

PC-CARD-DIO48

User's Manual



**MEASUREMENT
COMPUTING™**

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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, *InstaCal*, *Harsh Environment Warranty* and Measurement Computing Corporation are registered trademarks of Measurement Computing Corporation.

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1 INTRODUCTION

The PC-CARD-DIO48 is a data acquisition and control board for IBM PC compatible computers having PC-CARD/PCMCIA type slots. The primary functional elements of the board are a pair 82C55 digital I/O chips. The 82C55 chip uses TTL logic. Each has 24, digital, bi-directional (input or output) channels (Figure 1-1).

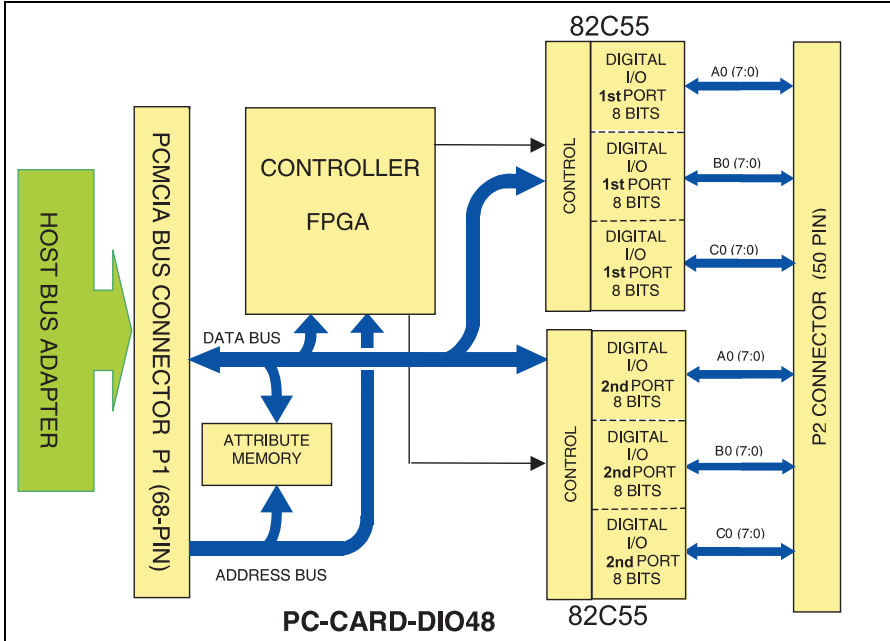


Figure 1-1. PC-CARD-DIO48 Block Diagram

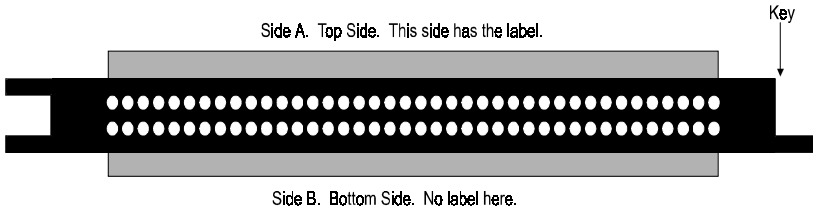
2 SOFTWARE INSTALLATION

InstaCal is the installation, calibration and test software supplied with your data acquisition / IO hardware. The complete *InstaCal* package is also included with the Universal Library. If you have ordered the Universal Library, use the Universal Library disk set to install *InstaCal*. The installation will create all required files and unpack the various pieces of compressed software. To install *InstaCal*, refer to the *Extended Software Installation Manual* for complete instructions.

3 HARDWARE INSTALLATION

The PC-CARD-DIO48 is completely plug and play. There are no switches or jumpers to set. Configuration is controlled by your systems' PCMCIA software. Simply insert the PC-CARD-DIO48 into any available slot. Refer to the orientation guide below for proper orientation of the card (the typical system orients the card with the label up).

Figure 3-1 shows a PCM card case looking into the connector which is inserted into the PCMCIA slot of your computer. The key helps to insure that the board is inserted correctly.



PCMCIA CARD ORIENTATION - View into PCMCIA connector. The end which goes into the PCMCIA slot.

