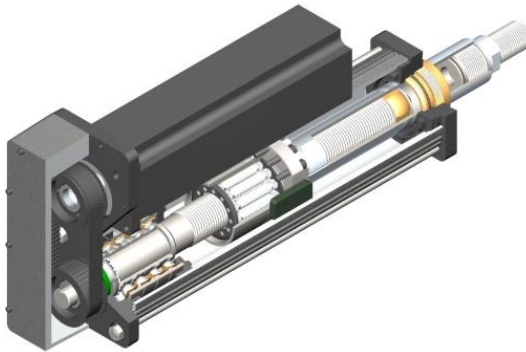


Force Tube Satellite Roller Screw Actuators Installation & Service Manual



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TABLE OF CONTENTS

1.0 Introduction

| | |
|--|---|
| 1.1 Warranty and Limitations of Liability..... | 3 |
| 1.2 Safety Considerations | 4 |
| 1.3 Force Tube (FT) Series Linear Actuators Overview | 5 |
| 1.4 Basic Actuator Construction | 5 |
| 1.5 Actuator Drive Train Configurations | 7 |

2.0 Installation

| | |
|-----------------------------------|----|
| 2.1 Mounting Configurations | 9 |
| 2.2 Mounting Considerations | 9 |
| 2.3 Lubrication | 10 |
| 2.4 Anti-Rotate System | 11 |

3.0 Maintenance & Service

| | |
|---|----|
| 3.1 Seals..... | 12 |
| 3.2 Bearings | 15 |
| 3.3 Drive Train | 16 |
| 3.4 Roller Screw | 18 |
| 3.5 End of Stroke Cushions | 19 |
| 3.6 Inspection and Lubrication Procedure..... | 20 |

4.0 Optional Equipment

| | |
|--|----|
| 4.1 Pre-Loaded Follower | 25 |
| 4.2 Mounting Options | 25 |
| 4.3 Standard Motor Mounting Configurations | 25 |
| 4.4 Limit Switches | 25 |
| 4.5 Rod Ends | 27 |
| 4.6 Motors | 27 |
| 4.7 Electronics | 27 |

5.0 Specifications

| | |
|---|----|
| 5.1 Life Calculations | 28 |
| 5.2 Load, Torque, and Linear Speed Calculations | 28 |
| 5.3 Load and Speed Ratings | 28 |

6.0 Troubleshooting

| | |
|--|----|
| 6.1 Mechanical Problems | 29 |
| 6.2 Electrical Problems | 29 |
| 6.3 Returning a Product for Repair | 30 |

1.0 Introduction

1.1 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 Exlar's database 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's 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 herein 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 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.

1.2 Safety Considerations

As with any electro-mechanical device, safety should be considered during installation and operation of your FT Series actuator. Throughout this manual you will see paragraphs marked with WARNING or CAUTION signs as shown below.



CAUTION



WARNING

Pay particular attention to these paragraphs. They are intended to provide you with helpful information to ensure a safe and trouble free installation and operation.



Care should be taken not to exceed the physical travel limits of FT Series actuators. Doing so will cause the actuator to end-crash internally. End crashes can physically damage the roller screw and the internal components of the actuator.

Care should be taken to avoid high speed impact with objects of high rigidity that immediately stop the travel of the actuator with no deceleration or energy absorption. An example would be a high speed impact of two solid steel parts. The resulting impact will create a very short effective deceleration time. Kinetic energy contained in the rotating inertia of the actuator and motor can possibly generate extremely high impact forces that exceed the mechanical capacities of the actuator and cause physical damage to the actuator. For applications requiring this type of impact, contact Exlar application engineering to insure that the actuator is properly sized or provisions are made to absorb the induced energy.

1.3 Force Tube (FT) Series Roller Screw Based Linear Actuators Overview

Exlar Force Tube actuators are offered in three standard frame sizes of 3.5 inch (FT35), 4.5 inch (FT45), 6 inch (FT60), and 8 inch (FT80). Continuous duty thrust load ratings of 2000 lbf up to 20,000 lbf with peak load ratings of 2-3 times the continuous load ratings (see section 5.0 for complete product specification).

Exlar FT Series actuators utilize a satellite roller screw mechanism that converts rotary motion to linear motion and is mounted within a sealed tube assembly. The roller screw follower (nut) is attached to the moveable “Force Tube” (output rod), which extends or retracts as the screw shaft is rotated. The general operating principle is illustrated below.

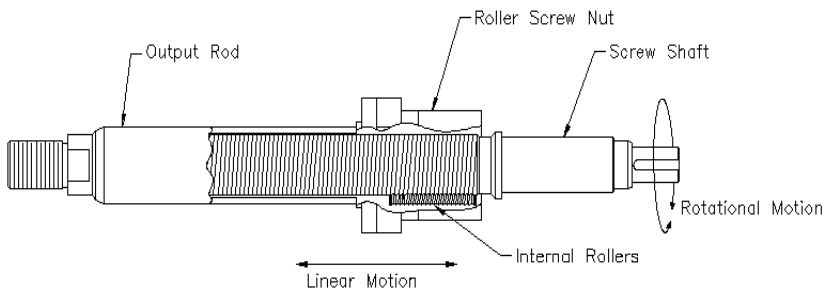


Figure 1: Actuator Operating Principle

The FT Series force tube design provides the contamination isolating advantages of hydraulic cylinders without the limitations of load, life, and speed which are inherent in ball screw and acme screw actuators. All rotary to linear conversion components are mounted within a sealed housing, preventing abrasive particles and other forms of contamination to enter the actuator’s critical mechanisms. This assures trouble-free operation in even the most severe environments.

1.4 Basic Actuator Construction

All FT Series actuators are completely sealed from the outside environment by the use of O-Rings on both ends of the extruded aluminum case. The output rod runs through a wiper and seal, which are captured within a gland insert that are typically employed in hydraulic type actuators.

The extruded aluminum case is epoxy coated (powder coated) on all external surfaces. In cases where a motor is mounted in a parallel configuration (see section 1.5) the pulley cover is also epoxy coated. All other aluminum parts (face plate, end plate, inline adapters etc.) are anodized. All steel mounting parts (flange plates, side lug plates, trunnion components, etc.) are finished with a black oxide. In all situations these finishes are intended to retard corrosion only.



In applications where corrosive chemicals are to come in contact with the actuator, it may be necessary to employ non-standard coatings or materials. Contact Exlar for more details.

