

AD Instruments

# PowerChrom Unit Owner's Guide



---

This document was, as far as possible, accurate at the time of printing. Changes may have been made to the software and hardware it describes since then, though: ADInstruments reserves the right to alter specifications as required. Late-breaking information may be supplied separately.

### **Trademarks of ADInstruments**

MacLab, PowerChrom, and PowerLab are registered trademarks of ADInstruments Pty Ltd. E-Corder and specific model names of recording units, such as PowerLab 2/20, are trademarks of ADInstruments Pty Ltd. Chart, Scope, PowerChrom, EChem and Peaks are trademarks of ADInstruments Pty Ltd.

### **Other Trademarks**

Apple, the Apple logo, AppleScript, AppleTalk, Mac, Macintosh, Power Macintosh, PowerBook, are registered trademarks of Apple Computer, Inc. Finder is a trademark of Apple Computer, Inc.

PowerPC is a trademark of International Business Machines Corporation.

Windows and Windows NT are registered trademarks of Microsoft Corporation.

All other trademarks are the properties of their respective owners.

---

Product: PowerChrom Unit (ML850)

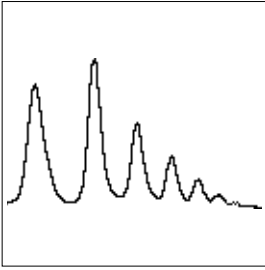
Document Number: U-ML850-OG-001B  
Copyright © March 2002  
ADInstruments Pty Ltd  
Unit 6, 4 Gladstone Road  
Castle Hill, NSW 2154  
Australia

Web: <http://www.adinstruments.com>  
Email: [support@adinstruments.com](mailto:support@adinstruments.com)

All rights reserved. No part of this document may be reproduced by any means without the prior written permission of ADInstruments Pty Ltd.

The logo for PowerLab ADInstruments features the text "PowerLab" in a large, bold, serif font, with "ADInstruments" in a smaller, all-caps serif font directly below it. The text is overlaid on a background of several thick, light gray diagonal brush strokes that sweep across the page from the bottom left towards the top right.

**PowerLab**  
ADInstruments



# Contents

---

## Contents iii

### 1 Overview 1

- How to Use this Guide 2
  - First, Check Your PowerChrom Unit! 2
  - The PowerChrom System 3
  - Computer Requirements: Windows 3
  - Computer Requirements: Macintosh 3
  - Other Hardware 4
  - The PowerChrom Program 4
- The PowerChrom Unit 4
  - The Front Panel 5
  - The Back Panel 6
  - The Instrument Connection Port 7

### 2 Setting Up the Unit 11

- Self-Testing 12
- Connecting the PowerChrom Using USB 13
  - USB Connection Rules 14
- Connecting External Equipment 15

### A Technical Aspects 17

- How Does it Work? 17
  - Detector Inputs 19
  - Analog Output 20
  - Injection Signal Input 21
  - Digital Outputs 21
- Connections 22
  - The Instrument Connection Port 22
- Recording Unit Accuracy 23
  - Sampling Operation 24
- The USB Connection 25

### B Troubleshooting 27

- Problems: Windows 27
- Problems: Macintosh 30

### C Specifications 33

#### Glossary 37

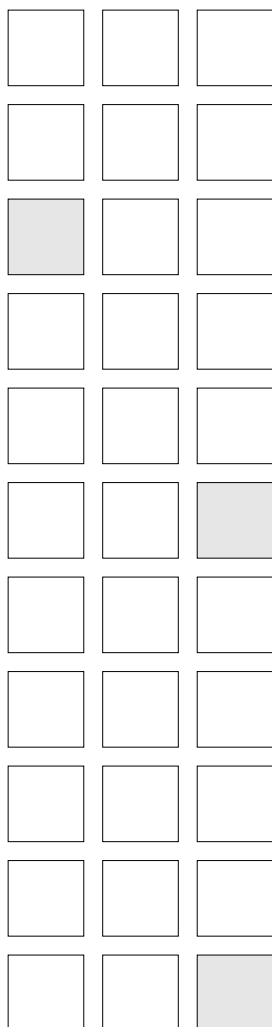
#### Index 41

#### Licensing & Warranty Agreement 43



# 1

## Overview



Your PowerChrom recording unit is used with the PowerChrom program, a general-purpose chromatography program for manual or automatic recording and analysis of chromatographic data. Together, they make up the PowerChrom system, for use with a Windows or Macintosh computer.

This chapter provides an overview of the PowerChrom system and describes the basic features, connectors, and indicators of the PowerChrom hardware.

---

# How to Use this Guide

This owner's guide describes how to set up and begin using your PowerChrom recording unit. The chapters provide an overview of the PowerChrom system (the combined software and hardware package), and a more detailed look at the features of your recording unit and its connection to your computer. The appendices provide technical information about the recording unit, and solutions to problems. At the end of this guide is a glossary of hardware terms, an index, and warranty information.

The specifications and diagrams included in the appendixes are there to help the more technically minded to understand what the recording unit can and cannot do, but this is not a service manual: only an authorised ADInstruments distributor should attempt repairs. If you modify the recording unit yourself, you void any rights you have under warranty.

The user's guide for the PowerChrom application program provides detailed information on the software side of the PowerChrom system and its uses in acquiring, storing, and analysing data. Read this after you have connected the PowerChrom unit to your computer.

## First, Check Your PowerChrom Unit!

Please do not attempt to connect the recording unit to a power outlet or computer or turn it on until you have read the first two chapters of this owner's guide, and have checked it as described below.

1. Check that all items in the accompanying packing list are included in the box.
2. Check that there are no obvious signs of external or internal damage to the recording unit.

If anything is missing, or the recording unit seems to be damaged in any way, contact your authorised ADInstruments distributor immediately, and describe the problem. Arrangements can be made to replace or repair the recording unit. (Up-to-date contact addresses are available in the software — see Appendix B in the *PowerChrom User's Guide* for details on how to find them.)

---

## **The PowerChrom System**

The PowerChrom system is an integrated system of hardware and software designed to record, display, and analyse experimental data. The hardware is the PowerChrom recording unit and the software is the PowerChrom program, which runs on the computer to which the unit is connected.

Your PowerChrom recording unit has considerable computing power of its own and performs many tasks that are necessary during data acquisition. Data transferred to the computer by the recording unit are available for display, manipulation, printing, storage, and retrieval.

### **Computer Requirements: Windows**

- A Pentium processor or better
- 32 MB available RAM
- 20 MB free hard disk space
- A USB interface on your computer (recent PCs should have this, but it may be added via a card if necessary)
- Windows 98, Me, 2000, XP or later Windows operating system (Windows 95 and NT will not work with USB)
- A computer and monitor that support an 800 x 600, 256 colour display or better.

### **Computer Requirements: Macintosh**

- A PowerPC processor
- 32 MB available RAM
- 20 MB free hard disk space

- 
- A USB interface on your computer (recent Macs should have this, but it may be added via a card if necessary)
  - Mac OS 8.6 or later.

## **Other Hardware**

Apart from the PowerChrom unit, you should have at least a basic chromatography system: a column, pump, injector, and detector. The PowerChrom system is designed to replace the usual printing integrator or chart recorder and integrator. It can support one or two detectors for a single column (say, a dual-channel variable UV detector), but not a diode array. There is limited support for pump control — for a binary solvent gradient — and for automation, but in general it is assumed that you already have controls in place for pumps and other devices (such as autosamplers).

## **The PowerChrom Program**

The PowerChrom application program and its user's guide are provided with each PowerChrom unit. The PowerChrom program provides a graphical environment for the recording and analysis of various chromatographic signals, and provides facilities for real-time recording, integration, and reporting. Its user's guide describes it in full.

You must install the software to use the recording unit. Installation instructions are included in the user's guide for the software.

## **The PowerChrom Unit**

It is a good idea to get familiar with some of the external features of your recording unit before connecting it to a power source. The rest of this chapter discusses the different features, connectors, and indicators of the PowerChrom unit.

## The Front Panel

The front panel of your PowerChrom unit has three indicators that show the various states of the system.

The Power indicator, the top indicator on the front panel, is a blue light, which simply shows that the recording unit is getting power. If this indicator does not light when the unit is switched on, check that power is turned on at the wall socket and the mains cord is plugged in correctly. If the indicator still fails to light then there may be an internal fault.

