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THORLABS

ZFS Series
Stepper Motor Actuators

User Guide



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Chapter 1 Overview

1.1 Description

Thorlabs has developed this series of high-resolution motorized actuators for use in high precision applications. The compact, 'folded' stepper motor design is aimed at customers whose priority is minimal length protruding from their Optimech and applications where the centre of gravity should be close to the contact point.

From drop-in replacements to custom mounts, these motorized actuators will satisfy even the most demanding requirements. Three different travel lengths are offered: 6.0 mm, 13.0 mm, and 25.0 mm.

The ZFS13B and ZFS25B actuators are shipped with a clamping bush fitted, ready for use with a 3/8" barrel mount. The ZFS6 and ZFS13 actuators thread into a ¼" -80 mounting bush.

The ZFS series Motorized Actuators use a stepper motor that provides sufficient torque for high load capabilities. The actuators allow very small step sizes over the entire travel range, delivering greater flexibility with negligible backlash and fine resolution. The design incorporates a 44:1 gear reduction head which, when combined with the 49,152 microsteps per revolution offered by the KST201 stepper motor driver gives a theoretical travel per microstep of 0.46 nm. The stepper motor allows for continuously variable speeds and the actuators use integrated hard stops that automatically cut the power when they have reached their mechanical limits.

The ZFS series Motorized Actuators are light, compact, and extremely durable. They are ideal for use in mirror mounts, translation stages, microscopes, OEM applications, and a wide variety of other components that require higher precision than most standard drive mechanisms allow.

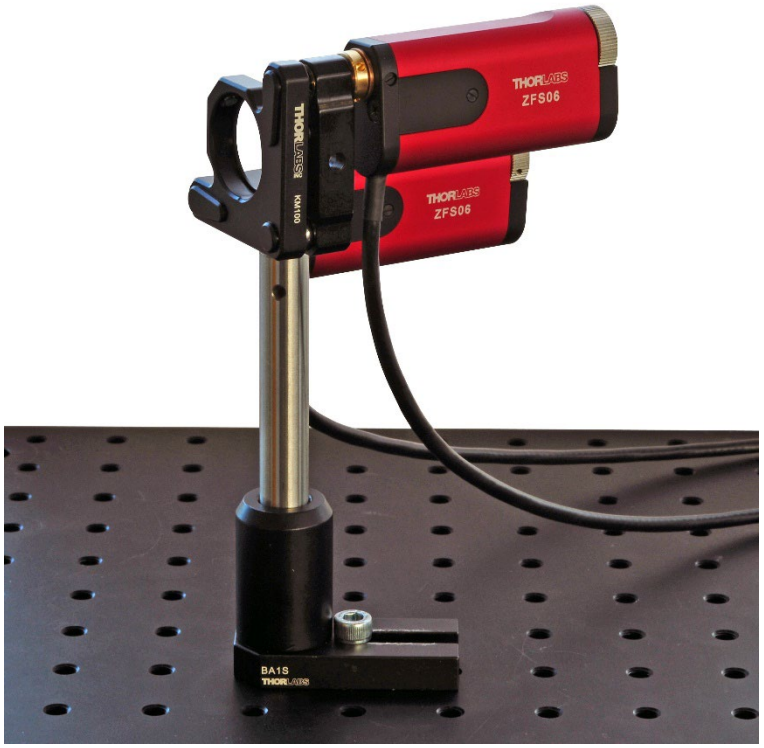


Fig. 1.1 ZFS06 fitted to KM100 Mirror Mount

Chapter 2 Safety

2.1 Safety Information

For the continuing safety of the operators of this equipment, and the protection of the equipment itself, the operator should take note of the **Warnings, Cautions** and **Notes** throughout this handbook and, where visible, on the product itself.

The following safety symbols may be used throughout the handbook and on the equipment itself.

The following safety symbols may be used throughout the handbook and on the equipment itself.



Warning: Risk of Electrical Shock

Given when there is a risk of injury from electrical shock.



Warning

Given when there is a risk of injury to users.



Caution

Given when there is a risk of damage to the product.

Note

Clarification of an instruction or additional information.

2.2 General Warnings



Warning

These Motorized Actuators can generate high forces. If handled improperly, they may cause injury. Be aware that failure of the motor controller may drive the unit into a hard stop and cause damage to the unit.

