ELL15Z and ELL15ZK
Motorized Zero Aperture Iris

User Guide

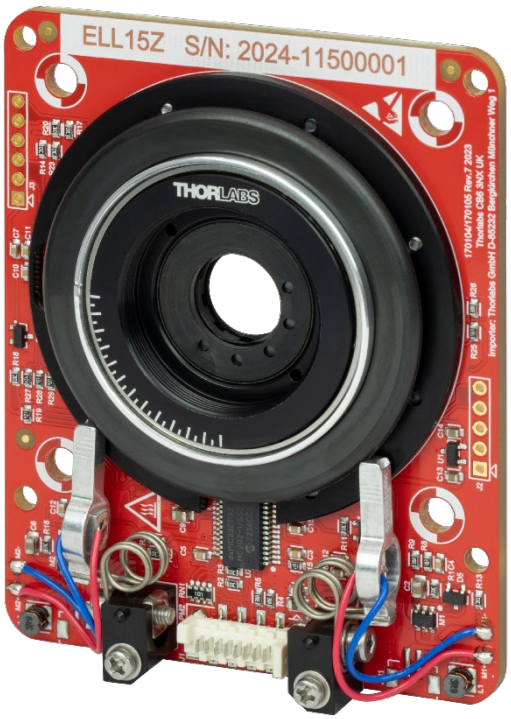


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Chapter 1 Introduction

1.1 Intended Use

The ELL15ZK Motorized Iris is a part of the Thorlabs series of resonant piezo motor circuits and bare modules for different applications. This motorized SM1 iris is post-mountable with a CP33B bracket and compatible with 30 mm and 60 mm cage systems and with SM1 threaded optics and tubes. It is for indoor use only. To ensure reliable operation, the unit should not be exposed to corrosive agents or excessive moisture, heat, or dust. 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.

The product may only be used in accordance with the instructions described in this manual. Any other use will invalidate the warranty.

1.2 Explanation of Safety Warnings

⚠CAUTION Caution indicates a hazard with a low level of risk that, if not avoided, could result in minor or moderate injury.

NOTICE Indicates information considered important but not hazard-related, such as possible damage to the product.

 Danger, Warning, or Caution

 Hot Surface

 ESD Component Caution

 The CE/UKCA markings on the product are the manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety, and environmental protection legislation.

 The symbol on the product, the accessories or packaging indicates that this device must not be treated as unsorted municipal waste but must be collected separately.

1.3 Description

This motorized iris is capable of closing down to a 0.0 mm diameter and is designed for applications requiring a 0.1 mm aperture resolution. This motor's resonant piezo design allows quick response times and precise positioning, making it especially effective in scanning applications.

The high-speed digital signal processing (DSP) architecture supports a multi-drop serial communication protocol, and a set of digital IO lines allows the user to manually control the movement and state by switching the lines between high (5 V) or low (0 V) voltage.

The ELL15Z has a central SM1 internal thread on both sides for mounting accessories like tubes or lenses. Ticks on the inner ring indicate an aperture position.

To achieve homing, a reflecting optical sensor (IR) for coarse positioning and a magnetic sensor for fine positioning are used in tandem. The Home Offset feature in the ELLO software allows the user to change the homing position.

The ELL15ZK evaluation kit includes a hand-held interface board for homing, manual jogging, positioning, and memorizing one custom position. The unit can also be driven remotely via PC-based software downloaded from www.thorlabs.com. The software download package includes a compatible USB driver and source code.

The module must be powered via an external 5 V power supply unit (PSU). A suitable PSU is supplied in the ELL15ZK iris kit or ELLC2 upgrade kit. The interface board has a DC Jack connector with dimensions of 6.3 mm OD (GND) and 2.1 mm ID (+5 V) for users who want to utilize a third-party PSU.

1.4 Technical Data

1.4.1 Specifications

Item #	ELL15Z and ELL15ZK
Performance	
Iris Aperture Range[a]	Ø0 - Ø11.5 mm
Minimum Lifetime	1 million Iris Movements
Recommended Duty Cycle[b]	40%
Maximum Closing Speed[c]	500 ms
Unidirectional Repeatability	±0.10 mm
Homing Repeatability	±0.10 mm
Backlash	0.20 mm
Encoder Resolution	1,000 counts/mm
Minimum Incremental Motion	0.01 mm
Minimum Motor Holding Torque (Both Motors Engaged)	0.01 N•m
Mechanical	
Limit Switches	Electronic and Mechanical
Mounting	30 mm Cage System: 4-40 Tapped Holes (4 Places) 60 mm Cage System: 3.0 mm Thru Holes (4 Places) Fixed Internal SM1 Threads (2 Places)
8-Conductor Ribbon Cable Length (Supplied)[d]	250 mm (9.8")
8-Conductor Ribbon Cable Length (Maximum)	3 m (9.8 ft)
Operating Temperature Range	15 to 40 °C (59 to 104 °F)
Dimensions (ELL15Z Only)	66.0 mm x 82.5 mm x 19.1 mm (2.60" x 3.25" x 0.75")
Weight (ELL15Z Only)	0.1 kg (0.22 lbs)
Electrical	
Rated Voltage	4.5 to 5.5 V
Typical Current Consumption During Movement	800 mA
Standby Current	50 mA
Motor Type	Elliptec Resonant Piezo

a. Under 1.0 mm aperture, the shape of the aperture is elliptical.
b. We recommend a duty cycle of 13 seconds running, followed by a 20-second cooling-down period. If the running time is shorter, then so is the required cool-down time.
c. Some natural variability in the maximum speed may be experienced. Max speed will increase with usage.

d. This is only supplied with the ELL15ZK kit.

