C H A P T E R ②

Installation

Complete the following installation steps before you use the OEM670/OEM675 drive.

INSTALLATION STEPS

① Verify shipment is correct.
② Install selectable resistors.
③ Mount the drive.
④ Mount the motor.
⑤ Connect the motor to the drive.
⑥ Connect inputs, outputs, and controller.
⑦ Connect a power supply to the drive.
⑧ Tune the drive (OEM670SD/OEM675SD only).

The sections in this chapter give basic instructions about how to complete each of these steps.

OEM670/OEM675 SHIP KIT

Inspect the OEM670/OEM675 upon receipt for obvious damage to its shipping container. Report any damage to the shipping company. Parker Compumotor cannot be held responsible for damage incurred in shipment. You should receive one or more drives, depending upon what you ordered. Compare your order with the units shipped.

Component	Part Number
OEM670 or OEM675 Drive	OEM670T, OEM675T, OEM670SD, OEM675SD
Resistor Kit	73-016979-01
Accessories	
OEM670/OEM675 User Guide	88-013599-01
Heatsink	OEM -HS1

User guides are not sent with each product. They are available upon request. Please order user guides as needed.

The following SM and NeoMetric Series servo motors are designed to be used with the OEM670/OEM675. Compare your order with the motors shipped.

Motor Size	Part Number
Size 16	SM160A, SM160B, SM161A, SM161B SM162A, SM162B
Size 23	SM230A, SM230B, SM231A, SM231B, SM232A, SM232B, SM233A, SM233B
Size 34	NO341D, NO341F, NO342E, NO342F
Size 70mm	NO701D, NO701F, NO702E, NO702F

INSTALLING SELECTABLE RESISTORS

You must install four resistors into sockets on the OEM670/OEM675's circuit board. Three of these are *foldback resistors*; they determine the parameters for the current foldback circuit, which can protect your motor from overheating due to prolonged high currents. The fourth resistor is a *response resistor*—it affects the gain and frequency response of the current loop.

The drive you ordered determines whether or not resistors are installed when it arrives:

OEM670 – Ships from factory with resistors installed. These resistors are not appropriate for most applications. You *must* select other resistors and install them in the drive.

OEM675 – Ships from factory without resistors installed. You must select and install resistors for the drive to work.

A resistor kit for use with Compumotor SM and NeoMetric Series motors is included with the drive. Resistors in the kit have a four digit code. The first three digits are resistance values; the fourth digit is a multiplier.

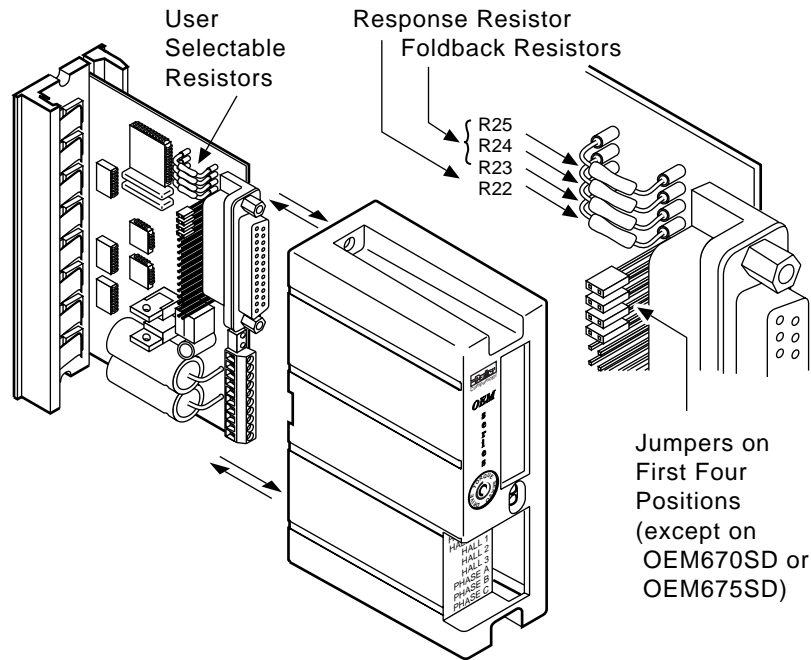Example: $3013 = 301 \times 10^3 = 301\text{K}\Omega$

$6492 = 649 \times 10^2 = 64.9\text{ K}\Omega$

Note: zero ohm resistors may be color coded (black band)

To install selectable resistors, remove the drive's molded plastic cover. Apply pressure to the D-connector while you hold the cover's sides. The circuit board will slide out. The resistors and their sockets are located near the corner of the board, close to the 25 pin D-connector, as shown below.

Selectable Resistor Locations

Remove any resistors that are in the sockets, and install those that you have selected. The next table shows recommended resistors for Compumotor SM and NeoMetric Series motors. For full details on further customizing the response and foldback circuits, or choosing resistors for non-Compumotor motors, see *Chapter ④ Special Internal Circuits*.

NOTE: A 34 pin header is located below the selectable resistors. Four jumpers should be installed in the first four positions, as shown in the drawing above. These jumpers must be installed for the OEM670T/OEM675T to work properly as a torque servo drive. Ordinarily, these jumpers are installed at the factory, and are shipped with the drive. (The jumpers are removed at the factory when an OEM670T is converted to an OEM670SD, or an OEM675T to an OEM675SD.)

RESISTOR SELECTION FOR COMPUMOTOR MOTORS

If your drive is an OEM670, use the first table below to select resistors for use with Compumotor's SM or NeoMetric Series motors. If your drive is an OEM675, use the second table.

OEM670 – Resistors for SM and Neometric Motors at 75VDC*

Motor	R22, $R_{response}$	R23, $T_{c\text{-}therm}$	R24, $I_{pk\text{-}tune}$		R24, $I_{pk\text{-}final}$		R25, I_{fold}	
SM160A**	100 KΩ	5.1 MΩ	348 KΩ	(5 A)	150 KΩ	(7.5 A)	500 KΩ	(1.5 A)
SM160B**	500 KΩ	10 MΩ	64.9 KΩ	(10 A)	0 Ω	(12 A)	100 KΩ	(2.8 A)
SM161A	100 KΩ	5.1 MΩ	450 KΩ	(4 A)	249 KΩ	(6 A)	500 KΩ	(1.5 A)
SM161B	301 KΩ	10 MΩ	124 KΩ	(8 A)	0 Ω	(12 A)	100 KΩ	(2.8 A)
SM162A	90.9 KΩ	5.1 MΩ	450 KΩ	(4 A)	249 KΩ	(6 A)	500 KΩ	(1.5 A)
SM162B	205 KΩ	10 MΩ	124 KΩ	(8 A)	0 Ω	(12 A)	100 KΩ	(2.8 A)
SM230A	100 KΩ	5.1 MΩ	348 KΩ	(5 A)	150 KΩ	(7.5 A)	500 KΩ	(1.5 A)
SM230B	301 KΩ	10 MΩ	64.9 KΩ	(10 A)	0 Ω	(12 A)	100 KΩ	(2.8 A)
SM231A	64.9 KΩ	5.1 MΩ	450 KΩ	(4 A)	249 KΩ	(6 A)	500 KΩ	(1.5 A)
SM231B	205 KΩ	10 MΩ	124 KΩ	(8 A)	0 Ω	(12 A)	100 KΩ	(2.8 A)
SM232A	40.2 KΩ	5.1 MΩ	450 KΩ	(4 A)	249 KΩ	(6 A)	500 KΩ	(1.5 A)
SM232B	150 KΩ	10 MΩ	124 KΩ	(8 A)	0 Ω	(12 A)	100 KΩ	(2.8 A)
SM233A	30.1 KΩ	5.1 MΩ	450 KΩ	(4 A)	249 KΩ	(6 A)	500 KΩ	(1.5 A)
SM233B	100 KΩ	10 MΩ	124 KΩ	(8 A)	0 Ω	(12 A)	100 KΩ	(2.8 A)
NO701D/NO341D	205 KΩ	10 MΩ	249 KΩ	(6 A)	90.9 KΩ	(9 A)	165 KΩ	(2.0 A)
NO701F/NO341F	750 KΩ	10 MΩ	90.9 KΩ	(9 A)	0 Ω	(12 A)	100 KΩ	(2.8 A)
NO702E/NO342E	750 KΩ	10 MΩ	182 KΩ	(7 A)	64.9 KΩ	(10 A)	165 KΩ	(2.0 A)
NO702F/NO342F	604 KΩ	10 MΩ	90.9 KΩ	(9 A)	0 Ω	(12 A)	100 KΩ	(2.8 A)

OEM675 – Resistors for SM Motors at 75VDC*

Motor	R22, $R_{response}$	R23, $T_{c\text{-}therm}$	R24, $I_{pk\text{-}tune}$		R24, $I_{pk\text{-}final}$		R25, I_{fold}	
SM160A	249 KΩ	5.1 MΩ	348 KΩ	(5 A)	150 KΩ	(7.5 A)	500 KΩ	(1.5 A)
SM160B	750 KΩ	10 MΩ	64.9 KΩ	(10 A)	0 Ω	(12 A)	100 KΩ	(2.8 A)
SM161A	301 KΩ	5.1 MΩ	450 KΩ	(4 A)	249 KΩ	(6 A)	500 KΩ	(1.5 A)
SM161B	750 KΩ	10 MΩ	124 KΩ	(8 A)	0 Ω	(12 A)	100 KΩ	(2.5 A)
SM162A	205 KΩ	5.1 MΩ	450 KΩ	(4 A)	249 KΩ	(6 A)	500 KΩ	(1.5 A)
SM162B	402 KΩ	10 MΩ	124 KΩ	(8 A)	0 Ω	(12 A)	100 KΩ	(2.5 A)
SM230A	402 KΩ	5.1 MΩ	348 KΩ	(5 A)	150 KΩ	(7.5 A)	500 KΩ	(1.5 A)
SM230B	1 MΩ	10 MΩ	64.9 KΩ	(10 A)	0 Ω	(12 A)	100 KΩ	(2.8 A)
SM231A	402 KΩ	5.1 MΩ	450 KΩ	(4 A)	249 KΩ	(6 A)	500 KΩ	(1.5 A)
SM231B	604 KΩ	10 MΩ	124 KΩ	(8 A)	0 Ω	(12 A)	100 KΩ	(2.5 A)
SM232A	205 KΩ	5.1 MΩ	450 KΩ	(4 A)	249 KΩ	(6 A)	500 KΩ	(1.5 A)
SM232B	500 KΩ	10 MΩ	124 KΩ	(8 A)	0 Ω	(12 A)	100 KΩ	(2.5 A)
SM233A	500 KΩ	5.1 MΩ	450 KΩ	(4 A)	249 KΩ	(6 A)	500 KΩ	(1.5 A)
SM233B	750 KΩ	10 MΩ	124 KΩ	(8 A)	0 Ω	(12 A)	100 KΩ	(2.5 A)

* For supply voltages less than 75VDC, calculate R22 using the following equation: $R22_{new} = (R22_{old} \cdot V_{bus})/75$, where $R22_{old}$ is the value from the table above (at 75VDC). R23, R24, R25 remain the same as for 75VDC.

