PCI-PID01

User Manual

Version 1.0d

DAQ SYSTEM
Measurement & Automation

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4. External Interface

5. Installation

6. Sample Program

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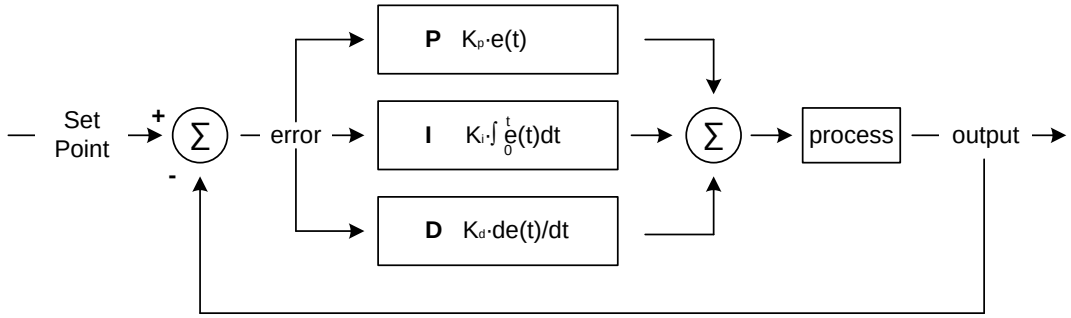
Reference

1. PID Control Concept

Proportional-Integral-Derivative controller (PID controller) is the typical form of the control scheme and most commonly used in real applications. PID controller basically has the feedback controller type, measure the output that you want to control the target, calculate the error that you want to compare with set value or reference value, this error value is used to calculate the values needed to control structure.



[Figure 1-1. PID Control Structure]

Standard form of PID controller is configured to calculate the control value (MV : manipulated variable) by adding three item of following expression.

$$MV(t) = K_p \cdot e(t) + K_i \cdot \int_0^t e(t)dt + K_d \cdot de(t)/dt$$

PID(Proportional–Integral–Derivative controller) that has a name because this item is proportional to their error value, the integral of error value, the derivative of error value. Three items meanings are as follows.

- Proportional : Control action that is proportional to the size of error value in the current state
- Integral : Acting to eliminate steady-state error value.
- Derivative : Braking to a sudden change of the output, reduce overshoot and improves stability.

PID controller is used above standard form. But in some case, there are many methods to use slightly modified form. For example, simplify the use of the controller with proportional item, or proportional-integral item, or proportional-derivative item. In this case, each of P, PI, PD is called.

The control parameter K_p, K_i, K_d is called a gain value or gain, Tuning is called the process of mathematical or experimental/empirical method to calculate the appropriate gain.

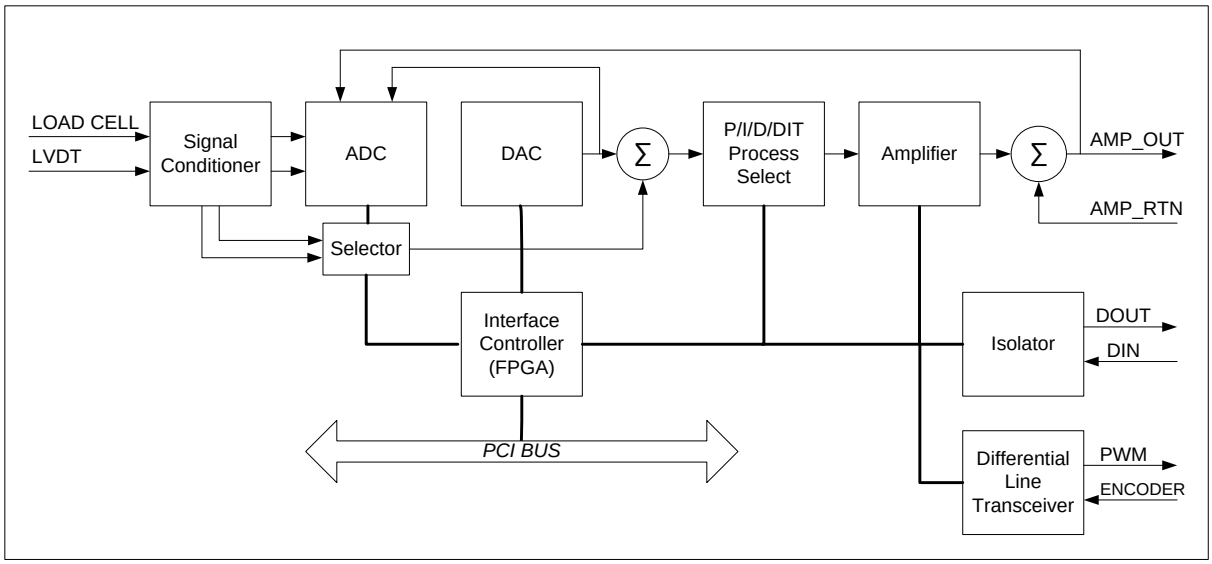
PID controller is used to measure the reaction of the automation system, as well as to control the reaction, in order to control the temperature, pressure, flow rate, rotation speed, etc.

➢ DAQ System Analog I/O Products

Products	Analog Input				Analog Output			Timer /Counter
	Sampling Rate	Resolution	Channel	Range(V)	Resolution	Channel	Range(V)	
PCI-AIO01		12/14/16	8 Single Ended /4 Differential	0~5, 0~10 ±5, ±10	12	2	0~10, ±10	
PCI-AIO02		12/14/16	8 Single Ended /4 Differential	0~5, 0~10 ±5, ±10	16	8	0~5, 0~10, 0~10.8 ±5, ±10, ±10.8	
PCI-AIO04		12/14/16	16Single Ended /8 Differential	0~5, 0~10 ±5, ±10	12	2	0~10, ±10	
PCI-AIO05		24	4 Single Ended /4 Differential	0~5, 0~10 ±5, ±10				
PCIe-AIO15		24	4 Single Ended /4 Differential	0~5, 0~10 ±5, ±10				
PCI-PID01	52Ksps	16/24	4	±10	16	1	±10	

