# PowerLab SP
Owner's Guide

for PowerLab/4SP, PowerLab/8SP, and PowerLab/16SP models
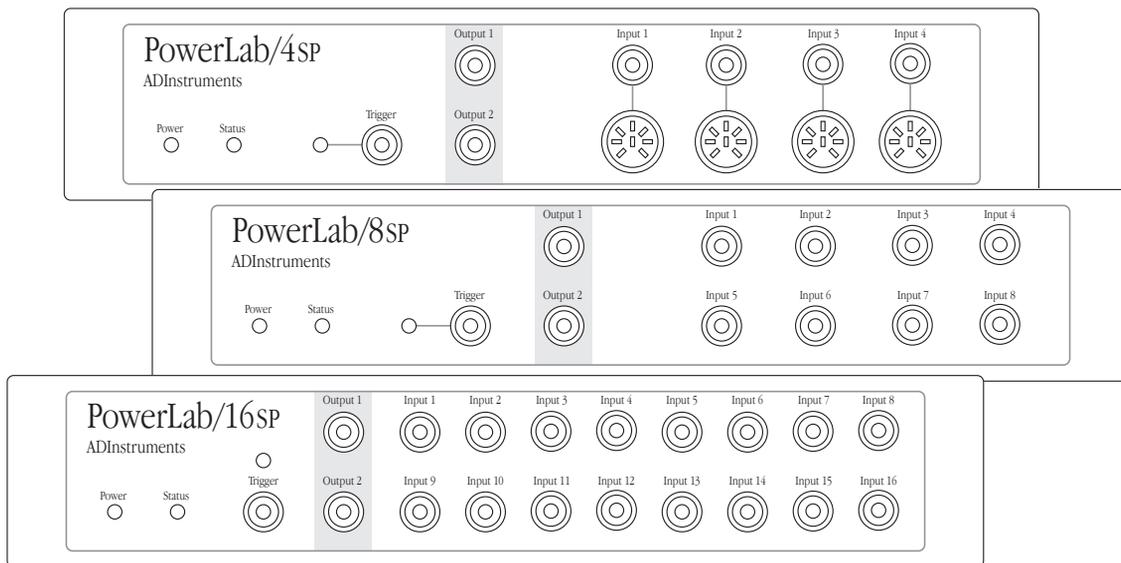
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Contents

Safety Notes

Product Intention

PowerLab systems have been designed only for use in teaching and research applications. They are not intended for clinical or critical life-care use and should never be used for these purposes, nor for the prevention, diagnosis, curing, treatment, or alleviation of disease, injury, or handicap.

Applicable Safety Standards

When used with insulated transducers or ADInstruments isolated front-ends, PowerLab systems are safe for human connection. The ML132 Bio Amp, ML135 Dual Bio Amp, ML408 Dual Bio Amp/Stimulator, ML116 GSR Amp, ML117 BP Amp and ML180 front-ends conform to international safety requirements. Specifically, these requirements are IEC601-1 and its addenda (Table S–1), and various harmonised standards worldwide (UL2601.1 in the USA, and AS/NZS3200.1 in Australia and New Zealand). In accordance with European standards they also comply with the electromagnetic compatibility requirements under EN60601-1, which encompasses the EMC directive. Further information is available on request.

Table S–1
Applicable safety standards met by ADInstruments isolated front-ends

EC Standard No.	International Standard — Medical electrical equipment
IEC601-1:1988	General requirements for safety
IEC601-1-1:1992	Safety requirements for medical electrical systems
IEC601-1-2:1993	Electromagnetic compatibility

General Safety Instructions

- Since the PowerLab is used in conjunction with a computer (which has much higher leakage currents) the subject must be at least 1.83 metres (6 feet) away from any of the equipment, to avoid contact with the computer. The Bio Amp or BP Amp cable provides enough distance. Alternatively, an isolation transformer can be used to supply power to both the PowerLab and the computer.

- The PowerLab /4SP, PowerLab /8SP and PowerLab /16SP should always be fitted with the recommended fuses for safe operation. Specific information on fuse types and replacement is given in a later chapter.

- The PowerLab /4SP, PowerLab /8SP and PowerLab /16SP are classified as Class I medical equipment, which means that protection against electric shock in the event of a fault relies on a direct connection through the power cable to your building's earth conductor. The power cable supplied with your PowerLab provides the required ground connection to the power outlet. If your building does not have power outlet sockets with a good ground connection, then you may use the ground connection on the rear of the PowerLab to provide the equipotential connection to the building's earth conductor. A ground connection is an essential part of this equipment's safety. Never use the PowerLab without a ground connection.

Safety Symbol Explanation

Every ADInstruments device designed for connection to humans, including the Bio Amp, BP Amp, GSR Amp and Stimulus Isolator, carries one or more of three safety symbols, as shown in Figure S–1. These symbols appear next to those input and output connectors that can be directly connected to human subjects.

Figure S–1
Equipment safety symbols on ADInstruments devices designed for safe connection to humans

BF symbol: Body-protected equipment

Warning symbol: see documentation

CF symbol: Cardiac-protected equipment

The three symbols are:

• **BF (body protected) symbol**. This means that the input connectors are suitable for connection to humans provided there is no direct electrical connection to the heart.

• **Warning symbol**. The exclamation mark inside a triangle means that you should consult the supplied documentation (you're reading it) for operating information or cautionary and safety information before using the device.

• **CF (cardiac protected) symbol**. (Appears on some models of Bio Amp, and every BP Amp.) This means that the input connectors are suitable for connection to humans even when there is direct electrical connection to the heart.

Cleaning and Sterilisation

This system is not supplied with materials or components likely to need sterilisation. If you need to clean peripherals likely to be in contact with different subjects, they can be cold-sterilised with an appropriate sterilising agent. No part of the system can be autoclaved.

Storage

It is recommended that the hardware be kept below 40 °C and above 0 °C in a moisture-free or low-humidity environment when not in use (storage only). Electronic components are susceptible to corrosive substances and atmospheres, so it is also advisable to keep the system away from laboratory chemicals.

Preventative Inspection and Maintenance

Both PowerLab systems and ADInstruments front-ends are maintenance free and do not require periodic calibration or adjustment to ensure medical safety. Internal diagnostic software performs system checks during power up and will report errors if a significant problem is found.

There is no need to open the instrument for inspection or maintenance, and doing so within the warranty period will void the warranty.

If you so wish, your PowerLab system can be periodically checked for basic medical safety by using an appropriate medical safety testing device. Tests such as earth leakage, earth bond, insulation resistance, patient leakage and auxiliary currents and power cable integrity can all be performed on the PowerLab system without having to remove the covers. You should follow the instructions for the testing device if performing such tests.

If the PowerLab system is found not to comply with such testing you should contact your PowerLab dealer to arrange for the equipment to be checked and serviced. You should not attempt to service the device yourself.

1 Overview
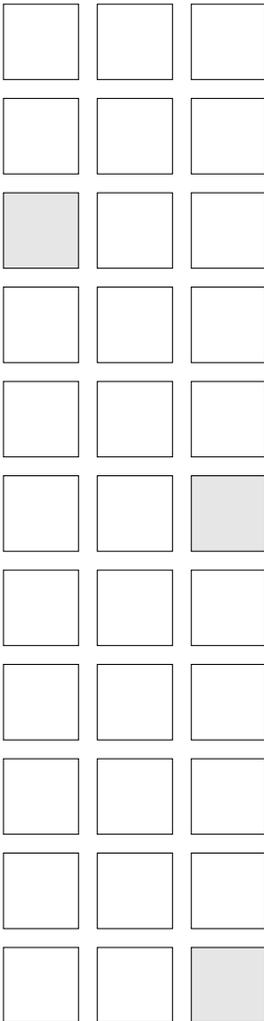
Your PowerLab recording unit, together with a range of specialised application programs, provides a versatile data recording and analysis system when used with a Windows or Macintosh computer. This chapter provides an overview of the PowerLab system and describes the basic features, connectors, and indicators of the SP series PowerLabs: the PowerLab/4SP, PowerLab/8SP, and PowerLab/16SP.

How to Use this Guide

This owner's guide describes how to set up and begin using your PowerLab recording unit. The chapters provide an overview of the PowerLab 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 appendixes 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 PowerLab 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 guides for the Chart and Scope application programs provide detailed information on the software side of the PowerLab system and its uses in acquiring, storing, and analysing data. Read them after you have connected the PowerLab to your computer.

First, Check Your PowerLab!

Please do not attempt to connect the PowerLab 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 damage to the PowerLab.

3. Check that there are no obvious signs of internal damage, such as rattling. Pick the PowerLab up, tilt it gently from side to side, and listen for anything that appears to be loose.

4. Check that the correct voltage for your country is shown on the back of the unit. Your PowerLab should be delivered with the

Figure 1–1

The voltage rating on the back panel of the PowerLab
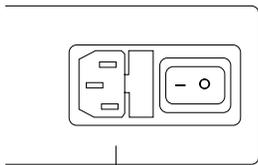
Check the voltage rating beneath the power switch

appropriate mains power voltage set, at either 100–120 volts or 220–240 volts. The setting is indicated at the right of the back panel of the unit, beneath the power switch.

If anything is missing, or the PowerLab seems to be damaged in any way, or if no voltage, or the wrong voltage, is shown on the back panel of the unit, contact your authorised ADInstruments distributor immediately, and describe the problem. Arrangements can be made to replace or repair the PowerLab. (Up-to-date contact addresses are available in the software — see Appendix B in one of the software user's guides for details.)

The PowerLab System

The PowerLab system is an integrated system of hardware and software designed to record, display, and analyse experimental data. The hardware consists of the PowerLab recording unit and possible ancillary devices (front-ends); the software consists of the application programs (such as Chart and Scope) that run on the computer to which the PowerLab is connected.

Your SP series PowerLab has considerable computing power of its own and performs many tasks that are necessary during data recording. Once the PowerLab transfers the data to the computer, the data are available for display, manipulation, printing, storage, and retrieval. The PowerLab/4SP has four inputs for recording external signals, the PowerLab/8SP has eight, and the PowerLab/16SP has 16.

Computer Requirements

Computer requirements for both Windows and Macintosh depend on whether you connect your /4SP, /8SP or /16SP PowerLab unit to your computer using a SCSI or a USB interface. SCSI allows faster transfer rates, but is less straightforward to use.

Windows

• A computer with a Pentium processor or better

• 32 MB free RAM (48 MB for Windows NT or 2000)

- Windows 95, 98, Me, NT 4.0, 2000 or later Windows operating system

- **Additional requirements for USB**: A USB interface on your computer (this may be added via a card if necessary); Microsoft Windows 98, Me, 2000, or later (Windows 95 and NT will not work with USB).

- **Additional requirements for SCSI**: An appropriate SCSI card and cable (we recommend that you use a card and cable supplied by ADInstruments — others may be suitable, but you should seek technical advice if in doubt); a software component called ASPI (ASPI will already be on your computer unless you are using Windows NT or 2000, in which case you can install it using the installer located on the PowerLab Installer CD).

Macintosh

These requirements assume you are using the latest version of Chart. An older version of Chart is available for use with older Macintosh computers.

