CPCI-DIO24H

User's Manual

Revision 1
October, 2000

MEGA-FIFO, the CIO prefix to data acquisition board model numbers, the PCM prefix to data acquisition board model numbers, PCM-DAS08, PCM-D24C3, PCM-DAC02, PCM-COM422, PCM-COM485, PCM-DMM, PCM-DAS16D/12, PCM-DAS16S/12, PCM-DAS16D/16, PCM-DAS16S/16, PCI-DAS6402/16, Universal Library, *Insta*Cal, *Harsh Environment Warranty* and Measurement Computing Corporation are registered trademarks of Measurement Computing Corporation.

IBM, PC, and PC/AT are trademarks of International Business Machines Corp. Windows is a trademark of Microsoft Corp. All other trademarks are the property of their respective owners.

Information furnished by Measurement Computing Corp. is believed to be accurate and reliable. However, no responsibility is assumed by Measurement Computing Corporation neither for its use; nor for any infringements of patents or other rights of third parties, which may result from its use. No license is granted by implication or otherwise under any patent or copyrights of Measurement Computing Corporation.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form by any means, electronic, mechanical, by photocopying, recording or otherwise without the prior written permission of Measurement Computing Corporation.

Notice

Measurement Computing Corporation does not authorize any Measurement Computing Corporation product for use in life support systems and/or devices without the written approval of the President of Measurement Computing Corporation Life support devices/systems are devices or systems which, a) are intended for surgical implantation into the body, or b) support or sustain life and whose failure to perform can be reasonably expected to result in injury. Measurement Computing Corp. products are not designed with the components required, and are not subject to the testing required to ensure a level of reliability suitable for the treatment and diagnosis of people.

(C) Copyright 2000, Measurement Computing Corp.

This page is blank.

1 INTRODUCTION

This manual provides information on the CPCI-DIO24H digital I/O board.
The CPCI-DIO24H uses 82C55 emulation for the digital I/O interface. The I/O lines are accessible through a 37-pin connector.

CPCI-DIO24H is a high drive, 24-line digital I/O board. The control register which sets the direction of the I/O ports is identical to an 82C55 in mode 0 (see 82C55 data sheet). The I/O pins are high drive TTL capable of sourcing 15 mA and sinking 64 mA.

This manual provides information on 82C55 (emulated) programming in mode 0 only.

The board is supported by Universal Library programming library.

2 INSTALLATION

The CPCI-DIO24H is easy to use. This procedure will help you quickly and easily setup, install and test your board. If you are unfamiliar with board installation, please refer to your computer's documentation.

2.1 SOFTWARE

The board has no switches and jumpers to set before installing the board in your cPCI system (chassis). By far the simplest way to configure your board is to use the *Insta*Cal™ program provided as part of your software package. *Insta*Cal™ will show you all available options, and will create a configuration file that your application software (and the Universal Library) will refer to so the software you use will automatically know the exact configuration of the board.

Please refer to the *Extended Software Installation Manual* regarding the installation and operation of *Insta*Cal™. The following hard copy information is provided as a matter of completeness, and will allow you to set the hardware configuration of the board if you do not have immediate access to *Insta*Cal™ and/or your computer.

2.2 HARDWARE

The CPCI-DIO24H board is completely plug and play. Simply follow the steps shown below to install your CPCI-DIO24H hardware.

1. Turn your cPCI system (chassis) off, and insert the CPCI-DIO24H.
2. Turn it on.
3. See the *Extended Software Installation Manual* for complete instructions.

The CPCI-DIO24H requires four standard I/O addresses as well as the addresses required for Plug-and-Play operation. The addresses are allocated by the PCI plug & play procedure and can not be modified. If you have installed ISA bus boards in the past you are familiar with the need to select a base address and interrupt level. On CPCI systems this is not of concern to you. It is not up to you to select a base address and ensure that it does not conflict with an installed port. In CPCI systems, the operating software and installation software do the selection and checking for you.

