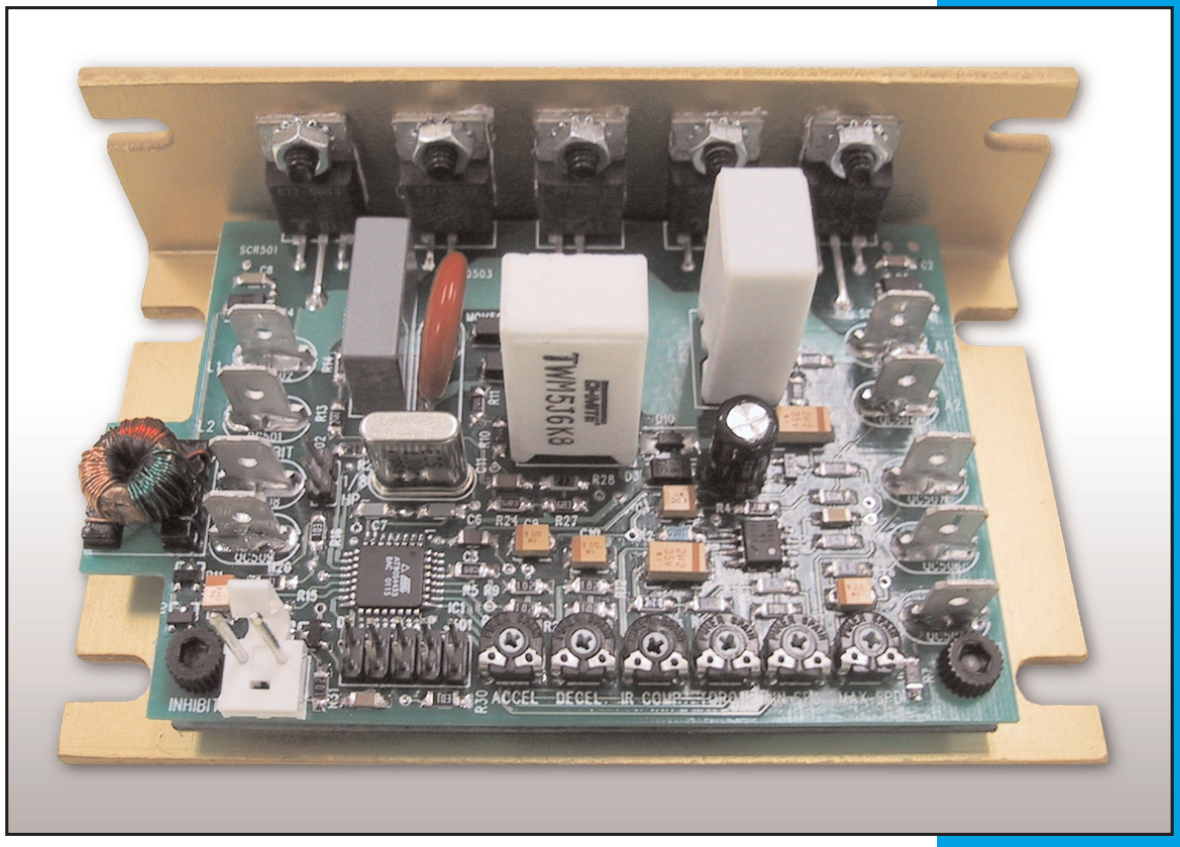
Minarik Automation & Control

M1 Series



SCR, Adjustable Speed Drives for DC Brush Motors

User's Manual

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.** 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 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.

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 trimpots. Use approved personal protective equipment and insulated tools if working on this drive with power applied.

Contents

Tables

Illustrations

Specifications

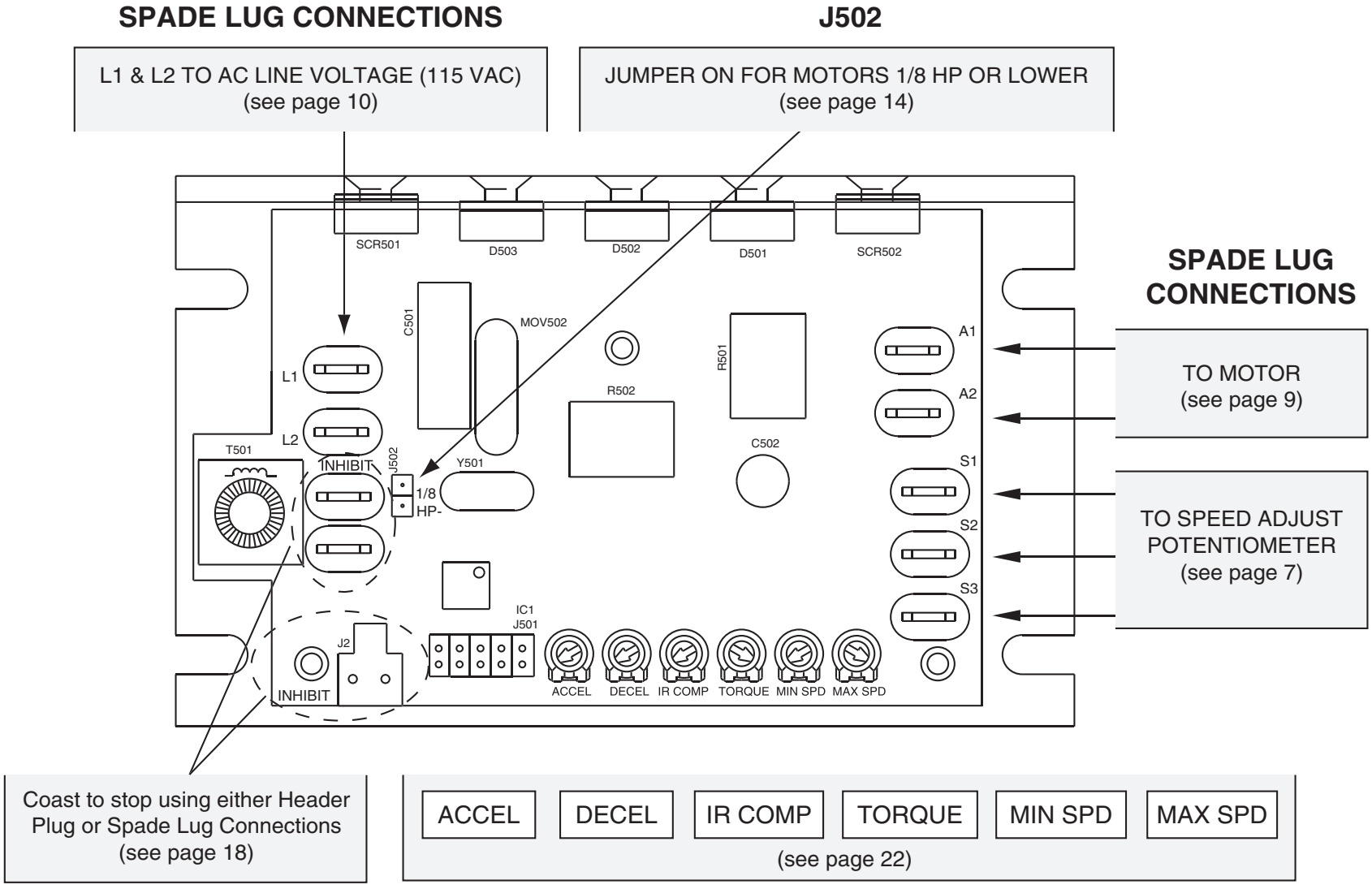
Model	Max Armature Current (Amps DC)	HP Range with 115 VAC Applied	Style
M1	5.0	1/15 - 1/2	Chassis
M1 (w/ heatsink)*	10.0	1/2 - 1	Chassis

