

# PIO-D56/D24

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## User Manual

### **Warranty**

All products manufactured by ICP DAS are warranted against defective materials for a period of one year from the date of delivery to the original purchaser.

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# 1. Introduction

The PIO-D56/PIO-D24 provides 56/24 TTL digital I/O lines. The PIO-D56/PIO-D24 consists of one 24-bit bi-directional port, one 16 bit input port and one 16 bit output port (only for PIO-D56). The 24-bit port supports three 8-bit groups PA, PB & PC. Each 8-bit group can be configured to function as either inputs or outputs individual. All groups at 24-bit bi-directional port are configured as inputs upon power-up or reset.

The user can use the DB-24PD to connect the input port for isolation purpose, or use DB-24RD to interface to the output port for relay control. The PIO-D56/PIO-D24 has one D-sub connector and two 20-pin flat cable (only for PIO-D56). The flat cable can be connected to ADP-20/PCI adapter. The adapter can be fixed on the chassis. It can be installed in a 5V PCI bus and can support truly “Plug & Play”.

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## 1.1 Features

- PCI bus
- Up to 56/24(PIO-D56/PIO-D24) channels of digital I/O
- All I/O lines buffered on the board
- Eight-bit groups independently selectable for I/O on 24-bit port
- Input / Output programmable I/O ports under software control
- Double side SMD, short card.
- Connects directly to DB-24PR, DB-24PD, DB-24RD, DB-24PRD, DB-16P8R, DB-24POR, DB-24SSR, DB-24C or any OPTO-22 Compatible daughter boards
- 4 interrupt sources: PC0,PC1,PC2,PC3
- One DB37 connector, two 20-pin flat cable connectors(only for PIO-D56)
- High driving capability
- Automatically detected by windows 95/98/NT
- No base address or IRQ switches to set

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## 1.2 Specifications

- **All inputs are TTL compatible**

Logic high voltage : 2.4V (Min.)

Logic low voltage : 0.8V (Max.)

- **All outputs are TTL compatible**

*OPTO-22 output (CON3)*

Sink current : 64mA (Max.)

Source current : 32mA(Max.)

*16-channel output (CON1)*

Sink current : 8mA (Max.)

Source current : 0.4mA(Max.)

- Environmental :

Operating Temperature: 0°C to 60°C

Storage Temperature: -20°C to 80°C

Humidity: 0 to 90% non-condensing

- Dimension: 143mm X 105mm

- Power Consumption: +5V @ 530mA/420mA(PIO-D56/PIO-D24)

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## 1.3 Order Description

- PIO-D56 : PCI bus 56-bit DI/O board
- PIO-D24 : PCI bus 24-bit DI/O board

### 1.3.1 Options

- DB-24PD : 24 channel isolated D/I board
- DB-24RD : 24 channels relay board
- DB-24PRD : 24 channels power relay board
- DB-16P8R : 16 channels isolated D/I and 8 channels relay output board
- DB-24POR : 24 channels PhotoMos output board
- DB-24C : 24 channels open-collector output board
- ADP-20/PCI : extender, 20-pin header to 20-pin header for PCI bus I/O boards
- NAPPCI/win : DLLs for Windows 95/98
- NAPPCI/wnt : DLLs for Windows NT 4.0
- NAPVIEW/1 : LabVIEW driver for Windows 95/98
- NAPVIEW/2 : LabVIEW driver for Windows NT

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## 1.4 PCI Data Acquisition Family

We provide a family of PCI-BUS data acquisition cards. These cards can be divided into three groups as follows:

**1. PCI-series: first generation, isolated or non-isolated cards**

PCI-1002/1202/1800/1802/1602: multi-function family, non-isolated

PCI-P16R16/P16C16/P16POR16/P8R8: D/I/O family, isolated

PCI-TMC12: timer/counter card, non-isolated

**2. PIO-series: cost-effective generation, non-isolated cards**

PIO-823/821: multi-function family

PIO-D144/D96/D64/D56/D48/D24: D/I/O family

PIO-DA16/DA8/DA4: D/A family

**3. PISO-series: cost-effective generation, isolated cards**

PISO-813: A/D card

PISO-P32C32/P64/C64: D/I/O family

PISO-P8R8/P8SSR8AC/P8SSR8DC: D/I/O family

PISO-730: D/I/O card

PISO-DA2: D/A card

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## 1.5 Product Check List

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

- one piece of PIO-D56(or PIO-D24) card
- one piece of company floppy diskette or CD
- one piece of release note

It is recommended to read the release note firstly. All important information will be given in release note as follows :

1. where you can find the software driver & utility
2. how to install software & utility
3. where is the diagnostic program
4. FAQ

### **Attention !**

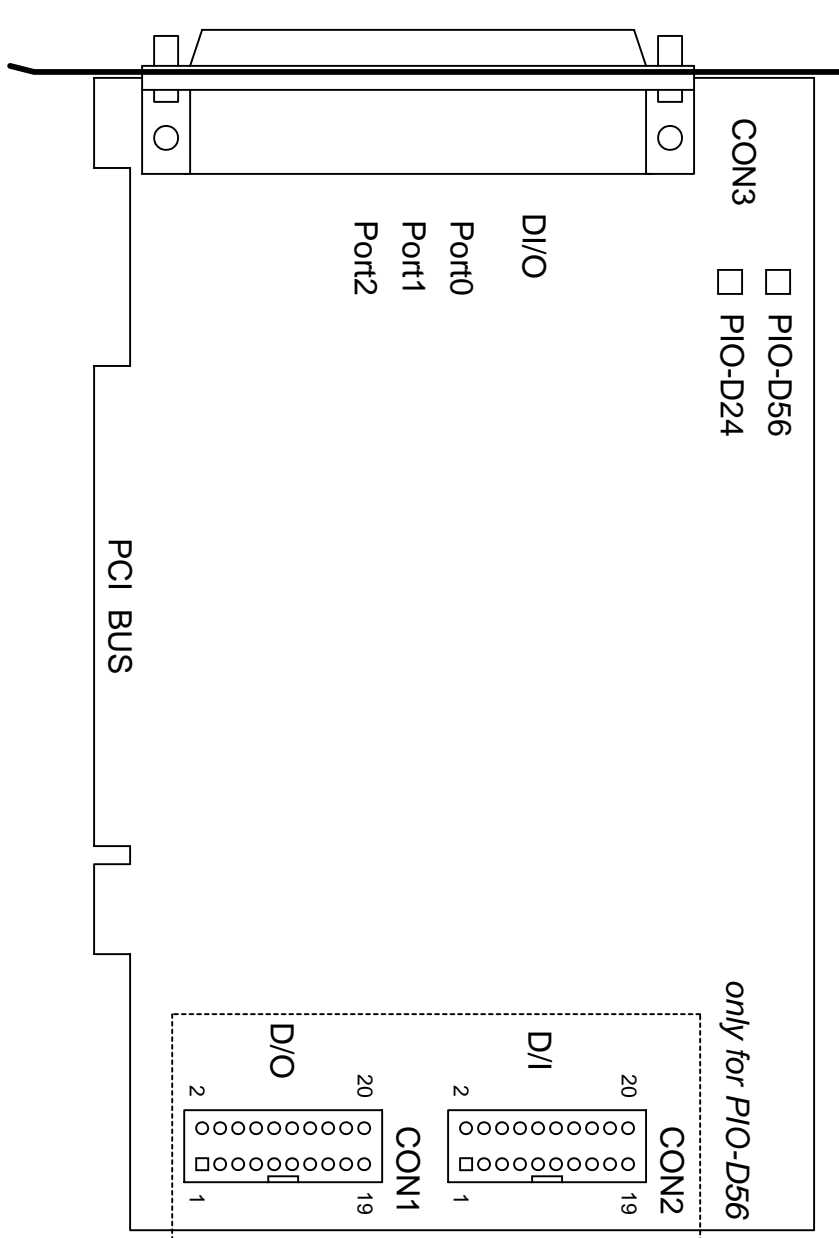
If any one of these items is missing or damaged, contact the dealer from whom you purchased the product. Save the shipping materials and carton in case you want to ship or store the product in the future.

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## 2. Hardware configuration

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### 2.1 Board Layout



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## 2.2 I/O port Location

The PIO-D56/PIO-D24 consists of one 24-bit bi-directional port, one 16 bit input port and one 16 bit output port (only for PIO-D56). The 24-bit port supports three 8-bit groups PA, PB & PC. Each 8-bit group can be configured to function as either inputs or outputs individual. All groups at 24-bit bi-directional port are configured as inputs upon power-up or reset. The I/O port location is given as follows:

Connector of PIO-D56/PIO-D24	PA0 ~ PA7	PB0 ~ PB7	PC0 ~ PC7
CON3 (DI/O)	Port0	Port1	Port2

Connector of PIO-D56	Description
CON1	D/O
CON2	D/I

Refer to Sec. 2.1 for board layout & I/O port location.

Note : PC0, PC1, PC2 and PC3 can be used as interrupt signal source. Refer to Sec. 2.4 for more information.

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## 2.3 Enable I/O Operation

### 2.3.1 DI/O Port Architecture (CON3)

When the PC is power-up, all operation of D/I/O port (CON3) is disable. The enable/disable of D/I/O port is controlled by the RESET\ signal. Refer to Sec. 3.3.1 for more information about RESET\ signal. The power-up states are given as follows :

- All D/I/O operations are disable
- All three D/I/O ports are configured as D/I port
- All D/O latch register are undefined.(refer to Sec. 2.3.2)

The user has to perform some initialization before using these D/I/O. The recommended steps are given as follows:

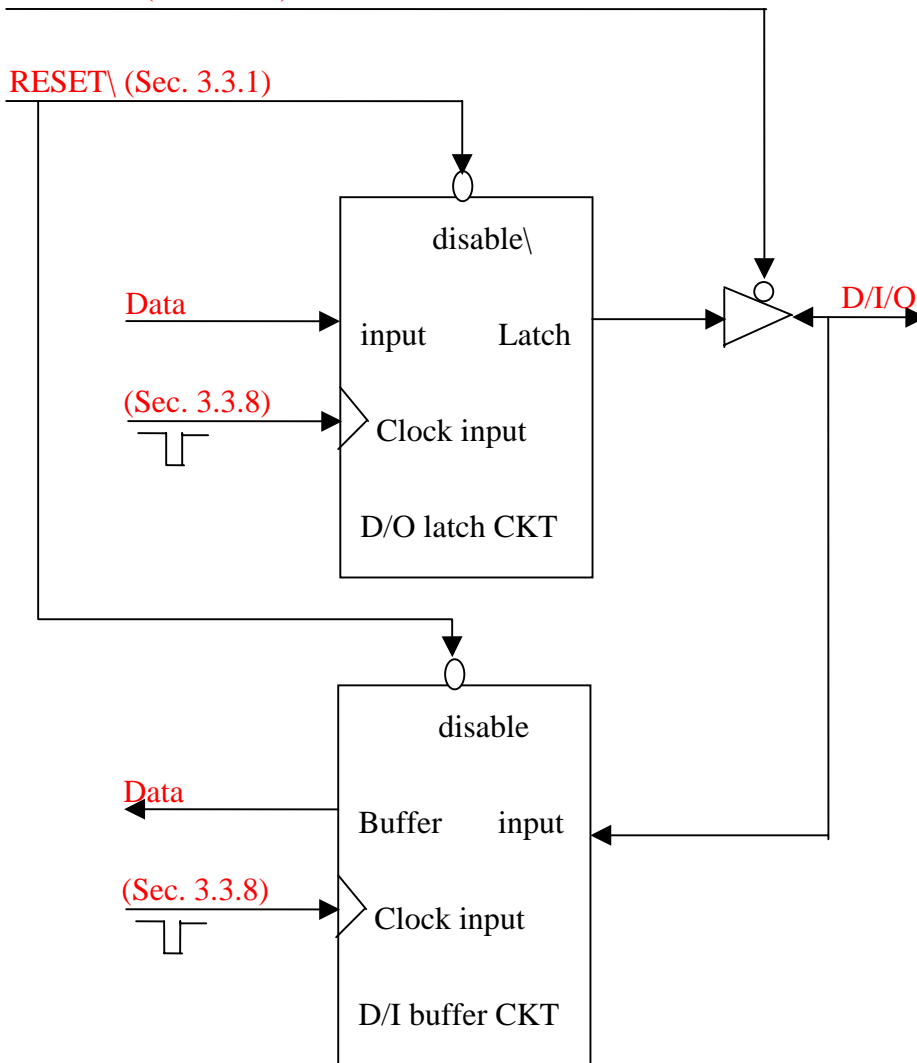
Step 1: find address-mapping of PIO/PISO cards (refer to Sec. 3.1)