Unless otherwise specified, the output rod on a standard FT Series actuator is manufactured from case hardened and chrome plated carbon steel. The case hardened chrome plated rod provides a very tough and wear resistant surface for the rod seal to operate against (rod end and chamfer are not chrome plated).



If the surface of the output rod gets dinged or severely scratched, the wiper and or rod seal may be compromised, causing contamination of the internal components in the actuator.



The base metal used in the standard output rod does not resist corrosive environments. Custom materials or plating may need to be used if the output rod is to come in contact with a corrosively aggressive environment. Contact Exlar for more details.

The standard tie rods on all FT Series actuators are manufactured out of 17-4 PH stainless steel and are very corrosion resistant to most non-chlorine based chemicals.

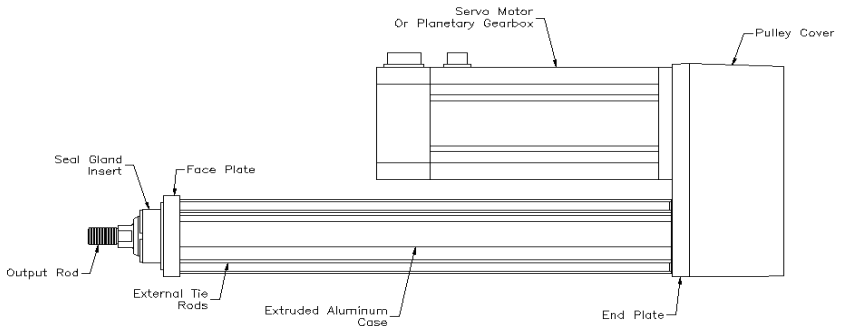


Figure 2: FT Actuator with Parallel Motor Mount

1.5 Actuator Drive Train Configurations

Exlar offers a base FT Series actuator model for the greatest flexibility in application. The base actuator includes: a high performance satellite roller screw assembly, pre-loaded angular contact bearings, an epoxy powder coated aluminum housing, stainless steel tie-rods, internal anti-rotation mechanism, a sealed output rod, and a keyed input shaft for attachment to a drive system. A typical base FT Series actuator is shown below.



Figure 3: Base FT Actuator

Exlar also offers an FT Series actuator, which is the base actuator along with one of a variety motor mounting configurations, combined in one product package. Parallel and in-line mounting options are offered as standard configurations. The parallel motor mounting configuration utilizes a high performance synchronous belt drive system, which while providing quiet operation, requires no re-tensioning for the life of the actuator as long as the motor is not removed or adjusted. The inline motor mounting configuration uses a zero backlash coupling to transmit power from the motor to the input shaft of the actuator.

Typically a drive ratio of 1:1 is used, but a 2:1 reduction ratio is also available as standard on the parallel motor mounting configuration. FT series actuators will also mate up with a wide variety of standard planetary gearboxes to attain higher input torque.

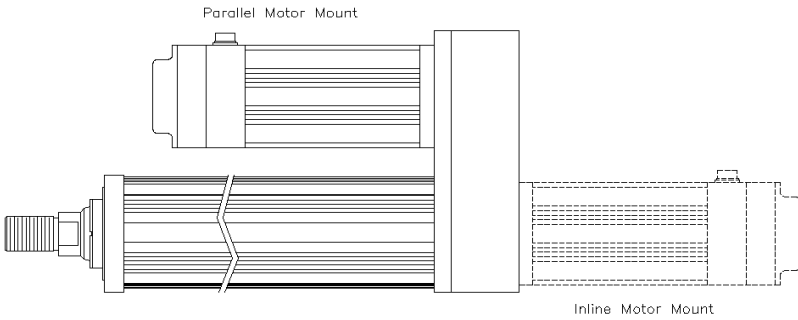


Figure 4: Motor Mounting Configurations

2.0 Installation

2.1 Mounting Configurations

The force tube actuators come with a variety of mounting configurations as well. Refer to the Exlar catalog to review what options are available on the desired frame size.

2.2 Mounting Considerations

As with any linear actuator product, misalignment of the FT Series actuator with respect to whatever load the actuator is being used to move is of great concern. Any misalignment will decrease the life of the components within the actuator and also may create problems within the application associated with misalignment. Therefore every effort should be made to minimize misalignment as much as is possible.



Excessive side load on the output rod of the actuator will dramatically reduce the life of the actuator and should be avoided completely.

An FT Series actuator with the Side Mount option comes with threaded holes in the face plate and the end plate. Exlar recommends using hardened fasteners to mount an FT actuator to your machine frame. Exlar also recommends threading the mounting fastener into as much of the threaded hole in the actuator as possible, to prevent possibly stripping out the threads in the actuator's mounting holes. *Note: Side Mount and Side Lug actuators may have reduced maximum load rating.*



All FT80 Side Mount actuators also come with a $\varnothing 5/8$ dowel pin hole in both the face plate and the end plate. These dowel pin holes must be used in conjunction with hardened dowel pins when side mounting an FT80. Failure to do so can cause damage to the actuator.

An FT actuator with the Extended Tie Rod mounting option comes with hex nuts on the face plate that are tightened down enough to keep the actuator together during shipping. When mounting the actuator to your machine, these nuts should be removed and the tie rods should be placed through your machine frame and the nuts used on the back side of your machine's mounting flange. The tie rod nuts should then be tightened with a torque wrench to the following values:

FT35 = 16 lbf-ft (22 N-m)

FT45 = 45 lbf-ft (61 N-m)

FT60 = 60 lbf-ft (81 N-m)

FT80 = 127 lbf-ft (172 N-m)

2.3 Lubrication

Exlar's FT Series actuators are shipped from the factory fully lubricated with high temperature grease. Exlar recommends using Mobilith SHC 220, a high performance, extreme-pressure grease. The unique physical properties of the synthetic base oil provide outstanding protection against wear, rust, corrosion and high or low-temperature degradation. Mobilith SHC allows for very low starting and running torque values. Its operating range is -40° C to 177°C (-40° F to 350° F).

Alternative lubrication for custom configurations is available. High performance gear oil and high performance grease are available. Exlar recommends using Mobil SHC 626 high performance gear oil for extreme applications. Oil-filled custom configurations can be provided with fill and drain plugs, and/or various devices for monitoring the oil level and condition. The application, orientation, travel speed, and other variables determine the oil level to be used. The proper oil level will be determined based on this information and the actuator will be supplied initially filled with the appropriate amount of oil.

Periodic inspection and renewal of the bearing and roller screw grease is recommended. Re-greasing and maintenance schedules are largely based upon customer applications. Contact the factory for general recommendations on re-greasing schedules.

