ER120 SERIES

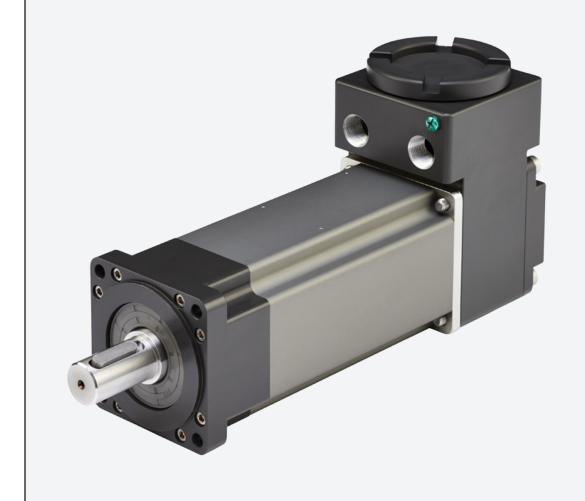
HAZARDOUS LOCATION ACTUATORS AND MOTORS

High precision positioning with integrated feedback

Ability to handle heavy loads over thousands of hours

High efficiency and 100% duty cycle

Class 1, Division 1 Classification



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ER120 Series

Explosion-Proof Rotary Motor and Gearmotor

For hazardous duty environments with constant exposure to flammable gasses or vapors* Exlar's ER Series rotary explosion-proof motors and gearmotors provide an excellent solution. Exlar's motors utilizing T-LAM technology, an innovative segmented winding, have been designed for efficiency, power and durability and provide a very high torque-to-size ratio when compared to other suppliers' motors.

The gearmotor comprises a brushless permanent magnet motor optimized for use with an integral planetary gear set. Through the uniform load sharing of several gears acting in concert, planetary gear heads are a very compact, reliable solution providing high torque, low backlash and low maintenance.

The ER Series motors are compatible with nearly any manufacturers' resolver-based amplifier.

The ER Series actuators are ideal for operating quarter turn or multi turn valves or shaft driven dampers in hazardous environments. These actuators are directly coupled shaft-to-shaft, eliminating ungainly mechanisms needed by the linear motion of pneumatics. Our compact T-LAM servo motors outperform any standard motor, providing excellent continuous modulating service.

* ER Series motors are rated for Class I, Division 1, Groups B, C and D. "Class I" means that flammable gasses or vapors may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. "Division 1" means that hazardous concentrations in the air may exist continuously, intermittently, or periodically under normal operating conditions. "Group B" allows for atmospheres containing hydrogen, or gasses (or vapors) of equivalent hazard, such as manufactured gas. "Group C" allows for atmospheres containing ethyl-ether vapors, ethylene or cyclo propane. "Group D" allows for atmospheres containing gasoline, hexane, naphtha, benzene, butane, alcohol, acetone, benzol, lacquer solvent vapors or natural gas. ER Series motors are not rated for operation in atmospheres containing acetylene.

Technical Characteristics				
Frame Sizes	4.72 in (120 mm)			
Torque Range	up to 4696 lbf-in (530 Nm)			
Maximum Speed	3000 rpm			



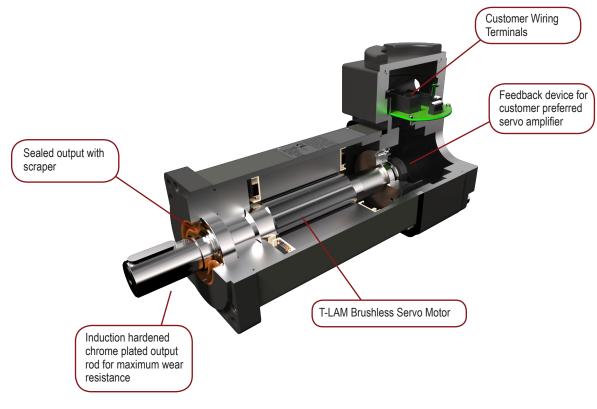


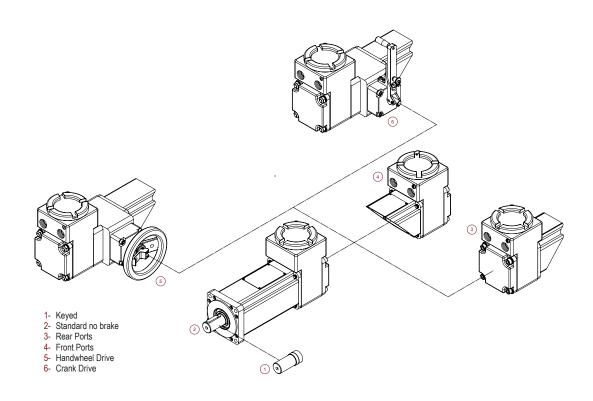


Operating Conditions and Usage					
Ambient Conditions:					
Ambient Operating Temperature	-29 to 93 -20 to 199				
Storage Temperature	-54 to 93				
IP Rating		IP65S			

Features
T-LAM technology yielding 35% increase in continuous motor torque over traditional windings
Resolver feedback
8 pole motors
Rod end options
1, 2, or 3 stack motor availability compatible with nearly any resolver based servo amplifier
Several mounting configurations
Potted NPT leads
Windings from 24 VDC to 460 VAC rms
Class 180H insulation system

Product Features





ER120 Explosion-Proof Motors

Industries and Applications

Process Control

Valve control
Damper control
Turbine control
Choke valves
Fuel control

Plunger pumps

Automotive

Paint booths Fuel control Engine test stands

Defense

Weapons room

Material Handling

Printing presses

In hazardous duty environments where exposure to flammable gasses or vapors may be ever present, ER Series explosion proof motors and gear motors stand up to the challenge making them perfect for paint booths and printing presses.





With life counts in the hundreds of millions of cycles, response times in milliseconds and accuracy of 0.10%, Exlar offers superior electric control valve actuation replacing other traditional electric, pneumatic, and hydraulic actuators.