- A Power Macintosh computer (or computer with a PowerPC microprocessor)

- 32 MB free RAM (64 MB recommended)

- Mac OS 8.6 or later (Mac OS 9.0 or later recommended)

- **Additional requirement for USB**: A USB interface on your computer (this may be added via a card if necessary)

- **Additional requirement for SCSI**: Either built-in SCSI or an appropriate SCSI card and cable (we recommend that you use a card and cable supplied by ADInstruments — others may be suitable, but you should seek technical advice if in doubt).

The Application Programs

Two main application programs and their documentation are provided with each PowerLab. Scope emulates a two-channel storage oscilloscope. Chart emulates a multi-channel chart recorder (up to 16

channels, depending on the PowerLab model). Both provide many other powerful features in addition, including computed functions, triggering options, software-controlled stimulus generation, and automated recording and analysis. Their user's guides describe them in full; the Getting Started with PowerLab manual gives summaries. You must install the software to use your PowerLab. Installation instructions are included in the user's guides for the software.

ADInstruments Front-Ends

Front-ends are optional ancillary devices that can be connected to the PowerLab to extend the system's capabilities. They afford additional signal conditioning and other features, and extend the types of experiments you can conduct and the data you can record. For instance, the Bio Amp is available if you need to perform electrically isolated measurements of biological signals (PowerLabs should *never* be connected to humans directly, unless it is through connections marked as safe). A PowerLab can have as many front-ends connected to it as it has analog inputs, roughly speaking. Front-ends are easily added to or transferred between PowerLabs. They are automatically recognised by the PowerLab system and seamlessly integrated into its programs, operating under full software control.

Your ADInstruments distributor will have full information on available front-ends and their uses and specifications, and will be happy to discuss your requirements.

The PowerLab

It is a good idea to get familiar with some of the external features of your PowerLab before connecting it to a power source. The rest of this chapter discusses the different features, connectors, and indicators of the PowerLab/4SP, PowerLab/8SP, and PowerLab/16SP.

The Front Panel

The front panel of your PowerLab provides most of the connectors for interfacing with external signals, and indicators for various functions. This section describes each of the front panel features.

The PowerLab/4SP has three indicators at the left of the front panel, one BNC connector for the external trigger, two BNC connectors for output, and four BNC connectors (marked Input 1 to Input 4), with four alternative Pod (DIN) connectors, for recording external signals.
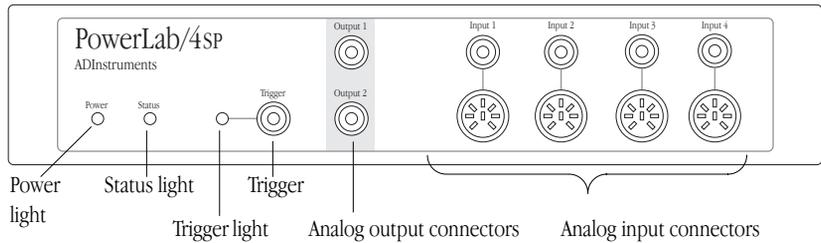
The PowerLab/8SP has three indicators at the left of the front panel, one BNC connector for the external trigger, two BNC connectors for output, and eight BNC connectors (marked Input 1 to Input 8), for recording external signals.
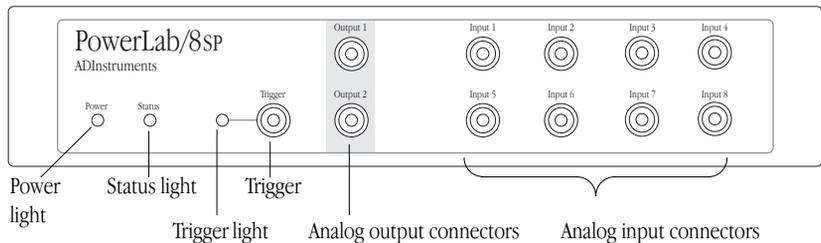
The PowerLab/16SP has three indicators at the left of the front panel, one BNC connector for the external trigger, two BNC connectors for output, and 16 BNC connectors (marked Input 1 to Input 16), for recording external signals.
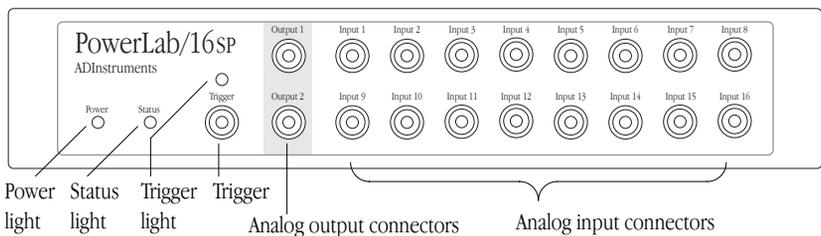
Power and Status Indicators

The Power indicator on the front panel is a green light, which simply shows that the PowerLab is getting power. The indicator next to it, the Status indicator, provides a visual indication of what the PowerLab is doing, and will flash different patterns and colours depending on the state of the PowerLab.

| Status Indicator	Meaning
Off	Idle and not yet initialised by the software.
Yellow flashes	When the PowerLab is powered up, the indicator flashes yellow a number of times equal to the SCSI ID. For example, 4 yellow flashes would indicate a SCSI ID number of 4.
Green constant	Idle, initialised, and waiting for a command from the computer.
Yellow constant	Sampling, or communicating with the computer.
Yellow flash then one or more red flashes	This indicates that the PowerLab has detected an internal fault during the power-up test. The number of red flashes after the yellow flash indicates the type of error that has been detected. This display will keep repeating until the power to the PowerLab is turned off.

Analog Inputs

▲ *Caution*
PowerLab inputs and outputs are not electrically isolated. Human subjects must not be connected directly to the PowerLab. If such measurements are to be made, an isolated front-end must be used, such as the Bio Amp.

The analog inputs used to record external signals can handle signals from ±10 V down to the microvolt (μV) range without the need for additional external amplification. Each PowerLab analog input has an independently programmable gain amplifier with its own filtering, and AC/DC coupling. You can set up each input independently to suit your requirements using the software. Note that applying more than ±15 V to the analog inputs can damage the circuitry.

The PowerLab/4sp has four independent analog inputs (marked Input 1 to Input 4), each with alternative connectors. The top BNC connector can be used for single-ended input, and the 8-pin DIN Pod connector below can be used for either single-ended or differential input. Single-ended inputs record the difference between signal and ground, and differential ones record the difference between positive and negative input signals. Do not attempt to record from both the BNC and Pod connectors for an input at the same time, or the signals will compete.

Pod connectors allow the connection of ADInstruments Pods — small, low-cost units that provide alternatives to front-ends for specific tasks, for use with precalibrated transducers and so on. (Pods are supported by Scope v3.6.3 and later, Chart for Macintosh v3.6.3 and later, and Chart for Windows v3.4.7 and later.) The Pod connectors on the PowerLab/4SP do not handle transducers directly unless the transducers are so labelled (unsuitable transducers will give a very weak signal). Transducers designed for direct connection can be provided with power and control, since the Pod connectors provide some functions of the I^2C output as well as alternative analog inputs to the BNC connectors.

The PowerLab/8SP has eight independent analog inputs (marked Input 1 to Input 8). All inputs are single-ended (with the signal referenced to ground), and have only positive connectors.

The PowerLab/16SP has 16 independent analog inputs (marked Input 1 to Input 16). All inputs are single-ended (with the signal referenced to ground), and have only positive connectors.

Analog Output

The PowerLab can generate a stimulus voltage through its analog output sockets (marked Output 1 and Output 2), giving positive, negative, differential, or independent stimuli, depending on the sockets used and the software settings. By default, the outputs are used for complementary (differential) stimulation, where Output 1 is positive and Output 2 is negative. When Output 1 is used, a positive stimulus voltage (set up in the software) gives a positive voltage output, and a negative voltage a negative one. When Output 2 is used, the voltage outputs are inverted. When both output sockets are used, the stimulus is the difference between the voltages at the positive and negative outputs: you could generate up to a 20-volt pulse, given a ±10 V stimulus.

The outputs can be used for independent stimulation in Scope and the Macintosh version of Chart, but not in the current version of Chart for Windows (v3.4). The details are discussed in the software user's guides.

Trigger

The external trigger connector allows you to use a digital signal level to synchronise recording to an external event. This input can handle voltages of up to ±12 V. The threshold voltage (the voltage above which the trigger circuit activates) is 2.9 volts for the SP series PowerLabs. When the trigger threshold is crossed, the indicator beside the external trigger connector will glow yellow. The external trigger is described in more detail in Appendix A, and the software documentation covers its practical use in normal recording.

The Back Panel

The PowerLab back panel provides the sockets to connect the PowerLab to the computer, front-ends, the power outlet, and so on. This section describes each of the back panel features. The back panels are the same for all the SP series PowerLabs.

Figure 1–5
The back panel of the
PowerLab/4SP, PowerLab/8SP,
and PowerLab/16SP
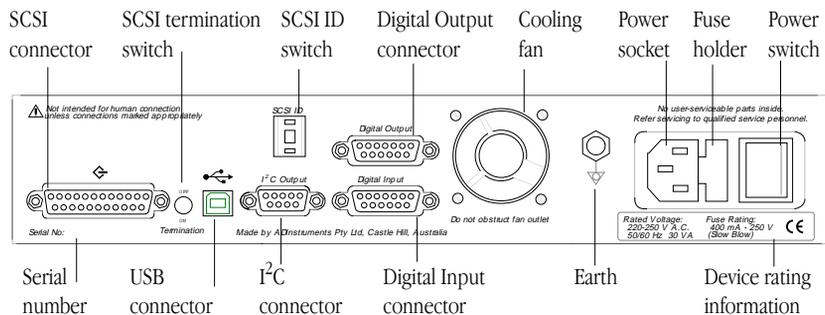
The USB Port

The PowerLab can connect to your computer using a USB (universal serial bus) port, which provides an alternative to the SCSI connection. This works with USB 1.1-compliant computers with USB connectors or a USB card. USB needs a Power Macintosh with Mac OS 8.5 or later, or a PC with Windows 98 or later.

A USB connection is a bit slower than SCSI for data transfer, and so may limit sampling rates (in Chart) or increase delay times between sweeps (in Scope), but it is less fussy. You can safely turn on or off, or disconnect or reconnect, a USB-connected PowerLab while the

computer remains on (this is *not* the case with SCSI). The application program (Chart or Scope) should not be on while this occurs, though. Please read the details on USB in Chapter 2 of this guide before connecting your PowerLab to your computer using USB.

The SCSI Port

The PowerLab can connect to your computer using a SCSI port, which provides an alternative to the USB connection. (SCSI is an acronym for small computer system interface, and is pronounced 'scuzzy' — which shows that engineers have no taste in acronyms). SCSI provides fast data transfer, but requires that specific rules be followed in order for it to work correctly: it is the most complex aspect of setting up a PowerLab system. Please read the details on SCSI in Chapter 2 of this guide before connecting your PowerLab to your computer using SCSI.

Each PowerLab has a single 25-pin connector for connecting SCSI cables, so it has to be used at the end of a SCSI chain. It is terminated internally, but the termination can be switched on and off using the SCSI Termination switch beside the SCSI connector (it should be on).

The SCSI ID Switch

The SCSI ID switch is there if you need to change the SCSI ID number of your PowerLab. The PowerLab is factory-set to an identification number of 4. The SCSI ID can be changed simply by pressing the control buttons while the PowerLab is turned off. The new ID takes effect when the PowerLab starts up again. Only some numbers are valid: they depend on the type of computer, whether it has built-in SCSI or a SCSI card, and the number of built-in and peripheral SCSI devices in the SCSI chain. This is discussed in the next chapter.

