

PCR32
Reference & Maintenance Manual



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**PCR32 Manual
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1) Overview

This user guide is designed to help you install and maintain your 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 PCR32 Stages

The PCR32 stage series is a custom, limited travel, single axis linear motor stage. Two models exist, one which yields 25mm of stroke between electrical limits and the other which yields 135mm of nominal stroke. They incorporate direct drive brushless linear motors and high resolution linear encoders in very low profile package. They deliver exceptionally smooth travel by utilizing precision cross roller bearings with an anti-creep feature to eliminate bearing cage migration. An index pulse on each encoder is used for determining a repeatable home position. Forward and reverse limit switches are encountered at the respective ends of each axis of travel (see Figure 4-1).

Travel	± 12.5mm Travel	± 67.5mm
Allowable Payload	3kg	4.5kg
Orientation	Vertical	Horizontal
Accuracy (slope corrected)	± 2.0µm	± 10.0µm
Repeatability	±0.1µm	±0.1µm
Rated speed	250mm/s (@ 10% duty cycle)	500mm/s (@ 10% duty cycle)
Max. Acceleration	0.30g	0.30g
Motor type	Linear motor (w/ Halls)	Linear motor (w/ Halls)
Limit Sensors	2 Normally Closed sensors	2 Normally Closed sensors
Home Sensor	None	None
Encoder type	Steel tape linear scale, 20µm grating period	Steel tape linear scale, 20µm grating period
Encoder resolution	Analog (sin-cos), 1µm digital, 5nm digital	Analog (sin-cos), 1µm digital, 5nm digital
Cleanroom class	10,000	10,000
Finish	Clear Anodized Aluminum Tooling Plate	Clear Anodized Aluminum Tooling Plate
Height	32 mm	32 mm
Width	85 x 117 mm	85 x 220 mm
Weight	≈1200g	≈2050g

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 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 4-1 illustrates this convention.

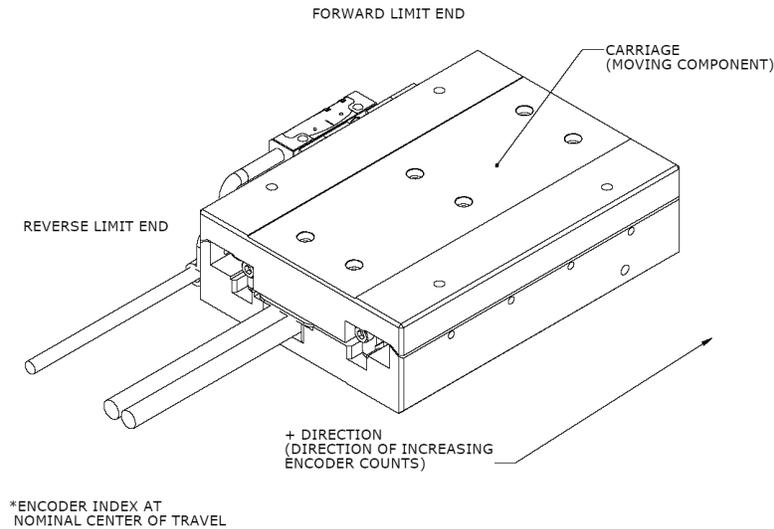


Figure 4-1: Positive direction convention

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 PCR32 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 $g = 9.8 \text{ m} / \text{s}^2$	

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



CAUTION: Extremely strong magnetic fields present! Damage or injury could result from ferrous materials being attracted to the magnets. Keep ferrous materials at least 100mm away from the stage.

A high power Neodymium Iron Boron magnet track is mounted to the underside of the PCR32 carriage. 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. Keep ferrous materials at least 100mm away from the stage to minimize the risk of items being attracted to the magnet track.

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.

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

5.3) Contamination

Applications in contaminated environments require the electrical, optical and mechanical components to be protected. The PCR32 series is intended for clean environments free from particulate and fluids. Additional protection must be designed for stages that are in dirty environments.

