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# PCI215

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## PROGRAMMABLE DIGITAL INPUT/OUTPUT AND COUNTER/TIMER BOARD

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This Instruction Manual is supplied with the PCI215 board to provide the user with sufficient information to properly utilise the product as purchased. 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.

**PCI215 Instruction Manual Part N° 8600 3514 Issue B2**

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## DECLARATION OF CONFORMITY

**AMPLICON LIVELINE LIMITED  
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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



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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 I/O 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 Features of the PCI215

The PCI215 board is designed to meet stringent performance requirements and ease of use.

- Six 16-bit, 10MHz counter/timers with on board 10MHz crystal oscillator timing source, each with six programmable counter modes.
- Crystal clock/divider with 5 rates, independently software selectable for each counter/timer clock input.
- 48 bit flexible, programmable digital I/O.
- Interrupt controlled operations, with the facility for interrupts to be generated from on board timers or one of six external signals.
- Count down, stopwatch, frequency/period measurement, frequency generation, square wave output, PWM output, and more.
- PCI Bus version 2.1 Plug and play interface.
- Device driver software compatible with Windows 95, 98, ME, NT, 2000, and XP.
- Linux drivers.
- Agilent/HP VEE, Visual Basic, VB.Net, C#.Net, and Delphi example software.
- Backwards compatible with PC215E and PC214E

### 1.3 General Description

The PCI215 is a plug-in, multi-function digital I/O board which provides 48 bits of parallel digital input/output and six 16 bit counter/timers. The board can be used on any PC that supports the PCI bus version 2.1. The card is supplied with Windows NT, 95, 98, Me, 2000 & XP compatible device drivers. Linux Comedi drivers are available from [www.comedi.org](http://www.comedi.org)

#### 1.3.1 The Software

The PCI215 is supplied with the SOFTMAN CD-ROM. This contains all the software for the card, and is documented in the Amplicon ADIO software manual. This manual can be accessed when the software is installed from the CD.

## 1.4 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 PCI215 outside its protective bag. Full static handling procedures are defined in British Standards Publication BSEN100015/BSEN100015-1:1992.

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 PCI215 is identified by the type number printed on the board.

**PCI215**      PCI Bus Analog input/output card      Part N° 9600 3513

2. Distribution software and manual on CD      Part N° 8698 6559 v2000A or later

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

## 1.5 The Amplicon Warranty Covering the PCI215

This product is covered by the warranty as detailed in the Terms and Conditions stated in the current domestic or international **Amplicon Liveline** catalogue.

## 1.6 Contacting Amplicon Liveline Limited for Support or Service

The PCI215 boards are designed and manufactured by Amplicon Liveline Ltd and maintenance is available throughout the supported life of the product.

### 1.6.1 Technical Support

Should this product appear defective, please check the information in this manual and the Ampdio32 manual 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 account number or postcode
- 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
- The version number of your Softman CD.

### 1.6.2 Repairs

If the PCI215 requires repair then please return the goods enclosing a repair order detailing the nature of the fault. If the PCI215 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 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 PCI215 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, 2000, or XP and allow full card functionality.

### 2.2 Host Computer Requirements

When installing one or more PCI215 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 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. Windows95, Windows 98, Windows Me, Windows NT 4.0, Windows 2000, or Windows XP.

### 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 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 a PCI slot. The PCI215 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 PCI215 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, 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

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 PCI215. 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'.

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 PCI215. 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 PCI215. 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 PCI215. 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 NT4.0 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 PCI215. This will extract and run file AMPDIO.EXE on the SOFTMAN CD. Follow the instructions to install the samples onto your PC.
2. After rebooting the PC, the PCI215 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 versions of the AMPDIO software prior to 4.32, please follow the instructions for installing a card in Windows NT 4.0 (see section 2.4.2). 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/XP 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 PCI215. 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 PCI215. This will extract and run file AMPDIO.EXE on the SOFTMAN CD. Follow the instructions to install the samples onto your PC.

**2.5 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.

## 2.6 Installation Testing

Ensure the PC and BIOS are PCI 2.1 compliant

### 2.6.1 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 4.30.

**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 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 properties dialog box, check there are no resource conflicts and that the PCI card has been assigned an IRQ.

### 2.6.2 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 '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 4.30.

**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 2.2.0.0.

**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' entries from the list in turn. For each selected entry, click the 'Settings' button.
- (d) For one of the listed DIO 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 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 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 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).

**2.6.3 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.

#### 2.6.4 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 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.

## 2.7 Register Assignment Summary

The PCI215 is allocated one Base Address (BA) in the available I/O space.

The board base address and PC IRQ are set up by the PCI enumerator software during installation. Interrupt sources are classified by the position in an interrupt source register and each source is maskable by a bit in an interrupt mask register.

