

# User's Guide

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**OME-PCI-1002**

**PCI Data Acquisition Board**

**Hardware Manual**



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The information contained in this document is believed to be correct, but OMEGA Engineering, Inc. accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.

**WARNING:** These products are not designed for use in, and should not be used for, patient-connected applications.

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# 1. Introduction

The OME-PCI-1002H/L card provides 12-bit ADC and two 16-bit digital I/O ports.

---

## 1.1 General Description

The OME-PCI-1002L and OME-PCI-1002H are high performance multifunction cards, with A/D and digital I/O for PC and compatible computers in a 5V PCI slot. This family has the following features: one 12-bit 110K A/D converter, 16 channels D/I, 16 channels D/O, programmable interrupt source and true “Plug and Play” support. The OME-PCI-1002H/L provides 32 single-ended analog inputs or 16 differential analog inputs, which are jumper selectable. The OME-PCI-1002L is the low-gain model equipped with a high speed PGA (programmable gain amp.) with programmable gain control of 1,2,4,8. The OME-PCI-1002H is the high-gain model equipped with a high-gain/high-resolution PGA with programmable gain control of 1,10,100,1000. There are 16 channels of TTL compatible digital output and 16 channels of TTL compatible digital input. This series provides three programmable trigger methods: software trigger, pacer trigger and external trigger. The external trigger can be configured as a post-trigger, pre-trigger or external pacer trigger. There are also several selectable interrupt sources: A/D conversion interrupt, pacer interrupt and external interrupt. This multifunction card also provides an A/D buffer and a data transfer rate of 2.7M words per second in non-burst mode. This powerful A/D control mechanism offers flexibility for various applications while minimizing system I/O overhead. The OME-PCI-1002 series is fully “Plug and Play” compatible and can operate at the full speed of the PCI bus (33MHz). This important feature makes the OME-PCI-1002 a high performance, cost effective solution for most data acquisition applications.

## 1.2 Block Diagram

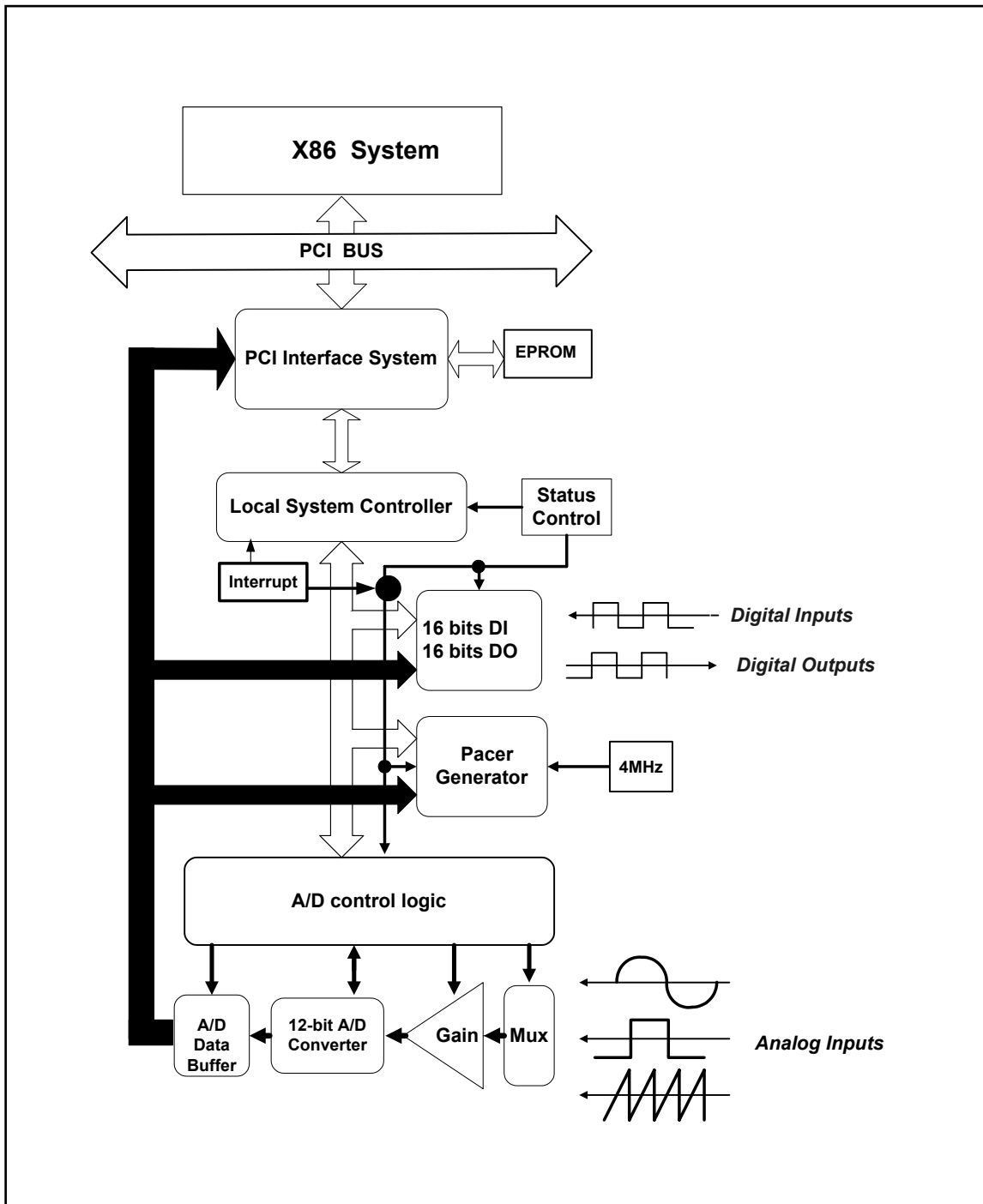


Figure 1-1. The OME-PCI-1002 series block diagram.

---

## 1.3 Features

- Bus: 5V PCI (Peripherals Component Interface) bus.
1. A/D:
    - One A/D converter with maximum 110K samples/second.
    - 32 single-ended / 16 differential programmable inputs for OME-PCI-1002L/H.
    - Three different A/D trigger methods.
    - Three different external trigger methods.
    - Programmable gain control, programmable offset control.
  2. DIO:
    - 16 digital inputs and 16 digital outputs (TTL compatible).
    - High-speed data transfer rate: 2.7M word/sec (non-burst mode).
  3. Timer:
    - One 16-bit machine independent timer for software (Timer 2).
    - Two 16-bit pacer timer for A/D converter and interrupt (Timer0, Timer1).

---

## 1.4 Specifications

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### 1.4.1 Power Consumption

- +5V @ 960mA maximum, OME-PCI-1002L/H
  - Operating temperature : 0°C to +70°C
- 

### 1.4.2 Analog Inputs

- Channels: ( software programmable )
  - 32 single-ended inputs/16 differential inputs, jumper selectable.
  - Gain control : ( software programmable )
    - OME-PCI-1002H, Gains - 1, 10, 100, 1000.
    - OME-PCI-1002L, Gains - 1, 2, 4, 8.
  - Input signal range :
    - OME-PCI-1002L: Bipolar
      - Range:  $\pm 10$ ,  $\pm 5V$ ,  $\pm 2.5V$ ,  $\pm 1.25V$
    - OME-PCI-1002H: Bipolar
      - Range:  $\pm 10$ ,  $\pm 1V$ ,  $\pm 0.1V$ ,  $\pm 0.01V$
  - Input current: 250 nA max (125 nA typical) at 25 °C.
  - Over voltage: continuous single channel to **70Vp-p**
  - Input impedance:
    - OME-PCI-1002H/L:  $10^{10}\Omega // 6pF$
-



---

### 1.4.3 D/I and D/O

- Channels: 16 channels DI, 16 channels DO
- DO: Digital output port
  - Output level: TTL compatible
  - Output current:  $I_{Oh} = 0.5\text{mA}$ ,  $I_{Ol} = 8\text{mA}$
- DI: Digital input port
  - Input level: TTL compatible
  - Input current: 50uA (max)

---

### 1.4.4 A/D Trigger Methods

- Trigger-methods :
  1. Software trigger
  2. Pacer trigger: 16-bit programmable timer/counter
  3. External trigger: Pre-trigger, Post-trigger, external Pacer trigger

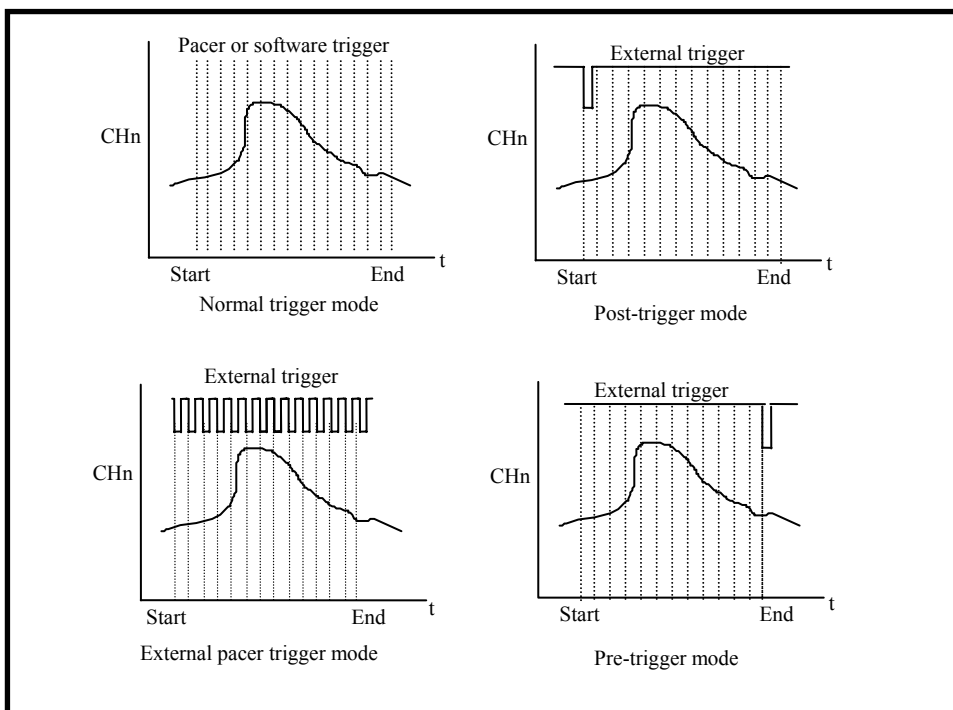


Figure 1-2. Trigger methods of OME-PCI-1002.

