PCI-DUAL-AC5

High-Output

Digital I/O Board

User's Guide

MEASUREMENT COMPUTING™

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1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The PCI-DUAL-AC5 is a 48-bit digital I/O board for PCI-compatible computers. Primarily designed as a direct interface to the industry-standard SSR-PB24 rack, the board is also highly useful as a general purpose digital I/O board (Figure 1-1).

The board emulates two 8255 chips, but offers much higher drive capability than the 8255. The board emulates only Mode 0 of the 8255 (no strobed I/O or bi-directional I/O bits). The board is completely plug-and-play with no on-board user-configurable switches or jumpers.

All inputs and outputs are TTL compatible, with the outputs capable of sinking 64 mA or sourcing 15 mA. All I/O is brought out to a 100-pin connector, which also allows connection to the PC's +5 Volt and Ground.

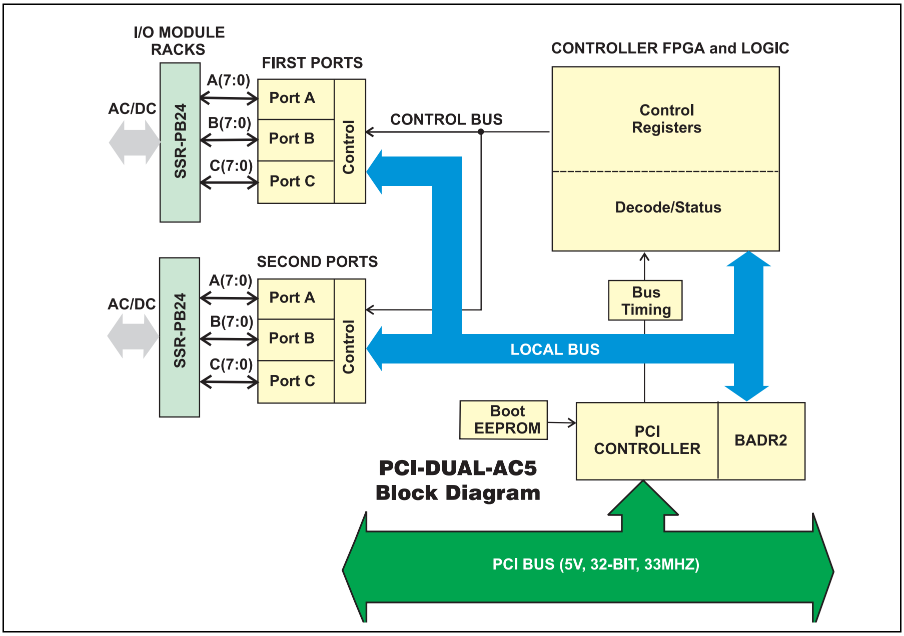

Figure 1-1. Functional Block Diagram

2 INSTALLATION

2.1 SOFTWARE INSTALLATION

The board has no switches or jumpers to set. The simplest way to configure and test your installation is to use the *Insta*Cal™ program provided on the CD (or floppy disk) received with the PCI-DUAL-AC5.

*Insta*Cal will create a configuration file that your application software (and the Universal Library) will refer to so the software you use will automatically have access to the exact configuration of the board.

Please refer to the *Extended Software Installation Manual* regarding the installation and operation of *Insta*Cal.

2.2 HARDWARE INSTALLATION

PCI products support plug-and-play . Simply follow the steps below to install your PCI hardware.

1. Turn your computer OFF, open it up and insert the PCI board into any available PCI slot.

   NOTE: DON'T UNPLUG THE COMPUTER.

2. Close up your computer and turn it ON.

3. Some operating systems, such as Windows 95 or 98, will automatically detect the board as it starts up. If the board's configuration file is already on the system, it will load without user interaction. If the configuration file is not detected, you will be prompted to insert the disk containing it. The required file is on the InstaCal disk you received with your board. The appropriate file will then be automatically loaded and the PCI board will appear in the Device Manager under DAS components.

If you have purchased the Universal Library programmers library, the installation program will install all the software required to run the PCI board as well as Universal Library programming language support.

