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# WARNER

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*Electrak® 2000  
Programmable Actuator Systems*



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**WARNER ELECTRIC®**



Danaher Linear has long been the leader in ball bearing screws and linear actuators. This new line of Electrak programmable linear actuators offers an expanded range of performance in life, load carrying capability, speed, duty cycle, accuracy and programmability. The ball screw actuators are rated for continuous duty and now can operate at speeds up to 25 inches per second or position loads up to 2000 pounds with repeatability of 0.0005". They are designed to operate up to 50 million cycles. The controls are Superior Electric step motor controls. They are programmable and a menu driven software package is available specifically designed for linear motion applications with terms expressed in linear engineering units rather than motor steps. The actuators are also available in either the standard parallel configuration or in a direct drive in-line package for applications with special size limitations.

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**New!**

**Parallel Actuators**



Handles loads up to 2000 lbs.  
 2 drive types  
 • Acme  
 • Ball Screw

**In-line Actuators**



Ideal for loads up to 1100 lbs.  
 2 drive types  
 • Acme  
 • Ball Screw

**Controls**



Controls are complete with I/O boards, input power cables, indexer and drive.  
 • Full and half-step  
 • Micro-stepping

**Programming**



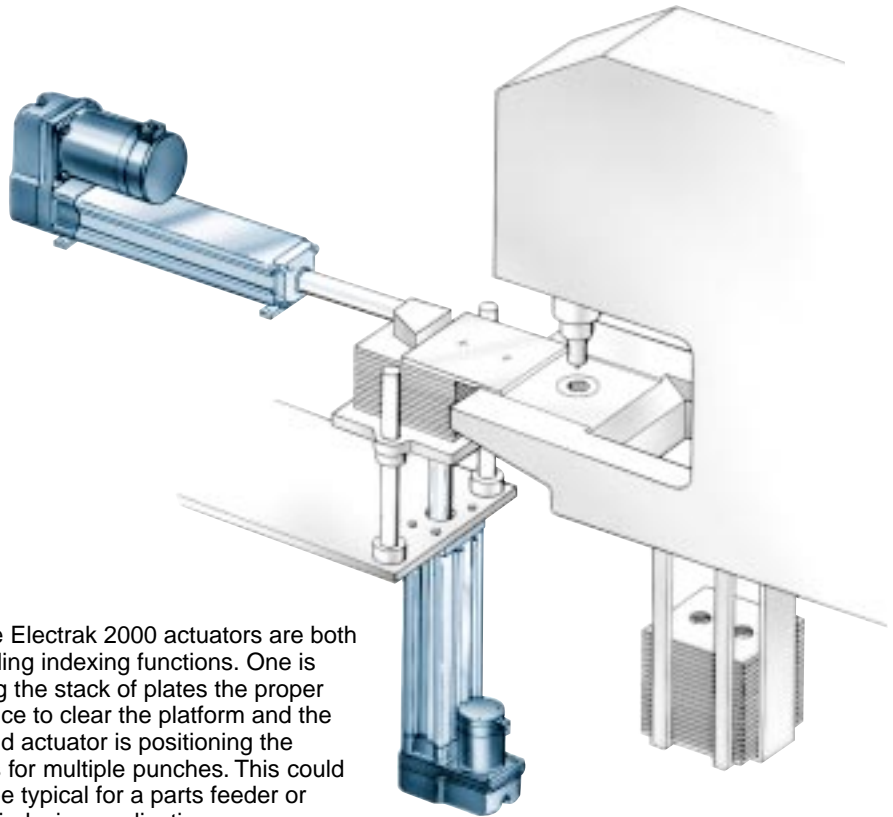
Software package for MS-DOS compatible computers

# Precise Linear Positioning

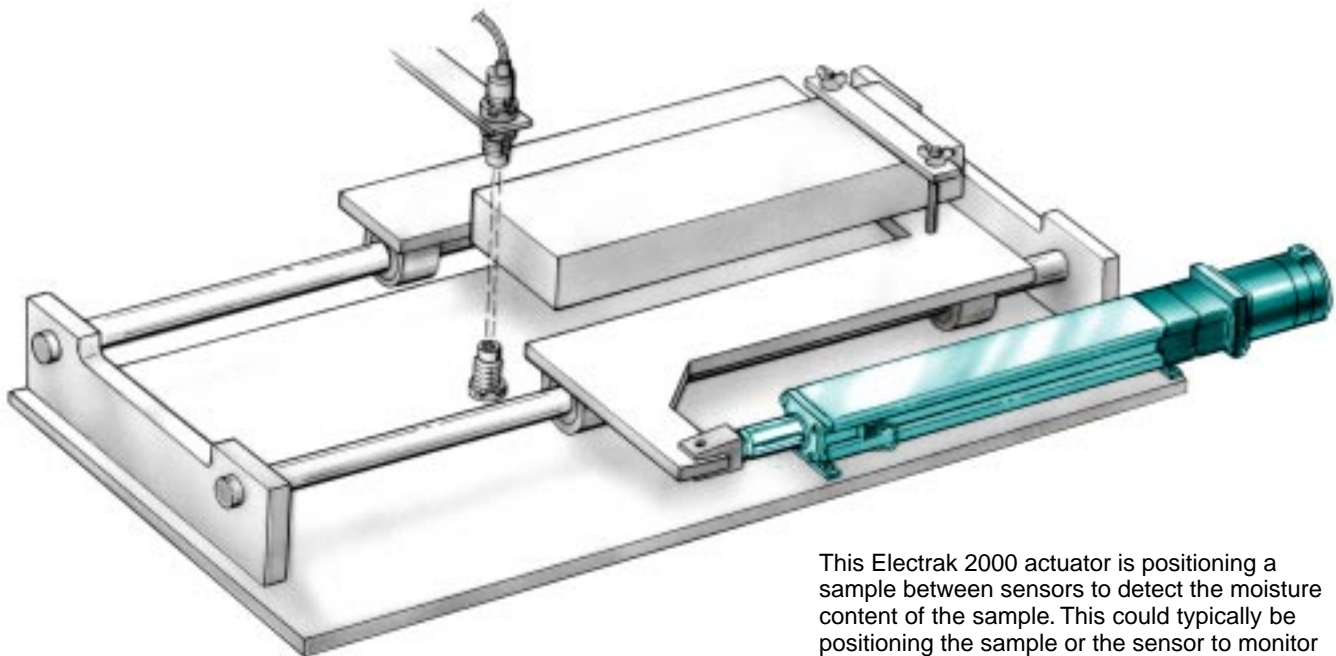
## Applications

Electrak 2000 actuator systems are designed to provide efficient linear motion control for applications requiring:

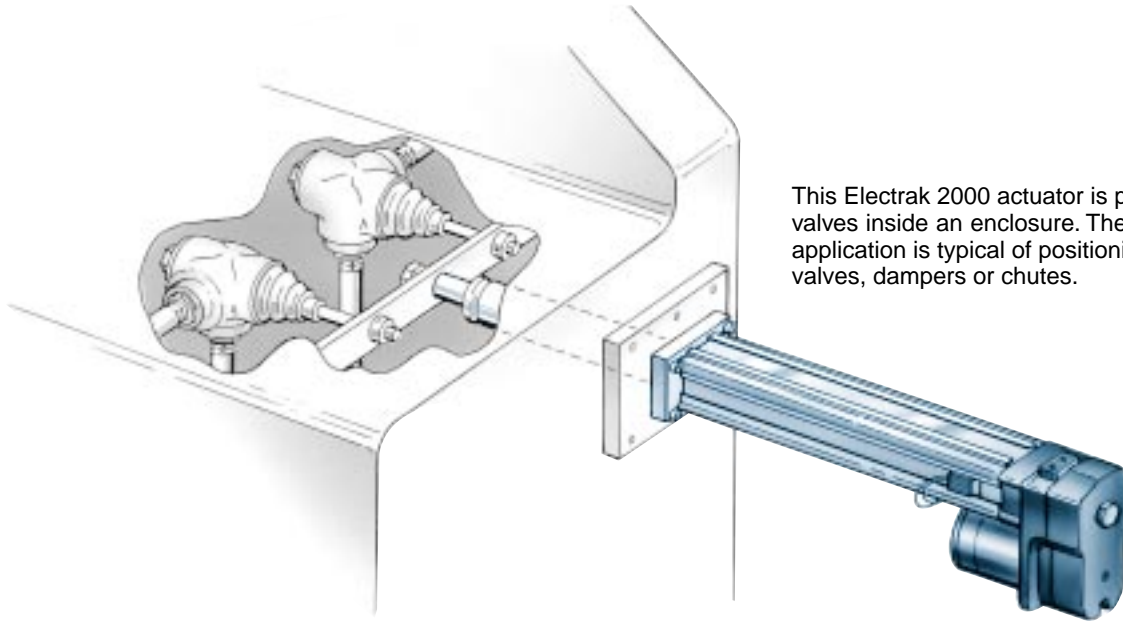
- programmability
- wide speed range (up to 25 in/sec)
- high load capability (up to 2000 lb)
- high duty cycle rate (up to 100%)
- maintenance free operation
- long life (up to 50 million cycles)



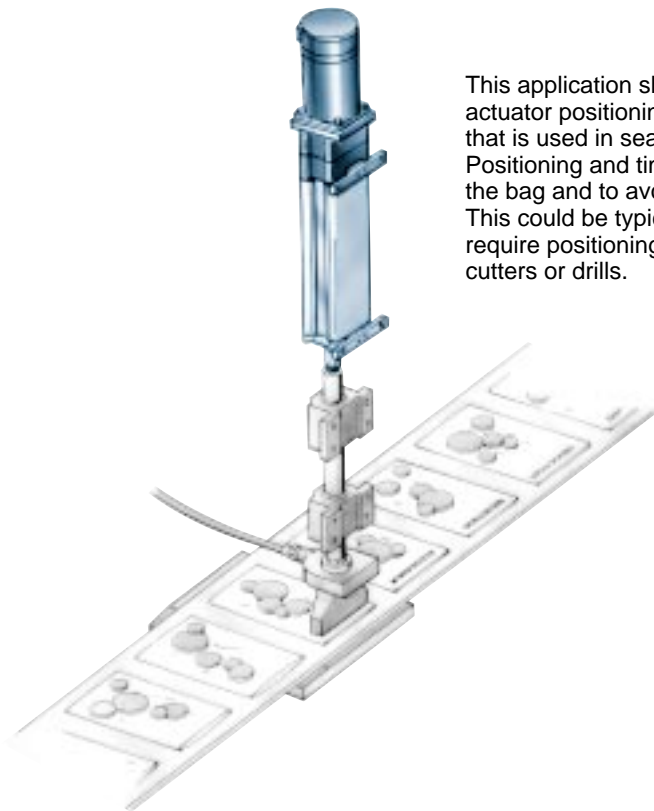
These Electrak 2000 actuators are both providing indexing functions. One is raising the stack of plates the proper distance to clear the platform and the second actuator is positioning the plates for multiple punches. This could also be typical for a parts feeder or other indexing applications.



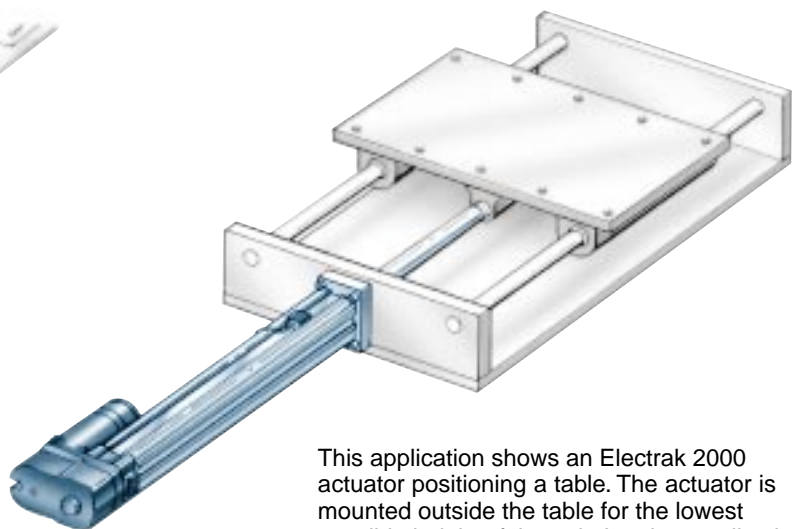
This Electrak 2000 actuator is positioning a sample between sensors to detect the moisture content of the sample. This could typically be positioning the sample or the sensor to monitor thickness, texture, width, imperfections, etc. The sensor could also be replaced by a welding head, router, laser or water jet cutting head.



This Electrak 2000 actuator is positioning valves inside an enclosure. The application is typical of positioning gates, valves, dampers or chutes.



This application shows the Electrak 2000 actuator positioning the heating head that is used in sealing plastic bags. Positioning and timing are critical to seal the bag and to avoid burning through it. This could be typical of applications that require positioning tooling work heads, cutters or drills.



This application shows an Electrak 2000 actuator positioning a table. The actuator is mounted outside the table for the lowest possible height of the unit. In other applications the actuator may be mounted below the platform and between the bearings with the platform passing over the actuator. Multiple units may be combined for x, y, and z axes.

# Design Features

## An inside look...

### Parallel configuration

(Shown with acme screw and gear drive. Other configurations are available.)

**Mounting options** include clevis, front flange, side tapped holes, and mounting feet

**Roller thrust bearings** on high load versions for smooth operation, high load capacity and long life. Ball bearings are used in high speed versions.

**Acme screw** with self locking operation eliminates backdriving in case of power failure or motor stall.

**Belt, gear or direct coupled** depending on ratio and configuration of the actuator

**Sealed motors** for wash down applications (IP-56 rated)

**Encoder** feedback option on the motor for closed loop positioning control

**Anti-rotation** feature prevents the extension tube from rotating.

**Holding brake** option on the motor is also available to control backdriving of ball screw version in the event of electrical power failures.

### In-line configuration

(Shown with ball screw and direct drive. Acme screw drive is also available.)

**Holding brake** option on the motor is also available to control backdriving of ball screw version in the event of electrical power failures.

**Direct coupled motor and lead screw** on all in-line actuators provide minimal system lash.

**Encoder** feedback option on the motor for closed loop positioning control

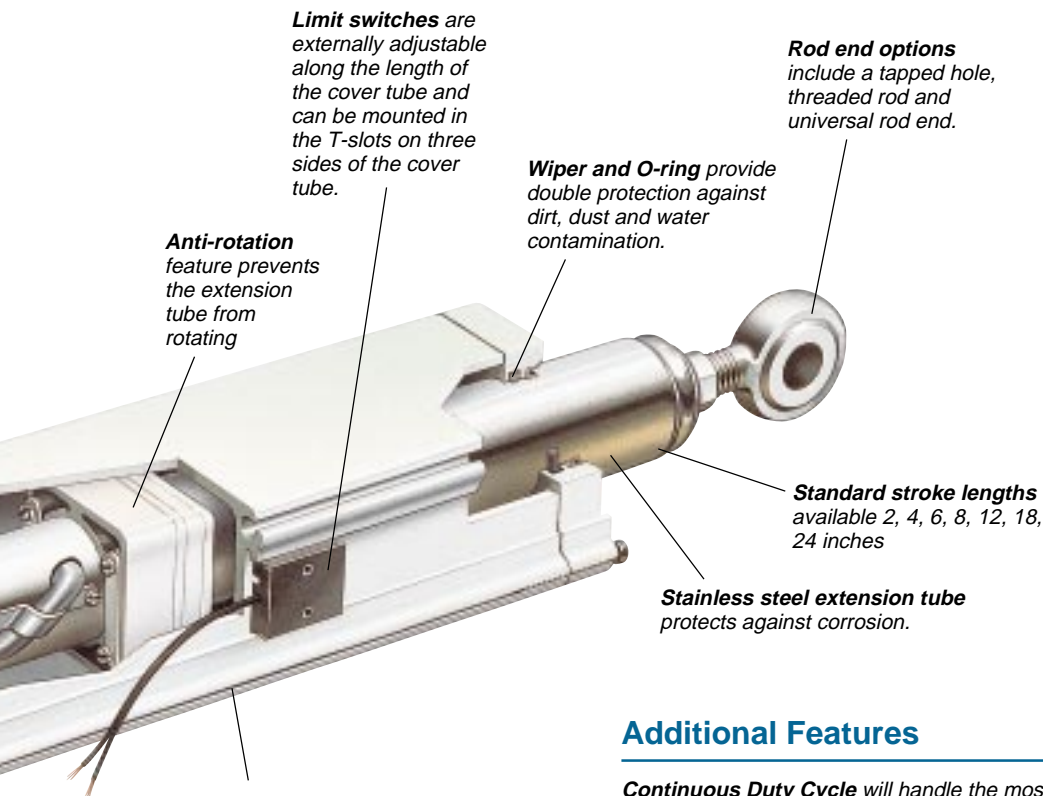
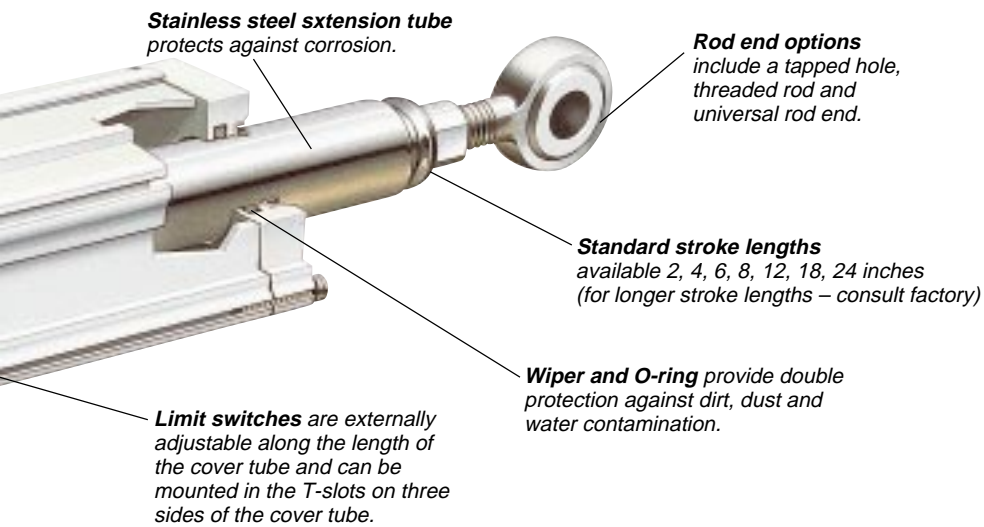
**Threaded cable entry and watertight connector** provides washdown capability.

**Screw terminals** on size 34 and size 42 motors provide ease of wiring.

**Sealed motors** for wash down applications (IP-56 rated)

**Roller thrust bearings** on high load versions for smooth operation, high load capacity and long life. Ball bearings are used in high speed versions.

**Ball screw** for high load and high speed applications



**Cover tube** of anodized extruded aluminum resists corrosion, is lightweight and allows positioning of sensors along its length.

## Actuator Components:

### Drive types

**Acme screw** – economical choice for lower load, speed and duty cycle requirements. Acme screws are self-locking by design and can not be back driven by the load. They are recommended for vertical applications or other applications where back driving can occur during loss of power. Acme screw actuators have a 50% maximum duty cycle rating.

**Ball bearing screw** – choice for higher speed and load applications. Ball bearing screws are highly efficient and consume little power in converting rotary motion into linear motion. Ball screw actuators have a 100% duty cycle rating. Motor power must be maintained to prevent backdriving by the load.

### Configurations

**Parallel** – this style of actuator allows the broadest performance range with various combinations of drive types and ratios, screw types and leads, and motor sizes. Speeds up to 15 inches per second at 20 lb. and loads up to 2000 lb. at 0.3 inches per second define the performance limits. A variety of mounting configurations are available for parallel style actuators to make installation as easy as possible.

**In-line** – direct drive with combinations of motors, screws and leads provides speeds up to 25 inches per second at 15 lb. and loads up to 1000 lb. at 0.2 inches per second. In-line actuators are available with front flange, trunion, side tapped holes, or foot mounting to suit a variety of applications.

