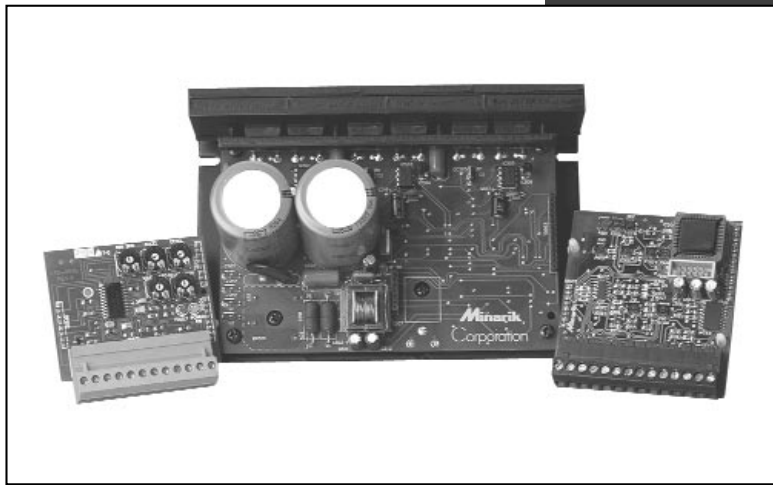


BOSS Series



User's Manual

BOSS Series Four Quadrant Brushless Drives

Copyright ©1999 by
Minarik Corporation

All rights reserved. No part of this manual may be reproduced or transmitted in any form without written permission from Minarik Corporation. The information and technical data in this manual are subject to change without notice. Minarik Corporation and its Divisions make no warranty of any kind with respect to this material, including, but not limited to, the implied warranties of its merchantability and fitness for a given purpose. Minarik Corporation and its Divisions assume no responsibility for any errors that may appear in this manual and make no commitment to update or to keep current the information in this manual.

Printed in the United States of America

⚠ Safety Warnings

- 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.
- Although the drive includes protective circuitry to prevent damage in the event of an accidental short circuit of the armature, it is not fail-safe. ***It is possible for a drive to run at full speed as a result of a component failure.*** Install a master switch in the drive's AC or DC voltage input line for stopping the drive in an emergency.
- **This drive is isolated from earth ground.** Avoid direct contact with the printed circuit board or with circuit elements to prevent the risk of serious injury or fatality. Use a non-metallic screwdriver for adjusting the calibration trimpots.



Contents

Safety Warnings	i
Contents	ii
Specifications	1
Dimensions	2
Installation	5
4Q plug-in card mounting	8
Speed adjust potentiometer mounting	9
Quick-connect terminal block	10
Motherboard connections	11
Regen dump circuit	12
4Q plug-in card connections	13
4Q Terminal Descriptions	14
Voltage follower	14
Motor hall sensor header (SW502)	16
Encoder follower	16
Mode select switches (SW501)	17
TB504	18
Startup	21
Line starting and line stopping	21
Operation	21
Calibration	23
FWD MAXSPD	24
REV MAXSPD	24
MIN	24
OS (zero offset)	25
GAIN	25
IR COMP	25
FWD TQLIM	26
REV TQLIM	26
ACCEL	27
DECEL	27
TACH (for use with tachometer feedback only)	28
Application Notes	29
Independent adjustable speeds	30
Troubleshooting	31
Diagnostic LEDs	32
Commutation Sequence Diagram	35
Replacement Parts	36
Unconditional Warranty	inside back cover

Illustrations

Figure 1. BOSS Series Dimensions	2
Figure 2. Regen Dump Circuit Dimensions	3
Figure 3. 4Q Mounting to the Motherboard	8
Figure 4. Speed Adjust Potentiometer Mounting	9
Figure 5. Quick-Connect Terminal Plug	10
Figure 6. Motherboard Connections	11
Figure 7. Regen Dump Circuit Connections	12
Figure 8. 4Q Terminal Connections	13
Figure 9. Voltage Signal Connections	15
Figure 10. Sensor Connections	15
Figure 11. Motor Hall Sensor Header	16
Figure 12. Mode Select Switches	17
Figure 13. TB504 Pin Assignments	18
Figure 14. Calibration Trimpot Layout	23
Figure 15. Mode Select Switches	28
Figure 17. Adjustable Speeds Using Potentiometers in Series	29
Figure 16. Multiple Fixed Speeds	29
Figure 18. Independent Adjustable Speeds	30
Figure 19. Commutation Sequence Diagram	35

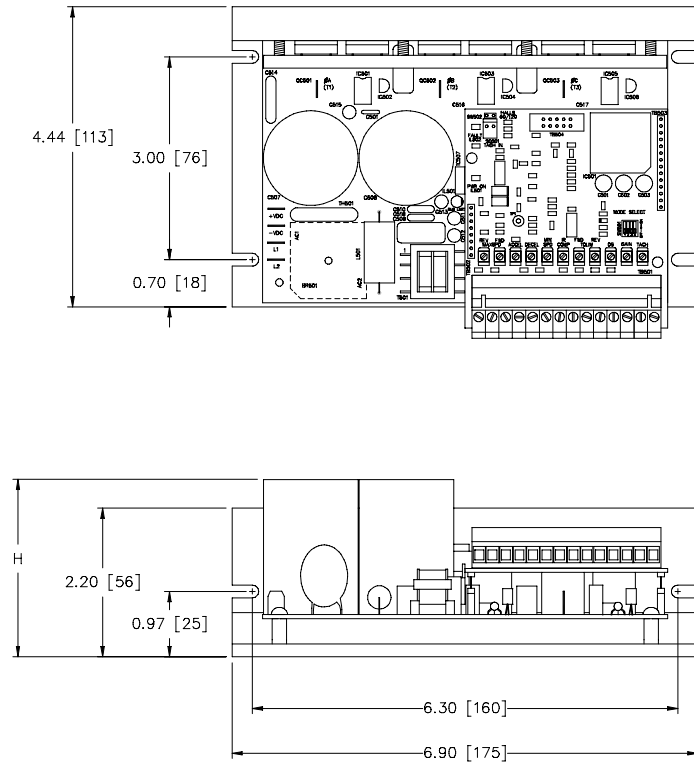
Tables

Specifications

Drive	Maximum Phase Current (AC Amps)	AC Input Voltage (±10%, 50-60 Hz) (VAC)	Maximum Output Voltage (VAC)
BOSS15-115AC-4Q	15	90-130	130
BOSS08-115AC-4Q	8	90-130	130
BOSS04-115AC-4Q	4	90-130	130
BOSS08-D240AC-4Q	8	90-240	240
BOSS04-D240AC-4Q	4	90-240	240

DC Voltage Input Range		
BOSSxx-115AC-4Q drives		100-180 VDC
BOSSxx-D240AC-4Q drives		100-360 VDC
Maximum Phase Current Limit	1.5 times Maximum Phase Current (continuous)	
Peak Phase Current Limit	2 times Maximum Phase Current (for 1 second)	
Minimum Output Voltage Range	0–50 VAC	
Acceleration Time Range (Zero to Max Speed)	0.5–6 seconds	
Deceleration Time Range (Max Speed to Zero)	0.5–6 seconds	
Speed Regulation (typical)	0.06% of base speed	
Speed Adjust Potentiometer	10KΩ	
Analog Input Voltage Range (isolated)	0±10 VDC	
Input Impedance (S2 to Common)	60KΩ	
Power Device Switching Frequency (6–step, trapezoidal)	22 KHz	
Hall sensor output (max)	+5 VDC @ 20mA	
Weight	2 lb	
Ambient Operating Temperature Range	0–40°C	