2. PCI-PID01 Block Diagram

2-1 Functional Block Diagram

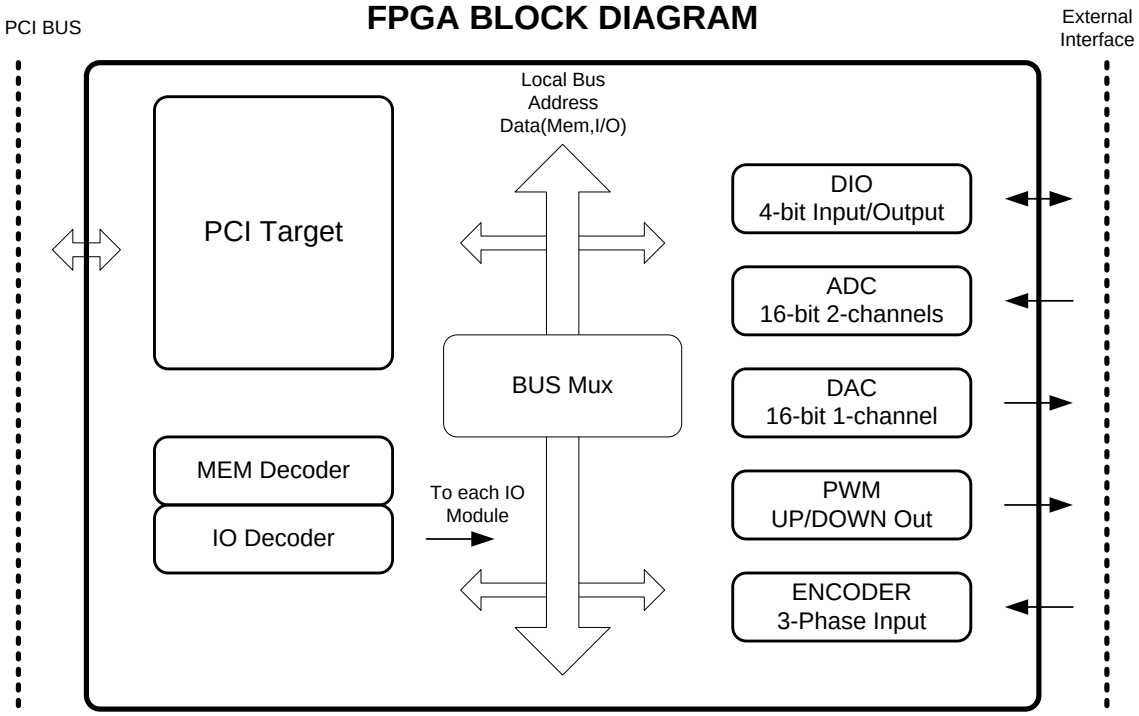


[Figure 2-1. Functional Block Diagram]

PCI-PID01 board has the ability to control external equipment depending on the hardware PID respond by adding the analog input of Load Cell, LVDT(Linear Variable Differential Transformer) and DA analog of the signals like above [Figure 2-1.]. In addition, the Digital Input/Output, PWM output, Encoder Input function has.

- **PCI 32-bit, 33MHz 5/3.3V Compatible Target Board**
- **Load cell/LVDT Analog Input**
- **20-bit Max. 52kSPS ADC**
- **16-bit Max. 3MSPS DAC**
- **±10V PID AMP Output**
- **Digital Input/Output(4-ch Input/4-ch Output)**
- **PWM UP/DOWN Output**
- **3-Phase ENCODER Input**

2-2 FPGA Block Diagram



[Figure 2-2. FPGA Block Diagram]

The interface controller of PCI-PID01 has the ability to control the external input and output from a user program through PCI BUS interface.

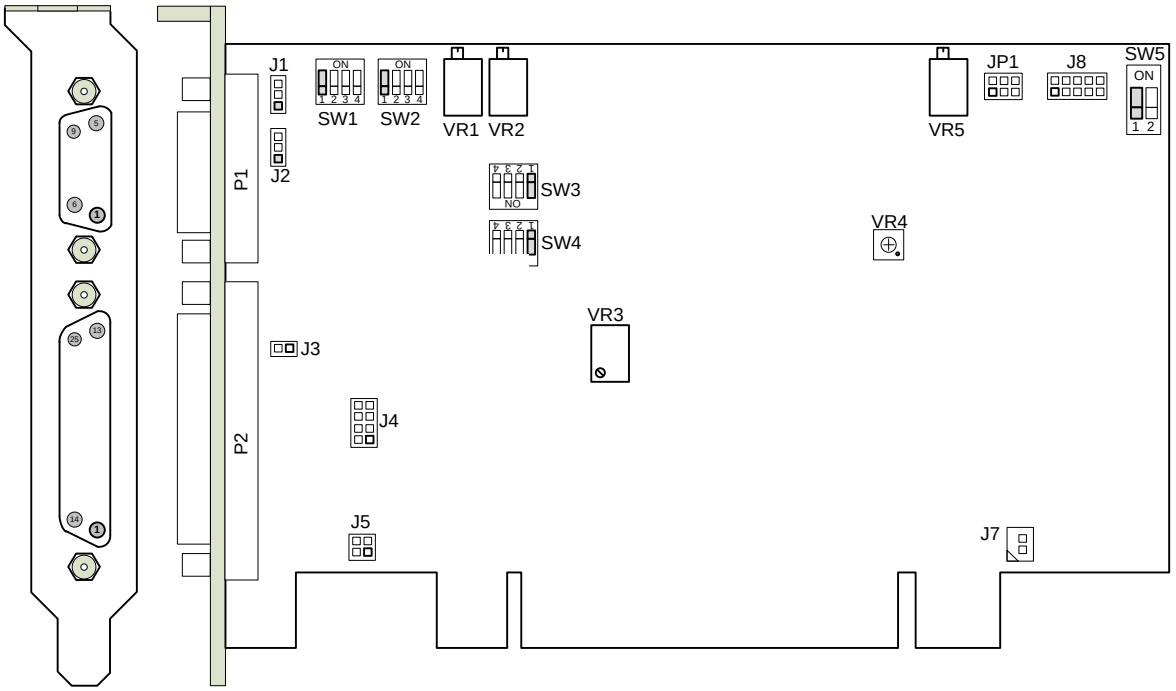
2-3 Product Features

List	Supported Attributes
Interface	PCI 32-bit, 33-Mhz 5/3.3V Compatible Bracket D-SUB 37-pin, 9-pin Connecter
Analog Input (ADC)	Channel : 4 개 Max. Input Range : ±10V Resolution : 20-bit Sampling : 5~10,000sps Channel 0, 1 : Load Cell, Displacement Sensor Input, Variable Application Channel 2(CMD) : Control Signal Channel 3(AMP) : Process Signal
Analog Control Signal (DAC)	Channel : DAC 1 for command(CMD) signal generation Resolution : 16-bit Max. Update : 3Msps Output Frequency Range : 0.00001~1000Hz
Analog Output (AMP_OUT)	Channel : 1 Output Level : ±10V Output Application Control : Digital Potentiometer Output Method : Voltage/Current Control
ENCODER Input	Channel : 1 (A,B,Z 3-Phase) Signal : Isolated Differential Line Drive Input
PWM Output	Channel : 1 (UP, DOWN) Signal : Isolated Differential Line Drive Output
Digital Input	Channel : 4 Input Range : 12V~24VDC, Isolated
Digital Output	Channel : 4 Output Range : 12V~24VDC, Isolated
Other	Board Sync Signal
Board Size	157 x100 mm (No Bracket)
Operation Temperature	
Operation Humidity	
Application	Kernel mode WDM Driver/User mode DLL
OS	Windows 2K/XP/7 32-bit
Components	PCI-PID01 Board, Installation CD(include sample program)

3. Board Connector

Each important board function is briefly described. For detailed function information, please refer to the parts specification.