Step 2: enable all D/I/O operation (refer to Sec. 3.3.1)

Step 3: configure the three ports (in CON3) to their expected D/I/O state & send the initial value to all D/O ports (refer to Sec. 3.3.8)

Refer to DEMO1.C for demo program.

I/O select (Sec. 3.3.7)



- The RESET\ is in Low-state → all D/I/O operation is disable
- The RESET\ is in High-state → all D/I/O operation is enable.
- If D/I/O is configured as D/I port → D/I= external input signal
- If D/I/O is configured as D/O port → D/I = read back of D/O
- If D/I/O is configured as D/I port → send to D/O will change the D/O latch register only. The D/I & external input signal will not change.

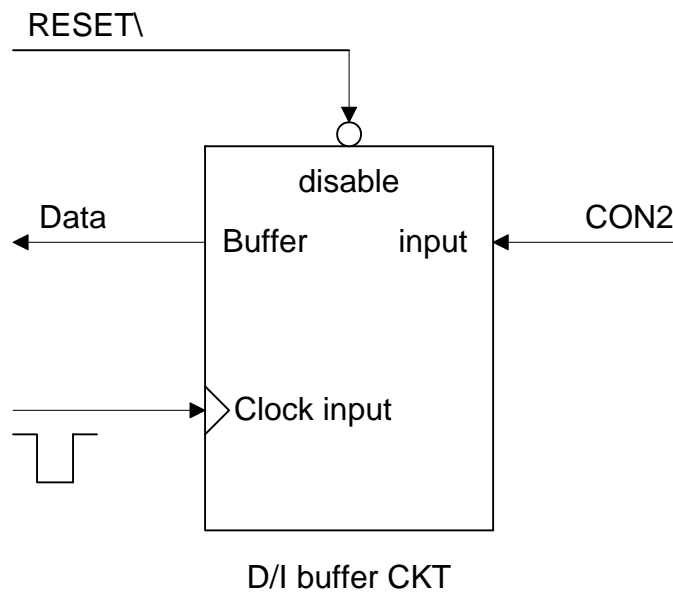


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## 2.3.2 DI Port Architecture (CON2)

When the PC is power-up, all operation of DI port (CON2) is disable. The enable/disable of DI port is controlled by the RESET\ signal. Refer to Sec. 3.3.1 for more information about RESET\ signal.

- The RESET\ is in Low-state → all DI operation is disable
- The RESET\ is in High-state → all DI operation is enable



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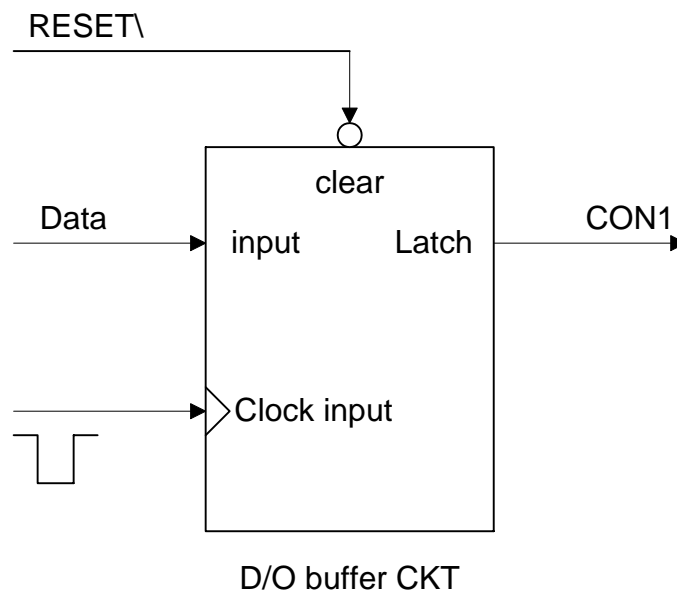
### 2.3.3 DO Port Architecture (CON1)

When the PC is power-up, all operation of DO port (CON1) is disable. The enable/disable of DO port is controlled by the RESET\ signal. Refer to Sec. 3.3.1 for more information about RESET\ signal.

- The RESET\ is in Low-state → all DO operation is disable
- The RESET\ is in High-state → all DO operation is enable

The power-up states are given as follows:

- All DO operations are disable
- All output latch be cleared to Low-Level



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## 2.4 Interrupt Operation

All PC0, PC1, PC2 and PC3 can be used as interrupt signal source. Refer to Sec. 2.1 for PC0/PC1/PC2/PC3 location. **The interrupt of PIO-D56/PIO-D24 is level-trigger & Active\_High.** The interrupt signal can be **inverted or non-inverted** programmable. The procedures of programming are given as follows:

1. make sure **the initial level is High or Low**
2. if the initial state is High → select the **inverted** signal (Sec. 3.3.6)
3. if the initial state is Low → select the **non-inverted** signal (Sec. 3.3.6)
4. enable the INT function (Sec. 3.3.4)
5. If the interrupt signal is active → program will transfer into the interrupt service routine → **if INT signal is High now → select the inverted input**  
→ **if INT signal is Low now → select the non-inverted input**

Refer to DEMO3.C & DEMO4.C for single interrupt source. Refer to DEMO5.C for four interrupt sources.

If only one interrupt signal source is used, the interrupt service routine does not have to identify the interrupt source. (refer to DEMO3.C & DEMO4.C)

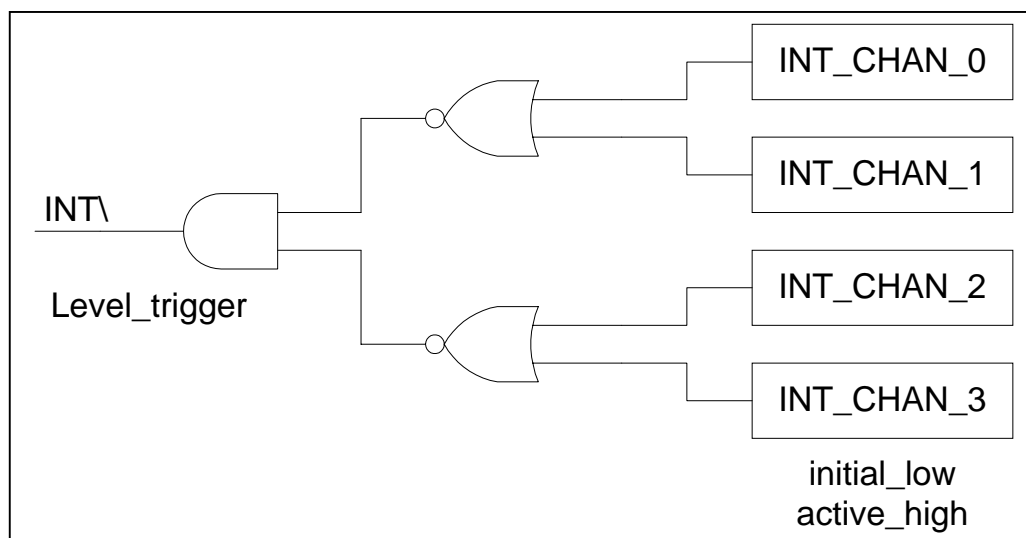
If there are more than one interrupt source, the interrupt service routine has to identify the active signals as follows : (refer to DEMO5.C)

1. Read the new status of the interrupt signal source
2. Compare the new status with the old status to identify the active signals
3. If PC0 is active, service PC0 & non-inverter/inverted the PC0 signal
4. If PC1 is active, service PC1 & non-inverted/inverted the PC1 signal
5. If PC2 is active, service PC2 & non-inverted/inverted the PC2 signal
6. If PC3 is active, service PC3 & non-inverted/inverted the PC3 signal
7. Save the new status to old status

**Limitation: if the interrupt signal is too short, the new status may be as same as old status. So the interrupt signal must be hold-active until the interrupt service routine is executed. This hold time is different for different O.S. The hold time can be as short as micro-second or as long as second. In general, 20ms is enough for all O. S.**

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## 2.4.1 Interrupt Block Diagram of PIO-D56/D24



**The interrupt output signal of PIO-D56/PIO-D24, `INT\`, is `Level_trigger` & `Active_Low`.** If the `INT\` generate a low-pulse, the PIO-D56/PIO-D24 will interrupt the PC once a time. If the `INT\` is fixed in low level, the PIO-D56/PIO-D24 will interrupt the PC continuously. So that **`INT_CHAN_0/1/2/3` must be controlled in a pulse type signals. They must be fixed in low level state normally and generated a high\_pulse to interrupt the PC.**

The priority of `INT_CHAN_0/1/2/3` is the same. If all these four signals are active at the same time, then `INT\` will be active only once a time. So the interrupt service routine has to read the status of all interrupt channels for multi-channel interrupt. Refer to Sec. 2.4 for more information.