I^{2}C Output

The I^{2}C output is a special port designed to connect to front-ends made by ADInstruments. It supplies power and communications. A PowerLab can have as many front-ends connected to it as it has analog inputs, roughly speaking. *Note*. You should not attempt to run other external devices from the I^{2}C port: it is designed for use only with ADInstruments front-ends. Only 50 mA maximum current can

be provided through this bus, so it should not be used for third-party devices drawing more current.

Digital Input and Output Ports

The digital input and output connectors let you monitor and control external devices respectively with the PowerLab. These recording automation and control features are available in the Macintosh version of Chart, but not in the current version of Chart for Windows (v3.4), or in Scope.

The digital input monitors state changes: you can have a predefined comment automatically inserted during recording when a digital input changes to a particular state. The eight lines of the connector allow monitoring of up to eight devices. The digital output can turn on and off external devices, for example, pumps, relays, and indicator lights, or can signal to some other device. The eight lines of the connector allow control of up to eight devices.

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 the use of digital inputs and outputs is given in the user's guide for the software.

Ground Connection

A special earthing (grounding) stud has been provided on the rear of the PowerLab. This is an equipotential bonding connection post compatible with the DIN 42801 standard. If the ground connector post is used, the power cord ground connection should not be used: a power cord with no ground connection should be used instead.

The ground connector post on the rear panel is used as a primary earth connection (equipotential connection point) in situations that require this type of connection, or if there is no ground provided via the power cord. Safety standards in laboratories and similar environments may require additional grounding protection when connecting equipment to human subjects. In such cases, an equipotential connection may be used for all linked equipment to prevent ground loops, and power cords with no ground connections should be available.

Power Connections

The power switch on the back right of the PowerLab turns the PowerLab on and off; the 3-pin IEC power socket is used to connect your PowerLab to a 3-pin earthed (grounded) power cable.

Power switch

Fuse holder
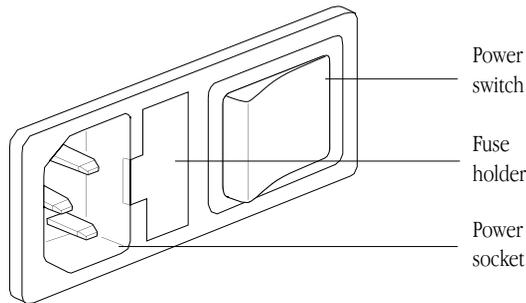
Power socket

Fuse Replacement

The fuse holder is located beside the power socket, and can only be opened when the power cable is removed. To check the fuses, remove the power cable from the PowerLab, and lever the fuse holder out using the tab at its left, which is recessed in the power socket. The fuse holder contains two 'slow-blow' fuses, which protect your PowerLab from power surges.

Fuses

Fuse holder
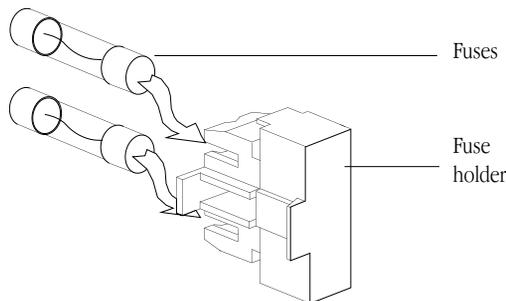
Replacement fuses must be of the correct type, as specified below for 100–120 volts or 220–240 volts operation:

- 100–120 V   1 Amp (5×20 mm) slow blow
                (voltage rating 120 or 250 V)

- 220–240 V   400 mA (5 × 20 mm) slow blow
                     (voltage rating 250 V only)

The correct voltage for your country is shown on the back of the PowerLab, by the power switch (see Figure 1–1, page 3).

Cooling Fan

The SP series PowerLabs can generate a fair amount of heat, so all of them are fitted with a cooling fan. The cooling fan is visible in the rear panel of the PowerLab. It maintains sufficient airflow in the enclosure to keep the circuitry within operating tolerances. The fan outlet must be kept unobstructed, and far enough from walls or other devices (at least three inches, 8 cm) so as to not impede ventilation.

It is also important to make sure that the air inlets underneath the PowerLab are unobstructed. Blocking the grilles may result in the PowerLab heating up enough internally to affect the performance of the system and reduce reliability.

2
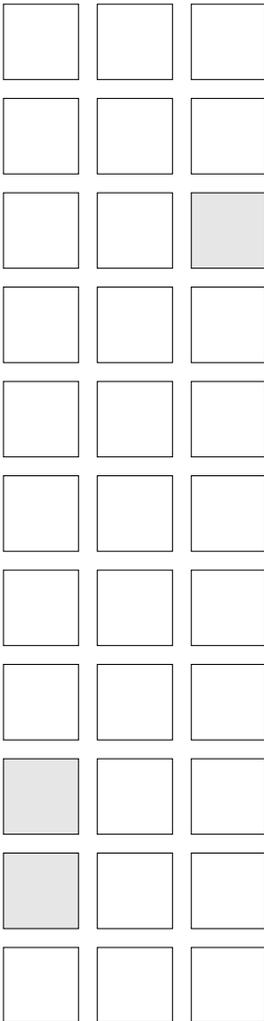
Setting Up

This chapter starts with the PowerLab's internal self-test, then looks at the USB connection. It also looks at the SCSI connection in some detail, including connection and termination rules, and setting the SCSI ID number. It discusses how to connect up your PowerLab to a Windows or Macintosh computer.

Self-Test

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

The PowerLab performs a diagnostic self-test each time it is switched on, whether or not it is connected to a computer. To test that your PowerLab is functioning properly when you turn it on, follow the instructions below, and observe the effects.

1. Connect the PowerLab 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.

    The Power indicator on the front panel should glow green while the PowerLab is on (see Figure 1–2, Figure 1–3, and Figure 1–4).

    The Status indicator should flash yellow a number of times equal to the SCSI ID of the PowerLab (see Table 1–1). If the internal diagnostic check finds no problems, the Status indicator turns off (showing that the PowerLab is idle; it only goes green when the software is running).

If the indicators perform as described above, then your PowerLab has successfully performed its internal self-test, and it can be safely connected to your computer. If your PowerLab would not successfully complete its self-test, something is wrong. If the Power indicator does not glow green when the power switch is turned on, then either the fuse has blown or there is a problem with the power cable or PowerLab itself.

If an error is detected during the self-test, the Status indicator will flash yellow and then a certain number of red flashes depending on the fault. Flashing lights are used when the problem is one that prevents the PowerLab communicating with the computer (such as a hardware fault), and so cannot be shown in the software. The error pattern will continue to be displayed, allowing you to take note of the type of error that occurred. The number of red flashes indicates the probable problem area. If the pattern is simply an alternating red

flash and yellow flash, then the SCSI ID has been set to the numbers 0 or 7, which cannot be used for an SP series PowerLab. Switch off your PowerLab, change the SCSI ID for the PowerLab using the control on its back panel, wait about five seconds, and then switch it back on.

If the error pattern is not simple alternating red and yellow flashes, then something may be wrong with the hardware itself. The pattern of red flashes indicates the likely problem area to ADInstruments technicians. Take note of pattern, switch off your PowerLab, wait about five seconds, and then switch it back on. If it still continues to flash the pattern, then the PowerLab needs repair. Contact your authorised ADInstruments distributor as soon as possible. Do not attempt to repair the PowerLab yourself. If your PowerLab has successfully performed its internal self-test, read on to find out how to connect it to your computer.

The USB Connection

This section is essential reading before trying to use your PowerLab with USB. The PowerLab is fitted with a USB (universal serial bus) port, which provides an alternative to the SCSI connection. This works with USB 1.1-compliant computers with USB connectors or a USB card. On a PC, USB requires Windows 98, Me, 2000 or later (95 or NT 4 won't do). On a Macintosh, USB needs a Power Macintosh with Mac OS 8.5 or later (but note that the latest PowerLab software requires Mac OS 8.6).

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 2–1
A USB tree: up to 126 devices can be linked to the computer

Up to 126 linked USB devices

Computer: root hub for the USB tree
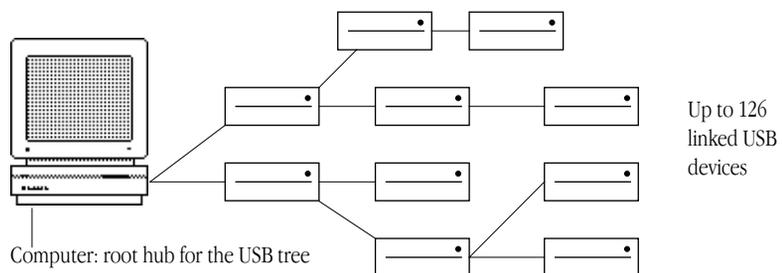
A hub is simply a device that lets you extend the USB tree. It connects to a USB device such as the computer, and multiple USB devices (including other hubs) can connect to it in turn. It provides power for those attached devices that need it. Up to five hubs can be connected between the computer and 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 is more tolerant than SCSI. It lets one 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. It has only one pair of connector types, unlike SCSI, and does not need termination as SCSI does.

USB still has some restrictions. A USB connection is a bit slower than SCSI for data transfer, and so may limit sampling rates (in Chart) or increase delay times between sweeps (in Scope). 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 time. Using a video camera and a scanner at the same time as a PowerLab may limit the sampling rates considerably.

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. The PowerLab needs a high-speed connection, and is provided with a suitable cable.

Connecting the PowerLab Using USB

Use the USB cable supplied with your PowerLab 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 (some non-standard ones might have

the letters 'USB' instead). USB cables are directional, and can only be connected one way: the narrow rectangular A plug connects to a hub (including the computer), and the squarer B plug with the bevelled top connects to a USB device, such as the PowerLab. Connecting Macintosh or Windows 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. Any USB icons on the plugs should be on top.

Figure 2–2
Connecting a PowerLab to a computer with USB

PowerLab connection

USB icon

Computer or hub connection

B plug

A plug
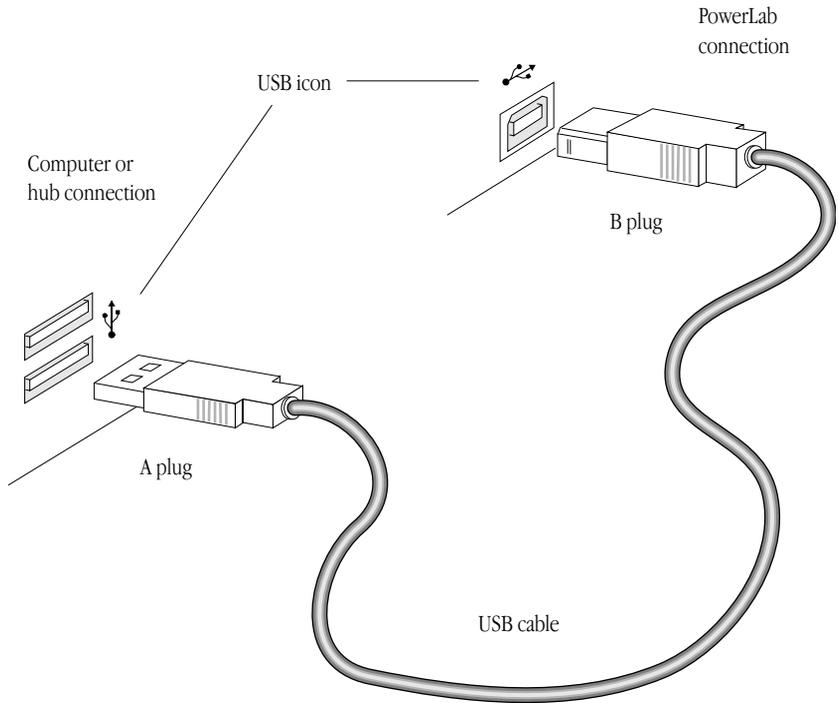
USB cable

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 Powerlab 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 PowerLab 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 PowerLab while a program is using it.*
Disconnecting a PowerLab while it is sampling is a bad idea and may cause problems in some circumstances. It is better to be safe than sorry, and not even disconnect a PowerLab while Chart or Scope is open. Stop sampling and quit the program first before disconnecting a PowerLab from USB.

