Stepper Motor
Linear
Actuators

Hybrid Linear Actuators

Series	Size (square)	Configuration#	Stroke (mm) C#	Stroke (mm) NC / EL#	Max Force (N)	Travel/step (micron)
21000	21 mm (0.8-in)	C / NC / EL	9 - 38.1	Up to ≈ 200	2 - 44	1.5 - 40
28000	28 mm (1.1-in)	C / NC / EL	12.7 - 63.5	Up to ≈ 250	15 - 90	3 - 50
35000	35 mm (1.4-in)	C / NC / EL	12.7 - 63.5	Up to ≈ 300	50 - 220	1.5 - 50
43000	43 mm (1.7-in)	C / NC / EL	12.7 - 63.5	Up to ≈ 400	100 - 220	1.5 - 50
57000	57 mm (2.3-in)	C / NC / EL	12.7 - 63.5	Up to ≈ 500	300 - 890	4 - 50
87000	87 mm (3.4-in)	C / NC / EL	12.7 - 63.5	Up to ≈ 500	400 - 2224	12.7 - 127

Double Stack Hybrid Linear Actuators

Series	Size (square)	Configuration#	Stroke (mm) C#	Stroke (mm) NC / EL#	Max Force (N)	Travel/step (micron)
28000	28 mm (1.1-in)	C / NC / EL	12.7 - 63.5	Up to ≈ 250	30 - 133 [A]	3 - 50
35000	35 mm (1.4-in)	C / NC / EL	12.7 - 63.5	Up to ≈ 300	50 - 220 [A]	15.8 - 127
43000	43 mm (1.7-in)	C / NC / EL	12.7 - 63.5	Up to ≈ 400	50 - 337	15.8 - 127
57000	57 mm (2.3-in)	C / NC / EL	12.7 - 63.5	Up to ≈ 500	150 - 890 [A]	12.7 - 127

[A] Maximum force limited by bearing capabilities.

Dual Action Actuators

Size (square)	Torque (Ncm)	Linear Stroke (mm)	Max Force	Travel/step (micron)	Load Limits
35 mm (1.4-in)	12.7	Up to 101.6†	50 - 220 N (25 lbs)	3 - 50	133 N (30 lbs)
43 mm (1.7-in)	13	Up to 101.6†	100 - 220 N (50 lbs)	1.5 - 50	222 N (50 lbs)

† Standard strokes: 25.4 mm (1-in.), 50.8 mm (2-in.) and 101.6 mm (4-in.).

Can-Stack Linear Actuators

Series	Ø Size	Configuration#	Stroke (mm) C#	Stroke (mm) NC / EL#	Max Force (N)	Travel/step (micron)
G4 19000	20 mm (.79-in)	C / NC / EL	14 - 31	Up to ≈ 150	12 - 50	25 - 100
G4 25000	26 mm (1-in)	C / NC / EL	13 - 31	Up to ≈ 150	20 - 90	12.7 - 100
G4 37000	36 mm (1.4-in)	C / NC / EL	17 - 38	Up to ≈ 150	30 - 260	12.7 - 100
LC15	15 mm (.59-in)	C	12.7	–	7	20
(Z)20000	20 mm (.79-in)	C / NC / EL	12.7	Up to ≈ 150	3 - 35	25 - 100
(Z)26000	26 mm (1-in)	C / NC / EL	12.7 - 31	Up to ≈ 150	10 - 80	6 - 100
36000	36 mm (1.4-in)	C / NC / EL	15.5	Up to ≈ 150	15 - 160	3 - 100
46000	46 mm (1.8-in)	C / NC / EL	23.1	Up to ≈ 200	20 - 260	12.7 - 400

Configurations = Captive / Non-captive / External Linear Lead-screws

Drives

	Type	Motor Leads	Input Voltage (VDC)	Current/Phase (I)	Number of Microsteps
40105	Chopper	4	20 - 40	2	2
44103	Chopper	4*	24 - 28	1	8
DCS4020	Chopper	4	24 - 40	2	2
DCM8028	Chopper	4 / 6 / 8	20 - 80 *E*	2.8	256
DCM8055	Chopper	4 / 6 / 8	20 - 80 *E*	5.5	256

* 5V motors only. E = For Europe – the max. input voltage must be limited to 70 VDC (CE regulations).

Integrated Electronic Drive

	Type	Input Voltage (VDC)	Programming	Connector	I/O inputs - I/O outputs
IDEA DRIVE	Chopper	12 - 48 VDC	Graphic User Interface	USB	4 opto-isolated

Suppose you, as an engineer, are tasked to design a machine or part of a machine that requires precise linear positioning. How would you go about accomplishing this? What is the most straightforward and effective method?

When students are trained in classic mechanical engineering, they are taught to construct a system using conventional mechanical components to convert rotary into linear motion. Converting rotary to linear motion can be accomplished by several mechanical means using a motor, rack and pinion, belt and pulley, and other mechanical linkages. The most effective way to accomplish this rotary to linear motion, however, is within the motor itself.

First, What Exactly Is a Stepper Motor-Based Linear Actuator?

A linear actuator is a device that develops a force and a motion through a straight line. A stepper motor-based linear actuator uses a stepping motor as the source of rotary power. Inside the rotor, there's a threaded precision nut instead of a shaft. The shaft is replaced by a leadscrew. As the rotor turns (as in a conventional stepper motor), linear motion is achieved directly through the nut and threaded screw. It makes sense to accomplish the rotary to linear conversion directly inside the motor, as this approach greatly simplifies the design of rotary to linear applications. This allows high resolution and accuracy ideal for use in applications where precision motion is required.

Basic Components

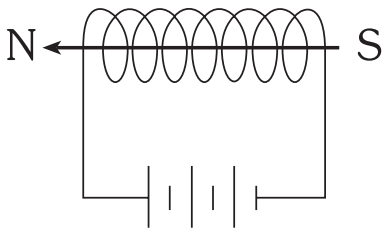
Stepper Motor

Why use a stepper motor instead of a conventional rotary motor? Unlike other rotary motors, steppers are unique in that they move a given amount of rotary motion for every electrical input pulse. This makes steppers a perfect solution for use in positioning applications. Depending on the type of stepper motor, our motors can achieve resolutions from 18 rotational degrees per step to 0.9 rotational degrees per step. This unique "stepping" feature coupled with the characteristics of the lead screw provides a variety of very fine positioning resolutions

How Does the Stepper Motor Work?

Permanent magnet stepper motors incorporate a permanent magnet rotor, coil windings, and a steel stator capable of carrying magnetic flux. Energizing a coil winding creates an electromagnetic field with a NORTH and SOUTH pole as shown in figure 1.

Figure 1. Magnetic field created by energizing a coil winding



The stator conducts the magnetic field and causes the permanent magnet rotor to align itself to the field. The stator magnetic field can be altered by sequentially energizing and de-energizing the stator coils. This causes a "stepping" action and incrementally moves the rotor resulting in angular motion.

"One-Phase On" Stepping Sequence

Figure 2 illustrates a typical step sequence for a simplified 2 phase motor. In step 1, phase A of the 2 phase stator is energized. This magnetically locks the rotor in the position shown, since unlike poles attract. When phase A is turned off and phase B is turned on, the rotor moves 90° clockwise. In step 3, phase B is turned off and phase A is turned on but with the polarity reversed from step 1. This causes another 90° rotation. In step 4, phase A is turned off and phase B is turned on, with polarity reversed from step 2. Repeating this sequence causes the rotor to move clockwise in 90° steps.

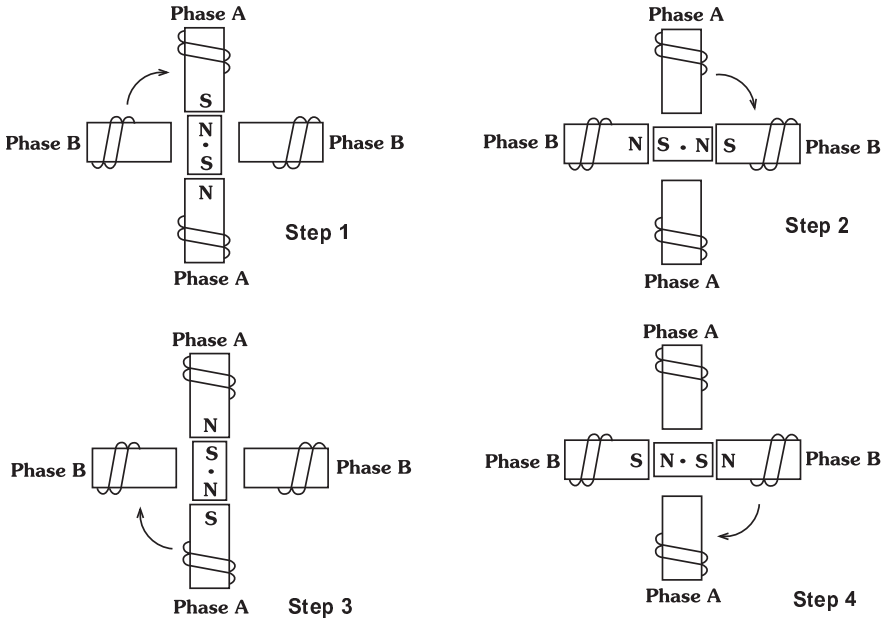


Figure 2. "One Phase On" stepping sequence for two phase motor

"Two-Phase On" Stepping Sequence

A more common method of stepping is "two phase on" where both phases of the motor are always energized. However, only the polarity of one phase is switched at a time, as shown in Figure 3. With two phase on stepping, the rotor aligns itself between the "average" north and "average" south magnetic poles. Since both phases are always on, this method provides 41.4% more torque than "one phase on" stepping.

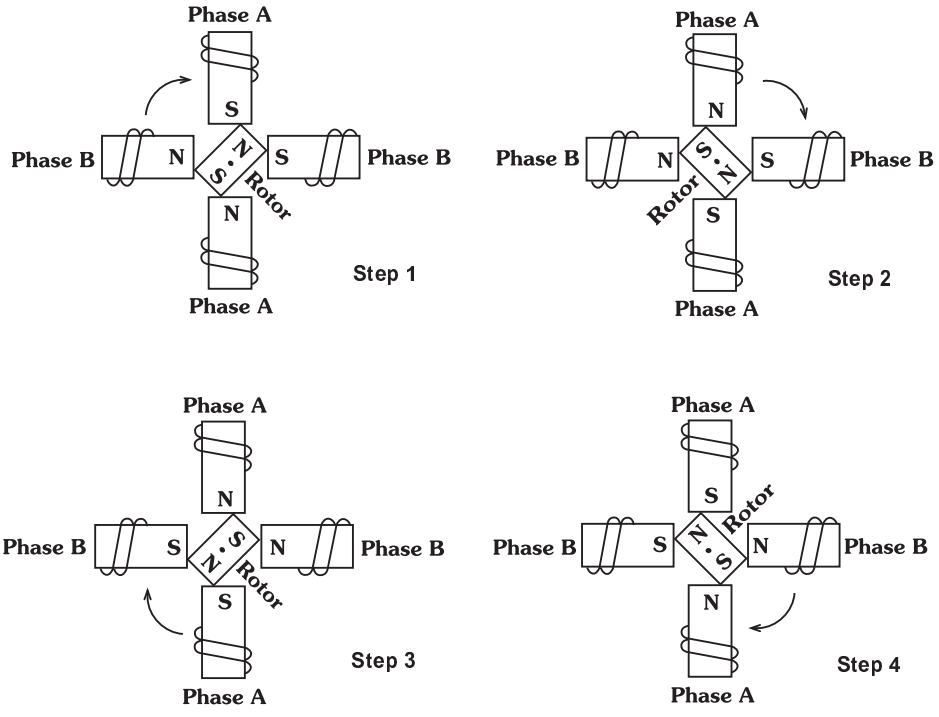


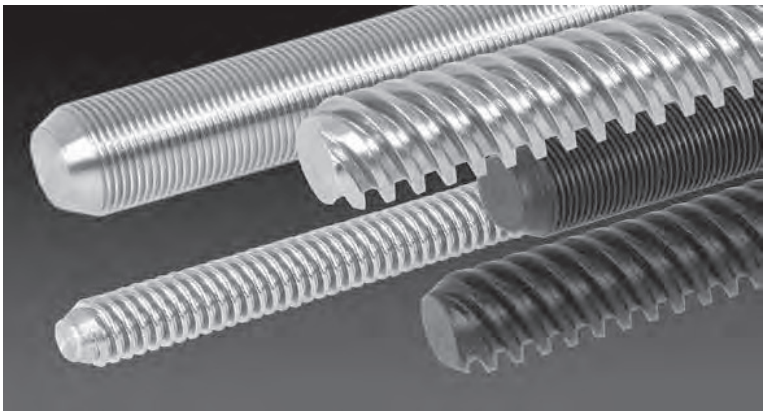
Figure 3. "Two Phase On" stepping sequence for two phase motor

Leadscrew

The acme leadscrew is a special type of screw that provides a linear force using the simple mechanical principle of the inclined plane. Imagine a steel shaft with a ramp (inclined plane) wrapped around it. The mechanical advantage (force amplification) is determined by the angle of the ramp which is a function of the lead, pitch, and diameter of the screw.

Lead – The axial distance a screw thread advances in a single revolution
Pitch – The axial distance measured between adjacent thread forms

The threads of the leadscrew allow a small rotational force to translate into a large load capability depending on the steepness of the ramp (the thread lead). A small lead (more threads per inch) will provide a high force and resolution output. A large lead (fewer threads) will provide a lower force, but a correspondingly higher linear speed from the same source of rotary power.



Examples of different thread configurations: Finer lead threads will provide higher force but lower speeds; Coarse lead threads will provide higher speeds but lower force.

Integrated Nut

Of equal, if not greater importance to the lead screw is the nut that drives the screw. This nut is often imbedded in the rotor of the stepping motor, which makes this actuator configuration unique from other rotary to linear techniques. The traditional nut material is a bearing grade bronze which lends itself to the required machining of the internal threads. Bronze is a traditional compromise between physical stability and lubricity. Compromise, however, is the key word since it excels at neither.

Friction Considerations

A much better material for a power nut in the linear actuator is a lubricated thermoplastic material. With the evolution of new engineered plastics, the screw threads may now travel with a lower overall coefficient of friction. This is illustrated below in Figure 4.

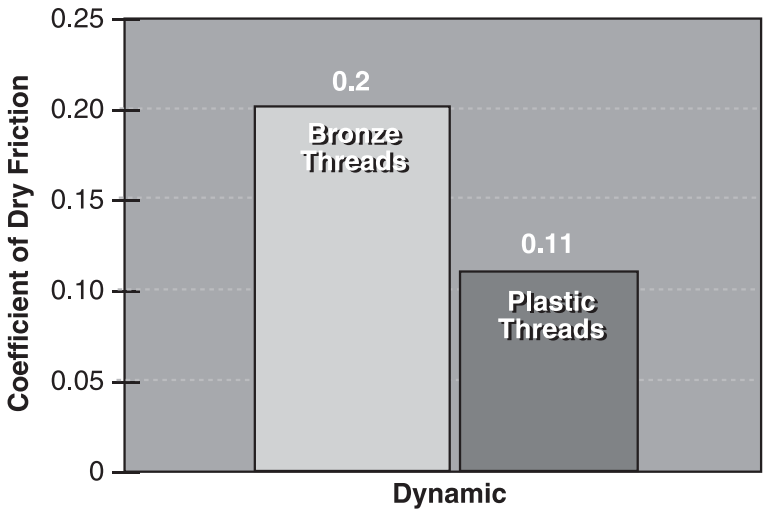


Figure 4.

FRICTION EFFECTS

Comparative friction effects of stainless steel on select rotor materials

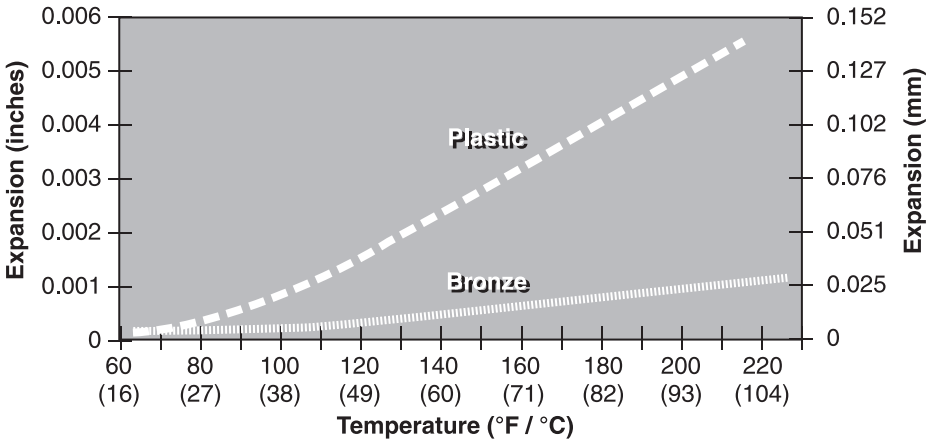
Thermal Considerations

Given the data, it was clear that a plastic drive nut provides the lower coefficient of friction when compared with bronze. Unfortunately, as good as the plastic is for threads, it is not stable enough for the bearing journals of a hybrid motor, which are critical in the hybrid motor design. Under a continuous full load condition, plastic bearing journals can expand as much as 0.004", where brass will expand only 0.001". This is illustrated in Figure 5. In order to achieve the high performance characteristics of the stepper motor, the design must maintain a stator-to-rotor airgap of only a few thousandths of an inch. This tight design requirement demands thermally stable bearing journals.

Figure 5.

THERMAL EFFECT

Linear thermal expansion for 1-inch (25.4 mm) samples

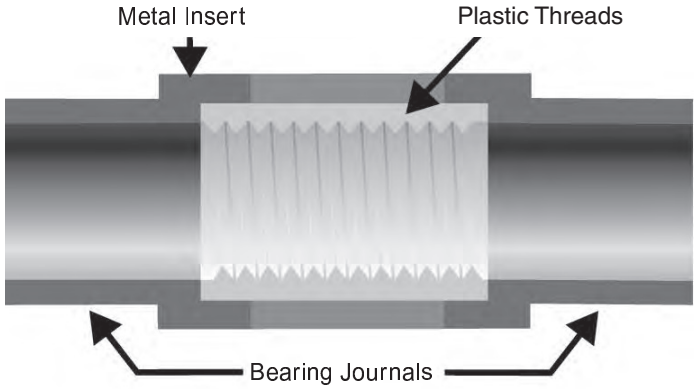


By injection molding plastic threads within a brass rotor assembly, both characteristics of low friction and high bearing journal stability is achieved (see figure 6).

Figure 6.

POWER NUT CONFIGURATION

Embedded in Permanent Magnet Rotor



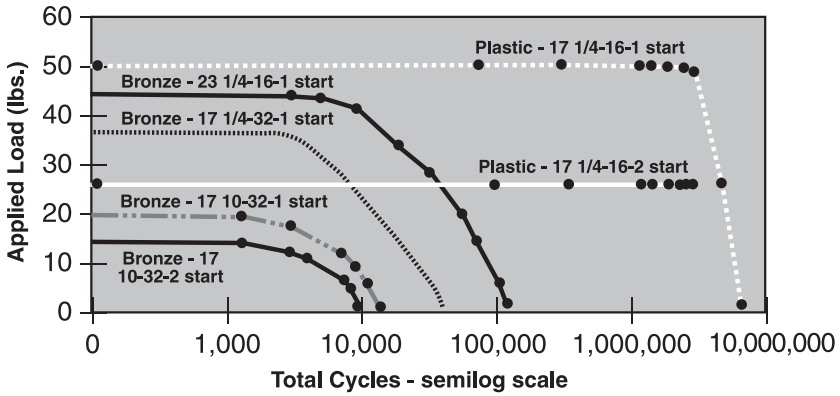
Effects on Actuator Life

The result is a product with quiet operation, higher efficiencies, and higher life expectancies. Motor life is improved by 10 to 100 times over the traditional bronze nut configuration, as illustrated in the life test chart in figure 7.

Figure 7.

LIFE TEST: BRONZE vs PLASTIC

Nuts used in Size 17 and 23 Hybrid Linear Actuators



Extending Actuator Life

With proper application consideration, Haydon linear actuators deliver up to 20 million cycles. Ultimately, motor fatigue and resultant life are determined by each customer's unique application.

There are some general guidelines that should be understood in order to insure maximum life. Ultimately, to determine an actuator's performance in a given system it's best to perform testing in the final assembly in "field conditions" or in a setting that closely approximates those conditions.

Since a stepper has no brushes to wear out, its life usually far exceeds that of other mechanical components of the system. If a stepper does fail there are certain components which are likely to be involved. Bearings and leadscrew/nut interface (in linear actuators) are typically the first components to experience fatigue. Required torque or thrust and operating environment are the factors which affect these motor components.

Extensive testing has shown that motor life increases exponentially with reduced operating loads. Environmental factors such as high humidity, exposure to harsh chemicals or gases, excessive dirt/debris, and heat will affect motor life. Mechanical factors in the assembly such as side loading of the shaft (linear actuators) or an unbalanced load (rotary motors) will also affect life.

Properly designing a system which minimizes these factors and also insuring the motor is operating within its electrical specifications will ensure maximum motor life. The first step in maximizing life is choosing a motor which has a safety factor of 2 or more. The second step is insuring the system is mechanically sound by minimizing side loading, unbalanced loads, and impact loads. Also insure techniques to allow effective heat dissipation. Air flow around the motor or mounting which provides some heat sinking are effective means to insure the motor operates at a safe temperature.

If these simple, yet effective guidelines are followed, the linear actuators will provide reliable operation over millions of cycles.

Putting It All Together

Figure 8 below is a cross section drawing of a "captive" type linear actuator. Captive indicates that there is already an anti-rotation mechanism built into the actuator through the use of a splined "anti-rotation" shaft and a "captive sleeve". The "captive" configuration is ideal for use in precision liquid drawing/dispensing and proportional valve control. Other forms of linear actuators are "non-captive" and "external linear" as pictured in Figures 9 and 10.

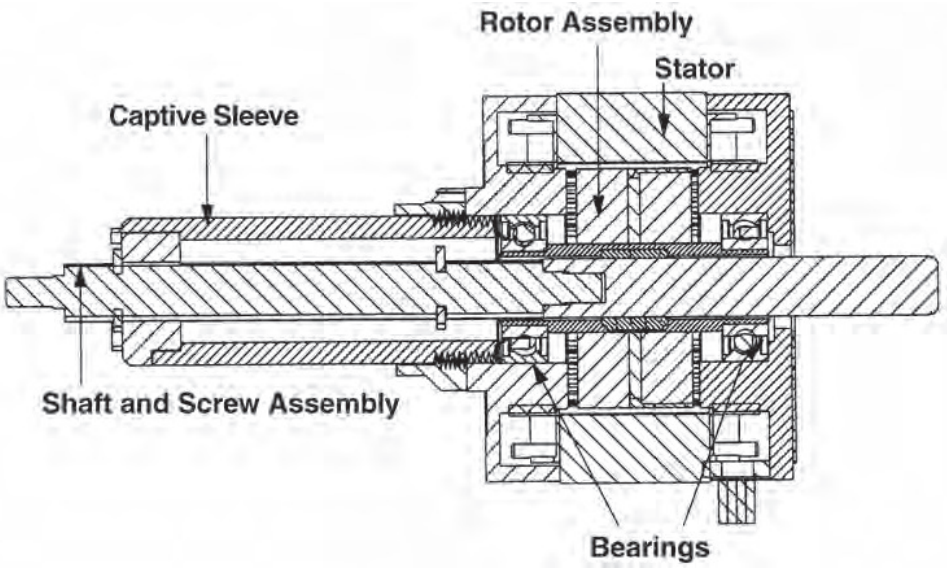


Figure 8.

TYPICAL HYBRID LINEAR ACTUATOR

Captive linear stepping actuator

Figure 9.

HYBRID LINEAR ACTUATORS

Size 17 Series (1.7-in / 43 mm square) captive, non-captive and external linear, available in 1.8 and 0.9 rotational degrees per step.

Figure 10.

CAN-STACK LINEAR ACTUATORS

26000 Series (Ø 1-in / 26 mm) Captive, external linear, non-captive available in 15 and 7.5 rotational degrees per step.

All This Theory Is Good, But How Are They Sized?

Sizing a linear actuator is quite easy once you understand the basic needs of the application. The following is the minimum information needed to begin sizing the proper device.

1) Linear force needed to move the load, expressed in Newtons (N)
2) Linear distance the load needs to be moved, expressed in meters (M)
3) Time required to move the load, expressed in seconds (s)
4) Table 1 – illustrated below
5) Performance curves illustrated in Haydon linear actuator catalogs

Power Requirements

The power required to meet the application is now calculated using the parameters above. This will allow the user to easily choose the correct motor framesize needed.

$$\text{P linear} = \frac{\text{(distance traveled in Meters) (force in Newtons)}}{\text{(Time to travel the distance in Seconds)}} = \text{watts}$$

Once the power is known in watts, choose the proper framesize of the actuator as listed in Table 1 (next page).

All stepper motor linear actuators require a drive to send the pulses to the motor. As seen in the table, the power for both an L/R drive and a chopper drive is listed. Most applications today use an electronic chopper drive. Unless the application is battery powered (as in a hand-held portable device), a chopper drive is highly recommended to get the maximum performance from the linear actuator.

Table 1. Frame Sizes and Performance Based On Required Output Power

Hybrid Single Stack					
				Max. Linear Power (watts)	
Series	Size	Max Force (N)	Linear Travel Per Step (micron)	L/R Drive	Chopper Drive
21000	8	44	1.5 – 40	0.3	0.37
28000	11	90	3 – 50	0.27	0.51
35000	14	220	1.5 – 50	0 .59	1.5
43000	17	220	1.5 – 50	1.02	2.31
57000	23	890	4 – 50	1.47	6
87000	34	2224	12.7 – 127	N/A	21.19

Hybrid Double Stack					
				Max. Linear Power (watts)	
Series	Size	Max Force (N)	Linear Travel Per Step (micron)	L/R Drive	Chopper Drive
28000	11	133	3 – 50	N/A	1.14
35000	14	220	15.8 – 127	N/A	2.7
43000	17	337	15.8 – 127	N/A	4.62
57000	23	890	12.7 – 127	N/A	10.08

Can-Stack					
				Max. Linear Power (watts)	
Series	Size Ø (mm)	Max Force (N)	Linear Travel Per Step (micron)	L/R Drive	Chopper Drive
G4 19000	20	50	25 – 100	0.17	0.35
G4 25000	26	90	12.7 – 100	0.26	0.53
G4 37000	36	260	12.7 – 100	0.44	0.66
15000	15	7	20	0.025	0.03
20000	20	16	25 – 100	0.05	0.06
Z20000	20	35	25 – 100	0 .09	0.23
26000	26	50	6 – 100	0.17	0.18
Z26000	26	80	6 – 100	0.18	0.48
36000	36	160	3 – 100	0.23	0.51
46000	46	260	12.7 – 400	0.55	1.13

Velocity

After calculating the mechanical power needed to meet the application requirements, the linear velocity in inches per second is calculated using the following equation.

$$\text{Velocity linear} = \frac{\text{Required travel distance (in)}}{\text{Time to achieve travel (s)}} = \text{in / s}$$

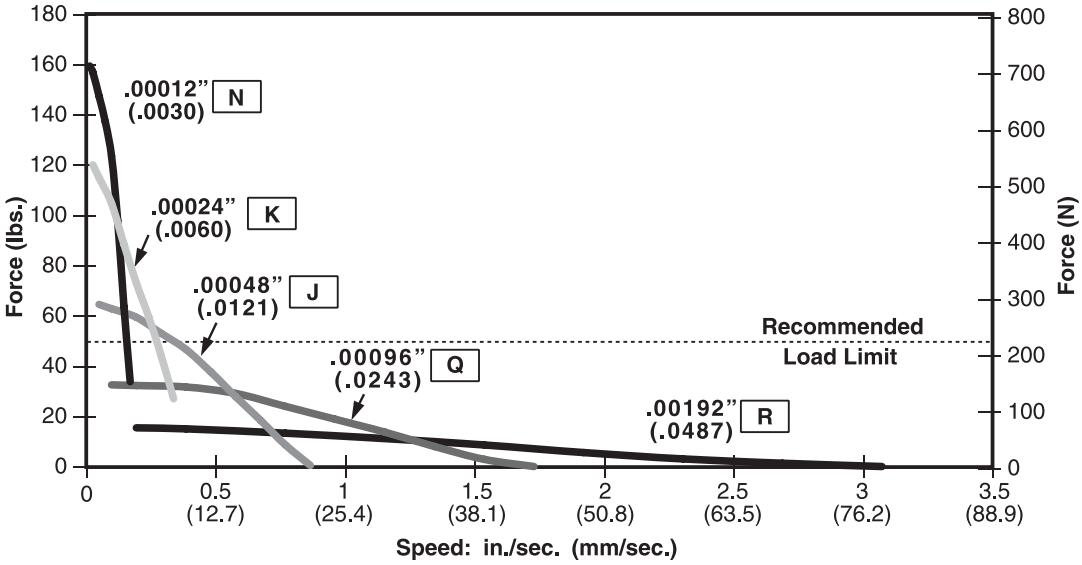
Force vs Linear Velocity Curves

Once the required actuator framesize is determined and the linear velocity is calculated, the "force vs linear velocity curve" is used to determine the proper resolution of the actuator lead screw.

Figure 11.

FORCE vs LINEAR VELOCITY SIZE 17 SERIES 43000

.218 (5.54 mm) Ø leadscrew, Bipolar, Chopper Drive, 100% Duty Cycle



Actuator Life

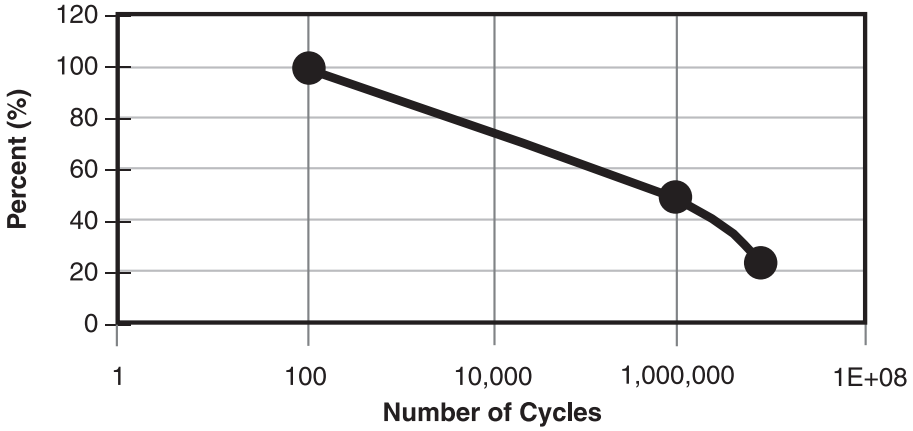
There are many variables that ultimately determine life of the actuator. The best way to predict life is through application testing, which is highly recommended.

There is, however, a first approximation technique that can help estimate this value. The stepper motor prime mover contains no brushes to wear out and also utilize precision long-life ball bearings. The main wear component is the power nut. The number of cycles can be summarized as a function of load, as illustrated in Figure 12 below.

Figure 12.

% RATED LOAD vs NUMBER OF CYCLES

Cycles on a standard stroke actuator



With proper application, Haydon linear actuators deliver up to 20 million cycles and Haydon rotary motors provide up to 25,000 hours of service. Ultimately motor fatigue and resultant life are determined by each customer's unique application. The following definitions are important for understanding motor life and fatigue.

Continuous Duty: Running a motor at its rated voltage.

25% Duty Cycle: Running a motor at double its rated power. The motor is "on" approximately 25% of the time. The motor generates about 60% more output than at rated voltage. Note, duty cycle is not related to the load placed on the motor.

Life: A linear actuator's life is the number of cycles that the motor is able to move at a prescribed load and maintain step accuracy. Rotary motor life is the number of hours of operation.

One Cycle: A linear actuator's cycle consists of extending and retracting back to the original position.

EXAMPLE #1

Application Requirements:

Required Force (lbs) =	15 lbs
Required Travel (inches) =	3 in
Time To Achieve Travel (sec) =	6 sec
Desired Cycles =	1,000,000
Linear Velocity (in / sec) =	3 in / 6 sec = 0.5 in / sec

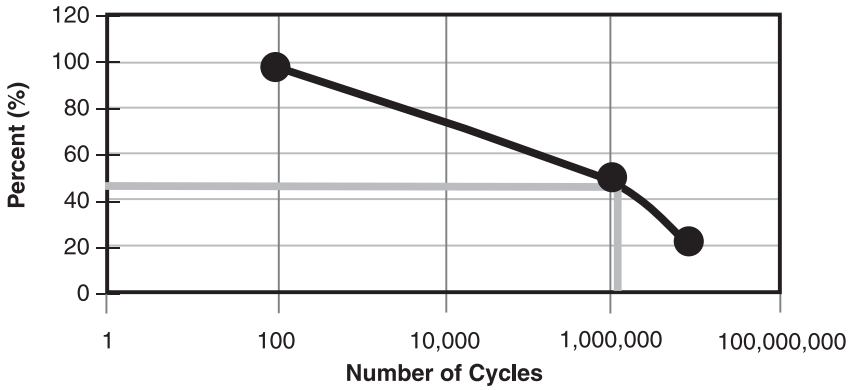
Calculate the initial rated force based on required # of cycles:

Step 1:
Refer to Figure 12 and determine the % wear after 1,000,000 cycles.
This is indicated with the blue line in Figure 13 below.

Figure 13.

LIFE EXPECTANCY

Cycles on a standard stroke actuator



Step 2:
As indicated in the chart, in order to get 1,000,000 cycles, a factor of 0.5 must be used when sizing the actuator. The initial rated force required in order to meet the load after 1,000,000 cycles is therefore…

15 lbs / 0.5 = 30 lbs

Step 3:
Convert lbs to Newtons (N)

30 lbs / (0.225 lbs / N) = 133 N

Determine required travel in meters

3 in x (0.0254 M / in) = 0.0762 M

Choose the proper framesize actuator using the selector chart

Step 1:
Determine the required linear mechanical power in watts

P_{linear} = (133 N x 0.0762 M) / 6 sec = 1.7 N-M / sec = 1.7 watts

Step 2:
Use **Table 1** to determine the correct framesize actuator. As discussed earlier in the paper, most applications will use a chopper drive to supply the required input pulses to the stepper motor. The 43000 (Size 17 Hybrid) was chosen for this application, as highlighted in the **"Hybrid Single Stack"** section of Table 1.

Hybrid Single Stack					
				Max. Linear Power (watts)	
Series	Size	Max Force (N)	Linear Travel Per Step (micron)	L/R Drive	Chopper Drive
21000	8	45	1.5 – 40	0.3	0.37
28000	11	90	3 – 50	0.27	0.51
35000	14	220	1.5 – 50	0 .59	1.5
43000	**17**	220	1.5 – 50	1.02	**2.31**
57000	23	880	4 – 50	1.47	6
87000	34	2200	12.7 – 127	N/A	21.19

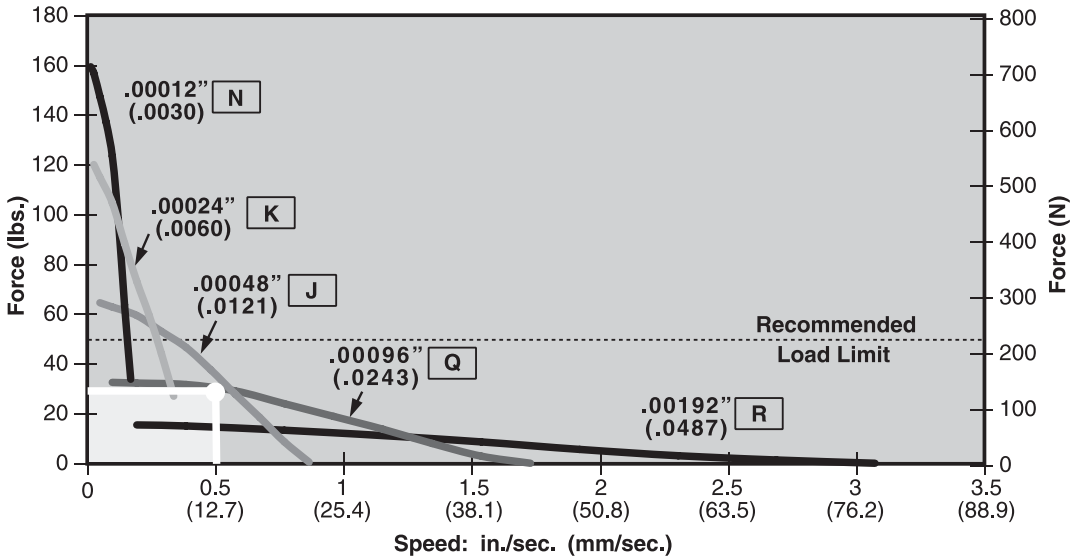
Determine the proper resolution using the "Force vs Linear Velocity" chart

As determined by the life calculation performed above, an initial load of 30 lbs is to be moved at a velocity of 0.5 in / sec. The resulting lead screw resolution required in the Size 17 hybrid motor is 0.00048" (J resolution), as indicated in figure 14 below.

Figure 14.

FORCE vs LINEAR VELOCITY SIZE 17 SERIES 43000

.218 (5.54 mm) Ø leadscrew, Bipolar, Chopper Drive, 100% Duty Cycle



Verify selection by checking force at the required step rate

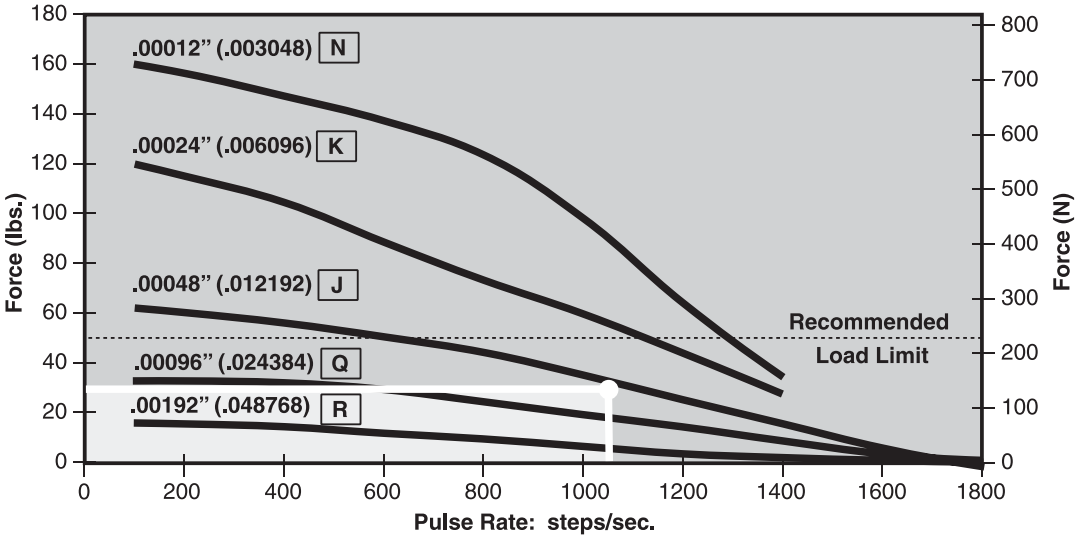
Earlier in the paper, it was discussed that the lead screw advances based on the number of input steps to the motor. Haydon performance curves are expressed in both "in/sec" (as illustrated in Figure 14) and also in "steps / sec" (Figure 15 below). As an effective check, verify the selection by checking the force at the required step rate.

Resolution chosen	0.00048 in / step ("J" screw)
Req'd linear velocity	0.5 in / sec
Req'd step rate	(0.5 in / sec) / (0.00048 in / step) = 1041 steps / sec

Figure 15.

FORCE vs PULSE RATE SIZE 17 SERIES 43000

.218 (5.54 mm) Ø leadscrew, Bipolar, Chopper Drive, 100% Duty Cycle



Figures 14 and 15 are good illustrations of how the pulses to the stepper motor translate into linear motion through the lead screw.

EXAMPLE #2

Haydon Kerk Motion Solutions, Inc. offers a line of Double Stack Hybrid Actuators that are designed to meet the needs of higher speed applications. This next example illustrates a typical situation where higher speed is required to perform the motion.

All other application requirements with the exception of the move velocity is unchanged from Example #1.

Application Requirements:

Required Force (lbs) =	15 lbs
Required Travel (inches) =	3 in
Time To Achieve Travel (sec) =	3 sec (modified application requirement)
Desired Cycles =	1,000,000
Linear Velocity (in / sec) =	3 in / 3 sec = 1.0 in / sec (modified linear velocity)

Calculate the initial rated force based on required # of cycles:

Step 1:
Refer to Figure 10 and determine the % wear after 1,000,000 cycles. This is indicated with the blue line in Figure 11. This will be identical to that shown in Sizing Example #1 because the number of desired cycles didn't change.

