HAMPTON

Installation,Operation and
Maintenance Manual

Vari Speed®R400
DC Motor Control

TABLE OF CONTENTS

INTRODUCTION

SAFETY

This equipment should be installed, adjusted and serviced by qualified electrical maintenance personnel familiar with the construction and operation of this type of equipment and the hazards involved.

It is the responsibility of the user or the person installing the controller to take diligent care, read all warnings and notes before proceeding to install or operate this control.

WARNING:

Improper installation of motor and controller may cause equipment failure and or serious personal injury. Follow the instructions and local, state and national safety codes for proper installation. Always disconnect power to the controller before making any wiring changes, or before inspecting equipment which the unit is controlling. It is the responsibility of the user or the person installing the controller to provide proper grounding and branch circuit protection for incoming power and motor overload according to National Electrical Codes (NEC) and local codes.

FEATURES

- Full wave DC regenerative control with excellent speed and torque performance for controlling the motor speed and torque for permanent magnet DC brush motors up to two horsepower

  The capability of frequently stopping and reversing the motor without the need of a dynamic brake resistor

  Allows the motor 4-quadrant operation with the ability to apply forward and reverse torque in both speed directions

  Isolation for all signal inputs

- Dual input voltage selection

- Fractional to two horsepower output

SPECIFICATIONS

CONTROL PARAMETERS

Parameter	Specification
Input	
Line voltage, single phase	120 or 240VAC (± 10%)
Line current max	15 Amp [3 Amp]*
Line frequency	50 or 60Hz
Output	
Armature current max. continuous	10.8 Amps DC [2 Amp]*
Motor rating at 120VAC	1/4-1 HP [1/30-1/8 HP]*
Motor rating at 240VAC	1/4-2HP [1/20-1/4 HP]*
Armature voltage at 120VAC	0 to ± 100VDC
Armature voltage at 240VAC	0 to ± 200VDC
Service factor	1.0
Overload for 1 minute	150%
Field Voltage at 120VAC (optional)	100VDC nominal
Field Voltage at 240VAC (optional)	200VDC nominal
Field current max. continuous (optional)	1.0 Amp DC
Performance	
Speed Range:	
Arm feedback @ full load	1:100
Tach feedbach @ full load	1:250
Speed Regulation:	
Arm feedback @ 95% load change	± 0.75 (% of base speed)
Tach feedback @ 95% load change	± 0.5 (% of set speed or 4RPM which ever is greater)
Linearity	± 0.3%
Formfactor at full load	1.25
Torque:	
Range @ full Load	1:100
Regulation @ 95% speed change	± 2 (% of base torque)

* NOTE: Values in [are for special fractional HP controllers only.

CONTROL PARAMETERS (CONTINUED)

Parameter	Specification
Adjustments	
Minimum speed	0 to 50 (% of rated output)
Maximum speed	50 to 100 (% of rated output)
Forward and Reverse acceleration	0.15 to 8 (Sec.)
FWD and REV current limit	0 to 150 (% of full load)
Current compensation IR	0 to 25 (% of rated output)
Stability regulation	
Process Signal Input and Output (all signal inputs are isolated)	
Voltage following input range	0 to ± 10 VDC (30KOhm input impedance)
Speed potentiometer input	2.5 to 5KOhm, 1/4w
Tach Input for 1800RPM motor	7 or 20.8 VDC/1000RPM
Input Logic	
Start (Active high 20.4-27.6)	2.3KOhm input impedance
Stop (Active low 0-4.0 VDC)	3.8KOhm
Disable (Active low 0-4.0 VDC)	3.4KOhm
Alarm Output	
Open collector transitor	
NPN (sinking)	75mA at 30VDC
24V Output for Alarm	Max 50mA
Ambient Temperature	
(mounted vertically)	0 to 55 °C

