Return to table of contents

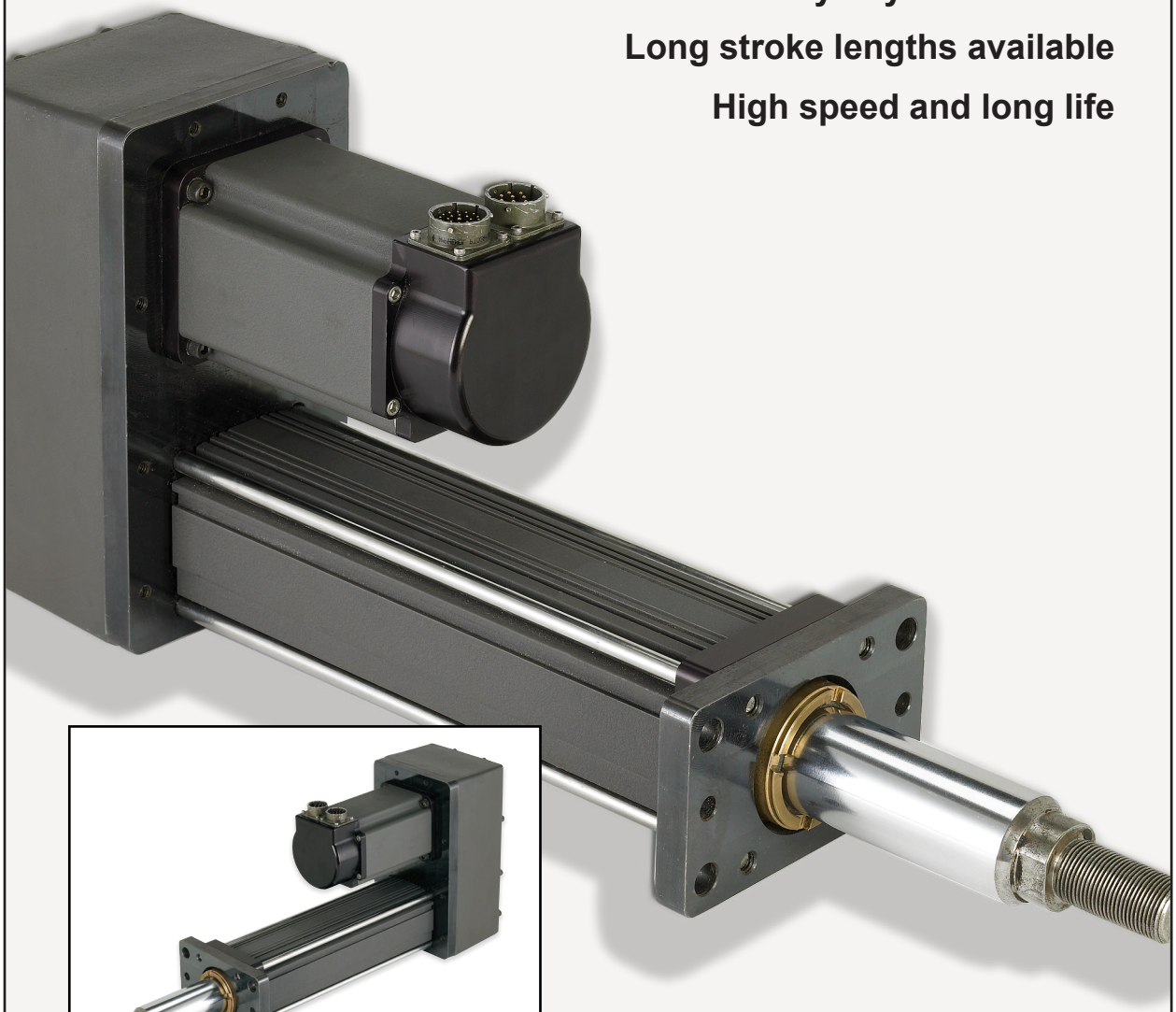
FT SERIES

HIGH FORCE ROLLER SCREW ACTUATOR

Mount virtually any servo motor

Long stroke lengths available

High speed and long life



Motors shown in drawings are for illustrative purposes only and are not included with FT Actuators.

FT Series

Linear Actuators

High Performance

As with all Exlar roller screw products, the FT Series actuators deliver heavy load capacity, high speed capabilities, and exceptionally long life when compared to other linear actuator technologies.

Other comparably-sized screw actuator products on the market, specifically ball screw and acme screw actuators, have relatively low load capacities, short working lives and limited speed capabilities. At equivalent sizes, under moderate to heavy loads, it is reasonable to project that FT units will deliver up to 15 times the working life of those other methods. For OEM designers, this often means much more power and durability can be achieved from a much smaller footprint when Exlar FT units are used.

Contamination Protection

The FT Series design has all the contamination-isolation advantages of hydraulic cylinders without the limited load, life, and speed of designs built around ball or acme screws. The bearing and roller screw components in the Exlar FT Series force tubes are mounted within the sealed housing. This prevents abrasive particles and other contaminants from entering the actuator's critical mechanisms, and assures trouble-free operation even in the most severe environments.

FT Series actuators are provided with standard grease lubrication. Custom provisions can be made for oil filled lubrication.

Feature	Standard
Long Strokes	6 inch, 12 inch, 18 inch, 24 inch, 36 inch, and 48 inch
Multiple Actuator Mountings	Side Mount, Side Lug, Extended Tie Rods, Rear Clevis, Front Flange, Side Trunnion, Rear Flange, Front/Rear Flange
Multiple Motor Mounting Configurations	Inline Direct Drive, Parallel 1:1 Drive, Parallel, 2:1 Reduction

Engineered Compatibility

Exlar has removed much of the end-user-engineering burden by designing the FT series to be compatible with a wide variety of standard motors. Motor mounting, actuator mounting, and gearing configurations are available to meet nearly any application's requirements.

Exlar FT Series force tube actuators use a planetary roller screw mounted inside a telescoping tube mechanism. The follower is attached to the moveable force tube, which then extends and retracts as the screw rotates. An external motor (supplied by Exlar or the customer) provides the rotational force.

Technical Characteristics	
Frame Sizes - in (mm)	3.5 (90), 4.8 (120), 6.0 (150), 8.0 (200)
Screw Leads - in (mm)	0.2 (5), 0.25 (6), 0.4 (10), 0.5 (12), 0.8 (20), 1.2 (30)
Standard Stroke Lengths in (mm)	6 (150)*, 12 (300), 18 (450), 24 (600), 36 (900), 48 (1200)
Force Range	up to 40,000 lbf (178 kN)
Maximum Speed	up to 60 in/sec (1524 mm/s)

*Not on FT60 or FT80

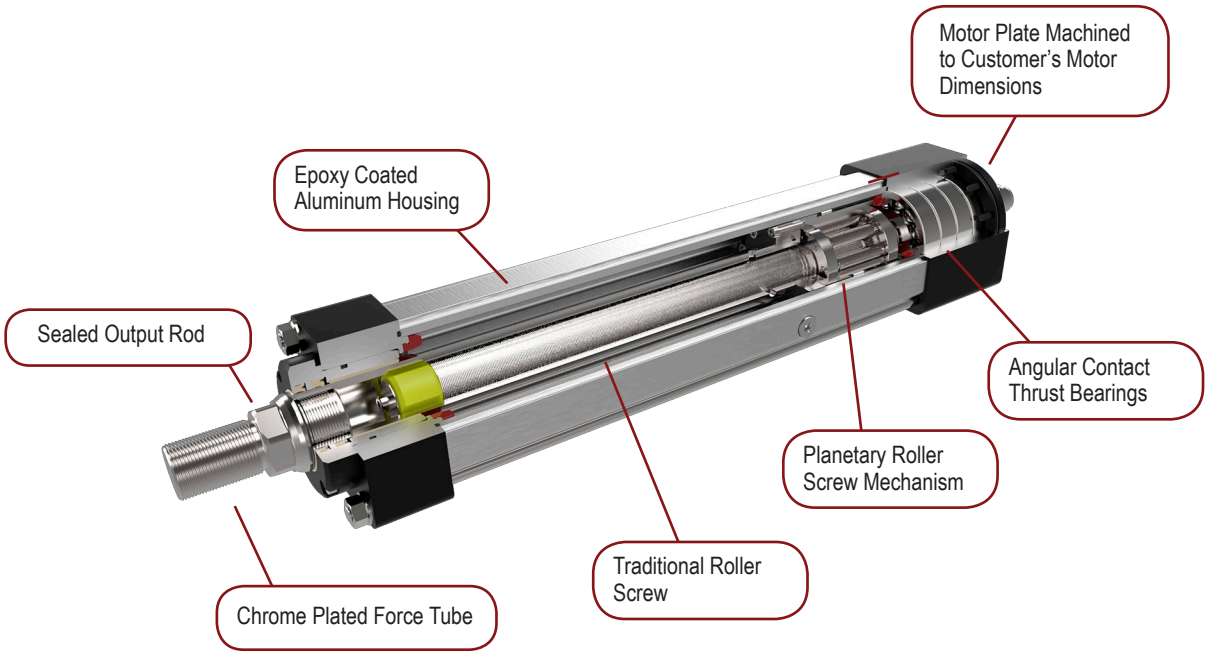
Operating Conditions and Usage		
Accuracy:		
Screw Lead Error	in/ft (µm / 300 mm)	0.001 (25)
Screw Travel Variation	in/ft (µm / 300 mm)	0.0012 (30)
Screw Lead Backlash*	in (mm)	0.002 (0.06)
Friction Torque Values	lbf-in (Nm)	FT35: 7.0 (0.79) FT45: 11.00 (1.24) FT60: 14.0 (1.58) FT80: 35.0 (3.95)
Efficiency:		
Motor Inline	%	80
Motor Parallel	%	80
Ambient Conditions:		
Standard Ambient Temperature	°C	0 to 65
Extended Ambient Temperature***	°C	-30 to 65
Storage Temperature	°C	-40 to 85
IP Rating**		IP65

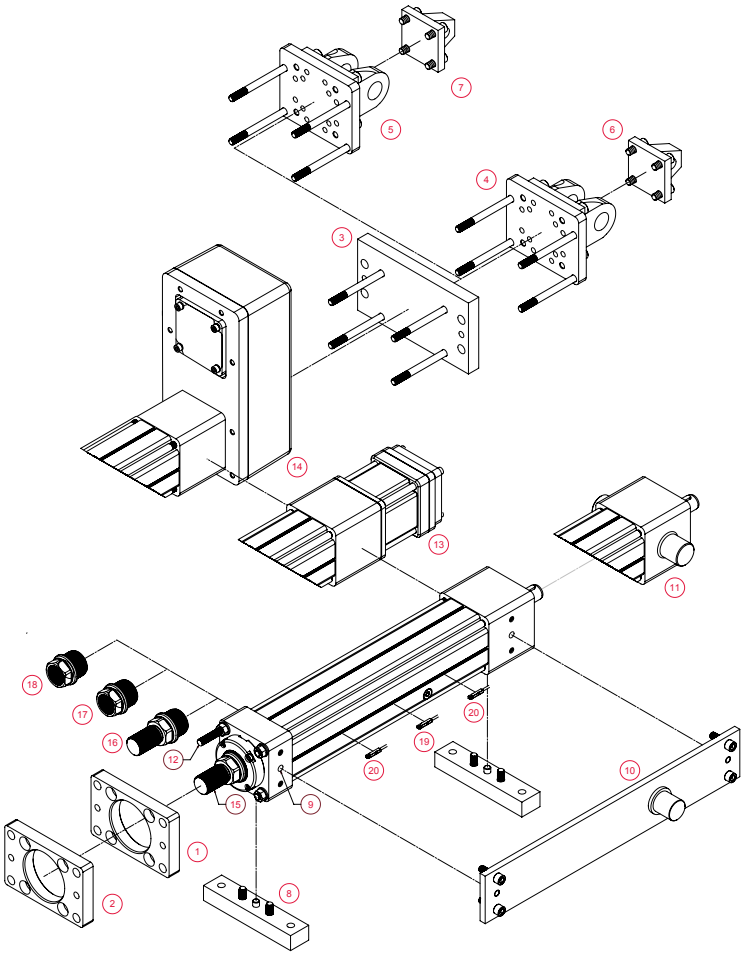
* System backlash will be different with various types of motor mounting arrangements and couplings. Please discuss your particular configuration with your local sales representative.

** For IP65S sealing of unit with motor mounted, please contact your local sales representative.

*** Consult Exlar for extended temperature operation.

Product Features





1 - Front/rear flange, English and front flange, English
2 - Front flange, metric
3 - Front/rear flange, English* and rear flange, English
4 - Rear clevis, English
5 - Rear clevis, metric
6 - Rear eye English
7- Rear eye, metric
9 - Side mount*, double side mount, metric side mount*, and metric double side mount
10 - Side trunnion and metric side trunnion
11 - Rear trunnion and metric rear trunnion
12 - Extended tie rods and metric extended tie rods
13 - Inline direct drive
14 - Parallel, 1:1 belt reduction
Parallel, 2:1 belt reduction
15 - Male, US standard thread and male, US standard thread SS
16 - Male, metric thread and male metric thread SS
17 - Female, US standard thread and female, US standard thread SS
18 - Female, metric thread and female, metric thread SS
19 - External limit switch - N.O., PNP or NPN
20 - External limit switch - N.C., PNP or NPN

*Consult Factory

Industries and Applications

Hydraulic cylinder replacement
Ball screw replacement
Pneumatic cylinder replacement

Automotive
- Lift station
- Automated assembly
- Riveting / fastening / joining
- Pressing

Sawmill/Forestry
- Saw positioning
- Fence positioning

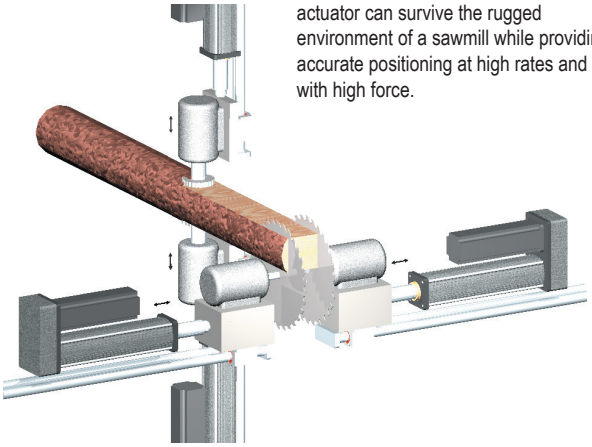
Process Control
- Conveyor diverters / gates
- Precision valve control
- Tension control

Machining
- Automated flexible fixturing
- Machine tool
- Parts clamping
- Precision grinders

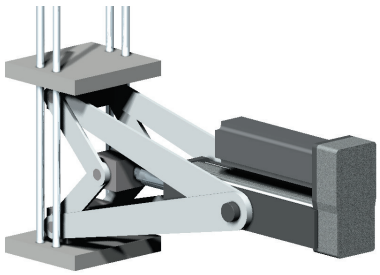
Entertainment / Simulation
- Action simulators
- Ride automation

Material Handling
- Stamping
- Indexing stages
- Product sorting
- Material cutting
- Web guidance
- Wire winding
- Pressing
- Tube bending

Test
- Test stands



The robust design of the FT series actuator can survive the rugged environment of a sawmill while providing accurate positioning at high rates and with high force.



With their high thrust capability, compact size and smooth controlled motion, FT Series actuators are an ideal replacement for hydraulics or pneumatics on injection mold toggles. Control improvements from an electromechanical servo system offer less abuse of valuable molds and more consistent performance.

Motors shown in drawings are for illustrative purposes only and are not included with FT Actuators.