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## 1.4.5 Interrupt Channel

- Interrupt: INTA (Automatically assigned by PCI-controller).
- Enable/Disable: Via PCI control register and add-on control register.
- Interrupt source: (Selected by on-board control register)
  1. A/D conversion interrupt
  2. Pacer 0 interrupt (Timer 0)
  3. Pacer 1 interrupt (Timer 1)
  4. External interrupt

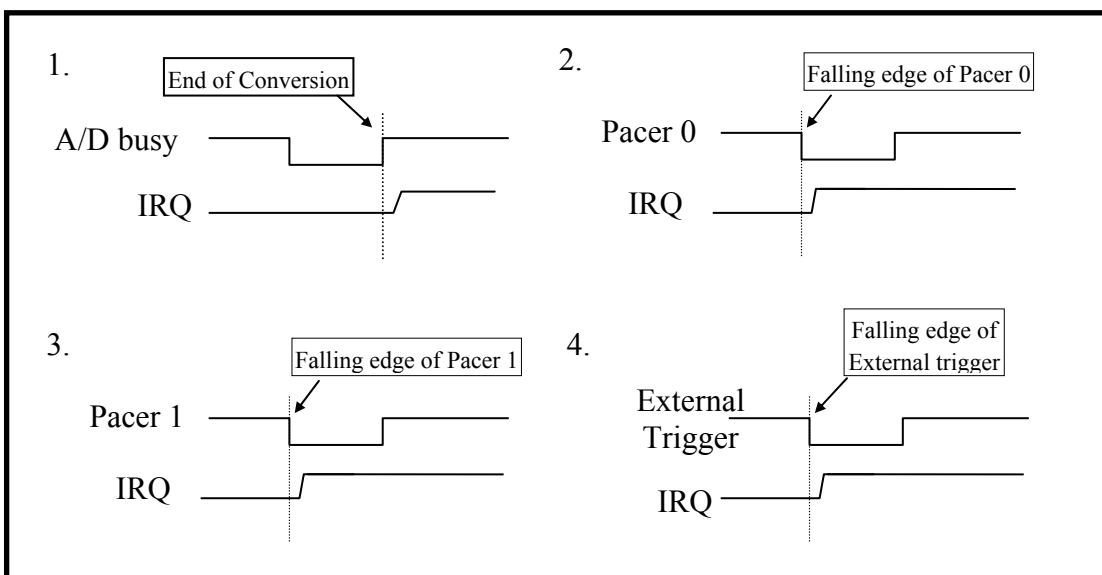


Figure 1-3. Programmable interrupt source.

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## 1.4.6 Programmable Timer/Counter

- Type: 82C54-8 programmable timer/counter.
- Timers:
  1. Timer 0 for Pacer trigger and interrupt
  2. Timer 1 for External trigger and interrupt
  3. Timer 2 for software machine independent timer
- Input Clock: 4 MHz.

---

## 1.5 Applications

- Signal analysis.
- FFT & frequency analysis.
- Transient analysis.
- Speech analysis.
- Temperature monitor.
- Vibration analysis.
- Energy management.
- Industrial and laboratory measurement and control.

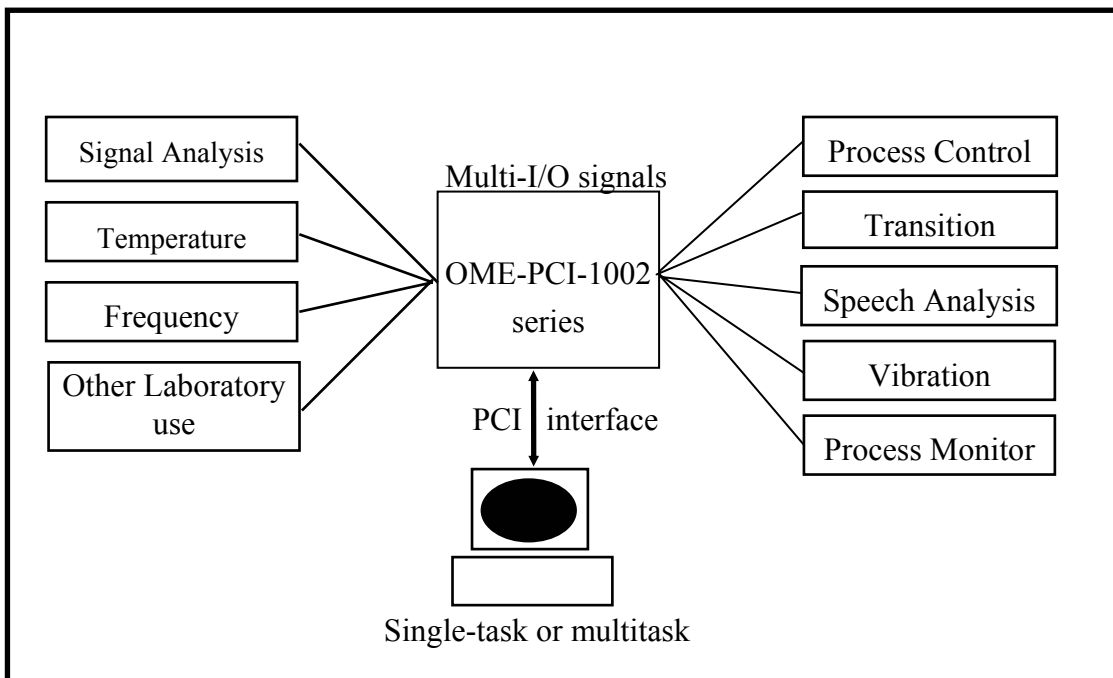


Figure 1-4. OME-PCI-1002 series multifunction cards.

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## 1.6 Product Check List

In addition to this manual, the package includes the following items:

- One OME-PCI-1002 card
- One CD-ROM

### **Release Notes**

The release notes contain the latest information updates. We strongly suggest that you read them first.

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## 2. Hardware Configuration

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### 2.1 Board Layout

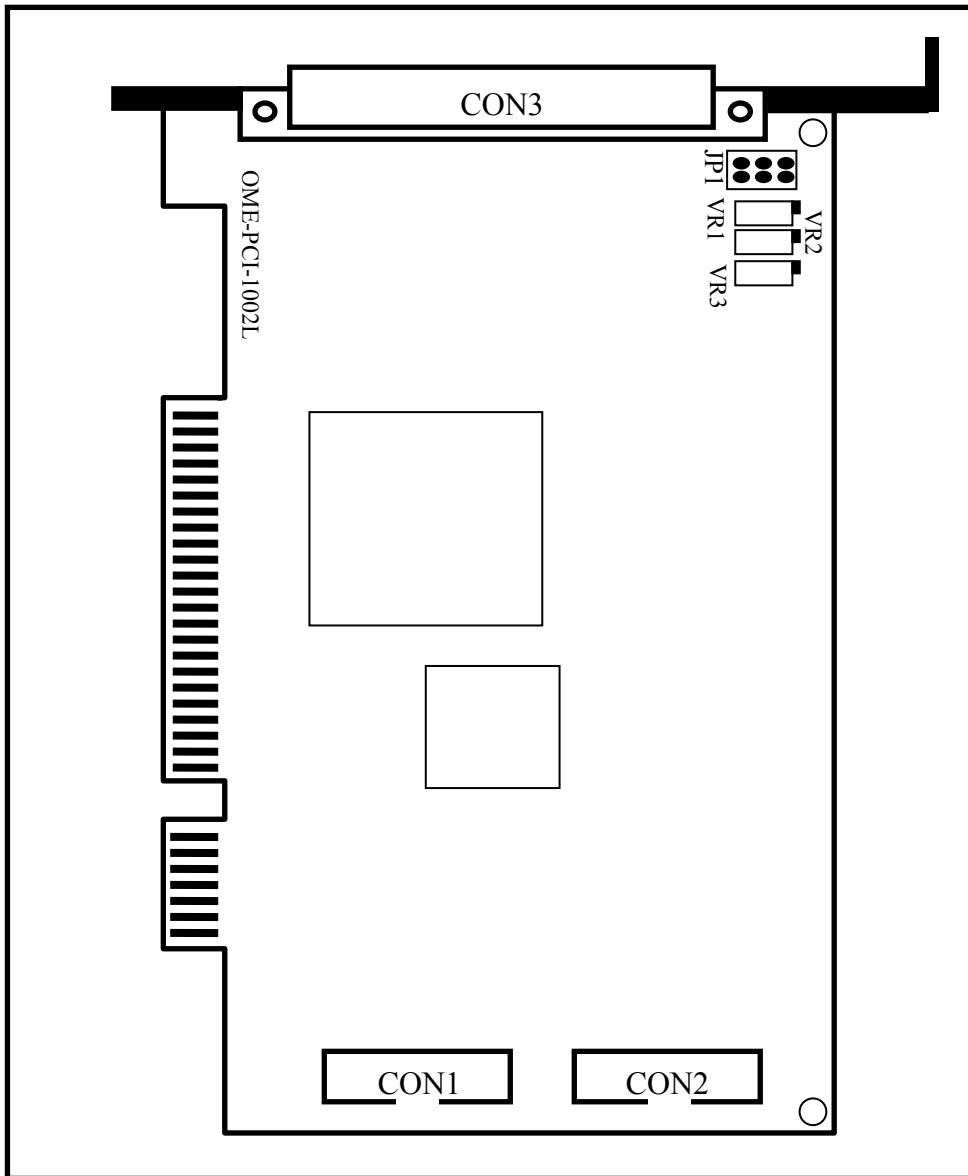
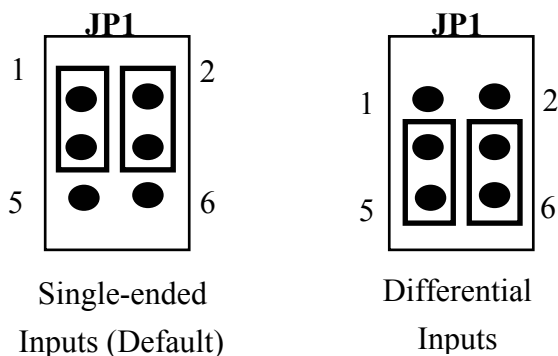


Figure 2-1. OME-PCI-1002 board layout.

