

PCI-1784U

**4-Axis Quadrature Encoder
& Counter Card**

User Manual

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If you think you have a defective product, follow these steps:

1. Collect all the information about the problem encountered. (For example, CPU speed, Advantech products used, other hardware and software used, etc.) Note anything abnormal and list any onscreen messages you get when the problem occurs.
2. Call your dealer and describe the problem. Please have your manual, product, and any helpful information readily available.
3. If your product is diagnosed as defective, obtain an RMA (return merchandise authorization) number from your dealer. This allows us to process your return more quickly.
4. Carefully pack the defective product, a fully-completed Repair and Replacement Order Card and a photocopy proof of purchase date (such as your sales receipt) in a shippable container. A product returned without proof of the purchase date is not eligible for warranty service.
5. Write the RMA number visibly on the outside of the package and ship it prepaid to your dealer.

Declaration of Conformity

CE

This product has passed the CE test for environmental specifications when shielded cables are used for external wiring. We recommend the use of shielded cables. This kind of cable is available from Advantech. Please contact your local supplier for ordering information.

FCC Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Class B

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FM

The PCI-1784U has passed the FM certification. According to the National Fire Protection Association, work sites are classified into different classes, divisions and groups, based on hazard considerations. PCI-1784U is compliant with the specifications of Class I, Division 2, Groups A, B, C and D indoor hazards.

Technical Support and Assistance

- Step 1. Visit the Advantech web site where you can find the latest information about the product.
- Step 2. Contact your distributor, sales representative, or Advantech's customer service center for technical support if you need additional assistance. Please have the following information ready before you call:
 - Product name and serial number
 - Description of your peripheral attachments
 - Description of your software (operating system, version, application software, etc.)
 - A complete description of the problem
 - The exact wording of any error messages

Safety Instructions

1. Read these safety instructions carefully.
2. Keep this User's Manual for later reference.
3. Disconnect this equipment from any AC outlet before cleaning. Use a damp cloth. Do not use liquid or spray detergents for cleaning.
4. For plug-in equipment, the power outlet socket must be located near the equipment and must be easily accessible.
5. Keep this equipment away from humidity.
6. Put this equipment on a reliable surface during installation. Dropping it or letting it fall may cause damage.
7. The openings on the enclosure are for air convection. Protect the equipment from overheating. **DO NOT COVER THE OPENINGS.**
8. Make sure the voltage of the power source is correct before connecting the equipment to the power outlet.

9. Position the power cord so that people cannot step on it. Do not place anything over the power cord.
10. All cautions and warnings on the equipment should be noted.
11. If the equipment is not used for a long time, disconnect it from the power source to avoid damage by transient overvoltage.
12. Never pour any liquid into an opening. This may cause fire or electrical shock.
13. Never open the equipment. For safety reasons, the equipment should be opened only by qualified service personnel.
14. If one of the following situations arises, get the equipment checked by service personnel:
 - a. The power cord or plug is damaged.
 - b. Liquid has penetrated into the equipment.
 - c. The equipment has been exposed to moisture.
 - d. The equipment does not work well, or you cannot get it to work according to the user's manual.
 - e. The equipment has been dropped and damaged.
 - f. The equipment has obvious signs of breakage.
15. **DO NOT LEAVE THIS EQUIPMENT IN AN ENVIRONMENT WHERE THE STORAGE TEMPERATURE MAY GO BELOW -20° C (-4° F) OR ABOVE 60° C (140° F). THIS COULD DAMAGE THE EQUIPMENT. THE EQUIPMENT SHOULD BE IN A CONTROLLED ENVIRONMENT.**
16. **CAUTION: DANGER OF EXPLOSION IF BATTERY IS INCORRECTLY REPLACED. REPLACE ONLY WITH THE SAME OR EQUIVALENT TYPE RECOMMENDED BY THE MANUFACTURER, DISCARD USED BATTERIES ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS.**

The sound pressure level at the operator's position according to IEC 704-1:1982 is no more than 70 dB (A).

DISCLAIMER: This set of instructions is given according to IEC 704-1. Advantech disclaims all responsibility for the accuracy of any statements contained herein.

Safety Precaution - Static Electricity

Follow these simple precautions to protect yourself from harm and the products from damage.

1. To avoid electrical shock, always disconnect the power from your PC chassis before you work on it. Don't touch any components on the CPU card or other cards while the PC is on.
2. Disconnect power before making any configuration changes. The sudden rush of power as you connect a jumper or install a card may damage sensitive electronic components.

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Introduction

Sections include:

- Features
- Applications
- Installation Guide
- Software Overview
- Device Driver Programming
- Accessories

Chapter 1 Introduction

Thank you for buying the Advantech PCI-1784U. The PCI-1784U is a 4-axis quadrature encoder and counter card for PCI bus. This card includes four 32-bit quadruple AB phase encoder counters, 8-bit timer with multi range time-base selector, four isolated digital inputs, and four isolated digital outputs. Its flexible interrupt sources are suitable for motor control and position monitoring.

The following sections of this chapter will provide further information about features of the multifunction cards, a Quick Start for installation, together with some brief information on software and accessories for the PCI-1784U card.

1.1 Features

- Four 32-bit up/down counters
- Single-ended or differential inputs
- Pulse/direction and up/down counter
- x1, x2, x4 counts for each encoder cycle
- Optically isolated up to 2500 V_{DC}
- 4-stage digital filter with selectable sampling rate
- Onboard 8-bit timer with wide range time-based selector
- Multiple interrupt sources for precision application
- Four isolated digital inputs
- Four isolated digital outputs with flexible function
- Board ID

The PCI-1784U offers the following main features:

Encoder Interface

Each channel includes a decoding circuit for incremental quadrature encoding. Inputs accept either single-ended or differential signals. Quadrature input works with or without an index, allowing linear or rotary encoder feedback.

Counters

The PCI-1784U has four independent 32-bit counters. The maximum quadrature input rate is 2 MHz, and the maximum input rate in counter mode is 8 MHz. You can individually configure each counter for quadrature decoding, pulse/direction counting or up/down counting.

Digital Input and Interrupts

The PCI-1784U provides four digital input channels. Each channel accepts digital input as an index input for a rotary encoder or as a home sensor input for a linear encoder. The card can generate an interrupt to the system based on a signal from its digital inputs, overflow/underflow and over-compare/under-compare of its counters, or on a programmed time interval. It can repeatedly generate interrupts at any time interval you specify, from 20 microseconds to 51 seconds. These interrupts let you precisely monitor the speed of a control system.

Flexible Digital Output function

The PCI-1784U provides four digital output channels. Each channel accepts digital output as a normal TTL output for a rotary encoder or as an indicated output with pulse/level mode for a linear encoder. The PCI-1784U can generate an indicated output based on a signal from over-compare/under-compare of its counters. The pulse width of an indicated output depends on the counter clock or clear interrupt.

Special Shielded Cable for Noise Reduction

The PCL-10137H shielded cable is specially designed for the PCI-1784U for reducing noise. Its wires are all twisted-pair type with the input signals and output signals separately shielded, providing minimal cross talk between signals and the best possible protection against EMI/EMC problems.

Keeping the Counter Values & Output Status after System Reset

Users can independently use the four counter channels. When the system is hot reset (power not shut down), the PCI-1784U can either retain the last counter values and the output status, or return to its default configuration, depending on the jumper setting. This practical function eliminates dangers caused by improper operation during unexpected system reset.

Board ID

The PCI-1784U has a built-in DIP Switch that helps define each card's ID when multiple PCI-1784U cards have been installed on the same PC chassis. The board ID setting function is useful when users build their system with multiple PCI-1784U cards. With correct board ID settings, you can easily identify and access each card during hardware configuration and software programming.

Note: For detailed specifications of the PCI-1784U, please refer to Appendix A, Specifications.

1.2 Applications

- Motion control
- Position sensing, monitoring and measuring
- Coordinate measuring machines
- X-Y table monitors
- Robotics
- Machine control

1.3 Installation Guide

Before you install your PCI-1784U card, please make sure you have the following necessary components:

PCI-1784U DA&C card

PCI-1784U User's Manual

Driver software Advantech DLL drivers (In the CD-ROM)

Wiring cable PCL-10137H (option)

Wiring board ADAM-3937 (option)

Computer PC with PCI-bus slot (Windows 2000/XP)

Other optional components are also available for enhanced operation:

Application software ActiveDAQPro, GeniDAQ or 3rd party software

After you get the necessary components and maybe some of the accessories for enhanced operation of your Multifunction card, you can then begin the Installation procedures. Figure 1-1 on the next page provides a concise flow chart to give users a broad picture of the software and hardware installation procedures:

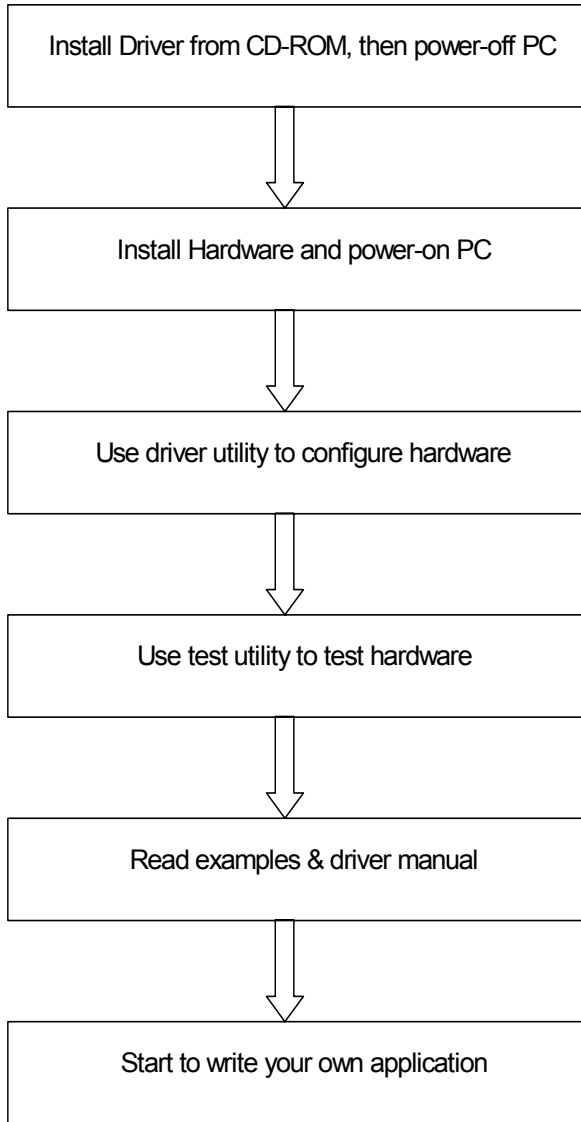


Figure 1.1: Installation Flow Chart

1.4 Software Overview

Advantech offers a rich set of DLL drivers, third-party driver support and application software to help fully exploit the functions of your PCI-1784U card:

- Device Drivers (on the companion CD-ROM)
- LabVIEW driver
- LabVIEWDAQ driver
- Advantech ActiveDAQPro
- Advantech GeniDAQ

Programming choices for DA&C cards: You may use Advantech application software such as Advantech Device Drivers. On the other hand, advanced users are allowed another option for register-level programming, although not recommended due to its laborious and time-consuming nature.

Device Drivers

The Advantech Device Drivers software is included on the companion CD-ROM at no extra charge. It also comes with all the Advantech DA&C cards. Advantech's device drivers feature a complete I/O function library to help boost your application performance. The Advantech Device Drivers for Windows 2000/XP works seamlessly with development tools such as Visual C++, Visual Basic, Inprise C++ Builder and Inprise Delphi.

Register-level Programming

Register-level programming is reserved for experienced programmers who find it necessary to write codes directly at the level of device registers. Since register-level programming requires much effort and time, we recommend that you use the Advantech Device Drivers instead. However, if register-level programming is indispensable, you should refer to the relevant information in *Appendix C, Register Structure and Format*, or to the example codes included on the companion CD-ROM.

1.5 Device Driver Programming

This section will provide you a roadmap to demonstrate how to build an application from scratch using Advantech Device Drivers with your favorite development tools such as Visual C++, Visual Basic, Delphi and C++ Builder. The step-by-step instructions on how to build your own applications using each development tool will be given in the *Device Drivers Manual*. Moreover, a rich set of example source codes is also given for your reference.

Programming Tools

Programmers can develop application programs with their favorite development tools:

- Visual C++
- Visual Basic
- Delphi
- C++ Builder

For instructions on how to begin programming works in each development tool, Advantech offers a *Tutorial Chapter* in the *Device Drivers Manual* for your reference. Please refer to the corresponding sections in this chapter on the *Device Drivers Manual* to begin your programming efforts. You can also look at the example source codes provided for each programming tool, since they can get you very well oriented.

The *Device Drivers Manual* can be found on the companion CD-ROM. Alternatively, if you have already installed the Device Drivers on your system, The *Device Drivers Manual* can be readily accessed through the **Start** button:

Start/Programs/Advantech Automation/Device Driver's Manual

The example source codes could be found under the corresponding installation folder such as the default installation path:

\\Program Files\\Advantech\\ADSAPI\\Examples

For information about using other function groups or other development tools, please refer to the *Creating Windows 2000/XP Application with Device Drivers* chapter and the *Function Overview* chapter on the *Device Drivers Manual*.

Programming with Device Drivers Function Library

Advantech Device Drivers offers a rich function library to be utilized in various application programs. This function library consists of numerous APIs that support many development tools, such as Visual C++, Visual Basic, Delphi and C++ Builder.

According to their specific functions or services, those APIs can be categorized into several function groups:

- Digital Input/Output Function Group
- Counter Function Group
- Port Function Group (direct I/O)
- Event Function Group

For the usage and parameters of each function, please refer to the *Function Overview* chapter in the *Device Drivers Manual*.

Troubleshooting Device Drivers Error

Driver functions will return a status code when they are called to perform a certain task for the application. When a function returns a code that is not zero, it means the function has failed to perform its designated function. To troubleshoot the Device Drivers error, you can pass the error code to **DRV_GetErrorMessage** function to return the error message, or you can refer to the *Device Drivers Error Codes* Appendix in the *Device Drivers Manual* for a detailed listing of the Error Code, Error ID and the Error Message.

1.6 Accessories

Advantech offers a complete set of accessory products to support the PCI-1784U card. These accessories include:

Wiring Cable

PCL-10137H The PCL-10137H shielded cable is specially designed for PCI-1784U cards to provide high resistance to noise. To achieve a better signal quality, the signal wires are twisted in such a way as to form a “twisted-pair cable,” reducing cross talk and noise from other signal sources. Furthermore, its analog and digital lines are separately sheathed and shielded to neutralize EMI/EMC problems.

Wiring Boards

ADAM-3937 The ADAM-3937 is a 37-pin D-type wiring terminal module for DIN-rail mounting. This terminal module can be readily connected to the Advantech PC-Lab cards and allow easy yet reliable access to individual pin connections for the PCI-1784U card.

Installation

Sections include:

- Unpacking
- Driver Installation
- Hardware Installation

Chapter 2 Installation

This chapter gives users an item checklist, proper instructions on unpacking, and step-by-step procedures for driver and card installation.

2.1 Unpacking

After receiving your PCI-1784U package, please inspect its contents first. The package should contain the following items:

- PCI-1784U card
- Companion CD-ROM (DLL driver included)
- User's Manual

The PCI-1784U card harbors certain electronic components vulnerable to *electrostatic discharge* (ESD). ESD could easily damage the integrated circuits and certain components if preventive measures are not carefully paid attention to.

Before removing the card from the antistatic plastic bag, you should take following precautions to ward off possible ESD damage:

- Touch the metal part of your computer chassis with your hand to discharge static electricity accumulated on your body. One can also use a grounding strap as well.
- Touch the anti-static bag to a metal part of your computer chassis before opening the bag.
- Take hold of the card only by the metal bracket when removing it out of the bag.

After taking out the card, first you should:

- Inspect the card for any possible signs of external damage (loose or damaged components, etc.). If the card is visibly damaged, please notify our service department or our local sales representative immediately. Avoid installing a damaged card into your system.

Also, pay extra caution to the following aspects to ensure proper installation:

✦ Avoid physical contact with materials that could hold static electricity such as plastic, vinyl and Styrofoam.

✦ Whenever you handle the card, grasp it only by its edges. DO NOT TOUCH the exposed metal pins of the connector or the electronic components.

Note: Keep the anti-static bag for future use. You might need the original bag to store the card if you have to remove the card from PC or transport it elsewhere.

2.2 Driver Installation

We recommend you to install the driver before you install the PCI-1784U card into your system, since this will guarantee a smooth installation process.

The Advantech Device Drivers Setup program for the PCI-1784U card is included on the companion CD-ROM that is shipped with your DA&C card package. Please follow the steps below to install the driver software:

Step 1: Insert the companion CD-ROM into your CD-ROM drive.

Step 2: The Setup program will be launched automatically if you have the autoplay function enabled on your system. When the Setup Program is launched, you'll see the following Setup Screen.

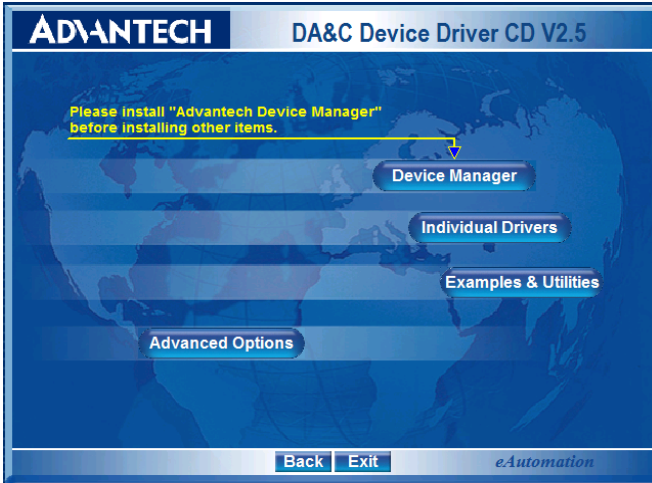
Note: If the autoplay function is not enabled on your computer, use Windows Explorer or Windows Run command to execute autorun.exe on the companion CD-ROM.



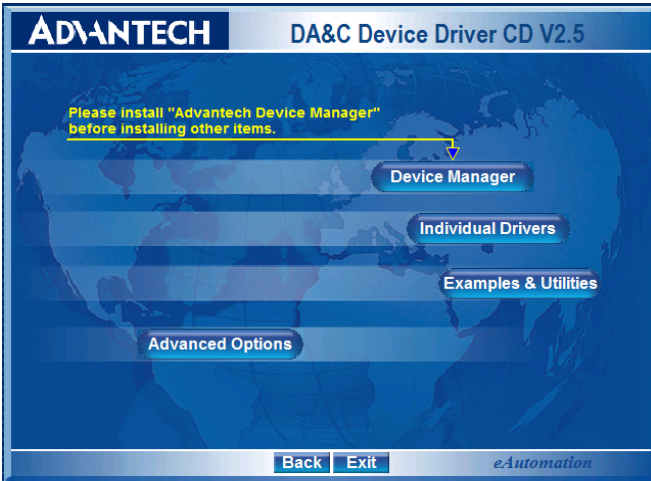
Step 3: Please click 'CONTINUE' to proceed to the next step.



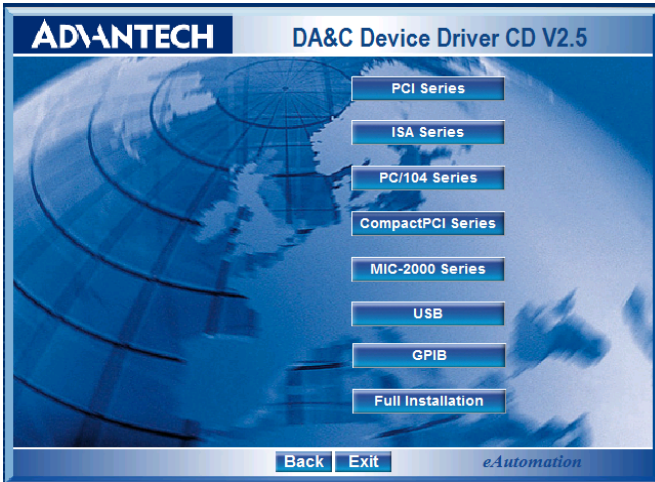
Step 4: Please select 'Installation' to proceed to the next step. A list of items will be shown on the screen: 'Device Manager', 'Individual Driver', 'Example & Utility', and 'Advance Options'.



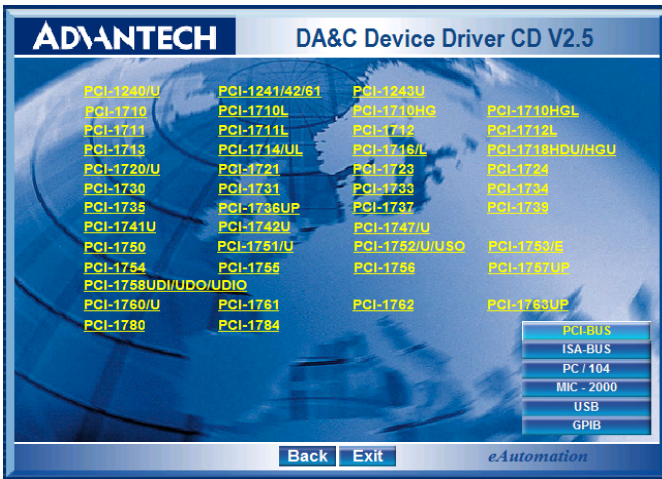
Step 5: Please install the ‘Device Manager’ first. For details on how to install the ‘Device Manager’ step by step, please see the software manual.



Step 6: When you’re finished installing the ‘Device manager’, you can install the driver of the corresponding card. Please click the ‘Individual Drivers’



Step 7: Select 'PCI Series'.



Step 8: Select 'PCI-1784' to install its driver. For more information about the software installation, please read the software manual.

2.3 Hardware Installation

Note: *Make sure you have installed the driver before you install the card (refer to 2.2 Driver Installation)*

After the DLL driver installation is completed, you can now go on to install the PCI-1784U card in any PCI slot on your computer. However, it is suggested that you should refer to the computer user manual or related documentation if you have any doubt. Please follow the steps below to install the card on your system.

Step 1: Turn off your computer and unplug the power cord and cables. TURN OFF your computer before installing or removing any components on the computer.

Step 2: Remove the cover of your computer.

Step 3: Remove the slot cover on the back panel of your computer.

Step 4: Touch the metal part on the surface of your computer to neutralize the static electricity that might be on your body.

Step 5: Insert the PCI-1784U card into a PCI slot. Hold the card by its edges and carefully align with the slot. Insert the card firmly into place. Use of excessive force must be avoided; the card might be damaged.

Step 6: Fasten the bracket of the PCI card on the back panel rail of the computer with screws.

Step 7: Connect appropriate accessories (37-pin cable, wiring terminals, etc. if necessary) to the PCI card.

Step 8: Replace the cover of your computer chassis. Re-connect the cables you removed in step 2.

Step 9: Plug in the power cord and turn on the computer.

Note: *In case you installed the card without installing the DLL driver first, Windows 2000/XP will recognize your card as an “unknown device” after rebooting, and will prompt you to provide the driver. You should ignore the prompting messages (just click the Cancel button) and set up the driver according to the steps described in 2.2 Driver Installation.*

After the PCI-1784U card is installed, you can verify whether it is properly installed on your system in the *Device Manager*:

The *device name* of the PCI-1784 should be listed on the *Device Manager* tab on the *System Property* Page.

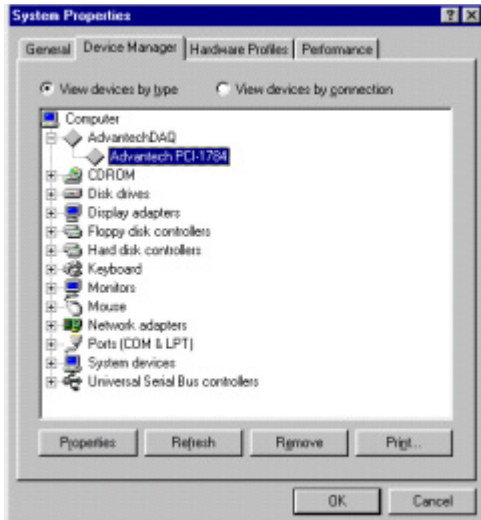


Figure 2.1: Device Name on the Device Manager

Note: *If your card is properly installed, you should see the device name of your card listed on the Device Manager tab. If it is marked with an exclamation sign “!”, your card has not been correctly installed. Select its device name and press the Remove button. Then go through the driver installation process again.*

After your card is properly installed on your system, you can now configure your device using the *Device Manager* program that has already been installed on your system during driver setup. A complete device installation procedure should include device setup, configuration and testing. After that, you can operate this card through the *operation*. The following sections will guide you through the *setup*, *configuration* and *testing* of your device.

2.4 Device Setup & Configuration

The *Device Manager* program is a utility that allows you to set up, configure and test your device, and later stores your settings on the system registry. These settings will be used when you call the APIs of *Advantech Device Drivers*.

Set up the Device (Windows 2000/XP only)

Step 1: Run the Device Installation program by accessing:
Start/ Programs/ Advantech Automation/ Device Manager/ Advantech Device Manager.

Step 2: The Advantech Device Manager will search for the device(s) already installed on your system (if any) automatically.

Step 3: The Installed Devices box will list the device(s) found on our system, such as the one in Figure 2.2.

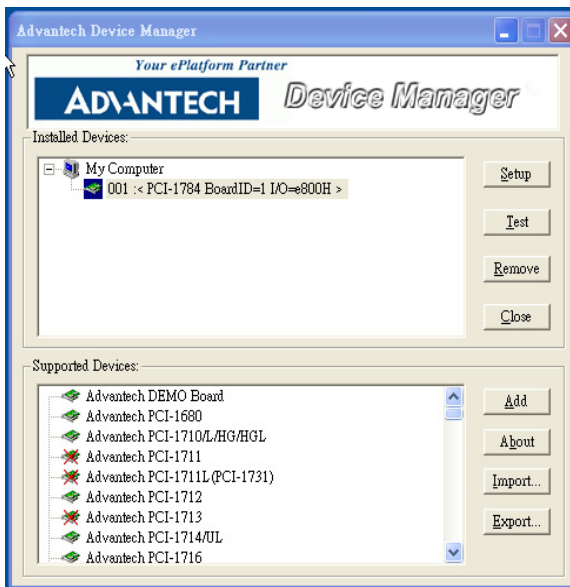
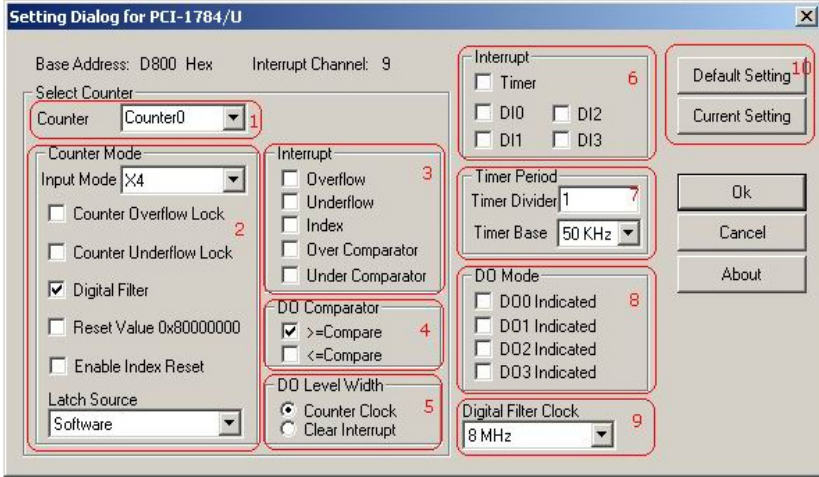


Figure 2.2: Device Manager Dialog Box

Device Configuration

PCI-1784/U device driver provides a device setting dialog box for user to set the driver default device property value and these values will be saved in the system. The device property will be referenced by the device driver functions.



Item 1: Select counter .

Item 2: Set counter input mode, overflow lock, underflow lock, digital filter, reset value and latch source.

Item 3: Set counter interrupt source.

Item 4: Set counter compare type.

Item 5: Set counter DO level width.

Item 6: Set counter interrupt source independent of counter channel.

Item 7: Set timer counter (count 4) timer divider and timer base clock.

Item 8: Set DO mode.

Item 9: Set digital filter clock.

Item 10: Default setting restore counter setting to default, Current Setting return the device current hardware settings.

Signal Connections

Sections include:

- Overview
- Switch & Jumper Settings
- Signal Connections

Chapter 3 Signal Connections

3.1 Overview

Maintaining signal connections is one of the most important factors in ensuring that your application system is sending and receiving data correctly. A good signal connection can avoid unnecessary and costly damage to your PC and other hardware devices. This chapter provides useful information about how to connect input and output signals to the PCI-1784U via the I/O connector.

3.2 Switch & Jumper Settings

The PCI-1784U card has one function switch and five jumper settings.

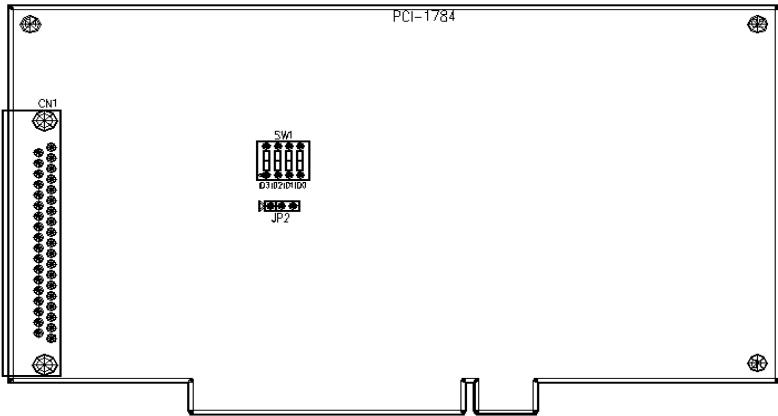




Figure 3.1: Card Connectors, Jumpers & Switches

Table 3.1: Summary of Jumper Settings

Name of Jumpers	Function Description
JP2	 Keep last status after hot reset
	 Default configuration

Resetting the Digital Outputs and Counter Value

Some users will want the capability of clearing each counter and the isolated digital output when the system (or PC) issues a reset signal on the PCI bus. Some users will want to clear their counter and digital output only as part of system power-on.

The PCI-1784U satisfies both these needs by providing jumper JP2. Depending on the application, this capability may allow the counter value and the isolated digital outputs to be "OFF" without requiring a complete shutdown of processes controlled by the card.

Complete loss of power to the chip clears the chip memory. Thus, no matter how JP2 is set, if the power to the PCI-1784U is disconnected, the counter value and the isolated digital output initial power-on state will be "OFF".

Board ID setting (SW1)

ID3	ID2	ID1	ID0	Board ID
1	1	1	1	0
1	1	1	0	1
1	1	0	1	2
1	1	0	0	3
1	0	1	1	4
1	0	1	0	5
1	0	0	1	6
1	0	0	0	7
0	1	1	1	8
0	1	1	0	9
0	1	0	1	10
0	1	0	0	11
0	0	1	1	12
0	0	1	0	13
0	0	0	1	14
0	0	0	0	15

Note: On: 1, Off: 0

3.3 Signal Connections

Pin Assignment

Figure 3.2 shows the pin assignments for the 37-pin I/O connector.

EGND	1	20	CH0A-
CH0A+	2	21	CH0B-
CH0B+	3	22	CH0Z-
CH0Z+	4	23	CH1A-
CH1A+	5	24	CH1B-
CH1B+	6	25	CH1Z-
CH1Z+	7	26	CH2A-
CH2A+	8	27	CH2B-
CH2B+	9	28	CH2Z-
CH2Z+	10	29	CH3A-
CH3A+	11	30	CH3B-
CH3B+	12	31	CH3Z-
CH3Z+	13	32	EGND
ID1 COM	14	33	ID1
ID10	15	34	ID3
ID12	16	35	EGND
EGND	17	36	IDO1
IDO0	18	37	IDO3
IDO2	19		

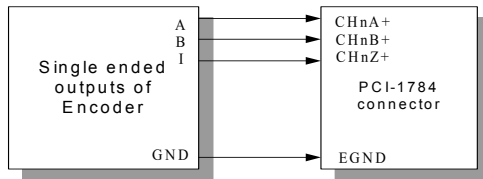
Figure 3.2: I/O Connector Pin Assignments

I/O Connector Signal Description

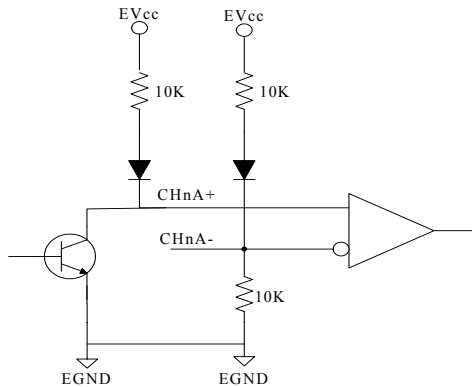
Table 3.2: I/O Connector Signal Descriptions

Signal Name	Reference	Direction	Description
EGND	-	-	External Ground.
CH<0..3>A+	EGND	Input	Channel <0..3> A differential positive-input.
CH<0..3>A-	EGND	Input	Channel <0..3> A differential negative-input.
CH<0..3>B+	EGND	Input	Channel <0..3> B differential positive-input.
CH<0..3>B-	EGND	Input	Channel <0..3> B differential negative-input.
CH<0..3>Z+	EGND	Input	Channel <0..3> Z differential positive-input.
CH<0..3>Z-	EGND	Input	Channel <0..3> Z differential negative-input.
IDI<0..3>	IDI COM	Input	Isolated Digital Input, Channels 0 through 3.
IDI COM	-	-	Common input of the Isolated Digital Input.
IDO<0..3>	EGND	Output	Isolated Digital Output, Channels 0 through 3.
EGND	-	-	External Ground.

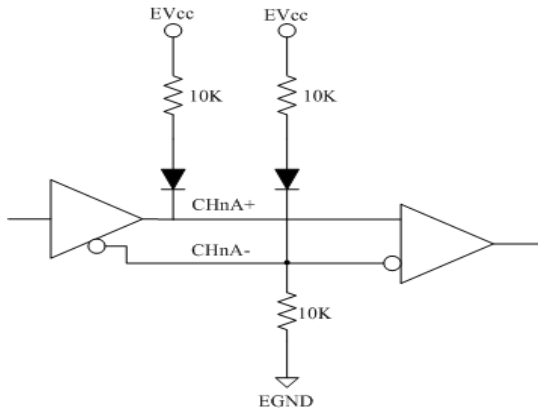
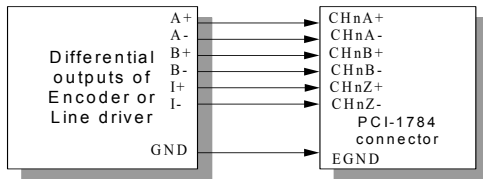
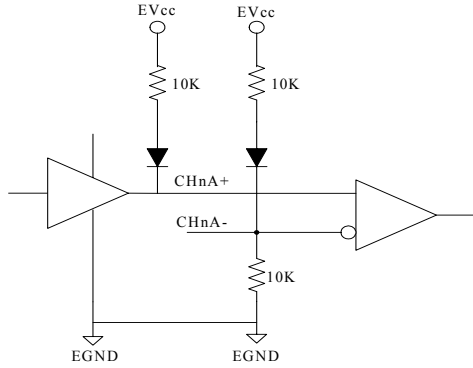
Quadrature Encoder Input



Open Collector



TTL



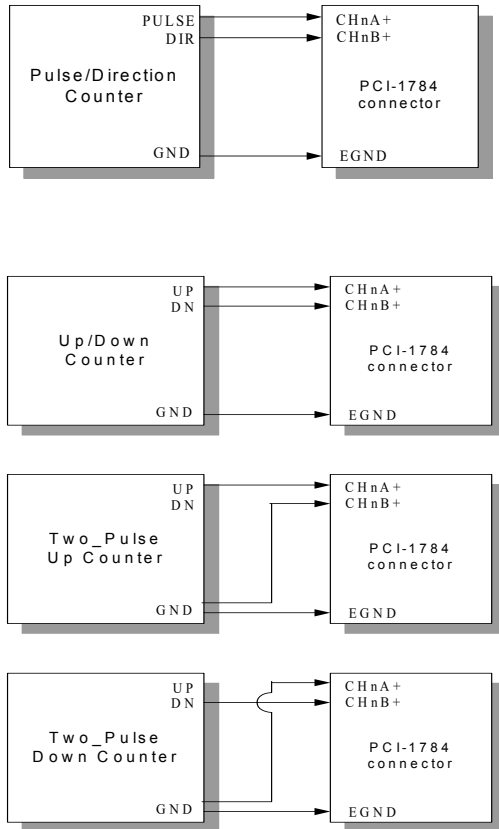


Figure 3.3: Quadrature Encoder (up/down) Input

Note: *In case you want to connect the Up/Down counter signal into the PCI-1784U, be sure that all the signals are connected. The floating connection will cause unexpected result.*

Isolated Digital Input

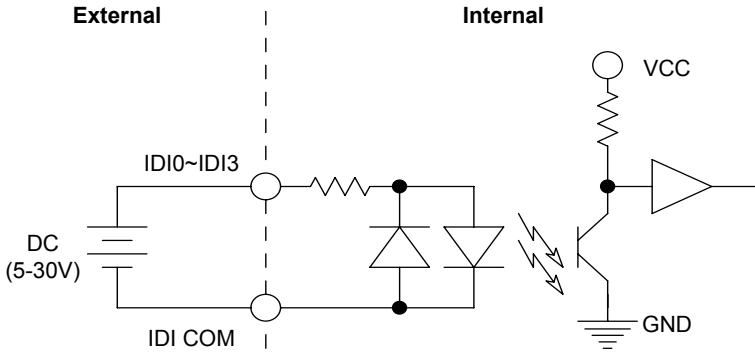


Figure 3.4: Isolated Digital Input Connections

Isolated Digital Output

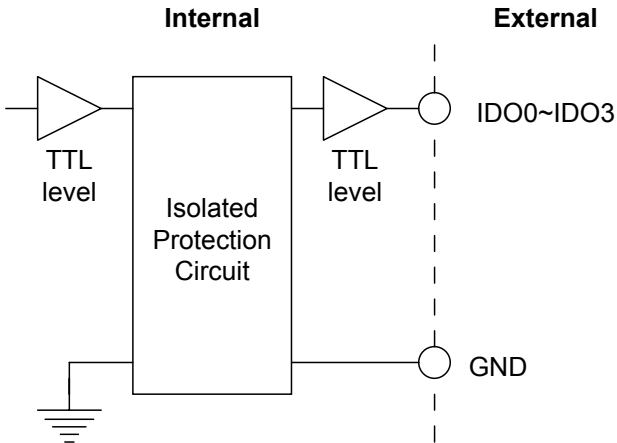


Figure 3.5: Isolated Digital Output Connections

APPENDIX
A

Specifications

Appendix A Specifications

Encoder Input

Axes	4 (independent)	
Resolution	32-bit	
Max. Quadrature Input Frequency	w/ Digital Filter	1.0 MHz
	w/o Digital Filter	2.0 MHz
Digital Filter	4 stage	
Drive Type	Single-ended or differential	
Counter Modes	Quadrature, Up/Down, Count/Direction	
Optical Isolation	2500 VDC	
Max. Input Pulse Frequency	x 1, x 2, x 4	
Sample Clock Frequency	8, 4, 2, or 1 MHz	
Input Voltage (Single Ended)	VIH (Max.)	12V
	VIH (Min.)	2.8V
	VIL (Max.)	0.8
Input Voltage (Differential Ended)	VIH	"CH+" - "CH-" > 0.2V
	VIL	"CH+" - "CH-" < -0.2V
	Max. Input Voltage	±12V

Timer

Resolution	8-bit
Time base	50 K, 5 K, 500, 50, 5 Hz

Isolated Digital Input

Channels	4	
Optical Isolation	2500 V _{DC}	
Opto-isolator response time	100µs	
Over-voltage Protect	70 V _{DC}	
Input Voltage	V _{IH} (max.)	30 V _{DC}
	V _{IH} (min.)	10 V _{DC}
	V _{IL} (max.)	3 V _{DC}
Input Current	10 V _{DC}	1.7 mA (typical)
	12 V _{DC}	2.1 mA (typical)
	24 V _{DC}	4.4 mA (typical)

Isolated Digital Output

Number of Channel	4
Optical Isolation	2500 V _{DC}
Response time	2µs
Supply Voltage	TTL level
Sink/Source Current	50 mA max./channel

Interrupt

Source	Counter overflow, Counter underflow, Index input, Compare, Timer, Digital input
---------------	---

Counter Latch

Source	Software, Timer, Index input, Digital input
---------------	---

General

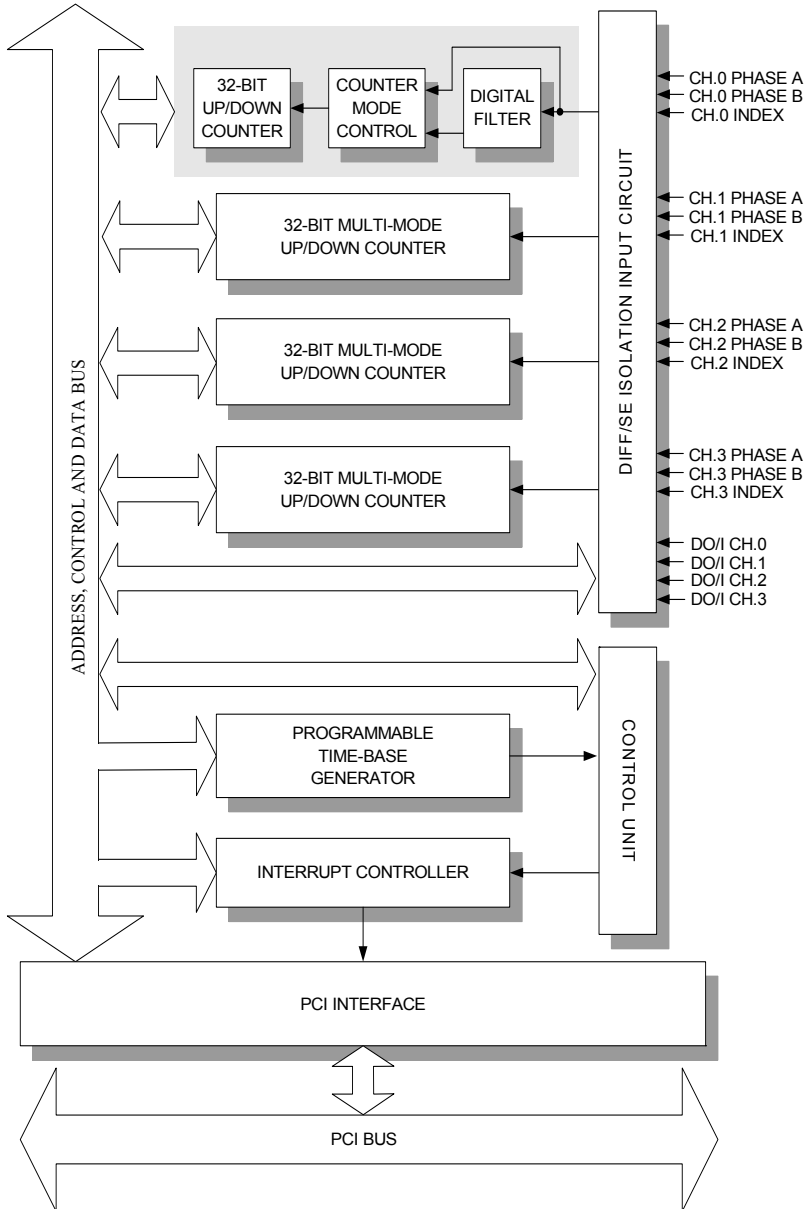
I/O Connector Type	37-pin D-sub female	
Dimensions	175 mm x 100 mm (6.9" x 3.9")	
Power Consumption	Typical	+5 V @ 200 mA
	Max.	+5 V @ 450 mA
Temperature	Operation	0~60°C (32~140°F) (refer to IEC 68-2-1,2)
	Storage	-20 ~ 70°C (-4 ~158°F)
Relative Humidity	5 ~ 95% RH non-condensing (refer to IEC 68-2-3)	
Certification	CE certified	

APPENDIX

B

Block Diagram

Appendix B Block Diagram



APPENDIX

C

Register Structure & Format

Appendix C Register Structure & Format

C.1 Overview

The PCI-1784U is delivered with an easy-to-use 32-bit DLL driver for user programming under the Windows 2000/XP operating systems. We advise users to program the PCI-1784U using the 32-bit DLL driver provided by Advantech to avoid the complexity of low-level programming by register.

The most important consideration in programming the PCI-1784U register levels is to understand the function of the card's registers. The information in the following sections is provided only for users who would like to do their own low-level programming.

C.2 I/O Port Address Map

The PCI-1784U requires 32 consecutive addresses in the PC's I/O space. The address of each register is specified as an offset from the card's base address. For example, BASE+0 is the card's base address and BASE+6 is the base address plus six bytes.

Table C-1 shows the function of each register of the PCI-1784U or driver and its address relative to the card's base address.

Table C.1: Register Format (Part 1)

Base Address + HEX		PCI-1784U Register Format															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
00H	W	Counter 0 Mode															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
	R	Counter 0 Latch Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
04H	W	Counter 1 Mode															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
	R	Counter 1 Latch Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
08H	W	Counter 2 Mode															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
	R	Counter 2 Latch Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
0CH	W	Counter 3 Mode															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
	R	Counter 3 Latch Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16

Table C.2: Register Format (Part 2)

Base Address + HEX		PCI-1784U Register Format															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
10H	W	Counter 0 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	Counter 0 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
14H	W	Counter 1 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	Counter 1 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
18H	W	Counter 2 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	Counter 2 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
1CH	W	Counter 3 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	Counter 3 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16

Table C.3: Register Format (Part 3)

PCI-1784U Register Format																
Base Address + HEX	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
20H W	Interrupt Control															
	DI3	DI2	DI1	DI0	IX3	IX2	IX1	IX0	UN3	UN2	UN1	UN0	OV3	OV2	OV1	OV0
	IE			TM					UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0
	R	Interrupt Status														
	DI3	DI2	DI1	DI0	IX3	IX2	IX1	IX0	UN3	UN2	UN1	UN0	OV3	OV2	OV1	OV0
	IF			TM					UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0
24H W	Clock Control															
															SC1	SC0
						TB2	TB1	TB0	DV7	DV6	DV5	DV4	DV3	DV2	DV1	DV0
	R	Clear Interrupt														
28H W	Software Latch															
													SL3	SL2	SL1	SL0
	R	Board ID														
													BD3	BD2	BD1	BD0
2CH W	Reset Counter															
													SR3	SR2	SR1	SR0
	R	N/A														
30H W	Digital Output															
													DO3	DO2	DO1	DO0
	DM3	DM2	DM1	DM0	LE3	LE2	LE1	LE0	UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0
	R	Digital Input/Output														
									DI3	DI2	DI1	DI0	DO3	DO2	DO1	DO0
	DM3	DM2	DM1	DM0	LE3	LE2	LE1	LE0	UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0

C.3 Counter 0/1/2/3 Mode - BASE+00/04/08/0CH

Table C.4: Register for Counter 0/1/2/3 Mode

Base Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
00H W	Counter 0 Mode															
	DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
04H W	Counter 1 Mode															
	DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
08H W	Counter 2 Mode															
	DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
0CH W	Counter 3 Mode															
	DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0

M2 ~ M0 Counter input mode control

- 000** Disable
- 001** Quadrature input x 1
- 010** Quadrature input x 2
- 011** Quadrature input x 4
- 100** 2 pulse input
- 101** 1 pulse input
- 110** N/A
- 111** N/A

RF Set counter reset value

- 0** 80000000h
- 1** 00000000h

OL Counter overflow lock control

- 0** Counter continues counting (wraps over) when counter overflow
- Counter locked when counter overflow

UL	Counter underflow lock control
0	Counter continues counting (wraps over) when counter underflow
1	Counter locked when counter underflow
DF	Digital Filter
0	Quadrature input frequency without digital filter
1	Quadrature input frequency with digital filter
SW	Software latch counter data
0	Disable software latch
1	Enable software latch
IX	Index latch counter data
0	Disable index latch
1	Enable index latch
TM	Timer latch counter data
0	Disable timer latch
1	Enable timer latch
DI0	DI0 latch counter data
0	Disable DI0 latch
1	Enable DI0 latch
DI1	DI1 latch counter data
0	Disable DI1 latch
1	Enable DI1 latch
DI2	DI2 latch counter data
0	Disable DI2 latch
1	Enable DI2 latch
DI3	DI3 latch counter data
0	Disable DI3 latch
1	Enable DI3 latch

C.4 Counter 0/1/2/3 Latch - BASE+00/04/08/0CH

Table C.5: Register for Counter 0/1/2/3 Latch Data

Base Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
00H R	Counter 0 Latch Data															
	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
04H R	Counter 1 Latch Data															
	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
08H R	Counter 2 Latch Data															
	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
0CH R	Counter 3 Latch Data															
	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16

D31 ~ D0 Counter latch data

C.5 Counter 0/1/2/3 Compare - BASE+10/14/18/1CH

Table C.6: Register for Counter 0/1/2/3 Compare Data

Base Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
10H	W	Counter 0 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	Counter 0 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
14H	W	Counter 1 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	Counter 1 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
18H	W	Counter 2 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	Counter 2 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
1CH	W	Counter 3 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	Counter 3 Compare Data															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16

D31 ~ D0 Counter compare data

C.6 Interrupt Control Register - BASE+20H

Table C.7: Register for Interrupt Control

Base Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
20H	W	Interrupt control															
		DI3	DI2	DI1	DI0	IX3	IX2	IX1	IX0	UN3	UN2	UN1	UN0	OV3	OV2	OV1	OV0
		IE			TM					UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0

OV_n Interrupt by overflow bit (*n*: 0 ~ 3)

0 Disable

1 Enable

UN_n Interrupt by underflow bit (*n*: 0 ~ 3)

0 Disable

1 Enable

IX_n Interrupt by index status bit (*n*: 0 ~ 3)

0 Disable

1 Enable

DI_n Interrupt by digital input bit (*n*: 0 ~ 3)

0 Disable

1 Enable

OC_n Interrupt by counter over compare bit (*n*: 0 ~ 3)

0 Disable

1 Enable

UC_n Interrupt by counter under compare bit (*n*: 0 ~ 3)

0 Disable

1 Enable

TM Interrupt by timer pulse bit

0 Disable

1 Enable

IE Overall interrupt enable bit

0 Disable

1 Enable

C.7 Interrupt Status Register - BASE+20H

Table C.8: Register for Interrupt Status

Base Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
20H	R	Interrupt status															
		DI3	DI2	DI1	DI0	IX3	IX2	IX1	IX0	UN3	UN2	UN1	UN0	OV3	OV2	OV1	OV0
		IF			TM					UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0

OV_n Counter overflow interrupt flag ($n: 0 \sim 3$)

0 Disable

1 Enable

UN_n Counter underflow interrupt flag ($n: 0 \sim 3$)

0 Disable

1 Enable

IX_n Index input interrupt flag ($n: 0 \sim 3$)

0 Disable

1 Enable

DI_n Digital input interrupt flag ($n: 0 \sim 3$)

0 Disable

1 Enable

OC_n Counter over compare interrupt by flag ($n: 0 \sim 3$)

0 Disable

1 Enable

UC_n Counter under compare interrupt flag ($n: 0 \sim 3$)

0 Disable

1 Enable

TM Timer pulse interrupt flag

0 Disable

1 Enable

IF Overall interrupt enable flag

0 Disable

1 Enable

C.8 Clear Interrupt - BASE+24H

Table C.9: Register for Clock Control

Base Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
24H	W	Clock Control															
																SC1	SC0
						TB2	TB1	TB0	DV7	DV6	DV5	DV4	DV3	DV2	DV1	DV0	

SC1 ~ SC0 Sampling clock select

00 8 MHz sampling clock

01 4 MHz sampling clock

10 2 MHz sampling clock

11 1 MHz sampling clock

DV7 ~ DV0 Timer divider control

TB2 ~ TB0 Timer time base select

000 50 KHz time base

001 5 KHz time base

010 500 Hz time base

011 50 Hz time base

100 5 Hz time base

101 N/A

110 N/A

111 N/A

C.11 Board ID — BASE+28H

The PCI-1784U offers Board ID register BASE+28H. With correct Board ID settings, user can easily identify and access each card during hardware configuration and software programming.

Table C.12: Board ID Data

Base Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
28H R	Board ID																
	0	0	0	0	0	0	0	0	0	0	0	0	0	BD3	BD2	BD1	BD0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BD3 ~ DB0 Board ID

BD0 LSB of the Board ID

BD3 MSB of the Board ID

BD3	BD2	BD1	BD0	Board ID
1	1	1	1	15
1	1	1	0	14
1	1	0	1	13
1	1	0	0	12
1	0	1	1	11
1	0	1	0	10
1	0	0	1	9
1	0	0	0	8
0	1	1	1	7
0	1	1	0	6
0	1	0	1	5
0	1	0	0	4
0	0	1	1	3
0	0	1	0	2
0	0	0	1	1
0	0	0	0	0

C.14 Digital Input/Output - BASE+30H

Table C.15: Register for Digital Input/Output

Base Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16		
30H	R	Digital Input/Output																
											DI3	DI2	DI1	DI0	DO3	DO2	DO1	DO0
		DM3	DM2	DM1	DM0	LE3	LE2	LE1	LE0	UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0	

DO3 ~ DO0 Digital output data

DI3 ~ DI0 Digital input data

OC n Digital output by over compare register (n : 0 ~ 3)

UC n Digital output by under compare register (n : 0 ~ 3)

LE n Digital output level control (n : 0 ~ 3)

0 Pulse with counter clock

1 Level with clear interrupt

DM n Digital output mode control (n : 0 ~ 3)

0 Normal

1 Indicated

APPENDIX **D**

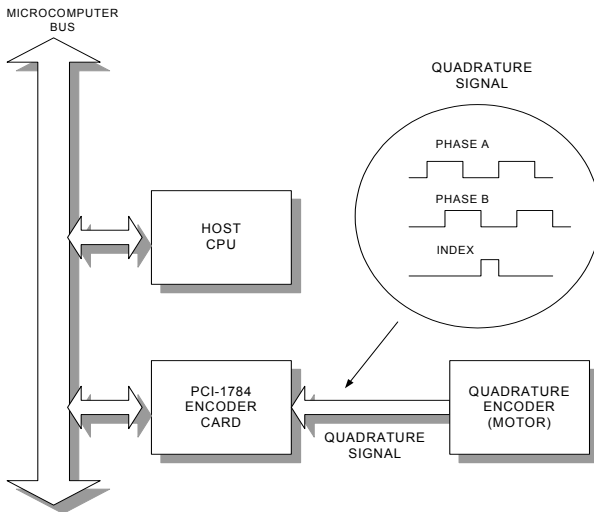
Operation

Appendix D Operation

D.1 Quadrature Encoder Introduction

In typical closed-loop control systems, also known as servo systems, the encoder interface senses motor position and sends a position signal to the controller. The diagram below shows a typical servo system.

The encoder generates pulses that indicate the shaft position. The encoder output includes two signals, commonly called channel A and channel B, which generate N pulses revolution. The two signals are shifted by a quarter of a cycle, as shown below. The shift between the two signals enables the controller to determine the direction of rotation, depending on whether channel A leads channel B or vice versa.



Single-ended vs. differential input

Most encoders produce square wave signals with TTL levels. Industrial systems often use encoders with differential signals, i.e. channel A and B and their complements. Differential signals can reduce sensitivity to noise and allow longer transmission distances. Encoders may also produce a third signal once per revolution known as the index or marker. The encoder interface can use the index signal to reset the counter, allowing you to monitor the position within the current revolution.

D.2 Counter Modes

The following table shows the maximum input rate for each input mode and system clock rate. Values are given for each system clock frequency.

Mode	Maximum input rate			
	8MHz	4MHz	2MHz	1MHz
Quadrature x1, x2, x4	2 MHz	1 MHz	500 KHz	250 KHz
2-pulse	8 MHz	4 MHz	2 MHz	1 MHz
Pulse/direction	8 MHz	4 MHz	2 MHz	1 MHz

Counter modes are as follows:

Quadrature Input Counter Mode

Quadrature input consists of two square wave inputs (A and B), which are 90° out of phase. The PCI-1784U counts square wave transitions and determines the direction by comparing whether channel A is leading channel B or vice versa.

There are three different counting methods in quadrature input mode:

- x1** The counter will increment (or decrement) the counter whenever a rising edge occurs on input channel A.
- x2** The counter will increment (or decrement) whenever a rising or falling edge occurs on input channel A.
- x4** The counter will increment (or decrement) whenever a rising or falling edge occurs on input channel A or B.

2-pulse Mode

In 2-pulse mode the PCI-1784U uses two input pulses as counting sources: one for clockwise (CW) and one for counterclockwise (CCW) counting. The counter will increment whenever a rising edge occurs on channel A. It will decrement whenever a rising edge occurs on channel B.

Pulse/Direction Mode

In pulse/direction mode the PCI-1784U uses one input line (A) for pulse input and one line (B) for direction. If channel B is high (1), the counter will decrement whenever a rising edge occurs in channel A. If channel B is low (0), the counter will increment whenever a rising edge occurs on channel A.

Disabled Mode

PCI-1784U will not accept input, but you can access all its registers.

You select the mode by programming the card's registers: BASE+00H for CH0, BASE+04H for CH1, BASE+08H for CH2 and BASE+0CH for CH3. See Appendix C for more information.

D.3 Digital Noise Filter

Noise immunity is the most important requirement for reliable encoder interface operation. The PCI-1784U conditions the input signal with a four stage digital filter. This filter reduces glitches (digital noise) or spikes by sampling the input at 1, 2, 4 or 8 MHz. The filter output waveforms change only when an input has the same value for four consecutive sampling edges. The filter thus rejects noise or pulses shorter than four sampling clock periods. You can optimize noise immunity by selecting the lowest sampling frequency that compatible with the highest input rate you expect.

The PCI-1784U accepts up to a 2 MHz quadrature frequency at 8 MHz filter sampling speed. At 2 MHz sampling speed it can still accept up to 500 KHz quadrature input frequency.

A 3600 rpm motor with 2000 ppr encoder will have a maximum quadrature frequency of $3600 \times 2000 \div 60 = 120$ KHz. In the above example the 2 MHz sampling clock will have noise immunity and will meet the required input frequency.

The following table shows the maximum noise pulse width that the filter will reject for each system clock frequency:

Clock frequency	Maximum width
8 MHz	0.5 usec.
4 MHz	1 usec.
2 MHz	2 usec.
1 MHz	4 usec.

D.4 Latch Mode

When you read a counter, you are actually reading a value latched into a buffer. The PCI-1784U provides seven different latching modes, only one of which is active at any given time. Make sure that you know which latching mode is current whenever you read the counter. Otherwise, you may read an old value or one that was latched at a different time than you expect. You select the latching mode for each channel individually.

The PCI-1784U's latching modes are as follows:

S/W Latch

Whenever you read a channel's data registers, the counter values will be latched in the buffer. Please refer to page 41 (BASE+28H) for detail information.

Index Latch

A rising edge on the channel's index input line will latch the channel's counter value.

DI/O Latch

A rising edge on the board's DI0 line will latch the counter value for the channel.

DI1 Latch

A rising edge on the DI1 line will latch the counter value for the channel.

DI2 Latch

A rising edge on the board's DI2 line will latch the counter value for the channel.

DI3 Latch

A rising edge on the DI3 line will latch the counter value for the channel.

Timer Latch

The card latches the counter value on a rising edge of pulses from the card's on-board timer.

D.5 Counter Reset Value

Bit 4 (RF) of registers BASE+00H, 04H, 08H and 0CH control the initial (reset) value of for each counter. You can select either 00000000 or 80000000 (hex). When the counter is reset, it will take this value.

When RF=0, the counter will reset to 80000000h.

When RF=1, the counter will reset to 00000000h.

D.6 Timer Function

The card can generate an interrupt to the system based on a signal from its digital inputs, overflow/underflow and over-compare / under-compare of its counters, or on a programmed time interval. It can repeatedly generate interrupts at any time interval you specify, from 20 microseconds to 51 second. These interrupts let you precisely monitor the speed of a control system.

D.7 Interrupt Function

The PCI-1784U can generate an interrupt to the PC for any of the following conditions:

Counter 0 overflow

Counter 1 overflow

Counter 2 overflow

Counter 3 overflow

Counter 0 underflow

Counter 1 underflow

Counter 2 underflow

Counter 3 underflow

Counter 0 index in

Counter 1 index in

Counter 2 index in

Counter 3 index in

DI0 input

DI1 input

DI2 input

DI3 input

Counter 0 over-compare

Counter 1 over-compare

Counter 2 over-compare

Counter 3 over-compare

Counter 0 under-compare

Counter 1 under-compare

Counter 2 under-compare

Counter 3 under-compare

Timer pulse

Note that you can use only one of the card's interrupt sources at a given time, unless you specially program your interrupt service routine to handle multiple interrupt sources.

You enable the PCI-1784U interrupt functions by accessed through the registers at BASE+20H. You will need to set the chip's interrupt mask register to exclude all but one of the interrupt lines.