PCIe-TC03

User Manual

Version 1.1

DAQ SYSTEM
Measurement & Automation

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5. Sample Program

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Reference

1. Introduction

PCIe-TC03 is a PCI Express bus industrial board with general pulse count, quadrature encoder count, timer and digital input/output functions. Control of each function is implemented and applied to FPGA (Field Programmable Gate Array), so function reinforcement or change is quick and easy.

➢ DAQ System Digital I/O Products

Product	No. In/Out	Timer/Counter	Specification
cPCI-DIO6400	32/32		Isolated Input/Output
cPCI-DIO02	128 channels Software Configurable		Read/Write in 8 Groups in 16-bit Units
PCI(e)-DIO6400	32/32		Isolated Input/Output
PCI-DIO6401	64/None		Isolated Input
PCI-DIO6402	None/64		Isolated Output
PCI-DIO01	32/32 Software Configurable	1/1	TTL Level Input/Output 32bit Counter/Timer
PCI-DIO02	128 channels Software Configurable	1/1	Read/Write in 8 Groups in 16-bit Units
PCI-DIO12	16/16 or 32/32 Software Configurable		128Mbyte DDR SDRAM Data transfer rate up to 400Mb/s
PCI-MOT01	24/24 (Isolated)		1 Channel PWM, 2 Channel Encoder, 1 Channel ADC
PCI-PWM02	6/12(Isolated)		4 Channel Triggered PWM outputs
PCI(e)-TC03	16/16	8/8	32bit resolution Differential Counter/Timer
PCI-EK01	24(shared)	1/1(32bit)	12bit 8 Channel A/D Input 12bit 8 Channel D/A Output
PCIe-DIO05	32/32		TTL Level Input/Output
USB-AIO10	24/24(Isolated)		4-Ch Analog Input and Output RS-232 115,200bps Interface
USB-DIO12800	128 channels Software Configurable		Read/Write in 8 Groups in 16-bit Units
USB-DIO6400	32/32		Isolated Input/Output 12Mbps
USB-MULTI	2/None		Isolated Input/Output 16bit Counter In & Timer Out
USB-PWM10	6/8(Isolated)		4 Channel Triggered PWM outputs

1-1 Product Features

| Items	Description	Remark
Hardware		
PC Interface	PCI Express x1	32bit/33Mhz
Operation Power	+5VDC at 250mA typical	
I/O Port	D-Sub37	Plug Type
Feature	16bit Isolated In/Out, 8-Ch 32bit Counter/Timer	
Isolated Digital Input	Number of Channels : 16 Number of Common Input : 2 Maximum Input Range(Non-polarity) : 30V Digital Logic Levels : Input High level 5 ~ 12V Input Low voltage 0 ~ 1.5V Input Resistance : 620ohm Isolation Voltage : 2500Vrms Isolated input voltage up to 30V Interrupt Sources : Programmed I/O, Photo isolation	
Isolated Digital Output	Number of Channels : 16 Output type : Open collector Supply Voltage : 5V PCI or Isolated 5V(inside equipped) Isolation Voltage : 5000Vrms Data Transfer : Programmed I/O, Photo isolation	
Timer	8 Independent 32bit Timers Isolation Counter Input & Timer Output Base Timer Clock : 1MH	
Counter (Option)	8 Independent 32bit General Counters	
Encoder Counter (Option)	4-Ch 32bit Quadrature Counters Encoder Signal : Line Drive(DS26LS32 Compatibility) Encoder Multiplication: x1, x2, x4 jumper selection	
Simultaneous use of boards	Max. 4	
Operating temperature range	0 ~ 60℃	
Storage temperature range	-20 ~ 80℃	
Humidity range	5 ~ 95%	Non-condensing
Board size	160mm X 100mm	PCB Board Size
Software		
OS	Windows 2000/XP/7/8/10 (32/64bit)	
API	Windows Client DLL API	
Support	Windows Application by User	
Support	Sample Program	VC++

