



**PCL50**  
**Reference & Maintenance Manual**



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**PCL50 Manual  
Revision Information**

Revision Date	Notes
8/27/13	Original Release
1/3/14	Revised Connector for M2 option (Table 6-3)
1/19/2015	New Logo

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For Specifications, Dimensioned Drawings and additional information, refer to the PCL50 Datasheet available from our website at [www.primatics.com](http://www.primatics.com).

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## 1) Overview

This user guide is designed to help you install and maintain your PCL50 Series 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 PCL50**

The PCL50 is a low profile linear positioning stage with a precision ground ballscrew drive train. The overall height is 50mm at the carriage and an XY stack is just 100mm tall. It is offered with travels of 50, 100, 200, 300 and 400mm and can be ordered with or without a NEMA 23 servo motor. The PCL50 includes fixed forward and reverse limit sensors for end of travel sensing and can be used for homing if a stepper motor is used. High stiffness and rigidity at low weight are achieved using an AL6061-T6 aluminum base.

The PCL50 can also be used with 3<sup>rd</sup> party drives and controls. Several cable assemblies are available for this purpose.

### ***Feature Summary***

- Travels of 50, 100, 200, 300 and 400mm
- Low profile. XY stack is only 100mm tall.
- Precision ground ballscrew drive train with 5mm lead or optional 10mm lead
- Quiet operation
- NEMA 23 in-line mount
- Optional 1/4" or 3/8" bore couplings available
- Optional NEMA 23 brushless motor w/ 4000 line encoder available
- Precision performance for a low price

### **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) Conventions

### 4.1) Direction of Motion

The positive direction of motion is defined as a motion away from the motor end of a stage. A positive direction of motion also signifies the encoder count is increasing. All cables and connectors are located at the motor end of the stage. The reverse limit switch is located on the motor end and the forward limit switch is located on the opposite end of the stage. Figure 5-1 illustrates this convention.

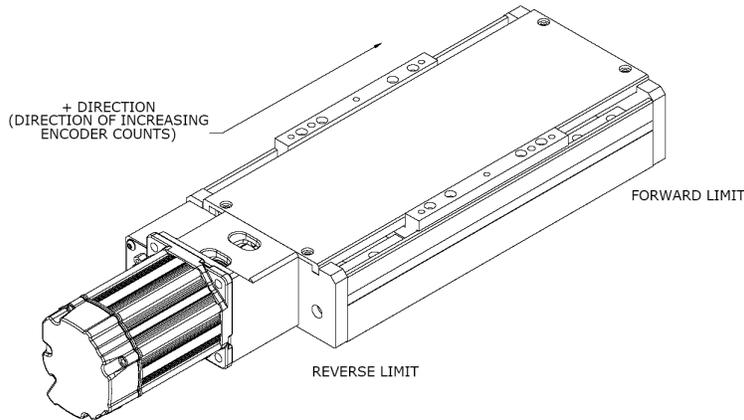


Figure 4-1: Positive direction convention

### 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 PCL50 are 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 $g = 9.8 \text{ m} / \text{s}^2$ .	

## **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 stage accuracy can be guaranteed. Stage accuracy can only 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) 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 due to thermal expansion. Humidity should be less than 85% and there should be no condensation in the environment in which the stage is used.

Ballscrew driven stages are susceptible to thermal expansion effects. The ballscrew nut can create a localized thermal gradient if driven at high speeds & duty cycles. Care must be taken to limit the duty cycle of the motor to maintain highest stage performance.

### **5.2) Contamination**

The PCL50 series is intended for clean environments free from small particulates and fluids. Applications in dirty or dusty environments require the electrical, optical and mechanical components to be protected. Additional protection must also be used for stages that will be splashed with fluids. Contact your local distributor or the factory for more information on this topic.

**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) Installing the PCL50 Positioning Stage**

**6.1) Tools you will need**

The hex wrenches and fasteners listed below are required to install the PCL50. “M” sizes refer to Metric sizes, and fractions refer to English sizes. In reference to screw sizes, the second dimension given refers to the length of the screw thread in mm. For example, “M4 x 16” would require an M4 screw that is 16 mm long. The term BHSC refers to Button Head Socket Screws.

**Hex Wrench Sizes**

Stage Base	Carriage	Coupling	Top Cover	Motor Mount
3mm	3mm	2.5mm	1.5mm	4mm

**Screw Sizes**

Stage Base	Carriage	Top Cover	Motor Mount
M4 x 16 SHCS (minimum)	M4 (length is payload dependant)	M3 x 6 BHCS	M5 x 12 SHCS

**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.

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.