You can safely turn on or off, or disconnect or reconnect, a USB-connected PowerLab while the computer remains on as long as the application program (Chart or Scope) is off when you do it.

The SCSI Connection

This section is essential reading before trying to use your PowerLab with SCSI. The user's guide for your computer may have a section on connecting SCSI devices, in which case you should read that as well.

The PowerLab is fitted with a SCSI port, which provides an alternative to the USB connection. SCSI (small computer system interface) is simply a communication standard for connecting a single chain of SCSI devices together on a common high-speed bus (information-carrying pathway). A SCSI connection can easily handle the 4 megabytes per second maximum data transfer rate of the PowerLab, although the speed of your computer may limit this. The PowerLab must be placed at the end of the SCSI chain (if it is the only device, then connected directly to the SCSI port of, or to an installed SCSI card in, the computer).

SCSI Connection Rules

1. *Never alter the SCSI chain while any SCSI devices are on.*
Disconnecting a SCSI device while there is SCSI hard disk activity

Up to 6 or 7 linked SCSI devices, each with a unique ID

Computer: reserves SCSI ID #7 for a SCSI card host adapter, or #0 and #7 if SCSI is built in

The last SCSI device must be terminated
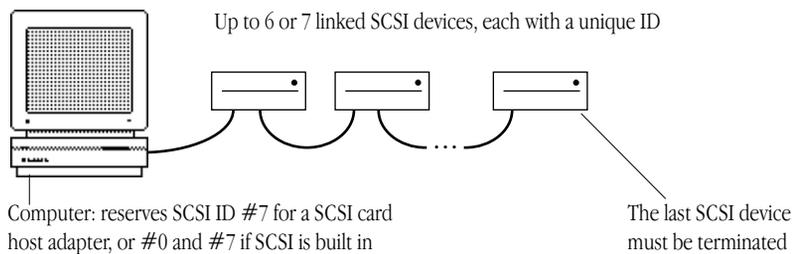
may cause data loss or electrical damage. Switch all devices off, including the computer, before adding or removing SCSI devices.

2. *Each SCSI device must have its own unique SCSI ID number.*
    No two SCSI devices can have the same SCSI ID number or malfunctions may result. SCSI ID numbers are discussed later.

3. *Total cable length should be less than 6 metres (20 feet).*
    The SCSI circuits can only transmit data reliably over short lengths of cable. The total length of the chain is important, including short lengths of cable inside the computer and other SCSI devices. Internal cabling can be from 10 to 30 cm (4 inches to 1 foot), depending on the device.

4. *The SCSI chain must be terminated correctly.*
    Failure to terminate the chain properly can result in intermittent communication, no communication, or failure of the computer to boot up. The correct way of terminating is discussed later.

5. *Turn SCSI devices on and off in the right sequence.*
    Turn on all external SCSI devices before the computer: this ensures that the SCSI bus is stable before your computer tries to use it. Turn off the computer before turning off other devices. This prevents external SCSI devices from 'hanging' the SCSI bus and preventing further access. Never operate with some devices in a chain turned off, as this degrades performance and signal quality.

6. *Avoid mixing cable types, brands, and styles.*
    A common source of trouble is mixing poor-quality SCSI cables with approved high-quality SCSI cables. Different cable types or brands may have different types of construction, impedance, and wire placement, and this can result in problems when they are

used together. Also, whenever possible, avoid using cable joiners
and junctions to extend cable lengths.

7. *Never attempt to make your own SCSI cable, or modify one.*
SCSI is sensitive to cable impedances and cable lengths. Only use
an approved SCSI cable from a reliable supplier, never 'something
the workshop whipped up'. If you need additional SCSI cables,
you should buy cables that are double-shielded (foil and braid),
with twisted pairs and shielded connector hoods for the most
reliable results. ADInstruments sells approved SCSI cables

Figure 2–4
The SCSI ID switch
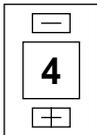
Setting the SCSI ID Number

Your PowerLab was set to a SCSI ID number of 4 at the factory before
shipping. To change its SCSI ID, turn off the PowerLab, and all other
connected devices in the SCSI chain, before changing the SCSI ID
number. The SCSI ID switch is located on the back panel of the
PowerLab. A small panel with push buttons above and below it
displays the SCSI ID number. Press the [–] button above the indicator
to decrease it or the [+] button below the indicator to increase it.

Do not set the SCSI ID to numbers already used by other SCSI devices
in the chain. The maximum number of devices within the same SCSI
chain is eight. Each device in the chain must have a unique SCSI
identification number assigned to it. The numbers range from 0 to 7,
with 7 the highest priority device. A computer with built-in SCSI
usually reserves the values 0 and 7. On the Macintosh, 7 is used for
the computer and 0 may be used for an internal SCSI hard disk (an
internal SCSI CD, if there is one, usually takes ID 3, as well). On a PC,
SCSI ID number 7 is usually reserved by a SCSI card host adapter or
built-in SCSI controller, and SCSI ID number 0 is used by an internal
SCSI hard disk, if there is one. To prevent most problems, therefore,
the numbers 0 or 7 cannot be used for an SP series PowerLab.

Externally connected devices should have readable SCSI ID switches
you can check, although some may have ID switches that are difficult
to see or read. Internally connected devices should be described in the
manual that came with your computer. If you are unsure about the
SCSI devices connected to a Macintosh computer, you can use tools
such as SCSIProbe (a free utility available from the Internet and user
groups), which lists all SCSI devices attached, what they are, and
which SCSI ID they use. If you are unsure about the SCSI devices

connected to a Windows computer (particularly internal ones), your PC technical support person or IS manager may be able to help.

To confirm that you have set the right SCSI ID number, turn on the PowerLab and watch to see if the Status indicator flashes yellow a number of times equal to its SCSI ID number.

SCSI Termination Rules

Terminating the SCSI bus is essential to preserve the integrity of the high-speed signals present on the bus. Termination helps keep these signals free from noise and prevents unwanted signal reflections up and down the bus. Without correct termination, the SCSI signals could be swamped by reflections from previous signals, resulting in a jumble of meaningless electronic noise. The way in which you terminate the SCSI chain will depend on the number of SCSI devices you wish to connect to your computer along with the PowerLab. The SCSI connection between your PowerLab and computer is a very good way to provide safe and reliable high-speed data transfer, provided that you follow the rules for proper termination.

A SCSI chain is correctly terminated by placing terminators at each end of the chain. The computer is terminated internally, so forming one end of the chain. (A SCSI host adapter will be terminated: if the SCSI controller and internal SCSI hard disk are both terminated, you may have to alter things — see the documentation that came with the card or computer.) The PowerLab should be at the other end of the chain, with its SCSI termination switch on.

Connecting the PowerLab: Macintosh

Those Macintosh computers without USB (and even some with USB) should have SCSI built in or available through a card. Not all SCSI cards are suitable, especially high-end ones (ultra-wide SCSI and the like). SCSI cards and cables with which the PowerLab should work reliably are sold by ADInstruments. Make sure that you have the correct, 25-pin to 25-pin SCSI cable to connect up your PowerLab. (Most PowerBooks and Duo Docks have a special space-saving square 29-pin SCSI connector, which requires another connector or adapter. This can be purchased separately from your Apple dealer.)

If the PowerLab is the only SCSI device to connect to the computer, then simply connect the two together with the correct SCSI cable, and turn the SCSI termination switch on. If you wish to use multiple SCSI devices with the computer, the first and last devices in the chain should be terminated. The PowerLab must be at the end of the chain, since it has only one SCSI connector, and its internal terminator must be switched on.

Macintosh or Macintosh-compatible

PowerLab/4SP, PowerLab/8SP, PowerLab/16SP

SCSI icon

25-pin connector

Termination Switch
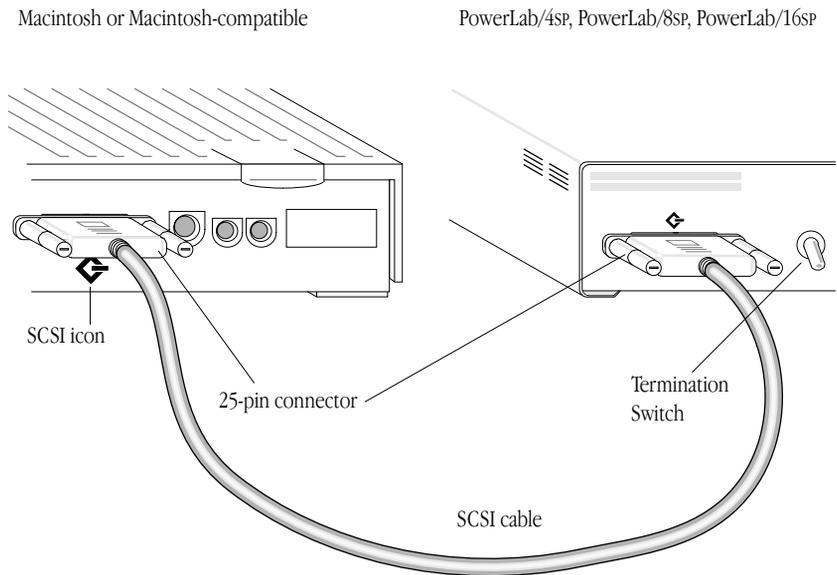
SCSI cable

Connecting the PowerLab: Windows

Most modern PC computers should have SCSI available through a card (some have it built in). Not all SCSI cards are suitable, especially high-end ones (ultra-wide SCSI and the like). ADInstruments sells SCSI cards and cables with which the PowerLab should work reliably. (It may not be possible to find a cable to fit all connections, though.)

Make sure that you have the correct SCSI cable to connect up your PowerLab. It requires a 25-pin D-style connector for the PowerLab. If you have a portable computer with a PC card SCSI adapter, then the card probably needs the specific cable that came with that particular card. You may have to purchase separately a cable adapter to connect the end of your SCSI cable to the 25-pin connector for the PowerLab.

The card should have full instructions on installation with it. The SCSI adapter card will usually be terminated, and at one end of the chain (this is always the case for PC card SCSI adapters), although if the computer has built-in SCSI, you may have an internal SCSI device in your PC that is terminated, with the host adapter in the middle of the chain. If there is a problem with cables, or you are unsure about any devices, such as a hard disk, connected to your computer on SCSI internally, your PC technical support person or IS manager should be able to help you.