Mechanical Specifications

FT35

		High Capacity			Standard Capacity		
		05	10	20	05	10	20
Screw Lead	in	0.197	0.394	0.787	0.197	0.394	0.787
	mm	5	10	20	5	10	20
Maximum Force[2]	lbf	5,000	5,000	5,000	5,000	5,000	5,000
	kN	22.2	22.2	22.2	22.2	22.2	22.2
Life at Maximum Force	in x 10^6	15.4	24.6	56.7	8.88	14.15	32.05
	km	392	626	1,440	225.6	359.4	814.2
C_a (Dynamic Load Rating)	lbf	21,400	19,850	20,800	17,800	16,500	17,200
	kN	95.2	88.3	92.5	79.2	73.4	76.5
Maximum Input Torque	lbf-in	196	392	783	196	392	783
	Nm	22.1	44.3	88.5	22.1	44.3	88.5
Max Rated RPM @ Input Shaft	RPM	4,500	4,500	4,500	4,500	4,500	4,500
Maximum Linear Speed @ Maximum Rated RPM	in/sec	14.7	29.5	59.3	14.7	29.5	59.3
	mm/sec	373	750	1,500	373	750	1,500

[1] FT35 actuators with high capacity screw option are 20 mm longer. See dimensions page 128.

[2] Maximum allowable actuator-generated force that can be applied routinely. Exceeding this force may result in permanent damage to the actuator. For high force, short stroke applications, consult factory.

Weights kg (lbs)

Base Actuator Weight	Stroke Length	6 Inch	12 Inch	18 Inch	24 Inch	36 Inch	48 Inch
	lb	30	35	40	45	55	65
	kg	14	16	18	21	25	30

Adder for Inline (excluding motor)	Adder for Parallel Drive (excluding motor)	Adder for Front Flange	Adder for Rear Flange	Adder for Rear Clevis	Adder for Rear Eye	Adder for Front/ Rear Angle Mounts	Adder for Two Trunnions	Adder for Two Foot Mounts
8 (3.6)	16 (7.3)	5.4 (2.5)	7.4 (3.4)	3.0 (1.4)	NA	NA	19.5 (8.9)	3.3 (1.5)

FT35 Reflective Inertias	5 mm Lead	10 mm Lead	20 mm Lead	
NMT Unit - J (0) NMT Unit - J (Stroke)	0.0004087 0.0000159	0.0004121 0.0000162	0.0004259 0.0000171	kg-m² (at input shaft) kg-m²/inch of stroke
Inline w/ Coupler - J (0) Inline w/ Coupler - J (Stroke)	0.0005127 0.0000159	0.0005161 0.0000162	0.0005299 0.0000171	
Parallel 1:1 - J (0) Parallel 1:1 - J (Stroke)	0.0011042 0.0000159	0.0011855 0.0000162	0.0014480 0.0000171	kg-m² (at motor shaft) kg-m²/inch of stroke
Parallel 2:1 - J (0) Parallel 2:1 - J (Stroke)	0.0014029 0.0000040	0.0014038 0.0000040	0.0015345 0.0000043	

*Pulleys for parallel mount match actuator max performance ratings

Standard Inline Coupling Inertia	
	Inertia
FT35	0.000104 kg-m² (0.000920 lbf-in s²)

Pulley inertias reflected at motor including typical pulleys, belt and standard bushings. Because of differences in belt and pulley selection due to particular motor choices, please contact your local sales representative if these values are critical to your application.

Intermediate and custom stroke lengths are available. Intermediate leads may also be available. Belt and pulley inertia varies with ratio and motor selection. Please contact your local sales representative.

*See definitions on page 124

FT45

		High Capacity		Standard Capacity	
		05	10	05	10
Screw Lead	in	0.197	0.394	0.197	0.394
	mm	5	10	5	10
Maximum Force[2]	lbf	10,000	10,000	10,000	10,000
	kN	44.5	44.5	44.5	44.5
Life at Maximum Force	in x 10^6	9.81	19.14	5.67	11.06
	km	249.2	486.3	144.0	280.9
C_a (Dynamic Load Rating)	lbf	36,800	36,500	30,650	30,400
	kN	163.7	162.4	136.3	135.2
Maximum Input Torque	lbf-in	392	783	392	783
	Nm	44.1	88.2	44.1	88.2
Max Rated RPM @ Input Shaft	RPM	3,500	3,500	3,500	3,500
Maximum Linear Speed @ Maximum Rated RPM	in/sec	11.5	23.0	11.5	23.0
	mm/sec	292	583	292	583

Weights kg (lbs)

Base Actuator Weight	Stroke Length	6 Inch	12 Inch	18 Inch	24 Inch	36 Inch	48 Inch
	lb	57	68	79	90	112	135
	kg	26	31	36	41	51	61

Adder for Inline (excluding motor)	Adder for Parallel Drive (excluding motor)	Adder for Front Flange	Adder for Rear Flange	Adder for Rear Clevis	Adder for Rear Eye	Adder for Front/ Rear Angle Mounts	Adder for Two Trunnions	Adder for Two Foot Mounts
7.1 (3.2)	42.5 (19.3)	6.1 (2.8)	17.4 (7.9)	18.9 (8.6)	19.8 (9)	NA	17.2 (7.8)	10.4 (4.7)

FT45 Reflective Inertias	5 mm Lead	10 mm Lead	
NMT Unit - J (0) NMT Unit - J (Stroke)	0.002463 0.000045	0.002474 0.000046	kg-m² (at input shaft) kg-m²/inch of stroke
Inline w/ Coupler - J (0) Inline w/ Coupler - J (Stroke)	0.002571 0.000045	0.002581 0.000046	kg-m² (at motor shaft) kg-m²/inch of stroke
Parallel 1:1 - J (0) Parallel 1:1 - J (Stroke)	0.006911 0.000045	0.006921 0.000046	
Parallel 2:1 - J (0) Parallel 2:1 - J (Stroke)	0.003466 0.000011	0.003469 0.000011	

*Pulleys for parallel mount match actuator max performance ratings

Standard Inline Coupling Inertia	
	Inertia
FT45	0.00010743 kg-m² (0.000951 lbf-in s²)

Pulley inertias reflected at motor including typical pulleys, belt and standard bushings. Because of differences in belt and pulley selection due to particular motor choices, please contact your local sales representative if these values are critical to your application.

*See definitions on page 124

FT60

		High Capacity			Standard Capacity		
		06	12	30	06	12	30
Screw Lead	in	0.236	0.472	1.181	0.236	0.472	1.181
	mm	6	12	30	6	12	30
Maximum Force[2]	lbf	20,000	20,000	20,000	20,000	20,000	20,000
	kN	89.0	89.0	89.0	89.0	89.0	89.0
Life at Maximum Force	in x 10^6	5.7	7.3	38.6	4.1	5.2	10.7
	km	145.8	184.7	981.1	104.8	133.1	271.9
C_a (Dynamic Load Rating)	lbf	57,933	49,750	63,958	51,900	44,600	41,700
	kN	257.7	221.3	284.5	230.9	198.4	185.5
Maximum Input Torque	lbf-in	940	1880	4699	940	1880	4699
	Nm	106	212	531	106	212	531
Max Rated RPM @ Input Shaft	RPM	2,000	2,000	2,000	2,000	2,000	2,000
Maximum Linear Speed @ Maximum Rated RPM	in/sec	7.9	15.8	39.0	7.9	15.8	39.0
	mm/sec	201	401	1000	201	401	1000

Intermediate and custom stroke lengths are also available. Intermediate leads may also be available. Belt and pulley inertia varies with ratio and motor selection.

* Maximum allowable actuator-generated force that can be applied routinely. Exceeding this force may result in permanent damage to the actuator. For high force, short stroke applications, consult factory.

Weights kg (lbs)

Base Actuator Weight	Stroke Length	12 inch	24 inch	36 Inch	48 Inch
	lb	100	130	160	190
	kg	45	59	72	86

Adder for Inline (excluding motor)	Adder for Parallel Drive (excluding motor)	Adder for Front Flange	Adder for Rear Flange	Adder for Rear Clevis	Adder for Rear Eye	Adder for Front/ Rear Angle Mounts	Adder for Two Trunnions	Adder for Two Foot Mounts
20.4 (9.3)	39.1 (17.7)	13.4 (6.1)	15.9 (7.2)	11.1 (5)	NA	NA	44.3 (20.1)	10.4 (4.7)

FT60 Reflective Inertias	6 mm Lead	12 mm Lead	30 mm Lead	
NMT Unit - J (0) NMT Unit - J (Stroke)	0.0078464 0.0002539	0.0078709 0.0002547	0.0080424 0.0002600	kg-m² (at input shaft) kg-m²/inch of stroke
Inline w/ Coupler - J (0) Inline w/ Coupler - J (Stroke)	0.0081764 0.0002539	0.0082009 0.0002547	0.0083724 0.0002600	kg-m² (at motor shaft) kg-m²/inch of stroke
Parallel 1:1 - J (0) Parallel 1:1 - J (Stroke)	0.0129357 0.0002539	0.0146113 0.0002547	0.0312682 0.0002600	
Parallel 2:1 - J (0) Parallel 2:1 - J (Stroke)	0.0049158 0.0000635	0.0057202 0.0000637	0.0214777 0.0000650	

*Pulleys for parallel mount match actuator max performance ratings

Standard Inline Coupling Inertia	
	Inertia
FT60	0.000330 kg-m² (0.002921 lbf-in s²)

Pulley inertias reflected at motor including typical pulleys, belt and standard bushings. Because of differences in belt and pulley selection due to particular motor choices, please contact your local sales representative if these values are critical to your application.

*See definitions on page 124

FT80

		High Capacity			Standard Capacity		
		06	12	30	06	12	30
Screw Lead	in	0.236	0.472	1.181	0.236	0.472	1.181
	mm	6	12	30	6	12	30
Maximum Force[2]	lbf	40,000	40,000	40,000	40,000	40,000	40,000
	kN	177.9	177.9	177.9	177.9	177.9	177.9
Life at Maximum Force	in x 10^6	3.1	4.4	16.3	1.94	2.55	5.00
	km	78.7	111.4	414.3	49.3	64.9	127
C_a (Dynamic Load Rating)	lbf	94,330	84,079	95,971	80,700	70,200	64,700
	kN	419.6	374	426.9	359	312.2	287.8
Maximum Input Torque	lbf-in	1,880	3,760	9,399	1,880	3,760	9,399
	Nm	212	425	1,062	212	425	1,062
Max Rated RPM @ Input Shaft	RPM	1,750	1,750	1,750	1,750	1,750	1,750
Maximum Linear Speed @ Maximum Rated RPM	in/sec	6.9	13.8	34.4	6.9	13.8	34.4
	mm/sec	175	351	875	175	351	875

Intermediate and custom stroke lengths are also available. Intermediate leads may also be available. Belt and pulley inertia varies with ratio and motor selection. Please contact your local sales representative.

* Maximum allowable actuator-generated force that can be applied routinely. Exceeding this force may result in permanent damage to the actuator. For high force, short stroke applications, consult factory.

Weights kg (lbs)

Base Actuator Weight	Stroke Length	12 Inch	24 Inch	36 Inch	48 Inch
	lb	190	265	340	415
	kg	86	120	153	187

Adder for Inline (excluding motor)	Adder for Parallel Drive (excluding motor)	Adder for Front Flange	Adder for Rear Flange	Adder for Rear Clevis	Adder for Rear Eye	Adder for Front/ Rear Angle Mounts	Adder for Two Trunnions	Adder for Two Foot Mounts
54.9 (24.9)	79.1 (35.9)	28.5 (17.5)	NA	NA	NA	NA	NA	34.8 (15.8)

FT80 Reflective Inertias	6 mm Lead	12 mm Lead	30 mm Lead	
NMT Unit - J (0) NMT Unit - J (Stroke)	0.0302504 0.0008022	0.0303275 0.0008035	0.0308673 0.0008124	kg-m² (at input shaft) kg-m²/inch of stroke
Inline w/ Coupler - J (0) Inline w/ Coupler - J (Stroke)	0.0314604 0.0008022	0.0315375 0.0008035	0.0320773 0.0008124	kg-m² (at motor shaft) kg-m²/inch of stroke
Parallel 1:1 - J (0) Parallel 1:1 - J (Stroke)	0.0721056 0.0008022	0.0535533 0.0008035	0.1342578 0.0008124	
Parallel 2:1 - J (0) Parallel 2:1 - J (Stroke)	0.0198765 0.0002006	0.0270490 0.0002009	0.0753395 0.0002031	

*Pulleys for parallel mount match actuator max performance ratings

Standard Inline Coupling Inertia	
	Inertia
FT80	0.0001210 kg-m² (0.010709 lbf-in s²)

Pulley inertias reflected at motor including typical pulleys, belt and standard bushings. Because of differences in belt and pulley selection due to particular motor choices, please contact your local sales representative if these values are critical to your application.

*See definitions on page 124

DEFINITIONS:

Maximum Force: Calculated Cubic Mean Load for the application should not exceed this value. (Values are derived from the design capacity of the FT Series actuator and should not be exceeded or relied upon for continuous operation.)

Life at Maximum Force: Estimated life that can be expected from the actuator when running at Maximum Force for intermittent periods of time. (Theoretical calculation based on the Dynamic Load Rating of the actuator and using the Maximum Force rating as the Cubic Mean Load.)

C_a (Dynamic Load Rating): A design constant used when calculating the estimated travel life of the roller screw.

Maximum Input Torque: The torque required at the screw to produce the Maximum Force rating. Exceeding this value can cause permanent damage to the actuator.

Maximum Rated RPM: The maximum allowable rotational screw speed determined by either screw length limitations or the rotational speed limit of the roller screw nut.

Maximum Linear Speed: The linear speed achieved by the actuator when Maximum Rated RPM is applied to the roller screw input shaft.

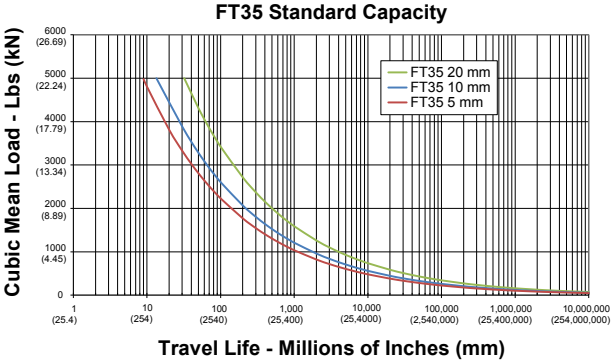
FT Series Accessories

Limit Switches (if required in addition to L1, L2, L3 option in actuator model)			
FT35, FT60, FT80			
Option	**Quantity**	**Part Number**	**Description**
L1	1	14453	Normally Closed PNP Limit Switch (10-30 VDC, 1m. 3 wire embedded cable)
L2	2	14453	Normally Closed PNP Limit Switch (10-30 VDC, 1m. 3 wire embedded cable)
L3	3	14453	Normally Closed PNP Limit Switch (10-30 VDC, 1m. 3 wire embedded cable)
L4			NA
L5			NA
L6			NA
FT45			
L1	1	43403	Normally Open PNP Limit Switch (10-30 VDC, 1m. 3 wire embedded cable)
L2	2	43404	Normally Closed PNP Limit Switch (10-30 VDC, 1m. 3 wire embedded cable)
L3	1 2	43403 43404	Normally Open PNP Limit Switch (10-30 VDC, 1m. 3 wire embedded cable) Normally Closed PNP Limit Switch (10-30 VDC, 1m. 3 wire embedded cable)
L4	1	67634	Normally Open NPN Limit Switch (10-30 VDC, 1m. 3 wire embedded cable)
L5	2	67635	Normally Closed NPN Limit Switch (10-30 VDC, 1m. 3 wire embedded cable)
L6	1 2	67634 67635	Normally Open NPN Limit Switch (10-30 VDC, 1m. 3 wire embedded cable) Normally Closed NPN Limit Switch (10-30 VDC, 1m. 3 wire embedded cable)

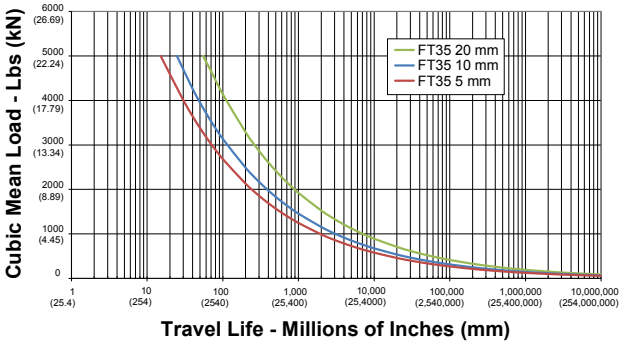
Consult your local sales representative to discuss maximum stroke length allowable with your final configuration.
Some accessories are available in stainless steel. Consult Exlar for availability and lead time.
*This option restricts max. load to 6.0 KN (1350 lbf) for K60, 8.9 KN (2000 lbf) for K75 and 9.3 KN (2100 lbf) for K90.

