

# USER'S MANUAL

## XP-AC Series

Pulse-Width Modulated,  
Adjustable Speed Drives  
for DC Brush Motors

**Models: XP02-115AC**  
**XP05-115AC**  
**XP10-115AC**

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## **Safety Warnings**

- Have a qualified electrical maintenance 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 proper grounding, 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. Install a master switch in the AC line for stopping the drive in an emergency.
- This drive is not isolated from earth ground. Circuit potentials are at 115 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 trimpots.

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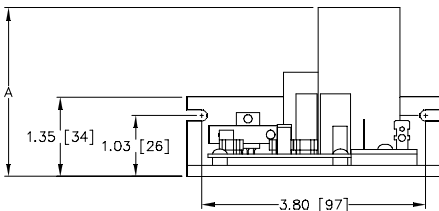
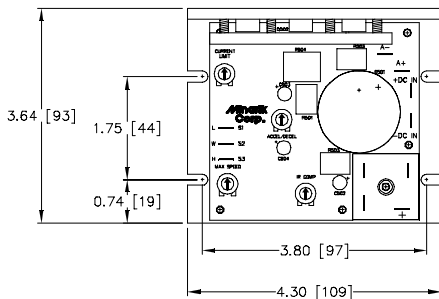
# Specifications

<b>Model</b>	<b>Max. Continuous Armature Current (Amps DC)</b>	<b>HP Range with 115 VAC Applied</b>
XP02-115AC	2	1/20 – 1/8
XP05-115AC	5	1/4 – 1/2
XP10-115AC	10 †	1/2 – 1

† Use heat sink part number 223-0159 when operating the drive above 5 ADC.

<b>AC Line Voltage</b>	115 VAC, $\pm 10\%$ , 50/60 Hz, single phase
<b>Armature Voltage Range</b>	0-130 VDC
<b>Form Factor (at base speed)</b>	1.05
<b>Acceleration/Deceleration Time Range (no load)</b>	0.5 – 6 seconds
<b>Analog Input Voltage Range [isolated; S1(+) to S2(-)]</b>	0-10 VDC
<b>Input Impedance (S1 to S2 with 5 VDC input)</b>	approximately 70K ohms
<b>Speed Regulation</b>	1% base speed or better
<b>Safety Certification</b>	UL Recognized Component, file # E132235 CSA Certified Component, file # LR41380
<b>Ambient Temp. Range (chassis drive)</b>	10°C-40°C
<b>Weight</b>	
XP02-115AC	0.66 lb
XP05-115AC	0.72 lb
XP10-115AC	0.82 lb

# Dimensions



SIX MOUNTING SLOTS  
0.19 [5] WIDE x 0.34 [9] DEEP

Model	Dimension "A"
XP02-115AC	1.77 [45]
XP05-115AC	2.36 [60]
XP10-115AC	2.88 [73]

ALL DIMENSIONS IN INCHES [MILLIMETERS]

**Figure 1. XP-AC Series Dimensions**



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# Installation

## Mounting

- Drive components are sensitive to electrostatic fields. Avoid contact with the circuit board directly. Hold drive by the chassis only.
- Protect the drive from dirt, moisture, and accidental contact. Provide sufficient room for access to the terminal block and calibration trim pots.
- Mount the drive away from other heat sources. Operate the drive within the specified ambient operating temperature range.
- Prevent loose connections by avoiding excessive vibration of the drive.
- Mount drive with its board in either a horizontal or vertical plane. Six 0.19 in. (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 must be earth grounded. Use a star washer beneath the head of at least one of the mounting screws to penetrate the anodized chassis surface and to reach bare metal.

## Wiring

- Use 18 AWG wire for speed adjust potentiometer wiring. Use 16 AWG wire for motor wiring.
- Twist logic wires (for speed adjust potentiometer) to avoid picking up unwanted electrical noise. Use shielded cable if wires are longer than 18 in. (46 cm).
- Keep logic wires away from power carrying lines or sources of electrical noise that can cause erratic operation. Never run speed adjust potentiometer wires in the same conduit used for motor and AC line voltage wires.
- 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.
- Keep logic wires away from the power carrying lines or sources of electrical noise that can cause erratic operation.