If the PowerLab is the only SCSI device to connect to the computer, then simply connect the two together with the correct SCSI cable, and turn the SCSI termination switch on. If you wish to use multiple SCSI devices with the computer, the first and last devices in the chain should be terminated. The PowerLab must be at the end of the chain, since it has only one SCSI connector, and its internal terminator must be switched on.

Figure 2–6
Connecting a PowerLab to the computer (25-pin connector shown)

PC computer

PowerLab/4sp, PowerLab/8sp, PowerLab/16sp

SCSI card

25-pin connector

Termination Switch

SCSI cable
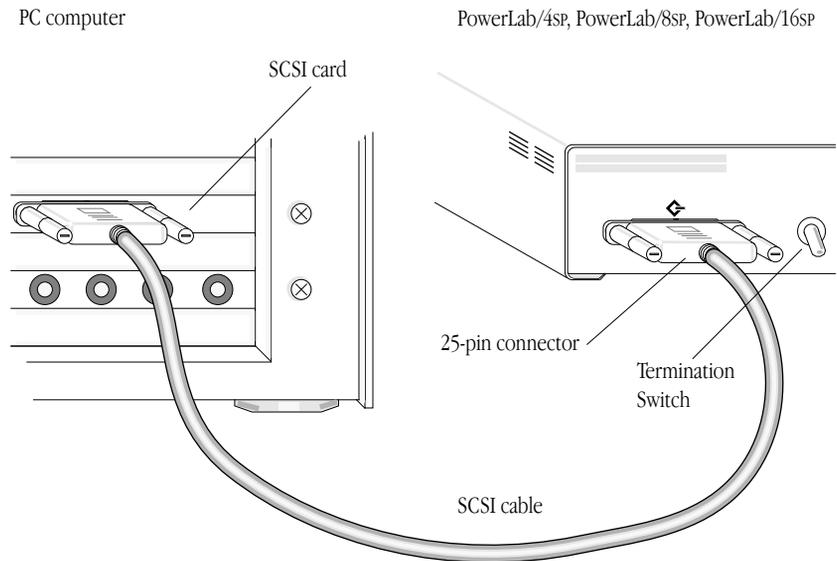
SCSI Cards with Windows NT or Older Computers

Windows 95 and 98 both come with a number of generic SCSI drivers already installed that should work with most cards, including any that ADInstruments supplies. Windows NT may not have the right

SCSI driver available, so the driver might have to be installed manually, perhaps from the original NT system CD. The SCSI card should have instructions on the driver it needs and how to install it.

Older, pre-PCI computers require a special ISA or ISO bus SCSI card. Such a card should come with its own manual, and may take some effort to set up. It will probably require assistance from a PC technical support person.

SCSI Strikes Back

Not following the SCSI device connection and termination protocols can lead to more problems than you might think. The possible dangers include loss of data, intermittent communications, corruption of data on a SCSI hard disk, failure of the computer to boot from a SCSI drive, and failure of the computer to recognise SCSI devices connected to it. Such problems are very unlikely, however, if you follow the rules.

A

Technical Aspects

This appendix describes some of the important technical aspects of the PowerLab/4SP, PowerLab/8SP, and PowerLab/16SP, to give some insight into how they work. You do not need to know the material here to use your PowerLab. It is likely to be of especial interest to the technically minded, indicating what the PowerLab 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 PowerLab voids your rights under warranty.

How Does it Work?

The PowerLab is essentially a smart peripheral device specifically designed to perform the various functions needed for data acquisition, signal conditioning, and pre-processing. It contains its own microprocessor, memory, and specialised analog amplifiers for signal conditioning. The block diagrams in Figure A–1, Figure A–2, and Figure A–3 show the essential elements of each PowerLab.

All sampling, output, and communication functions are controlled by an internal 32-bit, 68340 microprocessor running at 16 MHz (16 million cycles per second). This CPU (central processing unit) has access to 512 kilobytes of RAM (random access memory) for data storage and buffering prior to transmission to the computer. The PowerLab makes use of FIFO (first in, first out) memory devices, which provide a temporary storage area for both analog input and analog output signals. These storage areas help increase the processing capacity of the hardware by relieving the load on the PowerLab microprocessor.

The PowerLab can use SCSI or USB, whether built-in or via a card, to communicate with the computer. SCSI (small computer system interface) provides data transfer rates of up to 4 MB per second on fast computers. The lower-speed USB (universal serial bus) provides data transfer rates of up to 500 kB per second.

The PowerLab has four (PowerLab/4SP), eight (PowerLab/8SP), or 16 (PowerLab/16SP) analog inputs, used to record external signals. The outputs of their input amplifiers are multiplexed to a 16-bit ADC

Figure A–1
Block diagram of the
PowerLab/4SP

PowerLab Owner's Guide

(analog-to-digital converter). The ADC can sample at up to 200,000 samples per second. The CPU assembles groups of samples into blocks and then transmits them to the computer, where the application program receives, records, and displays the data. Sampled data from the ADC are stored in FIFOs until the CPU is ready to read them. The FIFOs let the CPU know when they are getting full, at which point it will read all of their data very quickly. This frees the CPU from the need to read every sample from the ADC as it is ready, so that it can perform other tasks.

The external trigger input (marked 'Trigger' on the front panel) is connected to a comparator circuit that triggers when the input

Figure A–2
Block diagram of the
PowerLab/8SP

voltage exceeds 2.9 volts. This signal is fed to circuitry that notifies the CPU that an external trigger event has been detected. The CPU then carries out the task for which the trigger is being used (such as pre-triggering or post-triggering). When the trigger threshold is crossed, the indicator beside the trigger connector glows yellow.

Two 14-bit DACs (digital-to-analog converters) are used to control the analog outputs of the PowerLab (marked 'Output 1' and 'Output 2' on the front panel). The DACs produce waveforms under software control that are fed through an attenuation network to produce different full-scale ranges. The signals are then buffered by a power

Figure A–3
Block diagram of the
PowerLab/16SP

amplifier to give them the capability to drive heavier loads. The PowerLab can store stimulation data in FIFOs, so that it can stimulate at a frequency independent of the analog input sampling rate. The FIFOs also allow the generation of much faster stimuli and continuous waveforms, with little or no load on the CPU.

The PowerLab is also fitted with an I^2C front-end expansion port. This 9-pin port supplies both power and control to ADInstruments front-ends using a 4-wire serial bus (two wires for standard I^2C and two control lines).

The digital input and output connectors provide a means of using the PowerLab to monitor and to control external devices respectively. The digital input monitors state changes: the eight lines of the connector allow monitoring of up to eight devices. The digital output can turn on and off external devices or can signal to some other device. The eight lines of the connector allow control of up to eight devices. These recording automation and control features are available in the Macintosh version of Chart, but not in the current version of Chart for Windows (v3.4), or in Scope.

The PowerLab uses an IEC601-1 compliant linear power supply, not a switching power supply, which makes it a little heavier, but a lot quieter electrically. It is important to note that the PowerLab has a limited amount of power available for external devices. Because of these power restrictions, you should not use the PowerLab as a power source for external devices other than front-ends produced by ADInstruments.

The Analog Inputs

PowerLab 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 analog 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 input amplifiers of the PowerLab/8SP and PowerLab/16SP are single-ended, but can be set by the software to be either positive or negative (inverting or non-inverting). The PowerLab/4SP input amplifiers can be set by the software to be either single-ended — positive or negative — or differential. In the differential setting, the amplifier

measures the difference between the positive and negative inputs of a Pod connector, irrespective of ground. Differential signals can only be recorded using the Pod connectors on the PowerLab/4SP; the BNC analog inputs on the PowerLabs are all single-ended.

It is important to note that the PowerLab grounds the inputs to amplifiers not in use. It also grounds each amplifier and measures the DC offset voltage when 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 diagrams below.
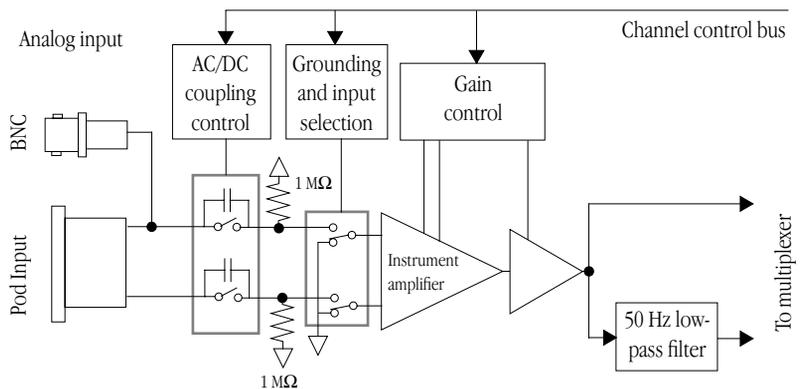
The input amplifiers can be set to pass both DC and AC signals, or to pass only AC signals without passing DC signals. Input impedance is one megohm (1 MΩ).

Each input produces either a filtered or an unfiltered signal. Each input is fitted with a software-selectable low-pass filter (a fourth-order anti-aliasing filter), which can be set at a range of frequencies from 20 kHz down to 1 kHz. The unfiltered signal has an effective bandwidth of 45 kHz (within the Nyquist frequency when sampling at 100,000 samples per second).

PowerLab Accuracy

Your PowerLab 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 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 that recording is started manually or by triggering or the gain is changed (that is, very often in most cases), 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 input through software correction, in a process transparent to the user.

Calibration facilities. It is recommended and sound practice to calibrate a measuring system from the transducer to the output. After applying two known values to a transducer (say at 20% and 80% of full scale) and recording the signal, you can use the units conversion feature of ADInstruments applications to convert and display transducer readings in the appropriate units. This will compensate for any minor inaccuracies in amplifier gain and transducer calibration.

The External Trigger

The external trigger provides a digital input for synchronising sampling to external devices. The external trigger input represents 1 TTL (transistor–transistor logic) load. The input is off for input voltages between –12 V and the external trigger level, and on between that and +12 V. The input will be overloaded if the voltage is outside the range –12 V to +12 V. The external trigger level is 2.9 V ± 0.25V; once on, the trigger turns off at 1.8 V ± 0.25V, giving a hysteresis voltage of 1.1 V. When the external trigger input is on, the indicator beside it is on.