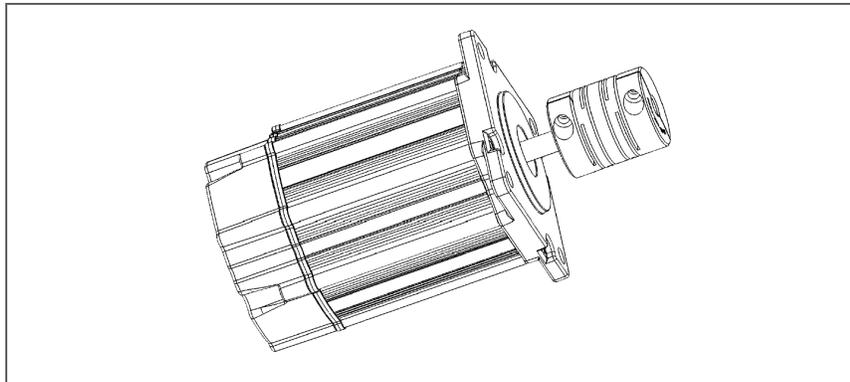
### 6.3) Installing Motors on Ballscrew Stages

If the stage was ordered without a Primatics supplied motor or coupling, the motor and coupling will have to be installed by the user.

#### 6.3.1) In-Line Motor Mounting

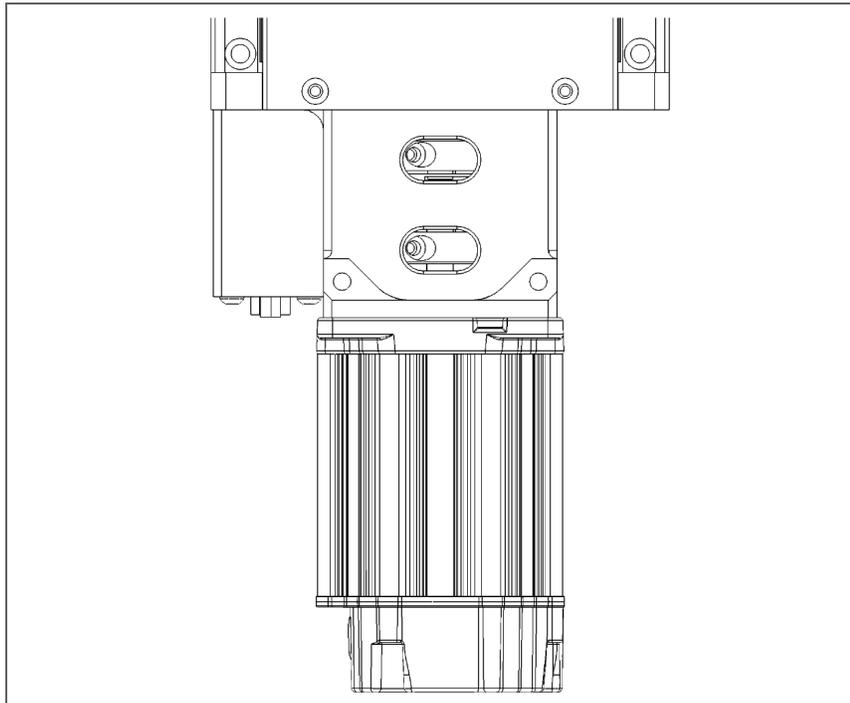
The following procedure is used to mount a NEMA23 motor on PCL50 stages:

- 1) Install the flexible coupling on the motor shaft.

