ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *Thorlabs / Exfo / Burleigh PCS-6000* at our website: *Click HERE*

Burleigh®
IN CONTROL

OPERATING MANUAL

PCS-6000 SERIES
Motorized Patch-Clamp Micromanipulator

035-00266 (Rev. 0)



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form, be it electronically, mechanically or by any other means such as photocopying, recording or otherwise, without the prior written permission of EXFO Photonic Solutions Inc. (EXFO).

Information provided by EXFO is believed to be accurate and reliable. However, no responsibility is assumed by EXFO for its use or for any infringements of patents or other rights of third parties that may result from its use. No license is granted by implication or otherwise under any patent rights of EXFO.

The information contained in this publication is subject to change without notice.

© 2007 EXFO Photonic Solutions Inc.

Words that EXFO considers trademarks have been identified as such. EXFO®, Burleigh® and Gibraltar® are registered trademarks. However, neither the presence nor absence of such identification affects the legal status of any trademark.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

CONTENTS

1. Introduction....1-1
Getting Started....1-1
Overview....1-1
Major Components....1-2
Micromanipulator Assembly....1-2
Axis Control Unit....1-2
Joystick....1-3
Controller Unit....1-3
Glossary of Symbols....1-3
Safety Warnings....1-4
2. Description....2-1
Mechanisms of Motion....2-1
Coarse Motion....2-1
Fine Motion....2-1
Configurations....2-2
Axes of Motion....2-2
Right and Left Configurations....2-3
Manipulator Configurations....2-3
3. Orientation....3-1
Control Unit....3-1
Front Panel....3-1
Rear Panel....3-3
Axis Control Unit (ACU)....3-4
Joystick....3-5
Graphical User Interface....3-6
Serial Port Communication....3-11
4. Installation....4-1
Unpacking the Unit....4-1
Removing the Shipping Clips....4-1
Mounting the Manipulator....4-2
Connecting the Cables....4-2
Mounting a Headstage and Pipette....4-3
5. Operation....5-1
Powering Up and Checking for Motor Motion....5-1
Positioning Under the Microscope and Checking for Piezo Motion....5-1
Adjusting the Approach Axis Angle....5-2
Setting the Adjustable Stop....5-3
Operational Hints....5-3
Joystick Control....5-3
Piezo Control....5-4

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Single Stepping 5-4
Drift Problems 5-4
6. Maintenance 6-1
Overview of Maintenance Required 6-1
Maintenance Schedule 6-1
Lubricating Motor Shafts 6-1
Electronic Maintenance 6-6
Replacing the Fuse(s) 6-6
Adjusting the Friction of the ACU Knobs 6-7
Adjusting the Friction and Eliminating Lateral Play in the Manual Adjustment Knobs 6-8
Troubleshooting 6-9
Problem: Excess motion of pipette tip during manual adjustment 6-9
Problem: No fine motion 6-10
Problem: No coarse motion 6-11
Problem: Drift 6-12
7. Specifications 7-1
Performance: 7-1
Environmental Specifications: 7-1
Product Safety: 7-2
WEEE Directive Compliance: 7-3

Warranty

Index

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1. INTRODUCTION

Getting Started

Thank you for purchasing a PCS-6000 Series motorized manipulator. This manual is intended to provide in-depth information on the operation and use of the PCS-6000.

Overview

Burleigh PCS-6000 Series patch-clamp micromanipulators from EXFO Life & Industrial Division are ultra-stable, high-resolution positioning systems designed for patch clamp recording. EXFO 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-6000 micromanipulator is mounted on or next to your microscope. Your headstage and pipette are mounted to the Burleigh PCS-6000 so that the end of the pipette is in the field of view of the microscope. The Burleigh PCS-6000 provides rapid motorized positioning with travel range of about 25 mm and steps as small as 5 μm. After preliminary positioning with the motors, fine positioning is obtained by using piezo actuators, with 150 μm or 300 μm travel. Special rotational adjustments are incorporated to allow optimum pipette working angle and easy pipette exchange. The Burleigh PCS-6000 is modular and allows numerous configurations so that it can be customized for each user.

The motor is controlled by a joystick that is separate and distinct from the fine motion control. The farther the joystick is moved from its rest position, the faster the stage moves. The fastest speed attainable is 2 mm/second. The fine motion of the piezo is controlled by the position of a large knob on the axis control unit (ACU). The knobs can be turned through 1080 degrees (three revolutions) to sweep the entire range of the piezo movement, either 150 or 300 μm. When the knob is left in a specific position, motion stops.

While the Burleigh PCS-6000 was designed for patch clamp recording, the characteristics of the instrument are useful for many other applications requiring high-precision positioning capabilities.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com



Figure 1-1: PCS-6000 Series patch-clamp micromanipulator

Major Components

Micromanipulator Assembly

The micromanipulator assembly consists of up to four linear stages and two rotary pivot stages assembled with a 90° bracket. Depending on the configuration, the linear stages can have no piezo, a 150 μm piezo or a 300 μm piezo, no long-travel adjustment mechanism, a manual long travel adjustment screw or a motor.

Axis Control Unit

The axis control unit (ACU) is a rectangular box with large rotary knobs that control the position of the piezo actuators. Normally it is placed next to the microscope.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Joystick

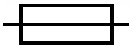
The joystick controls the speed and direction of the servo motors. The joystick assembly also includes switches to activate specific functions.

Controller Unit

The control unit contains the electronics that drive the piezo and the servo motors.

Glossary of Symbols

The following safety related symbols are used on this product and throughout this manual:

	**CAUTION – RISK OF DANGER** **Consult accompanying documentation prior to operation**
	**CAUTION** **Risk of Electrical Shock – Do not remove cover, no user serviceable parts inside**
	**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.**
	**Chassis Ground**
	**Motor Direction Switch**
	**Input/Output Control Signal**
	**Fuses – User Replaceable**
	**Safety Ground**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Safety Warnings

	**WARNING** **Should this equipment be used in a manner not specified by EXFO, the protection provided by the equipment may be impaired. Always follow the operating instructions as indicated!**
	**WARNING** **Refer servicing to qualified personnel. To prevent electrical shock, do not open or remove the cover of the controller or joystick.**
	**WARNING** **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.**
	**WARNING** **To reduce the risk of fire or shock, always replace the fuses with the same type and rating. Always detach the power supply cord prior to attempting to replace fuses!**
	**WARNING** **This unit contains high voltage components. It is recommended that only qualified technical personnel perform testing or repairs.**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2. DESCRIPTION

Mechanisms of Motion

PCS-6000 linear stages integrate piezo-flexure assemblies inside crossed roller bearing linear stages with a stepping motor for coarse motion. The joystick is used to control the coarse motion. A large knob on the axis control unit (ACU) controls the fine positioning obtained by use of a piezo. Two rotary pivot stages are incorporated into the manipulator to allow optimum adjustment of the pipette working angle and easy pipette exchange.

Coarse Motion

Coarse motion is provided by a stepping (servo) motor attached to the linear translation stage. The motor is controlled by a joystick that has a "dead zone" in the rest position. This is a safety feature so that a small accidental touch does not cause motion. The farther away from the neutral position the joystick is moved, the faster the motor moves the stages. The direction of motion of the motor is controlled by the direction of the joystick motion. It is possible to move along a diagonal line if the joystick is moved along a diagonal.

With a bit of practice an experienced operator can learn to position the pipette to within about 15 μm of the target with the coarse motion provided by the motor.

Fine Motion

The piezo-flexure stages integrated into the linear stage provide fine motion. These stages contain a piezoelectric ceramic element that expands when a voltage is applied across it. The piezoelectric element is mounted in a specially machined metal body that provides amplification of the motion.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

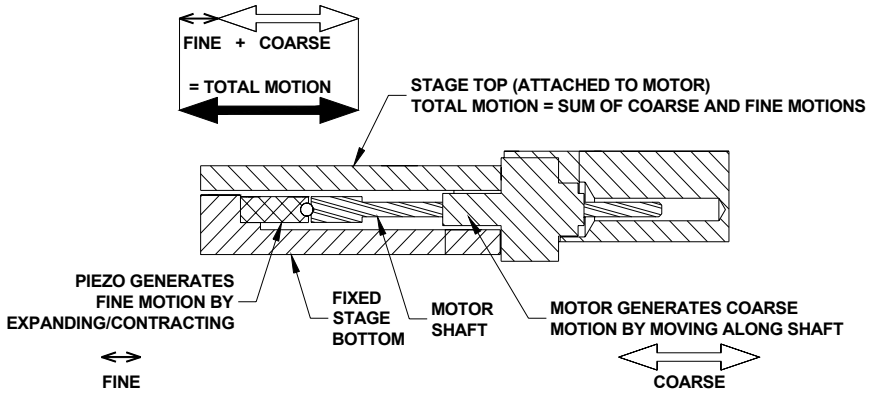


Figure 2-1: Section view of stage and piezo showing the additive nature

The voltage applied to the piezoelectric ceramic element is controlled by the position of the large knob on the ACU. The large knob is connected to a three-turn potentiometer (variable resistor). The expansion of the piezoelectric element is determined solely by the position of the knob. Thus, the motion of the stage follows the position of the knob. The motion is instantaneous and stops as soon as the knob is left in a single position.

Configurations

The PCS-6000 is a modular system. Different configurations are available for the linear stages. Stages normally are configured with a motor and either 150 or 300 μm piezos. Alternatives to the normal configurations are those that have coarse motion provided by a manual adjusting screw or no coarse motion all. It is possible to get coarse motion only with no fine piezo motion.

Axes of Motion

The four axes correspond to the following motions.

Axis number	Axis name	Motion type
1	X	Front to back from operator's perspective
2	Y	Left and right from the operator's perspective
3	Z	Vertical (up and down)
4	Approach	Angled (adjustable) axis that the head stage attaches to

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

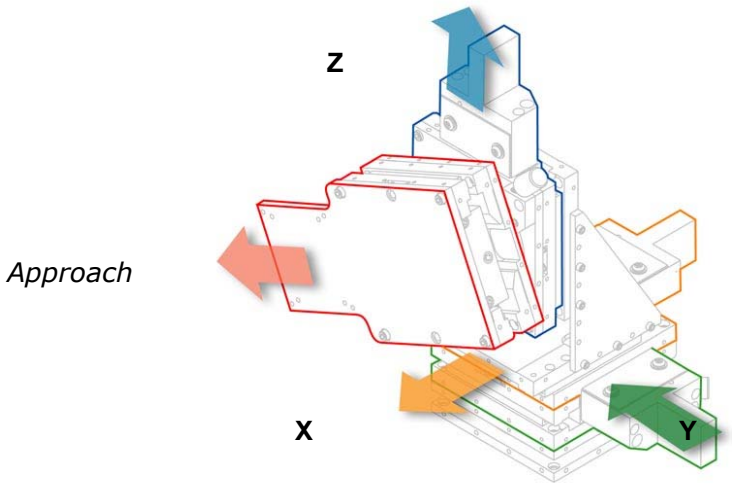


Figure 2-2: Graphic representation of axes

Right and Left Configurations

A right-hand configuration is used when the manipulator is placed on the right of the microscope. The manipulator is assembled such that the approach axis projects to the left and the rotary stage locking knobs are conveniently located on the outboard (right) side of the manipulator. The left-hand configuration essentially is a mirror image of the right hand.

Manipulator Configurations

PCS-6100

This configuration has three orthogonal axes:

- Axis 1 – front to back
- Axis 2 – left to right
- Axis 3 – vertical

Axis 1 and Axis 2 have manual knobs only with no piezo elements and no motors. Axis 3 has a motor and a 150-μm piezo. It is available in both right- and left-hand configurations.

In addition, there are two rotary stages – one that rotates in the horizontal plane and one in the vertical plane.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

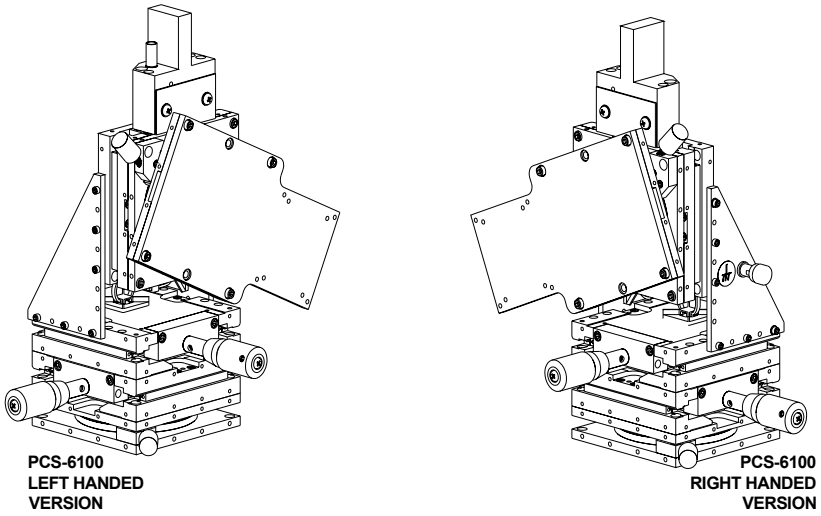


Figure 2-3: PCS-6100

PCS-6200

This configuration has three axes:

- Axis 1 – front to back
- Axis 3 – vertical
- Axis 4 – approach

All three axes have the motorized linear stages with 150-μm piezo elements.