The PowerLab has an optically isolated external trigger input, thus there is no direct connection between the external trigger ground and the ground of the device connected to it. This removes ground noise and current problems, and improves static discharge immunity. In order for the external trigger to work, though, a voltage must be applied between the outer ring and the inner pin on the connector. Applying a voltage to the centre pin won't result in triggering (as it could on earlier PowerLabs). The equivalent circuit of the external trigger is basically an LED (light-emitting diode) in series with a resistor, thus the device driving the external trigger must be capable of supplying at least 1 mA of current to cause the optocoupler to work. (The second diode shown below protects the optocoupler.)
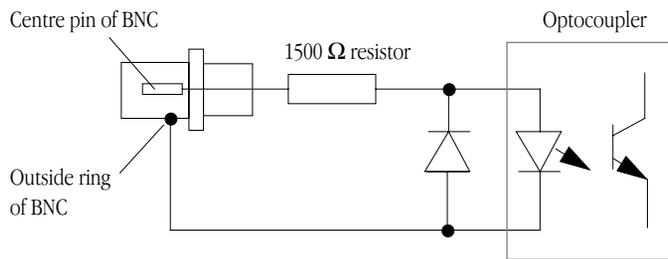
The Analog Output

The analog outputs provide computer-controlled variable outputs (±10 V) that can be used with the Chart and Scope applications either directly as a stimulator, or to control peripheral devices. All stimulation voltage is generated by the PowerLab via the output sockets on the front of the PowerLab (marked Output 1 and Output 2), giving positive, negative, differential, or independent stimuli, depending on the sockets used and the software settings.
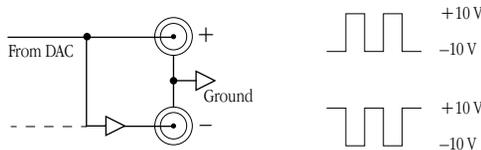
By default, the outputs are used for complementary (differential) stimulation, where Output 1 is positive and Output 2 is negative. When Output 1 is used, a positive stimulus voltage (set up in an application) gives a positive voltage output, and a negative voltage a

negative one. When Output 2 is used, the voltage outputs are inverted. When both output sockets are used, the stimulus is the difference between the voltages at the positive and negative outputs: you could generate up to a 20-volt pulse, given a ±10 V stimulus.

The outputs can be used for independent stimulation in Scope and the Macintosh version of Chart, but not in the current version of Chart for Windows (v3.4). The details are discussed in the software user's guides.

Connections

This section of the appendix contains 'pinout' and electrical details of some of the connectors fitted to the PowerLab. You should read it carefully before attempting to connect cables other than those supplied with the unit to the PowerLab. Using cables that are wired incorrectly can cause internal damage to the PowerLab and will void your rights under warranty.

USB Port

The PowerLab is fitted with a USB (universal serial bus) port, which provides an alternative to the SCSI connection. This works with computers with USB connectors or a USB card. USB needs a Power Macintosh with Mac OS 8.5 or later, or a PC with Windows 98 or later.
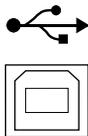
Figure A–8
The USB connector

Your PowerLab is supplied with a proper high-speed 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.

SCSI Port

The PowerLab uses a single 25-pin D-type female connector for the SCSI port. If you are using a Macintosh, you probably need a 25-pin

to 25-pin cable. If you are using a Windows PC, the connection at the other end of the cable depends on your set-up.
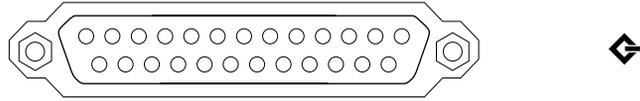
SCSI is sensitive to cable impedances and connection lengths. The incorrect wiring of a SCSI cable can result in damage to the SCSI circuitry, or random SCSI activities being performed. You should, therefore, use only approved SCSI cables such as the ones available from ADInstruments, and never attempt to make your own.

I^2C Expansion Port

The I^2C port on the back panel of the PowerLab provides expansion support for ADInstruments front-ends. This port provides both power and control signals for these front-ends. The I^2C bus has a daisy-chain structure that allows simple connection of additional front-ends to the system. A PowerLab can have as many front-ends connected to it as it has analog inputs, roughly speaking. You should not attempt to run other external devices from the I^2C port: it is designed for use only with ADInstruments front-ends. Only 50 mA maximum current can be provided through this bus, so it should not be used for third-party devices drawing more current.

Digital Input and Output Ports

The digital input port and digital output port are 15-pin connectors situated on the back panel of the PowerLab. The eight digital input lines respond to standard TTL signals with a threshold of 2.2 V. The eight digital output lines can turn on and off, or signal to, up to eight external TTL devices. The digital output lines are capable of driving five TTL loads overall (50 mA maximum load per line; 250 mA maximum total load).

Digital input

Digital output
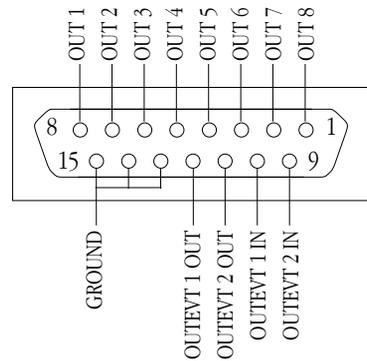
These recording automation and control features are available in the Macintosh version of Chart, but not in the current version of Chart for Windows (v3.4), or in Scope.

Pod Connectors

The Pod connectors on the PowerLab/4SP are 8-pin DIN connectors. (The PowerLab/8SP and PowerLab/16SP have single-ended BNC inputs only.) Do not attempt to record from both the BNC and Pod connectors for an input at the same time, or the signals will compete.

Pod connectors allow the connection of ADInstruments Pods — small, low-cost units that provide alternatives to front-ends for specific tasks, for use with precalibrated transducers and so on. (Pods are supported by Scope v3.6.3 and later, Chart for Macintosh v3.6.3 and later, and Chart for Windows v3.4.7 and later.) The Pod

connectors on the PowerLab/4SP do not handle transducers directly unless the transducers are so labelled (unsuitable transducers will give a very weak signal). Transducers designed for direct connection can be provided with power and control, since the Pod connectors provide some functions of the I^2C output as well as alternative analog inputs to the BNC connectors.

Figure A–12
The pin assignments for the Pod connector
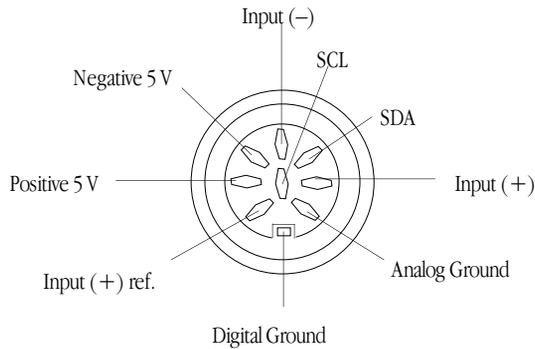
B

Troubleshooting

This appendix describes most of the common problems that can occur with your PowerLab recording unit. It covers how these problems are caused, and what you can do to alleviate them. If the solutions here do not work, your software guide may contain remedies for possible software problems. If none of the solutions here or in the software guide appears to help, then consult your ADInstruments distributor.

Problems: Macintosh

Nearly all the problems that users encounter are connection problems and SCSI problems. Improper connections can result in a loss of all or some of a signal. SCSI difficulties can cause data loss, failure of the computer to recognise that SCSI devices are attached to it, and difficulties using other SCSI devices. Incompatible SCSI adapter cards and cables may also cause problems. Obviously, the SCSI problems will not apply if you use USB.

The PowerLab Status indicator light flashes yellow then red when the PowerLab is turned on

▼ **Refer**
Self-Test, p. 16

If the pattern is simply an alternating red flash and yellow flash, then the SCSI ID has been set to the numbers 0 or 7, which cannot be used by an SP series PowerLab. Only 1 to 6 are valid SCSI ID numbers.

• Switch off your PowerLab and any other connected devices, change the SCSI ID for the PowerLab using the control on the back panel, wait about five seconds, and then switch it back on. Check any other connected SCSI devices as well at the same time.

An internal problem has been discovered by the diagnostic self-test (this is performed by the PowerLab each time it powers up).

- Turn everything off, and then after at least five seconds turn the PowerLab back on again. This should clear a temporary problem. If not, then the PowerLab may need repair. Take note of the flashing pattern, and consult your ADInstruments distributor.

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

The PowerLab is off or the power is switched off at the wall, the power cable is not connected firmly, or a fuse has blown.

- Check switches, power connections, and fuses.

A poor connection between PowerLab and computer, or bad cable.

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

SCSI problems: two SCSI devices on the bus have the same SCSI ID, or termination is incorrect or unsuitable.

- Check that each device has a unique ID number and that the SCSI chain is terminated correctly. (As a last resort, if the PowerLab is the only connected SCSI device, try leaving it unterminated.)

The SCSI adapter card is incompatible with the computer or the PowerLab or both. We cannot guarantee that the PowerLab will work reliably with a card we did not supply.

- Try another card, preferably one we supplied.

The PowerLab has an internal problem or has 'hung'.

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

The PowerLab is connected via USB and the computer does not properly support USB.

- USB needs a Power Macintosh with Mac OS 8.5 or later; it simply will not work with earlier hardware, such as a 68K Macintosh, or earlier operating systems, such as System 7: use SCSI with these.

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

A poor connection between PowerLab and computer, or bad cable.

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

SCSI problems: two SCSI devices on the bus have the same SCSI ID, or termination is incorrect or unsuitable.

- Check that each device has a unique ID number and that the SCSI chain is terminated correctly. (As a last resort, if the PowerLab is the only connected SCSI device, try leaving it unterminated.)

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

A poor connection between PowerLab and computer, or bad cable.

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

SCSI problems: two SCSI devices on the bus have the same SCSI ID, or termination is incorrect or unsuitable.

- Check that each device has a unique ID number and that the SCSI chain is terminated correctly. (As a last resort, if the PowerLab is the only connected SCSI device, try leaving it unterminated.)

The SCSI adapter card is incompatible with the computer or the PowerLab or both. We cannot guarantee that the PowerLab will work reliably with a card we did not supply.

- Try another card, preferably one we supplied.

Partitioning problems on the hard disk (while rare, this can happen even with new disks).

- Use disk-checking utility applications to check the SCSI driver and root directory on the hard disk. Partitioning programs may

also have effective low-level disk checking. The programs will probably fix the problems, or otherwise indicate what needs to be done (such as reinstalling the SCSI driver), and their manuals should explain the technical details involved.

The PowerBook computer stops working normally, and instead shows a diamond with its SCSI ID number on screen

The PowerBook is acting as a SCSI hard disk. This means that the wrong (30-pin) connector and cable were used to connect it to the PowerLab. You need a different (29-pin) cable and connector to make a normal SCSI connection to peripherals.

• Use the correct cable to connect your PowerBook to the PowerLab (the cable should be available from your Apple dealer).

Signals seem weak or interacting on the PowerLab/4SP

You may be using both the BNC connector and the Pod connector for an input at the same time, with resultant signal competition.

• Make certain that you use only *one* of the alternative connectors (BNC or Pod) for an input when recording.

Problems: Windows

Most problems that users encounter are connection problems and SCSI problems. Improper connections can result in a loss of all or some of a signal. SCSI difficulties can cause data loss, failure of the computer to recognise that SCSI devices are attached to it, and difficulties using other SCSI devices. Incompatible SCSI adapter cards and cables may also cause problems. Obviously, the SCSI problems will not apply if you use USB.

The PowerLab Status indicator light flashes yellow then red when the PowerLab is turned on

If the pattern is simply an alternating red flash and yellow flash, then the SCSI ID has been set to the numbers 0 or 7, which cannot be used by an SP series PowerLab. Only 1 to 6 are valid SCSI ID numbers.

- Switch off your PowerLab and any other connected devices, change the SCSI ID for the PowerLab using the control on the back panel, wait about five seconds, and then switch it back on. Check any other connected SCSI devices as well at the same time.

An internal problem has been discovered by the diagnostic self-test (this is performed by the PowerLab each time it powers up).

- Turn everything off, and then after at least five seconds turn the PowerLab back on again. This should clear a temporary problem. If not, then the PowerLab may need repair. Take note of the flashing pattern, and consult your ADInstruments distributor.

