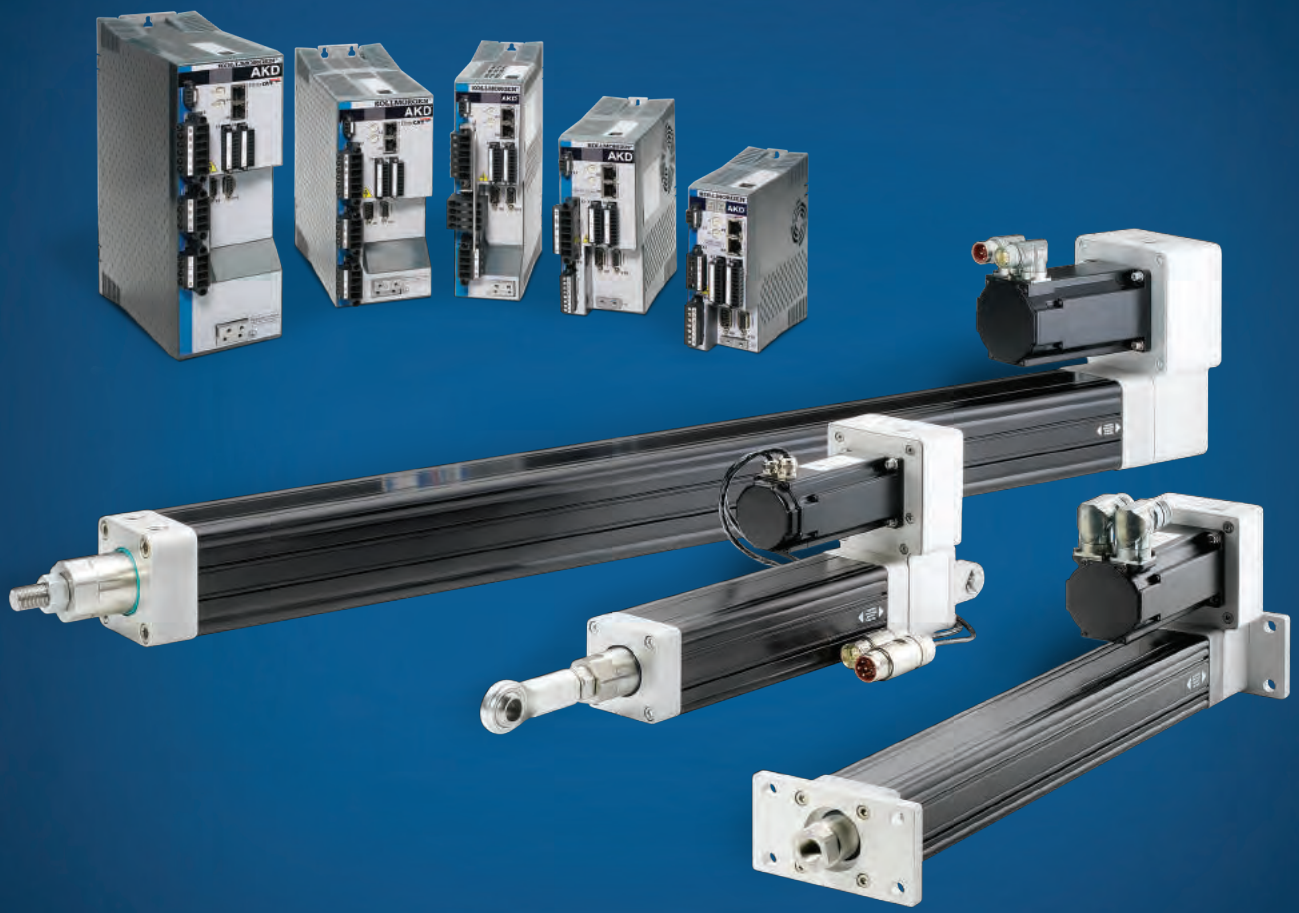
Electric Cylinder

Selection Guide



with AKD® Servo Drives and AKM® Servo Motors

KOLLMORGEN®

Because Motion Matters™

Kollmorgen: Your partner. In Motion.

Every solution comes from a real understanding of the challenges facing machine designers and users.

Innovators consistently rate Kollmorgen as one of their best motion systems manufacturing partners. Whether you are looking for classic servo motors, direct-drive servo motors, stepper motors, drives & amplifiers, gearing, actuation, or CNC & multi-axis motion controllers, Kollmorgen is one of the few companies in the world who actually designs and manufactures all of these products.

Our customers are leaders in many industries such as Aerospace & Defense, Printing, Packaging & Converting, Food & Beverage Processing, Medical Imaging, In Vitro Diagnostics & Laboratory Automation, Pharmaceutical Manufacturing, Material Forming and Cutting, Oil & Gas, and Robotics. Kollmorgen is also a leader in Warehouse Automation, including complete AGV systems, software, awareness and autonomy.

Our Automation Solutions can be found on Mars and in space, ships and submarines, O&G drilling and metrology, surgical robots and laser eye surgery, even inside artificial hearts. These are just a few applications that demand high-performance and high-quality while satisfying their specific needs.

Because motion matters, it's our focus: Motion can distinctly differentiate a machine and deliver a marketplace advantage by increasing its performance and dramatically improving overall equipment effectiveness (OEE).

High-performance motion can make your customer's machine more reliable and energy-efficient, enhance accuracy and improve operator safety. Motion also represents endless possibilities for innovation.

We've always understood this potential, and thus have kept motion at our core and in our Vison, Mission & Values, relentlessly developing products that offer precise control of torque, velocity and position accuracy in machines that rely on complex motion.

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Because Motion Matters™

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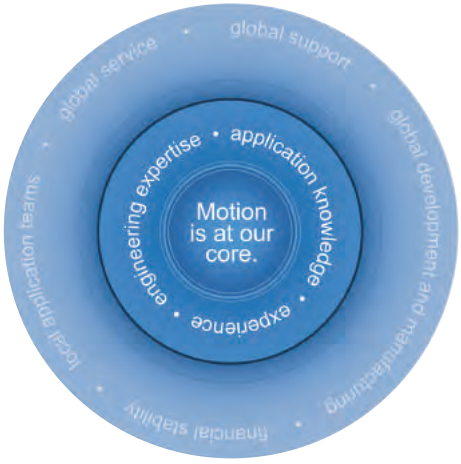
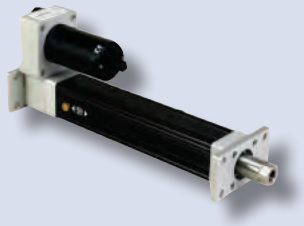


Linear Actuation & Positioning Systems

Kollmorgen offers a comprehensive range of linear actuator products including electric cylinders, rodless actuators, and precision tables to meet a wide range of application requirements. For actuator products not included in this catalog go to www.kollmorgen.com for information about other Kollmorgen linear positioning products.
(Products highlighted are included in this catalog).

	Model	Product Family	General Information
	Electric Cylinders[1]	EC1 EC2 EC3 EC4 EC5 N2	• Highest Force (Thrust) • Clean, Hydraulic Replacement • Compact Cross Section • Extends into Work Area
	Rodless Actuators (screw drive)	R2A R3 R4	• High Force (Thrust) • High Repeatability • Long Travel • Load Carrying Capability
	Rodless Actuators (belt drive)	R2A R3 R4	• Very High Speed • Quiet Operation • Long Travel • Load Carrying Capability
	Precision Tables	DS4 DS6	• High Accuracy & Repeatability • Low Maintenance, Long Life • High Moment Loads

Electric Cylinders (EC)

Primarily designed to apply a force through an extendable rod, electric cylinders are a clean and efficient replacement for hydraulic actuators and pneumatic cylinders, and an alternative to many types of linear transmissions. A wide variety of mounting and coupling alternatives significantly increases their problem solving potential.

Rodless Actuators

Long travel, quiet operation, and high moment loading differentiates rodless actuators from other mechanical transmissions.

Precision Tables

Positioning tables are used when accurate and repeatable motion is critical (1 part per 10,000 or better). These tables offer a wide variety of single and multi-axis configurations, open and closed frame tables, ball or lead screw driven, and overhung and constant support for Kollmorgen geometry configurations.

Model	Max Speed [3] In/s (mm/s)	Max Thrust [2, 3] Lb (N)	Repeatability [4, 5] In (mm)	Max Payload Lb (kg)	Max Travel In (mm)
Electric Cylinders[1]	52.5 (1330)	5620 (25,000)	to 0.0005 (0.013)	Note 1	59.1 (1500)
Rodless Actuators (screw drive)	39 (1000)	700 (3110)	to 0.0005 (0.013)	300 (136)	108 (2743)
Rodless Actuators (belt drive)	118 (3000)	300 (1330)	to 0.004 (0.10)	300 (136)	108 (2743)
Precision Tables	32.5 (825)	440 (1960)	3 microns (commercial grade) / 1.3 microns (precision grade)	794 (360)	79 (2000)

Notes:
1. Electric cylinders are designed primarily for thrust application where loads are supported externally.
2. Thrust ratings are based on mechanical limits rather than motor limits unless indicated otherwise.
3. Max speed and max thrust ratings are not necessarily available simultaneously
4. Repeatability is dependent on feedback resolution, load, friction, and drive gain settings.
5. Repeatability is unidirectional unless otherwise specified

Electric Cylinders

Kollmorgen Electric Cylinders offer a cost effective solution for linear positioning of supported or pivoting loads. They are descendents of hydraulic or pneumatic cylinders with many of the same design features but offer the benefit of providing a simpler and cleaner transmission.

When high thrust is required these rod type cylinders have the advantage over other linear components because the thrust is transmitted in-line. They also have the advantage of being isolated from the work area so can retract during other operations.

Flexibility in mounting allows either rigid or pivoting options depending on the requirement of the application. In addition to mounting options a wide variety of servo and stepper motor and drive products are offered as an integrated solution to provide the most cost effective combination of thrust, speed and positioning accuracy for your application.

Electric Cylinders Are Preferred When:

- Positioning an externally guided and supported load.
- Moving a load that pivots.
- There is a high concentration of airborne contaminants (rodless actuators are inherently less well protected).
- Replacing a hydraulic or pneumatic cylinder with an electro-mechanical solution.

Kollmorgen offers electric cylinder drive mechanisms designed around either lead screws or ballscrews. Ballscrews, being the more efficient of the two, utilize ballnuts riding on recirculating ball bearings resulting in higher speeds, loads and cycle rates. However, the more efficient design of ballscrew technology lends it to being backdriven when power is removed if precautions are not taken (e.g., electric brakes or counter loading).

Lead screws are capable of holding the load in position when power is removed, but are less efficient in operation.

Kollmorgen's guide system prevents rotation of the ball / lead nut, thus eliminating any torque loading to machine linkage

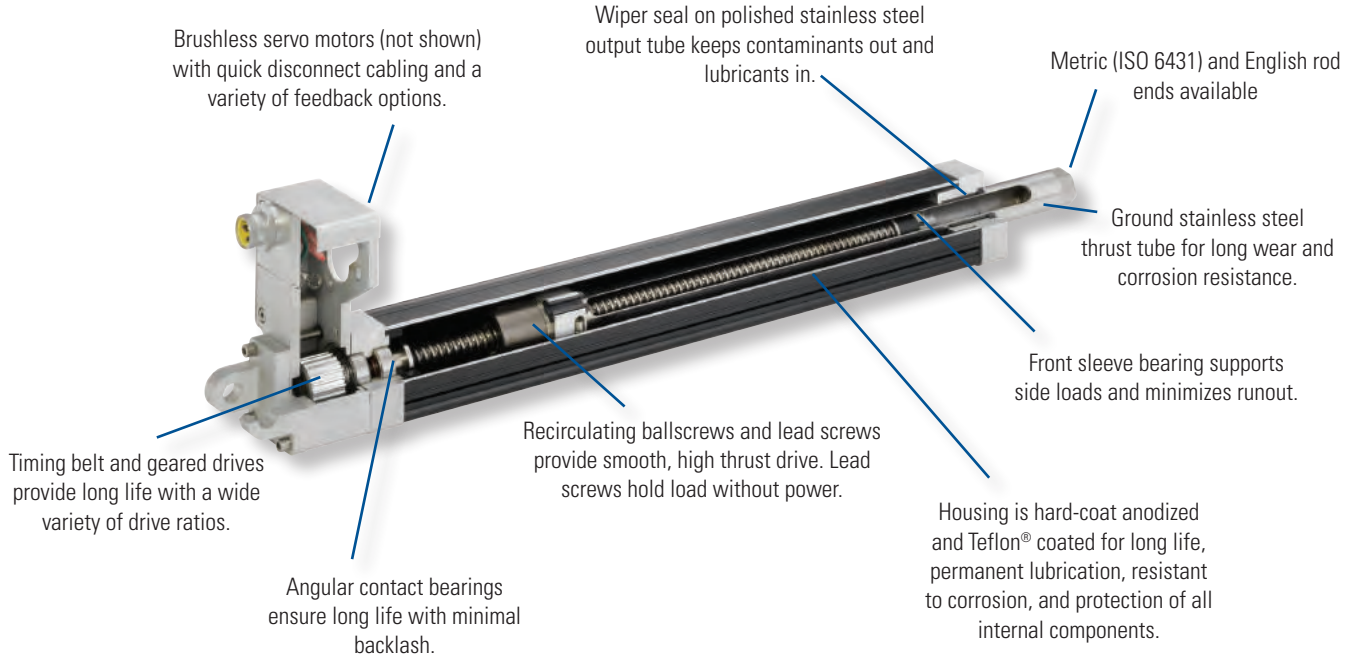
EC Servo Linear Actuators

- Designed for performance
- Highest quality precision rolled ballscrews and lead screws – for quiet, long-life operation
- Brushless Servo motor and Stepper motor options available
- Sealed for IP54 protection. IP65 option available.
- Thrust up to 25000 N [5620 lb]
- Speed up to 1.3 m/s [52.5 in/s]
- Metric design (ISO 6431)
- Available in 5 power ranges – EC1, 2, 3, 4 & 5

N2 Servo Linear Actuators

- Smallest Package Size
- Time-Proven Design
- Improved Durability Over Previous Designs
- Thrust up to 2670 N [600 lb]
- Speed up to 0.76 m/s [30 in/sec]
- English dimensions (to NFPA standards)
- Brushless Servo with encoder, resolver or SFD feedback
- Stepper motors also available

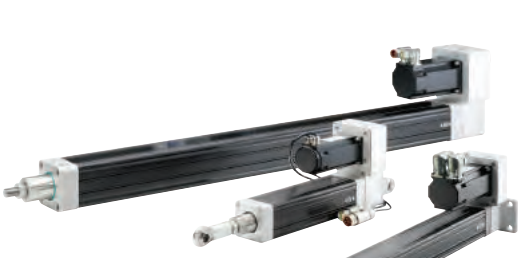
Typical Construction (EC2 cut-away shown)



Electric Cylinders

Features

Electric cylinders are direct descendents of hydraulic and pneumatic cylinders. Possessing many of the same unique design characteristics that made hydraulic and pneumatic cylinders popular, electric cylinders benefit from a cleaner and simpler power transmission. Decades of electric cylinder research and development has provided machine designers with a flexible, simple and unique approach to solving rigid or pivoting linear motion applications.



Electrically Powered, Maintenance Free

Today nearly all machines incorporate panel switches, sensors, lights, displays, PLCs or PCs. Electric power is nearly always available on the machine. Compressed air or hydraulic pumps are not always available or desirable. So why not simplify the machine by using the same control for all the axes of motion? A multi-axis programmable motor control can give you command of both rotary and linear motion. Lastly, the maintenance-free design provides another strong reason to consider electric cylinders in your next application.

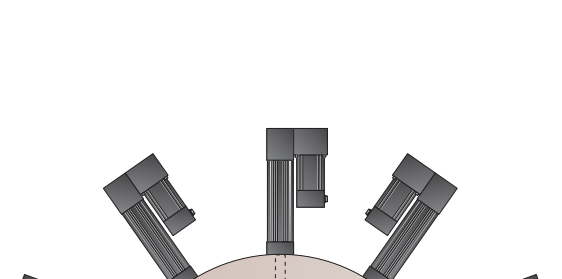
Straight Line Force Path

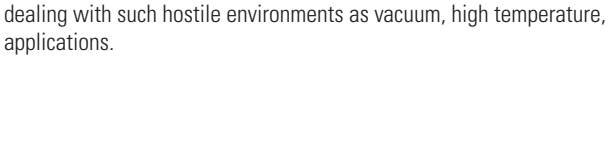
Straight-Line Thrust Transmission Use all available Power

When high thrust is required, rod type cylinders have the advantage over other actuation means in that all the thrust transmitting components are in-line. This provides the simplest and most efficient means of transmitting thrust to the load.

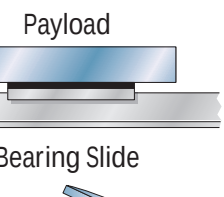
Non-Intrusive: Thrust rod can clear out of the way.

A primary advantage of rod-type electric cylinders is the capability to extend into a work area during an operation and then retract to clear the area for subsequent operations. Another benefit of the rod-type design is that the motor and main body of the electric cylinder can be isolated from the work area. This is very useful when dealing with such hostile environments as vacuum, high temperature, or wash down applications.





Mounting examples…
Above: Rigid (side lug mounts)
Right: Pivot (clevis)



Mounting Flexibility

As in most aspects of design, a little creativity goes a long way when attaching a cylinder to a machine. Two general types of mounting styles are available, rigid and pivoting. Rigid mounting options include side-tapped holes, front and rear flanges, side lugs and side angle brackets. These typically restrict motion to straight-line travel paths. Pivoting mounts such as the clevis or trunnion allow the cylinder to move as a link in a dynamic assembly. There are many applications for this “arc-motion” – conveyor diverter gates, pivoting rollers, lid lifters for chemical chambers, “scissors clamps” and so on.

Specification Overview

Series	N2		EC1	EC2		EC3		EC4	EC5
Std. Maximum Stroke Length [in (mm)]	* 22.5 (571.5)		7.87 (200)	29.53 (750)		39.37 (1000)		59.06 (1500)	59.06 (1500)
Type of Screw	Lead	Ball	Ball	Lead	Ball	Lead	Ball	Ball	Ball
Lead	0.2 in, 0.5 in	0.2 in, 0.5 in	3 mm	4 mm	16, 5 mm	4 mm	16, 10, 5 mm	25, 10 mm	32, 10 mm
Nom. Lead Screw Diameter	0.625 in	0.625 in	10 mm	16 mm	16 mm	20 mm	20 mm	25 mm	32 mm
Backlash [in (mm)]	0.016 (0.40)	0.015 (0.38)	0.015 (0.38)	0.016 (0.40)	0.010 (0.25)	0.016 (0.40)	0.010 (0.25)	0.12 (0.30)	0.12 (0.30)
Dimension Std.	English NFPA Std.		Metric ISO6431 Std.						
Bore size			30 mm	50 mm		63 mm		80 mm	100 mm
Brushless Servo Motor	AKM23		AKM1x	AKM23		AKM23, AKM42, AKM52		AKM42, AKM52	AKM42, AKM52
Stepper Motor	T22		CTP12	T22, T31		T22, T31		T31, T32, T41	T31,T32,T41
Max. Thrust [lb (N)]	600 (2670)		150 (667)	810 (3600)		1620 (7200)		2700 (12,000)	5620 (25,000)
Max. Velocity [in/sec (m/s)]	12 (0.3)	30 (0.76)	13 (0.33)	9.2 (0.23)	50 (1.27)	8.0 (0.20)	50 (1.28)	52.5 (1.33)	52.5 (1.33)
Max. Rated Duty Cycle (load, speed dependent) [%]	50	100	100	50	100	50	100	100	100
Limit Switches	Optional								
Std. Operating Temperature Range [C (F)]	0 to 60 (32 to 140)		-30 to 70 (-22 to 158)						
Moisture/ Contaminants	Humid, but Not Direct Contact		IP54 Std. IP65 Opt.						

*Note: Requires dual rod-end bearing option for length over 12"

EC3

Electric Cylinder Drive Comparison

The following chart will help pinpoint which linear drive mechanism is right for your application. Kollmorgen offers many positioner options, such as brakes, encoders, lubrication ports, preloaded nuts, and precision ground screws, that may help you meet your specification. If these standard options do not meet your requirements, please contact Kollmorgen for information regarding custom solutions.

Considerations	Lead Screw	Ball screw
Noise	Quiet	Noisy
Back Driving	Self locking	Easily backdrives
Backlash	Increases with wear	Constant throughout screw life
Repeatability	+/- 0.001	+/- 0.001
Duty Cycle	Moderate max. 60%	High max. 100%
Mechanical Efficiency	Low Bronze Nut - 40%	High 90%
Life and Mechanical Wear	Shorter life due to high friction	Longer
Shock Loads	Higher	Lower
Smoothness	Smooth operation at lower speeds	Smooth operation at all speeds
Speed	Low	High
Cost	$$$ Moderate	$$$ Moderate

Comments
Lead Screw: Sliding nut design provides quiet operation. **Ball screw:** Transmits audible noise as balls recirculate through nut during motion.
Lead Screw: Good for vertical applications. **Ball screw:** May require brake or holding device when no holding torque is applied to the screw.
Lead Screw: Considered worn-out when backlash exceeds 0.020". Typically 0.006" when shipped from factory. **Ball screw:** Typically constant at 0.006" (screw/nut only).
Lead Screw: Low duty cycle due to high friction from sliding surface design. **Ball screw:** High screw efficiency and low friction allow high duty cycle.
Lead Screw: Low efficiency sliding friction surfaces. **Ball screw:** High efficiency smooth rolling contact.
Lead Screw: Mechanical wear is function of duty cycle, load and speed. **Ball screw:** Virtually no mechanical wear when operated within rated load specifications.
Lead Screw: Better suited because of larger surface area. **Ball screw:** Brinelling of steel balls limits shock load capability.
Lead Screw: At extreme low speeds, units have a tendency to stop/start stutter (due to friction). **Ball screw:** Generally smoother than lead screw types through the entire speed range.
Lead Screw: Extreme speeds and accelerations can generate excessive heat and deform the screw. **Ball screw:** Can achieve higher speeds than the lead screw due to the efficiency of the ballnut vs. the sliding contact of the solid nut. Speeds in excess of ratings can deform screw.

Electric Cylinder Servo Systems

N2 & EC Series Electric Cylinder Servo Systems

N2 with AKM23

EC2 with AKM23

Kollmorgen's
Electric Cylinder Servo Systems provide an unprecedented level of flexibility.
Helping you build a better machine, faster.

- The N2 and EC Series Electric Cylinders offer an unprecedented degree of flexibility. This flexibility enables solution to be optimized for the application requirements reducing system cost and minimizing the electric cylinder size.
- The flexible design of the N2 and EC Series simplifies engineering design and system integration by providing an integrated gearing design of both timing belt and helical gearing.
- Integrated AKM brushless servo motor provides a system solution reducing application and engineering requirements as well as eliminates mechanical interface and interoperability issues.

Standard Configurable Electric Cylinder Designs:

	N2 Series	EC Series
Transport Screw	Precision ballscrew (2 and 5 [rev/in] pitch) Lead screw (5 and 8 [rev/in] pitch)	Precision ballscrew (3 to 32 [mm/rev] lead) Lead screw (4 [mm/rev] lead)
Integrated Gearing	Timing belt (1.0, 1.5, 2.0:1 ratios) Helical gear (2.5, 3.5, 12.0:1 ratios) Inline (direct coupled)	Timing belt (1.0, 1.5, 2.0:1 ratios) Helical gear (2.0, 2.5, 4.0, 5.0, 7.0, 10.0:1 ratios, model dependent) Inline (direct coupled)
Mounting Types	7 Parallel Mounts 5 Inline Mounts	8 Parallel Mounts 5 Inline Mounts
Rod-End Adapters	4 Types (English and Metric)	5 Types (English and Metric)
Stroke Lengths	Standard stroke (2 to 22.5 in) Custom stroke lengths available	Standard stroke lengths EC1 50 to 200 mm (7.87 in) EC2 50 to 750 mm (29.5 in) EC3 50 to 1000 mm (39.4 in) EC4 & EC5 50 to 1500 mm (59.1 in)

Options and Accessories

Electric Cylinder accessories and time-proven options have been designed for the industrial environment to simplify system integration. Options include limit switches, dual rod-end bearings, guide bearing, protective boot, and extended temperature ranges just to name a few. See the option and accessory section on pages 97-105 for more details.

N2 & EC Series Electric Cylinder Servo Systems

The Electric Cylinders Servo Systems are offered with the Advanced Kollmorgen Drive (AKD) series to provide the optimum combination of performance and price. Let your application and system requirements determine what solution integrates the best.

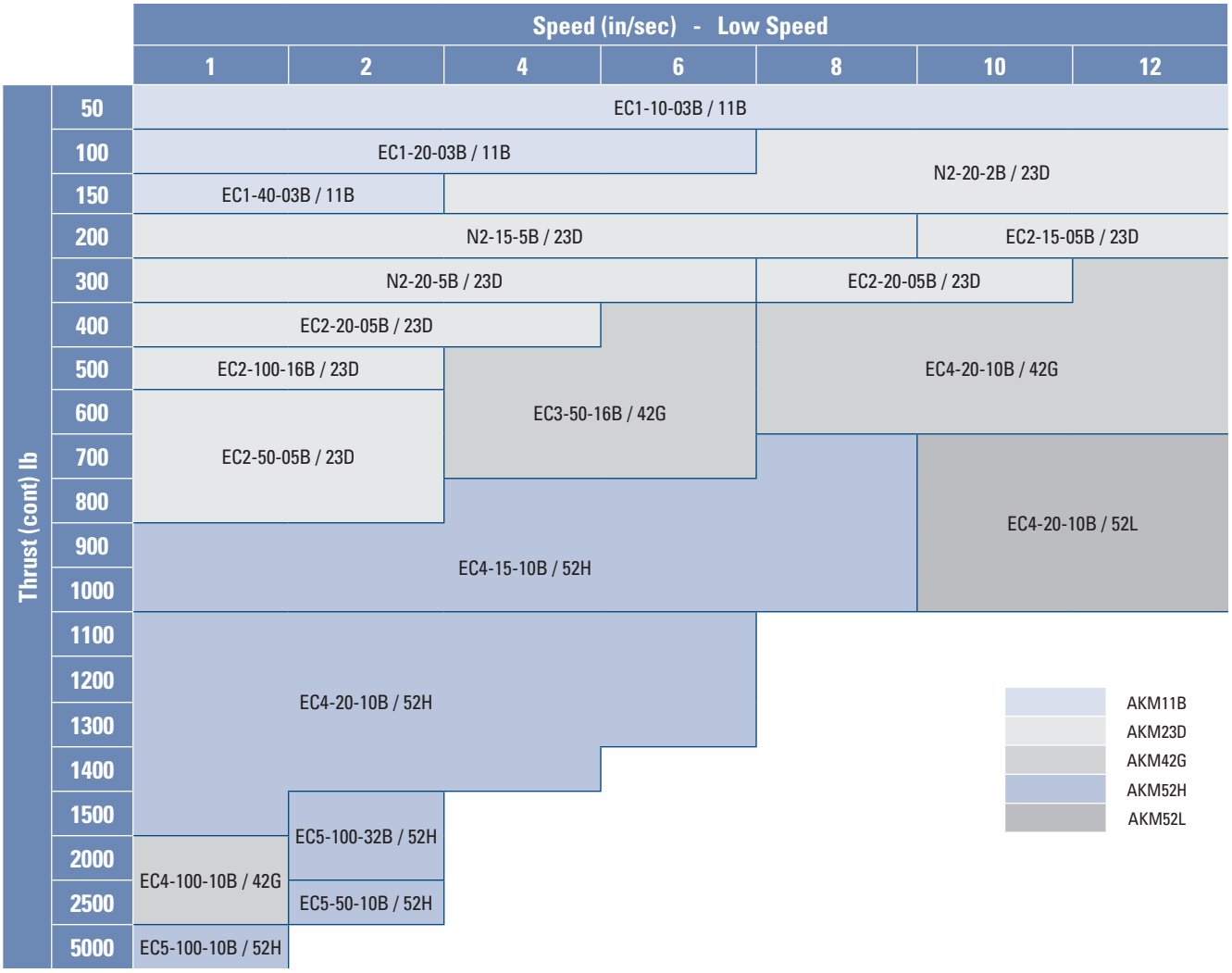
- Single vendor solution for the complete electro-mechanical system ensures system interoperability and a single dedicated Worldwide Motion-control supplier for support.
- The Electric Cylinder Servo Systems are available in drive and control technologies ranging form simple and intuitive positioning drives to fully programmable IEC 61131 based control systems:
- The Electric Cylinder Servo Systems leverage Kollmorgen's AKD diverse option configurations and AKM brushless servo motors for complete system flexibility and industry leading servo response and precision.

Flexible Drive Universal Control Options & Power Range	**AKD 120 / 240 / 480 Vac**
	• Base Unit: Analog torque and velocity, CanOpen®, step and direction, encoder following
	• Network Option Cards
	• EtherCAT®, SynqNet®, Modbus/TCP, and CANopen®
	• Simple Positioning System - Motion Task, Linked Motion Task, ACCEL/DECEL control, S-curve - Incremental, absolute positioning, Jog mode and more

Electric Cylinder Quick Selection Guide

Electric Cylinder / AKM Servo Motor Combinations

Low Speed Servo Options (up to 12 in/s)



Quick Selection Guide Reference

Systems listed in charts represent the most economical package to meet the criterion.

1) Select chart for application speed range
   Low Speed - Speeds up to rated linear speed of 12 in/sec
2) Select system by required continuous thrust (lbs) and required rated speed (in/sec).

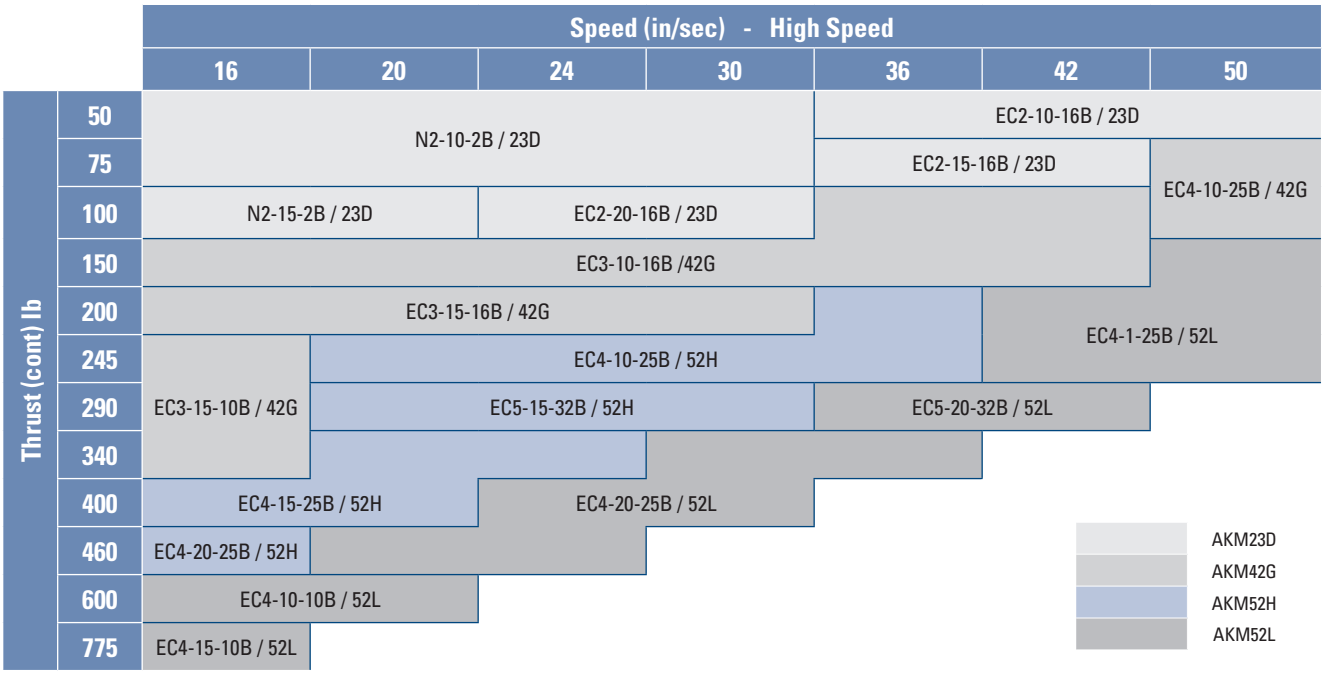
Other applications considerations (system resolution, inertia ratio, desired safety margins, etc) may result in selection of a different system.
For additional AKD system specifications see page 121.
For detailed force speed system curves for AKD, see pages 36-81.
Performance data represents continuous thrust (lb) at rated speed (in/s).
Based on AKD amplifier with 240 Vac, 3 phase supply.

EC2 – AKM42G – 10 – 05B – 300 – MP2 – FT1M*

EC Series | Motor Type | Drive Ratio | Screw Lead | Stroke Length | Cylinder Mount | Rod Ends

Electric Cylinder / AKM Servo Motor Combinations

High Speed Servo Options (12 in/s or greater)



Quick Selection Guide Reference

Systems listed in charts represent the most economical package to meet the criterion.

1) Select chart for application speed range
   High Speed - Speeds greater than 12 in/sec
2) Select system by required continuous thrust (lbs) and required rated speed (in/sec).

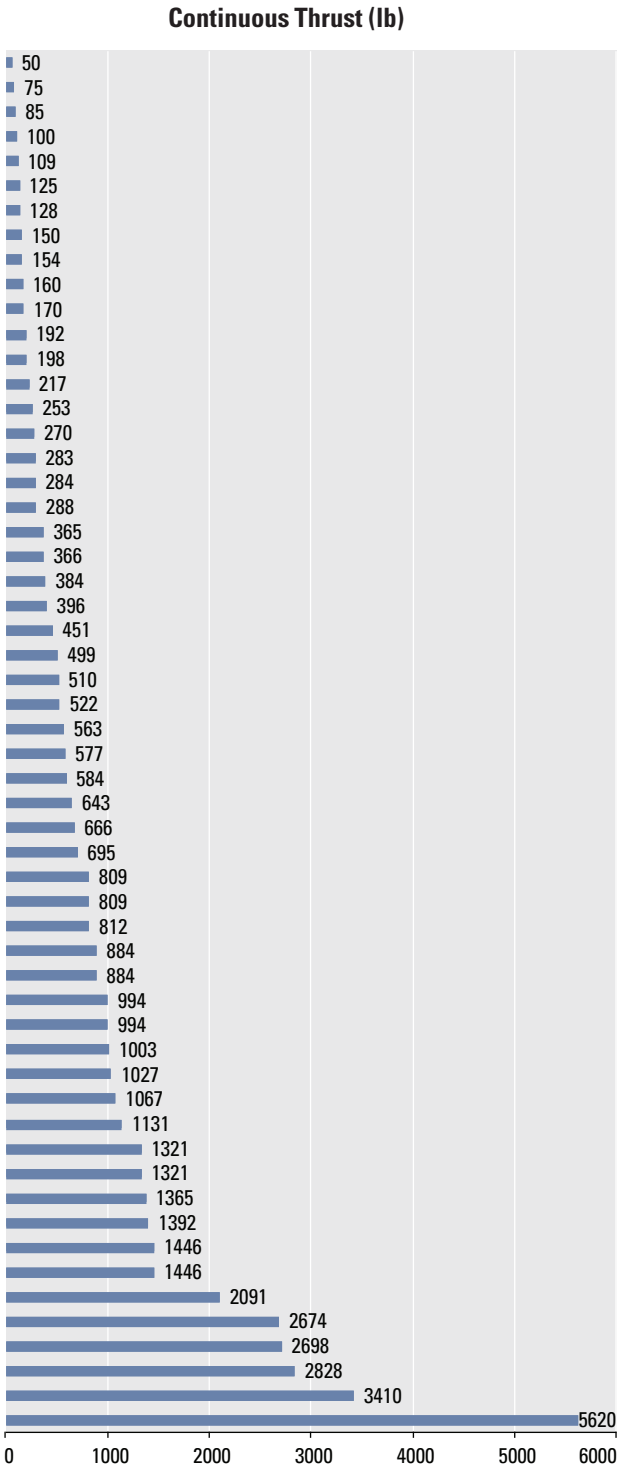
Other applications considerations (system resolution, inertia ratio, desired safety margins, etc) may result in selection of a different system.
For additional AKD system specifications see page 121.
For detailed force speed system curves for AKD, see pages 36-81.
Performance data represents continuous thrust (lb) at rated speed (in/s).
Based on AKD amplifier with 240 Vac, 3 phase supply.

Servo Motor Performance Summary

Low Speed Servo Performance

Pg	System	AKD Cont Amps	Cont Thrust @ Speed		Peak Thrust @ Speed		Max Thrust
			lb	in/s	lb	in/s	lb
42	EC1-AKM11B-xxx-10-03M	3 A	50	13.0	75	13.0	75
42	EC1-AKM13C-xxx-10-03M	3 A	75	13.0	75	13.0	75
36	N2-AKM23D-xxx-10-5A	3 A	85	12.0	260	12.0	312
42	EC1-AKM11B-xxx-20-03M	3 A	100	6.0	125	6.0	125
44	EC2-AKM23D-xxx-10-04A	3 A	109	9.2	337	9.2	396
42	EC1-AKM13C-xxx-20-03M	3 A	125	6.0	125	6.0	125
36	N2-AKM23D-xxx-15-5A	3 A	128	8.0	392	8.0	467
42	EC1-AKM11B-xxx-40-03M	3 A	150	3.0	150	3.0	150
37	N2-AKM23D-xxx-20-2B	3 A	154	15.0	468	15.0	561
45	EC2-AKM23D-xxx-15-04A	3 A	160	6.2	499	6.2	582
37	N2-AKM23D-xxx-20-5A	3 A	170	6.0	517	6.0	600
37	N2-AKM23D-xxx-10-5B	3 A	192	12.0	585	12.0	600
53	EC3-AKM23D-xxx-10-05B	3 A	198	10.2	708	9.4	712
45	EC2-AKM23D-xxx-20-04A	3 A	217	4.6	455	4.6	790
53	EC3-AKM23D-xxx-50-16B	3 A	253	6.2	885	6.2	909
45	EC2-AKM23D-xxx-15-05B	3 A	270	13.2	809	8.0	809
54	EC3-AKM23D-xxx-15-05B	3 A	283	10.2	1060	6.3	1070
73	EC5-AKM42G-xxx-10-10B	6 A	284	15.2	1503	15.2	1005
37	N2-AKM23D-xxx-15-5B	3 A	288	8.0	600	8.0	600
54	EC3-AKM23D-xxx-20-05B	3 A	365	9.5	1372	5.0	1469
46	EC2-AKM23D-xxx-20-05B	3 A	366	9.7	770	8.0	809
36	N2-AKM23D-xxx-20-5B	3 A	384	6.0	600	6.0	600
74	EC5-AKM42G-xxx-15-10B	6 A	396	15.2	1503	9.4	1508
74	EC5-AKM42G-xxx-50-32B	6 A	451	6.6	1530	6.6	1530
63	EC4-AKM42G-xxx-20-10B	6 A	499	14.0	2005	7.1	2005
74	EC5-AKM42G-xxx-20-10B	6 A	510	13.2	2005	7.1	2010
46	EC2-AKM23D-xxx-50-04A	3 A	522	1.8	809	1.8	809
55	EC3-AKM23D-xxx-70-10B	3 A	563	2.81	1620	2.81	1620
62	EC4-AKM42G-xxx-50-25B	6 A	577	5.1	1959	5.1	1959
46	EC2-AKM23D-xxx-100-16B	3 A	584	3.67	809	3.67	809
75	EC5-AKM52H-xxx-10-10B	6 A	643	14.5	1137	13.0	1974
63	EC4-AKM52H-xxx-10-10B	6 A	666	14.0	1137	13.0	1974
55	EC3-AKM42G-xxx-50-16B	6 A	695	6.25	1620	6.25	1620
46	EC2-AKM23D-xxx-100-04A	3 A	809	0.91	809	0.91	809
47	EC2-AKM23D-xxx-50-05B	3 A	809	2.3	809	2.3	809
55	EC3-AKM23D-xxx-50-05B	3 A	812	1.9	1619	1.9	1619
75	EC5-AKM42G-xxx-100-32B	6 A	884	3.3	2997	3.3	3000
75	EC5-AKM52L-xxx-15-10B	12 A	884	15.0	1891	15.0	2695
63	EC4-AKM52H-xxx-15-10B	6 A	994	9.5	2067	8.0	2698
75	EC5-AKM52H-xxx-15-10B	6 A	994	9.5	2067	8.0	2962
65	EC4-AKM52L-xxx-20-10B	12 A	1003	14.4	1907	13.5	2698
76	EC5-AKM52L-xxx-20-10B	12 A	1027	14.0	1966	13.0	3501
76	EC5-AKM52H-xxx-50-32B	6 A	1067	6.5	1851	6.5	1851
64	EC4-AKM42G-xxx-100-25B	6 A	1131	2.6	2698	2.6	2698
64	EC4-AKM52H-xxx-20-10B	6 A	1321	7.2	2187	6.6	2698
76	EC5-AKM52H-xxx-20-10B	6 A	1321	7.2	2193	6.5	3501
64	EC4-AKM52H-xxx-50-25B	6 A	1365	5.1	2365	5.1	2365
65	EC4-AKM52L-xxx-50-25B	12 A	1392	5.1	2369	5.1	2369
65	EC4-AKM42G-xxx-50-10B	6 A	1446	2.0	2698	2.0	2698
76	EC5-AKM42G-xxx-50-10B	6 A	1446	2.0	4898	2.0	4898
77	EC5-AKM52H-xxx-100-32B	6 A	2091	3.3	3624	3.3	3624
66	EC4-AKM52H-xxx-100-25B	6 A	2674	2.6	2698	2.6	2698
65	EC4-AKM42G-xxx-100-10B	6 A	2698	1.04	2698	1.04	2698
77	EC5-AKM42G-xxx-100-10B	6 A	2828	1.04	5620	1.04	5620
77	EC5-AKM52H-xxx-50-10B	6 A	3410	2.05	5620	2.05	5620
77	EC5-AKM52H-xxx-100-10B	6 A	5620	1.04	5620	1.04	5620

Ratings are based on the AKM servo motor and the corresponding AKD Drive.
See pages 110-115 for details on Drive & Motor System combinations.
Specifications are based on 230 Vac, 3 phase voltage supply.
Force Speed Curves located on pages 36-81.



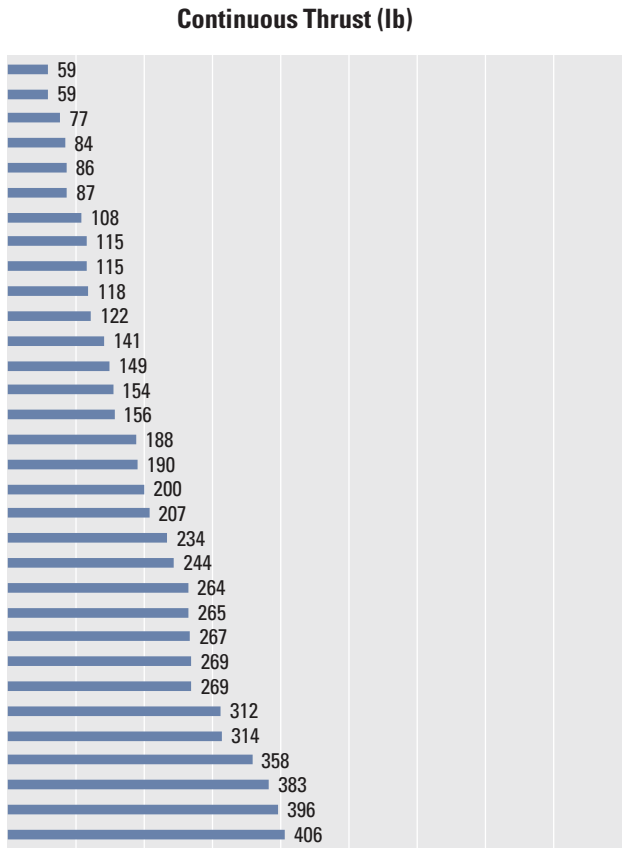
Plotted value is continuous thrust (lb), refer to chart for the associated rated speed value.

EC2 – AKM42G – 10 – 05B – 300 – MP2 – FT1M*

EC Series | Motor Type | Drive Ratio | Screw Lead | Stroke Length | Cylinder Mount | Rod Ends

High Speed Servo Performance

Pg	System	AKD Cont Amps	Cont Thrust @ Speed		Peak Thrust @ Speed		Max Thrust
			lb	in/s	lb	in/s	lb
44	EC2-AKM23D-xxx-10-16B	3 A	59	50.0	221	30.0	222
52	EC3-AKM23D-xxx-10-16B	3 A	59	50.0	221	30.0	222
36	N2-AKM23D-xxx-10-2B	3 A	77	30.0	233	30.0	280
44	EC2-AKM23D-xxx-15-16B	3 A	84	42.0	293	23.0	327
52	EC3-AKM23D-xxx-15-16B	3 A	86	41.0	332	20.0	334
72	EC5-AKM42G-xxx-10-32B	6 A	87	52.5	313	45.0	313
60	EC4-AKM42G-xxx-10-25B	6 A	108	52.0	400	35.0	402
44	EC2-AKM23D-xxx-20-16B	3 A	115	31.0	223	26.0	445
36	N2-AKM23D-xxx-15-2B	3 A	115	20.0	350	20.0	420
52	EC3-AKM23D-xxx-20-16B	3 A	118	30.0	457	12.5	459
72	EC5-AKM42G-xxx-15-32B	6 A	122	52.5	470	30.0	470
52	EC3-AKM23D-xxx-15-10B	3 A	141	21.0	520	13.0	534
60	EC4-AKM42G-xxx-15-25B	6 A	149	47.0	595	24.0	603
53	EC3-AKM42G-xxx-10-16B	6 A	154	45.2	598	24.0	628
72	EC5-AKM42G-xxx-20-32B	6 A	156	45.0	626	22.5	628
45	EC2-AKM23D-xxx-10-05B	3 A	188	16.0	385	16.0	712
53	EC3-AKM23D-xxx-20-10B	3 A	190	18.0	686	10.0	735
60	EC4-AKM42G-xxx-20-25B	6 A	200	35.0	802	17.5	804
72	EC5-AKM52H-xxx-10-32B	6 A	207	46.0	351	42.0	617
54	EC3-AKM42G-xxx-15-16B	6 A	234	30.0	495	25.0	888
60	EC4-AKM52L-xxx-10-25B	12 A	244	52.5	422	52.5	719
61	EC4-AKM52H-xxx-10-25B	6 A	264	36.0	441	33.0	790
73	EC5-AKM52L-xxx-15-32B	12 A	265	52.0	584	52.0	842
61	EC4-AKM52L-xxx-15-25B	12 A	267	48.5	699	43.0	1078
54	EC3-AKM42G-xxx-10-10B	6 A	269	20.9	958	15.0	1010
61	EC4-AKM42G-xxx-10-10B	6 A	269	21.0	1002	14.2	1005
73	EC5-AKM52H-xxx-15-32B	6 A	312	30.0	626	26.0	925
74	EC5-AKM52L-xxx-20-32B	12 A	314	46.0	614	42.0	1094
55	EC3-AKM42G-xxx-15-10B	6 A	358	18.9	820	15.0	1420
62	EC4-AKM42G-xxx-15-10B	6 A	383	17.5	1501	9.5	1508
61	EC4-AKM52H-xxx-15-25B	6 A	396	24.0	827	20.0	1185
62	EC4-AKM52L-xxx-20-25B	12 A	406	35.5	785	33.0	1400
73	EC5-AKM52H-xxx-20-32B	6 A	413	23.0	684	21.0	1094
62	EC4-AKM52H-xxx-20-25B	6 A	529	18.0	879	16.0	1400
63	EC4-AKM52L-xxx-10-10B	12 A	610	21.0	1055	21.0	1797
64	EC4-AKM52L-xxx-15-10B	12 A	772	18.6	1825	17.0	2695



Plotted value is continuous thrust (lb), refer to chart for the associated rated speed value.

Ratings are based on the AKM servo motor and the corresponding AKD Drive.
See pages 110-115 for details on Drive & Motor System combinations.
Specifications are based on 230 Vac, 3 phase voltage supply.
Force Speed Curves located on pages 36-81.

Electric Cylinder Stepper Systems

The Electric Cylinder Stepper Systems are offered with a versatile stepper drive and multiple hybrid stepper motor sizes to provide system flexibility. Let your application and system requirements determine what solution integrates best.

- Single vendor solution for the complete electro-mechanical system ensures system interoperability and single dedicated worldwide motion-control supplier for support.
- The Rodless Actuator Stepper Systems are available with standard step and direction drive functions, and enhanced drive technologies incorporating simple program control functionality (P7000 with -PL option).
- The Rodless Actuator Stepper Systems leverage multiple stepper motor sizes to provide the most cost effective solution to meet your machine's performance requirement.

	P70630 120/240 VAC
Advanced Stepper Motor Control Easy Commissioning Compatible with a Wide Range of Motors	• Base Unit: accepts step and direction inputs
	• An integrated position controller is available (-PN option) • Up to 68 absolute or incremental moves • Specify detailed move parameters or simply distance and time
	• Multistepping™ inserts fine micro-steps to smooth coarse low speed motion
	• Advanced auto-tuning provides outstanding low-speed performance

P7000 Stepper Drive Controller

P7000 stepper drives offer a unique level of system functionality, smoothness, high-speed performance and innovation unmatched in the industry.

The compact P7000 is designed to power Kollmorgen step motors ranging from NEMA size 17 up to NEMA size 42. Two power configurations are available for operation directly from AC power, or from a DC power supply.

There are two levels of control offered. The basic drive accepts step and direction inputs. P7000 drives are also available with an integrated position controller (-PN option). The drives are configured by either on-board dip switches, or with the P7000 tools software.

Advanced P7000 Features Make it the Best Choice to Meet Your Application Requirements

Multistepping™

Also known as auto-smoothing. The P7000 drive accepts full step pulse commands from the indexer and inserts fine micro-steps to smooth coarse low speed motion. This allows you to significantly upgrade machine performance without having to redesign machine control architecture.

Auto-Tuning

Advanced current auto-tuning techniques provide outstanding low-speed smoothness. The P7000 senses the motor's characteristics and automatically fine tunes itself to meet your high-performance needs. This reduces installation and set-up time.

Mid-Band Anti-Resonance Control

Reduces negative effects of mechanical resonance, allowing you to get more out of a smaller motor and virtually eliminating nuisance stalls and machine downtime.

Idle Current Reduction

If you do not require the motor's full torque to hold a load at rest, you can select the right amount of current (torque) to reduce motor heating and power consumption. This increases the life of the system.

Dynamic Smoothing

Quasi-S-curve algorithm reduces jerk, especially upon acceleration. Increases mechanical life of the machine and reduces energy consumption.

Intelligent Indexing Option (-PN)

Wizard-like P7000 helps you to develop and link motion tasks such as homing and conditional and unconditional indexing. You can be up-and-running quickly.

Modbus RTU Compatible

The intelligent indexing option (-PN) supports Modbus RTU to control motion with an external interface device. External interfaces make controlling motion simple for machine operators.

P7000 Tools

The position node option allows you to configure up to 63 absolute or relative moves. You can specify the moves' distance, acceleration, velocity, and deceleration rates, or simply specify the distance and total time for the move – P7000 will perform the calculations automatically.

Specifications	Units	P70530	P70360
Input voltage range	Volts	20 - 75 Vdc	120 or 240 Vac
Continuous current	Amps rms	5	2.5
Microstep peak current	Amps peak	7.1	3.5

Note: For complete P-eries model nomenclature, refer to page 166.

Electric Cylinder Quick Selection Guide

Electric Cylinder / Stepper Motor Combinations

Low Speed Stepper Options (up to 12 in/s)

Thrust (cont) lb	Speed (in/sec) - Low Speed: 1	2	3	4	6	8	10	12
15	EC1-10-03B / CTP12							
30	EC1-20-03B / CTP12		EC2-20-16B / T22T					
50	N2-20-2B / T22T							
100	EC2-15-05B - T22T					EC4-15-10B / T32T		
150	EC2-20-05B / T22T				EC4-20-10B / T32T			
200	EC2-20-05B / T22T		EC3-50-10B / T31T	EC4-20-10B / T41T				
300								
600	EC4-50-10B / T32T							
1000	EC4-50-10B / T41T							

CTP12
T22T
T31T
T32T
T41T

Quick Selection Guide Reference

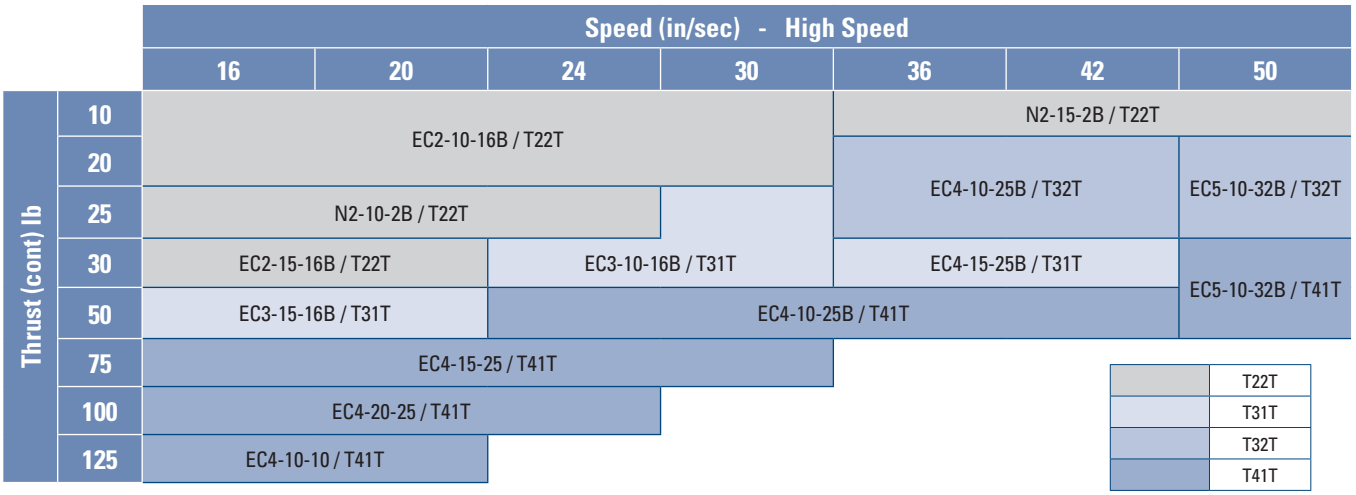
Systems listed in charts represent the most economical package to meet the criterion.

1) Select chart for application speed range
   Low Speed - Speeds up to rated linear speed of 12 in/sec
2) Select system by required continuous thrust (lbs) and required rated speed (in/sec).

Other applications considerations (system resolution, inertia ratio, desired safety margins, etc) may result in selection of a different system.
For additional P7000 system specifications see page 19.
For detailed force speed system curves for P7000, see pages 36-81.
Performance data represents continuous thrust (lb) at rated speed (in/s).
Based on P7000 drive with 120 or 240 Vac single phase supply.

Electric Cylinder / Stepper Motor Combinations

High Speed Stepper Options (12 in/s or greater)



Quick Selection Guide Reference

Systems listed in charts represent the most economical package to meet the criterion.

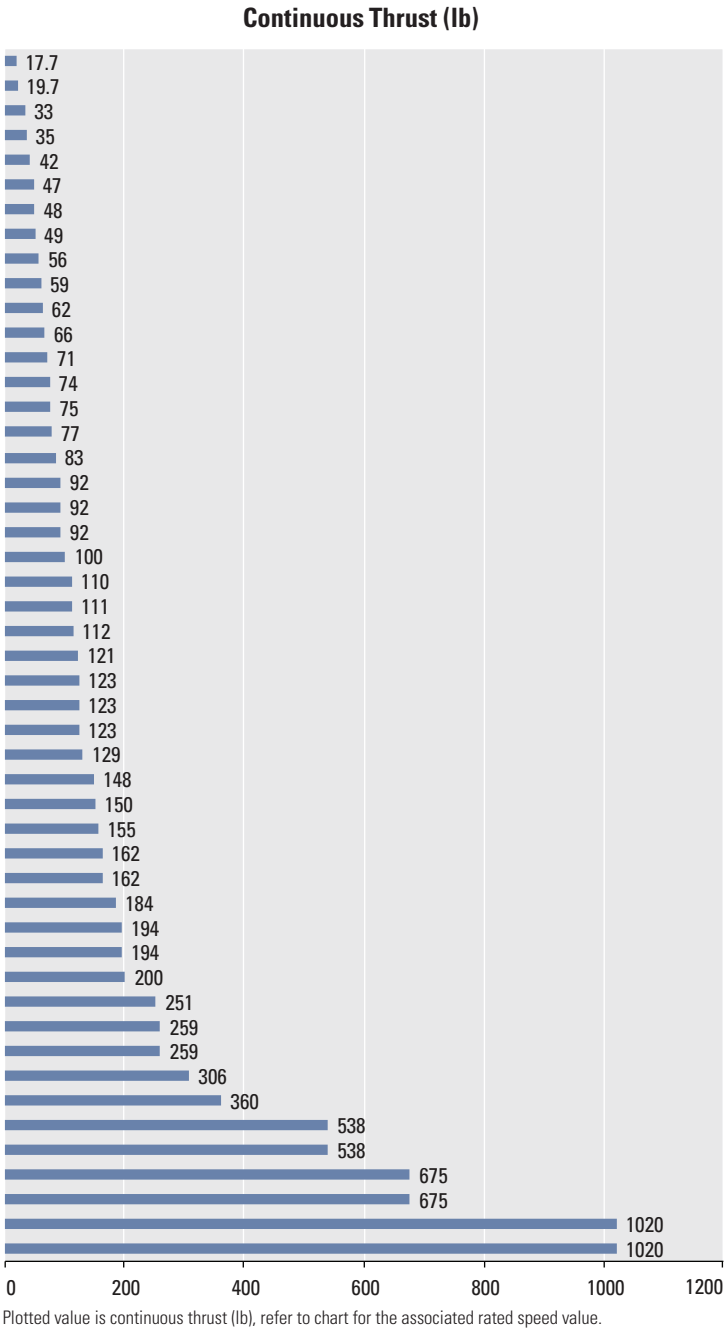
1) Select chart for application speed range
   High Speed - Speeds greater than 12 in/sec
2) Select system by required continuous thrust (lbs) and required rated speed (in/sec).

Other applications considerations (system resolution, inertia ratio, desired safety margins, etc) may result in selection of a different system.
For additional P7000 system specifications see page 19.
For detailed force speed system curves for P7000, see pages 36-81.
Performance data represents continuous thrust (lb) at rated speed (in/s).
Based on P7000 drive with 120 or 240 Vac single phase supply.

Stepper Motor Performance Summary

Low Speed Stepper Performance

Pg	System	Cont Thrust @ Speed		Max Thrust
		lb	in/s	lb
43	EC1-CTP12-10-03M	17.7	5.0	75
43	EC1-CTP12-10L-03M	19.7	5.0	75
39	N2-T22T-10-5A	33	10.0	113
43	EC1-CTP12-20-03M	35	2.5	125
48	EC2-T22T-10-04A	42	7.9	144
48	EC2-T22T-20-16B	47	15.7	162
56	EC3-T22T-20-16B	48	15.3	167
39	N2-T22T-15-5A	49	6.7	170
57	EC3-T22T-15-10B	56	13.1	194
40	N2-T22T-20-2B	59	12.5	204
49	EC2-T22T-15-04A	62	5.3	211
40	N2-T22T-20-5A	66	5.0	226
43	EC1-CTP12-40-03M	71	1.25	150
40	N2-T22T-10-5B	74	10.0	254
49	EC2-T22T-10-05B	75	9.8	259
57	EC3-T22T-20-10B	77	9.5	267
49	EC2-T22T-20-04A	83	3.9	287
58	EC3-T31T-15-10B	92	13.1	444
69	EC4-T31T-15-10B	92	13.1	444
79	EC5-T31T-15-10B	92	13.1	444
80	EC5-T32T-10-10B	100	15.3	569
49	EC2-T22T-15-05B	110	6.7	380
40	N2-T22T-15-5B	111	6.7	382
58	EC3-T22T-15-05B	112	6.6	388
70	EC4-T32T-15-10B	121	13.1	853
50	EC2-T31T-10-05B	123	9.8	592
69	EC4-T31T-20-10B	123	9.8	592
80	EC5-T31T-20-10B	123	9.8	592
80	EC5-T41T-10-10B	129	15.3	750
41	N2-T22T-20-5B	148	5.0	509
50	EC2-T22T-20-05B	150	4.9	517
58	EC3-T22T-20-05B	155	4.8	533
71	EC4-T32T-20-10B	162	9.8	1138
81	EC5-T32T-20-10B	162	9.8	1138
58	EC3-T31T-15-05B	184	6.6	888
70	EC4-T41T-15-10B	194	13.1	1125
80	EC5-T41T-15-10B	194	13.1	1125
50	EC2-T22T-50-04A	200	1.57	689
59	EC3-T31T-50-10B	251	3.9	1210
71	EC4-T41T-20-10B	259	9.8	1500
81	EC5-T41T-20-10B	259	9.8	1500
59	EC3-T22T-50-05B	306	2.0	1057
50	EC2-T22T-50-05B	360	2.0	809
71	EC4-T31T-50-10B	538	2.1	1445
81	EC5-T31T-50-10B	538	2.1	1445
71	EC4-T32T-50-10B	675	2.1	2700
81	EC5-T32T-50-10B	675	2.1	2780
71	EC4-T41T-50-10B	1020	2.1	2700
81	EC5-T41T-50-10B	1020	2.1	3660



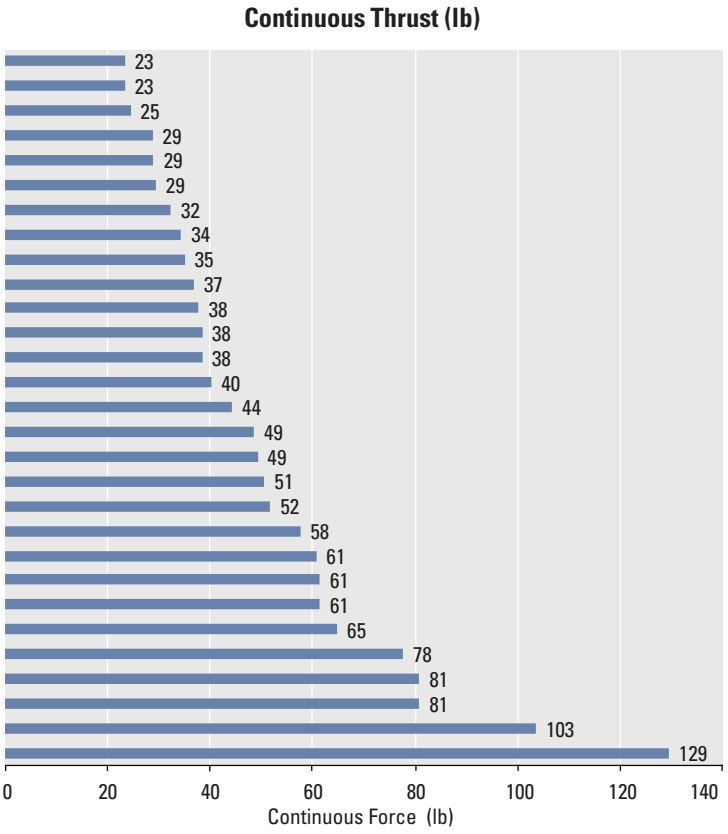
Ratings are based on the Hybrid stepper motor and P7000 drive with 120 or 240 Vac single phase supply.
See pages 110-115 for details on Drive & Motor System combinations.
Force Speed Curves located on pages 36-81.

Plotted value is continuous thrust (lb), refer to chart for the associated rated speed value.

High Speed Stepper Performance

Pg	System	Cont Thrust @ Speed		Max Thrust
		lb	in/s	lb
48	EC2-T22T-10-16B	23	31.5	81
56	EC3-T22T-10-16B	23	31.5	81
67	EC4-T31T-10-25B	25	49.2	118
78	EC5-T31T-15-32B	29	42.0	139
78	EC5-T32T-10-32B	29	52.5	178
39	N2-T22T-10-2B	29	25.0	102
67	EC4-T32T-10-25B	32	49.2	228
48	EC2-T22T-15-16B	34	21.4	119
56	EC3-T22T-15-16B	35	21.0	121
67	EC4-T31T-15-25B	37	32.8	178
78	EC5-T32T-15-32B	38	42.0	267
56	EC3-T31T-10-16B	38	31.5	185
78	EC5-T31T-20-32B	38	31.5	185
78	EC5-T41T-10-32B	40	52.5	234
39	N2-T22T-15-2B	44	16.7	153
68	EC4-T32T-15-25B	49	32.8	341
67	EC4-T31T-20-25B	49	24.6	237
79	EC5-T32T-20-32B	51	31.5	355
68	EC4-T41T-10-25B	52	49.2	300
57	EC3-T31T-15-16B	58	21.0	278
79	EC5-T41T-15-32B	61	42.0	351
57	EC3-T31T-10-10B	61	19.7	296
68	EC4-T31T-10-10B	61	19.7	296
68	EC4-T32T-20-25B	65	24.6	455
69	EC4-T41T-15-25B	78	32.8	450
69	EC4-T32T-10-10B	81	19.7	569
79	EC5-T41T-20-32B	81	31.5	469
70	EC4-T41T-20-25B	103	24.6	600
70	EC4-T41T-10-10B	129	19.7	750

Ratings are based the Hybrid stepper motor and P7000 drive with 120 or 240 Vac single phase supply.
See pages 110-115 for details on Drive & Motor System combinations.
Force Speed Curves located on pages 36-81.



Plotted value is continuous thrust (lb), refer to chart for the associated rated speed value.

N2 Series Electric Cylinder Specifications

General Specifications

Travel Lengths

Cylinder	Stroke Designator/Effective Travel Lengths						
Stroke length designator [in]	2.0	4.0	6.0	8.0	12.0	*18.0	*24.0
Effective Travel Length [in]	2.0	4.0	6.0	8.0	12.0	16.5	22.5

* Dual rod-end bearing required for 18 inch and 24 inch stroke units.
* Effective travel reduced by 1.5 inches respectively with dual rod-end bearing.
Custom travel lengths are available.

Construction Materials

Bearing Housings: Type 380 die cast aluminum, epoxy coated
Cylinder Housing: 6063-T6 aluminum, hard-coated anodized and Teflon® coated
Thrust Tube: 304 Series Stainless Steel, 1/4 hard, ground and polished
Wiper seal: Polyurethane

Speed Reducer Versions

Belt/Pulley: AT-5, polyurethane with steel tensile cords
Helical Gearing: Alloy steel, case hardened
Support Bearings: Ball bearings

Transport Screw Versions

Ballscrew: Carbon steel screw
Ballnut: Alloy steel, heat-treated ballnut
Lead screw: Carbon steel screw
Lead nut: Bronze lead nut (standard, recommended for servo system)
(Lubricated polyacetal plastic drive nut also available but not recommended for use with servomotor based systems.)

System Specifications

Electric Cylinder	Screw-Nut Type	Pitch [revs/in]	Screw Diameter [in]	Efficiency [%]	Minimum Backdrive Load [lb]	Maximum Thrust [lb]	Maximum Speed [in/s]	Backlash [mm (in)]	Repeatability [mm/300mm (in/ft)]
N2-2B	Ballscrew	2.0	0.625	90	10	* 552	** 30	0.38 (0.015)	+/-0.15 (+/-0.006)
N2-5B	Ballscrew	5.0	0.625	90	20	600	12	0.38 (0.015)	+/-0.15 (+/-0.006)
N2-5A-BZ	Bronze	5.0	0.625	40	400	600	** 12	0.40 (0.016)	+/-0.75 (+/-0.003)

* Thrust limited by AKM23 motor/drive T peak limit
** Maximum speed and Maximum Thrust specification define range of N2 series; not available on the same unit.
See Thrust Speed curves (pages 36-41) for comprehensive details.

Weight (approximate, without options)

Cylinder- Motor	Weight [kg]	Weight [lb]
N2-AKM23	= 2.3 + 0.0045 x [in stroke]	= 5.0 + 0.25 x [in stroke]
N2-T22	= 1.9 + 0.0045 x [in stroke]	= 4.2 + 0.25 x [in stroke]

Brushless Servomotor

Thrust Speed Curves: See pages 36-38
Servo System Specifications and Dimensions: See page 110

Stepper Motor

Thrust Speed Curves: See pages 39-41
Stepper System Specifications and Dimensions: See page 132

Properties

Electric Cylinder	Screw Type	Pitch [revs/in]	Screw Efficiency [%]	Transmission			Overall Efficiency [%]
				Ratio	Type	Efficiency [%]	
N2-...-10L-2B	Ballscrew	2.0	90	Inline/direct coupled	N/A	N/A	90
N2-...-10-2B	Ballscrew	2.0	90	1:1	Timing belt	90	81
N2-...-15-2B	Ballscrew	2.0	90	1.5:1	Timing belt	90	81
N2-...-20-2B	Ballscrew	2.0	90	2.0:1	Timing belt	90	81
N2-...-25-2B	Ballscrew	2.0	90	2.5:1	Helical gear	70	63
N2-...-10L-5B	Ballscrew	5.0	90	Inline/direct coupled	N/A	N/A	90
N2-...-10-5B	Ballscrew	5.0	90	1:1	Timing belt	90	81
N2-...-15-5B	Ballscrew	5.0	90	1.5:1	Timing belt	90	81
N2-...-20-5B	Ballscrew	5.0	90	2.0:1	Timing belt	90	81
N2-...-25-5B	Ballscrew	5.0	90	2.5:1	Helical gear	70	63
N2-...-10L-5A	Lead	5.0	40	Inline/direct coupled	N/A	N/A	40
N2-...-10-5A	Lead	5.0	40	1:1	Timing belt	90	36
N2-...-15-5A	Lead	5.0	40	1.5:1	Timing belt	90	36
N2-...-20-5A	Lead	5.0	40	2.0:1	Timing belt	90	36
N2-...-25-5A	Lead	5.0	40	2.5:1	Helical gear	70	28

N2 Series Electric Cylinders - General Specifications

N2 Series Electric Cylinder Inertia						
Rotary Inertia (Reflected to Motor) = A + B* (Stroke, in) + C * (Load weight, lb)						
Model N2 Series	Ratio	Reduction type	Screw	A	B	C
				oz-in^2	oz-in^2 / in	oz-in^2 / lb
N2-...-10-5B	1:1	Belt/pulley	Pitch 5 revs/in Dia 0.625 in Ballscrew	0.5702	0.0685	0.0162
N2-...-15-5B	1.5:1			0.2756	0.03045	0.0072
N2-...-20-5B	2:1			0.1689	0.0171	0.0041
N2-...-10-2B	1:1	Belt/pulley	Pitch 2 revs/in Dia 0.625 in Ballscrew	0.6532	0.07555	0.1013
N2-...-15-2B	1.5:1			0.3126	0.03355	0.0450
N2-...-20-2B	2:1			0.1895	0.01899	0.0253
N2-...-10-5A	1:1	Belt/pulley	Pitch 5 revs/in Dia 0.625 in Lead	0.06845	0.06845	0.0162
N2-...-15-5A	1.5:1			0.0304	0.0304	0.0072
N2-...-20-5A	2:1			0.0171	0.0171	0.0041

To convert inertia units from oz-in^2 to oz-in-sec^2 divide by 386.

