Z906, Z912, Z912B, Z925B
Motorized DC Servo Actuators

User Guide

Original Instructions

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Chapter 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.

Warning: Risk of Electrical Shock

Given when there is a risk of electric shock.

Warning

Given when there is a risk of injury to users.

Caution

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

Note

Clarification of an instruction or additional information.

1.1 General Warnings and Cautions

Warning

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 (e.g., 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 Z9 series motors are fitted to certain optomechanical products e.g., the GNL series Goniometers, it is possible that the motor will reach the mechanical hard stops of the stage before the motor limit switches are activated. In this case, DO NOT continue to drive the motor into the hard stop as this will damage the motor. The total current drawn should not exceed 80 mA.

Caution

To prevent damage to the threads when storing these units, be careful to fully retract the lead screw. Improper connection of the motor will result in permanent damage. All power supplied to the motor should be turned off before altering any connections to the motor. Check all connections before supplying power to the motor.

Chapter 2 Overview

2.1 Introduction

Thorlabs has developed this series of high-resolution motorized actuators for use in high precision applications. These motorized actuators can be used as custom mounts or drop-in replacements to meet even the most stringent requirements. The travel lengths offered are 6 mm, 12 mm and 25 mm.

The Z912B and Z925B actuators are shipped with a fitted clamping bush which is ready to be used with a 3/8" barrel mount. The Z906 and Z912 actuators thread into a ¼" - 80 mounting bush.

The Z9 Series Motorized Actuators use a 6 V DC servomotor that provides sufficient torque for high load capabilities. A precision encoder with 512 counts per revolution and a 67.49:1 gear reduction head provides a minimum resolution of 29 nm (not consistent) and minimum repeatable incremental motion of 0.2 µm. The actuators allow very small step sizes over the entire travel range, providing greater flexibility with negligible backlash and fine resolution. The DC servomotor allows for continuously variable speeds while the optical encoder allows closed loop operation. The actuators use integrated hard stops that automatically cut the power when they have reached their mechanical limits.

The Z9 Series Motorized Actuators are light, compact, and extremely durable. They are ideal for use in a wide range of components, including mirror mounts, translation stages, microscopes, OEM applications, and other items that require higher precision than most common drive mechanisms can provide.

Figure 1 Z9 Series Actuators

Chapter 3 Installation

3.1 Environmental Conditions

Warning

Operation outside the following environmental limits may adversely affect operator safety.

The unit is designed for indoor use only.

To ensure reliable operation, the unit should not be exposed to corrosive agents or excessive moisture, heat or dust.

The unit is not designed to be used in explosive environments.

If the unit has been stored at a low temperature or in an environment of high humidity, it must be allowed to reach ambient conditions before being powered up.

3.2 Connection Details and Specifications

3.2.1 Pin Assignments

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

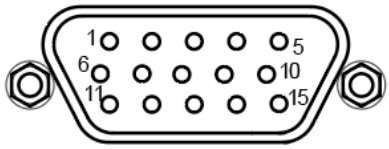

Figure 2 Output Connector

Pin	Description	Pin	Description
1	Ground (Limit and Vcc)	**9**	Resistive Identification
2	Forward Limit	**10**	5 VDC
3	Reverse Limit	**11**	Encoder Channel A
4	Reserved For Future Use	**12**	Reserved For Future Use
5	Motor (-)	**13**	Encoder Channel B
6	Reserved For Future Use	**14**	PIN 2 Ident EEPROM
7	Motor (+)	**15**	PIN 1 Ident EEPROM
8	Reserved For Future Use		

Caution

Do not connect a motor actuator while the K-Cube® is powered up.

3.2.2 Description of Connections

Motor (+): Supplies a + VDC supply to the motor of the actuator. The maximum current is 240 mA.

VDC: A connection should be made to a +5 VDC supply to power both channels A and B on the encoder.

Encoder Channels A and B: The Z9 series actuators use a Hall Effect encoder. Both channels A and B are supplied by the VDC (5 VDC) connection.

Ground: The ground connection for the encoder. A common ground for both the forward and reverse limit switches.

Motor (-): Supplies a - VDC supply to the motor of the actuator. The maximum current is 240 mA.

Reverse Limit: The reverse limit prevents over driving of the actuator at its minimum extension.

Forward Limit: The forward limit prevents over driving of the actuator at its full extension.

EEPROM: Electrically erasable programmable read-only memory. This helps in recognizing the device after connecting to the software.

Note. When a limit switch is activated, the switch makes contact, and the associated output line is connected to ground (pin 1).