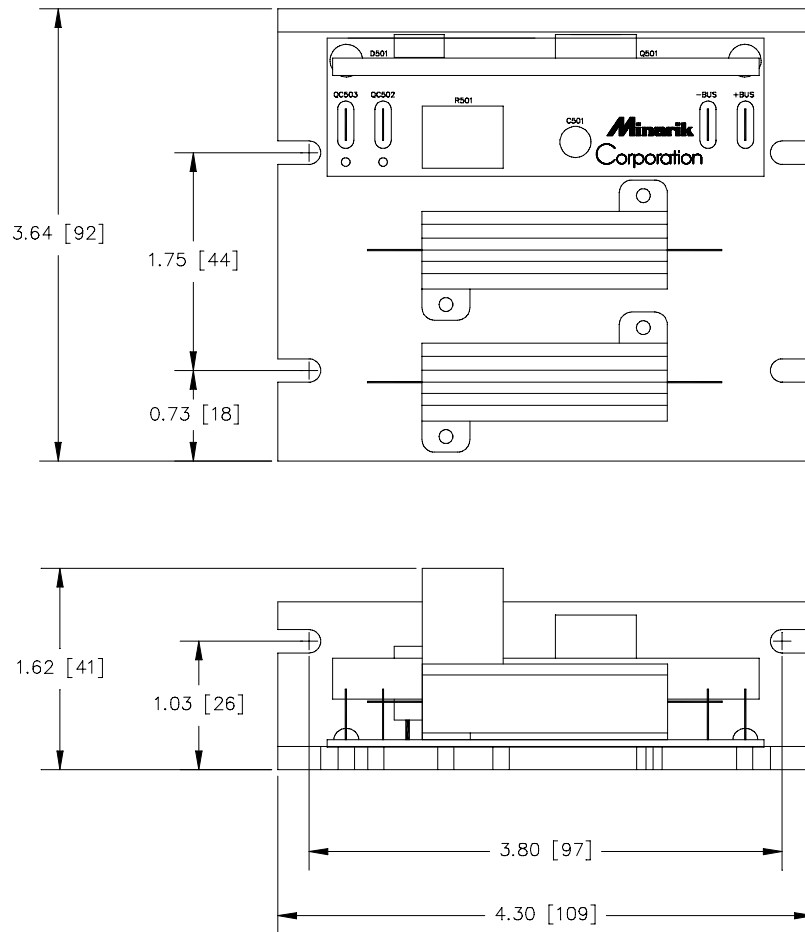
Dimensions



Drive	Dimension "H"
BOSSxx115AC-4Q	2.62 [67]
BOSSxx-D240AC-4Q	3.87 [98]

All Dimensions in Inches [Millimeters]

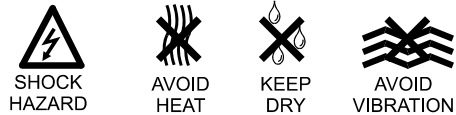
Figure 1. BOSS Series Dimensions



All Dimensions in Inches [Millimeters]

Figure 2. Regen Dump Circuit Dimensions

Installation



Mounting

- Printed circuit board components are sensitive to electrostatic fields. Avoid contact with the printed circuit board directly. Hold drive or regen dump circuit by the chassis only.
- Protect the drive and regen dump circuit from dirt, moisture, and accidental contact. Provide sufficient room for access to the terminal block and calibration trim pots.
- Mount the drive and regen dump circuit away from other heat sources. Operate within the specified ambient operating temperature range.
- Avoiding excessive vibration to prevent loose connections.
- Mount drive and regen dump circuit with its printed circuit board in either a horizontal or vertical plane. Six 0.19 inch (5 mm) wide slots on the chassis accept #8 pan head screws. Fasten either the large base or the narrow flange of the chassis to the subplate.
- The chassis does not have to be earth grounded. If you choose to ground the chassis, use a star washer beneath the head of at least one of the mounting screws to penetrate the anodized chassis surface and to reach bare metal.

Wiring


- Use 16–20 AWG wire for speed adjust potentiometer wiring. Use 14–16 AWG wire for AC line (L1, L2) and motor (A1 and A2) wiring.


Shielding guidelines

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

- 1) wire lengths exceed 18 inches, 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.

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.

Fusing

An external line fuse must be installed on all BOSS series drives. Connect the external line fuse in series with the AC voltage input or DC voltage input, whichever is used. See motherboard connections on page 8.

Table 1 lists the recommended line fuse sizes. Use fast acting fuses rated for 250 VAC or higher, and approximately 200% of the maximum phase current.

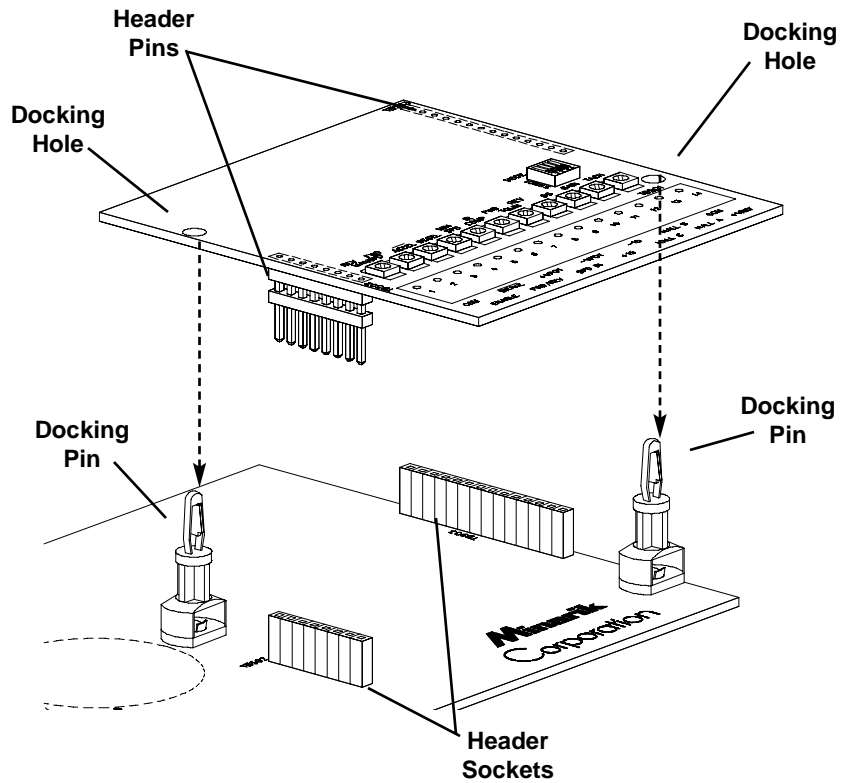
Table 1. Recommended Line Fuse Sizes

Model #	AC Line Fuse Size (AC Amps)
BOSS04-xxx-4Q	10
BOSS08-xxx-4Q	15
BOSS15-xxx-4Q	25

4Q plug-in card mounting

⚠ Warning Make sure AC or DC voltage input is disconnected for 30 seconds before installing or removing the 4Q plug-in card.