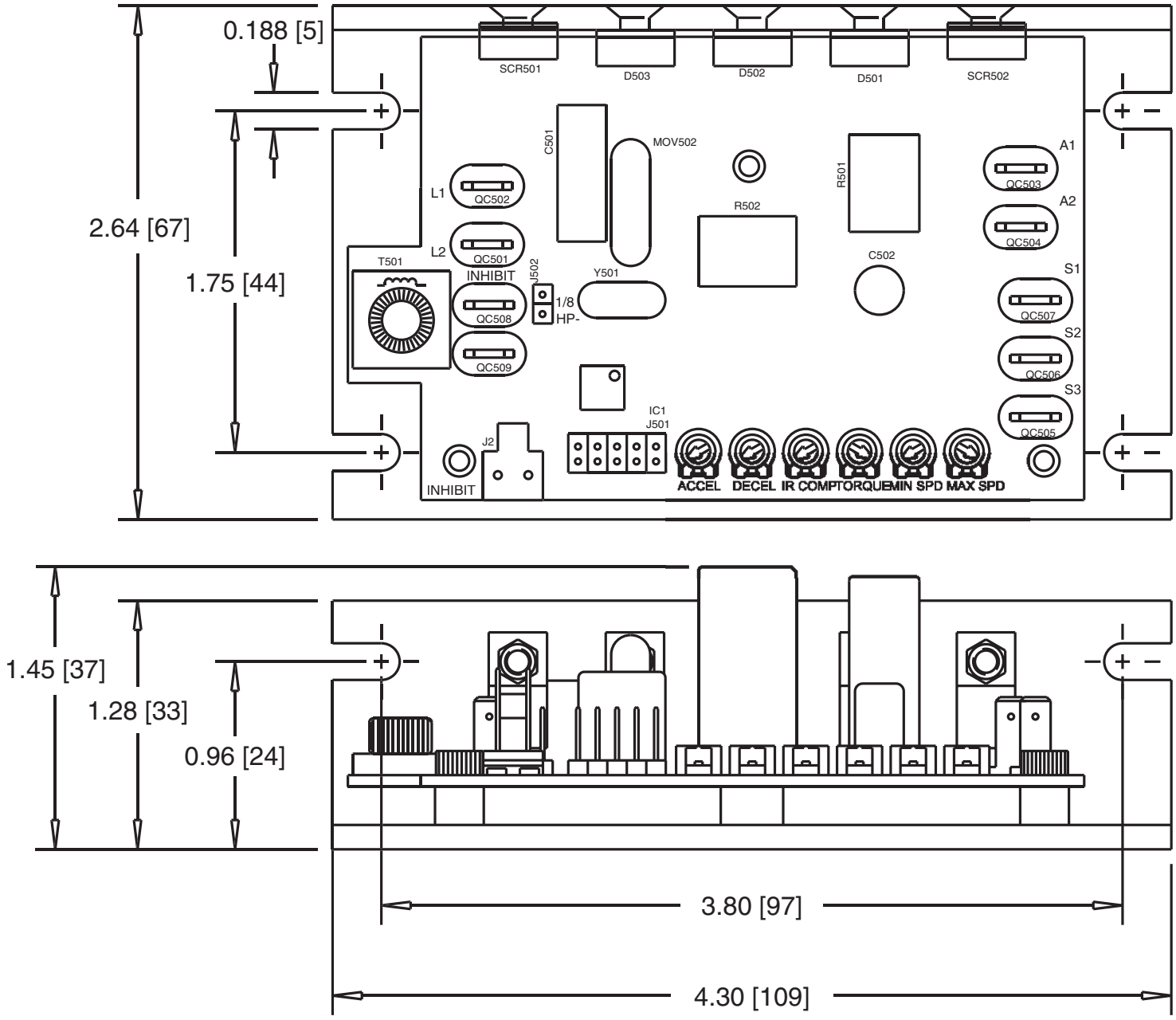
AC Line Voltage	115 VAC ±10%, 50/60 Hz, Single Phase
Armature Voltage (115 VAC Input)	0–90 VDC
Form Factor	1.37 at base speed
Accel. Time Range (for 0 - 90 Armature Voltage)	0.5 - 25 Seconds
Decel. Time Range (for 0 - 90 Armature Voltage)	0.5 - 25 Seconds
Analog Input Voltage Range (isolated; S1 to S2) for 0 - 90 Armature Voltage	0 - 4.5 VDC
Input Impedence (S1 to S2)	100K Ohms
Load Regulation	1% base speed or better
Vibration	1G max (0 - 50 Hz)
Ambient Temp. Range	10°C - 55°C

* M1 Series drives require an additional heat sink (p/n 223-0159) when continuous armature current is above 5ADC (see page 7).

Features and Benefits

- Speed Range and Regulation: 1% over 60:1 Speed Range.
- Six (6) User Adjustable Calibration Pots:
  ACCEL, DECEL, TORQUE, IR COMP, MIN SPEED, and MAX SPEED
- Stopping Modes: Coast to stop with inhibit terminals (N.O.). Choice of header plug or spade lug connections.
- Spade Terminals: Easy to use, low cost, and able to fit in a smaller package.





ALL DIMENSIONS IN INCHES [MILLIMETERS]

Figure 1. M1 Dimensions

Installation

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 before attempting 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 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 inch (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. To ground the chassis, 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

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.

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 may destroy the drive.

- Use 18-24 AWG wire for speed adjust potentiometer wiring.
- Use 14–16 AWG wire for AC line (L1, L2) and motor (A1 and A2) wiring.

Shielding guidelines

Warning

Under no circumstances should power and logic leads be bundled together. Induced voltage can cause unpredicatble 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 of logic 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.

Heat sinking

M1 Series drives require 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 heat sink compound (such as Dow Corning® 340 Heat Sink Compound) between the drive chassis and heat sink surface for optimum heat transfer.

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 (Figure 2, page 8). 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).

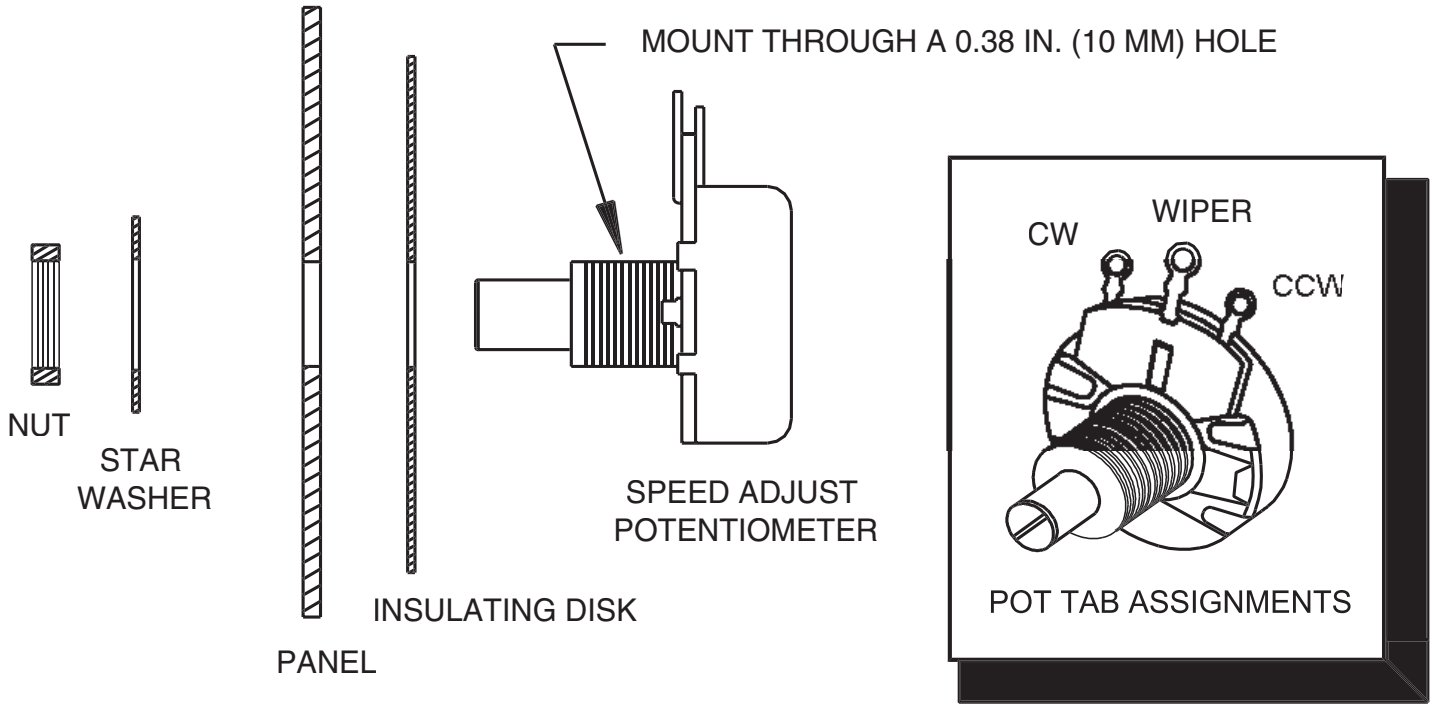


Figure 2. Speed Adjust Potentiometer

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 3 (page 12). The switch contacts should be rated at a minimum of 200% of motor nameplate current and 250 volts.

Power, fuse and motor connections

Connect the power input leads, an external line fuse and a DC motor to the drive's printed circuit board (PCB) as shown in Figure 3, page 12.

Motor

Minarik 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 this is opposite of the desired rotation, simply reverse the wiring of A1 and A2 with each other.

Connect a DC motor to PCB terminals A1 and A2 as shown in Figure 3, page 12. Ensure that the motor voltage rating is consistent with the drive's output voltage.

Power input

Connect the AC line power leads to terminals L1 and L2, or to a double-throw, single-pole master power switch (recommended). The switch should be rated at a minimum of 250 volts and 200% of motor current. Refer to Figure 3, page 12.

