KEITHLEY

PIO-96J Parallel Digital I/O Board
User's Manual

WARRANTY

Hardware

Keithley Instruments, Inc. warrants that, for a period of one (1) year from the date of shipment (3 years for Models 2000, 2001, 2002, 2010 and 2700), the Keithley Hardware product will be free from defects in materials or workmanship. This warranty will be honored provided the defect has not been caused by use of the Keithley Hardware not in accordance with the instructions for the product. This warranty shall be null and void upon: (1) any modification of Keithley Hardware that is made by other than Keithley and not approved in writing by Keithley or (2) operation of the Keithley Hardware outside of the environmental specifications therefore.

Upon receiving notification of a defect in the Keithley Hardware during the warranty period, Keithley will, at its option, either repair or replace such Keithley Hardware. During the first ninety days of the warranty period, Keithley will, at its option, supply the necessary on site labor to return the product to the condition prior to the notification of a defect. Failure to notify Keithley of a defect during the warranty shall relieve Keithley of its obligations and liabilities under this warranty.

Other Hardware

The portion of the product that is not manufactured by Keithley (Other Hardware) shall not be covered by this warranty, and Keithley shall have no duty of obligation to enforce any manufacturers' warranties on behalf of the customer. On those other manufacturers' products that Keithley purchases for resale, Keithley shall have no duty of obligation to enforce any manufacturers' warranties on behalf of the customer.

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Keithley warrants that for a period of one (1) year from date of shipment, the Keithley produced portion of the software or firmware (Keithley Software) will conform in all material respects with the published specifications provided such Keithley Software is used on the product for which it is intended and otherwise in accordance with the instructions therefore. Keithley does not warrant that operation of the Keithley Software will be uninterrupted or error-free and/or that the Keithley Software will be adequate for the customer's intended application and/or use. This warranty shall be null and void upon any modification of the Keithley Software that is made by other than Keithley and not approved in writing by Keithley.

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Other Software

OEM software that is not produced by Keithley (Other Software) shall not be covered by this warranty, and Keithley shall have no duty or obligation to enforce any OEM's warranties on behalf of the customer.

Other Items

Keithley warrants the following items for 90 days from the date of shipment: probes, cables, rechargeable batteries, diskettes, and documentation.

Items not Covered under Warranty

This warranty does not apply to fuses, non-rechargeable batteries, damage from battery leakage, or problems arising from normal wear or failure to follow instructions.

Limitation of Warranty

This warranty does not apply to defects resulting from product modification made by Purchaser without Keithley's express written consent, or by misuse of any product or part.

Disclaimer of Warranties

EXCEPT FOR THE EXPRESS WARRANTIES ABOVE KEITHLEY DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. KEITHLEY DISCLAIMS ALL WARRANTIES WITH RESPECT TO THE OTHER HARDWARE AND OTHER SOFTWARE.

Limitation of Liability

KEITHLEY INSTRUMENTS SHALL IN NO EVENT, REGARDLESS OF CAUSE, ASSUME RESPONSIBILITY FOR OR BE LIABLE FOR: (1) ECONOMICAL, INCIDENTAL, CONSEQUENTIAL, INDIRECT, SPECIAL, PUNITIVE OR EXEMPLARY DAMAGES, WHETHER CLAIMED UNDER CONTRACT, TORT OR ANY OTHER LEGAL THEORY, (2) LOSS OF OR DAMAGE TO THE CUSTOMER'S DATA OR PROGRAMMING, OR (3) PENALTIES OR PENALTY CLAUSES OF ANY DESCRIPTION OR INDEMNIFICATION OF THE CUSTOMER OR OTHERS FOR COSTS, DAMAGES, OR EXPENSES RELATED TO THE GOODS OR SERVICES PROVIDED UNDER THIS WARRANTY.

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Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

KEITHLEY Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the manual for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product may be impaired.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are rated Installation Category I and Installation Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Installation Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Installation Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the Manual.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided, in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

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If ⏚ or ⏚ is present, connect it to safety earth ground using the wire recommended in the user documentation.

The ⚠ symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The ⚡ symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

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1
General Description

This manual contains information and instructions for handling and using the PIO-96J board.

To follow the information and instructions contained in this manual, you must be familiar with data-acquisition principles, with your application, with your computer, and with the Windows® 95/98/NT operating system. The manual is organized as follows:

- Section 1 provides an overview of the hardware and descriptions of features, applications, supporting software, and accessories.
- Section 2 describes how to do the following:
    - Install the DriverLINX software and the documentation.
    - Unpack, set up, and install the board.
    - Configure and check the installation.
    - Use accessories to connect the board to external circuits.
- Section 3 describes typical applications.
- Section 4 briefly describes the need to program through the DriverLINX interface—provided with your board—and tells how to access the extensive DriverLINX documentation.
- Section 5 describes how to isolate common problems, how to troubleshoot your system, and how to obtain technical support.
- Appendix A contains specifications.
- Appendix B describes the I/O registers, for background reference only (you program the PIO-96J board through the DriverLINX interface, not at the register-level).

Features and operating characteristics

The PIO-96J is a 96-line parallel, digital I/O interface board designed for IBM® PC series computers and compatibles. The software currently supplied with these boards requires the Windows 95/98/NT operating system and a compatible microprocessor (preferably a Pentium microprocessor),

The PA and PB ports are byte-wide (8-bits) and configurable as inputs or outputs. The PC port is also byte-wide but can be divided into two separate 4-bit ports: PC lower and PC upper (each of which can be set up as either inputs or outputs). The PIO-96J emulates mode 0 of the Intel 8255 Programmable Peripheral Interface (PPI) as set by its control register. On power-up or whenever the computer's Hardware Reset line is asserted, all ports are cleared and set in a digital-input mode.

The PIO-96J uses 16 consecutive I/O addresses within the PC's I/O address space. The base address of the PIO-96J board is set by a base address switch. More than one PIO-96J may be installed in a single computer. However, each installed PIO-96J uses 16 I/O addresses (base address +0 through Base Address +15), and no two boards can use the same address.

The computer power supplies provide the +5V power for the I/O connectors. The computer provides this power for use in external applications such as the addition of pull-up resistors. The +5V supply may also be used to power external accessories, as long as you observe the total-available-power limits of your computer and ensure that the total connector pins' current is limited to less than 1A. **Do Not Connect the +5V Outputs to an external +5V Supply.**

I/O connections for each port use a 50-pin, 0.1 inch header connector. This configuration assures maximum shielding and minimum cross-talk by placing a ground wire in the cable between each I/O conductor. The mating connector socket is the 3M 3425-6050 (one required for each 24-bit port), or you may purchase a 24 inch cable with connectors on both ends (part number CACC-2000). Longer cables are available by specifying part number CACC-20NN, where NN is the number of feet added to the standard two-foot cable.

General areas of application for the PIO-96J include all parallel-digital I/O requirements such as communicating with peripherals, operating relays, and reading switch inputs.

Supporting software

DriverLINX software is supplied by Keithley with the PI0-HV board. DriverLINX provides convenient interfaces to configure and set I/O bits without register-level programming.

Most importantly, however, DriverLINX supports those programmers who wish to create custom applications using Visual C/C++, Visual Basic, or Delphi. DriverLINX accomplishes foreground and background tasks to perform data acquisition. The software includes memory and data buffer management, event triggering, extensive error checking, and context sensitive online help.

More specifically, DriverLINX provides application developers a standardized interface to over 100 services for creating foreground and background tasks for the following:

- Analog input and output
- Digital input and output
- Time and frequency measurement
- Event counting
- Pulse output
- Period measurement

In addition to basic I/O support, DriverLINX also provides:

- Built-in capabilities to handle memory and data buffer management
- A selection of starting and stopping trigger events, including pre-triggering, mid-point triggering and post-triggering protocols
- Extensive error checking
- Context-sensitive on-line help system

DriverLINX is essentially hardware independent, because its portable APIs work across various operating systems. This capability eliminates unnecessary programming when changing operating system platforms.

2
Installation

Overview

This section describes the following:

- Inventorying installation resources
- Installing the DriverLINX software needed to operate your PIO-96J board and all documentation for the board and software
- Configuring the installation in software
- Unpacking and inspecting the board, physically configuring the board, installing cables to the board, and then installing the board in your computer
- Checking the installation
- Making system connections

NOTE   *Install the DriverLINX software before installing the PIO-96J board.*
                Otherwise, the device drivers will be more difficult to install.

Inventorying required installation resources

Before installing DriverLINX and the board, do the following

1. Inventory your PIO-96J board's configuration settings.
2. Determine the resources that your PIO-96J board requires.
3. Inventory your computer's resources already allocated to other installed devices.
4. Determine whether your computer has sufficient resources for your PIO-96J board.
5. Determine whether your PIO-96J board can use your computer's free resources.