To mount the 4Q plug-in card to the motherboard, line up the motherboard docking pins to the docking holes (see Figure 3). Align the header pins on the plug-in card with the corresponding header sockets on the motherboard. Fasten the header pins into the header sockets until secure. The docking pin will lock the plug-in card into place when the header pins are correctly mounted into the header sockets.



(Make sure AC or DC voltage input is removed for 30 seconds before removing and installing 4Q plug-in card)

Figure 3. 4Q Mounting to the Motherboard

Speed adjust potentiometer mounting

Mount the speed adjust potentiometer through a 0.38 inches (1.0 cm) hole with the hardware provided (Figure 4). 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 potentiometer leads are longer than 18 inches (46 cm), use shielded cable.

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

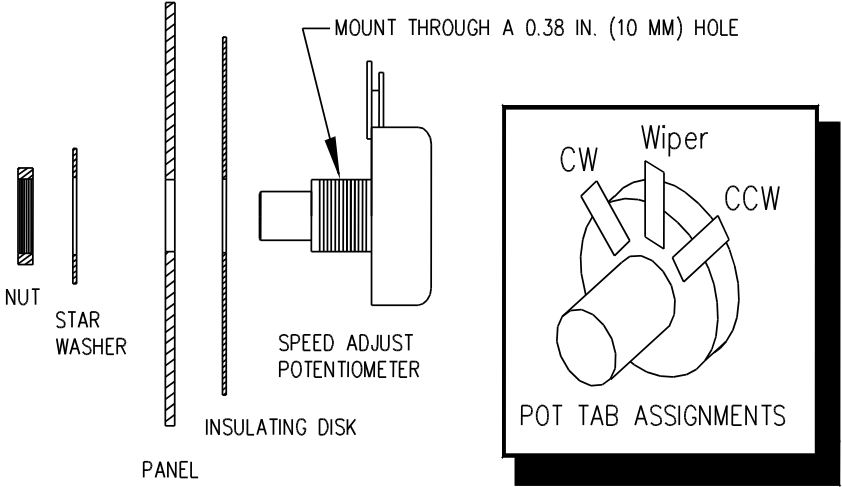


Figure 4. Speed Adjust Potentiometer Mounting

Quick-connect terminal block

The quick-connect terminal block, found on the 4Q plug in card, is composed of a header block and terminal plug (Figure 5). To use the quick-connect terminal block:

1. Carefully pull terminal plug from header block.
2. With a small flat-head screwdriver, turn terminal plug screw counterclockwise to open 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 plug into header block until securely fastened.

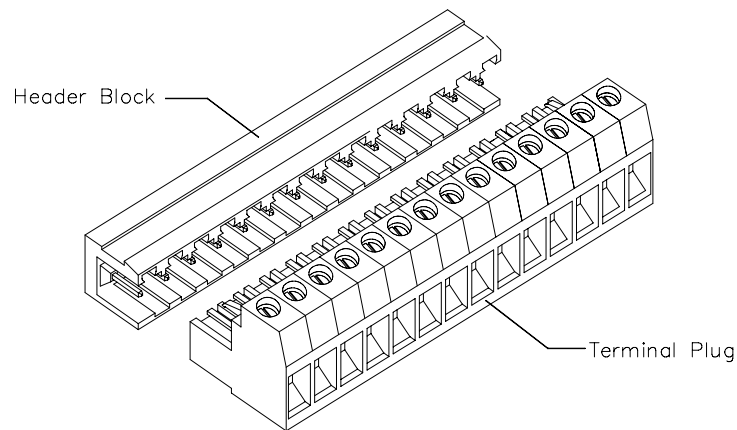


Figure 5. Quick-Connect Terminal Plug

Motherboard connections

See Figure 6 for motherboard connections. If the drive is powered by a DC voltage source, do not connect the AC voltage source to AC1 or AC2. Likewise, if the drive is being powered by ac AC voltage source, do not connect the DC voltage source to VDC+ and VDC-.

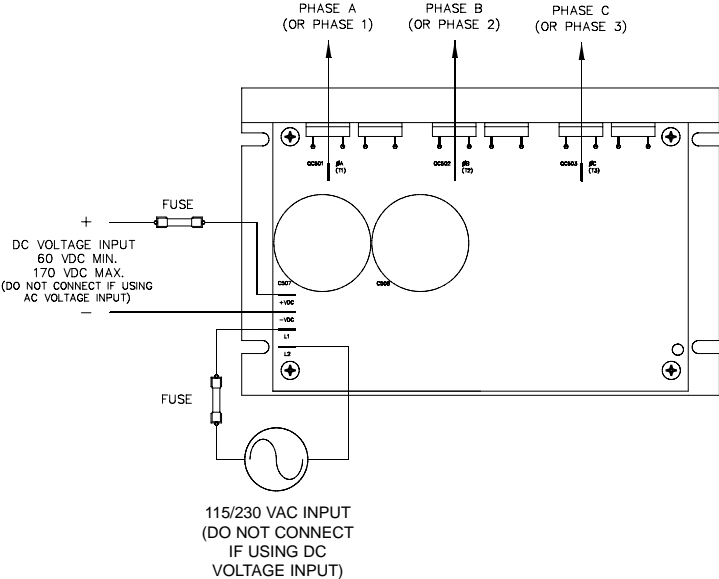


Figure 6. Motherboard Connections

Regen dump circuit

The regen dump circuit is required by all BOSS Series drives. Regenerative loads cause the bus voltage to increase. The regen dump circuit prevents the voltage across the bus capacitors from exceed their voltage rating. See Figure 7 for regen dump circuit connections.

Frequent regenerative reversing requires additional power resistors to be added to the regen dump circuit. Contact the Minarik factory for more assistance.

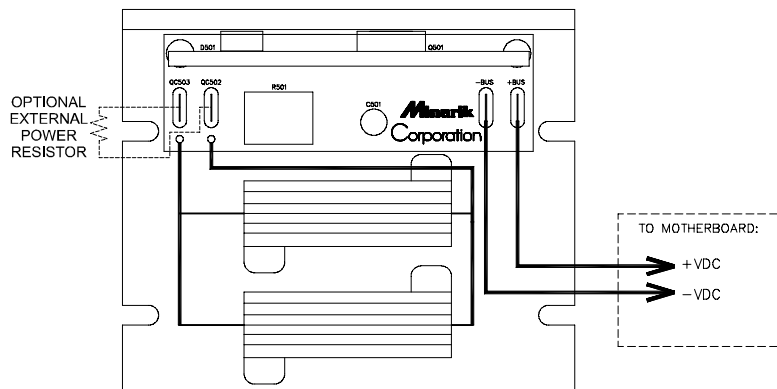


Figure 7. Regen Dump Circuit Connections

Table 2. ENABLE/BRAKE Configuration Options. See Figure 8 for terminal and switch locations.