**Figure 1–1**  
The front panel of the PowerChrom unit.



The Status indicator, the middle indicator, provides a visual indication of what the recording unit is doing, and will flash different patterns and colours depending on the state of the recording unit.

**Table 1–1**  
Status indicator states.

<i>Status Indicator</i>	<i>Meaning</i>
Off	Idle and not yet initialised by the PowerChrom software.
Green constant	Idle, initialised, and waiting for a command from the computer.
Yellow constant	Communicating with the computer.
Yellow flashing	Sampling (may show green between flashes).
Red flashes	This indicates that the recording unit has detected an internal fault during the power-up test. This display will keep repeating until the power to the recording unit is turned off.

The Inject Signal indicator (or Trigger), the lowest indicator, will glow yellow when contact closure occurs. The injection signal is the usual

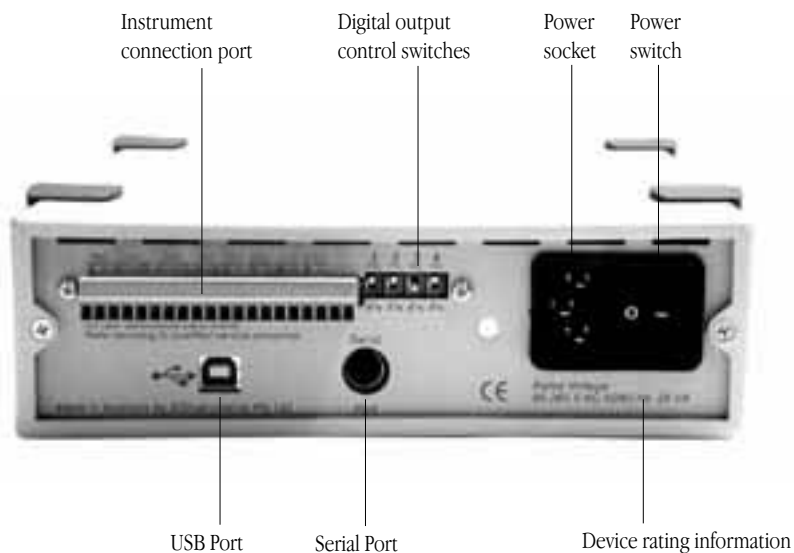
way for the PowerChrom software to set the injection point for a chromatography run.

## The Back Panel

The back panel of the PowerChrom unit provides the sockets to connect the recording unit to the computer and to the power outlet. It also provides a single connector which can deal with all the signals necessary to connect to external equipment for recording.

**Figure 1-2**

The back panel of the PowerChrom unit.



## The USB Port

The PowerChrom unit connects to your computer using a USB (Universal Serial Bus) port. This works with USB 1.1-compliant computers with USB connectors or a PCI USB card. To operate, USB needs a PC running Windows 98, Me, 2000, XP or later, or a Power Macintosh running Mac OS 8.6 or later.

You can safely turn on and off, or disconnect or reconnect, a USB-connected device while the computer remains on. However you should not disconnect the PowerChrom unit while the PowerChrom software is running.

---

## Serial Port

The serial port is not currently supported by software; however future versions of software may use this port for external device control.

## Power Connections

The power switch on the back right of the recording unit turns the unit on and off; the 3-pin IEC power socket is used to connect your recording unit to a 3-pin earthed (grounded) power cable. The power supply of the PowerChrom unit is a universal input switching type that will handle AC voltages from 90 to 260 V at frequencies between 50 and 60 Hz. There is no need to switch input voltages in different regions or countries.

## The Instrument Connection Port

All the connections that the PowerChrom recording unit uses for signal measurement and control are made through the single 20-pin Instrument Connection port on the back panel. This connector provides:

- two differential detector inputs for connection to detectors or other analog signal sources
- an injection signal or trigger input to set the run injection time when using the PowerChrom software
- four digital output control lines to control external equipment (either contact closures or TTL levels, set by the switches below)
- an analog output which can also be used for controlling external equipment, such as a pump.

The recording unit is shipped with a plug-in terminal strip that provides connections to all available inputs and outputs. You connect your own cables using the screws on the removable (plug-in) terminal strip, and referring to the labelling on the back panel of the recording unit. More information on using the digital output controls is available later in this guide.

---

## Detector Inputs

The PowerChrom unit has two independent detector input channels that are used to record external analog signals from attached detectors. Each input can be set up as differential (with the difference between the positive and negative inputs recorded), or single-ended (with the negative input referenced to ground).

The detector inputs used to record external signals are capable of handling signals from  $\pm 10$  V down to the microvolt ( $\mu\text{V}$ ) range without the need for additional external amplification. Each analog input has an independently programmable gain amplifier with its own filtering. You can set up each channel independently to suit your requirements using the PowerChrom program. The default input range is  $\pm 1$  V, but that can easily be changed using the software. Note that applying more than  $\pm 15$  V to the detector inputs could possibly damage the circuitry. The detector inputs are marked 'CH1' and 'CH2' and their ground connections are marked 'COM' (for common).

## Injection Signal (Trigger) Input

An external contact closure in the inject signal line is normally used to mark the sample injection time. The contact closure must be longer than 10 ms to be registered. The Inject Signal, or Trigger, indicator (the lowest one on the front panel), will glow yellow when contact closure occurs. The software guide covers its practical use in normal recording. The inject signal connections are marked 'Trig' (for Trigger).

## Analog Output

The PowerChrom unit can generate a controlled positive voltage through its analog output connections in the Instrument Connection port. The voltage is controlled from the PowerChrom software, in which the range (from 100 mV to 10 V) and the way the voltage varies within that range (from 0% to 100% of full scale) can be set. The analog output connections (positive and ground) are marked 'DAC' (for digital-to-analog converter).

---

## Digital Output Controls

The Instrument Connection port also provides four independent digital output controls. These outputs can be used to control external devices using the PowerChrom software (in methods). The digital outputs can provide logic levels (a nominal 5 V TTL) or contact closures, depending on the settings of the switches below them, and are therefore suitable for use with a wide range of external devices. The software can set the contact closure open or closed, or can set the logic voltage to be high or low, or send a pulse where the logic voltage changes from one state to the other for a brief time (from 16 to 32 ms, depending on internal timing).

Technical details of the digital input and output connectors are given later in this guide: please refer to the descriptions before attempting to connect equipment to them. More information on their use is given in the *PowerChrom User's Guide*. The digital output connections (positive and negative) are marked 'CTL1' to 'CTL4' (for control), and the Contact/TTL switches beneath them determine the manner in which each control functions.

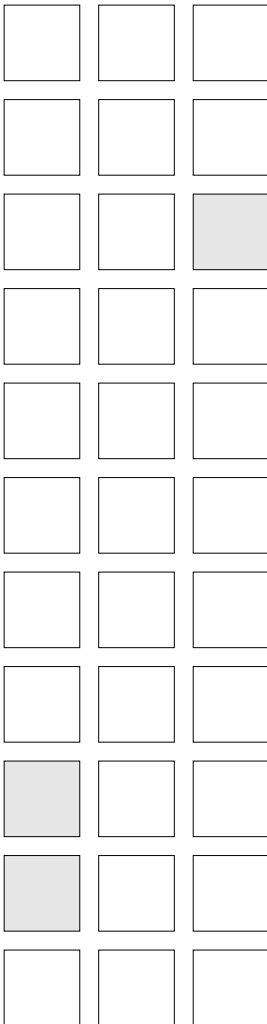


---

# 2

## C H A P T E R T W O

# Setting Up the Unit



This chapter starts with the PowerChrom unit's internal self-test, then describes how to connect up your recording unit to a Windows or Macintosh computer using USB, and how to connect external equipment.

---

# Self-Testing

Now that you are familiar with some of the features of your PowerChrom unit, you should check that it is working properly before you connect it to your computer.

The PowerChrom unit performs a self-test every time it is switched on, regardless of whether it is connected to a computer. To test that your recording unit is functioning properly when you turn it on, follow the instructions below, and observe the effects.

1. Connect the PowerChrom unit to a power outlet using the power cable that came with your unit. Turn the power on at the wall.
2. Turn on the power switch located on the rear of the unit.

All three indicators on the front panel should turn on at least briefly when the PowerChrom is first switched on. The Power indicator (the top light at the left of the front panel) should glow blue while the recording unit is on (see Figure 1–2). If the internal diagnostic check finds no problems, the Status indicator should flash yellow, and then stay green. The trigger indicator should flash yellow and then stay off.