Electrical and Mechanical Specifications

Licotifical	arrar	****			Opc	,01110	Jatic	110							
Motor Stator		1A8	1B8	118	138	158	168	2A8	2B8	238	258	268	338	358	368
RMS SINUSOIDAL COM	MUTATION D	ATA													
Continuous Motor	lbf-in	71.8	71.8	74.1	74.1	74.3	74.1	120.5	120.5	123.6	121.4	123.8	172.3	168.9	176.9
Torque	N-m	8.11	8.11	8.37	8.37	8.39	8.37	13.61	13.61	13.96	13.72	13.96	19.46	19.09	19.98
Dook Mater Torrus	lbf-in	143.6	143.6	148.2	148.2	148.6	148.2	241.0	241.0	247.2	242.8	247.2	344.5	337.8	353.7
Peak Motor Torque	N-m	16.22	16.22	16.74	16.74	16.79	16.74	27.23	27.23	27.93	27.43	27.93	38.93	38.17	39.96
Torque Constant (Kt)	lbf-in/A	5.3	5.3	4.3	8.7	15.7	17.3	5.3	5.3	8.7	15.8	17.3	8.5	15.8	17.5
(+/- 10% @ 25°C)	N-m/A	0.60	0.60	0.49	1.00	1.80	2.00	0.60	0.60	1.00	1.80	2.00	1.00	1.80	2.00
Continuous Current Ratio	ng A	15.2	15.2	19.1	9.5	5.3	4.8	25.5	25.5	15.9	8.6	8.0	22.7	11.9	11.3
Peak Current Rating	A	30.4	30.4	38.2	19.1	10.6	9.5	51.0	51.0	31.8	17.1	15.9	45.4	23.8	22.5
O-PEAK SINUSOIDAL C	OMMUTATIO	N													
Continuous Motor	lbf-in	71.8	71.8	74.1	74.1	74.3	74.1	120.5	120.5	123.6	121.4	123.6	74.1	74.1	74.1
Continuous Motor Torque	N-m	8.11	8.11	8.37	8.37	8.39	8.37	13.61	13.61	13.96	13.72	13.96	8.37	8.37	8.37
	lbf-in	143.6	143.6	148.2	148.2	148.6	148.2	241.0	241.0	247.2	242.8	247.2	344.5	337.8	353.7
Peak Motor Torque	N-m	16.22	16.22	16.74	16.74	16.79	16.74	27.23	27.23	27.93	27.43	27.93	38.93	38.17	39.96
		3.7	3.7	3.1	6.1	11.1	12.3	3.7	3.7	6.1	11.2	12.3	6.0	11.2	12.4
Torque Constant (Kt) (+/- 10% @ 25°C)	Ibf-in/A														
· • ·	N-m/A	0.42	0.42	0.35	0.70	1.25	1.39	0.42	0.42	0.70	1.27	1.39	0.68	1.27	1.40
Continuous Current Ratio		21.5	21.5	27.0	13.5	7.5	6.7	36.1	36.1	22.5	12.1	11.3	32.1	16.9	15.9
Peak Current Rating	A	43.0	43.0	54.0	27.0	15.0	13.5	72.1	72.1	45.0	24.2	22.5	64.2	33.7	31.9
MOTOR DATA	\/	20.4	20.4	00.0	FO 0	400.0	440.5	20.4	20.4	F0.0	400.0	440.5	50.0	400.0	440.0
Voltage Constant (Ke) (+/- 10% @ 25°C)	Vrms/Krpm	36.1	36.1	29.6	59.2	106.9	118.5	36.1	36.1	59.2	108.2	118.5	58.0	108.2	119.8
·	Vpk/Krpm	51.0	51.0	41.9	83.8	151.2	167.6	51.0	51.0	83.8	153.0	167.6	82.0	153.0	169.4
Pole Configuration	1							· · · · · · · · · · · · · · · · · · ·	3			I			
Resistance (L-L) (+/- 5% @ 25°C)	Ohms	0.31	0.31	0.20	0.80	2.60	3.21	0.13	0.13	0.34	1.17	1.35	0.20	0.72	0.81
Inductance (L-L) (+/- 15%)	mH	4.8	4.8	3.3	13.0	42.4	52.1	2.3	2.3	6.3	21.1	25.3	4.0	13.1	17.1
Armature Inertia	lbf-in-sec ²		0.00538 0.00818 0.01097												
(+/- 5%)	Kg-cm ²			6.0)82			9.242					12.400		
Brake Inertia	lbf-in-sec ²							0.00	0030						
Diake illertia	Kg-cm ²							0.3	339						
Brake Current @ 24VDC (+/- 10%)	А							1	.0						
Brake Holding Torque	lbf-in							1	77						
- Dry	(N-m)							2	.0						
Brake Engage/ Disengage Time	ms							13	/50						
Mechanical Time Constant ™	ms	0.94	0.94	0.91	0.91	0.9	0.91	0.58	0.58	0.57	0.59	0.57	0.47	0.47	0.45
Electrical Time Constant (te)	ms	15.73	15.73	16.26	16.26	16.34	16.25	18.41	18.41	18.72	18.06	18.72	20.08	20.19	21.16
Friction Torque	lbf-in	1.39	1.39	1.39	1.39	1.39	1.39	1.75	1.75	1.75	1.75	1.75	2.25	2.25	2.25
i notion forque	N-m	0.157	0.157	0.157	0.157	0.157	0.157	0.197	0.197	0.197	0.197	0.197	0.254	0.254	0.254
Bus Voltage	Vrms	24 VDC	48 VDC	115	230	400	460	24 VDC	48 VDC	230	400	460	230	400	460
Speed @ Bus Voltage	rpm	pm 300 750 3000			300	750		3000			3000				
Insulation Class								180	(H)						
Ambient Temperature Ra	ating							-29°C	to 93°C						
Insulation System Voltag	Insulation System Voltage Rating T4, 135°C Max			35°C Maxi	mum Allov	vable Surfa	ce Tempe	rature							

Test data derived using NEMA recommended aluminum heatsink 12" x 12" x 1/2" at 25°C ambient

Gearmotor Data

	1 Stack Motor		2 Stack Motor		3 Stack Motor	
SLG Armature Inertia* Ibf-in-sec² (Kg-cm²)	0.00538 (6.085)		0.00820 (9.274)		0.01102 (12.464)	
GEARING REFLECTED INERTIA	S	SINGLE REDUCTION	I	DOUBLE REDUCTION		
	Gear Stages	lbf-in-sec ²	(Kg-cm ²)	Gear Stages	lbf-in-sec ²	(Kg-cm ²)
	4:1	0.000851	(0.961)	16:1	0.000510	(0.576)
	5:1	0.000557	(0.629)	20:1, 25:1	0.000344	(0.389)
	10:1	0.000145	(0.164)	40:1, 50:1, 100:1	0.000092	(0.104)
Backlash at 1% rated torque:	10 Arc minutes	(Efficiency: Single r	eduction 91%)	13 Arc minutes	(Efficiency: Double F	Reduction: 86%)

^{*} Add armature inertia to gearing inertia for total ER geared system inertia

Gearmotor General Performance Specifications

Two torque ratings for the ER Series Gearmotors are given in the table below. The left hand columns give the maximum (peak) allowable output torque for the indicated ratios of each size ER Series Gearmotor. This IS NOT the rated output torque of the motor multiplied by the ratio of the reducer.