InstaCal selects and sets the I/O address from the range of available addresses. The address and other information is stored in the configuration file CB.CFG. This file is accessed by the Universal Library for programmers. Note also that the Universal

Library is the I/O board interface for packaged applications such as Labtech Notebook and HP-VEE, therefore the InstaCal settings must be made in order for these and other applications to run.

The board's base address is also stored in the system software. Once InstaCal installation software is run, other programming methods such as direct IN and OUT statements can write and read the CPCI-DIO24H registers by reference to the base address and the offset from base address corresponding to the chart of registers located elsewhere in this manual.

But a word of warning is in order here. Direct writes to the addresses simply by reference to the base address of the CPCI-DIO24H I/O registers are not advised. Since the addresses assigned by the PCI plug & play software are not under your control, there is no way to guarantee that your program will run in any other computer.

Not only that, but if you install another CPCI board in a computer after the CPCI-DIO24H addresses have been assigned, those addresses can be moved by the plug & play software when the second board is installed. It is best to use a library such as Universal Library or a program such as HP-VEE to make measurements with your CPCI-DIO24H.

2.3 TESTING THE INSTALLATION

After you have run the install program and set your base address with InstaCal, it is time to test the installation. The following section describes the InstaCal procedure to test that your board is properly installed.

With InstaCal running, choose the *TEST* item on the main menu.

a. Select the board you just installed

b. Select **Internal Test**

c. The internal control registers of the board will then be tested. If this test is successful, your board is installed correctly.

d. If the **Internal Test** is completed successfully, you may want to check that the I/O pins are working correctly. To check this select **External Test** and follow the instruction provided.

3 I/O CONNECTIONS

3.1 CABLES AND SCREW TERMINAL BOARDS

The CPCI-DIO24H connector is a standard 37-pin male “D” connector. The I/O connections can be brought out to easy-to-use screw terminals by purchasing a CFF37-series cable and a CIO-MINI37 screw terminal accessory board.

A mating female connector can be purchased from Measurement Computing Corp. or most other electronic supply outlets.

3.2 CONNECTOR DIAGRAM

The I/O connector is a 37-pin D-type connector (Figure 3-1). The pin-out is identical to the CIO-DIO24 except that –5VDC is not brought out.

The connector accepts female 37 D type connectors, such as those on the C37FF-2, a 2-foot cable.

If frequent changes to signal connections or signal conditioning is required, please refer to the information on the CIO-MINI37 or SCB-37 screw terminal boards.

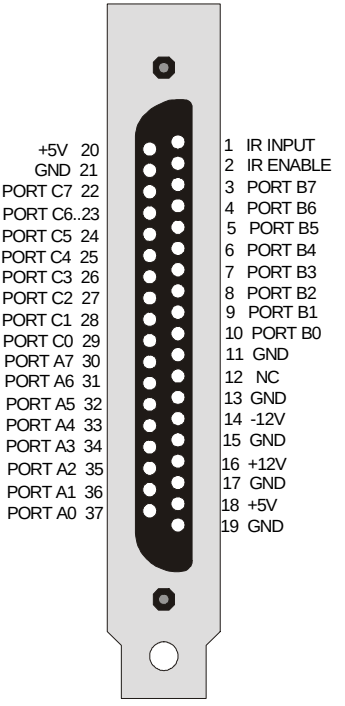


Figure 3-1. I/O Connector

3.3 SIGNAL CONNECTION CONSIDERATIONS

The CPCI-DIO24H signals are buffered (high output drive) TTL.

If you need to control or monitor non-TTL level signals with your board, please refer to our catalog or our web site for the following products.

CIO-ERB series, electromechanical relay output boards
CIO-SERB series, 10A electromechanical relay output boards
SSR-RACK series solid state I/O module racks
DR-Series, DIN rail mountable solid state I/O modules.

