



An American Control Electronics Brand

## *PCM2000A Series*

### *USER MANUAL*

PCM21000A  
PCM21010A  
PCM22000A

Dear Valued Consumer:

Congratulations on your purchase of the **PCM20000A 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.minarikdrives.com](http://www.minarikdrives.com) to learn more about our other drives.

Thank you for choosing **Minarik Drives!**

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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. Minarik Drives 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 protective equipment and insulated tools if working on this drive with power applied.

## Table of Contents

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<b>Section 1. Specifications .....</b>	<b>1</b>
<b>Section 2. Dimensions.....</b>	<b>2</b>
<b>Section 3. Installation .....</b>	<b>4</b>
Heat Sinking .....	4
Mounting .....	5
Speed Adjust Potentiometer .....	6
Wiring .....	7
Shielding Guidelines.....	8
Line Fusing .....	9
Connections.....	10
Power Inputs .....	10
Motor.....	10
Speed Adjust Potentiometer .....	11
Analog Input Signal .....	11
<b>Section 4. Operation.....</b>	<b>13</b>
Before Applying Power .....	13
Select Switches .....	14
Signal Select (SO501) .....	14
Startup .....	15
Starting and Stopping Methods .....	16
Line Starting and Stopping .....	16
Dynamic Braking .....	17
Decelerating to Minimum Speed.....	19
<b>Section 5. Calibration .....</b>	<b>20</b>
Minimum Speed (MIN SPD) .....	21
Maximum Speed (MAX SPD) .....	21
Signal Adjustment (SIG ADJ) .....	22
Torque (TORQUE) .....	23
IR Compensation (IR COMP) .....	24

<b>Section 6.Application Notes .....</b>	<b>26</b>
Multiple Fixed Speeds .....	26
Adjustable Speeds Using Potentiometers In Series.....	27
Independent Adjustable Speeds.....	28
RUN/JOG Switch.....	29
Leader-Follower Application .....	30
Single Speed Potentiometer Control Of Multiple Drives .....	31
Reversing.....	32
<b>Section 7. Troubleshooting.....</b>	<b>33</b>
Before Troubleshooting .....	33
<b>Section 8. Accessories &amp; Replacement Parts .....</b>	<b>36</b>
<b>Unconditional Warranty.....</b>	<b>37</b>

## List of Tables

---

Table 1	Recommended Line Fuse Sizes .....	9
Table 2	Minimum Recommended Dynamic Brake Resistor Values ...	18

## List of Figures

---

Figure 1	PCM20000A Series Dimensions .....	2
Figure 2	223-0159 Dimensions .....	3
Figure 3	Speed Adjust Potentiometer .....	6
Figure 4	PCM20000A Series Connections .....	12
Figure 5	Select Switches .....	14
Figure 6	Dynamic Brake Wiring .....	18
Figure 7	Run/Decelerate to Minimum Speed Switch .....	19
Figure 8	Recommended TORQUE and IR COMP Settings .....	25
Figure 9	Multiple Fixed Speeds .....	26
Figure 10	Adjustable Speeds Using Potentiometers in Series .....	27
Figure 11	Independent Adjustable Speeds .....	28
Figure 12	RUN/JOG Switch .....	29
Figure 13	Leader-Follower Application .....	30
Figure 14	Single Speed Potentiometer Control of Multiple Drives .....	31
Figure 15	Reversing Circuit Wiring .....	32