3 CONNECTIONS

3.1 SIGNAL CONNECTIONS

All the digital inputs and outputs on the PCI-DUAL-AC5 connector are TTL and are fully compatible with the inputs and outputs on the industry-standard PB-24 rack (Measurement Computing Corp., Model SSR-PB24).

IMPORTANT NOTE

> The PCI-DUAL-AC5 initializes all ports **as inputs** on power-up and Reset. TTL inputs are high impedance, but TTL leakage currents are high enough to turn on many kinds of external devices. If your application requires the outputs go to a known state on power-up or reset, install pull-up or pull-down resistors on the applicable output pins.

To simplify the use of pull up/down resistors, there are open positions to install Single Inline Package (SIP) resistors directly on the board. For further information regarding pull up/down resistors, please turn to application notes on pull up/down resistors contained in Section 6.1, Electronics and Interfacing.

3.2 CABLES

The PCI-DUAL-AC5 connector is accessible through the PCI slot expansion bracket. The connector is a standard 100-pin header connector. If you are connecting to the SSR-PB24 or equivalent, we recommend using the C100FE-# series cable. This cable splits the 100-pins into two edge-connectors which can connect to two SSR-PB24 racks (Figure 3-2). If you need direct access to the digital I/O's, use the C100FF-# series cables to connect two CIO-MINI50s or a CIO-TERM100. This combination brings all I/O connections out to convenient, easy-to-use screw terminals.

3.3 CONNECTOR DIAGRAM

The I/O connector for the board is a 100-pin header connector accessible from the rear of the PC through the expansion backplate. See Figure 3-1 for pin assignments.

The connector accepts 100-pin header connectors, such as on the C100FE-2, a 2-foot cable with two edge-connectors, or the C-100FF-2, a two-foot cable with two 50-pin header connectors.

If frequent changes to signal connections or signal conditioning is required, please refer to the information on the CIO-TERM100, CIO-SPADE50 and CIO-MINI50 screw terminal boards.

