

# **USER'S MANUAL**

## **MM23000 Series**

SCR, Dual Voltage,  
Adjustable Speed Drives  
for DC Brush Motors


## **Model MM23021C**

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Printed in the United States of America.

## Safety Warnings

- This symbol  denotes an important safety tip or warning. Please read these sections carefully prior to performing any of the instructions contained in that section.
- Have a qualified electrical maintenance technician install, adjust, and service this equipment. Follow the National Electrical Code and all other applicable electrical and safety codes, including the provisions of the Occupational Safety and Health Act (OSHA) when installing equipment.
- Reduce the chance of an electrical fire, shock, or explosion by proper grounding, over current protection, thermal protection, and enclosure. Follow sound maintenance procedures.



**It is possible for a drive to run at full speed as a result of a component failure.** 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.** 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.

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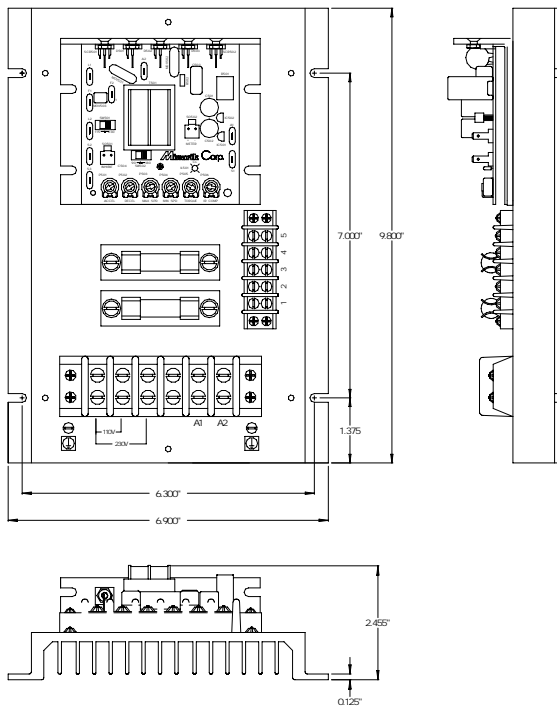
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# Specifications

<b>Model</b>	<b>Max. Armature Current (Amps DC)</b>	<b>Max HP with 115 VAC Applied</b>	<b>Max HP with 230 VAC Applied</b>	<b>Style</b>
<b>MM23021C</b>	18	1½	3	Chassis
<b>AC Line Voltage</b>	115 VAC or 230 VAC ±10%, 50/60 Hz, single phase			
<b>Armature Voltage (115 VAC Input)</b>	0–90 VDC			
<b>Armature Voltage (230 VAC Input)</b>	0–180 VDC			
<b>Form Factor</b>	1.37 at base speed			
<b>Analog Input Voltage Range (signal must be isolated)</b>	0 – 3.5 VDC			
<b>Field Voltage (115 VAC Input)</b>	50 VDC (F1 to L1); 100 VDC (F1 to F2)			
<b>Field Voltage (230 VAC Input)</b>	100 VDC (F1 to L1); 200 VDC (F1 to F2)			
<b>Max. Field Current</b>	1 ADC			
<b>Input Impedance (S1 to S2)</b>	100K ohms			
<b>Load Regulation</b>	1% base speed or better			
<b>Vibration</b>	0.5g max (0–50 Hz) 0.1g max (>50 Hz)			
<b>Safety Certification</b>	UL Recognized Component, file # E132235 CSA Certified Component, file # LR41380 CE Certificate of Compliance			
<b>Ambient Temp. Range (chassis drive)</b>	10°C–55°C			
<b>Weight</b>	1.5 lb.			

# Dimensions



ALL DIMENSIONS IN INCHES [MILLIMETERS]

**Figure 1. MM23021C Dimensions**



# Installation



## Mounting

- 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.
- Mount drive with its board in either a horizontal or vertical plane. Four 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.

## Heat sinking

The MM23021 has sufficient heat sinking in its basic configuration. No additional heat sinking is necessary.

## Field output

The field output is for shunt wound motors only. **Do not make any connections to F1 and F2 when using a permanent magnet motor.** See Table 1 for field output connections.

**Table 1. Field Output Connections**

<b>Line Voltage (VAC)</b>	<b>Approximate Field Voltage (VDC)</b>	<b>Connect Motor Field To</b>
115	50	F1 and L1
115	100	F1 and F2
230	100	F1 and L1
230	200	F1 and F2

Use 18 AWG wire to connect the field output to a shunt wound motor.