1.4.2 Mechanical Drawings

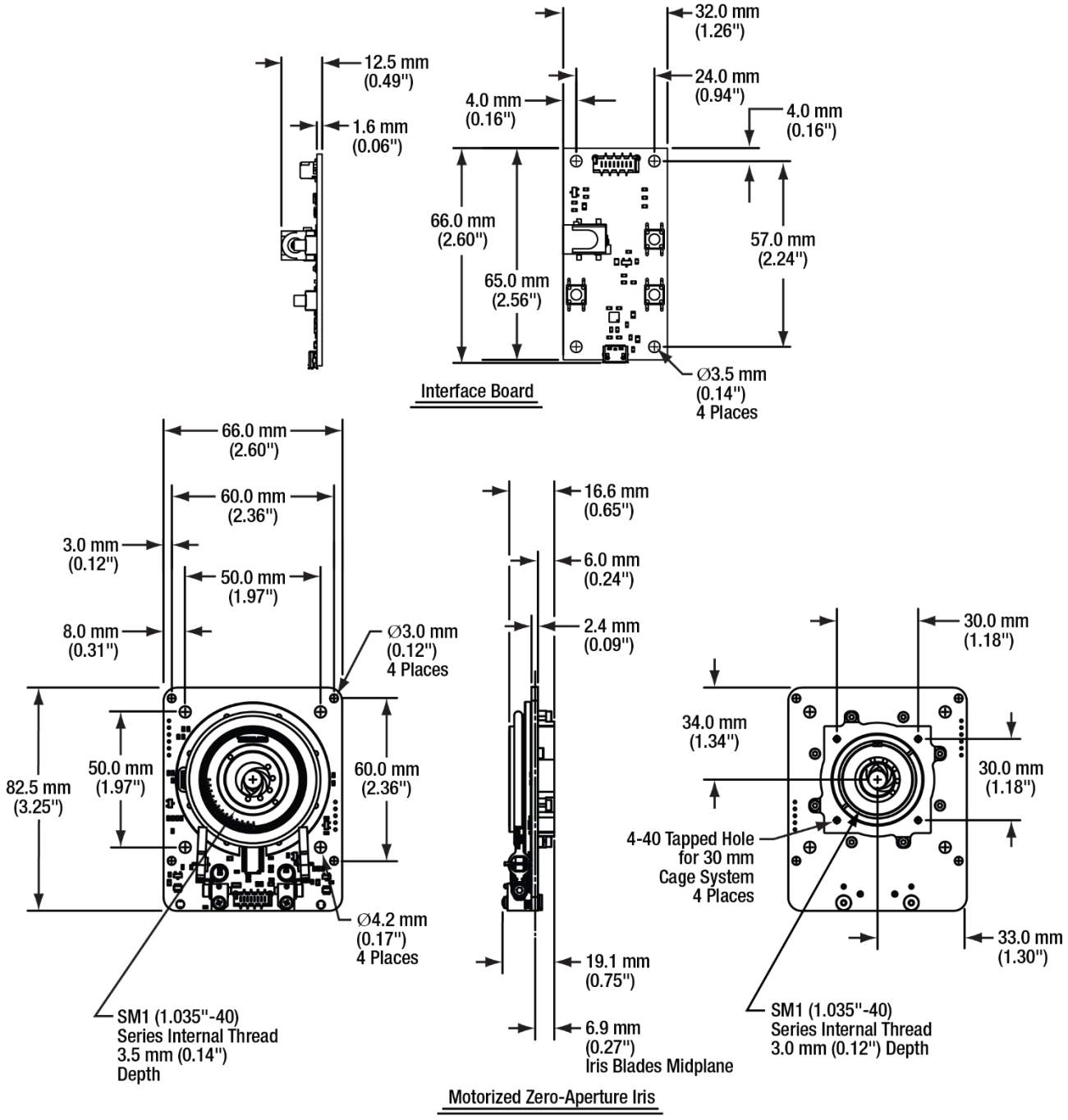


Figure 1 Mechanical Drawing for the Zero-Aperture Iris and Interface Board

1.5 Simplified Declaration of Conformity



EU Declaration of Conformity

Manufacturer: Thorlabs LTD

Address: 204 Lancaster Way, Ely, CB6 3NX

We hereby declare under our sole responsibility that:

Product: **ELL15Z and ELL15ZK**

Product description: **SM1 Motorized Zero Aperture Iris Kit**

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:* 8/6/2024

Position: General Manager

CE

Chapter 2 Safety

⚠WARNING

Risk of Electrical Shock
When connecting the iris to a PC, ensure that the PC is switched ON before connecting the stage to the USB port. Failure to do this could damage the PC.

If this equipment is used in a manner not specified by the manufacturer, its protection may be impaired, and excessive moisture may impair operation.

The equipment is susceptible to damage from electrostatic discharge. Anti-static precautions must be taken when handling the device, and suitable discharge appliances must be worn.

Fluid spillage, such as sample solutions, should be avoided. If spillage does occur, clean up immediately using absorbent tissue. Do not allow spilled fluid to enter the internal mechanism.

If the device is operated for a prolonged time, the motor housing may become hot. This does not affect motor operation but may cause discomfort if exposed skin is contacted.

Do not bend the Printed Circuit Board (PCB). A bending load of more than 500 g applied to the board may cause PCB to deform, which will degrade the controller's performance.

Do not expose the stage to magnetic fields, as this could affect the positioning and homing sensor operation. An external magnetic field near the sensor should be below +/- 5 mT.

Do not expose the stage to strong infrared light (e.g., direct sunlight), as this could interfere with the position sensor's operation.

During use, do not place the PCB directly onto electroconductive material, such as an optical tabletop or breadboard.

NOTICE

The device's home sensor relies on a 950 nm LED, which can leak from the device. This should be considered for environments that are especially sensitive to foreign light sources.

During installation and transport, the iris should be set to the Home position to prevent damage to the iris blades. Electrical shock or direct physical contact with the iris could damage the blades and internal mechanism of the device.



