Minarik Automation & Control

MM30000 Series

Model MM31640A

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 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.

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Specifications

Model	Max. Input Voltage (AC)	Max. Input Current (Amps AC)	Max. Armature Current (Amps DC)	Max HP	Style
MM31640A	115	3	2	1/8	Chassis

AC Line Voltage Tolerance	±10%, 50/60 Hz, single phase
Armature Voltage	0 – 90 VDC
Analog Input Voltage Range (signal must be isolated; S1 to S2)	0 – 3 VDC
Input Impedance (S1 to S2)	100K ohms
Vibration	0.5G max (0 – 50 Hz) 0.1G max (>50 Hz)
Ambient Temp. Range	10°C – 55°C
Weight	0.5 lb

Dimensions

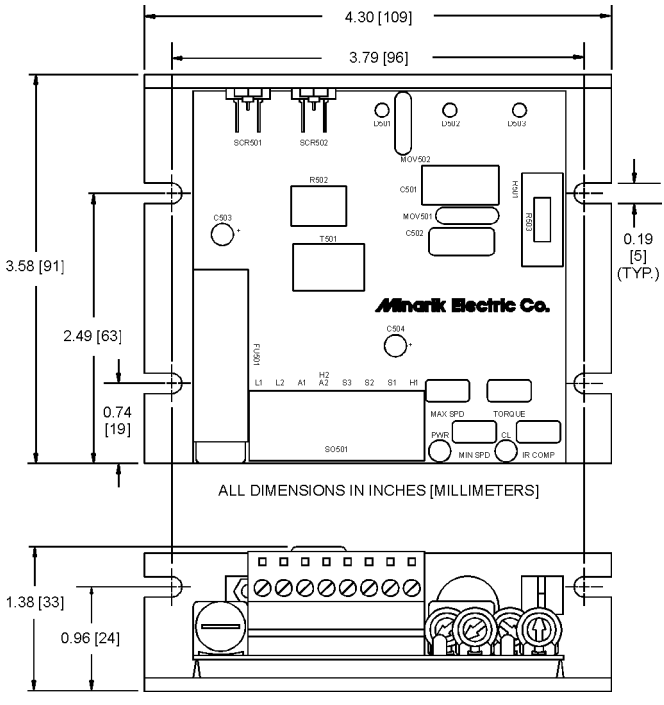


Figure 1. Dimensions

Installation

Mounting

Warning

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

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.

- Drive components are sensitive to electrostatic fields. Avoid direct contact with the circuit board. 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 heat sources. Operate the drive within the specified ambient operating temperature range.
- Prevent loose connections by avoiding excessive vibration of the drive.

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 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 (S1, S2, S3) 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 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 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.

Heat sinking

The MM31640A drives contain sufficient heat sinking in its basic configuration. No additional heat sinking is required.

Line fusing

The MM31640A comes with a single 3A line fuse preinstalled. The fuse size may be reduced to 1.5A if this control is used with motors smaller than 1/8 HP. Fuse kit 050-0066 (1 - 5A Fuse Kit) is available from Minarik. See *Replacement Parts* (page 39) for fuse kit contents.

Speed adjust potentiometer connections

Warning

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

Install the circular insulating disk between the mounting panel and the 10K ohm speed adjust potentiometer (see Figure 2). Mount the speed adjust potentiometer through a 0.38-inch (10 mm) hole with the hardware provided. Twist the speed adjust potentiometer wires to avoid picking up unwanted electrical noise.

