



AMERICAN  
CONTROL  
ELECTRONICS

## *PWL Series*

### *USER MANUAL*

PWL400-3

PWL400-5

PWL400-10

PWL400-15

PWL440-3

PWL440-10

PWL440-10-JOG



Dear Valued Consumer:

Congratulations on your purchase of the **PWL Series** drive. This User Manual was created for you to get the most out of your new device and assist with the initial setup. Please visit [www.americancontrolelectronics.com](http://www.americancontrolelectronics.com) to learn more about our other drives.

Thank you for choosing **American Control Electronics®!**

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# Safety First!

## SAFETY WARNINGS



Text in gray boxes denote important safety tips or warnings. Please read these instructions carefully before performing any of the procedures contained in this manual.

- **DO NOT INSTALL, REMOVE, OR REWIRE THIS EQUIPMENT WITH POWER APPLIED.** Have a qualified electrical technician install, adjust and service this equipment. Follow the National Electrical Code and all other applicable electrical and safety codes, including the provisions of the Occupational Safety and Health Act (OSHA), when installing equipment.
- Reduce the chance of an electrical fire, shock, or explosion by using proper grounding techniques, over-current protection, thermal protection, and enclosure. Follow sound maintenance procedures.



It is possible for a drive to run at full speed as a result of a component failure. AMERICAN CONTROL ELECTRONICS® (ACE) strongly recommends the installation of a master switch in the main power input to stop the drive in an emergency.

Circuit potentials are at 115 VAC or 230 VAC above earth ground. Avoid direct contact with the printed circuit board or with circuit elements to prevent the risk of serious injury or fatality. Use a non-metallic screwdriver for adjusting the calibration trim pots. Use approved personal protection equipment and insulated tools if working on this drive with power applied.

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## Section 1. Specifications

<i>Model</i>	<i>Maximum Armature Current (ADC)</i>	<i>HP Range with 130 VDC Motor</i>	<i>HP Range with 240 VDC Motor</i>	<i>Enclosure</i>
PWL400-3 PWL440-3	3	1/20 - 1/4	1/10 - 1/2	Chassis NEMA 4X
PWL400-5	5	1/8 - 1/2	1/4 - 1	Chassis
PWL400-10* PWL440-10 PWL440-10-JOG	10	1/4 - 1	1/2 - 2	Chassis NEMA 4X NEMA 4X
PWL400-15	15	1/4 - 1 1/2	1/2 - 3	Chassis

\* Heat sink kit part number HSK-0003 must be used when the continuous current output is over 5 amps.

### AC Line Voltage

115/230 VAC  $\pm$  10%  
50/60 Hz, single phase

### DC Armature Voltage

with 115 VAC Line Voltage  
with 230 VAC Line Voltage

0 - 130 VDC  
0 - 240 VDC

### Field Voltage

with 115 VAC Line Voltage  
with 230 VAC Line Voltage

50 VDC (F1/F+ to L1); 100 VDC (F1/F+ to F2/F-)  
100 VDC (F1/F+ to L1); 200 VDC (F1/F+ to F2/F-)

### Maximum Field Current

1 ADC

---

**Acceleration Time Range (with no load)**

*PWL400-3, PWL400-5, and PWL400-10*

*for 0 - 130 VDC Armature Voltage*

1 - 12 seconds

*for 0 - 240 VDC Armature Voltage*

1 - 12 seconds

*PWL400-15*

*for 0 - 130 VDC Armature Voltage*

1 - 9 seconds

*for 0 - 240 VDC Armature Voltage*

1 - 15 seconds

*PWL440-3*

*for 0 - 130 VDC Armature Voltage*

1 - 10 seconds

*for 0 - 240 VDC Armature Voltage*

1 - 19 seconds

*PWL440-10 and PWL440-10-JOG*

*for 0 - 130 VDC Armature Voltage*

1 - 10 seconds

*for 0 - 240 VDC Armature Voltage*

1 - 15 seconds

---

**Deceleration Time Range (with no load)**

*PWL400-3, PWL400-5, and PWL400-10*

*for 0 - 130 VDC Armature Voltage*

coast to a stop - 12 seconds

*for 0 - 240 VDC Armature Voltage*

coast to a stop - 12 seconds

*PWL400-15*

*for 0 - 130 VDC Armature Voltage*

coast to a stop - 10 seconds

*for 0 - 240 VDC Armature Voltage*

coast to a stop - 18 seconds

*PWL440-3*

*for 0 - 130 VDC Armature Voltage*

coast to a stop - 9 seconds

*for 0 - 240 VDC Armature Voltage*

coast to a stop - 19 seconds

*PWL440-10 and PWL440-10-JOG*

*for 0 - 130 VDC Armature Voltage*

coast to a stop - 10 seconds

*for 0 - 240 VDC Armature Voltage*

coast to a stop - 19 seconds

---

**Analog Input Range (Signal must be isolated; S1 to S2)**

*for 0 - 130 VDC Armature Voltage*

0 - 2.5 VDC

*for 0 - 240 VDC Armature Voltage*

0 - 5.0 VDC

---

**Input Impedance (S1 to S2)**

*PWL400-15*

50K ohms

*All other models*

100K ohms

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**Form Factor**

1.05

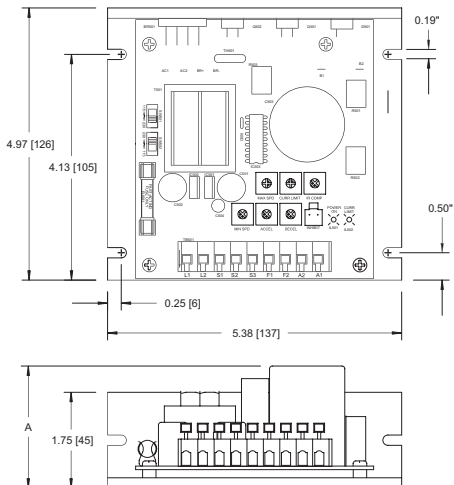
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<b>Load Regulation</b>	
<i>PWL400-15</i>	0.5% base speed or better
<i>All other models</i>	1% base speed or better
<b>Speed Range</b>	
	100:1
<b>Vibration</b>	
<i>PWL400-3, PWL400-5, PWL400-10</i>	0.5G maximum (0 - 50 Hz) 0.1G maximum (> 50 Hz)
<i>PWL400-15, PWL440-3, PWL440-10 and PWL440-10-JOG</i>	0.5G maximum (0 - 50 Hz) 0.1G maximum (> 50 Hz)
<b>Safety Certifications</b>	
	UL Recognized Component, File # E132235 CSA Certified Component, File # LR41380
<b>Ambient Temperature Range</b>	
	10°C - 40°C

## Suffix Definitions

-JOG: Basic Drive with Run/Jog Switch

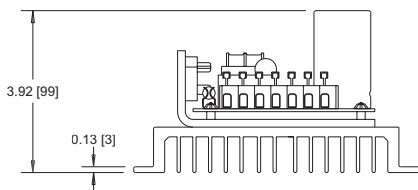
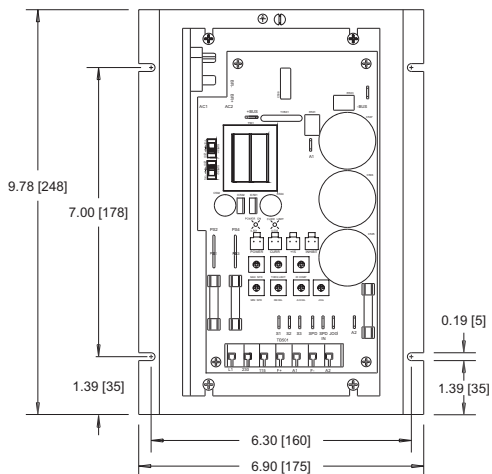
## Section 2. Dimensions



MODEL	DIMENSION "A" HEIGHT
PWL400-3	2.25 [57]
PWL400-5	3.00 [76]
PWL400-10	3.75 [95]