ADDRESS	PC215E	Write/Read	Bits	Group
BA + 00	PPI X Port A	Write/Read	8	Cluster X
BA + 01	PPI X Port B	Write/Read	8	
BA + 02	PPI X Port C	Write/Read	8	
BA + 03	PPI X Control	Write/Read	8	
BA + 04		Write/Read	8	
BA + 05		Write/Read	8	
BA + 06		Write/Read	8	
BA + 07		Write/Read	8	
BA + 08	PPI Y Port A	Write/Read	8	Cluster Y
BA + 09	PPI Y Port B	Write/Read	8	
BA + 0A	PPI Y Port C	Write/Read	8	
BA + 0B	PPI Y Control	Write/Read	8	
BA + 0C		Write/Read	8	
BA + 0D		Write/Read	8	
BA + 0E		Write/Read	8	
BA + 0F		Write/Read	8	
BA + 10	Ctr Z1 - 0	Write/Read	8	Cluster Z
BA + 11	Ctr Z1 - 1	Write/Read	8	
BA + 12	Ctr Z1 - 2	Write/Read	8	
BA + 13	Ctr Z1 - Control	Write/Read	8	
BA + 14	Ctr Z2 - 0	Write/Read	8	
BA + 15	Ctr Z2 - 1	Write/Read	8	
BA + 16	Ctr Z2 - 2	Write/Read	8	
BA + 17	Ctr Z2 - Control	Write/Read	8	
BA + 18		Write	8	Counter Connections Registers
BA + 19		Write	8	
BA + 1A	Clk con Z1/2	Write	8	
BA + 1B		Write	8	
BA + 1C		Write	8	
BA + 1D	Gat con Z1/2	Write	8	
BA + 1E	Int's enable/stat	Write/Read	6	Interrupts
BA + 1F	Spare			

**FIGURE 2-1 PCI215 REGISTER ASSIGNMENTS**

### 3 ELECTRICAL CONNECTIONS

This chapter describes the signal and control connections that the user must make between the PCI215 and any external devices. These I/O connections are made through the D-type connector protruding from the PC adapter 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 78 way D-type Connector (SK1 - User I/O)

Connections from the PCI215 to the user devices are made via a 78 way D-type connector. The pin assignments for this connector are shown in Figure 3.1.

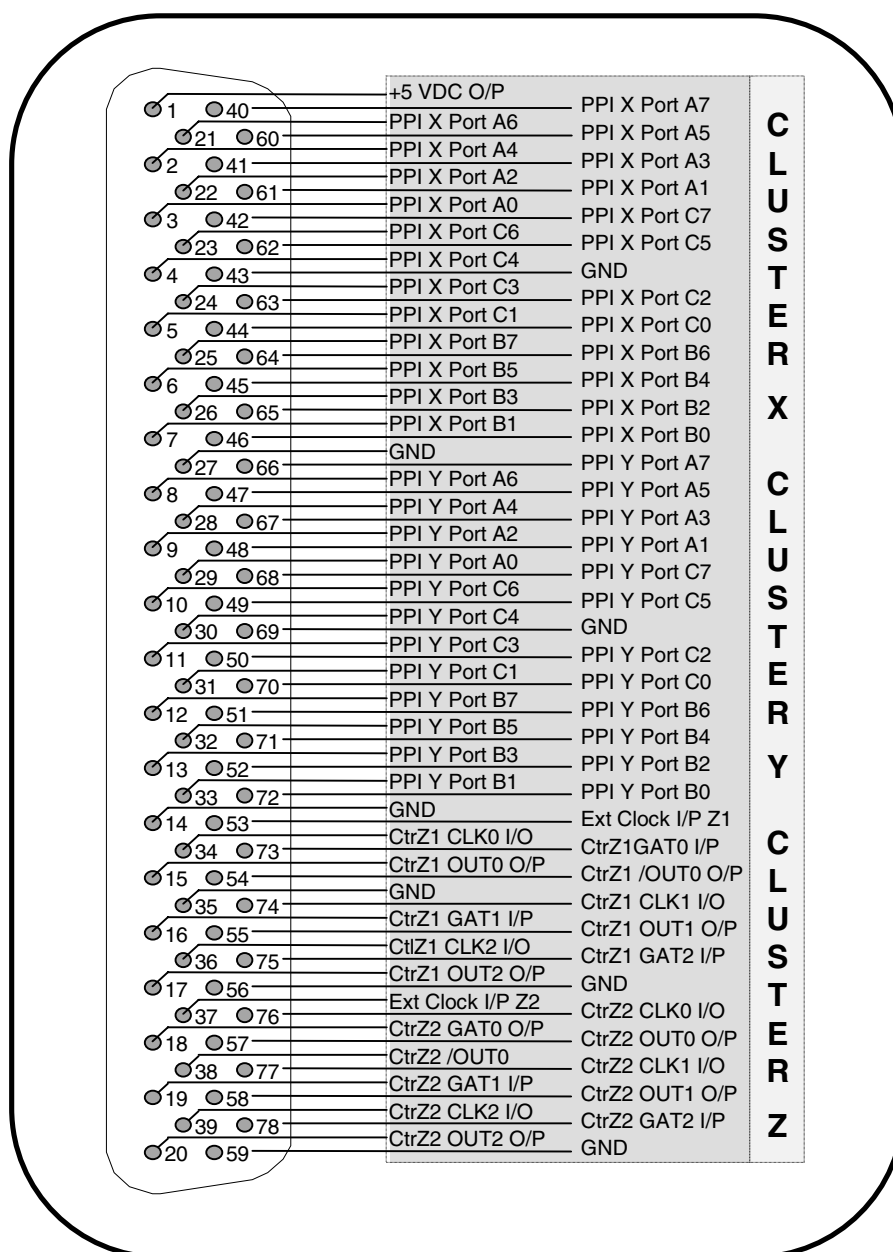


FIGURE 3-1 78 WAY D-TYPE CONNECTOR (SK1 - USER I/O)



Connection accessories are available from Amplicon:

<u>Description</u>	<u>Order Code</u>
EX233 termination and distribution panel (& manual)	9096 6333
EX213* 24 channel output panel with relays and Isolated logic panel	9096 6363
EX230* 24 channel input panel with isolated, common & contact closure inputs	9096 6373
78 pin connector kit	9194 5953
78 way cable (1m) EX233 interconnect cable	9096 6349
78 way interconnect cable (2m) for EX233	9099 3384
37 way cable (1m) EX233 to EX213/230	9101 4890

\*Only compatible with Digital I/O, not Counter Timer signals  
Full details of these termination panels are available in our catalogue.