Enable Switch Position (Terminals 1 – 2)	Brake Switch Position (Terminals 1 – 3)	Result
CLOSED	OPEN	RUN
CLOSED	CLOSED	REGEN BRAKE
OPEN	OPEN	COAST TO STOP
OPEN	CLOSED	COAST TO STOP

4Q plug-in card connections

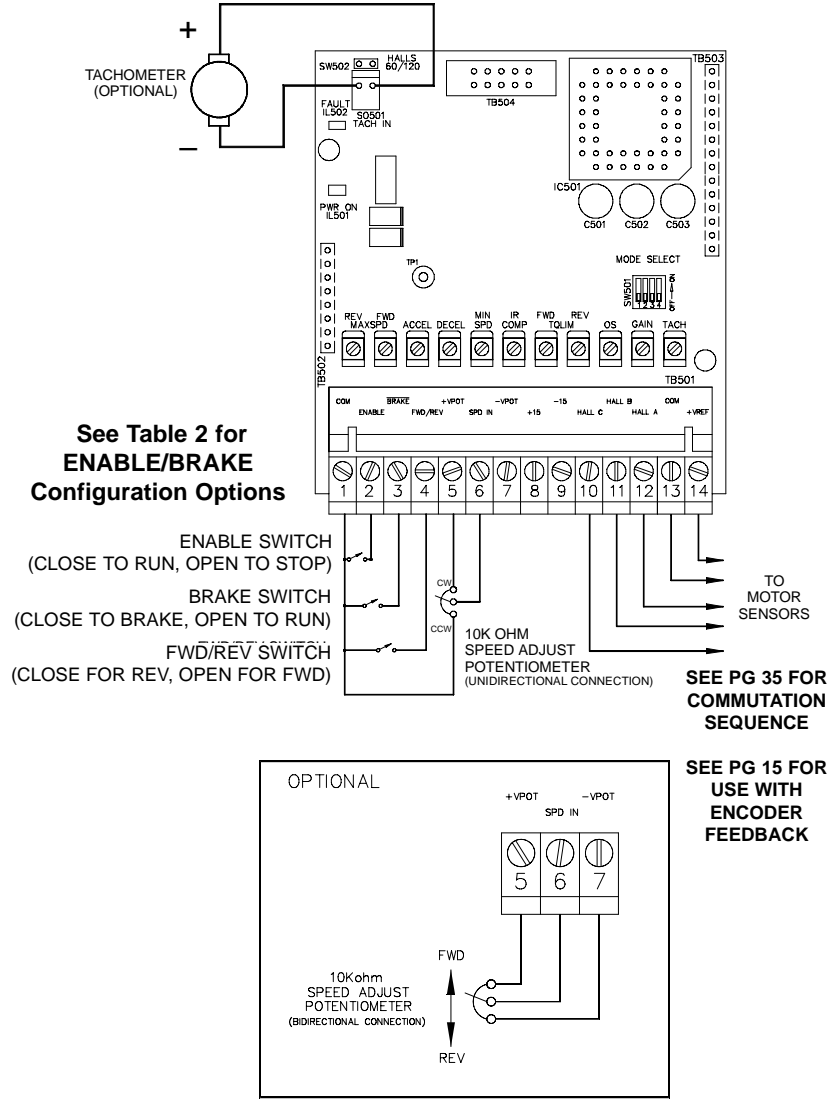



Figure 8. 4Q Terminal Connections

4Q Terminal Descriptions

COM (terminals 1 and 13)

Circuit common ( Do not connect to earth ground!)

Enable (terminal 2)

Short to COM to run the motor; leave open to coast to a stop.

Brake (terminal 3)

Short to COM to brake the motor; leave open to run the motor.

FWD/REV (terminal 4)

Short to COM to run the motor in the reverse direction; leave open to run the motor in the forward direction.

+V POT (terminal 5)

Floating +10 VDC reference for 10K Ω speed adjust potentiometer.

SPD IN (terminal 6)

Accepts floating (ungrounded) –10VDC to +10 VDC reference or 10K Ω speed adjust potentiometer wiper.

–V POT (terminal 7)

Floating –10 VDC reference for 10K Ω speed adjust potentiometer.

+ 15 (terminal 8)

Floating +15 VDC supply (25 mA maximum).

– 15 (terminal 9)

Floating –15 VDC supply (25 mA maximum).

HALL C,B,A (terminals 10–12)

Inputs from motor hall sensors.

+V Ref (terminal 14)

Floating +5 VDC supply for hall sensors. **NOTE: The maximum supply current at +5 VDC is 20mA.**

Voltage follower

Instead of using a speed adjust potentiometer, BOSS series drives may be wired to follow a floating (differential) –10 VDC to +10 VDC signal that is isolated from earth ground. Connect a voltage signal to terminals 1 and 6 (see Figure 9 for connections).

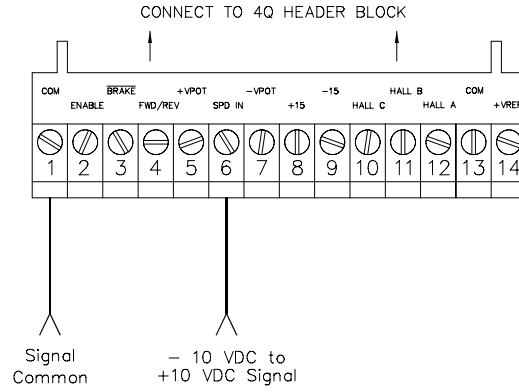
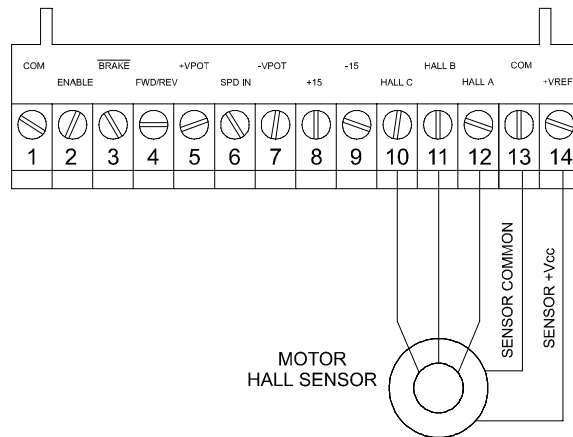


Figure 9. Voltage Signal Connections

USE THIS
ARRANGEMENT
IF SENSOR
DRAWS LESS
THAN 20 mADC



USE THIS
ARRANGEMENT
IF SENSOR
DRAWS MORE
THAN 20 mADC

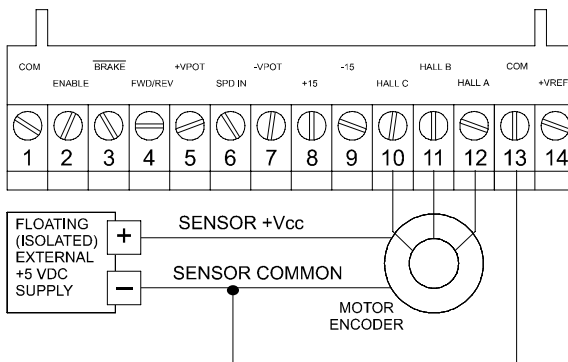


Figure 10. Sensor Connections

Motor hall sensor header (SW502)

Set the motor hall sensor header according to the hall effect feedback spacing (see Figure 11 for location). Jumper SW502 if the hall effect feedback spacing is 120°. Do not add a jumper if the hall effect feedback spacing is 60°.