CONTROL PRINCIPLE, FOUR QUADRANT CONTROL

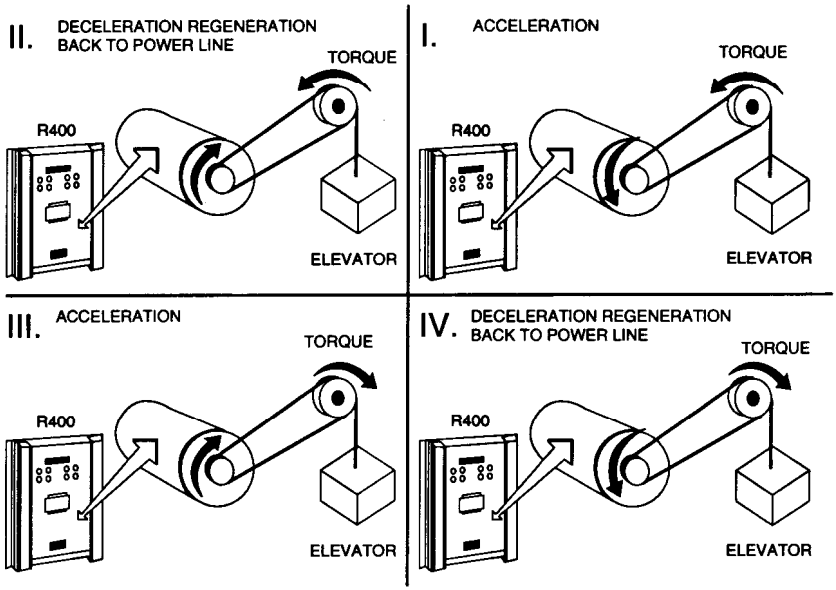
EXAMPLE: ELEVATOR APPLICATION

Quadrant I, Forward motor rotation; forward torque:
When the elevator is accelerating in an upward direction, The torque and speed are in the same direction.

Quadrant II, Reverse motor rotation; forward torque:
When the elevator is decelerating in a downward direction the speed of the elevator is also going downward, but the torque is in the opposite direction and is braking the speed of the elevator. The motion energy from the elevator, motor and gravity are being regenerated back to the power line.

Quadrant III, Reverse motor rotation; reverse torque:
When the elevator is accelerating (faster than the gravity) in downward direction, the torque and speed are in the same direction.

Quadrant IV, Forward motor rotation; reverse torque:
When the elevator is decelerating in an upward direction the speed of the elevator is still going upward, the torque is in the oposite direction and is braking the speed of the elevator. The motion energy from the elevator and motor are being regenerated back to the power line.



CONTROL PRINCIPLE, FOUR QUADRANT CONTROL

Switching from an upward direction to stop,
Quadrant I to IV;
When the elevator is accelerating in an upward direction and the Vari Speed R400 is given a stop command, the motor is forced into quadrant IV operation and the energy flow from the motor is regenerated back to the power line.

Switching from an downward direction to stop,
Quadrant III to II;
When the elevator is accelerating in a downward direction and the Vari Speed R400 is given a stop command, the motor is forced into quadrant II operation and the energy flow in the motor is regenerated back to the power line.

Switching from an upward to a downward direction,
Quadrant I to III via IV;
When the elevator is accelerating in an upward direction and the Vari Speed R400 is given a command for a downward direction, the motor is forced into quadrant IV, where the elevator is brought to a stop before the Vari Speed R400 takes the elevator to a downward direction.

Switching from a downward to an upward direction,
Quadrant III to I via II;
When the elevator is accelarting in a downward direction and the Vari Speed R400 is given a command for upward direction, the motor is forced into quadrant II, where the the elevator is brought to a stop before the Vari Speed R400 takes the elevator to an upward direction.

SPEED AND TORQUE CONTROL

The Vari Speed R400 can be operated as either a speed or a torque control.

In Speed Mode, a potentiometer or other analog reference will control the speed of the motor shaft.

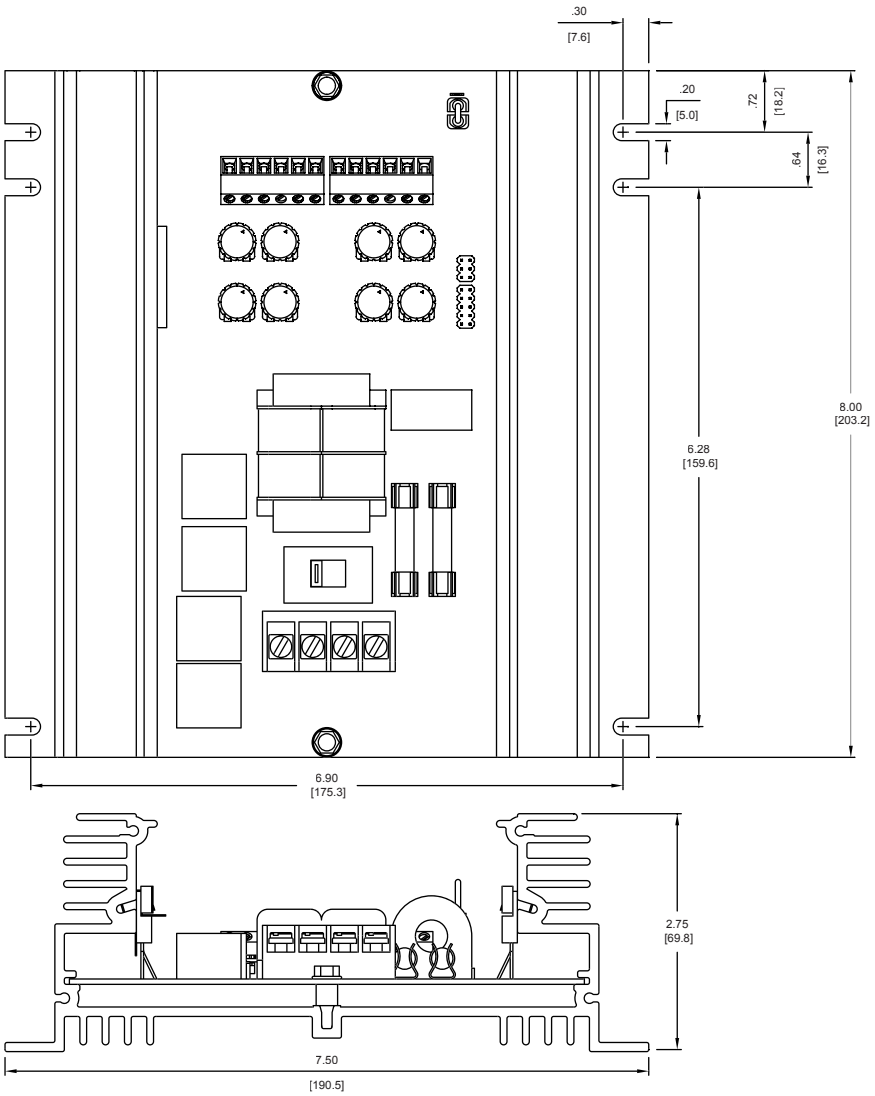
In Torque Mode, a potentiometer or other analog reference will control the torque of the motor shaft.