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

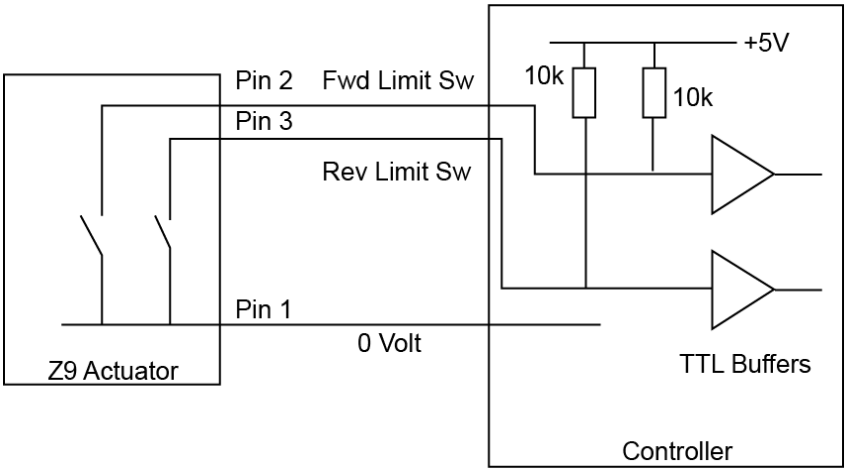

Figure 3 Z9 Series Limit Switch Circuit

Chapter 4 Operation and Maintenance

4.1 Compatible Drivers and Software

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

Two software options are offered for the Z9 Series Actuators - Kinesis® and XA. For information about operation using the software applications, please refer to the User Guides available on the website.

When using the Z9 actuators with the Kinesis software, firmware version 2.2.8 or higher, included in the Kinesis software version 1.14.40 or higher download, is required for using the KDC101 with the Z9 actuators. Prior versions of firmware will operate the Z9 actuators but will call the actuators Z8.

The Thorlabs compatible controller for this product is the KDC101 K-Cube® Single Channel DC Servo Controller. The use of these controllers ensures optimal performance. All performance specifications are guaranteed only with use of Thorlabs controllers and drivers.

4.2 Maintenance

The Z9 series have been tested to 100,000 cycles without reduced performance (with 9 N load on lead screw). Periodic greasing of the lead screw is advised, particularly in applications with a high duty cycle. The old grease needs to be cleaned off and regreased every 10,000 cycles. The contact point between the screw ball and the flat counter face may also require greasing if the device becomes noisy. Grease the lead screw thread as follows whenever the thread appears dry, or the motor is noisy:

1. Drive the motor to extend the lead screw to its full extent.
2. Remove the existing grease with a clean cloth dipped in Ultrasol or another equivalent solvent.
3. Apply a thin bead of high load, silicon free lubricant (e.g., GKZ8 Grease Kit) as shown below.

Figure 4 Greasing the Lead Screw

4. Drive the motor to retract the lead screw and distribute the grease.
5. Remove excess grease with a lint free cloth.

Chapter 5 Specifications

Item #	Z906	Z912	Z912B	Z925B
Mounting Barrel	¼"-80 Threaded		Ø3/8" (9.5 mm) Smooth	
Travel Range	6 mm	12 mm		25 mm
Homing Repeatability	±5 µm	±6 µm		±9 µm
Uncompensated Backlash	6 µm	13 µm		13 µm
Uncompensated Bidirectional Repeatability	±3 µm	±7 µm		±7 µm
Residual Backlash After Compensation[a]	0.1 µm	0.7 µm		0.7 µm
Compensated Bidirectional Repeatability	±0.3 µm	±0.7 µm		±0.8 µm
Travel Accuracy[b]	6 µm	9 µm		40 µm
Weight	0.13 kg	0.13 kg		0.13 kg
Cable Length	485.0 mm (19.09")			
Gear Reduction	67.49:1			
Lead Screw Pitch	1 mm			
Feedback	Motor Mounted Rotary Encoder 512 Counts/rev of the Motor 34,555 Counts/rev of Lead Screw			
Limit Switches	Electromechanical			
Motor Type	DC Servo			
Maximum Pushing Force	45 N			
Maximum Speed[c]	2.6 mm/s			
Maximum Acceleration	4 mm/s^2			
Minimum Repeatable Incremental Motion	0.2 µm			
Phase to Phase Resistance	33.0 Ω			
Phase to Phase Inductance	0.6 mH			
Tested Life (9N Load on Lead Screw)	>100,000 In and Out Cycles			
Operating Temperature	41° to 104° F (5° to 40° C)			
Connector Type	D-sub 15 Pin Male			
Compatible Controller	KDC101 K-Cube DC Servo Controller			

a. The system moves 300 µm inwards beyond the target before reaching the desired target on an inward move.

b. Default backlash compensation is present against a constant force.

c. At 2.6 mm/s, velocity ripple and distortion of the acceleration/deceleration profile may occur. For improved control, the maximum velocity should be limited to 2.3 mm/s.

