Minarik Automation & Control

USER'S MANUAL

XP–DC Series

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

Models: XP08–60DC
XP12–24DC
XP10–36/48DC
XP16–36/48DC
XP32–12/24DC
XP60–12/24DC

Printed in the United States of America.

Safety Warnings

- This symbol ⚠ denotes an important safety tip or warning. **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.** Minarik assumes the qualified technician is intimate with the dangers involving batteries, especially lead-acid type. This manual presupposes that you have taken all the necessary precautions to prevent a potentially fatal accident involving such batteries, and have followed all standard electrical precautions.

- 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.** Minarik strongly recommends the installation of a master switch in the main power input to stop the drive in an emergency.

This drive is isolated from 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. Use approved personal protective equipment and insulated tools if working on this drive with power applied.

Contents

Illustrations

Tables

Specifications

Model	Max. Armature Current (Amps DC)	Max. Armature Voltage[3] (VDC)	DC Voltage Input Range (VDC)
XP08–60DC	8 [1]	60	50–70
XP12–24DC	12 [1]	24	20–28
XP10–36/48DC	10 [2]	36 or 48 [4]	32–50
XP16–36/48DC	16 [1]	36 or 48 [4]	32–50
XP32–12/24DC	32 [2]	12 or 24 [4]	10–32
XP60-12/24DC	60 [2]	12 or 24 [4]	10–32

Acceleration Time Range	0.5 – 10 seconds
Deceleration Time Range	0.5 – 10 seconds
Analog Input Voltage Range (signal must be isolated; S1 to S2)	0 – 10 VDC
Input Impedance (S1 to S2)	80KΩ
Speed Regulation (% of base speed)	1%
Speed Range	80:1
Form Factor	1.01
Ambient Operating Temperature Range	10°C – 40°C
Weight	0.6 lb

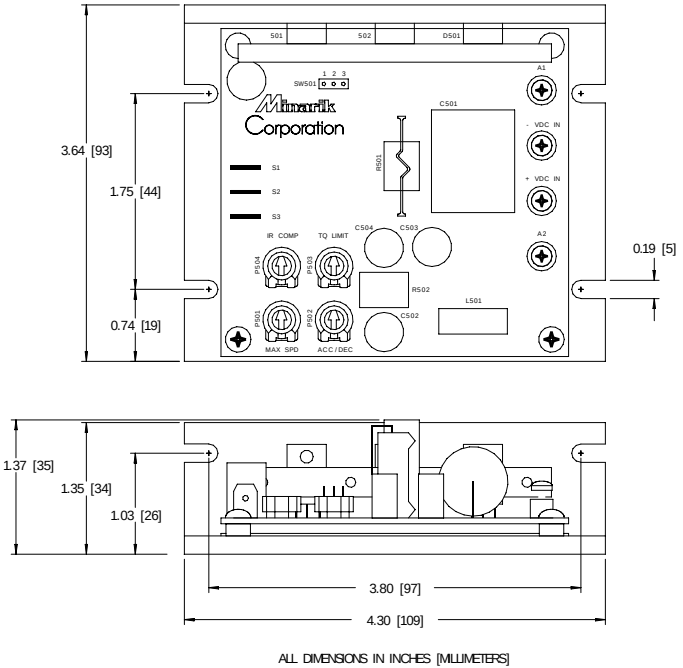
1 At 40°C ambient. No additional heat sink is necessary.

2 Heat sink kit 223-0159 or equivalent is required for XP10-series drives with continuous armature current above 5 ADC and for XP32 and XP60-series drives with continuous current above 20 amps.