DEMO5.C → for multi-channel interrupt source

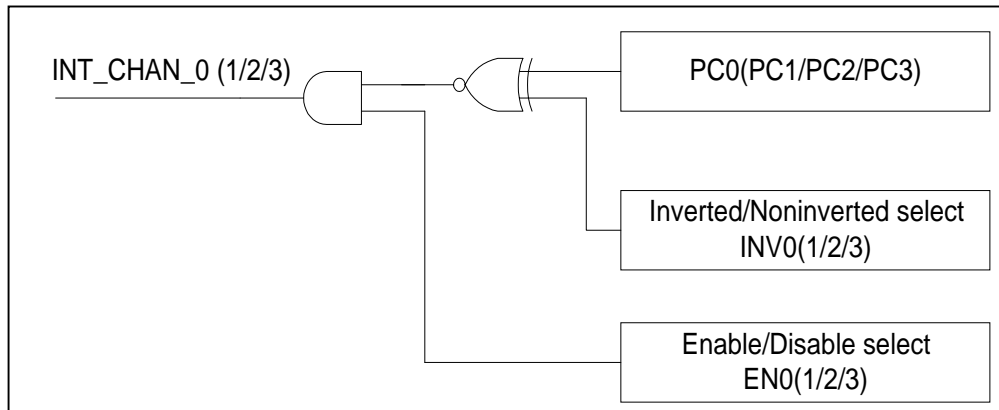
If only one interrupt source is used, the interrupt service routine doesn't have to read the status of interrupt source. The demo program, DEMO3.C & DEMO4.C are designed for single-channel interrupt demo as follows:

DEMO3.C → for `INT_CHAN_0` only (PC0 initial low)

DEMO4.C → for `INT_CHAN_0` only (PC0 initial high)

---

## 2.4.2 INT\_CHAN\_0/1/2/3



**The INT\_CHAN\_0 must be fixed in low level state normally and generated a high\_pulse to interrupt the PC.**

The EN0 (EN1/EN2/EN3) can be used to enable/disable the INT\_CHAN\_0(1/2/3) as follows : (Refer to Sec. 3.3.4)

EN0 (1/2/3) = 0 → INT\_CHAN\_0(1/2/3) = disable

EN0 (1/2/3) = 1 → INT\_CHAN\_0(1/2/3) = enable

The INV0 can be used to invert/non-invert the PC0 (1/2/3) as follows : (Refer to Sec.3.3.6)

INV0 (1/2/3) = 0 → INT\_CHAN\_0(1/2/3) = inverted state of PC0 (1/2/3)

INV0 (1/2/3) = 1 → INT\_CHAN\_0(1/2/3) = non-inverted state of PC0 (1/2/3)

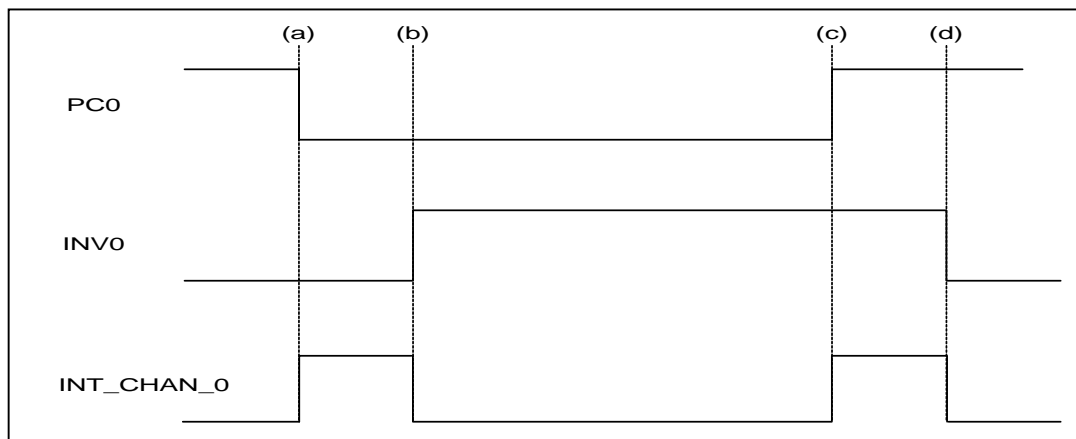
## 2.4.3 Initial\_high, active\_low Interrupt source

If the PC0 is a initial\_high, active\_low signal, the interrupt service routine should use INV0 to inverted/non-inverted the PC0 for high\_pulse generation as follows : ( Refer to DEMO4.C)

Initial set :

```
now_int_state=1;      /* initial state for PC0    */
outportb(wBase+0x2a,0); /* select the inverted PC0 */
```

```
void interrupt irq_service()
{
if (now_int_state==1)      /* now PC0 is changed to LOW          */(a)
{
/* --> INT_CHAN_0=!PC0=HIGH now      */
COUNT_L++;              /* find a LOW_pulse (PC0)           */
If((inport(wBase+7)&1)==0) /* the PC0 is still fixed in LOW    */
{
/* → need to generate a high_pulse */
outportb(wBase+0x2a,1); /* INV0 select the non-inverted input */(b)
/* INT_CHAN_0=PC0=LOW -->          */
/* INT_CHAN_0 generate a high_pulse */
now_int_state=0;        /* now PC0=LOW                      */
}
else now_int_state=1;    /* now PC0=HIGH                      */
/* don't have to generate high_pulse */
}
else
/* now PC0 is changed to HIGH          */(c)
{
/* --> INT_CHAN_0=PC0=HIGH now      */
COUNT_H++;              /* find a HIGH_pulse (PC0)         */
If((inport(wBase+7)&1)==1) /* the PC0 is still fixed in HIGH  */
{
/* need to generate a high_pulse */
outportb(wBase+0x2a,0); /* INV0 select the inverted input   */(d)
/* INT_CHAN_0=!PC0=LOW -->          */
/* INT_CHAN_0 generate a high_pulse */
now_int_state=1;        /* now PC0=HIGH                      */
}
else now_int_state=0;    /* now PC0=LOW                      */
/* don't have to generate high_pulse */
}
}
if (wIrq>=8) outportb(A2_8259,0x20);
outportb(A1_8259,0x20);
}
```



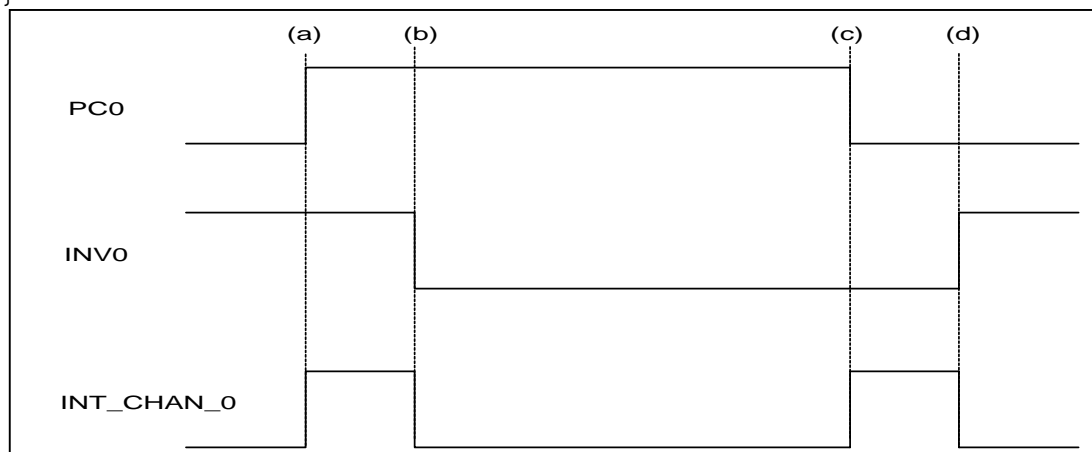
## 2.4.4 Initial\_low, active\_high Interrupt source

If the PC0 is a initial\_low, active\_high signal, the interrupt service routine should use INV0 to inverted/non-inverted the PC0 for high\_pulse generation as follows : ( Refer to DEMO3.C)

Initial set :

```
now_int_state=0;      /* initial state for PC0      */
outportb(wBase+0x2a,1); /* select the non-inverted PC0 */
```

```
void interrupt irq_service()
{
if (now_int_state==1)      /* now PC0 is changed to LOW      */(c)
{
/* --> INT_CHAN_0=!PC0=HIGH now      */
COUNT_L++;              /* find a LOW_pulse (PC0)      */
If((inport(wBase+7)&1)==0) /* the PC0 is still fixed in LOW */
{
/* → need to generate a high_pulse */
outportb(wBase+0x2a,1); /* INV0 select the non-inverted input */(d)
/* INT_CHAN_0=PC0=LOW -->      */
/* INT_CHAN_0 generate a high_pulse */
now_int_state=0;        /* now PC0=LOW      */
}
else now_int_state=1;    /* now PC0=HIGH      */
/* don't have to generate high_pulse */
}
else                      /* now PC0 is changed to HIGH      */(a)
{
/* --> INT_CHAN_0=PC0=HIGH now      */
COUNT_H++;              /* find a High_pulse (PC0)      */
If((inport(wBase+7)&1)==1) /* the PC0 is still fixed in HIGH */
{
/* need to generate a high_pulse */
outportb(wBase+0x2a,0); /* INV0 select the inverted input */(b)
/* INT_CHAN_0=!PC0=LOW -->      */
/* INT_CHAN_0 generate a high_pulse */
now_int_state=1;        /* now PC0=HIGH      */
}
else now_int_state=0;    /* now PC0=LOW      */
/* don't have to generate high_pulse */
}
}
if (wIrq>=8) outportb(A2_8259,0x20);
outportb(A1_8259,0x20);
}
```



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## 2.4.5 Multi Interrupt Source

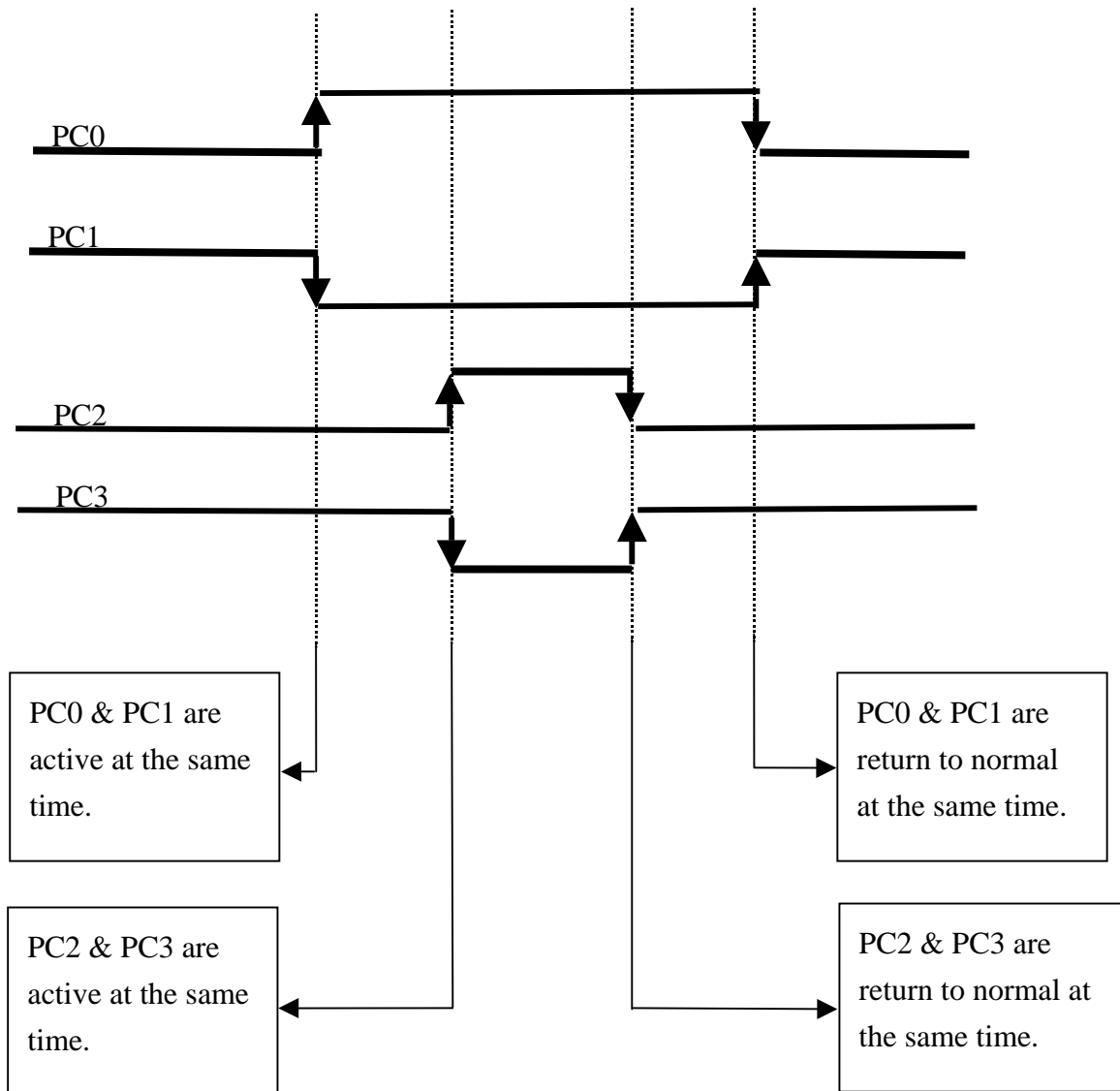
Assume : PC0 is initial Low, active High,

