PEX/PIO/PISO-DA

Series Card User Manual

Analog Output Boards

Version 3.1, Oct. 2013

SUPPORTS

Board includes PIO-DA4, PIO-DA8, PIO-DA16, PIO-DA4U, PIO-DA8U, PIO-DA16U, PISO-DA4U, PISO-DA8U, PISO-DA16U, PEX-DA4, PEX-DA8 and PEX-DA16.

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.

WARNING

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CONTACT US

If you have any question, please feel to contact us. We will give you quick response within 2 workdays.

Email: service@icpdas.com, service.icpdas@gmail.com

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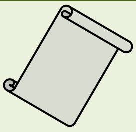
Packing List

The shipping package includes the following items:

	One multi-function card as follows: PEX-DA series: PEX-DA4/ PEX-DA8/ PEX-DA16 PIO-DAxU series: PIO-DA4U/ PIO-DA8U/ PIO-DA16U PISO-DAxU series: PISO-DA4U/ PISO-DA8U/ PISO-DA16U
	One printed Quick Start Guide
	One software utility CD
	One CA-4002 D-Sub Connect

★ Note!!
If any 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.

Related Information

Product Page:
http://www.icpdas.com/root/product/solutions/pc_based_io_board/pci/pio-da4.html

Documentation and Software for PIO-DA series classic:
CD:\NAPDOS\PCI\PIO-DA\
http://ftp.icpdas.com/pub/cd/iocard/pci/napdos/pci/pio-da/

Documentation and Software for UniDAQ SDK:
CD:\NAPDOS\PCI\UniDAQ\
http://ftp.icpdas.com/pub/cd/iocard/pci/napdos/pci/unidaq/

1. Introduction

The PEX-DA, PISO-DAxU and PIO-DAxU series cards (PCI Express/Universal PCI versions) are compatible with the PIO-DAx cards (PCI versions) and most users can replace the PIO-DAx by PEX-DA, PISO-DAxU or PIO-DAxU directly without software/driver modification. Please refer to user manual (ch 1.1) for the compatibility information.

The PISO-DA series adds high-voltage isolation design that offers a durable ability to keep users' computers safe from unexpected surge. It is the built-in high-quality isolation components that make PISO-DA series featuring 2500 V_{DC} bus-typed isolation! For the PEX-DA, PIO-DA and the PISO-DA series, their voltage output range is from -10 V to +10 V, and their current output range is from 0 to 20 mA. In addition, These cards also feature the following advantages by ICP DAS's innovation:

1. **Accurate and easy-to-use calibration.**
   ICP DAS provides the software calibration instead of the manual calibration so that no jumpers and trim-pots are required anymore. The calibration information can be saved in EEPROM for long-term use.
2. **Individual channel configuration.**
   In other words, every channel can be individually configured as voltage output or current output!
3. **Card ID.**
   ICP DAS provides the card ID function for PEX-DA, PISO-DAxU and PIO-DAxU (version 1.1 or above) series. Users can set card ID for each card and then recognize them one by one when more than two boards are used in a computer.

Note: This card needs a ±12 V power supply, which can be found in either a regular PC or an Industrial PC.

1.1 Features

- Supports +5 V PCI bus for PIO-DA4/DA8/DA16
- 16/8/4 channels, 14-bit analog output
- Voltage output range: ±10 V
- Current output range: 0 ~ 20 mA (sink)
- Two pacer timer interrupt source
- Double-buffered D/A latch
- Software calibration
- 16-channel DI, 16-channel DO
- One D-Sub connector, two 20-pin flat cable connectors
- Connects directly to DB-16P, DB-16R, DB-24C, DB-24PR and DB-24POR

[PISO-DA16U/DA8U/DA4U only]

- Built-in DC/DC converter with 3000 V_{DC} isolation
- Supports both +5 V and +3.3 V PCI bus
- 2500 V_{DC} bus-type and power isolation protection
- Digital input port can be set to pull-high or pull-low
- Card ID function.

[PIO-DA16U/DA8U/DA4U, PEX-DA16/DA8/DA4 only]

- Supports both +5 V and +3.3 V PCI bus for PIO-DA16U/DA8U/DA4U
- Supports PCI Express x 1 for PEX-DA16/DA8/DA4
- Digital input port can be set to pull-high or pull-low
- Card ID function

1.2 Comparison Table

Comparison Table of the Different Version Information:

	Version	D/I Register	Pin Assignment	Card ID
PIO-DA4 **PIO-DA8** **PIO-DA16**	-	0xE0/E4/E8/EC 0xF0/F4/F8/FC	A. GND (CN3.5/10/15/24/29)	**N/A**
PIO-DA4U **PIO-DA8U** **PIO-DA16U**	V1.0	0xE0/E4/E8/EC 0xF0/F4/F8/FC	A. GND (CN3.5/10/15/24/29)	**N/A**
PIO-DA4U **PIO-DA8U** **PIO-DA16U**	V1.1	0xE0/E4/E8/EC 0xF0/F4/F8/FC	A. GND (CN3.5/10/15/24/29)	**Yes**
PIO-DA4U **PIO-DA8U** **PIO-DA16U**	V1.2 or above	0xE0/E4	A. GND (CN3.5/10/15)	**Yes**
PISO-DA4U **PISO-DA8U** **PISO-DA16U**	V1.3 or above	0xE0/E4	A. GND (CN3.5/10/15/24/29)	**Yes**
PEX-DA4 **PEX-DA8** **PEX-DA16**	V1.0	0xE0/E4	A. GND (CN3.5/10/15)	**Yes**

1.3 Specifications

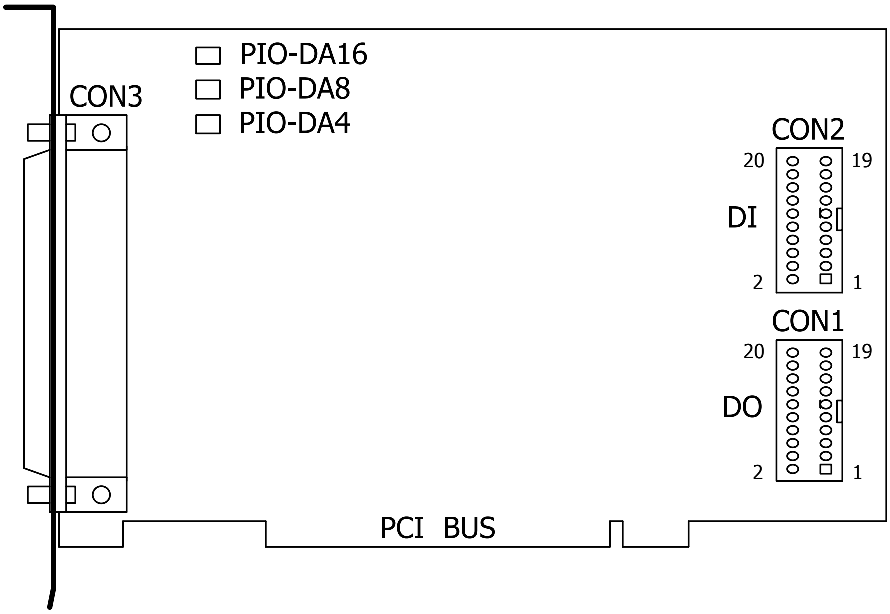
Model Name		PEX-DA4/DA8/DA16	PIO-DA4U/DA8U/DA16U	PISO-DA4U/DA8U/DA16U
Analog Output				
Isolation		N/A	N/A	2500 V (Bus Type)
Compatibility		4/8/16 independent		
Resolution		14-bit		
Accuracy		0.04% of FSR ± 2 LSB @ 25 °C, ± 10 V		
Output Rang		Voltage: +/- 10 V Current: 0 ~ 20 mA		
Output Driving		± 5 mA		
Slew Rate		0.71 V/μs		
Output Impedance		0.1 Ω max.		
Operating Mode		Software		
Digital Input				
Channels		16-ch		
Compatibility		5 V/TTL		
Input Voltage		Logic 0: 0.8 V max. Logic 1: 2.0 V min.		
Response Speed		200 KHz	1.0 MHz (Typical)	
Digital Output				
Channels		16-ch		
Compatibility		5 V/CMOS	5 V/TTL	
Output Voltage	Logic 0	0.1 V max.	0.4 V max.	
	Logic 1	4.4 V min.	2.4 V min.	
Output Capability	Sink	6 mA @ 0.33 V	2.4 mA @ 0.8 V	
	Source	6 mA @ 4.77 V	0.8 mA @ 2.0 V	
Response Speed		200 KHz	1.0 MHz (Typical)	
Timer/Counter				
Channels		3		
Resolution		16-bit		
Compatibility		5 V/TTL		
Reference Clock		Internal: 4 MHz		

Model Name	PEX-DA4/DA8/DA16	PIO-DA4U/DA8U/DA16U	PISO-DA4U/DA8U/DA16U
General			
Bus Type	PCI Express x1	3.3V/5V Universal PCI, 32-bit, 33MHz	
Data Bus	8-bit		
Card ID	Yes (4-bit)	Yes (4-bit) for Version 1.1 or above	Yes (4-bit)
I/O Connector	Female DB37 x 1, Male 20-bit ribbon x 2		
Dimensions (L x W)	188 mmx 97 mm	188 mmx 97 mm (Version 1.1 or above)	180 mmx 97 mm
Power Consumption	600 mA @ +5 V (PEX-DA4/PIO-DA4U) 800 mA @ +5 V (PEX-DA8/PIO-DA8U) 1400 mA @ +5 V (PEX-DA16/PIO-DA16U)		2200 mA @ +5 V (PISO-DA4U) 2400 mA @ +5 V(PISO-DA8U) 3000 mA @ +5 V(PISO-DA16U)
Operating Temperature	0 ~ 60 °C		
Storage Temperature	-20 ~ 70 °C		
Humidity	5 ~ 85% RH, non-condensing		

2. Hardware Configuration

2.1 Board Layout

- PIO-DAx Board Layout.



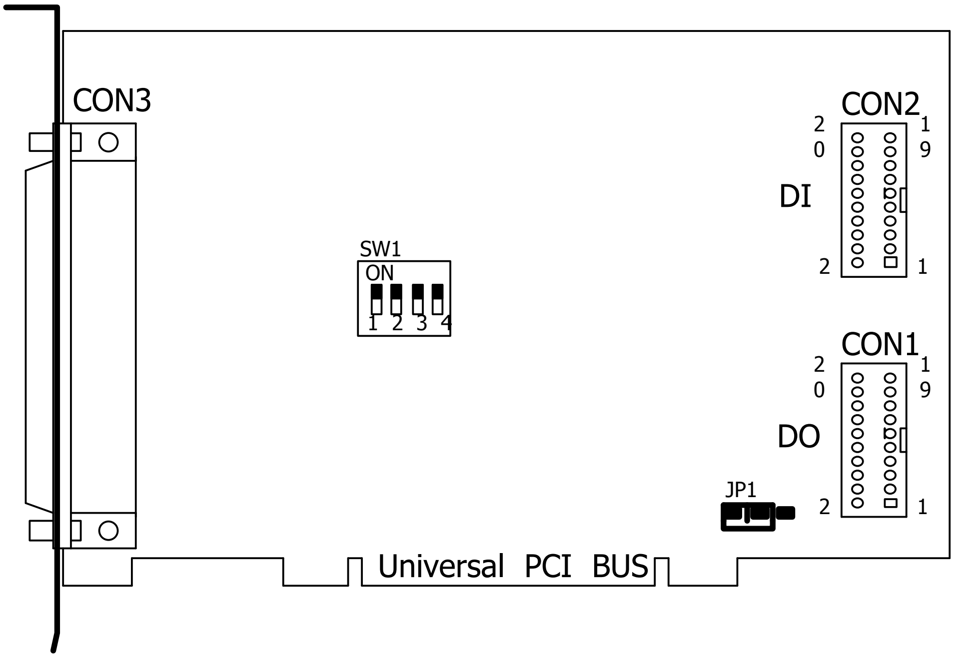
Note:

CON1: 16-channel D/O.

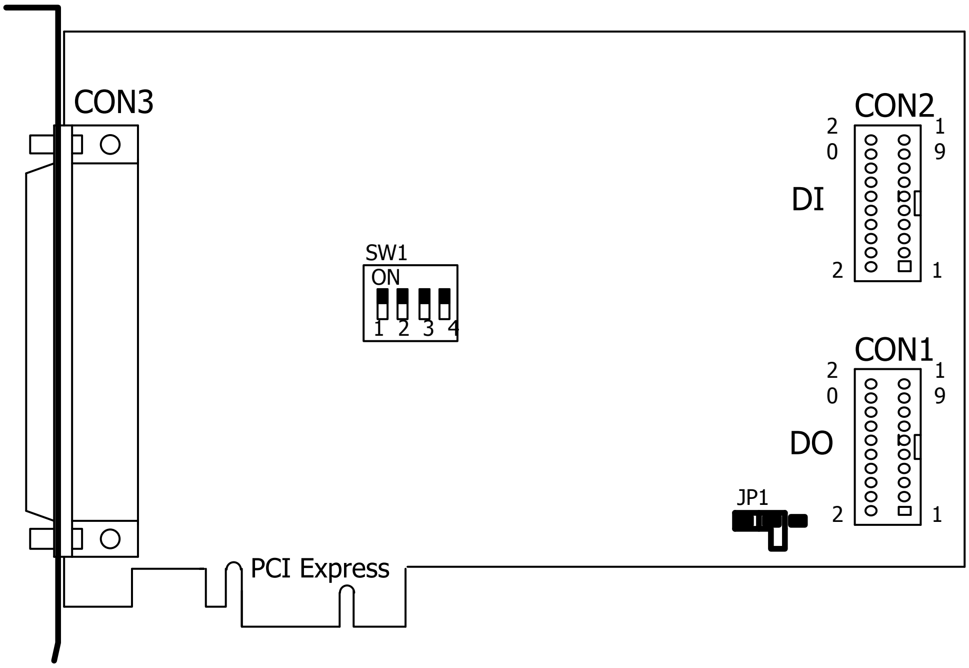
CON2: 16-channel D/I.

CON3: 4/8/16-channel D/A converter voltage/current output.

PIO-DAxU and PISO-DAxU Board Layout.



PEX-DA Board Layout.



Note:

CON1: 16-channel D/O.

CON2: 16-channel D/I.

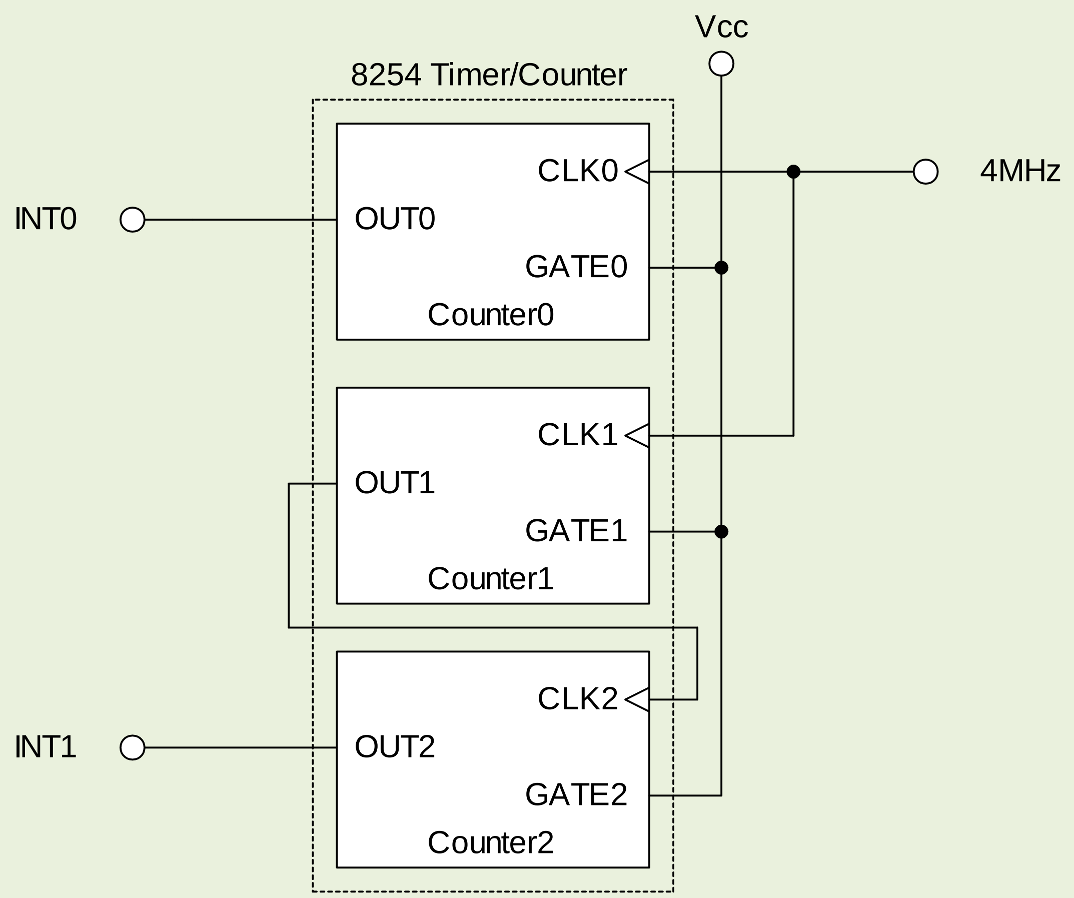
CON3: 4/8/16-channel D/A converter voltage/current output.

SW1: Card ID.

JP1: Pull-high/pull-low resisters for DI.

2.2 Counter Architecture

There is a single 8254(Timer/Counter) chip on the PEX/PIO/PISO-DA series board and provides two interrupt sources. The first is a 16-bit timer output (INT0) and the other one is a 32-bit timer output (INT1). The block diagram is shown below:



2.3 Interrupt Operation

There are two interrupt sources included in the PEX-DA and PIO/PISO-DAxU series. These two signals are named as INT0 and INT1, and their signal sources are as follows:

INT0: 8254 counter0 output (Refer to Sec. 2.2)
INT1: 8254 counter2 output (Refer to Sec. 2.2)

If only one interrupt signal source is used, the interrupt service routine doesn't have to identify the interrupt source. Refer to DEMO3.C and DEMO4.C for more information.

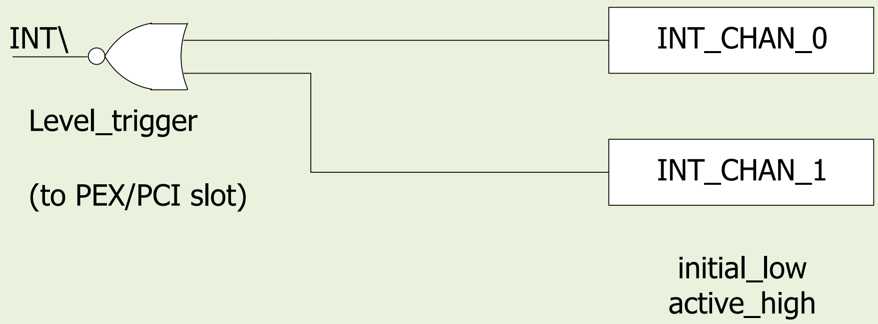
If there is more than one interrupt source, the interrupt service routine has to identify the active signals in the following manner: (Refer to DEMO5.C and DEMO6.C)

1. Read the new status of all interrupt signal sources
2. Compare the new status with the old status to identify the active signals
3. If INT0 is active, service it
4. If INT1 is active, service it
5. Save the new status to replace the old status

Note:

If the interrupt signal is too short, the new status may be the same as the old status. In that situation, the interrupt service routine will not be able to identify which interrupt source is active, so the interrupt signal must be hold_active for long enough until the interrupt service routine is executed. This hold_time is different for different OS versions. The hold_time can be as short as a micro-second or as long as second. In general, 20 mS should be long enough for all OS version.