NOTE   *The DriverLINX Installation and Configuration Guide, Chapter 1,*
                amplifies the inventory process in checklist items 1-5. (Ignore the rest
                of the checklist items for now.) To display this manual from your Driv-
                erLINX PIO Series CD-ROM, open the Windows Explorer, then dou-
                *ble click on **X:\Drvlinx4\Docs\Instconf.pdf**, where **X** = the letter of*
                the CD-ROM drive. Acrobat Reader must already be installed on the
                other system. If necessary, you can first install Acrobat Reader directly
                *from the CD-ROM by double clicking **X:\Acrobat\setup.exe**.*

Installing the DriverLINX software and documentation

NOTE   *Even if DriverLINX versions other than the PIO Series version are al-*
                ready installed on your system, you must also install the PIO Series
                DriverLINX version. In the process, some DriverLINX capabilities
                shared by all boards may be upgraded (test utilities, for example).

This section discusses installation of drivers, interfaces, and documentation. The component installation options provided by the DriverLINX setup program are as follows:

- **Install Drivers** — This required component installs only the files you need for configuring your hardware and running third-party data-acquisition applications that require DriverLINX.

- **Install Interfaces** — This optional component installs the files and example programs that you will need to develop custom applications for DriverLINX using C/C++, Visual Basic, and Delphi.
- **Install Documentation** — This optional component installs electronic documentation for DriverLINX that you can read, search, and print using the Adobe Acrobat Reader.
- **Install Acrobat** — This optional component installs the Adobe Acrobat Reader for the DriverLINX electronic documentation.

Install the DriverLINX software and board as follows:

1. Place the DriverLINX PIO Series CD-ROM in your drive and wait a few seconds. On most systems, setup starts automatically. If not, run the setup.exe file, found in the root directory of the CD-ROM.

   A DriverLINX Browser Introduction screen appears. Thereafter, the DriverLINX CD Navigator screen appears automatically after waiting a few seconds or after clicking 'Next'.

NOTE   *On the DriverLINX CD Navigator and other DriverLINX Browser screens, place the cursor over a menu item to see an explanation. A star next to a menu item means that it was selected previously.*

                 Before continuing with this installation, Keithley suggests clicking Read Me First on the DriverLINX CD Navigator and reviewing the brief information that appears.

2. On the DriverLINX CD Navigator screen, click **Install DriverLINX**. An Install These DriverLINX Components screen appears.

3. Click **Install Drivers**, and then follow the series of on-screen instructions. When done, the Install These DriverLINX Components screen reappears.

4. If you do not plan to develop custom application software for a PIO board, then skip to Step 5. If you do plan to develop custom application software, you must install DriverLINX interfaces before writing the software. Install them now by clicking 'Install Interfaces' and following the series of on-screen instructions. When done, the Install These DriverLINX Components screen reappears.

5. Click **Install Documentation** and follow the series of on-screen instructions. This step installs the manuals. When done, the Install These DriverLINX Components screen reappears.

6. If Acrobat Reader is not already installed on your system, install it now. You need Acrobat Reader to read the manuals, a section of which you must access in step 9. Click on **Install Acrobat** and follow the series of on-screen instructions. When done, the Install These DriverLINX Components screen reappears.

7. Click **Exit.** Then, on the screen that appears saying "Thank you for using DriverLINX," click **Done**. The System Settings Changed dialog box appears.

8. On the System Settings Changed dialog box, click '**No**'. (The system will be rebooted and configured later under "Configuring your installation.") The screen returns to the Windows desktop.

9. Print out one section of a DriverLINX manual that you will briefly review later during system configuration. Proceed as follows:

   a. Under **Programs → DriverLINX → Keithley** in the **Start** menu, click **On-line Manuals.** A menu document appears.

   b. In the menu document, scroll until you find the major category **Configuration**.

     c. Under **Configuration,** click **Hardware References**. A list of documents appears.

     d. In the list of documents, click **Keithley PIO Series**. Acrobat Reader opens and the manual entitled *Using DriverLINX with Your Hardware—Keithley PIO Series* appears.

     e. Print the following section from the *Using DriverLINX with Your Hardware—Keithley PIO Series* manual: "Configuring the PIO Series."

NOTE   *If your data acquisition system is not connected to a printer, you can display and print the Using DriverLINX with Your Hardware Keithley PIO Series manual sections from another system, directly from the CD-ROM (without installing anything). To display the manual, open the Windows Explorer, then double click on X:\Drvlinx4\Docs\Notes\kmbpio.pdf, where X = the letter of the CD-ROM drive. Acrobat Reader must already be installed on the other system. If necessary, you can first install Acrobat Reader directly from the CD-ROM by double clicking X:\Acrobat\setup.exe.*

10. Continue with "Configuring your installation."

Configuring your installation

1. Locate and briefly review the manual section, "Configuring the PIO Series," that you printed earlier during step 9 of "Installing the DriverLINX Software and Documentation." Reviewing this section will help prepare you to input information and select options when configuring your installation.

NOTE   *Be sure to note and follow all differences between installations for Windows NT and Windows 95/98.*

2. Reboot your computer. The DriverLINX Plug and Play Wizard appears on your screen automatically at the end of the boot cycle.

NOTE   *If you do not run the DriverLINX Plug and Play Wizard now, it will not reappear during the current computer session, although it may appear after a subsequent reboot. If you wish to configure your board sometime later, you can start the Plug and Play Wizard manually from a batch file. In the Windows Explorer, double click X:\Drvlinx4\Help\kmbpio.bat, where X is the letter of the drive on which DriverLINX is installed.*

3. On the Plug and Play Wizard, click **Wizard** and follow the series of on-screen instructions that appear. The Wizard will first lead you through the steps of installing your hardware—from a software viewpoint—and configuring it.

NOTE   *If your operating system is Windows NT, use Windows NT Diagnostics to find the free resources that the Plug and Play Wizard asks you to assign. However, if your board requires an interrupt, to reliably find a free ISA interrupt, you may need to: 1) configure your computer as having a non-Plug and Play operating system, using BIOS setup, and then 2) individually assign the interrupt to the ISA bus.*

4. Continue with the next section, "Preparing and installing your board."

Preparing and installing your board

CAUTION   **Ensure that the computer is turned OFF before installing or re-moving a board. Installing or removing a board while power is ON can damage your computer, the board, or both.**

Handle the board in a static-controlled workstation; wear a grounded wrist strap. Discharge static voltage differences between the wrapped board and the handling environment before removing the board from its protective wrapper. Failure to discharge static electricity before and during handling may damage semi-conductor circuits on the board.

Handle the board using the mounting bracket. Do not touch the circuit traces or connector contacts when handling the board.

Unwrapping and inspecting your board

After you remove the wrapped board from its outer shipping carton, proceed as follows:

1. Your PIO-96J board is packaged at the factory in an anti-static wrapper that must not be removed until you have discharged any static electricity by either of the following methods:

   • If you are equipped with a grounded wrist strap, you discharge static electricity as soon as you hold the wrapped board.

   • If you are not equipped with a grounded wrist strap, discharge static electricity by holding the wrapped board in one hand while placing your other hand firmly on a metal portion of the computer chassis (your computer must be turned off but grounded).

2. Remove your PIO-96J board from its anti-static wrapping material. (You may store the wrapping material for future use.)

3. Inspect the board for damage. If damage is apparent, arrange to return the board to the factory. (See "Technical support.")

4. Check the remaining contents of your package against the packing list, and immediately report any missing items.

5. If the inspection is satisfactory, proceed to "Physically configuring your board."

Physically configuring your board

Keithley configures your PIO-96J board by presetting a base I/O address. While the factory settings are suitable for most installations, make sure these settings are not already in use by other devices in your computer. If your board requires reconfiguration, you must set a new base address by setting the base address switches.

Locating the base address switches

Base address switches are located as shown in Figure 2-1.

Figure 2-1
Component locations

J1 = Base Address +0 - 3
J2 = Base Address +4 - 7
J3 = Base Address +8 - 11
J4 = Base Address +12 - 15
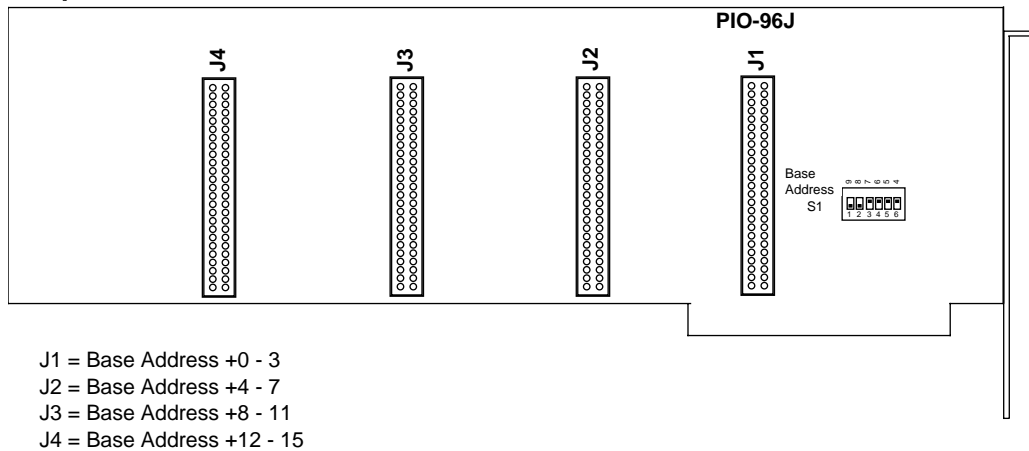
Setting the base I/O address

NOTE   *Before setting the base address switches, check the different require-*
              ments for Windows 95/98 and Windows NT. Refer to "Configuring the
              PIO Series" in Using DriverLINX with Your Hardware—Keithley PIO
              Series manual, which you printed in step 9 of "Installing the Driver-
              LINX Software and Documentation."