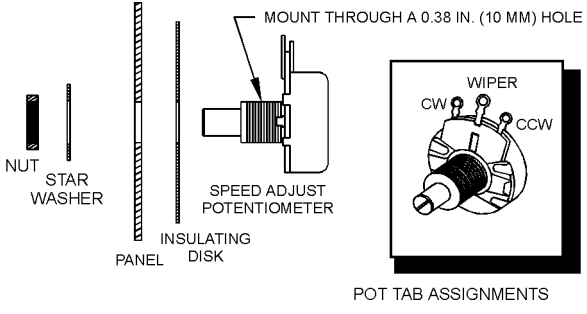


Figure 2. Speed Adjust Potentiometer Installation

Quick-connect terminal block

The quick-connect terminal block is composed of a header block and terminal plug. The removable terminal plug, Minarik part number 160-0098, connects to the header block as shown in Figure 3. To use the quick-connect terminal block:

1. Carefully pull the terminal plug from the header block.
2. With a small flat-head screwdriver, turn the terminal plug screw counterclockwise to open the wire clamp.
3. Insert stripped wire into the large opening in front of the plug.
4. Turn the terminal plug screw clockwise to clamp the wire.
5. Repeat steps 2–4 for each terminal until all connections are made.
6. Insert the plug into the header block until securely fastened.

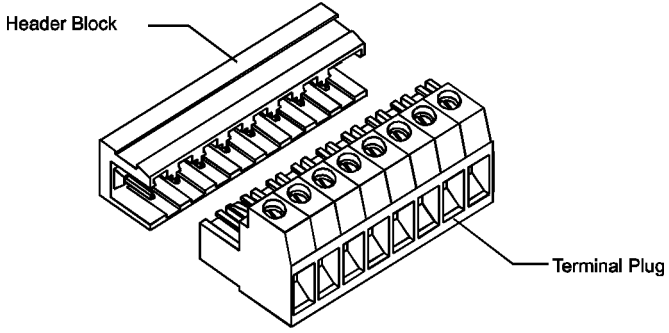


Figure 3. Quick-Connect Terminal Plug

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. The switch contacts should be rated at a minimum of 200% of motor nameplate current and 250 volts.

Connect the power input leads and DC motor to connector SO501 as shown in Figure 4 (page 10). Connect the speed adjust potentiometer and inhibit switch (if used) as shown in Figure 5 (page 11). Connect a voltage signal source (if used) as shown in Figure 6 (page 12).

Motor connections

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 with each other.

Connect a DC motor to SO501 terminals A1 and A2 as shown in Figure 4 (page 10). **Ensure that the motor voltage rating is consistent with the drive's output voltage.**

Power connections

Connect the AC line power leads to SO501 terminals L1 and L2, or to a double-throw, single-pole master power switch as shown in Figure 4 (recommended).

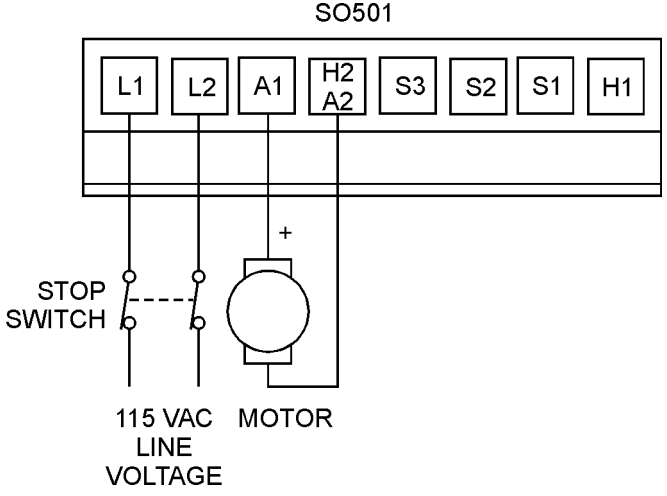


Figure 4. Power and Motor Connections

Signal and optional switch connections

Speed adjust potentiometer

Connect the speed adjust potentiometer to terminals S1, S2 and S3 of connector SO501 as shown in Figure 5. The CW terminal must be connected to S3.

Inhibit switch

Connect a single-pole, single-throw switch to the H1 and H2/A2 terminals of SO501 (Figure 5). Close the switch to coast the motor to minimum speed; open the switch to accelerate to set speed.