2.3.1 Interrupt Block Diagram



The interrupt output signal of PEX-DA and PIO/PISO-DAxU series cards, **INT\, is set to Level-Trigger and Active_Low.** If INT\ generates a low_pulse, the PIO-DA4/8/16 will interrupt the PC once each time. If INT\ is fixed at low_level, the PEX-DA and PIO/PISO-DAxU series will interrupt the PC continuously. So for **the signal pulse_type for INT_CHAN_0/1 must be controlled and must be fixed at a low_level state normally and a high_pulse generated to interrupt the PC.**

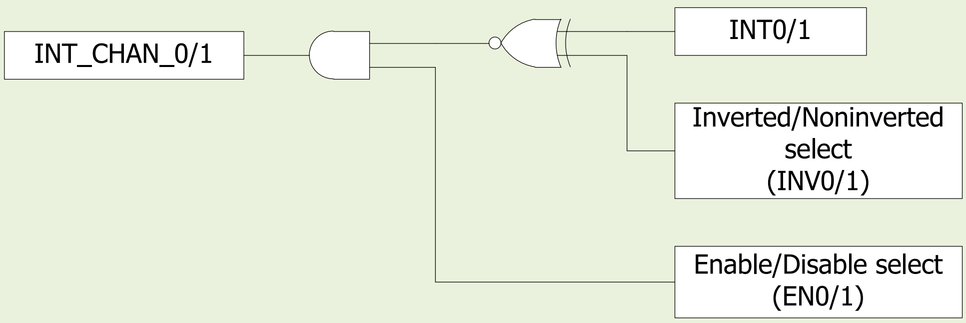
The priority of INT_CHAN_0/1 is the same. If both of these signals are active at the same time, then INT\ will only be active once at a time. So the interrupt service routine has to read the status of both interrupt channels to per form a multiple-channel interrupt. Refer to Sec. 2.3 for more information.

DEMO5.C → for INT_CHAN_0 & INT_CHAN_1

If only one interrupt source is used, the interrupt service routine doesn't have to read the status of the interrupt source. The demo programs, DEMO3.C and DEMO4.C, are designed to demons rate a single channel interrupt. See:

DEMO3.C → for INT_CHAN_1 only (initial high)
DEMO4.C → for INT_CHAN_1 only (initial low)

2.3.2 INT_CHAN_0/1



The architecture for INT_CHAN_0 and INT_CHAN_1 is shown in the above figure. The only difference between INT0 and INT1 is that the INT_CHAN_0 signal source is from the 8254 counter0 output and the INT_CHAN_1 signal source is from the 8254 counter2 output.

INT_CHAN_0/1 must be fixed at a low level state normally and a high_pulse generated to interrupt the PC.

EN0/1 can be used to enable/disable the INT_CHAN_0/1 in the following manner: (Refer to Sec. 6.3.4)
EN0/1 = 0 → INT_CHAN_0/1 = disabled
EN0/1 = 1 → INT_CHAN_0/1 = enabled

INV0/1 can be used to invert/non-invert INT0/1 in the following manner: (Refer to Sec. 6.3.5)
INV0/1 = 0 → INT_CHAN_0/1 = inverted state for INT0/1
INV0/1 = 1 → INT_CHAN_0/1 = non-inverted state for INT0/1

As noted above, **if INT\ is fixed at a low level state, the PEX-DA and PIO/PISO-DAxU series will interrupt the PC continuously, so the interrupt service routine should use INV0/1 to invert/non-invert the INT0/1 in order to generate a high_pulse** (Refer to the next section).

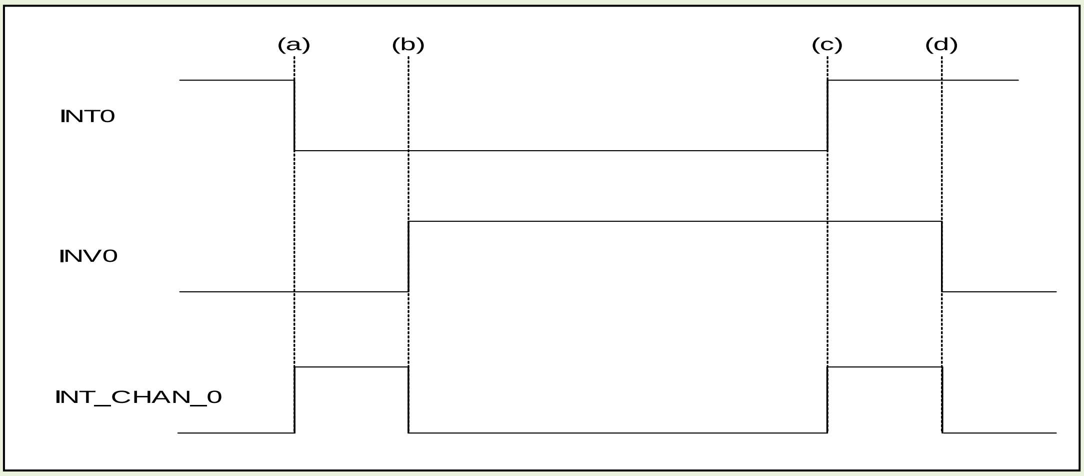
2.3.3 Initial_High, Ative_Low Interrupt Source

If INT0 (8254 counter0 output) is an initial_high, active_low signal (depending on 8254 counter mode), the interrupt service routine should use INV0 to invert/non-invert INT0 to generate a high_pulse in the following manner: (Refer to DEMO3.C)

Initial settings:

```
now_int_state=1;                    /* initial state for INT0       */
outportb(wBase+0x2a,0);             /* select the inverted INT0    */
```

```
 void interrupt irq_service()
{
if  (now_int_state==1)          /* now INT0 is changed to LOW          */(a)
    {                           /* --> INT_CHAN_0=!INT0=HIGH now       */
    COUNT_L++;                  /* find a LOW_pulse (INT0)             */
    If((inport(wBase+7)&1)==0)  /* the INT0 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=INT0=LOW -->             */
                                /* INT_CHAN_0 generate a high_pulse    */
      now_int_state=0;          /* now INT0=LOW                        */
      }
    else now_int_state=1;       /* now INT0=HIGH                       */
                                /* don't have to generate high_pulse   */
    }
else                            /* now INT0 is changed to HIGH         */(c)
    {                           /* --> INT_CHAN_0=INT0=HIGH now        */
    COUNT_H++;                  /* find a HIGH_pulse (INT0)            */
    If((inport(wBase+7)&1)==1)  /* the INT0 is still fixed in HIGH     */
      {                         /* need to generate a high_pulse       */
      outportb(wBase+0x2a,0);   /* INV0 select the inverted input     */(d)
                                /* INT_CHAN_0=!INT0=LOW -->            */
                                /* INT_CHAN_0 generate a high_pulse    */
      now_int_state=1;          /* now INT0=HIGH                       */
      }
    else now_int_state=0;       /* now INT0=LOW                        */
                                /* don't have to generate high_pulse   */
    }
if  (wIrq>=8) outportb(A2_8259,0x20);
outportb(A1_8259,0x20);
}
```



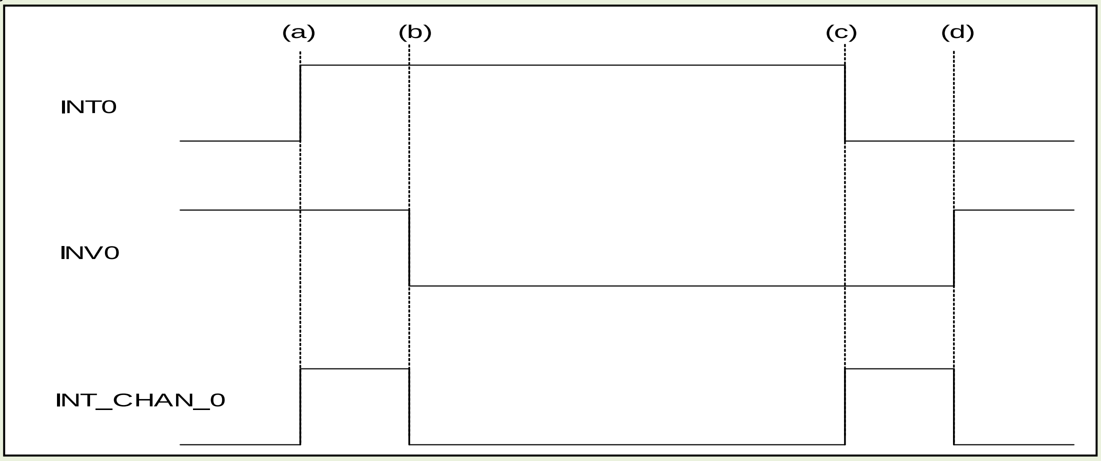
2.3.4 Initial_Low, Ative_High Interrupt Source

If INT0 (8254 counter0 output) is an initial_low, active_high signal (depending on the 8254 counter mode), the interrupt service routine should use INV0 to invert/non-invert INT0 to generate a high_pulse in the following manner: (Refer to DEMO4.C)

Initial setting:

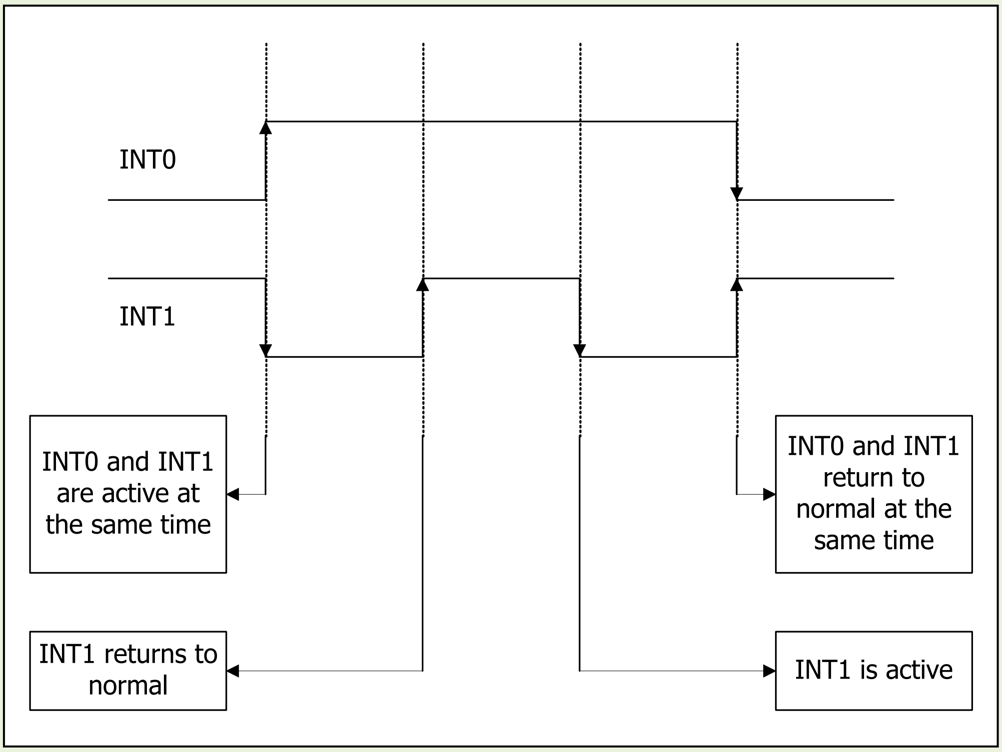
```
now_int_state=0;                    /* initial state for INT0              */
outportb(wBase+0x2a,1);            /* select the non-inverted INT0 */
```

```
void interrupt irq_service()
{
if  (now_int_state==1)         /* now INT0 is changed to LOW          */(c)
    {                          /* --> INT_CHAN_0=!INT0=HIGH now       */
    COUNT_L++;                 /* find a LOW_pulse (INT0)             */
    If((inport(wBase+7)&1)==0)/* the INT0 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=INT0=LOW -->            */
                               /* INT_CHAN_0 generate a high_pulse   */
      now_int_state=0;         /* now INT0=LOW                        */
      }
    else now_int_state=1;      /* now INT0=HIGH                       */
                               /* don't have to generate high_pulse  */
    }
else                           /* now INT0 is changed to HIGH         */(a)
    {                          /* --> INT_CHAN_0=INT0=HIGH now        */
    COUNT_H++;                 /* find a High_pulse (INT0)            */
    If((inport(wBase+7)&1)==1)/* the INT0 is still fixed in HIGH     */
      {                        /* need to generate a high_pulse       */
      outportb(wBase+0x2a,0); /* INV0 select the inverted input      */(b)
                               /* INT_CHAN_0=!INT0=LOW -->           */
                               /* INT_CHAN_0 generate a high_pulse   */
      now_int_state=1;         /* now INT0=HIGH                       */
      }
    else now_int_state=0;      /* now INT0=LOW                        */
                               /* don't have to generate high_pulse  */
    }
if  (wIrq>=8) outportb(A2_8259,0x20);
outportb(A1_8259,0x20);
}
```



2.3.5 Multiple Interrupt Source

Assume: INT0 is initial Low and active High,
INT1 is initial High and active Low
as below:



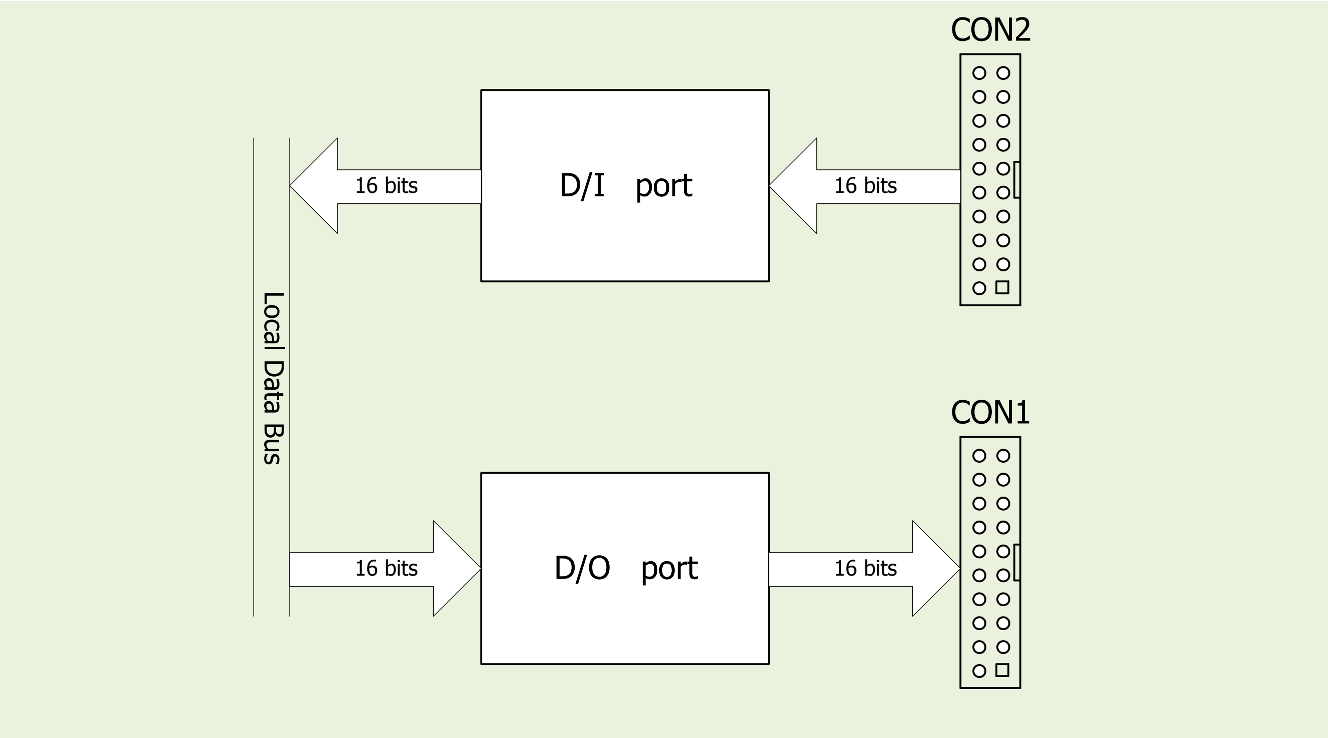
Refer to DEMO5.C for the source program. **All of these falling-edge and rising-edge can be detected using DEMO5.C.**

Note:
When the interrupt is active, the user program has to identify the active signals. These signals may all be active at the same time, so the interrupt service routine has to service all active signals at the same time.

```
/* ---------------------------------------------------------------------------------------------------------- */
/* Note : 1.The hold_time of INT_CHAN_0 & INT_CHAN_1 must long              */
/*                  enoug.                                                   */
/*              2.The ISR must read the interrupt status again to            */
/*                  identify the active interrupt source.                    */
/*              3.The INT_CHAN_0 & INT_CHAN_1 can be active at the same      */
/*                  time.                                                    */
/* ------------------------------------------------------------------------------------------------------ */

void interrupt irq_service()
{

/* now ISR can not know which interrupt is active                          */
new_int_state=inportb(wBase+7)&0x03;          /* read all interrupt      */
                                              /* signal state            */
int_c=new_int_state^now_int_state;            /* compare new_state to */
                                              /* old_state               */

if ((int_c&0x01)==1)                 /* INT_CHAN_0 is active              */
     {
     if ((new_int_state&1)==0)       /* INT0 change to low now            */
          {
          INT0_L++;
          }
     else                                 /* INT0 change to high now          */
          {
          INT0_H++;
          }
     invert=invert^1;                 /* generate high_pulse                */
     }

if ((int_c&0x02)==2)                 /* INT_CHAN_1 is active              */
     {
     if ((new_int_state&2)==0)       /* INT1 change to low now            */
          {
          INT1_L++;
          }
     else                                 /* INT1 change to high now          */
          {
          INT1_H++;
          }
     invert=invert^2;                 /* generate high_pulse                */
     }

now_int_state=new_int_state;         /* update interrupt status           */
outportb(wBase+0x2a,invert);         /* generate a high pulse             */

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

}
```

2.4 D/I/O block Diagram

The PEX-DA and PISO/PIO-DAxU series provides 16 digital input channels and 16 digital output channels, and all signal levels are TTL compatible. The connection diagram and block diagram are as follows:

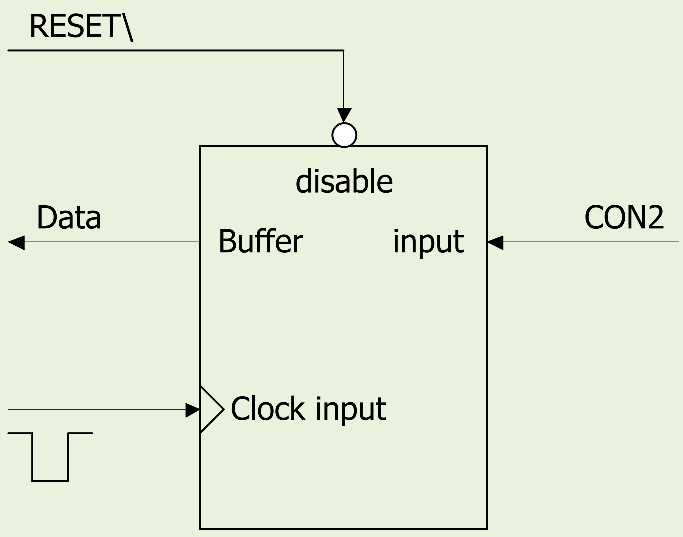


The D/I Port can be connected to a DB-16P, which is a 16-channel isolated digital input daughter board. The D/O Port can be connected to either a DB-16R or a DB-24PR. The DB-16R is a 16 channels relay output board. The DB-24PR is a 24 channels power relay output board.