## Connections

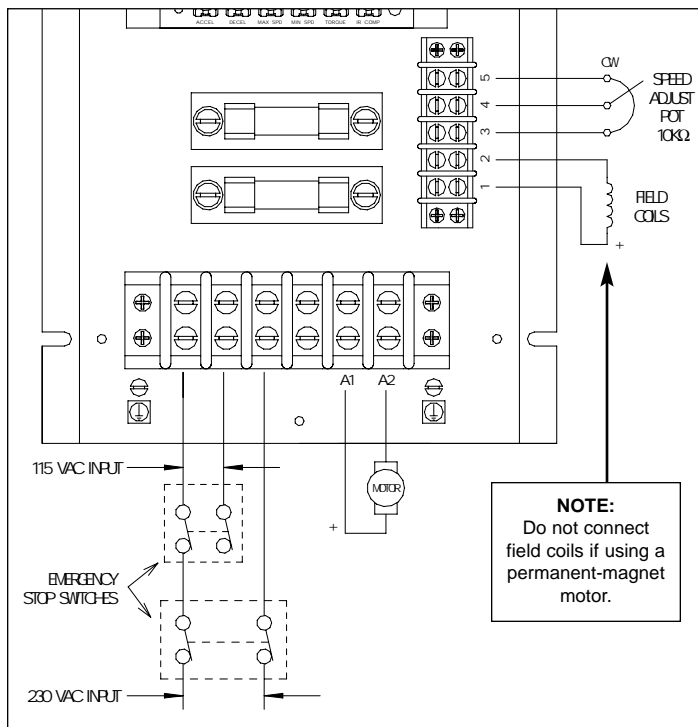


Figure 2. Chassis Drive Connections to Heat Sink Terminal Boards

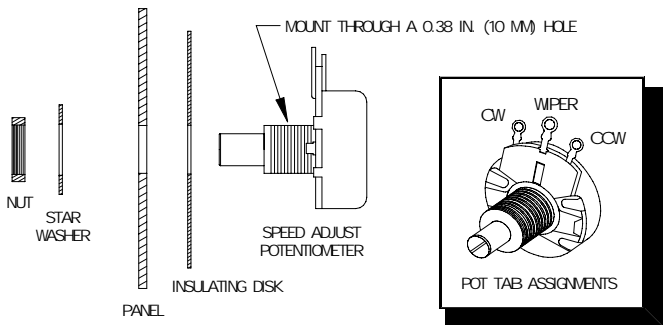
## Speed adjust potentiometer installation



### 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 panel and the 10K ohm speed adjust potentiometer. Mount the speed adjust potentiometer through a 0.38 inch (10 mm) hole with the hardware provided (Figure 3). Twist the speed adjust potentiometer wire to avoid picking up unwanted electrical noise. If potentiometer leads are longer than 18 inch (457 mm), use shielded cable.



**Figure 3. Speed Adjust Potentiometer**

## Shielding guidelines



### Warning

Under no circumstances should power and logic leads be bundled together. Induced voltage can cause unpredictable behavior 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 level leads is not practical, the user should twist all logic leads with themselves to minimize induced noise.

It may be necessary to earth ground the shielded cable. If noise is produced by devices other than the drive, ground the shield at the drive end. If noise is generated by a device on the drive, ground the shield at the end away from the drive. Do not ground both ends of the shield.

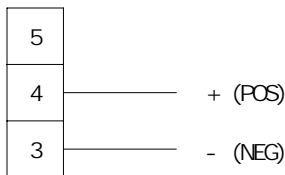
If the drive continues to pick up noise after grounding the shield, it may be necessary to add AC line filtering devices, or to mount the drive in a less noisy environment.

Logic wires from other input devices, such as motion controllers and PLL velocity controllers, must be separated from power lines in the same manner as the logic I/O on this drive.

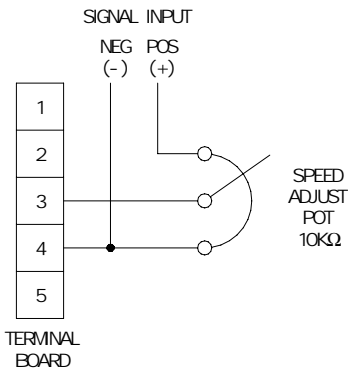
## Voltage follower

Instead of using a speed adjust potentiometer, the drive may be wired to follow an analog input voltage signal (0 – 3.5 VDC) that is isolated from earth ground (Figure 4). Connect the signal input (+) to terminal 4. Connect the signal common (–) to terminal 3. Make no connection to 5.