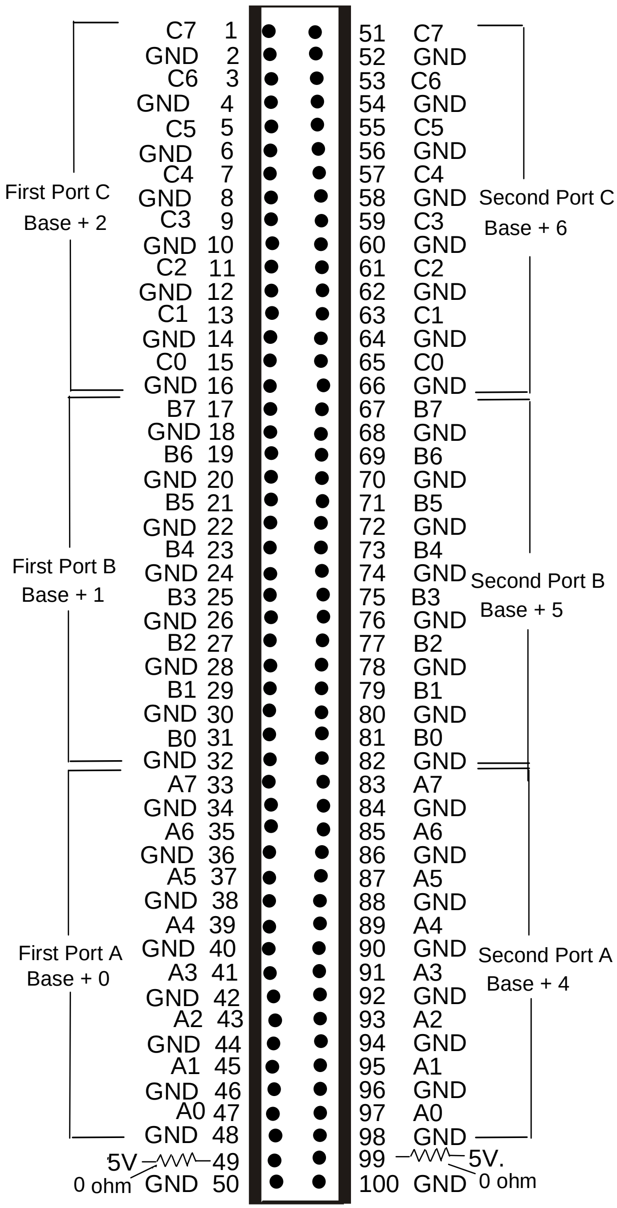

Figure 3-1 PCI-DUAL-AC5 100-Pin Connector

3.4 PCI-DUAL-AC5 to SSR-PB24 RACK CONNECTIONS

The PCI-DUAL-AC5 board provides 48 bits of digital I/O. However, most popular relay and SSR boards provide 24-bits of I/O. The PCI-DUAL-AC5 uses a dual-leg cable, C100FE-# to monitor and control SSRs on two SSR-PB24 racks. The configuration is shown in Figure 3-2 below. The 24-bits of digital I/O on PCI-DUAL-AC5 connector pins 1-48 (base address +0 through +2) control the first relay rack. The 24-bits of digital I/O on pins 51-99 (base address +4 through +6) control the second SSR rack.

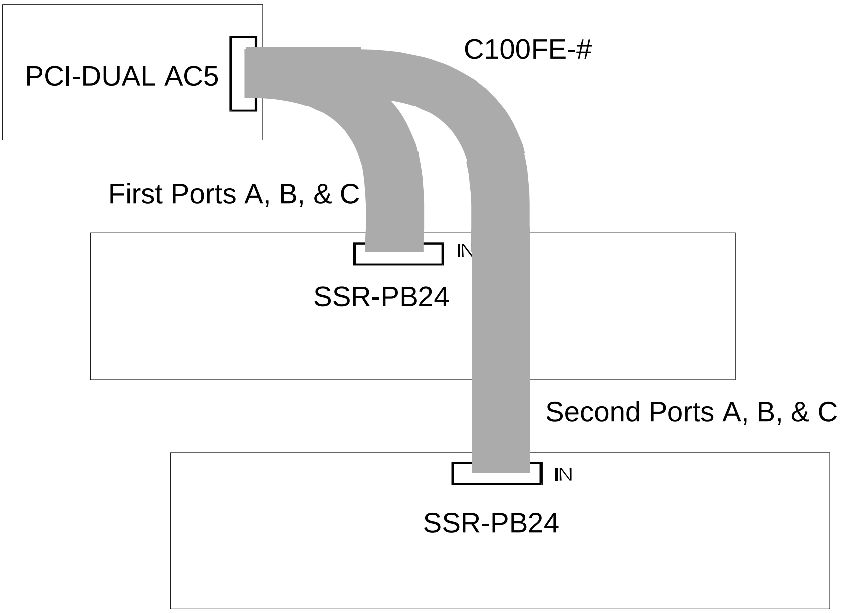

Figure 3-2. PCI-DUAL-AC5 to SSR-PB24 Cabling

Figure 3-3 is a pin translation of pins 51 thru 100 of the C100FE-# or C100FF-# cable to the second, 50-pin connector of the cable. (The first 50 pins are a one-to-one relationship to the first 50-pin connector.)

