Overview of Hybrid Linear Actuators

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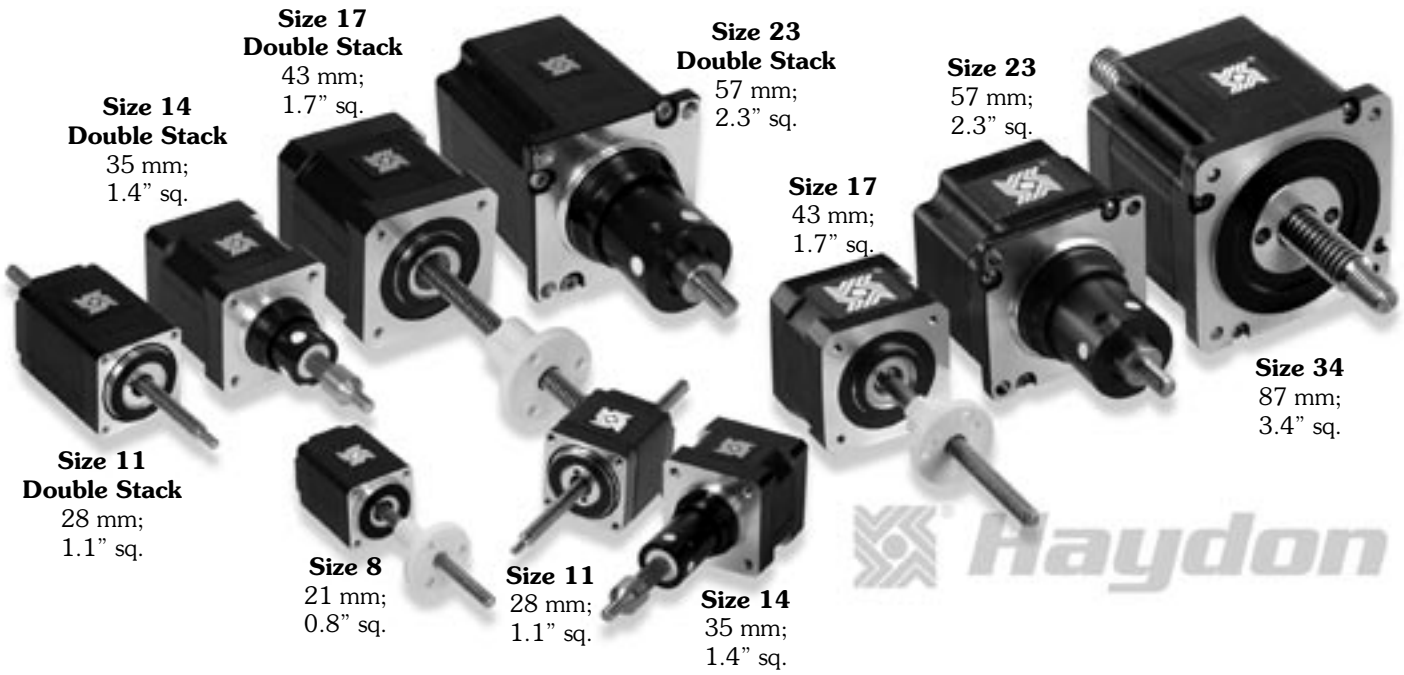


Haydon's line of hybrid linear actuators open new avenues for equipment designers who require high performance and exceptional endurance in a very small package. The various patented designs use a proprietary manufacturing process, which incorporates engineering thermoplastics in the rotor drive nut and a stainless steel acme lead screw. 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.

Haydon 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.

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 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 Part Numbers: Hybrids

A standard Haydon motor part number consists of 7 digits to 10 digits – XXXXX-VV-XXX.

- The **first two** digits indicate the motor's series or size (in mm). *Example: **35**000 Series = **35** mm sq.*
- The **third** digit or letter indicates the motor's step angle *Example: F = 1.8° non-captive; H = 1.8° captive or external linear; J = .9° non-captive; K = .9° captive or external linear*
  (NOTE: External linear actuators have the prefix "E" to distinguish them from the captive actuators; High Temperature actuators require the prefix "T")
- The **fourth** digit indicates number of leads. (4 = leads for bipolar; 6 = leads for unipolar).
- The **fifth** digit indicates the travel per step (see chart) *Example: N = .00012" (.003048 mm)*
- The **sixth and seventh** digits indicate the motor's voltage. Standard voltages are 5 (05) and 12 (12) V. We also have low inductance coils available for chopper drives. Custom voltages are also available.
- Digits **eight, nine, ten** indicate captive motor travel:

For Standard Captive Motor Travel:

–904 = .354" (9.0) travel... *(ONLY for Size 8 motor)*
–905 = 1/2" (12.7) travel
–907 = 3/4" (19.1) travel
–910 = 1" (25.4) travel
–912 = 1 1/4" (31.8) travel
–915 = 1 1/2" (38.1) travel
–920 = 2" (50.8) travel
–925 = 2 1/2" (63.5) travel
–900 = Standard External Linear Motor with grease and flanged nut

For Metric Captive Motor Travel:

–804 = 9.0 mm (.354") travel... *(ONLY for Size 8 motor)*
–805 = 12.7 mm (1/2") travel
–807 = 19.1 mm (3/4") travel
–810 = 25.4 mm (1") travel
–812 = 31.8 mm (1 1/4") travel
–815 = 38.1 mm (1 1/2") travel
–820 = 50.8 mm (2") travel
–825 = 63.5 mm (2 1/2") travel

SCREW LENGTH OPTIONS: For non-captive shaft and external linear motors various screw lengths are available to accommodate any travel requirement.

Travel Per Step Code Letter or Digit	Linear Travel Per Step		21000 Series Size 8 21 mm	28000 Series Size 11 28 mm	35000 Series Size 14 35 mm		43000 Series Size 17 43 mm		57000 Series Size 23 57 mm	87000 Series Size 34 87 mm
	Inches	Millimeters	Ø .138" (3.50) Screw	Ø .1875" (4.76) Screw	Ø .218" (5.54) Screw	Ø .250" (6.35) Screw	Ø .218" (5.54) Screw	Ø .250" (6.35) Screw	Ø .375" (9.53) Screw	Ø .625" (15.88) Screw
U	0.00006	0.0015*	●		▲		▲			
V	0.000078*	0.0020*				▲		▲		
AA	0.000098*	0.0025	●							
N	0.00012	0.0030*	●		●▲		●▲			
7	0.000125	0.0031*		●					▲	
P	0.00015625	0.0039*				●▲		●▲	▲	
AB	0.00019*	0.005	●							
X	0.00020833	0.0053*							▲	
K	0.00024	0.0060*	●		●▲		●▲			
9	0.00025	0.0063*		●					▲	
A	0.0003125	0.0079*				●▲		●▲	●	
AC	0.00039*	0.01	●							
S	0.0004167	0.0105*							●▲	
J	0.00048	0.0121*	●		●▲		●▲			
3	0.0005	0.0127		●					●▲	●
B	0.000625	0.0158*				●▲		●▲		●
AD	0.00078*	0.02	●							
T	0.0008333	0.0211*							●	
Q	0.00096	0.0243*			●▲		●▲			
1	0.001	0.0254		●					●▲	
C	0.00125	0.0317*				●		●		●
AE	0.00157*	0.04	●							
R	0.00192	0.0487*			●		●			
2	0.002	0.0508		●					●	
Y	0.0025	0.0635								●
AG	0.00375	0.0953								
Z	0.005	0.127								●