3-1 Connector Layout

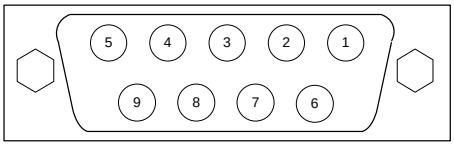


[Figure 3-1. Connector Layout]

3-2 Connector Description

3-2-1 Analog Input (P1)

This is an analog input signal connector from control equipment.



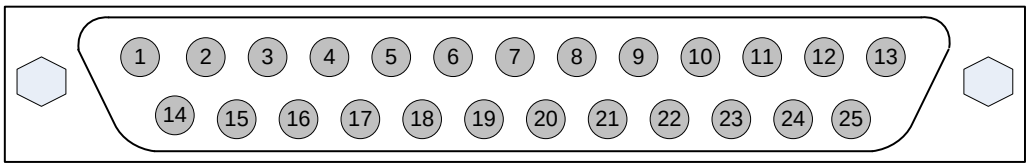
D-SUB-9S

[Table 1. Analog Input (P1) Connector]

Pin No.	Name	Description	Remark
1	VREF+	ADC Reference Power(+5V) Output	
2	VREF-	ADC Reference Power(-5V) Output	
3	AIN0+	Analog Input, CH0(+)	
4	AIN0-	Analog Input, CH0(-)	
5	AGND	Analog Ground	
6	+24V	Power(+24V)	
7	LGND	+24V Power Ground	Analog GND
8	AIN1+	Analog Input, CH1(+)	
9	AIN1-	Analog Input, CH1(-)	

3-2-2 Analog Output and Digital Control Connector (P2)

This is a connector for Analog Output(AMP), Digital Input/Output, PWM Output, ENCODER Input.



D-SUB-25P

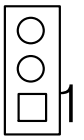
[Table 2. Analog Output and Digital Control (P2) Connector]

Pin No.	Name	Description	Remark
1	AMP_OUT	AMP Output	
2	AGND	Analog Ground	
3	DOUT0	Digital Output	
4	DOUT2	Digital Output	

5	DINCOM	Digital Input Common Port	
6	DIN1	Digital Input	
7	DIN3	Digital Input	
8	PWM_DN+	PWM Output, Down, Differential positive	
9	PWM_UP+	PWM Output, Up, Differential positive	
10	EN_Z+	Encoder Input, Z-Phase, Differential positive	
11	EN_B+	Encoder Input, B-Phase, Differential positive	
12	EN_A+	Encoder Input, A-Phase, Differential positive	
13	E_+5V	External +5V Input	
14	AMP_RTN	AMP Return Input	
15	DOUT_COM	Digital Output Common Port	
16	DOUT1	Digital Output	
17	DOUT3	Digital Output	
18	DIN0	Digital Input	
19	DIN2	Digital Input	
20	EGND	External Ground	
21	PWM_DN-	PWM Output, Down, Differential negative	
22	PWM_UP-	PWM Output, Up, Differential negative	
23	EN_Z-	Encoder Input, Z-Phase, Differential negative	
24	EN_B-	Encoder Input, B-Phase, Differential negative	
25	EN_A-	Encoder Input, A-Phase, Differential negative	

3-2-3 Analog Input Jumper (J1, J2)

This is a connector for analog signal to input within the equipment.



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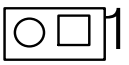
[Table 3. Analog Input Connector]

Pin No.	Name	Description	Remark
1	AIN+	Analog Signal Input, (+)	
2	AIN-	Analog Signal Input, (-)	
3	AGND	Analog Ground	

3-2-4 AMP Output Selection Jumper (J3)

Depending on the control types of the external equipment select the output method.



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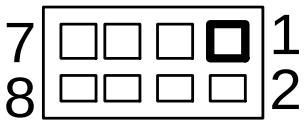
[Table 4. AMP Output Selection Connector]

Pin No.	Name	Description	Remark
1	ON	Voltage Output	
2	OFF	Current Output	

3-2-5 Maximum Current Setup Jumper (J4)



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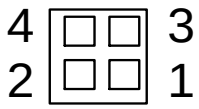
[Table 5. Maximum Current Setup Connector]

Pin No.	Name	Description	Remark
1-2	1A	Max. 1A	±10V Output Standards
3-4	500mA	Max. 500mA Control	±10V Output Standards
5-6	200mA	Max. 200mA Control	±10V Output Standards
7-8	100mA	Max. 100mA Control	±10V Output Standards

3-2-6 Shielding Circuit Power Connector (J5)

ENCODER, PWM circuit of board can be shielded from the outside. Without external shielding, it can be used to supply the internal power to Isolator, Lin-Driver/Receiver.



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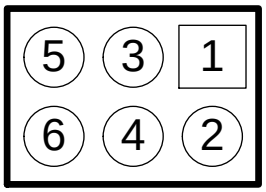
[Table 6. Shielding Circuit Power Connector]

Pin No.	Name	Description	Remark
1 - 2	+5V_PCI - E_+5V	System PCI power connected to the +5V external power.	
3 - 4	GND - EGND	System ground connected to the external ground.	

3-2-7 JTAG Interface Connector (JP1)

This is a connector for FPGA(U22) programming.



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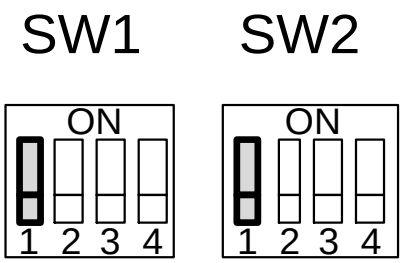
[Table 7. JTAG Interface Connector]

Pin No.	Name	Description	Remark
1	VCC	Reserved	Power, 3.3V
2	GND	Ground	Power
3	TCK	Test Clock	
4	TDO	Test Data Output	
5	TDI	Test Data Input	
6	TMS	Test Mode Select	

3-2-8 Analog Signal Gain Setup Switch (SW1, SW2)

Set to amplify the analog input signal (AIN0, AIN1). SW1 switch is used to amplify the signal AIN1. SW2 switch is used to amplify the signal AIN0.

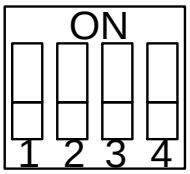


[Table 8. Analog Signal Amplification Setup Switch]

Switch Number and State				Amplification(times)	Remark
1	2	3	4		
O(ON)	X(OFF)	X	X	100.0	
O	O	X	X	199.0	
O	O	O	X	298.0	
X	X	X	O	399.4	
X	X	O	O	499.4	
X	O	O	O	597.4	
O	O	O	O	696.4	

3-2-9 Input Signal Frequency Setup Switch (SW3, SW4)

When analog input signal for AIN0, AIN1, respectably, as shown in [Table 8], the number of switches SW1, SW2 ON state, the maximum frequency is applied a Low-Pass Filter circuit.