Line fuse

Minarik drives require an external fuse for protection. Use fast acting fuses rated for 250 VAC or higher, and approximately 150% of the maximum armature current. Fuse only the HOT leg of the AC line that connects to L1 and leave L2 unfused. Table 1 (page 11) lists the recommended line fuse sizes.

Wire an external line fuse between the stop switch (if installed) and L1 terminal. The line fuse(s) should be rated at 250 volts and 150 - 200% of maximum motor nameplate current.

Table 1. Recommended Line Fuse Sizes

90 VDC Motor Horsepower	180 VDC Horsepower	Max. DC Armature Current (amps)	AC Line Fuse Size (amps)
1/20	1/10	0.5	1
1/15	1/8	0.8	1.5
1/8	1/4	1.5	3
1/6	1/3	1.7	3
1/4	1/2	2.5	5
1/3	3/4	3.5	8
1/2	1	5.0	10
3/4	1 1/2	7.5	15
1	2	10	15

Minarik Corporation offers two fuse kits: part number 050–0066 (1–5A Fuse Kit) and 050–0071 (5–15A Fuse Kit).

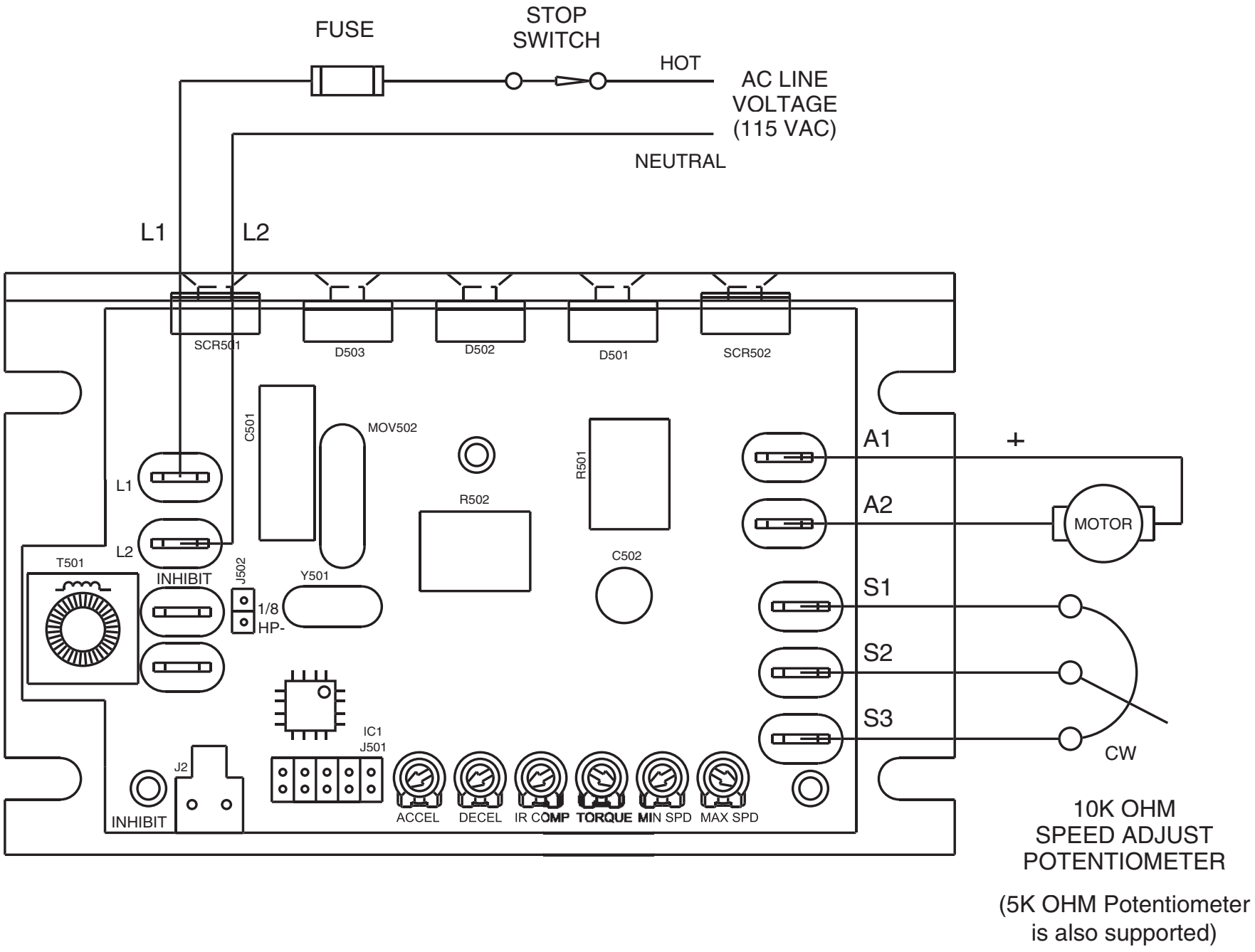


Figure 3. M1 Series Drive Connections

Horsepower Jumper Terminal (J502)

Jumper both header pins on J502 for 1/8 HP motors and lower. Jumper only 1 header pin for all other motors. The factory (default) setting is set to only 1 pin jumpered.

For J502 jumper location and settings, refer to Figure 4 (page 14).

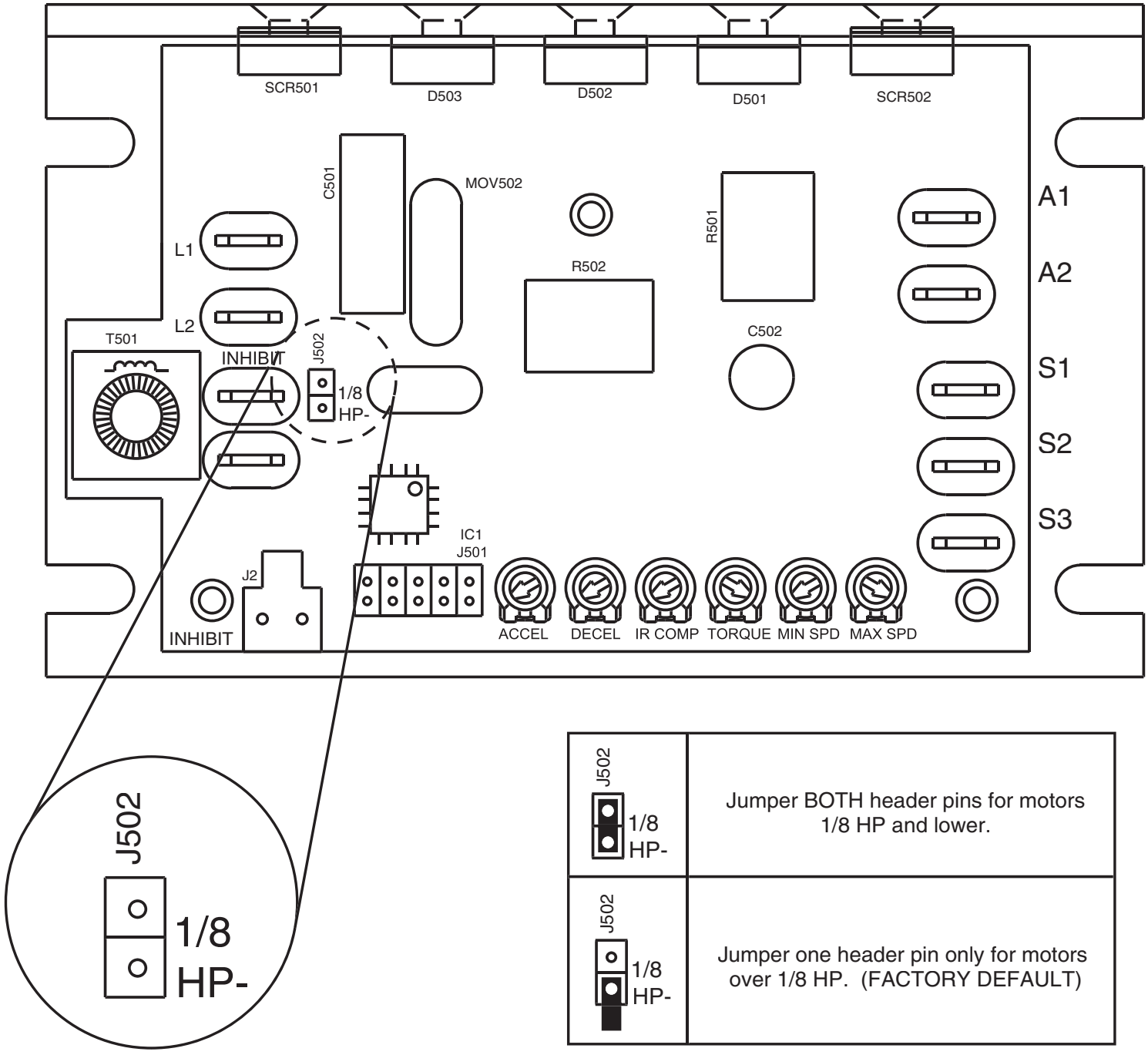


Figure 4. J502 Jumper Location and Settings

Voltage follower

Instead of using a speed adjust potentiometer, the drive may be wired to follow an analog input voltage signal that is isolated from earth ground (Figure 5). 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. An interface device, such as Minarik model PCM4, may be used to scale and isolate an analog input voltage.