In addition to voltage and load matching, digital signal sources often need to be filtered ("de-bounced"). A description of digital interfacing is in the section on Interface Electronics in this manual.

IMPORTANT NOTE

An 82C55 digital I/O chip initializes all ports as inputs on power up and reset. This emulation does also. A TTL input is a high impedance input. If you connect another TTL input device to the 82C55 it will probably be turned ON every time the 82C55 is reset, or, it might be turned OFF instead. Remember, the 82C55 which is reset is in INPUT mode.

To safeguard against unwanted signal levels, all devices being controlled by an 82C55 should be tied low (or high, as required) by 2.2K ohm resistors (in a SIP).

You will find positions for pull up and pull down resistor packs on your board. To implement these, please turn to the application note on pull up/down resistors.

4 SOFTWARE

We recommend that users take advantage of our Universal Library package's easy to use programming interfaces. However, if you are an experienced programmer, and wish to read and write directly to the board, we have provided a detailed register map in the next chapter.

4.1 UNIVERSAL LIBRARY

The Universal Library provides complete access to the CPCI-DIO24H functions from a range of programming languages. If you are planning to write programs, or would like to run the example programs for Visual Basic or any other language, please turn now to the Universal Library manual.

4.2 PACKAGED APPLICATIONS PROGRAMS

Most packaged application programs, such as SoftWIRE, DAS Wizard, Labtech Notebook and HP-VEE have drivers for the CPCI-DIO24H. If the package you own does not appear to have drivers for the boards, please fax or e-mail the package name and the revision number from the install disks. We will research the package for you and advise how to utilize the CPCI-DIO24H boards with the driver available.

Some application drivers are included with the Universal Library package, but not with the application package. If you have purchased an application package directly from the software vendor, you may need to purchase our Universal Library and drivers. Please contact us for more information.

5 I/O REGISTER MAPS

Table 5-1 below is the I/O register map of the CPCI-DIO24H. Sections 5.1 through 5.4 provide additional information on each of these registers.

Table 5-1. I/O Registers

REGISTER	READ FUNCTION	WRITE FUNCTION
BADR1+4Ch	Interrupt Status	Interrupt Control
BADR2 + 0	Input Port A Data	Output Port A Data
BADR2 + 1	Input Port B Data	Output Port B Data
BADR2 + 2	Input Port C Data	Output Port C Data
BADR2 + 3	none	Control Register

5.1 INTERRUPT STATUS/CONTROL REGISTER

BADR1 + 4Ch
READ/WRITE

31:15	14	13	12	11	10	9	8
x	x	x	x	x	CLRINT	x	LEVEL/ EDGE

7	6	5	4	3	2	1	0
x	PCIINT	x	x	x	INT	INTPOL	INTE

This register is 32-bits in length. Please note that the remainder of the register's bits have specific control functions. If you write the Interrupt Status register, please be sure to read the current status, change only the desired bits and then write the new status word.

INTE is the Interrupt Enable:
0 = disabled,
1 = enabled (default).

INTPOL is the Interrupt Polarity:
0 = active low (default),
1 = active high.

INT is the Interrupt Status:
0 = interrupt is not active,

1 = interrupt is active.

PCIINT is the PCI Interrupt Enable:

0 = disabled,

1 = enabled (default).

LEVEL/EDGE is the interrupt triggert control:

0 = level-triggered mode (default),

1 = edge-triggered mode

INTCLR is the interrupt clear (edge-triggered mode only):

0 = N/A,

1 = clear interrupt

5.2 CONTROL & DATA REGISTERS

A CPCI-DIO24H consists of an emulation of a 82C55 parallel I/O chip. The board uses three data and one control register and occupies four consecutive I/O locations. The board is easy to program with direct I/O register reads and writes.

Each register has eight bits which can constitute a byte of data or eight individual bit set/read functions.

As alternatives to register level programming, the CPCI-DIO24H is fully supported by optional Universal Library software as well as most high level data acquisition and control application packages (e.g. SoftWIRE).