## Heat sinking

Model XP10–115AC requires an additional heat sink when the continuous armature current is above 5 ADC. Use Minarik® part number 223–0159. All other chassis drives have sufficient heat sinking in their basic configurations. Use a thermally conductive

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heat sink compound (such as Dow Corning® 340 Heat Sink Compound) between the drive chassis and heat sink surface for optimum heat transfer.

## Line fusing

Protect all Minarik drives with AC line fuses. Use fast acting AC line fuses rated for 250 volts, and approximately 150% – 200% of the maximum armature current. Fuse only the “hot” side of the AC line (L1) if using 115 VAC line voltage. See the chart below for recommended line fuse sizes:

**Recommended Line Fuse Sizes**

Maximum Armature Current (DC Amps)	AC Line Fuse Rating (AC Amps)
1.5 and below	3
2.6	5
3.5	8
5.0	10
7.6	15
10	15

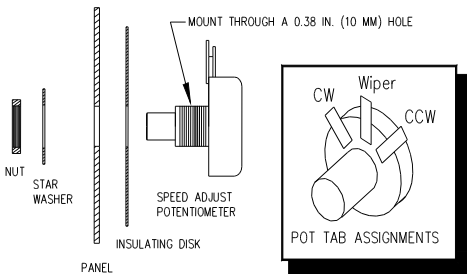
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## Speed adjust potentiometer

Mount the speed adjust potentiometer through a 0.38 in. (10 mm) hole with the hardware provided (Figure 2). 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 speed adjust potentiometer wires are longer than 18 in. (457 mm), use shielded cable. Keep speed adjust potentiometer wires separate from power leads (L1, L2, A-, A+).

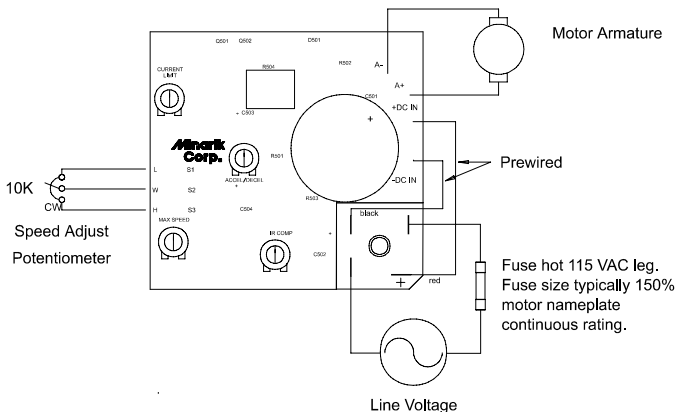
### **⚠ Warning**

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



**Figure 2. Speed Adjust Potentiometer**

## Connections



**Figure 3. XP-AC Connections**

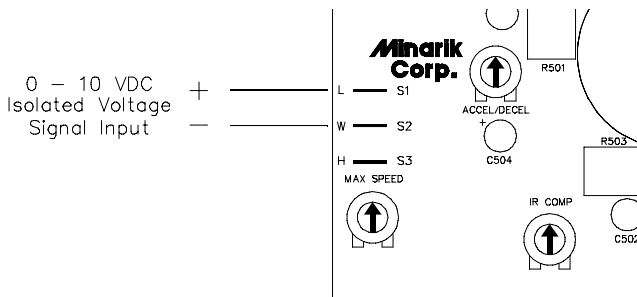
**ASSUMPTIONS:** Minarik drives supply motor voltage from A+ and A- terminals. It is assumed throughout this manual that, when A+ is positive with respect to A-, the motor will rotate clockwise (CW) while looking at the output shaft protruding from the front of the motor. If this is opposite of the desired rotation, simply reverse the wiring of A+ and A- with each other.