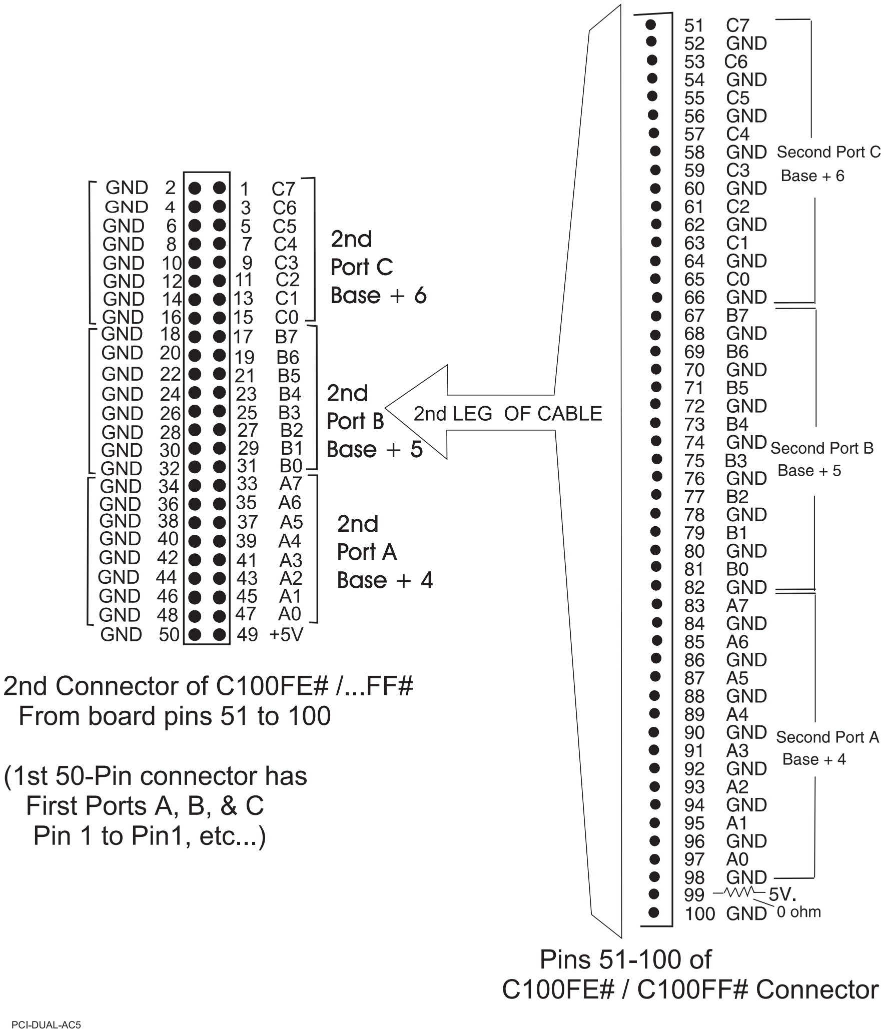

Figure 3-3. Pin Translation

2nd Leg of C100FF-# or C100FE-# to 50-Pin Connector

4 PROGRAMMING

4.1 REGISTER OVERVIEW

Register level programming should be attempted only by experienced programmers. The base addresses of PCI boards are assigned dynamically by the system. These addresses need to be determined by interrogation of the PLX 9052 interface. Discussion of how this is accomplished is beyond the scope of this manual.

As an alternative to register level programming, the PCI-DUAL-AC5 is fully supported by the optional Universal Library software as well as most high-level data acquisition and control application packages (e.g. SoftWIRE, HP Vee or Labtech Notebook).

The PCI-DUAL-AC5 emulates two 8255 parallel I/O chips operating in mode 0. Each emulation contains three data and one configuration register occupying four consecutive I/O addresses.

A detailed description of each register is included in subsequent sections. Each register has eight bits which can be one byte of data or eight individual read/write bits.

The register descriptions that follow have the following format:

7	6	5	4	3	2	1	0
A7	A6	A5	A4	A3	A2	A1	A0

Where the numbers along the top row are the bit positions within the 8-bit byte and the numbers and symbols in the bottom row are the functions associated with that bit.

To write to or read from a register in decimal or HEX, the weights In Table 4-1 apply:

Table 4-1. Register Bit Weights

BIT POSITION	DECIMAL VALUE	HEX VALUE
0	1	1
1	2	2
2	4	4
3	8	8
4	16	10
5	32	20
6	64	40
7	128	80

To write a control word or data to a register, the individual bits must be set to 0 or 1 then combined to form a byte. Data read from registers must be analyzed to determine which bits are on or off.

In summary form, the registers and their function are listed on Table 4-2. Within each register are eight bits which can constitute a byte of data or eight individual bit set/read functions.