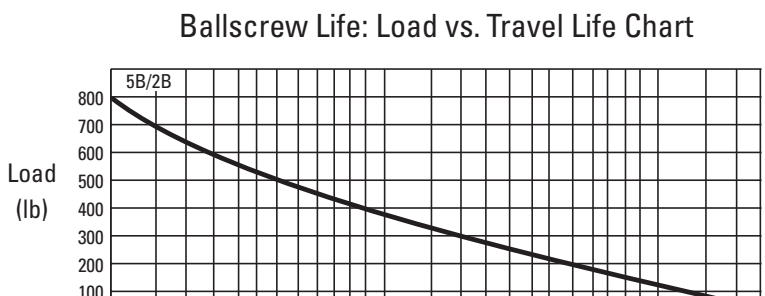
N2 Series Electric Cylinder Specifications

General Specifications

Ballscrew Life

Ballscrew life is rated in inches of travel at a given load. The values in the chart below indicates the travel life where 90% of all units in a sample will continue to work, while 10% have failed. This is similar to the B10 rating of a roller bearing mechanism. Be sure to consider acceleration loads as well as thrust, gravity and friction loads.

Ballscrew Life: Load vs. Travel Life Chart



Environmental Operation (see page 146 for additional information)

Temperature
32° to 140°F, [0° to 60°C]
H – High temperature option allows 32° to 160°F, [0° to 70°C]
F – Sub-freezing temperature option allows -20° to 105°F, [-29° to 40°C]

Moisture
Humid, but not direct moisture contact
W – Water resistant option allows some direct moisture contact

Contaminants
Non-corrosive, non-abrasive.
PB – Protective Boot option prevents moisture and dry contaminants from entering the cylinder through the wiper ring on the rod

N2 with AKM23

EC Series Electrical Cylinder Specifications

General Specifications

Travel Lengths

Cylinder	Travel Lengths [mm]											
EC1	50	100	150	200								
EC2	50	100	150	200	250	300	450	600	750			
EC3	50	100	150	200	250	300	450	600	750	1000		
EC4	50	100	150	200	250	300	450	600	750	1000	1250	1500
EC5	50	100	150	200	250	300	450	600	750	1000	1250	1500

Custom strokes available in increments of 10 mm.

Construction Materials

Bearing & Drive Housing: 6063-T6 aluminum, anodized
Guide Cylinder: 6063-T6 aluminum, hard anodized
Mounting Plates: 6061-T6 aluminum and cast aluminum plate, anodized
Thrust Tube: 300 Series Stainless Steel, 1/4 hard and ground
Thrust Bearings: Angular contact, high thrust ball bearings

Speed Reducer Versions

Belt/Pulley: AT-5, polyurethane with steel tensile cords
Helical Gearing: Alloy steel, case hardened

Transport Screw Versions

Ballscrew/Ballnut: Heat treated carbon steel alloy
Lead screw/Lead nut: Bronze; carbon steel alloy lead screw

Screw Properties					
Cylinder	Nominal Diameter [mm]	Lead [mm (in)] / rev.			
		Lead Screw	Ballscrew		
EC1	10		3 (0.118)		
EC2	16	4 (0.157)	5 (0.197)	16 (0.630)	
EC3	20	4 (0.157)	5 (0.197)	10 (0.395)	16 (0.630)
EC4	25		10 (0.394)	25 (0.984)	
EC5	32		10 (0.394)	32 (1.259)	

Servo System Weight (approximate, without options)

Cylinder- Motor	Weight [kg]	Weight [lb]
EC1-AKM11	= 0.864 + 0.0059 x [mm stroke]	= 1.9 + 0.33 x [in stroke]
EC1-AKM13	= 1.136 + 0.0059 x [mm stroke]	= 2.5 + 0.33 x [in stroke]
EC2-AKM23	= 4.18 + 0.0059 x [mm stroke]	= 9.2 + 0.33 x [in stroke]
EC3-AKM23	= 5.75 + 0.0082 x [mm stroke]	= 12.6 + 0.46 x [in stroke]
EC3-AKM42	= 6.70 + 0.0082 x [mm stroke]	= 14.7 + 0.46 x [in stroke]
EC4-AKM42	= 14.7 + 0.0188 x [mm stroke]	= 32.2 + 1.05 x [in stroke]
EC4-AKM52	= 17.1 + 0.0188 x [mm stroke]	= 37.7 + 1.05 x [in stroke]
EC5-AKM42	= 14.7 + 0.0188 x [mm stroke]	= 32.2 + 1.05 x [in stroke]
EC5-AKM52	= 17.1 + 0.0188 x [mm stroke]	= 37.7 + 1.05 x [in stroke]

Brushless Servomotor

Thrust Speed Curve Pages:

EC1 (pg.42), EC2 (pgs. 44-47),
EC3 (pgs. 52-55), EC4 (pgs. 60-66),
EC5 (pgs. 72-77)

Servo System Specifications and Dimensions:

Pages 110-115

EC Series Electric Cylinder Specifications

Stepper System Weight (approximate, without options)

Cylinder – Motor	Weight [kg]	Weight [lb]
EC1-CTP12	= 0.85 + 0.0059 x [mm stroke]	= 1.88 + 0.33 x [in stroke]
EC2-T22	= 3.80 + 0.0059 x [mm stroke]	= 8.36 + 0.33 x [in stroke]
EC2-T31	= 5.07 + 0.0059 x [mm stroke]	= 11.2 x 0.33 x [in stroke]
EC3-T22	= 5.37 + 0.0082 x [mm stroke]	= 11.8 + 0.46 x [in stroke]
EC3-T31	= 6.64 + 0.0082 x [mm stroke]	= 14.6 + 0.46 x [in stroke]
EC4-T31	= 13.6 + 0.0188 x [mm stroke]	= 29.9 + 1.05 x [in stroke]
EC4-T32	= 15.1 + 0.0188 x [mm stroke]	= 33.3 + 1.05 x [in stroke]
EC4-T41	= 16.3 + 0.0188 x [mm stroke]	= 35.9 + 1.05 x [in stroke]
EC5-T31	= 13.6 + 0.0188 x [mm stroke]	= 29.9 + 1.05 x [in stroke]
EC5-T32	= 15.1 + 0.0188 x [mm stroke]	= 33.3 + 1.05 x [in stroke]
EC5-T41	= 16.3 + 0.0188 x [mm stroke]	= 35.9 + 1.05 x [in stroke]

Stepper Motor

Thrust Speed Curve Pages:

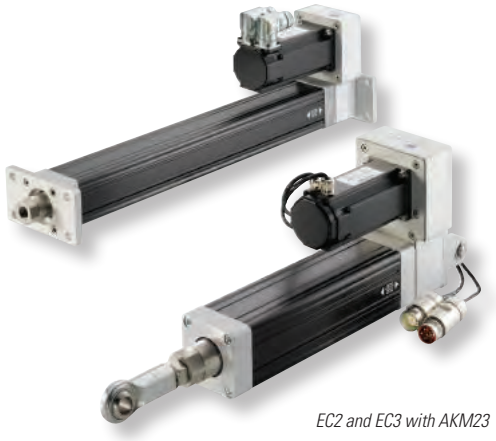
EC1 (pg. 43), EC2 (pgs. 48-50),
EC3 (pgs. 56-59), EC4 (pgs. 67-71),
EC5 (pgs. 78-81)

Stepper System Specifications and Dimensions:

See page 132

System Specifications - Backlash, Lead Accuracy

Cylinder	Lead [mm]	Type	Backlash [mm (in)]	Lead Accuracy [mm/300mm (in/ft)]	Repeatability [mm (in)]
EC1	3	Ball	0.381 (0.015)	+/-0.10 (+/-0.004)	+/-0.013 (+/-0.0005)
EC2	16, 5	Ball	0.25 (0.010)	+/-0.05 (+/-0.002)	+/-0.013 (+/-0.0005)
	4	Lead	0.40 (0.016)	+/-0.10 (+/-0.004)	+/-0.013 (+/-0.0005)
EC3	16, 10, 5	Ball	0.25 (0.010)	+/-0.05 (+/-0.002)	+/-0.013 (+/-0.0005)
	4	Lead	0.40 (0.016)	+/-0.10 (+/-0.004)	+/-0.013 (+/-0.0005)
EC4	25, 10	Ball	0.30 (0.012)	+/-0.05 (+/-0.002)	+/-0.013 (+/-0.0005)
EC5	32, 10	Ball	0.30 (0.012)	+/-0.05 (+/-0.002)	+/-0.013 (+/-0.0005)



EC2 and EC3 with AKM23

Environmental Operation (see page 146 for additional information)

Temperature

-30° to 70°C [-22° to 158°F]
When operating below 2°C [35°F] vent tubing fitting must be installed.
Consult the factory for more information.

Moisture/Contaminants

Limited ingress permitted.

IP 54 rated: Polyurethane thrust tube wiper seal.
Mating surfaces gasket sealed. Protected against dust and splashing water (non-corrosive, non-abrasive).

Vent Tube Fitting: A vent tube fitting is included, which can be installed to permit the Actuator to breathe from a non-contaminated area, or receive a positive pressure continuous purge (14-20 kPa [2-3 psi]).

PB Protective Boot (IP65) Option: An optional thrust tube boot prevents moisture and dry contaminants from bypassing the thrust tube wiper seal, providing IP65 protection when used with included vent tube fitting. The boot also prevents contaminant buildup on the thrust tube.

Clean Room & Vacuum Applications: Kollmorgen has designed special actuators for clean room and vacuum applications. Please consult the factory if your application requires special environmental compatibility.

Maintenance

The EC Series Actuator design eliminates the need for most routine maintenance. Re-lubrication is required in high cycle applications.

Lube Port

EC2 - EC5 models include a lube port and adapter for a standard grease gun.

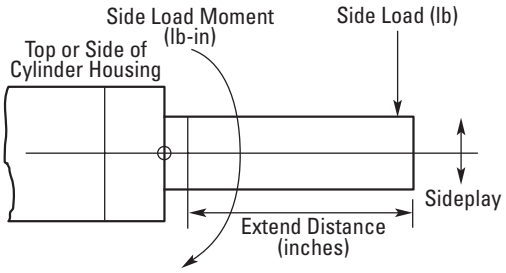
EC4 with AKM42

EC Series Electric Cylinder Specifications

Thrust Tube Torque Capacity

Thrust tube does not rotate during operation.
Maximum allowable torque during operation and installation is shown in the following table:

	Torque Capacity [lb-in (Nm)]
EC1	18 (2.0)
EC2	45 (5.0)
EC3	67 (7.5)
EC4	90 (10)
EC5	90 (10)

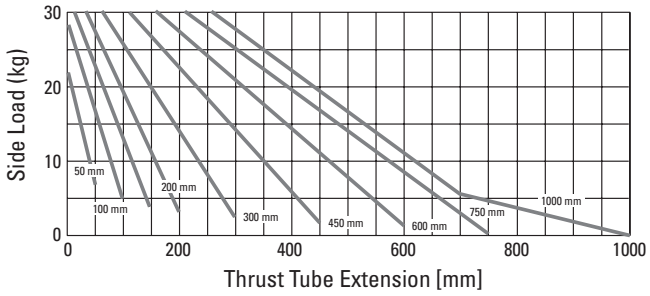


Thrust Tube Side Load Capacity vs. Extension

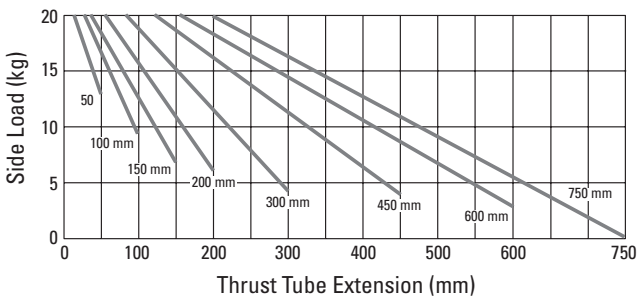
EC1

* Side loading is not recomended with the EC1.
Side loading will reduce the EC1 life.

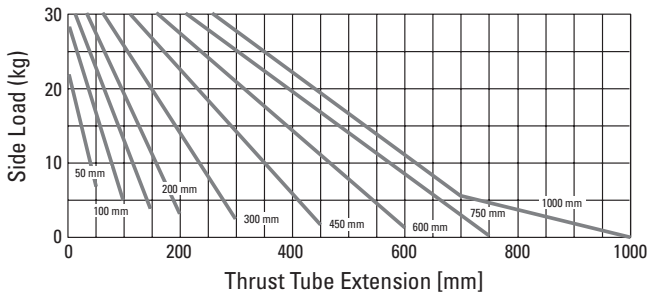
EC3



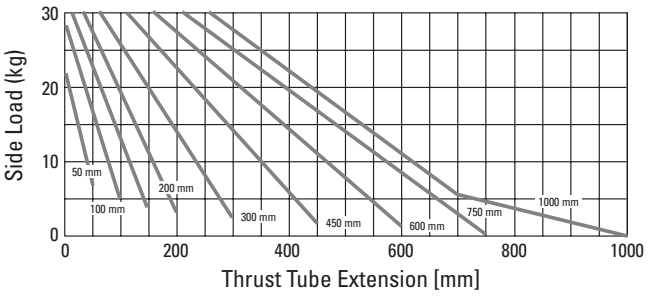
EC2



EC5



EC4



Life

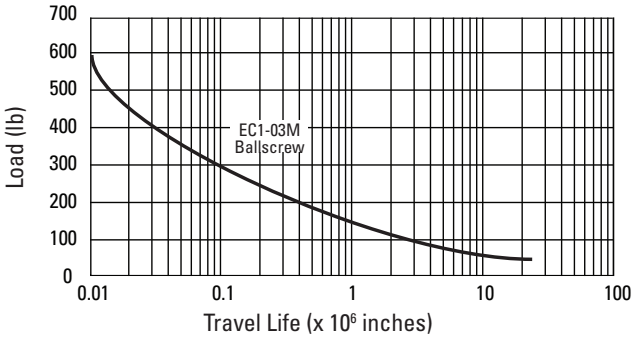
Ballscrew

Ballscrew life is rated in inches of travel at a given load. The values in the chart indicate the travel life where 90% of all units in a sample will continue to work, while 10% have failed. This is similar to the B10 rating of a roller bearing mechanism. Be sure to consider acceleration loads as well as thrust, gravity and friction loads.

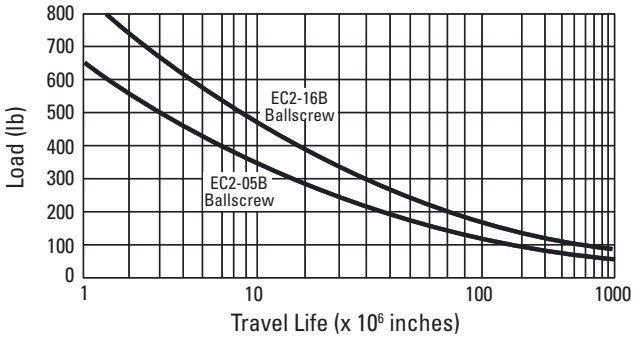
Lead Screw

Usable life for an lead screw is defined as the length of travel completed before backlash (of lead screw/nut) exceeds 0.020" [0.5 mm]. A travel life of 25 km [1 million inches] under the maximum rated load can be used as a general approximation. However, since directly dependent on application conditions (load, duty cycle, move profiles, and environment), it is difficult to predict a statistical travel life.

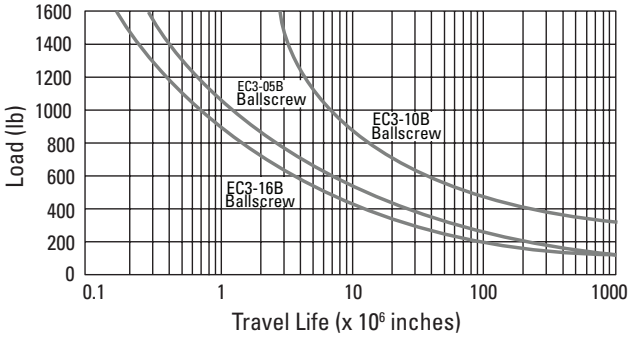
EC1 Ballscrew Life



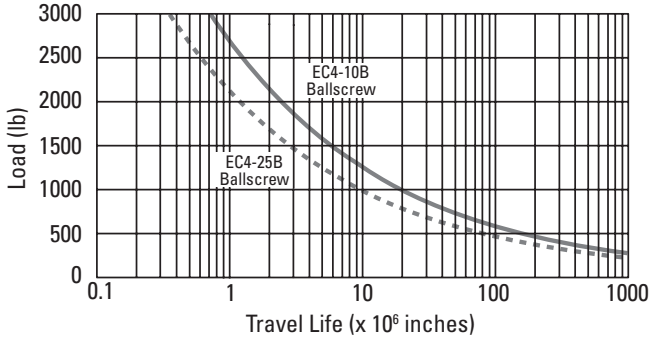
EC2 Ballscrew Life



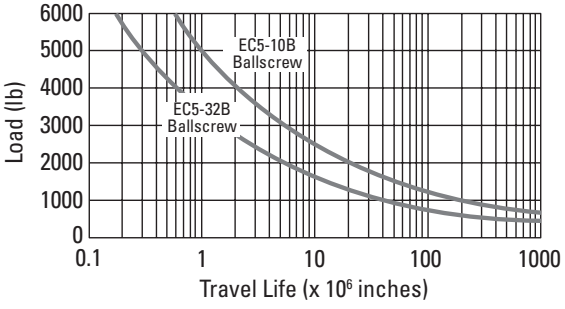
EC3 Ballscrew Life



EC4 Ballscrew Life



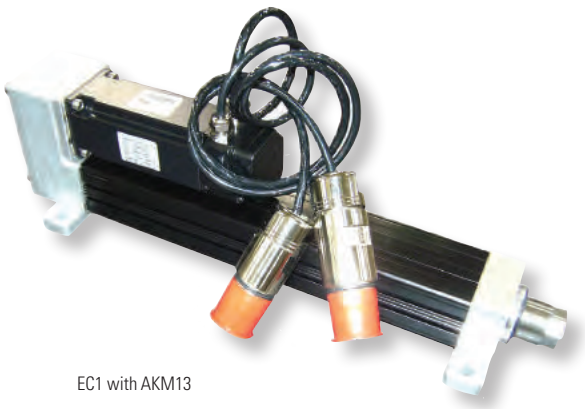
EC5 Ballscrew Life



EC Series Electric Cylinder Specifications

EC1 and EC2 General Specifications

EC Series Inertia						
Rotary Inertia (Reflected to Motor) = A + B* (Stroke, in) + C * (Load, lb)						
Model EC Series	Ratio	Reduction type	Screw	A	B	C
			Dia x Lead [mm]	lb-in-s^2	lb-in-s^2 / in	lb-in-s^2 / lb
EC1-...-10(L)-03M	1:1	Spur Gear	10 x 3	1.74 E-04	1.75 E-06	9.15 E-07
EC1-...-20-03M	2:1			5.60 E-05	4.37 E-07	2.89 E-07
EC1-...-40-03M	4:1			3.15 E-05	1.09 E-07	5.72 E-08
EC2-…-10(L)-16B	1:1	Belt/pulley	16 x 16	3.18 E-04	1.07 E-05	2.60 E-05
EC2-…-15-16B	1.470588:1			1.54 E-04	4.96 E-06	1.20 E-05
EC2-…-20-16B	2:1			1.01 E-04	2.68 E-06	6.51 E-06
EC2-…-50-16B	5.021579:1	Helical gear		5.37 E-05	4.25 E-07	1.03 E-06
EC2-…-100-16B	10.00540:1			4.60 E-05	1.07 E-07	2.60 E-07
EC2-…-10(L)-05B	1:1	Belt/pulley	16 x 5	2.90 E-04	8.30 E-06	2.54 E-06
EC2-…-15-05B	1.470588:1			1.41 E-04	3.84 E-06	1.18 E-06
EC2-…-20-05B	2:1			9.33 E-05	2.07 E-06	6.36 E-07
EC2-…-50-05B	5.021579:1	Helical gear		5.25 E-05	3.29 E-07	1.01 E-07
EC2-…-100-05B	10.00540:1			4.57 E-05	8.29 E-08	2.54 E-08
EC2-…-10(L)-04A	1:1	Belt/pulley	16 x 4	2.89 E-04	8.20 E-06	1.63 E-06
EC2-…-15-04A	1.470588:1			1.41 E-04	3.79 E-06	7.53 E-07
EC2-…-20-04A	2:1			9.33 E-05	2.05 E-06	4.07 E-07
EC2-…-50-04A	5.021579:1	Helical gear		5.25 E-05	3.25 E-07	6.45 E-08
EC2-…-100-04A	10.00540:1			4.57 E-05	8.19 E-08	1.626 E-08

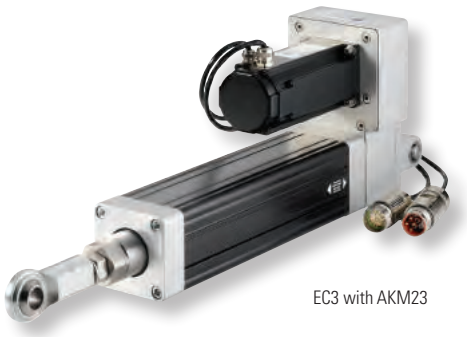


EC1 with AKM13

EC2 with AKM23

EC3 General Specifications

EC Series Inertia						
Rotary Inertia (Reflected to Motor) = A + B* (Stroke, in) + C * (Load, lb)						
Model	Ratio	Reduction type	Screw	A	B	C
EC 3 Series			Dia x Lead [mm]	lb-in-s^2	lb-in-s^2 / in	lb-in-s^2 / lb
EC3-…-10(L)-16B	1:1	Belt/pulley	16 x 16	1.19 E-03	1.18 E-05	2.60 E-05
EC3-…-15-16B	1.5:1			7.44 E-04	5.23 E-06	1.16 E-05
EC3-…-20-16B	2.0625:1			4.78 E-04	2.77 E-06	6.12 E-06
EC3-…-50-16B	5.037716:1	Helical gear		2.28 E-04	4.64 E-07	1.03 E-06
EC3-…-70-16B	7.000326:1			1.98 E-04	2.40 E-07	5.31 E-07
EC3-…-10(L)-10B	1:1	Belt/pulley	20 x 10	1.20 E-03	1.87 E-05	1.02 E-05
EC3-…-15-10B	1.5:1			7.43 E-04	8.33 E-06	4.52 E-06
EC3-…-20-10B	2.0625:1			4.81 E-04	4.41 E-06	2.39 E-06
EC3-…-50-10B	5.037716:1	Helical gear		2.29 E-04	7.38 E-07	4.01 E-07
EC3-…-70-10B	7.000326:1			1.98 E-04	3.82 E-07	2.08 E-07
EC3-…-10(L)-05B	1:1	Belt/pulley	20 x 5	1.20 E-03	1.87 E-05	1.02 E-05
EC3-…-15-05B	1.5:1			7.49 E-04	8.33 E-06	4.52 E-06
EC3-…-20-05B	2.0625:1			4.81 E-04	4.41 E-06	2.39 E-06
EC3-…-50-05B	5.037716:1	Helical gear		2.28 E-04	6.95 E-07	1.00 E-07
EC3-…-70-05B	7.000326:1			1.97 E-04	3.60 E-07	5.19 E-08
EC3-…-10(L)-04A	1:1	Belt/pulley	20 x 4	2.89 E-04	8.20 E-06	1.63 E-06
EC3-…-15-04A	1.5:1			1.41 E-04	3.79 E-06	7.53 E-07
EC3-…-20-04A	2.0625:1			9.33 E-05	2.05 E-06	4.07 E-07
EC3-…-50-04A	5.037716:1	Helical gear		5.25 E-05	3.25 E-07	6.45 E-08
EC3-…-70-04A	7.000326:1			4.57 E-05	8.19 E-08	1.63 E-08



EC3 with AKM23

*Complete EC nomemclature on pages 159-160.

EC Series Electric Cylinder Specifications

EC4 General Specifications

EC Series Inertia						
Rotary Inertia (Reflected to Motor) = A + B* (Stroke, in) + C * (Load, lb)						
Model	Ratio	Reduction type	Screw	A	B	C
EC 4 Series			Dia x Lead [mm]	lb-in-s^2	lb-in-s^2 / in	lb-in-s^2 / lb
EC4-…-10(L)-25B	1:1	Belt/pulley	25 x 25	4.91 E-03	7.01 E-05	6.36 E-05
EC4-…-15-25B	1.5:1			2.80 E-03	3.18 E-05	2.83 E-05
EC4-…-20-25B	2:1			2.71 E-03	1.75 E-05	1.59 E-05
EC4-…-50-25B	5.110442:1	Helical gear		6.27 E-04	2.69 E-06	2.43 E-06
EC4-…-100-25B	10.00729:1			3.47 E-04	7.00 E-07	6.35 E-07
EC4-…-10(L)-10B	1:1	Belt/pulley	25 x 10	4.68 E-03	5.54 E-05	1.02 E-05
EC4-…-15-10B	1.5:1			2.70 E-03	2.46 E-05	4.52 E-06
EC4-…-20-10B	2:1			2.65 E-03	1.39 E-05	2.54 E-06
EC4-…-50-10B	5.110442:1	Helical gear		6.18 E-04	2.12 E-06	3.90 E-07
EC4-…-100-10B	10.00729:1			3.45 E-04	5.53 E-07	1.020 E-07

EC4 with AKM42

EC5 General Specifications

EC Series Inertia						
Rotary Inertia (Reflected to Motor) = A + B* (Stroke, in) + C * (Load, lb)						
Model	Ratio	Reduction type	Screw	A	B	C
EC 5 Series			Dia x Lead [mm]	lb-in-s^2	lb-in-s^2 / in	lb-in-s^2 / lb
EC5-...-10(L)-32B	1:1	Belt/pulley	32 x 32	5.63 E-03	1.67 E-04	1.04 E-04
EC5-...-15-32B	1.5:1			3.12 E-03	7.41 E-05	4.63 E-05
EC5-...-20-32B	2:1			2.89 E-03	4.17 E-05	2.60 E-05
EC5-...-50-32B	5.110442:1	Helical gear		6.54 E-04	6.38 E-06	3.99 E-06
EC5-...-100-32B	10.00729:1			3.55 E-04	1.66 E-06	1.04 E-06
EC5-...-10(L)-10B	1:1	Belt/pulley	32 x 10	5.16 E-03	1.41 E-04	1.02 E-05
EC5-...-15-10B	1.5:1			2.91 E-03	6.26 E-05	4.52 E-06
EC5-...-20-10B	2:1			2.78 E-03	3.52 E-05	2.54 E-06
EC5-...-50-10B	5.110442:1	Helical gear		6.37 E-04	5.39 E-06	3.90 E-07
EC5-...-100-10B	10.00729:1			3.50 E-04	1.41 E-06	1.02 E-07

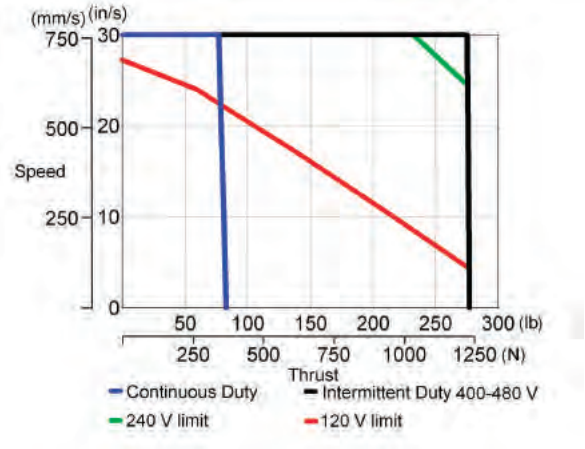
EC5 with AKM42

*Complete EC nomemclature on pages 159-160.

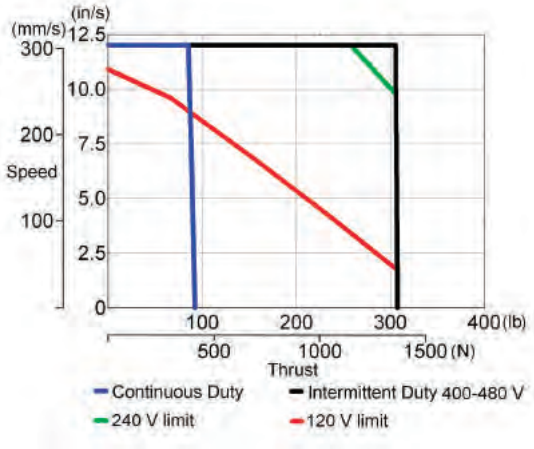
N2 Series Perfomance Curves

N2 Series Servo Thrust Speed Curves

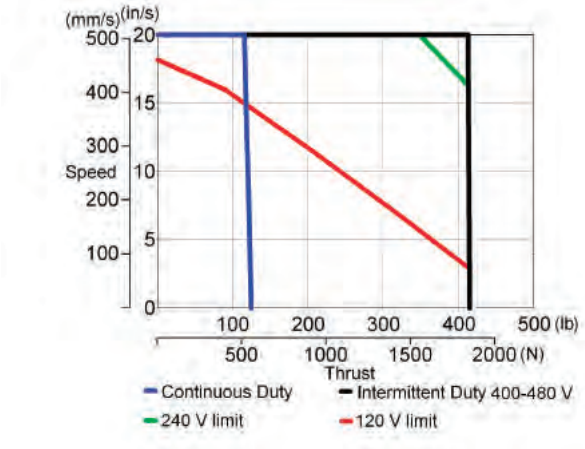
N2-AKM23D-xxx-10-2B/ AKD (3 A)



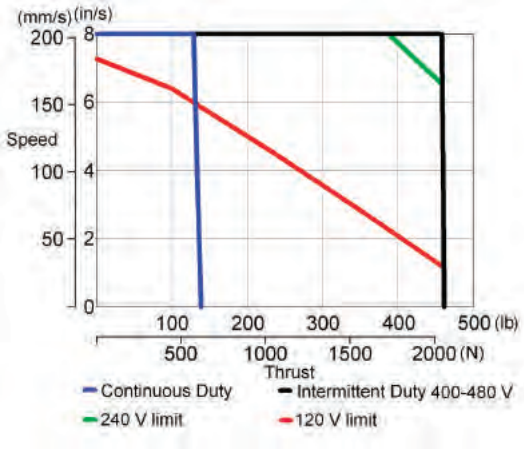
N2-AKM23D-xxx-10-5A/ AKD (3 A)



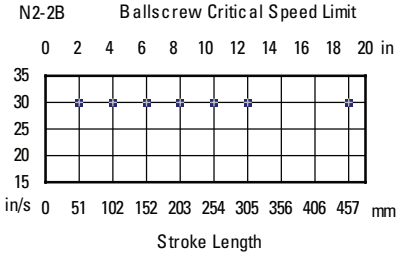
N2-AKM23D-xxx-15-2B/ AKD (3 A)

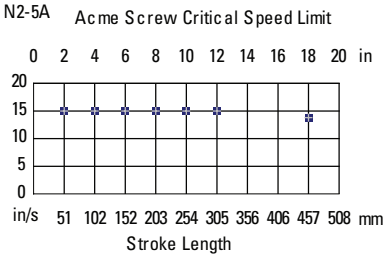


N2-AKM23D-xxx-15-5A/ AKD (3 A)



Critical Speed and Column Loading Limits

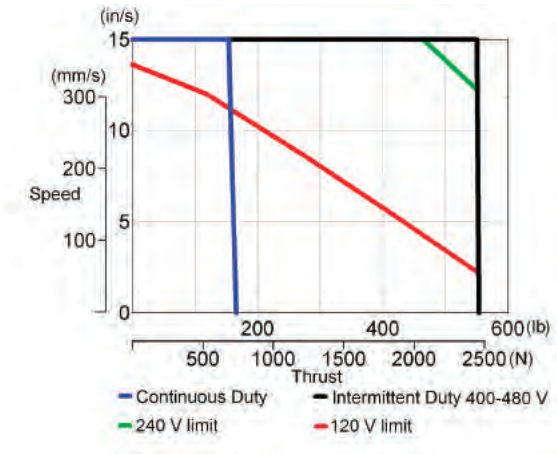




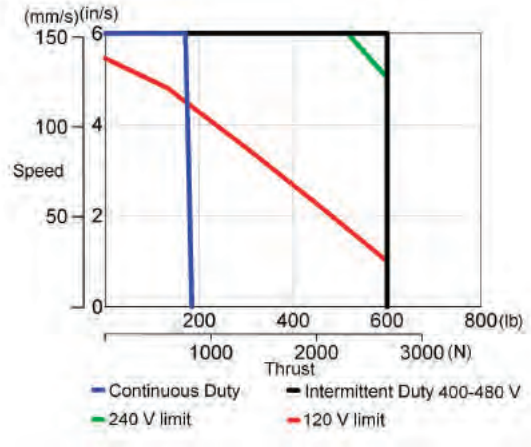
Note: No column loading limit if not shown.

N2 Series Servo Thrust Speed Curves

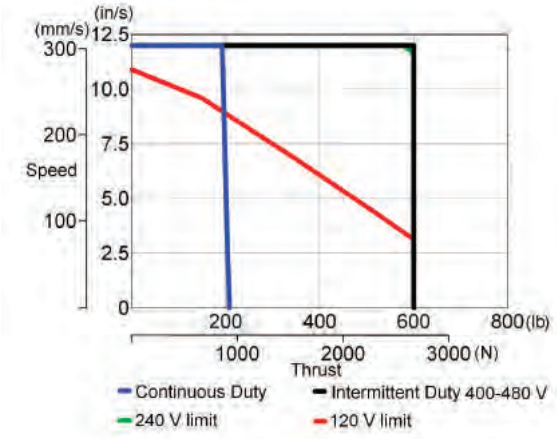
N2-AKM23D-xxx-20-2B/ AKD (3 A)



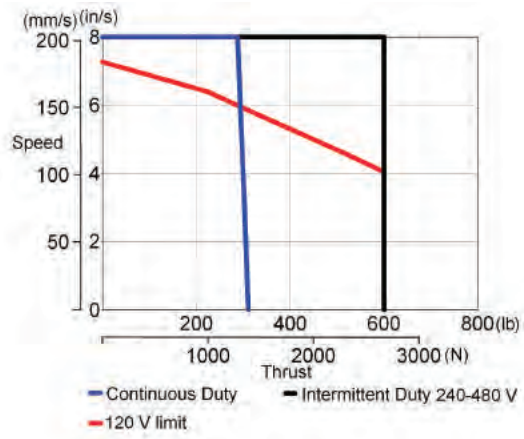
N2-AKM23D-xxx-20-5A/ AKD (3 A)



N2-AKM23D-xxx-10-5B/ AKD (3 A)

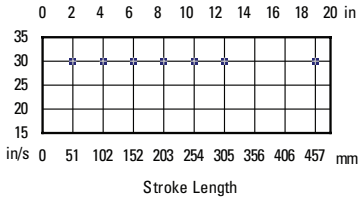


N2-AKM23D-xxx-15-5B/ AKD (3 A)

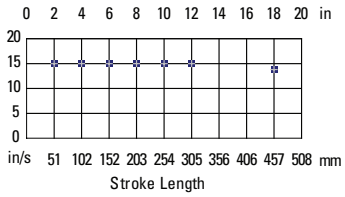


Critical Speed and Column Loading Limits

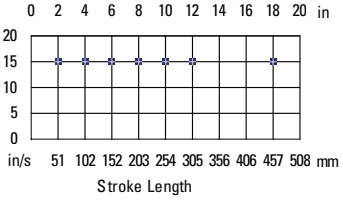
N2-2B Ballscrew Critical Speed Limit



N2-5A Acme Screw Critical Speed Limit



N2-5B Ballscrew Critical Speed Limit



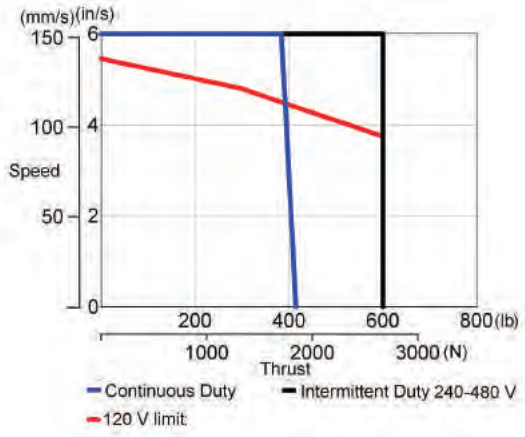
Note: No column loading limit if not shown.

*Complete N2 nomemclature on pages 157.

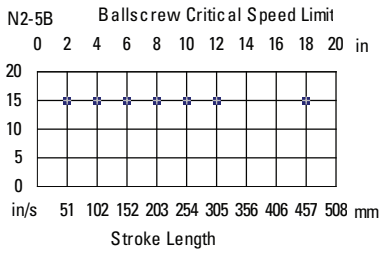
N2 Series Perfomance Curves

N2 Series Servo Thrust Speed Curves

N2-AKM23D-xxx-20-5B/ AKD (3 A)



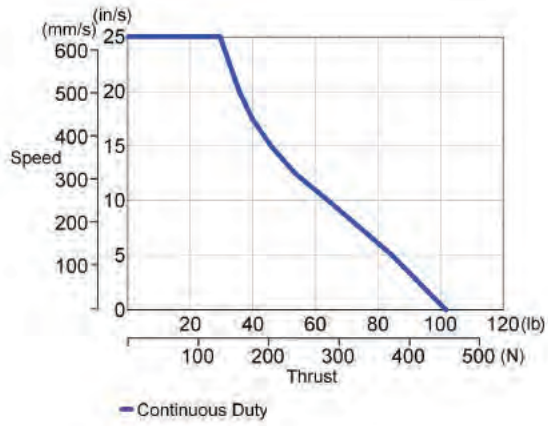
Critical Speed and Column Loading Limits



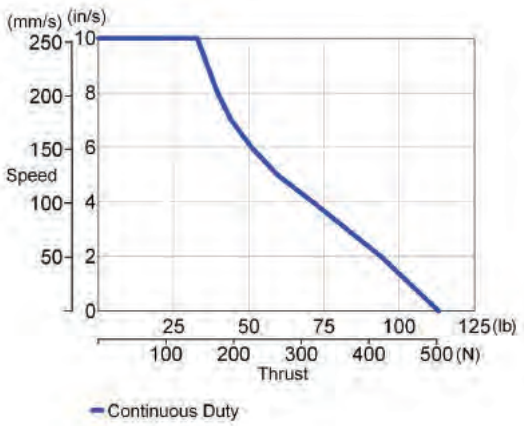
Note: No column loading limit if not shown.

N2 Series Stepper Thrust Speed Curves

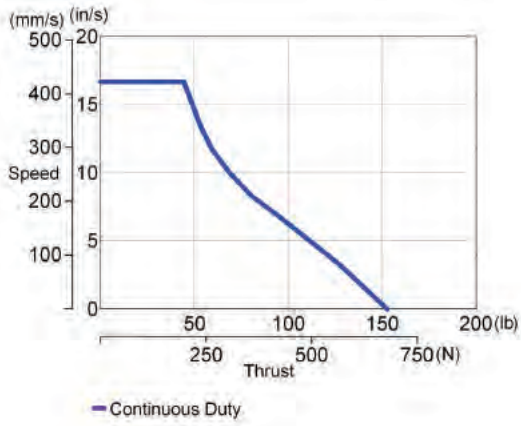
N2-T22T-10-2B/ P70360 (320 Vdc)



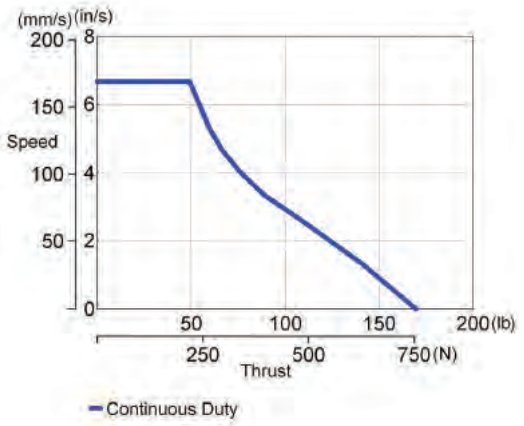
N2-T22T-10-5A/ P70360 (320 Vdc)



N2-T22T-15-2B/ P70360 (320 Vdc)

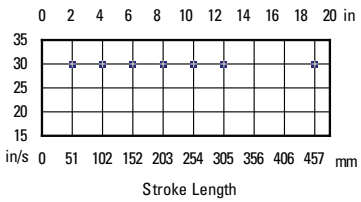


N2-T22T-15-5A/ P70360 (320 Vdc)

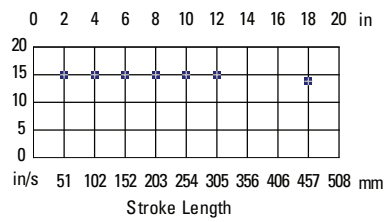


Critical Speed and Column Loading Limits

N2-2B Ballscrew Critical Speed Limit



N2-5A Acme Screw Critical Speed Limit



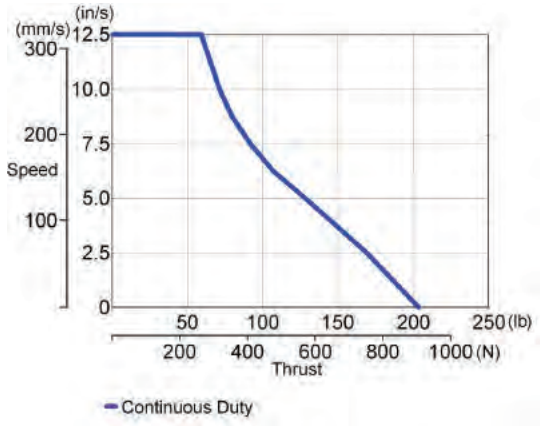
Note: No column loading limit if not shown.

*Complete N2 nomemclature on pages 158.

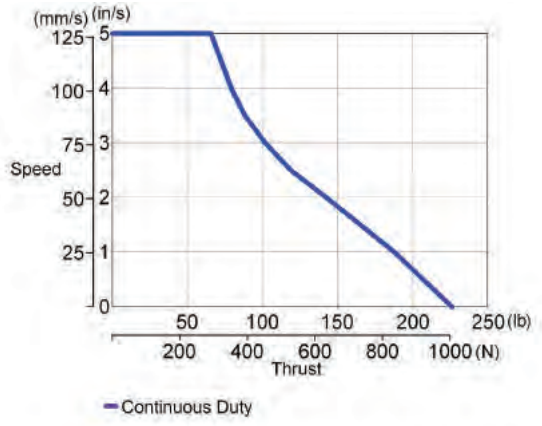
N2 Series Perfomance Curves

N2 Series Stepper Thrust Speed Curves

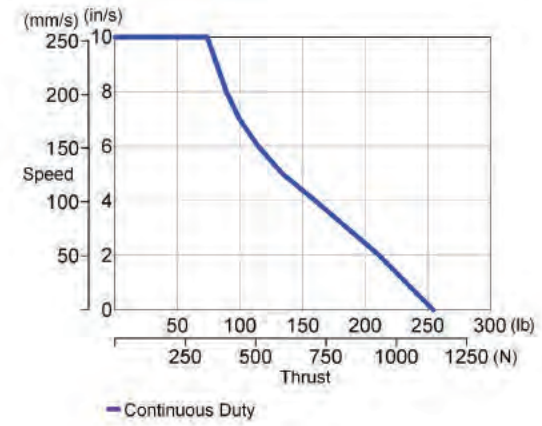
N2-T22T-20-2B/ P70360 (320 Vdc)



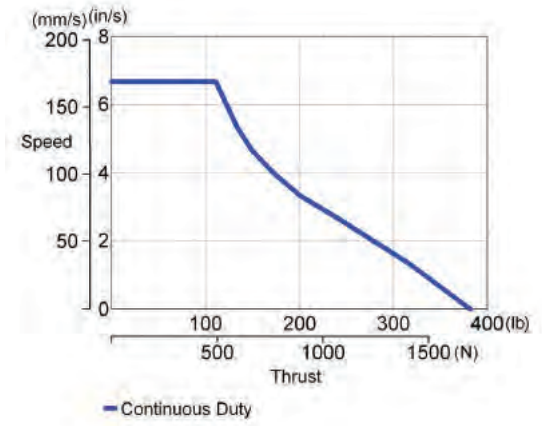
N2-T22T-20-5A/ P70360 (320 Vdc)



N2-T22T-10-5B/ P70360 (320 Vdc)

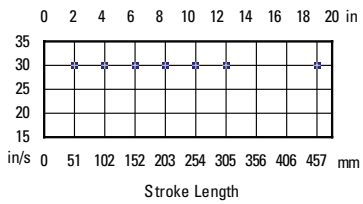


N2-T22T-15-5B/ P70360 (320 Vdc)

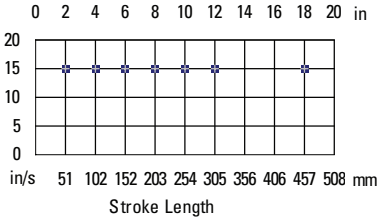


Critical Speed and Column Loading Limits

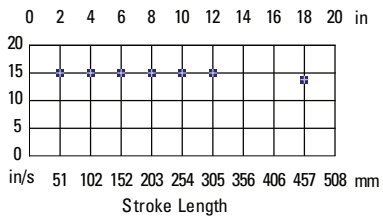
N2-2B Ballscrew Critical Speed Limit



N2-5B Ballscrew Critical Speed Limit



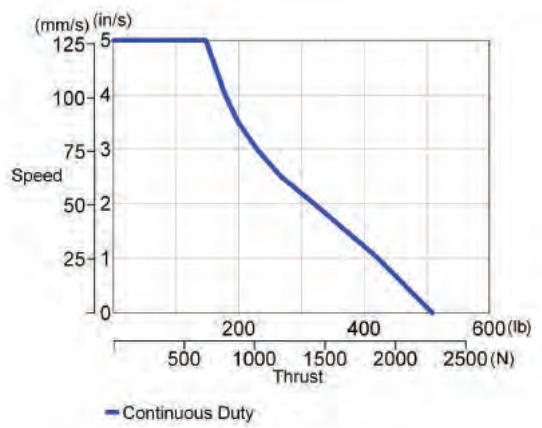
N2-5A Acme Screw Critical Speed Limit



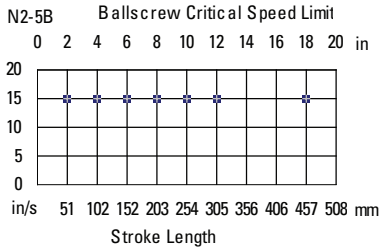
Note: No column loading limit if not shown.

N2 Series Stepper Thrust Speed Curves

N2-T22T-20-5B/ P70360 (320 Vdc)



Critical Speed and Column Loading Limits



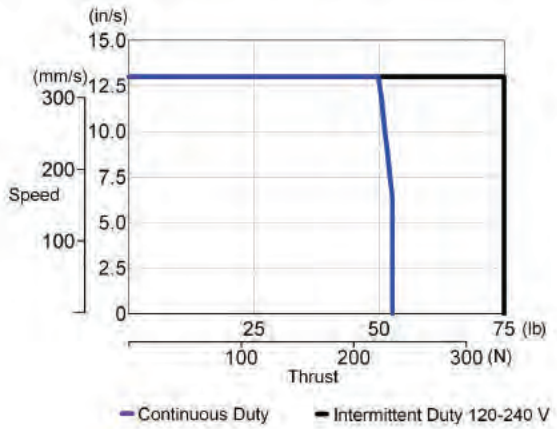
Note: No column loading limit if not shown.

*Complete N2 nomemclature on pages 158.

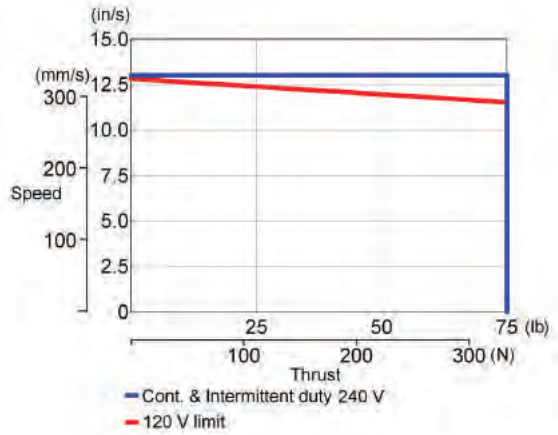
EC1 Series Perfomance Curves

EC1 Series Servo Thrust Speed Curves

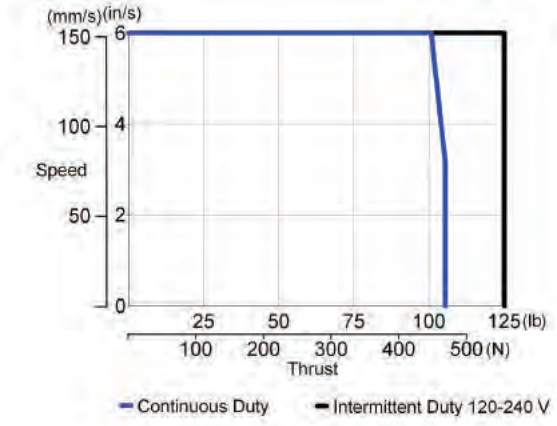
EC1-AKM11B-xxx-10-03M/ AKD (3 A)



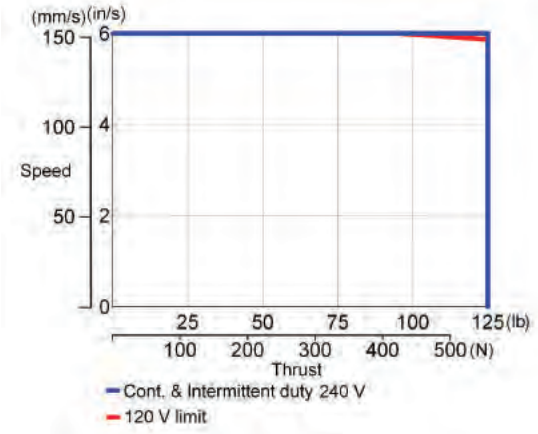
EC1-AKM13C-xxx-10-03M/ AKD (3 A)



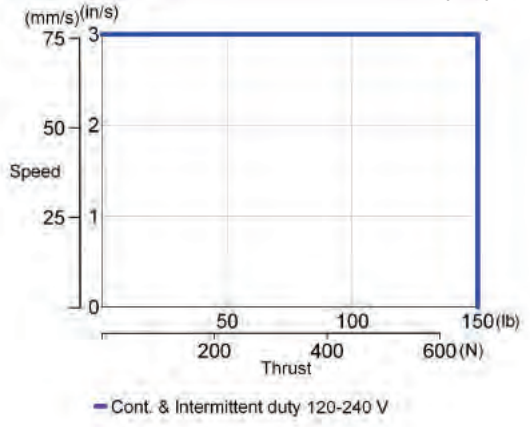
EC1-AKM11B-xxx-20-03M/ AKD (3 A)



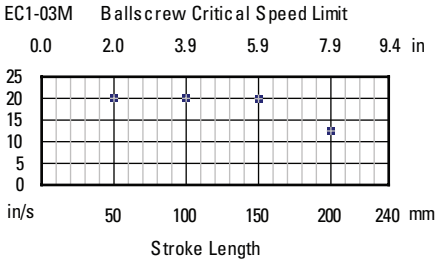
EC1-AKM13C-xxx-20-03M/ AKD (3 A)



EC1-AKM11B-xxx-40-03M/ AKD (3 A)



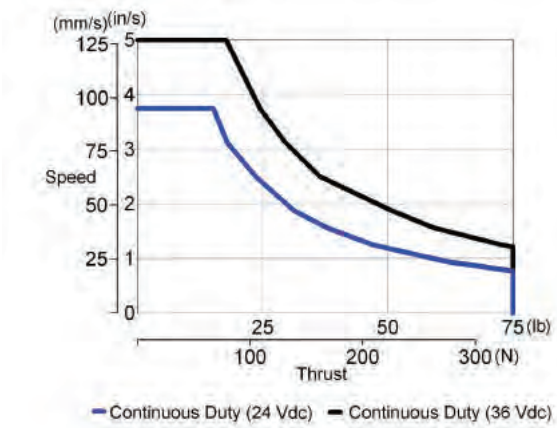
Critical Speed and Column Loading Limits



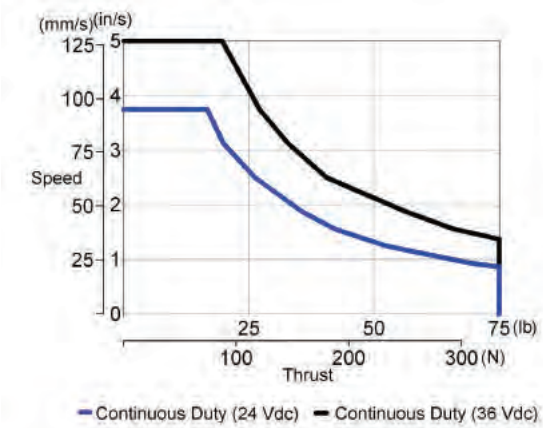
Note: No column loading limit if not shown.

EC1 Series Stepper Thrust Speed Curves

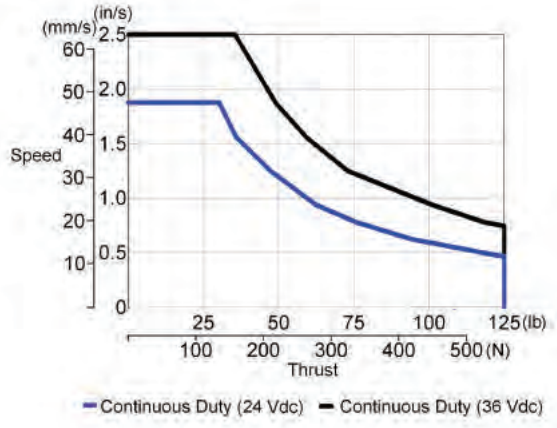
EC1-CTP12-10-03M/ P70530



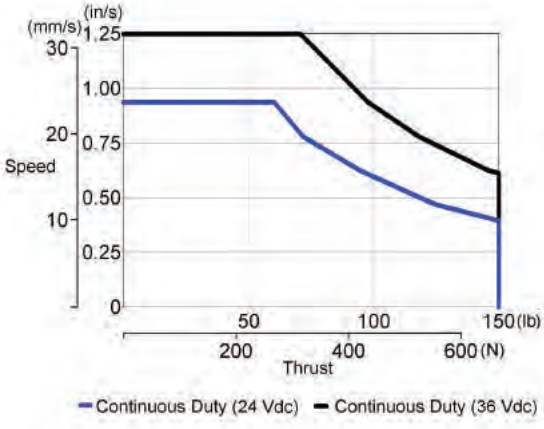
EC1-CTP12-10L-03M/ P70530



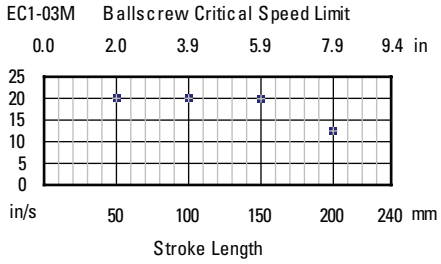
EC1-CTP12-20-03M/ P70530



EC1-CTP12-40-03M/ P70530



Critical Speed and Column Loading Limits



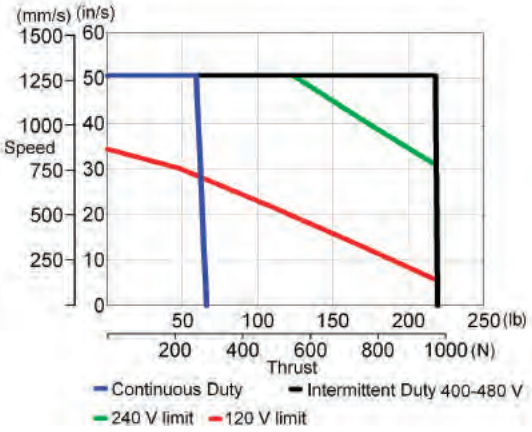
Note: No column loading limit if not shown.

*Complete EC nomemclature on pages 159-160.

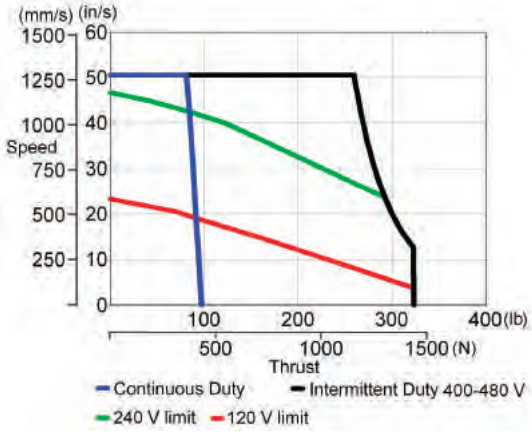
EC2 Series Perfomance Curves

EC2 Series Servo Thrust Speed Curves

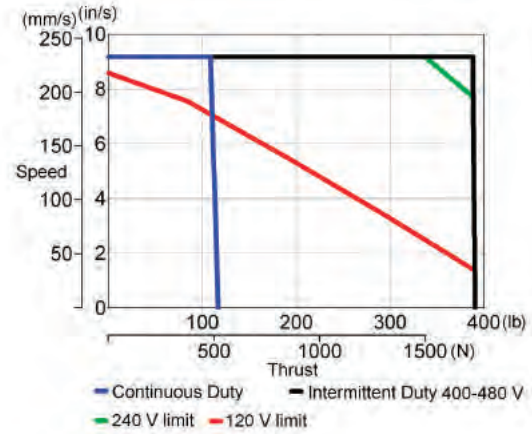
EC2-AKM23D-xxx-10-16B/ AKD (3 A)



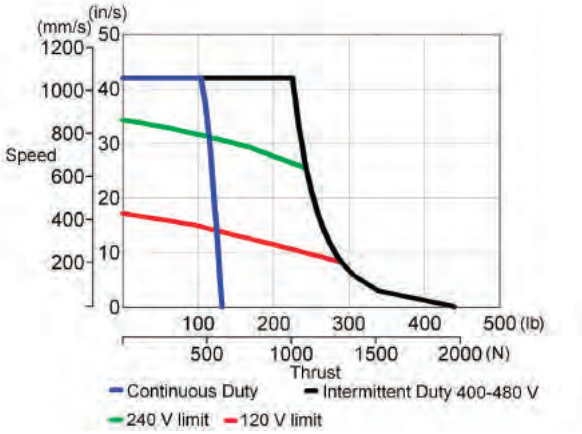
EC2-AKM23D-xxx-15-16B/ AKD (3 A)



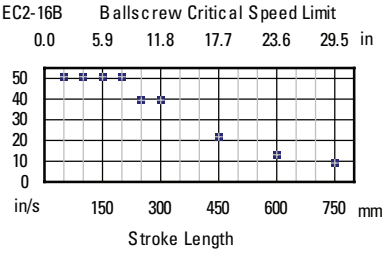
EC2-AKM23D-xxx-10-04A/ AKD (3 A)

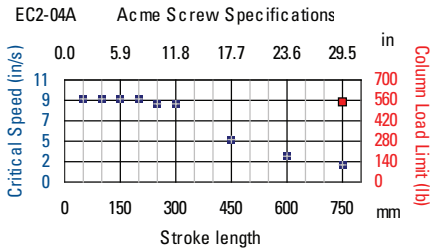


EC2-AKM23D-xxx-20-16B/ AKD (3 A)



Critical Speed and Column Loading Limits

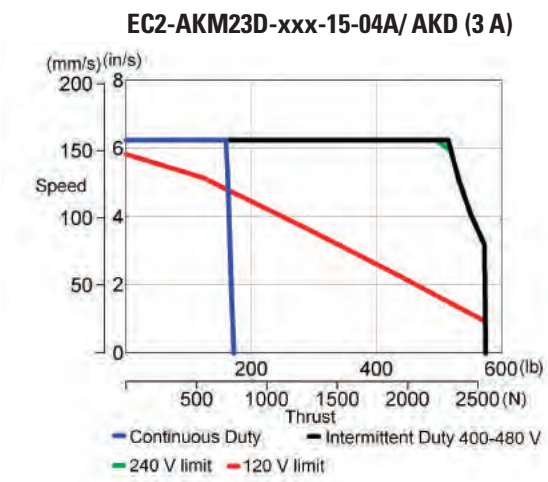




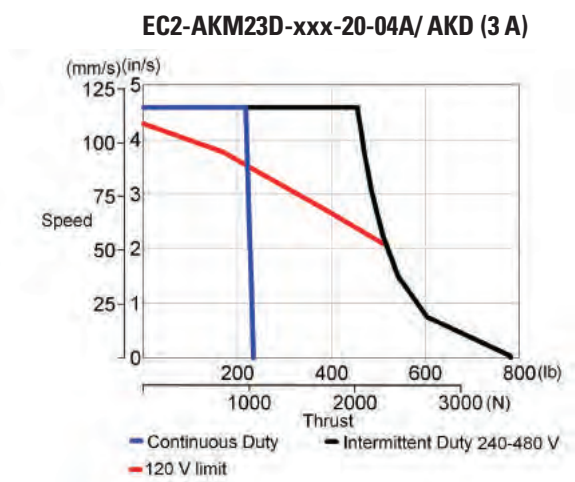
Note: No column loading limit if not shown.

EC2 Series Servo Thrust Speed Curves

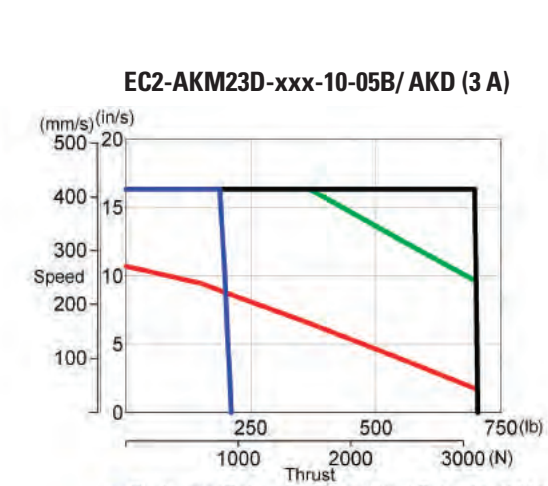
EC2-AKM23D-xxx-15-04A/ AKD (3 A)



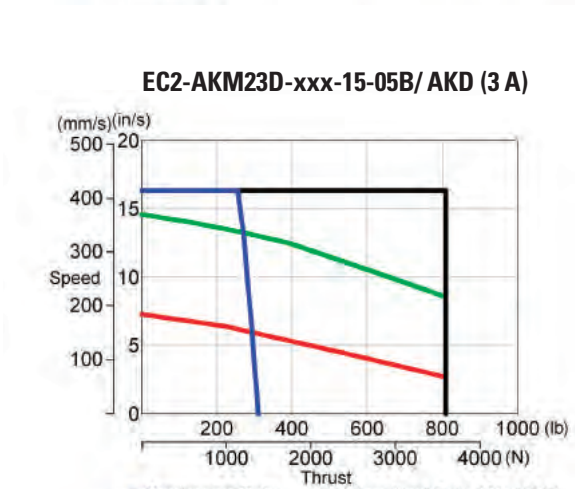
EC2-AKM23D-xxx-20-04A/ AKD (3 A)



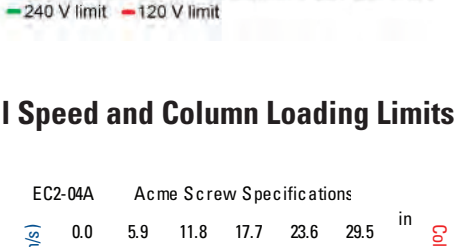
EC2-AKM23D-xxx-10-05B/ AKD (3 A)

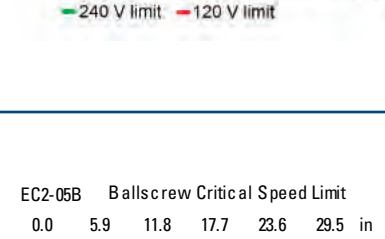


EC2-AKM23D-xxx-15-05B/ AKD (3 A)



Critical Speed and Column Loading Limits





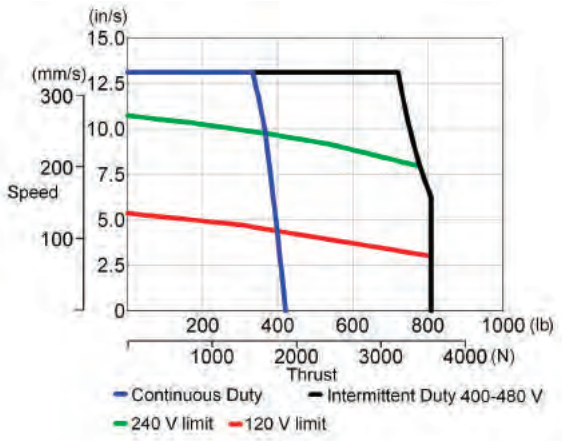
Note: No column loading limit if not shown.

*Complete EC nomemclature on pages 158-159.

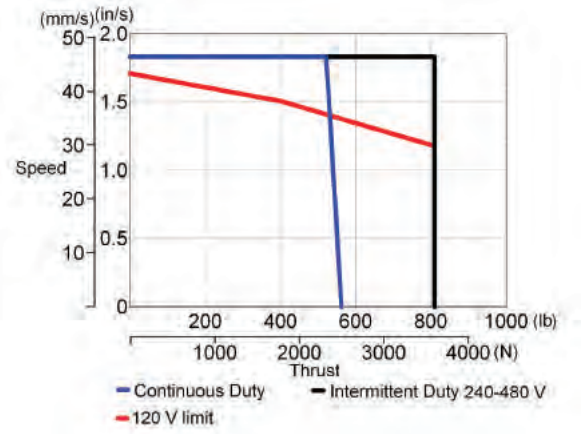
EC2 Series Perfomance Curves

EC2 Series Servo Thrust Speed Curves

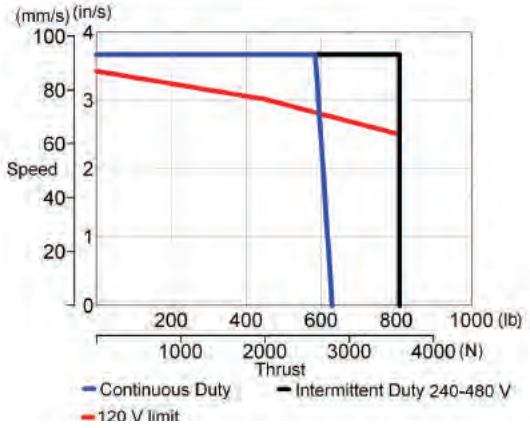
EC2-AKM23D-xxx-20-05B/ AKD (3 A)



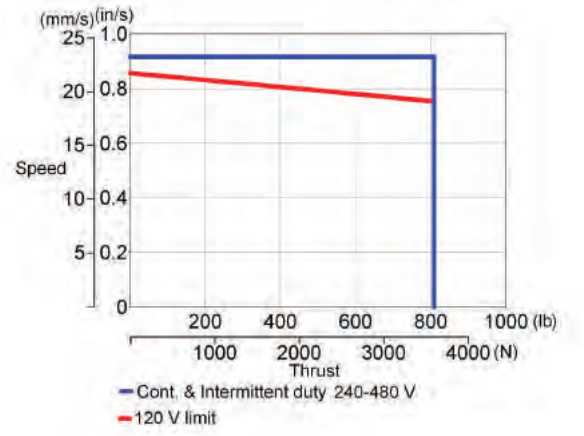
EC2-AKM23D-xxx-50-04A/ AKD (3 A)



EC2-AKM23D-xxx-100-16B/ AKD (3 A)

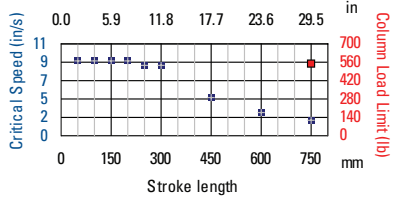


EC2-AKM23D-xxx-100-04A/ AKD (3 A)

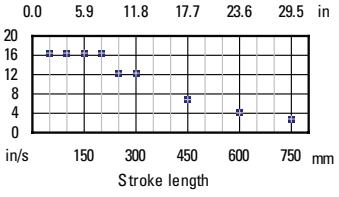


Critical Speed and Column Loading Limits

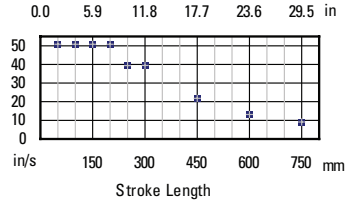
EC2-04A Acme Screw Specifications



EC2-05B Ballscrew Critical Speed Limit



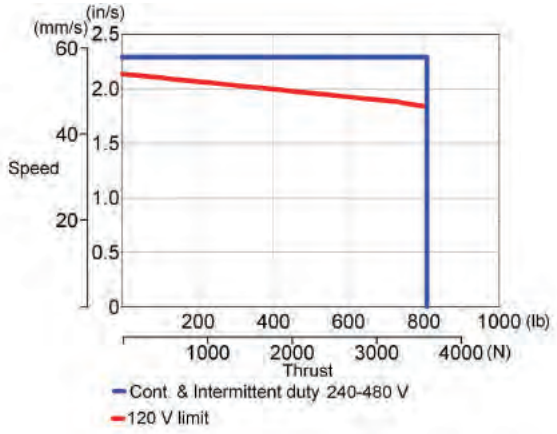
EC2-16B Ballscrew Critical Speed Limit



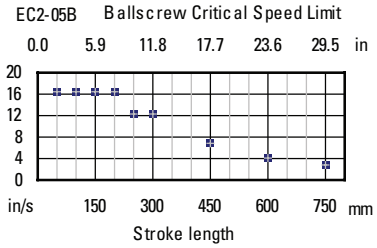
Note: No column loading limit if not shown.