In addition, there are two rotary stages – one that rotates in the horizontal plane and one in the vertical plane.

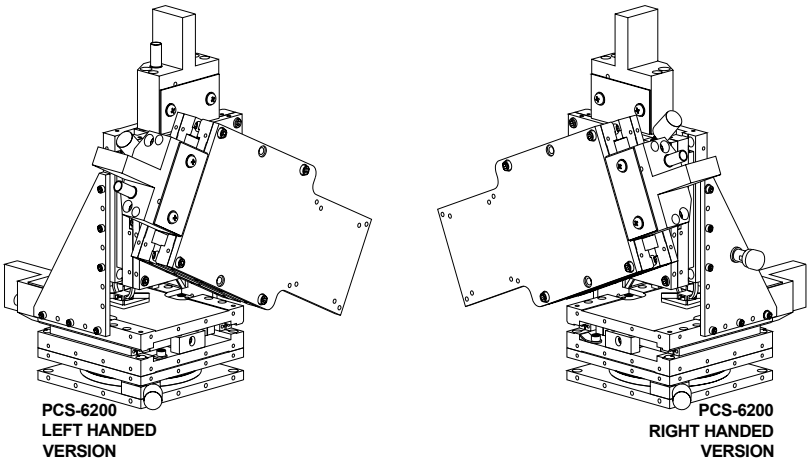


Figure 2-4: PCS-6200

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

PCS-6300

This configuration has three axes.

- Axis 1 – front to back
- Axis 3 – vertical
- Axis 4 – approach

All three axes have motorized linear stages. Axis 1 and Axis 3 have 150-μm piezo elements while Axis 4 has 300-μm piezo element.

In addition, there are two rotary stages – one that rotates in the horizontal plane and one in the vertical plane.

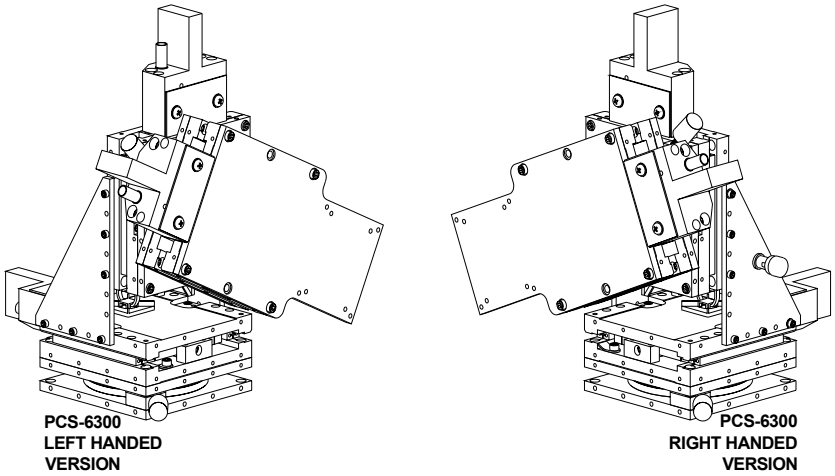


Figure 2-5: PCS-6300

PCS-6400

This configuration has three axes.

- Axis 1 – front to back
- Axis 3 – vertical
- Axis 4 – approach

All three axes have the motorized linear stages with 300-μm piezo elements.

In addition, there are two rotary stages – one that rotates in the horizontal plane and one in the vertical plane.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

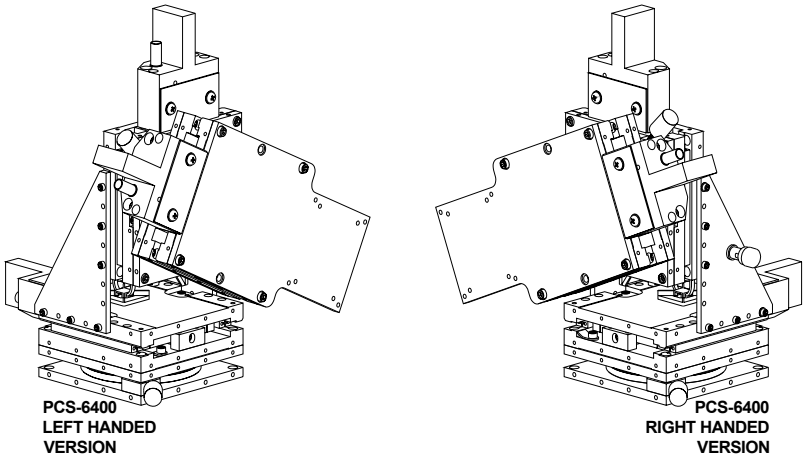


Figure 2-6: PCS-6400

PCS-6500

This configuration has four axes:

- Axis 1 – front to back
- Axis 2 – left to right
- Axis 3 – vertical
- Axis 4 – approach

Axis 1 and Axis 2 have motorized linear stages only. Axis 3 has a motor and 150-μm piezo element. Axis 4 has a 150-μm piezo element with no coarse motion.

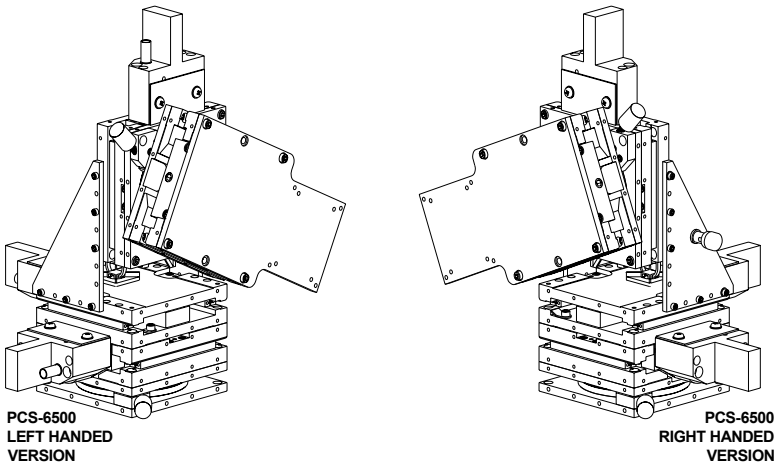


Figure 2-7: PCS-6500

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Additional configurations

Non-standard configurations are available by special order from the factory. Their product designation is PCS6000 – (XXXX). Special order configurations permit the combination of options to suit the exact experiment. Coarse and fine positioning options are listed in the table below.

Coarse Positioning Options	Fine Positioning Options
Motorized	300 μm
Manual	150 μm
Fixed at center	No fine positioning

Rotary Pivot Stage

Each PCS-6000 manipulator comes with two rotary pivot stages with adjustable stops (Figure 2-8). One is on the very bottom of the manipulator and allows for rotation in the X – Y plane (parallel to Z axis). The other is mounted to the moving portion of the vertical axis and allows for rotation in the Y – Z plane (parallel to the X axis). The rotary pivot stages enable the operator to rotate away to perform a task such as replace a pipette and then return very close to the original set point.

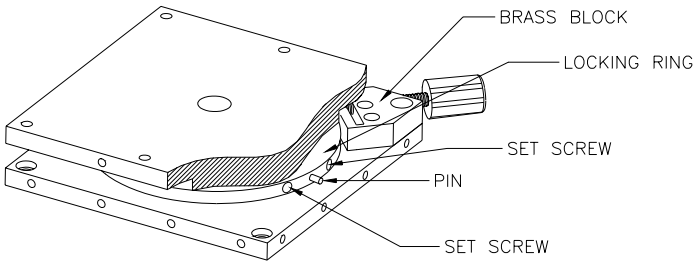


Figure 2-8: Rotary pivot stage with adjustable stop mechanism

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. ORIENTATION

Control Unit

The control unit supplies the drive signals to both the piezo actuators and the drive motors. The drive board for the motors is on top layer. The drive board for the piezo actuators is on the bottom.

Front Panel

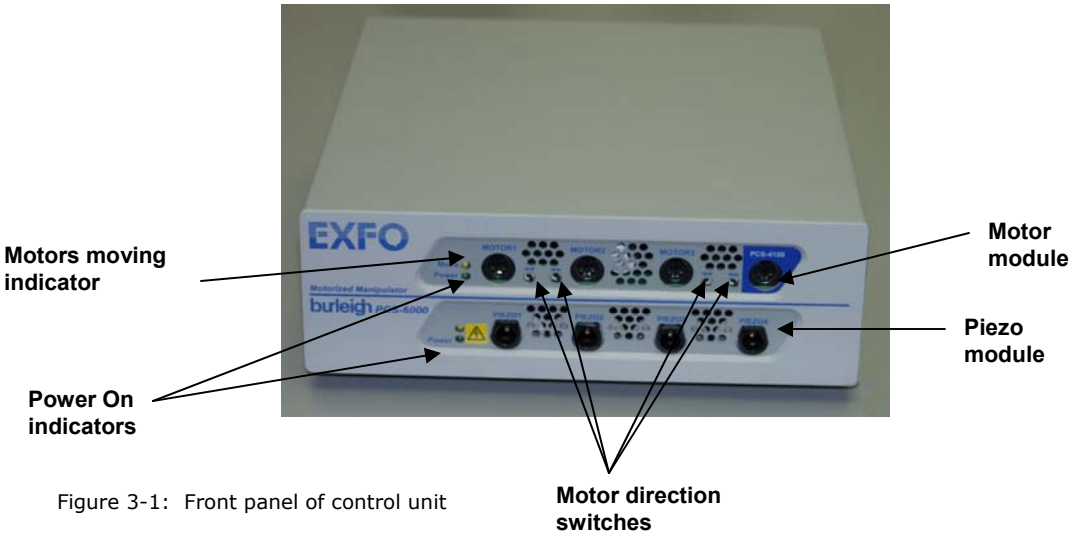


Figure 3-1: Front panel of control unit

Motor Control Board

There are four receptacles for motors on the motor control board. The motor drive circuits are identical in all four channels. The motors should be plugged into their corresponding receptacle. The motors are stepping motors with a base micro-step of step of 1.6 μm. The direction of the motor travel can be reversed by the small toggle switch next to the receptacle.

The motor control board has two lights on it. The green **Power** light indicates that the power to the board is on and that the board has completed its power on routine. The yellow **Move** light is lit only when one or more motors are being told to move.

When the joystick is displaced from its rest position, the microprocessor on the motor board provides the proper current drive waveforms to the motor causing it to move in the direction indicated by the joystick deflection. Within about ½ second after the joystick is returned to its rest position, the current to the motor shuts down to a very minute holding current. This prevents the loss of position.

If an axis is commanded to move beyond its physical limits in either direction, the axis motion stops but the motor continues to turn. This is called a "stall" condition and does not harm the motor as long as the motor does not remain in the stalled condition for a significant period of time (more than 15

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

seconds). Stall is detected by noticing that the **Move** light is on, but no motion is detected. The motor generates a clicking sound while in stall.

Several configurations of the PCS-6000 have less than four motors. In these instances, there are unused motor receptacles. There is no need to do anything special with these unused connections because they are inactive without a motor plugged into them.

Servo Motor Control Memory Options

The controller is available with 2 different memory options:

The "T" type configuration provides 2 memory presets which are functional on the manipulator stage connected to "Motor 2" input on the controller front panel. This is typically used on the manipulator for the *Approach axis.* This controller setting can be verified by 2 audible beeps when the controller is powered up.

The "C" type configuration provides 2 memory presets which are functional on the manipulator stage connected to "Motor 3" input on the controller front panel. This is typically used on the manipulator for the *Z (vertical) axis.* This controller setting can be verified by 3 audible beeps when the controller is powered up.



CAUTION

Never connect or disconnect the cables when the unit is on. This could cause an arc and damage to the control unit.

Piezo Control Board

The piezo control board is the lower board in the PCS-6000 control chassis. It has four receptacles for piezo units. Depending on the position of the knob on the ACU box, a voltage between 0 and 60 V DC is applied to the piezo unit.

Several configurations of the PCS-6000 have less than four piezo units. In these instances, there are unused piezo receptacles.



