primatics

PCR43
Reference & Maintenance Manual

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PCR43 Manual
Revision Information

Publication Date	Notes
March 2002	
April 2005	Updated look & formatting
January 2007	Updated Ordering Information
January 2008	Discontinued 40nm encoder option
January 2015	Update Lubrication instructions
January 2015	New Logo
September 2017	Table 7-1 pin a

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For Specifications, Dimensioned Drawings and additional information, refer to the PCR43 Datasheet available from our website at www.primatics.com.

1) Overview

This user guide is designed to help you install and maintain your PCR43 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.

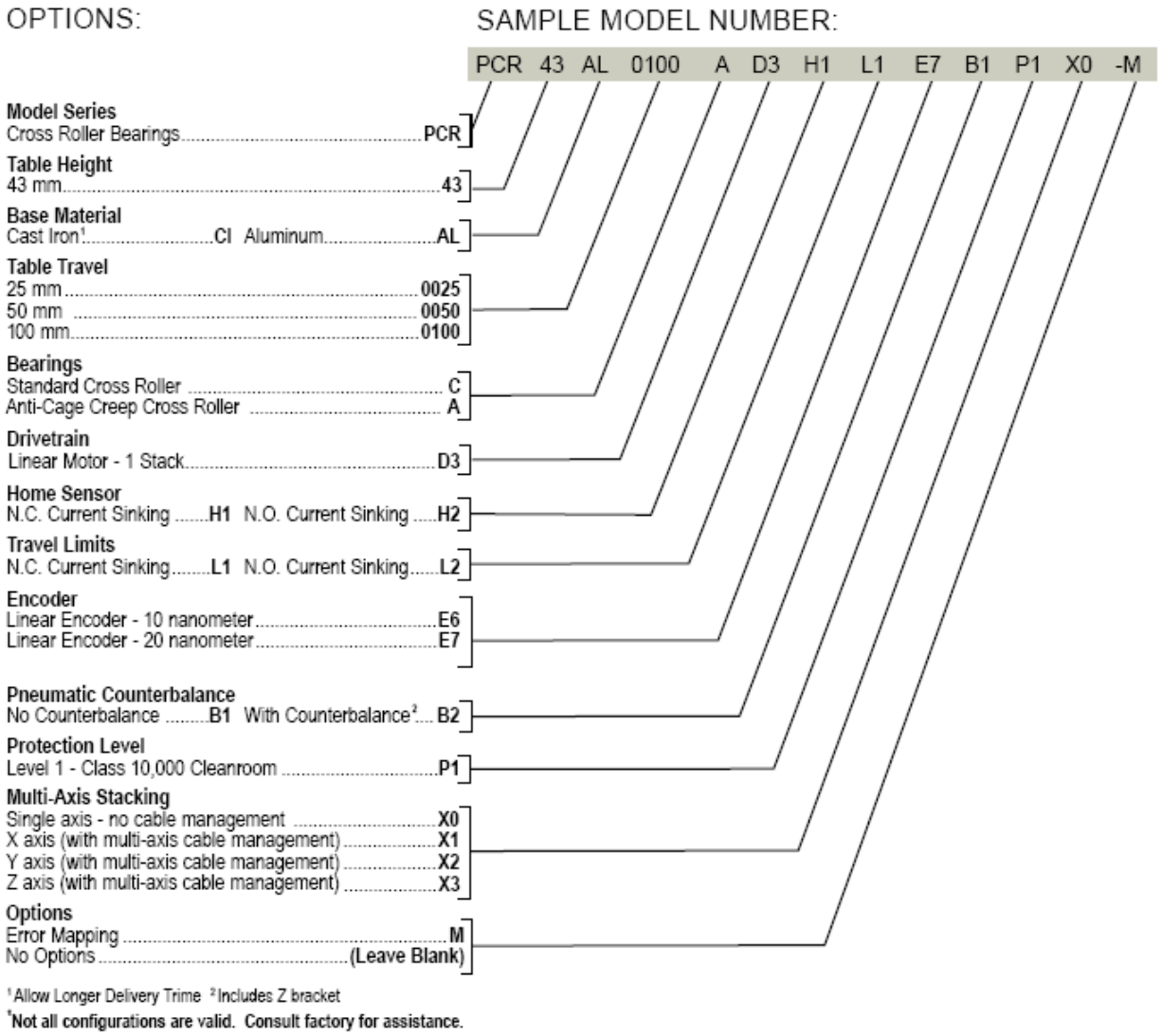
Step 6 Review preventive maintenance section for proper lubrication schedule.