Although the module can tolerate up to 8 kV of air discharge, it must be treated as ESD sensitive device. When handling the device, anti-static precautions must be taken and suitable discharge appliances must be worn.
The ribbon cable connector is made of plastic and is not particularly robust. Do not use force when making connections. Avoid plugging and unplugging repeatedly or unnecessarily to prevent connector failure.
The following actions could damage the performance of the unit:

- Do not touch the motor track during installation and operation.
- Make sure to prevent the wires from contacting the motors, springs, or any other moving components while handling the stage.

Do not expose the stage to magnetic fields as this could affect the positioning and homing sensor operation.



If the unit is integrated inside an enclosure, it can become very hot under certain conditions. Avoid placing the enclosure close to a heat source.

If the device is operated over a prolonged time, the motor housing may become hot. This does not affect motor operation but may cause discomfort if contacted by exposed skin.

During normal operation each motor is protected with a time out of 3 seconds to avoid overheating. The recommended duty cycle is 40%.

Chapter 3 Installation

3.1 Warranty Information

This precision device is only serviceable if returned and properly packed into the complete original packaging including the complete shipment plus the cardboard insert that holds the enclosed devices. If necessary, ask for replacement packaging. Refer servicing to qualified personnel.

3.2 Packing List

Lists of items for ELL15Z:

- Motorized Zero-Aperture Iris
- Picoflex Connector

Lists of items for ELL15ZK:

- Motorized Zero-Aperture Iris
- 5 V Power Supply with Region-Specific Power Adapter
- Interface Board
- 8-Conductor 28 AWG Ribbon Cable, 250 mm long
- USB 2.0 Micro-B Cable, 1.5 m long
- PC-Based Software for Download

3.3 Mounting

The unit can be mounted directly into a 60 mm cage system using the Ø3.0 mm through holes in the PCB. (Use 4-40 3/8" setscrew to mount the 60 mm cage rods).

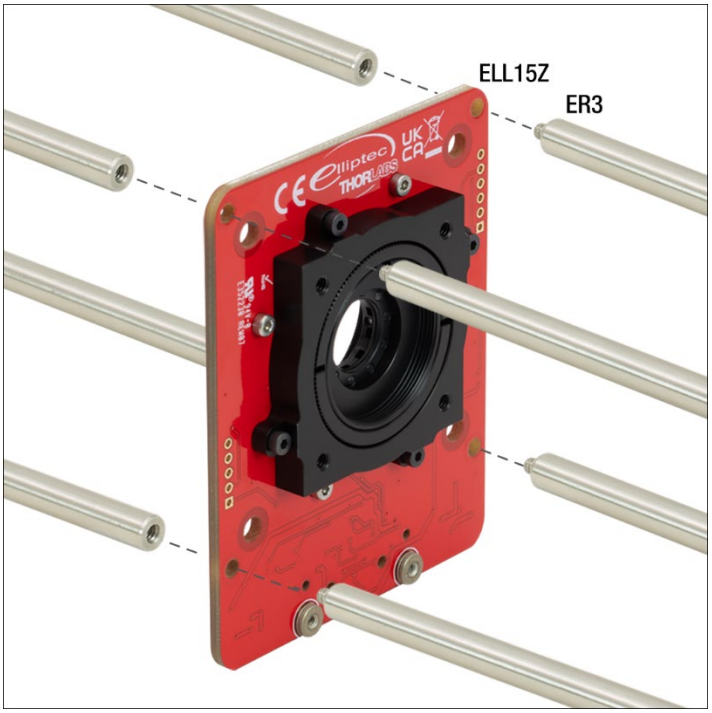


Figure 2 ELL15Z Mounted in a 60 mm Cage System

When combined with four SR-series posts, the iris can be fitted to our ER-series cage rods within a 30 mm cage system.

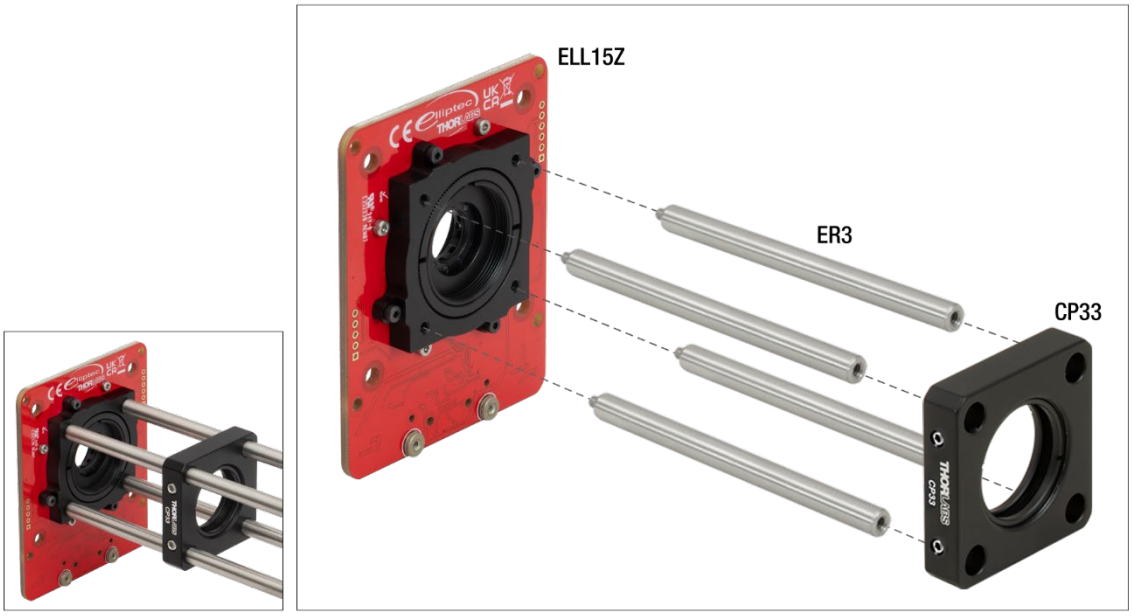


Figure 3 ELL15Z Mounted in a 30 mm Cage System



Figure 4 ELL15Z Post-Mounted with CP33B Bracket

Chapter 4 Operation

4.1 Getting Started

Perform the following:

1. Perform the mechanical installation as detailed in Mounting.
2. Turn on and boot up the host PC.
3. Connect the interface board to the stage if required.