Chapter 6 FAQ

6.1 Calculating Linear Displacement per Encoder Count

There are 512 encoder counts for the Z9 series motors for each motor revolution. The output shaft of the motor goes into a 67.49:1 planetary gear head. In order to complete one revolution of the 1.0 mm pitch lead screw, the motor must rotate 67.49 times which results in moving the lead screw forward by 1.0 mm.

To calculate the linear displacement of the actuator per encoder count:

512 x 67.49 = 34,555 encoder counts per revolution of the lead screw.

Linear displacement of the lead screw per encoder count is:

1.0 mm / 34,555 counts = 2.9 x 10^{-5} mm (29 nm).

6.2 Notes on Max Velocity and Acceleration/Deceleration Profile

Although the max velocity is quoted at 2.6 mm/s, it is possible to drive the Z9 series motor at speeds more than this figure. However, at higher velocities the controlled acceleration and deceleration profiles may be affected. If these controlled profiles are required, then the speed should be reduced to around 2.3 mm/s maximum.

Furthermore, the velocity ripple due to the PID loop in the KDC101 driver is greater when the unit is running at the higher velocities.

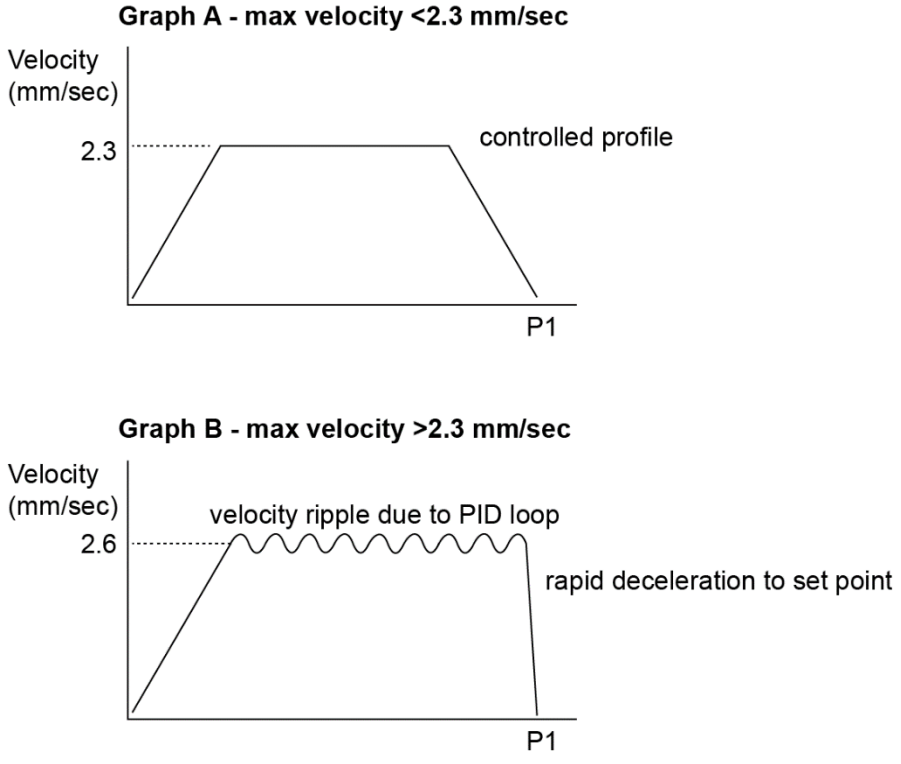

Figure 5 Effects of Higher Velocity on Acceleration/Deceleration Profile

Chapter 7 Certifications and Compliance

EU Declaration of Conformity

Manufacturer:

Address:

We hereby declare under our sole responsibility that:

Product:	**Z9 Series**
Product description:	**6, 12 & 25mm Motorized Linear Actuators (Vacuum-Compatible and Non-Vacuum Compatible)**

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:* 11/23/2023

Position: General Manager

CE

Chapter 8 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.

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