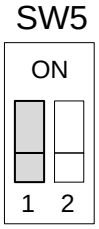
Slide, 4-pole

[Table 9. Frequency Setup Connector]

Switch(ON)	Maximum Frequency(fc)	Remark
1	1.592khz	
2	159.2hz	
3	16hz	
4	7hz	

3-2-10 Board Number Setup Switch ((SW5)

When mounting multiple boards in one system, depending on the DIP switch(SW5) recognize the number of the board. The maximum board that can be mounted is 4 in one system.



1	2	Board No.
OFF	OFF	0
ON	OFF	1
OFF	ON	2
ON	ON	3

[Figure 3-2. Board Number Setup Switch]

3-2-11 Analog Input Offset Control Switch (VR1, VR2)

This is a variable resistor for analog-to-digital conversion of the signal that is used to find the value of "0". VR1 switch is used to control the signal AIN1. VR2 switch is used to control the signal AIN0.

3-2-12 Square- wave Control Switch (VR3)

Adjust the frequency square-wave which is inserted in dithering mode.

3-2-13 VREF- Control Switch (VR4)

This is a variable resistor for controlling VREF-(-5V) voltage.

3-2-14 VREF+ Control Switch (VR4)

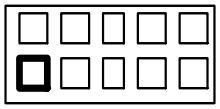
This is a variable resistor for controlling VREF+(+5V) voltage.

3-2-15 SYNC Signal Interface Connector (J8)

It is a synchronization signal connector between boards. Synchronous mode operation consists of one Master board and several Slave boards, and for synchronization signal connection, connect the J8 connector of each board with the same pin number.

If the board is a Master, it outputs the signals in Table 10, and if it is a Slave, it receives the signals.

When operating in independent mode, each board must operate as a Master, so the J8 connection cable must be removed as there is a risk of signal collision.



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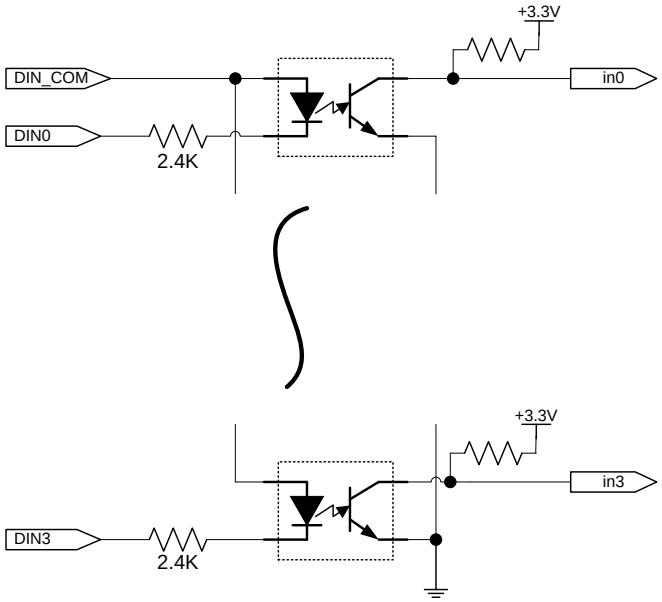
[Table 10. SYNC Signal Connector]

Pin No.	Name	Description	Remark
1	Trigger	Operation synchronization signal	3.3V CMOS
2-5	-	Reserved	
6	Clk_io	40Mhz Fixed clock signal	3.3V CMOS
7	Clk_pll	PLL Variable clock signal	3.3V CMOS

4. External Interface

4-1 Digital Input

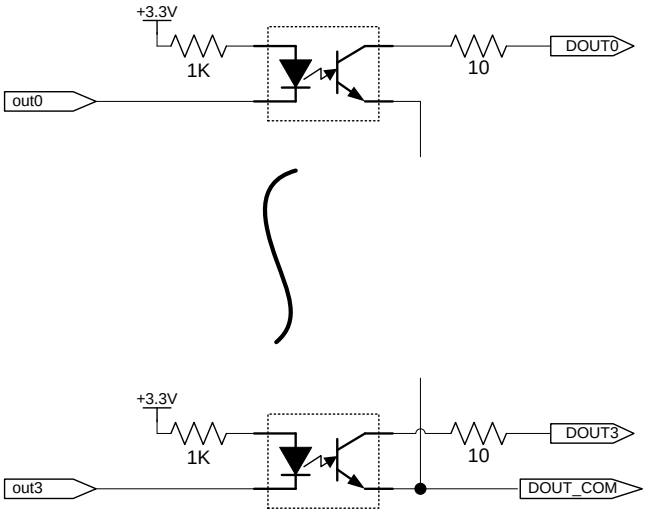
Digital inputs are separated by a Photo-diode. The board circuit is shown in [Fig 4-1].
By controlling the current flow DIN_COM and DIN pin will recognize the logic level on the board.



[Figure 4-1. Digital Input Circuit]

4-2 Digital Output

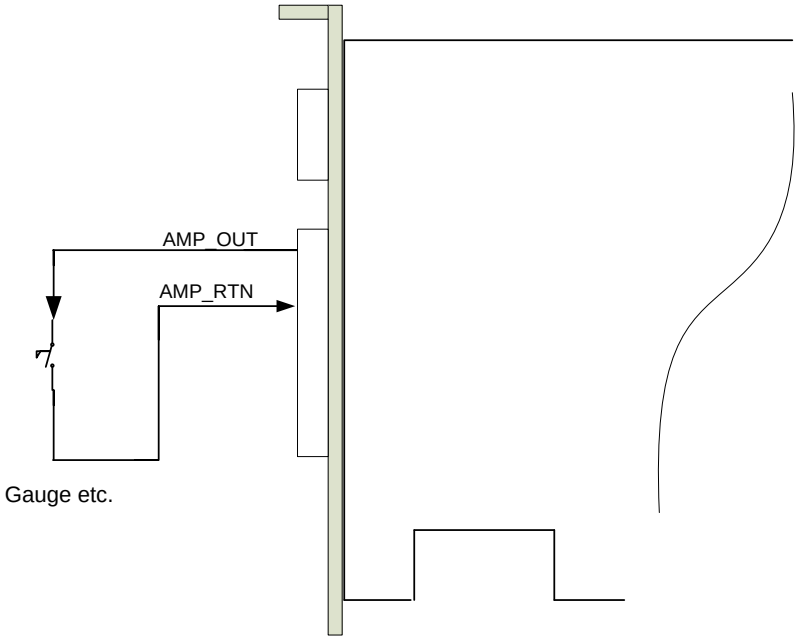
Also digital outputs are separated by a Photo-diode. The board circuit is shown [Fig 4-2], the current flows through the transistor depending on the out level from the inside is formed in the loop between DOUT and DOUT_COM can external control.