CAUTION: In Torque Mode without load the speed will only be limited by the setting of the current limit pots REV CL or FWD CL and the input line voltage.

Refer to detailed description of speed and torque selection in the Adjustments section of this manual.

INSTALLATION

The Vari Speed R400 should be mounted vertically in order to insure maximum heatsink efficiency.
NOTE: A minimum clearence of 2 inches on all four sides of the heatsink is required for proper airflow.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.20
[5.0]
.72
[18.2]
.64
[16.3]
8.00
[203.2]
6.28
[159.6]
6.90
[175.3]
2.75
[69.8]
7.50
[190.5]

POWER AND MOTOR CONNECTION

This equipment should be installed, adjusted and serviced by qualified electrical maintenance personnel familiar with the construction and operation of this type of equipment and the hazards involved.

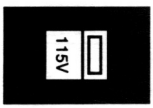
It is the responsibility of the user or the person installing the controller to take diligent care, read all warnings and notes before proceeding to install or operate this control.

> WARNING:
> Improper installation of motor and controller may cause equipment failure and or serious personal injury. Follow the instructions and local, state and national safety codes for proper installation. Always disconnect power to the controller before making any wiring changes, or before inspecting equipment which the unit is controlling. It is the responsibility of the user or the person installing the controller to provide proper grounding and branch circuit protection for incoming power and motor overload according to National Electrical codes (NEC) and local codes.

Two 20 Amp 250 VAC supplemental fuses are provided on the board.
Two 5 Amp 250 VAC supplemental fuses are provided on 176B8013

> WARNING:
> Verify that the SW1 AC Line Voltage Selector Switch is set for the appropriate AC line voltage before applying power. Damage to control could result if not properly set.