Step 2:
As indicated in Figure 11, in order to get 1,000,000 cycles, a factor of 0.5 must be used when sizing the actuator. The initial force required in order to meet the load after 1,000,000 cycles is therefore…

15 lbs / 0.5 = 30 lbs *(Unchanged from Example #1)*

Step 3:
Convert lbs to Newtons (N)

30 lbs / (0.225 lbs / N) = 133 N *(Unchanged from Example #1)*

Determine required travel in meters

3 in x (0.0254 M / in) = 0.0762 M (*(Unchanged from Example #1)*

Choose the proper framesize actuator using the selector chart

Step 1:
Determine the required linear mechanical power in watts

P_{linear} = (133N x 0.0762M) / 3s = 3.4 N-M / s = 3.4 watts *(This changed from 1.7 watts needed in Example #1)*

As shown from the result above, the required output power increased by 100% due to the application requirement change from a 6s Time to Achieve Travel (Example #1) to a 3s Time to Achieve Travel.

Step 2:
Assuming the mounting footprint is to remain unchanged (in this case, the Size 17 motor frame), using the Double Stack version of the actuator would easily meet the application requirements. This is highlighted in the **"Hybrid Double Stack"** section of **Table 1**.

Hybrid Double Stack					
				Max. Linear Power (watts)	
Series	Size	Max Force (N)	Linear Travel Per Step (micron)	L/R Drive	Chopper Drive
28000	11	133	3 – 50	N/A	1.14
35000	14	220	15.8 – 127	N/A	2.7
43000	**17**	350	15.8 – 127	N/A	**4.62**
57000	23	880	12.7 – 127	N/A	10.08

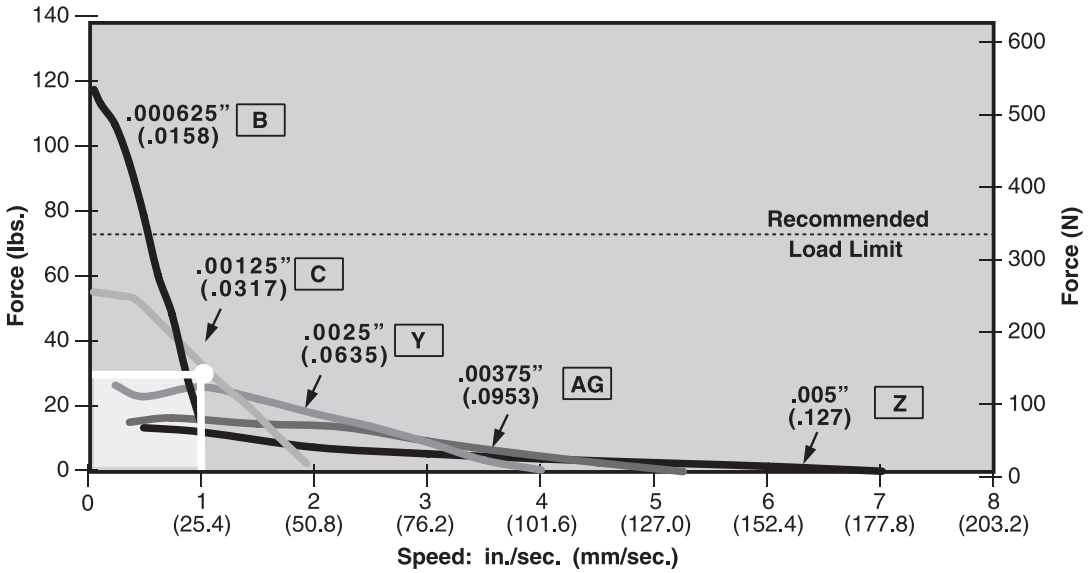
Determine the proper resolution using the "Force vs Linear Velocity" chart

As determined by the life calculation performed above, an initial load of 30 lbs is to be moved at a new velocity of 1.0 in/s. The intercept falls under curve "C". The resulting lead screw resolution required in the Size 17 double stack hybrid motor is 0.00125" (C resolution), as indicated in Figure 16 below.

Figure 16.

FORCE vs LINEAR VELOCITY SIZE 17 DOUBLE STACK SERIES 43000

.250 (6.35 mm) Ø leadscrew, Bipolar, Chopper Drive, 100% Duty Cycle



Verify selection by checking force at the required step rate

As discussed earlier, Haydon motor performance curves are expressed in both "in/sec" and also in "steps/sec". As an effective check, verify the selection by checking the force at the required step rate.

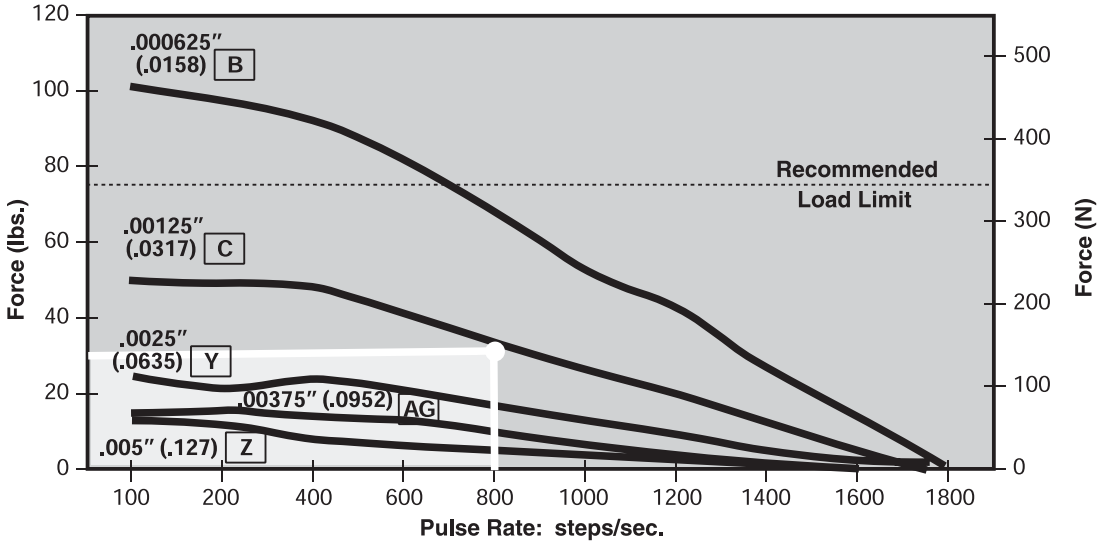
Resolution chosen	0.00125 in / step ("C" screw)
Required linear velocity	1.0 in / sec
Required step rate	(1.0 in / sec) / (0.00125 in / step) = 800 steps / sec

The intercept of the required force and pulse rate (load point) is confirmed to fall under curve "C" as calculated.

Figure 17.

FORCE vs PULSE RATE SIZE 17 DOUBLE STACK SERIES 43000

.250 (6.35 mm) Ø leadscrew, Bipolar, Chopper Drive, 100% Duty Cycle



Resolution, Accuracy, and Repeatability – What's The Difference??

In any linear motion application, the subject of resolution, accuracy, and repeatability inevitability comes up. These terms have very different meanings, but are in many cases, used interchangeably.

Resolution

This is defined as the incremental distance the actuator's output shaft will extend per input pulse.

Resolution is expressed as inches/step. As seen in the curves above, resolutions are available in fractions or subfractions of an inch per step allowing very controlled linear motion.

Resolution = (screw lead) / (360 deg / step angle)

Example: Screw lead = 0.096-in / rev (inch / revolution)
Step angle = 1.8 deg / step

Actuator Resolution = (0.096 in / rev) / (360 deg / (1.8 deg / step) = 0.00048 in / step (use **"J" screw**)

Accuracy

The difference between the theoretical distance and the actual distance traveled. Due to manufacturing tolerances in the individual components of the actuator, the actual travel will be slightly different. The tight design tolerances of the Haydon actuators allow this error to be very small, but nevertheless, it exists. See Figure 18.

For a Haydon™ hybrid linear actuator utilizing a screw with a 1-in lead, 360° of rotary motion will result in a theoretical 1-in stoke. In general, the tolerance of a Haydon Hybrid linear actuator with a 1-in move will be +/– 0.0005-in.

Repeatability

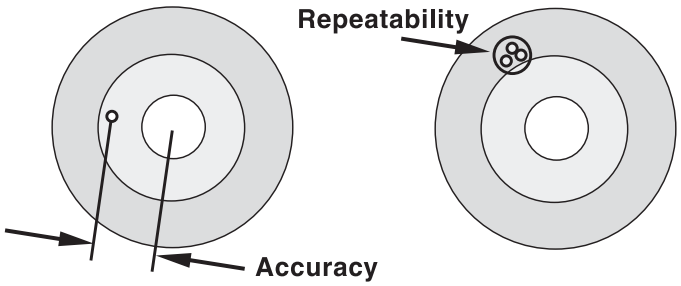
The range of positions attained when the actuator is commanded to approach the same target multiple times under identical conditions.

Example:

Allow the actuator to extend a commanded distance from its home position (starting point). Measure and record this distance and call it "x". Retract the actuator back to its home position. Command the actuator to repeatedly return to the commanded distance "x". The differences between the actual distances traveled and "x" is the repeatability.

Figure 18.

ACCURACY and REPEATABILITY



Resonance

Stepper motors have a natural resonant frequency as a result of the motor being a spring-mass system. When the step rate equals the motor's natural frequency, there may be an audible change in noise made by the motor, as well as an increase in vibration. The resonant point will vary with the application and load, but typically occurs somewhere between 100 and 250 steps per second. In severe cases the motor may lose steps at the resonant frequency. Changing the step rate is the simplest means of avoiding many problems related to resonance in a system. Also, half stepping or micro stepping usually reduces resonance problems. When accelerating/decelerating to speed, the resonance zone should be passed through as quickly as possible.

Selecting The Proper Motor-Checklist

In order to select the proper motor several factors must be considered. Is linear or rotary motion required? Following is a list of some of the basic requirements to consider when choosing a motor. This will help determine the best choice of an actuator or a rotary motor.

Rotary Motor	Linear Actuator
How much torque is required?	How much force is required?
What is the duty cycle?	What is the duty cycle?
What is desired step angle?	What is desired step increment?
What is the step rate or RPM?	What is the step rate or speed of travel?
Bipolar or unipolar coils?	Bipolar or unipolar coils?
Coil Voltage?	Coil Voltage?
Detent or holding torque requirements?	Must the screw hold position with power off or must it be "backdrivable"with power off?
Are there size restrictions?	Are there size restrictions?
What is anticipated life requirement?	What is anticipated life requirement?
Temperature of operating environment?	Temperature of operating environment?
Sleeve or ball bearings?	Captive or non-captive shaft?
Radial and axial load?	Type of driver?
Type of driver?	

Drives

Stepper motors require some external electrical components in order to run. These components typically include a power supply, logic sequencer, switching components and a clock pulse source to determine the step rate. Many commercially available drives have integrated these components into a complete package. Some basic drive units have only the final power stage without the controller electronics to generate the proper step sequencing.

Bipolar Drive

This is a very popular drive for a two phase bipolar motor having four leads. In a complete driver/controller the electronics alternately reverse the current in each phase. The stepping sequence is shown in figure 5.

Unipolar Drive

This drive requires a motor with a center-tap at each phase (6 leads). Instead of reversing the current in each phase, the drive only has to switch current from one coil to the other in each phase (figure 6). The windings are such that this switching reverses the magnetic fields within the motor. This option makes for a simpler drive but only half of the copper winding is used at any one time. This results in approximately 30% less available torque in a rotary motor or force in a linear actuator as compared to an equivalent bipolar motor.

L/R Drives

This type of drive is also referred to as a constant voltage drive. Many of these drives can be configured to run bipolar or unipolar stepper motors. L/R stands for the electrical relationship of inductance (L) to resistance (R). Motor coil impedance vs. step rate is determined by these parameters. The L/R drive should "match" the power supply output voltage to the motor coil voltage rating for continuous duty operation. Most published motor performance curves are based on full rated voltage applied at the motor leads. Power supply output voltage level must be set high enough to account for electrical drops within the drive circuitry for optimum continuous operation.

Performance levels of most steppers can be improved by increasing the applied voltage for shortened duty cycles. This is typically referred to as "over-driving" the motor. When over-driving a motor, the operating cycle must have sufficient periodic off time (no power applied) to prevent the motor temperature rise from exceeding the published specification.

Chopper Drives

A chopper drive allows a stepper motor to maintain greater torque or force at higher speeds than with an L/R drive. The chopper drive is a constant current drive and is almost always the bipolar type. The chopper gets its name from the technique of rapidly turning the output power on and off (chopping) to control motor current. For this setup, low impedance motor coils and the maximum voltage power supply that can be used with the drive will deliver the best performance. As a general rule, to achieve optimum performance, the recommended ratio between power supply and rated motor voltage is eight to one. An eight to one ratio was used for the performance curves in this catalog.

Microstepping Drives

Many bipolar drives offer a feature called microstepping. Microstepping electronically divides a full step into smaller steps. For instance, if one step of a linear actuator is 0.001 inch, this can be driven to have 10 microsteps per step. In this case, one microstep would normally be 0.0001 inch. Microstepping effectively reduces the step increment of a motor. However, the accuracy of each microstep has a larger percentage of error as compared to the accuracy of a full step. As with full steps, the incremental errors of microsteps are non-cumulative.

Summary

Stepper motors have been used in a wide array of applications for many years. With trends towards miniaturization, computer control and cost reduction, "hybrid" style stepper motor actuators are being used in an ever increasing range of applications. In particular the use of linear actuators has rapidly expanded in recent years. These precise, reliable motors can be found in many applications including blood analyzers and other medical instrumentation, automated stage lighting, imaging equipment, HVAC equipment, valve control, printing equipment, X-Y tables, integrated chip manufacturing, inspection and test equipment. This attractive technical solution eliminates the use of numerous components and the associated costs related to assembly, purchasing, inventory, etc. The applications for these motors are only limited by the designer's imagination.

Terminology

Detent or residual torque: The torque required to rotate the motor's output shaft with no current applied to the windings.

Drives: A term depicting the external electrical components to run a Stepper Motor System. This will include power supplies, logic sequencers, switching components and usually a variable frequency pulse source to determine the step rate.

Dynamic torque: The torque generated by the motor at a given step rate. Dynamic torque can be represented by PULL IN torque or PULL OUT torque.

Holding torque: The torque required to rotate the motor's output shaft while the windings are energized with a steady state D.C. current.

Inertia: The measure of a body's resistance to acceleration or deceleration. Typically used in reference to the inertia of the load to be moved by a motor or the inertia of a motor's rotor.

Linear step increment: The linear travel movement generated by the leadscrew with each single step of the rotor.

Maximum temperature rise: Allowable increase in motor temperature by design. Motor temperature rise is caused by the internal power dissipation of the motor as a function of load. This power dissipation is the sum total from I^2R (copper loss), iron (core) loss, and friction. The final motor temperature is the sum of the temperature rise and ambient temperature.

Pulse rate: The number of pulses per second (pps) applied to the windings of the motor. The pulse rate is equivalent to the motor step rate.

Pulses per second (PPS): The number of steps that the motor takes in one second (sometimes called "steps per second"). This is determined by the frequency of pulses produced by the motor drive.

Ramping: A drive technique to accelerate a given load from a low step rate, to a given maximum step rate and then to decelerate to the initial step rate without the loss of steps.

Single step response: The time required for the motor to make one complete step.

Step: The angular rotation produced by the rotor each time the motor receives a pulse. For linear actuators a step translates to a specific linear distance.

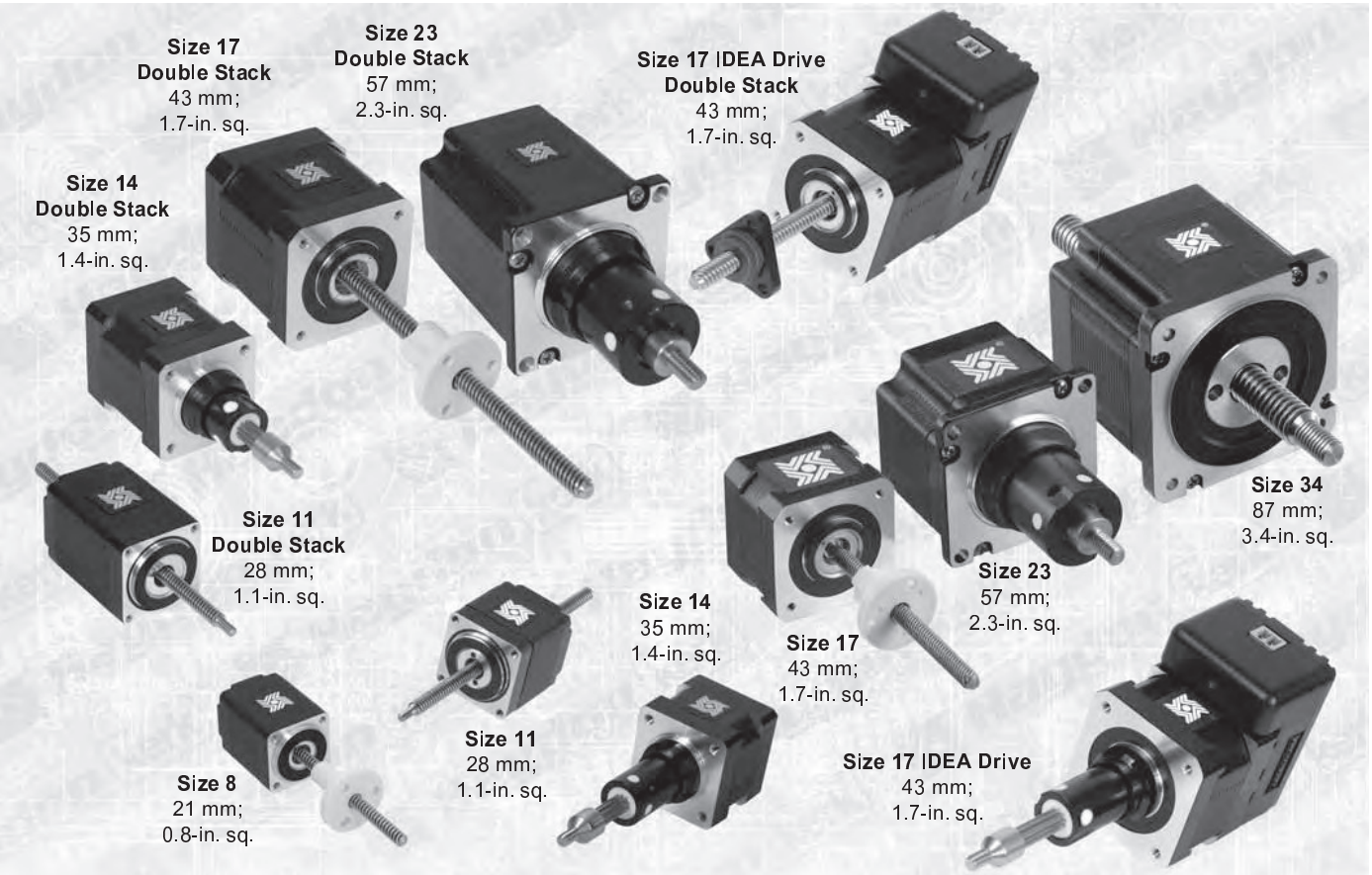
Step angle: The rotation of the rotor caused by each step, measured in degrees.

Steps per revolution: The total number of steps required for the rotor to rotate 360°.

Torque: The sum of the frictional load torque and inertial torque.

- **Pull out torque:** The maximum torque the motor can deliver once the motor is running at constant speed. Since there is no change in speed there is no inertial torque. Also, the kinetic energy stored in the rotor and load inertia help to increase the pull out torque.
- **Pull in torque:** The torque required to accelerate the rotor inertia and any rigidly attached external load up to speed plus whatever friction torque must be overcome. Pull in torque, therefore, is always less than pull out torque.

Torque to inertia ratio: Holding torque divided by rotor inertia.



Haydon Kerk Motion Solutions, Inc. hybrid linear actuators open new avenues for equipment designers who require high performance and exceptional endurance in a very small package. The various designs use a proprietary manufacturing process, which incorporates engineering thermoplastics in the rotor drive nut and a stainless steel leadscrew. This allows the motor to be much quieter, more efficient and more durable than the v-thread and bronze nut configuration commonly used in other actuators. Motor life is improved more than 10 times over the traditional bronze nut style – and it requires no maintenance and does not affect the cost. An additional feature is the bearing preload adjustment which, unlike other designs, does not protrude from the motor configuration commonly used in other actuators.

The hybrid actuators come in six sizes, from 21 mm square to 87 mm square. Each size has three designs available – captive, non-captive and an external linear version. Haydon also offers a series of Double Stack enhanced performance hybrid linear actuators available in four sizes, from 28 mm to 57 mm square. An integrated, programmable IDEA Drive is available for the Size 17 (43 mm) hybrid and Double Stack hybrid motors.

There are 28 different travels per step available, from .00006 inch (.001524 mm) to .005 inch (.127 mm). Micro stepping can be used for even finer resolution. Our 87 mm actuator delivers up to 500 pounds (2224 N) of force.

These linear actuators are ideal for applications requiring a combination of precise positioning, rapid motion and long life.

Typical applications include X-Y tables, medical equipment, semiconductor handling, telecommunications equipment, valve control, and numerous other uses. Sold at competitive prices, this product is an excellent value for incorporation into your next project. In addition to standard configurations, Haydon Kerk Motion Solutions can custom design these motors to meet your specific application needs. Lead time for standard prototype designs is usually 2 to 3 days, and 4 to 6 weeks for production orders.

Identifying the part number codes when ordering

24 HOUR ON-LINE PROTOTYPE AVAILABILITY www.HaydonKerk.com

Immediate availability of a standard selection of parts.

E	43	H	4	N	–	05	–	910

Prefix
(only when using the following)

E = External
P = Proximity Sensor
S = Home Switch
T = High Temp

Series number designation:

43 = 43000

Available Hybrids:
21000
28000
35000
43000
57000
87000

Style

F = 1.8° Non captive
H = 1.8° Captive
H = 1.8° Captive (Use "E" prefix for "External")
J = 0.9° Non-captive
K = 0.9° Captive
K = 0.9° Captive (Use "E" prefix for "External")
L = 1.8° Double Stack, Non-captive
M = 1.8° Double Stack, Captive
M = 1.8° Double Stack, (Use "E" prefix for "External")

Coils

4 = Bipolar (4 wire)
6 = Unipolar (6 wire)

G = IDEA Drive (Size 17, 43000 Series only)

Code ID Resolution Travel/Step

(Example: N = travels .00012-in per step)

(Refer to travel / step chart found on each Series product page.)

Voltage

(Example: 05 = 5 VDC; 12 = 12 VDC) Custom V available

Suffix:

Stroke
Example: –910 = 1-in
(Refer to Stroke chart on Captive motor series product page.)

Suffix also represents:

–900 = External Linear with grease and flanged nut

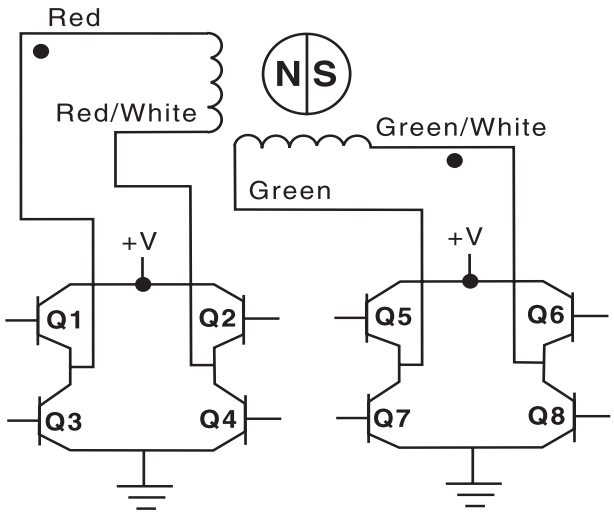
–XXX = Special or custom
(Special part numbers for custom screw lengths and design options will require an issued 3 digit suffix number. Please contact our sales or applications engineering department for assistance.)

EXAMPLES:

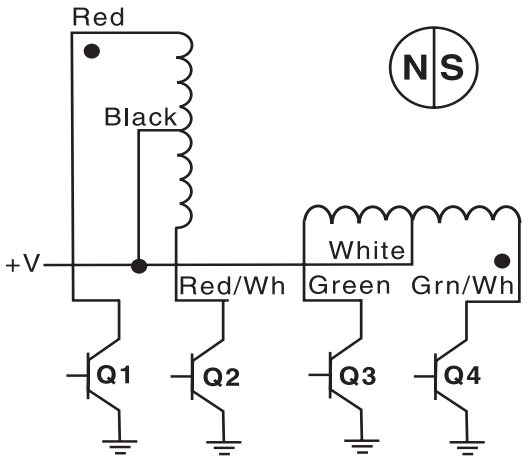
E43H4N-05-900 = External linear actuator, 43000 series, 1.8 degree, Bipolar coils, .00012-in travel per step, 5 volt DC, with grease and flanged nut.

43H4N-05-910 = 43000 series, 1.8 degree captive linear actuator, Bipolar, .00012-in travel per step, 5 volt DC, 1.0-in stroke.

Bipolar



Unipolar



Hybrid Linear Actuator: Stepping Sequence

EXTEND CW ↓

Bipolar	Q2-Q3	Q1-Q4	Q6-Q7	Q5-Q8
Unipolar	Q1	Q2	Q3	Q4
Step				
1	ON	OFF	ON	OFF
2	OFF	ON	ON	OFF
3	OFF	ON	OFF	ON
4	ON	OFF	OFF	ON
1	ON	OFF	ON	OFF

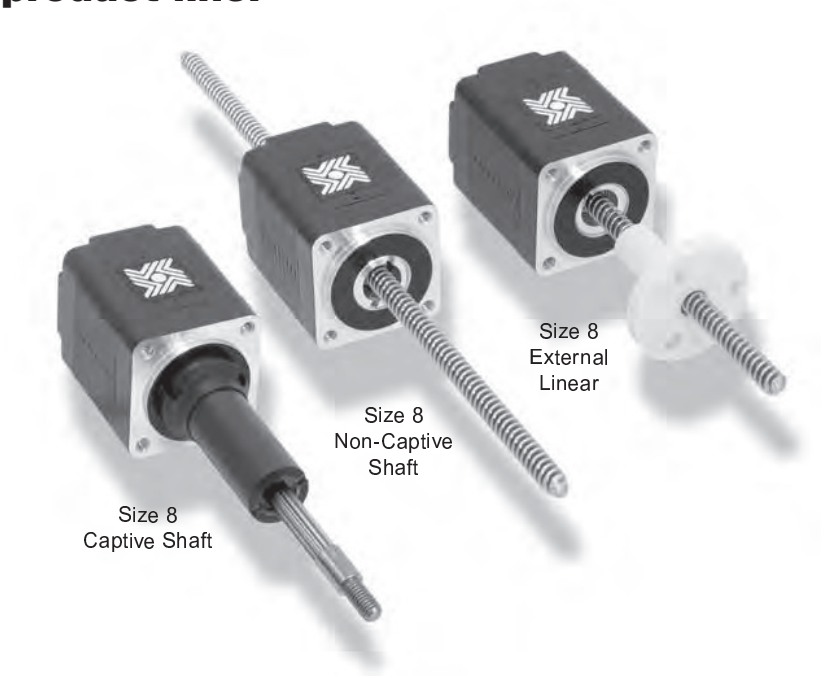
↑ RETRACT CCW

Note: Half stepping is accomplished by inserting an off state between transitioning phases.

One of the world's smallest linear actuators, the Size 8 precision motor is a recent addition to our extensive, award winning miniature stepper motor product line.

Equipment designers and engineers now have an even more compact option for their motion applications. The Haydon™ 21000 Series Size 8 linear actuator occupies a minimal 0.8" (21 mm) space and includes numerous patented innovations that provide customers high performance and endurance in a very small package.

Three designs are available, captive, non-captive and external linear versions. The 21000 Series is available in a wide variety of resolutions - from 0.00006" (.0015 mm) per step to 0.00157" (0.04 mm) per step. The Size 8 actuator delivers thrust of up to 10 lbs. (44 N).



Salient Characteristics

Size 8: 21 mm (0.8-in) Hybrid Linear Actuator (1.8° Step Angle)				
Part No.	Captive	21H4(X)-V		
	Non-captive	21F4(X)-V		
	External Lin.	E21H4(X)-V		
Wiring		Bipolar		
Winding voltage		2.5 VDC	5 VDC	7.5 VDC
Current/phase		.49 A	.24 A	.16 A
Resistance/phase		5.1 Ω	20.4 Ω	45.9 Ω
Inductance/phase		1.5 mH	5.0 mH	11.7 mH
Power consumption		2.45 W Total		
Rotor inertia		1.4 gcm^2		
Temperature rise		135°F Rise (75°C Rise)		
Weight		1.5 oz (43 g)		
Insulation resistance		20 MΩ		

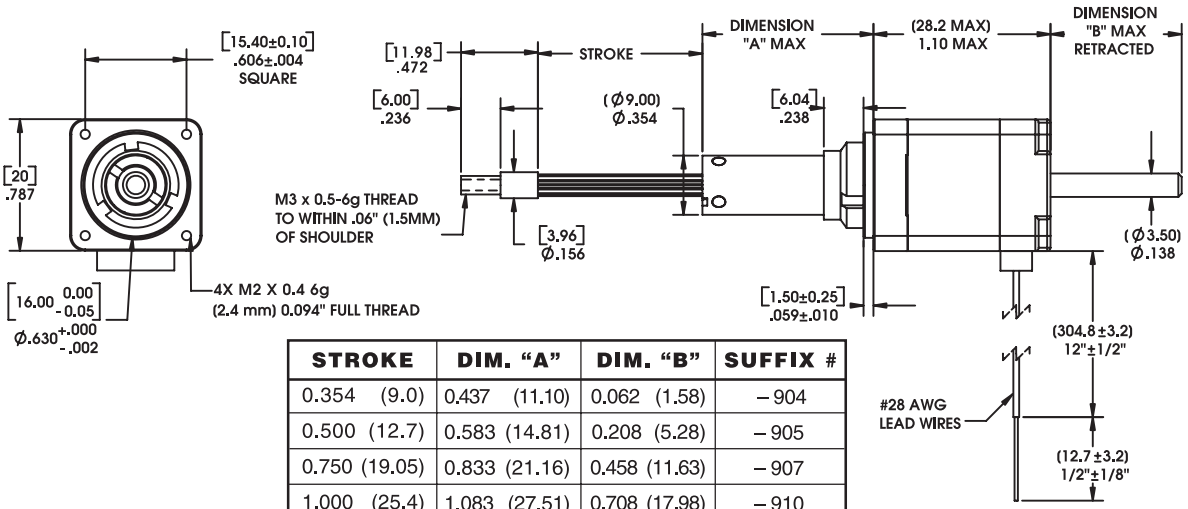
Linear Travel / Step Screw Ø.138"(3.50 mm) inches	mm	**Order Code I.D.**
.00006	.0015*	U
.000098*	.0025	AA
.00012	.0030*	N
.00019*	.005	AB
.00024	.006*	K
.00039*	.01	AC
.00048	.0121*	J
.00078*	.02	AD
.00157*	.04	AE

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

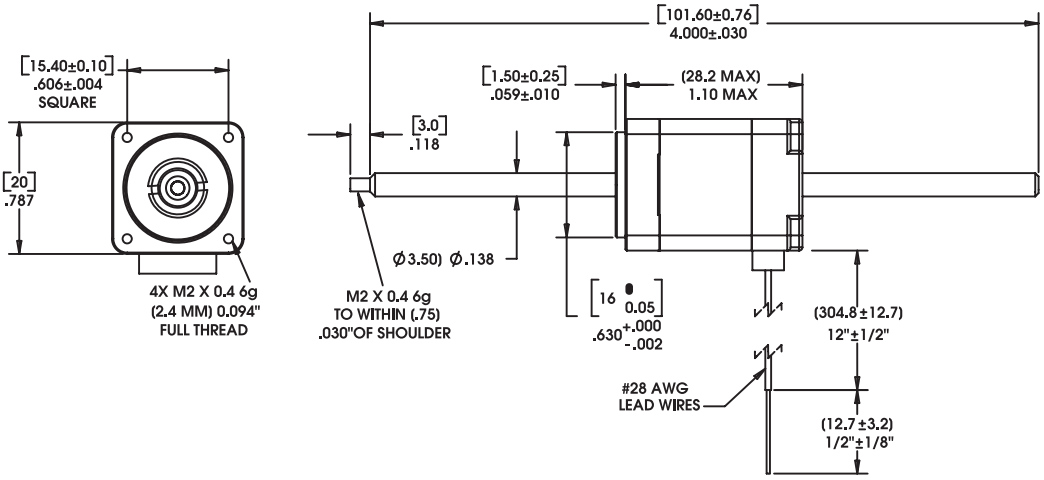
Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

Captive Leadscrew

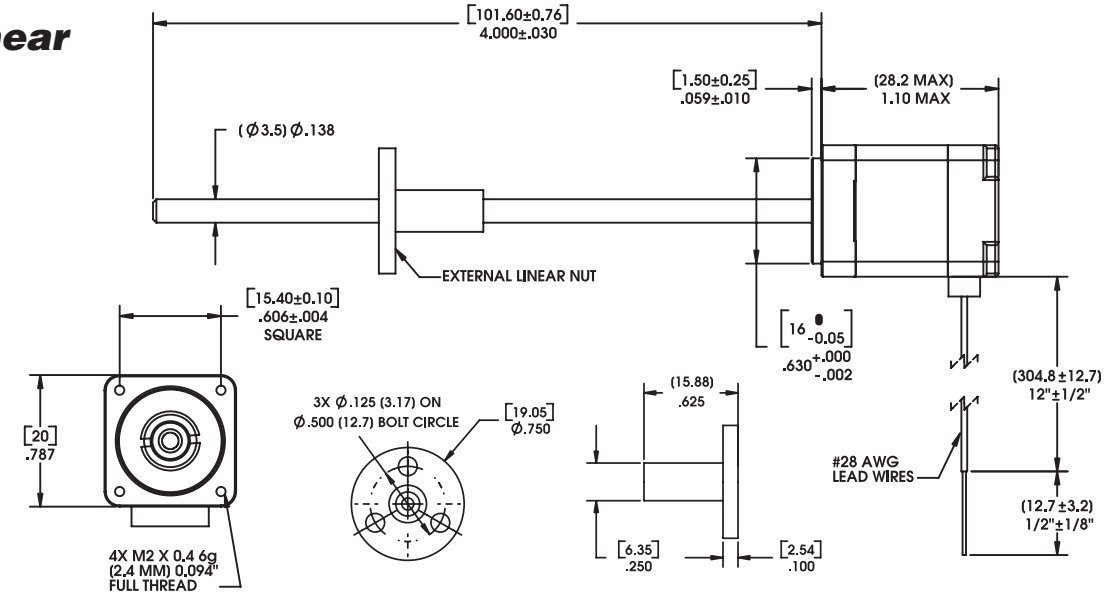


STROKE	DIM. "A"	DIM. "B"	SUFFIX #
0.354 (9.0)	0.437 (11.10)	0.062 (1.58)	– 904
0.500 (12.7)	0.583 (14.81)	0.208 (5.28)	– 905
0.750 (19.05)	0.833 (21.16)	0.458 (11.63)	– 907
1.000 (25.4)	1.083 (27.51)	0.708 (17.98)	– 910
1.250 (31.8)	1.333 (33.86)	0.958 (24.33)	– 912
1.500 (38.1)	1.583 (40.21)	1.208 (30.68)	– 915

Non-Captive Leadscrew



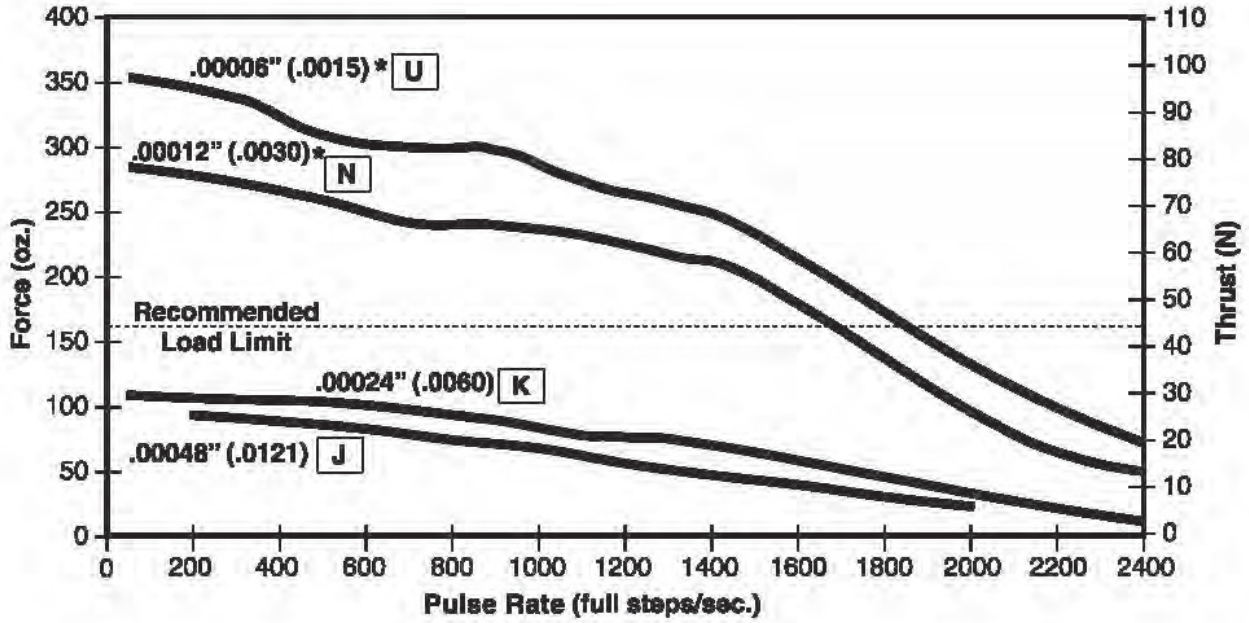
External Linear

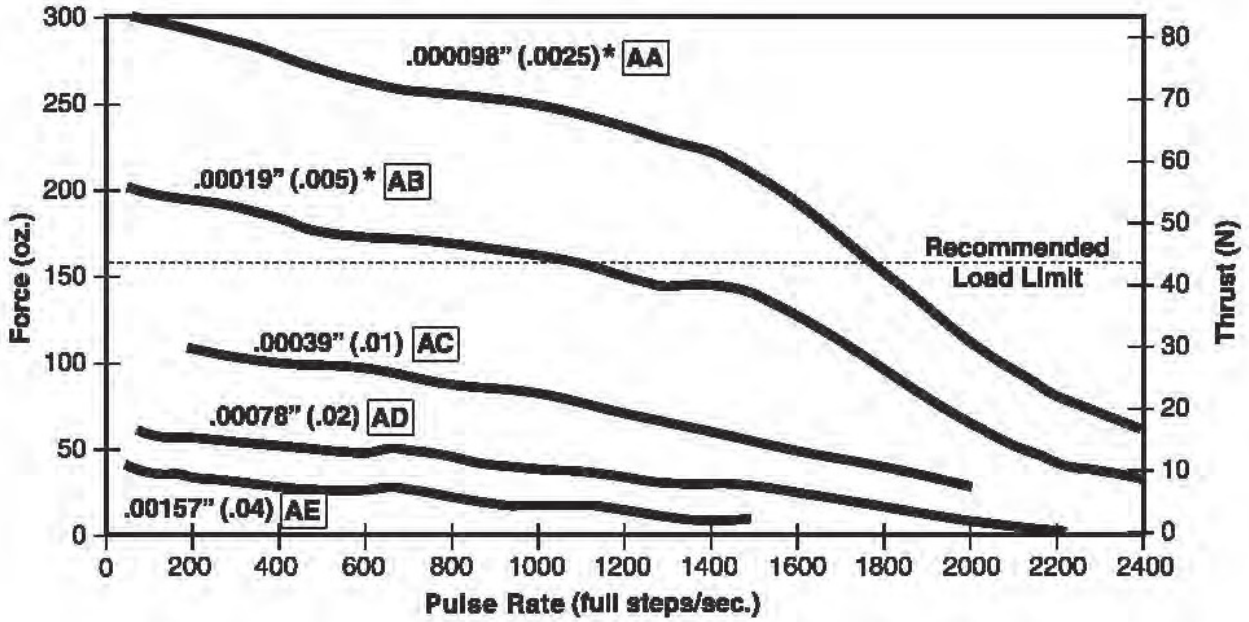


FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

Ø .138 (3.50) Leadscrew

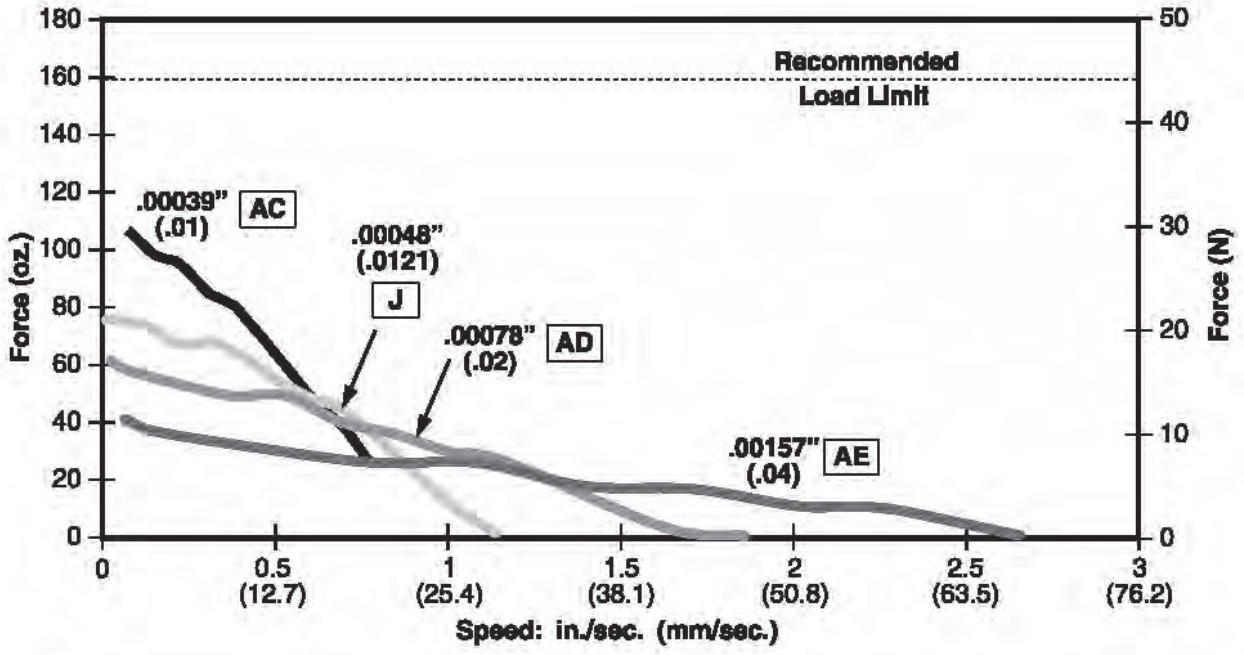


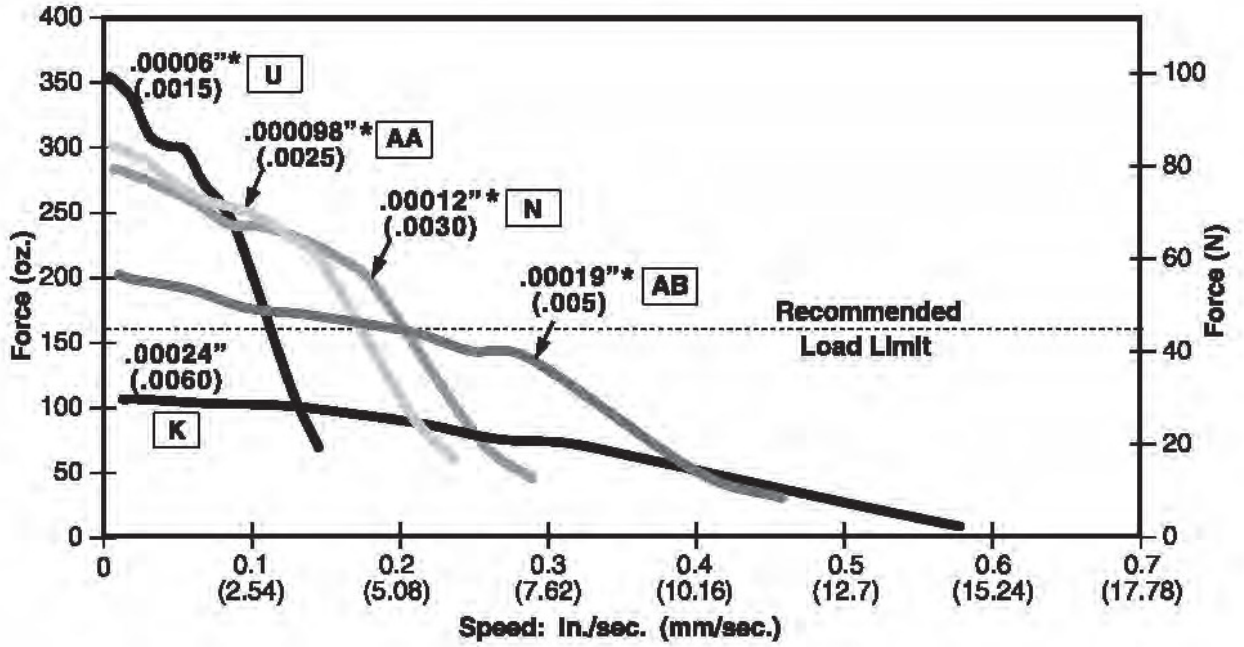


FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

Ø .138 (3.50) Leadscrew





*Care should be taken when utilizing these screw pitches to ensure that the physical load limits of the motor are not exceeded. Please consult the factory for advice in selecting the proper pitch for your application.

NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

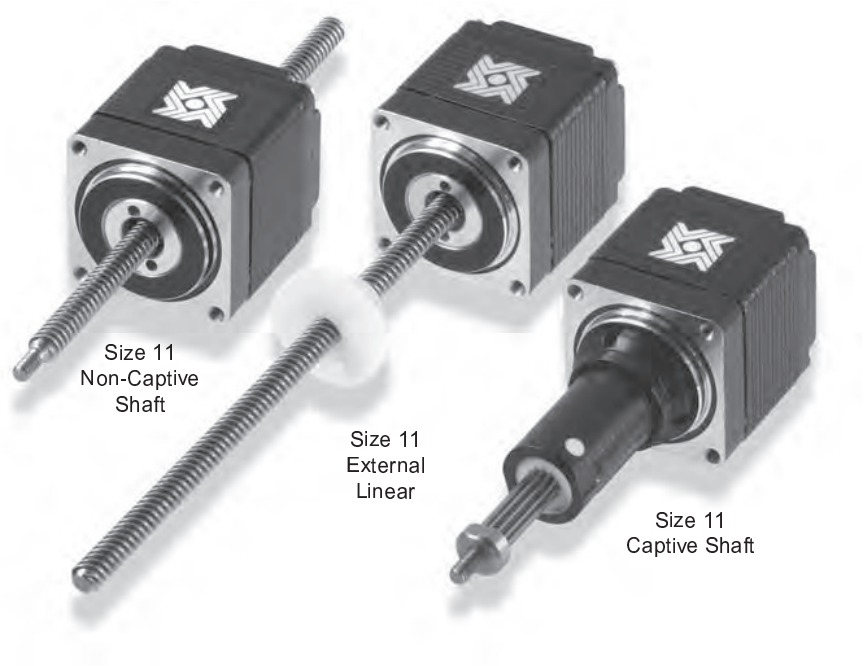
Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

Haydon™ brand Size 11 hybrid linear actuators offer compact, production-proven precision in motion.

The various patented designs deliver high performance, opening avenues for equipment designers who require performance and endurance in a very small package.

Three designs are available, captive, non-captive and external linear versions. The 28000 Series is available in a wide variety of resolutions - from 0.000125-in (.003175 mm) per step to 0.002-in (.0508 mm) per step. The Size 11 actuator delivers thrust of up to 20 lbs. (90 N).



Salient Characteristics

Size 11: 28 mm (1.1-in) Hybrid Linear Actuator (1.8° Step Angle)						
Part No.	Captive	28H4(X)-V			28H6(X)-V	
	Non-captive	28F4(X)-V			28F6(X)-V	
	External Lin.	E28H4(X)-V			E28H6(X)-V	
Wiring		Bipolar			Unipolar**	
Winding voltage		2.1 VDC	5 VDC	12 VDC	5 VDC	12 VDC
Current/phase		1.0 A	0.42 A	0.18 A	0.42 A	0.18 A
Resistance/phase		2.1 Ω	11.9 Ω	68.6 Ω	11.9 Ω	68.6 Ω
Inductance/phase		1.5 mH	6.7 mH	39.0 mH	3.3 mH	19.5 mH
Power consumption		4.2 W				
Rotor inertia		9.0 gcm^2				
Temperature rise		135°F Rise (75°C Rise)				
Weight		4.2 oz (119 g)				
Insulation resistance		20 MΩ				

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

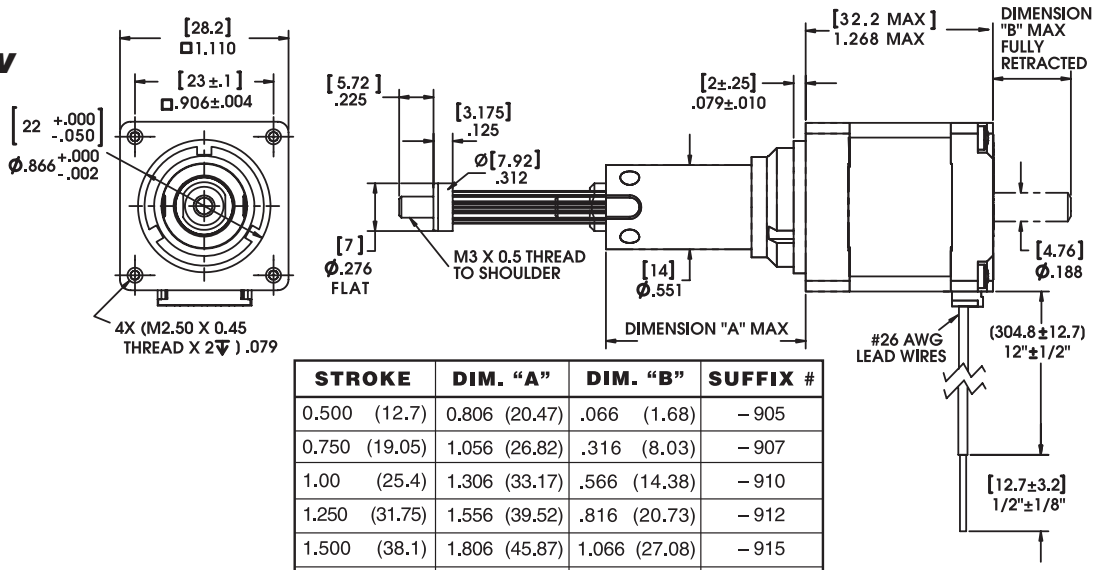
Linear Travel / Step Screw Ø.1875"(4.76mm) inches	mm	Order Code I.D.
.000125	.0031*	7
.00025	.0063*	9
.0005	.0127	3
.001	.0254	1
.002	.0508	2

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

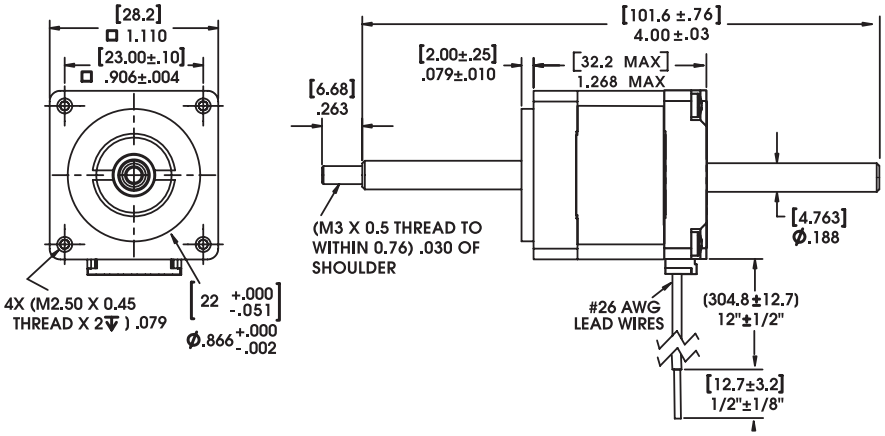
Captive Leadscrew



STROKE	DIM. "A"	DIM. "B"	SUFFIX #
0.500 (12.7)	0.806 (20.47)	.066 (1.68)	– 905
0.750 (19.05)	1.056 (26.82)	.316 (8.03)	– 907
1.00 (25.4)	1.306 (33.17)	.566 (14.38)	– 910
1.250 (31.75)	1.556 (39.52)	.816 (20.73)	– 912
1.500 (38.1)	1.806 (45.87)	1.066 (27.08)	– 915
2.00 (50.8)	2.306 (58.57)	1.566 (39.78)	– 920
2.500 (63.5)	2.806 (71.27)	2.066 (52.48)	– 925

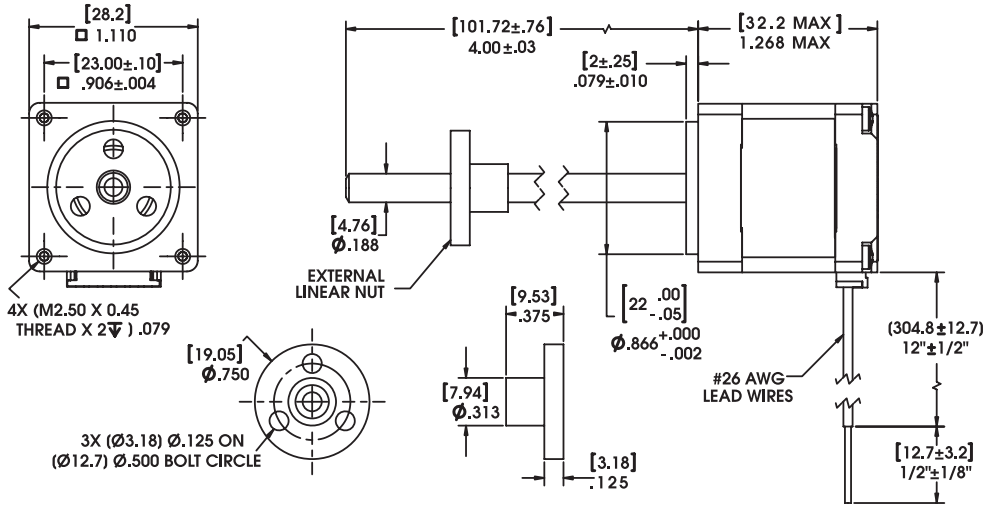
Integrated connector option, see page 115

Non-Captive Leadscrew



Integrated connector option, see page 115

External Linear

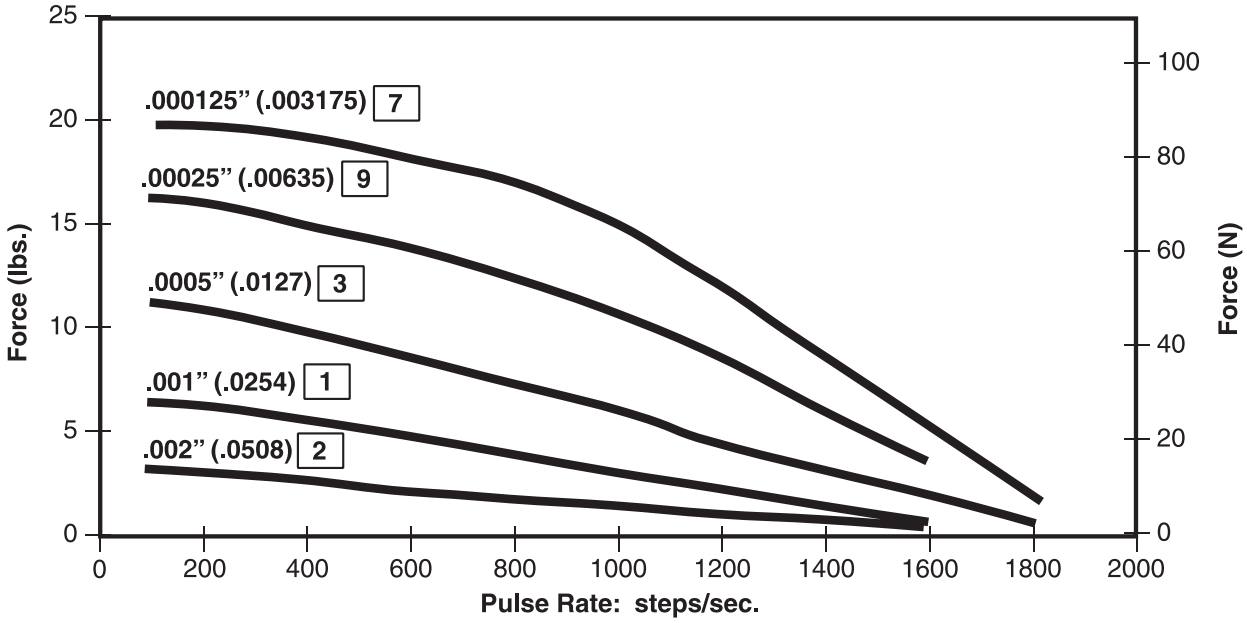


Integrated connector option, see page 115

FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

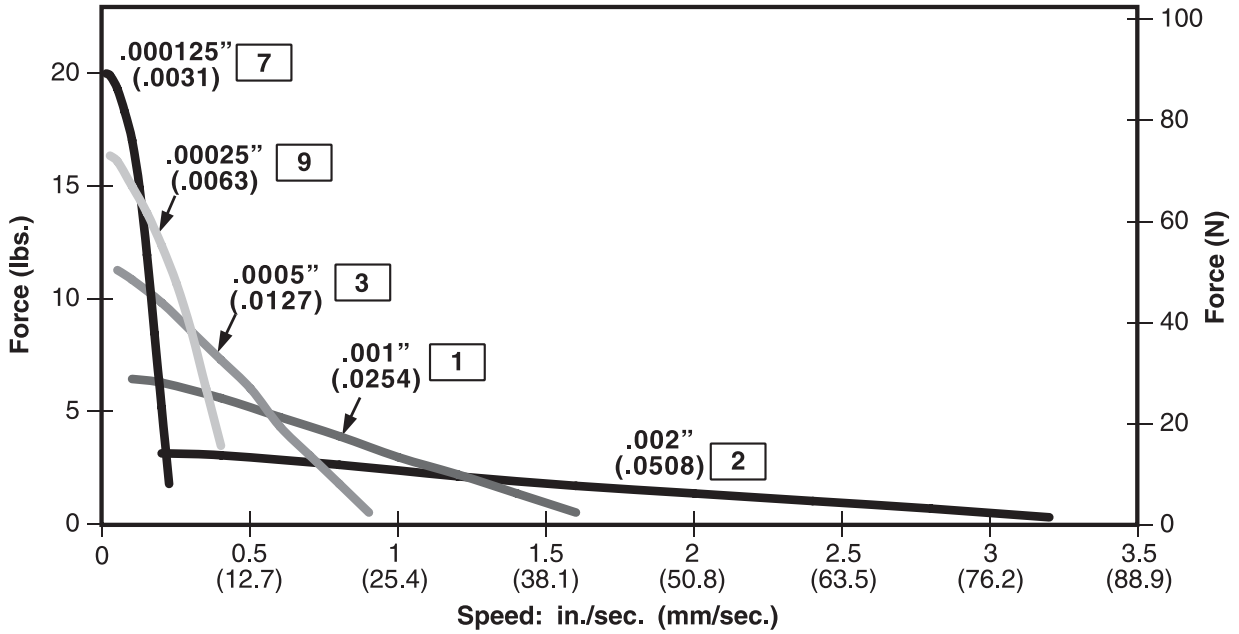
Ø .187 (4.75) Leadscrew



FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

Ø .187 (4.75) Leadscrew



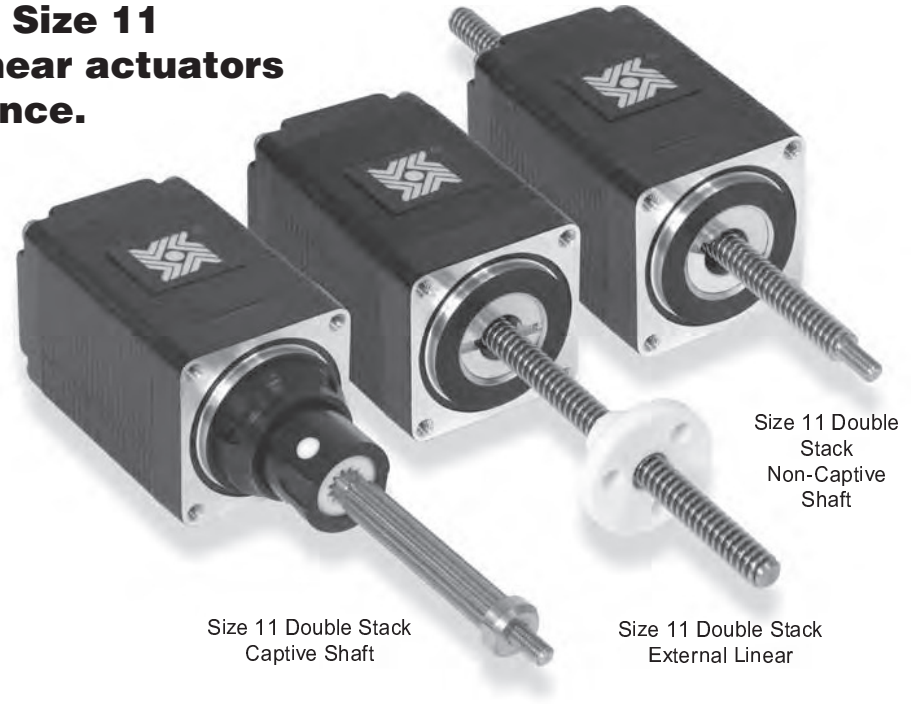
NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

Haydon™ 28000 Series Size 11 Double Stack hybrid linear actuators for enhanced performance.

Three designs are available, captive, non-captive and external linear versions. The 28000 Series is available in a wide variety of resolutions - from 0.000125" (.003175 mm) per step to 0.002" (.0508 mm) per step. The Size 11 actuator delivers thrust of up to 30 lbs. (133 N).



Size 11 Double Stack Non-Captive Shaft

Size 11 Double Stack Captive Shaft

Size 11 Double Stack External Linear

Salient Characteristics

Size 11: 28 mm (1.1-in) Double Stack Hybrid Linear Actuator (1.8° Step Angle)				
Part No.	Captive	28M4(X)-V		
	Non-captive	28L4(X)-V		
	External Lin.	E28M4(X)-V		
Wiring		Bipolar		
Winding voltage		2.1 VDC	5 VDC	12 VDC
Current/phase		1.9 A	750 mA	350 mA
Resistance/phase		1.1 Ω	6.7 Ω	34.8 Ω
Inductance/phase		1.1 mH	5.8 mH	35.6 mH
Power consumption		7.5 W Total		
Temperature rise		135°F Rise (75°C Rise)		
Weight		5.8 oz (180 g)		
Insulation resistance		20 MΩ		
Max. Load Limit		30 lbs (133 N)		

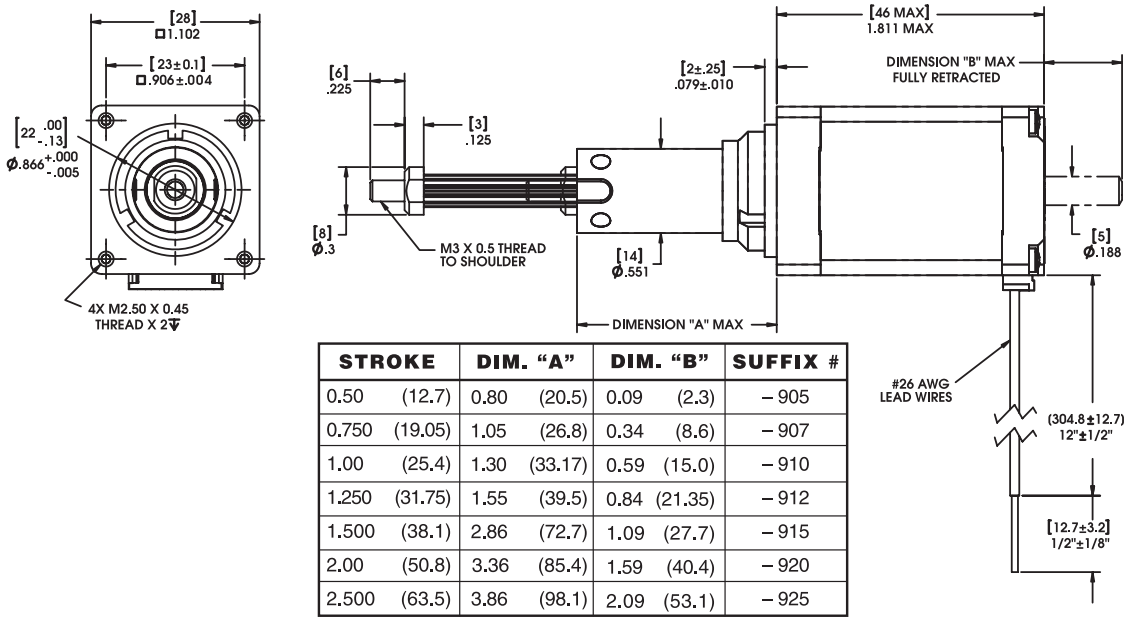
Linear Travel / Step Screw Ø.1875"(4.76mm) inches	mm	Order Code I.D.
.000125	.0031*	7
.00025	.0063*	9
.0005	.0127	3
.001	.0254	1
.002	.0508	2

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

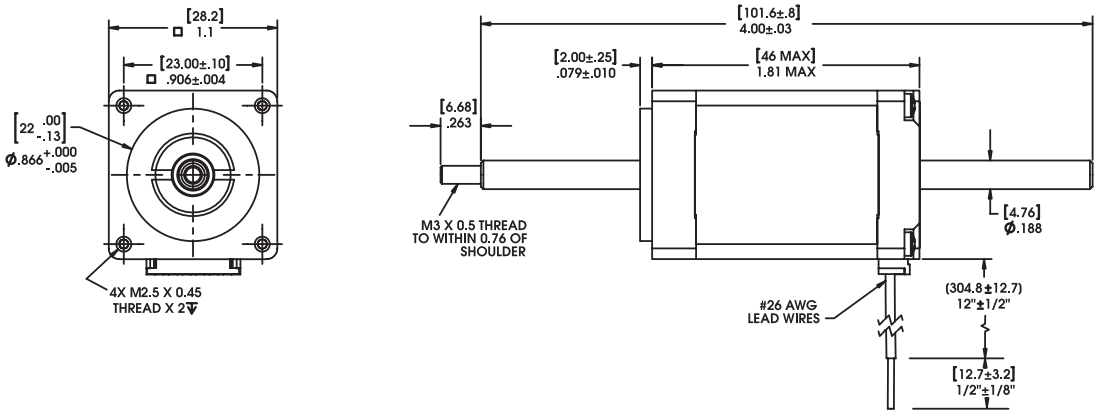
Captive Leadscrew



STROKE		DIM. "A"		DIM. "B"		SUFFIX #
0.50	(12.7)	0.80	(20.5)	0.09	(2.3)	– 905
0.750	(19.05)	1.05	(26.8)	0.34	(8.6)	– 907
1.00	(25.4)	1.30	(33.17)	0.59	(15.0)	– 910
1.250	(31.75)	1.55	(39.5)	0.84	(21.35)	– 912
1.500	(38.1)	2.86	(72.7)	1.09	(27.7)	– 915
2.00	(50.8)	3.36	(85.4)	1.59	(40.4)	– 920
2.500	(63.5)	3.86	(98.1)	2.09	(53.1)	– 925

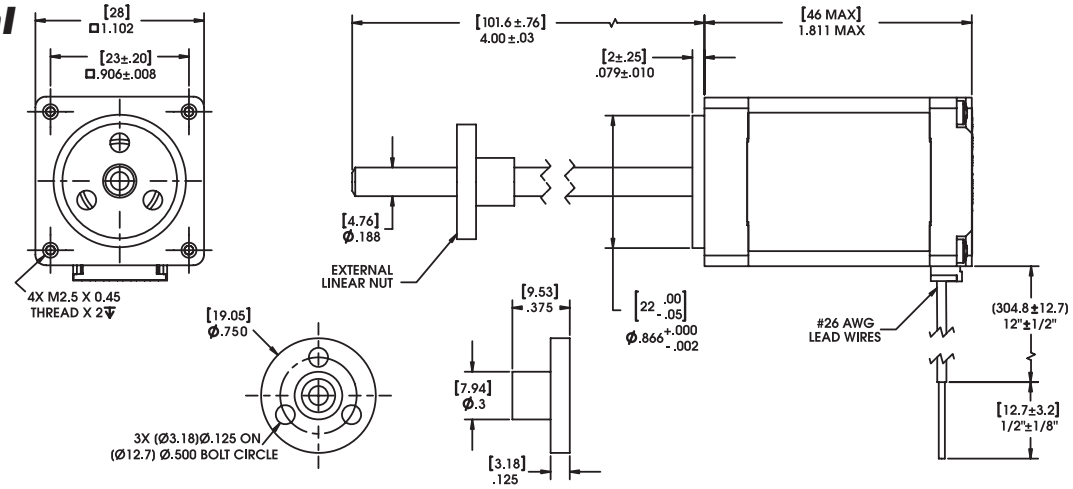
Integrated connector option, see page 115

Non-Captive Leadscrew



Integrated connector option, see page 115

External Linear

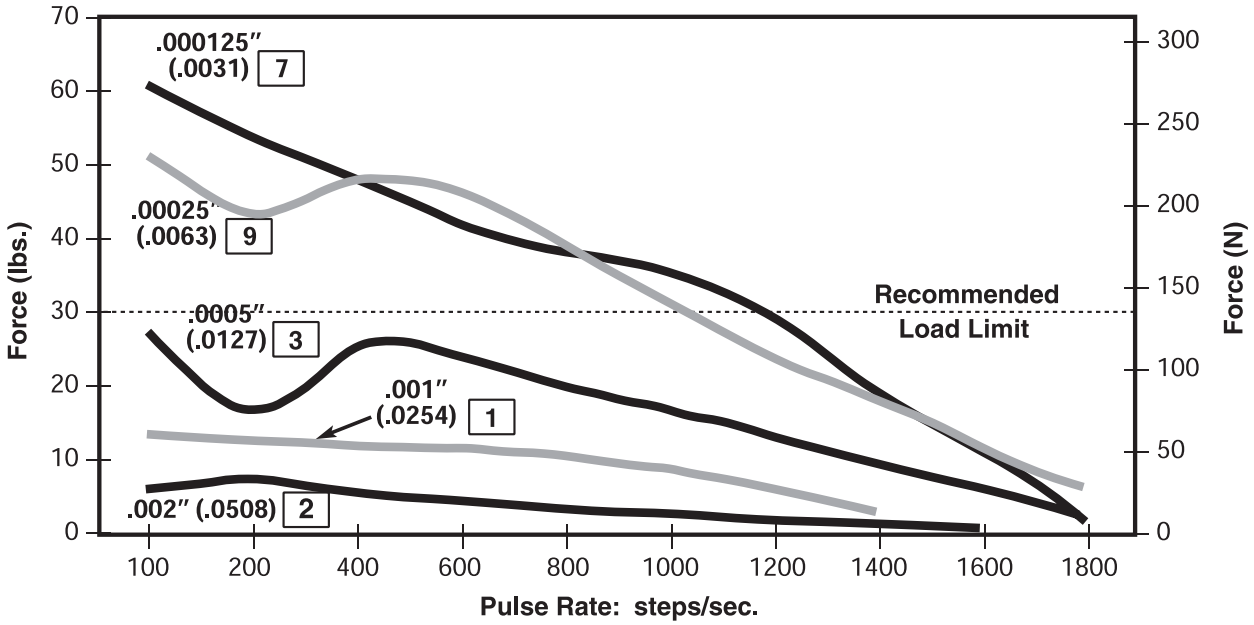


Integrated connector option, see page 115

FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

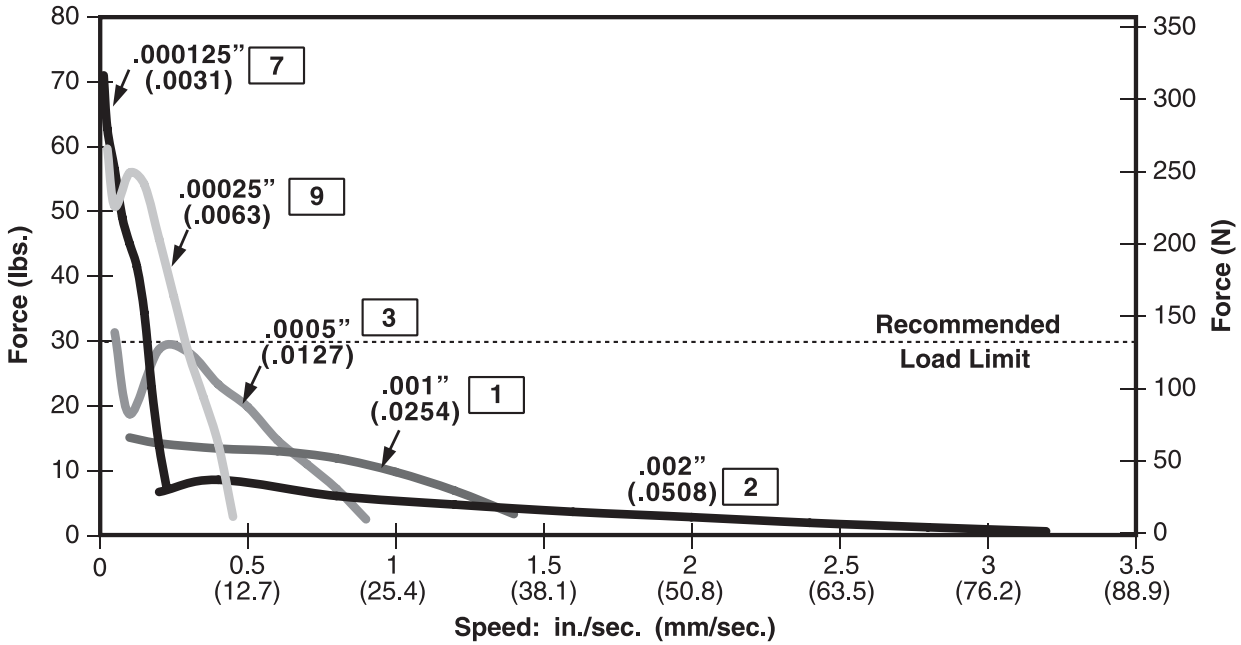
Ø .187 (4.75) Leadscrew



FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

Ø .187 (4.75) Leadscrew



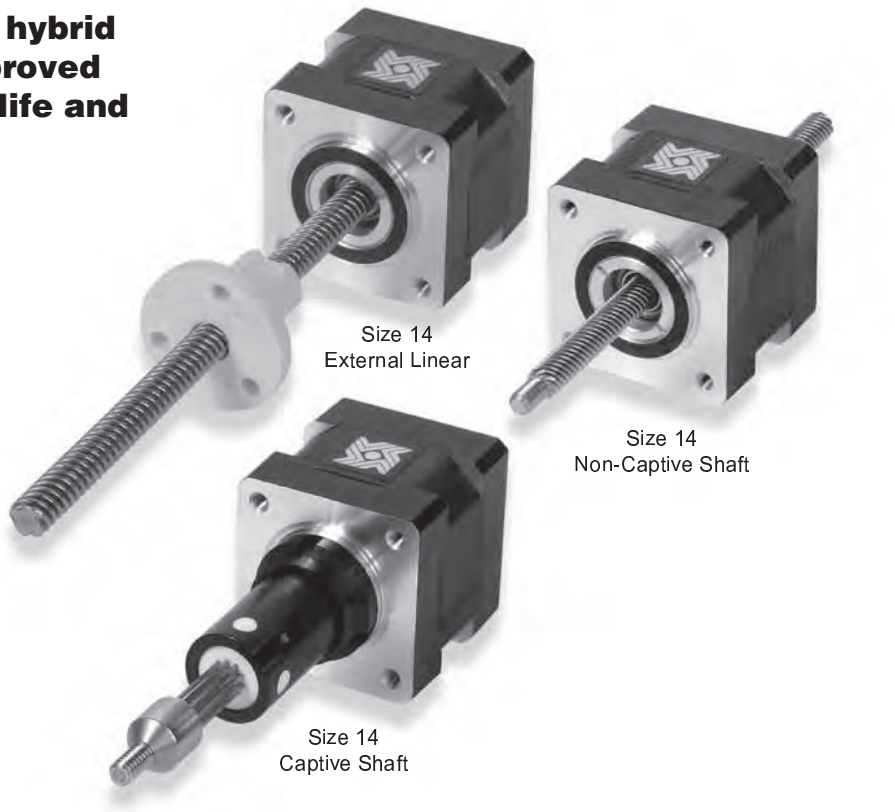
NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

Haydon™ 35000 Series Size 14 hybrid linear actuators have been improved to provide higher force, longer life and improved performance.

The various designs deliver exceptional performance and new linear motion design opportunities. Three designs are available, captive, non-captive and external linear versions. The 35000 Series is available in a wide variety of resolutions - from 0.00012-in (.003048 mm) per step to 0.00192-in (.048768 mm) per step. The motors can also be microstepped for even finer resolutions. The Size 14 actuator delivers thrust of up to 50 lbs. (222 N).