It is possible to select a configuration of the motor selection and gear ratio such that the rated motor torque, multiplied by the gear ratio exceeds these ratings. It is the responsibility of the user to ensure that the settings of the system, including the amplifier, do not allow these values to be exceeded.

The right hand columns give the output torque at the indicated speed which will result in 10,000 hour (L10). The setup of the system, including the amplifier, will determine the actual output torque and speed.

Output Torque Ratings – Mechanical

ER120	Maximum Allowable Output	Output Torque @ Speed for 10,000 Hour Life - Ibf-in (Nm)				
Ratio	Torque Ibf-in (Nm)	1000 RPM	2000 RPM	3000 RPM		
4:1	4696 (530.4)	1392 (157.3)	1132 (127.9)	1000 (112.9)		
5:1	4066 (459.4)	1445 (163.3)	1175 (132.8)	1040 (117.5)		
10:1	2545 (287.5)	1660 (187.6)	1350 (152.6)	1200 (135.6)		
16:1	4696 (530.4)	2112 (238.6)	1714 (193.0)	1518 (171.0)		
20:1	4696 (530.4)	2240 (253.1)	1840 (207.9)	1620 (183.0)		
25:1	4066 (459.4)	2350 (265.5)	1900 (214.7)	1675 (189.2)		
40:1	4696 (530.4)	2800 (316.4)	2240 (253.1)	2000 (225.9)		
50:1	4066 (459.4)	2900 (327.7)	2350 (265.5)	2100 (237.3)		
100:1	2545 (287.5)	2500 (282.5)	2500 (282.5)	2400 (271.2)		

Radial Load and Bearing Life

RPM	ER120 lbf (N)	RPM	ER120 (Gear) lbf (N)
50	579 (2576)	50	1223 (5440)
100	460 (2046)	100	971 (4318)
250	339 (1508)	250	715 (3181)
500	269 (1197)	500	568 (2525)
1000	214 (952)	1000	451 (2004)
3000	148 (658)	3000	218 (970)

Side load ratings shown below are for 10,000 hour bearing life at 25 mm from motor face at given rpm.

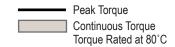
Visit www.exlar.com for full details on radial load and bearing life.

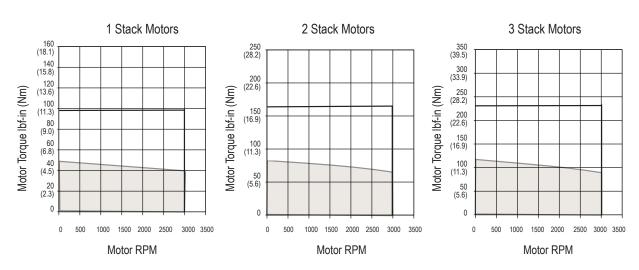
Motor and Gearmotor Weight

	Motor	Gear	motor
ER120	Motor Weight lb (kg)	1 Stage lb (kg)	2 Stage lb (kg)
1 Stack	29.9 (13.56)	37.7 (17.10)	43.2 (19.60)
2 Stack	37.4 (16.96)	45.2 (20.50)	50.7 (23.00)
3 Stack	44.8 (20.32)	52.7 (23.90)	58.3 (26.45)

^{*} For brake option add 0.9 lb (0.408 kg) mass.

Speed/Torque Curves





For gearmotors, divide speed by gear ratio; multiply torque by gear ratio and effciency. Efficencies: 1 Stage = 0.91, 2 Stage = 0.86 Test data derived using NEMA recommended aluminum heatsink 12" x 12" x 1/2" at 25°C ambient.

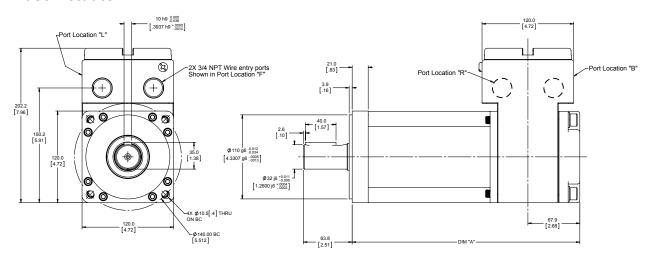
Notes



ER120 Explosion-Proof Motors

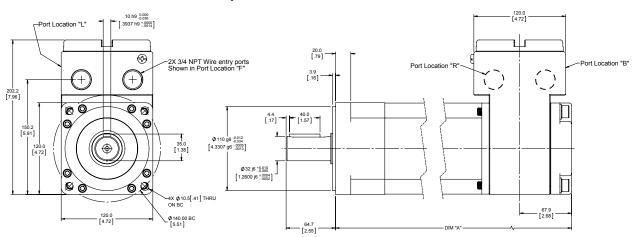
Dimensions

Base Actuator



Gear R	eduction	Dimension "A"
Stages Stacks		Length mm (in)
0	1	297.9 (11.73)
	2	348.7 (13.73)
	3	399.5 (15.73)

ER120 with Gear Reduction Option



Gear Reduction		Dimension "A"		
Stages Stacks		Length mm (in)		
1	1	389.8 (15.35)		
	2	440.7 (17.35)		
	3	491.5 (19.35)		

Gear	Reduction	Dimension "A"
Stages Stacks		Length mm (in)
2	1	429.9 (16.93)
	2	480.8 (18.93)
	3	531.6 (20.93)

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.

ER = Model Series

ER = Explosion proof rotary actuator

AAA = Frame Size

120 = 120 mm

BBB = Gear Reduction Ratio

Single reduction ratio

004 = 4:1 005 = 5:1

010 = 10:1

Double reduction ratio (N/A on 075 mm)

016 = 16:1

020 = 20:1

025 = 25:1

040 = 40:1

050 = 50:1

100 = 100:1

C = Shaft Type

K = Keved

R = Smooth/round

D = Connections

F = Two 0.75 in NPT Ports, Front Facing (as viewed from rod end)

 Two 0.75 in NPT Ports, Back Facing (as viewed from rod end)

R = Two 0.75 in NPT Ports, Right Facing (as viewed from rod end)

 Two 0.75 in NPT Ports, Left Facing (as viewed from rod end)

F = Brake Options

S = Standard no brake

B = Brake

GGG = Feedback Type

See page 207 for detailed information

HHH = Motor Stator, All 8 Pole

		•	
118=1 Stack	115 Vrms	158 = 1 Stack	
138 = 1 Stack		258 = 2 Stack	400 Vrms
238 = 2 Stack	230 Vrms	358 = 3 Stack	
338 = 3 Stack		168 = 1 Stack	
		268 = 2 Stack	460 Vrms
		368 = 3 Stack	

II = Speed Designations

30 = 3000 rpm

MM = Mechanical Options 1

HW = Manual drive, handwheel with Interlock switch

CD = Crank drive with interlock switch

NOTES:

1. For extended temperature operation consult factory for model number.

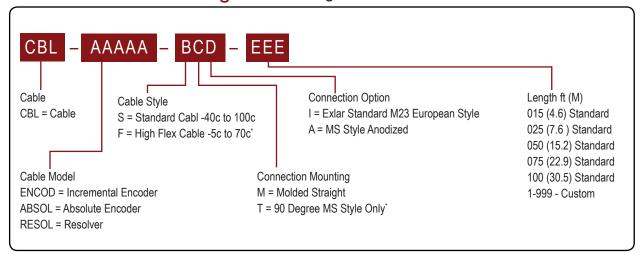
Contact your local sales representative regarding all special actuator components.