2) Introduction – About the PCR43

Each Primatics PCR43 positioning stage is designed for precision movement in one axis. They feature a highly compact design and deliver exceptionally smooth travel by utilizing precision cross roller bearings. The stages can be stacked to make X-Y or X-Y-Z systems.

Many customers choose the Primatics Motion Drive Chassis (MDC) to power PCR43 stages. The MDC is a modular system that packages motor drivers, encoder interfaces, power supplies and safety systems into a single chassis. It acts as an intermediary between a Galil Optima, National Instruments 7344 or Delta Tau PMAC II motion control cards and a Primatics positioning stage. Pre-wired high-flex cables are available to allow a convenient connection from the stage to the MDC chassis. The MDC drive chassis interfaces 3rd party controllers via a removable interconnect module. These interconnect modules conform to each manufacturers interconnect cable, and internally route all the command and I/O signals.

Optionally, a Primatics positioning stage can be used with many third party controller and amplifier systems. In this case, a pigtailed cable is available to simplify the connection between the PCR43 stage and controls.



3) Model Configuration

⚠ 4) 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.

5) Stage & Manual Conventions

5.1) 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 positioner. Figure 5-1 illustrates this convention.

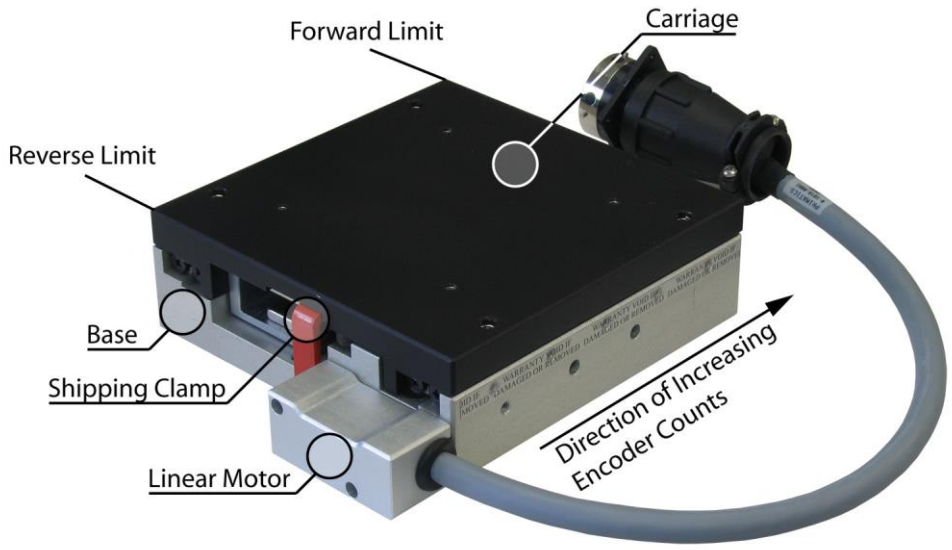


Figure 5-1: Positive direction convention

5.2) 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 PCR 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 m / s^2

6) 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.

6.1) 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.

6.2) 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.

Humidity should be less than 85% and there should be no condensation.

6.3) Contamination

Applications in contaminated environments require the electrical, optical and mechanical components to be protected. The PCR43 series is intended for clean environments free from particulate and fluids. Additional protection must be designed for stages that are in dirty environments.

6.4) 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.

7) Installing the PCR43 Positioning Stage

7.1) Tools you will need

The PCR43 linear positioning stage uses M5x18mm (minimum) sockethead cap screws in the base plate mounting. M5 and M3 tapped holes are available for customer use for mounting payloads to the carriage.

7.2) 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. If so equipped, remove the red shipping clamp from the stage (see Figure 5-1).

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.