[Figure 4-2. Digital Output Circuit]

4-3 AMP Connection

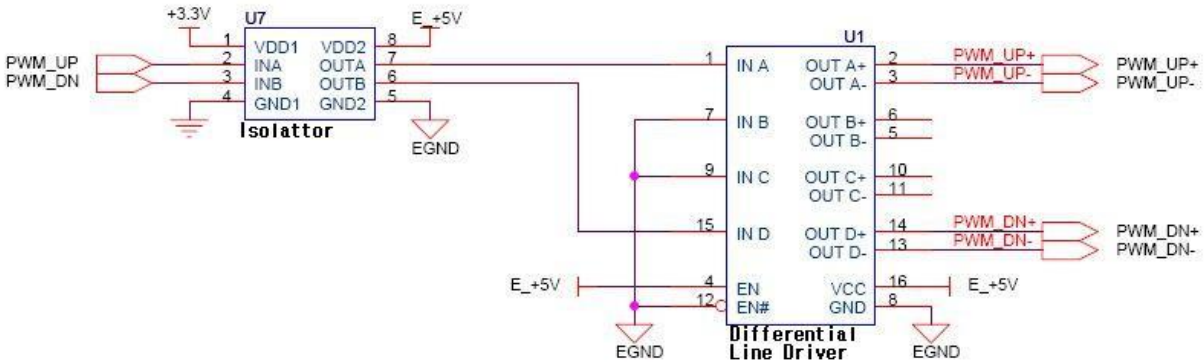
This is an output AMP_OUT signal for PID control. It can be controlled the voltage, current according J3 setup. Connect with an external device as shown in [Figure 4-3].



[Figure 4-3. AMP Connection]

4-4 PWM Output

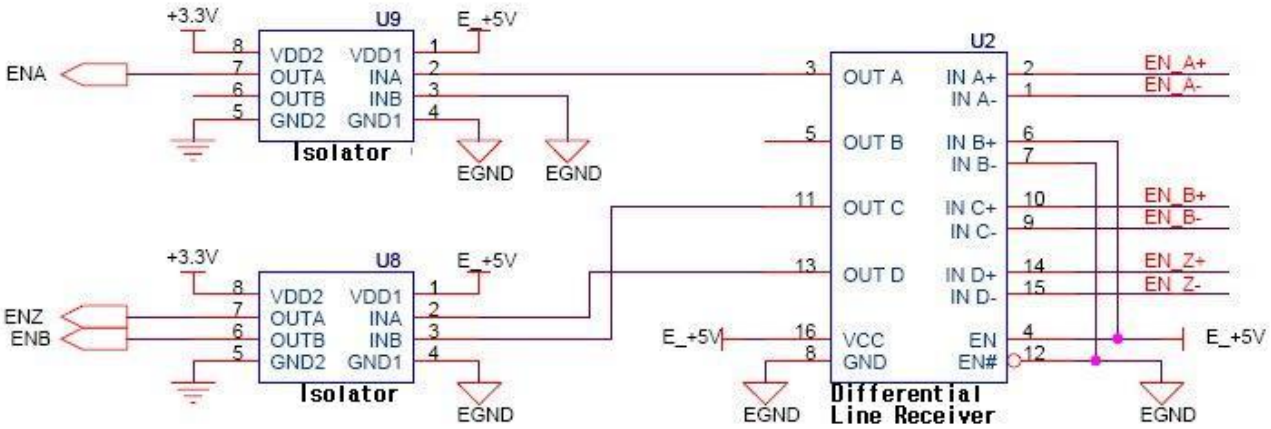
PWM output is composed of Isolator and Line Driver as shown in [Figure 4-4]. To operate the corresponding IC, internal or external power (E_+5V, 5VDC) is supplied. (Refer to 3.2.6 Settings)



[Figure 4-4. PWM Output Circuit]

4-5 Encoder Input

Encoder input circuit is as shown in [Figure 4-5], and consists of Line Receiver and Isolator. To operate the corresponding IC, internal or external power (E_+5V, 5VDC) is supplied. (Refer to 3.2.6 Settings)



[Figure 4-5. Encoder Input Circuit]

5. Installation

After unpacking, inspect the board carton to make sure there are no damages on the board.