## Voltage follower

Instead of using a speed adjust potentiometer, the drive may be wired to follow a 0–10 VDC voltage signal that is isolated from earth ground (Figure 4). Connect the signal input (+) to S1. Connect the signal common (–) to S2. Make no connection to S3. A potentiometer can be used to scale the analog input voltage. To achieve greater linearity and control, use an interface device such as Minarik® model PCM4 to scale the analog input voltage. Follow the same wiring guidelines used for speed adjust potentiometer wiring (see page 4).

### **⚠ Warning**

Do not connect a non-isolated input voltage signal to any XP Series drive. Connecting a non-isolated signal will damage the drive.



**Figure 4. Voltage Follower Connections**

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# Operation

## Startup

*Note:* Before applying power, verify that no conductive material is present on the printed circuit board.

To start the drive:

1. Turn the speed adjust potentiometer full counterclockwise (CCW). If the drive is following a voltage signal, set the voltage signal to 0 VDC.
2. Apply AC line voltage.
3. Slowly advance the speed adjust potentiometer clockwise (CW). If the drive is following a voltage signal, slowly increase the voltage signal. The motor slowly accelerates as the potentiometer is turned CW, or the 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.

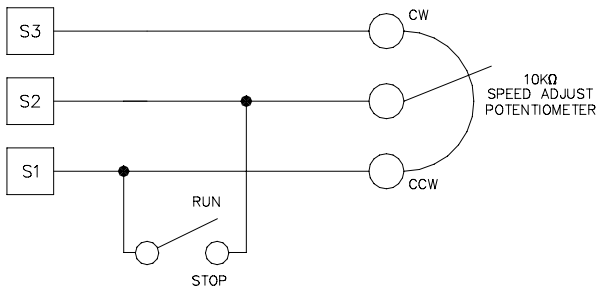
If the motor or drive does not perform as described, disconnect the AC line voltage immediately. Refer to the Troubleshooting section, page 27, for further assistance.

## Line starting and line stopping

Line starting and line 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. When AC line voltage is removed, the motor coasts to a stop.

## Decelerating to a stop

A switch may be used to decelerate the motor to a stop. Connect the switch as shown in Figure 5. Close the switch between S1 and S2 to stop the motor from set speed. Open the switch to accelerate the motor to set speed. The ACCEL/DECEL trimpot setting determines the rate at which the motor accelerates and decelerates, respectively.



**Figure 5. Run/Decelerate to Zero Speed Switch**



## Dynamic braking

Dynamic braking may be used to rapidly stop a motor (Figure 6). For the RUN/BRAKE switch, use a double pole, double throw switch rated for at least the maximum DC armature voltage and maximum braking current.

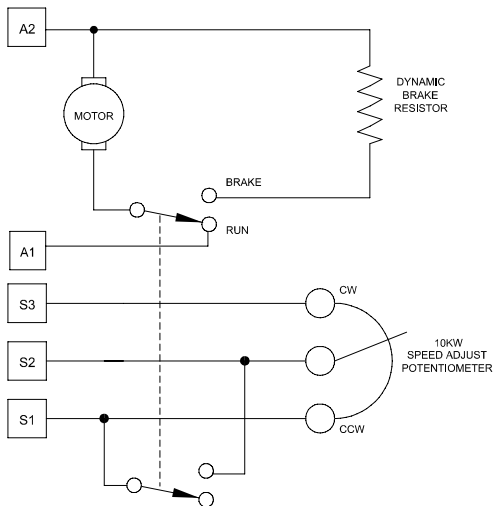


Figure 6. Dynamic Brake Connection

Size the dynamic brake resistor according to the motor current rating (see the table below). The dynamic brake resistance listed in the table is the smallest recommended resistance allowed to prevent possible demagnetization of the motor. The motor stops less rapidly with higher brake resistor values.

### Recommended Dynamic Brake Resistor Sizes

<b>Motor Armature Current Rating</b>	<b>Minimum Dynamic Brake Resistor Value</b>	<b>Minimum Dynamic Brake Resistor Wattage</b>
Less than 2 ADC	1 ohm	1W
2–3 ADC	5 ohm	5W
3–5 ADC	10 ohm	10W
5–10 ADC	20 ohm	20W
10–17 ADC	40 ohm	50W

For motors rated  $\frac{1}{17}$  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.