Hall sensors are not allowed to be advanced or retarded. To reverse motor rotation, the BOSS drive switches hall sensor sequence, eliminating the need to switch motor leads.

BOSS series drives provide a +5 VDC, 20mA maximum output to drive the Hall sensors. This voltage is provided at TB501 terminal 14 (positive or high) and terminal 13 (common or low) on the 4Q plug-in card.

Encoder follower

Instead of using a speed adjust potentiometer, BOSS series drives may be wired to follow an optical encoder input as shown in Figure 10.

⚠ Warning! Use only +5 VDC encoders. Do not connect any other type of encoder to the BOSS reference voltage terminals.

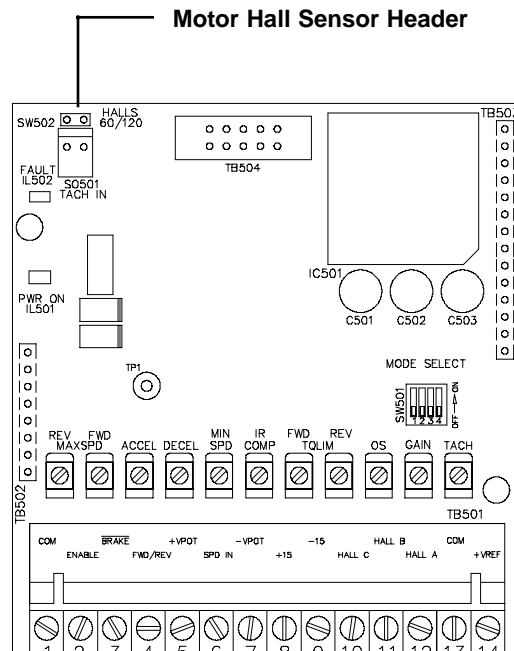


Figure 11. Motor Hall Sensor Header

Mode select switches (SW501)

The mode select switches set the BOSS drive to one of the four operating modes:

1. Voltage Mode (no internal velocity loop)
2. Velocity Mode (voltage mode plus internal velocity loop)
3. Tachometer Feedback Mode
4. Current Mode (no voltage or velocity loops)

Set the mode select switches according to the appropriate operating mode. Refer to Table 3 for mode select switch settings, and Figure 12 for mode select switch location.

Table 3. Mode select switch settings

Operating Modes	Mode Select Switch			
	1	2	3	4
Voltage Mode (no internal velocity loop)	ON	OFF	OFF	ON
Velocity Mode (Voltage Mode plus internal velocity loop)	ON	OFF	ON	ON
Tachometer Feedback Mode	ON	OFF	X	OFF
Current Mode	OFF	ON	X	X

X = Don't care.

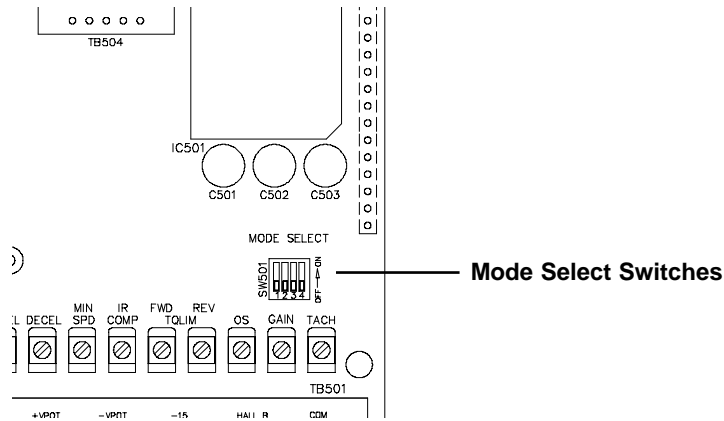


Figure 12. Mode Select Switches

TB504

TB504 is a 10-pin male connector used for non-isolated drive diagnostics outputs. See Figure 13 for connector location and Table 4 for pin functions.

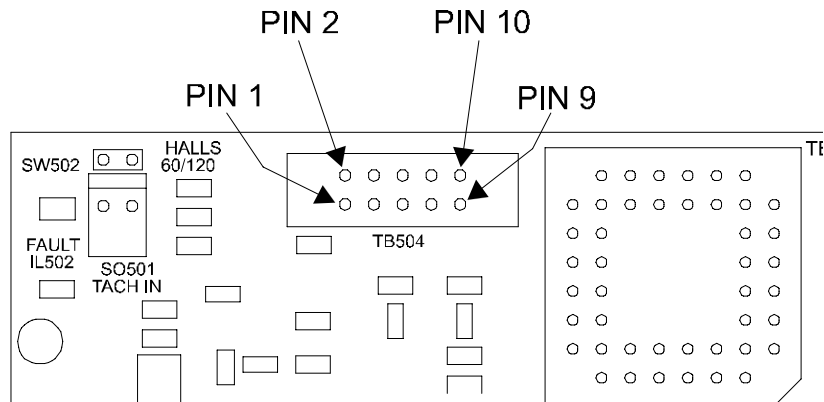
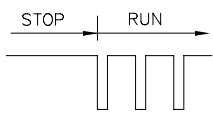
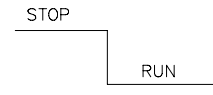
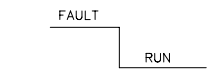
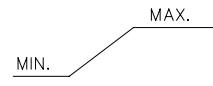
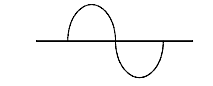
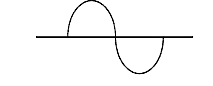
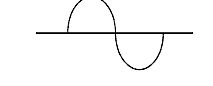


Figure 13. TB504 Pin Assignments

Table 4. TB504 Pin Functions

Pins	Description	Waveform
Pin 1- Tachometer Out	12 pulses per revolution, 5 VDC square wave output; proportional to motor speed.	
Pin 2- Run/Stop	0 VDC when Run/Stop switch is set for run; 5 VDC when Run/Stop switch is set for stop.	
Pin 3- Fault Out	5 VDC when the drive is in a fault condition.	
Pin 4- Circuit Common: ⚠ Do not connect to earth ground!	Circuit common. All other pins are referenced to circuit common. ↓	0 volts.
Pin 5- I_{AVG} Out	0–10 VDC output corresponding to the sum of all AC phase currents (AC phase currents are rectified, summed, then scaled to 0–10 VDC output).	
Pin 6- AC Current - Phase A	AC current in phase A is converted to voltage output (500 mV per amp AC).	
Pin 7- AC Current - Phase B	AC current in phase B is converted to voltage output (500 mV per amp AC).	
Pin 8- AC Current - Phase C	AC current in phase C is converted to voltage output (500 mV per amp AC).	
Pin 9 and 10 (not used)	No function	None.