NOTICE

The unit is easily damaged by connections with incorrect polarity. Pin 1 of the connector on the PCB is marked with an arrow (refer to Figure 5 and Figure 8) which should be adjacent to the red wire in the connecting cable.

4. Connect the stage to 5 V supply and switch 'ON' (A 5 V PSU is supplied with the ELL15ZK kit).

NOTICE

Boot up the PC before connecting the USB cable. Do not connect a powered ELL to a PC that is not active.

5. Connect the interface board to the PC with the supplied USB cable.
6. If required, wait for the drivers to be installed.

4.1.1 Homing

Homing is achieved using a combination of a reflecting optical sensor (IR) for coarse positioning, then a magnetic sensor for fine positioning (the magnetic sensor is also used for positioning during subsequent moves). Using the ELLO software, the user can modify the homing position using the home offset.

NOTICE

The home sensor of the device relies on a 950 nm LED which can leak from the device. This should be taken into consideration for environments that are especially sensitive to foreign light sources.

At startup, the device's default setting is auto-homing. This function can be deactivated using the command indicated in the **Communications Protocol Manual.**

4.2 Controlling the Iris

The iris can be controlled in the following ways:

1. PC runs the Elliptec software with the interface board.
2. Develop a custom application using the messages stated in the communications protocol document.
3. Apply voltages into Connector J1’s digital lines. Refer to Figure 8. It provides jogging and homing functionality.
4. Manually rotating the iris to reach a desired aperture.

To improve repeatability for a given position, absolute movements should be made from an aperture greater than 1 mm to the target position.

NOTICE

In all modes, the iris aperture is requested and displayed from 0.0 to 11.5 mm. The aperture cannot be driven past 11.5 mm or 0.0 mm. The iris is limited mechanically and by the encoder. An error message appears if a request is outside the acceptable range.

The black motor track should be cleaned when turning the aperture manually, before actuating the stage with motors again.

4.2.1 Interface Board

The stage will move when the unit powers up and it will check the sensors before looking for the home position At startup, the device's default setting is auto-homing. This function can be deactivated using the command indicated in the Communication Protocol Manual. The stage must be homed before performing any jog moves.

The interface board supplied with ELL15ZK Evaluation Kit and ELLC2 features three buttons (marked JOG, FW and BW) that allow control of the iris aperture position. Button JOG (hold) + FW (open) can be used to increase the aperture up to 11.5 mm and JOG (hold) + BW (close)to close the aperture. The interface board also connects to the host PC and to the external 5 V power supply. The external PSU connector allows the unit to be used in the absence of a PC, with control being provided via the interface board buttons.

The PWR LED (LED1) is lit green when power is applied to the unit. The INM LED (LED2) is lit red when the device being driven is in motion. A blinking INM LED (LED2) means that the memory function has been activated.

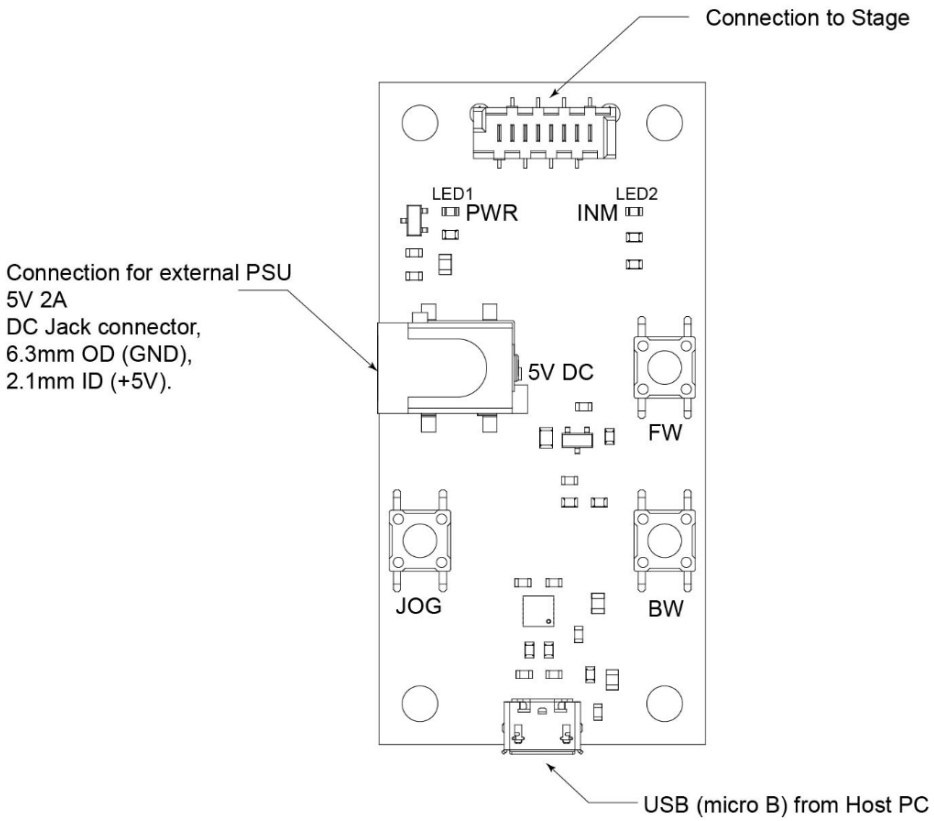


Figure 5 Interface Board Details

1. Home the stage by pressing the BW (backward) button.
2. To close the iris (jog backward) press and hold JOG and then press BW. The default jog step value is 0.5 mm aperture. The jog step size can be changed in the ELLO software, refer to the help file in the installation folder for details.
3. To open the iris (jog forward) press and hold JOG and then press FW (forward).
4. One custom aperture setting can be saved using the interface board.
5. Press and hold FW until the red LED on the interface blinks 3 times along with making 3 beeps.
6. The custom aperture can be recalled by pressing FW briefly. The red LED will blink once. (The custom setting will only remain saved while the device is powered). If a custom position has not yet been saved, pressing the FW on the interface board will, by default, open the iris to 11.5 mm aperture.
7. The saved position can be overwritten by repeating step 5.