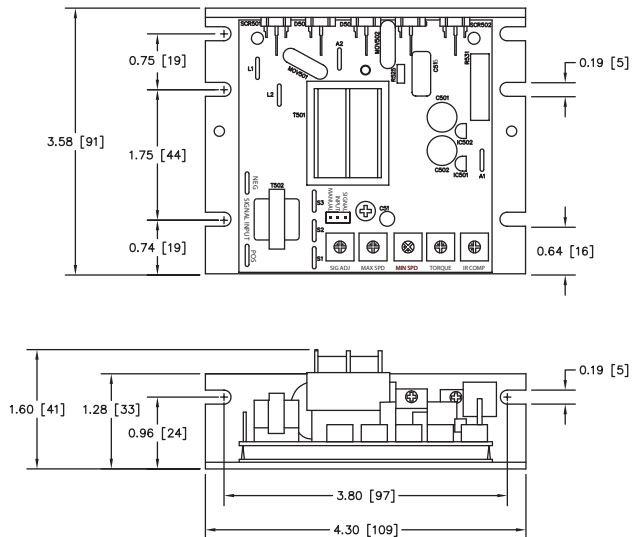
## Section 1. Specifications

<i>Model</i>	<i>Line Input Voltage (VAC)</i>	<i>Armature Voltage Range (VDC)</i>	<i>Maximum Armature Current (ADC)</i>	<i>HP Range</i>
PCM21010A	115 VAC	0 - 90 VDC	2.0	1/20 - 1/6
PCM21000A	115 VAC	0 - 90 VDC	10.0*	1/4 - 1
PCM22000A	230 VAC	0 - 180 VDC	10.0*	1/2 - 2

\* Heat sink kit part number 223-0159 must be used when the continuous current output is over 5 amps.

<b>AC Line Voltage</b>	115 or 230 VAC $\pm$ 10%, 50/60 Hz, single phase
<b>Acceleration Time</b>	approx. 2 seconds
<b>Deceleration Time</b>	approx. 2 seconds
<b>Analog Input Range</b>	0 - 10 VDC
<b>Input Impedance (NEG to POS)</b>	1K ohms
<b>Form Factor</b>	1.37 at base speed
<b>Load Regulation</b>	1% base speed or better
<b>Speed Range</b>	60:1
<b>Vibration</b>	0.5G maximum (0 - 50 Hz) 0.1G maximum (> 50 Hz)
<b>Safety Certifications</b>	UL/cUL Recognized Equipment, File # E132235 CSA Certified Component, File # LR41380
<b>Ambient Temperature Range</b>	10°C - 55°C

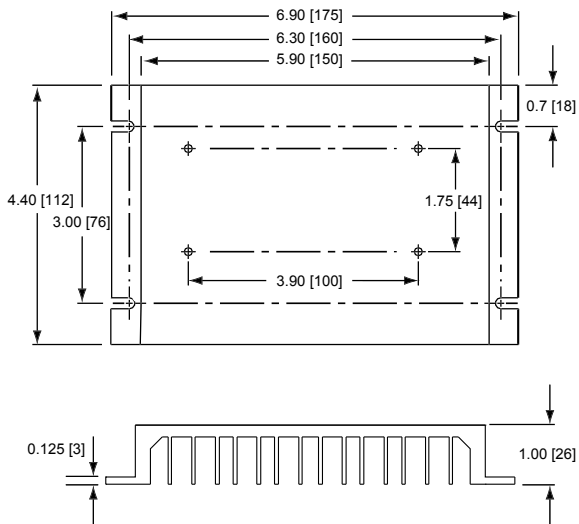
## Section 2. Dimensions



ALL DIMENSIONS IN INCHES [MILLIMETERS]

Figure 1. PCM2000A Series Dimensions





ALL DIMENSIONS IN INCHES [MILLIMETERS]

Figure 2. 223-0159 Dimensions

### Section 3. Installation

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**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.

#### Heat Sinking

Models PCM21000A and PCM22000A require an additional heat sink when the continuous armature current is above 5 amps. Use Minarik Drives heat sink kit part number 223-0159. 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.

## 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. Eight 0.19" (5 mm) wide slots in the chassis accept #8 pan head screws. Fasten either the large base or the narrow flange of the chassis to the subplate.
- The chassis 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.

## 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.

If using a remote potentiometer with a chassis drive, mount the speed adjust potentiometer through a 0.38 in. (10 mm) hole with the hardware provided (Figure 3). Install the circular insulating disk between the panel and the 10K ohm speed adjust potentiometer.

Twist the speed adjust potentiometer wire 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, A1, A2).

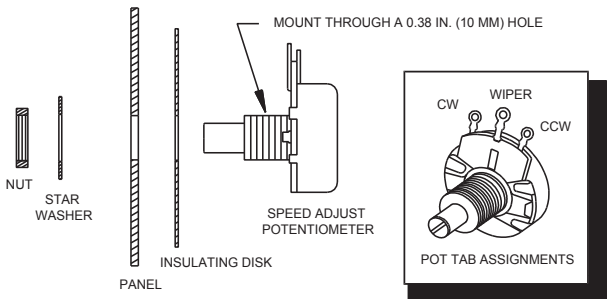


Figure 3. Speed Adjust Potentiometer

## 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.

This product does not have internal solid state motor overload protection. It does not contain speed-sensitive overload protection, thermal memory retention or provisions to receive and act upon signal from remote devices for over temperature protection. If motor over protection is needed in the end-use product, it needs to be provided by additional equipment in accordance with NEC standards.