## Additional Features

**Continuous Duty Cycle** will handle the most rigorous applications. (Ball screw version)

**Life** up to 50 million cycles depending upon screw type and load

**Resolution** is less than 0.0005 inches depending on the control selected.

**Ambient temperature rating** of -40° to +150° F allows a wide range of applications.

**Parallel or in-line versions** for different space requirements

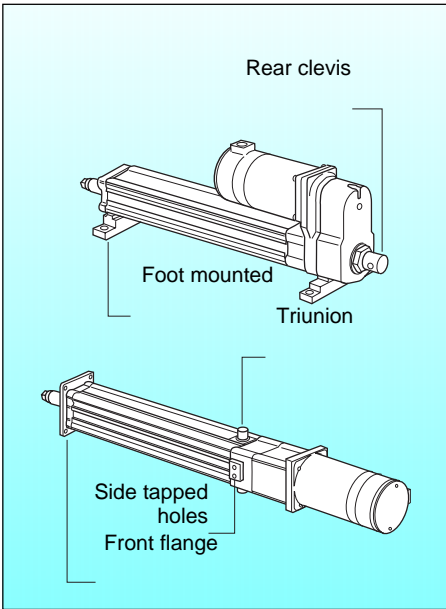
**Load ratings** up to 2,000 lb. at .3 inches per second continuous

**Speed** up to 25 inches per second continuous at 15 lbs., variable up to the maximum speed. A constant speed regardless of load up to load/speed rating of the actuator

**Programmable positioning** available with Superior Electric controls

**Software package** available that is menu driven and units are expressed in linear terms for easier and faster programming. No need to learn special codes

**Hazardous location versions** are available. Contact the factory for explosion proof or dust ignition proof models.



### Mounting styles

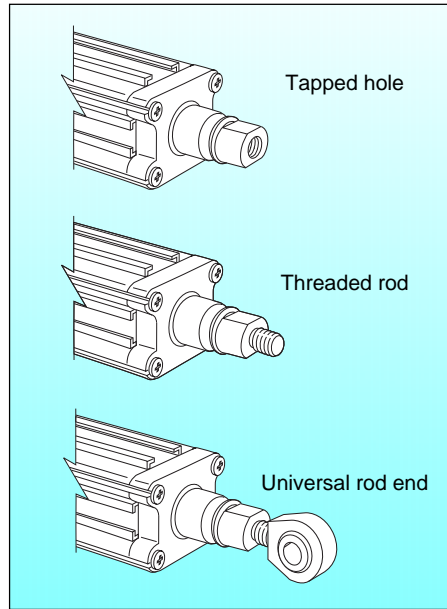
**Rear clevis mounting** – fast and easy connection of the actuator to a fixed member with a pin. The clevis is on the axis of the screw and helps to minimize side loading in one direction. The orientation of the rear clevis is available in 90° increments. This style of mounting is available only with the parallel configuration. It is also the least rigid mounting style.

**Triunion mounting** – provides a pivot point on the body of the actuator. Parallel pins are attached to the T-slots on each side of the actuator.

**Mounting feet** – are used to raise the actuator off of the mounting surface while keeping it parallel to the surface. Mounting feet rigidly mount the actuator to the surface.

**Side tapped holes** – drilled and tapped holes are in the side of the actuator to rigidly mount the actuator to the surface. This option with either the tapped hole or threaded rod provides the most accurate and repeatable performance for the actuator.

**Front flange** – this allows the actuator to be mounted by the front flange on the cover tube. This is also a rigid mounting system and does not permit any side to side motion of the actuator. This is not recommended for over 12" stroke length in horizontal applications due to the over hanging load.

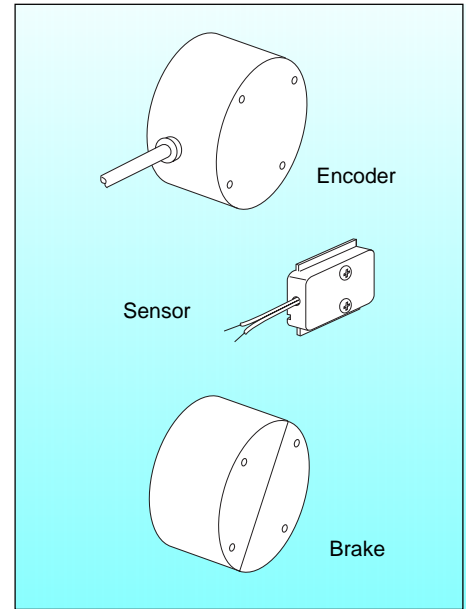


### Rod end options

**Tapped hole** – this allows the load to be attached to the rod end by a bolt. This is a very rigid mount and care should be taken to avoid side loads.

**Threaded rod** – this allows the load to be attached to the rod end by a nut. This is also a very rigid mount and care should be taken to avoid side loads.

**Universal rod end** – provides two degrees of freedom for the load. The load is attached by a pin.

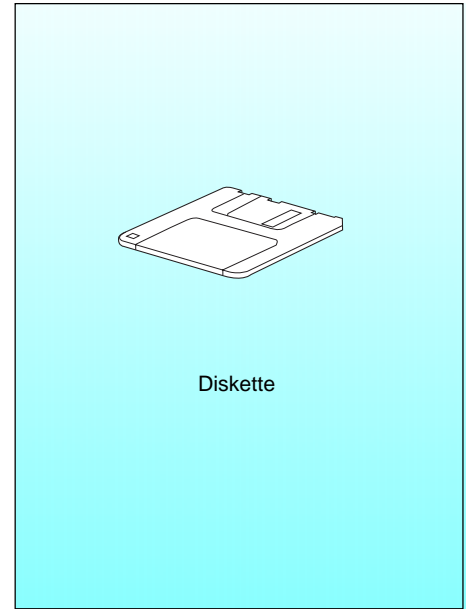
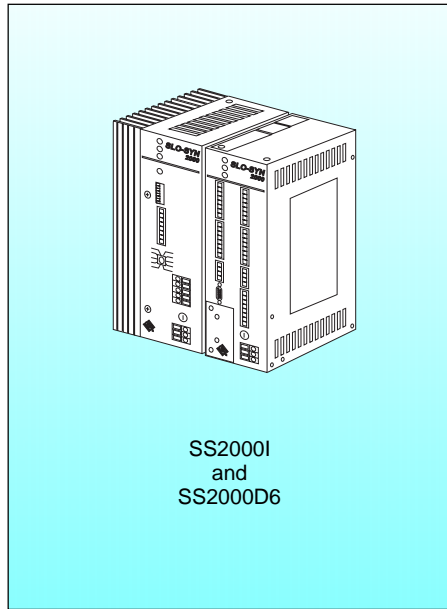
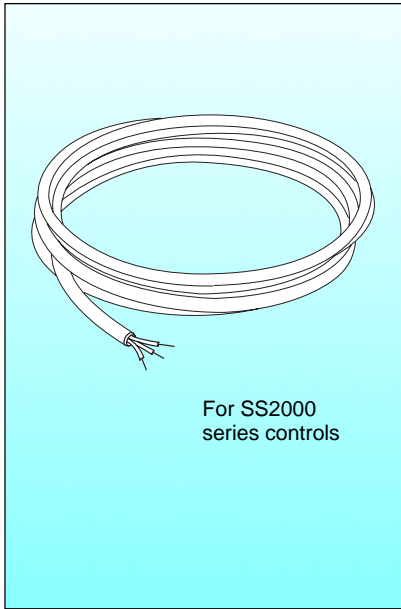


### Options and Accessories

**Encoder** – 400 or 500 line optical encoder can be driven off of either the lead screw or motor to provide confirmation of actual position.

**Brake** – an electrically released, spring set brake mounted on the motor can control backdriving of the ball screw actuators when the power is cut.

**Sensors** – additional magnetic sensors can be placed on three sides of the actuator to provide end of stroke limits or intermediate confirmation of position.



### Cable

**Cable** – a cable which interconnects the control and actuator is required. It is available in 10, 25, or 50 foot lengths.

### Controls

**SloSyn 2000** control is available as a separate indexer and driver. It is switch selectable between full, half or microstepping and is designed for use with size 34 three stack motors (BI93 or BP93) and size 42 motors (BI12). Current output is selectable on the drive portion of the control up to 6 amps. (Size 34 motors require 3 amps, size 42 motors require 6 amps). The I/O wire directly to the control.

### Programming options

**Software diskette packet** – this diskette allows the control to be programmed directly from an IBM® compatible personal computer. It provides the handshake, is menu driven and displays in linear units rather than steps. A 10 foot cable is provided to connect the computer to the control. The software diskette packet is included with the control.

	Acme Screw Models				Ball Screw Models									
<b>Maximum Dynamic Load (lbs.)</b>	150	250	300	1000	500	700	1000	2000	250	400	500	440	1100	
<b>Maximum Speed (in./sec.)</b>	9	6	4	1.75	7	5	4	1.9	17	14	12	25	10	
<b>Drive Ratio</b>	1.0:1	1.5:1	2.0:1	5.0:1	1.0:1	1.5:1	2.0:1	5.0:1	1.0:1	1.5:1	2.0:1	1.0:1	1.0:1	
<b>Screw Lead</b>	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.5	0.5	0.5	0.2	
<b>**Step Motor Frame Size</b>	93	93	93	93	93	93	93	93	93	93	93	12	12	
<b>Control Required</b>	SS2000I and SS2000D6				SS2000I and SS2000D6				SS2000I and SS2000D6			SS2000I and SS2000D6		

\* Maximum speeds are not possible at maximum rated dynamic load.  
Consult the speed / load charts on pages 10-15 for actual performance ratings.

\*\* 93 = size 34 triple stack  
12 = size 42 (in line only)



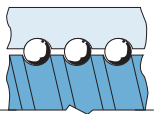
# Selection Procedures

## Information needed:

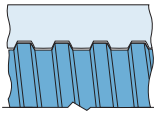
- Max.load = \_\_\_\_\_ lbs
- Max speed = \_\_\_\_\_ inches per second
- Duty cycle = \_\_\_\_\_ % on time verses off time
- Stroke length = \_\_\_\_\_ inches
- Life = \_\_\_\_\_ cycles, inches, hours
- Acceleration = \_\_\_\_\_ inches per second<sup>2</sup>
- Resolution = \_\_\_\_\_ inches
- Back driving load = \_\_\_\_\_yes \_\_\_\_\_no

## STEP 1

**Determine actuator performance characteristics:** determine the load, speed, duty cycle, life and stroke length. If the application requires load holding in the event of power failure there are two reliable solutions: 1) A load holding brake can be used on ball screws to prevent backdriving in the event of a power failure while providing the superior performance of a ball screw. **Warning! A load holding brake will not prevent a ball screw actuator from backdriving if it is overloaded and stalls.** 2) Acme screws can be selected. Acme screws are a lower cost alternative but do limit actuator load, speed, duty cycle and life. Acme screws will not backdrive even if an actuator is overloaded and stalls.



Ball bearing screw



Acme screw

## STEP 2

Calculate Total Force (lbs)

TOTAL FORCE =

Acceleration Force + Friction Force + Weight

Note: In horizontal applications the weight component of the total force should be zero.

ACCELERATION FORCE =

Mass x Acceleration

$$\frac{\text{weight (lbs)}}{32.2 \text{ ft/sec}^2} \times \frac{\text{velocity (in/sec.)}}{\text{time to speed (sec)}} \times \frac{1 \text{ ft}}{12 \text{ in.}}$$

FRICITION FORCE =

Weight (lbs) x coefficient of friction of the bearing supports ( $\mu$ )

Typical  $\mu$  = .001 for linear ball ways  
 = .005 for roller way bearings  
 = .005 for ball bearing splines

WEIGHT =

Weight of object being lifted\*

\*In horizontal applications the weight of the load must be totally supported by linear ways or bushings, the actuator should push and pull the load only. The actuator should not be side loaded.

## STEP 3

**Select the actuator which has the optimum load and extension speed** for your application based on the performance curves on pages 10 and 11. Several actuators may meet your requirements. Acme screw units are generally less expensive but are limited to a maximum of 50% duty cycle. If you are unsure about your actual load/speed requirements you may want to limit the selection to actuators which provide sufficient reserve capacity. **Warning! Do not exceed the load/speed performance curves. Exceeding the curve will cause the motor to stall and produce zero torque. This could result in backdriving the actuator.**

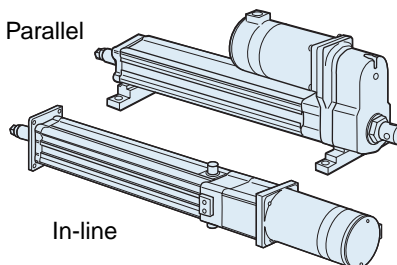
To estimate the life of an actuator in your particular application please refer to the lead screw life chart on page 36.

Note: All load and speed curves represent the typical performance based on the appropriate Superior Electric controls. The use of other controls may reduce the performance of the actuators significantly.

## STEP 4

**Determine actuator configuration:** If the load is less than 1000 pounds determine the desired actuator configuration- parallel or in-line. If the load is above 1000 pounds the only configuration available is parallel. If an actuator is available as an in-line or parallel version both part numbers will be shown on the performance charts.

Parallel

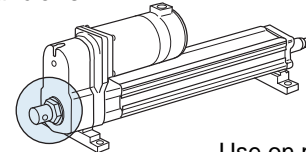


In-line

## STEP 5

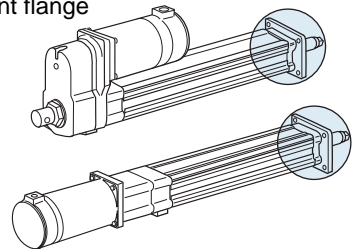
**Select mounting options:** choose the mounting method for the actuator body- rear clevis (not available on in-line version), front flange, trunion, side tapped holes or mounting feet. These options are shown below and described on page 6.

Rear clevis

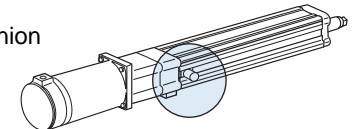


Use on parallel models only

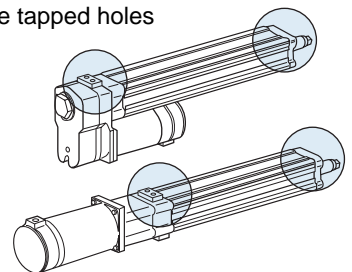
Front flange



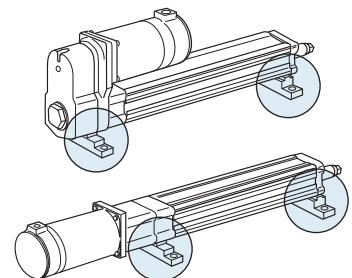
Trunion



Side tapped holes

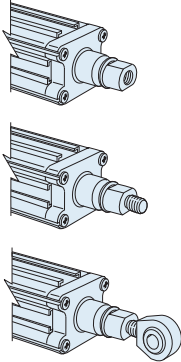


Mounting feet



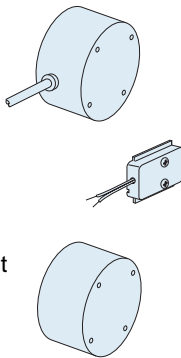
### STEP 6

**Select rod end options:** choose the type of connection you want on the extension tube  $\frac{1}{2}$  – 20 UNF tapped hole 1.37 min deep,  $\frac{1}{2}$  – 20 UNF threaded rod .75 max long or .500 diameter spherical rod end. Further information about the options is available on page 6.



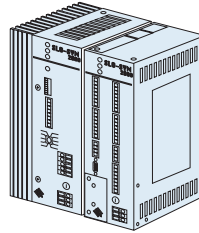
### STEP 7

**Select options and accessories:** choose the options and accessories that you want including an optical encoder driven either off the motor or the lead screw, additional sensors for use as over travel limit switches or a spring set brake mounted on the motor. Choose a 400 line encoder when using a full or half-step control and a 500 line encoder when using a micro-stepping control. Be sure and select a verification control when using an encoder. See page 34 for explanation of catalog numbering system.



### STEP 8

**Select control:** Choose from the Superior Electric controls described on page 32. The SS2000D6 and SS2000I is used with all BI93, BP93 and BI12 actuators. The micro-stepping controls will provide 0.0005 inches resolution in any screw/drive combination. The full and half-step control will provide the resolution indicated in the following chart. Gear ratios of 5:1, 10:1 or 20:1 will provide 0.0005 inches resolution with any screw lead and either control. Verification controls should be selected when an encoder is chosen as an actuator option.



SS2000D6 & SS2000I

#### Resolution Full-step

Gear Ratio	Screw Lead	
	.200	.500
1:1	.0010	.0025
1.5:1	.0006	.0017
2:1	.0005	.0013

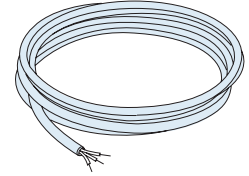
#### Half-step

Gear Ratio	Screw Lead	
	.200	.500
1:1	.0005	.0013
1.5:1	.0005	.0008
2:1	.0005	.0006

Each control comes with an I/O terminal board. The I/O terminal board allows the limit switch signals to be fed into the PAC 440 control by a 25 pin "D" connector with ribbon cable which is provided. The terminal strip plugs directly into the SS2000I.

### STEP 9

**Select cable between actuator and control:** If you are using one of the Superior Electric controls from the catalog select a cable to run from the control to the actuator. It is available in 10, 25, or 50 foot lengths.



#### Part Numbers

Cable Length	For SS2000D6 Control
	10 ft.
25 ft.	B216022-032
50 ft.	B216022-033

Encoder feedback cable (for use only with verification controls and encoder feedback option.)

10 ft.	(included with SS2000I-V)
25 ft.	250-9014

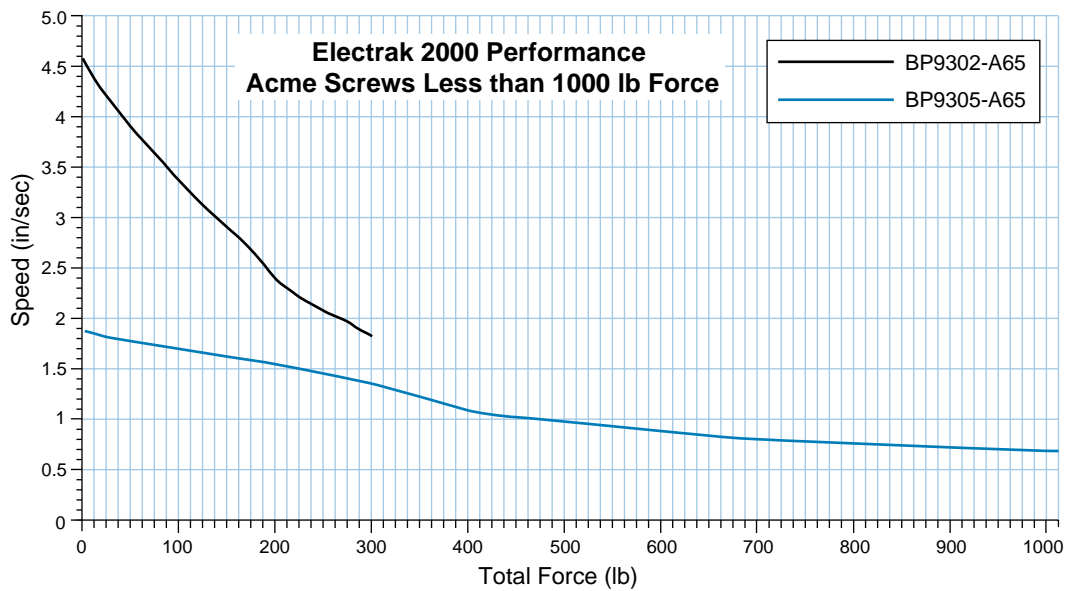
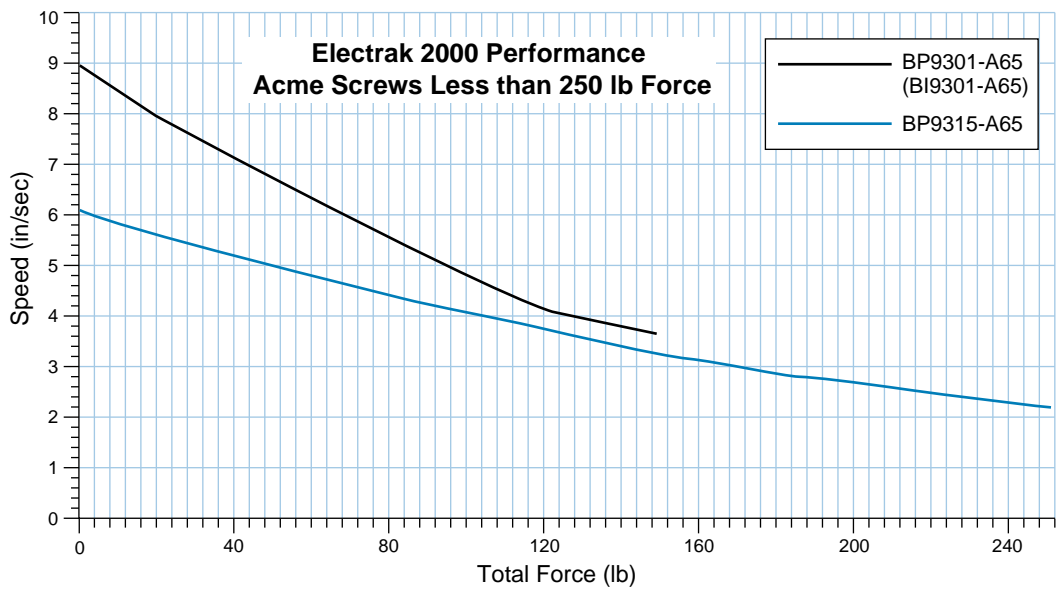
### STEP 10