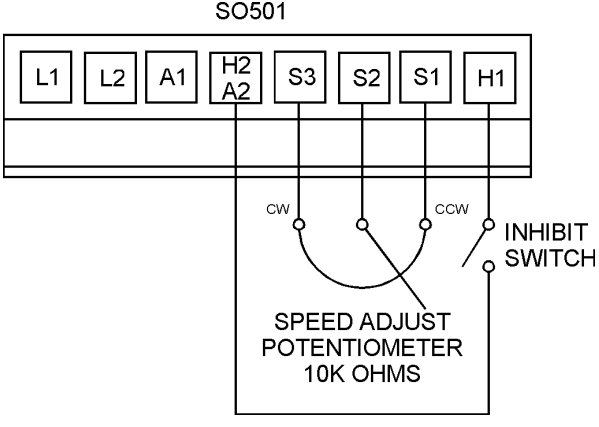


Figure 5. Signal and Optional Switch Connections

Voltage follower

Instead of using a speed adjust potentiometer, the drive may be wired to follow a 0 - 3 VDC analog input voltage signal that is isolated from earth ground (Figure 6). 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.

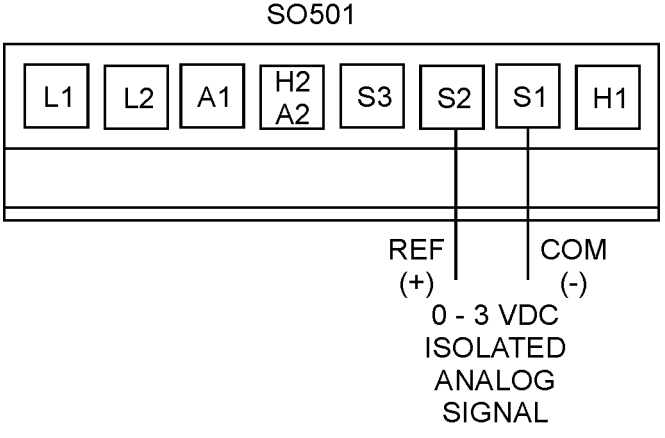


Figure 6. Voltage Follower Connections

Operation

Warning

Dangerous voltages exist on the drive when it is powered. BE ALERT. High voltages can cause serious or fatal injury.

Before applying power

- Verify that no conductive material is present on the printed circuit board.
- Verify that the AC supply is properly balanced.

Drive startup and shutdown

1. Set the reference signal or speed adjust potentiometer to minimum speed.
2. Ensure that the INHIBIT switch is set to the RUN (open) position.
2. Apply AC line voltage.
3. Slowly turn the speed adjust potentiometer or increase the reference signal until the desired speed is reached.

To shut down the drive:

To decelerate the motor from set speed to a stop, set the speed adjust potentiometer to zero speed. To coast the motor from set speed to a stop, remove AC line voltage from the drive or short SO501 terminals H1 and H2.

Reversing

Refer to ***Application Notes*** (page 25) for reversing options, or contact your Minarik sales representative.

Starting and Stopping Methods

Warning

For frequent starts and stops, use dynamic braking, inhibit mode, or decelerating to a stop (shorting S2 to S1). 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.

Minarik strongly recommends the installation of an emergency stop switch for chassis drives. The switch contacts should be rated at a minimum of 250 volts and 200% of maximum motor current.

Line starting and stopping

When AC line voltage is applied to the drive, the motor accelerates to the set speed. When AC line voltage is removed, the motor coasts to a stop. Line stopping (removing AC line voltage) is recommended for stopping in emergency situations only. It is not recommended for frequent starting and stopping.

Decelerating to minimum speed

The switch shown in Figure 7 may be used to decelerate a motor to a minimum speed. Closing the switch between S1 and S2 decelerates the motor from set speed to a minimum speed determined by the MIN SPD trimpot setting. If the MIN SPD trimpot is set full CCW, the motor decelerates to zero speed when the switch between S1 and S2 is closed. By opening the switch, the motor accelerates to set speed.

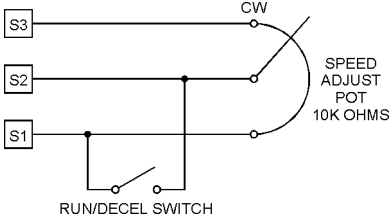


Figure 7. Run/Decelerate to Zero Speed Switch

Coast to minimum speed using INHIBIT terminals

Short the INHIBIT (H1 and H2/A2) terminals of terminal board SO501 to coast the motor to minimum speed (Figure 8). Reopen 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.