An analog input voltage range of approximately 0 – 4.3 VDC is required to produce an armature voltage range of 0–90 VDC.

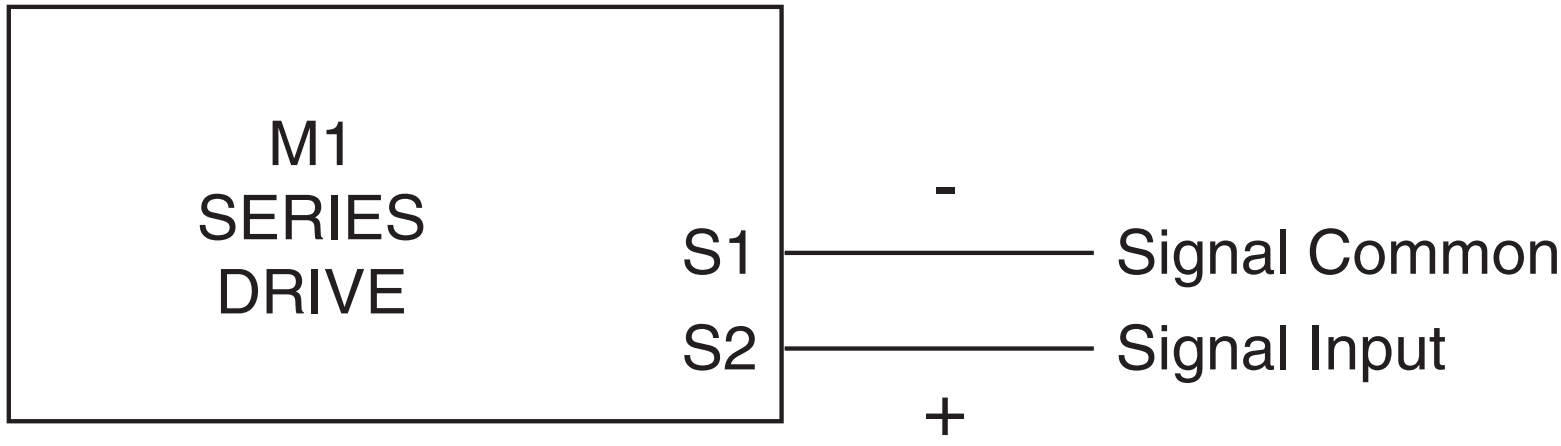


Figure 5. Voltage Follower Connections

Operation

Warning

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 37, for further assistance.

Before applying power

- Verify that no conductive material is present on the printed circuit board.

Startup

1. Turn the speed adjust potentiometer full counterclockwise (CCW).
2. Apply AC line voltage.
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 AC line voltage from the drive to coast the motor to a stop.

Starting and stopping methods

Warning

Decelerating to minimum speed, dynamic 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 AC line power (both L1 and L2) is the only acceptable method for emergency stopping.

For this reason, **Minarik strongly recommends installing an emergency stop switch** (see connection diagram on page 12).

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.

Inhibit terminals

M1 series drives offer two ways to INHIBIT:

1. Header Plug
2. Spade Lugs (Q508 and Q509)

Short the INHIBIT terminals to coast the motor to stop (see Figure 6 on page 19 for INHIBIT terminal location). Open the INHIBIT terminals to accelerate the motor to set speed.

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

Minarik Corporation offers two accessory plug harnesses for connecting to the INHIBIT header plug: part number 201-0024 [inhibit plug with 18 inches (46 cm) leads]; and part number 201-0079 [inhibit plug with 36 inches (91 cm) leads].

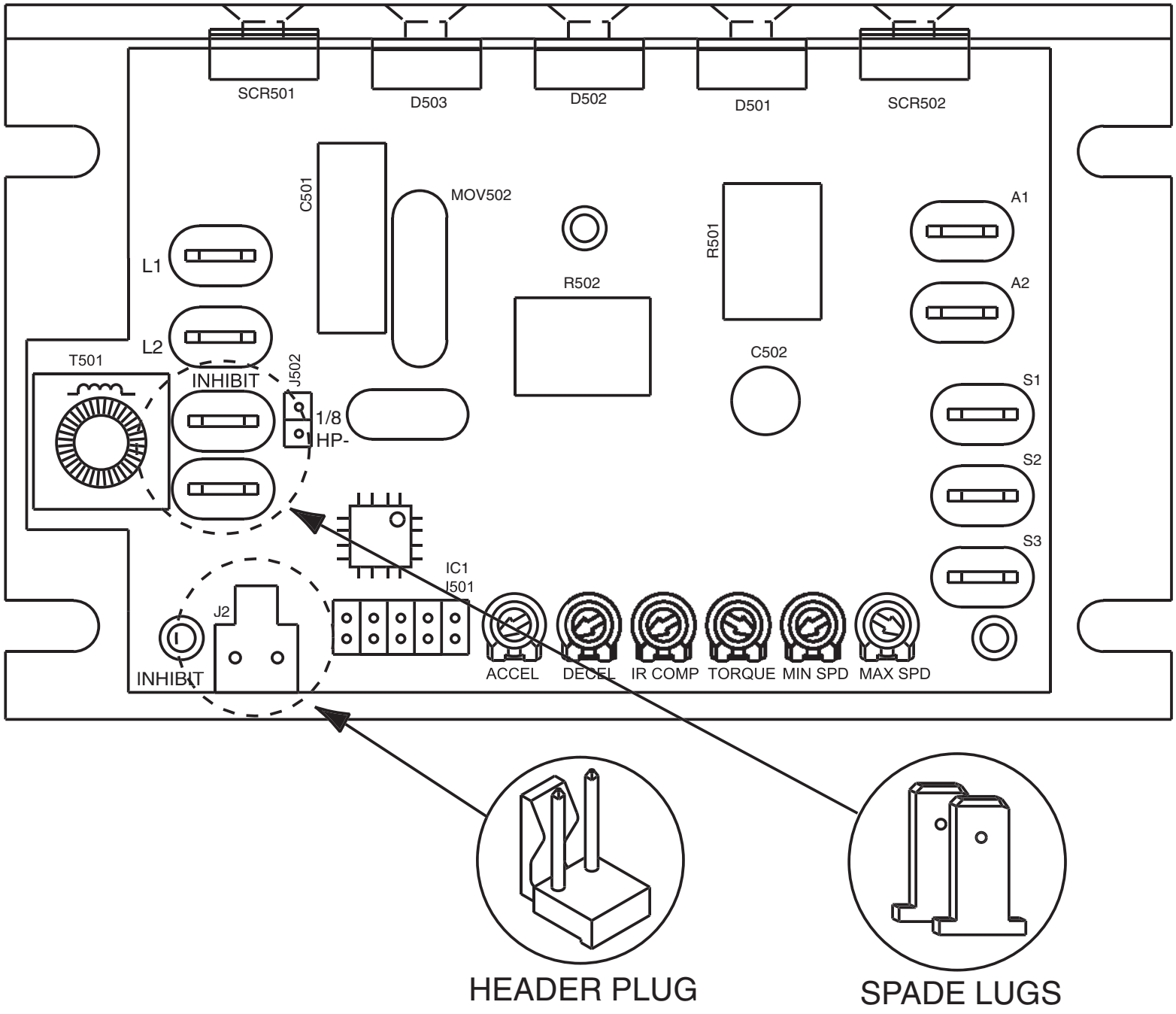


Figure 6. INHIBIT Terminals

Table 2. Minimum Recommended Dynamic Brake Resistor Values

Motor Armature Voltage	Dynamic Brake Resistor Value
90 VDC	15 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.