If the maximum signal is greater than 3.5V, use the speed adjust pot as a trimmer. See Figure 5 for connections. With the signal at maximum, use the speed adjust pot to set the motor to the desired maximum speed. It is advised that the speed adjust pot be secured to preclude inadvertent tampering with this important setting.



**Figure 4. Voltage Follower Connections**



**Figure 5. Voltage Follower Connections With Signal Greater than 3.5VDC**

# Operation



## Warning

Change voltage switch settings only when the drive is disconnected from AC line voltage. Make sure both switches are set to their correct position. If the switches are improperly set to a lower voltage position, the motor will not run at full voltage and may cause damage to the transformer. If the switches are improperly set to a higher voltage position, the motor will overspeed, which may cause motor damage.

## Before applying power

- Set voltage switch SW501 to either 115V or 230V to match the AC line voltage. Set voltage switch SW502 to either 90V or 180V to match the maximum armature voltage (see Figure 6).

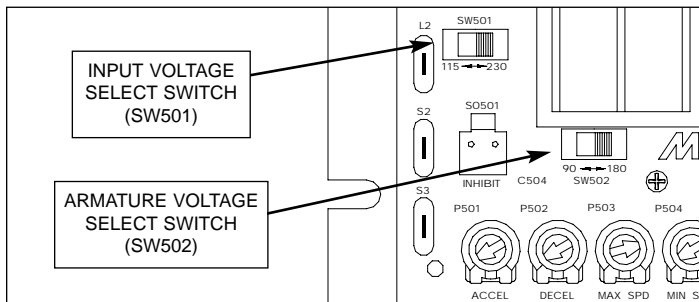


Figure 6. Voltage Switches

## 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.

## 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.

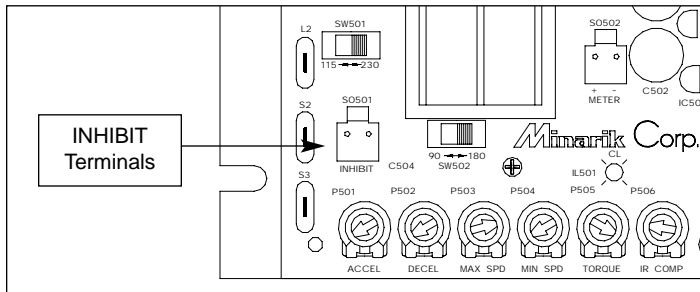


## Inhibit terminals

Short the INHIBIT terminals to coast the motor to minimum speed (see Figure 7 for INHIBIT terminal location). Reopen the INHIBIT terminals to accelerate the motor to set speed.

Twist inhibit wires and separate them from other 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.

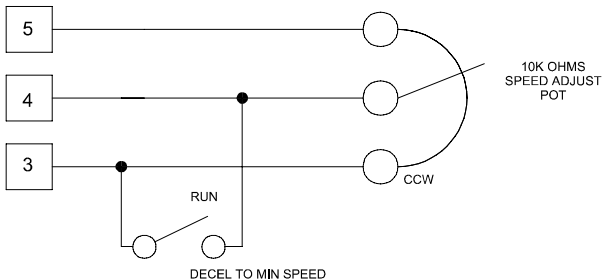
Minarik Corporation offers two accessory plug harnesses for connecting to the INHIBIT terminals: part number 201-0024 [inhibit plug with 18 inches (46 cm) leads]; and part number 201-0079 [inhibit plug with 36 inches (91 cm) leads].



**Figure 7. INHIBIT Terminals**

## Decelerating to minimum speed

The switch shown in Figure 8 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. The DECEL trimpot setting determines the rate at which the drive decelerates. By opening the switch, the motor accelerates to set speed at a rate determined by the ACCEL trimpot setting.



