# PCI230+ & PCI260+

## MULTI-FUNCTION ANALOG AND DIGITAL INPUT/OUTPUT BOARDS

This Instruction Manual is supplied with the PCI230+/260+ to provide the user with sufficient information to utilise the purchased product in a proper and efficient manner. The information contained has been reviewed and is believed to be accurate and reliable, however **Amplicon Liveline Limited** accepts no responsibility for any problems caused by errors or omissions. Specifications and instructions are subject to change without notice.

**PCI230+/260+ Instruction Manual Part Nº 9605 2504 Issue A3**



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Approved for issue by A.S. Gorbold, Operations Director

## CE DECLARATION OF CONFORMANCE

Certificate Number: 1643

Manufacturer's Name: Amplicon Liveline Limited
Manufacturer's Address: Centenary Industrial Estate, Hollingdean Road, Brighton, UK, BN2 4AW

Declares that the product

Product Name: PCI230+ (95052503)
Model Number:
Product Options:

Conforms to the following Product Specifications

☐ **Low Voltage Directive 73/23/EEC**

Standard EN60950:2000 Safety of information Technology equipment

Report Number(s):

☑ **EMC Directive 89/336/EEC**

Harmonised EMC Emissions Standard (Class A / B)

EN 55022:1998

Harmonised EMC Immunity Standard(s)

EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-11

Report Number(s): 1643

Signed [signature] Name A. Gordon

Dated 16th Aug 2005

## CE DECLARATION OF CONFORMANCE

Certificate Number: 1642

Manufacturer's Name: Amplicon Liveline Limited
Manufacturer's Address: Centenary Industrial Estate, Hollingdean Road, Brighton, UK, BN2 4AW

Declares that the product

Product Name: PCI260+ (95052513)
Model Number:
Product Options:

Conforms to the following Product Specifications

☐ **Low Voltage Directive 73/23/EEC**

Standard EN60950:2000 Safety of information Technology equipment

Report Number(s):

☑ **EMC Directive 89/336/EEC**

Harmonised EMC Emissions Standard (Class A / B)

EN 55022:1998

Harmonised EMC Immunity Standard(s)

EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-11

Report Number(s): 1642

Signed [signature] Name A. Gordon

Dated 16th Aug 2005

# PCI230+ & PCI260+
# MULTI-FUNCTION ANALOG AND DIGITAL INPUT/OUTPUT BOARDS

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# 1 INTRODUCTION

## 1.1 The Amplicon 200 Series

The **Amplicon 200 Series** of Personal Computer based data acquisition products provides very high performance, affordable hardware with user sympathetic software. The 200 Series is designed for users requiring fast or complex data input/output to the host PC and comprises a range of boards and software to handle most analog and digital signal types.

When a large scale system is required, multiple boards can be added from the 200 Series without conflict.

## 1.2 The Products Described in this Manual

The PCI230+/260+ range of boards share some common circuitry and features and are referred to in this manual either generically or individually:

| | |
|---|---|
| PCI230+/260+ | Refers to both boards |
| PCI230+ | Refers to the PCI230+ only |
| PCI260+ | Refers to the PCI260+ only |

## 1.3 Features of the PCI230+/260+

The PCI230+/260+ range of boards are designed to meet stringent performance requirements and ease of use.

- PCI Bus, Universal, Plug and play interface
- Device driver software compatible with Windows & Linux providing continuous conversion rates up to 500,000 samples per second
- 16-channel multiplexed analog to digital conversion with selectable input voltage ranges
- True differential input capability
- 4096-sample FIFO memory for analog to digital conversions allowing up to 4096 samples for one channel or 256 samples for 16 channels to be stored on the board
- Automatic ADC offset null calibration on power up
- Advanced ADC acquisition trigger modes including; analog trigger (edge or level) with hysteresis and pre-trigger facility and acquisition trigger on external TTL input
- Three, Intel 82C54 compatible, 16-bit counter/timers with on board 10 MHz crystal oscillator timing source
- PCI230+ only, 2-channel, 12-bit digital to analog conversion with output voltage ranges of ±10V bipolar or 0 to +10 V unipolar
- PCI230+ only, 1024-sample FIFO memory for digital to analog conversions allowing up to 1024 samples for one channel or 512 samples for two channels to be stored on the board for smooth waveform generation
- PCI230+ only, DAC FIFO wrap mode allowing arbitrary waveforms to be stored on the board and played continuously from the DAC outputs
- PCI230+ only, 24-bit flexible, Intel 82C55 compatible, programmable digital input/output
- Interrupt controlled operations, with the facility for interrupts to be generated by the end of a conversion, by a regular timer/counter output, on FIFO status or by an external signal
- Example software
- LabVIEW compatible, including advanced acquisition trigger modes
- PCI230/260 backward compatible

## 1.4 General Description

The PCI230+/260+ range of boards provide multi-channel data acquisition functions for any PC that supports PCI bus version 2.1.

All models are supported by Windows 98, NT, 2000, and XP drivers. These drivers allow the advanced features of the boards to be fully utilised by the application software. The Windows 98 driver is also compatible with Windows 95.

Linux Comedi drivers are available from www.comedi.org.

**PCI230+** Provides 16 channel, FIFO buffered, 16-bit analog-to-digital input facilities and two-channel, FIFO buffered, 12-bit, digital-to-analog output with interrupt control. It also provides 24 bits of parallel digital input/output and three 16-bit counter/timers.

**PCI260+** Provides 16 channel, FIFO buffered, 16-bit analog to digital input facilities and three 16-bit counter/timers only.

### 1.4.1 Enhanced Features

The PCI230+ and PCI260+ support all relevant features of the earlier ISA bus products, i.e. the PC30AT and the PC26AT. In addition the PCI230+/260+ have many advanced features.

In common with the earlier PCI230/260, the PCI230+ and PCI260+ both have a 4096-sample FIFO for buffering input samples from the A/D converter. The boards can be set up to store samples in the FIFO autonomously until the FIFO is full, at which time the board will issue an interrupt to the PC. In many cases this will give vast performance advantages allowing the processor much more time between requests to service the board.

To further enhance acquisition flexibility, the PCI230+/260+ have advanced acquisition triggering modes that support an analog trigger on specified input (edge or level) with hysteresis and pre-trigger facility. Acquisitions can also be triggered from an external TTL input. These features greatly improve LabVIEW compatibility.

The PCI230+/260+ boards have true differential input capability. They can either have eight differential or 16 single-ended inputs.

Input signal protection was an option on earlier boards, the PCI230+/260+ boards include protection circuits on all analog and digital inputs as standard making them more tolerant of external fault conditions.

The PCI230+ now has a 1024 sample DAC FIFO that works to reduce the demands on the PC in the same way as the ADC FIFO. The DAC FIFO has a FIFO wrap mode that can be used to replay the same samples time and again allowing the card to be used for arbitrary waveform generation.