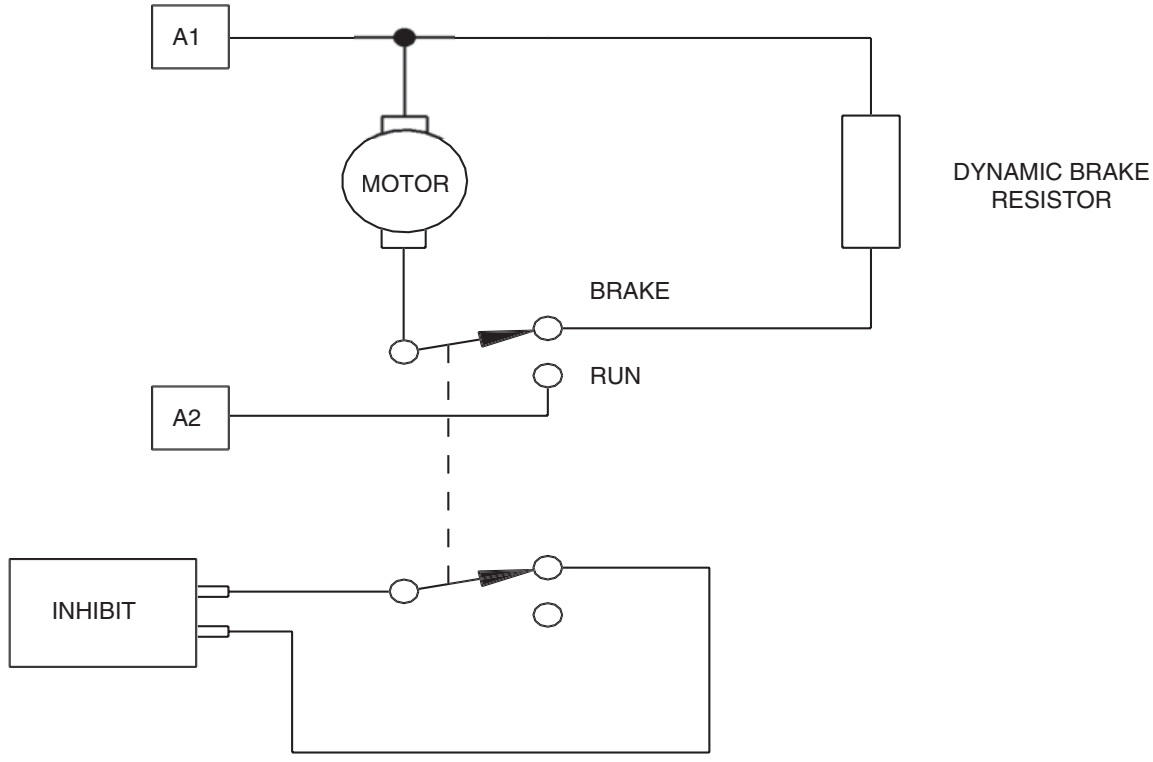


Figure 7. Dynamic Brake Connection

Dynamic braking

Warning

For frequent starts and stops, short the inhibit terminals, decelerate to a minimum speed, or apply a dynamic brake to the motor. Do not use any of these methods for emergency stopping. They may not stop a drive that is malfunctioning. Remove AC line power (both L1 and L2) is the only acceptable method for emergency stopping.

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

Dynamic braking may be used to rapidly stop a motor (Figure 7, page 20). For the RUN/BRAKE switch, use a two pole, two position switch rated for at least 125 VDC, 6 amps. 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 (page 20) for recommended dynamic brake resistor sizes.

Calibration

Warning

Dangerous voltages exist on the drive when it is powered. 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.

M1 Series drives have six user-adjustable trimpots: Accel, Decel, IR Comp, Torque, Min Spd, and Max Spd. Each drive is factory calibrated to its maximum current rating. Re-adjust the calibration trimpot 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 trimpot is identified on the printed circuit board.

MINIMUM SPEED (MIN SPD)

The MIN SPD trimpot establishes the motor speed obtained in response to the minimum input signal. It is factory set for zero speed.

To calibrate the MIN SPD pot, apply the minimum signal. Adjust the MIN SPD trimpot until the motor runs at the desired speed or is just at the threshold of rotation.

MAXIMUM SPEED (MAX SPD)

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

To calibrate MAX SPD:

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

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

TORQUE

Warning

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 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 (page 26) 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 trimpot to minimum (full CCW).
3. Set the speed adjust potentiometer to maximum speed (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 TORQUE trimpot CW until the armature current is 150% of motor rated armature current.
7. Turn the speed adjust potentiometer CCW until the motor stops.
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 trimpot 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.

See Figure 8 (page 26), for recommended IR COMP settings.

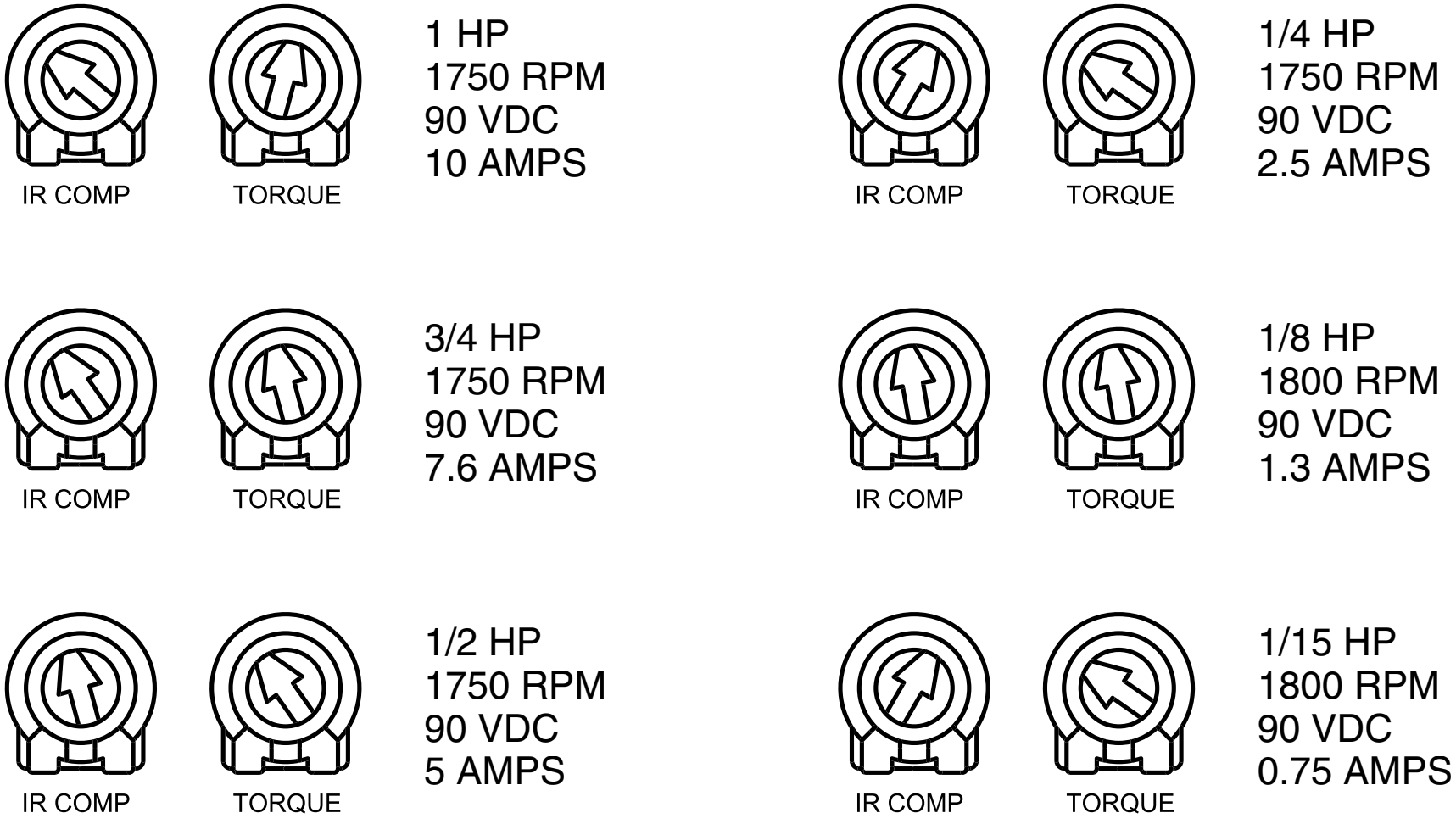


Figure 8. Recommended Torque and IR COMP Settings (actual settings may vary with each application)

ACCELERATION (ACCEL)

The ACCEL setting determines the time the motor takes to ramp to a higher speed. See Specifications on page 1 for approximate acceleration times. ACCEL is factory set for the fastest acceleration time (full CCW).

To set the acceleration time:

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

DECELERATION (DECEL)

The DECEL setting determines the time the motor takes to ramp to a lower speed. See Specifications on page 1 for approximate deceleration times. DECEL is factory set for the fastest deceleration time (full CCW).

To set the deceleration time:

1. Set the speed adjust potentiometer full CW. The motor should run at maximum speed.
2. Turn the speed adjust potentiometer full CCW and measure the time it takes the motor to go from maximum to minimum speed.
3. If the time measured in step 2 is not the desired deceleration time, turn the DECEL trimpot CW for a slower deceleration time, or CCW for a faster deceleration time. Repeat steps 1 through 3 until the deceleration time is correct.