Operation

Startup

1. Verify that no conductive material is present on the PCB.
2. Check that the ENABLE switch is in the enable position (closed).
3. Check that the $\overline{\text{BRAKE}}$ switch is in the run position (open).
4. Set the FWD/REV switch to the direction you want the motor to rotate upon startup.
5. Apply AC voltage input or DC voltage input to the drive.
6. Slowly advance the speed adjust potentiometer clockwise (CW) or increase the voltage signal. The motor slowly accelerates as the potentiometer is turned CW or the voltage is increased. Continue until the desired speed is reached.

To reverse motor direction:

Switch the FWD/REV switch to the opposite position. (To prevent possible demagnetization of the motor, consider braking the motor to a stop before reversing polarity. Once reversed, release the brake input.)

To brake the motor:

Close the $\overline{\text{BRAKE}}$ switch.

To coast the motor to a stop without disconnecting power:

Open the ENABLE switch.

Line starting and line stopping

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

Calibration

Boss Series drives have eleven user-adjustable trimpots. Each drive is factory calibrated to its maximum horsepower rating. Readjust the calibration trimpot settings to accommodate lower horsepower motors.

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

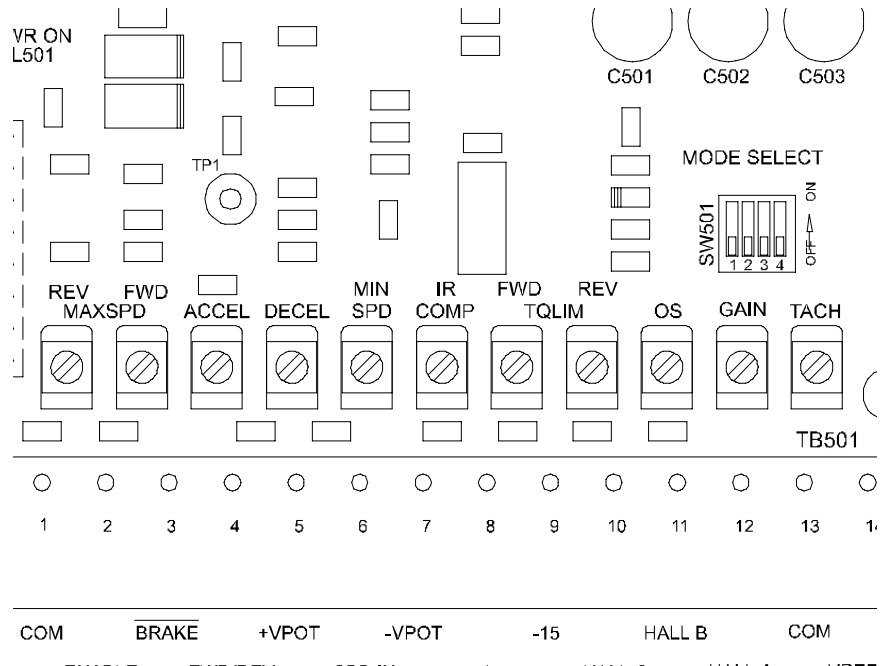


Figure 14. Calibration Trimpot Layout

FWD MAXSPD

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

To calibrate FWD MAXSPD:

1. Set the FWD MAXSPD trimpot full CCW.
2. Set the FWD/REV switch (if installed) to FWD. If no switch is installed, install a jumper between terminals 1 (COM) and 4 (FWD/REV) of TB501 .
3. Set the speed adjust potentiometer or voltage input signal for maximum speed.
4. Adjust the FWD MAXSPD trimpot to the desired maximum speed.

REV MAXSPD

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

To calibrate REV MAXSPD:

1. Set the REV MAXSPD trimpot full CCW.
2. Set the FWD/REV switch (if installed) to REV. If no switch is installed, remove the jumper between terminals 1 (COM) and 4 (FWD/REV) of TB501 .
3. Set the speed adjust potentiometer or voltage input signal for maximum speed.
4. Adjust the REV MAXSPD trimpot to the desired maximum speed.

MIN

The MIN setting determines the minimum speed when the speed adjust potentiometer or voltage input signal is set for minimum speed. It is factory set to zero speed.

To calibrate MIN SPD:

1. Set the MIN SPD trimpot to the center position (12 o'clock).
2. Set the speed adjust potentiometer or voltage input signal for minimum speed.
3. Adjust the MIN SPD trimpot to the desired minimum speed.

OS (zero offset)

The OS setting adjusts the zero offset voltage in the internal velocity loop. This affects the gain circuit which controls motor regulation. Calibrating OS requires a voltmeter to measure the zero offset voltage.

To calibrate OS:

1. Verify that there is no load on the motor.
2. Run the motor at any arbitrary speed (for example 1000 RPM).
3. Using a voltmeter, measure the voltage from circuit common to test point TP1.
4. Using a non-metallic screwdriver, calibrate the OS trimpot until the voltmeter reads approximately 0 VDC.

GAIN

The gain setting determines how much effect the OS setting will have on the regulation. Calibrate the gain trimpot only when the drive is operating in Velocity Mode.

Set the gain trimpot full CCW for minimum regulation, or full CW for maximum regulation. Test the motor gain by applying a load to the motor and checking the change in motor speed. The drive will maintain motor speed better with higher gain settings.

IR COMP

The IR COMP setting determines the maximum limit the drive can regulate. Calibrate the IR COMP setting only when the drive is operating in the Velocity Mode.

If the GAIN trimpot is set for full gain (full CW) and the drive still needs more regulation, increase the IR COMP setting CW. If the GAIN trimpot is set for full gain and the drive has too much regulation, decrease the IR COMP setting.

FWD TQLIM

The FWD TQLIM setting determines the maximum current limit for accelerating and driving the motor in the forward direction. It is factory set at 120% of rated motor current.

To calibrate FWD TQLIM:

1. With the power disconnected from the control, connect a AC ammeter in series with one of the motor phases.
2. Reapply power to the drive, and run the motor at 200 RPM in the forward direction.
3. Carefully stall the motor. The current limit value should register on the ammeter. If it does not, stall the motor again until the ammeter shows the current limit value.
4. Adjust the FWD TQLIM trimpot CW until the phase current is 120% of motor rated current.
5. Remove the stall from the motor.

REV TQLIM

The REV TQLIM setting determines the maximum current limit for accelerating and driving the motor in the reverse direction. It is factory set at 120% of rated motor current.

To calibrate REV TQLIM:

1. With the power disconnected from the control, connect a AC ammeter in series with one of the motor phases.
2. Reapply power to the drive, and run the motor at 200 RPM in the reverse direction.
3. Carefully stall the motor. The current limit value should register on the ammeter. If it does not, stall the motor again until the ammeter shows the current limit value.
4. Adjust the REV TQLIM trimpot CW until the phase current is 120% of motor rated current.
5. Remove the stall from the motor.

ACCEL

The ACCEL setting determines the time the motor takes to ramp to a higher speed in the forward direction or a lower speed in the reverse direction. ACCEL is factory set for the fastest acceleration time (full CCW).