WARNING

Dangerous voltage may be present. Do not plug anything into the piezo receptacle when the unit is turned on. Ensure the unit is turned off before connecting any piezo cables.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Rear Panel

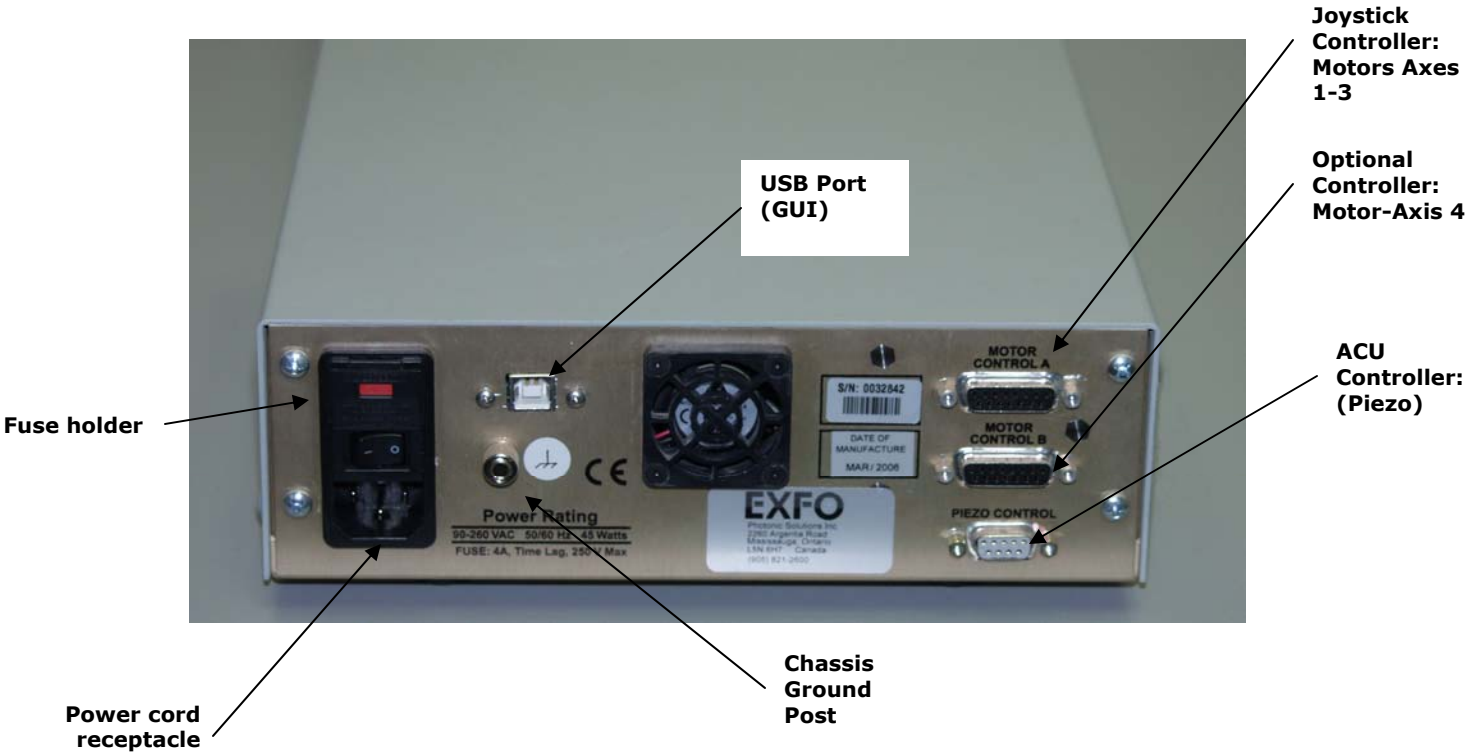


Figure 3-2: Rear panel of control unit

Operating Voltage

The unit contains a universal power supply. No changes are needed to switch from 110V AC 60 Hz to another allowed voltage and frequency (see Section 7, *Specifications* for details).

The power switch uses the IEC standard symbols to indicate power condition - **|** is ON, and **O** is off. See Section 6, *Maintenance* for fuse replacement.

Chassis Ground

The three-way binding post is part of the chassis ground to the PCS-6000. The chassis of the PCS-6000 is connected to the safety ground in the line cord.

Joystick and ACU Connections

The joystick and the ACU plug into their respective connections on the back of the unit.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Axis Control Unit (ACU)

The axis control unit (ACU) allows you to adjust the piezo elements for fine positioning. The ACU connects to the rear of the PCS-6000 control unit via a nine-pin connector. Depending on the model, it can have as many as four control knobs. Each knob is attached to a three-turn potentiometer.

The resolution of each potentiometer is approximately 0.04% (one part in 2500). The position resolution of each axis is the maximum travel of the piezo motion divided by 2500. Therefore, a 300 μm stage has 120 nm of resolution, and a 150 μm stage has 60 nm of resolution.

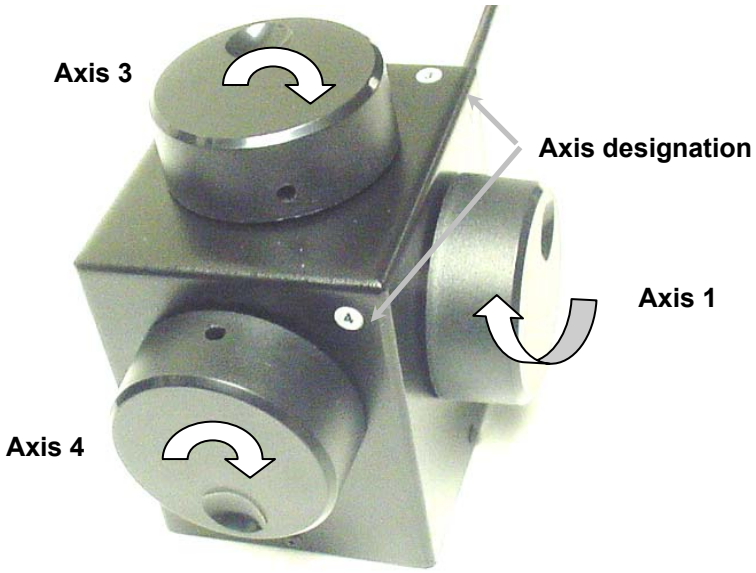


Figure 3-3: Front view of axis control unit (ACU)

There is a number on each face of the ACU that corresponds to the axis that knob controls. The piezo cables from the manipulator should be plugged into the corresponding receptacle. If desired, the cables can be interchanged when connecting them to the control unit so that a specific knob can control any stage.

It also is possible to adjust the resistance to turning of the large knob to enhance the tactile feedback (refer to Section 6, *Adjusting the Friction of the Axis Control Unit Knobs*.)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Joystick

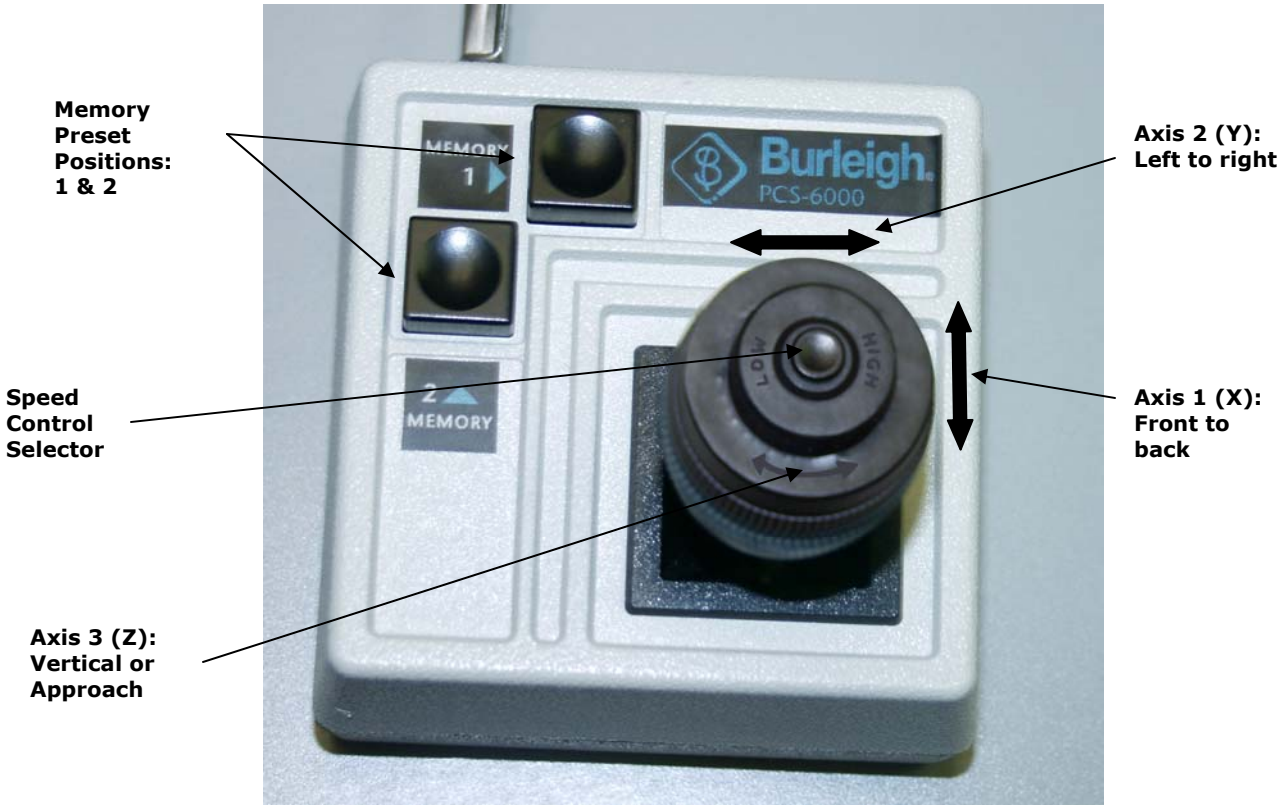


Figure 3-4: Joystick- Servo Motor Control

The joystick is used to control the servo motors to provide coarse positioning. The joystick itself has three axes of motion: front to back (X-axis), left to right (Y-axis) and rotating the knob right to left for the (Z or approach axis).

The joystick controller consists of a 3 axis control, a high/ low speed control button and 2 separate memory position buttons to control position on either the Z or Approach axes. An additional push button switch on the end on the joystick control knob toggles between high and low speed. Speed change is accomplished by pressing and holding down the button. One beep indicates low speed has been selected, and two beeps indicate that high speed has been selected. The vertical or approach axis is controlled by rotating the large knob on the joystick to the right or left.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

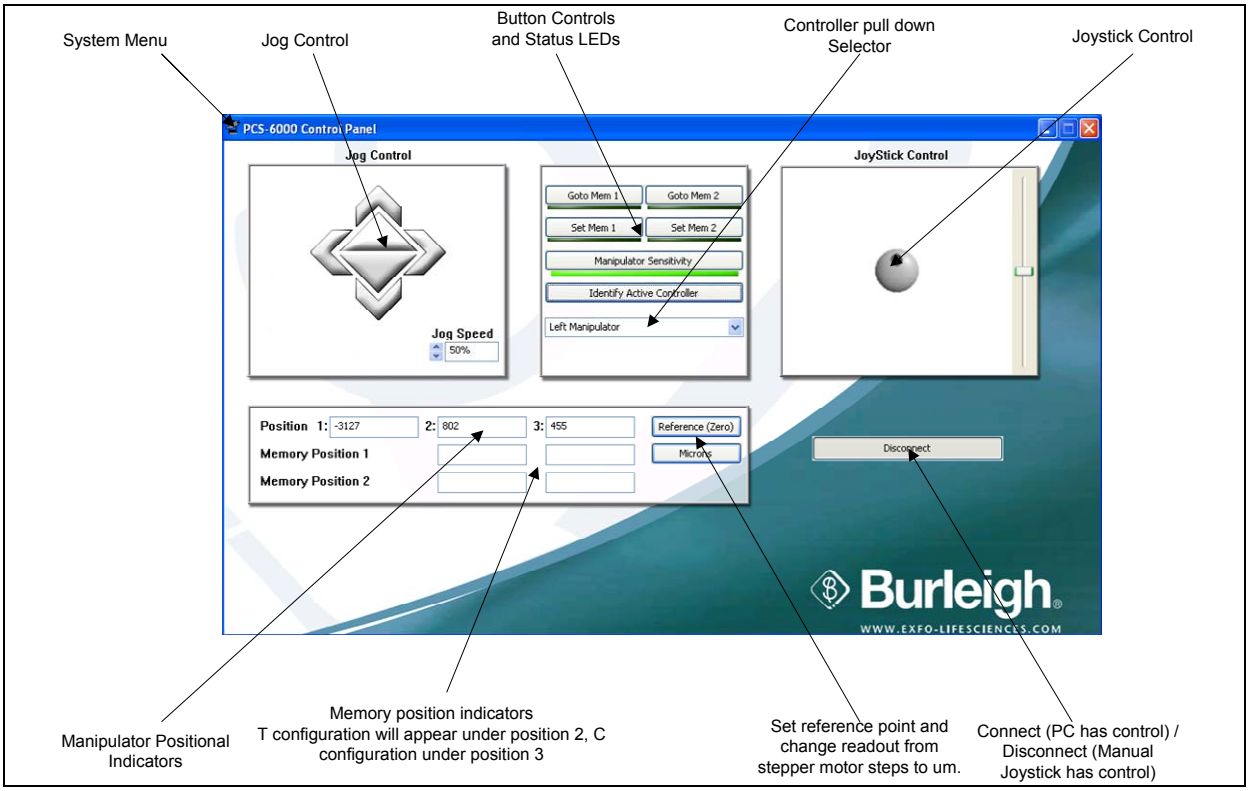
Moving the joystick results in "velocity control." This means that the farther from the rest position the joystick moves, the faster the motor runs. This is similar to the gas pedal of an automobile – the farther it is pushed, the faster the car runs. There is an intentional dead zone when the joystick is left alone. This dead zone serves as a buffer to the outside world. A slight bump of the joystick does not result in an unwanted movement. The direction of travel of any axis can be reversed with respect to the joystick motion by changing the position of the mini toggle switch marked with the double arrow next to each motor cable connection on the front panel of the controller.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

PCS 6000 Graphical User Interface

When the PCS-6000 is connected to a PC via a USB cable, the controller status is immediately available via the PCS-6000 control panel.

The following screen shot shows the control panel and the available controls.