Size 14
External Linear

Size 14
Non-Captive Shaft

Size 14
Captive Shaft

Salient Characteristics

Size 14: 35 mm (1.4-in) Hybrid Linear Actuator (1.8° Step Angle)						
Part No.	Captive	35H4(X)-V			35H6(X)-V	
	Non-captive	35F4(X)-V			35F6(X)-V	
	External Lin.	E35H4(X)-V			E35H6(X)-V	
Wiring		Bipolar			Unipolar**	
Winding voltage		2.33 VDC	5 VDC	12 VDC	5 VDC	12 VDC
Current/phase		1.25 A	0.57 A	0.24 A	0.57 A	0.24 A
Resistance/phase		1.86 Ω	8.8 Ω	50.5 Ω	8.8 Ω	50.5 Ω
Inductance/phase		2.8 mH	13 mH	60 mH	6.5 mH	30 mH
Power consumption		5.7 W				
Rotor inertia		27.0 gcm^2				
Temperature rise		135°F Rise (75°C Rise)				
Weight		5.7 oz (162 g)				
Insulation resistance		20 MΩ				

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

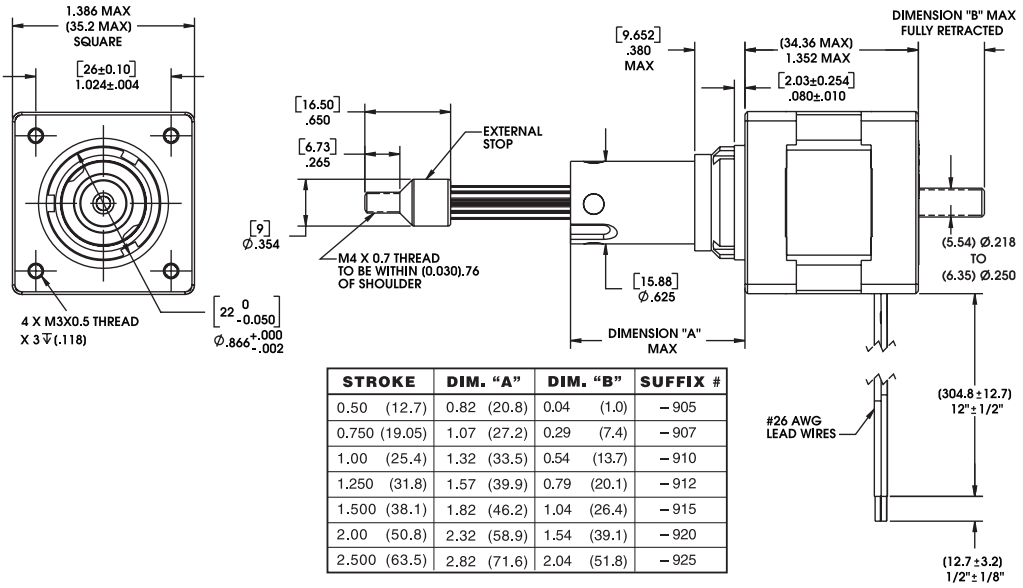
Linear Travel / Step					
Screw Ø .218" (5.54 mm)		**Order Code I.D.**	Screw Ø .250" (6.35 mm)		**Order Code I.D.**
inches	mm		inches	mm	
.00012	.0030*	N	.00015625	.0039*	P
.00024	.0060*	K	.0003125	.0079*	A
.00048	.0121*	J	.000625	.0158*	B
.00096	.0243*	Q	.00125	.0317*	C
.00192	.0487*	R			

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

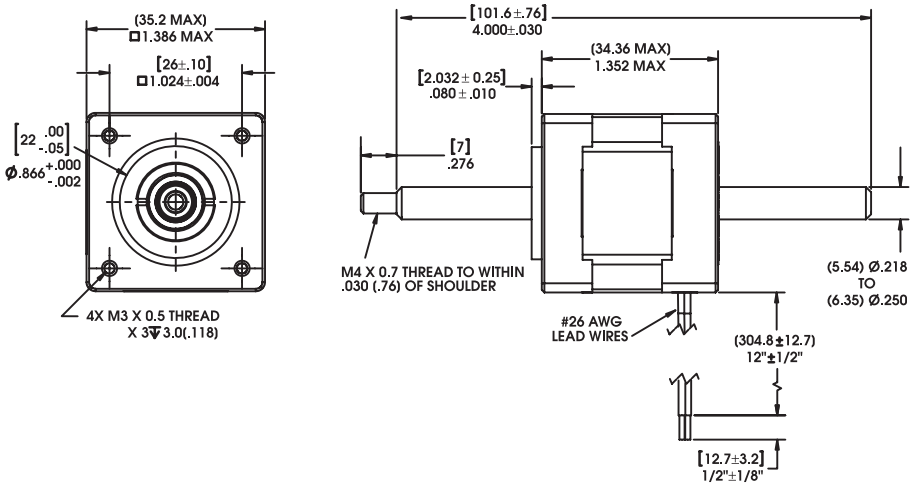
Captive Leadscrew



STROKE	DIM. "A"	DIM. "B"	SUFFIX #
0.50 (12.7)	0.82 (20.8)	0.04 (1.0)	–905
0.750 (19.05)	1.07 (27.2)	0.29 (7.4)	–907
1.00 (25.4)	1.32 (33.5)	0.54 (13.7)	–910
1.250 (31.8)	1.57 (39.9)	0.79 (20.1)	–912
1.500 (38.1)	1.82 (46.2)	1.04 (26.4)	–915
2.00 (50.8)	2.32 (58.9)	1.54 (39.1)	–920
2.500 (63.5)	2.82 (71.6)	2.04 (51.8)	–925

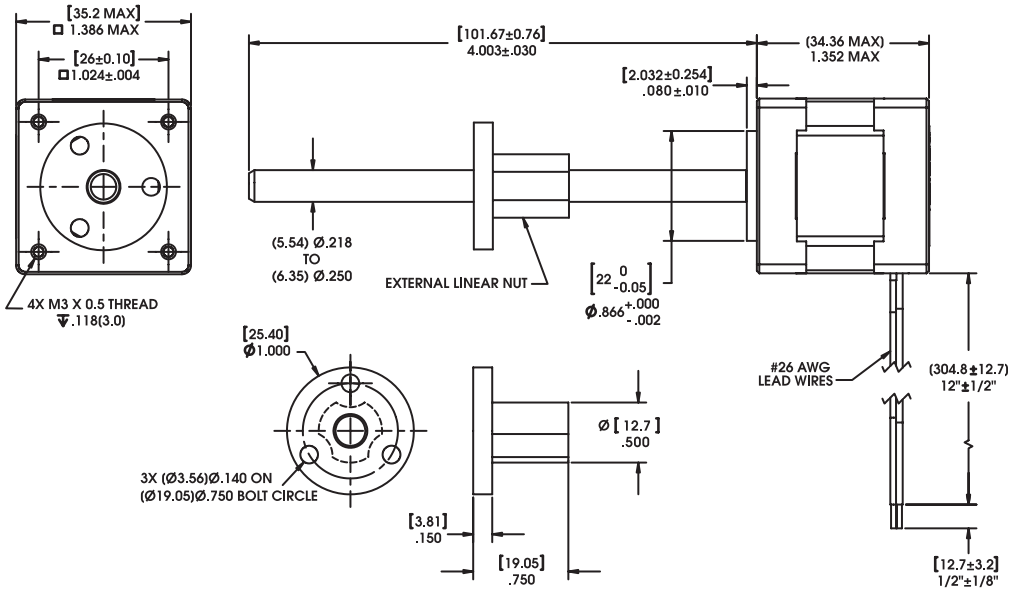
Integrated connector option, see page 115

Non-Captive Leadscrew



Integrated connector option, see page 115

External Linear

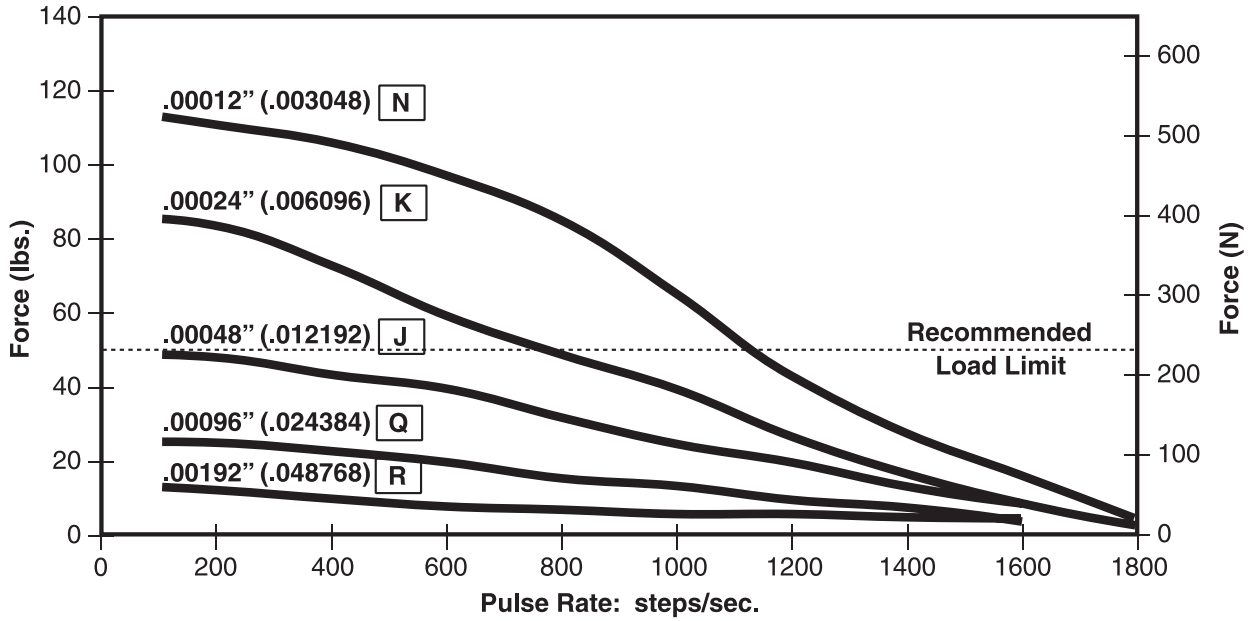


Integrated connector option, see page 115

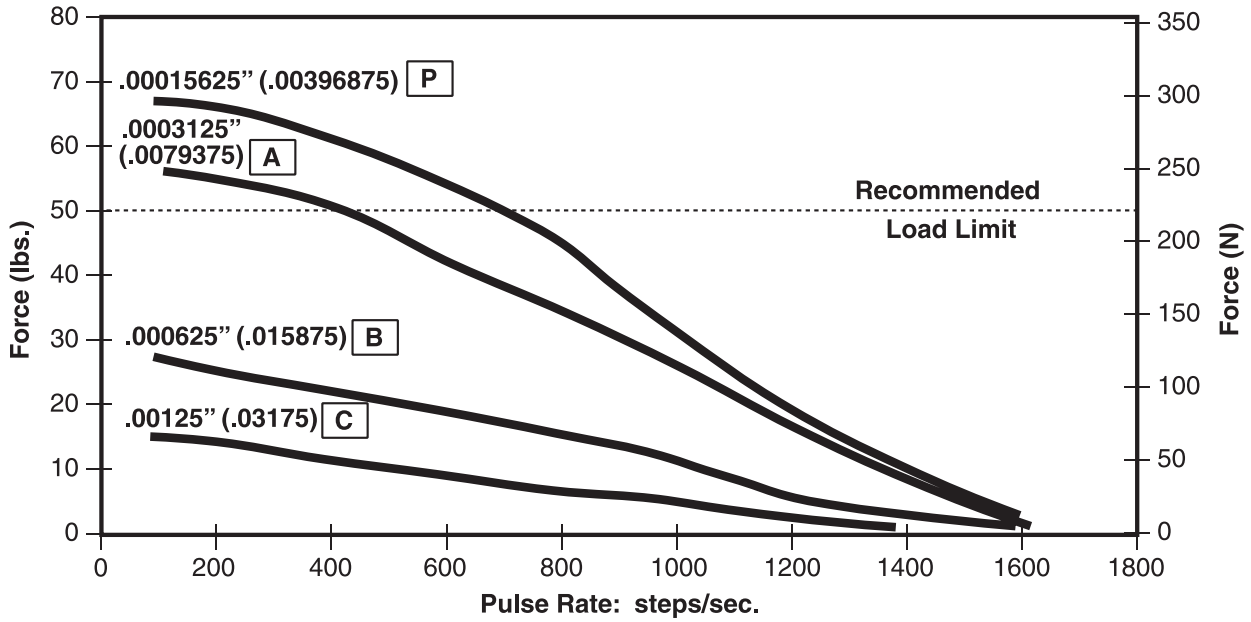
FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

Ø .218 (5.54) Leadscrew



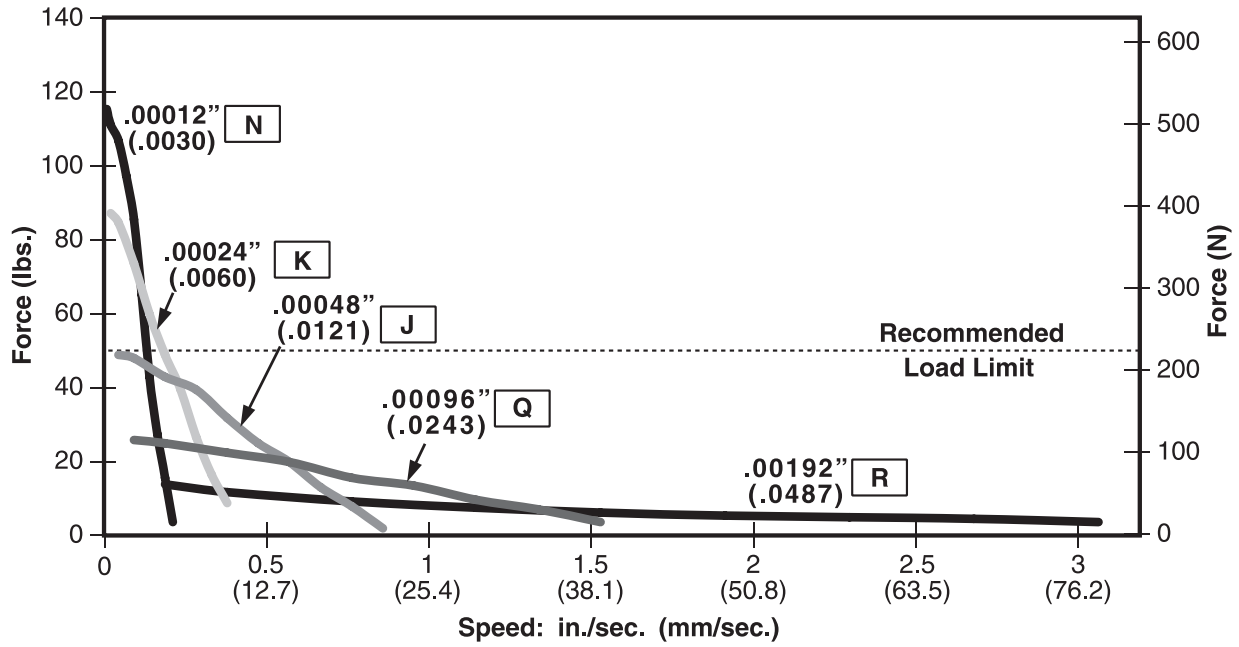
Ø .250 (6.35) Leadscrew



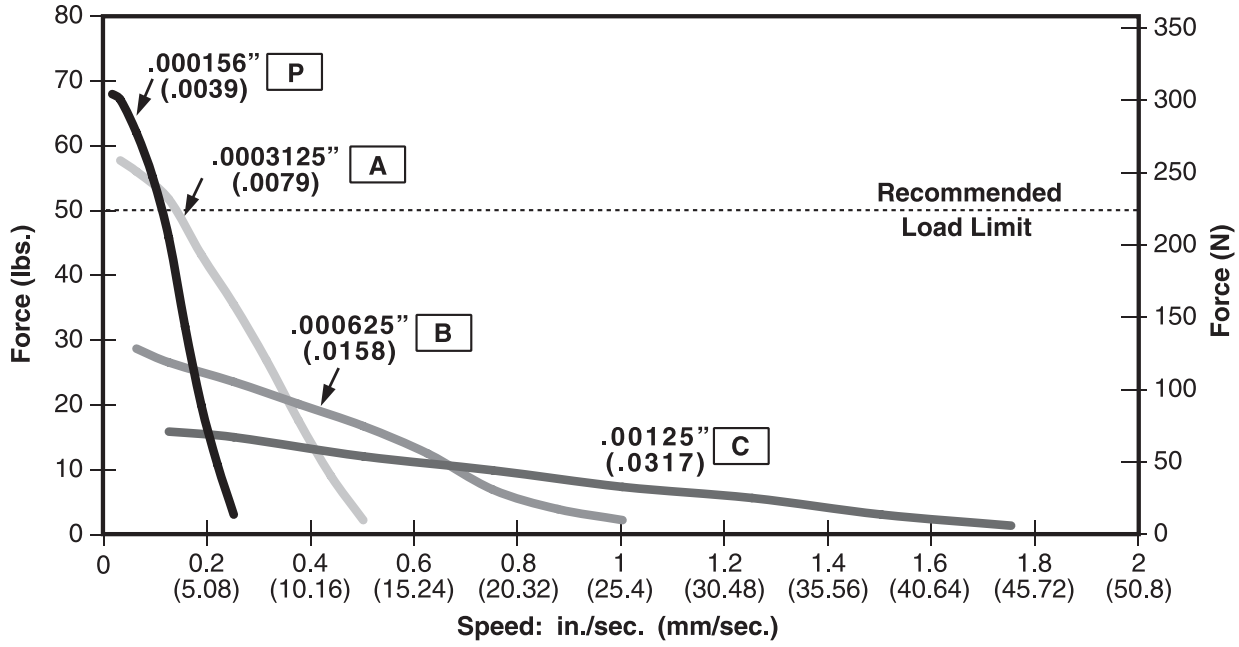
FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

Ø .218 (5.54) Leadscrew



Ø .250 (6.35) Leadscrew



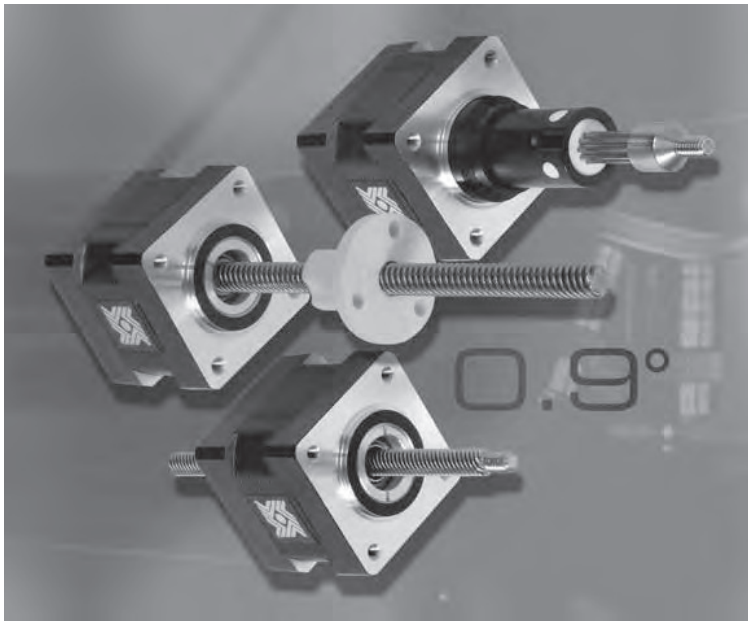
NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

Precision step movement down to 1.5 micron with up to 50 lbs (222 N) force.

The Haydon™ 35000 Series Size 14, 0.9° high resolution (standard resolution = 1.8°) motor has been engineered to precisely deliver reliable high speed, force, up to 50 lbs (222 N), as well as a full step movement as low as 1.5 microns. These compact units provide a cost effective solution for engineers requiring positional accuracy and high speed linear travel. Haydon can custom design this motor for virtually any customer specific application.



Salient Characteristics

Size 14: 35 mm (1.4-in) Hybrid Linear Actuator (0.9° Step Angle)						
Part No.	Captive	35K4(X)-V			35K6(X)-V	
	Non-captive	35J4(X)-V			35J6(X)-V	
	External Lin.	E35K4(X)-V			E35K6(X)-V	
Wiring		Bipolar			Unipolar**	
Winding voltage		2.33 VDC	5 VDC	12 VDC	5 VDC	12 VDC
Current/phase		1.25 A	0.57 A	0.24 A	0.57 A	0.24 A
Resistance/phase		1.86 Ω	8.8 Ω	50.5 Ω	8.8 Ω	50.5 Ω
Inductance/phase		2.8 mH	13 mH	60 mH	6.5 mH	30 mH
Power consumption		5.7 W				
Rotor inertia		27 gcm^2				
Temperature rise		135°F Rise (75°C Rise)				
Weight		5.7 oz (162 g)				
Insulation resistance		20 MΩ				

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

Linear Travel / Step					
Screw Ø .218" (5.54 mm) inches	mm	**Order Code I.D.**	Screw Ø .250" (6.35 mm) inches	mm	**Order Code I.D.**
.00006	.0015*	U	.000078*	.00198*	V
.00012	.0030*	N	.00015625	.0039*	P
.00024	.0060*	K	.0003125	.0079*	A
.00048	.0121*	J	.000625	.0158*	B
.00096	.0243*	Q			

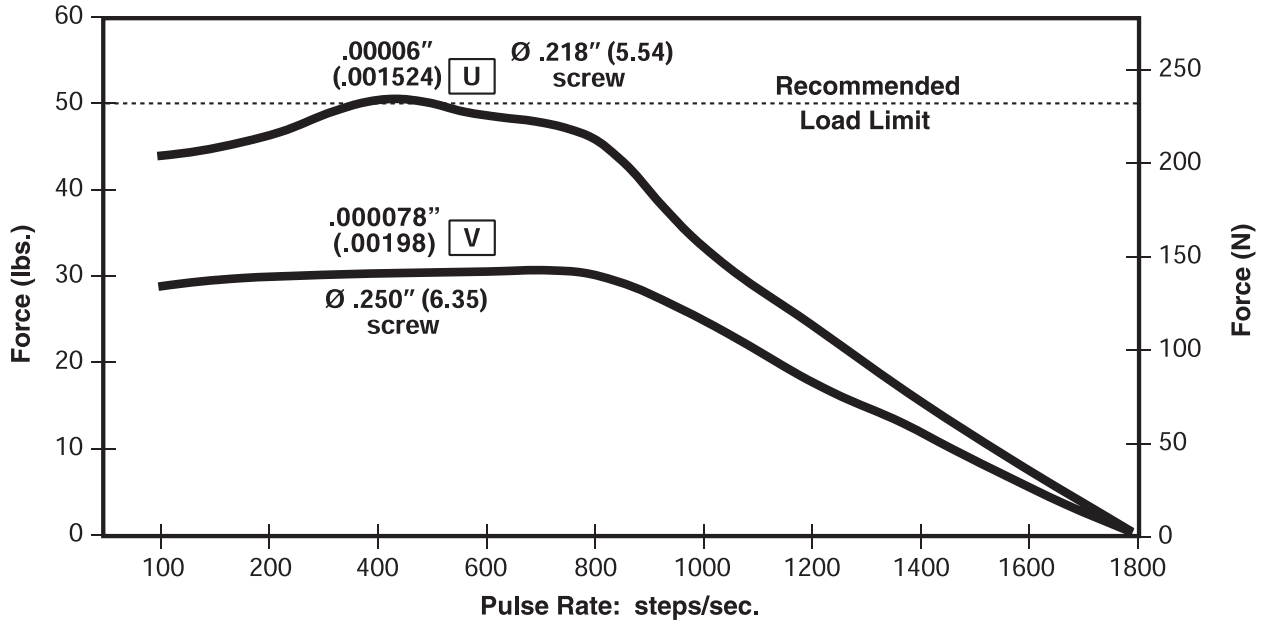
*Values truncated

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

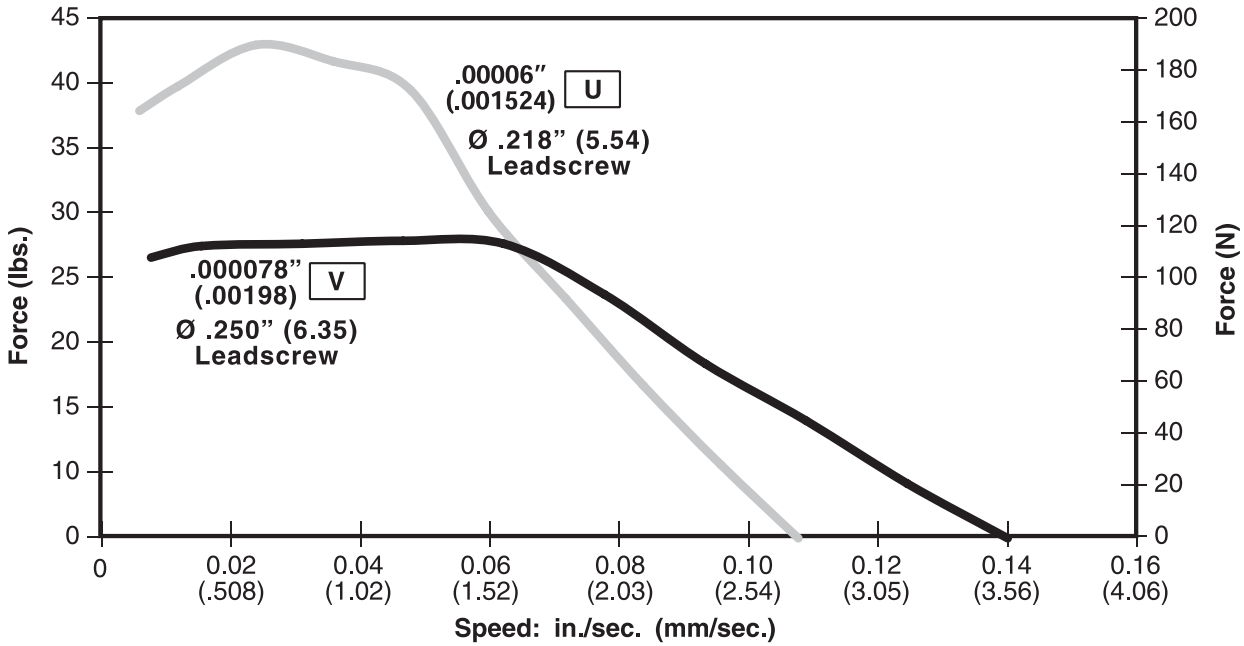
Ø .218 (5.54) and Ø .250 (6.35) Leadscrews



FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

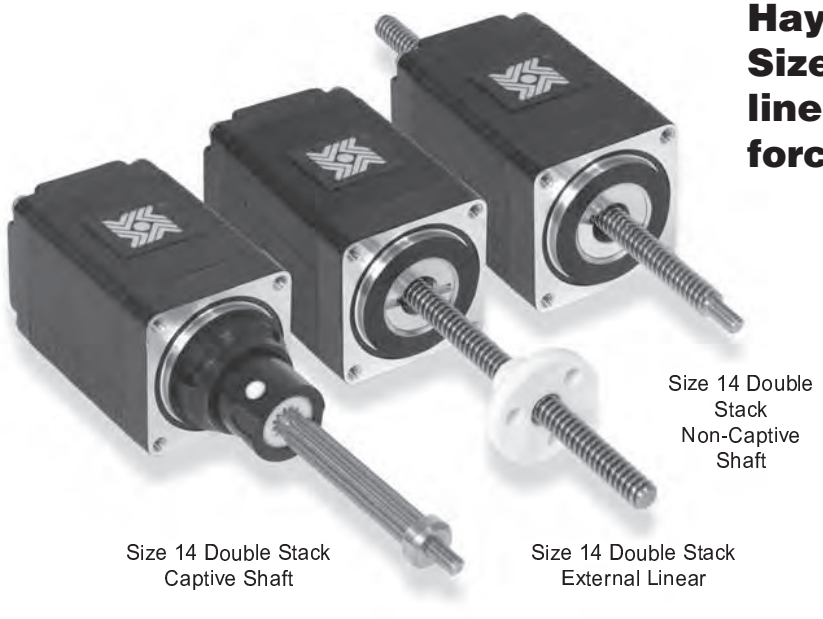
Ø .218 (5.54) and Ø .250 (6.35) Leadscrews



NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.



Size 14 Double Stack Non-Captive Shaft

Size 14 Double Stack Captive Shaft

Size 14 Double Stack External Linear

Haydon™ 35000 Series Size 14 Double Stack hybrid linear actuators have improve force and performance.

The Size 14 Double Stack designs deliver exceptional performance and new linear motion design opportunities.

Three designs are available, captive, non-captive and external linear versions. The 35000 Series is available in a wide variety of resolutions - from 0.000625-in (.0158 mm) per step to 0.005-in (.127 mm) per step. The motors can also be microstepped for even finer resolutions. The Size 14 actuator delivers thrust of up to 50 lbs. (222 N).

Salient Characteristics

Size 14: 3 mm (1.4-in) Double Stack Hybrid Linear Actuator (1.8° Step Angle)				
Part No.	Captive	35M4(X)-V		
	Non-captive	35L4(X)-V		
	External Lin.	E35M4(X)-V		
Wiring		Bipolar		
Winding voltage		2.33 VDC	5 VDC	12 VDC
Current/phase		2 A	910 mA	380 mA
Resistance/phase		1.2 Ω	5.5 Ω	31.6 Ω
Inductance/phase		1.95 mH	7.63 mH	65.1 mH
Power consumption		9.1 W Total		
Temperature rise		135°F Rise (75°C Rise)		
Weight		8.5 oz (240 g)		
Insulation resistance		20 MΩ		
Max. Load Limit		50 lbs (222 N)		

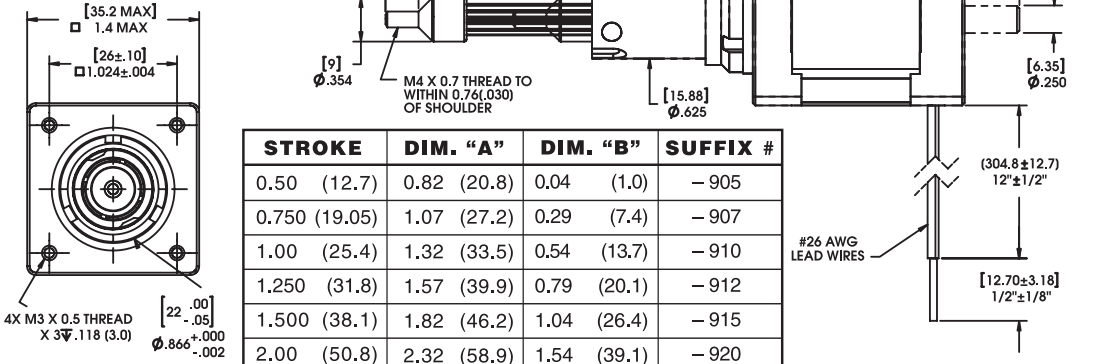
Linear Travel / Step Screw Ø.250" (6.35 mm) inches	mm	**Order Code I.D.**
.000625	.0158*	B
.00125	.0317*	C
.0025	.0635	Y
.00375	.0953	AG
.005	.127	Z

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

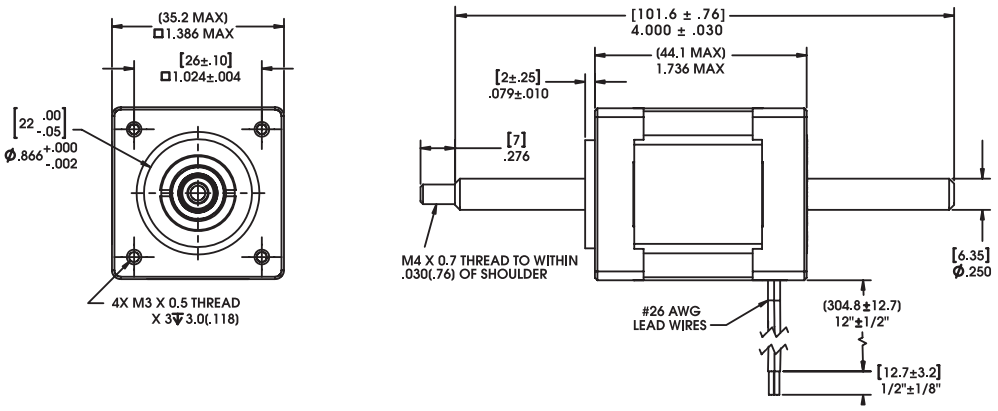
Captive Leadscrew



STROKE	DIM. "A"	DIM. "B"	SUFFIX #
0.50 (12.7)	0.82 (20.8)	0.04 (1.0)	– 905
0.750 (19.05)	1.07 (27.2)	0.29 (7.4)	– 907
1.00 (25.4)	1.32 (33.5)	0.54 (13.7)	– 910
1.250 (31.8)	1.57 (39.9)	0.79 (20.1)	– 912
1.500 (38.1)	1.82 (46.2)	1.04 (26.4)	– 915
2.00 (50.8)	2.32 (58.9)	1.54 (39.1)	– 920
2.500 (63.5)	2.82 (71.6)	2.04 (51.8)	– 925

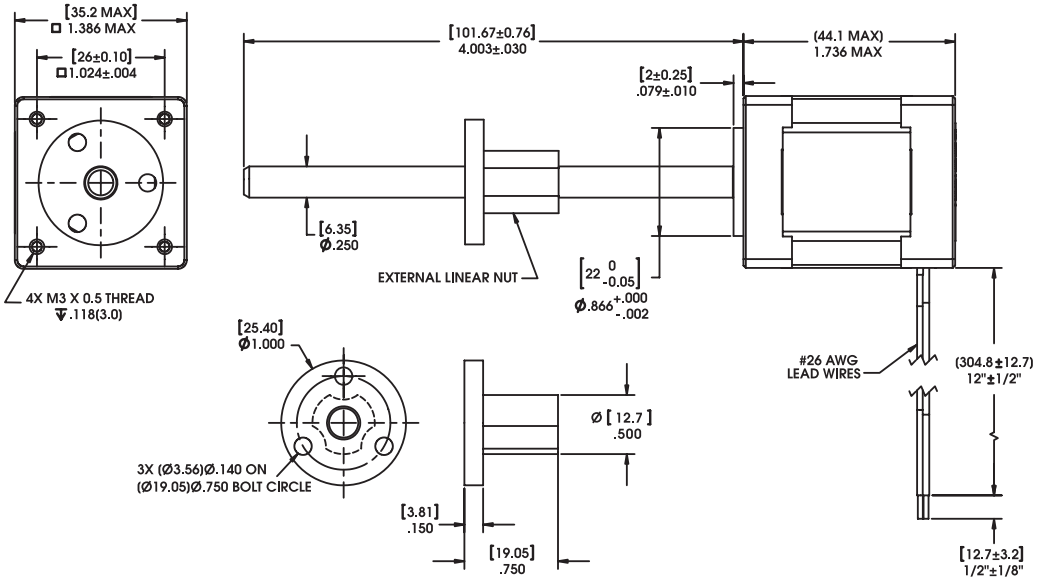
Integrated connector option, see page 115

Non-Captive Leadscrew



Integrated connector option, see page 115

External Linear

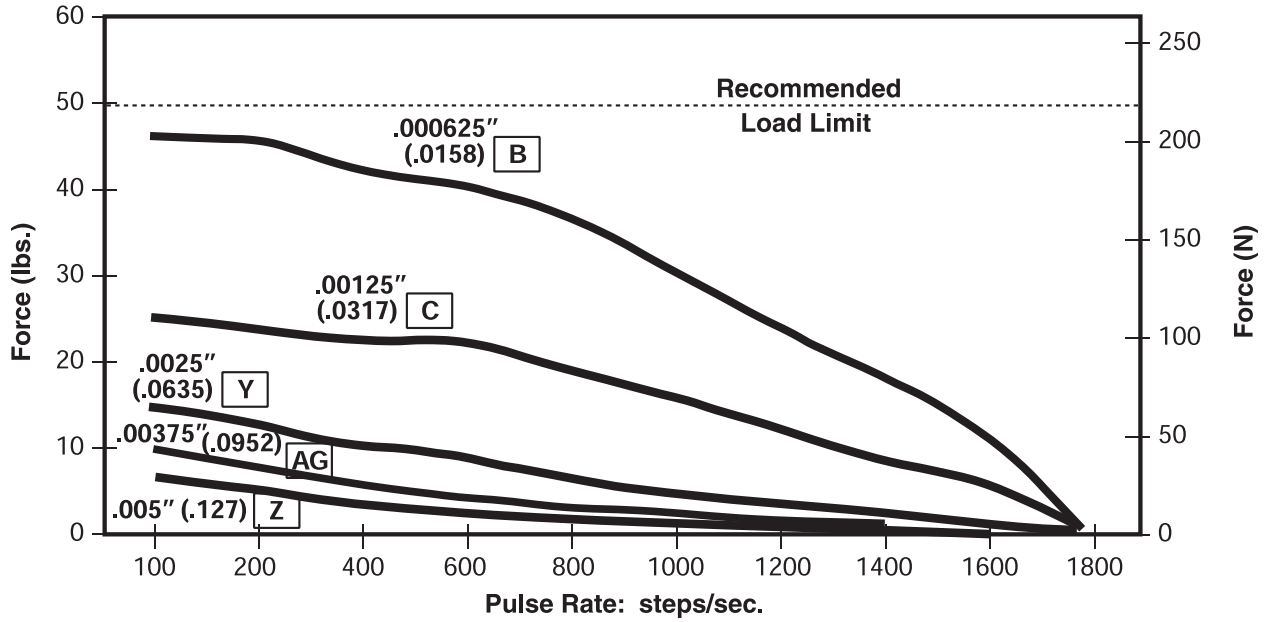


Integrated connector option, see page 115

FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

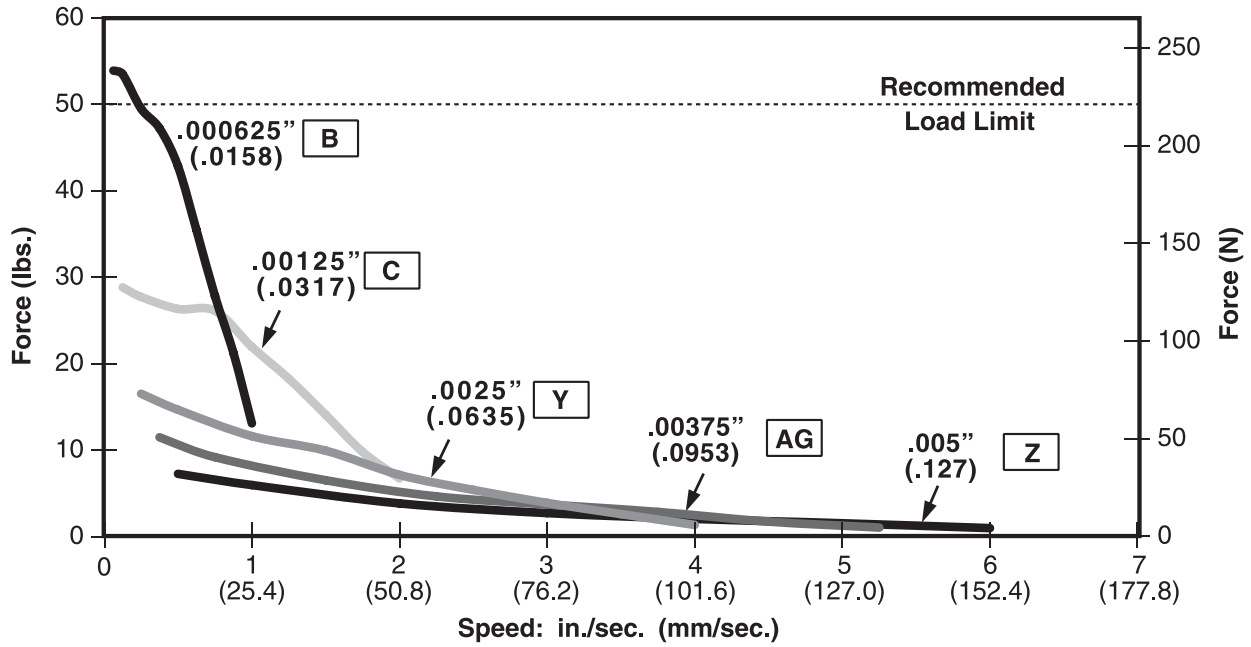
Ø .250 (6.35) Leadscrew



FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

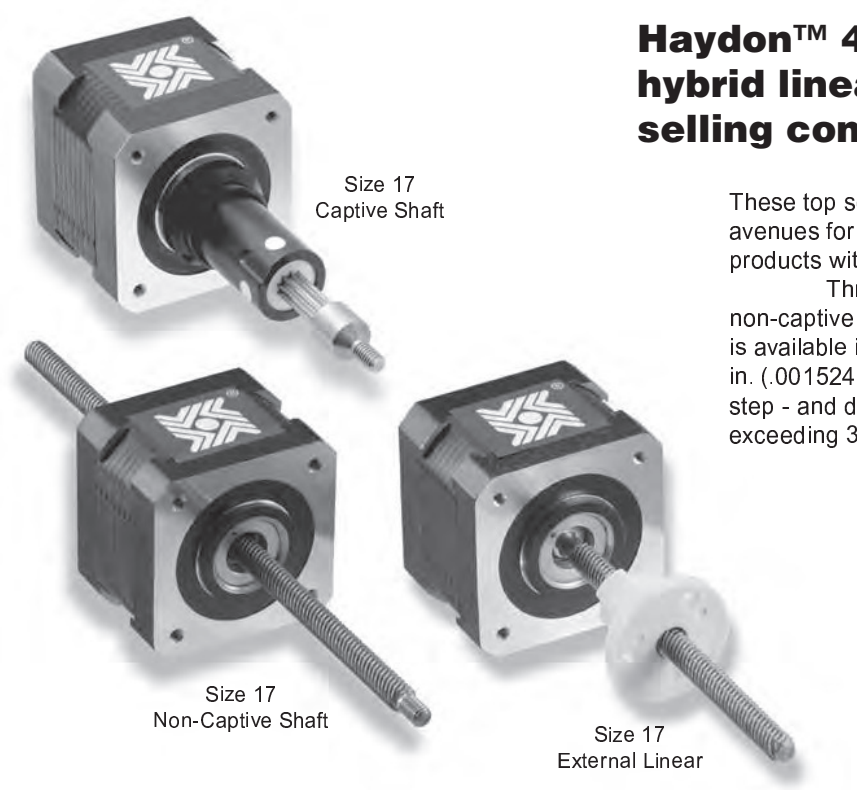
Ø .250 (6.35) Leadscrew



NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.



Haydon™ 43000 Series Size 17 hybrid linear actuators are our best selling compact hybrid motors.

These top selling designs deliver high performance, opening avenues for equipment designers who previously settled for products with inferior performance and endurance.

Three designs are available, captive, non-captive and external linear versions. The 43000 Series is available in a wide variety of resolutions - from 0.00006-in. (.001524 mm) per step to 0.00192-in. (.048768 mm) per step - and delivers thrust of up to 50 lbs. (222 N), or speeds exceeding 3 inches (7.62 cm) per second.