#### **⚠ Warning**

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

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# Calibration

Each drive is factory calibrated to its maximum horsepower rating. Readjust the calibration trimpot settings to accommodate lower horsepower motors.

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

## MAX SPD

The MAX SPD setting determines the motor speed when the speed adjust potentiometer is turned full CW. It is factory set for maximum rated speed.

To calibrate, set the MAX SPD trimpot full CCW. Turn the speed adjust potentiometer full CW. Adjust the MAX SPD trimpot until the desired maximum motor speed is reached.

## ACCEL/DECEL

The ACCEL/DECEL setting determines the time the motor takes to ramp to a higher (or lower) speed. See Specifications on page 1 for approximate acceleration times. The ACCEL/DECEL setting is factory set to its minimum value (full CCW).

Turn the ACCEL/DECEL trimpot CW to increase the acceleration and deceleration time, and CCW to decrease the acceleration and deceleration time.

## **IR COMP**

The IR COMP setting determines the degree to which motor speed is held constant as the motor load changes. It is factory set for optimum motor regulation.

Recalibrate the IR COMP setting when using a lower horsepower motor. Refer to the recommended IR COMP settings on page 30, or recalibrate using the following procedure:

If the motor does not maintain set speed as the load changes, gradually rotate the IR COMP trimpot CW. If the motor oscillates (overcompensation), the IR COMP trimpot may be set too high (CW). Turn the IR COMP trimpot CCW to stabilize the drive.

## **CURRENT LIMIT**

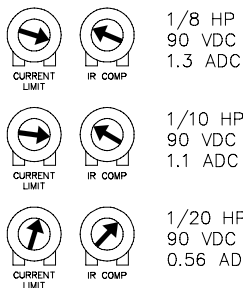
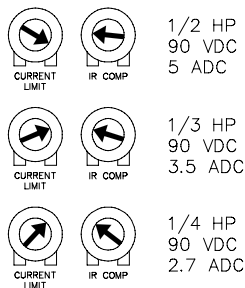
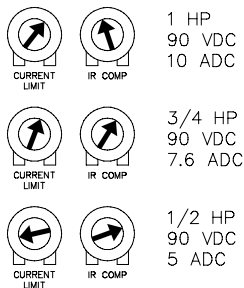
The CURRENT LIMIT setting determines the maximum armature current output of the drive. It is factory set at 120% of rated motor current.

Recalibrate the CURRENT LIMIT setting when using a lower horsepower motor. Refer to the recommended CURRENT LIMIT settings on page 30, or recalibrate using the following procedure:

1. With the power disconnected from the drive, connect a DC ammeter (0–15 A minimum scale) in series with the armature.
2. Set the CURRENT LIMIT trimpot to minimum (full CCW).
3. Connect power to the drive. The motor should remain stopped.
4. Lock the motor armature. Be sure that the motor is firmly mounted.
5. Set the speed adjust potentiometer to maximum (full CW).
6. Adjust the CURRENT LIMIT trimpot CW slowly until the armature current is 120% of motor rated armature current.
7. Set the speed adjust potentiometer to minimum and remove the stall from the motor.

### **⚠ WARNING**

Although the CURRENT LIMIT can be set to exceed the motor's maximum armature current rating, we recommend you do not run the motor continuously beyond that rating. Continuous operation beyond the maximum armature current rating may cause thermal degradation of the motor and drive.