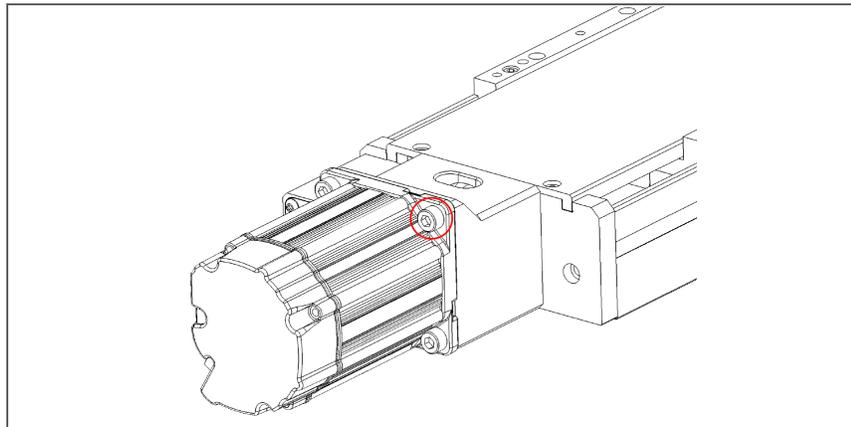


- 2) Slip the coupling over the ballscrew shaft and seat the motor in the motor pilot. The coupling clamp bolt should be visible. If the clamp bolt is not visible or the ballscrew shaft does not extend past the clamping bolt, repeat Step 1 and slide the coupling forward or back.

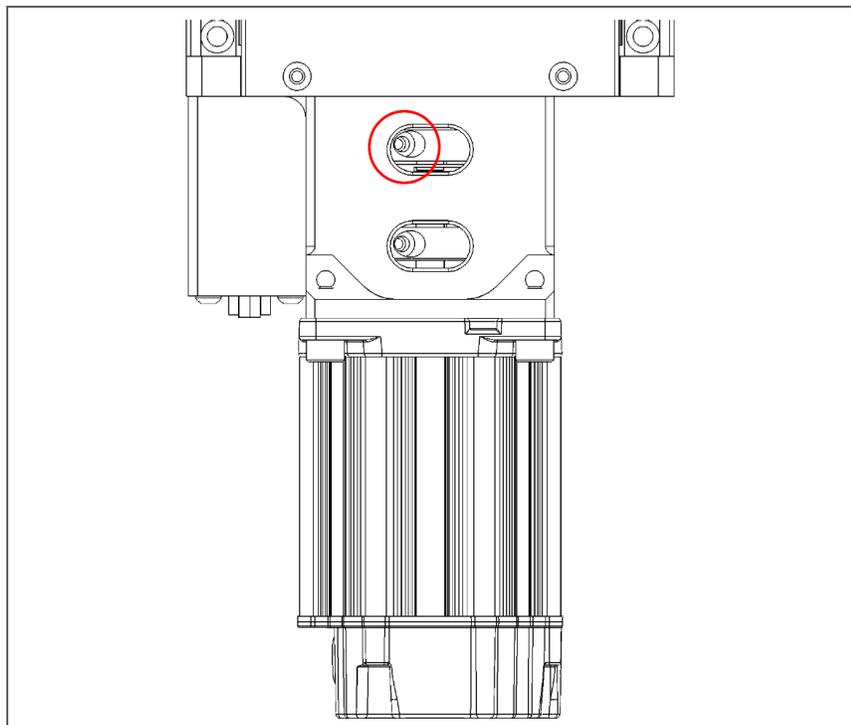
Make sure the coupling is not compressed axially against the shoulder on the ballscrew when the motor is seated.



3) Mount the motor to the stage with four fasteners. Fully tighten all four fasteners.



4) Make sure the coupling is not compressed axially against the shoulder on the ballscrew when the motor is seated, then fully tighten the coupling clamp screw. The coupling should be fully tightened when the coupling is in its "relaxed" state.



### 6.4) Mounting surface preparation

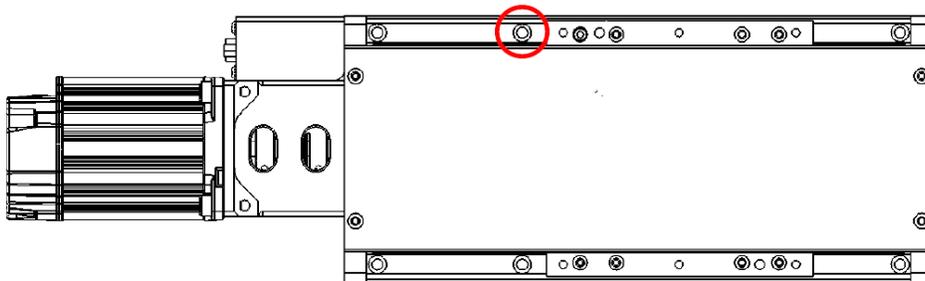
The characteristics of the surface to which the positioning stage is mounted will have a large effect on system performance. An accurate and flat positioning stage will conform to the shape of the mounting surface; therefore a flat mounting surface is required. The flatness and straightness specifications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

- 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 $\mu$ m.

### 6.5) Mounting the Stage

- 1) Remove top cover (if needed).
- 2) Insert mounting screws in counterbores circled below. Move the carriage by hand to gain access to all the counterbores.