**Although the OEM670 can be used with the SM160A and SM160B motors, Compumotor recommends using the OEM675 for optimum performance with the SM160A and SM160B motors.

R24 – "pk-tune" and "pk-final"
Note that there are two values recommended for R24. Use the first value (*pk-tune*) when you begin your tuning procedure. This keeps peak currents low, to avoid the damaging currents that instability during tuning can cause. As you refine your tuning settings, replace R24 with the second value (*pk-final*), if your application requires more torque.

The following two sections describe how to choose resistor values for other motors.

Selecting Foldback Resistors

The OEM670 ships with resistors already installed; the OEM675 ships without resistors.

Default Foldback Resistors (as shipped)

Res. #:	Function	OEM670	OEM675
R25	Foldback Current	23.7 KΩ (6A)	none installed
R24	Peak Current	Ø Ω (12A)	none installed
R23	Time Constant	5.1 MΩ	none installed

If you use an OEM670, the values above may not be suitable for your application. If your system cannot withstand the peak torque, if your controller cannot detect a mechanical jam, or if you use an OEM675, you should determine foldback resistor values appropriate to your application and install them in your drive.

For full details about how to choose foldback resistor values, and about how the foldback circuit works, see *Chapter ④ Special Internal Circuits*.

Selecting a Response Resistor

The OEM670 ships with a response resistor already installed: the OEM675 ships without a response resistor.
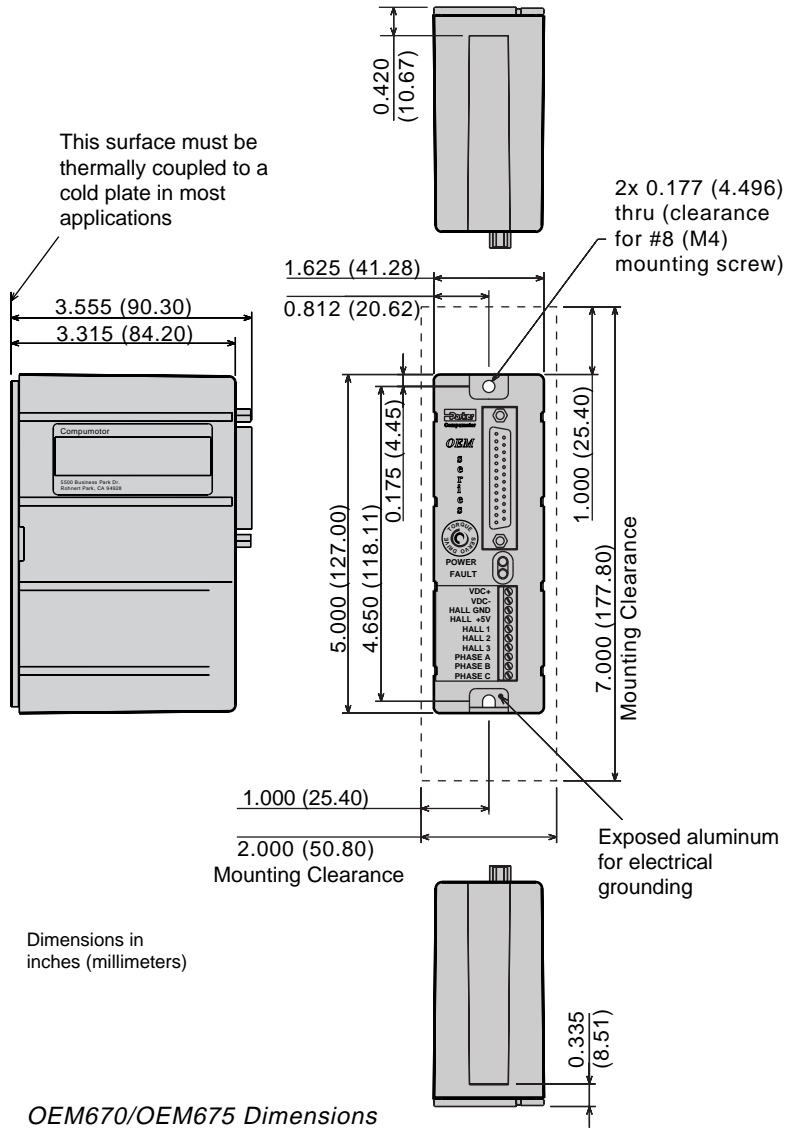
Default Response Resistor (as shipped)

Res. #:	Function	OEM670	OEM675
R22	Optimize gain and frequency response	100 KΩ	none installed

If you use an OEM670, and your motor is not well matched to the default resistor, your system might not perform as well as you expect. In this case, or if you use an OEM675, improve your system's performance by selecting an appropriate response resistor, and installing it in the drive.

For full details about how to choose a value for the response resistor, and about how the circuit works, see *Chapter ④ Special Internal Circuits*.

DRIVE MOUNTING

This surface must be
thermally coupled to a
cold plate in most
applications

2x 0.177 (4.496)
thru (clearance
for #8 (M4)
mounting screw)

0.420 (10.67)

1.625 (41.28)

0.812 (20.62)

1.000 (25.40)

3.555 (90.30)

3.315 (84.20)

0.175 (4.45)

5.000 (127.00)

4.650 (118.11)

7.000 (177.80)
Mounting Clearance

Compumotor

5500 Business Park Dr.
Rohnert Park, CA 94928

VDC+
VDC-
HALL GND
HALL +5V
HALL 1
HALL 2
HALL 3
PHASE A
PHASE B
PHASE C

POWER
FAULT

1.000 (25.40)

2.000 (50.80)
Mounting Clearance

Exposed aluminum
for electrical
grounding

Dimensions in
inches (millimeters)

0.335 (8.51)

OEM670/OEM675 Dimensions

DRIVE DIMENSIONS

The OEM670/OEM675 is designed to minimize panel area, or
footprint, in an equipment cabinet. Dimensions are shown in
the drawing. You can mount the drive in a "minimum depth"
configuration if you use an optional heatsink. (See below.)

PANEL LAYOUT

Move profiles and loads affect the amount of heat dissipated by the OEM670/OEM675. Applications with low average power (less than 3 Amps continuous motor current) and mild ambient temperatures may not require a heatsink.

The OEM670/OEM675 is designed to operate within the following temperature guidelines:

❏ Maximum Ambient Temperature: 45°C (113°F)

❏ Maximum Heatsink Temperature   45°C (113°F)

For applications with higher power or elevated ambient temperatures, you may need to mount the drive in a way that removes heat from it. The drive uses a heatplate design as a pathway to dissipate its excess heat; it should be mounted to a heatsink or a suitable heat sinking surface.

The OEM670/OEM675 is overtemperature protected. (See *Chapter ④ Special Internal Circuits* for more information.)

Mounting Without a Heatsink
The next drawing shows the recommended panel layout for mounting the OEM670/OEM675 without a heatsink.

Dimensions in inches (millimeters)

Panel Layout (Without a Heatsink)
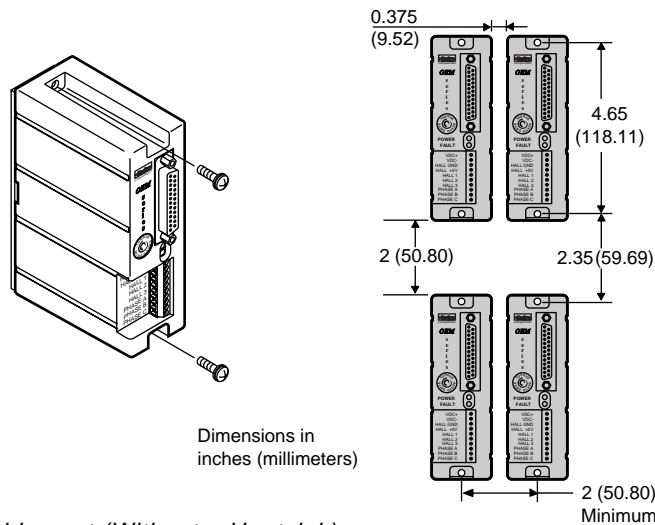
Mounting With Compumotor Heatsink OEM-HS1

A heatsink designed to work with the OEM670/OEM675 can be purchased from Compumotor (Part Number OEM-HS1). This heatsink is sufficient for most applications operating in 45°C (113°F) or lower ambient temperatures.

The drive may be mounted in two different configurations. One configuration uses a minimum amount of mounting area (*minimum area*). The other configuration uses a minimum amount of mounting depth (*minimum depth*).

Heatsink dimensions are shown in the next drawing.

OEM-HS1 Heatsink Dimensions
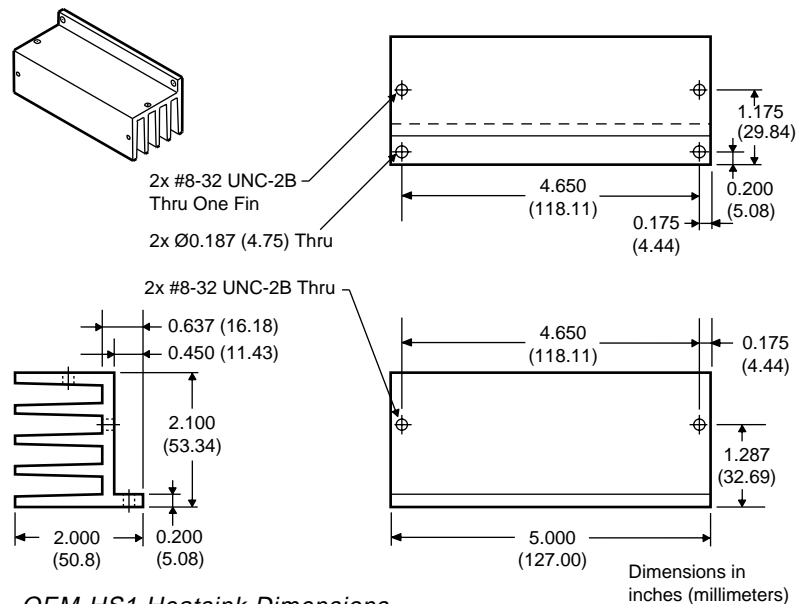
Two #8-32 screws are needed to mount the OEM670/OEM675 to the OEM-HS1 heatsink. Use a *star washer* on the bottom screw to ensure proper electrical grounding. Use two #8 screws to mount the OEM-HS1 to the cabinet.