The graphical user interface provides remote control functionality of multiple PCS-6000 controllers. After launching the control panel, the software will automatically scan for PCS-6000 controllers connected to the PC and will add them to the controller pull down selector list. The most recently found controller will be automatically selected in the list. When controllers are powered down or disconnected from the PC, they will be automatically removed from the controller pull down selector list.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Graphical User Interface for PCS-6000 control panel

The graphical user interface provides 2 modes of operation. When the GUI "Connect" is enabled it provides remote PC control of the 3 servo motor axes provided with the manipulator. This control is provided by the jog and joystick controls available on the interface. When the GUI "Disconnect" is enabled it provides the reference position of all 3 servo motor axes as well as "Memory 1" and "Memory 2" position settings on the hand held joystick connected to the controller.

PCS-6000 Software minimum PC configuration requirements.

The following are the minimum requirements for a PC to be used with the PCS-6000 control panel software:

- 300MHz Pentium or equivalent processor
- 128MB of system memory
- 5MB available storage
- SVGA 1024 x 768 resolution, 16-bit colour
- Available USB 1.1 port
- Windows 2000 SP4 or Windows XP SP2

Installing the PCS-6000 control panel software.

Note: You will need hardware installation privileges on your PC to install the software.

1. Do not connect the PCS-6000 controller to the PC.
2. Insert the PCS-6000 Software CD into your CD-ROM drive.
3. The installation wizard will automatically appear. If the installation wizard does not appear, open "My Computer", double click on your CD-ROM drive, double click on the "PCS-6000" folder and double click on the "Setup" icon.
4. Follow the screen prompts to install the software.
5. Connect the controller to the computer using any available USB port.
6. The computer will automatically detect the controller and will ask for the drivers, select automatic installation.
7. During the driver installation, Windows may state that the drivers do not have a valid security certificate, click on the "Continue Anyway" button.
8. Remove the software installation CD.
9. To access the control panel, click on "Start", "Programs", "Exfo", "Exfo PCS-6000 Control Panel".

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Controlling unit functions via the graphical user interface:

Please refer to the screen shot of the graphical user interface on the page 3-6 for the available functions as detailed below:

Connect / Disconnect –	This button will change its text depending on whether or not the control has been PC enabled or if it allows the handheld joystick control. When the PC control has been enabled, the jog and joystick controls will automatically appear on the GUI. In this mode "Disconnect" will be displayed in the connection box. Clicking on "Disconnect" will relinquish control to the handheld joystick. The jog and joystick controls will disappear; the connection box will indicate "Connect". In this mode with the manual joystick operational, the manipulator position indicators will still indicate the 3 axis positions. Additionally, if the memory positions 1 & 2 are set on the manual joystick, these will be appear in the Memory position indicator boxes.
Reference (Zero) –	This button sets a zero point on all 3 available manipulator servo motor axes as an additional reference.
Position 1-	This indicator box provides the position of the manipulator's servo motor the X-axis.
Position 2-	This indicator box provides the position of the manipulator's servo motor on the Y-axis.
Position 3-	This indicator box provides the position of the manipulator's servo motor on the Z or Approach axis; depending on the system configuration.
Microns -	This button changes the readouts for positional and memory locations from stepper motor steps to µm.
Set Mem 1 -	This button sets the current position displayed as the memory position 1. When the memory position has been set, the step or µm position will be displayed in the Memory Position 1 box, and the green status bar will be illuminated. Note: The left memory position 1 box is for "T" configured controllers. This configuration has the memory presets activated for the "Motor 2" connection; typically used for the *Approach axis.* The right memory position 1 box is for "C" configured controllers. This configuration has the memory presets activated for the "Motor 3" connection; typically used for the *Z (vertical) axis.* Note: "T" configured controllers provide 2 audible beeps on power-up, while "C" configured controllers provide 3 audible beeps on power-up.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Set Mem 2 - This button sets the current position displayed as the memory position 2. When the memory position has been set, the step or um position will be displayed in the Memory Position 2 box, and the green status bar will be illuminated. Note: The left memory position 2 box is for "T" configured controllers. This configuration has the memory presets activated for the "Motor 2" connection; typically used for the *Approach axis.* The right memory position 2 box is for "C" configured controllers. This configuration has the memory presets activated for the "Motor 3" connection; typically used for the *Z (vertical) axis.* Note: "T" configured controllers provide 2 audible beeps on power-up, while "C" configured controllers provide 3 audible beeps on power-up.

Goto Mem 1 - This button sends the controller to the first programmed memory position, the green bar under this button will illuminate while the memory position is being recalled. Pressing this button during a memory move stops the memory move. Note: This button will only function when the memory position 1 has been set. A green illuminated bar under the "Set Mem 1" button indicates that the Memory 1 position has been set.

Goto Mem 2 - This button sends the controller to the second programmed memory position, the LED under this button will illuminate while the memory position is being recalled. Pressing this button during a memory move stops the memory move. Note: This button will only function when the memory position 2 has been set. To determine if the memory one position has been set, look at the LED under the "Set Mem 2" button.

Manipulator Sensitivity - This button sets the sensitivity of the manipulator to either High or Low. The sensitivity changes the maximum speed for both the Jog and Joystick controls. When the green status bar under this button is illuminated, the speed setting is high.

Identify Controller - This button tells the controller to blink its "Move" LED located on the front panel 3 times for identification purposes. This facilitates identification of a particular controller in multiple controller setups.

Manipulator Selector - The manipulator selector by default displays the serial number of all controllers found. You may change the serial number identifier by typing over the serial number and pressing the TAB key.

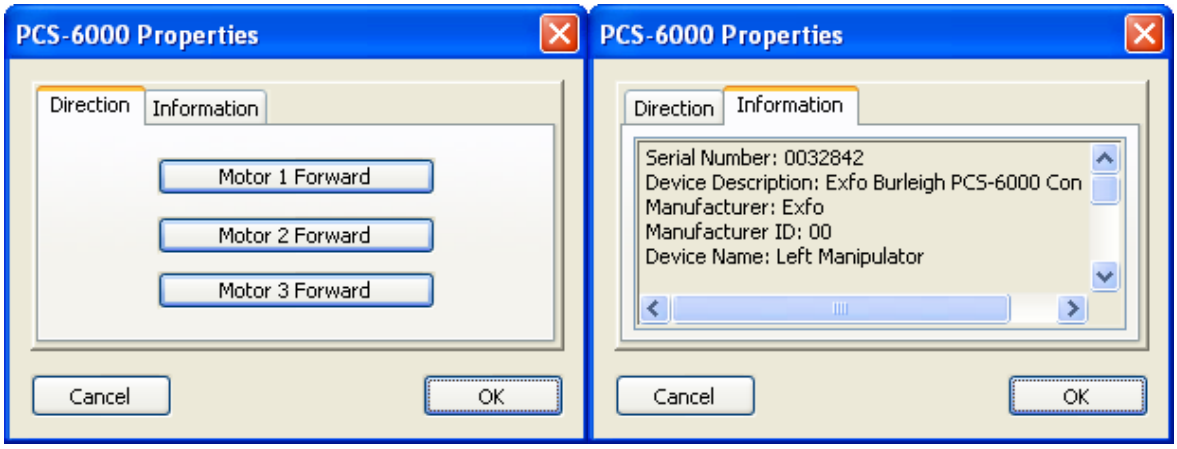
Jog Control - The Jog control moves the controller in the three positional axes. The outer right and left chevrons move manipulator along the X-axis. The outer upper and lower chevrons move the manipulator along the Y-axis. The inner up and down arrow heads move manipulator along the Z-axis or the Approach axis depending on the particular configuration.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Jog Speed - The Jog speed control changes the speed at which the jog controls will move the manipulator. Note: The controller will not operate with the speed set at < 15%

Joystick Control - The Joystick control moves the manipulator, the speed increases as the joystick is moved from the centre of the control. Moving the joystick control knob right and left moves the manipulator along the X-axis. Moving the joystick control knob up and down will move the manipulator along the Y-axis. Moving the slider bar on the right hand side of this control up or down moves the manipulator along the Approach or Z-axis. The functionality of the slider bar may be duplicated by right clicking on the joystick knob and moving the mouse right and left.

PCS-6000 Properties - The PCS-6000 properties menu option under the system menu has 2 different modes. The first tab is “Direction” and allows the motor direction for the currently selected controller to be switched as with the switches on the front of the PCS-6000 controller. The second tab “Information” shows detailed information about the controller currently selected.

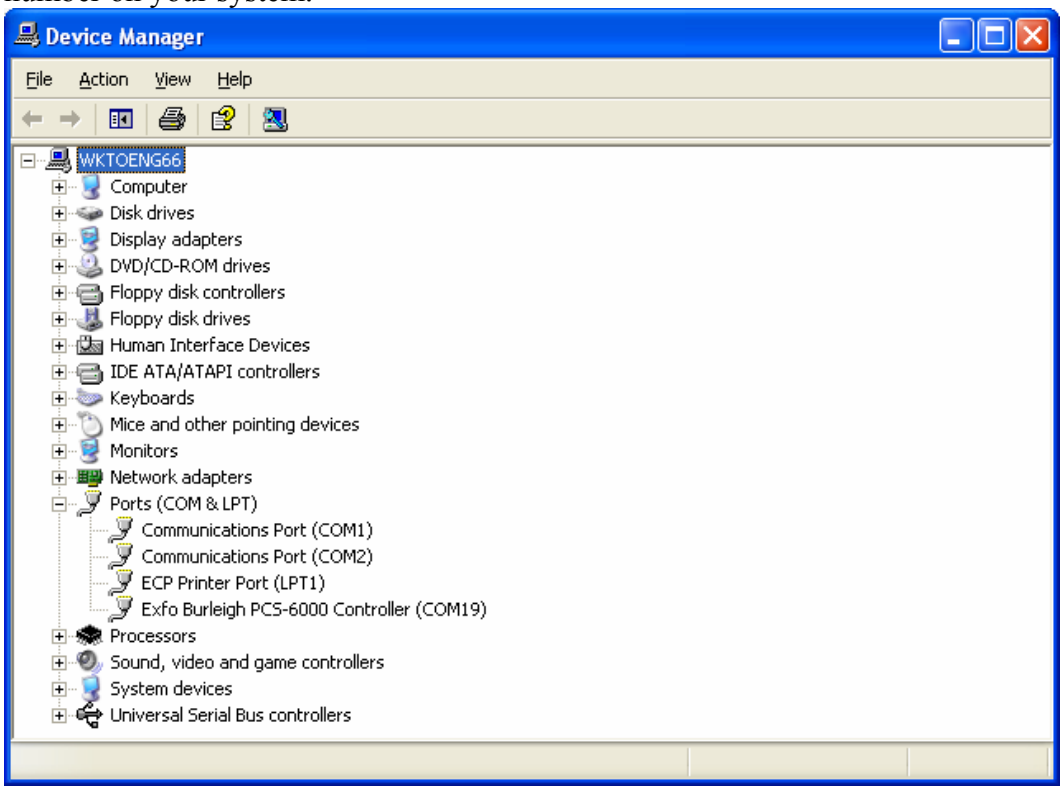


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Serial port communication with the PCS-6000 controller:
The PCS-6000 controller may be communicated with using a Windows virtual COM Port. To determine the virtual COM port your controller is connected to, perform the following instructions (Note: Depending on your OS and control panel settings these steps may vary from system to system. The steps below are for Windows XP with the control panel in "Classic View").

Note: Ensure that the following system parameters are enabled:
19,200 Baud, No Parity, 8 data bits, 1 stop bit. No hardware flow control.

1. Open your Control Panel.
2. Double click on your "System" icon.
3. Select the "Hardware" tab.
4. Click on the "Device Manager" button.
5. Expand the "Ports (COM & LPT)" item in the tree.
6. Find the "Exfo Burleigh PCS-6000 Controller (COMXX)". The XX is the virtual COM port number on your system.



7. Close the Device Manager, the System dialog box and the control panel.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The serial port commands to control the PCS-6000 controller are as follows:

The communications structure is split into two sections, the first section is the commands that are transmitted to the PCS-6000 controller, and the second section is the responses that are received by the PC.

'A' Transmission Packet

The 'A' Packet (also known as the Activity Packet) has 7 bytes which are outlined in the following table.

Byte	Name	Description
0	Packet Header	The packet header in an 'A' Packet is the character 'A'.
1	X Component	This 8-bit integer represents the joystick displacement in the motor 1 direction. Note: 0x80 is no motion.
2	Y Component	This 8-bit integer represents the joystick displacement in the motor 2 direction. Note: 0x80 is no motion.
3	Z Component	This 8-bit integer represents the joystick displacement in the motor 3 direction. Note: 0x80 is no motion.
4	Buttons Component	This byte is such that each of its bits is as follows: bit 7: unused and must be 0; bit 6: unused and must be 0; bit 5: unused and must be 0; bit 4: 1 equals 'Go to Memory Position 2' command, 0 is default; bit 3: 1 equals 'Go to Memory Position 1' command, 0 is default; bit 2: 1 equals 'Program Memory Position 2' command, 0 is default; bit 1: 1 equals 'Program Memory Position 1' command, 0 is default; bit 0: unused and must be 0.
5	Carriage Return	The second last byte of an 'A' Packet is the value 0x0D.
6	Checksum	The checksum is equal to the sum of all bytes within the packet masked with the value 0x7F.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

'Q' Transmission Packet

The 'Q' Packet has 3 bytes which are outlined in the following table.

Byte	Name	Description
0	Packet Header	The packet header in a 'Q' Packet is the character 'Q'.
1	Carriage Return	The second last byte of a 'Q' Packet is the value 0x0D.
2	Checksum	The checksum is equal to the sum of all bytes within the packet masked with the value 0x7F. In a 'Q' Packet, the checksum is always equal to 0x5E.