EC2 Series Servo Thrust Speed Curves

EC2-AKM23D-xxx-50-05B/ AKD (3 A)



Critical Speed and Column Loading Limits



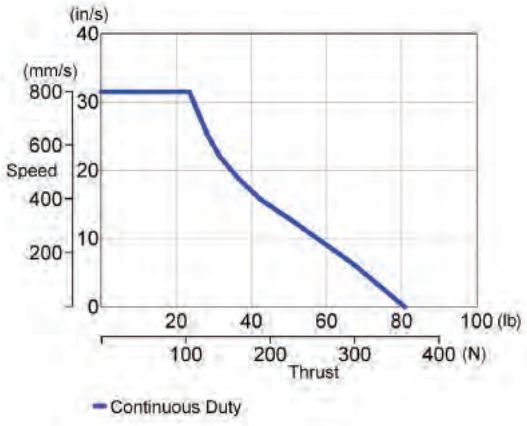
Note: No column loading limit if not shown.

*Complete EC nomemclature on pages 158-159.

EC2 Series Perfomance Curves

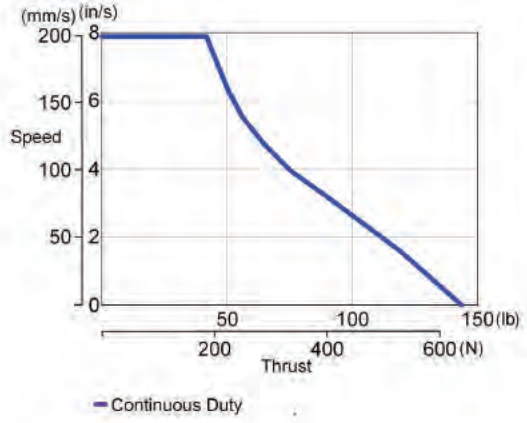
EC2 Series Stepper Thrust Speed Curves

EC2-T22T-10-16B/ P70360 (320 Vdc)

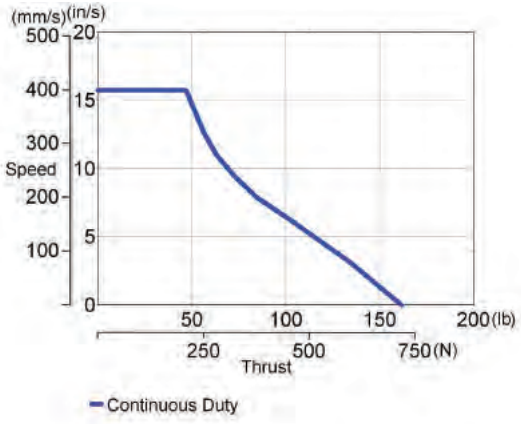


EC2-T22T-15-16B/ P70360 (320 Vdc)

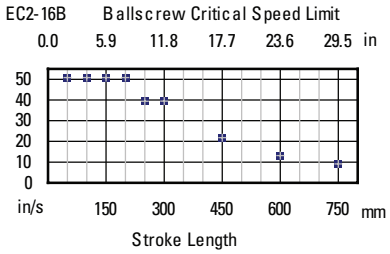
EC2-T22T-10-04A/ P70360 (320 Vdc)

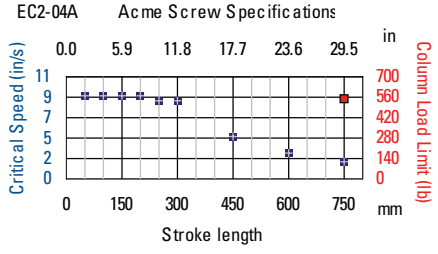


EC2-T22T-20-16B/ P70360 (320 Vdc)



Critical Speed and Column Loading Limits

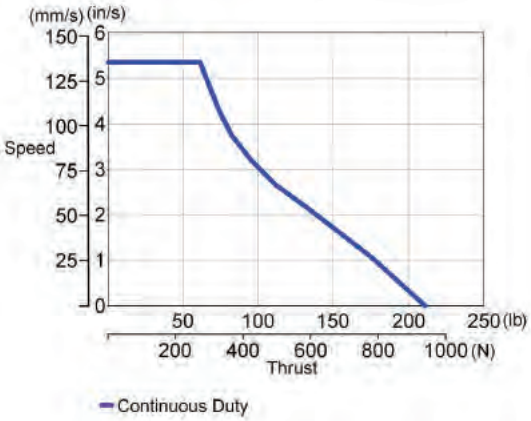




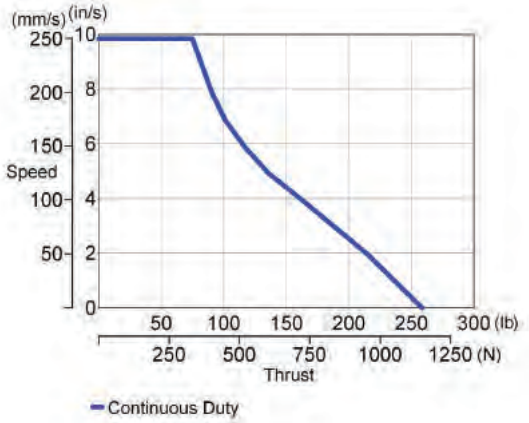
Note: No column loading limit if not shown.

EC2 Series Stepper Thrust Speed Curves

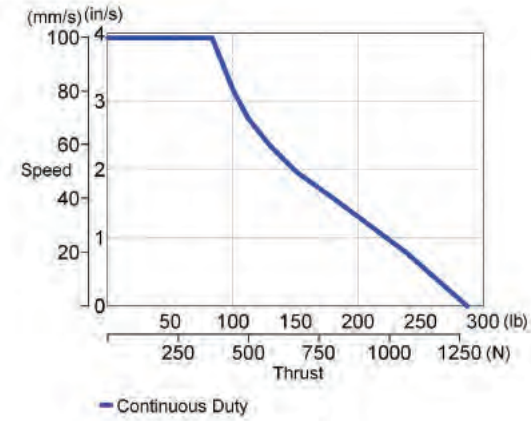
EC2-T22T-15-04A/ P70360 (320 Vdc)



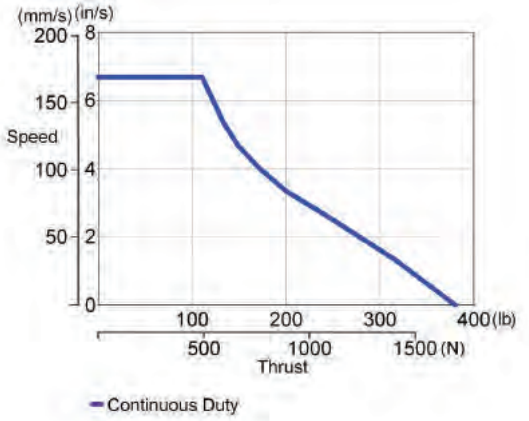
EC2-T22T-10-05B/ P70360 (320 Vdc)



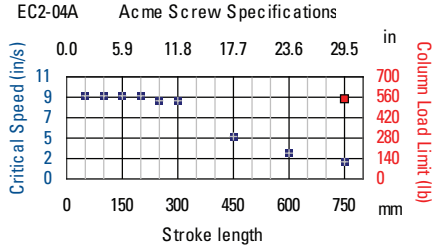
EC2-T22T-20-04A/ P70360 (320 Vdc)

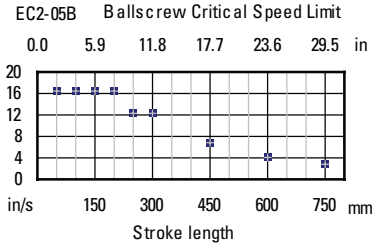


EC2-T22T-15-05B/ P70360 (320 Vdc)



Critical Speed and Column Loading Limits





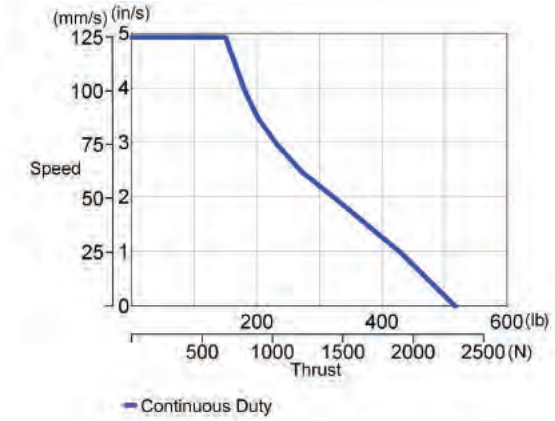
Note: No column loading limit if not shown.

*Complete EC nomemclature on pages 158-159.

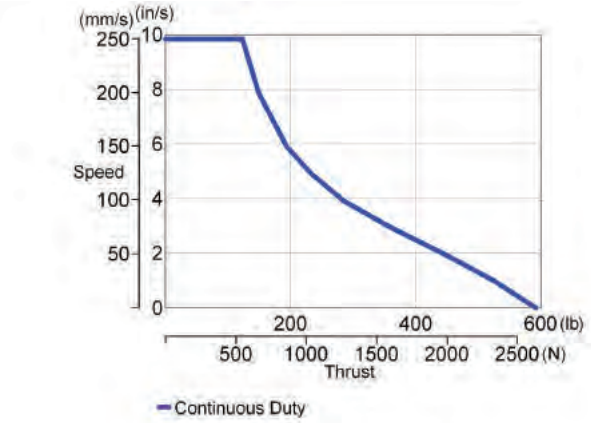
EC2 Series Perfomance Curves

EC2 Series Stepper Thrust Speed Curves

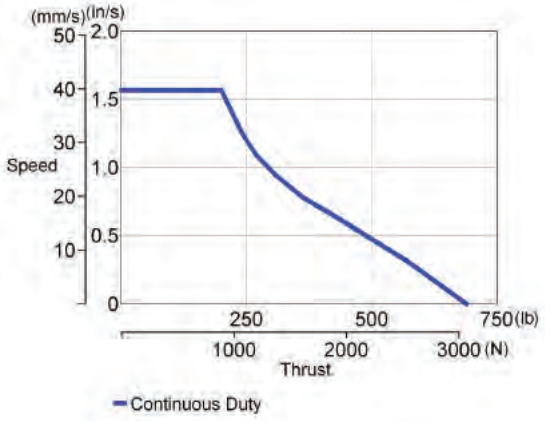
EC2-T22T-20-05B/ P70360 (320 Vdc)



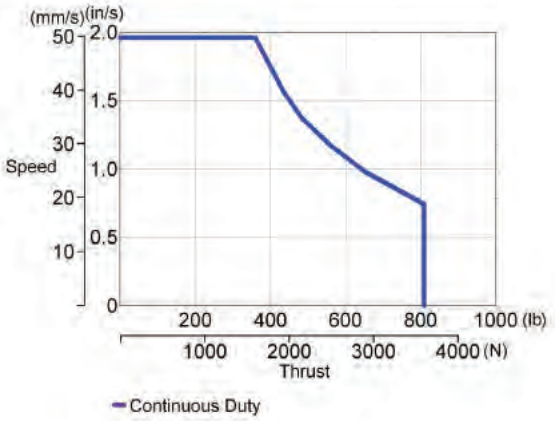
EC2-T31T-10-05B/ P70360 (320 Vdc)



EC2-T22T-50-04A/ P70360 (320 Vdc)

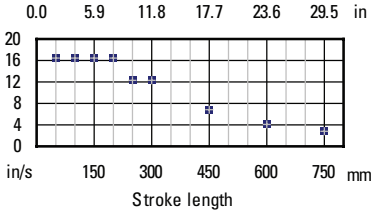


EC2-T22T-50-05B/ P70360 (320 Vdc)

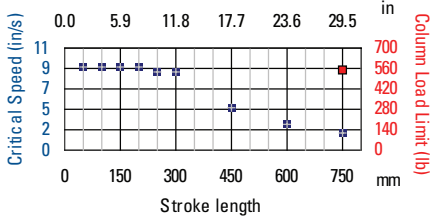


Critical Speed and Column Loading Limits

EC2-05B Ballscrew Critical Speed Limit

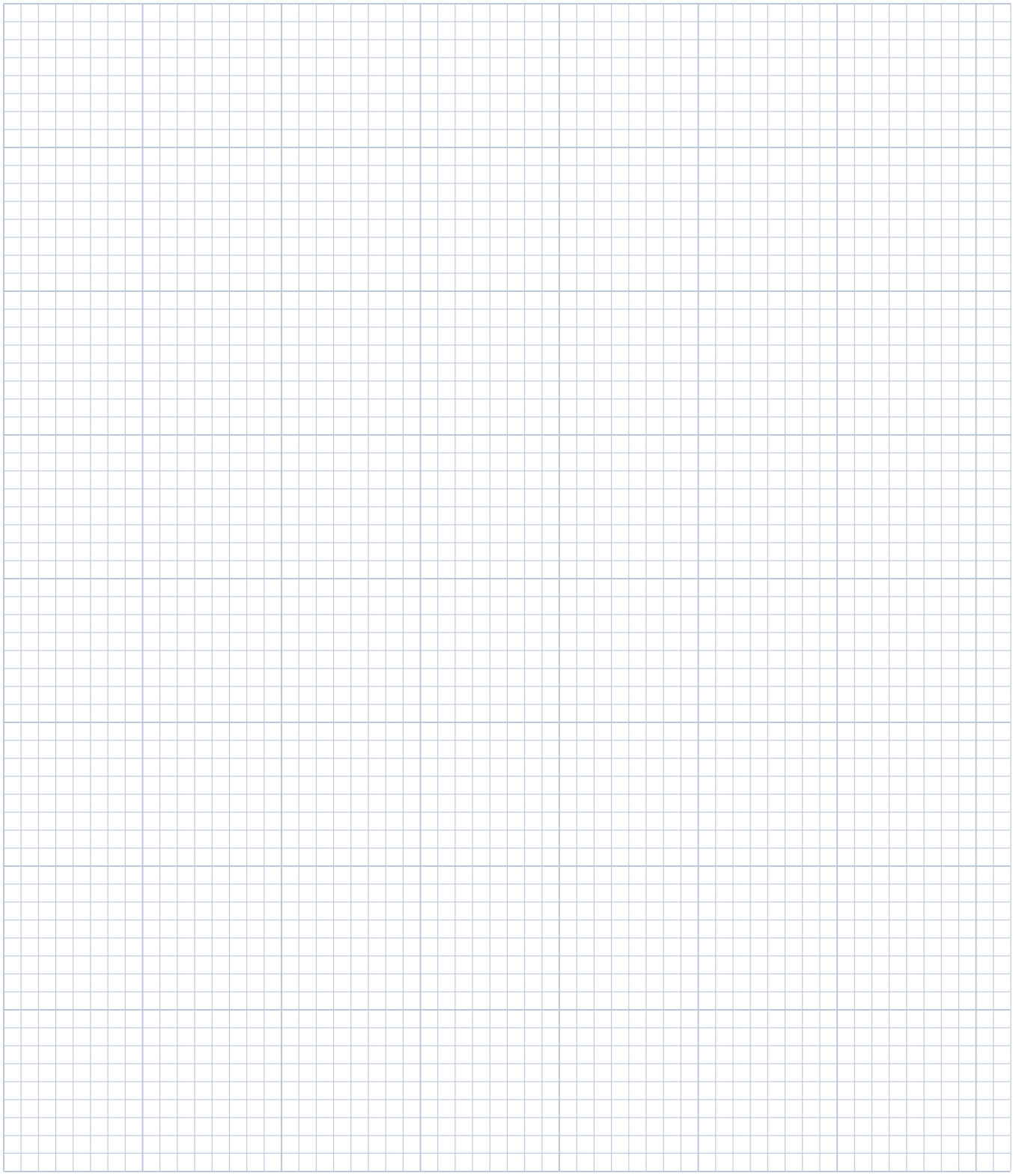


EC2-04A Acme Screw Specifications



Note: No column loading limit if not shown.

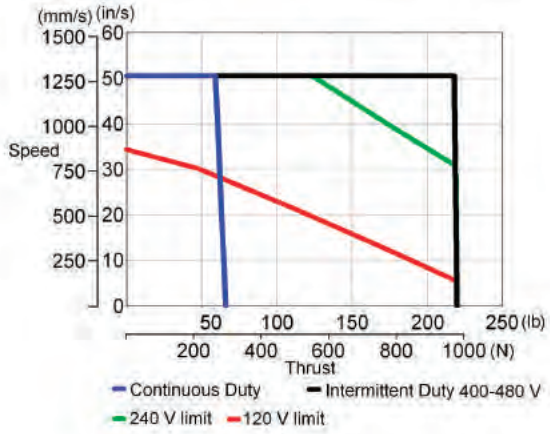
Notes



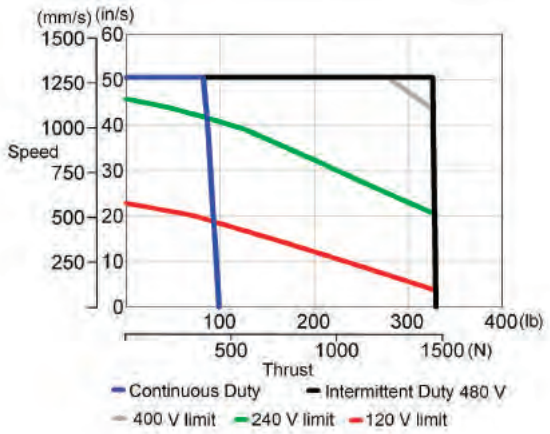
EC3 Series Perfomance Curves

EC3 Series Servo Thrust Speed Curves

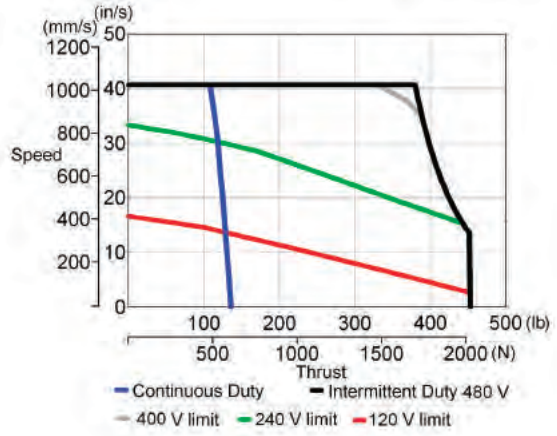
EC3-AKM23D-xxx-10-16B/ AKD (3 A)



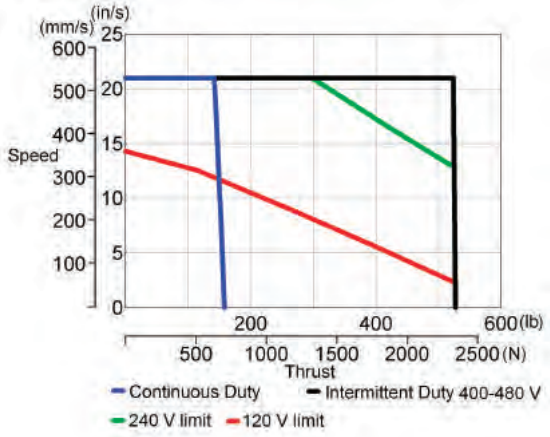
EC3-AKM23D-xxx-15-16B/ AKD (3 A)



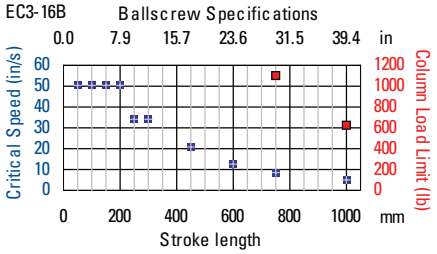
EC3-AKM23D-xxx-20-16B/ AKD (3 A)

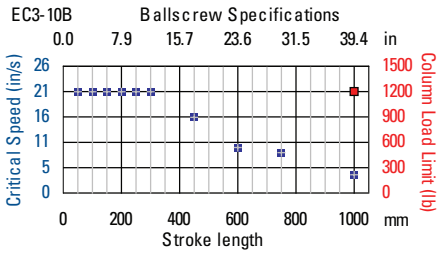


EC3-AKM23D-xxx-15-10B/ AKD (3 A)



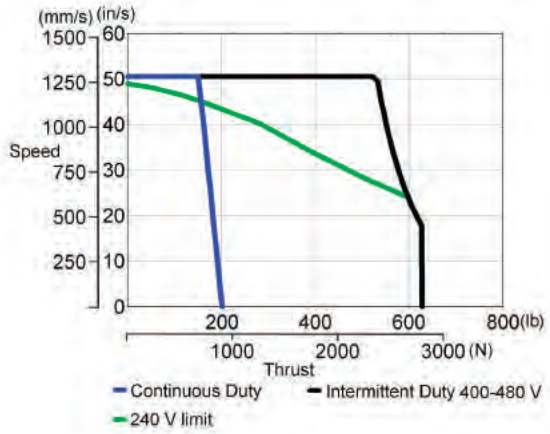
Critical Speed and Column Loading Limits



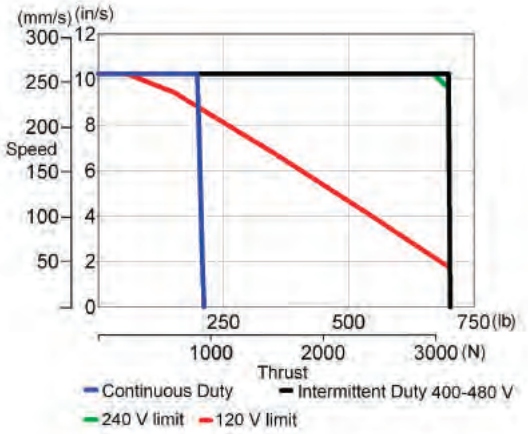


EC3 Series Servo Thrust Speed Curves

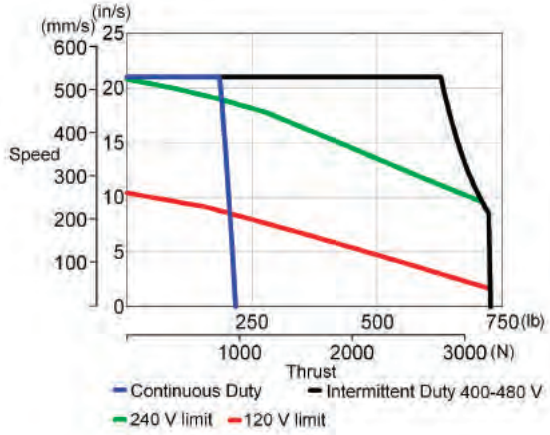
EC3-AKM42G-xxx-10-16B/ AKD (6 A)



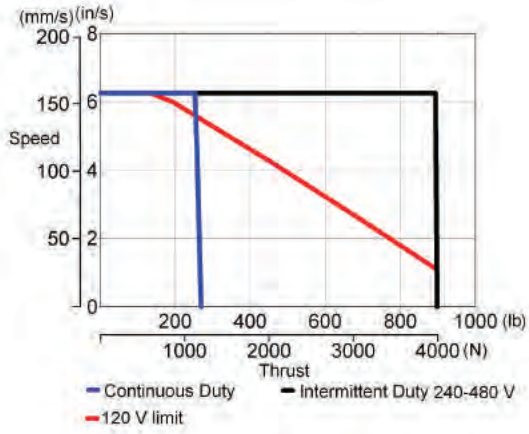
EC3-AKM23D-xxx-10-05B/ AKD (3 A)



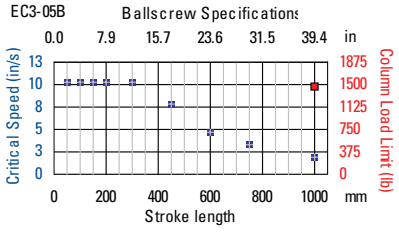
EC3-AKM23D-xxx-20-10B/ AKD (3 A)

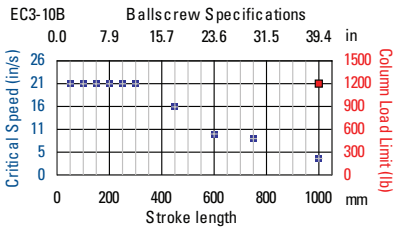


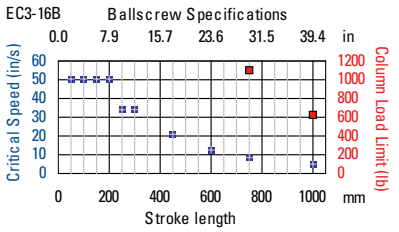
EC3-AKM23D-xxx-50-16B/ AKD (3 A)



Critical Speed and Column Loading Limits





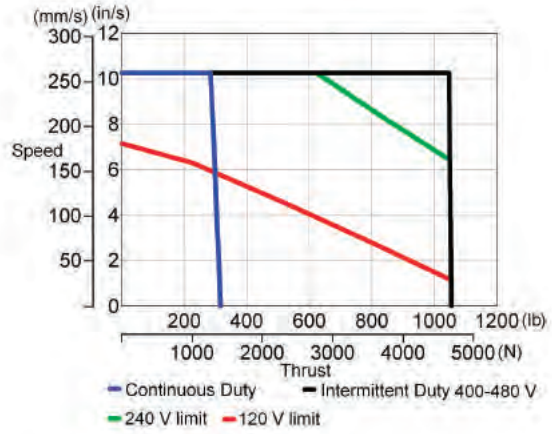


*Complete EC nomemclature on pages 158-159.

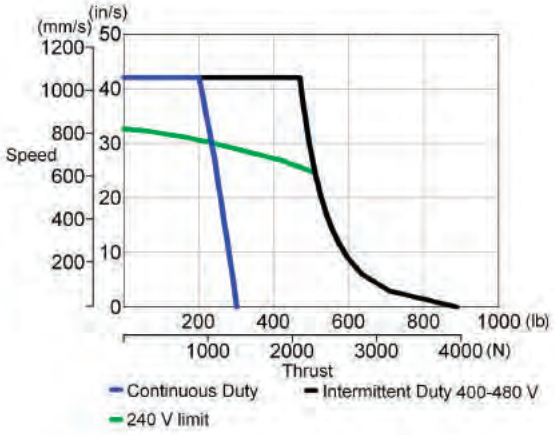
EC3 Series Perfomance Curves

EC3 Series Servo Thrust Speed Curves

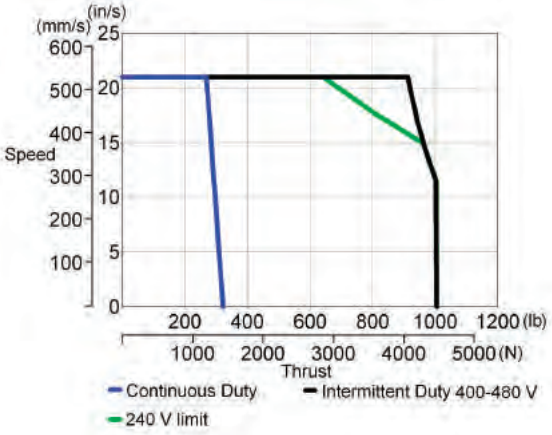
EC3-AKM23D-xxx-15-05B/ AKD (3 A)



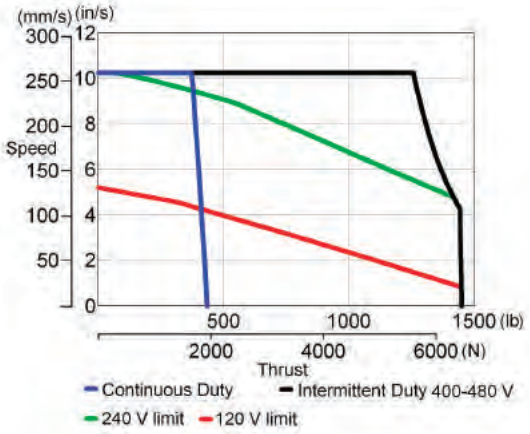
EC3-AKM42G-xxx-15-16B/ AKD (6 A)



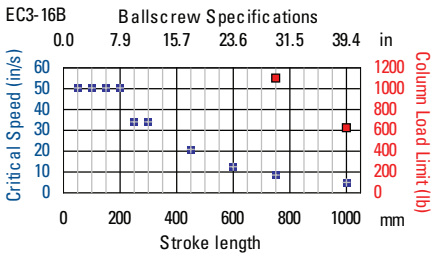
EC3-AKM42G-xxx-10-10B/ AKD (6 A)

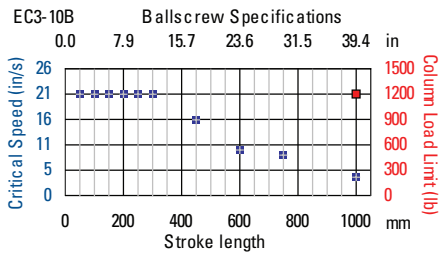


EC3-AKM23D-xxx-20-05B/ AKD (3 A)



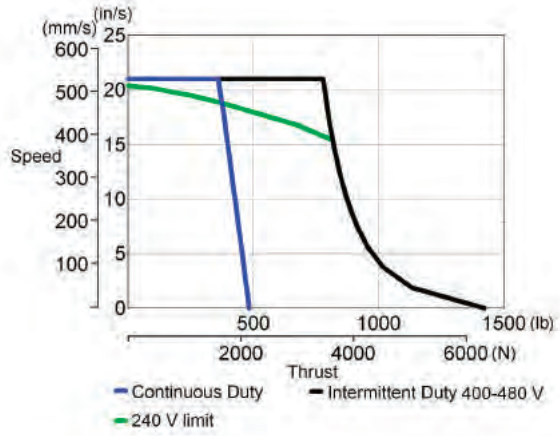
Critical Speed and Column Loading Limits



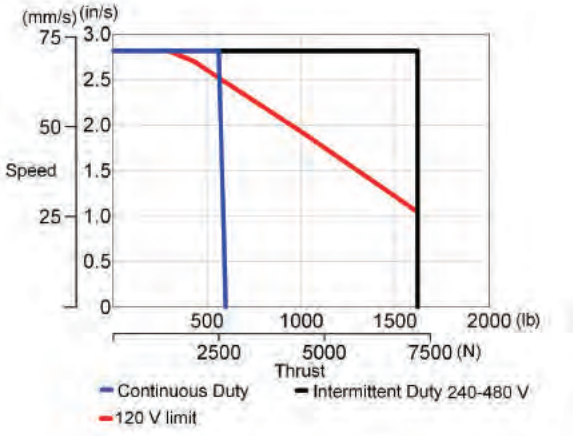


EC3 Series Servo Thrust Speed Curves

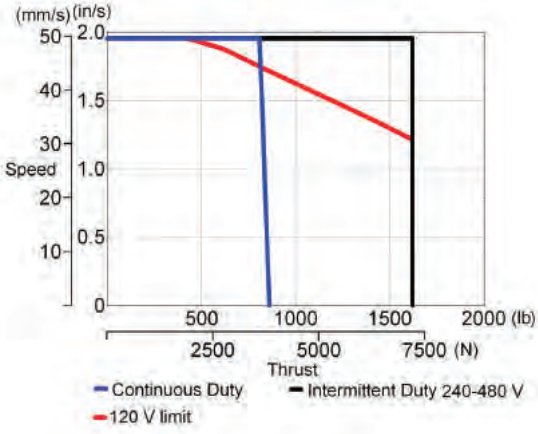
EC3-AKM42G-xxx-15-10B/ AKD (3 A)



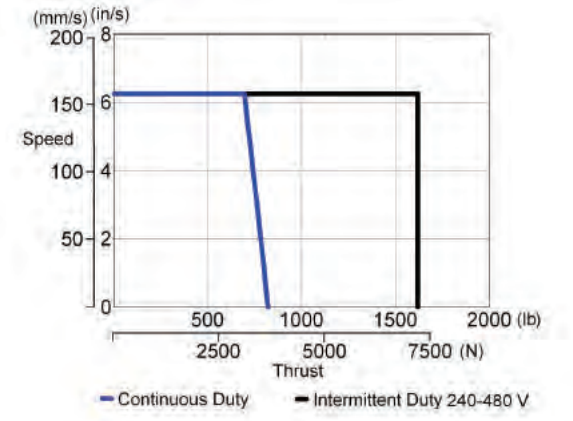
EC3-AKM23D-xxx-70-10B/ AKD (3 A)



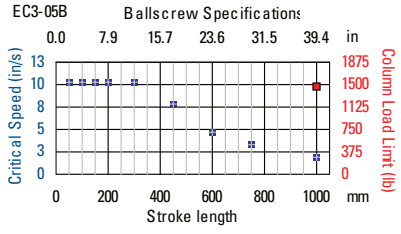
EC3-AKM23D-xxx-50-05B/ AKD (3 A)

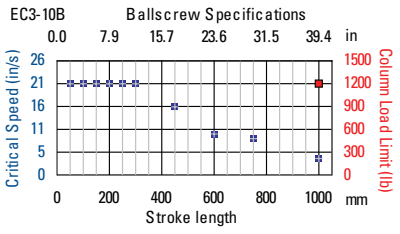


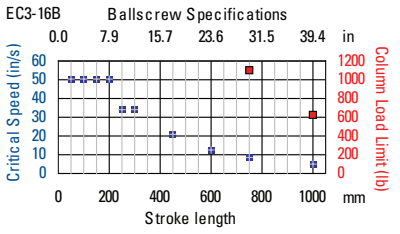
EC3-AKM42G-xxx-50-16B/ AKD (6 A)



Critical Speed and Column Loading Limits





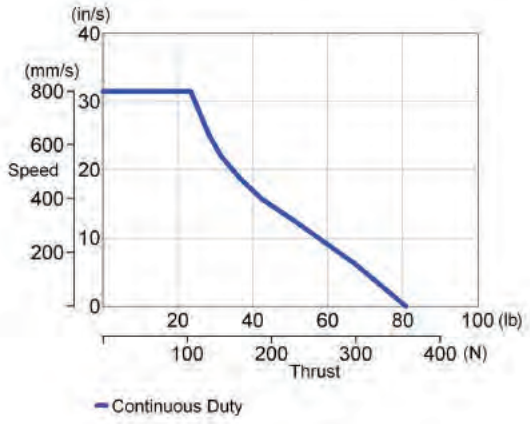


*Complete EC nomemclature on pages 158-159.

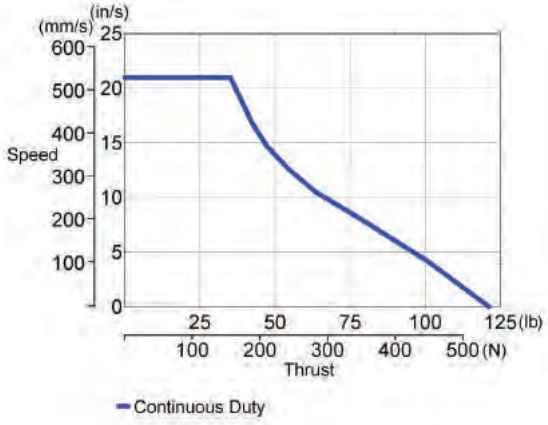
EC3 Series Perfomance Curves

EC3 Series Stepper Thrust Speed Curves

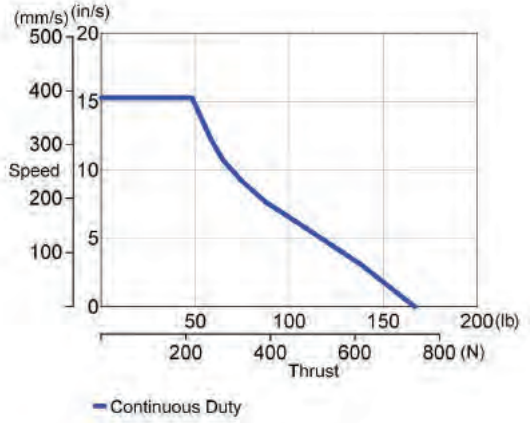
EC3-T22T-10-16B/ P70360 (320 Vdc)



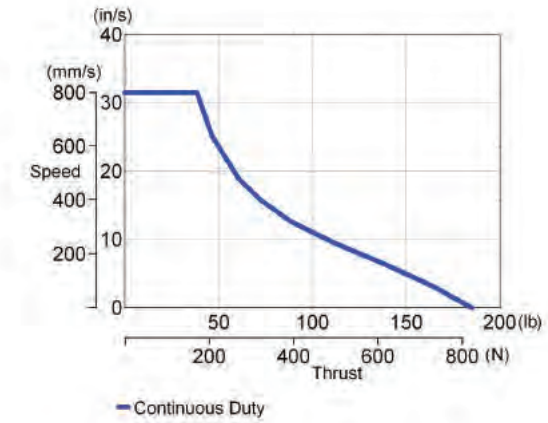
EC3-T22T-15-16B/ P70360 (320 Vdc)



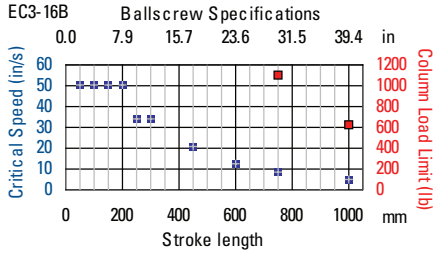
EC3-T22T-20-16B/ P70360 (320 Vdc)



EC3-T31T-10-16B/ P70360 (320 Vdc)

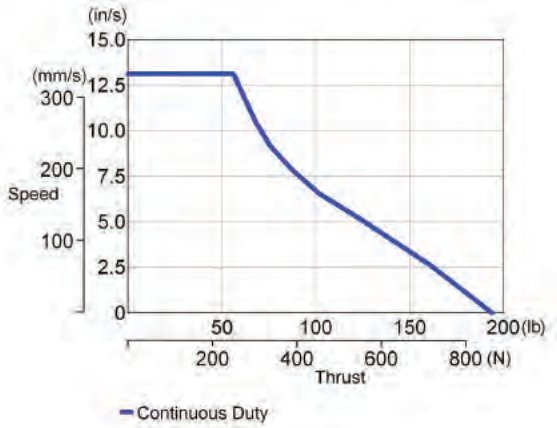


Critical Speed and Column Loading Limits

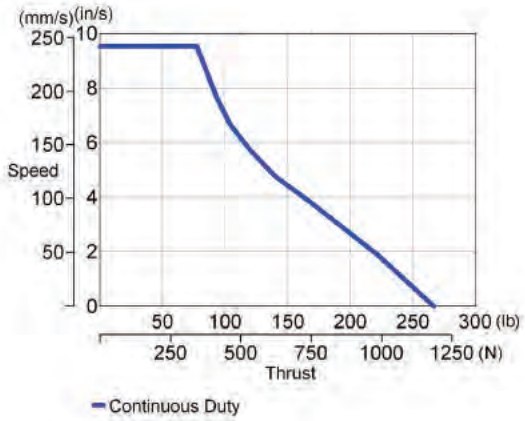


EC3 Series Stepper Thrust Speed Curves

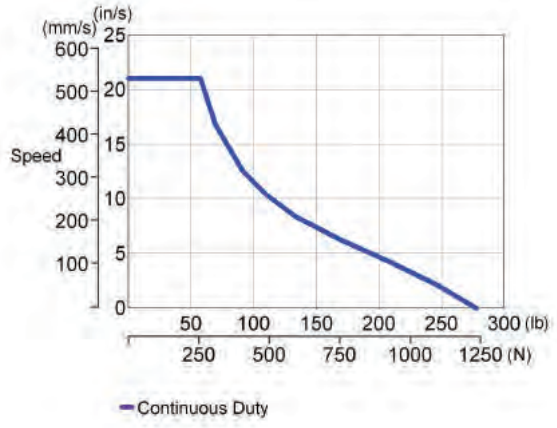
EC3-T22T-15-10B/ P70360 (320 Vdc)



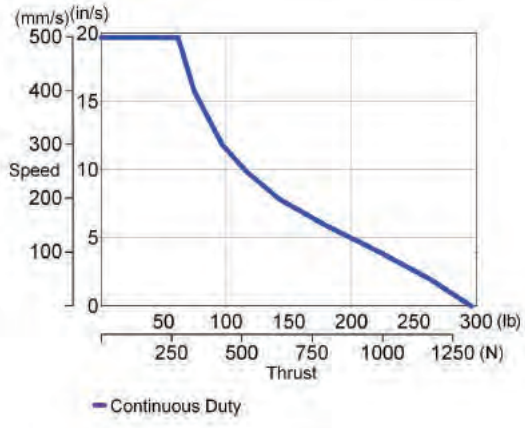
EC3-T22T-20-10B/ P70360 (320 Vdc)



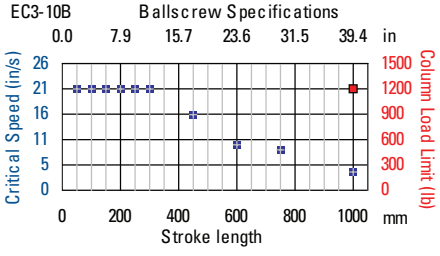
EC3-T31T-15-16B/ P70360 (320 Vdc)

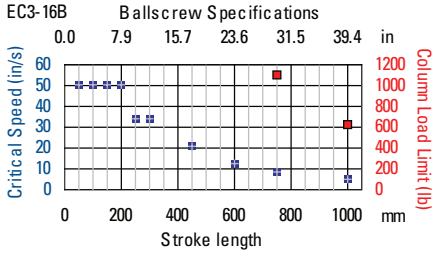


EC3-T31T-10-10B/ P70360 (320 Vdc)



Critical Speed and Column Loading Limits



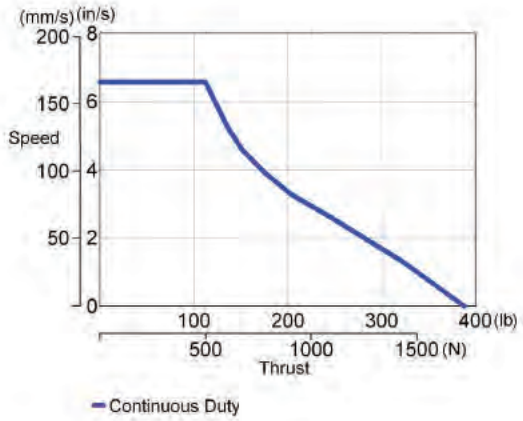


*Complete EC nomemclature on pages 158-159.

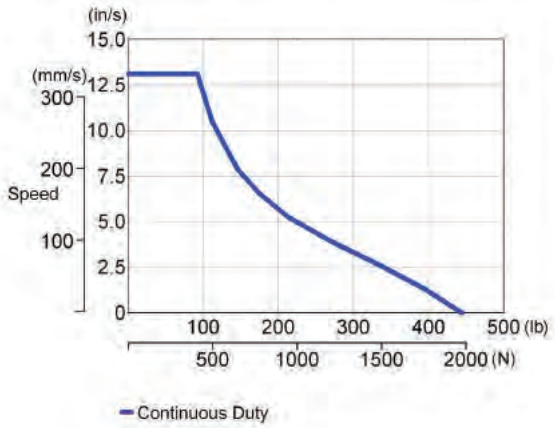
EC3 Series Perfomance Curves

EC3 Series Stepper Thrust Speed Curves

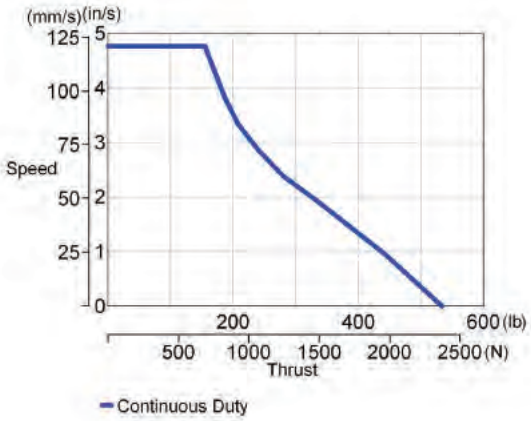
EC3-T22T-15-05B/ P70360 (320 Vdc)



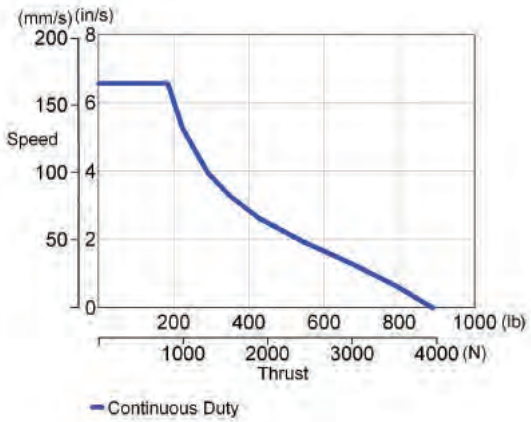
EC3-T31T-15-10B/ P70360 (320 Vdc)



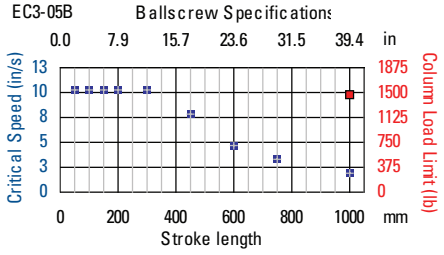
EC3-T22T-20-05B/ P70360 (320 Vdc)

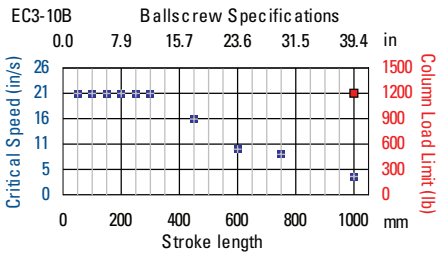


EC3-T31T-15-05B/ P70360 (320 Vdc)



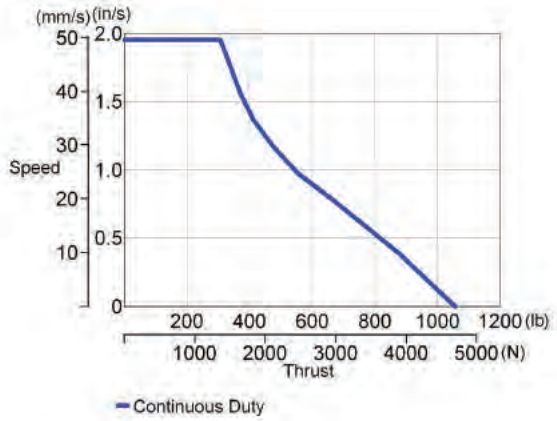
Critical Speed and Column Loading Limits



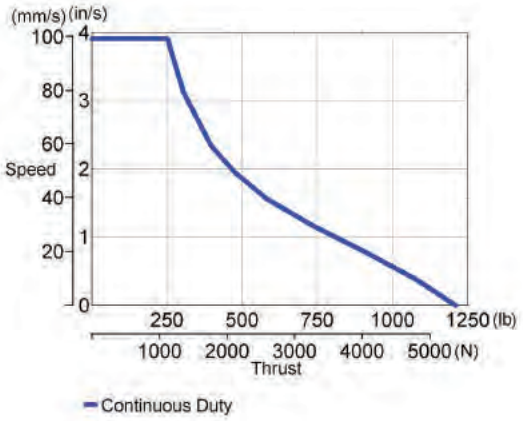


EC3 Series Stepper Thrust Speed Curves

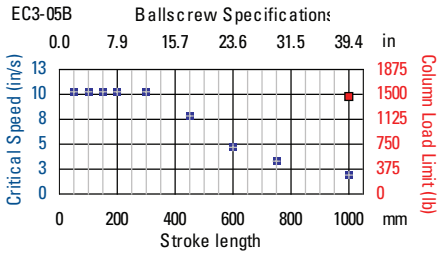
EC3-T22T-50-05B/ P70360 (320 Vdc)

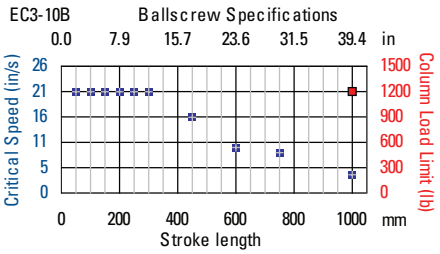


EC3-T31T-50-10B/ P70360 (320 Vdc)



Critical Speed and Column Loading Limits



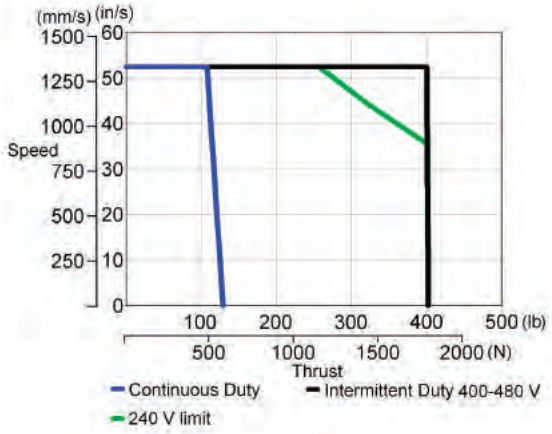


*Complete EC nomemclature on pages 158-159.

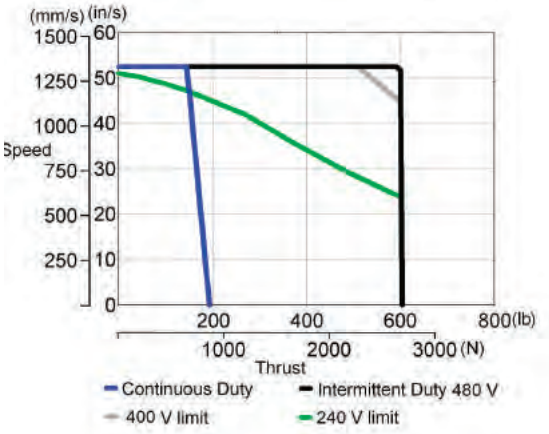
EC4 Series Perfomance Curves

EC4 Series Servo Thrust Speed Curves

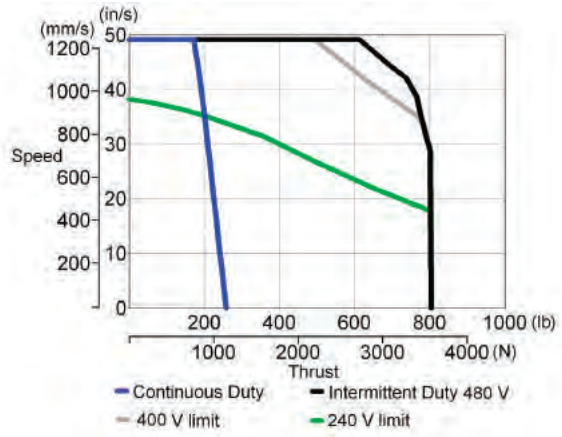
EC4-AKM42G-xxx-10-25B/ AKD (6 A)



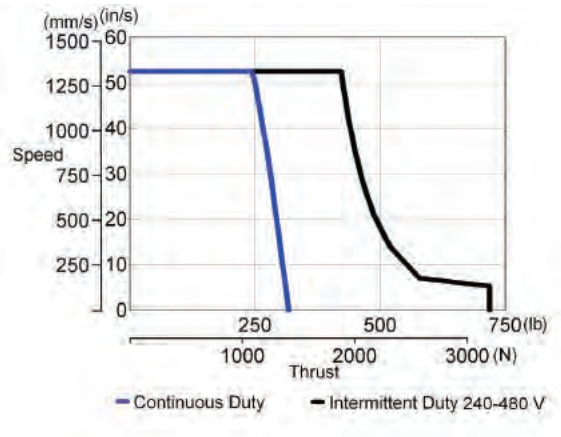
EC4-AKM42G-xxx-15-25B/ AKD (6 A)



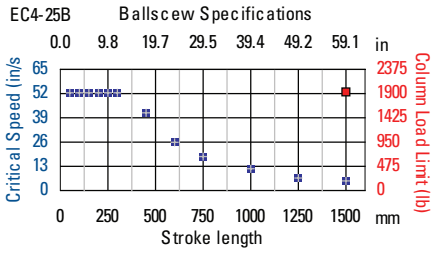
EC4-AKM42G-xxx-20-25B/ AKD (6 A)



EC4-AKM52L-xxx-10-25B/ AKD (12 A)

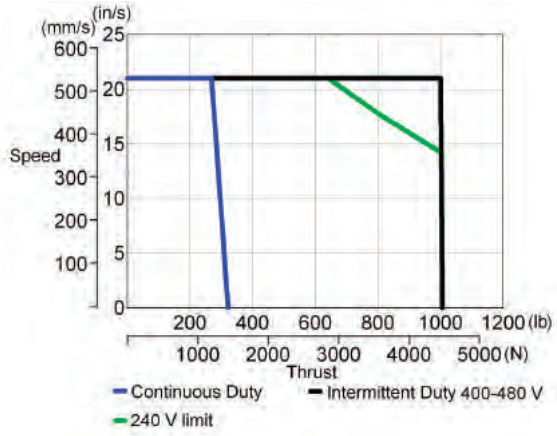


Critical Speed and Column Loading Limits

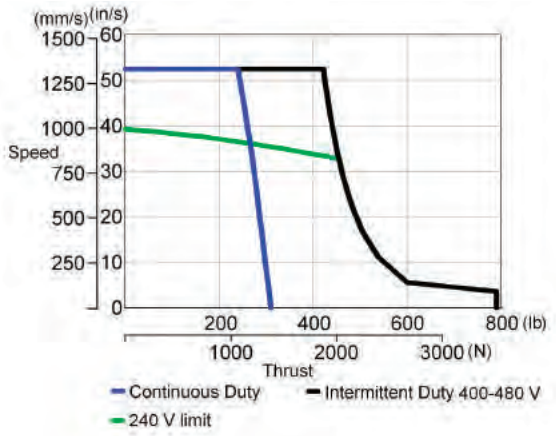


EC4 Series Servo Thrust Speed Curves

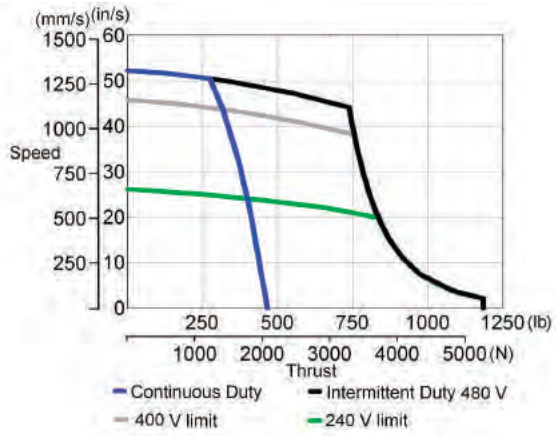
EC4-AKM42G-xxx-10-10B/ AKD (6 A)



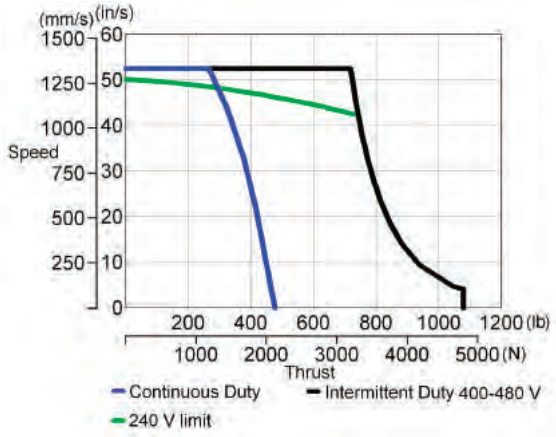
EC4-AKM52H-xxx-10-25B/ AKD (6 A)



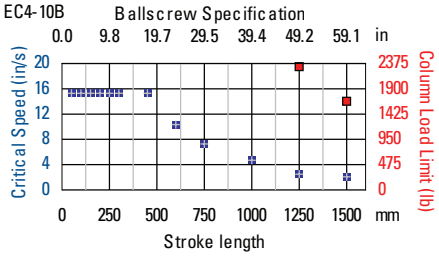
EC4-AKM52H-xxx-15-25B/ AKD (6 A)

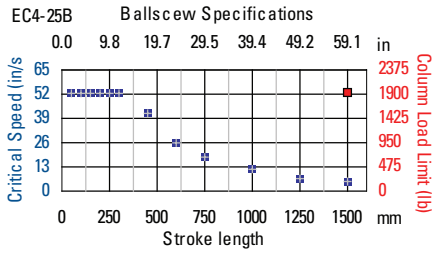


EC4-AKM52L-xxx-15-25B/ AKD (12 A)



Critical Speed and Column Loading Limits



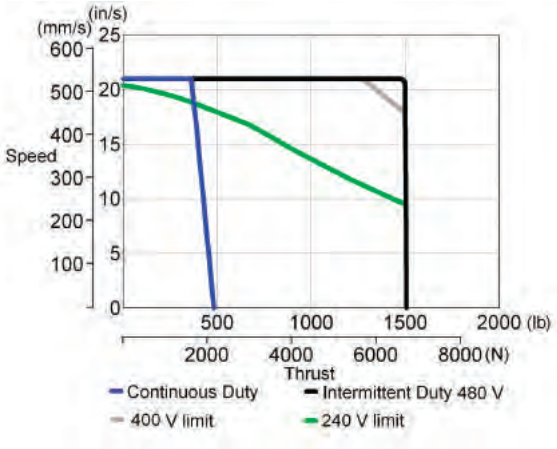


*Complete EC nomemclature on pages 158-159.

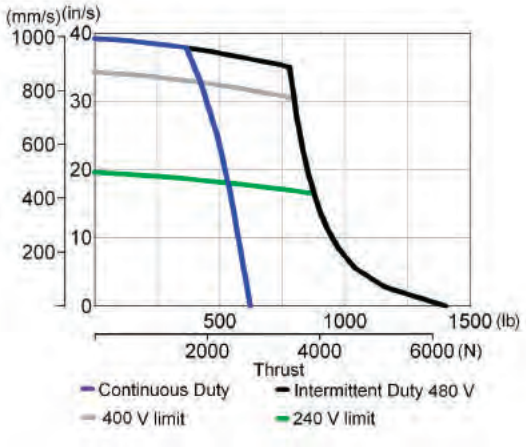
EC4 Series Perfomance Curves

EC4 Series Servo Thrust Speed Curves

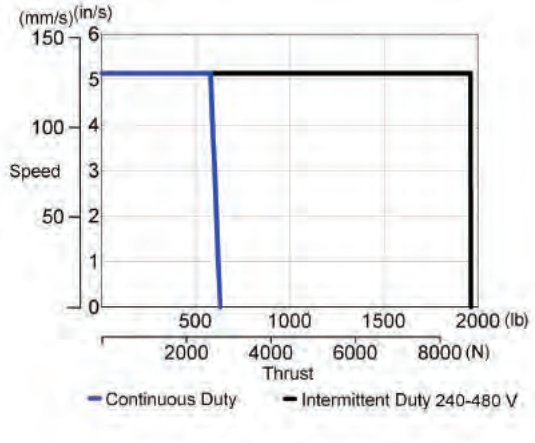
EC4-AKM42G-xxx-15-10B/ AKD (6 A)



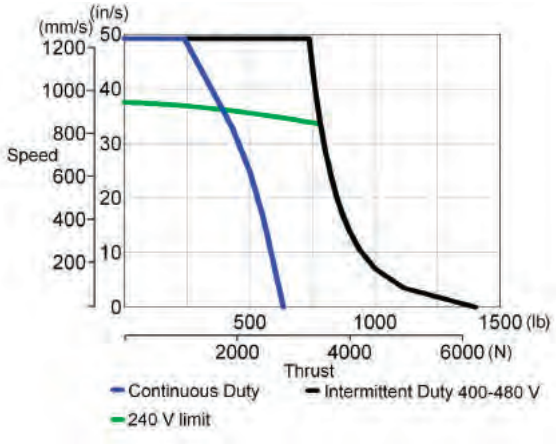
EC4-AKM52H-xxx-20-25B/ AKD (6 A)



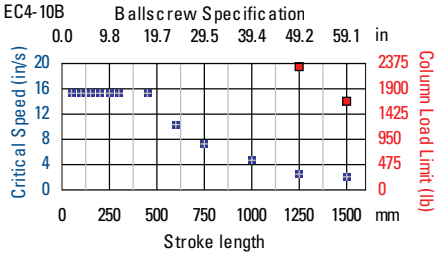
EC4-AKM42G-xxx-50-25B/ AKD (6 A)

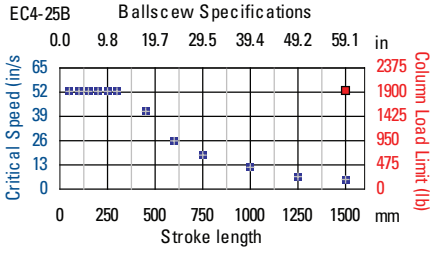


EC4-AKM52L-xxx-20-25B/ AKD (12 A)



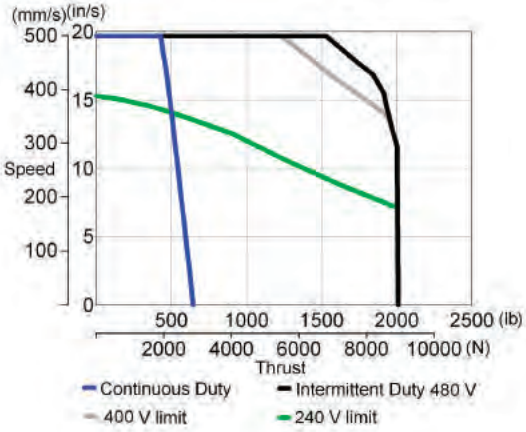
Critical Speed and Column Loading Limits



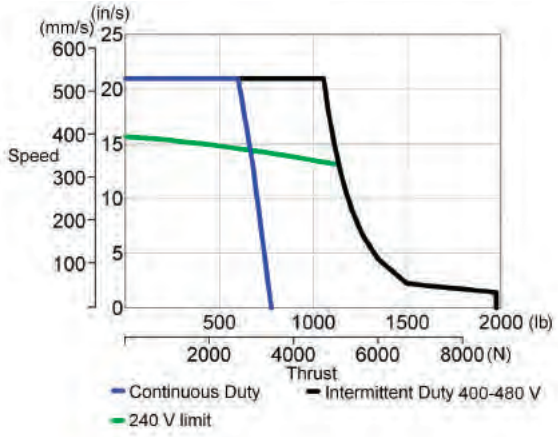


EC4 Series Servo Thrust Speed Curves

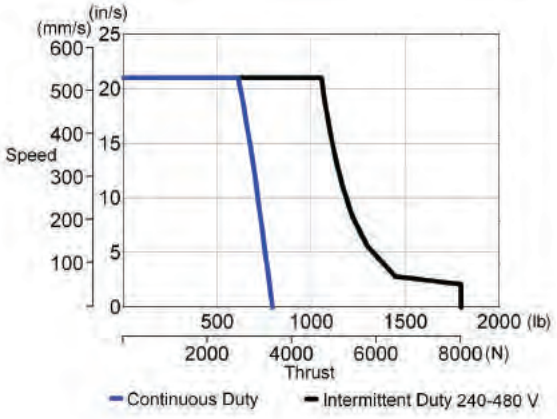
EC4-AKM42G-xxx-20-10B/ AKD (6 A)



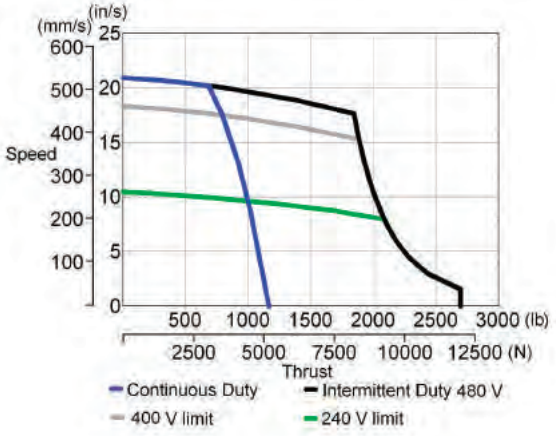
EC4-AKM52H-xxx-10-10B/ AKD (6 A)



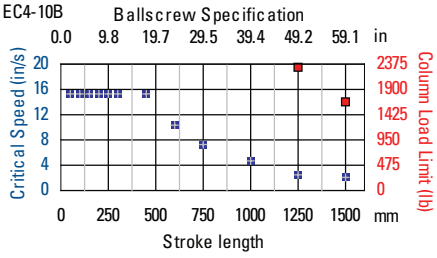
EC4-AKM52L-xxx-10-10B/ AKD (12 A)



EC4-AKM52H-xxx-15-10B/ AKD (6 A)



Critical Speed and Column Loading Limits

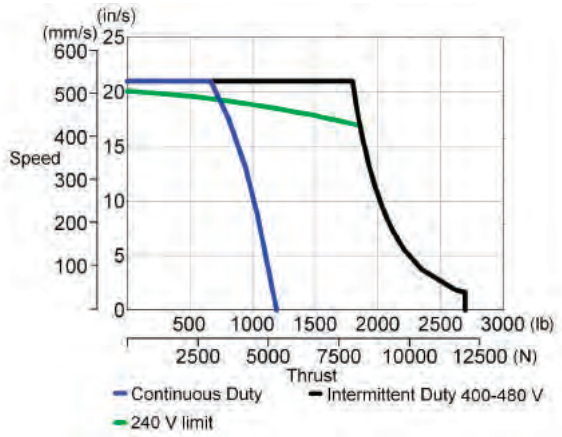


*Complete EC nomemclature on pages 158-159.

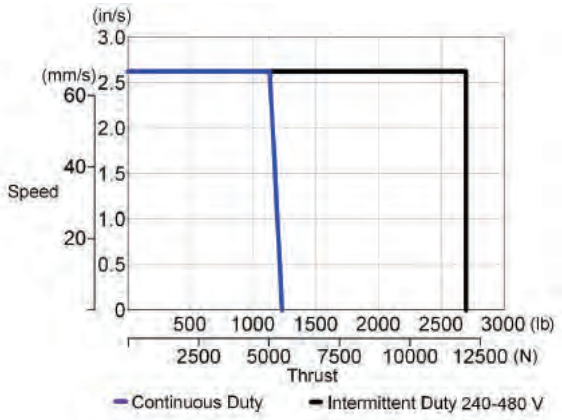
EC4 Series Perfomance Curves

EC4 Series Servo Thrust Speed Curves

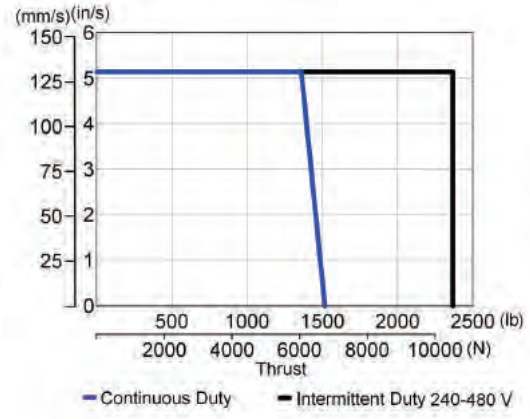
EC4-AKM52L-xxx-15-10B/ AKD (12 A)



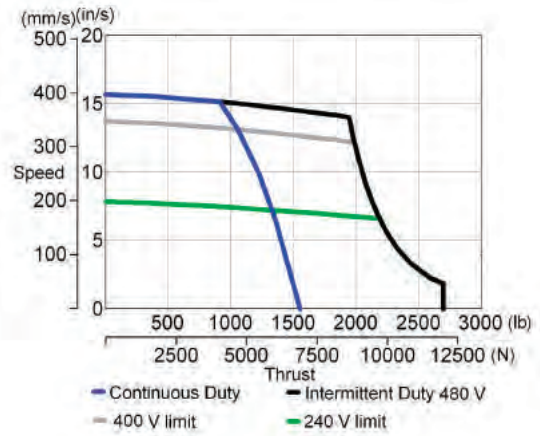
EC4-AKM42G-xxx-100-25B/ AKD (6 A)



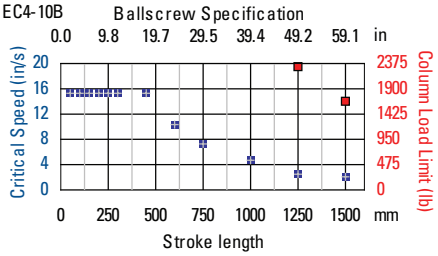
EC4-AKM52H-xxx-50-25B/ AKD (6 A)

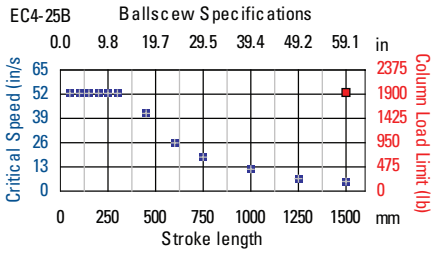


EC4-AKM52H-xxx-20-10B/ AKD (6 A)



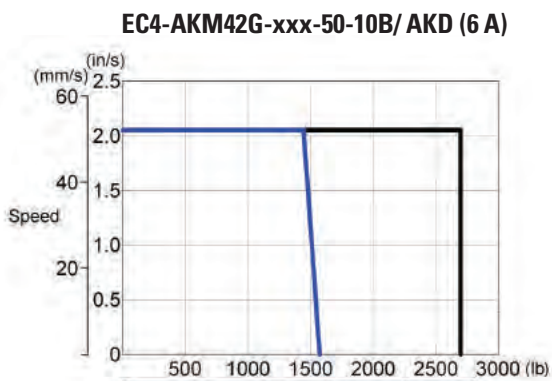
Critical Speed and Column Loading Limits



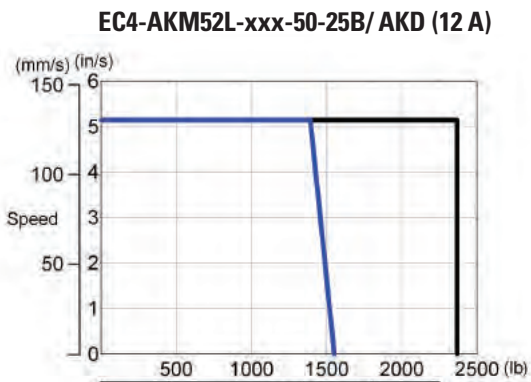


EC4 Series Servo Thrust Speed Curves

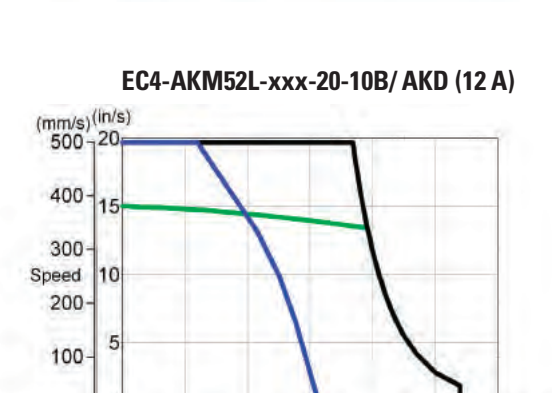
EC4-AKM42G-xxx-50-10B/ AKD (6 A)



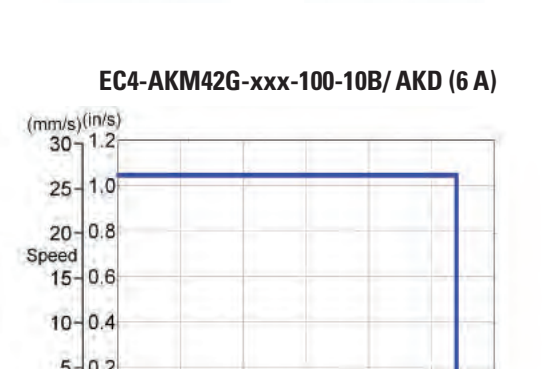
EC4-AKM52L-xxx-50-25B/ AKD (12 A)



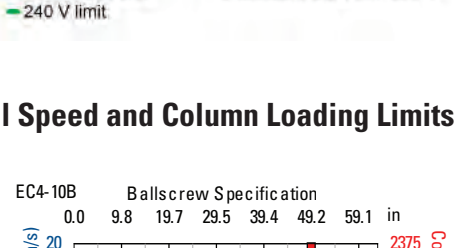
EC4-AKM52L-xxx-20-10B/ AKD (12 A)

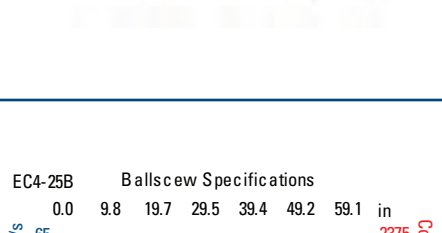


EC4-AKM42G-xxx-100-10B/ AKD (6 A)



Critical Speed and Column Loading Limits



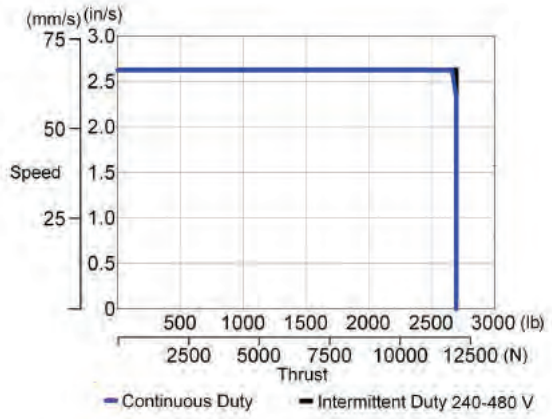


*Complete EC nomemclature on pages 158-159.