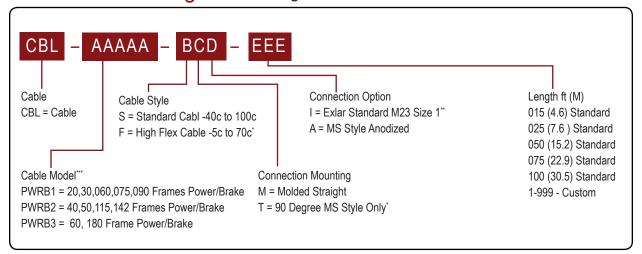
For options or specials not listed above or for extended temperature operation, please contact Exlar

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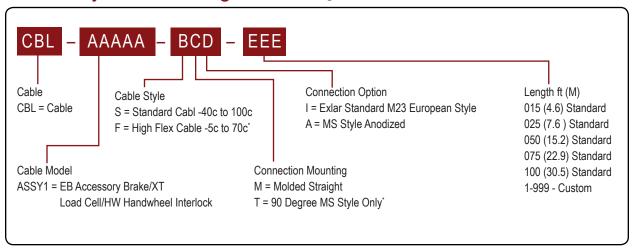
Feedback Cable Configuration - e.g. CBL-ENCOD-SMI-015



Power Cable Configuration - e.g. CBL-PWRB1-SMI-015



Accessory Cable Configuration - e.g. CBL-ASSY1-SMI-015



All Exlar cables rated IP65 when mated to actuator.

^{*} Non-standard options - require longer lead times.

^{**} PWRB3 uses M40 size 1.5.

^{***} Special stator winding may require a special power cable.

Manufacturers Feedback Cable Selection Guide

Amplifier/Drive Selected	Feedback Selected	Manufacturers Part Number
Allen-Bradley/Rockwell: All Drives	RA1/RA2/RA3/RA4 AB8/AB9/ABB	2090-CFBM7DF-CDAxyy
AMKASYN: All Drives	AK1/AK2	DS Series Absolute Encoder Cable
Beckhoff: All Drives	BE1	ZK4000-26yy-2zzz
B&R Automation: All Drives	BR1 BR2	8CRxxx.12-1 8CExxx.12-1
Emerson/Control Techniques: Unidrive SP/Epsilon EP	CT1/CT3 CT2/EM2/EM5 CT4/CT7 CT5 CT5	SSBCABXXXX UFCSXXX SIBAAAXXXX SRBBBBXXXX SRBBABXXXX
En/Epsilon/MDS	CT4/CT7 EM2/EM5	SIBAEAXXXX CFCSXXX
Elau: All Drives	EU1/EU4	SH Series Absolute Encoder Cable
G&L Motion Control/Danaher Motion: MMC Smart Drive/ Digital MMC Control	GL1 GL2 GL3 GL4	ENC-H&F ENC-L&M ENC-NSM ENDAT-AKM
Indramat/Bosch-Rexroth: DKC Series/DIAX IndraDrive	IN1 IN5 IN6 IN7	IKS4001 IKS4001 IKS4374 RKG4200
Jetter Technologies: JetMove 2xx	JT1	JH/JL Series Resolver Cable Nr. 23
JetMove 6xx Kollmorgen/Danaher: All Drives	JT1 KM4 KM5 KM6	JH/JL Series Resolver Cable Nr. 423 AKM Series Sine Encoder Based (Absolute) Encoder with Duel Intercontec Connectors use B,C, or G Connector Options AKM Series Resolver Based with Duel Intercontec Connectors use B,C, or G Connector Options AKM Series Encoder Based with Intercontec Connectors use B,C, or G Connector Options
Lenze/AC Tech: All Drives	LZ1 LZ5 LZ6	MCS Series Absolute Encoder Cable MCS Series Resolver Cable MCS Series Incremental Encoder Cable
Mitsubishi: MR-J3	MT1	MR-J3ENSCBLxxM-H
Momentum: All Drives	MN1 MN2 MN3 MN4	SC-AE1-xxx SC-AE2-xxx SC-IE1-xxx SC-RS1-xxx
Ormec: All Drives	OR2	Consult Exlar
Parker Compumotor: All Drives	PC6 PC7 PC8 PC9/ PCØ	SMH Series Incremental Encoder Cable SMH Series Resolver Cable COMPAX3 F-2C1-xx or Aries F-1A1-xx F-2B1-xx
Pacific Scientific: All Drives	PS3	CEF-RO-XXX-900X
Stober Drives: FDS/MDS 5000	SB3	Stober Absolute Encoder Cable
Siemens: 611U/Masterdrives/SMC20	SM2 SM3/SM4 SM5	6FX5002-2CF02 6FX5002-2EQ10 6FX5002-2CA31
SEW/Eurodrive: All Drives	SW1 SW3	CMP Series Resolver Cable CMP Series Absolute Encoder Cable
Yaskawa: Sigma II Series	YS2/YS3	JZSP-CMP02-XX(B)
Sigma V M	YS5	JZSP-CVP07-XX-(B)