### 1.4.2 The Hardware

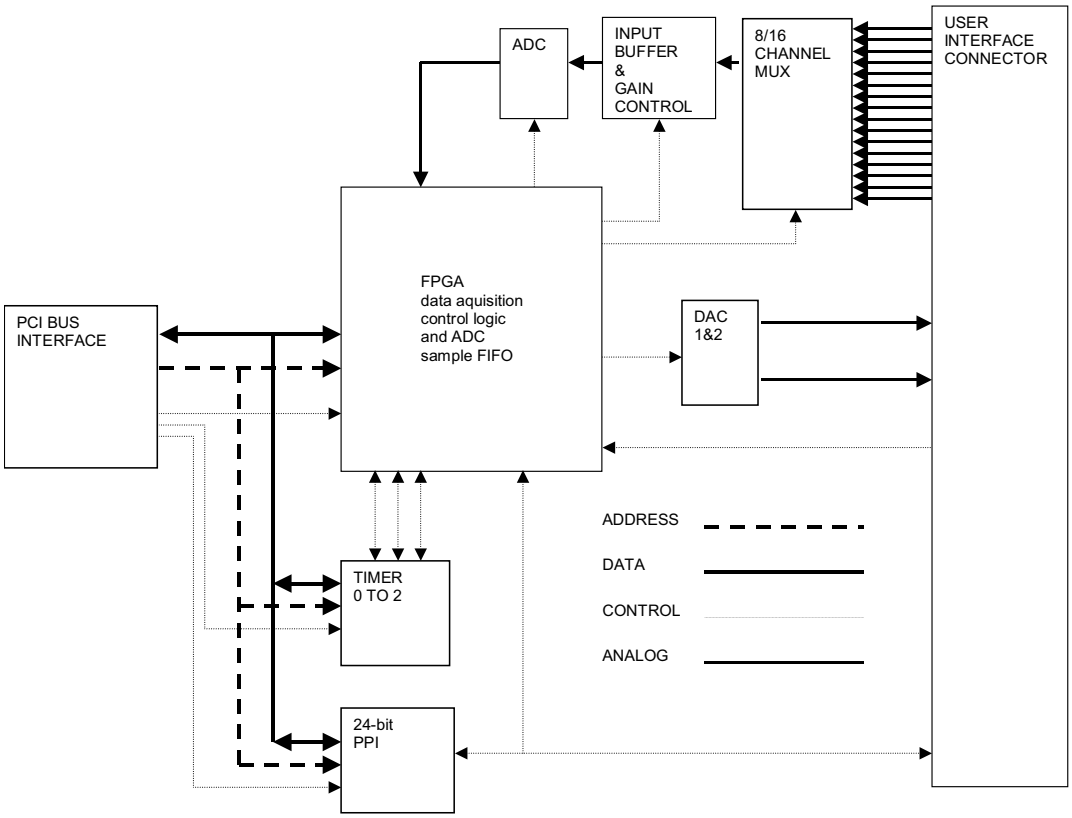


**FIGURE 1-1 PCI230+ BLOCK SCHEMATIC**

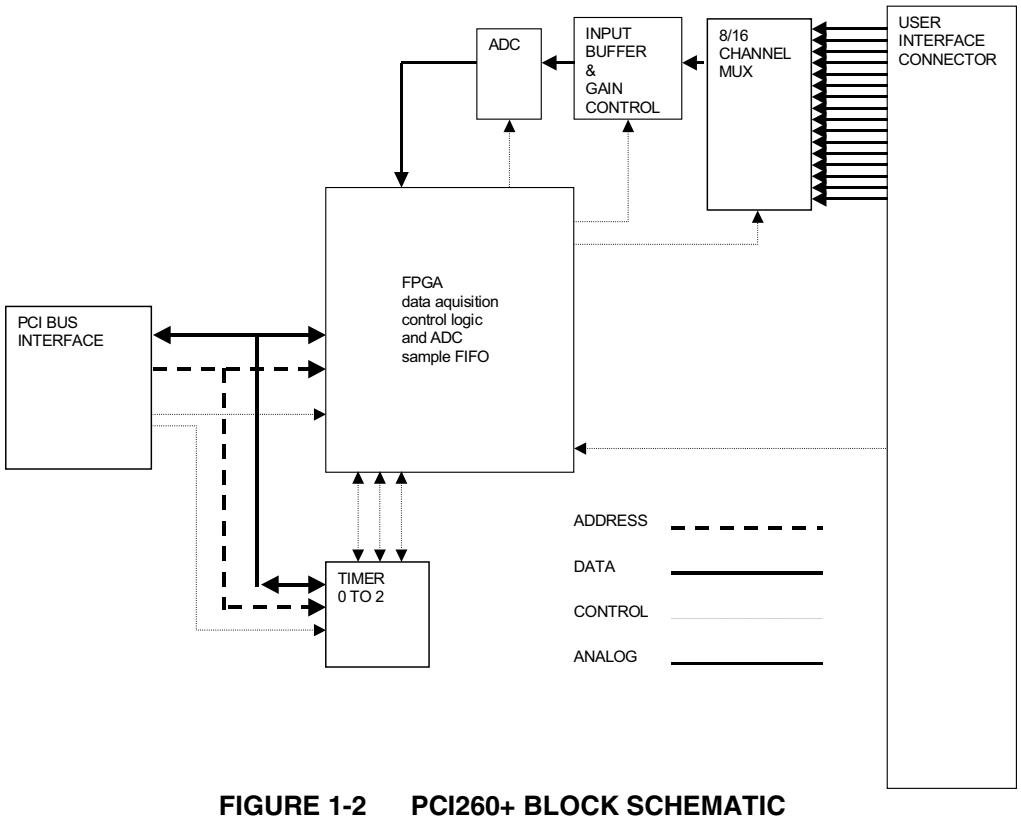


**FIGURE 1-2 PCI260+ BLOCK SCHEMATIC**

### 1.4.3 The Software

Software is supplied with the PCI230+/260+ on the SOFTMAN CD-ROM Part No 8698 6559 as part of the standard package. This package comprises Windows drivers and application examples and is documented in the Amplicon ADIO manual elsewhere on the CD ROM.

The distribution software is supplied on compact disk. Optional software is packed and supplied separately.

The Comedi drivers for Linux, available from www.comedi.org also support the PCI230+/260+ boards.

**Languages supported**

| | |
|---|---|
| Borland C/C++ | V4.5 or later |
| Microsoft Visual C/C++ | V4.2 or later |
| Borland Delphi | V3.0 or later |
| Visual Basic | V5.0 or later |
| Visual Basic.NET | Framework 1.1 or later |
| Borland C++Builder | V2.0 or later |
| Excel VBA | Office97 |
| Agilent VEE | V5 or later |
| LabVIEW | 6.0 or later |
| C#.NET | Framework 1.1 or later |

**Functions supported**

Initialisation
Analog Input
Analog Output
Analog and Digital Trigger
Digital I/O
Counter / timer operations
Interrupt Handling with buffer transfers as per the Windows 32 DIO Driver version 4.0 or later
LabVIEW Analog input: scope (with trigger), meter, chart recorder.
LabVIEW Analog output: function generator.
LabVIEW Counter timer: count events, generate pulse, generate frequency, generate strobes, simple frequency measurement

**Example programs**

Delphi, Visual Basic, VB.NET, Agilent VEE, LabVIEW, DAX, C#.NET

For the latest information on all software including example programs, functions, operating systems and languages supported, refer to the Amplicon website.

## 1.5 What the Package Contains

### ⚠ CAUTION

Some of the components on the board are susceptible to electrostatic discharge, and proper handling precautions should be observed. As a minimum, an earthed wrist strap must be worn when handling the PCI230+/260+ board outside its protective bag.

Full static handling procedures are defined in British Standards Publication BSEN100015/BSEN10015-1:1992

When removed from the bag, inspect the board for any obvious signs of damage and notify Amplicon if such damage is apparent. Do not plug a damaged board into the host computer. Keep the protective bag for possible future use in transporting the board.

The package as delivered from **Amplicon Liveline Ltd**. contains:-

1. The plug-in card as ordered, in a protective bag. The model will be one of the following, and is identified by the type number printed on the board.

| | | |
|---|---|---|
| PCI230+ | PCI Bus Analog input/output card | Part Nº 9605 2503 |
| PCI260+ | PCI Bus Analog input card | Part Nº 9605 2513 |

2. The included distribution software and manual on CD Part Nº 8698 6559

3. Any additional accessories (mating connectors, software etc.) may be packed separately.

## 1.6 The Amplicon Warranty Covering the PCI230+/260+

This product is covered by the warranty as detailed in the Terms and Conditions stated on the web site at www.amplicon.co.uk.

## 1.7 Contacting Amplicon Liveline Limited for Support or Service

The PCI230+/260+ boards are designed and manufactured by Amplicon Liveline Ltd and maintenance is available throughout the supported life of the product.

### 1.7.1 Technical Support

Should this product appear defective, please check the information in this manual and any 'Help' or 'READ.ME' files appropriate to the program in use to ensure that the product is being correctly applied.

If a problem persists, please request Technical Support in one of the following ways:

| | | |
|---|---|---|
| Telephone: | UK | 01273 944 835 |
| Fax: | UK | 01273 570 215 |
| Email | | support@amplicon.com |
| Web: | | www.amplicon.com |

It will assist the support engineer if you have the following information available when you call:

Date of purchase
Your postcode or your account number
The Operating System you are running under
The specification of your computer
The nature of your problem and the results of any tests you have conducted.

### 1.7.2 Repairs

If the PCI230+/260+ requires repair then please return the goods enclosing a repair order detailing the nature of the fault. If the PCI230+/260+ is still under warranty, there will be no repair charge unless any damage is a consequence of improper use.

For traceability when processing returned goods, a Returned Materials Authorisation (RMA) procedure is in operation. Before returning the goods, please request an individual RMA number by contacting Amplicon Technical Support. Give the reason for the return and, if the goods are still under warranty, the original invoice number and date. Repair turnaround time is normally five working days but the Service Engineers will always try to co-operate if there is a particular problem of time pressure.

Please mark the RMA number on the outside of the packaging to ensure that the package is accepted by the Goods Inwards Department.

Address repairs to:
The Service Department
AMPLICON LIVELINE LIMITED
Centenary Industrial Estate
Brighton, East Sussex
BN2 4AW
England

# 2 GETTING STARTED

## 2.1 General Information

The PCI230+/260+ cards are Plug and Play compatible and come complete with all the software required to install and operate the card in any PCI version 2.1 compliant host PC running under Windows 95, 98, NT, 2000, or XP and allow full card functionality.

## 2.2 Host Computer Requirements

When installing one or more PCI230+/260+ series boards, ensure that the host computer has sufficient capacity. Take into account other boards or adapters that may be installed in the computer when assessing physical space, address space in the I/O map, interrupt levels and the power requirements.

This analog interface board is suitable for use in any PC compatible computer that can provide a single PCI Bus version 2.1 slot, with sufficient space for a half-length card.

In certain circumstances the card can be used in non PCI 2.1 compliant PCI systems that do not provide 3.3 volt power supply to the PCI bus connector. The card has a jumper selectable option to derive its own 3.3 volt supply from the 5 volt supply.

The computer must run under one of the following operating systems. Windows 95, Windows 98, Windows NT 4.0, Windows 2000, Windows XP or Linux.

## 2.3 Installing the Board

**CAUTION**

**BEFORE INSTALLING THE CARD IN THE PC ENSURE THAT THE POWER SUPPLY JUMPER, 'J3' IS IN THE CORRECT POSITION.**

**ENSURE THAT THE POWER TO THE COMPUTER IS SWITCHED OFF BEFORE INSTALLING OR REMOVING ANY EXPANSION BOARD. OBSERVE HANDLING PRECAUTIONS NOTED IN SECTION 1.4.**

**REPAIR OF DAMAGE CAUSED BY MIS-HANDLING IS NOT COVERED UNDER THE AMPLICON WARRANTY.**

**DO NOT MAKE ANY MODIFICATIONS TO A BOARD THAT IS ON EVALUATION**

### 2.3.1 Power Supply Jumper

Before inserting the card in your PC, please ensure that the power supply selection jumper 'J3' is in the correct position for your PC.

Most modern PCs with PCI bus revision 2.1 or later will provide a 3.3V power supply on the PCI connector. Therefore the jumper should not be moved from the 3V3 position before installation of the card in these PCs.

If you are sure that your PC does not have a 3.3V supply, but only a 5V power supply on the PCI connector, then fit jumper 'J3' in the 5V position.

If you are unsure in any way the please leave the jumper in the 3V3 position. Damage to the card or the PC could result from installing he card with the jumper in the 5V position when the PC already provides 3.3V to the PCI bus connector.

### 2.3.2 Hardware Installation

The PCI230+/260+ board is a Plug and Play device. The installation software supplied will handle the configuration of the board.

When the board is physically installed in the PC, and the PC is rebooted, The Windows 95, Windows 98, Windows 2000, or Windows XP operating system will detect new hardware and prompt for installation of the device drivers. Windows NT 4.0 will not be aware of the board until the drivers have been installed.

## 2.4 Software Installation

The ADIO software manual, supplied with this card has full details of Windows 32-bit driver installation information. Refer to the Amplicon website for the latest version of the manual.

### 2.4.1 Windows 95/98 Installation

The Windows 98 drivers supplied with this card are compatible with installation and operation under Windows 95.

**To install the drivers under Windows 95:**

1. Turn on the PC and allow the operating system to discover new hardware. Insert the SOFTMAN CD into the CD-ROM drive and click the ‘Next’ button on the first ‘Update Device Driver Wizard’ dialog.

2. If Windows fails to find the correct INF file automatically, click on the ‘Other Locations’ button, browse to the top-level directory of the SOFTMAN CD and click ‘OK’.

3. Windows should correctly identify the board as a PCI230+ or PCI260+. Click the ‘Finish’ button.

4. Windows will now proceed to copy the driver software from the CD. If Windows asks for the ‘Amplicon DIO Drivers Disk’ to be inserted, ensure the SOFTMAN CD is in the drive, click ‘OK’, click ‘Browse’, browse to the top-level directory of the SOFTMAN CD (which contains the file Windows is trying to find) and click ‘OK’.

