

# MAC Series

Models:

**MAC03-115AC**

**MAC06-115AC**

**MAC03-D240AC**

**MAC06-D240AC**



**Variable-frequency drives for 3-phase AC motors**

**Minarik** Automation  
& Control

**USER'S MANUAL**





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# 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.
- 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. **DO NOT INSTALL, REMOVE, OR REWIRE THIS EQUIPMENT WITH POWER APPLIED.**
-  • 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 AC 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.

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## General Information

The Minarik AC (MAC) Series are solid-state, microprocessor-based, variable-frequency AC motor drives. With a 120 or 240 VAC, 50/60 Hz, single-phase input, MAC drives are factory calibrated for an output of 0 to 60 Hz\*. They will operate any 1 HP or smaller, 115- or 208/230-volt†, three-phase AC induction motor through a speed range of zero\* through nameplate speed. They can be user calibrated for 0 through 400 Hz output.

Although MAC inverters can operate over a 100:1 speed range, most motors will operate over a 10:1 speed range with constant torque at 0\* to 60 Hz and constant horsepower above 60 Hz. (Inverter-duty motors may operate satisfactorily over a 20:1 speed range, while vector-duty motors may operate satisfactorily over a 30:1 speed range.) Some motors can be satisfactorily operated at speeds as low as 100 rpm (speed range 25:1). Below 100 rpm, some motors may show signs of “stepping” or “cogging”, or they may run warmer.



*\*Actual minimum frequency will depend on motor type and the load to which it is connected.*

*†Motor voltage should be matched to the nominal AC line voltage (e.g., 208VAC motor for 208VAC nominal input; 115VAC motor for 115VAC nominal input).*



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MAC Series drives feature solid-state reversing with adjustable acceleration and deceleration. They also feature adjustable current limit and I<sup>2</sup>T class 10 current trip to protect the motor, the control and the driven machine from damage caused by motor overload or machine jamming. The MAC may also interface with motor thermal protection through the enable circuit.

-  The MAC is very efficient when the two (2) torque boost settings are properly adjusted; the accel torque boost is applied only during acceleration. Other drives, with only one torque boost setting, can cause motor overheating by applying too much during steady-state operating conditions.
  
-  Caution should be taken when operating fan-cooled motors at low speeds because their fans may not move sufficient air to properly cool the motor. Minarik recommends “inverter-duty” motors when the speed range is beyond 6:1.

## MAC Series Features

- **Microprocessor-based**
- **Solid-state circuitry**
- **Adjustable minimum and maximum speed**
- **Adjustable acceleration and deceleration**
- **Solid-state reversing**
- **Adjustable current limit**
- **I<sup>2</sup>T current trip (class 10)**
- **Adjustable torque power boost during acceleration**
- **Adjustable voltage boost at low speeds**
- **Adjustable slip compensation**
- **Multiple motor operation**

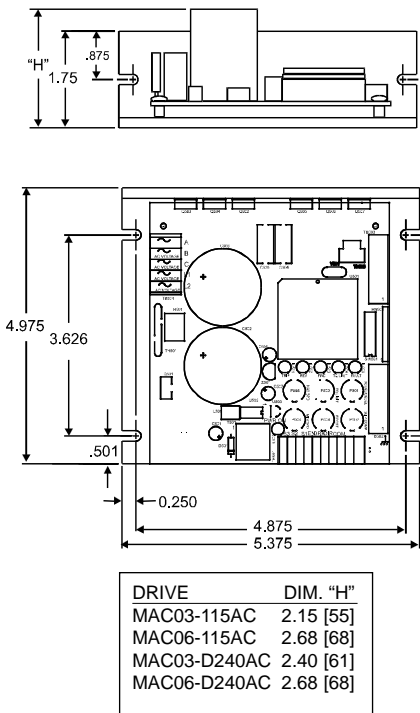
# Specifications

<b>Drive</b>	<b>Peak Phase Current (ADC)</b>	<b>HP Range with 115 VAC Applied</b>	<b>HP Range with 240 VAC Applied</b>
<b>MAC03-115AC</b>	3	1/15–1/4	NA
<b>MAC06-115AC</b>	6†	1/6–1/2	NA
<b>MAC03-D240AC</b>	3	1/15–1/4	1/6 – 1/2
<b>MAC06-D240AC</b>	6†	1/6–1/2	1/2 – 1
† Requires Minarik heat sink kit p/n 223-0269 when ambient temperature is greater than 25° C			
<b>AC Voltage Input Range</b>			
<b>MACxx-115AC drives</b>	120VAC ± 10%, 50/60 Hz single phase		
<b>MACxx-D240AC drives</b>	120/240VAC ± 10%, 50/60 Hz single phase		
<b>Output Frequency Range</b>			3 – 400 Hz
<b>Minimum Output Frequency Range</b>			0–11 Hz
<b>Maximum Output Frequency Range (60 Hz output)</b>			40–400 Hz
<b>Acceleration Time Range (no load)</b>			0.5 – 10 seconds
<b>Deceleration Time Range (no load)</b>			0.5 – 10 seconds
<b>Analog Input Voltage Range (isolated; S1 (-) to S2 (+))</b>			0 – 10 VDC
<b>Input Impedance</b>			~ 50KΩ
<b>Slip Compensation</b>			better than 1%
<b>Vibration</b>			0.5G max (20–50 Hz) 0.1G max (>50 Hz)
<b>Weight</b>			1.2 lb
<b>Ambient Operating Temperature Range</b>			10 – 40°C††

††MAC06-D240AC is rated at 3 amps continuous AC @ 25° C ambient without heat sink. Derate to 2 amps above 25° C, or use heat sink kit p/n 223-0269.



# Dimensions



ALL DIMENSIONS IN INCHES [MILLIMETERS]

**Figure 1. Dimensions**



# Installation



SHOCK  
HAZARD



AVOID  
HEAT



KEEP  
DRY



AVOID  
VIBRATION

## Mounting



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

- 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. Six 0.19 in. (5 mm) wide slots in the chassis accept #8 pan head screws. Fasten either the large base or the narrow flange of the chassis to the subplate.



- The chassis must be earth grounded. Use a star washer beneath the head of at least one of the mounting screws to penetrate the anodized chassis surface and to reach bare metal.

## Wiring

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



### Warning

**This drive is isolated from earth ground.** 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. Use a non-metallic screwdriver for the calibration trimpots.

**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.

## Shielding guidelines


As a general rule, Minarik recommends shielding of all conductors if:


- 1) wire lengths exceed 6 inches for PWM drives or 18 inches for SCR drives, with separation of power and logic leads;
- 2) wire lengths exceed 4 inches and power and logic leads must be bundled together\*;



3) radiated and/or conducted noise must be minimized due to concerns about immunity or general compliance (CE, FCC, etc.)

\*Minarik considers this an unfavorable condition and does not recommend bundling of power and logic leads for any length.

 If it is not practical to shield power conductors, Minarik recommends shielding all logic-level leads. If shielding is not practical, the user should twist all logic leads with themselves to minimize induced noise.

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

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.

## Fusing

MAC series drives require external AC power line fuses. Connect the external line fuse(s) in series with the AC voltage input. See Connections on page 9. Use fast-acting fuses rated for 250 VAC or higher, and approximately 150% of the maximum armature current.

## Heat sinking

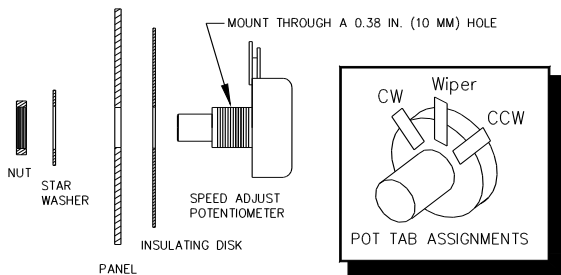
MAC06-series drives require an additional heat sink (Minarik® part number 223-0269) when the continuous phase current is above 5 amps. All other MAC series drives have sufficient heat sinking in their basic configuration. Use a thermally conductive heat sink compound (such as Dow Corning® 340 Heat Sink Compound) between the drive chassis and heat sink surface for optimum heat transfer.

## Speed adjust potentiometer

Mount the speed adjust potentiometer through a 0.38 in. (10 mm) hole with the hardware provided (Figure 2). Install the circular insulating disk between the panel and the 10K ohm speed adjust potentiometer. Twist the speed adjust potentiometer wire to avoid picking up unwanted electrical noise. If speed adjust potentiometer wires are longer than 18 in. (457 mm), use shielded cable. Keep speed adjust potentiometer wires separate from power leads (L1, L2, U, V, W).

## Warning

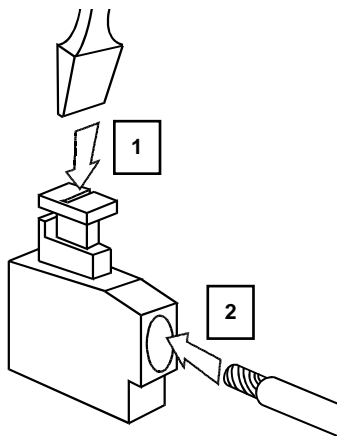
Be sure that the potentiometer tabs do not make contact with the enclosure. Grounding the input will cause damage to the drive.



**Figure 2. Speed Adjust Potentiometer**

## Cage-clamp terminals

MAC Series drive connections include cage-clamp terminals (see Figure 3). To insert a wire into a terminal:



1. Press down on the lever arm using a small screwdriver.
2. Insert wire into the wire clamp.
3. Release the lever arm to clamp wire.

**Figure 3. Cage-Clamp Terminal**

## Power, Fuse and Motor Connections

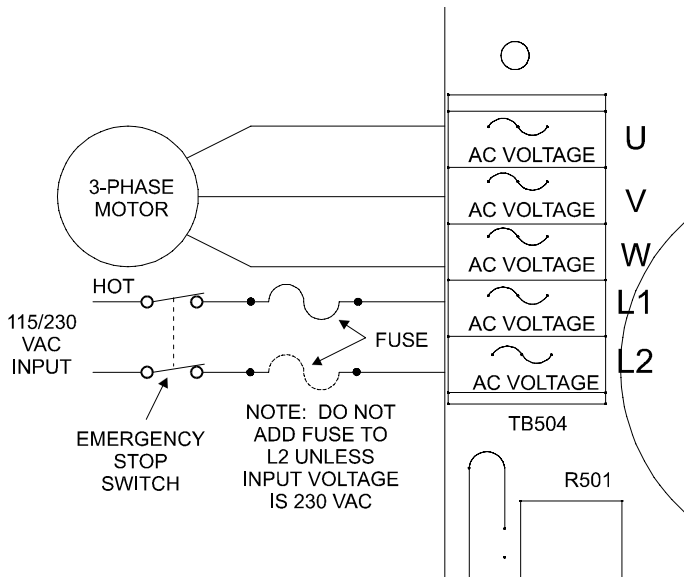


Figure 4. Power and Motor Connections

## Signal and Optional Switch Connections

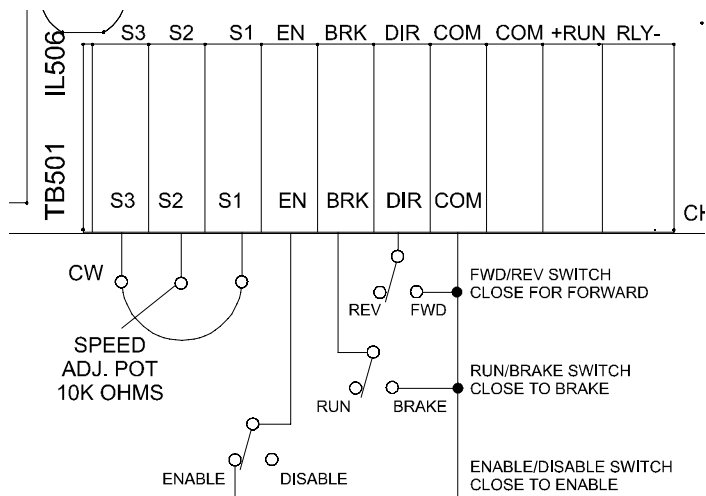


Figure 5. Signal and Optional Switch Connections

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# Operation




## Warning!

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

## Startup

1. Verify that no conductive material is present on the PCB.

-  2. Verify that the correct voltage is connected to the inputs before applying power. Motor voltage should be matched to the nominal AC line voltage (e.g., 208VAC motor for 208VAC nominal input; 115VAC motor for 115VAC nominal input).

3. Set the speed adjust potentiometer to zero (full CCW). Set all switches to the OFF, DOWN or CCW position.

4. Set the FWD-REV switch (if installed) to the desired direction. If no switch is installed, install or remove a jumper across the DIR and COM terminals, as required.

5. Set the ENABLE/DISABLE switch (if installed) to ENABLE, or short the EN and COM terminals on TB501. Set the RUN/BRK switch (if installed) to RUN, or remove the jumper between the BRK and COM terminals on TB501.
  
6. Apply 120 or 240VAC, 50/60 Hz, single-phase power to the drive. The green POWER LED will come on. If it does not, check the external line fuses to ensure that they are properly installed and not blown. The amber FWD or REV LED will light, indicating the direction of motor shaft rotation.
  
7. If you attempt to start and the red TQ LIMIT LED comes on, the control has entered torque limit mode. To avoid this occurrence, you may:
  - a. increase the current limit setting\* ;
  - b. lengthen the acceleration time enough to accommodate the needed starting torque by adjusting the ACCEL/DECEL trimpot; or
  - c. increase the accel torque power boost by setting the BOOST trimpot DIP switches.

Refer to the *Calibration* section for information on adjusting these trimpots.

\*Do not set the current limit setting above 150% of the motor's nameplate current rating. (Multiply the motor's current rating by 1.5 and set the current limit trimpot accordingly. See the *Calibration* section for details.)




## To reverse motor direction:

When the motor is running in the forward direction, the amber FWD LED will light; when the motor is running in reverse, the amber REV LED will come on. To reverse the direction of motor shaft rotation while the motor is running, set the FWD/REV switch to the opposite position. If no FWD/REV switch is installed, open or short the DIR and COM terminals on TB501, as required. The amber LED showing the newly selected direction will light the instant the motor changes direction.

When a new direction is selected, there is no need to close the BRAKE input or open the ENABLE input. The control will automatically decelerate the motor down to zero speed and then reverse direction, accelerating and decelerating at a rate controlled by the ACCEL/DECEL trimpot setting.

## To brake the motor:

 **Warning!** Allowing the RUN/BRAKE switch to remain in the BRAKE position for an extended period of time may cause motor overheating. Minarik recommends that you disable the drive or remove power if the motor is to remain idle. See Figure 5 for ENABLE/DISABLE switch installation.

To brake the motor, close the RUN/BRAKE switch, or place a jumper across the BRK and COM terminals of TB501. Refer to *Application Notes* for instructions on switch installation.

## **To coast the motor to a stop without disconnecting power:**

Open the ENABLE/DISABLE switch, or remove the jumper between the EN and COM terminals of TB501. Refer to Application Notes for instructions on switch installation.

## **I<sup>2</sup>T trip operation (class 10 characteristics)**

I<sup>2</sup>T trip level is based on the current limit setting. It protects the drive from phase-to-phase short circuits, a mechanical jam, or other potentially catastrophic conditions. If an overload or jam occurs, the amber FWD or REV LED will go out and the red CURRENT LED and TRIP LED will come on. After the overload or jam has been corrected, open, then close the ENABLE input to reset and restart the drive.

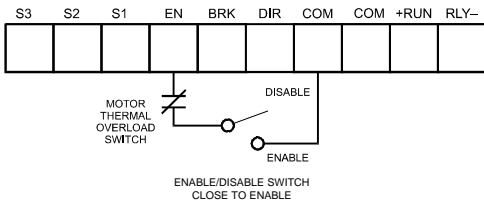
## **Drive thermal protection**

MAC series drives have built-in thermal protection. If the power stage temperature reaches 100° C, the drive will turn off. The red TRIP LED will then light to indicate a temperature overload condition.

## Thermal protection of the motor

The enable input can also act as a motor thermal protection circuit for motors having a built-in thermal protector. These thermal protectors are operated only by motor heat and open the enable circuit when the motor reaches a temperature which could cause damage to the motor winding.

Normally, these thermal protectors automatically close the circuit when the motor has cooled to a safe temperature. In operation, when the drive is disabled, or when the motor overheats, the thermal protector opens the circuit.



**Figure 6. Thermal Overload Switch with Optional Enable/Disable Switch**


## Line starting and line stopping

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

- ⚠** **Minarik strongly recommends the installation of a master power switch in the voltage input line (see Figure 4, *Power, Fuse and Motor Connections*).** The switch contacts should be rated at a minimum of 200% of motor nameplate current and 250 volts.

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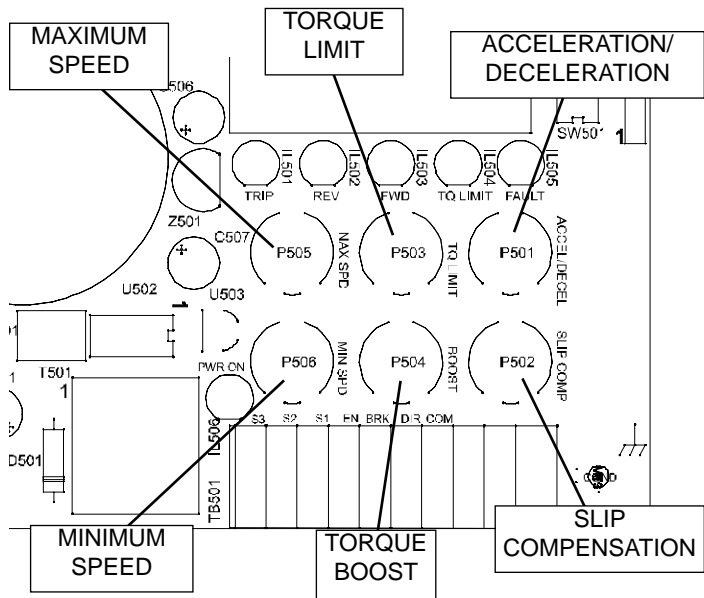
# Calibration

 MAC Series drives have six user-adjustable trimpots. Each drive is factory calibrated to its maximum horsepower rating. Readjust the calibration trimpot settings to accommodate lower horsepower motors. See Figure 7 for trimpot location.

All adjustments increase with CW rotation and decrease with CCW rotation. Each trimpot is identified on the printed circuit board.

  **Warning!**  
SHOCK  
HAZARD

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



**Figure 7. Calibration Trimpot Layout**

## Max Frequency DIP Switch Settings

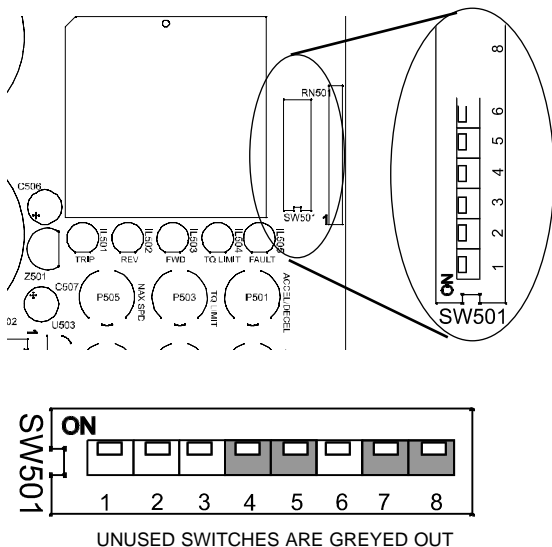


Figure 8. DIP Switch Layout

**⚠ Note:** Whenever a DIP switch state is changed, it will be ignored by the microprocessor until the drive is disabled, then re-enabled.

**Table 1. Max Frequency DIP Switch Settings**

MAX FREQUENCY <sup>1</sup> (Hz)	DIP SWITCH SETTING			BASE SPEED DIP SWITCH SETTING			
	1	2	3	6	BASE <sup>3</sup>	6	BASE <sup>4</sup>
60†	ON	ON	OFF	ON	60	OFF	60
120	OFF	ON	OFF	OFF	60	OFF	120
240	ON	OFF	OFF	ON	60	OFF	240
400 <sup>2</sup>	OFF	OFF	NA	OFF	400	NA	400
50	ON	ON	ON	ON	50	ON	50
100	OFF	ON	ON	OFF	50	ON	100
200	ON	OFF	ON	ON	50	ON	200
400	OFF	OFF	NA	OFF	400	NA	400

† = Default (factory) setting.

### Footnotes



1. Max frequency should match the motor's nameplate frequency. If you intend to overspeed the motor by exceeding its nameplate rating, contact the motor manufacturer to assure you do not exceed the motor's mechanical limits.

2. For this setting, the motor should be rated at 400 Hz.

3. Point at which the drive switches from constant torque to constant horsepower.

4. If the base speed is extended, low-end torque will be reduced so that the motor can achieve desired torque through the entire speed range. Speed can only be extended with a 208/230/ 240V motor.



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## Calibration Procedure Setup for 60 Hz Motors:

*(See Figure 8, pg. 18)*

1. Set all switches and trim pots to the OFF, CCW, or DOWN position. Set the TQ LIM trim pot full CW.
2. Set DIP switches 1, 2, and 6 to ON; set DIP switches 3, 4, 5, 7 and 8 to OFF. See Figure 8 for DIP switch locations.
3. Set the speed adjust pot full CCW.
4. Set the TQ BOOST trim pot (Figure 7, pg 17) to the 12 o'clock position.

### MIN SPD

Apply power to the drive. Slowly rotate the MIN SPD trim pot CW until the motor begins to turn, then slowly rotate the pot CCW until the motor just stops. This step calibrates the MIN SPD pot to zero speed without hysteresis.


### MAX SPD

Rotate the speed adjust pot full CW. Using a hand-held tachometer or analog frequency meter as a reference, adjust the MAX SPD trim pot until the desired speed or frequency is reached.

## TQ LIM

With the speed still set to to maximum and a clamp-on meter clipped around one of the motor leads, load the motor shaft to 120% of the motor nameplate rating.

Rotate the TQ LIM trimpot CCW until the current limit LED (not the TRIP LED) lights. Then rotate the TQ LIM trimpot CW until the LED just turns off.

-  Do not exceed 120% of the motor nameplate rating. The “modified” I<sup>2</sup>T algorithm in the microprocessor allows you to reach 150% – and, under certain circumstances, 200%.

## SLIP COMP

Release the motor load (unlock the shaft). Allow the motor shaft to settle at the maximum speed. Slowly load the motor until the AC phase current is at its maximum (100%). If the motor slowed at all, rotate the SLIP COMP trimpot CW until the motor shaft rotates at the original set speed.

## TQ BOOST

Set the speed adjust pot to the slowest speed at which you intend to run the motor under load.

Apply a load to the shaft of the motor. This load should be equivalent to the worst-case load the motor will see in your application.

If the motor slows or stalls, increase the torque boost by turning the BOOST trimpot CW until the desired speed under load is observed.

When adjustment of the BOOST trimpot is complete, disable the drive and release the load.

## ACCEL/DECEL

Quickly set the speed adjust pot to zero speed (full CCW) and note the time the motor takes to stop. If the deceleration time differs from the desired time, adjust the ACCEL/DECEL trimpot until the desired time is reached. Rotating the ACCEL/DECEL pot CW slows acceleration, thereby increasing the ramp time.



Rotating the ACCEL/DECEL pot full CCW does not allow the motor to slow faster than it can coast. (To stop more quickly, you may close the BRAKE input to inject DC into the motor.)

Set the speed adjust pot to zero (full CCW). Disable the drive by opening the ENABLE/DISABLE switch or removing the jumper from the EN and COM terminals.

## Accel Torque Boost Adjustment

**OPTIONAL:** To increase system efficiency, the accel torque boost may be reduced at this time. Torque boost should be set to zero if the motor has no load or a slight load. To reduce accel torque boost, perform the following:

1. Disable the drive.
2. Set DIP switch 4 to ON. Set DIP switch 5 to OFF. This will set the torque boost to 110% (see table 3, pg. 25).

3. Enable the drive and rotate the speed adjust pot full CW (maximum speed). If no change is noticed (for example, if the motor accelerates quickly enough and does not go into current limit), disable the drive and go to step 4. If an unacceptable difference was noted, restore the DIP switch settings to the previous step.

4. Set DIP switch 4 to OFF and DIP switch 5 to ON. This will reduce the torque boost to 105% (see Table 3, pg. 25). Repeat step 3 above.

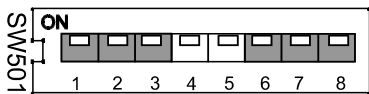


5. Finally, reduce torque boost to 100% by repeating steps 1 – 3 above, except with DIP switch 4 and 5 set to ON.

6. The drive is now calibrated for optimum efficiency and minimal motor heating.

**Table 2. Torque Boost Calibration DIP Switch Settings**

ACCEL TQ BOOST (%)†	DIP SWITCH SETTING	
	4	5
100††	ON	ON
105	OFF	ON
110	ON	OFF
120	OFF	OFF



UNUSED SWITCHES ARE GREYED OUT

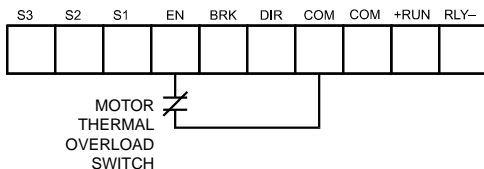
† Accel torque boost, as a percentage of the TQ boost pot setting, is applied by the drive during acceleration. Once the desired speed is reached, accel torque boost is turned off and only the TQ boost remains.

†† Factory (default) setting.

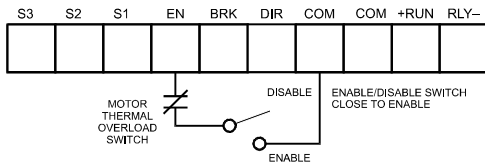
# Application Notes

## Thermal Protection Switch Installation

To provide additional protection for the motor and drive, install a thermal overload protection switch as shown in Figure 9. An option is to install an ENABLE/DISABLE switch in series with the thermal protection switch (Figure 10).



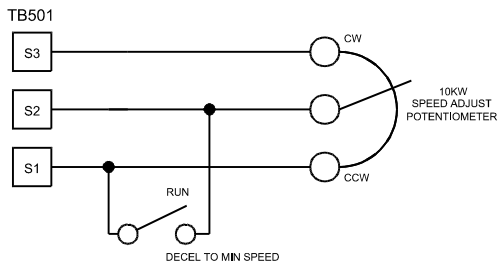
**Figure 9. Thermal Overload Protection Switch Installation**



**Figure 10. Thermal Overload Protection Switch Installation With Optional Enable/Disable Switch**

## Decelerate to minimum speed

The circuit shown in Figure 11 may be used to decelerate a motor to a minimum speed. Closing the switch between S2 and S1 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 S2 and S1 is closed. Calibrate the ACCEL and DECEL trimpots to control the acceleration and deceleration ramp. Set the switch to the RUN position to accelerate the motor to set speed.



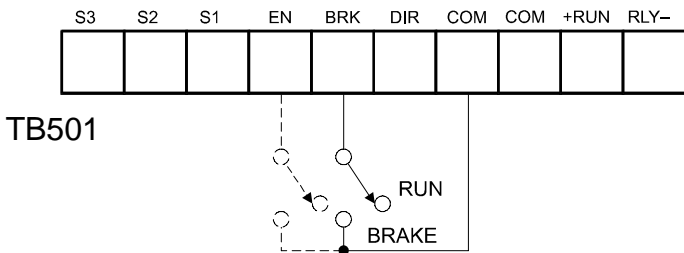
**Figure 11. Run/Decelerate to Stop Switch**



## Decelerate to minimum with DC injection braking

To quickly stop the motor, install a RUN/BRAKE switch between the BRK and COM terminals of TB501 as shown in Figure 12. Closing the switch will inject an additional DC voltage into the motor armature, causing the motor to stop much more quickly than by the disabling method, or the method shown in Figure 11.

**⚠ Warning!** Allowing the RUN/BRAKE switch to remain in the BRAKE position for an extended period of time may cause motor overheating. Minarik recommends that you disable the drive (as shown in Figure 12) or remove power if the motor is to remain idle. Disable the drive or remove power after the motor has come to a stop.



**Figure 12. RUN/BRAKE Switch Shown with Optional Enable/Disable Switch**

## Independent adjustable speeds with FWD-REV switch

Replace the speed adjust potentiometer with two single-pole multi-position switches, 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.

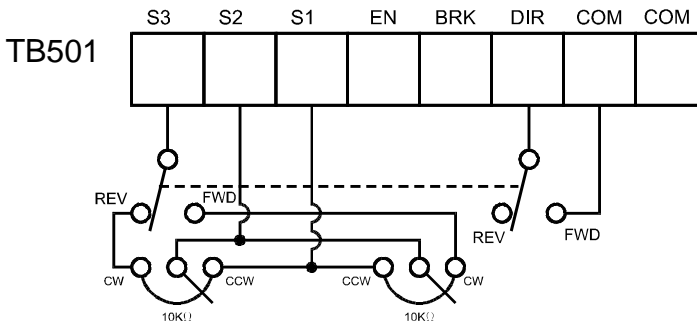
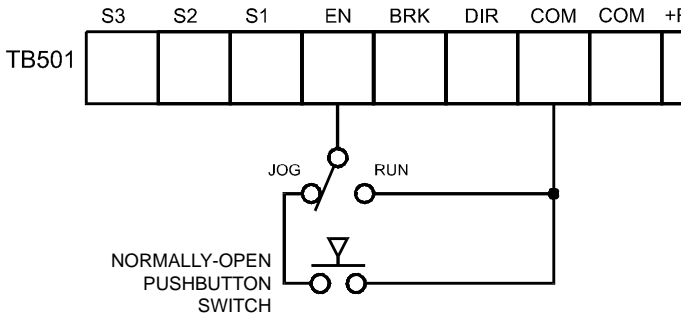


Figure 13. Independent Adjustable Speeds

## RUN/JOG switch

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

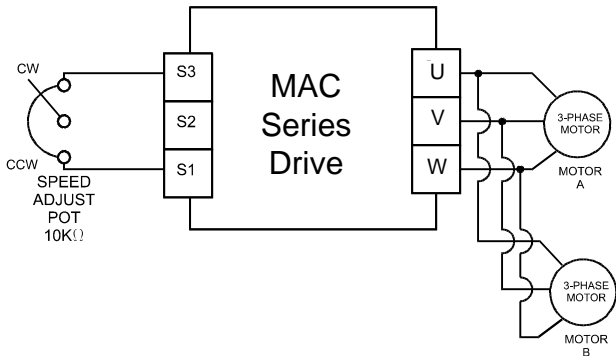
Connect the RUN/JOG switch and JOG pushbutton to terminal board TB501 as shown in Figure 14. The motor coasts to a stop when the RUN/JOG switch is set to JOG. Press the JOG pushbutton to jog the motor. Return the RUN/JOG switch to RUN for normal operation.



**Figure 14. RUN/JOG Switch**

## Single speed potentiometer control of multiple motors

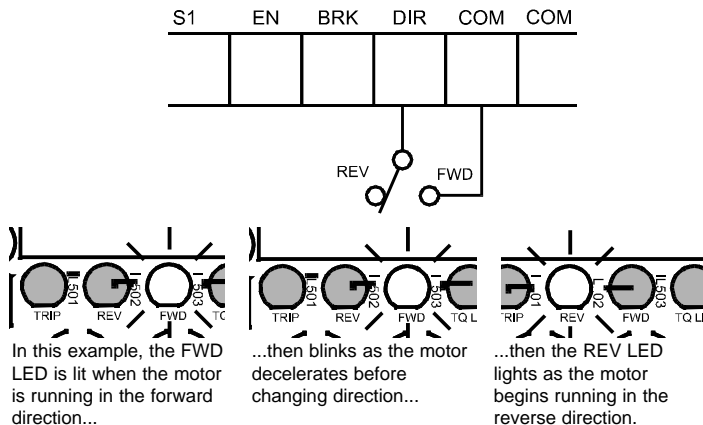
The MAC series of controls is capable of operating up to eight 3-phase motors simultaneously. All motors must be of the same type and must control similar loads. Connect each motor as shown in Figure 15 below.



**Figure 15. Single Speed Potentiometer Control of Multiple Drives**

## Reversing

To reverse the direction of motor shaft rotation, remove or install a jumper between the DIR and COM terminals of TB501, as required. An option is to install a single-pole, two-position switch as shown in Figure 16. The drive will brake the motor before reversing, so there is no need to wait for the motor to coast to a stop before changing direction. The amber FWD or REV LED will blink as the drive decelerates the motor but before it has changed direction.



**Figure 16. Reversing Circuit Connection**



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# Troubleshooting



## Warning!

Dangerous voltages exist on the drive when it is powered, and up to 30 seconds after power is removed and the motor stops. When possible, disconnect the voltage input from the drive while troubleshooting. Be alert. High voltages can cause serious or fatal injury.

## Before troubleshooting

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

- Disconnect AC or DC voltage input from the drive. Wait 30 seconds for power to discharge. The green POWER LED will blink while power is discharging.
- Check the drive closely for damaged components.
- Check that no wire chips 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 phase current and RMS voltage are consistent with the motor ratings.

## Diagnostic LEDs

MAC-series drives contain six diagnostic LEDs (see Figure 17, pg. 36):

### **POWER ON (green)**

The POWER ON LED lights when power is applied to the drive.

### **FAULT (red)**

The FAULT LED lights in any of the following conditions:

1. Failure of the power stage or its components.
2. The monitor detects an overcurrent condition of more than 250% of the drive's rating.
3. A short between any two of the three AC phases.
4. Loss of phase.

### **TRIP I<sup>2</sup>T (red)**

The TRIP LED lights when a thermal overload has occurred. The TRIP and TQ LIM LEDs light at the same time if the motor load exceeds 250% of the motor's rated current or I<sup>2</sup>T class-10 conditions. If the TRIP and TQ LIM LEDs are lit at the same time, the drive has gone into current overload.



## **REV (amber)**

The REV LED lights to show the motor is moving in the reverse direction. The LED blinks when the direction input has changed until the motor changes direction.

## **FWD (amber)**

The FWD LED lights to show the motor is moving in the forward direction. The LED blinks when the direction input has changed until the motor changes direction.

## **TQ LIM (red)**

The TQ LIM (torque limit) LED will light at the same time as the TRIP LED if the current required to move the load exceeds the TQ LIMIT trimpot setting.

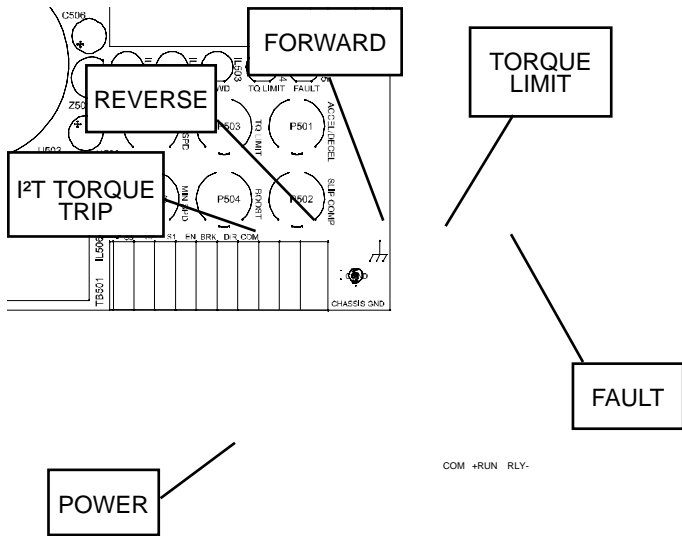


Figure 17. Diagnostic LED Layout

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## LED fault indications

### **Green POWER LED does not light when power is applied.**

1. The input voltage may be too low. Check that the input voltage is above 90 VAC.
2. Check that the external fuse(s) is/are not blown. Replace if necessary.
3. Check the connections to the terminal block for loose, broken or miswired leads.

### **Green POWER LED blinks after power is turned off.**

1. Power has been removed from the drive and the power supply is discharging.

### **Red CURRENT TRIP LED is lit steadily (does not blink) at the same time as the TQ LIM LED .**

1. The motor load has exceeded the I<sup>2</sup>T class 10 current characteristics. Check there is no phase-to-phase short.
2. If no short exists, check that there is no jammed load.

**Red TRIP LED is lit steadily (does not blink); red TQ LIM LED is not lit.**

1. The drive has gone into thermal overload (drive temperature has exceeded 100° C).

**Red FAULT LED is lit.**

1. The control has a power stage failure.
2. The motor load is more than 250% above current limit setting.
3. The motor has a phase-to-phase short circuit or possible loss of phase.

**Red TQ LIMIT LED is lit.**

1. The TQ LIMIT trimpot is out of calibration and must be adjusted.. See Calibration for information on adjusting the trimpot.
2. The motor load is greater than 120% of the torque limit setting, but less than 250%.
3. Torque boost is set too high.

**Amber REV LED blinks; FWD LED not lit.**

1. The drive was running in the reverse direction when the direction (DIR) input state was changed. The REV LED blinks until the direction of motor shaft rotation is actually reversed.

**Amber FWD LED blinks; REV LED not lit.**

1. The drive was running in the forward direction when the direction (DIR) input state was changed. The FWD LED blinks until the direction of motor shaft rotation is actually reversed.