4.2.2 Software Control

When connected to the host PC, the iris can be controlled remotely, via the Elliptec software.

1. Download the ELLO software from the downloads section at **www.thorlabs.com** . Double click the saved .exe file and follow the on-screen instructions.
2. Connect the interface board to the unit.
3. Connect the interface board to the 5 V Power Supply and switch on.
4. Connect the interface board to the PC USB port and wait for the drivers to be installed.
5. Run the ELLO software.

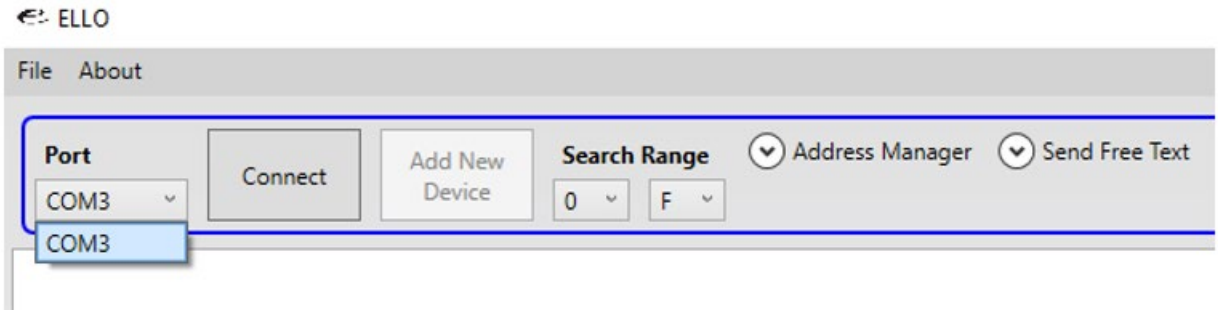


Figure 6 Software Control Main Window

6. In the top left of the GUI panel displayed, select the COM port to which the device is connected, and click 'Connect'. The software will search the comms bus and enumerate the device.
7. By default, the unit is set to perform auto-homing. This function can be deactivated using the command 'ah' indicated in the communication protocol manual. When auto-homing is deactivated, the unit must be homed before using the 'Home' button.
8. The GUI and device are now ready for use. Refer the help file supplied with the software for more information.

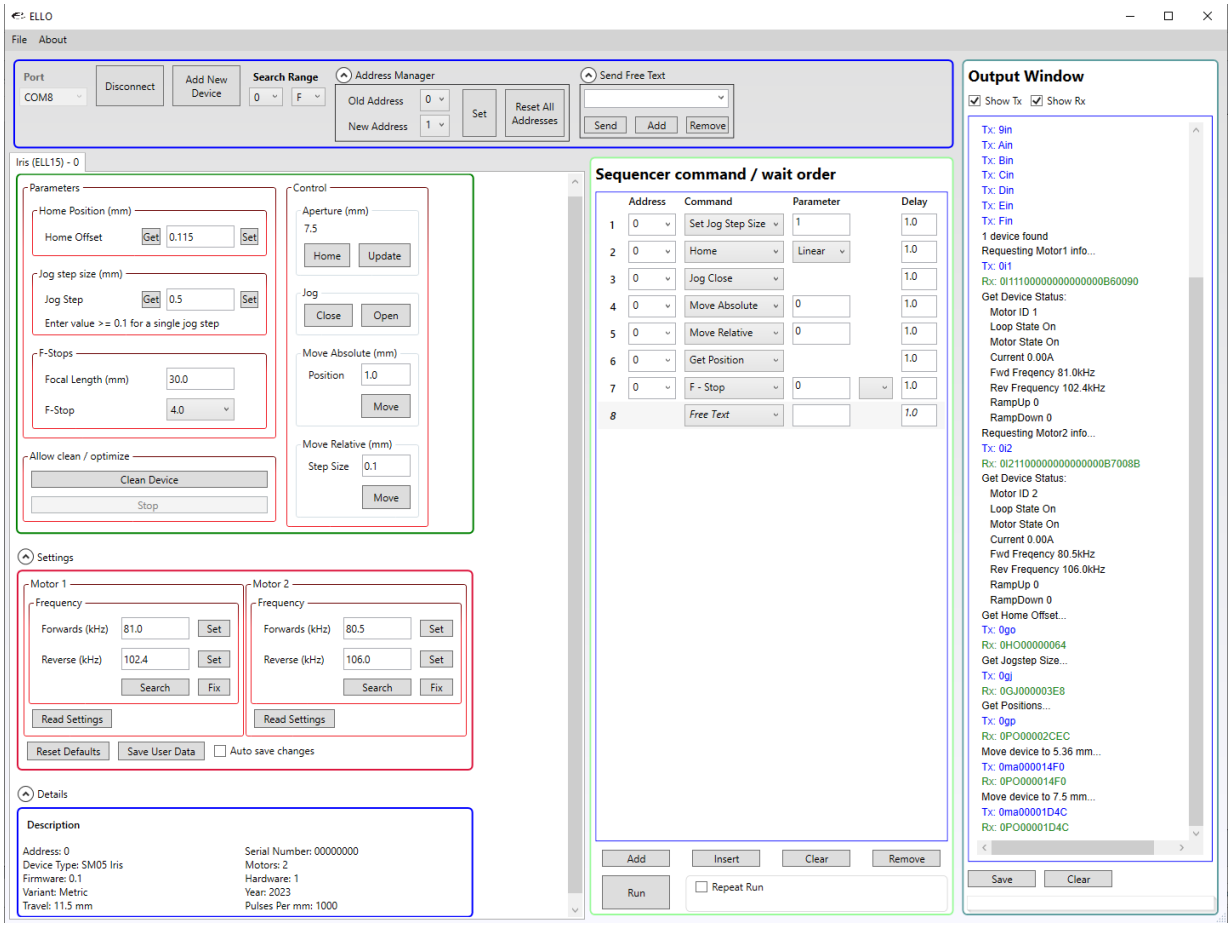


Figure 7 Output Window

F-Stop Function:

The iris can be set automatically to a F-Stop position using the F-Stop function in ELLO.