- 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, Minarik Drives recommends shielding of all conductors. If it is not practical to shield power conductors, it is recommended to shield 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.

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

Drives should be fused for protection. Use fast acting fuses rated for 250 VAC or higher and 150% of maximum armature current. Fuse HOT L1 only when the line voltage is 115 VAC. Fuse both L1 and L2 when the line voltage is 230 VAC. Table 1 lists the recommended line fuse sizes.

**Table 1. Recommended Line Fuse Sizes**

<i>90 VDC Motor Horsepower</i>	<i>180 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>

Minarik Drives offers fuse kits. See Section 8: Accessories and Replacement Parts 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.

**Minarik Drives strongly recommends the installation of a master power switch in the voltage input line, as shown in Figure 4 (page 12).** The switch contacts should be rated at a minimum of 200% of motor nameplate current and 250 volts.

### Power Input

Connect the AC line power leads to terminals L1 and L2. Minarik Drives 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 4 on page 12.

### Motor

Drives supply motor armature voltage from A1 and A2 terminals. It is assumed throughout this manual that, when A1 is positive with respect to A2, the motor will rotate clockwise (CW) while looking at the output shaft protruding from the front of the motor. 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 4 on page 12. Ensure that the motor voltage rating is consistent with the drive's output voltage.



### 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 4 on page 12.

### Analog Input Signal

Instead of using a speed adjust potentiometer, the drive may be wired to follow an analog input voltage signal that is either isolated or non-isolated from earth ground (Figure 4 on page 12). Connect the signal common (-) to NEG. Connect the signal reference (+) to POS. A potentiometer can be used to scale the analog input voltage. An interface device, such as Minarik Drives model PCM4, may be used to scale an analog input voltage.

An analog input voltage range of 0–10 VDC is required to produce an armature voltage range of 0–90 VDC with 115 VAC line voltage or 0–180 VDC with 230 VAC line voltage.

# PCM2000A Series

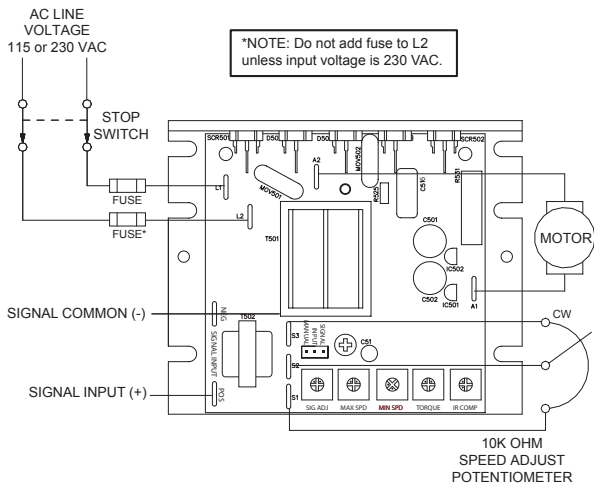


Figure 4. PCM2000A Series Connections

## Section 4. Operation

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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 33, for further assistance.

### Before Applying Power

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

## Select Switches

### Signal Select (SO501)

Set the signal select jumper SO501 to MANUAL to use a speed adjust potentiometer or to SIGNAL to use a 0-10 VDC analog signal to control motor speed. See Figure 5.

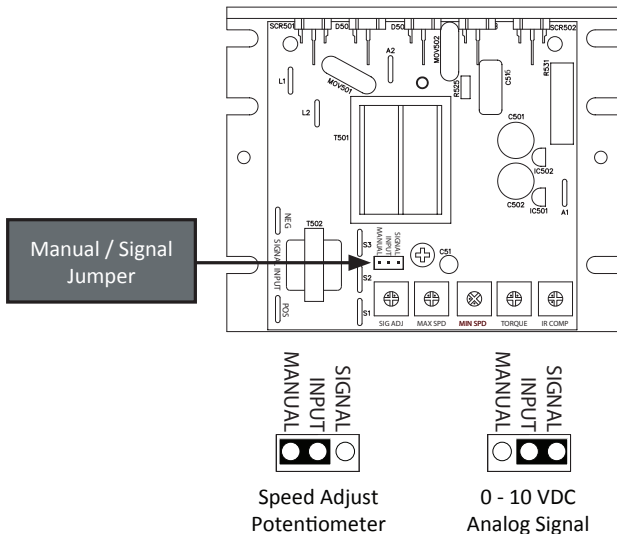


Figure 5. Select Switches

## Startup

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.