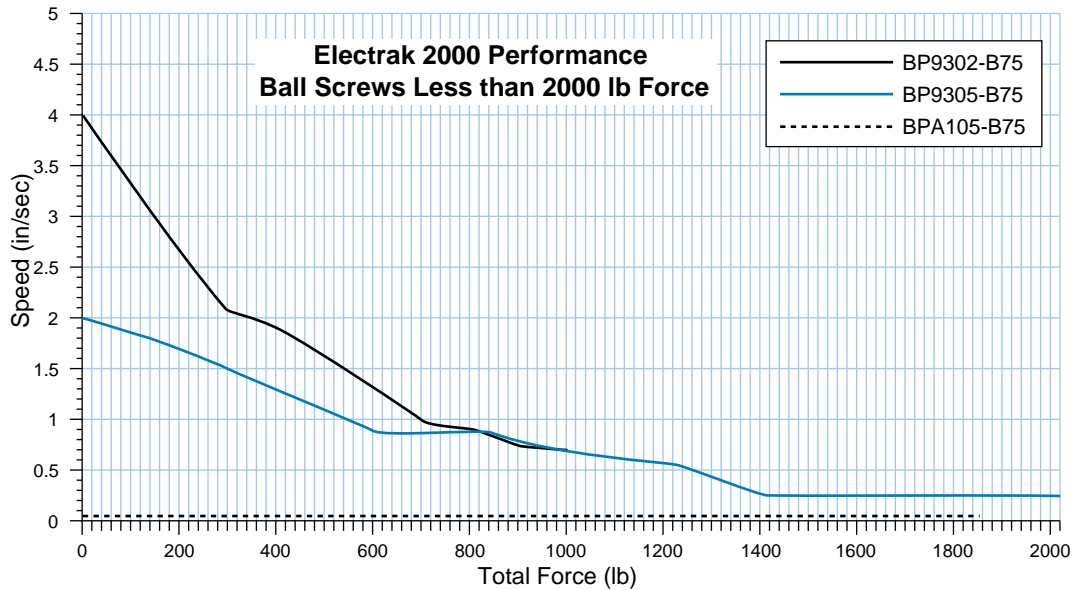
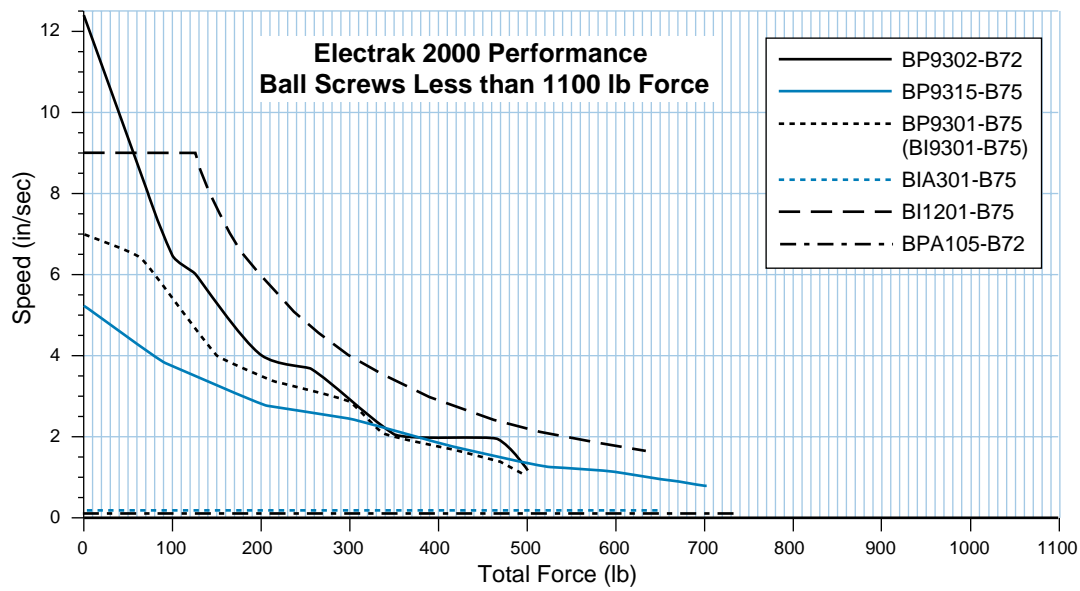
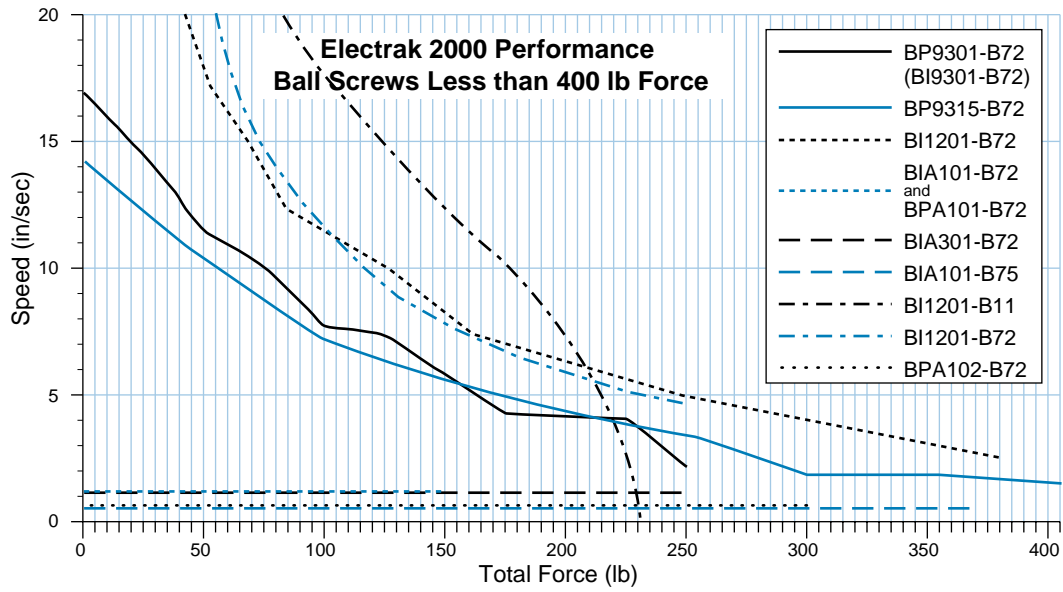
A software package for the SS2000 control is included with the SS2000I. It allows programming the control through the serial (RS232) port of an IBM® compatible personal computer. The program is supplied on a diskette and is completely menu driven, so it is easy to use and does not require memorizing complicated instructions. It also allows programming in linear units instead of steps, degrees or revolutions. A 10 foot long cable with 9 pin "D" connectors on each end is included to connect the computer to the control for programming. A 9 pin to 25 pin adapter is included for those computers with 25 pin serial ports.

# Performance Charts

When selecting the correct actuator be sure that you **do not exceed the load/speed curve**. If the load/speed curve is exceeded the motor produces no torque and the load may backdrive the screw, or the control may lose steps not knowing the exact position of the load. Using the motion profiles on page 30 you can calculate the acceleration, top speed and deceleration needed to accomplish a particular move within a set time frame. Be sure that the acceleration and deceleration rates that you choose do not cause you to exceed the load/speed curve. If you wish to estimate the life of an actuator in your particular application please refer to the lead screw life chart on page 36.

Detailed charts for each actuator are shown on pages 12–15.





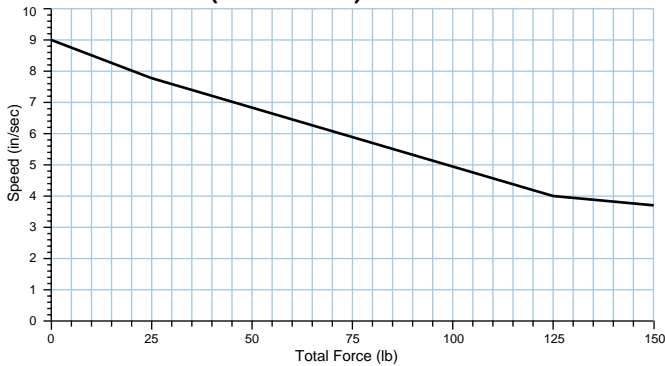
# Performance Charts

These charts show the detailed performance of each actuator. When using the charts please note that the values for load and speed axes are different for each actuator chart. If you want to easily compare the performance of various actuators please refer to the charts on pages 10 and 11. The individual performance charts are arranged in the same order as on the composite charts on pages 10 and 11.

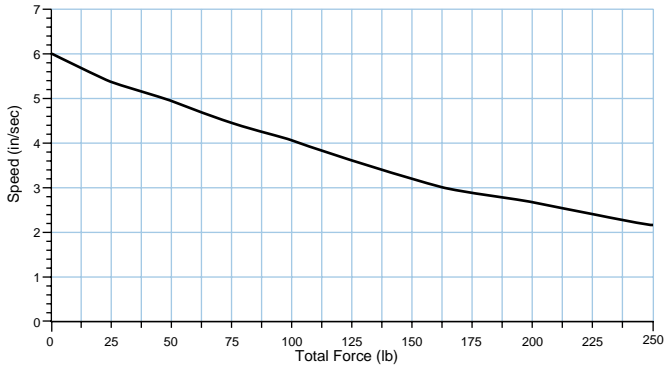
When selecting an actuator be sure to choose an actuator whose performance curve exceeds your requirements with a margin of reserve. **Warning! If you exceed the load speed curves the actuator will stall and may backdrive!** The control may lose the position of the load and should be reset.

If you wish to estimate the life of an actuator in your particular application please refer to the lead screw life chart on page 36.

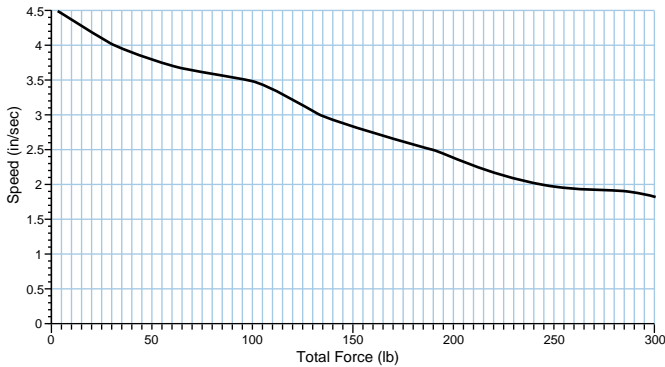
**Acme Screws Less than 250 Lb. Force**  
BP9301-A65 (BI9301-A65)



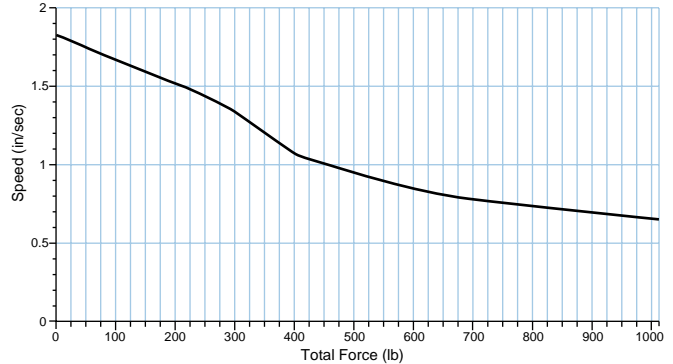
**Acme Screws Less than 250 Lb. Force**  
BP9315-A65



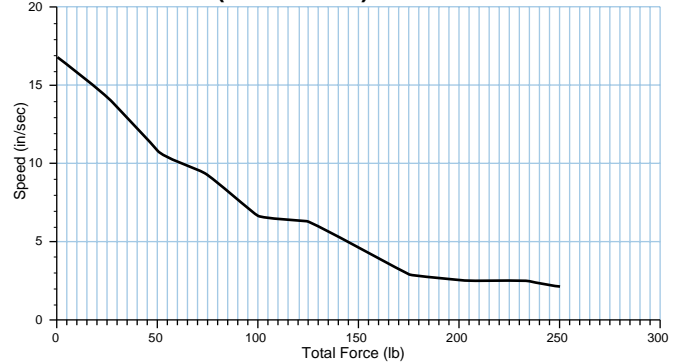
**Acme Screws Less than 1000 Lb. Force**  
BP9302-A65



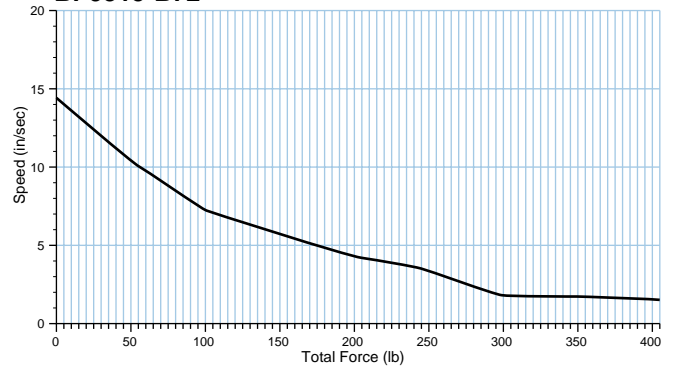
**Acme Screws Less than 1000 Lb. Force**  
BP9305-A65



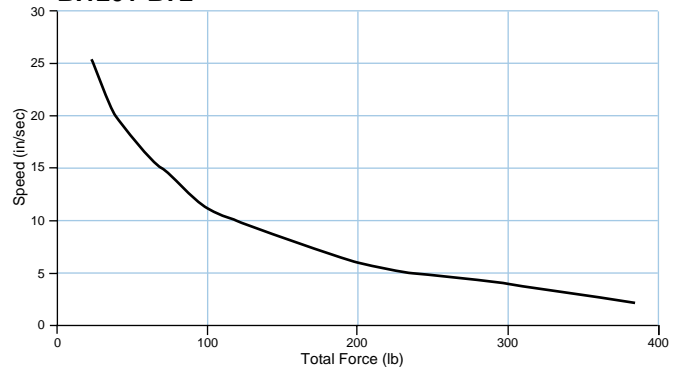
**Ball Screws Less than 400 Lb. Force**  
BP9301-B72 (BI9301-B72)



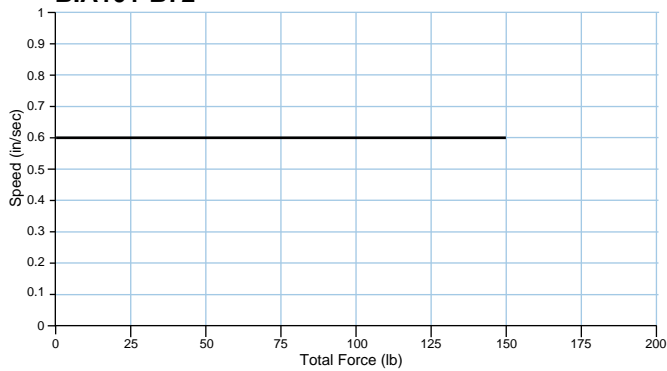
**Ball Screws Less than 400 Lb. Force**  
BP9315-B72



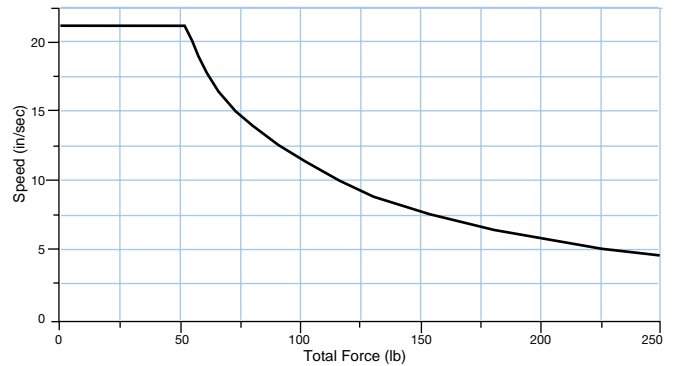
**Ball Screws Less than 400 Lb. Force**  
BI1201-B72



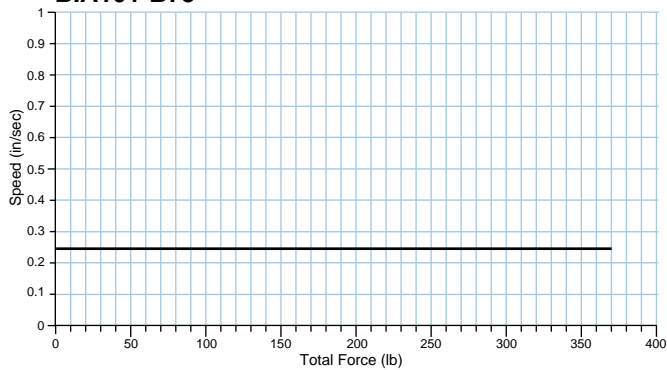
**Ball Screws Less than 400 Lb. Force**  
**BIA101-B72**



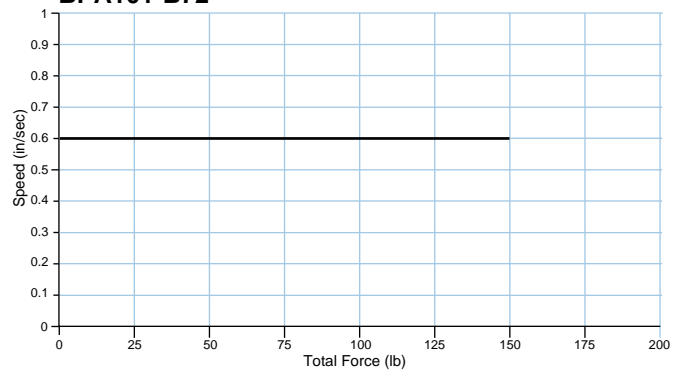
**Ball Screws Less than 400 Lb. Force**  
**BI1201-B72**



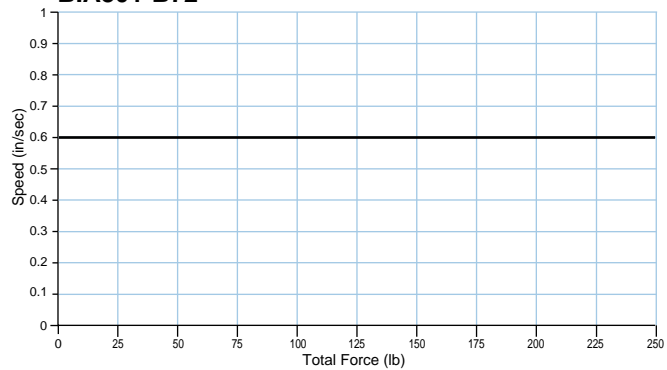
**Ball Screws Less than 400 Lb. Force**  
**BIA101-B75**



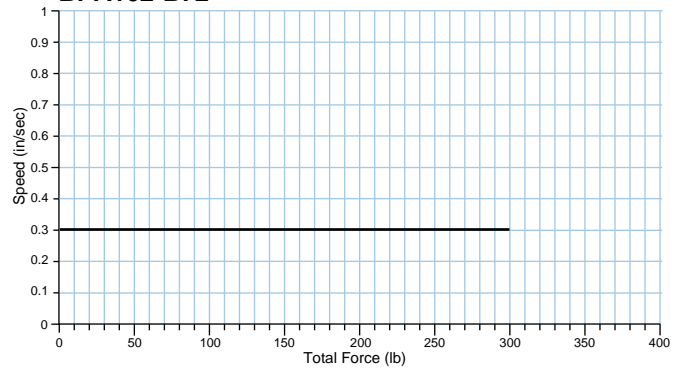
**Ball Screws Less than 400 Lb. Force**  
**BPA101-B72**



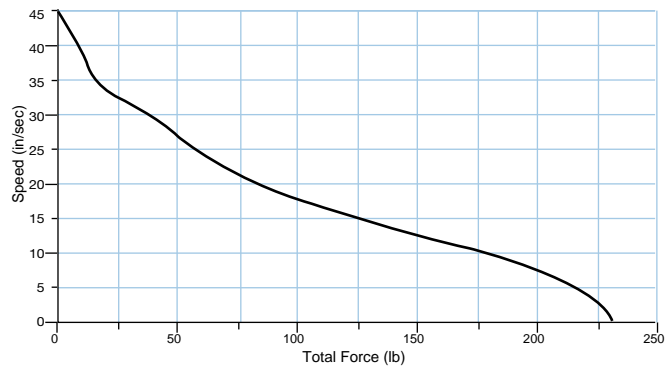
**Ball Screws Less than 400 Lb. Force**  
**BIA301-B72**