5. When Windows has finished installing the driver software, click ‘Yes’ to restart the computer.

To install the example software, rerun Amplicon Softman CD and select the 'Access your manual and software' button, and then double click on the '32 bit'' software button for the PCI230+/260+. This will extract and run file AMPDIO.EXE on the SOFTMAN CD. Follow the instructions to install the samples onto your PC.

**To install the drivers under Windows 98:**

1. Turn on the PC and allow the operating system to discover new hardware. Insert the SOFTMAN CD into the CD-ROM drive. On the ‘Add New Hardware Wizard’ dialog, select the ‘Search for the best driver for your device’ option and click ‘Next’.

2. Make sure the ‘CD-ROM drive’ option is checked and click ‘Next’. If Windows fails to find the correct INF file, click ‘Back’, select the ‘Specify a location’ option, click the ‘Browse’ button, browse to the top-level directory of the SOFTMAN CD and click ‘OK’.

3. Windows should correctly identify the board as a PCI230+ or PCI260+. Click ‘Next’.

4. Windows will process to copy the driver software from the CD. When it has finished, click the ‘Finish’ button.

To install the example software, rerun Amplicon Softman CD and select the 'Access your manual and software' button, and then double click on the '32 bit'' software button for the PCI230+/260+. This will extract and run file AMPDIO.EXE on the SOFTMAN CD. Follow the instructions to install the samples onto your PC.

### 2.4.2 Windows NT 4.0 Installation

Please ensure that PLUG & PLAY OS (or equivalent) option on the BIOS settings screen is set to NO or OFF.

The driver is installed as part of the set-up process for the remaining software.

1. To install the example software, rerun Amplicon Softman CD and select the 'Access your manual and software' button, and then double click on the '32 bit'' software button for the PCI230+/260+. This will extract and run file ADIO32.EXE on the SOFTMAN CD. Follow the instructions to install the samples onto your PC.

2. After rebooting the PC, the PCI230+ or PCI260+ will be detected by the installed driver and configured automatically.

3. The Amplicon DIO control panel applet can be used to verify that the board has been detected. This will also show the base address and IRQ settings for the board.

### 2.4.3 Windows 2000/XP Installation

For AMPDIO software versions 4.32 and later, a ‘Plug and Play’ Windows 2000 driver is used. This section describes how to install a PCI card to use this Plug and Play driver under Windows 2000 or Windows XP.

**To install the drivers under Windows 2000:**

1. Turn on the PC and allow the operating system to discover new hardware. Insert the SOFTMAN CD into the CD-ROM drive. If Windows opens the ‘Welcome to the Found New Hardware Wizard’ page, press ‘Next’ and go to step 2. If Windows just asks for a disk labelled ‘Amplicon DIO Drivers Disk’ go to step 5.

2. Select the ‘Search for a suitable driver for my device (recommended)’ option and press ‘Next.

3. Check the ‘CD-ROM drives’ option. Press ‘Next’.

4. On the ‘Driver Files Search Results’ page, Windows should say ‘Windows found a driver for this device’. Press ‘Next’.

5. If Windows asks for a disk labelled ‘Amplicon DIO Drivers Disk’ when trying to copy files, click ‘OK’ to cancel the alert box, then browse to the root directory on the CD-ROM and press ‘Open’, then ‘OK’. Windows will copy the files and install the driver.

6. On the ‘Completing the Found New Hardware’ screen, Windows should correctly identify the device as a PCI230+ or PCI260+. Press ‘Finish’

**To install the drivers under Windows XP:**

1. If installing from CD-ROM rather than from the self-extract target directory, ensure the Amplicon SOFTMAN CD-ROM is in the CD-ROM drive.

2. When Windows detects the new hardware and opens the 'Welcome to the Found New Hardware Wizard' page, press 'Next'.

3. If installing from the CD-ROM, select the 'Install the software automatically (Recommended)' option. If installing from the self-extract target directory, select the 'Install from a list or specific location (Advanced)' option. Press 'Next'.

4. If installing from the self-extract target directory, select the 'Search for the best driver in these locations' option, deselect the 'Search removable media (Floppy, CD-ROM...)' option, select the 'Include this location in the search' option, press the 'Browse' button and browse to the self-extract target directory. Then press 'Next'.

5. Windows will install the driver and reach the 'Completing the Found New Hardware Wizard' page.

6. On the 'Completing the Found New Hardware Wizard' page, press 'Finish'.

To install the example software, rerun Amplicon Softman CD and select the 'Access your manual and software' button, and then double click on the '32 bit' software button for the PCI230+/260+. This will extract and run file AMPDIO.EXE on the SOFTMAN CD. Follow the instructions to install the samples onto your PC.

## 2.5 Card Configuration

### 2.5.1 Base Address Selection

The plug and play BIOS and/or operating system automatically sets the board’s base address when the system is started.

### 2.5.2 Interrupt Level Selection (IRQ)

The interrupt signal from each channel can be assigned to any appropriate IRQ available in the PC. The Plug and Play BIOS and/or operating system automatically sets the board’s IRQ level when the system is started.

The interrupt operations comply with the requirements laid down in the PCI Bus version 2.2 specification, allowing full IRQ sharing.

The PCI bus assigns PCI interrupts to PC IRQ levels and allows multiple PCI interrupts to share the same IRQ. The same IRQ level can be shared with other PCI boards in the PC.

The interrupt request line, signals the host PC (Permanent Master) that the PCI230+/260+ board requires service. The host PC acknowledges the interrupt and performs the required action using the appropriate interrupt service routine.

## 2.6 Application Software

Example application software, including source code for the applications and the DLL are supplied with the board. The software supplied with this card supports operation with Windows 95, 98, NT, 2000 and XP. Refer to the AMPDIO W32 DRIVERS document for details.

## 2.7 LabVIEW Software

Software supplied with the board allows the PCI230+ and PCI260+ to be used with the National Instruments LabVIEW package. It includes ready-to-use examples and a manual covering driver installation and LabVIEW configuration.

## 2.8 Installation Testing

### 2.8.1 Verifying Installation for Windows 95/98

**To verify the correct driver has been installed:**

(a) Use Windows Explorer to browse to the <WINDOWS>\system directory.
(b) Click on the AMPDIO.VXD file and select 'Properties' from the explorer 'File' menu.
(c) Click on the 'Version' tab on the properties dialog box.
(d) Verify that the file version is at least 4.11.

**To verify the card has been detected:**

(a) Open the Control Panel, e.g. via 'Start' -> 'Settings' -> 'Control Panel'.
(b) Double click the 'System' icon (or open it from the Control Panel's File menu).
(c) On the System Properties dialog box, click the 'Device Manager' tab.
(d) Click the 'View devices by type' radio button if this is not already selected.
(e) Look for and select the PCI card under the branch labeled 'Amplicon Analog/Digital IO Counter Timer Cards'.
(f) Check the device status message box to make sure the device appears to be working correctly.
(g) Click the 'Properties' button.
(h) On the prepares dialog box, check there are no resource conflicts and that the PCI card has been assigned an IRQ.

### 2.8.2 Verifying Installation for Windows NT 4.0

Please verify that the Windows NT build is at least 1381 (Service Pack 3). Ensure that the card has been correctly inserted into a slot on the PC's PCI bus and the PC has been rebooted.

**To verify the correct driver has been installed:**

(a) Use Windows NT Explorer to browse to the <WINDOWS>\system32\drivers directory.
(b) Click on the AMPDIO.SYS file and select to 'Properties' from the Explorer 'File' menu.
(c) Click on the 'Version' tab on the properties dialog box.
(d) Verify that the File version is at least 4.11.

**To verify the correct control panel extension has been installed:**

(a) Use Windows NT Explorer to browse to the Windows\system32 directory.
(b) Click on the AMPDIO.CPL file and select 'Properties' from the Explorer 'File' menu.
(c) Click on the 'Version' tab on the properties dialog box.
(d) Verify that the file version is at least 2.0.0.0.

**To verify that the driver is running:**

(a) Open the Control Panel, e.g. via 'Start' -> 'Settings' -> 'Control Panel'.
(b) Double click the 'Devices' icon (or open it from the Control Panel's File menu).
(c) Look down the list for the device called 'AmpDIO' and verify that its status is 'Started'.

**To verify that the driver has recognised the card:**

(a) Open the Control Panel, e.g. via 'Start' -> 'Settings' -> 'Control Panel'.
(b) Double click the 'Amplicon DIO' icon (or open it from the Control Panel's File menu).
(c) Select each of the 'DIO*n*' entries from the list in turn. For each selected entry, click the 'Settings' button.
(d) For one of the listed DIO*n* entries, the dialog box which pops up should list the PCI card type, its location on the PCI bus (e.g. 0/20) and a status in square brackets. If the status says '[OK]', then a card of the indicated type has been detected at the indicated location on the PCI bus.

**N.B.:**
(a) If any of the DIO*n* entries correspond to ISA cards, a different dialog box will be shown when 'Settings' is clicked for that entry.
(b) If there are 8 DIO*n* entries DIO0 through DIO7 and the new card does not appear to be amongst them or appears to be marked '[BAD]'. The new card may have been detected but not used by the driver. Try deleting one of the DIO*n* entries. If the 'Add PCI' button becomes active, click it and see if the new card appears in the drop-down list of cards.
(c) PCI cards will also be marked '[BAD]' if the driver has not been started since the system was last rebooted (e.g. if has been set to start manually).

### 2.8.3 Verifying Installation for Windows 2000

**To verify the correct driver has been installed:**

(a) Use Windows 2000 Explorer to browse to the <WINDOWS>\system32\drivers directory.
(b) Click on the AMPDIO2K.SYS file and select 'Properties' from the explorer 'File' menu.
(c) Click on the 'Version' tab on the properties dialog box.
(d) Verify that the file version is at least 4.32.
(e) Use Windows 2000 Explorer to browse to the <WINDOWS>\system32 directory.
(f) Click on the AMPDIOCO.DLL file and select 'Properties' from the explorer 'File' menu.
(g) Click on the 'Version' tab on the properties dialog box.
(h) Verify that the file version is at least 4.32.

**To verify the card has been detected:**

(a) Open the Control Panel, e.g. via 'Start' -> 'Settings' -> 'Control Panel'.
(b) Double click the 'System' icon (or open it from the Control Panel's File menu).
(c) On the System Properties dialog box, click the 'Hardware' tab and press the 'Device Manager' button.
(d) On the Device Manager dialog box, ensure the 'Devices by type' option is selected on the 'View' menu.