Addresses in the I/O space of your computer can range from 0000h to FFFFh, for a total of 65,535 locations. IBM recommends a base I/O address between 100h and 3FFh only and reserves some addresses in this range for computer and I/O device use.

The base-address switch is preset at the factory for a default base I/O address of 300h (the address reserved by many computers for a prototype board). If 300h was assigned to the board when you ran the DriverLINX Plug and Play Wizard, you do not need to reset the address switch. Otherwise, reset the base address switch to conform to the base address assigned when you ran the Wizard. Use the information shown in Figure 2-2 to determine settings for a new address.

NOTE   *A base I/O address switch has value only when set to its OFF position.*

Figure 2-2
Base address switch values
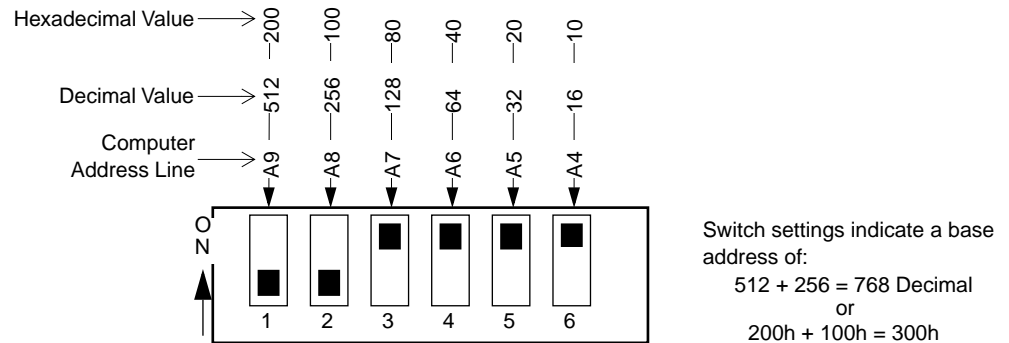
Notice that the least-significant address line in Figure 2-2 is A4. This line has a decimal value of 16. Therefore, the address you select is on a 16-bit boundary, giving the board access to 16 I/O address ports.

When you have finished setting the address switches, do the following:

1. Check to ensure that the switches are set correctly.
2. Record the switch settings for future reference.
3. Continue with the next section, "Installing the needed interface cables."

Installing the needed interface cables

Each 24-bit port on the PIO-96J uses a 50-pin connector as an interface to input/output connections. This connector is compatible with the manufacturer's CACC-2000 series of cables. However, note that the standard CACC-2000 cable is only 24 inches long. Since the connector and up to 14 inches (worst case) of the I/O cable will be inside the computer, the standard CACC-2000 cable may be too short. Longer cables are available. Order a CACC-20NN, where NN is the additional number of feet (beyond the standard 24 inches) needed.

Users requiring screw terminals rather than simple cable connections should purchase the STA-50 Screw Terminal Adapter Box. Each port on the PIO-96J will require a separate STA-50 (four total).

Clamping cables to the board

The mounting plate of your PIO-96J board contains an adjustable cable clamp that can secure the flat cables. See Figure 2-3.

Figure 2-3
Cable clamp on the mounting plate of a PIO-96J board
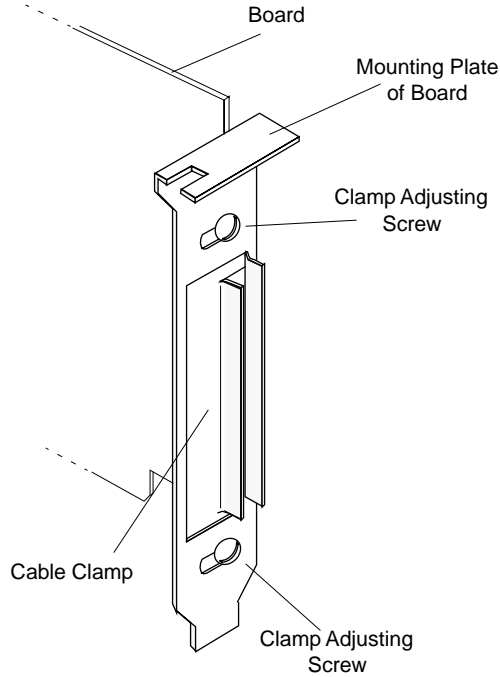
To clamp one or more cables to your board, use the following procedure:

1. Remove the two clamp-adjusting screws and the clamp from the board's mounting plate.
2. Feed a cable through the hole in the mounting plate, and plug the cable connector into the I/O connector.
3. If your board is using more than one cable, feed the next cable through the hole in the mounting plate, and plug the cable connector into the next available I/O connector.
4. Repeat step 3 until all cables are in place on the board, as shown in Figure 2-4.

Figure 2-4
Cabling in place on a PIO-96J board
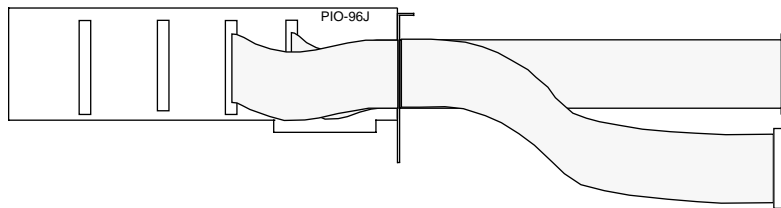
5. Re-install the clamp and clamp-adjusting screws so that the clamp holds the cabling firmly in place, as shown in Figure 2-5.

Figure 2-5
Cable clamp securing single cable
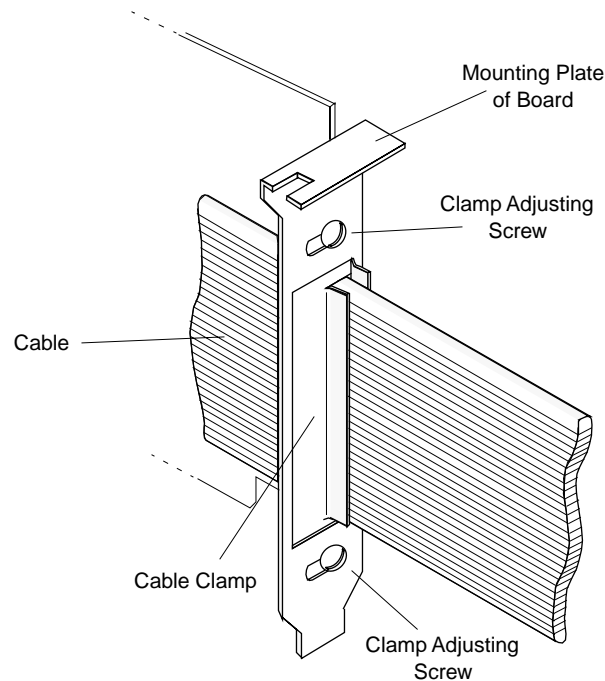
Installing cable shielding

To shield cabling for your PIO-96J board, perform the following steps:

1. With cabling installed and clamped, wrap all cables together with a piece of tape to mark a shield boundary at a point ½-inch or more away from the inside surface of the mounting plate, as shown in Figure 2-6.

2. Remove the two clamp-adjusting screws and the clamp from the board's mounting plate.

3. Unplug the cable connectors from the board, and pull the taped cabling back through the mounting plate until the tape marker is beyond the clamping area.

4. Beginning at the tape marker, cover the cabling with a single piece of jacket (customer supplied) to the desired length, as shown in Figure 2-7.

5. Remove tape from cabling, and use scissors to cut 1⁄2-inch flaps in the jacket on both sides of the cable, as shown in Figure 2-8.

6. Fold the flaps back on both sides of cabling to expose the shield surface, as shown in Figure 2-9.

7. Slide cabling back through mounting plate and plug the cable connectors back into the board, placing shield surface directly in line with mounting-plate clamp, as shown in Figure 2-10.