Manufacturers Power/Brake Cables

Models:		GSM/GSX20, GSM/GSX30, SLM/SLG060, SLM/SLG090					
Amplifier/Drive Selected	Feedback Selected	Power only 4 wire	Power + Brake/Therm	Brake Cable			
Allen-Bradley/Rockwell: All Drives	RA1/RA2/RA3/RA4 AB8/AB9/ABB	2090-CPWM7DF-16Axyy	2090-CPBM7DF-16Axyy	N/A			
AMKASYN: All Drives	AK1/AK2	N/A	DS Series Power Cable Size 1	N/A			
Beckhoff: All Drives	BE1	N/A	ZK4000-2xx1-2xxxx	N/A			
B&R Automation: All Drives	BR1/BR2	N/A	8CMxxx.12-1	N/A			
Emerson/Control Techniques: All Drives	CT1/CT3/CT4/CT5/CT7 CT2/EM2/EM5	PSBxA CMDS	PBBxA N/A	N/A CBMS			
Elau: All Drives	EU1/EU4	N/A	E-MO-111	N/A			
G&L Motion Control/ Danaher Motion: MMC Smart Drive/ Digital MMC Control	GL1 GL2 GL3 GL4	PWR-H&F16AA N/A PWR-NSM16AA N/A	N/A PWR-L&M16-64 N/A PWR-AKM16-64	Exlar CBL-ASSY1-xxA-xxx N/A Exlar CBL-ASSY1-xxA-xxx N/A			
Indramat/Bosch-Rexroth: DKC Series/DIAX IndraDrive	IN1/IN5/IN6 IN7	N/A N/A	MKD/MHD Power Cable Size 1 MSK Power Cable Size 1	N/A N/A			
Jetter Technologies: All Drives	JT1	N/A	JH/JL Power Cable Size 1 #24.1	N/A			
Kollmorgen/Danaher: All Drives	KM4/KM5/KM6	N/A	AKM Connector with B,C, or G Options	N/A			
Lenze/AC Tech: All Drives	LZ1/LZ5/LZ6	N/A	MCS Power Cable Size 1	N/A			
Mitsubishi: MR-J3	MT1	MR-J3P2-xM	N/A	MR-J3BRKS1-xM			
Momentum: All Drives	MN1/MN2/MN3/MN4	PCBL1.5-MNT-xxx	PCBL1.5-MNB-xxx	N/A			
Ormec: All Drives	OR2		Consult Exlar				
Parker Compumotor: All Drives	PC6/PC7 PC8/PC9/PC0	N/A N/A	SMH Power Cable Size 1 P-3B1-xx	N/A N/A			
Pacific Scientific: All Drives	PS3	N/A	PMA Power Cable Size 1	N/A			
Stober Drives: FDS/MDS 5000	SB3	N/A	Stober Power Cable Size 1	N/A			
Siemens: All Drives with flying leads	SM2/SM3/SM4/SM5		6FX5002-5DA01	N/A			
SEW/Eurodrive: All Drives	SW1/SW3	N/A	CMP Power Cable Size 1	N/A			
Yaskawa: Sigma II Series	YS2 YS3	N/A B1E-xxA	N/A B1BE-xxA	N/A N/A			

Manufacturers Power/Brake Cables

GSM/GSX40	, GSX50, SLM/SL	G115, SLM142		GSX60 & SLM180	
Power only 4 wire	Power + Brake/Therm	Brake Cable	Power only 4 wire	Power + Brake/Therm	Brake Cable
2090-CPWM7DF- 14Axyy	2090-CPBM7DF-14Axyy	N/A	2090-CPWM7DF-10Axyy	2090-CPBM7DF-10Axyy	N/A
N/A	DS Series Power Cable Size 1	N/A	N/A	DS Series Power Cable Size 1.5	N/A
N/A	ZK4000-2xx1-2xxxx	N/A	N/A	Exlar CBL-PWRB3-xxl- xxx	N/A
N/A	8CMxxx.12-3	N/A	N/A	8CMxxx.12-5	N/A
PSBxA CMMS	PBBxA N/A	N/A CBMS	PSBxB CMLS	PBBxB N/A	N/A CBMS
N/A	E-MO-112	N/A	N/A	E-MO-114	N/A
PWR-H&F14-AA N/A N/A N/A	N/A PWR-L&M14-6H N/A PWR-AKM14-6H	Exlar CBL-ASSY1- xxA-xxx N/A N/A N/A	PWR-H&F10-AA N/A N/A N/A	N/A PWR-L&M12-6H N/A PWR-AKM12-6H	Exlar CBL-ASSY1- xxA-xxx N/A N/A N/A
N/A N/A	MKD/MHD Power Cable Size 1 MSK Power Cable Size 1	N/A N/A	N/A N/A	MKD/MHD Power Cable Size 1.5 MSK Power Cable Size 1.5	N/A N/A
N/A	JH/JL Power Cable Size 1 #24.1	N/A	N/A	Exlar CBL-PWRB3- xxl-xxx	N/A
N/A	AKM Connector with B,C, or G Options	N/A	N/A	Under 24 AMP use CP-508-ENBN-XXX Over 24 AMP Contact Kollmorgen Vendor	N/A
N/A	MCS Power Cable Size 1	N/A	N/A	MCS Power Cable Size 1.5	N/A
MR-J3P6-xM	N/A	MR-J3BRKS1-xM	MR-J3P7-xM	N/A	MR-J3BRKS1-xM
PCBL2.5-MNT-xxx	PCBL2.5-MNB-xxx	N/A	PCBL4.0-MNT-xxx	PCBL4.0-MNB-xxx	N/A
	Consult Exlar			Consult Exlar	
N/A N/A	SMH Power Cable Size 1 P-4B1-xx	N/A N/A	N/A N/A	SMH Power Cable Size 1.5 P-6B2-xx	N/A N/A
N/A	PMA Power Cable Size 1	N/A	N/A	Exlar CBL-PWRB3- xxl-xxx	N/A
N/A	Stober Power Cable Size 1	N/A	N/A	Stober Power Cable Size 1.5	N/A
	6FX5002-5DA11	N/A		6FX5002-5DA61	N/A
N/A	CMP Power Cable Size 1	N/A	N/A	CM Power Cable Size 1.5	N/A
B1E-xxA N/A	B1BE-xxA N/A	N/A N/A	B2E-xxA N/A	B2BE-xxA N/A	N/A N/A

(Please note: Euro style connectors are size 1.5 M40 connectors. If the manufacturer does not offer a size 1.5 M40 power cable, an Exlar Power Cable must be purchased.

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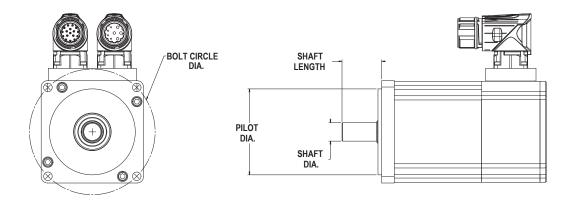
Motor Mount Codes for the FT and K Series

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.