Follow the procedure in section 3.6 for renewing the lubrication.



Upon initial startup of your FT Series actuator, cold grease may cause increased motor torque to operate actuator. Once grease has warmed up required motor torque should decrease. Elevated operating temperatures may result in shorter lubrication renewal periods.

For lubrication of seals see section 3.1.

For inspection and lubrication procedure see section 3.6.

2.4 Anti-Rotate Mechanism

Note: Anti-rotate option not available with stainless steel case.

Exlar's FT Series actuators have an internal anti-rotate mechanism guided by extruded channels in the actuator case. The anti-rotates are comprised of a high performance, thermal and abrasion-resistant polymer. This precise mechanism will limit angular backlash to 0.35 degrees rotation and is designed to withstand the high force and speed created by these actuators. However, there is a limit to the amount of torque they can withstand, and every effort should be made to resist installation torque applied when tightening a nut or coupling on the output rod. There are wrench flats provided on every standard output rod to aid in resisting installation torque.

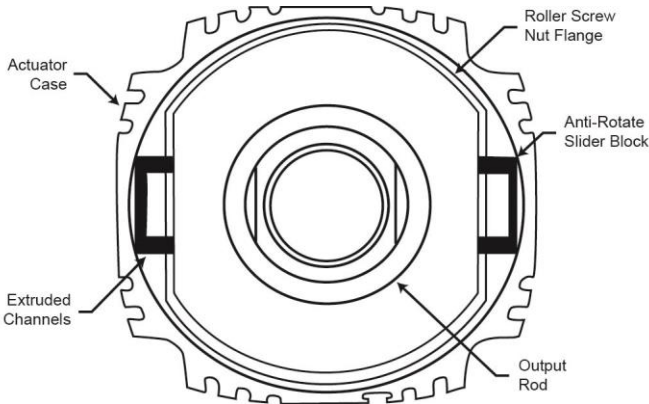


Figure 5a: Anti-Rotate Mechanism (FT35, FT60, and FT80)

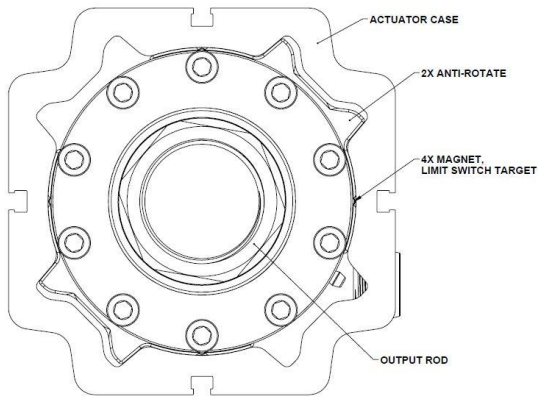


Figure 5b: Anti-Rotate Mechanism (FT45)



During installation do not apply more than the following values for torque to the output rod without opposing that torque. Doing so can damage the anti-rotate mechanism inside the actuator.

FT35 = 12 lbf-ft (16 Nm)

FT45 = 50 lbf-ft (67 Nm)

FT60 = 50 lbf-ft (67 Nm)

FT80 = 100 lbf-ft (135 Nm)

3.0 Maintenance & Service

3.1 Seals

Both ends of the extruded housing on the FT actuator are sealed using O-rings. The outer diameter of the output rod is sealed with a gland that utilizes a dual seal system with a wiper seal on the outside and a high pressure rod seal within the seal cartridge. Please note that grease filled actuators have different wipers and rod seals than oil filled actuators. Just below the gland seal thread another O-ring is used to seal the gland seal itself to the front plate of the actuator. The input shaft is sealed using a spring loaded shaft seal that is contained within the back plate of the actuator. These seals are lubricated on initial assembly with grease; however the front gland seal should have a small amount of mineral oil applied to it periodically depending on amount of actuator use or storage to keep the seal operating smoothly and to prolong life.

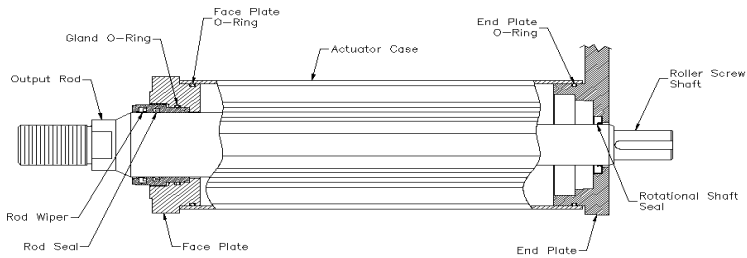
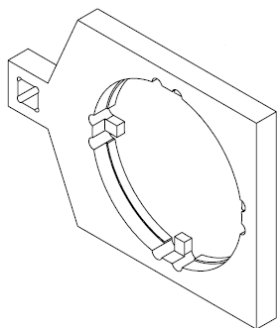


Figure 6: Actuator Sealing Details

Seal Gland Insert Replacement and Seal Kits

| | Frame | Seal Gland PN | Description/Size | Exlar Wrench PN | Description/Size | Torque lb-ft (Nm) |
|---------------------|-------|---------------|--------------------------|-----------------|----------------------------------|-------------------|
| Grease Units | FT35 | 19022 | Bronze Ø1.75 ID | 63901 | Wrench, Front Seal Bushing, FT35 | 75 (102) |
| | FT45 | 63615 | Seal Gland Assembly - BA | NA | NA | NA |
| | FT60 | 19023 | Bronze Ø3.00 ID | 63902 | Wrench, Front Seal Bushing, FT60 | 100 (136) |
| | FT80 | 19024 | Bronze Ø4.00 ID | 63903 | Wrench, Front Seal Bushing, FT80 | 100 (136) |
| Oil Units | FT35 | 43309 | Bronze Ø1.75 ID | 63901 | Wrench, Front Seal Bushing, FT35 | 75 (102) |
| | FT45 | 63615 | Seal Gland Assembly - BA | NA | NA | NA |
| | FT60 | 43313 | Bronze Ø3.00 ID | 63902 | Wrench, Front Seal Bushing, FT60 | 100 (136) |
| | FT80 | 43314 | Bronze Ø4.00 ID | 63903 | Wrench, Front Seal Bushing, FT80 | 100 (136) |