Estimated Service Life

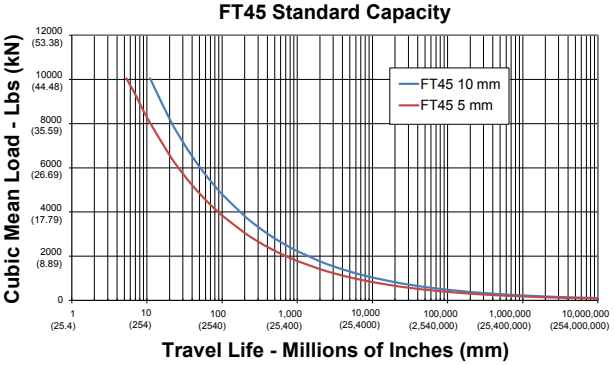
FT35 Standard Capacity



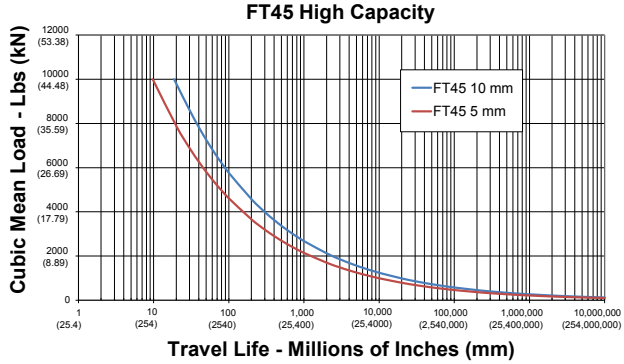
FT35 High Capacity



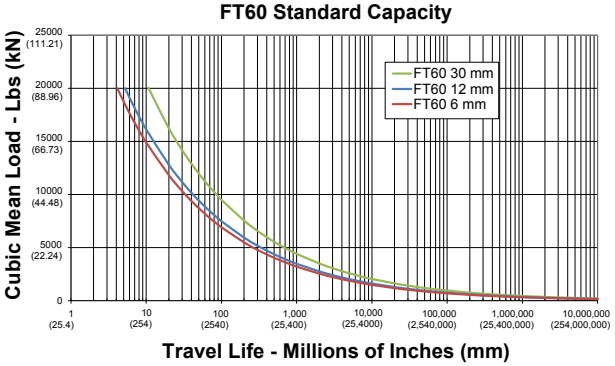
FT45 Standard Capacity



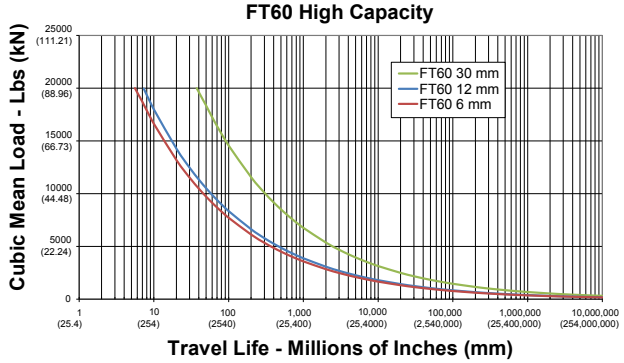
FT45 High Capacity



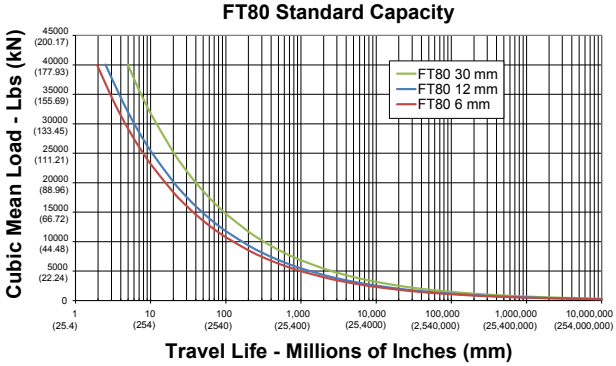
FT60 Standard Capacity



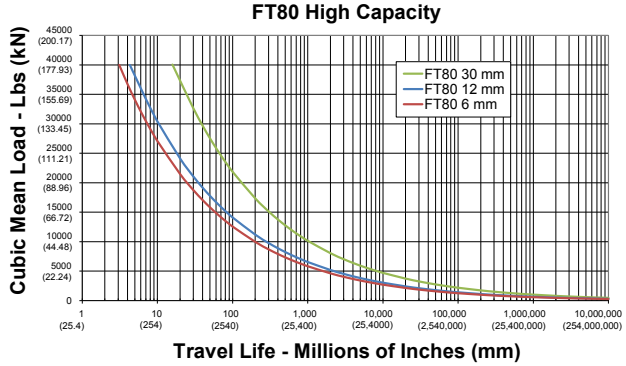
FT60 High Capacity



FT80 Standard Capacity



FT80 High Capacity



Service Life Estimate Assumptions:

- Sufficient quality and quantity of lubrication is maintained throughout service life (please refer to engineering reference on page 212 for lubrication interval estimates.)
- Bearing and screw temperature between 20° C and 40° C
- No mechanical hard stops (external or internal) or impact loads
- No external side loads
- Does not apply to short stroke, high frequency applications such as fatigue testing or short stroke, high force applications such as pressing. (For information on calculating estimating life for unique applications please refer to the engineering reference on page 212.

The L_{10} expected life of a roller screw linear actuator is expressed as the linear travel distance that 90% of properly maintained roller screws manufactured are expected to meet or exceed. This is not a guarantee and these charts should be used for estimation purposes only.

The underlying formula that defines this value is:
Travel life in millions of inches, where:

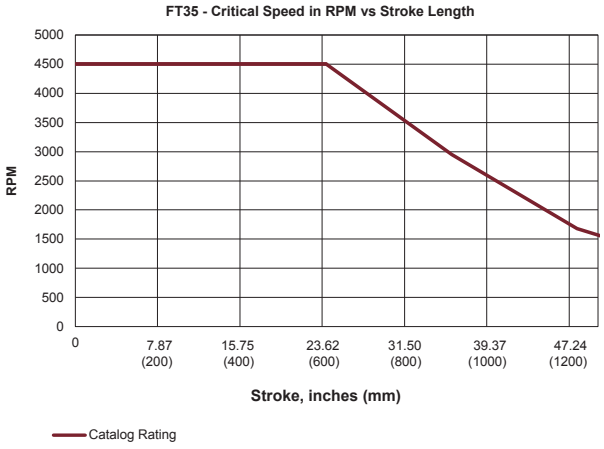
C_a = Dynamic load rating (lbf)
F_{cml} = Cubic mean applied load (lbf)
ℓ = Roller screw lead (inches)

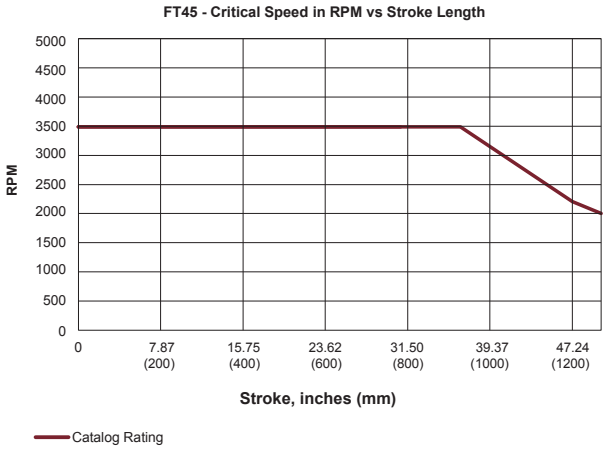
$$L_{10} = \left(\frac{C_a}{F_{cml}} \right)^3 \times \ell$$

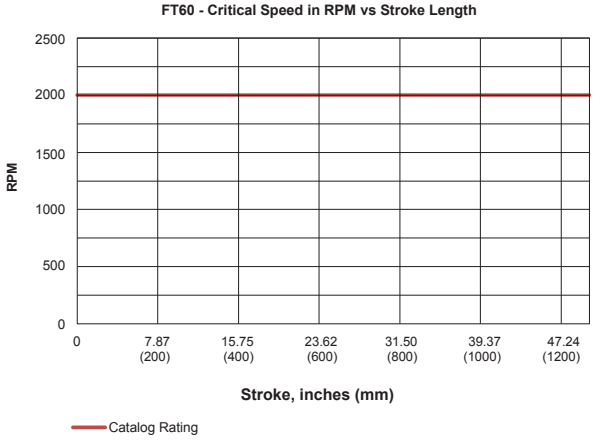
For additional details on calculating estimated service life, please refer to the Engineering Reference, page 212.

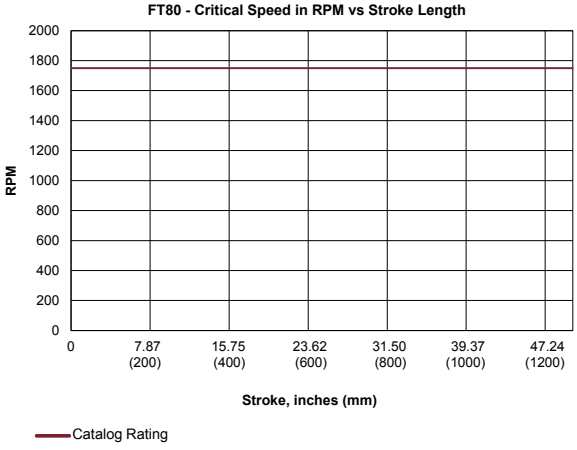
Data Curves

Critical Speed vs Stroke Length:



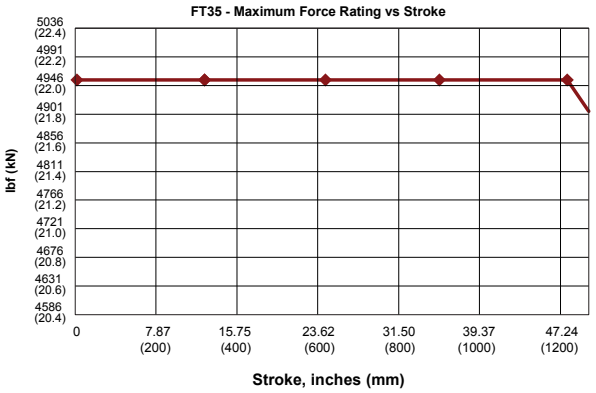


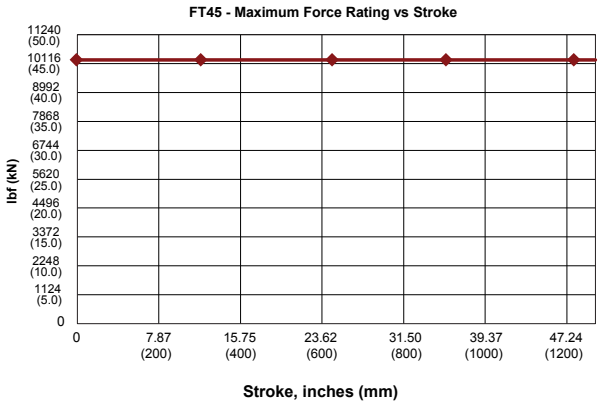


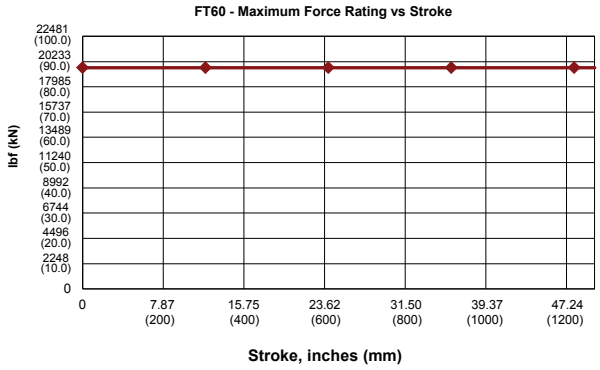


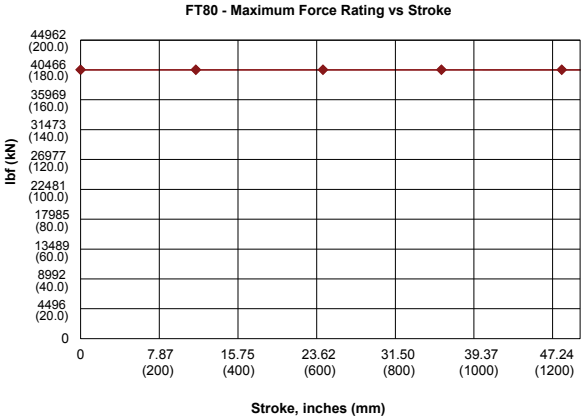
* With longer stroke length actuators, the rated speed of the actuator is determined by the critical speed

Maximum Force Rating





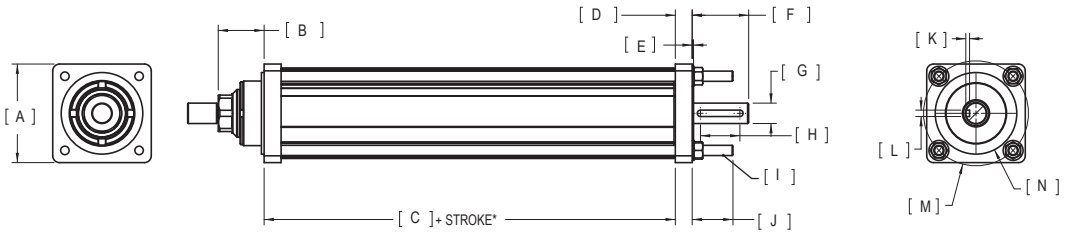




* With longer stroke length actuators, the rated speed of the actuator is determined by the critical speed

Dimensions

Base Actuator (FT35, FT60, FT80)

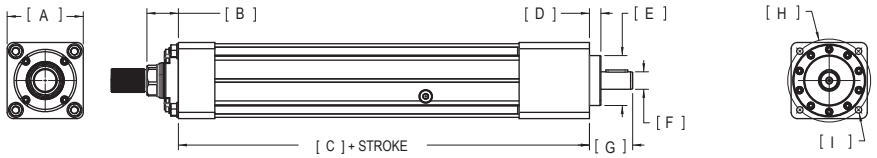


		FT35	FT60	FT80
A	in	□ 3.63	□ 6.38	□ 8.50
	mm	92.1	161.9	215.9
B	in	1.69	2.25	3.03
	mm	42.9	57.1	77.0
C	in	9.1*	15.3	19.8
	mm	232*	389	503
D	in	0.62	0.83	0.90
	mm	15.7	21.1	22.9
E	in	0.05	0.10	0.10
	mm	1.3	2.5	2.5
F	in	2.08	2.41	3.34
	mm	52.8	61.2	84.7
G	in	Ø 0.748 +0.00/-0.0005	Ø 1.378 +0.00/-0.0006	Ø 2.362 +0.00/-0.0005
	mm	19.0 +0.00/-0.013	35.0 +0.00/-0.016	60.0 +0.00/-0.013
H	in	1.45	1.60	1.48
	mm	36.8	40.5	37.5