**Clearing LED fault indications**

Reset all LED fault indications using the following procedure:

1. Disable the drive by opening the ENABLE input (remove the jumper between the EN and COM terminals of TB501).
2. Re-install the jumper between the EN and COM terminals of TB501 to close the ENABLE input and restart the drive.

To make this process easier, Minarik recommends installing a single-pole, single-throw DISABLE/ENABLE switch between the EN and COM terminals of terminal board TB501. See Application Notes for more information.

<b>Problem</b>	<b>Possible Cause</b>	<b>Suggested Solution</b>
External line fuse blows	<ol style="list-style-type: none"> <li>1. Line fuses are the wrong size.</li> <li>2. Motor cable or armature is shorted to ground.</li> <li>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>1. Check that line fuses are properly sized for the motor being used.</li> <li>2. Check motor cable and armature for shorts.</li> <li>3. Add a blower to cool the drive components; increase TQ LIM settings.</li> </ol>
External line fuse does not blow, but the motor does not run	<ol style="list-style-type: none"> <li>1. Speed adjust potentiometer or voltage input signal is set to zero speed.</li> <li>2. Speed adjust potentiometer or voltage input signal is not properly connected to drive input; connections are open.</li> <li>3. Drive is “tripped” off or has gone into thermal overload.</li> <li>4. Drive has been disabled.</li> </ol>	<ol style="list-style-type: none"> <li>1. Increase the speed adjust potentiometer setting or voltage input signal.</li> <li>2. Check connections to input. Verify that connections are not open.</li> <li>3. Check diagnostic LEDs for drive condition. Remove motor load.</li> <li>4. Ensure that EN and COM terminals are properly connected.</li> </ol>

<b>Problem</b>	<b>Possible Cause</b>	<b>Suggested Solution</b>
External line fuse does not blow, but the motor does not run (cont.)	5. Drive is in brake mode.  6. Drive is in current limit.  7. Drive is not receiving AC voltage input.  8. Motor is not connected.	5. Ensure that BRAKE terminal is not shorted to COM terminal.  6. Verify that motor is not jammed. Increase FWD TQLIM or REV TQLIM setting if they are set too low.  7. Apply AC line voltage to L1 and L2.  8. Connect motor to drive outputs U, V and W.
Motor runs too slow or too fast at set speed	1. Switches are set incorrectly.  2. MIN or MAX SPD are not calibrated.	1. Verify all switch settings.  2. Calibrate MIN and MAX SPD trimpots.
Motor will not reach the desired speed	1. Base speed DIP switches are incorrectly set.  2. MAX SPD setting is too low.  3. BOOST and SLIP COMP settings are too low.	1. Reset DIP switches.  2. Increase MAX setting.  3. Recalibrate BOOST and SLIP COMP settings.

<b>Problem</b>	<b>Possible Cause</b>	<b>Suggested Solution</b>
Motor will not reach the desired speed (cont.)	4. Nominal input voltage may be too low for motor  5. Motor is overloaded.	4. Compare motor voltage to input voltage replace motor if necessary (see page 11)  5. Check motor load. Resize the motor if necessary.
Motor pulsates or surges under load	1. SLIP COMP is set too high.  2. Motor “bouncing” in and out of torque limit.	1. Adjust the SLIP COMP setting slightly CCW until the motor speed stabilizes.  2. Make sure motor is not undersized for load; adjust TQ LIM setting CW.
Motor does not reverse	1. Bad FWD/REV switch connection.  2. Reversing circuit not working properly.  1. TQ LIMIT set too low.	1. Check FWD/REV switch connection.  2. Check reversing circuit by shorting FWD/REV terminal to COM terminal with jumper wire.



<b>Problem</b>	<b>Possible Cause</b>	<b>Suggested Solution</b>
<p>TQ is unsatisfactory at high speeds.</p>	<ol style="list-style-type: none"> <li>2. TQ BOOST set too low.</li> <li>3. Load may exceed rating of motor/drive.</li> <li>4. Nominal input voltage may be too low for motor.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check TQ LIM setting.</li> <li>2. Check boost setting.</li> <li>3. "Fix" load (i.e., straighten mounting, coupling, etc.); or replace motor and drive with motor and drive rated for higher horsepower.</li> <li>4. Compare motor voltage to input voltage. Replace motor if necessary (see page 11).</li> </ol>

For additional assistance, contact your local Minarik<sup>®</sup> distributor, or the factory direct: Tel: (800) MINARIK Fax: (775) 823-9495

## 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>MAC03-115AC</b>	C502-503	470 uF, 200 VDC Capacitor	011-0114					
	Q502-Q507	IGBT	070-0085					
	TH501	20-amp Thermistor	033-0007					
	TB501	10-pin Terminal Block	160-0153					
	TB504	5-pin Terminal Block	10K $\Omega$ Potentiometer Kit	202-0003				
					Chassis	223-0208		
							Bar Clamp	222-0209
<b>MAC06-115AC</b>	Same parts as MAC03-115AC except:							
	C502-503	1000 uF, 200 VDC Capacitor	011-0096					
<b>MAC03-D240AC</b>	Same parts as MAC03-115AC except:							
	C502-503	470 uF, 400 VDC Capacitor	011-0120					
<b>MAC06-D240AC</b>	Same parts as MAC06-115AC except:							
	C502-503	470 uF, 400 VDC Capacitor	011-0120					

# 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 from date of manufacture thereof. Within this warranty period, the Corporation will repair or replace such products that are returned to Minarik Corporation, 901 East Thompson Avenue, Glendale, CA 91201-2011 USA.

This warranty shall not apply to any product that has been repaired by unauthorized persons. 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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