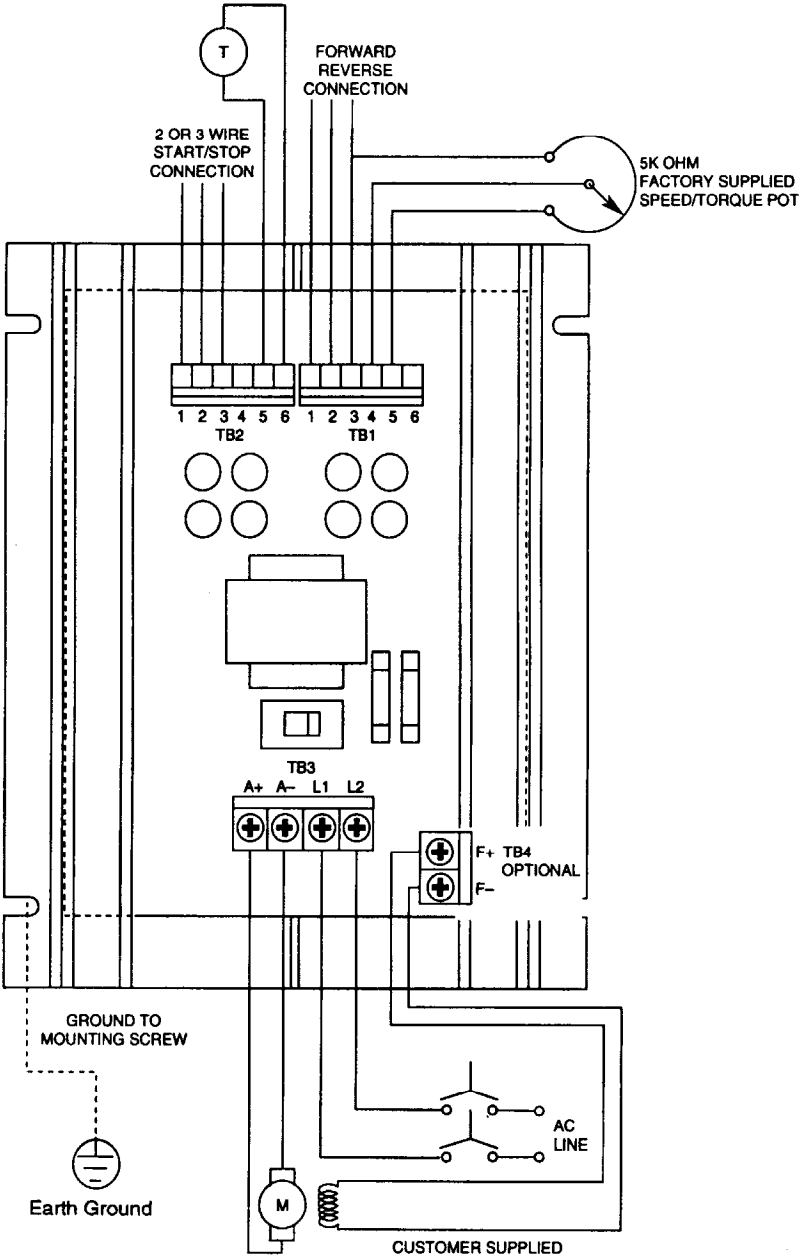
SW1



120V Line voltage and
90V motor connection

240V Line voltage and
180V motor connection

GENERAL WIRING



RECOMMENDED AC LINE PROTECTION

AC Line Voltage	Motor Horsepower	Semiconductor Fuse Amps	Use Bussman
	1/30-1/8	4	FWX4 A14F
	1/4	4	FWX4 A14F
120	1/3	5	FWX5 A14F
	1/2	10	FWX10 A14F
	3/4	15	FWX15 A14F
	1	20	FWX20 A14F
	1/20-1/4	4	FWX4 A14F
	1/2	4	FWX4 A14F
240	3/4	5	FWX5 A14F
	1	10	FWX10 A14F
	1-1/2	15	FWX15 A14F
	2	20	FWX20 A14F

Two 20 Amp, 250VAC Littelfuse 314's are provided on the board. (Two 5 Amp, 250VAC Littelfuse 314's are provided on 1/30-1/8 and 1/20-1/4 HP units.)

The Vari Speed R400 has a 5000 Amp short circuit rating when protected by the above fuses.

WARNING:
Improper installation of motor and controller may cause equipment failure and or serious personal injury. Follow the instructions and local, state and national safety codes for proper installation. Always disconnect power to the controller before making any wiring changes, or before inspecting equipment which the unit is controlling. It is the responsibility of the user or the person installing the controller to provide proper grounding and branch circuit protection for incoming power and motor overload according to National Electrical codes (NEC) and local codes.

THREE WIRE START/STOP CONNECTION

The disable and stop contact must be a normally closed contact. The Run contact must be a normally open contact.

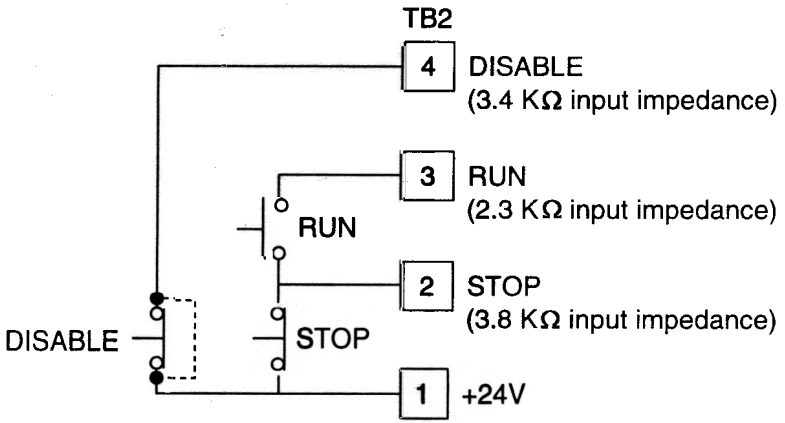
With the Disable contact momentarily opened the drive will brake the motor to zero speed as fast as possible and will not be ready for Start until the Disable contact is closed again and the Stop contact is momentarily opened.

With the Disable contact closed, momentarily open the Stop contact, the motor will stop following the decel ramp.

With the Disable and Stop contacts closed, momentarily close the Start contact, the motor will follow the accel ramp up to the set speed.

With the Run contact closed the motor speed can be adjusted with the speed potentiometer.

NOTE:
If a Disable contact is not used terminals 1 and 4 must be jumpered together.
PLC and PC with relay output card can be connected.



