

POF65
Reference & Maintenance Manual



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1) Overview

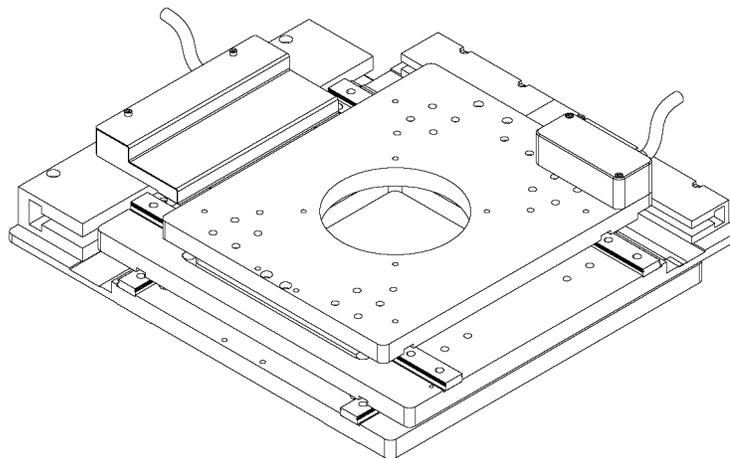
This user guide is designed to help you install and maintain your custom linear positioning stage application. Follow these steps to ensure correct stage installation and maximum stage life:

- Step 1* Review this entire user manual. Become familiar with all installation procedures prior to integrating your system.
- Step 2* Review the safety summary to develop an understanding of standard safety practices when installing and operating automated equipment.
- Step 3* Familiarize yourself with the conventions summary.
- Step 4* Review installation procedures. For best results, follow these procedures carefully.
- Step 5* Once you successfully complete all the installation procedures, you will be ready to install and operate your stage.
- Step 6* Review preventive maintenance section for proper lubrication schedule.

2) Introduction – About the XY Stage

The POF65 is a XY linear stage with large aperture. It incorporates two direct drive brushless linear motors and high resolution linear encoders in a low profile package. A home switch and index pulse on each encoder are used for determining a repeatable home position. Forward and reverse limit switches are encountered at the respective ends of each axis of travel.

| | |
|---------------------------|---|
| Travel | Upper axis = $\pm 65\text{mm}$ Lower axis = $\pm 65\text{mm}$ |
| Payload | 5kg |
| Orientation | Horizontal |
| Accuracy | $\pm 4\mu\text{m}$ full travel (slope corrected) |
| Encoder Resolution | 0.1 μm , 0.2 μm , or 1 μm |
| Repeatability | $\pm 0.5\mu\text{m}$, $\pm 0.7\mu\text{m}$, $\pm 1\mu\text{m}$ (resolution dependent) |
| Straightness | +/- 2.5 microns |
| Flatness | +/- 2.5 microns |
| Orthogonality | 10 arc-sec |
| Rated speed | 600mm/s |
| Motor type | Linear motor |
| Limit Sensors | 2 Normally Closed sensors |
| Home Sensor | Yes, transition in center of travel |
| Encoder type | linear metal tape scale |
| Cleanroom class | 10,000 |
| Finish | Black Anodize |
| Height | 65 mm |
| Width | 368 x 407 mm |
| Weight | $\approx 17\text{ kg}$ |



3) Personal Safety

Please review before installing your positioning stage

Observe common industrial safety practices when installing and operating automated equipment.

- Have power connections made by qualified personnel.
- Keep fingers and other items out of any opening in the stage while it is in operation since injury or damage may result.
- Provide a safe access route and adequate room for servicing.
- Perform the recommended periodic maintenance described in this document.
- Verify that the work envelope is free of obstructions before the positioning stage is powered.
- Insure that you have the feedback wired properly to the controller before applying power to the positioning stage. Improper feedback connections can cause a motor run-away condition that has the potential to damage the stage and injure an operator.
- Only trained operators of the positioning stage should be allowed near the work environment.
- If so equipped, identify emergency stop circuits and actuators in the workcell.
- Note the places in the workcell where pinch points occur, and provide adequate safety clearance or safety curtain.
- Never operate the motor in a location that could be splashed by water, exposed to corrosive or flammable gases or is near combustible substances since this may cause an electric shock, fire or malfunction.
- Never touch the motor, driver, or peripheral devices when the power is on or immediately after the power is turned off. The high temperature of these parts may cause burns.