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 PCR32 Positioning Stage

6.1) Tools you will need

The PCR32 linear positioning stage uses M4x12mm (minimum) sockethead cap screws in the base plate mounting. M4 tapped holes are available for customer use for mounting payloads to the carriage.

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. 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.
- 5) Remove the red shipping brackets 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. 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 PCR32 Stage

The 25mm travel stage has four mounting holes that can be accessed by moving the carriage to expose the mounting holes. Clearance surrounding the ends of the stage is required to be able to move the carriage enough for access to the mounting holes. The carriage must be able to freely cycle $\pm 13\text{mm}$ about center to gain access to the mounting holes.

The 135mm travel stage has eight mounting holes that can be accessed by moving the carriage to its forward and reverse limits. **⚠** When tightening the mounting screws, tighten the center screws first, then radiate outwards. Figure 6-1 shows the location of the mounting holes.

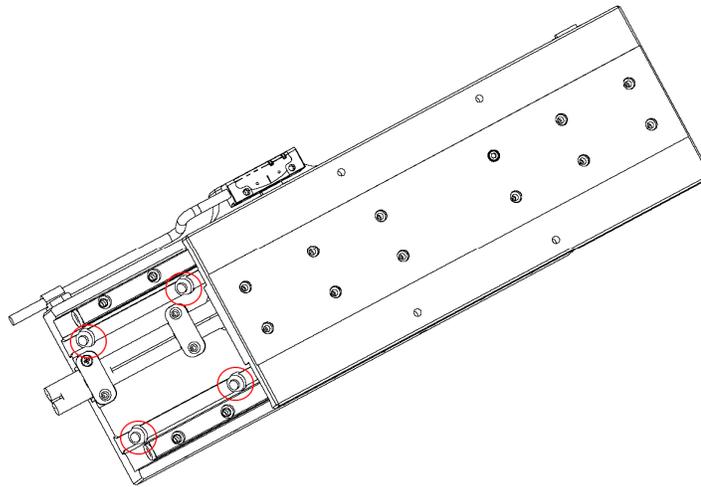


Figure 6-1: Mounting Hole Locations

It is important that clearance is maintained between the moving carriage and the cables exiting the stage. Make sure the cables are restrained in such a way that the carriage won't rub the exiting cables. See image below for area of potential contact.



6.5) Electrical Connections

Electrical connections to the stage are through single circular connector common to other Primatics servo stages. See the Table below for the pin-out of this connector.

Table 6-1: Axis Electrical Connector, 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	Not used
M	DCCOM for Temp sensor
N	Not used
P	Not used
R	Not used
S	Signal Shield
T	Hall V+
U	Hall V-
V	Encoder ground
W	Encoder Index +
X	Encoder Index -
Y	Forward Limit Switch – referenced to Encoder ground
Z	Reverse Limit Switch – referenced to Encoder ground
a	Key
b	Hall A
c	Hall B
d	Temperature sensor – referenced to DCCOM
e	Hall C

6.5.1) Hall Effect Commutation Sequence

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

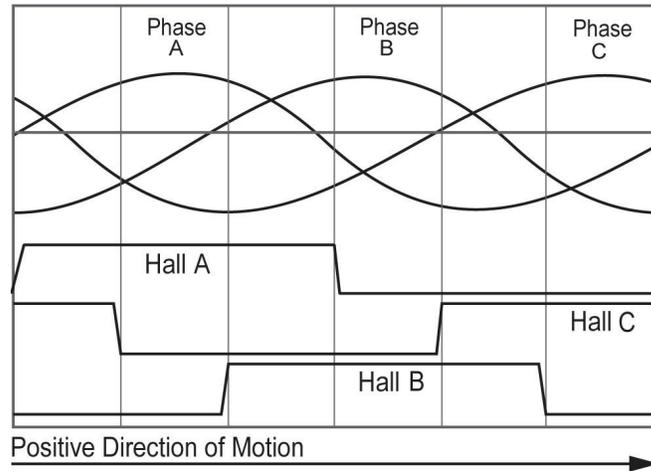


Figure 6-2: Motor Phase and Hall Sensor Timing

6.5.2) Encoder Timing Diagram

The following diagrams show the signal timing for the Encoder options

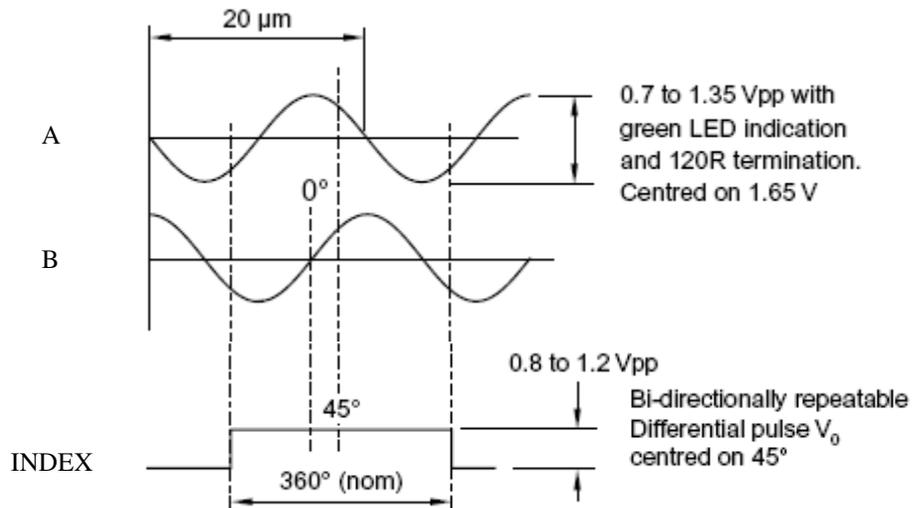


Figure 6-3: Timing diagram for SIN-COS encoder signals

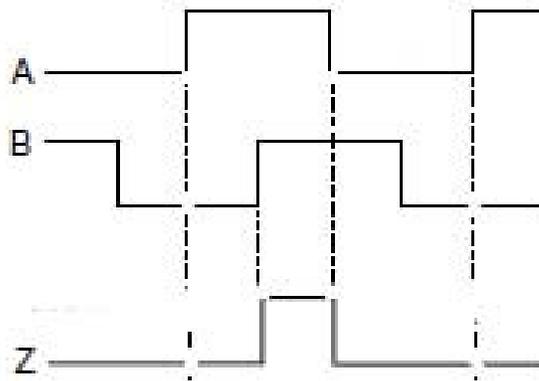


Figure 6-4: Timing diagram for digital encoder signals

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 of travel. Repeatability is guaranteed both directions. The reference mark output is synchronized with the incremental channels, giving it a unit of resolution pulse width. During a homing routine, the stage should travel to a limit switch transition, and then start searching for the index in the opposite 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

Primatics P/N	9-0044-0044
Continuous Force (N) ¹	5
Continuous Current (Amps) ¹	1.8
Peak Force (N) ²	27
Peak Current (Amps) ²	10
Force Constant (N/Amps _{rms})	2.75
Back EMF Constant (V/m/sec)	2.5
Resistance (Ω)	1.57
Inductance (mH)	0.45
Magnetic Pitch (mm)	22.86
Thermal Resistance (C/W)	4.8

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

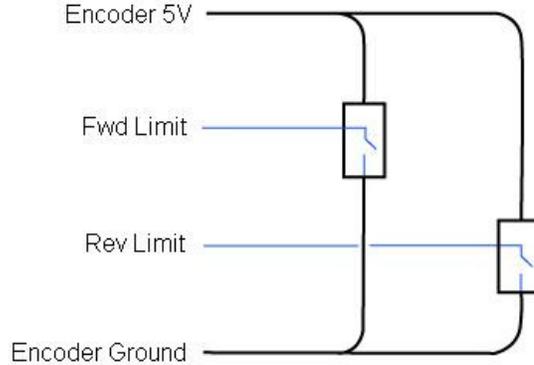
6.5.5) PTC Thermistor

A PTC thermistor is embedded within the linear motor forcers. In normal operation, its resistance is less than 100 Ohms and configured to respond when the motor temperature surpasses 90°C.

6.6) Limit Sensors

Each axis includes two limit sensors for detecting the limit of forward and reverse travel. The sensors are part of the linear encoder. The switch points are set by the location of magnetic actuators on the encoder scale. The limit switches and encoder index are fixed at the factory and cannot be adjusted. Figure 6-5 shows the equivalent schematic for these switches.

Figure 6-5: Equivalent Limit, Home, and Temp circuit schematic



The limit switch positions are preset at the factory. The limits are nominally set to yield slightly more travel than specified in the model configuration.

Table 6-3: 25mm Travel Limit and Index Transition Ranges

+14mm	Bumper
+14.0mm	Forward Limit trips
+12.8mm	
+12.5mm	Nominal travel
+1.0mm	Center of travel (encoder index)
0	
-1.0mm	Nominal travel
-12.5mm	
-12.8mm	Reverse Limit trips
-14.0mm	
-14mm	Bumper

Table 6-4: 135mm Travel Limit and Index Sensor Transition Ranges

+69mm	Bumper
+69.0mm	Forward Limit trips
+67.8mm	
+67.5mm	Nominal travel
+1.0mm	Center of travel (encoder index)
0	
-1.0mm	
-67.5mm	Nominal travel
-67.8mm	Reverse Limit trips
-69.0mm	
-69mm	Bumper

6.7) 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.

7.1) 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.

7.2) Linear Scale Cleaning

Care must be taken not to scratch or contaminate the gold linear encoder scale that is mounted to the side of the carriage. Smudges and fingerprints can be cleaned with a cotton swab and Isopropyl alcohol. *Do NOT use acetone, methylated spirits, or chlorinated solvents.*

The stage should periodically be wiped down with a clean, lint free cloth. Do not use compressed air since it may force contaminants into the linear bearings. The linear motor is a non-contacting device and does not require preventative maintenance.

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

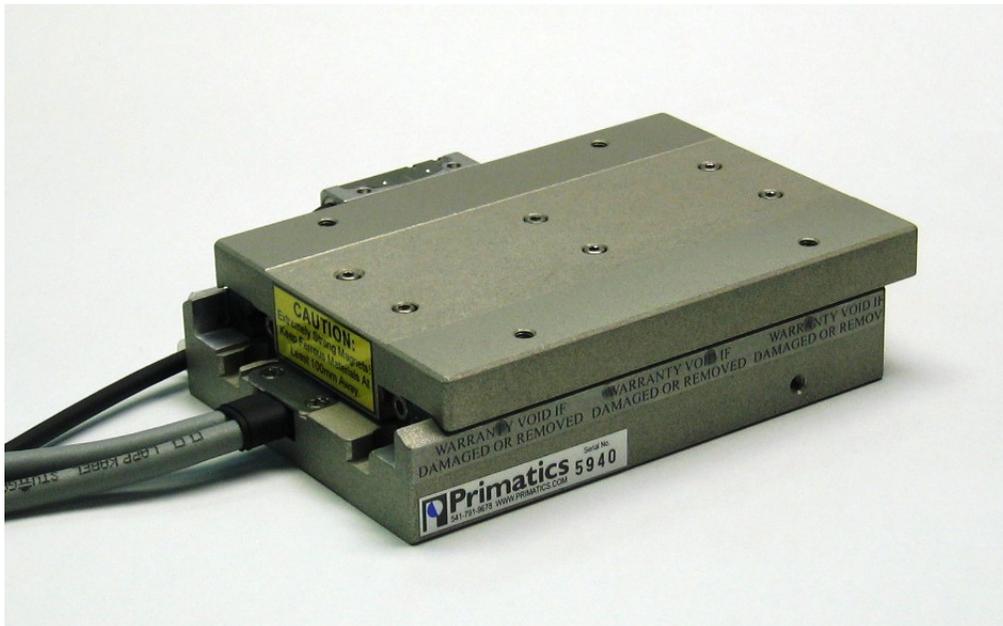


Figure 8-1: Unit Serial Number Location