THORLABS

PCS-5000 Series Motorized Patch-Clamp Micromanipulator

User Guide

Table of Contents

Chapter 1 Warning Symbols

Below is a list of warning symbols you may encounter in this manual or on your device.

Symbol	Description
	Safety Ground
	Motor Direction Switch
	Chassis Ground
	Caution: Risk of Electric Shock. This unit contains high voltage components. It is recommended that only qualified technical personnel perform testing and repairs.
	Caution: Risk of Danger. Should this equipment be used in a manner not specified by Thorlabs, Inc., the protection provided by the equipment may be impaired. Always follow the operating instructions as indicated! IEC Class I Product: Use only the 3-prong AC power cord supplied with this equipment. Always insert the power cord into an electrical outlet provided with a protective earth contact.
	Caution: Indicates a potentially hazardous situation that, if not avoided, may result in component damage. Do not proceed unless you understand and meet the required conditions.
	Input/Output Control Signal
	Fuses- User Replcable

Chapter 2 Introduction

Thank you for purchasing the PCS-5000 Series Motorized Patch-Clamp Micromanipulator. This manual intends to provide in-depth information on the operation and use of the PCS-5000.

2.1. Overview

Burleigh PCS-5000 Series Motorized Patch-Clamp Micromanipulators from Thorlabs, Inc. are ultra-stable, high-resolution positioning systems designed for patch clamp recording. Thorlabs, Inc. has incorporated more than 20 years of experience and knowledge in piezoelectric actuators, precision mechanics, and electronic control to create a system that maximizes your research productivity.

The Burleigh PCS-520 Micromanipulator will be mounted on or next to your microscope. Your headstage and pipette should be mounted to the Burleigh PCS-520 such that the end of the pipette is in the field of view of the microscope. The Burleigh PCS-520 provides fine positioning control using PZT actuators, which travel 150 *µm* or 300 *µm*. Special rotational adjustments are incorporated to allow optimum pipette working angles and easy pipette exchange. Manual linear stages provide coarse position control that allow 25 *mm* of travel.

The fine motion of the Burleigh PCS-520 is controlled by 0 to 60 V signals generated by the PCS-PS60 amplifier driver and the Burleigh PCS-503 Axis Control Unit. Rotation of the potentiometers allows precise control of the voltage applied to the PZT actuators.

While the Burleigh PCS-5000 was designed for patch clamp recording, it can also be used for many other applications requiring high-precision positioning capabilities.

Figure 2–1 PCS-5000 Series Motorized Patch-Clamp Micromanipulator

2.2. Major Components

2.2.1. PCS-520 Micromanipulator Assembly

The micromanipulator assembly consists of three linear stages and two rotary pivot stages assembled with a 90° bracket. The linear stages can have no PZT, a 150 *µm* PZT or a 300 *µm* PZT.

2.2.2. PCS-503 Axis Control Unit

The Axis Control Unit (ACU) is a table-top device that produces 0 to 60 V drive signals for controlling three independent PZT axes via rotary.

2.2.3. PCS-PS60 Power Supply

The power supply provides a constant low noise supply voltage for one or two PCS-503 ACU.

2.2.4. PCS-500-RP Rotation Adapter Plate

The table below describes the various models of the PCS-5000 Series Motorized Patch-Clamp Micromanipulator.

Configuration Summary of PCS-5000					
Model	Components	PZT Travel in *um*			Comments/Application
		Axis 1 (Y)	Axis 2 (Z)	Axis 3 (Approach)	
PCS-520-N	PCS-520-N PCS-500-RP	-	-	-	Three-axis manual manipulator with 25 *mm* travel. No PZT actuators or motors. Provides basic mechanical-manual positioning.
PCS-5000	PCS-520-150/1 PCS-503 PCS-PS60 PCS-500-RP	-	-	150	Three-axis micromanipulator with 25 *mm* of manual travel. One translation stage provides 150 *µm* PZT fine motion.
PCS-5100	PCS-520-300/1 PCS-503-3 PCS-PS60 PCS-500-RP	-	-	300	Three-axis micromanipulator with 25 *mm* of manual travel. One translation stage provides 300 *µm* PZT fine motion.

Configuration Summary of PCS-5000					
PCS-5200	PCS-520-150/3 PCS-503-3 PCS-PS60 PCS-500-RP	150	150	150	Three-axis micromanipulator with 25 *mm* of manual travel. All three translation stages provide 150 *µm* PZT fine motion.
PCS-5300	PCS-520-150/2-300/1 PCS-503 PCS-PS60 PCS-500-RP	150	150	300	Three-axis micromanipulator with 25 mm of manual travel. Two translation stages provide 150 µm PZT fine motion. One translation stage provides 300 µm PZT fine motion. Recommended system for working in slices where longer PZT travel on the Approach Axis PZT is required.
PCS-5400	PCS-520-300/3 PCS-503 PCS-PS60 PCS-500-RP	300	300	300	Three-axis micromanipulator with 25 mm of manual travel. All three translation stages provide 300 µm of PZT fine motion. Highest PZT range for working in thick slices where maximum flexibility is needed.

Chapter 3 Description

3.1. Theory of Operation

The PCS-520 Micromanipulator will be mounted to your microscope. Your headstage and pipette are mounted to the PCS-520. The manual knobs on the PCS-520 linear stages are used to move the pipette tip into the field of view of the microscope and ensure the limited range of the PZT flexure stages is sufficient to achieve the final desired position. Two rotary pivot stages are incorporated into the PCS-520 to allow optimum adjustment of the pipette working angle and easy pipette exchange.

The PZT flexure stages ***(Figure 3-1)***, integrated into the PCS-520, provide fine motion. The active element in each linear stage is a piezoelectric ceramic element that expands when a voltage is applied across it. The microstage has flexure joints (machined in a metal body) that amplify the motion of the piezoelectric element

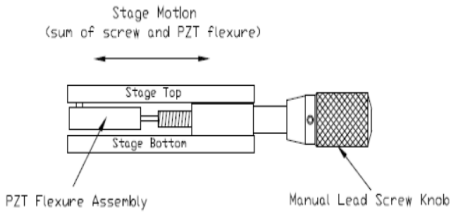


Figure 3–1 Schematic Drawing of PZT Flexure Stage

A drive signal from 0 to 60 V corresponds to zero maximum extension of the flexure stage. This drive signal is created in the PCS-PS60 Power Supply and PCS-503 Axis Control Unit. You precisely control the output voltage of the power supply (and the corresponding of the flexure stages) by rotating the potentiometers on the PCS-503. Thus, your fingertip commands are instantly converted to pipette movements with one-to-one precision.

3.2. Micromanipulator Assembly

The PCS-520 Micromanipulator Assembly ***(Figure 3-2)*** integrates PZT-flexure assemblies inside crossed roller bearing linear stages. This design is specifically intended for the operation of multiple manipulators on the same microscope for double-patching experiments.

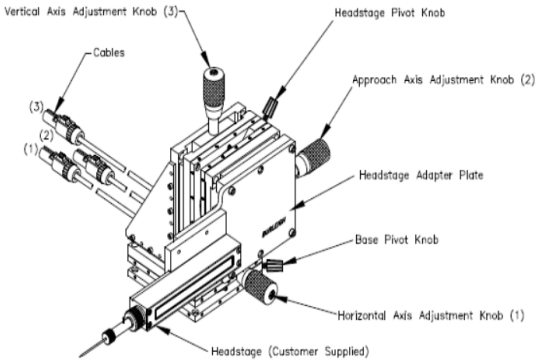


Figure 3–2 PCS-520 Micromanipulator Assembly

The PCS-520 consists of three linear stages, two rotary pivot stages, a headstage adapter plate, and two 90° brackets. Standardized dimensions, mounting holes, and fasteners make it easy to configure the micromanipulator for right-side, left-side, or orthogonal operation.

An adjustment screw on each linear stage provides 25 *mm* coarse travel with better than 5 *µm* resolution; allowing you to easily position a pipette tip near a preparation by turning three screws. The aluminum and crossed roller bearing construction provides high stiffness and stability coupled with light weight and low friction. Thermal sensitivity and vibration sensitivity are minimized. Manual position adjustments can be made without inducing excessive pipette position noise.

A piezoelectric stack is integrated into a proprietary metal flexure to provide amplified PZT travel.

The adjustment knob and the cable for each of the linear stages are numbered to help you configure the cables to the ACU so any knob can control any stage (see *PCS-503 Axis Control Unit* on Page 8).

The rotary pivot stages provide a 360° adjustment range with adjustable and repeatable stops and a mechanical locking mechanism. The base pivots around the vertical axis, so you can swing the entire micromanipulator away from the microscope for routine exchange of the pipette. The headstage pivots around the horizontal axis, so you can raise the headstage to exchange pipettes, and then lower it to a precise and repeatable angle. This pivot also allows you to optimize the angle of approach for inverted or upright microscopes where space and working distance are critical, or to minimize the amount of patch pipette in solution and the corresponding capacitance.