7.3) 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. In the absence of a sufficiently flat surface, a three point mounting scheme can be utilized to rely on the inherent flatness of the stage. This technique can introduce negative dynamic effects in moment load applications because a large portion of the stage base is not in contact with the mounting surface. 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 5-8µm.

7.4) Mounting the PCR43

The PCR43 has four mounting holes that can be accessed by moving the carriage to its forward and reverse limits. Figure 7-1 shows the location of these mounting holes.

Figure 7-1: Mounting Hole Locations

7.5) Electrical Connections

All PCR43 models are terminated with a 450mm flexible cable with a 28 position circular connector on the end. The pin-out of this connector is shown with Table 7-1. This particular configuration is optimized for use with Primatics MDC drive chassis via an extension cable. Connections to other drives and controls are also made through this connector.

A popular option for applications not using the Primatics MDC drive chassis is the pigtailed extension cable. This is similar to the extension cable used to connect a stage to the MDC drive chassis, except the end that connects to the motor drive and controller is un-terminated. Section 7.5.1 shows the conductor assignments for this cable (when ordered with a ballscrew drivetrain and without an encoder).

Table 7-1: Axis Connector (Motor, encoder, limits, home, temp)
FCI circular connector, 28 pins, size 20 shell

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	12VDC - for limit, home, and temp sensor
M	DCCOM
N	Home – Switch to DCCOM when on forward side of home position
P	Not used
R	Not used
S	Chassis
T	Hall V+
U	Hall V-
V	Encoder Common
W	Encoder Index +
X	Encoder Index -
Y	Forward Limit Switch – switch to DCCOM in normal operation
Z	Reverse Limit Switch – switch to DCCOM in normal operation
a	Key
b	Hall A
c	Hall B
d	Temperature monitor – connect to DC Common for temperature OK
e	Hall C

7.5.1) Color Codes for Pigtailed Cable

Cable consists of 3 independent shielded “pods”: One for motor signals, one for encoder signals & a 3rd for sensors. Each of the pods is described below.

Cable 1

Color	Function
Black	Motor A
Red	Motor B
White	Motor C
Shld	Motor Shield

Cable 2

Color	Function
Red	Encoder 5V
White	Encoder A+ output
Yellow	Encoder A- output
Green	Encoder B+ output
Blue	Encoder B- output
Shld	Encoder Shield
Black	Encoder Common
Orange	Encoder Index +
Brown	Encoder Index -

Cable 3

Color	Function
Green	12VDC
Blue	DCCOM
White	Home
Wht/Red	Not used
Wht/Black	Not used
Shld	Chassis
Black	Hall V+
Brown	Hall V-
Violet	Forward Limit Switch
Gray	Reverse Limit Switch
Red	Hall A
Orange	Hall B
Tan	Temperature Monitor
Yellow	Hall C