### **3.2 Voltage Outputs Available on SK1**

In addition to the 48 digital I/O lines and counter timer lines, the +5VDC PC voltage rail is brought out on SK1, the I/O connector. No more than 1.0 Amp should be drawn from the +5V rail. Refer to the computer technical reference manual for current availability from the source power supplies.

### **3.3 Use of Shielded Cables**

In order to maintain compliance with the EMC directive, 89/336/EEC, it is mandatory that the final system integrator uses good quality screened cables for external connections. It is up to the final system integrator to ensure that compliance with the Directive is maintained. Amplicon Liveline offers a series of good quality screened cables for this purpose. Please contact our sales staff.

## 4 USING THE PCI215

### 4.1 Counter Timers Setup & Control

The PCI215 has two 82C54 counter timers (CTRs), which occupy clusters Z1 & Z2. Each 82C54 provides three 16-bit counter/timers which can be independently programmed to operate in any one of the six modes with BCD or Binary count functions as follows:

- Mode 0    Interrupt on Terminal Count
- Mode 1    Hardware Re-triggerable One-shot
- Mode 2    Rate Generator
- Mode 3    Square Wave
- Mode 4    Software Triggered Mode
- Mode 5    Hardware Triggered Strobe (Re-triggerable)

All timing operations are under the control of a 10 MHz crystal clock source. This source is used internally and divided down for input to the 16 bit programmable counter/timers. 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 modes as described above. The various interconnections are set up by the 'Counter Connections Register' under initial program control.

7	6	5	4	3	2	1	0
X	X	Z1/2 0= Z1 1= Z2	Counter Timer 00 – Counter 0 01 – Counter 1 10 – Counter 2 11 – Reserved	Clock Source 000 - CLKn 001 - 10MHz 010 - 1MHz 011 - 100kHz 100 - 10kHz 101 - 1kHz 110 - OUT n-1 111 - Ext Clock			

**FIGURE 4-1    GROUP Z CLOCK CONFIGURATION REGISTERS**

7	6	5	4	3	2	1	0
X	X	Z1/2 0= Z1 1= Z2	Counter Timer 00 – Counter 0 01 – Counter 1 10 – Counter 2 11 – Reserved	Gate Source 000 - VCC, enabled 001 - GND, disabled 010 - GATn 011 - /OUT n-2 100 - Reserved 101 - Reserved 110 - Reserved 111 - Reserved			

**FIGURE 4-2    GROUP Z GATE CONFIGURATION REGISTERS**

## 4.2 Digital I/O

The PCI215 has two 82C55 Programmable Peripheral Interface (PPI) chips with all functions of ports A and B, and optionally port C, available to the user. The operational mode for each port is established by writing to the control register of the 82C55. The 24 I/O pins of each user PPI are brought out to the 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 can be shared with other functions.

The control word written to the 82C55 control register also establishes whether the port is configured to operate as input, output or bi-directional. The control word is 8 bits and has two formats. When bit 7 is set to 1, the control word is used to establish the operational modes for the ports. When set to 0, the control word is used to write bits to Port C for status/control purposes.

The digital I/O facility of the PCI215 provides 48 lines in two clusters of three 8 bit ports, labeled:  
DIO Port XA0 - XA7, DIO Port XB0 - XB7 and DIO Port XC0 - XC7;  
DIO Port YA0 - YA7, DIO Port YB0 - YB7 and DIO Port YC0 - YC7.

Each cluster is divided into two groups of 12 bits each. Group A comprises the 8 bits of port A and the high order 4 bits of port C. Group B comprises the 8 bits of port B and the low order 4 bits of port C. When port C is split in this mode, a nibble (four bits) of data read from or written to port C occupies the appropriate high or low end of a full byte, the other four bits not being used.

### Mode 0 (Basic I/O)

This mode is the power-up default with all ports set as input (i.e. high impedance).

In mode 0, the PPI provides simple I/O operations. No control signals are required and the ports defined as input reflect the current state of digital signals on the lines (no latching). The lines of output defined ports are set to zero on the mode change, and when a port is loaded, the outputs are latched to that value

All 24 bits can be used for input or output arranged as any combination of two 8 bit ports and two 4 bit ports.

### Mode 1 (Strobed I/O)

Mode 1 provides I/O operations on Group A and/or Group B each with a simple handshake protocol. In either group, the 4-bit port is used for status and control of the associated 8-bit port. An IRQ facility in this mode is available on the PCI215.

Each 8-bit port can be used uni-directionally for either input or output operations, both being latched.

### Mode 2 (Strobed Bi-directional I/O)

This mode of operation can be applied to group A only, and provides one 8 bit bi-directional data port and one 5 bit control and status port with IRQ facility. Both input and output operations are latched. Port B can be used in mode 0 or 1 while port A is in mode 2.