2.4.1 D/I Port Architecture (CON2)

When the PC is powered up, all DI port (CON2) operation are disabled. The enabled/disabled status of a DI port is controlled by the RESET\ signal. Refer to Sec. 6.3.1 for more information about the RESET\ signal.

- The RESET\ signal is in the Low-state → all DI operations are disabled
- The RESET\ signal is in the High-state → all DI operations are enabled



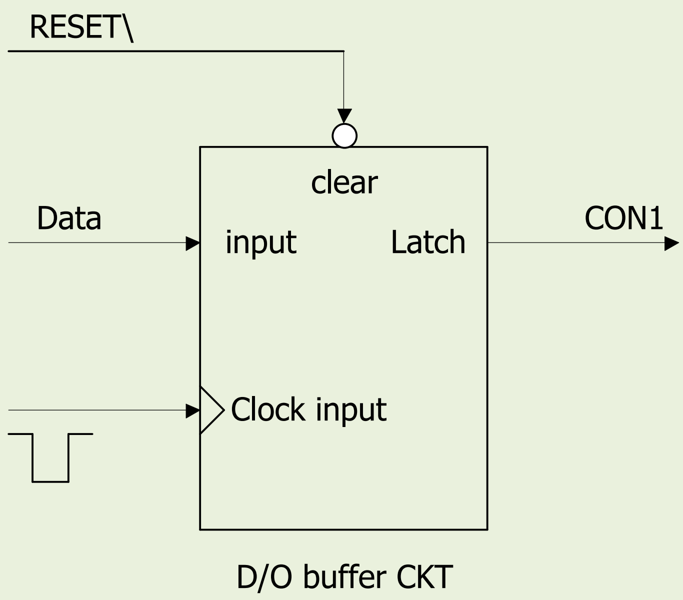
D/I buffer CKT

2.4.2 D/O Port Architecture (CON1)

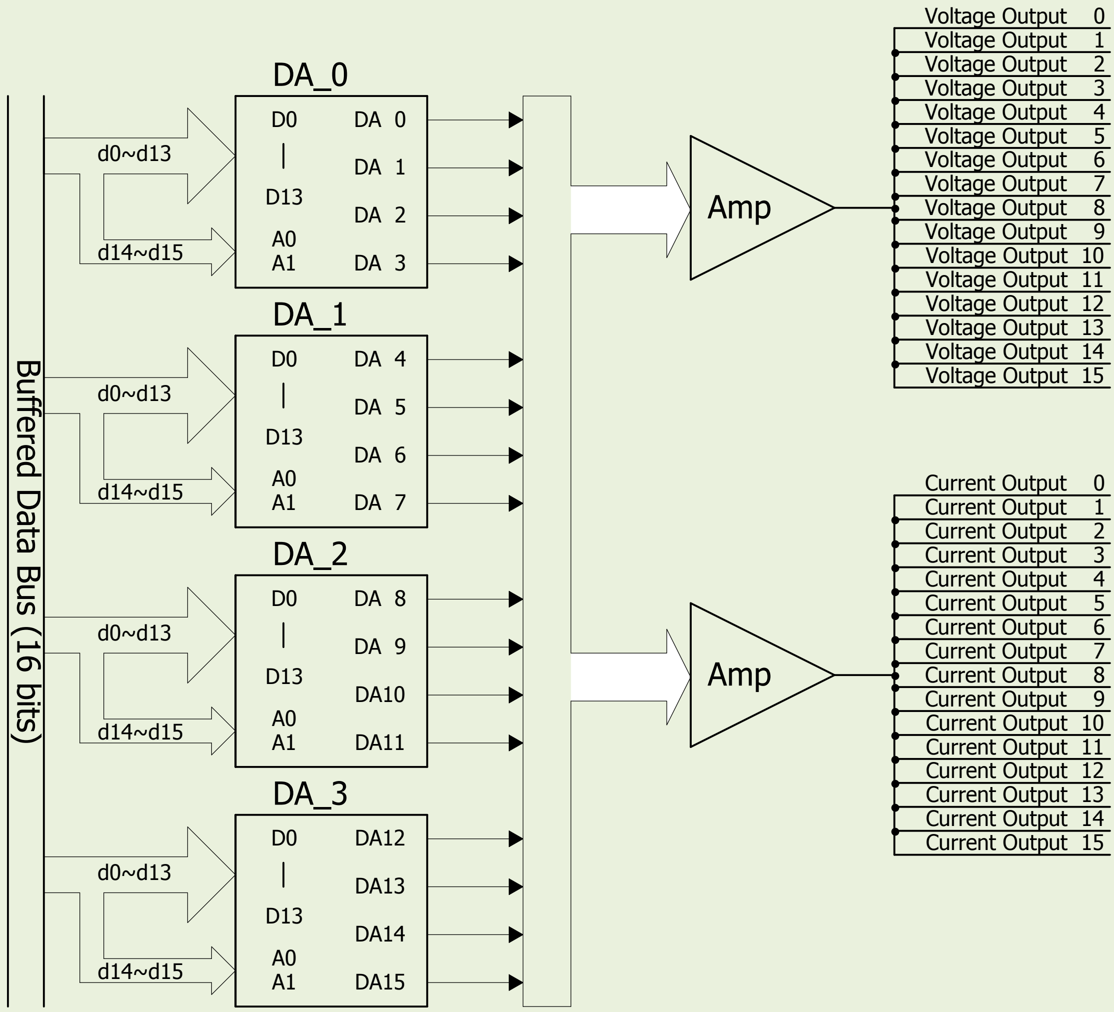
When the PC is powered up, the states of all DO channels are cleared low. The RESET\ signal is used to clear the DO states. Refer to Sec. 6.3.1 for more information about the RESET\ signal.

- The RESET\ signal is in the Low-state → all DO channels are cleared to the low state

The block diagram of DO is as follows:



2.5 D/A Architecture



The PEX-DA and PISO/PIO-DAxU provides 4/8/16 channels of double-buffered digital to analog output and provides voltage output and current output simultaneously.

2.6 D/A Conversion Operations

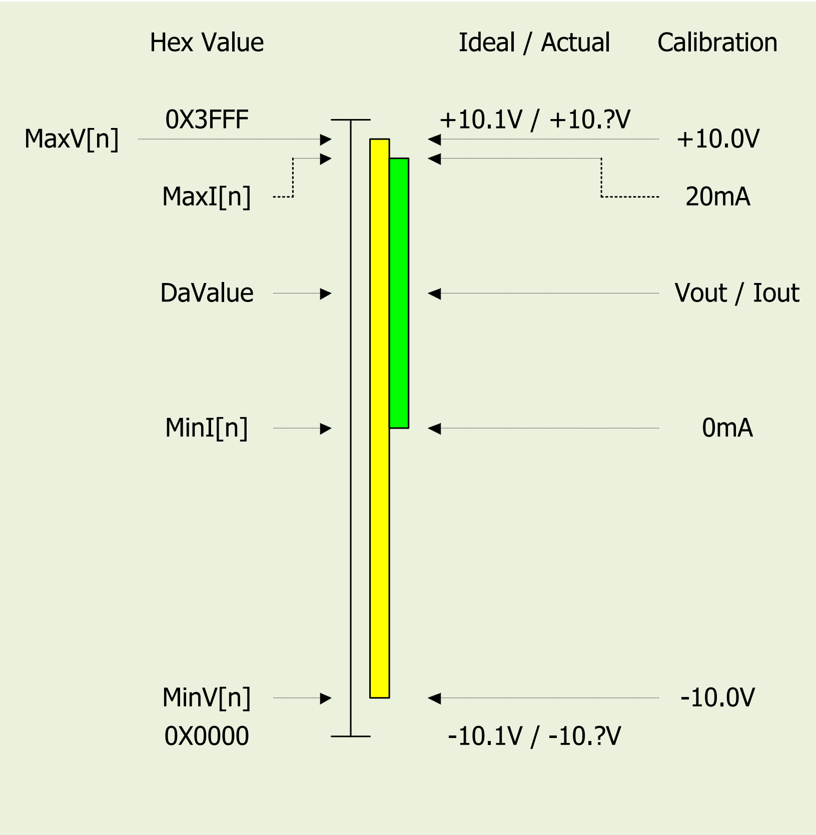
The D/A converters on PEX-DA and PISO/PIO-DAxU series cards use 14-bit resolution, so the digital data values range from 0x0000 to 0x3fff. The hardware is designed to output voltage in a range from -10.1 ~ +10.1 volts, as follows:

0x0000 → about –10.1 volts
0x3FFF → about +10.1 volts

In a conventional design, there will be some VRs that need to be adjusted so that the voltage output for 0x0000 = -10.0 V and 0x3fff = +10.0 V. In addition, these VRs also have to be adjusted so that the current output for 0x1fff = 0 mA and 0x3fff = 20 mA. In conventional designs, these VRs are commonly used for voltage/current output, so the user has to perform some calibration when changing from voltage to current. Also, if these VRs are changed, the user has to re-perform the calibration. This procedure is complex and creates a heavy workload. The PEX-DA and PISO/PIO-DAxU series uses software calibration to replace this complex procedure in the following manner:

- For each voltage output channel, find two hex values MaxV[n] and MinV[n] (stored in the onboard EEPROM). MaxV[n] is mapped to exactly +10 V and MinV[n] is mapped to exactly –10 V.

- For each current output channel, also find two hex values MaxI[n] and MinI[n] (stored in the onboard EEPROM). MaxI[n] is mapped to exactly 20 mA and MinI[n] is mapped to exactly 0 mA.



Consequently, the software can be used to calibrate the analog output without the need for any hardware Trim-pot adjustment. For example,

Channel n	MinV[n]	MaxV[n]	MinI[n]	MaxI[n]
0	134	16297	8180	15943
1	137	16293	8172	15976
2	132	16296	8199	15949
3	134	16391	8177	15963
4	135	16298	8165	15955
5	131	16292	8150	15947
6	136	16295	8172	15968
7	134	16297	8163	15961
8	134	16294	8188	15959
9	132	16295	8169	15948
10	135	16298	8172	15946
11	133	16296	8177	15975
12	131	16292	8159	15942
13	134	16297	8173	15973
14	132	16293	8168	15949
15	133	16295	8175	15965

If the user wants to send Vout(volts) to Channel n, the calibrated hex value, DaValue, sent to D/A converter can be calculated in the following way:

```
DeltaV[n]=20.0/(MaxV[n]–MinV[n]);            /* DeltaV[n]=volts per count at channel_n */
DaValue=(Vout+10.0)/DeltaV[n]+MinV[n];       /* DaValue=Hex value to send to the D/A */
pio_da16_da(n,DaValue);                      /* send the DaValue to Channel n    */
```

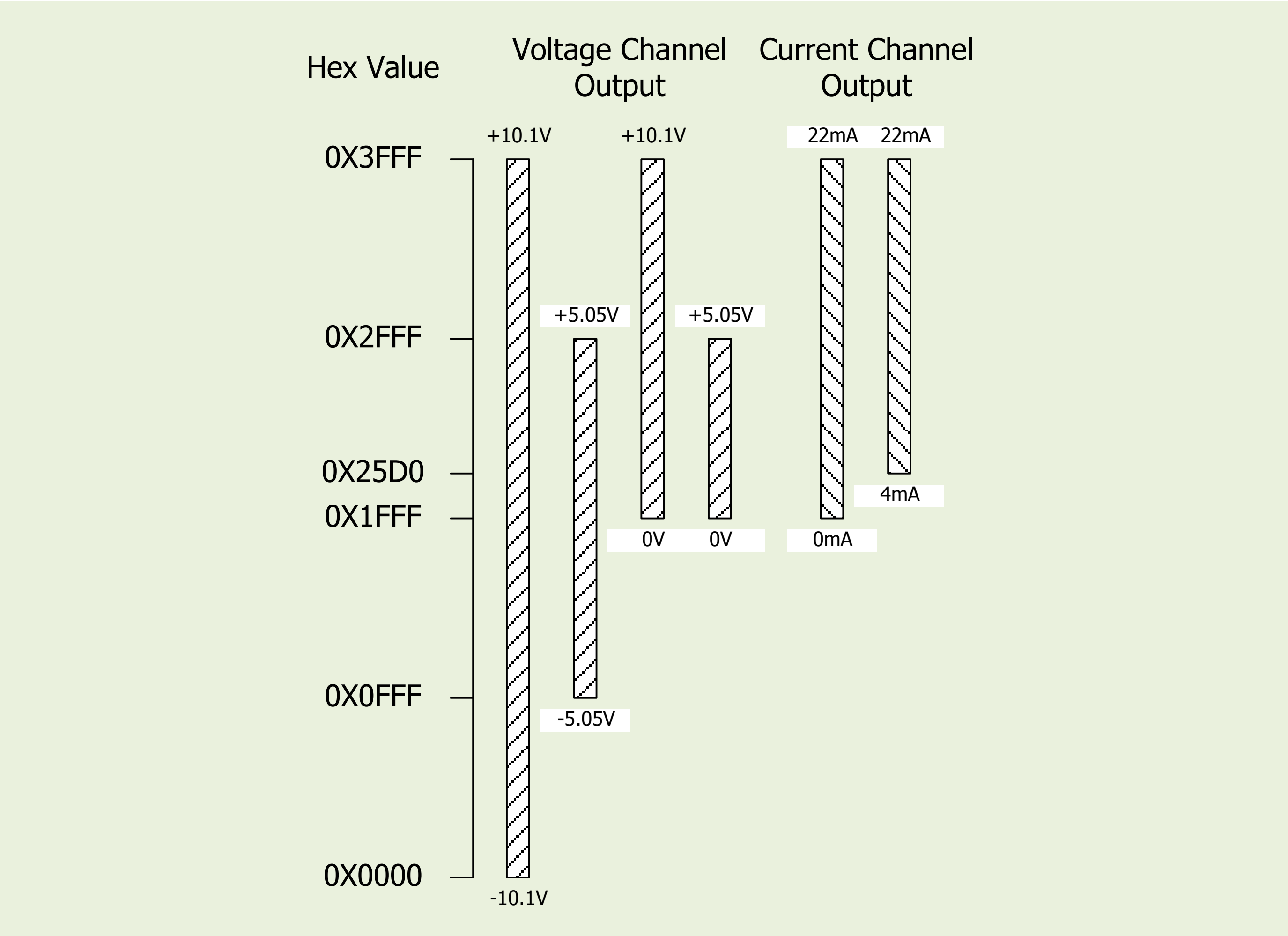
If the user wants to send Iout(mA) to Channel n, the calibrated hex value, DaValue, sent to the D/A converter can be calculated in the following way: (Refer to DEMO9.C)

```
DeltaI[n]=20.0/(MaxI[n]–MinI[n]);            /* DeltaI[n]=mA per count at channel_n */
DaValue=Iout/DeltaI[n]+MinI[n];              /* DaValue=Hex value send to D/A     */
pio_da16_da(n,DaValue);                      /* send the DaValue to Channel n    */
```

Refer to DEMO7.C and DEMO9.C for more information.

2.6.1 Output Range and Resolution

The voltage output range for PEX-DA and PISO/PIO-DAxU series cards is always ±10.1 V, and the current output range is always 0~22 mA, as illustrated below:



The resolution for each range is as follows:

Configuration	Equivalent Bits	Resolution
-10 V ~ +10 V	14-bit	1.22 mV
0 V ~ 10 V	13-bit	1.22 mV
-5 V ~ +5 V	13-bit	1.22 mV
0 V ~ +5 V	12-bit	1.22 mV
0 mA ~ 20 mA	13-bit	2.70 µA
4 mA ~ 20 mA	13-bit	2.70 µA

2.6.2 ±10 V Voltage Output

The voltage output for PEX-DA and PISO/PIO-DAxU series cards is always in the range of ±10.1 V. If the user needs to output a voltage in the range of ±10 V, the software calibration is the same as that described in Sec. 2.6. Consequently, Vout will be in the range of ±10 V, so the DaValue will approximately be from 0x0000 to 0x3fff, which means that the resolution is about 14 bits.

2.6.3 ±5 V Voltage Output

The voltage output for PEX-DA and PISO/PIO-DAxU series cards is always in the range of ±10.1 V. If the user needs to output a voltage in the range of ±5 V, the software calibration is same as that described in Sec. 2.6. Consequently, Vout will be in range of +5 V, so the DaValue will approximately be from 0x0fff to 0x2fff, which means that the resolution is about 13 bits.

2.6.4 0~10 V Voltage Output

The voltage output for PEX-DA and PISO/PIO-DAxU series cards is always in the range of ±10 V.1. If the user needs to output a voltage in the range of 0~10 V, the software calibration is the same as that described in Sec.2.6. Consequently, Vout will be in the range of 0~10 V, so the DaValue will approximately be from 0x1fff to 0x3fff, which means the resolution is about 13 bits.

2.6.5 0~5 V Voltage Output

The voltage output for PEX-DA and PISO/PIO-DAxU series cards is always in the range of ±10.1 V. If the user needs to output a voltage in the range of 0~5 V, the software calibration is the same as that described in Sec. 2.6. Consequently, Vout will be in the range 0~5 V, so the DaValue will approximately be from 0x1fff to 0x2fff, which means that the resolution is about 12 bits.

2.6.6 0~20 mA Current Output

The current output for PEX-DA and PISO/PIO-DAxU series cards is always in the range of 0~22 mA. If the user needs to output a current in the range of 0~20 mA, the software calibration is the same as that described in Sec. 2.6. Iout will be in the range of 0~20 mA, so the DaValue will approximately be from 0x1fff to 0x3fff, which means that the resolution is about 13 bits.

2.6.7 4~20 mA Current Output

The current output for PEX-DA and PISO/PIO-DAxU series cards is always in the range of 0~22 mA. If the user needs to output a current in the range of 4~20 mA, the software calibration is the same as that described in Sec. 2.6. Iout will be in the range of 4~20 mA, so the DaValue will approximately be from 0x2600 to 0x3fff, which means that the resolution is about 13 bits.

2.6.8 No VR and No Jumper Design

In a conventional 12-bit D/A board, for example the A-626/A-628, there are many jumpers that allow the following functions to be performed:

(1) Selecting the reference voltage (internal -10/-5/or external)
(2) Selecting unipolar/bipolar (0-10 V or ±10 V)
(3) Selecting different output ranges (0-10 V or 0-5 V)

There are also many VRs that allow the following functions to be performed:

(1) Adjustment of the output voltage offset
(2) Full-scale adjustment of the output voltage
(3) Adjustment of the output current offset
(4) Full-scale adjustment of the output current

There are so many VRs and jumpers that if makes QC and re-calibration very difficult. Every step must be handled manually, meaning that calibrating these D/A boards is not an enjoyable task.