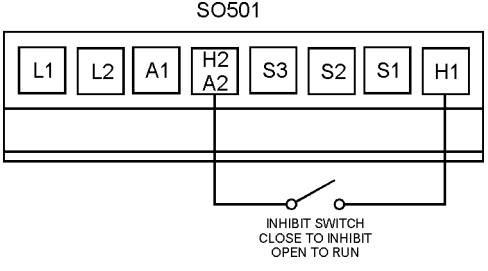


Figure 8. Run/Decelerate to Minimum Speed Switch

Dynamic braking

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.

NOTE: 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 resistor with 12 gauge wire.

Dynamic braking may be used to rapidly stop a motor (Figure 9, page 18). 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.

Table 1. Recommended Dynamic Brake Resistor Sizes

Motor Armature Current Rating	Minimum Dynamic Brake Resistor Value	Minimum Dynamic Brake Resistor Wattage
Less than 2 ADC	1 ohm	1W
2–3 ADC	5 ohm	5W

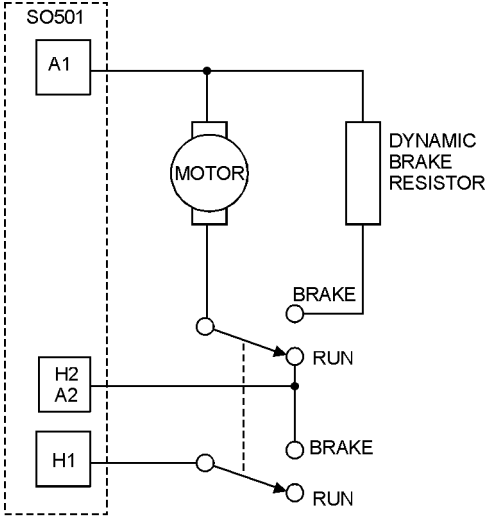


Figure 9. Dynamic Brake Connection

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.

The MM31640A drive has four user-adjustable trimpots. Each drive is factory calibrated to its maximum current rating. Readjust the calibration trimpot settings to accommodate lower current rated motors. See Figure 10 (page 20) for trimpot location.

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.

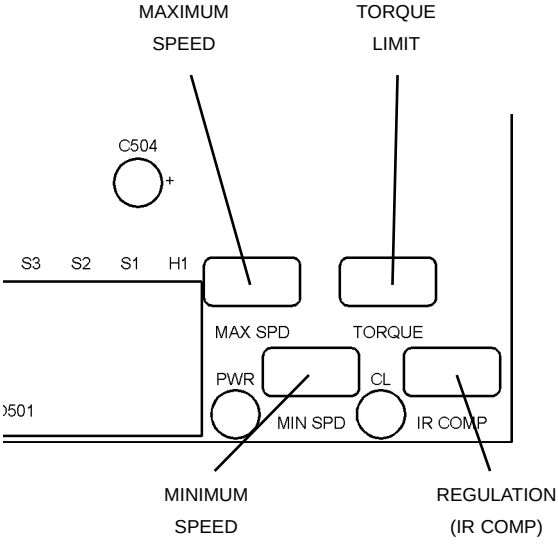


Figure 10. Calibration Trimpot Layout

Calibration procedure

Calibrate the drive using the following procedure:

1. Set the MIN SPD and MAX SPD trimpots to zero (full CCW).
2. Set the TORQUE trimpot to maximum (full CW).
3. Set the IR COMP trimpot to midrange (approximate 12 o'clock position).
4. Set the signal input (analog voltage signal or speed adjust potentiometer) to zero.
5. Apply power to the drive.
6. Calibrate the trimpots as follows:

MINIMUM SPEED (MIN SPD)

The MIN SPD setting determines the motor speed when the speed adjust potentiometer is turned full CCW. It is factory set for zero speed.