### Mixed Mode

The ports of the PPI can be programmed to operate in a mixed combination of modes that in some cases leave bits of port C unused for control or status purposes. These unused bits can be programmed for use as inputs or outputs.

### 4.3 Digital I/O Conditions

The digital I/O lines on ports A, B and C of clusters X and Y, are TTL compatible.

When an input line is left open circuit, its high input impedance makes it susceptible to static charge and interference and the state may be indeterminate. Ensure that signals to any inputs are within the specifications, and that any unused input lines are grounded or masked out in software.

### 4.4 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. 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 bias resistor).

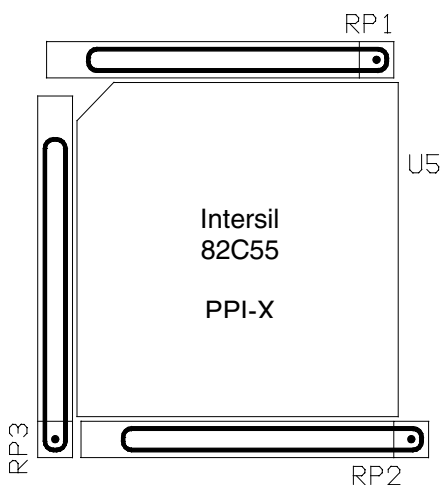
The bus hold feature affects the behaviour of the device when its data lines are configured as inputs. When a digital I/O line is configured as input, its value is normally defined by the input signal. When there is no signal, then the value can be defined using bias resistors (a pull up will define a '1' value, and a pull down resistor will define a '0' value).

Users of the PCI215 may need to review their input drive circuits to ensure they can source / sink sufficient current to overcome the 'bus hold current' of the Intersil 82C55.

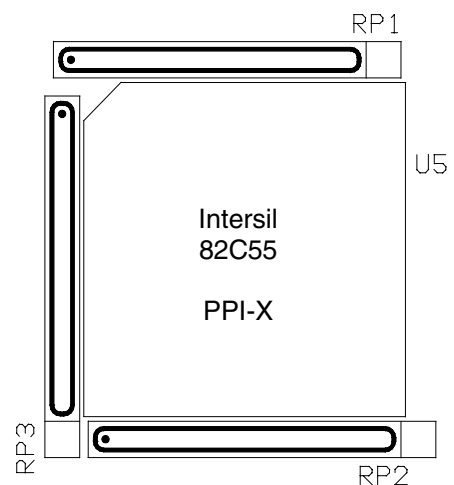
The PCI215 card has always been fitted with pull-up resistors, which are now in sockets. On power up all the I/O lines default to inputs and therefore all the I/O pins will be pulled high until configured as inputs or outputs by the system software.

The PCI215 now has 10-pin sockets instead of 9-pin, which are supplied with the resistors fitted in pull up configuration.

**PULL UP CONFIGURATION**  
(Factory Default)



**PULL DOWN CONFIGURATION**



**FIGURE 4-3 82C55 BIAS RESISTOR POSITIONS**

If users need to ensure that any of the I/O pins are low at power up, they need to pull the line low. This can be done by moving the resistor pack to the pull down position of the socket, see Figure 4-3 and Figure 4-4, or using external circuitry to ensure that the line is pulled down low with enough resistance to overcome the bus hold current and pull-up resistor.

	PORT A	PORT B	PORT C
PPI-X	RP1 (4.7 kohm)	RP2 (100 kohm)	RP3 (100 kohm)
PPI-Y	RP4 (4.7 kohm)	RP5 (100 kohm)	RP6 (100 kohm)

**FIGURE 4-4 PORTS AND BIAS RESISTORS**

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
- External 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. If the line is changed from an output to an input, the most recent 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”, 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.

The PCI215 card now has strong 4.7 kohm pull ups fitted to port A in sockets, to overcome the bus hold facility and force the input to “high”. The user will need to check that the device driving the line is capable of sourcing / sinking the new higher current.

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. The 4.7 kohm pull-up resistor on the PCI215 will appear in parallel with any external pull-up, increasing the current sink requirement of the driver.

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

Where  $R_{\text{ext\_pullup}}$  is the value of any external pull-up resistance fitted, and VCC is the input voltage.

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 sockets allow users to remove the 4.7 kohm pull-up resistors, when not required. The hold current is strong (400  $\mu$ A maximum) so the pull down resistors need to be less than 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 chip 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 unless 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.

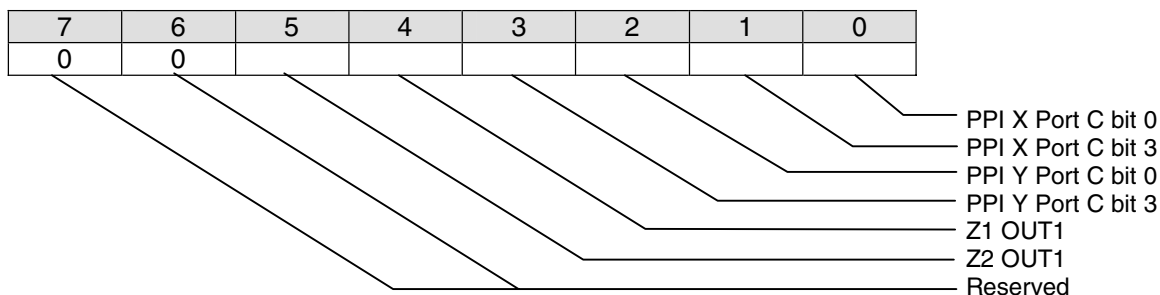
PCI215 card has always had weak 100 kohm pull ups fitted ensuring that the input will default to a high unless driven low by an external circuit.