**Figure 8. Run/Decelerate to Minimum Speed Switch**

## Dynamic braking



### Warning

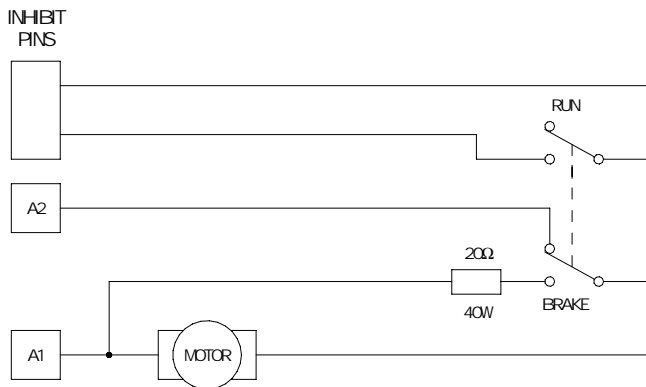
For frequent starts and stops, short the inhibit terminals, decelerate to a minimum speed, or apply a dynamic brake to the motor. Do not use any of these methods for emergency stopping. They may not stop a drive that is malfunctioning.

**Removing 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 garmotors that are not properly sized for the application.

Dynamic braking may be used to rapidly stop a motor (Figure 9). For the RUN/BRAKE switch, use a two pole, two position switch rated for at least 15 amps at 180 VDC. For the dynamic brake resistor, use a 40 watt minimum, high-power, wire-wound 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.



**Figure 9. Dynamic Brake Connections**

# Calibration

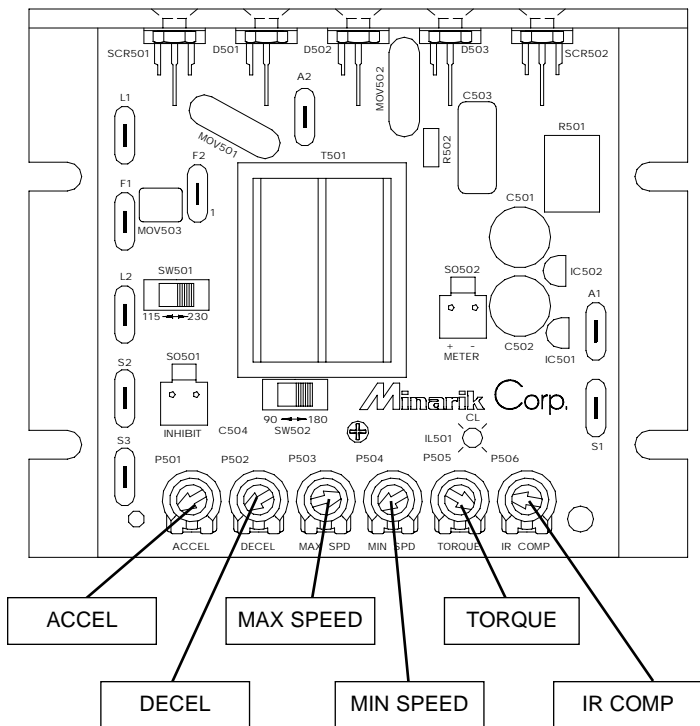


## Warning

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.

MM23000 Series drives have six user adjustable trimpots: MIN SPD, MAX SPD, TORQUE, IR COMP, ACCEL, and DECEL. Refer to Figure 10, page 16 for trimpot layouts. Each drive is factory calibrated to its maximum current rating. Readjust the calibration trimpot settings to accommodate lower current rated motors.

All trimpot settings increase with clockwise (CW) rotation, and decrease with counterclockwise (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 setting determines the motor speed when the speed adjust potentiometer is turned full CCW. It is factory set to zero speed.

To calibrate, turn the speed adjust potentiometer full CCW. Adjust the MIN SPD trimpot until the motor has stopped (for zero speed setting), or is running at the desired minimum speed.

## **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. Turn the speed adjust potentiometer full CW. Adjust the MAX SPD trimpot until the desired maximum motor 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

Although TORQUE LIMIT is set to 120% of drive 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 11, page 22, 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 120% 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.

To calibrate IR COMP refer to the recommended IR COMP settings in Figure 11, page 22, or use the following procedure:

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 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.

## **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 slower acceleration time, or CCW for a faster 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.

## 90 VDC MOTORS

1 HP  
1800 RPM  
10 AMPS



TQ



IR COMP

3/4 HP  
1800 RPM  
7.5 AMPS



TQ



IR COMP

## 180 VDC MOTORS

3 HP  
1800 RPM  
14 AMPS



TQ



IR COMP

1 1/2 HP  
1800 RPM  
7.5 AMPS



TQ



IR COMP

2 HP  
1800 RPM  
10 AMPS



TQ



IR COMP

1 HP  
1800 RPM  
5 AMPS



TQ



IR COMP

**Figure 11. Typical TORQUE and IR COMP Settings**

# Application Notes

## Multiple fixed speeds

Replace the speed adjust potentiometer with series resistors with a total series resistance of 10K ohms (Figure 12). Add a single pole, multi-position switch with the correct number of positions for the desired number of fixed speeds.