When Windows starts up, it doesn't recognise the PowerLab

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

- Leave the wizard on its default settings and click the OK button. Insert the CD, or Disk 1 of the provided installation disks. The PowerLab setup information file should be selected in the dialog box that appears. Click the OK button, and continue.

There is an alert about ASPI when the software starts up

ADInstruments software needs ASPI (advanced SCSI programming interface) to communicate with the PowerLab. An alert appears if it can't be found. ASPI is present by default in Windows 95 or later (although it could have been removed), but not in Windows NT 4. A version suitable for most SCSI cards supplied by ADInstruments is provided on the software CD. Other SCSI cards should come with instructions on what to do.

- Install the appropriate version of ASPI on the computer, or ask your PC technical support person or IS manager to do it.

The computer refuses to boot with the PowerLab connected

The SCSI adapter card is incompatible with the computer or the PowerLab or both. We cannot guarantee that the PowerLab will work

reliably with a card we did not supply, and some computers and SCSI adapter cards just won't work together.

- Try another card, preferably one we supplied. Ask your PC technical support person or IS manager to check compatibility.

A poor connection between PowerLab and computer, or bad cable.

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

SCSI problems: two SCSI devices on the bus have the same SCSI ID, or termination is incorrect or unsuitable.

- Check that each device has a unique ID number and that the SCSI chain is terminated correctly. (As a last resort, if the PowerLab is the only connected SCSI device, try leaving it unterminated.)

The computer is running off a SCSI hard drive, and the PowerLab has an internal problem or has 'hung'.

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

The computer can't find the PowerLab

The PowerLab is off or the power is switched off at the wall, the power cable is not connected firmly, or a fuse has blown.

- Check switches, power connections, and fuses.

A poor connection between PowerLab and computer, or bad cable.

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

SCSI problems: two SCSI devices on the bus have the same SCSI ID, or termination is incorrect or unsuitable.

- Check that each device has a unique ID number and that the SCSI chain is terminated correctly. (As a last resort, if the PowerLab is the only connected SCSI device, try leaving it unterminated.)

The PowerLab has an internal problem or has 'hung'.

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

Windows NT may not have the right SCSI driver available (it does not have many already installed, as do Windows 95 and 98).

- The driver might have to be installed manually, perhaps from the original NT system CD. The SCSI card should have instructions on the driver it needs and how to perform the installation.

The PowerLab is connected via USB and the computer does not properly support USB.

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

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

A poor connection between PowerLab and computer, or bad cable.

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

SCSI problems: two SCSI devices on the bus have the same SCSI ID, or termination is incorrect or unsuitable.

- Check that each device has a unique ID number and that the SCSI chain is terminated correctly. (As a last resort, if the PowerLab is the only connected SCSI device, try leaving it unterminated.)

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

The SCSI adapter card is incompatible with the computer or the PowerLab or both. We cannot guarantee that the PowerLab will work

reliably with a card we did not supply, and some computers and SCSI adapter cards just won't work together.

- Try another card, preferably one we supplied. Ask your PC technical support person or IS manager to check compatibility.

A poor connection between PowerLab and computer, or bad cable.

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

SCSI problems: two SCSI devices on the bus have the same SCSI ID, or termination is incorrect or unsuitable.

- Check that each device has a unique ID number and that the SCSI chain is terminated correctly. (As a last resort, if the PowerLab is the only connected SCSI device, try leaving it unterminated.)

Signals seem weak or interacting on the PowerLab/4SP

You may be using both the BNC connector and the Pod connector for an input at the same time, with resultant signal competition.

- Make certain that you use only *one* of the alternative connectors (BNC or Pod) for an input when recording.

C

Specifications

PowerLab/4sp Specifications

Input

Number of inputs:	4
Input configuration:	Single-ended or differential (the latter only through the Pod connectors)
Amplification ranges:	±2 mV to ±10 V full scale in 12 steps

± 10 V
± 5 V
± 2 V
± 1 V
± 0.5 V
± 0.2 V
± 0.1 V
± 50 mV
± 20 mV
± 10 mV
± 5 mV
± 2 mV

Maximum input voltage:	±15 volts
Input impedance:	≈ 1 MΩ $\|$ 47 pF @ DC
Low-pass filtering:	1, 2, 5, 10, or 20 kHz (software-selectable)
AC coupling:	DC or 0.1 Hz (software-selectable)
Frequency response (–3 dB):	20 kHz @ ±10 V full scale, all ranges

DC drift:	Software-corrected
CMRR (differential):	96 dB @ 50 Hz (typical)
Input crosstalk:	–110 dB typical
Input noise:	< 1 μV_{rms} referred to input
Pod connectors:	Combine power, I^2C and single-ended or differential analog input signals on one connector, support Pods, particular transducers, etc.

Supply voltage:	±5 V regulated
Maximum current:	50 mA per pod port
Communications:	2-wire I^2C
Signal input:	Positive and negative analog inputs
Connector type:	8-pin DIN.

Sampling

ADC resolution:	16 bits (150 µV resolution at 10 V range)
Linearity error:	±1 LSB (from 0 °C to 70 °C)
Maximum sampling rates:	200 kHz on one channel; 100 kHz on two channels; 40 kHz on three or four channels.
Available sampling rates:	200 kHz down to 0.003 Hz using Chart 200 kHz down to 2 Hz using Scope 200 kHz to 1 Hz using Chart for Windows
	Sampling on USB rather than SCSI may limit the maximum sampling rates.

Output Amplifier

Number of outputs:	2
Output configuration:	Single-ended or differential
Output resolution:	14 bits (0.6 mV resolution at 10 V range)
Maximum output current:	±25 mA
Output impedance:	0.1 Ω typical
Slew rate:	10 V/µs
Settling time:	2 µs (to 0.01% of FSR for LSB change)

Linearity error:	±1 LSB (from 0 °C to 70 °C)
Output ranges:	±200 mV to ±10 V full scale in six steps
	± 10 V
	± 5 V
	± 2 V
	± 1 V
	± 500 mV
	± 200 mV

External Trigger

Trigger threshold:	+2.9 V (TTL compatible)
Hysteresis:	1.1 V (turns off at +1.8 V)
Input load:	1 TTL load
Maximum input voltage:	±12 V
Minimum pulse width:	5 µs

Microprocessor and Data Communication

Processor:	16 MHz 68340
Memory:	512 K RAM
Data communication:	SCSI (up to 4 megabytes/s, maximum, dependent on computer)
	USB (up to 500 kilobytes/s, maximum dependent on setup)

Expansion Ports

I^2C expansion port:	Power and control bus for front-end units. Supports up to 16 front-ends, but limited to the PowerLab's free connectors. Interface communications rate of up to 10,000 bits/s.
Digital output:	8 independent lines, TTL output level (50 mA maximum load per line; 250 mA maximum total load)
Digital input:	8 independent lines, TTL input level, threshold 2.2 V

Physical Configuration

Dimensions (w × h × d):	300 mm × 60 mm × 300 mm (11.8″ × 2.4″ × 11.8″)
Weight:	4.5 kg (9 lb 13 oz)
Operating voltage:	220–240 V or 110–120 V (internally set)
Nominal power needs:	12.5 VA (no front-ends attached)
Maximum power needs:	18 VA (full complement of front-ends)
Replacement fuses:	100–120 V: 1 Amp (5 × 20 mm) slow blow (voltage rating 120 or 250 V)
	220–240 V: 400 mA (5 × 20 mm) slow blow (voltage rating 250 V only)
Operating temperature range:	0 to 35 °C, 0 to 90% humidity (non-condensing)

PowerLab/8SP Specifications

Input

Number of inputs:	8
Input configuration:	Single-ended
Amplification ranges:	±2 mV to ±10 V full scale in 12 steps
	± 10 V ± 5 V ± 2 V ± 1 V ± 0.5 V ± 0.2 V ± 0.1 V ± 50 mV ± 20 mV ± 10 mV ± 5 mV ± 2 mV
Maximum input voltage:	±15 volts
Input impedance:	$\approx 1\ \text{M}\Omega \parallel 47\ \text{pF}$ @ DC

Low-pass filtering:	1, 2, 5, 10, or 20 kHz (software-selectable)
AC coupling:	DC or 0.1 Hz (software-selectable)
Frequency response (–3 dB):	20 kHz @ ±10 V full scale, all gain ranges
DC drift:	Software-corrected
CMRR (differential):	96 dB @ 50 Hz (typical)
Input crosstalk:	–110 dB typical
Input noise:	$< 1\ \mu V_{rms}$ referred to input

Sampling

ADC resolution:	16 bits (150 µV resolution at 10 V range)
Linearity error:	±1 LSB (from 0 °C to 70 °C)
Maximum sampling rates:	200 kHz on one channel; 100 kHz on two channels; 40 kHz on three or four channels; 20 kHz on five to eight channels.
Available sampling rates:	200 kHz down to 0.003 Hz using Chart 200 kHz down to 2 Hz using Scope 200 kHz to 1 Hz using Chart for Windows Sampling on USB rather than SCSI may limit the maximum sampling rates.

Output Amplifier

Number of outputs:	2
Output configuration:	Single-ended or differential
Output resolution:	14 bits (0.6 mV resolution at 10 V range)
Maximum output current:	±25 mA
Output impedance:	$0.1\ \Omega$ typical
Slew rate:	10 V/µs
Settling time:	2 µs (to 0.01% of FSR for LSB change)
Linearity error:	±1 LSB (from 0 °C to 70 °C)

Output ranges:	±200 mV to ±10 V full scale in six steps
	± 10 V
	± 5 V
	± 2 V
	± 1 V
	± 500 mV
	± 200 mV

External Trigger

Trigger threshold:	+2.9 V (TTL compatible)
Hysteresis:	1.1 V (turns off at +1.8 V)
Input load:	1 TTL load
Maximum input voltage:	±12 V
Minimum pulse width:	5 µs

Microprocessor and Data Communication

Processor:	16 MHz 68340
Memory:	512 K RAM
Data communication:	SCSI (up to 4 megabytes/s, maximum, dependent on computer)
	USB (up to 500 kilobytes/s, maximum dependent on setup)

Expansion Ports

I^2C expansion port:	Power and control bus for front-end units. Supports up to 16 front-ends, but limited to the PowerLab's free connectors. Interface communications rate of up to 10,000 bits/s.
Digital output:	8 independent lines, TTL output level (50 mA maximum load per line; 250 mA maximum total load)
Digital input:	8 independent lines, TTL input level, threshold 2.2 V

Physical Configuration

Dimensions (w × h × d):	300 mm × 60 mm × 300 mm (11.8″ × 2.4″ × 11.8″)
Weight:	4.8 kg (10 lb 8 oz)
Operating voltage:	220–240 V or 110–120 V (internally set)
Nominal power needs:	17 VA (no front-ends attached)
Maximum power needs:	30 VA (full complement of front-ends)
Replacement fuses:	100–120 V: 1 Amp (5 × 20 mm) slow blow (voltage rating 120 or 250 V)
	220–240 V: 400 mA (5 × 20 mm) slow blow (voltage rating 250 V only)
Operating temperature range:	0 to 35 °C, 0 to 90% humidity (non-condensing)

PowerLab/16SP Specifications

Input

|	
Number of inputs:	16
Input configuration:	Single-ended
Amplification ranges:	±2 mV to ±10 V full scale in 12 steps
	± 10 V ± 5 V ± 2 V ± 1 V ± 0.5 V ± 0.2 V ± 0.1 V ± 50 mV ± 20 mV ± 10 mV ± 5 mV ± 2 mV
Maximum input voltage:	±15 volts
Input impedance:	≈ 1 MΩ ‖ 47 pF @ DC

Low-pass filtering:	1, 2, 5, 10, or 20 kHz (software-selectable)
AC coupling:	DC or 0.1 Hz (software-selectable)
Frequency response (–3 dB):	20 kHz @ ±10 V full scale, all gain ranges
DC drift:	Software-corrected
CMRR (differential):	96 dB @ 50 Hz (typical)
Input crosstalk:	–110 dB typical
Input noise:	$< 1 \ \mu V_{rms}$ referred to input

Sampling

ADC resolution:	16 bits (150 μV resolution at 10 V range)
Linearity error:	±1 LSB (from 0 °C to 70 °C)
Maximum sampling rates:	200 kHz on one channel; 100 kHz on two channels; 40 kHz on three or four channels; 20 kHz on five to eight channels; 10 kHz on nine to sixteen channels.
Available sampling rates:	200 kHz down to 0.003 Hz using Chart 200 kHz down to 2 Hz using Scope 200 kHz to 1 Hz using Chart for Windows Sampling on USB rather than SCSI may limit the maximum sampling rates.