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 sockets allow users to remove the 100 kohms pull-up resistors when not required. The hold current is strong (400  $\mu$ A maximum) so the pull down resistors need to be less than 1.7 kohm.

As this is a new feature of the 82C55, both new and existing users of the PCI215 need to review their input drive circuits to ensure they can source / sink sufficient current to overcome the 'bus hold current'.

### 4.5 IER Interrupts Enable / Status Register

This is a read and write register. When written to it is an interrupt enable / mask register. Set the relevant bit high to enable any particular interrupt. When read it is the interrupt status register. If enabled and active prior to reading the ISR the corresponding bit will be set.



## 5 PROGRAMMING THE PCI215

The PCI215 is 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.

### 5.1 Copyright

Software supplied with the PCI215 is **Amplicon** copyright. Permission is granted for the purchaser of the PCI215 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 PCI215 hardware purchased from **Amplicon Liveline Limited**.

### 5.2 Guide to User Programming

When developing an application specific program, it is advised that the supplied driver and dynamic link library functions be used for 32-bit Windows applications. Please refer to the ADIO software manual, **ampdio32manual.pdf**, for details of programming using the functions in the DLL.

The relevant sections in the Win32 Drivers manual are as follows:

- 1 INTRODUCTION
- 2 GETTING STARTED
- 3 DRIVER FUNCTIONS AND CONCEPTS, introductory section
  - 3.1 Timer Counter Functions
  - 3.2 Digital I/O Functions
  - 3.4 Using Interrupts
- 4 SOFTWARE INSTALLED WITH THE DRIVER
- 5 STRUCTURE AND ASSIGNMENTS OF THE REGISTERS
  - 5.4.1 82C55 Programmable Peripheral Interface Registers
  - 5.4.2 82C54Counter Timer Registers
  - 5.4.3 Clock and Gate Configuration Registers
- 6 PROGRAMMING WITH THE ADIO DRIVER
  - 6.3 Using the Dynamic Link Library
  - 6.4 Windows 32 Library Functions
    - 6.4.1 Initialization Functions
    - 6.4.2 Interrupt Control Functions
    - 6.4.3 Thread Priority Functions
    - 6.4.4 Data Buffer Functions
    - 6.4.5 Timer/Counter Functions
    - 6.4.6 Differential Counter Functions
    - 6.4.7 Millisecond Stopwatch Functions
    - 6.4.8 Frequency/Pulse Generation Functions
    - 6.4.9 Frequency Input and Regeneration Functions
    - 6.4.10 Digitally Controlled Oscillator Functions
    - 6.4.11 Digital Input/Output Functions
    - 6.4.12 Switch Scanner Matrix Functions
    - 6.4.13 Basic User Interrupt Callbacks
    - 6.4.14 Buffered User Interrupt Callbacks
    - 6.4.15 Non-Callback Buffered User Interrupts

- 6.4.21 Support for Agilent VEE
- 6.4.21.1 Timer Counter Functions In HP VEE
- 6.4.23 Driver Interface Functions
- 6.5 Library Error Codes
- 7 IOCTL Interface

For programming at register level, reference should to be made to section 2 describing the assignments of each I/O register in the PCI215. Support is not available for this method of programming.

### 5.3 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 PCI215 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 CD, and/or the **Amplicon Product Catalogue** or Sales Department for the latest information.

### 5.4 Notes for Users of the PC214E & PC215E

The PCI215 is a PCI bus compatible replacement for the PC214E and PC215E ISA Multifunction I/O cards. Where the PCI215 is used in systems previously using the PC214E or PC215E, the user should note the following.

#### Base Address and IRQ

The I/O Base address and IRQ are assigned by the PC Plug and Play BIOS, rather than being set by jumpers. These tend to get reassigned by the BIOS when PCI hardware is added or removed.

If using the supplied Windows 32-bit driver and DLL, calls to the registerBoard function should be replaced by calls to registerBoardEx or registerBoardPci which do not rely on the base address or IRQ remaining fixed. Please refer to the ADIO software manual, **ampdio32manual.pdf**, for details.

#### Interrupt Sharing

The PCI215 interrupts are level-sensitive and the IRQ is usually shared by other PCI cards. The PCI215 asserts the interrupt while its interrupt status register at BA + 1E is non-zero, indicating that an enabled interrupt condition has occurred and has not yet been cleared.

An interrupt routine for the PCI215 should check the card's interrupt status register to see if it is asserting the interrupt.

#### PC215E

The PCI215 provides the same functions as the PC215E.

If using the supplied Windows 32-bit driver and DLL note the following:

1. If using the registerBoard or registerBoardPci functions, the card type PCI215 (=215) may be used instead of PC215E (=215). They have the same numeric value.



**PC214E**

The PCI215 provides the same functions as the PC215E. Differences between the PC214E and PC215E/PCI215 are as follows:

1. The PC215E and PCI215 have two 82C54 counter/timer chips (a total of six counter/timer channels) as opposed to the PC214E's single 82C54 counter/timer chip.
2. The PC215E and PCI215 have interrupt status and interrupt enable registers which allow multiple interrupt sources to be used simultaneously. PC214E interrupt set-up code must be modified for the PC215E or PCI215 to write to the interrupt enable register to select the correct interrupt source(s). PC214E interrupt service code must be modified for the PC215E or PCI215 to check the interrupt status register and to write to the interrupt enable register afterwards to unlatch and re-enable interrupt source(s) which were flagged by the interrupt status register.
3. The PC215E and PCI215 have clock source selection and gate source selection registers. If modifying a PC214E application which uses counter/timers, it is necessary to write to these registers to set up the clock and gate sources which were previously determined by the jumper settings on the PC214E.