		FT35	FT60	FT80
I	in	3/8- 16 UNC - 2A	9/16 - 12 UNC - 2A	3/4- 10 UNC - 2A
	mm	M8 x 1.25 6g	M14 x 2.0 6g	M20 x 2.5 6g
J	in	1.50	2.0	2.0
	mm	38.1	50.7	50.7
K	in	0.138 +0.004/-0.00	0.197 +0.008/-0.00	0.278 +0.005/-0.00
	mm	3.5 +0.1 0.0	5.0 +0.2 -0.0	7.0 +0.1 -0.0
L	in	0.236 -0.00/-0.002	0.3937 +0.0006/-0.0020	0.709 -0.001/-0.002
	mm	6.0 -0.012/-0.042	10.0 -0.015/-0.051	18.0 -0.018/-0.061
M	in	Ø 3.860 BC	Ø 6.79 BC	Ø 9.33 BC
	mm	98.0	172.4	237.0
N	in	Ø 3.00	Ø 5.00	Ø 6.75
	mm	76.2	127.0	171.5

*Add 20 mm if choosing high capacity option for the FT35

Base Actuator (FT45)

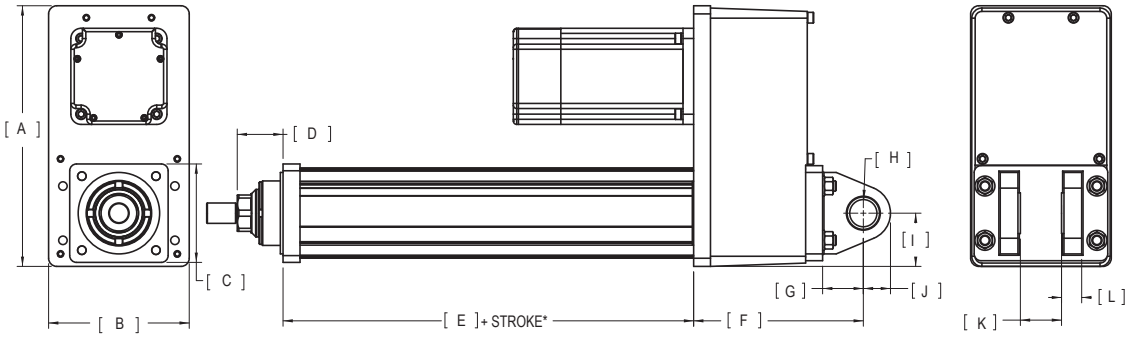


		FT45
A	in	□ 4.80
	mm	122.0
B	in	1.99
	mm	50.5
C	in	13.9
	mm	354
D	in	0.72
	mm	18.3
E	in	Ø 3.15
	mm	80.00

		FT45
F	in	Ø 1.102 +0.00/-0.0005
	mm	28.0 +0.00/-0.013
G	in	2.73
	mm	69.3
H	in	Ø 5.236 BC
	mm	133.0
I	in	4X M12X1.75 - 6H ↓ 1.0
	mm	26

Pre-sale drawings and models are representative and are subject to change. Certified drawings and models are available for a fee. Consult your local Exlar representative for details.

Clevis Mount



		FT35	FT45 (Option C)	FT45 (Option G)	FT60
A	in	9.60	14.55	14.55	15.55
	mm	243.8	369.5	369.5	395.0
B	in	5.18	7.48	7.48	8.53
	mm	131.6	190.0	190.0	216.7
C	in	□ 3.63	□ 4.80	□ 4.80	□ 6.38
	mm	92.1	122.0	122.0	161.9
D	in	1.69	1.99	1.99	2.25
	mm	42.9	50.5	50.0	57.1
E	in	9.1*	13.9	13.9	15.3
	mm	232*	354	354	368
F	in	6.3	9.0	7.9	9.0
	mm	159	229	201	229
G	in	1.50	2.12	1.26	2.5
	mm	38.1	53.8	32.0	63.5
H	in	Ø 1.000** +0.002 / -0.001	Ø 1.378 ±0.001	Ø 0.787 H9	Ø 1.750*** +0.002 / -0.001
	mm	25.4 +0.05 / -0.03	35.0 ±0.03	20.00 H9	44.45 +0.05 / -0.03
I	in	2.0	3.1	3.1	3.43
	mm	50	78	78	87.1
J	in	1.00	1.4	0.6	2.13
	mm	25.4	35	15	54.0
K	in	0.74	1.0	0.6	2.51
	mm	19	25	15	63.9
L	in	1.52	2.03	1.18	1.25
	mm	38.5	51.6	30.0	31.8

Parallel motor mount shown.

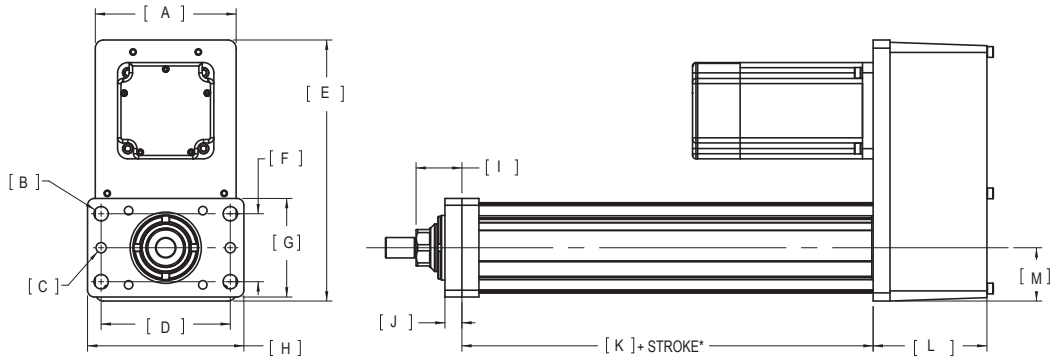
*Add 20 mm if choosing high capacity option for the FT35.

** If "G" metric clevis option, Ø 27 mm + 0.00 / - 0.06

*** If "G" metric clevis option, Ø 45 mm + 0.00 / - 0.08

Pre-sale drawings and models are representative and are subject to change. Certified drawings and models are available for a fee. Consult your local Exlar representative for details.

Front Flange

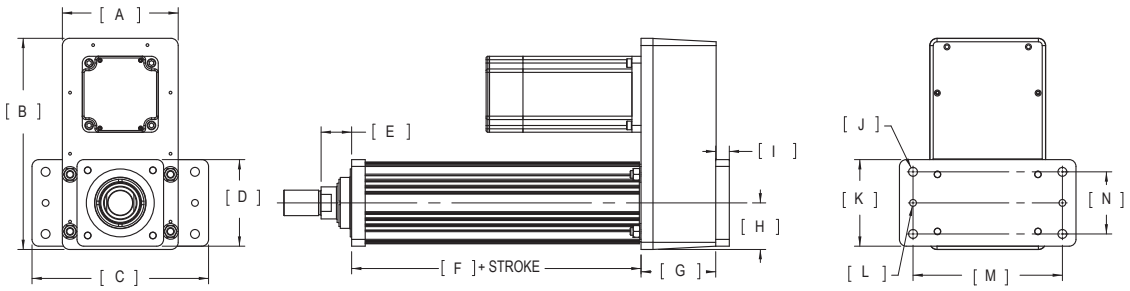


		FT35	FT45	FT60	FT80
A	in	5.18	7.48	6.82	8.77
	mm	131.6	190.0	173.2	222.8
B	in	Ø 0.53	Ø 0.69	Ø 0.66	Ø 0.78
	mm	13.5	17.5	16.7	19.8
C	in	Ø 0.375 +0.001 / -0.000	Ø 0.500 +0.001 / -0.000	Ø 0.501 +0.001 / -0.000	Ø 0.625 +0.001 / -0.000
	mm	9.53 +0.03 / 0.00	12.70 +0.03 / 0.00	12.7 +0.03 / 0.00	15.9 +0.025 / 0.000
D	in	4.75	6.38	8.32	10.75
	mm	120.7	161.9	211.2	273.1
E	in	9.6	14.55	14.32	17.33
	mm	243.8	369.5	363.7	440.2
F	in	2.50	3.82	4.57	6.00
	mm	63.5	97.0	116.2	152.4
G	in	3.63	5.00	6.38	8.50
	mm	92.1	127.0	161.9	215.9
H	in	5.8	7.63	10.00	12.75
	mm	146	193.7	254.0	323.9
I	in	1.69	1.99	2.25	3.03
	mm	42.9	50.5	57.1	77.0
J	in	0.63	1.00	1.00	1.25
	mm	15.9	25.4	25.4	31.8
K	in	9.1*	13.9	15.3	19.8
	mm	232*	354	388	503
L	in	4.19	5.26	4.6	6.43
	mm	106.3	133.7	116	163.3
M	in	1.96	3.05	3.19	4.40
	mm	49.8	77.5	81.0	111.8

*Add 20 mm if choosing high capacity option for the FT35.

Pre-sale drawings and models are representative and are subject to change. Certified drawings and models are available for a fee. Consult your local Exlar representative for details.

Rear Flange (FT35, FT60)

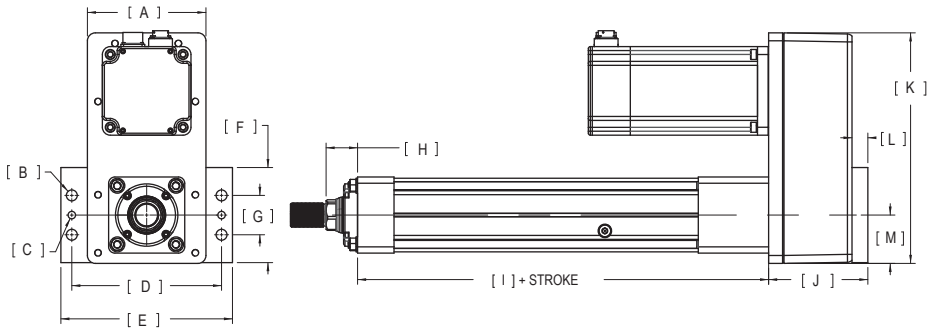


		FT35	FT60
A	in	5.18	8.53
	mm	131.6	216.7
B	in	9.60	15.55
	mm	243.8	395.0
C	in	9.00	13.00
	mm	228.6	330.2
D	in	□ 3.63	□ 6.38
	mm	92.1	161.9
E	in	1.69	2.25
	mm	42.9	57.1
F	in	9.1*	15.3
	mm	232*	388
G	in	4.13	5.50
	mm	104.8	139.7

*Add 20 mm if choosing high capacity option for the FT35

		FT35	FT60
H	in	1.96	3.43
	mm	49.8	87.1
I	in	0.63	1.00
	mm	15.9	25.4
J	in	Ø 0.53	Ø 0.66
	mm	13.5	16.7
K	in	3.5	6.38
	mm	88.9	161.9
L	in	Ø 0.375 +0.001/-0.000	Ø 0.501 +0.001/-0.000
	mm	Ø 9.53 +0.03/-0.00	12.7 +0.03/0.00
M	in	6.5	11.00
	mm	165.1	279.4
N	in	2.50	4.58
	mm	63.5	116.2

Rear Flange (FT45)

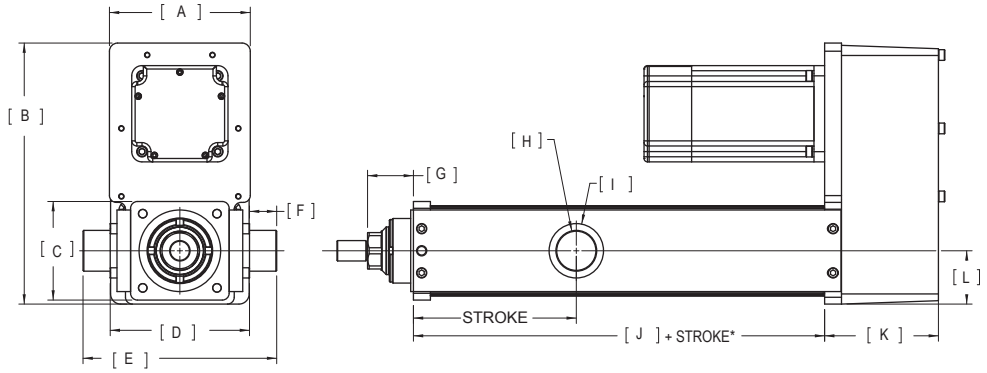


	A	B	C	D	E	F	G
in	7.48	Ø 0.69	Ø 0.472 +0.001/-0.00	9.45	10.83	6.00	2.48
mm	190.0	17.5	12.00 +0.03/0.00	240.0	275.0	152.4	63.1

	H	I	J	K	L	M
in	1.99	13.9	6.26	14.55	1.00	3.05
mm	50.5	354	159.0	369.5	25.4	77.5

Pre-sale drawings and models are representative and are subject to change. Certified drawings and models are available for a fee. Consult your local Exlar representative for details.

Trunnion Mount (FT35, FT60)

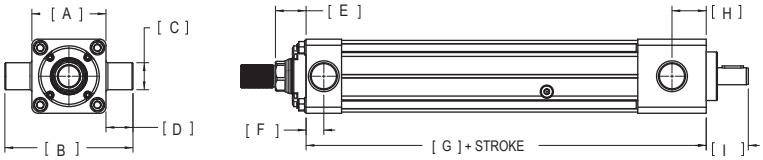


		FT35	FT60
A	in	5.18	6.82
	mm	131.6	173.2
B	in	9.60	14.32
	mm	243.8	363.7
C	in	□ 3.63	□ 6.38
	mm	92.1	161.9
D	in	5.12	8.13
	mm	130.1	206.4
E	in	7.12	12.13
	mm	180.9	308.0
F	in	1.00	2.00
	mm	25.4	50.8

		FT35	FT60
G	in	1.69	2.25
	mm	42.9	57.1
H	in	Ø 1.500** ±0.001	Ø 2.500*** ±0.001
	mm	38.1 ±0.03	63.50 ±0.03
I	in	Ø 2.00	Ø 3.50
	mm	50.8	88.9
J	in	9.1*	15.3
	mm	232*	388
K	in	4.19	4.57
	mm	106.3	116.1
L	in	1.96	3.19
	mm	49.8	81.0

*Add 20 mm if choosing high capacity option. for the FT35.
** If "Q" metric side trunnion option, Ø 35 mm h7
*** If "Q" metric side trunnion option, Ø 60 mm h9

Trunnion Mount (FT45)



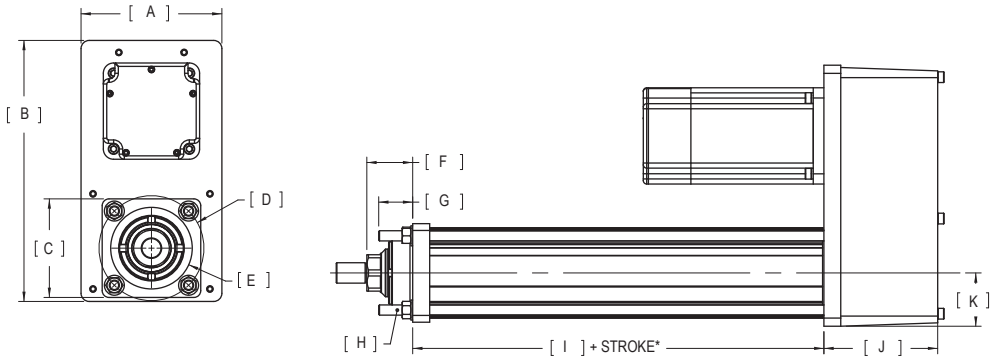
		Imperial (A or 2)	Metric (V or P)
A	in	□ 4.80	□ 4.80
	mm	122.0	122.0
B	in	8.30	7.95
	mm	210.9	202.0
C	in	Ø 1.750 +0.000/-0.002	Ø 1.969 +0.000/-0.002
	mm	44.45 0.00/-0.05	50.00 0.00/-0.05
D	in	1.75	1.57
	mm	44.5	40.00
E	in	1.99	1.99
	mm	50.5	50.5

		Imperial (A or 2)	Metric (V or P)
F	in	1.15	1.15
	mm	29.2	29.2
G	in	13.9	13.9
	mm	354	354
H	in	2.22	2.22
	mm	56.4	56.4
I	in	2.73	2.73
	mm	69.3	69.3

*Front trunnion mount stroke length limited to 18 inches or less.

Pre-sale drawings and models are representative and are subject to change. Certified drawings and models are available for a fee. Consult your local Exlar representative for details.