Figure 2-6
Cabling taped to show shield boundary
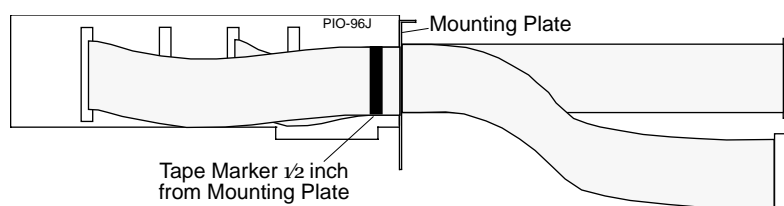
Figure 2-7
Cabling wrapped with jacket to tape boundary
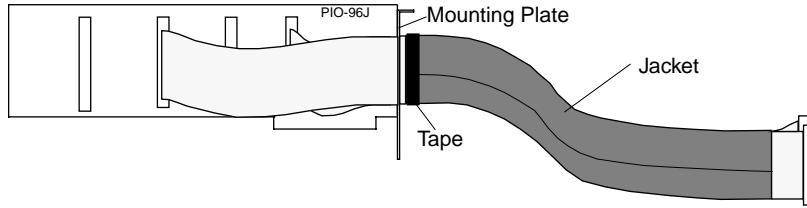
Figure 2-8
Jacket trimmed with scissors to make 1/2-inch flaps
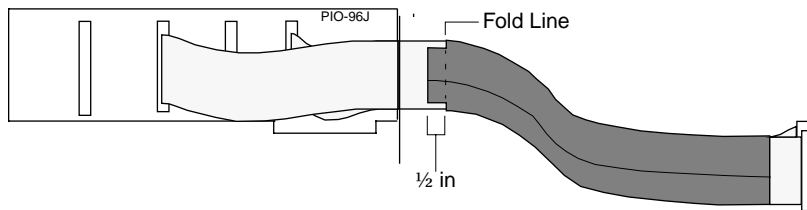
Figure 2-9
Jacket with flaps folded back to expose shield surface
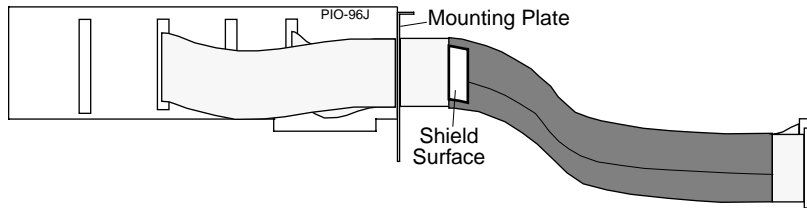
Figure 2-10
Cabling reconnected, placing shield surface in line with clamp
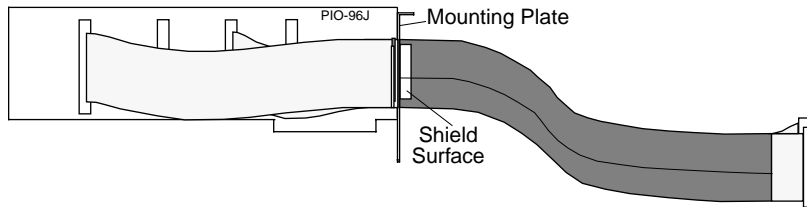
8. Re-install the clamp and clamp-adjusting screws so the clamp holds the cabling firmly in place while bearing firmly on the shield surface of the jacket flap, as shown in Figure 2-11.

NOTE   This shielding procedure assures CE Mark compliance.

Figure 2-11
Detail of clamped cable showing installed jacket
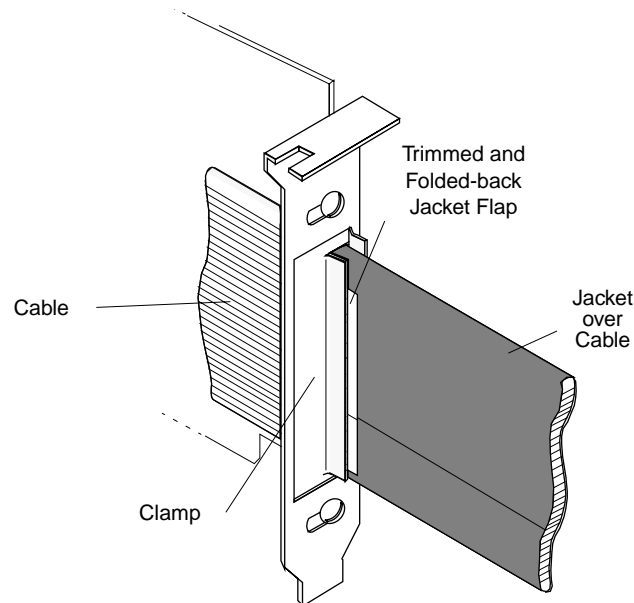
9. Continue with "Installing your board in the computer."

Installing your board in the computer

CAUTION   **Installing or removing a board while power is ON can damage your computer.**

Use the following steps to install a PIO-96J board in an expansion slot of your computer:

1. Turn off power to the computer and all attached equipment.
2. Remove the computer chassis cover.
3. Select an unoccupied expansion slot in the rear panel, and remove the corresponding dummy mounting plate.
4. Make sure the settings of the base address switch match the settings shown in the configuration utility.
5. Insert and secure the board in the selected expansion slot, feeding any cable ends through the rear panel of the computer as you insert the board.
6. Replace the computer cover.
7. Continue with "Checking your installation."

Checking your installation

The ability to start the DriverLINX AIO Panel utility, which is available after you install DriverLINX, verifies that DriverLINX and the board are installed and configured satisfactorily.

You can also test the functions of the PIO-96J board, without needing to write an application program, by connecting appropriate digital signals and observing the responses with the DriverLINX AIO Panel. Before connecting signals, first read the next section, "Connecting the board to your external circuits."

I/O bit tests

General information

1. Start the AIO Panel as follows:
    a. In the **Start** menu, click **Programs**.
    b. Find the **DriverLINX ▶ Test Panels** folder, under which you should find the **AIO Panel** entry.
    c. Click on the **AIO Panel** entry. The **Analog I/O Panel** should appear, similar to the example in Figure 2-12. (If you have other DriverLINX devices installed in addition to the digital input/output card you are testing, they will also be listed. In that case, select the desired digital I/O card and the proper device number before proceeding.)

Figure 2-12
An AIO Panel example
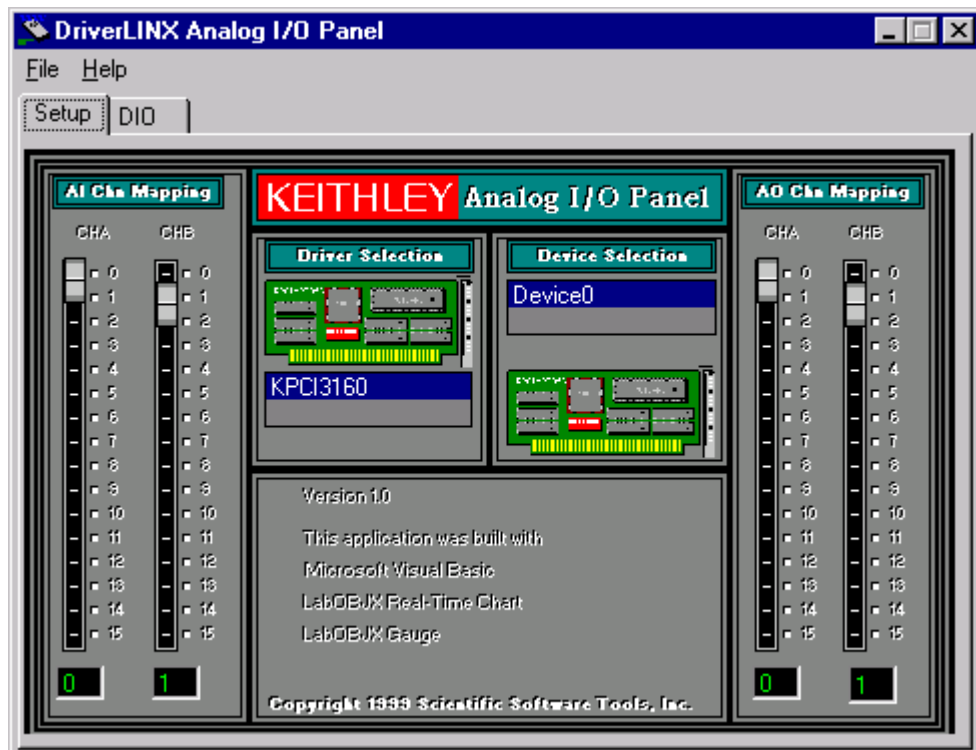
NOTE   *The "Driver Selection" column will show the actual DriverLINX driver(s) you have installed.*

2. On the **AIO Control Panel**, click the **DIO** tab.

Figure 2-13
DIO channel tab example
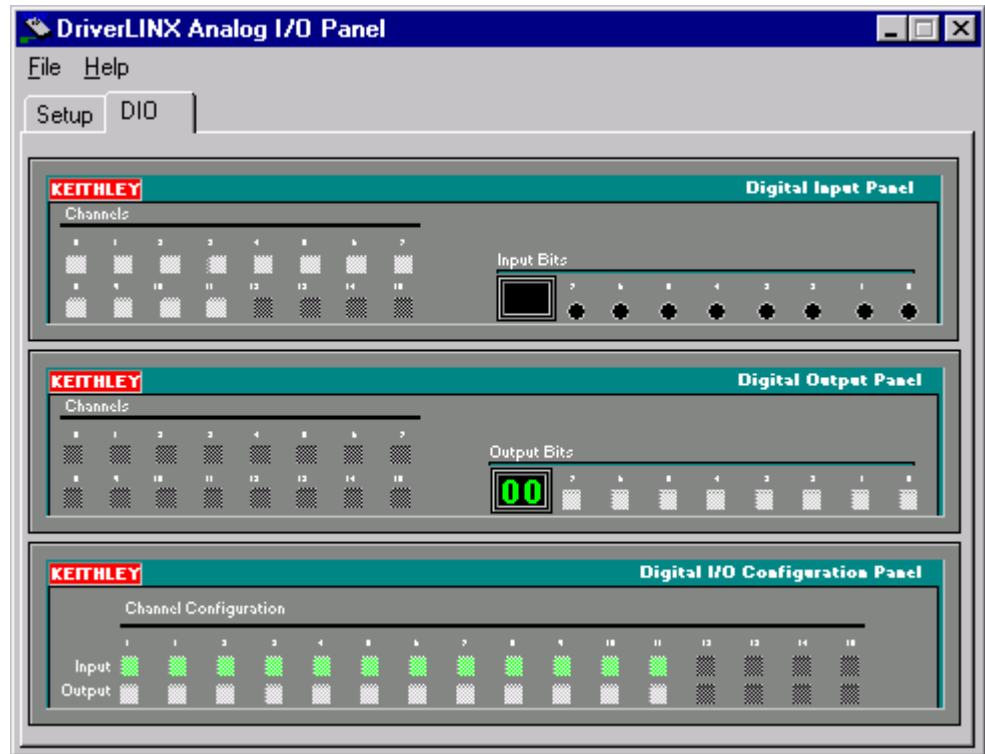
NOTE   *The on-screen digital I/O controller works as follows:*

- *Channels 0 to 15 refer to the 8-bit general-purpose registers of your digital input-output card. (Depending on which card is used, the number of valid 8-bit registers will vary.) Bits displayed on the **Digital Input Panel** and the **Digital Output Panel** are numbered 0-7 for every channel. Refer elsewhere in this manual for a description of the available ports and their direction.*

- *Invalid channels and settings appear as dark gray squares. For example:*

    - *Non-existent channels always appear as dark gray squares.*

    - *Channels configured as inputs will appear as dark gray squares on the output panel.*

- *Valid channels and settings appear as white squares when OFF and green squares when ON. (When the manual is printed in black and white, valid channels and settings appear as white squares when OFF and as light gray squares when ON.)*

- *The two-digit numeric displays under **Input Bits** and **Output Bits** show the hexadecimal values of the adjacent bit patterns.*

- *To configure a valid channel either for input or output, use the **Digital Channel Configuration Panel**. Click on either the **Input** or **Output** square below the channel number. Note: this selection will be disabled for channels which are fixed as input or output by hardware design.*

- *To turn ON output-channel bits, use the **Digital Output Panel**. First select the channel number of the bits to be turned on by clicking on the appropriate square under **Channels**. Then, turn ON a bit by clicking the appropriate square under **Output Bits**. Turn OFF a bit in the same way.*

- *To read an input-channel bit, use the **Digital Input Panel**. First select the channel number to be checked by clicking the appropriate square under **Channels**. Then, read the numbered bit under **Input Bits**. OFF input bits appear as black dots and ON input bits appear as green dots. (When the manual is printed in black and white, OFF input bits appear as black dots and ON input bits appear as light gray dots.)*

3. Under **Digital I/O Configuration Panel**, configure channels as shown in Figure 2-14. (Actual channels available will vary according to your hardware.)

Figure 2-14
Configuring the digital I/O channels as inputs and outputs
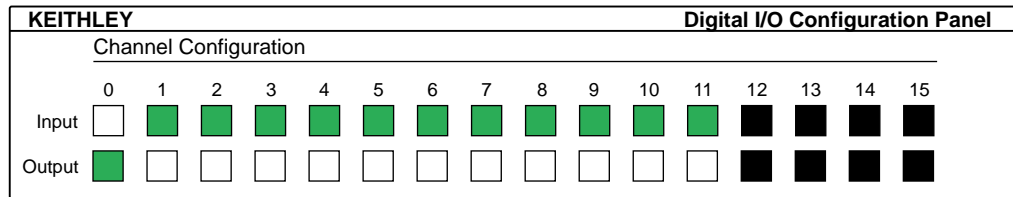
NOTE   *For clarity when the manual is printed in black and white, the control colors in Figure 2-14 and subsequent drawings will be shown as follows:*

Illustration	Color on Actual Panel	Function
BLACK	DARK GRAY	Invalid
WHITE	LIGHT GRAY	OFF
GRAY	GREEN	ON

4. In the **Digital Output Panel** under **Channels**, click on a channel (here, channel **0**) as shown in Figure 2-15.

Figure 2-15
Configuring channel 0 for output bit pattern A
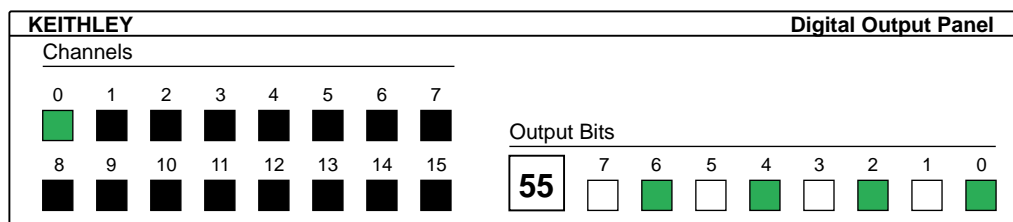
5. In the **Digital Output Panel** under **Output Bits**, set the bits of the channel as desired as shown in Figure 2-15. (Click on each bit position to turn it ON or OFF.)

6. In the **Digital Input Panel** under **Channels**, click on a channel to select it and display the logical state of its input lines.

Output set test

The output set test checks whether logic levels measured at all output pins agree with output bit patterns set by software, using a DriverLINX graphical interface (AIO Panel).

NOTE   *This test is performed without user circuits being connected to the outputs.*

Perform the output set test as follows:

1. Ready the following equipment:
   - A digital voltmeter (DVM) or a digital multimeter (DMM) set to measure voltages, or a logic probe capable of reading TTL logic levels.
   - A suitable accessory and cable for the board being tested.
2. Turn OFF the host computer.
3. Connect the cable and accessory to your board.
4. Turn ON the host computer and boot Windows 95/98/NT.
5. Click the Windows 95/98/NT **Start** tab.
6. Start the AIO Panel as follows:
   a. In the **Start** menu, click **Programs**.
   b. Find the **DriverLINX ▶ Test Panels** folder, under which you should find the **AIO Panel** entry.
   c. Click on the **AIO Panel** entry. The **Analog I/O Panel** should appear, similar to the example in Figure 2-16. (If you have other DriverLINX devices installed in addition to the digital input/output card you are testing, they will also be listed. In that case, select the desired digital I/O card and the proper device number before proceeding.)

Figure 2-16
An AIO Panel example

7. On the **AIO Panel**, click the **DIO** tab.

NOTE   *To read an input-channel bit, use the **Digital Input Panel**. First, select*
               the channel number to be checked by clicking the appropriate square
               *under **Channels**. Then, read the numbered bit under **Input Bits**. OFF*
               input bits appear as black dots and ON input bits appear as green dots.
               (When the manual is printed in black and white, OFF input bits appear
               as black dots and ON input bits appear as light gray dots.) Further
               information about this panel, how to make changes, and how to interpret
               displays, is given in "I/O Bit Tests" of this section.

8. Under **Digital I/O Configuration Panel**, configure the output channels to be tested as shown
    in Figure 2-17. (Actual output channels available will vary according to your hardware.)

Figure 2-17
**Configuring the digital I/O channels as inputs and outputs**

KEITHLEY															Digital I/O Configuration Panel

Channel Configuration

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Input	□	□	□	■	■	■	■	■	■	■	■	■	▪	▪	▪	▪
Output	■	■	■	□	□	□	□	□	□	□	□	□	▪	▪	▪	▪

NOTE   *In Figure 2-17 and subsequent drawings of digital I/O controller panels,*
               the squares below invalid channels are colored black instead of dark
               gray—for clarity when the manual is printed in black and white.

9. In the **Digital Output Panel** under **Channels**, click on an output channel (channel **0** in this
    example) as shown in Figure 2-18.

Figure 2-18
Configuring channel 0 for output bit pattern A

KEITHLEY								Digital Output Panel

Channels

0	1	2	3	4	5	6	7
■	□	□	▪	▪	▪	▪	▪

8	9	10	11	12	13	14	15
▪	▪	▪	▪	▪	▪	▪	▪

Output Bits

55	7	6	5	4	3	2	1	0
	□	■	□	■	□	■	□	■

10. In the **Digital Output Panel** under **Output Bits**, set the bits of channel **0** for bit pattern A as
    shown in Figure 2-18.

11. Measure the voltage between signal ground and each bit of the output port with a DMM or
    DVM. Make measurements at the cabled mating connector of your accessory.

12. Each bit set to ON in the **AIO Panel** should output a logic-high signal at the corresponding
    I/O terminal, reading typically about 4 volts (minimum of 2.2 volts) at a DMM/DVM. Each
    bit set to OFF in the **AIO Panel** should output a logic-low signal at the corresponding   I/O
    terminal, reading typically about 0 volts (maximum of 0.8 volts) at a DMM/DVM. Do one of
    the following:

NOTE   *The typical values shown are valid for boards with TTL compatible out-*
               puts. For boards with relay outputs (REL-16, PDISO-8, and PIO-32) the
               output will be a relay contact closure. For boards with open collector
               outputs (PIO-HV) use a pull up resistor to an appropriate voltage to
               detect output state. Refer to the hardware description in this user's
               guide for more details on the output's electrical specification.

- If the bit patterns set on the **AIO Panel** do not agree with the logic levels measured at the I/O terminals, the board is not functioning properly. Stop here, and determine why.
- If the bit patterns set on the **AIO Panel** agree with the logic levels measured at the I/O terminals, then repeat steps 9, 10, and 11 for remaining output channels.

13. In the **Digital Output Panel** under **Channels**, click on the output channel to test (channel **0** in this example) as shown in Figure 2-19.

Figure 2-19
Configuring channel 0 for output bit pattern B
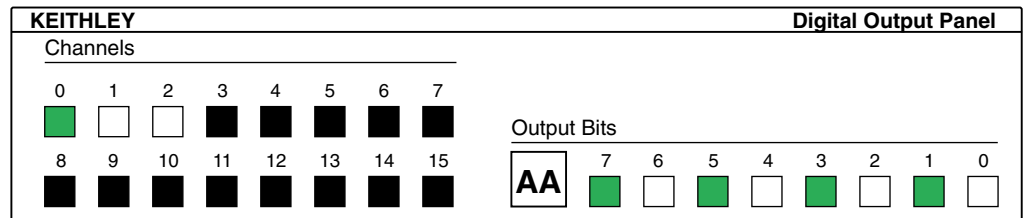
14. In the **Digital Output Panel** under **Output Bits**, set the bits of channel **0** for bit pattern B as shown in Figure 2-19.

15. Measure the voltage between signal ground and each bit of the output port with a DMM or DVM. Make measurements at the STA-50 terminals or the cabled mating connector that is connected to the selected CONN-3160-D1 50-pin connector.

16. Again, each bit set to ON in the **AIO Panel** should output a logic-high signal at the corresponding I/O terminal, reading typically about 4 volts (minimum of 2.2 volts) at a DMM/DVM. Each bit set to OFF in the **AIO Panel** should output a logic-low signal at the corresponding I/O terminal, reading typically about 0 volts (maximum of 0.8 volts) at a DMM/DVM.

NOTE   *The typical values shown are valid for boards with TTL compatible out-*
               puts. For boards with relay outputs (REL-16, PDISO-8, and PIO-32) the
               output will be a relay contact closure. For boards with open collector
               outputs (PIO-HV) use a pull up resistor to an appropriate voltage to
               detect output state. Refer to the hardware description in this user's
               guide for more details on the output's electrical specification.

- If the bit patterns set on the **AIO Panel** do not agree with the logic levels measured at the I/O terminals, the board is not functioning properly. Stop here, and determine why.
- If the bit patterns set on the **AIO Panel** do agree with the logic levels measured at the I/O terminals, and you have performed an output set test for all ports, the board is functioning properly.

17. Repeat steps 13, 14, and 15 for additional output channels.

Input read test

A similar test of input circuitry can be performed by applying an input signal of suitable type to each input line and verifying that the appropriate input indicator changes state. Refer to the hardware description in this user's guide for more details on the input's electrical specifications.

Connecting the board to your external circuits

After the software and board are installed, configured, and checked, you are ready to connect the board to your external circuits. Do the following:

1. Turn off the power to your computer.
2. Review the pin assignments for each I/O connector on your board, as discussed in the next section.
3. Connect the cables to your external system using appropriate accessories, which are discussed under "Connecting I/O cables and interface accessories."
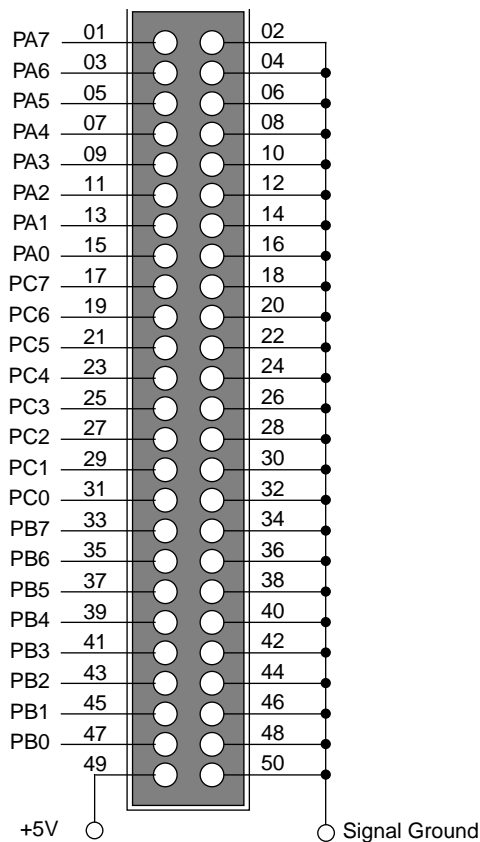
Identifying I/O connector pin assignments for the PIO-96J

All connections to the PIO-96J are made through four identical 50-pin I/O connectors located along the board. The pin assignments for each of these connectors are shown in Figure 2-20 (a top view of the pins).

Each of these connectors interfaces with accessories and external circuits via 50-conductor cables, as discussed earlier in this manual under "Installing the needed interface cables." The pin assignments in Figure 2-20 also apply to the connectors on these cables.

Figure 2-20
Board I/O connector pinout

PA7	01	02
PA6	03	04
PA5	05	06
PA4	07	08
PA3	09	10
PA2	11	12
PA1	13	14
PA0	15	16
PC7	17	18
PC6	19	20
PC5	21	22
PC4	23	24
PC3	25	26
PC2	27	28
PC1	29	30
PC0	31	32
PB7	33	34
PB6	35	36
PB5	37	38
PB4	39	40
PB3	41	42
PB2	43	44
PB1	45	46
PB0	47	48
	49	50

+5V   Signal Ground

Mating connector is part number 3M 3425-6050

Connecting I/O cables and interface accessories

CAUTION   **If a cable is connected to the board, make sure power to both the board and all external circuits is turned OFF before connecting this cable to the external circuits. Making connections while the board and/or the external circuit is powered can damage the board, the external circuit, or both.**

Using cables and accessories is illustrated in Figure 2-21. Each item is described in Table 2-1. For more information about these products, refer to your Keithley data acquisition or full line catalog or consult your Keithley dealer.
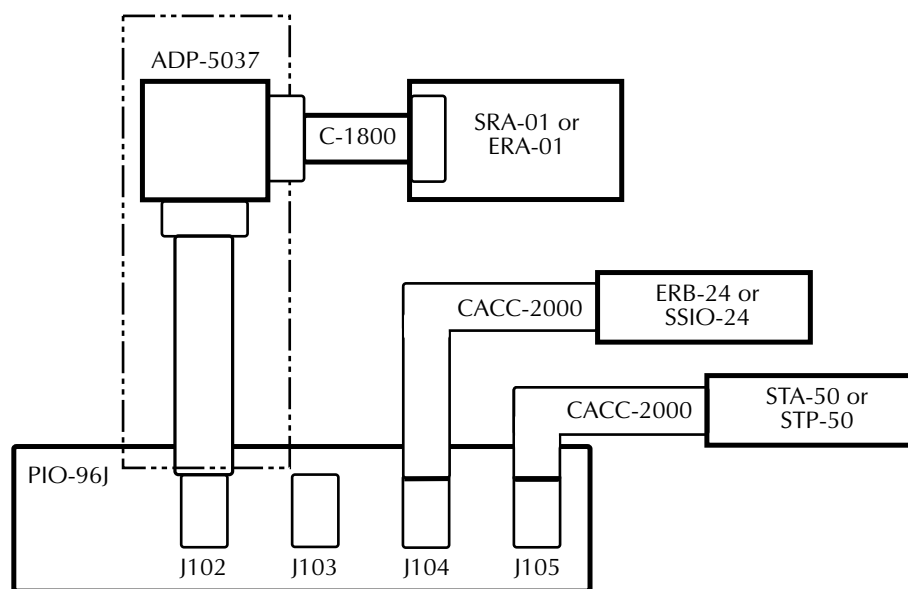
Figure 2-21
Using cables and accessories

Table 2-1
Description of manufactured cables and accessories

Cable/accessory	Description
ADP-5037	PIO-96 to 37-pin conversion cable.
CACC-2000	Cable, 24 in., PIO-96J to STA-50, STP-50, ERB-24, or SSIO-24.
ERA-01	8-channel SPDT relay output assembly. Requires C1800 and ADP-5037 cables.
ERB-24	24-channel DPDT relay output board. Requires CACC-2000 cable.
SRA-01	8-channel solid state I/O module accessory. Requires C1800 and ADP-5037 cables.
SSIO-24	24-channel solid state I/O module board. Requires CACC-2000 cable.
STA-50	Universal 50-pin screw terminal board. Requires CACC-2000 cable.
STP-50	Screw terminal panel with 50-pin male header. Requires CACC-2000 cable.

3
Programming

You do not program the registers of your PIO-96J board directly through Windows 95/98/NT. Instead, you program register changes through the application programming interface (API) of DriverLINX. DriverLINX is provided on the CD-ROM that comes with your board and should now be installed on your system. (Refer to Section 2.) Using DriverLINX, you can program the board in Visual C/C++, Visual Basic, and Delphi.

DriverLINX features are summarized in Section 1. For detailed information about DriverLINX in general and about programming with DriverLINX specifically, refer to your DriverLINX documentation.

To access the DriverLINX documents on-line, Acrobat Reader (version 3.0 or greater) must be installed on your computer.

To access the DriverLINX documentation after you have installed it on your computer, do the following:

1. Click the Windows 95/98/NT **Start** tab.
2. In the **Start** menu, click **Programs**.
3. Find the **DriverLINX** folder, under which you should find the **On-line Manuals** entry.
4. Click on the **On-line Manuals** entry. The DriverLINX Printable Documentation table of contents opens via Acrobat reader.
5. Scroll through the DriverLINX Printable Documentation table of contents and find the document or document category that you want.
6. Click on the wanted document or document category. Either the selected document appears or a list of documents that fit the selected category appears.
7. If a list appears, click on the title of the document that you want. The desired document appears.

To access the DriverLINX documentation from the CD-ROM that came with your board, do the following:

1. In Windows Explorer, double click on **X:\Drvlinx4\Docs\Toc.pdf,** where **X** is the drive letter of your CD-ROM drive. The DriverLINX Printable Documentation table of contents opens via Acrobat reader.
2. Scroll through the DriverLINX Printable Documentation table of contents and find the document or document category that you want.
3. Click on the wanted document or document category. Either the selected document appears or a list of documents that fit the selected category appears.
4. If a list appears, click on the title of the document that you want. The desired document appears.

4
Applications

Monitoring contact closure at an input

An onboard 10 kΩ pull-up resistor (RN1 – RN12), which can be connected between each channel and the +5V, prevents a floating input when a contact is open and gives CMOS compatibility for TTL signals. (This customer-installed resistor, part number 09698, can be ordered from Keithley). Figure 4-1 shows how this resistor makes an input of a PIO-96J board an effective circuit for monitoring contact closure. See Figure 4-1 for resistor connections.

Figure 4-1
Contact-closure monitoring at an input of a PIO-96J board
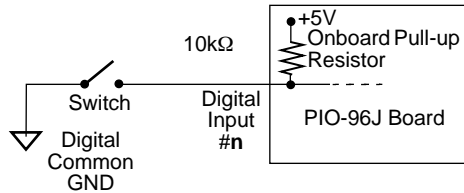
Table 4-1
Resistor network connections

Connector	Resistor network	Input connection
J1	RN10	PA0 - PA7
	RN11	PC0 - PC7
	RN12	PB0 - PB7
J2	RN7	PA0 - PA7
	RN8	PC0 - PC7
	RN9	PB0 - PB7
J3	RN4	PA0 - PA7
	RN5	PC0 - PC7
	RN6	PB0 - PB7
J4	RN1	PA0 - PA7
	RN2	PC0 - PC7
	RN3	PB0 - PB7

Eliminating contact bounce

While you can eliminate contact bounce through your application program, you can also insert a de-bounce circuit between the contacts and the input of your PIO-96J board. Figure 4-2 shows a typical de-bounce circuit.

Figure 4-2
**De-bounce circuit for an input of a PIO-96J board**
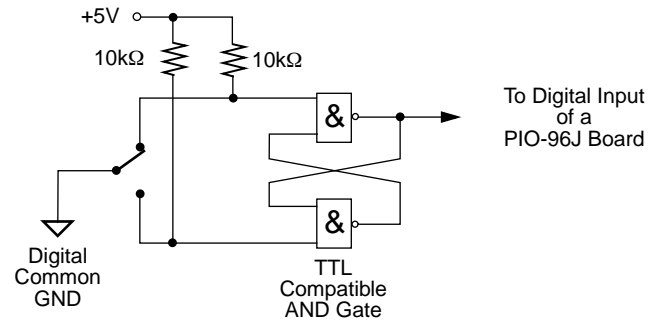
Boosting relay drive current

PIO-96J boards can drive relays other than the standard solid-state relays. The maximum output current for each channel of a PIO-96J board is 24mA at 5V. If your relay requires more than 24mA or more than 5V, you can boost the drive current and/or voltage for relay control using the circuit shown in Figure 4-3.

Figure 4-3
NPN transistor relay control for an output of a PIO-96J board
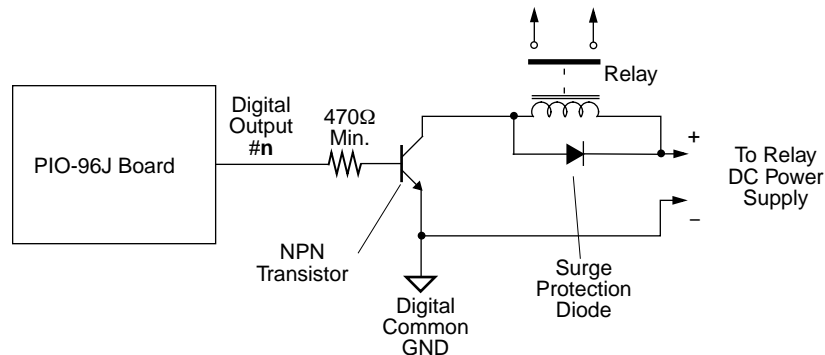
For drive-current requirements between 15mA and 100mA, select an NPN transistor with appropriate current capacity. The power transistor must be rated for the required supply voltage and must have a collector current rating no higher than 0.5A. If higher current is needed, substitute a Darlington NPN transistor.

5
Troubleshooting

Introduction

If your PIO-96J board is not operating properly, use the information in this section to isolate the problem before calling Technical Support. If the problem appears serious enough to warrant technical support, refer to "Technical Support" for information on how to contact an applications engineer.

Identifying symptoms and possible causes

Use the troubleshooting information in Table 5-1 to try to isolate the problem. Table 5-1 lists general symptoms and possible solutions for problems with the PIO-96J board.

Table 5-1
Troubleshooting information

Symptom	Possible cause	Possible solution
Board does not respond	DriverLINX is not installed correctly or the combined DriverLINX/board installation is not properly configured.	Reinstall and/or reconfigure DriverLINX if necessary. Refer to "Installing the DriverLINX software and documentation" in Section 2 and to "Configuring the PIO Series" in the manual *Using DriverLINX With Your Hardware—Keithley PIO Series.*
	Base address is incorrect or not consistent with what the program is addressing.	Check the base address switch setting on the board against the setting shown in the configuration utility. If the base address is set correctly, make sure no other computer device is using any of the I/O locations beginning at the specified base address. If necessary, reconfigure the base address.
	The board configuration is incorrect.	Check the remaining settings in the configuration file.
	The board is incorrectly aligned in the accessory slot.	Check the board for proper seating.
	The board is damaged.	Contact Technical Support.
Intermittent operation	The most common cause of this problem is that the I/O bus speed is in excess of 8MHz.	Reduce I/O bus speed to a maximum of 8MHz (to change the I/O bus speed, run BIOS setup). See your computer documentation for instructions on running BIOS setup.
	Vibrations or loose connections exist.	Cushion source of vibration and tighten connections.
	The board is overheating.	Check environmental and ambient temperature. See your computer documentation.
	Electrical noise exists.	Provide better shielding or reroute unshielded wiring.

Table 5-1 (cont.)
Troubleshooting information

Symptom	Possible cause	Possible solution
Data appears to be invalid	The most common cause of this problem is that the I/O bus speed is in excess of 8MHz.	Reduce I/O bus speed to a maximum of 8MHz (to change the I/O bus speed, run BIOS setup). See your computer documentation for instructions on running BIOS setup.
	An open connection exists.	Check wiring to screw terminal.
	Another system resource is using the specified base address.	Reconfigure the base address of the PIO-96J board. Check the I/O assignments of other system resources and reconfigure, if necessary.
	Transducer is not connected to channel being read.	Check the transducer connections.
Computer does not boot	Board not seated properly.	Check the installation of the board.
	The base address setting of the PIO-96J board conflicts with that of another system resource.	Check the base address settings of your system resources; each address must be unique.
	The power supply of the host computer is too small to handle all the system resources.	Check the needs of all system resources and obtain a larger power supply.
System lockup	A timing error occurred.	Restart your computer.

If your board is not operating properly after using the information in Table 5-1, continue with the following paragraphs to further isolate the problem.

Getting error information from DriverLINX

The two DriverLINX error reporting features summarized below may be helpful in identifying problem causes. Refer to your DriverLINX documentation for more information.

DriverLINX Event Viewer

The DriverLINX Event Viewer displays the Windows system event log. Applications and hardware drivers make entries in the system event log to assist in predicting and troubleshooting hardware and software problems.

DriverLINX uses the event log to report problems during driver loading or unexpected system errors. The event log can assist in troubleshooting resource conflicts and DriverLINX configuration errors. If you are having trouble configuring or initializing a Logical Device, check the event log for information from the DriverLINX driver.

Using the DriverLINX Event Viewer, you can view, save and e-mail DriverLINX event log entries under Windows 95/98 or Windows NT. DriverLINX event log entries can help you or technical support troubleshoot data-acquisition hardware and software problems.

Device initialization error messages

During device initialization, DriverLINX performs a thorough test of all possible subsystems on PIO-96J boards as well as the computer interface. If DriverLINX detects any problems or unexpected responses, it reports an error message to help isolate the problem. The device initialization error messages fall into three basic categories:

- **Device not found** — Board address does not match hardware setting or conflicts with another board. Verify the board's address settings. Also, do not confuse hexadecimal with decimal addresses in the DriverLINX Device Configure dialog box.

- **Invalid IRQ level or Invalid DMA level** — Selected level does not match hardware setting, conflicts with another board's IRQ/DMA levels, or is dedicated to the computer's internal functions (COM port, disk drive controller, network adapter, etc.)

- **Hardware does not match configuration** — Operating mode/range switch or jumper setting does not match selection(s) made in the DriverLINX Device Configuration dialog box.

Testing the board and host computer

To isolate the problem to the PIO-96J board or to the host computer, use the following steps.

CAUTION   **Removing a board with the power ON can cause damage to your board and/or computer.**

1. Turn the power to the host computer OFF, and remove power connections to the computer.
2. While keeping connections to accessories intact, unplug the cable to the main I/O connector of the PIO-96J board.
3. Remove the board from the computer and visually check for damage. If a board is obviously damaged, refer to "Technical support" for information on returning the board.
4. With the PIO-96J board out of the computer, check the computer for proper operation. Power up the computer and perform any necessary diagnostics.

At this point, if you have another PIO-96J board that you know is functional, you can test the slot and I/O connections using the instructions in the next section. If you do not have another board, call technical support.

Testing the accessory slot and I/O connections

When you are sure that the computer is operating properly, test the computer accessory slot and I/O connections using another PIO-96J board that you know is functional. To test the computer accessory slot and the I/O connections, follow these steps:

1. Remove computer power again, and install a PIO-96J board that you know is functional. Do not make any I/O connections.

2. Turn computer power ON and check operation with the functional board in place. This test checks the computer accessory slot. If you were using more than one board when the problem occurred, use the functional board to also test the other slot.

3. If the accessory slots are functional, use the functional board to check the I/O connections. Reconnect and check the operation of the I/O connections, one at a time.

4. If operation fails for an I/O connection, check the individual inputs one at a time for shorts and opens.

5. If operation remains normal to this point, the problem is in the PIO-96J board(s) originally in the computer. If you were using more than one board, try each board one at a time in the computer to determine which is faulty.

6. If you cannot isolate the problem, refer to the following paragraph for information on obtaining technical support.

Technical support

Before returning any equipment for repair, call Keithley for technical support at:

1-800-348-3735
Monday - Friday, 8:00 a.m. - 5:00 p.m., Eastern Time

An applications engineer will help you diagnose and resolve your problem over the telephone.

Please make sure you have the following information available before calling the factory for technical support:

PIO-96J Board	Model	_____
Configuration	Serial #	_____
	Revision code	_____
	Base address setting	_____
	Interrupt level setting	_____
	Number of channels	_____
Computer	Manufacturer	_____
	CPU type	_____
	Clock speed (MHz)	_____
	KB of RAM	_____
	Video system	_____
	BIOS type	_____
Operating System	DOS version	_____
	Windows version	_____
	Windows mode	_____
Software Package	Name	_____
	Serial #	_____
	Version	_____
	Invoice/Order #	_____
Compiler	Language	_____
(if applicable)	Manufacturer	_____
	Version	_____
Accessories	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____

When returning equipment for repair, include the following information:

- Your name, address, and telephone number.
- The P.O. number and date of equipment purchase.
- Model and serial number of the product.
- A description of the problem or its symptoms.
- The RMA number on the **outside** of the package.

Repackage the equipment, using the original anti-static wrapping, if possible, and handle it with ground protection. Ship the equipment to:

> **ATTN: RMA #_____**
> **Repair Department**
> **Keithley Instruments, Inc.**
> **28775 Aurora Road**
> **Cleveland, Ohio 44139**
>
> **Telephone 1-888-KEITHLEY**
> **FAX (440) 248-6168**

NOTE   *If you are submitting your equipment for repair under warranty, you must include the invoice number and date of purchase.*

                  To enable Keithley to respond as quickly as possible, you must include the RMA number on the outside of the package.

A
Specifications

Specifications for PIO-96J boards are listed in the following tables.

Table A-1
Digital input/output specifications

Feature	Value
Number of channels	96, bidirectional
I/O interface	One 8255A Mode 0 emulation circuit for each group of 24 channels
I/O signal	LS-TTL, non-isolation
Pull-up resistors (customer supplied)	10kΩ, one per channel (RN1 – RN12)

Table A-2
Input parameter specifications

Feature	Value
V_{IH}	2V minimum
V_{IL}	0.8V maximum
I_{IH}	20μA maximum at $V_I = 2.7V$
I_{IL}	−0.2mA maximum at $V_I = 0.4V$

Table A-3
Output parameter specifications

Feature	Value
V_{OH}	2.4V minimum at $I_{OH} = -3mA$
V_{OL}	0.4V maximum at $I_{OL} = 12mA$
I_{OH}	−15mA maximum
I_{OL}	24mA maximum

Table A-4
General specifications

Feature	Value
Base I/O address range	Any 16-bit boundary
Base I/O address	DIP switch selectable; default is 300h
External connections	One 50-pin connector for each 24-channel group
Operating temperature	32˚ to 122˚F (0˚ to 50˚C)
Storage temperature	32˚ to 158˚F (0˚ to 70˚C)
Relative humidity	20 to 90%, noncondensing
Power consumption	+5VDC, 1.6A typical
+5V line from all I/O connectors	1A maximum
Physical dimensions	9 × 4.2 × 0.75 inches (229 × 107 × 19mm)

Specifications are subject to change without notice.

B

I/O Address Map

The PIO-96J uses 16 locations in I/O address space (see Table B-1). Note that the PIO-96J requires a full block of 16 I/O addresses. For correct operation, no other adapter can conflict with any I/O address within this range (even if the upper ports will not be used).

Table B-1
I/O address locations

Location		Function	Type
Bits 0-23			
Base Address	+0	J1 PA Port	Read/Write
	+1	J1 PB Port	Read/Write
	+2	J1 PC Port	Read/Write
	+3	J1 Control	Write Only
Bits 24-47			
Base Address	+4	J2 PA Port	Read/Write
	+5	J2 PB Port	Read/Write
	+6	J2 PC Port	Read/Write
	+7	J2 Control	Write Only
Bits 48-71			
Base Address	+8	J3 PA Port	Read/Write
	+9	J3 PB Port	Read/Write
	+10	J3 PC Port	Read/Write
	+11	J3 Control	Write Only
Bits 72-95			
Base Address	+12	J4 PA Port	Read/Write
	+13	J4 PB Port	Read/Write
	+14	J4 PC Port	Read/Write
	+15	J4 Control	Write Only

The 24 digital I/O channels of a group include three 8-channel ports, as follows: Port A, Port B, and Port C. Table B-2 shows the I/O addressing of these ports.

Table B-2
I/O address map for a PIO-96J

Base I/O Address	Write	Read
+0h	J1-Port A	J1-Port A
+1h	J1-Port B	J1-Port B
+2h	J1-Port C	J1-Port C
+3h	J1-Control Word	—
+4h	J2-Port A	J2-Port A
+5h	J2-Port B	J2-Port B
+6h	J3-Port C	J2-Port C
+7h	J2-Control Word	—
+8h	J3-Port A	J3-Port A
+9h	J3-Port B	J3-Port B
+Ah	J3-Port C	J3-Port C
+Bh	J3-Control Word	—
+Ch	J4-Port A	J4-Port A
+Dh	J4-Port B	J4-Port B
+Eh	J4-Port C	J4-Port C
+Fh	J4-Control Word	—

Note that in Table B-2, each group of ports has its own Control Word. The Control Word for a particular group determines whether each port in that group is functioning as an input or an output. Control Words are described in the following paragraphs.

Control word register

Before using your board, you must set the Control Word for each group to configure the ports as inputs or outputs. The Control Word for each group is contained in an 8-bit, write-only, Control Word register for that group. Table B-3 shows the bit assignments of a Control Word register.

Table B-3
Bit assignments for a control word register

Bit #	Value
7	1
6	0
5	0
4	Port A: 1 = input; 0 = output
3	Port C (upper four bits): 1 = input; 0 = output
2	0
1	Port B: 1 = input; 0 = output
0	Port C (lower four bits): 1 = input; 0 = output

Note that you can set Port A, Port B, and the upper and lower four bits of Port C independently. As an example, the following register bits show a Control Word of 93h. This Control Word sets Ports A, B, and C-Lower as inputs while setting Port C-Upper as an output.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	0	1	0	0	1	1

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Specifications are subject to change without notice.

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