If the indicators perform as described above, then your PowerChrom unit has successfully performed its internal self-test, and it can be safely connected to your computer.

If the Power indicator does not glow blue when the power switch is turned on, then either there is a problem with the power source, power cable or PowerChrom unit itself. Check the connections. If an error is detected during the self-test, the Status indicator will flash red, indicating that the problem is one that prevents the PowerChrom communicating with the computer (such as a hardware fault). Turn everything off, and then after at least five seconds turn the PowerChrom back on again. This should clear a temporary problem.

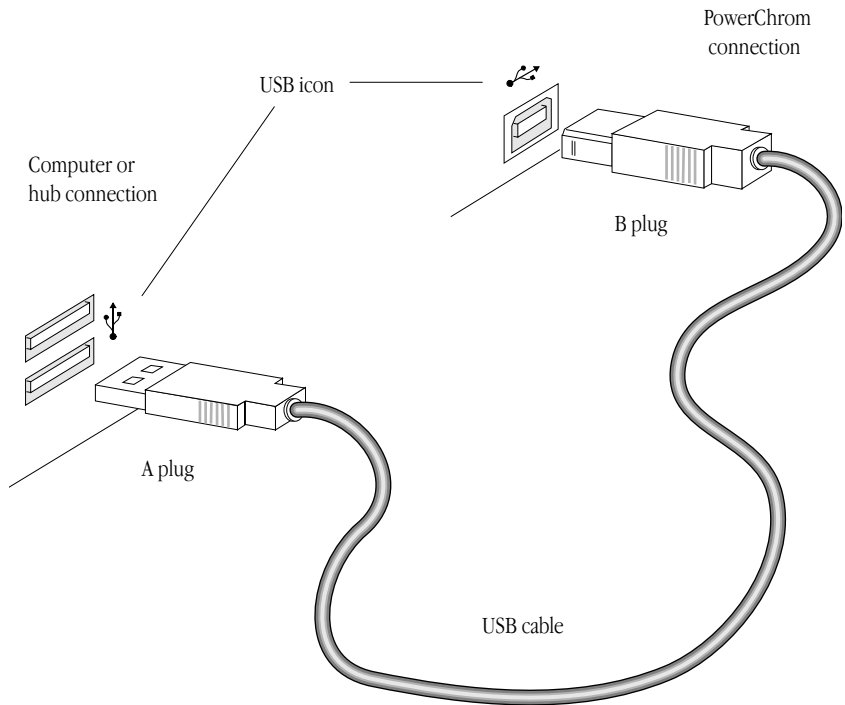
If the PowerChrom does not seem to be getting power, or the Status indicator flashes red even after restarting, contact your authorised ADInstruments distributor as soon as possible. Do not attempt to repair the PowerChrom yourself.

# Connecting the PowerChrom Using USB



Use the USB cable supplied with your PowerChrom to connect the USB port on its back panel to the USB port on the computer, or to an active USB hub connected to the computer. USB ports and cables should be marked with a trident-like icon as shown in the margin (some might have the letters 'USB' instead). USB cables are directional, and can only be connected one way: the narrow rectangular plug ('A plug' in Figure 2-1) connects to the computer or other hub, and the squarer plug with the bevelled top ('B plug' in Figure 2-1) connects to the PowerChrom.

**Figure 2-1**  
Connecting a PowerChrom unit to a computer with USB.



Connecting Windows or Macintosh computers should be much the same in this case: just look for the icons. If the connection is to a USB card installed in the computer, there might not be any icons on the

---

card. The narrow rectangular sockets for the USB 'A plug' are distinctive, though.

## USB Connection Rules

1. *Cable length should be less than 5 metres (16 feet) between devices.*  
Devices include USB hubs. There are a maximum of five hubs on any branch, so the maximum distance between the computer and the PowerChrom is 30 metres (98 feet). Do not use extension cables, use hubs between approved high-speed cables.
2. *Never attempt to make your own USB cable, or modify one.*  
USB is sensitive to cable impedances and cable lengths. Only use a certified USB cable from a reliable supplier, never a cheap brand or 'something the workshop whipped up'. Your PowerChrom is supplied with the proper USB cable. If you need additional USB cables, you should buy high-speed cables (fully shielded, twisted-pair, and with standard USB connections) for reliable results.
3. *Don't disconnect the PowerChrom while a program is using it.*  
Disconnecting a PowerChrom while the PowerChrom software is open, and especially while it is sampling, may cause problems. Stop sampling and close the program before disconnecting your PowerChrom.

You can safely turn on or off, or disconnect or reconnect, a USB-connected PowerChrom while the computer remains on, as long as the application program not running when you do it. (Although USB is a hot-pluggable standard, Windows 2000 may complain, bringing up an alert. The alert lets you install a control in your taskbar to avoid potential problems in future.)

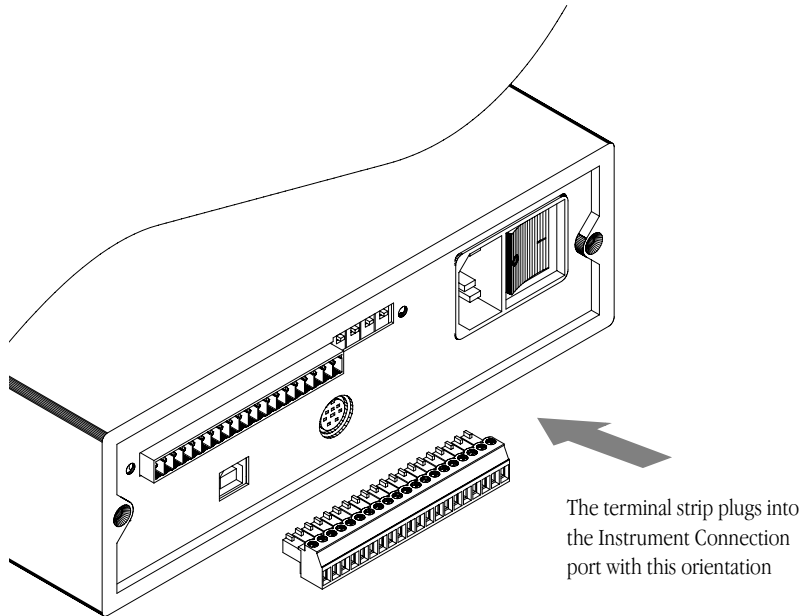
Technical information on the USB connection can be found in Appendix A Technical Aspects, p. 17.

# Connecting External Equipment

All the connections that the PowerChrom recording unit uses for signal measurement and control are made through the single 20-pin Instrument Connection port on the back panel.

**Figure 2-2**

The Instrument Port terminal strip.



The terminal strip plugs into the Instrument Connection port with this orientation

The recording unit is shipped with a plug-in terminal strip that provides connections to all available inputs and outputs. Refer to the labelling on the back panel of the recording unit when connecting your own equipment cables. The terminal strip is designed to accept the bared ends of wires or bare metal connectors that are inserted into it; the screws are then tightened firmly, and it is then plugged into the Instrument Connection port. Refer to Appendix A for technical details of the connections.

▼ **Refer**

*The Instrument Connection Port, p. 22*

The leftmost terminals are the ones most frequently used: the injector signal and detector inputs. The injector signal input ('TRIG') of the recording unit is used by the PowerChrom software to mark the injection time for a run. A contact closure longer than 10 ms will be registered as an injection event. The polarity of this connection is not critical unless the equipment's injector supplies a voltage level, in which case the positive output of the injector should be connected to

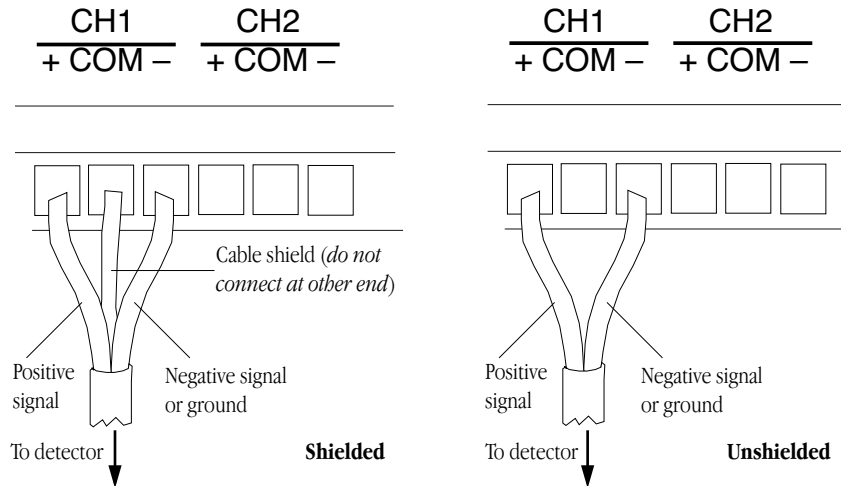
the + Trig input. The maximum voltage input should be no greater than 6 volts.