'M' Transmission Packet

The 'M' Packet has 3 bytes which are outlined in the following table.

Byte	Name	Description
0	Packet Header	The packet header in an 'M' Packet is the character 'M'.
1	Carriage Return	The second last byte of an 'M' Packet is the value 0x0D.
2	Checksum	The checksum is equal to the sum of all bytes within the packet masked with the value 0x7F. In an 'M' Packet, the checksum is always equal to 0x5A.

'C' Transmission Packet

The 'C' Packet has 3 bytes which are outlined in the following table.

Byte	Name	Description
0	Packet Header	The packet header in a 'C' Packet is the character 'C'.
1	Carriage Return	The second last byte of a 'C' Packet is the value 0x0D.
2	Checksum	The checksum is equal to the sum of all bytes within the packet masked with the value 0x7F. In a 'C' Packet, the checksum is always equal to 0x50.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

'D' Transmission Packet

The 'D' Packet has 3 bytes which are outlined in the following table.

Byte	Name	Description
0	Packet Header	The packet header in a 'D' Packet is the character 'D'.
1	Carriage Return	The second last byte of a 'D' Packet is the value 0x0D.
2	Checksum	The checksum is equal to the sum of all bytes within the packet masked with the value 0x7F. In a 'D' Packet, the checksum is always equal to 0x51.

'I' Transmission Packet

The 'I' Packet has 3 bytes which are outlined in the following table.

Byte	Name	Description
0	Packet Header	The packet header in an 'I' Packet is the character 'I'.
1	Carriage Return	The second last byte of an 'I' Packet is the value 0x0D.
2	Checksum	The checksum is equal to the sum of all bytes within the packet masked with the value 0x7F. In an 'I' Packet, the checksum is always equal to 0x56.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

'O' Response Packet

The 'O' response packet is received when a command is sent to the PCS 6000 controller correctly. The 'O' response is returned for all command except 'Q' and 'M' which have their own response packets described below. The 'O' Packet has 3 bytes which are outlined in the following table.

Byte	Name	Description
0	Packet Header	The packet header in an 'O' Packet is the character 'O'.
1	Carriage Return	The second last byte of an 'O' Packet is the value 0x0D.
2	Checksum	The checksum is equal to the sum of all bytes within the packet masked with the value 0x7F. In an 'O' Packet, the checksum is always equal to 0x5C.

'E' Response Packet

The 'E' response packet is received when a command is sent to the PCS 6000 controller incorrectly. The 'E' Packet has 3 bytes which are outlined in the following table.

Byte	Name	Description
0	Packet Header	The packet header in an 'E' Packet is the character 'E'.
1	Carriage Return	The second last byte of an 'E' Packet is the value 0x0D.
2	Checksum	The checksum is equal to the sum of all bytes within the packet masked with the value 0x7F. In an 'E' Packet, the checksum is always equal to 0x52.

'Q' Response Packet

The 'Q' response packet has 13 bytes which are outlined in the following table. This packet is returned when the 'Q' command is received by the PCS 6000 controller correctly.

Byte	Name	Description
0	Packet Header	The packet header in a Query Packet is the character 'Q'.
1-3	X Position	These 3 bytes contain the 24-bit variable representing the current position of Motor 1.
4-6	Y Position	These 3 bytes contain the 24-bit variable representing the current position of Motor 2.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7-9	Z Position	These 3 bytes contain the 24-bit variable representing the current position of Motor 3.
10	Status	This byte is such that each of its bits is as follows: bit 7: has a value of 1 if the unit is in the 'C' configuration, 0 if the unit is in the 'T' configuration; bit 6: has a value of 1 if the unit is controlled by the PC GUI; bit 5: has a value of 1 is the fast speed is enabled; bit 4: has a value of 1 if Motor 2/3 is active recalling a memory position; bit 3: unused and will always be 0; bit 2: has a value of 1 if Memory Position 2 is set; bit 1: has a value of 1 if Memory Position 1 is set; bit 0: has a value of 1 if a memory position has changed.
11	Carriage Return	The second last byte of a Query Packet is the value 0x0D.
12	Checksum	The checksum is equal to the sum of all bytes within the packet masked with the value 0x7F.

'M' Response Packet

The 'M' response packet has 9 bytes which are outlined in the following table. This packet is returned when the 'M' command is received by the PCS 6000 controller correctly.

Byte	Name	Description
0	Packet Header	The packet header in a Memory Packet is the character 'M'.
1-3	Memory Position 1	These 3 bytes contain the 24-bit variable representing Memory Position 1.
4-6	Memory Position 2	These 3 bytes contain the 24-bit variable representing Memory Position 2.
11	Carriage Return	The second last byte of a Memory Packet is the value 0x0D.
12	Checksum	The checksum is equal to the sum of all bytes within the packet masked with the value 0x7F.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. INSTALLATION

Unpacking the Unit

Carefully unpack the unit and inspect for shipping damage. Severe damage to the packaging may indicate component damage. Notify your shipping/receiving department immediately.

Removing the Shipping Clips

To prevent damage to the stages and piezo during shipment, the stage top and bottom are displaced from their normal positions with shipping clips. These clips are under tension and must be removed carefully to prevent damage. Use the procedure below to reduce the risk of damage.

1. Use the 5/64" hex driver (red handle) to remove the screw that goes through the thick portion of the clip (Figure 4-1).

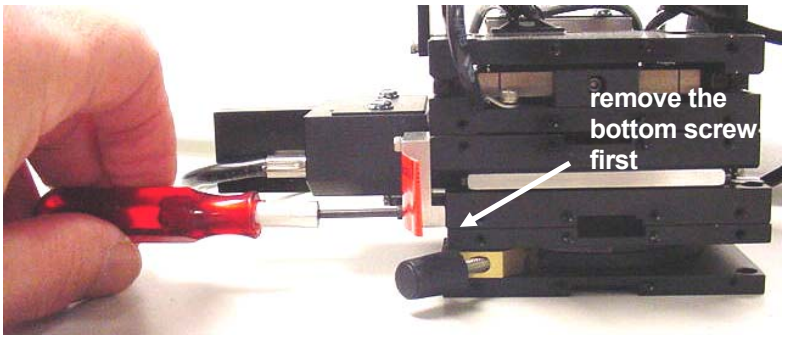


Figure 4-1: Remove the bottom screw first

2. Gently push the moveable portion of the stage to create about a 1 mm gap between the thick portion of the clip and the stationary stage member (Figure 4-2).

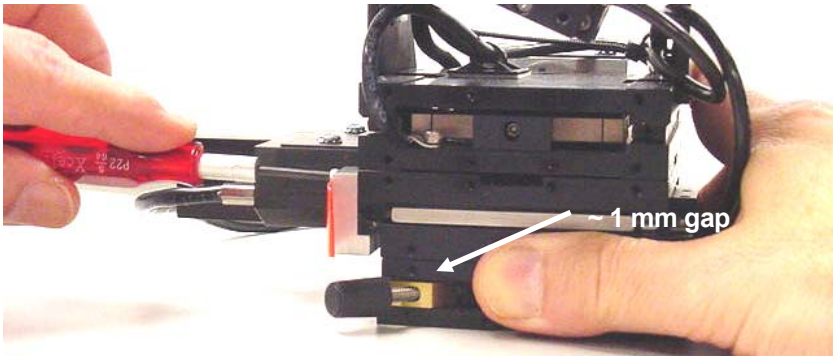


Figure 4-2: Create a 1-mm gap

3. Remove the top screw and gently allow the stage to return to its rest position.
4. Repeat steps 1-3 for the remaining shipping clips.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Mounting the Manipulator

1. Locate the rotation plate adapter and determine the approximate location where it is to be mounted.
2. If the mounting surface has a grid of ¼ -20 tapped holes, use the hardware supplied to mount it to the mounting surface.
3. If the mounting surface has a grid of through holes or if a through hole needs to be made, anchor the rotation plate adapter with the a ¼ -20 screw coming up through mounting surface and into the center tapped hole of the rotation plate adapter.
4. Loosen the two set screws on the locking ring of both the rotary pivot stages.

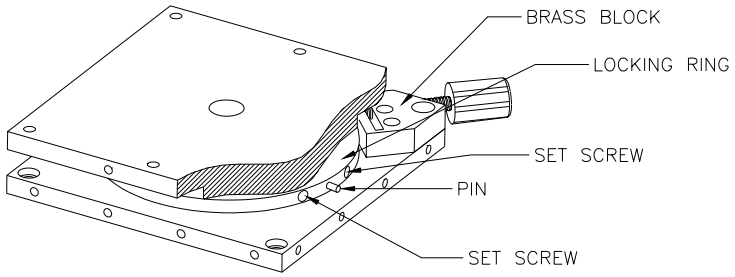


Figure 4-3: Rotary pivot stage

5. Fasten the manipulator to the rotation plate adapter using ¼ " 4-40 socket head cap screws through the corners of the bottom plate of the rotary pivot stage.

Connecting the Cables

Verify that the PCS-6000 control unit is turned off and the unit is unplugged. Position the control unit in the appropriate location (usually this is outside of the Faraday cage and separate from the vibration isolation table). Do not plug in yet.
Plug the cables from the manipulator into the front panel of the control unit. Cables are labeled with numerals that correspond to the location in the front panel (note that one or more positions may be empty).

	**IMPORTANT** **Anchor the manipulator cables to the vibration isolation table so that disturbing the cables does not couple directly to the manipulator.**
	**IMPORTANT** **Be sure there is enough slack in the cables to prevent tension on the stages when the stages move or the manipulator rotates.**

4. If desired, connect ground wires to the binding posts provided (back of the control unit and the support gusset of the manipulator.)
5. Adjust the stops on the rotary stage that is attached to the vertical stage (Axis 3). See instructions above for details.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6. Position the joystick and ACU in a convenient location in the workstation. Plug the cables into the back of the control unit. The joystick and ACU are set up so that the cables from the units exit away from the operator.

Mounting a Headstage and Pipette

The PCS-6000 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. 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). Use the A holes for the HEKA EPC-9 headstage; use the B holes for AXON headstages.
3. Use the 5/64 Allen wrench to tighten the screws.

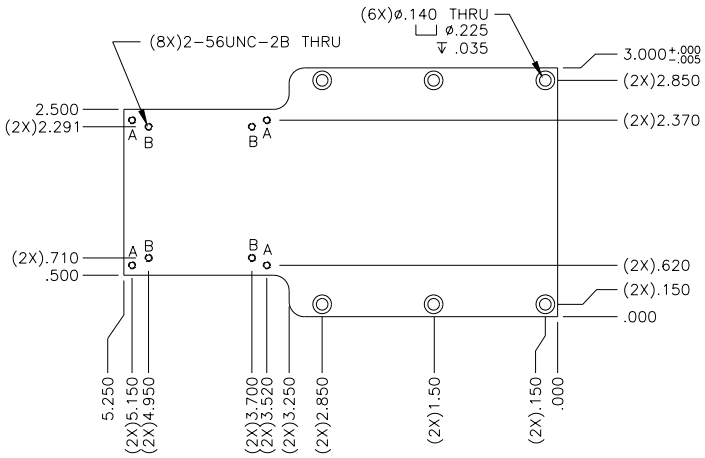


Figure 4-4: Headstage adapter plate

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5. OPERATION

Powering Up and Checking for Motor Motion

1. Plug in the AC line cord and turn on the control unit. After a second or two, the power indicators light on both the upper (motor) and lower (piezo) modules.



CAUTION

Never connect or disconnect the cables when the unit is on. This could cause an arc and damage the control unit.

2. If Axis 4 is present, move the joystick to the right and verify that the **Move** indicator comes on. Verify that Axis 4 (Approach) moves. If it moves in the wrong direction, change the position of the motor direction switch closest to the plug labeled **MOTOR4**.
3. If Axis 4 is not present but Axis 2 is, then momentarily push the Axis 4/2 Selector switch on the joystick to toggle between Axis 2 and Axis 4. When the switch button is released, the number of tones indicates which axis has been selected. (Note: Axis 4 is always selected on power up.)
4. If Axis 2 is selected, move the joystick to the right and verify that the **Move** indicator comes on. Verify that Axis 2 (pure left/right) moves. If it moves in the wrong direction, change the position of the motor direction switch closest to the plug labeled **MOTOR2**.
5. Move the joystick in the orthogonal direction (away from the operator) and observe that the Axis 1 (front/back) moves. If it moves in the wrong direction, change the position of the motor direction switch closest to the plug labeled **MOTOR1.**
6. Rotate the knob on the joystick clockwise to verify that Axis 3 (pure vertical) moves downward. If it moves in the wrong direction, change the position of the motor direction switch closest to the plug labeled **MOTOR3**.

Positioning Under the Microscope and Checking for Piezo Motion

1. Either attach the head stage to the front plate of the manipulator or attach the Steep/Shallow head stage adapter. See Section 4, *Mounting a Headstage and Pipette*.



IMPORTANT

Steep/Shallow head stage adapters shipped as part of PCS-5000 series products require the addition of a spacer plate to allow full back and forth motion of the sliding dovetail. Consult EXFO Life Sciences & Industrial Division if the spacer plate is needed.