Extended Tie Rod Mount (FT35, FT60, FT80)

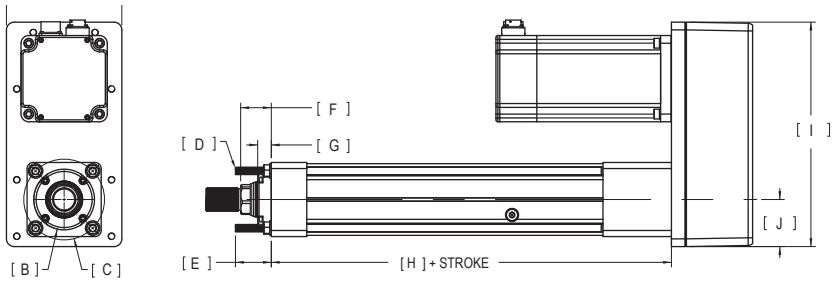


		FT35	FT60	FT80
A	in	5.18	6.82	8.77
	mm	131.6	173.2	222.8
B	in	9.60	14.32	17.33
	mm	243.8	363.7	440.2
C	in	□ 3.63	□ 6.38	□ 8.50
	mm	92.1	161.9	215.9
D	in	Ø 3.86 BC	Ø 6.79 BC	Ø 9.33 BC
	mm	98.0	172.4	237.0
E	in	Ø 3.000 +0.000/-0.002	Ø 5.000 +0.000/-0.002	Ø 6.75 +0.000/-0.002
	mm	76.20 0.00/-0.05	127.0 0.00/-0.05	171.45 0.00/-0.05
F	in	1.69	2.25	3.03
	mm	42.9	57.1	77.0

		FT35	FT60	FT80
G	in	1.25	2.00	3.50
	mm	31.8	50.8	88.9
H	in	3/8-16 UNC-2A	9/16-12 UNC-2A	3/4-10 UNC-2A
	mm	M8 x 1.25 6g	M14 x 2.0 6g	M20 x 2.5 6g
I	in	9.1*	15.3	19.8
	mm	232*	388	503
J	in	4.19	4.57	6.43
	mm	106.3	116.1	163.3
K	in	1.96	3.19	4.40
	mm	49.8	81.0	111.8

*Add 20 mm if choosing high capacity option for the FT35

Extended Tie Rod Mount (FT45)

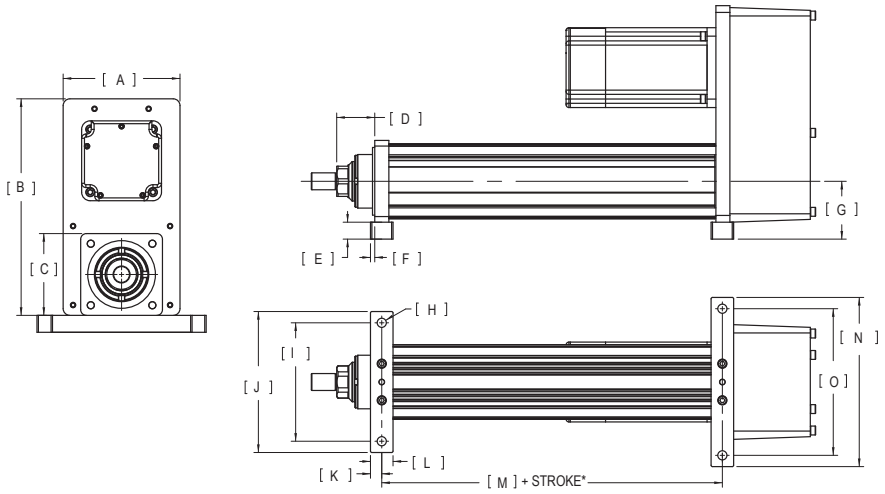


	A	B	C	D	E
in	7.48	Ø 3.937	Ø 5.236 BC	1/2-13 UNC	2.3
mm	190.0	100.00	133.00	M12 x 1.75 6g	59

	F	G	H	I	J
in	1.99	0.88	13.9	14.55	3.05
mm	50.5	22.4	354	369.5	77.5

Pre-sale drawings and models are representative and are subject to change. Certified drawings and models are available for a fee. Consult your local Exlar representative for details.

Side Lug Mount (FT35, FT60, FT80)



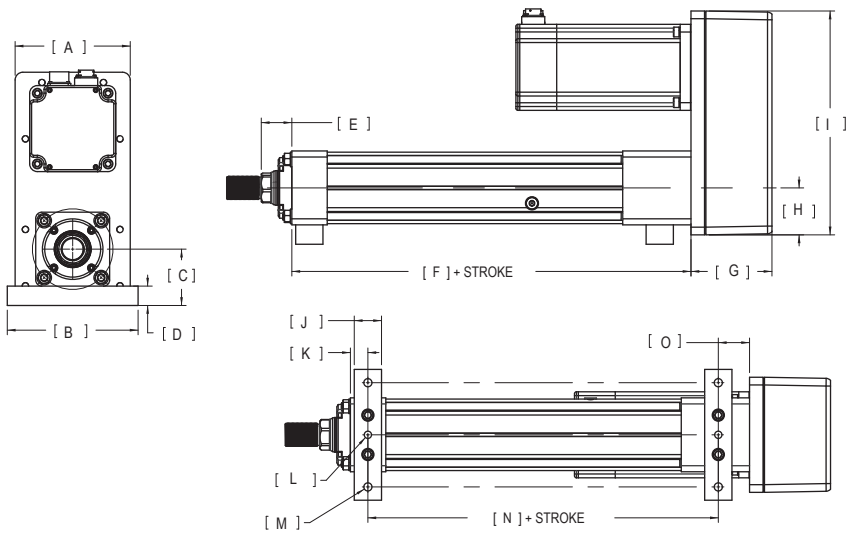
		FT35	FT60	FT80
A	in	5.18	6.82	8.77
	mm	131.6	173.2	222.8
B	in	9.60	14.32	17.33
	mm	243.8	363.7	440.2
C	in	□ 3.63	□ 6.38	□ 8.50
	mm	92.1	161.9	215.9
D	in	1.69	2.25	3.03
	mm	42.9	57.1	77.0
E	in	0.75	1.0	2.00
	mm	19.1	25.4	50.8
F	in	0.19	0.50	0.50
	mm	4.8	12.7	12.7
G	in	2.56	4.19	6.25
	mm	65.1	106.4	158.75

*Add 20 mm if choosing high capacity option for the FT35.

		FT35	FT60	FT80
H	in	Ø 0.41	Ø 0.53	Ø 0.78
	mm	10.3	13.5	19.8
I	in	5.25	8.50	12.75
	mm	133.4	215.9	323.9
J	in	6.25	10.00	10.75
	mm	158.8	254.0	273.1
K	in	0.50	1.00	1.25
	mm	12.7	25.4	31.8
L	in	1.00	2.00	2.50
	mm	25.4	50.8	63.5
M	in	9.1*	15.3	19.6
	mm	232*	388	498
N	in	7.50	10.00	12.75
	mm	190.5	254.0	323.9
O	in	6.5	8.50	10.75
	mm	165.1	215.9	273.1

Pre-sale drawings and models are representative and are subject to change. Certified drawings and models are available for a fee. Consult your local Exlar representative for details.

Side Lug Mount (FT45)

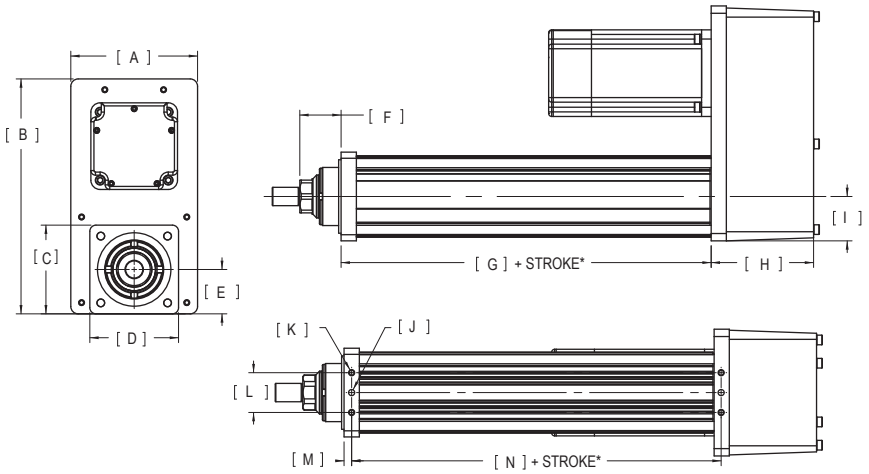


		FT45
A	in	7.48
	mm	190.0
B	in	8.50
	mm	215.9
C	in	3.66
	mm	93.0
D	in	1.26
	mm	32.0
E	in	1.99
	mm	50.5
F	in	13.9
	mm	354
G	in	5.26
	mm	133.6

		FT45
H	in	3.05
	mm	77.5
I	in	14.55
	mm	369.5
J	in	1.77
	mm	45.0
K	in	1.14
	mm	28.9
L	in	Ø 0.472 +0.001/0.000
	mm	12.0 +0.03/0.00
M	in	Ø 0.53
	mm	13.5
N	in	10.77
	mm	273.6
O	in	2.03
	mm	51.6

Pre-sale drawings and models are representative and are subject to change. Certified drawings and models are available for a fee. Consult your local Exlar representative for details.

Side Mount



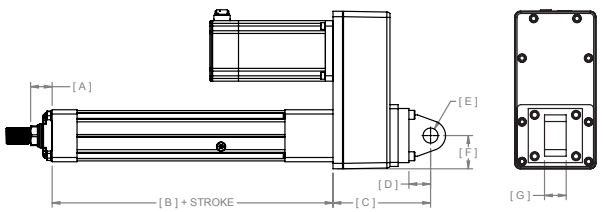
*Add 20 mm if choosing high capacity option.

		FT35	FT60	FT80
A	in	5.18	6.82	8.77
	mm	131.6	173.2	222.8
B	in	9.60	14.32	17.38
	mm	243.8	363.7	440.2
C	in	□ 3.63	□ 6.38	□ 8.50
	mm	92.1	161.9	215.9
D	in	□ 3.63	□ 6.38	□ 8.50
	mm	92.1	161.9	215.9
E	in	1.81	NA	NA
	mm	46.0	NA	NA
F	in	1.69	2.25	3.03
	mm	42.9	57.1	77.0
G	in	9.1*	15.3	19.8
	mm	232*	388	503

*Add 20 mm if choosing high capacity option for the FT35.
[1] If "J" or "K" metric side mount options, M6 x 1.0 ↧ 9 mm with Ø 6 mm M7 ↧ 9 mm dowel hole
[2] If "J" or "K" metric side mount options, M12 x 1.75 ↧ 19 mm with Ø 12 mm M7 ↧ 12 mm Dowel Hole
[3] If "J" or "K" metric side mount options, M16 x 2.0 ↧ 16 mm with Ø 12 mm M7 ↧ 12 mm dowel hole

		FT35	FT60	FT80
H	in	4.19	4.57	6.43
	mm	106.3	116.1	163.5
I	in	1.81	3.19	4.25
	mm	46.1	81.0	108.0
J		Ø 0.2500↓0.400[1] +0.0000/ -0.0005	Ø 0.5000↓1.00[2] +0.0000/ -0.0005	Ø 0.6250↓1.375[3] +0.0000/ -0.0005
K		1/4-20 UNC- 2B ↓ .63[1]	1/2-13 UNC-2B ↓ 1.13[2]	5/8-11 UNC- 2B ↓ 1.25[3]
L	in	1.63	2.50	4.00
	mm	41.3	63.5	101.6
M	in	0.31	0.50	0.75
	mm	8	12.7	19.1
N	in	9.1*	15.3	19.6
	mm	232*	388	498

Rear Eye Mount

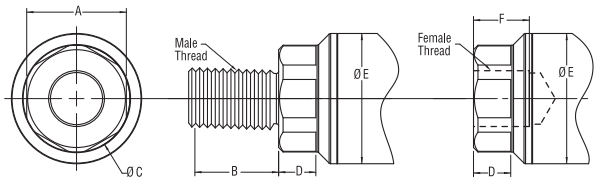


		FT45 (Option Y)	FT45 (Option W)
A	in (mm)	1.99 (50.5)	1.99 (50.5)
B	in (mm)	13.9 (354)	13.9 (354)
C	in (mm)	9.01 (228.9)	7.90 (200.7)
D	in (mm)	2.00 (50.8)	1.26 (32.0)
E	in (mm)	1.378 ± 0.001 (35.0 ±0.03)	0.787 H9 (20.00 H9)
F	in (mm)	3.07 (77.9)	3.07 (77.9)
G	in (mm)	2.00 (50.8)	1.18 (30.0)

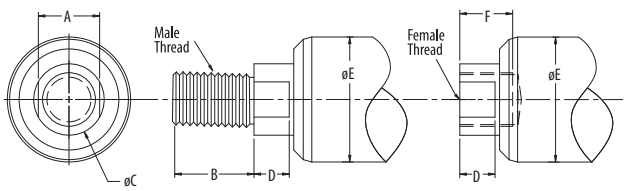
Pre-sale drawings and models are representative and are subject to change. Certified drawings and models are available for a fee. Consult your local Exlar representative for details.

Rod Ends

FT35, FT45, FT60



FT80

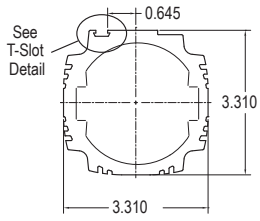


	A	B	ØC	D	ØE	F	Male U.S.	Male Metric	Female U.S.	Female Metric
FT35	1.34 (34)	1.125 (28.6)	1.434 (36.4)	0.50 (12.7)	1.750 (44.5)	0.750 (19.1)	3/4-16 UNF-2A	M16x1.5 6g	3/4-16 UNF-2B	M16x1.5 6h
FT45	1.81 (46.0)	2.25 (57.2)	2.0 (50.8)	0.63 (15.9)	2.250 (57.2)	1.50 (38.1)	1 1/2-12 UN-2A	M36x3 6g	1 1/2-12 UN-2B	M36x3 6h
FT60	2.36 (60.0)	2.750 (69.9)	2.360 (59.9)	0.750 (19.1)	3.000 (76.2)	2.000 (50.8)	1 7/8-12 UN-2A	M42x4.5 6g	1 7/8-12 UN-2B	M42x4.5 6h

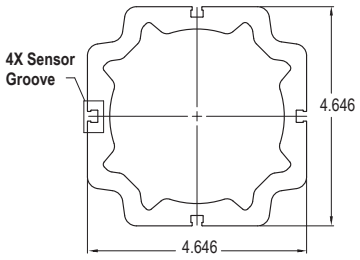
	A	B	ØC	D	ØE	F	MaleU.S.	Male Metric	Female U.S.	Female Metric
FT80	2.75 (69.9)	4.019 (102.1)	3.143 (79.8)	1.000 (25.4)	4.000 (101.6)	2.250 (57.2)	2 1/2-12 UN-2A	M56x5.5 6g	2 1/2-12 UN-2B	M56x5.5 6h

Dimensions shown in inches (mm)

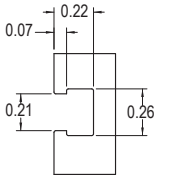
Case Dimensions



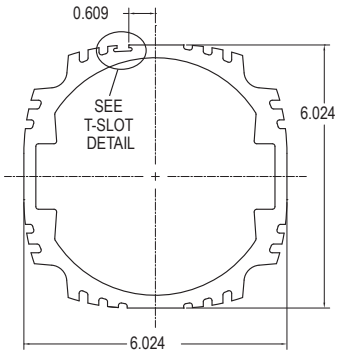
FT35



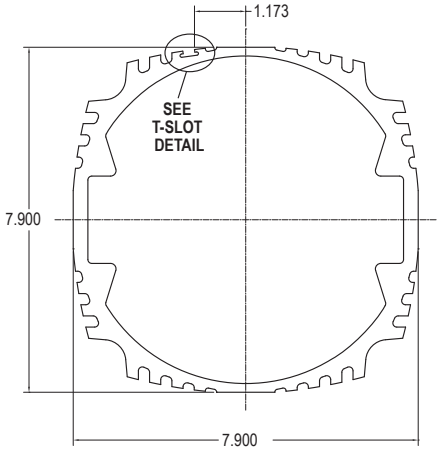
FT45



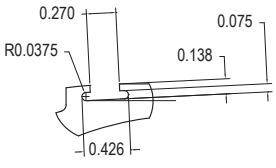
Detail 4X Sensor Groove



FT60



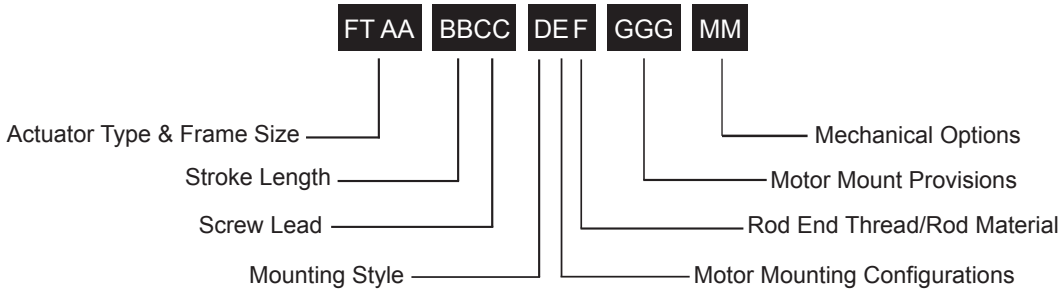
FT80



T-Slot Detail

Pre-sale drawings and models are representative and are subject to change. Certified drawings and models are available for a fee. Consult your local Exlar representative for details.