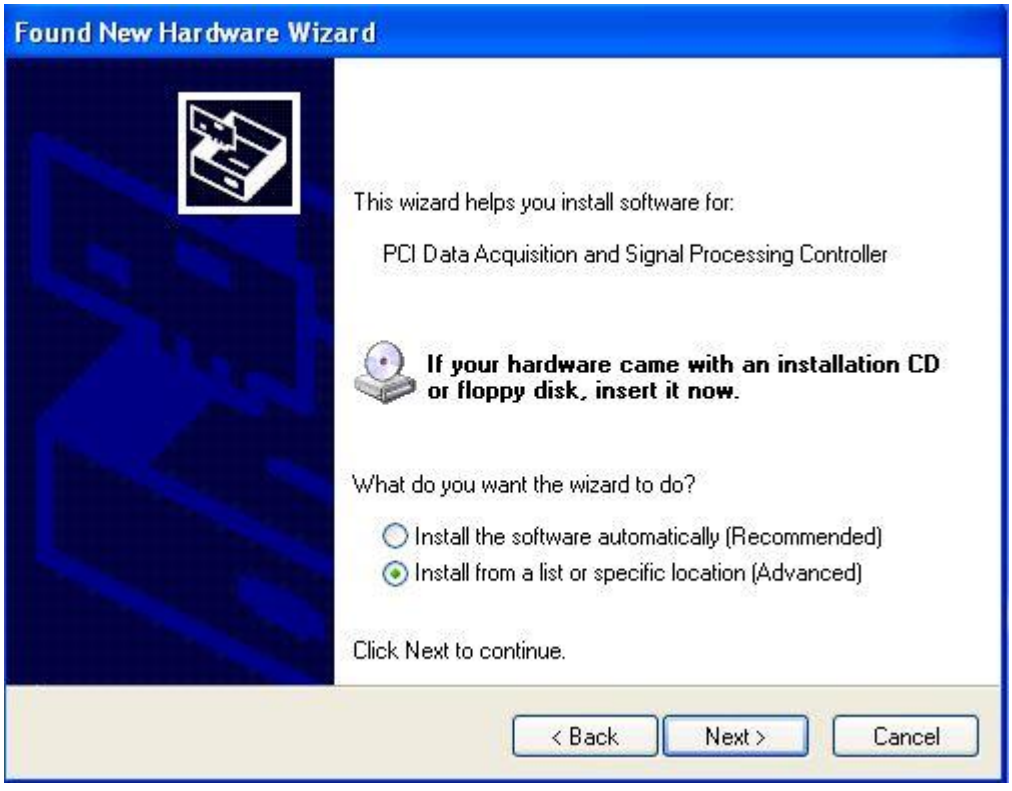
5-1 Package Content

1. PCI-PID01 Board
2. CD (Driver/Manual/API/Sample Source etc.)

5-2 Installation Sequence

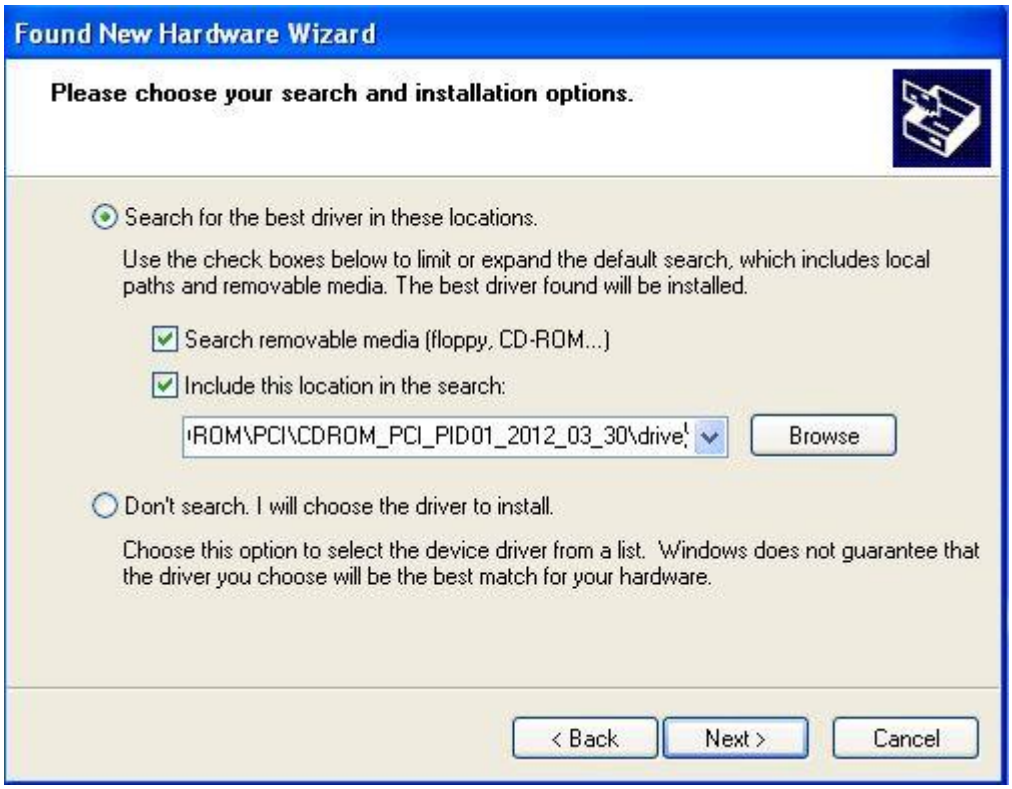
Board the environment, the use of Windows 2000 SP4 or higher, Windows XP SP1 or over, Windows 7 should be used. First, turn off the power of the PC is plugged PCI-PID01 board into the PCI Slot after that PC power is applied. The following describes the procedure to install the device on a Windows XP

After that you can show the below picture of "Found New Hardware Wizard" window.



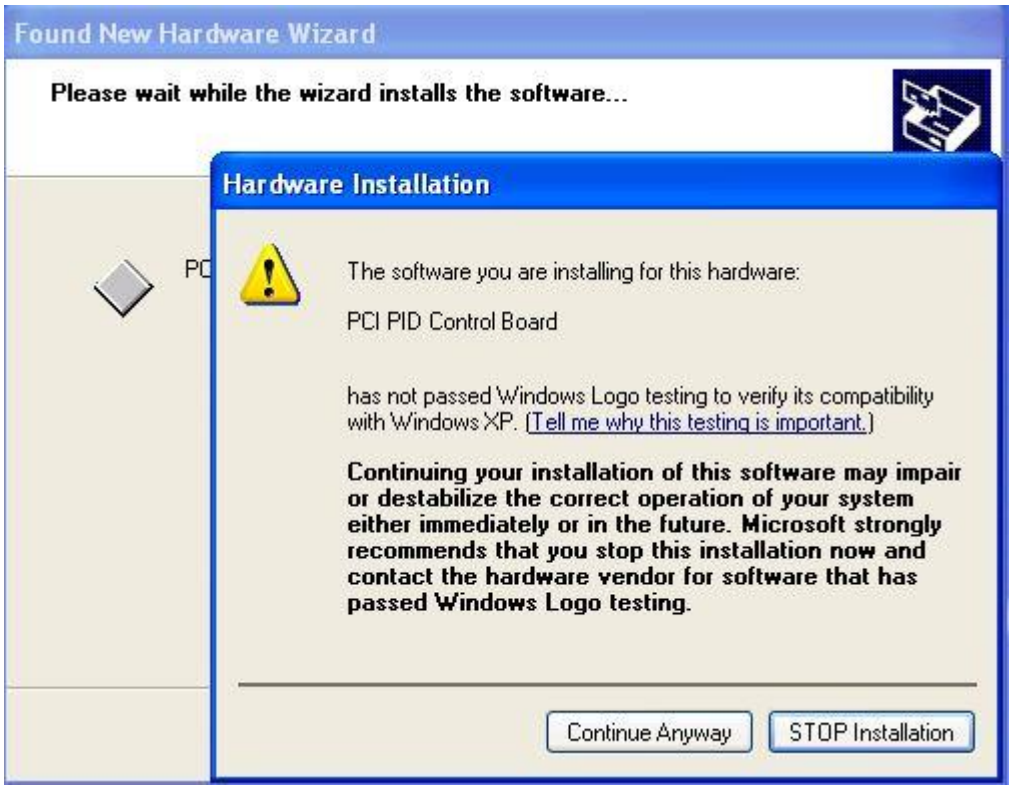
[Figure 5-1. New Hardware Search Wizard]

If new hardware is found, Wizard will ask you to install the corresponding driver. For installation of the driver, select the item "Install from a list or specific location (Advanced)" and click "Next" as in the figure.