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## 2.2 Jumper Setting

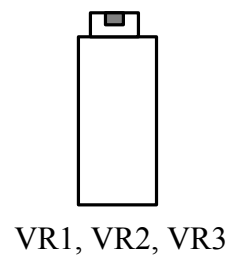
There is only one jumper on the OME-PCI-1002. JP1 is used to select the analog input type. For single-ended inputs, users should connected pin 1, 3 and pin 2, 4. For differential inputs, Pin 3, 5 and Pin 4, 6 should be connected.



---

## 2.3 A/D Calibration

- A/D Calibration for OME-PCI-1002 card
  - Step 1: Apply +10V to channel 0.
  - Step 2: Apply +0V to channel 1.
  - Step 3: Apply -10V to channel 2.
  - Step 4: Run DEMO6.EXE.
  - Step 5: Adjust **VR1** until channel 0 = fff or ffe
  - Step 6: Adjust **VR2** until channel 1 = 800 or 801
  - Step 7: Adjust **VR3** until channel 2 = 000 or 001
  - Step 8: Repeat Step 4 & Step 5 & Step 6 until all read properly.



## 2.4 System Block Diagram

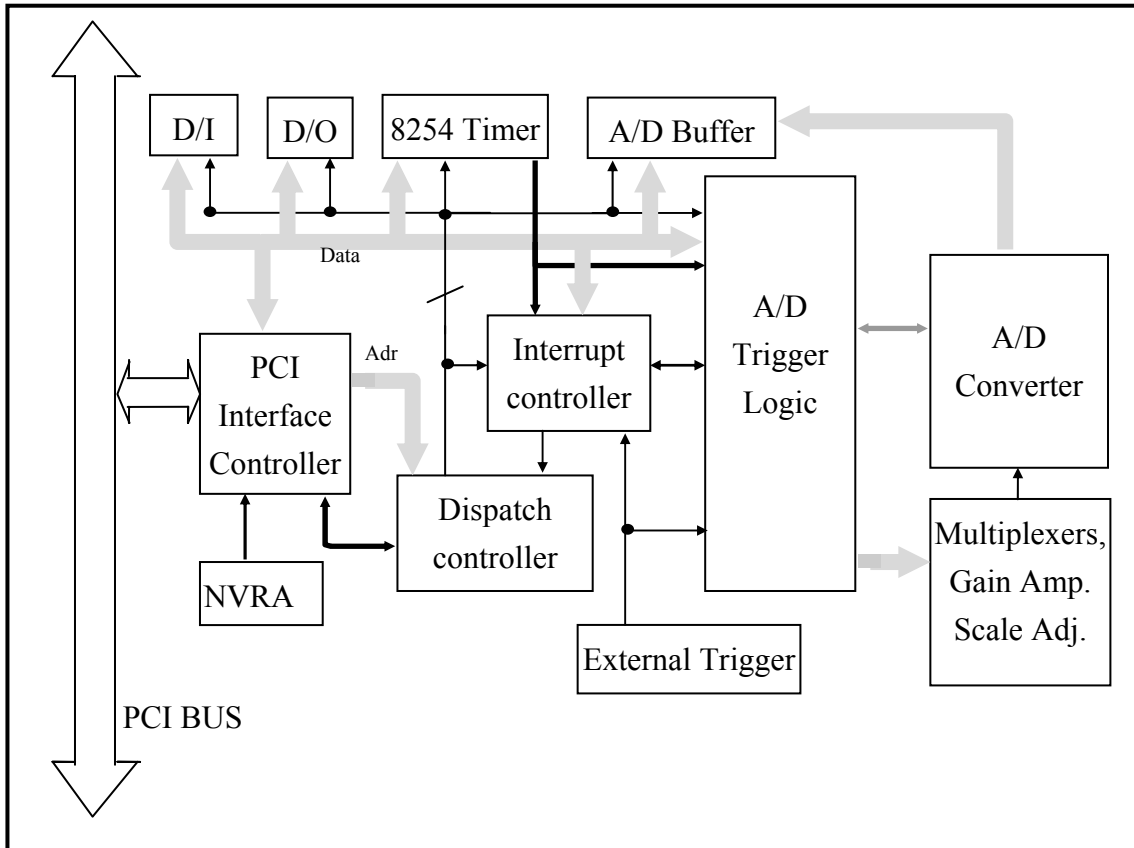


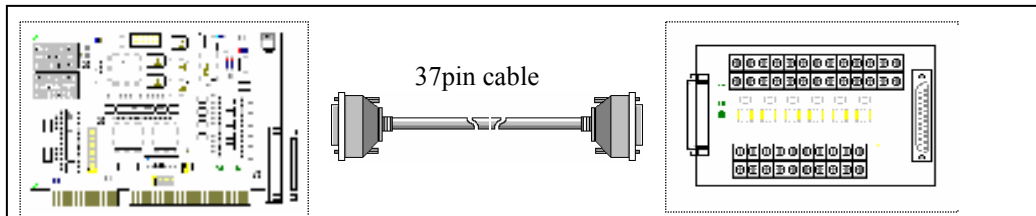
Figure 2-2. OME-PCI-1002 System Function Block.

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## 2.5 Daughter Boards

### 2.5.1 OME-DB-1825

The OME-DB-1825 is a daughter board designed for 32-channel AD cards such as the OME-PCI-1002. Refer to the OME-DB-1825 user manual for details.



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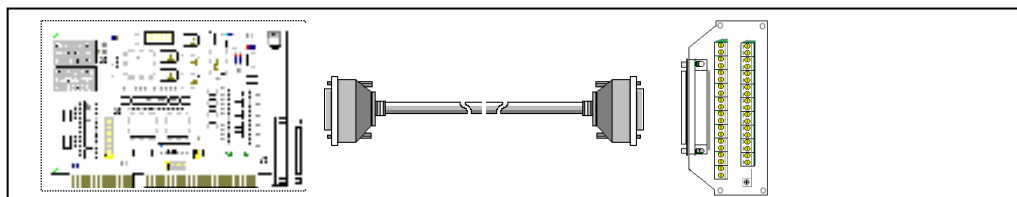
### 2.5.2 OME-DB-8225

The OME-DB-8225 provides a **on-board CJC** (Cold Junction Compensation) circuit for thermocouple measurement and a **terminal block** for easy signal connection. The CJC is connected to A/D channel\_0. The OME-PCI-1002 can connect CON3 direct to the OME-DB-8225 through a 37-pin D-sub connector. Refer to the OME-DB-8225 user manual for details.

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### 2.5.3 OME-DB-37

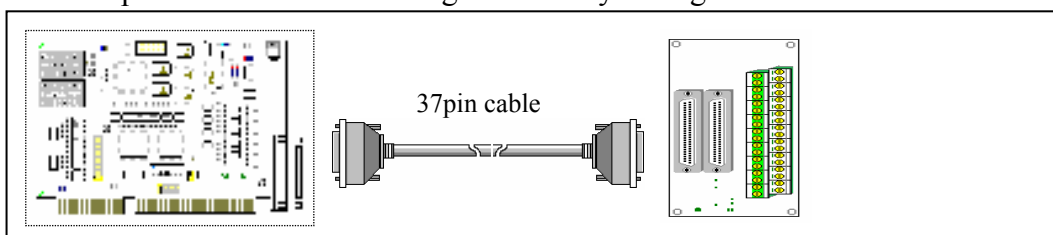
The OME-DB-37 is a general purpose daughter board for boards with D-sub 37 pin connectors. It is designed for easy wiring.



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### 2.5.4 OME-DN-37

The OME-DN-37 is a DIN rail mount general purpose daughter board for boards with D-sub 37 pin connectors. It is designed for easy wiring.

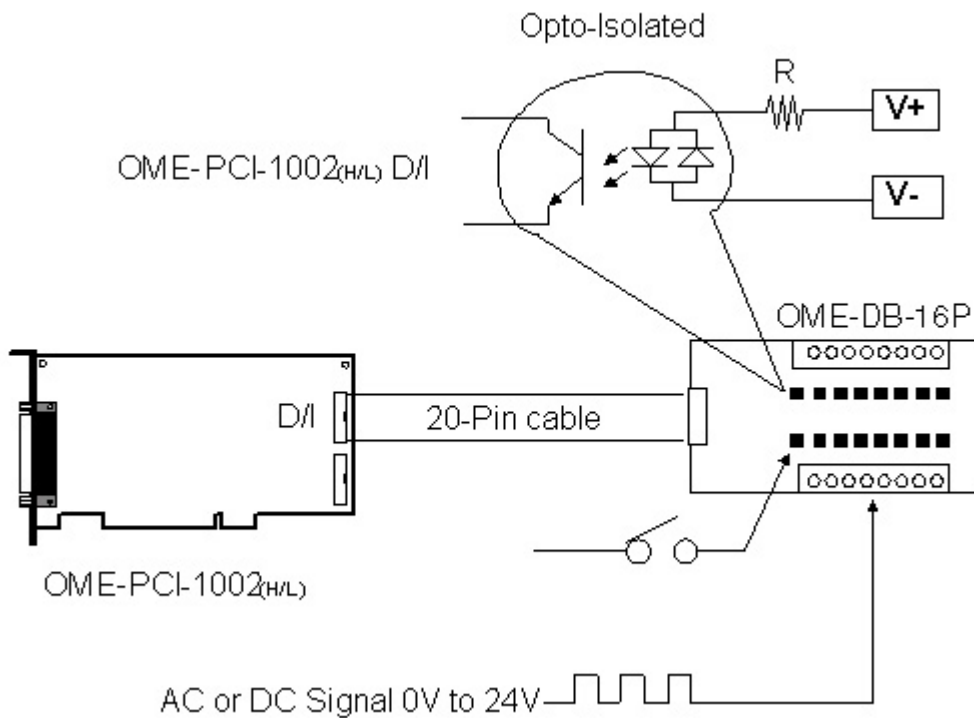




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## 2.5.5 OME-DB-16P Isolated Input Board