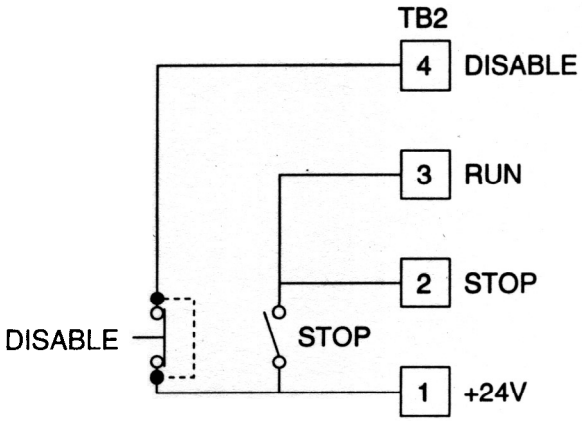
TWO WIRE START/STOP CONNECTION

The Disable contact must be a normally closed contact. The Run/Stop contact must be a On/Off contact.

With the Disable contact momentarily opened the drive will brake the motor to zero speed as fast as possible and will not be ready for start until the Disable contact is closed again and the Run/Stop contact is momentarily opened.

With the Disable contact closed, open the Run/Stop contact, the motor will will follow the decel ramp to a stop.

NOTE:
If a Disable contact is not used terminals 1 and 4 must be jumpered together.

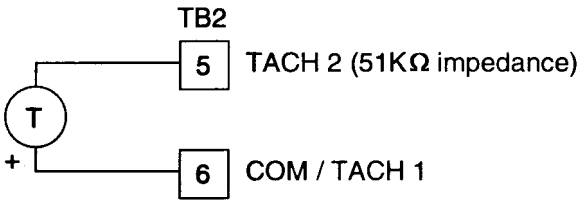


TACH FEEDBACK CONNECTION

NOTE:
Turn IR Compensation full counter-clockwise when using Tach feedback.

Connect the positive (+) voltage from the DC tach to TACH 1 and the negative (-) voltage from the tach to TACH 2 of terminal block TB2.

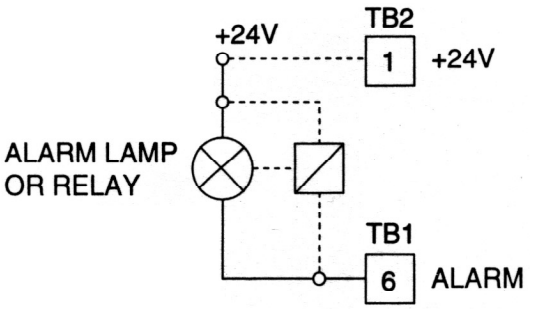
WARNING:
Incorrect connection of the tach leads to the control will cause the motor to go to Max. speed.



ALARM OUTPUT CONNECTION

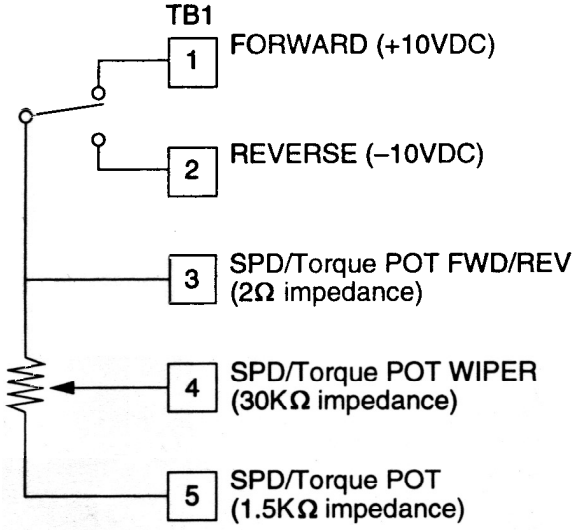
The Alarm output (ALARM) on terminal block TB1 is active low when the drive is in current limit.

The Alarm terminal is an open collector and can sink 75mA. Maximum 50mA load is allowed if terminal (+24V) on terminal block TB2 is used as a supply for the alarm.