### 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, Minarik Drives strongly recommends installing an emergency stop switch on both AC line inputs (see Figure 4 on page 12).

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 6 on page 18). 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 2 on page 18 for recommended dynamic brake resistor sizes.

Table 2. Minimum Recommended Dynamic Brake Resistor Values

<i>Motor Armature Voltage</i>	<i>Dynamic Brake Resistor Value</i>
90 VDC	15 ohms
180 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.

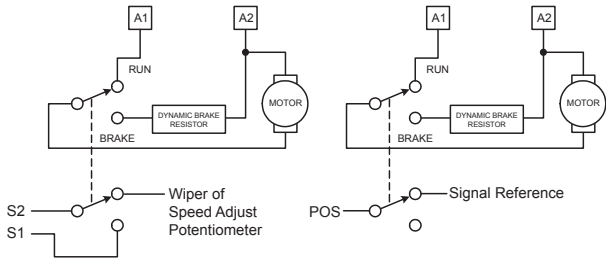


Figure 6. Dynamic Brake Wiring



## Decelerating to Minimum Speed

The switches shown in Figure 7 may be used to decelerate a motor to a minimum speed. If using a speed adjust potentiometer, closing the switch between S1 and S2 decelerates the motor to minimum speed. If using an analog input signal, opening the switch in line with the signal input will decelerate the motor to minimum speed. If the MIN SPD trim pot is set full CCW, the motor decelerates to zero speed.

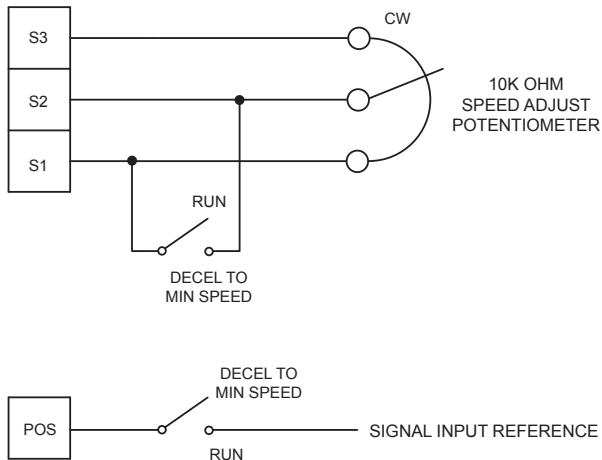


Figure 7. Run/Decelerate to Minimum Speed Switch

### 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.

PCM20000A 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 is set for maximum speed.

To calibrate MAX SPD:

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

### Signal Adjustment (SIG ADJ)

The SIG ADJ setting determines the maximum motor speed when the input voltage signal is set for maximum speed.

To calibrate SIG ADJ:

1. Set the SIG ADJ trim pot full CCW.
2. Set the input voltage signal for maximum speed.
3. Adjust SIG ADJ until the desired maximum speed is reached.

## Torque (TORQUE)



TORQUE 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 Minarik Drives representative for assistance.

The TORQUE setting determines the maximum torque for accelerating and driving the motor. To calibrate TORQUE, refer to the recommended TORQUE settings in Figure 8 on page 25 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 TORQUE trim pot to minimum (full CCW).
3. Set the speed adjust potentiometer full CW 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 TORQUE 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 Figure 8 on page 25 for recommended IR COMP settings.

PCM21000A



PCM22000A



PCM21010A



Figure 8. Recommended TORQUE and IR COMP Settings  
(actual settings may vary with each application)

## 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 9). Add a single pole, multi-position switch with the correct number of positions for the desired number of fixed speeds.