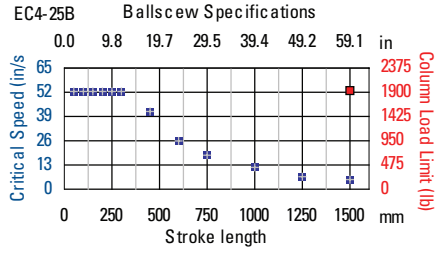
EC4 Series Perfomance Curves

EC4 Series Servo Thrust Speed Curves

EC4-AKM52H-xxx-100-25B/ AKD (6 A)

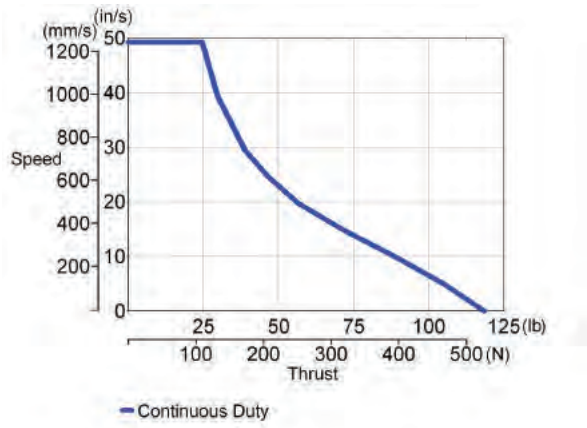


Critical Speed and Column Loading Limits

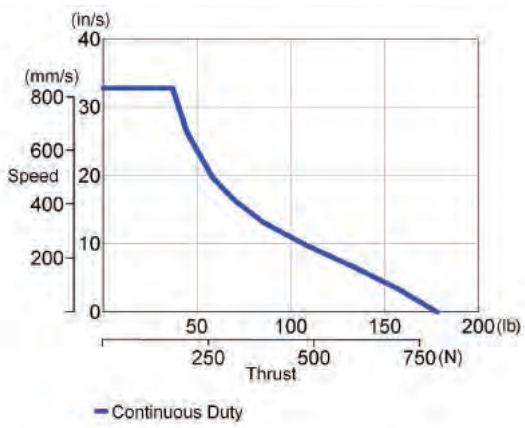


EC4 Series Stepper Thrust Speed Curves

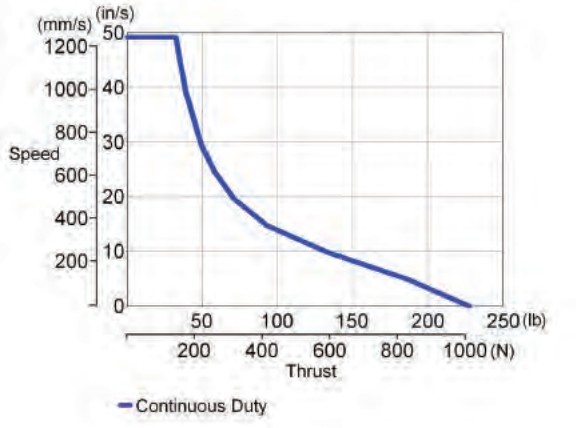
EC4-T31T-10-25B/ P70360 (320 Vdc)



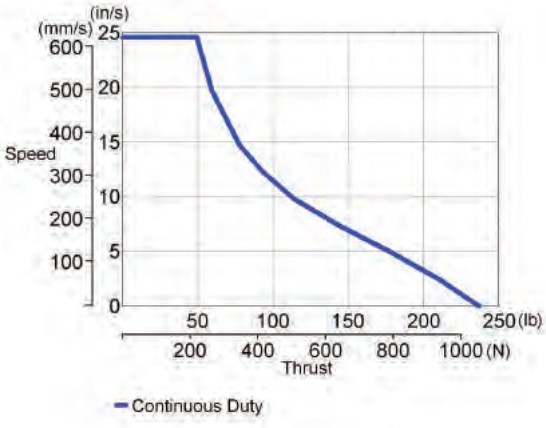
EC4-T31T-15-25B/ P70360 (320 Vdc)



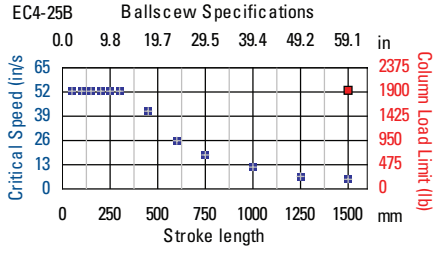
EC4-T32T-10-25B/ P70360 (320 Vdc)



EC4-T31T-20-25B/ P70360 (320 Vdc)



Critical Speed and Column Loading Limits

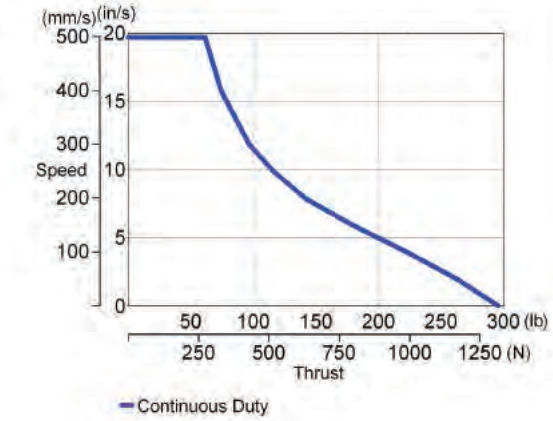


*Complete EC nomemclature on pages 158-159.

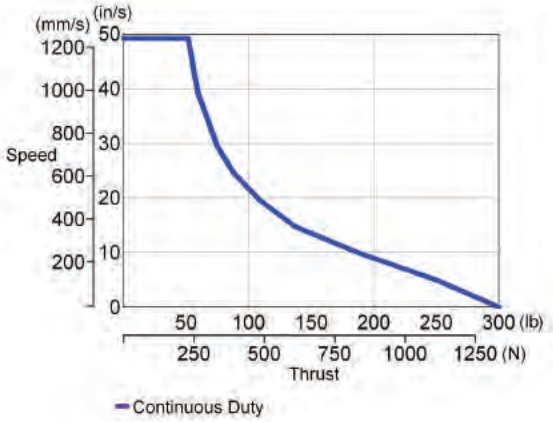
EC4 Series Perfomance Curves

EC4 Series Stepper Thrust Speed Curves

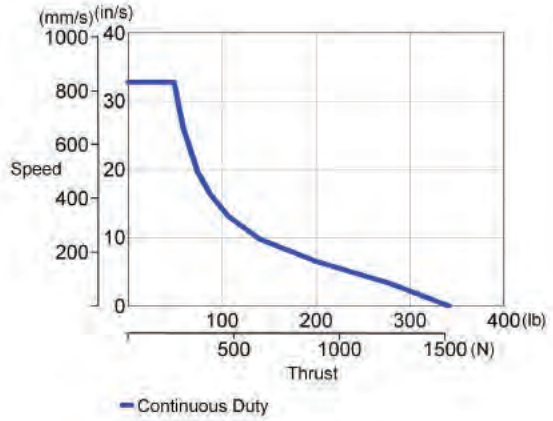
EC4-T31T-10-10B/ P70360 (320 Vdc)



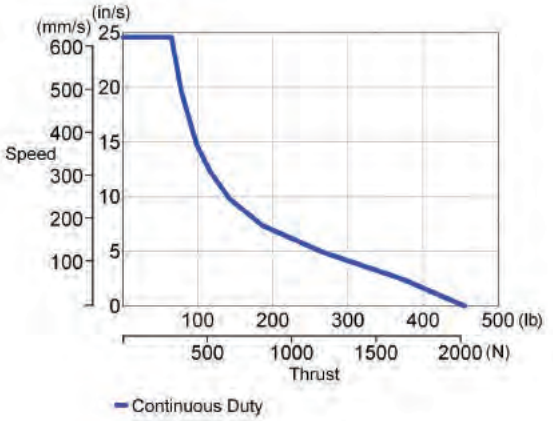
EC4-T41T-10-25B/ P70360 (320 Vdc)



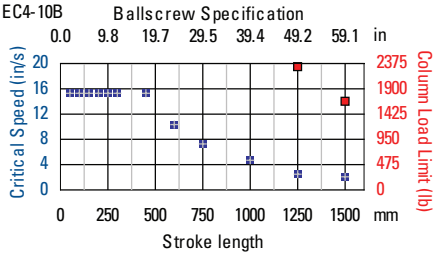
EC4-T32T-15-25B/ P70360 (320 Vdc)

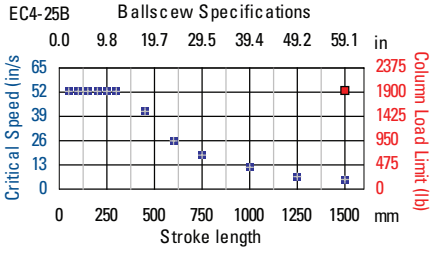


EC4-T32T-20-25B/ P70360 (320 Vdc)



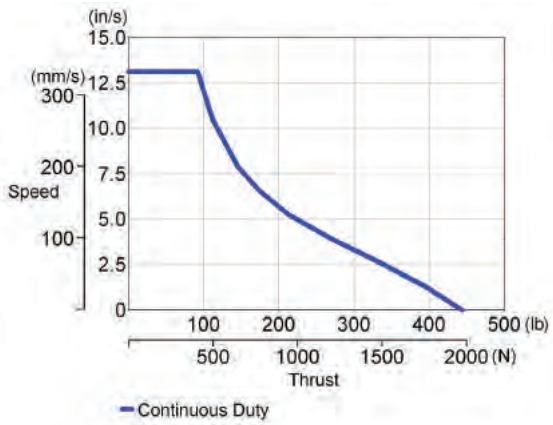
Critical Speed and Column Loading Limits



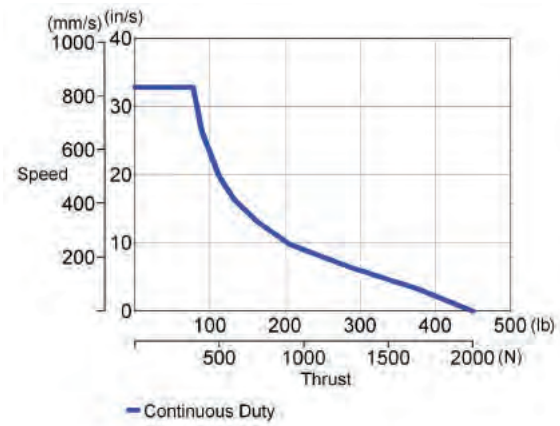


EC4 Series Stepper Thrust Speed Curves

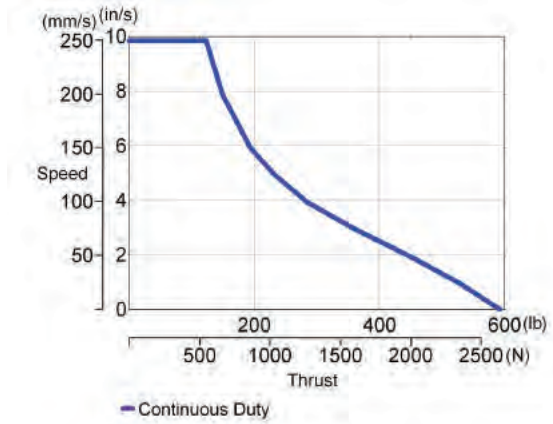
EC4-T31T-15-10B/ P70360 (320 Vdc)



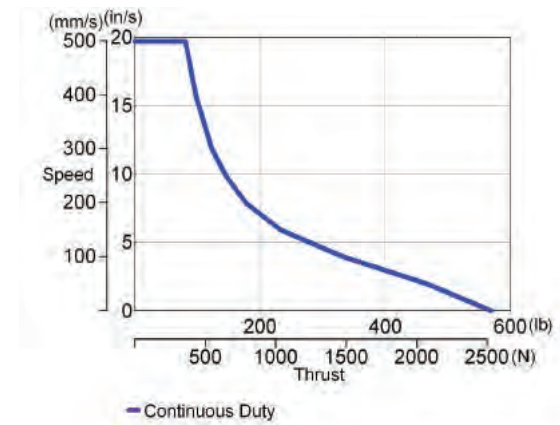
EC4-T41T-15-25B/ P70360 (320 Vdc)



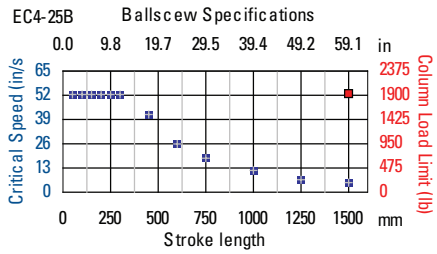
EC4-T31T-20-10B/ P70360 (320 Vdc)

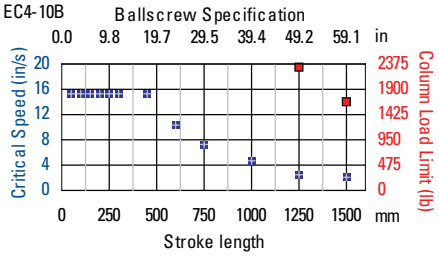


EC4-T32T-10-10B/ P70360 (320 Vdc)



Critical Speed and Column Loading Limits



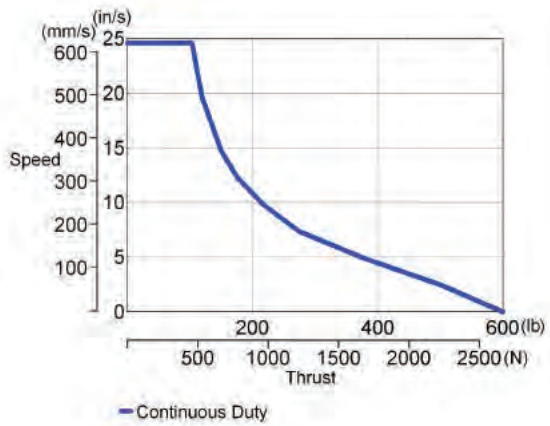


*Complete EC nomemclature on pages 158-159.

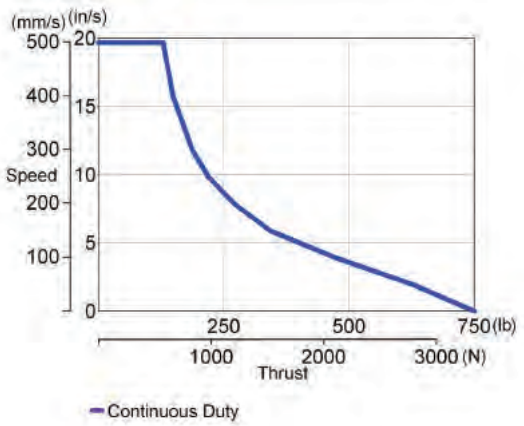
EC4 Series Perfomance Curves

EC4 Series Stepper Thrust Speed Curves

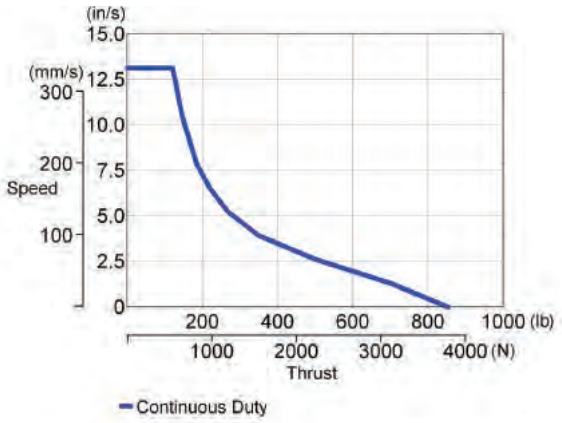
EC4-T41T-20-25B/ P70360 (320 Vdc)



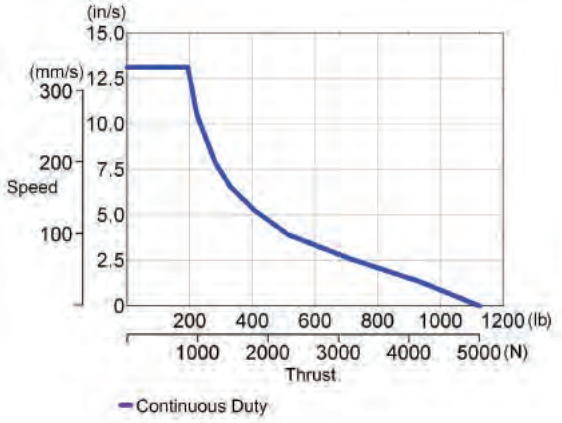
EC4-T41T-10-10B/ P70360 (320 Vdc)



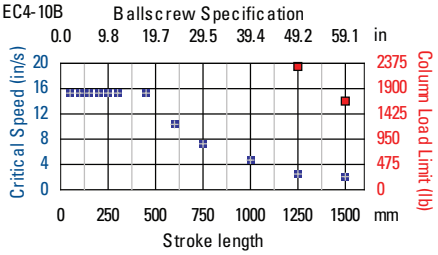
EC4-T32T-15-10B/ P70360 (320 Vdc)

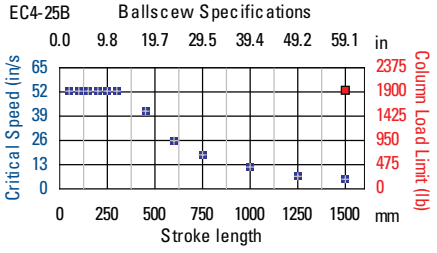


EC4-T41T-15-10B/ P70360 (320 Vdc)



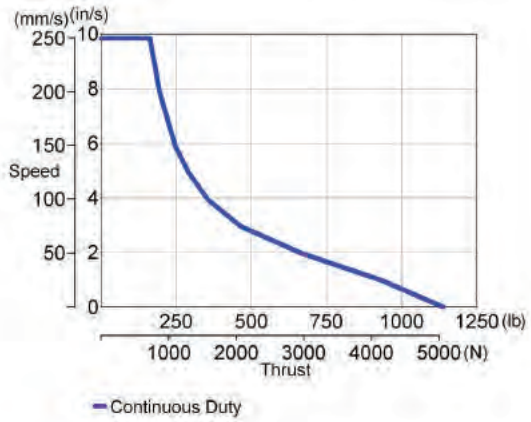
Critical Speed and Column Loading Limits



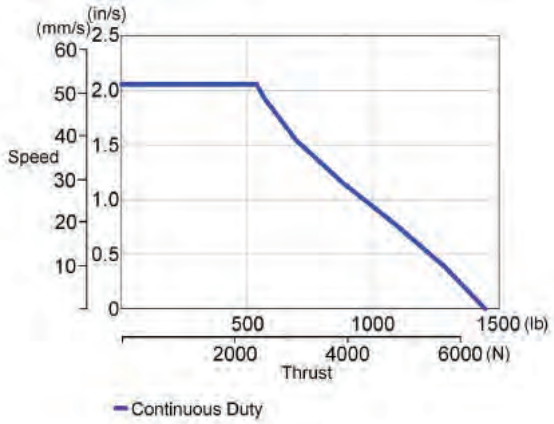


EC4 Series Stepper Thrust Speed Curves

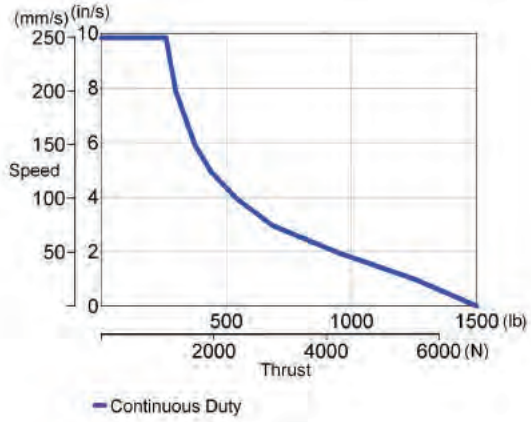
EC4-T32T-20-10B/ P70360 (320 Vdc)



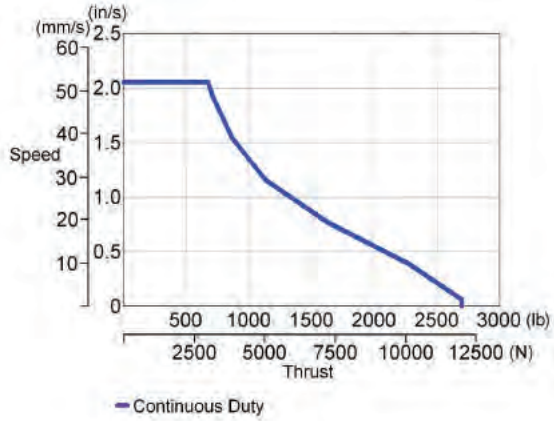
EC4-T31T-50-10B/ P70360 (320 Vdc)



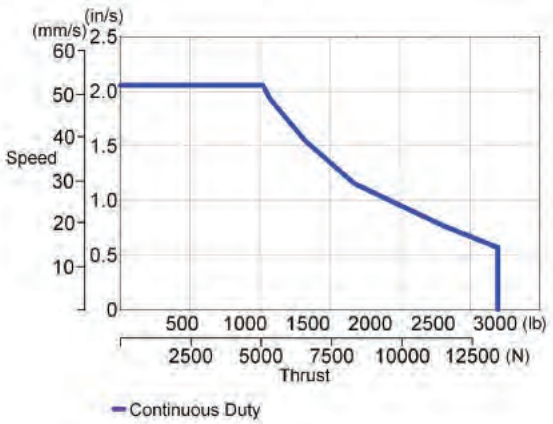
EC4-T41T-20-10B/ P70360 (320 Vdc)



EC4-T32T-50-10B/ P70360 (320 Vdc)

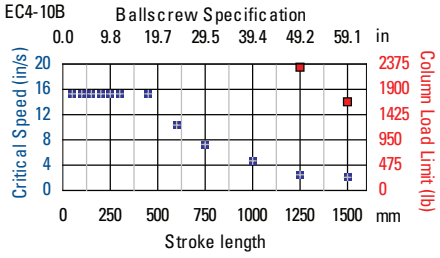


EC4-T41T-50-10B/ P70360 (320 Vdc)



*Complete EC nomemclature on pages 158-159.

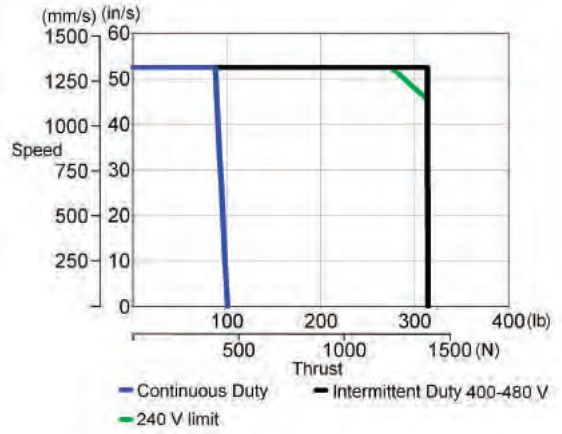
Critical Speed and Column Loading Limits



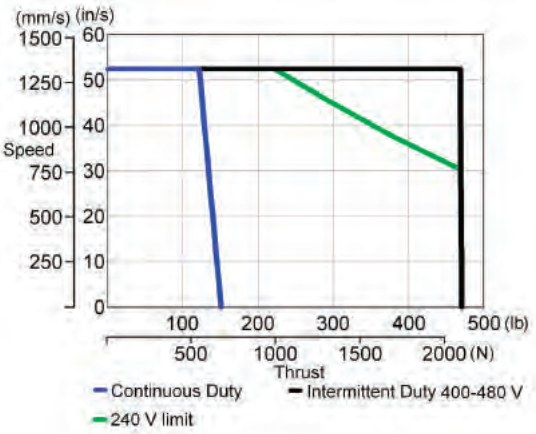
EC5 Series Perfomance Curves

EC5 Series Servo Thrust Speed Curves

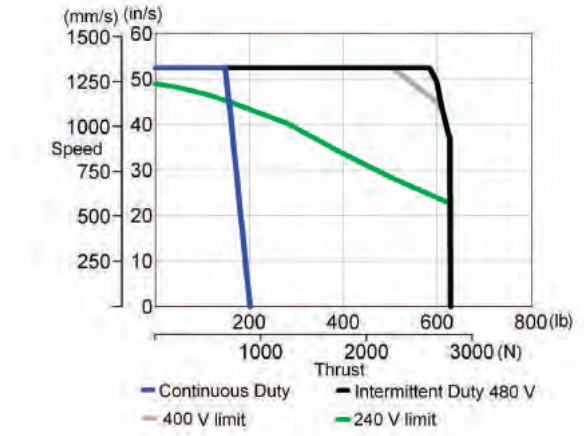
EC5-AKM42G-xxx-10-32B/ AKD (6 A)



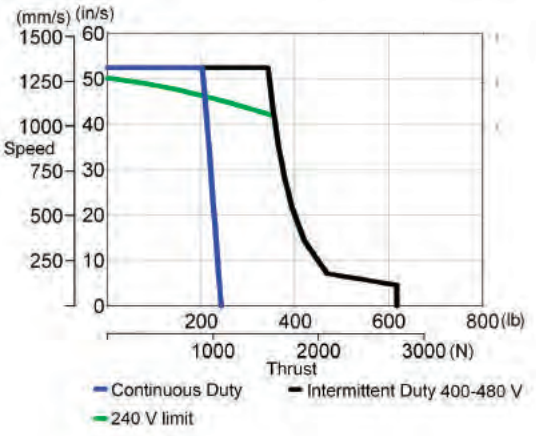
EC5-AKM42G-xxx-15-32B/ AKD (6 A)



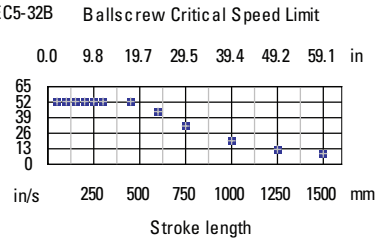
EC5-AKM42G-xxx-20-32B/ AKD (6 A)



EC5-AKM52H-xxx-10-32B/ AKD (6 A)



Critical Speed and Column Loading Limits



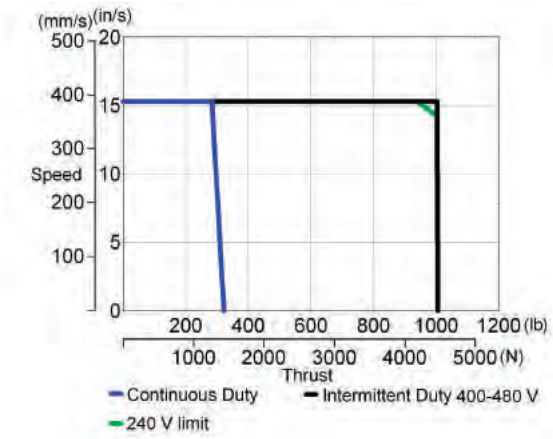
Note: No column loading limit if not shown.

EC5 – AKM42G – 10 – 05B – 300 – MP2 – FT1M*

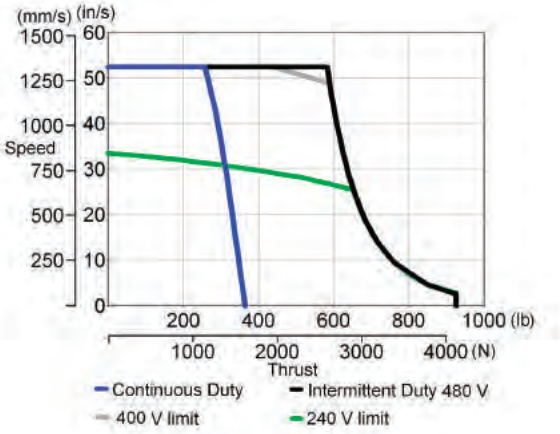
EC Series | Motor Type | Drive Ratio | Screw Lead | Stroke Length | Cylinder Mount | Rod Ends

EC5 Series Servo Thrust Speed Curves

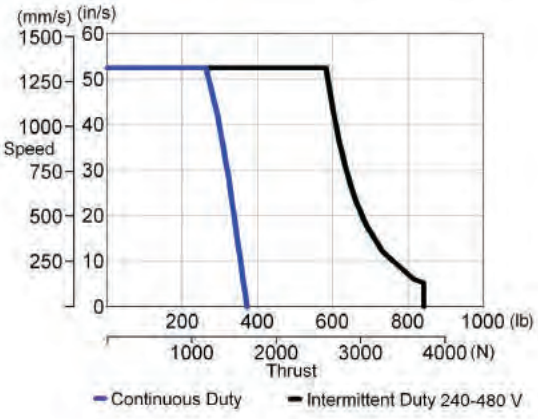
EC5-AKM42G-xxx-10-10B/ AKD (6 A)



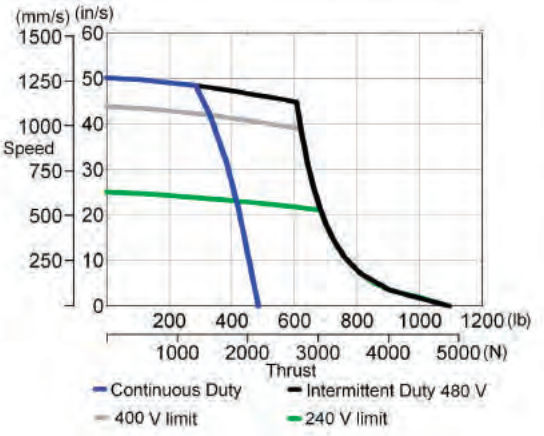
EC5-AKM52H-xxx-15-32B/ AKD (6 A)



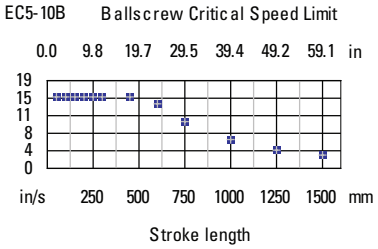
EC5-AKM52L-xxx-15-32B/ AKD (12 A)

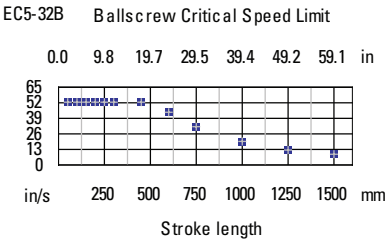


EC5-AKM52H-xxx-20-32B/ AKD (6 A)



Critical Speed and Column Loading Limits





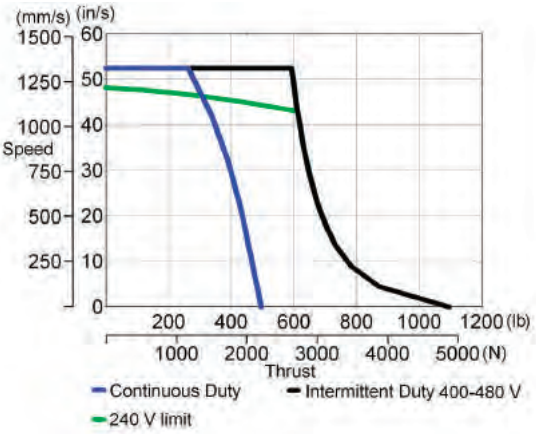
Note: No column loading limit if not shown.

*Complete EC nomemclature on pages 158-159.

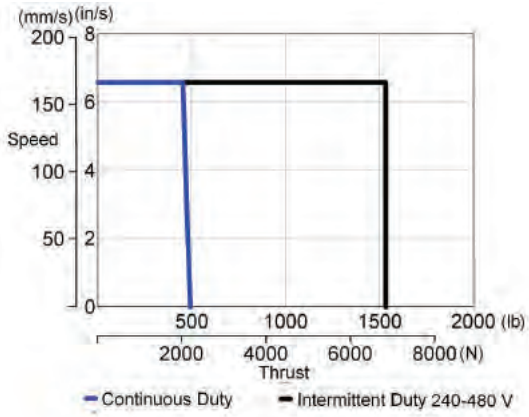
EC5 Series Perfomance Curves

EC5 Series Servo Thrust Speed Curves

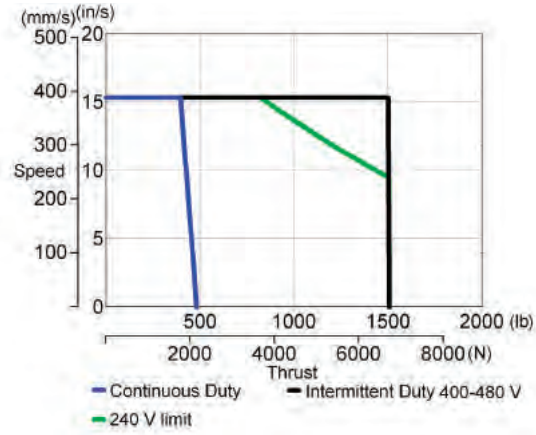
EC5-AKM52L-xxx-20-32B/ AKD (12 A)



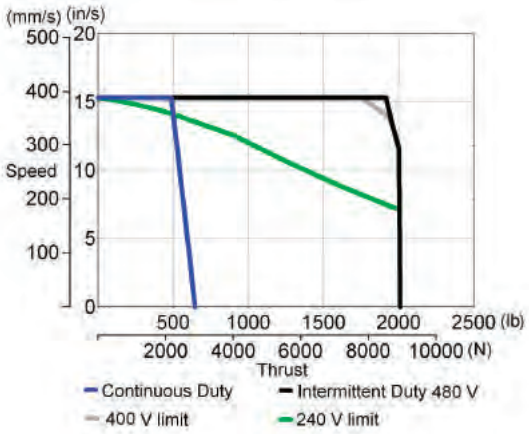
EC5-AKM42G-xxx-50-32B/ AKD (6 A)



EC5-AKM42G-xxx-15-10B/ AKD (6 A)

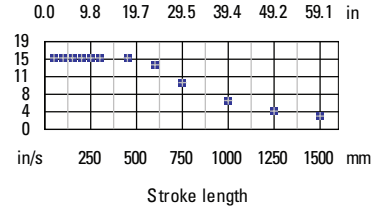


EC5-AKM42G-xxx-20-10B/ AKD (6 A)

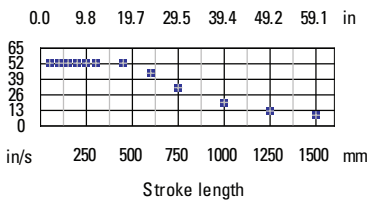


Critical Speed and Column Loading Limits

EC5-10B Ballscrew Critical Speed Limit



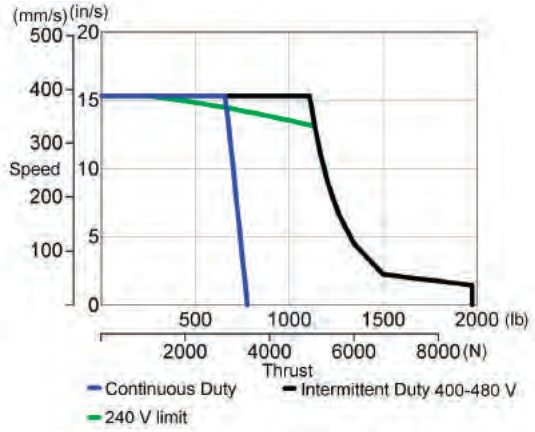
EC5-32B Ballscrew Critical Speed Limit



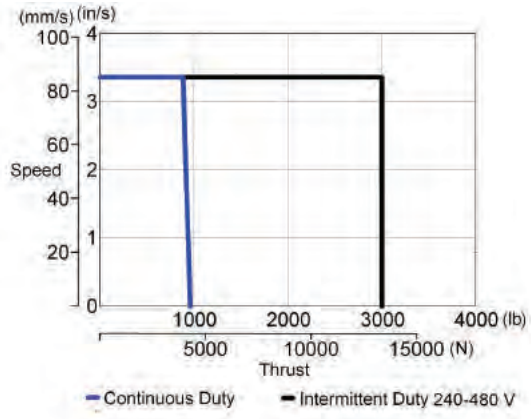
Note: No column loading limit if not shown.

EC5 Series Servo Thrust Speed Curves

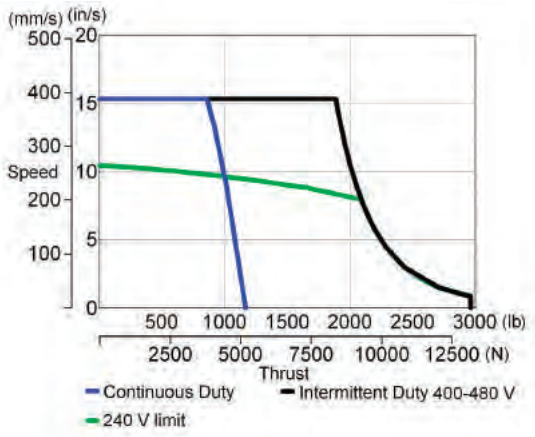
EC5-AKM52H-xxx-10-10B/ AKD (6 A)



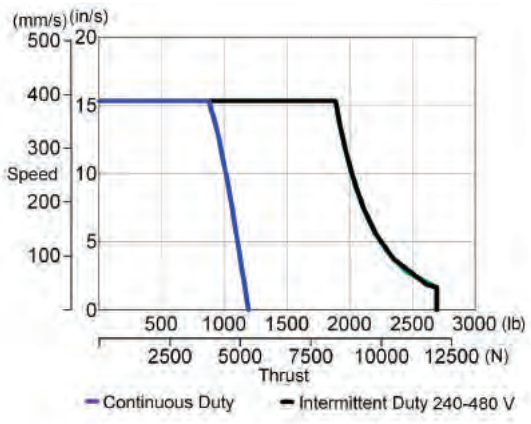
EC5-AKM42G-xxx-100-32B/ AKD (6 A)



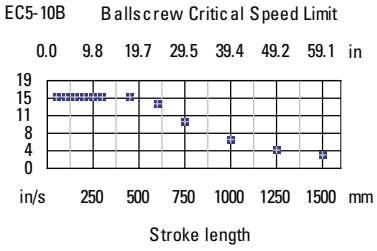
EC5-AKM52H-xxx-15-10B/ AKD (6 A)

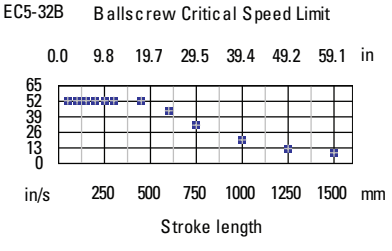


EC5-AKM52L-xxx-15-10B/ AKD (12 A)



Critical Speed and Column Loading Limits





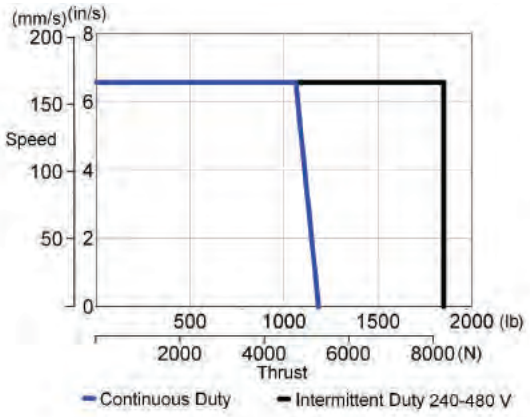
Note: No column loading limit if not shown.

*Complete EC nomemclature on pages 158-159.

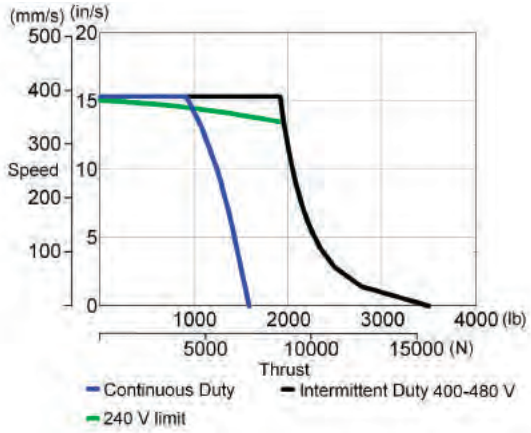
EC5 Series Perfomance Curves

EC5 Series Servo Thrust Speed Curves

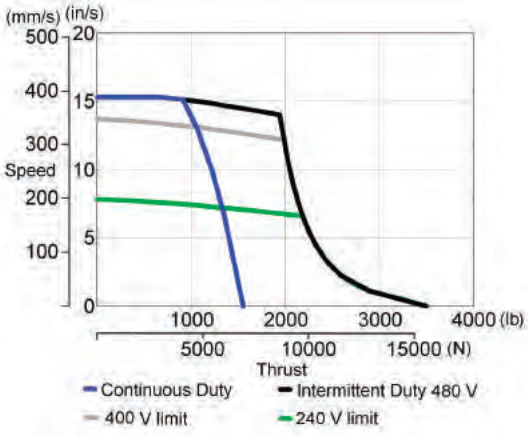
EC5-AKM52H-xxx-50-32B/ AKD (6 A)



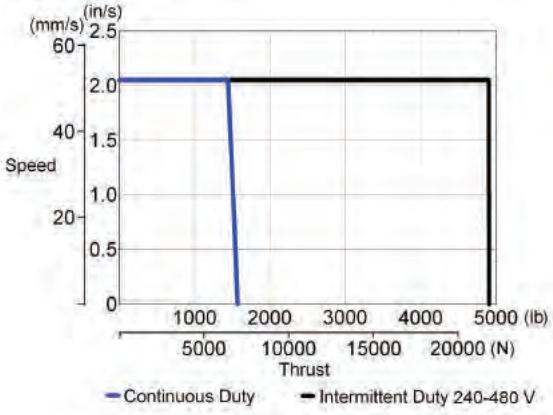
EC5-AKM52L-xxx-20-10B/ AKD (12 A)



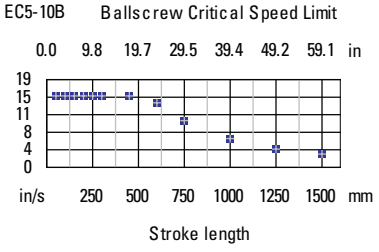
EC5-AKM52H-xxx-20-10B/ AKD (6 A)

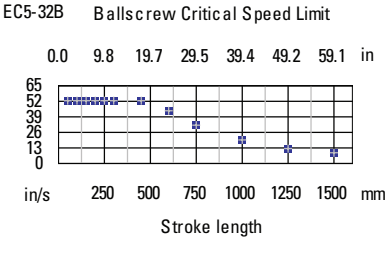


EC5-AKM42G-xxx-50-10B/ AKD (6 A)



Critical Speed and Column Loading Limits

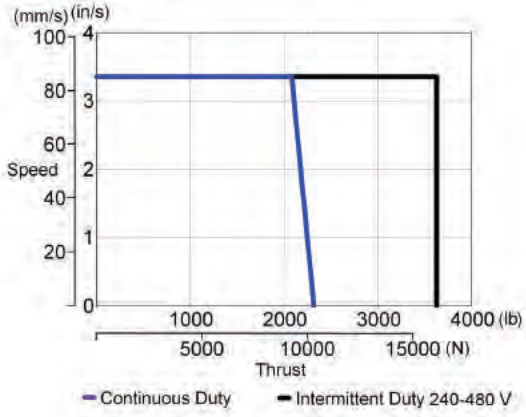




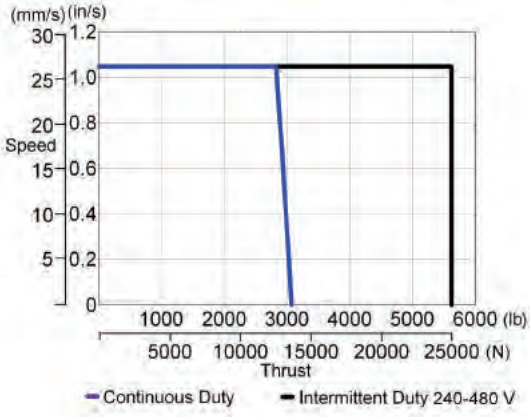
Note: No column loading limit if not shown.

EC5 Series Servo Thrust Speed Curves

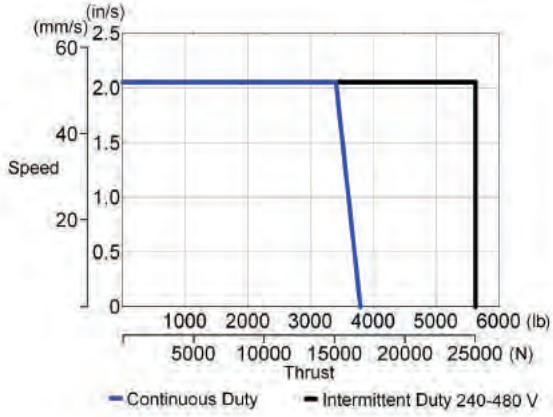
EC5-AKM52H-xxx-100-32B/ AKD (6 A)



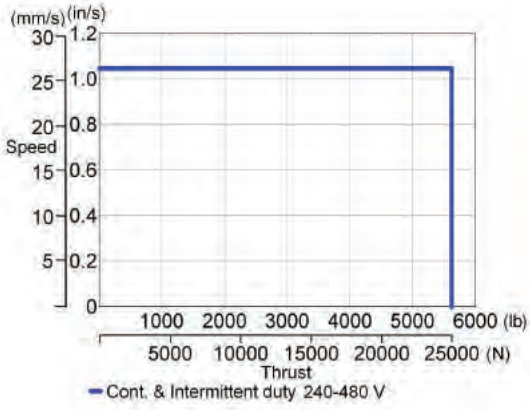
EC5-AKM42G-xxx-100-10B/ AKD (6 A)



EC5-AKM52H-xxx-50-10B/ AKD (6 A)

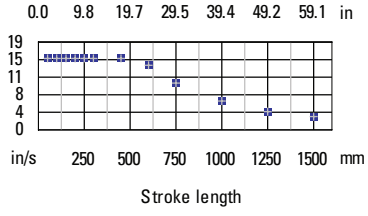


EC5-AKM52H-xxx-100-10B/ AKD (6 A)

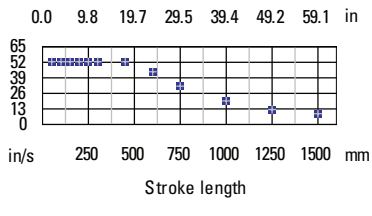


Critical Speed and Column Loading Limits

EC5-10B Ballscrew Critical Speed Limit



EC5-32B Ballscrew Critical Speed Limit



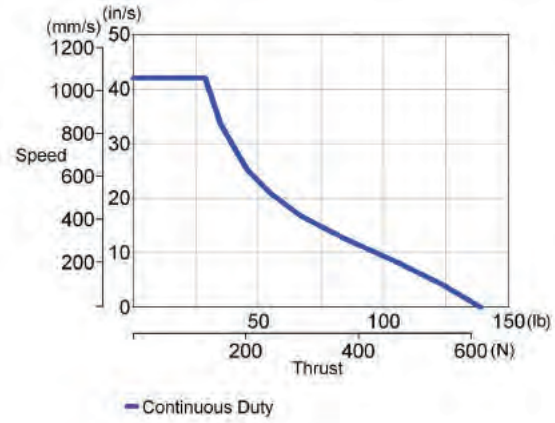
Note: No column loading limit if not shown.

*Complete EC nomemclature on pages 158-159.

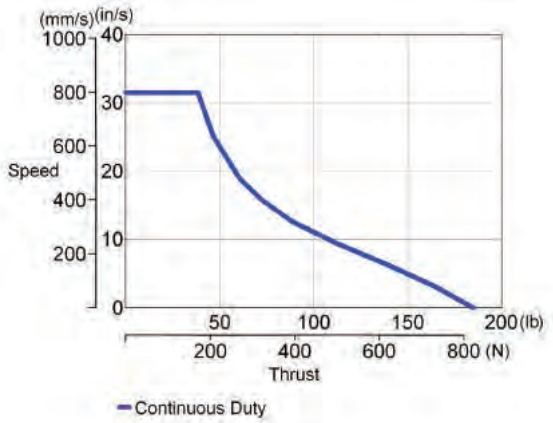
EC5 Series Perfomance Curves

EC5 Series Stepper Thrust Speed Curves

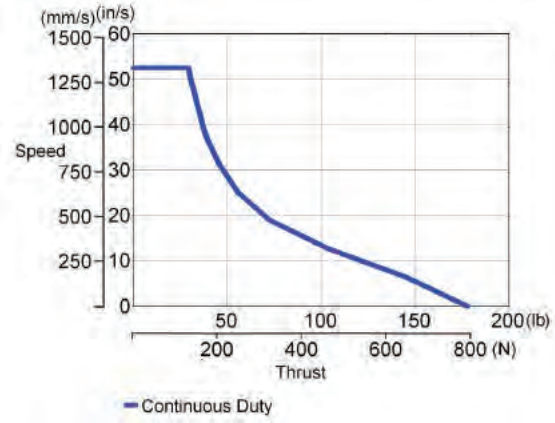
EC5-T31T-15-32B/ P70360 (320 Vdc)



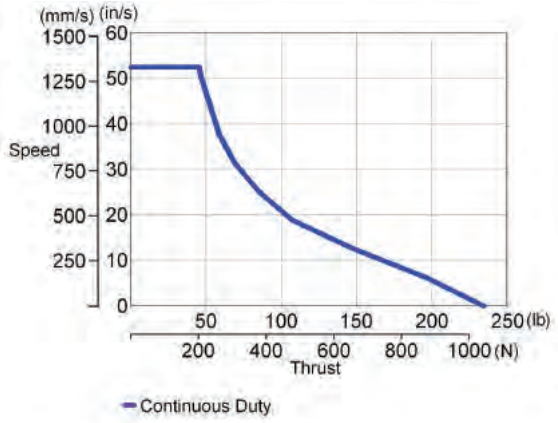
EC5-T31T-20-32B/ P70360 (320 Vdc)



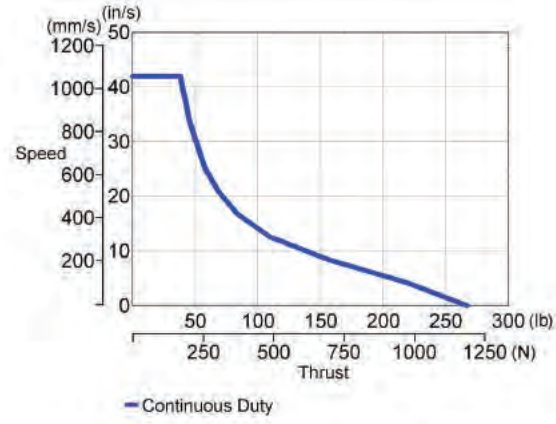
EC5-T32T-10-32B/ P70360 (320 Vdc)



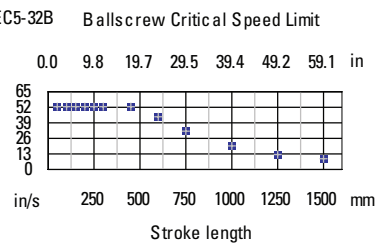
EC5-T41T-10-32B/ P70360 (320 Vdc)



EC5-T32T-15-32B/ P70360 (320 Vdc)



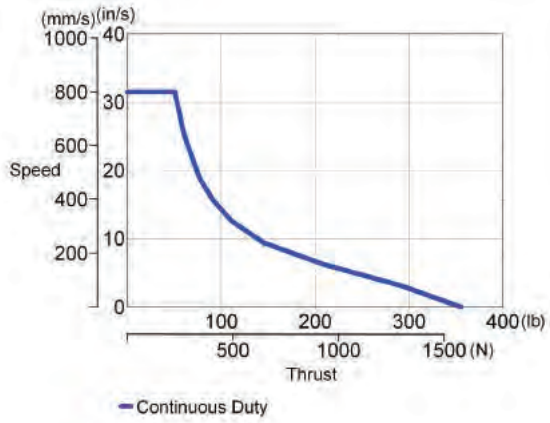
Critical Speed and Column Loading Limits



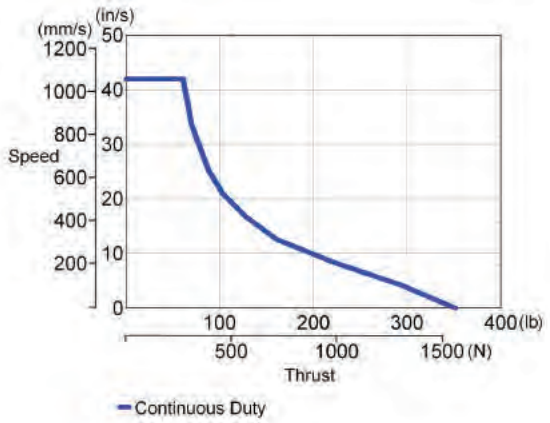
Note: No column loading limit if not shown.

EC5 Series Stepper Thrust Speed Curves

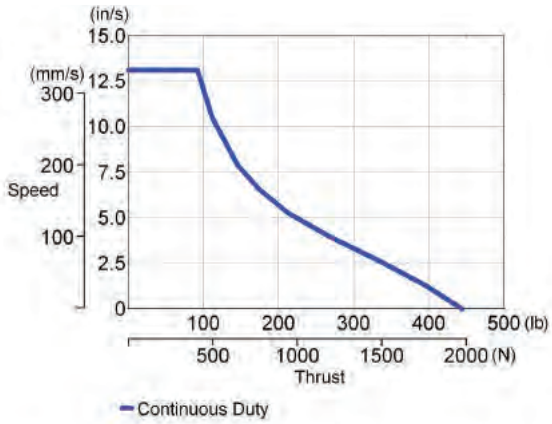
EC5-T32T-20-32B/ P70360 (320 Vdc)



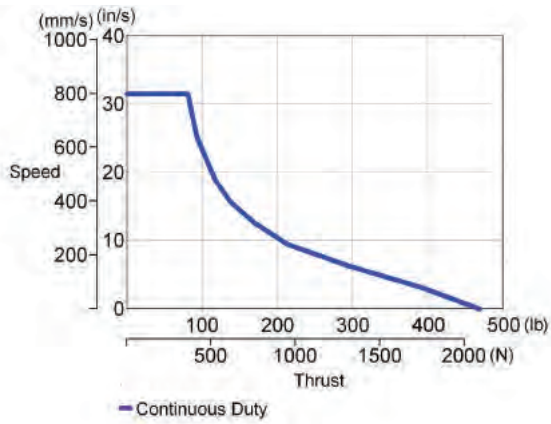
EC5-T41T-15-32B/ P70360 (320 Vdc)



EC5-T31T-15-10B/ P70360 (320 Vdc)

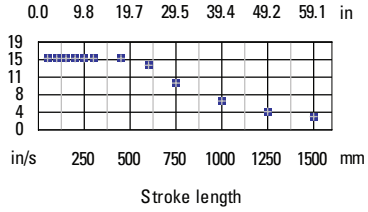


EC5-T41T-20-32B/ P70360 (320 Vdc)

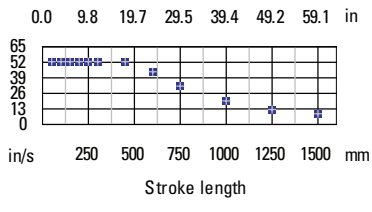


Critical Speed and Column Loading Limits

EC5-10B Ballscrew Critical Speed Limit



EC5-32B Ballscrew Critical Speed Limit



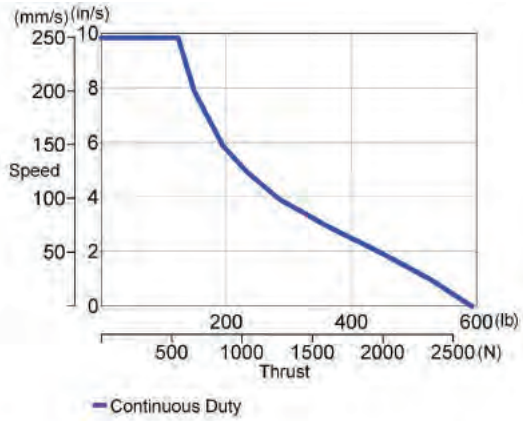
Note: No column loading limit if not shown.

*Complete EC nomemclature on pages 158-159.

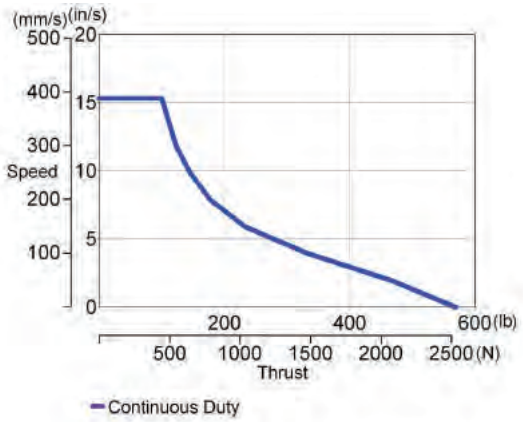
EC5 Series Perfomance Curves

EC5 Series Stepper Thrust Speed Curves

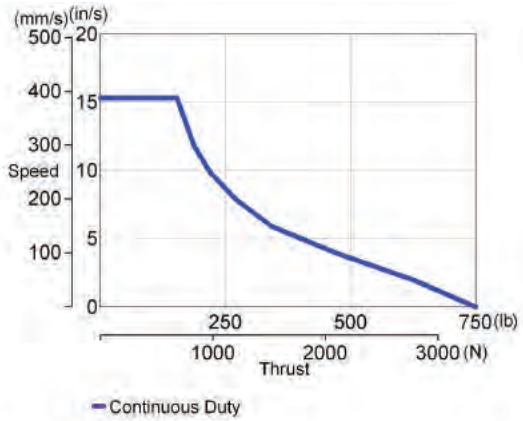
EC5-T31T-20-10B/ P70360 (320 Vdc)



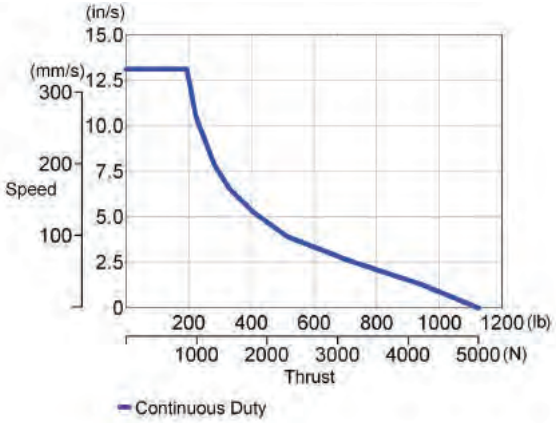
EC5-T32T-10-10B/ P70360 (320 Vdc)



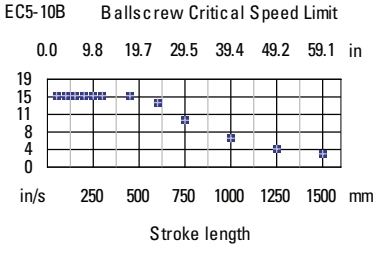
EC5-T41T-10-10B/ P70360 (320 Vdc)



EC5-T41T-15-10B/ P70360 (320 Vdc)



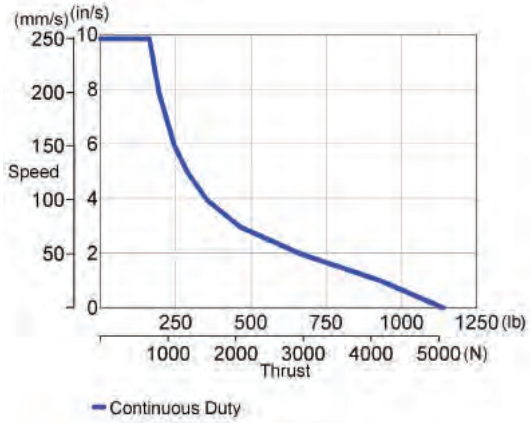
Critical Speed and Column Loading Limits



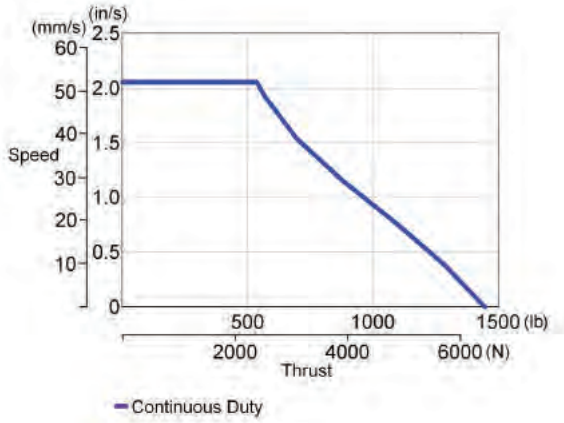
Note: No column loading limit if not shown.

EC5 Series Stepper Thrust Speed Curves

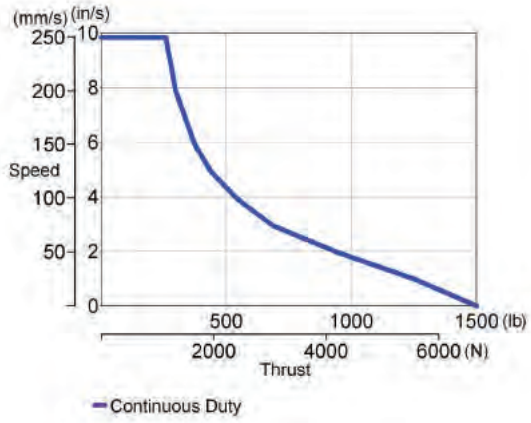
EC5-T32T-20-10B/ P70360 (320 Vdc)



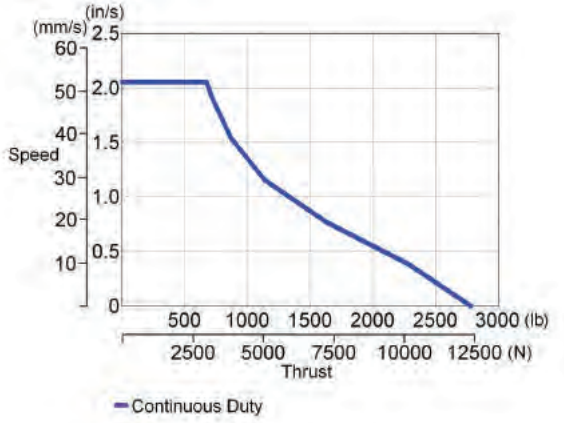
EC5-T31T-50-10B/ P70360 (320 Vdc)



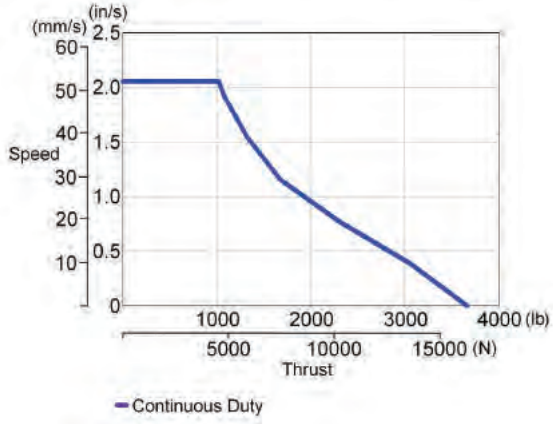
EC5-T41T-20-10B/ P70360 (320 Vdc)



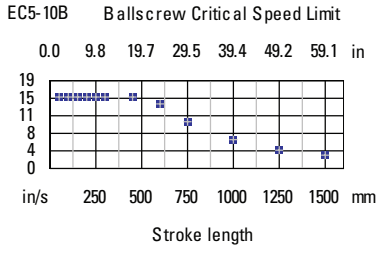
EC5-T32T-50-10B/ P70360 (320 Vdc)



EC5-T41T-50-10B/ P70360 (320 Vdc)



Critical Speed and Column Loading Limits



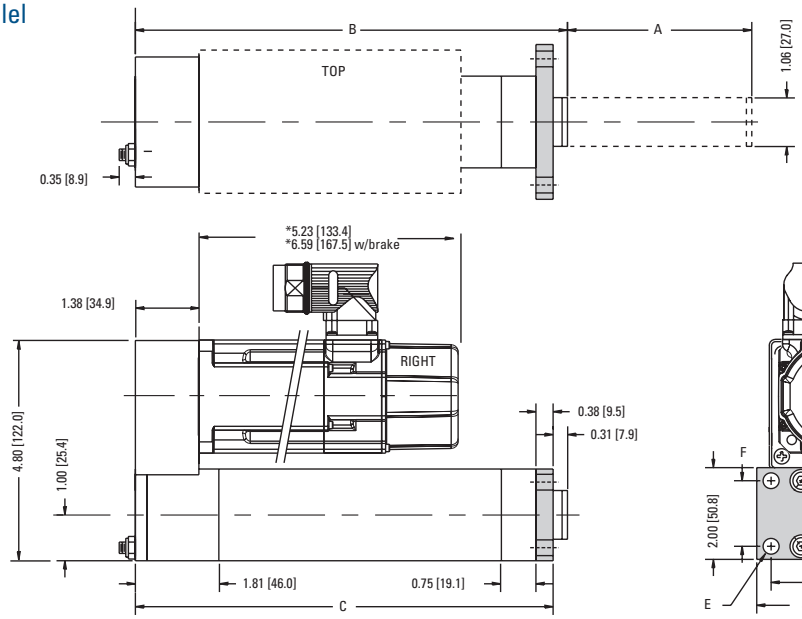
Note: No column loading limit if not shown.

*Complete EC nomemclature on pages 158-159.

N2 Series Outline Drawings

MF1 Front Rectangular Flange Mount

Parallel



	English Option	Metric Option
	MF1 (inches)	MF1M (mm)
D	2.75	72*
E	0.34	9*
F	1.43	36*

* Meets ISO 40mm bore standard

A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

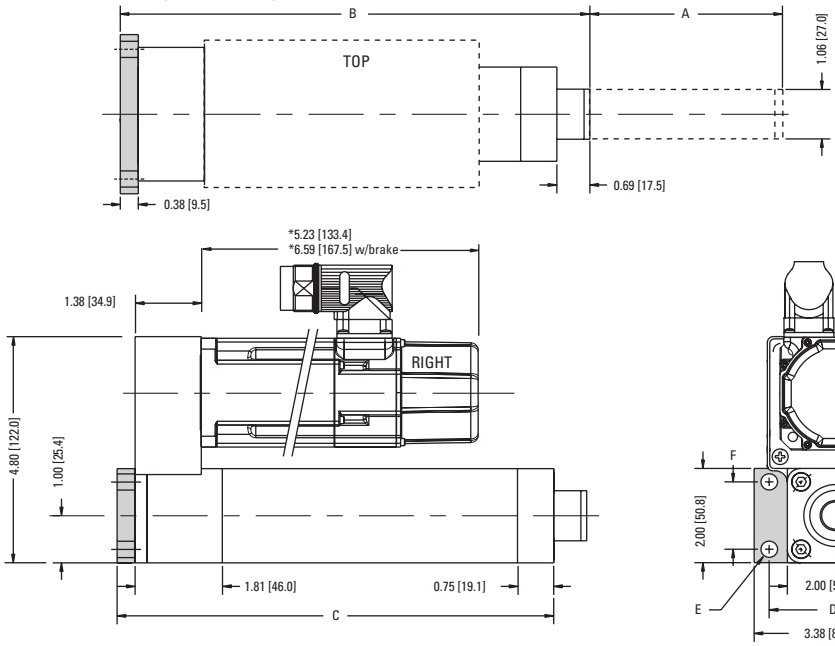
* AKM23 with motor mounted connectors.