Salient Characteristics

Size 17: 43 mm (1.7-in) Hybrid Linear Actuator (1.8° Step Angle)						
Part No.	Captive	43H4(X)-V			43H6(X)-V	
	Non-captive	43F4(X)-V			43F6(X)-V	
	External Lin.	E43H4(X)-V			E43H6(X)-V	
Wiring		Bipolar			Unipolar**	
Winding voltage		2.33 VDC	5 VDC	12 VDC	5 VDC	12 VDC
Current/phase		1.5 A	700 mA	290 mA	700 mA	290 mA
Resistance/phase		1.56 Ω	7.2 Ω	41.5 Ω	7.2 Ω	41.5 Ω
Inductance/phase		1.9 mH	8.7 mH	54.0 mH	4.4 mH	27.0 mH
Power consumption		7 W				
Rotor inertia		37 gcm^2				
Temperature rise		135°F Rise (75°C Rise)				
Weight		8.5 oz (241 g)				
Insulation resistance		20 MΩ				

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

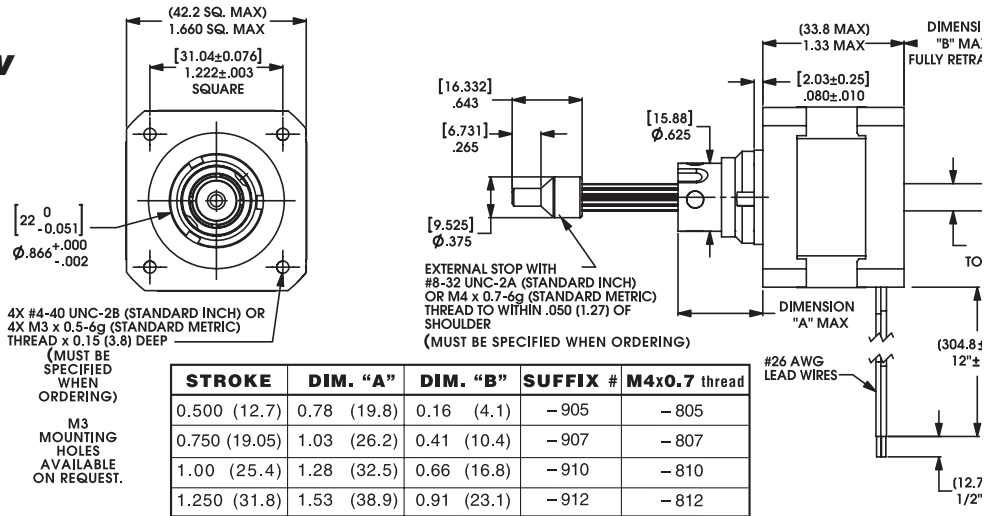
Linear Travel / Step					
Screw Ø .218" (5.54 mm) inches	mm	**Order Code I.D.**	Screw Ø .250" (6.35 mm) inches	mm	**Order Code I.D.**
.00012	.0030*	N	.00015625	.0039*	P
.00024	.0060*	K	.0003125	.0079*	A
.00048	.0121*	J	.000625	.0158*	B
.00096	.0243*	Q	.00125	.0317*	C
.00192	.0487*	R			

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C. Also available, motors with high temperature capability windings up to 155°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

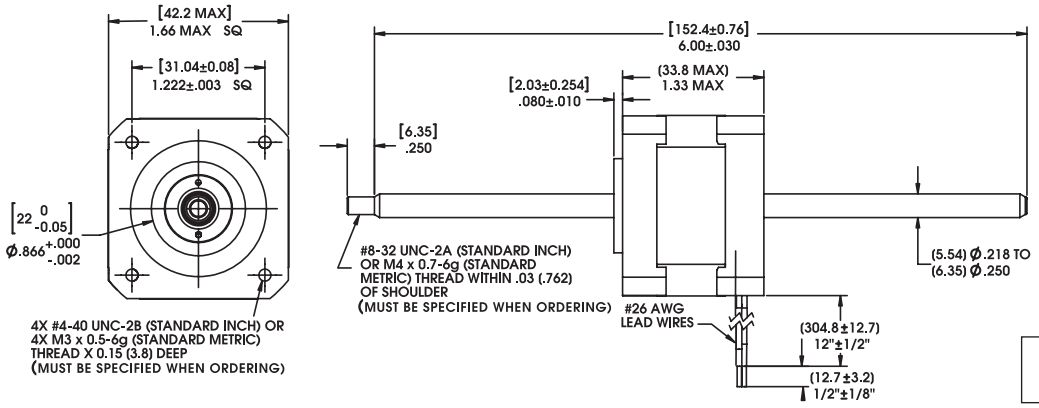
Captive Leadscrew



STROKE	DIM. "A"	DIM. "B"	SUFFIX #	M4x0.7 thread
0.500 (12.7)	0.78 (19.8)	0.16 (4.1)	–905	–805
0.750 (19.05)	1.03 (26.2)	0.41 (10.4)	–907	–807
1.00 (25.4)	1.28 (32.5)	0.66 (16.8)	–910	–810
1.250 (31.8)	1.53 (38.9)	0.91 (23.1)	–912	–812
1.500 (38.1)	1.78 (45.2)	1.16 (29.5)	–915	–815
2.00 (50.8)	2.28 (57.9)	1.66 (42.2)	–920	–820
2.500 (63.5)	2.78 (70.6)	2.16 (54.9)	–925	–825

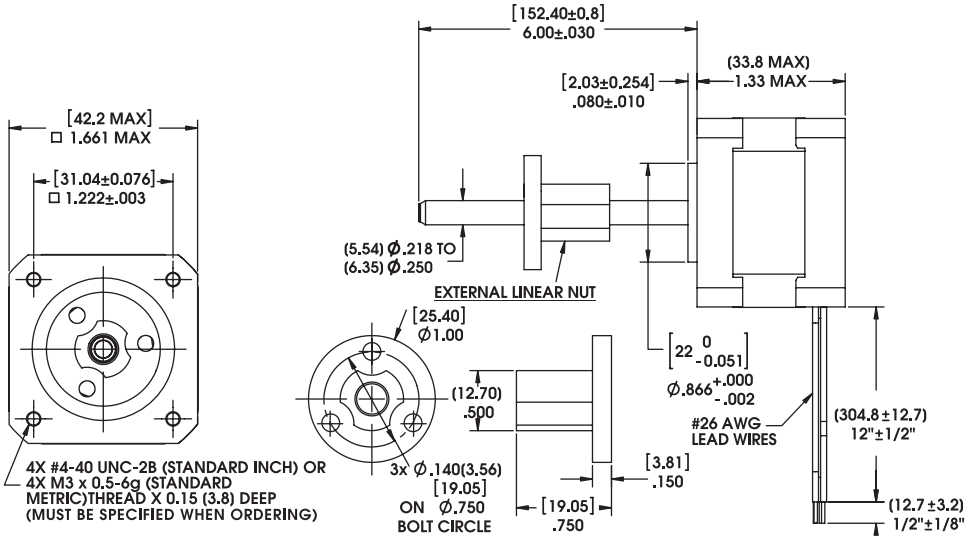
Integrated connector option, see page 115

Non-Captive Leadscrew



Integrated connector option, see page 115

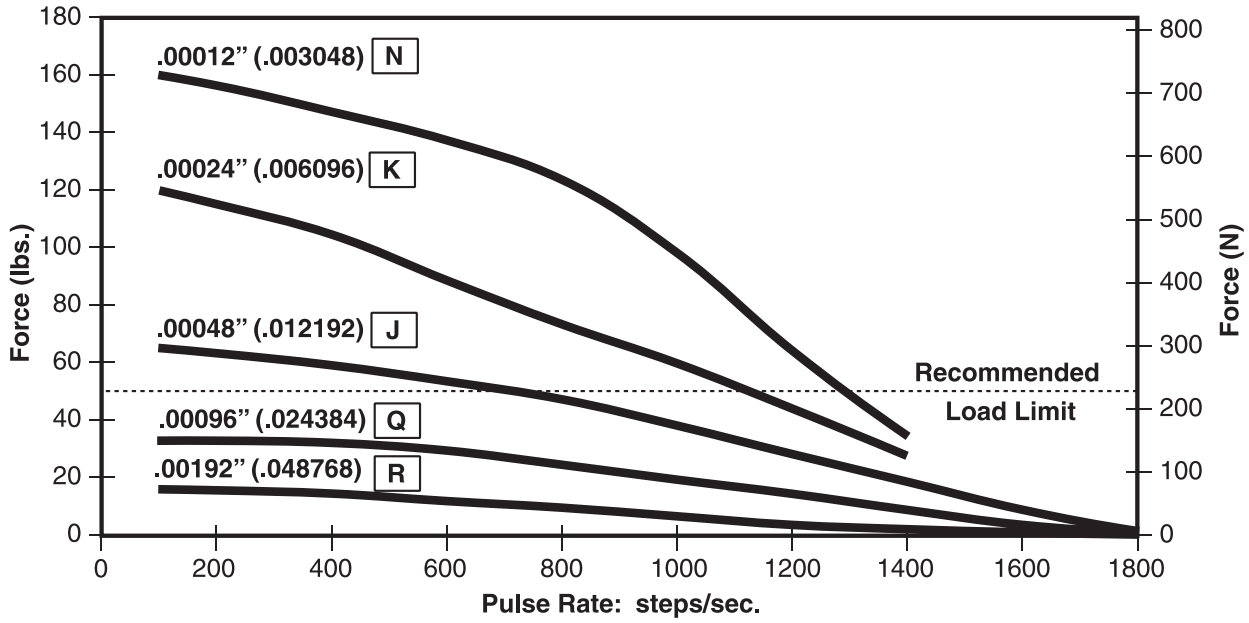
External Linear



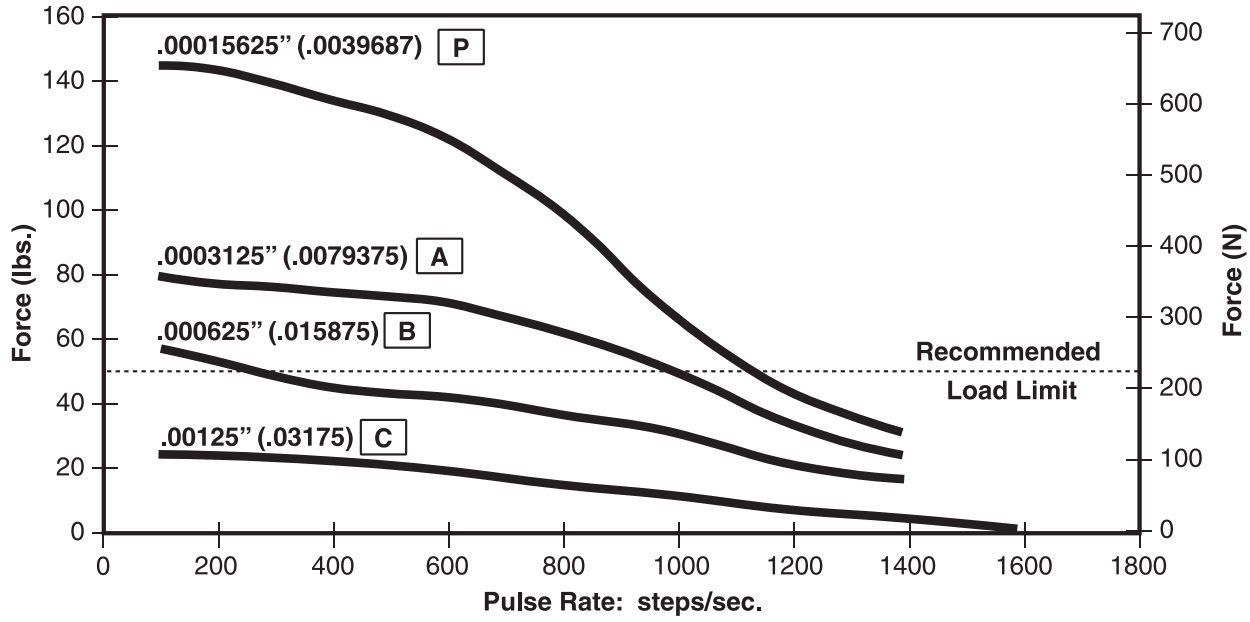
Integrated connector option, see page 115

FORCE vs. PULSE RATE Bipolar • Chopper • 100% Duty Cycle

Ø .218 (5.54) Leadscrew



Ø .250 (6.35) Leadscrew



NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

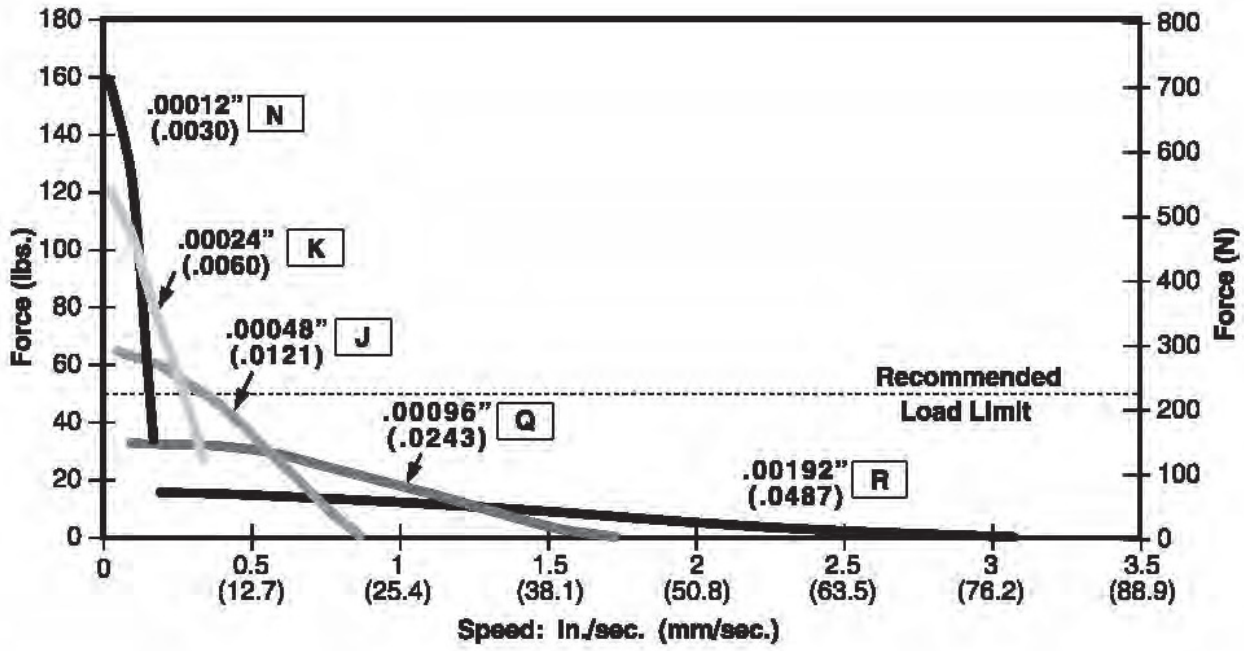
Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

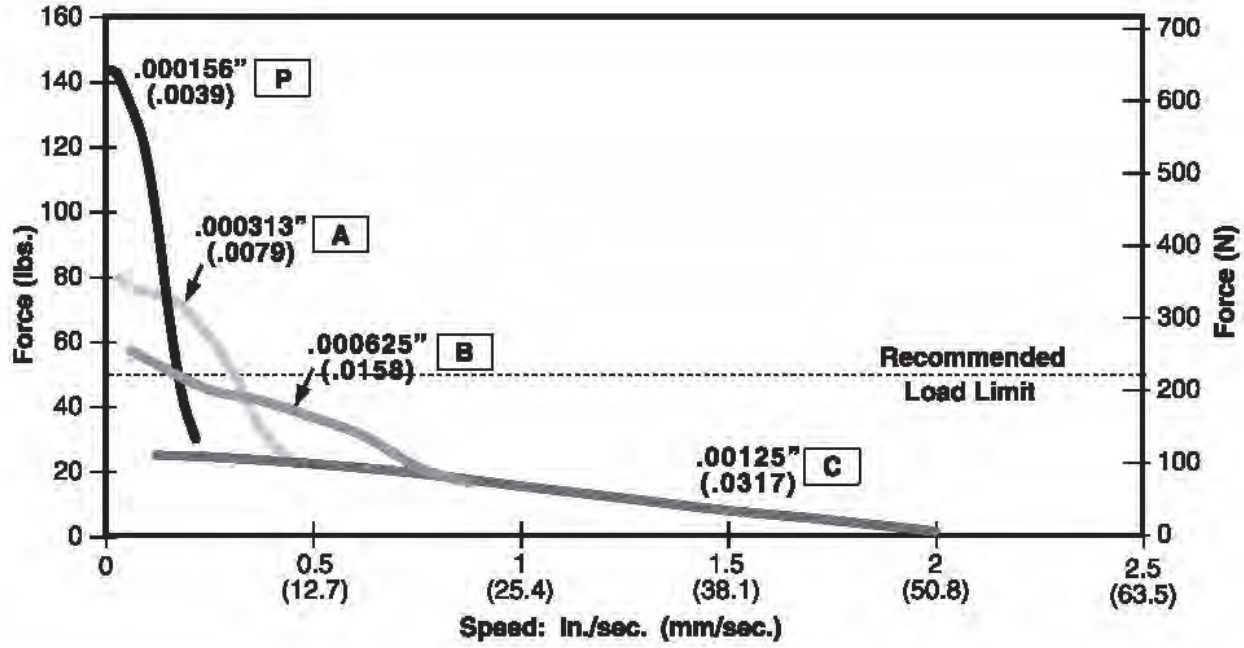
FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

Ø .218 (5.54) Leadscrew



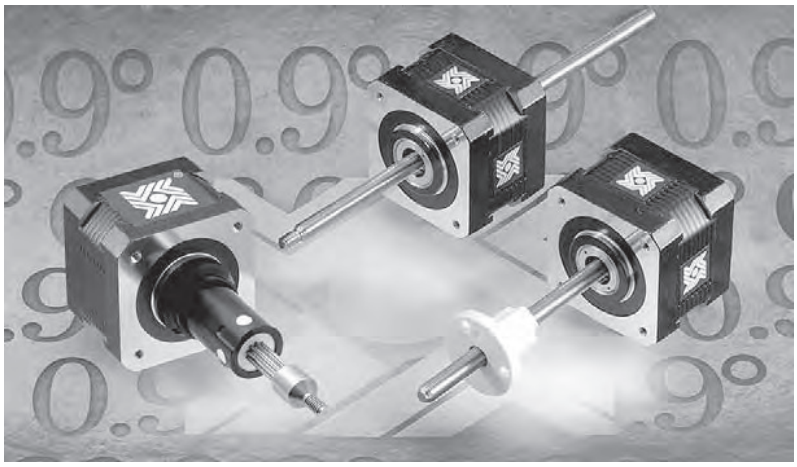
Ø .250 (6.35) Leadscrew



NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.



Haydon™ 43000 Series Size 17, 0.9° high resolution hybrid motor has been specially engineered to deliver high speed, force and endurance.

The Size 17 High Resolution Actuator features a production-proven, patented rotor drive nut that delivers trouble-free, long-term performance.

Combined with a stainless steel lead-screw, the motor delivers an extremely smooth, precise motion.

Designed for applications that require long-life reliability, precise positioning and rapid motion.

Salient Characteristics

Size 17: 43 mm (1.7-in) Hybrid Linear Actuator (0.9° Step Angle)						
Part No.	Captive	43K4(X)-V			43K6(X)-V	
	Non-captive	43J4(X)-V			43J6(X)-V	
	External Lin.	E43K4(X)-V			E43K6(X)-V	
Wiring		Bipolar			Unipolar**	
Winding voltage		2.33 VDC	5 VDC	12 VDC	5 VDC	12 VDC
Current/phase RMS		1.5 A	700 mA	290 mA	700 mA	290 mA
Resistance/phase		1.56 Ω	7.2 Ω	41.5 Ω	7.2 Ω	41.5 Ω
Inductance/phase		2.6 mH	12.0 mH	70.0 mH	6.0 mH	35.0 mH
Power consumption		7 W				
Rotor inertia		37 gcm^2				
Temperature rise		135°F Rise (75°C Rise)				
Weight		8.5 oz (241 g)				
Insulation resistance		20 MΩ				

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

Linear Travel / Step					
Screw Ø .218" (5.54 mm) inches	mm	**Order Code I.D.**	Screw Ø .250" (6.35 mm) inches	mm	**Order Code I.D.**
.00006	.0015*	U	.000078*	.00198*	V
.00012	.0030*	N	.00015625	.0039*	P
.00024	.0060*	K	.0003125	.0079*	A
.00048	.0121*	J	.000625	.0158*	B
.00096	.0243*	Q			

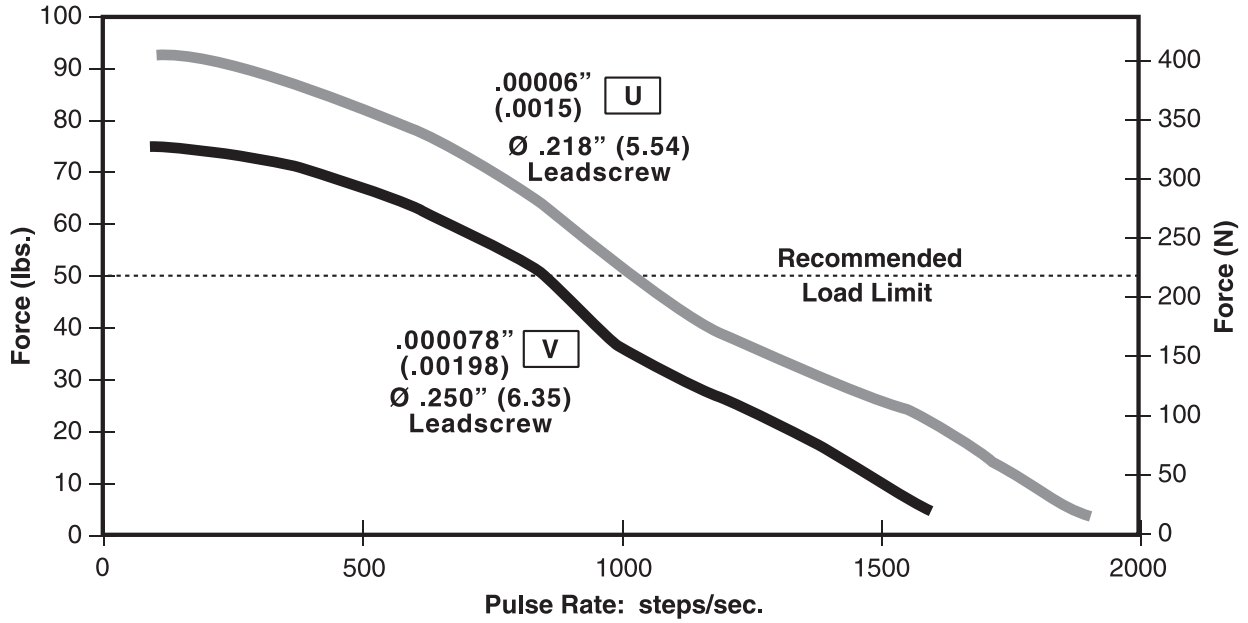
*Values truncated

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

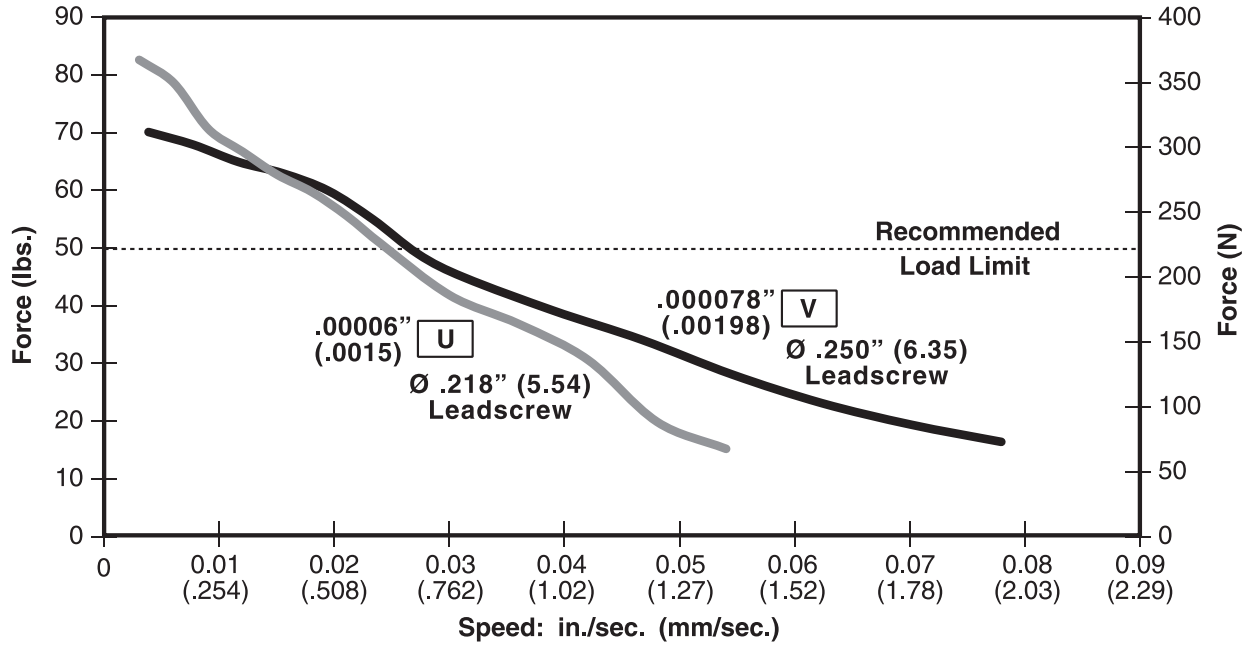
Ø .218 (5.54) and Ø .250 (6.35) Leadscrews



FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

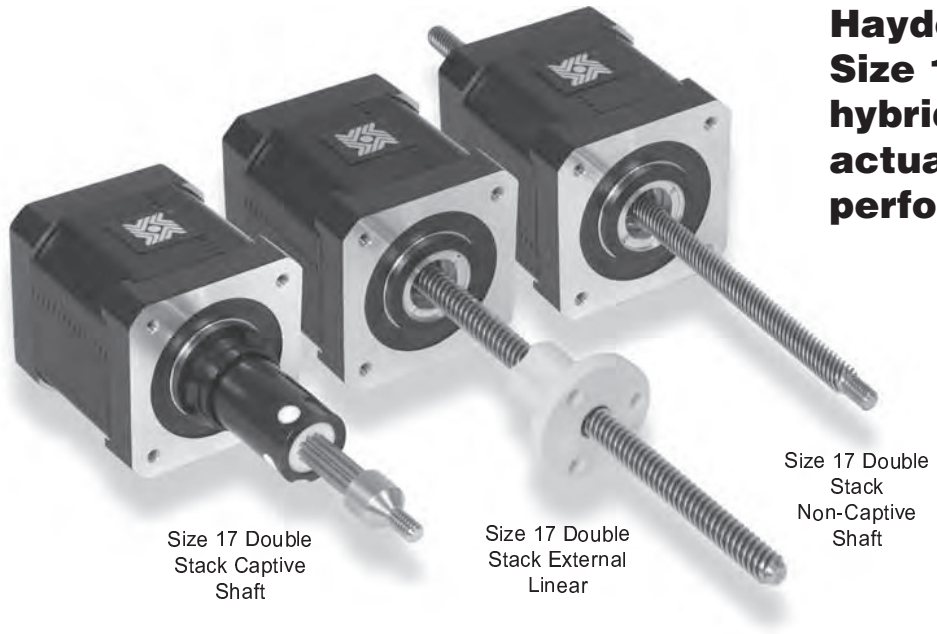
Ø .218 (5.54) and Ø .250 (6.35) Leadscrews



NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.



Size 17 Double Stack Captive Shaft

Size 17 Double Stack External Linear

Size 17 Double Stack Non-Captive Shaft

Haydon™ 43000 Series Size 17 Double Stack hybrid linear actuators offer greater performance.

The versatile designs deliver exceptional performance and new linear motion design opportunities.

Three designs are available, captive, non-captive and external linear versions. The 43000 Series is available in a wide variety of resolutions - from 0.000625-in (.0158 mm) per step to 0.005-in (.127 mm) per step. The motors can also be microstepped for even finer resolutions. The Size 17 Double Stack actuator delivers thrust of up to 75 lbs. (337 N).

Salient Characteristics

Size 17: 43 mm (1.7-in) Double Stack Hybrid Linear Actuator (1.8° Step Angle)				
Part No.	Captive	43M4(X)-V		
	Non-captive	43L4(X)-V		
	External Lin.	E43M4(X)-V		
Wiring		Bipolar		
Winding voltage		2.33 VDC	5 VDC	12 VDC
Current/phase		2.6 A	1.3 A	550 mA
Resistance/phase		0.9 Ω	3.8 Ω	21.9 Ω
Inductance/phase		1.33 mH	8.21 mH	45.1 mH
Power consumption		10.4 W Total		
Temperature rise		135°F Rise (75°C Rise)		
Weight		12.5 oz (352 g)		
Insulation resistance		20 MΩ		
Max. Load Limit		75 lbs (337 N)		

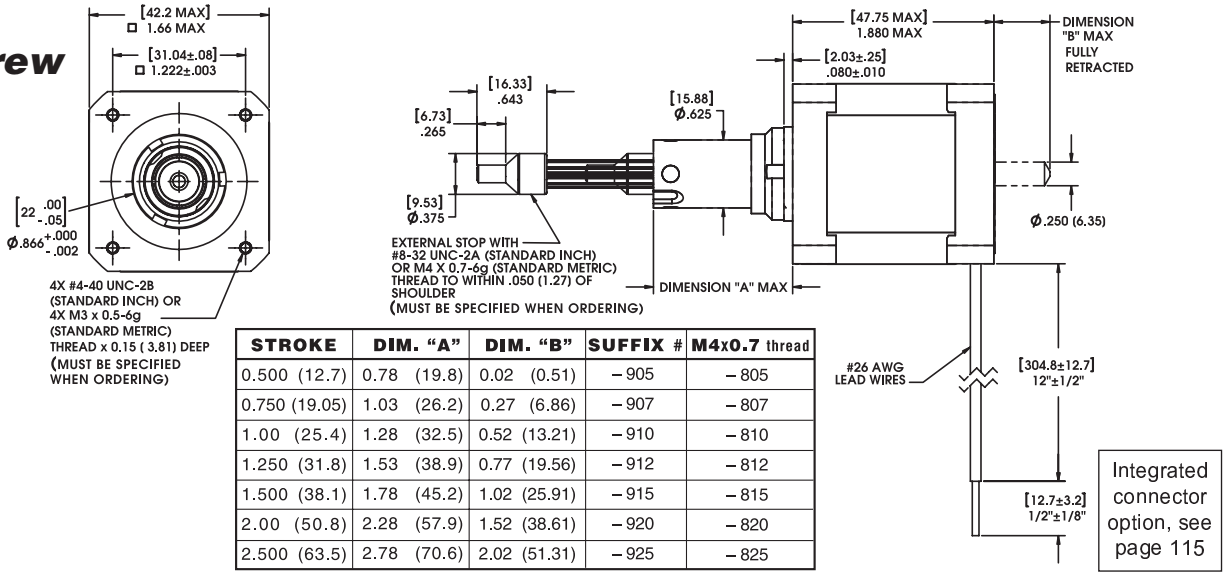
Linear Travel / Step Screw Ø.250" (6.35 mm) inches	mm	**Order Code I.D.**
.000625	.0158*	B
.00125	.0317*	C
.0025	.0635	Y
.00375	.0953	AG
.005	.127	Z

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

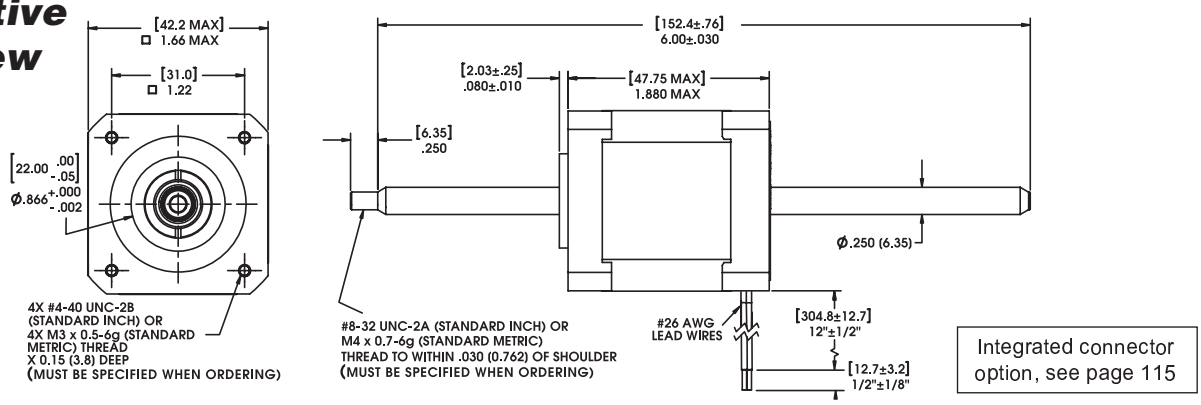
Captive Leadscrew



STROKE	DIM. "A"	DIM. "B"	SUFFIX #	M4x0.7 thread
0.500 (12.7)	0.78 (19.8)	0.02 (0.51)	– 905	– 805
0.750 (19.05)	1.03 (26.2)	0.27 (6.86)	– 907	– 807
1.00 (25.4)	1.28 (32.5)	0.52 (13.21)	– 910	– 810
1.250 (31.8)	1.53 (38.9)	0.77 (19.56)	– 912	– 812
1.500 (38.1)	1.78 (45.2)	1.02 (25.91)	– 915	– 815
2.00 (50.8)	2.28 (57.9)	1.52 (38.61)	– 920	– 820
2.500 (63.5)	2.78 (70.6)	2.02 (51.31)	– 925	– 825

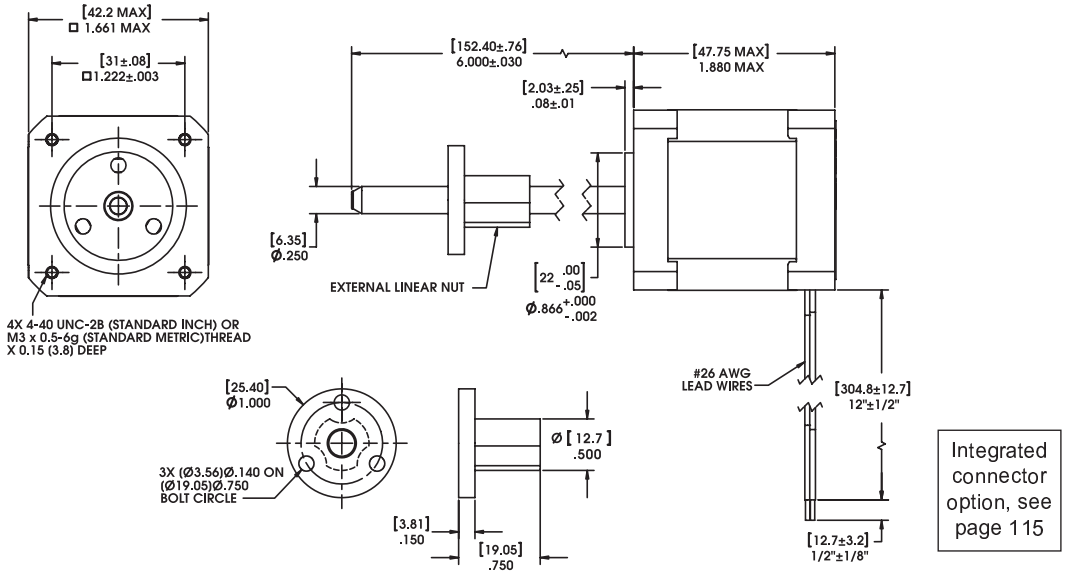
Integrated connector option, see page 115

Non-Captive Leadscrew



Integrated connector option, see page 115

External Linear

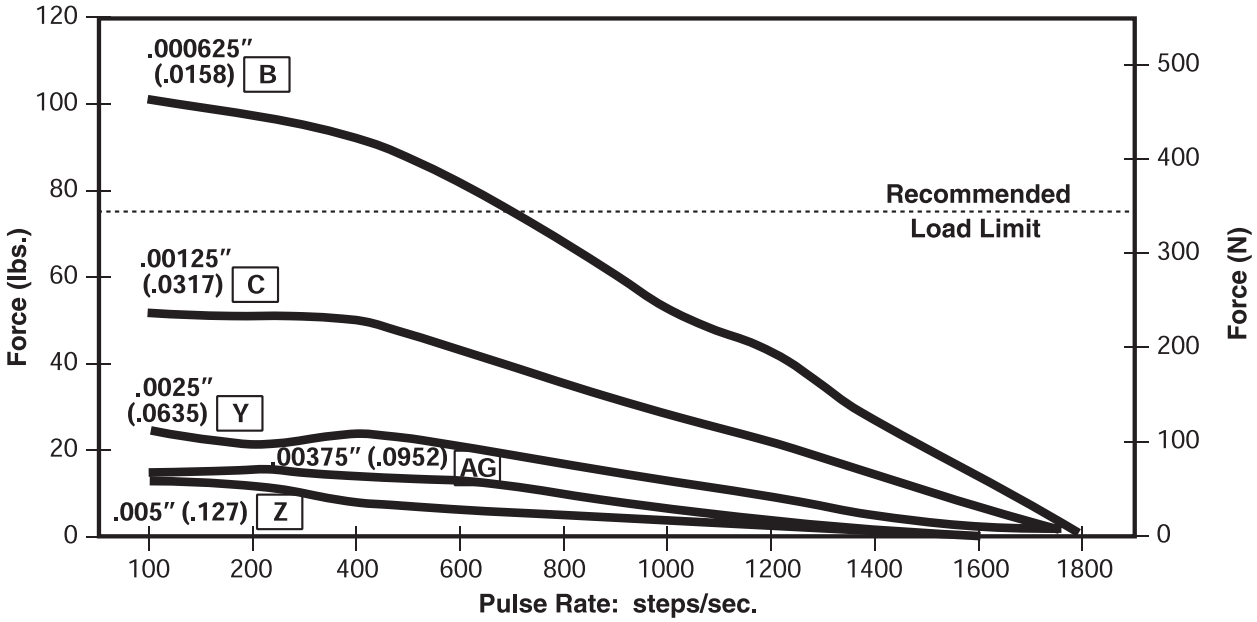


Integrated connector option, see page 115

FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

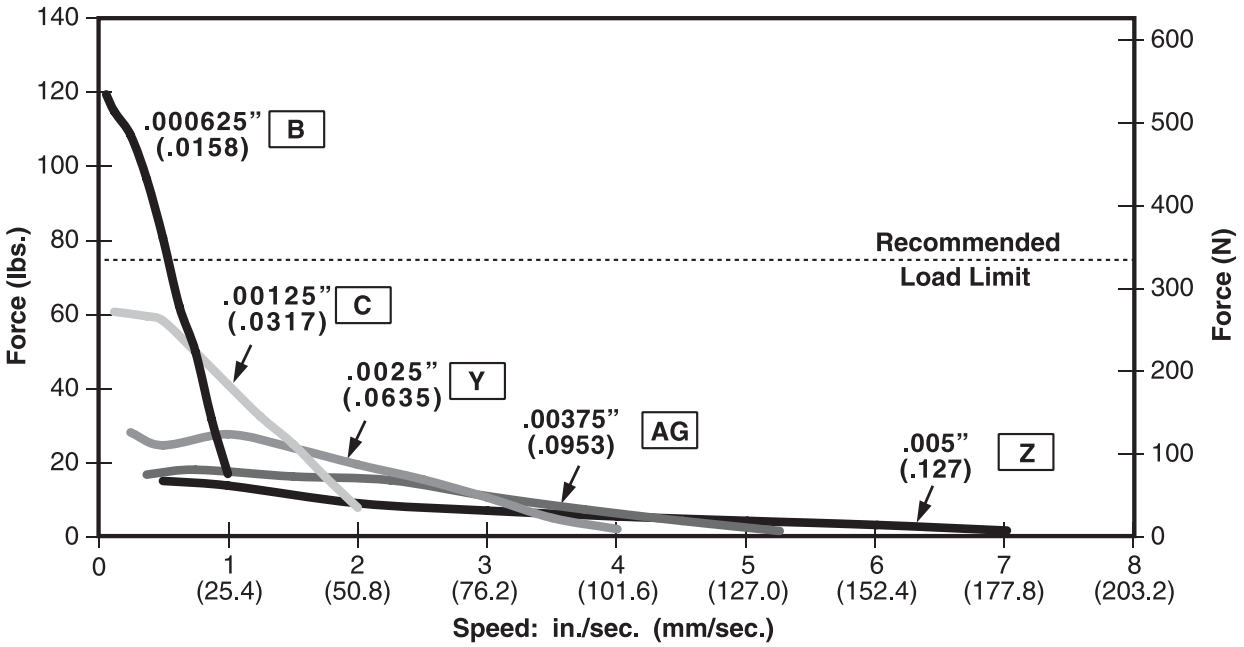
Ø .250 (6.35) Leadscrew



FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

Ø .250 (6.35) Leadscrew



NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

Haydon™ IDEA™ Drive 43000 Series Size 17 programmable hybrid linear actuators

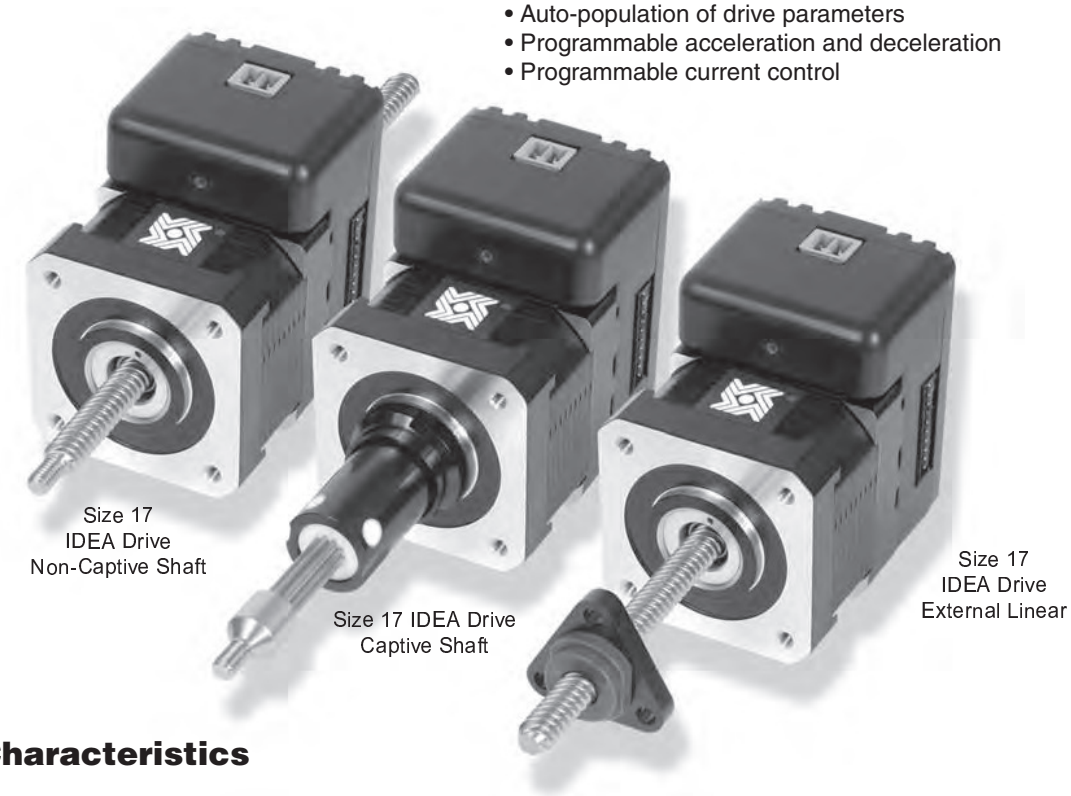
The IDEA™ Drive Size 17 hybrid stepper motor linear actuator integrates a motor, linear translation, and programming capability in a single compact package. Programming is through a simple-to-use patent pending Graphic User Interface.