PC1 is initial High, active Low

PC2 is initial Low, active High

PC3 is initial High, active Low

as follows :



Refer to DEMO5.C for source program. **All these four falling-edge & rising-edge can be detected by DEMO5.C.**

**Note: when the interrupt is active, the user program has to identify the active signals. These signals maybe active at the same time. So the interrupt service routine has to service all active signals at the same time.**



```

void interrupt irq_service()
{
new_int_state=inportb(wBase+7)&0x0f; /* read all interrupt state */
int_c=new_int_state^now_int_state; /* compare which interrupt */
/* signal be change */
/* INT_CHAN_0 is active */
if ((int_c&0x1)!=0)
{
if ((new_int_state&0x01)!=0) /* now PC0 change to high */
{
CNT_H1++;
}
else /* now PC0 change to low */
{
CNT_L1++;
}
invert=invert^1; /* to generate a high pulse */
}

if ((int_c&0x2)!=0)
{
if ((new_int_state&0x02)!=0) /* now PC1 change to high */
{
CNT_H2++;
}
else /* now PC1 change to low */
{
CNT_L2++;
}
invert=invert^2; /* to generate a high pulse */
}

if ((int_c&0x4)!=0)
{
if ((new_int_state&0x04)!=0) /* now PC2 change to high */
{
CNT_H3++;
}
else /* now PC2 change to low */
{
CNT_L3++;
}
invert=invert^4; /* to generate a high pulse */
}

if ((int_c&0x8)!=0)
{
if ((new_int_state&0x08)!=0) /* now PC3 change to high */
{
CNT_H4++;
}
else /* now PC3 change to low */
{
CNT_L4++;
}
invert=invert^8; /* to generate a high pulse */
}
now_int_state=new_int_state;
outportb(wBase+0x2a,invert);
if (wIrq>=8) outportb(A2_8259,0x20);
outportb(A1_8259,0x20);
}

```

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## 2.5 Daughter Boards

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### 2.5.1 DB-37

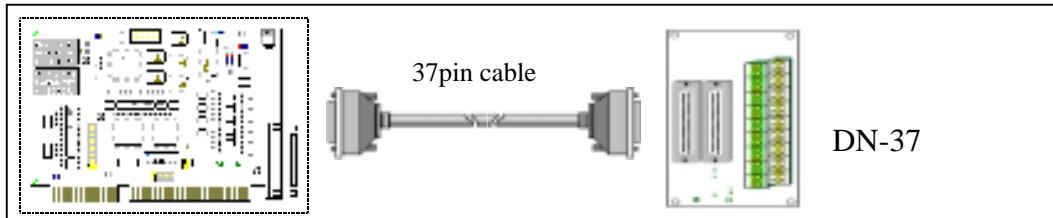
The DB-37 is a general purpose daughter board for D-sub 37 pins. It is designed for easy wire connection.



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### 2.5.2 DN-37

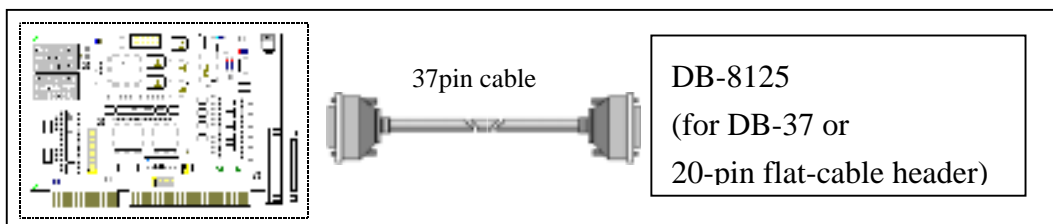
The DN-37 is a general purpose daughter board for DB-37 with DIN-Rail Mounting. It is designed for easy wire connection..



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### 2.5.3 DB-8125

The DB-8125 is a general purpose screw terminal board. It is designed for easy wire connection. There are one DB-37 & two 20-pin flat-cable header in the DB-8125.



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## 2.5.4 ADP-20/PCI

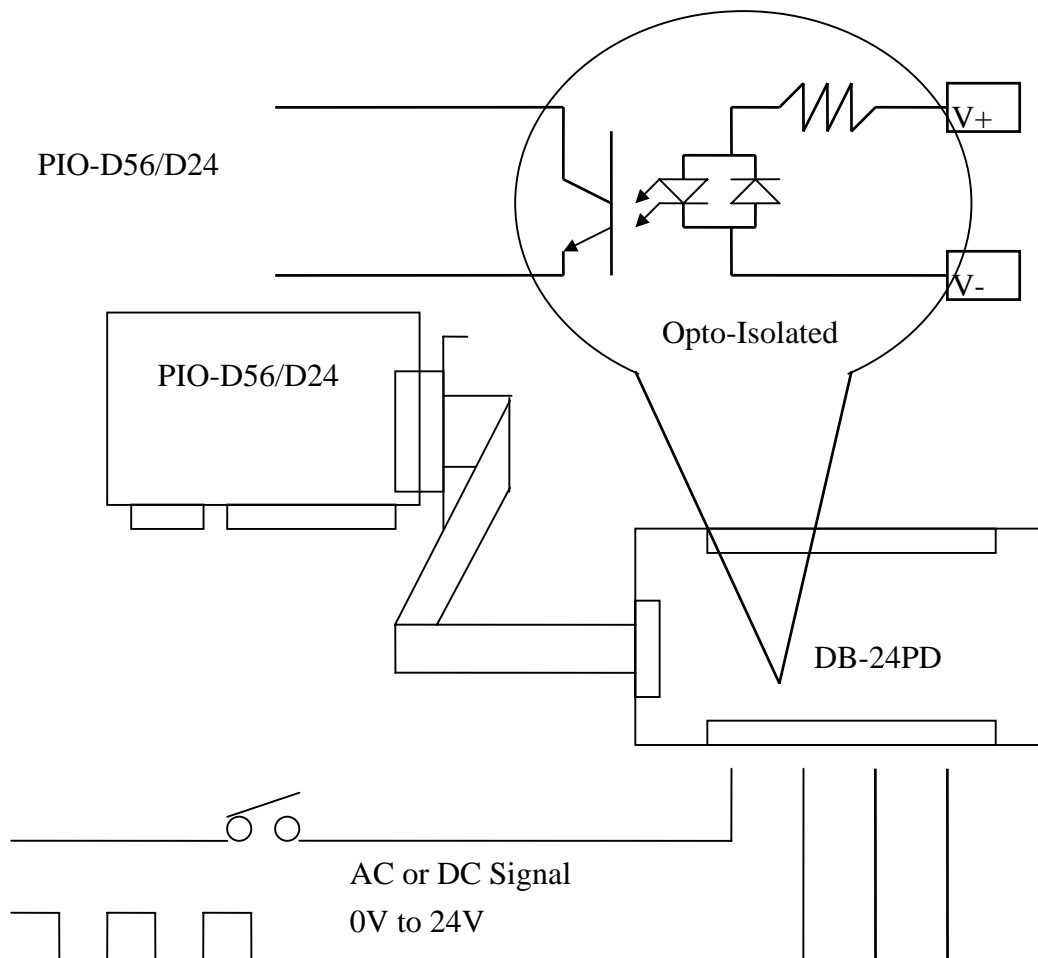
The ADP-20/PCI is a extender for 20-pin header. One side of ADP-20/PCI can be connected to a 20-pin header. The other side can be mounted on the PC chassis as follows :



NOTE : The user can choose the suitable extender for his own application

## 2.5.5 DB-24PD Isolated Input Board

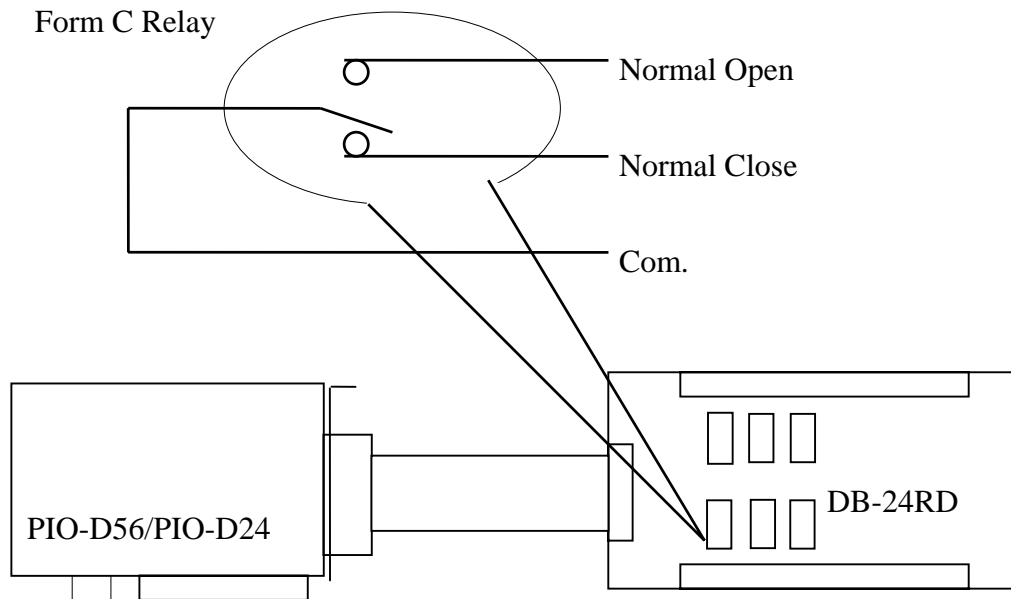
The DB-24PD is a 24-channel isolated digital input daughter board. The optically isolated inputs of the DB-24PD consist of a bi-directional optocoupler with a resistor for current sensing. You can use the DB-24PD to sense DC signal from TTL levels up to 24V or use the DB-24PD to sense a wide range of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



	DB-24PD
50-pin flat-cable header	Yes
D-sub 37-pin header	Yes

## 2.5.6 DB-24RD Relay Board

The DB-24RD, 24-channel relay output board, consists of 24 form C relays for efficient switch of load by programmed control. The relay are energized by apply 12V/24V voltage signal to the appropriated relay channel on the 50-pin flat connector. There are 24 enunciator LEDs for each relay, light when their associated relay is activated.