To avoid injury never put anything in the gap between the Actuator and any rigid structure.



Caution

If the actuator encounters a hard stop while still in the middle of its range (i.e. a translation stage at the end of its travel range), the motor should be stopped as soon as possible to prevent damage to the gear head or motor and to keep the unit from overheating.

When the ZFS motors are fitted to certain optomech products e.g. the GNL series Goniometers, it is possible that the motor will reach the mechanical hardstops of the stage before the motor limit switches are activated. In this case, DO NOT continue to drive the motor into the hardstop as this will damage the motor.



Caution

The control PC used to operate the driver for the ZFS series actuators must be running APT Software version 2.17.0 or higher.

Earlier versions of software do not support this product.

The latest software can be downloaded from the software downloads section of www.thorlabs.com.

Chapter 3 Connection Details

3.1 Pin Assignments

Pin assignments for the male D-Type connector on the motor flying lead are described below.

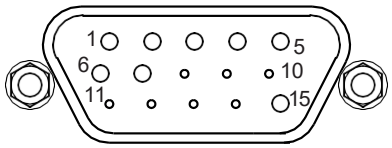


Fig. 3.1 Output Connector

Pin	Description	Pin	Description
1	Limit Ground	**9**	Reserved for Future Use
2	CCW Limit Switch	**10**	Vcc (+5 VDC)
3	CW Limit Switch	**11**	Reserved for Future Use
4	Motor Phase B -	**12**	Reserved for Future Use
5	Motor Phase B +	**13**	Reserved for Future Use
6	Motor Phase A -	**14**	Reserved for Future Use
7	Motor Phase A +	**15**	Ground
8	Reserved for Future Use		

3.2 Description of connections

Limit Ground: a common ground for both the forward and reverse limit switches.

CCW Limit: the counterclockwise (reverse) limit prevents over driving of the actuator at its minimum extension.

CW Limit: the clockwise (forward) limit prevents over driving of the actuator at its full extension.

When using a third-party controller, the limit switch inputs must be connected via a 10 k pull up resistor as shown below. When either switch operates, the associated input is pulled to ground and the TTL buffers switch.

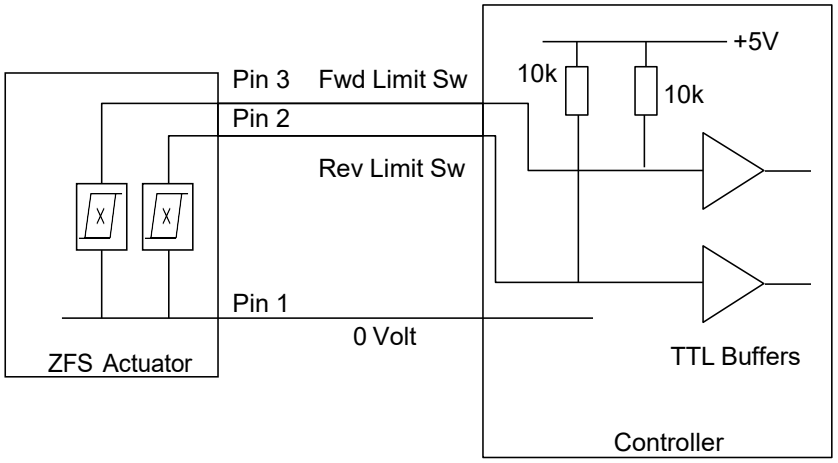


Fig. 3.2 ZSF Limit Switch Circuit

Motor Phases: supplies 15 VDC 1A to the motor of the actuator.

Chapter 4 Operation and Maintenance

4.1 Selecting the Stage Type

To ensure that a particular stage is driven properly by the system, several parameters must first be set. These parameters relate to the physical characteristics of the stage being driven (e.g. min and max positions, leadscrew pitch, homing direction etc.).

To assist in setting these parameters correctly, it is possible to associate a specific stage type and axis with the motor controller channel. Once this association has been made, the server applies automatically, suitable default parameter values on boot up of the software.

Note

Thorlabs often releases updated firmware for bug fixes and support for new features. We recommend all users to download the latest version of Kinesis software and use the included firmware update utility. Failure to do this could result in stages not being recognized by the latest controllers.