Three designs are available, captive, non-captive and external linear versions. The 43000 Series is available in a wide variety of resolutions - from 0.00012-in. per step to 0.00192-in. (3.0 to 48.7 microns) per step - and delivers thrust of up to 50 lbs. (222 N), or speeds exceeding 3 inches (7.62 cm) per second.

Note: See page 199 for more information on the IDEA™ Drive

Programmable IDEA™ Drive FEATURES:

- RoHS Compliant
- +12 to +48 VDC
- USB Communication
- Microstepping: Full, 1/2, 1/4,/1/8, 1/16, 1/32, 1/64
- Max. thrust: 220 N (50 lbs.)
- Graphic User Interface
- Auto-population of drive parameters
- Programmable acceleration and deceleration
- Programmable current control



Salient Characteristics

Size 17: 43 mm (1.7-in) Hybrid Linear Actuator (1.8° Step Angle)		
Part No.	Captive	43HG(X)-V
	Non-captive	43FG(X)-V
	External Lin.	E43HG(X)-V
Wiring		Bipolar
Winding voltage		2.33 VDC

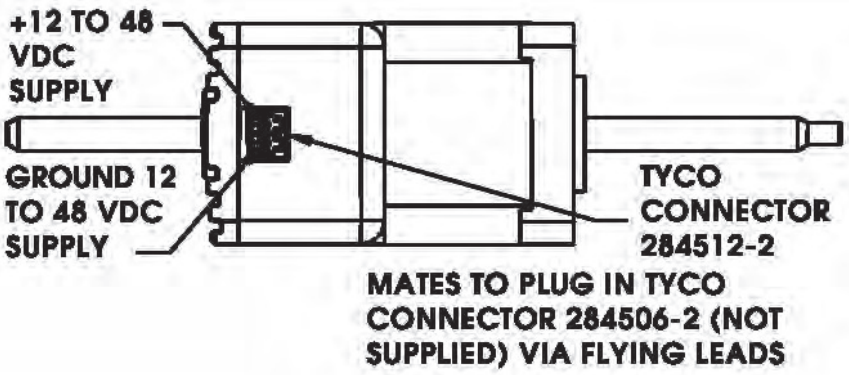
Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

Linear Travel / Step					
Screw Ø .218" (5.54 mm) inches	mm	**Order Code I.D.**	Screw Ø .250" (6.35 mm) inches	mm	**Order Code I.D.**
.00012	.0030*	N	.00015625	.0039*	P
.00024	.0060*	K	.0003125	.0079*	A
.00048	.0121*	J	.000625	.0158*	B
.00096	.0243*	Q	.00125	.0317*	C
.00192	.0487*	R			

*Values truncated

Haydon Kerk Motion Solutions, Inc. • www.HaydonKerk.com • Phone: 800.243.2715 • International: 203.756.7441

Computer Connector Data



Pin Configuation Data

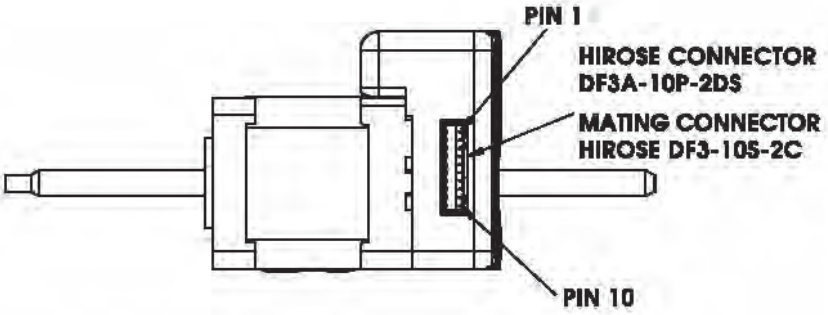
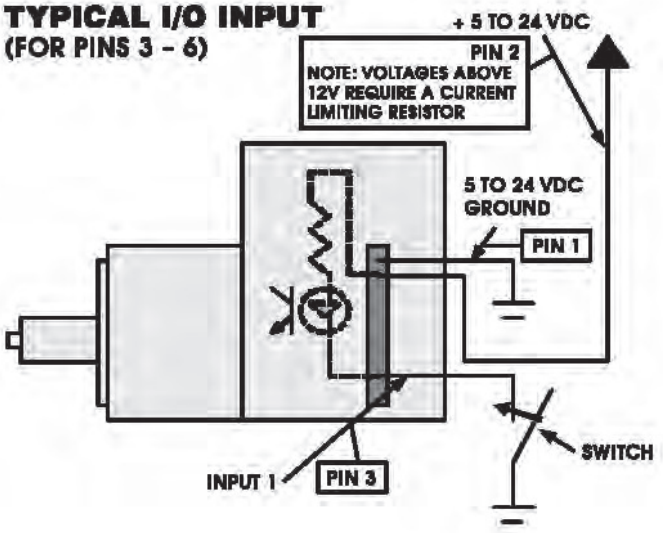


TABLE COMMON FOR EACH PRODUCT CONFIGURATION

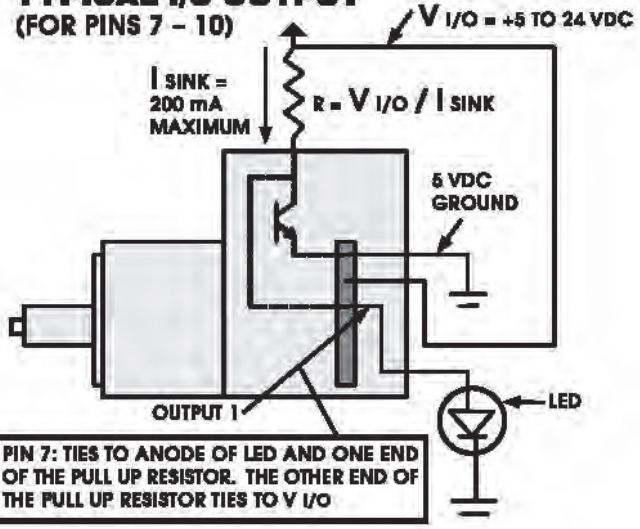
PIN POSITION	DESCRIPTION	NOTES
PIN 1	GROUND I/O SUPPLY	5 TO 24 VDC
PIN 2	+ I/O SUPPLY	5 TO 24 VDC
PIN 3	INPUT 1	
PIN 4	INPUT 2	
PIN 5	INPUT 3	
PIN 6	INPUT 4	
PIN 7	OUTPUT 1	
PIN 8	OUTPUT 2	
PIN 9	OUTPUT 3	
PIN 10	OUTPUT 4	

Typical Input / Output Data

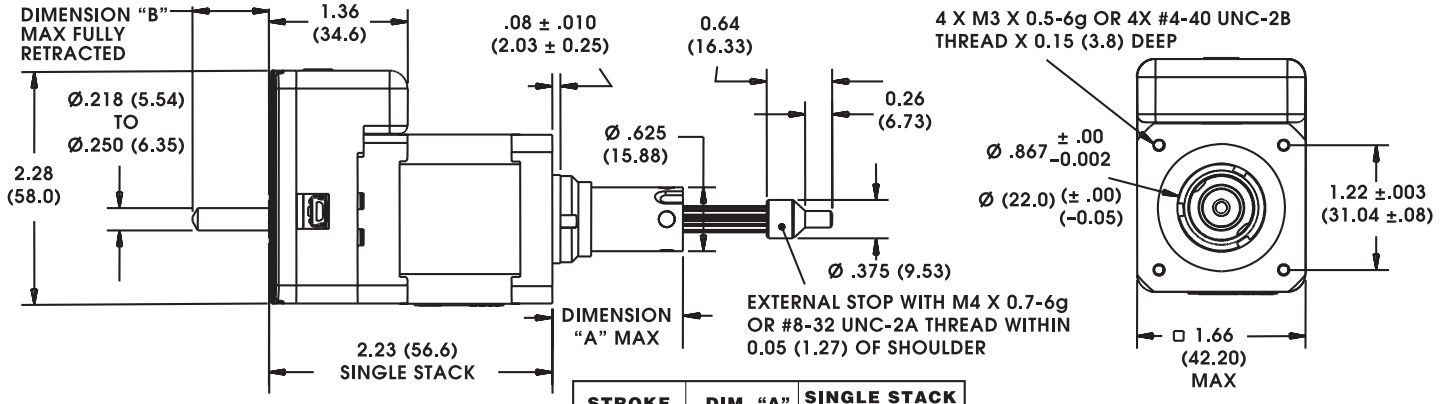
TYPICAL I/O INPUT
(FOR PINS 3 – 6)



TYPICAL I/O OUTPUT
(FOR PINS 7 – 10)

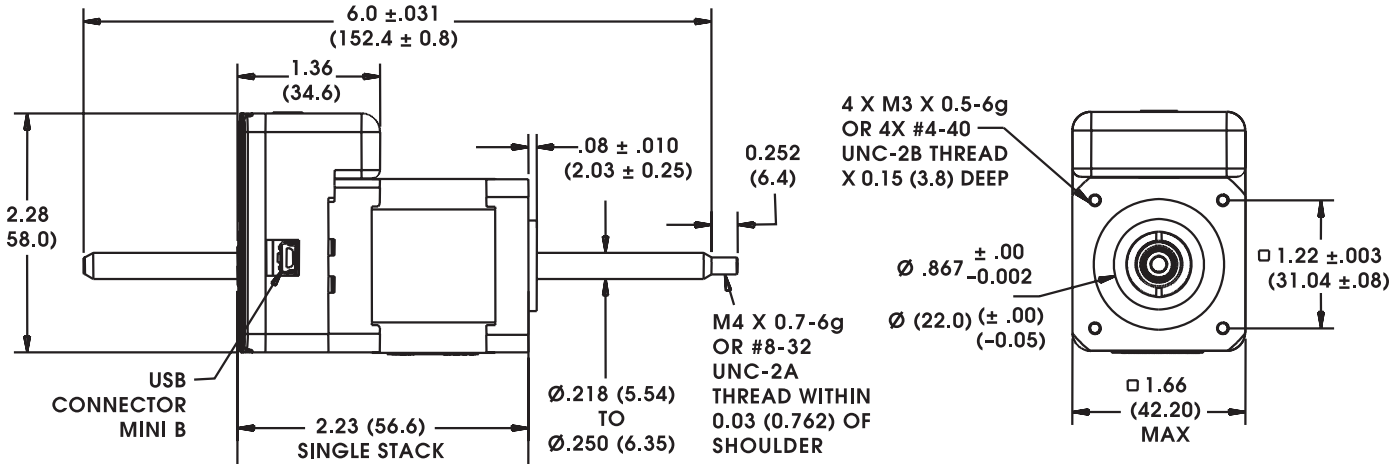


Captive Leadscrew

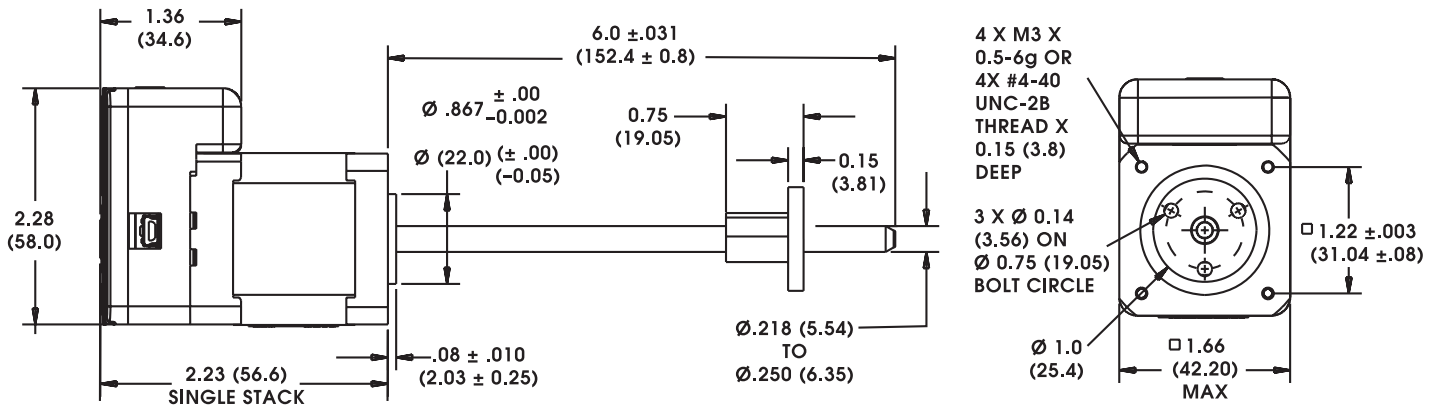


STROKE	DIM. "A"	SINGLE STACK DIM. "B"
0.500 (12.7)	0.78 (19.8)	0 (0)
0.750 (19.05)	1.03 (26.2)	0 (0)
1.00 (25.4)	1.28 (32.5)	0 (0)
1.250 (31.8)	1.53 (38.9)	0 (0)
1.500 (38.1)	1.78 (45.2)	0.232 (5.9)
2.00 (50.8)	2.28 (57.9)	0.732 (18.6)
2.500 (63.5)	2.78 (70.6)	1.232 (31.3)

Non-Captive Leadscrew

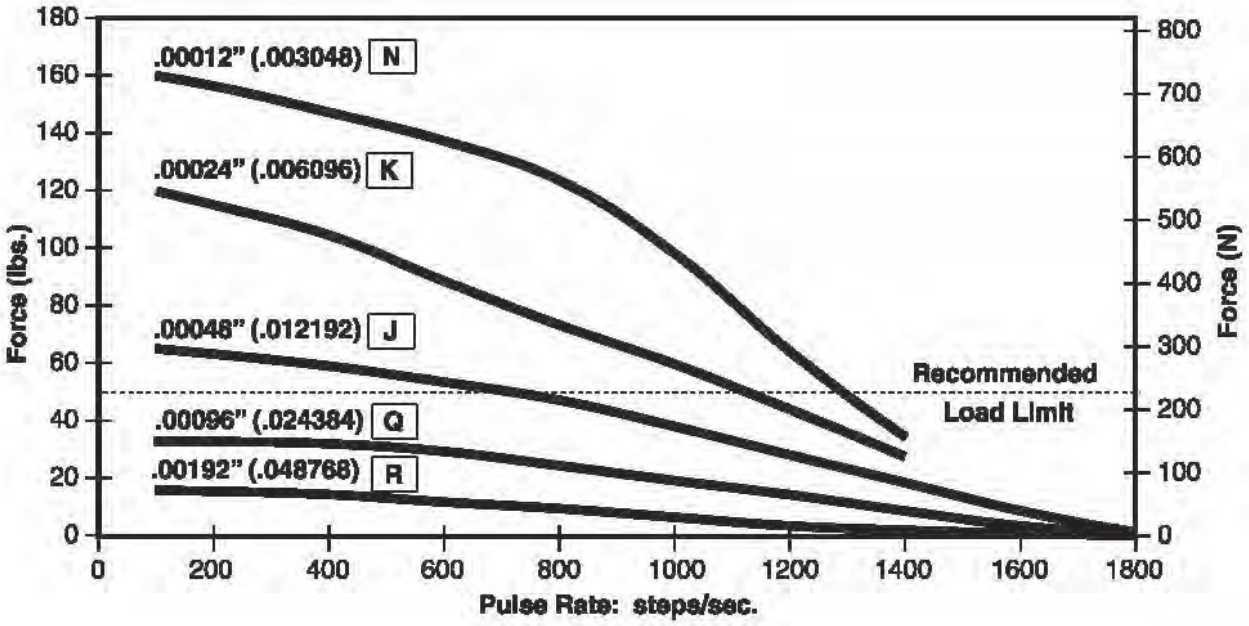


External Linear

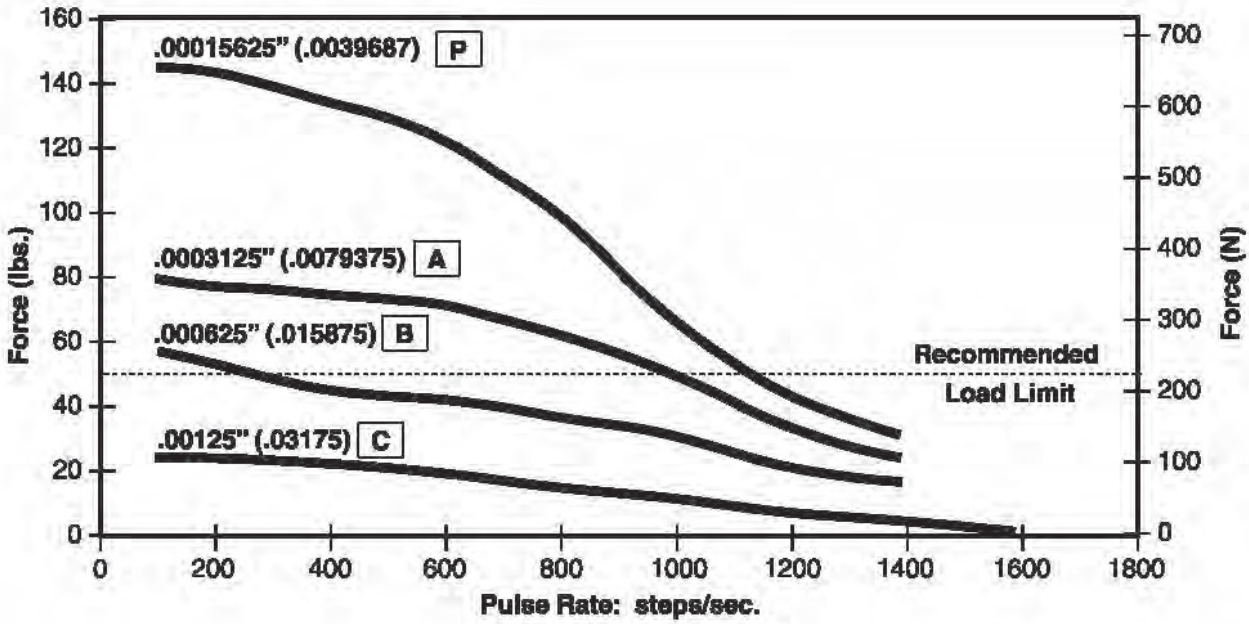


FORCE vs. PULSE RATE Bipolar • Chopper • 100% Duty Cycle

Ø .218 (5.54) Leadscrew



Ø .250 (6.35) Leadscrew



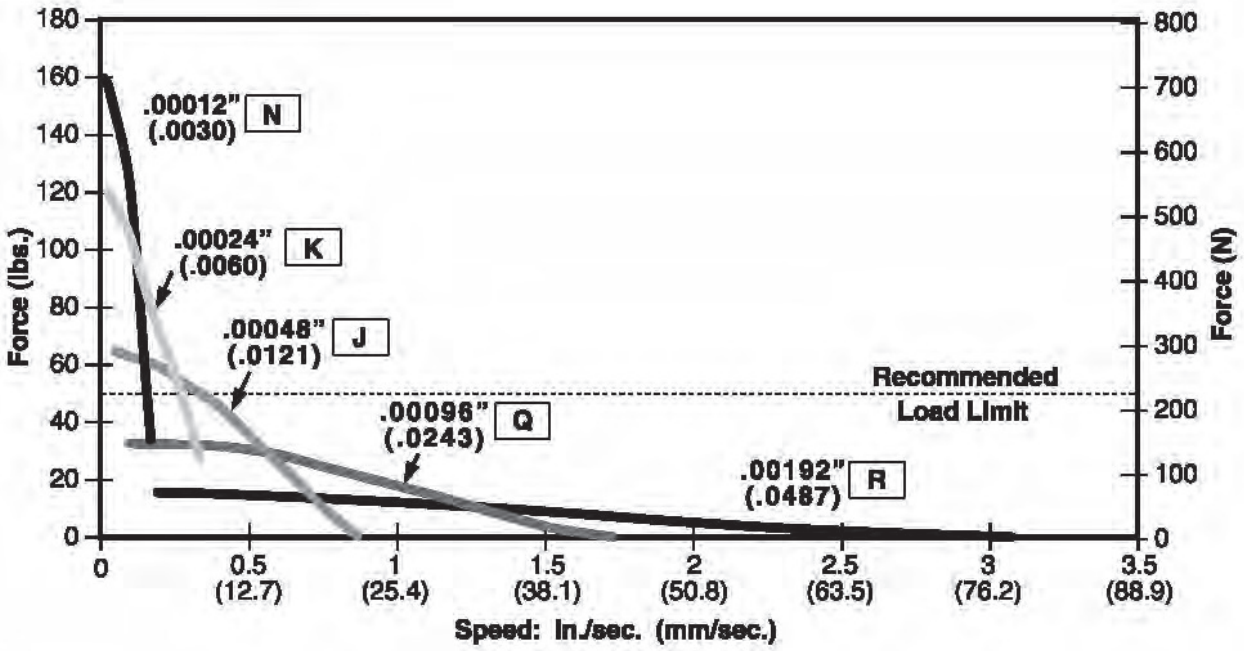
NOTE: All chopper drive curves were created with a 2.33 volt motor and a 20 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

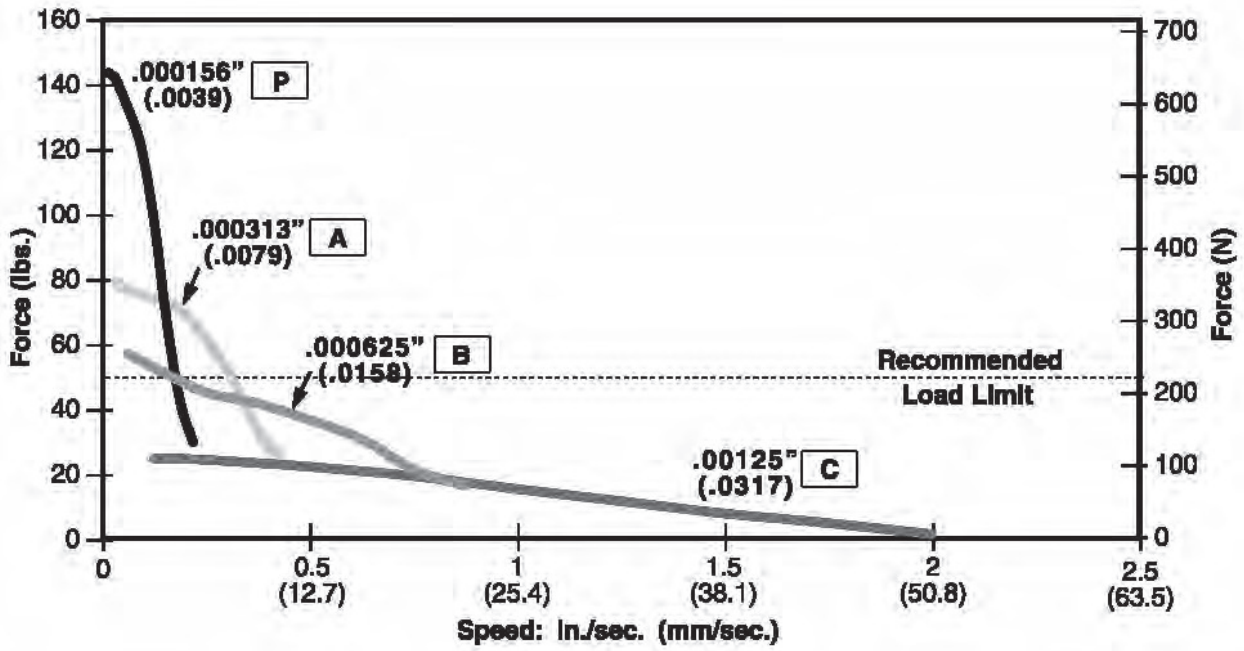
FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

Ø .218 (5.54) Leadscrew



Ø .250 (6.35) Leadscrew



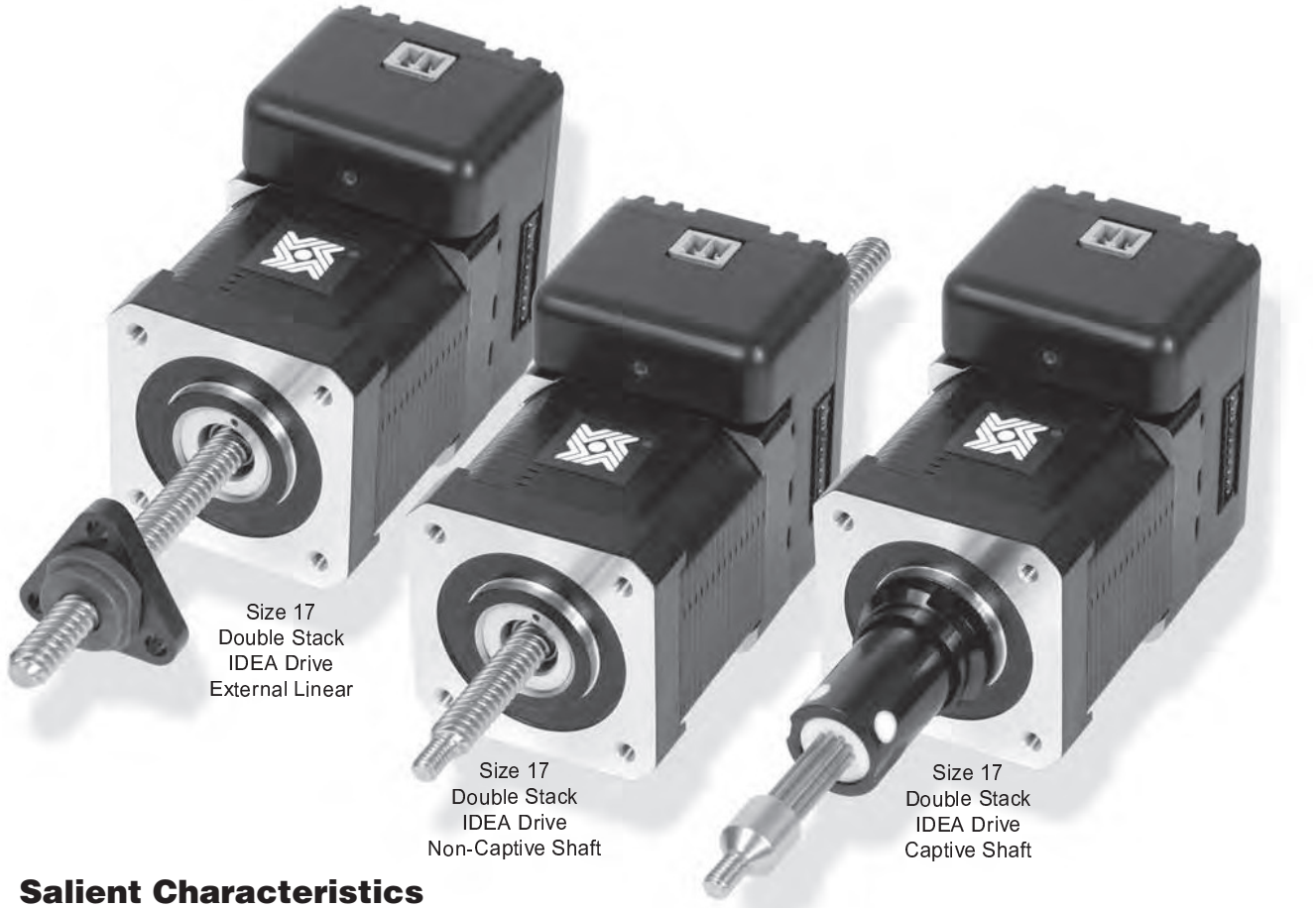
NOTE: All chopper drive curves were created with a 2.33 volt motor and a 20 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

Haydon™ IDEA™ Drive 43000 Series Size 17 Double Stack programmable enhanced performance hybrid linear actuators

For greater performance applications the IDEA Drive may be integrated with a Size 17 Double Stack hybrid stepper motor linear actuator to provide better linear translation and convenient programming through a simple-to-use patent pending Graphic User Interface.

Three designs are available, captive, non-captive and external linear versions. The 43000 Double Stack Series is available in a wide variety of resolutions - from 0.000625-in. per step to 0.005-in. (.0158 to .127 microns) per step - and delivers thrust of up to 50 lbs. (222 N), or speeds exceeding 3 inches (7.62 cm) per second.



Size 17
Double Stack
IDEA Drive
External Linear

Size 17
Double Stack
IDEA Drive
Non-Captive Shaft

Size 17
Double Stack
IDEA Drive
Captive Shaft

Salient Characteristics

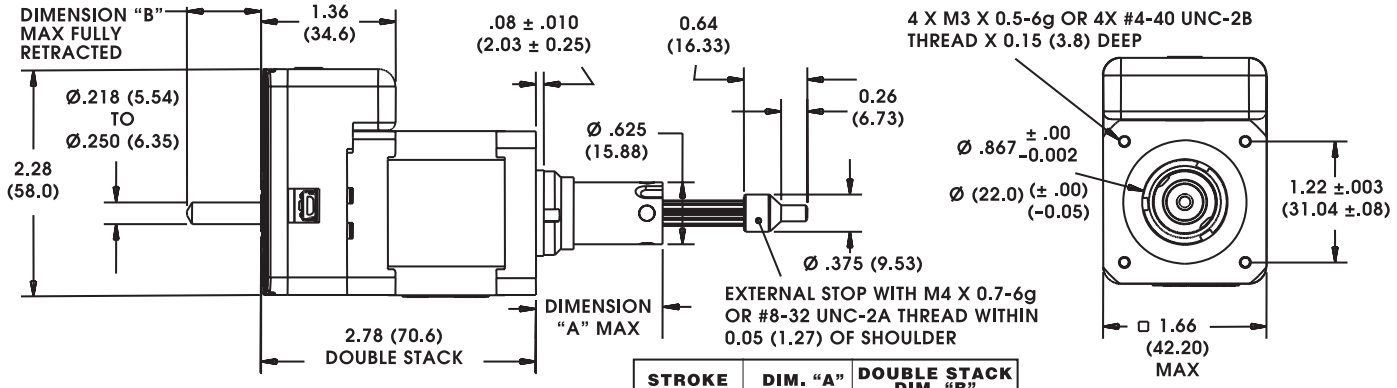
Size 17: 43 mm (1.7-in) Hybrid Linear Actuator (1.8° Step Angle)		
Part No.	Captive	43MG(X)-V
	Non-captive	43LG(X)-V
	External Lin.	E43MG(X)-V
Wiring		Bipolar
Winding voltage		2.33 VDC

Linear Travel / Step Screw Ø .250" (6.35 mm) inches	mm	**Order Code I.D.**
.000625	.0158*	B
.00125	.0317*	C
.0025	.0635*	Y
.00375	.0953*	AG
.005	.127*	Z

*Values truncated

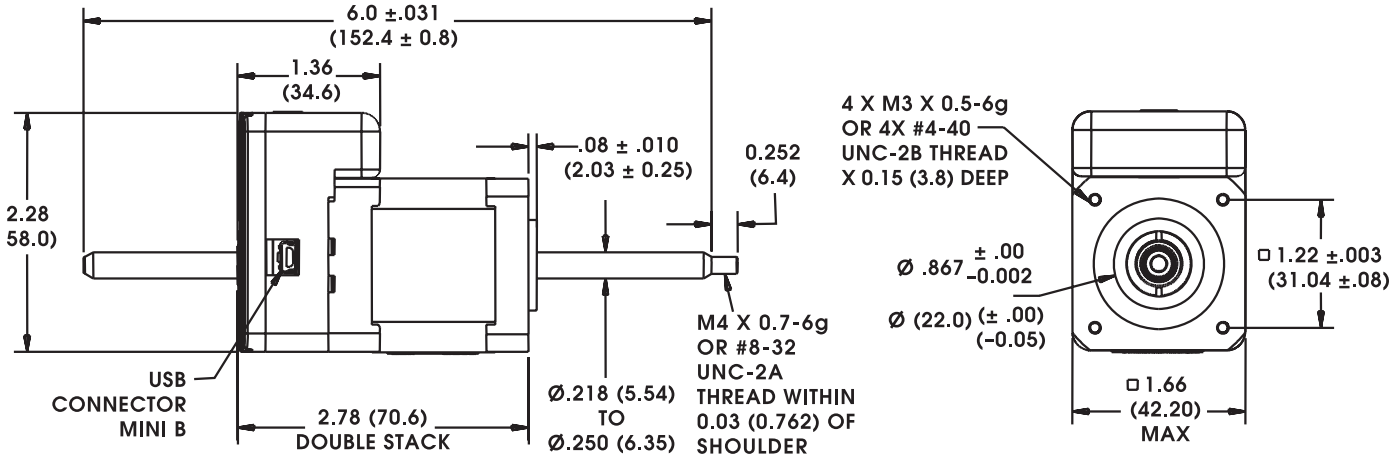
Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

Captive Leadscrew

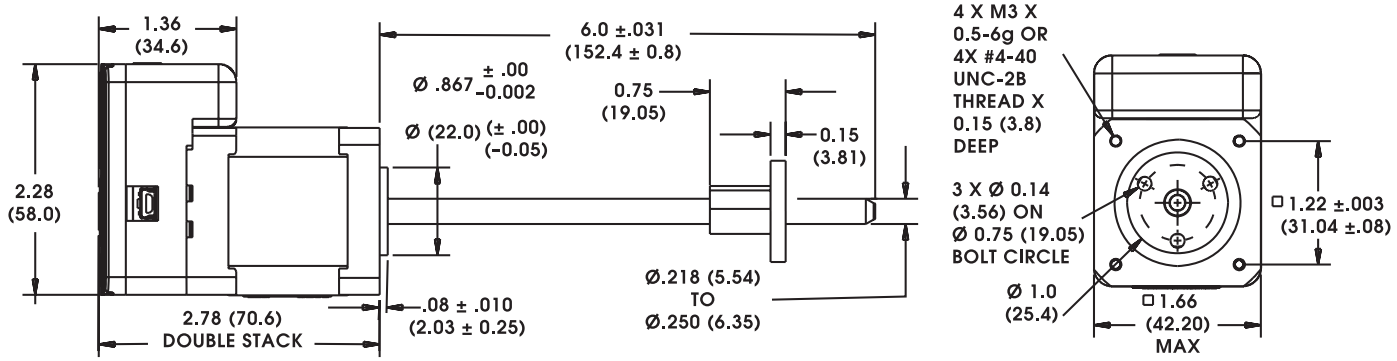


STROKE	DIM. "A"	DOUBLE STACK DIM. "B"
0.500 (12.7)	0.78 (19.8)	0 (0)
0.750 (19.05)	1.03 (26.2)	0 (0)
1.00 (25.4)	1.28 (32.5)	0 (0)
1.250 (31.8)	1.53 (38.9)	0 (0)
1.500 (38.1)	1.78 (45.2)	0.091 (2.5)
2.00 (50.8)	2.28 (57.9)	0.591 (15.0)
2.500 (63.5)	2.78 (70.6)	1.091 (27.7)

Non-Captive Leadscrew



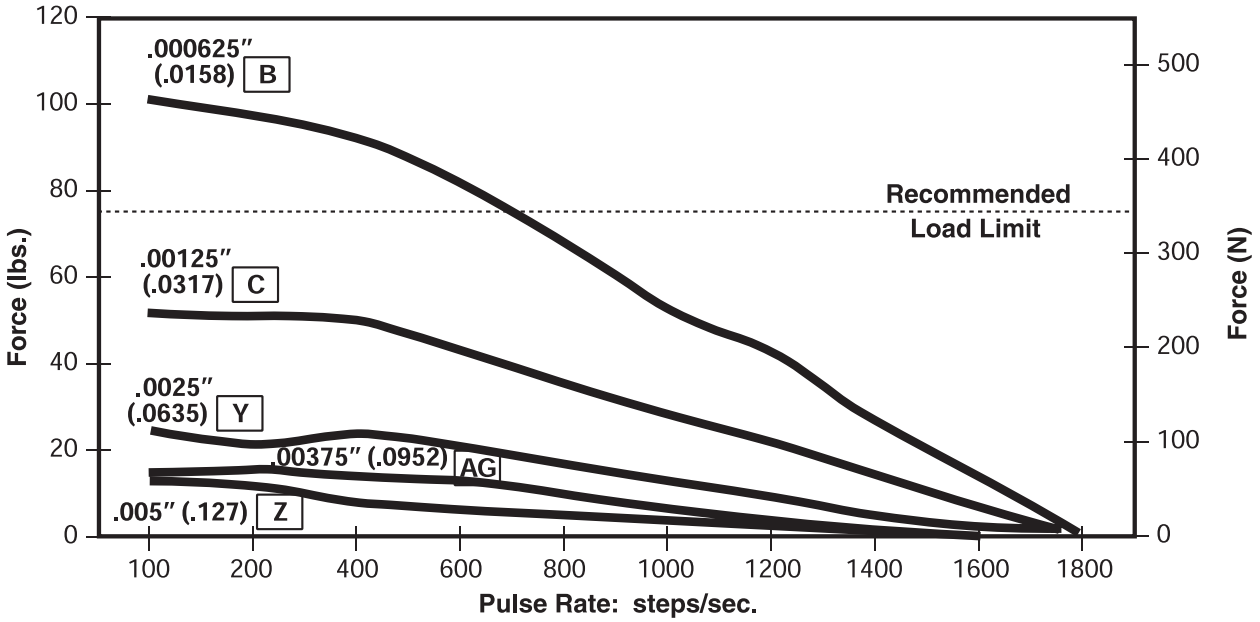
External Linear



FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

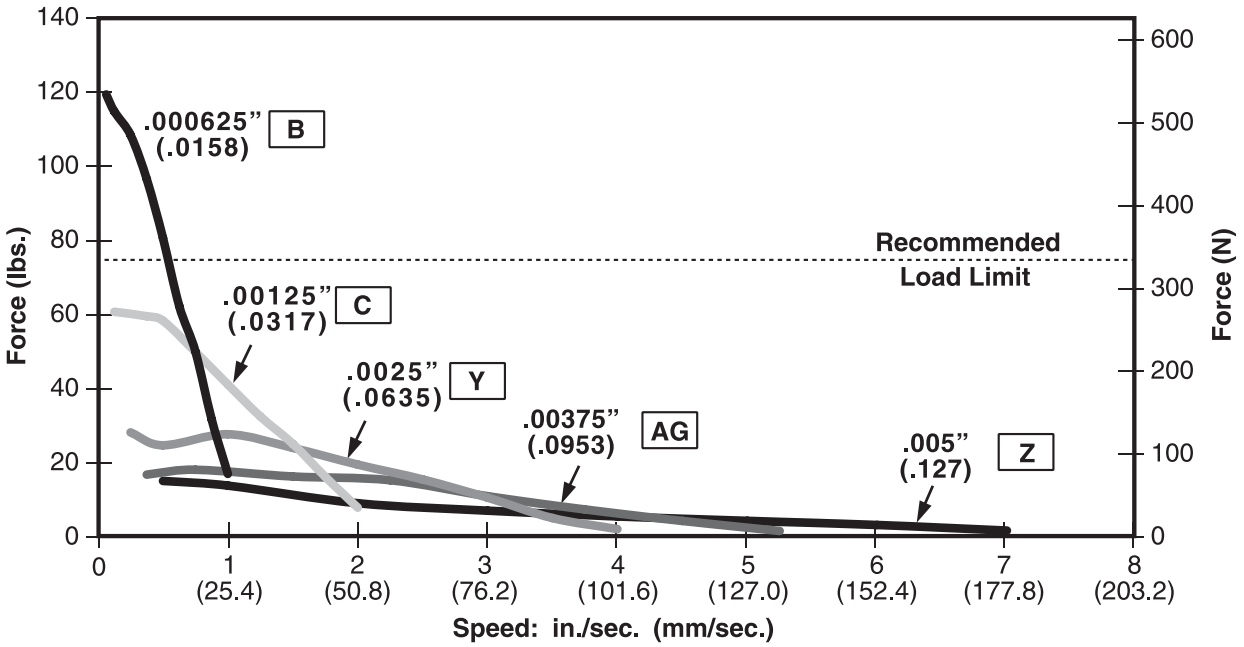
Ø .250 (6.35) Leadscrew



FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

Ø .250 (6.35) Leadscrew



NOTE: All chopper drive curves were created with a 2.33 volt motor and a 20 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

Haydon™ Size 23 Hybrids... for applications that require forces up to 200 lbs. (890 N)

Size 23
External Linear

The Haydon™ Size 23 incorporates the same high performance and durable design as the Size 17.