- 3) Tighten Screws. When mounting the base down to the surface plate, tighten the bolts at one end of the stage first and move towards the other end.
- 4) Replace top cover (if needed).

**6.6) Electrical Connections**

Electrical connections to the stage differ by model configuration. Each configuration includes the connector for the internal limit sensors. Table 6-1 describes these connections. The failsafe brake, option –B, uses a 2 pin connector described in Table 6-2. The M2 motor/encoder option pinout is described in Table 6-3.

**Table 6-1: PCL50 Limit Connector**

DSub, 9 pins. Mates with DSub 9 sockets

Pin	Function
1	Limit power: 5-24VDC
2	Limit signal ground
3	Forward Limit
4	Reverse Limit
5	Home
6	Not used
7	Not used
8	Not used
9	Not used

**Table 6-2: PCL50 Brake Option (-B)**

Molex Mini-Fit, 2 position with sockets. Mates with Molex 39-01-2021

Pin	Function
1	Motor A
2	Motor B

**Table 6-3: PCL50 Servo Motor / Encoder (M2)**

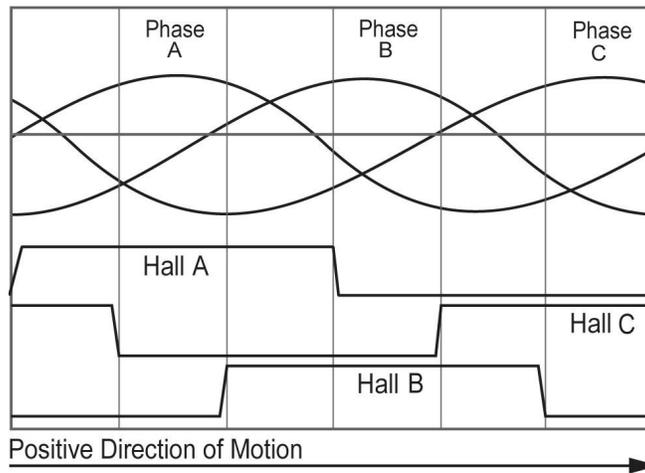
Canon circular connector, size 20 shell, 28 pins, panel mount

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 limits
M	DCCOM
N	Not used
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 -

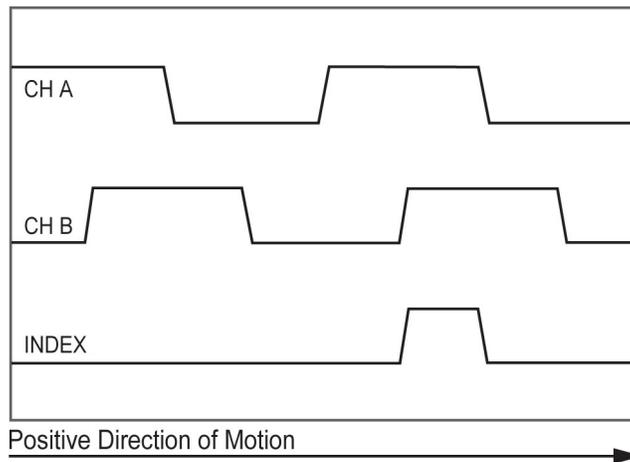
Y	Forward Limit Switch
Z	Reverse Limit Switch
A	Signal Shield
b	Hall A
c	Hall B
d	Not used
e	Hall C

**6.6.1) Hall Effect Commutation Sequence**

In the event that user amplifier and controls are being implemented, use the following motor commutation timing charts.



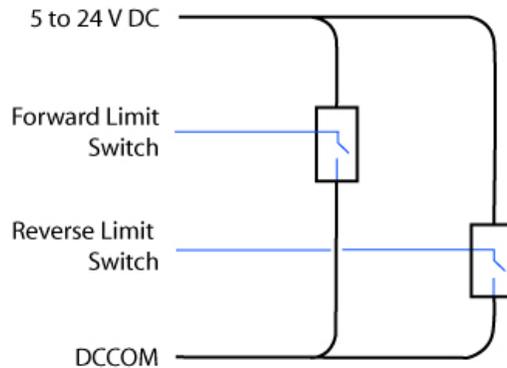
**Figure 6-1: Motor commutation chart**



**Figure 6-2: Timing diagram for the encoder signals**

### 6.7) Limit Sensors

Each PCL50 stage includes Forward and Reverse Limit sensors. The limit sensors are optical slot switches which are more repeatable than magnetic or inductive versions. Figure 6-3 shows the equivalent schematic for these switches.