To ensure correct operation, it is important to select the correct stage and axis type as described above. Selecting an incompatible stage/axis type could result in reduced velocity and/or resolution, and in the worst case could cause the motor to run into the end stops or home incorrectly.

4.1.1 Using Kinesis Software

1) Install the electronic hardware and connect the modules to the relevant axes of the associated stages (see the handbooks for the associated controller).
2) For each Stepper Motor Controller in your system, fit the interlock plug (supplied) to the MOTOR CONTROL connector on the rear panel.
3) Ensure that the device is connected to the PC and powered up.
4) Run the Kinesis software - Start/All Programs/Thorlabs/Kinesis/Kinesis.
5) On start-up, the 'Actuator/Startup Settings' window is displayed This window allows the correct actuator to be selected.

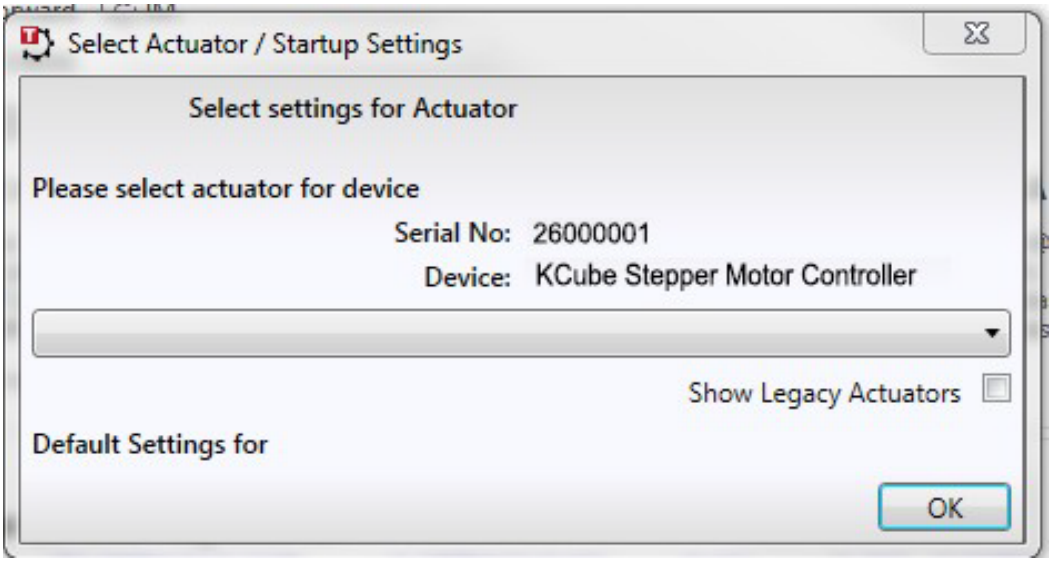


Fig. 4.1 Select Actuator Stage Settings Window - 1

6) Click the arrow to the right of the window and select your actuator type (e.g. HS ZFS13) from the list displayed.

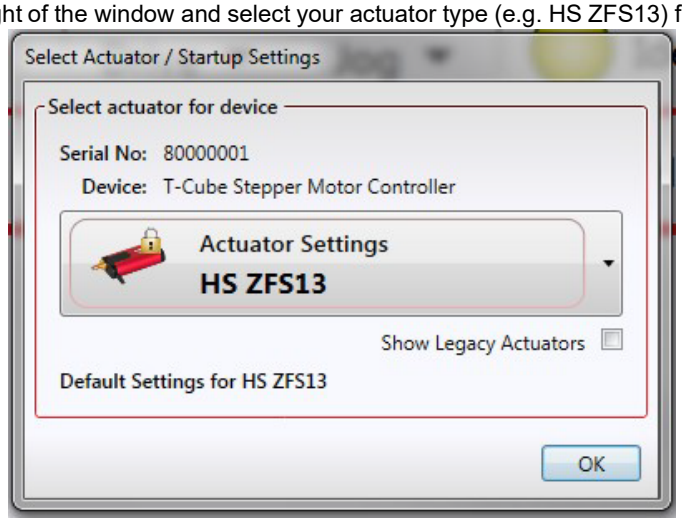


Fig. 4.2 Select Actuator Stage Settings Window - 2

7) Click OK.
8) The server reads in the stage and controller information automatically. Refer to the handbook for the associated controller for more information on driving the actuator/stage.