2. Position a pipette under the microscope and verify motor motion. Use the High speed/Low speed selector on the joystick to select motor speed. High is indicated by two short beeps, while low is announced by one short beep.
3. Rotate the knobs on the ACU control to verify the piezo fine motion controls work.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Adjusting the Approach Axis Angle

The Approach Axis can be set to any angle.

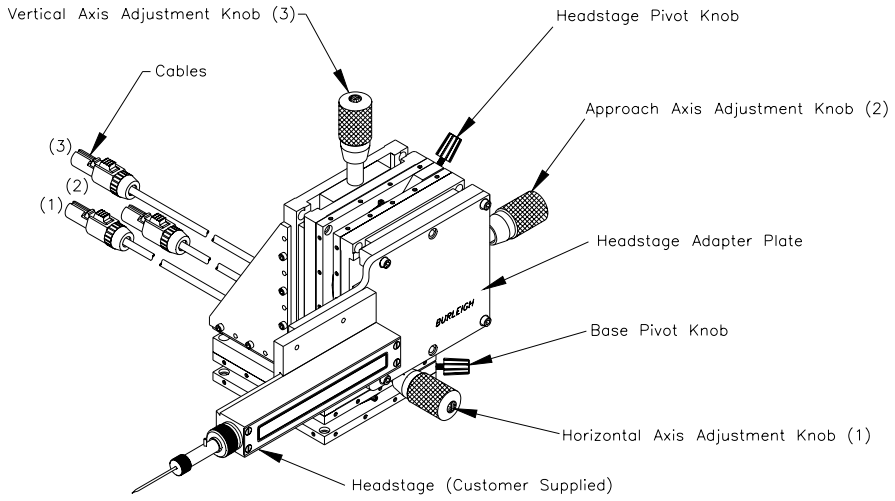


Figure 5-1: Adjusting the angle of the Approach Axis

1. Use the joystick to adjust each of the motorized stages to the center of travel.
2. Use the manual adjusting knob to center any manual stages.
3. Affix the micromanipulator to the mounting surface.



IMPORTANT

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

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

   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.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

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.

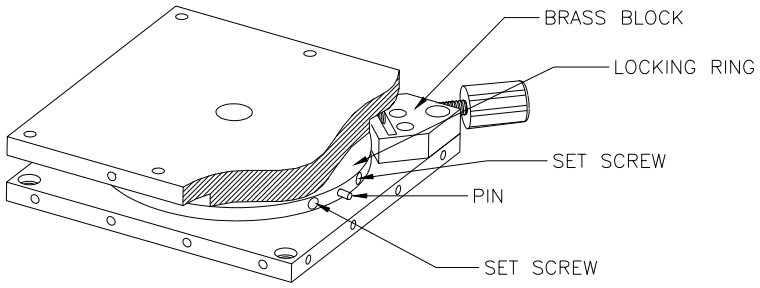


Figure 5-2: Adjustable stop mechanism

1. Position the headstage at the desired angle (see previous procedure).
2. If you have not already done so, use a .050” Allen wrench to loosen the set screws in the locking ring.
3. On the headstage pivot stage, carefully rotate the locking ring counter-clockwise (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” Allen wrench. The other set screw is covered by the brass block. This is normal.
4. On the base pivot stage, rotate the locking ring clockwise (counter-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 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” Allen wrench. The other set screw is covered by the brass block. This is normal.

Operational Hints

Joystick Control

Moving the joystick from its rest position to the left causes motion to the left. Motion to the right causes motion to the right. The farther from the rest position, the faster the motion. There is an intentional “dead zone” around the neutral position of the joystick. This helps prevent slight accidental bumps from causing unwanted movements. Use the High speed/Low speed selector to toggle between the speed ranges.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Piezo Control

The knobs on the ACU determine the piezo position. When a knob is turned, the pipette follows the motion. Stage position depends on the where the knob is left.

Single Stepping

The motors are stepping motors with a base step size of better than 5 µm. With a little of practice, an operator will learn that it is easy to get a single step. Use the High speed/ Low speed selector until only one beep is heard when it is released. A quick movement of the joystick from its rest position and back triggers just a single step. It is helpful to practice by watching the **Move** indicator come on when the joystick is displaced enough for the motor to be given motion commands.

Drift Problems

Stability

PCS-6000 series micromanipulators have the ability to hold the position of its stages to high precision. The performance specification is less than 1 µm per hour per axis. When the observed stability is not at this level, many times there are a number of causes. Occasionally a single item contributes to most of the problem.

Cable stress

Tension from the cables that operate the manipulator and/or cables to the headstage can cause drift problems. Many times this type of problem can be greatly reduced, if not eliminated, by providing a defined loop in the cable between the manipulator and the vibration table.

Loose mechanical components also can cause problems.

For more information refer to the Burleigh Application Note: *Pipette Drift Sources and Solutions for Patch Clamp Recording Experiments.*

Warm up

If it is required to maintain stability of 1 µm per hour, be sure that the manipulator has been turned on for 60 minutes. There is no harm done if the manipulator is left on overnight.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6. MAINTENANCE

Overview of Maintenance Required

Maintenance Schedule

PCS-6000 systems require a limited amount of routine maintenance. Items requiring periodic attention are listed below:

Interval between service	Item	Comments
First month and every three months thereafter	Bearing ways	Inspect for rust or corrosion
	Looseness of mounting screws	Verify nothing has loosened up
	Connection to electrical binding post (manipulator and back of control unit)	Verify still tight
	General cleanliness and absence of chemical spills	
18-month interval if heavy usage	Lubricate motor shafts	Refer to next section
24-month interval if normal usage	Lubricate motor shafts	Refer to next section
	Check for smoothness of operation of piezo control knobs	
	Check for smoothness of operation of joystick	

Lubricating Motor Shafts

1. While the PCS-6000 is still electrically connected, align the stages as shown in Figure 6-1.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

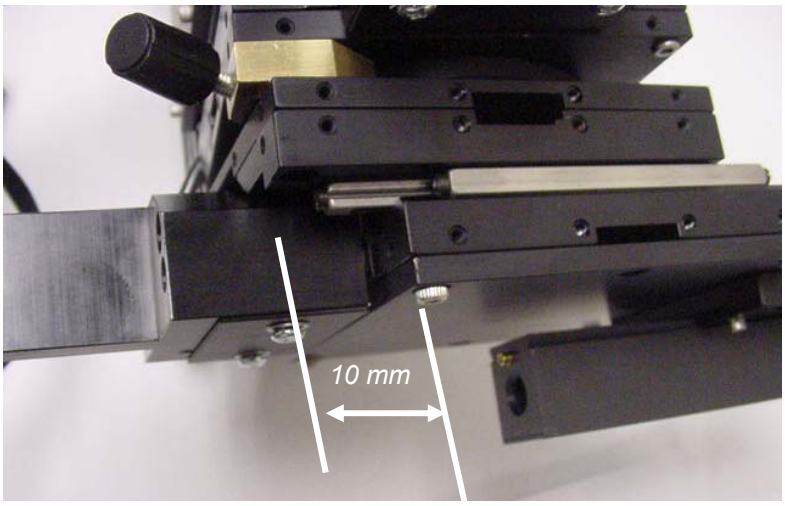


Fig 6-1: Align stages before turning off the power

2. Remove manipulator from the Faraday cage and place on a well-lit work table.
3. Holding the stage as shown in Figure 6-2, shift the top to take pressure off of the motor. A convenient way to do this is to place a thumb on the base and the opposing forefinger on the movable section and squeeze.

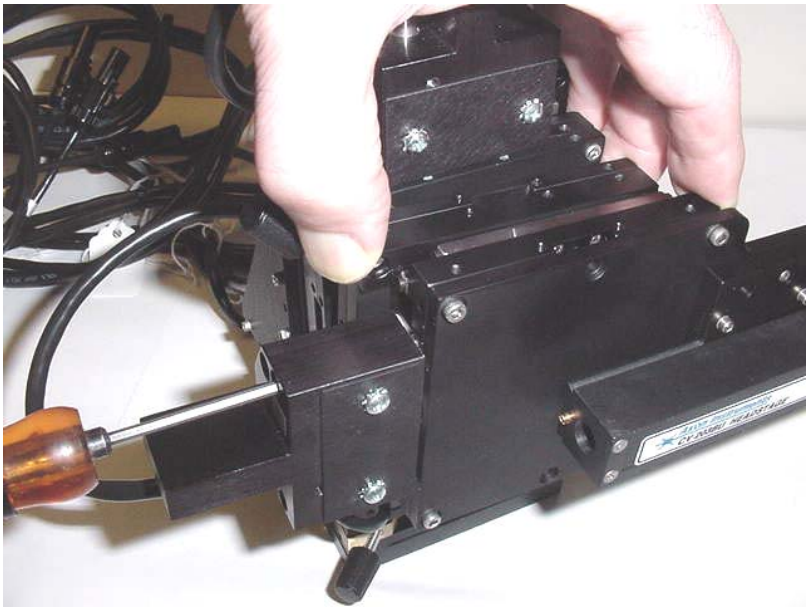


Figure 6-2: Take pressure off the motor and remove module

4. Use a 3 /32 hex driver to remove the motor module.
5. Gently relax the pressure and allow the stage to move to its natural position.
6. Grasp the anti-rotate coupling and remove from the motor by unscrewing in a counter-clockwise direction (Figure 6-3).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

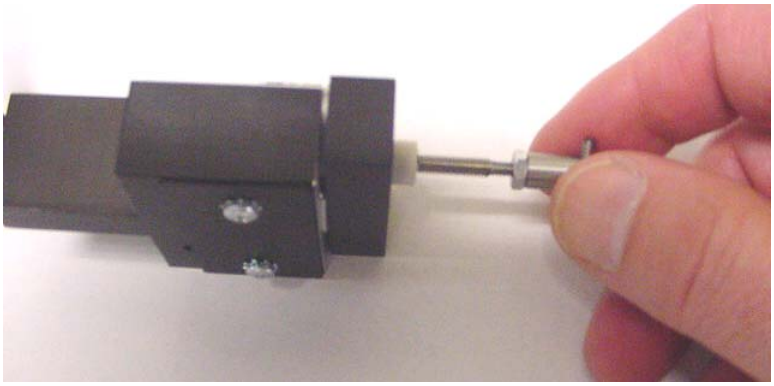


Fig 6-3: Remove the screw by turning counter-clockwise

7. Apply lubricant to the screw (Figure 6-4). Only a small bead of lubricant is needed along the central 1 inch of shaft.

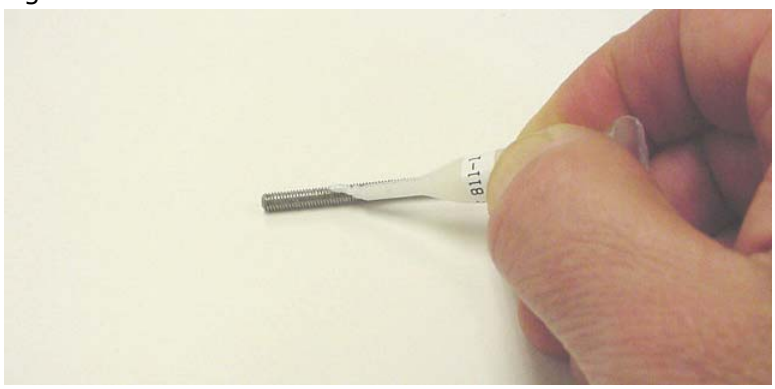


Fig 6-4: Apply lubricant along length central 1" of the motor shaft

8. Apply a small amount of lubricant to the sides of the anti-rotate dowel pin (Figure 6-5).

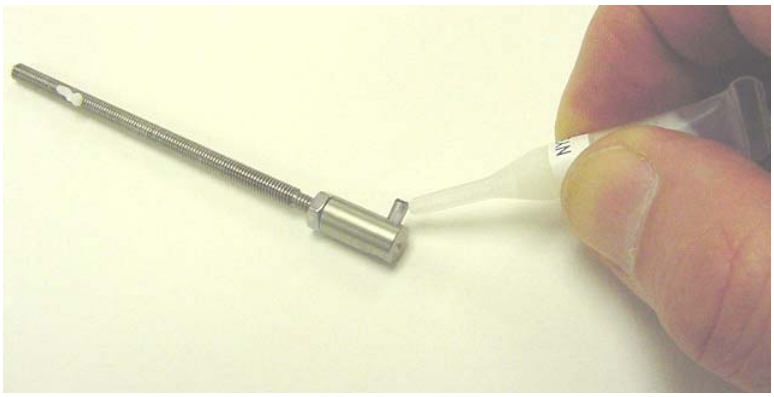


Figure 6-5: Apply lubricant to anti-rotate dowel pin

9. Screw shaft into motor as shown in Figure 6-6. Note that the shaft is screwed in all the way (Figure 6-5).
10. Orient the anti-rotate pin as shown in Figure 6-7.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