(e) Look for and select the PCI card under the branch labeled ‘Amplicon Analog/Digital IO Counter Timer Cards’.
(f) Double click on the selected card (or select ‘Properties’ on the File menu).
(g) Check the device status message box to make sure the device appears to be working correctly.
(h) Click the ‘Settings’ tab and check that the card has been assigned a valid DIO port.
(i) Click the ‘Resources’ tab, check there are no resource conflicts and that the PCI card has been assigned an IRQ.

### 2.8.4 Verifying Installation for Windows XP

**To verify the correct driver has been installed:**

(a) Use Windows Explorer to browse to the <WINDOWS>\system32\drivers directory.
(b) Click on the AMPDIO2K.SYS file and select 'Properties' from the explorer 'File' menu.
(c) Click on the 'Version' tab on the properties dialog box.
(d) Verify that the file version is at least 4.32.
(e) Use Windows Explorer to browse to the <WINDOWS>\system32 directory.
(f) Click on the AMPDIOCO.DLL file and select 'Properties' from the explorer 'File' menu.
(g) Click on the 'Version' tab on the properties dialog box.
(h) Verify that the file version is at least 4.32.

**To verify the card has been detected:**

(a) Open the Control Panel, e.g. via 'Start' -> 'Control Panel' -> 'Performance and Maintenance'.
(b) Double click the 'System' icon.
(c) On the System Properties dialog box, click the 'Hardware' tab and press the 'Device Manager' button.
(d) On the Device Manager dialog box, ensure the 'Devices by type' option is selected on the 'View' menu.
(e) Look for and select the PCI card under the branch labeled 'Amplicon Analog/Digital IO Counter Timer Cards'.
(f) Double click on the selected card (or select 'Properties' on the File menu).
(g) Check the device status message box to make sure the device appears to be working correctly.
(h) Click the 'Settings' tab and check that the card has been assigned a valid DIO port number.
(i) Click the 'Resources' tab, check there are no resource conflicts and that the PCI card has been assigned an IRQ.

# 3 MAKING THE CONNECTIONS

This chapter describes the signal and control connections that the user can make between the PCI230+/260+ and any external devices. These input/output connections are made through the D-type connector protruding from the PC adapter slot corresponding to the chosen board position. The metal shell is connected to the local PC chassis ground. All signals are referred to the relevant signal ground.

## 3.1 PCI230+/260+ User Interface Connector pin assignments

Pin assignments for the PCI230+ 50 way connector SK1 are as shown in Figure 3.1. The pin assignments for the PCI260+ 25 way plug PL1 are shown in Figure 3.2.

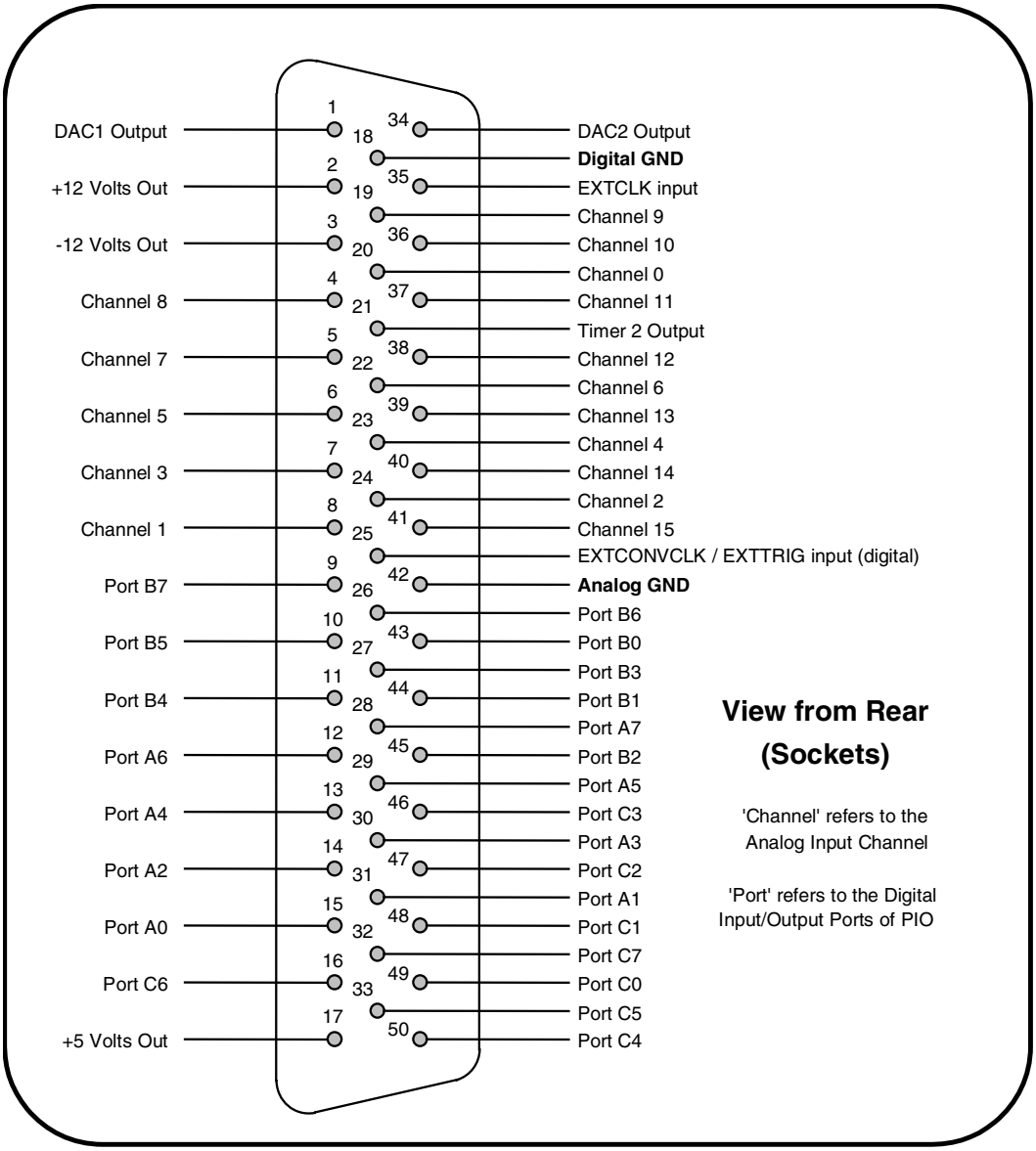


**FIGURE 3-1 PCI230+ SK1 50 WAY USER INTERFACE PIN DESIGNATIONS**

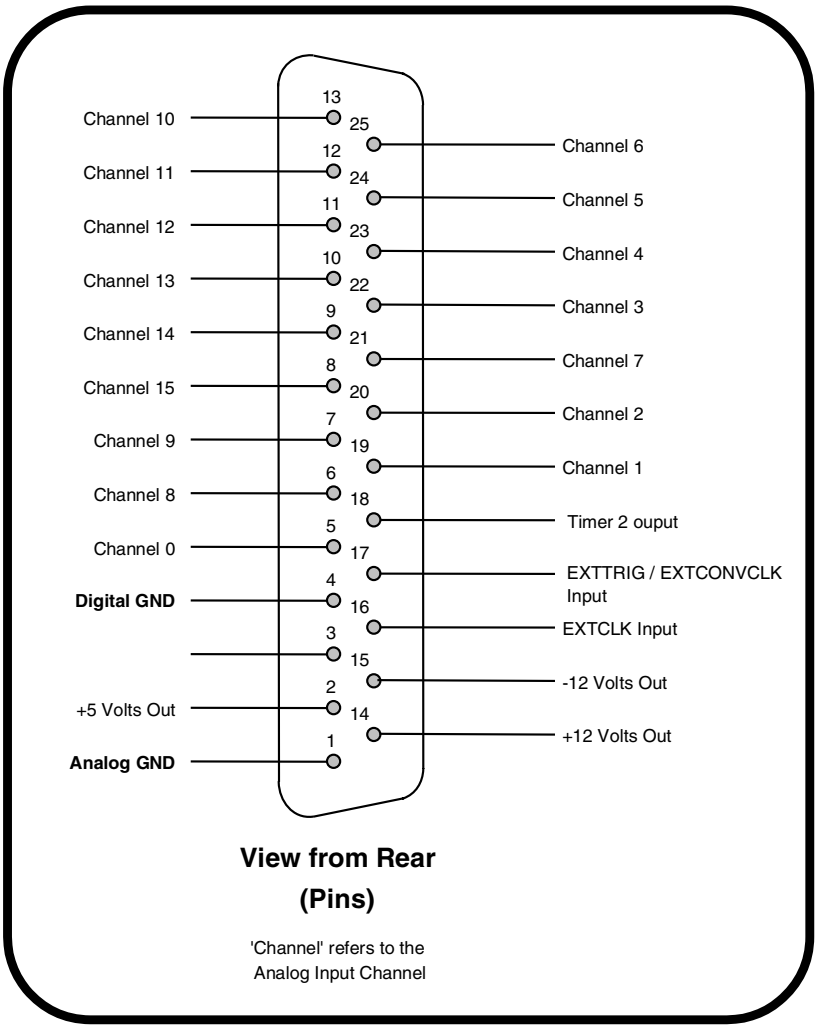


**FIGURE 3-2 PCI260+ PL1 25 WAY USER INTERFACE PIN DESIGNATIONS**

## 3.2 Pin Descriptions

### 3.2.1 Power and ground connections

| Pin name | Function |
|---|---|
| Analog GND | Ground reference connection for analog circuitry |
| +12 Volts Out | + 12 volt power supply for external analog circuitry, fused at 300mA |
| -12 Volts Out | - 12 volt power supply for external analog circuitry, fused at 300mA |
| +5 Volts Out | + 5 volt power supply for external circuitry, fused at 300mA |
| Digital GND | Ground reference connection for digital circuitry |

### 3.2.2 ADC Acquisition Control signals

| Pin name | Function |
|---|---|
| EXTCLK | External clock input for use by counter timers |
| EXTCONVCLK/ EXTTRIG | External ADC sample conversion clock, or External advanced digital acquisition trigger input |

### 3.2.3 ADC Input signals

| Pin name | Function | |
|---|---|---|
| | Single-ended mode | Differential mode |
| Channel 0 | Analog input 0 | Differential input 0 + |
| Channel 1 | Analog input 1 | Differential input 0 - |
| Channel 2 | Analog input 2 | Differential input 1 + |
| Channel 3 | Analog input 3 | Differential input 1 - |
| Channel 4 | Analog input 4 | Differential input 2 + |
| Channel 5 | Analog input 5 | Differential input 2 - |
| Channel 6 | Analog input 6 | Differential input 3 + |
| Channel 7 | Analog input 7 | Differential input 3 - |
| Channel 8 | Analog input 8 | Differential input 4 + |
| Channel 9 | Analog input 9 | Differential input 4 - |
| Channel 10 | Analog input 10 | Differential input 5 + |
| Channel 11 | Analog input 11 | Differential input 5 - |
| Channel 12 | Analog input 12 | Differential input 6 + |
| Channel 13 | Analog input 13 | Differential input 6 - |
| Channel 14 | Analog input 14 | Differential input 7 + |
| Channel 15 | Analog input 15 | Differential input 7 - |

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### 3.2.4 PCI230+ Digital to Analog converter Outputs

| Pin name | Function |
|---|---|
| DAC1 Output | Analog output for DAC channel 1 |
| DAC2 Output | Analog output for DAC channel 2 |

### 3.2.5 PCI230+ Digital I/O signals

| Pin name | Function |
|---|---|
| Port A0:7 | PPI port A I/0 Pins 0 to 7 |
| Port B0:7 | PPI port B I/0 Pins 0 to 7 |
| Port C0 | PPI port C I/0 Pin 0, External CLK or GATE input to counter timer 0, or External Interrupt |
| Port C1 | PPI port C I/0 Pin 0, External CLK or GATE input to counter timer 1 |
| Port C2 | PPI port C I/0 Pin 0, External CLK or GATE to counter timer 2 |
| Port C3 | PPI port C I/0 Pin 0, or External Interrupt |
| Port C4:7 | PPI port C, I/0 Pins 4 to 7 |

## 3.3 Signal Termination Assemblies

Connections to the PCI230+/260+ I/O lines are made via D-Type connectors on the rear panel. The on-board connectors are 50 way female for the PCI230+ SK1 and 25 way male for the PCI260+ PL1. The mating connectors are available as accessories. Provision is made for securing by screw jacks. The following cables and connection assemblies are available from Amplicon:

| Amplicon Part Number | Device |
|---|---|
| 9096 5132 | 50 way screw termination assembly (female) for PCI230+ |
| 9096 6359 | 50 way 1 metre connecting cable (male to male) for PCI230+ |
| 9099 1952 | 25 way screw termination assembly (female) for PCI260+ |
| 9095 6179 | 25 way 1 metre connecting cable (male to female) for PCI260+ |

### 3.3.1 PCI230+ Screw Termination Assembly

A screw terminal assembly and interconnecting cable of 1 metre length can be supplied as optional accessories. See above for product codes and descriptions.

The screw terminal assembly is installed outside of the PC, within the reach of the interconnecting cable, and can be mounted on a DIN rail if desired. The terminal numbers correspond to the 50 way connector pin-out.

Terminal M connected to the shell of the D type connector. Terminal C, not connected.

### 3.3.2 PCI260+ Screw Termination Assembly

A screw terminal assembly and interconnecting cable of 1 metre length can be supplied as optional accessories. See above for product codes and descriptions.

The screw terminal assembly is installed outside of the PC, within the reach of the interconnecting cable, and can be mounted on a DIN rail if desired. The terminal numbers correspond to the 25 way connector pin-out.

### 3.4 Analog Inputs

There are 16 channels for analog input signals and these are designated channel numbers 0 through 15 (Ch0 to Ch15).

In differential mode eight differential inputs are formed from adjacent pairs of input channels.

It is important that no input voltage is allowed to exceed the limits of the input protection circuitry, i.e. input voltage must not exceed ±20 V dc.

### 3.5 Use of Shielded Cables

The standard, optional cables are shielded, and if the user manufactures custom cables for use in a severe or noisy environment, it is advisable to use overall shielded cables.

### 3.6 The Ground Connections

Each connector is equipped with one or more different ground connections and care must be taken in the use of these grounds and the cable design to ensure that the EMC requirements are met.

The choice of proper, screened cables is important for the system to maintain Electro-Magnetic Compatibility.

To preserve the integrity of the PCI230+/260+ analog input/output accuracies, care must be taken to employ the correct connection techniques.

The analog inputs can be single-ended or differential.

By single-ended we mean signals that are defined by the difference in voltage between one line (denoted signal) and a common return line (denoted ground). Each of the 'signal' lines should be wired to the appropriate Channel # pin on the I/O connector.

Restricted connector space allows the allocation of only one common return / ground pin for all analog input/output signals to the PCI230+/260+, and this pin (SK1/42 on the PCI230+ & PL1/1 on the PCI260+) is therefore common to analog input and output channels. Digital I/O lines are referred to a second ground pin at SK1/18 on the PCI230+ and PL1/4 on the PCI260+. Connections for single-ended analog input and output for the PCI230+ are shown diagrammatically below.

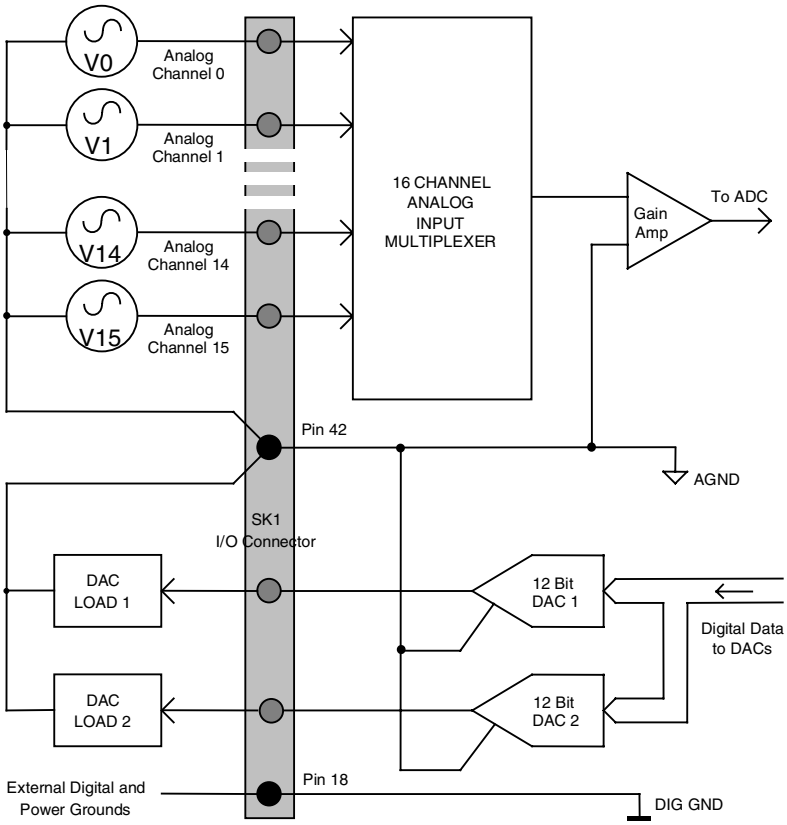



**FIGURE 3-3 ANALOG INPUT/OUTPUT WIRING**

To maintain measurement accuracy, the following precautions must be observed:-

- Use separate ground wires for analog input, analog output, digital I/O and power lines. Keep the common ground impedance to a minimum by making the ground point as close as possible to the PCI230+/260+ I/O connector or terminal block, and/or use a heavier gauge wire for the ground connection.

- If analog input lines are long, each line should be individually shielded to keep noise pick-up to a minimum. The shield can be the signal return wire in which case it will be connected at each end, or if twin (signal and return) shielded cables are used, it may be advantageous to connect the shield at one end only.

- In order to reduce the absolute gain error to less than one least significant bit all devices connected to the analog inputs should have a source impedance of less than 15Ω.

- Input voltages must not exceed the full scale for the selected range.

# 4 USING THE PCI230+/260+

This chapter describes the various hardware operations associated with implementing the user's application. Programming operations are discussed in the Amplicon ADIO driver manual elsewhere on the SOFTMAN CD ROM. Details of the registers and software are given in chapters 5 and 6 respectively.

Reference should also be made to chapter 2 'Getting Started' and chapter 3 'Making the Connections' before implementing any of the described operations.

## 4.1 Analog Inputs

There are 16 channels of analog input and these are designated channel numbers 0 through 15 (Ch0 to Ch15). The signal on the addressed channel is selected by the multiplexer, internally normalised by the gain stage and applied to the Analog to Digital Converter (ADC) input for conversion to digital form.

In differential mode eight differential inputs are formed from adjacent pairs of input channels.

It is important that no input voltage is allowed to exceed the limits of the input protection circuitry, i.e. input voltage must not exceed ±20 V dc.

The digital data available from the ADC is a 16-bit conversion result. See Figure 4-3, for a description of the ADC output codes.

## 4.2 Analog Input Voltage Range

The input voltage range is established by the gain setting of the analog amplifiers preceding the ADC. The voltage range is set by means of software.

| Unipolar input voltage range | Bipolar input voltage range |
|---|---|
| | ±10 |
| 0-10 | ±5 |
| 0-5 | ±2.5 |
| 0-2.5 | ±1.25 |

**FIGURE 4-1 INPUT VOLTAGE RANGES**

## 4.3 Analog Input FIFO

Samples taken by the ADC are passed to a 4096 sample first in first out (FIFO) memory. This means that the card can store samples locally and interrupt the host PC when there are enough samples to be collected. This reduces the load on the processor as data transfers over the PCI bus are much faster when multiple samples are transferred.

More importantly, when running under multi-tasking operating systems such as Windows NT, 95, 98, 2000 & XP, response to interrupts may be very slow. If the processor is busy on a different task at the time an interrupt comes from the PCI230+/260+ it may take considerable time before the interrupt is serviced.

If there was no FIFO and the card could only store one sample at once, this would greatly limit the maximum usable sample rate of the ADC. There would be a chance of missing samples if the next one came before the previous one was read by the host.

The FIFO allows many samples to be stored locally preventing samples from being overwritten before the host can respond to the PCI230+/260+ interrupt. This feature greatly extends the maximum sample rate of the system for multi-tasking operating systems.

The PCI230+/260+ introduces two new FIFO features. The FIFO level can now be read by the system software at any time. There is a new user programmable FIFO threshold register. The FIFO can now be set to generate an interrupt to the host when the FIFO level reaches the threshold. The PCI230+/260+ implements the FIFO in the programmable logic inside the Field Programmable Gate Array (FPGA).

## 4.4 Analog Input Modes

### 4.4.1 Software Controlled Sampling

The ADC can be made to take a single sample under direct software control when deterministic sample timing is unimportant.

To complete an A/D conversion cycle under software control, first set the card into software controlled mode and select the desired channel. Then initiate a conversion.

The ADC data word is read as one sixteen bit word.

### 4.4.2 Hardware Controlled Sampling

In this mode sample timing is controlled by a hardware generated clock. It has none of the variable timing latency associated with software driven conversions and is used for acquiring continuous time signals. The sample clock may come from one of the 82C54 counter/timers or the external control input EXTCONVCLK / EXTTRIG if required.

If we take the most simple case where a number of samples are acquired from a single analog channel, typically the driver software will use one of the counters to generate the sample conversion clock. It will program the counter as a pulse generator at the required sampling interval. The clocking frequency of each counter can be:

- The counter/timers CLK Input from the SK1 connector
- The Internal 10MHz clock
- The Internal 1MHz clock
- The Internal 100kHz clock
- The Internal 10kHz clock
- The Internal 1 kHz clock
- The output of the preceding counter/timer
- The dedicated external clock input.

The counter divide ratio loaded into the counter determines the frequency of the conversion command signals. A single counter provides time intervals (frequencies) programmable in the range 2.0 µSecs (500 kHz) to over 65 seconds. Longer periods can be obtained by cascading counters.

Alternatively the conversion clock source may be from an external trigger input.

At the end of the conversion, the sample is transferred to the FIFO, if the FIFO is enabled. Otherwise an interrupt request IRQ is transmitted to the PC.

Dependent on how the system has been configured by the software and if the FIFO is enabled, an interrupt request, IRQ, is transmitted to the PC when the FIFO is;

- Empty
- Half Full
- Full
- Level reaches the user programmable threshold.

### 4.4.3 Sampling Multiple Channels (Channelling)

The arrangement of the counter/timers on the PCI230+/260+ is flexible enough to allow optimal multiple channel acquisition.

If more than one channel is enabled, each time a sample is initiated, the card automatically samples the next channel in ascending number order from the channels enabled in the ADC channel enable register.

In this way the card automatically cycles all analog inputs building up results sequentially in the FIFO if it is enabled.

If a 'scan' is defined as the act of taking a single sample from all enabled channels, one counter/timer is configured as a rate generator and used to control the interval between scans. The output of this counter/timer is used to trigger a 'one shot' monostable function of another timer. This 'one shot' output is used to gate another counter/timer set as a rate generator. This counter/timer generates the conversion clock to the ADC. The length of the one shot is set to gate one conversion clock for each enabled channel. The conversion clock counter/timer frequency controls the 'inter-channel delay' (time between taking samples from successive channels). In some applications it is important to take samples from all enabled channels as close in time to each other as practical. Some time is required to allow time for the analog multiplexer to switch, the input amplifier to settle, and the ADC to acquire and convert the signal. The inter-channel delay is therefore set so be as short as practical.

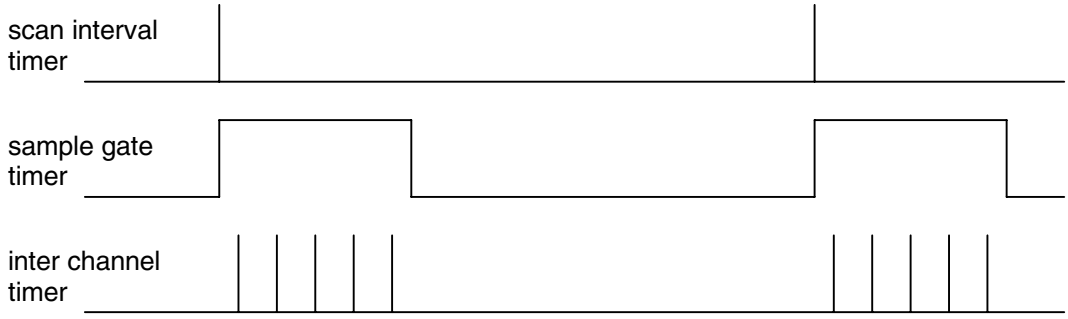



**FIGURE 4-2 MULTI CHANNEL ACQUISITION WITH FIVE CHANNELS ENABLED**

### 4.4.4 Advanced Acquisition Trigger

The PCI230+/260+ introduces the concept of the acquisition trigger. The acquisition trigger is used to initiate the acquisition of a number of samples at the pre-programmed sample rate on occurrence of a trigger event. The samples are stored in the FIFO until the acquisition ends. When all samples have been taken, the acquisition terminates and the PCI230+/260+ awaits the next acquisition trigger event

If more than one channel is enabled the PCI230+/260+ automatically changes channels each time a sample is taken.

There are currently two sources of acquisition trigger event:

### 4.4.5 External Digital Trigger

This new trigger mode will trigger one complete (programmable length) buffer's worth of sample data to be acquired from the ADC when the external trigger input to the card becomes active. It can be configured to be active high or low and edge or level triggered.

### 4.4.6 Analog Trigger

This new trigger mode will trigger one complete buffer's worth of sample data to be acquired from the ADC when the selected analog input crosses a pre-programmed threshold. The trigger can be configured to become active when the signal is above or below the trigger threshold. This is called level trigger. Alternatively the trigger can be configured to become active when the signal rises above or falls below the trigger threshold. This is called edge trigger mode and will suit oscilloscope type applications amongst others. This trigger mode supports trigger threshold hysteresis and variable depth pre-trigger sample storage.

### 4.4.7 Analog Trigger Hysteresis

The analog trigger function, when in edge trigger mode has a variable analog trigger hysteresis feature. In rising/falling edge trigger mode the analog input must fall/rise below the hysteresis level before the trigger is armed. Otherwise when the Analog trigger is set to rising edge mode for example, it would be possible that any noise present on the signal around the falling edge could cause the trigger to be activated.

### 4.4.8 Pre-Trigger

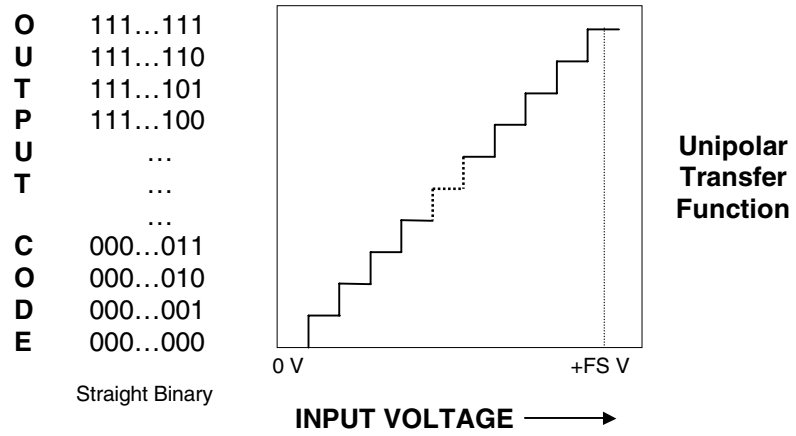
The Analog trigger mode supports a variable depth 'pre-trigger' function. This allows samples from before the trigger event to be stored so the user can record the signal immediately prior to the trigger event. This mode is useful in Oscilloscope type applications.

### 4.4.9 Automatic offset calibration

The PCI230+/260+ includes the facility to calculate and calibrate for voltage offsets within the analog input circuitry. A 'state machine' exists within the FPGA that automatically calculates the zero voltage offset by connecting the differential amplifier inputs together and taking an ADC sample for each gain setting in both bipolar and unipolar modes. In this way the zero input offset voltages are calculated for each gain and range setting. These offset values are calculated when power is applied to the PCI230+ and stored within the FPGA. Offset corrected ADC samples are calculated during operation.

### 4.4.10 ADC Transfer Functions

The ADC transfer functions for unipolar and bipolar operation, when programmed for complementary or straight binary output are shown diagrammatically below.



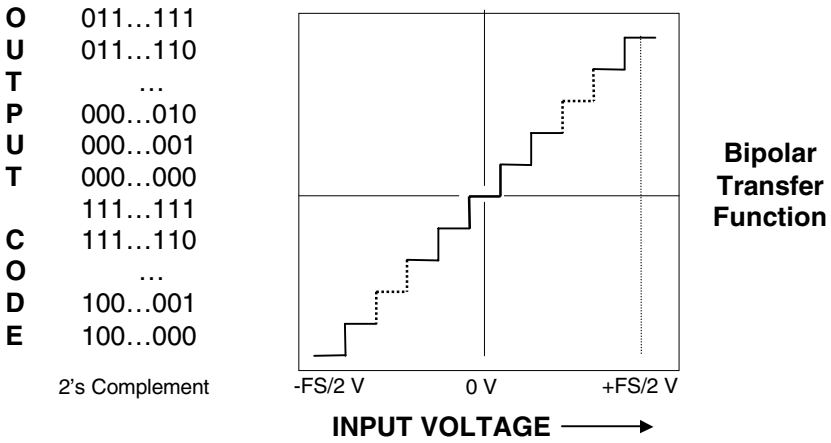




**FIGURE 4-3 ANALOG TO DIGITAL CONVERTER OUTPUT CODES**

Normally straight binary is used for unipolar operation and 2's compliment for bipolar operation and from the diagrams it can be seen that the following values will be returned as conversion results:

**Unipolar Operation (straight binary)**

| Input Voltage | Returned Value (hex) | Returned Value (dec) |
|---|---|---|
| Zero | 0 | 0 |
| Half Full Scale (+1/2 V) | 8000 | 32768 |
| Full Scale (+V) | FFFF | 65535 |

**Bipolar Operation (2's compliment)**

| Input Voltage | Returned Value (hex) | Returned Value (dec) |
|---|---|---|
| Negative Full Scale (–V) | 8000 | –32768 |
| Zero | 0 | 0 |
| Full Scale (+V) | 7FFF | 32767 |

## 4.5 Analog Outputs (PCI230+ Only)

The PCI230+ provides two channels of analog output, from individual digital to analog converters. The two channels are labeled DAC 1 and DAC 2 on the I/O connector. The output ranges of the DACs can be selected to be unipolar (0 to +10 volts) or bipolar (±10 volts). Selection is made in software by writing to the DACCON register.

**NB** the output ranges of both DACs change together, i.e. they are both bipolar or both unipolar.

DAC 1 and DAC 2 provide 12-bit digital to analog conversion. The 12 significant bits are written into the 12 most significant bits of a 16-bit word that is written to the converter. The least significant four bits of the word default to zero and are reserved to allow for future expansion. Data values must be written according to the following table:-

**Unipolar Operation**

Writing 0 to DAC 1 or 2, gives 0 volts output.
Writing 65520 ($FFF0_{16}$) gives +10 volts output.

**Bipolar Operation**

Writing –32768 ($8000_{16}$) gives –10 volts output.
Writing 32752 ($7FF0_{16}$) to DAC 1 or 2 gives +10 volts output.
Writing 0 gives 0 volts output.