4.1.2 Using APT Software

1) Shut down all applications using the APT server (e.g. APT User or your own custom application).
2) Run the APT Config utility - Start/All Programs/Thorlabs/APT Config/APT Config.
3) From the 'APT Configuration Utility' window, click the 'Stage' tab.

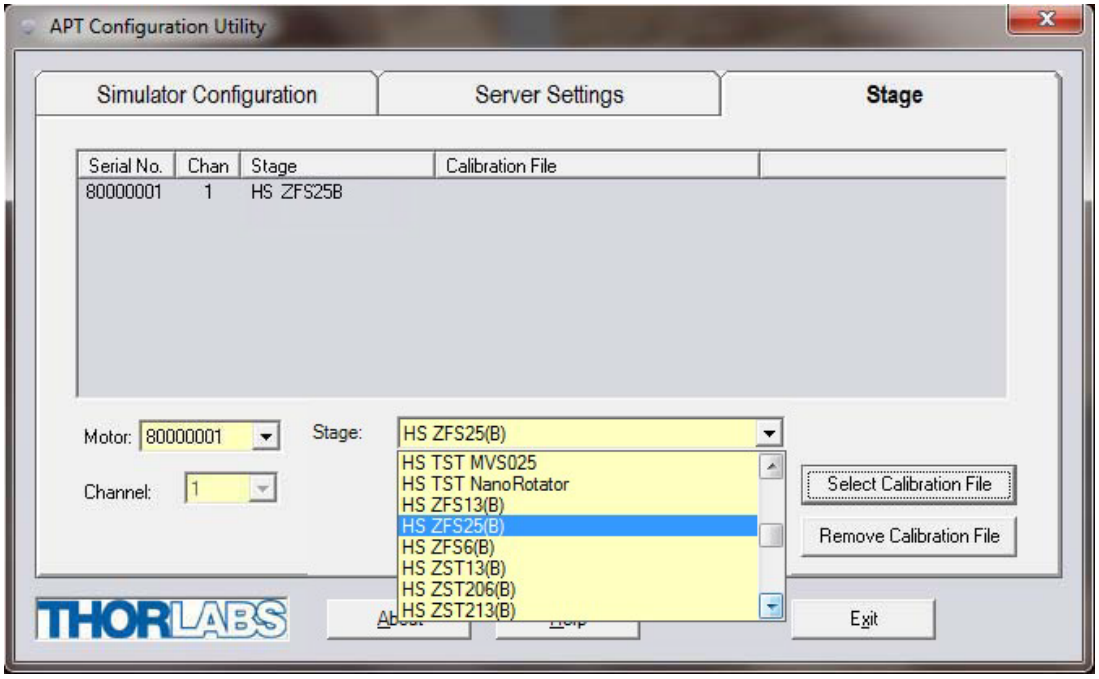


Fig. 4.1 APT Configuration Utility - Stage Tab

4) In the ‘Motor’ field, select the serial number of the stepper motor controller to be configured (this number can be found on the rear panel of the controller unit).

Note

To ensure correct operation, it is important to select the correct stage type for your controller. Selecting an incompatible stage type could result in reduced velocity/resolution. In rare cases the actuator may be inoperable.

5) In the ‘Stage’ field, select your actuator type from the list displayed (e.g. ZST206).
6) Click the 'Add Stage Association' button.

7) A default configuration is set at the factory and stored in the non-volatile memory of the motor controller. The server reads in the stage and controller information on start up. See the handbook supplied with the stepper motor controller for further information.

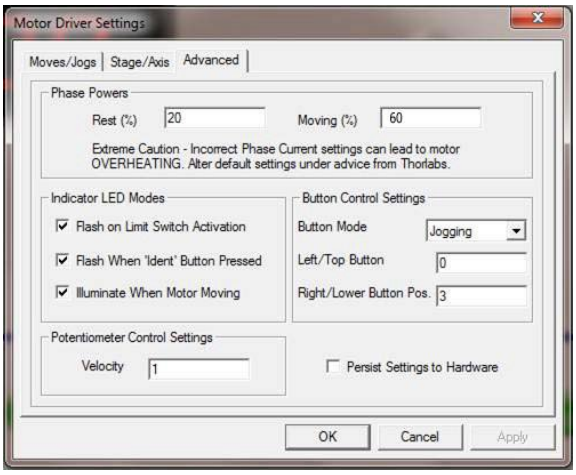
Moving at Slow Speeds

The recommended controller for the ZFS motors is the KST201 K-Cube driver. When the motor is being driven by a legacy TST001 driver, certain operating conditions may cause the motor to become quite hot to the touch. This is not a fault condition but may be inconvenient in cases where the unit is being handled. In this case, the moving phase powers should be reduced to around 60% as follows:

Note

The KST201 driver sets the moving phase powers automatically and they cannot be adjusted by the user.