3 Or up to 95% of available battery voltage.

4 Maximum armature voltage is selectable by connecting jumper to pins 2 and 3 of SW501 (see page 8).

Dimensions



ALL DIMENSIONS IN INCHES [MILLIMETERS]

Figure 1. XP–DC Series Dimensions

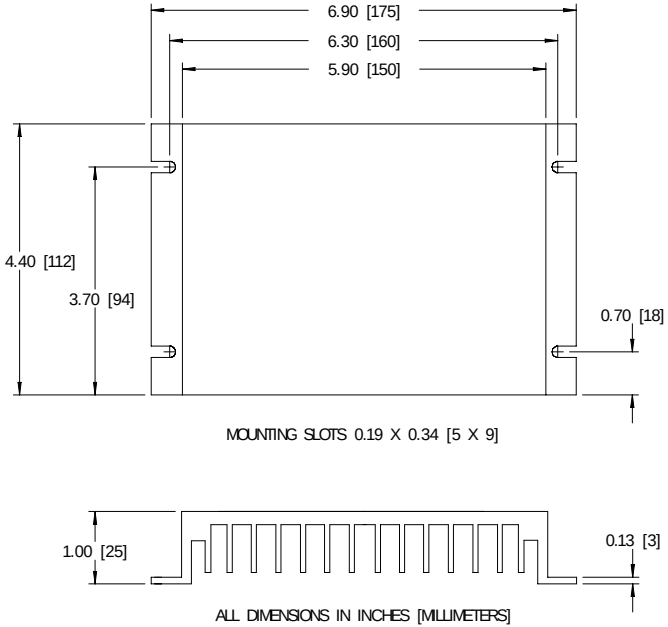


Figure 2. XP-DC Heat Sink Dimensions

Installation

Mounting

Warning

Do not install, rewire, or remove this control with input power applied. Doing so may cause fire or serious injury. Make sure you have read and understood the Safety Warnings on pg i before attempting installation.

- 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 trimpots.
- 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.

Wiring

Warning

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

This drive is isolated from earth 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. Opening any one motor lead may destroy the drive.

This drive is not diode-protected from reverse battery voltage. You must assure that POS (+) is wired to +VDC IN and NEG (–) is wired to –VDC IN.

Use 18 AWG wire for speed adjust potentiometer wiring.

- Size the DC voltage input and motor wire according to the following chart:

Table 1. Wire Gauge/Length Chart

Phase Current (amps)	Wire Gauge (AWG)	Maximum Wire Length (feet)
0 – 19	14	8
20 – 32	10	10
60	8	10

Shielding guidelines

Warning

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

As a general rule, Minarik recommends shielding of all conductors.

If it is not practical to shield power conductors, Minarik recommends shielding all logic-level leads. If shielding 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.

Heat sinking

XP10–DC series drives require an additional heat sink when the continuous armature current is above 5 ADC. XP32–DC and XP60–DC series drives require an additional heat sink when the continuous armature current is above 20 ADC. All other chassis drives have sufficient heat sinking in their basic configurations.

Use Minarik® part number 223–0159 for XP10, XP32 and XP60 series drives when the above conditions are met. Apply a thermally conductive heat sink compound (such as Dow Corning® 340 Heat Sink Compound) between the drive chassis and heat sink surface for optimum heat transfer.

Fuse / Circuit breaker protection

All Minarik drives should be protected by a fuse or circuit breaker. Use a fast acting fuse or circuit breaker rated for approximately 200% of the maximum armature current and armature voltage. Connect the fuse or circuit breaker to the VDC+ IN side of the DC voltage input.

Switch 501 (SW501)

XP10-, XP16-, XP32- and XP60-series drives are shipped with SW501 open (no jumper applied). This allows you to use 48 VDC motors with the XP10–36/48DC and XP16–36/48DC, or 24 VDC motors with the XP32–12/24DC and XP60–12/24DC. To use lower voltage DC motors (36 VDC or 12 VDC, respectively) jumper pins 2 and 3 with the jumper provided. See Figure 3 for the location of SW501.