## 4.6 Analog Output Modes (PCI230+ Only)

### 4.6.1 Software Controlled D/A Conversion

D/A conversion is activated by writing the 16-bit data directly into the DACs (the 4 least-significant bits are ignored). Conversion begins as soon as the value is written.

### 4.6.2 Interrupt Controlled D/A Conversion

In this mode, one or two channels may be enabled and all enabled channels are written when a conversion (scan) trigger occurs. Conversion (scan) timing is controlled by a hardware generated clock. It has none of the variable timing latency associated with software driven conversions and is used for outputting continuous time signals. The conversion (scan) clock may come from one of the 82C54 counter/timers or the external control input EXTCONVCLK / EXTTRIG if required.

The driver software will use one of the counters to generate the conversion (scan) clock. It will program the counter as a pulse generator at the required sampling interval. The clocking frequency of each counter can be:

- The counter/timers CLK Input from the SK1 connector
- The Internal 10MHz clock
- The Internal 1MHz clock
- The Internal 100kHz clock
- The Internal 10kHz clock
- The Internal 1 kHz clock
- The output of the preceding counter/timer
- The dedicated external clock input.

The counter divide ratio loaded into the counter determines the frequency of the conversion command signals. A single counter provides time intervals (frequencies) programmable in the range 4.0 µSecs (250 kHz) to over 65 seconds. Longer periods can be obtained by cascading counters.

Alternatively the conversion clock source may be from an external trigger input.

At the start of the conversion, samples are transferred from the DAC FIFO (if the FIFO is enabled) or from the driver's buffer (if using timer interrupts) to each of the enabled DAC channels.

Dependent on how the system has been configured by the software and whether the FIFO is enabled, an interrupt request, IRQ, is transmitted to the PC when the FIFO is;

- Empty
- Half Full
- Full

The software may be configured to use timer interrupts instead of the DAC FIFO. In this case, the driver will be programmed to write to the enabled DAC channels when there is a rising edge on the output of counter channel 1. The counter channel is programmed to generate such interrupts at the required rate.

If the DAC FIFO is not being used, the EXTCONVCLK / EXTTRIG input cannot be used to generate an interrupt to trigger a conversion, but interrupts can be generated on a rising edge of PPI port C0 or port C3 instead to achieve the same effect. Bits C0 to C3 of the PPI chip should be programmed as inputs to do this.

If the DAC FIFO is not being used and individual timer or external interrupts are used instead, the DAC update interval is subject to jitter caused by interrupt latency within the system.

### 4.6.3 Power Supplies

Power Supplies. Both positive and negative supply voltages to the DACs and associated analog circuitry are derived from the PCI bus's +12 and –12 volt power supplies. Inductor and capacitor filters are employed to prevent noise from the PC appearing on the DAC outputs. Ground connection between digital and analog systems is at a single star point.

## 4.7 PPI Digital Inputs and Outputs (PCI230+ Only)

The PCI230+ has an 82C55 Programmable Peripheral Interface (PPI) chip with all functions of ports A and B, and optionally port C, available to the user. All 24 I/O pins of the user PPI are brought out to the 50 way D-type connector, and can be used to control other external devices, or to accept control inputs from an external device. Some port C lines are shared with other functions.

### 4.7.1 PCI230+ PPI Port Shared I/O Connections

The PPI port C connections have shared functionality. Four of the port C I/O pins with corresponding I/O connector pins (PC0 on SK1/49, PC1 on SK1/48, PC2 on SK1/47, and PC3 on SK1/46,) are routed to the on-board FPGA for possible internal or external input/output to the system. The function of each line can be set by software to provide one of several possibilities as shown in Figure 4-4.

When external signals are connected via SK1, then the low and/or high half byte of the PPI port C as appropriate must be programmed as input and the input signal voltage must not exceed +5.3 V. The Windows device driver will take care of this.

| SK1 PIN | PPI PORT | ALTERNATE FUNCTION |
|---|---|---|
| 49 | PC0 | Ext. Clock to CLK0 Input, GATE for counter 0 or External Interrupt input |
| 48 | PC1 | Ext. Clock to CLK1 Input or GATE for counter 1 |
| 47 | PC2 | Ext. Clock to CLK2 Input or GATE for counter 2 |
| 46 | PC3 | External Interrupt input |

**FIGURE 4-4 PCI230+ PPI PORT SHARED I/O CONNECTIONS**

### 4.7.2 Digital Input/Output Conditions

Brief specifications of the digital input/output lines on ports A, B and C are:-

Inputs - 'Low' input voltage -0.3v to +0.8v. ) TTL
'High' input voltage +2.2v to +5.3v. ) compatible

When an input line is left open circuit, the state is indeterminate. Ensure that signals to any inputs are within the above limits, and that any unused input lines are grounded or masked out in software.

Outputs - 'Low' output voltage, +0.4v max. at 2.5 mA
'High' output voltage, +3.7v min at –2.5 mA.

### 4.7.3 Intersil 82C55 Differences from Oki 82C55

In order to meet RoHS compliance, the OKI 82C55 chip originally fitted on non-RoHS compliant revisions of this board has been replaced with an Intersil 82C55 chip. The Intersil 82C55 has an added feature to the I/O buffer called Bus Hold which can hold either a 0 or 1 depending on the circuitry attached.

The bus hold feature affects the behavior of the device when its data lines are configured as inputs. When a digital I/O line is configured as input, its value is normally defined by the driver driving that line. When there is no driver, then the value can be defined using pull resistors (a pull up will define a '1' value, and a pull down resistor will define a '0' value). The boards with the Intersil part have additionally a feature called a "bus hold". This element will remember the last value that line was driven to and will try to hold that value by driving the line weakly (similar to a pull resistor).

Users of the PCI230+ need to review their input drive circuits to ensure they can source / sink sufficient current to overcome the 'bus hold current' of the 82C55.

If users need to ensure that any of the I/O pins are low at power up, (e.g. when the I/O pin will later be defined as an output that needs to be low at power up) they need to provide the means externally to ensure that the line is pulled down low with enough resistance to overcome the bus hold current.

Because the bus hold currents are quite strong, existing pull downs may not be strong enough to overcome the bus hold feature.

The bus hold feature may have unwanted effects on your implementation, if:

- At power up the I/O lines need to be in a low state
- Pull down resistors are used to hold the I/O line in a known state.
- Input driving circuits have insufficient current source / sink capability.

In all other cases, the application should NOT be affected by this specification change.

The bus hold implementation on Port A is different to that used on ports B and C.

### Port A Bus Hold

The bus hold circuit on Port A of the Intersil 82C55 can hold a high or low state and is active as long as the line is configured as an input. When the line changes direction from output to input, the last value written to the line will determine whether the bus hold circuit pulls the line high or low. If the last value written was a high voltage, the bus hold will try to keep the high value. If the last value written was a low, the bus hold will try to keep the low value.

Special care is needed if open collector drivers are used. Open collector drivers actively drive a 0 to the line, but rely on a pull up resistor in order to drive a 1.

$$\text{sink current} = \frac{(VCC - 0.8)}{R_{ext\_pullup}} + 1.3\ mA$$

Where $R_{ext\_pullup}$ is the value of any external pull-up resistance fitted.

If external pull-down resistors are used to hold the line low then the value of the pull down resistors will need to be low enough to overcome the bus hold current. The hold current is strong (400 μA maximum) so the pull down resistors need to be <1.7 kohm.

If series resistors are used on the outputs of devices driving the data inputs then these resistors values will also need to be reduced.

### Port B and C Bus Hold

The bus hold circuit on ports B and C of the Intersil part can only hold a high state (‘1’) and is only active from the time the line is configured as an input until the line recognizes a low value on the input. Once the line is driven to a low value (by some external device), the bus hold for that line is disabled and will not be enabled again until the port is reconfigured as an input. If the last value driven to the line was high, the bus hold will try to keep the value high, so the line will remain high when no driver is actively driving it.

If external pull down resistors are used to hold the line low then the value of the pull down resistors will need to be low enough to overcome the bus hold current. The hold current is strong (400 μA maximum) so the pull down resistors need to be <1.7 kohm.

As this is a new feature of the 82C55, both new and existing users of the PCI230+ need to review their input drive circuits to ensure they can source / sink sufficient current to overcome the ‘bus hold current’ of the 82C55.

### 4.7.4 Digital Input/Output Connections

The three ports of the PPI are all terminated on the rear 50 way 'D' type connector SK1, and use pin 18 as the digital ground connection.

To maintain accuracy of the analog channels, external wiring techniques should provide separate ground paths for the digital and analog circuits.

### 4.7.5 Counter Timer Connections

The 8254 counter timers on the PCI230+/260+ are used for control of data acquisition cycles. Counter timer control clock and gate inputs are accessible via the rear 50 way 'D' type connector SK1 on the PCI230+ but these would not be directly accessed by the user in normal operation.

## 4.8 Multiple PCI230+/260+ Boards in a Single Application

More than one PCI230+/260+ board may be installed in a single host. To install more than one PCI230+/260+ in the host PC, the following points should be checked:

1. Sufficient space is available to mount the required number of boards.
2. Sufficient power is available for all the plug-in boards and adapters. Each PCI230+/260+ requires 5V at up to 350 mA.

The base address of each PCI230+/260+ card is automatically set to a different value at installation,

## 4.9 Testing and Troubleshooting

Ensure that the card has installed correctly and that the wiring to the connector is correct before commencing the tests.

If the card has installed correctly the inputs and outputs can be verified using the software example programs.
Both to be found in the :\Amplicon\ampdio\Ex_delph directory

OSSCOPE.EXE is a 2 channel oscilloscope application that displays analog inputs 0 & 1 on your PC.

SIGGEN.EXE is an analog signal generator program that may be used to test the DAC outputs on the PCI230+.

If the card has not installed correctly there could be a hardware problem. To check that your PC hardware and BIOS can detect the card you may run the FINDCARD.EXE program found in the C:\amplicon\ampdio subdirectory of the installed software. This software runs under MSDOS or Windows 95/98 so if your system runs under Windows NT or 2000 you will need to make a DOS boot disk containing FINDCARD.EXE and boot your system from it, before running the test program.

If FINDCARD.EXE discovers your card then you will know that your PC is compatible with the card.

If FINDCARD.EXE does not find your card then contact Amplicon Technical support.

# APPENDICES

## A PCI230+/260+ TECHNICAL SPECIFICATIONS

**Except where otherwise stated, all figures quoted in the specifications are typical at 25°C.**

### A.1 HARDWARE SPECIFICATION

**FUNCTION** PCI bus compatible multi-function data acquisition board providing high speed, sixteen channel analog input, two channel analog outputs with counter/timer facilities and 24 bit digital input/output.