● **Standard Motor** ▲ **High Resolution Motor** *Values truncated

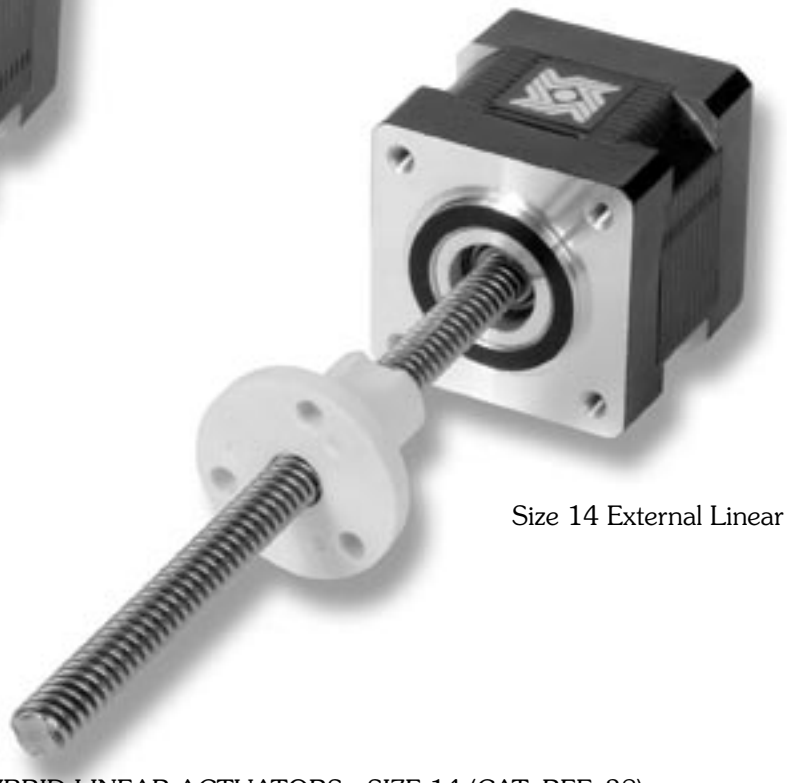
35000 Series Size 14 Linear Actuator

Haydon's Series 35000 Size 14 hybrid linear actuators have been improved to provide higher force, longer life and improved performance. 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 35000 Series is available in a wide variety of resolutions - from 0.00012" (.003048 mm) per step to 0.00192" (.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 Non-Captive Shaft

Size 14 Captive Shaft



Size 14 External Linear

Series 35000 Size 14 Linear Actuator

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Salient Characteristics

Size 14: 35 mm (1.4") 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**	
Operating 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) 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			