Motor Mount Drawing



Feedback Types for GSX, GSM, SLG, SLM, EL, and ER

Commonly Ordered Options Shown in BOLD

(Also specify the Amplifier/Drive Model being used when ordering)

- Standard Incremental Encoder 2048 line (8192 cts) per rev. index pulse, Hall commutation, 5VDC
- Standard Resolver Size 15, 1024 line (2048 cts) per rev. two pole resolver
- Motor files for use with select Emerson/CT, Rockwell /AB and Danaher/Kollmorgen Drives are available at www.exlar.com

Allen-Bradley/Rockwell: (Note: AB8, AB9 and ABB callouts are available only on spare/replacement actuators that have been previously ordered. For all new configurations using a Rockwell drive, please select from the options below. Consult Exlar for integration questions)3

Note: RA1, RA2, RA3, and RA4 callouts not available for SLM motors.

- RA1 = Hiperface Stegmann SKM36 multi-turn absolute encoder. MPL Type V feedback (128 sin/cos) and Type 7 SpeedTec connectors and wiring when using the "M" connector option. 20 and 30 frame sizes only. (Formerly ABB)1
- RA2 = Hiperface Stegmann SRM50 multi-turn absolute encoder. MPL Type M feedback (1024 sin/cos) and Type 7 SpeedTec connectors and wiring when using the "M" connector option. 40, 50 and 60 frame sizes only. (Formerly AB9)
- RA3 = Standard incremental encoder. MPL Type M feedback (2048 line) and Type 7 SpeedTec connector and wiring when using the "M" connector option. (Formerly AB8)
- RA4 = Standard Resolver. MPL Type R feedback (4 pole) and Type 7 SpeedTec connectors and wiring when using the "M" connector option. (Formerly AB6)

Advanced Motion Control:

AM1 = Standard Incremental Encoder

AM2 = Encoder 1000 line, w/commutation, 5 VDC

AM3 = Standard Resolver

AM5 = Encoder 5000 line, w/commutation, 5 VDC

Baldor:

BD2 = Std Resolver - BSM motor wiring w/M23 connectors for 'M' option BD3 = Std Incremental Encoder – BSM motor wiring w/M23 connectors for 'M' option

Beckhoff:

BE2 = EnDat Heidenhain EQN1125 multi-turn absolute encoder - AM5XX motor wiring w/M23 euro connectors for 'M' option

B&R Automation:

BR1 = Standard Resolver

BR2 = EnDat Heidenhain EQN1125/1325 multi-turn absolute encoder - 8LS/8LM motor wiring w/M23 euro connectors for 'M' option

Copley Controls:

CO1 = Standard Incremental Encoder

CO2 = Standard Resolver

Control Techniques/Emerson:

- CT1 = Hiperface Stegmann SRM050 multi-turn absolute encoder - 40-50-60 Frame Size. FM/UM/EZ motor wiring w/M23 euro connectors for 'M' option
- CT3 = Hiperface Stegmann SKM036 multi-turn absolute encoder - 20-30 Frame Size. FM/UM/EZ motor wiring w/M23 euro connectors for 'M' option
- CT4 = Standard Incremental Encoder -

FM/UM/EZ motor wiring w/M23 euro connectors for 'M' option

- CT5 = Std Resolver FM/UM/EZ motor wiring w/M23 euro connectors for 'M' option
- CT7 = Encoder 5000 line, with commutation,

5 VDC - FM/UM/EZ motor wiring w/M23 euro connectors for 'M' option

CT9 = Unidrive SP with EnDat Heidenhain EQN1125 multi-turn absolute encoder w/M23 connectors

Continued on next page

Commonly Ordered Options Shown in BOLD

Elmo Motion Control:

- EL1 = Standard Resolver
- EL2 = Standard Incremental Encoder
- EL3 = EnDat Heidenhain EQN1125 multi-turn absolute encoder

Emerson/Control Techniques:

- EM2 = Std Incremental Encoder NT motor wiring w/MS connectors for 'M' option
- EM5 = Encoder 5000 line, with commutation, 5 VDC NT motor wiring w/MS connectors for 'M' option

Elau:

- EU1 = Hiperface Stegmann SRM050 multi-turn absolute encoder – 40-50-60 Frame Size. SH motor wiring w/MS connectors for 'M' option
- EU4 = Hiperface Stegmann SKM036 multi-turn absolute encoder 20-30 Frame Size. SH motor wiring w/MS connectors for 'M' option.

Exlar:

- EX4 = Standard Resolver
- EX5 = Standard Resolver with KTY84 thermistor
- EX6 = EnDat Heidenhain EQN1125 multi-turn absolute encoder
- EX7 = Incremental encoder, 5000 line with commutation, 5Vdc
- EX8 = Hiperface Stegmann SRM50 multi-turn absolute encoder

Indramat/Bosch-Rexroth:

- IN6 = Std Resolver MKD/MHD motor wiring w/M23 euro connectors for 'M' option
- IN7 = Hiperface Stegmann SKM036 multi-turn absolute encoder – MSK motor wiring w/M23 euro connectors for 'M' option – plug & play option
- IN8 = Indradrive EnDat Heidenhain EQN1125 multi-turn absolute w/M23 connectors

Kollmorgen/Danaher:

- KM4 = EnDat Heidenhain EQN1325 multi-turn absolute encoder (Sine Encoder) – AKM motor wiring w/M23 Intercontec euro connectors for 'M' option
- KM5 = Standard Resolver AKM motor wiring w/M23 Intercontec euro connectors for 'M' option
- KM6 = Standard Incremental Encoder AKM motor wiring w/ M23 Intercontec euro connectors for 'M' option

Lenze/AC Tech:

- LZ1 = Hiperface Stegmann SRM050 multi-turn absolute encoder MCS motor wiring w/M23 euro connectors for 'M' option
- LZ5 = Standard Resolver MCS motor wiring w/ M23 euro connectors for 'M' option
- LZ6 = Standard Incremental Encoder MCS motor wiring w/ M23 euro connectors for 'M' option

Mitsubishi2:

MT2 = DSL Stegmann MR-J4 compatible

Parker Compumotor:

- PC6 = Std Incremental Encoder SMH motor wiring w/M23 connectors for 'M' option European only
- PC7 = Std Resolver SMH motor wiring w/M23 connectors for 'M' option European only
- PC8 = Standard Incremental Encoder MPP series motor wiring w/PS connectors for 'M' option US Only
- PC9 = Hiperface Stegmann SRM050 multi-turn absolute encoder MPP motor wiring w/PS connectors for 'M' option US Only
- PC0 = Standard Resolver MPP motor wiring w/PS connectors for 'M' option US Only

Schneider Electric:

SC2 = Hiperface Steamann SKM036 multi-turn absolute encoder – BSH motor wiring w/M23 euro connectors for 'M' option

Stober Drives:

- SB3 = EnDat Heidenhain EQN1125 multi-turn absolute encoder ED/EK motor wiring w/M23 euro connectors for 'M' option
- SB4 = Standard Resolver ED/EK motor wiring W/23 connector for "M" option