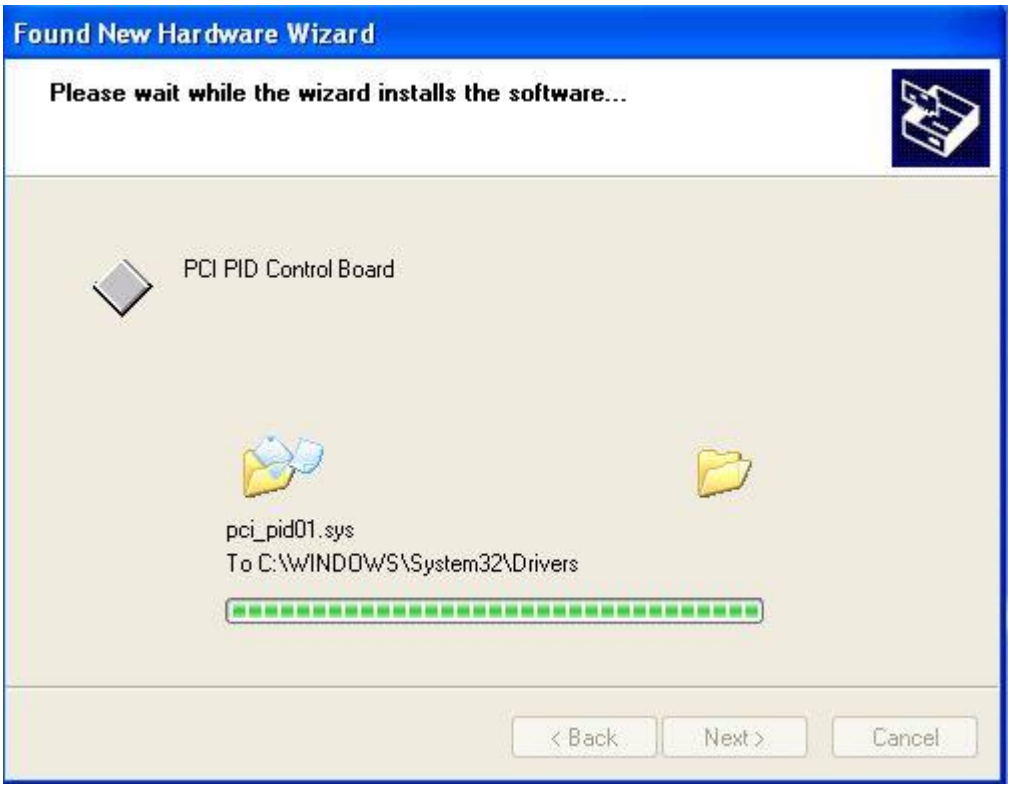


CD is located in the driver window as shown below or to find a specific location on the "Next" button click.

The driver folder includes a file of **"pci_pid01.inf"** and **"pci_pid01.sys"** that it is necessary for driver installation. A warning message appears during installation here, press "Continue Anyway" button. You can show below message window. The process progress as follows.



[Figure 5-2. Warning Message]

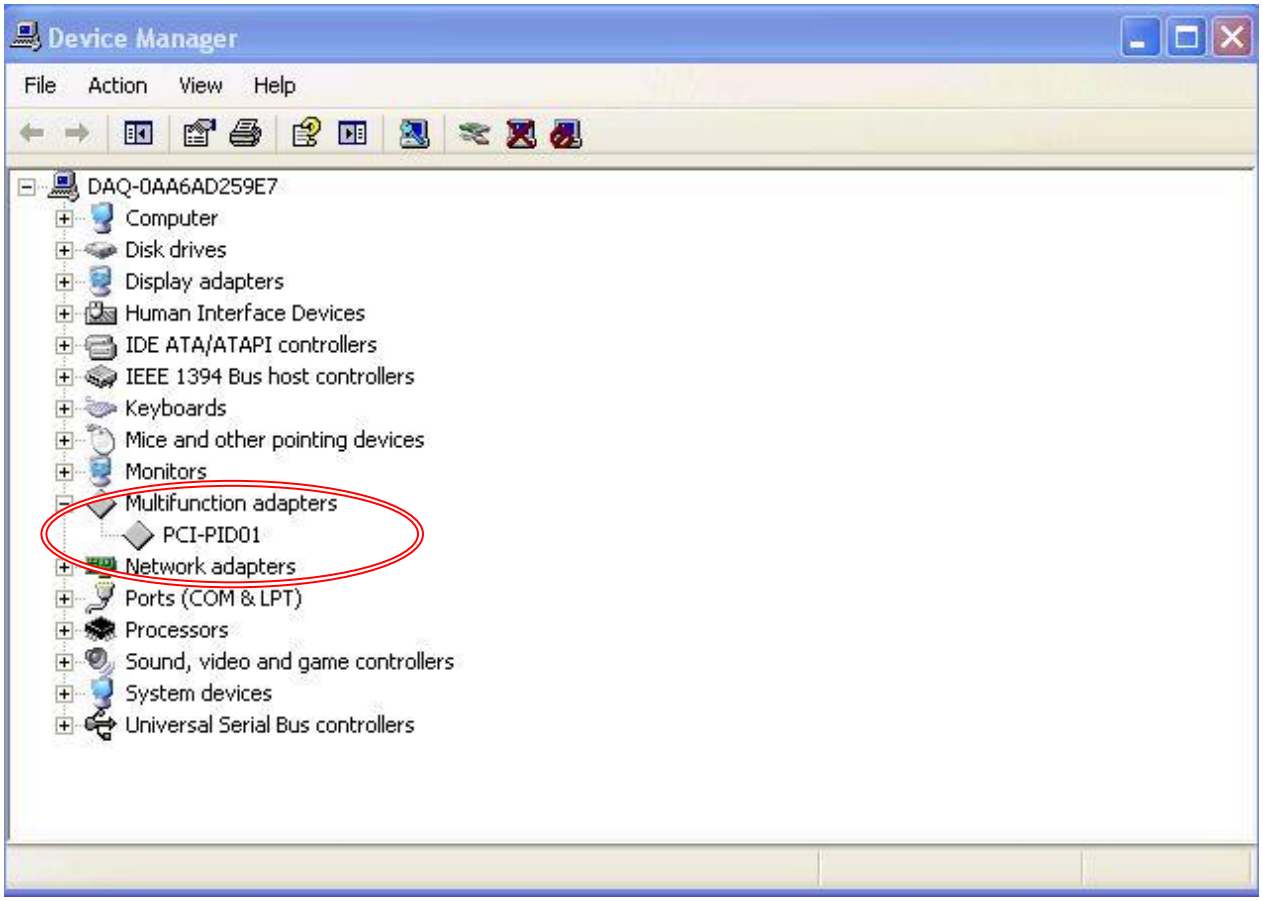


[Figure 5-3. Installation Processing]

If the installation is completely finished, you can show below message window.