Note:

Channel : 24 Form C Relay

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

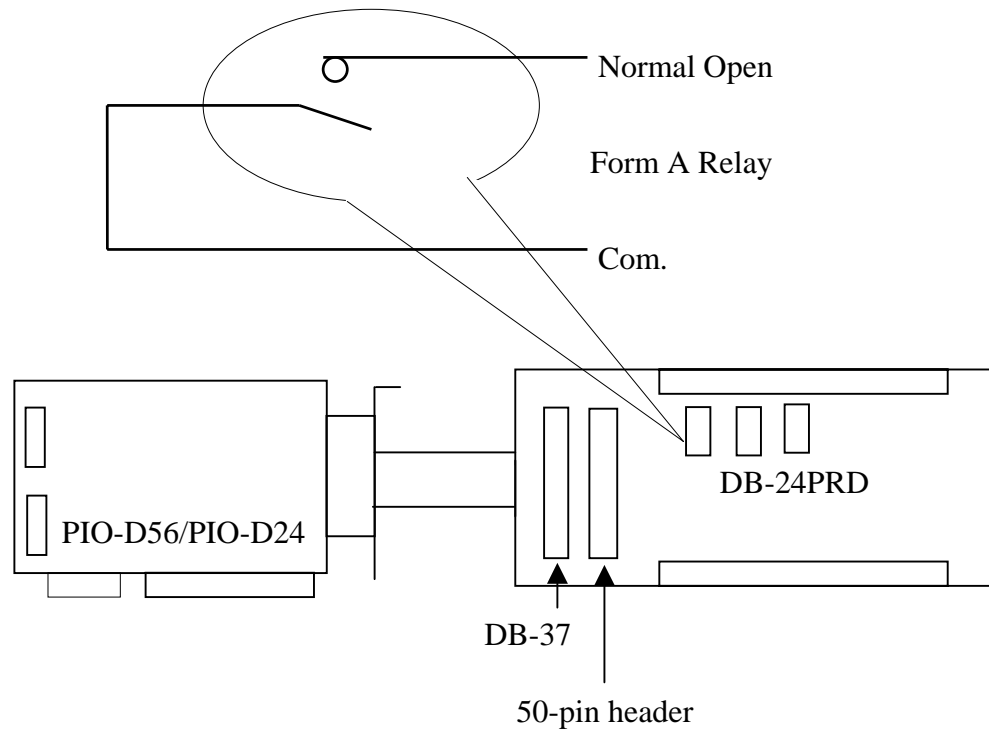
	DB-24RD
50-pin flat-cable header	Yes
D-sub 37-pin header	Yes

DB-24R, DB-24RD	24*Relay (120V, 0.5A)
DB-24PR,DB-24PRD	24* Power Relay (250V, 5A)
DB-24POR	24*photoMOS Relay (350V, 01.A)
DB-24SSR	24*SSR (250VAC, 4A)
DB-24C	24*O.C. (30V, 100 mA)
DB-16P8R	16*Relay (120V, 0.5A) + 8*isolated input

## 2.5.7 DB-24PRD, DB-24POR, DB-24C

DB-24PRD	24*power relay, 5A/250V
DB-24POR	24*photoMOS relay, 0.1A/350VAC
DB-24C	24*open collector, 100mA per channel, 30V max.

The DB-24PRD, 24-channel power relay output board, consists of 8 form C and 16 form A electromechanical relays for efficient switching of load programmed control. The contact of each relay can control a 5A load at 250ACV/30VDCV. The relay is energized by applying a 5 voltage signal to the appropriate relay channel on the 20-pin flat cable connector(just used 16 relays) or 50-pin flat cable connector.(OPTO-22 compatible, for DIO-24 series). Twenty - four enunciator LEDs, one for each relay, light when their associated relay is activated. To avoid overloading your PC's power supply , this board needs a +12VDC or +24VDC external power supply.



Note:

50-Pin connector(OPTO-22 compatible), for DIO-24, DIO-48, DIO-144,  
PIO-D144, PIO-D96, PIO-D56, PIO-D48, PIO-D24

Channel : 16 Form A Relay , 8 Form C Relay

Relay : switching up to 5A at 110ACV / 5A at 30DCV

---

## 2.5.8 Daughter Boards Comparison Table

	20-pin flat-cable	50-pin flat-cable	D-sub 37-pin
DB-37	No	No	Yes
DN-37	No	No	Yes
ADP-37/PCI	No	Yes	Yes
ADP-50/PCI	No	Yes	No
DB-24P	No	Yes	No
DB-24PD	No	Yes	Yes
DB-16P8R	No	Yes	Yes
DB-24R	No	Yes	No
DB-24RD	No	Yes	Yes
DB-24C	Yes	Yes	Yes
DB-24PR	Yes	Yes	No
Db-24PRD	No	Yes	Yes
DB-24POR	Yes	Yes	Yes
DB-24SSR	No	Yes	Yes

Note : There is no 50-pin flat cable header in PIO-D56/PIO-D24. The PIO-D56/PIO-D24 has one DB-37 connector and two 20 pin flat-cable headers(only for PIO-D56).

---

## 2.6 Pin Assignment

CON3: 37 pin of D-type female connector.

Pin Number	Description	Pin Number	Description
1	N. C.	20	VCC
2	N. C.	21	GND
3	P1B7	22	P2C7
4	P1B6	23	P2C6
5	P1B5	24	P2C5
6	P1B4	25	P2C4
7	P1B3	26	P2C3
8	P1B2	27	P2C2
9	P1B1	28	P2C1
10	P1B0	29	P2C0
11	GND	30	P0A7
12	N.C.	31	P0A6
13	GND	32	P0A5
14	N.C.	33	P0A4
15	GND	34	P0A3
16	N.C.	35	P0A2
17	GND	36	P0A1
18	VCC	37	P0A0
19	GND	XXXXXXX	This pin not available

**All signals are TTL compatible.**



CON2 : 20-pin header (only for PIO-D56)

Pin Number	Description	Pin Number	Description
1	DI0	2	DI1
3	DI2	4	DI3
5	DI4	6	DI5
7	DI6	8	DI7
9	DI8	10	DI9
11	DI10	12	DI11
13	DI12	14	DI13
15	DI14	16	DI15
17	GND	18	GND
19	Vcc	20	+12V

CON1 : 20-pin header (only for PIO-D56)

Pin Number	Description	Pin Number	Description
1	DO0	2	DO1
3	DO2	4	DO3
5	DO4	6	DO5
7	DO6	8	DO7
9	DO8	10	DO9
11	DO10	12	DO11
13	DO12	14	DO13
15	DO14	16	DO15
17	GND	18	GND
19	Vcc	20	+12V

**All signals are TTL compatible.**

---

## 3. I/O Control Register

---

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

The plug&play BIOS will assign a proper I/O address to every PIO/PISO series card in the power-up stage. The fixed IDs of PIO/PISO series cards are given as follows:

- **Vendor ID = E159**
- **Device ID = 0002**

The sub IDs of **PIO-D56/PIO-D24** are given as follows :

- **Sub-vendor ID= 80**
- **Sub-device ID = 01**
- **Sub-aux ID = 40**

We provide all necessary functions as follows :

1. **PIO\_DriverInit(&wBoard, wSubVendor, wSubDevice, wSubAux)**
2. **PIO\_GetConfigAddressSpace(wBoardNo,\*wBase,\*wIrq, \*wSubVendor, \*wSubDevice, \*wSubAux, \*wSlotBus, \*wSlotDevice)**
3. **Show\_PIO\_PISO(wSubVendor, wSubDevice, wSubAux)**

All functions are defined in PIO.H. Refer to Chapter 4 for more information. The important driver information is given as follows :

#### 1. Resource-allocated information:

- wBase : BASE address mapping in this PC
- wIrq: IRQ channel number allocated in this PC

#### 2. PIO/PISO identification information:

- wSubVendor: subVendor ID of this board
- wSubDevice: subDevice ID of this board
- wSubAux: subAux ID of this board

#### 3. PC's physical slot information:

- wSlotBus: hardware slot ID1 in this PC's slot position
- wSlotDevice: hardware slot ID2 in this PC's slot position

The utility program, **PIO\_PISO.EXE**, will detect & show all PIO/PISO cards installed in this PC. Refer to Sec. 4.1 for more information.

---

## 3.1.1 PIO\_DriverInit

### PIO\_DriverInit(&wBoards, wSubVendor, wSubDevice, wSubAux)

- wBoards=0 to N → number of boards found in this PC
- wSubVendor → subVendor ID of board to find
- wSubDevice → subDevice ID of board to find
- wSubAux → subAux ID of board to find

This function can detect all PIO/PISO series card in the system. It is implemented based on the PCI plug & play mechanism-1. It will find all PIO/PISO series cards installed in this system & save all their resource in the library.