1) Perform the system set up described in the previous section, then run the APTUser utility.
2) Click the 'Setting' button on the motor GUI panel and select the Advanced tab.



3) In the Phase Powers Field, set the Moving (%) power to '60'.
4) Click OK.
5) Select the Move/Jogs tab and adjust the Max Vel setting as required (see handbook supplied with the controller for more information).
6) Click OK.

4.2 Using the Manual Knob

The motor can be positioned manually by turning the knob at the back of the unit. Turning the knob clockwise (when viewed from the back as shown) will cause the drive shaft to be withdrawn.

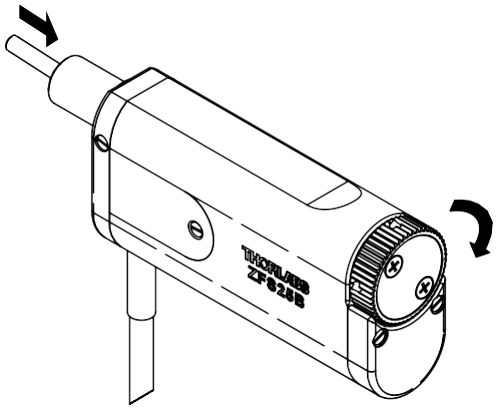
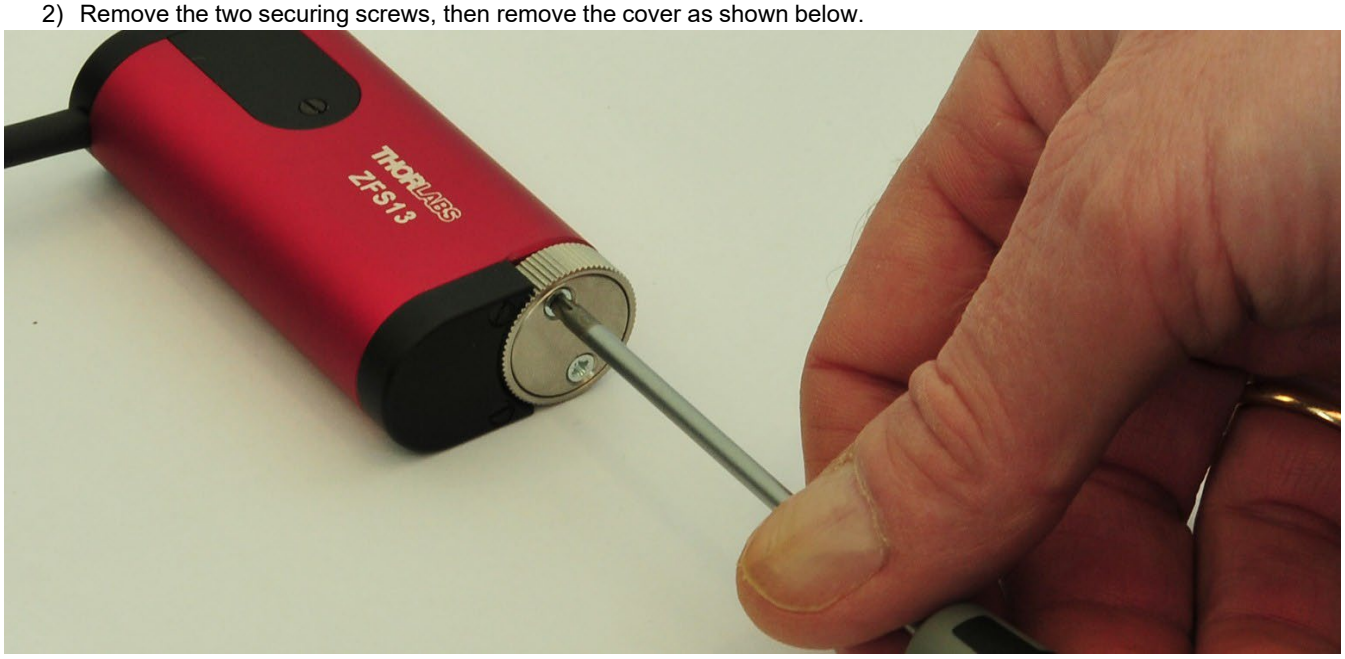