- Set the focal length of the optical system manually.

- Choose the F-stop using the drop-down menu (only feasible F-Stop values are shown).

  (There is no automatic check in the sequencer. All F-Stops are shown).

- The unit will move to the desired position.

4.2.3 Communications Protocol

Custom move applications can be written in languages such as C# and C++.

The communication bus allows multi-drop communication with speeds at 9600 baud, 8-bit data length, 1 stop bit, no parity.

Protocol data is sent in ASCII HEX format, while module addresses and commands are mnemonic character (no package length is sent). Modules are addressable (default address is “0”) and addresses can be changed and/or saved using a set of commands. Lower case commands are sent by the user while upper case commands are replies by the module.

Please refer to the Communications Protocol manual for more details about commands and data packet formats.

4.2.4 Connecting Multiple Devices

When a device is first connected to the PC, it is assigned the default address '0'. The software can run multiple devices; however, before more than one device can be recognized, each device must be assigned a unique address. See below for a brief overview; detailed instructions are contained in the help file supplied with the software.

1. Connect the first unit to the PC USB port, wait for the frequency search to finish, then run the ELLO software and load the unit.
2. Change the address of the first device in the Address Manager (refer to Figure 7) and press “Set”.
3. Save the address of the unit (using save user, command “us”) or click “Save User Data” in the Settings section.
4. Connect the next device to the ELLB Control Bus Distributor (refer user manual on **www.thorlabs.com**) or to a daisy chain (refer to Figure 12).
5. Change the address of the second device and repeat the above steps for additional units.
6. Multiple devices can be controlled individually, either via the ELLO software or by a third-party application written using the messages detailed in the protocol document. Control via the interface board is applied to all devices simultaneously. While using several units, sufficient power supplies must be used with maximum 4.0 A.

NOTICE If the changes are not saved the unit will revert to the previous settings.

4.2.5 Controlling the Iris Without the Interface Board

In the absence of the interface board, the iris is controlled via digital lines: Forward, Backward and Jog/Mode (J1 pins 7, 6 and 5) by shorting the corresponding line to ground (pin 1).

When the stage is moving, the open drain IN MOTION digital line (pin 4) is driven low (active low) to confirm movement. The IN MOTION line goes high (inactive) when the move is completed or the maximum time-out (3 seconds) is reached.

NOTICE

Do not exceed the voltage and current ratings stated in Figure 8.
Do not reverse polarity.