The headstage/pipette is mounted on a flat adapter plate which has mounting holes for the most common headstages.

3.3. PCS-PS60 Power Supply

The PCS-PS60 ***(Figures 3-3 and 3-4)*** provides a regulated, very low noise constant voltage output for the PCS-503 ACU. This power supply can be shared by two PCS 520/PCS 503 systems when multiple manipulators are required on the same microscope.

3.3.1. Front Panel

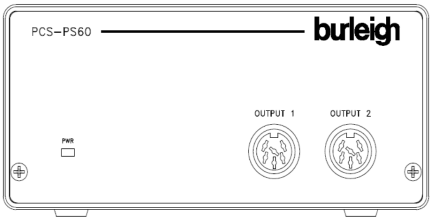


Figure 3–3 PCS-PS60 Front Panel

PWR Indicator

The PWR Indicator illuminates when AC power is on.

Output1

This interface allows you to connect the PCS-503 ACU to the PCS-PS60.

IMPORTANT

Always turn off the PCS-PS60 before you connect or disconnect the ACU.

Output 2

This interface allows you to connect a second PCS-503 ACU to the PCS-PS60.

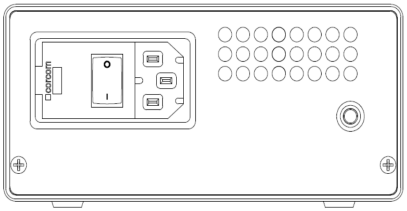


Figure 3–4 PCS-PS60 Rear Panel

Primary Power Module

This is a multi-functional assembly which integrates several functions including: the standard IEC style receptacle for attaching the line cord to the unit, the power switch, fuse holder and line voltage selector.

The selected line voltage (~150V or ~230V) appears in the window of the fuse cover.

The power switch uses the IEC standard symbols to indicate power condition: "|" is ON, and "O" is off.

CAUTION

Connect the PCS-PS60 to earthed mains outlet only.

Chassis Ground

The three-way binding post located on the rear panel of the PCS-PS60 is part of the chassis ground. The chassis ground binding post may be utilized for grounding of external conductor shields if required.

3.4. PCS-503 Axis Control Unit

The PCS-503 ACU allows you to position the pipette precisely while observing the preparation and pipette under the microscope. The ACU connects to the PCS-PS60 Power Supply and provides simple, convenient control of the PZT actuators. It has three orthogonal control knobs ***(Figure 3-5)*** connected to three turn potentiometers. The resolution of each potentiometers is 0.04% (one part in 2500). The position resolution of each axis is the maximum travel of the PZT flexure stage divided by 2500. Therefore, a 300 *µm* stage has 120 *nm* of resolution and a 150 *µm* stage has 60 *nm* of resolution.

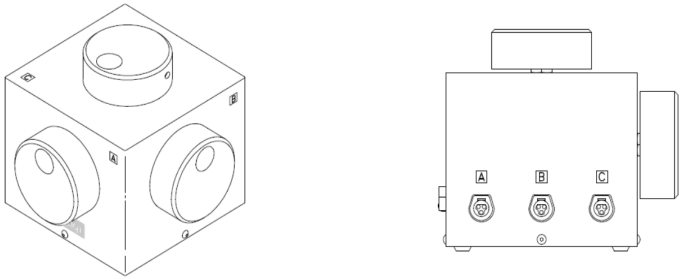


Figure 3–5 PCS-503 Axis Control Unit

You can configure the cables to the ACU so any knob can control any stage. The adjustment knob and the cable for each of the linear stages are numbered 1, 2 and 3. The ACU knobs and the connectors on the ACU are labeled A, B and C. For example, to have knob A control stage 1, plug cable 1 into connector A.

You can also adjust the potentiometer on the PCS-503 to achieve the smoothest possible position control (See *Adjusting the Friction of the PCS-503 Axis Control Unit Knobs* on Page 28).

Chapter 4 Installation

4.1. Packaging

The PCS-5000 has been packaged in a special carton designed to give maximum protection during shipment. If the outside of the shipping carton is damaged, notify your shipping department immediately. They may wish to notify the carrier at this point.

If the shipping carton is undamaged externally, remove and identify the following:

- PCS-503 Axis Control Unit
- PCS-PS60 Power Supply
- PCS-520 Micromanipulator
- PCS-500-RP Rotation Adapter Plate

Optional components may include:

- PCS-500 Series microscope mount
- PCS-500-PP universal post and platform mount

If any components are missing, contact Thorlabs, Inc. or your local representative. **Save the special carton for storage or transportation of the PCS-5000.**

4.2. Removing the Shipping Clips

To remove the shipping clips, follow the steps listed below:

1. Turn the coarse adjustment knob clockwise one to two turns or until the shipping clip is loose enough to be twisted on the shaft ***(Figure 4-1)***.
2. Holding the stage from which you are removing the clip, slide the clip off the shaft. Gently let the stage slide back into position.
3. Save the shipping clips for storage or transportation of the micromanipulator.

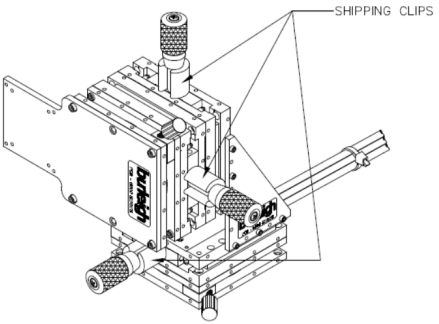


Figure 4–1 Location of Shipping Clips

4.3. Installing the Microscope Mount

Correct mounting is essential for providing good system performance. It is important that the mounting system be mechanically and thermally stable, while providing flexibility for different experimental set-ups.

We recommend using a microscope mount that attaches directly to the user's microscope. This method provides good stability and convenience.

4.3.1. PCS-500 Series Microscope Mounts (Optional)

The optional PCS-500 Series microscope mounts provide a stable platform for the PCS-5000 patch-clamp micromanipulator. They are designed for simple installation by the user and to minimize interference with other microscope accessories.

The PCS-500 Series microscope mounts allow you to mount the PCS-5000 micromanipulator directly to a variety of inverted microscopes:

Model	Description
PCS-500-18	Mount for the Leica DMIRB/E
PCS-500-14	Mount for the Nikon Diaphot 200/300 and TE 200/300
PCS-500-12	Mount for the Nikon TMD
PCS-500-11	Mount for the Olympus IMT-2
PCS-500-17	Mount for the Olympus IX50/IX70
PCS-500-13	Mount for the Zeiss Axiovert 10 with fixed stage
PCS-500-19	Mount for the Zeiss Axiovert 25
PCS-500-16A	Mount for the Zeiss Axiovert 100
PCS-500-15	Two-sided mount for the Nikon Diaphot 200/300 and TE 200/300

Thorlabs will continue to add to this list of microscope mounts as new microscopes (that are popular with patch clamp users) are introduced.

If your microscope is not included, please consult Thorlabs. Other mounting solutions are available as special orders.

To install the PCS-500 Series microscope mount, follow the installation instructions shipped with each mount.

4.3.2. Universal Post and Platform Mount (Optional)

For cases where a microscope mount is not available, a post mount can be utilized as an alternative. A universal solution that is particularly useful for upright microscopes is a post and platform that is secured to the top surface of the isolation table the microscope is on. Thorlabs offers two universal post and platform mounts.

Model	Description
PCS-500-PP11	Universal Post and Platform with Magnetic Base
PCS-500-PP12	Universal Post and Platform without Magnetic Base

To install the PCS-500 Series universal post and platform mount, follow the installation instructions shipped with each mount.

Because the post is mounted separately from the microscope, it is important that the microscope be rigidly mounted to the same base plate as the post mount. This may require modification to the microscope, i.e., removing the rubber feet, and/or clamping the microscope to the base plate.

4.3.3. Gibraltar Platform Adapters (Optional)

The Gibraltar™ platform and X-Y stage allow the microscope objective to be moved in X, Y, and Z directions without moving the preparation and patch pipettes. Using the manual micrometer screws on the X-Y stage and the microscope focusing knob, you can easily move the objective between fields of view without disturbing an established patch recording.

Models are available with a black aluminum or ferromagnetic stainless steel top. The Gibraltar platform can be used with a base plate for free-standing tabletop use or by directly bolting the posts to the tapped holes in the vibration isolation table. Models are available for the following microscopes:

Zeiss Axioskop FS Microscope

Model	Description
GIBRALTAR FS-1	Complete platform and X-Y stage with base for Zeiss Axioskop- FS, black plated aluminum top
GIBRALTAR FS-1SS	Complete platform and X-Y stage with base for Zeiss Axioskop- FS, steel honeycomb top
GIBRALTAR FS-2	Complete platform and X-Y stage to mount to vibration isolation table with tapped holes for Zeiss Axioskop-FS, black plated aluminum top
GIBRALTAR FS-2SS	Complete platform and X-Y stage to mount to vibration isolation table with tapped holes for Zeiss Axioskop-FS, steel honeycomb top

Zeiss Axioscope FS-2 Microscope

Model	Description
GIBRALTAR 2FS-1	Complete platform and X-Y stage with base for Zeiss Axioskop- FS-2, black plated aluminum top
GIBRALTAR 2FS-1SS	Complete platform and X-Y stage with base for Zeiss AxioskopFS- 2, steel honeycomb top
GIBRALTAR 2FS-2	Complete platform and X-Y stage to mount to vibration isolation table with tapped holes for Zeiss Axioskop FS-2, black plated aluminum top
GIBRALTAR 2FS-2SS	Complete platform and X-Y stage to mount to vibration isolation table with tapped holes for Zeiss Axioskop FS-2, steel honeycomb top

Olympus BX50WI Microscope

Model	Description
GIBRALTAR BX-1	Complete platform and X-Y stage with base for Olympus BX50WI, black plated aluminum top
GIBRALTAR BX-1SS	Complete platform and X-Y stage with base to mount to vibration isolation table with tapped holes for Olympus BX50WI, steel honeycomb top
GIBRALTAR BX-2	Complete platform and X-Y stage to mount to vibration isolation table with tapped holes for Olympus BX50WI, black plated aluminum top
GIBRALTAR BX-2SS	Complete platform and X-Y stage to mount to vibration isolation table with tapped holes for Olympus BX50WI, black plated aluminum top

Nikon E600FM Microscope

Model	Description
GIBRALTAR EFN-1	Complete platform and X-Y stage with base for Nikon E600FN, black plated aluminum top
GIBRALTAR EFN-1SS	Complete platform and X-Y stage with base to mount to vibration isolation table with tapped holes for Nikon E600FN, steel honeycomb top

Model	Description
GIBRALTAR EFN-2	Complete platform and X-Y stage to mount to vibration isolation table with tapped holes for Nikon E600FN, black plated aluminum top
GIBRALTAR EFN-2SS	Complete platform and X-Y stage to mount to vibration isolation table with tapped holes for Nikon E600FN, steel honeycomb top

Leica DM LFS Microscope

Model	Description
GIBRALTAR LFS-1	Complete platform and X-Y stage with base for Leica DMLFS, black plated aluminum top
GIBRALTAR LFS-1SS	Complete platform and X-Y stage with base for Leica DMLFS, steel honeycomb top
GIBRALTAR LFS-2	Complete platform and X-Y stage to mount to vibration isolation table with tapped holes for Leica DMLFS, black plated aluminum top
GIBRALTAR LFS-2SS	Complete platform and X-Y stage to mount to vibration isolation table with tapped holes for Leica DMLFS, steel honeycomb top

Inverted Microscopes

Model	Description
GIBRALTAR IRBE	Complete platform and X-Y Stage with base for Leica DMIRB/E, steel honeycomb top
GIBRALTAR IX70	Complete platform and X-Y Stage with base for Olympus IX50/IX70, steel honeycomb top
GIBRALTAR TE3	Complete platform and X-Y Stage with base for Nikon Diaphot TE300, steel honeycomb top
GIBRALTAR A100	Complete platform and X-Y Stage with base for Zeiss Axiovert 100, steel honeycomb top

4.4. Mounting the PCS-520 to Your Microscope

The PCS-500-RP Rotation Adapter Plate ***(Figure 4-2)*** allows you to position your micromanipulator at any angle. This kinematically designed adapter plate allows the PCS-520 to be mounted using one 1/4-20 screw on centerline and secured at any angle.

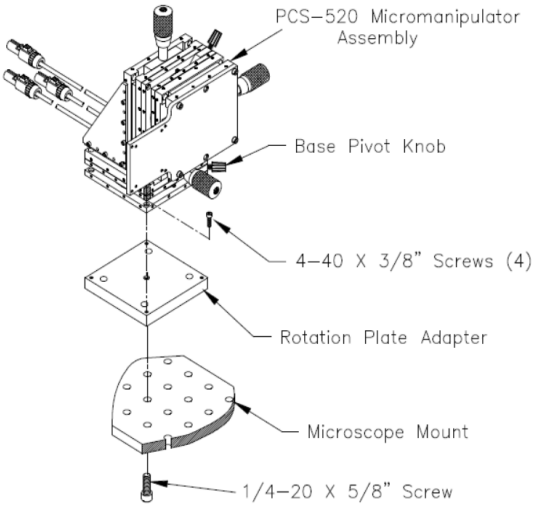


Figure 4–2 Mounting the PCS-520 with the PCS-500-RP Rotation Adapter Plate

CAUTION

To prevent damage to the micromanipulator assembly, do not turn any of the adjustment knobs while the shipping clips are installed.

1. Remove the shipping clips as described in *Removing the Shipping Clips* on Page 10.
2. If you need to reconfigure the micromanipulator, follow the appropriate procedure in *Configuring the PCS-520 Micromanipulator Assembly* on Page 17.
3. Using the .050" hex wrench provided, slightly loosen the set screws of the adjustable stop mechanism on the headstage pivot stage and the base pivot stage ***(Figure 4-3)***. To prevent binding, be sure these screws remain recessed in the holes even when loosened.

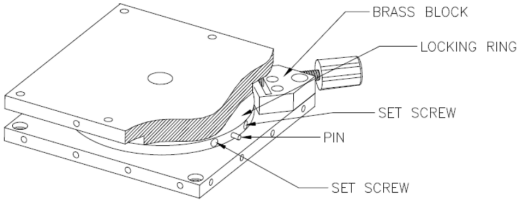


Figure 4–3 Rotary Pivot Stage- Adjustable Stop Mechanism

4. To gain access to the clearance holes, loosen the base pivot knob and rotate the upper section of the micromanipulator assembly while keeping the lower section stationary.
5. To mount the PCS-520 Micromanipulator Assembly using the PCS-500-RP Rotation Adapter Plate:
    a. Use four 4-40 X 3/8” screws to attach the rotation adapter plate to the bottom of the PCS-520 Micromanipulator assembly, with the circular cutout in the rotation adapter plate toward the microscope mount.
    b. Attach the PCS-520 with rotation adapter plate to the PCS-500 (or equivalent) microscope mount, using one 1/4-20 X 5/8 screw in the central threaded hole of the rotation plate.
6. To mount the PCS-520 Micromanipulator without the PCS-500-RP Rotation Adapter Plate, use the counter board holes on the stage bottom. To get the best stability, mount the stage using four 4-40 socket head cap screws, two on each side of the centerline.

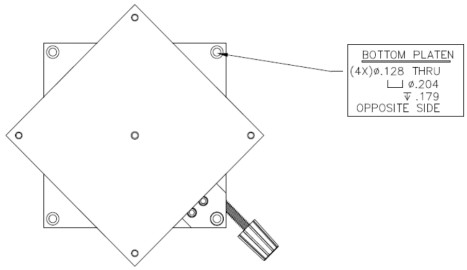


Figure 4–4 Mounting Hole Pattern in Rotary Pivot Stage

7. Instal the headstage and the pipette (see *Mounting a Headstage and Pipette* on Page 23).
8. Connect the PCS-PS60 and the PCS-503 (see *Setting Up the PCS-PS60 and the PCS-503* on Page 24).

4.5. Configuring the PCS-520 Micromanipulator Assembly

Standardized dimensions, mounting holes and fasteners make it easy to configure the micromanipulator for right-side operation (below), left-side operation (Page 18) or orthogonal operation (Page 19).

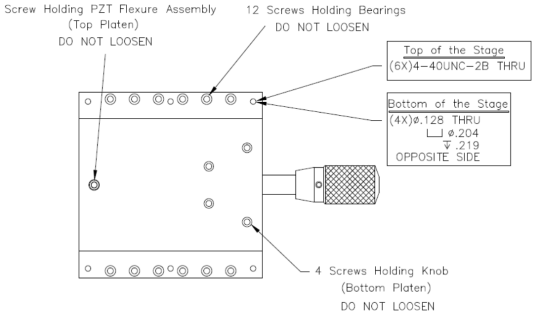


Figure 4–5 Mounting Hold Pattern in Linear Stage

CAUTION

Do not loosen or remove any of the screws holding the stage together or the stage will have to be returned to Thorlabs for reassembly.

4.5.1. Right-Side Operation

When shipped, the PCS-520 Micromanipulator Assembly is normally configured for right-side operation ***(Figure 4-6)***. To convert a PCS-520 configured from left-side or orthogonal operation to right-side operation, simply do the left-side/orthogonal configuration in reverse.

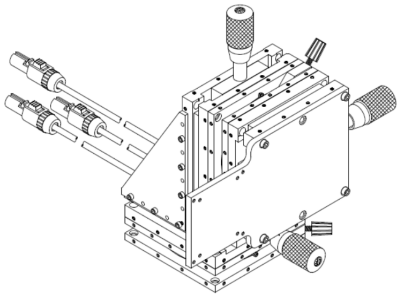


Figure 4–6 PCS-520 Right-Side Operation

4.5.2. Left-Side Operation

To reconfigure the PCS-520 for left-side operation:

1. If the micromanipulator assembly is already mounted for right-side operation, remove the pipette and the headstage. Then remove the PCS-520 from the microscope mount.
2. Use a 0.050" hex wrench to loosen the set screw on the base rotary pivot stage locking ring ***(Figure 4-7)***. Loosen the base pivot knob and turn the base rotary pivot stage 90° to reposition the base pivot knob. Make sure both set screws are recessed into the locking ring, and then reposition the locking ring until the pin contacts the brass block. One set screw will be covered by the brass block. Tighten the remaining set screw.

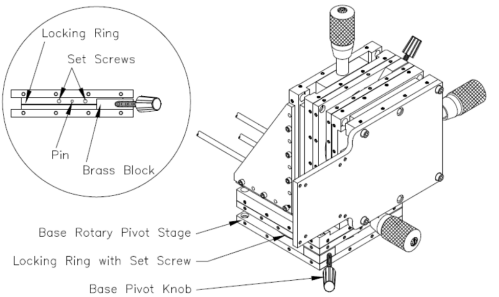


Figure 4–7 Repositioning the Base Rotary Pivot Stage

3. Loosen the headstage rotary pivot knob ***(Figure 4-8)*** and turn the headstage rotary pivot stage so you can access the 4-40 screws holding the rotary pivot stage to the linear stage for the vertical axis.
4. Remove the four 4-40 screws holding the rotary pivot stage to the linear stage for the vertical axis.

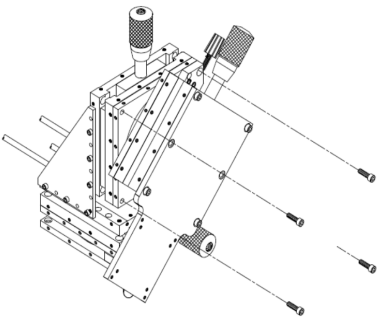


Figure 4–8 Removing the Headstage Rotary Pivot

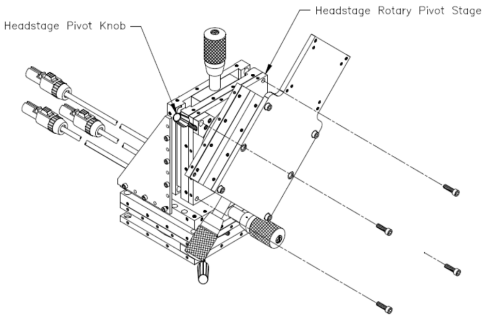


Figure 4–9 Reconfiguring the PCS-520 for Left-Side Operation

5. Turn the rotary pivot stage 90° to reposition the headstage pivot knob and reinstall the four screws ***(Figure 4-9)***.
6. Set the headstage to the desired angle.
7. Attach the PCS-520 to the microscope mount.
8. If necessary, adjust the right-angle brackets (See *Right-Angle Bracket Adjustments* on Page 22).
9. Install the headstage ad the pipette (See *Mounting a Headstage and Pipette* on Page 23).

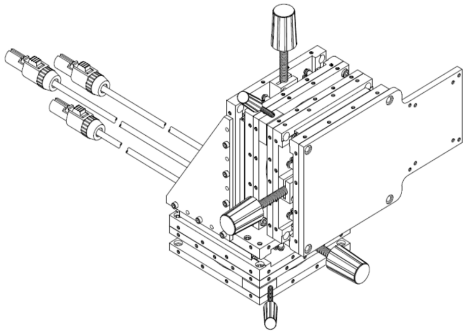


Figure 4–10 PCS-520 Left-Side Configuration

4.5.3. Orthogonal Approach Axis

The PCS-520 Micromanipulator is supplied with the Y and Z linear stages mounted at right angles. The approach stage is in line with the pipette. To mount the approach linear stage orthogonal to the other axes, follow the steps below:

1. If the micromanipulator assembly is already mounted for left- or right-side operation, remove the pipette and the headstage.
2. Remove the four 4-40 screws and the headstage adapter plate ***(Figure 4-11)***.

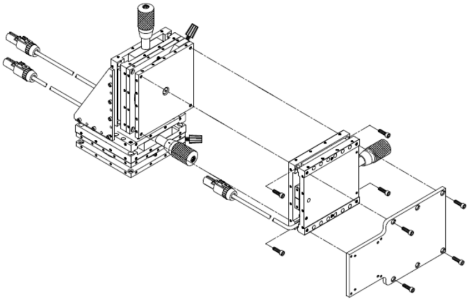


Figure 4–11 Removing the Headstage Adapter Plate and Approach Axis Linear Stage

3. Turn the approach axis adjustment knob to move the approach axis linear stage to the extremes of travel and gain access to the screws. Remove the four 4-40 screws and the approach axis linear stage for the approach axis as shown in ***Figure 4-12***.
4. Rotate the headstage rotary pivot stage so you can access the four screws holding the rotary pivot stage to the linear stage for the vertical axis. Remove the four 4-40 screws and the rotary pivot stage.

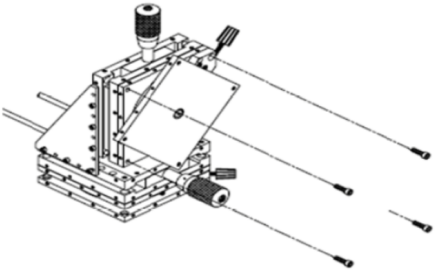


Figure 4–12 Removing the Headstage Rotary Pivot

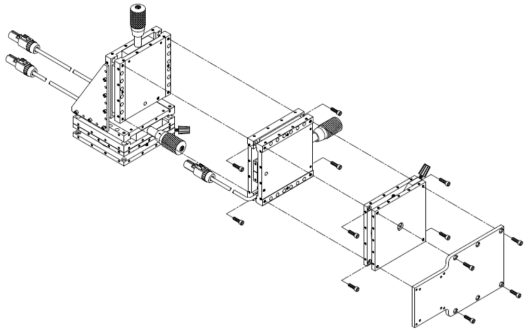


Figure 4–13 Reconfiguring the PCS-520 for Orthogonal Operation

5. Use the four screws to attach the linear stage for the approach axis to the linear stage for the vertical axis ***(Figure 4-13)***.
6. Use the four screws to attach the rotary pivot stage for the headstage to the linear stage for the approach axis.
7. Use the four screws to attach the headstage adapter plate to the rotary pivot stage for the headstage.
8. If necessary, adjust the right-angle brackets (see *Right-Angle Bracket Adjustments* below).
9. Install the headstage and the pipette (see *Mounting a Headstage and Pipette* on Page 23).

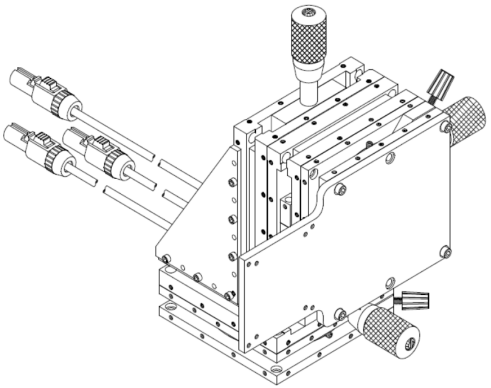


Figure 4–14 Orthogonal Approach Axis Configuration

4.5.4. Right-Angle Bracket Adjustments

In some cases, the 25 *mm* adjustment range of the micrometers is insufficient to put the pipette tip in the proper position (for example, in changing from a steep approach angle to a shallow approach angle). For these cases, the right-angle bracket can be adjusted.

The pipette can be raised or lowered by moving the mounting location of the Z-axis stage up or down on the right-angle bracket. The end of the stage base can extend 30 *mm* (1.2") past the end of the bracket without compromising the rigidity.

The pipette can be moved forward or backward by moving the mounting location of the right-angle bracket forward or backward on the Y-axis stage. The end of the bracket can extend 38 *mm* (1.5") past the edge of the Y-axis without compromising the rigidity.

CAUTION

These adjustments require loosening the screws holding the stages to the right angle bracket. Do not inadvertently drop or damage the micromanipulator and headstage. Remove the pipette to prevent accidental breakage

Each bracket has five holes on the short axis and seven holes on the long axis ***(Figure 4-15)***.

Each of the linear and rotation stages has four holes on each edge ***(Figure 4-16)***.

The brackets are attached with three screws on the short axis and thee screws on the long axis.

By using different combinations of holes, you can reposition the brackets to change the configuration of the PCS-520.

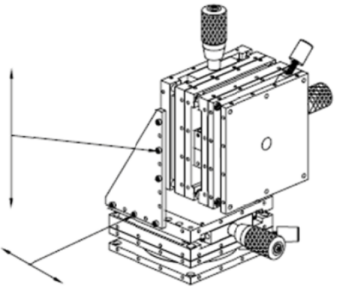


Figure 4–15 Bracket Adjustment

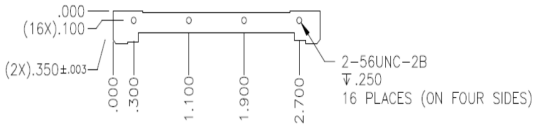


Figure 4–16 Mounting Hole Pattern on Stage

Bracket adjustments can be made regardless of right-sided, left-sided, or orthogonal configuration.

CAUTION

When making right-angle bracket adjustments, make sure the electrical cables have adequate clearance from any part of the micromanipulator assembly. Damage can result to the signal cabling if the cable restricts motion of the stage.

4.6. Mounting a Headstage and Pipette

The PCS-5000 comes with an adapter plate for mounting typical patch clamp recording headstages. The adapter plate includes tapped holes to attach directly to the plate supplied with the AXON CV-5 and CV 203B headstages, as well as holes for use with the HEKA EPC-9 headstage ***(Figure 4-17)***. Additional holes may be added for other headstages.

1. Make sure the mating surfaces are clean and free of debris.
2. Attach the headstage using four 2-56 x 3/8 screws (two extra screws are provided).
3. Use the A holes for the HEKA EPC-9 headstage.
4. Use the B holes for the AXON headstages.
5. Use the 5/64 hex wrench to tighten the screws.

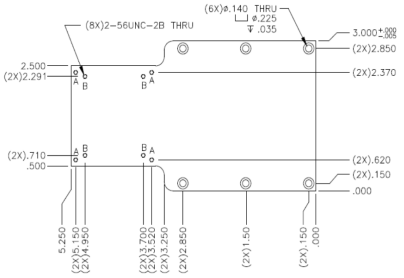


Figure 4–17 Headstage Adapter Plate

6. To adjust the position of the headstage, change the position of the four 4-40 screws holding the headstage adapter plate to the PCS-520 ***(Figure 4-18)***.

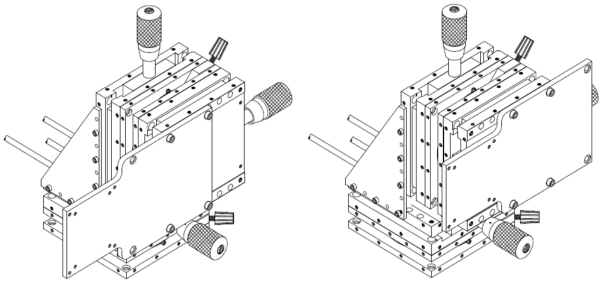


Figure 4–18 Alternate Positions for Headstage Adapter Plate

4.7. Setting up the PCS-PS60 and the PCS-503

1. Place the PCS-PS60 and the PCS-503 Axis Control Unit on a firm horizontal surface.
2. Connect each linear stage of the PCS-520 Micromanipulator assembly to the PCS-503 ACU.

CAUTION

For double-patching experiments requiring the operation of multiple manipulators on the same microscope, connect another PCS-520 Micromanipulator assembly to a second PCS-503 Axis Control Unit.

3. Attach the PCS-503 ACU to the Output 1 connector on the front of the panel of the PCS-PS60.
4. If necessary, attach the second PCS-503 ACU to the Output 2 connector on the front panel of the PCS-PS60.

CAUTION

Before inserting the line cord, check that the line voltage selector in the line filter on the rear panel of the instrument matches the local line voltage.

5. Attach the AC line cord to an outlet.
6. Turn on the power switch. The PWR indicator should light. When the power switch is tuned on, you might hear a slightly audible hum.

Chapter 5 Operation

5.1. Adjusting the Approach Axis Angle

The approach axis can be set to any angle.

5.1.1. Changing the Angle

Using the three adjustment knobs ***(Figure 5-1)***, adjust each of the manual stages to the center of travel. Affix the micromanipulator to the mounting surface.

IMPORTANT

Always try to set home position in this manner. This will assure maximum stability of the micromanipulator and give the greatest amount of flexibility in positioning devices around the microscope objective.

1. Loosen the base pivot knob
2. Hold the headstage to prevent it from slipping and loosen the headstage pivot knob.
3. Position the approach axis angle as desired, placing the pipette under the objective of the microscope. Carefully tighten the base pivot knob until the stages are locked in position.
4. Looking through the microscope objective and using the three adjustment knobs, position the pipette where you want it.

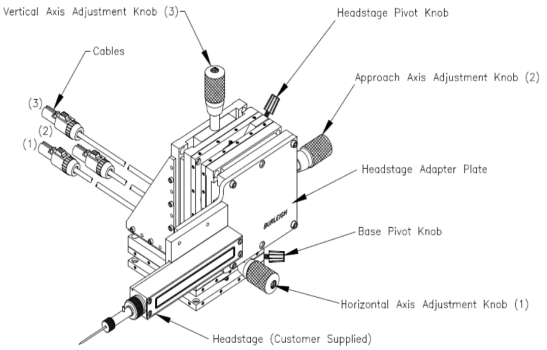


Figure 5–1 Approach Axis Angle Adjustment

Both the headstage pivot stage and base pivot stage provide an adjustable stop so the approach axis can be moved, then reset back to the same angle. This is useful when changing pipettes (See *Changing Pipettes*, below).

5.1.2. Setting the Adjustable Stop

The adjustable stop mechanism on each rotary pivot stage consists of a locking ring, two set screws, a pin, and a brass block ***(Figure 5-2)***.

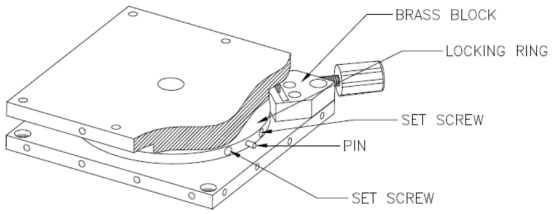


Figure 5–2 Adjustable Stop Mechanism

1. Position the headstage at the desired angle (see previous procedure).
2. If you have not already done so, use a .050" hex wrench to loosen the set screw in the locking ring (see step 3 in *Mounting the PCS-520 to your Microscope* on Page 15).
3. On the headstage pivot stage, carefully rotate the locking ring counterclockwise (clockwise if mounted on the left side), until the pin rests against the brass block. With the headstage pivot stage facing you, the pin should be resting below the brass block. Tighten the visible set screw with the .050" hex wrench. (The other set screw will be covered by the brass block; this is normal.)
4. On the base pivot stage, rotate the locking ring clockwise (counterclockwise if mounted on the left side), until the pin rests against the brass block. With the headstage facing you, the pin should rest against the brass block to the right of the base pivot knob (to the left if mounted on the left side). Tighten the visible set screw with the .050" hex wrench. (Again, the other set screw will be covered by the brass block.)

5.2. Changing Pipettes

Begin by loosening the headstage. The rotary pivot stages allow you to rotate the entire micromanipulator assembly forward, which greatly simplifies the pipette exchange procedure. In this forward position, the headstage and pipette holder are very accessible and pipettes are easy to remove and insert. After a new pipette is installed the micromanipulator assembly is rotated back to a precise and repeatable position. You operate the base rotary pivot stage in the same manner as the headstage pivot stage (See *Adjusting the Approach Axis Angle* on Page 25).

1. Pivot knob and the base pivot knob
2. Using the headstage pivot stage and the base pivot stage, rotate the pipette up and out from the microscope objective. Headstage and pipette

are now in the forward position and very accessible for pipette exchange.

3. After the pipette exchange, swing the pipette back under the objective as far as it will go in both the horizontal and vertical planes. The adjustable stops you set in the procedure above return the pipettes to the original home position. Tighten the pivot knob on both the headstage pivot stage and the base pivot stage.

CAUTION

To hold the headstage steady while you exchange pipettes, temporarily tighten the headstage pivot knob.

4. Check the field of view in your microscope. Allowing for some variation in pipette lengths, you should be back in home position and ready to proceed.

5.3. Positioning the Pipette

In the PCS-520, fine positioning is performed using the three PZT actuators in the linear stages. Coarse positioning is performed using the manual adjustment knobs. Be careful when adjusting the knobs. Do not turn them if you can feel a change in the resistance to motion. Pay careful attention to the cables as shown in ***Figure 5-3***. Make sure they are not forced into any surface that will restrict motion of the stage.

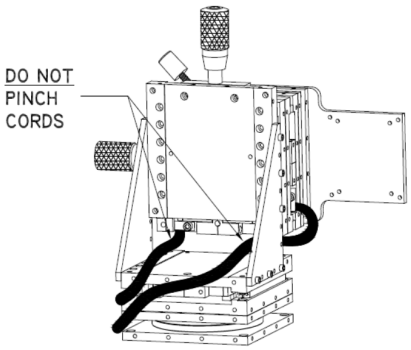


Figure 5–3 Cable Routing

CAUTION

Do not force the manual adjustment knobs. A change in resistance of the coarse knob indicates the stage is at an end of travel or there is an obstruction. Readjust the stage position or clear the obstruction. Damage can occur to the micromanipulator if you continue to adjust the knob.

5.3.1. Controlling the PZT Position

The PCS-503 Axis Control Unit (ACU) has three independent voltage output channels, one for each PZT microstage in the micromanipulator. The voltage on each channel is controlled by a potentiometer on the PCS-503. Turning the knob fully counterclockwise results in a 60 V output while fully clockwise (three revolutions) results in a 0 V output. The 0.04% resolution and the layout of the ACU are described in PCS-503 ACU.

To make the approach to the cell easier, set the approach axis voltage to 0 V (ACU knob fully counter-clockwise). Set the Y and Z axes' voltage to 30 V (ACU knob in mid-range).

5.4. Adjusting the Friction of the PCS-503 Axis Control Unit Knobs

Follow these steps to adjust the friction of the control knobs on the PCS-503 ACU.

1. Place the ACU on a flat surface, with the control knob you want to adjust facing up.
2. Loosen the lock screw on the control knob.
3. Press down the control knob until the desired friction level is obtained.
4. Tighten the lock screw.
5. Repeat steps 1-4 for the other control knobs.

5.5. Adjusting the Friction and Eliminating Lateral Play in the PCS-520 Adjustment Knobs

The sleeve can be rotated to adjust the friction and lateral stability of the adjustment knobs on the PCS-520 Micromanipulator. A special wrench ***(Figure 5-4)*** is included in the toolkit to easily rotate the sleeve.

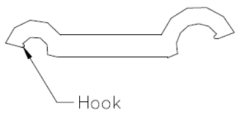


Figure 5–4 Special Spanner Wrench

1. Locate the catch hole on the sleeve ***(Figure 5-5)***. Position the smaller head of the wrench around the sleeve, making sure the hook catches on the hole.

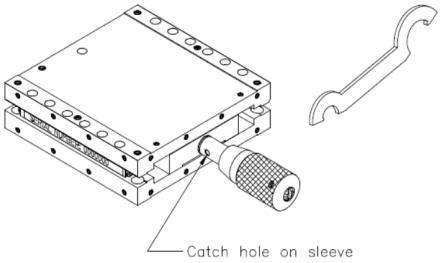


Figure 5–5 Locating the Catch Hole

2. Turn the wrench clockwise to tighten the sleeve, increasing the friction. By repositioning the wrench underneath and turning counterclockwise, the sleeve can be loosened, decreasing the friction of the adjustment knob ***(Figure 5-6)***. Do not loosen the sleeve all the way; it should be snug. If the sleeve is loose, the adjustment knob will be free to move laterally or to "wiggle." To increase the lateral stability, simply tighten the sleeve.

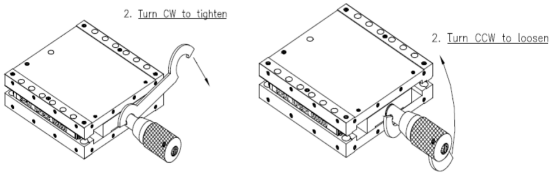


Figure 5–6 Adjusting the Sleeve

5.6. General Recommendation

5.6.1. Poling the PZT Actuators

If the PZT actuators have not been used for several months they should be "poled" to ensure optimum stability. The poling process re-aligns the electric dipoles in the piezoelectric ceramic material. To "pole" the actuators, set the voltage for one actuators at 60 V (ACU knobs fully counterclockwise) for one minute and repeat the process for all actuators.

Chapter 6 Troubleshoot

The PCS-5000 is designed to be a stable, low-drift system. It is modular to allow greater flexibility and ease of service. Our experience has shown you can correct most problems yourself. However, we strongly recommend against disassembly or user repair of the PZT actuators and cross roller bearing stages.

If the system is not functioning correctly, refer to the troubleshooting guide below to identify possible causes of problems. If this guide is not successful, contact Thorlabs Customer Service or your local representative for further help.

6.1. Troubleshooting

Problem: Excess motion of pipette tip during manual adjustment

Typical Symptoms:

- Excess or erratic motion of pipette tip
- Pipette sensitive to vibration
- "Losing" cells after making a seal

Probable Causes:

- Instability is generally caused by loose mechanical connections or dirt/debris between the mating surfaces

What to Check:

Micromanipulator and Linear Stages:

Check that the following screws are tight:

- Locking screws on rotary and pivot stages
- Screws holding headstage to headstage mount
- Screws holding linear stages to each other
- Screws holding linear stages to mounting system

Mounting System

- Check that the mounting system is stable.
- Check that all the screws are tight.
- Check that mating surfaces are free of dirt, debris, and burrs.
- Refer to Installing the Microscope Mount on Page 11 for recommended mounting systems.
- Refer to the installation instructions for the PCS-500 microscope mounts.

CAUTION

In the cases where the PCS-5000 is not attached directly to the microscope, it is important that the microscope itself is stable. The microscope and the mount holding the PCS-5000 must both be rigidly attached to the same base plate or optical table. This may mean a modification to the microscope, for example, removing the rubber feet and/or providing some way to clamp it to the base plate.

Problem: No Motion

Typical Symptoms:

- No motion (or less motion than specified for the stage) when ACU knobs are adjusted.

Probable Causes:

- Lack of fine motion is usually caused by a mechanical interference between the piezo and some part of the microscope such as the stage, sample chamber, or condenser.
- The piezo cables may not be properly connected to the patch clamp driver.
    - The PZT actuators are designed for high reliability, it is unlikely that one of them will become defective.

What to Check:

Linear Stages

- Visually check for interference.
- Check that no part of the micromanipulator is rubbing or hitting the microscope mount.
- Check that the system moves correctly when manually adjusted.

Problem: Drift

Typical Symptoms:

- Pipette tip moving after manual and PCT adjustments are completed
- "Losing" cells after making a seal
    - Also refer to the troubleshooting section *Problem: Excess Motion of Pipette Tip During Manual Adjustment*, above.

Probable Causes

- The solid-state design of the PCS-5000 produces negligible heat and associated internal thermal drift. Extreme thermal drift is usually caused by thermal changes in the lab environment. The most thermally sensitive components are the headstage, the pipette holder and the pipette itself. If the PCS-5000 is not mounted directly to the microscope, then the mounting system also may contribute to drift.

What to Check

Linear Stages

- Check that the PCS-503 is warmed up and stabilized (20 minutes).
- Check that the system (PCS-5000, mount and microscope) is protected from drafts.
- Check for heat sources near the system (for example: power supplies, heaters, lamps, sunlight).
- Check for ambient temperature changes during the experiment.
    - For more information about minimizing thermal drift, refer to the following Application Note, available from Thorlabs, Inc.: Frederick Sachs, A Low Drift Micropipette Holder, European Journal of Physiology (1995) 429:434-435.

6.2. Fuse Holder

CAUTION

Always replace the fuse(s) with the same type of rating: T0.3A, 250V.

This fuse holder has dual-line fusing.

The fuse holder can hold either 1/4" x 1/4" or 5 x 20 *mm* style fuses.

6.2.1. Changing the Fuse(s)/Voltage

To remove the fuse holder to replace a defective fuse(s), or to reconfigure the input voltage to either 115 V or 230 V, follow the steps below:

1. The voltage visible through the fuse access door ***(Figure 6-1)*** is the set voltage rating.
2. Set the power switch to the off “0” position and disconnect the AC line cord. Insert a flathead screwdriver under the tab on the fuse access door. Rotate the screwdriver to pop open the cover.

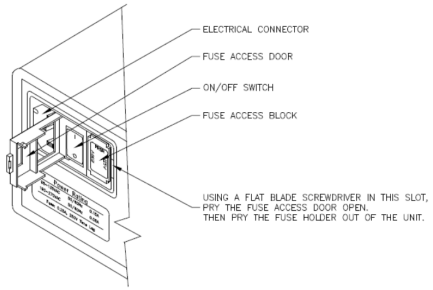


Figure 6–1 Removing the Fuse Holder

3. Insert the flathead screwdriver in the groove on the right side of the red fuse holder and gently pull out the fuse holder.

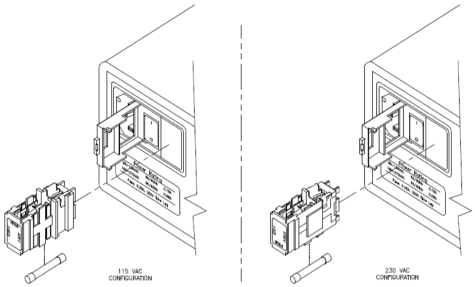


Figure 6–2 Position of Dual Fuse Holder Positions

4. Remove the fuses from their locations and verify the condition of both fuses.
    a. **To replace the fuse(s)**, simply insert a new fuse in the same location.
    b. Reinstall fuse holder assembly with the correct line voltage appearing in the window.

6.2.2. Troubleshooting the PCS-PS60 Power Supply

The PCS-PS60 has been designed for reliable operation but if problems arise, the following troubleshooting guide may be useful in identifying the cause:

Symptom	Cause	Remedy
PWR indicator on the front panel does not light	No Power	Check the AC line cord connection to primary power module. Check the AC line cord connection to power mains.
	Blown fuse(s)	Change the fuse(s)

CAUTION

High voltages are present inside the PCS-PS60. Do not remove the top cover of the instrument.

6.3. Reinstalling the Shipping Clips

To prevent damage to the PZT flexure assembly, you must reinstall the shipping clips for each linear stage prior to storage or shipment of the PCS-5000 ***(Figure 6-3)***.

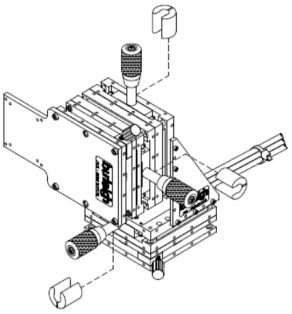


Figure 6–3 Location of the Shipping Clips

1. Turn the adjustment knob so that the edge of the top platen is 1/4" forward of the edge of the bottom platen ***(Figure 6-4)***.

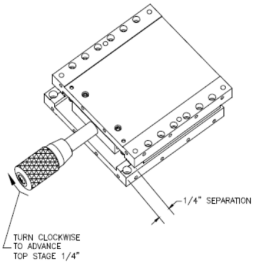


Figure 6–4 Stage Preparation

2. Carefully release the preload on the stage by sliding the top platen backward so that it is once again aligned with the bottom platen. Install the shipping clip on the stage.
3. Gently allow the stage to slide so that the coarse adjustment knob is resting against the shipping slip. Turn the knob counterclockwise until it stops and is snug against the clip.

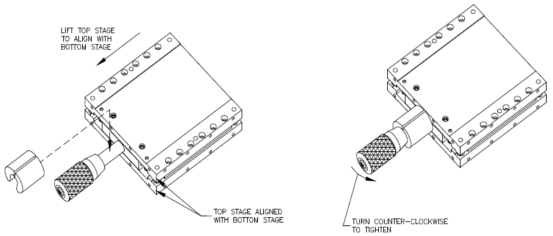


Figure 6–5 Shipping Clip Installation

6.4. Cleaning Instructions

To clean the exterior of the axis control unit, the manipulator, or the PCS-PS60 Power Supply enclosure use only a dry or slightly dampened (with water) cloth. Be sure to unplug the supply cord prior to cleaning the unit(s).

CAUTION

DO NOT attempt to remove the covers of either the axis control unit or the PCS-PS60 Power Supply! Hazardous voltages are present.

Chapter 7 Specifications

Environmental Specifications	
Operating Conditions	
Ambient Temperature	50 to 40 °C
Altitude	2000 m maximum
Atmospheric Pressure	70 to 106 kPa
Relative Humidity	15 to 95% (non-condensing)
Installation Category	II
Pollution Degree	2
Transport and Storage Conditions	
Temperature	-40 to 70 °C
Relative humidity	10 to 100%
Atmospheric Pressure	50 to 106 kPa

Product Safety	
IEC 61010-1:2001	Safety Requirement for Electrical Equipment for Measurement, Control and Laboratory Use Part I.
EN 61010-1:2001	Safety Requirement for Electrical Equipment for Measurement, Control and Laboratory Use
CAN/CSA C22.2 No. 61010-1-04	Safety Requirement for Electrical Equipment for Measurement, Control and Laboratory Use Part I; General Requirements
UL61010-1:2 nd	Safety Requirement for Electrical Equipment for Measurement, Control and Laboratory Use Part I; General Requirements
IEC Equipment Class: I Installation Category: II Pollution Degree: 2	

Electromagnetic Compatibility	
EN 61326-1:2001/A1/A2	Electromagnetic Compatibility Immunity Testing-Measurement, Control and Laboratory Equipment
CE Marking:	
Council Directive 73/23/EEC	Low Voltage Directive
Counsil Directive 89/336/EEC	EMC Directive

FCC CLASS A Digital or Peripheral-Information to User

This devices complies with Part 15 of the FCC Rules .Operation is subject to the following two conditions:

(1) this device may not cause harmful interference and

(2) this device must accept any interference received, including interference that may cause undesired operation

PCS-520 Micromanipulator Assembly	
Number of Axes	3 Linear Axes, 2 Rotational Axes
Range of Motion for Linear Stages	
Coarse Motion	25 mm
PZT Motion Options	None, 150 µm or 300 µm
Fine Motion Actuator	PZT Stack with Flexure Amplifier
Operating Voltage	0 to 60 V
Cable Length	2.9 meters
Types of Stages	Linear Crossed-Roller Bearings with Aluminum Construction
Weight	3.25 lbs

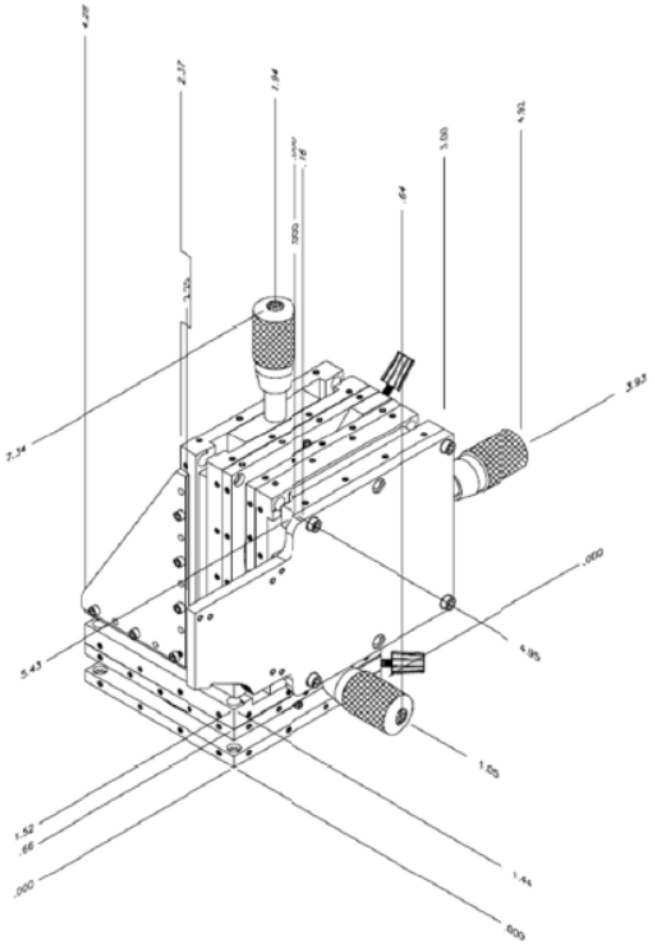
PCS-520 Micromanipulator Assembly	
General	
AC Power	100-120 / 220 - 240 V. 0.3 A
Line Frequency	50/60 Hz
Fuse	TO.3A 250 V
Weight	2.3 lbs
Dimensions	5.57" x 7.00 x 2.52" (144 mm x 178 mm x 64 mm)
High Voltage Outputs	
Output Voltage	68 ± 0.5 V (No Load)
Output Independance	2 Ω
Noise and Ripple	< 0.8 mV RMS, from 1 Hz to 100 kHz < 0.2 mV RMS, from 1 Hz to 1 kHz
Long-Term Stability	± 0.1 V
Front Panel	
Axis Control Unit	2 Female, 6-pin, mini-DIN Style Connectors
Rear Panel	
Power Module	On/Off Switch, Fuse(s), Voltage Selection
Chassis Ground	Chassis Three-Way Grounding Post

Pin#	**Description**	**Pin#**	**Description**	**Pin#**	**Description**
1	68 V Nominal	3	Not Used	5	Not Used
2	GND	4	GND	6	Not Used

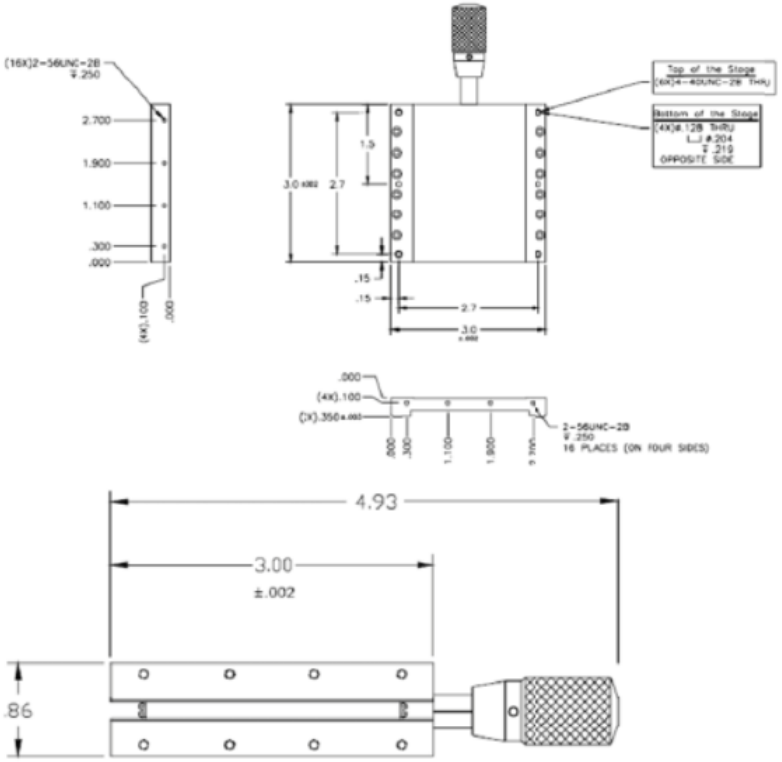
PCS-503 Axis Control Unit	
Number of Axes	3 Axes
Contorl Type	3-Turn Potentiometer
Ouput Voltage	0 to 60 V
Voltage Stability	Better than 0.1% (after 20 min initial warm-up period)
Reolution	0.04% (1 part in 2500)
Cable Length	2.9 m
Weight	1.5 lbs

Chapter 8 Dimensions

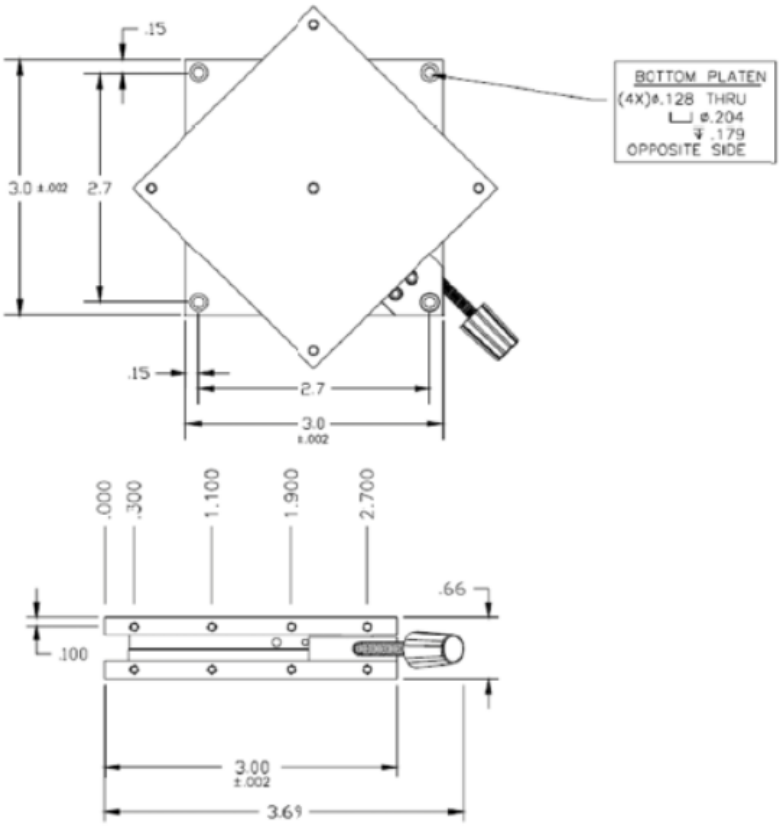
8.1. PCS-520



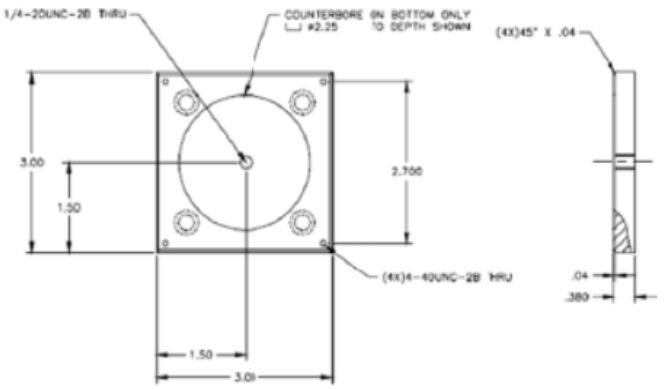
8.2. Linear Stage



8.3. Rottary Stage



8.4. Rotation Adapter Plate



The inside set of four mounting holes on the roation plate adapter is not suited to mount the PCS-5000 Series Micromanipulator. They are used to mount a PCS-3000 Series Micromanipulator or for mounting the manipulator to a surface with tapped holes.

Chapter 9 Regulatory

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabsoffers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

This offer is valid for Thorlabselectrical and electronic equipment:

- Sold after August 13, 2005
- Marked correspondingly with the crossed out “wheelie bin” logo (see right)
- Sold to a company or institute within the EC
- Currently owned by a company or institute within the EC
- Still complete, not disassembled and not contaminated

Wheelie Bin Logo

As the WEEE directive applies to self-contained operational electrical and electronic products, this end of life take back service does not refer to other Thorlabsproducts, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB’s, housings etc.).

If you wish to return a Thorlabsunit for waste recovery, please contact Thorlabsor your nearest dealer for further information.

9.1. Waste Treatment is Your Own Responsibility

If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

9.2. Ecological Background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

Chapter 10 Warranty

Burleigh PCS-5000 Series Motorized Patch-Clamp Micromanipulators are warranted against defects in material and workmanship for a period of two years after date of delivery. During the warranty period, Thorlabs, Inc. will repair or, at its option, replace parts that prove defective when the instrument is returned prepaid to Thorlabs, Inc.

Before return of an instrument, please call Thorlabs, Inc. for return authorization. The warranty will not apply if the instrument has been damaged by accident, misuse, or as a result of modification by persons other than Thorlabs, Inc. personnel.

The liability of Thorlabs, Inc. (except as to title) arising out of supplying of said product, or its use, whether under the foregoing warranty, a claim of negligence, or otherwise, shall not in any case exceed the cost of correcting defects in the products as herein provided. Upon expiration of the warranty period specified herein, all liability shall terminate. The foregoing shall constitute the sole remedy of the buyer. In no event shall the seller be liable for consequential or special damages.

Chapter 11 Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.

USA, Canada, and South America
Thorlabs, Inc.
sales@thorlabs.com
techsupport@thorlabs.com

Europe
Thorlabs GmbH
europe@thorlabs.com

France
Thorlabs SAS
sales.fr@thorlabs.com

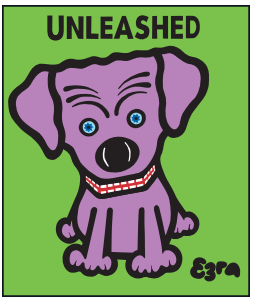
Japan
Thorlabs Japan, Inc.
sales@thorlabs.jp

UK and Ireland
Thorlabs Ltd.
sales.uk@thorlabs.com
techsupport.uk@thorlabs.com

Scandinavia
Thorlabs Sweden AB
scandinavia@thorlabs.com

Brazil
Thorlabs Vendas de Fotônicos Ltda.
brasil@thorlabs.com

China
Thorlabs China
chinasales@thorlabs.com



THORLABS

www.thorlabs.com