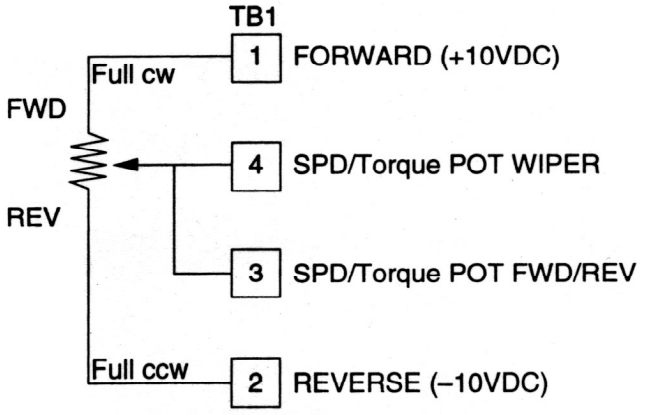


POTENTIOMETER CONNECTION

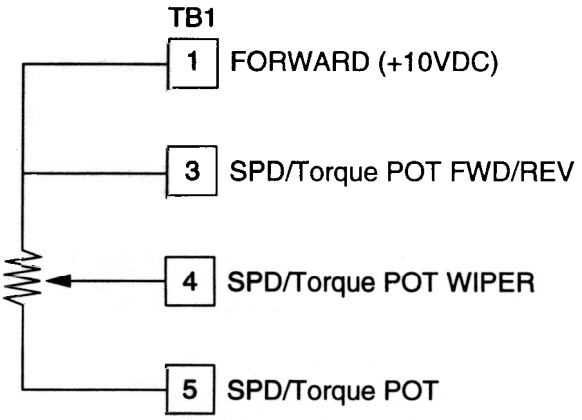
Bidirectional (with switch) operation example:
A speed or torque adjustment potentiometer can be wired with an external switch. This will operate the motor shaft in a forward or reverse direction, in speed or torque applications.



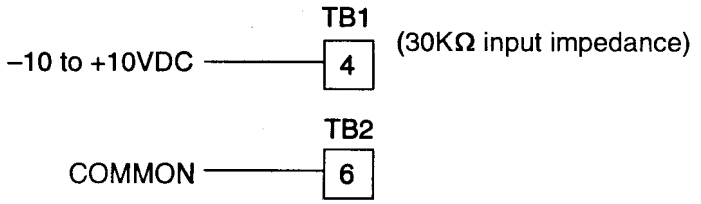
Bidirectional (without switch) operation example:
Directional changes of the motor shaft in speed or torque operations is accomplished by adjusting the potentiometer.
(The Min. pot can not be used).



Unidirectional operation example:
For operation of the motor shaft in forward direction, in speed and torque applications



External analog voltage input example:
A positive voltage connected to TB1, 4 will operate the motor shaft in a forward direction, in a speed or torque application.
A negative input voltage at TB1, 4 will operate the motor shaft in a reverse direction, in speed or torque applications.
(The Min. pot can not be used.)



OPERATION

Indicator LED Functions:
LED1 (Green); on when the drive is ready to run,
LED2 (Red); on when the drive is in current limit,
LED3 (Yellow); on when the drive is disabled,
LED4 (Green); on when the control has power on.

ADJUSTMENTS

NOTE: Before making any adjustments, start control and run the motor fully loaded for at least 15 minutes so that the motor temperature will stabilize. (Motor speed will increase as temperature increases unless tachometer feedback is used.) After the stabilization of the motor's temperature, proceed with the adjustments in the following order:

Current Limit [CL], (clockwise increases current)

Two each are available for adjusting FWD/REV current limit in the speed or torque mode.

Speed Method:
1. Start the machine in FWD operation and apply maximum load to the motor, and turn FWD Current Limit trimpot fully clockwise.
2. Turn the Current Limit trimpot counter-clockwise until the Current Limit LED (red) lights, and the machine starts to slow down.
3. Turn the Current Limit trimpot clockwise until the Current Limit LED (red) just turns off.
4. Repeat steps 1, 2 and 3 in REV Speed direction if it is a bidirectional application.

Torque Method:
1. Start the R400 and the machine.
2. Turn the Torque pot to the desired load.
3. Turn the Current Limit trim pot ccw slowly until the motor slows down and the CL LED (red) comes on.
4. Turn the Current Limit trimpot cw until the Current Limit LED (red) turns off.

IR Compensation [IR] (clockwise increases compensation)

NOTE: For torque control, turn IR to full minimum (ccw). IR Compensation is not used with tachometer feedback be sure that this adjustment is set and left in the full counter-clockwise position. In order to optimize speed performance with this adjustment, some means of determining motor shaft speed is required (i.e., hand-held tachometer). This adjustment is provided to overcome the motors natural tendency to slow down with increasing load while operating in the speed mode.

1. Set motor speed to one-half of base speed rating.
2. Load motor to 100% nameplate current or maximum application rating whichever is less.
3. Turn IR clockwise until motor speed returns to original unloaded RPM.
4. Remove load and notice if RPM increases beyond original setting. If so, adjust trimpot while changing from no load to full load to achieve the minimum RPM fluctuation during the load change.

NOTE: Setting IR adjust too high can create motor instability. Adjust IR pot ccw until motor speed stability is achieved.

Minimum Speed/Torque [MIN] (clockwise increases)

1. Produce a 0% input command by turning the speed/torque pot fully counter-clockwise (ccw) or providing a 0 VDC input on 4 of TB1 whichever is appropriate.
2. Produce a Run condition.
3. Adjust MIN trimpot until desired minimum speed/torque is set. If desired minimum is zero, adjust trimpot so that the motor barely stops turning or 0 voltage exists on armature. (This will give the best motor response.)
4. MINIMUM may be adjusted from 0 to 50% of motor base speed/ torque. This concludes the MIN adjustment, it is recomended to set the MAX adjustment as outlined next.

