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Declaration of Conformity

Amplicon products are designed and manufactured in the United Kingdom under a quality system approved by the British Standards Institution

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 859 893 84 Issue A4

Prepared by D.N. Cooper
Approved for issue by A.S. Gorbold, Operations Director

DECLARATION OF CONFORMITY

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BRIGHTON BN2 4AW UK

We declare that the product(s) described in this Instruction Manual are manufactured by Amplicon Liveline Limited and perform in conformity with the following standards or standardisation documents:

Electro Magnetic Compatibility (EMC):

EMC Directive	89/336/EEC
LVD Directive	73/23/EEC
CE Directive	93/68/EEC

Jim Hicks, I. Eng, MIEIE
Managing Director
Amplicon Liveline Limited

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. For analog input systems, the capacity of the PC mounted hardware can be extended by external expansion panels to provide a convenient to use system with low cost per channel and maintained high performance.

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 version 2.1 plug and play interface.
- Device driver software compatible with Windows NT, 95, 98, Me & 2000.
- Flexible, independent addressing
- Low power consumption
- 16-channel multiplexed analog to digital conversion
- ADC conversion rates up to 312 ksps.
- 4096-sample FIFO memory for analog to digital converter allowing upto 4096 samples for one channel or 256 samples for sixteen channels to be stored on the card.
- Selectable input voltage ranges
- PCI230 only, 2-channel, 12-bit digital to analog conversion with output voltage ranges of ±10 V bipolar or 0 to +10 V unipolar.
- Three 16-bit counter/timers with on board 10 MHz crystal oscillator timing source.
- A frequency counter facility for measuring external frequencies.
- PCI230 only, 24 bit flexible, programmable digital input/output.
- Interrupt controlled operations, with the facility for interrupts to be generated by the end of a conversion, by the FIFO, by a regular timer/counter output or by an external signal.
- An on board DC to DC converter which provides power to the analog circuits, thus reducing the effects of PC induced noise.
- Free demonstration software and the provision of library routines as a DLL for easy user programming (includes interface files for C and example software written in Delphi 3.0, Visual Basic 5.0 and HP Vee 5.0).

1.4 General Description

The PCI230/260 range of boards provide multi-channel data acquisition functions for any IBM PC or compatible computer that supports PCI bus version 2.1

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

PCI230 Provides 16-channel, FIFO buffered, 12-bit analog-to-digital input facilities and 2-channel, 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, 12-bit analog to digital input facilities and three 16-bit counter/timers only.

1.4.1 Enhanced Features

The PCI230/260 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. The PCI230 & PCI260 both have a 4096-sample FIFO for buffering input samples from the ADC. The cards can be set up to store samples in the FIFO autonomously until the FIFO is full at which time the card 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 card.

1.4.2 The Hardware

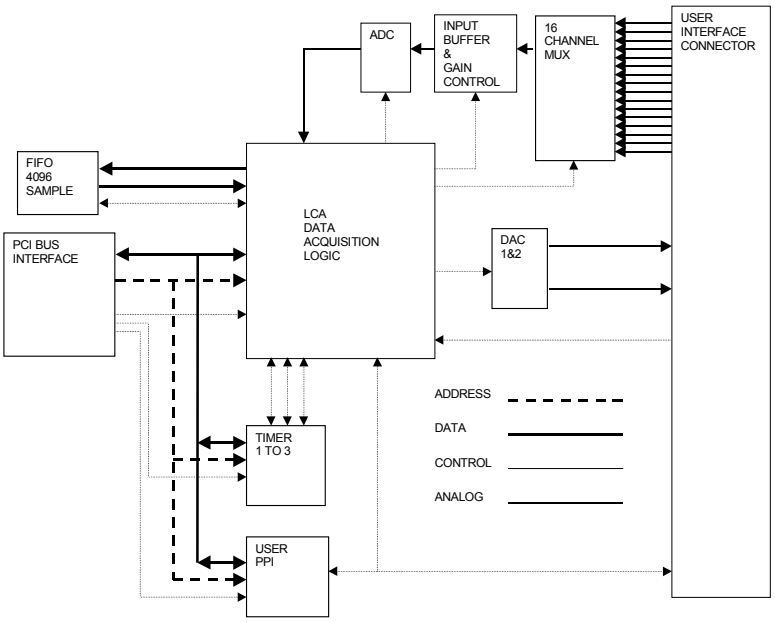


FIGURE 1.1 PCI230 BLOCK SCHEMATIC

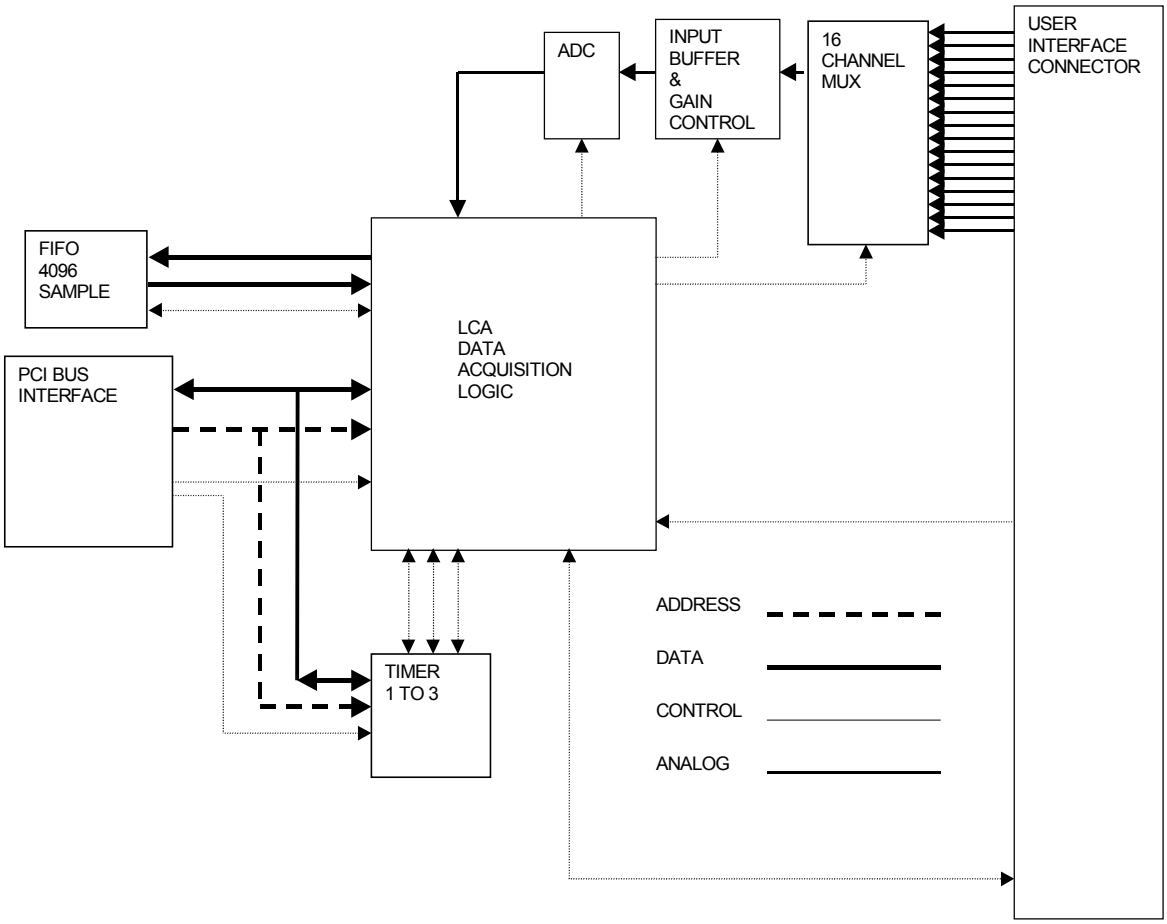


FIGURE 1.2 PCI260 BLOCK SCHEMATIC

1.4.3 The Software

The PCI230/260 is supplied with the SOFTMAN CD-ROM Part No 869 865 59, this contains all the software for the card, and is documented in the Amplicon ADIO manual elsewhere on the CD ROM.

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	909 893 83
PCI260	PCI Bus Analog input card	Part Nº	909 893 73

2. The included distribution software and manual on CD Part Nº 869 865 59

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 in the current domestic or international **Amplicon Liveline** catalogue.

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 608 331
	International	+44 1273 608 331
Fax:	UK	01273 570 215
	International	+44 1273 570 215
Email		support@amplicon.co.uk
Web:		www.amplicon.co.uk www.amplicononline.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 Customer Services by telephone or fax on the above numbers. 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: Customer Services 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, Me, NT 4.0 or 2000 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.

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

2.3 Installing the Board

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 OTHER THAN SWITCH CHANGES TO A BOARD THAT IS ON EVALUATION

Please refer to the manufacturer's hardware manual supplied with the PC for instructions on how to remove the cover and install devices into an input/output slot. The PCI230/260 may be installed in any available position in the machine provided that there is no restriction specified for that location by the computer manufacturer.

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

When the board is physically installed in the PC, and the PC is rebooted, The Windows 95, Windows 98, Windows Me or Windows 2000 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

Please refer to the ADIO software manual, ampdio32manual.pdf, for the latest Windows 32-bit driver installation information.

2.4.1 Windows 95/98/Me Installation

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

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 or Windows Me:

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 n 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 Installation

For versions of the AMPDIO software prior to 4.32, please follow the instructions for installing a card in Windows NT 4.0 (see section **Error! Reference source not found.**). For versions 4.30 and 4.31, the supplied AMPDIOV4.INF file will allow the supported PCI cards to appear under Device Manager, but these are just dummy entries. For versions prior to 4.30 the supported PCI cards will appear as unknown devices under Device Manager.

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.

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 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 booted.

2.5.2 Interrupt Level Selection (IRQ)

Careful checking of interrupt assignment in your system is recommended prior to card installation using the plug and play software. The operating system will inform of any contention when selecting an IRQ level during installation. The normal allocation of hardware interrupt levels is tabled below.

The interrupt signal from each channel can be assigned to any appropriate IRQ available in the PC. The plus and play BIOS and/or operating system automatically sets the board's IRQ level when the system is booted.

The interrupt operations comply with the requirements laid down in the PCI Bus version 2.1 specification, allowing full IRQ sharing

The interrupt request line, IRQ 3-5, IRQ7, IRQ10-12 or IRQ15, signals the host PC (Permanent Master) that the PCI230/260 adaptor requires service. The host PC acknowledges the interrupt and performs the required action using the appropriate interrupt service routine.

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.

Careful checking of interrupt assignment in your system is recommended prior to card installation using the plug and play software. The operating system will inform of any contention when selecting an IRQ level during installation. The normal allocation of hardware interrupt levels is tabled below.

PCI230/260 Selected IRQ Level	Host PC IRQ Name	Host PC Interrupt Number (hex)	Host PC Description of Usage
—	IRQ 0	8	Timer
—	IRQ 1	9	Keyboard
—	IRQ 2	A	Interrupt 8 - 15
3	IRQ 3	B	COM or SDLC
4	IRQ 4	C	COM or SDLC
5	IRQ 5	D	LPT2
—	IRQ 6	E	Floppy Disk
7	IRQ 7	F	LPT1
—	IRQ 8	70	Real Time Clock
—	IRQ 9	71	Re-directed to IRQ2
10	IRQ10	72	Unassigned
11	IRQ11	73	Unassigned
12	IRQ12	74	Unassigned (or PS2-mouse)
—	IRQ13	75	Co-processor
—	IRQ14	76	IDE channel 1
15	IRQ15	77	IDE channel 2

2.6 Application Software

Example application software, including source code for the applications and the DLL are supplied in the self-extracting archive AMPDIO.EXE along with the SETUP program. When the self-extracting archive is run and software is extracted to a suitable directory (e.g. C:\AMPLICON\AMPDIO), the examples and DLL source code can be found in subdirectories off this directory. The software supplied with this card supports operation with Windows 95, 98, Me, 2000 & NT 4.0 only. Refer to the AMPDIO W32 DRIVERS document (**ampdio32manual.pdf**) for details.

2.7 Installation Testing

Ensure the PC and BIOS are PCI 2.1 compliant

2.7.1 Verifying Installation for Windows 95/98/Me

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 labelled 'Amplicon Analogue/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 properies dialog box, check there are no resource conflicts and that the PCI card has been assigned an IRQ.

2.7.2 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 DIO1 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).

2.7.3 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 Analogue/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 DIO port number in the range DIO0 to DIO7.

(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 must make between the PCI230/260 and any external devices. These input/output connections are made through the D-type connector protruding from the PC adaptor slot corresponding to the chosen board position. The metal shell 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.

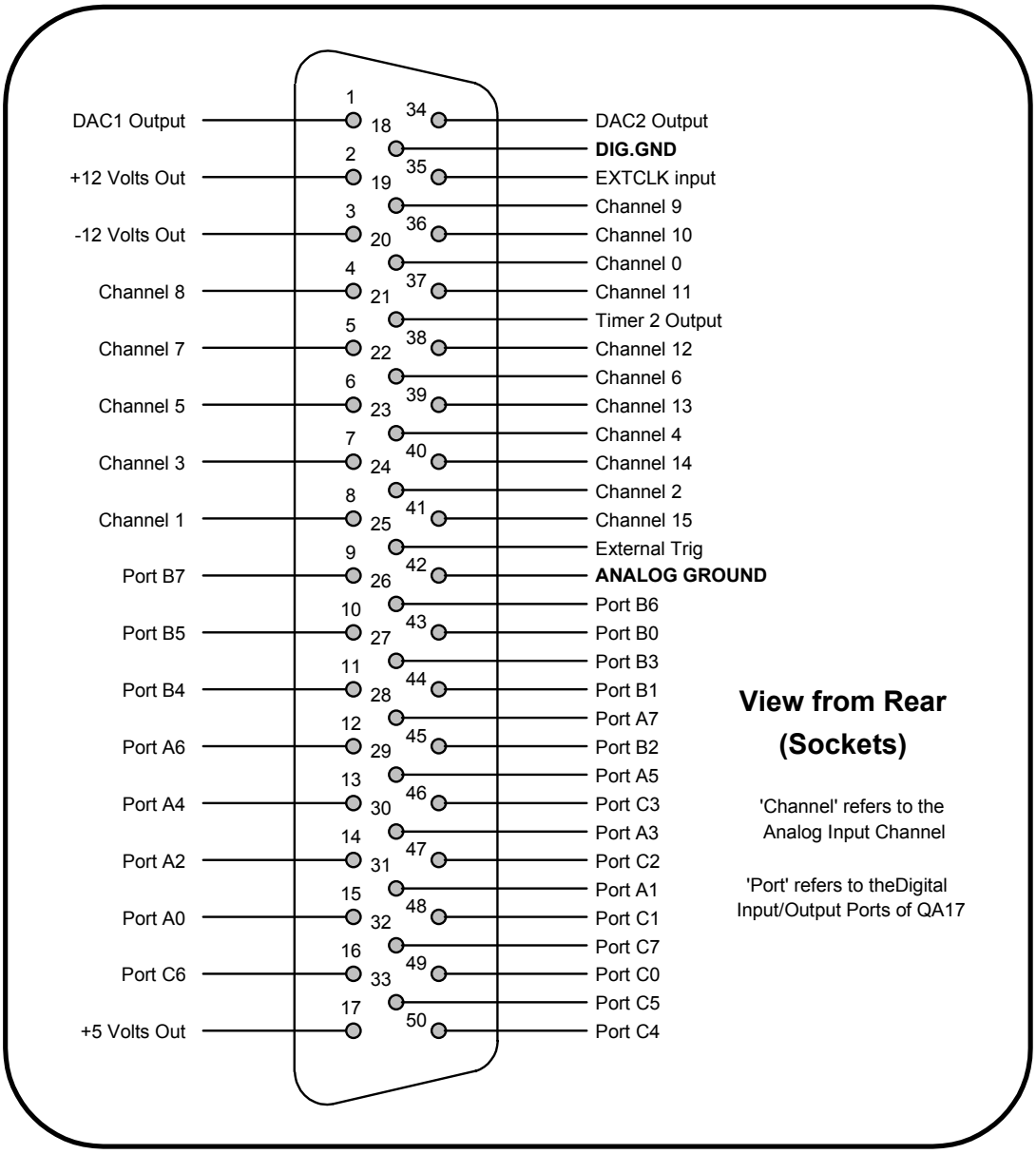


FIGURE 3.1 PCI230 SK1 50 WAY USER INTERFACE PIN DESIGNATIONS

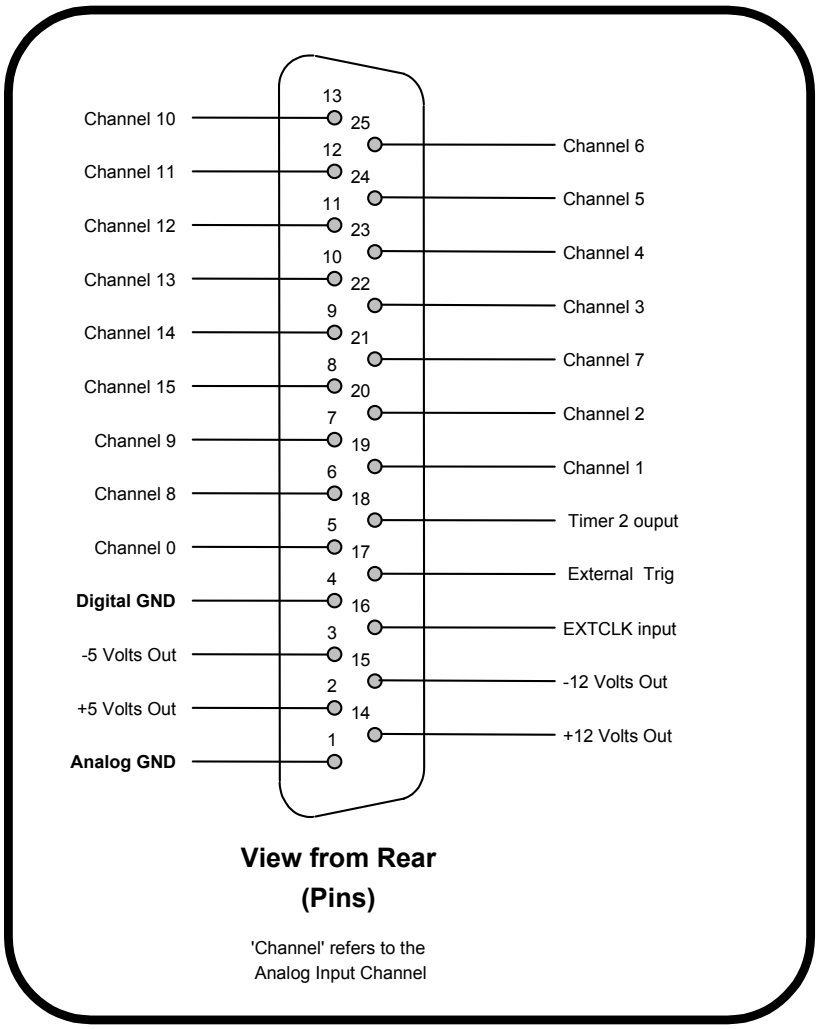


FIGURE 3.2 PCI260 PL1 25 WAY USER INTERFACE PIN DESIGNATIONS

3.2 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:

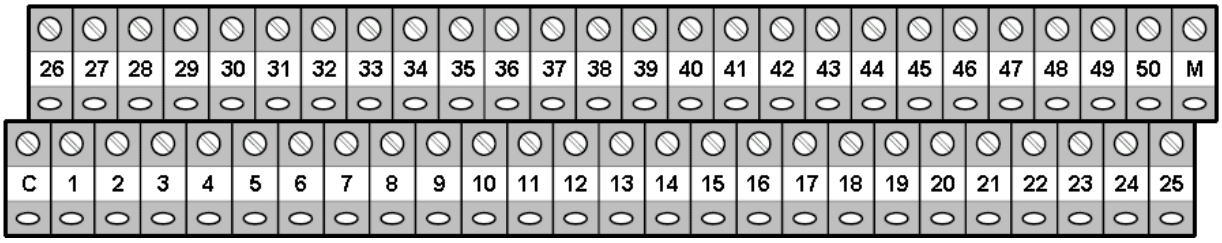
Amplicon Part Number	Device
708 703 95	50 way D type mating connector (male) for PCI230
909 651 32	50 way screw termination assembly (female) for PCI230
909 663 59	50 way 1 metre connecting cable (male to male) for PCI230
708 703 90	25 way D type mating connector (female) for PCI260
909 919 52	25 way screw termination assembly (female) for PCI260
909 561 79	25 way 1 metre connecting cable (male to female) for PCI230

3.2.1 PCI230 Screw Termination Assembly

User connections for the PCI230 can be made by wiring directly to a 50 way D type mating connector (male).

Alternatively for much easier connection to plant or experimental signal wiring, a screw terminal assembly and interconnecting cable of 1 metre length can be supplied as optional accessories. See above paragraph 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.

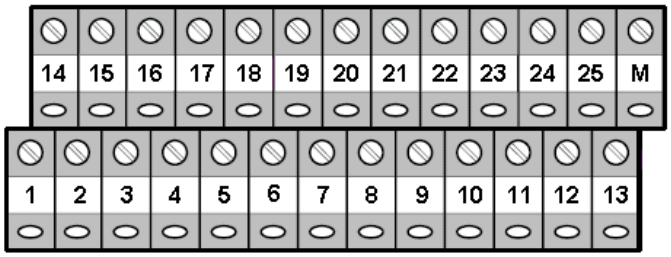
FIGURE 3.3 50-WAY SCREW TERMINAL ASSEMBLY PIN DESIGNATIONS

3.2.2 PCI260 Screw Termination Assembly

User connections for the PCI260 can be made by wiring directly to a 25 way D type mating connector (female).

Alternatively for much easier connection to plant or experimental signal wiring, 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.



Terminal M connected to the shell of the D type connector.

FIGURE 3.4 25-WAY SCREW TERMINAL ASSEMBLY PIN DESIGNATIONS

3.3 Analog Inputs

There are 16 channels of single-ended analog input and these are designated channel numbers 0 through 15 (Ch0 to Ch15).

It is important that no input voltage is allowed to exceed the limits of the multiplexer, i.e. signal voltage must not exceed ±15 volts when the power to the PCI230/260 is on or ± 2 volts when the power is off.

3.4 Use Of Shielded Cables

The standard, optional cables are not shielded, but if the user manufactures custom cables for use in a severe or noisy environment, it may be considered advisable to use overall shielded cables.

DANGER
High Voltage

BE AWARE

DANGER OF ELECTRIC SHOCK

When the PCI230/260 board is in use in an open computer chassis, high voltages may be exposed on the connector and associated circuitry.

3.5 PCI Bus Back-plane Bus Connections

Connections between the host PC and the PCI230/260 are through an 82 pin, edge connector on the PC PCI bus. The user will not normally require access to this I/O connector information but these standard back-plane connections are included for troubleshooting and diagnostic purposes.

The PCI230/260 does not use all the functions of the bus.

82 Pin Connector (Pins B1 and A1 are at the bracket end of the board)

	-12V	<		B1	A1	<		TRST#	
	TCK	<		B2	A2	<	>	+12V	
	Ground	<		B3	A3	<	>	TMS	
	TDO		>	B4	A4	<		TDI	
	+5V	<		B5	A5	<	>	+5V	
	+5V	>		B6	A6	<	>	INTA#	
	INTB#	<		B7	A7	<	>	INTC#	
	INTD#	<	>	B8	A8	<	>	+5V	C
	PRSNT1#	<		B9	A9	<	>	Reserved	O
	Reserved	<		B10	A10	<		+5V	M
S	PRSNT2#	<		B11	A11	<	>	Reserved	P
O	Ground	<		B12	A12	<	>	Ground	O
L	Ground	<	>	B13	A13	<	>	Ground	N
D	Reserved	<	>	B14	A14	<	>	Reserved	E
E	Ground	<	>	B15	A15	<	>	RST#	N
R	CLK	<	>	B16	A16	<	>	+5V(I/O)	T
	Ground	<	>	B17	A17	<	>	GNT#	
S	REQ#	<	>	B18	A18	<	>	Ground	S
I	+5V	<	>	B19	A19	<	>	Reserved	I
D	AD[31	<	>	B20	A20	<	>	AD[30]	D
E	AD[29	<	>	B21	A21	<	>	+3.3V	E
	Ground	<	>	B22	A22	<	>	AD[28]	
	AD[27	<	>	B23	A23	<	>	AD[26]	
	AD[25	<	>	B24	A24	<	>	Ground	
	+3.3V	<	>	B25	A25	<	>	AD[24]	
	C/BE[3	<	>	B26	A26	<	>	IDSEL	
	AD[23	<		B27	A27	<	>	+3.3V	
	Ground	<		B28	A28	<	>	AD[22]	
	AD[21	<		B29	A29	<	>	AD[20]	
	AD[19	<		B30	A30	<	>	Ground	
	+3.3V	<		B31	A31	<	>	AD[18]	
	AD[17			B32	A32	<	>	AD[16]	
	C/BE[2			B33	A33	<	>	+3.3V	
	Ground			B34	A34	<	>	FRAME#	
	IRDY			B35	A35	<	>	Ground	
	+3.3V			B36	A36	<	>	TRDY#	
	DEVSEL			B37	A37	<	>	Ground	
	Ground			B38	A38	<	>	STOP#	
	LOCK			B39	A39	<	>	+3.3V	
	PERR			B40	A40	<	>	SDONE	
	+3.3V			B41	A41	<	>	SBO#	
	SERR			B42	A42	<	>	Ground	
	+3.3V			B43	A43	<	>	PAR	
	C/BE[1			B44	A44	<	>	AD[15]	
	AD[14			B45	A45	<	>	+3.3V	
	Ground			B46	A46	<	>	AD[13]	
	AD[12			B47	A47	<	>	AD[11]	
	AD[10			B48	A48	<	>	Ground	
	Ground			B49	A49	<	>	AD9	
				B50	A50	<	>		
				B51	A51	<	>		
	AD8			B52	A52	<	>	C/BE0	
	AD7			B53	A53	<	>	+3.3V	
	+3.3V			B54	A54	<	>	AD6	
	AD5			B55	A55	<	>	AD4	
	AD3			B56	A56	<	>	Ground	
	Ground			B57	A57	<	>	AD2	
	AD1			B58	A58	<	>	AD0	
	+5V			B59	A59	<	>	+5V	
	ACK64#			B60	A60	<	>	REQ64#	
	+5V			B61	A61	<	>	+5V	
	+5V			B62	A62	<	>	+5V	

FIGURE 3.5 PC BACK-PLANE PCI BUS CONNECTIONS

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 are single-ended. Differential measurements are made by subtracting adjacent channels.

By single ended we mean that all signals have individual 'high' lines, each of which should be wired to the appropriate Channel # pin on the I/O connector, and a common ground for all the signal 'low' lines.

Restricted connector space allows the allocation of only one 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 PL1/2 On the PCI260). Connections for single-ended analog input and output for the PCI230 are shown diagrammatically below.

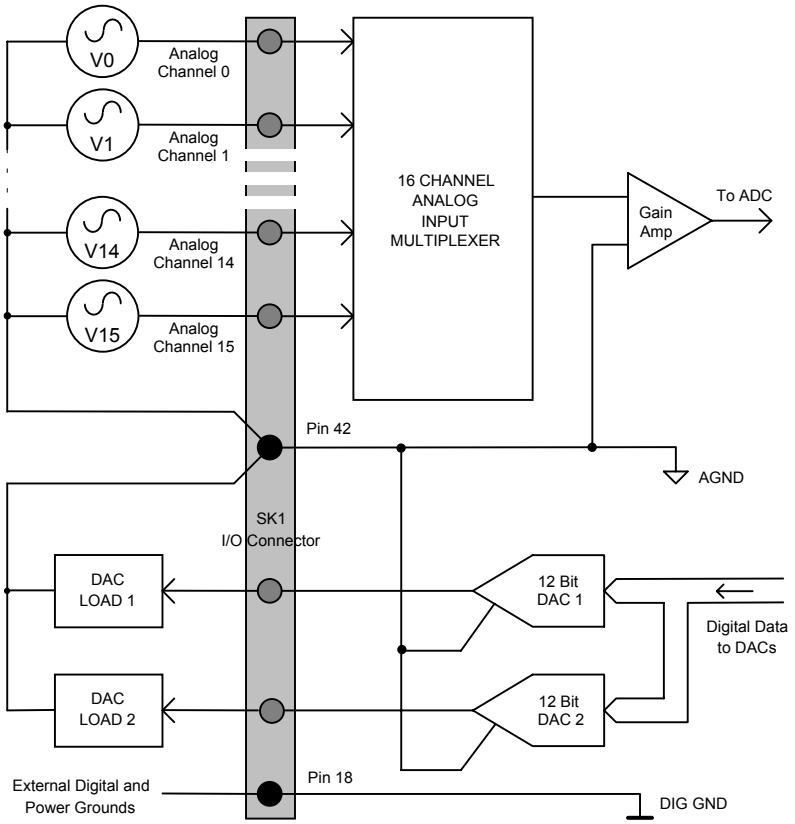


FIGURE 3.6 ANALOG INPUT/OUTPUT WIRING

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.

- All devices connected to the analog inputs must have a source impedance of less than 250Ω. (This source impedance represents a 1 bit error)

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

3.2.2 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.

Each channel input signal must have its ground reference connected to the analog ground pin on the 50 way D type connector SK1/42.

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

FIGURE 3.7 INPUT VOLTAGE RANGES

3.2.3 Input Attenuators

Although the PCI230/260 has pre-defined input ranges, a hardware modification can be incorporated to allow higher or intermediate input voltages to be handled. The scaling can be across all channels or on a channel by channel basis.

The modification is accomplished by drilling out a link for the required channel and inserting an appropriate resistor (or resistor networks if the same input range is required on all channels). Each channel is provided with a 1.0MΩ ±1% high stability input resistor in networks RN1 and RN2, and the inserted resistor forms a simple attenuator in conjunction with this input resistor. See below.

PLEASE NOTE. IF PROPERLY UNDERTAKEN, THESE MODIFICATIONS WILL NOT INVALIDATE THE WARRANTY. NO MODIFICATION SHOULD BE MADE TO A PCI230/260 UNDER EVALUATION.

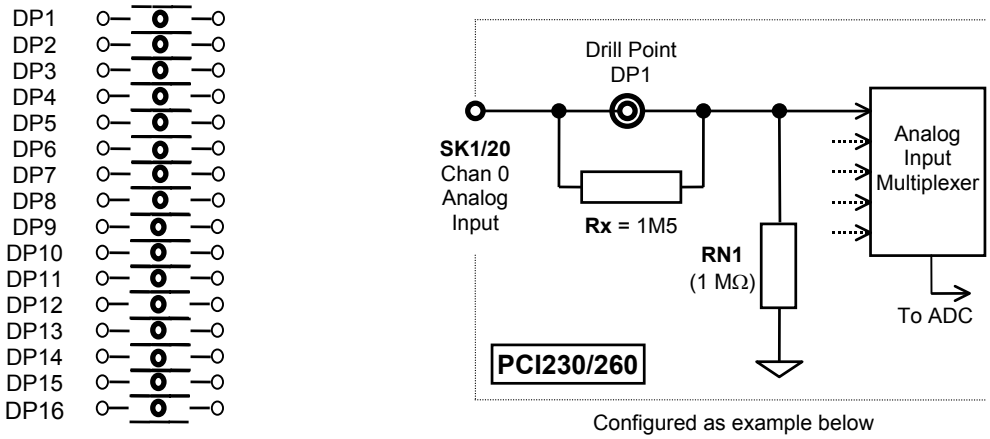


FIGURE 3.8 INPUT ATTENUATORS

Optional resistors DP1 to DP16 are not fitted to production PCI230/260 boards, but each input resistor position is connected through a severable link. The links corresponding to each input channel and the positions for the input resistors can be located using the PCI230/260 printed circuit board schematic and layout diagrams shown in APPENDIX B The drill point is located at the centre of the resistor footprint indicated in the table below.

Channel Number	PCI230 Input Connector Location	Resistor
0	SK1/20	DP1
1	SK1/8	DP2
2	SK1/24	DP3
3	SK1/7	DP4
4	SK1/23	DP5
5	SK1/6	DP6
6	SK1/22	DP7
7	SK1/5	DP8
8	SK1/4	DP9
9	SK1/19	DP10
10	SK1/36	DP11
11	SK1/37	DP12
12	SK1/38	DP13
13	SK1/39	DP14
14	SK1/40	DP15
15	SK1/41	DP16

FIGURE 3.6 PCI230 INPUT ATTENUATOR RESISTOR LOCATIONS

EXAMPLE

To obtain a range of ±25 volts on analog input channel 0, while retaining ranging of ±10 volts on the other 15 channels:

1. Carefully drill out the drill point at the selected link, DP1 at the centre of the resistor ident, leaving the position clear to insert a resistor.

2. Calculate the required resistor, Rx, thus:-

   In this example the maximum input voltage must be ±10 volts for a full scale reading, with Vin ±25 volts maximum.

$$\frac{\text{Full Scale Reading}}{\text{Max Input Voltage}} = \frac{1.0\ \text{M}\Omega}{1.0\ \text{M}\Omega + \text{Rx}}$$

$$\therefore \text{Rx} = \frac{1.0\ \text{M}\Omega \times \text{Max Input Voltage}}{\text{Full Scale Reading}} - 1.0\text{M}\Omega$$

$$\therefore \text{Rx} = \frac{1.0\ \text{M}\Omega \times 25}{10} - 1.0\text{M}\Omega = 1.5\text{M}\Omega$$

3. Insert a 1M5 high stability resistor in the position vacated by drilling out link at DP1.

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 elseware 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 single-ended 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 ADC input for conversion to digital form. The voltage reference and the sample/hold circuitry are integrated in the ADC chip.

Differential inputs are formed from adjacent pairs of single-ended inputs. Samples taken on adjacent channels are subtracted digitally before passing to the FIFO for storage.

4.2 Analog Input FIFO

Samples taken by the ADC are passed to a 4096 sample first in first out memory (FIFO). 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 bytes are transferred. When running under multi-tasking operating systems such as Windows NT, 95, 98, Me and 2000, 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 it may take considerable time before the interrupt is serviced.

This would greatly limit the maximum usable sample rate of the ADC, if there was no FIFO and the card could only store one sample at once. 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 interrupt. This feature greatly extends the maximum sample rate of the system for multi-tasking operating systems.

4.3 Analog Input Modes

4.3.1 Software Controlled Sampling

The ADC can be made to take a single sample under direct software control. This mode can be set by writing to the ADCCON register..

The required input channel is first selected by writing four address bits CHAN[3..0] on ADCCON bits 15 to 12, with 0 for channel 0 and F_{16} for channel 15.

To complete an A/D conversion cycle under software control, first set the card into software controlled mode and select the desired channel. Then write to the ADCDATA register to begin a conversion. At the start of the conversion CCOMPLETE (ADCCON bit 15) goes low. When

CCOMPLETE goes high again (at the end of the conversion) the 12 bit conversion result can be interrogated.

The ADC data word is read as one sixteen bit word. The twelve bit data word (conversion result) is left justified occupying bits 4-15. The least significant bits D0-3 are read as zero. This is to allow for future expansion to sixteen bit ADCs.

4.3.2 Interrupt Controlled Sampling

In this mode timing is controlled by a hardware generated clock. The clock may come from one of the 82C54 timer/counters. The driver software will default to use Counter 1 and will program it as a square wave generator at the required sampling interval. The clocking frequency of Counter 1 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 Counter 1 determines the frequency of the conversion command signals. This single counter provides time intervals (frequencies) programmable in the range 2.0 µSecs (500 kHz) to over 10 minutes (6 per hour). Longer periods can be obtained by cascading counters 0 and 1.

Alternatively the conversion clock source may be from one of the other counters or an external trigger input.

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

Dependant 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

4.3.3 Chanelling

Each time a sample is initiated In interrupt controlled sampling mode the card automatically samples the next channel in ascending number order from the channel pairs 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.

Channels can only be enabled as pairs to simplify the digital design when forming differential inputs

4.3.4 ADC Transfer Functions

The ADC transfer functions for unipolar and bipolar operation are shown diagrammatically below.

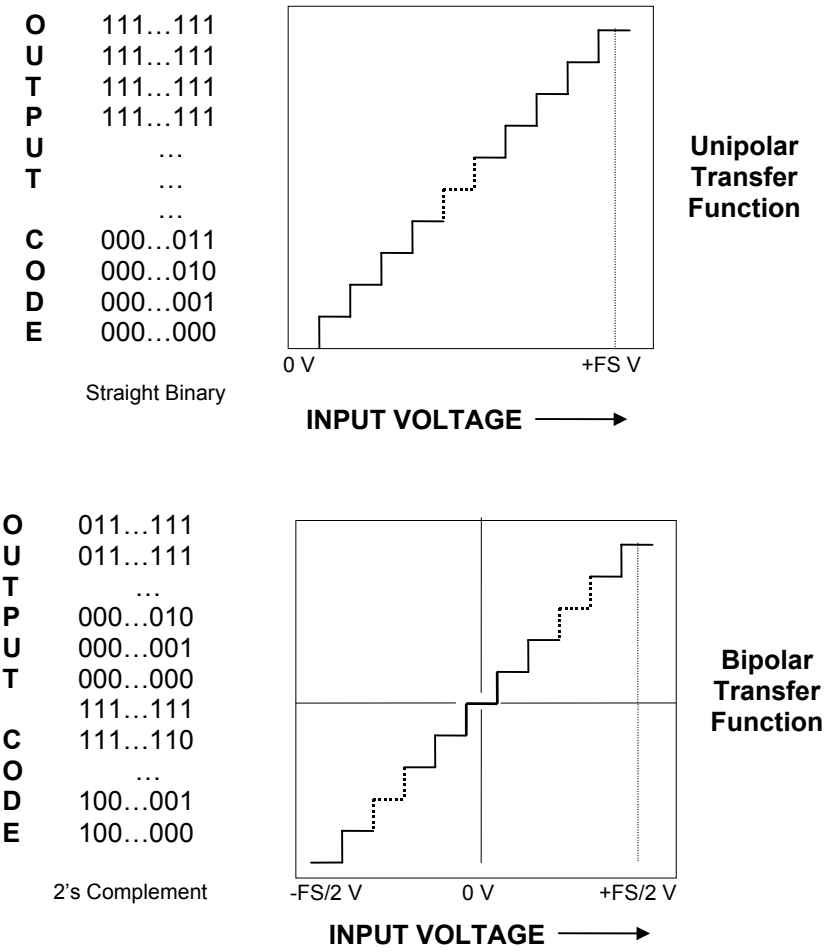


FIGURE 4.1 ANALOG TO DIGITAL CONVERTER OUTPUT CODES

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 (N.B. the 12-bit values from the ADC are multiplied by 16):

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)	FFF0	65520

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)	7FF0	32752

4.4 Analog Outputs (PCI230 Only)

The PCI230 provides two channels of analog output, from individual digital to analog converters. The two channels are labelled 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.

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

N.B. Unlike the PC30AT, DAC 1 &. DAC 2 outputs are available on one pin only. This is to allow use of the extra pins to provide flexible clocking arrangements for the counter timers.

4.5 Analog Output Modes (PCI230 Only)

4.5.1 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.

4.5.2 Interrupt Controlled D/A Conversion

In this mode timing is controlled by a hardware generated clock. The clock may come from one of the 82C54 timer/counters. The driver software will default to use Counter 0 and will program it as a square wave generator at the required sampling interval. The clocking frequency of Counter 0 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 Counter 0 determines the frequency of the interrupt signals, and hence the update rate of the DAC channels. This single counter provides time intervals (frequencies) programmable in the range 2.0 µSecs (500 kHz) to over 10 minutes (6 conversions per hour). Longer periods can be obtained by cascading counters 2 and 0.

If enabled the rising edge of the counter 0 output generates an IRQ. The Interrupt Service Routine for this mode must write the data to the DAC.

Power Supplies. Both positive and negative supply voltages to the DACs and associated analog circuitry are derived from an isolated dc to dc converter. Ground connection between digital and analog systems is at a single star point.

4.6 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.

4.6.1 PCI230 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 LCA (ALTERA FLEX6016) 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 the table in figure 3.7.

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.

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 4.2 PCI230 SHARED I/O CONNECTIONS

4.7 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,

4.8 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 varified 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 generater 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/Me 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 compatiable with the card.

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

5 STRUCTURE AND ASSIGNMENTS OF THE REGISTERS

The set of demonstration programs and routines provided with the PCI230/260 allows user access to all the operational functions of the board. However, in some circumstances, the user may wish to program the application at the lowest level using input/output instructions. This section provides the necessary information on the accessible registers.

5.1 Register Assignments

The PCI230/260 registers occupy two blocks of thirty two, consecutive address locations in the I/O space. Tables summarising the register assignments for each type of card are shown in figures 5.1 & 5.2. Please note that the actual register address is the base address configured on the board plus the register offset given in the table.

5.2 Register Groups

There are two register groups occupied by the PCI230/260. I/O Space 1 is eight bits wide I/O Space 2 is sixteen bits wide. Sixteen bit data transfers are employed where appropriate, and high speed is achieved by the use of the sixteen bit transfers to read blocks of data from the FIFO, 4096 12 bit words to a block.

5.3 Register Assignment Summary

5.3.1 PCI230 I/O Registers

I/O Space 1

PC i/o PORT ADDRESS (Base + Offset)	FUNCTION	8/16 bit	IN/ OUT	200 series driver Mnemonic
BA1 + 00_{16}	Data to/from port A of User PPI	8	In/out	PPI-X A
BA1 + 01_{16}	Data to/from port B of User PPI	8	In/out	PPI-X B
BA1 + 02_{16}	Data to/from port C of User PPI	8	In/out	PPI-X C
BA1 + 03_{16}	Control word for User PPI	8	Out	PPI-X CMD
BA1 + 04_{16}	RESERVED			X2
BA1 + 06_{16}	RESERVED			X2
BA1 + 08_{16}	RESERVED			Y1
BA1 + $0A_{16}$	RESERVED			Y1
BA1 + $0C_{16}$	RESERVED			Y2
BA1 + $0E_{16}$	RESERVED			Y2
BA1 + 10_{16}	RESERVED			Z1
BA1 + 12_{16}	RESERVED			Z1
BA1 + 14_{16}	82C54 Counter/timer – Counter 0	8	In/out	Z2 CT0
BA1 + 15_{16}	82C54 Counter/timer – Counter 1	8	In/out	Z2 CT1
BA1 + 16_{16}	82C54 Counter/timer – Counter 2	8	In/out	Z2 CT2
BA1 + 17_{16}	82C54 Counter/timer – Control Word	8	Out	Z2 CTC
BA1 + 18_{16}	RESERVED			
BA1 + 19_{16}	RESERVED			
BA1 + $1A_{16}$	Group Z Clock Configuration Register	8	Out	ZCLK_SCE
BA1 + $1B_{16}$	RESERVED			
BA1 + $1C_{16}$	RESERVED			
BA1 + $1D_{16}$	Group Z Gate Configuration Register	8	Out	ZGAT_SCE
BA1 + $1E_{16}$	ISR Interrupt source mask register / Interrupt status register	8	In/out	INT_SCE
BA1 + $1F_{16}$	RESERVED			

I/O Space 2

PC i/o PORT ADDRESS (Base + Offset)	FUNCTION	8/16 bit	IN/ OUT	200 series driver Mnemonic
BA2 + 00_{16}	DACCON Control register for DAC1-3.	16	In/Out	DACCON
BA2 + 02_{16}	DACOUT1 Output data register for DAC1.	16	Out	DACOUT1
BA2 + 04_{16}	DACOUT2 Output data register for DAC2.	16	Out	DACOUT2
BA2 + 06_{16}	RESERVED (DACOUT3 Output data register for DAC3.)	16	Out	DACOUT3
BA2 + 08_{16}	ADCDATA ADC or FIFO sample data	16	In/out	ADCDATA
BA2 + $0A_{16}$	ADCCON ADC & FIFO Control register	16	In/Out	ADCCON
BA2 + $0C_{16}$	ADCEN channel 0-15 enables	16	In/Out	ADCEN
BA2 + $0E_{16}$	ADCG channel 0-15 gain settings	16	In/Out	ADCG

FIGURE 5.1 PCI230 REGISTER ASSIGNMENTS

5.3.2 PCI260 I/O Registers

I/O Space 1

PC i/o PORT ADDRESS (Base + Offset)	FUNCTION	8/16 bit	IN/ OUT	200 series driver Mnemonic
BA1 + 00_{16}	Data to/from port A of User PPI	8	In/out	PPI-X A
BA1 + 01_{16}	Data to/from port B of User PPI	8	In/out	PPI-X B
BA1 + 02_{16}	Data to/from port C of User PPI	8	In/out	PPI-X C
BA1 + 03_{16}	Control word for User PPI	8	Out	PPI-X CMD
BA1 + 04_{16}	RESERVED			X2
BA1 + 06_{16}	RESERVED			X2
BA1 + 08_{16}	RESERVED			Y1
BA1 + $0A_{16}$	RESERVED			Y1
BA1 + $0C_{16}$	RESERVED			Y2
BA1 + $0E_{16}$	RESERVED			Y2
BA1 + 10_{16}	RESERVED			Z1
BA1 + 12_{16}	RESERVED			Z1
BA1 + 14_{16}	RESERVED			Z2
BA1 + 16_{16}	RESERVED			Z2
BA1 + 18_{16}	RESERVED			
BA1 + 19_{16}	RESERVED			
BA1 + $1A_{16}$	Group Z Clock Configuration Register	8	Out	ZCLK_SCE
BA1 + $1B_{16}$	RESERVED			
BA1 + $1C_{16}$	RESERVED			
BA1 + $1D_{16}$	Group Z Gate Configuration Register	8	Out	ZGAT_SCE
BA1 + $1E_{16}$	ISR Interrupt source mask register / Interrupt status register	8	In/out	INT_SCE
BA1 + $1F_{16}$	RESERVED			

I/O Space 2

PC i/o PORT ADDRESS (Base + Offset)	FUNCTION	8/16 bit	IN/ OUT	200 series driver Mnemonic
BA2 + 00_{16}	RESERVED			
BA2 + 02_{16}	RESERVED			
BA2 + 04_{16}	RESERVED			
BA2 + 06_{16}	RESERVED			
BA2 + 08_{16}	ADCDATA ADC or FIFO sample data	16	In/out	ADCDATA
BA2 + $0A_{16}$	ADCCON ADC & FIFO Control register	16	In/Out	ADCCON
BA2 + $0C_{16}$	ADCEN channel 0-15 enables	16	In/Out	ADCEN
BA2 + $0E_{16}$	ADCG channel 0-15 gain settings	16	In/Out	ADCG

FIGURE 5.2 PCI260 REGISTER ASSIGNMENTS

5.4 The Register Details

The following paragraphs describe the operations of each of the accessible registers. Additional information on the register usage can be found in chapter 4 'USING THE PCI230/260'.

5.4.1 DACCON DAC Control Register (PCI230 Only)

15	14	13	12	11	10	9	8
X	X	X	X	X	X	X	X

7	6	5	4	3	2	1	0
X	X	X	X	X	X	0= NotBusy 1= DACBusy	0= unipolar 1= bipolar

5.4.2 DACOUT1 Output data to DAC1 (PCI230 Only)

15 ($8000)	14 ($4000)	13 ($2000)	12 ($1000)	11 ($800)	10 ($400)	9 ($200)	8 ($100)
D11	D10	D9	D8	D7	D6	D5	D4

7 ($80)	6 ($40)	5 ($20)	4 ($10)	3 ($8)	2 ($4)	1 ($2)	0 ($1)
D3	D2	D1	D0	RESERVED FOR EXPANSION			

5.4.3 DACOUT2 Output data to DAC2 (PCI230 Only)

15 ($8000)	14 ($8000)	13 ($2000)	12 ($1000)	11 ($800)	10 ($400)	9 ($200)	8 ($100)
D11	D10	D9	D8	D7	D6	D5	D4

7 ($80)	6 ($40)	5 ($20)	4 ($10)	3 ($8)	2 ($4)	1 ($2)	0 ($1)
D3	D2	D1	D0	RESERVED FOR EXPANSION			

5.4.4 ADCDATA Input data from FIFO or direct from ADC, or initiate ADC conversion from software

READ

15 ($8000)	14 ($4000)	13 ($2000)	12 ($1000)	11 ($800)	10 ($400)	9 ($200)	8 ($100)
AD11	AD10	AD9	AD8	AD7	AD6	AD5	AD4

7 ($80)	6 ($40)	5 ($20)	4 ($10)	3 ($8)	2 ($4)	1 ($2)	0 ($1)
AD3	AD2	AD1	AD0	RESERVED FOR EXPANSION			

5.4.5 ADCCON Control register for ADC and FIFO

WRITE

15 ($8000)	14 ($4000)	13 ($2000)	12 ($1000)	11 ($800)	10 ($400)	9 ($200)	8 ($100)
		Global reset	Fifo reset	FIFO Interrupt Trigger Level 000 FIFO Empty 001 FIFO Not Empty 010 FIFO Not Half Full 011 FIFO Half Full 100 FIFO Not Full 101 FIFO Full			FIFO Enable

7 ($80)	6 ($40)	5 ($20)	4 ($10)	3 ($8)	2 ($4)	1 ($2)	0 ($1)
X	X	X	input mode 0 = single ended 1 = diff	input range 0 = unipolar 1 = bipolar	Start conversion source 000 – None 001 – Software 010 – Ext Trig+ve edge 011 – Ex Trig -ve edge 100 – CT Z2 output 0 101 – CT Z2 output 1 110 – CT Z2 output 2		

READ

15 ($8000)	14 ($4000)	13 ($2000)	12 ($1000)	11 ($800)	10 ($400)	9 ($200)	8 ($100)
ADC BUSY	FIFO HALF FULL	FIFO FULL	FIFO EMPTY	FIFO Interrupt Trigger Level 000 FIFO Empty 001 FIFO Not Empty 010 FIFO Not Half Full 011 FIFO Half Full 100 FIFO Not Full 101 FIFO Full			FIFO Enable

7 ($80)	6 ($40)	5 ($20)	4 ($10)	3 ($8)	2 ($4)	1 ($2)	0 ($1)
X	X	FIFO FULL LATCH	input mode 0 = single ended 1 = diff	input range 0 = unipolar 1 = bipolar	Start conversion source 000 – None 001 – Software 010 – Ext Trig +ve edge 011 – Ext Trig -ve edge 100 – CT Z2 output 0 101 – CT Z2 output 1 110 – CT Z2 output 2		

5.4.6 ADCEN channel enables

15 ($8000)	14 ($4000)	13 ($2000)	12 ($1000)	11 ($800)	10 ($400)	9 ($200)	8 ($100)
Ch 15	Ch 14	Ch 13	Ch 12	Ch 11	Ch 10	Ch 9	Ch 8

7 ($80)	6 ($40)	5 ($20)	4 ($10)	3 ($8)	2 ($4)	1 ($2)	0 ($1)
Ch 7	Ch 6	Ch 5	Ch 4	Ch 3	Ch 2	Ch 1	Ch 0

1=enable 0=disable

5.4.7 ADCG0 channel gain settings 0-7

7	6	5	4	3	2	1	0
Ch 6 & 7		Ch 4 & 5		Ch 2 & 3		Ch 0 & 1	

15	14	13	12	11	10	9	8
Ch 14 & 15		Ch 12 & 13		Ch 10 & 11		Ch 8 & 9	

Bit pattern	Unipolar input range	Bipolar input range
00		±10
01	0-10	±5
10	0-5	±2.5
11	0-2.5	±1.25

5.4.8 Timing and Control

All timing of operations in the PCI230 is under the control of a 10 MHz crystal clock source. This source is used internally and divided down for input to an 82C54 triple 16 bit programmable counter/timer. The clock input to the counter/timer can also be selected as an external clock source.

The counter/timer output, or by alternative selection, external triggers, provide the trigger pulses used in the three modes as described above. The various interconnections are set up by the 'Counter Connections Register' under initial program control.

The output of 16 bit programmable counter/timer two OUT2 is available to the user on pin 21 of the 50 way connector.

5.4.9 Group X CLOCK Configuration Register

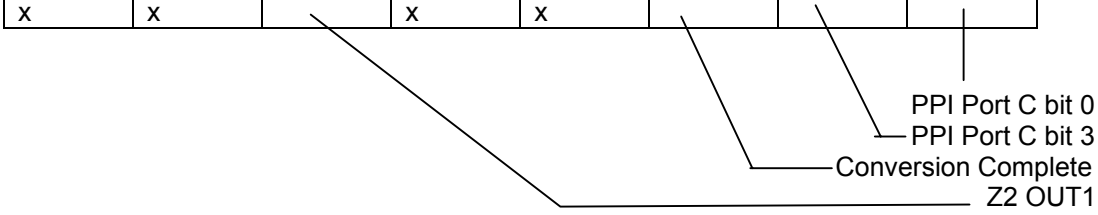
7 ($80)	6 ($40)	5 ($20)	4 ($10)	3 ($8)	2 ($4)	1 ($2)	0 ($1)
X	X	X	Counter Timer 00 – Counter 0 01 – Counter 1 10 – Counter 2 11 – Reserved		Clock Source 000 – PPCn 001 - 10MHz 010 - 1MHz 011 - 100kHz 100 - 10kHz 101 - 1kHz 110 - OUT n-1 111 - Ext Clock		

5.4.10 Group X GATE Configuration Register

7 ($80)	6 ($40)	5 ($20)	4 ($10)	3 ($8)	2 ($4)	1 ($2)	0 ($1)
X	X	X	Counter Timer 00 – Counter 0 01 – Counter 1 10 – Counter 2 11 – Reserved		Gate Source 000 - VCC, enabled 001 - GND, disabled 010 – PPCn 011 - OUT n+1 100 – Reserved 101 – Reserved 110 – Reserved 111 – Reserved		

5.4.11 IER Interrupt Enables / Status Register

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



N.B. PPICn bits are not present on the PCI260

6 PROGRAMMING THE PCI230/260

The PCI230 and PCI260 are supplied with Windows 95, Windows NT and Windows 2000 specific drivers. The Windows 95 driver is also compatible with Windows 98 and Windows Me. Programming for use under other operating systems is beyond the scope of this manual. A Dynamic Link Library (DLL) is supplied to provide an Application Programming Interface (API) for user programs.

6.1 Copyright

Software supplied with the PCI230/260 is **Amplicon** copyright. Permission is granted for the purchaser of the PCI230/260 to incorporate any part of the **Amplicon** copyright software into related application programs, and to use, resell or otherwise distribute such application programs for operation with PCI230/260 hardware purchased from **Amplicon Liveline Limited.**

6.2 Guide to User Programming

When developing an application specific program, it is advised that the supplied dynamic link library functions are used for Windows applications. However if there are good reasons for writing code to access the device driver directly, then a study of the source code supplied will be of assistance.

For programming at register level, reference should to be made to section 5 describing the function and assignments of each I/O register in the PCI230/260.

6.3 Interfacing with Commercial Software Packages

The supplied software examples are not intended to be stand alone applications programs, other than for demonstration and test purposes. To meet most user requirements, either a dedicated program must be written using the functions and examples provided or the PCI230/260 can be interfaced to a commercial applications package.

Other Applications Packages

Further interface packages to commercial software will be made available as requirements expand. Check the 'README' files on the distribution diskette, and/or the **Amplicon Product Catalogue** or Sales Department for the latest information.

APPENDICES

APPENDIX 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 output 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.
Input Configuration	All channels are single-ended, differential inputs, where required are formed by subtraction of successive inputs. One common ground return for all analog signals.
Analog Input mode	Analog inputs may be either all unipolar or bipolar. This is selected in software by the driver.
Analog Input Ranges	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	12 bits (1 part in 4096)
Conversion Time	1.6µSecs
Sample and Hold	On chip. 0.35 µSecs track time
On-chip Reference	2.5v ± 0.01 V. Reference temperature coefficient ± 20 ppm/° C
Overall Accuracy	±2 least significant bits (typical) (Includes calibration, linearity and noise errors)
Specified at	+25° C ambient temperature ±10 volts bipolar input voltage range
Analog Input Connector	The sixteen single-ended 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. After conversion, an interrupt request is generated and the data word is immediately available for input.

Channeling Mode

Group of channels between one and sixteen for single ended or one and eight for bipolar operation are selected in software. Each group of conversions initiated by timer or external trigger. After conversion next channel in group selected automatically by hardware. If FIFO enabled all samples passed to FIFO after processing an interrupt generated when FIFO reaches required level. If FIFO mode disabled an interrupt request is generated for each sample and the data word is immediately available for input.

Data Acquisition FIFO mode

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

Programable Gain

Gain of each channel set in software. The choice of gains are; 1,2,4 or 8.

Data Acquisition Rate

Maximum sampling rate per channel

Single channel operation	312 ksps
Switched channel operation	312 ksps

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/Me/NT/2000 allowing time to store samples to disk in single channel operation are:

Software sampled	10 ksps
FIFO mode	312 ksps

Trigger Input

External software trigger via Ext. Trig pin on the ADC interface.

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

Minimum load 2K ohms per channel

Output Current 5 mA max per channel

Output Settling Time 5 µSecs

Short Circuit Output Outputs will withstand a short circuit to ground for one minute. Maximum short circuit current 35 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 Accuracy ±5 least significant bits (typical) (Includes calibration, linearity and noise errors).

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

Analog Output Connector The two single-ended analog output channels are terminated on two parallel pin pairs of the user I/O connector.

Analog Output Modes Program Controlled Mode

DAC channel data loaded in two bytes and converted under program control.

Interrupt Controlled Mode

Each data output word for conversion initiated by timer or external interrupt.

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 Outputs

The non-inverted, buffered outputs counters 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' output voltage, +0.3V max at +2.0 mA

'High' output 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' input voltage	–0.5 to +0.8 V
	'High' input voltage	+2.2 to +5.3 V
Outputs	'Low' output	+0.4 V max at +2.5 mA
	'High' output	+3.5 V min at –2.5 mA

Digital Input/Output Connections

The 24 digital I/O lines plus power and ground are available on 24 pins of the user I/O connector.

A.1.5 PC INTERFACE

Compatibility

PCI 2.1 bus slave only.

Base Address

Each channel discrete base address individually set by plug and play installation software.

Registers occupy two blocks of thirty-two contiguous 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
Data FIFO	4096 words (8192 bytes) shared between enabled channels Full, half-full and empty flags and re-transmit (wraparound) function. Byte wide FIFOs connected in parallel.
POWER RAILS	+5 V from PC bus. ±15 V derived from on board dc-dc converter. +5 V output at 100mA available on I/O connector.
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 NT, 2000 & 95/98/Me Driver Software provides Application level access to all the advanced features of the card from these operating systems.

A.3 Environmental Conditions

A.3.1 Environment

The PCI230/260 is designed to operate in a PC/AT environment. Particular attention is paid at the design stage to minimise emission of noise and susceptibility to external radiated noise.

Specific conditions

I/O Positions Required	One PCI bus version 2.1 I/O adapter slot with room for half-length card.	
Board Dimensions	Length Height	162 mm 92 mm plus edge connectors.
Temperature Range	Operating Storage	0° C to +60° C -20 to +70° C
Power Requirements	5 VDC	from host computer power supply.

	350 mA PCI230 typical operating 250 mA PCI260 typical operating Excluding power supplied to external system via user connector.
Dissipation	Each PCI230 will dissipate typically 1.7 Watts of heat Each PCI260 will dissipate typically 1.2 Watts of heat.
Handling	Normal static handling precautions apply. Damage could result if not observed

A.4 Order Codes

The Order Code for the PCI230 is 909 893 83
The Order Code for the PCI260 is 909 893 73

A.5 Optional Accessories

A.5.1 Hardware Options

Amplicon Order Code	Description
70870390	25way 'D' socket with solder buckets
90891952	25way screw terminal assy
90956179	1 metre 25way screened cable
70870395	50way 'D' plug with solder buckets
90965132	50way screw terminal assy
90966359	1 metre 50way screened cable

APPENDIX B

CIRCUIT LAYOUT AND SCHEMATIC DRAWINGS

A full layout drawing and circuit diagram of the PCI230/260 Board are given in this appendix.

B.1 Assembly Detail

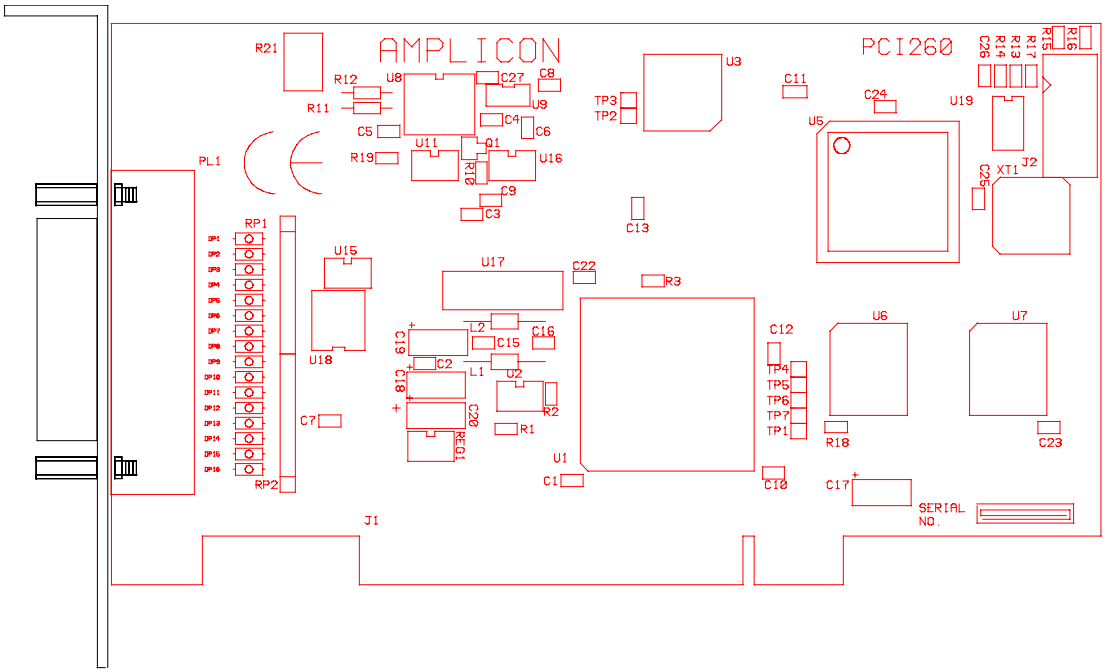


FIGURE B.1 PCI260 LAYOUT

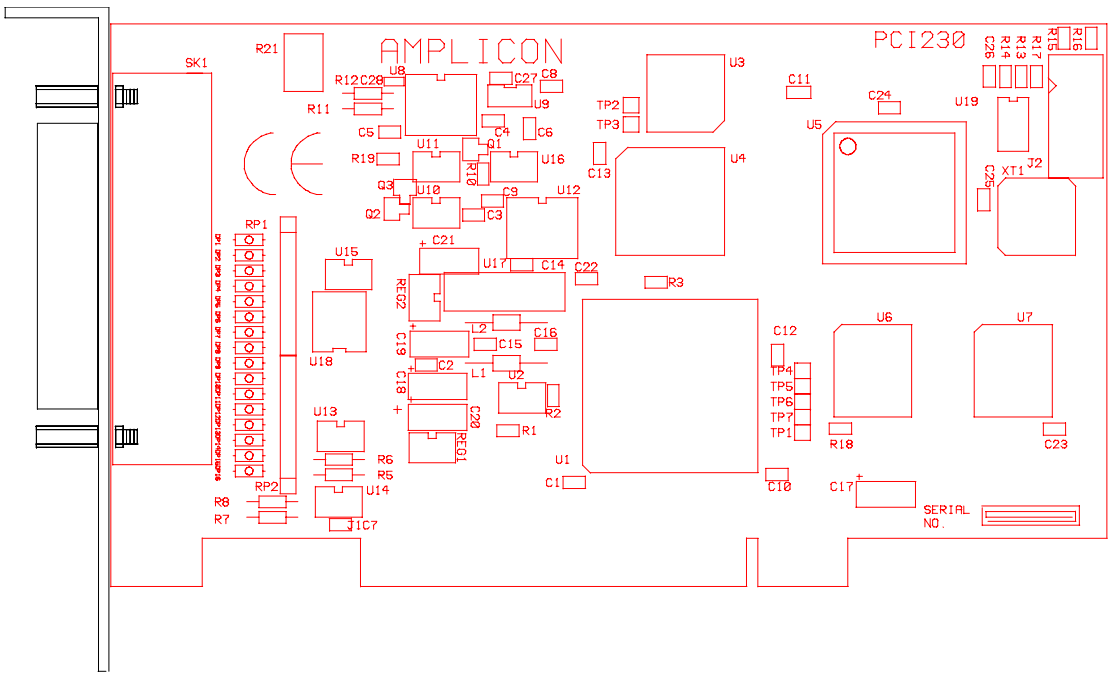


FIGURE B.2 PCI230 LAYOUT

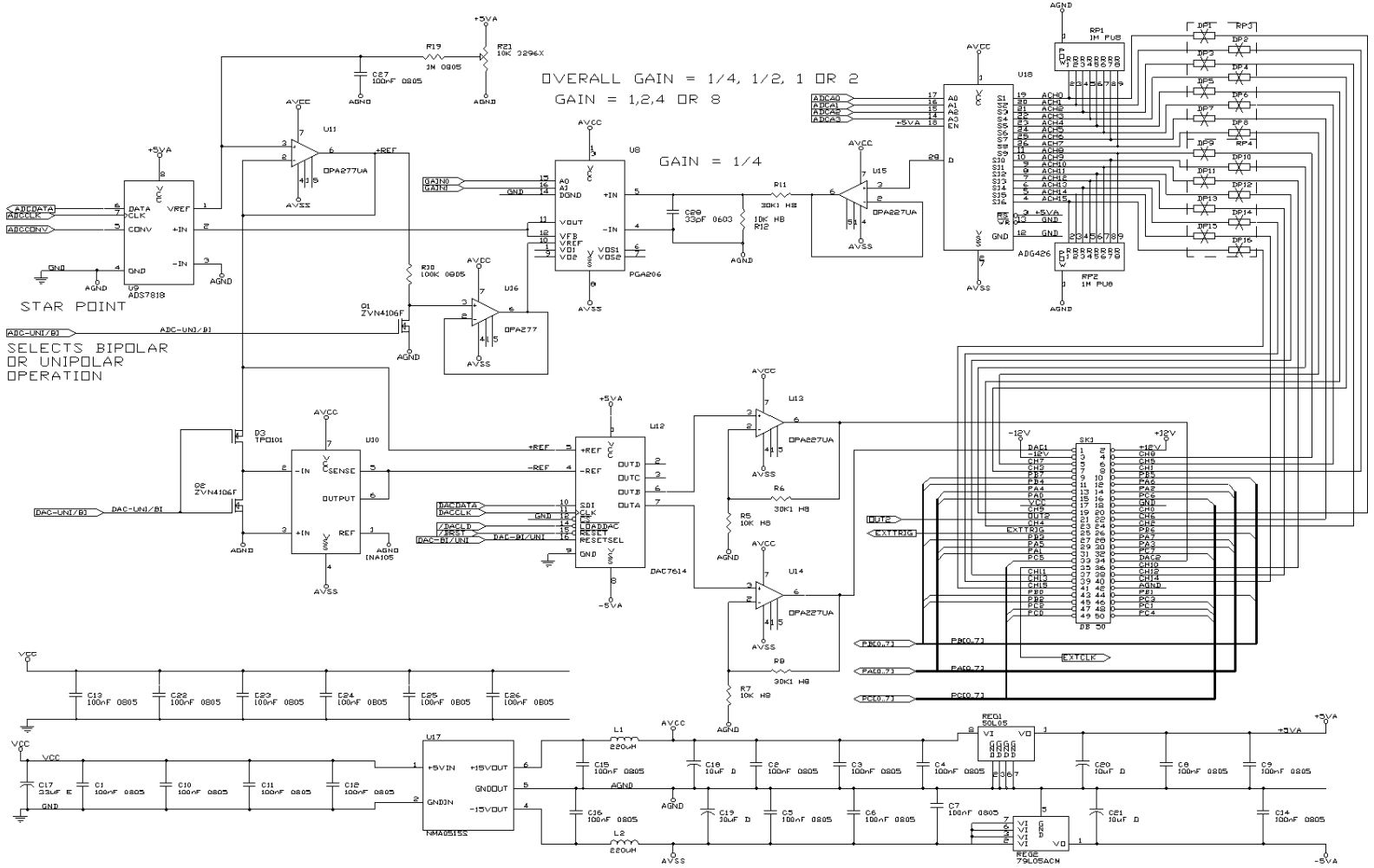


FIGURE B.3 PCI230 CIRCUIT DIAGRAM (1)

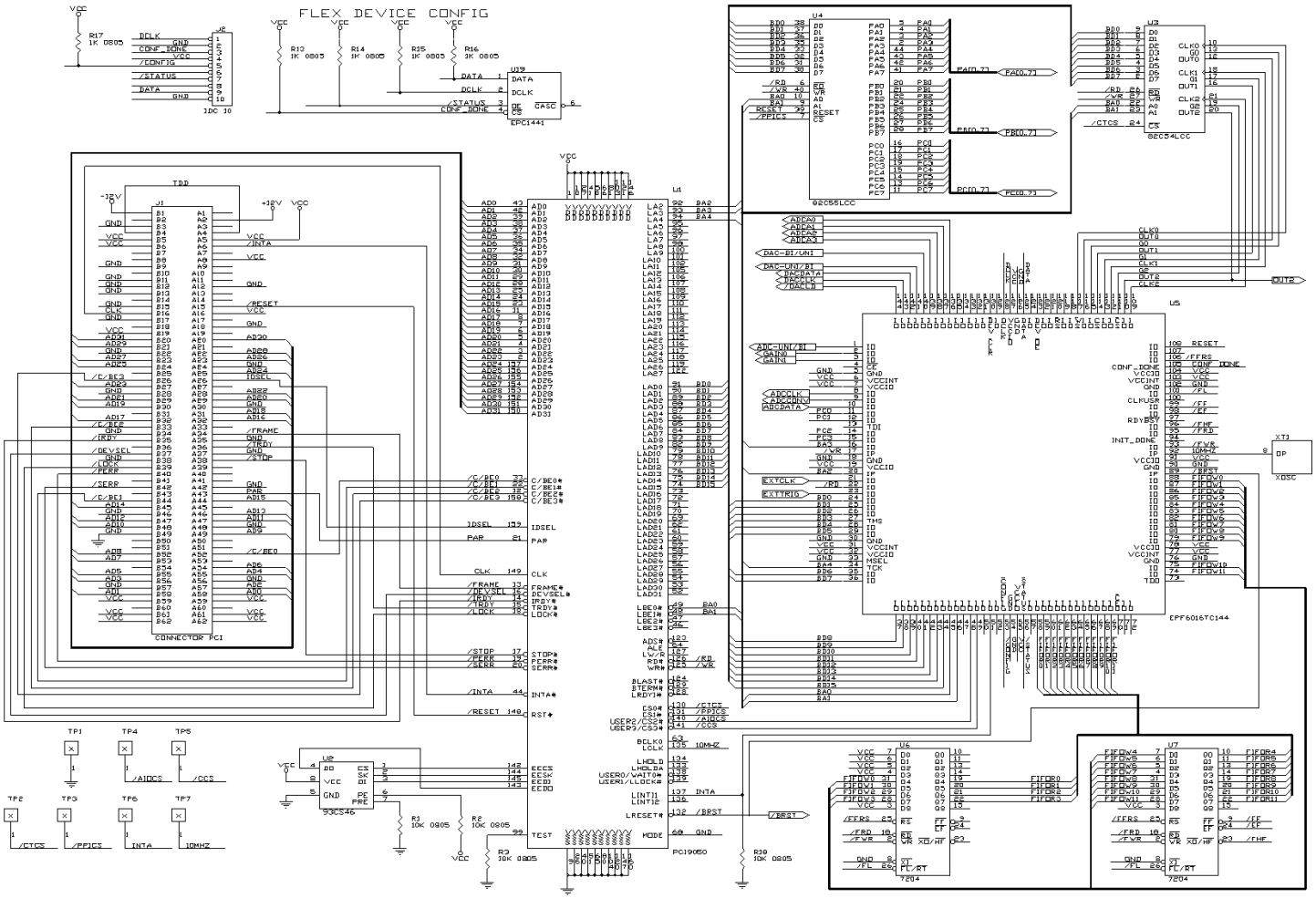


FIGURE B.4 PCI230 CIRCUIT DIAGRAM (2)

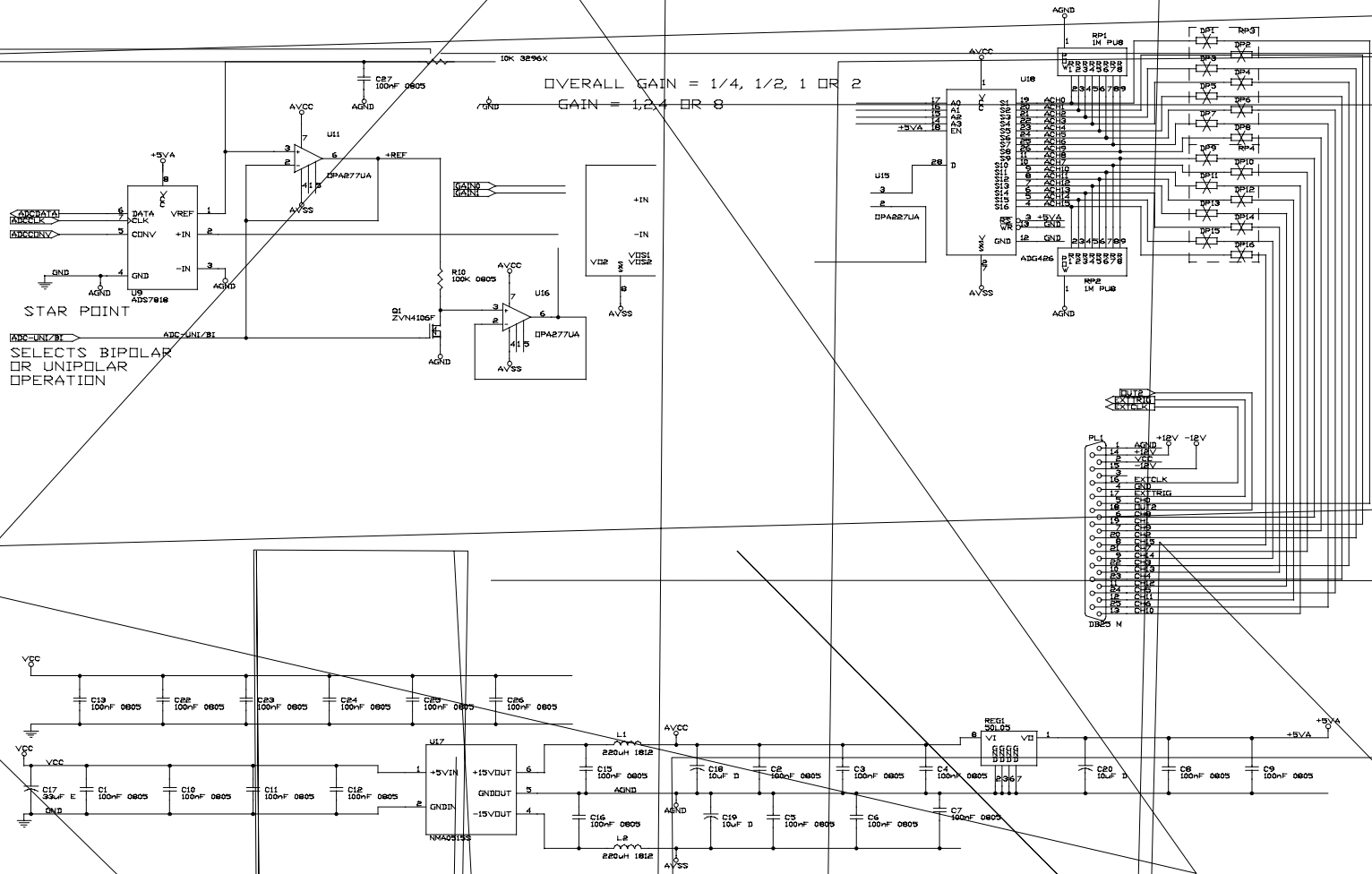


FIGURE B.5 PCI260 CIRCUIT DIAGRAM (1)

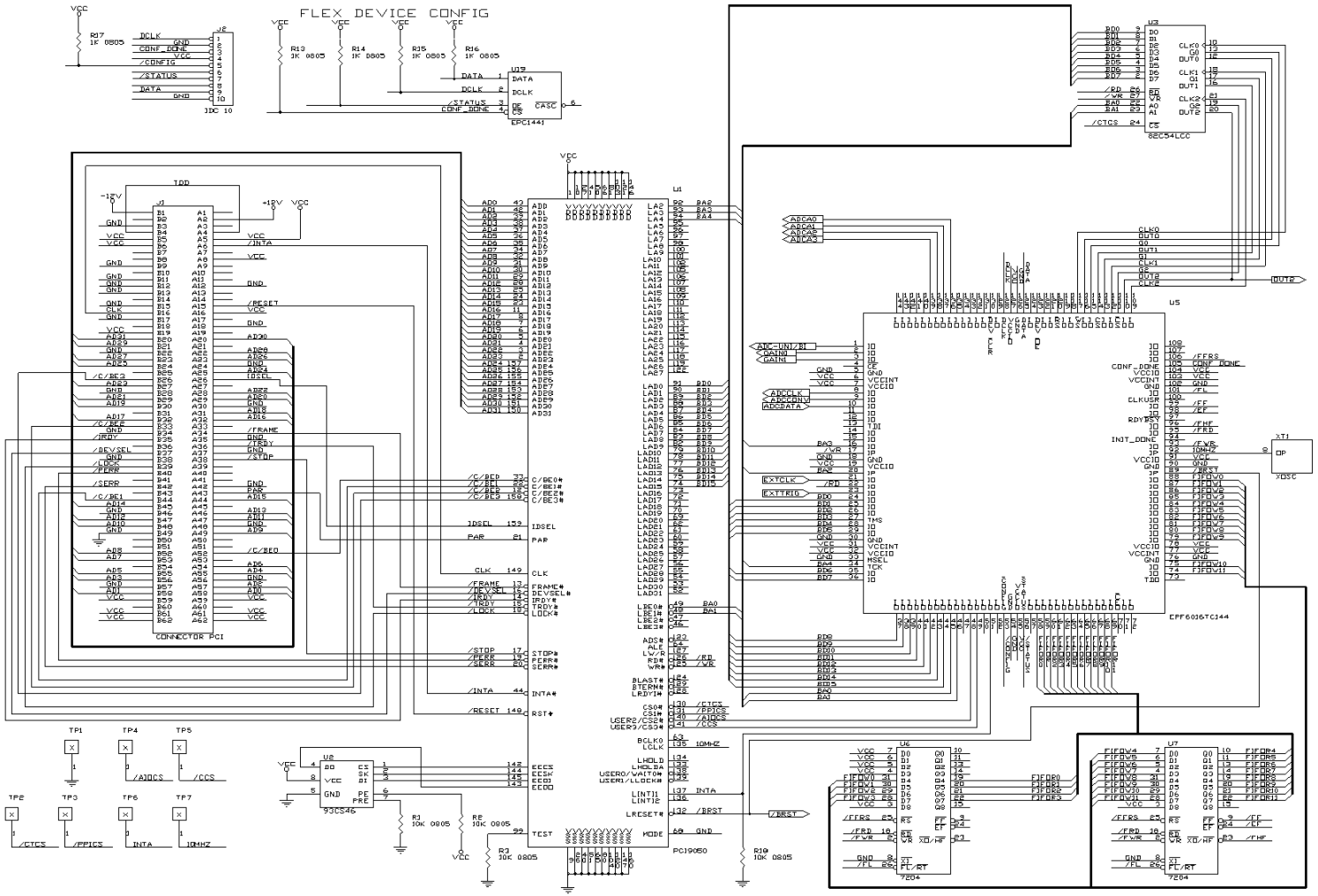


FIGURE B.6 PCI260 CIRCUIT DIAGRAM (2)