FT Series Ordering Guide



Commonly Ordered Options Shown in BOLD

AA = FT Frame Size
35 = 3.5 inch (90 mm)
45 = 4.8 inch (122 mm)
60 = 6.0 inch (150 mm)
80 = 8.0 inch (200 mm)

BB = Stroke Length
06 = 6 inch (152 mm) FT35, FT45
12 = 12 inch (305 mm) FT35, 45, 60, 80
18 = 18 inch (457 mm) FT35, 45
24 = 24 inch (610 mm) FT35, 45, 60, 80
36 = 36 inch (914 mm) FT35, 45, 60, 80
48 = 48 inch (1219 mm) FT35, 45, 60, 80

CC = Screw Lead
05 = 0.2 inch, FT35, 45
06 = 0.23 inch, FT60, 80
10 = 0.39 inch, FT35, 45
12 = 0.47 inch, FT60, 80
20 = 0.79 inch, FT35
30 = 1.18 inch, FT60, 80

D = Mounting Style [1]
N = None
F = Front flange, English
Z = Front flange, Metric, FT45
R = Rear flange, English [4, 5]
C = Rear clevis, English [4, 5]
G = Rear clevis, Metric [4, 5]
Y = Rear eye, English [4], FT45
W = Rear eye, Metric [4], FT45
L = Side lugs
S = Side mount, English FT35, 60, 80
J = Side mount, Metric FT35, 60, 80
T = Side trunnion mount, English [5, 6] FT35, 60, 80
Q = Side trunnion mount, Metric [5, 6] FT35, 60, 80
2 = Rear trunnion mount, English, FT45
P = Rear trunnion mount, Metric, FT45
E = Extended tie rods, English
M = Extended tie rods, Metric

E = Motor Mounting Configurations [3]
N = None
I = Inline direct drive (includes Exlar standard coupling)
P = Parallel, 1:1 belt reduction
Q = Parallel, 2:1 belt reduction

F = Rod End
M = Male, US standard thread
A = Male, metric thread
F = Female, US standard thread
B = Female, metric thread
W = Male, US standard thread SS, rod end only
R = Male metric thread SS, rod end only
V = Female, US standard thread SS, rod end only
L = Female, metric thread SS, rod end only

GGG = Motor Mount Provisions [3,4]
See page 206 for Motor Mount Code.

MM = Mechanical Options [2]
XT = High capacity roller screw

Limit Switches
(adjustable position throughout stroke)
L1 = One N.O., PNP (FT35, 45, 60, 80)
L2 = Two N.C., PNP (FT35, 45, 60 80)
L3 = One N.O., PNP & Two N.C., PNP (FT35, 45, 60, 80)
L4 = One N.O., NPN (FT45)
L5 = Two N.C., NPN (FT45)
L6 = One N.O., NPN & Two N.C., NPN (FT45)

*See Page 124 for Limit Switch details

Please provide a drawing of motor dimensions with all orders to insure proper mounting compatibility.

For options or specials not listed above or for extended temperature operation, please contact Exlar

NOTES:
1. Mounting face size, shaft length and other details of particular motors may require special adapters or provisions for mounting. Always discuss your motor selection with your local sales representative.
2. For extended temperature operation consult factory for model number.
3. MAX Std. motor size: FT35: 5.6 inch/142 mm, FT45: 7.1 inch/180 mm, FT60: 7.9 inch/200 mm, FT80: 8.5 inch/215 mm
   For oversized motors, contact your local sales representative.
4. Not available with inline motor mount, contact your local sales representative.
5. Application details must be approved for use with an FT80.
6. IP65 environmental sealing option not available.

Contact your local sales representative regarding all special actuator components.

Return to table of contents

Motor Mount Codes for the FT and K Series

Bolt Circle Diameter (mm)	Pilot Diameter (mm)	Shaft Diameter (mm)	Shaft Length (mm)	Key Width (mm)	Motor Mount Code
63	40	9	20	3	IEA
63	40	9	24	3	IEB
63	40	11	23	4	IEC
63	40	14	30	5	IED
70	50	11	30	4	JGC
70	50	12	30	NA	JGB
70	50	14	30	5	JGA
70	50	16	30	5	EGB
75	60	11	23	4	IHA
75	60	14	30	5	IHB
90	70	11	30	4	JKE
90	70	14	30	5	JKD
90	70	16	35	NA	JKC
90	70	16	40	5	JKG
90	60	19	40	6	JKF
90	70	19	40	6	JKA
95	65	14	30	5	ELA
95	50	14	30	5	ELC
95	65	16	30	5	ELB
100	80	10	32	3	IMD
100	80	14	30	5	IMA
100	80	14	40	5	JMC
100	80	16	40	5	IMB
100	80	16	40	5	JMA
100	80	19	40	6	IMC
100	80	19	55	6	JMD
100	80	22	48	6	EMB
115	95	19	40	6	INA
115	95	19	55	6	JNC
115	95	22	45	8	JND
115	95	22	70	NA	JNB
115	95	24	45	8	JNA
115	95	24	50	8	INB
130	95	19	40	6	IPC
130	110	19	40	6	IPA
130	110	24	50	8	IPB
130	95	24	50	8	IPD
130	110	32	65	10	EPB
145	110	19	55	5	JQG
145	110	22	55	6	JQF

Bolt Circle Diameter (mm)	Pilot Diameter (mm)	Shaft Diameter (mm)	Shaft Length (mm)	Key Width (mm)	Motor Mount Code
145	110	22	70	8	JQE
145	110	22	55	8	JQH
145	110	24	55	8	JQD
145	110	24	65	8	JQC
145	110	28	55	8	JQB
145	110	28	63	8	JQA
165	130	24	50	8	IRA
165	95	24	50	8	IRG
165	110	24	50	8	IRF
165	130	28	60	8	IRB
165	130	32	50	10	IRD
165	130	32	58	10	IRC
165	130	32	80	10	IRE
190	155	32	60	10	I2A
200	114.3	22	55	6	JSE
200	114.3	28	55	8	JSF
200	114.3	35	70	10	JSB
200	114.3	35	80	10	JSA
200	114.3	42	113	10	JSD
215	180	24	50	10	ITA
215	180	28	60	10	ITB
215	180	32	58	10	ITC
215	130	32	60	10	ITE
215	180	32	80	10	ITD
215	180	38	80	10	ITF
215	180	42	82	12	ITG
235	200	35	70	10	JUC
235	200	42	85	12	JUB
235	200	42	116	12	JUD
235	200	55	116	NA	JUA
265	230	38	80	10	IVA
265	230	38	110	10	IVB
265	230	42	110	12	IVC
265	230	55	110	16	JVA
265	230	60	140	18	JVC
265	230	65	140	18	JVB
300	250	48	82	14	IWB
300	250	48	112	14	IWA
300	250	60	140	18	JWA

*Consult factory if dimension is not shown.

Sizing and Selection of Exlar Linear and Rotary Actuators

Move Profiles

The first step in analyzing a motion control application and selecting an actuator is to determine the required move profile. This move profile is based on the distance to be traveled and the amount of time available in which to make that move. The calculations below can help you determine your move profile.

Each motion device will have a maximum speed that it can achieve for each specific load capacity. This maximum speed will determine which type of motion profile can be used to complete the move. Two common types of move profiles are trapezoidal and triangular. If the average velocity of the profile, is less than half the maximum velocity of the actuator, then triangular profiles can be used. Triangular Profiles result in the lowest possible acceleration and deceleration. Otherwise a trapezoidal profile can be used. The trapezoidal profile below with 3 equal divisions will result in 25% lower maximum speed and 12.5% higher acceleration and deceleration. This is commonly called a 1/3 trapezoidal profile.

The following pages give the required formulas that allow you to select the proper Exlar linear or rotary actuator for your application. The first calculation explanation is for determining the required thrust in a linear application.

The second provides the necessary equations for determining the torque required from a linear or rotary application. For rotary applications this includes the use of reductions through belts or gears, and for linear applications, through screws.

Pages are included to allow you to enter your data and easily perform the required calculations. You can also describe your application graphically and fax it to Exlar for sizing. Reference tables for common unit conversions and motion system constants are included at the end of the section.

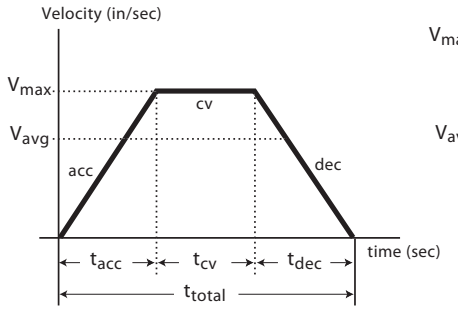
Linear Move Profile Calculations

Vmax = max.velocity-in/sec (m/sec)
Vavg = avg. velocity-in/sec (m/sec)
tacc = acceleration time (sec)
tdec = deceleration time (sec)
tcv = constant velocity (sec)
ttotal = total move time (sec)
acc = accel-in/sec^2 (m/sec^2)
dec = decel-in/sec^2 (m/sec^2)
cv = constant vel.-in/sec (m/sec)
D = total move distance-in (m)
or revolutions (rotary)

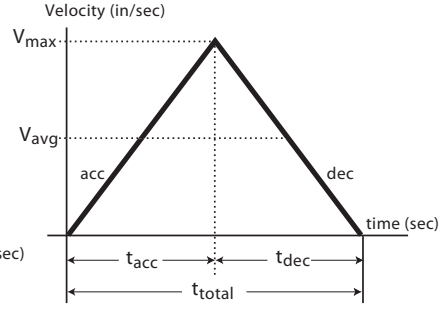
Standard Equations

Vavg = **D** / ttotal
If tacc = **t**dec **Then: V**max =
(**t**total/(**t**total-tacc)(**V**avg)
and
D = Area under profile curve
D = (1/2(**t**acc+**t**dec)+**t**cv)(**V**max)

Trapezoidal Move Profile



Triangular Move Profile



Trapezoidal Equations

If tacc = **t**cv = **t**dec **Then:**
Vmax = 1.5 (**V**avg)
D = (2/3) (**t**total) (**V**max)
acc = dec = $\frac{\mathbf{V}max}{\mathbf{t}acc}$

Triangular Equations

If tacc = **t**total/2 **Then:**
Vmax = 2.0 (**V**avg)
D = (1/2) (**t**total) (**V**max)
acc = dec = $\frac{\mathbf{V}max}{\mathbf{t}acc}$

Terms and (units)

THRUST = Total linear force-lbf (N)
Ø = Angle of inclination (deg)
Ffriction = Force from friction-lbf (N)
tacc = Acceleration time (sec)
Facc = Acceleration force-lbf (N)
v = Change in velocity-in/sec (m/s)
Fgravity = Force due to gravity-lbf (N)
μ = Coefficient of sliding friction
Fapplied = Applied forces-lbf (N)
(refer to table on page 136 for different materials)
WL = Weight of Load-lbf (N)
g = 386.4: Acceleration of gravity - in/sec^2 (9.8 m/sec^2)

Thrust Calculation Equations

THRUST = **F**friction + [**F**acceleration] + **F**gravity + **F**applied

THRUST = **W**Lμcosø + [(**W**L /386.4) (**v**/tacc)] + **W**Lsinø + **F**applied

Sample Calculations: Calculate the thrust required to accelerate a 200 pound mass to 8 inches per second in an acceleration time of 0.2 seconds. Calculate this thrust at inclination angles(ø) of 0˚, 90˚ and 30˚. Assume that there is a 25 pound spring force that is applied against the acceleration.

WL = 200 lbm, v = 8.0 in/sec., **t**a = 0.2 sec., **F**app. = 25 lbf, μ = 0.15

ø = 0˚

THRUST = **W**Lμcosø + [(**W**L /386.4) (**v**/tacc)] + **W**Lsinø + **F**applied
= (200)(0.15)(1) + [(200/386.4)(8.0/0.2)] + (200)(0) + 25

= 30 lbs + 20.73 lbs + 0 lbs + 25 lbs = **75.73 lbs force**

ø = 90˚

THRUST = **W**Lμcosø + [(**W**L /386.4) (**v**/tacc)] + **W**Lsinø + **F**applied
= (200)(0.15)(0) + [(200/386.4)(8.0/0.2)] + (200)(1) + 25

= 0 lbs + 20.73 lbs + 200 lbs + 25 lbs = **245.73 lbs force**

ø = 30˚

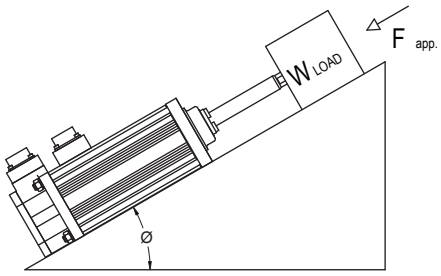
THRUST = **W**Lμcosø + [(**W**L /386.4) (**v**/tacc)] + **W**Lsinø + **F**applied
= (200)(0.15)(0.866) + [(200/386.4)(8.0/0.2)] + (200)(0.5) + 25

= 26 lbs + 20.73 lbs + 100 + 25 = **171.73 lbs force**

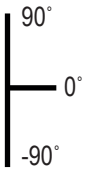
Thrust Calculations

Definition of thrust:

The thrust necessary to perform a specific move profile is equal to the sum of four components of force. These are the force due to acceleration of the mass, gravity, friction and applied forces such as cutting and pressing forces and overcoming spring forces.



Angle of Inclination



Note: at ø = 0˚
cosø = 1; sinø = 0
at ø = 90˚
cosø = 0; sinø = 1

It is necessary to calculate the required thrust for an application during each portion of the move profile, and determine the worst case criteria. The linear actuator should then be selected based on those values. The calculations at the right show calculations during acceleration which is often the most demanding segment of a profile.

Motor Torque Calculations

When selecting an actuator system it is necessary to determine the required motor torque to perform the given application. These calculations can then be compared to the torque ratings of the given amplifier and motor combination that will be used to control the actuator's velocity and position.

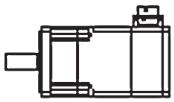
When the system uses a separate motor and screw, like the FT actuator, the ratings for that motor and amplifier are consulted. In the case of the GSX Series actuators with their integral brushless motors, the required torque divided by the torque constant of the motor (Kt) must be less than the current rating of the GSX or SLM motor.

Inertia values and torque ratings can be found in the GSX, FT, and SLM/SLG Series product specifications.