Table 4-2. Register Functions Summary

ADDRESS	READ FUNCTION	WRITE FUNCTION	SIZE
BADR0	No user functions	No user functions	32 bit
BADR1	No user functions	No user functions	32 bit
BADR2 + 0	First Port A Data	First Port A Output	8-bit Byte
BADR2 + 1	First Port B Data	First Port B Output	8-bit Byte
BADR2 + 2	First Port C Data	First Port C Output	8-bit Byte
BADR2 + 3	None	Configure First Ports	8-bit Byte
BADR2 + 4	Second Port A Data	Second Port A Output	8-bit Byte
BADR2 + 5	Second Port B Data	Second Port B Output	8-bit Byte
BADR2 + 6	Second Port C Data	Second Port C Output	8-bit Byte
BADR2 + 7	None	Configure 2nd Ports	8-bit Byte

4.2 DIGITAL I/O REGISTERS

1st PORT A DATA **2nd PORT A DATA**
BADR2 + 0 BADR2 + 4

7	6	5	4	3	2	1	0
A7	A6	A5	A4	A3	A2	A1	A0

1st PORT B DATA **2nd PORT B DATA**
BADR2 + 1 BADR2 + 5

7	6	5	4	3	2	1	0
B7	B6	B5	B4	B3	B2	B1	B0

Ports A & B can be programmed as input or output. Each is written to and read from in bytes, although for control and monitoring purposes individual bits are used.

Bit set/reset and bit read functions require that unwanted bits be masked out of reads and OR'ed into writes.

1st PORT C DATA **2nd PORT C DATA**
BADR2 + 2 BADR2 + 6

7	6	5	4	3	2	1	0
C7	C6	C5	C4	C3	C2	C1	C0
CH3	CH2	CH1	CH0	CL3	CL2	CL1	CL0

Port C can be used as one 8-bit port, for either inputs or outputs, or it can be split into two 4-bit ports which can be independently input or output.

The notation for the upper 4-bit port is CH3-CH0, and for the lower, CL3-CL0.

Although it can be split, every read and write to port C carries eight bits of data so unwanted information must be AND'ed out of reads, and writes must be OR'ed with the current status of the other port.

INPUT PORTS
In 8255 mode 0 (emulation), ports configured for input read the state of the input lines at the moment the read is executed. Transitions are not latched.

OUTPUT PORTS
In 8255 mode 0 (emulation), ports configured for output hold the output data written. The output byte can be read back by reading a port configured for output.

1st PORT CONFIGURATION BADR2 + 3

2nd PORT CONFIGURATION BADR2 + 7

7	6	5	4	3	2	1	0
D7	D6	D5	D4	D3	D2	D1	D0

Information on programming 8255 emulation in mode 0 is included here. PCI-DUAL-AC5 only supports Mode 0 (Input/Output).

When the PC is powered-up or reset, all 48 lines are set to Input mode and no further programming is needed to configure the lines as TTL inputs.

The codes for configuring the board’s inputs and outputs are shown in Table 4-3.

Table 4-3. Configuration Registers BADR2 + 3 and BADR 2 + 7

D4	**D3**	**D1**	**D0**	**HEX**	**DEC**	**A**	**CU**	**B**	**CL**
0	0	0	0	0	0	OUT	OUT	OUT	OUT
0	0	0	1	1	1	OUT	OUT	OUT	IN
0	0	1	0	2	2	OUT	OUT	IN	OUT
0	0	1	1	3	3	OUT	OUT	IN	IN
0	1	0	0	8	8	OUT	IN	OUT	OUT
0	1	0	1	9	9	OUT	IN	OUT	IN
0	1	1	0	A	10	OUT	IN	IN	OUT
0	1	1	1	B	11	OUT	IN	IN	IN
1	0	0	0	10	16	IN	OUT	OUT	OUT
1	0	0	1	11	17	IN	OUT	OUT	IN
1	0	1	0	12	18	IN	OUT	IN	OUT
1	0	1	1	13	19	IN	OUT	IN	IN
1	1	0	0	18	24	IN	IN	OUT	OUT
1	1	0	1	19	25	IN	IN	OUT	IN
1	1	1	0	1A	26	IN	IN	IN	OUT
1	1	1	1	1B	27	IN	IN	IN	IN

NOTE: D7, D6, D5 & D2 are Don’t-Care.