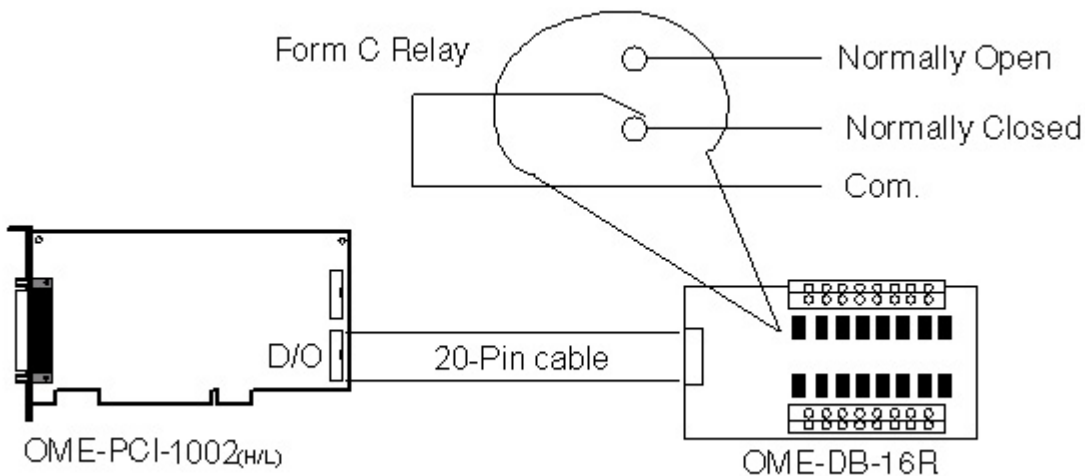
The OME-DB-16P is a 16-channel isolated digital input daughter board. The optically isolated inputs of the OME-DB-16P consist of a bi-directional optocoupler with a resistor for current sensing. You can use the OME-DB-16P to sense DC signal from TTL levels up to 24V or use the OME-DB-16P to sense a wide range of AC signals. You can use this board to isolate the computer from large common-mode voltage, ground loops and transient voltage spike that often occur in industrial environments.



---

## 2.5.6 OME-DB-16R Relay Board

The OME-DB-16R, 16-channel relay output board consists of 16 form C relays that can be switched under program control. Applying 5 volts to the appropriate relay channel through the 20-pin flat connector can energize the relays. Each relay has its own LED that will light when the relay is energized. To avoid overloading your PC's power supply, the board provides screw terminals for external power.



Note: Channel: 16 Form C Relay

Relay: Switching up to 0.5A at 110ACV or 1A at 24 DCV

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## 2.6 Analog Input Signal Connection

The OME-PCI-1002 can measure signals in the single-ended or differential mode. In the differential mode each channel has a unique signal HIGH and signal LOW connection. In the single-ended mode all channels have a unique signal HIGH connection but share a common LOW or ground connection. Differential connections are very useful for low level signals (millivolt), since they better reject electrical noise that can affect the quality of the measurement. A differential connection is also necessary when a common ground is unacceptable. The benefit of using a single-ended connection is that twice the number of channels is available. In general, a single-ended connection is often a good choice when working with higher level signals (5V or 10V for example), especially if the signal is coming from an isolated device such as a signal conditioner. Several different types of wiring diagrams are discussed below.

Figure 2-3A shows a differential connection to a grounded source. If the source is grounded, making a second connection to the card's ground could cause a ground loop resulting in erroneous data. **It is important to note that the maximum common mode voltage between the input source and AGND is 70Vp-p. If the card is connected to a source with a common mode voltage greater than 70Vp-p, the input multiplexer will be permanently damaged!** When measuring common mode voltage, it is best to use an oscilloscope rather than a multi-meter.

Figure 2-3B shows a differential connection to a floating source. In such cases a connection should be made between the low channel input and analog ground.

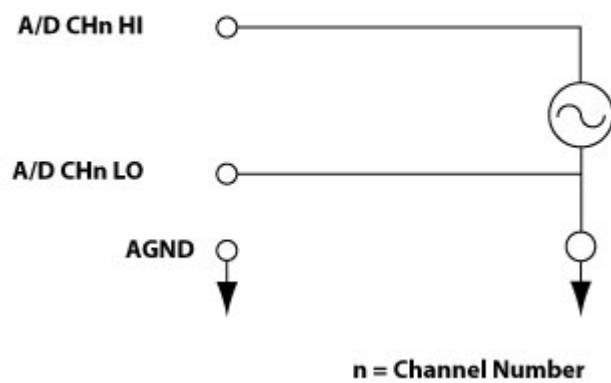
Figure 2-4 shows connection of multiple sources in single-ended mode. This connection assumes creating one common ground will not cause a problem. This is normally the case when connecting to devices that are isolated or floating.

Figure 2-5 demonstrates how to connect bridge transducers. Bridge transducers include strain gauges, load cells and certain type of pressure transducers. The diagram assumes that there is a single external power supply providing power to the bridge. Each bridge is connected to a differential channel. No connection is made between channel low and analog ground. A connection should be made between analog ground and the negative of the power supply. An isolated power supply is strongly suggested.

Figure 2-6 demonstrates how to connect a 4-20mA current loop. Since the card reads voltages, the current is converted to voltage by passing it through a shunt resistor. By Ohms law ( $V=IR$ ), when using a  $250\Omega$  resistor, 4 mA will be converted to 1V and 20mA to 5V. If the source is linear, the output voltage range will also be linear.

**Figure 2-3A**

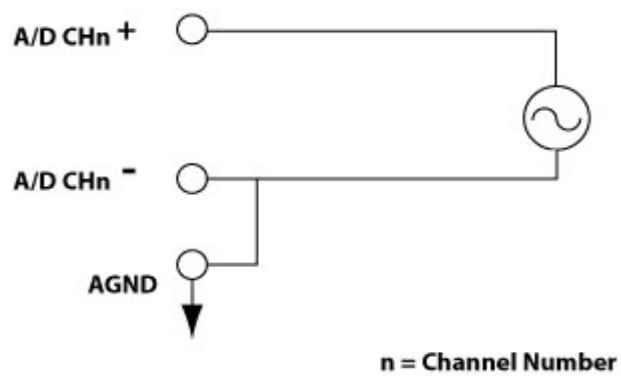
**Connecting to a Grounded Source in Differential Mode**



*If the source is grounded, a second ground connection on the card could result in a ground loop.*