Do not use a star washer between the back of the OEM670/OEM675 heatplate and the mounting surface. The mounting surface must be flat. Use silicone thermal joint compound or thermal pads to facilitate heat transfer from the drive's heatplate to your mounting surface.
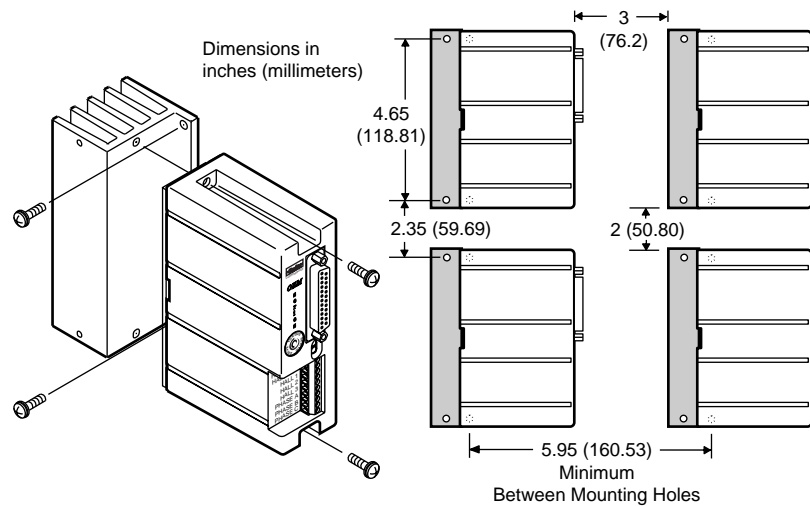
A heatsink with holes tapped for metric screws is available. Its part number is OEM-HS1-M4. Consult your Compumotor sales guide for more information.

The next drawing shows the panel layout for minimum area.
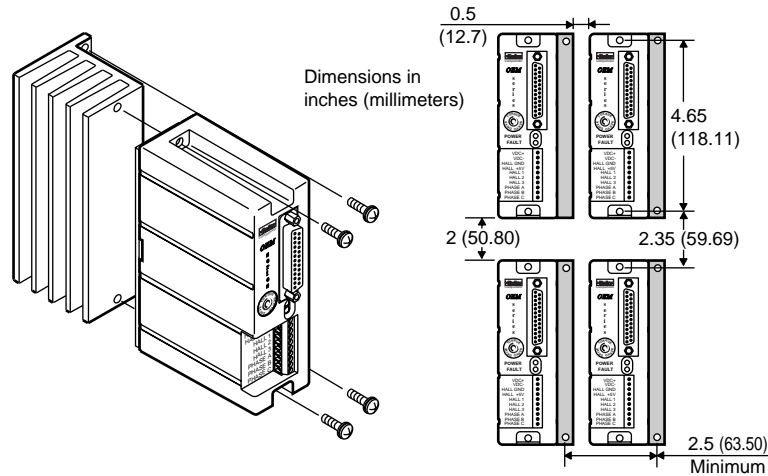
OEM-HS1 Minimum Area Panel Layout

The following drawing shows dimensions for a minimum depth panel layout.

OEM-HS1 Minimum Depth Panel Layout

MOTOR MOUNTING

The following guidelines present important points about motor mounting and its effect on performance.

For mechanical drawings of SM and NeoMetric Series servo motors, see *Chapter ③ Specifications*

WARNING
Improper motor mounting can reduce system performance and jeopardize personal safety.

Servo motors used with the OEM670/OEM675 can produce large torques and high accelerations. This combination can shear shafts and mounting hardware if the mounting is not adequate. High accelerations can produce shocks and vibrations that require much heavier hardware than would be expected for static loads of the same magnitude.

The motor, under certain move profiles, can produce low-frequency vibrations in the mounting structure. These vibrations can cause metal fatigue in structural members if harmonic resonances are induced by the move profiles you are using. A mechanical engineer should check the machine design to ensure that the mounting structure is adequate.

CAUTION
Consult a Compumotor Applications Engineer (800-358-9070) before you machine the motor shaft. Improper shaft machining can destroy the motor's bearings. Never disassemble the motor.

Servo motors should be mounted by bolting the motor's face flange to a suitable support. Foot mount or cradle configurations are not recommended because the motor's torque is not evenly distributed around the motor case. Any radial load on the motor shaft is multiplied by a much longer lever arm when a foot mount is used rather than a face flange.

MOTOR HEATSINKING

Performance of a servo motor is limited by the amount of current that can flow in the motor's coils without causing the motor to overheat. Most of the heat in a brushless servo motor

is dissipated in the stator—the outer shell of the motor. Performance specifications usually state the maximum allowable case temperature. Exceeding this temperature can permanently damage the motor.

If yours is a demanding application, your motor may become quite hot. The primary pathway through which you can remove the heat is through the motor's mounting flange. Therefore, mount the motor with its flange in contact with a suitable heatsink.

Specifications for Compumotor SM and NeoMetric Series servo motors apply when the motor is mounted to a ten inch by ten inch aluminum mounting plate, 1/4 inch thick. To get rated performance in your application, you must mount the motor to a heatsink of at least the same thermal capability. Mounting the motor to a smaller heatsink may result in decreased performance and a shorter service life. Conversely, mounting the motor to a larger heatsink can result in enhanced performance.

ATTACHING THE LOAD

Your mechanical system should be as stiff as possible. Because of the high torques and accelerations of servo systems, the ideal coupling between a motor and load would be completely rigid. Rigid couplings require perfect alignment, however, which can be difficult or impossible to achieve. In real systems, some misalignment is inevitable. Therefore, a certain amount of flexibility may be required in the system. Too much flexibility can cause resonance problems, however.

These conflicting requirements are summarized below.

❏ Maximum Stiffness (in the mechanical system)

❏ Flexibility   (to accommodate misalignments)

❏ Minimum Resonance (to avoid oscillations)

The best design solution may be a compromise between these requirements.

MISALIGNMENT & COUPLERS

The type of misalignment in your system will affect your choice of coupler.

Parallel Misalignment
The offset of two mating shaft center lines, although the center lines remain parallel to each other.

Angular Misalignment
When two shaft center lines intersect at an angle other than zero degrees.

End Float
A change in the relative distance between the ends of two shafts.

There are three types of shaft couplings: single-flex, double-flex, and rigid. Like a hinge, a single-flex coupling accepts angular misalignment only. A double-flex coupling accepts both angular and parallel misalignments. Both single-flex and double-flex, depending on their design, may or may not accept endplay. A rigid coupling cannot compensate for any misalignment.

Single-Flex Coupling
When a single-flex coupling is used, one and only one of the shafts must be free to move in the radial direction without constraint. **Do not use a double-flex coupling in this situation:** it will allow too much freedom and the shaft will rotate eccentrically, which will cause large vibrations and catastrophic failure. **Do not use a single-flex coupling with a parallel misalignment:** this will bend the shafts, causing excessive bearing loads and premature failure.

Double-Flex Coupling
Use a double-flex coupling whenever two shafts are joined that are fixed in the radial and angular direction (This is the most common situation. It results from a combination of angular and parallel misalignment).

Rigid Coupling
As mentioned above, rigid couplings would be ideal in servo systems, but are not generally recommended because of

system misalignment. They should be used only if the motor or load is on some form of floating mounts that allow for alignment compensation. Rigid couplings can also be used when the load is supported entirely by the motor's bearings. A small mirror connected to a motor shaft is an example of such an application.

RESONANCE ISSUES

A coupler that is too flexible may cause a motor to overshoot its commanded position. When the encoder sends a position feedback signal, the controller will command a correction move in the opposite direction. If the resonant frequency of the system is too low (too flexible), the motor may overshoot again and again. In extreme cases, the system could become an oscillator.

To solve resonance problems, increase the mechanical stiffness of the system to raise the resonant frequency so that it no longer causes a problem.

If you use a servo as a direct replacement for a step motor, you may need to modify your mechanical coupling system to reduce resonance. For example, we recommend using a bellows-style coupler with servo motors, rather than the helical-style coupler that is often used with step motors. Helical couplers are often too flexible, with resonant frequencies that can cause problems. Bellows couplers are stiffer, and perform better in servo systems.

CONNECTING A MOTOR TO THE DRIVE

The OEM670/OEM675 drive is designed to work with three-phase brushless motors equipped with Hall effect sensors or equivalent feedback signals. The typical motor has a permanent-magnet rotor with four poles (two pole pairs).

Connect your motor's phase wires and Hall effect sensor wires to the 10-pin screw terminal on the OEM670/OEM675. Each terminal is labeled with the name of the wire you should connect to it.

POWER
FAULT

| VDC+ |
| VDC- |
| HALL GND |
| HALL +5 |
| HALL 1 |
| HALL 2 |
| HALL 3 |
| PHASE A |
| PHASE B |
| PHASE C |

Hall Effect Connections
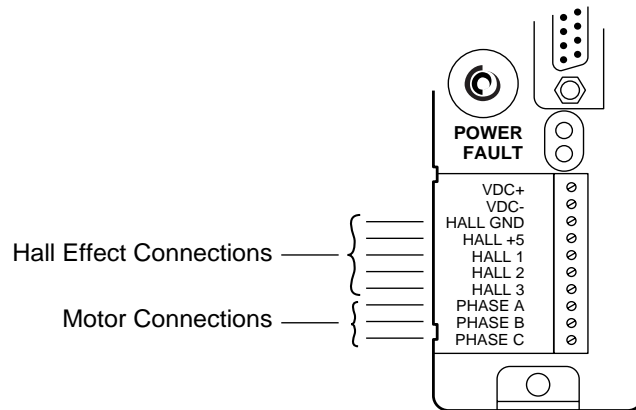
Motor Connections

10-Pin Screw Terminal

14 AWG (2.5 mm^2) is the maximum wire size that can fit in the connector.

CAUTION
Do not turn on power unless the motor's Hall effect sensors, Hall +5, and Hall GND are connected to the drive. The motor may be destroyed by overheating if these connections are not made.