5 SPECIFICATIONS

Typical for 25°C unless otherwise specified.

Current consumption

+5V Operating	1.129 A typical, 1.802 A max.

Digital Input / Output

Digital Type (main connector)	8255 mode 0 emulation
Output:	74S244
Input:	74LS373
Configuration	4 banks of 8, 4 banks of 4, programmable by bank as input or output
Number of channels	48 I/O
Output High	2.4 volts min. @ –15 mA
Output Low	0.5 volts max. @ 64 mA
Input High	2.0 volts min, 7 volts absolute max
Input Low	0.8 volts max, –0.5 volts absolute min
Power-up / reset state	Input mode (high impedance)
Miscellaneous	Locations provided for installation of pull-up or pull-down resistors.

Environmental

Operating temperature range	0 to 70°C
Storage temperature range	–40 to 100°C
Humidity	0 to 95% non-condensing

6 ELECTRONICS AND INTERFACING

This chapter contains information necessary for the safe and reliable installation of the PCI-DUAL-AC5 board. It contains four key topics:

1. Pull up/pull down Resistors
2. Unconnected Inputs
3. Solid State Relays
4. Voltage Dividers.

6.1 PULL UP & PULL DOWN RESISTORS

IMPORTANT CAUTION

WHEN THE PCI-DUAL-AC5 IS POWERED-UP OR RESET, ALL DIGITAL I/O PINS ARE CONFIGURED AS INPUTS.

TTL inputs usually, but not reliably, float high. The direction they float is dependent on the characteristics of the circuit and is unpredictable.

This means that if devices such as solid state relays, are driven by digital I/O pins, they can be switched on whenever the computer is powered-on or is reset. To prevent unwanted switching at power-on or reset, force all digital I/O pins to a known state by pulling all pins either high or low through a 2.2K resistor tied to either 5V or GND.

The pull-up resistor pulls the input to a high state (+5V) when the board is in input mode, as it would be on power-up or reset. A 2200 ohm resistor draws only 2 mA. A grounded 2200 ohm pull-down resistor pulls the I/O line low when the board is in input mode.

In a 2.2K, eight-resistor Single Inline Packages (SIP), one side of all resistors are connected to a single common point and brought out to a pin. The common line, which is marked (usually with a dot or line), is at one end of the SIP. The other ends of the resistors are brought out to the other eight pins (Figure 6-1). See Figure 6-2 for a schematic showing a SIP installed in both the pull-up and pull-down positions

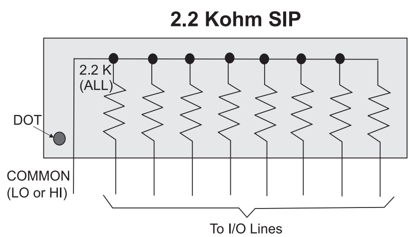

Figure 6-1. Eight-Resistor SIP Schematic

The PCI-DUAL-AC5 is equipped with positions for pull-up/pull-down resistors in Single Inline Packages (SIPs). The positions are marked Port 0A, Port 0B, Port 0C, and Port 1A, and Port 1B, and Port 1C. They are located adjacent to the board's I/O connector.

When installed, the SIP establishes either a high or low logic level at each of the of eight I/O lines (Figure 6-2). At each board location, A, B, and C, there are 10 holes in a line. The hole on one end is marked "HI" and is connected to +5V. The other end is marked "LO" and is connected to GND. The eight holes in the middle connect to eight lines of the port, A, B, or C.

Install the SIP with the common pin (marked with a dot) in either the HI or LO hole, then solder the SIP in place.

We recommend using 2.2K SIPs (Our part number is SP-K2.29C).

Use a different value only if you have determined the necessity of doing so.