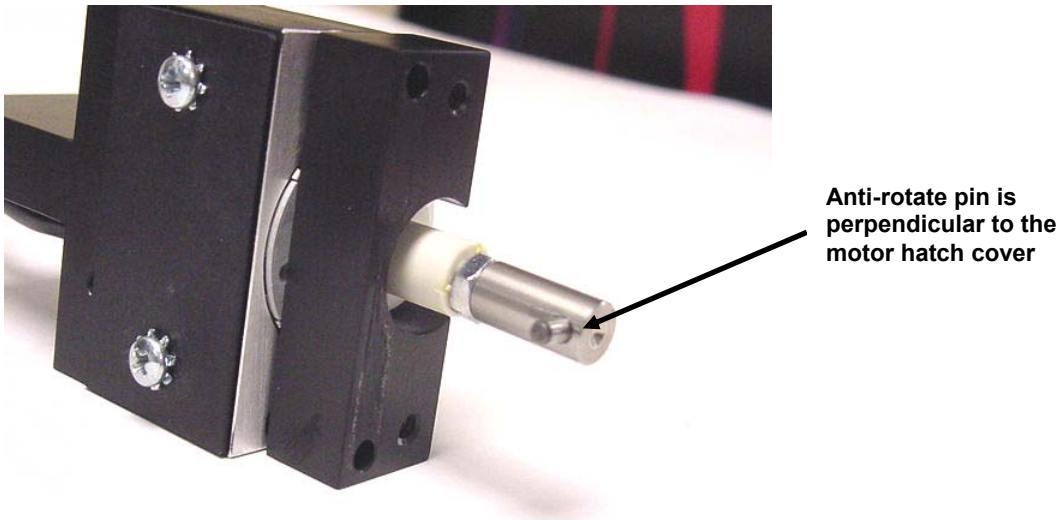


Fig 6-6: Anti rotate unit fully retracted and angled for assembly

11. Locate the anti-rotate slot in the moveable stage (Figure 6-6).

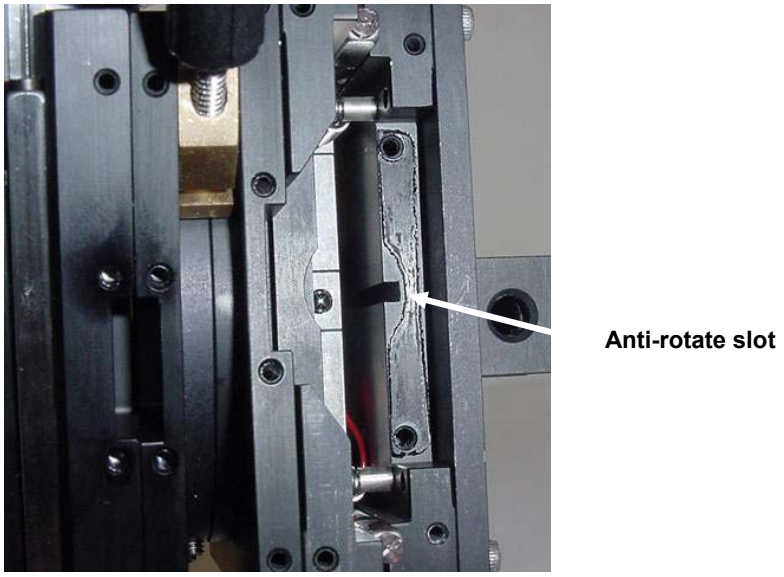


Fig 6-7: Location of the anti-rotate slot

12. Align the anti-rotate pin on the motor shaft to the slot and slide the motor module into the stage taking care to maintain the pin in the slot.
13. Loosely tighten the 4-40 screws to barely snug the motor module to the stage. It is helpful to hold the stage as shown in Figure 6-8.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

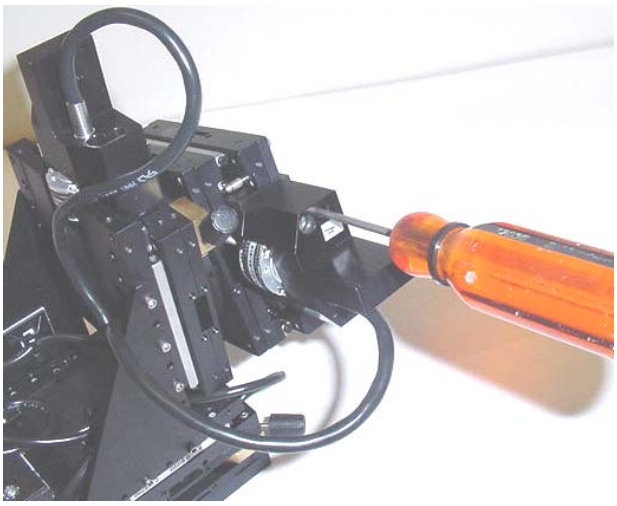
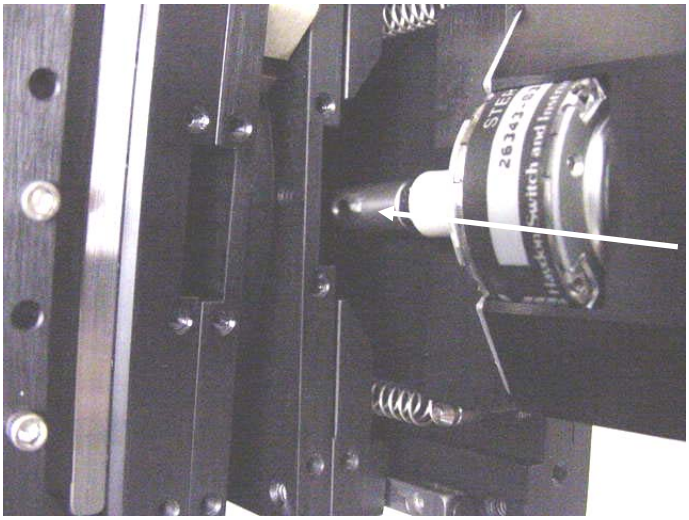


Figure 6-8: Insert into slot and loosely tighten the 4-40 screws

14. Displace the move able section of the stage to expose the end of the shaft. Verify that pin is in slot (see Figures 6-9 and 6-10).



Bottom of anti-rotate pin is visible. Shaft of pin is not visible.

Figure 6-9: Correct alignment of pin in slot (only the bottom of the pin is visible)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

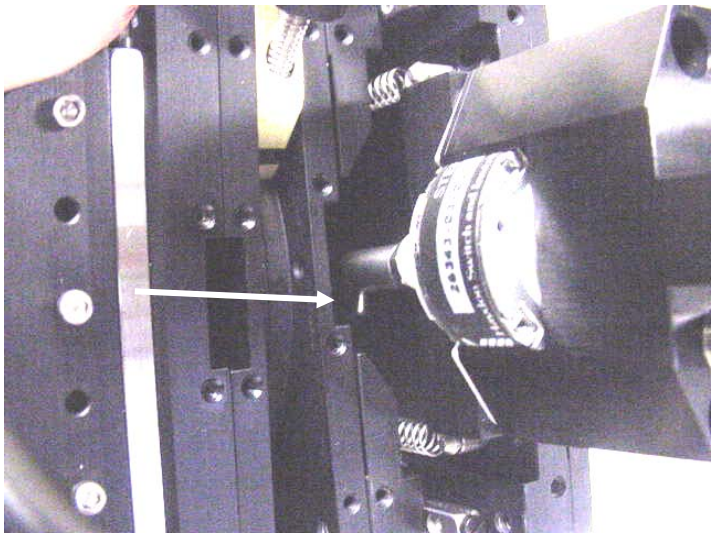


Figure 6-10: Incorrect alignment (pin is not captured in the slot)

15. If the alignment is correct, finish tightening the 4-40 screws that hold the motor module to the stage.

Electronic Maintenance

There are no maintenance or user-serviceable items inside the control unit, ACU or joystick.



WARNING

There are no operator-serviceable components inside the PCS-6000 control unit. Dangerous voltages are exposed when the cover is removed. Do not attempt to open or service the unit yourself.

Replacing the Fuse(s)

The unit is supplied with a dual line fuse holder. In the unlikely event the main power line fuse(s) has blown, it can be replaced. The fact that the main fuse may have been blown is evidenced by the lack of any indicator lights on the front of the control unit. (A failed internal power supply may cause similar symptoms but there is no field fix possible for that condition.)

To replace the fuse(s):

1. Turn off the unit and disconnect from the power source.
2. Remove the fuse holder by prying up as shown in Figure 6-11.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

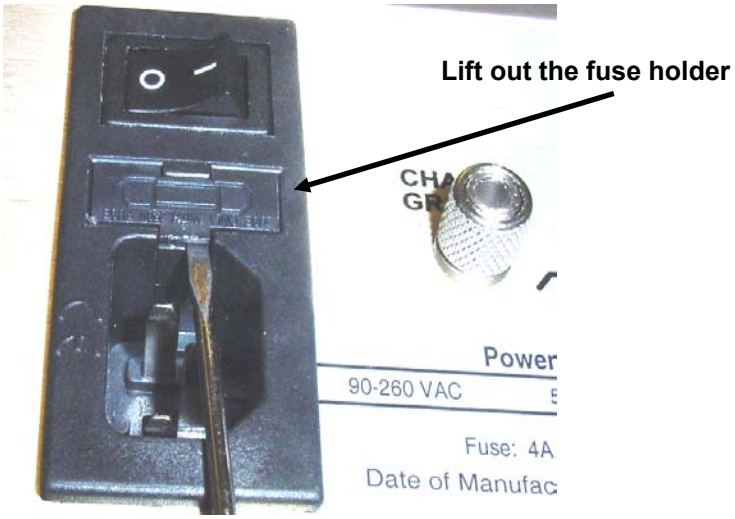


Figure 6-11: Removing the fuse holder

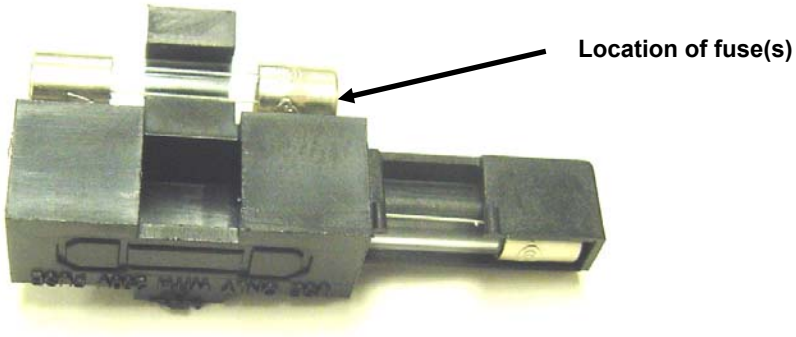


Figure 6-12: Removing and replacing the fuse

3. Be sure to replace fuse(s) with the same rating: T-type 4.0A, 250V.

Adjusting the Friction of the ACU Knobs

To adjust the friction of the control knobs on the ACU.

1. Place the ACU on a flat stable surface, with the control knob you want to adjust facing up Figure 6-13).
2. Loosen the two lock screws on the control knob.
3. Press down on the control knob until the desired friction level is obtained.
4. Maintaining the pressure on the knob, tighten the lock screws.
5. Repeat steps 1 - 4 for the other control knobs.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

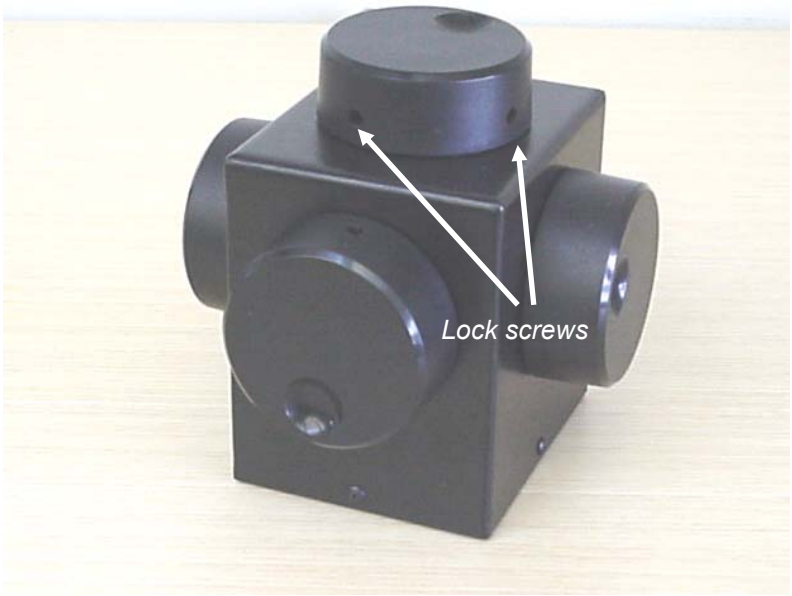


Figure 6-13: Adjusting the friction of an ACU knob

Adjusting the Friction and Eliminating Lateral Play in the Manual Adjustment Knobs

The sleeve can be rotated to adjust the friction and lateral stability of the adjustment knobs on the manual stages. A special spanner wrench (Figure 6-14) included in the toolkit can be used to easily rotate the sleeve.