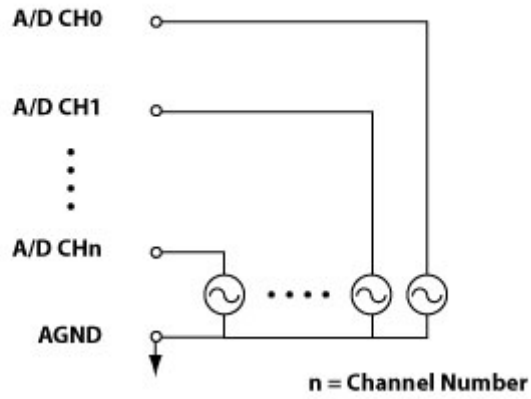
**Figure 2-3B**

**Connecting to a Floating Source in Differential Mode**



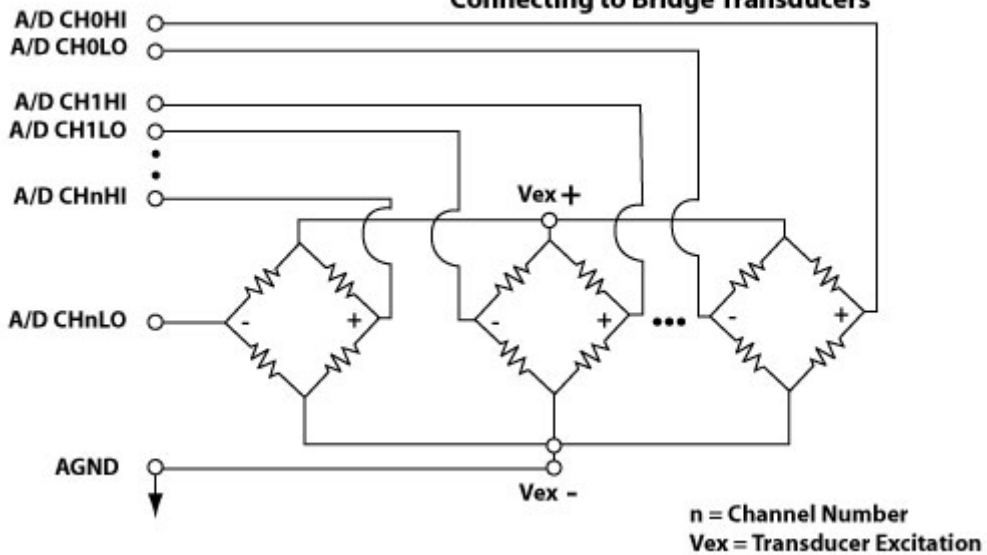
**Figure 2-4**

**Connecting to Multiple Sources  
in Single-Ended Mode**



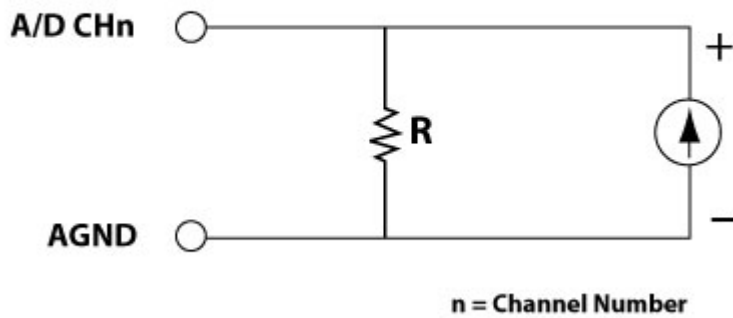
**Figure 2-5**

**Connecting to Bridge Transducers**



**Figure 2-6**

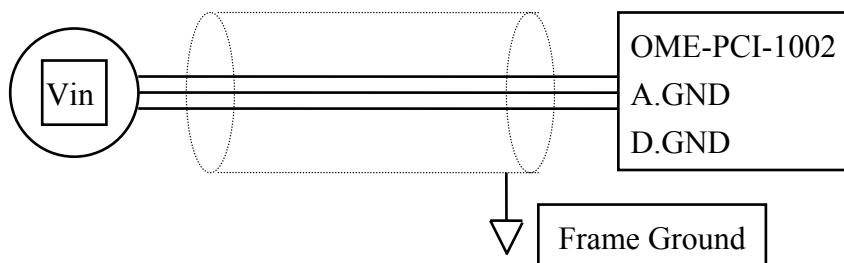
**Connecting to a 4 - 20 mA Source**



**R is a shunt resistor. A 250 $\Omega$  shunt resistor converts 4-20mA to 1-5Vdc.**

## Signal Shielding

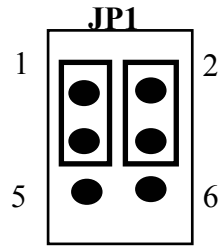
- The signal shielding connections in Figure 2-3 to Figure 2-6 are all the same
- Use a single connection to **frame ground (not A.GND or D.GND)**



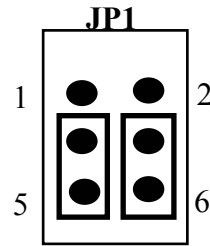
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## 2.7 Jumper Settings

There is only one jumper on the OME-PCI-1002. JP1 is used to select the analog input type. For single-ended inputs, users should connect Pin-1, 3 and Pin-2, 4. For differential inputs, Pin-3, 5 and Pin-4, 6 should be connected.



Single-ended  
Inputs (Default)



Differential  
Inputs

---

## 2.8 The Connectors

CON1: Digital output connector pin assignment.

Pin	Name	Pin	Name
1	Digital output 0	2	Digital output 1
3	Digital output 2	4	Digital output 3
5	Digital output 4	6	Digital output 5
17	Digital output 6	8	Digital output 7
9	Digital output 8	10	Digital output 9
11	Digital output 10	12	Digital output 11
13	Digital output 12	14	Digital output 13
15	Digital output 14	16	Digital output 15
17	PCB ground	18	PCB ground
19	PCB +5V	20	PCB +12V

1	2
3	4
5	6
7	8
9	10
11	12
13	14
15	16
17	18
19	20

CON2: Digital input connector pin assignment.

Pin	Name	Pin	Name
1	Digital input 0	2	Digital input 1
3	Digital input 2	4	Digital input 3
5	Digital input 4	6	Digital input 5
17	Digital input 6	8	Digital input 7
9	Digital input 8	10	Digital input 9
11	Digital input 10	12	Digital input 11
13	Digital input 12	14	Digital input 13
15	Digital input 14	16	Digital input 15
17	PCB ground	18	PCB ground
19	PCB +5V	20	PCB +12V



CON3: Analog input/output connector pin assignment. (For OME-PCI-1002H/L)

Pin	Name	Pin	Name
1	Analog input 0/0+	20	Analog input 16/0-
2	Analog input 1/1+	21	Analog input 17/1-
3	Analog input 2/2+	22	Analog input 18/2-
4	Analog input 3/3+	23	Analog input 19/3-
5	Analog input 4/4+	24	Analog input 20/4-
6	Analog input 5/5+	25	Analog input 21/5-
7	Analog input 6/6+	26	Analog input 22/6-
8	Analog input 7/7+	27	Analog input 23/7-
9	Analog input 8/8+	28	Analog input 24/8-
10	Analog input 9/9+	29	Analog input 25/9-
11	Analog input 10/10+	30	Analog input 26/10-
12	Analog input 11/11+	31	Analog input 27/11-
13	Analog input 12/12+	32	Analog input 28/12-
14	Analog input 13/13+	33	Analog input 29/13-
15	Analog input 14/14+	34	Analog input 30/14-
16	Analog input 15/15+	35	Analog input 31/15-
17	Analog ground	36	N.C.
18	N.C.	37	Digital ground
19	External trigger		

Notes:

1. When configured for differential inputs (JP1 3-5, 4-6), Pins 1-16 are the positive inputs and Pins 20-35 are the negative inputs.
2. N.C. = No Connection

---

## 3. I/O Registers

---

### 3.1 How to Find the I/O Address

The Plug & Play BIOS will assign a valid I/O address to all OME-PCI-1002 cards in the system during the computer's power-on stage. The ID numbers of OME-PCI-1002 are shown below:

- **Vendor ID** = 1234
- **Device ID** = 1002

#### **Associated Driver Functions:**

##### **1. P1002\_DriverInit(&wBoard)**

This function detects the number of OME-PCI-1002 cards in the system.

- wBoard=1 → only one OME-PCI-1002 in this PC system.
- wBoard=2 → there are two OME-PCI-1002 in this PC system.

##### **2. P1002\_GetConfigAddressSpace(wBoardNo, \*wBase, \*wIrq, \*wPLX)**

Use this function to determine the resources for all cards installed in the system.

This is used when writing directly to the card's I/O addresses.

- wBoardNo=0 to N → totally N+1 cards of OME-PCI-1002
- wBase → base address of the board control word
- wIrq → allocated IRQ channel number of this board
- wPLX → base address of PCI-interface-IC

---

The sample program code is shown below:

```
/* Step1: Detect all OME-PCI-1002 card first */
wRetVal=P1002_DriverInit(&wBoards);
printf("There are %d OME-PCI-1002 Cards in this PC\n",wBoards);

/* Step2: save resource of all OME-PCI-1002 cards installed in this PC */
for (i=0; i<wBoards; i++)
{
P1002_GetConfigAddressSpace(i,&wBase,&wIrq,&wPLX);
printf("\nCard_%d: wBase=%0x, wIrq=%0x, wPLX=%0x", i,wBase,wIrq,wPLX);
wConfigSpace[i][0]=wBaseAddress; /* save all resource of this card */
wConfigSpace[i][1]=wIrq;          /* save all resource of this card */
wConfigSpace[i][2]=wPLX;         /* save all resource of this card */
}

/* Step3: control the OME-PCI-1002 directly */
wBase=wConfigSpace[0][0];          /* get base address the card_0      */
outpw(wBase+0x20,wDoValue);        /* control the D/O states of card_0 */
wDiValue=inpw(wBase+0x20);         /* read the D/I states of card_0    */

wBase=wConfigSpace[1][0];          /* get base address of card_1      */
outpw(wBase+0x20,wDoValue);        /* control the D/O states of card_1 */
wDiValue=inpw(wBase+0x20);         /* read the D/I states of card_1    */

wPLX=wConfigSpace[2][2];           /* get PCI-interface base address of card-2 */
_outpd(wPLX+0x4c,0x41);           /* channel_1, interrupt active_Low */
...
...
...
_outpd(wPLX+0x4c,0);               /* disable all interrupts          */
```

---

## 3.2 The I/O Address Map

The OME-PCI-1002 registers are given below. The address of each register is determined by adding the offset to the base address of the corresponding section.

Section	Offset	Name	Access	Length
1	4ch	PCI interrupt control register	R/W	8/16/32 bits
2	00h	8254 timer1	R/W	8/16/32 bits
	04h	8254 timer2	R/W	8/16/32 bits
	08h	8254 timer3	R/W	8/16/32 bits
	0Ch	8254 control register	W	8/16/32 bits
	10h	Analog input channel control register	W	8/16/32 bits
	10h	Status register	R	8/16/32 bits
	14h	Analog input gain control register	W	8/16/32 bits
	18h	General control register	W	8/16/32 bits
	1Ch	A/D software trigger	W	8/16/32 bits
	1Ch	Clear Interrupt	R	8/16/32 bits
	20h	Digital output register	W	16/32 bits
	20h	Digital input register	R	16/32 bits
	30h	A/D data register	R	16/32 bits

---

## 3.2.1 Section 1

Although there are 128 I/O ports used by the on-board PCI interface controller, only one register is used for most applications. The user should not modify the other registers! The PCI interrupt control register (**4Ch**) controls the interrupts generated by the system. The register is set to “disable interrupt” after power-on or hardware reset signal, thus no interrupts will be generated before this register is activated even if the user enables the add-on interrupt! In order to enable the PCI-interrupt, write **43h** to this register. Write **03h** to this register if you want to disable the PCI interrupts.

Following is the format of the PCI interrupt control register:

Bit 31-Bit 7	Bit6	Bit5-Bit3	Bit2	Bit1-Bit0
Not used	Interrupt Enable	Not used	Interrupt Flag	Interrupt Select

Bit 6: Write an ‘1’ to enable the PCI-interrupt and a ‘0’ to disable PCI interrupt.

Bit 2: This bit is read-only. A ‘1’ indicates that the Add-on has

generated an interrupt, ‘0’ means that Add-on did not generate an interrupt.

Bit1-0: Always write 1 to these two bits.

Note:

1. Since the OME-PCI-1002 supports “Plug and Play”, the interrupt number will automatically be assigned by your system. The user can determine the interrupt number by using standard PCI utilities or by using the OME-PCI-1002 software driver.
2. If your system supports “Shared IRQ”, several peripherals may share the same IRQ at the same time. You must use Bit-2 to find out if an IRQ was generated from the OME-PCI-1002 or a different device!
3. For more information about the PCI interrupt control, please refer to the user reference manual of the PLX-9050.