**Figure 6-3: Equivalent Limit circuit schematic**

The forward and reverse limit sensors are factory set to give full advertised travel. That is a PCL50 with 100mm of travel will travel at least 50mm in either direction from the center of travel before activating a limit sensor. Each sensor is active from its activation point through the end of travel at the hard stop.

Figure 6-4 illustrates the limit sensor factory nominal default positions.

	PCL50-50	PCL50-100	PCL50-200	PCL50-300	PCL50-400
Absolute hardstop	+32.5mm	+57.5mm	+107.5mm	+157.5mm	+207.5mm
Bumper contact	+28mm	+53mm	+103mm	+153mm	+203mm
Forward limit trips	+27mm	+52mm	+102mm	+152mm	+202mm
Nominal travel	+25mm	+50mm	+100mm	+150mm	+200mm
Center of travel	0	0	0	0	0
Nominal travel	-25mm	-50mm	-100mm	-150mm	-200mm
Reverse limit trips	-26mm	-51mm	-101mm	-151mm	-201mm
Bumper contact	-27mm	-52mm	-102mm	-152mm	-202mm
Absolute hardstop	-28mm	-53mm	-103mm	-153mm	-203mm
Absolute hardstop	-32.5mm	-57.5mm	-107.5mm	-157.5mm	-207.5mm

**Figure 6-4: Typical Limit Sensor Transition Ranges**

**6.7.1) Limit Options:**

The Limit switches are ordered in either the Normally Closed (L1) or Normally Open (L2) 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.

**L2:** When the carriage is in the normal operating range of travel, both limit switches are open. When the carriage encounters a limit the switch closes. The switch will open again when the carriage is moved away from the switch.

**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 carriage by hand in the positive direction and verify the encoder count is increasing. Runaway conditions caused by miswired encoders can result in stage damage and personal injury. Move the carriage 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. The stage should be kept clean and a soft, lint-free cloth should be used wipe down the stage. Do not use compressed air to spray away dust since this may force dust into crevices.

### **7.1) Lubrication**

It is recommended to use only the following greases for lubricating the ballscrew and linear bearings. Do not mix different greases as a chemical incompatibility may occur. Primatics offers a grease kit that has all the necessary hardware to re-lubricate the ballscrew and linear bearings.

For low duty cycle applications, it is recommended that the ballscrew and linear guides are re-greased every 4-6 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.

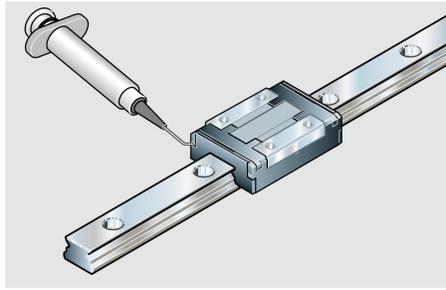
**ALWAYS DISCONNECT MOTOR POWER BEFORE RE-LUBRICATING THE STAGE.**

#### **7.1.1) Ballscrew Lubrication**

The ballscrew should be re-greased with NSK grease part **#GRS PS2**. To gain access to the component to grease, remove the stage top cover after power has been disconnected from the stage. Push out the plastic plug from rear endplate and move the carriage towards the rear endplate. The grease fitting for the ballscrew can now be accessed through the hole in the rear endplate. Typical grease volume is up to 1 cm<sup>3</sup> or until grease is seen extruding from the ballnut. Cycle the stage back and forth to distribute the grease and then wipe off any excess. Reinstall plastic plug and top cover.

#### **7.1.2) Linear Guide Lubrication**

The linear bearings should be re-greased with **Dynalube 520**. To gain access to the linear guides, remove the stage top cover after power has been disconnected from the stage. On the end of each bearing block are two small grease holes where grease is injected using a syringe (see Figure 8-1). Typical grease volume is up to 0.03 cm<sup>3</sup> per hole (0.06 per bearing block) or until grease is seen extruding from the sides of the bearing block. Cycle the stage back and forth to distribute the grease and then wipe off any excess. Reinstall the top cover.



**Figure 7-1: Bearing block lubrication ports**

## **8) 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:	<a href="http://www.primatics.com">www.primatics.com</a>
E-mail:	<a href="mailto:service@primatics.com">service@primatics.com</a>

### **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**