4) Stage & Manual Conventions

4.1) Direction of Motion

The positive direction of motion for both axes is defined as shown in Figure 4-1. A positive direction of motion also signifies the encoder count is increasing. The forward limit switches are encountered just before the end of travel in the forward direction. The reverse limit operates similarly in the reverse direction.

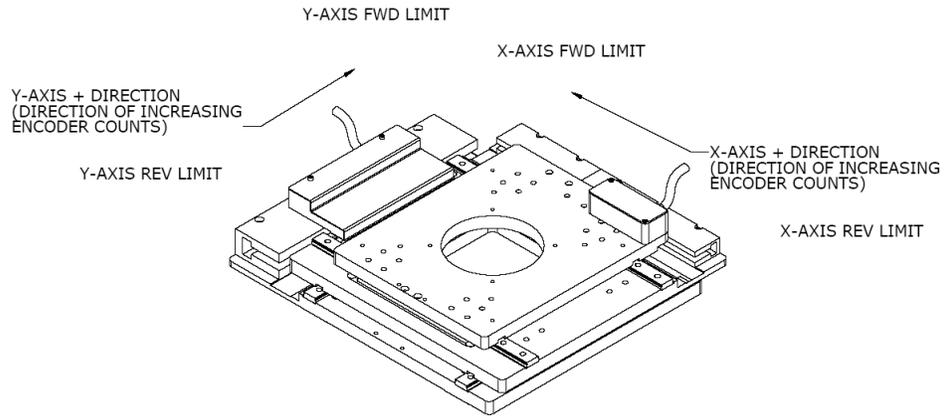


Figure 4-1: Positive direction convention

4.2) Units of Measure

Primatics uses the metric system for all specifications and dimensions. All linear dimensions are specified in millimeters. Accuracy, repeatability, resolution, flatness and straightness for the XY stage is specified in microns. Load capacity is specified in kilograms and moment capacity is given in Newton-meters. All torque specifications are given in Newton-meters. Thrust specifications are given in Newtons.

The following table gives some common conversions into English units:

| Metric Unit | English Unit |
|--|----------------|
| 1 Kilogram equals | 0.0685 slug* |
| 1 micron equals | 0.0000394 inch |
| 1 millimeter equals | 0.0394 inch |
| 1 Newton-meter equals | 8.85 in-lbs |
| 1 Newton equals | 0.2248 lbs |
| *1 Kg has a weight of 2.205 lb when $g = 9.8 \text{ m} / \text{s}^2$ | |
| *1 Kg has a weight of 2.205 lb when $g = 9.8 \text{ m} / \text{s}^2$ | |

5) Installation Preparations

This section outlines installation environments. Unfavorable installation conditions may cause electric shock, fire, or breakdown. Certain breakdown situations or malfunctions in particular may lead to serious injury or other consequences. Assure that the unit is used under the following installation conditions:

- Indoors, free from being splashed by water
- No corrosive or inflammable gases present
- Well ventilated place, minimum level of dust or waste
- An environmental temperature range between 0-40°C, and humidity between 20-80% RH (location with no condensation) Note - These values show the range in which operation can be carried out safely, but not the environmental range in which stages accuracy can be guaranteed. Stage accuracy can be guaranteed at 20°C +/- 1°C.
- Location should not be affected by electrical noise.
- Location should be where inspection and cleaning can be performed without difficulty.

5.1) Linear Motors

Linear motors have large magnetic flux that can draw ferrous metals inside them from large distances, destroy magnetic media, and disrupt some electronic circuits. Materials attracted to the magnets can pinch fingers and cause injury. Great care must be taken when operating less than 25mm from the surface of the motor.

In addition, braking is difficult for linear motors making them inappropriate for many vertical applications. Make sure no load is attached to the linear motor stage when stage is first connected to the electronics. Linear motors can generate large accelerations and improper wiring to the control system can result in a high-speed crash.