Maximum Speed/Torque [MAX] (clockwise increases)

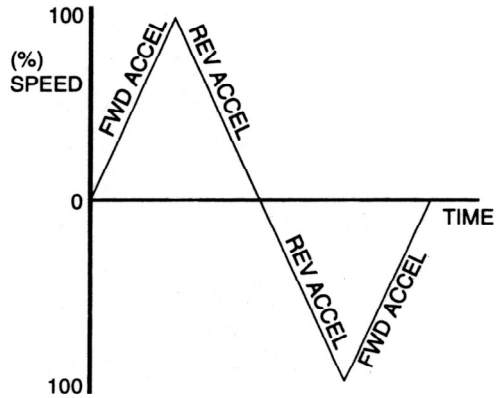
1. Produce a 100% input command by adjusting the Speed/Torque pot full clockwise (cw) or provide a 10 VDC signal on 4 of TB1, which ever is appropriate.
2. If the control is not already running, produce a run command.
3. Adjust the MAX trimpot until desired maximum speed/torque is set.

NOTE: Extended motor speed/torque can be achieved with the trimpot. MAX may be adjusted from 50% of motor base speed/torque to approximately 110% of base speed/torque. Caution should be taken not to exceed maximum motor nameplate ratings.

Forward and Reverse Acceleration (FWD ACCEL, REV ACCEL)

The FWD ACCEL trimpot determines the amount of time it takes the control voltage to reach full ouput in the forward direction. It also determines the amount of time it takes the control voltage, in the reverse direction, to reach zero output. (FWD ACCEL is the Reverse Decel.)

The REV/ACCEL trimpot determines the amount time it takes the control voltage to reach full output in the reverse direction and time it takes for the control voltage, inthe forward direction, to reach zero output. (REV ACCEL is the Forward Decel.)



The FWD and REV ACCEL trimpots are factory adjusted to 3.5 sec. The acceleration times are adjustable to a maximum of 8 seconds.

NOTE: The FWD and REV CL trimpots may override the rapid accel and decel settings.

Stability potentiometer (PT5)

The STAB pot is used to adjust the dynamic response of the speed regulator of the drive. The speed regulator constantly compares the speed reference and feedback signals. If there is any discrepency (caused by the variation of the reference, load, etc.) between the two signals, the regulator will try to eliminate it.

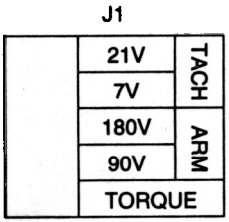
The response of the regulator will be faster and stronger (smaller time constant and higher gain) when the pot is turned more counter-clockwise. In general, this will result in better dynamics. However, too sharp a response may cause instability, that is, the regulator may over-react , sometimes may not be able to find a balance point.

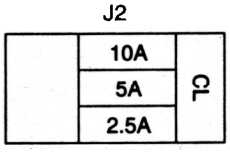
Adjustment may be done by starting the drive several times with the PT5 turned more ccw every time until unstable operation occurs, then turning PT5 back a little to make the operation stable. PT5 should be turned more ccw with heavier load, higher inertia or faster cycling. In torque mode, PT5 has little effect. It may be turned to fully ccw.

SETTING SELECTOR JUMPER J1 AND J2:

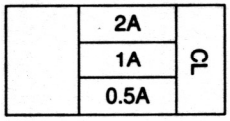
With the J1 jumper you have the option to select **one** of the following settings;

- Speed Mode, two tachometer feedback voltages:
  - 7V at 1000 RPM motor speed
  - 20.8V at 1000 RPM motor speed
- Speed Mode, two armature feedback voltages:
  - 90V at 120VAC line input
  - 180V at 240VAC line input
- Torque Mode: one selection
  - Torque





SPECIAL FRACTIONAL HP UNITS



With the J2 jumper you have the option to select 2.5, 5.0 and 10 Amp motors. Only one setting is possible at a time:

Armature Voltage	AC line Voltage	Max Motor Size	Selector Position
90VDC	120VAC	1/4HP [1/30HP]*	2.5A [0.5]*
90VDC	120VAC	1/2HP [1/6HP]*	5A [1.0A]*
90VDC	120VAC	1HP [1/8HP]*	10A [2.0A]*
180VDC	240VAC	1/2HP [1/16HP]*	2.5A [0.5A]*
180VDC	240VAC	1HP [1/8HP]*	5A [1.0A]*
180VDC	240VAC	2HP [1/4HP]*	10A [2.0A]*

* NOTE: Values in brackets [ ] are for special fractional HP controllers only.