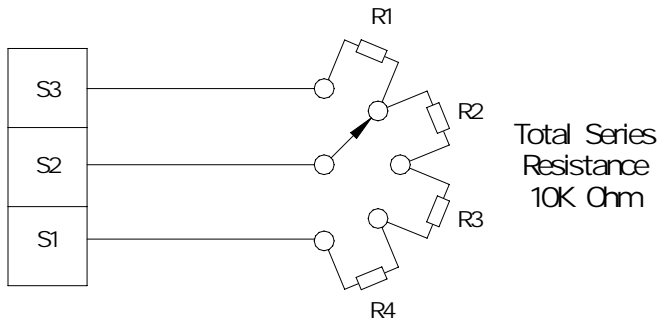
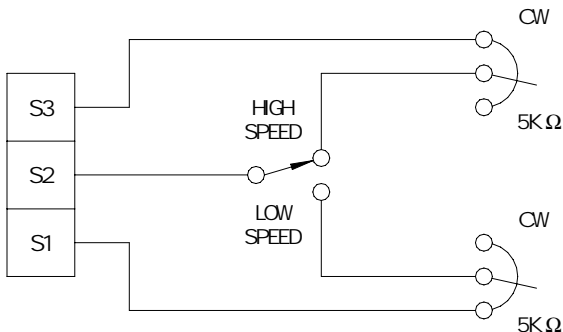


Figure 12. Multiple Fixed Speeds

## Adjustable speeds using potentiometers in series

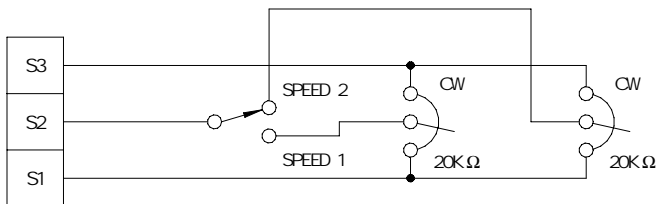
Replace the speed adjust potentiometer with a single pole, multi-position switch, and two or more potentiometers in series, with a total series resistance of 10K ohms. Figure 13 shows a connection for high and low speed adjust potentiometers.



**Figure 13. 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 14 shows the connection of two independent speed adjust potentiometers that can be mounted at two separate operating stations.



**Figure 14. Independent Adjustable Speeds**

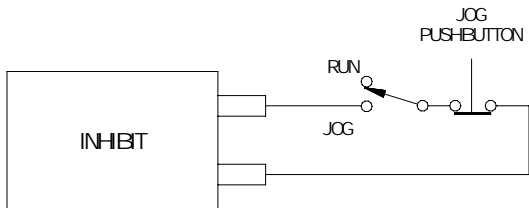
## **RUN/JOG switch**

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.

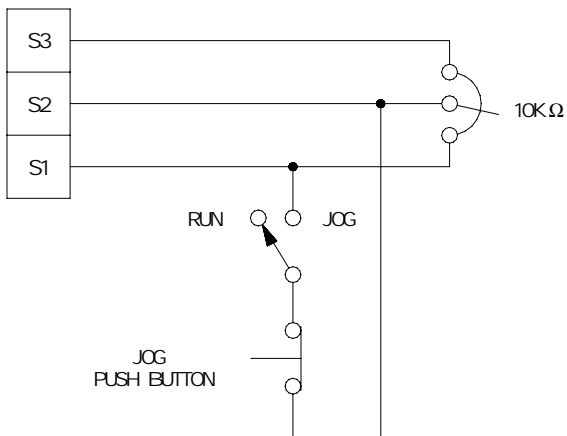
In the first wiring option, connect the RUN/JOG switch and JOG pushbutton to the inhibit plug as shown in Figure 15. The motor coasts to a stop when the RUN/JOG switch is set to JOG. Press the JOG pushbutton to jog the motor. Return the RUN/JOG switch to RUN for normal operation.

In the second wiring option, connect the RUN/JOG switch and the JOG pushbutton as shown in the Figure 16. 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.