The detector inputs ('CH1' and 'CH2') of the recording unit record the detector signals of the chromatography equipment. These inputs can connect differential or single-sided outputs from the detector equipment (using the + and - terminals in either case). The use of differential inputs gives the system much greater immunity to external electrical interference when a suitable cable is used. For best results, use a twisted-pair cable, with a braided shield connected to the COM terminal. The cable shield should *not* be connected at the equipment end!

If polarity is not observed when connecting to detector equipment, the signal will be inverted — although this can be easily fixed in the PowerChrom software (in the Input Amplifier dialog box).

**Figure 2-3**

Detector connection: the preferred 2-wire connection with cable shield, and the alternate 2-wire unshielded cable connection.



# A

## Technical Aspects

This appendix provides technical information on the PowerChrom recording unit. You do not need to know the material here to set up or use your PowerChrom system. It is likely to be of especial interest to the technically minded, indicating what the unit can and cannot do, and its suitability for particular purposes. You should not use it as a service manual: remember that user modification of the recording unit voids your rights under warranty. This appendix also contains technical information on the USB connection.

### How Does it Work?

The PowerChrom unit is essentially an intelligent peripheral device specifically designed to perform the various functions needed for chromatographic data acquisition and pre-processing. It contains its own microprocessor, memory, and specialised analog amplifiers for signal conditioning. The block diagram in Figure A-1 show its basic elements.

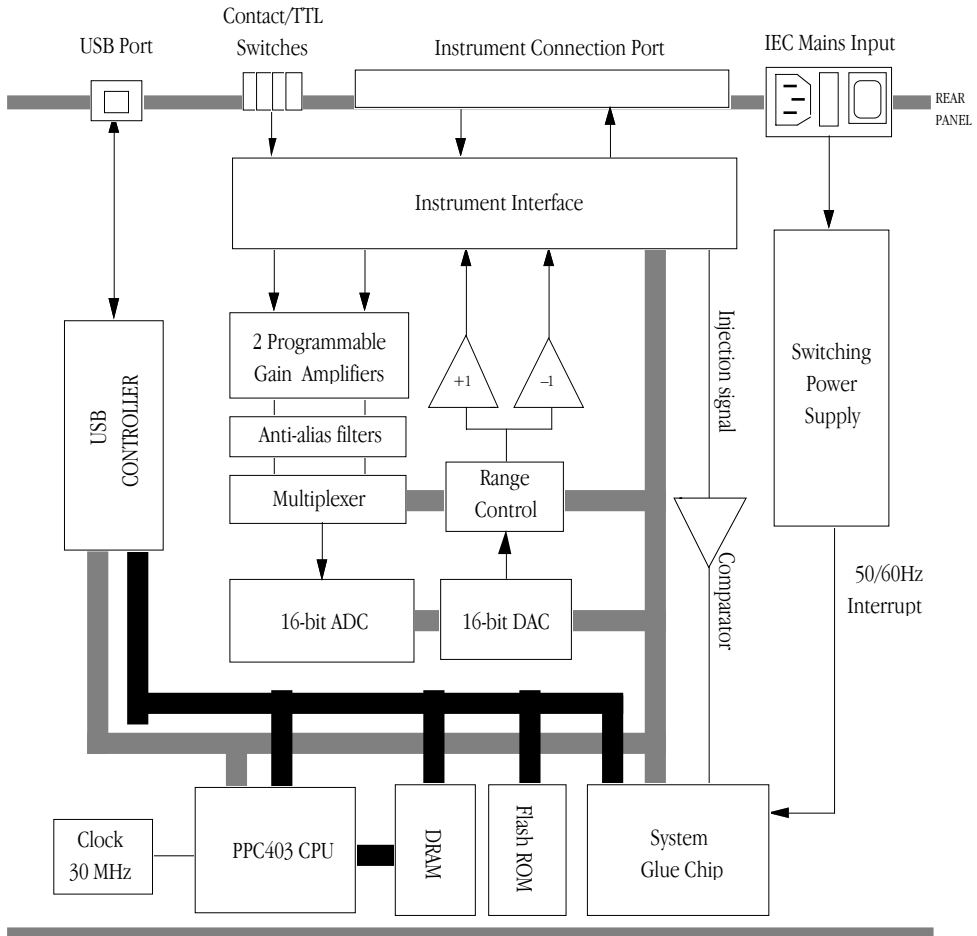
All sampling, output, and communications is controlled by an internal PowerPC 403 microprocessor running at 60 MHz (60 million cycles per second). The microprocessor has access to 4 megabytes of RAM (random access memory) for data storage and buffering prior to transmission to the computer. The recording unit uses USB (Universal Serial Bus) to transfer recorded data to the computer and for the computer to control the PowerChrom unit.

The recording unit has two input channels, used to condition analog signals (more detail is given later). The outputs of these amplifiers are

multiplexed to a 16-bit analog-to-digital converter. This ADC is capable of a maximum sampling rate of 100 kilohertz (100 000 samples per second), but is presently limited by the software to speeds appropriate to recording chromatographic data. The CPU (central processing unit) assembles groups of samples into blocks and then transmits them via the USB connection to the computer, where the PowerChrom program receives, records, and displays the data.

A 16-bit DAC (digital-to-analog converter) is used to control the analog output of the recording unit available through the Instrument Connection port. The DAC produces waveforms under software control that are fed through an attenuation network to produce

**Figure A-1**  
Block diagram of the  
PowerChrom unit.



---

different full-scale ranges. The signal is then buffered by a power amplifier to give it the capability to drive heavier loads.

The injection signal input of the Instrument Connection port is connected to a comparator circuit that triggers when a contact closure is present. The injection signal is coupled to the recording unit via an optical switch providing high voltage isolation. The details of this connection are described later in this appendix.

The four digital output connections of the Instrument Connection port provide a means of using the recording unit to control external devices. The digital output signals can be provided as either signal levels and contact closures, depending on the settings of the Contact/TTL switches below them, and can be used to turn on and off external devices or to signal to some other device. More detail on these controls is provided later in this appendix.

The recording unit uses a universal input switching power supply.

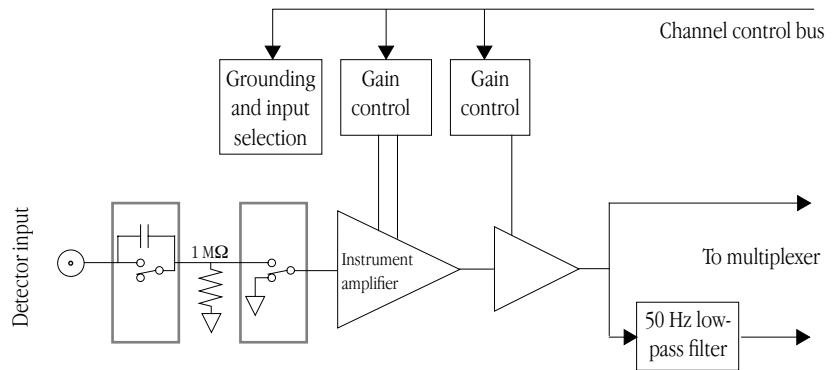
## Detector Inputs

The recording unit's analog input amplifiers have been designed with a considerable amount of computer-controlled gain (up to  $\times 5000$ ). Thus it is possible to record a variety of signals without any external pre-amplification. Each channel input is a separate DC amplifier, with programmable gain able to be set independently (the gain is set through the software range control: the less the range, the more the gain). The recording unit's input amplifiers can be set up as differential inputs (with the difference between the positive and negative inputs recorded), allowing connection to a wide range of detectors and other equipment while providing the best noise immunity. They can also be set up as single-sided inputs (with the difference between the positive and ground inputs recorded). Applying more than  $\pm 15$  V to the detector inputs could possibly damage the circuitry.