If the Hall effects are not connected, the drive determines that it is configured to run a *brushed* servo motor. With power and a command input applied, the drive will send the commanded DC current through the motor. If the motor is a *brushless* motor, it will not turn. Full current may flow in the motor and cause overheating, or destroy the motor within a short period of time.

CONNECTING COMPUMOTOR SM AND NEOMETRIC SERIES MOTORS

To connect a Compumotor SM or NeoMetric Series motor to the OEM670/OEM675, follow the color code shown below for flying lead or cable versions. (These motors have additional wires not used by the OEM670/OEM675. See *Chapter ③ Specifications* for colors and functions of the additional wires.)

Function	Wire Color
Hall Ground	White/Green
Hall +5V	White/Blue
Hall 1	White/Brown
Hall 2	White/Orange
Hall 3	White/Violet
Phase A	Red/Yellow
Phase B	White/Yellow
Phase C	Black/Yellow

Connect each motor wire to its appropriate screw terminal on the OEM670/OEM675. Wire sizes used for Compumotor motors are:

Phase:	18 AWG (O.75 mm^2)
Hall/Encoder:	24 AWG (0.25 mm^2)

CONNECTING MOTORS FROM OTHER VENDORS

Before connecting a motor from another vendor, you must determine which motor phase wires correspond to Phase A, Phase B, and Phase C on the OEM670/OEM675. Similarly, you must determine which Hall effect wires correspond to Hall 1, Hall 2, and Hall 3.

Connect each wire to its appropriate terminal on the OEM670/OEM675. Ensure that the Hall effect sensors accurately transmit information about rotor position, and that motor current is commutated to the correct motor phases. See *Chapter ⑤ Hall Effect Sensors* for more information.

If your drive arrived with a response resistor installed, you should consider using a different response resistor. See *Chapter ④ Special Internal Circuits* for details about selecting a response resistor to improve your system's performance.

CONNECTING A BRUSHED DC SERVO MOTOR

You can use the OEM670/OEM675 as a drive for brushed DC servo motors. Follow these steps:

① Make no connections to the drive's Hall inputs.
② Connect the drive's Phase A to your motor's positive input.
③ Connect the drive's Phase C to your motor's negative input.

Under these conditions, the drive's internal logic determines that a brushed motor is connected. DC current will flow out of Phase A, through the motor, and back into the drive through Phase C. The amount and polarity of the current will be determined by the command input signal.

SHIELDED MOTOR CABLES

Prevent electrical noise from interfering with the signals that the Hall effect sensors send to the drive. Position the motor as close to the drive as possible. If you need to connect a long cable between the drive and motor, we recommend you use a shielded cable for the Hall wires (Hall 1, Hall 2, Hall 3, +5V, GND). Run the power wires (phase A, B, and C) separately from the Hall wires.

MOTOR GROUNDING

For safety reasons, the motor should be grounded. Often, the motor can be grounded through the equipment to which it is mounted. This requires a good electrical connection between the motor's mounting flange and the equipment, and that the equipment be connected to ground. Check with the National Electrical Code (NEC) and your local electrical code to ensure you use proper grounding methods.

Proper grounding can also reduce electrical noise.

OEM670T/OEM675T INPUTS AND OUTPUTS

Note: This section describes inputs and outputs for the OEM670T and OEM675T. See the following section for OEM670SD and OEM675SD input/output descriptions.

Connect command and enable signals from your controller to the 25 pin D-connector mounted on the OEM670T/OEM675T. The D-connector also contains a fault output, a current monitor output, and a voltage source for isolated controllers.
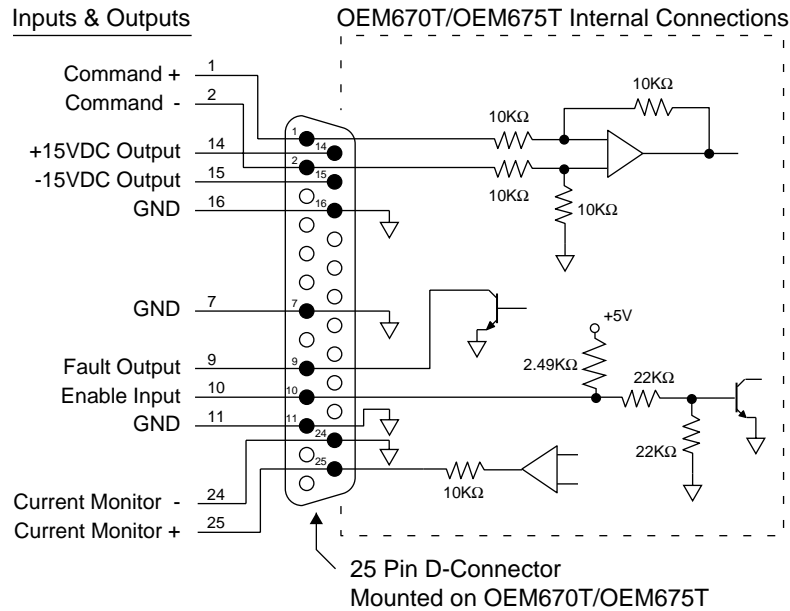
OEM670T/OEM675T Inputs & Outputs, and Internal Connections

The following sections give details about each input and output, and a discussion about which ground pins to use for each I/O signal.

COMMAND INPUT

The OEM670T/OEM675T monitors an analog voltage signal, called *command input*, at its input terminals (Command + and Command –). It sends an output current to the motor that is

proportional to the command input signal. Your controller's command voltage can range from -10VDC to +10VDC.

The OEM670T/OEM675T will produce 1.2 amps for each volt present at its input terminals. A 10 volt command input will result in peak current (12A) flowing to the motor. Smaller voltages result in proportionally less current, with a Ø volt command input resulting in no current to the motor.

Positive voltages cause the OEM670T/OEM675T to produce currents that turn the motor's shaft clockwise. Negative voltages cause currents that turn the shaft counterclockwise. As the next drawing shows, shaft rotation is defined as the direction the shaft rotates, as viewed from the mounting flange end of the motor.
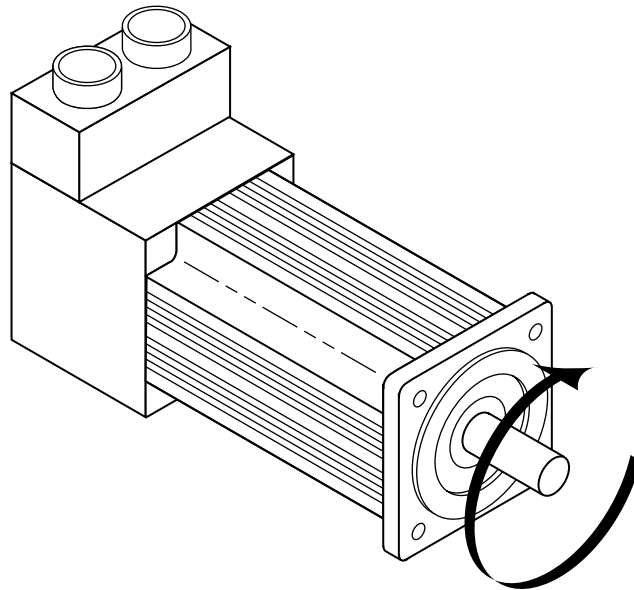
Clockwise Shaft Rotation

Connect your controller's command output signal to the OEM670T/OEM675T's command input terminals, Pin 1 and Pin 2, as described in the following sections.

Controller with Single-Ended Output

If your controller uses a single-ended output—a single terminal that produces a voltage ranging from -10VDC to +10VDC—connect that output to Command Plus (Pin 1) on the OEM670T/OEM675T.

Connect wires from the OEM670T/OEM675T's Command Minus and Ground terminals to the controller's ground terminal. If you connect the wires as shown in the next drawing, you will minimize electrical noise in the circuit.
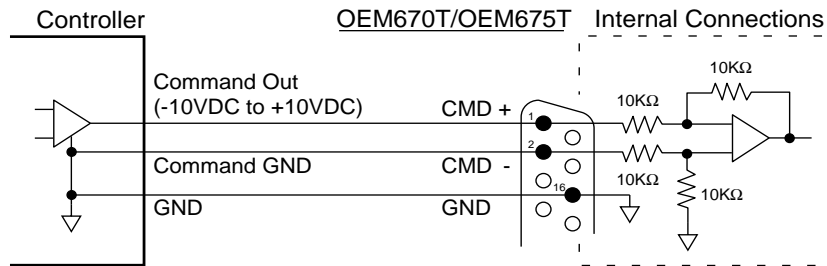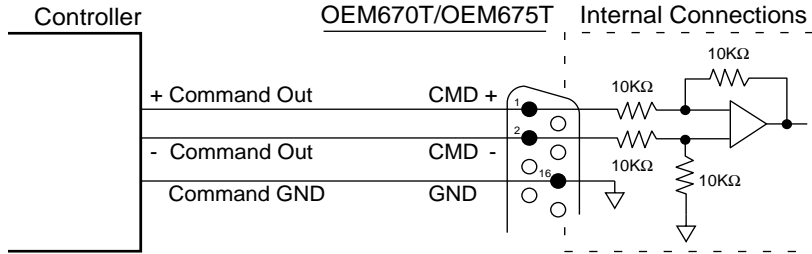

Controller—Single-Ended Output Connections

Bring both wires from the OEM670T/OEM675T to the controller, and connect them both to the controller. This will ensure that the OEM670T/OEM675T's Command Minus input and Ground input are both referenced to the controller's ground terminal.

Controller with Differential Output

If your controller has a differential output, then it has two command signals. One is a signal that ranges from -5VDC to +5VDC. The other signal ranges from +5VDC to -5VDC. The two signals mirror each other—their magnitudes are equal, but they have opposite signs.

Your controller should also have a ground terminal to use as a reference for the positive and negative command outputs.

Controller—Differential Output Connections

The figure above shows how to connect these three outputs to the OEM670T/OEM675T.