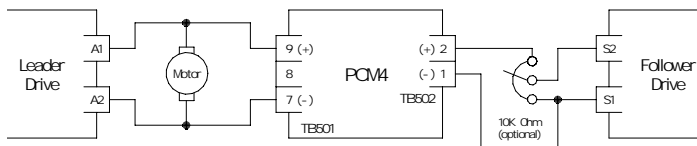
**Figure 15. RUN/JOG Switch Connection to Inhibit Plug**



**Figure 16. RUN/JOG Switch Connection to Speed Adjust Potentiometer**

## Leader-follower application

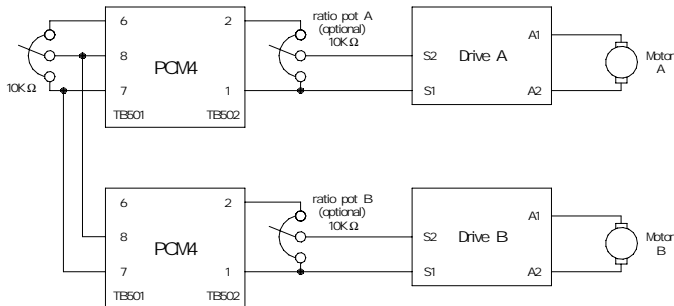
In this application, use a PCM4 to monitor the speed of the leader motor (Figure 17). The PCM4 isolates the leader motor from the follower drive, and outputs a voltage proportional to the leader motor armature voltage. The follower drive uses this voltage reference to set the speed of the follower motor. An optional ratio potentiometer may be used to scale the PCM4 output voltage.



**Figure 17. Leader-Follower Application**

## Single speed potentiometer control of multiple drives

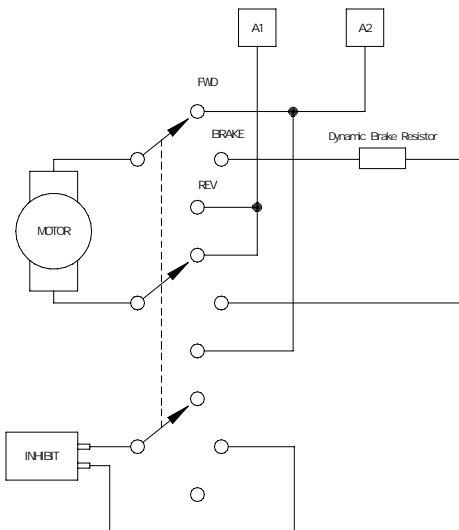
Multiple drives can be controlled with a single speed adjust potentiometer using a PCM4 at the input of each drive to provide isolation (Figure 18). Optional ratio potentiometers can be used to scale the PCM4 output voltage, allowing independent control of each drive.



**Figure 18. Single Speed Potentiometer Control of Multiple Drives**

## Reversing

A dynamic brake may be used when reversing the motor direction (Figure 19). 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 13, for recommended dynamic brake resistor sizes.



**Figure 19. Reversing Circuit Connection**

## Reversing with a DIGI-LOK<sup>®</sup> controller, model DLC600

A DIGI-LOK<sup>®</sup> controller, model DLC600 can be used in a reversing application. The DIGI-LOK<sup>®</sup> must be inhibited while braking. Without the inhibit feature, the DIGI-LOK<sup>®</sup> will continue to regulate. This will cause overshoot when the DIGI-LOK<sup>®</sup> is switched back to the drive. Figure 20 shows the connection of the reversing circuit to a MM23000 series drive and to a DLC600. **Note:** Only one DLC option (Optical Encoder or Magnetic Pickup) may be used at a time.

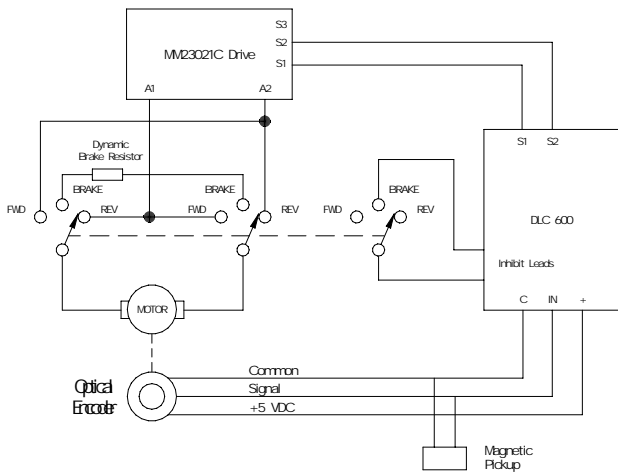


Figure 20. Reversing with a DLC600

# 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 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 voltage selection switch settings match the AC line and output voltages.
7. Check that the drive's rated armature and field outputs are consistent with the motor ratings.