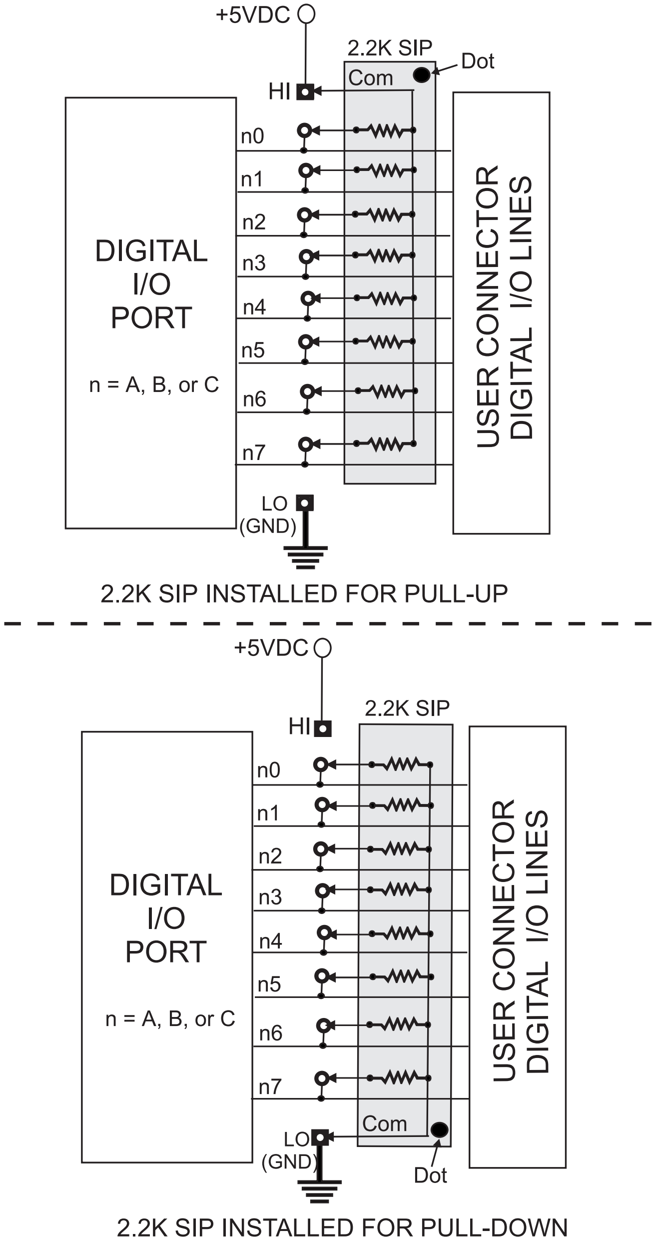

Figure 6-2. Pull-Up and Pull-Down Resistor SIPs Schematic

6.2 UNCONNECTED INPUTS FLOAT

Keep in mind that unconnected inputs float. If you are using a PCI-DUAL-AC5 board for input, and have unconnected inputs, ignore the data from those lines.

In other words, if you connect bit A0 and not bit A1, do not be surprised if A1 stays low, stays high or tracks A0. It is unconnected and so is not specified. The board is not malfunctioning. In the absence of a pull-up/down resistor, any input to a PCI-DUAL-AC5 which is unconnected is unspecified.

You do not have to tie input lines, and unconnected lines will not affect the performance of connected lines. Just make sure to mask out any unconnected bits in software.

6.3 TTL TO SOLID STATE RELAYS

Many applications require digital outputs to switch AC and DC voltage motors on and off or to monitor AC and high DC voltages. These AC and high DC voltages cannot be controlled or read directly by the TTL digital lines of a PCI-DUAL-AC5.

Solid State Relays, allow control and monitoring of AC and high DC voltages and provide 750V isolation. Solid State Relays (SSRs) are the recommended method of interfacing to AC and high DC signals.

The most convenient way to use solid state relays and a PCI-DUAL-AC5 board is to purchase a Solid State Relay Rack. The rack recommended for the PCI-DUAL-AC5 board is the SSR-PB24 from Measurement Computing Corp.

6.4 VOLTAGE DIVIDERS

If you wish to measure a signal which varies over a span greater than the input span of a digital input, a voltage divider can drop the voltage of the input signal to the level the digital input can measure.