It is important to note that the recording unit disconnects from the Instrument Connection port and grounds the inputs to amplifiers not in use. It also grounds each amplifier and measures the DC offset voltage if the gain is changed. In this way, the software corrects for any DC drift or offset in the circuits that may develop over time or

between readings. The operation of the input amplifiers is illustrated by the block diagram in Figure A-2.

**Figure A-2**  
Block/schematic diagram of the input amplifier circuitry.



Input impedance is one megohm (1 MΩ). Each input produces either a filtered or an unfiltered signal. Each input is fitted with a software-selectable low-pass filter (50 Hz) which can be turned on and off as necessary.

Using differential analog inputs for the detectors gives the system much greater immunity to external electrical interference, when used in conjunction with a suitable cable. The best detector input cable would be a twisted pair with a braided shield. The shield should be connected to the detector input's analog ground (the COM terminal).

## Analog Output

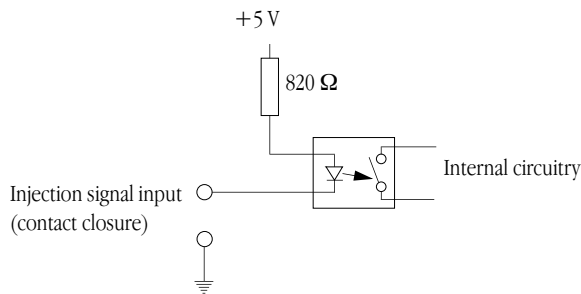
The analog output provides a computer-controlled variable output (0–10 V) that can be used with the PowerChrom application to control peripheral devices. The output amplifier can deliver up to 50 mA. All stimulation voltage is generated by the recording unit via the DAC connections in the Instrument Connection port (+ and COM), giving a positive voltage only. The voltage is controlled from the PowerChrom program in the hardware settings for the pump output, in which the range (from 100 mV to 10 V) can be chosen, and in methods, where the way the voltage varies within that range (from 0% to 100% of full scale) can be set.

## Injection Signal Input

The injection signal input uses a solid-state relay input to recognise external relay closures. A closure of 10 ms or more results in the registering of the injection signal with the PowerChrom program. The input can also be connected to a logic or voltage level output of another instrument provided the device can sink several milliamperes of current. The equivalent circuit of the injector signal input is shown below.

**Figure A-3**

The equivalent circuit of the injection signal input.



## Digital Outputs

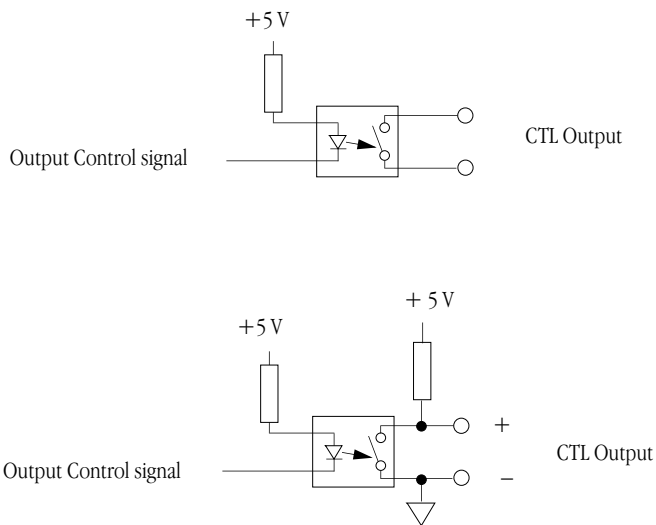
There are four digital control outputs (marked CTL1 through to CTL4), each of which provide a logic level or contact closure depending on the position of the corresponding switches to the right of the connector. The equivalent circuits of the outputs in the two different modes is shown in Figure A-4.

In the contact closure position (switch in the down position) the output is shorted when the software sets it to Close/Low. The output relay will be in the open position when the software sets it to the Open/High position.

In TTL mode (TTL symbol) the positive output will be pulled high by a resistor. When the relay is shorted via software (it sets it to Close/Low), the positive output will go low (it will be at ground potential). Note that in TTL mode the negative terminal must be grounded either by using a ground reference from the equipment it controls or by connecting it to the analog output (DAC) ground (marked COM). This makes sure there is a solid ground from which the output can be referenced.

**Figure A-4**

The equivalent circuit of the digital output: in contact closure mode (top); in TTL mode (bottom).



## Connections

This section of the appendix describes the connectors fitted to the recording unit, specifically the Instrument Connection port, and contains 'pinout' and electrical details. You should read the section carefully before attempting to connect any cables. Using cables that are wired incorrectly can cause internal damage to the recording unit and will void your rights under warranty.

### The Instrument Connection Port

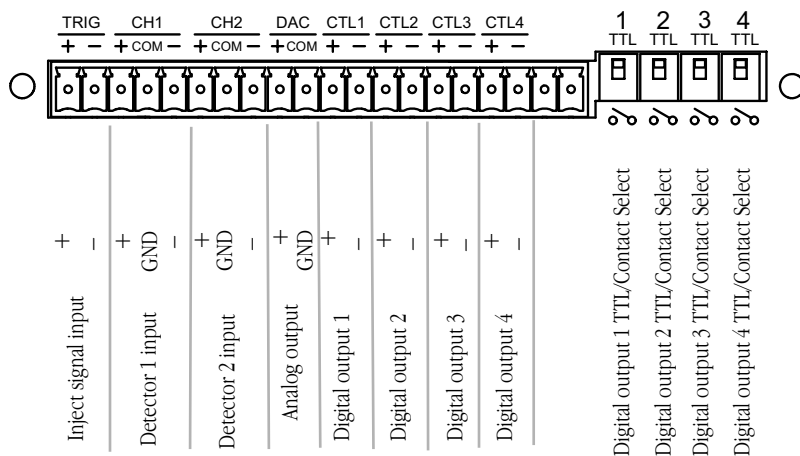
The single 20-pin Instrument Connection port on the back panel is the only means of connection to the recording unit's internal measurement and control circuitry. It provides a range of connections:

- two differential analog detector signal inputs
- one differential analog output for control
- one digital inject signal input
- four digital control outputs.

The recording unit is shipped with a plug-in terminal strip that provides connections to all available inputs and outputs. You connect your own cables using the screws in the terminal strip and referring to the labelling on the back panel of the recording unit. The pin assignments of the Instrument Connection port are shown below.

**Figure A-5**

The pin assignments for the Instrument Connection port.



## Recording Unit Accuracy

Your recording unit was calibrated at the factory to an accuracy of better than 0.1%. Some 'zero drift' or 'gain drift' can occur with time. This can affect the accuracy of measurements, especially at the highest input gains. The recording unit can be recalibrated, but in most circumstances this is not necessary in its lifetime. There are several reasons for this.

**DC drift compensation.** Each time recording is started manually or by triggering (the usual situation), the input to the amplifier is grounded and any DC due to the amplifier's drift with temperature and age is measured. The measured voltage is removed from the readings for that channel through software correction, in a process transparent to the user.

**Calibration.** Quantitative chromatography requires calibration, and the PowerChrom program has all the facilities needed to calibrate any

---

measurements made versus standards in a variety of ways. The process of calibrating easily compensates for any minor inaccuracies in amplifier gain over time.

## **Sampling Operation**

The PowerChrom system ‘oversamples’; that is it samples at a much higher rate than the rate at which data points are actually recorded. This has two benefits: it reduces mains noise in most situations, and it improves the amplitude resolution of the signal.

The PowerChrom system oversamples by sampling at 10 or 20 kHz (depending on whether low pass filtering is on or off, see below). Each recorded data point is then calculated by taking the average of the 10 or 20 kHz samples over the sampling interval corresponding to the rate selected in the software. Provided the sampling rate is less than the mains frequency (which is usual — 10 Hz is a common sampling rate for chromatography), this averaging will occur over an integral number of mains cycles, thereby averaging out the effect of noise.

The amplitude of a signal recorded with PowerChrom can be resolved into 64 000 possible values over the chosen range. (The PowerChrom unit has a 16-bit analog-to-digital converter (ADC, which can resolve a signal into  $2^{16}$  or 65 536 possible amplitude values. The software fits 64 000 of these to the range, allowing some leeway above and below it for signal extremes.) When the signal amplitude is varying slowly between only a few of these discrete values, averaging interpolates between them, effectively giving a greater resolution.