5.3 DIGITAL I/O REGISTERS

Port A Data
Base Address +0

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

Port B Data
Base Address +1

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

Ports A and B can be programmed as input or output. Each is written to and read from in bytes. 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 ORed into writes.

Port C Data
Base Address +2

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 of either input or output, 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 PCH3 to PCH0, and for the lower, PCL3 to PCL0.

Although it can be split, every read and write to port C carries 8 bits of data so unused bits must be ANDed out of reads, and writes must be ORed with the current status of the other port.

5.4 OUTPUT PORTS

In 82C55 mode 0 configuration, ports configured for output hold the output data written to them. This output byte can be read back by reading a port configured for output

5.5 INPUT PORTS

In 82C55 mode 0 configuration, ports configured for input read the state of the input lines at the moment the read is executed, transitions are not latched.

D7	D6	D5	D4	D3	D2	D1	D0
MS	M3	M2	A	CU	M1	B	CL
	Group A				Group B		

NOTE:

The CPCI-DIO24H can be programmed to operate in Input or Output (mode 0) only.

Included here is information on programming the CPCI-DIO24H in mode 0. Modes 1 (strobed I/O) and 2 (bi-directional strobed I/O) are not supported.

When the PC is powered up or RESET, the CPCI-DIO24H is reset. This places all 24 lines in Input mode. No further programming is needed to use the 24 lines as TTL inputs.

To program the CPCI-DIO24H for other modes, the following control code byte must be assembled into an 8 bit byte.

MS = Mode Set. 1 = mode set active

M3	**M2**	**Group A Function**	
0	0	Mode 0	Input/Output
N/A	N/A	Mode 1	Strobed Input/Output
N/A	N/A	Mode 2	Bi-Directional Bus

A	**B**	**CL**	**CH**	**Independent Function**
1	1	1	1	Input
0	0	0	0	Output

M1 = 0 is mode 0 for group B. Input / Output

The Ports A, B, C-High (CH), and C-Low (CL) can be independently programmed for input or output. (The only mode supported is (0), Input/Output mode.) The codes for programming in this mode are shown in Table 5-2 below.

Table 5-2. Port Configuration Codes

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

.

6 SPECIFICATIONS

Power Consumption

+5V Operating	625 mA typical, 960 mA max

Digital Input / Output

Digital type	8255 mode 0 emulation
Number of I/O	24
Configuration	2 banks of 8 and 2 banks of 4 or 3 banks of 8
Input low voltage	0.8V max
Input high voltage	2.0V min
Output low voltage (IOL = 64 mA)	0.5V max
Output high voltage (IOH = –12 mA)	2.4V min
Absolute maximum input voltage	–0.5V , +7V
Power-up / reset state	Input mode (high impedance)
Pull-Up/Pull-Down Resistors	Dual footprint allows pull-up or pull-down configuration.

Interrupts

Interrupts	INTA# - mapped to IRQn via PCI BIOS at boot-time
Interrupt enable	External (IRQ_ENABLE) active low, disabled by default through internal resistor to TTL high and programmable through PLX9052
Interrupt sources	External source (IRQ_INPUT) Polarity programmable through PLX9052 Edge or level triggered programmable through PLX9052 Assertion Time: 40 ns min

Environmental

Operating temperature range	0 to 50°C
Storage temperature range	–20 to 70°C
Humidity	0 to 90% non-condensing

Mechanical

Card dimensions	3U cPCI: 160.0mm L x 100.0mm W x 20.3mm H

Connector Pin Out

Pin	***Signal Name***	***Pin***	***Signal Name***
1	IRQ_INPUT	20	+5V
2	IRQ_ENABLE	21	GND
3	Port B7	22	Port C7
4	Port B6	23	Port C6
5	Port B5	24	Port C5
6	Port B4	25	Port C4
7	Port B3	26	Port C3
8	Port B2	27	Port C2
9	Port B1	28	Port C1
10	Port B0	29	Port C0
11	GND	30	Port A7
12	N/C	31	Port A6
13	GND	32	Port A5
14	-12V	33	Port A4
15	GND	34	Port A3
16	+12V	35	Port A2
17	GND	36	Port A1
18	+5V	37	Port A0
19	GND		

7 ELECTRONICS AND INTERFACING

This short, simple introduction to the electronics most often needed by digital I/O board users covers a few key concepts.