If using the supplied Windows 32-bit driver and DLL note the following:

2. If using the registerBoard or registerBoardPci functions, use the card type PC215E (=215) or PCI215 (=215) instead of PC214E (=214).
3. When setting up user interrupts, make sure the correct interrupt source is selected.
4. The DLL provides functions for setting the clock sources and gate sources.

## APPENDICES

### APPENDIX A TECHNICAL SPECIFICATIONS

#### A.1 Electrical Specification

##### COUNTER / TIMER

<b>Features</b>	PCI215 has two 82C54 or equivalent counter/timers CTRs (arranged as Z1 & Z2). Each CTR provides: Three independent 16 bit counters Six programmable counter modes, binary or BCD		
<b>Internal Clock Source</b>	10 MHz, derived from crystal controlled oscillator or software selectable Initial tolerance <span style="float: right;">±50 ppm</span> Frequency drift over temp. range <span style="float: right;">±50 ppm</span>		
<b>Clock Divider</b>	Clock pre-scalers provide alternative clock frequencies of 10MHz, 1MHz, 100kHz, 10 kHz, 1kHz. Or external clock source.		
<b>External Clock/Gate Input</b>	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.		
<b>Counter Outputs</b>	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': +0.3V max at +2.0 mA 'High': +3.8V min at -2.0 mA.		

**DIGITAL I/O**

**Digital I/O Ports** 48 I/O lines arranged as two clusters (X, Y) of three 8 bit ports (A, B and C).

Each cluster also programmable as two groups of 12 bits (group A, group B) and used in three modes of operation. Each Control block (Group A and Group B) accepts "commands" from the Read/Write Control logic, receives "control words" from the internal data bus and issues proper commands to its associated ports.

Control Group A - Port A and Port C upper (C7 - C4)

Control Group B - Port B and Port C lower (C3 - C0)

Mode 0: Basic I/O (Group A, group B)

Mode 1: Strobed I/O (Group A, group B)

Mode 2: Bidirectional bus (Group A only)

Digital Inputs	'Low' input voltage	-0.3V to +0.8V. )	TTL
	'High' input voltage	+2.2V to +5.3V. )	compatible
	Bus hold current	400uA	

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

User I/O Connector      78 way female D type. 48 digital I/O lines, counter/timer signals, power and ground.

Address Range      The board's address range is assigned by the plug and play mechanism.

IRQ Range      Port C3 Interrupt is assigned an IRQ by the plug and play mechanism.

Power      Powered by +5 Volts from the host PC bus.

PCI215 draws 220mA or up to 300mA when all 48 digital output lines are fully loaded.

+5 VDC at 1A PC bus voltage is available at the user I/O connector:

**A.2 Software Specification**

The distribution software is supplied on a CD-ROM.

Windows 95, 98, NT, 2000 & XP Driver Software provides Application level access to all the advanced features of the card from these operating systems.

### A.3 Environmental Conditions

#### Environment

The PCI215 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

<b>I/O Positions Required</b>	One PCI bus version 2.1 I/O adapter slot with room for half-length card.
<b>Board Dimensions</b>	Length 144 mm Height 108 mm plus edge connectors.
<b>Temperature Range</b>	Operating 0° C to +60° C Storage -20 to +70° C
<b>Humidity Range</b>	Operating and storage 5% to 95% relative humidity, non-condensing
<b>Power Requirements</b>	5 VDC from host computer power supply.  250 mA PCI215 typical operating  Excluding power supplied to external system via user connector.
<b>Dissipation</b>	Each PCI215 will dissipate typically 1.0 Watts of heat
<b>Handling</b>	Normal static handling precautions apply. Damage could result if not observed

#### Order Codes

The Order Code for the PCI215 is 9600 3513

#### Optional Accessories

<b>Amplicon Order Code</b>	<b>Description</b>
9096 6333	EX233 termination and distribution panel (& manual)
9096 6363	EX213 24 channel output panel with relays and Isolated logic panel
9096 6373	EX230 24 channel input panel with isolated, common & contact closure inputs
9194 5953	78 pin connector kit
9099 3384	78 way interconnect cable (2m) for EX233
9096 6349	78 way interconnect cable (1m) for EX233
9101 4890	37 way cable (1m) EX233 to EX213/230

## APPENDIX B      CIRCUIT LAYOUT AND SCHEMATIC DRAWINGS

Full circuit diagrams and layout drawings of the PCI215 are given in this appendix.