TROUBLESHOOTING GUIDE

This guide is intended to be used as an aid in determining the failed component in a system.

If you require assistance call 724-861-0150 or FAX 724-861-0160.

Motor will not run:

1. Is the Power LED4 (green) on? If it is go to step #5.
2. Check that the AC line circuit breaker and/or line fuses are OK.
3. Check that the Voltage Selector switch on the PCB is in the proper position for the AC line voltage being used.
4. Check with a DC voltmeter the voltage between "+24V" (TB2,1) and "COM" (TB2,6), if it less than 20VDC, there is a possible drive failure.
5. Start the drive, is the "Run" LED1 on? If it is go to Step 8.
6. Be sure the 2 and 3 wire Start/Stop and Disable connection and the push button have the right function.
7. Check to see that the potentiometer connection, the direction switch and the speedpot command speed are properly installed.
8. Verify that the CL (red) LED2 is not on and that the current selector J2 is in the right position.
9. Check the motor and the motor wiring.

Circuit Breaker tripping or fuses blowing on power up:

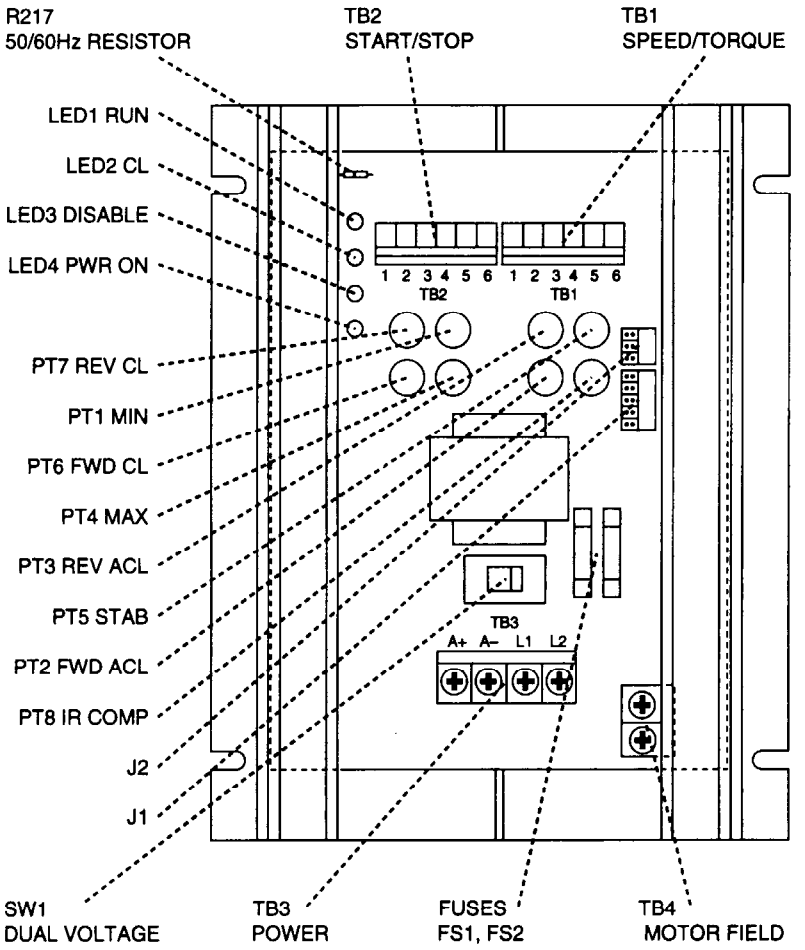
1. Check wiring for shorts or shorts to ground, also in the motor wiring.
2. Check for worn or improperly seated motor brushes.
3. Check the line voltage selector switch for the proper setting.
4. Possible defective control, contact factory.

Fuse blowing:

1. Check wiring for shorts or shorts to ground, also in the motor wiring.
2. Check for worn or improperly seated motor brushes.
3. Is motor load too heavy? Check for jam-up, or excessive load.
4. Possible defective control, contact factory.

No motor control:

1. Check Speed/Torque pots, wiring and resistance value.
2. Feedback selector J1 not set properly.
3. Tach feedback does not have proper polarity.
4. Possible defective control, contact factory.


R217
50/60Hz RESISTOR
TB2
START/STOP
TB1
SPEED/TORQUE
LED1 RUN
LED2 CL
LED3 DISABLE
LED4 PWR ON
PT7 REV CL
PT1 MIN
PT6 FWD CL
PT4 MAX
PT3 REV ACL
PT5 STAB
PT2 FWD ACL
PT8 IR COMP
J2
J1
1 2 3 4 5 6
TB2
1 2 3 4 5 6
TB1
TB3
A+ A– L1 L2
SW1
DUAL VOLTAGE
TB3
POWER
FUSES
FS1, FS2
TB4
MOTOR FIELD