Figure 3-1. Card Orientation

If you are using an operating system with support for Plug and Play (such as Windows 95 or 98), a dialog box will pop up upon insertion of the card indicating that new hardware has been detected. If the information file for this board is not already loaded onto your PC, you will be prompted for a disk containing it. The *InstaCal* software that was supplied with your board (as well as the optional Universal Library software) contains this file. Just insert the disk or CD and click OK.

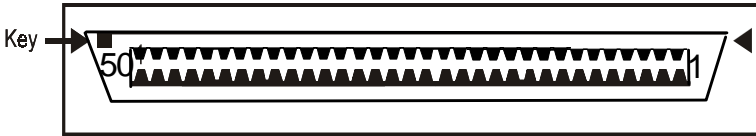
In order to easily test your installation, it is recommended that you install InstaCal, the installation, calibration and test utility that was supplied with your board. Refer to the *Extended Software Installation Manual* for information on the initial setup, loading, and installation of InstaCal and optional Universal Library software.

4 INTERFACING

The PC-CARD-DIO48 has 48 digital input/output channels. The 48 I/O channels are processed by two 82C55 chips, each chip handling three “ports” A, B, and C (24 channels total per 82C55).

4.1 PC-CARD-DIO48 CONNECTOR

Figure 4-1 is a PC-CARD-DIO48 case looking into the connector. The key helps to insure that the cable is inserted in the correct orientation.



PIN NO.	NAME	PORT NO.	PIN NO.	NAME	PORT NO.
1	A7	2	26	A6	1
2	A6	2	27	A5	1
3	A5	2	28	A4	1
4	A4	2	29	A3	1
5	A3	2	30	A2	1
6	A2	2	31	A1	1
7	A1	2	32	A0	1
8	A0	2	33	B7	1
9	B7	2	34	B6	1
10	B6	2	35	B5	1
11	B5	2	36	B4	1
12	B4	2	37	B3	1
13	B3	2	38	B2	1
14	B2	2	39	B1	1
15	B1	2	40	B0	1
16	B0	2	41	C7	1
17	C7	2	42	C6	1
18	C6	2	43	C5	1
19	C5	2	44	C4	1
20	C4	2	45	C3	1
21	C3	2	46	C2	1
22	C2	2	47	C1	1
23	C1	2	48	C0	1
24	C0	2	49	+5V	-
25	A7	1	50	GND	-

Figure 4-1. I/O Connector Pin-out & Orientation

4.2 CABLING

Measurement Computing offers two cables for connecting the PC-CARD-DIO48 to a screw-type terminal board or other signal conditioning interface board.

The first is a CPCC-50F-39 cable. It is 39 inches (990mm) long and is compatible with all standard 50-pin screw terminal products such as the CIO-MINI50 and SCB-50. Refer the connector diagram above (Figure 4-1) for the functions of the signals at the screw terminals.

As an alternative, the CPCC-50M-4 is a four-inch long adapter cable. It is required when a C50FF-series cable is to be used.

See Figure 4-2 for a map of the two methods of cabling from the PC-CARD-DIO48 to one of a variety of screw terminal or signal conditioning boards.

Figure 4-3 is a cable map of the ways that two SSR-RACK24 or CIO-ERB24 relay racks can be cabled to the PC-CARD-DIO48.