Sample program 1: find all PIO-D56/PIO-D24 in this PC

```
wSubVendor=0x80; wSubDevice=1; wSubAux=0x40; /* for PIO-D56/D24 */
wRetVal=PIO_DriverInit(&wBoards, wSubVendor, wSubDevice, wSubAux);
printf("Threr are %d PIO-D56/PIO-D24 Cards in this PC\n", wBoards);

/* step2: save resource of all PIO-D56/PIO-D24 cards installed in this PC */
for (i=0; i<wBoards; i++)
{
    PIO_GetConfigAddressSpace(i, &wBase, &wIrq, &wID1, &wID2, &wID3,
                              &wID4, &wID5);
    printf("\nCard_%d: wBase=%x, wIrq=%x", i, wBase, wIrq);
    wConfigSpace[i][0]=wBaseAddress; /* save all resource of this card */
    wConfigSpace[i][1]=wIrq; /* save all resource of this card */
}
```

Sample program 2: find all PIO/PISO in this PC(refer to Sec. 4.1 for more information)

```
wRetVal=PIO_DriverInit(&wBoards, 0xff, 0xff, 0xff); /*find all PIO_PISO*/
printf("\nThrer are %d PIO_PISO Cards in this PC", wBoards);
if (wBoards==0 ) exit(0);
printf("\n-----");
for(i=0; i<wBoards; i++)
{
    PIO_GetConfigAddressSpace(i, &wBase, &wIrq, &wSubVendor,
                              &wSubDevice, &wSubAux, &wSlotBus, &wSlotDevice);
    printf("\nCard_%d: wBase=%x, wIrq=%x, subID=[ %x, %x, %x ],
           SlotID=[ %x, %x ]", i, wBase, wIrq, wSubVendor, wSubDevice,
           wSubAux, wSlotBus, wSlotDevice);
    printf(" --> ");
    ShowPioPiso(wSubVendor, wSubDevice, wSubAux);
}
```

The sub IDs of PIO/PISO series card are given as follows:

PIO/PISO series card	Description	Sub_vendor	Sub_device	Sub_AUX
PIO-D144	144 * D/I/O	80	01	00
PIO-D96	96 * D/I/O	80	01	10
PIO-D64	64 * D/I/O	80	01	20
PIO-D56	24* D/I/O + 16*D/I + 16*D/O	80	01	40
PIO-D48	48*D/I/O	80	01	30
PIO-D24	24*D/I/O	80	01	40
PIO-823	Multi-function	80	03	00
PIO-821	Multi-function	80	03	10
PIO-DA16	16*D/A	80	04	00
PIO-DA8	8*D/A	80	04	00
PIO-DA4	4*D/A	80	04	00
PISO-C64	64 * isolated D/O	80	08	00
PISO-P64	64 * isolated D/I	80	08	10
PISO-P32C32	32 + 32	80	08	20
PISO-P8R8	8* isolated D/I + 8 * 220V relay	80	08	30
PISO-P8SSR8AC	8* isolated D/I + 8 * SSR /AC	80	08	30
PISO-P8SSR8DC	8* isolated D/I + 8 * SSR /DC	80	08	30
PISO-730	16*DI + 16*D/O + 16* isolated D/I + 16* isolated D/O	80	08	40
PISO-813	32 * isolated A/D	80	0A	00
PISO-DA2	2 * isolated D/A	80	0B	00

Note : The sub-IDs will be added more and more without notice. The user can refer to PIO.H for the newest information.

---

## 3.1.2 PIO\_GetConfigAddressSpace

**PIO\_GetConfigAddressSpace(wBoardNo,\*wBase,\*wIrq, \*wSubVendor,  
\*wSubDevice,\*wSubAux,\*wSlotBus, \*wSlotDevice)**

- wBoardNo=0 to N → totally N+1 boards found by PIO\_DriveInit(...)
- wBase → base address of the board control word
- wIrq → allocated IRQ channel number of this board
- wSubVendor → subVendor ID of this board
- wSubDevice → subDevice ID of this board
- wSubAux → subAux ID of this board
- wSlotBus → hardware slot ID1 of this board
- wSlotDevice → hardware slot ID2 of this board

The user can use this function to save resource of all PIO/PISO cards installed in this system. Then the application program can control all functions of PIO/PISO series card directly.

The sample program source is given as follows :

```
/* step1: detect all PIO-D56/PIO-D24 cards first */
wSubVendor=0x80; wSubDevice=1; wSubAux=0x40; /* for PIO-D56/D24 */
wRetVal=PIO_DriverInit(&wBoards, wSubVendor,wSubDevice,wSubAux);
printf("Threr are %d PIO-D56/PIO-D24 Cards in this PC\n",wBoards);

/* step2: save resource of all PIO-D56/PIO-D24 cards installed in this PC */
for (i=0; i<wBoards; i++)
{
    PIO_GetConfigAddressSpace(i,&wBase,&wIrq,&t1,&t2,&t3,&t4,&t5);
    printf("\nCard_ %d: wBase=%x, wIrq=%x", i,wBase,wIrq);
    wConfigSpace[i][0]=wBaseAddress; /* save all resource of this card */
    wConfigSpace[i][1]=wIrq; /* save all resource of this card */
}

/* step3: control the PIO-D56/PIO-D24 directly */
wBase=wConfigSpace[0][0];/* get base address the card_0 */
output(wBase,1); /* enable all D/I/O operation of card_0 */

wBase=wConfigSpace[1][0];/* get base address the card_1 */
output(wBase,1); /* enable all D/I/O operation of card_1 */
```

---

### 3.1.3 Show\_PIO\_PISO

#### Show\_PIO\_PISO(wSubVendor,wSubDevice,wSubAux)

- wSubVendor → subVendor ID of board to find
- wSubDevice → subDevice ID of board to find
- wSubAux → subAux ID of board to find

This function will show a text string for this special subIDs. This text string is the same as that defined in PIO.H

The demo program is given as follows :

```
wRetVal=PIO_DriverInit(&wBoards,0xff,0xff,0xff); /*find all PIO_PISO*/
printf("\nThrer are %d PIO_PISO Cards in this PC",wBoards);
if (wBoards==0 ) exit(0);

printf("\n-----");
for(i=0; i<wBoards; i++)
{
    PIO_GetConfigAddressSpace(i,&wBase,&wIrq,&wSubVendor,
        &wSubDevice,&wSubAux,&wSlotBus,&wSlotDevice);

    printf("\nCard_%d:wBase=%x,wIrq=%x,subID=[%x,%x,%x],
        SlotID=[%x,%x]",i,wBase,wIrq,wSubVendor,wSubDevice,
        wSubAux,wSlotBus,wSlotDevice);
    printf(" --> ");
    ShowPioPiso(wSubVendor,wSubDevice,wSubAux);
}
```

---

## 3.2 The Assignment of I/O Address

The plug & play BIOS will assign the proper I/O address to PIO/PISO series card. If there is only one PIO/PISO board, the user can identify the board as card\_0. If there are two PIO/PISO boards in the system, the user will be very difficult to identify which board is card\_0 ? The software driver can support 16 boards max. Therefore the user can install 16 boards of PIO/PSIO series in one PC system. How to find the card\_0 & card\_1 ?

**It is difficult to find the card NO. The simplest way to identify which card is card\_0 is to use wSlotBus & wSlotDevice as follows :**

1. Remove all PIO-D56/PIO-D24 from this PC
2. Install one PIO-D56/PIO-D24 into the PC's PCI\_slot1, run PIO\_PISO.EXE & record the wSlotBus1 & wSlotDevice1
3. Remove all PIO-D56/PIO-D24 from this PC
4. Install one PIO-D56/D24 into the PC's PCI\_slot2, run PIO\_PISO.EXE & record the wSlotBus2 & wSlotDevice2
5. repeat (3) & (4) for all PCI\_slot?, record all wSlotBus? & wSlotDevice?

The records may be as follows:

PC's PCI slot	wSlotBus	wSlotDevice
Slot_1	0	0x07
Slot_2	0	0x08
Slot_3	0	0x09
Slot_4	0	0x0A
PCI-BRIDGE		
Slot_5	1	0x0A
Slot_6	1	0x08
Slot_7	1	0x09
Slot_8	1	0x07

The above procedure will record all wSlotBus? & wSlotDevice? in this PC. These values will be mapped to this PC's physical slot. This mapping will not be changed for any PIO/PISO cards. So it can be used to identify the specified PIO/PISO card as follows:

**Step 1: Record all wSlotBus? & wSlotDevice?**

**Step2: Use PIO\_GetConfigAddressSpace(...) to get the specified card's wSlotBus & wSlotDevice**

**Step3: The user can identify the specified PIO/PISO card if he compare the wSlotBus & wSlotDevice in step2 to step1.**

---

## 3.3 The I/O Address Map

The I/O address of PIO/PISO series card is automatically assigned by the main board ROM BIOS. The I/O address can also be re-assigned by user. **It is strongly recommended not to change the I/O address by user. The plug & play BIOS will assign proper I/O address to each PIO/PISO series card very well.** The I/O address of PIO-D56/PIO-D24 are given as follows:

Address	Read	Write
Wbase+0	RESET\ control register	Same
Wbase+2	Aux control register	Same
Wbase+3	Aux data register	Same
Wbase+5	INT mask control register	Same
Wbase+7	Aux pin status register	Same
Wbase+0x2a	INT polarity control register	Same
Wbase+0xc0	read Port0	write Port0
Wbase+0xc4	read Port1	write Port1
Wbase+0xc8	read Port2	write Port2
Wbase+0xcc	read configuration	Port0~Port2 configuration
Wbase+0xd0	read CON2 Low byte (only for PIO-D56)	write CON1 Low byte (only for PIO-D56)
Wbase+0xd4	read CON2 high byte (only for PIO-D56)	write CON1 high byte (only for PIO-D56)

**Note.** Refer to Sec. 3.1 for more information about wBase.



---

### 3.3.1 RESET\ Control Register

(Read/Write): wBase+0

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	RESET\

**Note. Refer to Sec. 3.1 for more information about wBase.**

When the PC is first power-on, the RESET\ signal is in Low-state. **This will disable all D/I/O operations.** The user has to set the RESET\ signal to High-state before any D/I/O command.

```
outportb(wBase,1);    /* RESET\=High → all D/I/O are enable now */
outportb(wBase,0);    /* RESET\=Low → all D/I/O are disable now */
```

---

### 3.3.2 AUX Control Register

(Read/Write): wBase+2

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Aux7	Aux6	Aux5	Aux4	Aux3	Aux2	Aux1	Aux0

**Note. Refer to Sec. 3.1 for more information about wBase.**

Aux?=0 → this Aux is used as a D/I

Aux?=1 → this Aux is used as a D/O

When the PC is first power-up, All Aux? signal are in Low-state. All Aux? are designed as D/I for all PIO/PISO series. Please set all Aux? in D/I state.

---

### 3.3.3 AUX data Register

(Read/Write): wBase+3

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Aux7	Aux6	Aux5	Aux4	Aux3	Aux2	Aux1	Aux0

**Note. Refer to Sec. 3.1 for more information about wBase.**

When the Aux? is used as D/O, the output state is controlled by this register. This register is designed for feature extension, so don't control this register now.

---

## 3.3.4 INT Mask Control Register

(Read/Write): wBase+5

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	EN3	EN2	EN1	EN0

**Note. Refer to Sec. 3.1 for more information about wBase.**

EN0=0 → disable PC0 as a interrupt signal (default)

EN0=1 → enable PC0 as a interrupt signal

```
outportb(wBase+5,0);      /* disable interrupt          */
outportb(wBase+5,1);      /* enable interrupt PC0       */
outportb(wBase+5,0x0f);   /* enable interrupt PC0, PC1,PC2,PC3 */
```

---

## 3.3.5 Aux Status Register

(Read/Write): wBase+7

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Aux7	Aux6	Aux5	Aux4	Aux3	Aux2	Aux1	Aux0

**Note. Refer to Sec. 3.1 for more information about wBase.**

Aux0=PC0, Aux1=PC1, Aux2=PC2, Aux3=PC3, Aux7~4=Aux-ID. Refer to DEMO5.C for more information. The Aux 0~3 are used as interrupt source. The interrupt service routine has to read this register for interrupt source identification. Refer to Sec. 2.5 for more information.