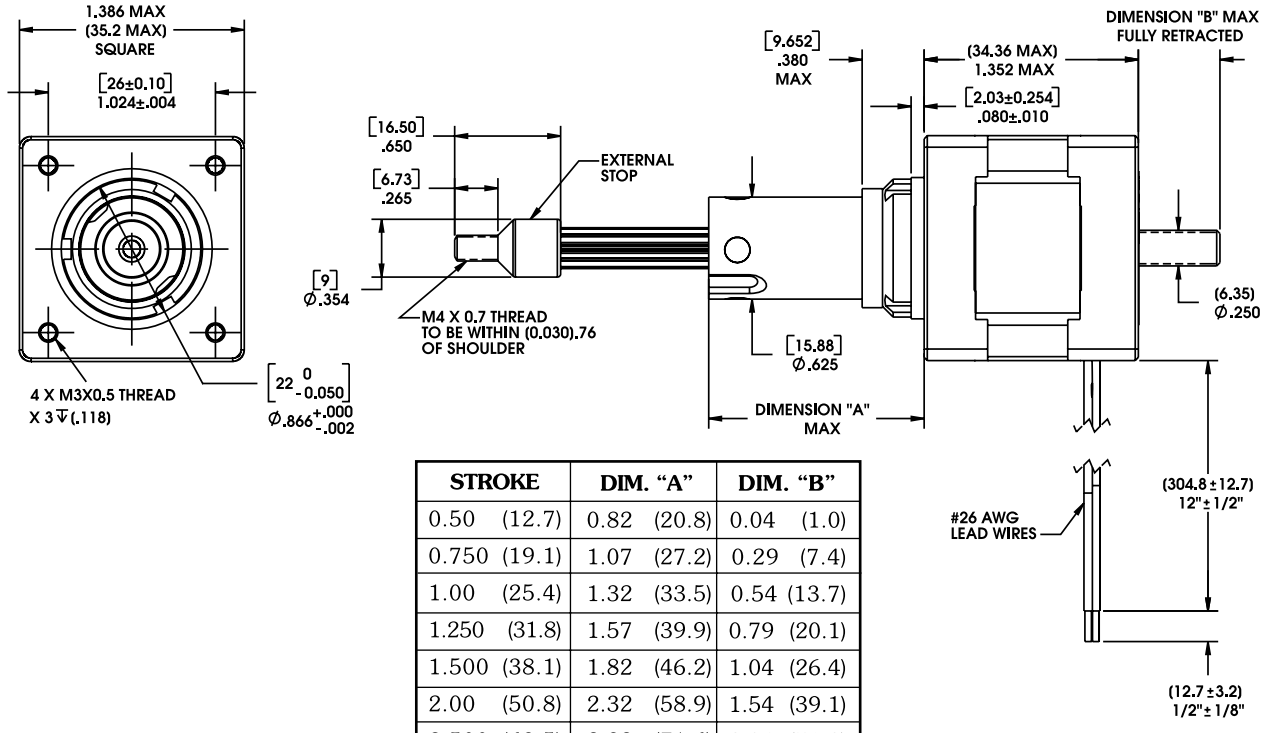
*Values truncated

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

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

Series 35000 Size 14 Dimensional Drawings

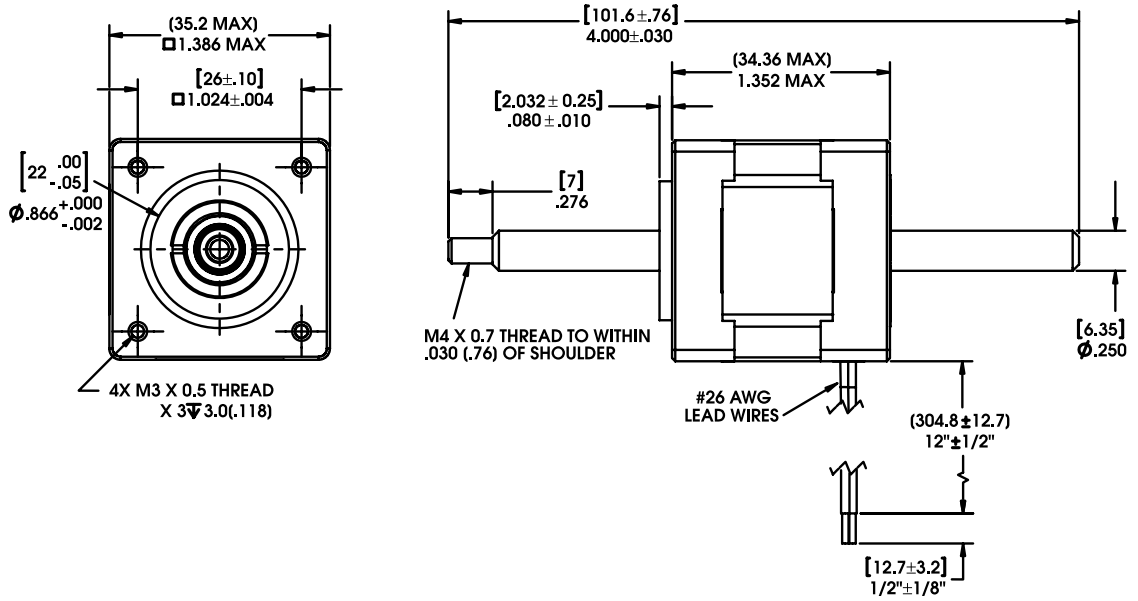
Captive Shaft



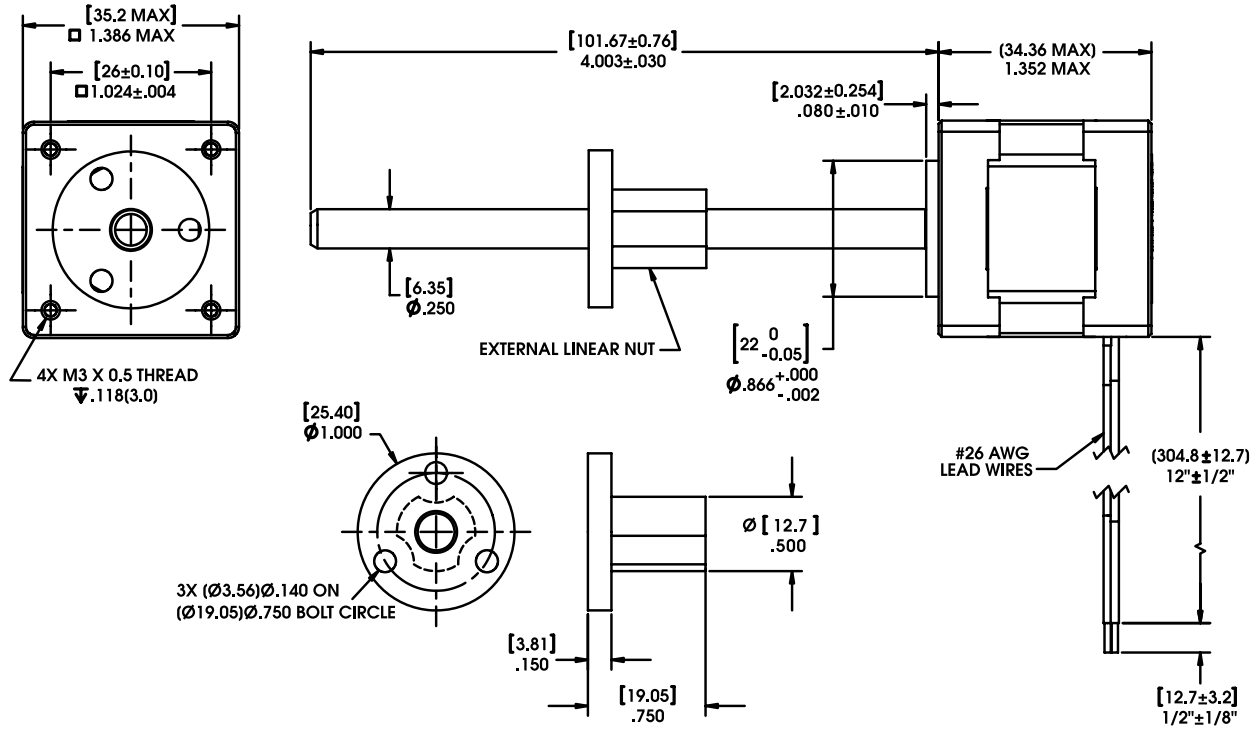
STROKE		DIM. "A"		DIM. "B"	
0.50	(12.7)	0.82	(20.8)	0.04	(1.0)
0.750	(19.1)	1.07	(27.2)	0.29	(7.4)
1.00	(25.4)	1.32	(33.5)	0.54	(13.7)
1.250	(31.8)	1.57	(39.9)	0.79	(20.1)
1.500	(38.1)	1.82	(46.2)	1.04	(26.4)
2.00	(50.8)	2.32	(58.9)	1.54	(39.1)
2.500	(63.5)	2.82	(71.6)	2.04	(51.8)