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

(800) MINARIK (phone) or (800) 394-6334 (fax).

<b>Problem</b>	<b>Possible Causes</b>	<b>Suggested Solutions</b>
Line fuse blows.	<ol style="list-style-type: none"><li data-bbox="387 228 648 277">1. Line fuse is the wrong size.</li><li data-bbox="387 336 648 385">2. Motor cable or armature is shorted to ground.</li><li data-bbox="387 418 648 544">3. Nuisance tripping caused by a combination of ambient conditions and high-current spikes (i.e. reversing).</li></ol>	<ol style="list-style-type: none"><li data-bbox="685 228 935 303">1. Check that the line fuse is correct for the motor size.</li><li data-bbox="685 336 935 385">2. Check motor cable and armature for shorts.</li><li data-bbox="685 418 935 650">3. Add a blower to cool the drive components; decrease TORQUE settings, <b>or</b> resize motor and drive for actual load demand, <b>or</b> check for incorrectly aligned mechanical components or “jams”.</li></ol>

<b>Problem</b>	<b>Possible Causes</b>	<b>Suggested Solutions</b>
Line fuse does not blow, but the motor does not run.	<ol style="list-style-type: none"><li>1. Speed adjust pot or reference voltage is set to zero speed.</li><li>2. INHIBIT terminals are jumpered.</li><li>3. S2 is shorted to S1.</li><li>4. Drive is in current limit.</li><li>5. Drive is not receiving AC line voltage.</li><li>6. Motor is not connected.</li></ol>	<ol style="list-style-type: none"><li>1. Increase the speed adjust potentiometer setting or reference voltage.</li><li>2. Remove jumper from the INHIBIT terminals.</li><li>3. Remove short.</li><li>4. Verify that motor is not jammed. Increase TORQUE setting if they are set too low.</li><li>5. Apply AC line voltage to L1 and L2.</li><li>6. Connect motor to A1 and A2.</li></ol>
Motor does not stop when the speed adjust potentiometer is full CCW.	MIN SPD setting is too high.	Calibrate MIN SPD.
Motor runs in the opposite direction (non-reversing drives).	Motor connections to A1 and A2 are reversed.	Reverse connections to A1 and A2.



<b>Problem</b>	<b>Possible Causes</b>	<b>Suggested Solutions</b>
Motor runs too fast.	<ol style="list-style-type: none"><li>1. MAX SPD and MIN SPD are set too high.</li><li>2. Motor field connections are loose (shunt wound motors only).</li></ol>	<ol style="list-style-type: none"><li>1. Calibrate MAX SPD and MIN SPD.</li><li>2. Check motor field connections.</li></ol>
Motor will not reach the desired speed.	<ol style="list-style-type: none"><li>1. MAX SPD setting is too low.</li><li>2. IR COMP setting is too low.</li><li>3. TORQUE setting is too low.</li><li>4. Motor is overloaded.</li></ol>	<ol style="list-style-type: none"><li>1. Increase MAX SPD setting.</li><li>2. Increase IR COMP setting.</li><li>3. Increase TORQUE setting.</li><li>4. Check motor load. Resize the motor if necessary.</li></ol>
Motor pulsates or surges under load.	<ol style="list-style-type: none"><li>1. IR COMP is set too high.</li><li>2. Motor bouncing in and out of current limit.</li></ol>	<ol style="list-style-type: none"><li>1. Adjust the IR COMP setting slightly CCW until the motor speed stabilizes.</li><li>2. Make sure motor is not undersized for load; adjust TORQUE trimpot CW.</li></ol>

# CE Compliance

Minarik Corporation hereby certifies that its MM23000C series drives have been approved to bear the “CE” mark provided the conditions of approval have been met by the end user.

The MM23000C series has been tested to the following specifications:

**EN55011:1991 (emissions), and  
EN50082-1:1992 (immunity)**

Compliance allows Minarik’s MM23000C series to bear the CE mark.

The end user, as described herein, falls into one of two categories:

1. The Consumer will deploy a stand-alone unit as an integral, yet external, portion of the machine being operated.
2. The Original Equipment Manufacturer (OEM) will implement the product as a component of the machine being manufactured.

In addition to EMI/RFI safeguards inherent in the MM23000C series’ design, external filtering is required.

## Line filters

Minarik requires the Corcom<sup>®</sup> line filters listed below.

**Table 2. Corcom<sup>®</sup> Filters**

<b>Nameplate Current of Motor Wired to the Drive</b>	<b>Corcom<sup>®</sup> Filter Part Number</b>
0 to 4 amps	6VV1
4.1 to 13 amps	20VV1

If the exact line filter is not available, the specifications are as follows:

L = 1.8 milliHenries.

C = 0.01 microFarads (line-to-ground); 1.1 microFarads (line-to-line).

R = 330Kohms.

Rated current: 1.4 times maximum DC motor current.

Filter type: Balanced 2-section.

The line filters should be wired to the AC line within 0.25 meters of the drive. The ground connection from the line filter must be wired to solid earth ground (resistance less than 500 ohms); not machine ground. This is very important!

If the end-user is using a CE-approved motor, the correct line filter listed above is all that is necessary to meet the EMC directives listed herein.

## Armature filters

If the end-user is not using a CE-approved motor, a second filter, part no. CE<sub>XX</sub>MM, must be used on the armature. XX = rated current of the filter. Minarik Filters are listed below.

**Table 3. Minarik Filters**

<b>Nameplate Current of Motor Wired to the Drive</b>	<b>Minarik Filter Part Number</b>
0 to 4 amps	CE4MM
4.1 to 13 amps	CE20MM

The filters listed above are Real-Pole Balanced-Pi 3-pole filters. If the exact filter is not available, the specifications are as follows:

$L \ \& \ L1 = 2 \times (0.8)$  milliHenries.

$C \ \& \ C1 = 2 \times (0.1)$  microFarads @ 400W VDC.

$R_{in} = 0.1$  ohm;  $R_{out} = 1.2$  ohm.

The filters listed above must be wired to the DC output of the drive, as close to the drive as possible.

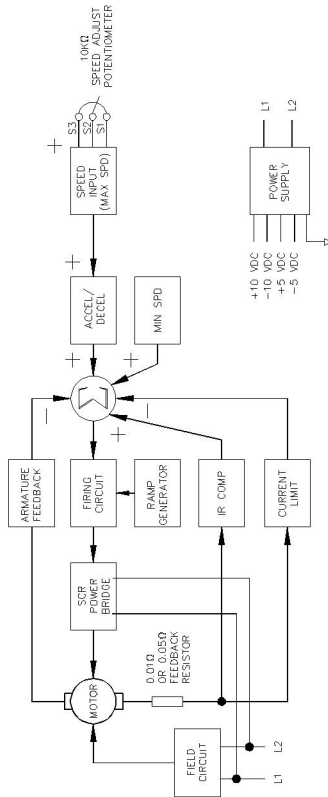
The end user must use the filters listed in this section to comply with CE. The OEM may choose to provide alternative filtering that encompasses the Minarik drive and other electronics within the same panel.

The OEM has this liberty because CE is a machinery directive. Whether or not every component in the OEM's machinery meets CE, the OEM must still submit his machine for CE approval.

Thus, no component must necessarily meet CE within the machine, as long as the OEM takes the necessary steps to guarantee the machine does meet CE. By the same token, even if every component in the OEM's machine does meet CE, the machine will not necessarily meet CE as a machine.

Using CE-approved wiring practices (like proper shielding) and the filters listed in this section help the drive meet EN55011 (1991 emissions standard) and EN50082-1 (1992 immunity standard).

# Functional Diagrams



**Figure 21. MM23000 Series Block Diagram**

# Replacement Parts

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

**Table 3. Replacement Parts**

<b>Model No.</b>	<b>Symbol</b>	<b>Description</b>	<b>Minarik P/N</b>
<b>MM23021C</b>	SCR501, 502	S8025L SCR	072-0042
	D501-503	800 V, 20 A Diode	071-0041
	R501	0.01 $\Omega$ , 5 W Resistor	032-0129
	T501	3FD-224-001 Transformer	230-0083
		10K $\Omega$ potentiometer kit	202-0031

## 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 breach of warranty contained in Paragraph A, or of any other warranties, express or implied, or claim of liability that might, despite Paragraph B, be decided against the Corporation by lawful authority, the Corporation shall under no circumstances be liable for any consequential damages, losses, or expense arising in connection with the use of, or inability to use, the Corporation's product for any purpose whatsoever.

An adjustment made under warranty does not void the warranty, nor does it imply an extension of the original 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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