Controller with Isolated Output

Some controllers have isolated command outputs, and may require a voltage source to power their outputs. The OEM670T/OEM675T has three pins available to power isolated outputs on a controller. These pins provide:

- ❏ +15VDC   on Pin 14
- ❏ -15VDC   on Pin 15
- ❏ GROUND   on Pin 16

The next figure shows a typical controller with isolated differential outputs, and illustrates how you can connect it to the OEM670T/OEM675T.
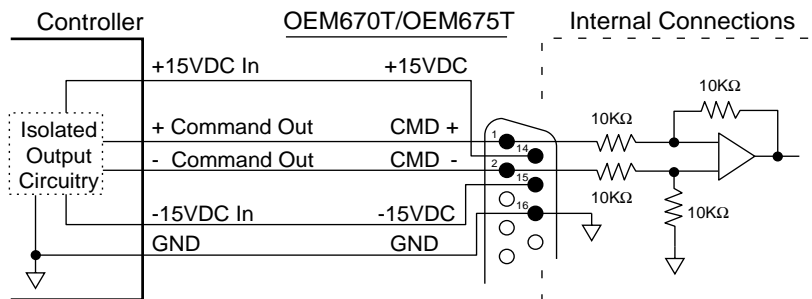
Controller—Isolated Output Connections

If your controller has an isolated single-ended output, connect

the ±15VDC outputs as shown in this figure. Connect the command and ground signals as shown earlier in the section on single-ended outputs.
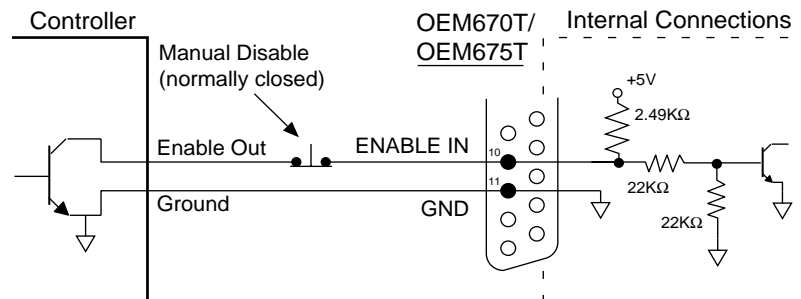
ENABLE INPUT

When the enable input of the OEM670T/OEM675T is connected to ground, the OEM670T/OEM675T is enabled, and will function normally. To disable the OEM670T/OEM675T, break the connection to ground, or connect the enable input to +5VDC.

WARNING

Dangerous conditions can result if the enable input is not connected to a suitable controller output. Many controllers produce uncontrolled command output voltages during power up, power down, fault, or reset conditions. Unpredictable and potentially dangerous machine movement may occur if the OEM670T/OEM675T's enable input is not properly connected.

The next figure shows how to connect a controller with an open collector enable output to the OEM670T/OEM675T.

When the transistor in the controller is on, the controller's enable output is effectively tied to ground. This grounds the OEM670T/OEM675T's enable input, and the OEM670T/OEM675T is enabled.
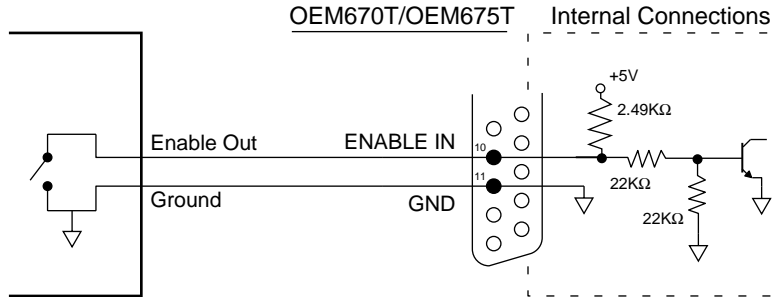

Enable Input Connected to a Controller

This figure also shows an optional switch that can be used as a manual disable switch. The switch is normally closed. When it is opened, the drive will be disabled.

As the next figure shows, the OEM670T/OEM675T could also be enabled simply by closing a switch that connects its enable input to ground.


Enable Input Connected to a Switch

Connecting a jumper between the OEM670T/OEM675T's enable input and ground is a quick way to temporarily enable the OEM670T/OEM675T. You may wish to do this, for example, if you need to test the OEM670T/OEM675T when it is not connected to a controller. Enabling the drive in this manner may be dangerous, however—see the warning above.

FAULT OUTPUT

When the OEM670T/OEM675T is operating normally, its fault output is low. Under these conditions, an internal transistor acts as a switch, and grounds the fault output. To signal a fault, the OEM670T/OEM675T will turn off the transistor, and the fault output will float. The next drawing shows this circuit.
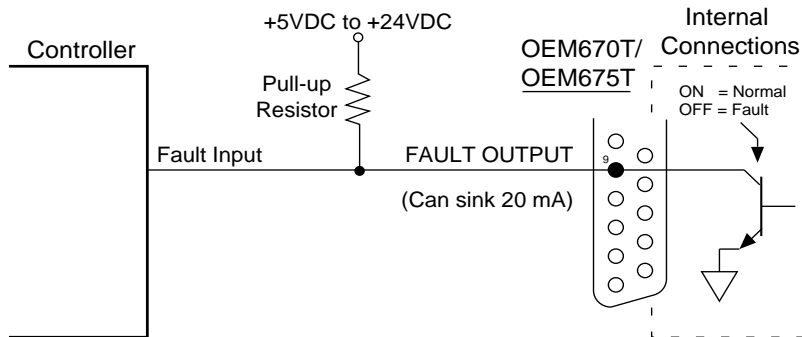
Fault Output

Use a pull-up resistor connected to a DC voltage source to ensure the appropriate signal level at your controller's fault input. The OEM670T/OEM675T can sink 20 mA maximum. Use the following formula to calculate the value of your pull-up resistor.

$$R_{pull\text{-}up} = V_S \: / \: 5 \text{ mA}$$

where

V_S is the value of your DC voltage source.

You can use the OEM670T/OEM675T's fault output as a signal to your controller that a fault has occurred. The following conditions will cause the fault output to go high.

		LED	Status
Condition		**RED**	**GREEN**
Drive Not Enabled		On	On
Over Temperature	(Latched)	On	On
Overvoltage	(Latched)	On	On
Undervoltage		On	On
Short Circuit	(Latched)	On	OFF
Power Supply Fault	(Latched)	On	OFF

The foldback circuit illuminates the red LED, but it does not make the fault output go high.

Latched means you must cycle power before the drive will operate again.

CURRENT MONITOR

You can use the OEM670T/OEM675T's current monitor output to measure motor current. Connect pin 25 to the positive input of your oscilloscope, meter, etc. Use pin 24 as a signal ground for your oscilloscope or meter.

The OEM670T/OEM675T monitors the actual motor current. It puts out a voltage on pin 25 that is proportional to current, with 1 volt out = 1.2 amps of motor current. Positive voltages correspond to clockwise rotation (as viewed from the mounting flange end of the motor). Negative voltages correspond to counterclockwise rotation.

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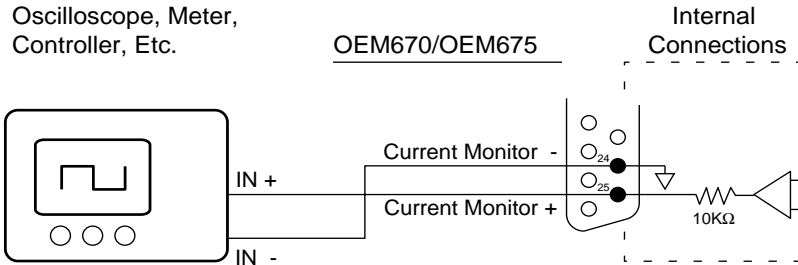
Current Monitor Output Connections

GROUND PINS – ANALOG AND DIGITAL

The OEM670T/OEM675T has four ground pins, located at pins 7, 11, 16, and 24. For noise-sensitive circuits, such as command input and current monitor output, use the "analog" ground pins, 16 and 24. For digital circuits, such as the enable input or the fault output, use the "digital" ground pins, 7 and 11.

Why the distinction? The analog grounds are for use with signals where electrical noise should be kept to a minimum. Digital circuits can be quite noisy. If a clean analog ground is connected to a noisy digital ground, some of the noise from the digital circuit may be coupled into the analog circuit.

The four grounds are eventually connected together inside the OEM670T/OEM675T, but there are features in the internal circuitry that keep noise in digital circuits from entering sensitive analog circuits. So, for noise sensitive signals, use the analog grounds.

Type of Ground	Pin #	Intended Use
Analog Ground	16	Command Input
	24	Current Monitor
Digital Ground	11	Enable Input
	7	Fault Output, or
		Misc. Digital Circuitry

OEM670SD/OEM675SD INPUTS AND OUTPUTS

Note: This section describes inputs and outputs for the OEM670SD and OEM675SD. See the previous section for OEM670T and OEM675T input/output descriptions.

You *must* connect step and direction, enable, and encoder signals to the OEM670SD/OEM675SD for it to work. Connections are described below under *Required Inputs*. Use the drive's other inputs and outputs, described under *Optional Inputs and Outputs*, for your application's specific requirements.
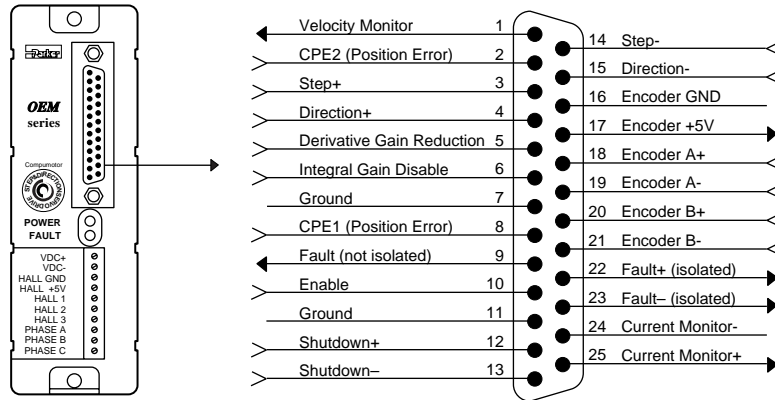
CLOCKWISE AND COUNTERCLOCKWISE – DEFINITIONS

Shaft rotation is defined as the direction the shaft rotates, when viewed from the mounting flange end of the motor. (See the drawing several pages earlier, which illustrates the clockwise direction.)

Unlike a step motor system, which operates *open loop*, the OEM670SD/OEM675SD is a *closed loop* servo system. It requires feedback from the encoder for stability. For each step pulse received while Direction+ is positive, the drive will make the motor turn in the positive direction a distance of one positive encoder count. For stability, it is important that you connect your system so that a positive step command causes the encoder position to increment, not decrement.