**Ball Screws Less than 400 Lb. Force**  
**BPA102-B72**

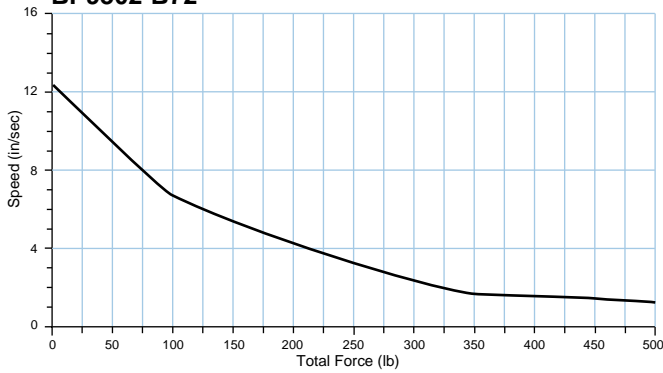


**Ball Screws Less than 400 Lb. Force**  
**BI1201-B11**

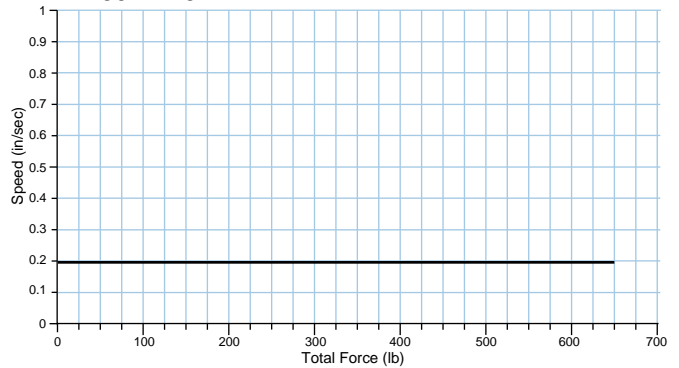


# Performance Charts

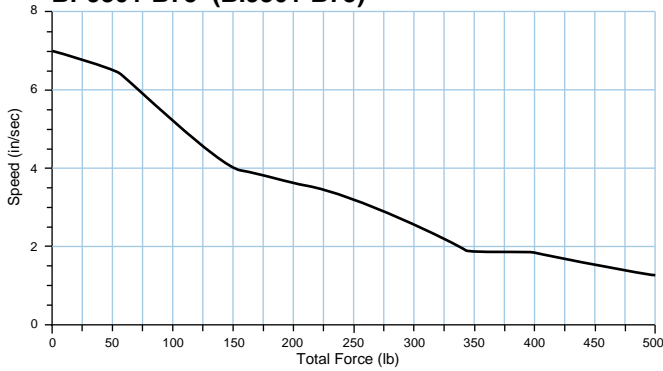
**Ball Screws Less than 1100 Lb. Force**  
**BP9302-B72**



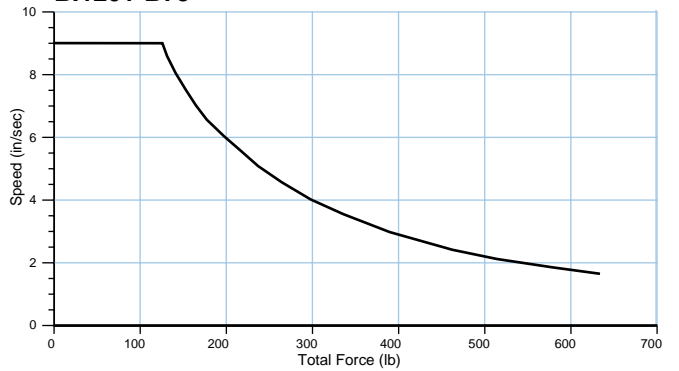
**Ball Screws Less than 1100 Lb. Force**  
**BIA301-B75**



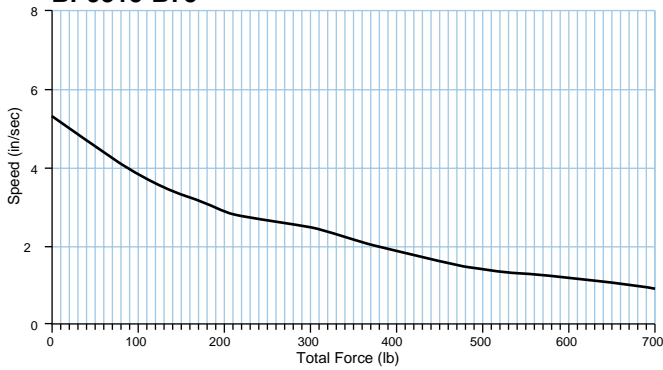
**Ball Screws Less than 1100 Lb. Force**  
**BP9301-B75 (BI9301-B75)**



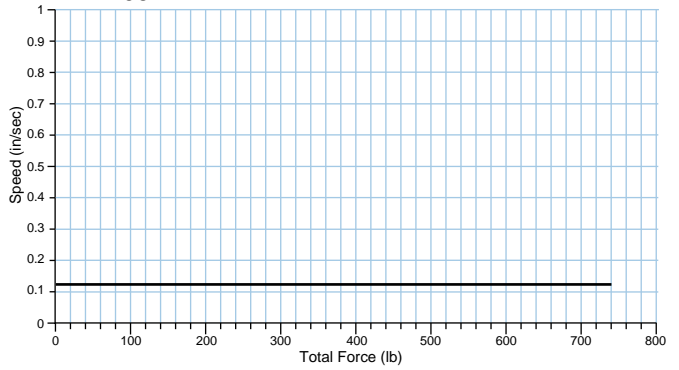
**Ball Screws Less than 1100 Lb. Force**  
**BI1201-B75**



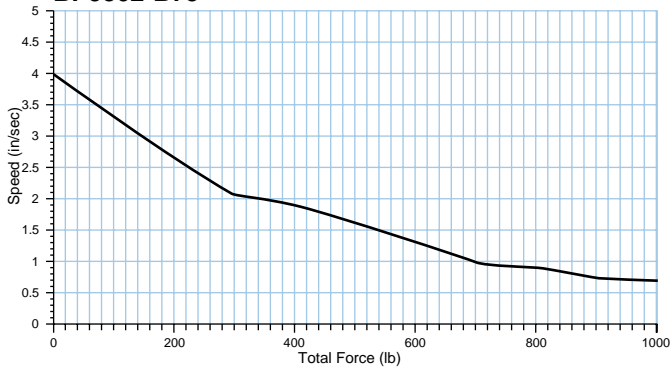
**Ball Screws Less than 1100 Lb. Force**  
**BP9315-B75**



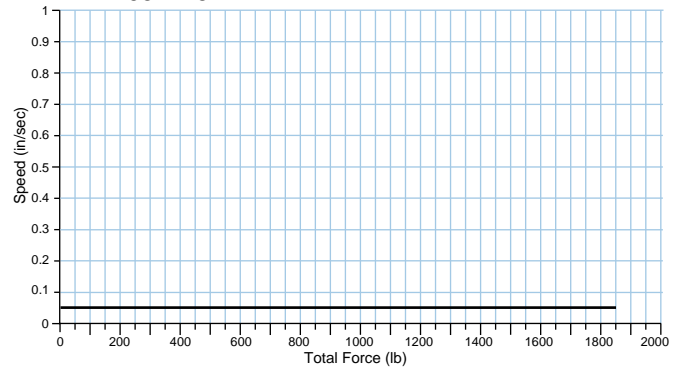
**Ball Screws Less than 1100 Lb. Force**  
**BPA105-B72**



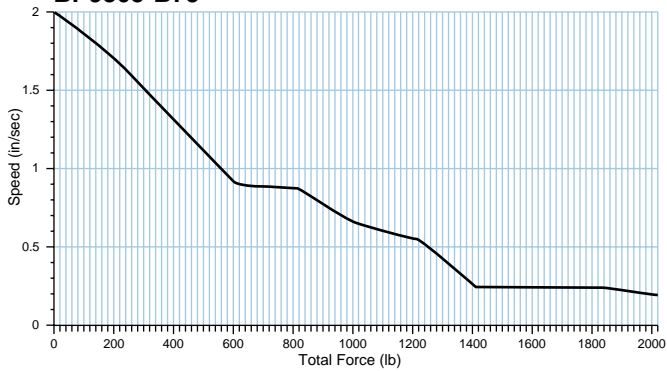
**Ball Screws Less than 2000 Lb. Force**  
**BP9302-B75**



**Ball Screws Less than 2000 Lb. Force**  
**BPA105-B75**



**Ball Screws Less than 2000 Lb. Force**  
**BP9305-B75**





# Parallel Configuration Ball Screw Drive

Ball screw actuators are used in applications that require duty cycles up to 100%, high load or high speed capability. Electrically released brakes can be used to prevent back-driving of the screw with power off. Ball screw units are available in either in-line or parallel configurations. In-line versions are direct drive and parallel versions are either belt driven or gear driven. Flange, clevis, foot, and side tapped holes provide versatile actuator mounting and the three rod end options provide either a very rigid connection for precise applications or a compliant connection for applications that require multiple degrees of freedom.



## Specifications

Dynamic Load:	up to 2000 lb at .3 in/sec
Static Load:	up to 2000 lb
Speed:	up to 17 inches/sec at 40 lbs
Acceleration:	up to 50 inches/sec <sup>2</sup> at no load
Duty Cycle:	up to 100%
Life:	up to 50 million cycles (use chart on page 36)
End Play:	0.010 inch max.
Resolution:	0.0005 inches (depending on screw lead and control)
Limit Switches:	home limit switch standard, other switches may be added on three sides of the cover tube
Stroke Lengths:	2,4,6,8,12,18,24 inches standard (consult factory for other stroke lengths)
Ambient Temperature:	-40° to 150° F (-40° to 65°C)
Washdown Protected: (IP56)	standard (direct spray applications require optional venting, contact factory. For washdown applications requiring a brake or encoder, contact factory.)
Motors:	size 34 step motors
Motor amperage:	BP93 3 amps

## Options

Mounting options:	Rear clevis Trunion Side tapped holes Mounting feet Front flange
Rod ends:	Tapped hole Threaded rod Spherical rod end
Brake:	Load holding brakes are available mounted on the motor to prevent back driving the load with the power off. The brake is spring set and electrically released to prevent load movement during power off conditions.
Encoders:	Encoders are available mounted on either the motor or the lead screw. The output of the encoder is either 400 or 500 pulses per revolution. The pulses per inch depends on the gear ratio and lead of the screw. The 400 line encoder should be used with a full and half-step control and the 500 line encoder should be used with a micro-stepping control.
Hazardous duty applications:	Contact the factory

## Actuator Accessories

### Sensors

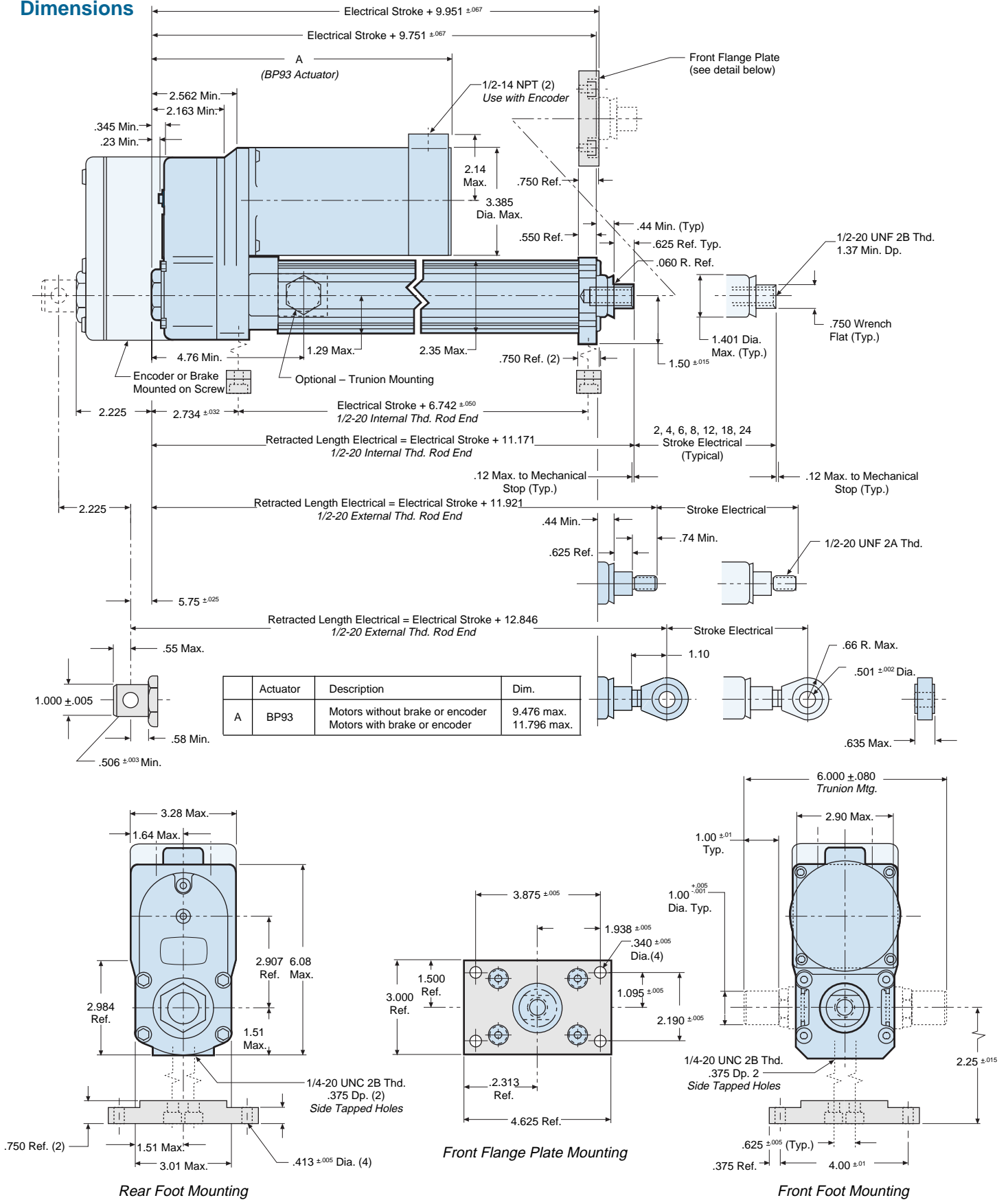
Sensor rating is 10W @ 120VAC or 200VDC. A N.O. (normally open) sensor is provided with the actuator for home position. Channels are manufactured on three sides of the cover tube to accept additional sensors. The sensors are simply inserted in the end of the channel and moved to the desired position. Set screws secure the sensor in place. The leads from the sensor are then wired to the I/O board supplied with the control. The SS2000 controls do not require diodes on inputs and can accept either N.O. or N.C. sensor inputs but not both.

	Part Number
N.O. without diode	840-9005 (for use with SS2000 control)
N.C. without diode	840-9008 (for use with SS2000 control)

### Control to Actuator cable

Cable Length	For SS2000D6 Control
10 feet	B216022-031 (included)
25 feet	B216022-032
50 feet	B216022-033

# Dimensions



# Parallel Configuration Acme Screw Drive

Acme screw actuators are used for applications that require no more than 50% duty cycle, loads up to 1000 lb. at 0.4 inches per second or speeds up to 8.5 inches per second at 10 lb. Acme screw units are also a good choice for applications that must not be allowed to back drive. The acme screw has enough friction to hold the load in position with power off or a motor stall condition. The life expectancy of an acme screw will be less than that of a ball screw in a particular application. Acme screw units are also a lower cost option than ball screw units for similar load or speed ratings. Acme screw units are available in either in-line or parallel configurations. In-line versions are direct drive and parallel versions are either belt driven or gear driven.



## Specifications

Dynamic Load:	up to 1000 lb at .4 in/sec
Static Load:	up to 1000 lb
Speed:	up to 8.5 inches/sec at 10 lbs
Acceleration:	up to 25 inches/sec <sup>2</sup> at no load
Duty Cycle:	up to 50%
Life:	up to 1 million cycles (see chart on page 36)
End Play:	0.010 inch max.
Resolution:	0.0005 inches (depending on screw lead and control)
Limit Switches:	home limit switch standard, other switches may be added on three sides of the cover tube
Stroke Lengths:	2,4,6,8,12,18,24 inches standard (consult factory for other stroke lengths)
Ambient Temperature:	-40° to 150° F (-40° to 65°C)
Washdown Protected: (IP56)	standard (direct spray applications require optional venting, contact factory. For washdown applications requiring a brake or encoder, contact factory.)
Motors:	size 34 step motors
Motor amperage:	BP93 3 amps

## Options

Mounting options:	Rear clevis Trunion Side tapped holes Mounting feet Front flange
Rod ends:	Tapped hole Threaded rod Spherical rod end
Encoders:	Encoders are available mounted on either the motor or the lead screw. The output of the encoder is either 400 or 500 pulses per revolution. The pulses per inch depends on the gear ratio and lead of the screw. The 400 line encoder should be used with a full and half-step control and the 500 line encoder should be used with a micro-stepping control.
Hazardous duty applications:	Contact the factory

## Actuator Accessories

### Sensors

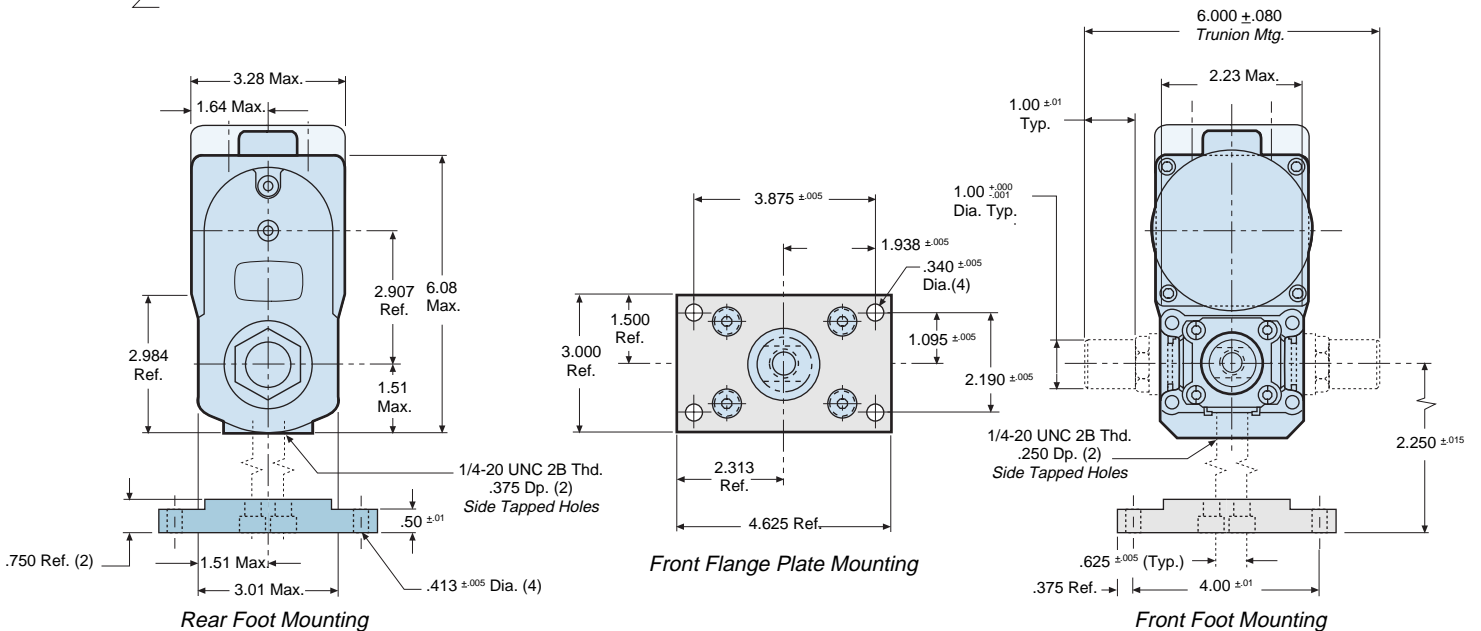
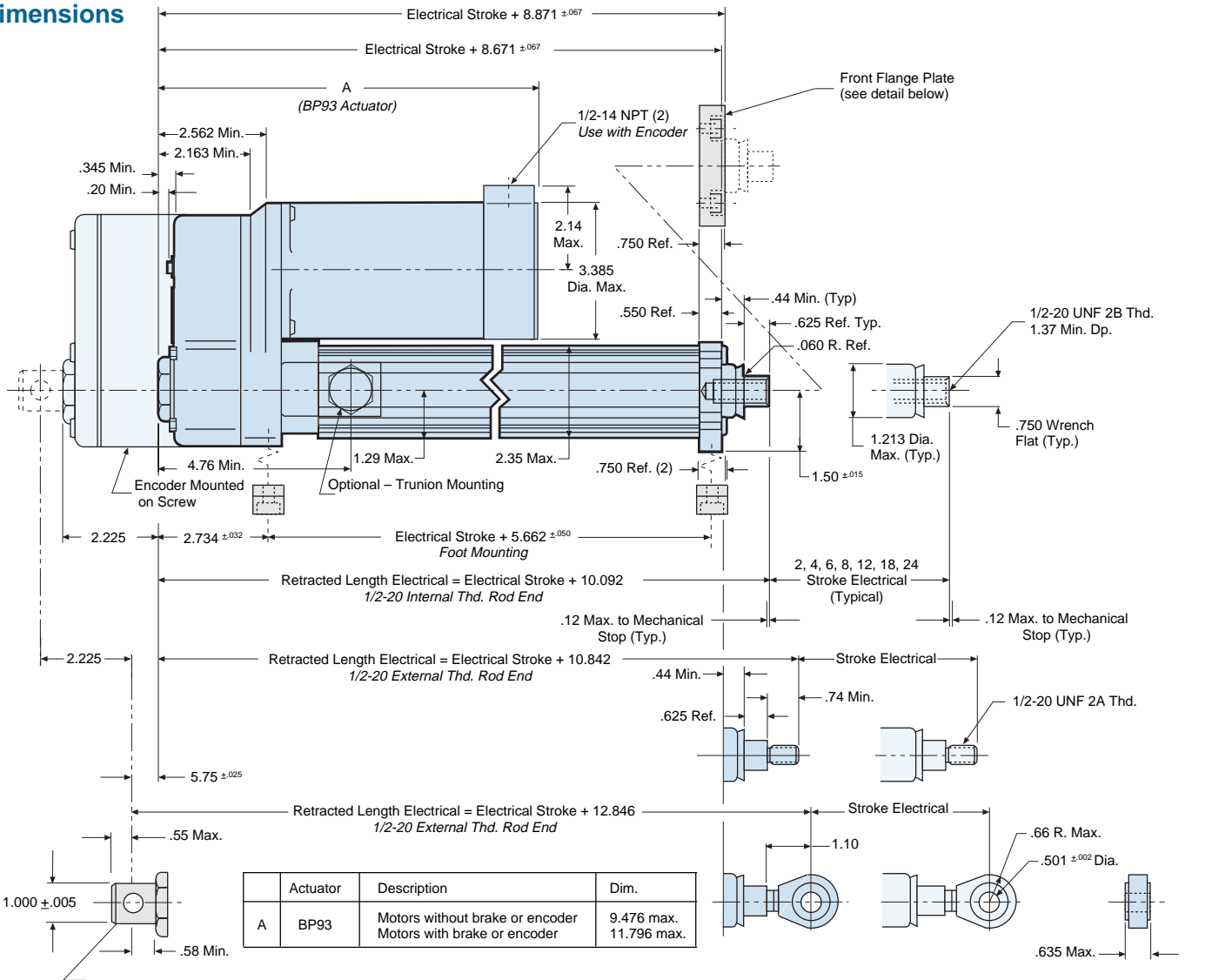
Sensor rating is 10W @ 120VAC or 200VDC. A N.O. (normally open) sensor is provided with the actuator for home position. Channels are manufactured on three sides of the cover tube to accept additional sensors. The sensors are simply inserted in the end of the channel and moved to the desired position. Set screws secure the sensor in place. The leads from the sensor are then wired to the I/O board supplied with the control. The SS2000 controls do not require diodes on the inputs and can accept either N.O. or N.C. sensor inputs but not both.