B	Retract Length	C	Mounting length
inch	5.37 + S	inch	5.06 + S
mm	136.4 + S	mm	128.5 + S

S = stroke

MF2 Rear Rectangular Flange Mount

Parallel



	English Option	Metric Option
	MF2 (inches)	MF2M (mm)
D	2.75	72*
E	0.34	9*
F	1.43	36*

* Meets ISO 40mm bore standard

A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

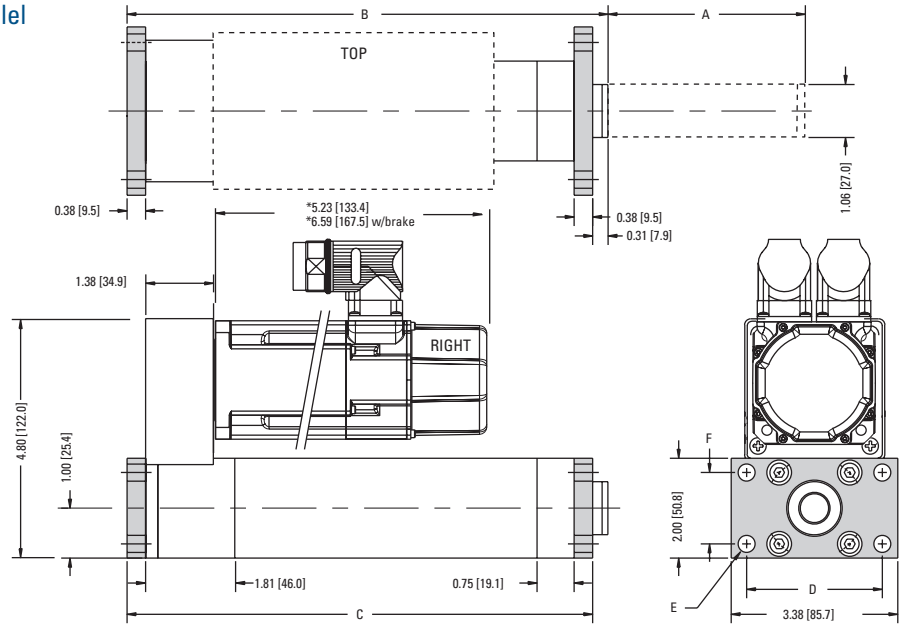
* AKM23 with motor mounted connectors.

B	Retract Length	C	Mounting length
inch	5.75 + S	inch	5.06 + S
mm	146.1 + S	mm	128.5 + S

S = stroke

MF3 Front and Rear Rectangular Flange Mount

Parallel



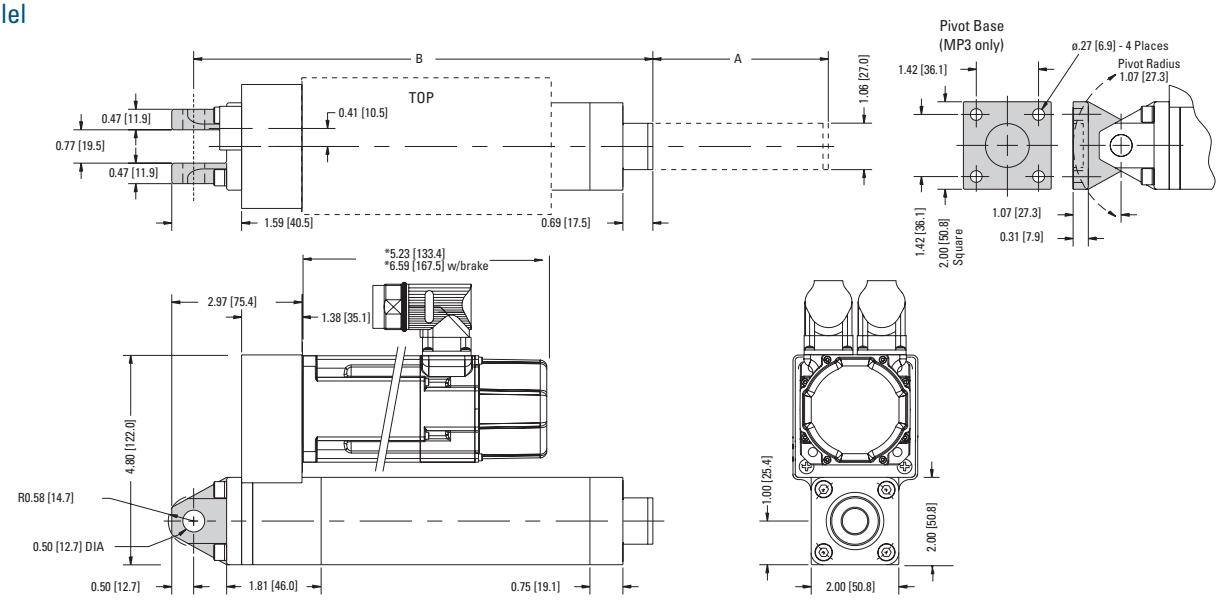
A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

B	Retract Length	C	Mounting length
inch	5.75 + S	inch	5.44 + S
mm	146.1 + S	mm	138.2 + S

* AKM23 with motor mounted connectors.

S = stroke

Parallel



A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

B	Retract Length
inch	6.47 + S
mm	164.4 + S

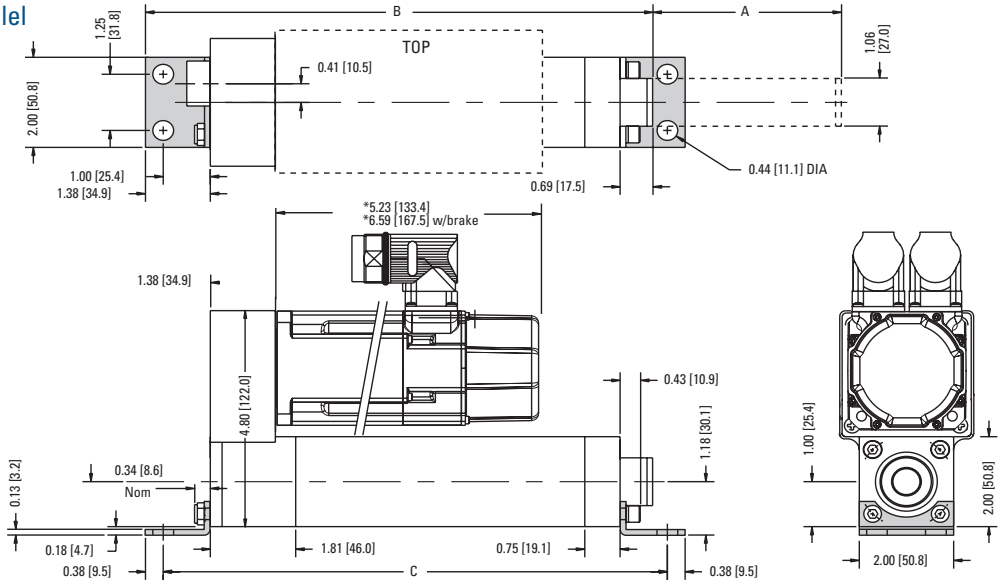
* AKM23 with motor mounted connectors.

S = stroke

N2 Series Outline Drawings

MS1 Side End Angles Mount

Parallel



A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

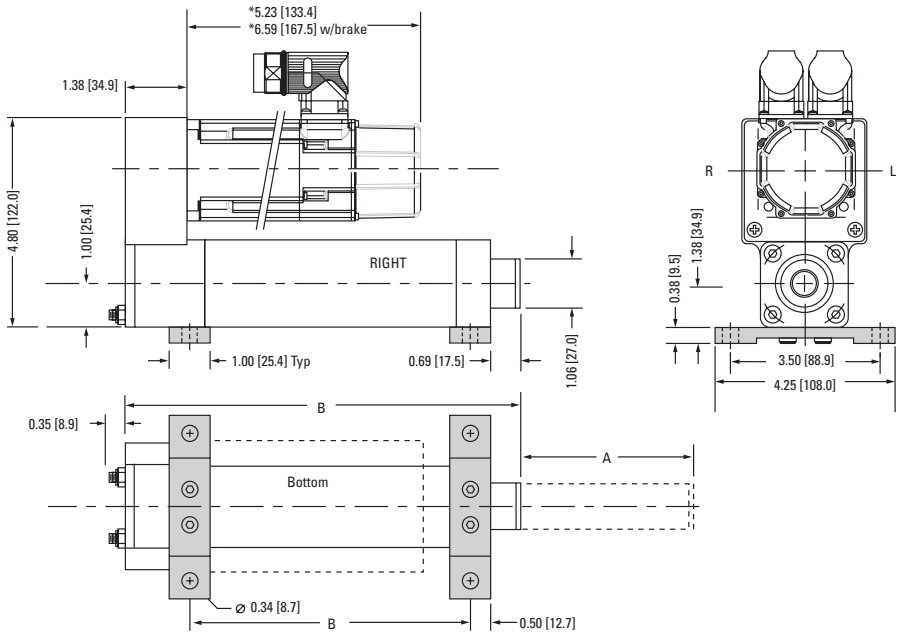
B	Retract Length	C	Mounting length
inch	6.75 + S	inch	6.69 + S
mm	171.5 + S	mm	169.9 + S

* AKM23 with motor mounted connectors.

S = stroke

MS2 Side Foot Mount

Parallel



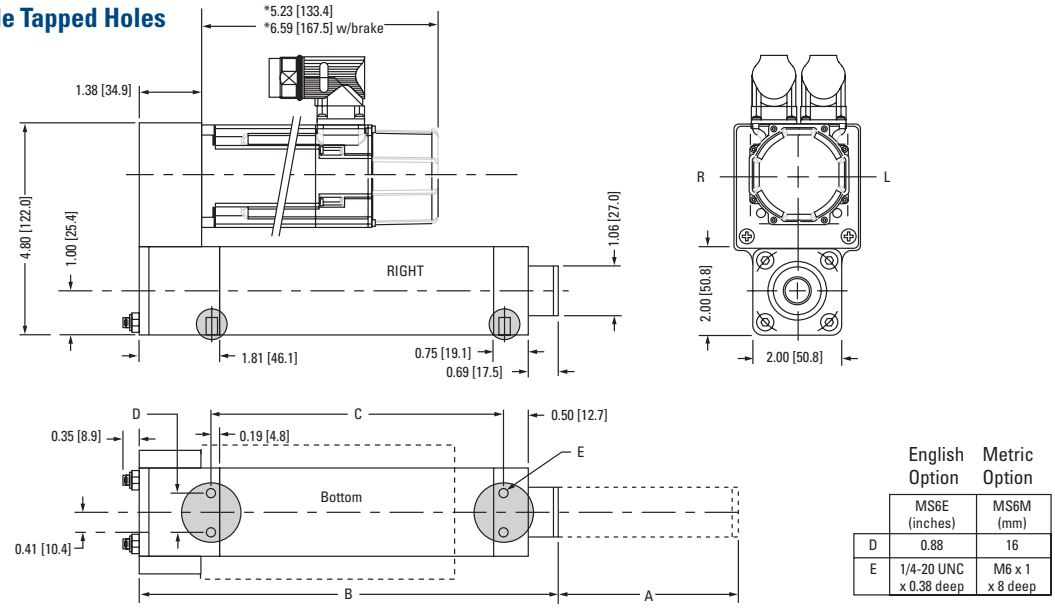
A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

B	Retract Length	C	Mounting length
inch	5.37 + S	inch	2.56 + S
mm	136.4 + S	mm	65.0 + S

* AKM23 with motor mounted connectors.

S = stroke

MS6 Side Tapped Holes
Parallel



	English Option	Metric Option
	MS6E (inches)	MS6M (mm)
D	0.88	16
E	1/4-20 UNC x 0.38 deep	M6 x 1 x 8 deep

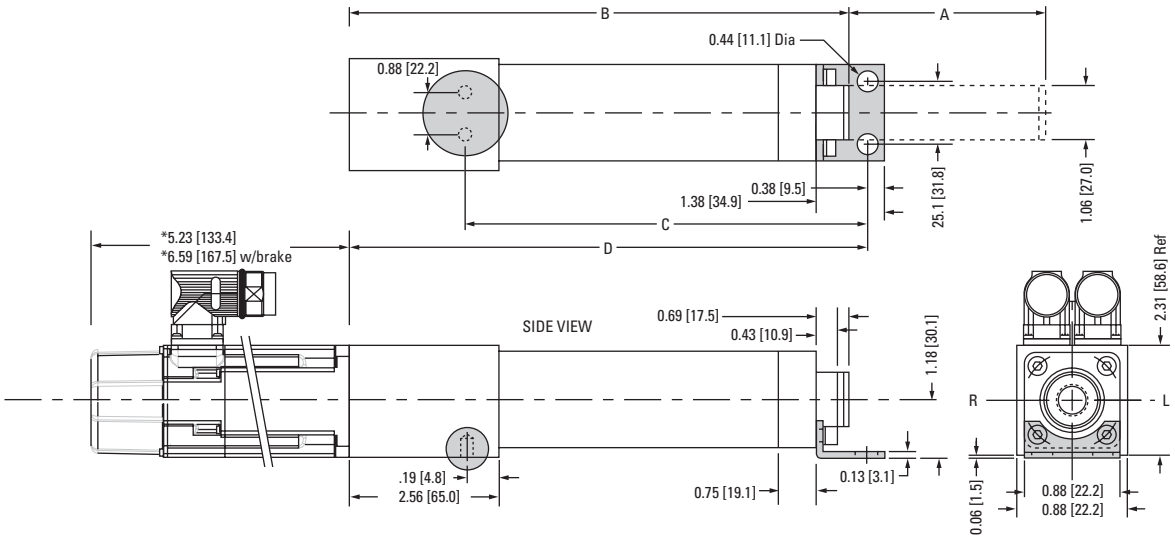
A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

B	Retract Length	C	Mounting length
inch	5.37 + S	inch	2.56 + S
mm	136.4 + S	mm	65.0 + S

* AKM23 with motor mounted connectors.

S = stroke

MS1 Side End Angles
Inline



A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

B	Retract Length	C	Mounting length
inch	6.12 + S	inch	4.06 + S
mm	155.4 + S	mm	103.1+ S

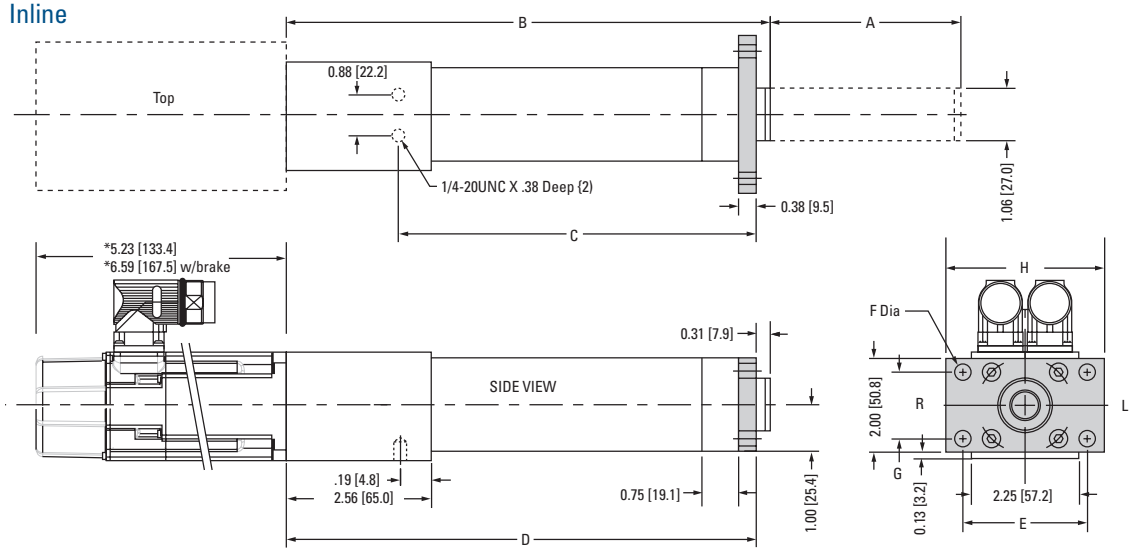
* AKM23 with motor mounted connectors.

S = stroke

N2 Series Outline Drawings

MF1 Front Flange

Inline



	English Option	Metric Option
	MF1 (inches)	MF1M (mm)
E	2.75	72*
F	0.34	9*
G	1.43	36*
	3.38	85.7*

*Meets ISO 40mm bore standard

A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

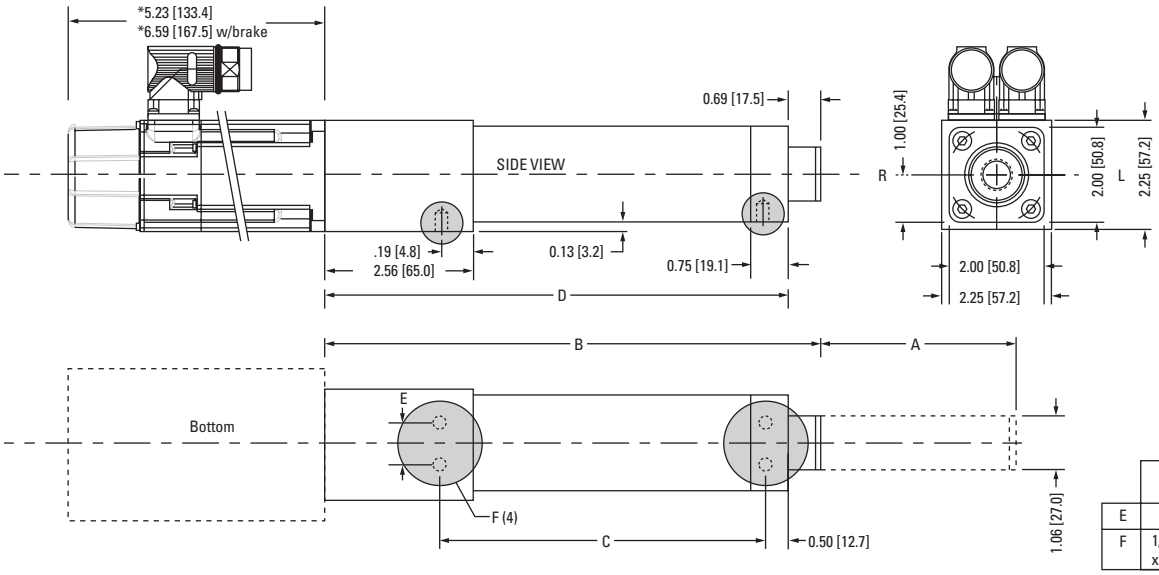
* AKM23 with motor mounted connectors.

B	Retract Length	C	Mounting length	D	Mounting length
inch	6.12 + S	inch	3.44 + S	inch	5.81 + S
mm	155.4 + S	mm	87.4 + S	mm	147.5 + S

S = stroke

MS6 Side Tapped Holes

Inline



	English Option	Metric Option
	MS6E (inches)	MS6M (mm)
E	0.88	16
F	1/4-20 UNC x 0.38 deep	M6 x 1 x 8 deep

A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

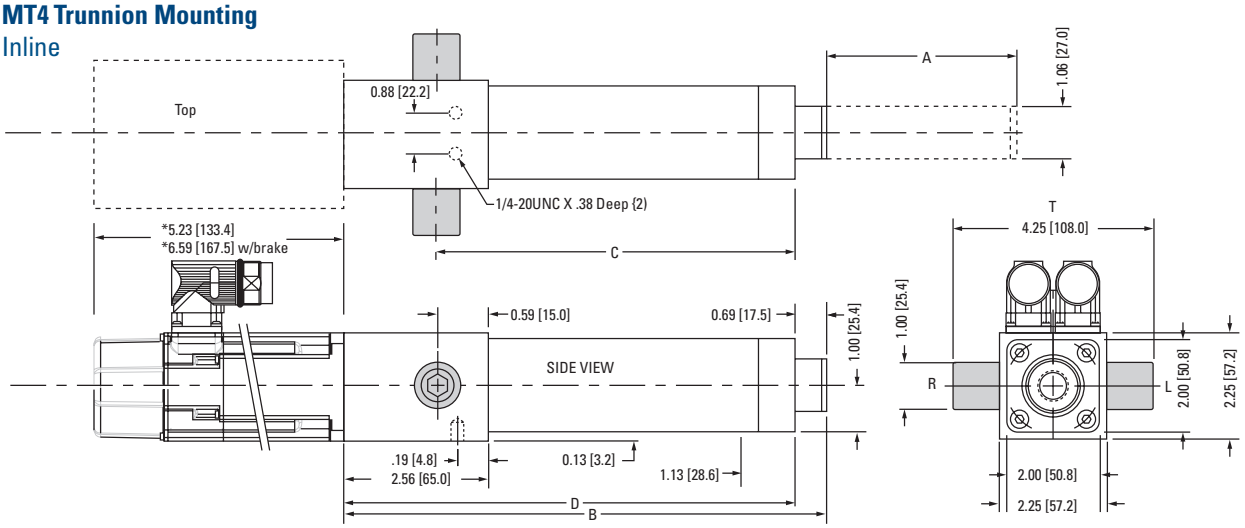
* AKM23 with motor mounted connectors.

B	Retract Length	C	Mounting length	D	Mounting length
inch	6.12 + S	inch	2.56 + S	inch	5.43 + S
mm	155.4 + S	mm	65.0 + S	mm	137.8 + S

S = stroke

MT4 Trunnion Mounting

Inline



A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

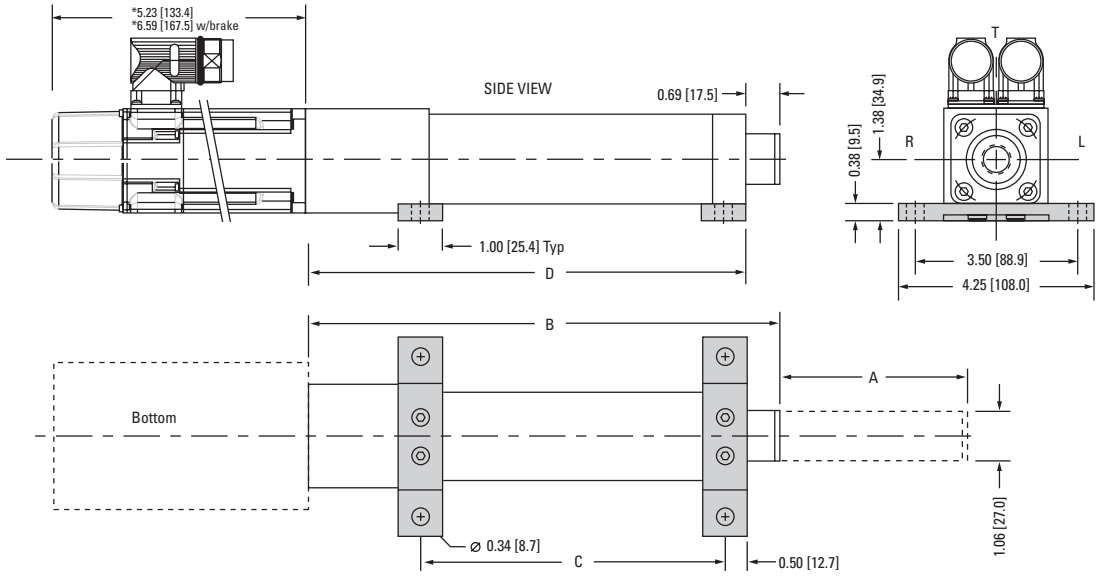
B	Retract Length	C	Mounting length	D	Mounting length
inch	6.12 + S	inch	3.47 + S	inch	5.43 + S
mm	155.4 + S	mm	88.1 + S	mm	137.8 + S

* AKM23 with motor mounted connectors.

S = stroke

MS2 Side Foot

Inline



A	Standard Stroke Lengths Available						
inch	2.0	4.0	6.0	8.0	12.0	18.0	24.0
mm	50.8	101.6	152.4	203.2	304.8	457.2	609.6

B	Retract Length	C	Mounting length	D	Mounting length
inch	6.12 + S	inch	2.56 + S	inch	5.43 + S
mm	155.4 + S	mm	65.0 + S	mm	137.8 + S

* AKM23 with motor mounted connectors.

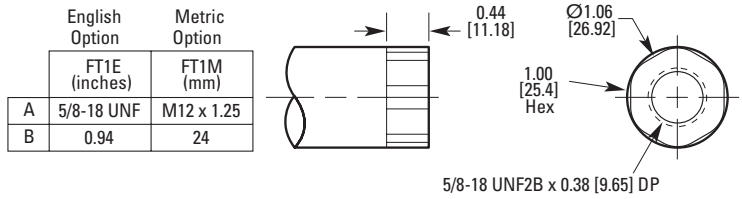
S = stroke

N2 Series Outline Drawings

N2 Series Rod End Dimensions

FT1 Female Threads Dimensions in [mm]

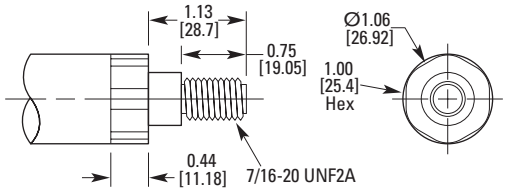
	English Option	Metric Option
	FT1E (inches)	FT1M (mm)
A	5/8-18 UNF	M12 x 1.25
B	0.94	24



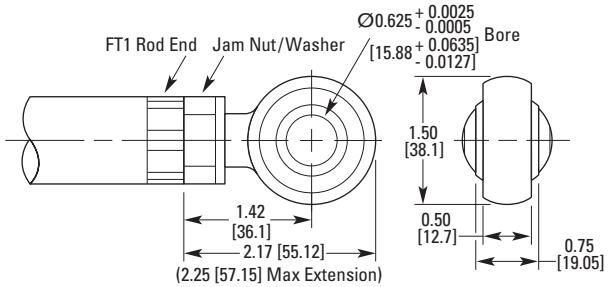
MT1 Male Threads Dimensions in [mm]

	English Option	Metric Option
	MT1E (inches)	MT1M (mm)
A	7/16-20 UNF	M12 x 1.25*
B	0.75	24*

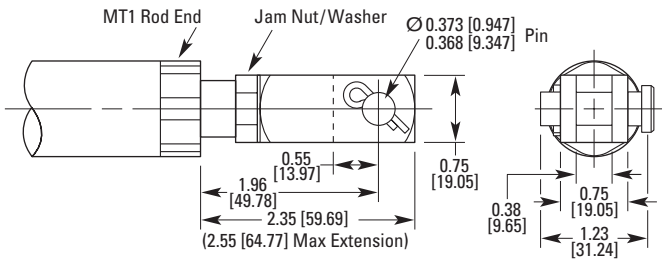
* Meets ISO 40mm bore standard



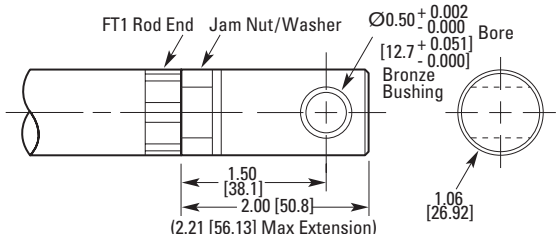
FS2 Spherical Joint Dimensions in [mm]



FC2 Clevis with Pin Dimensions in [mm]



FE2 with Bronze Bushing Dimensions in [mm]

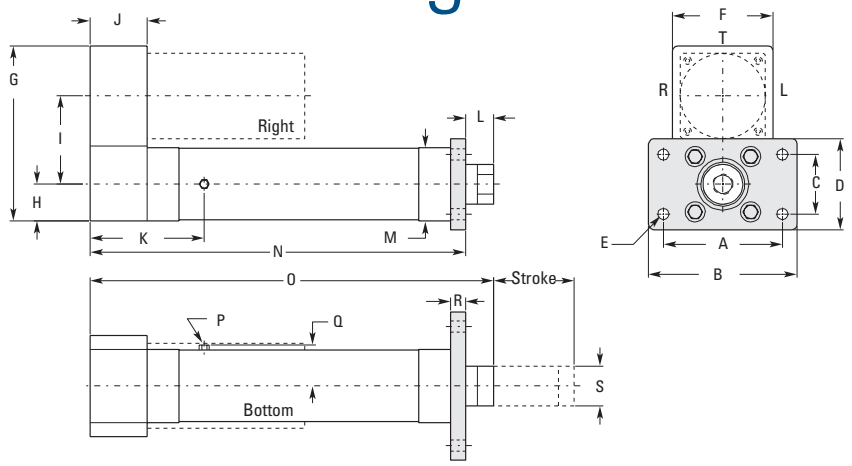


Notes

EC Series Outline Drawings

MF1 Front Flange
Parallel

Flange dimensions in accordance with ISO 6431 for:	
Type	Bore Size
EC1	30 mm
EC2	50 mm
EC3	63 mm
EC4	80 mm
EC5	100 mm



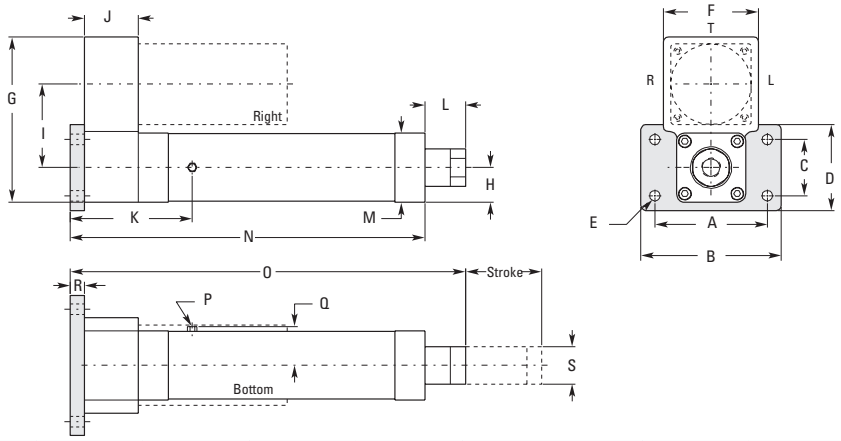
	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F mm (in)	G mm (in)	H mm (in)	I mm (in)	J mm (in)	K mm (in)
EC1	60.0 (2.36)	74.0 (2.91)	28.0 (1.10)	40.0 (1.57)	6.60 (0.26)	48.0 (1.89)	82.6 (3.25)	19.0 (0.75)	41.8 (1.65)	31.3 (1.23)	-
EC2	90.0 (3.54)	114.3 (4.50)	45.0 (1.77)	63.5 (2.50)	9.0 (0.35)	79.8 (3.14)	144.0 (5.7)	28.4 (1.12)	74.7 (2.94)	41.7 (1.64)	88.6 (3.49)
EC3	100.0 (3.94)	127.0 (5.00)	50.0 (1.97)	69.1 (2.72)	9.0 (0.35)	95.5 (3.76)	169.7 (6.7)	34.8 (1.37)	*87.6/89.7 (*3.45/3.53)	49.3 (1.94)	94.2 (3.71)
EC4 (-MF1E)	127.0 (5.00)	152.4 (6.00)	69.9 (2.75)	96.3 (3.79)	13.5 (0.53)	127.0 (5.00)	221.0 (8.7)	46.1 (1.81)	111.1 (4.37)	71.9 (2.83)	150.9 (5.94)
EC5	150.0 (5.91)	186.9 (7.36)	75.0 (2.95)	114.3 (4.50)	14.2 (0.56)	127.0 (5.00)	221.0 (8.7)	46.1 (1.81)	111.1 (4.37)	71.9 (2.83)	150.9 (5.94)

	L mm (in)	M mm (in)	N Cyl Length mm (in)	O Retract length mm (in)	P Breather port Hex type	P Breather port Hex mm (in)	Q mm (in)	R mm (in)	S mm (in)
EC1	10.2 (0.40)	38.1 (1.50)	113.8 + S (4.48 + S)	124.0 + S (4.88 + S)	-	-	-	10.0 (0.39)	22.2 (0.88)
EC2	25.0 (0.98)	56.9 (2.24)	218.5 + S (8.6 + S)	243.4 + S (9.58 + S)	1/8 NPT	11.1 (0.44)	34.8 (1.37)	9.5 (0.37)	28.0 (1.10)
EC3	25.0 (0.98)	69.6 (2.74)	246.3 + S (9.7 + S)	271.1 + S (10.67 + S)	1/8 NPT	11.1 (0.44)	41.1 (1.62)	12.7 (0.50)	35.0 (1.38)
EC4 (-MF1E)	41.4 (1.63)	92.2 (3.63)	365.8 + S (14.4 + S)	406.9 + S (16.02 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	12.7 (0.50)	50.0 (1.97)
EC5	35.0 (1.38)	92.2 (3.63)	365.8 + S (14.4 + S)	406.9 + S (16.02 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	19.1 (0.75)	50.0 (1.97)

* AKM23 / AKM42 dimension

MF2 Rear Flange
Parallel

Flange dimensions in accordance with ISO 6431 for:	
Type	Bore Size
EC2	50 mm
EC3	63 mm
EC4	80 mm
EC5	100 mm



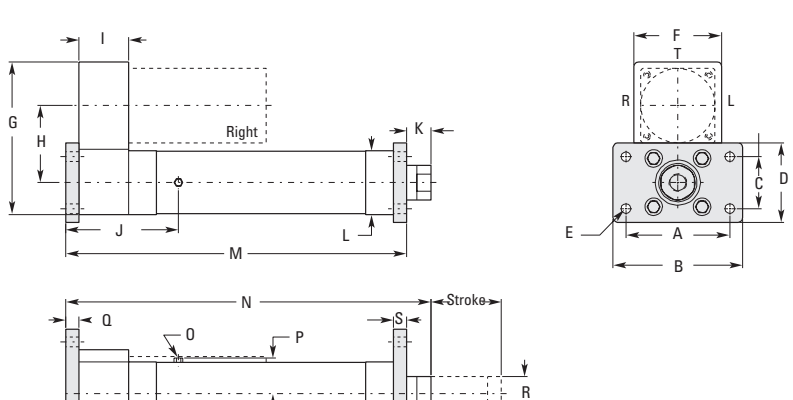
	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F mm (in)	G mm (in)	H mm (in)	I mm (in)	J mm (in)	K mm (in)
EC2	90.0 (3.54)	114.3 (4.50)	45.0 (1.77)	63.5 (2.50)	9.0 (0.35)	79.8 (3.14)	147.3 (5.80)	28.45 (1.12)	74.7 (2.94)	41.7 (1.64)	98.3 (3.87)
EC3	100.0 (3.94)	127.0 (5.00)	50.0 (1.97)	69.1 (2.72)	9.0 (0.35)	95.5 (3.76)	169.7 (6.68)	34.8 (1.37)	*87.6/89.7 (*3.45/3.53)	49.3 (1.94)	106.9 (4.21)
EC4 (-MF1E)	127.0 (5.00)	152.4 (6.00)	69.9 (2.75)	96.3 (3.79)	13.5 (0.53)	127.0 (5.00)	221.0 (8.70)	46.1 (1.81)	111.1 (4.37)	71.9 (2.83)	163.5 (6.44)
EC5	150.0 (5.91)	186.9 (7.36)	75.0 (2.95)	114.3 (4.50)	14.2 (0.56)	127.0 (5.00)	221.0 (8.70)	46.1 (1.81)	111.1 (4.37)	71.9 (2.83)	169.9 (6.69)

	L mm (in)	M mm (in)	N Cyl Length mm (in)	O Retract length mm (in)	P Breather port Hex type	P Breather port Hex mm (in)	Q mm (in)	R mm (in)	S mm (in)
EC2	34.5 (1.36)	56.9 (2.24)	218.5 + S (8.6 + S)	253.0 + S (9.96 + S)	1/8 NPT	11.1 (0.44)	34.8 (1.37)	9.5 (0.37)	28.0 (1.10)
EC3	37.7 (1.48)	69.6 (2.74)	246.3 + S (9.7 + S)	284.3 + S (11.19 + S)	1/8 NPT	11.1 (0.44)	41.1 (1.62)	12.7 (0.50)	35.0 (1.38)
EC4 (-MF1E)	54.1 (2.13)	92.2 (3.63)	365.8 + S (14.4 + S)	419.6 + S (16.52 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	12.7 (0.50)	50.0 (1.97)
EC5	54.1 (2.13)	92.2 (3.63)	365.8 + S (14.4 + S)	419.6 + S (16.52 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	19.1 (0.75)	50.0 (1.97)

* AKM23 / AKM42 dimension

MF3 Front and Rear Flanges
Parallel

Flange dimensions in accordance with ISO 6431 for:	
Type	Bore Size
EC2	50 mm
EC3	63 mm
EC4	80 mm
EC5	100 mm



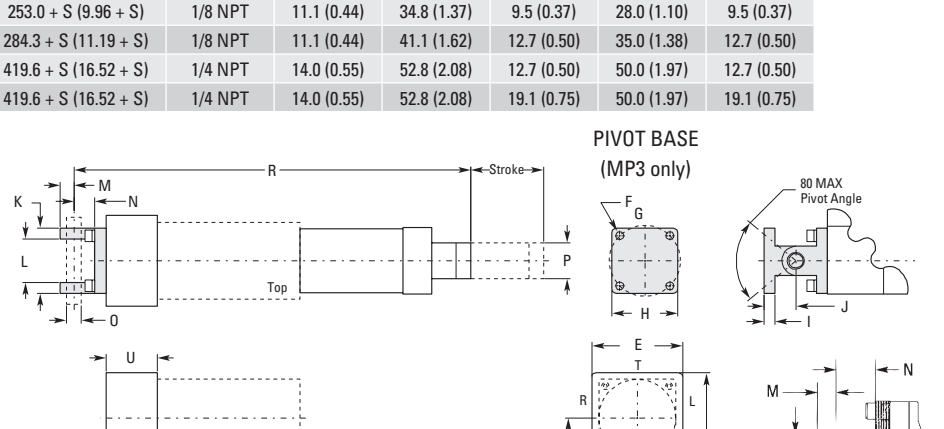
	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F mm (in)	G mm (in)	H mm (in)	I mm (in)	J mm (in)	K mm (in)
EC2	90.0 (3.54)	114.3 (4.50)	45.0 (1.77)	63.5 (2.50)	9.0 (0.35)	79.8 (3.14)	147.3 (5.80)	74.7 (2.94)	41.7 (1.64)	98.3 (3.87)	25.0 (0.98)
EC3	100.0 (3.94)	127.0 (5.00)	50.0 (1.97)	69.1 (2.72)	9.0 (0.35)	95.5 (3.76)	169.7 (6.68)	*87.6/89.7 (*3.45/3.53)	49.3 (1.94)	106.9 (4.21)	25.0 (0.98)
EC4 (-MF3E)	127.0 (5.00)	152.4 (6.00)	69.9 (2.75)	96.3 (3.79)	13.5 (0.53)	127.0 (5.00)	221.0 (8.70)	111.1 (4.37)	71.9 (2.83)	163.5 (6.44)	41.4 (1.63)
EC5	150.0 (5.91)	186.9 (7.36)	75.0 (2.95)	114.3 (4.50)	14.2 (0.56)	127.0 (5.00)	221.0 (8.70)	111.1 (4.37)	71.9 (2.83)	169.9 (6.69)	35.1 (1.38)

	L mm (in)	M Cyl Length mm (in)	N Retract length mm (in)	O Breather port Hex		P mm (in)	Q mm (in)	R mm (in)	S mm (in)
				type	mm (in)				
EC2	56.9 (2.24)	228.1+ S (8.98 + S)	253.0 + S (9.96 + S)	1/8 NPT	11.1 (0.44)	34.8 (1.37)	9.5 (0.37)	28.0 (1.10)	9.5 (0.37)
EC3	69.6 (2.74)	259.3 + S (10.21 + S)	284.3 + S (11.19 + S)	1/8 NPT	11.1 (0.44)	41.1 (1.62)	12.7 (0.50)	35.0 (1.38)	12.7 (0.50)
EC4 (-MF3E)	92.2 (3.63)	387.5 + S (14.9 + S)	419.6 + S (16.52 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	12.7 (0.50)	50.0 (1.97)	12.7 (0.50)
EC5	92.2 (3.63)	378.5 + S (14.9 + S)	419.6 + S (16.52 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	19.1 (0.75)	50.0 (1.97)	19.1 (0.75)

* AKM23 / AKM42 dimension

MP3 Clevis Mount with Pivot Base and Pin
Parallel

Flange dimensions in accordance with ISO 6431 for:	
Type	Bore Size
EC1	30 mm
EC2	50 mm
EC3	63 mm
EC4	80 mm
EC5	100 mm



	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F mm (in)	G mm (in)	H mm (in)	I mm (in)	J mm (in)	K mm (in)	L mm (in)	M mm (in)
EC1	43.7 (1.72)	-	418 (1.65)	82.6 (3.25)	48.0 (1.89)	5.5 (0.22)	48.0 (1.89)	46.0 (1.81)	8.0 (0.31)	30.0 (1.18)	-	19.9/20.1 (0.782/0.792)	8.0 (0.31)
EC2	56.9 (2.24)	34.8 (1.37)	74.7 (2.94)	144.0 (5.67)	79.8 (3.14)	5.4 (0.21)	61.7 (2.43)	56.9 (2.24)	9.5 (0.37)	25.4 (1.00)	57.0 (2.24)	32.0/32.6 (1.26/1.28)	12.7 (0.50)
EC3	69.6 (2.74)	41.1 (1.62)	87.6/89.7* (3.45/3.53*)	169.7 (6.68)	95.5 (3.76)	6.5 (0.26)	76.0 (2.99)	69.3 (2.73)	9.5 (0.37)	31.5 (1.24)	69.3 (2.73)	40.0/40.6 (1.58/1.60)	15.2 (0.60)
EC4	92.2 (3.63)	52.8 (2.08)	111.1 (4.37)	221.0 (8.70)	127.0 (5.00)	11.1 (0.44)	98.8 (3.89)	91.4 (3.60)	15.7 (0.62)	44.4 (1.75)	91.4 (3.60)	60.0/60.5 (2.36/2.38)	19.6 (0.77)
EC5	92.2 (3.63)	52.8 (2.08)	111.1 (4.37)	221.0 (8.70)	127.0 (5.00)	11.1 (0.44)	98.8 (3.89)	91.4 (3.60)	15.7 (0.62)	44.4 (1.75)	91.4 (3.60)	60.0/60.5 (2.36/2.38)	19.6 (0.77)

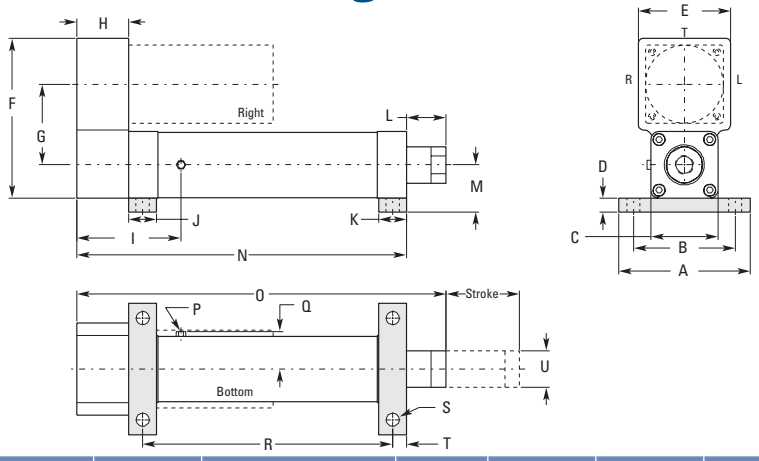
	N mm (in)	O mm (in)	P mm (in)	Q Cyl Length mm (in)	R Retract length mm (in)	S Breather port Hex		T mm (in)	U mm (in)	V mm (in)	W mm (in)
						type	mm (in)				
EC1	17.2 (0.68)	9.86/10.1 (0.388/0.398)	22.2 (0.88)	109.9 + S (4.33 + S)	147.5 + S (5.81 + S)	-	-	-	31.3 (1.23)	20.2 (0.80)	19.1 (0.75)
EC2	15.7 (0.62)	11.9/12.0 (0.470/0.472)	28.0 (1.10)	218.5 + S (8.6 + S)	267.5 + S (10.5)	1/8 NPT	11.1 (0.44)	98.3 (3.87)	41.7 (1.64)	34.5 (1.36)	28.5 (1.12)
EC3	21.8 (0.86)	15.9/16.0 (0.628/0.630)	35.0 (1.38)	242.7 + S (9.55 + S)	302.6 + S (11.91 + S)	1/8 NPT	11.1 (0.44)	103.9 (4.09)	49.3 (1.94)	37.7 (1.48)	34.8 (1.37)
EC4	28.7 (1.13)	19.9/20.0 (0.785/0.787)	50.0 (1.97)	368.3 + S (14.5 + S)	451.4 + S (17.77 + S)	1/4 NPT	14.0 (0.55)	166.6 (6.56)	71.9 (2.83)	54 (2.13)	46.1 (1.81)
EC5	28.7 (1.13)	19.9/20.0 (0.785/0.787)	50.0 (1.97)	368.3 + S (14.5 + S)	451.4 + S (17.77 + S)	1/4 NPT	14.0 (0.55)	166.6 (6.56)	71.9 (2.83)	54 (2.13)	46.1 (1.81)

* AKM23 / AKM42 dimension

EC Series Outline Drawings

MS2 Side Lugs
Parallel

Flange dimensions in accordance with ISO 6431 for:	
Type	Bore Size
EC1	30 mm
EC2	50 mm
EC3	63 mm
EC4	80 mm
EC5	100 mm



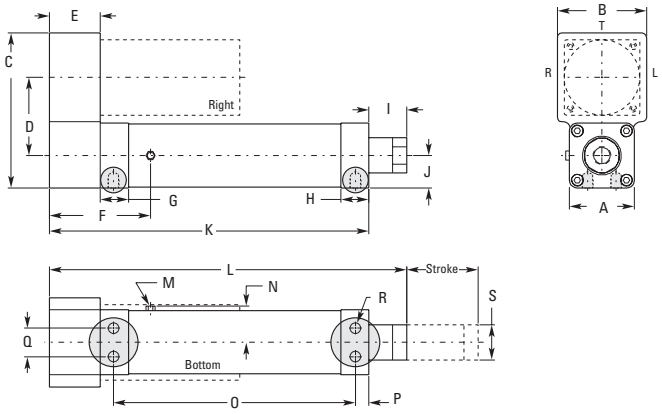
	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F mm (in)	G mm (in)	H mm (in)	I mm (in)	J mm (in)	K mm (in)
EC1	78.0 (3.07)	62.0 (2.44)	43.7 (1.72)	8.0 (0.31)	48.0 (1.89)	82.6 (3.25)	41.8 (1.65)	31.3 (1.23)	-	20.0 (0.79)	20.0 (0.79)
EC2	114.3 (4.50)	85.0 (3.35)	56.9 (2.24)	9.5 (0.37)	79.8 (3.14)	144.0 (5.67)	74.7 (2.94)	41.7 (1.64)	88.6 (3.49)	22.1 (0.87)	22.1 (0.87)
EC3	127.0 (5.00)	100.0 (3.94)	69.6 (2.74)	12.7 (0.50)	95.5 (3.76)	169.7 (6.68)	87.6/89.7 * (3.45/3.53 *)	49.3 (1.94)	94.2 (3.71)	25.0 (0.98)	25.0 (0.98)
EC4	181.1 (7.13)	140.0 (5.51)	92.2 (3.63)	19.1 (0.75)	127.0 (5.00)	221.0 (8.70)	111.1 (4.37)	71.9 (2.83)	150.9 (5.94)	38.1 (1.50)	38.1 (1.50)
EC5	181.1 (7.13)	140.0 (5.51)	92.2 (3.63)	19.1 (0.75)	127.0 (5.00)	221.0 (8.70)	111.1 (4.37)	71.9 (2.83)	150.9 (5.94)	38.1 (1.50)	38.1 (1.50)

	L mm (in)	M mm (in)	N Cyl Length mm (in)	O Retract length mm (in)	P Breather port Hex type	P Breather port Hex mm (in)	Q mm (in)	R mm (in)	S mm (in)	T mm (in)	U mm (in)
EC1	20.5 (0.81)	27.1 (1.06)	103.5 + S (4.07 + S)	124.0 + S (4.88 + S)	-	-	-	65.6 + S (2.58 + S)	6.6 (0.26)	10.0 (0.39)	22.2 (0.88)
EC2	34.5 (1.36)	38.1 (1.50)	208.8 + S (8.22 + S)	243.4 + S (9.58 + S)	1/8 NPT	11.1 (0.44)	34.8 (1.37)	144.8 + S (5.7 + S)	9.0 (0.35)	11.0 (0.43)	28.0 (1.10)
EC3	37.7 (1.48)	47.5 (1.87)	233.4 + S (9.19 + S)	271.1+ S (10.67 + S)	1/8 NPT	11.1 (0.44)	41.1 (1.62)	158.8 + S (6.25 + S)	11.0 (0.43)	12.5 (0.49)	35.0 (1.38)
EC4	54.0 (2.13)	65.3 (2.57)	353.1 + S (13.9 + S)	406.9+ S (16.02 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	242.6 + S (9.55 + S)	18.0 (0.71)	19.1 (0.75)	50.0 (1.97)
EC5	54.0 (2.13)	65.3 (2.57)	353.1 + S (13.9 + S)	406.9+ S (16.02 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	242.6 + S (9.55 + S)	18.0 (0.71)	19.1 (0.75)	50.0 (1.97)

* AKM23 / AKM42 dimension

MS6 Side Tapped Holes
Parallel

Flange dimensions in accordance with ISO 6431 for:	
Type	Bore Size
EC1	30 mm
EC2	50 mm
EC3	63 mm
EC4	80 mm
EC5	100 mm



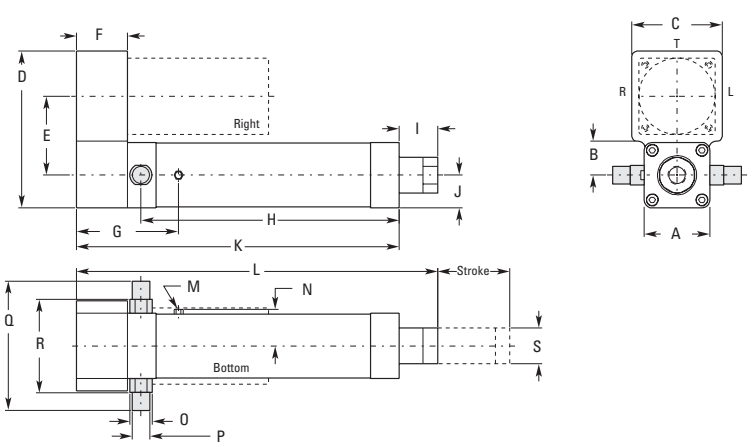
	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F mm (in)	G mm (in)	H mm (in)	I mm (in)	J mm (in)	K Cyl Length mm (in)
EC1	43.7 (1.72)	48.0 (1.89)	82.6 (3.25)	41.8 (1.65)	31.3 (1.23)	-	10.5 (0.41)	19.2 (0.76)	20.2 (0.80)	19.1 (0.75)	103.5 + S (4.07 + S)
EC2	56.9 (2.24)	79.8 (3.14)	144.0 (5.67)	74.7 (2.94)	41.7 (1.64)	88.6 (3.49)	22.1 (0.87)	22.1 (0.87)	34.5 (1.36)	28.5 (1.12)	208.8 + S (8.22 + S)
EC3	69.6 (2.74)	95.5 (3.76)	169.7 (6.68)	87.6/89.7 * (3.45/3.53 *)	49.3 (1.94)	94.2 (3.71)	25.1 (0.99)	25.1 (0.99)	37.7 (1.48)	34.8 (1.37)	233.4 + S (9.19 + S)
EC4	92.2 (3.63)	127.0 (5.00)	221.0 (8.70)	111.1 (4.37)	71.9 (2.83)	150.9 (5.94)	40.0 (1.57)	40.0 (1.57)	54.0 (2.13)	46.1 (1.81)	353.1 + S (13.9 + S)
EC5	92.2 (3.63)	127.0 (5.00)	221.0 (8.70)	111.1 (4.37)	71.9 (2.83)	150.9 (5.94)	40.0 (1.57)	40.0 (1.57)	54.0 (2.13)	46.1 (1.81)	353.1 + S (13.9 + S)

	L Retract length mm (in)	M Breather port Hex type	M Breather port Hex mm (in)	N mm (in)	O Mounting Length mm (in)	P mm (in)	Q mm (in)	R (MS6E) Thread	R (MS6M) Thread	S mm (in)
EC1	124.0 + S (4.88 + S)	-	-	-	65.7 + S (2.59 + S)	9.94 (0.39)	16.0 (0.63)	-	M6 x 1-6H x 6.8 mm Dp	22.2 (0.88)
EC2	243.4 + S (9.58 + S)	1/8 NPT	11.1 (0.44)	34.8 (1.37)	144.8 + S (5.7 + S)	11.0 (0.43)	25.0 (0.98)	5/16-18 UNC-2B x 0.33 Dp	M8 x 1.25-6H x 8.4 mm Dp	28.0 (1.10)
EC3	271.1 + S (10.67 + S)	1/8 NPT	11.1 (0.44)	41.1 (1.62)	158.8 + S (6.25 + S)	12.5 (0.49)	30.0 (1.18)	3/8-16 UNC-2B x 0.40 Dp	M10 x 1.50-6H x 10.2 mm Dp	35.0 (1.38)
EC4	406.9 + S (16.02 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	242.6 + S (9.55 + S)	19.1 (0.75)	40.6 (1.60)	5/8-18 UNF-2B x 0.55 Dp	M16 x 2-6H x 14 mm Dp	50.0 (1.97)
EC5	406.9 + S (16.02 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	242.6 + S (9.55 + S)	19.1 (0.75)	40.6 (1.60)	5/8-18 UNF-2B x 0.55 Dp	M16 x 2-6H x 14 mm Dp	50.0 (1.97)

* AKM23 / AKM42 dimension

MT4 Trunnion
Parallel

Flange dimensions in accordance with ISO 6431 for:	
Type	Bore Size
EC2	50 mm
EC3	63 mm
EC4	80 mm
EC5	100 mm



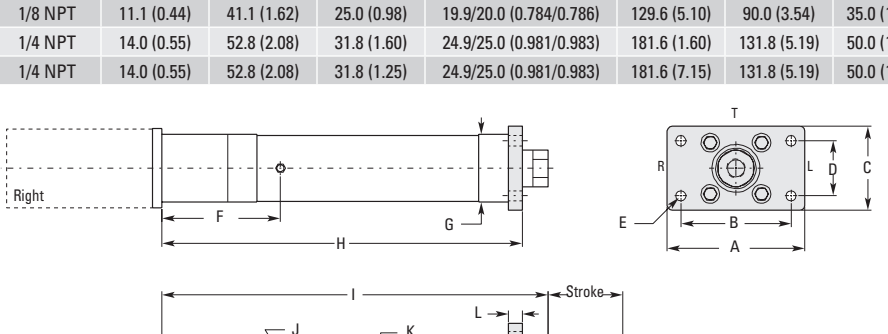
	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F mm (in)	G mm (in)	H Mounting Length mm (in)	I mm (in)	J mm (in)
EC2	56.9 (2.24)	28.5 (1.12)	79.8 (3.14)	144.0 (5.67)	74.7 (2.94)	41.7 (1.64)	88.6 (3.49)	155.8 + S (6.13 + S)	34.5 (1.36)	28.5 (1.12)
EC3	69.6 (2.74)	38.6 (1.52)	95.5 (3.76)	169.7 (6.68)	87.6/89.7* (3.45/3.53 *)	49.3 (1.94)	94.2 (3.71)	171.2 + S (6.74 + S)	37.7 (1.48)	34.8 (1.37)
EC4	92.2 (3.63)	48.0 (5.94)	127.0 (5.00)	221.0 (8.70)	111.1 (4.37)	71.9 (2.83)	150.9 (5.94)	261.6 + S (10.30 + S)	54.0 (2.13)	46.1 (1.81)
EC5	92.2 (3.63)	48.0 (1.89)	127.0 (5.00)	221.0 (8.70)	111.1 (4.37)	71.9 (2.83)	150.9 (5.94)	261.6 + S (10.30 + S)	54.0 (2.13)	46.1 (1.81)

	K Cyl Length mm (in)	L Retract length mm (in)	M Breather port Hex		N mm (in)	O mm (in)	P mm (in)	Q mm (in)	R mm (in)	S mm (in)
			type	mm (in)						
EC2	208.8+ S (8.22 + S)	243.4 + S (9.58 + S)	1/8 NPT	11.1 (0.44)	34.8 (1.37)	19.1 (0.75)	15.9/16.0 (0.627/0.629)	106.9 (4.21)	75.0 (2.95)	28.0 (1.10)
EC3	233.4+ S (9.19 + S)	271.1 + S (10.67 + S)	1/8 NPT	11.1 (0.44)	41.1 (1.62)	25.0 (0.98)	19.9/20.0 (0.784/0.786)	129.6 (5.10)	90.0 (3.54)	35.0 (1.38)
EC4	353.1 + S (13.9 + S)	406.9 + S (16.02 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	31.8 (1.60)	24.9/25.0 (0.981/0.983)	181.6 (1.60)	131.8 (5.19)	50.0 (1.97)
EC5	353.1 + S (13.9 + S)	406.9 + S (16.02 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	31.8 (1.25)	24.9/25.0 (0.981/0.983)	181.6 (7.15)	131.8 (5.19)	50.0 (1.97)

* AKM23 / AKM42 dimension

MT1 Front Flange
Inline

Flange dimensions in accordance with ISO 6431 for:	
Type	Bore Size
EC1	30 mm
EC2	50 mm
EC3	63 mm
EC4	80 mm
EC5	100 mm



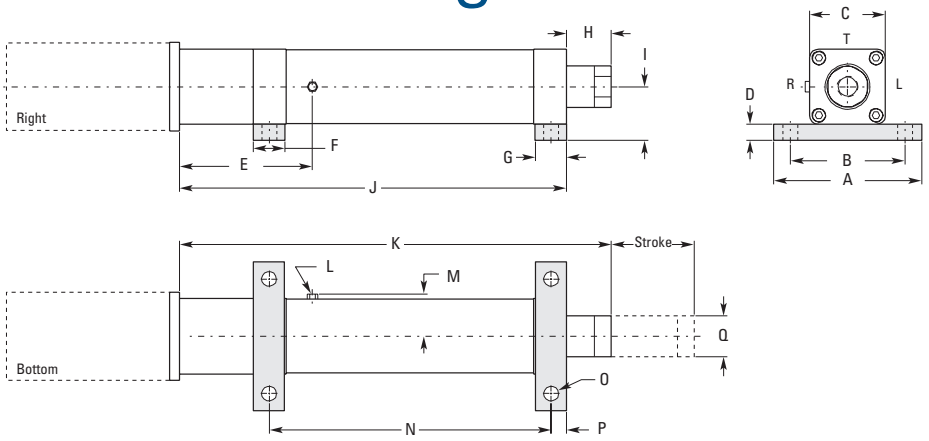
	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F mm (in)	G mm (in)	H Cyl Length mm (in)
EC1	74.0 (2.91)	60.0 (2.36)	40.0 (1.57)	28.0 (1.10)	6.6 (0.26)	-	38.1 (1.50)	111.7 + S (4.40 + S)
EC2	114.3 (4.50)	90.0 (3.54)	63.5 (2.50)	45.0 (1.77)	9.0 (0.35)	100.7 (3.96)	56.9 (2.24)	230.5 + S (9.08 + S)
EC3	127.0 (5.00)	100.0 (3.94)	69.1 (2.72)	50.0 (1.97)	9.0 (0.35)	121.3 (4.78)	69.6 (2.74)	273.4 + S (10.76 + S)
EC4	152.4 (6.00)	127.0 (5.00)	96.3 (3.79)	69.85 (2.75)	13.5 (0.53)	169.2 (6.66)	92.2 (3.63)	390.3 + S (15.37 + S)
EC5	186.9 (7.36)	155.0 (6.10)	114.3 (4.50)	75.0 (2.95)	14.2 (0.56)	169.2 (6.66)	92.2 (3.63)	390.3 + S (15.37 + S)

	I Retract length mm (in)	J Breather port Hex		K mm (in)	L mm (in)	M mm (in)	N mm (in)
		type	mm (in)				
EC1	122.1 + S (4.81 + S)	-	-	-	10.0 (0.39)	22.2 (0.88)	10.2 (0.40)
EC2	255.5 + S (10.06 + S)	1/8 NPT	11.1 (0.44)	34.8 (1.37)	9.5 (0.37)	28.0 (1.10)	25.0 (0.98)
EC3	298.3 + S (11.74 + S)	1/8 NPT	11.1 (0.44)	41.1 (1.62)	12.7 (0.50)	35.0 (1.38)	25.0 (0.98)
EC4	425.3 + S (16.74 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	12.7 (1.60)	50.0 (1.97)	41.1 (1.60)
EC5	425.3 + S (16.74 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	19.1 (0.75)	50.0 (1.97)	35.0 (1.38)

EC Series Outline Drawings

MS2 SideLugs
Inline

Flange dimensions in accordance with ISO 6431 for:	
Type	Bore Size
EC1	30 mm
EC2	50 mm
EC3	63 mm
EC4	80 mm
EC5	100 mm

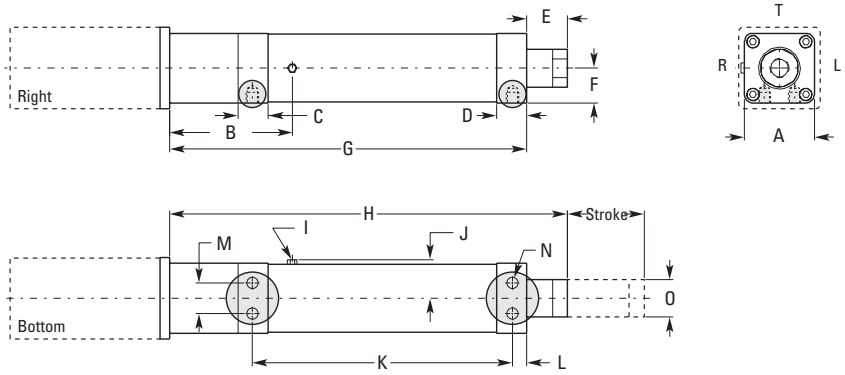


	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F mm (in)	G mm (in)	H mm (in)	I mm (in)	J Cyl Length mm (in)
EC1	78.0 (3.07)	62.0 (2.44)	43.7 (1.72)	8.0 (0.31)	-	20.0 (0.79)	20.0 (0.79)	20.5 (0.81)	27.1 (1.06)	101.7 + S (4.00 + S)
EC2	114.3 (4.50)	85.0 (3.35)	56.9 (2.24)	9.5 (0.37)	100.7 (3.96)	22.1 (0.87)	22.1 (0.87)	34.5 (1.36)	38.1 (1.50)	220.9 + S (8.70 + S)
EC3	127.0 (5.00)	100.0 (3.94)	69.6 (2.74)	12.7 (0.50)	121.3 (4.78)	25.0 (0.98)	25.0 (0.98)	37.7 (1.48)	47.5 (1.87)	260.5 + S (10.25 + S)
EC4	181.1 (7.13)	140.0 (5.51)	92.2 (3.63)	19.1 (0.75)	169.2 (6.66)	38.1 (1.50)	38.1 (1.50)	54.0 (2.13)	65.3 (2.57)	371.3 + S (14.62 + S)
EC5	181.1 (7.13)	140.0 (5.51)	92.2 (3.63)	19.1 (0.75)	169.2 (6.66)	38.1 (1.50)	38.1 (1.50)	54.0 (2.13)	65.3 (2.57)	371.3 + S (14.62 + S)

	K Retract length mm (in)	L Breather port Hex		M mm (in)	N mm (in)	O mm (in)	P mm (in)	Q mm (in)
		type	mm (in)					
EC1	122.1 + S (4.81 + S)	-	-	-	65.8 + S (2.59 + S)	6.6 (0.26)	10.0 (0.39)	22.2 (0.88)
EC2	255.5 + S (10.06 + S)	1/8 NPT	11.1 (0.44)	34.8 (1.37)	144.8 + S (5.7 + S)	9.0 (0.35)	11.0 (0.43)	28.0 (1.10)
EC3	298.1 + S (11.74 + S)	1/8 NPT	11.1 (0.44)	41.1 (1.62)	158.8 + S (6.25 + S)	11.0 (0.43)	12.5 (0.49)	35.0 (1.38)
EC4	425.3 + S (16.74 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	242.6 + S (9.55 + S)	18.0 (0.71)	19.1 (0.75)	50.0 (1.97)
EC5	425.3 + S (16.74 + S)	1/4 NPT	14.0 (0.55)	52.8 (2.08)	242.6 + S (9.55 + S)	18.0 (0.71)	19.1 (0.75)	50.0 (1.97)

MS6 Side Tapped Holes
Inline

Flange dimensions in accordance with ISO 6431 for:	
Type	Bore Size
EC1	30 mm
EC2	50 mm
EC3	63 mm
EC4	80 mm
EC5	100 mm

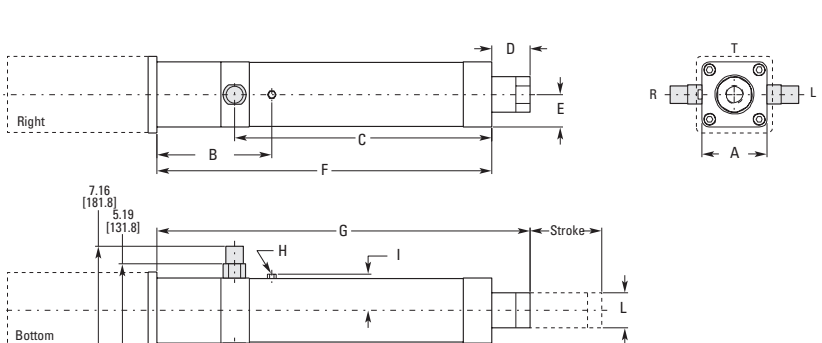


	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F mm (in)	G Cyl Length mm (in)	H Retract length mm (in)	I Breather port Hex	
									type	mm (in)
EC1	43.7 (1.72)	-	-	19.2 (0.76)	20.5 (0.81)	19.1 (0.75)	101.7 + S (4.00 + S)	122.1 + S (4.81 + S)	-	-
EC2	56.9 (2.24)	100.7 (3.96)	22.1 (0.87)	22.1 (0.87)	34.5 (1.36)	28.5 (1.12)	220.9 + S (8.70 + S)	255.5 + S (10.06 + S)	1/8 NPT	11.1 (0.44)
EC3	69.6 (2.74)	121.3 (4.78)	25.1 (0.99)	25.1 (0.99)	37.7 (1.48)	34.8 (1.37)	260.5 + S (10.25 + S)	298.1 + S (11.74 + S)	1/8 NPT	11.1 (0.44)
EC4	92.2 (3.63)	169.2 (5.94)	40.0 (1.57)	40.0 (1.57)	54.0 (2.13)	46.1 (1.81)	371.3 + S (14.62 + S)	425.3 + S (16.74 + S)	1/4 NPT	14.0 (0.55)
EC5	92.2 (3.63)	169.2 (6.66)	40.0 (1.57)	40.0 (1.57)	54.0 (2.13)	46.1 (1.81)	371.3 + S (14.62 + S)	425.3 + S (16.74 + S)	1/4 NPT	14.0 (0.55)

	J mm (in)	K mm (in)	L mm (in)	M mm (in)	N (MS6E) mm (in)	N (MS6M mm (in)	O mm (in)
EC1	-	65.8 + S (2.59 + S)	9.9 (0.39)	16.0 (0.63)	-	M6 x 1-6H x 6.8 mm Dp	22.2 (0.88)
EC2	34.8 (1.37)	144.8 + S (5.7 + S)	11.0 (0.43)	25.0 (0.98)	5/16-18 UNC-2B x 0.33 Dp	M8 x 1.25-6H x 8.4 mm Dp	28.0 (1.10)
EC3	41.1 (1.62)	158.8 + S (6.25 + S)	12.5 (0.49)	30.0 (1.18)	3/8-16 UNC-2B x 0.40 Dp	M10 x 1.50-6H x 10.2 mm Dp	35.0 (1.38)
EC4	52.8 (2.08)	242.6 + S (9.55 + S)	19.1 (0.75)	40.6 (1.60)	5/8-18 UNF-2B x 0.55 Dp	M16 x 2-6H x 14 mm Dp	50.0 (1.97)
EC5	52.8 (2.08)	242.6 + S (9.55 + S)	19.1 (0.75)	40.6 (1.60)	5/8-18 UNF-2B x 0.55 Dp	M16 x 2-6H x 14 mm Dp	50.0 (1.97)

MT4 Trunnion Mounting
Inline

Flange dimensions in accordance with ISO 6431 for:	
Type	Bore Size
EC2	50 mm
EC3	63 mm
EC4	80 mm
EC5	100 mm



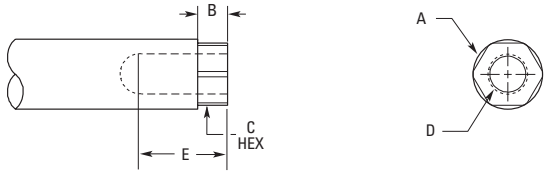
	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F Cyl Length mm (in)	G Retract length mm (in)
EC2	56.9 (2.24)	100.7 (3.96)	155.8 + S (6.13 + S)	34.5 (1.36)	28.5 (1.12)	220.9 + S (8.70 + S)	255.5 + S (10.06 + S)
EC3	69.6 (2.74)	121.3 (4.78)	171.2 + S (6.74 + S)	37.7 (1.48)	34.8 (1.37)	260.5 + S (10.25 + S)	298.1 + S (11.74 + S)
EC4	92.2 (3.63)	169.2 (5.94)	261.6 + S (10.30 + S)	54.0 (2.13)	46.1 (1.81)	371.3 + S (14.62 + S)	425.3 + S (16.74 + S)
EC5	92.2 (3.63)	169.2 (6.66)	261.6 + S (10.30 + S)	54.0 (2.13)	46.1 (1.81)	371.3 + S (14.62 + S)	425.3 + S (16.74 + S)

	H Breather port Hex		I	J	K	L	M	N
	type	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)
EC2	1/8 NPT	11.1 (0.44)	34.8 (1.37)	19.1 (0.75)	15.9/16.0 (0.627/0.629)	28.0 (1.10)	106.9 (4.21)	75.0 (2.95)
EC3	1/8 NPT	11.1 (0.44)	41.1 (1.62)	25.0 (0.98)	19.9/20.0 (0.784/0.786)	35.0 (1.38)	129.6 (5.10)	90.0 (3.54)
EC4	1/4 NPT	14.0 (0.55)	52.8 (2.08)	31.8 (1.60)	24.9/25.0 (0.981/0.983)	50.0 (1.97)	181.6 (1.60)	131.8 (5.19)
EC5	1/4 NPT	14.0 (0.55)	52.8 (2.08)	31.8 (1.25)	24.9/25.0 (0.981/0.983)	50.0 (1.97)	181.6 (7.15)	131.8 (5.19)

EC Series Outline Drawings

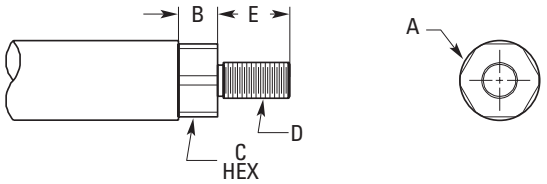
EC Series Rod End Dimensions

FT1 Female Threads Dimensions in [mm]



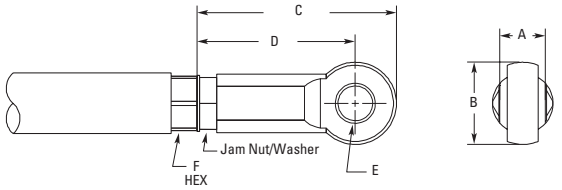
	A mm (in)	B mm (in)	C mm (in)	D FT1M	D FT1 [FT1E]	E mm (in)
EC1	20.8 (0.80)	7.6 (0.30)	19.0 (0.70)	M10 x 1.25 mm	-	17.0 (0.70)
EC2	27.8 (1.09)	12.0 (0.47)	25.4 (1.0)	M16 × 2.0 mm	5/8-18 UNF	19.0 (0.75)
EC3	34.9 (1.375)	17.2 (0.68)	31.8 (1.25)	M16 × 2.0 mm	5/8-18 UNF	25.4 (1.00)
EC4	50.0 (1.97)	20.0 (0.79)	47.6 (1.875)	M20 × 1.5 mm	1-14 UNS	31.0 (1.22)
EC5	50.0 (1.97)	20.0 (0.79)	47.6 (1.875)	M24 × 2.0 mm	1-12 UNF	31.0 (1.22)

MT1 Male Threads Dimensions in [mm]



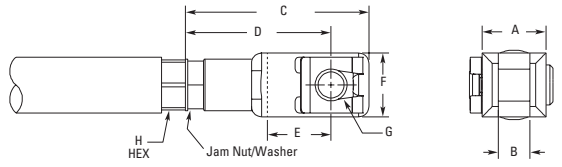
	A mm (in)	B mm (in)	C mm (in)	D MT1M	D MT1 [MT1E]	E mm (in)
EC1	20.8 (0.80)	7.6 (0.30)	19 (0.70)	M10 x 1.25 mm	-	27.0 (1.06)
EC2	27.8 (1.09)	12.0 (0.47)	25.4 (1.00)	M16 × 2.0 mm	5/8-18 UNF	32.0 (1.26)
EC3	34.9 (1.375)	17.2 (0.68)	31.8 (1.25)	M16 × 2.0 mm	5/8-18 UNF	32.0 (1.26)
EC4	50.0 (1.97)	20.0 (0.79)	47.6 (1.875)	M20 × 1.5 mm	3/4-16 UNF	40.0 (1.57)
EC5	50.0 (1.97)	20.0 (0.79)	47.6 (1.875)	M24 × 2.0 mm	1-12 UNF	40.0 (1.57)

FS2 Spherical Joint Dimensions in [mm]



	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F HEX mm (in)
EC1	14.0 (0.55)	26.0 (1.02)	67.5 (2.66)	54.4 (2.14)	9.98/10.1 (0.393/0.396)	17.0 (0.70)
EC2	21.0 (0.83)	38.0 (1.50)	92.2 (3.63)	73.2 (2.88)	16.0/16.1 (0.629/0.633)	25.4 (1.00)
EC3	21.0 (0.83)	38.0 (1.50)	92.2 (3.63)	73.2 (2.88)	16.0/16.1 (0.629/0.633)	31.8 (1.25)
EC4	25.0 (0.98)	46.0 (1.81)	111.0 (4.37)	88.0 (3.46)	20.0/20.1 (0.787/0.790)	47.6 (1.875)
EC5	31.0 (1.22)	60.0 (2.36)	138.5 (5.45)	108.5 (4.27)	24.9/25.0 (0.979/0.984)	47.6 (1.875)

FC2 Clevis with Pin Dimensions in [mm]



	A mm (in)	B mm (in)	C mm (in)	D mm (in)	E mm (in)	F mm (in)	G mm (in)	H HEX mm (in)
EC1	20.0 (0.78)	10 (0.39)	62.9 (2.48)	50.9 (2.00)	32 (1.26)	20 (0.79)	9.88/10.0 (0.389/0.393)	17.0 (0.67)
EC2	32.0 (1.26)	16.0 (0.63)	92.2 (3.63)	73.2 (2.88)	32.0 (1.26)	32.0 (1.26)	15.9/16.0 (0.625/0.630	25.4 (1.00)
EC3	32.0 (1.26)	16.0 (0.63)	92.2 (3.63)	73.2 (2.88)	32.0 (1.26)	32.0 (1.26)	15.9/16.0 (0.625/0.630	31.8 (1.25)
EC4	40.0 (1.57)	20.0 (0.79)	116.0 (4.57)	91.0 (3.58)	40.0 (1.57)	40.0 (1.57)	19.9/20.0 (0.782/0.787	47.6 (1.875)
EC5	50.0 (1.97)	25.0 (0.98)	145.5 (5.73)	113.5 (4.47)	50.0 (1.97)	50.0 (1.97)	24.9/25.0 (0.979/0.984	47.6 (1.875)

Electric Cylinder Options

Brake Option

The BS and motor brake options are typically used with electric cylinders employing ball screw drive assemblies. The electrically released, spring set brake prevents backdriving when the unit is at rest, or in case of a power failure.