If the system is connected incorrectly, each step pulse will cause the encoder to move in the wrong direction, causing increasing position errors. This could lead to instability and a *motor runaway*, in which the motor spins faster and faster, eventually going out of control.

|				
Velocity Monitor	1		14	Step-
CPE2 (Position Error)	2		15	Direction-
Step+	3		16	Encoder GND
Direction+	4		17	Encoder +5V
Derivative Gain Reduction	5		18	Encoder A+
Integral Gain Disable	6		19	Encoder A-
Ground	7		20	Encoder B+
CPE1 (Position Error)	8		21	Encoder B-
Fault (not isolated)	9		22	Fault+ (isolated)
Enable	10		23	Fault– (isolated)
Ground	11		24	Current Monitor-
Shutdown+	12		25	Current Monitor+
Shutdown–	13			

OEM670SD/OEM675SD Inputs & Outputs, and Internal Connections

REQUIRED INPUTS

Step & Direction Inputs

Connect your indexer to the step and direction inputs, as shown in the next drawing. These inputs are optically isolated. For best performance, your indexer should drive the inputs differentially. Single-ended operation is also possible, especially at lower step frequencies (where the diode switching speed is not as critical).
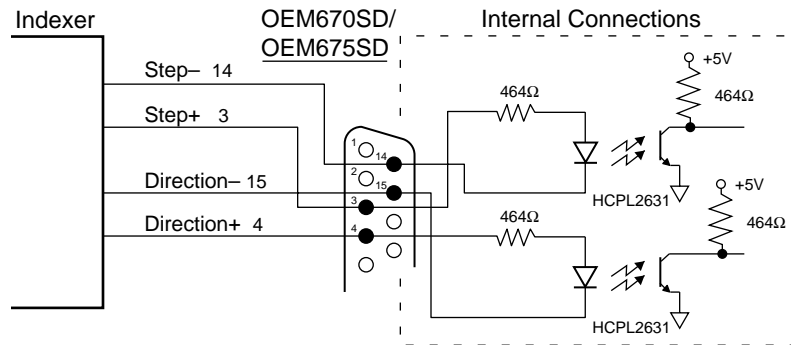
Step & Direction Inputs

Specifications for the step and direction inputs are as follows:

Specifications	**Step+/Step–** (pins 3 & 14) **Dir+/Dir–** (pins 4 & 15)
Applied Voltage	5 V maximum
Input Current	12 mA maximum 6.3 mA minimum
Step Pulse	500 nsec minimum pulse width
Setup Time	Direction input may change polarity coincident with the last step pulse. The direction input must be stable for 500 nsec before the drive receives the first step pulse.

You can use an input voltage higher than 5V if you install a resistor, in series with the input, to limit current to the range specified above.

Enable Input
You must connect the enable input to ground *before* you power up the drive, in order for the drive to be enabled. This input is internally pulled up to +5V. If you break the connection to ground while the drive is on, the OEM670SD/OEM675SD's fault circuitry will activate with these results:

❏ The drive will shut down power output to the motor.
❏ The motor will freewheel (it may not stop immediately).
❏ The red Fault LED will be illuminated.
❏ The fault output will become active (no current will flow through it).

To reset the drive, reestablish the connection between enable and ground, and cycle power.

In most applications, you can permanently wire the enable input to ground. If you need to disable the drive during normal operations, you should use the shutdown input—it allows you to re-enable the drive from the indexer without cycling power. The shutdown input is described later in this section.

If you need to disable the drive in an emergency, use the enable input—*not* the shutdown input. Connect a *manual disable* switch to the enable input, as the next drawing shows. The switch is normally closed. When it is opened, the drive will be disabled. The load can freewheel—therefore, you should use a brake to stop the motor immediately in applications where a freewheeling motor can cause injury or damage.
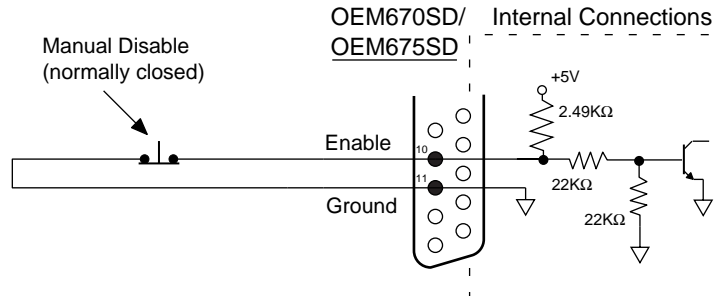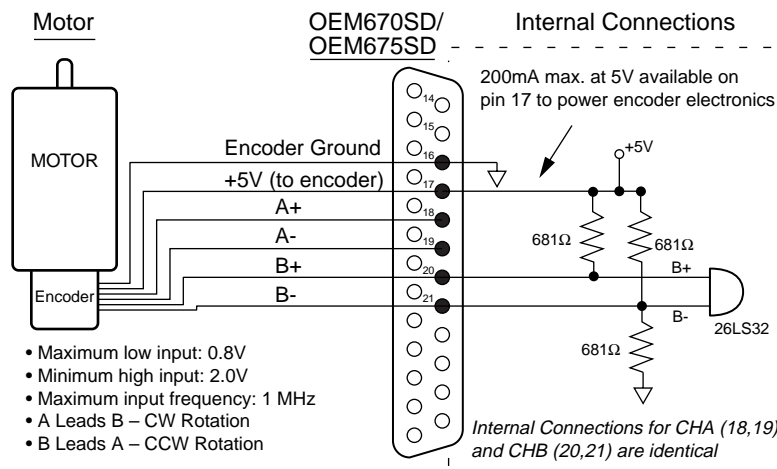
Enable Input Connected to a Switch

WARNING

Do not use the ENABLE INPUT by itself as an emergency stop. The motor can freewheel when the drive is disabled and may not stop immediately. Use a mechanical brake or some other method to stop the motor quickly.

Encoder Input Connections

You must connect an encoder to the OEM670SD/ OEM675SD's encoder inputs. These are differential inputs; therefore, your encoder should have differential outputs. Single-ended operation is possible, but is more susceptible to electrical noise and is not recommended. If you use an OEM Series motor, see *Specifications: Encoder* in *Chapter ③ Specifications* for the pinout of the encoder connector. Up to 200 mA at 5 volts is available on pin 17 to power encoder electronics.


- Maximum low input: 0.8V
- Minimum high input: 2.0V
- Maximum input frequency: 1 MHz
- A Leads B – CW Rotation
- B Leads A – CCW Rotation

Encoder Input

OPTIONAL INPUTS AND OUTPUTS

Connect any of the optional inputs and outputs that your application requires. Each is described below.

Shutdown Input
Use the isolated shutdown input on pins 12 and 13 if you need to temporarily disable the drive during normal operations. You may wish to do this, for example, to manually move the load to a desired position. Make connections according to the following diagram. The inputs are designed for 5V operation. You can use higher voltages if you connect an external resistor in series with Shutdown+ to limit the input current.
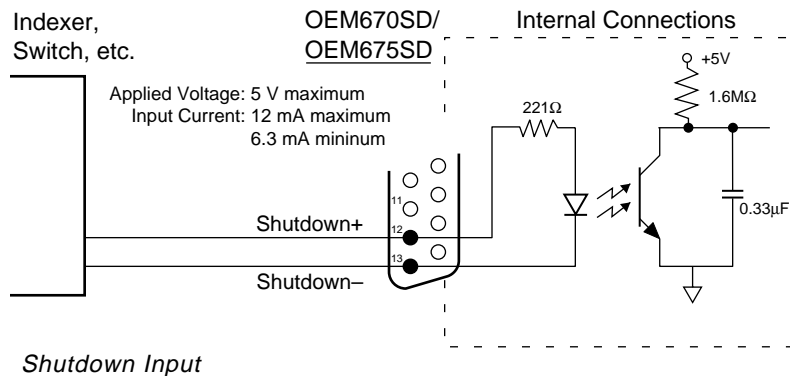
Shutdown Input

When +5V is applied to the Shutdown+ input, the OEM670SD/OEM675SD's power output stage remains active, but its internal controller commands zero torque. This allows the motor shaft to be manually positioned. The controller will ignore encoder counts and position error as the shaft turns. Approximately one second after the shutdown input is released, the internal controller accepts the new position as the commanded position, and reestablishes servo action.

While the OEM670SD/OEM675SD is in shutdown, it's small internal offset torque will be applied to the load. This torque is usually too low to overcome friction and cause motion. In some applications, however, the shaft may need to be held in the desired position during shutdown.

Note that shutdown in the OEM670SD/OEM675SD functions differently than shutdown in a step motor drive. When a step

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motor drive is shut down, it actually shuts down its power output stage. When it comes out of shutdown, the step motor drive will command phase currents that immediately apply torque to the shaft, which holds it in some position between the poles.

CPE1 and CPE2 – Position Error Inputs

You can *configure position error* (CPE) with two position error inputs, CPE1 and CPE2, on pins 8 and 2 respectively. Position error faults provide warnings of impending problems such as increased friction, or of immediate problems such as a mechanical jam. Position error is measured in post-quadrature encoder counts. Four settings are available, as the next table shows.
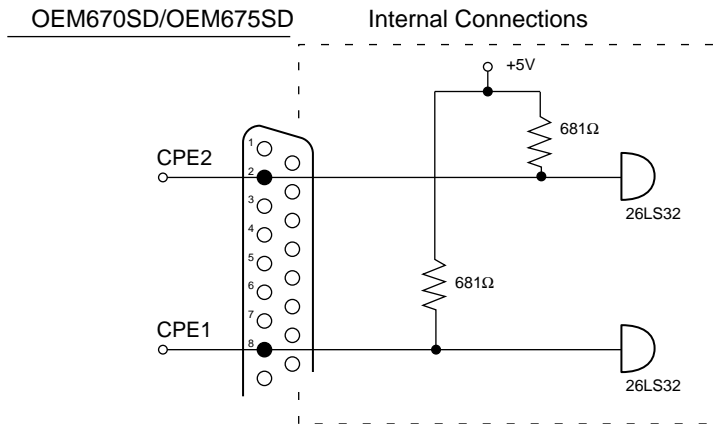
CPE1 and CPE2 – Position Error Inputs

Position Error Settings			Number of Revolutions	
			500 Line	1000 Line
CPE1	CPE2	Error*	Encoder	Encoder
low	low	2047	1.024	0.512
high	low	4095	2.048	1.024
low	high	8191	4.096	2.048
(default) high	high	16383	8.196	4.096

high = not connected
low = connected to ground
*error is measured in post-quadrature encoder counts

When the OEM670SD/OEM675SD ships from the factory, neither CPE1 nor CPE2 is connected to ground. This is the

default setting; it selects the widest position error range. You might begin with this setting when you start configuring your system. This will give you the widest range of motion. Once your system is tuned and performing properly, you can select one of the other three settings by connecting either or both of the inputs to ground.