---

## 3.2.2 Section 2

This group of registers is used by the add-on control logic. 64 bytes of I/O locations are used. Their detailed descriptions are shown below

---

### 3.2.2.1 The 8254 Registers

The 8254, programmable timer/counter, is used to generate periodic interrupts, A/D trigger and the machine independent timer. Addresses 00h, 04h, 08h and 0Ch are used to program the 8254.

Timer 0 is used as Pacer 0 and timer 1 is used as Pacer 1. Timer 2 is used as the machine independent timer (P1002\_Dealy() function). Refer to Intel's "Microsystem Components Handbook" for detailed programming information.

---

### 3.2.2.2 The DI / DO Register

Address 20h is used for DI / DO ports. Write to this port to send data to the DO register. Read from this port to input DI data.

---

### 3.2.2.3 The A/D Buffer

Address 30h is used for the A/D buffer. This is a read-only address. Reading from this port will return the data from A/D buffer. The format of A/D buffer is:

Bit15-12	Bit11-0
Analog input channel	A/D data

Bit15-12: The channel number of the analog input. Only lower 4 bits of channel number are shown in this register.

Bit11-0: The A/D data.

---

### 3.2.2.4 The Status Register

Address **10h** is used is the status register. Reading from this address will return the data from the status register. The format of status register is:

Bit7-6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Gain Control	8245 Timer 1	8245 Timer 0	8245 Timer 2	Reserved	Analog input type	A/D Busy

Bit 7-6: Current A/D gain control.

Bit 5 : Output of 8254 timer 1.

Bit 4 : Output of 8254 timer 0.

Bit 3 : Output of 8254 timer 2.

Bit 2 : Reserved. Used for hardware testing.

Bit 1 : Analog input type, '1' indicated that analog input type is single-ended and '0' indicated analog input is differential.

Bit 0 : A/D busy signal. '0' indicates busy, A/D is under conversion. '1' indicates not busy, A/D is complete conversion and is idle now.

---

### 3.2.2.5 The A/D Software Trigger Register

Writing to port **1Ch** will generate an A/D trigger signal.

Note: Since the user can trigger at a rate greater than the speed of A/D converter (125K), a delay time may be required between successive software triggers

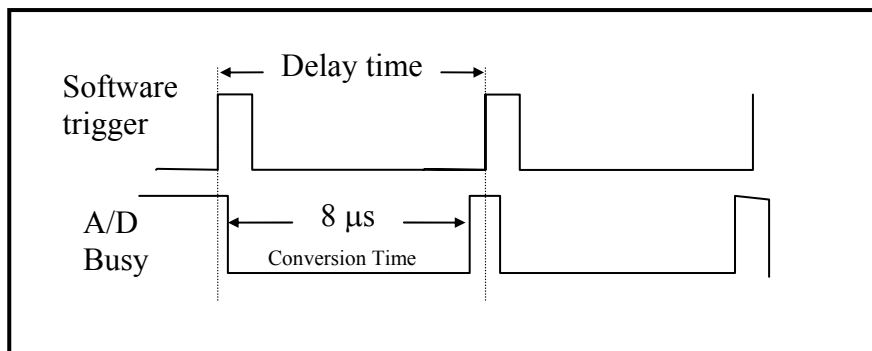


Figure 3-1. Software triggered delay time.

---

### 3.2.2.6 Clear Interrupt

Reading from 1Ch will clear the add-on interrupt.

---

### 3.2.2.7 The Analog Input Selection Register

The analog input channel selection register uses address 10h and address 14h is used by the analog gain control selection register. Write 0-31 to port 10h to select the channel number (for differential input, write 0-15). Write 0-3 to port 14h to select the gain control.

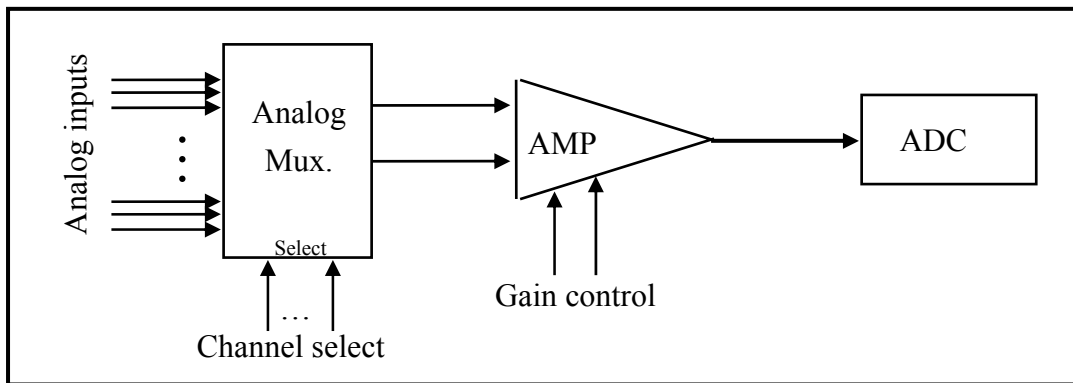


Figure 3-2. Analog input control.

Note:

1. For single ended inputs, channels 0-31 are available. For differential inputs, channels 0-15 are available. If you enter a channel number greater than the number available, those channels will be ignored. Thus, for single-ended inputs, only the last 5 bits are taken as the channel number. And for differential inputs, only the last 4 bits are taken as the channel number.
2. Only the last two digits are used as the gain control code. The gain control codes and corresponding gains are shown below :

For OME-PCI-1002L:

Gain code	[0 0]	[0 1]	[1 0]	[1 1]
Gain	1	2	4	8



---

For OME-PCI-1002H:

[Bit1,Bit0]	[0 0]	[0 1]	[1 0]	[1 1]
Gain	1	10	100	1000

3. These registers are set to 0 after power-on or a hardware reset signal.

---

### 3.2.2.8 The General Control Register

The general control register (18h) is used to control the add-on interrupt source and the A/D trigger method. The format of this register is:

Bit4-2	Bit 1-0
Interrupt source selection register	A/D trigger method selection register

#### 3.2.2.8.1 Interrupt Source Selection

There are four interrupt sources selectable for the OME-PCI-1002 (see section 1.4.4).

[Bit4,Bit3,Bit2]	Description
[ 0, 0, 0 ]	No interrupt source, disable all interrupts.
[ 0, 0, 1 ]	Interrupt after A/D conversion completes.
[ 0, 1, 0 ]	Interrupt after 8254 timer 0 falling.
[ 0, 1, 1 ]	Interrupt after external trigger falling.
[ 1, 0, 0 ]	Interrupt after 8254 timer 1 falling.
Others	No interrupt source, disable all interrupts.

Note: Bit 3-3 of general control register is set to 0 after a hardware reset.

---

### 3.2.2.8.2 Trigger Method Selection

There are several trigger methods that can be selected by the user (see section 1.4.5):

[Bit1, Bit0 ]	Descriptions
[ 0, 0 ]	General trigger mode. 8254 timer 0 trigger (internal pacer trigger ) or software trigger.
[ 0, 1 ]	External clock trigger mode.
[ 1, 0 ]	Pre-trigger mode.
[ 1, 1 ]	Post-trigger mode.

Note:

1. In the general trigger mode, both the 8254 timer 0 and the software trigger are used as the A/D trigger signals. The timer 0 and the software trigger should not be used at the same time! This means the **user should not generate a software trigger while the 8254 timer 0 is activated!**
2. In the external clock trigger mode, an external input is taken as the A/D trigger signal. A single falling edge of the external trigger will generate a single A/D trigger.
3. The pre-trigger mode employs the 8254 timer 1. The user should first configure timer 1, then set the trigger mode to pre-trigger. Once the pre-trigger mode has been activated, it will automatically turn on timer 1 and start the A/D trigger. This will continue until a falling edge from an external trigger signal is received. Any change to the trigger mode selection will turn off the pre-trigger mode.
4. The post-trigger mode employs the 8254 timer 1. The user should first configure timer 1, then set the trigger mode to post-trigger. Once the post-trigger mode has been activated, it will automatically turn off the timer 1 until it receives a falling edge from an external signal. Any change to the trigger mode selection will turn off the post-trigger mode.
5. The A/D trigger selection is set to 0 after power-on or hardware reset.

---

# 4. Function Operation

---

## 4.1 Digital I/O

The OME-PCI-1002 series provides 16 digital input channels and 16 digital output channels. All signals are TTL compatible. The connector and block diagrams are given below:

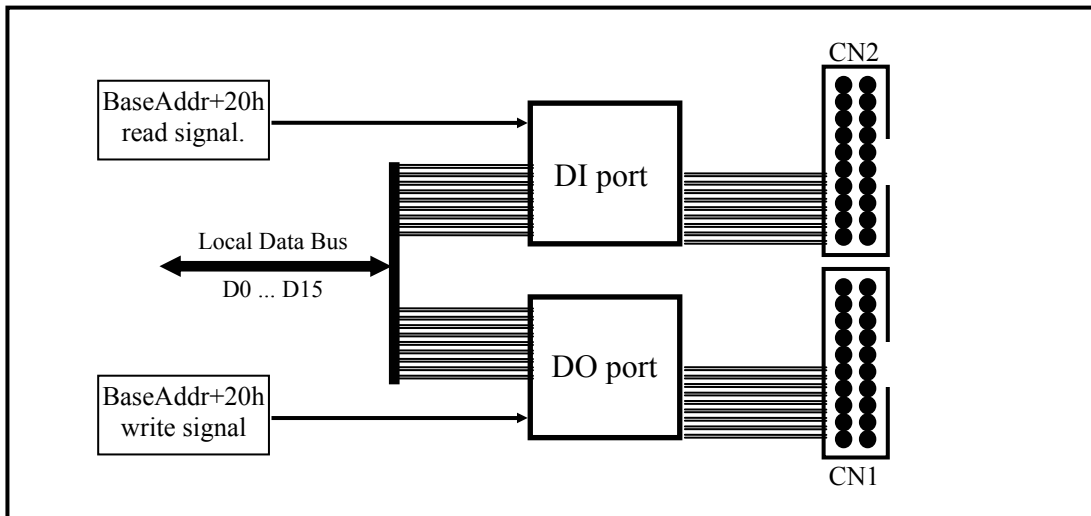


Figure 4.1. DIO function diagram.