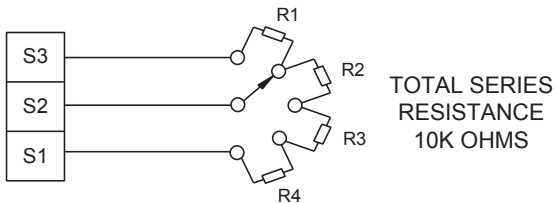


Figure 9. Multiple Fixed Speeds



## Adjustable Speeds Using Potentiometers In Series

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

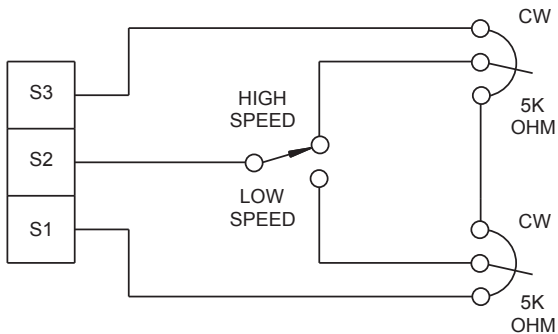


Figure 10. Adjustable Speeds Using Potentiometers In Series



## RUN/JOG Switch

Connect the RUN/JOG switch and the JOG pushbutton as shown in Figure 12. 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.

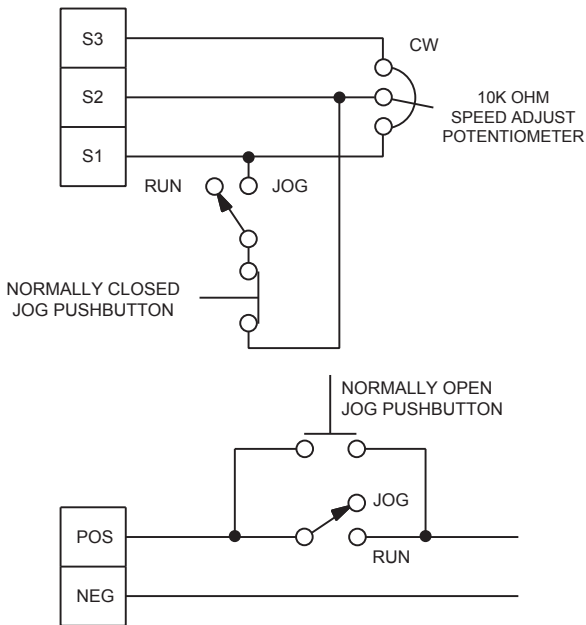


Figure 12. RUN/JOG Switch

## Leader-Follower Application

In this application, use a PCM4 to monitor the speed of the leader motor (Figure 13). The PCM4 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 PCM4 output voltage.

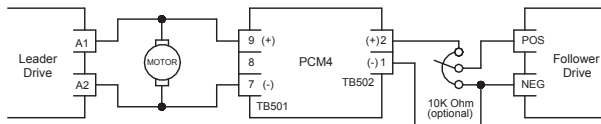


Figure 13. Leader-Follower Application

## Single Speed Potentiometer Control Of Multiple Drives

Multiple drives can be controlled with a single speed adjust potentiometer using a USIM-8 at the input of each drive to provide isolation (Figure 14). Optional ratio potentiometers can be used to scale the USIM-8 output voltage, allowing independent control of each drive.

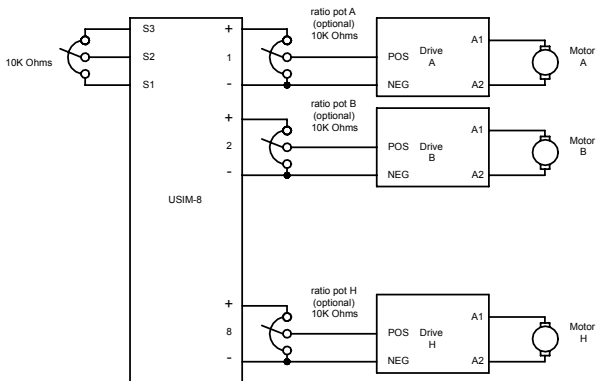


Figure 14. Single Speed Potentiometer Control of Multiple Drives

## Reversing

A dynamic brake may be used when reversing the motor direction (Figure 15). 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 18 for recommended dynamic brake resistor sizes.