### B.1 ASSEMBLY DETAIL

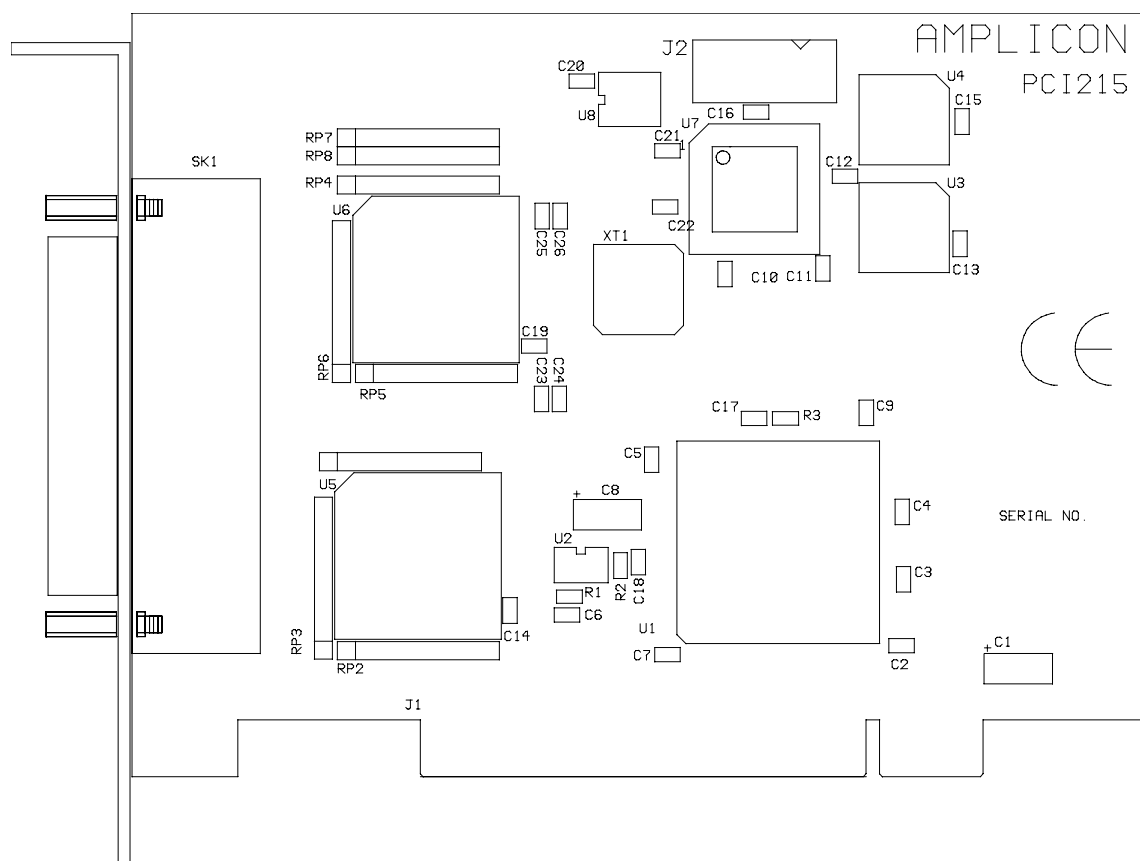


FIGURE B-1      PRINTED CIRCUIT LAYOUT

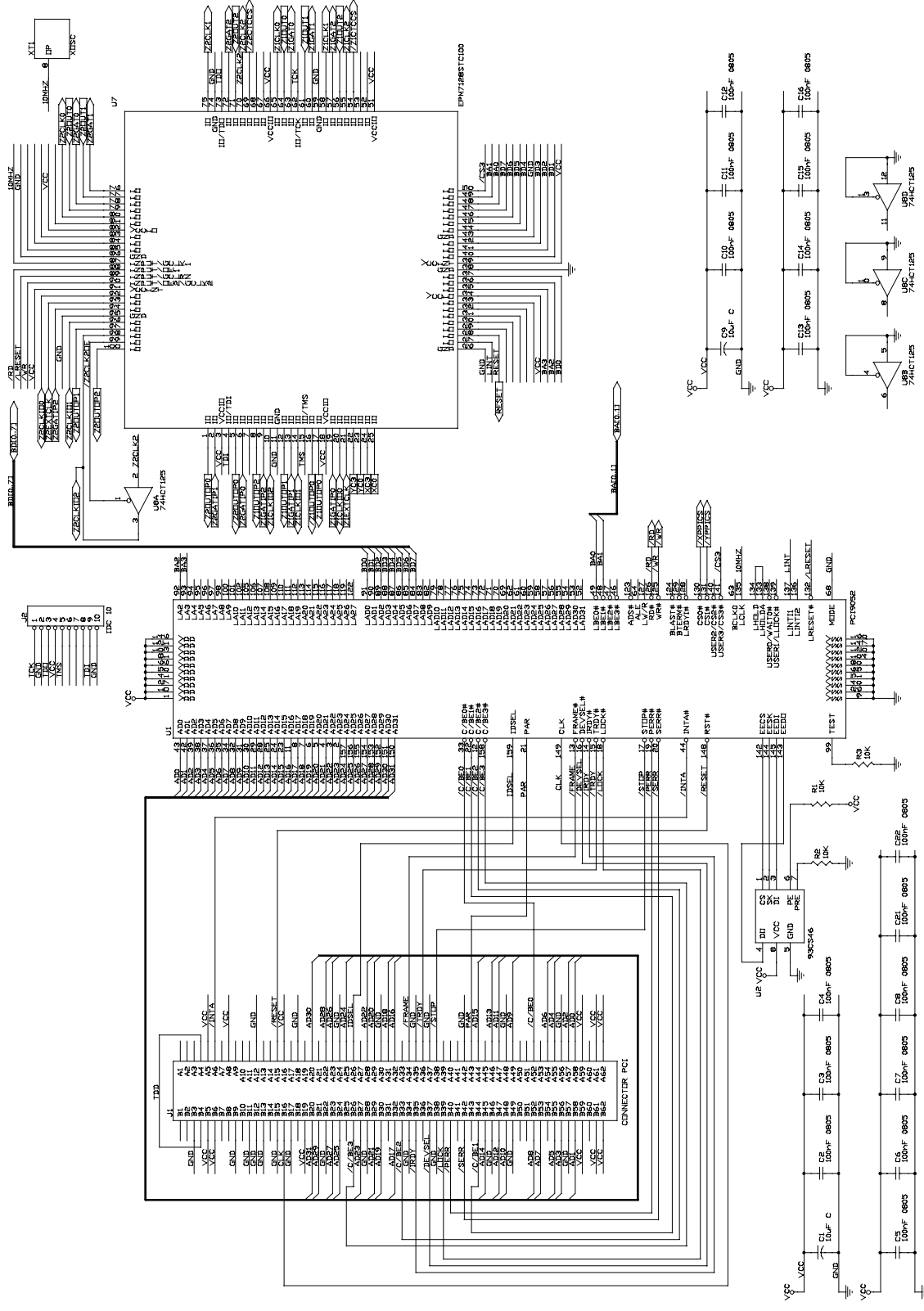