## **Filtering**

If oversampling has not sufficiently reduced noise in your signal, the digital low-pass filter in the PowerChrom software can be used (if you do not have a problem with noise in your signal, then leave the digital low-pass filter off, as it tends to negate the increased amplitude resolution produced by oversampling). If the digital low-pass filter is turned on the hardware will sample at 20 kHz irrespective of the sampling rate selected in the software; if it is

turned off, the hardware will sample at 10 kHz irrespective of the sampling rate chosen.

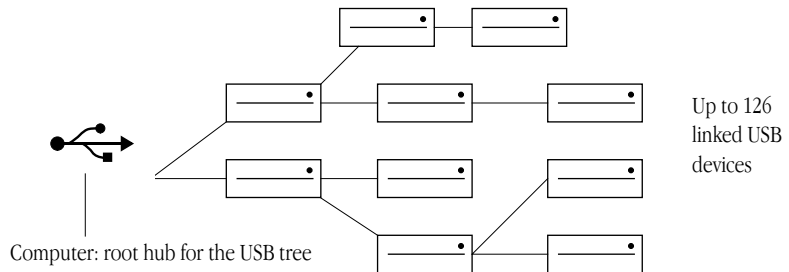
## The USB Connection

The PowerChrom is fitted with a USB (universal serial bus) port, which provides its means of connection to a computer. This works with USB 1.1-compliant computers with USB connectors or a PCI USB card. USB needs a PC running Windows 98, Me, 2000, XP or later, or a Power Macintosh running Mac OS 8.6 or later.

USB devices are connected in a tree-like structure, with the host, the computer, forming the root of the tree, and hubs allowing multiple devices to connect to them, like the branches of the tree.

**Figure A-6**

A USB tree: up to 126 devices can be linked to the computer.



A hub is simply a device that lets you extend the USB tree. It connects to a USB device such as the computer, and multiple USB devices (including other hubs) can connect to it in turn. It provides power for those attached devices that need it. Up to five hubs can be connected between the computer and the furthest USB device. As many as 127 devices can be connected on one tree, counting the computer. The cable between any USB devices (including hubs) must allow a signal to be transmitted in a certain time; in practical terms this means it must be no more than 5 metres (16 feet) in length. Thus, no device can be more than 30 metres (98 feet) from the computer.

USB allows you to plug in and remove devices while the computer is on. It re-enumerates (provides addresses for) devices as they are connected and disconnected, rather than requiring fixed ID numbers.

---

USB still has some restrictions. Since all the devices on a USB tree have a common communication pathway, if you have many devices with a lot of information to transfer, they compete for capacity (bandwidth).

USB has two sorts of cables, which it should not be possible to interchange. Low-speed cables are cheaper, and suitable for mice and so on. They are either captive (one end is permanently fixed to the device) or use a custom connection, not a standard USB one. All detachable USB cables are high speed, with fully shielded twisted-pair cables, and standard USB connections: a narrow rectangular A plug at one end and a squarer B plug with a bevelled top at the other. All devices that can act as hubs have high-speed connections.

# B

## Troubleshooting

This appendix describes most of the common problems that can occur with your PowerChrom unit. It covers how these problems are caused, and what you can do to alleviate them. If the remedies here do not work, your *PowerChrom User's Guide* contains remedies for possible software problems.

If none of the solutions to problems here or in the *PowerChrom User's Guide* appear to have any effect, then consult your ADInstruments distributor.

### Problems: Windows

Most problems that users encounter are connection problems. Improper connections can result in a loss of all or some of a signal.

*The PowerChrom Status indicator light flashes red, or red and yellow, when the PowerChrom is turned on*

**Possible cause:** Either there is a low-level software or firmware problem (if there are red and yellow flashes), or an internal hardware problem has been discovered by the diagnostic self-test (performed by the PowerChrom each time it powers up).

- **Solution:** Turn everything off, and then after at least five seconds turn the PowerChrom back on again. This should clear a temporary problem. If not, then the software may have a serious fault, and may need to be reinstalled, or the PowerChrom may need repair. Consult your ADInstruments distributor.

▼ **Refer**  
*Self-Testing, p. 12*

---

*When Windows starts up, it doesn't recognise the PowerChrom*

**Possible cause:** This should happen only the first time PowerChrom hardware is connected to the computer. Windows may bring up the New Hardware wizard, and ask if you want to install a driver.

- **Solution:** Leave the wizard on its default settings and click the OK button. Insert the PowerChrom installer CD. The PowerChrom setup information file should be selected in the dialog box that appears. Click the OK button, and continue.

*The computer refuses to boot with the PowerChrom connected*

**Possible cause:** A poor connection between PowerChrom and computer, or bad cable.

- **Solution:** Ensure that the cable is firmly attached at both ends and try again. If there is still a problem, try a new cable.

**Possible cause:** The PowerChrom has an internal problem or has 'hung'.

- **Solution:** Turn everything off, and then after at least five seconds turn the PowerChrom back on again. Turn on the computer and try using the software again.

*There is an alert when the PowerChrom is disconnected or turned off*

**Possible cause:** USB is a hot-pluggable standard, meaning that you should be able to turn on or off, or disconnect or reconnect, a USB-connected PowerChrom safely while the computer remains on, as long as the application program is not running when you do it. Windows 2000 may complain, though, bringing up an alert.

- **Solution:** The Windows 2000 alert lets you install a control in your taskbar to deal with this. Install the control, and use it before you disconnect or turn off the PowerChrom, to avoid the alert.

*The computer can't find the PowerChrom*

**Possible cause:** The PowerChrom is off or the power is switched off at the wall or the power cable is not connected firmly.

- 
- **Solution:** Check switches and power connections.

**Possible cause:** A poor connection between PowerChrom and computer, or bad cable.

- **Solution:** Ensure that the cable is firmly attached at both ends and try again. If there is still a problem, try a new cable.

**Possible cause:** The PowerChrom has an internal problem or has 'hung'.

- **Solution:** Turn everything off, and then turn the PowerChrom back on again after at least five seconds. Turn on the computer and try using the software again.

**Possible cause:** The connected computer does not properly support USB.

- **Solution:** USB needs a USB 1.1-compliant PC with Windows 98, Me, 2000, XP or later; it simply will not work with earlier operating systems, such as Windows 95 or Windows NT 4.

*The computer hangs up while recording, or there is data loss*

**Possible cause:** A poor connection between PowerChrom and computer, or bad cable.

- **Solution:** Ensure that the cable is firmly attached at both ends and try again. If there is still a problem, try a new cable.

*The PowerChrom doesn't work or the program crashes after a short time*

**Possible cause:** A poor connection between PowerChrom and computer, or bad cable.

- **Solution:** Ensure that the cable is firmly attached at both ends and try again. If there is still a problem, try a new cable.

---

# Problems: Macintosh

Most problems that users encounter are connection problems. Improper connections can result in a loss of all or some of a signal.

▼ **Refer**  
*Self-Testing, p. 12*

*The PowerChrom Status indicator light flashes red, or red and yellow, when the PowerChrom is turned on*

**Possible cause:** Either there is a low-level software or firmware problem (if there are red and yellow flashes), or an internal hardware problem has been discovered by the diagnostic self-test (performed by the PowerChrom unit each time it powers up).

- **Solution:** Turn everything off, and then after at least five seconds turn the PowerChrom back on again. This should clear a temporary problem. If not, then the software may have a serious fault, and may need to be reinstalled, or the PowerChrom may need repair. In this case consult your ADInstruments distributor.

*The computer refuses to boot with the PowerChrom connected, or the computer can't find the PowerChrom*

**Possible cause:** The PowerChrom is off or the power is switched off at the wall, the power cable is not connected firmly, or a fuse has blown.

- **Solution:** Check switches, power connections, and fuses.

**Possible cause:** A poor connection between PowerChrom and computer, or bad cable.

- **Solution:** Ensure that the cable is firmly attached at both ends and try again. If there is still a problem, try a new cable.

**Possible cause:** The PowerChrom has an internal problem or has 'hung'.

- **Solution:** Turn everything off, and then after at least five seconds turn the PowerChrom back on again. Turn on the computer and try using the software again.

---

**Possible cause:** The connected computer does not properly support USB.

- **Solution:** USB needs a Power Macintosh with Mac OS 8.6 or later; it simply will not work with earlier hardware, such as a 68K Macintosh, or earlier operating systems, such as System 7.