Wrench, Front Seal Bushing

Seal Kits

| Grease Units | | |
|---------------------|-----------|------------------------|
| Frame | PN | Description |
| FT35 | 19028 | Seal Kit for Ø1.75 FSB |
| FT60 | 19029 | Seal Kit for Ø3.00 FSB |
| FT80 | 19030 | Seal Kit for Ø4.00 FSB |

| Oil Units | | |
|------------------|-----------|-------------------------------|
| Frame | PN | Description |
| FT35 | 43531 | Parker Seal Kit for Ø1.75 FSB |
| FT60 | 43532 | Parker Seal Kit for Ø3.00 FSB |
| FT80 | 43533 | Parker Seal Kit for Ø4.00 FSB |

| Grease and Oil Units | | |
|-----------------------------|-----------|-------------------------|
| Frame | PN | Description |
| FT45 | 63032 | Wiper, AY, 2.25 inch ID |
| | 63033 | Seal, BT, 2.25 inch ID |

3.2 Bearings

There are four angular contact bearings mounted in duplex arrangement, which are used to support the roller screw mechanism within the FT series actuator. The bearings are mounted in such a manner so that both the inner and outer races are pre-loaded. The inner races of the bearings are pre-loaded using a bearing jam nut and lock washer to ensure that the pre-loaded condition is not lost. The outer races are pre-loaded using either the external or internal tie rods.

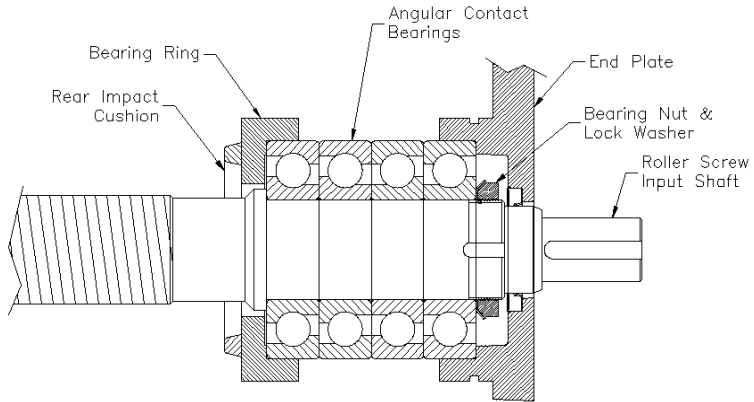


Figure 7a: Roller Screw Support Bearing Detail – FT35, FT60, and FT80

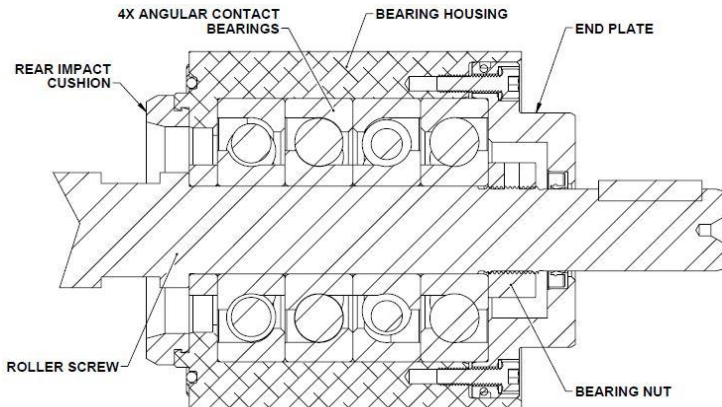


Figure 8: Roller Screw Support Bearing Detail – FT45

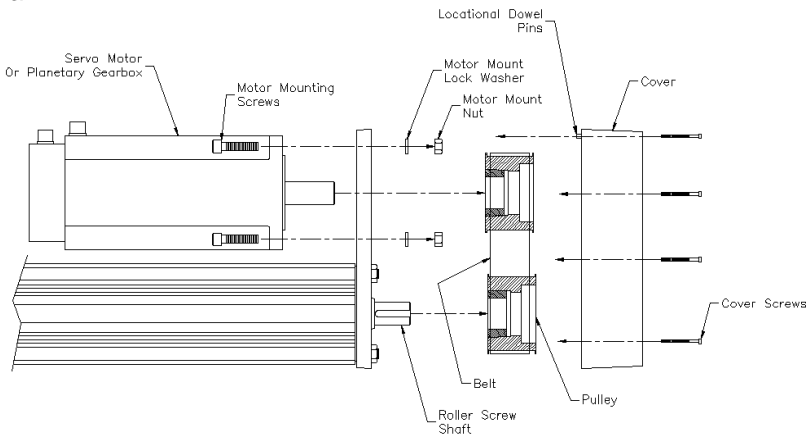
3.3 Drive Train

The FT Series actuators are combined in a parallel motor mounting configuration using a synchronous belt. The drive train does not require any lubrication but any oil or dirt contamination within the belt drive system will decrease belt effectiveness and life. The belt and pulley system should be inspected periodically for excessive wear and proper tensioning.



Do not remove the belt cover while the actuator is operating. Always remove power from the attached motor before removing the belt cover to service any component of the drive train (i.e. belts, pulleys, bushings, inline couplings, gears, etc...). Failure to do so can result in damage to the actuator or cause serious injury to the operator.

Improper belt tension can cause premature belt wear and/or failure as well as belt noise and slippage. Consult Exlar for questions regarding proper belt tensioning. The following picture is only an example of a typical belt and pulley drive train in an FT Series actuator. For specific service concerns relating to your FT Series actuator's drive train consult Exlar.



*Figure 9: Parallel Motor Mount Drive Train Assembly**

**Note: FT45 model includes backside idler pulley, as well as cover and motor gaskets*

Proper Belt Tension

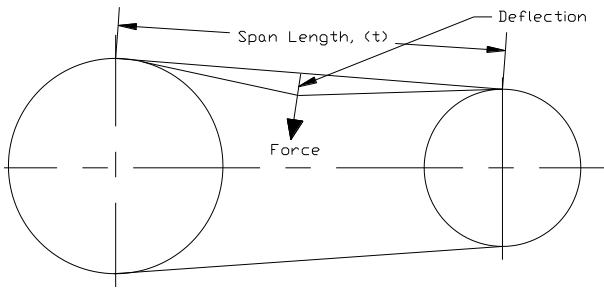


Figure 9: Belt Tension Diagram

These belt drives do not require as much tension as other belt drives that depend on friction to transmit the load. The installation procedure should begin by installing the belt with a snug fit, not too tight or too loose. Now, measure the belt span length, (t), as shown in the picture above. With one pulley free to rotate, use a spring scale to apply a perpendicular force to the center of the belt width at the mid-point of the belt span. For belts wider than 2", it is suggested that a strip of key stock or something similar be placed across the belt under the point of force to prevent distortion. The appropriate amount of force for each belt is shown on the customer approval drawing, or you may contact Exlar Applications Engineering for assistance.

Measure the deflection of the belt at the mid-point. While applying the correct force, there should be 1/64" of deflection for each inch of belt span. For example, the total deflection for a 32" belt span is $32" * 1/64" = 1/2"$.

A sonic tension meter may also be used if available.

FT45 Belt Tensioning

The FT45 uses a flat backside idler pulley to apply and retain tension in the belt drive. The belt will come properly tensioned from the factory, but follow the steps below if belt re-tensioning is required.

1. Remove the rear cover and gasket by removing the M12 socket head cap screws.
2. Relieve tension in the belt by loosening the M12 hex nut on the idler pulley, and backing out the M10 set screw in the side of the motor mounting plate.
3. Adjust the belt tension by threading the set screw in or out against the idler pulley T-nut.
4. Adjust the set screw as needed until the appropriate tension is achieved.

5. Fix the idler pulley in place by applying torque to the hex nut: 40 lb-ft (54 N-m).
6. Verify belt tension is at appropriate level after applying torque to idler nut. Readjust if necessary.
7. Reinstall the gasket and rear cover with the socket head cap screws. Torque the screws to the appropriate value(s) specified in the tables below.

| General Assembly Torques | |
|---------------------------------|-------------------|
| Pulley Cover Screws (1/4-20) | 62 lb-in (7 N-m) |
| (3/8-16) | 16 lb-ft (22 N-m) |

| Motor Mounting Torques (Stainless Steel Mounting Hardware) | | | |
|---|---------------------|----------------------|---------------------|
| Screw Size Inch | Torque | Screw Size Metric | Torque |
| 8-32 | 19 lb-in (2.1 N-m) | M2x0.4 | 2 lb-in (0.2 N-m) |
| 10-32 | 29 lb-in (3.3 N-m) | M2.5x0.45 | 7 lb-in (0.8 N-m) |
| 1/4-20 | 62 lb-in (7 N-m) | M4.x0.7 | 19 lb-in (2.1 N-m) |
| 5/16-18 | 9 lb-ft (12 N-m) | M5x0.8 | 29 lb-in (3.3 N-m) |
| 3/8-16 | 16 lb-ft (22 N-m) | M6x1.0 | 62 lb-in (7 N-m) |
| 7/16-14 | 26 lb-ft (35 N-m) | M8x1.25 | 9 lb-ft (12 N-m) |
| 1/2-13 | 41 lb-ft (56 N-m) | M10x1.5 | 16 lb-ft (22 N-m) |
| 9/16-12 | 50 lb-ft (68 N-m) | M12x1.75 | 26 lb-ft (35 N-m) |
| 5/8-11 | 69 lb-ft (94 N-m) | M14x2.0 | 50 lb-ft (68 N-m) |
| 11/16-12 | 95 lb-ft (129 N-m) | M16x2.0 | 69 lb-ft (94 N-m) |
| 3/4-10 | 122 lb-ft (165 N-m) | M20x2.5 | 122 lb-ft (165 N-m) |

3.4 Roller Screw

The satellite roller screw used within the FT Series actuators is a precision-machined mechanism, which is fully greased upon assembly. Lubrication of the roller screw should be maintained in accordance with section 2.3. The biggest enemies to this mechanism are shock loading and radial loads (side loads). Loading the roller screw in such a manner will cause premature failure.



Do not run the roller screw into the end of its stroke (in either extension or retraction), as this will severely damage the actuator and/or application.

3.5 End of Stroke Cushions

Every standard FT Series actuator is equipped with rubber impact bumpers, which are designed to protect the actuator from accidental over extension or retraction.



This is a fail-safe only and should not be used as a limit to stroke.

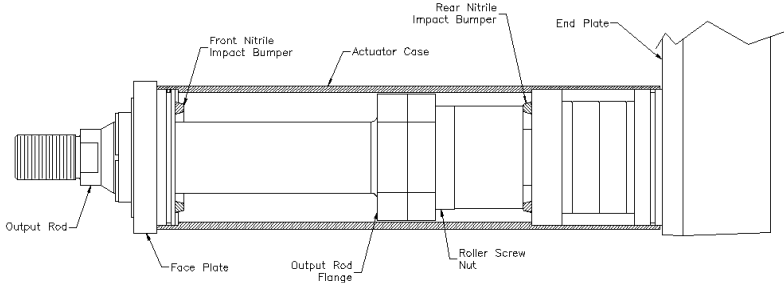


Figure 10: Actuator End of Stroke Cushions

FT Series actuators are designed with an additional 1 inch of travel over nominal stroke. This allows users to utilize the full nominal stroke without causing damage by end crashing.



Care should be taken not to exceed the physical travel limits of FT Series actuators. Doing so will cause the actuator to end-crash internally. End crashes can physically damage the roller screw and the internal components of the actuator.

3.6 Inspection and Lubrication Procedure

The following disassembly and reassembling procedures are general guidelines. Individual designs may differ from these procedures and any questions should be verified with Exlar before reassembling and reinstalling the actuator into your machine or application. For both procedures refer to the drawings included in the disassembly procedure for reference only.



If your actuator has a preloaded roller screw, do not remove it from the cylinder. Preloaded screws require special tooling and procedures for proper disassembly and reassembly. Contact Exlar to arrange for maintenance of a preloaded screw actuator.

Disassembly:

1. Remove the actuator assembly from the application or machine by removing power from the motor, disconnecting main rod coupling and actuator mounting bolts or fasteners. If the servo motor/gearbox is mounted inline proceed to step 5. If the servo motor is parallel mounted skip steps 5 and 6.
2. Remove pulley cover by removing cover screws and pulling cover away from end plate. There are dowel pins that are pressed into the pulley cover that will hold the cover to the end plate and may make it difficult to pull the cover away from the end plate.
3. Loosen motor mounting screws and slide motor down to relieve tension on belt. For an FT45 model, relieve belt tension with idler as outlined in Section 3.3.
4. Remove screws from roller screw shaft pulley and use these same screws to push the pulley bushing off of the pulley using the back out threads provided in the pulley or bushing. Once the pulley becomes loose remove it and the belt. Then remove the motor pulley and bushing and remove the motor from the end plate taking note to record how far from the end plate that the bushing is mounted. This will aid in reassembling the drive train.

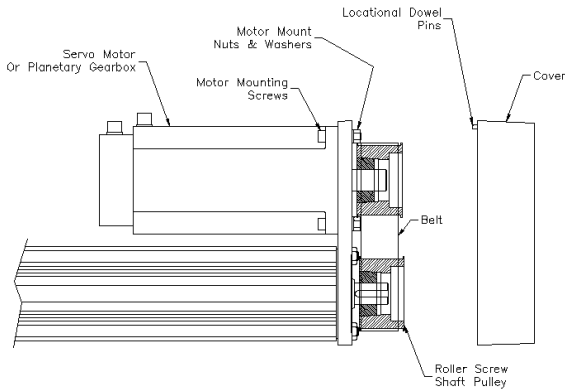


Figure 11: Parallel Motor Mount Disassembly

5. Loosen the inline coupling screws; access them through the plug holes or adapter cover in the side of the inline adapter. Remove the servo motor (and if necessary, the motor mounting plate) after removing the motor mounting screws.
6. Remove the inline adapter after removing the adapter mounting screws.

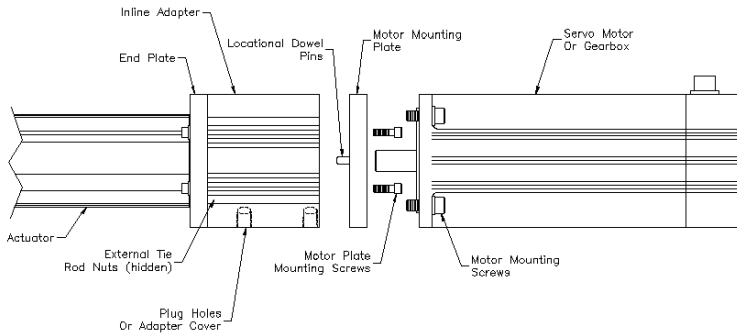


Figure 12: Inline Motor Mount Disassembly

7. Remove the external tie rod nuts and washers. If there are any side mounted trunnion plates, remove these at this time as well.
8. Pull the face plate (and or flange plate) away from the case along with the external tie rods. Then pull the case in the same direction and remove it from the actuator. The roller screw and bearings will now be exposed. For an FT45 model, the bearings will remain inside the rear bearing housing.

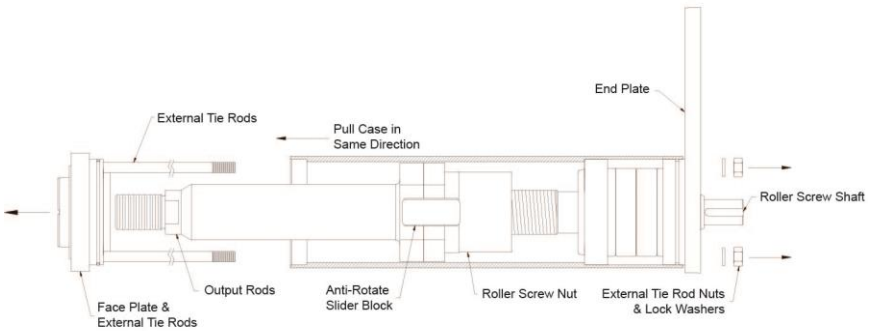


Figure 13: Actuator Disassembly

9. To expose the bottom set of angular contact bearings for re-lubrication you will need to remove the end plate. This is pressed onto the outer race of the bearings (on FT80's you will need to remove the internal tie rod nuts first, on FT45 remove M6 screws from end plate). Pull it away from the bearing pack to expose the bottom bearing. Tapping lightly with a rubber mallet may be necessary to free the end plate. You will now be able to re-grease the roller screw and bearings.

Regreasing:

1. It is a good idea to remove old grease before applying new grease to roller screw bearings and anti-rotate slider tracks. To re-grease the roller screw, fully extend the output rod by rotating the roller screw nut and output rod exposing as much of the roller screw as possible. FOREIGN OBJECTS WILL DAMAGE THE ROLLER SCREW AND SHOULD BE PREVENTED FROM STICKING TO THE GREASE. Apply new grease with a brush or grease gun. Apply enough grease to cover 1/3 of the roller screw diameter on the entire exposed length. Excessive grease is unnecessary and will only require higher motor torque to operate the actuator. Screw the roller screw nut back down until almost fully retracted.
2. To re-grease the bearings, obtain a grease gun with a needle that will fit in between the balls of the bearings. Insert the needle into the bearings to work grease into the inside two bearings, then grease the outside two. Again, excessive grease is unnecessary and will only require higher motor torque to operate the actuator.

- To re-grease the anti-rotate slider block tracks in the case, apply a thin bead (approximately 1/8" diameter) to each of the four outside corners and the middle of the outer wall of the rectangular tracks in the case using a grease gun. Extend the beads as far into the case as possible, and work from both ends of the case if necessary. If the actuator is too long to obtain continuous beads along the entire track length, the slider will distribute some of the grease as it travels through the first few cycles after reassembly.

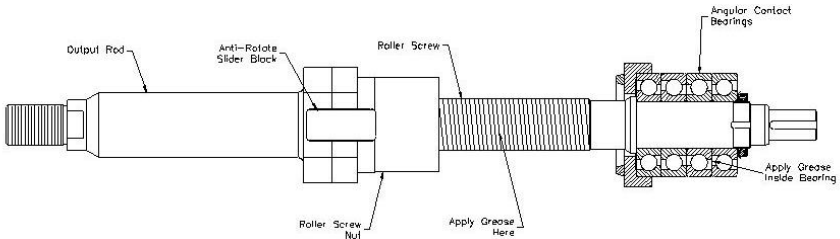


Figure 14a: Actuator Greasing Detail

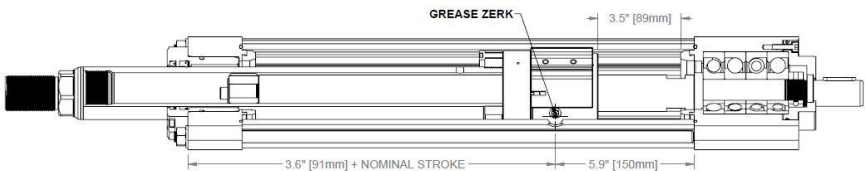


Figure 14b: FT45 Grease Port

Apply grease into zerk through port in case, cycle actuator to distribute grease.
Approximately 2cc of grease recommended per nominal inch of stroke.
Example: 12" Stroke actuator = 24cc of grease.