A voltage divider takes advantage of Ohm's law, which states,

> Voltage = Current * Resistance (V = IR)

and Kirkoff's voltage law which states,

> The sum of the voltage drops around a circuit will be equal to the voltage drop for the entire circuit.

Implied in the above is that any variation in the voltage drop for the circuit as a whole will have a *proportional* variation in all the voltage drops in the circuit.

In a voltage divider, the voltage across one of the resistors in a circuit is proportional to the value of this resistor compared to the total resistance in the circuit (Figure 6-3).

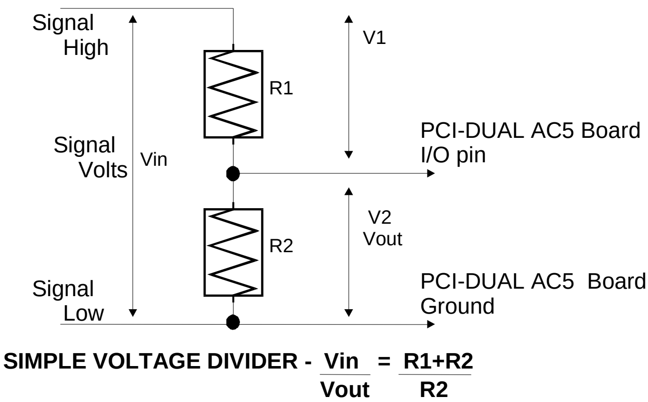

Figure 6-3. Simple Voltage Divider

The object in using a voltage divider is to choose two resistors with the proper proportions relative to the full scale of the digital input and the maximum signal voltage.

Dropping the voltage proportionally is called attenuation. The formula for attenuation is:

$$\text{Attenuation} = \frac{R1 + R2}{R2}$$

The variable Attenuation is the proportional difference between the maximum signal voltage and the full scale of the voltage input.

$$2 = \frac{10K + 10K}{10K}$$

For example, if the signal varies between 0 and 20 volts and you wish to apply that to a board having a full scale input range of 0 to 10 volts, the attenuation must be 2:1 or just 2.

$$R1 = (A - 1) * R2$$

For a given attenuation, pick a handy resistor and call it R2, then use this formula to calculate R1.

Digital inputs may require the use of voltage dividers:

For example, if you wish to monitor a digital signal that is at 0 volts when off and 24 volts when ON, you cannot connect that directly to the PCI-DUAL-AC5 digital inputs. The voltage must be dropped to 5 volts max. when ON. The Attenuation is 24:5 or 4.8. Use the equation above to find an appropriate R1 if R2 is 10K. Remember that a TTL input is "ON" when the input voltage is greater than 2.5 volts.

$$R1 = (4.8 - 1) * 10K$$

$$R1 = 38K$$

$$4.8 = \frac{(38K + 10K)}{10K}$$

IMPORTANT NOTE

The resistors, R1 and R2, are going to dissipate all the power in the divider circuit according to the equation $W = I^2R$ (Power = Current squared * Resistance). The higher the value of the resistance (R1 + R2) the less power dissipated by the divider circuit.

Here are two simple rules:

For attenuation of 5:1 or less, no resistor should be less than 10K.

For attenuation of greater than 5:1, no resistor should be less than 1K.

For your notes.

EC Declaration of Conformity

We, Measurement Computing Corporation, declare under sole responsibility that the product:

PCI-DUAL-AC5	Digital I/O Board
Part Number	Description

to which this declaration relates, meets the essential requirements, is in conformity with, and CE marking has been applied according to the relevant EC Directives listed below using the relevant section of the following EC standards and other normative documents:

EU EMC Directive 89/336/EEC: Essential requirements relating to electromagnetic compatibility.

EU 55022 Class B: Limits and methods of measurements of radio interference characteristics of information technology equipment.

EN 50082-1: EC generic immunity requirements.

IEC 801-2: Electrostatic discharge requirements for industrial process measurement and control equipment.

IEC 801-3: Radiated electromagnetic field requirements for industrial process measurements and control equipment.

IEC 801-4: Electrically fast transients for industrial process measurement and control equipment.

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