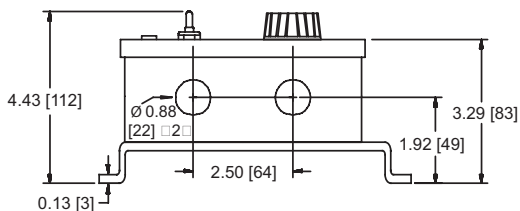
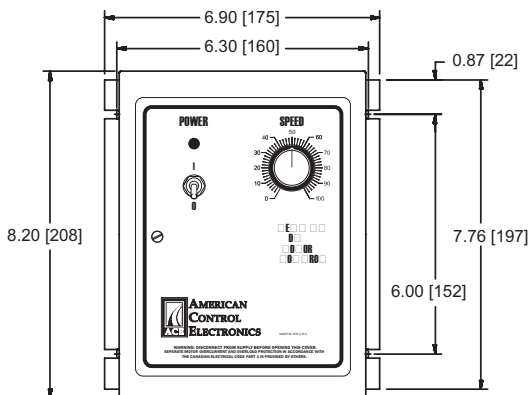
ALL DIMENSIONS IN INCHES [MILLIMETERS]

Figure 1. PWL400-3, PWL400-5, and PWL400-10 Dimensions



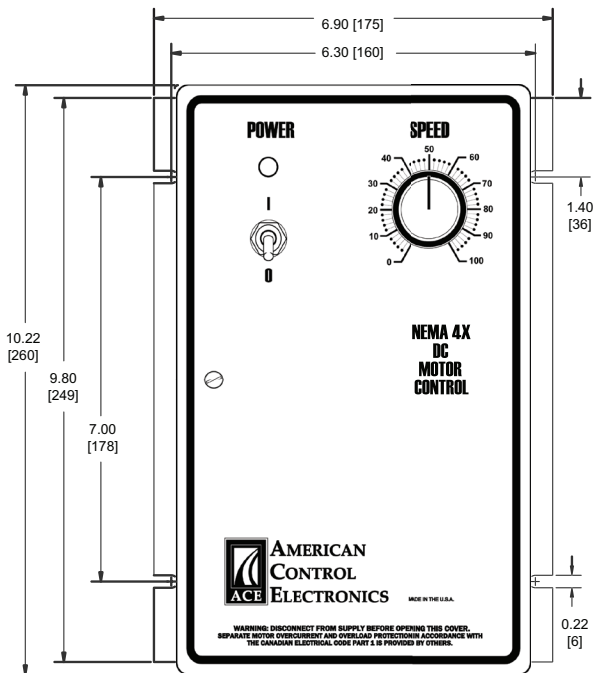
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Figure 2. PWL400-15 Dimensions



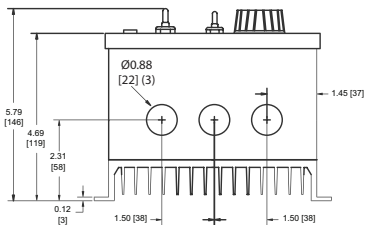
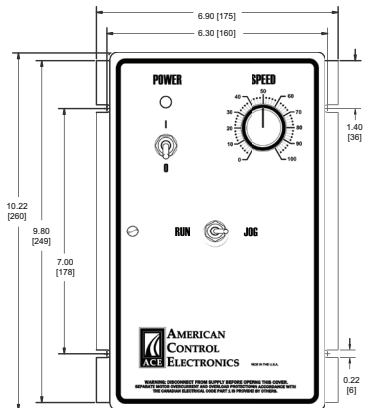
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Figure 3. PWL440-3 Dimensions



ALL DIMENSIONS IN INCHES [MILLIMETERS]

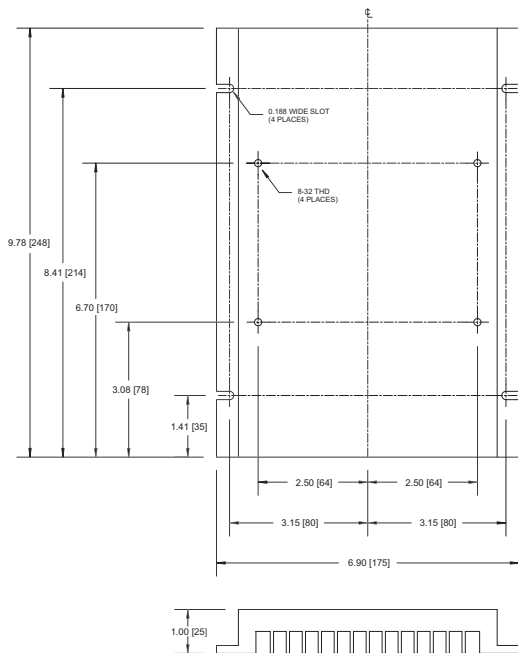
Figure 4. PWL440-10 Dimensions



ALL DIMENSIONS IN INCHES [MILLIMETERS]

Figure 5. PWL400-10-JOG Dimensions





ALL DIMENSIONS IN INCHES [MILLIMETERS]

Figure 6. HSK-0003 Dimensions

## Section 3. Installation



**Do not install, rewire, or remove this control with input power applied.** Failure to heed this warning may result in fire, explosion, or serious injury. Make sure you read and understand the Safety Precautions on page i before attempting to install this product.

### Chassis Drives

#### Mounting

- Drive components are sensitive to electrostatic discharge. Avoid direct contact with the circuit board. Hold the drive by the chassis or heat sink only.
- Protect the drive from dirt, moisture, and accidental contact.
- Provide sufficient room for access to the terminals and calibration trim pots.
- Mount the drive away from heat sources. Operate the drive within the specified ambient operating temperature range.
- Prevent loose connections by avoiding excessive vibration of the drive.
- Mount the drive with its board in either a horizontal or vertical plane. Six 0.19" (5 mm) wide slots in the chassis and four in the heat sink accept #8 pan head screws. Fasten either the large base or the narrow flange of the chassis or heat sink to the subplate.
- The chassis or heat sink should be earth grounded. Use a star washer beneath the head of at least one of the mounting screws to penetrate the anodized surface and to reach bare metal.

**Heat Sinking**

The PWL series drive PWL400-10 requires an additional heat sink when the continuous armature current is above 5 amps. Use ACE heat sink kit part number HSK-0003. All other chassis drives have sufficient heat sinking in their basic configuration. Use a thermally conductive heat sink compound (such as Dow Corning® 340 Heat Sink Compound) between the chassis and the heat sink surface for optimum heat transfer.

## Speed Adjust Potentiometer



Be sure that the potentiometer tabs do not make contact with the potentiometer's body. Grounding the input will cause damage to the drive.

Mount the speed adjust potentiometer through a 0.38 in. (10 mm) hole with the hardware provided (Figure 7). Install the circular insulating disk between the panel and the 10K ohm speed adjust potentiometer.

Twist the speed adjust potentiometer wires to avoid picking up unwanted electrical noise. If the speed adjust potentiometer wires are longer than 18 in. (46 cm), use shielded cable. Keep the speed adjust potentiometer wires separate from power leads (L1, L2, 115, 230, A1, A2, F1, F2, F+, F-).

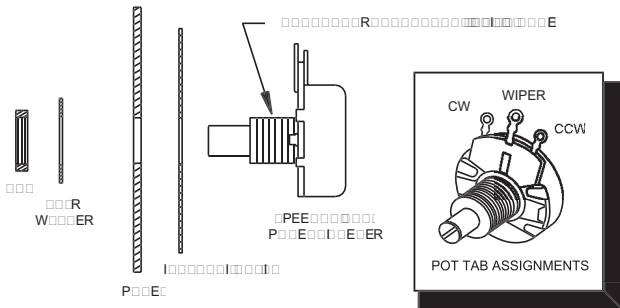


Figure 7. Speed Adjust Potentiometer

## Wiring



**Do not install, rewire, or remove this control with input power applied.** Failure to heed this warning may result in fire, explosion, or serious injury.

Circuit potentials are at 115 or 230 VAC above ground. To prevent the risk of injury or fatality, avoid direct contact with the printed circuit board or with circuit elements.

Do not disconnect any of the motor leads from the drive unless power is removed or the drive is disabled. Opening any one motor lead while the drive is running may destroy the drive.

- Use 18 - 24 AWG wire for logic wiring. Use 14 - 16 AWG wire for AC line and motor wiring.

## Shielding Guidelines



Under no circumstances should power and logic level leads be bundled together. Induced voltage can cause unpredictable behavior in any electronic device, including motor controls.