7.5.2) Hall Effect Commutation Sequence

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

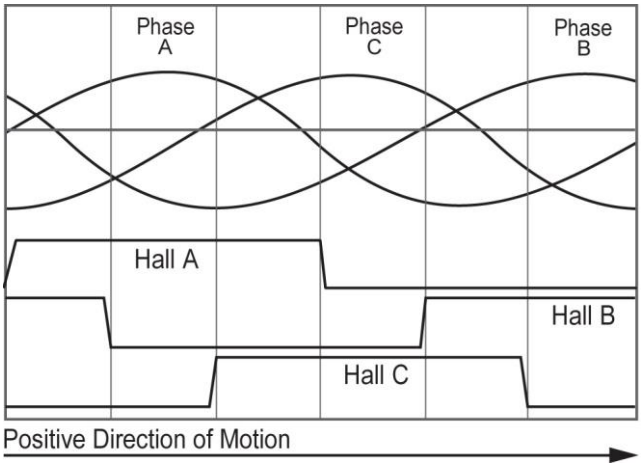


Figure 7-2: Motor commutation chart

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

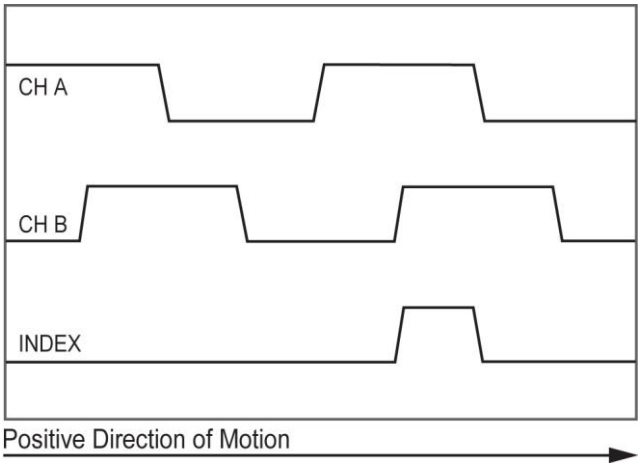


Figure 7-3: Timing diagram for the encoder signals

7.6) Home and Limit Sensors

Each PLG stage includes Forward and Reverse Limit sensors and a Home sensor. Figure 7-4 shows the equivalent schematic for these switches.

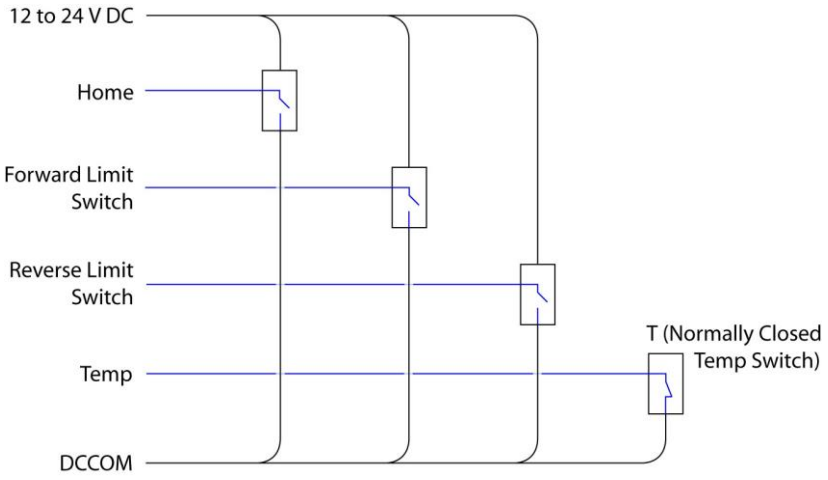


Figure 7-4: Equivalent Limit, Home, and Temp circuit schematic

7.6.1) Home Options:

The Home switch is ordered in either the Normally Closed (H1) or Normally Open (H2) 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.

H2: Switch is open when carriage is between the negative (reverse) end of travel and the home transition point. It is closed from the transition point to forward end of travel.

7.6.2) 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.

7.7) Limit & Home Switch Adjustment

The limit and home switch positions have been preset at the factory and cannot be adjusted. The limit sensors and home sensors are offered as normally closed or normally open, and they can only be adjusted at the factory prior to shipment. Both limit switches are normally closed and moving from the reverse limit switch to the forward limit switch causes the home switch to transition from closed to open. See Figure 7-2 for an illustration of this.

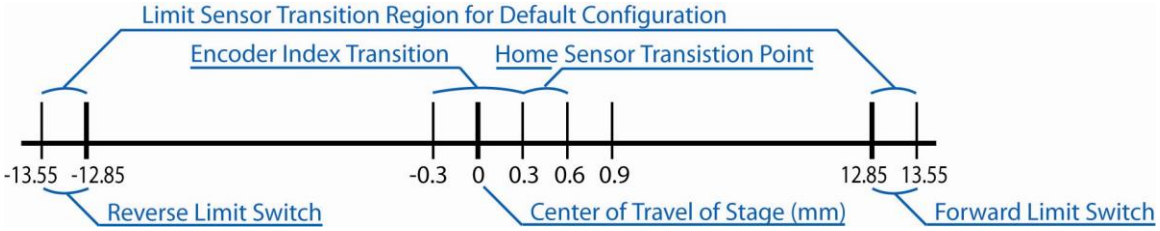


Figure 7-5: Limit & Home Sensors

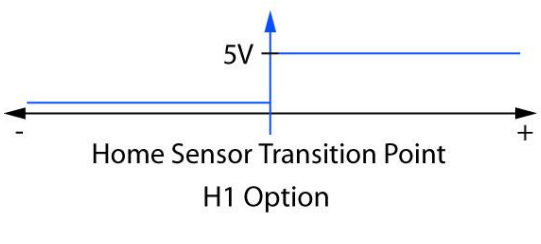


Figure 7-6A: Home Vane Configuration H1, L1 Options (Normally Closed)