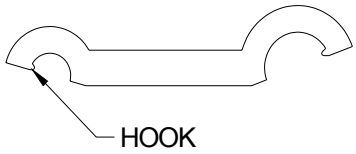


Figure 6-14: Spanner wrench

1. Locate the catch hole on the sleeve (Figure 6-15). Position the smaller head of the wrench around the sleeve, making sure the hook catches on the hole.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

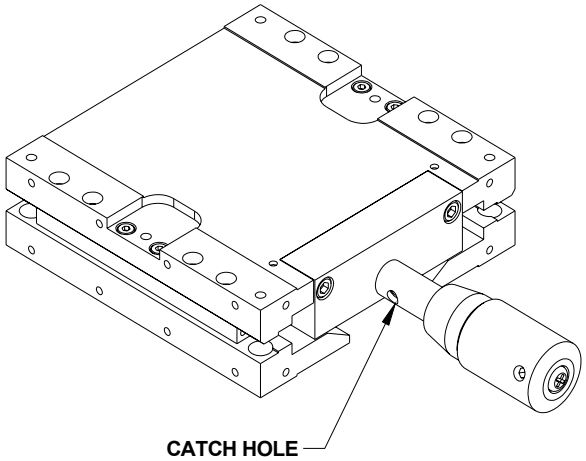


Figure 6-15: Locating the catch hole

2. Turn the wrench clockwise to tighten the sleeve, increasing the friction (Figure 6-16). Repositioning the wrench underneath and turning counter-clockwise loosens the sleeve, decreasing the friction of the adjustment knob. Do not loosen the sleeve all the way. It always should be snug. If it is loose, the adjustment knob is free to move laterally or to "wiggle." To increase the lateral stability, simply tighten the sleeve.

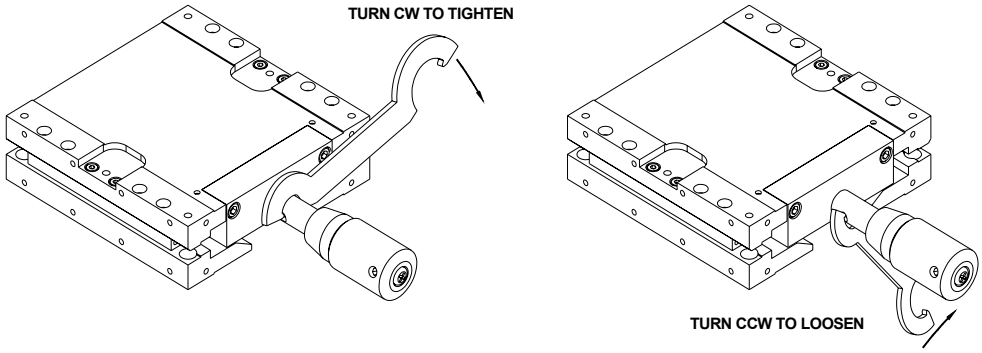


Figure 6-16: Tightening the sleeve (left) and loosening the sleeve (right)

Troubleshooting

Problem: Excess motion of pipette tip during manual adjustment

Typical symptoms

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

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Also refer to *Drift* later in this section.

Probable Causes

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

What to Check

Micromanipulator and Linear Stages

- Check that all screws are tight.
  a. Locking screws on rotary pivot stages.
  b. Screws holding headstage to headstage mount.
  c. Screws holding linear stages to each other.
  d. Screws holding linear stages to mounting system.
- Check that mating surfaces between the linear stages, and the mounting system are free of dirt, debris and burrs.
- Check to see that tension and vibrations are not coupled from the wires into the manipulator. Leave a vibration loop between the vibration table and the manipulator.

Mounting System

- Check that the mounting system is stable.
- Check that all screws are tight.
- Check that mating surfaces are free of dirt, debris and burrs.



IMPORTANT

In cases where the PCS-6000 is not attached directly to the microscope, it is important that the microscope itself is stable. The microscope and the mount holding the PCS-6000 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 fine motion

Typical Symptoms

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

Probable Causes

- Lack of fine motion usually is 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 control unit.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- The cable to the ACU may have become disconnected at the back of the control unit.

What to Check

- Cables for linear stages are properly plugged in.
- Visually check for interference.
- Check that no part of the micromanipulator is rubbing or hitting the microscope mount.
- Gently verify that the axis is free to move when it is manually pushed.

Problem: No coarse motion

Typical Symptoms

- When joystick is activated, no motion is observed.

Probable Causes

- Motor may be running but end of travel has been reached and motor is in Stall condition.
- End of travel may have been reached and motor is stuck.
- Incorrect connection of the motor cables.
- The cable to the joystick may have become disconnected at the back of the control unit.
- May be trying to move Axis 2 but only Axis 4 exists.

What to Check

Linear Stages

- Cables for linear stages are properly plugged in.
- Visually check for interference.
- Check that no part of the micromanipulator is rubbing or hitting the microscope mount.
- Verify that the orange **Move** light becomes lighted when the joystick is activated.
- Using gentle finger pressure, displace the axis to take pressure off the mechanism and activate the motor for about four or five seconds. Slowly return the stage to its normal position and check for motion. If none, try again, running the motor in the opposite direction.
- Listen closely to the motor to hear any noise. If the motor is running, a noise should be heard.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Problem: Drift

Typical Symptoms

- Pipette tip moving after manual and piezo adjustments are completed.
- "Losing" cells after making a seal.

  Also refer to Section 6, *Troubleshooting,* for information on excess motion of the pipette tip during manual adjustment.

Probable Causes

The solid-state design of the PCS-6000 produces negligible heat and associated internal thermal drift. Extreme thermal drift usually is 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

- Check that the unit is warmed up and stabilized (30 minutes normally or 60 minutes for drift less than 1 μm per hour).
- Check that the system (PCS-6000, 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 Life Sciences & Industrial Division:

  Pipette Drift Sources and Solutions for Patch Clamp Recording Experiments.

  Also: Frederick Sachs, *A Low Drift Micropipette Holder*, European Journal of Physiology (1995) 429:434-435.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7. SPECIFICATIONS

Performance:			
Travel	Piezo 150 or 300 μm	Motorized 25 mm nominal	Manual 25 mm nominal
Resolution	60 nm (150 μm) OR 120 nm (300 μm)	1.6 μm minimum step size	32 threads per inch lead screw
Speed	Directly proportional to rate knob turns	Variable between ½ μm and 2 mm/sec	
Stability	< 1 μm per hour		

Environmental Specifications:	
Operating Conditions	
Ambient Temperature:	5ºC to 40ºC
Altitude:	2000m max.
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 +70ºC
Relative Humidity:	10% to 100%
Atmospheric Pressure:	50 to 106 kPa

Dimensions and Weight	Manipulator	Controls
Dimensions (L x W x H)	7” x 8.5” x 7.5”	12” x 10” x 8.5”
Weight	5 lbs	6 lbs
Power Requirements		
Voltage and Frequency	100 to 240 V 50/60 Hz	
Fuse	T4A, 250V, [5x20mm]	

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Product Safety:	
IEC 61010-1:2001	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use Part I.
EN 61010-1:2001	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use
CAN/CSA C22.2 No. 61010-1-04	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use Part I; General Requirements
UL 61010-1: 2nd Edition	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use Part 1; General Requirements
IEC Equipment Class: I Installation Category: II Pollution Degree: 2	Enclosure: IPX0

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
Council Directive 89/336/EEC	EMC Directive

FCC Class A Digital Device or Peripheral – Information to User

This device 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.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

WEEE Directive (2002/96/EC)



The symbol above indicates that this product should not be disposed of along with municipal waste, that the product should be collected separately, and that a separate collection system exists for all products that contain this symbol within member states of the European Union.

- The equipment that you bought has required the extraction and use of natural resources for its production. It may contain hazardous substances that could impact health and the environment.
- In order to avoid the dissemination of those substances in our environment and to diminish the pressure on the natural resources, we encourage you to use the appropriate take-back systems. Those systems will reuse or recycle most of the materials of your end life equipment in a sound way.
- The crossed-out wheeled bin symbol indicated above invites you to use those systems.
- If you need more information on the collection, reuse and recycling systems, please contact your local or regional waste administration.

Directive WEEE/ (2002/96/EC)

Le symbole ci-dessus indique
- que ce produit ne devrait pas être éliminé avec les déchets enlevés par la municipalité
- que ce produit devrait être collecté séparément, et
- qu'un système de collecte séparé existe dans les pays membres de l'Union européenne pour tous les produits comportant ce symbole.

- La production de l'équipement que vous avez acheté a nécessité l'extraction et l'utilisation de ressources naturelles; il peut contenir des substances dangereuses qui peuvent avoir un effet sur la santé et sur l'environnement.
- Pour éviter la dissémination de ces substances dans notre environnement et pour minimiser la consommation de ressources naturelles, nous souhaitons vous inciter à utiliser les systèmes de consignation/restitution; ces systèmes permettent le recyclage ou la réutilisation rationnelle des matériaux de l'équipement à la fin de sa période de vie utile.
- Le symbole représenté ci-dessus (poubelle sur roues avec signe d'interdiction) est une invitation pour vous à recourir à de tels systèmes.
- Pour d'autre information sur les systèmes de collecte, réutilisation et recyclage, veuillez contacter les responsables locaux et régionaux de la gestion des déchets.

WEEE-Richtlinie (2002/96/EC)

Das obige Symbol sagt aus, dass dieses Produkt nicht mit dem normalen Müll entsorgt, sondern getrennt gesammelt werden sollte, und dass für alle Produkte, die mit diesem Symbol gekennzeichnet sind, innerhalb der Europäischen Union ein getrenntes Sammelsystem eingerichtet wurde.

- Für die Herstellung des von Ihnen gekauften Geräts war die Gewinnung und Nutzung natürlicher Ressourcen erforderlich. Es kann gefährliche Substanzen enthalten, die eine Auswirkung auf Gesundheit und Umwelt haben.
- Damit diese Substanzen nicht in die Umwelt gelangen und damit der Druck auf die natürlichen Ressourcen gemindert wird, bitten wir Sie, die entsprechenden Rücknahmesysteme in Anspruch zu nehmen. Diese Systeme sorgen für eine Wiederverwendung oder Wiederverwertung der meisten Materialen der Altgeräte auf umweltschonende Weise.
- Das oben gezeigte, durchkreuzte Mülltonnensymbol soll Sie einladen, diese Systeme zu benutzen.
- Sollten Sie weitere Informationen über Systeme zur Sammlung, Wiederverwendung und Wiederverwertung haben, so setzen Sie sich bitte mit ihrer zuständigen Müllentsorgung in Verbindung.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

WARRANTY

Burleigh PCS-6000 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, EXFO Life Sciences & Industrial Division will repair or, at its option, replace parts that prove defective when the instrument is returned prepaid to EXFO Life Sciences & Industrial Division.

Before return of an instrument, please call EXFO Life Sciences & Industrial Division 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 Life Sciences & Industrial Division personnel.

The liability of EXFO Life Sciences & Industrial Division (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.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Index

ACU 3-4, 6-8
Adjustments
- ACU control knob friction 6-8
- Approach Axis angle 5-2
- Friction of ACU knobs 6-8
- Friction of manual adjustment knobs 6-8
- Lateral play in manual adjustment knobs 6-8
- Manual control knob 6-8
- Setting the adjustable stop 5-3

Approach axis 2-2
Approach axis angle 5-2
Axes of motion 2-2
Configurations 2-2
- Left-hand 2-3
- Non-standard 2-6
- PCS-6100 2-3
- PCS-6200 2-4
- PCS-6300 2-5
- PCS-6400 2-5
- PCS-6500 2-6
- Right-hand 2-3

Connecting the cables 4-2
Control unit
- Front panel 3-1
- Rear panel 3-3

Description
- ACU 1-2
- Control unit 1-3
- Joystick 1-2
- Micromanipulator assembly 1-2

Drift 6-12
Electronic maintenance 6-6
Headstage 6-10, 6-12
Headstage adapter plate 4-3
Installation 4-1
- Connecting the cables 4-2
- Mounting a headstage 4-3
- Mounting a pipette 4-3
- Mounting the manipulator 4-2
- Removing the shipping clips 4-1
- Unpacking 4-1

Linear stages 6-10, 6-11
Lubricating motor shafts 6-1
Maintenance 6-1
- Electronics 6-6
- Lubricating motor shafts 6-1
- Replacing the fuse 6-6

Maintenance schedule 6-1
Major components 1-2
Mechanism of motion
- Coarse 2-1
- Fine 2-1

Micromanipulator 6-10
Mounting a headstage 4-3
Mounting a pipette 4-3
Mounting the manipulator 4-2
Operation 5-1
- Adjusting the Approach Axis angle 5-2
- Checking for motor motion 5-1
- Checking for piezo motion 5-1
- Positioning under the microscope 5-1
- Powering up 5-1
- Setting the adjustable stop 5-3

Operation hints 5-3
Overview 1-1
PCS-6100 2-3
PCS-6200 2-4
PCS-6300 2-5
PCS-6400 2-5
PCS-6500 2-6
Piezo 6-12
Pipette
- Mounting 4-3

Removing the shipping clips 4-1
Replacing the fuse 6-6
Resolution 3-3
Rotary pivot stage 2-6
Specifications 7-1
Steep/shallow headstage adapters 5-1
Troubleshooting 6-9
- Drift 6-12
- Excess motion in pipette tip 6-9
- No coarse motion 6-11
- No fine motion 6-10

Unpacking 4-1
X axis 2-2
Y axis 2-2
Z axis 2-2

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

EXFO Life Sciences & Industrial Division
2260 Argentia Rd
Mississauga, Ontario
L5N 6H7
Canada

Tel: 1.905.821.2600 | Fax: 1.905.821.2055
Toll free: 1.800.668.8752 (USA & Canada)

www.exfo-lifesciences.com | **burleigh@exfo.com**

EXFO Electro-Optical Engineering Inc
400 Godin Ave
Quebec City, Quebec
G1M 2K2
Canada

Tel: 1.418.683.0211 | Fax: 1.418.683.2170

PCS-6000 Series Motorized
Patch-Clamp
Micromanipulator

IN CONTROL Life Sciences & Industrial Division

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP