

PCI-1747U

**250KS/s, 16-bit, 64-ch Analog
Input Card with Universal PCI
Bus**

User Manual

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- 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:
 - Product name and serial number
 - Description of your peripheral attachments
 - Description of your software (OS, version, software, etc.)
 - A complete description of the problem
 - The exact wording of any error messages

Packing List

Before setting up the system, check that the items listed below are included and in good condition. If any item does not accord with the table, please contact your dealer immediately.

- 1 x PCI-1747U card
- 1 x Companion CD-ROM (DLL driver included)
- 1 x User Manual (This manual)

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Introduction

This chapter introduces PCI-1747U and shows how to install the software. It also has information on useful accessories.

Sections include:

- Introduction
- Features
- Installation Guide
- Software
- Accessories

Chapter 1 Introduction

1.1 Introduction

Thank you for buying the Advantech PCI-1747U PCI card. PCI-1747U is a high-resolution high channel count analog input card for the PCI bus. Its sampling rate is up to 250 kS/s and 16-bit resolution provides the power needed for most data acquisition applications. PCI-1747U provides 64 single-ended, 32 differential analog input channels or a combination of these. It also has built in a 1k-sample FIFO buffer for analog input data.

The following sections will provide further information about features of the multifunction cards, a quick installation guide, and some brief information on software and accessories for the PCI-1747U card.

1.2 Features

The Advantech PCI-1747U provides users with the most requested measurement and control functions as below:

- 16-bit high resolution
- 250 kS/s sampling rate
- Auto calibration function
- 64 S.E. or 32 Diff. AI, or a combination
- Unipolar/Bipolar input range
- 1k samples FIFO for AI
- Universal PCI bus (support 3.3 V or 5 V PCI bus signal)
- BoardID

1.2.1 Auto-Calibration Function

The PCI-1747U provides an auto-calibration function with an calibration utility. The built-in calibration circuitry of the PCI-1747U corrects gain and offset errors in analog input channels, thereby eliminating the need for external equipment and user adjustments.

1.2.2 BoardID

The PCI-1747U has a built-in DIP switch that helps define each card's unique ID when multiple PCI-1747U cards have been installed on the same PC chassis. The BoardID setting function is very useful when building a system with multiple PCI-1747U cards. With the correct BoardID settings, you can easily identify and access each card during hardware configuration and software programming.

1.2.3 Plug-and-Play Function

The PCI-1747U is a Plug-and-Play device, which fully complies with PCI Specification Rev 2.2. During card installation, there is no need to set jumpers or DIP switches. Instead, all bus-related configurations such as base I/O address and interrupt are automatically done by the Plug-and-Play function.

1.2.4 Automatic Channel/Gain/SD/BU Scanning

The PCI-1747U features an automatic channel/gain/SD/BU scanning circuit. This circuit controls multiplexer switching during sampling in a way that is more efficient than software implementation. An on-board SRAM stores different gain, SD (Single-Ended/Differential) and BU (Bipolar/Unipolar) values for each channel. This combination lets users perform multi-channel high-speed sampling with different gain, SD and BU values for each channel.

1.2.5 PCI-Bus Mastering Data Transfer

PCI-1747U supports PCI-Bus mastering DMA for high-speed data transfer and gap-free analog input. By setting aside a block of memory in the PC, the PCI-1747U performs bus-mastering data transfers without CPU intervention, setting the CPU free to perform more urgent tasks such as data analysis and graphics manipulation. The function makes it possible to run all I/O functions simultaneously at full speed without losing data.

1.2.6 On-board FIFO Memory

PCI-1747U provides 1K samples on-board FIFO (First In First Out) memory buffer for AD. This is an important feature for faster data transfer and more predictable performance under the Windows system.

1.2.7 On Board Programmable Timer/Counter

PCI-1747U provides a programmable timer counter for generating a pacer trigger for the A/D conversion. The timer/counter chip is 82C54, which includes three 16-bit counter 10 MHz clocks. Two counters are cascaded together to make a 32-bit timer for pacer trigger time base.

1.3 Installation Guide

Before you install your PCI-1747U card, please make sure you have the following necessary components:

- PCI-1747U analog input card
- PCI-1747U User Manual
- Driver software Advantech DLL drivers (included in the companion CD-ROM)
- Wiring cable PCL-10168
- Wiring board ADAM-3968
- Computer Personal computer or workstation with a PCI-bus slot(running Windows 98/2000/XP)

Some other optional components are also available for enhanced operation:

- Application software ActiveDAQ, GeniDAQ or other third-party software packages

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. Fig. 1-1 on the next page provides a concise flow chart to give users a broad picture of the software and hardware installation procedures:

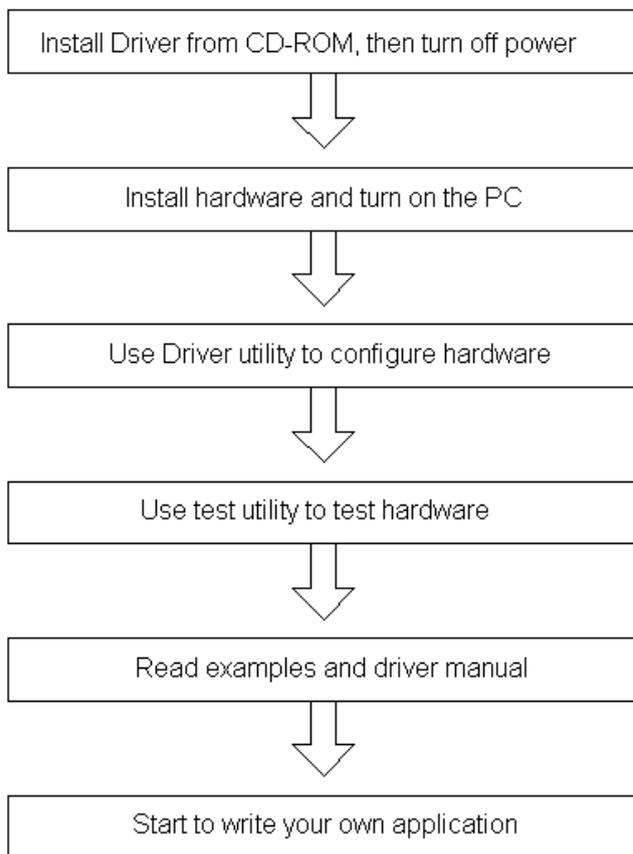


Figure 1.1: Installation Flow Chart

1.4 Software

Advantech offers a rich set of DLL drivers, third-party driver support and application software to help fully exploit the functions of your PCI-1747U card:

- DLL driver (on the companion CD-ROM)
- LabVIEW driver
- Advantech ActiveDAQ
- Advantech GeniDAQ

For more information on software, please refer to Chapter 4, Software Overview.

Users who intend to program directly at the registers of the Multifunction card have register-level programming as an option. Since register-level programming is often difficult and labor-intensive, it is usually recommended only for experienced programmers. For more information, please refer to Appendix C, Register Structure and Format.

1.5 Accessories

Advantech offers a complete set of accessory products to support the PCI-1747U cards. These accessories include:

1.5.1 PCL-10168 Wiring Cable

The PCL-10168 shielded cable is specially designed for PCI-1747U 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.

1.5.2 ADAM-3968 Wiring Boards

The ADAM-3968 is a 68-pin SCSI 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-1747U card.

Installation

This chapter provides a packaged item checklist, proper instructions about unpacking and step-by-step procedures for both driver and card installation.

Note that PCI-1747U is used as an example.

Sections include:

- Unpacking
- Driver Installation
- Hardware Installation
- Device Setup & Configuration
- Device Testing

Chapter 2 Installation

2.1 Unpacking

After receiving your PCI-1747U package, please inspect its contents first. The package should contain the following items:

- PCI-1747U card
- Companion CD-ROM (DLL driver included)
- User Manual

The PCI-1747U 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. Or one can also use a grounding strap.
- Touch the antistatic 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, you should first:

- 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 the 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 antistatic bag for future use. You might need the original bag to store the card if you have to remove the card from the PC or transport it elsewhere.*

2.2 Driver Installation

We recommend installing the driver before you plug the PCI-1747U Card into your system, since this will guarantee a smooth installation process.

The 32-bit DLL driver Setup program for the PCI-1747U card is included on the companion CD-ROM that is shipped with your DAS 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 *Autorun* function enabled on your system. When the *Setup* program is launched, you'll see the following setup screen.



Figure 2.1: Setup Screen

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

Step 3: Select the *Installation* option, then the *Individual Drivers* option.

Step 4: Select the specific device then just follow the installation instructions step by step to complete your device driver setup.



Figure 2.2: Driver Setup

For further information on driver-related issues, an online version of the *DLL Drivers Manual* is available by accessing the following path:

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

2.3 Hardware Installation

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

After the DLL driver installation is completed, you can go on to install the PCI-1747U card in any PCI slot on your computer. But it is suggested that you refer to the computer user manual or related documentations if you have any doubts. 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 any static electricity that might be in your body.

Step 5: Insert the PCI-1747U card into a PCI slot. Hold the card only by its edges and carefully align it with the slot. Insert the card firmly into place. Use of excessive force must be avoided; or 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 (68-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 *If you installed the card without installing the DLL driver first, Windows 98 will recognize your card as an “unknown device” after rebooting, and will prompt you to provide the necessary 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-1747U card is installed, you can verify whether it is properly installed on your system in the *Device Manager*:

1. Access the Device Manager through Start/ Control Panel/ System/ Device Manager.
2. The device name of PCI-1747U should be listed on the *Device Manager*.

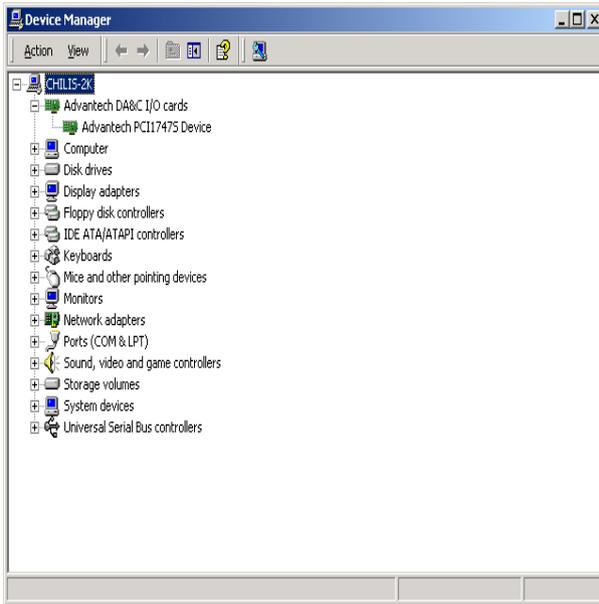


Figure 2.3: Device Manager

Note *If your card is properly installed, you should see the device name of your card listed on the Device Manager tab. If you see your device name listed, but marked with an exclamation sign “!”, it means your card has not been correctly installed. In this case, remove the card device from the Device Manager by selecting 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 itself already been installed on your system during driver setup. A complete device installation procedure should include device setup, configuration and testing. 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

Step 1: To install the I/O device for your card, you must first 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 2.4.

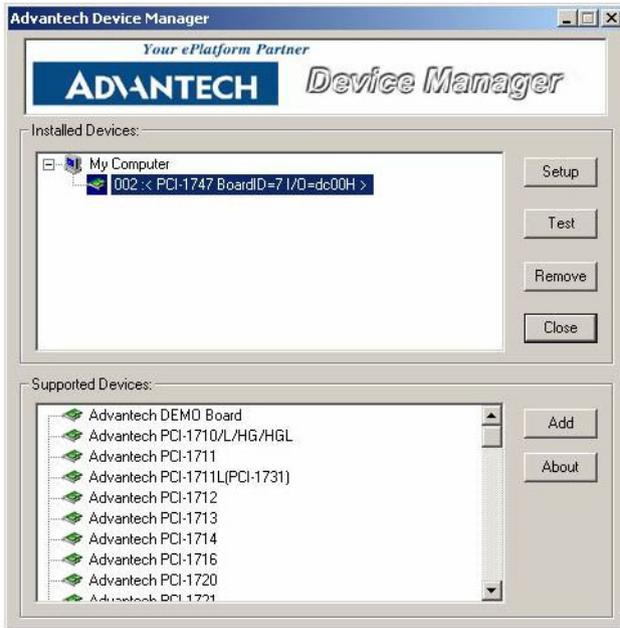


Figure 2.4: Device Manager dialog box

Step 4: In the Device Setting dialog box (Figure 2.5), you can configure the A/D channel as Single-ended or Differential.

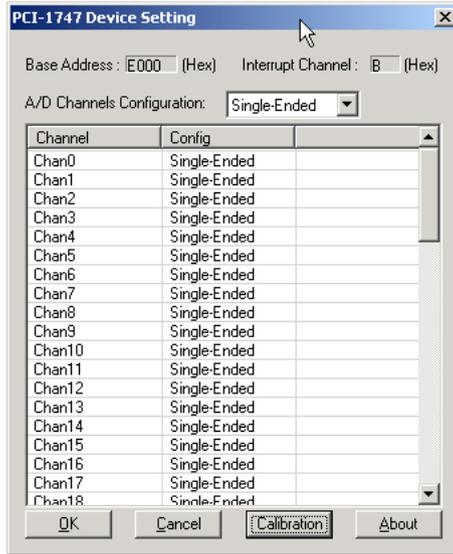


Figure 2.5: Figure 2.5 The Device Setting dialog box

Note As we have noted, the device name "002 :< PCI-1747 BoardID=7 I/O=dc00H>" begins with a device number "002", which is specifically assigned to each card. The device number is passed to the driver to specify which device you wish to control.

2.5 Auto-Calibration

This chapter provides brief information on PCI-1747U calibration. Regular calibration checks are important to maintain accuracy in data acquisition and control application. A calibration utility is included in the Device Manager.

The PCI-1747U has been calibrated at the factory for initial use. However, a calibration of the analog input function every six months is recommended.

2.5.1 Test Point

We have provided two test points on board for you to check the reference voltage (Figure 2.6). Before the calibration procedure begins, you will need a precise 4 1/2-digit digital multi-meter for the voltage reference.

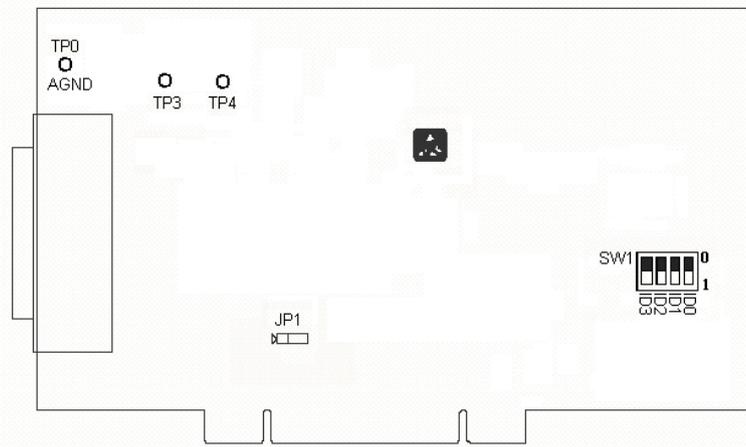


Figure 2.6: Locations of test points

The following steps will guide you through the PCI-1747U software calibration.

Step 1: Press the Setup button on the Device Manager Dialog box. Select the Single-Ended or the Differential. (Figure 2.5 Device Setting)

Step 2: Click the Calibration Button to start the Auto-Calibration panel (Figure 2.7)

Step 3: Use the digital multi-meter to measure the voltage on test points and press the spin button on the Calibration dialog box to adjust to the correct reference voltage.

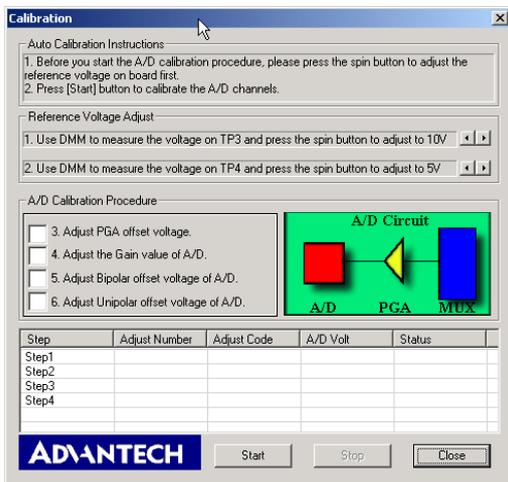


Figure 2.7: Auto-Calibration dialog box

Step 4: Press the start button to calibrate A/D channels automatically.

Step 5: Auto-calibration is finished (Figure 2.8)

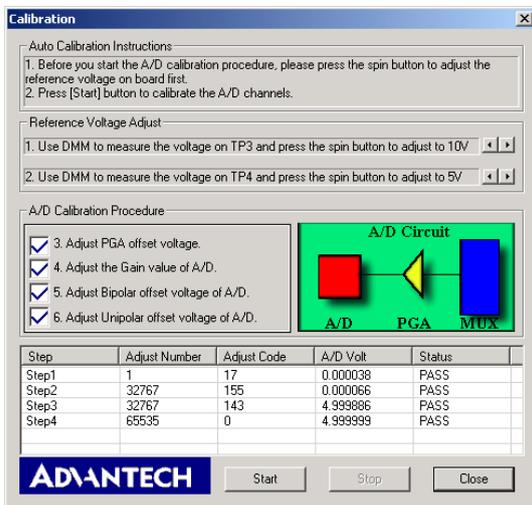


Figure 2.8: A/D Auto-Calibration is finished.

2.6 Device Testing

Following through the *Setup* and *Configuration* procedures to the last step described in the previous section, you can now proceed to test the device by clicking the **Test** Button on the *Device Manager* Dialog box. A *Device Test* dialog box will appear accordingly(Figure 2.9):

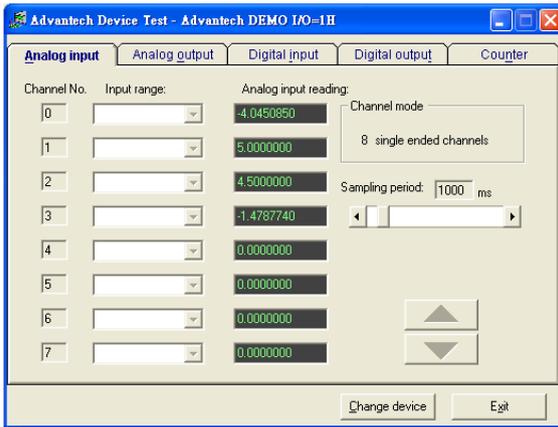


Figure 2.9: Device Test dialog box

Only after your card device is properly set up, configured and tested, can the device installation procedure be counted as complete. After the device installation procedure is completed, you can safely proceed to the next chapter, *Signal Connections*.

Signal Connections

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 PCI-1747U via the I/O connector.

Sections include:

- I/O Connector
- Analog Input Connections
- Trigger Source Connections
- Field Wiring Considerations

Chapter 3 Signal Connections

3.1 I/O Connector

The I/O connector on the PCI-1747U is a 68-pin connector that enables you to connect to accessories with the PCL-10168 shielded cable.

Fig. 3-1 shows the pin assignments for the 68-pin I/O connector on the PCI-1747U, and table 3-1 shows the I/O connector signal description.

3.1.1 I/O Connector Signal Description

Table 3.1: I/O Connector Signal Description

Signal Name	Reference	Direction	Description
AI<0..63>	AIGND	Input	Analog Input Channels 0 through 63. Each Channel pair, AI<i, i+1> (I = 0, 2, 4...62), can be configured as either two single-ended inputs or one differential input.
AGND	--	--	Analog Input Ground. The ground reference is connected together on the PCI-1747U card.

3.1.2 Pin Assignment

AI0	68	34	AI1
AI2	67	33	AI3
AI4	66	32	AI5
AI6	65	31	AI7
AI8	64	30	AI9
AI10	63	29	AI11
AI12	62	28	AI13
AI14	61	27	AI15
AGND	60	26	AGND
AI16	59	25	AI17
AI18	58	24	AI19
AI20	57	23	AI21
AI22	56	22	AI23
AI24	55	21	AI25
AI26	54	20	AI27
AI28	53	19	AI29
AI30	52	18	AI31
AI32	51	17	AI33
AI34	50	16	AI35
AI36	49	15	AI37
AI38	48	14	AI39
AI40	47	13	AI41
AI42	46	12	AI43
AI44	45	11	AI45
AI46	44	10	AI47
AGND	43	9	AGND
AI48	42	8	AI49
AI50	41	7	AI51
AI52	40	6	AI53
AI54	39	5	AI55
AI56	38	4	AI57
AI58	37	3	AI59
AI60	36	2	AI61
AI62	35	1	AI63

Figure 3.1: I/O Connector Pin Assignments

3.2 Analog Input Connections

3.2.1 Single-ended Channel Connections

The single-ended input configuration has only one signal wire for each channel, and the measured voltage (V_m) is the voltage of the wire as referenced against the common ground.

A signal source without a local ground is also called a “floating source”. It is fairly simple to connect a single-ended channel to a floating signal source. In this mode, the PCI-1747U provides a reference ground for external floating signal sources. *Fig. 3-2* shows a single-ended channel connection between a floating signal source and an input channel on PCI-1747U.

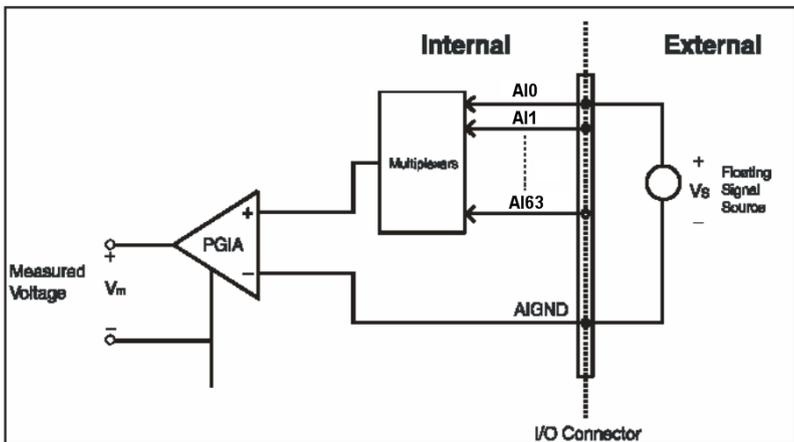


Figure 3.2: Single-ended Channel Connections

3.2.2 Differential Channel Connections

The differential input channels operate with two signal wires for each channel, and the voltage difference between both signal wires is measured. On PCI-1747U, when all channels are configured to differential input, up to 32 analog channels are available.

If one side of the signal source is connected to a local ground, the signal source is ground-referenced. Therefore, the ground of the signal source and the ground of the card will not be exactly of the same voltage. The difference between the ground voltages forms a common-mode voltage (V_{cm}).

To avoid the ground loop noise effect caused by common-mode voltages, you can connect the signal ground to the Low input. *Figure 3-3* shows a differential channel connection between a ground-reference signal source and an input channel on the PCI-1747U. With this connection, the PGIA rejects a common-mode voltage V_{cm} between the signal source and the PCI-1747U ground, shown as V_{cm} in *Figure 3-3*.

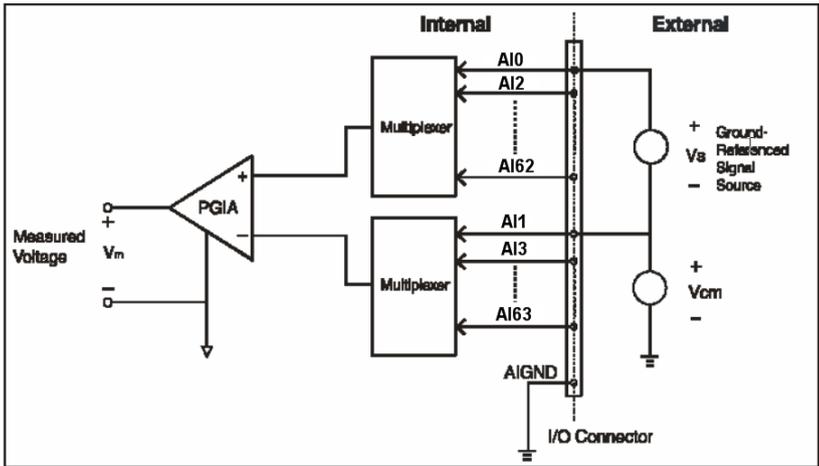


Figure 3.3: Differential Connection - Ground Signal

If a floating signal source is connected to the differential input channel, the signal source might exceed the common-mode signal range of the PGIA, and the PGIA will be saturated with erroneous voltage-readings. You must therefore reference the signal source against the AIGND.

Figure 3.4 shows a differential channel connection between a floating signal source and an input channel on PCI-1747U. In this figure, each side of the floating signal source is connected through a resistor to the AIGND. This connection can reject the common-mode voltage between the signal source and the PCI-1747U ground.

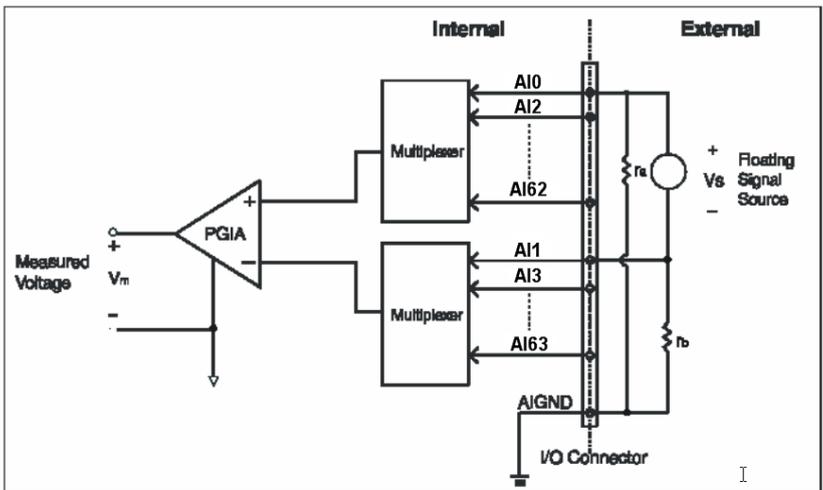


Figure 3.4: Differential Connection - Floating Signal

However, this connection has the disadvantage of loading the source down with the series combination (sum) of the two resistors. For r_a and r_b , for example, if the input impedance r_s is 1 kW, and each of the two resistors are 100 kW, then the resistors load down the signal source with 200 kW (100 kW + 100 kW), resulting in a -0.5% gain error. The following gives a simplified representation of the circuit and calculating process.

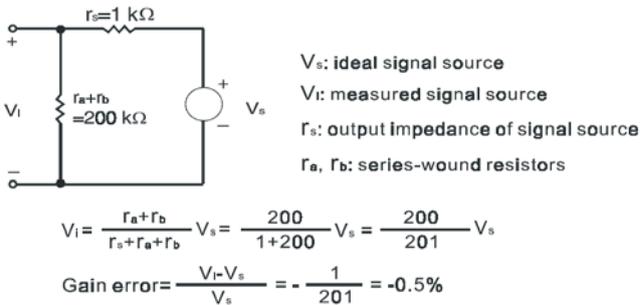


Figure 3.5: Example

3.3 Trigger Source Connections

3.3.1 Internal Pacer Trigger Connection

PCI-1747U includes one 82C54 compatible programmable Timer/Counter chip that provides three 16-bit counters connected to a 10 MHz clock, each designated specifically as Counter 0, Counter 1 and Counter 2. Counter 0 is a counter which counts events from an input channel. Counter 1 and Counter 2 are cascaded to create a 32-bit timer for pacer triggering. For detailed information, please refer to Appendix D.

3.4 Switch and Jumper Settings

The PCI-1747U card has one jumper and one Board ID switch setting. The following image shows the layout of PCI-1747U:

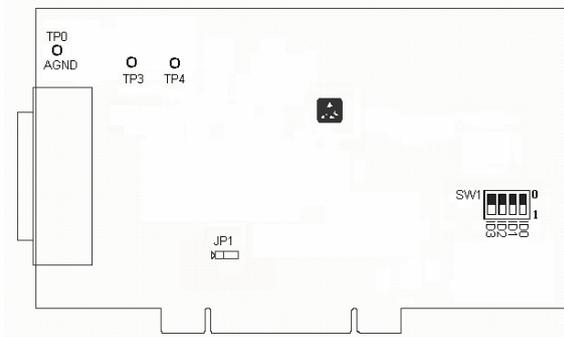


Figure 3.6: Jumpers and Switch Locations

3.4.1 JP1

	Keep the last status after hot reset
	Load default values while reset

3.4.2 Board ID

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

Software Overview

This chapter gives you an overview of the software programming choices available and a quick reference to source codes examples that can help you be better informed when programming. After following the instructions given in *Chapter 2*, it is hoped that you feel comfortable enough to proceed further.

Sections include:

- Software Overview
- Programming Choices
- DLL Driver Programming

Chapter 4 Software Overview

4.1 Software Overview

Programming choices for DAS cards: You may use Advantech application software such as Advantech DLL driver. 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.

4.2 Programming Choices

4.2.1 DLL Driver

The Advantech DLL Drivers software is included on the companion CD-ROM at no extra charge. It also comes with all the Advantech DAS cards. Advantech's DLL driver features a complete I/O function library to help boost your application performance. The Advantech DLL driver for *Windows 98/2000/XP* works seamlessly with development tools such as Visual C++, Visual Basic, Borland C++ Builder and Borland Delphi.

4.2.2 Register-Level Programming

Register-level programming is reserved for experienced programmers who find it necessary to write code directly at the level of device registers. Since register-level programming requires much effort and time, we recommend that you use the Advantech DLL 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.

4.3 DLL Driver Programming Roadmap

This section will provide you a roadmap to demonstrate how to build an application from scratch using Advantech DLL driver 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 *DLL Drivers Manual*. Moreover, a rich set of example source codes are also given for your reference.

4.3.1 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 in each development tool, Advantech offers a *Tutorial Chapter* in the *DLL Drivers Manual* for your reference. Please refer to the corresponding sections in this chapter on the *DLL Drivers Manual* to begin your programming efforts. You can also take a look at the example source codes provided for each programming tool, since they can be very helpful.

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

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

The example source codes can 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 98/2000/XP Application with DLL Driver* chapter and the *Function Overview* chapter on the *DLL Drivers Manual*.

4.3.2 Programming with DLL Driver Function Library

Advantech DLL driver 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, these APIs can be categorized into several function groups:

- Analog Input Function Group
- Analog Output Function Group
- Digital Input/Output Function Group
- Counter Function Group
- Temperature Measurement Function Group
- Alarm Function Group
- Port Function Group
- Communication Function Group
- Event Function Group

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

4.3.3 Troubleshooting DLL Driver 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 DLL driver error, you can pass the error code to **DRV_GetErrorMessage** function to return the error message. Or you can refer to the *DLL Driver Error Codes Appendix* in the *DLL Drivers Manual* for a detailed listing of the Error Code, Error ID and the Error Message.

APPENDIX A

Specifications

Sections include:

- Analog Input
- General

Appendix A Specifications

A.1 Analog Input

Channels	64 single-ended or 32 differential or combination					
Resolution	16-bit					
FIFO Size	1K samples					
Max. Sampling Rate	250 kS/s					
Input range and Gain List	Gain	0.5	1	2	4	8
	Unipolar	N/A	0~10	0~5	0~2.5	0~1.25
	Bipolar	±10	±5	±2.5	±1.25	±0.625
Bandwidth for PGA (MHz)	Gain	0.5	1	2	4	8
	Bandwidth	4.0	4.0	2.0	1.5	0.65
Common mode voltage	±11 V max. (operational)					
Max. Input voltage	±20 V					
Input Impedance	100 MΩ/10pF(Off); 100 MΩ/100pF(On)					
Accuracy	DC	DNLE: ±1LSB				
		INLE: ±1LSB				
		Zero (Offset) error: Adjustable to ±2 LSB				
		Gain	0.5	1	2	4
	Gain error(% FSR)	0.03	0.02	0.02	0.03	0.04
	AC	THD: -90 dB				
		ENOB: 13.5 bits				
Clocking and Trigger Inputs	Trigger Mode	Software, on-board programmable pacer				
	A/D pacer clock	250 kHz (max.); 2.328MHz (min.)				

Note *The sampling rate depends on the computer hardware architecture and software environment. The rates may vary due to programming language, code efficiency, and CPU utilization and so on.*

A.2 General

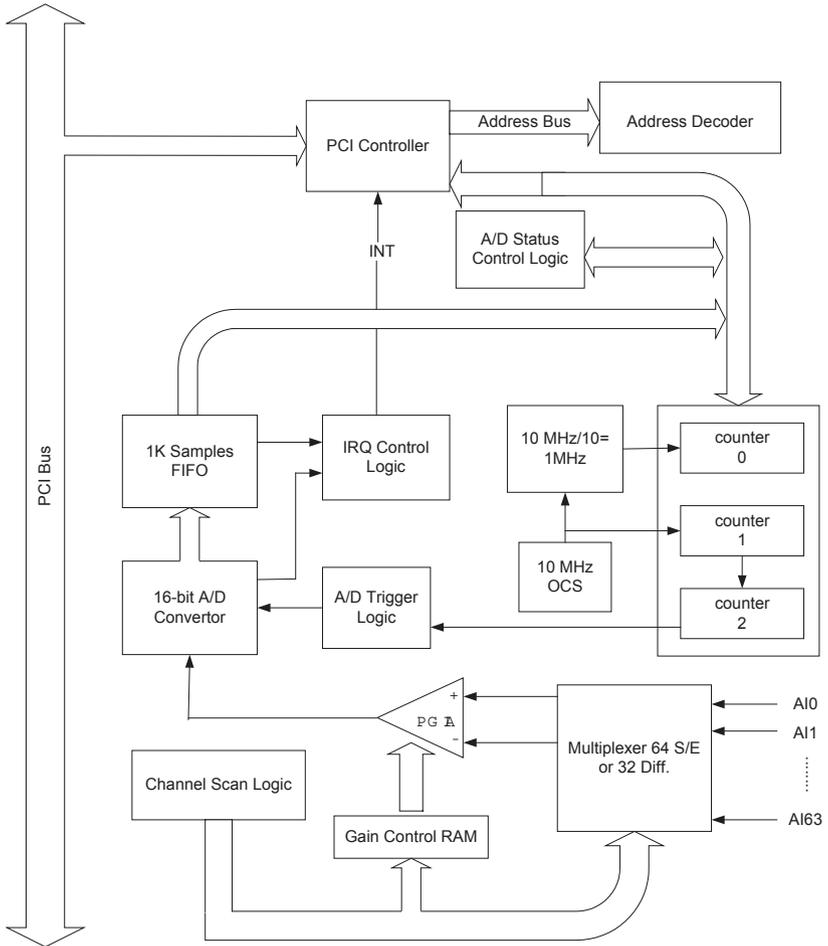
I/O Connector Type	68-pin SCSI-II female	
Dimensions	175 x 100 mm (6.9" x 3.9")	
Power Consumption	Typical	+5 V @ 850 mA +12 V @ 600 mA
	Max.	+5 V @ 1 A
Temperature	Operation	0~+60°C(32~158°F) (refer to IEC 68-2-1,2)
	Storage	-20~+85°C(-4~185°F)
Relative Humidity	5~95%RH non-condensing (refer to IEC 68-2-3)	
Certification	CE certified	

APPENDIX

B

Block Diagram

Appendix B Block Diagram



APPENDIX

C

Register Structure and Format

Appendix C Register Structure and Format

C.1 Overview

PCI-1747U is delivered with an easy-to-use 32-bit DLL driver for user programming under the *Windows 98/2000/XP* operating systems. We recommend to program the PCI-1747U using the 32-bit DLL driver provided by Advantech to avoid the complexity of low-level programming by registers.

The most important consideration in programming the PCI-1747U at the register level 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

PCI-1747U 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, $\text{BASE}+0$ is the card's base address and $\text{BASE}+7$ is the base address plus seven bytes.

Table C-1 shows the function of each register of the PCI-1747U or driver and its address relative to the card's base address.

You need to use a 16-bit (word) command to read/write each register.

Table C.1: PCI-1747U Register Format (Part 1)

Base Address +decimal	Read							
	7	6	5	4	3	2	1	0
	A/D Data							
1	AD15	AD14	AD13	AD12	AD11	AD10	AD9	AD8
0	AD7	AD6	AD5	AD4	AD3	AD2	AD1	AD0
	N/A							
3								
2								
	N/A							
5								
4								
	A/D Status Register							
7	CAL				AD IRQ	F/F	F/H	F/E
6			ONE/FH	IRQEN			PACER	SW
	N/A							
9								
8								
	N/A							
11								
10								
	N/A							
13								
12								
	N/A							
15								
14								

Base Address +decimal	Read							
	7	6	5	4	3	2	1	0
	N/A							
17								
16								
	N/A							
19								
18								
	Board ID							
21								
20								
	N/A							
23								
22								
	Counter 0							
25								
24								
	Counter 1							
27								
26								
	Counter 2							
29								
28								
	Counter Control							
31								
30								

Base Address +decimal	Write							
	7	6	5	4	3	2	1	0
	Software A/D Trigger							
1								
0								
	A/D Channel Range Setting							
3								
2								
	Multiplexer Control							
5			STO5	STO4	STO3	STO2	STO1	STO0
4			STA5	STA4	STA3	STA2	STA1	STA0
	A/D Control Register							
7	CAL							
6			ONE/ FH	AD IRQEN			PACER	SW
	Clear Interrupt and FIFO							
9	Clear FIFO							
8	Clear interrupt							
	N/A							
11								
10								
	N/A							
13								
12								
	N/A							
15								
14								

Base Address +decimal	Write							
	7	6	5	4	3	2	1	0
	N/A							
17								
16								
	Calibration Command and Data							
19					CM3	CM2	CM1	CM0
18	D7	D6	D5	D4	D3	D2	D1	D0
	N/A							
21								
20								
	N/A							
23								
22								
	Counter 0							
25								
24								
	Counter 1							
27								
26								
	Counter 2							
29								
28								
	Counter Control							
31								
30								

C.3 A/D Data — BASE+0 and BASE+1

BASE+0 and BASE+1 hold the result of A/D conversion data. The 16 bits of data from the A/D conversion are stored in BASE+1 bit 7 to bit 0 and BASE+0 bit 7 to bit 0.

Table C.2: PCI-1747U Register for A/D data

Read	A/D Data							
Bit #	7	6	5	4	3	2	1	0
BASE + 1	AD15	AD14	AD13	AD12	AD11	AD10	AD9	AD8
BASE + 0	AD7	AD6	AD5	AD4	AD3	AD2	AD1	AD0

AD15 ~ AD0 Result of A/D Conversion

AD0 the least significant bit (LSB) of A/D data

AD15the most significant bit (MSB)

C.4 Software A/D Trigger — BASE+0

You can trigger an A/D conversion by software, the card's on-board pacer.

BASE+6, Bit 2 to bit 0, select the trigger source.

(see *Section C.7, Control Register -- BASE+6*)

If you select software triggering, a write to the register BASE+0 with any value will trigger an A/D conversion.

C.5 A/D Channel Range Setting — BASE+2

Each A/D channel has its own input range, controlled by a gain code stored in the on-board RAM.

To change the range code for a channel:

- Write the same channel in BASE+4 (the start channel) and BASE+5 (the stop channel) (refer to *Section C.6*).
- Write the gain code to BASE+2 bit 0 to bit 2.

Table C.3: Register for A/D channel range setting

Write	A/D Channel Range Setting							
Bit #	7	6	5	4	3	2	1	0
BASE + 2			S/D	B/U		G2	G1	G0

S/D Single-ended or Differential

0 single-ended

1 differential.

B/U Bipolar or Unipolar

0 bipolar

1 unipolar.

G2 to G0 Gain Code (listed as *Table C.4*)

Table C.4: Gain codes for PCI-1747U

Gain	Input Range(V)	B/U	Gain Code		
			G2	G1	G0
1	-5 to +5	0	0	0	0
2	-2.5 to +2.5	0	0	0	1
4	-1.25 to +1.25	0	0	1	0
8	-0.625 to +0.625	0	0	1	1
0.5	-10 to +10	0	1	0	0
	N/A	0	1	0	1
	N/A	0	1	1	0
	N/A	0	1	1	1
1	0 to 10	1	0	0	0
2	0 to 5	1	0	0	1
4	0 to 2.5	1	0	1	0
8	0 to 1.25	1	0	1	1
	N/A	1	1	0	0
	N/A	1	1	0	1
	N/A	1	1	1	0
	N/A	1	1	1	1

Example: To set channel 3 as gain=1

1. Write channel 3 to BASE+4 as 00000011.
2. Write channel 3 to BASE+5 as 00000011.
3. Refer to the gain code list, write gain=1 to BASE+2 as 00000000.

C.6 MUX Control — BASE+4 and BASE+5

Table C.5: Register for multiplexer control

Write	Multiplexer Control							
Bit #	7	6	5	4	3	2	1	0
BASE + 5			STO5	STO4	STO3	STO2	STO1	STO0
BASE + 4			STA5	STA4	STA3	STA2	STA1	STA0

STA5 ~ STA0 Start Scan Channel Number

STO5 ~ STO0 Stop Scan Channel Number

- When you set the gain code of analog input channel n, you should set the Multiplexer start & stop channel number to channel n to prevent any unexpected errors. In fact BASE+4 bit 5 to bit 0, STA5 ~ STA0, act as a pointer to channel n's address in the SRAM when you program the A/D channel setting (*refer to Section C.5*).

Caution! *We recommend you to set the same start and stop channel when writing to the register BASE+2. Otherwise, if the A/D trigger source is on, the multiplexer will continuously scan between channels and the range setting may be set to an unexpected channel. Make sure the A/D trigger source is turned off to avoid this kind of error.*

The write-only registers of BASE +4 and BASE+5 control how the multiplexers (Multiplexer) scan.

- BASE+4 bit 5 to bit 0, STA5 ~ STA0, hold the start scan ch. number.
- BASE+5 bit 5 to bit 0, STO5 ~ STO0, hold the stop scan ch. number.

Writing to these two registers automatically initializes the scan range of the Multiplexer. Each A/D conversion trigger also sets the Multiplexer to the next channel. With continuous triggering, the Multiplexer will scan from the start channel to the stop channel and then repeat. The following examples show the scan sequences of the Multiplexer.

C.6.1 Example 1

If the start scan input channel is AI3 and the stop scan input channel is AI7, then the scan sequence is AI3, AI4, AI5, AI6, AI7, AI3, AI4, AI5, AI6, AI7, AI3, AI4...

C.6.2 Example 2

If the start scan channel is AI13 and the stop scan channel is AI2, then the scan sequence is AI13, AI14...AI63, AI0, AI1, AI2.

The scan logic of the PCI-1747U card is powerful and easily understood. You can set the gain code, B/U and S/D, for each channel. For the Analog Input function, we set two AI channels AI<i, i+1> (i= 0, 2, 4, ..., 62) to work as a pair. For example, AI0 and AI1 is a pair. When in single-ended mode, we can get data from AI0 and AI1 separately. But if we set them in differential mode, the results polling AI0 and AI1 will be the same. That is if we set AI0 and AI1 as differential input channels, we can get the correct result no matter if we poll channel 0 or channel 1.

But if we want to use the multiple channel's input function, things will be a bit different. If we set two AI channels as differential channels, it will take one channel in the data array. Since the resulted data array of the multi-channel scan function is ranked with the order of channel, let us give an example to make it more clear. Now we set channel 0, 1 as differential and 2, 3 as single ended and then 4, 5 in differential mode. And we set the start channel as channel 0 and number of channels as 4, the result will be:

```
##.#### -> channel 0,1
##.#### -> channel 2
##.#### -> channel 3
##.#### -> channel 4,5
##.#### -> channel 0,1
##.#### -> channel 2
##.#### -> channel 3
##.#### -> channel 4,5
##.#### -> channel 0,1
```

Warning! *Only even channels can be set as differential. An odd channel will become unavailable if its preceding channel is set as differential.*

C.7 Control Register — BASE+6 and BASE+7

The write-only register BASE+6 and BASE+7 allows users to set an A/D trigger source and an interrupt source.

Table C.6: Control Register

Write	A/D Status Register							
Bit #	7	6	5	4	3	2	1	0
BASE + 7	CAL							
BASE + 6			ONE/FH	IRQEN			PACER	SW

SW Software trigger enable bit

1 enable

0 disable.

PACER Pacer trigger enable bit

1 enable

0 disable.

Note: Users cannot enable SW and PACER concurrently.

IRQEN Interrupt enable bit.

0 Disable

1 Enable

ONE/FH Interrupt source bit

0 Interrupt when an A/D conversion occurs

1 Interrupt when the FIFO is half full.

CAL Analog calibration bit

0 Normal mode

All analog input channels are connected to 68 pin SCSI-II connector respectively.

1 Calibration mode

The wiring becomes that AI0, 2, 4, 6 are connected to 0 V (AGND), AI1 is connected to +10V, AI3 is connected to +5V, AI5 is connected to +2.5V, and AI7 is connector to +1.25V automatically.

C.8 Status Register — BASE+6 and BASE+7

The registers of BASE+6 and BASE+7 provide information for A/D configuration and operation.

Table C.7: Status Register

Write	A/D Status Register							
Bit #	7	6	5	4	3	2	1	0
BASE + 7	CAL				IRQ	F/F	F/H	F/E
BASE + 6			ONE/FH	IRQEN			PACER	SW

The content of the status register of BASE+6 is the same as that of the control register.

F/E FIFO Empty flag

This bit indicates whether the FIFO is empty.

1 means that the FIFO is empty.

F/H FIFO Half-full flag

This bit indicates whether the FIFO is half-full.

1 means that the FIFO is half-full.

F/F FIFO Full flag

This bit indicates whether the FIFO is full.

1 means that the FIFO is full.

IRQ Interrupt flag

This bit indicates the interrupt status.

1 means that an interrupt has occurred.

C.9 Clear Interrupt and FIFO — BASE+8 and BASE+9

Writing data to either of these two bytes clears the interrupt and/or the FIFO.

Table C.8: Register to Clear Interrupt and FIFO

Write	Clear Interrupt and FIFO							
Bit #	7	6	5	4	3	2	1	0
BASE + 9	Clear FIFO							
BASE + 8	Clear Interrupt							

C.10 Calibration Registers — BASE+18 and BASE+19

The PCI-1747U calibration registers BASE+16 and BASE+17 for user to calibrate the A/D and D/A.

Table C.9: Calibration Command and Data Register

Write	Command and Data							
Bit #	7	6	5	4	3	2	1	0
BASE + 19					CM3	CM2	CM1	CM0
BASE + 18	D7	D6	D5	D4	D3	D2	D1	D0

D7 to D0 Calibration data

D0 LSB of the calibration data

D7 MSB of the calibration data

CM3 to CM0 Calibration Command and *Table C-18* lists the command code for PCI-1747U

Table C.10: Calibration Command and Data Register

Meaning/Command Code	CM3	CM2	CM1	CM0
PGA offset adjust (Coarse)	0	0	0	0
PGA offset adjust (Fine)	0	0	0	1
A/D bipolar offset adjust (Coarse)	0	0	1	0
A/D bipolar offset adjust (Fine)	0	0	1	1
A/D unipolar offset adjust (Coarse)	0	1	0	0
A/D unipolar offset adjust (Fine)	0	1	0	1
A/D gain adjust (Coarse)	0	1	1	0
A/D gain adjust (Fine)	0	1	1	1
10V reference adjust	1	0	0	0
5V reference adjust	1	0	0	1

C.10.1 Calibration Procedure:

1. Adjust 10V reference: use DMM to measure the voltage on TP3 and adjust to 10.0000V
2. Adjust 5V reference: use DMM to measure the voltage on TP4 and adjust to 5.00000V
3. PGA offset adjust:
4. Bipolar offset adjust:
5. Unipolar offset adjust:
6. Gain adjust:

C.11 Board ID Registers — BASE+20

The PCI-1747U offers BoardID register BASE+20. With correct BoardID settings, users can easily identify and access each card during hardware configuration and software programming.

Table C.11: Register for Board ID

Read	Board ID							
Bit #	7	6	5	4	3	2	1	0
BASE + 20					BD3	BD2	BD1	BD0

C.12 Programmable Timer/Counter Registers

The four registers of BASE+24, BASE+26, BASE+28 and BASE+30 are used for the 82C54 programmable timer/counter. Please refer to *Appendix D. 82C54 Counter Chip Functions* for detailed application information.

Note: *Users would have to use a 16-bit (word) command to read/write from/to each register.*

82C54 Counter Chip Function

Sections Include:

- The Intel 82C54
- Counter Read/Write and Control Registers

Appendix D 82C54 Counter Chip Function

D.1 The Intel 82C54

The PCI-1747U uses one Intel 82C54-compatible programmable interval timer/counter chip. The popular 82C54 chip offers three independent 16-bit counters, counter 0, counter 1 and counter 2. You can program each counter for maximum count values from 2 to 65535.

The 82C54 has a maximum input clock frequency of 10 MHz. The PCI-1747U provides 10 MHz input frequencies to the counter chip from an on-board crystal oscillator.

Counter 0

On the PCI-1747U, counter 0 can be a 16-bit timer when the clock source is set as an internal source.

Counter 1 & 2

Counter 1 and counter 2 of the counter chip are cascaded to create a 32-bit timer for the pacer trigger. A low-to-high edge of counter 2 output will trigger an A/D conversion.

D.2 Counter Read/Write and Control Registers

The 82C54 programmable interval timer uses four registers at addresses BASE + 24(Dec), BASE + 26(Dec), BASE + 28(Dec) and BASE + 30(Dec) for read, write and control of counter functions. Register functions appear below:

Table D.1:

Register	Function
BASE + 24(Dec)	Counter 0 read/write
BASE + 26(Dec)	Counter 1 read/write
BASE + 28(Dec)	Counter 1 read/write
BASE + 30(Dec)	Counter control word

Since the 82C54 counter uses a 16-bit structure, each section of read/write data is split into a least significant byte (LSB) and most significant byte (MSB). To avoid errors, it is important that you make read/write operations in pairs and keep track of the byte order.

The data format for the control register is as below:

BASE+30(Dec) 82C54 control, standard mode								
Bit	D7	D6	D5	D4	D3	D2	D1	D0
Value	SC1	SC0	RW1	RW0	M2	M1	M0	BCD

D.2.1 Description

SC1 & SC0 Select counter		
Counter	SC1	SC0
0	0	0
1	0	1
2	1	0
Read-back command	1	1

RW1 & RW0 Select read / write operation		
Operation	RW1	RW0
Counter latch	0	0
Read/write LSB	0	1
Read/write MSB	1	0
Read/write LSB first, then MSB	1	1

M2, M1 & M0 Select operating mode				
M2	M1	M0	Mode	Description
0	0	0	0	Stop on terminal count
0	0	1	1	Programmable one shot
X	1	0	2	Rate generator
X1	1	1	3	Square wave rate generator
1	0	0	4	Software triggered strobe
1	0	1	5	Hardware triggered strobe

BCD Select binary or BCD counting	
BCD	Type
0	Binary counting 16-bits
1	Binary coded decimal (BCD) counting

If you set the module for binary counting, the count can be any number from 0 up to 65535. If you set it for BCD (Binary Coded Decimal) counting, the count can be any number from 0 to 9999.

If you set both SC1 and SC0 bits to 1, the counter control register will be in read-back command mode. The control register data format then becomes:

BASE + 30(Dec) 82C54 control, read-back mode								
Bit	D7	D6	D5	D4	D3	D2	D1	D0
Value	1	1	CNT	STA	C2	C1	C0	X

- CNT = 0 Latch count of selected counter(s)
- STA = 0 Latch status of selected counter(s)
- C2, C1 & C0 Select counter for a read-back operation
- C2 = 1 select Counter 2
- C1 = 1 select Counter 1
- C0 = 1 select Counter 0

If you set both SC1 and SC0 to 1 and STA to 0, the register selected by C2 to C0 contains a byte which shows the status of the counter. The data format of the counter read/write register then becomes:

BASE+24/26/28(Dec) Status read-back mode								
Bit	D7	D6	D5	D4	D3	D2	D1	D0
Value	OUT	NC	RW1	RW0	M2	M1	M0	BCD

- OUT** Current state of counter output
- NC** Null count is 1 when the last count written to the counter register has been loaded into the counting element

D.3 Counter Operating Modes

The 82C54 programmable interval timer uses four registers at addresses $\text{BASE} + 24(\text{Dec})$, $\text{BASE} + 26(\text{Dec})$, $\text{BASE} + 28(\text{Dec})$ and $\text{BASE} + 30(\text{Dec})$ for read, write and control of counter functions. Register functions appear below:

MODE 0 - Stop on Terminal Count

The output will initially be low after you set operation to this mode. After you load the count into the selected count register, the output will remain low and the counter will count. When the counter reaches the terminal count, its output will go high and remain high until you reload it with the mode or a new count value. The counter continues to decrement after it reaches the terminal count. Rewriting a counter register during counting has the following results:

1. Writing to the first byte stops the current counting.
2. Writing to the second byte starts the new count.

MODE 1 - Programmable One-shot Pulse

The output is initially high. The output will go low on the count following the rising edge of the gate input. It will then go high on the terminal count. If you load a new count value while the output is low, the new value will not affect the duration of the one-shot pulse until the succeeding trigger. You can read the current count at any time without affecting the one-shot pulse. The one-shot is re-triggerable, thus the output will remain low for the full count after any rising edge at the gate input.

MODE 2 - Rate Generator

The output will be low for one period of the input clock. The period from one output pulse to the next equals the number of input counts in the counter register. If you reload the counter register between output pulses,

the present period will not be affected, but the subsequent period will reflect the value.

The gate input, when low, will force the output high. When the gate input goes high, the counter will start from the initial count. You can thus use the gate input to synchronize the counter.

With this mode the output will remain high until you load the count register. You can also synchronize the output by software.

MODE 3 - Square Wave Generator

This mode is similar to Mode 2, except that the output will remain high until one half of the count has been completed (for even numbers), and will go low for the other half of the count. This is accomplished by decreasing the counter by two on the falling edge of each clock pulse. When the counter reaches the terminal count, the state of the output is changed, the counter is reloaded with the full count and the whole process is repeated.

If the count is odd and the output is high, the first clock pulse (after the count is loaded) decrements the count by 1. Subsequent clock pulses decrement the count by 2. After time-out, the output goes low and the full count is reloaded. The first clock pulse (following the reload) decrements the counter by 3. Subsequent clock pulses decrement the count by two until time-out, then the whole process is repeated. In this way, if the count is odd, the output will be high for $(N+1)/2$ counts and low for $(N-1)/2$ counts.

MODE 4 -Software-Triggered Strobe

After the mode is set, the output will be high. When the count is loaded, the counter will begin counting. On terminal count, the output will go low for one input clock period then go high again. If you reload the count register during counting, the new count will be loaded on the next CLK pulse. The count will be inhibited while the GATE input is low.

MODE 5 - Hardware-Triggered Strobe

The counter will start counting after the rising edge of the trigger input and will go low for one clock period when the terminal count is reached. The counter is re-triggerable.