---

## 3.3.6 Interrupt Polarity Control Register

(Read/Write): wBase+0x2A

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	INV3	INV2	INV1	INV0

**Note. Refer to Sec. 3.1 for more information about wBase.**

INV0=1 → select the non-inverted signal from PC0

INV0=0 → select the inverted signal from PC0

outportb(wBase+0x2a,0x0f); /\* select the non-inverted input PC0/1/2/3 \*/

outportb(wBase+0x2a,0x00); /\* select the inverted input of PC0/1/2/3 \*/

outportb(wBase+0x2a,0x0e); /\* select the inverted input of PC0 \*/

/\* select the non-inverted input PC1/2/3 \*/

outportb(wBase+0x2a,0x0c); /\* select the inverted input of PC0/1 \*/

/\* select the non-inverted input PC2/3 \*/

**Refer to Sec. 2.4 for more information.**

**Refer to DEMO5.C for more information.**

---

## 3.3.7 I/O Selection Control Register

(Write): wBase+0xcc

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	Port2	Port1	Port0

**Note. Refer to Sec. 3.1 for more information about wBase.**

Port? = 1 → this port is used as a D/O port

Port? = 0 → this port is used as a D/I port

outportb(wBase+0xcc,0x00); /\* configure Port0/1/2 as D/I port \*/

outportb(wBase+0xcc,0x04); /\* configure Port0/1 as D/I port \*/

/\* configure Port2 as D/O port \*/

### 3.3.8 Read/Write 8-bit data Register

(Read/Write):wBase+0xc0/0xc4/0xc8/0xd0/0xd4

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

**Note.** Refer to Sec. 3.1 for more information about wBase.

There are five/three 8-bit I/O ports in the PIO-D56/PIO-D24. Each port is easy to read/write by access his owns data register.

```

outputb(wBase+0xc0,Val);      /* write to D/O port          */
Val=inportb(wBase+0xc0);     /* read from D/I port        */

outputb(wBase+0xcc,0x07);    /* configure Port0~Port2 as DO port */
outputb(wBase+0xc0,i1);     /* write to Port0            */
outputb(wBase+0xc0,i2);     /* write to Port1            */
outputb(wBase+0xc0,i3);     /* write to Port2            */

outputb(wBase+0xcc,0x01);    /* configure Port0 as DO port */
                             /* Port1~Port2 as DI port    */
outputb(wBase+0xc0,i1);     /* write to Port0            */
j2=inportb(wBase+0xc4);     /* read Port1                */
j3=inportb(wBase+0xc8);     /* read Port2                */

l=inportb(wBase+0xd0);      /* read CON2 Low byte        */
h=inportb(wBase+0xd4);      /* read CON2 High byte       */
Val=(h<<8)+l;              /* Val is 16 bit data        */

outputb(wBase+0xd0,Val);    /* write to CON1 Low byte    */
outputb(wBase+0xd4,(Val>>8)); /* write to CON1 high byte   */

```

---

## 4. Demo program

It is recommended to read the release note first. All important information will be given in release note as follows :

1. where you can find the software driver & utility
- 2. how to install software & utility**
3. where is the diagnostic program
4. FAQ

There are many demo programs given in the company floppy disk or CD.  
After the software installation, the driver will be installed into disk as follows :

- \TC\\*. \* → for Turbo C 2.xx or above
- \MSC\\*. \* → for MSC 5.xx or above
- \BC\\*. \* → for BC 3.xx or above
  
- \TC\LIB\\*. \* → for TC library
- \TC\DEMO\\*. \* → for TC demo program
  
- \TC\LIB\Large\\*. \* → TC large model library
- \TC\LIB\Huge\\*. \* → TC huge model library
- \TC\LIB\Large\PIO.H → TC declaration file
- \TC\LIB\Large\TCPIO\_L.LIB → TC large model library file
- \TC\LIB\Huge\PIO.H → TC declaration file
- \TC\LIB\Huge\TCPIO\_H.LIB → TC huge model library file
  
- \MSC\LIB\Large\PIO.H → MSC declaration file
- \MSC\LIB\Large\MSCPIO\_L.LIB → MSC large model library file
- \MSC\LIB\Huge\PIO.H → MSC declaration file
- \MSC\LIB\Huge\MSCPIO\_H.LIB → MSC huge model library file
  
- \BC\LIB\Large\PIO.H → BC declaration file
- \BC\LIB\Large\BCPIO\_L.LIB → BC large model library file
- \BC\LIB\Huge\PIO.H → BC declaration file
- \BC\LIB\Huge\BCPIO\_H.LIB → BC huge model library file

NOTE: The library is validate for all PIO/PISO series cards.

---

## 4.1 PIO\_PISO

```
/* ----- */
/* Find all PIO_PISO series cards in this PC system */
/* step 1 : plug all PIO_PISO cards into PC */
/* step 2 : run PIO_PISO.EXE */
/* ----- */

#include "PIO.H"

WORD wBase,wIrq;
WORD wBase2,wIrq2;

int main()
{
int i,j,j1,j2,j3,j4,k,jj,dd,j11,j22,j33,j44;
WORD wBoards,wRetVal;
WORD wSubVendor,wSubDevice,wSubAux,wSlotBus,wSlotDevice;
char c;
float ok,err;

clrscr();
wRetVal=PIO_DriverInit(&wBoards,0xff,0xff,0xff); /*for PIO-PISO*/
printf("\nThrer are %d PIO_PISO Cards in this PC",wBoards);
if (wBoards==0 ) exit(0);

printf("\n-----");
for(i=0; i<wBoards; i++)
{
PIO_GetConfigAddressSpace(i,&wBase,&wIrq,&wSubVendor,
&wSubDevice,&wSubAux,&wSlotBus,&wSlotDevice);

printf("\nCard_%d:wBase=%x,wIrq=%x,subID=[%x,%x,%x],
SlotID=[%x,%x]",i,wBase,wIrq,wSubVendor,wSubDevice,
wSubAux,wSlotBus,wSlotDevice);
printf(" --> ");
ShowPioPiso(wSubVendor,wSubDevice,wSubAux);
}

PIO_DriverClose();
}
```

**NOTE: the PIO\_PISO.EXE is valid for all PIO/PISO cards.** The user can execute the PIO\_PISO.EXE to get the following information:

- List all PIO/PISO cards installed in this PC
- List all resources allocated to every PIO/PISO cards
- List the wSlotBus & wSlotDevice for specified PIO/PISO card identification.  
(refer to Sec. 3.2 for more information)

---

## 4.1.1 PIO\_PISO.EXE for Windows

User can find this utility in the company CD or floppy disk. It is useful for all PIO/PISO series card.

After executing the utility, every detail information for all PIO/PISO cards that installed in the PC will be show as follows :



---

## 4.2 DEMO1

```
/* demo 1 : D/O demo of CON3 */
/* step 1 : connect a DB-24C to CON3 of PIO-D56/PIO-D24 */
/* step 2 : run DEMO1.EXE */
/* step 3 : check the LEDs of DB-24C will turn on sequentially */
/* ----- */
#include "PIO.H"

WORD wBase,wIrq;

int main()
{
int i1,i2,i3;
long i;
WORD wBoards,wRetVal,t1,t2,t3,t4,t5,t6;
WORD wSubVendor,wSubDevice,wSubAux,wSlotBus,wSlotDevice;
char c;

clrscr();

/* step1 : find address-mapping of PIO/PISO cards */
wRetVal=PIO_DriverInit(&wBoards,0x80,0x01,0x40);/* for PIO-D56/D24*/
printf("\n(1) Threr are %d PIO-D56/D24 Cards in this PC",wBoards);
if ( wBoards==0 ) exit(0);
printf("\n\n----- The Configuration Space -----");
for(i=0;i<wBoards;i++)
{
PIO_GetConfigAddressSpace(i,&wBase,&wIrq,&wSubVendor,
&wSubDevice,&wSubAux,&wSlotBus,&wSlotDevice);
printf("\nCard_%d:wBase=%x,wIrq=%x,subID=[%x,%x,%x],SlotID=
[%x,%x]",i,wBase,wIrq,wSubVendor,wSubDevice,
wSubAux,wSlotBus,wSlotDevice);
printf(" --> ");
ShowPioPiso(wSubVendor,wSubDevice,wSubAux);
}
PIO_GetConfigAddressSpace(0,&wBase,&wIrq,&t1,&t2,&t3,&t4,&t5);
/* select card_0 */
/* step2 : enable all D/I/O port */
outportb(wBase,1); /* /RESET -> 1 */
/* step3 : configure I/O direction */
outportb(wBase+0xcc,0x07); /* set CON3 as D/O ports */

i=1;
for (;;)
{
i1=i&0xff;
i2=(i>>8)&0xff;
i3=(i>>16)&0xff;
outportb(wBase+0xc0,i1);
outportb(wBase+0xc4,i2);
outportb(wBase+0xc8,i3);
delay(10000);
i=i<<1;
i=i&0xffffffff;
if (i==0) i=1;
if (kbhit()!=0) break;
}
PIO_DriverClose();
}
```



---

## 4.3 DEMO2

```
/* demo 2 : DI/O demo of CON1, CON2 & CON3 */
/* step 1 : connect DB-24P to CON3 of PIO-D56/PIO-D24 */
/*          : connect CON1 to CON2 of PIO-D56 */
/* step 2 : run DEMO2.EXE */
/* step 3 : check the information on screen D/I will same as D/O */
/*          : check the result on screen will same as CON3 input */
/* ----- */

#include "PIO.H"

WORD wBase,wIrq;

int main()
{
int i1,i2,i3,j1,j2,j3;
WORD wBoards,wRetVal,t1,t2,t3,t4,t5,t6;
WORD wSubVendor,wSubDevice,wSubAux,wSlotBus,wSlotDevice;
char c;
long i;

clrscr();

/* step1 : find address-mapping of PIO/PISO cards */
.
.
/* step2 : enable all D/I/O port */
outportb(wBase,1); /* /RESET -> 1 */

/* step3 : configure I/O direction */
outportb(wBase+0xcc,0x00); /* set CON3 as D/I ports */
i=1;

for (;;)
{
gotoxy(1,7);
i1=i&0xff;
i2=(i>>8)&0xff;
outportb(wBase+0xd0,i1);
outportb(wBase+0xd4,i2);
j1=inportb(wBase+0xd0);
j2=inportb(wBase+0xd4);
printf("\nDO = [%2x,%2x], DI = [%2x,%2x]",i2,i1,j2,j1);
if ((j1!=i1)|| (j2!=i2))
{
printf("\n\nError .....");
}
else printf("\nO.K. ....");
j1=inportb(wBase+0xc0);
j2=inportb(wBase+0xc4);
j3=inportb(wBase+0xc8);
printf("\n\nD/I of CON3 [PA, PB, PC] = [%2x,%2x,%2x] ",j1,j2,j3);
i=i<<1;
i=i&0xffff;
if (i==0) i=1;
if (kbhit()!=0) return;
}
PIO_DriverClose();
}
```