When we designed the PEX-DA and PISO/PIO-DAxU series, we tried to remove many/the these majorities of VRs and jumpers, but still retain the same precision and performance. In the long run, we selected a 14-bit D/A converter and adapted the software calibration to provide at least the same performance and precision as the A-626/A-628:

Configuration	Equivalent Bits	Resolution
-10 V ~ +10 V	14-bit	1.22 mV
0 V ~ 10 V	13-bit	1.22 mV
-5 V ~ +5 V	13-bit	1.22 mV
0 V ~ +5 V	12-bit	1.22 mV
0 mA ~ 20 mA	13-bit	2.70 μA
4 mA ~ 20 mA	13-bit	2.70μA

- All these VRs and jumpers have been removed.
- All calibrations can be performed using software.
- All channel configurations can be selected using software, meaning that there is no need to change any hardware.
- Precision is at least the same as the A-626/A628.
- All 16 channels can be configured and used in different configurations at the same time. (For example, channel_0=±10 V, channel_1=4~20 mA, channel_2=0~5 V, etc)
- All these features can be implemented on a small, compact and reliable half-size PCB.

2.6.9 Factory Software Calibration

t is recommended that a 16-bit A/D card is used to calibrate the PISO-DA/PIO-DA series cards. The I-7000 series is a set of precise remote control modules and the I-7017 is an 8-channel 16-bit precision A/D module (24-bit sigma-delta A/D converter). Two I-7017 modules are used for voltage output calibration and another two for current output calibration.

The steps required to calibrate the voltage for channel_n are as follows:

Step 1: DaValue=0
Step 2: Send the DaValue to channel_n on the PIO/PISO card
Step 3: Measure the voltage of channel_n on the I-7017
If this value is >= -10 V, then go to Step 5
Step 4: Increase the DaValue, then return to Step 2
Step 5: MinV[n]=DaValue-1
Step 6: DaValue=0x3fff
Step 7: Send the DaValue to channel_n on the PIO/PISO card
Step 8: Measure the voltage of channel_n on the I-7017
If this value is >= +10 V, then go to Step 10
Step 9: Increase the DaValue, then return to Step 7
Step 10: MaxV[n]=DaValue

Note: MinV[n] and MaxV[n] are described in *Sec. 2.6*

The steps required to calibrate the current for channel_n are as follows:

Step 1: DaValue=0x1fff
Step 2: Send the DaValue to hannel_n on the PIO/PISO card
Step 3: Measure the current of channel_n on the I-7017
If this value is >= 0 mA, then go to Step 5
Step 4: Increase the DaValue, the return to Step 2
Step 5: MinI[n]=DaValue-1
Step 6: DaValue=0x3fff
Step 7: Send the DaValue to channel_n on the PIO/PISO card
Step 8: Measure the current of channel_n on the I-7017
If this value is >= 20 mA, than go to Step 10
Step 9: Increase the DaValue, the return to Step 7
Step 10: MaxI[n]=DaValue

Note: MinI[n] and MaxI[n] are described in *Sec. 2.6*

2.6.10 User Software Calibration

The users can perform calibration themselves using a voltage meter and a current meter.

Step 1: Run DEMO12.EXE

Step 2: Select the card number for the PEX/PIO/PISO card that you want to calibrate

Step 3: Select the item (MinV[n]/MaxV[n]/MinI[n]/MaxI[n]) that you want to calibrate

Step 4: Measure the analog output using the voltage meter or the current meter and decide whether to increase or decrease the DaValue. The DaValue will immediately be sent to the D/A converter. The user can then determine the correct value for DaValue that is mapped to the accurate output value.

Step 5: Repeat Step 4 for each channel

After this procedure, the new data for MinV[n]/MaxV[n]/MinI[n]/MaxI[n] will be stored in the onboard EEPROM.

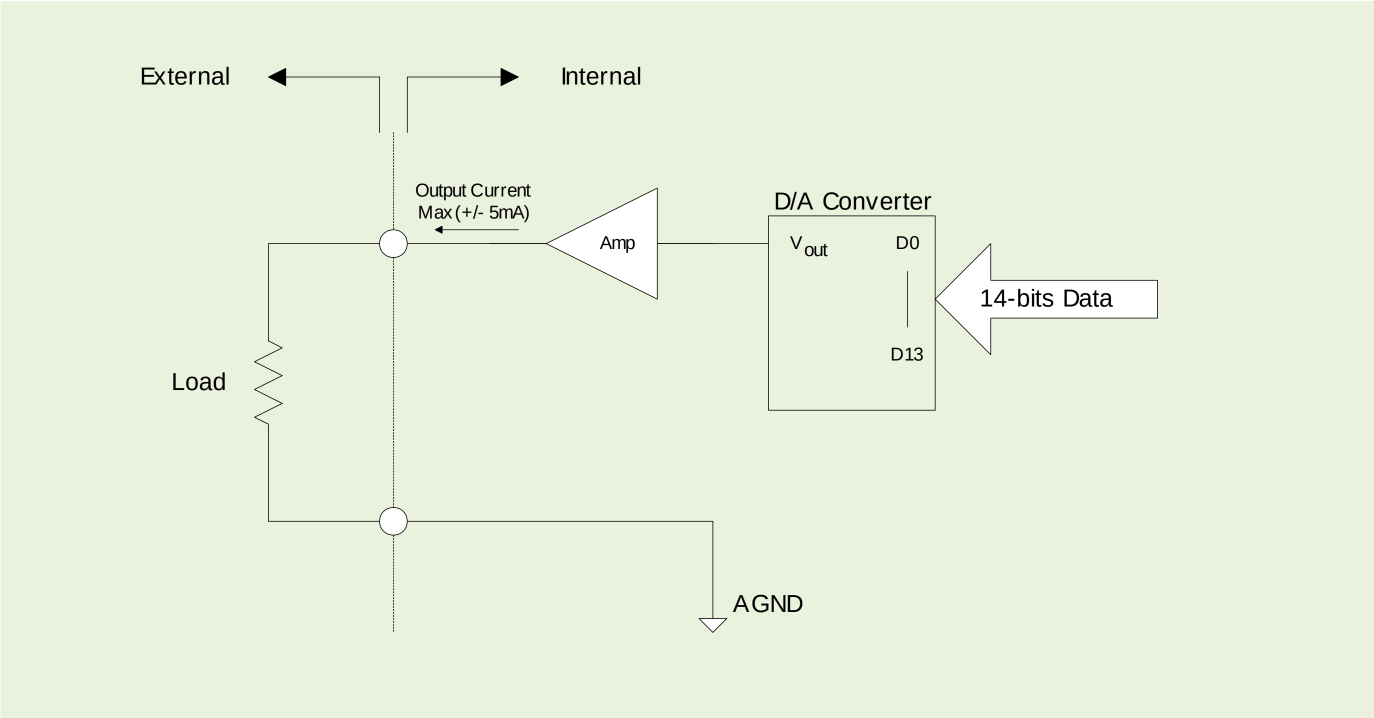
DEMO10.EXE can be executed to back up the old calibration data to "A:\DA16.DAT" before a new calibration is performed.

If an error occurs while the new calibration is being performed, DEMO11.EXE can be executed to download the data from "A:\DA16.DAT" to the EEPROM.

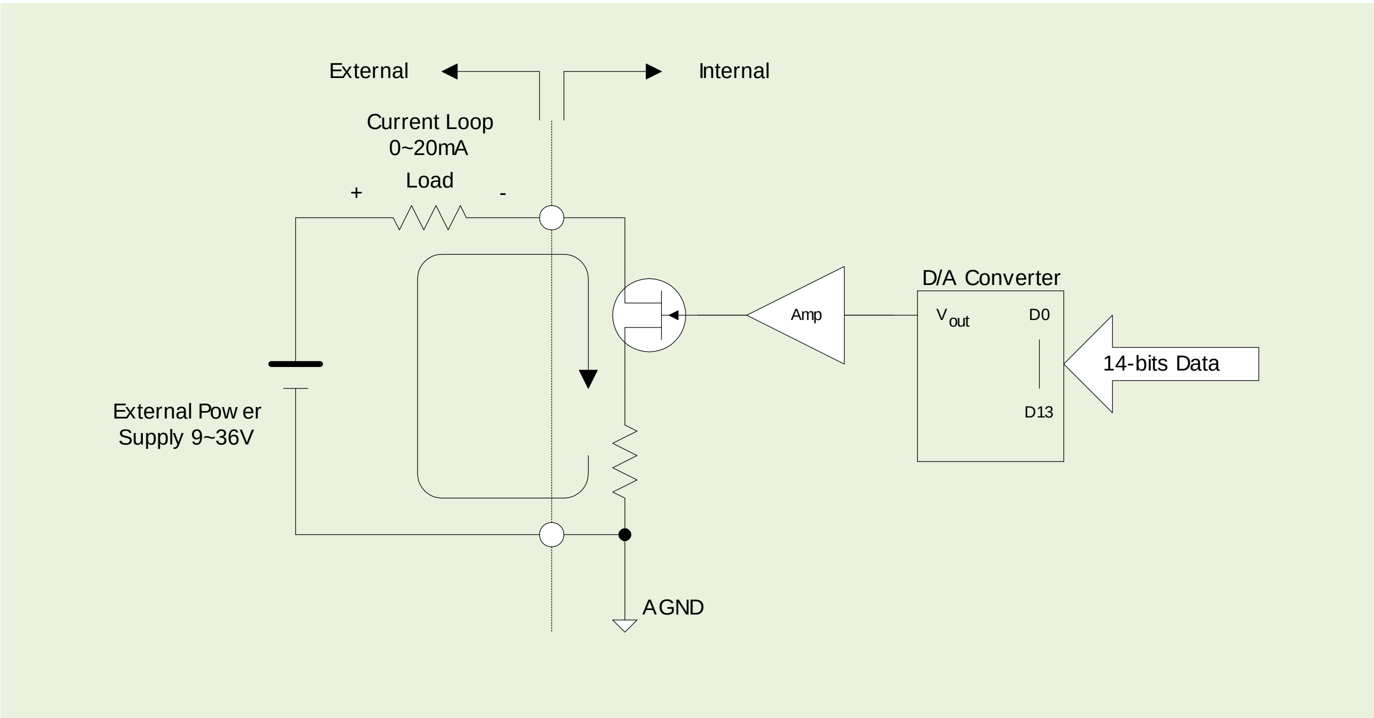
DEMO10.EXE → Save the old calibration data
DEMO11.EXE → Download the old calibration data
DEMO12.EXE → Perform a new calibration

Note:
Demo10.exe, Demo11.exe and Demo12.exe are DOS programs that can run on either a pure DOS or a FreeDOS (http://www.freedos.org/) system. These DOS programs do not work on the DOS command prompt within Windows.

2.6.11 Voltage Output Connection

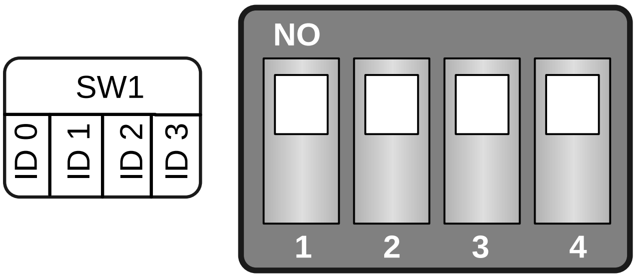


2.6.12 Current Output Connection



2.7 Card ID Switch

The PEX-DA , PIO-DAxU (ver. 1.1 or above) and PISO-DAxU has a Card ID switch (SW1) with which users can recognize the board by the ID via software when using two or more PEX-DA , PIO-DAxU (ver. 1.1 or above) and PISO-DAxU series cards in one computer. The default Card ID is 0x0. For detail SW1 Card ID settings, please refer to Table 2.7.



(Default Settings)

Table 2.7 (*) Default Settings; OFF → 1; ON → 0

Card ID (Hex)	1 ID0	2 ID1	3 ID2	4 ID3
(*) 0x0	ON	ON	ON	ON
0x1	**OFF**	ON	ON	ON
0x2	ON	**OFF**	ON	ON
0x3	**OFF**	**OFF**	ON	ON
0x4	ON	ON	**OFF**	ON
0x5	**OFF**	ON	**OFF**	ON
0x6	ON	**OFF**	**OFF**	ON
0x7	**OFF**	**OFF**	**OFF**	ON
0x8	ON	ON	ON	**OFF**
0x9	**OFF**	ON	ON	**OFF**
0xA	ON	**OFF**	ON	**OFF**
0xB	**OFF**	**OFF**	ON	**OFF**
0xC	ON	ON	**OFF**	**OFF**
0xD	**OFF**	ON	**OFF**	**OFF**
0xE	ON	**OFF**	**OFF**	**OFF**
0xF	**OFF**	**OFF**	**OFF**	**OFF**

2.8 Pin Assignments

CON1

Pin Assignment	Terminal No.	Terminal No.	Pin Assignment
DO 0	01	02	DO 1
DO 2	03	04	DO 3
DO 4	05	06	DO 5
DO 6	07	08	DO 7
DO 8	09	10	DO 9
DO 10	11	12	DO 11
DO 12	13	14	DO 13
DO 14	15	16	DO 15
GND	17	18	GND
+5V	19	20	+12V

CON2

Pin Assignment	Terminal No.	Terminal No.	Pin Assignment
DI 0	01	02	DI 1
DI 2	03	04	DI 3
DI 4	05	06	DI 5
DI 6	07	08	DI 7
DI 8	09	10	DI 9
DI 10	10	12	DI 11
DI 12	12	14	DI 13
DI 14	14	16	DI 15
GND	16	18	GND
+5V	18	20	+12V

CON3(PISO-DAxU)

Pin Assignment	Terminal No.	Terminal No.	Pin Assignment
VO_0	01	20	IO_0
VO_1	02	21	IO_1
VO_2	03	22	IO_2
VO_3	04	23	IO_3
A.GND	05	24	A.GND
VO_4	06	25	IO_4
VO_5	07	26	IO_5
VO_6	08	27	IO_6
VO_7	09	28	IO_7
A.GND	10	29	A.GND
VO_8	11	30	IO_8
VO_9	12	31	IO_9
VO_10	13	32	IO_10
VO_11	14	33	IO_11
A.GND	15	34	IO_12
VO_12	16	35	IO_13
VO_13	17	36	IO_14
VO_14	18	37	IO_15
VO_15	19		

CON3(PEX-DA/PIO-DAxU)

Pin Assignment	Terminal No.	Terminal No.	Pin Assignment
VO_0	01	20	IO_0
VO_1	02	21	IO_1
VO_2	03	22	IO_2
VO_3	04	23	IO_3
A.GND	05	24	N/A
VO_4	06	25	IO_4
VO_5	07	26	IO_5
VO_6	08	27	IO_6
VO_7	09	28	IO_7
A.GND	10	29	N/A
VO_8	11	30	IO_8
VO_9	12	31	IO_9
VO_10	13	32	IO_10
VO_11	14	33	IO_11
A.GND	15	34	IO_12
VO_12	16	35	IO_13
VO_13	17	36	IO_14
VO_14	18	37	IO_15
VO_15	19		

3. Hardware Installation

Note!!

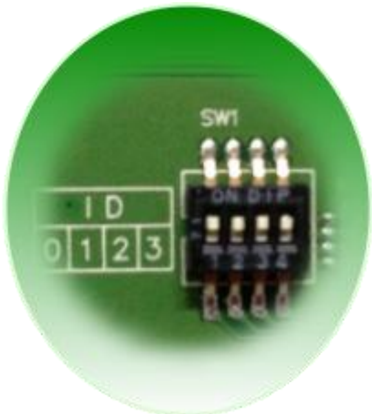
It's recommended to install driver first, since some operating system (such as Windows 2000) may ask you to restart the computer again after driver installation. This reduces the times to restart the computer.

To install your PEX-DAx, PISO-DAxU and PIO-DAxU series card, complete the following steps:

Step 1: Installing DAQ card driver on your computer first.

For detailed information about the driver installation, please refer to Chapter 4 Software Installation.

Step 2: Configuring Card ID by the SW1 DIP-Switch.



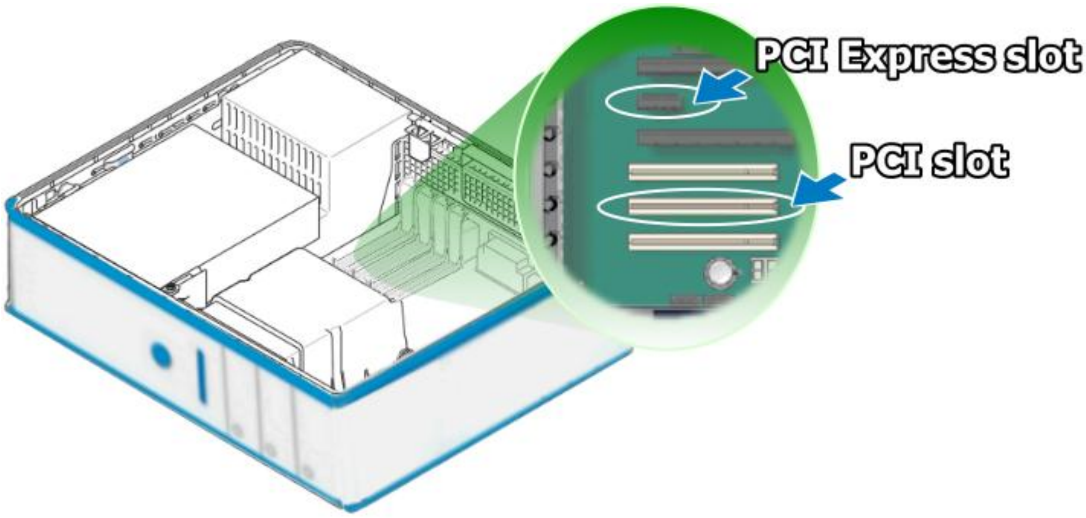
For detailed information about the card ID (SW1), please refer to Sec. 2.7 Car ID Switch.

Note!! The card ID function only supports PEX-DAx, PISO-DAxU and PIO-DAxU (ver.1.1 or above).

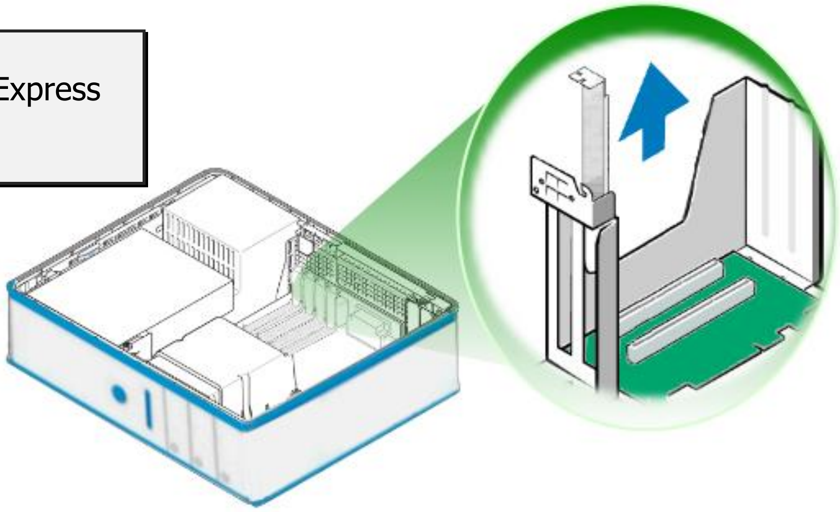
Step 3: Shut down and power off your computer.