Siemens:

- SM2 = Standard Resolver 1FK7 motor wiring w/M23 connectors for 'M' ontion
- SM3 = EnDat Heidenhain EQN1325 multi-turn absolute encoder - 40-50-60 Frame Size. 1FK7 motor wiring w/M23 euro connectors for 'M' option
- SM4 = EnDat Heidenhain EQN1125 multi-turn absolute encoder 20-30 Frame Size. 1FK7 motor wiring w/M23 euro connectors for 'M' option
- SM9 = Siemens Heidenhain EQN1325 4096 (12 bits) multi-turn absolute w/M23 connectors

SEW/Eurodrive:

- SW1 = Standard Resolver CM motor wiring w/ M23 euro connectors for 'M' option
- SW2 = Standard Incremental Encoder
- SW3 = Hiperface Stegmann SRM050 multi-turn absolute encoder CM motor wiring w/ M23 euro connectors for 'M' option

Yaskawa:

YS5 = Yaskawa Sigma V absolute encoder

NOTES:

- 1. Not compatible with Kinetix 300 Drives.
- N/A with holding brake unless application details are discussed with your local sales representative.
- All rotary motors to be used with Kinetix or Sercos based systems will require prior approval from Rockwell Automation.

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/sec² (m/sec²)

cv = constant vel.-in/sec (m/sec)

D = total move distance-in (m) or revolutions (rotary)

Standard Equations

 \mathbf{V} avg = \mathbf{D} / ttotal

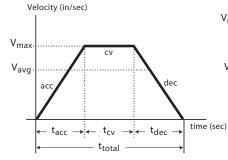
If tacc = tdec Then: Vmax = (ttotal/(ttotal-tacc)(Vavg)

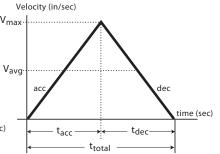
D = Area under profile curve

D = (1/2(tacc+tdec)+tcv)(Vmax)

Trapezoidal Move Profile

Triangular Move Profile





Trapezoidal Equations

If tacc = tcv = tdec Then:

Vmax = 1.5 (Vavg)

 $\mathbf{D} = (2/3)$ (ttotal) (Vmax)

acc = dec = Vmax

Triangular Equations

If tacc = ttotal/2 Then:

Vmax = 2.0 (Vavg)

 $\mathbf{D} = (1/2)$ (ttotal) (Vmax)

acc = dec = Vmax

Sizing and Selection of Exlar Linear Actuators

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/sec² (9.8 m/sec²)

Thrust Calculation Equations

THRUST = Ffriction + [Facceleration] + Fgravity + Fapplied

THRUST = WLµcosø + [(WL/386.4) (v/tacc)] + WLsinø + Fapplied

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., ta = 0.2 sec., Fapp. = 25 lbf, $\mu = 0.15$

 $ø = 0^{\circ}$

THRUST = \mathbf{W} L μ cos \emptyset + [(\mathbf{W} L /386.4) (\mathbf{v} /tacc)] + \mathbf{W} Lsin \emptyset + \mathbf{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

 $ø = 90^{\circ}$

THRUST = WLµcosø + [(WL/386.4) (v/tacc)] + WLsinø + Fapplied

= (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**

0 = 30

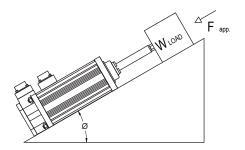
THRUST = **W**L μ cos \emptyset + [(**W**L /386.4) (**v**/tacc)] + **W**Lsin \emptyset + **F**applied = (200)(0.15)(0.866) + [(200/386.4)(8.0/0.2)] + (200)(0.5) + 25

= 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
$$\emptyset = 0^{\circ}$$
 0°
 $\cos \emptyset = 1$; $\sin \emptyset = 0$
at $\emptyset = 90^{\circ}$
 $\cos \emptyset = 0$; $\sin \emptyset = 1$

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.

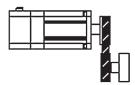
Motor with screw (GSX, GSM, FT, & EL)



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



Motor with belt and pulley



Terms and (units)

= Required motor torque, lbf-in (N-m)

= Required motor acceleration torque, lbf-in (N-m) λа

= Applied force load, non inertial, lbf (kN)

= Screw lead, in (mm)

= 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

= Screw or ratio efficiency

= Gravitational constant, 386.4 in/s² (9.75 m/s²)

= Angular acceleration of motor, rad/s²

= Mass of the applied load, lb (N)

JL = Reflected Inertia due to load, lbf-in-s² (N-m-s²)

Jr = Reflected Inertia due to ratio, lbf-in-s² (N-m-s²)

Js = Reflected Inertia due to external screw, lbf-in-s² (N-m-s²)

Jm = Motor armature inertia, lbf-in-s² (N-m-s²)

= Length of screw, in (m)

= Density of screw material, lb/in³ (kg/m³)

= Radius of screw, in (m)

= pi (3.14159)π

= Dynamic load rating, lbf (N)

Velocity Equations

Screw drive: $V_1 = \omega m^* S/2\pi$ in/sec (m/sec)

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

Torque Equations

Torque Under Load

Screw drive (GS, FT or separate screw): $\lambda =$ **S** • F Ibf-in (N-**m**)

Belt and Pulley drive: $\lambda = T_1 / R \eta$ lbf-in (N-**m**)

Gear or gear reducer drive: $\lambda = T_1 / R \eta lbf - in (N-m)$

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 2 π) / \mathbf{t}_{acc} , rad/sec².

$$\mathbf{J}_{S} = \frac{\mathbf{m} \cdot \mathbf{L} \cdot \rho \times \mathbf{r}^{4}}{2 \cdot \mathbf{g}} \text{ lb - in - } \mathbf{s}^{2} \text{ (N - } \mathbf{m} - \mathbf{s}^{2} \text{)}$$

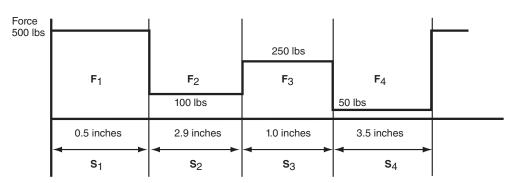
Total Torque per move segment

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

Calculating Estimated Travel Life of Exlar Linear Actuators

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

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

Value from example numbers is 217 lbs.