To calibrate, set the MIN SPD trimpot full CCW. Set the speed adjust potentiometer or reference signal to minimum. Adjust the MIN SPD trimpot until the desired minimum motor speed is reached.

MAXIMUM SPEED (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. Set the speed adjust potentiometer or reference voltage to maximum. Adjust the MAX SPD trimpot until the desired maximum motor speed is reached.

REGULATION (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.

To calibrate IR COMP (exact calibration):

1. Turn the IR COMP trimpot full CCW.
2. Set 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.

Approximate IR COMP calibration:

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 motor speed. See Figure 11 (page 24) for typical TORQUE and IR COMP settings.

TORQUE LIMIT (TORQUE)

> **Warning**
>
> Although TORQUE LIMIT is set to 120% of maximum drive current rating, continuous operation beyond that 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. TORQUE is factory set at 120% of maximum drive current. You must recalibrate the TORQUE setting if using a lower current motor. See Figure 11 (page 24) for typical TORQUE and IR COMP settings.

1. With no power applied to the drive, connect a DC ammeter in series with the motor armature.
2. Set the TORQUE trimpot to full CCW.
3. Carefully lock the motor armature. Ensure that the motor is firmly mounted.
4. Apply line power. The motor should be stopped.

5. Set the speed potentiometer or reference signal to maximum speed. The motor should remain stopped.
6. Slowly rotate the TORQUE trimpot clockwise (CW) until the ammeter reads 120% of maximum motor armature current.
7. Set the speed adjust potentiometer or reference signal to zero speed.
8. Remove power from the drive.
9. Remove the lock from the motor shaft.
10. Remove the ammeter in series with the motor armature.

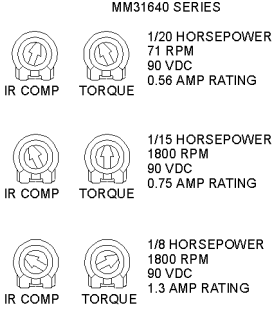


Figure 11. Typical IR COMP and TORQUE Settings (settings may vary by application)

Application Notes

Reversing with dynamic braking

A dynamic brake may be used when reversing the motor direction (Figure 12). 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.

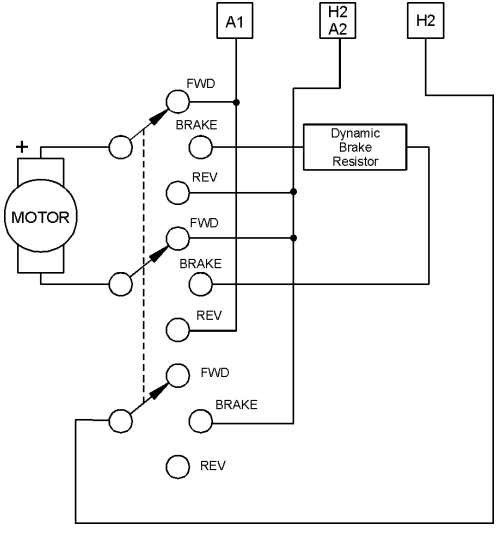
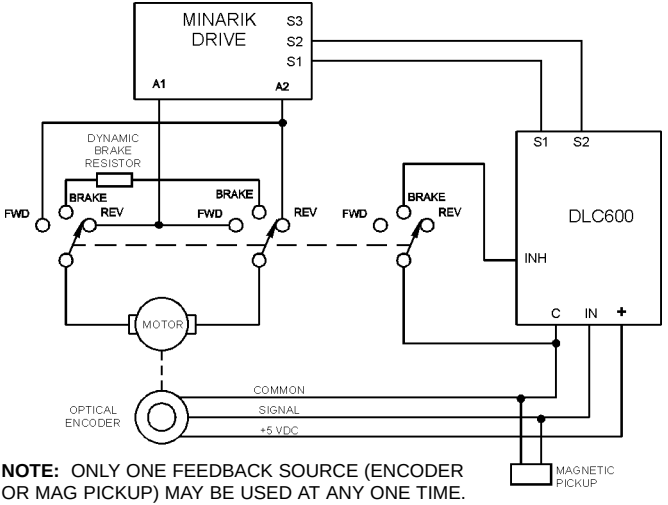


Figure 12. Reversing Circuit Connection

Reversing with a DLC600

DIGI-LOK® controller DLC600 can be used in a reversing application. The controller must be inhibited while braking. Without the inhibit feature, the controller will continue to regulate, causing overshoot when the DIGI-LOK is switched back to the drive.