Application Notes

Multiple fixed speeds

Replace the speed adjust potentiometer with series 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.

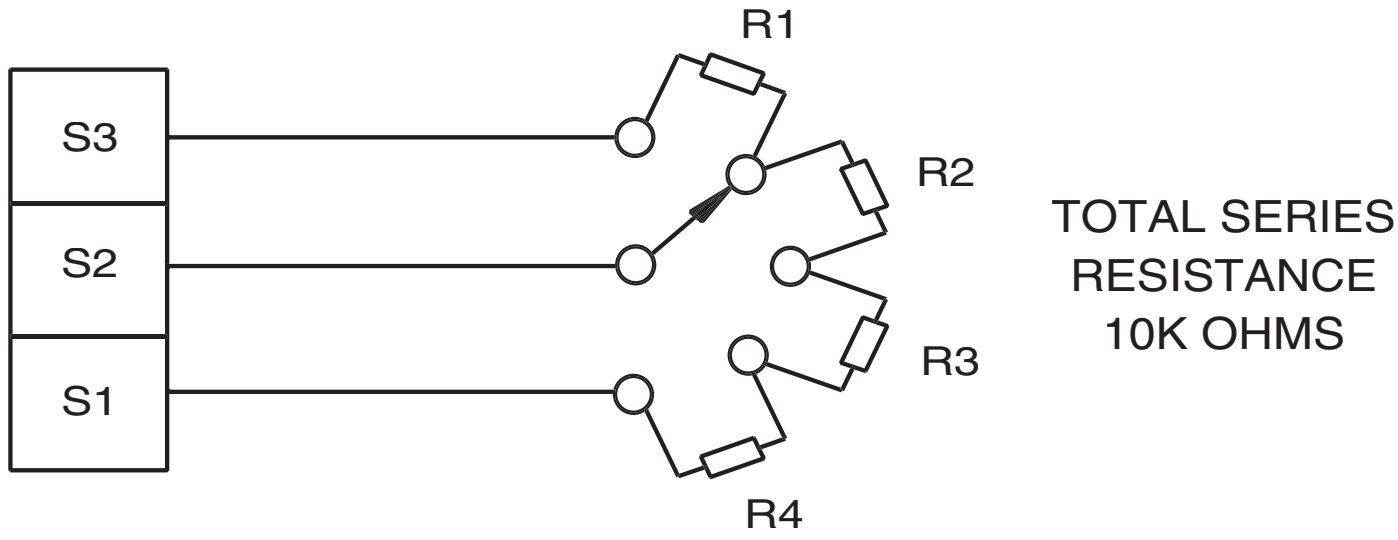


Figure 9. Multiple Fixed Speeds

Adjustable speeds using potentiometers in series

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

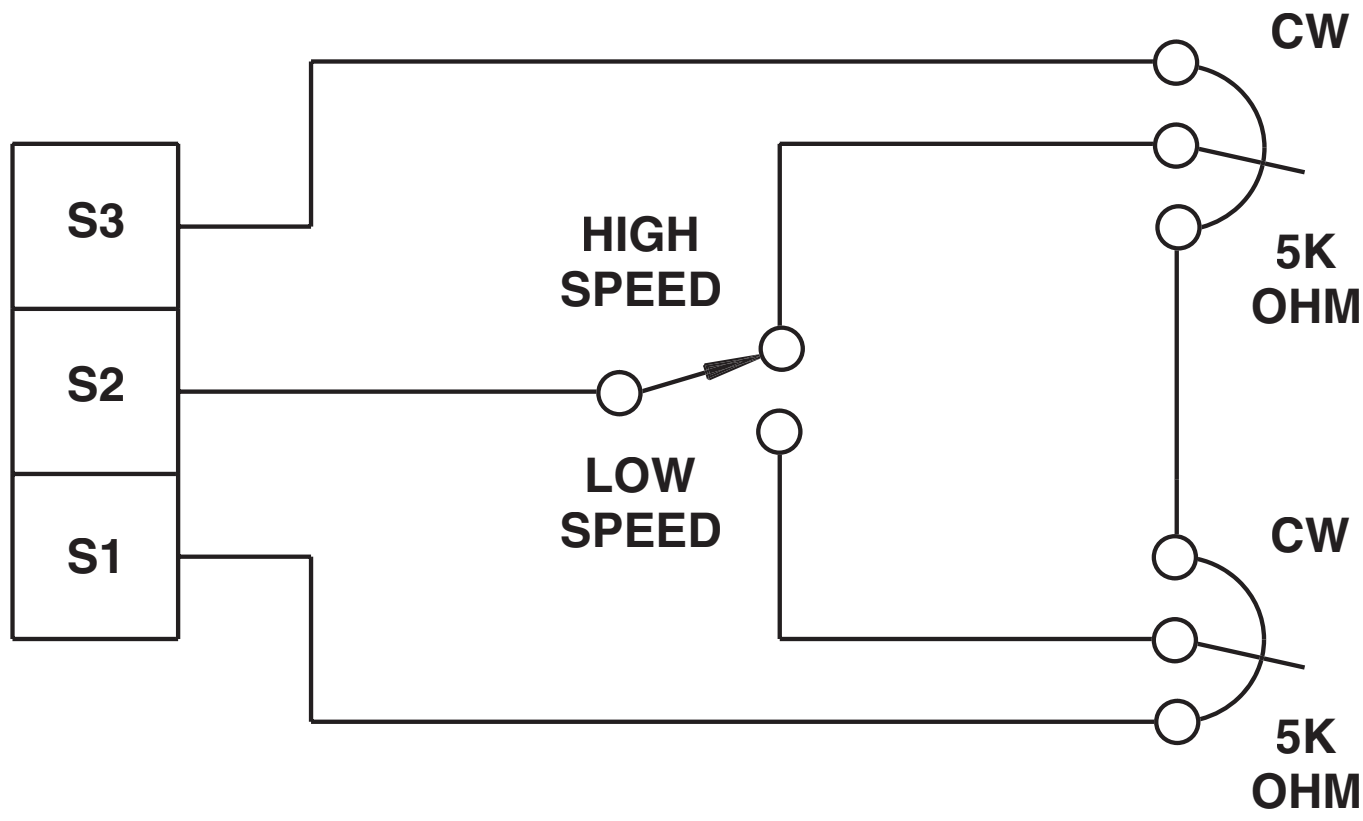


Figure 10. Adjustable Fixed Speeds Using Potentiometers in Series

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

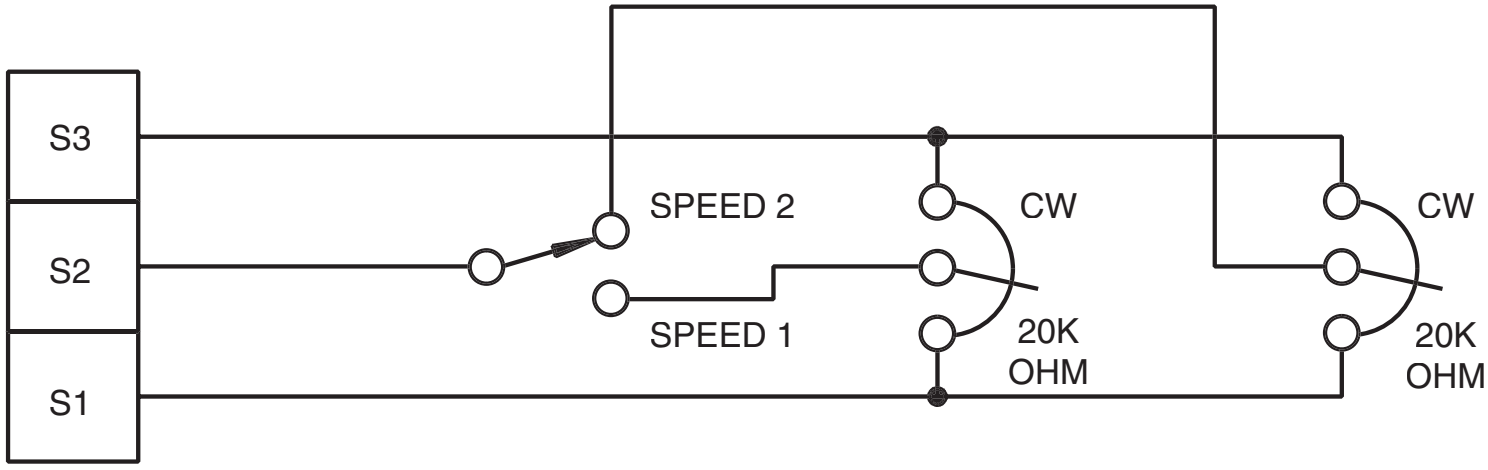


Figure 11. Independent Adjustable Speeds

RUN/JOG switch

RUN/JOG switch option #1

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

In the first wiring option, connect the RUN/JOG switch and JOG pushbutton to the Inhibit plug as shown in Figure 12. The motor coasts to minimum speed (as determined by the MIN SPD trimpot setting) when the RUN/JOG switch is set to JOG. Press the JOG pushbutton to jog the motor. Return the RUN/JOG switch to RUN for normal operation.

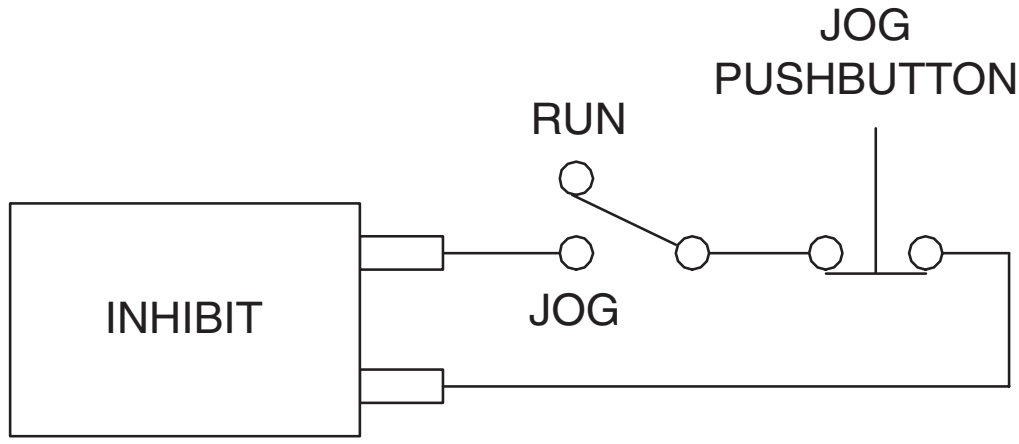


Figure 12. RUN/JOG Switch Connection to Inhibit Plug (Option #1)

RUN/JOG switch option #2

In the second wiring option, connect the RUN/JOG switch and the JOG pushbutton as shown in Figure 13. When the RUN/JOG switch is set to JOG, the motor decelerates to minimum speed (minimum speed is determined by the MIN SPD trimpot setting). Press the JOG pushbutton to jog the motor. Return the RUN/JOG switch to RUN for normal operation.

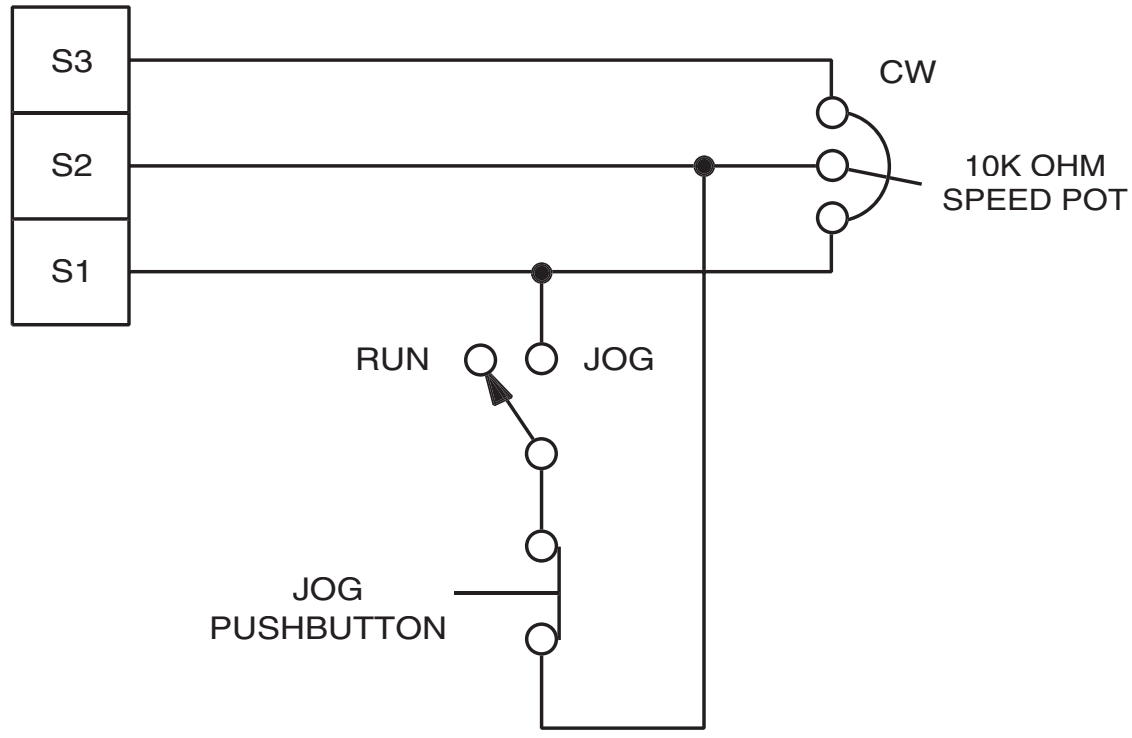


Figure 13. RUN/JOG Switch Connection to Speed Adjust Potentiometer (Option #2)

Leader-follower application

In this application, use a PCM4 to monitor the speed of the leader motor (Figure 14). 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.

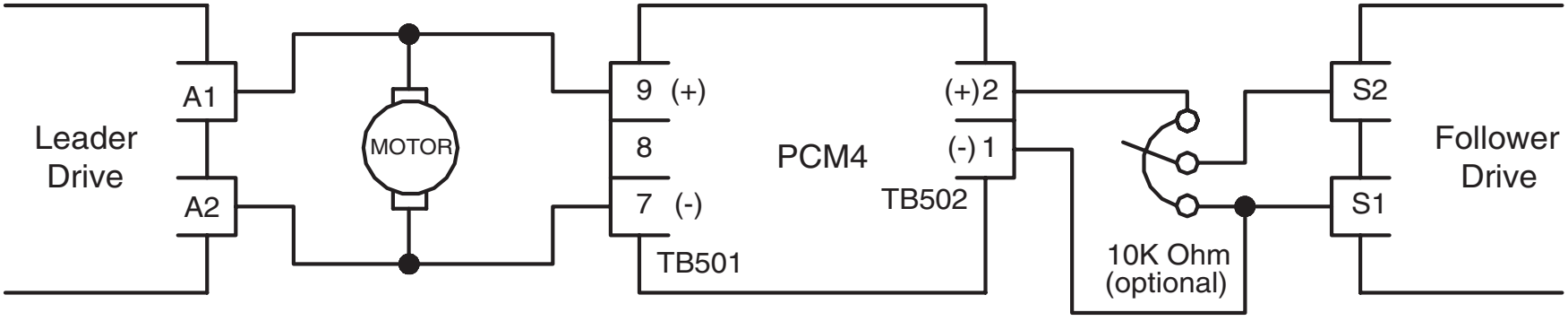


Figure 14. Leader-Follower Application

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, page 21, for recommended dynamic brake resistor sizes.

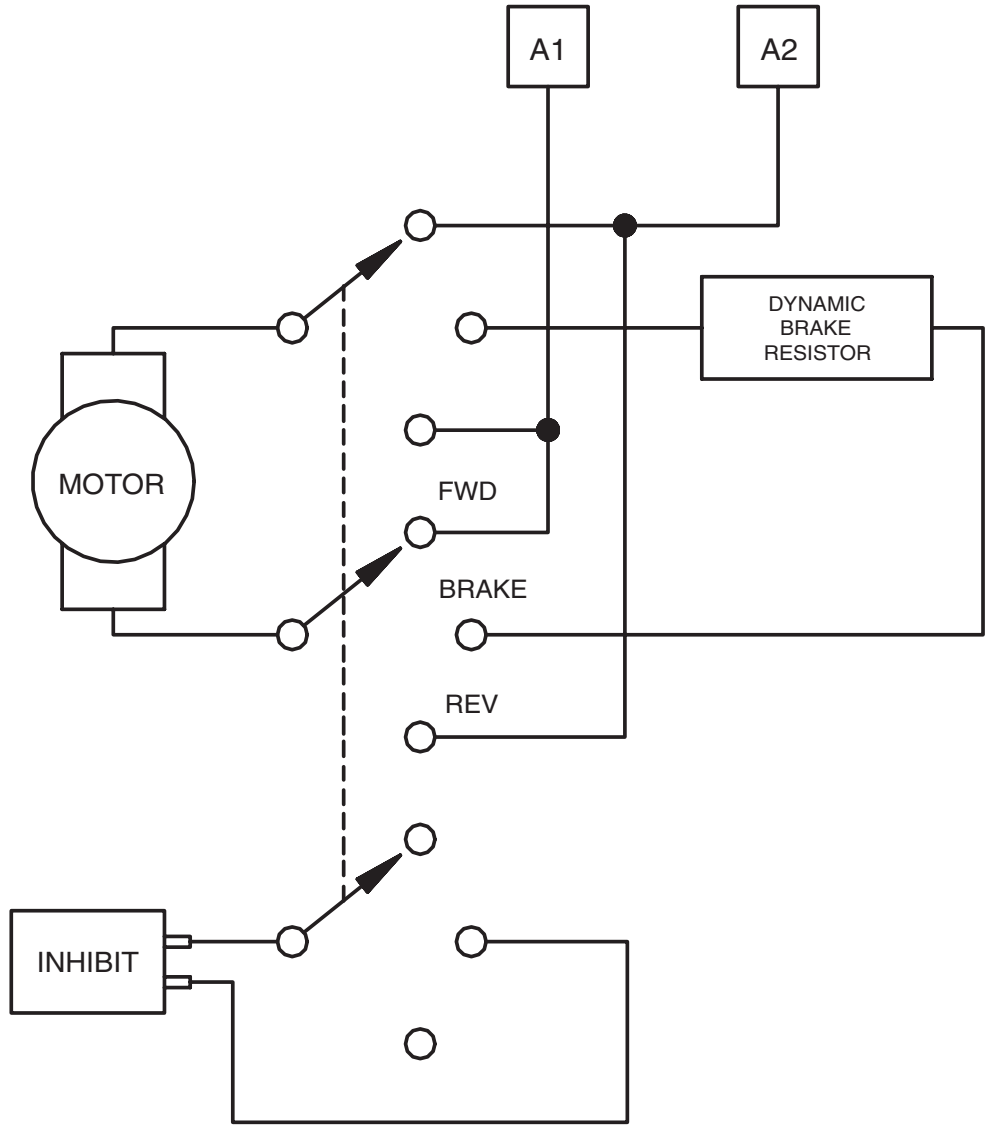


Figure 15. Reversing Circuit Connection

Reversing with a DIGI-LOK controller

A DIGI-LOK controller, model DLC600, 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 a M1 Series drive and DLC600.

NOTE: Only one DLC option (Optical Encoder or Magnetic Pickup) may be simultaneously.

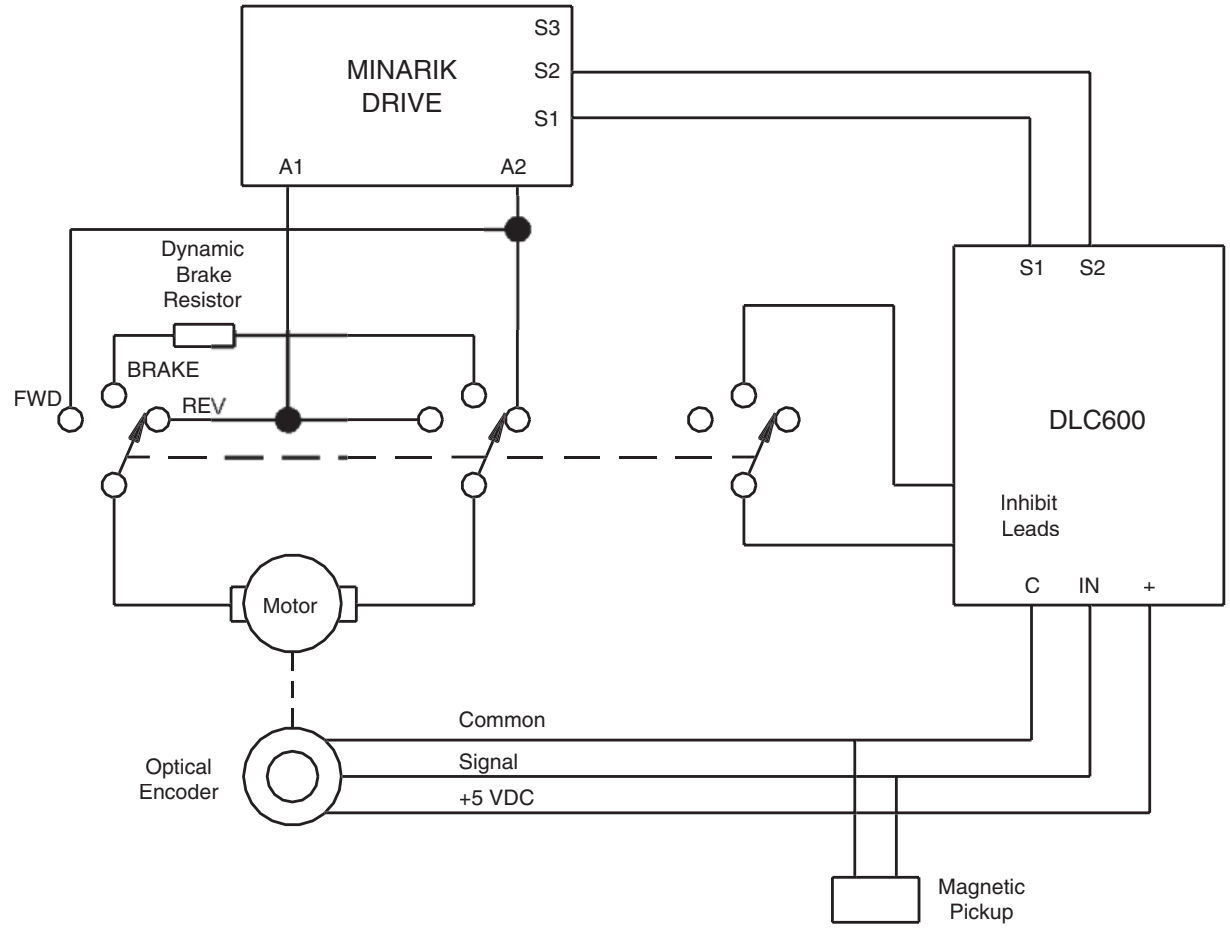


Figure 16. Reversing with a DLC600

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 the 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 drive's rated armature is consistent with the motor rating.

For additional assistance, contact your local Minarik Distributor, or the factory direct at: TEL: 1-800-MINARIK (646-2745) or FAX: 1-800-394-6334

Problem	Possible Causes	Suggested Solutions
Line fuse blows.	1. Line fuse is the wrong size. 2. Motor cable or armature is shorted to ground.	1. Check that the line fuse is correct for the motor size. 2. Check motor cable and armature for shorts.

Problem	Possible Causes	Suggested Solutions
Line fuse does not blow, but the motor does not run.	1. Speed adjust pot or speed reference voltage is set to zero speed.	1. Increase the speed adjust pot or speed reference voltage setting.
	2. INHIBIT terminals are jumpered.	2. Remove jumper from the INHIBIT terminals.
	3. S2 is shorted to S1.	3. Remove short.
	4. Drive is in current limit.	4. Verify that the motor is not jammed. Increase TORQUE setting if they are set too low. See page 24.
	5. Drive is not receiving AC line voltage.	5. Apply AC line voltage to L1 and L2.
	6. Motor is not connected.	6. Connect motor to A1 and A2.

Problem	Possible Causes	Suggested Solutions
Motor does not stop when the speed adjust potentiometer is full CCW	1. MIN SPD setting is too high.	1. Calibrate MIN SPD. See page 23.
Motor runs in the opposite direction (non-reversing drives)	1. Motor connections to A1 and A2 are reversed.	1. Reverse connections to A1 and A2.
Motor runs too fast	1. MAX SPD and MIN SPD are set too high.	1. Calibrate MAX SPD and MIN SPD. See page 23.

Problem	Possible Causes	Suggested Solutions
Motor will not reach the desired speed	1. MAX SPD setting is too low. 2. IR COMP setting is too low. 3. TORQUE setting is too low. 4. Motor is overloaded.	1. Increase MAX SPD setting. See page 23. 2. Increase IR COMP setting. See page 27. 3. Increase TORQUE setting. See page 24. 4. Check motor load. Resize the motor and drive if necessary.
Motor pulsates or surges under load.	1. IR COMP is set too high. 2. Motor bouncing in and out of current limit.	1. Adjust the IR COMP setting slightly CCW until the motor speed stabilizes. See page 27. 2. Make sure motor is not undersized for load; adjust TORQUE trimpot CW. See page 24.

Replacement Parts

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

Table 3. Replacement Parts

Model No.	Symbol	Description	Minarik P/N
M1	SCR501, 502	800 V, 20 A SCR	072-0043
	D501-503	800 V, 20 A Diode	071-0039
	R501	0.01 Ohm, 5W Resistor	032-0129
	T501	13Z1300 SCR Transformer	230-0123
		10K OHM, 5W Potentiometer	120-0009

NOTES

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 breech 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.

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