*The computer hangs up while recording, or there is data loss*

**Possible cause:** Poor cable connection between the recording unit and the computer, or a bad cable.

- **Solution:** Ensure that the cable is firmly attached at both ends and try again. If there is still a problem, try a new cable.

*The hardware doesn't work or the program crashes after a short time*

**Possible cause:** Poor cable connection between the recording unit and the computer, or a bad cable.

- **Solution:** Ensure that the cable is firmly attached at both ends and try again. If there is still a problem, try a new cable.



# C

## A P P E N D I X C

# Specifications

### Analog Detector Inputs

Number of input channels: 2

Input configuration: Single-ended or differential

Amplification range:  $\pm 2$  mV to  $\pm 10$  V full scale in 12 steps

<i>Range</i>	<i>Hardware Resolution</i>
$\pm 10$ V	312.5 $\mu$ V
$\pm 5$ V	156.25 $\mu$ V
$\pm 2$ V	62.5 $\mu$ V
$\pm 1$ V	31.25 $\mu$ V
$\pm 0.5$ V	15.625 $\mu$ V
$\pm 0.2$ V	6.25 $\mu$ V
$\pm 0.1$ V	3.125 $\mu$ V
$\pm 50$ mV	1.5625 $\mu$ V
$\pm 20$ mV	625 nV
$\pm 10$ mV	312.5 nV
$\pm 5$ mV	156.25 nV
$\pm 2$ mV	62.5 nV

Maximum input voltage:  $\pm 15$  volts

Input impedance:  $\approx 1$  M $\Omega$  || 47 pF @ DC

Low-pass filtering: 20 kHz fixed second-order filter.  
Further digital filtering in software

Frequency response (-3 dB):	20 kHz @ $\pm 10$ V full scale, all ranges
DC drift:	Software corrected
CMRR (differential):	96 dB @ 50 Hz (typical)
Channel crosstalk:	-110 dB typical
Input noise:	$< 2.4 \mu\text{V}_{\text{rms}}$ referred to input (DC to 20 kHz)

## Output Amplifier

Output configuration:	Single-ended
Output resolution:	16 bits
Maximum output current:	$\pm 15$ mA maximum
Output impedance:	$0.1 \Omega$ typical
Slew rate:	$6 \text{ V}/\mu\text{s}$
Settling time:	$2 \mu\text{s}$ (to 0.01% of FSR for LSB change)
Linearity error:	$\pm 1$ LSB (from $0^\circ\text{C}$ to $70^\circ\text{C}$ )
Output range:	$\pm 200$ mV to $\pm 10$ V (software-selectable)

<i>Range</i>	<i>Resolution</i>
$\pm 10$ V	5 mV
$\pm 5$ V	2.5 mV
$\pm 2$ V	1 mV
$\pm 1$ V	$500 \mu\text{V}$
$\pm 500$ mV	$250 \mu\text{V}$
$\pm 200$ mV	$100 \mu\text{V}$
$\pm 100$ mV	$50 \mu\text{V}$

---

## Microprocessor and Data Communication

CPU:	PPC403GCX (60 MHz)
Internal Memory:	4 MB DRAM
Data communication:	USB (up to 800 kilobytes/s, dependent on setup)

## Sampling

ADC resolution:	16 bits (312 $\mu$ V resolution at the 10 V range)
Signal resolution:	20–24 bits with oversampling
Linearity error:	$\pm 2$ LSB (from 0 °C to 70 °C)
Available sampling rates:	200 Hz down to 0.2 Hz (12/min) with PowerChrom application program

## Instrument Connection Port

Instrument Connection port:	20-pin port. Accepts strip terminal.
Strip terminal:	Plugs into Instrument port. Allows easy connection to everything.

## Injection Signal Input

Input type:	Contact closure (available through Instrument Connection port)
Closure registration:	Contact closure must be longer than 10 ms to be registered as inject signal.

---

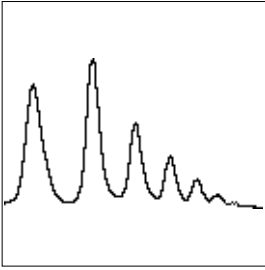
## Digital Output Controls

Signals provided:	4 digital outputs: (available through Instrument Connection port); contact closure or TTL level (set by Contact/TTL switches near instrument port)
Contact closure outputs:	Maximum current, 300 mA; maximum voltage, 250 V. Switching time: Close, 2 ms; Open, 1 ms
Digital level outputs:	TTL level outputs. Designed to drive 1 TTL input load (1 mA)

## Physical Configuration

Dimensions (w × h × d):	200 mm (w) × 65 mm (h) × 250 mm (d) (7.9" × 2.6" × 9.8")
Weight:	2.13 kg (4 lb 11 oz)
Operating voltage:	90 – 260 V AC 50/60 Hz
Nominal power needs:	6 VA (25 mA @ 240 V or 52 mA @ 115 V)
Operating temperature range:	0 to 35 °C, 0 to 90% humidity (non-condensing)

*ADInstruments reserves the right to alter these specifications at any time.*



# Glossary

This glossary covers terms used in this owner's guide (and may differ slightly from the terms in other ADInstruments guides). General and specific computer terminology is covered in the documentation that came with your computer.

**ADC** (analog-to-digital converter). A device that converts analog information into some corresponding digital voltage or current.

**amplitude.** The maximum vertical distance of a periodic wave from the zero or mean position about which the wave oscillates.

**analog.** Varying smoothly and continuously over a range. An analog signal varies continuously over time, rather than changing at discrete intervals.

**analog input.** Refers to the analog input connections on the Instrument Connection port. These inputs are designed to accept up to  $\pm 10$  volts. Inputs can be either single-sided or differential.

**analog output.** This refers to the analog output connection on the Instrument Connection port. The analog output provides

a software-controlled variable output ( $\pm 10$  V) that can be used to control a peripheral device such as a pump.

**analysis.** When the recording unit is not physically connected to the computer, the PowerChrom software can be used to analyse and manipulate existing files if the analysis option is chosen.

**Chart.** An application supplied with a PowerLab that emulates a multi-channel chart recorder, with powerful analysis features (Windows or Macintosh).

**connector.** A plug, socket, jack, or port used in connecting one electronic device to another, such as a recording unit to a computer (via a cable, of course).

**CPU** (central processing unit). A hardware device that performs logical and arithmetical operations on data as specified in the instructions: the heart of most computers.

**DAC** (digital-to-analog converter). A device that converts digital information into some corresponding analog voltage or current. A DAC drives the analog output on the unit.

---

**DC offset.** The amount of DC (direct current) voltage present at the output of an amplifier when zero voltage is applied to the input; or the amount of DC voltage present in a transducer in its equilibrium state.

**differential input.** Input where the recorded signal is the difference between the positive and negative input voltages: if both were fed exactly the same signal, zero would result. Differential inputs are less sensitive to external electrical interference.

**digital.** Varying discretely. A digital signal changes to discrete values at discrete intervals, rather than varying continuously over time.

**envelope form.** The overall shape of a signal, outlined by the minimum and maximum recorded values. Often used to display quickly changing signals.

**filter.** An electronic device or a program that alters data in accordance with specific criteria. Filters in the recording unit can be used to reduce or to eliminate electronic noise from data readings.

**frequency.** The number of complete cycles per second of a waveform. Frequency is usually expressed in hertz, Hz (cycles per second), kilohertz, kHz (thousands of cycles per second), or megahertz, MHz (millions of cycles per second).

**frequency response.** The bandwidth in which a circuit passes a signal without unacceptable attenuation. A low-pass filter's frequency response is considered to be the frequency at which the output voltage becomes 0.707 ( $1/\sqrt{2}$ ) of the input voltage or

has been attenuated by 3 decibels. For example, if a low-pass filter has a frequency response of 200 Hz, it means that the signal is effectively unattenuated up to 150 Hz, and is 0.707 of the original value at 200 Hz.

**gain.** The amount of amplification of a signal.

**hertz (Hz).** The unit of frequency of vibration or oscillation, defined as the number of cycles per second. The recording unit's maximum burst sampling rate is 100 kilohertz. (See frequency.)

**Inject signal input.** Refers to the digital input (Trigger) on the Instrument Connection port of the recording unit. This input is designed to allow sampling to be started from an external source.