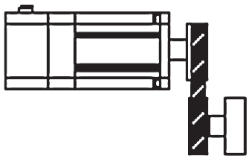
For the GSX Series the screw and motor inertia are combined.

Motor with screw (GSX, GSM, FT, & EL)

Motor & motor with reducer (SLM/SLG & ER)



Motor with belt and pulley



Terms and (units)

λ	=	Required motor torque, lbf-in (N-m)
λa	=	Required motor acceleration torque, lbf-in (N-m)
F	=	Applied force load, non inertial, lbf (kN)
S	=	Screw lead, in (mm)
R	=	Belt or reducer ratio
TL	=	Torque at driven load lbf-in (N-m)
vL	=	Linear velocity of load in/sec (m/sec)
ωL	=	Angular velocity of load rad/sec
ωm	=	Angular velocity of motor rad/sec
η	=	Screw or ratio efficiency
g	=	Gravitational constant, 386.4 in/s^2 (9.75 m/s^2)
α	=	Angular acceleration of motor, rad/s^2
m	=	Mass of the applied load, lb (N)
JL	=	Reflected Inertia due to load, lbf-in-s^2 (N-m-s^2)
Jr	=	Reflected Inertia due to ratio, lbf-in-s^2 (N-m-s^2)
Js	=	Reflected Inertia due to external screw, lbf-in-s^2 (N-m-s^2)
Jm	=	Motor armature inertia, lbf-in-s^2 (N-m-s^2)
L	=	Length of screw, in (m)
ρ	=	Density of screw material, lb/in^3 (kg/m^3)
r	=	Radius of screw, in (m)
π	=	pi (3.14159)
C	=	Dynamic load rating, lbf (N)

Velocity Equations

Screw drive: $\mathbf{V}_L = \omega m * S/2\pi$ in/sec (m/sec)

Belt or gear drive: $\omega m = \omega_L * R$ rad/sec

Torque Equations

Torque Under Load

Screw drive (GS, FT or separate screw): $\lambda = \frac{S \bullet F}{2 \bullet \pi \bullet \eta}$ lbf-in (N-**m**)

Belt and Pulley drive: $\lambda = \mathbf{T}_L / R\,\eta$ lbf-in (N-**m**)

Gear or gear reducer drive: $\lambda = \mathbf{T}_L / R\,\eta$ lbf - in (N-**m**)

Torque Under Acceleration

$\lambda a = (\mathbf{J}_m + \mathbf{J}_R + (\mathbf{J}_s + \mathbf{J}_L)/R^2)\alpha$ lbf-in

α = angular acceleration = ((RPM / 60) x 2π) / $\mathbf{t}_{acc}$, rad/sec^2.

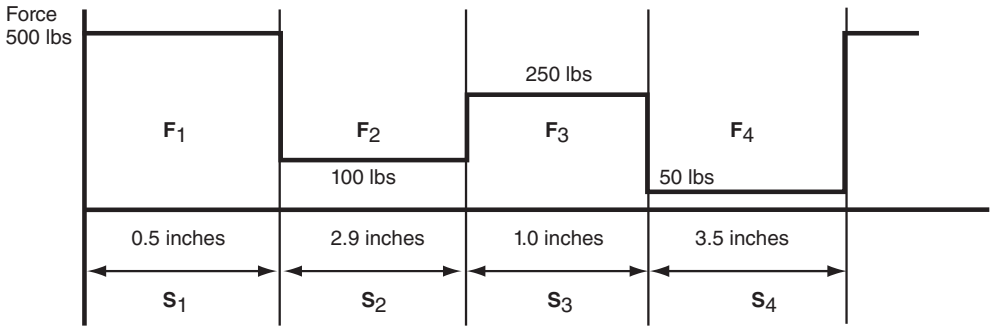
$\mathbf{J}_S = \frac{\pi \bullet \mathbf{L} \bullet \rho \times r^4}{2 \bullet g}$ lb - in - s^2 (N - **m** - s^2)

Total Torque per move segment

$\lambda T = \lambda a + \lambda$ lbf-in (N-m)

Mean Load Calculations

For accurate lifetime calculations of a roller screw in a linear application, the cubic mean load should be used. Following is a graph showing the values for force and distance as well as the calculation for cubic mean load. Forces are shown for example purposes. Negative forces are shown as positive for calculation.



S = Distance traveled during each move segment

Cubic Mean Load Equation

$$F_{cml} = \sqrt[3]{\frac{F_1^3 S_1 + F_2^3 S_2 + F_3^3 S_3 + F_4^3 S_4}{S_1 + S_2 + S_3 + S_4}}$$

Value from example numbers is 217 lbs.

Lifetime Calculations

The expected L_{10} life of a roller screw is expressed as the linear travel distance that 90% of the screws are expected to meet or exceed before experiencing metal fatigue. The mathematical formula that defines this value is below. The life is in millions of inches (mm). This standard L_{10} life calculation is what is expected of 90% of roller screws manufactured and is not a guarantee. Travel life estimate is based on a properly maintained screw that is free of contaminants and properly lubricated. Higher than 90% requires de-rating according to the following factors:

95% x 0.62 96% x 0.53
97% x 0.44 98% x 0.33
99% x 0.21

Single (non-preloaded) nut:

$$L_{10} = \left(\frac{C_a}{F_{cml}} \right)^3 \times \ell$$

If your application requires high force over a stroke length shorter than the length of the nut, please contact Exlar for derated life calculations. You may also download the article “Calculating Life Expectency” at www.exlar.com.

Note: The dynamic load rating of zero backlash, preloaded screws is 63% of the dynamic load rating of the standard non-preloaded screws. The calculated travel life of a preloaded screw will be 25% of the calculated travel life of the same size and lead of a non-preloaded screw for the same application.

Total Thrust Calculations

Terms and (units)

THRUST = Total linear force-lbf (N)

$\mathbf{F}_{friction}$ = Force from friction-lbf (N)

$\mathbf{F}_{acc}$ = Acceleration force-lbf (N)

$\mathbf{F}_{gravity}$ = Force due to gravity-lbf (N)

$\mathbf{F}_{applied}$ = Applied forces-lbf (N)

386.4 = Acceleration of gravity - in/sec^2 (9.8 m/sec^2)

Variables

Ø = Angle of inclination - deg..... = _____

tacc = Acceleration time - sec..... = _____

v = Change in velocity - in/sec (m/s)..... = _____

μ = Coefficient of sliding friction ..... = _____

$\mathbf{W}_L$ = Weight of Load-lbm (kg)..... = _____

$\mathbf{F}_{applied}$ = Applied forces-lbf (N) ..... = _____

Thrust Calculation Equations

THRUST = [$\mathbf{F}_{friction}$] + [$\mathbf{F}_{acceleration}$] + $\mathbf{F}_{gravity}$ + $\mathbf{F}_{applied}$

THRUST = [$\mathbf{W}_L$ x μ x cosø] + [($\mathbf{W}_L$ /386.4) x (**v** / $\mathbf{t}_{acc}$)] + $\mathbf{W}_L$sinø + $\mathbf{F}_{applied}$

THRUST = [( )x( )x( )] + [(/386.4) x (/)] + [( ) ( )] + ( )

THRUST = [ ] + [( ) x ( )] + [ ] + ( )

= _____ lbf.

Calculate the thrust for each segment of the move profile. Use those values in calculations below.
Use the units from the above definitions.

Cubic Mean Load Calculations

$$\sqrt[3]{\frac{F_1^3 S_1 + F_2^3 S^2 + F_3^3 S_3 + F_4^3 S_4}{S_1 + S_2 + S_3 + S_4}}$$

F_1= _____ S_1= _____ $F_1^3 S_1$ = _____

F_2= _____ S_2= _____ $F_2^3 S_2$ = _____

F_3= _____ S_3= _____ $F_3^3 S_3$ = _____

F_4= _____ S_4= _____ $F_4^3 S_4$ = _____

Move Profiles may have more or less than four components. Adjust your calculations accordingly.

Torque Calculations

Terms and (units)

λ = Torque, lb-in (N-m) ..... = ----------

F = Applied Load, non inertial, lbf (N) ..... = ----------

S = Screw lead, in (m) ..... = ----------

η = Screw or ratio efficiency (~85% for roller screws) ..... = ----------

g = Gravitational constant, 386 in/s2 (9.8 m/s2) ..... = ----------

α = Acceleration of motor, rad/s2 ..... = ----------

R = Belt or reducer ratio ..... = ----------

$\mathbf{T_L}$ = Torque at driven load, lbf-in (N-m) ..... = ----------

$\mathbf{V_L}$ = Linear velocity of load, in/sec (m/sec) ..... = ----------

ω_L = Angular velocity of load, rad/sec ..... = ----------

ω_m = Angular velocity of motor, rad/sec ..... = ----------

m = Mass of the applied load, lbm (kg) ..... = ----------

$\mathbf{J_R}$ = Reflected Inertia due to ratio, lb-in-s2 (N-m-s2) ..... = ----------

$\mathbf{J_S}$ = Reflected Inertia due to screw, lb-in-s2 (N-m-s2) ..... = ----------

$\mathbf{J_L}$ = Reflected Inertia due to load, lb-in-s2(N-m-s2) ..... = ----------

$\mathbf{J_M}$ = Motor armature inertia, lb-in-s2 (N-m-s2) ..... = ----------

π = pi ..... = 3.14159

$\mathbf{K_t}$ = Motor Torque constant, lb-in/amp (N-m/amp) ..... = ----------

* For the GS Series J_S and J_M are one value from the GS Specifications.

Torque Equations

Torque From Calculated Thrust.

$\lambda = \frac{SF}{2 \cdot \pi \cdot \eta}$ lb - in (N - m) = ( ) x ( )/2π (0.85) = ( ) x ( )/5.34 = ----------

Torque Due To Load, Rotary.

Belt and pulley drive: $\lambda = T_L / R \eta$ lbf-in (N-m)

Gear or gear reducer drive: $\lambda = T_L / R\eta$ lbf-in (N-m)

Torque During Acceleration due to screw, motor, load and reduction, linear or rotary.

$I = (\mathbf{J_m} + (\mathbf{J_S} + \mathbf{J_L}) / \mathbf{R}^2) \alpha$ lb-in (N-**m**) = [( ) + (+) / ( )] ( ) = ----------

Total Torque = Torque from calculated Thrust + Torque due to motor, screw and load

( ) + ( ) + ( ) = _____

Motor Current = $\lambda / \mathbf{K_t}$ = ( ) / ( ) = _____

Exlar Application Worksheet

FAX to:
Exlar Actuation Solutions
(952) 368-4877
Attn: Applications Engineering

Date: _____ Company Name: _____

Address: _____

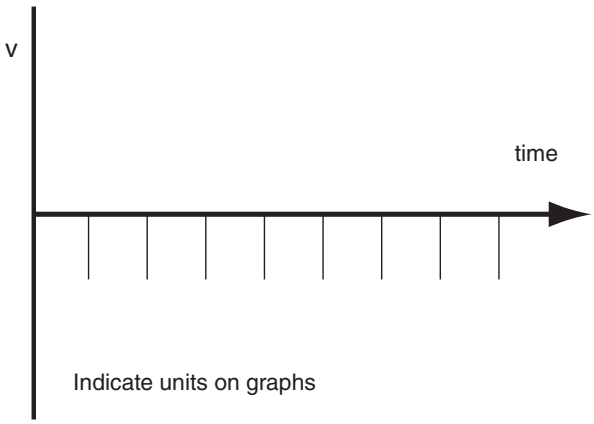
City: _____ State: _____ Zip Code: _____

Phone: _____ Fax: _____

Contact: _____ Title: _____

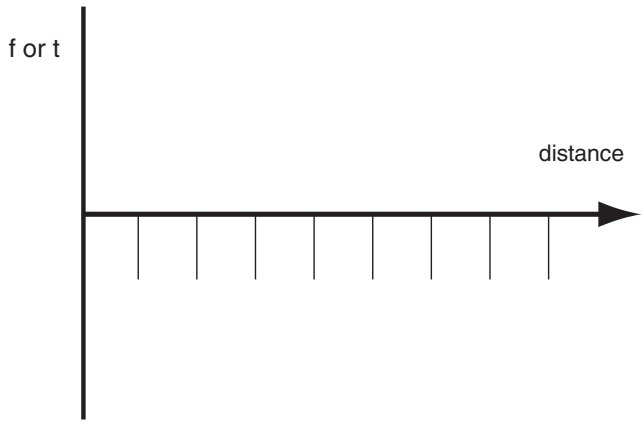
Sketch/Describe Application

Velocity vs. Time



Indicate units on graphs

Force or Torque vs. Distance



Exlar Application Worksheet

Date: _____ Contact: _____ Company: _____

Stroke & Speed Requirements

Maximum Stroke Needed	_____	inches (mm), revs
Index Stroke Length	_____	inches (mm), revs
Index Time	_____	sec
Max Speed Requirements	_____	in/sec (mm/sec), revs/sec
Min Speed Requirements	_____	in/sec (mm/sec), revs/sec
Required Positional Accuracy	_____	inches (mm), arc min

Load & Life Requirements

Gravitational Load	_____	lb (N)
External Applied Load	_____	lbf (N)
Inertial Load	_____	lbf (N)
Friction Load	_____	lbf (N)
Rotary Inertial Load	_____	lbf-in-sec^2 (Kg-m^2)
or rotary mass, radius of gyr. lb (kg)	_____	in (mm)
Side Load (rot. or lin. actuator)	_____	lb (N)

Force Direction _____ Extend _____ Retract _____ Both

Actuator Orientation _____ Vertical Up _____ Vertical Down _____ Horizontal

_____ Fixed Angle _____ Degrees from Horizontal

_____ Changing Angle _____ to _____

Cycling Rate	_____	Cycles/min/hr/day
Operating Hours per Day	_____	Hours
Life Requirement	_____	Cycles/hr/inches/mm

Configuration

Mounting: _____ Side _____ Flange _____ Ext Tie Rod _____ Clevis _____ Trunnion

Rod End: _____ Male _____ Female _____ Sph Rod Eye _____ Rod Eye _____ Clevis

Rod Rotation Limiting: _____ Appl Inherent _____ External Required

Holding Brake Required: _____ Yes _____ No

Cable Length: _____ ft (m)

Rotary Inertia To obtain a conversion from A to B, multiply by the value in the table.