When power is applied, the brake releases and the cylinder is free to move. When power is off, springs engage the brake to hold the load in position.

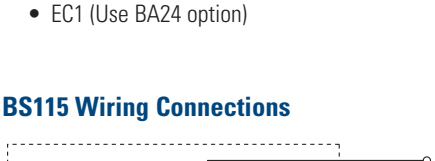
The BS brake is mounted directly to the ballscrew to provide holding torque, without relying on the rest of the drive train.

When using a motor mounted brake the brake torque is multiplied by the belt or gear reduction, and does not interfere with certain rear mounting options. But, if the belt fails, the brake will be inoperative.

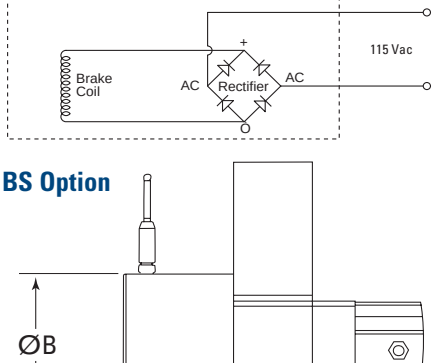
BS is not available with:

- Inline motor orientation
- Rear mounting options: -MP2, -MP3, -MS1, -MF2, -MF3
- EC1 (Use BA24 option)

BS115 Wiring Connections



BS Option



Series	Dim "A" in [mm]	Dim "B" in [mm]
EC2	2.73 (69.3)	3.09 (78.5)
EC3	3.32 (84.3)	3.83 (97.3)
EC4	3.94 (100.0)	5.58 (141.7)
EC5	3.94 (100.0)	5.58 (141.7)

BS Ballscrew Brake Option

Mounting Location: Ballscrew (see dimensions)
Voltage Options: 115 Vac (-BS115), 24 Vdc (-BS24), 24 Vac (-BA24)
Cable Type/Length: EC2/3/4/5 – 3.7 m [12 ft] with quick disconnect
N2 – 3.7 m [12 ft] flying leads (no quick disconnect)
Holding Torque: EC2 – 3.9 N-m [35 lb-in], 12.5 W electrical power
EC3 – 6.7 N-m [60 lb-in], 17 W electrical power
EC4/5 – 39.2 N-m [350 lb-in], 15 W electrical power
N2 – 3.4 N-m [30 lb-in], 13 W electrical power

Screw		With BS Option N [lb]	Without BS Option N [lb]
N2	-2B Ball	1100 [240]	—
	-5B Ball	2670 [600]	—
	-5A Lead (w/ T22)	2670 [600]	445 [100]
	-5A Lead (w/ T31)	2670 [600]	1780 [400]
	-8A Lead	-	2670 [600]
EC2	-16B Ball	1550 [350]	—
	-05B Ball	3600 [810]	—
	-04A Lead	3600 [810]	3600 [810]
EC3	-16B Ball	2660 [600]	—
	-10B Ball	4260 [960]	—
	-05B Ball	7200 [1620]	—
	-04A Lead	7200 [1620]	7200 [1620]
EC4	-25B Ball	9940 [2230]	—
	-10B Ball	12000 [2700]	—
EC5	-32B Ball	7770 [1750]	—
	-10B Ball	24800 [5590]	—

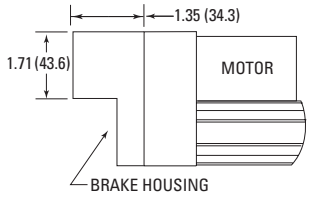
Notes:

- High vibration in a machine may cause an lead screw to backdrive at lower values than indicated above. In such applications, a brake may be necessary.
- The BS and motor brakes should only be used to hold static (already stopped) leads. They are not designed for repeated use as dynamic brakes.
- Quick-disconnect cable provided only on EC models. N2 includes flying leads cable from grommet on brake can.

BA Brake Options:	Motor Brake AKM	BA24 for EC1
Mounting Location:	Rear motor shaft	Inline with motor shaft within gear housing
Voltage Options:	24 Vdc	24 Vdc
Cable Type/Length:	Part of motor cable set	Flying Leads
Holding Torque:	See holding torque table	0.56 Nm (5.0 lb-in)

	Holding Torque Nm (lb-in)
AKM23	1.42 (12.6)
AKM42	5.30 (46.9)
AKM52	14.50 (128)

BA24 Option



Example for BS or BA24 Options

$$\text{Holding Force (N)} = \frac{\text{Brake (Nm)} \times 2\pi \times 1000 \times \text{gear ratio}}{\text{Lead (mm/rev)}}$$

Example: EC3-AKM42G- ■■■-15-16B

$$\text{Holding Force} = \frac{5.3 \times 2\pi \times 1000 \times 1.5}{16} = 3120 \text{ N}$$

Electric Cylinder Options

N2 Dual Rod-End Bearing Option

DB Dual Rod-End Bearing

Our standard N2 Series electric cylinder contains a single rod-end bearing. The dual rod-end bearing (DB) option increases thrust tube side load capacity and reduces undesirable thrust tube runout, while reducing the stroke by 1.5 inches. (All EC Series cylinders are equipped with a dual rod-end bearing automatically, so this option does not apply to them.)

DB available with:

- N2 Series 12 inch stroke and below

DB required with:

- N2 Series above 12 inch stroke

Notes:

- The DB option reduces stroke by 1.5 inches (e.g. 18" with DB yields only 16.5" actual stroke.)

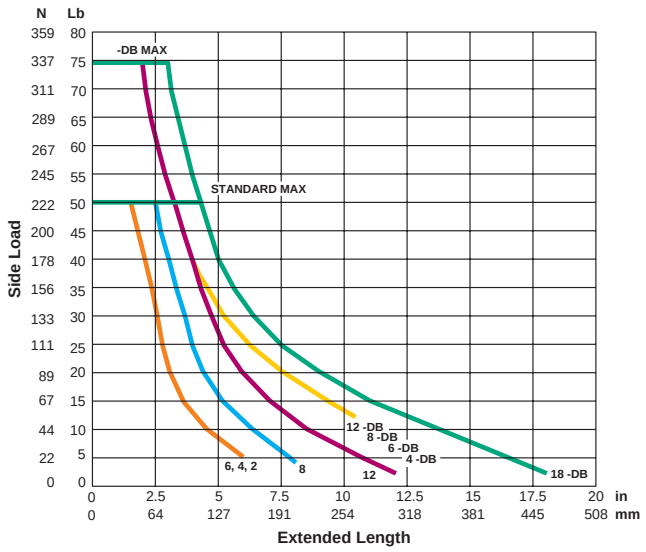
Side Load

All Kollmorgen electric cylinders are designed to withstand a limited amount of side load on the thrust tube. The thrust tube in a standard N2 Series cylinder is supported by a single rod-end bearing and by a patented internal guide assembly. This bearing system has a limited capacity to handle side loads, shown in the curve below.

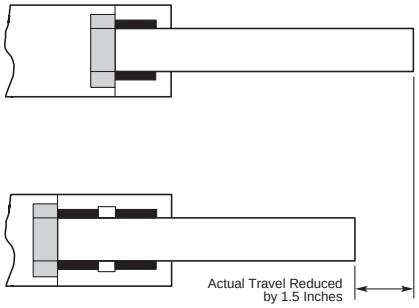
When increased side load capacity or stiffness is required, or when moving a load that is not externally supported, the dual rod-end bearing (DB) option is recommended. This option adds a second thrust tube rod-end bearing for additional support, while subtracting 1.5 inches from the available stroke. N2 models above 12 inches stroke require the DB option.

Another means of increasing side load capacity is to use the higher capacity EC series, which includes the dual rod-end bearing in its standard configuration.

N2 Series — Side Load Capacity vs. Extended Length



Standard N2 Cylinder (Single Bearing)



DB Option (Dual Bearings)

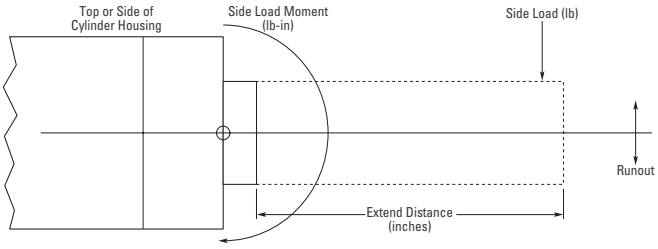
Runout

The -DB option reduces thrust tube runout by lengthening the thrust tube support bearing in the rod-end housing.

Kollmorgen recommends the DB option to reduce runout whenever the thrust tube is the only means of guiding the load. Performance improvement is most observable for cylinders with stroke length above 12 inches, or whenever runout is critical as the thrust tube approaches full extension.

For the least amount of runout possible for a standard product, specify the DB option and also increase the stroke of the cylinder while "short-stroking" the unit.

If the load is guided externally by linear bearings, the standard bearing is preferred since it allows greater mounting misalignment and minimal friction.



Selection Criteria

DB Option	Standard
When using clevis or trunnion mount	When rigidly mounted
>12 in	<12 in
Unguided thrust tube	Guided thrust tube (externally)
High side load	
Low runout critical	

Linear Potentiometer Option

L Linear Potentiometer Option

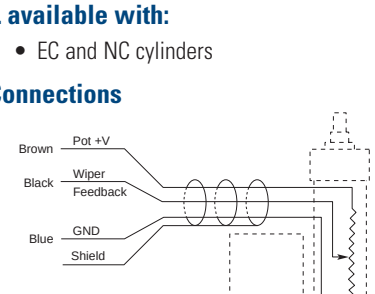
The L linear potentiometer option is required for operation with our Analog Position Controls, and is used in applications where analog position feedback voltage signal is needed.

The linear potentiometer resides within the cylinder housing and is energized by an external DC voltage source. The potentiometer wiper arm is attached to the drive nut/guide flange assembly, and moves the same distance as the thrust tube. The signal from the linear potentiometer is an absolute voltage, proportional to linear displacement of the cylinder.

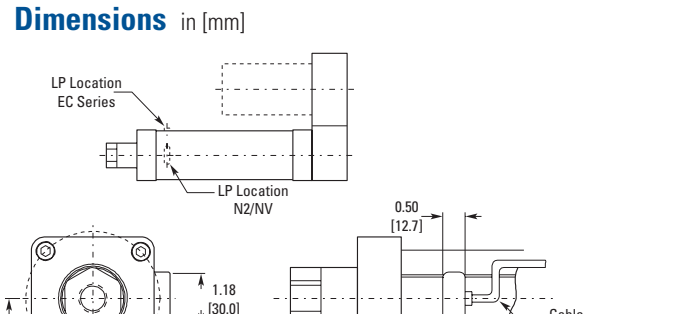
L available with:

- EC and NC cylinders

Connections



Dimensions in [mm]



Cylinder Model	Dim. A [in (mm)]	Dim. B [in (mm)]
N2	1.38 (35.1)	1.01 (25.7)
EC2	1.47 (37.3)	1.12 (28.5)
EC3	1.72 (43.7)	1.37 (34.8)
EC4	2.15 (54.5)	1.82 (46.1)
EC5	2.15 (54.5)	1.82 (46.1)

* Linear pot option not available for EC1

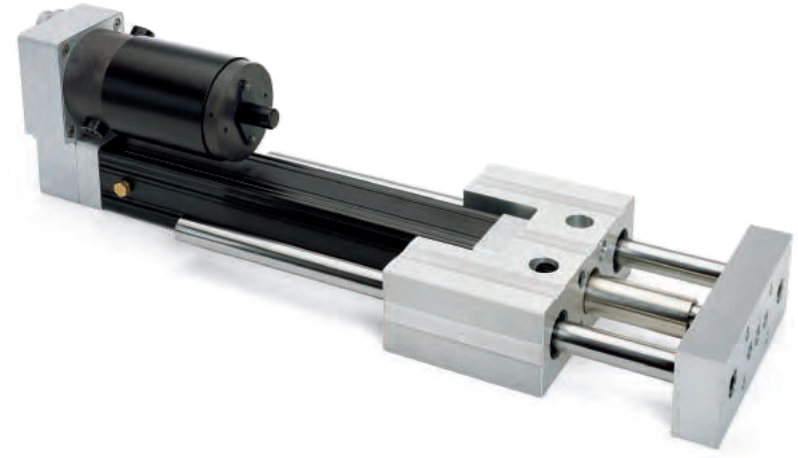
Specifications

Operating Temperature: -28° to +70°C [-20° to +160°F]
Power Rating: 1.0 Watt max. (11 mA at 24 V; 6 mA at 12 V; 3 mA at 5 V)
Resistance: see table below
Linearity: see table below
Stroke: Available in the lengths shown below. Consult factory for lengths.

Cylinder Model	Stroke [in (mm)]	Resistance (± 30%)	Linearity
N2	2.00 (50.8)	3000	±1% of full stroke
	4.00 (102)	6000	
	6.00 (152)	9000	
	8.00 (203)	9000	
	10.0 (254)	9000	
	12.0 (305)	7000	
	16.5 (419)	7000	
EC2, EC3, EC4, EC5	1.97 (50)	3000	±1% of full stroke
	3.94 (100)	6000	
	5.91 (150)	9000	
	7.87 (200)	9000	
	9.84 (250)	9000	
	11.8 (300)	7000	
	17.7 (450)	7000	
	23.6 (600)	7000	

Electric Cylinder Options

Linear Rod Bearing Option



LR Linear Rod Bearing Option

The LR linear rod bearing option is used in applications where side loads are present, or when the load is not externally supported.

Reasons for using the LR Linear Rod Bearing are:

- Increased side load capacity
- Anti-rotation–reduces any rotational motion of the moving load
- Higher positioning efficiency when side loads are present
- Lower thrust tube runout

LR available with:

- EC2

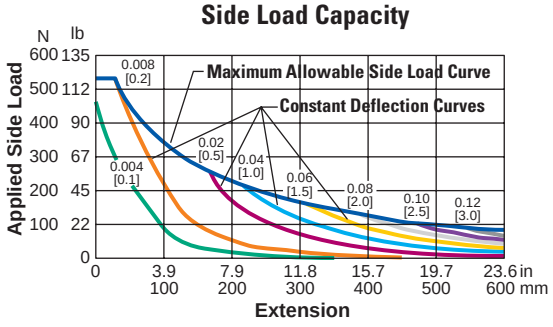
LR not available with:

- MF1, MF3, MS1, MS2 mounting options

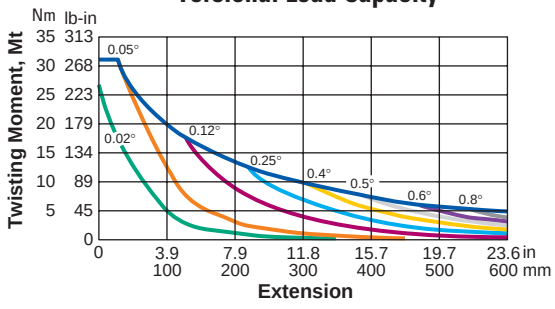
Weight calculation:

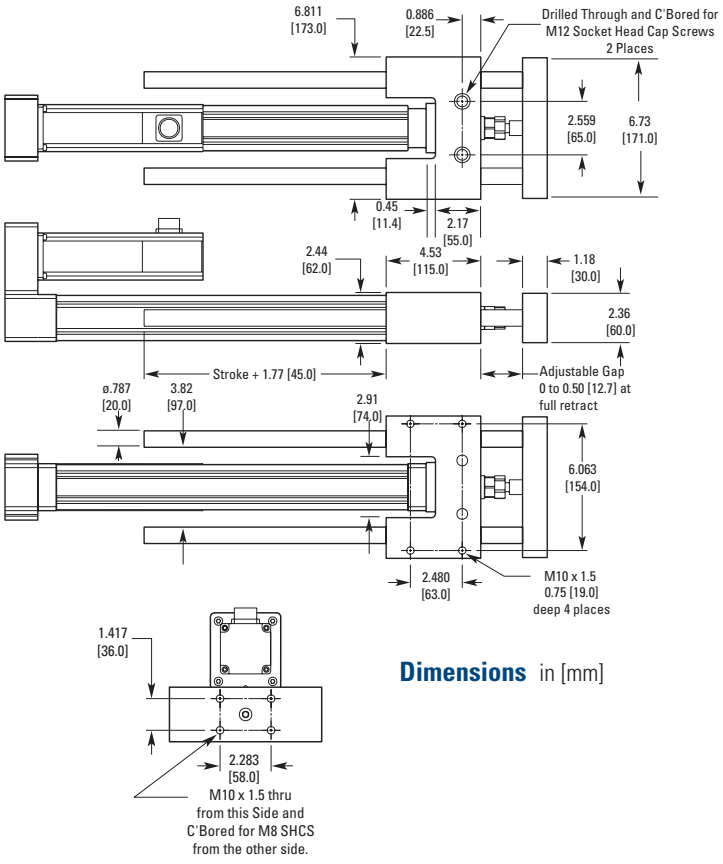
Weight (lb_f) = 0.0147 stroke (mm) + 7.6 lb_f

Side Load Capacity



Torsional Load Capacity





Dimensions in [mm]

To order the Linear Rod Bearing as a separate component:
Linear Rod Bearing Part Number

Example: LR-EC2-0200-A

LR	–	EC2	–	0200	—	A
LR		EC2		Stroke in mm		Revision

Protective Boot Option

PB Protective Boot Option

With the PB option, a durable polyurethane boot protects the thrust tube area from solid contaminants (dust, wood and metal shavings), and splashed liquids, etc.

EC Series cylinders equipped with the PB are protected to the IP65 standard. Note that some Kollmorgen motor options are not protected to this level.

Consult the factory for assistance when special environmental protection is required.

We also have special options for clean room applications, where outgassing and contamination by the cylinder are a concern.

PB available with:

- All EC and N2 Electric Cylinders

Dimensions in [mm]

When fully retracted, the boot gathers on an extra length of thrust tube. The extra thrust tube length is tabulated here.

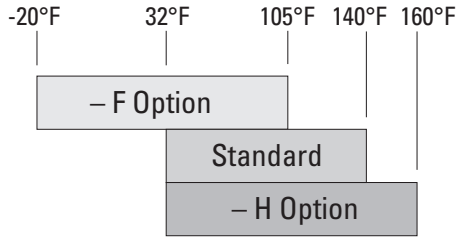
Cylinder Model		Dimensions	
Series	Stroke Length	Dim. L Add'l Length in [mm]	Boot Diameter in [mm]
EC2	0-149 mm	1.16 [29.5]	2.50 [63.5]
	150-299	1.83 [46.5]	
	300-449	2.54 [64.5]	
	450-600	3.21 [81.5]	
	601-750	3.75 [95.3]	
EC3	0-199 mm	1.46 [37.1]	3.00 [76.2]
	200-399	2.13 [54.0]	
	400-599	2.83 [71.9]	
	600-800	3.54 [89.9]	
	801-1000	4.06 [103.1]	
EC4	0-249 mm	1.60 [40.6]	3.75 [95.3]
	250-499	2.47 [62.7]	
	500-749	3.35 [85.1]	
	750-999	4.17 [105.9]	
	1000-1249	5.05 [128.3]	
	1250-1500	5.93 [150.6]	
EC5	0-249 mm	1.60 [40.6]	3.75 [95.3]
	250-499	2.47 [62.7]	
	500-749	3.35 [85.1]	
	750-999	4.17 [105.9]	
	1000-1249	5.05 [128.3]	
	1250-1500	5.93 [150.6]	
N2	0-2.57 in	0.75 [19.1]	2.50 [63.5]
	2.58-5.08	1.00 [25.4]	
	5.09-7.59	1.30 [33.0]	
	7.60-10.11	1.40 [35.6]	
	10.12-15.19	1.90 [48.3]	
	15.20-16.50	2.80 [71.1]	

Electric Cylinder Options

N2 Environmental Options

Temperature Ranges (N2 Series)

	Operating	Storage
Standard N2	32° to 140°	-40° to 185°
[F (C)]	(0° to 60°)	(-40° to 85°)
F Freezing	-20° to 105°	-40° to 185°
[F (C)]	(-29° to 41°)	(-40° to 85°)
H High Temp	32° to 160°	-40° to 185°
[F (C)]	(0° to 70°)	(-40° to 85°)



Note: F and H can not be ordered on the same cylinder.

H High Temperature

The H high temperature option allows operation in high temperature environments (to 160°F [70°C]) by changing certain plastic parts within the cylinder to bronze.

H available with:

- All N2 Series

Notes:

- Consideration must be given to the operating temperature ranges of the motor, encoder, and limit switches.

F Sub-Freezing Environment Option

In extremely cold conditions the lubricating grease in the positioner thickens, rubber parts (belts and stops) stiffen, and mechanical clearances tighten. This option includes two alterations:

1. Bearing grease is replaced with a less viscous lubricant.
2. Lead nut tolerances are increased. Both thread clearance and pitch length are increased to allow for the varying coefficients of expansion between the steel leadscrew and polyacetal or bronze drive nut.

The result is a device which can operate at these low temperatures, but with reduced life (due to the pre-worn lead nut surfaces).

Contact Kollmorgen for more details. No change is necessary in ball nut models since there is steel to steel contact (same coefficient of thermal expansion).

F Sub-Freezing Environment Option available with :

- All N2 Series

Notes:

- This option increases system backlash to 0.025 inches (0.64 mm) max. for lead screw units.
- Should a -F sub-freezing option lead screw unit be operated at room temperature or above, noisy operation and increased backlash are normal.

W Water Resistant Option

The water resistant option (W) is recommended in applications where the cylinder is exposed to light mist or occasional splashing with water or non-corrosive liquids. In addition to a sealant on all mating surfaces, a 10 foot (3 m) breather tube and fitting is provided to allow the unit to breathe from a non-contaminated dry area. Or, the customer may choose to apply positive, low pressure (2-3 psi [14-20 kPa]) dry air to the cylinder through this fitting.

W available with:

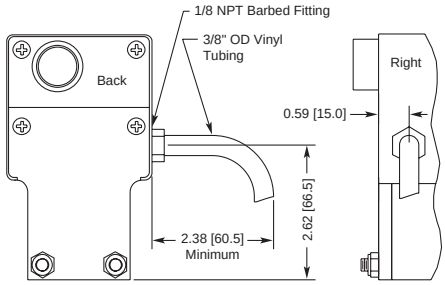
- All N2 Series

Notes:

- The -W option does not provide a waterproof cylinder. The cylinder cannot be submerged or immersed repeatedly in water.

W Breather Dimensions

N2 Series Cylinders



Electric Cylinder Accessories

Accessories

Magnetic Position Sensors

Kollmorgen Electric Cylinders are equipped with position indicating magnets installed internally on both sides of the guide cylinder. Non-contacting position sensors are available to sense the magnet as it passes by.

Position sensors mount directly to standard EC and N2 Series cylinders. NPN or PNP sensors are available in normally open or normally closed switch configurations. These sensors use a Hall-effect element and simple solid state electrical circuit. See page 114 for product specifications.

End-of-Travel Limits

To maximize cylinder life, Kollmorgen recommends the use of end-of-travel "limit switches" (position sensors) with all cylinders.

The purpose of an end-of-travel sensor is to signal the controller that the cylinder is about to travel beyond its normal safe operating region, and is nearing its physical end of stroke. The controller brings the cylinder to a stop to prevent physical contact, and to avoid damage to the cylinder, the load, or the machine. The sensors must be located such that an adequate stopping distance is provided between the sensing position and the physical end of stroke. Normally closed switches are generally used for end-of-travel sensing. Normally closed switches are considered "fail safe" because when a cable becomes accidentally severed or disconnected, motion is prevented.

Position Sensing

Programmable position controls use position sensors for two purposes. A normally open switch is generally used to establish a home, or zero reference position. Normally closed switches are used for extend and retract end-of-travel limits.

Electric Cylinder Accessories

Position Sensors

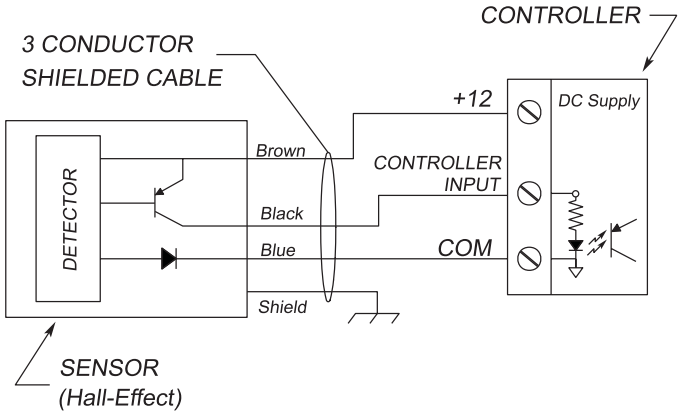
Position Sensor Specifications

		EC1		N2 and EC2 - EC5	
		EC1-18P-03	EC1-18P-NC-03	PSP-1	PSP-2
Connection	Connection	Norm. open	Norm. closed	Norm. open	Norm. closed
	Led Color	Red		Yellow	Red
	Switch Type	Hall-effect			
	Output Type	Sourcing (PNP)			
	Number of Leads	3 + Shield			
Supply	Voltage	4.5 to 28 Vdc		10–24 Vdc	
	Current	10 mA @ 24 Vdc		7 mA @ 12 Vdc; 13 mA @ 24 Vdc	
	Power	0.28 W		0.24 W	
Output	DC Voltage max	28 Vdc		24 Vdc	
	AC Voltage max	AC not allowed			
	Current max	100 mA			
	Power max	3 W			
Temperature	Operating Temperature	14° to 158°F [-10° to 70°C]		-4° to 158°F [-20° to 70°C]	
	Storage Temperature	14° to 158°F [-10° to 70°C]		-4° to 176°F [-20° to 80°C]	
	Protection Rating	IP67			
	CE Approved	Yes			

Hall-Effect Switches

- Higher tolerance to vibration
- Greater durability and reliability (no moving parts)
- Requires external DC power. Available on Kollmorgen controls.

Wiring for EC1-18P-03, EC1-18P-NC-03, PSP-1 and PSP-2



Notes:
1. Normally closed PNP sensors are recommended to provide fail-safe operation
2. NPN Hall effect sensors are also compatible with Kollmorgen drive however require a pull-up resistor.

Position Sensors

Position Sensor Mounting

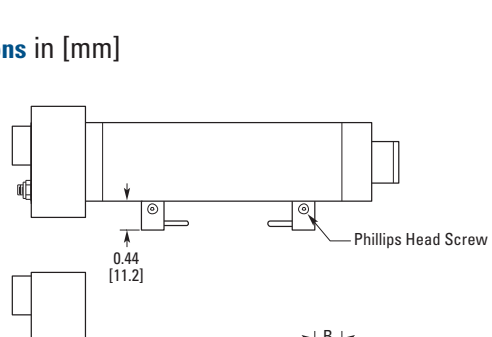
The diagrams below show sensor mounting location when cylinder magnet and sensor are physically aligned.

This location is recommended as a starting point when setting up a cylinder for the first time. Depending on the speed and payload of the application, switches may need to be moved inward to prevent hard-stop crash when the load travels at full speed past a limit switch.

Notes:

- Position sensors can be mounted along either side of a cylinder.
- Recommended minimum distance between switches is 0.65 inches.
- Using position sensors for end-of-travel protection reduces effective travel distance. Consult factory for details.

Dimensions in [mm]



Note: Dimensions "A" and "B" are Approximate End of Stroke Locations for the Position Sensors.

Model	Dim "A" in [mm]	Dim "B" in [mm]
N2 Lead	1.00 (25.4)	0.70 (17.8)
N2 Ball	1.40 (35.6)	0.30 (7.6)

Ordering Information

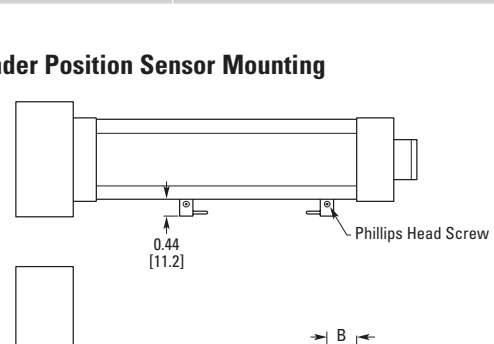
Position Sensors and Quick Disconnect Cables

See page 162 for information on all position sensor options for EC1.
See page 163 for information all position sensor options for N2/EC2-EC5 products.

Spare Quick Disconnect Cables

Model Number	Description
QPS-4M	13 ft [4 m] extension cable
QPS-9M	30 ft [9 m] extension cable

EC Cylinder Position Sensor Mounting



Note: Dimensions "A" and "B" are Approximate End of Stroke Locations for the Position Sensors.

Model	Dim "A" in [mm]	Dim "B" in [mm]
EC1	0.748 (19.0)	0.551 (14.0)
EC2	2.90 (73.7)	1.90 (48.3)
EC3	3.03 (77.0)	2.23 (56.6)
EC4	5.39 (137.0)	2.48 (63.0)
EC5	5.39 (137.0)	2.48 (63.0)

AKM® Servo Motor

Kollmorgen's AKM family of servo motors gives you unprecedented choice and flexibility from a wide range of standard products so you can select the best servo motor for your application. By pairing AKM servo motors with our family of plug-and-play AKD® servo drives, selecting the right motion control products has never been easier. Pick from thousands of servo motor/servo drive combinations outlined in this selection guide or go to our website to find the best solution for your application.

Standard AKM servo motors and AKD servo drives offer the best of both worlds – the exact specifications of a custom solution with the faster delivery times and lower cost of a standard catalog product. For your truly unique motion control applications, work with our engineering team to customize a solution for your machine design. Either way, standard product or customized, we can help you choose the motion control solution that meets your exact requirements.

The Benefits of AKM® Servo Motor

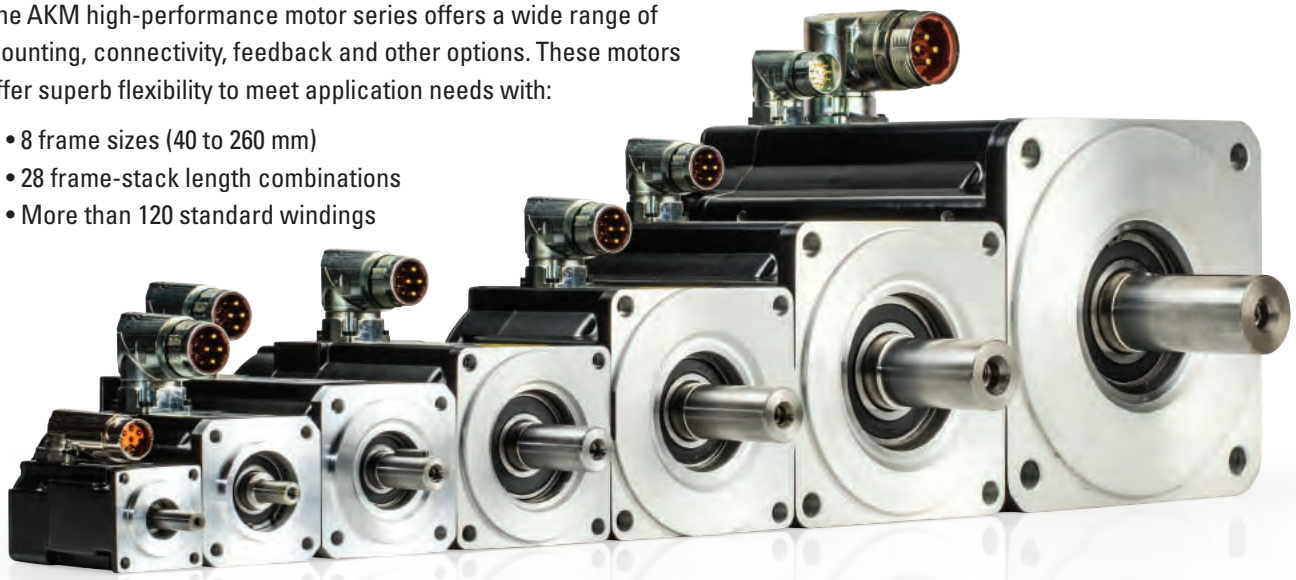
• Best-in-Class Performance	• Industry-leading motor power density • Same size AKM/AKD system delivers up to 47% more shaft power • Compensation for stiff and compliant transmissions and couplings • Exceptionally low cogging
• Flexibility to Find an Exact-fit Solution in a Standard Product	• AKM offers 28 frame-stack combinations and 120 standard windings in a single motor line • 4.8 million possible AKM part number combinations and growing • Simplifies or eliminates mechanical modifications and engineering adaptation • Available with single cable technology with digital feedback (Digital Resolver SFD3 or HIPERFACE® DSL) • Washdown and Food Grade options for AKM • Higher torque models up to 180 Nm of continuous torque
• Ease-of-Use and Faster Commissioning	• Plug-and-play motor recognition drive commissioning • Reduce cycle time and sensor-and-wiring costs by eliminating traditional homing methods • Reduction in set-up time for each servo system

AKM® Servo Motor Series

AKM Motors Offer Extremely High Torque Density and High Acceleration

The AKM high-performance motor series offers a wide range of mounting, connectivity, feedback and other options. These motors offer superb flexibility to meet application needs with:

- 8 frame sizes (40 to 260 mm)
- 28 frame-stack length combinations
- More than 120 standard windings



Features

Torque
0.16 to 180 Nm continuous stall torque (1.4 to 1590 lb-in) in 28 frame/stack combinations. Specific torques are often available from multiple frame sizes to optimize mounting and inertia matching capabilities.

Speed
Speeds up to 8000 rpm meet high speed application requirements. Windings tailored to lower speeds are also available.

Voltage
AKM motors can be applied to all standard global voltages. Windings are specifically tailored to work with drives powered by 75 Vdc, 120, 240, 400 or 480 Vac.

Mounting
Multiple mounting standards are available to meet common European, North American, and Japanese standards.

Feedback
AKM motors include resolver, encoder (commutating), Sine-Absolute encoder or SFD (Smart Feedback Device) feedback options to meet specific application requirements.

Smoothness
Smooth performance results from low-cog, low-harmonic distortion magnetic designs.

Connectivity
Rotatable IP65 connectors, straight IP67 connectors or low cost IP20 Molex plugs are both available to provide flexibility. Single connectors/plugs (combined power and feedback) are also available to minimize motor and cable cost (SFD and DSL only).

Thermal
Windings are rated conservatively at 100°C rise over a 40°C ambient while using 155°C (class F) insulation materials. Motors meet applicable UL, CSA, and CE requirements and include thermistors.

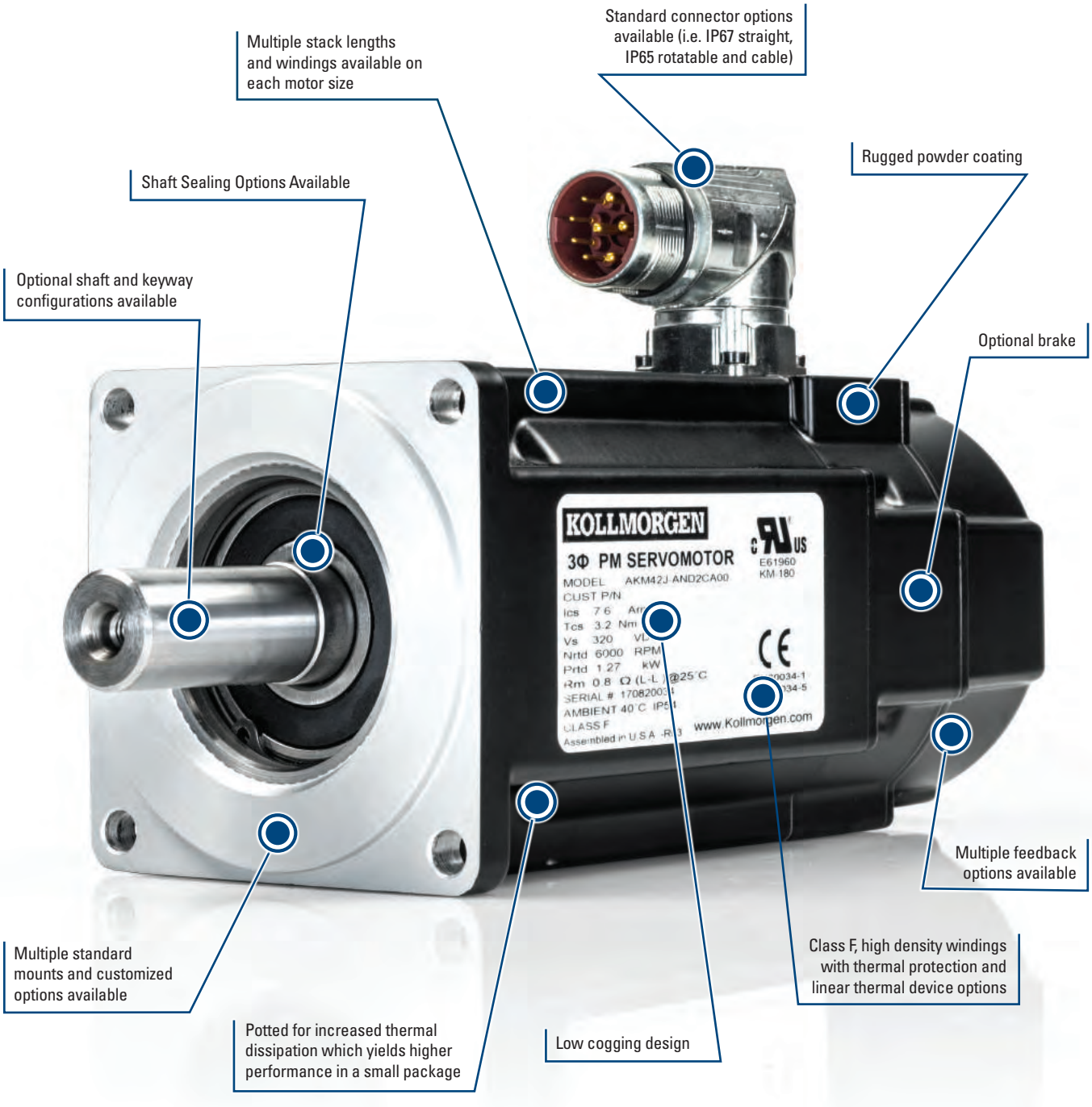
Additional Options:

- Holding Brakes
- Shaft sealing options available
- Feedback devices
- Shaft and mounting variations
- Custom windings
- Connectivity

Kollmorgen Cables Offer the Complete Solution

Kollmorgen offers complete cable solutions for connecting drives and motors. This includes static, low cost cable sets for simple applications to high bend, high flex, hybrid cables that combine feedback and power in one cable. Not sure which cable offering would best suit your needs? No problem. Kollmorgen Customer Support is available to discuss cable options and what makes the most sense for your machine.

Kollmorgen AKM Configurable Servo Motor Features



EN60034-1
EN60034-5
E61960
E103510
PS155-1
KM-180

AKM® Brushless Servo System Specifications

AKM11, 13, and 23 Servo Motor Performance with AKD Servo Drive

AKM Servo Motor	AKM11B 120/240 Vac	AKM13C 120/240 Vac	AKM23D 120/240 Vac
Servo Drive	**AKD**	**AKD**	**AKD**
Drive [Ic/Ip] Arms	3.0 / 9.0	3.0 / 9.0	3.0 / 9.0
Feedback Type	SFD	SFD	SFD
T Cont Stall [lb-in (Nm)]	1.62 (0.183)	3.62 (0.409)	10.3 (1.16)
T Peak Stall [lb-in (Nm)]	6.26 (0.707)	15.3 (1.73)	34.0 (3.84)
RPM Max 240 Vac	8000	8000	6540
Drive	AKD-x00306	AKD-x00306	AKD-00306
Motor	AKM11B-CNC	AKM13C-CNC	AKM23D-BNC
Motor/Brake	–	–	AKM23D-B2C
Value Line Cables*			
Power	VP-507BEAN-xx-x	VP-507BEAN-xx-x	VP-507BEAN-xx-x
Power/Brake	VF-DA0474N-xx-x	VF-DA0474N-xx-x	VP-508CFAN-xx-x
SFD Feedback	VF-RA2474N-xx-x	VF-RA2474N-xx-x	VF-DA0474N-xx-x
Resolver Feedback	–	–	VF-RA2474N-xx-x
Sine Encoder Feedback	–	–	VF-SB4474N-xx-x

*Value Line Cables are not suitable for flexing applications. For flexing applications request information about Performance Line Cables. Cable part number suffix xx-x indicates cable length in meters. Example: suffix 03-0 equals 3.0 meters. Available lengths include 1.0, 3.0, 6.0, 9.0, or 12.0 meters.

AKM11, 13, and 23 Mechanical Specifications

	AKM11	AKM13	AKM23
Motor Inertia [lb-in-s^2 (kg-cm^2)] (based on SFD)	1.5E-5 (0.0169)	4.0E-5 (0.045)	0.00019 (0.22)
Brake Inertia [lb-in-s^2 (kg-cm^2)] (additional)	–	–	0.000011 (0.012)
Motor Weight [lb (kg)]	0.77 (0.35)	1.4 (0.63)	3.0 (1.38)

AKM1X

AKM23

AKM42 and 52 Servo Motor Performance with AKD Servo Drive

AKM Servo Motor	AKM42G 120/240 Vac	AKM52H 120/240 Vac	AKM52H 400/800 Vac
Servo Drive	**AKD**	**AKD**	**AKD**
Drive [Ic/Ip] Arms	6.0 / 18.0	6.0 / 18.0	6.0 / 18.0
Feedback Type	SFD	SFD	SFD
T Cont Stall [lb-in (Nm)]	31.2 (3.53)	75.0 (8.48)	75.0 (8.48)
T Peak Stall [lb-in (Nm)]	97.0 (11.0)	191 (21.6)	191 (21.6)
RPM Max 240 Vac	4460	2390	4780
Drive	AKD-x00606	AKD-x00606	AKD-x00607
Motor	AKM42G-BNC	AKM52H-BNC	AKM52H-BNC
Motor/Brake	AKM42G-B2C	AKM52H-B2C	AKM52H-B2C
Value Line Cables*			
Power	VP-507BEAN-xx-x	VP-507BEAN-xx-x	VP-507BEAN-XX-X
Power/Brake	VP-508CFAN-xx-x	VP-508CFAN-xx-x	VP-508CFAN-XX-X
SFD Feedback	VF-DA0474N-xx-x	VF-DA0474N-xx-x	VF-DA0474N-XX-X
Resolver Feedback	VF-RA2474N-xx-x	VF-RA2474N-xx-x	VF-RA2474N-XX-X
Sine Encoder Feedback	VF-SB4474N-xx-x	VF-SB4474N-xx-x	VF-SB4474N-XX-X

*Value Line Cables are not suitable for flexing applications. For flexing applications request information about Performance Line Cables. Cable part number suffix xx-x indicates cable length in meters. Example: suffix 03-0 equals 3.0 meters. Available lengths include 1.0, 3.0, 6.0, 9.0, or 12.0 meters.

AKM42 and 52 Mechanical Specifications

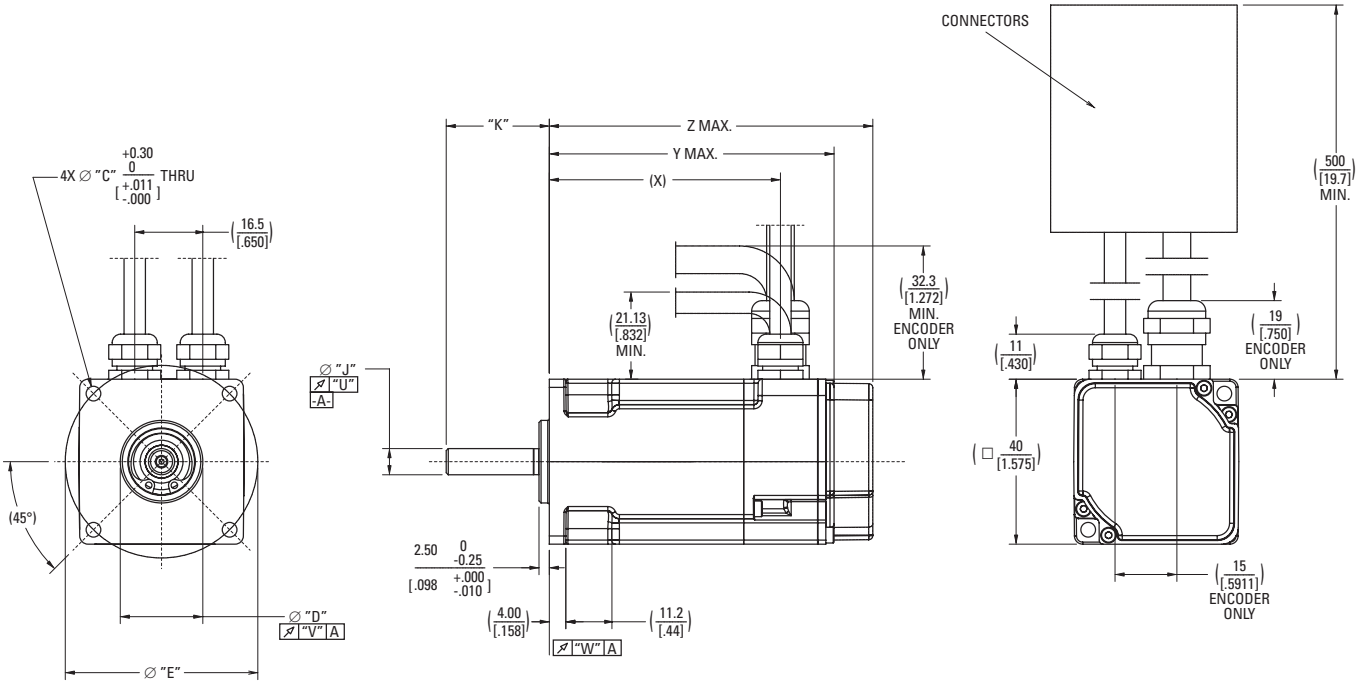
	AKM42	AKM52
Motor Inertia [lb-in-s^2 (kg-cm^2)] (based on SFD)	0.0013 (1.5)	0.0055 (6.2)
Brake Inertia [lb-in-s^2 (kg-cm^2)] (additional)	0.00006 (0.068)	0.00015 (0.17)
Motor Weight [lb (kg)]	7.5 (3.39)	12.8 (5.8)

AKM42

AKM52

AKM® Brushless Servo System Specifications

AKM1x Frame Outline Drawings



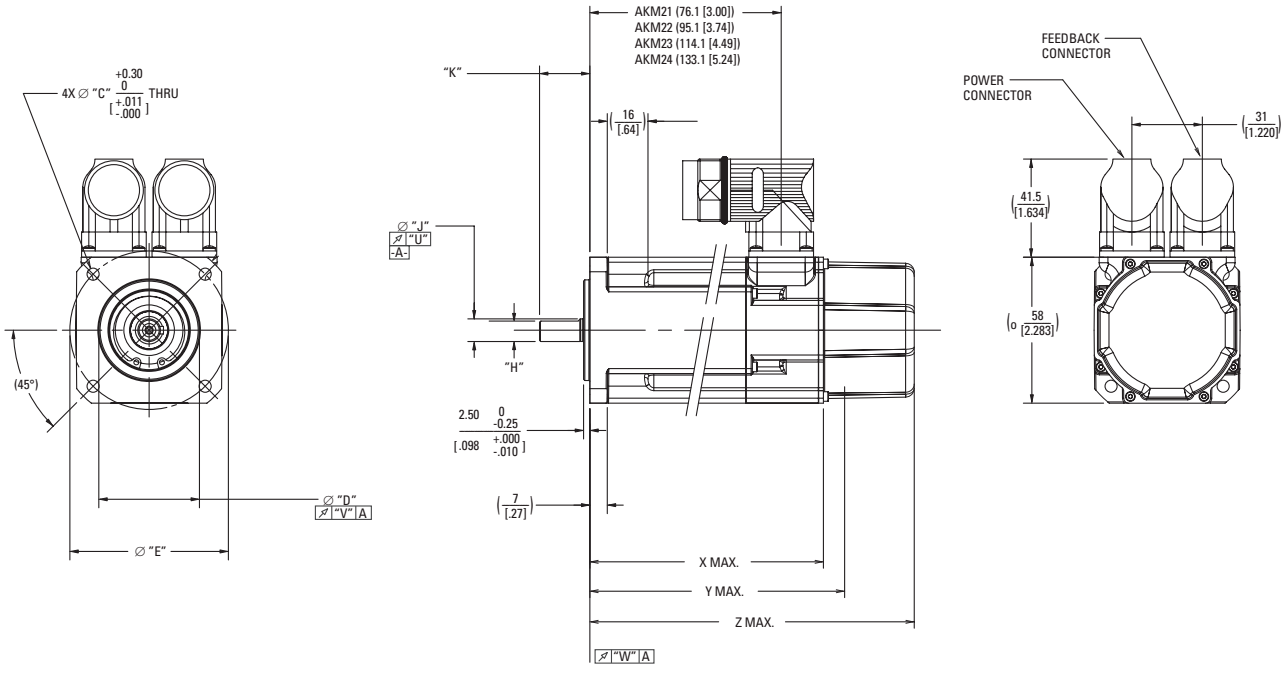
AKM1x Frame Dimensions

Mounting Flange-Shaft	"C"	"D"	"E"	"F"	"H"	"J"	"K"	"L"	"M"	"N"
AN	4.30 [0.169]	30 [1.811]	46.0 [1.811]	–	–	8.0 [0.3150]	25.0 [0.984]	–	–	–

(X)	Y MAX	Z MAX (W/ BRAKE)	MODEL
56.1 [2.21]	69.6 [2.74]	79.0 [3.11]	AKM11
94.1 [3.70]	107.6 [4.24]	117.0 [4.61]	AKM13

Dimensions are in mm [inches].
Product designed in metric.
English conversions provided for reference only.

AKM2x Frame Outline Drawings



AKM2x Frame Dimensions

Mounting Flange-Shaft	"C"	"D"	"E"	"H"	"J"	"K"	"U"	"V"	"W"
EF	5.10 [0.201]	38.10 [1.500]	66.68 [2.625]	8.64 [0.340]	9.525 [0.3750]	20.57 [0.810]	0.051 [0.0020]	0.10 [0.004]	0.10 [0.004]

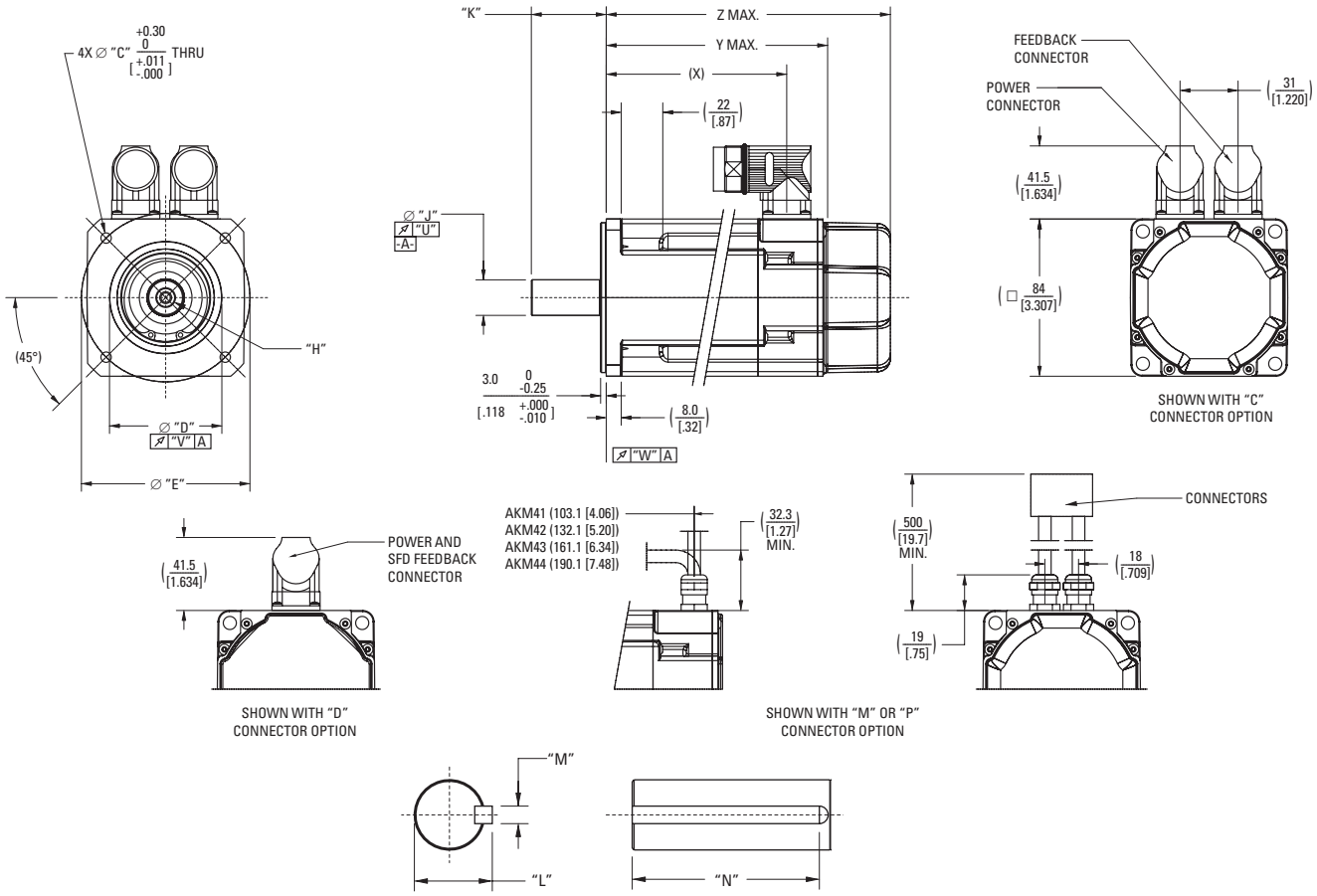
(X MAX) ("C" Connector Option W/ Resolver)	Y MAX	Z MAX (W/ BRAKE)	MODEL
86.2 [3.39]	95.4 [3.76]	129.5 [5.10]	AKM21
105.2 [4.14]	114.4 [4.50]	148.5 [5.85]	AKM22
124.2 [4.89]	133.4 [5.25]	167.5 [6.59]	AKM23
143.2 [5.64]	152.4 [6.00]	186.5 [7.34]	AKM24

Dimensions are in mm [inches].
Product designed in metric.
English conversions provided for reference only.

*Complete AKM series model nomenclature can be found on page 165.

AKM® Brushless Servo System Specifications

AKM4x Frame Outline Drawings



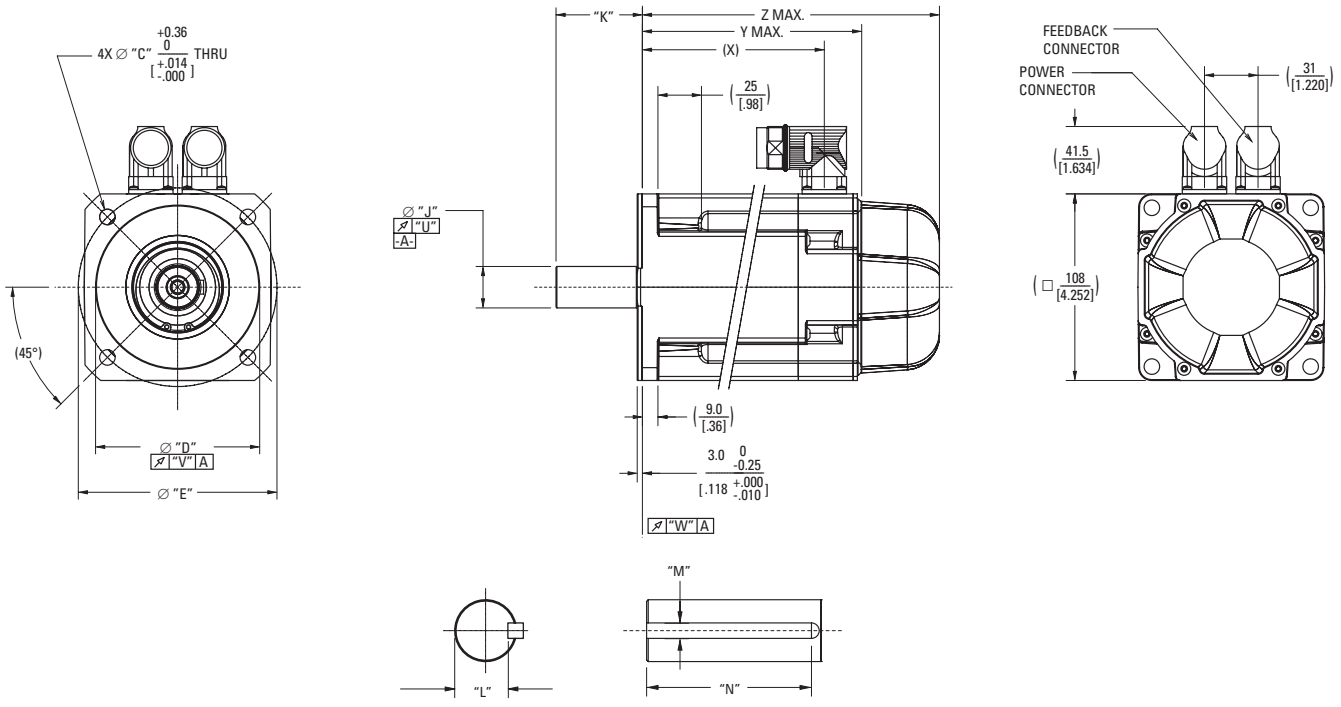
AKM4x Frame Dimensions

Mounting Flange-Shaft	"C"	"D"	"E"	"H"	"J"	"K"	"L"	"M"	"N"	"U"	"V"	"W"
EK	5.54 [0.218]	73.025 [2.8750]	98.43 [3.875]	–	12.700 [0.5000]	31.75 [1.250]	14.09 [0.555]	3.175 [0.1250]	19.05 [0.750]	0.051 [0.0020]	0.10 [0.004]	0.10 [0.004]

(X)	Y MAX	Z MAX (W/ BRAKE)	MODEL
96.4 [3.80]	118.8 [4.68]	152.3 [6.00]	AKM41
125.4 [4.94]	147.8 [5.82]	181.3 [7.14]	AKM42
154.4 [6.08]	176.8 [6.96]	210.3 [8.28]	AKM43
183.4 [7.22]	205.8 [8.10]	239.3 [9.42]	AKM44

Dimensions are in mm [inches].
Product designed in metric.
English conversions provided for reference only.

AKM5x Frame Outline Drawings



AKM5x Frame Dimensions

Mounting Flange-Shaft	"C"	"D"	"E"	"J"	"K"	"L"	"M"	"N"	"U"	"V"	"W"
EK	8.33 [0.328]	55.563 [2.1874]	125.73 [4.950]	15.875 [0.625]	44.45 [1.75]	13.16 [0.518]	4.737 [0.1865]	34.9 [1.375]	0.051 [0.0020]	0.10 [0.004]	0.10 [0.004]

Z MAX SINE ENCODER (NO BRAKE)	Z MAX SINE ENCODER (W/ BRAKE)	(X)	Y MAX	Z MAX (W/ BRAKE)	MODEL
146.0 [5.75]	189.0 [7.44]	105.3 [4.15]	127.5 [5.02]	172.5 [6.79]	AKM51
177.0 [6.97]	220.0 [8.66]	136.3 [5.37]	158.5 [6.24]	203.5 [8.01]	AKM52

Dimensions are in mm [inches].
Product designed in metric.
English conversions provided for reference only.

*Complete AKM series model nomenclature can be found on page 165.

AKD® Servo Drive

Our AKD series is a complete range of Ethernet-based servo drives that are fast, feature-rich, flexible and integrate quickly and easily into any application. AKD ensures plug-and-play commissioning for instant, seamless access to everything in your machine. And, no matter what your application demands, AKD offers industry-leading servo performance, communication options, and power levels, all in a smaller footprint.

This robust, technologically advanced family of drives delivers optimized performance when paired with our best-in-class components, producing higher quality results at greater speeds and more uptime. With Kollmorgen servo components, we can help you increase your machine's overall equipment effectiveness (OEE) by 50%.

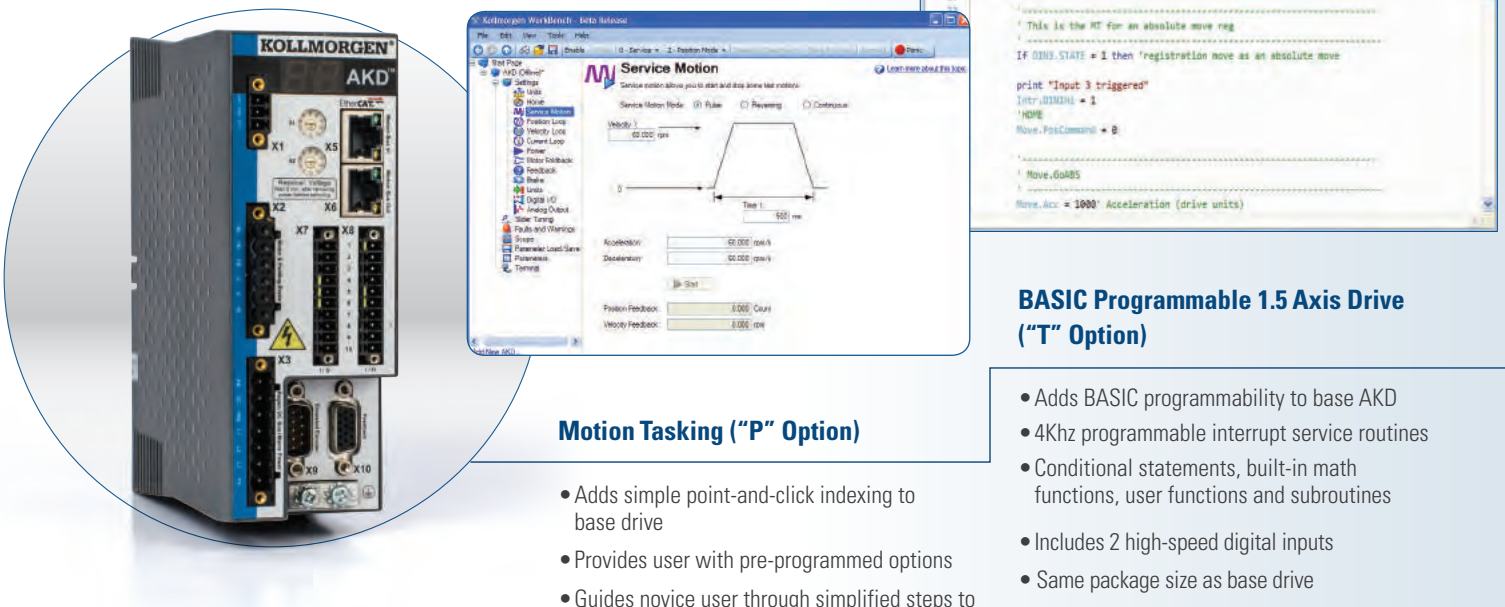
The Benefits of AKD Servo Drive

• Optimized Performance in Seconds	• Auto-tuning is one of the best and fastest in the industry • Automatically adjusts all gains, including observers • Immediate and adaptive response to dynamic loads • Precise control of all motor types • Compensation for stiff and compliant transmission and couplings
• Greater Throughput and Accuracy	• Up to 27-bit-resolution feedback yields unmatched precision and excellent repeatability • Very fast settling times result from a powerful dual processor system that executes industry-leading and patent pending servo algorithms with high resolution • Advanced servo techniques such as high-order observer and bi-quad filters yield industry-leading machine performance • Highest bandwidth torque-and-velocity loops. Fastest digital current loop in the market
• Easy-to-use Graphical User Interface (GUI) for Faster Commissioning and Troubleshooting	• Six-channel real-time software oscilloscope commissions and diagnoses quickly • Multi-function Bode Plot allows users to quickly evaluate performance • Auto-complete of programmable commands saves looking up parameter names • One-click capture and sharing of program plots and parameter settings allow you to send machine performance data instantly • Widest range of programming options in the industry
• Flexible and Scalable to Meet any Application	• 3 to 48 Arms continuous current; 9 to 96 Arms peak • Very high power density enables an extremely small package • True plug-and-play with all standard Kollmorgen servo motors and actuators • Supports a variety of single and multi-turn feedback devices—Smart Feedback Device (SFD), EnDat2.2, 01, BiSS, analog Sine/Cos encoder, incremental encoder, HIPERFACE®, and resolver • Tightly integrated Ethernet motion buses without the need to add large hardware: EtherCAT®, SynqNet®, Modbus® TCP, EtherNet/IP™, PROFINET® RT, SERCOS® III, and CANopen® • Scalable programmability from base torque-and-velocity through multi-axis master

Scalable Programmability

Kollmorgen delivers cutting-edge technology and performance with the AKD® servo drive and KAS controls platform. Whether your application requires a single axis or over 100 fully synchronized axes, Kollmorgen's intuitive software and tools scale to meet your needs. From simple analog torque control to the latest high-performance automation network, the AKD servo drive packs power and flexibility for virtually any application into one of the most compact footprints of any digital servo drive in the industry.