#### A.1.1 ANALOG INPUT

**Number of Input Channels** Sixteen single-ended or eight differential user input channels.

**Analog Input mode** Analog inputs may be either all single- ended or differential. This is selected in software by the driver.

**Analog Input Ranges** Analog inputs may be either all unipolar or bipolar. This is selected in software by the driver. The gain (and therefore input range) of each analog input channel is individually software programmable.

| | |
|---|---|
| Bipolar | ±1.25 V, ±2.5 V, ±5.0 V, ±10.0 V |
| Unipolar | 0 to +2.5 V, 0 to +5.0 V, 0 to +10.0 V |

**Input Impedance** 1.0 MΩ / <100 pF each channel

**Analog to Digital Converter**

| | |
|---|---|
| ADC Resolution | 16 bits (1 part in 65536) |
| Conversion Time | 1.6µs, |
| Sample and Hold | On chip. 0.4 µs track time. |
| On-chip Reference | Derived from on board or external reference voltage. |

**Overall Analog Conversion Accuracy** (Includes calibration, linearity and noise errors) ±4 least significant bits (typical)

Specified at +25° C ambient temperature
±10 volts bipolar input voltage range

**Voltage Reference**

| | |
|---|---|
| Initial Accuracy | 0.05% |
| Temp coefficient | 3 ppm/ °C |

The 16 analog input channels are terminated on sixteen pins of the user I/O connector.

**Data Acquisition Modes**

Program Controlled Mode

Channel selected and converted under program control.

Interrupt Controlled Mode

Each conversion initiated by timer or external trigger. At the end of the conversion the sample is transferred to the FIFO if the FIFO is enabled. Otherwise an interrupt request IRQ is generated and the data word is immediately available for transfer.

Channelling Mode

Group of channels between one and 16 for single- ended or one and 8 for differential operation are selected in software. Each group of conversions (scan) initiated by timer or external trigger. After conversion the next channel in the group is selected automatically by hardware. If the FIFO is enabled all samples are passed to the FIFO after processing. An interrupt is generated when the FIFO reaches required level. If the FIFO is disabled, an interrupt request is generated for each sample and the data is immediately available for transfer.

**Data Acquisition FIFO mode**

If FIFO mode is selected, samples are passed to the 4096 sample FIFO. An Interrupt is generated when sufficient data is collected in the FIFO.

**Programmable Gain**

Gain of each channel set in software to gains is 1, 2, 4 or 8.

**Data Acquisition Rate**

Maximum sampling rate per channel

| | |
|---|---|
| Single channel operation | 500 kS/s |
| Two channel switched | 125 kS/s |
| 16 channels switched | 15.6 kS/s |

Maximum sample rate is reduced when switching channels because extra time needs to be allowed for the amplifiers to settle when the input channel is switched. The maximum data acquisition rate may be limited by the performance of the host PC, the operational mode of the PCI230+ and the program.

Typical maximum continuous useable sampling rates under Windows 95, 98, NT, 2000 or XP allowing time to store samples to disk in single channel operation are:

| | |
|---|---|
| Software sampled | 10 kS/s |
| FIFO mode | 500 kS/s |

**Acquisition trigger**

External digital trigger

Via Ext Trig pin on the ADC interface. This trigger mode will trigger one complete buffer's worth of sample data to be acquired from the ADC when the external trigger input to the card becomes active

Analog trigger

This will trigger one complete buffer's worth of sample data to be acquired from the ADC when the selected analog input crosses a pre programmed threshold.

### A.1.2 ANALOG OUTPUT (PCI230+ Only)

**Number of Output Channels**

Two analog output channels using separate D to A converters followed by buffer amplifiers.

**Output Configuration**

Channels are single-ended and are either both bipolar or both unipolar. One common ground return for all analog signals.

**Analog Output Ranges**

Analog output channels are software programmable for bipolar or unipolar operation.

| | |
|---|---|
| Bipolar | ±10.0 V |
| Unipolar | 0 to +10.0V |

**Output Impedance**

<1Ω each channel

**Output Current**

10 mA max per channel (minimum load resistance of 1K)

**Output Settling Time**

10 µs

**Short Circuit Output**

Outputs will withstand a short circuit to ground for one minute. Maximum short circuit current 50 mA.

**Digital to Analog Converter**

| | |
|---|---|
| DAC Resolution | 12 bits (1 part in 4096) |
| Settling Time | 1 µSecs typical (Converter only) |
| Reference | Derived from ADC on chip reference voltage |

**Overall Analog Conversion Accuracy** (Includes calibration, linearity and noise errors)

±0.2% of reading (typical)
Specified at: +25° C ambient temperature
±10 volts output range

**Analog Output Connector**

The two single-ended analog output channels are terminated on the user I/O connector.

**Analog Output Modes**

Software Controlled Mode

DAC channel data loaded and converted under program control.

FIFO Hardware Controlled Channelling Mode

Group of channels between one and two are selected in software. Each group of conversions (scan) initiated by timer or external trigger. Data is fed from the PC to the DAC FIFO and then to the enabled DAC channels from the FIFO under control of an internal timer or external trigger.

Interrupts are generated when the FIFO has room for more data or when the FIFO becomes empty at the end of transfer in non-continuous mode.

Interrupt Controlled Channelling Mode (Without FIFO)

Group of channels between one and two are selected in software. Each group of conversions (scan) initiated by an interrupt from a particular source. This interrupt can be a rising edge on the output of counter channel 1, or a rising edge on PPI port C0 or C3. Data is fed from the PC via a driver buffer to the enabled DAC channels.

FIFO Wraparound Mode

Group of channels between one and two are selected in software. Data is fed from the PC to the DAC FIFO until the desired number of samples has been loaded (a total maximum of 1024 samples). Each group of conversions (scan) initiated by timer or external trigger. Data is fed from the FIFO to the enabled DAC channels and then back to the FIFO cyclically.

**Data Acquisition FIFO mode**

If FIFO mode is selected, samples are passed to the DAC via the 1024 sample FIFO.

**Analog Output Update Rate**

The maximum output update rate may be limited by the performance of the host PC, the operational mode of the PCI230+ and the program.

### A.1.3 COUNTER / TIMER

**Features**

82C54 or equivalent counter/timer provides:

Three independent 16 bit counters
Six programmable counter modes, binary or BCD

**Internal Clock Source**

10 MHz, derived from crystal controlled oscillator or software selectable

| | |
|---|---|
| Initial tolerance | ±50 ppm |
| Frequency drift over temp. range | ±50 ppm |

**Clock Divider**

Clock pre-scalers provide alternative clock frequencies of 10MHz, 1MHz, 100kHz, 10kHz, 1kHz, or external clock source.

**External Clock/Gate Input**

The three counter clock inputs, and two counter gate inputs can be driven by external signals. This signal is referred to digital ground and must be within the range:

| | | |
|---|---|---|
| Input Voltage | '0' or Low | –0.3 to +0.8 volts |
| | '1' or High | +2.2 to +5.3 volts |
| External Clock | 10 MHz (max) Square Wave | |

A TTL compatible signal will normally meet these requirements.

**Counter Output**

The non-inverted output of counter two OUT2 is available on the user I/O connector. This output signal is referred to digital ground and the characteristics are:

Output Voltage

'Low' voltage, +0.3V max at +2.0 mA

'High' voltage, +3.8V min at –2.0 mA.

### A.1.4 DIGITAL INPUT/OUTPUT (PCI230+ Only)

**Features**

82C55 or equivalent Programmable Peripheral Interface (PPI) provides:

Three 8 bit I/O ports
Three programmable operation modes
Bit manipulation

All ports are normally available to the user

**Digital Input/Output Conditions**

The 24 digital input/output lines comprising ports A, B and C meet the following conditions:

| | |
|---|---|
| Inputs | 'Low' voltage –0.5 to +0.8 V<br>'High' voltage +2.2 to +5.3 V |
| Outputs | 'Low' +0.4 V max at +2.5 mA.<br>'High' +3.5 V min at –2.5 mA. |

**Digital Input/Output Connections**

Connections to the 24 digital I/O lines are via the user I/O connector.

### A.1.5 PC INTERFACE

**Compatibility**

PCI 2.1/2.2 bus, Universal, slave only.

**Base Address**

The PCI230+/260+ requires two PCI base addresses, in I/O or memory space. Each discrete base address is individually set by the plug and play installation software.

Registers occupy two blocks of thirty-two contiguous 8-bit PCI address locations above each base address.

**Interrupts**

Single PCI interrupt. Multi-function, each interrupt maskable and read by interrupt status word. Interrupt functions to include:

Divided Clock interrupt
External interrupt source (2)
Conversion complete (or FIFO interrupt)

**Power-up Default**

On power-up, all DAC outputs will be at zero volts

**POWER RAILS**

+5 V at 300mA typical from PCI bus.
+3.3 V at 500mA typical from PCI bus.
±12 V at 50 to 150mA typical from PCI bus.

+5 V output at 100mA (protected by resettable fuse) available on I/O connector.

| | |
|---|---|
| | ±12 V output at 100mA (protected by resettable fuse) available on I/O connector. |
| **Dissipation** | Each PCI230+ will dissipate typically 1.7 W as heat.<br>Each PCI260+ will dissipate typically 1.2 W as heat |
| **Board Dimensions** | Length 153 mm<br>Height 91 mm plus edge connectors. |
| **Multiple Boards** | Any number of PCI230+/260+ boards commensurate with physical space, I/O address space and power availability can be supported in a single PC. |

## A.2 SOFTWARE SPECIFICATION

The distribution software is supplied on a CD-ROM.

Windows 95, 98, NT, 2000 and XP driver software provides Application level access to all the advanced features of the card from these operating systems.

## A.3 Environmental Conditions

### Specific conditions

| | |
|---|---|
| **Temperature Range** | Operating 0° C to +60° C<br>Storage -20 to +70° C |
| **Humidity Range** | Operating & Storage 5% to +95% relative humidity, non-condensing. |
| **Handling** | Normal static handling precautions apply. Damage could result if not observed. |

## A.4 Order Codes

The Order Code for the PCI230+ is 9605 2503
The Order Code for the PCI260+ is 9605 2513

## A.5 Optional Accessories

| Amplicon Order Code | Description |
|---|---|
| 9089 1952 | 25-way screw terminal assembly |
| 9095 6179 | 1 metre 25-way screened cable |
| 9096 5132 | 50-way screw terminal assembly |
| 9096 6359 | 1 metre 50-way screened cable |