Series 35000 Size 14 Dimensional Drawings

Non-Captive Linear



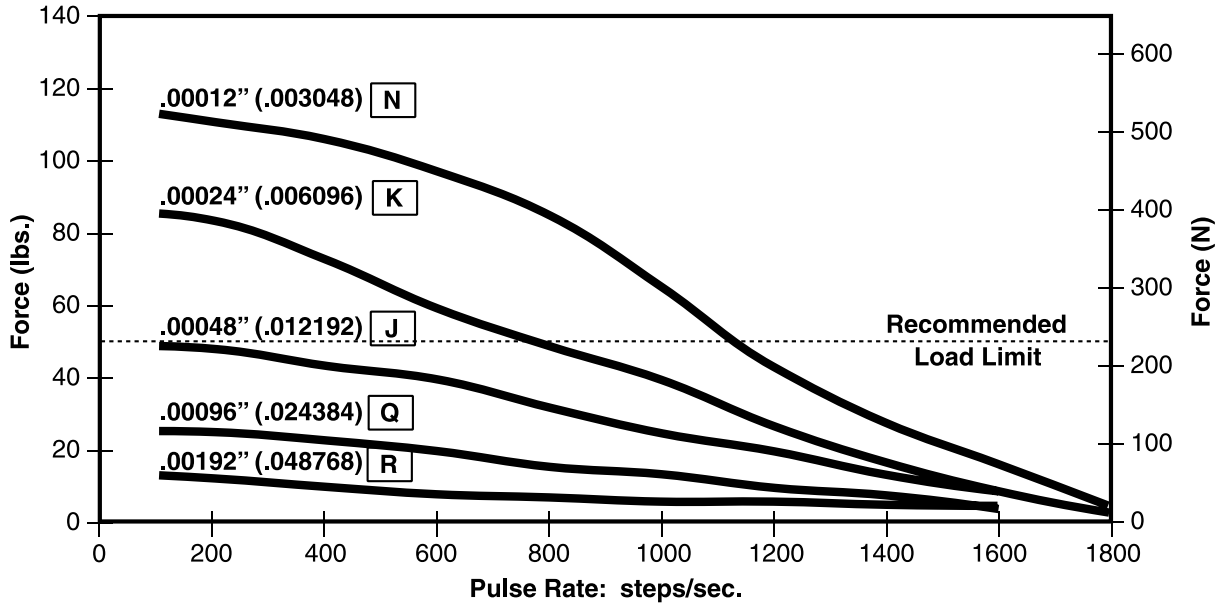
External Linear



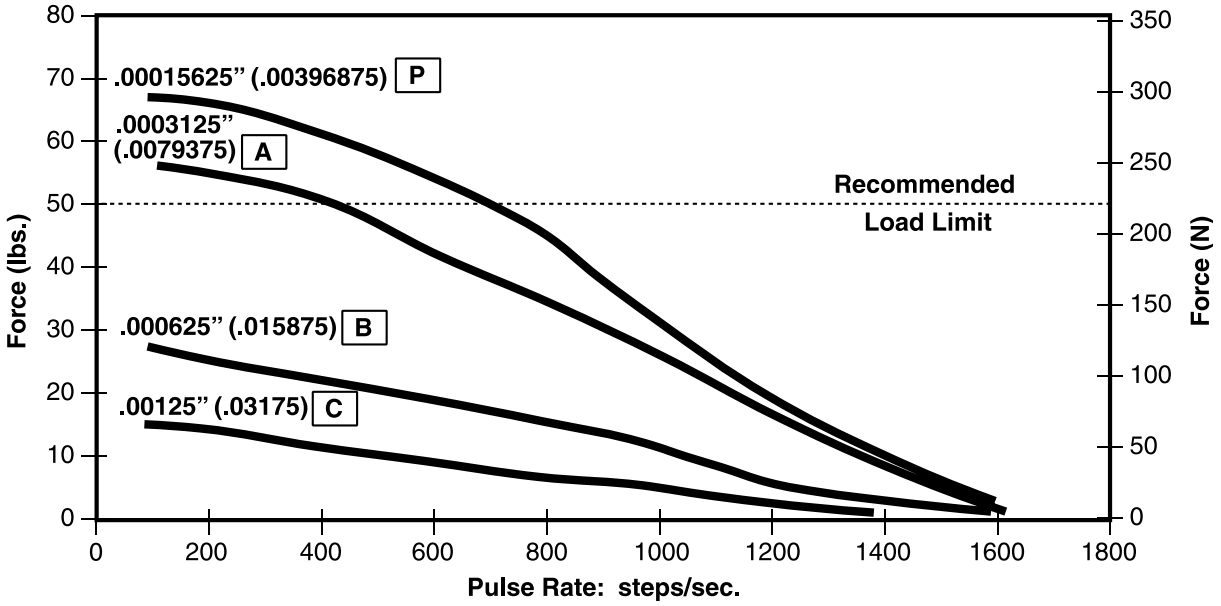
Series 35000 Size 14 Speed Curves

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.

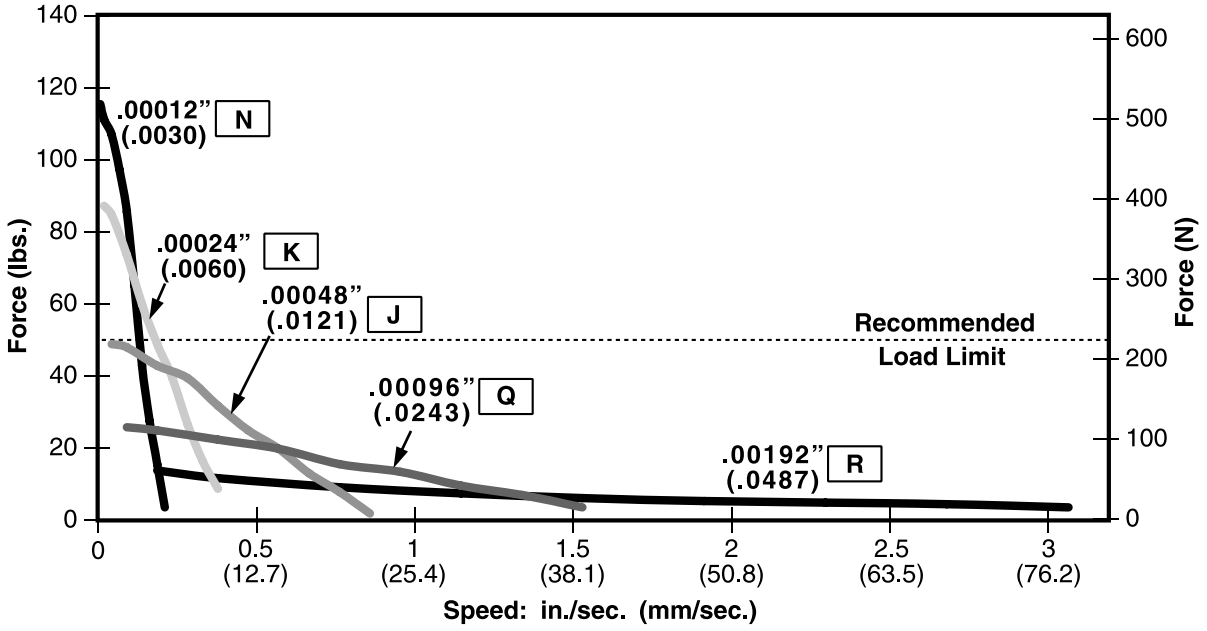
Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

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

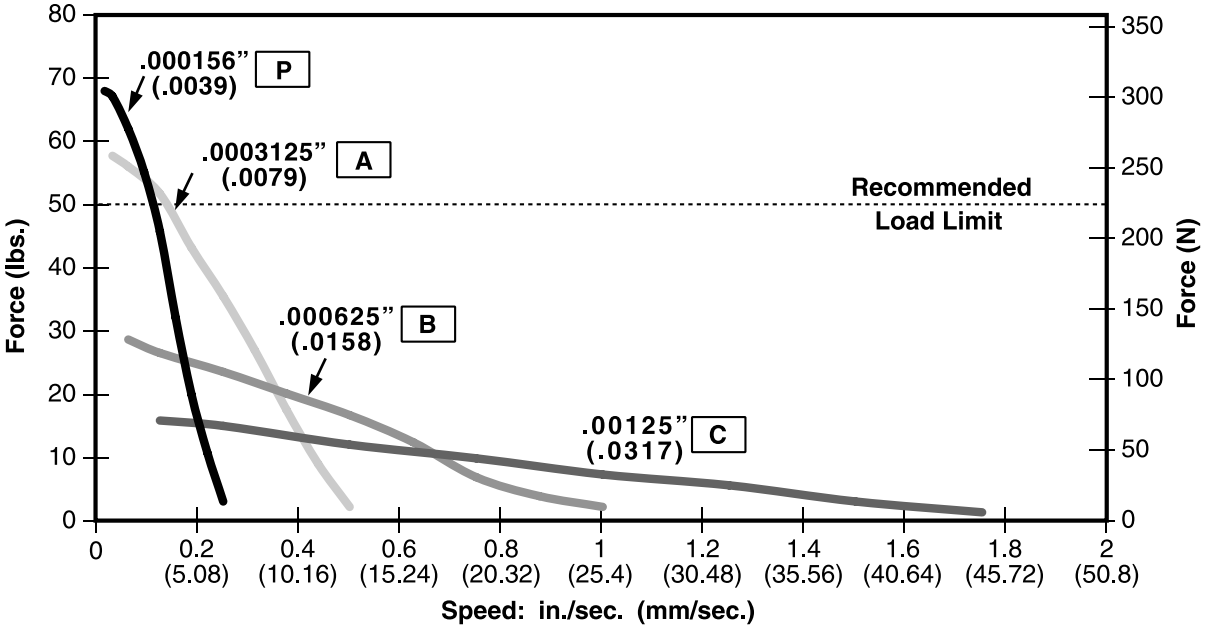
Series 35000 Size 14 Speed Curves

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.