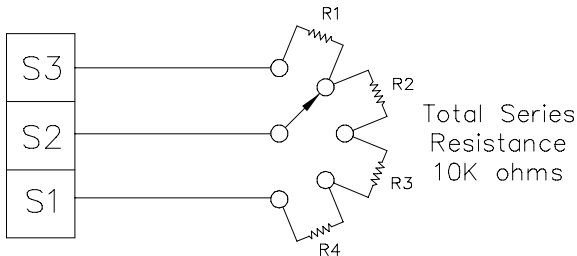
**XP02-115AC****XP05-115AC****XP10-115AC**

**Figure 7. Typical CURRENT LIMIT and IR COMP Settings  
(actual settings may vary with each application)**

# Application Notes

## Multiple fixed speeds

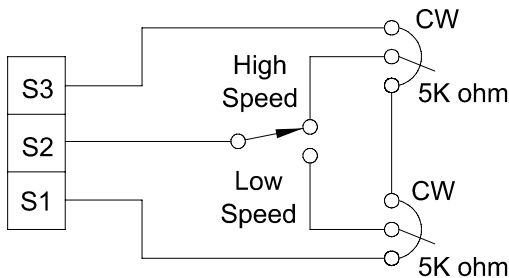
Replace the speed adjust potentiometer with series resistors with a total series resistance of 10K ohms (Figure 8). Add a single pole, multi-position switch with the correct number of positions for the desired number of fixed speeds.



**Figure 8. Multiple Fixed Speeds**

## Adjustable speeds using potentiometers in series

Replace the speed adjust potentiometer with a single pole, multi-position switch, and two or more potentiometers in series, with a total series resistance of 10K ohms. Figure 9 shows a connection for fixed high and low speed adjust potentiometers.



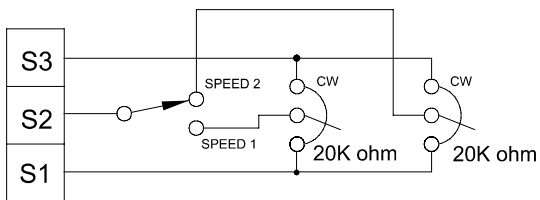
Two Non-Overlapping Speed Ranges

**Figure 9. Adjustable Fixed Speeds Using Potentiometers in Series**



## Independent adjustable speeds

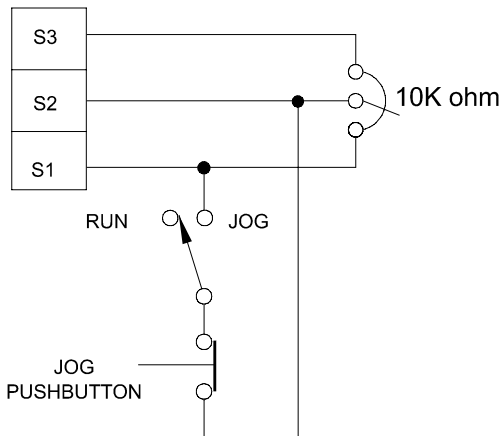
Replace the speed adjust potentiometer with a single pole, multi-position switch, and two or more potentiometers in parallel, with a total parallel resistance of 10K ohms. Figure 10 shows the connection of two independent speed adjust potentiometers that can be mounted at two separate operating stations.