5.2) Heat and Humidity

All positioning stages are assembled and tested at 20°C. Any stage calibrations are also performed at 20°C. For optimum accuracy the ambient temperature should be maintained at 20°C. Deviations from this nominal temperature may result in degraded accuracy performance.

Large thermal gradients in the interior of the stage can result from motor heat created by high acceleration moves. Care must be taken to limit the duty cycle of the linear motor to maintain stage performance. Airflow across the motor will help minimize thermal expansion effects and increase the allowable duty cycle. This can be accomplished with the POF65 fan kit part number 0-1175-0060.

5.3) Contamination

Applications in dirty or dusty environments require the electrical, optical and mechanical components to be protected. The XY series is intended for clean environments free from small particulates and fluids.

5.4) Electrical Noise

Electrical noise is the corruption of signals carried over low voltage wires. Encoder signals can be corrupted resulting in spurious encoder counts thus causing the stage to drift. Grounding, shielding, and spatial separation are all countermeasures to reduce the influences of electrical noise on performance. You can minimize the potential for electrical noise by observing the following installation precautions:

- Physically separate low voltage conductors from those carrying high voltage.
- Ensure that all components are properly grounded.
- Ensure that all wiring is properly shielded.

6) Installation Procedures

6.1) Tools you will need

The XY linear positioning stage uses eight M6x18mm socket-head cap screws for the base plate mounting. The carriage plate has eight M4x0.7 and four M5x0.8 tapped holes for customer mounting. A 4mm hex key is required to remove the red shipping bracket.

6.2) Unpacking

Carefully remove the stage from its shipping crate and inspect it for evidence of shipping damage. Report any damage immediately to your authorized dealer. Remove the red shipping clamp from the stage.

Improper handling of the stage may degrade its performance. Follow these guidelines when handling and mounting your stage.

- 1) Do not drop the stage onto its mounting surface. Place the stage gently on the mounting surface. Impact loads can cause high spots on mounting surfaces, misalignment of drive components and warping of the base.
- 2) Do not drill holes into the stage. If additional holes are necessary, contact your local distributor.
- 3) Lift the stage by its base structure only. Do not lift by the motor drive assembly.
- 4) Stage disassembly and alteration, unless specified otherwise, may void warranty.
- 5) Remove the red shipping bracket prior to use.

6.3) Mounting surface preparation

The characteristics of the surface the positioning stage is mounted to will have a large effect on system performance. An accurate and flat positioning stage will conform to the shape of its mounting surface, therefore a flat mounting surface is required. The flatness and straightness specifications can be affected under large loads. For best results in maintaining stage specifications we suggest the following:

- 1) Use a laboratory Grade AA granite surface plate
- 2) Before mounting stage, inspect for burrs or dings on the stage mounting surfaces
- 3) Clean all mounting surfaces with acetone

In the absence of a granite surface plate, we recommend a base plate made of the same material as the base of the stage. A mounting surface constructed out of a material different from the stage base material can introduce warping in the stage in the presence of a thermal gradient. The surface flatness should match the requirements of the application; a good starting point is to have the mounting surface flat to less than 5-8 μ m.

6.4) Mounting the XY stage

The XY stage has eight mounting holes that can be accessed by moving the X-Axis and Y-axis to expose 4 access holes. Figure 6-1 shows the location of these access holes. When tightening the mounting screws, tighten the center screws first, then radiate outwards.