Fig. 4.3 Knob Rotation

4.3 Maintenance

Periodic greasing of the lead screw is advised, particularly in applications with a high duty cycle or whenever the thread appears dry, or the motor is noisy.

1) Turn the knurled knob at the back of the motor until the drive rod is fully extended.
2) Remove the two securing screws, then remove the cover as shown below.



3) Using a syringe, apply a thin bead of high load, silicon free lubricant (e.g. Apiezon 100) to the lead screw as shown below.

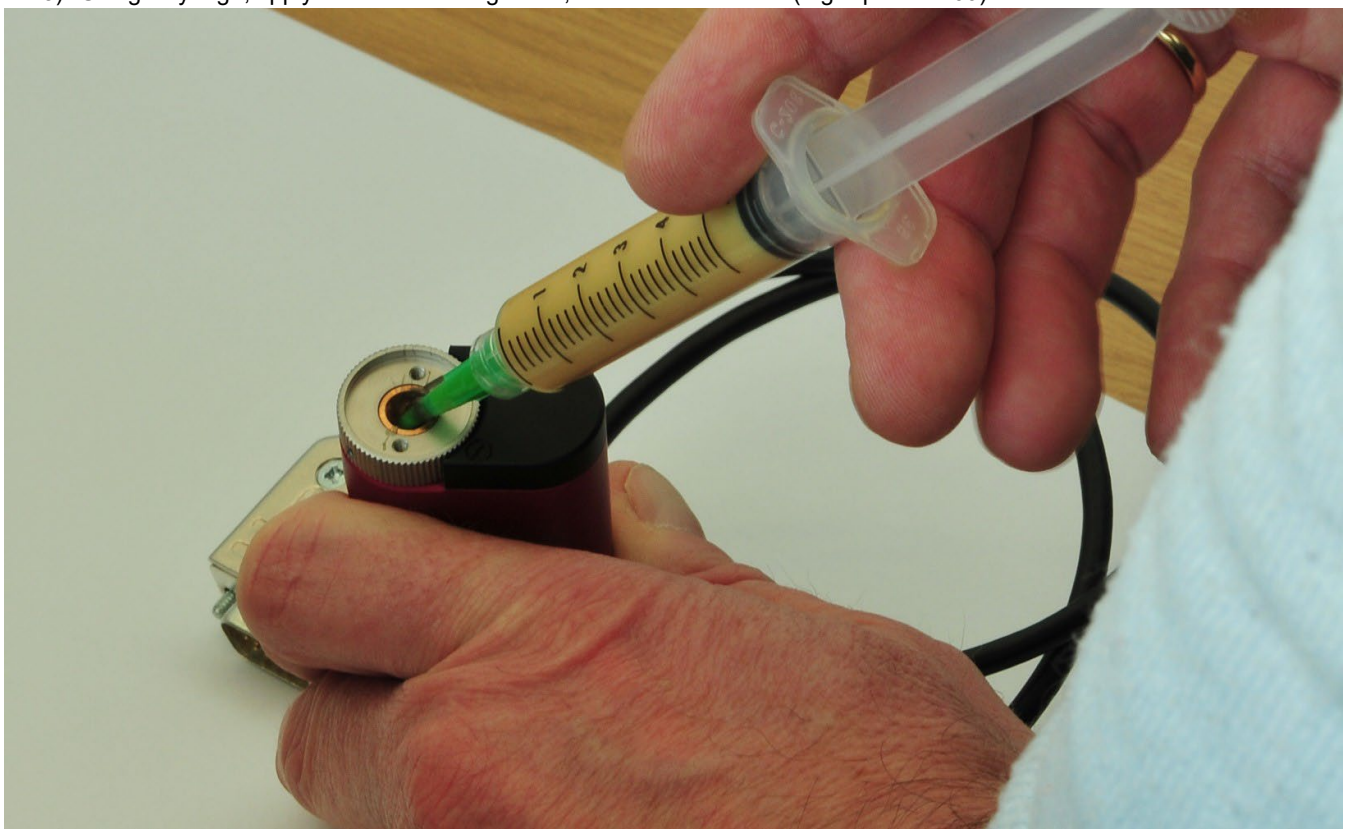


Fig. 4.4 Greasing the Leadscrew

4) Drive the motor to extend the lead screw and distribute the grease.
5) Remove access grease using a lint free cloth.
6) Refit the cover and securing screws.

Chapter 5 Specifications

5.1 General Specifications

Specification	ZFS6	ZFS13/ ZFS13B	ZFS25B
Travel Range	6 mm	13 mm	25 mm
Gear Ratio	400:9 (approximately 44:1)		
Lead Screw Pitch	1.0 mm		
Microsteps per revolution of motor (when driven by KST201 Driver)	24 full steps, 2048 µsteps per full step 49,152 µsteps per revolution		
Repeatability	<5.0 µm		
Home Location Accuracy	<5.0 µm		