- Patented auto-tuning delivers optimized performance in seconds.
- 1.5MHz current loop and 16KHz velocity loops offers greater bandwidth and performance Optimized performance in seconds
- Greater throughput and accuracy
- Easy-to-use Graphical User Interface (GUI) for faster commissioning and troubleshooting
- Flexible and scalable to meet any application



- Controlled by analog torque-and-velocity commands
- Includes electronic gearing via X9 connector
- Includes access to 11 digital I/O and 2 analog I/O on base drive
- Includes 2 high-speed digital inputs
- Expandable to 31 digital I/O and 4 analog I/O

Motion Tasking ("P" Option)

- Adds simple point-and-click indexing to base drive
- Provides user with pre-programmed options
- Guides novice user through simplified steps to create indexing moves
- Network connectivity to EtherCAT®, CANopen®, Profinet® RT, Ethernet/IP™, TCP/IP, SynqNet® and others
- MODBUS port for communication with HMI

BASIC Programmable 1.5 Axis Drive ("T" Option)

- Adds BASIC programmability to base AKD
- 4Khz programmable interrupt service routines
- Conditional statements, built-in math functions, user functions and subroutines
- Includes 2 high-speed digital inputs
- Same package size as base drive
- Expandable to 31 digital I/O and 4 analog I/O
- Optional integrated SD card for easy backup and drive cloning
- Includes electronic camming functionality

Programmable Drive Multi-Axis Master PDMM ("M" Option)

- Scalable solution for use as a single-axis drive with integrated programmable automation controller
- Choose from all five IEC 61131-3 languages for soft PLC process programming
- Program motion using your choice of PLCopen for motion or our innovative Pipe Network™
- 4KHz PLC scan rate and EtherCAT® updates
- Complete line of HMI panels with integrated software to simplify GUI development
- Exclusive function blocks, such as "wait," enable your program to act as a scanning or sequential language
- On-board I/O includes 17 digital (with 2 high speed inputs) and 2 analog
- Connects to AKT™ network I/O for nearly unlimited expandability

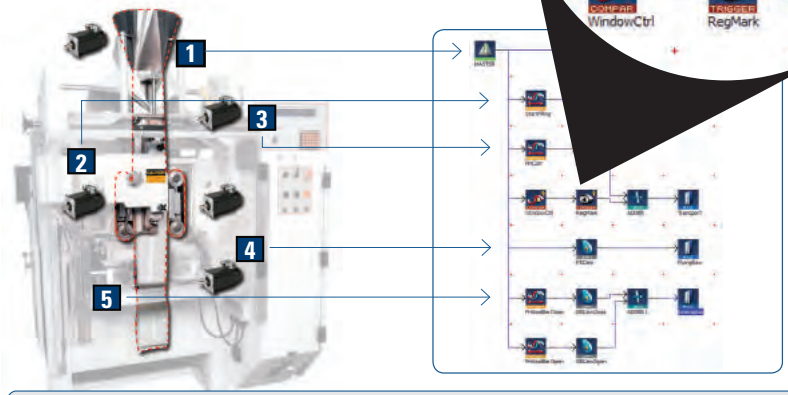
Seamlessly add additional axes and AKD PDMM serves as a high-performance multi-axis machine controller

- SD card for easy backup and system updates
- IoT-enabled integrated webserver for diagnostics and troubleshooting from any computer or mobile device
- Provide true synchronized-path control of up to 16 axes
- Reduce cabinet size and wiring requirements with a single, compact package
- Easily manage remote I/O and the I/O of all attached drives via EtherCAT®
- Use industry standard PLCopen for motion, or step up to Kollmorgen's Pipe Network™ to program sophisticated camming and gearing applications in a matter of minutes

Pipe Network™

Kollmorgen Visual Motion Programming

- Accelerate development by programming tasks in hours that would otherwise take weeks
- Improved coding quality through visual programming and by using pre-built modules that have been thoroughly tested and optimized
- Easy knowledge transfer, replacing pages of complex code with easily understood graphical representations
- Available on PDMM controllers



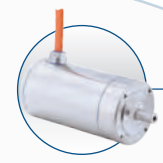
Pipe Network provides a one-to-one translation of a mechanical system into a logical world as shown in the Vertical Form Fill and Seal machine above. Click and build your motion program in minutes, or contact Kollmorgen for examples of common machine architectures to further accelerate your development.

Programming

Multi-Axis Programming

AKD® Servo Drive

The AKD servo drive delivers cutting-edge technology and performance with one of the most compact footprints in the industry. These feature-rich drives provide a solution for nearly any application, from basic torque-and-velocity applications, to indexing, to multi-axis programmable motion with embedded Kollmorgen Automation Suite™. The versatile AKD sets the standard for power density and performance.



AKMH™ Hygienic Stainless Steel Motors

AKM® 2G Servo Motors

Frameless Brushless Direct Drive Motors

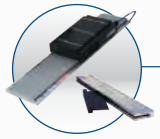
AKD®-N Decentralized Servo Drive

Control of motors with AKD® PDMM programmable multi-axis master

Cartridge DDR® Motors

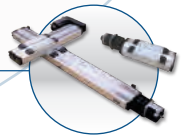
AKD® Servo Drive

Housed DDR® Motors



Direct Drive Linear Motors

Linear Actuators



Multi-Axis Precision Tables

Best-in-Class Components

AKD works seamlessly with Kollmorgen motors and actuators–well-known for quality, reliability, and performance.

Industry-leading power density

General Specifications

120 / 240 Vac 1 & 3 Phase (85 -265 V)	Continuous Current (Arms)	Peak Current (Arms)	Drive Continuous Output Power Capacity (Watts)	Internal Regen (Watts) (Ohms)		Height mm (in)	Width mm (in)	Depth mm (in)	Depth with Cable Bend Radius mm (in)
AKD-x00306	3	9	1100	0	0	168 (6.61)	59 (2.32)	156 (6.14)	184 (7.24)
AKD-x00606	6	18	2000	0	0	168 (6.61)	59 (2.32)	156 (6.14)	184 (7.24)
AKD-x01206	12	30	4000	100	15	196 (7.72)	78 (3.07)	187 (7.36)	215 (8.46)
AKD-x02406	24	48	8000	200	8	247 (9.72)	100 (3.94)	228 (8.98)	265 (10.43)

240/480 Vac 3 Phase (187-528 V)	Continuous Current (Arms)	Peak Current (Arms)	Drive Continuous Output Power Capacity (Watts)	Internal Regen (Watts) (Ohms)		Height mm (in)	Width mm (in)	Depth mm (in)	Depth with Cable Bend Radius mm (in)
AKD-x00307	3	9	2000	100	33	256 (10.08)	70 (2.76)	185 (7.28)	221 (8.70)
AKD-x00607	6	18	4000	100	33	256 (10.08)	70 (2.76)	185 (7.28)	221 (8.70)
AKD-x01207	12	30	8000	100	33	256 (10.08)	70 (2.76)	185 (7.28)	221 (8.70)
AKD-x02407	24	48	16,000	200	23	306 (12.01)	105 (4.13)	228 (8.98)	264 (10.39)
AKD-x04807	48	96	35,000	–	–	385 (15.16)	185 (7.28)	225 (8.86)	260 (10.23)

Note: For complete AKD model nomenclature, refer to page 164.

AKD® BASIC Drives

High Performance Capabilities in an Integrated Drive/Control Solution

Add co-engineering to your toolbox. Save money, simplify your machine and customize performance to meet the specific needs of each customer or application – as needed, today or tomorrow.

Our new Kollmorgen AKD® BASIC drives add BASIC-programmable machine and motion control to the superior performance of our AKD drive platform. So engineers can quickly customize performance at the drive level without touching the PLC. In fact, for many applications you can avoid the expense, wiring and cabinet space of a PLC altogether.

Whether you rely on your own engineering expertise or Kollmorgen's, the base and Expanded I/O versions of our AKD BASIC drive give you the unprecedented machine and motion control flexibility in a compact, fully integrated drive package. It's one more example of our co-engineering mission to help you deliver exactly what your customers want – when they want it – in solutions that are more cost-effective to build, simpler in design and faster to market.

AKD BASIC Language Programmable Drive

In addition to the wide selection and key features of our proven AKD, the standard version of our AKD BASIC drive offers:

- **Programmable machine control built into the drive,** so you can engineer perfect axis-level performance without touching the machine controller. In fact, AKD BASIC can eliminate the need for a PLC in single and 1.5 axis applications – reducing wiring requirements, panel space, design complexity and cost.
- **High performance motion control built into the drive,** enabling increased speed for more complex moves in a simpler design with reduced wiring.
- **BASIC Language programming,** providing simple program flow control in a solution that's easy to learn, quick to master and universally accepted.
- **An integrated development environment,** allowing single-point programming, de-bugging, commissioning, tuning and management of your AKD BASIC drive from within AKD WorkBench. Our BASIC editor provides innovative features that speed development time and reduce coding errors.
- **Source code lockout with password protection,** freeing you to differentiate your product with drive-level control while safeguarding your intellectual property.

I/O Capabilities	Base Version	Expanded I/O Version
Digital Inputs	8	20
Digital Outputs	3	13
Analog Inputs	1	2
Analog Outputs	1	2

Expanded I/O AKD BASIC Programmable Drive

Building on the features of the AKD BASIC drive, we also offer an expanded I/O version that adds:

- **A total of 20 digital inputs, 13 digital outputs, 2 analog inputs and 2 analog outputs,** reducing or eliminating the need for remote I/O and its associated installation and wiring costs.
- **An SD memory card slot** for loading, and restoring programs and parameters, without the need for a PC.

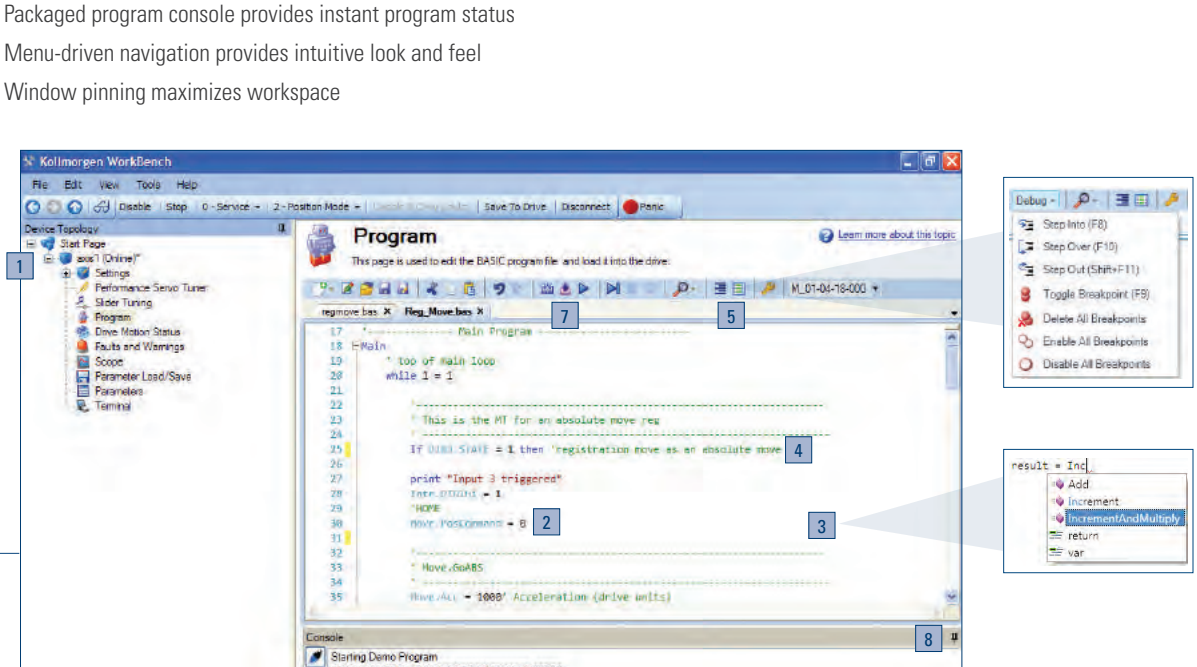
Development Tools that Speed Programming and Improve Quality

Co-engineering is a powerful tool. To make it easy for you to provide better solutions for your customers, we provide an innovative BASIC programming environment within Kollmorgen WorkBench. So there's only one software package to use for all of your drive setup, configuration, tuning and management tasks in addition to motion and machine control programming.

Pre-built code templates give your application a head-start, while automatic formatting, highlighting and other ease-of-use features increase programming speed and accuracy. Complete access to all programming capabilities and drive features within a single environment helps speed your development of complete, optimally engineered solutions.

Novice users will enjoy a short ramp-up time to productive coding, while experienced users will discover well-designed tools that take their programming skills to new levels of speed and quality.

1. Integrated axis setup
2. Code snippets simplify formatting
3. Auto-complete helps speed coding and reduce errors
4. Automatic color coding makes it easy to distinguish comments, parameters, print statements and other types of code
5. Full debugger accelerates development
6. Packaged program console provides instant program status
7. Menu-driven navigation provides intuitive look and feel
8. Window pinning maximizes workspace



AKD® PDMM Drive-Resident Controller

Build Simpler and Better with Drive-Resident Machine and Motion Control

Extend your design options. Control as many as eight axes or more without the need for a PLC or PAC. Reduce cabinet space and wiring requirements. Program perfect machine and motion control for any project using a single, fully integrated programming environment. Build a better machine at a lower cost.

Our new addition to the AKD® drive family combines one servo axis, a master controller that supports multiple additional axes, and the full automation capability of Kollmorgen Automation Suite™—all in a single, compact package.

Welcome to the AKD® PDMM programmable drive, multi-axis master.

Performance Specifications

120/240 Vac 1- and 3-Phase	Continuous Current (Arms)	Peak Current (Arms)	H (mm/inches)	W (mm/inches)	D (mm/inches)
AKD-M00306-MCEC-0000	3	9	168 / 6.61	89 / 3.50	156 / 6.14
AKD-M00606-MCEC-0000	6	18	168 / 6.61	89 / 3.50	156 / 6.14
AKD-M01206-MCEC-0000	12	30	196 / 7.72	107 / 4.21	187 / 7.36
AKD-M02406-MCEC-0000	24	48	248 / 9.76	96 / 3.78	228 / 8.98

240/400/480 Vac 3-Phase	Continuous Current (Arms)	Peak Current (Arms)	H (mm/inches)	W (mm/inches)	D (mm/inches)
AKD-M00307-MCEC-0000	3	9	256 / 10.08	99 / 3.90	185 / 7.28
AKD-M00607-MCEC-0000	6	18	256 / 10.08	99 / 3.90	185 / 7.28
AKD-M01207-MCEC-0000	12	30	256 / 10.08	99 / 3.90	185 / 7.28
AKD-M02407-MCEC-0000	24	48	306 / 12.05	99 / 3.90	228 / 8.98
AKD-M04807-MCEC-0000	48	96	385 / 15.16	185 / 7.28	225 / 8.85

Features

- Kollmorgen Automation Suite™ provides fully integrated programming, testing, setup and commissioning
- Embedded web server utility simplifies service
- Control 32 axes or more* while reducing machine footprint
  - EtherCAT® multi-axis master motion controller integrated with a standard AKD® drive axis
  - Full IEC61131-3 soft PLC for machine control, with support for all 5 programming languages
  - Choice of PLCopen for motion or Pipe Network™ for programming motion control
  - 32 KB non-volatile memory stores machine data to eliminate scrap upon restart after power failure
  - SD Card slot simplifies backup and commissioning, with no PC required
  - On-board I/O includes 13 digital inputs, 4 digital outputs, 1 analog input, 1 analog output (expandable with AKT series of remote I/O)
- Works with Kollmorgen Visualization Builder for programming AKI human-machine interface panels

*Maximum axis count depends on motion/automation complexity and performance (8 axes nominal based on medium complexity at 4 kHz network update rate)

A Single, Scalable Development Suite

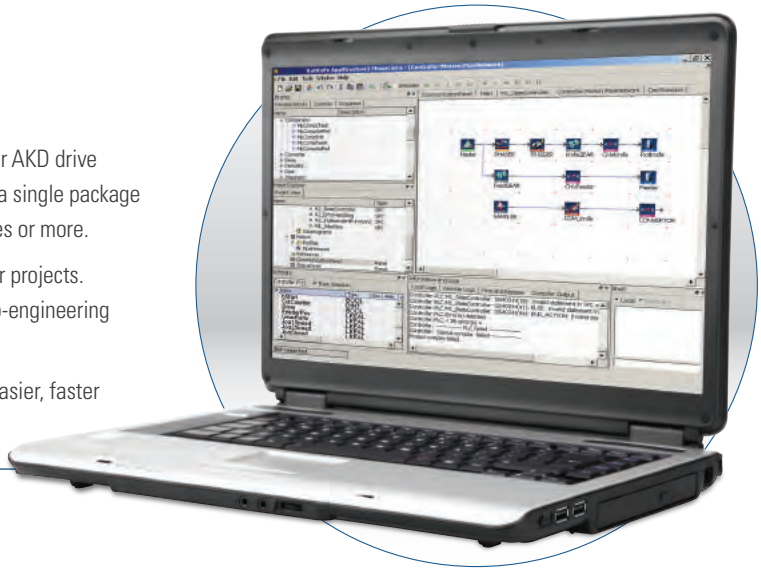
Kollmorgen Automation Suite™ simplifies and accelerates development through a unified system of software, hardware, and collaborative co-engineering. This scalable solution provides a fully integrated development environment for any application, whether you're programming a single axis of motion, a multi-axis AKD® PDMM system, or a PCMM-based system up to 64 axes or more. Kollmorgen Automation Suite has been proven to:

- Improve product throughput by up to 25% with industry-leading motion bandwidth
- Reduce scrap by up to 50% with world-class servo accuracy, seamless power-failure recovery and highly dynamic changeovers
- Increase precision for better quality, reduced waste and less downtime using EtherCAT®—the field bus with motion bus performance
- Enable more adaptable, sustainable and innovative machines that measurably improve marketability and profitability

A Single Family of Servo Drives

Kollmorgen AKD® servo drives deliver cutting-edge performance in a compact footprint. From basic torque-and-velocity applications, to indexing, to multi-axis programmable motion, these feature-rich drives offer:

- Plug-and-play compatibility with your servo motor
- All the advantages of Kollmorgen´s breadth of motor platforms including AKM®, CDDR®, and other direct-drive technologies
- The fastest velocity and position loop updates
- Full-frequency auto-tuning for perfect motion across the performance spectrum
- Real-time feedback from a wide variety of devices



Our Best Drive and Automation Solution in a Single Package

The AKD PDMM programmable drive, multi-axis master combines our AKD drive platform with the full feature set of Kollmorgen Automation Suite in a single package —providing complete machine and motion control for up to eight axes or more.

You need only one development suite and one drive family for all your projects. And you can rely on one source for all the motion components and co-engineering expertise you need to build a better machine.

With AKD PDMM, the best in machine engineering has never been easier, faster or more cost-effective.

Servo Drive Accessories

Ethernet Connectivity

- Ethernet-based AKD servo drive provides the user with multiple bus choices
- EtherCAT® (DSP402 protocol), Modbus® TCP, SynqNet®, EtherNet/IP™, PROFINET® RT, SERCOS III, and CANopen®
- No option cards are required

Industrial Design

- Rugged circuit design and compact enclosure for space-saving, modern appearance – minimizes electrical noise emission and susceptibility
- Full fault protection
- UL, cUL listed, CE, and EAC
- No external line filters needed (480 Vac units) for CE & UL compliance
- Removable screw terminal connectors for easy connections
- DC Bus sharing

Safe-Torque-Off (STO)

- Switches off the power stage to ensure personnel safety and prevents an unintended restart of the drive, even in fault condition
- Allows logic and communication to remain on during power stage shut down
- AKD-x003 – AKD-x024: SIL2 / PL d
- AKD-x048: SIL3 / PL e

Internal Regenerative Braking Resistor

(all models except 120/240 V AC 3 Aeff and 6 Aeff , as well as 480 V AC, 48 Aeff)

- Simplifies system components
- Saves overhead of managing external regeneration when internal regeneration is sufficient

Performance Servo Tuner (PST)

- Exclusive patent pending auto-tuner reaches optimized set-up in seconds
- Handles inertia mismatches up to 1000:1
- Industry leading bandwidth under compliant and stiff load conditions, no matter the mechanical bandwidth of the machine

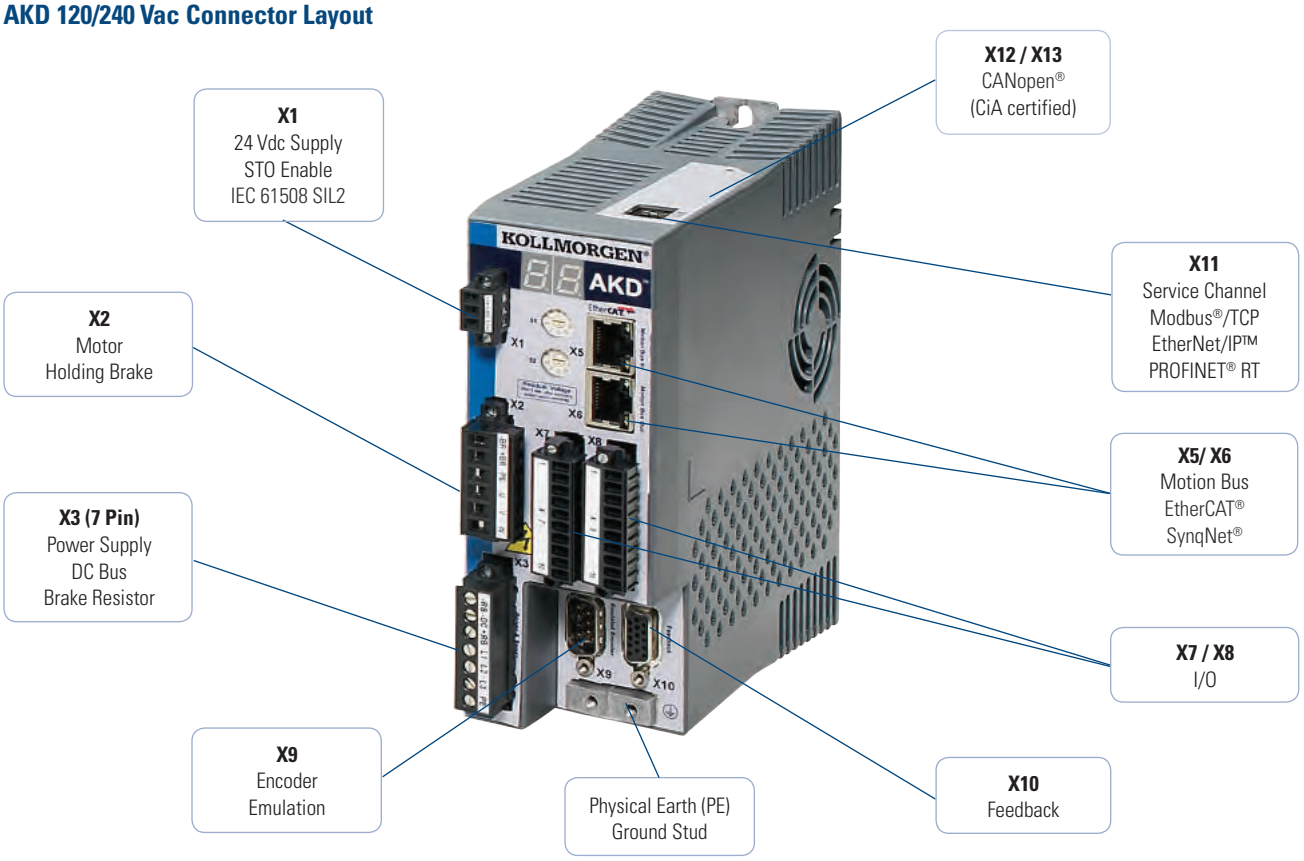
Plug-and-Play with Kollmorgen Motors and Actuators

- Electronic motor nameplates allow parameters to automatically load for fast commissioning
- Motion in seconds
- Custom motor parameters easily entered

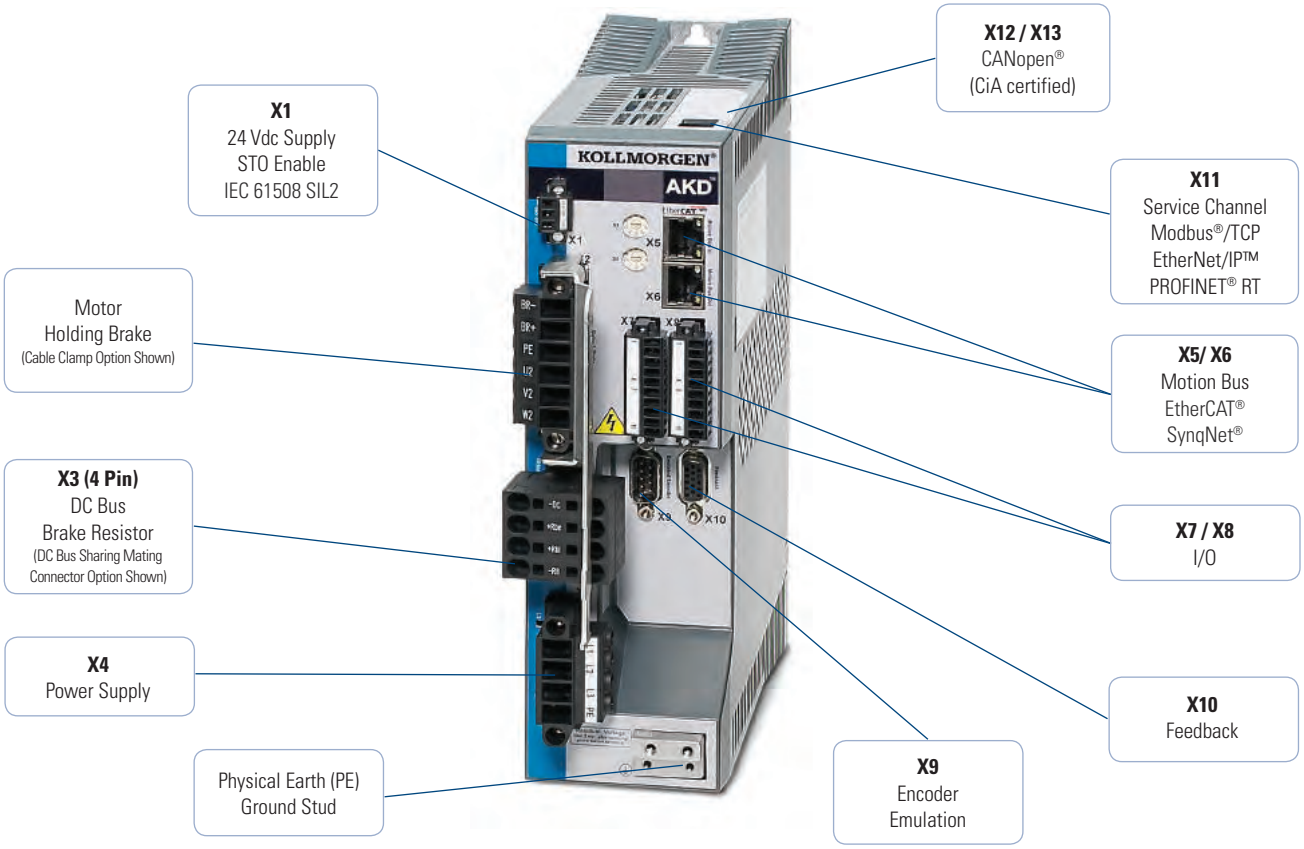
I/O (Base Drive)

- 8 digital inputs (1 dedicated to enable)
- 2 high-speed digital inputs (maximum time delay of 1.0 µs)
- 3 digital outputs (1 dedicated to fault relay)
- 1 analog input - 16 bit
- 1 analog output - 16 bit

AKD 120/240 Vac Connector Layout



AKD 240/480 Vac Connector Layout

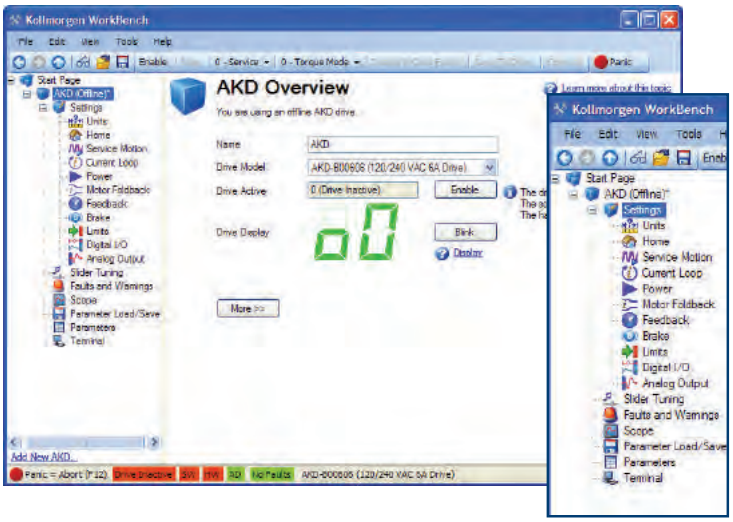


Kollmorgen Workbench

Our simple Graphical User Interface (GUI), Kollmorgen WorkBench, is designed to expedite and streamline the user's experience with the AKD® servo drive. From easy application selection and reduced math, to a sleek six-channel scope; the user interface is extremely easy to use. Kollmorgen WorkBench supports intuitive access to the exclusive Performance Servo Tuner (PST) available inside AKD. The patent pending PST makes auto-tuning the AKD high-performance servo drive with world-class Kollmorgen motors very simple.

User-Friendly Environment

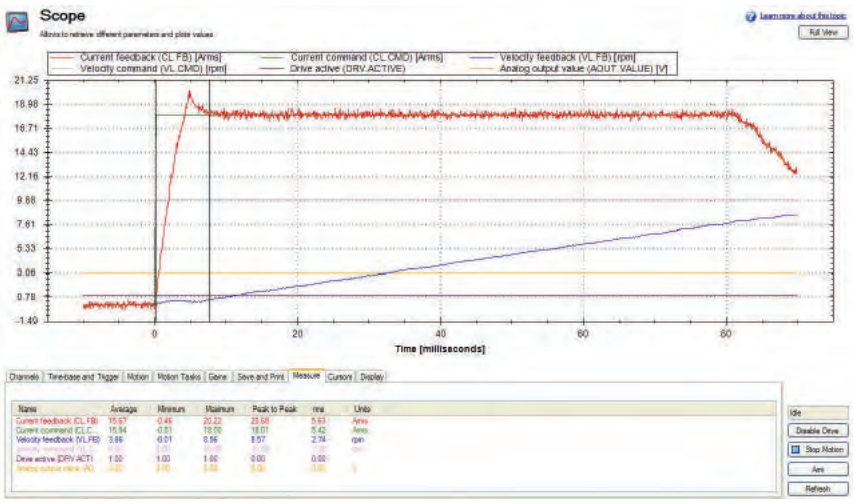
Logical flow, colorful icons and easy access simplify interactions with the AKD servo drive. The folder structure allows for instant identification and easy navigation.



Sleek Six-Channel "Real-Time" Software Oscilloscope

The easy-to-use AKD servo drive interface has a sleek digital oscilloscope that provides a comfortable environment for users to monitor performance. There are multiple options to share data in the format you prefer at the click of a button.

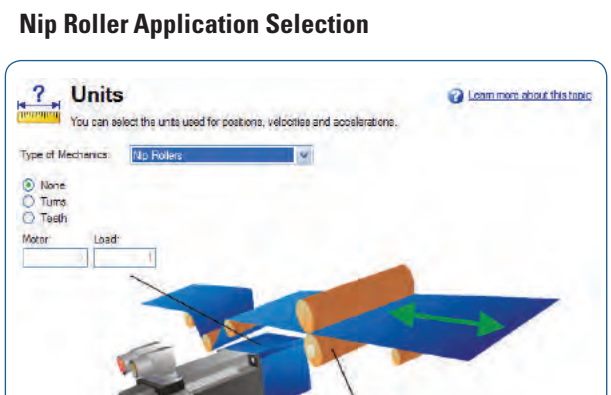
- Save as an image
- Load to an e-mail
- Print



Application Selection

Simplifies set-up by allowing use of machine or application-based units. Nip roller and rack and pinion set-ups shown.

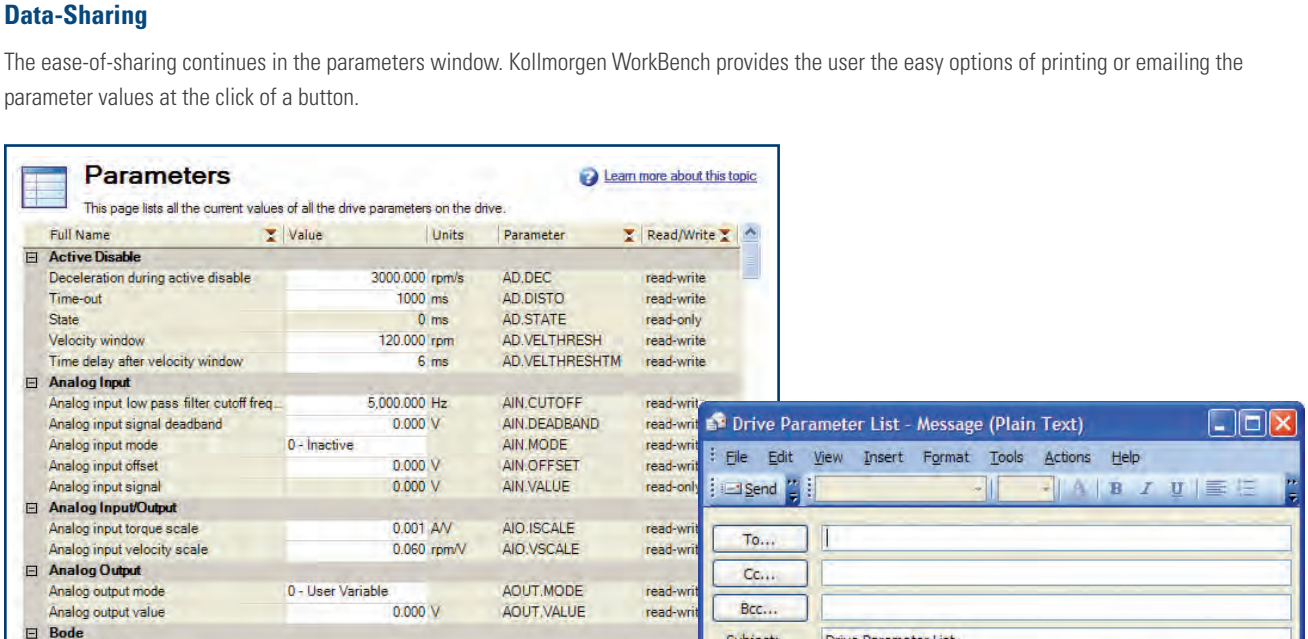
Nip Roller Application Selection



Rack and Pinion Application Selection

Data-Sharing

The ease-of-sharing continues in the parameters window. Kollmorgen WorkBench provides the user the easy options of printing or emailing the parameter values at the click of a button.



AKD® Servo Drive

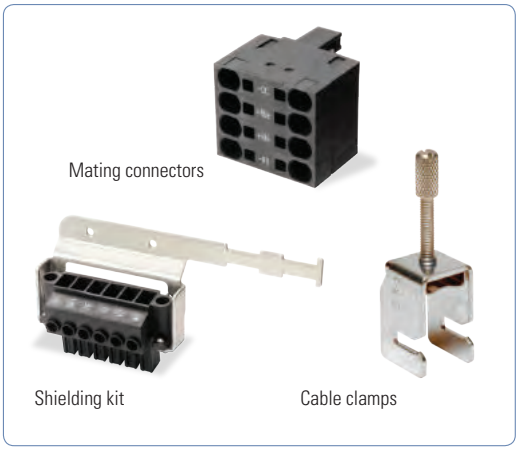
Feedback & I/O

AKD® servo drive is specifically designed with the versatility, communications, and power you need to expand machine performance and increase integration speeds. Motor set-up is plug-and-play and multiple Ethernet connectivity options provide both open and closed protocols. Online troubleshooting and data verification enable faster, bug-proof programming. And a broad power range in a smaller, compact design allows you to use these robust drives with a single interface while experiencing industry-leading, high-performance servo loops.

AKD Specifications

	Standard Drive	With I/O expansion - AKD-T only
Encoder Output or AUX Encoder Input	2.5 MHz Maximum line frequency	
Feedback	Smart Feedback Device (SFD), EnDat2.2, EnDat2.1, BiSS, analog Sine/Cos encoder, incremental encoder, HIPERFACE®, and resolver	
Logic supply	24 Vdc	
Digital input (24 Vdc)	8 (1 dedicated to enable)	20 (1 dedicated to enable)
Digital output (24 Vdc)	3 (1 dedicated to fault relay)	13 (1 dedicated to fault relay)
Analog input (+/- 10 Vdc, 16-bit)	1	2
Analog output (+/- 10 Vdc, 16-bit)	1	2
Programmable inputs	7	19
Programmable outputs	2	12
Sink/Source inputs/outputs	Yes	Yes

Servo Drive Accessories



Mating Connectors and Shielding Kit

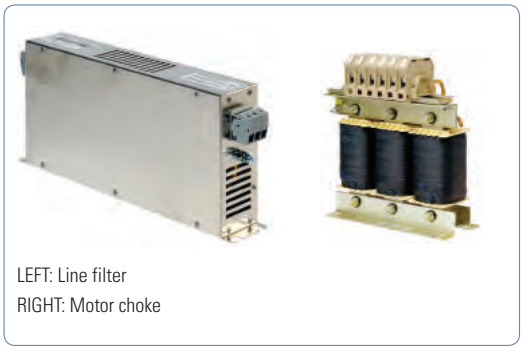
Kollmorgen's servo drives are equipped with screwable mating connectors. Alternative connectors for common DC, bus, and main ports are also available. We offer shielding kits for our flexible cables for use in environments with strong interference.

Shielding Solutions

AKD servo drives can be equipped with shielding plates.

Brake Resistors

We offer a full line of brake resistors up to 6000 watts. Brake resistors are impedance matched with AKD and are available in many sizes and form factors.



LEFT: Line filter
RIGHT: Motor choke

Chokes and Filters

Line filters are offered to improve reliability and to protect the life of the machine in less stable environments. Motor chokes reduce radiated emissions and are recommended for applications with cable lengths >25 meters.

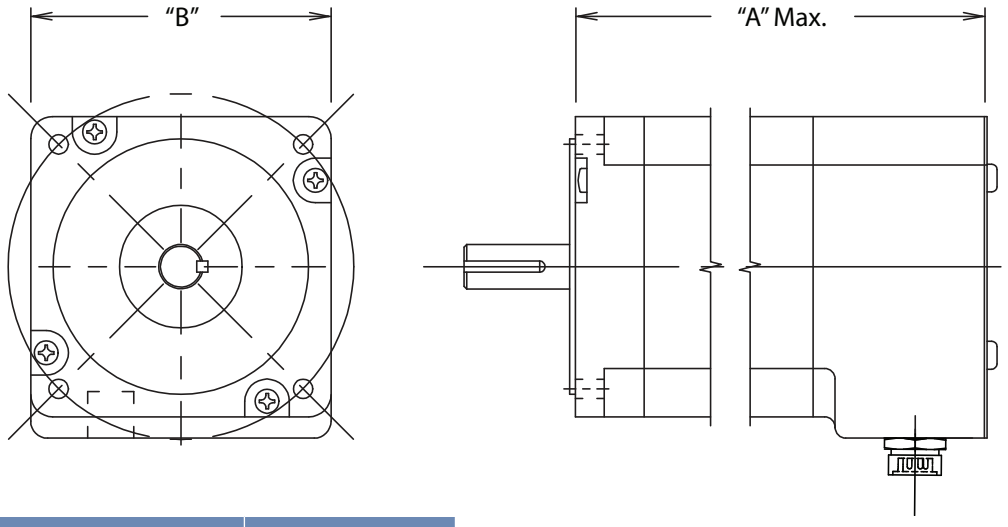
Stepper Motor System Specifications

T22, T31, T32, T41 Stepper System Performance with P70360

Motor	System Voltage [Vdc]	Continuous Current [Arms]	Continuous Torque [lb-in (Nm)]	Nmax. [rpm]	Motor Inertia [lb-in-s^2 (kg-cm^2)]	Motor Weight [lb (kg)]
CTP12	24	1.0	3.73 (0.422)	1800	6.2E-5 (0.070)	0.75 (0.34)
	36		4.02 (0.454)	2400		
T22V	160	1.5	17.5 (1.98)	3000	0.000350 (0.395)	2.2 (1.0)
T22T	320	0.77				
T31V	160	2.8	40.2 (4.54)	3000	0.00127 (1.43)	5.0 (2.27)
T31T	320	1.4				
T32V	160	3.2	74.7 (8.44)	3000	0.00237 (2.68)	8.42 (3.82)
T32T	320	1.6				
T41T	320	2.8	101 (11.4)	3000	0.00489 (5.52)	11.0 (5.0)

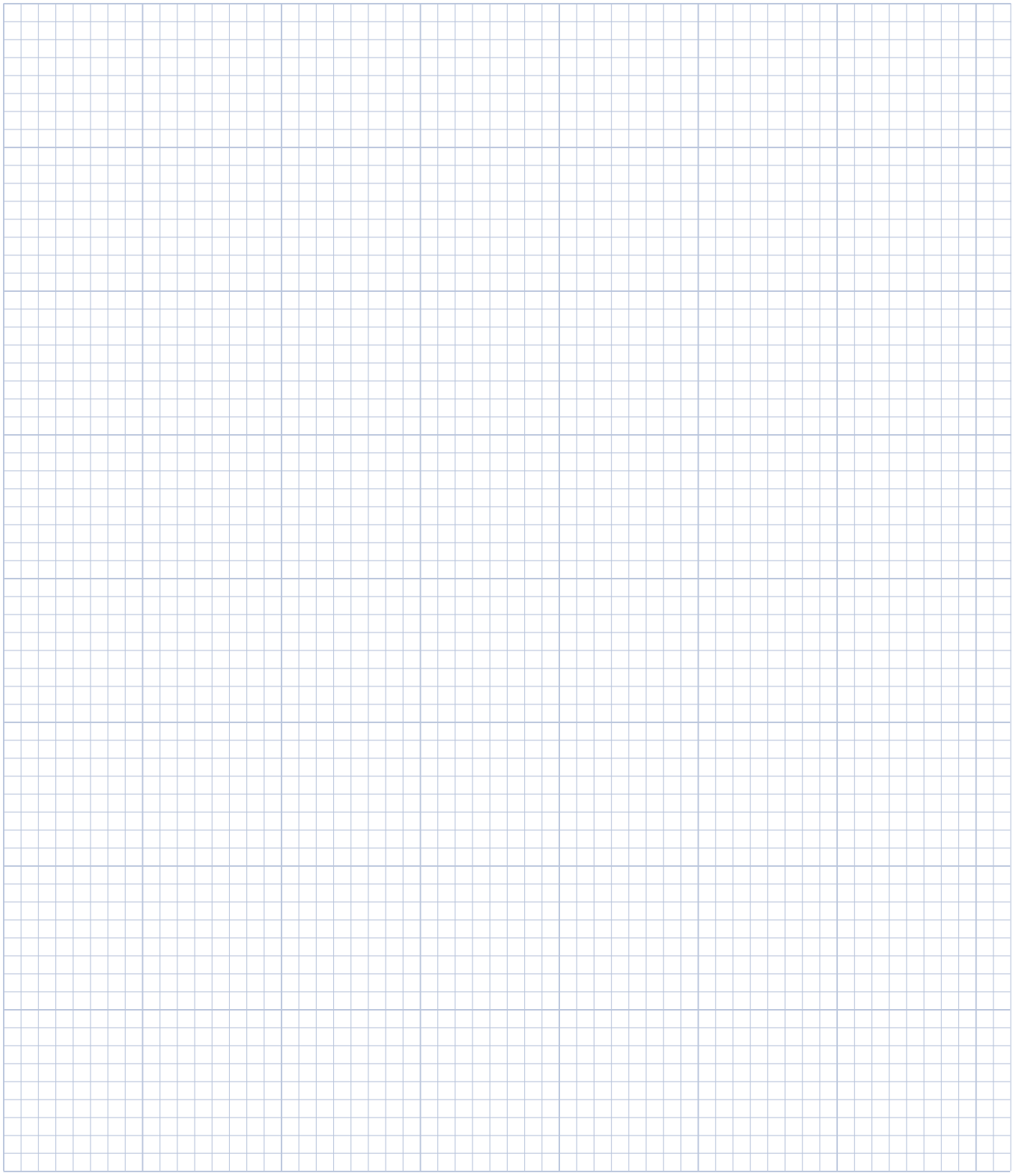
Cables options:
See R series nomenclature page 121 for details about cable availability defined within positioner part number.

Typical Stepper Motor Frame Dimensions



Model	Square dimension "B" [in (mm)]	"A" [in (mm)]
CTP12	1.68 (42.67)	1.90 (48.3)
T22	2.240 (56.90)	3.60 (77.72)
T31	3.38 (85.85)	4.44 (112.8)
T32	3.38 (85.85)	5.96 (151.4)
T41	4.325 (109.9)	5.20 (132.1)

Notes



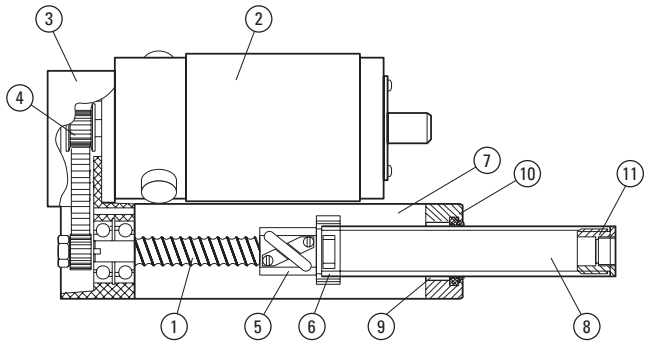
Linear Positioning

Rod Type or Rodless?

Rod Type electric cylinders are similar in configuration to a hydraulic or pneumatic actuator and are preferred when you need to position an externally supported load, move a load that pivots, retrofit a hydraulic or pneumatic actuator, or have "reach in requirements".

EC and N2 electric cylinders (see the N2 series figure, right) use ballscrews (1) to convert rotary motion into linear motion. The motor (2) is mounted to the bearing housing (3), and the motor's power is transmitted to the screw through a gear, or timing-belt reduction (4). The screw turns and moves the ball nut (5), which is connected to a guide flange (6). The guide flange keeps the nut from rotating, by sliding through the guide cylinder (7). The thrust tube (8) is threaded on to the nut, and is supported by the sleeve bearing (9) in the rod-end housing (10). The load is attached to the rod end (11).

N2 Series

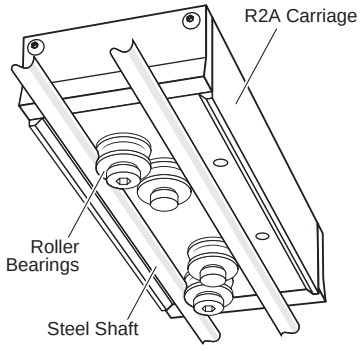


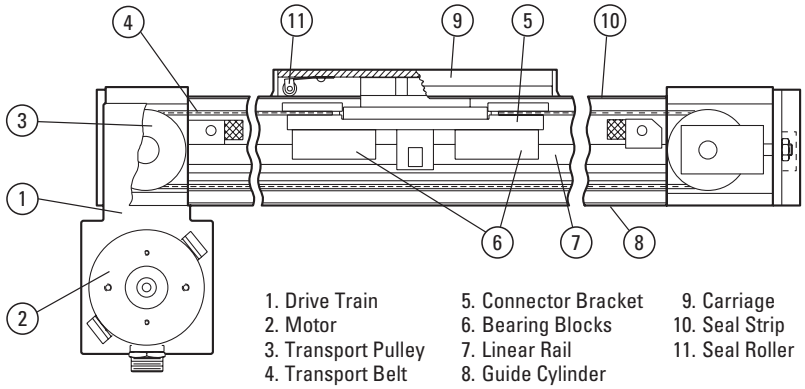
1. Ballscrew
2. Motor
3. Bearing Housing
4. Drive Train
5. Ball Nut
6. Guide Flange
7. Guide Cylinder
8. Thrust Tube
9. Sleeve Bearing
10. Rod End Housing
11. Rod End

Rodless actuators have a bearing support system and a carriage that runs the length of the body. This type of actuator is preferred when you need to save space by eliminating external guides and ways, when high speed and long stroke lengths are needed, when the shortest overall work envelope is needed, or when a multi axis Cartesian System is required.

R2A, R3 and R4 rodless actuators use a ballscrew or a transport belt to convert the motor's power to linear thrust. Pictured below is a belt-drive positioner. As in the EC and N2 electric cylinders, there is a timing belt, or gear reduction (1) between the motor (2) and the driven pulley (3). The transport belt (4) runs over two pulleys and each end is connected to the connector bracket (5). The connector bracket is connected to two bearing blocks (6) that ride on the recirculating ball-bearing rail (7) that is mounted in the guide cylinder (8). The carriage (9) is mounted to the connector bracket and the seal strip (10) runs between them. The connector bracket lifts the seal as the carriage moves, while roller wheels (11) in the carriage push the seal back in place.

R2A Actuators have no bearing blocks, but instead have roller wheels for bearing support (as seen in the figure below). Four track-roller bearings run on two hardened and ground steel shafts, pressed into the extrusion.





1. Drive Train
2. Motor
3. Transport Pulley
4. Transport Belt
5. Connector Bracket
6. Bearing Blocks
7. Linear Rail
8. Guide Cylinder
9. Carriage
10. Seal Strip
11. Seal Roller

Linear Actuation Operation

Rotary to Linear Conversion

Linear motion systems driven by rotating electric motors commonly employ one of three rotary-to-linear conversion systems: **ballscrew, belt drive, or lead screw.**

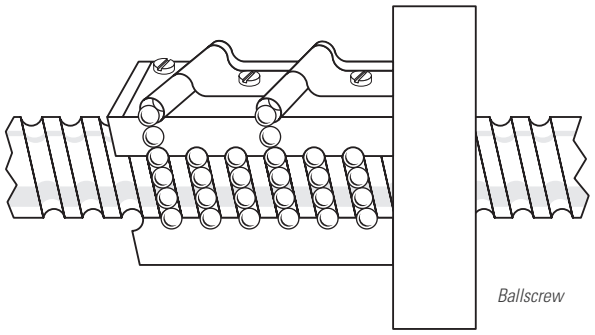
Ball / Lead Screw

Screw-drive mechanisms, whether lead screw or ballscrew provide high thrust (to thousands of pounds), but are often limited by critical speed, maximum recirculation speed of ball nut circuits, or sliding friction of lead nut systems.

Ballscrew

The majority of linear motion applications convert motor torque to linear thrust using ballscrews due to their ability to convert more than 90% of the motor's torque to thrust. As seen below the ballnut uses one or more circuits of recirculating steel balls which roll between the nut and ballscrew threads. Ballscrews provide an effective solution when the application requires:

- High efficiency - low friction
- High duty cycle (> 50%)
- Long life - low wear

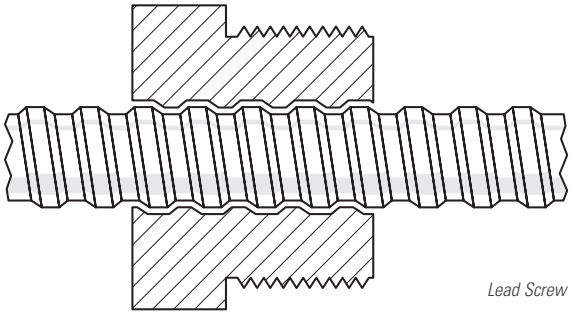


Ballscrew

Lead Screw

The lead screw uses a plastic or bronze solid nut that slides along the threads of the screw, much like an ordinary nut and bolt. Since there are no rolling elements between the nut and the lead screw, lead screws yield only 30-50% of the motor's energy to driving the load. The remaining energy is lost to friction and dissipated as heat. This heat generation limits the duty cycle to less than 50%. A great benefit of the lead screw is its ability to hold a vertical load in a power-off situation (refer to the Backdrive specifications for lead screw positioners). The lead screw is a good choice for applications requiring:

- Low speeds
- Low duty cycles (50%)
- The ability to hold position while motor power is off



Lead Screw

Electric Cylinder Vs. Hydraulics & Pneumatics

Linear Technology Comparison

For many applications, hydraulic or pneumatic linear cylinders are a better choice than their electromechanical alternatives. For example, when extremely heavy loads (>25,000 N [5,620 lb]) must be moved, hydraulic cylinders are usually the best solution.

Or, when very light loads must be moved rapidly and repeatedly from one fixed location to another fixed location, pneumatic cylinders may be the most economical solution.

	Kollmorgen Electric Cylinders	Hydraulic Cylinders	Pneumatic Cylinders
Installation	All electric operation requires simple wiring; directly compatible with other electronic controls.	Requires expensive plumbing, filtering, pumps, etc. Must pay close attention to compatibility of components.	Requires expensive plumbing, filtering, pumps, etc.
Precise Positioning	Cost-effective, repeatable (to ±0.013 mm [±0.0005 in]), rigid multi-stop capabilities.	Requires expensive position sensing and precise electro-hydraulic valving to implement; has tendency to creep.	Most difficult to achieve. Requires expensive position sensing and precise valving to implement; has tendency to creep.
Control	Solid-state microprocessor-based controls allow automatic operation of complex motion sequences.	Requires electronic/fluid interfaces and sometimes exotic valve designs. Hysteresis, dead zone, supply pressure and temperature changes complicate control.	Inherently non-linear, compressible power source severely complicates servo control. Compressibility can be an advantage in open loop operation.
Speed	Smooth, variable speed capabilities from 0.5 to 1330 mm/sec [0.02 to 52.5 in/sec].	Difficult to control accurately. Varies with temperature and wear. Stick slip can be a problem.	More susceptible to stick slip and varying load. Well-suited for high speed applications to 5 m/sec [200 in/sec].
Reliability	Repeatable, reproducible performance throughout useful life of product; little maintenance required.	Very contamination sensitive. Fluid sources require maintenance. Seals are prone to leak. Good reliability with diligent maintenance.	Very contamination sensitive. Air sources require proper filtration. Good reliability, but usually many system components are involved.
Power	Up to 25,000 N [5620 lb], 3 kW [4 hp].	Virtually unlimited force. Most powerful.	Up to 5,000 lb. Typically used below 0.75 kw [1 hp].
Cycle Life	Up to millions of cycles at rated load. Easy to predict.	Dependent on design and seal wear; usually good.	Dependent on seal wear, usually good.
Environment	Standard models rated for -20° to 160° F. Inherently clean and energy efficient.	Temperature extremes can be a major problem. Seals are prone to leak. Waste disposal is increasingly problematic.	Temperature extremes can be a major problem. Seals prone to leak. Air-borne oil can be a problem.
Safe Load Holding	Lead screw units are self-locking if power fails. Fail-safe brakes available for ball-screw models.	Complex back-up safety devices must be used.	Complex back-up safety devices must be used.
Cost	Moderate initial cost; very low operating cost.	Components often cost less, but installation and maintenance are increased. Hydraulic power unit cost is high if not pre-existing. Most economical above 7.5 kw [10 hp].	Components often cost less, but installation and maintenance are increased. Most cost-effective for low power, simple point-to-point applications.

Automation Control

But when simplicity, flexibility, programmability, accuracy and reliability are important and loads are within the capacity of the technology, electromechanical solutions often are the most desirable.

Further, electromechanical systems are inherently more compatible with today's automation controls.

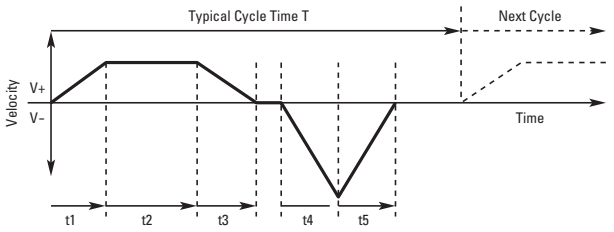
	ELECTRIC CYLINDER	PNEUMATIC ACTUATORS	HYDRAULIC ACTUATORS
OPERATES WITHOUT COMPRESSED AIR	YES	NO	YES
OPERATES WITHOUT COMPRESSED FLUID	YES	YES	NO
OPERATES WITHOUT VALVES, PIPES OR HOSES	YES	NO	NO
SMOOTH, CONTROLLABLE SPEED	YES	NO	PARTIAL
HOLDS POSITION WITHOUT POWER	YES	NO	PARTIAL
OPERATES IN TEMPERATURE EXTREMES	YES	NO	NO
ACCURATE MID-STROKE POSITIONING	YES	NO	NO
GUIDED AGAINST ROTATION	YES	NO	NO
HIGH CYCLE CAPABILITY	YES	YES	LIMITED
CAN BE OPERATED WITHOUT LIMIT SWITCHES	YES	YES	YES

Linear Sizing Calculations

Move Profile

Rotary and linear actuator selection begins with the calculation of speed, thrust and torque requirements. In order to determine the torque required, the acceleration of the mass being moved must be calculated. A **"move profile",** or a **plot of load velocity vs. time,** is sketched in order to simplify the **peak acceleration** and **peak velocity** calculations.

Typical Machine Cycle



(1) Total distance, $$d_{tot} = v_{MAX}\left[\frac{t_1}{2} + t_2 + \frac{t_3}{2}\right]$$

(2) Max velocity, $$v_{MAX} = \frac{d_{tot}}{\left(\frac{t_1 + t_3}{2}\right) + t_2}$$

(3) Acceleration, $$a = \frac{v_{MAX}}{t_{ACCEL}}$$

The figure above is an example of a typical machine cycle, and is made up of two Move Profiles; the first is an example of a **trapezoidal profile,** while the second is a **triangular profile.** The horizontal axis represents time and the vertical axis represents velocity (linear or rotary). The load accelerates for a time (t_1), has a constant velocity or slew section (t_2), and decelerates to a stop (t_3). There it dwells for a time, accelerates in the negative direction (t_4), and decelerates back to a stop (t_5) without a slew region. The equations needed to calculate Peak Velocity and Acceleration for a general trapezoidal profile are shown in the figure. A triangular profile can be thought of as a trapezoidal profile where $t_2 = 0$.

The Move Profile sketch contains some important information:

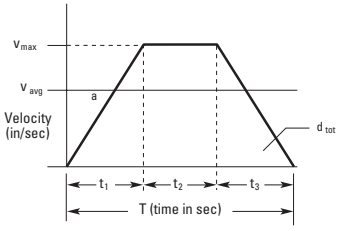
- **Peak acceleration** is the steepest slope on the curve, in this case during t_4 or t_5.
- **Maximum velocity** is at the highest or lowest point over the entire curve, here at the peak between t_4 and t_5.
- **Distance** is equal to the area under the curve. Area above the time axis represents distance covered in the positive direction, while negative distance falls below this axis. The distance equation (1) is just a sum of the areas of two triangles and a rectangle.

Trapezoidal and Triangular Profiles

A couple of assumptions can greatly simplify the general equations. For the Trapezoidal profile we assume $t_1=t_2=t_3$, and for the Triangular we assume $t_3=t_4$. Substituting these assumptions into equations (2) and (3) yields the equations shown in the figure below.

For a given distance (or area), a triangular profile requires lower acceleration than the trapezoidal profile. This results in a lower thrust requirement, and in turn, a smaller motor. On the other hand, the triangular profile's peak speed is greater than the trapezoidal, so for applications where the motor speed is a limiting factor, a trapezoidal profile is usually a better choice.

Trapezoidal Move Profile



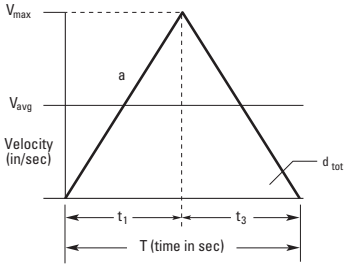
$$v_{AVE} = \frac{d_{tot}}{t_{tot}}$$

$$t_1 = t_2 = t_3 = \frac{t_{tot}}{3}$$

$$v_{MAX} = 1.5\,\frac{d_{tot}}{t_{tot}} = 1.5\,v_{AVE}$$

$$a = 4.5\,\frac{d_{tot}}{(t_{tot})^2}$$

Triangular Move Profile



$$v_{AVE} = \frac{d_{tot}}{t_{tot}}$$

$$t_1 = t_3 = \frac{t_{tot}}{2} \qquad t_2 = 0$$

$$v_{MAX} = \frac{2d_{tot}}{t_{tot}} = 2\,v_{AVE}$$

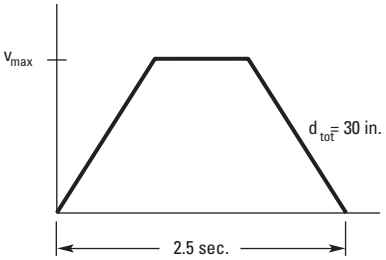
$$a = \frac{4d_{tot}}{(t_{tot})^2} = \frac{2v_{MAX}}{t_{tot}}$$

Move Profile

Example 1

Calculate the peak acceleration and velocity for an object that needs to move 30 inches in 2.5 seconds. Assume a Trapezoidal Profile.

Solution



$$v_{AVE} = \frac{30\text{ in}}{2.5\text{ sec}} = 12\text{ in/sec}$$

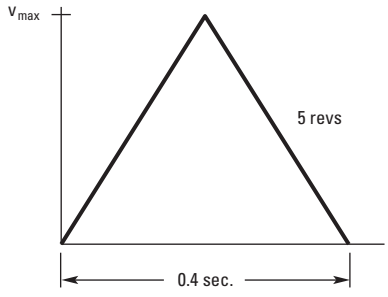
$$v_{MAX} = 1.5\ \frac{d_{tot}}{t_{tot}} = 18\text{ in/sec}$$

$$a = 4.5\ \frac{d_{tot}}{(t_{tot})^2} = 21.6\text{ in/sec}^2$$

Example 2

Calculate, in radians/sec, the peak acceleration and velocity for an cylinder that needs to move 5 revolutions in 0.4 seconds. Assume a Triangular Profile.

Solution



$$d_{tot} = \frac{5\text{ revs} \times 2\pi\text{ rad}}{\text{rev}} = 31.42\text{ rad}$$

$$v_{AVE} = \frac{31.42\text{ rad in}}{0.4\text{ sec}} = 78.55\ \frac{\text{rad}}{\text{sec}}$$

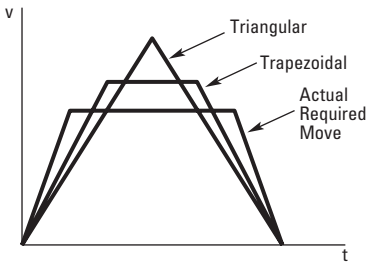
$$v_{MAX} = 2\ v_{AVE} = 157.1\ \frac{\text{rad}}{\text{sec}}$$

$$a = 4\ \frac{d_{tot}}{T^2} = 785.5\ \frac{\text{rad}}{\text{sec}^2}$$

Example 3

This is an example of a case when triangular and trapezoidal move profiles are not adequate approximations. Assume a maximum positioner speed is 6 inches/sec. Sketch a move profile that will complete a 10 inch move in 2 seconds. What is the minimum allowable acceleration rate in inches/sec^2?

Solution



Triangular

$$v_{AVE} = \frac{10\text{ in}}{2\text{ sec}} = 5\text{ in/sec}$$

$v_{MAX} = 2 \times v_{AVE} = 10$ in/sec ($v_{MAX} > 6$ in/sec – too fast)

Trapezoidal

$v_{MAX} = 1.5 \times v_{AVE} = 7.5$ in/sec ($v_{MAX} > 6$ in/sec – too fast)

These are too fast, so we need to find t_1 as follows:

Required Profile

$$d_{tot} = v_{MAX}\ \left(\frac{(t_1 + t_3)}{2} + t_2 \right)$$

$$\frac{d}{v_{MAX}} = \left(\frac{(t_{tot} - t_2)}{2} \right) + t_2 = \frac{t_{tot}}{2} + \frac{t_2}{2}$$

solving for t_2,

$$t_2 = \left(\frac{d_{tot}}{v_{MAX}} - \frac{t_{tot}}{2} \right) \times 2 = \left(\frac{10\text{ in}}{6\text{ in/sec}} - \frac{2\text{ sec}}{2} \right) \times 2$$

$$t_2 = 1.33\text{ sec}$$

Now assume $t_1 = t_3$, so

$$t_1 = (t_{tot} - t_2)/2 = 0.33\text{ sec.}$$

Finally, calculate acceleration

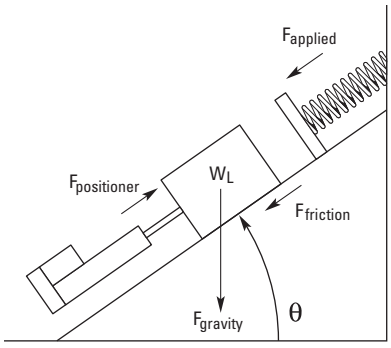
$$a = \frac{v_{MAX}}{t_1} = \frac{6\text{ in/sec}}{0.33\text{ sec}} = 18\ \frac{\text{in}}{\text{sec}^2}$$

Linear Sizing Calculations

Thrust Calculation

The thrust required to move a mass a given distance within a given time may be calculated by summing all of the forces that act on the mass. These forces generally fall within the following four categories:

- **Gravity** is important when something is being raised or lowered in a system. Lifting a mass vertically is one example, as is sliding something on an incline.
- **Friction forces** exist in almost all systems and must be considered.
- **Applied forces** come from springs, other actuators, magnets, etc., and are the forces that act on the mass other than friction, gravity, and the actuator's thrust. The spring shown in the figure below is an example of an Applied force.
- **Actuator thrust** is the required force, and is what we need to determine.



The figure above shows a general case where the force required by the actuator must be determined. All of the above forces are included, and it is important to note that all of these forces can change over time, so the thrust must be calculated for each section of the move profile. The worst case thrust and speed required should be used to pick the appropriate actuator. All of these forces added up (Σ) must be equal to mass × acceleration, or:

$$\Sigma F = m \times a, \text{ or,} \quad (1)$$

$$F_{actuator} - F_{applied} - F_{friction} - F_{gravity} = ma = \left(\frac{W_t}{g} \right) a \quad (2)$$

$$F_{actuator} = \left(\frac{W_t}{g} \right) a + F_{applied} + F_{friction} + F_{gravity} \quad (3)$$

where $W_t = W_{load} + W_{actuator}$ (4)

$F_{friction} = \mu W_L \cos\theta$, and

$F_{gravity} = W_L \sin\theta$

$W_{actuator}$ becomes important when the acceleration force, $(W_t/g)a$, is a significant part of the thrust calculation. For simplicity, start by neglecting this weight, and calculate the required thrust without it. After selecting an actuator, add its mass to the mass of the load and recalculate. To make these equations clear, lets begin with an example.

Example 1

We would like to move a 200 lb weight a distance of 10 inches in 2 seconds. The mass slides up and incline with a friction coefficient of 0.1 at an angle of 45°. There is a spring that will be in contact with the mass during the last 0.5 inch of travel and has a spring rate of 100 lb/in. What is the maximum thrust and velocity?

Solution

We need to look at the thrust requirement during each part of the move, and find the points of maximum thrust and maximum speed. Choosing a trapezoidal profile we calculate that v_{max} is 7.5 in/sec and the peak acceleration is 11.25 in/sec^2 (see Move Profile Section).

Acceleration Section:

Ma = 200 lb/386 in/sec^2 × 11.25 in/sec^2
= 5.83 lb

$F_{applied}$ = 0 lb
$F_{friction}$ = [200 lb × cos (45)] × 0.1 = 14.14 lb
$F_{gravity}$ = 200 lb × sin (45) = 141.4 lb
F_{total} = 161 lb

Slew Section:

Ma = 0 lb (since a=0)
$F_{applied}$ = 0 lb
$F_{friction}$ = [200 lb × cos (45)] × 0.1 = 14.14 lb
$F_{gravity}$ = 200 lb × sin (45) = 141.4 lb
F_{total} = 156 lb

Deceleration Section:

Ma = 200 lb/386 in/sec^2 × -11.25 in/sec^2
= -5.83 lb

$F_{applied}$ = K × x = 0.5 in × 100 lb/in =50 lb
(worst case)

$F_{friction}$ = [200 lb × cos (45)] × 0.1 = 14.14 lb
$F_{gravity}$ = 200 lb × sin (45) = 141.4 lb
F_{total} = 200 lb

So the worst case required thrust is 200 lb. And the worst case velocity is 7.5 in/sec.

Thrust Calculation

Actuator Mass

In applications where the acceleration force, $(W_t/g)a$, is a significant part of the required thrust, the actuator mass must be considered in the thrust calculation. After an actuator is chosen, the actuator weight (linear inertia), $W_{actuator}$, is added to the weight of the load. $W_{actuator}$ can be determined using the tables and equation in the actuator data section. To illustrate, we will use the previous example.

1. The first step is to pick a linear actuator with the above thrust and speed capability. One such actuator is an EC3-AKM42-20-16B-300. This is an EC3 Electric Cylinder with a AKM42 motor, a 2:1 gear reduction, a 16 mm lead ballscrew, and a 300 mm stroke.
2. The next step is to look up the effective Actuator Linear Inertia in the tables located in the particular actuator section (do not include the "load" term in the equation). An entry from this table can be seen in the table below. The AKM42 motor inertia is 0.0013 in-lb-sec^2. The effective actuator weight, calculated from the table is 297 lb.
3. The final step is to add this weight to the weight of the load, W_L, and recalculate the peak thrust required for each section of the move profile (do not add this weight to the gravity or friction terms):

Acceleration Section:

Ma = 447 lb/386 in/sec^2 × 11.25 in/sec^2

= 13.03 lb

F_{total} = 169 lb

Slew Section:

Ma = 0 lb (since a=0)

Deceleration Section:

Ma = 447 lb/386 in/sec^2 × -11.25 in/sec^2)

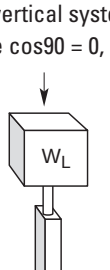
= -13.03 lb

F_{total} = 193 lb

We can see from this calculation that the addition of this extra "acceleration weight" increases the thrust required during acceleration, but reduces the peak thrust required during deceleration. The EC3-AKM42-20-16B-300 will work in the application.