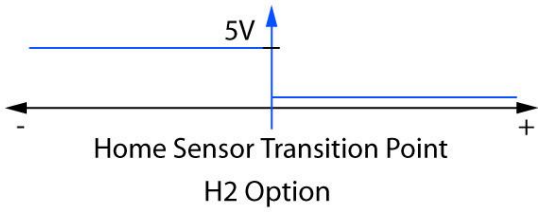


Figure 7-6B: Home Vane Configuration H2, L2 Options (Normally Open)

7.8) 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.

7.8.1) Pneumatic Counterbalance for Z-axis Operation

A pneumatic counterbalance and Z bracket option is available for vertical operation of the PCR43. Counterbalancing is achieved using a glass lined air cylinder, aircraft cable and pulley assembly and a precision pressure regulator. Counterbalance operation is as follows:

1) Remove any shipping brackets and protective shipping items on the counterbalance assembly.
2) With the servo off, the payload should be mounted to the Z-axis carriage and the carriage should be resting at the end of travel under gravity. Max allowable payload for counterbalance is 4.5kg (10lbs) including the weight of the carriage.
3) Clean, dry, filtered air should enter the inlet side (see marking on regulator) of the pressure regulator (@ 690kPa (100psi) max) and should exit the regulator and enter into the air cylinder via polyurethane tubing. Starting with the regulator valve closed (no air passing through), slowly open the valve until the cylinder pressurizes and the stage carriage slowly rises upwards. Slightly close the valve until the carriage stops rising. Move the carriage up and down by hand noting the resistance and adjusting the pressure regulator slightly to iterate in on uniform resistance upwards and downwards.
4) The counterbalancing can be optimized even more by cycling the z-axis with the servo and adjusting the regulator until the torque requirements for constant velocity are the same for travel upward and downward.
5) The pressure regulator should be located as close to the cylinder as possible to improve the response of the system.
6) Due to the extremely low friction level of the air cylinder, it is normal for there to be slight air leakage past the piston and end seals. Adequate capacity of the air supply source should be ensured so that continuous counterbalancing can be maintained.

8) Preventive Maintenance

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

8.1) Lubrication

Use Nye Rheolube 737B low viscosity grease to lubricate the linear guide components. For low duty cycle applications, it is recommended that the linear guides be 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 elements may be required to determine the proper lubrication interval.

After power has been disconnected from the stage, a light film of grease can be applied along the length of the crossed roller bearings when the stage is at either extreme end of travel. Cycle the stage back and forth to distribute the grease and wipe off any excess.

The motor and linear encoder is a non-contact device and does not need lubrication.

8.2) Bearing Cage Creep

The bearing elements (cross roller bearings) in the PCR43 offer extremely smooth and precise motion which is required to obtain repeatability of less than ±50nm but unfortunately there is a tradeoff for such low friction. Cage creep is the slow migration of the bearing roller elements which will cause the effective travel to be decreased. This phenomenon may occur over time, especially if accelerations and decelerations are not the same and if a stage is in a vertical orientation.

If the stage no longer gets full travel, the roller elements need to be re-centered. This is done by moving the carriage to one end of travel and pushing the carriage by hand until you feel the cages slide. Move the carriage to the opposite end and repeat the procedure. It should take a moderate amount of force (≈88N (20lbs)) to get the cages to slide. If there is metal to metal sound and feel at the end of travel then the cages need to slide. If there is a soft compressive (rubber) feeling at the end of travel, then the cages are properly aligned and the carriage is compressing the end of travel bumpers.

If the stage was ordered with the ACS option, cage creep is eliminated and this section can be ignored.

9) Troubleshooting & Service

9.1) 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

9.2) 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 (located shown below)
- Symptom of problem
- History of troubleshooting steps already taken

Figure 9-1: Unit Serial Number Location