	<b>Part Number</b>
N.O. without diode	840-9005 (for use with SS2000 control)
N.C. without diode	840-9008 (for use with SS2000 control)

### Control to Actuator cable

<b>Cable Length</b>	<b>For SS2000D6 Control</b>
10 feet	B216022-031 (included)
25 feet	B216022-032
50 feet	B216022-033

# Dimensions



# In-line Configuration

## Ball Screw Drive

In-line ball screw actuators are used in applications that require duty cycles up to 100%, loads up to 1100 lbs. at 0.2 inches per second, or speeds up to 25 inches per second at 15 lbs. Electrically released brakes are required to prevent back-driving of the screw with power off. In-line versions are direct drive and are available in three load and speed versions. Flange, foot, trunion and side tapped holes provide versatile actuator mounting and the three rod end options provide either a very rigid connection for precise applications or a compliant connection for applications that require multiple degrees of freedom.



### Specifications

Dynamic Load:	up to 1100 lb at 0.2 in/sec
Static Load:	up to 1100 lb
Speed:	up to 25 inches/sec at 15 lbs
Acceleration:	up to 50 inches/sec <sup>2</sup> at no load
Duty Cycle:	up to 100%
Life:	up to 50 million cycles (see chart on page 36)
End Play:	0.010 inch max.
Resolution:	0.0005 inches (depending on screw lead and control)
Limit Switches:	home limit switch standard, other switches may be added on three sides of the cover tube
Stroke Lengths:	2,4,6,8,12,18,24 inches standard (consult factory for other stroke lengths)
Ambient Temperature:	-40° to 150° F (-40° to 65°C)
Washdown Protected: (IP56)	standard (direct spray applications require optional venting, contact factory. For washdown applications requiring a brake or encoder, contact factory.)
Motors:	size 34 or 42 step motors
Motor amperage:	BI93 3 amps BI12 6 amps

### Options

Mounting options:	Trunion Side tapped holes Mounting feet Front flange
Rod ends:	Tapped hole Threaded rod Spherical rod end
Brake:	Load holding brakes are available mounted on the motor to prevent back driving the load with the power off. The brake is spring set and electrically released to prevent load movement during power off conditions.
Encoders:	Encoders are available mounted on the motor. The output of the encoder is either 400 or 500 pulses per revolution. The pulses per inch depends on the lead of the screw. The 400 line encoder should be used with a full and half-step control and the 500 line encoder should be used with a micro-stepping control. (In-line actuators can not have both a brake and an encoder)
Hazardous duty applications:	Contact the factory

### Actuator Accessories

#### Sensors

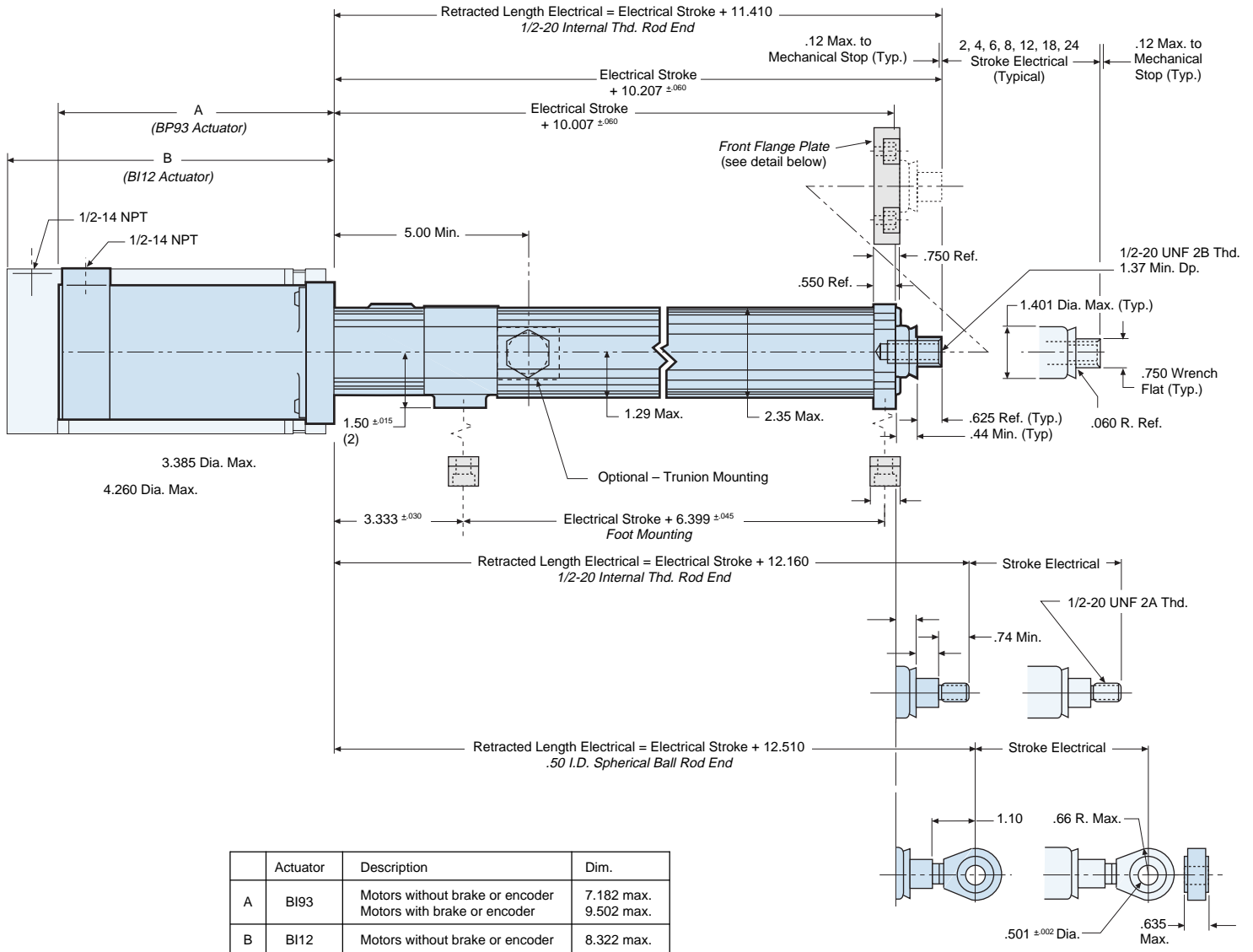
Sensor rating is 10W @ 120VAC or 200VDC. A N.O. (normally open) sensor is provided with the actuator for home position. Channels are manufactured on three sides of the cover tube to accept additional sensors. The sensors are simply inserted in the end of the channel and moved to the desired position. Set screws secure the sensor in place. The leads from the sensor are then wired to the I/O board supplied with the control. The SS2000 controls do not require diodes on inputs and can accept either N.O. or N.C. sensor inputs but not both.

	<b>Part Number</b>
N.O. without diode	840-9005 (for use with SS2000 control)
N.C. without diode	840-9008 (for use with SS2000 control)

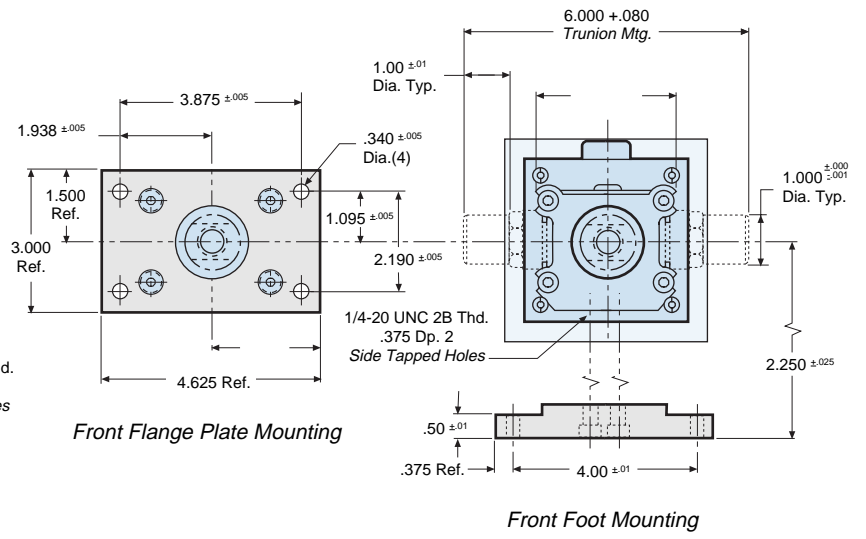
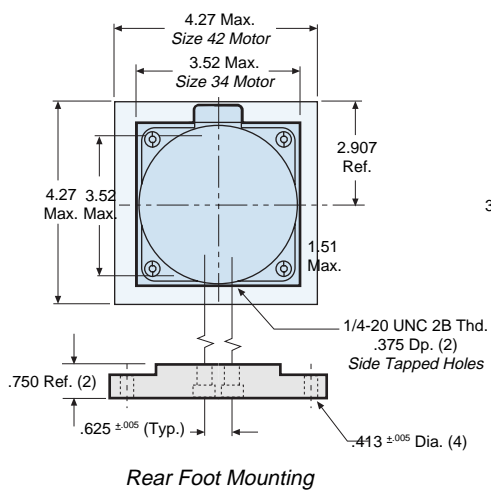
#### Control to Actuator cable

<b>Cable Length</b>	<b>For SS2000D6 Control</b>
10 feet	B216022-031 (included)
25 feet	B216022-032
50 feet	B216022-033

# Dimensions



	Actuator	Description	Dim.
A	BI93	Motors without brake or encoder Motors with brake or encoder	7.182 max. 9.502 max.
B	BI12	Motors without brake or encoder	8.322 max.



# In-line Configuration

## Acme Screw Drive

In-line Acme screw actuators are used for applications that require no more than 50% duty cycle, loads up to 150 lbs. at 3 inches per second or speeds up to 8.5 inches per second at 8 lbs. Acme screw units are also a good choice for applications that must not be allowed to back drive. The acme screw has enough friction to hold the load in position with power off or a motor stall condition. Acme screw units are also a lower cost option than ball screw units for similar load or speed ratings. In-line versions are directly coupled between the motor and lead screw.



### Specifications

Dynamic Load:	up to 150 lb at 3 in/sec
Static Load:	up to 1000 lb
Speed:	up to 8.5 inches/sec at 8 lbs
Acceleration:	up to 25 inches/sec <sup>2</sup> at no load
Duty Cycle:	up to 50%
Life:	up to 1 million cycles (see chart on page 36)
End Play:	0.010 inch max.
Resolution:	0.0005 inches (depending on screw lead and control)
Limit Switches:	home limit switch standard, other switches may be added on three sides of the cover tube
Stroke Lengths:	2,4,6,8,12,18,24 inches standard (consult factory for other stroke lengths)
Ambient Temperature:	-40° to 150° F (-40° to 65°C)
Washdown Protected: (IP56)	standard (direct spray applications require optional venting, contact factory. For washdown applications requiring a brake or encoder, contact factory.)
Motors:	size 34 step motors
Motor amperage:	BI93 3 amps

### Options

Mounting options:	Trunion Side tapped holes Mounting feet Front flange
Rod ends:	Tapped hole Threaded rod Spherical rod end
Encoders:	Encoders are available mounted on the motor. The output of the encoder is either 400 or 500 pulses per revolution. The pulses per inch depends on the lead of the screw. The 400 line encoder should be used with a full and half-step control and the 500 line encoder should be used with a micro-stepping control.
Hazardous duty applications:	Contact the factory

### Actuator Accessories

#### Sensors

Sensor rating is 10W @ 120VAC or 200VDC. A N.O. (normally open) sensor is provided with the actuator for home position. Channels are manufactured on three sides of the cover tube to accept additional sensors. The sensors are simply inserted in the end of the channel and moved to the desired position. Set screws secure the sensor in place. The leads from the sensor are then wired to the I/O board supplied with the control. The SS2000 controls do not require diodes on inputs and can accept either N.O. or N.C. sensor inputs but not both.

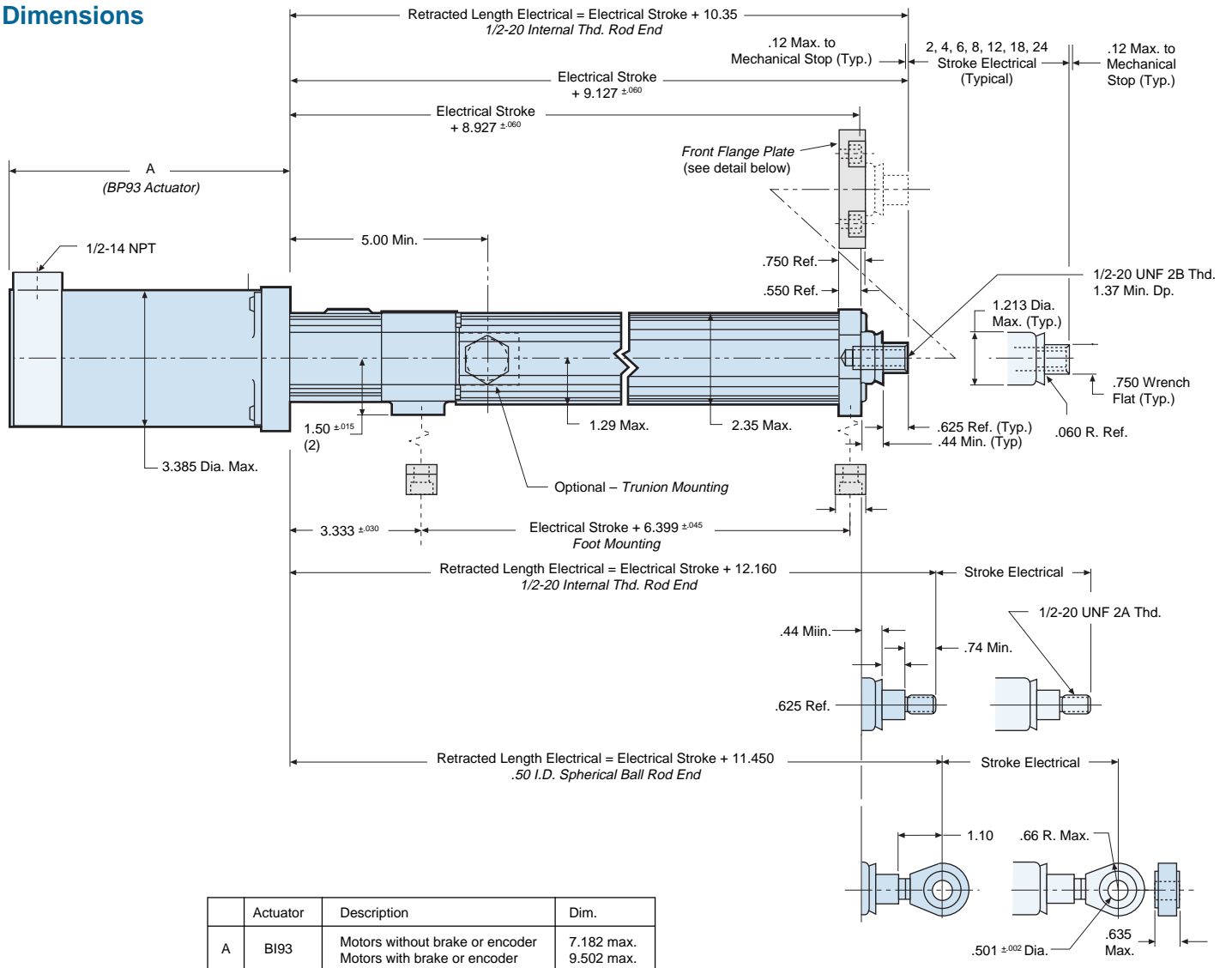
#### Part Number

N.O. without diode	840-9005	(for use with SS2000 control)
N.C. without diode	840-9008	(for use with SS2000 control)

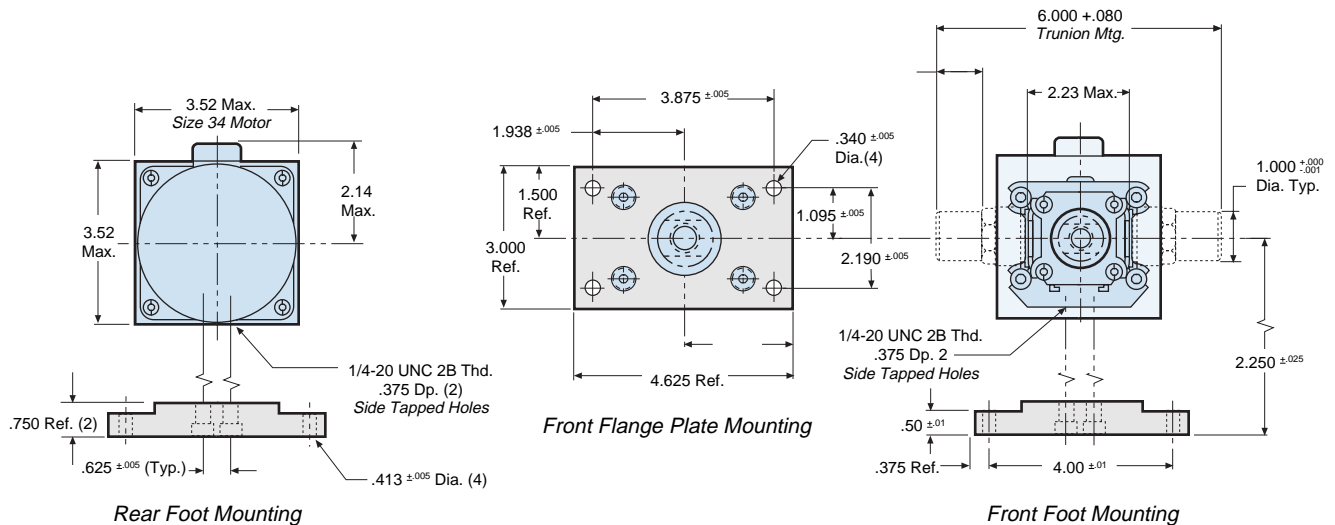
#### Control to Actuator cable

Cable Length	For SS2000D6 Control
10 feet	B216022-031 (included)
25 feet	B216022-032
50 feet	B216022-033

# Dimensions



Actuator	Description	Dim.
A	BI93 Motors without brake or encoder Motors with brake or encoder	7.182 max. 9.502 max.





# In-line Configuration

## High Speed Programmable Actuator

This high speed version of the Electrak 2000 actuator is designed to operate up to 45 inches per second at no load. The load/speed chart shows the actuator will also operate up to 5 inches per second with a 200 lb. load. This in-line ball screw actuator is direct drive and available with flange, foot, trunion and side tapped holes for a variety of mounting options. The combination of mounts with rod end options provides either a very rigid connection for precise applications or a compliant connection for applications that require multiple degrees of freedom. The SS2000I indexer and SS2000D12 drive provides the ability to program and operate the actuator. It is an ideal replacement for air cylinders in applications requiring variable speeds and strokes.