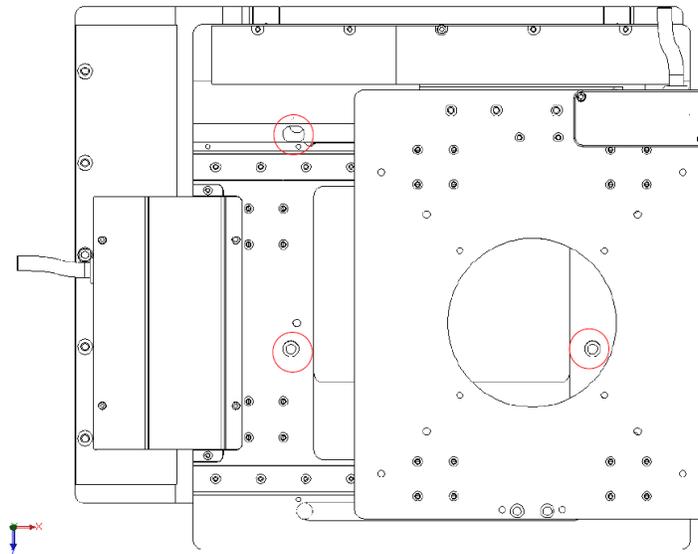


Figure 6-1: Mounting Hole Access Locations\
(4th access hole not shown)

6.5) Electrical Connections

Electrical connections to the stage are through single 28 pin connector as shown in Table 6-1.

Table 6-1: Electrical Connector, 28pin panel mount

| Pin | Function |
|-----|---|
| A | Motor A |
| B | Motor B |
| C | Motor C |
| D | Motor Shield |
| E | Encoder 5V – power for encoder |
| F | Encoder A+ output |
| G | Encoder A- output |
| H | Encoder B+ output |
| J | Encoder B- output |
| K | Encoder Shield |
| L | 12 - 24VDC - for limit & home |
| M | DCCOM |
| N | Home |
| P | Brake release output (24VDC) for optional brake |
| R | Brake return for optional brake |
| S | Stage Base |
| T | Hall V+ |
| U | Hall V- |
| V | Encoder 0V |
| W | Encoder Index + |
| X | Encoder Index - |
| Y | Forward Limit Switch |
| Z | Reverse Limit Switch |
| a | Signal Shield |
| b | Hall A |
| c | Hall B |
| d | Temperature monitor – connect to DC Common for temperature OK |
| e | Hall C |



6.5.1) Motor Commutation Diagram

The following diagram shows the motor signal timing for the Servo Motor option

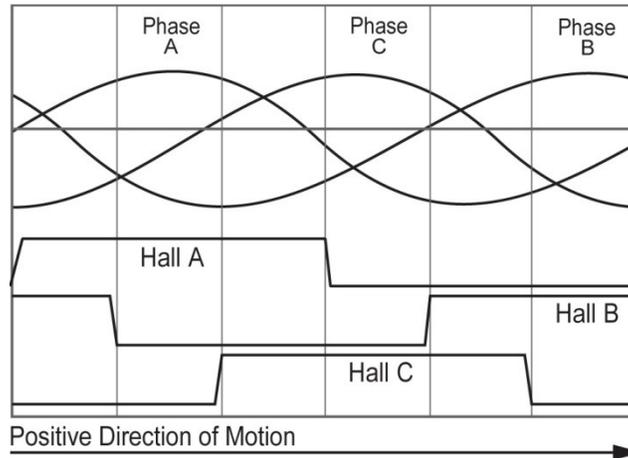


Figure 6-2: Motor commutation chart

6.5.2) Encoder Timing Diagram

The following diagram shows the encoder signal timing for the Encoder option

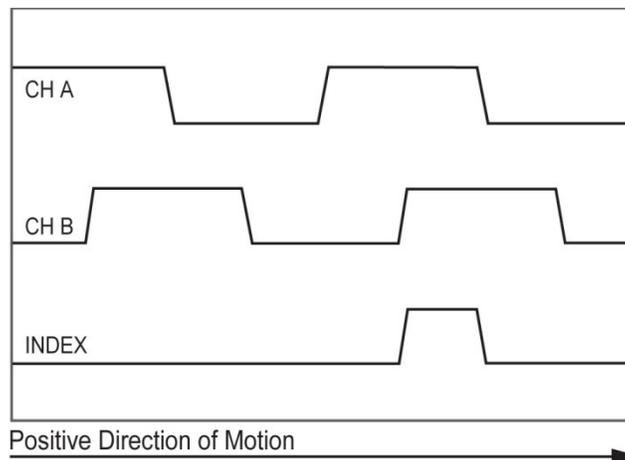


Figure 6-3: Timing diagram for the encoder signals

6.5.3) Encoder Index

The linear encoder reference signal (index) is located at the nominal center of travel and is output in both directions but repeatability is guaranteed only in one phased direction. The reference mark output is synchronized with the incremental channels, giving it a unit of resolution pulse width. The encoder index is phased in the negative direction. Therefore, during a homing routine, the stage should travel to the home vane transition, and then start searching for the index in the minus direction. It is recommended that the

homing procedure be performed as part of any power-up sequence to ensure the correct datum position is recorded.