Vertical and Horizontal Cases

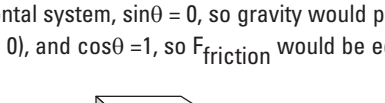
In a vertical system, θ is 90°, sin90 = 1, and $F_{gravity}$ is equal to W_L. Since cos90 = 0, $F_{friction}$ = 0.



$$F_{actuator} = (W_t/g)a + F_{applied} + F_{gravity}$$

$$\boxed{F_{actuator} = (W_t/g)a + F_{applied} + W_L}$$

In a horizontal system, sinθ = 0, so gravity would play no part ($F_{gravity}$ = 0), and cosθ =1, so $F_{friction}$ would be equal to μW_L, or 50 lb.

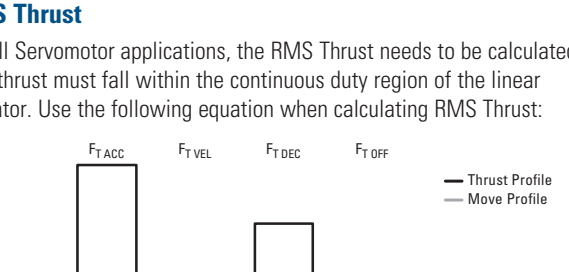


$$F_{actuator} = (W_t/g)a + F_{applied} + F_{friction}$$

$$\boxed{F_{actuator} = (W_t/g)a + F_{applied} + \mu W_L}$$

RMS Thrust

For all Servomotor applications, the RMS Thrust needs to be calculated. This thrust must fall within the continuous duty region of the linear actuator. Use the following equation when calculating RMS Thrust:



$$F_{T\,RMS} = \sqrt{\frac{(F_{T\,ACC})^2 t_a + (F_{T\,VEL})^2 t_v + (F_{T\,DEC})^2 t_d + (F_{T\,OFF})^2 t_{off}}{t_a + t_v + t_d + t_{off}}}$$

EC Series Inertia						
Rotary Inertia (Reflected to Motor) = A + B* (Stroke, in) + C * (Load, lb)						
Model	Ratio	Reduction Type	Screw	A	B	C
EC 3 Series			Dia x Lead (mm)	lb-in sec^2	lb-in sec^2 / in	lb-in sec^2 / lb
EC3-…-10-16B	1:1	Belt/pulley	16 x 16	1.188 E-03	1.176 E-05	2.604 E-05
EC3-…-15-16B	1.5:1			7.435 E-04	5.228 E-06	1.157 E-05
EC3-…-20-16B	2:1			4.779 E-04	2.765 E-06	6.121 E-06
EC3-…-50-16B	5:1	Helical gear		2.280 E-04	4.635 E-07	1.026 E-06
EC3-…-70-16B	7:1			1.975 E-04	2.401 E-07	5.314 E-07

AKM42 Mechanical Specifications

Motor Inertia (based on resolver)	0.0013 lb-in-sec^2

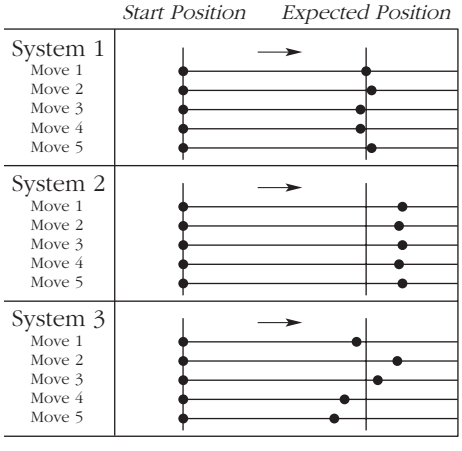
Linear Motion Terminology

Linear Actuator Precision

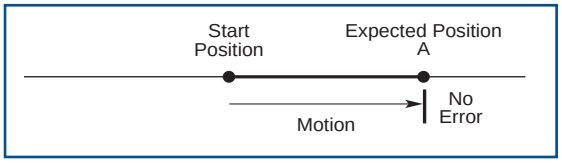
Parameter	Definition	Dominating Factors
Absolute Accuracy	The maximum error between expected and actual position.	• Accuracy of the motor/drive system • Screw pitch error (lead accuracy) • System backlash (drive train, screw and nut assembly)
Repeatability	The ability of a positioning system to return to a location during operation when approaching from the same direction, at the same speed and deceleration rate.	• Angular repeatability of the motor/drive system • System friction • Changes in load, speed, and deceleration • Angular resolution of the motor/drive system
Resolution	The smallest positioning increment achievable. In digital control systems, resolution is the smallest specifiable position increment.	• Drive Train Reduction • Screw Pitch • Lead screw Assembly wear
Backlash	The amount of play (lost motion) between a set of moveable parts.	• Drive train wear • Spaces between moving parts

Accuracy and Repeatability

Assume three linear positioning systems each attempt five moves from an absolute zero position to absolute position "A". The individual end positions of each move are charted on a linear scale below to demonstrate their accuracy and repeatability by displaying their proximities to the expected position.



Ideal System



Degree of Accuracy	Degree of Repeatability	Comment
High	High	System 1 is both accurate and repeatable, the end positions are tightly grouped together and are close to the expected position.
Low	High	System 2 is inaccurate but repeatable, the end positions are tightly grouped around a point but are not close to the expected position.
Low	Low	System 3 is neither accurate nor repeatable, the end positions are not tightly grouped and are not close to the expected position.

Linear Actuator Precision

Backlash

The clearance between elements in a drive train or lead screw assembly which produces a mechanical "dead band" or "dead space" when changing directions, is known as the **backlash** in a system.

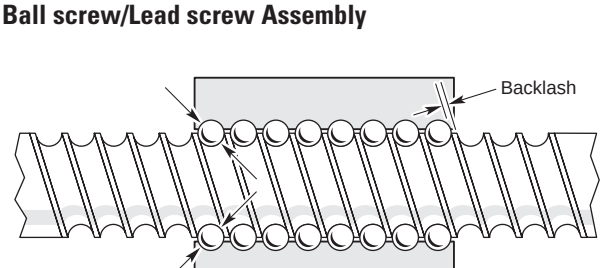
In most mechanical systems, some degree of backlash is necessary to reduce friction and wear. In a Kollmorgen Linear Actuator System, system backlash will typically be 0.010 – 0.015 inches. Usually 0.006 – 0.008" is attributed to the ball screw / lead screw assembly. For ball screws this will remain constant throughout the life of a cylinder, while for lead screws it will increase with wear.

Reducing the Effects of Backlash

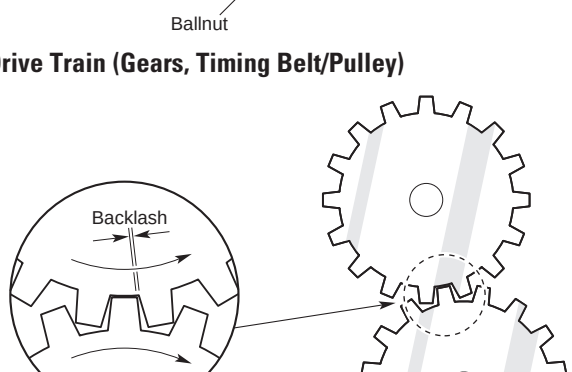
1. Approach a stop position from the same direction.
2. Apply a constant linear force on the cylinder thrust tube or carriage. This is done automatically for cylinders used in vertical orientations with a backdriving load.
3. For programmable positioning devices it is possible to program out backlash by specifying a small incremental move (enough to take out the backlash) prior to making your normal moves in a particular direction.
4. Use a preloaded nut on a ball screw to counteract the backlash. Contact Kollmorgen about the precision ground screw option which reduces backlash in the drive nut.
5. An inline positioner with the motor directly coupled to the ball screw has less backlash than parallel or reverse parallel units which utilize a gear train or drive belt/pulley.

Primary Sources of Backlash

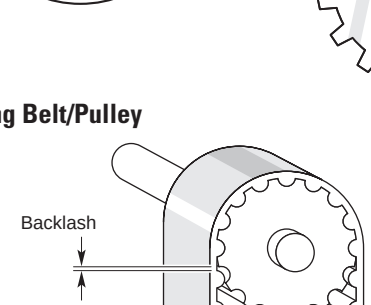
1. Ball screw/Lead screw Assembly



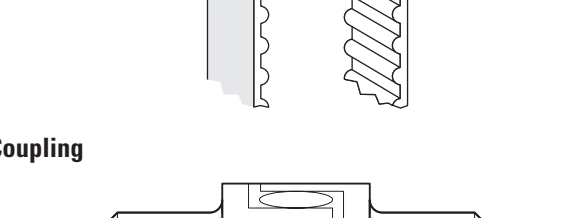
2. Drive Train (Gears, Timing Belt/Pulley)



3. Timing Belt/Pulley



4. Coupling



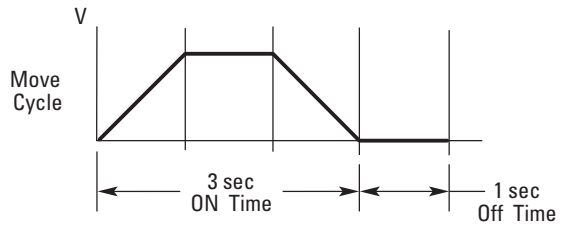
Linear Motion Terminology

Duty Cycle

Duty Cycle is the ratio of motor-on time to total cycle time and is used to determine the acceptable level of running time so that the thermal limits of the motor or positioner components are not exceeded. Inefficiencies cause a temperature rise in a system, and when the temperature reaches a critical point, components fail. Letting the system to rest idle during the cycle allows these system components to cool. Duty Cycle is limited by lead screw and motor thermal limits. Use the following equation and example to determine Duty Cycle:

$$\text{Duty Cycle} = \frac{\text{ON TIME}}{\text{ON TIME + OFF TIME}} \times 100$$

Example:



Duty Cycle = $\frac{3 \text{ sec} \times 100}{3 + 1 \text{ sec}}$ = 75%

Leadscrew Limitations

Cylinders with **lead screws** have sliding friction surfaces and are limited to a maximum 50% duty cycle regardless of motor capability. The friction in the lead screw causes rapid heating, and continuous operation is likely to end in a ruined nut or screw. For positioner with **ballscrews** the motor is the only duty-cycle limitation when used within the listed speed vs. thrust curves in the catalog.

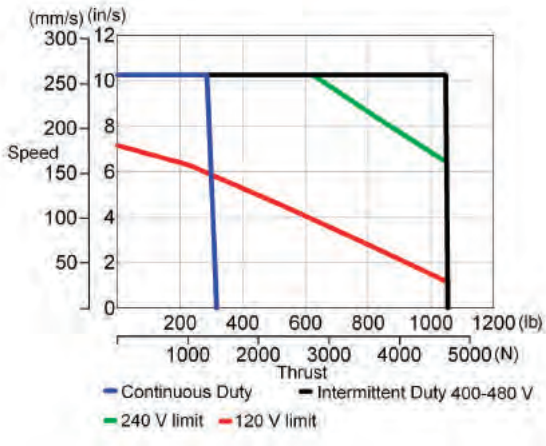
Motor Type

Electric motors incur heat losses via a number of paths, namely, friction, ohmic (I^2R) losses in copper windings, hysteresis and eddy current induction in magnetic core materials, and proximity and/or skin effect in windings. As a result duty cycle can be limited by the motor winding temperature limitations.

Servomotors

Linear Positioners using AKM series motors must have their peak (F_{peak}) and continuous (F_{RMS}) thrust requirements determined to establish their safe operation within an application. F_{RMS} can be determined using the RMS Thrust equation in the Thrust Calculation section. Plotting F_{RMS} on the positioner Speed vs. Thrust curve indicates the allowable limit. For ballscrew positioners, F_{RMS} must fall within the continuous duty region, while for lead screws it must also fall within the continuous limit and not exceed a 50% duty cycle within that limit. F_{peak} must fall within remaining operating envelope. The speed vs. thrust curve below is an example of proper servo electric cylinder sizing.

EC3-AKM23D-xxx-15-05B/ AKD (3 A)



Critical Speed and Column Loading

Critical Speed

All ballscrew systems have a rotational speed limit where harmonic vibrations occur. With Kollmorgen cylinders, this limit is a function of unsupported ballscrew length. Operation beyond this critical speed will cause the ballscrew to vibrate (whip violently) eventually bending or warping the screw.

Column Strength

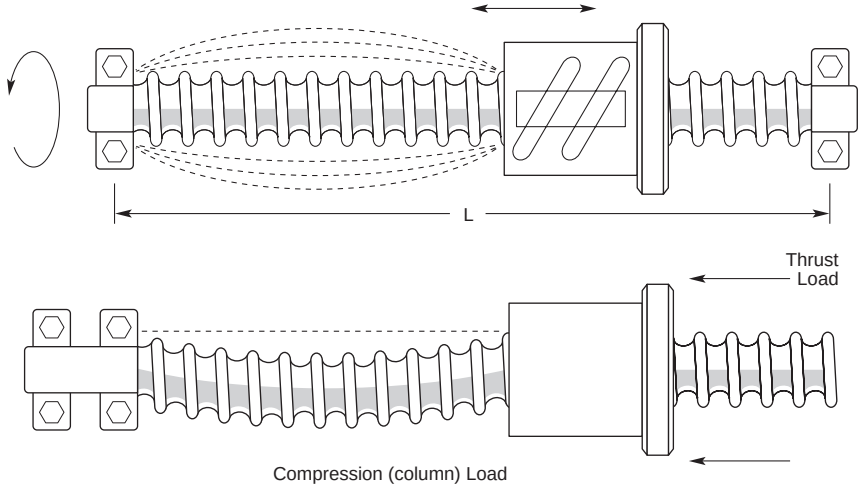
All ballscrews have a maximum column loading limit which causes the screw to compress as load increases. In Kollmorgen cylinders this limit is a function of unsupported leadscrew length. Exceeding this limit will cause the ballscrew to buckle and become permanently damaged.

Determining the Limits

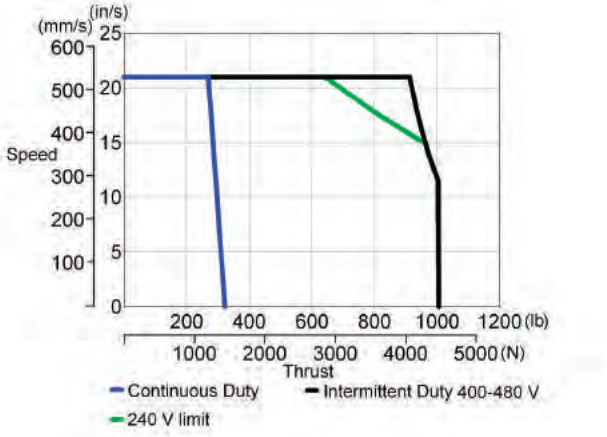
Critical Speed and Column Loading information for each screw type (i.e. 2B, 5A, 8A, 5B …) can be found at the bottom of each Performance Curve page for that particular linear actuator size.

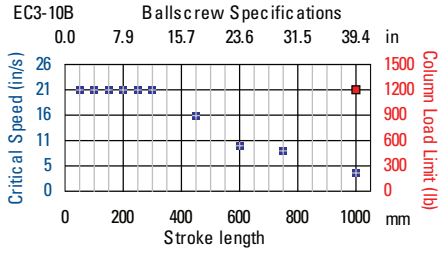
Example

Find the Column Load and Critical Speed limits for an EC3-AKM42G-xxx-10-10B to the right. Reading off the chart, the column loading limit exceeds this system's performance envelope for all stroke lengths. The critical speed limit will begin interfering with the intermittent envelope for stroke lengths greater than 300 mm. The usable speed/ thrust is restricted to less than these values as seen in the modified speed vs. thrust curve.



EC3-AKM42G-xxx-10-10B/ AKD (6 A)





Environmental Considerations

Environmental conditions are an important design consideration when selecting a Kollmorgen Linear Actuator. Kollmorgen units are self-contained systems which are protected from "direct contact" with harsh environments by an aluminum housing with a durable anodized and epoxy coated surface finish. However, extreme conditions can have an adverse effect on cylinder operation and life. Factors such as extreme temperature, liquids or abrasive contaminants (gaining internal access) can impede performance and cause premature wear of mechanical parts. Review the information below when sizing your application to choose appropriate options or protective measures.

Primary Environmental Factors

- Temperature
- Liquid contaminants
- Particle contaminants

Rod Type

Temperature

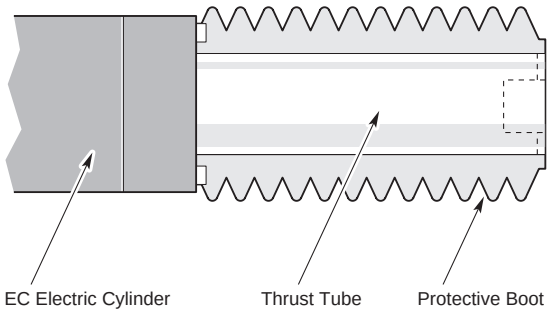
- N2 electric cylinders are rated for use between 0 and 60°C (32 to 140°F).
- EC electric cylinders are rated for use between -30 and 70°C (-22 to 158°F)

Particle and Liquid Contaminants

- N2 series electric cylinders are protected against dust but are not protected against direct water (or any liquid) contact. Liquid or moisture can gain access into the housing, eventually corroding internal components.
- EC electric cylinders are sealed and gasketed and are rated to IP54. They are protected against dust and light water sprays and splashing.

Protective Boot Option

The PB option is available for EC electric cylinders and increases the positioner's resistance to liquids. The diagram to the right shows a typical installation of an EC with the PB option. This option protects the actuator to IP65. Note that some motor options are not protected to this level. The PB option is not available with R-series Rodless positioners.

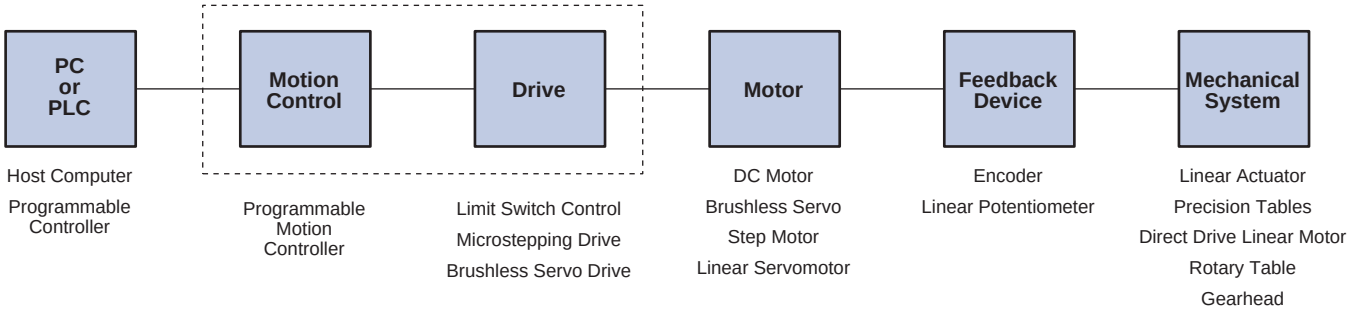


Custom Environmental Options

Kollmorgen has over 30 years experience designing custom linear actuators. We have designed fully encapsulated linear actuators for Corrosive, Food Processing, and Washdown environments, and have experience designing for Cleanroom compatible environments. Call Kollmorgen for more information regarding Custom environmental options.

Introduction to Motion Control

Many different components are used in a variety of combinations to create a complete motion control or positioning system. Kollmorgen offers the broadest range of products spanning the complete spectrum from mechanical linear positioners to microstepping and brushless servo drives to programmable motion controllers. A successful application depends on choosing the right combination of positioner, motor, drive, and control technology. More than one technology may meet the requirements of your application. In this case, factors such as performance, cost, flexibility, and simplicity may determine your selection.



Glossary of Motion Control Terminology

Absolute Move
A move referenced from a fixed absolute zero position.

Acceleration
The change in velocity as a function of time, going from a lower speed to a higher speed.

Accuracy
An absolute measurement defining the difference between expected and actual position.

Lead Screw
A screw which uses a threaded screw design with sliding surfaces between the screw and nut.

Backdrive
Tendency of a cylinder to creep out of its set position due to an applied load or force.

Backlash
The amount of play (lost motion) between a set of moveable parts when changing the direction of travel. Typically seen in drive trains, ball/lead screws, & bearings.

Ball screw
A screw assembly which uses a ball nut which houses one or more circuits of recirculating steel balls which roll between the nut and screw.

Bearing
A support device which allows a smooth, low friction motion between two surfaces loaded against each other.

Bushing
A cylindrical metal sleeve inserted into a machine part to reduce friction between moving parts.

Closed Loop
A positioning system which employs feedback information to regulate the output response.

Cogging
Motor torque variations which occur at low speeds due to a weak magnetic field.

Critical Speed
Rotational speed of a ball screw at which vibrations (whipping) will occur.

Current
The flow of charge through a conductor.

Cycle
One complete extension and retraction of a positioner.

Deceleration
The change in velocity as a function of time, going from a higher speed to a lower speed.

Drive Ratio
The ratio of motor revolutions per ball/lead screws revolution.

Drive Train
The arrangement by which the motor is coupled to the ball/lead screws. Typically provided by gears, timing belt/pulley or direct coupling.

Duty Cycle
The ratio of motor on time and total cycle time within a given cycle of operation.

$$\text{Duty Cycle}\ (\%) = \frac{\text{Motor ON Time}}{\text{Total Cycle Time}} \times 100$$

Dwell Time
Time within a move cycle where no motion occurs.

Efficiency
Ratio of output power vs. input power.

Electric Cylinder
A self contained system which converts rotary motion (from a motor) to linear motion.

Encoder
An electromechanical device which produces discrete electrical pulses directly related to the angular position of the input shaft, providing high resolution feedback data on position, velocity, and direction.

Force
The action of one body on another which tends to change the state of motion of that body. Typically described in terms of magnitude, direction, and point of application.

Friction
The resistance to motion of two surfaces that touch.

Helical Gear
Gears with teeth that spiral around the gear.

Incremental Move
A move referenced from the current set position.

Inertia
Property of an object that resists a change in motion. It is dependent on the mass and shape of the object. The greater an object's mass, the greater its inertia, and the more force is necessary to accelerate and decelerate.

Lead
The linear distance a nut will travel with one revolution of the Ball / Lead Screw.

Screw Assembly
Device which converts rotary motion to linear motion.

Mass
The quantity of matter that an object contains.

Microprocessor
A device that incorporates many or all functions of a computer in a single integrated circuit. Used to perform calculations and logic required to do motion or process control.

Moment (Load)
Rotational forces applied to a linear axis, typically expressed as yaw, pitch, and roll.

Motion Profile
A method of describing a move operation in terms of time, position, and velocity. Typically velocity is characterized as a function of time or distance which results in a triangular or trapezoidal profile.

Motor
A device which converts electrical energy into mechanical energy.

Non-Volatile Memory
Memory that does not lose information on loss of power.

Open Loop

A positioning system which does not employ feedback information.

Overshoot

The amount by which a parameter being controlled exceeds the desired value. Typically referring to velocity or position in servo systems.

Pitch

The number of revolutions a Ball / Lead Screw must turn for the nut to travel one inch (single start only).

PLC (Programmable Logic Controller)

A programmable device which utilizes "ladder" logic to control a bank of inputs and outputs which are interfaced to external devices.

Power

How much work is done in a specific amount of time.

Repeatability

The ability of a positioning system to return to an exact location during operation (from the same direction with the same load and speed).

Resistance

The opposition to the flow of charge through a conductor.

Resolution

The smallest positioning increment achievable. In digitally programmed systems it is the smallest specifiable positioning increment.

Resonance

Oscillatory behavior in a mechanical body when operated or subjected to a periodic force occurring at its natural frequency.

RS232C

A method of Serial Communication where data is encoded and transmitted on a single line in a sequential time format.

Servo Motor

A motor which is used in closed loop systems where feedback is used to control motor velocity, position, or torque.

Stepper Motor

Motor which translates electrical pulses into precise mechanical movements. Through appropriate drive circuitry, controlling the rate and quantity of pulses will control the motor's velocity and position.

Thrust

The measurement of linear force.

Torque

A measure of angular force which produces rotational motion.

Velocity (Speed)

The change in position as a function of time.

Voltage

Difference in electrical potential between two points.

Weight

Force of gravity acting on a body. Determined by multiplying the mass of the object by the acceleration due to gravity.

Conversion Tables

Torque

A \ B	dyne-cm	**gm-cm**	oz-in	**kg-cm**	lb-in	**N-m**	lb-ft	**kg-m**
dyne-cm	1	**$1.019x10^{-2}$**	$1.416x10^{-5}$	**$1.0197x10^{-6}$**	$8.850x10^{-7}$	**10^{-7}**	$7.375x10^{-6}$	**$1.019x10^{-6}$**
gm-cm	980.665	**1**	$1.388x10^{-2}$	**10^{-3}**	$8.679x10^{-4}$	**$9.806x10^{-5}$**	$7.233x10^{-5}$	**10^{-5}**
oz-in	$7.061x10^{4}$	**72.007**	1	**$7.200x10^{-2}$**	$6.25x10^{-2}$	**$7.061x10^{-3}$**	$5.208x10^{-3}$	**$7.200x10^{-4}$**
kg-cm	$9.806x10^{5}$	**1000**	13.877	**1**	0.8679	**$9.806x10^{-2}$**	$7.233x10^{-2}$	**10^{-2}**
lb-in	$1.129x10^{6}$	**$1.152x10^{3}$**	16	**1.152**	1	**0.112**	$8.333x10^{-2}$	**$1.152x10^{-2}$**
N-m	10^{7}	**$1.019x10^{4}$**	141.612	**10.197**	8.850	**1**	0.737	**0.102**
lb-ft	$1.355x10^{7}$	**$1.382x10^{4}$**	192	**13.825**	12	**1.355**	1	**0.138**
kg-m	$9.806x10^{7}$	**10^{5}**	$1.388x10^{3}$	**100**	86.796	**9.806**	7.233	**1**

Inertia (Rotary)

A \ B	gm-cm^2	**oz-in^2**	gm-cm-s^2	**kg-cm^2**	lb-in^2	**oz-in-s^2**	lb-ft^2	**kg-cm-s^2**	lb-in-s^2	**lb-ft-s^2 or slug-ft-s^2**
gm-cm^2	1	**$5.46x10^{-2}$**	$1.01x10^{-3}$	**10^{-3}**	$3.417x10^{-4}$	**$1.41x10^{-5}$**	$2.37x10^{-6}$	**$1.01x10^{-4}$**	$8.85x10^{-7}$	**$7.37x10^{-4}$**
oz-in^2	182.9	**1**	0.186	**0.182**	0.0625	**$2.59x10^{-3}$**	$4.34x10^{-4}$	**$1.86x10^{-4}$**	$1.61x10^{-4}$	**$1.34x10^{-5}$**
gm-cm-s^2	980.6	**5.36**	1	**0.9806**	0.335	**$1.38x10^{-2}$**	$2.32x10^{-3}$	**10^{-3}**	$8.67x10^{-4}$	**$7.23x10^{-5}$**
kg-cm^2	1000	**5.46**	1.019	**1**	0.3417	**$1.41x10^{-2}$**	$2.37x10^{-3}$	**$1.019x10^{-3}$**	$8.85x10^{-4}$	**$7.37x10^{-5}$**
lb-in^2	$2.92x10^{3}$	**16**	2.984	**2.925**	1	**$4.14x10^{-2}$**	$6.94x10^{-3}$	**$2.96x10^{-3}$**	$2.59x10^{-3}$	**$2.15x10^{-4}$**
oz-in-s^2	$7.06x10^{4}$	**386.08**	72.0	**70.615**	24.13	**1**	0.1675	**$7.20x10^{-2}$**	$6.25x10^{-2}$	**$5.20x10^{-3}$**
lb-ft^2	$4.21x10^{5}$	**2304**	429.71	**421.40**	144	**5.967**	1	**0.4297**	0.3729	**$3.10x10^{-2}$**
kg-cm-s^2	$9.8x10^{5}$	**$5.36x10^{3}$**	1000	**980.66**	335.1	**13.887**	2.327	**1**	0.8679	**$7.23x10^{-2}$**
lb-in-s^2	$1.129x10^{4}$	**$6.177x10^{3}$**	$1.152x10^{3}$	**$1.129x10^{3}$**	386.08	**16**	2.681	**1.152**	1	**$8.33x10^{-2}$**
lb-ft-s^2 or slug-ft^2	$1.355x10^{7}$	**$7.41x10^{4}$**	$1.38x10^{4}$	**$1.35x10^{4}$**	$4.63x10^{3}$	**192**	32.17	**13.825**	12	**1**

Angular Velocity

A \ B	deg/s	**rad/s**	rpm	**rps**
deg/s	1	**1.75 x 10^{-2}**	0.167	**2.78 x 10^{-3}**
rad/s	57.3	**1**	9.55	0.**159**
rpm	6	0.**105**	1	**1.67 x 10^{-2}**
rps	360	**6.28**	60	**1**

Linear Velocity

A \ B	in/min	**ft/min**	in/sec	**ft/sec**	mm/sec	**m/sec**
in/min	1	0.**0833**	0.0167	**1.39 x10^{-3}**	0.42	**4.2 x10^{-4}**
ft/min	12	**1**	0.2	0.**0167**	5.08	**5.08 x10^{-3}**
in/sec	60	**5**	1	**0.083**	25.4	**0.0254**
ft/sec	720	**60**	12	**1**	304.8	0.**3048**
cm/sec	23.62	**1.97**	0.3937	0.**0328**	10	**0.01**
m	2362.2	**196.9**	39.37	**3.281**	1000	**1**

Abbreviated Terms

C	=	Celsius	lb(f)	=	pound force
cm	=	centimeter	lb(m)	=	pound mass
F	=	Fahrenheit	min	=	minute
ft	=	foot	mm	=	millimeter
g	=	gravity	m	=	meter
gm	=	gram	N	=	Newton
gm(f)	=	gram force	oz(f)	=	ounce force
hp	=	horse power	oz(m)	=	ounce mass
in	=	inch	rad	=	radians
kg	=	kilogram	rpm	=	revs per minute
kg(f)	=	kilogram force	rps	=	revs per second
kw	=	kilowatt	s	=	seconds

Metric Prefixes

Name	Abbreviation		Multiple
Giga	G	10^{9}	1,000,000,000
Mega	M	10^{6}	1,000,000
Kilo	k	10^{3}	1,000
Hecto	h	10^{2}	100
deka	da	10^{1}	10
—	—	10^{0}	1
deci	d	10^{-1}	.1
centi	c	10^{-2}	.01
milli	m	10^{-3}	.001
micro	µ	10^{-6}	.000001
nano	n	10^{-9}	.000000001

Conversion Tables

(To convert from A to B, multiply by entry in table)

Length

A \ B	in	ft	micron (μm)	mm	cm	m
in	1	**0.0833**	$2.54x10^{4}$	**25.4**	2.54	**0.0254**
ft	12	**1**	$3.048x10^{5}$	**304.8**	30.48	**0.3048**
micron(μm)	$3.937x10^{-7}$	**$3.281x10^{-6}$**	1	**0.001**	$1.0x10^{-4}$	**$1.0x10^{-6}$**
mm	0.03937	**0.00328**	1000	**1**	0.1	**0.001**
cm	0.3937	**0.03281**	$1.0x10^{4}$	**10**	1	**0.01**
m	39.37	**3.281**	$1.0x10^{6}$	**1000**	100	**1**

Mass

A \ B	gm	kg	slug	lb(m)	oz(m)
gm	1	**0.001**	$6.852x10^{-5}$	**$2.205x10^{-3}$**	0.03527
kg	1000	**1**	$6.852x10^{-2}$	**2.205**	35.274
slug	14590	**14.59**	1	**32.2**	514.72
lb(m)	453.6	**0.45359**	0.0311	**1**	16
oz(m)	28.35	**0.02835**	$1.94x10^{-3}$	**0.0625**	1

Force

A \ B	lb(f)	N	dyne	oz(f)	kg(f)	gm(f)
lb(f)	1	**4.4482**	4.448×10^{5}	**16**	0.45359	**453.6**
N	0.22481	**1**	100.000	**3.5967**	0.10197	——
dyne	2.248×10^{-6}	**0.00001**	1	**$3.59x10^{-5}$**	——	**980.6**
oz(f)	0.0625	**0.27801**	$2.78x10^{4}$	**1**	0.02835	**28.35**
kg(f)	2.205	**9.80665**	——	**35.274**	1	**1000**
gm(f)	$2.205x10^{-3}$	——	$1.02x10^{-3}$	**0.03527**	0.001	**1**

Note: lb(f) = 1slug x 1 ft/s^2 N = 1kg x 1 m/s^2 dyne = 1gm x 1 cm/s^2

Power

A \ B	Watts	kw	hp(english)	hp(metric)	ft-lb/s	in-lb/s
Watts	1	**1×10^{-3}**	1.34×10^{-3}	**1.36×10^{-3}**	0.74	**8.88**
kw	1000	**1**	1.34	**1.36**	738	**8880**
hp(english)	746	**0.746**	1	**1.01**	550	**6600**
hp(metric)	736	**0.736**	0.986	**1**	543	**6516**
ft-lb/s	1.35	**1.36×10^{-3}**	1.82×10^{-3}	**1.84×10^{-3}**	1	**12**
in-lb/s	**0**.113	**1.13×10^{-4}**	1.52×10^{-4}	**1.53×10^{-4}**	8.3×10^{-2}	**1**

NEMA and Material Specifications

Material Densities

	oz/in³	lb/in³	gm/cm³
Aluminum	1.57	0.098	2.72
Brass	4.96	0.31	8.6
Bronze	4.72	0.295	8.17
Copper	5.15	0.322	8.91
Plastic	0.64	0.04	1.11
Steel	4.48	0.28	7.75
Hard Wood	0.46	0.029	0.8
Soft Wood	0.28	0.018	0.48

Friction Coefficients

(Sliding)	μ_s
Steel on Steel	0.58
Steel on Steel (Greased)	0.15
Aluminum on Steel	0.45
Copper on Steel	0.36
Brass on Steel	0.40
Plastic on Steel	0.2
Linear Bearings	0.001

Mechanism Efficiencies

Lead Screw (Bronze Nut)	0.4
Lead Screw (Plastic Nut)	0.5
Ball Screw	0.9
Helical Gear	0.7
Spur Gear	0.6
Timing Belt/Pulley	0.9

Temperature

°F = (1.8 x °C) + 32

°C = 0.555 (°F - 32)

Gravity

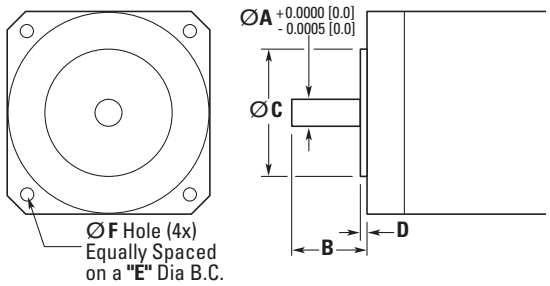
(Acceleration Constant)

g = 386 in/s² = 32.2 ft/s² = 9.8 m/s²

NEMA Standard Motor Dimensions

Dimension (in)	NEMA 17	NEMA 23	NEMA 34	NEMA 42
"A" Motor Shaft Diameter	0.197	0.250	0.375	0.625
"B" Motor Shaft Length*	0.945	0.810	1.250	1.380
"C" Pilot Diameter	0.866	1.500	2.875	2.186
"D" Pilot Length*	0.080	0.062	0.062	0.062
"E" Mounting Bolt Circle	1.725	2.625	3.875	4.950
"F" Bolt Hole Size	0.127	0.195	0.218	0.218

* These dimensions can be less than value indicated.



Application Worksheet

For selection assistance, fax, to your local Kollmorgen Distributor or directly to Kollmorgen

Prepared By

Name _____

Company _____

Phone _____

Fax _____

Email _____

Address _____

Prepared For

Name _____

Company _____

Phone _____

Fax _____

E-mail _____

Address _____

User's primary business _____

_____

Type of machine Kollmorgen product to be used on _____

_____

Current Kollmorgen user? Yes ☐ No ☐

Project Time Frame

Proposal ____/____/____

Build prototype ____/____/____

In production ____/____/____

Volume Requirements

Next 12 months: _____

Year 2: _____

Year 3: _____

Action Required

☐ Demo

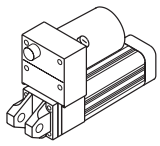
☐ Recommend product

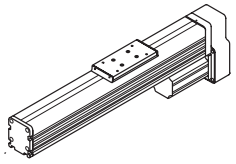
☐ Price quotation

☐ Call me to discuss

Please include drawings, comments or additional information on separate pages.

☐ Electric Cylinder or ☐ Rodless Actuator





Loads

Payload

Weight _____ lb

☐ Payload Externally Supported, by _____ (rails, etc.)

Hold Position:
☐ After move ☐ Power off

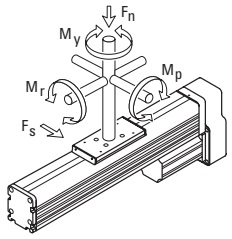
Carriage Loads (Rodless only)

M_p _____ lb-in

M_r _____ lb-in

M_y _____ lb-in

Side Load _____ lb



Orientation

☐ Vertical

☐ Horizontal

☐ Inclined _____ (angle from horizontal plane)

Motion

Travel

Stroke Length Required _____ in
(= usable travel distance + min. 2 inches for limit switches)

Shortest Move _____ in

Speed (WCM=Worst-Case Move)

WCM Distance _____ in

Time for WCM _____ sec

or

Max. Speed _____ in/sec

Min. Speed _____ in/sec

Complete Move Profile Chart (see p. 100)

Precision

Repeatability _____ in

Accuracy _____ in

Max. Backlash _____ in

Resolution _____ in

Straightness/Flatness _____ in

Thrust Calculation (See Engineering Section in this catalog for assistance)

Thrust

Thrust = Force ACCELERATED MASS + Force FRICTION + Force GRAVITY + Force EXTERNAL

_____ lb = _____ lb + _____ lb + _____ lb + _____ lb

Duty Cycle/Life

Duty Cycle

Total Cycle Time _____ sec. Extend/Retract Cycles per day _____

Sum of Move Times _____ sec. Move Distance per cycle _____

Complete Move Profile Chart (see next page)

Required Life

Units: ☐ Inches ☐ Meters ☐ Cycles ☐ Months ☐ Years

Minimum Life _____

Maintenance/Lube Interval _____

Environment

Operating Temperature

☐ Normal 32-140°F [0-60°C]

☐ High Temp. _____ °F / °C

☐ Low Temp. _____ °F / °C

Contaminants (Check all that apply)

Solid: _____

☐ non-abrasive ☐ coarse chips

☐ abrasive ☐ fine dust

Liquid: _____

☐ Dripping ☐ Non-corrosive

☐ Mist / Spray ☐ Corrosive

☐ Splashing

☐ High Pressure

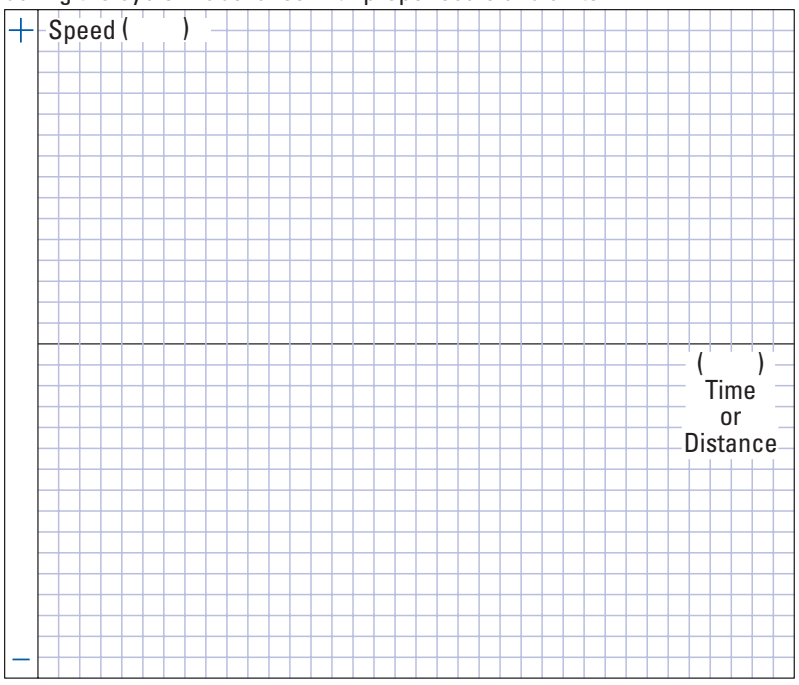
Conditions

☐ Washdown ☐ Outdoor ☐ Vacuum ☐ Cleanroom

Application Worksheet

Move Profile

Graph your most demanding cycle, include accel/decel, velocity and dwell times. You may also want to indicate load variations and I/O changes during the cycle. Label axes with proper scale and units.



Control Method

☐ Motion or Fieldbus Network _____

☐ Manual Jog

☐ Limit Switches

☐ Digital (Step & Direction)
☐ Analog Torque
☐ Programmable (Basic)

☐ Analog Velocity
☐ Analog Position
☐ IEC61131 Control

Description of Application

Motor Type Preferred

☐ Servo ☐ Stepper

☐ Other _____

Axes of Motion

☐ Single ☐ Multiple # _____

☐ Synchronized

Interface

☐ Fieldbus _____

☐ PLC ☐ Computer

☐ Analog I/O ☐ RS232

☐ Digital I/O Control

☐ Other _____

Operator

☐ Keypad/LCD Display

☐ Pushbuttons

☐ HMI Size (H x W): _____

Supply Voltage

☐ 110 Vac ☐ 220 Vac

☐ 400 Vac ☐ 480 Vac

☐ Other _____

Feedback Required

☐ Encoder ☐ Linear Potentiometer

☐ Other _____

Resolution Required _____

Input Functions

Output Functions

Model Nomenclature

N2 Series Electric Cylinder with AKM Servo Motors

N2 – AKM23D – BNC – 15 – 5B – 8 – MP2 – FT1M – ( ) – CO

N2 Series

Motor Type*

AKM23D = AKM23D-EFxxx-00 brushless servo
AKM23C = AKM23C-EFxxx-00 brushless servo

Motor Options

Bxx = Rotatable IP65 connectors
Cxx = 0.5 m shielded cables w/ IP65 connectors
xNx = No brake
x2x = 24 Vdc power-off holding brake
xxR = Resolver
xx2 = 2048 LPR incremental comm. encoder
xxC = Smart Feedback Device (SFD)

Drive Ratio

10 = 1.0:1 drive belt/pulley
10L = 1.0:1 inline coupling (direct 1:1 coupling is the only ratio available for inline models)
15 = 1.5:1 drive belt/pulley
20 = 2.0:1 drive belt/pulley
25 = 2.5:1 helical gears

Screw Pitch, Type

2B = 2 rev/inch ballscrew
5B = 5 rev/inch ballscrew
5A = 5 rev/inch lead screw
8A = 8 rev/inch lead screw

Stroke Length**

2 = 2 inch total stroke
4 = 4 inch total stroke
6 = 6 inch total stroke
8 = 8 inch total stroke
12 = 12 inch total stroke
18 = 18 inch total stroke (requires -DB option, effective stroke is 16.5")
24 = 24 inch total stroke (requires -DB option, effective stroke is 22.5")
nn.n = Custom stroke lengths available in 0.1 inch increments

Cable

CO = No cable supplied, motor includes connectors. Default for all AKM servo motors; select Kollmorgen cables based on motor/drive pairings.

Options***

(add multiple in the following sequence, omit if no option required)

BS24 = 24 Vdc brake on lead screw (not available with 10L ratio, or with MF2, MF3, MS2, MP2, MP3 mounting options)
DB = Dual rod end bearing
PB = Protective boot
W = Water resistant
F = Sub-freezing temperature
H = High temperature prep
L = Linear potentiometer (only for valid std. lengths)

Rod Ends

FC2 = Clevis (includes MT1M)
FE2 = Female eye rod end
FS2 = Spherical joint (includes FT1M)
FT1M = Female thread (metric)
FT1E = Female thread (English)
MT1M = Male thread (metric)
MT1E = Male thread (English)

Cylinder Mounting

MF1 = Front rectangular flange
MF2 = Rear rectangular flange
MF3 = Front & rear rectangular flange
MP2 = Rear double clevis without pivot base
MP3 = Rear double clevis with pivot base
MS1 = Side end angle
MS2 = Side lugs
MS6M = Side tapped holes (metric)
MS6E = Side tapped holes (English)
MT4 = Trunion

* Contact customer support for AKM combinations outside of those listed.
** For custom lengths round up to next standard incremental plus add standard cut fee.
*** Contact customer support for non-standard pricing and lead times.
Note: Options shown in blue text are considered standard.

N2 Series Electric Cylinder with Stepper Motors

N2 – T22T – 15 – 5B – 8 – MP2 – FT1M – ( )

N2 Series

Motor Type

T22T = T22NSLS-LDN-SS-02
T22V = T22NSLE-LDN-SS-02

Drive Ratio

10 = 1.0:1 drive belt/pulley
10L = 1.0:1 inline coupling (direct 1:1 coupling is the only ratio available for inline models)
15 = 1.5:1 drive belt/pulley
20 = 2.0:1 drive belt/pulley
25 = 2.5:1 helical gears

Screw Pitch, Type

2B = 2 rev/inch ballscrew
5B = 5 rev/inch ballscrew
5A = 5 rev/inch lead screw
8A = 8 rev/inch lead screw

Stroke Length*

2 = 2 inch total stroke
4 = 4 inch total stroke
6 = 6 inch total stroke
8 = 8 inch total stroke
12 = 12 inch total stroke
18 = 18 inch total stroke (requires -DB option, effective stroke is 16.5")
24 = 24 inch total stroke (requires -DB option, effective stroke is 22.5")
nn.n = Custom stroke lengths available in 0.1 inch increments

Options**

(add multiple in the following sequence, omit if no option required)

BS24 = 24 Vdc brake on lead screw (not available with 10L ratio, or with MF2, MF3, MS2, MP2, MP3 mounting options)
DB = Dual front braking
PB = Protective boot
W = Water resistant
F = Sub-freezing temperature
H = High temperature prep
L = Linear potentiometer (only for valid std. lengths)

Cables

CO = w/o motor cable
blank = 12 ft. motor cable
C25 = 25 ft. motor cable
C50 = 50 ft. motor cable

Rod Ends

FC2 = Clevis (includes MT1M)
FE2 = Female eye rod end
FS2 = Spherical joint (includes FT1M)
FT1M = Female thread (metric)
FT1E = Female thread (English)
MT1M = Male thread (metric)
MT1E = Male thread (English)

Cylinder Mounting

MF1 = Front rectangular flange
MF2 = Rear rectangular flange
MF3 = Front & rear rectangular flange
MP2 = Rear double clevis without pivot base
MP3 = Rear double clevis with pivot base
MS1 = Side end angle
MS2 = Side lugs
MS6M = Side tapped holes (metric)
MS6E = Side tapped holes (English)
MT4 = Trunion

* For custom lengths round up to next standard incremental plus add standard cut fee.
** Contact customer support for non-standard pricing and lead times.
Note: Options shown in blue text are considered standard.

EC Series Electric Cylinder with AKM Servo Motors

EC Series	Motor Type	Motor Options	Drive Ratio	Screw Lead	Stroke Length	Cylinder Mounting	Rod Ends	Options	Cable Option
EC2	– AKM23D	– BNC	– 10	– 05B	– 300	– MP2	– FT1M	– ( )	– CO

EC Series

EC1
EC2
EC3
EC4
EC5

Motor Type

	Available
AKM11B = AKM11B-ANCNx-00 brushless servo	EC1
AKM13C = AKM13C-ANCNx-00 brushless servo	EC1
AKM23D = AKM23D-EFxxx-00 brushless servo	EC2, EC3
AKM23C = AKM23C-EFxxx-00 brushless servo	EC2, EC3
AKM42G = AKM42G-EKxxx-00 brushless servo	EC3, EC4, EC5
AKM42E = AKM42E-EKxxx-00 brushless servo	EC3, EC4, EC5
AKM52G = AKM52G-EKxxx-00 brushless servo	EC4, EC5
AKM52H = AKM52H-EKxxx-00 brushless servo	EC4, EC5
AKM52L = AKM52L-EKxxx-00 brushless servo	EC4, EC5
X = Customer-supplied motor (motor described in Options element of part number)	All

Motor Options

	Available
Bxx = Rotatable IP65 connectors	AKM2
Cxx = 0.5 m shielded cables w/ IP65 connectors	AKM1, AKM2
Cxx = Rotatable IP65 connectors	AKM4, AKM5
xNx = No brake	AKM1, AKM2, AKM4, AKM5
x2x = 24 Vdc power-off holding brake	AKM2, AKM4, AKM5
xxR = Resolver	AKM1, AKM2, AKM4, AKM5
xx2 = 2048 LPR incremental comm. encoder	AKM1, AKM2, AKM4, AKM5
xxC = Smart Feedback Device (SFD)	AKM1, AKM2, AKM4, AKM5

Drive Ratio

	Available
10 = 1.0:1 drive belt/pulley (EC1 – helical)	All
10L = 1.0:1 inline coupling (direct 1:1 coupling is the only ratio available for inline models)	All
15 = 1.5:1 drive belt/pulley	EC2, EC3, EC4, EC5
20 = 2.0:1 drive belt/pulley (EC1 – helical)	Not valid for EC3-AKM42
40 = 4.0:1 helical gears	EC1 only
50 = 5.0:1 helical gears	EC2, EC3, EC4, EC5
70 = 7.1:1 helical gears	EC3 only
100 = 10.0:1 helical gears	EC2, EC4, EC5

Screw Lead

	Available
03M = 3 mm/rev ballscrew	EC1
05B = 5 mm/rev ballscrew	EC2, EC3
10B = 10 mm/rev ballscrew	EC3, EC4, EC5
16B = 16 mm/rev ballscrew	EC2, EC3
25B = 25 mm/rev ballscrew	EC4
32B = 32 mm/rev ballscrew	EC5
04A = 4 mm/rev lead screw	EC2, EC3

Stroke Length

	Available
50 = 50 mm total stroke	All
100 = 100 mm total stroke	All
150 = 150 mm total stroke	All
200 = 200 mm total stroke	All
250 = 250 mm total stroke	EC2, EC3, EC4, EC5
300 = 300 mm total stroke	EC2, EC3, EC4, EC5
450 = 450 mm total stroke	EC2, EC3, EC4, EC5
600 = 600 mm total stroke	EC2, EC3, EC4, EC5
750 = 700 mm total stroke	EC2, EC3, EC4, EC5
1000 = 1,000 mm total stroke	EC3, EC4, EC5
1250 = 1,250 mm total stroke	EC4, EC5
1500 = 1,500 mm total stroke	EC4, EC5
nnn = Custom stroke lengths available in 10 mm increments	

Cylinder Mounting

	Available
MF1 = Front rectangular flange	EC1, EC2, EC3, EC5
MF1E = Front rectangular flange (English)	EC4 only
MF1M = Front rectangular flange (metric)	EC4 only
MF2 = Rear rectangular flange	EC2, EC3, EC5
MF2E = Rear rectangular flange (English)	EC4 only
MF2M = Rear rectangular flange (metric)	EC4 only
MF3 = Front & rear rectangular flange	EC2, EC3, EC5
MF3E = Front & rear rectangular flange	EC4 only
MF3M = Front & rear rectangular flange	EC4 only
MP2 = Rear double clevis without pivot base	All
MP3 = Rear double clevis with pivot base	All
MS1 = Side end angle	EC2, EC3
MS2 = Side lugs	All
MS6M = Side tapped holes (metric)	All
MS6E = Side tapped holes (English)	EC2, EC3, EC4, EC5
MT4 = Trunnion	EC2, EC3, EC4, EC5

Rod Ends

	Available
FC2 = Clevis (includes MT1M)	All
FS2 = Spherical joint (includes FT1M)	All
FT1M = Female thread (metric)	All
FT1E = Female thread (English)	EC2, EC3, EC4, EC5
MT1M = Male thread (metric)	All
MT1E = Male thread (English)	EC2, EC3, EC4, EC5

Options

(add multiple in the following sequence, omit if no options)

BA24 = 24 Vdc brake on actuator (EC1 only, not available with 10L ratio or MS1 mounting options)
BS24 = 24 Vdc brake on ballscrew (not available with EC1 or 10L ratio, or with MF2(x), MF3(x), MS1, MP2(x), MP3(x) mounting options)
BS115 = 115 Vac brake on ballscrew (not available with EC1 or 10L ratio, or with MF2(x), MF3(x), MS1, MP2(x), MP3(x) mounting options)
PB = Protective boot*
L = Linear potentiometer (only valid through 600 mm stroke, standard lengths)*
17X = NEMA 17 mountless motor (EC1 only)

Cable

CO = No cable supplies, motor includes connectors.
Default for all AKM Servo Motors; select cable as an accessory.
*Contact customer service for EC1

Note: Options shown in blue text are considered standard.

EC Series Electric Cylinder with Stepper Motors

EC Series	Motor Type	Drive Ratio	Screw Lead	Stroke Length	Cylinder Mounting	Rod Ends	Options	Cable Option
EC2	– T22T	– 10	– 05B	– 300	– MP2	– FT1M	– ( )	– C0

EC Series

EC1
EC2
EC3
EC4
EC5

Motor Type

	Available
CTP12 = CTP12xLF10MMA00 stepper motor	EC1
T22T = T22NSLS-LDN-SS-02 stepper motor	EC2, EC3
T22V = T22NSLE-LDN-SS-02 stepper motor	EC2, EC3
T31x = N31HSFH-LSS-SS-02 stepper motor	EC2, EC3, EC4, EC5
T32x = N32HSFS-LEK-SS-02 stepper motor	EC4, EC5
T41T = N41HSFS-LSS-SS-03 stepper motor	EC4, EC5

Where: x = V for 160 Vdc, or T for 320 Vdc

Drive Ratio

	Available
10 = 1.0:1 drive belt/pulley (EC1 – helical)	All
10L = 1.0:1 inline coupling (direct 1:1 coupling is the only ratio available for inline models)	All
15 = 1.5:1 drive belt/pulley	EC2, EC3, EC4, EC5
20 = 2.0:1 drive belt/pulley (EC1 – helical)	Not valid for EC3-AKM42
40 = 4.0:1 helical gears	EC1 only
50 = 5.0:1 helical gears	EC2, EC3, EC4, EC5
70 = 7.1:1 helical gears	EC3 only
100 = 10.0:1 helical gears	EC2, EC4, EC5

Screw Lead

	Available
03M = 3 mm/rev ballscrew	EC1
05B = 5 mm/rev ballscrew	EC2, EC3
10B = 10 mm/rev ballscrew	EC3, EC4, EC5
16B = 16 mm/rev ballscrew	EC2, EC3
25B = 25 mm/rev ballscrew	EC4
32B = 32 mm/rev ballscrew	EC5
04A = 4 mm/rev lead screw	EC2, EC3

Stroke Length

	Available
50 = 50 mm total stroke	All
100 = 100 mm total stroke	All
150 = 150 mm total stroke	All
200 = 200 mm total stroke	All
250 = 250 mm total stroke	EC2, EC3, EC4, EC5
300 = 300 mm total stroke	EC2, EC3, EC4, EC5
450 = 450 mm total stroke	EC2, EC3, EC4, EC5
600 = 600 mm total stroke	EC2, EC3, EC4, EC5
750 = 700 mm total stroke	EC2, EC3, EC4, EC5
1000 = 1,000 mm total stroke	EC3, EC4, EC5
1250 = 1,250 mm total stroke	EC4, EC5
1500 = 1,500 mm total stroke	EC4, EC5
nnn = Custom stroke lengths available in 10 mm increments	

Cylinder Mounting

	Available
MF1 = Front rectangular flange	EC1, EC2, EC3, EC5
MF1E = Front rectangular flange (English)	EC4 only
MF1M = Front rectangular flange (metric)	EC4 only
MF2 = Rear rectangular flange	EC2, EC3, EC5
MF2E = Rear rectangular flange (English)	EC4 only
MF2M = Rear rectangular flange (metric)	EC4 only
MF3 = Front & rear rectangular flange	EC2, EC3, EC5
MF3E = Front & rear rectangular flange	EC4 only
MF3M = Front & rear rectangular flange	EC4 only
MP2 = Rear double clevis without pivot base	All
MP3 = Rear double clevis with pivot base	All
MS1 = Side end angle	EC2, EC3
MS2 = Side lugs	All
MS6M = Side tapped holes (metric)	All
MS6E = Side tapped holes (English)	EC2, EC3, EC4, EC5
MT4 = Trunnion	EC2, EC3, EC4, EC5

Rod Ends

	Available
FC2 = Clevis (includes MT1M)	All
FS2 = Spherical joint (includes FT1M)	All
FT1M = Female thread (metric)	All
FT1E = Female thread (English)	EC2, EC3, EC4, EC5
MT1M = Male thread (metric)	All
MT1E = Male thread (English)	EC2, EC3, EC4, EC5

Options

(add multiple in the following sequence, omit if no options)

BA24 = 24 Vdc brake on actuator (EC1 only, not available with 10L ratio or MS1 mounting options)
BS24 = 24 Vdc brake on ballscrew (not available with EC1 or 10L ratio, or with MF2(x), MF3(x), MS1, MP2(x), MP3(x) mounting options)
BS115 = 115 Vac brake on ballscrew (not available with EC1 or 10L ratio, or with MF2(x), MF3(x), MS1, MP2(x), MP3(x) mounting options)
PB = Protective boot*
L = Linear potentiometer (only valid through 600 mm stroke, standard lengths)*

Cable

	Available
C0 = without motor cable	All (standard for CTP12)
blank = 12 ft. motor cable	EC2, EC3, EC4, EC5 (standard for T series)
C25 = 25 ft. motor cable	EC2, EC3, EC4, EC5
C50 = 50 ft. motor cable	EC2, EC3, EC4, EC5

*Contact customer service for EC1

Note: Options shown in bold blue text are considered standard.

Electric Cylinder Option Details

1-5 Base Model Number

Choose the model with sufficient speed and thrust with a comfortable safety margin. Refer to the Speed vs. Thrust curves.

EC cylinders with gear or timing belt drive reductions have the motor mounted parallel to the screw. Inline models have the motor coupled directly to the screw with no reduction.

6. Stroke Length

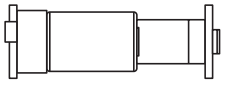
Standard lengths are listed, and custom lengths are also available. To maximize cylinder life, the thrust tube should not impact the physical end-of-travel on either end. Extra travel length is necessary to decelerate the load to a stop when an end-of-travel limit switch is encountered. This extra travel distance depends on load and speed.

7. Cylinder Mounting

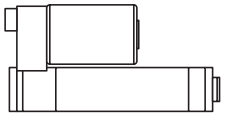
Specify any one of these cylinder mounting options. Dimensional drawings are on pages 40-45.

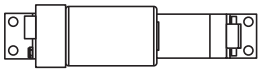
Cylinder base mount options -MS1,-MP2, -MP3, -MF2, -MF3 cannot be ordered with inline models.

MF1 Front Flange
MF2 Rear Flange
MF3 Both Flanges

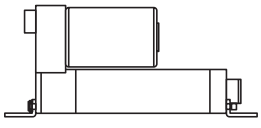


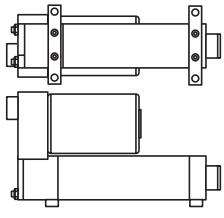
MS1 Side End Angles



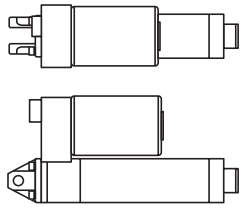


MS2 Side Lugs

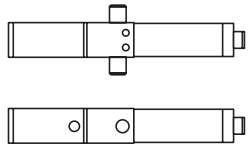




MP3 Rear Clevis
(MP2 omits pivot base)



MT4 Trunnion



Pivot Mount Caution:

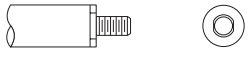
When utilizing a pivot mounting option (MP2, MP3 or MT4) in conjunction with a pivot rod end (FS2 or FC2), it is recommended that the electric cylinder be extended only to 90–95% of its full stroke. This increases the system's rigidity and extends the life of the guide bearings and rod seal.

8. Rod Ends

Four rod end types are available:

FT1M or FT1E
Female Thread

MT1M or MT1E
Male Thread



FS2 Spherical Joint

FC2 Clevis

9. Other Options

See Options and Accessories Section for complete specifications.

* Limit sensors are sold as accessories

EC1 Series Position Sensors

Hall Effect Sensors (NPN)	
Part Number	**Description**
EC1-18N	Hall effect switch (NPN, normally open), without cable
EC1-18N-NC	Hall effect switch (NPN, normally closed), without cable
EC1-18N-03	Hall effect switch (NPN, normally open), 3 m leads
EC1-18N-NC-03	Hall effect switch (NPN, normally closed), 3 m leads
EC1-18N-QD	Hall effect switch (NPN, normally open), 150 mm quick disconnect cable
EC1-18N-NC-QD	Hall effect switch (NPN, normally closed), 150 mm quick disconnect cable

Hall Effect Sensor (PNP)	
Part Number	**Description**
EC1-18P	Hall effect switch (PNP, normally open), without cable
EC1-18P-NC	Hall effect switch (PNP, normally closed), without cable
EC1-18P-03	Hall effect switch (PNP, normally open), 3 m leads
EC 1-18P-NC-03	Hall effect switch (PNP, normally closed), 3 m leads
EC1-18P-QD	Hall effect switch (PNP, normally open), 150 mm quick disconnect cable
EC1-18P-NC-QD	Hall effect switch (PNP, normally closed), 150 mm quick disconnect cable

Spare Cables	
Part Number	**Description**
QPS-4M	Spare quick disconnect cable, 4 m
QPS-9M	Spare quick disconnect cable, 9 m

N2/EC2-EC5 Series Position Sensors

Magnetic Reed Switches	
Part Number	**Description**
PSR-1	Magnetic reed switch (normally open), 3 m leads
PSR-2	Magnetic reed switch (normally closed), 3 m leads
PSR-1Q	Magnetic reed switch (normally open), 4 m quick disconnect
PSR-2Q	Magnetic reed switch (normally closed), 4 m quick disconnect
PSR-1Q-NC	Magnetic reed switch (normally open), without cable
PSR-2Q-NC	Magnetic reed switch (normally closed), without cable
PSR-1Q-C9M	Magnetic reed switch (normally open), 9 m quick disconnect
PSR-2Q-C9M	Magnetic reed switch (normally closed), 9 m quick disconnect

Hall Effect Sensors (NPN)	
Part Number	**Description**
PSN-1	Hall effect switch (NPN, normally open), 3 m leads
PSN-2	Hall effect switch (NPN, normally closed), 3 m leads
PSN-1Q	Hall effect switch (NPN, normally open), 4 m quick disconnect
PSN-2Q	Hall effect switch (NPN, normally closed), 4 m quick disconnect
PSN-1Q-NC	Hall effect switch (NPN, normally open), without cable
PSN-2Q-NC	Hall effect switch (NPN, normally closed), without cable
PSN-1Q-C9M	Hall effect switch (NPN, normally open), 9 m quick disconnect
PSN-2Q-C9M	Hall effect switch (NPN, normally closed), 9 m quick disconnect

Hall Effect Sensor (PNP)	
Part Number	**Description**
PSP-1	Hall effect switch (PNP, normally open), 3 m leads
PSP-2	Hall effect switch (PNP, normally closed), 3 m leads
PSP-1Q	Hall effect switch (PNP, normally open), 4 m quick disconnect
PSP-2Q	Hall effect switch (PNP, normally closed), 4 m quick disconnect
PSP-1Q-NC	Hall effect switch (PNP, normally open), without cable
PSP-2Q-NC	Hall effect switch (PNP, normally closed), without cable
PSP-1Q-C9M	Hall effect switch (PNP, normally open), 9 m quick disconnect
PSP-2Q-C9M	Hall effect switch (PNP, normally closed), 9 m quick disconnect

Spare Cables	
Part Number	**Description**
QPS-4M	Spare quick disconnect cable, 4 m
QPS-9M	Spare quick disconnect cable, 9 m

Other	
Part Number	**Description**
PCA-5204	E-Manual (CD-ROM), Files available Online for free download

AKD® Servo Drive

AKD – B 003 06 – NB AN – 0000

AKD Series

Version

B = Base drive
C = Central power supply for AKD-N (Requires CB Extention)
N = Decentralized drive (Requires DB, DF, or DS Extention)
P = Position indexer (motion tasking)
T = AKD BASIC Language Programmable drive (Requires IC or NB Extention)
M = Multi-axis Master Drive (Requires MC Extension option, and EC Connectivity option)

Current Rating

003 = 3 Amp
006 = 6 Amp
010 = 10kW (for AKD-C, this field refers to power.)
012 = 12 Amp
024 = 24 Amp
048 = 48 Amp

Voltage

06 = 120/240 Vac 1Ø/3Ø (24 Amp Drive: 240 Vac 3Ø only)
07 = 240/480 Vac 3Ø (Version C: 07 = 400/480 Vac 3Ø I Version N: 07 = 560/680 Vdc)

Variants

0000 = Standard

Connectivity*

	Drive Version Availability
AN = Analog command	B, P, T
CN = CANopen®	P
EC = EtherCAT®	C, M, N, P
EI = EtherNet/IP™	P
PN - PROFINET®	P
SQ = SynqNet®	B

*Motion Tasking is included as a free upgrade with CN, EC, EI and PN

Extension

CB = without extention (AKD-C version only)
DB = hybrid motor cable (AKD-N version only)
DF = additional EtherCAT® port + feedback connector (AKD-N version only)
DS = local STO + feedback connector (AKD-N version only)
IC = Expanded I/O version and SD card slot (AKD-T version only)
NB = Without extensions

Note: Options shown in blue text are considered standard.

AKM® Brushless Servo Motor

AKM 6 2 P – A N C N DA 00

AKM Series

Flange Size

1	40 mm
2	58 mm
3	70 mm
4	84 mm
5	108 mm
6	138 mm
7	188 mm
8	260 mm

Rotor Length

1
2
3
4
5

Winding Type

A to Z

S	Special

Flange

A	IEC with tolerance N
B	NEMA
C	Alternative IEC standard
D	Other standard
G	Alternative IEC standard
H	Alternative IEC standard
R	IEC with tolerance R
M, T	Reinforced bearing AKM8
W	Flange coating for Washdown, IEC
S	Special

Version

00	Standard motor without shaft seal
01	With shaft seal
0W	Washdown
0F	Washdown Food
FAN	Fan Option for AKM7 only
xx	Special

Feedback Device

For all options see following page

S	Special

Brake

2	24 V holding brake
N	Without brake
S	Special

Connections

For all options see following page

S	Special

Shaft

C	Keyway
K	Open keyway
N	Smooth shaft
S	Special

P-Series Stepper Drive

P7 03 6 0 – SD N __

P-Series
P5 = P5000 Series
P6 = P6000 Series
P7 = P7000 Series

Current Rating
03 = 2.5 Arms continuous, 3.5 Arms peak (AC models only)
05 = 5 Arms continuous, 7.2 Arms peak (DC models only)
06 = 5.7 Arms Continuous, 8.0 Amps peak*

Voltage Range
3 = 20 - 75 Vdc
6 = 120/240 Vac (160/320 Vdc)

Electrical Options
0 = None

Customization
Omit field for standard configurations
000 = Optimized for Standard POWERPAC
001 = Optimized for Enhanced POWERPAC
PMX = Optimized Powermax Settings

Feedback Device
N = No feedback, with mating connectors (P6000)
O = No feedback, no connectors

Fuctionality
PN = Motion node indexing
SD = Step/direction base drive, Internal VCO (P5000)
R4 = RS485 (P70360 only)

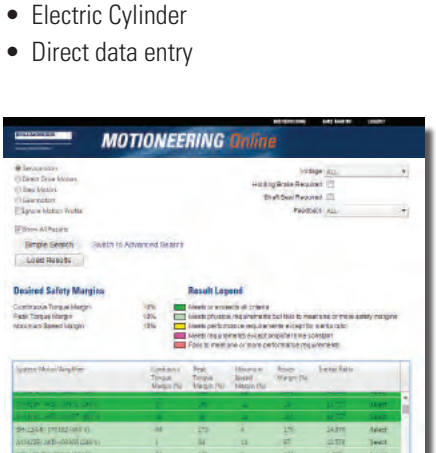
MOTIONEERING® Online

MOTIONEERING® Online – Kollmorgen has revamped, modernized and put online one of the most respected applications sizing programs of the last 20 years. You now can access this application sizing and selection tool wherever you have access to the internet. MOTIONEERING Online is just a start of a series of releases that will empower you to optimize solutions for your toughest applications. Sizing frameless motors and drive systems has never been easier. Using a mechanism project concept for collecting and saving multiple axes of load information, MOTIONEERING® Online can automatically calculate application results and compare against a catalog of systems - recommending the most optimized set of Kollmorgen system solutions available.

Versatile units-of-measure selection options for mechanism and motion profile data-entry, with the ability to convert data into other available units, makes this a convenient international tool. A user-friendly Help file teaches program functions and algorithms used to provide results.

Mechanism Projects

- Direct drive entry, lead screw, conveyor
- Rack and pinion, nip rolls
- Direct Drive Rotary
- Electric Cylinder
- Direct data entry



Solution Set Search Screen

- Color-coded indication of system's ability to meet application requirements
- Review system components specifications
- Save, print, or create a pdf application report
- Evaluate system performance curve with application points

MOTIONEERING® Online Features:

- Inertia Calculator - lets you build up inertia based on odd shapes by additive or subtractive methods
- Custom Motion Profile - easy to add entire segments or copy segments to repeat
- Environmental Factor - takes into account your ambient temperature
- Project by Project Units - You can tailor your units on a project by project basis, or use the global units settings

MOTIONEERING Online Supported Browsers

- IE, Chrome, Firefox, Safari

www.kollmorgen.com/motioneering

About Kollmorgen

Since its founding in 1916, Kollmorgen's innovative solutions have brought big ideas to life, kept the world safer, and improved peoples' lives. Today, its world-class knowledge of motion systems and components, industry-leading quality, and deep expertise in linking and integrating standard and custom products continually delivers breakthrough motion solutions that are unmatched in performance, reliability, and ease-of-use. This gives machine builders around the world an irrefutable marketplace advantage and provides their customers with ultimate peace-of-mind.

For assistance with your application needs in North America, contact us at: 540-633-3545, support@kollmorgen.com or visit www.kollmorgen.com for a global contact list.

KOLLMORGEN®

Because Motion Matters™

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