Figure 13 shows the connection of the reversing circuit to an MM30000 series drive and a DLC600.



NOTE: ONLY ONE FEEDBACK SOURCE (ENCODER OR MAG PICKUP) MAY BE USED AT ANY ONE TIME.

Figure 13. Reversing with a DLC600

Independent Adjustable Speeds

Connect two speed adjust potentiometers, with a single pole two position switch to select between two independent speeds shown in the forward direction (Figure 14). The speed adjust potentiometers can be mounted at two separate operating stations.

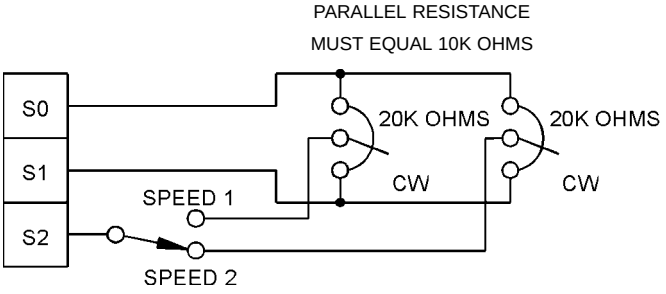


Figure 14. Independent Adjustable Speeds

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

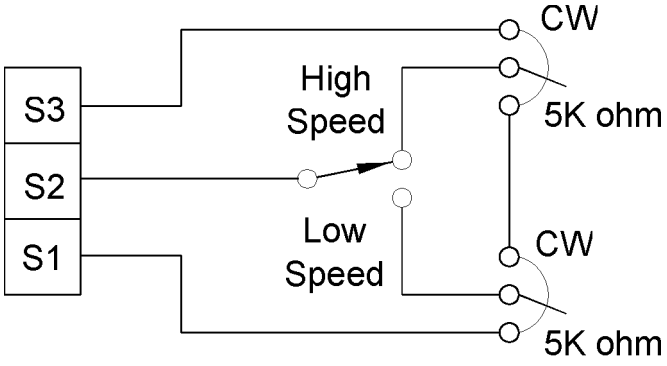


Figure 15. Adjustable Fixed Speeds Using Potentiometers in Series

Multiple fixed speeds

Replace the speed adjust potentiometer with series resistors with a total series resistance of 10K ohms (Figure 16). Add a single pole, multi-position switch with the correct number of positions for the desired number of fixed speeds.

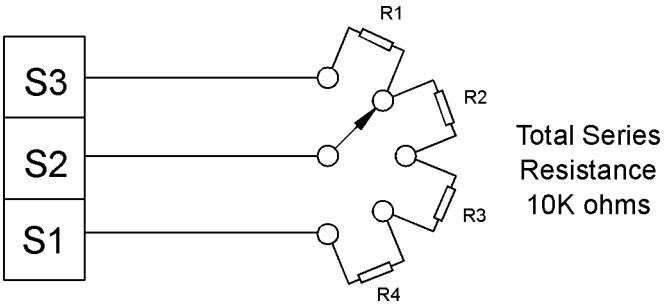


Figure 16. Multiple Fixed Speeds

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 17. When the RUN/JOG switch is set to JOG, the motor decelerates to minimum speed. Press the JOG pushbutton to jog the motor. Return the RUN/JOG switch to RUN for normal operation.