FIGURE B-2 PCI215 CIRCUIT DIAGRAM (SHEET 1)

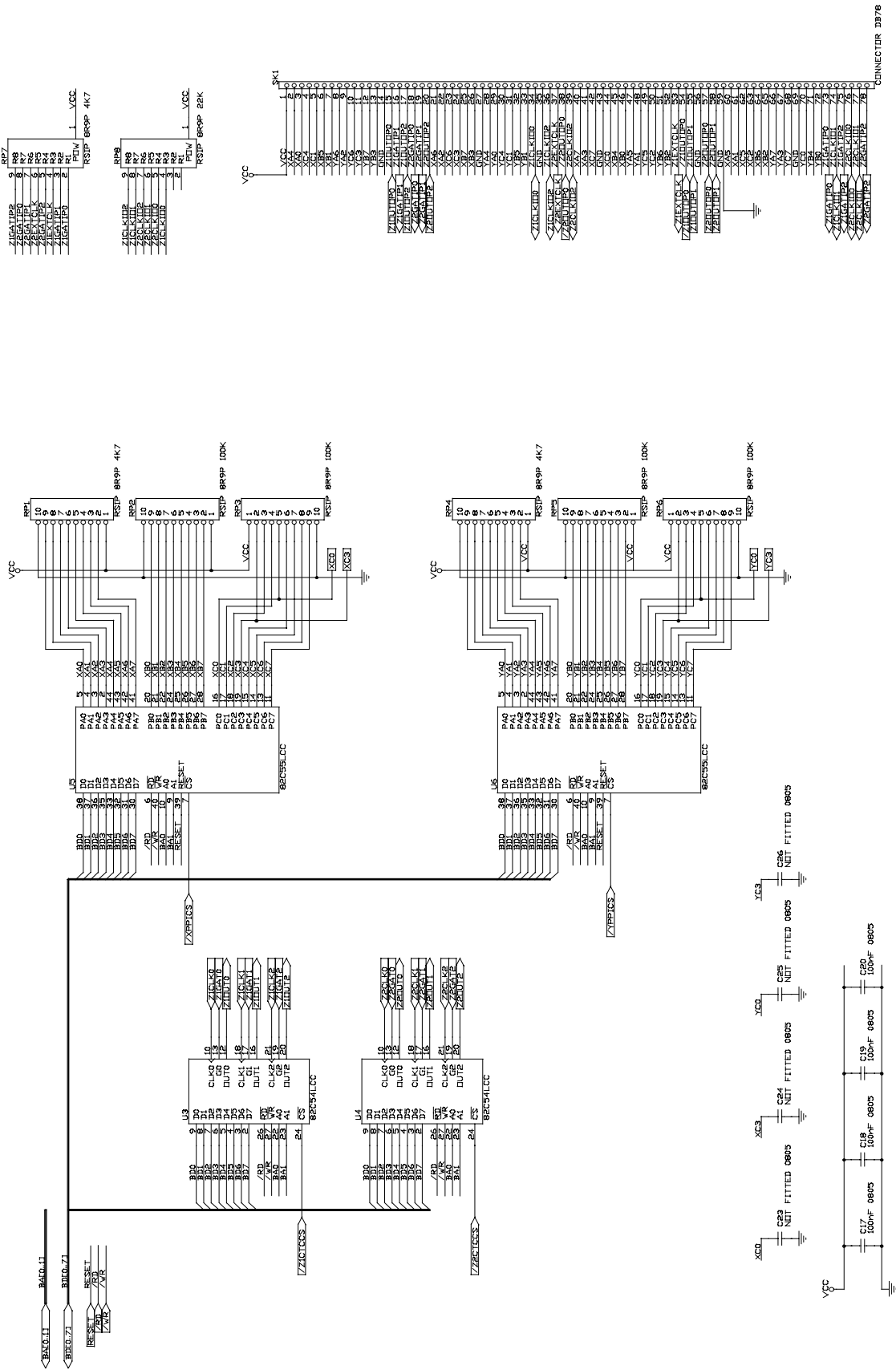


FIGURE B-3 PCI215 CIRCUIT DIAGRAM (SHEET 2)