**Figure 10. Independent Adjustable Speeds**

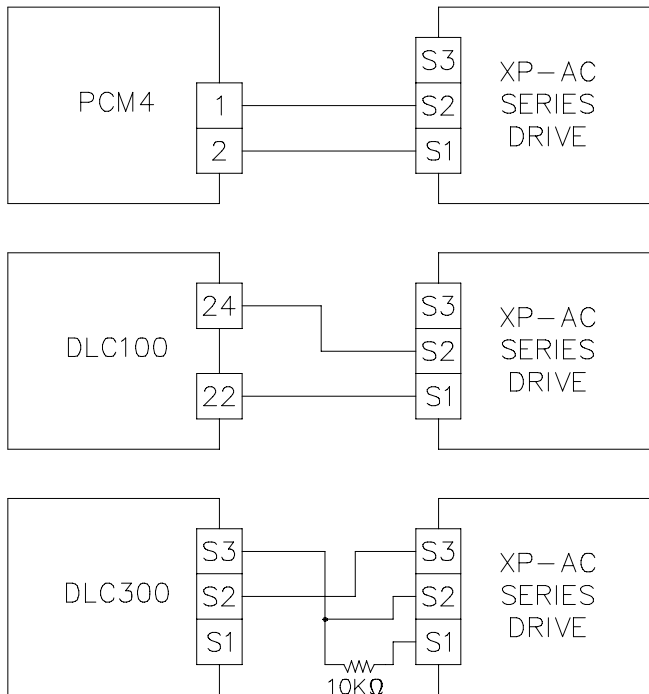
## RUN/JOG switch

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 single pole, normally closed, momentary operated pushbutton for the JOG pushbutton as shown in Figure 11. When the RUN/JOG switch is set to JOG, the motor decelerates to zero speed. Press the JOG pushbutton to jog the motor. Return the RUN/JOG switch to RUN for normal operation.



**Figure 11. RUN/JOG Switch Connection to Speed Adjust Potentiometer**

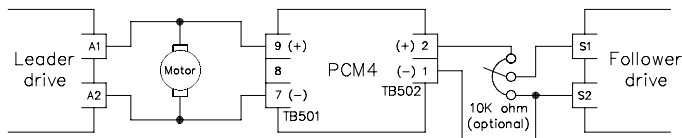
## Connection to other Minarik devices



**Figure 12. Connecting an XP-AC Series Drive to a PCM4, DLC100, and DLC300**

## Leader-follower application

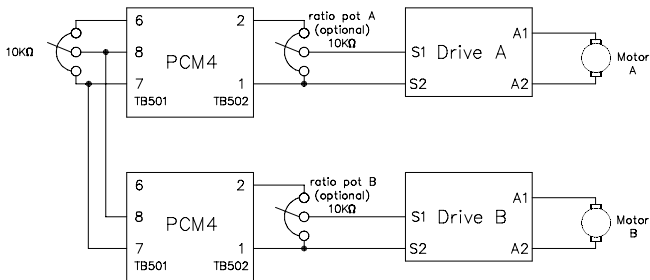
In this application, use a PCM4 to monitor the speed of the leader motor (Figure 13). The PCM4 isolates the leader motor from the follower drive, and outputs a voltage proportional to the leader motor armature voltage. The follower drive uses this voltage reference to set the speed of the follower motor. 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

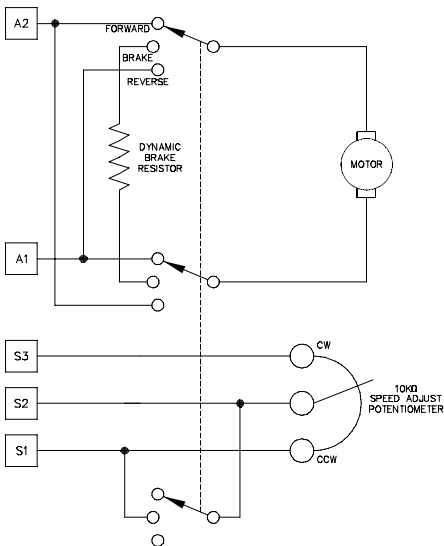
Multiple drives can be controlled with a single speed adjust potentiometer using a PCM4 at the input of each drive to provide isolation (Figure 14). Optional ratio potentiometers can be used to scale the PCM4 output voltage, allowing independent control of each drive.



**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 for sizing the dynamic brake resistor.

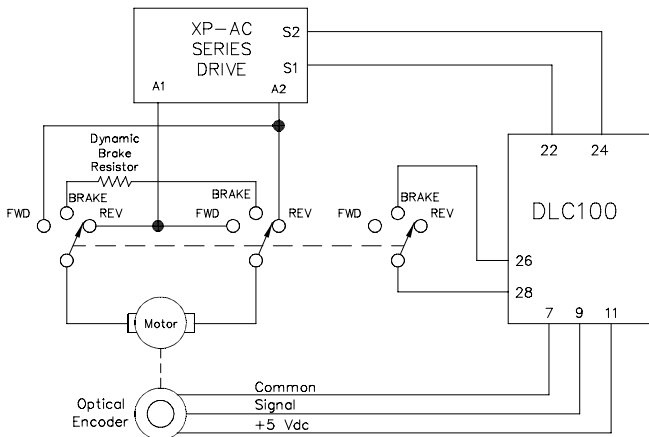


**Figure 15. Reversing Circuit Connection**

## Reversing with a DIGI-LOK® controller

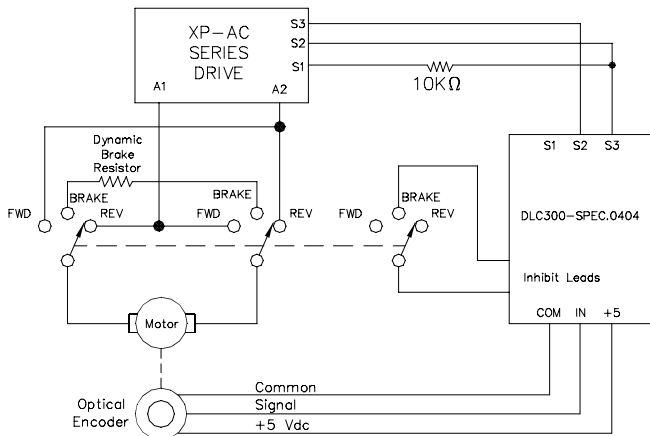
A DIGI-LOK® controller, model DLC100 or DLC300–SPEC.0404 can be used in a reversing application. The DIGI-LOK® must be inhibited while braking. Without the inhibit feature, the DIGI-LOK® will continue to regulate. This will cause overshoot when the DIGI-LOK® is switched back to the drive.

Figure 16 shows the connection of the reversing circuit to an XP-AC Series drive and a DLC100.



**Figure 16. Reversing with a DLC100**

Figure 17 shows the connection of the reversing circuit to an XP-AC Series drive and a DLC300-SPEC.0404.



**Figure 17. Reversing with a DLC300-SPEC.0404**



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# Troubleshooting

## Warning

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

## Before troubleshooting

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

- Disconnect AC line voltage from the drive.
- Check the drive closely for damaged components.
- Check that no conductive or other foreign material has become lodged on the printed circuit board.
- Verify that every connection is correct and in good condition.
- Verify that there are no short circuits or grounded connections.
- Check that the voltage selection switch settings match the AC line and output voltages.
- Check that the drive's rated armature and field outputs are consistent with the motor ratings.

**Motor does not run**

1. Check for blown fuses or tripped circuit breaker.
2. Check that the speed adjust potentiometer is securely connected to S1, S2, and S3. If an input voltage signal is used, check that the connections to S1 and S2 are secure.
3. Check that S1 and S2 are not shorted together.
4. Check that the drive receives AC power at L1 and L2.
5. Check that the motor is not jammed or restricted from movement.
6. Check that the drive is not in current limit. Recalibrate the CURRENT LIMIT trimpot if it is set too low (see page 16 for recommended trimpot settings).

**Fuse blows or circuit breaker trips**

1. Check all wiring for shorts, grounds, or misconnections.
2. Check that the drive is configured to match the motor rating.
3. Check that the motor is not jammed or restricted from movement.
4. Check that the fuse size is correct for the motor being driven.

**Motor runs too fast at the maximum speed setting**

Check that the MAX SPD setting is not set too high.

**Motor runs in the opposite direction**

1. Remove AC line voltage.
2. Reverse connections to the motor armature.

**Motor slows under load**

1. Check that the drive has been correctly calibrated for the motor.
2. Check that the motor is not overloaded.
3. Readjust the IR COMP slightly CW until motor runs at proper speed.

**Motor is unstable under load**

Readjust the IR COMP setting slightly CCW until motor speed stabilizes.

**Motor only runs at full speed**

Check that S2 and S3 are not shorted together.

For additional assistance, contact your local Minarik<sup>®</sup> distributor, or the factory direct: phone (818) 502-1528; fax (818) 502-0716.