### Specifications

Dynamic Load:	Up to 225 lb. at 5 in./sec.
Static Load:	Up to 225 lb. without brake option
Speed:	Up to 45 in./sec. at no load
Acceleration:	Up to 50 in./sec./sec. at no load
Duty Cycle:	Continuous
Life:	Up to 50 million cycles
End Play:	0.010 inch maximum
Resolution:	0.0005 based on 1/10 microstep
Limit Switches:	Home limit switch standard, other switches may be added on two sides of the cover tube
Stroke Lengths:	2, 4, 6, 8, 12, 18, 24 inch standard (for other lengths, contact the factory)
Ambient Temperature:	-40°F to 150°F (-40°C to 65°C)
Environment Protection:	(IP42) standard (Dripping water) (For washdown applications, contact factory.)
Motor:	MH112 Step motor
Brake:	Due to the high efficiency of the ball screw actuator, an electrically released spring set brake mounted on the motor will be required to control back driving or load holding.

### Options

Mounting options:	Front flange plate Trunion Side tapped holes Foot mount
Rod ends:	Universal rod end 1/2 – 20 Tapped hole 1/2 – 20 External threaded rod
Brake and encoder:	Brake on motor Encoder on motor No brake or encoder
Encoder type:	400 line encoder 500 line encoder

### Actuator Accessories

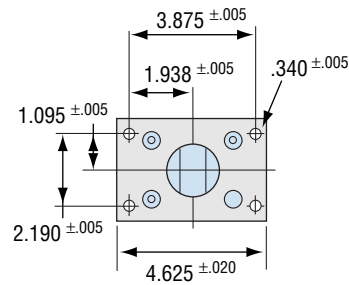
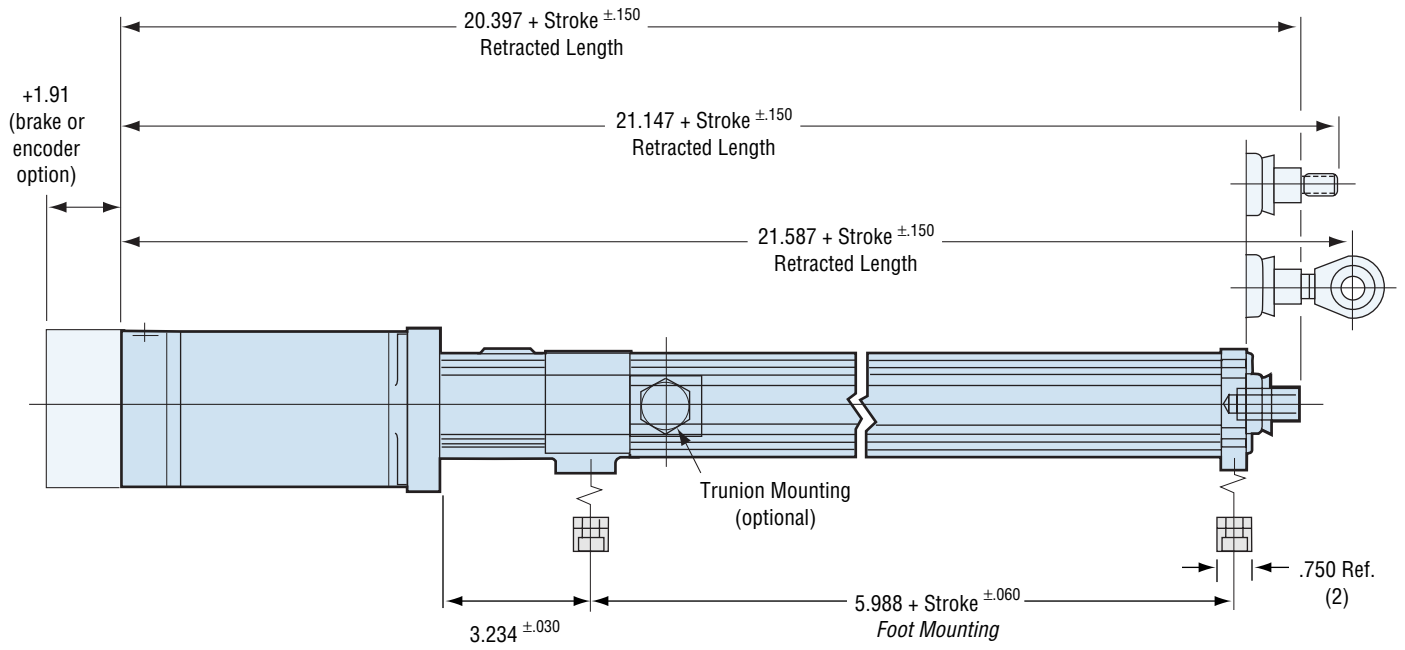
#### Sensors for end of stroke indication

	Part Number	
N.O.	840-9005	(for use with SS2000 control)
N.C.	840-9008	(for use with SS2000 control)

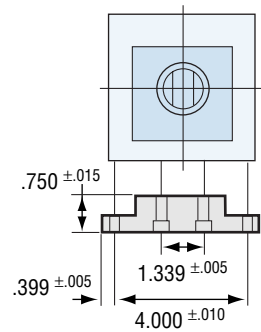
#### Programmable Motion Control

Indexer	SS2000I
12 amp Drive	SS2000D12

## Dimensions



Front Flange Plate Mounting



Front Foot Mounting

# Parallel or In-line Configuration AC Synchronous Electrak Actuator

The AC synchronous Electrak 2000 provides constant speed motion for cycling applications, where programmability is not required. These actuators provide 100% duty cycle and can be easily reversed using limit switches for end of stroke control. All actuators operate on 115 vac. Models are available with 5 load ratings. The actuators are also available in both in-line and parallel versions for different mounting, size and load requirements. The required capacitor is included with each actuator.



## Specifications

Dynamic Load:	Up to 1850 lb. at 0.05 in./sec.
Static Load:	Up to 1850 lb.
Speed:	Up to .6 in./sec. at 150 lb. load
Duty Cycle:	Continuous
Life:	Up to 50 million cycles
End Play:	0.010 inch maximum
Limit Switches:	Two limit switches standard, other switches may be added on three sides of the cover tube (either relays or mechanical limit switches are required for reversing the motors)
Stroke Lengths:	2, 4, 6, 8, 12, 18, 24 inch standard (for other lengths, contact the factory)
Ambient Temperature:	-40°F to 150°F (-40°C to 65°C)
Motor:	AC synchronous 72 RPM

## Options

Mounting options:	Clevis Front flange plate Trunion Side tapped holes Foot mount
Rod ends:	Universal rod end 1/2 – 20 Tapped hole 1/2 – 20 External threaded rod
Brake and encoder:	For brake or encoder consult factory

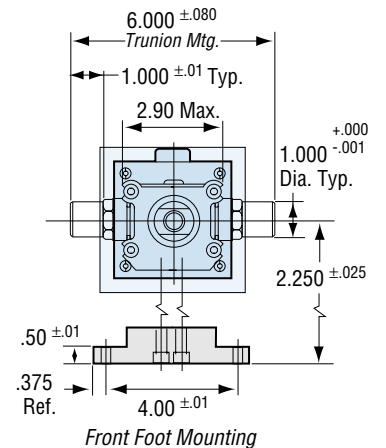
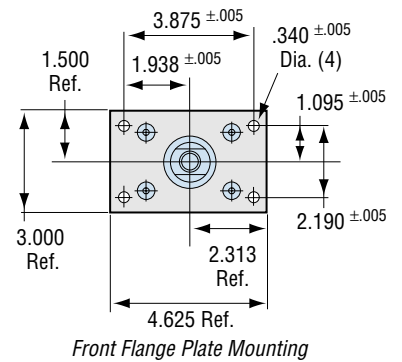
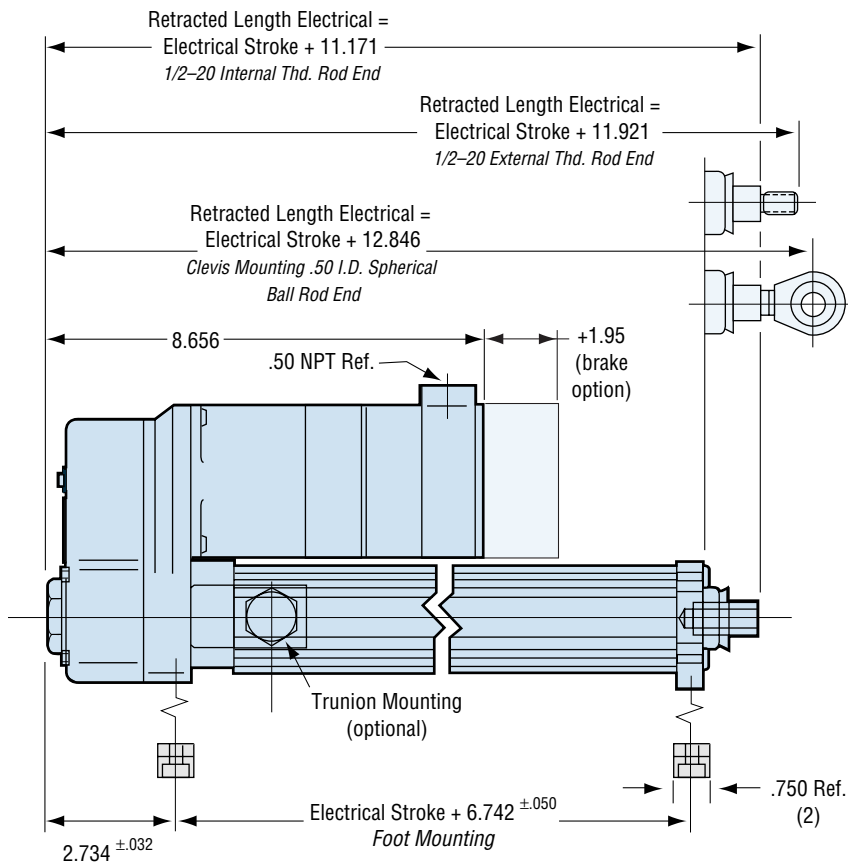
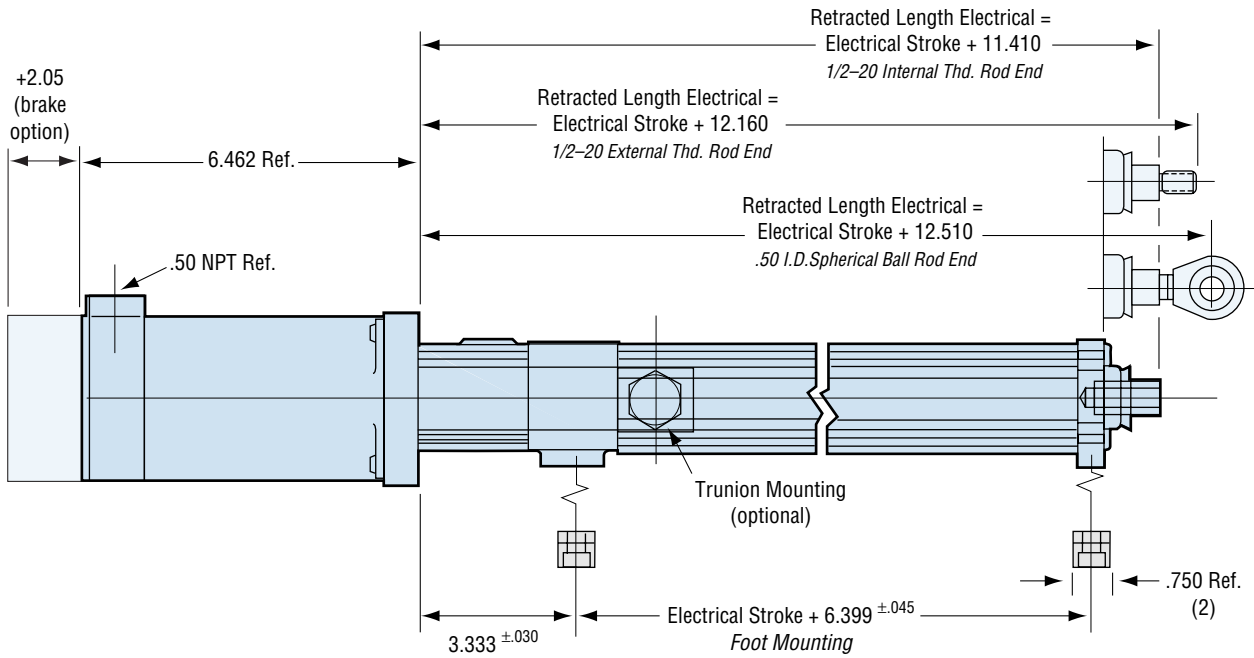
## Actuator Accessories

### Sensors for end of stroke indication

(not for direct reversal of motor, requires relays or mechanical limit switches)

	Part Number
N.O.	840-9005
N.C.	840-9008

## Dimensions

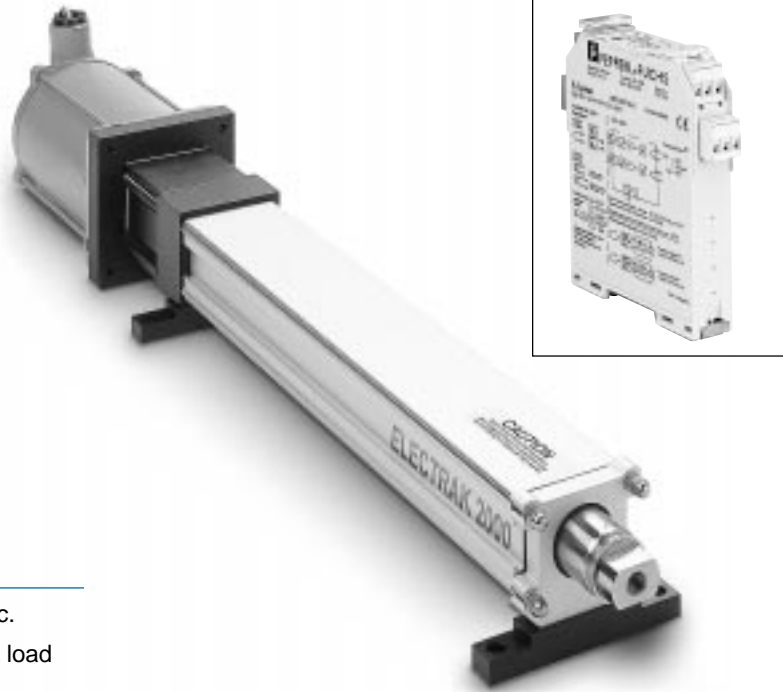


# In-line Configuration

## AC Synchronous Electrak Actuator Suitable for Class 1, Group D Locations

The AC synchronous Electrak 2000 provides constant speed motion for cycling applications, where programmability is not required. The actuator provides 100% duty cycle and can be easily reversed using limit switches for end of stroke control. All actuators operate on 115 vac. Two models are in-line with load ratings of 250 and 650 pounds. The required capacitor and resistor are included with each actuator.

“Hazardous Duty” locations as defined by the National Electrical Code Class 1, Group D requirements. “Class 1” is designated as locations in which flammable gasses or vapors are, or may be, present in the air in quantities sufficient to cause explosions or ignitable mixtures. “Group D” includes atmospheres containing gasoline, petroleum, naphtha, acetone, lacquer, solvent vapors or natural gas.



### Specifications

Dynamic Load:	Up to 650 lb. at 0.2 in./sec.
Speed:	Up to .6 in./sec. at 250 lb. load
Duty Cycle:	Continuous
Life:	Up to 50 million cycles
End Play:	0.010 inch maximum
Limit Switches:	1-NO and 1-NC with 50 foot leads and 2 channel intrinsically safe barrier included.
	Note: Barrier and motor capacitor must be located out of the hazardous area. Any electrical devices used with the actuator should have a designation as suitable for Class 1 Group D areas.
Stroke Lengths:	2, 4, 6, 8, 12, 18, 24 inch standard (for other lengths, contact the factory)
Ambient Temperature:	-40°F to 150°F (-40°C to 65°C)
Washdown Protected:	IP53
Motor:	AC synchronous Hazardous Duty X-700 72 RPM
UL Listed:	UL Listed with switches and barrier.

### Options

Mounting options:	Front flange plate Trunion Side tapped holes Foot mount
Rod ends:	Universal rod end 1/2 – 20 Tapped hole 1/2 – 20 External threaded rod
Brake and encoder:	No brake or encoder available with H.D. motor

### Actuator Accessories

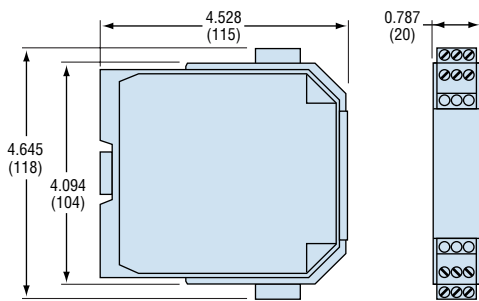
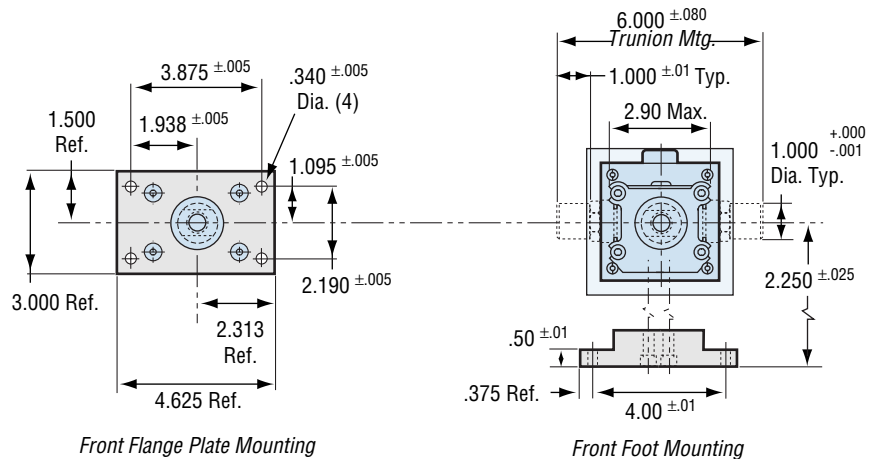
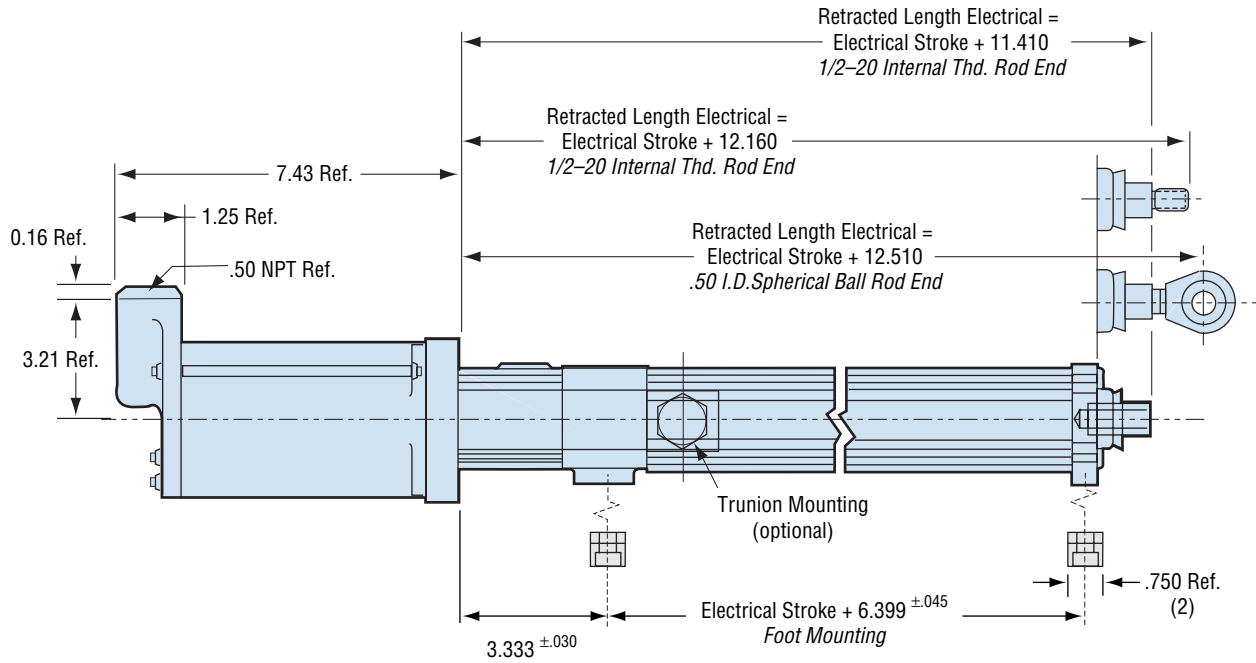
#### Limit Switches

NO with 50 ft. lead	840-9028
NC with 50 ft. lead	840-9030

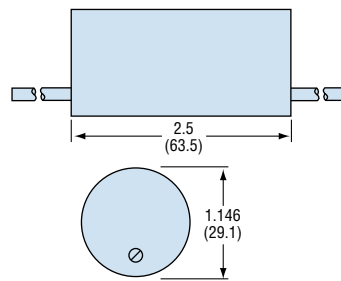
#### Intrinsically Safe Barrier

2 channel AC	904-9105
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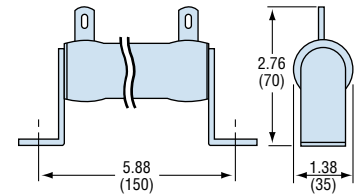
## Dimensions



Switch Diagram



Capacitor



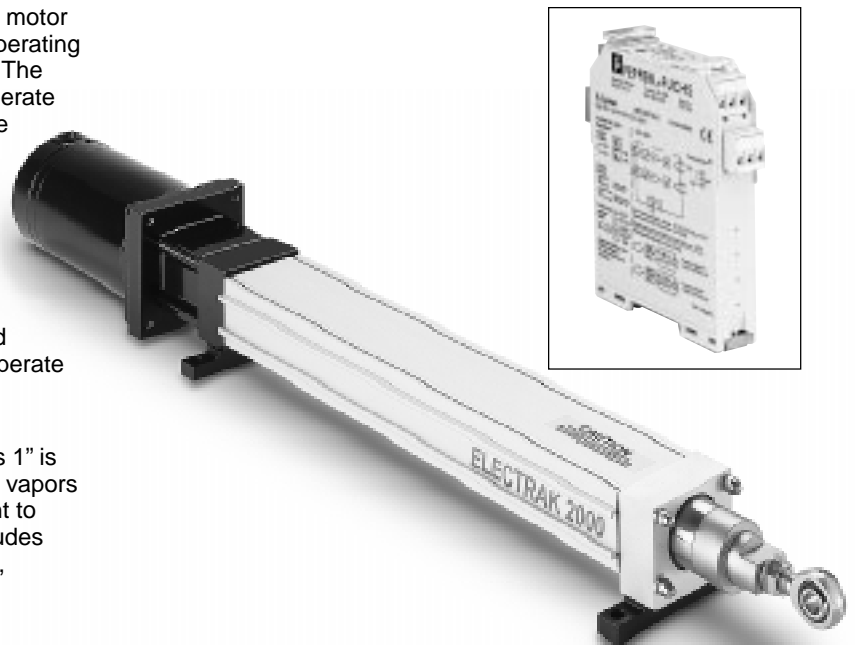
Resistor

# In-line Configuration

## Programmable Hazardous Duty Electrak Actuator

This version of the Electrak 2000 actuator uses a step motor designed to meet the NEC specifications for motors operating in Class 1 Group D locations. Two models are offered. The load/speed chart shows that both actuators will still operate up to 5 inches per second with a 200 lb. load, while the high load model can move 625 pounds at 1.5 in./sec. This in-line ball screw actuator is direct drive and available with flange, foot trunion and side tapped holes for a variety of mounting options. The combination of mounts with rod end options provides either a very rigid connection for precise applications or a compliant connection for applications that require multiple degrees of freedom. The SS2000I indexer and SS2000D6 drive provides the ability to program and operate the actuator.