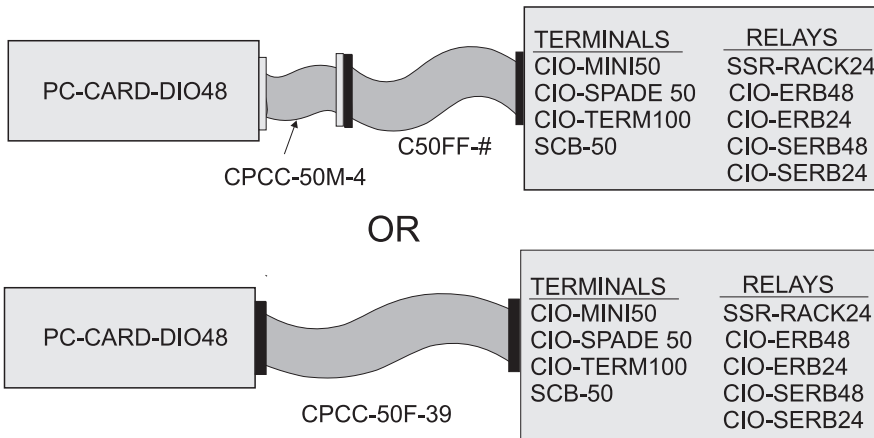


Figure 4-2. Cable Maps

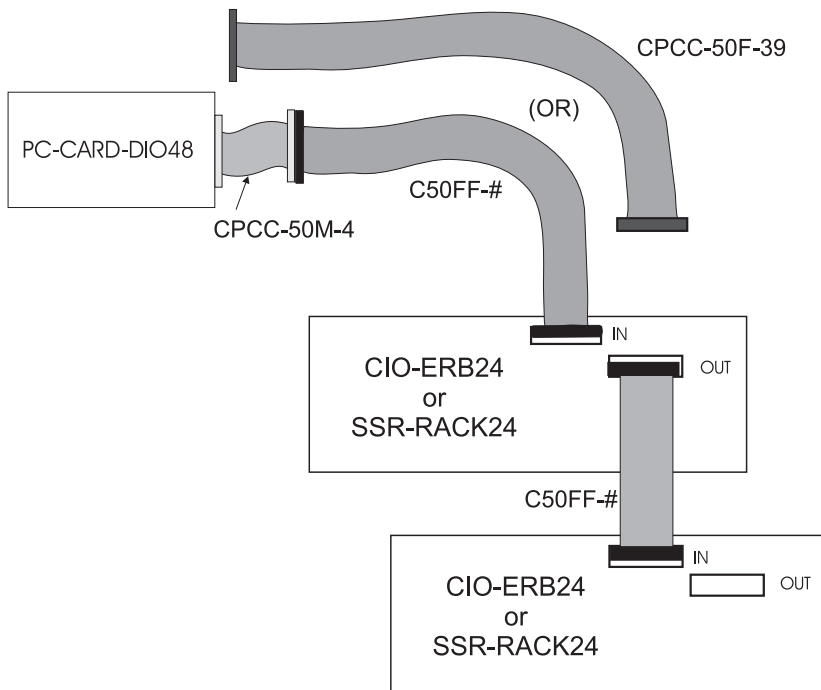


Figure 4-3 Cable Map to CIO-ERB24 or SSR-RACK24

5 PROGRAMMING & APPLICATIONS

5.1 PROGRAMMING LANGUAGES

Universal Library provides complete access to the PC-CARD-DIO48 functions from a range of programming Windows 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.

5.2 PACKAGED APPLICATIONS PROGRAMS

Many packaged application programs, such as SoftWIRE™, have drivers for the PC-CARD-DIO48. If the package you own does not appear to have drivers, please call us with the package name and the revision number from the install disks. We will research the package for you and advise you on how to obtain the correct drivers.

6 CALIBRATION & SERVICES

There is no calibration required. The case cannot be opened and there are no parts inside which you can service. There are no socketted components.

Opening the PC-CARD-DIO48 case will void your warranty! If you PC-CARD-DIO48 requires service, please contact the factory for an RMA# and return it.

7 I/O ADDRESS MAP & REGISTER FUNCTIONS

A base address register controls the beginning, or “Base” address of the I/O addresses occupied by the registers of the PC-CARD-DIO48. Nine addresses are used. The base address is assigned by PCMCIA software, read by *InstaCal* and stored in the CB.CFG file installed in your computer. Please read about installing and using InstaCal.

7.1 CONTROL REGISTERS

After installation and a base address has been established, the PC-CARD-DIO48 can be controlled by reading and writing to the registers. While it is possible to write your own control routines, many have been written and are available in Universal Library for Windows programming languages.

NOTE ON REGISTER PROGRAMMING SUPPORT

Only limited support for assembly language or direct register programming is available. Register level programming should only be attempted by experienced programmers. We support the use of the PC-CARD-DIO48 through high level languages using Universal Library and the example programs provided.

7.2 PORT ADDRESSES & FUNCTIONS

Table 7-1 lists the card registers and their function. All registers perform 8-bit byte operations. A Port C can be divided into two, 4-bit ports, CU (upper) and CL (lower).

Table 7-1. Card Register Functions

REGISTER	READ	WRITE
CORREG	COR REGISTER	COR REGISTER
CCSRREG	CCSR REGISTER	CCSR REGISTER
Base + 0	Digital Input - 1st Port A Data	Digital Output - 1st Port A Data
Base + 1	Digital Input - 1st Port B Data	Digital Output - 1st Port B Data
Base + 2	Digital Input - 1st Port C Data	Digital Output - 1st Port C Data
Base + 3	No readback function	1st 8255 Configuration
Base + 4	Digital Input - 2nd Port A Data	Digital Output - 2nd Port A Data
Base + 5	Digital Input - 2nd Port B Data	Digital Output - 2nd Port B Data
Base + 6	Digital Input - 2nd Port C Data	Digital Output - 2nd Port C Data
Base + 7	No readback function	2nd 8255 Configuration

7.2.1 CORR Register

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

There are no functions supported in the COR.

7.2.2 CCSR Register

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

There are no functions supported in the CCSR.

7.2.3 BASE + 0 1st DIO Port A

READ/WRITE

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

The direction of this port is set by writing a control word to BASE + 3. The port is one byte wide and can be set as eight-in or eight-out. Data is written to and read from this port in bytes.

If programmed for output, a write to this register will update the outputs. A zero sets the output to TTL Low. A one sets the output to TTL High. NOTE: TTL High is not actually 5V but something less. The current high/low bit settings can be read back from the port by reading it.

If programmed for input, a read will capture the current state of all eight input lines (eight bits) of the port. Writing to an input port has no function.

7.2.4 BASE + 1 1st DIO Port B

READ/WRITE

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

The direction of this port is set by writing a control word to BASE + 3. The port is one byte wide and can be set as eight in or eight out. Data is written to and read from this port in bytes.

If programmed for output, a write to this register will update the outputs. A zero sets the output to TTL Low. A one sets the output to TTL High. NOTE: TTL High is not actually 5V, but something less. The current high/low bit settings can be read back from the port by reading it.

If programmed for input, a read will capture the current state of all eight input lines (8 bits) of the port. Writing to an input port has no function.

7.2.5 BASE + 2 1st DIO Port C

READ/WRITE

7	6	5	4	3	2	1	0
CH7	CH6	CH5	CH4	CL3	CL2	CL1	CL0

The direction of this port is set by writing a control word to BASE + 3. The port is one byte wide but can be configured in two, 4-bit nibbles. It can be set as eight-in, eight-out, or split to four-in and four-out. Data is written to and read from this port in bytes even when split as four + four. The rules for writing and reading data apply regardless of eight or four + four operation.

If programmed for output, a write to this register will update the outputs. A zero sets the output to TTL Low. A one sets the output to TTL High.

NOTE: TTL High is not necessarily 5V. The current high/low bit settings can be read back from the port by reading it.

If programmed for input, a read will capture the current state of all eight input lines (8 bits) of the port. Writing to an input port has no function.

7.2.6 BASE + 3 1st 82C55 Configuration Register

WRITE

7	6	5	4	3	2	1	0
1 (MS)	0 (M3)	0 (M2)	D4 (A)	D3 (CU)	0 (M1)	D1 (B)	D0 (CL)
Group A				Group B			

The 82C55 can be programmed to operate in Input/ Output (mode 0), Strobed Input/ Output (mode 1) or Bi-Directional Bus (mode 2).

Information on programming the 82C55 in mode 0 is included here. To program an 82C55 for Mode 1 or 2 you will need the Applications Manual that is available at www.measurementcomputing.com/82c55.

When the PC is powered up or RESET, the 82C55 is reset. This places all 48 lines in Input mode and no further programming is needed to use the 48 lines as TTL inputs. To program the 82C55 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
0	1	Mode 1 Strobed Input / Output
1	X	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

M1 = 1 is mode 1 for group B. Strobed Input / Output

The Ports A, B, C High (CH) and C Low (CL) can be independently programmed for input or output.

The two groups of 82C55 ports, group A and group B, can be independently programmed in one of several modes. The most commonly used mode is mode 0, input/output mode. The codes for programming the 82C55 in this mode are in Table 7-2.

Table 7-2. 82C55 Mode 0 Programming Modes

D4	D3	D1	D0	HEX	DEC	A	B	C U	CL
0	0	0	0	80	128	OUT	OUT	OUT	OUT
0	0	0	1	81	129	OUT	OUT	OUT	IN
0	0	1	0	82	130	OUT	IN	OUT	OUT
0	0	1	1	83	131	OUT	IN	OUT	IN
0	1	0	0	88	136	OUT	OUT	IN	OUT
0	1	0	1	89	137	OUT	OUT	IN	IN
0	1	1	0	8A	138	OUT	IN	IN	OUT
0	1	1	1	8B	139	OUT	IN	IN	IN
1	0	0	0	90	144	IN	OUT	OUT	OUT
1	0	0	1	91	145	IN	OUT	OUT	IN
1	0	1	0	92	146	IN	IN	OUT	OUT
1	0	1	1	93	147	IN	IN	OUT	IN
1	1	0	0	98	152	IN	OUT	IN	OUT
1	1	0	1	99	153	IN	OUT	IN	IN
1	1	1	0	9A	154	IN	IN	IN	OUT
1	1	1	1	9B	155	IN	IN	IN	IN

D7 is always one; D6, D5, and D2 are always zero.

7.2.7 BASE + 4 2nd DIO Port A

READ/WRITE

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

The I/O direction of this port is set by writing a control word to BASE + 7. The port is one byte wide and can be set as eight-in or eight-out. Data is written to and read from this port in bytes.

If programmed for output, a write to this register will update the outputs. A zero sets the output to TTL Low. A one sets the output to TTL High. NOTE: TTL High is not necessarily 5V. The current high/low bit settings can be read back from the port by reading it.

If programmed for input, a read will capture the current state of all eight input lines (eight bits) of the port. Writing to an input port has no function.

7.2.8 BASE + 5 2nd DIO Port B

READ/WRITE

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

The direction of this port is set by writing a control word to BASE + 7. The port is one byte wide and can be set as eight in or eight out. Data is written to and read from this port in bytes.

If programmed for output, a write to this register will update the outputs. A zero sets the output to TTL Low. A one sets the output to TTL High. NOTE: TTL High is not actually 5V but something less. The current high/low bit settings can be read back from the port by reading it.

If programmed for input, a read will capture the current state of all eight input lines (8 bits) of the port. Writing to an input port has no function.

7.2.9 BASE + 6 2nd DIO Port C

READ/WRITE

7	6	5	4	3	2	1	0
CH7	CH6	CH5	CH4	CL3	CL2	CL1	CL0

The direction of port C is set by writing a control word to BASE + 7. The port is one byte wide but can be configured in two, 4-bit nibbles. It can be set as eight-in, eight-out, or split to four-in and four-out. Data is written to and read from this port in bytes even when split as four + four. The rules for writing and reading data apply regardless of whether eight or four + four operation is used.

If programmed for output, a write to this register will update the outputs. A zero sets the output to TTL Low. A one sets the output to TTL High. The current high/low bit settings can be read back from the port by reading it.

If programmed for input, a read will capture the current state of all eight input lines (8 bits) of the port. Writing to an input port has no function.

7.2.10 BASE + 7 2nd 82C55 Configuration Register

WRITE

7	6	5	4	3	2	1	0
1 (MS)	0 (M3)	0 (M2)	D4 (A)	D3 (CU)	0 (M1)	D1 (B)	D0 (CL)
Group A				Group B			

The 82C55 can be programmed to operate in Input/ Output (mode 0), Strobed Input/ Output (mode 1) or Bi-Directional Bus (mode 2).

To program the 82C55 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	
0		1		Mode 1 Strobed Input / Output	
1		X		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

M1 = 1 is mode 1 for group B. Strobed Input / Output

The Ports A, B, C High (CH) and C Low (CL) can be independently programmed for input or output.

The two groups of ports, group A and group B, can be independently programmed in one of three modes. The most commonly used mode is mode 0, input/output mode.

NOTE: Measurement Computing's Universal Library supports 82C55 Mode 0 only.

The codes for programming the 82C55 in mode 0 are in Table 7-2.

8 SPECIFICATIONS

Typical for 25°C unless otherwise specified.

POWER CONSUMPTION

+5V (normal operation) 37 mA typical, 55 mA max

DIGITAL I/O

Digital Type 82C55
Configuration 4 ports of 8 each plus 4 nibbles of 4 each,
programmable by port (or nibble) as input or
output.
Number of channels 48 I/O
Output High 3.7 volts min @ -2.5 mA
Output Low 0.4 volts max @ 2.5 mA
Input High 2.2 volts min, 5.5 volts absolute max
Input Low 0.8 volts max, -0.5 volts absolute min
Power-up / reset state Input mode (high impedance)

ENVIRONMENTAL

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

9 ELECTRONICS AND INTERFACING

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

9.1 PULL-UP/PULL-DOWN RESISTORS

NOTE ON 82C55 ** PLEASE READ **

The 82C55 when powered up or reset, defaults all data lines to the input mode. This presents a high impedance. With some TTL input chips, the 82C55 high impedance input can cause the input to float high and turn the device on. **If you are using the PC-CARD-DIO48 to control a digital device and it is critical that it remain off (outputs grounded) on power-up or reset, attach 2.2K Ohm pull-down resistors to each output line.**

Remember, if you have the 82C55 interfaced to an input chip, when the computer is powered up you have an input connected to an input. This is an undefined connection.

Unconnected inputs will float. If you are using the board for inputs, and have unconnected inputs, ignore the data from those lines.

For example, 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 as such is unspecified. The input buffer is not malfunctioning. In the absence of a pull-up/pull-down resistor, any input which is unconnected, is unspecified.

The nature of the input means it will typically float high. However, depending on the drive requirements of the device you are driving, they may float up or down. The 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 board outputs have gone 'high' after power up. The result is that the controlled device gets turned on. That is why you need pull up/down resistors.

Figure 9-1 shows digital outputs with a pull-up resistor and a pull-down resistor attached.

The pull-up resistor holds the output at +5V if not driven low by the register. The value of 2.2K ohms requires only 2.3 mA of drive current.

If the board is reset and enters high impedance input, the line is pulled high.

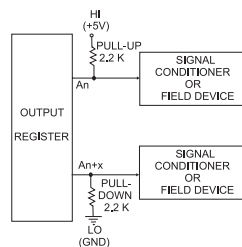


Figure 9-1. Pull-up/Pull-Down Resistors

At that point, both the board AND the device being controlled will sense a high signal. In output mode, when a "1" is written to the output bit, the register has enough power to override the pull-up resistor's current and drive the line to 0 volts.

A pull-down resistor accomplishes the opposite task in that the line is pulled low when the board is reset. The register has enough power to drive the line high.

A resistor value of 2.2K is recommended. Use other values only if you have determined the necessity for doing so.

9.2 TTL TO SOLID STATE RELAYS

Many applications require digital inputs to monitor AC and DC voltages. High AC and DC voltages cannot be applied directly by the TTL digital lines.

Solid State Relays, such as those available from Measurement Computing Corp. allow control and monitoring of high AC and DC voltages and provide 400V isolation. Solid State Relays (SSRs) are recommended for interfacing to high voltages.

The most convenient way to use solid state relays is to purchase a Solid State Relay Rack. SSR Racks are available from Measurement Computing Corp.

9.3 VOLTAGE DIVIDERS

An alternative method of measuring a signal which varies over a range greater than the input range of a digital input, is to use a voltage divider. When correctly designed, it can drop the voltage of the input signal to a safe level the digital input can accept.

Ohm's law states:

$$\text{Voltage} = \text{Current} \times \text{Resistance}$$

Kirkoff's law states:

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

In a voltage divider, the voltage across one resistor in a series circuit is proportional to the total resistance divided by the one resistor (see formula in Figure 9-2 and below).

The object in a voltage divider is to choose two resistors having the proportions of the maximum voltage of the input signal to the maximum allowed input voltage.

The formula for attenuation is:

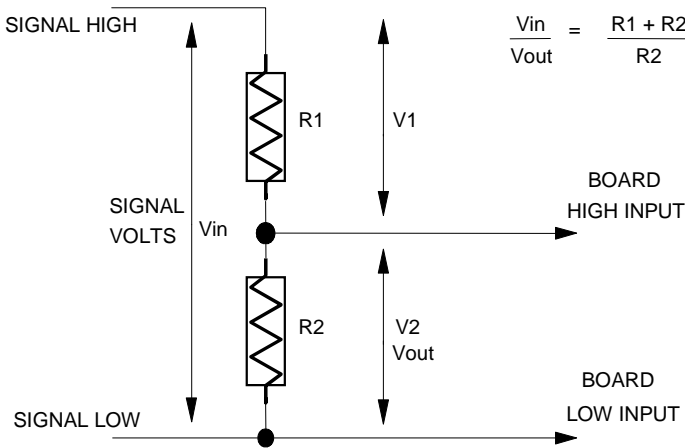
$$\text{Attenuation} = \frac{R1 + R2}{R2}$$

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

$$R1 = (A-1) \times R2$$

For example, if the signal varies between 0 and 20 volts and you wish to measure that with an analog input with a full scale range of 0 to 10 volts, the attenuation (A) is 2:1 or just 2.

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



SIMPLE VOLTAGE DIVIDER

Figure 9-2. Voltage Divider Schematic

Digital inputs often require the use of 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 a digital input. The voltage must be dropped to 5 volts max when on. The attenuation is 24:5 or 4.8.

Using the equation above, if R2 is 1K, R1 = (4.8-1) x 1000 = 3.8K.

Remember that a TTL input is 'on' when the input voltage is greater than 2.5 volts.

NOTE

The resistors, R1 and R2, are going to dissipate power in the divider circuit according to the equation $W = I^2 \times R$; (Current (I) = Voltage/Resistance). Here is a simple rule:

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

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

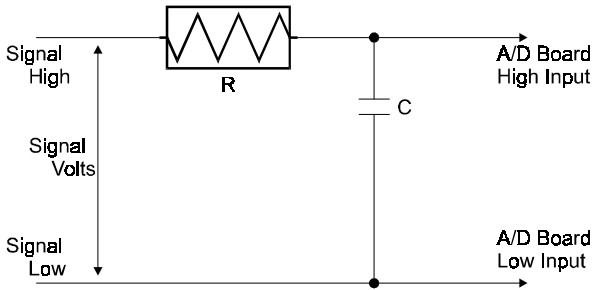
9.4 LOW PASS FILTERS DE-BOUNCE INPUTS

A low-pass filter can be installed between a source and a board. It prevents frequencies higher than the cutoff frequency from entering the board's inputs.

The cutoff frequency is that frequency above which no variation of voltage with respect to time may enter the circuit. For example, if a low-pass filter had a cutoff frequency of 30 Hz, interference associated with line voltage (60 Hz) would be mostly filtered out but a signal of 25 Hz would pass with less attenuation.

Also, a low-pass filter is often used to remove contact bounce noise signals from a switch or a relay contacts. In a digital circuit, a low pass filter can be used to “de-bounce” an input from a switch or external relay. (Unless switch/relay contacts are mercury-whetted, they tend to bounce briefly on closure, generating a pulsating noise signal. This can easily lead to erroneous counts unless filtered out.)

A simple low-pass filter can be constructed from one resistor (R) and one capacitor (C). The cutoff frequency is determined according to the formula:



$$\text{LOW PASS FILTER} - F_c = \frac{1}{2 * \pi * R * C}$$

Figure 9-3. Low Pass filter Schematic

$$F_c = \frac{1}{2 \pi R C}$$

Where $\pi = 3.14...$

R = ohms

C = farads

Fc = cutoff frequency in cycles/second.

$$R = \frac{1}{2\pi C F_c}$$

EC Declaration of Conformity

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

<u>PC-CARD-DIO48</u>	<u>PCMCIA Digital I/O Board</u>
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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