As a general rule, AMERICAN CONTROL ELECTRONICS® (ACE) recommends shielding of all conductors. If it is not practical to shield power conductors, ACE recommends shielding all logic-level leads. If shielding of all logic-level leads is not practical, the user should twist all logic leads with themselves to minimize induced noise.

It may be necessary to earth ground the shielded cable. If noise is produced by devices other than the drive, ground the shield at the drive end. If noise is generated by a device on the drive, ground the shield at the end away from the drive. Do not ground both ends of the shield.

### Shielding Guidelines (continued)

If the drive continues to pick up noise after grounding the shield, it may be necessary to add AC line filtering devices, or to mount the drive in a less noisy environment.

Logic wires from other input devices, such as motion controllers and PLL velocity controllers, must be separated from power lines in the same manner as the logic I/O on this drive.

### Line Fusing

Models PWL400-3, PWL400-5, and PWL400-10 are preinstalled with one line fuse in fuse holder FU501. They require an additional line fuse on L2 if the input voltage is 230 VAC. Table 1 on page 15 lists the recommended line fuse sizes. Model PWL400-15 is preinstalled with two line fuses in fuse holders FU501 and FU502.

Models PWL400-15 is preinstalled with 20 amp fuses. Model PWL400-10 is preinstalled with a 20 amp fuse. Model PWL400-5 is preinstalled with a 10 amp fuse. Model PWL400-3 is preinstalled with a 8 amp fuse.

Preinstalled line fuses are rated at or close to maximum horsepower. If the horsepower rating of the motor being used is less than the maximum horsepower rating of the drive, the line fuse may have to be replaced with a lower rated one. Fuses should be rated for 250 VAC or higher and approximately 150% of the maximum armature current. Refer to Table 1 on page 15 for recommended fuse values.

Table 1. Recommended Line Fuse Sizes

<i>90 / 130 VDC Motor Horsepower</i>	<i>180 / 240 VDC Motor Horsepower</i>	<i>Maximum DC Armature Current (amps)</i>	<i>AC Line Fuse Size (amps)</i>
<i>1/20</i>	<i>1/10</i>	<i>0.5</i>	<i>1</i>
<i>1/15</i>	<i>1/8</i>	<i>0.8</i>	<i>1.5</i>
<i>1/8</i>	<i>1/4</i>	<i>1.5</i>	<i>3</i>
<i>1/6</i>	<i>1/3</i>	<i>1.7</i>	<i>3</i>
<i>1/4</i>	<i>1/2</i>	<i>2.5</i>	<i>5</i>
<i>1/3</i>	<i>3/4</i>	<i>3.5</i>	<i>8</i>
<i>1/2</i>	<i>1</i>	<i>5.0</i>	<i>10</i>
<i>3/4</i>	<i>1 ½</i>	<i>7.5</i>	<i>15</i>
<i>1</i>	<i>2</i>	<i>10</i>	<i>15</i>
<i>1 1/2</i>	<i>3</i>	<i>15</i>	<i>25</i>

ACE offers fuse kits. See Section 9: Accessories and Replacement Parts on page 61 for fuse kit part numbers.

### Connections



**Do not connect this equipment with power applied.** Failure to heed this warning may result in fire, explosion, or serious injury.

**ACE strongly recommends the installation of a master power switch in the voltage input line, as shown in Figure 9 (page 19) and Figure 10 (page 20).** The switch contacts should be rated at a minimum of 200% of motor nameplate current and 250 volts.

### Cage-Clamp Terminal Block

PWL series drives use a cage-clamp terminal block. To connect a wire to the cage-clamp terminal block (see Figure 8), use a small screwdriver to press down on the lever arm. Insert a wire stripped approximately 0.25 inches (6 mm) into the opening in front of the terminal block. Release the lever arm to clamp the wire.

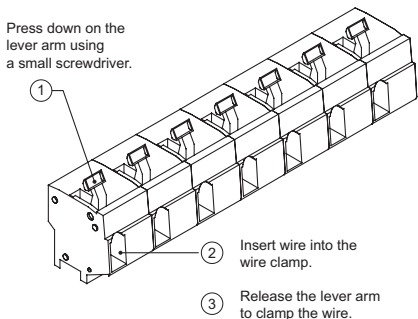


Figure 8. Cage Clamp Terminal Block



## Power Input

For models PWL400-3, PWL400-5, and PWL400-10, connect the AC line power leads to terminals L1 and L2. For model PWL400-15 connect the AC line power leads to terminals L1 and L2 (115) if using a 115 VAC line or to terminals L1 and L2 (230) if using a 230 VAC line. ACE recommends the use of a single-throw, double-pole master power switch. The switch should be rated at a minimum of 250 volts and 200% of motor current. Refer to Figure 9 on page 19 and Figure 10 on page 20.

## Motor

ACE drives supply motor armature voltage from A1 and A2 terminals, where A1 is positive with respect to A2. If the motor does not spin in the desired direction, remove power and reverse the A1 and A2 connections.

Connect a DC motor to terminals A1 and A2 as shown in Figure 9 on page 19 and Figure 10 on page 20. Ensure that the motor voltage rating is consistent with the drive's output voltage.

## Field Output Connections



The field output is for shunt wound motors only. Do not make any connections to F1 / F+ and F2 / F- when using a permanent magnet motor.

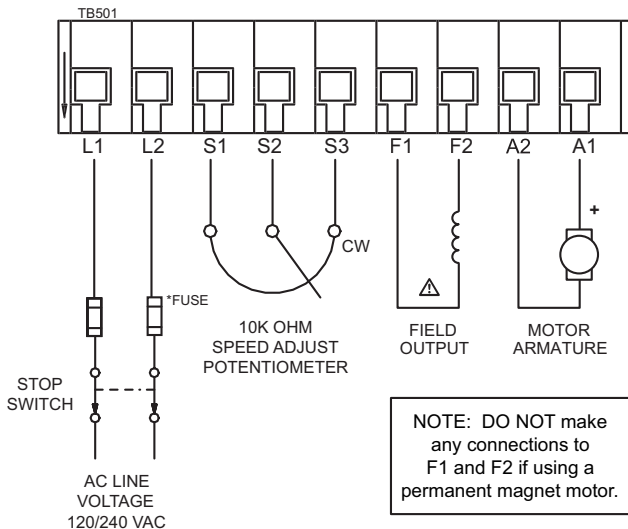
See Table 2 for field output connections. Use 14 - 16 AWG wire to connect the field output to a field / shunt wound motor.

Table 2. Field Output Connections

<i>Line Voltage (VAC)</i>	<i>Approximate Field Voltage (VDC)</i>	<i>PWL400-3, PWL400-5, PWL400-10 Connections</i>	<i>PWL400-15 Connections</i>
115	50	F1 and L1	F+ and L1
115	100	F1 and F2	F+ and F-
230	100	F1 and L1	F+ and L1
230	200	F1 and F2	F+ and F-

## Speed Adjust Potentiometer

Use a 10K ohm, 1/4 W potentiometer for speed control. Connect the counter-clockwise end of the potentiometer to S1, the wiper to S2, and the clockwise end to S3. If the potentiometer works inversely of the desired functionality (e.g. to increase motor speed you must turn the potentiometer counterclockwise), power off the drive and swap the S1 and S3 connections. Refer to Figure 9 on page 20 and Figure 10 on page 21.



\* NOTE: Do not add fuse to L2 unless input voltage is 230 VAC.

Figure 9. PWL400-3, PWL400-5, and PWL400-10 Connections

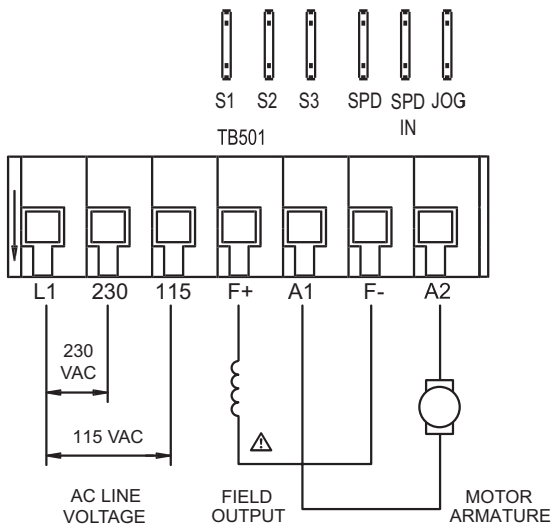


Figure 10. PWL400-15 Connections

## Analog Input Signal

Instead of using a speed adjust potentiometer, the drive may be wired to follow an analog input voltage signal that is isolated from earth ground (Figure 11). Connect the signal common (-) to S1. Connect the signal input (+) to S2. Make no connection to S3. A potentiometer can be used to scale the analog input voltage. An interface device, such as ACE model ISO202-1, may be used to scale and isolate an analog input voltage.