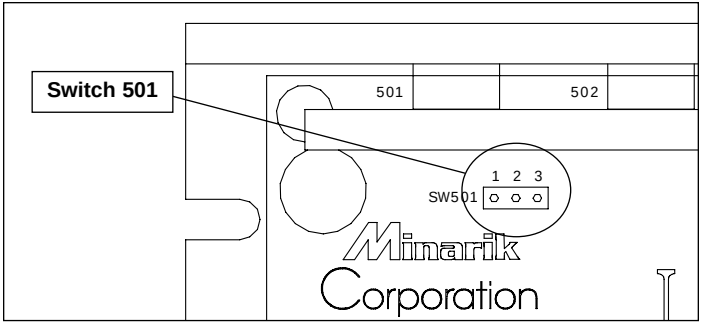


Figure 3. Switch 501

Speed adjust potentiometer

Warning

Be sure that the potentiometer tabs do not make contact with the potentiometer enclosure. 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 (see Figure 4 on Page 10). 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, A1, A2).

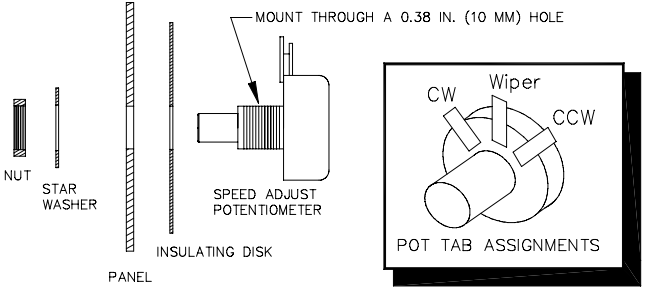


Figure 4. Speed Adjust Potentiometer

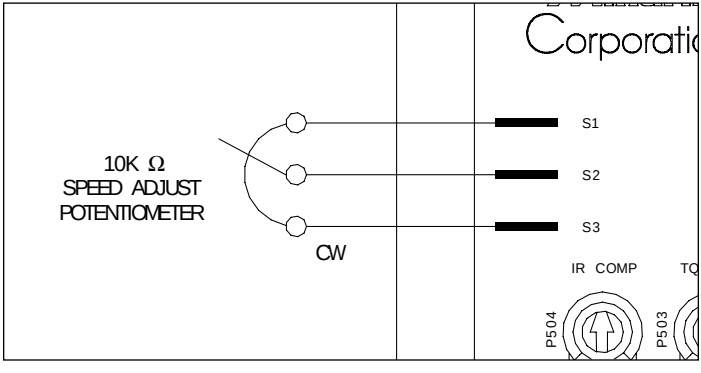


Figure 5. Speed Adjust Potentiometer Connections

Connections

Warning

Do not connect this equipment with power applied. Failure to heed this directive may result in fire or serious injury.

Minarik strongly recommends the installation of a master power switch in the voltage input line, as shown in Figure 6, page 13. The switch contacts should be rated at a minimum of 200% of motor nameplate current and 150% of the input voltage.

Power, fuse and motor connections

Connect the power input leads, an external line fuse and a motor to the drive's printed circuit board (PCB) as shown in Figure 6, page 13.

Motor

Minarik drives supply motor 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 this is opposite of the desired rotation, simply reverse the wiring of A1 and A2.

Connect a DC motor to PCB terminals A1 and A2 as shown in Figure 6, page 13. **Ensure that the motor voltage rating is consistent with the drive's output voltage.**

Power input

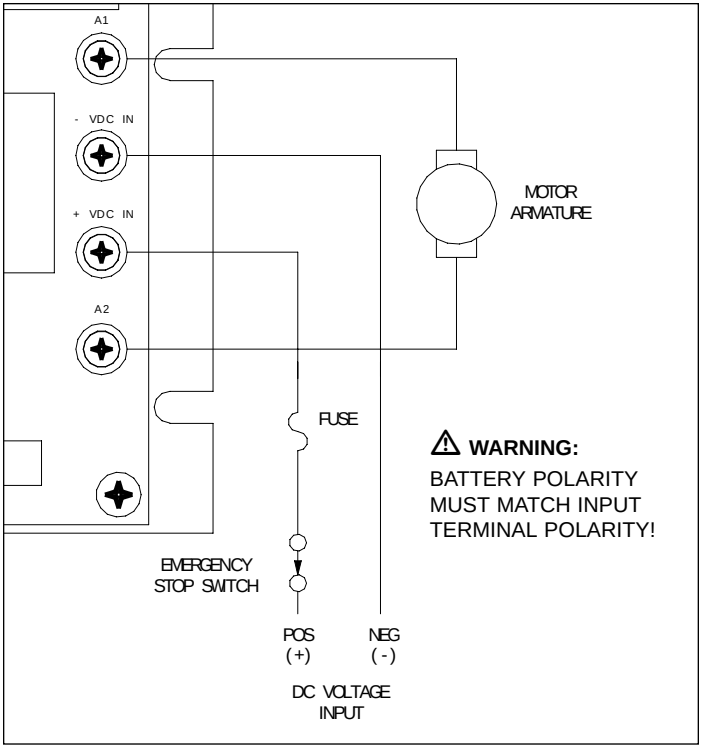
Warning

This drive is not diode-protected from reverse battery voltage. You must assure that POS (+) is wired to +VDC IN and NEG (–) is wired to –VDC IN.

Connect the DC power leads to terminals + VDC IN and - VDC IN, or to a single-throw, single-pole master power switch as shown in Figure 6, page 13 (recommended).

Line fuse

Wire an external line fuse between the stop switch (if installed) and the + VDC IN terminal on the circuit board. The line fuse(s) should be rated at 150% of input voltage and 150 - 200% of maximum motor nameplate current.



You must use OSHA® approved ring terminals (provided) or equivalent.
DO NOT USE BARE COPPER WIRE!

FIgure 6. Power, Fuse and Motor Armature Connections

Voltage follower

Instead of using a speed adjust potentiometer, the drive may be wired to follow an isolated (floating, or differential) 0–10 VDC signal that is isolated from earth ground (Figure 7). Connect the signal input (+) to S2. Connect the signal common (–) to S1. Make no connection to S3. A potentiometer can be used to scale the analog input voltage. Use a battery to achieve greater linearity and control.

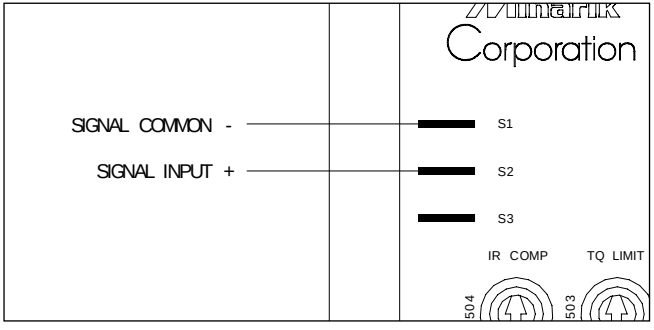


Figure 7. Voltage Follower Connections

Operation

Warning

Dangerous voltages exist on the drive when it is powered, and up to 30 seconds after power is removed and the motor stops. BE ALERT. High voltages can cause serious or fatal injury. For your safety, use personal protective equipment (PPE) when operating this drive.

Before applying power

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

Startup and shutdown

To start the drive:

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

If the motor or drive does not perform as described, disconnect the DC voltage input immediately. Refer to the Troubleshooting section (page 29) for further assistance.

Starting and stopping methods

Warning!

Decelerating to minimum speed, regenerative braking, or coasting to a stop 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 DC line power is the only acceptable method for emergency stopping.

For this reason, **Minarik strongly recommends installing an emergency stop switch** (see ***Connections*** on page 11).

Frequent decelerating to minimum speed produces 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.

Line starting and line stopping

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

Decelerating to zero speed

A single pole, single throw switch may be used to decelerate a motor to zero speed (see Figure 8). Close the switch between S1 and S2 to decelerate the motor from set speed to zero speed. Open the switch to accelerate the motor from zero speed to set speed. The ACCEL/DECEL trimpot setting determines the rate at which the motor accelerates and decelerates.

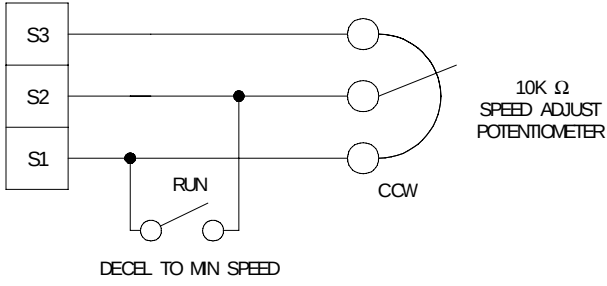


Figure 8. Run/Decelerate to Zero Speed Switch

Calibration

Warning

Dangerous voltages exist on the drive when it is powered, and up to 30 seconds after power is removed and the motor stops. When possible, disconnect the voltage input from the drive before adjusting the trimpots. If the trimpots 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.

Each drive is factory calibrated to its maximum armature voltage and current rating. Readjust the calibration trimpot settings to accommodate a motor with a lower armature and current rating.

All adjustments increase with clockwise rotation (CW), and decrease with counter-clockwise rotation (CCW). Use a non-metallic screwdriver for calibration. Each trimpot is identified on the printed circuit board. (see Figure 9)

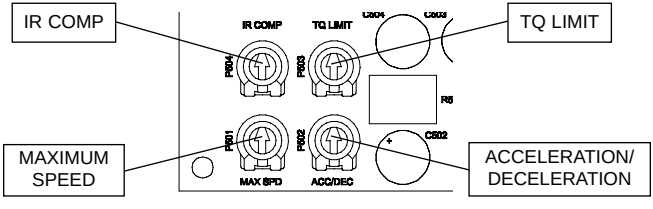


Figure 9. Calibration Trimpot Layout

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 MAX SPD:

1. Set the MAX SPD trimpot full CCW.
2. Apply power to the drive and turn the speed adjust potentiometer full CW. If an input voltage signal is used instead of a speed adjust pot, set the input signal to maximum.
3. Adjust the MAX SPD trimpot until the desired maximum motor speed is reached.

ACC/DEC

The ACC/DEC setting determines the time the motor takes to accelerate to a higher speed, or decelerate to a lower speed. See ***Specifications*** on page 1 for approximate acceleration and deceleration times. The ACC/DEC setting is factory set to its minimum value (full CCW).

To calibrate ACC/DEC:

1. Set the ACC/DEC trimpot full CCW.
2. Apply power to the drive and turn the speed adjust potentiometer full CW. If an input voltage signal is used instead of a speed adjust pot, set the input signal to maximum. Note the time that the drive takes to accelerate to the desired speed.
3. Adjust the ACC/DEC trimpot until the desired acceleration time is reached. Turn the ACC/DEC 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.

Use the following procedure to recalibrate the IR COMP setting :

1. Set the IR COMP trimpot to minimum (full CCW).
2. Rotate the speed adjust potentiometer until the motor runs at midspeed without load (for example, 900 RPM for an 1800 RPM motor). A hand held 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 trimpot until the motor runs at the speed measured in step 2. If the motor oscillates (overcompensation), the IR COMP trimpot may be set too high (CW). Turn the IR COMP trimpot CCW to stabilize the motor.
5. Unload the motor.

TQ LIMIT

Warning

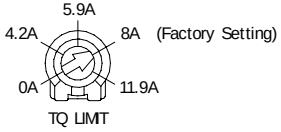
TORQUE LIMIT should be set to 120% of motor nameplate current rating. Continuous operation beyond this setting may damage the motor. If you intend to operate beyond the rating, contact your Minarik representative.

The TQ LIMIT setting determines the maximum armature current output of the drive.

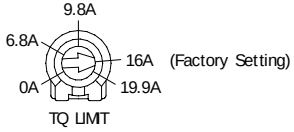
Recalibrate the TQ LIMIT setting when a lower current limit is required. Refer to the TQ LIMIT settings in Figure 10, or recalibrate using the following procedure:

1. With the power disconnected from the control, connect a DC ammeter in series with the armature.
2. Set the TQ LIMIT trimpot to minimum (full CCW).
3. Set the speed adjust potentiometer to maximum (full CW).
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 TQ LIMIT trimpot CW slowly until the armature current is 120% of motor rated armature current.
7. Set the speed adjust potentiometer to minimum
8. Remove the power from the drive and unlock the motor shaft.
9. Remove the ammeter in series with the motor armature if it is no longer needed and re-apply power to the drive.

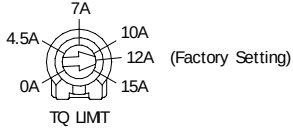
XP08 - 60DC



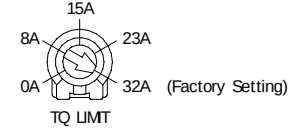
XP16 - 36 / 48DC



XP12 - 24DC



XP32 - 12 / 24DC



XP10 - 36 / 48DC

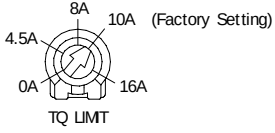


Figure 10. Approximate TQ LIMIT Settings

Application Notes

Multiple fixed speeds

Replace the speed adjust potentiometer with series resistors with a total series resistance of 10K ohms (Figure 11). Add a single pole, multi-position switch with the correct number of positions for the desired number of fixed speeds.

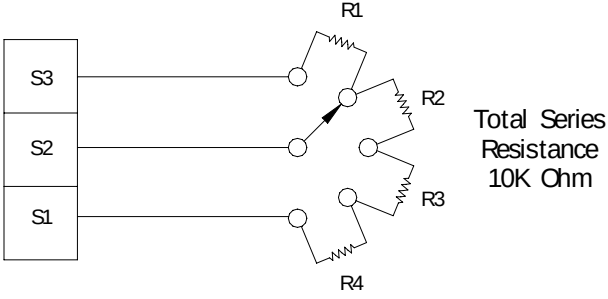


Figure 11. Multiple Fixed Speeds

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 12 shows a connection for fixed high and low speed adjust potentiometers.

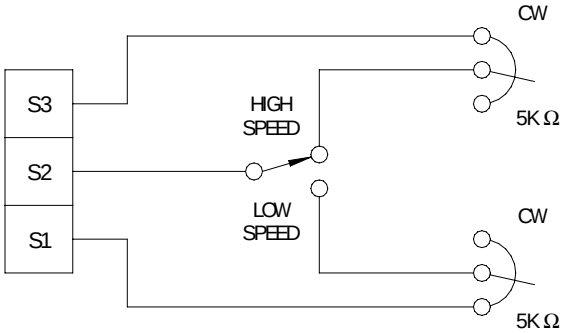


Figure 12. Adjustable Fixed Speeds Using Potentiometers in Series

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 13 shows the connection of two independent speed adjust potentiometers that can be mounted at two separate operating stations.

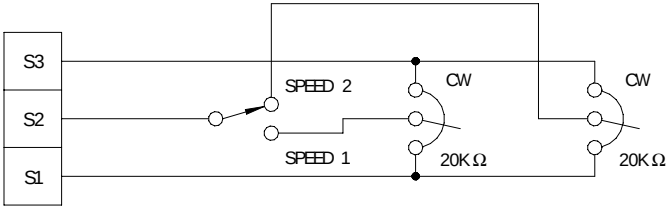


Figure 13. Independent Adjustable Speeds

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 (see Figure 14). 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.

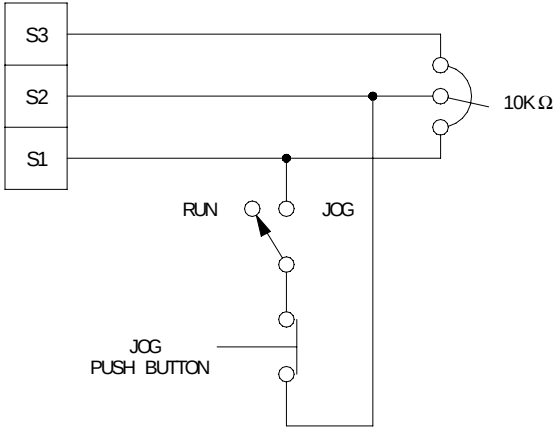


Figure 14. RUN/JOG Switch Connection to Speed Adjust Potentiometer

Troubleshooting

Warning

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 DC voltage input 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 all connections are correct and in good condition.
5. Verify that there are no short circuits or grounded connections.
6. Check that the drive's rated armature voltage and current is consistent with the motor ratings.

For additional assistance, contact your local Minarik® distributor, or the factory direct:
1-800-MINARIK (646-2745) or Fax: 1-800-394-6334

Motor does not run

1. Check for blown fuses or tripped circuit breaker.
2. Verify that the speed adjust potentiometer is not set to zero position.
3. Verify that the drive is receiving DC voltage input.
4. Check that the drive is not in current limit. It may be necessary to increase the TQ LIMIT setting if it is set to a value lower than the current rating of the motor. (see page 23)
5. Check that the motor is not jammed or restricted from movement.

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 or circuit breaker size is correct for the motor being driven.

Motor runs too fast at the maximum speed setting

1. Check that the MAX SPD setting is not set too high. (see page 20)

Motor runs in the opposite direction

1. Remove DC voltage input.
2. Reverse connections to the motor armature. (see page 11)

Motor is unstable under load

1. Readjust the IR COMP setting slightly CCW until motor speed is stabilized. (see page 22)

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. (see page 22)

Block Diagram

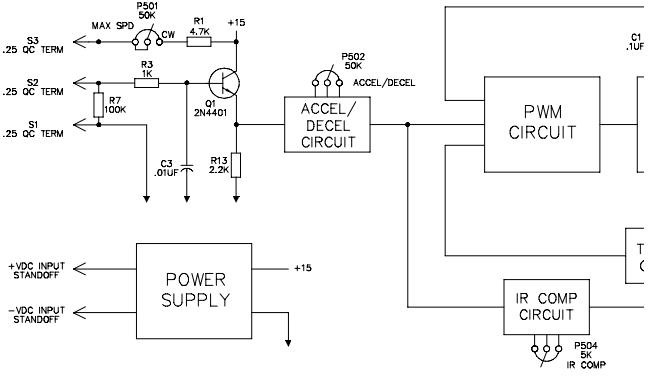
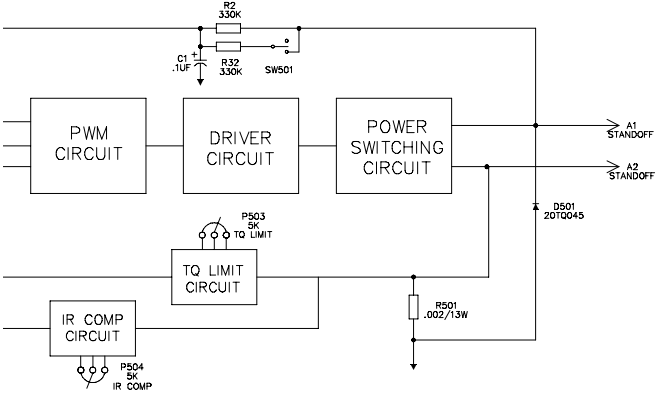


Figure 15. XP–DC Series Block Diagram


R2
330K
C1
.1UF
R32
330K
SW501
PWM
CIRCUIT
DRIVER
CIRCUIT
POWER
SWITCHING
CIRCUIT
A1
STANDOFF
A2
STANDOFF
D501
20TQ045
P503
5K
TQ LIMIT
TQ LIMIT
CIRCUIT
R501
.002/13W
IR COMP
CIRCUIT
P504
5K
IR COMP

Replacement Parts

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

Table 2. Replacement Parts

Model No.	Symbol	Description	Minarik® P/N
All Drives		10KW Pot Kit w/ Ring Term.	202–0073
		2 Pin Shunt	164–0181
XP08–60DC	C501	15 MF, 100 V Capacitor	011–0119
	D501	100 V, 15 A Diode	071–0059
	R501	0.01 W, 5 W Resistor	032–0129
	Q502	N-Channel MOSFET	070–0076
	R502	1 KW, 5W Resistor	032–0098
XP12–24DC	C501	2200 MF, 35 V Capacitor	011–0121
	D501	20 A, 45 V Diode	071–0058
	R501	0.01 W, 5 W Resistor	032–0129
	Q502	N-Channel MOSFET	070–0060
	R502	150 W, 5W Resistor	032–0138
XP10–36/48DC	C501	15 MF, 100 V Capacitor	011–0119
	D501	100 V, 15 A Diode	071–0059
	R501	0.01 W, 5 W Resistor	032–0129
	Q502	N-Channel MOSFET	070–0076
	R502	500 W, 5W Resistor	032–0139
XP16–36/48DC	C501	15 MF, 100 V Capacitor	011–0119
	D501	100 V, 15 A Diode	071–0059
	R501	0.01 W, 5 W Resistor	032–0129
	Q501,502	N-Channel MOSFET	070–0076
	R502	500 W, 5W Resistor	032–0139

Model No.	Symbol	Description	Minarik® P/N
XP32–12/24DC	C501	2200 MF, 35 V Capacitor	011–0121
	D501	20 A, 45 V Diode	071–0058
	L501	1000mH Choke	240–0026
	R501	0.002 W, 13 W Resistor	032–0133
	Q501,502	N-Channel MOSFET	070–0060
	R502	0.2 W, 5W Resistor	032–0093
XP32–12/24DC	C501	2200 MF, 35 V Capacitor	011–0121
	D501	20 A, 45 V Diode	071–0058
	L501	1000mH Choke	240–0026
	R501	0.002 W, 13 W Resistor	032–0133
	Q501,502	N-Channel MOSFET	070–0060
	R502	0.2 W, 5W Resistor	032–0093
XP60–12/24DC	C501	5600 MF, 35 V Capacitor	011-0117
	D501	20 A, 45 V Diode	071–0058
	L501	1000mH Choke	240–0026
	R501	0.002 W, 13 W Resistor	032–0133
	Q501,502	N-Channel MOSFET	070–0060
	R502	0.2 W, 5W Resistor	032–0093

Notes

Unconditional Warranty

A. Warranty

Minarik Corporation (referred to as "the Corporation") warrants that its products will be free from defects in workmanship and material for twelve (12) months or 3,000 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 Minarik Corporation, 901 East Thompson Avenue, Glendale, CA 91201-2011 USA.

This warranty applies only to standard catalog products, and does not apply to specials. Any returns for 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.

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 breech 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 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, 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
901 East Thompson Avenue
Glendale, California 91201-2011
Tel: 1-800-MINARIK (646-2745)
Fax: 1-800-394-6334
www.minarikcorp.com
Document Number 250–0223, Revision 2
Printed in the U.S.A – 12/00
U.S.A. $10.00, Canada $11.00