The position error feature works as follows. Internally, the drive generates a control voltage proportional to the difference between the number of step pulses received and the number of post-quadrature encoder counts received. The first 2047 counts in each direction produce an increasing error voltage. This creates an increasing torque to move the load towards the commanded position. After the first 2047 counts, maximum torque is being commanded. Additional error counts have no immediate effect on torque, but they are accumulated until the error is reduced by shaft motion, or the CPE limit is reached. Reaching the limit causes a fault that disables the drive and illuminates the red LED. You can clear the fault by cycling power. Or, you can use the shutdown input to reset the drive—this will clear the position error fault.

Velocity Monitor Output

A velocity monitor is available on pin 1. Its output is a voltage signal proportional to encoder speed. You can connect a voltmeter to the output to measure velocity, or you can connect an oscilloscope to help you tune your system. See the *Tuning* section at the end of this chapter for more information.

The signal is always positive, regardless of the direction of encoder rotation. It is scaled so that a pre-quadrature encoder count frequency of 10 kHz produces an output of one volt. The maximum output is +10V. (For example, a 1000 line encoder rotating at 100 rps (100 kHz) will produce the maximum signal of +10V. The same encoder at 10 rps will produce a signal of +1V.)

Encoder counts come slowly at low velocities, which can cause the velocity monitor to show ripple at four times the line frequency, resulting in a "fat" trace on the oscilloscope.

The next drawing shows typical connections to the velocity monitor. Use pin 24 as a ground reference for your signal.

Oscilloscope, Meter, etc.

OEM670SD
OEM675SD
Velocity Monitor

Internal Connections

Signal Scaling: 1V per 10 kHz
encoder frequency
(pre-quadrature)
Range: 0V to +10V max
(always positive)
Load: 2 KΩ min load

IN +

IN -

Monitor Reference
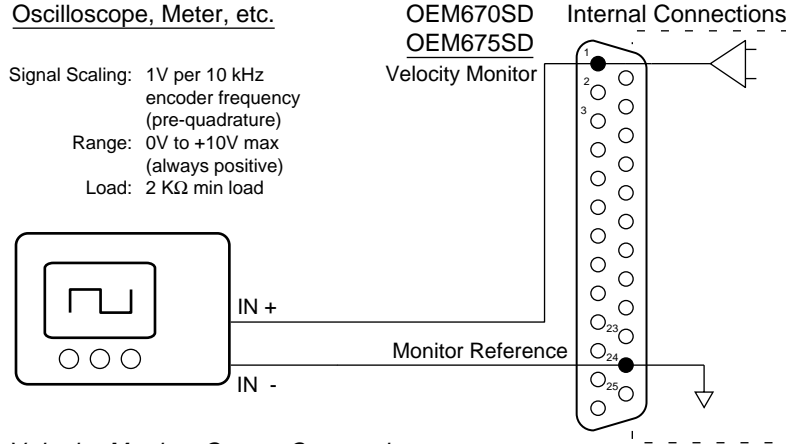
Velocity Monitor Output Connections

Derivative Gain Reduction – Input

This input (pin 5) can affect the derivative gain in the
OEM670SD/OEM675SD's internal feedback loop. If no con-
nections are made to the input, it leaves the gain unchanged.
If the input is connected to ground, the drive gradually re-
duces derivative gain to a low value whenever motion stops.
When commanded motion starts again, or if the motor shaft
moves, the drive instantly increases derivative gain to the
value set by the derivative tuning pot. See the *Tuning* section
at the end of this chapter for more information. The internal
schematic for the input is shown in the next drawing.

OEM670SD/OEM675SD   Internal Connections

+5V

10KΩ   10KΩ

Derivative Gain Reduction

Integral Gain Disable

Ground

26LS32

26LS32
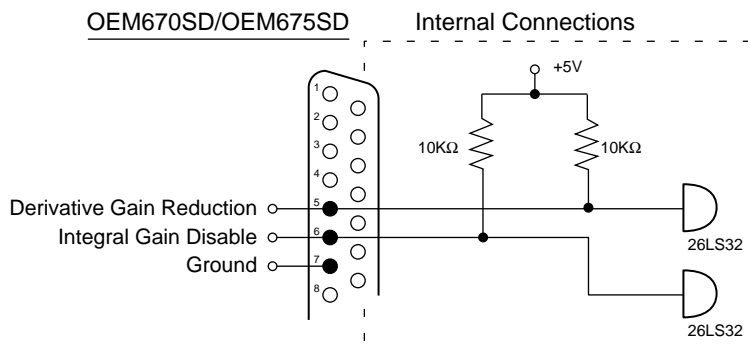
Derivative Gain Reduction & Integral Gain Disable Inputs

Integral Gain Disable – Input

This input (pin 6) can disable the integral gain in the OEM670SD/OEM675SD's internal feedback loop. If this input is grounded, integral gain is disabled. If it is not grounded, integral gain is determined by the tuning pot setting. We recommend disabling integral gain by grounding pin 6, as an initial setting to simplify tuning. You can add integral gain later, if necessary. The internal schematic for the input is shown above. See the *Tuning* section at the end of this chapter for more information.

Fault Output – Isolated and Non-Isolated

The OEM670SD/OEM675SD has two fault output signals. One is isolated (pins 22 and 23); the other is not isolated (pin 9). We recommend that you use the isolated fault output if you need a fault signal for your system. The schematic and specifications are:
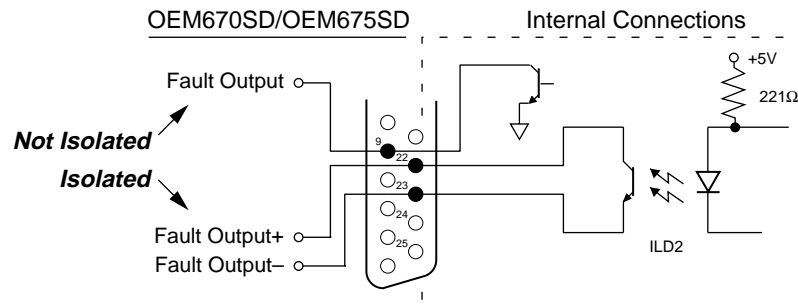
Fault Output – Isolated and Non-Isolated

Specifications	Isolated Fault Output (pin 22 & 23)	Non-Isolated Fault Output (pin 9)
Maximum Applied Voltage	50 V	24 V
Maximum Current	10 mA	20 mA
Active Level	No Fault: Transistor *on*, current flows	
	Fault: Transistor *off*, no current flows	

When the OEM670SD/OEM675SD is operating normally, each fault output's internal transistor is in the "on" state, and conducts current. If the OEM670SD/OEM675SD detects a fault, it turns off the transistors, and current stops flowing.

You can use the OEM670SD/OEM675SD's fault output as a signal to an indexer or PLC that a fault has occurred. The following conditions will activate the fault output.

		LED Status	
Fault Condition		Red	Green
Drive Not Enabled		On	On
Over Temperature	*(latched)*	On	On
Overvoltage	*(latched)*	On	On
Undervoltage	*(latched)*	On	On
Excess Position Error	*(latched)*	On	On
Short Circuit	*(latched)*	On	Off
Power Supply Fault	*(latched)*	On	Off
Foldback		Foldback is not a fault; the red LED is *ON* during foldback, but the fault output is not activated.	

Latched means you must cycle power before the drive will operate again. You can also use the shutdown input to clear position error faults, and to clear some undervoltage faults.

Current Monitor

The OEM670SD/OEM675SD's current monitor output is identical to the OEM670T/OEM675T's current monitor output. See the current monitor description in the previous section, *OEM670T/OEM675T Inputs and Outputs*, for more information.

CONNECTING A POWER SUPPLY

The OEM670/OEM675 requires a single external power supply with these features:

❑ 24VDC to 75VDC

❑ Fast Transient Response (can quickly supply enough current to meet your application's requirements)

❑ Power Dump (not required for all applications)

The power dump may be required if your system produces excess regenerated energy. To avoid damage, dissipate the regenerated energy in a power resistor, store it in extra ca-

pacitance (a blocking diode may be needed), or provide some other means to absorb regenerated energy.

For information about power supply selection, regeneration, and power dump methods, see *Chapter ⑥ Power Supply Selection.* The following table briefly lists the type of power supply you can use for different applications.

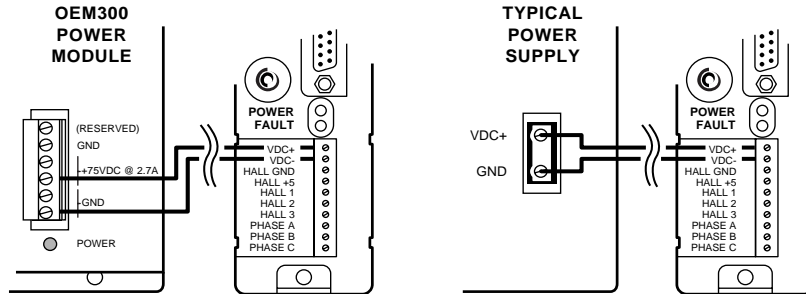| APPLICATION	RECOMMENDED POWER SUPPLY
Very Low Power (low regen)	24-48VDC Switching Power Supply 24-48VDC Linear Unregulated Supply OEM300 Power Module
Low Power (with regen)	Switching Power Supply with blocking diode and extra capacitance. Linear Unregulated Supply OEM300 Power Module
High Power (low regen)	Linear Unregulated Supply with Transformer OEM1000 Power Supply
High Power (with regen)	Linear Unregulated Supply with added Capacitance or added Power Dump OEM1000 Power Supply

The Compumotor OEM300 Power Module is a single unit that contains a 75VDC/300W power supply, integral power dump, and several protective circuits.

The Compumotor OEM1000 Power Supply is a linear power supply that can provide 1000W/15A at 70VDC.

CONNECTING THE POWER SUPPLY

Connect your power supply to the 10 pin screw terminal on the OEM670/OEM675. The next drawing shows connections for a typical power supply, and for an OEM300 Power Module.

OEM300
POWER
MODULE

(RESERVED)
GND

+75VDC @ 2.7A

GND

POWER

POWER
FAULT

VDC+
VDC-
HALL GND
HALL +5
HALL 1
HALL 2
HALL 3
PHASE A
PHASE B
PHASE C

TYPICAL
POWER
SUPPLY

VDC+

GND

POWER
FAULT

VDC+
VDC-
HALL GND
HALL +5
HALL 1
HALL 2
HALL 3
PHASE A
PHASE B
PHASE C

Power Supply Connections

❏ Connect the positive DC terminal of your power supply
   to the VDC+ input on the OEM670/OEM675's 10-pin
   screw terminal.