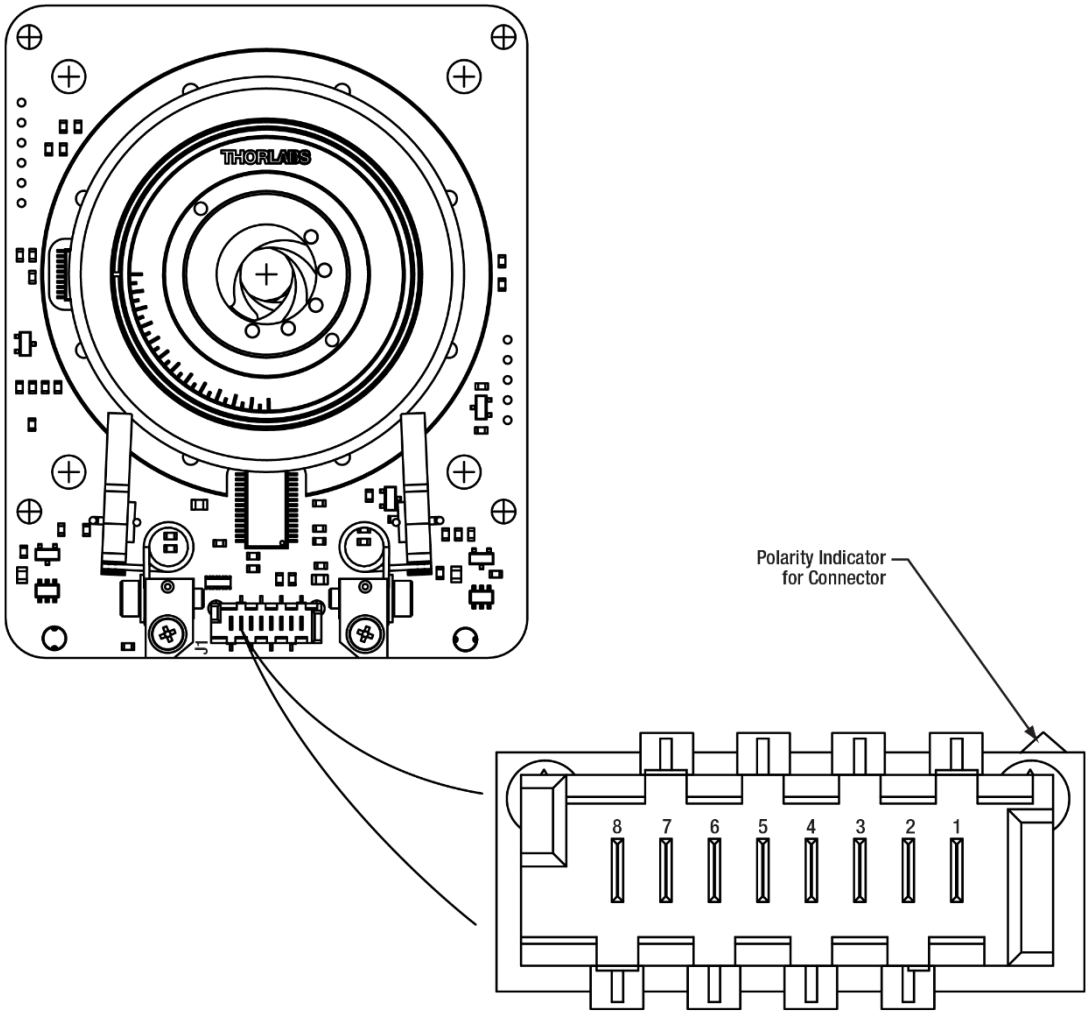


Figure 8 Connector J1 Pin Out Details

Pin	Type	Function
1	PWR	Ground
2	OUT	ODTX - Open Drain, Transmit 3.3 V TTL RS232
3	IN	RX Receive - 3.3 V TTL RS232
4	OUT	In Motion, Open Drain, Active Low, Max 5 mA
5	IN	JOG/Mode, Active Low, Max 5 V
6	IN	BW Backward, Active Low, Max 5 V
7	IN	FW Forward, Active Low, Max 5 V
8	PWR	VCC +5 V ±10%; 800 mA

Connector model number MOLEX 90814-0808 Farnell order code 1518211

Mating connector model number MOLEX 90327-0308 Farnell order code 673160

4.3 Frequency Search

Due to load, build tolerances and other mechanical variances, the default resonating frequency of a particular motor may not be that which delivers best performance. A frequency search can be performed using the Main GUI Settings panel in the ELLO software, or by using the serial communication line (SEARCHFREQ_MOTORX message), which offers a way to optimize the operating frequencies for backward and forward movement.

This search can also be performed manually by restoring the factory settings – refer to 4.5 below.

4.4 Periodic Cycling of Devices Over Full Range of Travel

Periodically, devices should be moved over the full range of travel, from one end to the other. This will minimize the buildup of debris on the track and will prevent the motors digging a groove over the most used area of contact. The Clean Mechanics function in the ELLO software or 'cm' command can be used to perform this task. For continuous operation, it is advised to execute Clean Mechanics weekly.

4.5 Restoring Factory Settings

Factory settings can be restored during the startup (calibration) test as follows:

1. Disconnect the USB cable and remove power from the unit.
2. Press and hold the BW button (do not release until step 5).
3. POWER UP with a 5 V power supply.
4. WAIT for red LED to switch on.
5. Release BW. The unit will reboot and load the default factory values.

4.6 Simultaneous Movement of Devices

If more than one device is connected to the comms bus, the movement of the devices can be synchronized. This can be achieved either by using the interface board, or by software. Refer the Communications Protocol manual for details on how to use the 'ga' message to synchronize moves. If using the interface board, synchronized movement is hard wired, so pressing the JOG, FW or BW buttons will move all devices if multiple devices are connected.

Chapter 5 Maintenance

The equipment is susceptible to damage from electrostatic discharge. When handling the device, anti-static precautions must be taken, and suitable discharge appliances must be worn.

The stage and interface board are robust to general handling. To ensure reliable operation, keep the surface of the plastic track contacted by the motors free of oils, dirt, and dust. It is not necessary to wear gloves while handling the unit, but avoid touching the track to keep it free of oils from fingerprints. If it is necessary to clean the track, it may be wiped with isopropyl alcohol or mineral spirits (white spirit). Do not use acetone, as this solvent will damage the plastic track.

Chapter 6 Troubleshooting and Repair

6.1 Frequently Asked Questions

Iris moving slowly or times out.
Check that the track is not contaminated. Do not touch the moving parts (motor, track and moving world) to avoid grease contamination.

Check the powering order (refer to section **Error! Reference source not found.**) and ensure the recommended power supply is used as the power supply is critical (refer to **Error! Reference source not found.**). Ensure that the power supply is plugged in before the USB cable.

Iris not moving.
Check power supply lines ratings (polarity, voltage drop or range, available current) or reduce cable length.

Check module is not in boot loader mode (power cycle the module to exit boot loader). Current consumption must be higher than 36 mA at 5 V.

Make sure the device address is entered correctly if using ELLO or custom software.

Make sure that the unit is not mechanically blocked.

Iris does not complete homing commands.
Power cycle the unit.

Perform a frequency search on both motors.

Reset home offset to 0.

Iris switching time increased / max load decreased.
Check power supply voltage provided on J1 connector, increase voltage within specified limits if voltage drop along cable goes below 5 V during system operation.

Clean the moving surfaces. Do not touch the moving parts (motor, track and moving world) to avoid grease contamination.

Temperature change may affect the device performance. The software's frequency search function will make necessary adjustments (required current could reach 1.2 A during frequency search, use an additional 5 V 2A power supply and a USB connection).

Integrators should search for optimal frequency on every power up sequence (commands “s1”, “s2” refer to the Communications Protocol Manual).

How do I restore the factory (default) settings?
Factory settings can be restored during initialization (refer to section **Error! Reference source not found.**).

The unit is not responding after powering up.

If the user holds down the JOG, BW and FW lines to ground and initiates the power sequence, the module will enter into a boot loader (firmware update) mode.

Power cycle the unit again without pressing the 3 buttons at the same time to exit from the boot loader mode.

The device is not responding during cleaning.

This is normal.

The cleaning routines block a device and the associated communication bus for several minutes. When routine is initiated, the bus is unavailable until the routine is completed, and the device replies busy ‘0GS09’ to all commands except the stop command ‘0st’ (for a unit at address 0). The stop request can take up to 5 seconds to abort the operation.

During this routine, the unit may increase in temperature by several degrees. Consecutive cleaning routines should be avoided due to the inherent temperature increase.

After cleaning, allow a 20 min cool down period before use.

Is the device suitable for continuous operation?

Users should aim for a duty cycle of less or equal to 40% wherever possible, and never exceed a duty cycle of 60% for continuous high frequency operation.

What is the typical product lifetime?