Output Amplifier

Number of outputs:	2
Output configuration:	Single-ended or differential
Output resolution:	14 bits (0.6 mV resolution at 10 V range)
Maximum output current:	±25 mA
Output impedance:	0.1 Ω typical
Slew rate:	10 V/μs
Settling time:	2 μs (to 0.01% of FSR for LSB change)
Linearity error:	±1 LSB (from 0 °C to 70 °C)

Output ranges:	±200 mV to ±10 V full scale in six steps
	± 10 V ± 5 V ± 2 V ± 1 V ± 500 mV ± 200 mV

External Trigger

Trigger threshold:	+2.9 V (TTL compatible)
Hysteresis:	1.1 V (turns off at +1.8 V)
Input load:	1 TTL load
Maximum input voltage:	±12 V
Minimum pulse width:	5 µs

Microprocessor and Data Communication

Processor:	16 MHz 68340
Memory:	512 K RAM
Data communication:	SCSI (up to 4 megabytes/s, maximum, dependent on computer)
	USB (up to 500 kilobytes/s, maximum dependent on setup)

Expansion Ports

I^2C expansion port:	Power and control bus for front-end units. Supports up to 16 front-ends, but limited to the PowerLab's free connectors. Interface communications rate of up to 10,000 bits/s.
Digital output:	8 independent lines, TTL output level (50 mA maximum load per line; 250 mA maximum total load)
Digital input:	8 independent lines, TTL input level, threshold 2.2 V

Physical Configuration

Dimensions (w × h × d):	300 mm × 60 mm × 300 mm (11.8″ × 2.4″ × 11.8″)
Weight:	5 kg (10 lb 10 oz)
Operating voltage:	220–240 V or 110–120 V (internally set)
Nominal power needs:	25 VA (no front-ends attached)
Maximum power needs:	35 VA (full complement of front-ends)
Replacement fuses:	100–120 V: 1 Amp (5 × 20 mm) slow blow (voltage rating 120 or 250 V)
	220–240 V: 400 mA (5 × 20 mm) slow blow (voltage rating 250 V only)
Operating temperature range:	0 to 35 °C, 0 to 90% humidity (non-condensing)

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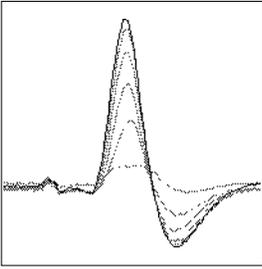
Glossary

This covers terms used in this owner's guide, those for ADInstruments front-ends, and the user's guides for ADInstruments software. General and specific computer terminology should be covered in the material that came with your computer, or in a recent dictionary.

AC coupling. A filter option. When AC coupling is chosen, a 0.1 Hz high-pass filter before the first amplification stage removes DC and frequency components below 0.1 Hz. This removes slowly changing baselines.

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 in discrete steps.

analog input. This refers to the connectors on the front of the PowerLab marked 'Input'. These inputs are designed to accept up to ±10

volts. Inputs can be either single-sided or differential (the latter only in the case of the Pod connectors).

analog output. This refers to the connectors on the front of the PowerLab marked 'Output'. The analog output provides a software-controlled variable output (±10 V) that can be used with applications either directly as a stimulator, or to control peripheral devices.

analysis. When the PowerLab is not physically connected to the computer, then ADInstruments software can be used to analyse and manipulate existing files if the analysis option is chosen.

BNC. A sort of cable or connector; a BNC-to-BNC cable connects two BNC connectors.

bridge transducer. A type of transducer using a Wheatstone bridge circuit. In its basic form, the bridge consists of four two-terminal elements (usually strain gauges) connected to form a quadrilateral. An excitation source is connected across one diagonal, and the transducer output is taken across the other.

bus. A data-carrying electrical pathway.

Chart. An application supplied with a PowerLab that emulates a multi-channel chart recorder, with other powerful options. (Macintosh and Windows versions differ.)

connector. A plug, socket, jack, or port used to connect one electronic device to another (via a cable): a PowerLab to a computer, say.

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.

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 using both positive and negative inputs on a PowerLab. The recorded signal is the difference between the positive and negative input voltages: if both were fed exactly the same signal, zero would result. Can reduce the noise from long leads.

digital. Varying discretely. A digital signal changes to discrete values rather than varying continuously. A digital time display might read 2:57 instead of using the positions of a pair of hands on a clock face.

DIN (Deutsche Industrie Norm). A sort of cable or connector; there are various sorts with different numbers of pins.

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

excitation voltage. The voltage supplied to a bridge circuit from which the transducer output signal is derived. Manipulating the transducer changes the measurement elements of the bridge circuit, producing a change in its output voltage.

external trigger. Refers to the connector on the front of the PowerLab marked 'Trigger'. This input lets recording be started from an external source. The trigger level (the voltage necessary to have an effect) depends on the hardware and cannot be changed.

filter. An electronic device or a program that alters data in accordance with specific criteria. Filters in the PowerLab can be used to reduce or to eliminate electronic noise or drift 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 too much attenuation. A low-pass filter's frequency response is the frequency where the output voltage becomes 0.707 ($1/\sqrt{2}$) of the input voltage or has been attenuated by 3 decibels. If a low-pass filter has a frequency response of 200 Hz, say, then the signal is effectively unattenuated up to 150 Hz, and is 0.707 of the original value at 200 Hz.

front-end. An ancillary device that extends PowerLab capabilities, providing additional signal conditioning and features for specialised work. Front-ends are recognised automatically by the PowerLab system and seamlessly integrated into its applications, operating under full software control.

gain. The amount of amplification of a signal.

half-bridge transducer. A bridge transducer only using half of the full-bridge circuit. It consists of two elements of equal value with an excitation voltage applied across them. The output of the transducer is taken at the junction of the two elements.

hertz (Hz). The unit of frequency of vibration or oscillation, defined as the number of cycles per second. The PowerLab's maximum sampling rate can be up to 100 kHz for E series and 200 kHz for SP and ST PowerLabs.

high-pass filter (HPF). A filter that passes high-frequency signals, but filters low ones, by blocking DC voltages and attenuating frequencies below a certain frequency, called the cutoff, or –3 dB, frequency.

I^{2}C. The I^{2}C (eye-squared-sea) connection is used by the PowerLab to control front-ends. It provides power and communications using a 4-wire serial bus (two wires for standard I^{2}C and two control lines).

IEC. International Electrotechnical Commission.

low-pass filter (LPF). A filter that passes low-frequency signals and DC voltages, but filters high ones, by attenuating frequencies above a certain frequency, called the cutoff, or –3 dB, frequency.

Macintosh. A family of Apple computers with built-in graphics and an elegant user interface. Of the Mac OS (operating system) versions, System 7 is needed and System 7.6 recommended normally; a Power Macintosh and Mac OS 8.5 or later are needed for USB.

MacLab. An earlier name for the PowerLab, before it became cross-platform.

Peaks. A simple chromatography analysis package. It reads acquired data from Macintosh Chart, Scope, or text files. (Available for Macintosh only.)

Pod connector. A special 8-pin DIN connector on some PowerLabs giving differential or single-sided connections for some analog inputs (Inputs 1 to 4 on the PowerLab/4SP). Pods can connect to them, and they can also provide power and control for some types of transducers.

Pods. Small, low-cost units that connect to the Pod connectors on the PowerLab. They give alternatives to front-ends for specific tasks, for use with precalibrated transducers and so on.

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. (Available for Macintosh only.)

PowerChrom System. The system consists of a PowerChrom recording unit and the

PowerChrom program. It provides general-purpose manual or automatic recording and analysis of chromatographic peaks.

PowerLab. The PowerLab hardware unit is a self-contained data acquisition hardware unit that connects to a Windows or Macintosh computer. When used in conjunction with programs such as Chart and Scope, it functions as a versatile laboratory instrument.

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

range. In Chart and Scope, the range is the greatest positive and negative voltage that can be displayed, usually from ±2 mV to ±10 V, in 12 steps. (Range is inversely proportional to gain, the extent of amplification.)

Scope. An application supplied with a PowerLab that emulates a two-channel storage oscilloscope, with added powerful options. (Macintosh and Windows versions are very similar.)

SCSI (small computer system interface). A connection protocol that provides a computer with fast access to peripheral devices, but has to be set up carefully. SCSI devices can be linked together in a chain, and require termination to prevent signal loss.

serial. A connection protocol for sending information sequentially, one bit at a time, over a single wire. (The PowerLab/800 has a slow serial connection, for use with early Macintosh computers.)

TChart. A simplified version of the Chart program once used for teaching. Its manual of experiments is now available for Chart.

terminator. A device used in a SCSI chain to maintain signal integrity. Some models of PowerLab have them built in.

transducer. A physical device that converts a mechanical, thermal, or electrical stimulus into a proportional electrical output. For example, there are common transducers to measure force, displacement, temperature, pressure, and similar parameters.

trigger. A signal such as a voltage pulse, used to determine when sampling will begin. Sampling can be made to begin when the trigger level is reached, after it, or even prior to it. See also external trigger.

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

USB (universal serial bus). A relatively new low-to-medium speed connection protocol, for linking multiple peripherals from mice to printers. (Available on new PowerLabs, such as the SP series PowerLabs.)

waveform. The shape of a wave; a graph of a wave's amplitude over time.

Windows. An operating system for PCs with a graphical user interface. Chart for Windows and Scope for Windows require Windows 95 or NT 4 or later. Windows 98, Me, 2000 or later is needed for USB.

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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®, PowerChrom®, and PowerLab® 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. ADI is not responsible for any problems with the computer system not directly related to ADI products.

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.

To obtain service under this warranty, the Purchaser must notify ADI of the defect before the warranty expires. Unless other arrangements are made, ADI will provide an RMA (Return Merchandise Authority) number, and a service centre address to which the Purchaser must ship the defective product at his or her own expense. The product should be packed safely (preferably in its original packaging) and have the RMA number on the shipping label, beneath the address. ADI will pay return shipping.

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 or set of disks 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 should be 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 with ADI products. Services not directly related to ADI products may incur a charge.

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.