B	Kg-m²	Kg-cm²	g-cm²	kgf-m-s²	kgf-cm-s²	gf-cm-s²	oz-in²	ozf-in-s²	lb-in²	lbf-in-s²	lb-ft²	lbf-ft-s²
A												
Kg-m²	1	10^4	10^7	0.10192	10.1972	$1.01972x10^4$	$5.46745x10^4$	$1.41612x10^2$	$3.41716x10^3$	8.850732	23.73025	0.73756
Kg-cm²	10^{-4}	1	10^3	$1.01972x10^5$	$1.01972x10^3$	1.01972	5.46745	$1.41612x10^{-2}$	0.341716	$8.85073x10^{-4}$	$2.37303x10^{-3}$	$7.37561x10^{-5}$
g-cm²	10^{-7}	10^{-3}	1	$1.01972x10^{-8}$	$1.01972x10^{-6}$	$1.01972x10^{-3}$	$5.46745x10^{-3}$	$1.41612x10^{-5}$	$3.41716x10^{-4}$	$8.85073x10^{-7}$	$2.37303x10^{-6}$	$7.37561x10^{-8}$
kgf-m-s²	9.80665	$9.80665x10^4$	$9.80665x10^7$	1	10^2	10^5	$5.36174x10^5$	$1.388674x10^3$	$3.35109x10^4$	86.79606	$2.32714x10^2$	7.23300
kgf-cm-s²	$9.80665x10^{-2}$	$9.80665x10^2$	$9.80665x10^5$	10^{-2}	1	10^5	$5.36174 x10^3$	13.8874	$3.35109x10^{-2}$	0.86796	2.32714	$7.23300x10^{-2}$
gf-cm-s²	9.80665x10-5	0.980665	$9.80665x10^2$	10^{-5}	10^{-3}	1	5.36174	$1.38874 x10^{-2}$	0.335109	$8.67961x10^{-4}$	$2.32714x10^{-3}$	$7.23300x10^{-5}$
oz-in²	$1.82901x10^{-5}$	0.182901	$1.82901x10^2$	$1.86505x10^{-6}$	$1.86505x10^{-4}$	0.186506	1	$2.59008 x10^{-3}$	$6.25 x10^{-2}$	$1.61880x10^{-4}$	$4.34028x10^{-4}$	$1.34900x10^{-3}$
oz-in-s²	$7.06154x10^{-3}$	70.6154	$7.06154x10^4$	$7.20077x10^4$	$7.20077x10^{-2}$	72.0077	$3.86089x10^2$	1	24.13045	$6.25 x10^{-2}$	0.167573	$5.20833x10^{-4}$
lb-in²	$2.92641x10^{-4}$	2.92641	$2.92641x10^3$	$2.98411x10^5$	$2.98411x10^3$	2.98411	16	$4.14414 x10^2$	1	$2.59008x10^{-3}$	$6.94444x10^{-3}$	$2.15840x10^{-4}$
lbf-in-s²	0.112985	$1.129x10^3$	$1.12985x10^6$	$1.15213x10^2$	1.15213	$1.51213 x10^3$	$6.1774 x10^3$	16	$3.86088x10^2$	1	2681175	$8.3333x10^{-2}$
lbf-ft²	$4.21403x10^{-2}$	$4.21403x10^2$	$4.21403x10^5$	$4.29711x10^3$	0.429711	4.297114	$2.304 x10^3$	5.96755	144	0.372971	1	$3.10809x10^{-2}$
lbf-ft-s²	1.35583	$1.35582x10^4$	$1.35582x10^7$	0.138255	13.82551	$1.38255x10^4$	$7.41289x10^4$	192	$4.63306x10^3$	12	32.17400	1

Torque To obtain a conversion from A to B, multiply A by the value in the table.

B	N-m	N-cm	dyn-cm	Kg-m	Kg-cm	g-cm	oz-in	ft-lb	in-lb
A									
N-m	1	10^{-2}	10^7	0.109716	10.19716	$1.019716 x10^4$	141.6199	0.737562	8.85074
N-cm	102	1	10^5	$1.019716 x10^3$	0.1019716	$1.019716 x10^2$	1.41612	$7.37562 x10^{-3}$	$8.85074 x10^{-2}$
dyn-cm	10-7	10^{-5}	1	$1.019716 x10^{-8}$	$1.019716 x10^{-6}$	$1.019716 x10^{-3}$	$1.41612 x10^{-5}$	$7.2562 x10^{-8}$	$8.85074 x10^{-7}$
Kg-m	9.80665	$980665x10^2$	$9.80665 x10^7$	1	10^2	10^5	$1.38874 x10^3$	7.23301	86.79624
Kg-cm	9.80665x10-2	9.80665	$9.80665 x10^5$	10^{-2}	1	10^3	13.8874	$7.23301 x10^{-2}$	0.86792
g-cm	9.80665x10-5	$9.80665x10^{-3}$	$9.80665 x10^2$	10^{-5}	10^{-3}	1	$1.38874 x10^{-2}$	$7.23301 x10^{-5}$	$8.679624 x10^{-4}$
oz-in	7.06155x10-3	0.706155	$7.06155 x10^4$	$7.20077 x10^{-4}$	$7.20077 x10^{-2}$	72,077	1	$5.20833 x10^{-3}$	$6.250 x10^{-2}$
ft-lb	1.35582	$1.35582x10^2$	$1.35582 x10^7$	0.1382548	13.82548	$1.382548 x10^4$	192	1	12
in-lb	0.113	11.2985	$1.12985 x10^6$	$1.15212 x10^{-2}$	1.15212	$1.15212 x10^3$	16	$8.33333 x10^{-2}$	1

Common Material Densities

Material	oz/in³	gm/cm³
Aluminum (cast or hard drawn)	1.54	2.66
Brass (cast or rolled)	4.80	8.30
Bronze (cast)	4.72	8.17
Copper (cast or hard drawn)	5.15	8.91
Plastic	0.64	1.11
Steel (hot or cold rolled)	4.48	7.75
Wood (hard)	0.46	0.80
Wood (soft)	0.28	0.58

Coefficients of Sliding Friction

Materials in contact	μ
Steel on Steel (dry)	0.58
Steel on Steel (lubricated)	0.15
Aluminum on Steel	0.45
Copper on Steel	0.36
Brass on Steel	0.44
Plastic on Steel	0.20
Linear Bearings	0.001

Standard Ratings for Exlar Actuators

The standard IP rating for Exlar Actuators is IP54S or IP65S. Ingress protection is divided into two categories: solids and liquids.

For example, in IP65S the three digits following "IP" represent different forms of environmental influence:

- The first digit represents protection against ingress of solid objects.
- The second digit represents protection against ingress of liquids.
- The suffix digit represents the state of motion during operation.

Digit 1 - Ingress of Solid Objects	
The IP rating system provides for 6 levels of protection against solids.	
1	Protected against solid objects over 50 mm e.g. hands, large tools.
2	Protected against solid objects over 12.5 mm e.g. hands, large tools.
3	Protected against solid objects over 2.5 mm e.g. large gauge wire, small tools.
4	Protected against solid objects over 1.0 mm e.g. small gauge wire.
5	Limited protection against dust ingress.
6	Totally protected against dust ingress.

Digit 2 - Ingress of Liquids	
The IP rating system provides for 9 levels of protection against liquids.	
1	Protected against vertically falling drops of water or condensation.
2	Protected against falling drops of water, if the case is positioned up to 15 degrees from vertical.
3	Protected against sprays of water from any direction, even if the case is positioned up to 60 degrees from vertical.
4	Protected against splash water from any direction.
5	Protected against low pressure water jets from any direction. Limited ingress permitted.
6	Protected against high pressure water jets from any direction. Limited ingress permitted.
7	Protected against short periods (30 minutes or less) of immersion in water of 1m or less.
8	Protected against long durations of immersion in water.
9	Protected against high-pressure, high-temperature wash-downs.

Suffix			
S	Device standing still during operation	M	Device moving during operation

Notes

Return to table of contents

1. OFFER AND ACCEPTANCE: These terms and conditions constitute Seller's offer to Buyer and acceptance by Buyer and any resulting sale is expressly limited to and conditioned upon Seller's terms and conditions as set forth below. If Buyer objects to any of Seller's terms and conditions, such objections must be expressly stated and brought to the attention of Seller in a written document which is separate from any purchase order or other printed form of Buyer. Such objections, or the incorporation of any additional or different terms or conditions by Buyer into a resulting order shall constitute non-acceptance of these Terms and Conditions, releasing Seller from any obligation or liability hereunder and a proposal for different terms and conditions which shall be objected to by Seller unless expressly accepted in writing by an authorized representative of Seller. Acknowledgment copy, if any, shall not constitute acceptance by Seller of any additional or different terms or conditions, nor shall Seller's commencement of effort, in itself, be construed as acceptance of an order containing additional or different terms and conditions.

2. PRICES: Published prices and discount schedules are subject to change without notice. They are prepared for the purpose of furnishing general information and are not quotations or offers to sell on the part of the company.

3. TRADE TERMS: Shipment terms are FCA, shipping point (Exlar, Chanhassen, MN). FCA (Free Carrier) per Incoterms 2010 means the Seller delivers the goods, cleared for export into the custody of the first carrier named by the buyer at the named place, above. This term is suitable for all modes of transport, including carriage by air, rail, road, and containerized/multi-modal transport. Title of the merchandise transfers from Exlar Corporation to the Buyer when it is received from Exlar by the carrier. Where allowable, Exlar will arrange the transportation via the carrier specified by the Buyer. The Buyer is responsible for all costs associated with the shipment.

4. PAYMENT TERMS: Subject to approval of Buyer's credit, the full net amount of each invoice is due and payable in cash within thirty (30) days of shipment. No payment discounts are offered, and minor inadvertent administrative errors contained in an invoice are subject to correction and shall not constitute reason for untimely payment. If, in the judgment of the Seller, the financial credit of Buyer at any time does not justify continuance of production or shipment of any product(s) on the payment terms herein specified, Seller may require full or partial payment prior to completion of production or shipment, or may terminate any order, or any part thereof, then outstanding. Custom products and blanket orders are subject to payment terms: 30% due at time of order, 70% due net 30 days from shipment.

5. MINIMUM BILLING: Minimum billing will be $50.00.

6. DELAYS: Exlar shall not be liable for any defaults, damages or delays in fulfilling any order caused by conditions beyond Seller's control, including but not limited to acts of God, strike, lockout, boycott, or other labor troubles, war, riot, flood, government regulations, or delays from Seller's subcontractors or suppliers in furnishing materials or supplies due to one or more of the foregoing clauses.

7. CANCELLATIONS: All cancelled orders for standard products are subject to order cancellation charges. The minimum cancellation charge will be 20% of the order total. Standard products, if unused may be returned in accordance with the current return policy. All returns are subject to prior approval by Exlar, and return charges may apply. No return credit for any product will be issued or authorized prior to evaluation of the product by Exlar. Custom product is not returnable. Orders for custom product are not cancelable.

8. QUANTITY PRICING AND BLANKET ORDER PRICING TERMS: Blanket order quantity pricing requires a complete delivery schedule for the volume being ordered, with all units scheduled to deliver within a 15 month period from the placement of the purchase order to the final scheduled shipment. Any requests to change the delivery schedule of a blanket order must be received in writing 60 days prior to the requested change. Failure to take delivery of the entire ordered volume will result in back charges equal to the difference in quantity price between the volume ordered and the volume received times the number of units received. A cancellation charge in accordance with the cancellation policy (item 7) will apply to any reduction in delivered volume from the original ordered quantity.

For orders receiving quantity discounts, but not as scheduled blanket orders, the same quantity pricing rules apply. Failure to take delivery of the entire quantity ordered will result in back charges equal to the difference in quantity price between the volume ordered and the volume received times the number of units received. Cancellation charges in accordance with the cancellation policy (item 7) will apply to any reduction in delivered volume from the original ordered quantity. For either blanket orders or quantity orders, in addition to any applicable cancellation charges, the customer is responsible for the value of any additional inventory allocated specifically to their order. Charges for this inventory will be invoiced in addition to cancellation charges, along with any back charges for quantity variance.

9. DESTINATION CONTROL STATEMENT: Exlar products, technology or software are exported from the United States in accordance with the Export Administration Regulations (EAR) or International Traffic in Arms Regulations (ITAR) as applicable. Diversion, transfer, transshipment or disposal contrary to U.S. law is prohibited.

10. EXPORT CONTROL AND SHIPMENT REGULATIONS: Purchaser agrees at all times to comply with all United States laws and regulations as well as International Trade Laws, as they may exist from time to time, regarding export licenses or the control or regulation of exportation or re-exportation of products or technical data sold or supplied to Distributor. Seller may terminate or suspend this order, without remedy, should the Purchaser become an entity identified on any US export denial listing. Products ordered may require authorization and/or validated export license from a U.S. government agency. Seller may terminate or suspend this order, without remedy, should a government agency approval be denied.

11. GOVERNING LAW AND VENUE: This order shall be governed by, and construed in accordance with the laws of the State of Minnesota, U.S.A. All disputes shall be resolved by a court of competent jurisdiction in the trial courts of Carver County, in the State of Minnesota.

12. ATTORNEY FEES: Reasonable attorney's fees and other expenses of litigation must be awarded to the prevailing party in an action in which a remedy is sought under this order.

13. NON-WAIVER: The failure by the Seller to require performance of any provision shall not affect the Seller's right to require performance at any time thereafter, nor shall a waiver of any breach or default of this Order constitute a waiver of any subsequent breach or default or a waiver of the provision itself.

14. MERGER AND INTEGRATION: These Terms and Conditions contain the entire agreement of the parties with respect to the subject matter of this order, and supersede all prior negotiations, agreements and understandings with respect thereto. Purchase orders may only be amended by a written document duly executed by buyer and seller.

15. INDEMNITY: Buyer agrees to indemnify, defend and hold harmless Exlar from any claims, loss or damages arising out of or related to Seller's compliance with Buyer's designs, specifications or instructions in the furnishing of products to Buyer, whether based on infringement of patents, copyrights, trademark or other right of others, breach of warranty, negligence, or strict liability or other tort.

WARRANTY AND LIMITATION OF LIABILITY: Products are warranted for two years from date of manufacture as determined by the serial number on the product label. Labels are generated and applied to the product at the time of shipment. The first and second digits are the year and the third and fourth digits represent the manufacturing week. Product repairs are warranted for 90 days from the date of the repair. The date of repair is recorded within the Exlar database and tracked by individual product serial number.

Exlar Corporation warrants its product(s) to the original purchaser and in the case of original equipment manufacturers, to their original customer to be free from defects in material and workmanship and to be made only in accordance with Exlar standard published catalog specifications for the product(s) as published at the time of purchase. Warranty or performance to any other specifications is not covered by this warranty unless otherwise agreed to in writing by Exlar and documented as part of any and all contracts, including but not limited to purchase orders, sales orders, order confirmations, purchase contracts and purchase agreements. In no event shall Exlar be liable or have any responsibility under such warranty if the product(s) has been improperly stored, installed, used or maintained, or if Buyer has permitted any unauthorized modifications, adjustments and/or repairs to such product(s). Seller's obligation hereunder is limited solely to repairing or replacing (at its opinion), at the factory any product(s), or parts thereof, which prove to Seller's satisfaction to be defective as a result of defective materials, or workmanship and within the period of time, in accordance with the Seller's stated product warranty (see Terms and Conditions above), provided, however, that written notice of claimed defects shall have been given to Exlar within thirty (30) days from the date of any such defect is first discovered. The product(s) claimed to be defective must be returned to Exlar, transportation prepaid by Buyer, with written specification of the claimed defect. Evidence acceptable to Exlar must be furnished that the claimed defects were not caused by misuse, abuse, or neglect by anyone other than Exlar.

Components such as seals, wipers, bearings, brakes, bushings, gears, splines, and roller screw parts are considered wear parts and must be inspected and serviced on a regular basis. Any damage caused by failure to properly lubricate Exlar products and/or to replace wear parts at appropriate times, is not covered by this warranty. Any damage due to excessive loading is not covered by this warranty.

The use of products or components under load such that they reach the end of their expected life is a normal characteristic of the application of mechanical products. Reaching the end of a product's expected life does not indicate any defect in material or workmanship and is not covered by this warranty.

Costs for shipment of units returned to the factory for warranty repairs are the responsibility of the owner of the product. Exlar will return ship all warranty repairs or replacements via UPS Ground at no cost to the customer.

For international customers, Exlar will return ship warranty repairs or replacements via UPS Expedited Service and cover the associated shipping costs. Any VAT or local country taxes are the responsibility of the owner of the product.

The foregoing warranty is in lieu of all other warranties (except as Title), whether expressed or implied, including without limitation, any warranty of merchantability, or of fitness for any particular purpose, other than as expressly set forth and to the extent specified herein, and is in lieu of all other obligations or liabilities on the part of Exlar.

Seller's maximum liability with respect to these terms and conditions and any resulting sale, arising from any cause whatsoever, including without limitation, breach of contract or negligence, shall not exceed the price specified of the product(s) giving rise to the claim, and in no event shall Exlar be liable under this warranty otherwise for special, incidental or consequential damages, whether similar or dissimilar, of any nature arising or resulting from the purchase, installation, removal, repair, operation, use or breakdown of the product(s) or any other cause whatsoever, including negligence.

The foregoing warranty shall also apply to products or parts which have been repaired or replaced pursuant to such warranty, and within the period of time, in accordance with Seller's stated warranty.

NO PERSON INCLUDING ANY AGENT OR REPRESENTATIVE OF EXLAR CORPORATION IS AUTHORIZED TO MAKE ANY REPRESENTATION OR WARRANTY ON BEHALF OF EXLAR CONCERNING ANY PRODUCTS MANUFACTURED BY EXLAR, EXCEPT TO REFER PURCHASERS TO THIS WARRANTY.