Lifetime Calculations

The expected \mathbf{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 \mathbf{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:

$$L_{10} = \left(\begin{array}{c} C_{a} \\ F_{cml} \end{array} \right)^{3} \times \ell$$

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)			Variables			
THRUS	ST = Total linear force-lbf (N)	Ø	= Angle of inclination - deg =			
F friction	= Force from friction-lbf (N)	t acc	= Acceleration time - sec =			
\mathbf{F}_{acc}	= Acceleration force-lbf (N)	V	= Change in velocity - in/sec (m/s) =			
F gravity	= Force due to gravity-lbf (N)	μ	= Coefficient of sliding friction =			
Fapplied	= Applied forces-lbf (N)	\mathbf{W}_{L}	= Weight of Load-Ibm (kg) =			
386.4	= Acceleration of gravity - in/sec² (9.8 m/sec²)	Fapplied	= Applied forces-lbf (N) =			

Thrust Calculation Equations

THRUST = [
$$\mathbf{F}_{friction}$$
] + [$\mathbf{F}_{acceleration}$] + $\mathbf{F}_{gravity}$ + $\mathbf{F}_{applied}$
THRUST = [$\mathbf{W}_{L} \times \mu \times \cos \emptyset$] + [($\mathbf{W}_{L} / 386.4$) $\times (\mathbf{v} / \mathbf{t}_{acc})$] + $\mathbf{W}_{L} \sin \emptyset$ + $\mathbf{F}_{applied}$
THRUST = [()x()x()] + [(/386.4) x (/)] + [() ()] + ()
THRUST = [] + [()x()] + [] + ()

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

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

Torque Calculations & Equations

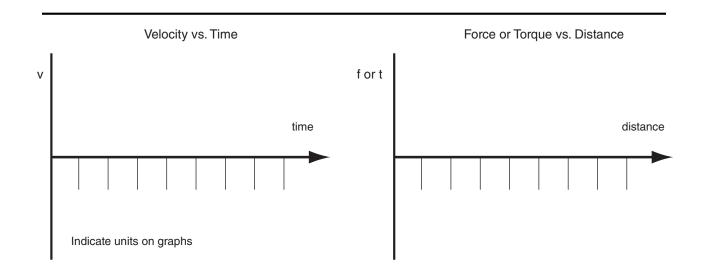
Torque Calculations

_		
Те	rms and (units)	
λ	= Torque, Ib-in (N-m)	=
F	= Applied Load, non inertial, lbf (N)	=
S	= Screw lead, in (m)	=
ŋ	= 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	=
\textbf{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, Ib-in-s2 (N-m-s2)	=
$\textbf{J}_{\mathbb{S}}$	= Reflected Inertia due to screw, Ib-in-s2 (N-m-s2)	=
	= Reflected Inertia due to load, Ib-in-s2(N-m-s2)	=
J_{L}		
J _M	= Motor armature inertia, lb-in-s2 (N-m-s2)	=
_	= Motor armature inertia, lb-in-s2 (N-m-s2)	=
J _M		= = 3.14159
\mathbf{J}_{M} π \mathbf{K}_{t}	= Motor armature inertia, lb-in-s2 (N-m-s2)	= = 3.14159
\mathbf{J}_{M} π \mathbf{K}_{t}	= Motor armature inertia, Ib-in-s2 (N-m-s2) = pi	= = 3.14159
J _M π K _t *For	= Motor armature inertia, lb-in-s2 (N-m-s2) = pi = Motor Torque constant, lb-in/amp (N-m/amp) the GS Series J _S and J _M are one value from the GS Specifications.	= = 3.14159
J _M π K _t * For	= Motor armature inertia, lb-in-s2 (N-m-s2) = pi = Motor Torque constant, lb-in/amp (N-m/amp) the GS Series J _S and J _M are one value from the GS Specifications.	= = 3.14159
J _M π K _t * For	= Motor armature inertia, lb-in-s2 (N-m-s2) = pi = Motor Torque constant, lb-in/amp (N-m/amp) the GS Series J _S and J _M are one value from the GS Specifications.	= <u>3.14159</u> =
J _M π K _t *For	= Motor armature inertia, lb-in-s2 (N-m-s2)	= <u>3.14159</u> =
J _M π K _t *For	= Motor armature inertia, lb-in-s2 (N-m-s2) = pi = Motor Torque constant, lb-in/amp (N-m/amp) the GS Series J _S and J _M are one value from the GS Specifications. Orque Equations rque From Calculated Thrust. λ = SF / 2•π•η (D - in (N - m) = (= = 3.14159 =
J _M π K _t *For	= Motor armature inertia, lb-in-s2 (N-m-s2)	= = 3.14159 =
J _M π K _t *For	= Motor armature inertia, lb-in-s2 (N-m-s2)	= = 3.14159 =

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



Exlar Application Worksheet

Date:	Contact:		Company:	
Stroke & Speed Re	quirements			
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 Require	ements			
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 Require	ed	
Holding Brake Require	d:	Yes	No	
Cable Length:	_ ft (m)			

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

В	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
А												
Kg-m ²	1	10⁴	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-cm ²	10-4	1	10³	1.01972x10⁵	1.01972x10 ³	1.01972	5.46745	1.41612x10 ⁻²	0.341716	8.85073x10 ⁻⁴	2.37303x10 ⁻³	7.37561x10 ⁻⁵
g-cm ²	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-s ²	9.80665	9.80665x10 ⁴	9.80665x10 ⁷	1	10²	10⁵	5.36174x10 ⁵	1.388674x10 ³	3.35109x10 ⁴	86.79606	2.32714x10 ²	7.23300
kgf-cm-s ²	9.80665x10 ⁻²	9.80665x10 ²	9.80665x10 ⁵	10 ⁻²	1	10⁵	5.36174 x10 ³	13.8874	3.35109x10 ⁻²	0.86796	2.32714	7.23300x10 ⁻²
gf-cm-s ²	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-s ²	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-in ²	2.92641x10 ⁻⁴	2.92641	2.92641x10 ³	2.98411x10⁵	2.98411x10 ³	2.98411	16	4.14414 x10 ²	1	2.59008x10 ⁻³	6.94444x10 ⁻³	2.15840x10 ⁻⁴
lbf-in-s ²	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-s ²	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.

В	N-m	N-cm	dyn-cm	Kg-m	Kg-cm	g-cm	oz-in	ft-lb	in-lb
А									
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	10⁵	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	10⁵	1.38874 x10 ³	7.23301	86.79624
Kg-cm	9.80665x10-2	9.80665	9.80665 x10 ⁵	10 ⁻²	1	10³	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

Commission and Domontoo							
oz/in³	gm/cm³						
1.54	2.66						
4.80	8.30						
4.72	8.17						
5.15	8.91						
0.64	1.11						
4.48	7.75						
0.46	0.80						
0.28	0.58						
	1.54 4.80 4.72 5.15 0.64 4.48 0.46						

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

Product Ambient Temperatures/IP Ratings

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



Terms and Conditions

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
- 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.