High Resolution Size 14 Linear Actuator

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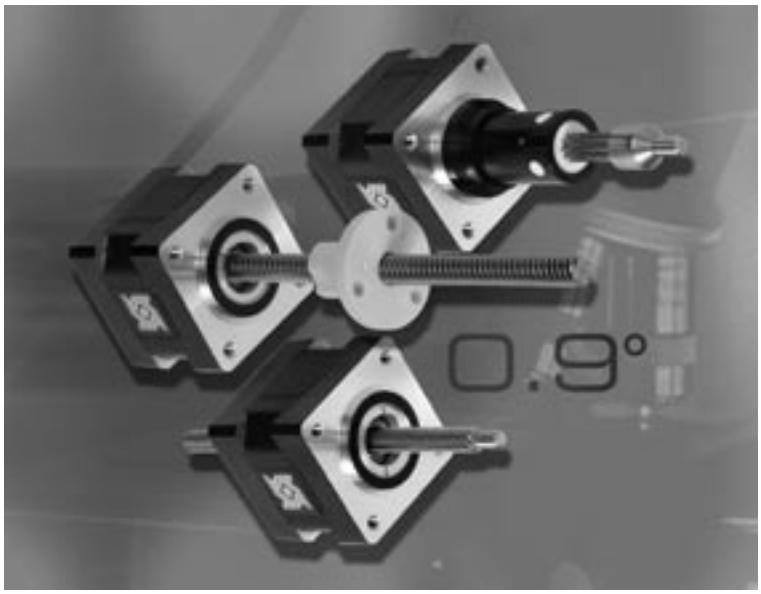


This Haydon Series 35000 Size 14, 0.9° high resolution (standard resolution = 1.8°) motor has been engineered to precisely deliver reliable high speed, force, up to 50 lbs (222 N), as well as a full step movement as low as 1.5 microns. These compact units provide a cost effective solution for engineers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

Salient Characteristics

Size 14: 43 mm (1.4") 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**	
Operating 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.

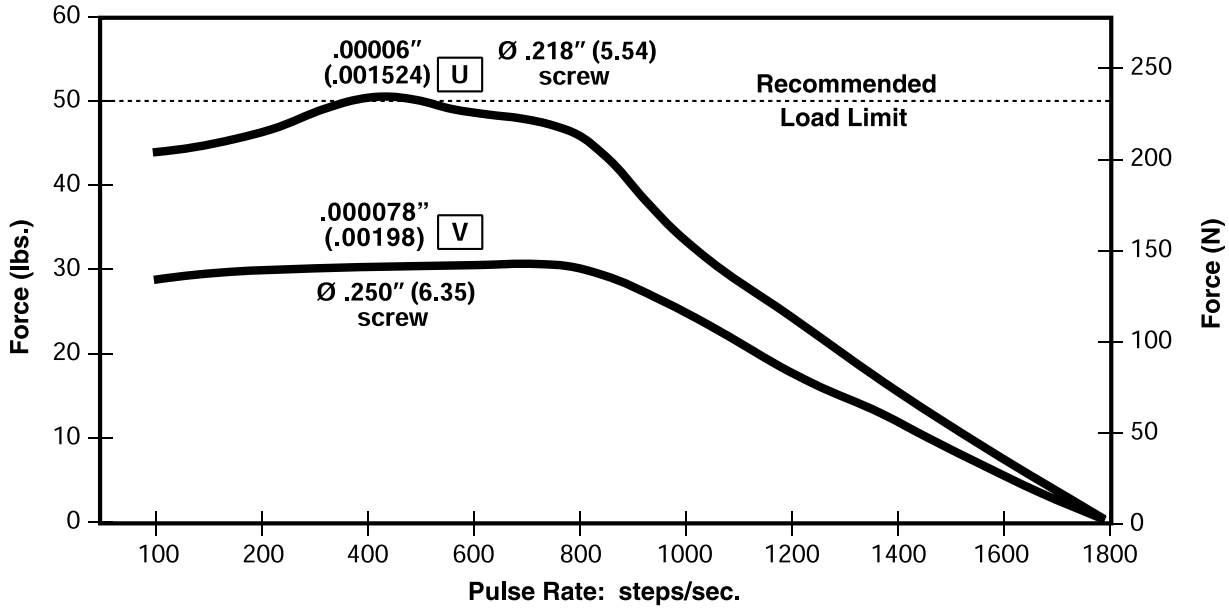
Linear Travel / Step					
Screw Ø .218" (5.54 mm) inches	mm	**Order Code I.D.**	Screw Ø .250" (6.35 mm) inches	mm	**Order Code I.D.**
.00006	.0015*	U	.000078*	.00198*	V
.00012	.0030*	N	.00015625	.0039*	P
.00024	.0060*	K	.0003125	.0079*	A
.00048	.0121*	J	.000625	.0158*	B
.00096	.0243*	Q			

*Values truncated

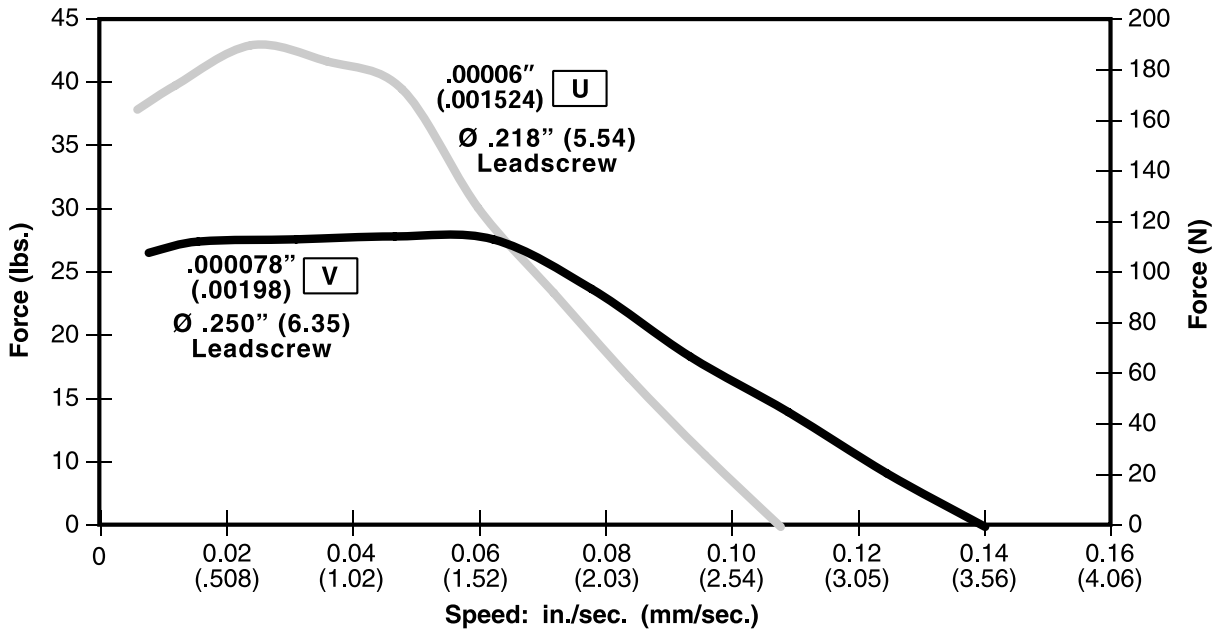
Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

Series 35000 Size 14 Hi-Res Speed Curves

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



FORCE vs. LINEAR VELOCITY Bipolar • Chopper • 100% Duty Cycle



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.