**low-pass filter (LPF).** A form of filter that passes low-frequency signals and DC voltages but attenuates frequencies above a certain frequency, called the cutoff, or  $-3$  dB, frequency. Also known as high-frequency, or HF, filter.

**Macintosh.** A family of Apple computers with built-in graphics and an elegant and intuitive user interface.

**MacLab.** The original name for the PowerLab before it went cross-platform; the PowerLab system now replaces the MacLab system.

**macro.** A user-defined shorthand for a group of commands. Macros can speed up routine tasks, and even automate experiments.

**oversampling.** A technique to reduce noise and increase resolution by sampling at a high speed and averaging the results.

---

**Peaks.** A simple chromatography analysis package. It does not record data, but reads acquired data from Chart, Scope, or text files (Chart 3 for Macintosh only).

**port.** A socket in a computer where you plug in a cable for connection to a network or a peripheral device. Also, any connection for transferring data, for instance between the CPU and main memory.

**PowerChrom.** A versatile, flexible, and powerful chromatography program for use with a PowerChrom recording unit (Windows and Macintosh).

**PowerChrom system.** The system consists of a recording unit and the PowerChrom software. It provides a general-purpose system for manual or automatic recording and analysis of chromatographic peaks.

**PowerChrom unit.** The PowerChrom recording unit is a self-contained data acquisition hardware unit that connects to a computer running the Windows or Macintosh operating systems. It is optimised for use with the PowerChrom software.

**PowerLab system.** The system consists of a recording unit and applications software (and possibly ancillary devices). It provides a multi-purpose data recording, display, and analysis environment for experimental data.

**range.** In PowerChrom, the range is the maximum positive and negative voltage that can be displayed, from  $\pm 2$  mV to  $\pm 10$  V, in twelve steps. (Range is inversely proportional to gain, the amount of amplification.)

**Scope.** An application supplied with the PowerLab that emulates a two-channel storage oscilloscope, with added powerful options (for Windows and Macintosh).

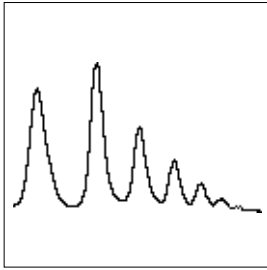
**terminator.** A device used in a SCSI chain to maintain signal integrity. Some devices, such as internal hard disks, have them built in.

**TTL (transistor-transistor logic).** A family of integrated circuits with bipolar circuit logic: TTLs are used in computers and related devices. TTL is also a standard for interconnecting such circuits, which defines the voltages used to represent logical zeroes and ones (binary 0 and 1).

**USB (Universal Serial Bus).** A serial communication standard used for connecting peripheral devices to computers supporting the standard. It provides data communication up to 12 megabits/s over a simple interconnection cable. The standard is designed to be 'hot-pluggable' which simply means that USB devices can be plugged in or removed while the the devices are on.

**waveform.** The shape of a wave (a graph of a wave's amplitude over time).





# Index

- 
- A**  
ADC (analog-to-digital converter) 18, 24  
analog inputs 8  
analog output 8, 18, 20  
analog-to-digital converter 18, 24
- B**  
back panel 6  
block diagram 18
- C**  
checking the PowerChrom unit 2  
computer requirements 3  
    Windows 3  
connections 22–23  
    detector inputs 16  
    digital outputs 19  
    external equipment 15–16  
    PowerChrom to computer 13–14  
    USB 13–14  
connectors 15–16, 22–23
- D**  
DAC 8  
DAC (digital-to-analog converter) 18  
DC drift 19  
detector inputs 8, 16, 20  
digital outputs 9, 19, 21  
digital-to-analog converter 18
- F**  
front panel 5–6
- H**  
hardware requirements 4
- I**  
Inject Signal indicator 5  
injection signal input 8, 19, 21  
Instrument Connection port 7–9, 15–16, 22–23
- M**  
mains frequency rejection 24
- N**  
New Hardware wizard 28  
noise 24
- O**  
oversampling 24
- P**  
Power indicator 5  
power switch 7  
PowerChrom 4  
    sampling operation 24  
PowerChrom system 3  
PowerChrom unit  
    accuracy 23
-

---

- back panel 6
- checking 2
- front panel 5–6
- input amplifiers 19
- self-test 12
- user modification 17
- voltage rating 5
- power-on self-test 12
- problems and solutions
  - Macintosh 30–31
  - Windows 27–29

## **S**

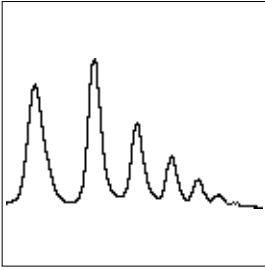
- sampling operation 24
- sampling speed 24
- SCSI
  - port 22
- self-test 12
- Status indicator 5

## **T**

- technical specifications 33–36
- terminal strip 15, 23
- Trigger indicator 5

## **U**

- USB
  - cables 14
  - connection 13–14
  - connection rules 14
  - technical details 25–26
- user modification 17



---

# Licensing & Warranty Agreement

---

## Extent

This Agreement is between ADInstruments Pty Ltd [‘ADI’] and the purchaser [‘the Purchaser’] of any ADI product — software, hardware, or both — and covers all obligations and liabilities on the part of ADI, the Purchaser, and other users of the product. The Purchaser (or any user) accepts the terms of this Agreement by using the product. Any changes to this Agreement must be recorded in writing and have ADI’s and the Purchaser’s consent.

## Copyright and Trademarks

ADI develops proprietary computer software and hardware, including MacLab<sup>®</sup>, PowerChrom<sup>®</sup>, and PowerLab<sup>®</sup> units. All ADI software, hardware, and documentation is protected by copyright, and may not be reproduced or altered in any way, nor may products be derived from or based on it. ADI retains the exclusive ownership of the trademarks and registered trademarks represented by its company name, logo, and product names.

## Responsibilities

The Purchaser and any others using any ADI product agree to use it in a sensible manner for purposes for which it is suited, and agree to take responsibility for their actions and the results of their actions.

If problems arise with an ADI product, ADI will make all reasonable efforts to fix them. This service may incur a charge, depending on the nature of the problems, and is subject to the other conditions in this Agreement.

## Limitations

ADI products are produced to high standards, and should perform substantially as described in the supplied documentation. There is a limited hardware warranty, and technical support is provided for all products.

Nevertheless, since ADI products could be affected by external factors (for instance, the computer system on which they run), absolute performance and reliability cannot be guaranteed. No warranty, either express or implied or statutory, other than that contained in this Agreement, is made in respect to ADI products. The Purchaser therefore assumes all risks as to the performance and reliability of the products, and the results gained using them.

No claim for damages of any sort arising from the use or misuse of ADI products can be made against ADI or its agents or employees.

---

## **Hardware Warranty**

ADI warrants that the hardware purchased by the Purchaser shall be free of defects in material and workmanship for one year from its date of purchase. If there is such a defect, ADI will repair or replace the equipment as appropriate, and the duration of the warranty shall be extended by the length of time needed for repair or replacement. The Purchaser should contact ADI for return authorisation before sending back defective products.

This warranty applies only to hardware used normally and within its operating specifications. It does not cover hardware modified in any way, subjected to unusual physical, electrical, or environmental stress, used with incorrectly wired or substandard connectors or cables, or with the original identification marks altered.

## **Software License**

The Purchaser has the non-exclusive right to use the supplied ADI software. (The Purchaser's employees or students, for instance, are entitled to use it, provided they adhere to this Agreement.)

The Purchaser can make as many backup copies of ADI software as is reasonable. Each separate purchase of a software program, however, licenses it to be used on only one computer at any given time. Although multiple copies of a purchased program may exist, two or more copies must not be used simultaneously. Site licenses (multiple-user licenses) are treated as if five copies of a program were purchased separately, even if only one CD is provided.

## **Technical Support**

Once a customer registration form has been filled out and sent in, the Purchaser is entitled to free technical support for any ADI product for one year from its date of purchase. (A customer registration form is included with each product: if for some reason you cannot find one, contact ADI for another.) This involves help and advice concerning installation, operation, particular uses, and problems that may arise in the use of ADI products.

## **Jurisdiction**

This Agreement shall be governed by the laws of New South Wales in Australia, and any proceedings concerning it shall be heard and resolved by the Supreme Court of New South Wales in Australia.