To calibrate ACCEL:

1. Set the speed adjust potentiometer or voltage input signal for minimum speed. The motor should run at minimum speed.
2. Set the speed adjust potentiometer or voltage input signal to maximum forward speed, 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.

DECEL

The DECEL setting determines the time the motor takes to ramp to a higher speed in the reverse direction or a lower speed in the forward direction. DECEL is factory set for the fastest acceleration time (full CCW).

To calibrate DECEL:

1. Set the speed adjust potentiometer or voltage input signal for maximum forward speed. The motor should run at maximum speed.
2. Set the speed adjust potentiometer or voltage input signal for minimum speed 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.

TACH (for use with tachometer feedback only)

A DC tachometer can be used to augment the hall-effect feedback. Since a tachometer can generate an error voltage down to zero speed, the speed range can be widened considerably.

Calibrate the TACH setting only when a tachometer is used. The TACH setting determines the degree to which motor speed is held constant as the motor load changes.

To calibrate the TACH trimpot:

1. Connect the tachometer to the TACH IN header (SO501).
2. Set the MODE SELECT switch (SW501) for armature feedback as follows:
Set switches 1 and 4 to ON. Set switches 2 and 3 to OFF.
3. Run the motor at full speed. Measure the armature voltage across A1 and A2 using a voltmeter.
4. Run the motor at either minimum speed or zero speed
5. Set the MODE SELECT switch (SW501) for tach feedback as follows:
Set switch 1 to ON. Set switches 2, 3 and 4 to OFF.
6. Set the IR COMP trimpot full CCW.
7. Set the TACH trimpot full CW.
8. Run the motor at full speed.
9. Adjust the TACH trimpot until the armature voltage is the same value as the voltage measured in step 3.

Check that the tachometer is properly calibrated. The motor should run at the same set speed when SW501 is set to either armature or tachometer feedback.

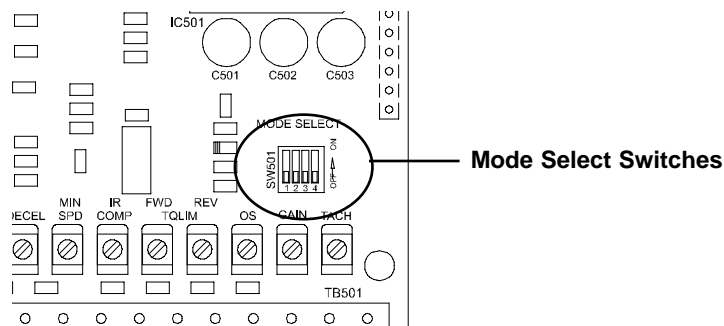


Figure 15. Mode Select Switches

Application Notes

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.

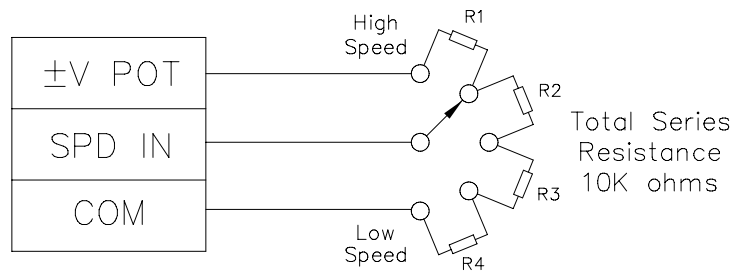


Figure 16. Multiple Fixed Speeds

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

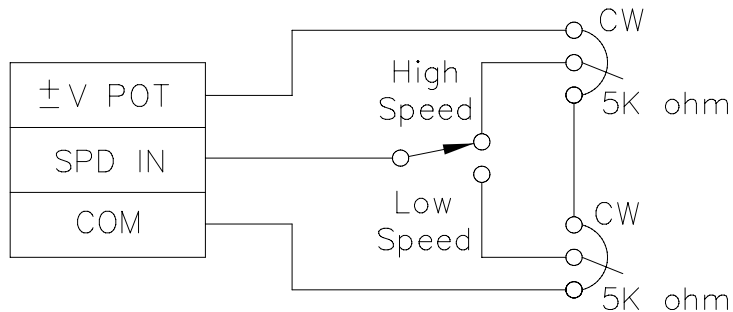


Figure 17. Adjustable Speeds Using Potentiometers in Series

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

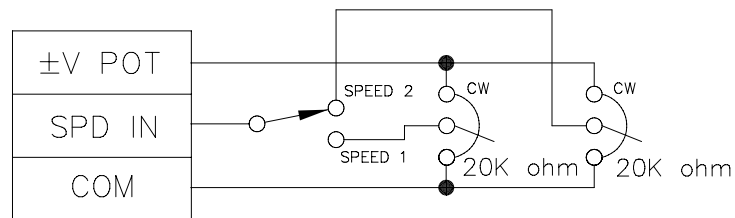


Figure 18. Independent Adjustable Speeds

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 AC or DC 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
- 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.

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

1-800-MINARIK (646-2745) or Fax: 1-800-394-6334

Diagnostic LEDs

Diagnostic LEDs on the 4Q plug-in card:

POWER ON The green POWER ON LED lights when power is applied to the drive and the plug-in card is connected properly.

FAULT The red FAULT LED lights in any of the following conditions:

1. The hall sensors are miswired, not operating properly, demand more than 20 mADCcurrent @ +5V, or not properly nulled.
2. The drive reaches its peak phase current limit.
3. The drive has insufficient AC or DC power.
4. The enable switch is open (drive is disabled).
5. The drive reaches maximum bus voltage limit.

Diagnostic LEDs on the motherboard:

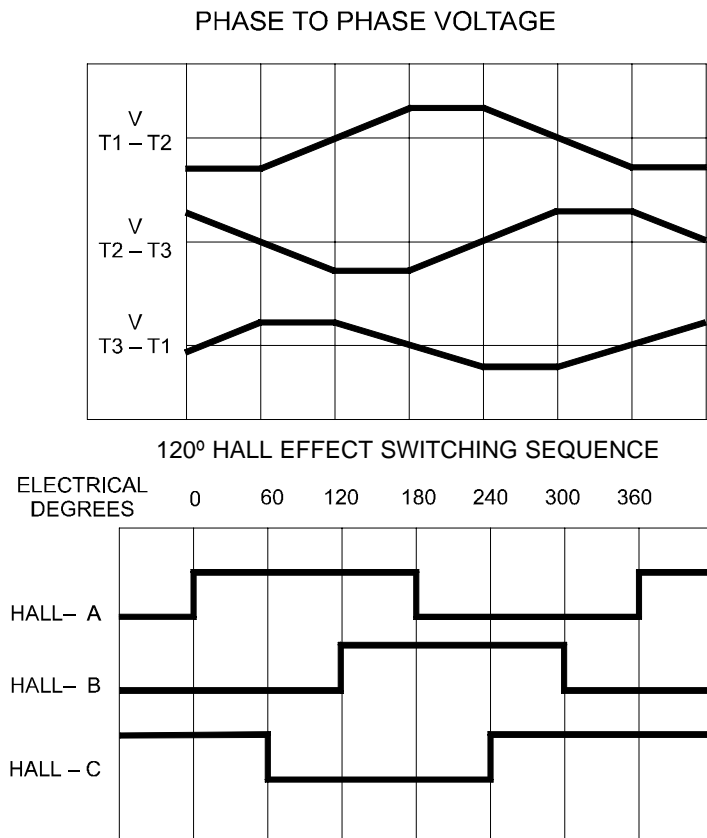
BUS LIMIT The red BUS LIMIT LED lights when the drive exceeds maximum bus voltage.