Reassemble the Actuator:

- Apply a small amount of grease to the rear shaft seal. Press or tap the end plate back onto the bearing pack with a rubber mallet, taking care not to damage the rotational seal. The end plate must go onto the bearing O.D. straight or it will not go on easily. If it gets stuck, take it off and restart it on the bearing O.D. again. The FT80 model has 3/8-16 tie rods that pre-load the outer races of the bearings, torque to 35 lb-ft. The FT45 requires M6x1 socket head cap screws

in end plate; apply light Loctite and torque to 100 lb-in. Alternate tightening in a cross circular pattern to allow for a straight, uniform assembly.

2. Slip the case down over the output rod (deeper bore goes towards the bearing pack), while taking care to line up the limit switch groove in the case with the target magnet that is located in the output rod flange. Magnet is located in the output rod flange on all FT's, except the FT45 where the magnets are carried in the anti-rotation mechanism. Also make sure that the anti-rotate sliders line up with the extruded channels in the case. Orient the switch in the desired position and push the case down over the bearing ring and end plate O-Ring. On FT35's and FT60's the case WILL NOT seat on the end plate when fully assembled and on FT80's the case WILL seat on the end plate. The FT45 case will fully seat against the rear bearing housing.
3. Apply a small amount of grease to the output rod seal and some to the output rod and slide the face plate with external tie rods down over the case and output rod and insert the tie rods through their respective holes in the end plate. The rod seal in the seal gland insert will take some pressure to get it past the chamfer on the output rod, however take care not to damage the seal or wiper.
4. Put the lock washers and nuts on the external tie rods and tighten the nuts with a torque wrench to the following values below:

FT35 = 16 lbf-ft (22Nm)

FT45 = 45 lbf-ft (61Nm)

FT60 = 60 lbf-ft (81Nm)

FT80 = 127 lbf-ft (172Nm)

5. The motor and drive train can now be reassembled. On FT's that have a belt and pulley drive train (parallel motor mount) check the belt for wear. If the belt has excessive wear it may be necessary to replace it. When reassembling the pulleys and belt it is important to line up the pulleys to each other while obtaining the maximum amount of bushing engagement on the motor shaft. If the pulleys are not lined up premature wear could cause the belt to fail. Consult Exlar for the proper belt tension and pulley/bushing screw torque. On inline motor mounted drive trains consult Exlar for proper screw torque for inline coupling.

If any additional maintenance or repair is needed, consult Exlar. It may be necessary to return the actuator to the factory for refurbishment.

4.0 Optional Equipment

4.1 Pre-Loaded Follower

Exlar is able to provide a zero backlash FT series actuator by employing a pre-loaded screw follower. These pre-loaded followers can be made in standard leads and stroke lengths and operate under the same principals as the non-pre-loaded followers. However a pre-loaded screw follower will have a decreased life due to the initial force applied to the rollers inherent in the pre-loaded condition. *See section 5.0 for details regarding these life calculations.*

The anti-rotate mechanism inside every FT actuator has angular backlash associated with it and should be considered when applying an FT actuator in a backlash critical application. Different coupling methods may also affect overall system backlash.

4.2 Mounting Options

The FT product has a variety of standard mounting options to couple to the end use system. These configurations vary based upon frame size, and the Exlar catalog should be consulted to determine the desired model and mounting configuration. If a custom mount is required contact Exlar with the requirements.

4.3 Standard Motor Mounting Configurations

The FT Series actuators are offered in two standard motor mounting configurations, parallel and inline. Each standard motor mount is designed to accommodate any one of the many standard servo motors or planetary gearboxes offered from a wide variety of manufactures. Exlar suggests that you send the motor to our facility for mounting on the actuator to avoid problems associated with mounting the belt drive or inline coupling system. *See section 1.5 for more details.*

4.4 Limit Switches

The FT Series actuator is offered with externally mounted stroke limiting switches which can be moved externally to limit how far the actuator output rod will travel before it trips the limit switch. The switch is a Hall Effect type switch that is triggered by a target magnet that is located on the back end of the output rod inside of the actuator housing. The standard switches are normally closed with PNP output. The switch power is 10-30 VDC with a no-load operating current of 2 mA and a load current of less than or equal to 200 mA. The time delay for the switch is 5 mS and the maximum approach speed is 10 m/S. Follow the diagram below for proper wiring and operation of the limit switches.

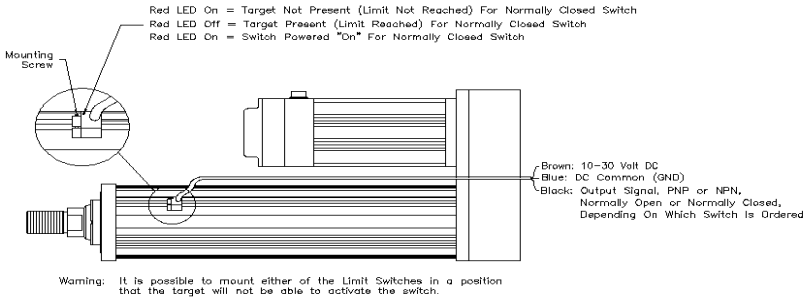


Figure 15A: Adjustable Limit Switch Wiring (FT35, FT60, FT80)

FT45 Limit Switch Operation

The FT45 actuator is equipped for adjustable externally mounted limit switches. Exlar offers magnetic inductive proximity switches that are triggered by a target magnet that is located in the anti-rotate mechanisms inside of the actuator housing. The location of the four target magnets allow switches to be mounted on any side of the actuator.

The limit switches are available with normally open and normally closed output, channel mount magnetic sensing prox.

L# options: External Limit Switches, channel mount magnetic sensing prox, please specify.

| Configuration of Logic of Standard Switch Option Selections | | | |
|---|-----------------|-----------------------|-----------------|
| Option | SW1 | SW2 | SW3 |
| L1 | Not Supplied | Normally Open | Not Supplied |
| L2 | Normally Closed | Not Supplied | Normally Closed |
| L3 | Normally Closed | Normally Open | Normally Closed |
| Switch Type | | | |
| Exlar Part Number | | | |
| Normally Closed Switch | 43404 | Turck PN BIM-UNT-RP6X | |
| Normally Open Switch | 43403 | Turck PN BIM-UNT-AP6X | |

For custom logic combinations, contact Exlar applications engineering. See switch manufacturer's documentation for additional limit switch information.