With 115 VAC line voltage, an analog input voltage range of 0–2.5 VDC is required to produce an armature voltage range of 0–130 VDC. With 230 VAC line voltage, an analog input voltage range of 0–5.0 VDC is required to produce an armature voltage range of 0–240 VDC.

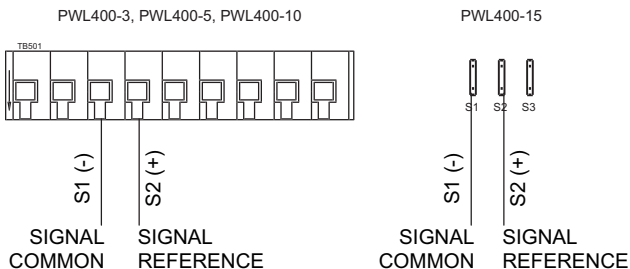


Figure 11. Analog Input Signal Connections

### Cased Drives



**Do not install, rewire, or remove this control with input power applied.** Failure to heed this warning may result in fire, explosion, or serious injury. Make sure you read and understand the Safety Precautions on page i before attempting to install this product.

### Mounting (NEMA 4X Enclosures)

NEMA 4X cased drives come with two 0.88 inch (22 mm) conduit knockout holes at the bottom of the case. The units may be vertically wall mounted using the four 0.19 inch (5 mm) slotted holes on the attached heat sink. For motor loads less than 5 ADC, the drive may be bench mounted horizontally or operated without mounting.

1. Install the mounting screws.
2. For access to the terminal strip, turn the slotted screw on the front cover counterclockwise until it is free from the case. The right side of the cover is hinged to the case. Pull the slotted screw to open the case.
3. Carefully remove the conduit knockouts by tapping them into the case and twisting them off with pliers.
4. Set the POWER switch to the OFF position before applying the AC line voltage.
5. Install conduit hardware through the 0.88 inch (22 mm) knockout holes. Connect external wiring to the terminal block.
6. Grasp the slotted screw and tilt the front cover back into place. Avoid pinching any wires between the front cover and the case.
7. Turn the slotted screw clockwise until tight to secure the front cover.

## Wiring



**Do not install, rewire, or remove this control with input power applied.** Failure to heed this warning may result in fire, explosion, or serious injury.

Circuit potentials are at 115 or 230 VAC above ground. To prevent the risk of injury or fatality, avoid direct contact with the printed circuit board or with circuit elements.

Do not disconnect any of the motor leads from the drive unless power is removed or the drive is disabled. Opening any one motor lead while the drive is running may destroy the drive.

- Use 18 - 24 AWG wire for logic wiring. Use 14 - 16 AWG wire for AC line and motor wiring.

## Line Fusing

Models PWL440-10 and PWL440-10-JOG are preinstalled with 15 amp fuses. Model PWL440-3 is preinstalled with 8 amp fuses.

Preinstalled line fuses are rated at or close to maximum horsepower. If the horsepower rating of the motor being used is less than the maximum horsepower rating of the drive, the line fuse may have to be replaced with a lower rated one. Fuses should be rated for 250 VAC or higher and approximately 150% of the maximum armature current. Refer to Table 1 on page 15 for recommended fuse values.

### Connections



**Do not connect this equipment with power applied.** Failure to heed this warning may result in fire, explosion, or serious injury.

### Power Input

Connect the AC line power leads to screw terminals L1 and 115 if using a 115 VAC line or to screw terminals L1 and 230 if using a 230 VAC line. Refer to Figure 12 on page 26 and Figure 13 on page 27.

### Motor

ACE drives supply motor voltage from A1 and A2 terminals, where A1 is positive with respect to A2. If the motor does not spin in the desired direction, remove power and reverse the A1 and A2 connections.

For model PWL440-3, connect a DC motor to screw terminals 7 (A1) and 6 (A2) as shown in Figure 12 on page 26. For models PWL440-10 and PWL440-10-JOG, connect a DC motor to screw terminals 5 (A1) and 7 (A2) as shown in Figure 13 on page 27. Ensure that the motor voltage rating is consistent with the drive's output voltage.



## Field Output Connections



The field output is for shunt wound motors only. Do not make any connections to F1 and F2 or F+ to F- when using a permanent magnet motor.

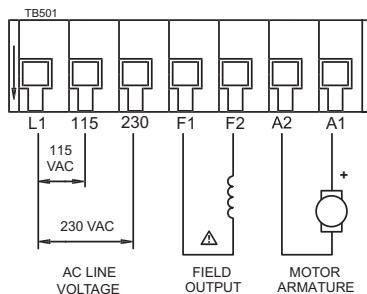
See Table 3 for field output connections. Use 14 - 16 AWG wire to connect the field output to a shunt wound motor.

Table 3. Field Output Connections

<i>Line Voltage (VAC)</i>	<i>Approximate Field Voltage (VDC)</i>	<i>PWL440-3 Connections</i>	<i>PWL440-10, PWL440-10-JOG Connections</i>
115	50	F1 and L1	F+ and L1
115	100	F1 and F2	F+ and F-
230	100	F1 and L1	F+ and L1
230	200	F1 and F2	F+ and F-

## Analog Input Signal

Instead of using the speed adjust potentiometer on the front cover, the drive may be wired to follow an analog input voltage signal that is isolated from earth ground. See page 21 for details and wiring.



**NOTE: DO NOT** make any connections to F1 and F2 if using a permanent magnet motor.

Figure 12. PWL440-3 Connections

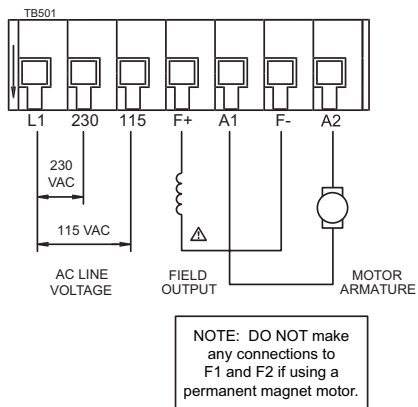


Figure 13. PWL440-10 and PWL440-10-JOG Connections

## Section 4. Operation



Change voltage switch settings only when the drive is disconnected from AC line voltage. Make sure both switches are set to their correct position. If the switches are improperly set to a lower voltage position, the motor will not run at full voltage and may cause damage to the transformer. If the switches are improperly set to a higher voltage position, the motor will overspeed, which may cause motor damage, or result in bodily injury or loss of life.

Dangerous voltages exist on the drive when it is powered. BE ALERT. High voltages can cause serious or fatal injury. For your safety, use personal protective equipment (PPE) when operating this drive.

If the motor or drive does not perform as described, disconnect the AC line voltage immediately. Refer to the Troubleshooting section, page 58, for further assistance.

### Before Applying Power

1. Verify that no foreign conductive material is present on the printed circuit board.
2. Ensure that all switches are properly set.

## Select Switches

### Input Voltage Select (SW501, SW502)

Set the input voltage select switches SW501 and SW502 to either 115 or 230 to match the AC line voltage. See Figure 14.

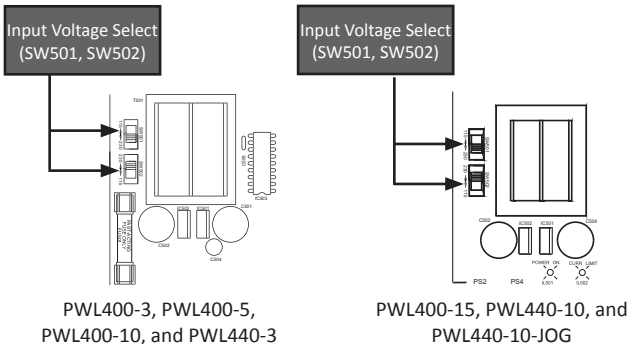


Figure 14. Select Switches

### **Operation Modes (PWL400-15, PWL440-10, and PWL440-10-JOG)**

#### **Run Mode**

In Run Mode, the external potentiometer adjusts the speed (voltage) of the motor. The on-board MAX SPD trim pot sets the maximum speed to the motor. The drive comes factory set for Run Mode.