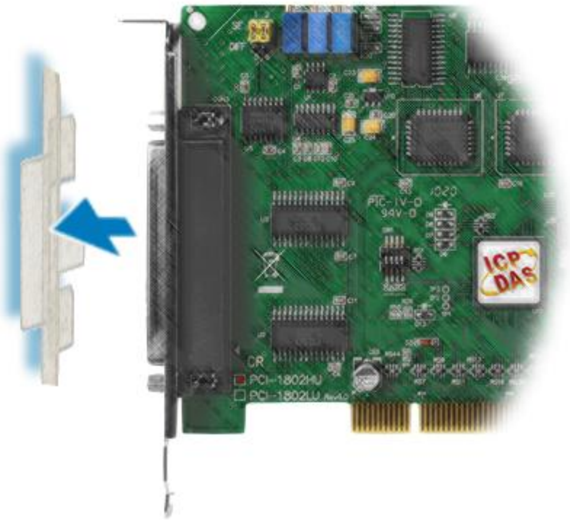
Step 4: Remove all covers from the computer.

Step 5: Select an empty PCI/PCI Express slot.



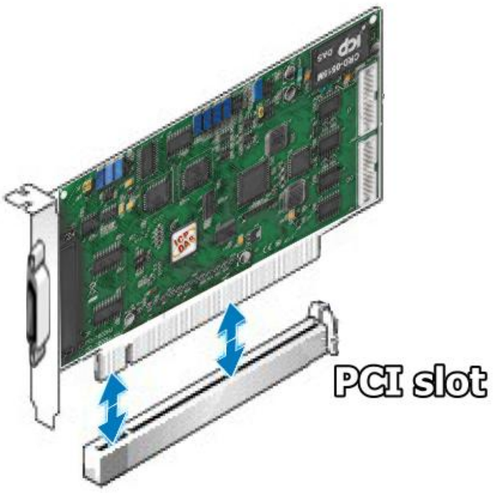
Step 6: Remove the PCI/PCI Express slot cover form the PC.

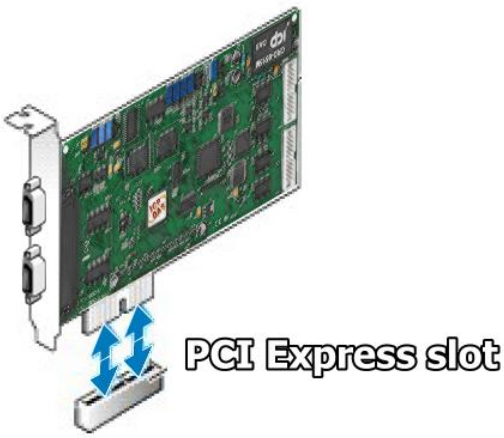


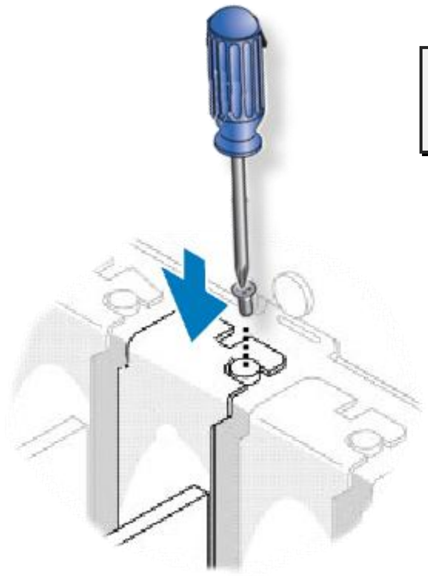


Step 7: Remove the connector cover form the DAQ card.

Step 8: Carefully insert your DAQ card into the PCI/PCI Express slot.



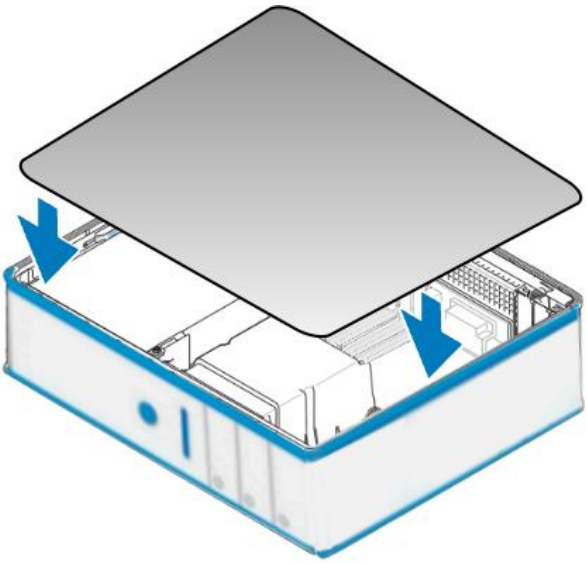




Step 9: Tighten the captive Phillips screw.

Confirm the PEX-DAx, PISO-DAxU and PIO-DAxU series card is mounted on the motherboard.

Step 10: Replace the computer cover.



Step 11: Power on the computer.

Follow the prompt message to finish the Plug&Play steps, please refer to Chapter 4 Software Installation.

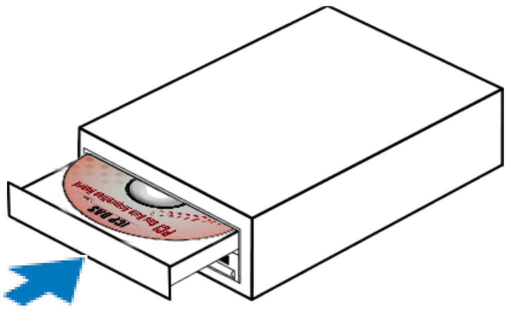
4. Software Installation

The PEX-DAx, PISO-DAxU and PIO-DAxU series card can be used in DOS, Linux and Windows 98/NT/2K and 32-bit/64-bit Windows XP/2003/Vista/7/8. This chapter shows you the detail steps to install these drivers. The recommended installation procedure for **Windows** is given in Sec. 4.1 ~ 4.3.

4.1 Driver Installing Procedure

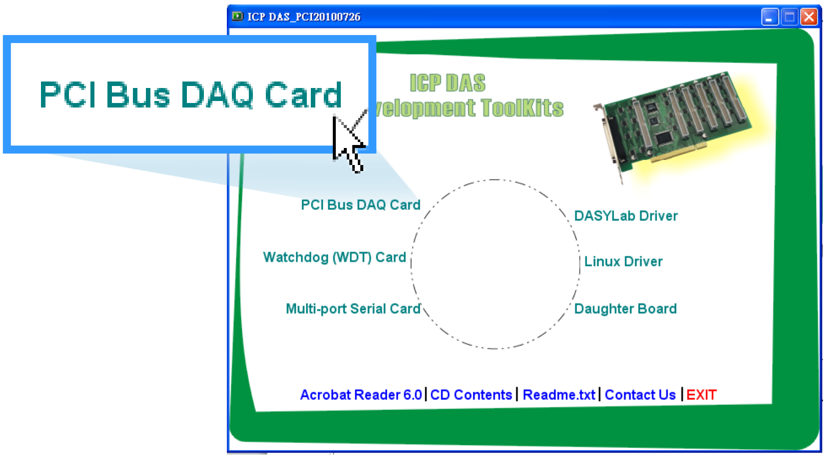
Follow these steps:

Step 1: Run the companion CD.



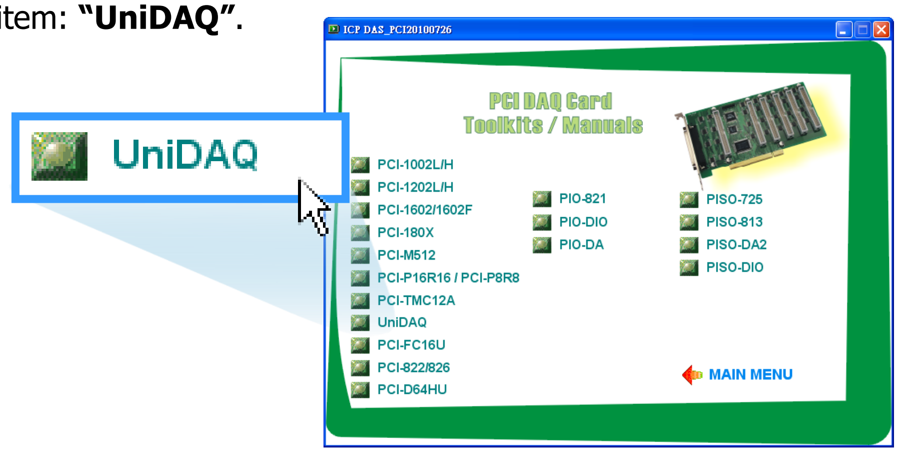
Insert the companion CD into the CD-ROM driver and wait a few seconds until the installation program starts automatically. If it does not start automatically for some reason, then please double-click the file **\NAPDOS\AUTO32.EXE** on the CD.

Step 2: Click the item:
PCI Bus DAQ Card.

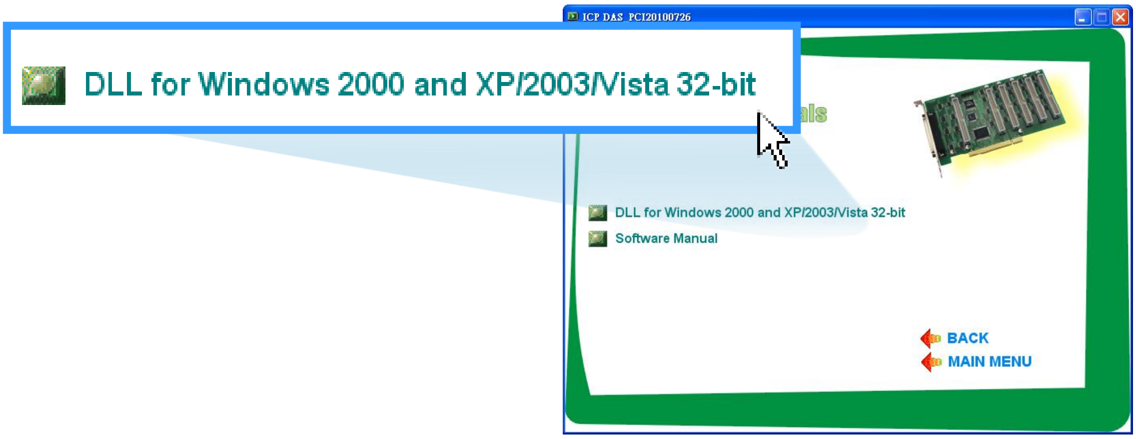


Step 3: Please install the appropriate driver for your OS.

1. Click the item: **"UniDAQ"**.



2. Click the item: **"DLL for Windows 2000 and XP/2003/Vista 32-bit"**.



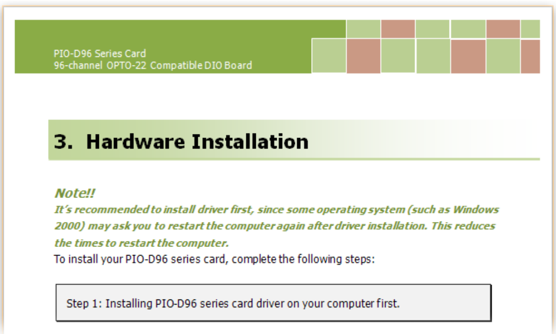
3. Double-Click **"UniDAQ_Win_Setup_x.x.x.x_xxxx.exe"** file in the **"Driver"** folder.

4. Click the **"Next>"** button to start the installation.
5. Check your DAQ Card is or not on supported list, Click the **"Next>"** button.
6. Select the installed folder, the default path is C:\ICPDAS\UniDAQ, confirm and click the **"Next>"** button.
7. Check your DAQ card on list, then click the **"Next>"** button.
8. Click the **"Next>"** button on the **Select Additional Tasks** window.
9. The demo program can be obtained from the following link and then click the **"Next>"** button.
10. Select **"No, I will restart my computer later"** and then click the **"Finish"** button.

For detailed information about the UniDAQ driver installation, please refer to UniDAQ DLL Software Manual. The user manual is contained in: CD:\NAPDOS\PCI\UniDAQ\Manual\
http://ftp.icpdas.com/pub/cd/iocard/pci/napdos/pci/unidaq/manual/

4.2 PnP Driver Installation

Step 1: Turn off the computer and install the DAQ card into the computer.


PIO-D96 Series Card
96-channel OPTO-22 Compatible DIO Board

3. Hardware Installation

Note!!
It's recommended to install driver first, since some operating system (such as Windows 2000) may ask you to restart the computer again after driver installation. This reduces the times to restart the computer.
To install your PIO-D96 series card, complete the following steps:

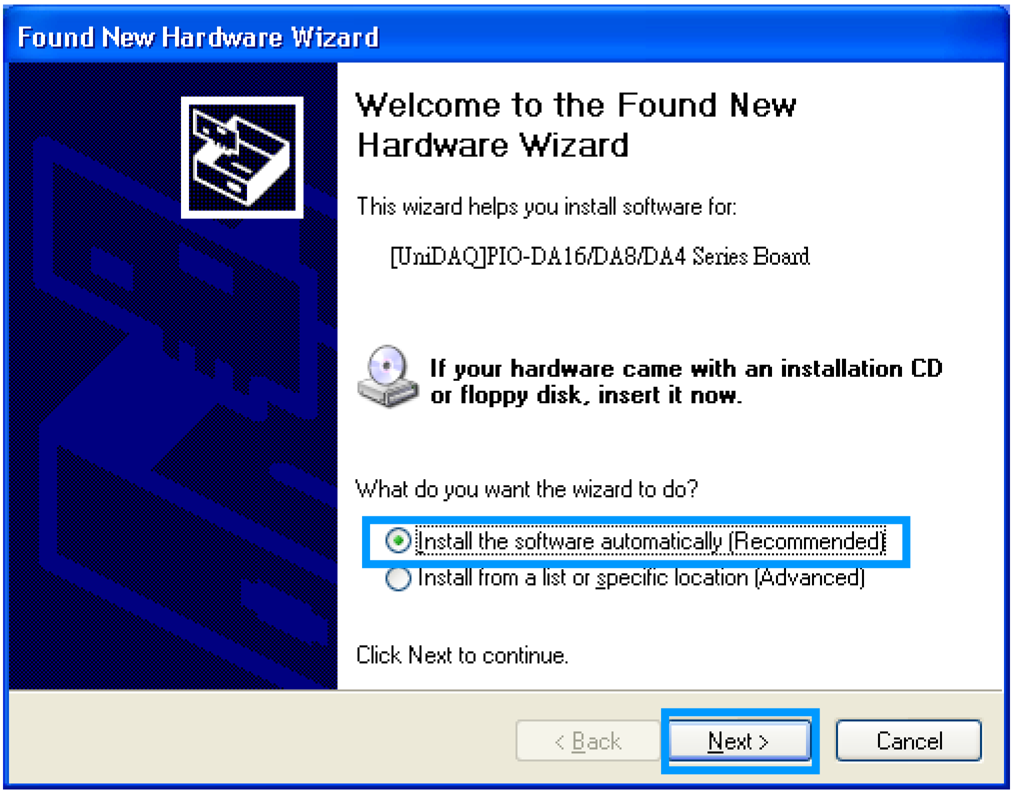
Step 1: Installing PIO-D96 series card driver on your computer first.

For detailed information about the hardware installation of PEX-DAx, PISO-DAxU and PIO-DAxU series card, please refer to Chapter 3 Hardware Installation.

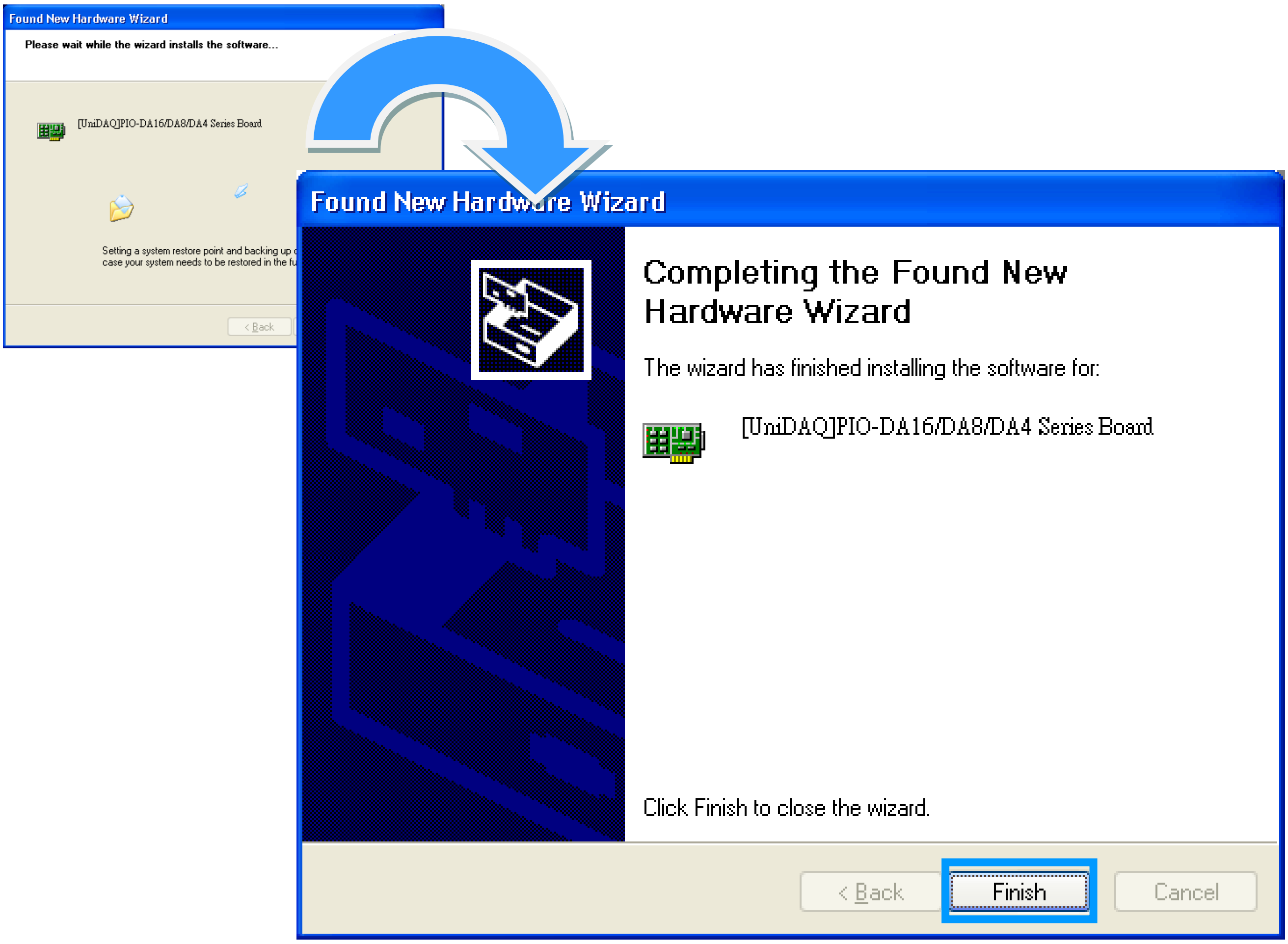
Step 2: Power on the computer and system should find the new card and then continue to finish the Plug&Play steps.

Note: Some Windows OS will load the driver automatically to complete the installation at boot.

Step 3: Select **"Install the software automatically [Recommended]"** and click the **"Next>"** button.



Step 4: Click the **"Finish"** button.



Step 5: Windows pops up **"Found New Hardware"** dialog box again.

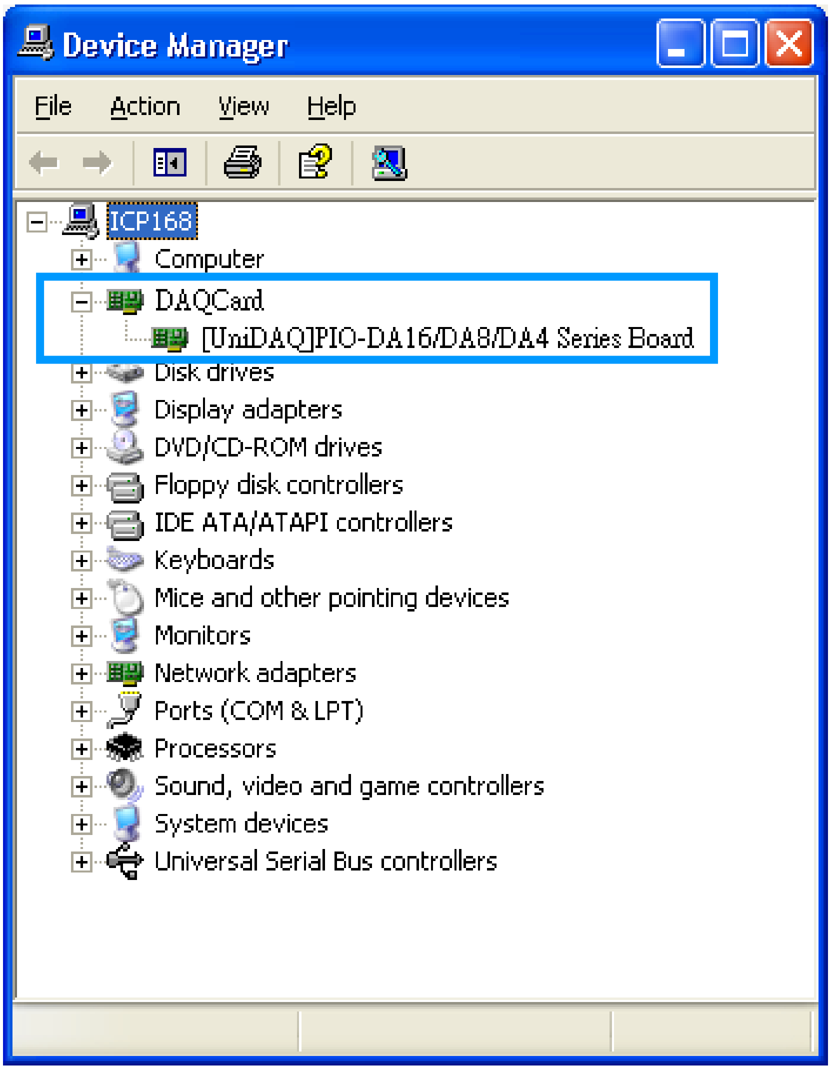
4.3 Confirm the Successful Installation

Make sure the PEX-DAx, PISO-DAxU and PIO-DAxU series card installed is correct on the computer as follows:

Step 1: Select the **"Start" → "Control Panel"** and then double click the **"System"** icon on Windows.

Step 2: Click the **"Hardware"** tab and then click the **"Device Manager"** button.

Step 3: Check the PEX-DAx, PISO-DAxU and PIO-DAxU series card which listed correctly or not, as illustrated below.



5. Testing PIO-DA Card

This chapter can give you the detail steps about self-test. In this way, user can confirm that PEX-DAx, PISO-DAxU and PIO-DAxU series card well or not. Before the self-test, you must complete the hardware and driver installation. For detailed information about the hardware and driver installation, please refer to Chapter 3 Hardware Installation and Chapter 4 Software Installation.

5.1 Self-Test Wiring

5.1.1 DIO Test Wiring

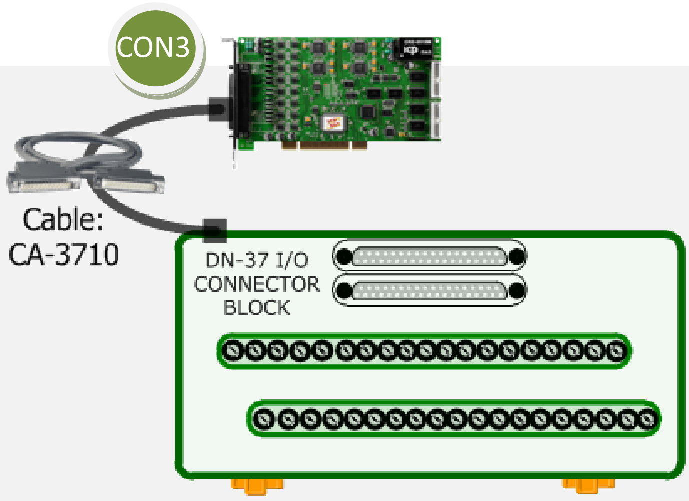
1. Prepare for device:
   - ☑ One CA-2002 (optional) cable.

2. Use the CA-2002 to connect the CON1 with CON2 on board.

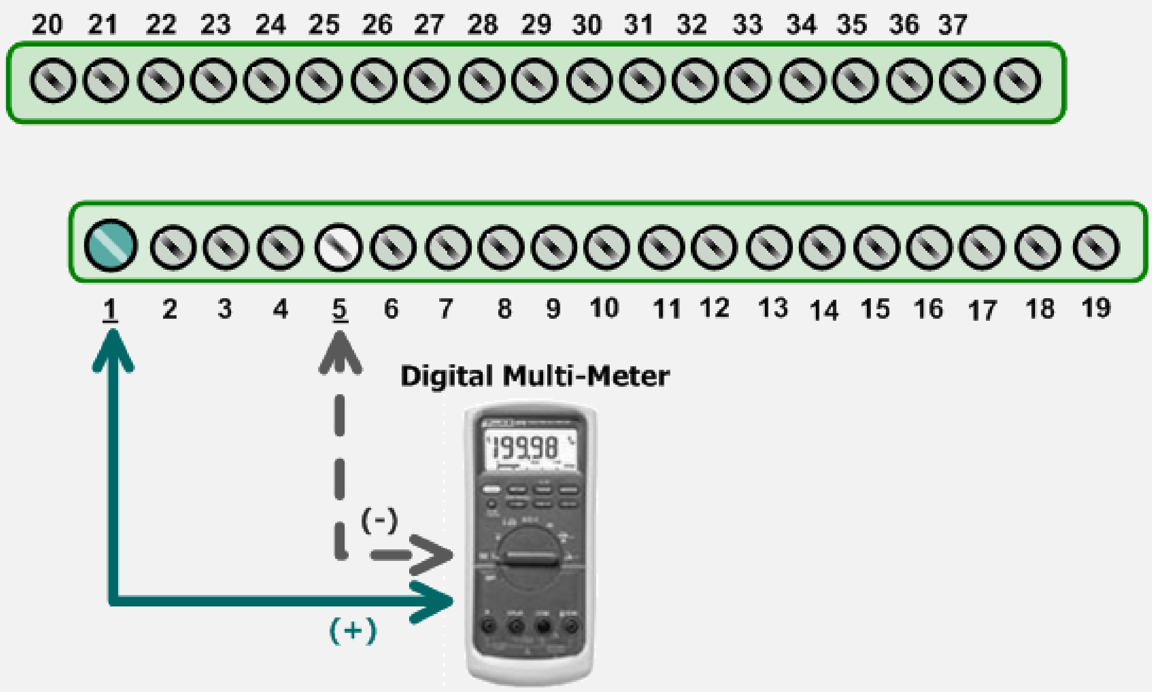
5.1.2 Analog Output Test Wiring

1. Prepare for device:
   - ☑ One DN-37 (optional) wiring terminal board.
   - ☑ One CA-3710 (optional) cable.
   - ☑ Digital Multi-Meter.

2. Connect a DN-37 to the CON3.



3. Connect the <u>positive probe (+) of Multi-meter</u> to <u>VO_0 (Pin 0)</u>, and then the <u>negative probe (-) of Multi-meter</u> to <u>A.GND (Pin 05)</u>.

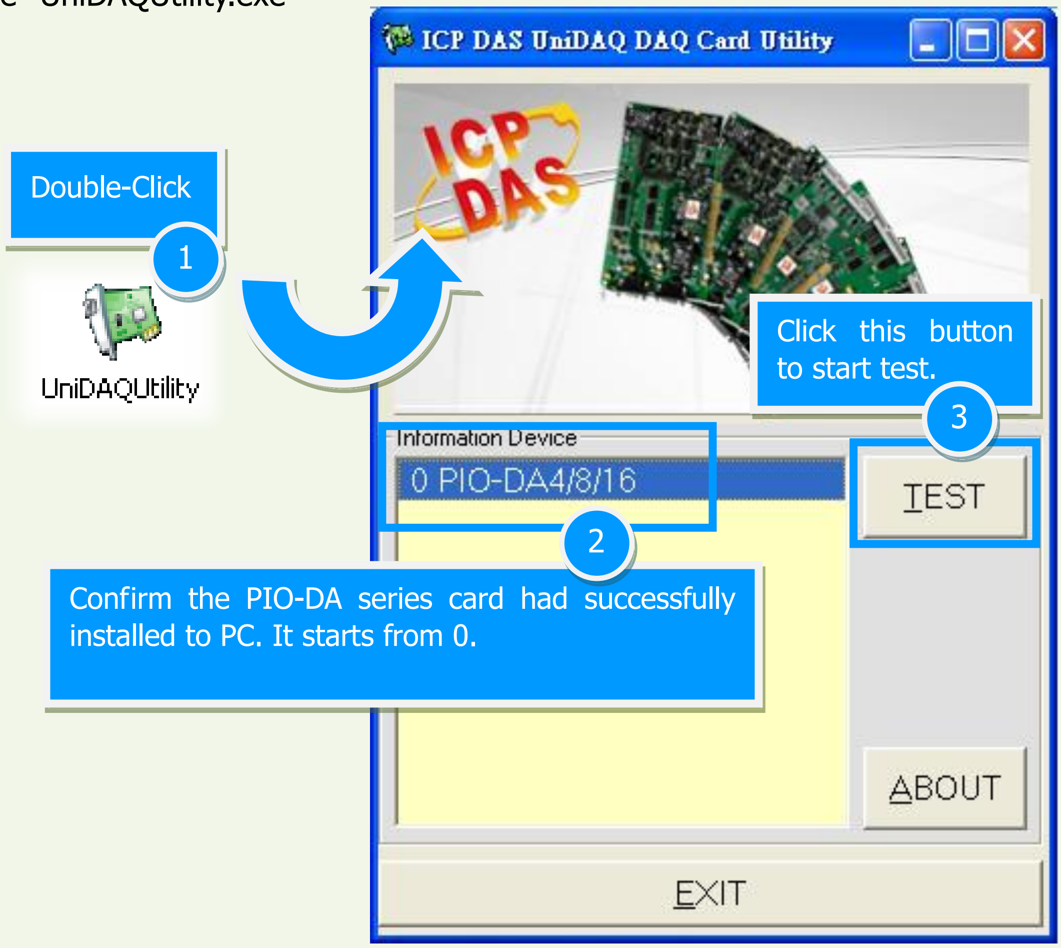


5.2 Execute the Test Program

1. Execute the UniDAQ Utility Program. The UniDAQ Utility.exe will be placed in the default path after completing installation.

Default Path: C:\ICPDAS\UniDAQ\Driver\

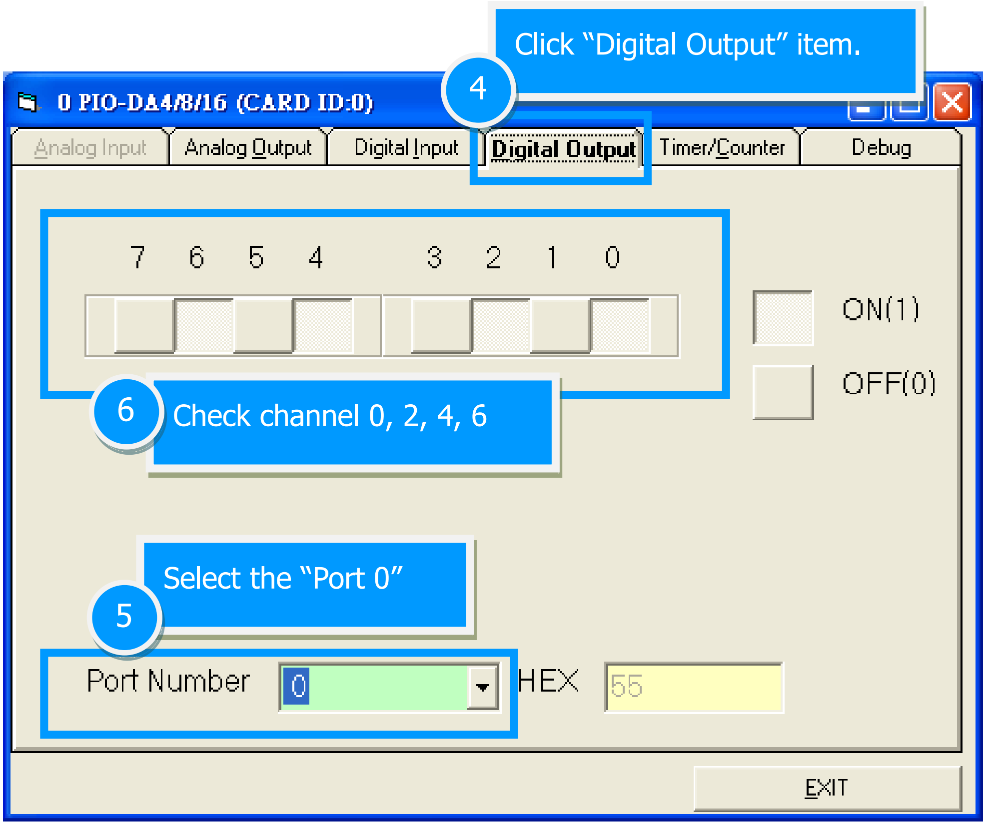
Double click the "UniDAQUtility.exe"

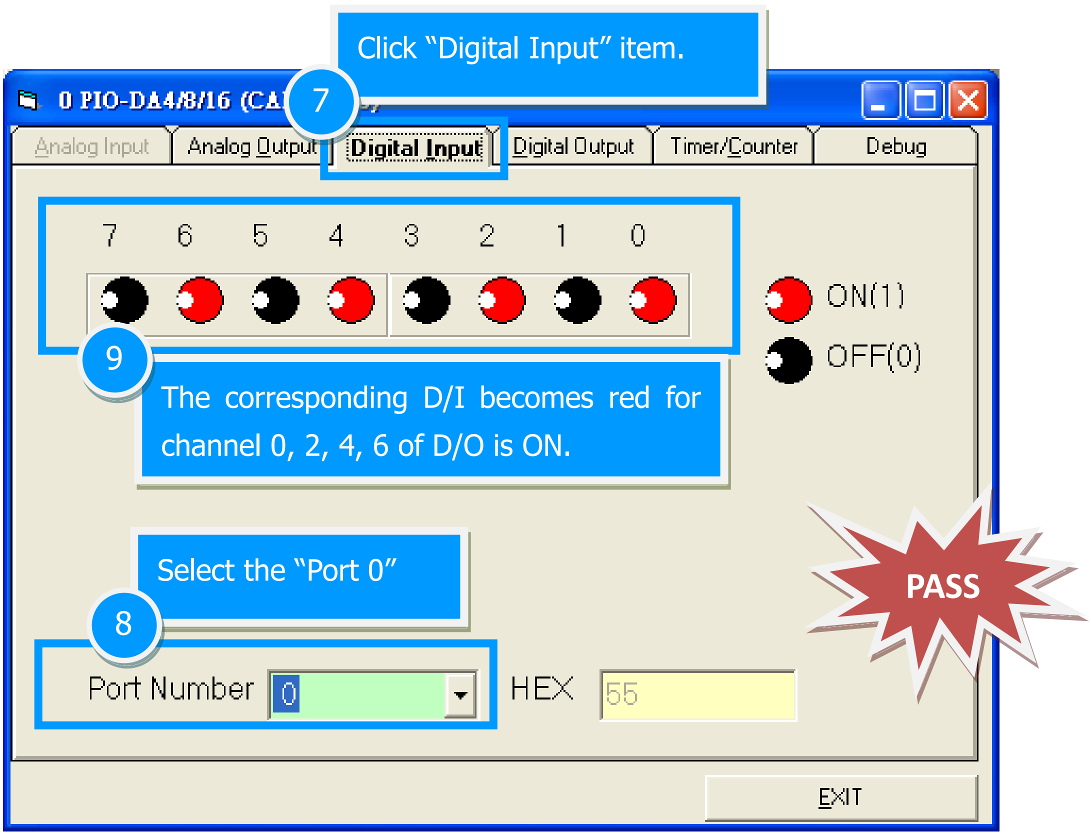


Note!!

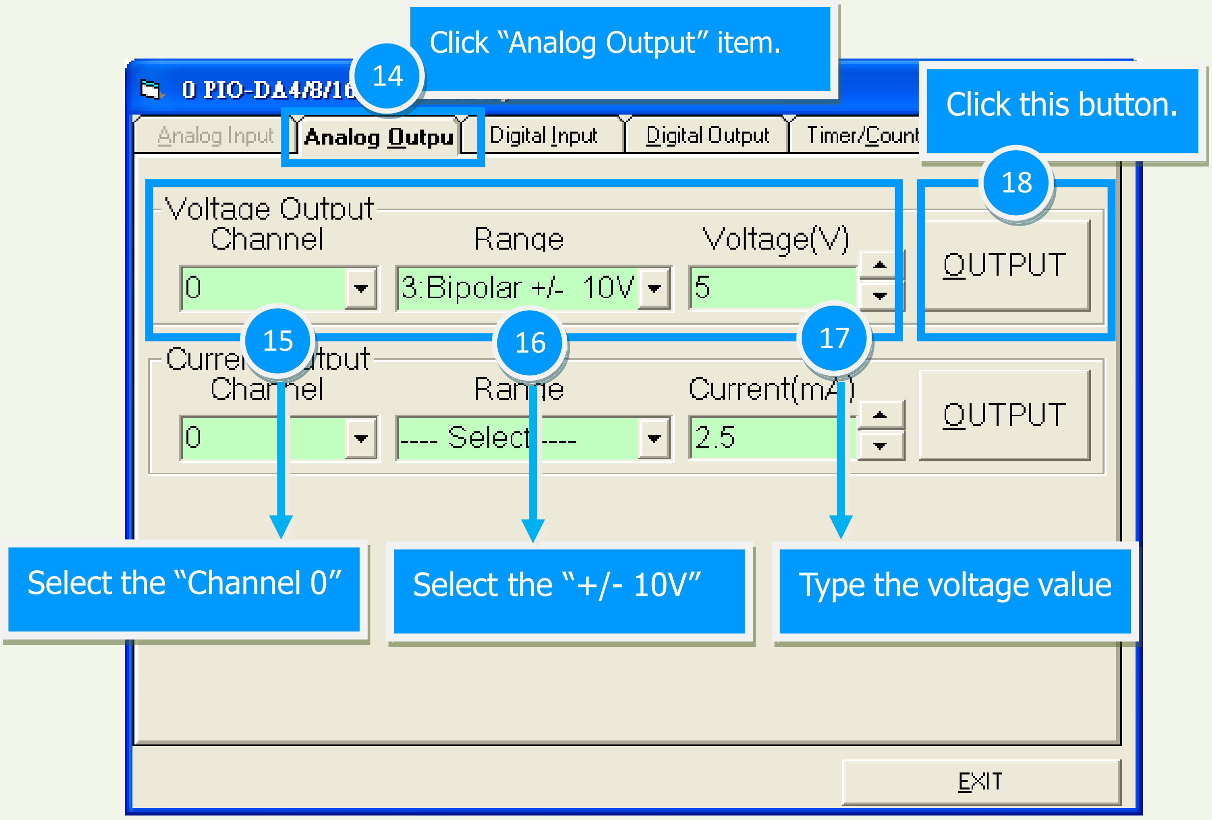
The PEX-DAx software is fully compatible with the PIO-DAxU series software.

2. Get **Digital Output/Input Function** test result.

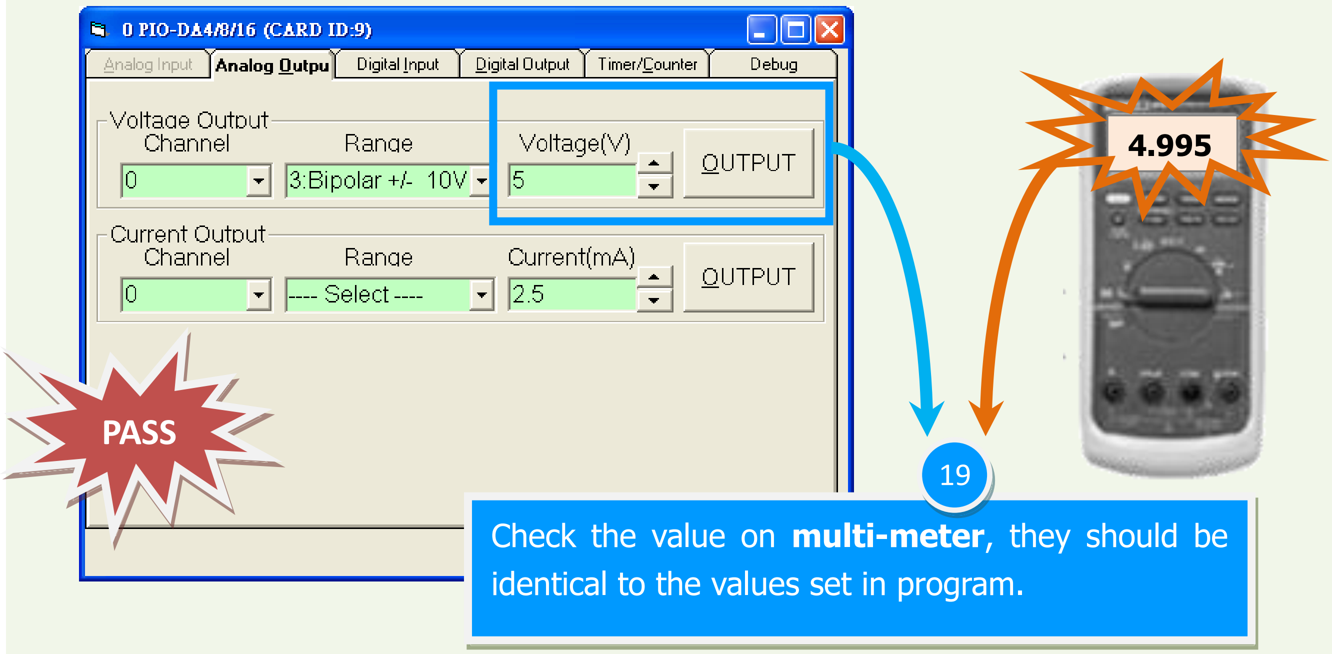




3. Get **Analog Output Function** test result.



The value read on meter may be a little difference from the DA value because of the resolution limit of meter or the measurement error.



6. I/O Control Register

6.1 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-on stage. The fixed IDs for the PEX-DAx, PISO-DAxU and PIO-DAxU series card are given as follows:

Table 6-1:

	PIO-DA4 PIO-DA8 PIO-DA16		PIO-DA4 PIO-DA8 PIO-DA16	PIO-DA4U PIO-DA8U PIO-DA16U	PISO-DA4U PISO-DA8U PISO-DA16U	PEX-DA4 PEX-DA8 PEX-DA16
Version	1.0 ~ 3.0	4.0 ~ above	1.0 ~ above	1.0 ~ above	1.0 ~ above	1.0 ~ above
Vendor ID	0xE159	0xE159	0xE159	0xE159	0xE159	0xE159
Device ID	0x02	0x01	0x01	0x01	0x01	0x01
Sub Vendor ID	0x80	0x4180	0x4180	0x4180	0x4180	0x4180
Sub Device ID	0x04	0x00	0x00	0x00	0x00	0x00
Sub-Axu ID	0x00	0x00	0x00	0x00	0x00	0x00

6.1.1 PIO_PISO.EXE Utility for Windows

The PIO_PISO.EXE utility program will detect and present all information for ICPDAS I/O cards installed in the PC, as shown in the following Figure6-1. Details of how to identify the PEX-DAx, PISO-DAxU and PIO-DAxU series card of ICPDAS data acquisition boards based on the **Sub-vendor**, **Sub-device** and **Sub-Aux ID** are given in Table 6-1.

The **PIO_PISO.exe** utility is located on the CD as below and is useful for all PIO/PISO series cards. (CD:\NAPDOS\PCI\Utility\Win32\PIO_PISO\)
http://ftp.icpdas.com/pub/cd/iocard/pci/napdos/pci/utility/win32/pio_piso/

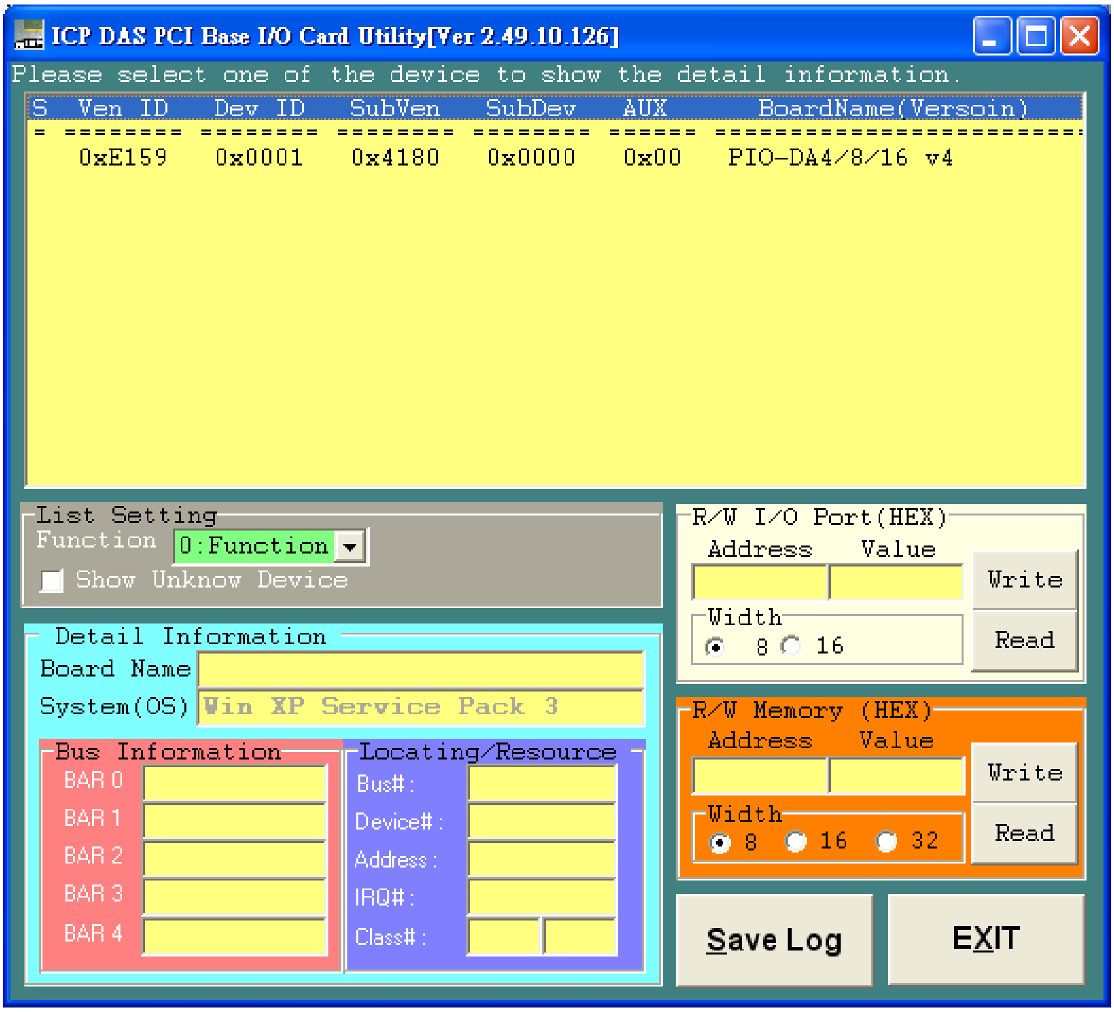


Figure 6-1

ICP DAS provides the following necessary functions:

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)

6.1.2 PIO_DriverInit

PIO_DriverInit(&wBoards, wSubVendor,wSubDevice,wSubAux)

wBoards=0 to N	The number of boards found in this PC
wSubVendor	The subVendor ID of the board you are seeking
wSubDevice	The subDevice ID of the board your are seeking
wSubAux	The subAux ID of the board you are seeking

This function can be used to detect all PIO/PISO series cards within your system. Implementation is based on the PCI Plug&Play mechanism. The function locates all PIO/PISO series cards installed in this system and save the relevant resource information in the library.

Sample program 1: Detect all PEX/PISO/PIO-DA series cards installed in this PC.

```
/* Step 1: Detect all PEX/PISO/PIO-DAx series cards installed in this PC */
wSubVendor=0x80; wSubDevice=4; wSubAux=0x00; /* For PIO-DA4/8/16 series cards*/

wRetVal=PIO_DriverInit(&wBoards, wSubVendor,wSubDevice,wSubAux);
printf("There are %d PIO-DA16 Cards in this PC\n",wBoards);

/* Step 2: Save the resource information for all PIO-DA4/8/16 series 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 the resource information for this card */
   wConfigSpace[i][1]=wIrq;                /*Save the resource information for this card */
}
```

Sample program 2: Detect all PIO/PISO cards installed in this PC.

```
/* Step 1: Detect all PIO/PISO series cards installed in this PC */
wRetVal=PIO_DriverInit(&wBoards,0xff,0xff,0xff);   /* Detect all PIO_PISO series cards */

printf("\nThere are %d PIO_PISO Cards in this PC",wBoards);

if (wBoards==0 ) exit(0);

/* Step 2: Save the resource information for all PIO/PISO cards installed in this PC */
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);
   }
```

6.1.3 PIO_GetConfigAdressSpace

PIO_GetConfigAddressSpace(wBoardNo,*wBase,*wIrq, *wSubVendor,*wSubDevice,*wSubAux,*wSlotBus, *wSlotDevice)

wBoards=0 to N	The total number of boards using the PIO_DriverInit(...) function
wBase	The base address of the board control word
wIrq	The allocated IRQ channel number for this board
wSubVendor	The subVendor ID of this board
wSubDevice	The subDevice ID of this board
wSubAux	The subAux ID of this board
wSlotBus	The bus number of the slot used by this board
wSlotDevice	The device number of the slot used by this board

The function can be used to save the resource information for all PIO/PISO cards installed in this system. The application program can then directly control all functions of the PIO/PISO series card.

Detect the configuration address space for your PEX/PISO/PIO-DA series cards.

```
/* Step 1: Detect all PEX/PISO/PIO-DA series cards */
wSubVendor=0x80; wSubDevice=4; wSubAux=0x00;    /*For PIO_DA4/8/16 series cards */

wRetVal=PIO_DriverInit(&wBoards, wSubVendor,wSubDevice,wSubAux);
printf("There are %d PIO-DA16/8/4 Cards in this PC\n",wBoards);

/* Step 2: Save the resource information for all PEX/PISO/PIO-DA 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 the resource information for this card*/
    wConfigSpace[i][1]=wIrq;              /*Save the resource information for this card*/
 }
/* Step 3: Control the PEX/PISO/PIO cards directly */
wBase=wConfigSpace[0][0];        /* get the base address for card_0 */
outport(wBase,1);                /* enable all D/I/O operations of card_0 */

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

6.1.4 Show_PIO_PISO

Show_PIO_PISO(wSubVendor,wSubDevice,wSubAux)

wSubVendor	The subVendor ID of the board you are seeking
wSubDevice	The subDevice ID of the board you are seeking
wSubAux	The subAux ID of the board you are seeking

This function will display a text string showing these special subIDs, which are the same as those defined in the PIO.H include file.

The code for the demo program is as follows:

```
/* Detect all PIO_PISO series cards installed in this PC */
wRetVal=PIO_DriverInit(&wBoards,0xff,0xff,0xff);
printf("\nThere 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);

   }
```

6.2 The Assignment of I/O Address

The plug&play BIOS will assign the proper I/O address to PEX-DAx, PISO-DAxU and PIO-DAxU series card. If there is only one PEX-DAx, PISO-DAxU and PIO-DAxU series card, the user can identify the board_0. If there are two PEX-DAx, PISO-DAxU and PIO-DAxU series cards in the system, the user will be very difficult to identify which board is board_0. The software driver can support 16 boards max. Therefore the user can install 16 boards in one PC system.

Sometimes, it is difficult to find the card number. The easiest way to identify which card is card_0 is to use the wSlotBus and wSlotDevice functions in the following manner:

Step 1: Remove all PEX/PISO/PIO-DA series cards from the PC.

Step 2: Install a PEX/PISO/PIO-DA series card into PCI_slot1 on the PC and then run PIO_PISO.EXE. Record the results shown for wSlotBus1 and wSlotDevice1.

Step 3: Remove all PEX/PISO/PIO-DA series cards from the PC.

Step 4: Install a PEX/PISO/PIO-DA series card into PCI_slot2 on the PC and then run PIO_PISO.EXE again. Record the result shown for wSlotBus2 and wSlotDevice2.

Step 5: Repeat (3) and (4) for all PCI_slots and record the results shown for each wSlotBus and wSlotDevice.

A possible sample record:

Table 6-2:

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 procedure outlined above can be used to record all wSlotBus and wSlotDevice information for all slots in the PC. This mapping is fixed for each PC, and can then be used to identify a specific PIO-PISO card in the following manner:

Step 1: Record all wSlotBus and wSlotDevice information.

Step 2: Use the PIO_GetConfigAddressSpace(…) function to retrieve the wSlotBus and wSlotDevice information for the specified card.

Step 3: The specified PIO-PISO card can be identified from the two results.

6.3 The I/O Address Map

The I/O address for PEX-DAx, PISO-DAxU and PIO-DAxU series cards is automatically assigned by the ROM BIOS of the PC and provides Plug&Play capabilities for PIO/PISO series cards. The PEX-DAx, PISO-DAxU and PIO-DAxU series I/O addresses are mapped as follows:

Table 6-3: Refer to Sec. 6.1.3 for more information about wBase.

Address	Read	Write
wBase+0	Reserved	RESET\ control register
wBase+2	Reserved	Aux control register
wBase+3	Aux data register	Aux data register
wBase+5	Reserved	INT mask control register
wBase+7	Aux pin status register	Same
wBase+0x2a	Reserved	INT polarity control register
wBase+0xc0	Read 8254-Counter0	Write 8254-Counter0
wBase+0xc4	Read 8254-Counter1	Write 8254-Counter1
wBase+0xc8	Read 8254-Counter2	Write 8254-Counter2
wBase+0xcc	Read 8254 control word	Write 8254 control word
wBase+0xd4	Read the Card ID	Reserved
wBase+0xe0	Read the Low byte of D/I	DA_0 chip select
wBase+0xe4	Read the High byte of D/I	DA_1 chip select
wbase+0xe8	Read the Low byte of D/I **(for PEX/PIO-DA only)**	DA_2 chip select
wBase+0xec	Read the High byte of D/I **(for PEX/PIO-DA only)**	DA_3 chip select
wBase+0xf0	Read the Low byte of D/I **(for PEX/PIO-DA only)**	Write the Low byte of D/A
wBase+0xf4	Read the High byte of D/I **(for PEX/PIO-DA only)**	Write the High byte of D/A
wBase+0xf8	Read the Low byte of D/I **(for PEX/PIO-DA only)**	Write the Low byte of D/O
wBase+0xfc	Read the High byte of D/I **(for PEX/PIO-DA only)**	Write the High byte of D/O

6.3.1 RESET\ Control Register

(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\

When the PC's power is first turned on, RESET\ signal is in a Low-state. **This will disable all DI/DO operations.** The user has to set the RESET\ signal to a High-state before any DI/DO command applications are initiated.

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

6.3.2 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

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 turned on, all Aux signals are in a Low-state. All Aux are designed as D/I for all PIO/PISO series. Please set all Aux to the DI state.

6.3.3 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

When the Aux is used for D/O, the output state is controlled by this register. This register is designed for feature extension. Therefore, do not use this register.

6.3.4 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	0	0	EN1	EN0

EN0=0→ Disable INT0 as an interrupt signal (Default).
EN0=1→ Enable INT0 as an interrupt signal

EN1=0→ Disable INT1 as an interrupt signal (Default)
EN1=1→ Enable INT1 as an interrupt signal

```
For example:
outportb(wBase+5,0);      /*Disable all interrupt */
outportb(wBase+5,1);      /* Enable interrupt of INT0 */
outportb(wBase+5,2);      /* Enable interrupt of INT1 */
outportb(wBase+5,3);      /* Enable both interrupt channels */
```

Refer to the following demo programs for more information:
DEMO3.C and DEMO4.C → single interrupt source
DEMO5.C and DEMO6.C → multiple interrupt source

6.3.5 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

Aux0=INT0, Aux1=INT1, Aux2~3= EEPROM control, Aux4~7=Aux-ID. Refer to Sec. 4.1 for more information. Aux0~1 are used as interrupt sources. The interrupt service routine needs to read this register to identify the interrupt sources. Refer to Sec. 2.3 for more information.

6.3.6 Interrupt Polarity 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	0	0	INV1	INV0

INV0/1=0→ select the inverted signal from INT0/1
INV0/1=1→ select the non-inverted signal from INT0/1

For example:

```
outportb(wBase+0x2a,0);   /*Select the inverted input from both channels */
outportb(wBase+0x2a,3);   /*Select the non-inverted input from both channels */

outportb(wBase+0x2a,2);   /*Select the inverted input from INT0 */
                          /*Select the non-inverted input from the others */
```

Refer to Sec. 2.3 and the DEMO3/4/5/6.C files for more information.

6.3.7 Read/Write 8254 Register

(Read/Write): wBase+0xc0=8254-counter-0
(Read/Write): wBase+0xc4=8254-counter-1
(Read/Write): wBase+0xc8=8254-counter-2
(Read/Write): wBase+0xcc=8254 control word

8254 Control Word

SC1	SC0	RL1	RL0	M2	M1	M0	BCD

[SC1, SC0]:

00: counter0
01: counter1
10: counter2
11: read-back command

[RL1, RL0]:
00: counter latch instruction
01: read/write low counter byte only
10: read/write high counter byte only
11: read/write low counter byte first, then high counter byte

[M2, M1, M0]:

000:	mode0	interrupt on terminal count
001:	mode1	programmable one-shot
010:	mode2	rate generator
011:	mode3	square-wave generator
100:	mode4	software-triggered pulse
101:	mode5	hardware-triggered pulse

[BCD]:
0: binary count
1: BCD count

For example:

```
WORD pio_da16_c0(char cConfig, char cLow, char cHigh) /*COUNTER_0*/
{
outportb(wBase+0xcc,cConfig);
outportb(wBase+0xc0,cLow);
outportb(wBase+0xc0,cHigh);
return(NoError);
}
WORD pio_da16_c1(char cConfig, char cLow, char cHigh) /*COUNTER_1*/
{
outportb(wBase+0xcc,cConfig);
outportb(wBase+0xc4,cLow);
outportb(wBase+0xc4,cHigh);
return(NoError);
}
WORD pio_da16_c2(char cConfig, char cLow, char cHigh) /*COUNTER_2*/
{
outportb(wBase+0xcc,cConfig);
outportb(wBase+0xc8,cLow);
outportb(wBase+0xc8,cHigh);
return(NoError);
}
```

6.3.8 Read Card ID Register

(Read): wBase+0xd4

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	ID3	ID2	ID1	ID0

For example:

```
wCardID = inportb(wBase+0xd4);            /* read Card ID(0x0~0x15) */
```

Note: The Card ID function is only supported by the PEX-DA, PISO-DAxU and PIO-DAxU(Ver. 1.1 or above)

6.3.9 Digital Input Register

(Read): wBase+0xe0 → Low byte of the D/I port

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0

(Read): wBase+0xe4 → High byte of the D/I port

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DI15	DI14	DI13	DI12	DI11	DI10	DI9	DI8

For example:

```
wDiLoByte = inportb(wBase+0xe0);          /* Read the D/I state (DI7~DI0) */
wDiHiByte = inportb(wBase+0xe4);          /* Read the D/I state (DI15~DI8) */
wDiValue = (wDiHiByte<<8)|wDiLoByte;
```

Refer to the DEMO2.C file for more information.

6.3.10 Digital Output Register

(Write): wBase+0xf8 → Low byte of the D/O port

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DO7	DO6	DO5	DO4	DO3	DO2	DO1	DO0

(Write): wBase+0xfc → High byte of the D/O port

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DO15	DO14	DO13	DO12	DO11	DO10	DO9	DO8

For example:

```
outportb(wBase+0xf8,wDoValue);          /*Controls the DO state (DO7~DO0) */
outportb(wBase+0xfc,wDoValue>>8);       /*Controls the DO state (DO15~DO8) */
```

Refer to the DEMO1/2.C file for more information.

6.3.11 D/A Select Register

There are 1/2/4 D/A converters in PEX/PISO/PIO-DA series cards. It is necessary to select which D/A converter is desired after the D/A data has be sent. D/A channels are allocated as follows:

Write	A1	A0	Description
wBase+0xe0 DA_0	0	0	D/A output channel 0
	0	1	D/A output channel 1
	1	0	D/A output channel 2
	1	1	D/A output channel 3
wbase+0xe4 DA_1	0	0	D/A output channel 4
	0	1	D/A output channel 5
	1	0	D/A output channel 6
	1	1	D/A output channel 7
wbase+0xe8 DA_2	0	0	D/A output channel 8
	0	1	D/A output channel 9
	1	0	D/A output channel10
	1	1	D/A output channel11
wbase+0xec DA_3	0	0	D/A output channel12
	0	1	D/A output channel13
	1	0	D/A output channel14
	1	1	D/A output channel15

```
For example:
outportb(wBase+0xf0,wDaValue);                /* output the low byte for D/A data */

outportb(wBase+0xf4,(wDaValue>>8)|0x02); /*output the high byte for D/A data and*/
                                          /*select channel 2 on this converter*/

outportb(wBase+0xe0,0);                   /*select DA_0*/
                                          /* after this procedure, the wDaValue will */
                                          /* be sent to channel_2 */
```

Refer to the DEMO6.C, DEMO7.C, DEMO8.C and DEMO9.C files for more information.

6.3.12 D/A Data Output Register

(Write): wBase+0xf0

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

(Write): wBase+0xf4

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
A1	A0	D13	D12	D11	D10	D9	D8

Each D/A converter have four analog output channels. When writing data to the D/A converter, the relevant channel to be used is indicated by A1 and A0.

D/A programming sequence:
1. Send data to the D/A converter. (This data will be buffered)
2. Select the D/A converter. (Start the conversion)

For example:

```
outportb(wBase+0xf0,wDaValue);              /* output low byte of D/A data*/
outportb(wBase+0xf4,(wDaValue>>8)|0x02);  /* output high byte of D/A data and */
                                           /* select channel 2 on this converter */
outportb(wBase+0xe0,0);                     /* select DA_0 */
                                            /* after this procedure wDaValue will */
                                            /* be sent to channel_2 */
pio_da16_da(2,wDaValue);       /* send wDaValue to channel_2 */

void pio_da16_da(char cChannel_no,int iVal)
{
        iVal=iVal+(cChannel_no%4)*0x4000;         /* cChannel_no: 0 - 15     */
        outportb(wBase+0xf0,iVal);                 /* iVal: 0x0000 - 0x3fff   */
        outportb(wBase+0xf4,(iVal>>8));
        outportb(wBase+0xe0+4*(cChannel_no/4),0xff);
        }
```

Refer to the DEMO6/7/8/9.C files for more information.

7. Demo Program

7.1 Demo Program for Windows

All demo programs will not work properly if the DLL driver has not been installed correctly. During the DLL driver installation process , the install-shields will register the correct kernel driver to the operation system and copy the DLL driver and demo programs to the correct position based on the driver software package you have selected (Win98/Me/NT/2K and 32-/64-bit winXP/2003/Vista/7/8). Once driver installation is complete, the related demo programs and development library and declaration header files for different development environments will be presented as follows.

Demo Program for PIO-DA Series Classic Driver:

The demo program of PIO-DA series is contained in:
CD:\NAPDOS\PCI\PIO-DA\DLL_OCX\Demo\
http://ftp.icpdas.com/pub/cd/iocard/pci/napdos/pci/pio-da/dll_ocx/demo/

There are about demo program given as follows:
Includes the BCB, Csharp, Delphi, VB.net, VC.net, VB and VC demo programs with source code.

- DA demo: D/A Output demo
- DIO demo: D/I/O demo
- DIO2 demo: D/I/O LED interface
- Interrupt demo: Single interrupt

For detailed information about the DLL function of the PIO-DA series, please refer to DLL Software Manual (CD:\NAPDOS\PCI\PIO-DA\Manual\)

Demo Program for UniDAQ SDK Driver

The demo program is contained in:
CD:\NAPDOS\PCI\UniDAQ\DLL\Demo\
http://ftp.icpdas.com/pub/cd/iocard/pci/napdos/pci/unidaq/dll/demo/

There are about demo program given as follows:
Includes the BCB, Delphi, VB.net, VC.net, VB and VC demo programs with source code.

- Analog Input Pacer
- Analog Input Pacer Continue
- Analog Input Pacer Scan
- Analog Input Pacer Scan Continue
- Analog Input Pacer Scan EXT
- Analog Input Polling
- Analog Output
- Analog Output Current
- Digital I/O
- Digital I/O by Card ID

For detailed information about the DLL function and demo program of the UniDAQ, please refer to UniDAQ DLL Software Manual (CD:\NAPDOS\PCI\UniDAQ\Manual\)

7.2 Demo Program for DOS

The related DOS software and demos are located on the CD as below:

CD:\NAPDOS\PCI\PIO-DA\dos\
http://ftp.icpdas.com/pub/cd/iocard/pci/napdos/pci/pio-da/dos/

After installing the software, the following drivers will be installed onto your hard disk:

- \TC*.* → for Turbo C 2.xx or above
  \TC\LIB*.* → for TC library
  \TC\DEMO*.* → for TC demo programs

  \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*.* → for MSC 5.xx or above
  \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*.* → for BC 3.xx or above
  \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

Note: The library is valid for all PIO/PISO series cards.

There are about demo program given as follows:

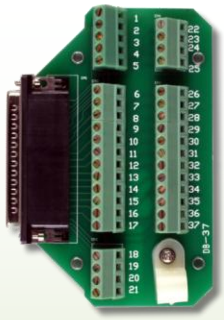
- DEMO1.EXE: D/O demo program
- DEMO2.EXE: D/I/O demo program
- DEMO3.EXE: Single interrupt source (initial high)
- DEMO4.EXE: Single interrupt source (initial low)
- DEMO5.EXE: Two interrupt source
- DEMO6.EXE: Waveform generator without calibration
- DEMO7.EXE: Waveform generator with calibration
- DEMO8.EXE: D/A hex value output without calibration
- DEMO9.EXE: D/A hex value output with calibration
- DEMO10.EXE: Save EEPROM data to file
- DEMO11.EXE: Download EEPROM data from file
- DEMO12.EXE: User software calibration
- DEMO13.EXE: Factory calibration

Note: The calibration demos programs can only be used in a DOS system.

Appendix: Daughter Board

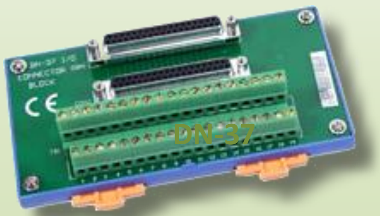
A1. DB-37 and DN-37

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



DB-37

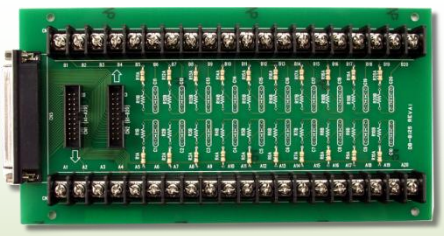
- **DN-37:** The DN-37 is a general purpose daughter board for DB-37 pins with DIN-Rail Mountings. They are also designed for easy wire connection via pin-to-pin.



DN-37

A2. DB-8125

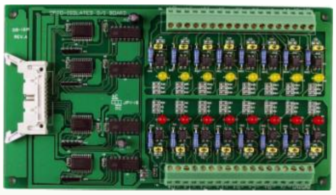
The DB-8125 is a general-purpose screw terminal board, and is designed for easy wiring. The DB-8128 uses one DB-37 and two 20-pin flat-cable headers.



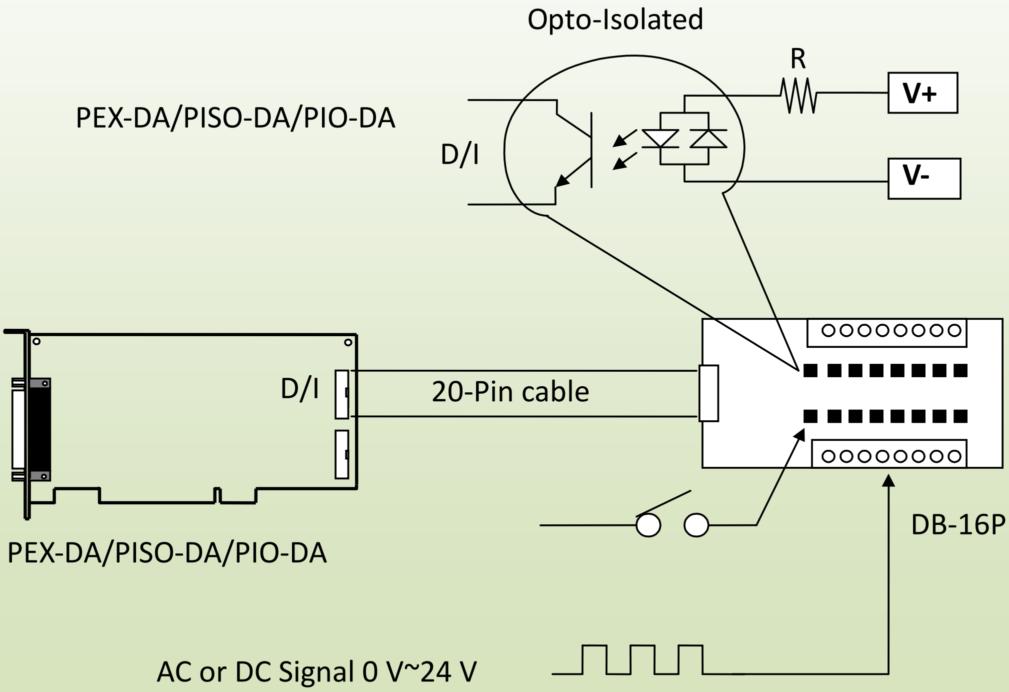
DB-8125

A3. DB-16P Isolated Input Board

The DB-16P is a 16-channel isolated digital input daughter board. The optically isolated inputs of the DB-16P are consisted of are bi-directional optocoupler with resistor for current sensing. You can use the DB-16P to sense DC signal from TTL levels up to 24 V or use the 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.

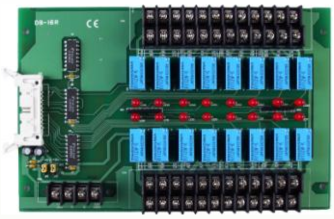


DB-16P

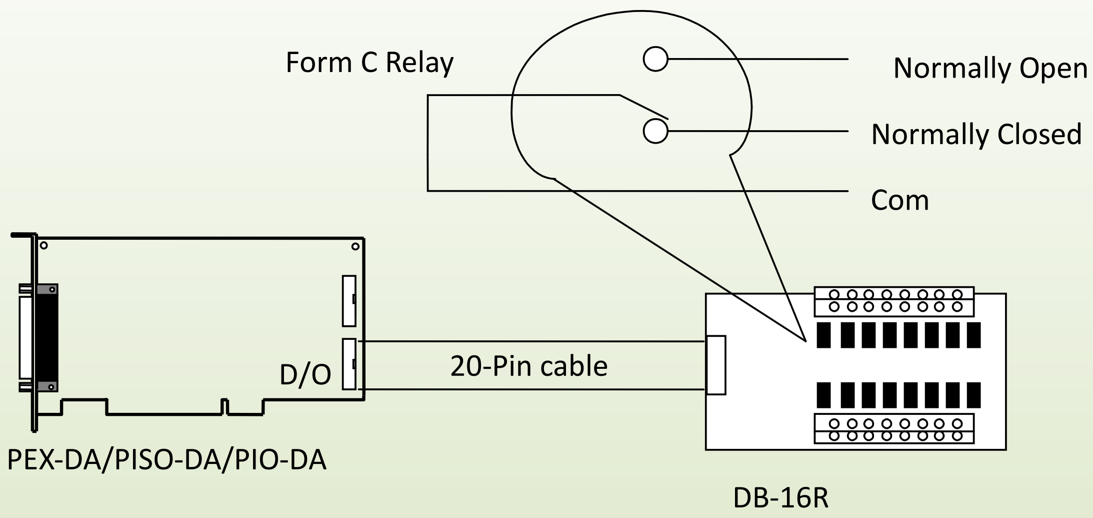


A5. DB-16R Relay Board

The DB-16R, 16-channel relay output board, consists of 16 Form C relays for efficient switching of load by programmed control. It is connector and functionally compatible with 785 series board but with industrial type terminal block. The relay is energized by applying 5 voltage signal to the appropriate relay channel on the 20-pin flat connector. There are 16 enunciator LEDs for each relay, light when their associated relay is activated. To avoid overloading your PC's power supply, this board provides a screw terminal for external power supply.



DB-16R

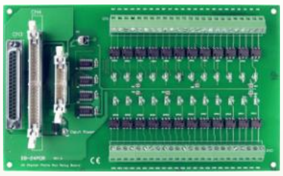


Note!!

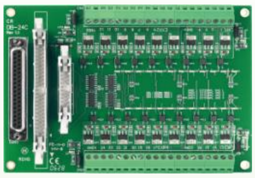
Channel: 16 Form C Relay
Relay: Switching up to 0.5 A at 110 V_{AC}/ 1 A at 24 V_{DC}

A6. DB-24PR/DB-24POR/DB-24C Power Relay Board

The DB-24PR is a 24-channel power relay output board that consists of 8 Form C and 16 Form A electromechanical relays that enable efficient switching of loads though a programmable control. The contact of each relay can control a 5 A load at 250 VAC/30 VDC. The relay is powered by applying a 5 V signal to the appropriate relay channel via the 20-pin flat cable connector, which only uses 16 relays or 50-pin flat cable connector. (OPTO-22 compatible, for the DIO-24 series). There are 24 LEDs, one for each relay, which are illuminated when their associated relay is activated. To avoid overloading the power supply of your PC, this board requires a +12 VDC or +24 VDC external power supply.

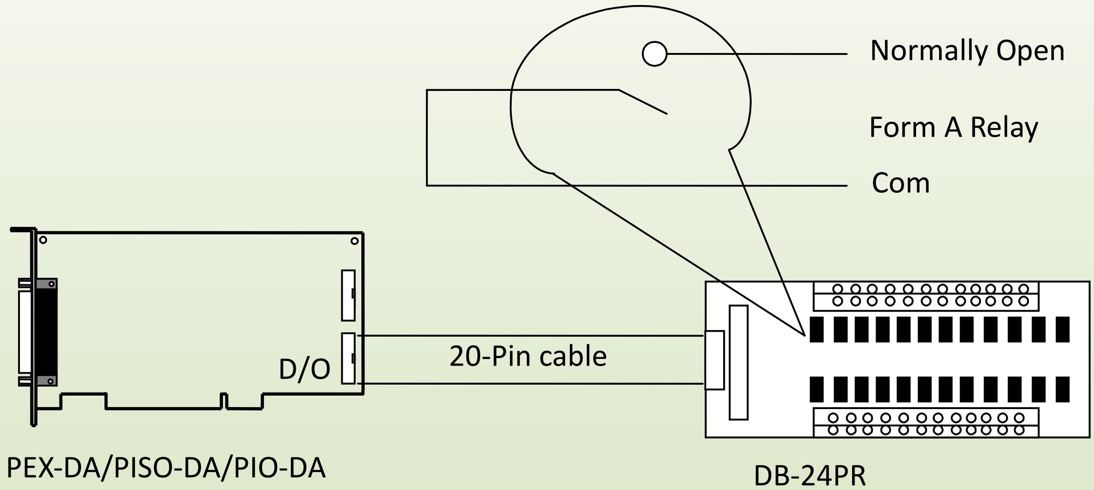


DB-24POR



DB-24C

DB-24PR



Note!!

50-Pin Connector (OPTO-22 compatible) for DIO-24/48/144 and PIO-D96/144/48/24.
20-Pin connector for 16-ch D/O board, A-82x, A-62x, DIO-64, ISO-DA16/DA8, PIO-D56 and PEX/PISO/PIO-DA
Channel: 16 Form A Relay and 8 Form C Relay
Relay: Switching up to 5 A at 110 V_{AC}/ 5 A at 30 V_{DC}