Problem	Possible Causes	Suggested Solutions
Line fuse blows	<ol style="list-style-type: none"> 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 (i.e. reversing). 	<ol style="list-style-type: none"> 1. Check that line fuses are properly sized for the motor being used. 2. Check motor cable and armature for shorts. 3. Add a blower to cool the drive components; increase FWD TQLIM or REV TQLIM settings.
Line fuse does not blow, but the motor does not run	<ol style="list-style-type: none"> 1. Speed adjust potentiometer or voltage input signal is set to zero speed. 2. Speed adjust potentiometer or voltage input signal is not connected to drive input properly; connections are open. 3. <u>ENABLE</u> terminal is open; <u>BRAKE</u> terminal is shorted to COM. 4. Drive is in current limit. 5. Drive is not receiving AC voltage input or DC voltage input. 6. Motor is not connected. 7. Hall sensors not connected 8. Encoder requires more than 20 mA DC to run. 	<ol style="list-style-type: none"> 1. Increase the speed adjust potentiometer setting or voltage input signal. 2. Check connections to input. Verify that connections are not open. 3. Check connections. 4. Verify that motor is not jammed. Increase FWD TQLIM or REV TQLIM setting if they are set too low. 5. Apply AC line voltage to L1 and L2, or DC voltage input to +VDC or -VDC. 6. Check motor connections. 7. Connect hall sensors. 8. Connect separate power supply which can provide sufficient voltage and current to sensors. NOTE: Voltage must be floating (isolated)!

Problem	Possible Causes	Suggested Solutions
Motor runs too slow or too fast at set speed	<ol style="list-style-type: none"> 1. Switches or jumpers are set incorrectly. 2. MIN SPD, FWD MAXSPD, and REV MAXSPD are not calibrated. 3. Hall sensors miswired. 	<ol style="list-style-type: none"> 1. Verify all switch and jumper settings. 2. Calibrate MIN SPD , FWD MAXSPD, and REV MAXSPD. 3. Check hall sensor connections.
Motor will not reach the desired speed	<ol style="list-style-type: none"> 1. MAXSPD, and REV MAXSPD settings are too low. 2. GAIN and IR COMP setting is too low. 3. Motor is overloaded. 4. Hall sensors miswired. 	<ol style="list-style-type: none"> 1. Increase MAXSPD, and REV MAXSPD settings. 2. Recalibrate GAIN and IR COMP settings. 3. Check motor load. Resize the motor if necessary. 4. Check hall sensor connections.
Motor pulsates or surges under load	<ol style="list-style-type: none"> 1. GAIN is set too high. 2. Motor "bouncing" in and out of torque limit. 	<ol style="list-style-type: none"> 1. Adjust the GAIN setting slightly CCW until the motor speed stabilizes. 2. Make sure motor is not undersized for load; adjust FWD TQLIM and REV TQLIM settings.
Motor does not reverse	<ol style="list-style-type: none"> 1. Bad FWD/REV switch connection. 2. Reversing circuit not working properly. 3. Hall sensors miswired. 	<ol style="list-style-type: none"> 1. Check FWD/REV switch connection. 2. Check reversing circuit by shorting FWD/REV terminal to COM terminal with jumper wire. 3. Check hall sensor connections.

For additional assistance, contact your local Minarik® Distributor, or the factory direct: phone (702) 823-9475 or fax: (702) 823-9495

Commutation Sequence Diagram



FOR CLOCKWISE ROTATION VIEWING MOTOR FROM MOUNTING FACE

Figure 19. Commutation Sequence Diagram

Replacement Parts

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

Model No.	Symbol	Description	Minarik P/N
BOSS15-115AC-4Q		Four Quadrant Plug-In Card	4Q
	BR501	Power Bridge	073-0010
	Q501-506	300V 35A MOSFET	070-0054
	Q507	IRFP440 MOSFET	070-0077
	C507-508	1500 μ F, 250VAC Capacitor	011-0089
		10K Ω , 5W Potentiometer	120-0009
	14 Pin Terminal Plug	160-0136	
BOSS08-115AC-4Q		Four Quadrant Plug-In Card	4Q
	BR501	Power Bridge	073-0010
	Q501-506	300V 35A MOSFET	070-0054
	Q507	IRFP440 MOSFET	070-0077
	C507-508	1000 μ F, 200VAC Capacitor	011-0096
		10K Ω , 5W Potentiometer	120-0009
	14 Pin Terminal Plug	160-0136	
BOSS04-115AC-4Q		Four Quadrant Plug-In Card	4Q
	BR501	Power Bridge	073-0010
	Q501-506	300V 35A MOSFET	070-0054
	Q507	IRFP440 MOSFET	070-0077
	C508	1000 μ F, 200VAC Capacitor	011-0096
	C507 not used	10K Ω , 5W Potentiometer	120-0009
	14 Pin Terminal Plug	160-0136	
BOSS08-D240AC-4Q		Four Quadrant Plug-In Card	4Q
	BR501	Power Bridge	073-0010
	Q501-506	INXFH26N50 MOSFET	070-0079
	Q507	IRFP440 MOSFET	070-0077
	C507-508	1000 μ F, 400VAC Capacitor	011-0099
		10K Ω , 5W Potentiometer	120-0009
	14 Pin Terminal Plug	160-0136	
BOSS04-115AC-4Q		Four Quadrant Plug-In Card	4Q
	BR501	Power Bridge	073-0010
	Q501-506	INXFH26N50 MOSFET	070-0079
	Q507	IRFP440 MOSFET	070-0077
	C508	1000 μ F, 400VAC Capacitor	011-0099
	C507 not used	10K Ω , 5W Potentiometer	120-0009
	14 Pin Terminal Plug	160-0136	
Fuse Kits		3-8A Fuse Kit	050-0069
		5-20A Fuse Kit	050-0073
12" Ribbon Cable			134-0038

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.

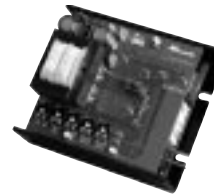
Other drives from Minarik Corporation:



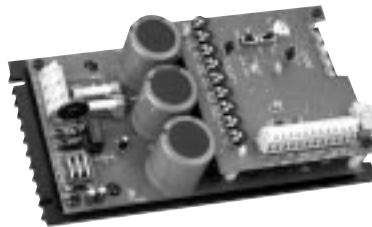
NRG-2Q Series



RG5500U



MMRG Series



NRG-4Q Series



901 E Thompson Avenue
Glendale, CA 91201-2011
Tel.: 1-800-MINARIK (646-2745)
Fax: 1-800-394-6334
www.minarikcorp.com

Document number 250-0253, Revision 4
Printed in the U.S.A - 2/99

\$11.00 North America - \$12.00 Outside North America