6.5.4) Motor Parameters

| | Y-axis (Lower) | X-axis (Upper) |
|--|---------------------------|---------------------------|
| Primatics P/N | 9-0044-0038 | 9-0044-0025 |
| Continuous Force (N) ¹ | 48 | 16 |
| Continuous Current (Amps _{rms}) ¹ | 2.0 | 1.2 |
| Peak Force (N) ² | 220 | 83 |
| Peak Current (Amps _{rms}) ² | 8.9 | 6.3 |
| Force Constant (N/Amps _{rms}) | 24.7 | 13.2 |
| Back EMF Constant (V/m/sec) | 24.7 | 13.2 |
| Resistance (Ω) | 4.5 | 6.4 |
| Inductance (mH) | 6 | 4 |
| Magnetic Pitch (mm) | 60.96 | 60.96 |
| Motor Thermal Resistance (C/W) | 1.4 | 2.6 |
| Stage Thermal Resistance (C/W) | 0.75 | 0.75 |

¹ At 25°C temperature rise ² At 10% duty cycle and 1 second maximum

6.6) Home and Limit Sensors

The home & limit switches uses reflective sensors located in the stage. A white reflective strip with black masking is viewed with these reflective sensors. One half of this strip is covered with a black mask. When the sensor is over the white area, the output signal conducts current and closes the home switch. When the sensor is over the black, the switch is open. The home switch is fixed at the factory and cannot be adjusted. End of travel optical limit switches trigger when the axis is past its nominal travel from center. A reference index on the encoder is located at the nominal center of travel. The limit switches and encoder index are fixed at the factory and cannot be adjusted. See Figures 6-4, & 6-5 for clarification.

Each XY stage includes Forward and Reverse Limit sensors and a Home sensor. Figure 6-4 shows the equivalent schematic for these switches.

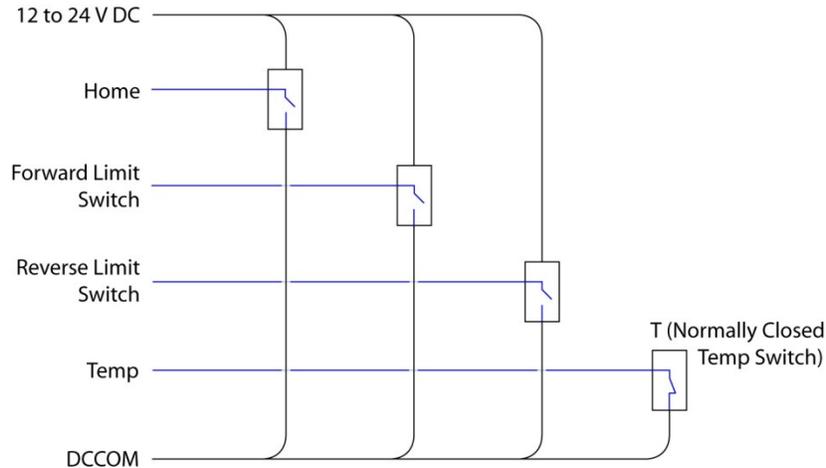


Figure 6-4: Equivalent Limit, Home, and Temp circuit schematic

6.6.1) Home Options:

The Home switches are factory configured as the Normally Closed (H1) configuration.

H1: Switch is closed when carriage is between the negative (reverse) end of travel and the home transition point. It is open from the transition point to forward end of travel.

6.6.2) Limit Options:

The Limit switches are factory configured as the Normally Closed (L1) configuration.

L1: When the carriage is in the normal operating range of travel, both limit switches are closed. When the carriage encounters a limit the switch opens. The switch will close again when the carriage is moved away from the switch.