“Hazardous Duty” locations as defined by the National Electrical Code Class 1, Group D requirements. “Class 1” is designated as locations in which flammable gasses or vapors are, or may be, present in the air in quantities sufficient to cause explosions or ignitable mixtures. “Group D” includes atmospheres containing gasoline, petroleum, naphtha, acetone, lacquer, solvent vapors or natural gas.



### Specifications

Dynamic Load:	Up to 625 lb. at 1.5 in./sec.
Static Load:	Up to 625 lb.
Speed:	Up to 20 in./sec. at 50 lb.
Acceleration:	Up to 50 in./sec./sec. at no load
Duty Cycle:	Continuous
Life:	Up to 50 million cycles
End Play:	0.010 inch maximum
Resolution:	0.0005 based on 1/10 microstep
Repeatability:	0.0005 inches (depending on mounting)
Limit Switches:	1-NO with 50 foot lead and 2 channel intrinsically safe barrier included.  Note: Barrier must be located out of the hazardous area. Any electrical devices used with the actuator should have a designation as suitable for Class 1 Group D areas.
Stroke Lengths:	2, 4, 6, 8, 12, 18, 24 inch standard (for other lengths, contact the factory)
Ambient Temperature:	-40°F to 150°F (-40°C to 65°C)
Washdown Protected:	IP53 (Water spray)
Motor:	MX112 Step motor meets the specification for motors operating in “Hazardous Duty” locations as defined by the National Electrical Code Class 1, Group D requirements. 50 foot cable included.
UL Listed:	UL Listed with switches and barrier.

### Options

Mounting options:	Front flange plate Trunion Side tapped holes Foot mount
Rod ends:	Universal rod end 1/2 – 20 Tapped hole 1/2 – 20 External threaded rod
Brake and encoder:	No brake or encoder available for XP actuator

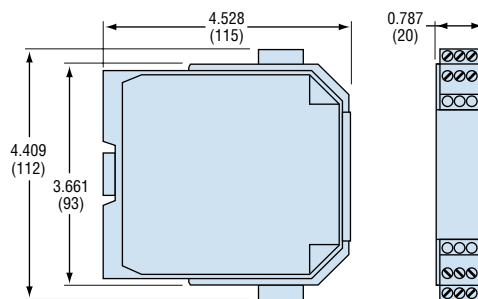
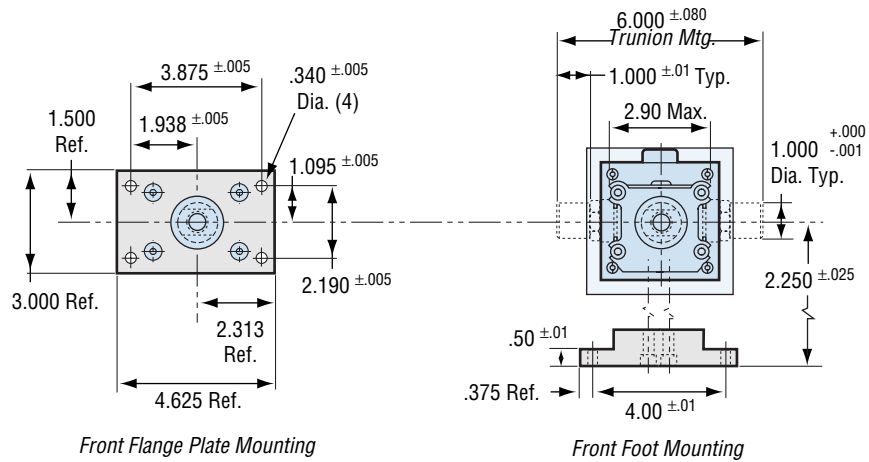
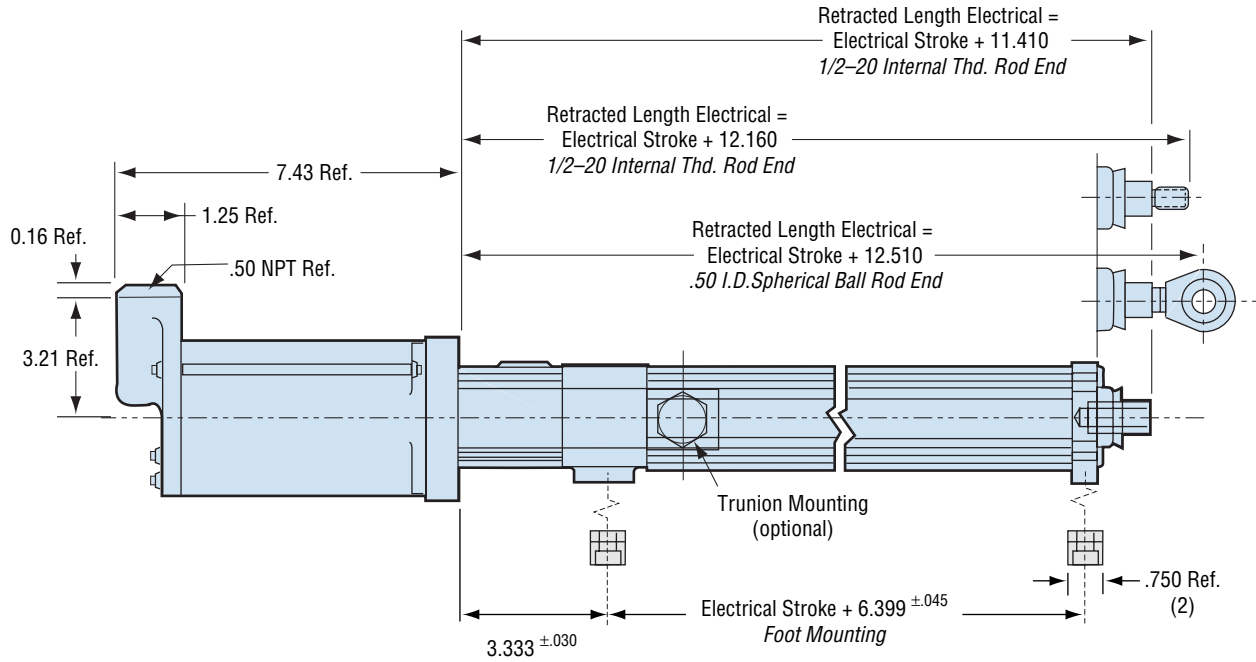
### Actuator Accessories

#### Programmable Motion Control

*Must be mounted out of the hazardous area*

Indexer	SS2000I
6 amp Drive	SS2000D6
Limit Switches	
NO with 50 ft. lead	840-9028
NC with 50 ft. lead	840-9030
Intrinsically Safe Barrier	
2 channel AC	904-9105
2 channel DC	904-9103

## Dimensions



Switch Diagram



# Controls

## For BP93, BI12 Actuators

### SS2000I Programmable Motion Control

The SS2000 control consists of a SS2000I indexer and SS2000D6 6 amp drive. The SS2000I indexer includes the MS2000 programming software and an RS232 cable. The SS2000D6 includes a 10 foot motor power cable. Both the indexer and drive must be ordered to operate an Electrak 2000 actuator.

### Options

#### Plug In Closed Loop Module With Memory Board

This module can be added to any SS2000I control to convert it into a Closed Loop unit. The module replaces the memory board on a standard open loop control. The change can be done from the front of the control without requiring access on either side, allowing the module to be added without removing the SS2000I control. A 10 foot cable is included. Order part number 221147-001. For factory installed Closed Loop Module, order control as SS2000I-V.

#### BCD Switch Option

Up to two BCD switches can be connected to an SS2000I control for entry of BCD data. BCD switch data is scalable. Applications for this function include moving to a set position, selecting one of several programs, or selecting move distance and speed.

Kit 221157-001 provides just the BCD switch assembly. **A cable is required** to connect the switch to the control. The cables are listed separately below. If a second switch is required, order part number 221157-002, which includes a switch assembly and an 18-inch long ribbon cable for daisy chaining two switches.

Cable Length	Part Number
5 feet	C215851-007
10 feet	C215851-008

#### Dual Mounting Bracket

For mounting SS2000I and SS2000D6 together  
221459-001

### Features

- Single point, removable terminal strips for all I/O
- All I/O are optically isolated, switch selectable for sinking or sourcing
- Thirteen programmable inputs with three dedicated high speed inputs
- Eight programmable outputs with short circuit protection
- Can control two drives, one at a time
- Subroutines and loops nestable to four levels
- MS2000 programming software for use with DOS compatible computers
- Internal AC line filter and MOV provide protection from noise on input power
- Optional plug in module for closed loop operation (encoder required on actuator)
- UL recognized

### Specifications

Dimensions	9.5"H x 5.6"D x 2.5"W	
Weight	3.6 lb	
Input Power	90 to 265Vac, 50/60 Hz	
Current	less than 0.4 ampere at 115Vac	
	<b>Sink Mode</b>	<b>Source Mode</b>
Outputs		
Load Power Supply	built in 24v supply or external 12 to 24v	
Current rating	50ma	50ma
Voltage rating	24vdc	
On state voltage	2.0 V max @ 50 ma	20 V min @ 50 ma
On state leakage	0.6 ma max @ 24 vdc	0.6 ma max
Inputs		
On state voltage range	2.3 to 12 volts	10 to 24 vdc
Input current	2.3 ma @ 12 volts 6.5 ma @ 0 volts	2.3 ma @ 10 volts 6.5 ma @ 24 volts
Operating temperature	+32°F to +122°F	
Storage temperature	-40°F to +167°	
Humidity	95% Max. noncondensing	

### SS2000D6 Drive

#### Features

- Switch selectable step resolutions (full step to 1/250 microstep)
- Optically isolated inputs
- Boost Current, Reduce Current and Windings Off function
- Built in AC line filter plus MOV
- Self test function
- Latched short circuit protection
- Unlatched undervoltage and transient overvoltage protection
- UL recognition

#### D6 only

- Motor phase current switch selectable from 1 to 6 amps

#### D12 only

- Motor phase current switch selectable from 1 to 12 amps

### Specifications

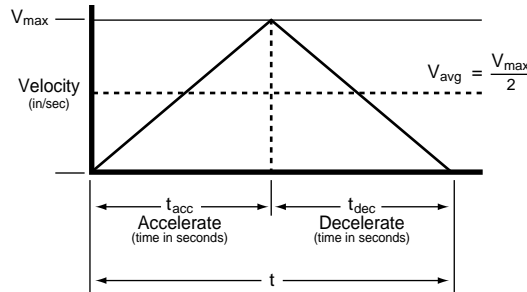
	D6	D12
Dimensions	9.5"H x 5.6"D x 3.8"W	9.7"H x 7.51"D x 13.13"W
Weight	6.5 lb	18 lb
Input Power	90 to 132Vac, 50/60 Hz	90 to 264Vac, 50/60 Hz
Drive Power Dissipation	50 watts (worst case)	200 watts
Operating temperature	+32°F to +122°F	+32°F to +122°F
Storage temperature	-40°F to +167°	-40°F to +167°
Humidity	95% Max. noncondensing	95% Max. noncondensing

# Motion Profiles

## Triangular Motion Profile

In this motion profile the actuator is linearly accelerated and decelerated to provide the desired incremental move time. All of the movement is either in acceleration or deceleration with no steady run speed.

Move distance (x) in time (t)  
 Distance x/2 is moved in time t/2 (accelerate)  
 Distance x/2 is moved in time t/2 (decelerate)



$$V_{avg} = x/t$$

$$V_{max} = 2 V_{avg} = 2 x/t$$

$$t_{acc} = t_{dec} = 1/2 t$$

$$a = \frac{V_{max}}{t_{acc}}$$

a = Acceleration (in/sec<sup>2</sup>)  
 x = Total distance (in)  
 t = Total move time (sec)  
 t<sub>acc</sub> = Time to accelerate (sec)  
 t<sub>dec</sub> = Time to decelerate (sec)  
 V<sub>max</sub> = Maximum velocity (in/sec)  
 V<sub>avg</sub> = Average velocity (in/sec)

Calculate:

$$V_{avg} = x/t = 12/8 = 1.5 \text{ inches / second}$$

$$V_{max} = 2 \times V_{avg} = 2 \times 1.5 = 3 \text{ inches / second}$$

$$t_{acc} = t_{dec} = (1/2) t = 4 \text{ seconds}$$

$$a = \frac{V_{max}}{t_{acc}} = \frac{3 \text{ in/sec}}{4 \text{ sec}} = .75 \text{ in/sec}^2$$

Therefore when programming set actuator speed to 3 inches / second and acceleration to .75 inches / second / second

## Example of Triangular Motion Profile

Given:

Move distance (x) = 12 inches

Time to move (t) = 8 seconds

## Trapezoidal Motion Profile

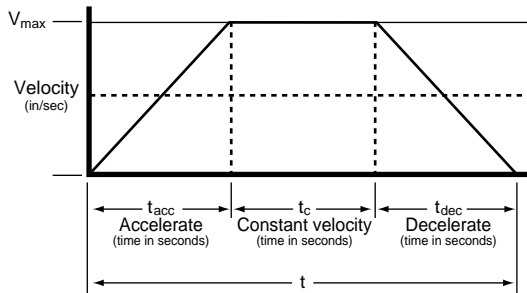
In this type motion profile the actuator is linearly accelerated to and decelerated from the desired running speed to provide the desired incremental move time.

## Example of Trapezoidal Motion Profile

Given: Move distance (x) = 18 inches

Time (t) = 8 seconds

Maximum acceleration rate = 2 inches / second / second



a = Acceleration (in/sec<sup>2</sup>)  
 d = Deceleration (in/sec<sup>2</sup>)  
 x = Total distance (in)  
 t = Total move time (sec)  
 t<sub>acc</sub> = Time to accelerate (sec)  
 t<sub>dec</sub> = Time to decelerate (sec)  
 V<sub>max</sub> = Maximum velocity (in/sec)  
 V<sub>avg</sub> = Average velocity (in/sec)  
 t<sub>c</sub> = Time at constant velocity

Calculate:

$$V_{avg} = x/t = 18/8 = 2.25 \text{ inches / second}$$

$$\text{Assume } t_c = 0.75 \times t = 0.75 \times 8 = 6 \text{ seconds}$$

$$t_{acc} = t_{dec} = (t - t_c)/2 = (8-6)/2 = 1$$

$$V_{max} = V_{avg} \times t / (1/2 \times t_{acc} + t_c + 1/2 \times t_{dec})$$

$$V_{max} = 2.25 \times 8 / (1/2 \times 1 + 6 + 1/2 \times 1) = 2.25 \times 8 / 7 = 2.57$$

$$a = \frac{V_{max}}{t_{acc}} = \frac{2.57}{1} = 2.57 \text{ in/sec}^2$$

Since this is greater than the maximum allowable acceleration rate of 2 inches / second / second some parameters must be modified to reduce the acceleration. The acceleration rate required can be reduced by increasing the time allowed for acceleration. This is done by decreasing the time at constant speed. Doing this increases the value of maximum speed (V<sub>max</sub>).

Assume t<sub>c</sub> = 5 seconds

$$\text{then } t_{acc} = (8 - 5) / 2 = 1.5 \text{ seconds}$$

$$V_{max} = 2.25 \times 8 / (1/2 \times 1.5 + 5 + 1/2 \times 1.5) = 2.25 \times 8 / 6.5 = 2.77 \text{ inches / second}$$

$$a = \frac{V_{max}}{t_{acc}} = \frac{2.77}{1.5} = 1.85 \text{ in/sec}^2$$

Therefore when programming set actuator speed to 2.77 inches / second and acceleration to 1.85 inches / second / second

# Ordering Information

## Catalog Numbering System

### Step motor actuator

B = Step motor actuator

### Actuator style

P = Parallel I = In-line

### Motor size

93 = size 34 – triple stack  
 12 = size 42 (in-line only)  
 A1 = 115 VAC synchronous

### Gear ratio

01 = 1:1 (in-line or parallel style) direct or belt  
 15 = 1.5:1 (parallel style only) belt  
 02 = 2:1 (parallel style only) belt  
 05 = 5:1 (parallel style only) gear  
 10 = 10:1 (parallel style only) gear  
 20 = 20:1 (parallel style only) gear

### Screw type

A = Acme B = Ball

### Screw diameter

1 = 1.000 6 = .625 7 = .750

### Screw lead

1 = 1.000 2 = .500 5 = .200

### Stroke length in inches †

02 = 2 inches 04 = 4 inches  
 06 = 6 inches 08 = 8 inches  
 12 = 12 inches 18 = 18 inches  
 24 = 24 inches

### Mounting

C = Clevis (parallel style only)  
 P = Front flange plate  
 T = Trunion  
 S = Side tapped holes  
 F = Foot mount

### Rod end type

R = Universal rod end  
 I = 1/2–20 Tapped hole  
 X = 1/2–20 External threaded rod

### Brake and Encoder\*

K = Brake on motor<sup>1</sup>  
 M = Encoder on motor<sup>1</sup>  
 E = Encoder on screw<sup>2</sup>  
 B = Brake on screw and Encoder on motor<sup>1,3,4</sup>  
 D = Brake on motor<sup>1</sup> and Encoder on screw<sup>2</sup>  
 N = No brake or encoder

### Encoder type

4 = 400 line encoder (available on size 34 triple stack motors only)  
 5 = 500 line encoder

† Consult factory for other stroke lengths.

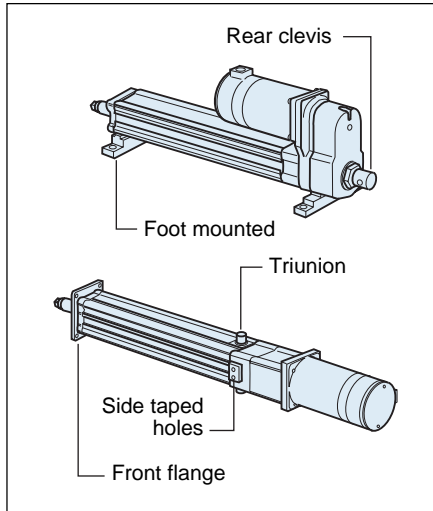
\* Only available on size 34 or 42 motors (BI93, BP93, BI12 actuators.) Consult the factory if the encoder is to be used with other than a Warner Electric control.