The magnetic inductive switch power is 10-30 VDC with a no-load operating current of <10mA and a load current of less than or equal to 200 mA.

Wiring diagram

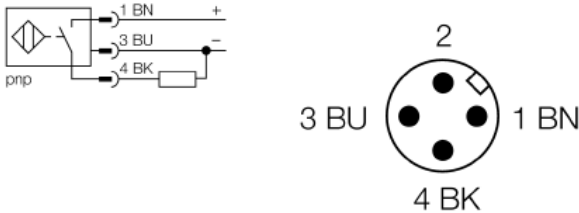


Figure 15B: Adjustable Limit Switch Wiring (FT45)

4.5 Rod Ends

FT series actuators are available as standard with male or female rod ends with either U.S. Unified or Metric threads. Each standard rod end is also equipped with wrench flats to aid in attachment to the load.

4.6 Motors

FT Series actuators are designed to accept virtually any type of standard electric servo motor or planetary gear reducer that are available through various manufactures. Due to motor size, torque or speed, not all motors or reducers can be mounted to each standard Force Tube Actuator. Custom motor mounting may be required. See section 5.0 for torque specifications required to drive application load levels.

4.7 Electronics

Electronics and drive amplifiers to match the appropriate motors are available through the same manufactures that supply the motors. All maintenance and service guidelines contained within the motor manufacture manuals should be followed to avoid service problems associated with the amplifier and motor.

5.0 Specifications

5.1 Life Calculations

The expected life of the roller screw in an FT actuator is expressed as the linear travel distance that 90% of the screws are expected to meet or exceed before experiencing metal fatigue. This is not a guarantee. For accurate lifetime calculations of a roller screw in a linear application, cubic mean load should be used. Consult the catalog for ratings and formulas associated with life calculations.

5.2 Load, Torque, and Linear Speed Calculations

The thrust load applied by the FT actuator is dependent on the amount of torque that is applied to the roller screw shaft and the lead of the roller screw within the actuator. It is important to include any gearbox reduction and or drive train belt and pulley reduction into this equation as well. The equation that defines the amount of torque required for a corresponding thrust force is listed in the Exlar catalog. Reference this catalog for torque calculations and ratings.

It is also important to recognize that motor torque will be required to accelerate the inertial components of the system in addition to the thrust. Consult Exlar's sizing guideline for further details.

The linear speed that the FT actuator will produce at the end of the output rod is a function of rotational speed of the roller screw shaft and roller screw lead. It is important to include any gearbox reduction and or drive train belt and pulley reduction into this equation as well. Reference the Exlar catalog for ratings and formulas regarding the linear speed of the FT actuators.

5.3 Load and Speed Ratings

Each FT actuator model has an associated maximum force rating. The maximum force rating is a value that should never be exceeded either by or applied to the actuator. Each FT actuator has a peak force rating that is derived from the design capacity of the FT actuator, and should not be exceeded or relied upon for continuous operation. Consult the Exlar catalog for maximum force ratings.



DO NOT exceed maximum force ratings of the FT actuators. Doing so can and will cause damage to the actuator and put the operator at risk of injury.

The speed rating of the actuator is dependent on stroke length and diameter of the roller screw inside the actuator. The maximum rotational screw speed of the FT actuators should be maintained below the maximum rotational screw speed. Consult the Exlar catalog for maximum rotational speeds.

6.0 Troubleshooting

6.1 Mechanical Problems

This section will provide you with a helpful guideline to troubleshooting various problems that may occur during operation and installation of your FT actuator.

| Symptom/ Problem | Possible Cause | Problem Solution |
|--|--|---|
| Abnormally loud whining coming from actuator. | Misalignment or Side Load | Check alignment with application, remount actuator if necessary. Remove side load. |
| Abnormally loud whining coming from actuator. | Improper servo tuning | Consult tuning guidelines for servo motor and drive. |
| Actuator motor rotates but output rod does not extend or retract. | Belt or inline coupling failure | Disconnect power to motor, remove belt cover and inspect belt or inline coupling. Replace if necessary. |
| Motor does not operate. | Motor electrical problem | Consult motor manufacturer. |
| Output rod has excessive rotation, or rotates but does not extend. | Anti-rotate failure | Replace anti-rotate mechanism |
| Case rotates along with output rod rotation. | Insufficient external tie rod torque. | Check assembly torque on tie rods. See section 3.6 |
| Excessive motor current to operate actuator. | An internal mechanism binding, application binding, roller screw failure. Operation over peak load rating. | Consult Exlar |

6.2 Electrical Problems

All electrical problems associated with the motor used to drive the roller screw in an FT actuator should be taken up with that motor manufacturer. Exlar will assist in contacting the appropriate person.

If an externally mounted limit switch is not operating properly, check all power connections to the switch and make sure that the switch is wired properly. If the actuator has been disassembled, check to make sure that the switch groove in the case was lined up with the target magnet inside the actuator. *Refer to the diagram in section 4.4 for further details regarding wiring.*

6.3 Returning Product for Repair

PROCEDURE:

- Please discuss the return with Exlar Technical Support prior to requesting an RGA number to see if it is possible to resolve the issue prior to return.
- If it is determined that an RGA number is required, please do so by completing the RGA Request Form (available at exlar.com) or contacting the Returned Goods Administrator. Phone 952-500-6200 or email cha_returns@curtisswright.com
 - International Repairs: Closely follow instructions provided by the Exlar Returned Goods Administrator. Failure to comply with issued instructions may result in delays for repair and return.
- Exlar requires a purchase order at the time of RGA; \$0 on warranty returns, or for the standard evaluation charge per unit on all non-warranty units for the evaluation fee.
- Following the evaluation, you will receive a quote from Exlar on the charges that will apply. If the actuator repair is approved, the evaluation fee will be waived and we will request an amended PO for the actual repair value.

Product Repair Lead Time

| | Evaluation Time: (Quote + Eval Report) | Repair Time: (After Parts Received) | Evaluation & Additional Fees* |
|-------------------|---|--|---|
| Standard | < 10 days | < 7 days | Eval Fee |
| Standard Expedite | < 3 days | < 3 days | Eval Fee + Expedite Fee |
| Xtreme™ Expedite | < 24 hours | < 24 hours | Eval Fee + Xtreme Fee + Mat'l Expedite Fees |

* Assumes completion of entire RGA Request Form. An additional fee per unit may be applied to orders having incomplete RGA Request Forms.

Note: repair times and costs may vary based upon required component part availability.