6.7) Limit and Home Switch Adjustment

The limit and home switch positions are preset at the factory. The limits are nominally set to yield slightly more travel than specified in the model configuration. The nominal home switch transition point is about 2mm to the positive side of the center of travel.

| Position (mm) | |
|--------------------------|----------------------------------|
| +71 | Bumper Contact |
| +66.8 +66.15 +65.5 | Forward Limit trips |
| +65 | Nominal travel |
| +2.7 +2.0 +1.3 | Hemisphere |
| +1.0 0 -1.0 | Center of travel (encoder index) |
| -65 | Nominal travel |
| -65.5 -66.15 -66.8 | Reverse Limit trips |
| -71 | Bumper Contact |

Figure 6-5: X-axis & Y-axis Limit and Home Sensor Transition Ranges

6.8) Recommended System Test

Before attaching a load or applying power to your stage, verify the encoder and limit switches are working properly. Move the stage by hand in the positive direction and verify the encoder count is increasing (see Figure 4-1). Runaway conditions caused by miswired encoders can result in stage damage and personal injury. Move stage to each end of travel to ensure limit switches are working properly. When closing the position loop for the first time, set the torque limit of your controller to a low value and use conservative tuning gains. Once the control loop is working properly, payloads can be added to the stage carriage.

7) Preventive Maintenance

Performing preventive maintenance procedures on your stage will extend its life and improve its long-term performance.

7.1) Lubrication

Use clean room grease to lubricate the linear guide components. We recommend NSK grease part #GRS LG2. For low duty cycle applications, it is recommended that the linear guides are re-greased every six months. High duty cycle applications may require more frequent re-lubrication. Lubrication intervals depend on duty cycle, load and ambient conditions. Inspection of the drive train elements may be required to determine the proper lubrication interval. Primatics offers a grease kit that has all the necessary hardware to re-lubricate the linear bearings.

On the end of each bearing block is a small hole where grease is injected using a syringe (see Figure 7-1). Cycle the stage back and forth to distribute the grease and wipe off any excess.

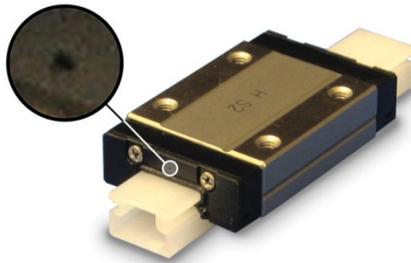


Figure 7-1: Bearing block lubrication port

8) Troubleshooting & Service

8.1) Troubleshooting Help

For further assistance contact the factory:
M-F 8AM to 5PM Pacific Time

| | |
|------------|-----------------------|
| Phone: | [541] 791-9678 |
| Fax: | [541] 791-9410 |
| Toll Free: | [888] 754-3111 |
| Web: | www.primatics.com |
| E-mail: | service@primatics.com |

8.2) Service

Should your device require factory service, contact the factory for a Return Materials Authorization (RMA). When inquiring about an RMA please have the following information available:

- Your contact information (name, phone, email, address)
- Unit Serial Number
- Symptom of problem
- History of troubleshooting steps already taken

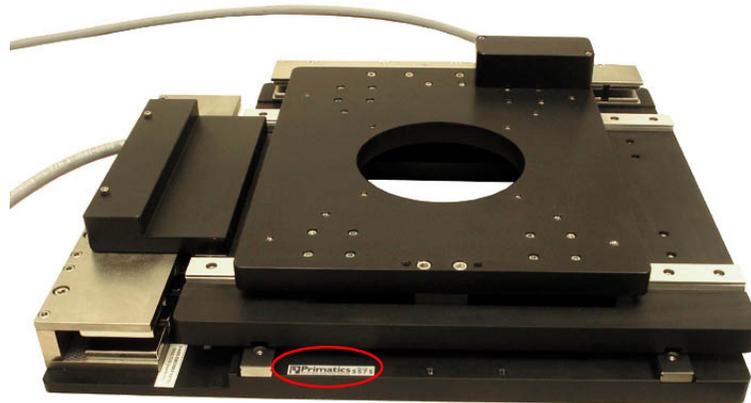


Figure 8-1: Unit Serial Number Location