<sup>1</sup> Increases motor length by 2.32 inches

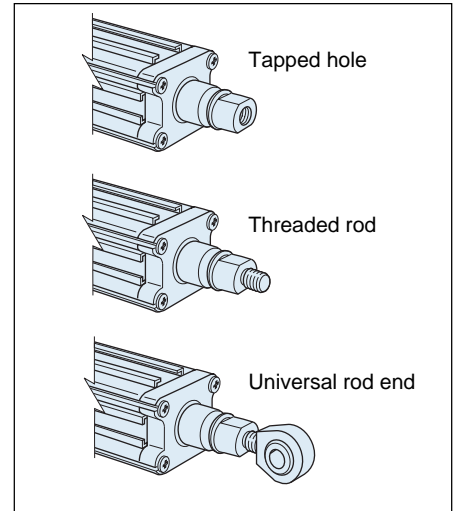
<sup>2</sup> Encoders on the lead screw do not provide the proper signals for use with Verification Indexers. Encoder must be on the motor to take advantage of the features of a Verification Indexer.

<sup>3</sup> Not available on in-line models.

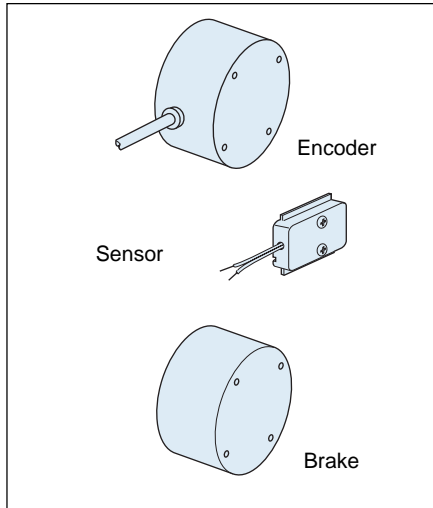
<sup>4</sup> Not available on models with over 1000 lb. capacity. Must use option "D" instead.



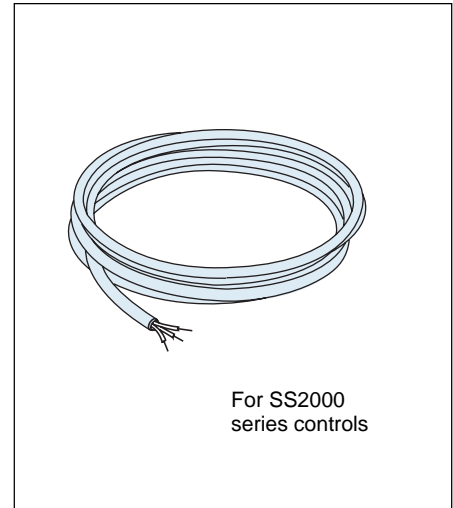
Mounting styles



Rod end options

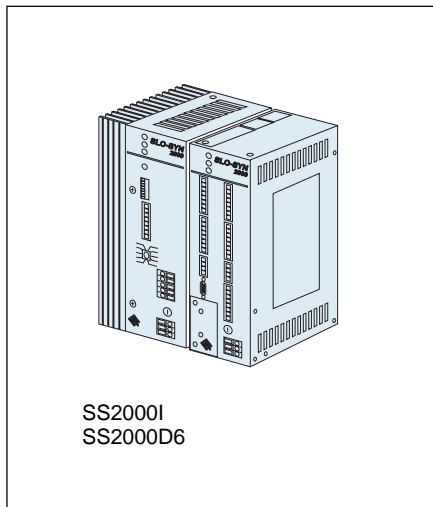


Options and Accessories



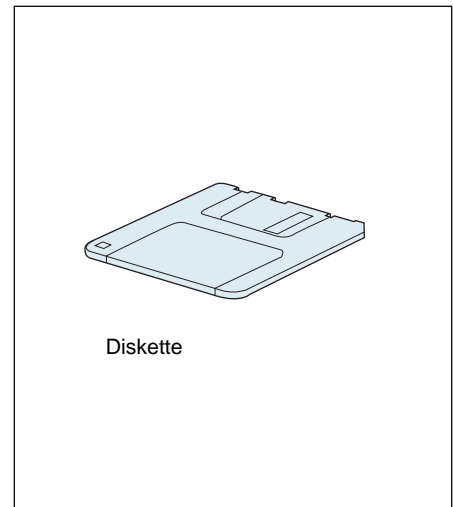
Cable

For SS2000 series controls



SS2000I  
 SS2000D6

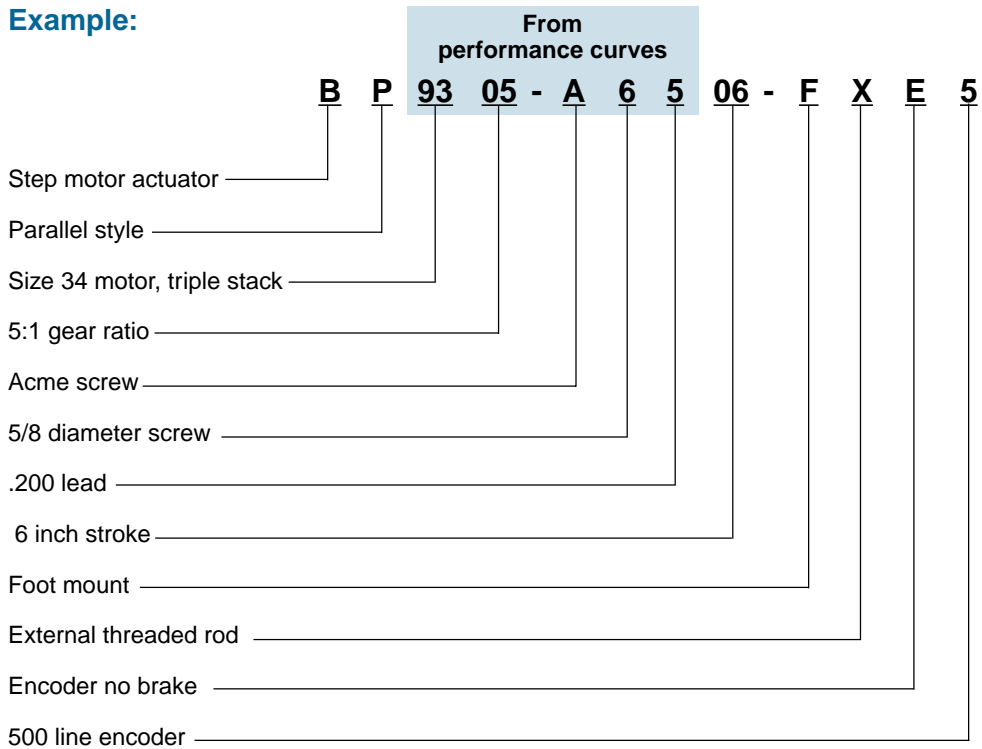
Controls



Diskette

Programming options

**Example:**



**How to Order**

The Electrak 2000 system requires an actuator, a control, a cable to the actuator and a programming option. To order an Electrak 2000 as a complete system with or without options specify the following information:

1. Select the actuator model number using the part number system for Electrak 2000.

2. Select any additional sensors as needed:	<u>Part Number</u>
N.O. without diode (for use with SS2000 controls)	840-9005
N.C. without diode (for use with SS2000 controls)	840-9008

3. Choose the control from the following options:  
 SS2000D6 & SS2000I – for use with a BP93, BI93 or BI12 type actuator  
 Verification controls for actuators utilizing encoder feedback  
 SS2000D6 & SS2000I-V – for use with BP93, BI93 or BI12 type actuator

\*Includes I/O board and diodes.

4. Choose the cable between the actuator and control from the following chart:

		For actuator encoder to control. (only for use with verification control)
<b>Cable Length</b>	<b>For SS2000 Control</b>	<b>For SS2000I-V Control</b>
10 feet	B216022-031 (included)	250-9013 (included with SS2000I-V)
25 feet	B216022-032	250-9014
50 feet	B216022-033	—
100 feet	B216022-035	—

5. Choose the programming option from the following:

Software package for use with MS-DOS computer ..... Software package and interface cable included with each control.

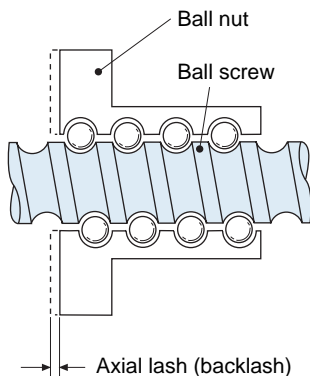
# Glossary

## Acceleration

The change in velocity as a function of time.

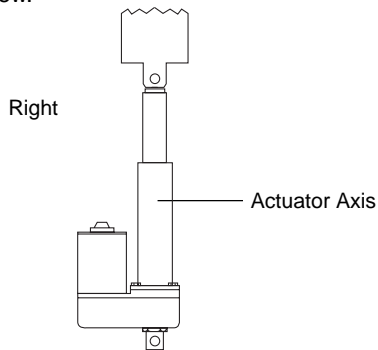
## Axial lash/backlash

The axial free motion between the ball nut and screw without rotation between the two components. Backlash can also occur in gear sets and bearings.



## Axial load

Load through the axis of the actuator screw.



## Ambient temperature

The temperature of the air surrounding the actuator or control.

## Backdriving

The load causing the ball screw to reverse direction with no power applied.

## Backlash compensation

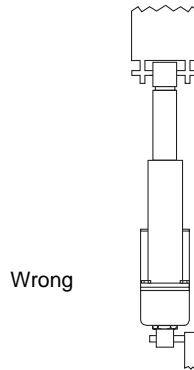
Technique of always approaching a point from the same direction to eliminate the axial lash in the system.

## Ball bearing screw

A lead screw type where the nut does not directly contact the screw but rather runs on a recirculating series of ball bearings generating about 90% efficiency.

## Cantilevered mount

A mount where the actuator is not supported on both sides. Cantilevered mounts are not recommended.



## Clevis mount

U-shaped shackle that has ends drilled to receive a pin or bolt.

## Compression load

A load that would tend to compress the actuator.

## Cover tube

The outside tube which covers the extension tube and screw assembly. The cover tube also has a channel on three sides for mounting sensors.

## Cycle

One full extension and retraction back to the starting point.

## "D" connector

Either a 9 or 25 pin connector for use with RS-232 communication. The connector has a "D" shape to prevent reversing the connection.

## Diode

A solid state one-way switch used in series with the input devices when connecting them to the I/O board

## Duty cycle

The ratio of motor "on" time to total cycle time.

$$\text{Duty cycle} = \frac{\text{on time}}{\text{on time} + \text{off time}}$$

## Eccentric load

Off center load which may cause binding and shorten actuator lead screw life.

## Encoder

A device which translates mechanical motion into electrical pulses which can be counted by a control.

## Extension rate

The speed at which the actuator extends or retracts. The extension speed is load dependent and the actuator must **not** be programmed to exceed the load/speed curve.

## Extension tube

The cylinder which extends in and out of the actuator

## Holding brake

Anti-backdriving brake which holds the position of the ball screw actuator under tension or compression with the power off.

## Home

A reference position in a motion control system. Often designated as the zero position.

## Hysteresis

The difference in actuation distance of a reed switch or Hall Effect switch as it moves through a magnetic field.

## Inertia

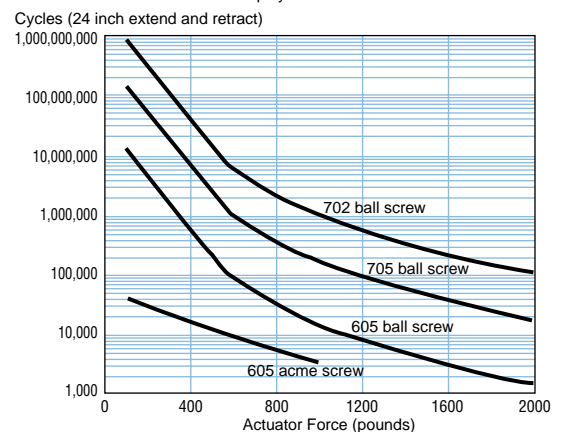
A measure of an object's resistance to change in velocity.

## Lead screw life

Acme screw – the length of travel that Acme screws complete before end play exceeds 0.020". Ball screw – the length of travel that 90% of a group of ball bearing screws will complete or exceed before the first evidence of fatigue develops. See lead screw life chart.

## Life of Lead Screws

Ball screws = 90% survival  
Acme screws = end play exceeds .020"



### Limit switch

A switch used to limit motion or travel in a particular direction.

### Load

The force axially imposed on the actuator

### Logic ground

An electrical potential to which all control signals in a particular system are referenced.

### Micro-stepping

A control technique that proportions current in stepmotor windings to provide additional intermediate positions between poles. It also provides higher positional resolution and smooths rotation over wide speed ranges. It provides somewhat lower torque than full or half-step operation.

### Open collector

A transistor which is connected to operate like a single pole single throw (SPST) switch. The load must be connected between the open collector and the voltage source.

### Open loop

A motion system where no external feedback devices are used to provide position or velocity correction information.

### PC

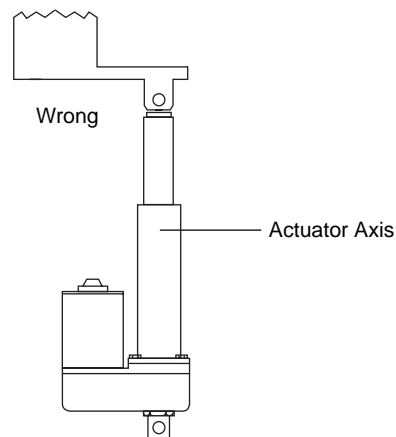
Abbreviation for personal computer.

### Pulse rate

The frequency of step pulses applied to a step motor. The pulse rate multiplied by the resolution of the motor yields the rotational speed of the motor in revolutions per second. The rotations per second multiplied by the lead of the screw and divided by the gear ratio provides the extension speed in inches per second.

### Radial load

A load on the side of the actuator extension tube. Normally considered to be detrimental to the life of the unit. Also referred to as "side load".



### Ramping

The acceleration and deceleration of a step motor. Ramping is required to overcome the inertia of the load without stalling the step motor.

### Reed switch

A sealed magnetically operated mechanical switch. The switch either opens or closes when passing through a magnetic field.

### Repeatability

The degree to which the positioning accuracy for a given move can be duplicated given the same control signals and loads.

### Resolution

The smallest positioning increment that can be achieved. This depends on the lead of the screw, gear ratio and using either full, half or micro-stepping controls.

### Retracted length

Minimum length of the actuator in its retracted state.

### RS-232

A data communications standard that encodes a string of information on a single line in a time sequential format.

### Side load

Force applied perpendicular to the axis of the extension tube. (see radial load)

### Static load

The maximum non-operating load capacity.

### Stroke length

The total travel of the extension tube from full retract to full extend.

### Tension load

A load that would tend to stretch the actuator.

### Thermal dissipation

The transfer of heat from a system to its environment.

### Trapezoidal motion profile

A type of motion profile in which the actuator is linearly accelerated to and decelerated from the desired running speed to provide the desired incremental move time. See page 33 for an example.

### Triangular motion profile

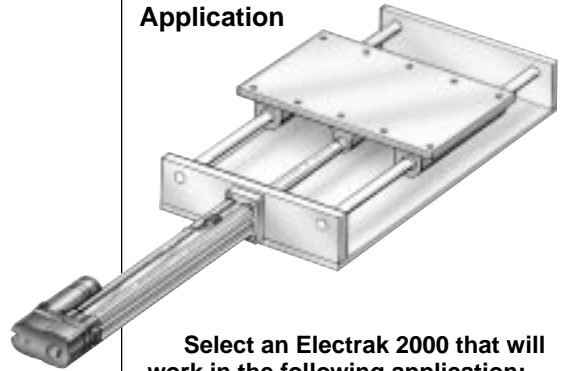
A type of motion profile in which the actuator is linearly accelerated and decelerated to provide the desired incremental move time. All of the movement is either in acceleration or deceleration with no steady run speed. See page 33 for an example.

# Electrak 2000 Selection Example

## STEP 1 – Obtain information needed:

Load = 1000 lbs  
 Max. speed = 6 inches per second  
 Duty cycle = 100 % on time verses off time  
 Stroke length = 8 inches  
 Life = 50 million cycles, inches, hours  
 Acceleration =  $\frac{\text{Velocity}}{\text{time to speed}} = \frac{6 \text{ in/sec}}{.25 \text{ sec}} = \frac{\text{in}}{\text{sec}^2}$   
 Resolution = .0010 inches  
 Backdriving load = X no        yes  
 Application Configuration: Horizontal X Vertical         
 Actuator Configuration: Parallel X In-line         
 Mounting Configuration: Foot Mount        Front Flange X  
                                   Side Tapped        Trunion         
                                   Rear Clevis (parallel only)         
 Rod End Type: Threaded Rod X Tapped Hole        Universal Rod End         
 Options: Encoder        Brake         
 Accessories: Additional Sensors         
 Actuator cable length:        10 ft. X 25 ft.        50 ft.  
 Programming Accessory:        SSP 525 (Pendant) X Disk 250 (included with control)

## Application



### Select an Electrak 2000 that will work in the following application:

The customer wishes to move a load of 1000 lbs. The load is supported by two linear bearings with a coefficient of friction of .001 each. The load will move at 6 in/sec and must reach this speed in .25 seconds. The stroke required is 8 inches. The customer does not require a brake or encoder. The actuator should be front flange mounted. The customer requires an external rod mounting option.

### List the complete actuator part number.

## STEP 2 – Calculate Total Force (lbs)

Total Force = Acceleration Force + Friction Force + Weight

Acceleration Force = Mass x Acceleration

$$\begin{aligned}
 &= \frac{\text{weight}}{32.2 \text{ ft/sec}^2} \times \frac{\text{velocity (in/sec.)}}{\text{time to speed (sec)}} \times \frac{1 \text{ ft}}{12 \text{ in.}} \\
 &= \frac{1000 \text{ lbs}}{32.2 \text{ ft/sec}^2} \times \frac{6 \text{ in/sec.}}{.25 \text{ sec}} \times \frac{1 \text{ ft}}{12 \text{ in.}} \\
 &= 62.11 \text{ lbs.}
 \end{aligned}$$

Friction Force = Weight (lbs) x coefficient of friction of the bearing supports ( $\mu$ )\*

Note: In this application, 2 linear bearings supporting 500 lbs each. = 2 x 500 x .001 = 1 lb.

Weight = Weight of object being moved (lbs)

Horizontal applications actuator does not support the weight of the load.

Total Force = 62.11 + 1 = 63.11 lb at 6 in/sec.

\*Typical  $\mu$  = .001 for linear ways = .005 for roller way bushings = .005 for ball bearing splines

## STEP 3

Referring to the charts on pages 10 and 11, with a total force of 63.11 lbs and a velocity of 6 in/sec, the following actuators will work.

BP9301-A65  
 BP9301-B72  
 BP9315-B72  
 BP9302-B72  
 BI1201-B72  
 BI1201-B75

Although all will work, we select BP9301-B72 for long life and moderate cost.

## STEP 4 – Determine actuator configuration

Choose either BP model (Parallel) or BI model (in-line) we selected a BP9301-B72.

## STEP 5 – Select mounting options

We select front flange mounted.

## STEP 6 – Select rod end options

We select threaded rod.

## STEP 7 – Select options and accessories

Application does not require a holding brake, encoder or additional sensors.

## STEP 8 – Select control

The selected actuator has a size 34, three stack motor which requires a SS2000D6 and SS2000I Control.

## STEP 9 – Select cable length between actuator and control

25 ft cable for a SS2000 control Part # B216022-032.

## STEP 10 – Select programming accessories.

Software included with the control. The complete part # for the selected actuator is BP9301-B7208-PXN.

# Electrak 2000 Application Data Form

Fax: 815-389-6678

Load = \_\_\_\_\_ lbs  
Max. speed = \_\_\_\_\_ inches per second  
Duty cycle = \_\_\_\_\_ % on time verses off time  
Stroke length = \_\_\_\_\_ inches  
Life = \_\_\_\_\_ cycles, inches, hours  
Acceleration =  $\frac{\text{Velocity}}{\text{time to speed}} = \frac{\text{in}}{\text{sec}^2}$   
Resolution = \_\_\_\_\_ inches  
Backdriving load = \_\_\_\_\_ no \_\_\_\_\_ yes  
Application Configuration: Horizontal \_\_\_\_\_ Vertical \_\_\_\_\_  
Actuator Configuration: Parallel \_\_\_\_\_ In-line \_\_\_\_\_  
Mounting Configuration: Foot Mount \_\_\_\_\_ Front Flange \_\_\_\_\_  
Side Tapped \_\_\_\_\_ Trunion \_\_\_\_\_  
Rear Clevis (parallel only) \_\_\_\_\_  
Rod End Type: Threaded Rod \_\_\_\_\_ Tapped Hole \_\_\_\_\_ Universal Rod End \_\_\_\_\_  
Options: Encoder \_\_\_\_\_ Brake \_\_\_\_\_  
Accessories: Additional Sensors \_\_\_\_\_  
Actuator cable length: \_\_\_\_\_ 10 ft. \_\_\_\_\_ 25 ft. \_\_\_\_\_ 50 ft.  
Programming Accessory: \_\_\_\_\_ SSP 525 (Pendant) \_\_\_\_\_ Disk 250 (included with control)

Refer to pages 6 and 7 for pictures and descriptions