## 4.2 The 8254 Timer

The OME-PCI-1002 series provide 3 independent 16-bit timer/counters. Each timer has a different function. **Timer 0 is used as Pacer 0. Timer 1 is used as Pacer 1. Timer 2 is used as the machine independent timer.** The block diagram is given as follows:

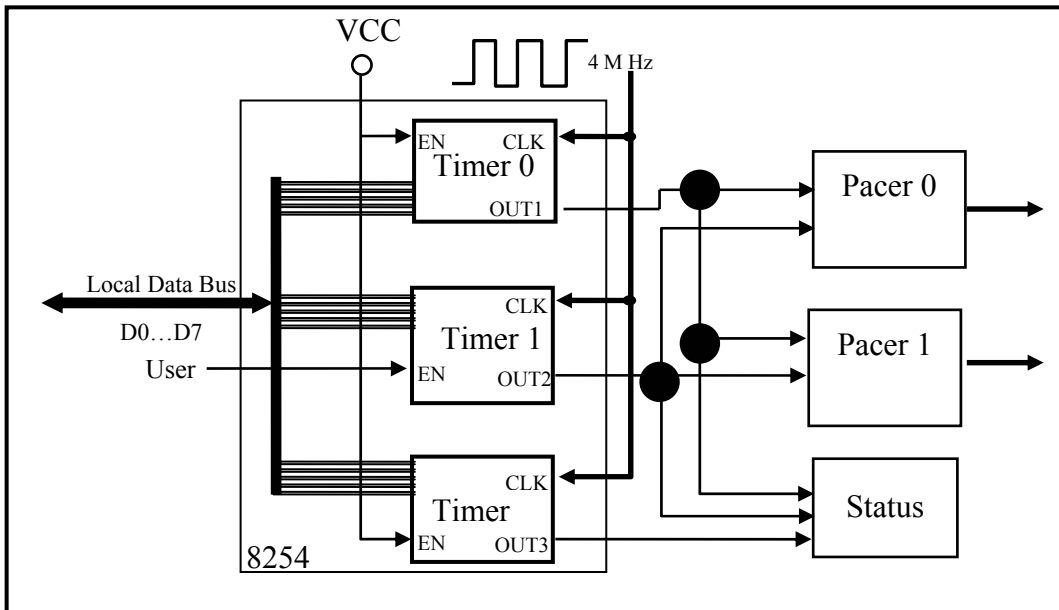


Figure 4-2. 8254 Block Diagram.

## 4.3 The A/D trigger

The block diagram of the A/D trigger is shown below:

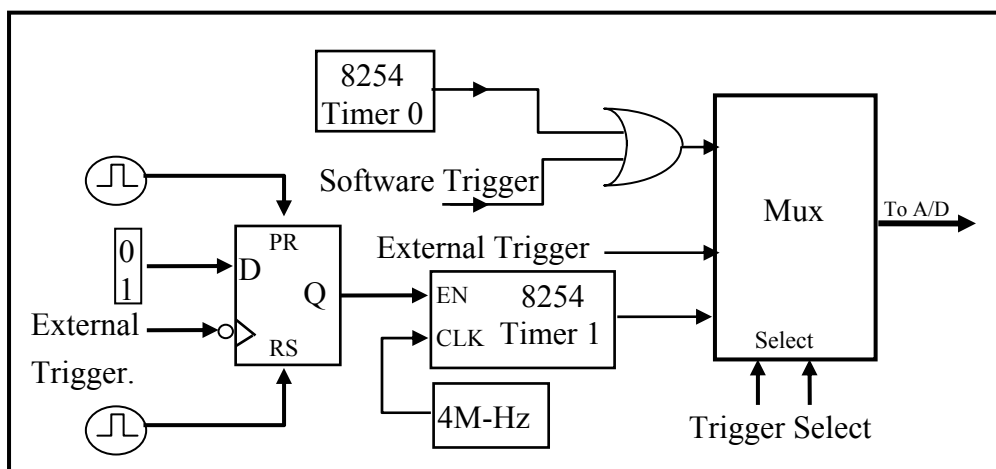
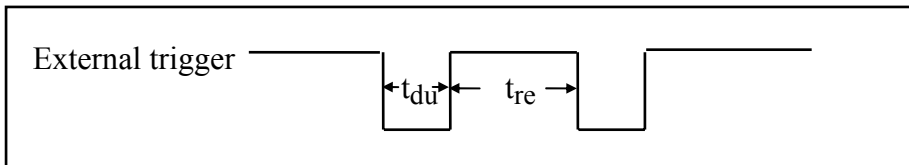


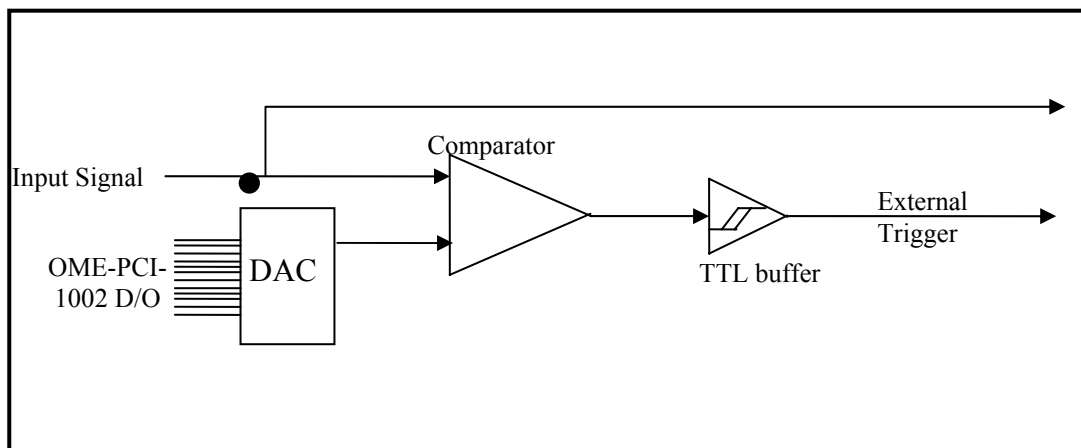
Figure 4-3. A/D Trigger Controller.

The A/D trigger logic can initiate an A/D conversion upon an external trigger. Valid external trigger signals must be TTL compatible and meet minimum pulse width requirements. The requirements are shown below:



Symbol	Name	Minimum	Maximum
$T_{du}$	Duration time	40ns	$\infty$
$T_{re}$	Recover time	100ns	$\infty$

Note: The OME-PCI-1002 is designed only for time sensitive triggers (trigger is dependent only on the time of the falling edge of signal). For a level sensitive external trigger (trigger is dependent on the level of the input signal), the user can build the following external circuit the OME-PCI-1002:



---

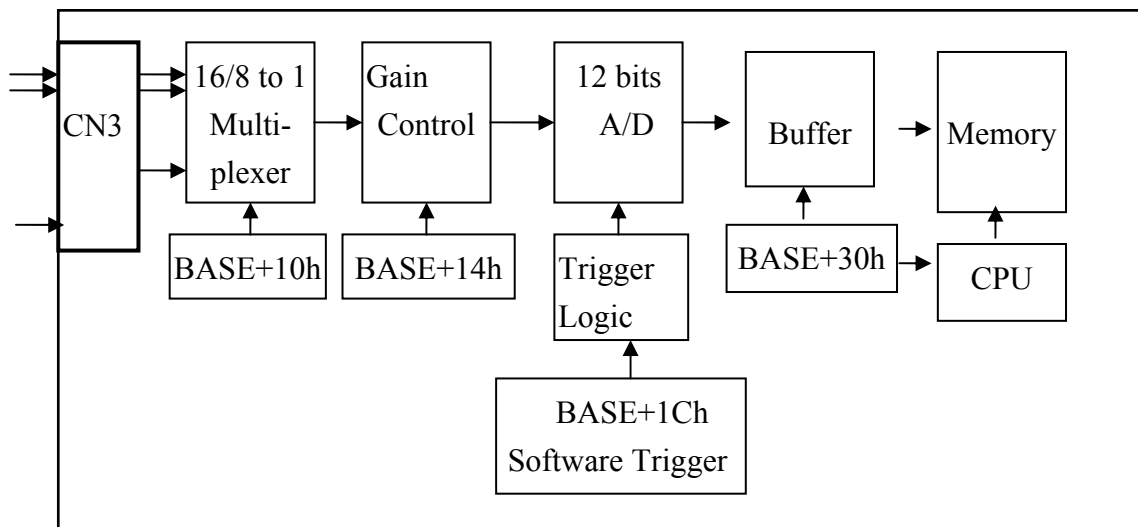
## 4.4 A/D Conversion

An A/D conversion can be initiated three different ways: software command, internal programmable interval timer or external trigger. At the end of the A/D conversion, it is possible to transfer the data by polling a status register and reading the data when ready or by generating a hardware interrupt and an interrupt service routine. All modes are selected by a control register on the OME-PCI-1002 and are supported by the utility software.

Below are key points for successfully collecting A/D data:

- A/D data register, BASE+30h, stores the A/D conversion data.
- A/D data conversion ready register, BASE +10h. Check if A/D data is ready.
- A/D gain control register, BASE+14h, select gain.
- A/D multiplexer control register, BASE+10h, select analog input channel.
- A/D mode control register, BASE+0Ch, select trigger type and transfer type.
- A/D software trigger control register, BASE+1Ch.
- JP1 select single-ended or differential input.
- **3 Triggers: Software, Pacer, and External trigger.**
- **2 Transfer Modes: Polling and Interrupt.**

The block diagram is given follows:



OME-PCI-1002H/L

---

Before performing A/D conversions, the JP1 jumper should be set for single-ended or differential.