❏ Connect the ground terminal of your power supply to
   VDC- on the OEM670/OEM675.

To reduce electrical noise, minimize the length of the power
supply wires and twist them tightly together.

Grounding
Internally, the Hall Ground and the grounds on the 25 pin D-
connector (pins 7, 11, 16, 24) are connected to VDC-. Do not
connect your power supply's ground to these pins, however.
Connect it only to VDC-.

The shell of the 25 pin D-connector and the heatplate are
connected internally. They are not connected to VDC-, Hall
Ground, or the D-connector grounds (pins 7, 11, 16, 24).

Wire size
Use 18 AWG (0.75 mm^2) or greater diameter wire for power
connections. For applications that use high peak power, use
larger diameter wires. 14 AWG (2.5 mm^2) wire is the biggest
wire that will fit in the 10-pin screw terminal.

Tuning – OEM670T/OEM675T Torque Drive

The OEM670T/OEM675T Torque Drive requires no tuning adjustments. See your controller's user guide for instructions on controller tuning adjustments.

Tuning – OEM670SD/OEM675SD Step & Direction Drive

You must tune the OEM670SD/OEM675SD's internal *Proportional Integral Derivative* (PID) servo control loop for optimum system performance.   A properly tuned system will exhibit smooth motor rotation, accurate tracking, and fast settling time.

TUNING THEORY

The OEM670SD/OEM675SD generates a move profile based on step and direction signals from the indexer. Incoming steps represent *commanded position*, and go to a summing node. Incoming encoder counts represent *actual position*, and also go to the summing node. During a move, actual position will differ from commanded position by at least several encoder counts. Actual position is subtracted from commanded position at the summing node—the resulting difference is the *position error*, which is converted into an analog voltage. This analog error signal is the input to the PID control loop, whose block diagram is shown below.
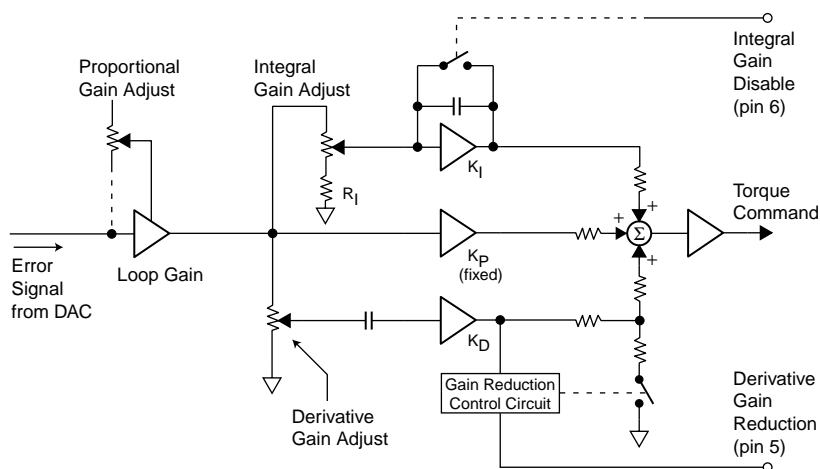
PID Control Loop – Block Diagram

You can adjust three potentiometers (pots) to tune the PID loop. These pots control the settings for proportional gain, integral gain, and derivative gain. You have two other options: you can connect pin 5 to ground to reduce derivative gain; and you can connect pin 6 to ground to disable integral gain.

Each tuning parameter is described in the following sections.

Proportional Gain

Proportional gain provides a torque that is directly proportional to the *magnitude* of the error signal. Proportional gain is similar to a spring—the larger the error, the larger the restoring force. It determines the stiffness of the system and affects the following error. High proportional gain gives a stiff, responsive system, but can result in overshoot and oscillation. Damping—provided by derivative gain—can reduce this overshoot and oscillation.

Notice from the block diagram that adjusting proportional gain affects the loop gain. This means that integral gain and derivative gain are both affected by changes in the proportional gain tuning pot. This arrangement simplifies tuning; once you set the integral and derivative gains in the correct ratio to proportional gain, you only need to adjust proportional gain—integral and derivative gain will follow.

Derivative Gain

Derivative gain provides a torque that is directly proportional to the *rate of change* of the error signal. When the error's instantaneous rate of change, or *derivative*, increases, derivative gain also increases. Derivative gain opposes rapid changes in velocity. It will dampen the resonance effects of proportional gain. With higher derivative gain, you can use higher proportional gain.

Derivative Gain Reduction (Grounding Pin 5)

Many applications require high derivative gain for proper performance. High derivative gain, however, can cause jitter and audible shaft noise when the motor is at rest. Many applications have enough stiction that high derivative gain is not necessary for stability when the system is at rest. If your application must hold position with minimum jitter or noise, connect pin 5 to ground (see the *Inputs and Outputs* section earlier in this chapter). With this pin grounded, the drive will

gradually reduce derivative gain to a low value whenever
motion stops. When motion starts again, or if the motor shaft
moves, the drive will instantly increase derivative gain to the
value set by the tuning pot.

Integral Gain

Integral gain provides a torque that is directly proportional to
the sum, over time, of the error signal—the *integral* of the
error. If the error persists, integral gain provides a restoring
force that grows larger with time. Integral gain can remove
steady state errors that are due to gravity or a constant static
torque. It can also correct velocity lag and following error in a
constant velocity system.

Too much integral gain can cause overshoot during accelera-
tion and deceleration, which will increase settling time. You
should use only as much as your application requires; if your
application does not need any integral gain, you should
disable it by grounding pin 6 (see below).

Integral Gain Disable (Grounding Pin 6)

You can *permanently* disable integral gain by wiring pin 6 to
ground. Notice on the block diagram that even if you zero the
integral gain pot, integral gain is not reduced to zero, just to a
lower value. There will still be integral gain in the system
(because of voltage on resistor R_I). The only way you can
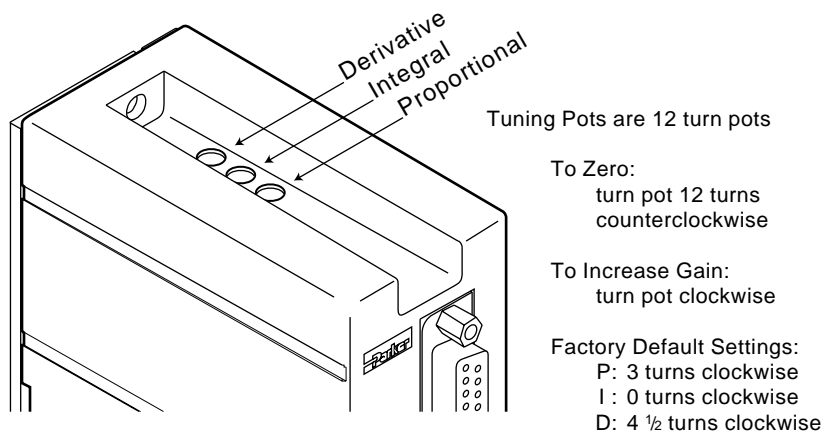eliminate integral gain is to connect pin 6 to ground.

Or, you can use a control signal to *temporarily* disable integral
gain, by connecting pin 6 to ground only during acceleration
and deceleration. This will disable integral gain during those
parts of the move, which should decrease overshoot and
settling time. When the system reaches constant velocity or
comes to rest, use your control signal to break the ground
connection, which will re-enable integral gain.

TUNING PROCEDURE

In the procedure described below, you will systematically vary
the tuning pots until you achieve a move that meets your
requirements for accuracy and response time. For the best
results, make a consistent, repetitive move that is representa-
tive of your application.

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Access to the pots is through three holes in the top of the
drive's plastic cover. The proportional gain pot is closest to the
front of the drive; the integral gain pot is in the middle; and
the derivative gain pot is closest to the heatsink. Turn the
pots clockwise to increase the gains.

Tuning Pots are 12 turn pots

To Zero:
    turn pot 12 turns
    counterclockwise

To Increase Gain:
    turn pot clockwise

Factory Default Settings:
    P: 3 turns clockwise
    I : 0 turns clockwise
    D: 4 ½ turns clockwise

Tuning Pot Locations

① **Disable Integral Gain (optional)**
If you do not need integral gain in your application, wire
pin 6 to ground to permanently disable integral gain (see
above). If you do use integral gain, tuning will be simplified
if you disable it now, and re-enable it in *Step ⑦* below.

② **Set up the Velocity Monitor (optional)**
Connect an oscilloscope to the velocity monitor output on
pin 1 of the 25 pin D-connector, as described earlier in the
Inputs and Outputs section. You can tune without the
velocity monitor, but using it will clearly show how your
system responds when you adjust the tuning pots.

③ **Set Pots to their Default Values**
The tuning pots were set at default values when the
OEM670SD/OEM675SD shipped from the factory. If yours
is a new unit, skip this step and proceed to step ④. Other-
wise, follow this procedure to return the settings to their
default values:

1. Turn each pot 12 turns counterclockwise (zero each pot).
2. Turn the proportional gain pot 3 turns clockwise.
3. Leave the integral gain pot at zero.
4. Turn the derivative gain pot 4½ turns clockwise.

These settings will provide a stable but "mushy" response with most motors and light loads.

④ **Increase Proportional Gain**
Increase proportional gain until the system oscillates or becomes unstable, then decrease the gain until the system returns to stability (at least ½ turn counterclockwise).

⑤ **Increase Derivative Gain**
Increase derivative gain until the system oscillates or becomes unstable, then decrease the gain until the system returns to stability (at least ½ turn counterclockwise).

⑥ **Repeat Step ④ and Step ⑤**
With the increased damping from step ⑤, you should now be able to increase proportional gain further. With higher proportional gain, you may need higher derivative gain. So, iteratively repeat steps ④ and ⑤ until your system is critically damped. In general, you will want values for proportional and derivative gain that are as high as possible, without producing unacceptable motor vibrations, overshoot, or ringing.

⑦ **Adjust Integral Gain**
If you need integral gain in your application, adjust it now. You should set integral gain to the lowest value that will correct following errors and static position errors, but not increase overshoot or settling time. Adjusting integral gain may require you to readjust the derivative and integral gain pots. In a system without static torque loading, you may wish to disable integral gain entirely (see ① above).

This completes the tuning procedure.