IMPORTANT NOTE
WHENEVER THE 82C55 (OR ITS EMULATION) IS POWERED ON OR RESET, ALL PINS ARE SET TO HIGH IMPEDANCE-INPUT.

This means that if you have output devices such as solid state relays, they can be switched on whenever the computer is powered on or reset. To prevent unwanted switching and to drive all outputs to a known state after power on or reset, pull all pins either high or low through a 2.2K resistor.

7.1 PULL UP & PULL DOWN RESISTORS

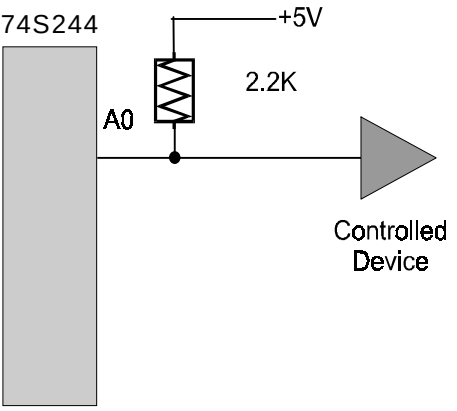
Whenever the CPCI-DIO24H is powered on or reset, the control register is set to a known state. That state is mode 0, all ports input.

When used as an output device to control other TTL input devices, the CPCI-DIO24H applies a voltage level of 0V for low and 2.5V to 5V for high.

The concept of output voltage for an CPCI-DIO24H in input mode is meaningless. Do not connect a volt meter to the floating input of an CPCI-DIO24H. It will show you nothing of meaning. In input mode, the CPCI-DIO24H is in 'high Z' or high impedance. If your CPCI-DIO24H output was connected to another input chip (the device you were controlling), the inputs of that chip are left floating whenever the CPCI-DIO24H is in input mode.

If the inputs of the device you are controlling are left to float, they may float up or down. Which way they float is dependent on the characteristics of the circuit and the electrical environment; and may be unpredictable! This is why it often appears that the CPCI-DIO24H has gone 'high' after power up. The result is that your controlled device gets turned on! That is why you need pull up/down resistors.

Shown here is a CPCI-DIO24H digital output with a 2.2K pull-up resistor attached.
The pull-up resistor provides a reference to +5V while its value of 2200 ohms requires only 2.3 mA of drive current



When the CPCI-DIO24H is reset, its outputs become high impedance inputs, the lines are pulled high. At that point, both the CPCI-DIO24H AND the device being controlled sense a high signal.

When the CPCI-DIO24H is switched to output mode, the CPCI-DIO24H has more than enough power to over ride the pull-up/down resistor's high signal and drive the line low. If the CPCI-DIO24H asserts a high signal, the pull-up resistor guarantees that the line goes to +5V.

Of course, a pull-down resistor accomplishes the same task except that the line is pulled low when the CPCI-DIO24H is reset. The CPCI-DIO24H has more than enough power to drive the line high.

The CPCI-DIO24H series boards are equipped with three positions for pull-up/down resistor Single Inline Packages (SIPs). The positions are marked PORT A, PORT B, and PORT C and are located adjacent to the I/O connector.

A 2.2K, eight-resistor SIP has one end of each resistor connected to a common pin. The other ends connect to external pins protruding from the SIP. The common pin is marked with a dot and is at one end of the SIP.

A SIP can be installed to either pull-up or pull-down. At three locations (PORT A, PORT B and PORT C on the board) there are 10 holes in a line. One end of the line is +5V, the other end is GND. They are marked “HI” and “LO”. The eight holes in the middle are connected to the 8 lines of the port, A, B, or C.

Insert the SIP with the common pin in either the HI hole for pull-up or the LO hole for pull-down operation.

We recommend using 2.2K SIPs. Use other values only if you have calculated the necessity of doing so.

NOTE: UNCONNECTED INPUTS FLOAT!

Keep in mind that unconnected inputs float. If you are using the board for inputs, 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 therefore unspecified. The board is not malfunctioning. In the absence of a pull-up/pull-down, any input to a CPCI-DIO24H 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 that you mask out any unconnected bits in software!

7.2 TTL TO SOLID STATE RELAYS

Many applications require digital outputs to switch AC and DC voltage motors on and off and to monitor AC and DC voltages. These AC and high DC voltages cannot be controlled or read directly by the TTL digital lines of a CPCI-DIO24H.

Solid State Relays, such as those available from Measurement Computing Corp. 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 CPCI-DIO24H board is to use a Solid State Relay Rack. A SSR Rack has a circuit board with output buffer chips which are powerful enough to switch the SSR and sockets to plug SSRs into. SSR Racks are available from Measurement Computing Corp. and most manufacturers of SSRs. If you have only a few outputs to control, you may also wish to consider the DR-OAC or DR-ODC, single point, DIN mountable SSRs.

The high current outputs of the board is suitable to drive SSRs directly.

7.3 VOLTAGE DIVIDERS

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

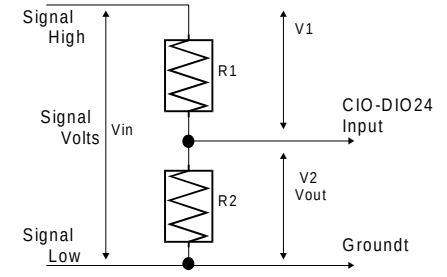
A voltage divider takes advantage of Ohm's law, which states,

Voltage = Current * Resistance

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 voltage across the total resistance in the circuit.

In a voltage divider, two resistors must have proper proportions relative of the full scale of the digital input to the maximum signal voltage.



SIMPLE VOLTAGE DIVIDER - $\frac{Vin}{Vout} = \frac{R1+R2}{R2}$

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

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

Attenuation is the proportional difference between the signal voltage max and the full scale of the analog input.

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

For example, if the signal varies between 0 and 10 volts and you wish to measure that with an CPCI-DIO24H board with a full scale range of 0 to 5 volts, the attenuation is 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 can readily use voltage dividers. For example, if you wish to measure a digital signal that is at 0 volts when off and 24 volts when on, you cannot connect that directly to the CPCI-DIO24H 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 1K. Remember that a TTL input is 'on' when the input voltage is greater than 2.5 volts.

IMPORTANT NOTE

The resistors, R1 and R2, are going to dissipate all the power in the divider circuit according to the equation Current = Voltage / Resistance. The higher the value of the resistance (R1 + R2) the less power dissipated by the divider circuit. Here is a simple rule:

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 < 1K.

The CIO-TERMINAL is a 16" by 4" screw terminal board with two, 37-pin D-type connectors and 56 screw terminals (12 - 22 AWG). Designed for table top, wall or rack mounting, the board provides prototype, divider circuit, filter circuit and pull-up resistor positions which you can complete with the proper value components for your application.

EC Declaration of Conformity

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

Part Number	Description
CPCI-DIO24H	Digital I/O board with High Current outputs

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.

Carl Haapaoja, Director of Quality Assurance

Measurement Computing Corporation
16 Commerce Boulevard,
Middleboro, MA 02346
(508) 946-5100
Fax: (508) 946-9500
E-mail: info@measurementcomputing.com
www. measurementcomputing.com