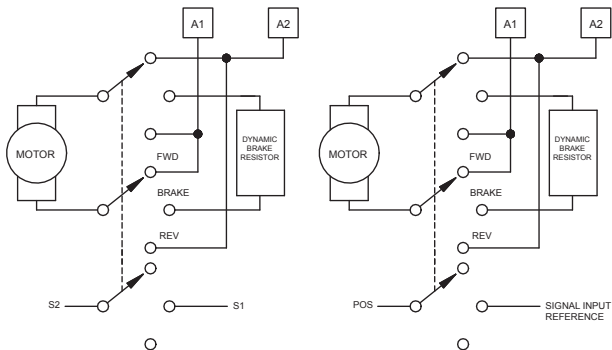


Figure 15. Reversing Circuit Wiring

## Section 7. 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 selection switch settings are correctly set.
7. Check that the drive's rated armature is consistent with the motor ratings.

For additional assistance, contact your local Minarik Drives distributor or the factory direct:

(800) MINARIK or FAX: (800) 394-6334

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 TORQUE settings, resize motor and drive for actual load demand, or check for incorrectly aligned mechanical components or "jams". See page 23 for information on adjusting the TORQUE 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.
	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 TORQUE setting if set too low.
	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.
<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.
	1. SIG ADJ is set too high.	1. Calibrate SIG ADJ.
<b>Motor will not reach the desired speed.</b>	1. MAX SPD setting is too low.	1. Increase MAX SPD setting.
	2. SIG ADJ setting is too low.	2. Increase SIG ADJ setting.
	3. IR COMP setting is too low.	3. Increase IR COMP setting.
	4. TORQUE setting is too low.	4. Increase TORQUE setting.
	5. Motor is overloaded.	5. 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.
	2. Motor bouncing in and out of current limit.	2. Make sure motor is not undersized for load; adjust TORQUE trim pot CW.

## Section 8. Accessories & Replacement Parts

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### Displays

Closed Loop.....	DLC600
Open Loop.....	VT-8

### Heat Sinks

Chassis .....	223-0159
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### Kits

#### Potentiometer & Connector

Pot Kit .....	202-0031
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#### Fuse

1.5 - 5 Amp Fuse Kit.....	050-0066
1 - 8 Amp Fuse Kit with Pico Fuse.....	050-0068
3 - 8 Amp Fuse Kit with Pico Fuse.....	050-0069
5 - 15 Amp Fuse Kit.....	050-0071

### Logic Cards

#### Current Sensing

5 Amps.....	CSC1-5
20 amps.....	CSC1-20

## Unconditional Warranty

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### A. Warranty

American Control Electronics 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, American Control Electronics 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. American Control Electronics is not responsible for removal, installation, or any other incidental expenses incurred in shipping the product to and from the repair point.

### B. Disclaimer

The provisions of Paragraph A are American Control Electronics's sole obligation and exclude all other warranties of merchantability for use, expressed or implied. American Control Electronics further disclaims any responsibility whatsoever to the customer or to any other person for injury to the person or damage or loss of property of value caused by any product that has been subject to misuse, negligence, or accident, or misapplied or modified by unauthorized persons or improperly installed.

### C. Limitations of Liability

In the event of any claim for breach of any of American Control Electronics's obligations, whether expressed or implied, and particularly of any other claim or breach of warranty contained in Paragraph A, or of any other warranties, expressed or implied, or claim of liability that might, despite Paragraph B, be decided against American Control Electronics by lawful authority, American Control Electronics shall under no circumstances be liable for any consequential damages, losses, or expenses arising in connection with the use of, or inability to use, American Control Electronics's product for any purpose whatsoever.

An adjustment made under warranty does not void the warranty, nor does it imply an extension of the original 12-month warranty period. Products serviced and/or parts replaced on a no-charge basis during the warranty period carry the unexpired portion of the original warranty only.

If for any reason any of the foregoing provisions shall be ineffective, American Control Electronics's liability for damages arising out of its manufacture or sale of equipment, or use thereof, whether such liability is based on warranty, contract, negligence, strict liability in tort, or otherwise, shall not in any event exceed the full purchase price of such equipment.

Any action against American Control Electronics based upon any liability or obligation arising hereunder or under any law applicable to the sale of equipment or the use thereof, must be commenced within one year after the cause of such action arises.



PCM21010A



PCM21000A



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