# Block Diagrams

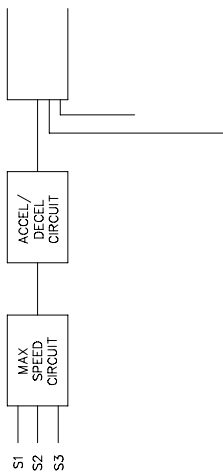


Figure 18. XP-AC Series Block Diagram

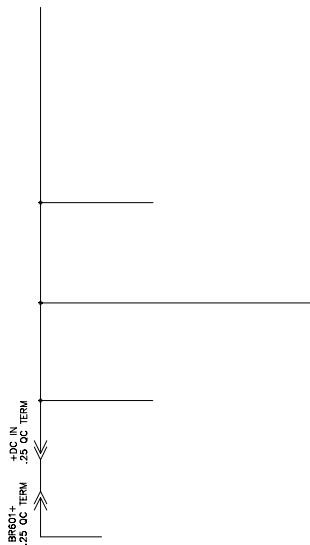


Figure 19. XP-AC Series Input Circuit Diagram

# Replacement Parts

Replacement parts are available from Minarik Corporation and its distributors for this drive series.

**Table 4. Replacement Parts**

<b>Model No.</b>	<b>Symbol</b>	<b>Description</b>	<b>Minarik® P/N</b>
<b>XP02-115AC</b>	C501	220 $\mu$ F, 200 V Capacitor	011-0069
	D501	16 A, 300 V Diode	071-0054
	Q502	Power MOSFET	070-0043
	R501,502	0.2 $\Omega$ , 5 W Resistor	032-0093
	R503	8.2 K $\Omega$ , 5 W Resistor	032-0126
	R504	3.3 K $\Omega$ , 10 W Resistor	032-0131
	BR601	25 A, 800 V Diode Bridge 10 K $\Omega$ Potentiometer Kit	073-0007 202-0066
<b>XP05-115AC</b>	C501	1000 $\mu$ F, 200 V Capacitor	011-0096
	D501	16 A, 300 V Diode	071-0054
	Q501, 502	Power MOSFET	070-0043
	R502,501	0.05 $\Omega$ , 5 W Resistor	032-0113
	R503	8.2 K $\Omega$ , 5 W Resistor	032-0126
	R504	3.3 K $\Omega$ , 10 W Resistor	032-0131
	BR601	25 A, 800 V Diode Bridge 10 K $\Omega$ Potentiometer Kit	073-0007 202-0066
<b>XP10-115AC</b>	C501	1500 $\mu$ F, 250 V Capacitor	011-0089
	D501	16 A, 300 V Diode	071-0054
	Q501, 502	Power MOSFET	070-0043
	R502,501	0.01 $\Omega$ , 5 W Resistor	032-0129
	R503	8.2 K $\Omega$ , 5 W Resistor	032-0126
	R504	3.3 K $\Omega$ , 10 W Resistor	032-0131
	BR601	25 A, 800 V Diode Bridge 10 K $\Omega$ Potentiometer Kit	073-0007 202-0066

## Limited Warranty

**A. Warranty** - Minarik Corporation (referred to as "the Corporation") warrants that its products will be free from defects in workmanship and material for two (2) years or 6,000 hours, whichever comes first, from date of shipment thereof. Within this warranty period, the Corporation will repair or replace such products that are: (1) returned to Minarik Corporation, 901 East Thompson Avenue, Glendale, CA 91201-2011 USA; and, (2) determined by the Corporation to be defective.

This warranty shall not apply to any product that has been subject to misuse, negligence, or accident; or misapplied; or repaired by unauthorized persons; or improperly installed. The Corporation 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 the Corporation's sole obligation and exclude all other warranties of merchantability for use, express or implied. The Corporation 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 the Corporation's obligations, whether express or implied, and particularly of any other claim or breach of warranty contained in Paragraph A, or of any other warranties, express or implied, or claim of liability that might, despite Paragraph B, be decided against the Corporation by lawful authority, the Corporation shall under no circumstances be liable for any consequential damages, losses, or expense arising in connection with the use of, or inability to use, the Corporation'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 two (2) year or 6,000 hour 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, the Corporation'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 the Corporation 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.

**Minarik** Corporation

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