5-3 Device Check

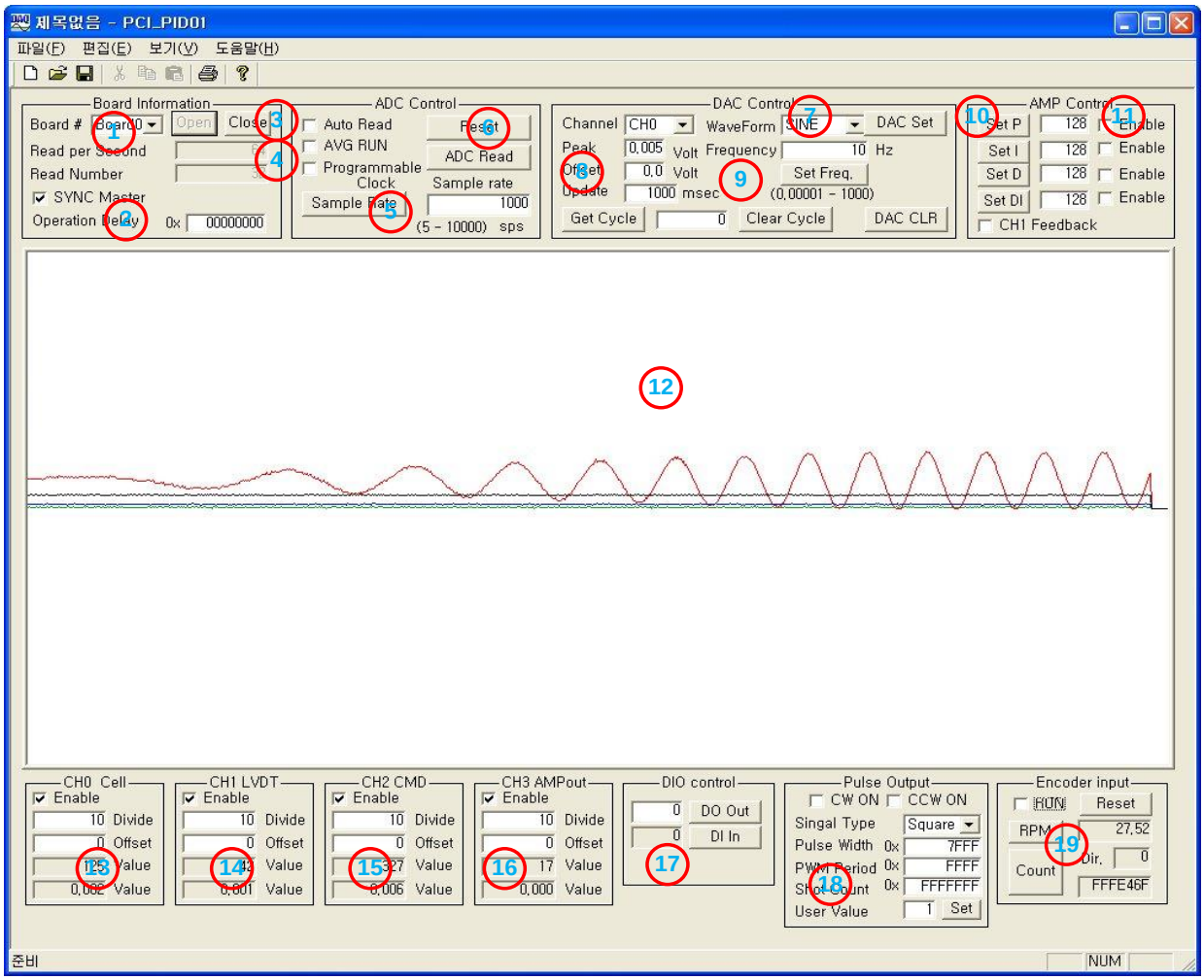
If the installation is completely finished, you confirm it in the following ways. Do the following steps to show up the "Device Manager" window. [My Computer -> properties -> Hardware -> Device Manager -> **Multifunction Adaptors -> PCI-PID01**]



If you can see the "PCI-PID01" at Multifunction Adaptors, the driver installation is to have been over. (Check the red circle)

Notice : After installation, you should re-boot the system for the proper operation.

6. Sample Program



[Figure 6-1. Sample Program]

Board operation operates in synchronous mode and independent mode. In the synchronous mode, a function is operated by a synchronization signal between boards, and the independent mode is a mode for individual board operation.

Synchronous mode consists of one master board and one or more slave boards, each board connected with a J8 connector. Trigger and clock signals are output from the master board.

Independent mode is operated individually without interworking between boards. The cable of the J8 connector should be removed, and the program should be run by setting it to "SYNC Master".

[Table 11. Sample Program Description]

No.	Items	Description	Remark
1	Board No.	Select the number of the board installed in the system.	
2	SYNC	Provides synchronization function between boards when operating using multiple boards. In the master board, you can select "Master" and adjust the operation time by "Operation Delay" value. In case of master, the trigger signal and two clocks are output to the J8 connector. In the case of a slave, the trigger input signal is asserted, and after delay by the "Operation Delay" value, the board operation is performed in synchronization with the clock. The delay time is in units of 25 nsec.	
3	AUTO READ	Automatically run the PID program. All functions are applied and displayed on the Graph.	
4	Programmable Clock(PLL)	PLL clock and 40Mhz oscillator clock are selected and used as ADC clock.	
5	Sample Rate	Set the number of AD samples per second.	
6	Reset	Initialize the ADC chip.	
7	Waveform	Select the DAC control signal (command) type.	
8	Peak, offset	Specifies the peak value and offset of the control signal. The peak value ranges from -9.9 to +9.9V.	
9	Set Frequency	Set the frequency of the control signal.	
10	GAIN Set	Set the gain of P/I/D/Dither. It is 0~255 of the set value.	
11	Enable	Select P/I/D/Dither control.	
12	Graph	Displays ADC input channels, Load Cell, LVDT, Reference (DAC) and AMP_OUT signals.	
13	CH0 Cell	Displays ADC channel 0 (AIN0) input signal. Controls the graph display and displays the current value.	
14	CH1 LVDT	Displays ADC channel 1 (AIN1) input signal.	
15	CH2 Command	Display DAC output on ADC channel 2 (AIN2).	
16	CH3 AMPout	Display AMP_OUT output on ADC channel 3 (AIN3).	
17	DIO Control	Execute Digital Input/Output.	
18	Pulse Output	PWM signal is output in CW(UP), CCW(DOWN) direction. Signal is output by selecting the square wave	

		(Square)/PWM (Pattern)/User signal type and selecting the direction by setting the duration time of the signal. (Refer to API) As for the signal, pulses are output as many as the number of Shot Counts.	
19	Encoder input	Displays the quadrature encoder counter value, rotation direction, and RPM value. The rotation direction is forward when '0', and the RPM value is initialized after 10 seconds if there is no input.	

Appendix

A-1 Repair Regulations

Thank you for purchasing DAQ SYSTEM's product. Please refer to the following regarding Customer Service stipulated by DAQ SYSTEM.

(1) Please read the user's manual and follow the instructions before using the DAQ SYSTEM product.

(2) When returning the product to be repaired, please send it to the head office with the symptoms of the malfunction as well.

(3) All DAQ SYSTEM products have a one-year warranty.
-. The warranty period is counted from the date the product is shipped from DAQ SYSTEM.
-. Peripherals and third-party products not manufactured by DAQ SYSTEM are covered by the manufacturer's warranty.
-. If repair is required, please contact the contact points below.

(4) Even during the free repair warranty period, paid repairs are made in the following cases.
① Failure or damage caused by not following the user's manual
② Failure or damage caused by customer negligence during product transportation after purchase
③ Natural phenomena such as fire, earthquake, flood, lightning, pollution, etc. or power supply exceeding the recommended range malfunction or damage
④ Failures caused by inappropriate storage environment (eg, high temperature, high humidity, volatile chemicals, etc.) damaged
⑤ Failure or damage due to unreasonable repair or modification
⑥ Products whose serial number has been changed or intentionally removed
⑦ In the event that DAQ SYSTEM determines that it is the customer's negligence for other reasons

(5) The customer must bear the shipping cost of returning the repaired product to DAQ SYSTEM.

(6) The manufacturer is not responsible for any problems caused by incorrect use regardless of our Warranty provisions.

References

1. PCI System Architecture

-- MindShare Inc.

2. PCI Local Bus Specification

-- PCI-SIG

3. AN201 How to build application using APIs

-- DAQ system

4. AN242 PCI-PID01 API Programming

-- DAQ system

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Contact Point

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