ELL15Z product lifetime is restricted by the wearing of moving surfaces and the motor contact as motion is started (due to resonance build up) and performed (due to friction). Lifetime will depend on several factors (e.g., high duty cycles, number of frequency searches, number of homing operations, load etc.) and users must consider all these factors when considering lifetime. For example, homing often requires more travel than a simple motion, and a frequency search may not generate any motion at all, but still energizes the motors fully.

A typical lifetime is 1 million iris movements.

6.2 Notes on Making a Picoflex Cable for Use when Daisy Chaining Devices

The multi-drop communications bus offers the option of connecting the stage to a hybrid network of up to 16 Elliptec resonant motor products and controlling the connected units with a device such as a microprocessor. When multiple units are connected to the same interface board, all can be controlled simultaneously using either the software or the buttons on the interface board.

When making a cable to operate multiple devices it is important to observe the correct pin orientation. The following procedure offers guidance in making such a cable.

1. Gather the parts required.

   a) Ribbon cable 3M 3365/08-100 (Farnell 2064465xxxxx).

   b) Female crimped connectors as required – model number MOLEX 90327-0308 (Farnell order code 673160) (Qty 1 female connector above is shipped with each ELL15Z).

   c) Suitable screwdriver and scissors or another cutting tool.

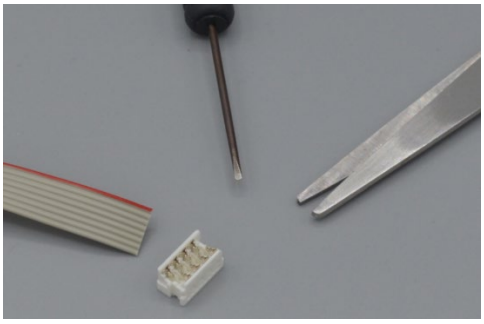


Figure 9 Suitable Tools

2. Orientate the first connector to correctly mate with the connector on the stage, then arrange the ribbon cable as shown with the red wire aligned with pin 1 (identified on the PCB by a small triangle shown in the yellow circle in Figure 10). Slide the connector onto the ribbon cable as shown.

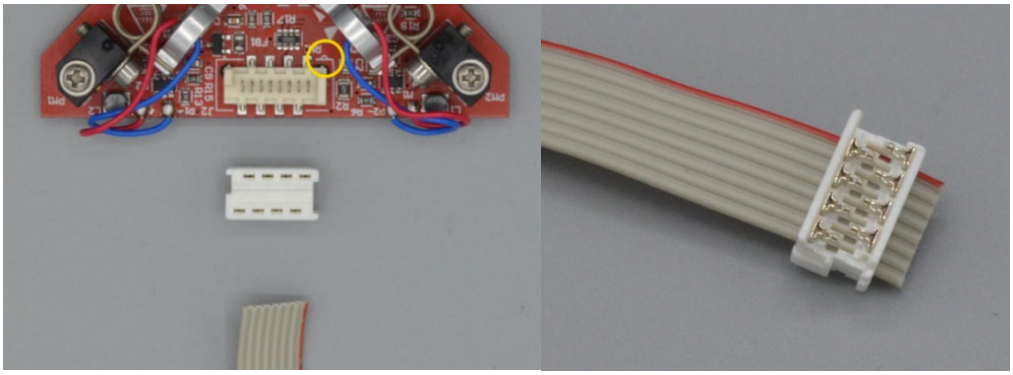


Figure 10 Slide the Connectors onto the Ribbon Cable

3. Using a screwdriver or other suitable tool, push down the crimp of each pin to make connection with the ribbon cable.

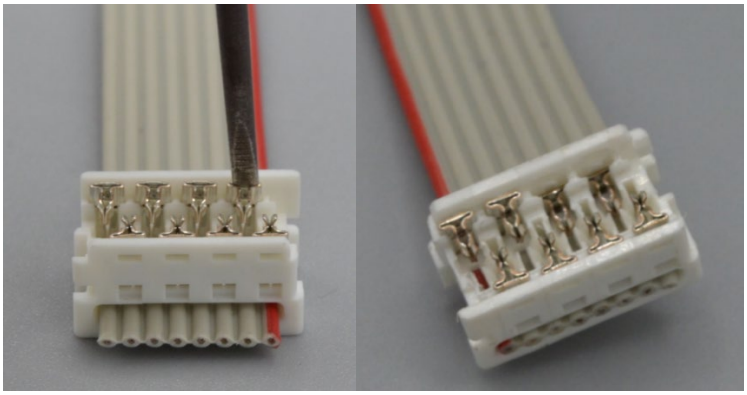


Figure 11 Push Down Crimp

4. If other connectors are required, they should be fitted at this point. Slide each connector onto the cable, paying attention to the orientation as shown below, then crimp as detailed in step (3).

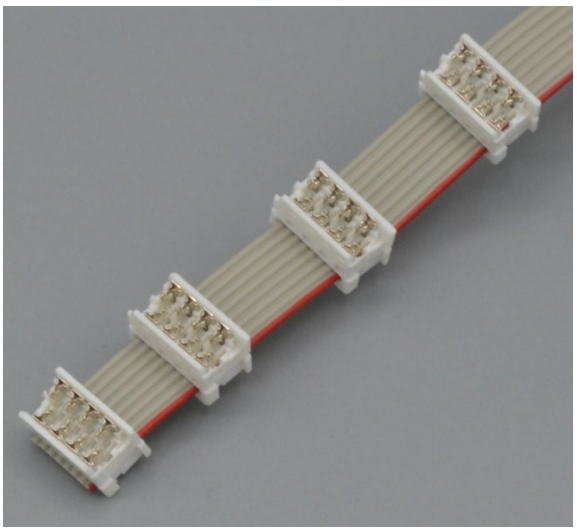


Figure 12 Slide Connector

5. Fit the terminating connector which will mate with the interface board, taking care to align the cable red wire with pin 1 as detailed in step (2).

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.



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