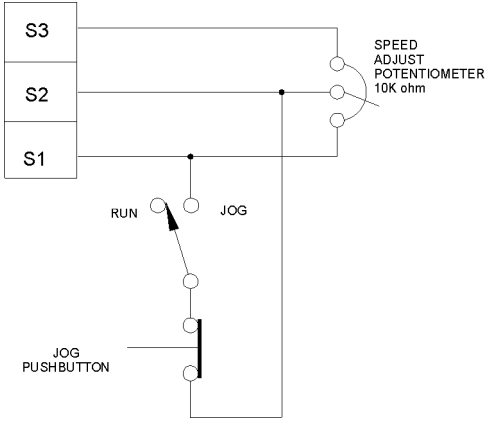


Figure 17. RUN/JOG Switch Connection to Speed Adjust Potentiometer

Leader-follower application

In this application, use a PCM4 to monitor the speed of the leader motor (Figure 18). 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.

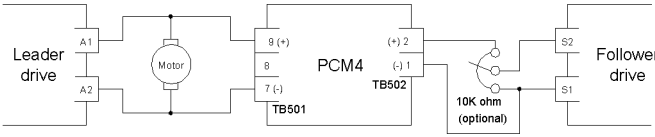


Figure 18. Leader-Follower Application

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 19). Optional ratio potentiometers can be used to scale the PCM4 output voltage, allowing independent control of each drive.

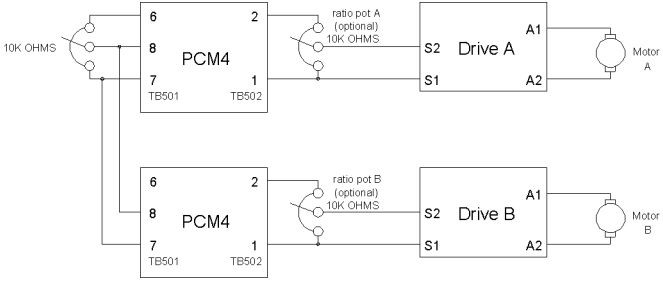


Figure 19. Single Speed Potentiometer Control of Multiple Drives

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:

- 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 drive's rated armature outputs are consistent with the motor ratings.

For additional assistance, contact your local Minarik distributor, or the factory direct:
(800) 646-2745 (phone) or (800) 394-6334 (fax).

Diagnostic LEDS

MM31640A-series drives have two diagnostic LEDs mounted on the printed circuit board (see Figure 20).

POWER (PWR)

The green POWER LED lights when AC line voltage is applied to the drive. It is extinguished when power is removed.

CURRENT LIMIT (CL)

The red CURRENT LIMIT LED lights when the drive's DC current output to the motor exceeds the limit set by the TORQUE trimpot. If this occurs, one or more of the following conditions may exist:

1. The TORQUE trimpot setting may be too low for the motor and load. Adjust the TORQUE setting as described starting on page 23. Under no circumstances may the TORQUE setting exceed 120% of maximum motor current.

2. The load is too great for the motor and/or drive. You may need to reduce the load, or install a motor or drive which has a greater current rating than the one currently in use.

3. The motor or related mechanical linkages may be jammed. Remove AC line voltage and carefully inspect the motor and load for incorrect alignment.