To run the drive in Run Mode, jumper terminals SPD and SPD IN.

#### **Jog Mode**

In Jog Mode, the motor runs at a constant speed (voltage). The on-board JOG trim pot sets the constant speed to the motor.

To run the drive in Jog Mode, jumper terminals SPD IN and JOG.

## Startup

### **PWL400-3, PWL400-5, PWL400-10, and PWL400-15**

1. Turn the speed adjust potentiometer full counterclockwise (CCW) or set the input voltage signal to minimum.
2. Apply AC line voltage.
3. Slowly advance the speed adjust potentiometer clockwise (CW) or increase the input voltage signal. The motor slowly accelerates as the potentiometer is turned CW or as the input voltage signal is increased. Continue until the desired speed is reached.
4. Remove AC line voltage from the drive to coast the motor to a stop.

### **PWL440-3 and PWL440-10**

1. Set the POWER switch to the OFF position.
2. Turn the speed adjust potentiometer to "0" (full CCW) or set the input voltage signal to minimum.
3. Apply AC line voltage.
4. Set the POWER switch to the ON position.
5. Slowly advance the speed adjust potentiometer clockwise (CW) or increase the input voltage signal. The motor slowly accelerates as the potentiometer is turned CW or as the input voltage signal is increased. Continue until the desired speed is reached.
6. Set the POWER switch to the OFF position to coast the motor to a stop.

### PWL440-10-JOG

1. Make sure the RUN/JOG switch is set to RUN.
2. Turn the speed adjust potentiometer to "0" (full CCW) or set the input voltage signal to minimum.
3. Set the POWER switch to the ON position.
4. Slowly advance the speed adjust potentiometer clockwise (CW) or increase the input voltage signal. The motor slowly accelerates as the potentiometer is turned CW or as the input voltage signal is increased. Continue until the desired speed is reached.
5. To jog the motor, set the RUN/JOG switch to JOG. The motor will JOG at a speed set by the internal JOG trim pot. To stop jogging, set the switch to the RUN position. The drive will then run the motor at the speed set by the speed adjust potentiometer on the front cover.
6. Set the POWER switch to the OFF position to coast the motor to a stop.



## Starting and Stopping Methods



Dynamic braking, coasting to a stop, or decelerating to minimum speed is recommended for frequent starts and stops. Do not use any of these methods for emergency stopping. They may not stop a drive that is malfunctioning. Removing AC line power (both lines) is the only acceptable method for emergency stopping.

For this reason, ACE strongly recommends installing an emergency stop switch on both AC line inputs (see Figure 9 on page 19 and Figure 10 on page 20).

Frequent starting and stopping can produce high torque. This may cause damage to motors, especially gearmotors that are not properly sized for the application.

### Automatic Restart Upon Power Restoration

All drives automatically run to set speed when power is applied and the inhibit is not active.

### Line Starting and Stopping

Line starting and stopping (applying and removing AC line voltage) is recommended for infrequent starting and stopping of a drive only. When AC line voltage is applied to the drive, the motor accelerates to the speed set by the speed adjust potentiometer or analog signal. When AC line voltage is removed, the motor coasts to a stop.

### Dynamic Braking



Wait for the motor to completely stop before switching back to RUN. This will prevent high armature currents from damaging the motor or drive.

Dynamic braking may be used to rapidly stop a motor (Figure 15 on page 35). For the RUN/BRAKE switch, use a two pole, two position switch rated for at least the armature voltage rating and 150% of the armature current rating. For the dynamic brake resistor, use a 40 watt minimum, high power, wirewound resistor.

Sizing the dynamic brake resistor depends on load inertia, motor voltage, and braking time. Use a lower-value, higher-wattage dynamic brake resistor to stop a motor more rapidly. Refer to Table 4 on page 35 for recommended dynamic brake resistor sizes.

Table 4. Minimum Recommended Dynamic Brake Resistor Values

<i>Motor Armature Voltage</i>	<i>Dynamic Brake Resistor Value</i>
130 VDC	15 ohms
240 VDC	30 ohms

For motors rated 1/17 horsepower and lower, a brake resistor is not necessary since the armature resistance is high enough to stop the motor without demagnetization. Replace the dynamic brake with 12-gauge wire.

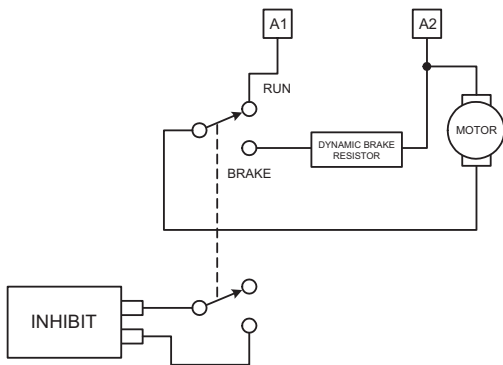


Figure 15. Dynamic Brake Wiring

## Inhibit Terminals

Short the INHIBIT terminals to coast the motor to zero speed (see Figure 16 for INHIBIT terminal location). Open the INHIBIT terminals to accelerate the motor to set speed.

Twist inhibit wires and separate them from power-carrying wires or sources of electrical noise. Use shielded cable if the inhibit wires are longer than 18 inches (46 cm). If shielded cable is used, ground only one end of the shield to earth ground. Do not ground both ends of the shield.

ACE offers two accessory plug harnesses for connecting to the INHIBIT terminals: part number KTW-0001 [plug with 18 in. (46 cm) leads]; and part number KTW-0002 [plug with 36 in. (91 cm) leads].

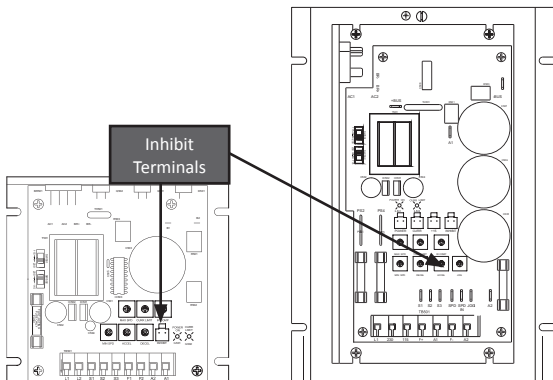


Figure 16. Inhibit Terminals

## Decelerating to Minimum Speed

The switch shown in Figure 17 may be used to decelerate a motor to a minimum speed. Closing the switch between S1 and S2 decelerates the motor from set speed to a minimum speed determined by the MIN SPD trim pot setting. If the MIN SPD trim pot is set full CCW, the motor decelerates to zero speed when the switch between S1 and S2 is closed. The DECEL trim pot setting determines the rate at which the drive decelerates. By opening the switch, the motor accelerates to set speed at a rate determined by the ACCEL trim pot setting.

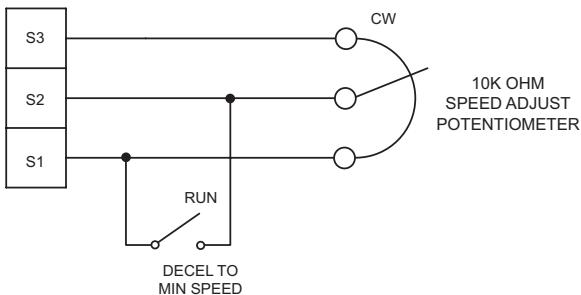


Figure 17. Run/Decelerate to Minimum Speed Switch

### Section 5. Calibration

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Dangerous voltages exist on the drive when it is powered. When possible, disconnect the voltage input from the drive before adjusting the trim pots. If the trim pots must be adjusted with power applied, use insulated tools and the appropriate personal protection equipment. **BE ALERT.** High voltages can cause serious or fatal injury.

PWL series drives have user-adjustable trim pots. Each drive is factory calibrated to its maximum current rating. Readjust the calibration trim pot settings to accommodate lower current rated motors.

All adjustments increase with CW rotation, and decrease with CCW rotation. Use a non-metallic screwdriver for calibration. Each trim pot is identified on the printed circuit board.

## Minimum Speed (MIN SPD)

The MIN SPD setting determines the minimum motor speed when the speed adjust potentiometer or input voltage signal is set for minimum speed. It is factory set for zero speed.

To calibrate the MIN SPD:

1. Set the MIN SPD trim pot full CCW.
2. Set the speed adjust potentiometer or input voltage signal for minimum speed.
3. Adjust MIN SPD until the desired minimum speed is reached or is just at the threshold of rotation.

## Maximum Speed (MAX SPD)

The MAX SPD setting determines the maximum motor speed when the speed adjust potentiometer or input voltage signal is set for maximum speed.

To calibrate MAX SPD:

1. Set the MAX SPD trim pot full CCW.
2. Set the speed adjust potentiometer or input voltage signal for maximum speed.
3. Adjust MAX SPD until the desired maximum speed is reached.

**Note:** Check the MIN SPD and MAX SPD adjustments after recalibrating to verify that the motor runs at the desired minimum and maximum speed.

### **Jog (JOG) (PWL400-15, PWL440-10, and PWL440-10-JOG only)**

The JOG setting determines the constant motor speed when the drive is set to Jog Mode.

To calibrate the Jog trim pot:

1. Make sure the drive is set to Jog Mode. This is done by connecting the SPD IN and JOG terminals. If using the PWL440-10-JOG, set the RUN / JOG switch on the front cover to JOG.
2. Turn the JOG trim pot until the motor runs at the desired JOG speed.



## Torque (CURR LIMIT or TORQ LIMIT)



CURR LIMIT should be set to 150% of motor nameplate current rating. Continuous operation beyond this rating may damage the motor. If you intend to operate beyond the rating, contact your ACE representative for assistance.

The CURR LIMIT setting determines the maximum torque for accelerating and driving the motor. To calibrate CURR LIMIT, refer to the recommended CURR LIMIT settings in Figures 18 through 21 (pages 43 through 46) or use the following procedure:

1. With the power disconnected from the drive, connect a DC ammeter in series with the armature.
2. Set the CURR LIMIT trim pot to minimum (full CCW).
3. Set the speed adjust potentiometer or input voltage signal to maximum speed.
4. Carefully lock the motor armature. Be sure that the motor is firmly mounted.
5. Apply line power. The motor should be stopped.
6. Slowly adjust the CURR LIMIT trim pot CW until the armature current is 150% of motor rated armature current.
7. Turn the speed adjust potentiometer CCW or decrease the input voltage signal.
8. Remove line power.
9. Remove the stall from the motor.
10. Remove the ammeter in series with the motor armature if it is no longer needed.

### IR Compensation (IR COMP)

The IR COMP setting determines the degree to which motor speed is held constant as the motor load changes.

Use the following procedure to recalibrate the IR COMP setting:

1. Set the IR COMP trim pot to minimum (full CCW).
2. Increase the speed adjust potentiometer or input voltage signal until the motor runs at midspeed without load (for example, 900 RPM for an 1800 RPM motor). A handheld tachometer may be used to measure motor speed.
3. Load the motor armature to its full load armature current rating. The motor should slow down.
4. While keeping the load on the motor, rotate the IR COMP trim pot until the motor runs at the speed measured in step 2. If the motor oscillates (overcompensation), the IR COMP trim pot may be set too high (CW). Turn the IR COMP trim pot CCW to stabilize the motor.
5. Unload the motor.

See Figures 18 through 21 (pages 43 through 46) for recommended IR COMP settings.

## MODELS PWL400-3, PWL440-3

























		1/4 HP 90 VDC 2.50 AMPS			1/2 HP 180 VDC 2.50 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	
		1/8 HP 90 VDC 1.25 AMPS			1/4 HP 180 VDC 1.25 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	
		1/20 HP 90 VDC 0.50 AMPS			1/10 HP 180 VDC 0.50 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	
		1/4 HP 130 VDC 1.75 AMPS			1/2 HP 240 VDC 1.90 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	
		1/8 HP 130 VDC 0.90 AMPS			1/4 HP 240 VDC 0.95 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	
		1/20 HP 130 VDC 0.35 AMPS			1/10 HP 240 VDC 0.40 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	

Figure 18. Recommended CURR LIMIT and IR COMP Settings  
for models PWL400-3 and PWL440-3  
(actual settings may vary with each application)

MODELS PWL400-5

























		1/2 HP 90 VDC 5.00 AMPS			1 HP 180 VDC 5.00 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	
		1/4 HP 90 VDC 2.50 AMPS			1/2 HP 180 VDC 2.50 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	
		1/8 HP 90 VDC 1.25 AMPS			1/4 HP 180 VDC 1.25 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	
		1/2 HP 130 VDC 3.50 AMPS			1 HP 240 VDC 3.75 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	
		1/4 HP 130 VDC 1.75 AMPS			1/2 HP 240 VDC 1.90 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	
		1/8 HP 130 VDC 0.90 AMPS			1/4 HP 240 VDC 0.95 AMPS
CURR LIMIT	IR COMP		CURR LIMIT	IR COMP	

Figure 19. Recommended CURR LIMIT and IR COMP Settings  
for model PWL400-5  
(actual settings may vary with each application)

## MODELS PWL400-10

























		1 HP 90 VDC 10.0 AMPS			2 HP 180 VDC 10.0 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1/2 HP 90 VDC 5.00 AMPS			1 HP 180 VDC 5.00 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1/4 HP 90 VDC 2.50 AMPS			1/2 HP 180 VDC 2.50 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1 HP 130 VDC 7.00 AMPS			2 HP 240 VDC 7.50 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1/2 HP 130 VDC 3.50 AMPS			1 HP 240 VDC 3.75 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1/4 HP 130 VDC 1.75 AMPS			1/2 HP 240 VDC 1.90 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	

Figure 20. Recommended CURREN LIMIT and IR COMP Settings  
for model PWL400-10  
(actual settings may vary with each application)

## MODELS PWL400-15, PWL440-10, and PWL440-10-JOG

































		1-1/2 HP 90 VDC 15.0 AMPS			3 HP 180 VDC 15.0 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1 HP 90 VDC 10.00 AMPS			2 HP 180 VDC 10.0 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1/2 HP 90 VDC 5.00 AMPS			1 HP 180 VDC 5.00 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1/4 HP 90 VDC 2.50 AMPS			1/2 HP 180 VDC 2.50 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1-1/2 HP 130 VDC 10.5 AMPS			3 HP 240 VDC 11.3 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1 HP 130 VDC 7.00 AMPS			2 HP 240 VDC 7.50 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1/2 HP 130 VDC 3.50 AMPS			1 HP 240 VDC 3.75 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	
		1/4 HP 130 VDC 1.75 AMPS			1/2 HP 240 VDC 1.90 AMPS
CURREN LIMIT	IR COMP		CURREN LIMIT	IR COMP	

Figure 21. Recommended CURR LIMIT and IR COMP Settings for models PWL400-15, PWL440-10, and PWL440-10-JOG (actual settings may vary with each application)

## Acceleration (ACCEL)

The ACCEL setting determines the time the motor takes to ramp to a higher speed. See Specifications on page 2 for approximate acceleration times. ACCEL is factory set for the shortest acceleration time (full CCW).

To set the acceleration time:

1. Set the speed adjust potentiometer or input voltage signal for minimum speed. The motor should run at minimum speed.
2. Set the speed adjust potentiometer or input voltage signal for maximum speed. Measure the time it takes the motor to go from minimum to maximum speed.
3. If the time measured in step 2 is not the desired acceleration time, turn the ACCEL trim pot CW for a longer acceleration time or CCW for a shorter acceleration time. Repeat steps 1 through 2 until the acceleration time is correct.

## Deceleration (DECEL)

The DECEL setting determines the time the motor takes to ramp to a lower speed. See Specifications on page 2 for approximate deceleration times. DECEL is factory set for the fastest deceleration time (full CCW).

To set the deceleration time:

1. Set the speed adjust potentiometer or input voltage signal for maximum speed. The motor should run at maximum speed.
2. Set the speed adjust potentiometer or input voltage signal for minimum speed. Measure the time it takes the motor to go from maximum to minimum speed.
3. If the time measured in step 2 is not the desired deceleration time, turn the DECEL trim pot CW for a longer deceleration time or CCW for a shorter deceleration time. Repeat steps 1 through 2 until the deceleration time is correct.