The 57000 Series Hybrid Linear Actuator is available in a wide variety of resolutions - from 0.0003125-in. (.0079375 mm) per step to 0.002-in. (.0508 mm) per step. They deliver a thrust of up to 200 lbs. (890 N) or speeds exceeding 2.0-in. (5.08 cm) per second.

Size 23 Captive
Shaft

Size 23
Non-Captive
Shaft

Salient Characteristics

Size 23: 57 mm (2.3-in) Hybrid Linear Actuator (1.8° Step Angle)						
Part No.	Captive	57H4(X)-V			57H6(X)-V	
	Non-captive	57F4(X)-V			57F6(X)-V	
	External Lin.	E57H4(X)-V			E57H6(X)-V	
Wiring		Bipolar			Unipolar**	
Winding voltage		3.25 VDC	5 VDC	12 VDC	5 VDC	12 VDC
Current/phase		2.0 A	1.3 A	.54 A	1.3 A	.54 A
Resistance/phase		1.63 Ω	3.85 Ω	22.2 Ω	3.85 Ω	22.2 Ω
Inductance/phase		3.5 mH	10.5 mH	58 mH	5.3 mH	23.6 mH
Power consumption		13 W				
Rotor inertia		166 gcm^2				
Temperature rise		135°F Rise (75°C Rise)				
Weight		18 oz (511 g)				
Insulation resistance		20 MΩ				

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

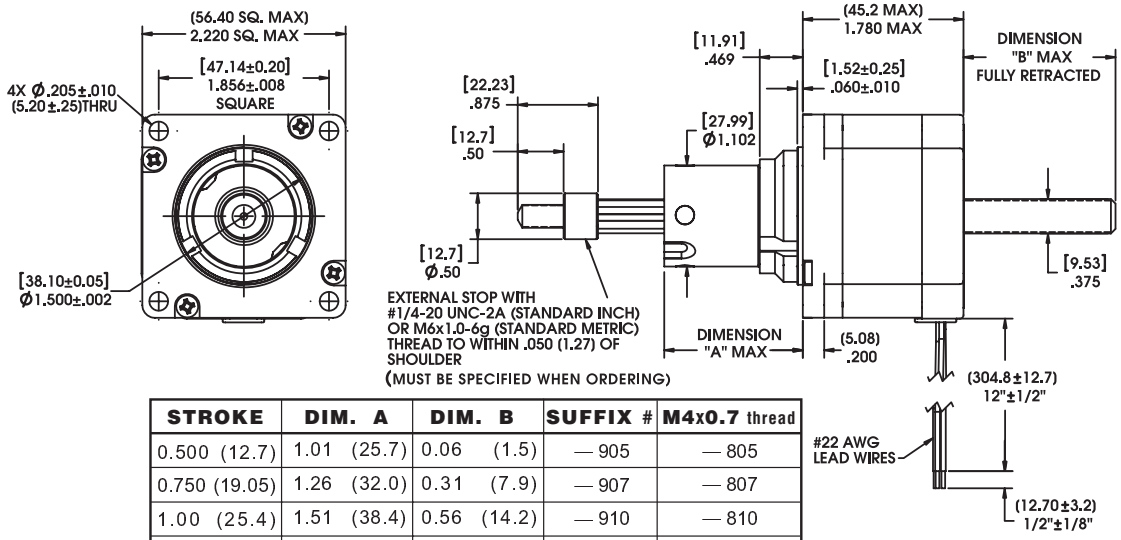
Linear Travel / Step Screw Ø.375"(9.53 mm) inches	mm	Order Code I.D.
.0003125	.0079*	A
.0004167	.0105*	S
.0005	.0127	3
.0008333	.0211*	T
.001	.0254	1
.002	.0508	2

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

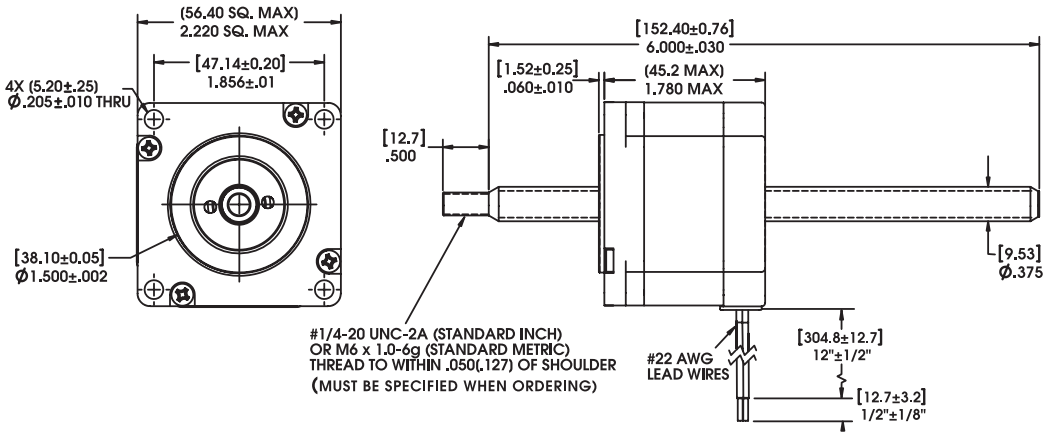
Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

Captive Leadscrew

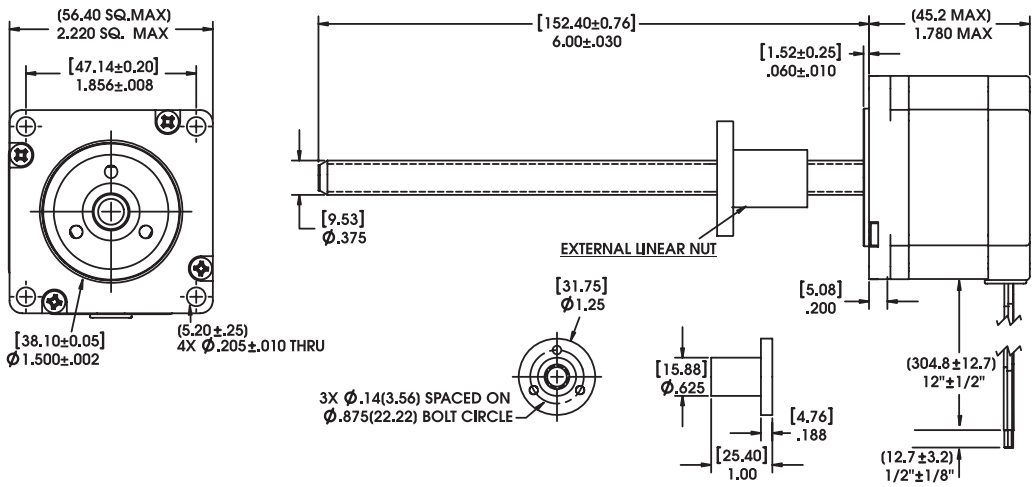


STROKE	DIM. A	DIM. B	SUFFIX #	M4x0.7 thread
0.500 (12.7)	1.01 (25.7)	0.06 (1.5)	— 905	— 805
0.750 (19.05)	1.26 (32.0)	0.31 (7.9)	— 907	— 807
1.00 (25.4)	1.51 (38.4)	0.56 (14.2)	— 910	— 810
1.250 (31.8)	1.76 (44.7)	0.81 (20.6)	— 912	— 812
1.500 (38.1)	2.01 (51.1)	1.06 (26.9)	— 915	— 815
2.00 (50.8)	2.51 (63.8)	1.56 (39.6)	— 920	— 820
2.500 (63.5)	3.01 (76.5)	2.06 (52.3)	— 925	— 825

Non-Captive Leadscrew



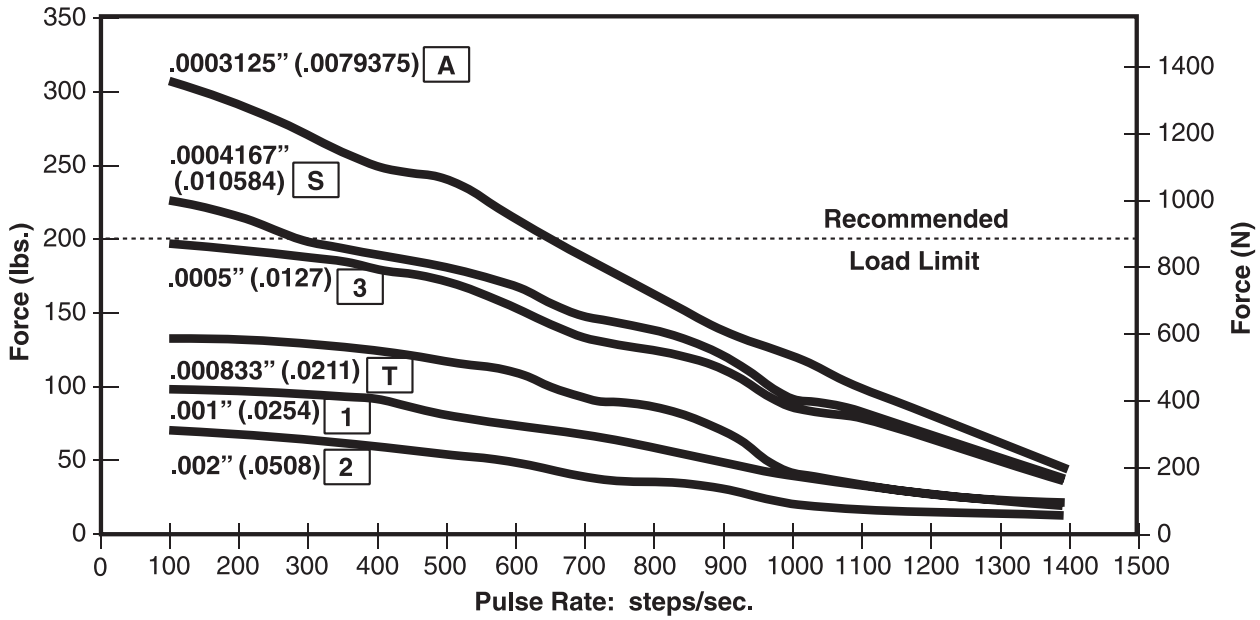
External Linear



FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

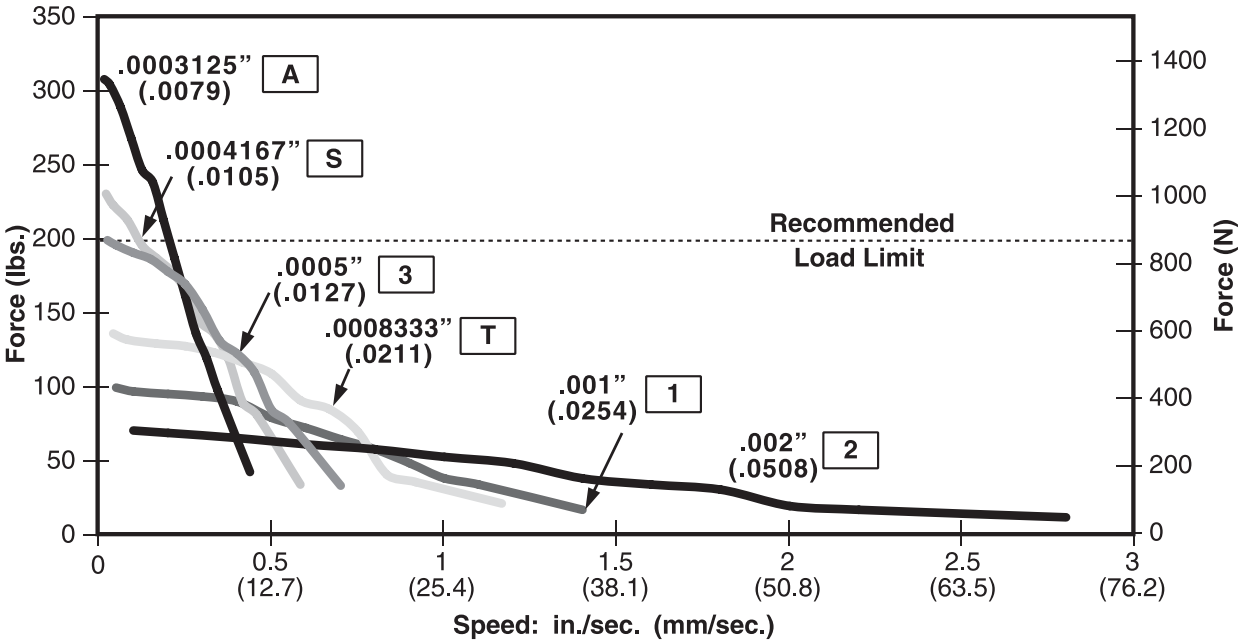
Ø .375 (9.53) Leadscrew



FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

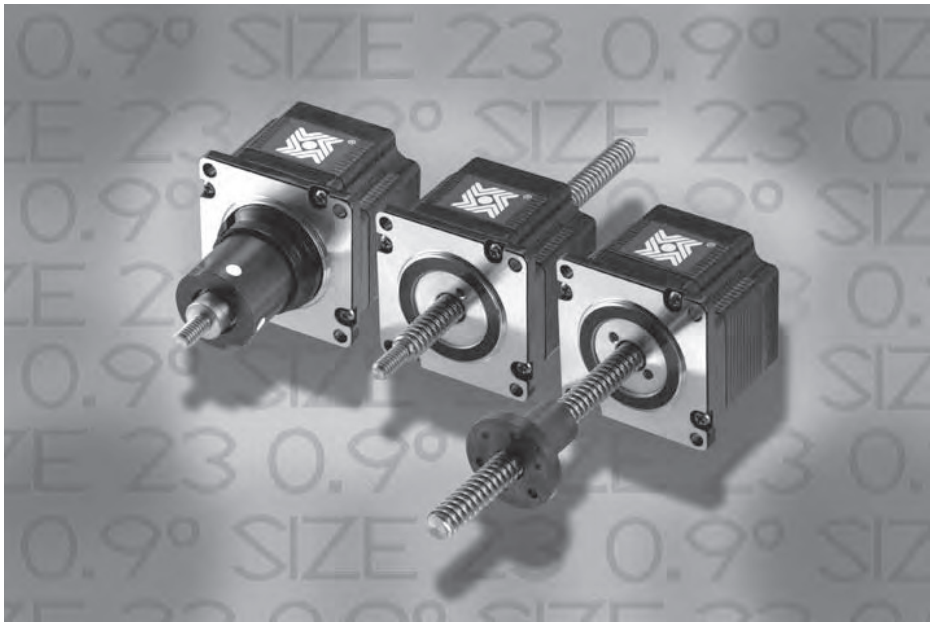
Ø .375 (9.53) Leadscrew



NOTE: All chopper drive curves were created with a 5 volt motor and a 75 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.



A full linear step movement as low as 2 microns and a thrust capability up to 200 lbs (890 N)

The Haydon™ 57000 Series Size 23, 0.9° high resolution (standard resolution = 1.8°) hybrid offers precise motion with excellent motion control. Combined with a stainless steel leadscrew and a production-proven, patented rotor drive nut this motor is designed for trouble-free, long-term performance. Adaptable to customer specifications.

Salient Characteristics

Size 23: 57 mm (2.3-in) Hybrid Linear Actuator (0.9° Step Angle)						
Part No.	Captive	57K4(X)-V			57K6(X)-V	
	Non-captive	57J4(X)-V			57J6(X)-V	
	External Lin.	E57K4(X)-V			E57K6(X)-V	
Wiring		Bipolar			Unipolar**	
Winding voltage		3.25 VDC	5 VDC	12 VDC	5 VDC	12 VDC
Current/phase		2.0 A	1.3 A	0.54 A	1.3 A	0.54 A
Resistance/phase		1.63 Ω	3.85 Ω	22.2 Ω	3.85 Ω	22.2 Ω
Inductance/phase		4.2 mH	13 mH	68 mH	6 mH	27 mH
Power consumption		13 W				
Rotor inertia		37 gcm^2				
Temperature rise		135°F Rise (75°C Rise)				
Weight		18 oz (511 g)				
Insulation resistance		20 MΩ				

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

Linear Travel / Step Screw Ø.375"(9.53 mm) inches	mm	Order Code I.D.
.000125	.0031*	7
.00015625	.003969	P
.00020833	.00529166	X
.00025	.00635	9
.0004167	.01058418	S
.0005	.0127	3
.001	.0254	1

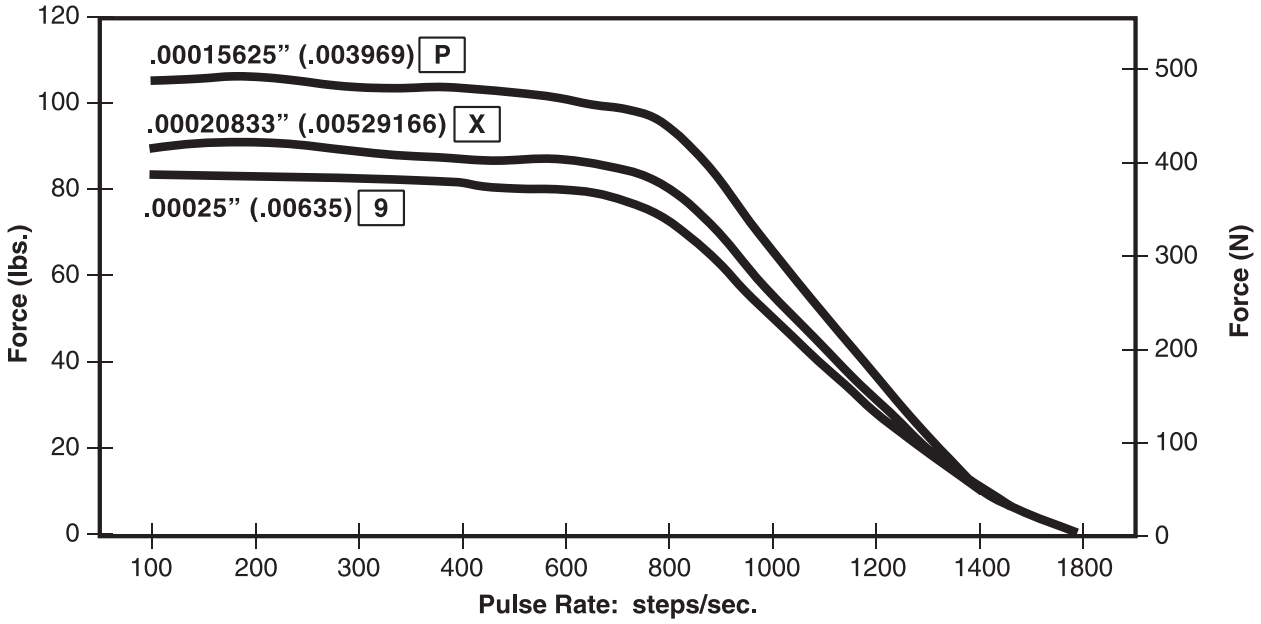
*Values truncated

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

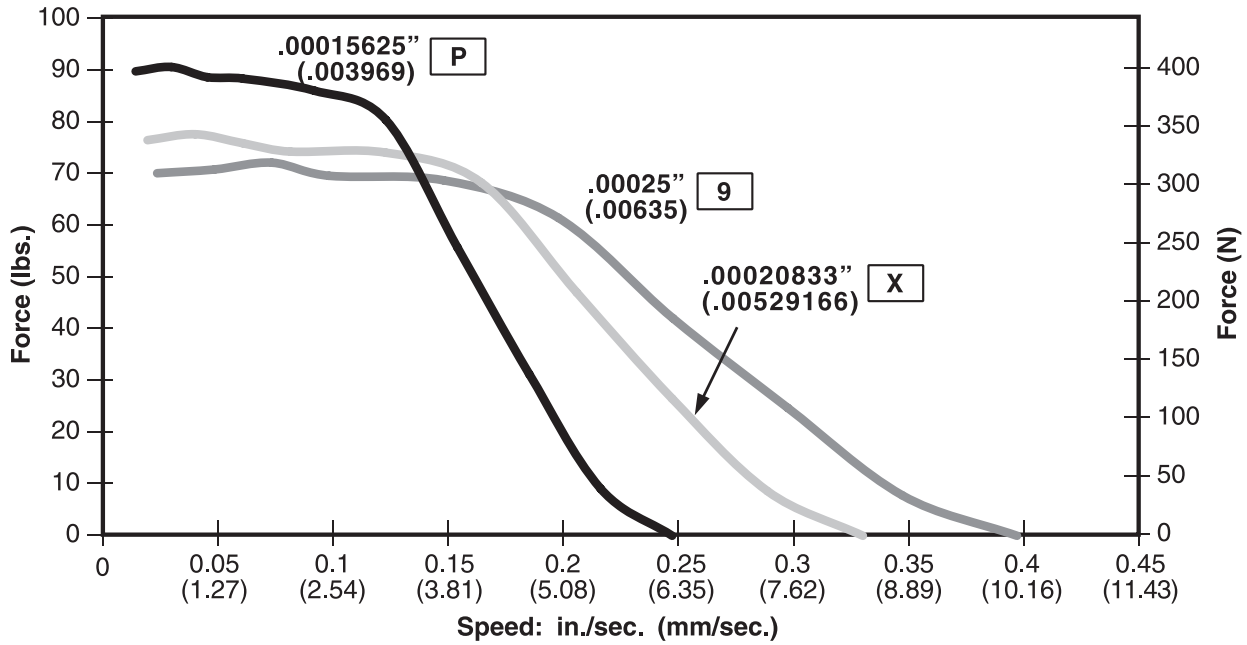
Ø .375 (9.53) Leadscrew



FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

Ø .375 (9.53) Leadscrew



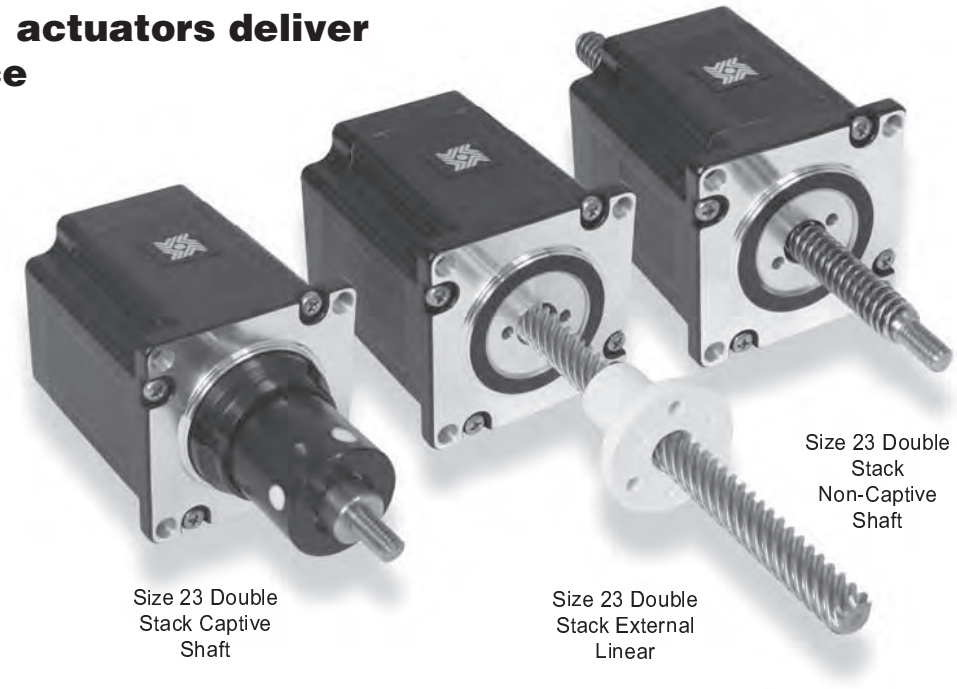
NOTE: All chopper drive curves were created with a 5 volt motor and a 75 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

Haydon™ 57000 Series Size 23 Double Stack hybrid linear actuators deliver greater performance in a compact size.

The various patented designs deliver exceptional performance and new linear motion design opportunities. Three designs are available, captive, non-captive and external linear versions. The 57000 Series is available in a wide variety of resolutions - from 0.0005-in (.0127 mm) per step to 0.005-in (.127 mm) per step. The motors can also be microstepped for even finer resolutions. The Size 23 actuator delivers thrust of up to 200 lbs. (890 N).



Size 23 Double Stack Captive Shaft

Size 23 Double Stack External Linear

Size 23 Double Stack Non-Captive Shaft

Salient Characteristics

Size 23: 57 mm (2.3-in) Double Stack Hybrid Linear Actuator (1.8° Step Angle)				
Part No.	Captive	57M4(X)-V		
	Non-captive	57L4(X)-V		
	External Lin.	E57M4(X)-V		
Wiring		Bipolar		
Winding voltage		3.25 VDC	5 VDC	12 VDC
Current/phase		3.85 A	2.5 A	1 A
Resistance/phase		0.8 Ω	2.0 Ω	12.0 Ω
Inductance/phase		2.3 mH	7.6 mH	35.0 mH
Power consumption		25 W Total		
Temperature rise		135°F Rise (75°C Rise)		
Weight		32 oz (958 g)		
Insulation resistance		20 MΩ		
Max. Load Limit		200 lbs (890 N)		

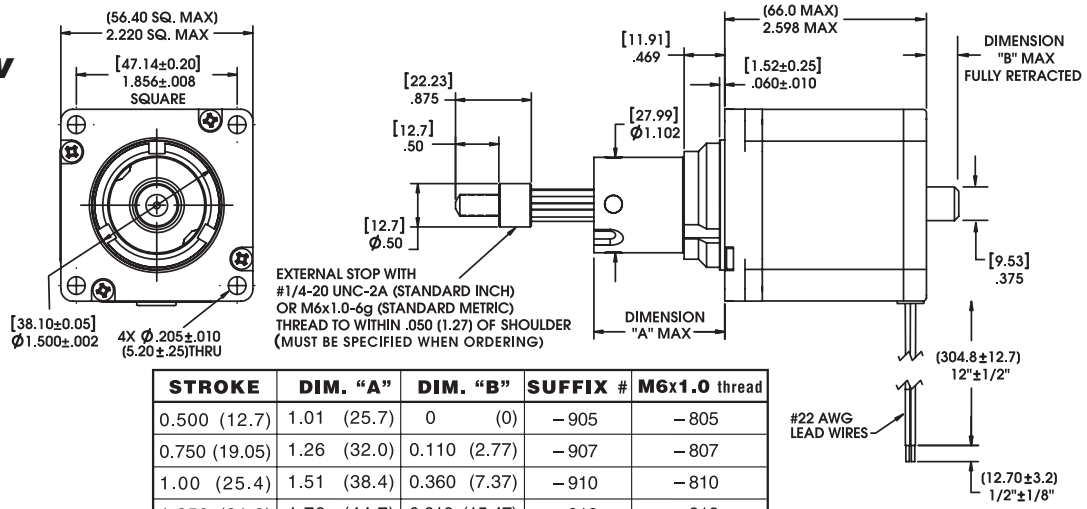
Linear Travel / Step Screw Ø.375" (9.53 mm) inches	mm	Order Code I.D.
.0005	.0127	3
.001	.0254	1
.002	.0508	2
.0025	.0635	Y
.005	.127	Z

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

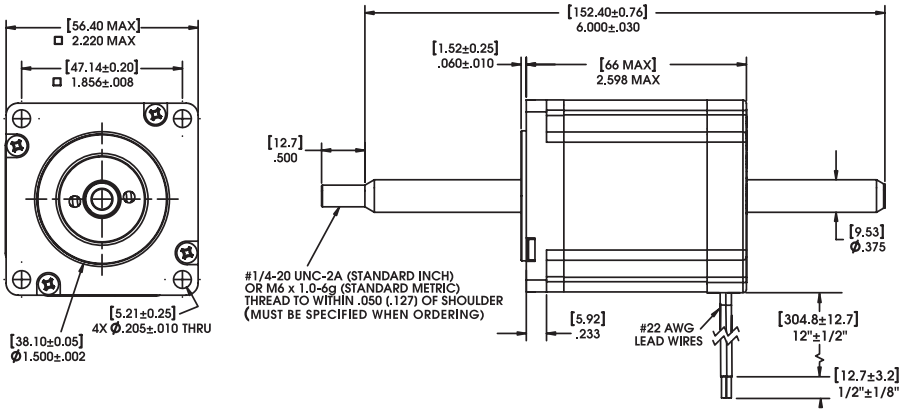
Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

Captive Leadscrew

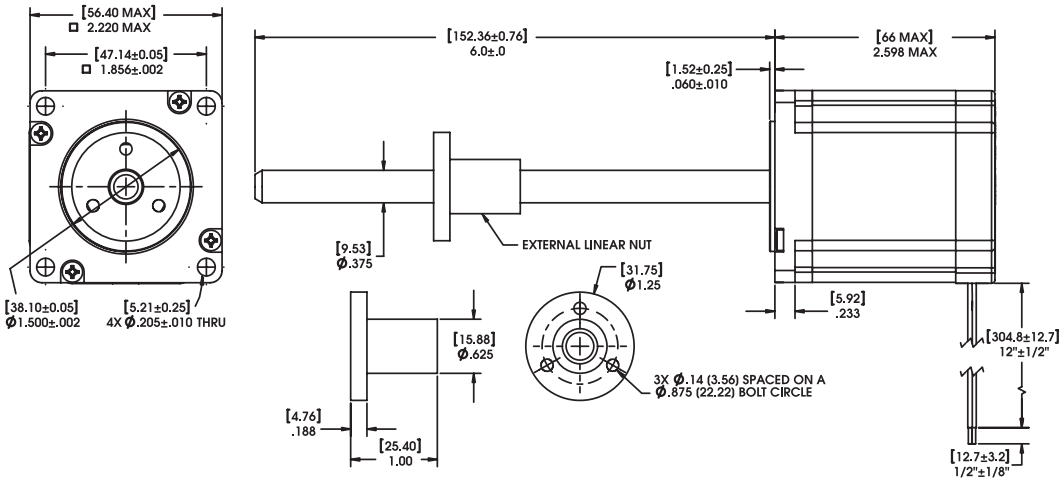


STROKE	DIM. "A"	DIM. "B"	SUFFIX #	M6x1.0 thread
0.500 (12.7)	1.01 (25.7)	0 (0)	–905	–805
0.750 (19.05)	1.26 (32.0)	0.110 (2.77)	–907	–807
1.00 (25.4)	1.51 (38.4)	0.360 (7.37)	–910	–810
1.250 (31.8)	1.76 (44.7)	0.610 (15.47)	–912	–812
1.500 (38.1)	2.01 (51.1)	0.860 (21.83)	–915	–815
2.00 (50.8)	2.51 (63.8)	1.360 (34.52)	–920	–820
2.500 (63.5)	3.01 (76.5)	1.860 (47.22)	–925	–825

Non-Captive Leadscrew



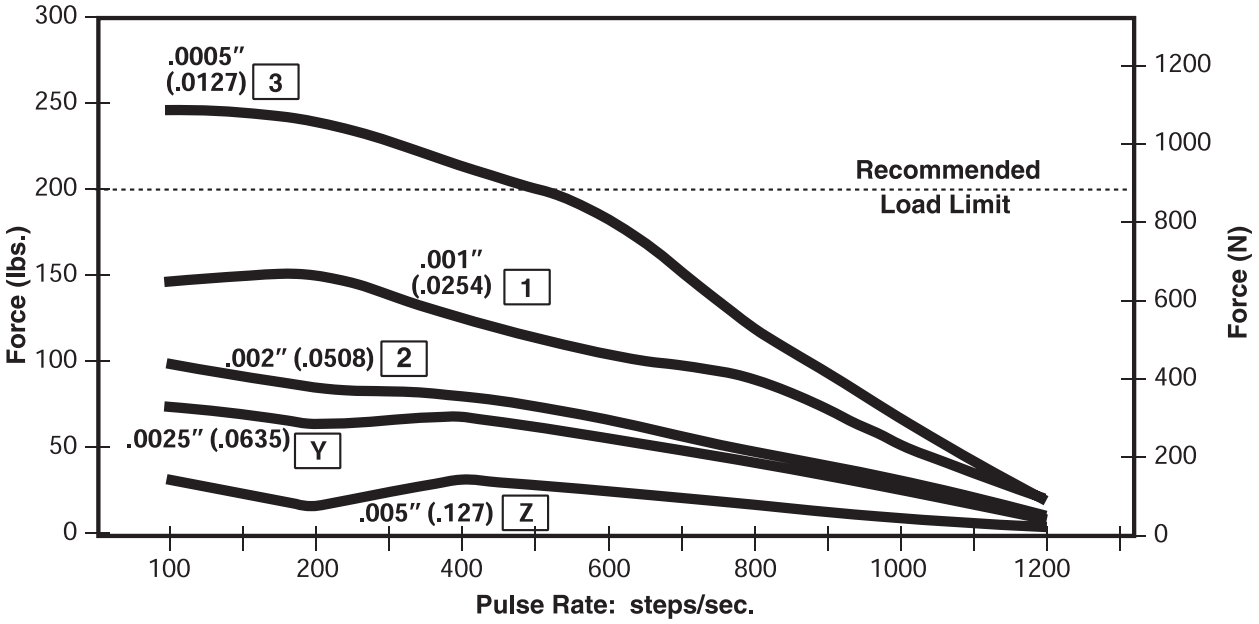
External Linear



FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

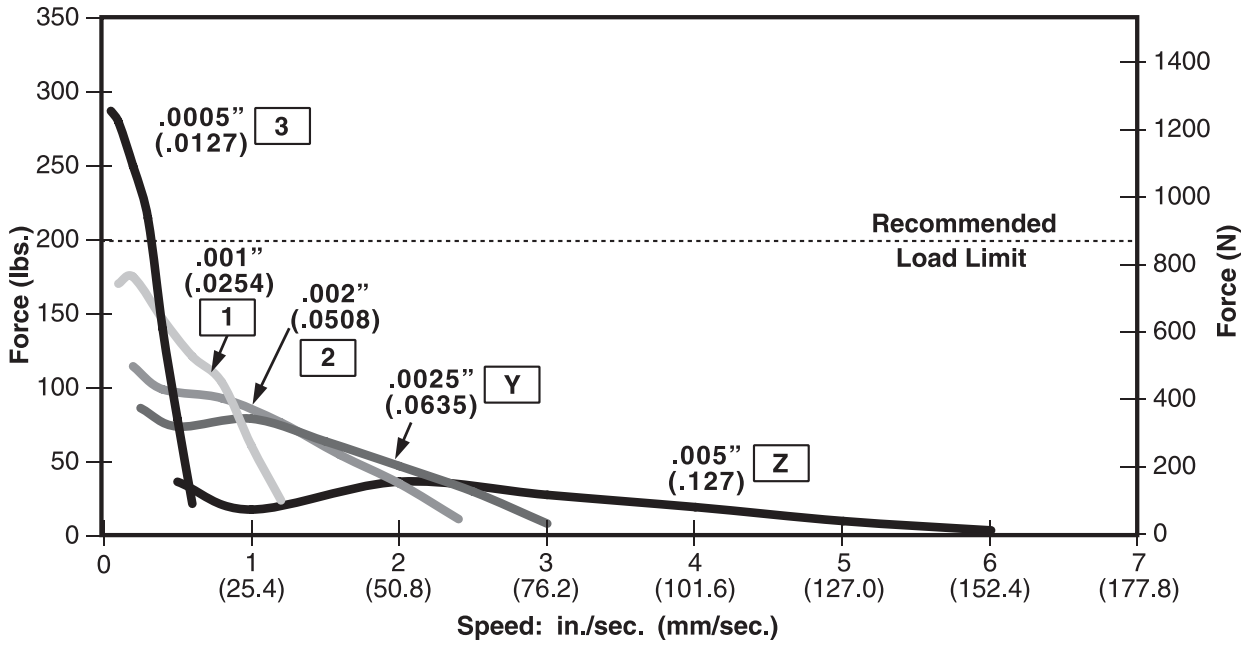
Ø .375 (9.53) Leadscrew



FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

Ø .375 (9.53) Leadscrew



NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

Size 34
Captive
Shaft

Size 34
Non-Captive
Shaft

Size 34
External Linear

87000 Series, Size 34... our largest, most powerful linear actuator is also available with a captive, non-captive, and external linear shaft design

Despite its large size and strength, this motor incorporates the same precision, high performance and durable patented designs featured in our entire hybrid product line.

The 87000 series delivers forces up to 500 lbs. (2224 N) in a compact, 3.4-in (87 mm) square package.

The 87000 Series is available in a wide variety of resolutions - from 0.0005-in (.0127 mm) per step to 0.005-in (.127 mm) per step. Speeds exceed 3.0-in (7.62 cm) per second.

In addition to our standard configurations, Haydon Kerk Motion Solutions, Inc. can custom build this powerful motor to meet your specific motion requirements. The in-house design and engineering team is available to assist you with a solution to fit your needs and your budget.

Salient Characteristics

Size 34: 87 mm (3.4-in) Hybrid Linear Actuator (1.8° Step Angle)						
Part No.	Captive	87H4(X)-V			87H6(X)-V	
	Non-captive	87F4(X)-V			87F6(X)-V	
	External Lin.	E87H4(X)-V			E87H6(X)-V	
Wiring		Bipolar			Unipolar*	
Winding voltage		2.85 VDC	5 VDC	12 VDC	5 VDC	12 VDC
Current/phase		5.47 A	3.12 A	1.3 A	3.12 A	1.3 A
Resistance/phase		0.52 Ω	1.6 Ω	9.23 Ω	1.6 Ω	9.23 Ω
Inductance/phase		2.86 mH	8.8 mH	51 mH	4.4 mH	25.5 mH
Power consumption		31.2 W				
Rotor inertia		1760 gcm^2				
Temperature rise		135°F Rise (75°C Rise)				
Weight		5.1 lbs. (2.3 Kg)				
Insulation resistance		20 MΩ				

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

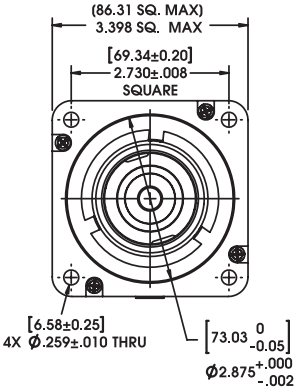
Linear Travel / Step Screw Ø.625"(15.88 mm) inches	mm	**Order Code I.D.**
.0005	.0127	3
.000625	.0158*	B
.00125	.0317*	C
.0025	.0635	Y
.005	.127	Z

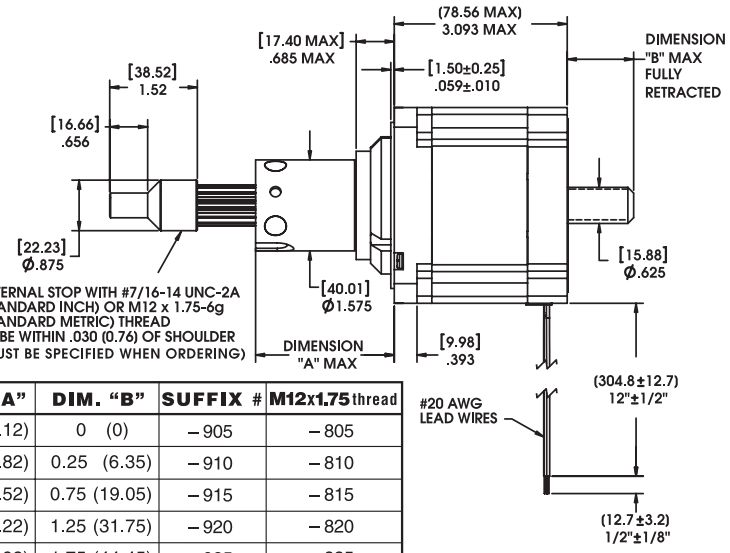
*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

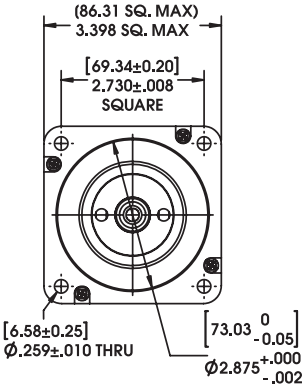
Captive Leadscrew

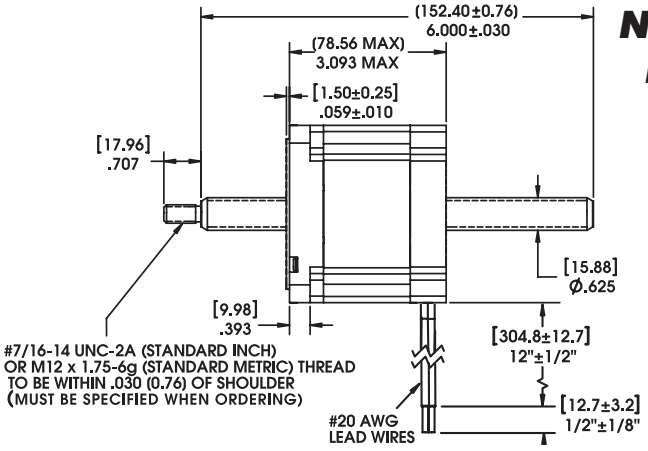




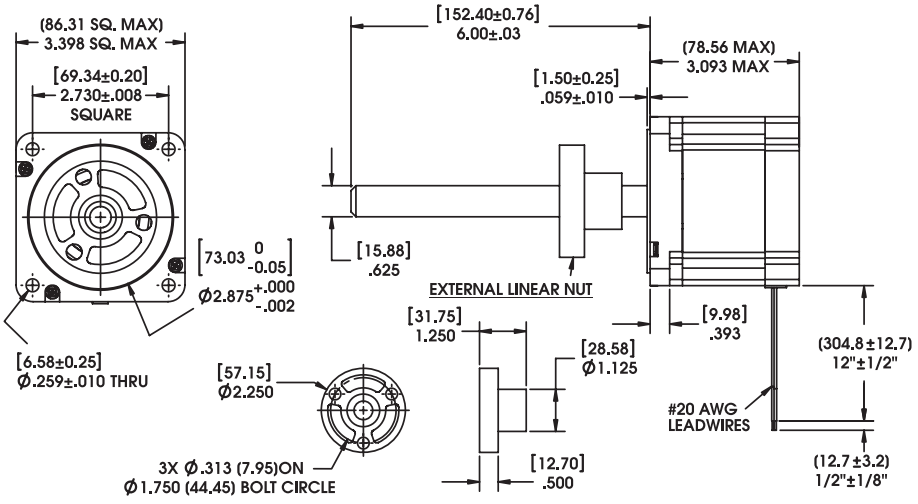
STROKE	DIM. "A"	DIM. "B"	SUFFIX #	M12x1.75 thread
0.50 (12.7)	1.225 (31.12)	0 (0)	–905	–805
1.00 (25.4)	1.725 (43.82)	0.25 (6.35)	–910	–810
1.50 (38.1)	2.225 (56.52)	0.75 (19.05)	–915	–815
2.00 (50.8)	2.725 (69.22)	1.25 (31.75)	–920	–820
2.50 (63.5)	3.225 (81.92)	1.75 (44.45)	–925	–825

Non-Captive Leadscrew





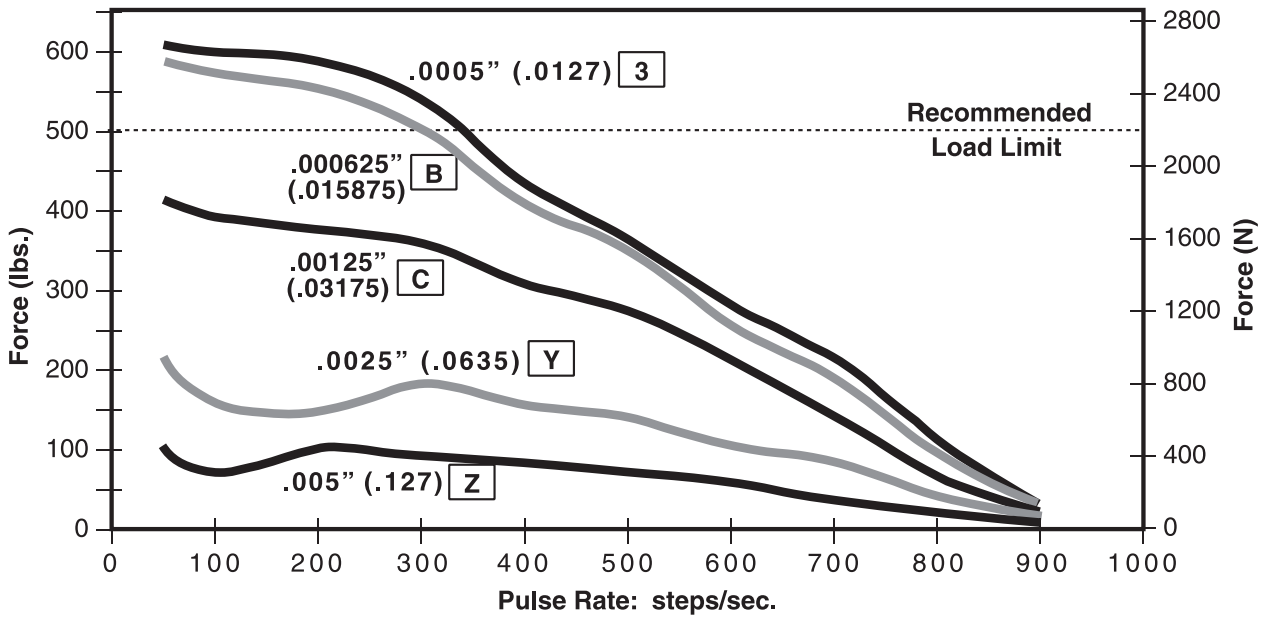
External Linear



FORCE vs. PULSE RATE

Bipolar • Chopper • 100% Duty Cycle

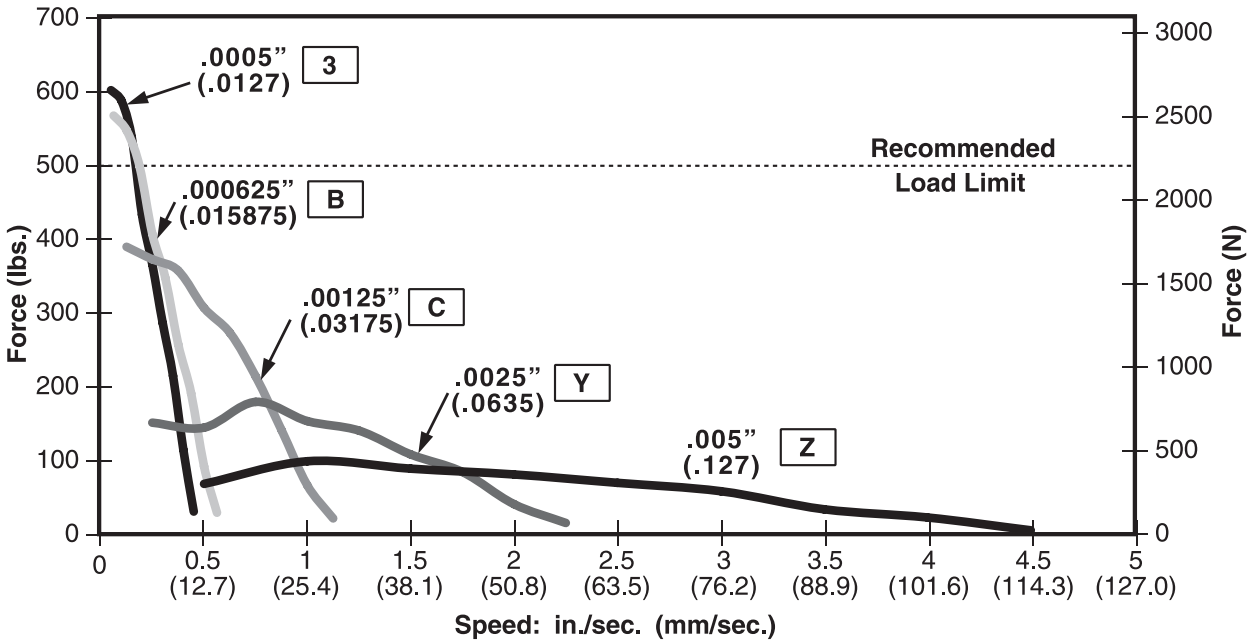
Ø .625 (15.88) Leadscrew



FORCE vs. LINEAR VELOCITY

Bipolar • Chopper • 100% Duty Cycle

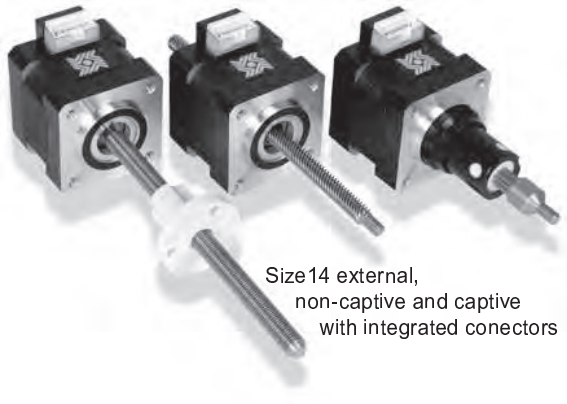
Ø .625 (15.88) Leadscrew



NOTE: All chopper drive curves were created with a 5 volt motor and a 75 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

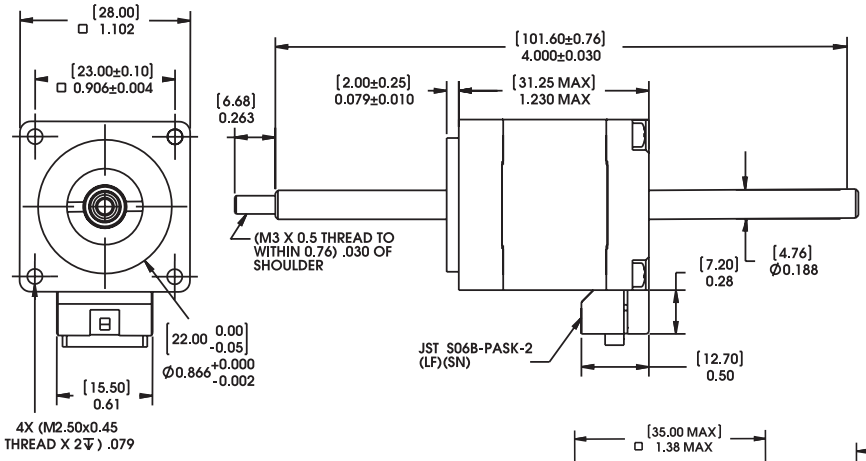


Size14 external, non-captive and captive with integrated conectors

Integrated Connectors for Size 11, Size 14 and Size 17 Hybrid Linear Actuators

Hybrid Size 11, Size 14 and Size 17 linear actuators are available with an integrated connector. Offered alone or with a harness assembly, this connector is RoHS compliant and features a positive latch in order for high connection integrity. The connector is rated up to 3 amps and the mating connector will handle a range of wire gauges from 22 to 28. This motor is ideal for those that want to plug in directly to pre existing harnesses. In addition to standard configurations, Haydon Kerk Motion Solutions™ can custom design this motor to meet your specific application requirements.

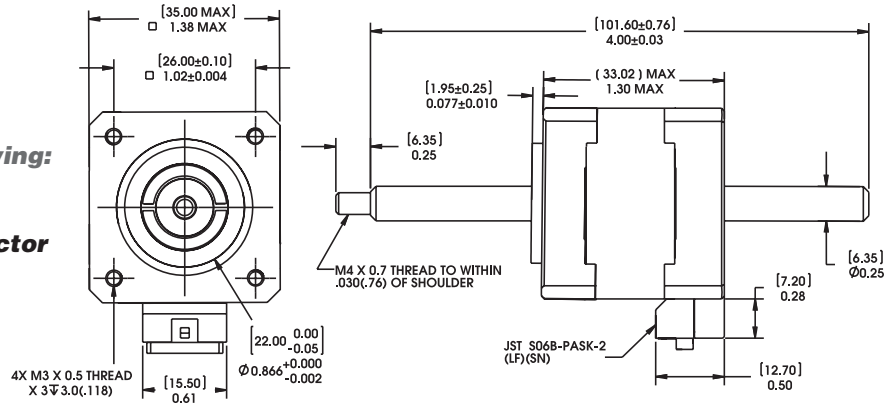
Dimensional Drawing: Series 28000 Size 11 with Integrated Connector



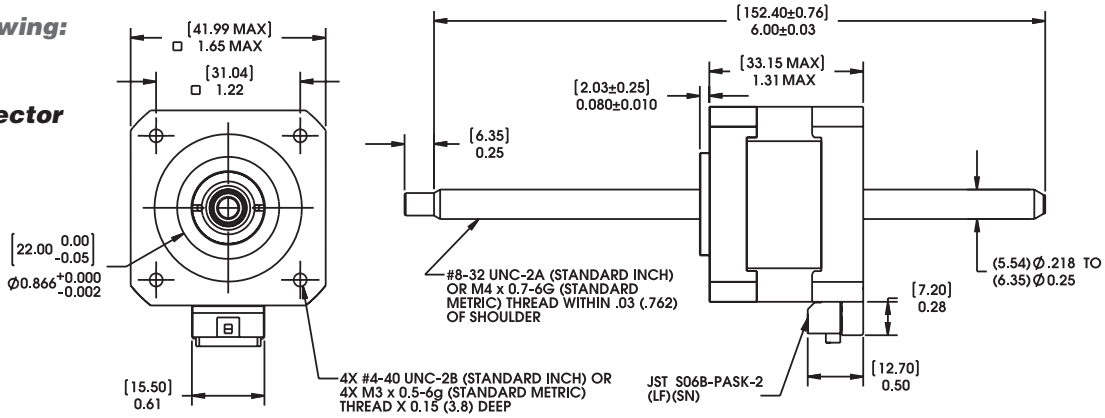
Mating Connector:
JST part number PAP-06V-S
Wire to Board Connector:
JST part number SPHD-001T-P0.5

Pin #	Bipolar	Unipolar
1	Phase 2 Start	Phase 2 Start
2	Open	Phase 2 Common
3	Phase 2 Finish	Phase 2 Finish
4	Phase 1 Finish	Phase 1 Finish
5	Open	Phase 1 Common
6	Phase 1 Start	Phase 1 Start

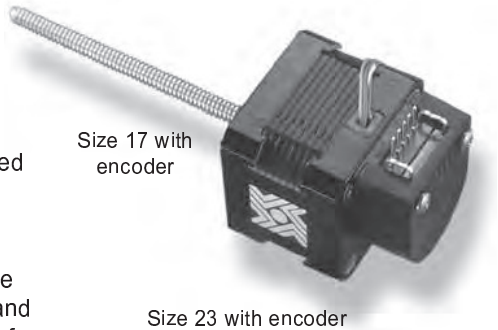
Dimensional Drawing: 35000 Series Size 14 with Integrated Connector



Dimensional Drawing: 43000 Series Size 17 with Integrated Connector



Encoders designed for all sizes of hybrid linear actuators



Size 17 with encoder

Size 23 with encoder

All Haydon™ hybrid linear actuators are available with specifically designed encoders for applications that require feedback. The compact optical incremental encoder design is available with two channel quadrature TTL squarewave outputs. An optional index is also available as a 3rd channel. The Size 8 encoder provides resolutions for applications that require 250 and 300 counts per revolution. The Size 11, 14 and 17 encoder provides resolutions for applications that require 200, 400 and 1,000 counts per revolution. The Size 23 and 34 encoder is offered in resolutions of 200, 400, 1,000 and 2,000 counts per revolution. Encoders are available for all motor configurations – captive, non-captive and external linear.

Simplicity and low cost make the encoders ideal for both high and low volume motion control applications. The internal monolithic electronic module converts the real-time shaft angle, speed, and direction into TTL compatible outputs. The encoder module incorporates a lensed LED light source and monolithic photodetector array with signal shaping electronics to produce the two channel bounceless TTL outputs.

Electrical Specifications

	Minimum	Typical	Maximum	Units
Input voltage	4.5	5.0	5.5	VDC
Output signals	4.5	5.0	5.5	VDC

- 2 channel quadrature TTL squarewave outputs.
- Channel B leads A for a clockwise rotation of the rotor viewed from the encoder cover.
- Tracks at speeds of 0 to 100,000 cycles/sec.
- Optional index available as a 3rd channel (one pulse per revolution).

Operating Temperature

	Minimum	Maximum
Size 8	- 10°C (14°F)	85°C (185°F)
Size 11, 14, 17, 23, 34	- 40°C (- 40°F)	100°C (212°F)

Mechanical Specifications

	Maximum
Acceleration	250,000 rad/sec^2
Vibration (5 Hz to 2 kHz)	20 g

Resolution

4 standard Cycles Per Revolution **(CPR)** or *Pulses Per Revolution* ***(PPR)***

Size 8 Encoder

CPR	250	300
PPR	*1000*	*1200*

Size 11, 14 & 17 Encoders

CPR	200	400	1000*
PPR	*800*	*1600*	*4000**

Others are available.

Size 23 and 34 Encoders

CPR	200	400*	1000	2000
PPR	*800*	*1600**	*4000*	*8000*

*Index Pulse Channel not available.

Single Ended Encoder Pinout Size 8

Connector Pin #	Description
1	+5 VDC Power
2	Channel A
3	Ground
4	Channel B

Single Ended Encoder Pinout Size 11, 14, 17 23, 34

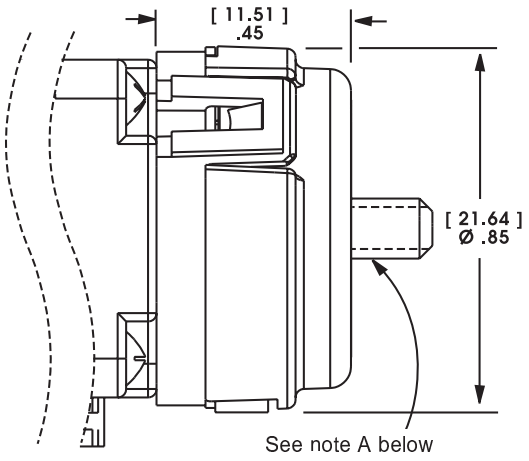
Connector Pin #	Description
1	Ground
2	Index (optional)
3	Channel A
4	+5 VDC Power
5	Channel B

Differential Ended Encoder Pinout Size 11, 14, 17 23, 34

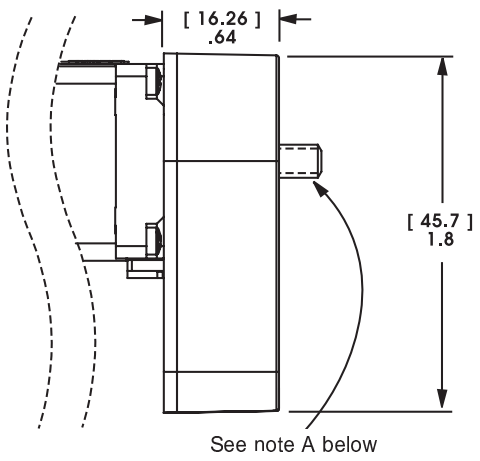
Connector Pin #	Description
1	Ground
2	Ground
3	– Index
4	+ Index
5	Channel A –
6	Channel A +
7	+5 VDC Power
8	+5 VDC Power
9	Channel B –
10	Channel B +

Encoder Dimensional Drawings

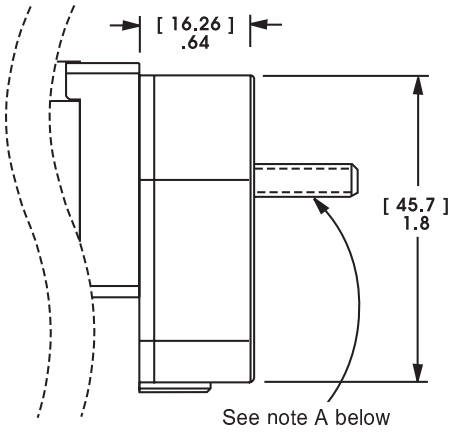
E4 21000 Series Size 8



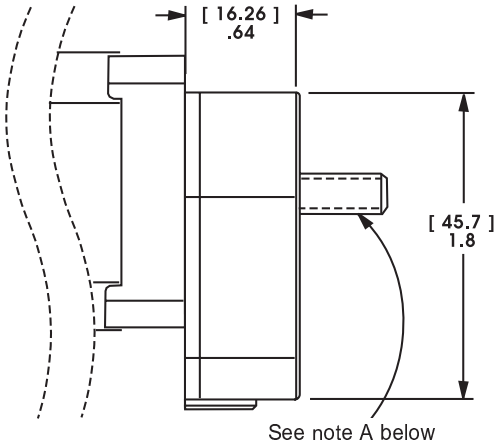
E5 28000 Series Size 11



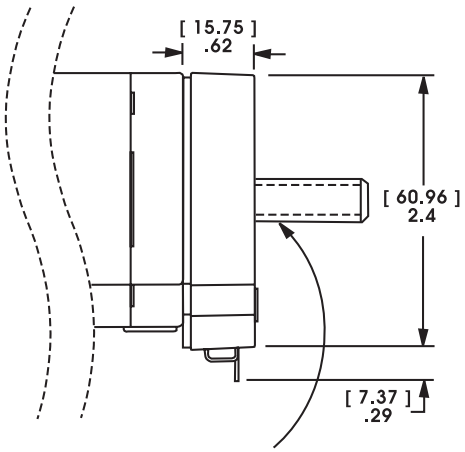
E5 35000 Series Size 14



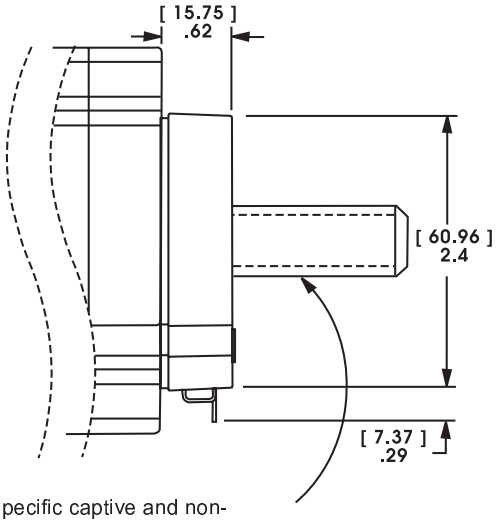
E5 43000 Series Size 17



E3 57000 Series Size 23



E3 87000 Series Size 34



Note A: Leadscrew extends beyond encoder on specific captive and non-captive motors. External linear shaft extension is available upon request.

Encoder Ready Option for all sizes of Hybrids

Haydon Hybrid Linear Actuators can now be manufactured as an encoder ready actuator. These encoder ready actuators can be used to install several popular hollow shaft encoders. They are available with an extended rotor journal and a threaded rear housing. The motors use a proprietary manufacturing process which incorporates engineering thermoplastics in the rotor drive nut and a stainless steel Acme leadscrew that allows the motor to be much more efficient and durable than today's more commonly used V-thread/bronze nut configurations.

Extended Rotor Journal for all Hybrid sizes

Haydon Hybrid Linear Actuators are available with an extended rotor journal. This extended rotor journal can be used for encoder installation, manual adjustment, or flag installation for a positioning sensor.

Size 23 Mounting Face Plate for Size 17 Hybrids

Haydon Kerk Motion Solutions, Inc. offers a size 23 mounting pattern for its hybrid Size 17 linear actuators. The advantage of using this configuration is to replace existing costly, inefficient Size 23 linear actuators with a lower cost, high performance Size 17 motor.

Home Position Switch for all Hybrids (except Size 8)

A miniature electronic home position switch capable of monitoring the home positions of linear actuators. The switch mounts on the rear sleeve of captive linear motors and allows the user to identify start, stop or home postions. When ordering motors with the home position switch, the part number should be preceded by an "S" prefix.

End of Stroke Proximity Sensor for all sizes of Hybrids

The sensor incorporates a hall effect device, which is activated by a rare earth magnet embedded in the end of the internal screw. The compact profile of the sensor allows for installation in limited space applications.

The sensor has virtually unlimited cycle life. Special cabling and connectors can also be provided. When ordering motors with the proximity sensor, the part number should be preceded by a "P" prefix.

Black Ice™ Teflon® Coated Leadscrews for all Hybrids (certain conditions apply)

Where applications require the use of a "greaseless" screw and nut interface Haydon Kerk Motion Solutions™ offers Teflon® coated leadscrews.

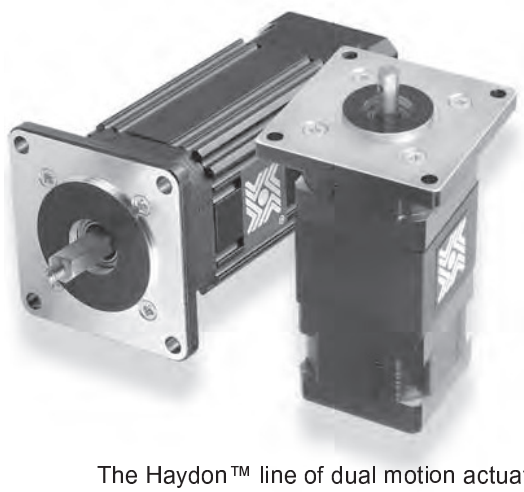
A "dry" (non-lubricated) Teflon coated leadscrew provides improved performance in both life and thrust as compared to a conventional stainless steel leadscrew. Teflon can be applied to a wide variety of lead-screw pitches and is available for Haydon™ brand captive, non-captive and external linear linear actuators.

Integrated Anti-backlash Nut for all Hybrids (except Size 34)

All sizes (except Size 34) of captive and non-captive hybrid stepper motors can be equipped with an integral anti-backlash feature.

There is a normal backlash between the lead screw and integral rotor nut. Haydon™ actuators are designed for millions of cycles. However, over time additional backlash could increase and eventually double. Haydon Kerk Motion Solutions™ Integrated Anti-backlash nut can eliminate all backlash. Designed specifically for the Haydon captive and non-captive hybrid motors, these nuts use an opposing spring force to eliminate backlash between the screw and the nut interface. The nuts will self-compensate and accommodate any wear.

Haydon Kerk Motion Solutions™ application engineers can help you select the appropriate preload for your application.



A single unit that axially moves a component to an insertion position and then rotates it

In certain applications, it is required to have both rotary and linear motion. Such an application, for example, is in the robotic picking and placing of components where it may be required to axially move a component to an insertion position and then rotate the component to screw it in place. Another type of application requiring a shaft, which may selectively rotate and/or reciprocate, is in the precise control of laparoscopic and other such medical instruments.

In either type of application, it is frequently required that the linear motion be locked while rotary motion takes place. Conventional motor arrangements are often complicated and heavy, a substantial disadvantage for robotics applications. A problem with motors having linear motion is that the motors frequently provide inadequate output shaft support when heavy side loads are imposed on the output shafts.

The Haydon™ line of dual motion actuators provides independent linear and rotary motion from a compact package. The actuators are based on unique, patented designs and incorporate proven motor technology. These units simplify product development by replacing what would otherwise be far more bulky and complex mechanisms. Another feature of this design is to provide an electric motor in which linear and rotary motions are controllable independently of one another.

A limitless number of operating parameters are offered allowing each device to be custom manufactured according to customer specific application requirements. For a rotary/linear motor, it is desirable that the linear and rotary motions be controllable independently of one another. These devices can be run using a standard two axis stepper motor driver. Performance can be enhanced using chopper and/or microstepping drives.

For linear actuator data for the dual motion actuators please see the 35000 Series (Size 14) and 43000 Series (Size 17) hybrid linear actuators sections of this catalog. The curves for the rotary portion of the motors appear in the pages that follow.

Part Number Construction: Dual Motion Actuators

LR	35	K	H	4	J	–	05	–	910

Prefix

LR = Linear/ Rotary

Series number designation

35 = 35000
Available Series:
35000
43000

(Series numbers represent width^2 of motor body)

Rotary Step Angle

H = 1.8°
K = 0.9°
M = 1.8° Double Stack
P = 0.9° Double Stack

Linear Step Angle

H = 1.8°
K = 0.9°
M = 1.8° Double Stack
P = 0.9° Double Stack

Coils

4 = Bipolar (4 wire)
6 = Unipolar (6 wire)

Code ID Resolution Travel/Step

(Example: J = travels .00048-in per step)

(Refer to travel /step chart found on each Series product page.)

Voltage

(Example: 05 = 5 VDC; 12 = 12 VDC) Custom V available

Suffix:

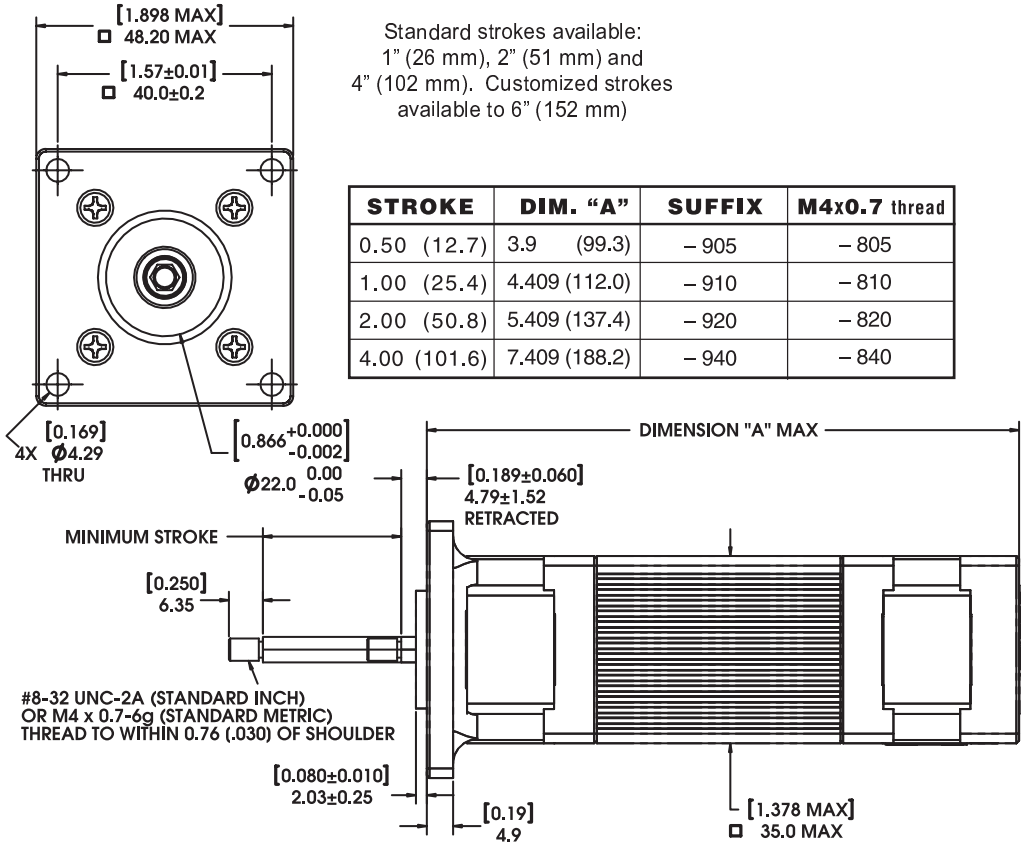
Stroke
Example: –910 = 1-in (26 mm)

–XXX = Special or custom
(Special part numbers for custom screw lengths and design options will require an issued 3 digit suffix number. Please contact our sales or applications engineering department for assistance.)

EXAMPLE:

LR35KH4AB-05-910 = Dual motion, 35000 Series (Size 14, 1.5-in, 35 mm sq.), 0.9° rotary, 1.8° linear, bipolar coils, .00048-in (0.0121 mm), 5 Volts DC, 1-in (26 mm) stroke

Dimensional Drawings



Standard strokes available: 1" (26 mm), 2" (51 mm) and 4" (102 mm). Customized strokes available to 6" (152 mm)

STROKE	DIM. "A"	SUFFIX	M4x0.7 thread
0.50 (12.7)	3.9 (99.3)	– 905	– 805
1.00 (25.4)	4.409 (112.0)	– 910	– 810
2.00 (50.8)	5.409 (137.4)	– 920	– 820
4.00 (101.6)	7.409 (188.2)	– 940	– 840

Technical Specification

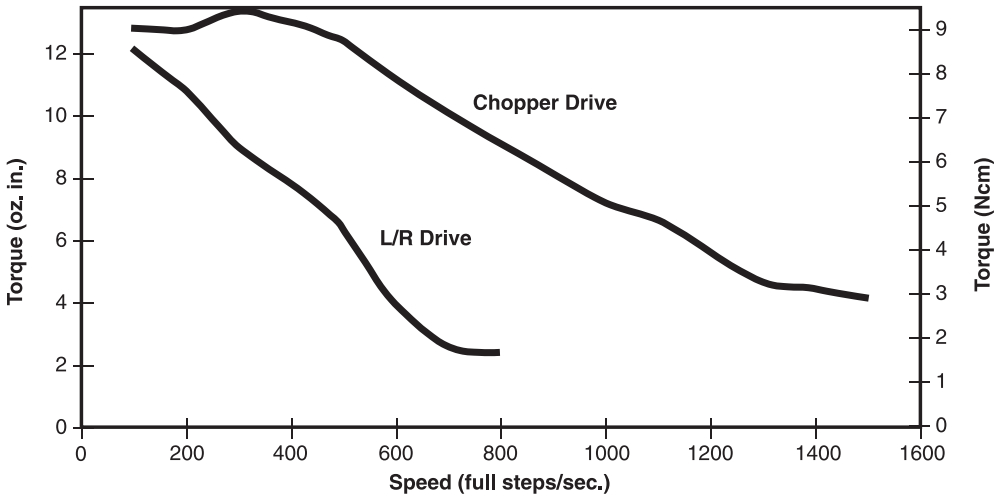
Linear Travel / Step inches	mm	Order Code I.D.
0.000098*	0.0025	AA
0.00012	0.0030*	N
0.00019*	0.005	AB
0.00024	0.0060*	K
0.00039*	0.01	AC
0.00048	0.0121*	J
0.00078*	0.02	AD
0.00157*	0.04	AE

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

35000 Series Size 14 • Rotary Function • Bipolar • 100% Duty Cycle

Torque curves for 35000 Series Linear Actuators. See FORCE/SPEED curves for 35000 Series Linear Actuator on pages 68 and 69.



NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

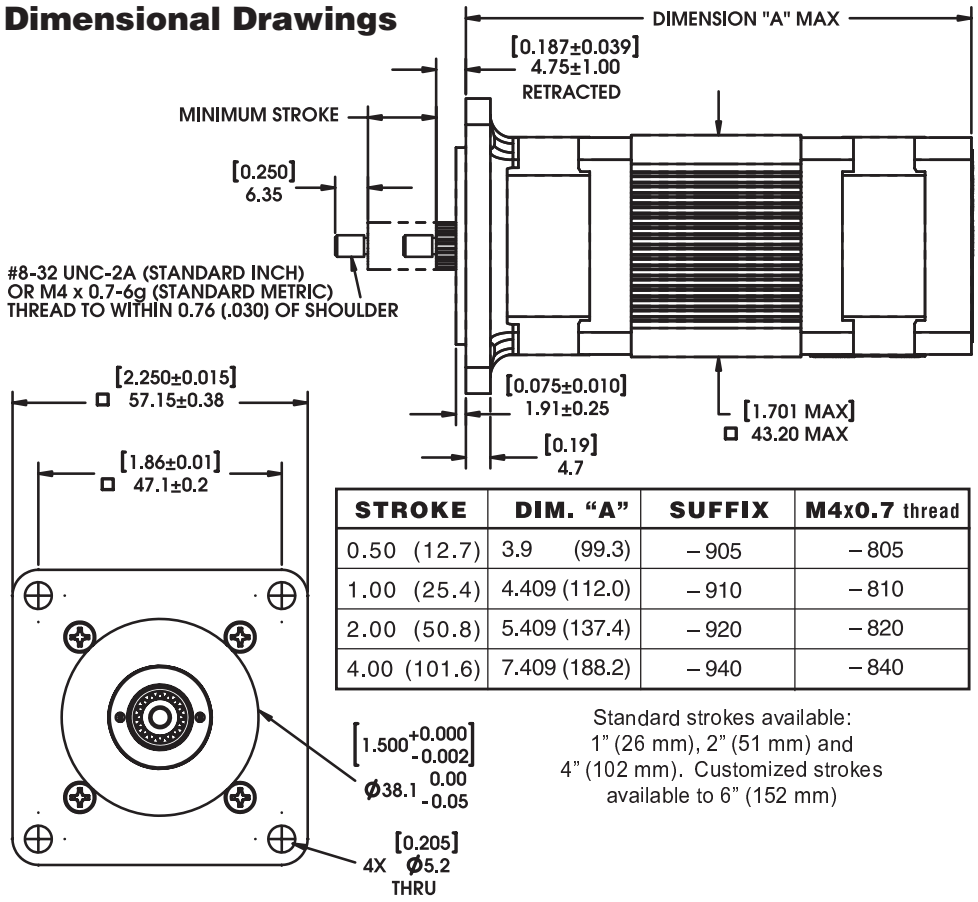
Technical Specification

Linear Travel / Step inches	Linear Travel / Step mm	Order Code I.D.
0.000078*	0.00198*	V
0.00012	0.0030*	N
0.000156259	0.0039*	P
0.0003125	0.0079*	A
0.0004167	0.0105*	S
0.00048	0.0121*	J
0.0005	0.0127	3
0.000625	0.0158*	B
0.00078*	0.02	AD
0.0008333	0.0211*	T
0.00096	0.0243*	Q
0.001	0.0245	1
0.00125	0.0317*	C
0.00192	0.0487*	R
0.002	0.0508	2

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Dimensional Drawings

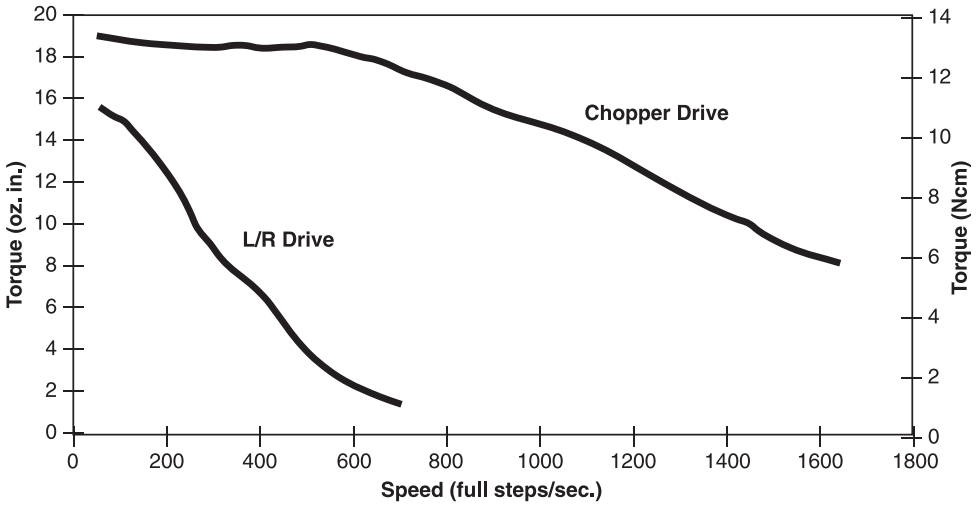


STROKE	DIM. "A"	SUFFIX	M4x0.7 thread
0.50 (12.7)	3.9 (99.3)	– 905	– 805
1.00 (25.4)	4.409 (112.0)	– 910	– 810
2.00 (50.8)	5.409 (137.4)	– 920	– 820
4.00 (101.6)	7.409 (188.2)	– 940	– 840

Standard strokes available: 1" (26 mm), 2" (51 mm) and 4" (102 mm). Customized strokes available to 6" (152 mm)

43000 Series Size 17 • Rotary Function • Bipolar • 100% Duty Cycle

Torque curves for 43000 Series Linear Actuators. See FORCE/SPEED curves for 43000 Series Linear Actuator on pages 77 and 78.



NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.