Backlash	<15 µm		
Maximum Force	40 N (8.99 lbs)		
Max Speed	2.0 mm/sec		
Max Acceleration	10.0 mm/sec^2		
Calculated Min. Incremental Motion	0.46 nm		
Motor Type	2 Phase Stepper		
Limit Switches	Hall Effect Sensor		
Operating Temperature	5 to 40 °C (41 to 104 °F)		
Cable Length	0.6 m (2 ft)		
Connector	HDDB15		
Compatible Controller	KST201 K-Cube Stepper Motor Controller		

5.2 ZFS Motor Unit Specifications

Specification	ZFS Series
Phase resistance (@ 20°C)	12.5 Ohms
Nominal current per phase (both phases ON)	0.25 A
Phase inductance @(1kHz)	6.3 Ohms
Back EMF	4.4V/k step/s

5.3 How to Calculate the Linear Displacement per Microstep

The ZFS series motors have 24 full steps per revolution and when driven by the KST201 drivers there are 2048 microsteps per full step, giving 49,152 microsteps per revolution of the motor. The output shaft of the motor goes into a 400:9 gear head. This requires the motor to rotate 44.445 times to rotate the 1.0 mm pitch lead screw one revolution. The result is the lead screw advances by 1.0 mm.

To calculate the linear displacement of the actuator per microstep:

No Microsteps x Gearbox Ratio = 49,152 x 44.445 = 2,184,560.64

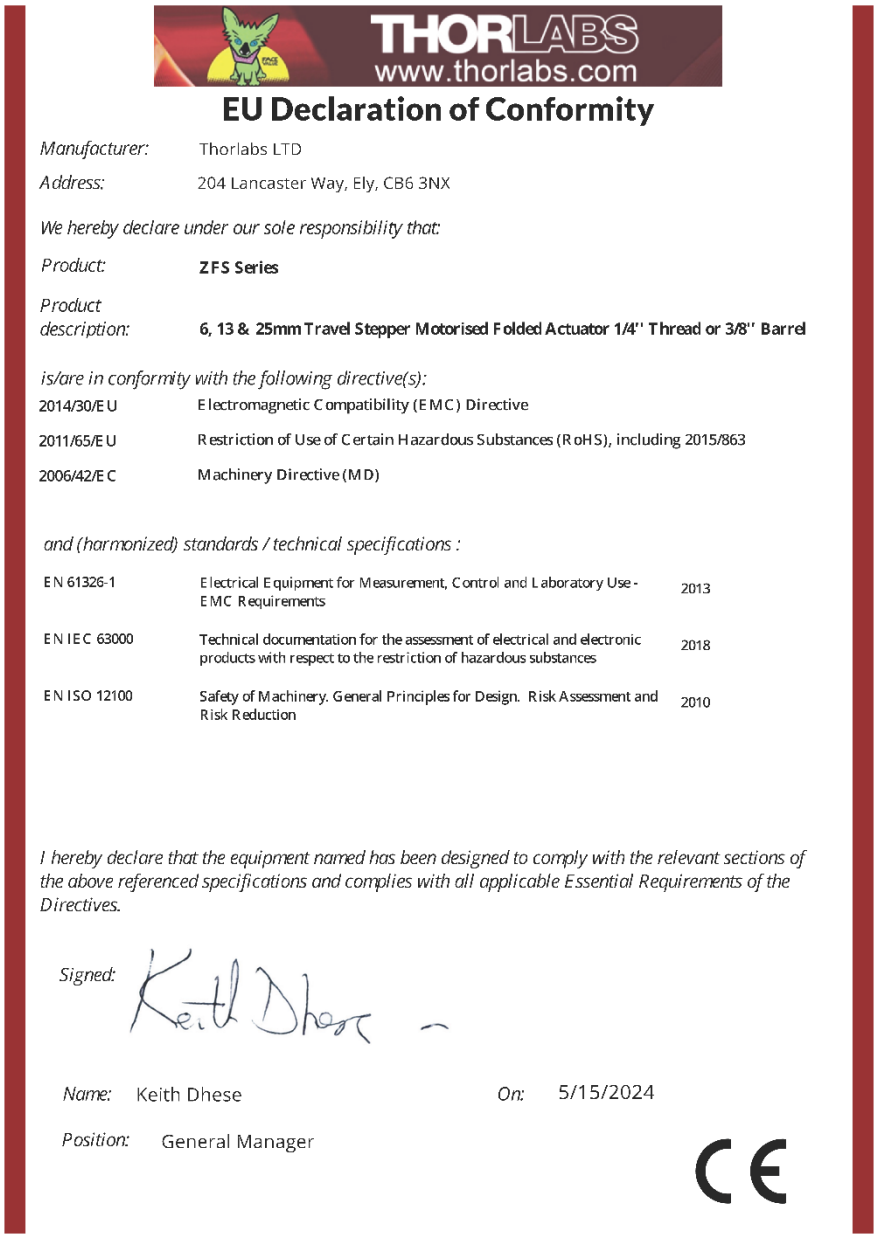
Linear displacement of the lead screw per microstep:

1.0 mm / 2,184,560.64 = 0.46 x 10^{-6} mm (0.46 nm)

Chapter 6 Regulatory

6.1 Declarations Of Conformity

6.1.1 For Customers in Europe



THORLABS
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EU Declaration of Conformity

Manufacturer: Thorlabs LTD

Address: 204 Lancaster Way, Ely, CB6 3NX

We hereby declare under our sole responsibility that:

Product: **ZFS Series**

Product description: **6, 13 & 25mm Travel Stepper Motorised Folded Actuator 1/4'' Thread or 3/8'' Barrel**

is/are in conformity with the following directive(s):

2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS), including 2015/863
2006/42/EC	Machinery Directive (MD)

and (harmonized) standards / technical specifications :

EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013
EN IEC 63000	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances	2018
EN ISO 12100	Safety of Machinery. General Principles for Design. Risk Assessment and Risk Reduction	2010

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications and complies with all applicable Essential Requirements of the Directives.

Signed: Keith Dhese

Name: Keith Dhese *On:* 5/15/2024

Position: General Manager

CE

6.1.2 For Customers in the USA

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by the company could void the user's authority to operate the equipment.

Chapter 7 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.



USA, Canada, and South America
Thorlabs, Inc.
sales@thorlabs.com
techsupport@thorlabs.com

UK and Ireland
Thorlabs Ltd.
sales.uk@thorlabs.com
techsupport.uk@thorlabs.com

Europe
Thorlabs GmbH
europe@thorlabs.com

Scandinavia
Thorlabs Sweden AB
scandinavia@thorlabs.com

France
Thorlabs SAS
sales.fr@thorlabs.com

Brazil
Thorlabs Vendas de Fotônicos Ltda.
brasil@thorlabs.com

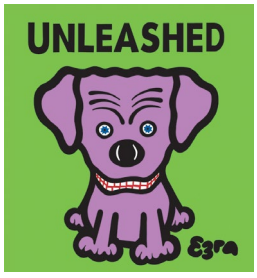
Japan
Thorlabs Japan, Inc.
sales@thorlabs.jp

China
Thorlabs China
chinasales@thorlabs.com

Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return "end of life" Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out "wheelie bin" logo (see right), were sold to and are currently owned by a company or institute within the EC and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. "End of life" units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.



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