## Section 6. Application Notes

### Multiple Fixed Speeds

Replace the speed adjust potentiometer with a series of resistors with a total series resistance of 10K ohms (Figure 22). Add a single pole, multi-position switch with the correct number of positions for the desired number of fixed speeds.

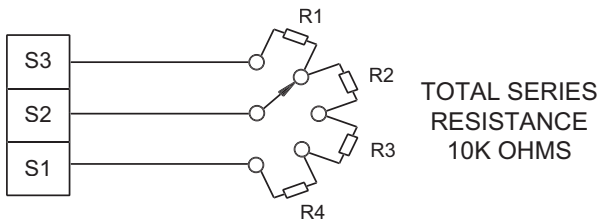


Figure 22. Multiple Fixed Speeds



## Adjustable Speeds Using Potentiometers In Series

Replace the speed adjust potentiometer with a series of potentiometers with a total series resistance of 10K ohms (Figure 23). Add a single pole, multi-position switch with the correct number of positions for the desired number of fixed speeds.

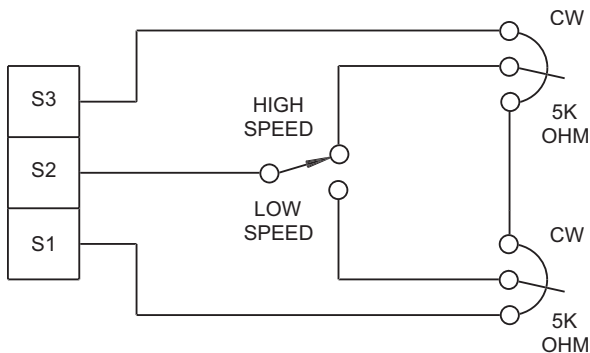


Figure 23. Adjustable Speeds Using Potentiometers In Series

## Independent Adjustable Speeds

Replace the speed adjust potentiometer with a single pole, multi-position switch, and two or more potentiometers in parallel, with a total parallel resistance of 10K ohms. Figure 24 shows the connection of two independent speed adjust potentiometers that can be mounted at two separate operating stations.

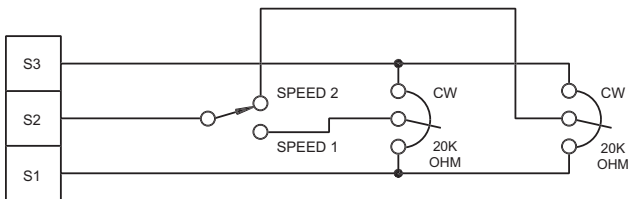


Figure 24. Independent Adjustable Speeds

## RUN/JOG Switch - Inhibit Connection

Using a RUN/JOG switch is recommended in applications where quick stopping is not needed and frequent jogging is required. Use a single pole, two position switch for the RUN/JOG switch, and a normally closed momentary pushbutton for the JOG pushbutton.

Connect the RUN/JOG switch and JOG pushbutton to the inhibit plug as shown in Figure 25. The motor coasts to a stop when the RUN/JOG switch is set to JOG. Press the JOG pushbutton to jog the motor. Return the RUN/JOG switch to RUN for normal operation.

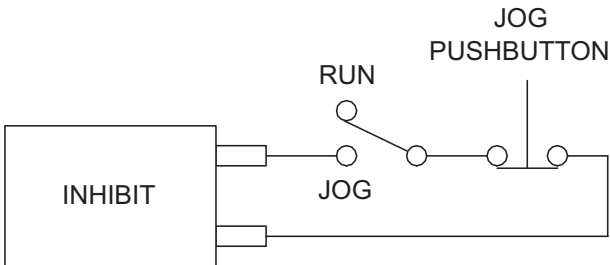


Figure 25. RUN/JOG Switch - Connection to Inhibit Plug

## RUN/JOG Switch - Potentiometer Connection

Connect the RUN/JOG switch and the JOG pushbutton as shown in Figure 26. When the RUN/JOG switch is set to JOG, the motor decelerates to minimum speed (minimum speed is determined by the MIN SPD trim pot setting). Press the JOG pushbutton to jog the motor. Return the RUN/JOG switch to RUN for normal operation.

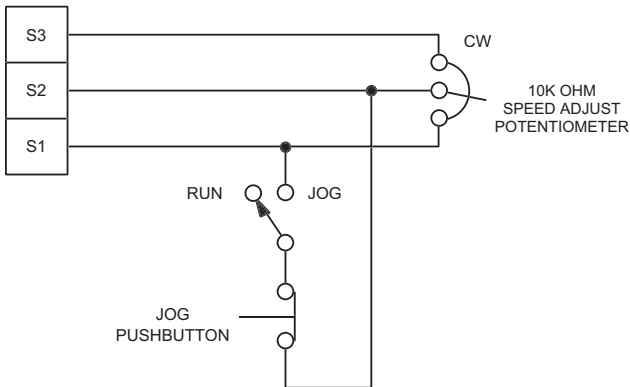


Figure 26. RUN/JOG Switch - Connection to Speed Adjust Potentiometer

## Leader-Follower Application

In this application, use a ISO202-1 to monitor the speed of the leader motor (Figure 27). The ISO202-1 isolates the leader motor from the follower drive, and outputs a voltage proportional to the leader motor armature voltage. The follower drive uses this voltage reference to set the speed of the follower motor. An optional ratio potentiometer may be used to scale the ISO202-1 output voltage.

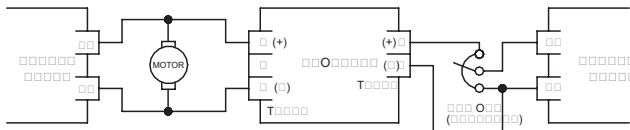


Figure 27. Leader-Follower Application

## Single Speed Potentiometer Control Of Multiple Drives

Multiple drives can be controlled with a single speed adjust potentiometer using an ISO101-8 at the input of each drive to provide isolation (Figure 28). Optional ratio potentiometers can be used to scale the ISO101-8 output voltage, allowing independent control of each drive.

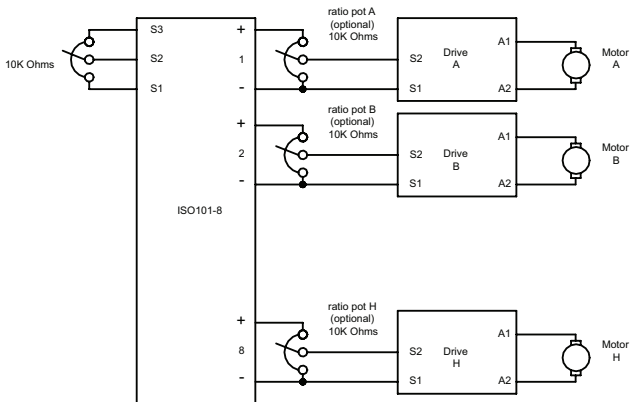


Figure 28. Single Speed Potentiometer Control of Multiple Drives

## Reversing

A dynamic brake may be used when reversing the motor direction (Figure 29). Use a three pole, three position switch rated for at least the maximum DC armature voltage and maximum braking current. Wait for the motor to stop completely before switching it to either the forward or reverse direction. See the Dynamic Braking section on page 35 for recommended dynamic brake resistor sizes.

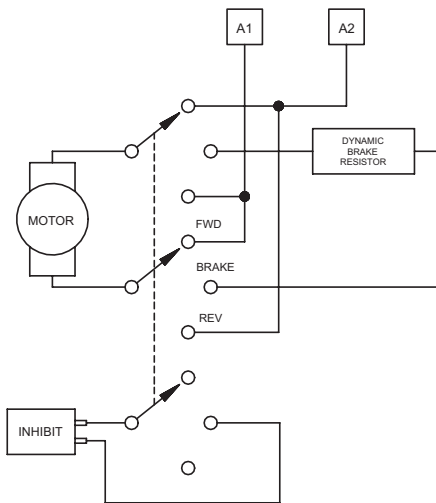


Figure 29. Reversing Circuit Wiring

## Reversing with a CLD100-1 Controller

A CLD100-1 controller can be used in a reversing application. The CLD100-1 must be inhibited while braking. If the inhibit feature is not used, the CLD100-1 will continue to regulate. This will cause overshoot when the motor is reconnected to the drive. Figure 30 shows a wiring diagram of the reversing circuit using a PWL series drive and a CLD100-1.

**Note: Only one feedback device (Optical Encoder or Magnetic Pickup) may be connected to a CLD100-1 at a time.**

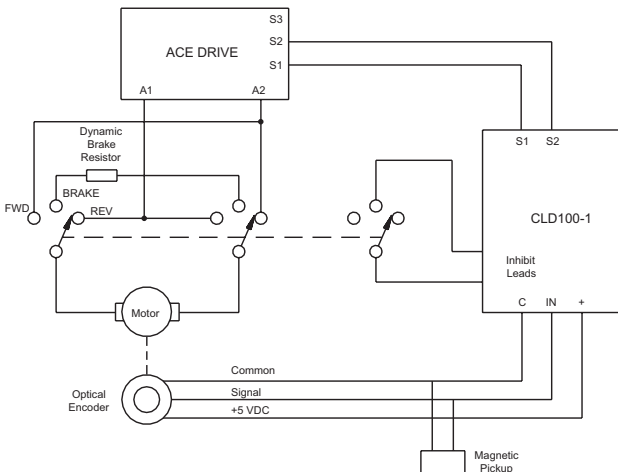


Figure 30. Reversing with a CLD100-1



## Section 7. Diagnostic LEDs

PWL series drives are equipped with two diagnostic LEDs:

- Power (POWER ON): Green LED lights whenever AC line voltage is applied to the drive.
- Current Limit (CURR LIMIT): Red LED lights whenever the drive reaches current limit.

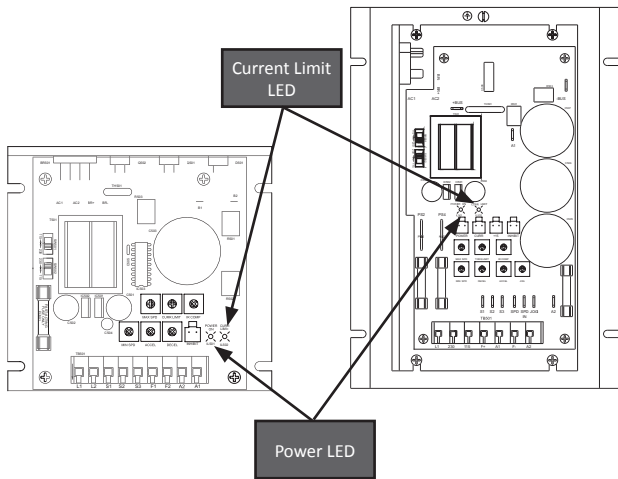


Figure 31. Diagnostic LED Locations

## Section 8. Troubleshooting



Dangerous voltages exist on the drive when it is powered. When possible, disconnect the drive while troubleshooting. High voltages can cause serious or fatal injury.

### Before Troubleshooting

Perform the following steps before starting any procedure in this section:

1. Disconnect AC line voltage from the drive.
2. Check the drive closely for damaged components.
3. Check that no conductive or other foreign material has become lodged on the printed circuit board.
4. Verify that every connection is correct and in good condition.
5. Verify that there are no short circuits or grounded connections.
6. Check that the switch settings are correctly set.
7. Check that the drive's rated armature and field outputs are consistent with the motor ratings.

For additional assistance, contact your local AMERICAN CONTROL ELECTRONICS distributor, or the factory direct:

1-815-624-6915 or FAX: 1-815-624-6965

PROBLEM	POSSIBLE CAUSE	SUGGESTED SOLUTIONS
<b>Line fuse blows.</b>	1. Line fuse is the wrong size.	1. Check that the line fuse is correct for the motor size.
	2. Motor cable or armature is shorted to ground.	2. Check motor cable and armature for shorts.
	3. Nuisance tripping caused by a combination of ambient conditions and high-current spikes (i.e. reversing).	3. Add a blower to cool the drive components, decrease CURR LIMIT settings, resize motor and drive for actual load demand, or check for incorrectly aligned mechanical components or "jams". See page 41 for information on adjusting the CURR LIMIT trim pot.
<b>Line fuse does not blow, but the motor does not run.</b>	1. Speed adjust potentiometer or input voltage signal is set to zero speed.	1. Increase the speed adjust potentiometer setting or input voltage signal.
	2. INHIBIT mode is active.	2. Remove the short from the INHIBIT terminals.
	3. S2 is shorted to S1.	3. Remove the short.
	4. Drive is in current limit.	4. Verify that the motor is not jammed. Increase CURR LIMIT setting if set too low. See page 41.
	5. Drive is not receiving AC line voltage.	5. Apply AC line voltage.
	6. Motor is not connected.	6. Remove power. Connect the motor to A1 and A2. Reapply power.

PROBLEM	POSSIBLE CAUSE	SUGGESTED SOLUTIONS
<b>Motor does not stop when the speed adjust potentiometer is full CCW.</b>	1. MIN SPD is set too high.	1. Calibrate MIN SPD. See page 39.
<b>Motor runs in the opposite direction</b>	1. Motor connections to A1 and A2 are reversed.	1. Remove power. Reverse connections to A1 and A2. Reapply power.
<b>Motor runs too fast.</b>	1. MAX SPD is set too high.	1. Calibrate MAX SPD. See page 39.
	2. Motor field connections are loose (shunt wound motors only).	2. Check motor field connections.
<b>Motor will not reach the desired speed.</b>	1. MAX SPD setting is too low.	1. Increase MAX SPD setting. See page 39.
	2. IR COMP setting is too low.	2. Increase IR COMP setting. See page 42.
	3. CURR LIMIT setting is too low.	3. Increase CURR LIMIT setting. See page 41.
	4. Motor is overloaded.	4. Check motor load. Resize the motor and drive if necessary.
<b>Motor pulsates or surges under load.</b>	1. IR COMP is set too high.	1. Adjust the IR COMP setting slightly CCW until the motor speed stabilizes. See page 42.
	2. Motor bouncing in and out of current limit.	2. Make sure motor is not undersized for load; adjust CURR LIMIT trim pot CW. See page 41.

## Section 9. Accessories & Replacement Parts

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### Displays

Closed Loop.....	CLD100-1
Open Loop.....	OLD100-1

### Heat sinks

Chassis.....	HSK-0003
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### Kits

#### Potentiometer & Connector

10K Pot, Insulating Washer.....	KTP-0001
10K Pot, Insulating Washer, 3 Insulated Tabs.....	KTP-0009

#### Fuse

2 1.5 Amp 250 V 3AG Fast-blow Glass Fuses.....	KTF-0001
2 3 Amp 250 V 3AG Fast-blow Glass Fuses.....	KTF-0002
2 5 Amp 250 V 3AG Fast-blow Glass Fuses.....	KTF-0003
2 8 Amp 250 V 3AG Fast-blow Glass Fuses.....	KTF-0004
2 10 Amp 250 V 3AB Normal-blow Ceramic Fuses.....	KTF-0005
2 15 Amp 250 V 3AB Normal-blow Ceramic Fuses.....	KTF-0006
2 20 Amp 250 V 3AB Normal-blow Ceramic Fuses.....	KTF-0007

#### Wiring

Inhibit Plug (18 in. leads).....	KTW-0001
Inhibit Plug (36 in. leads).....	KTW-0002

### Logic Cards

#### Current Monitoring

5 Amps.....CMC100-5

20 Amps.....CMC100-20

#### Isolation

Uni-directional, 8 outputs.....ISO101-8

Bi-directional, 1 output.....ISO202-1

## Unconditional Warranty

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### A. Warranty

American Control Electronics®, referred to as “the Corporation” warrants that its products will be free from defects in workmanship and material for twelve (12) months or 3000 hours, whichever comes first, from date of manufacture thereof. Within this warranty period, the Corporation will repair or replace, at its sole discretion, such products that are returned to American Control Electronics, 14300 De La Tour Drive, South Beloit, Illinois 61080 USA.

This warranty applies only to standard catalog products, and does not apply to specials. Any returns of special controls will be evaluated on a case-by-case basis. The Corporation is not responsible for removal, installation, or any other incidental expenses incurred in shipping the product to and from the repair point.

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