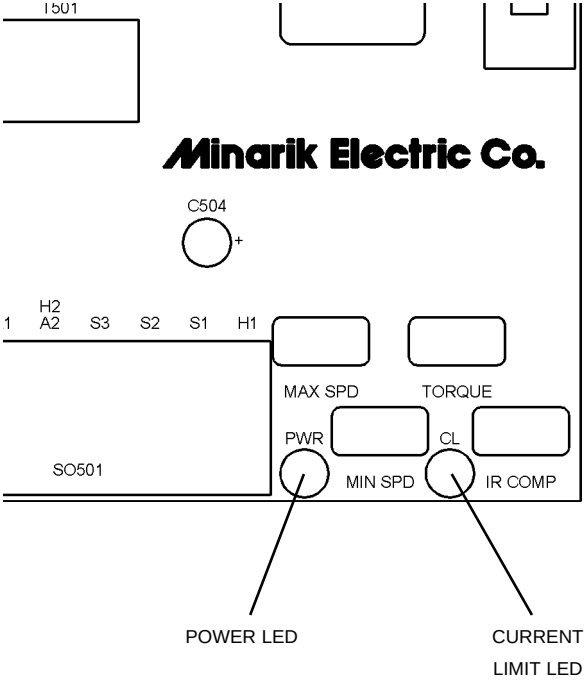


Figure 20. Diagnostic LED Locations

Symptom	Possible Causes	Suggested Solutions
Line fuse blows	1. Line fuses are the wrong size. 2. Motor cable or armature is shorted to ground. 3. Nuisance tripping caused by a combination of ambient conditions and high-current spikes.	1. Check that line fuses are the proper size. 2. Check motor cable and armature for shorts. 3. Add a blower to cool the drive components; decrease TORQUE settings, **or** resize motor and drive for actual load demand, **or** check for incorrectly aligned mechanical components or "jams". See page 23 for information on adjusting the TORQUE trimpot.
Line fuse does not blow, but the motor does not run	1. Speed adjust potentiometer or reference signal is set to zero speed. 2. Speed adjust potentiometer or reference signal connections are open.	1. Increase reference signal or speed adjust potentiometer setting. 2. Check that the reference signal or speed adjust potentiometer connections are not open.

Symptom	Possible Causes	Suggested Solutions
Line fuse does not blow, but the motor does not run (cont.)	3. Drive is overloaded. 4. Drive is not receiving AC line voltage. 5. Motor is not connected.	3. Verify that the motor is not jammed. Increase TORQUE setting (page 23). 4. Apply AC line voltage to L1 and L2. 5. Connect motor to A1 and A2.
Motor runs too fast at maximum speed setting	1. MIN SPD and MAX SPD settings are too high.	1. Recalibrate MIN SPD (page 21) and MAX SPD (page 22).
Motor runs too slow or too fast	MIN SPD and MAX SPD are not calibrated.	1. Recalibrate MIN SPD (page 21) and MAX SPD (page 22).
Motor will not reach the desired speed.	1. MAX SPD setting is too low. 2. IR COMP setting is too low. 3. Motor is overloaded.	1. Increase MAX SPD setting (page 22). 2. Increase IR COMP setting (page 22). 3. Check motor load. Resize the motor or drive if necessary.

Symptom	Possible Causes	Suggested Solutions
Motor pulsates or surges under load	1. IR COMP is set too high.	1. Adjust the IR COMP setting slightly CCW until the motor speed stabilizes (page 22).
	2. Control is in current limit mode.	2. Check that motor is of sufficient horsepower and amperage.

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
MM31640A	C503–504	22 uF, 25 VDC Capacitor	011-0046
	D501–503	1N5406 Diode	071-0007
	SCR501–502	S6008L3 High-power SCR	072-0024
	R501	0.1 Ohm, 5W Resistor	032-0014
	R502	5K Ohm, 5W Resistor	032-0088
		Chassis	222-0079
		10K Ohm Pot Kit	202-0003
202-0003 POTENTIOMETER KIT CONTENTS			
1 EA 10K OHM Potentiometer, 5W, 5% TOL			120-0009
1 EA 3/8-32 X 1/2 NUT			151-0007
1 EA 3/8IN INT TOOTH LOCK WSHR			152-0007
1 EA POT INSULATING WASHER			156-0022
1 -5A FUSE KIT CONTENTS (050-0066)			
2 EA 1 AMP 3AG FAST-ACTING FUSE			050-0042
2 EA 1-1/2 AMP 3AG FAST-ACTING			050-0026
2 EA 3 AMP 3AG FAST-ACTING FUSE			050-0021
2 EA 5 AMP 3AG FAST-ACTING FUSE			050-0022

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.

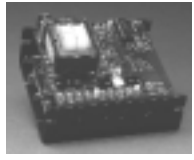
If for any reason any of the foregoing provisions shall be ineffective, the Corporation's liability for damages arising out of its manufacture or sale of equipment, or use thereof, whether such liability is based on warranty, contract, negligence, strict liability in tort, or otherwise, shall not in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

Other drives from Minarik Corporation:

NRGD Series

DLC600



MMRGD Series

BOSS Series

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