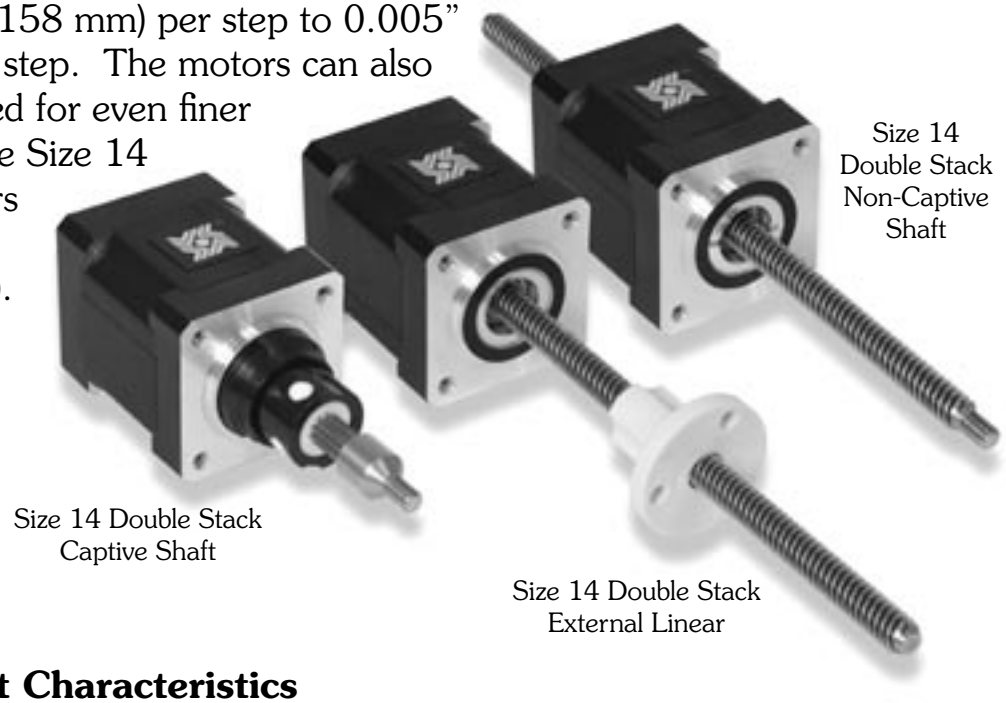
With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

35000 Double Stack Series Size 14 Linear Actuator

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

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 35000 Series is available in a wide variety of resolutions - from 0.000625" (.0158 mm) per step to 0.005" (.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).



Size 14 Double Stack Non-Captive Shaft

Size 14 Double Stack Captive Shaft

Size 14 Double Stack External Linear

Salient Characteristics

Size 14: 3 mm (1.4") 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		
Operating 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.

Identifying Part Numbers: Hybrid Double Stack

A Double Stack Haydon motor part number consists of 7 digits to 10 digits – XXXXX-VV-XXX.

- The **first two** digits indicate the motor's series or size (in mm). *Example: **35**000 Series = **35** mm sq.*
- The **third** digit or letter indicates the double stack motor's step angle: *Example: L = 1.8° non-captive; M = 1.8° captive or external linear; N = .9° non-captive; P = .9° captive or external linear* (NOTE: External linear actuators have the prefix "E" to distinguish them from the captive actuators; High Temperature actuators require the prefix "T")
- The **fourth** digit indicates number of leads. (4 = leads for bipolar; 6 = leads for unipolar).
- The **fifth** digit indicates the travel per step (see chart) *Example: 9 = .00025" (.0063 mm)*
- The **sixth and seventh** digits indicate the motor's voltage. Standard voltages are 5 (05) and 12 (12) V. We also have low inductance coils available for chopper drives. Custom voltages are also available.
- Digits **eight, nine, ten** indicate captive motor travel:

For Double Stack Captive Motor Travel:

–**905** = 1/2" (12.7) travel
–**907** = 3/4" (19.1) travel
–**910** = 1" (25.4) travel
–**912** = 1 1/4" (31.8) travel
–**915** = 1 1/2" (38.1) travel
–**920** = 2" (50.8) travel
–**925** = 2 1/2" (63.5) travel
–**900** = Standard External Linear Motor with grease and flanged nut

For Metric Double Stack Captive Motor Travel:

–**804** = 9.0 mm (.354") travel... *(ONLY for Size 8 motor)*
–**805** = 12.7 mm (1/2") travel
–**807** = 19.1 mm (3/4") travel
–**810** = 25.4 mm (1") travel
–**812** = 31.8 mm (1 1/4") travel
–**815** = 38.1 mm (1 1/2") travel
–**820** = 50.8 mm (2") travel
–**825** = 63.5 mm (2 1/2") travel

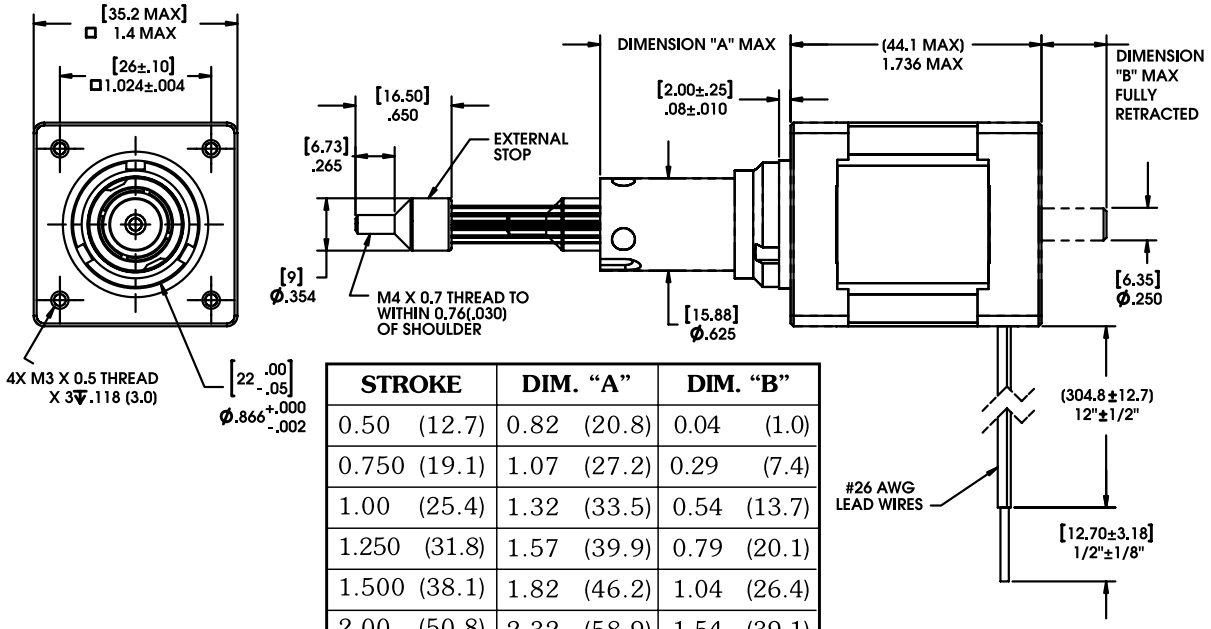
SCREW LENGTH OPTIONS: For non-captive shaft and external linear motors various screw lengths are available to accommodate any travel requirement.

Travel Per Step Code Letter or Digit	Linear Travel Per Step		28000 DS Series Size 11 28 mm	35000 DS Series Size 14 35 mm	43000 DS Series Size 17 43 mm	57000 DS Series Size 23 57 mm
	Inches	Millimeters	Ø .1875" (4.76) Screw	Ø .250" (6.35) Screw	Ø .250" (6.35) Screw	Ø .375" (9.53) Screw
7	0.000125	0.0031*	●			
9	0.00025	0.0063*	●			
3	0.0005	0.0127	●			●
B	0.000625	0.0158*		●	●	
1	0.001	0.0254	●			●
C	0.00125	0.0317*		●	●	
2	0.002	0.0508	●			●
Y	0.0025	0.0635		●	●	●
AG	0.00375	0.0953		●	●	
Z	0.005	0.127		●	●	●

*Values truncated

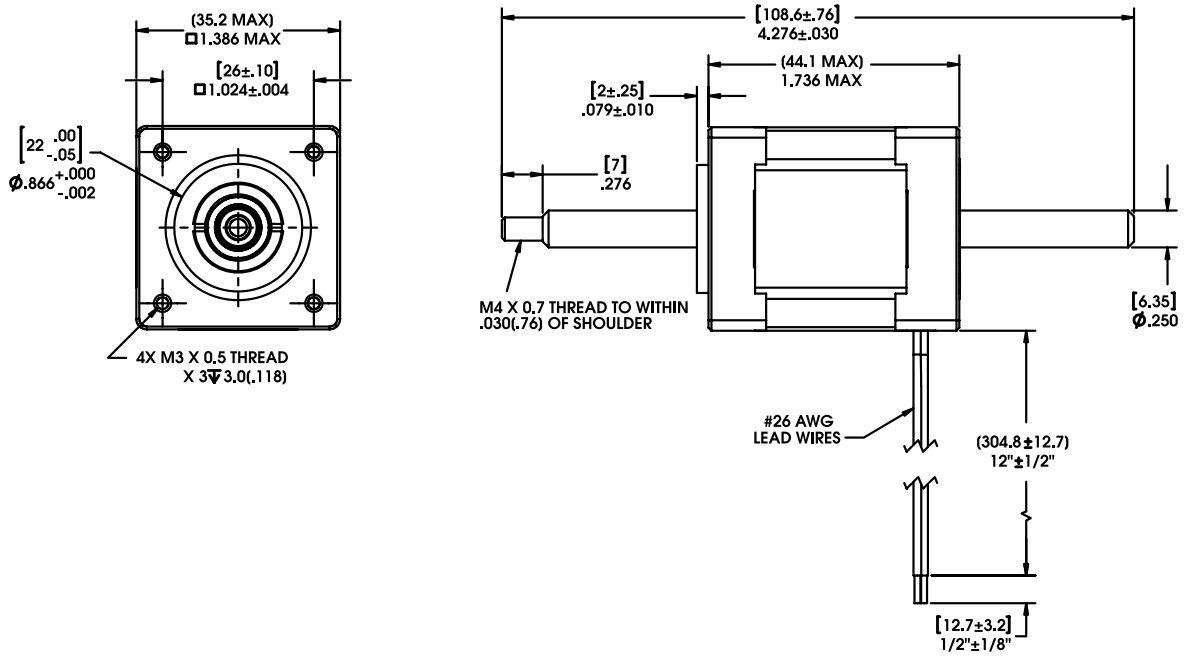
Series 35000 Double Stack Dimensional Drawings

Captive Shaft – Size 14 Double Stack

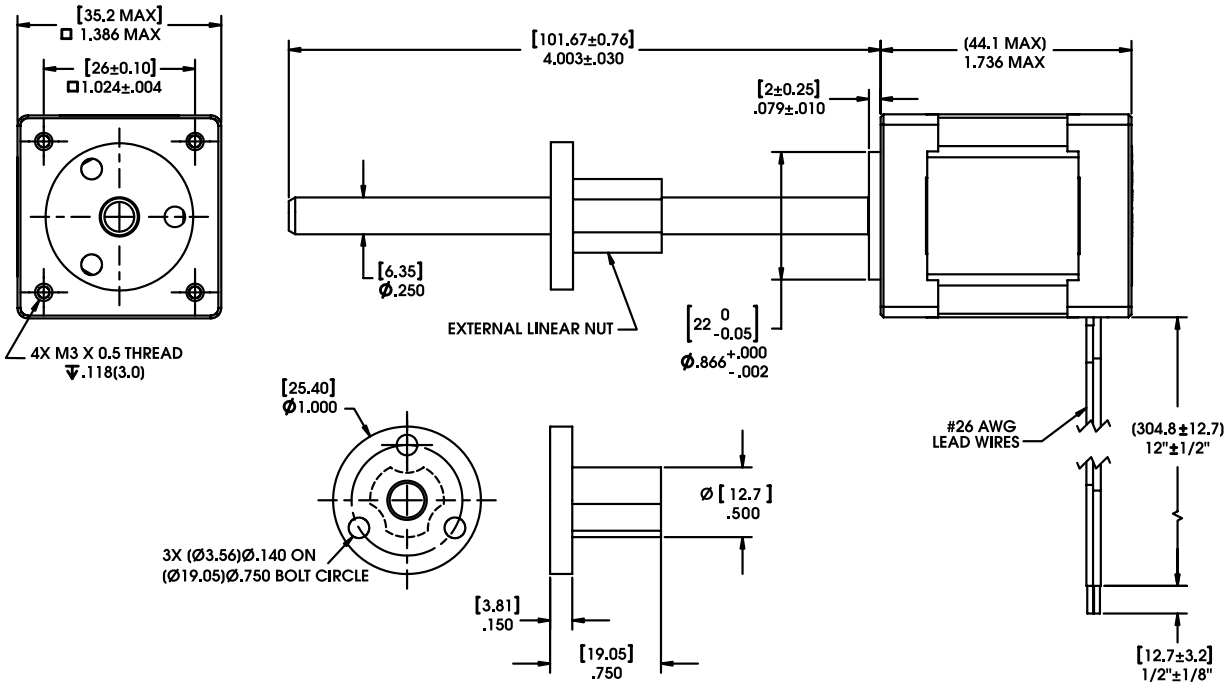


STROKE	DIM. "A"	DIM. "B"
0.50 (12.7)	0.82 (20.8)	0.04 (1.0)
0.750 (19.1)	1.07 (27.2)	0.29 (7.4)
1.00 (25.4)	1.32 (33.5)	0.54 (13.7)
1.250 (31.8)	1.57 (39.9)	0.79 (20.1)
1.500 (38.1)	1.82 (46.2)	1.04 (26.4)
2.00 (50.8)	2.32 (58.9)	1.54 (39.1)
2.500 (63.5)	2.82 (71.6)	2.04 (51.8)

Non-Captive Shaft – Size 14 Double Stack

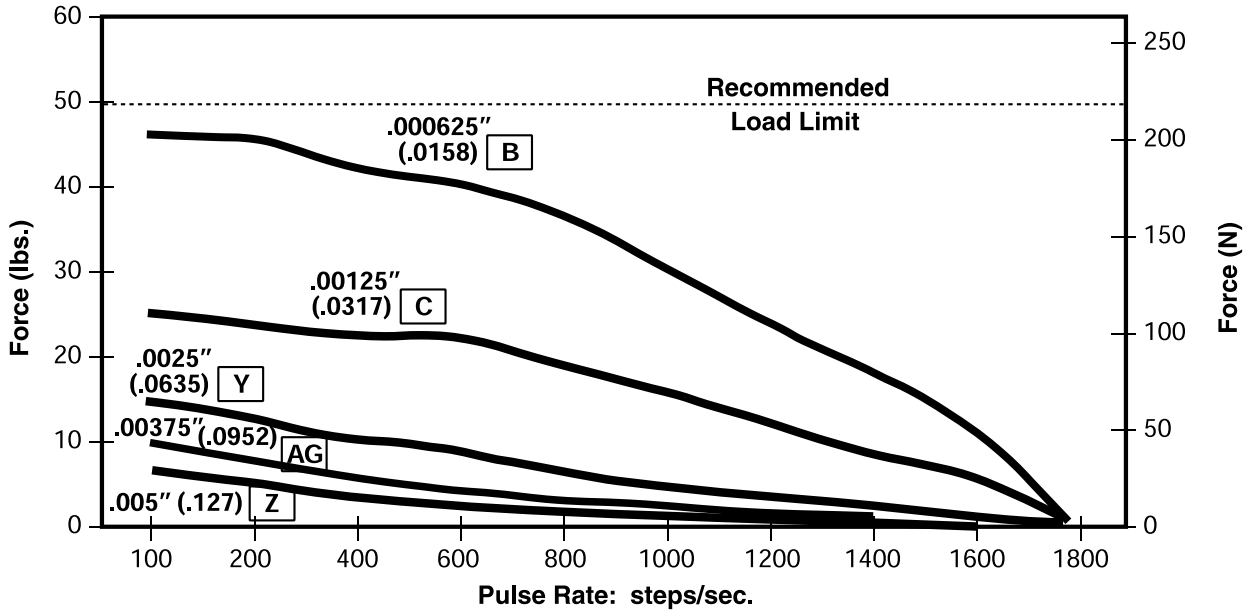


External Linear – Size 14 Double Stack

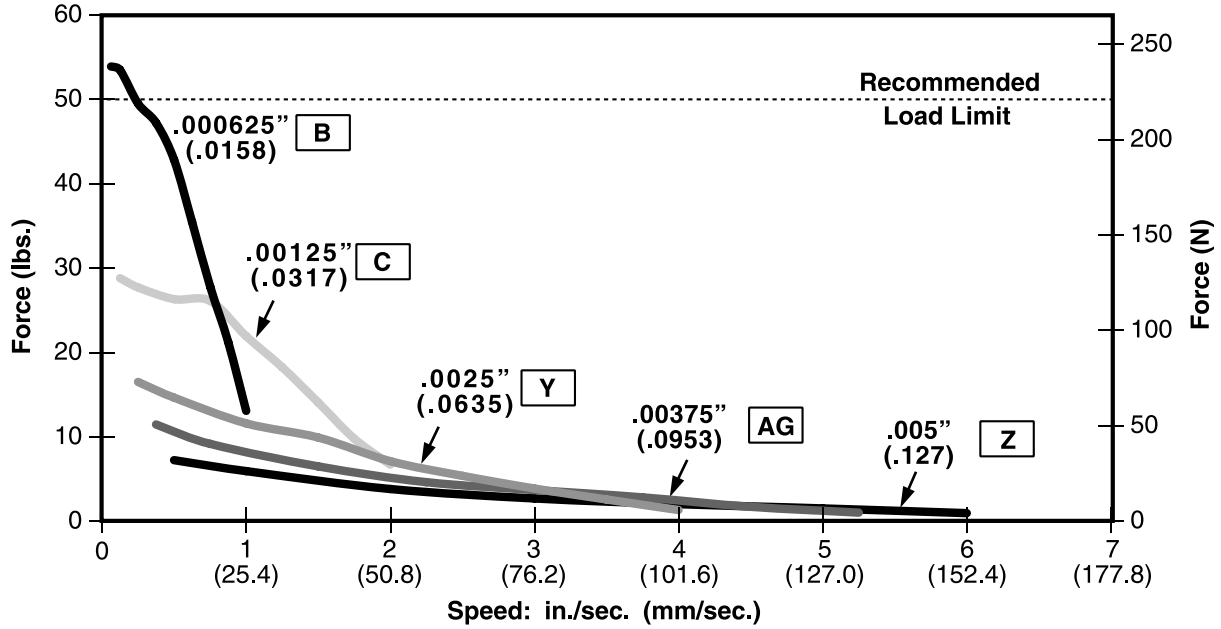


Series 35000 Size 14 Double Stack Speed Curves

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



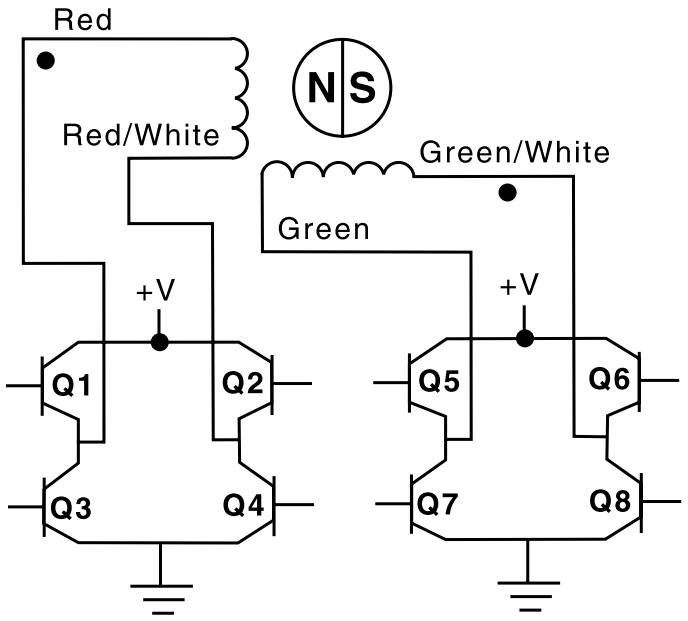
NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

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.

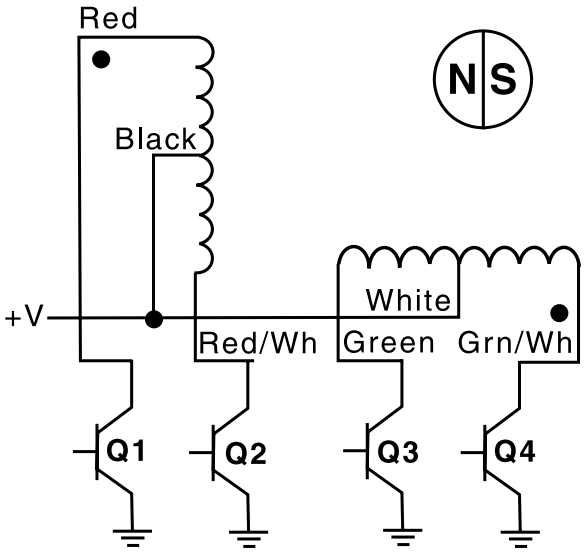
With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

Hybrid Linear Actuator Wiring

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.

Overview of Haydon Stepper Motor Products

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Hybrid Linear Actuators

(see Hybrid Linear Actuator Product Catalog for details)

Series	Size (square)	Configuration#	Stroke (mm)		Max Force (N)	Travel/step (micron)
			C#	NC / EL#		
21000	21 mm (0.8-in)	C / NC / EL	6.4 - 38.1	Up to ≈ 200	2 - 45	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 - 880	4 - 50
87000	87 mm (3.4-in)	C / NC / EL	12.7 - 63.5	Up to ≈ 500	400 - 2200	12.7 - 127

Double Stack Hybrid Linear Actuators

(see Hybrid Linear Actuator Product Catalog for details)

Series	Size (square)	Configuration#	Stroke (mm)		Max Force (N)	Travel/step (micron)
			C#	NC / EL#		
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 - 350	15.8 - 127
57000	57 mm (2.3-in)	C / NC / EL	12.7 - 63.5	Up to ≈ 500	150 - 880 [A]	12.7 - 127

[A] Maximum force limited by bearing capabilities.

Dual Action Actuators

(see Hybrid Linear Actuator Product Catalog for details)

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

(see Can-Stack Linear Actuator Product Catalog for details)

Series	Ø Size	Configuration#	Stroke (mm)		Max Force (N)	Travel/step (micron)
			C#	NC / EL#		
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

(see Hybrid or Can-Stack Linear Actuator Product Catalog for details)

	Type	Motor Leads	Input Voltage (VDC)	Current/Phase (I)	Number of Microsteps
40105	Chopper	4	24 - 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).