---

---

## 4.4 DEMO3

```
/* demo 3 : Count high pulse of PC0                                     */
/*          (initial Low & active High)                               */
/* step 1 : run DEMO3.EXE                                             */
/* -----                                                            */

#include "PIO.H"

#define A1_8259 0x20
#define A2_8259 0xA0
#define EOI     0x20

WORD init_low();
WORD wBase,wIrq;

static void interrupt irq_service();
int COUNT,irqmask,now_int_state;

int main()
{
int i,j;
WORD wBoards,wRetVal,t1,t2,t3,t4,t5,t6;
WORD wSubVendor,wSubDevice,wSubAux,wSlotBus,wSlotDevice;
char c;

clrscr();

/* step1 : find address-mapping of PIO/PISO cards                      */
:
:
/* select card_0 */
/* step2 : enable all D/I/O port                                       */
outputb(wBase,1); /* /RESET -> 1 */

/* step3 : configure I/O direction                                     */
outputb(wBase+0xcc,0x00); /* set CON3 as D/I ports */

COUNT=0;
init_low();
printf("\n\n***** show the count of High_pulse *****\n");

for (;;)
{
gotoxy(1,8);
printf("\nCOUNT=%d",COUNT);
if (kbhit()!=0) break;
}
outputb(wBase+5,0); /* disable all interrupt */

PIO_DriverClose();
}

/* Use PC0 as external interrupt signal                                 */
WORD init_low()
{
disable();
outputb(wBase+5,0); /* disable all interrupt */
if (wIrq<8)
{
irqmask=inportb(A1_8259+1);
outputb(A1_8259+1,irqmask & 0xff ^ (1<<wIrq));
setvect(wIrq+8,irq_service);
}
```

```

    }
else
    {
    irqmask=inportb(A1_8259+1);
    outportb(A1_8259+1,irqmask & 0xfb);          /* IRQ2 */
    irqmask=inportb(A2_8259+1);
    outportb(A2_8259+1,irqmask & 0xff ^ (1<<(wIrq-8)));
    setvect(wIrq-8+0x70,irq_service);
    }

outportb(wBase+5,1);          /* enable interrupt (PC0) */
now_int_state=0;             /* now ini_signal is low */
outportb(wBase+0x2a,1);      /* select the non-inverte */
enable();
}

void interrupt irq_service()
{
if (now_int_state==1)        /* now PC0 change to low */
    {
    /* INT_CHAN_0 = !PC0 */
    if ((inportb(wBase+7)&1)==0) /* PC0 still fixed in low */
        {
        /* need to generate a high pulse */
        outportb(wBase+0x2a,1); /* INVO select noninverted input */
        now_int_state=0;        /* now PC0=low */
        }
    else now_int_state=1;      /* now PC0=High */
    }
else                          /* now PC0 change to high */
    {
    /* INT_CHAN_0 = PC0 */
    COUNT++;
    if ((inportb(wBase+7)&1)==1) /* PC0 still fixed in high */
        {
        /* need to generate a high pulse */
        outportb(wBase+0x2a,0); /* INVO select inverted input */
        now_int_state=1;        /* now PC0=high */
        }
    else now_int_state=0;      /* now PC0=low */
    }
}

if (wIrq>=8) outportb(A2_8259,0x20);
outportb(A1_8259,0x20);
}

```

---

## 4.5 DEMO4

```
/* demo 4 : Count high pulse of PC0                                     */
/*           (initial High & active Low)                             */
/* step 1 : run DEMO4.EXE                                           */
/* ----- */

#include "PIO.H"

#define A1_8259 0x20
#define A2_8259 0xA0
#define EOI     0x20

WORD init_high();
WORD wBase,wIrq;

static void interrupt irq_service();
int COUNT,irqmask,now_int_state;

int main()
{
int i,j;
WORD wBoards,wRetVal,t1,t2,t3,t4,t5,t6;
WORD wSubVendor,wSubDevice,wSubAux,wSlotBus,wSlotDevice;
char c;

clrscr();

/* step1 : find address-mapping of PIO/PISO cards                    */
:
:
/* select card_0 */
/* step2 : enable all D/I/O port                                     */
outputb(wBase,1);
/* /RESET -> 1 */

/* step3 : configure I/O direction                                  */
outputb(wBase+0xcc,0x00);
/* set CON3 as D/I ports */

COUNT=0;
init_high();
printf("\n\n***** show the count of Low_pulse *****\n");

for (;;)
{
gotoxy(1,7);
printf("\nCOUNT=%d",COUNT);
if (kbhit()!=0) break;
}
outputb(wBase+5,0);
/* disable all interrupt */

PIO_DriverClose();
}

/* Use PC0 as external interrupt signal                             */
WORD init_high()
{
disable();
outputb(wBase+5,0);
/* disable all interrupt */
if (wIrq<8)
{
irqmask=inportb(A1_8259+1);
outputb(A1_8259+1,irqmask & 0xff ^ (1<<wIrq));
setvect(wIrq+8,irq_service);
}
```

```

    }
else
    {
        irqmask=inportb(A1_8259+1);
        outportb(A1_8259+1,irqmask & 0xfb);          /* IRQ2 */
        irqmask=inportb(A2_8259+1);
        outportb(A2_8259+1,irqmask & 0xff ^ (1<<(wIrq-8)));
        setvect(wIrq-8+0x70,irq_service);
    }

outportb(wBase+5,1);          /* enable interrupt (PC0) */
now_int_state=1;             /* now ini_signal is high */
outportb(wBase+0x2a,0);      /* select the inverte */
enable();
}

void interrupt irq_service()
{
if (now_int_state==1)        /* now PC0 change to low */
    {                        /* INT_CHAN_0 = !PC0 */
        COUNT++;
        if ((inportb(wBase+7)&1)==0) /* PC0 still fixed in low */
            {                /* need to generate a high pulse */
                outportb(wBase+0x2a,1); /* INVO select noninverted input */
                now_int_state=0;        /* now PC0=low */
            }
        else now_int_state=1;         /* now PC0=High */
    }
else                          /* now PC0 change to high */
    {                          /* INT_CHAN_0 = PC0 */
        if ((inportb(wBase+7)&1)==1) /* PC0 still fixed in high */
            {                    /* need to generate a high pulse */
                outportb(wBase+0x2a,0); /* INVO select inverted input */
                now_int_state=1;        /* now PC0=high */
            }
        else now_int_state=0;        /* now PC0=low */
    }
if (wIrq>=8) outportb(A2_8259,0x20);
outportb(A1_8259,0x20);
}

```

---

## 4.6 DEMO5

```
/* demo 5 : Four interrupt source */
/*      PC0 : initial Low , active High */
/*      PC1 : initial High , active Low */
/*      PC2 : initial Low , active High */
/*      PC3 : initial High , active Low */
/* step 1 : run DEMO5.EXE */
/* ----- */

#include "PIO.H"

#define A1_8259 0x20
#define A2_8259 0xA0
#define EOI     0x20

WORD init();
WORD wBase,wIrq;

static void interrupt irq_service();
int irqmask,now_int_state,new_int_state,invert,int_c,int_num;
int CNT_L1,CNT_L2,CNT_L3,CNT_L4;
int CNT_H1,CNT_H2,CNT_H3,CNT_H4;

int main()
{
int i,j;
WORD wBoards,wRetVal,t1,t2,t3,t4,t5,t6;
WORD wSubVendor,wSubDevice,wSubAux,wSlotBus,wSlotDevice;
char c;

clrscr();

/* step1 : find address-mapping of PIO/PISO cards */
:
/* select card_0 */
/* step2 : enable all D/I/O port */
outportb(wBase,1); /* /RESET -> 1 */

/* step3 : configure I/O direction */
outportb(wBase+0xcc,0x00); /* set CON3 as D/I ports */

init();
printf("\n***** show the count of pulse *****\n");

for (;;)
{
gotoxy(1,7);
printf("\n(CNT_L,CNT_H)=(%d,%d) (%d,%d) (%d,%d) (%d,%d)
%x",CNT_L1,CNT_H1,CNT_L2,CNT_H2,CNT_L3,CNT_H3,CNT_L4,CNT_H4,int_num);
if (kbhit()!=0) break;
}

outportb(wBase+5,0); /* disable all interrupt */
PIO_DriverClose();
}

/* Use PC0, PC1, PC2 & PC3 as external interrupt signal */
WORD init()
{
disable();
outportb(wBase+5,0); /* disable all interrupt */
```

```

if (wIrq<8)
{
    irqmask=inportb(A1_8259+1);
    outportb(A1_8259+1,irqmask & 0xff ^ (1<<wIrq));
    setvect(wIrq+8,irq_service);
}
else
{
    irqmask=inportb(A1_8259+1);
    outportb(A1_8259+1,irqmask & 0xfb);          /* IRQ2 */
    irqmask=inportb(A2_8259+1);
    outportb(A2_8259+1,irqmask & 0xff ^ (1<<(wIrq-8)));
    setvect(wIrq-8+0x70,irq_service);
}

invert=0x05;
outportb(wBase+0x2a,invert);          /* PC0 = non-inverte input */
                                        /* PC1 =   inverte input */
                                        /* PC2 = non-inverte input */
                                        /* PC3 =   inverte input */

now_int_state=0x0a;                   /* PC0 = Low */
                                        /* PC1 = High */
                                        /* PC2 = Low */
                                        /* PC3 = High */

CNT_L1=CNT_L2=CNT_L3=CNT_L4=0;        /* Low_pulse counter */
CNT_H1=CNT_H2=CNT_H3=CNT_H4=0;        /* High_pulse counter */
int_num=0;
outportb(wBase+5,0x0f);                /* enable interrupt PC0,PC1 */
enable();                               /* PC2,PC3 */
}
/* ----- */
/* NOTE:1.The hold-time of INT_CHAN_0/1/2/3 must long enough */
/*      2.The ISR must read the interrupt status again to the */
/*      active interrupt sources. */
/*      3.The INT_CHAN_0&INT_CHAN_1 can be active at the same time*/
/* ----- */
void interrupt irq_service()
{
    char c;

    int_num++;
    new_int_state=inportb(wBase+7)&0x0f; /* read all interrupt state */
    int_c=new_int_state^now_int_state;    /* compare which interrupt */
                                        /* signal be change */
    if ((int_c&0x1)!=0)                   /* INT_CHAN_0 is active */
    {
        if ((new_int_state&0x1)!=0)/* now PC0 is change to high */
        {
            CNT_H1++;
        }
        else /* now PC0 is change to low */
        {
            CNT_L1++;
        }
        invert=invert^1; /* to generate a high pulse */
    }
    if ((int_c&0x2)!=0) /* INT_CHAN_1 is active */
    {
        if ((new_int_state&0x2)!=0)/* now PC1 is change to high */
        {
            CNT_H2++;
        }
    }
}

```

```

else /* now PC1 is change to low */
{
CNT_L2++;
}
invert=invert^2; /* to generate a high pulse */
if ((int_c&0x4)!=0) /* INT_CHAN_2 is active */
{
if ((new_int_state&0x4)!=0)/* now PC2 is change to high */
{
CNT_H3++;
}
else /* now PC2 is change to low */
{
CNT_L3++;
}
invert=invert^4; /* to generate a high pulse */
}
if ((int_c&0x8)!=0) /* INT_CHAN_3 is active */
{
if ((new_int_state&0x8)!=0)/* now PC3 is change to high */
{
CNT_H4++;
}
else /* now PC3 is change to low */
{
CNT_L4++;
}
invert=invert^8; /* to generate a high pulse */
}
now_int_state=new_int_state;
outportb(wBase+0x2a,invert);

if (wIrq>=8) outportb(A2_8259,0x20);
outportb(A1_8259,0x20);
}

```