sec. (0 to full speed)
- Dimensions:** ..... in: 5.5 W x 8.0 D x 2.7 H  
cm: 14.0 W x 20.4 D x 6.9 H
- Net Weight:** ..... 2.5 LB. (1.12 kg.)





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# GENERAL INFORMATION

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## About This Manual

This manual contains the basic information needed to install and operate a Continuous Belt IR Furnace Drive Motor with a Bodine Model ABL-3911C Control.

## Safety Standards

This equipment is 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), and U.L.

## CONTROL DESCRIPTION AND FEATURES

The ABL-3911C Brushless DC Motor Controls are chassis style controls, mounted into the furnace motor control enclosure at the furnace exit. They operate from a nominal 115 VAC, 50/60 Hz. Power source and provide electronic commutation and phase current switching needed to operate brushless DC motors. DIP switch selectable current limit settings allow the controls to be used with several fractional horsepower motors and gearmotors.

The ABL-3911C provides a 130 Volt filtered output for improved form factor, plus a built-in dynamic braking module. It allows motor speed to be manually or electronically controlled.

Motor direction of rotation, braking or disabling, and soft starts and stops can be controlled with manual switch inputs, but are generally controlled by the furnace programmable logic controller (PLC). Since the control's signal common is not at ground potential, interface circuitry is required to isolate logic signals from the control. Trim potentiometers on the control board allow additional fine tuning of minimum and maximum speed settings, torque, acceleration and deceleration time. A built-in smart reversing circuit prevents plug reversing by braking the motor to a stop before changing its direction. A built-in shutdown circuit disables the control during overvoltage, undervoltage, or invalid commutation sensor state conditions.

Specific motor sizes which can be used with this control are listed in the Chart in Table 1.

## Accessory Items

- Model 3983 Connection Cable Assembly - connects Bodine brushless DC motors to ABL-3911C and ABL-3921C controls. Length: 6 foot.
- Model 3982 Extension Cable - extends cable between motor and control by six feet. Both ends equipped with circular connectors for easy connection between Model 3983 Cable and motor. Length: 6 ft.
- Model 3984 Isolated Interface Module

## Inspecting the Control

Carefully examine the control (and any optional kits or parts) to verify part number. Parts errors should be reported to the manufacturer.

Before installation or troubleshooting, review the application to confirm that the proper motor and control have been selected. This confirmation should be done after reading this manual and all applicable safety standards.

## Normal Operating Conditions

All control nameplate ratings are based on the following normal operating conditions.

1. *Duty Cycle:* 8 hours/day; 5 days/week, without frequent reversals or starts and stops.
2. *Maximum Ambient Temperature:* 50 C (122 F) for chassis controls; 40 C (104 F) for all encased 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%.

## 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. When fuses are replaced, they must always conform to the values and ratings specified on the control's nameplate or in the fuse chart located in Table 1.

## Servicing

Emergency field repairs must be made only by authorized service representatives. Repairs made by persons not authorized by FurnacePros will void the warranty. 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, components or motors. To ensure continued compliance with the design specifications and safety standards, the electronic control or motor should be returned to FurnacePros.

### **WARNING**

*To avoid injury because of unsuspected mechanical motion always disconnect the 115 VAC power to the control before performing any service procedures on the motor, control , or driven equipment.*

# INSTALLATION INSTRUCTIONS

## WARNING

*This control should only be installed by a qualified technician, electrician or electrical maintenance person familiar with its operation and associated hazards. The National Electrical Code (NEC), local electrical and safety codes, and when applicable, the Occupational Safety and Health Act (OSHA) should be observed to reduce hazards to personnel and property. The user must provide a proper enclosure for chassis type controls.*

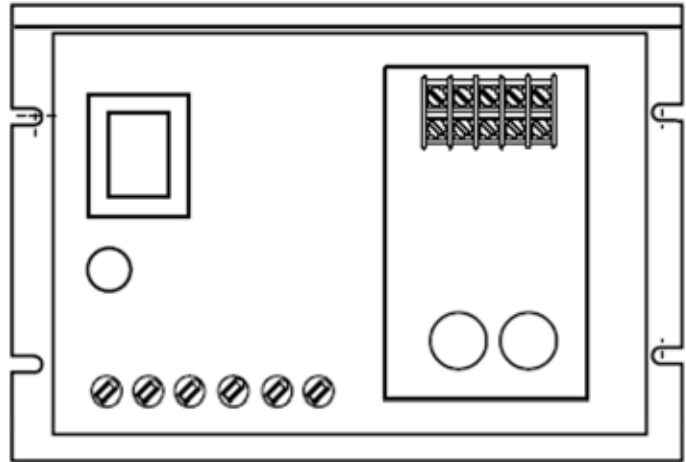
*Circuitry is not at ground potential. Do not perform work on or near the control while it is connected to the AC line.*

## CAUTION

*Exposed circuit boards should be protected from electrostatic discharge. The control board uses CMOS circuitry. Static discharge into the control board must be avoided to prevent component damage.*

## Mounting the Control

The mounting template (provided in the center of this manual) can be used to position and mark the location of mounting holes on the surface where the control is to be located. The control should be mounted vertically, using the slots on either the narrow or wide surfaces of the heatsink. This arrangement provides optimum air flow around the control. See Figure 2.



## Electrical connections

Read the following instructions as well as all of the applicable safety recommendations, before making any electrical connections between the control, motor, or motion control electronics.

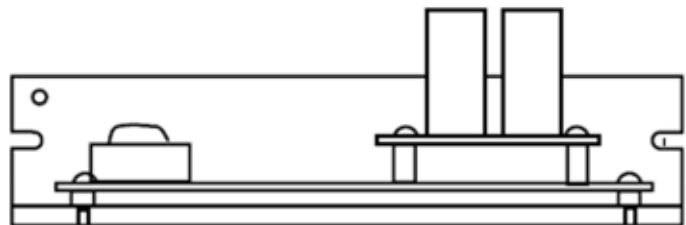


Figure 2 Heat sink orientation

## WARNING

*The 115 VAC power line to the control should be the very last connection made. Disconnect the power line before making any other electrical connections.*

**Cable Assembly:** The Model 3983 Cable Assembly, shown in Figure 3, is designed to simplify the electrical connections to the ABL-3911C Control. One end of the cable which connects to the motor is terminated with a circular type connector. The other end which connects to the control has a six-pin rectangular connector, three individual motor phase leads with quick disconnects, and an earth ground lead. This cable assembly must be modified for installation on furnace drive applications (see Page 5).

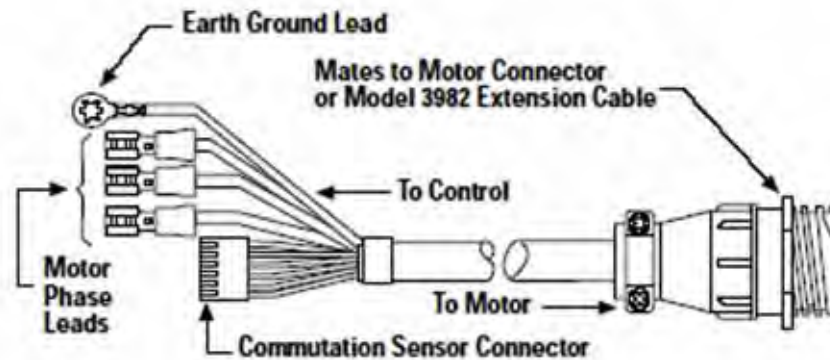


Figure 3 - Model 3983 Cable Assembly

**WARNING**

*The shield common is at a dangerous potential above ground and presents a voltage hazard. Contact with the shield could cause serious injury or death. If a special cable is fabricated, care should be taken to insulate all exposed shield to avoid serious injury. The shield should only be connected to COM terminal on the Commutation Sensor Input Connector at the control. No other shield connection should be made.*

**CAUTION**

*Only copper wire with a minimum 60°C rated insulation is recommended if FurnacePros supplied Bodine cable assemblies are not used. The control terminal block will accept leads up to 14 guage (18 guage is the smallest recommended size).*

**Horsepower (DIP Switch) Settings:** Figure 4 shows a Horsepower Select switch on the main control board which contains eight switch levers numbered 1 through 8. The chart in Table 1 shows the proper DIP switch settings for various Bodine furnace drive motor types.

Determine the first four digits of the motor's type number from the nameplate. Find the same four digits in the chart in Table 1 to determine the proper settings of the DIP switches. An insulated alignment tool should be used to adjust the switch settings.

Control Model No.	Bodine Motor or Gearmotor Type	Hp	Rated Speed (RPM)	DIP Switches "On" Position	Line Fuse (F1)	Motor Fuse (F2)	AC rms Input Current
ABL-3911C	22B2...	1/16	2,500	2,6,8	ABC 15	MDA 6/10	2.7
	22B3...	1/11		1,2,6,8		MDA 8/10 3.6	3.6
	22B4...	1/8		1,3,6,8		MDA 1-1/4 4.8	4.8
	34B3...	1/5		1,2,3,6,8		MDA 1-1/2	6.7
	<b>34B4...</b>	<b>1/4</b>		<b>2,4,6,8</b>		<b>MDA 2</b>	<b>8.0</b>
	34B6...	3/8		1,5,6,8		MDA 3	11.1

Table 1 - Horsepower (DIP Switch) Settings and Fuse Selection Chart

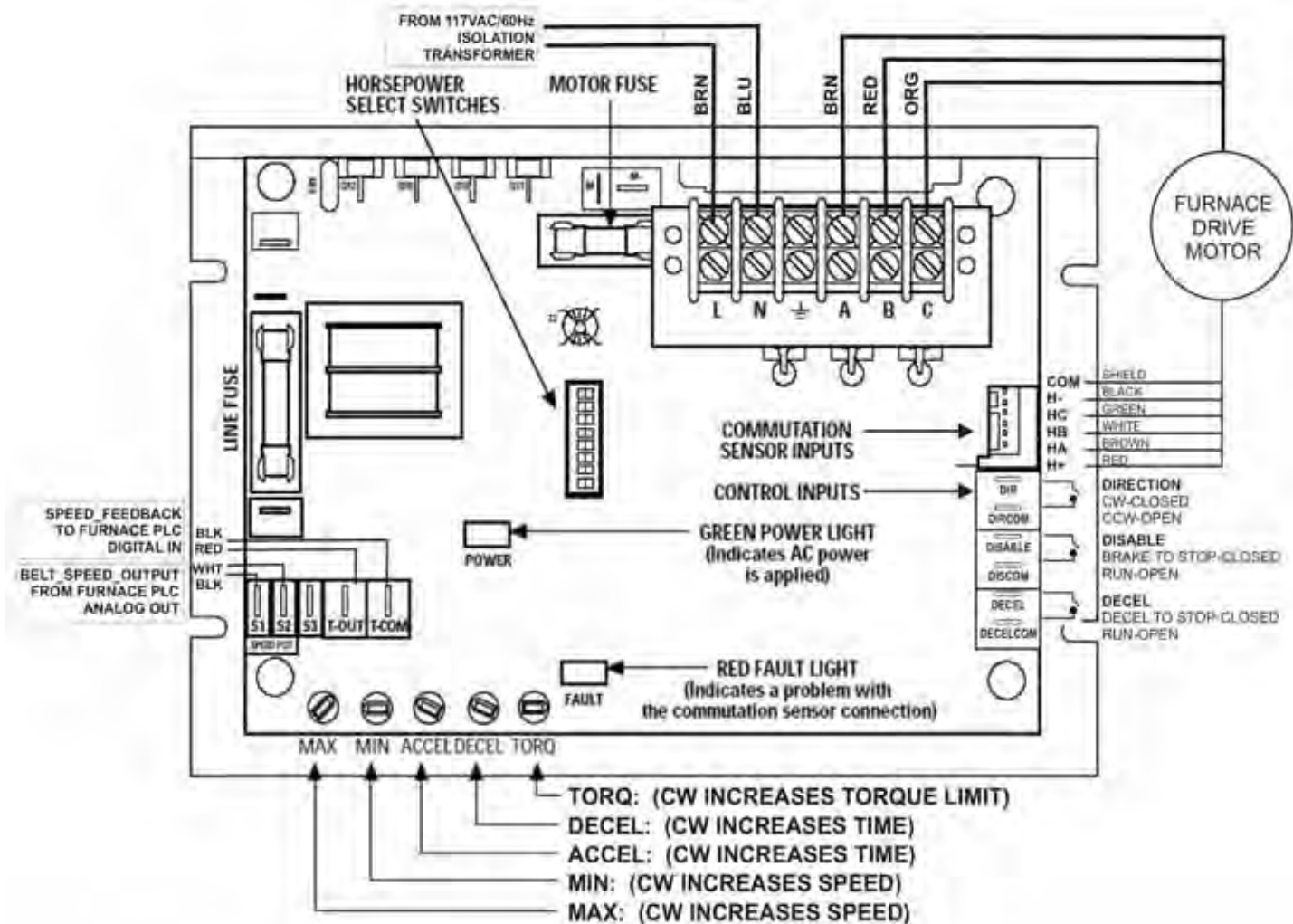


Figure 4 - Control Circuit Board Detail

**Commutation Sensor Connections:** The commutation sensor leads are prewired in the Model 3983 cable assembly and terminated in a six-pin connector (Figure 3). There is a corresponding "Commutation" connector on the main control board (Figure 4). Mate the polarized cable connector to the "Commutation" connector. The connectors can only mate one way.

**Motor Phase Connections:** If installing a new cable, locate the barrier terminal block mounted to the bracket above the main control board and make the following modifications. Refer to Figure 4:

1. Cut the quick connect terminals from the brown, red, and orange motor phase leads.
2. Strip away approximately 1/4 inch of the insulation from the leads.
3. Connect the stripped leads to the barrier terminal block as follows:
  - Brown to Terminal "A BRN"
  - Red to Terminal "B RED"
  - Orange to Terminal "C ORG"

**Fuse Installation:** The control input and output are fused. The line input fuse has been installed at the factory. The control output or "Motor Fuse" must be selected based on the size of the motor.

**Line Fuse:** The location of line fuse (F1) is shown in Figure 4. It should always be replaced with a fuse of the same type and rating. Its rating can be determined by referring to the chart in Table 1.

**Motor Fuse:** The location of motor fuse (F2) is shown in Figure 4. The fuse rating will vary with the size of the motor used. To determine the proper fuse rating, locate the first four digits of your motor's type number on the motor nameplate. Find the same four digits in the chart in Table 1 to determine the fuse size. The ABL-3911C and ABL-3921C are supplied with the fuses listed in Table 1.

**Manual Control Input Connections:** Motor speed, braking, direction of rotation and deceleration can be controlled manually or electronically. Refer to the following procedures for connecting control inputs.

### CAUTION

The control board signal common is not at ground potential. Any external signal or equipment connected to the control must be electrically isolated from ground (e.g., with relay contacts or optical isolation module). Non-isolated signals will damage the control and/or associated external equipment.

**Manual Speed Control: (optional)** Although the motor speed is controlled by the furnace PLC, a Manual Speed Potentiometer Kit can alternately be used with the Model ABL-3911C to control motor speed. The motor speed kit includes a 10k Ohm potentiometer, mounting hardware, and three 24-inch long leads terminated on one end with 1/4 inch quick connects. To connect the speed potentiometer, proceed as follows:

1. Solder the three leads to the potentiometer as shown in Figure 1.
2. Mount the potentiometer in the desired location.
3. Connect the speed pot to the control board terminals as follows:
  - Blue to Terminal "S1"
  - Orange to Terminal "S2"
  - Yellow to Terminal "S3"

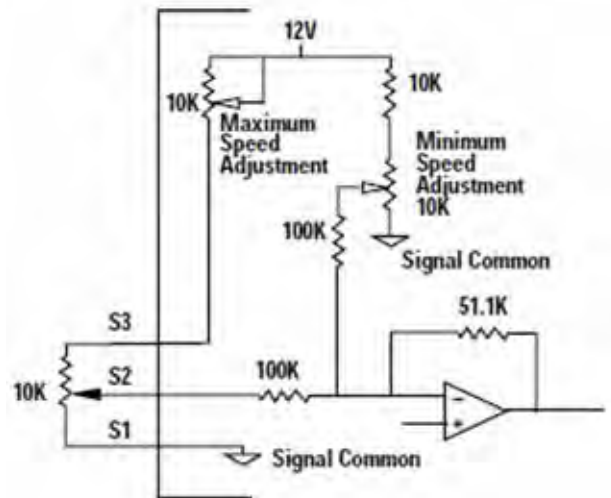


Figure 6 - Manual Speed Potentiometer Interface details

*Manual Braking (Disable), Direction of Rotation, and Deceleration:*

Mechanical switches or relays can be used to switch the control inputs. Figure 7 shows a schematic representation of manual or relay switched inputs.

NOTE: Shielded cable is recommended for these connections.

The following chart lists the control functions relative to the state of the mechanical switches or relays.

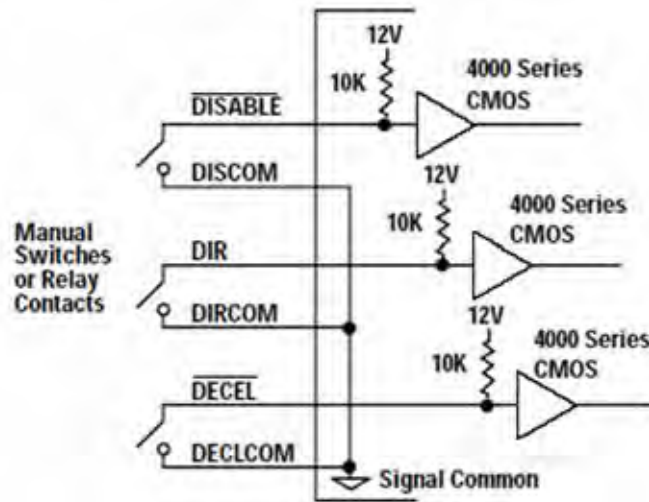


Figure 7 - Manual Switch and Relay Control Inputs.

Switch	Closed	Open
DISABLE	Fast Stop	Run
DIR	CW	CCW
DECEL	Slow Stop	Run

1. Dynamic braking will occur when the DISABLE switch is closed
2. A "Smart Reverse Circuit" prevents plug reversing when the DIRection switch is opened or closed. The motor brakes to a stop before changing direction.
3. The DECEL switch controls soft stops. The degree of deceleration can be varied with the trim potentiometers on the control board. See Page 21.
4. The output shafts of gearmotors with odd number of stages (Bodine type designations ending with W3, E1, or E3) will rotate in the opposite direction.



**Electronic Control Input Connections:** Optional Interface boards provide electrical isolation between the input signal and the brushless DC motor control circuitry, and are recommended for motion control applications requiring electronic control of motor speed, rotational direction, deceleration, and braking.

*Electronic Speed Control (optional):* Motor speed can be controlled with a 0 to +10 VDC isolated signal with 0.1 mA current capability in lieu of the manual speed potentiometer. This speed control input should be connected to terminal S2 on the control board. The common side of the signal must also be isolated and connected to terminal S1 on the main control board.

*PLC Logic Signal Control of Braking, Direction of Rotation, and Deceleration:*

On the furnace, motor braking (or disable), direction of rotation and deceleration is controlled using optically isolated logic signals from the PLC programmable controller.

**WARNING**

*Never rely on logic circuitry as a means of disabling the motor or control. To prevent unsuspected mechanical motion and potential injury, the 115 VAC power should always be disconnected whenever logic circuits or the driven equipment are serviced.*

Exercise extreme caution when using Programmable Logic Controllers (PLCs). Although the output modules are optically isolated output modules, their output commons may be connected to other circuitry either within or connected to the PLC. In such cases, the PLC outputs should be isolated from the control board, by a relay or by an electronic isolation module, to prevent damage to the PLC or the ABL Control.

When a Programmable Controller with a relay output module is not available, AC or DC outputs from the PLC can be used to drive separate relay coils. See PLC user's manual for application information. See Figure 7 to determine how to connect relay contacts to the ABL-3911C.

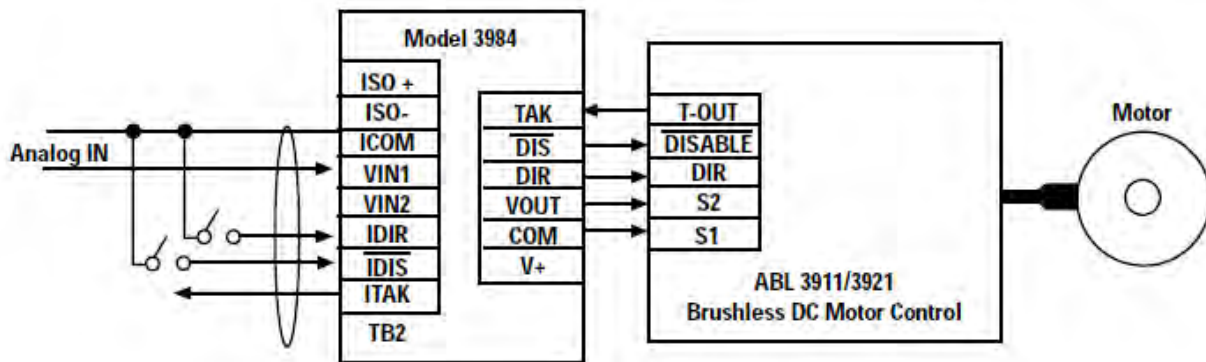


Figure 8 - Connection to Model 3984 Isolation Interface

*Signal Isolation Using the Bodine Model 3984 Interface Module:* Follow the installation instructions provided with the module to isolate the input signals between the control electronics and the ABL Control. See Figure 8 for connections.



**Tachometer Output:** When used with the Bodine ABL-3911/3921 Brushless DC Motor Controls, the Model 3984 module provides a digital tachometer output at the ITAK terminal for monitoring motor speed. The output pulse levels are low to high to low. The typical pulse width is 0.8 msec. for the ABL-3911 and 0.19 msec. for the ABL-3921. Twelve pulses correspond to one motor revolution. The ITAK output provides an un-terminated open collector output. A pull-up resistor or another logic device is required for measuring the output. See Figure 9 for assistance in interfacing the ITAK output.

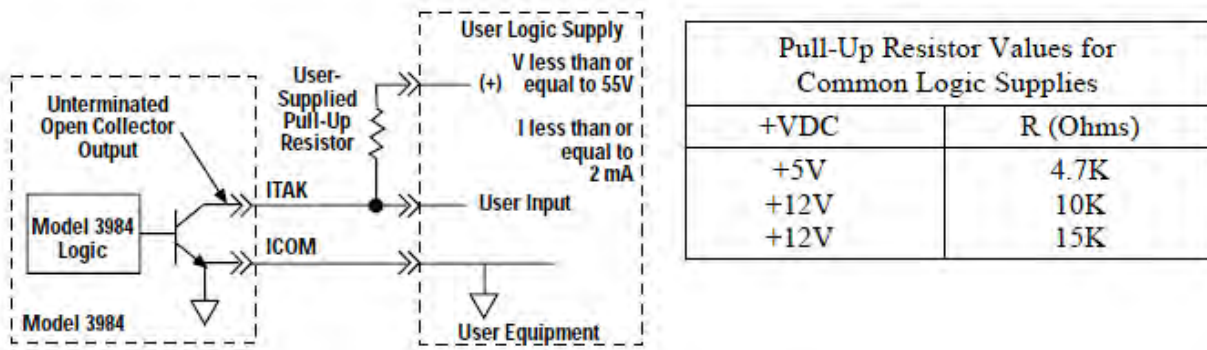


Figure 9 - Tachometer output

**AC Power Connections:** Power should always be the last connection made during installation and the first item to be disconnected before servicing.

**WARNING**

*The control and motor must be securely and adequately connected to earth ground as indicated below. Failure to ground properly may result in serious injury.*

**Power Input:** Refer to Figure 4. Locate the barrier terminal block mounted to the bracket above the main control board and connect AC power to the barrier terminal block as follows:

1. Hot side of 115 VAC line to Terminal "L".
2. Neutral side of 115 VAC line to Terminal "N".
3. Cut the ring terminal off the Ground (Green/Yellow) wire of the 3983 cable. Strip the insulation 1/4" and connect the wire to the terminal labeled with the chassis ground symbol. This terminal should also be used to connect the system to earth ground.



# OPERATING INSTRUCTIONS

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## **WARNING**

*Explosions, fires, or electric shock hazards can be reduced through thermal and over-current protection, good maintenance, proper grounding, and enclosure selection. Review safety considerations outlined in "Safety Precautions" and "Installing the Control."*

### **Preliminary Checks**

1. Before starting the control, check all fuses, connections, and adjustments such as horsepower DIP switch settings.
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. Mechanical considerations such as proper mounting and alignment of products, and safe loads on shafts and gears should be reviewed. 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.

### **Controlling the Speed using a Potentiometer Control**

## **WARNING**

*The 115 VAC line to the driver should be switched off before starting.*

1. Turn input power OFF and set the speed potentiometer to ZERO (fully counterclockwise). If a Disable switch is used, close the switch. If a Direction switch is used set it for the desired direction of rotation. If a Deceleration switch is used, open the switch. See Chart in Installation Instructions, Manual Control Input Connections.
2. Connect the 115 VAC power line to the external power source. Then turn on the 115 VAC input power to the control.
3. Open the Disable switch, if used.
4. Turn speed potentiometer knob until motor rotates. Then adjust the potentiometer to achieve the desired speed. If you wish to reduce the torque level, refer to Internal Adjustments below.
5. If the motor does not operate, first observe if the green POWER light and red FAULT light are on (refer to Figure 4 for location). Then disconnect the AC power to the control and check all connections and fuses. If a fuse is blown and the motor is not locked (stalled) or overloaded, do not replace the fuse.

The control may be damaged. Refer to Troubleshooting on page 22 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 in Table 1.

### **Internal Adjustments**

Your control has been factory-adjusted for the following settings:

<i>Minimum speed</i>	0 RPM
<i>Maximum speed</i>	2,500 RPM

<i>Acceleration</i>	2 seconds
<i>Deceleration</i>	2 seconds
<i>Torque</i>	200% of rated (based on proper DIP switch settings)

Refer to Figure 4 for the trim potentiometer locations and approximate initial settings. If you need to readjust the control for your specific applications, proceed as follows:

**WARNING**

*Use a nonmetallic or insulated adjustment tool (such as a television 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:** The MIN and MAX trim potentiometers have been factory calibrated. The lowest MIN trim potentiometer setting (fully counterclockwise) corresponds to 0 RPM and the highest MIN setting (fully clockwise) corresponds to approximately 30% of rated speed.

The lowest MAX trim potentiometer setting (fully counterclockwise) corresponds to 60% of rated speed and the highest MAX trim potentiometer setting (fully clockwise) corresponds to approximately 120% of rated speed. Refer to Figure 4 for trim potentiometer location and settings. Adjustment of the MIN and MAX trim potentiometers may have to be repeated several times to arrive at the desired speeds.

NOTE: Increasing the MIN potentiometer setting will increase the maximum speed beyond nameplate speed. The MAX trim potentiometer will need to be readjusted.

**Torque (Current) Limiting Adjustment:** The TORQ trim potentiometer (Figure 4) has been calibrated to limit current to 200 to 250% of the motor's rated current, assuming the DIP switches are set properly. The motor's torque output can be reduced to zero or stall torque. Turn the TORQ trim potentiometer counterclockwise to decrease the torque and clockwise to increase the torque.

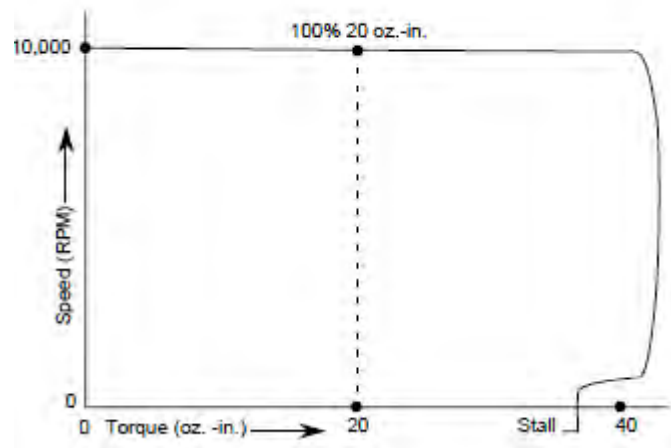


Figure 10. Speed/torque Curve showing decreased torque limit at lower speeds.

**Acceleration Adjustment :** Adjusting the ACCEL trim potentiometer (See Figure 4) counterclockwise decreases the motor's acceleration time down to a minimum of approximately 0.2 seconds. A clockwise adjustment increases the rate up to a maximum of approximately 10 seconds.

**Deceleration Adjustment:** Adjusting the DECEL trim potentiometer (See Figure 4) counterclockwise decreases the motor's deceleration time down to a minimum of approximately 0.2 seconds. A clockwise adjustment increases the rate up to a maximum of approximately 10 seconds.

# TROUBLESHOOTING

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Your control should not require maintenance under normal conditions. If you encounter a problem, read all applicable instruction literature provided with this control and accessories, and double-check the wiring. The charts on the following pages also provide assistance in troubleshooting those problems which usually occur during normal installation and operation.

*If the problem persists, contact FurnacePros 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 FurnacePros or Bodine Electric Company. Performing repairs, adjustments or removing screws not authorized by FurnacePros or Bodine Electric Company will void the Warranty.*

**WARNING**

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

## TROUBLESHOOTING TABLE

<b>SYMPTOM</b>	<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
CONTROL BLOWS LINE FUSE	Control or motor connected to or shorted to earth ground	Check for shorts and repair control and/or motor as required.
	Shorted phase leads wiring incorrect	Correct wiring.
	Damaged control Components	Contact Manufacturer Service Center for assistance.
MOTOR WILL NOT START AND POWER LIGHT IS OFF	Open line fuse	Replace fuse. Refer to Table 1 for proper value.
	Open line switch	Close the line switch.
MOTOR WILL NOT START AND POWER LIGHT IS ON	Motor overloaded	Correct load or choose larger motor.
	TORQ trim pot is out of adjustment	Visually check setting (Figure 4). Adjust TORQ trim pot, page 12.
	Open motor fuse	Replace fuse. Refer to Table 1 for proper values
	Speed potentiometer set to zero	Increase speed potentiometer setting.
	Closed DISABLE switch	Open DISABLE switch and restart.
	Closed DECEL switch	Open the DECEL switch.
	Electrical noise on DISABLE and/or DECEL input	Use shielded cable.
	Damaged motor	Repair or replace motor.
MOTOR WILL NOT START AND FAULT LIGHT IS ON	Mistake in motor commutation sensor connections	Correct wiring.
	Electric noise on commutation sensor inputs	Use shielded cable.
	Damaged motor	Repair or replace motor.
MOTOR WILL NOT COME UP TO SPEED	MAX trim pot set too low	Adjust trim pot, page 12.
	Speed potentiometer set to low	Increase speed potentiometer setting.
	Motor overloaded	Reexamine the load parameters.
	TORQ trim pot is out of adjustment	Visually check setting (Figure 4). Adjust TORQ trim pot, page 12.
	Wrong horsepower setting	Check DIP switch setting, page 4.
	Damaged component on the control board	Contact Manufacturer Service Center for assistance.

<b>SYMPTOM</b>	<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
MOTOR SPEED IS UNSTABLE OR PULSATES	Wrong horsepower setting	Check DIP switch setting, page 4.
	Motor and load not correctly aligned	Perform alignment.
	Damaged motor	Repair or replace motor.
	Speed potentiometer set too low	Increase speed potentiometer setting.
MOTOR WILL NOT MAINTAIN SPEED UNDER LOAD	Wrong horsepower	Check DIP switch setting, page 4. setting
	TORQ trim pot is out of adjustment	Visually check setting (Figure 4). Adjust TORQ trim pot, page 12.
	Motor overloaded	Reexamine the load parameters.
MOTOR WILL NOT STOP WITH SPEED POT ADJUSTED AT ZERO	MIN trim potentiometer is set too high	Turn the MIN trim pot CW until motor stops.
	Open connection on speed potentiometer	Check S1, S2, S3 connections.
	Defective speed potentiometer	Replace the potentiometer.
Note: The Disable input should be used when the motor is expected to remain stopped.		
NO SPEED ADJUSTMENT	Defective speed potentiometer	Replace the potentiometer.
	Open connection on speed potentiometer	Check S1, S2, S3 connections.



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