The software driver supports both polling and interrupt driven A/D, however, polling is the simplest way to perform an A/D conversion.

The settling time of multiplexer depends on the impedance of the signal source. Because the driver does not incorporate the settling time, **the user needs to program a delay when switching from one channel to another or when changing gains.**

### **Suggested Settling Times**

One settling time is suggested for all ranges of the OME-PCI-1002L. The settling time for the OME-PCI-1002H is based on the analog input range. The table below shows the suggested settling times for each range.

**OME-PCI-1002L Settling Time:** 33  $\mu$ s for all ranges

<b>OME-PCI-1002H Settling Time</b>	
<b>Input Range</b>	<b>Settling Time</b>
$\pm 10V$	23 $\mu$ S
$\pm 5V$	28 $\mu$ S
$\pm 0.1V$	140 $\mu$ S
$\pm 0.01V$	1300 $\mu$ S

The software driver provides a **machine independent timer, P1002\_Delay()**, for settling time delay. If the user calls P1002\_Delay(), counter 0 will be reserved and can not be used as a user programmable timer/counter.

**The A/D converter requires a trigger signal to start an A/D conversion cycle.** The OME-PCI-1002 supports three trigger modes, **software, pacer and external trigger**.

---

## 4.4.1 A/D Conversion Trigger Modes

The OME-PCI-1002 supports three trigger modes.

### **1 : Software Trigger :**

Write any value to A/D software trigger control register, BASE+1Ch, will initiate a A/D conversion cycle. This mode is very simple but very difficult to control sampling rate.

### **2 : Pacer Trigger Mode :**

The block diagram of pacer timer is shown in section 3.2. The sample rate of pacer is very precise.

### **3 : External Trigger Mode :**

When a rising edge of external trigger signal is applied, an A/D conversion will be performed. The external trigger source comes from Pin-17 of CON3.

---

## 4.4.2 A/D Transfer Modes

OME-PCI-1002 supports two transfer modes.

### **1 : polling transfer :**

This mode can be used with all trigger modes. You must **disable timer 0** before polling. The A/D data can be read from the register at BASE+30h. Before reading the data first check the A/D ready bit at register BASE +10h READY\_BIT=0.

### **2 : interrupt transfer:**

This mode can be used with the pacer trigger or an external trigger. A hardware interrupt signal is sent to the PC when an A/D conversion is completed.

**For interrupt transfer, the use of the driver software is strongly recommended.**



---

## Software Trigger and Polling Techniques

The steps below should be followed for software triggering and polling:

1. Send 00h to A/D mode control register (software trigger + polling transfer)
2. Send channel number to multiplexer control register.
3. Send the gain control code value to gain control register.
4. Send any value to software trigger control register to generate a software trigger signal.
5. Scan the READY bit of the A/D high byte data until READY=0
6. Read the 12 bits A/D data.
7. Convert the 12 bits binary data to the floating point value.

For example:

```
/* ----- */
/* DEMO 3: AdPolling */
/* Compiler: Borland C++ 3.1, Mode Large */
/* Output Code: HEX code */
/* ----- */

#include "P1002.H"
WORD wBaseAddr,wIrq;
//-----
WORD P1002_Delay(WORD wDownCount)
{
    WORD h,l;
    int count;
    wDownCount &= 0x7fff;
    if (wDownCount<1) wDownCount=1;
    /* Clock in=4M --> count 4000 = 1 ms, count 1 = 0.25 us */

    l=wDownCount&0xff;
    wDownCount=wDownCount / 256;
    h=wDownCount&0xff;

    outp(wBaseAddr+3*4,0xB0); /* mode_0, counter_2 */
    outp(wBaseAddr+2*4,l); /* counter_2 low byte first */
    outp(wBaseAddr+2*4,h); /* counter_2 high byte ,0x07D0=2000 */

    outp(wBaseAddr+3*4,0x80); /* latch counter_2 */
```

---

```

l=inp(wBaseAddr+2*4);          /* delay starting two clks */
h=inp(wBaseAddr+2*4);

for (count=32767;count>0;count--){
    outp(wBaseAddr+12,0x80); /* latch counter_2 */
    l=inp(wBaseAddr+8);
    h=inp(wBaseAddr+8);
    if (h>=0x80) return NoError;
}
return TimeOut;
}

//-----
void AdPolling(UCHAR channel, UCHAR gain, WORD delay)
{
    outp(wBaseAddr+0x18,0);    // Select Mode 0
    outp(wBaseAddr+0x10,channel);
    outp(wBaseAddr+0x14,gain);
    P1002_Delay(delay);
    outp(wBaseAddr+0x1c,01);    // A/D software trigger
}

void SetupTimer(WORD wChannel, WORD wCoef)
{
    WORD cmd;
    wChannel=wChannel&0x03;
    cmd=0x34+(wChannel<<6);
    outpw(wBaseAddr+3*4, cmd);
    outp(wBaseAddr+wChannel*4, (UCHAR)(wCoef&0xff));
    outp(wBaseAddr+wChannel*4, (UCHAR)(wCoef>>8));
}

//=====
void main()
{
    int i,j;
    WORD wBoards,wRetVal,wPLX;
    WORD Drdy,wAdData=0;

```

---

---

```

char c;

clrscr();
P1002_DriverInit(&wBoards);
printf("\n(1) Threr are %d OME-PCI-1002 Cards in this PC",wBoards);
if ( wBoards==0 )
{
    putchar(0x07); putchar(0x07); putchar(0x07);
    printf("(1) There are no OME-PCI-1002 card in this PC !!!\n"); exit(0);
}

printf("\n(2) Show the Configuration Space of all OME-PCI-1002:");
for(i=0; i<wBoards; i++)
{
    P1002_GetConfigAddressSpace(i,&wBaseAddr,&wIrq,&wPLX);
    printf("\n Card_%d: wBaseAddr=%x, wIrq=%x, wPLX=%x",i,wBaseAddr,wIrq,wPLX);
}

P1002_GetConfigAddressSpace(0,&wBaseAddr,&wIrq,&wPLX); /* select card_0 */
printf("\n(3) *** Card_0, wBaseAddr=%x ***\n",wBaseAddr);
SetupTimer(0,1); // AdPolling have to disable timer 0
AdPolling(0,0,23); // channel=0, gain=+/-10, delay=23us

for(i=0;i<10;i++)
{
    outp(wBaseAddr+0x1c,01); // A/D software tirgger
    while(1)
    {
        if( ((inp(wBaseAddr+0x10))&0x01)==1) // check A/D busy?
            break;
    }
    wAdData=((inp(wBaseAddr+0x30))&0x0fff);
    printf("\nRang:+/-10V, Counter %d ,ADC channel 0 value: 0x%xH",i,wAdData);
}
P1002_DriverClose();
}

```

---

---

## 5. Software and Demo Program

### 1. Demo programs for DOS

- ...\\1002\BC\LARGE\DEMO> ← demo program
- ...\\1002\BC\LARGE\LIB> ←library and driver
  
- DEMO1: Digital output.
- DEMO2: Digital output and Digital input test by itself.
- DEMO3: A/D Polling for channel 0.
- DEMO4: A/D Polling for channel 0,1,2,3 and defferent gain 1,2,4,8.
- DEMO5: A/D Pacer trigger.
- DEMO6: A/D Calibration.
- DEMO7: Find card number.

### 2. Demo program for Windows95/98/NT

- Refer to CD-ROM.

---

## 6. Diagnostic Program

---

### 6.1 Power-ON Plug & Play Test

Below are the steps for the power-on Plug & Play test:

Step 1: Power-off the PC

Step 2: Install OME-PCI-1002 without any extra external connections

Step 3: Power-on the PC and watch the PC screen very carefully

Step 4: The PC will perform its self-test first

Step 5: The PC will detect the non-PCI physical devices installed in the system

Step 6: The PC will display the information for these devices

Step 7: The PC will detect the PCI Plug & Play devices installed in the system

**All PCI-device information will be shown → pay careful attention**

**→ There will be a PCI device with vendor\_ID=1234, device\_ID=1002 (OME-PCI-1002)**

If the Plug & Play ROM-BIOS successfully detects the OME-PCI-1002 card during the power-on state, the DOS and Windows software driver will also be able to detect the card. If the Plug & Play ROM-BIOS can not find the OME-PCI-1002, the software driver will not function. Therefore the user must make sure that the power-on detection is correct.

---

### 6.2 Driver Plug & Play Test

Step 1: Power-off the PC.

Step 2: Install OME-PCI-1002 without any extra external connector.

Step 3: Power-on PC and run DEMO7.EXE.

Step 4: The I/O base address of all OME-PCI-1002 cards installed in the system will be displayed.

Step 5: Verify that the total number of boards is correct

Step 6: If more than one card, install a 20-pin flat cable on one of the OME-PCI-1002

---

cards.

Step 7: If a card's D/O=D/I → this is the physical card number, remember this number.

Step 8: Repeat the previous two steps to find the physical card number of all boards.

## 6.3 D I/O Test

Step 1: Power-off the PC.

Step 2: Install one OME-PCI-1002 card with a 20-pin flat cable between CON1 & CON2.

Step 3: Power-on the PC then run DEMO2.EXE.

Step 4: The DO and DI are displayed as TEST OK or TEST ERROR.

---

## 6.4 A/D Test

- A/D Test for OME-PCI-1002 card

Step 1: Power-off the PC.

Step 2: Install one OME-PCI-1002 card.

Step 3: Power-on PC, run DEMO6.EXE

Step 4: Apply +10V to channel 0.

Step 5: Apply +0V to channel 1.

Step 6: Apply -10V to channel 2.

Step 7: Run DEMO6.EXE.

Step 8: Check channel 0 = fff or ffe?

Step 9: Check channel 1 = 800 or 801?

Step 10: Check channel 2 = 000 or 001?



## WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of 13 months from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

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CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

## RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR WARRANTY RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR NON-WARRANTY REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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