1-2   Product Applications

◆ **Data acquisition**
◆ **Laboratory instrumentation**
◆ **Process control systems**

2. PCIe-TC03 Block Diagram

PCIe-TC03 consists of 8 32-bit counters or 4 32-bit Quadrature Encoder counters, 8 32-bit timers, 16-bit digital input and 16-bit digital output circuits as shown in [Figure 2-1].
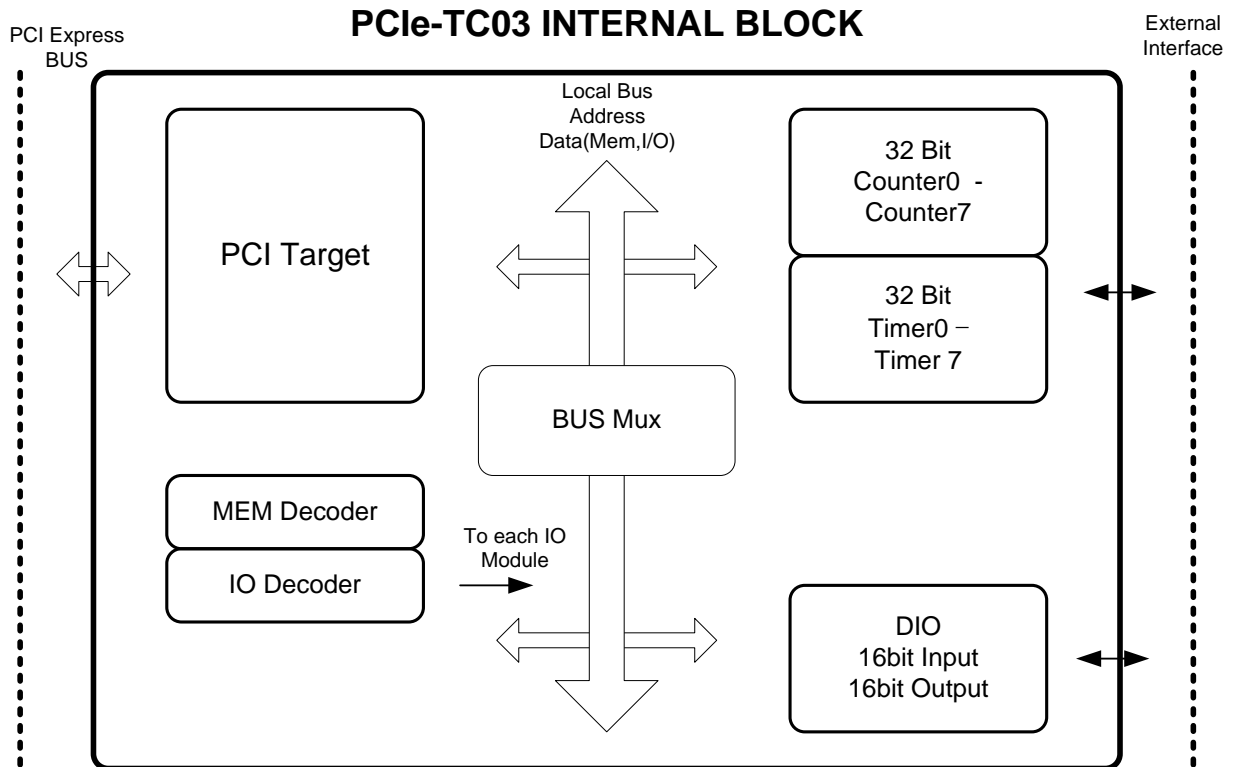
[Figure 2-1.   PCIe-TC03 Internal Block Diagram]

GENERAL DESCRIPTION
- ◆ **8-port 32-bit GENERAL timer**
- ◆ **8 port 32-bit counter or 4 channel 32-bit Quad Encoder counter (front 2 channels default)**
- ◆ **16-bit isolated input/output ports**

3. PCIe-TC03 Board Description

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

3-1 Board Layout
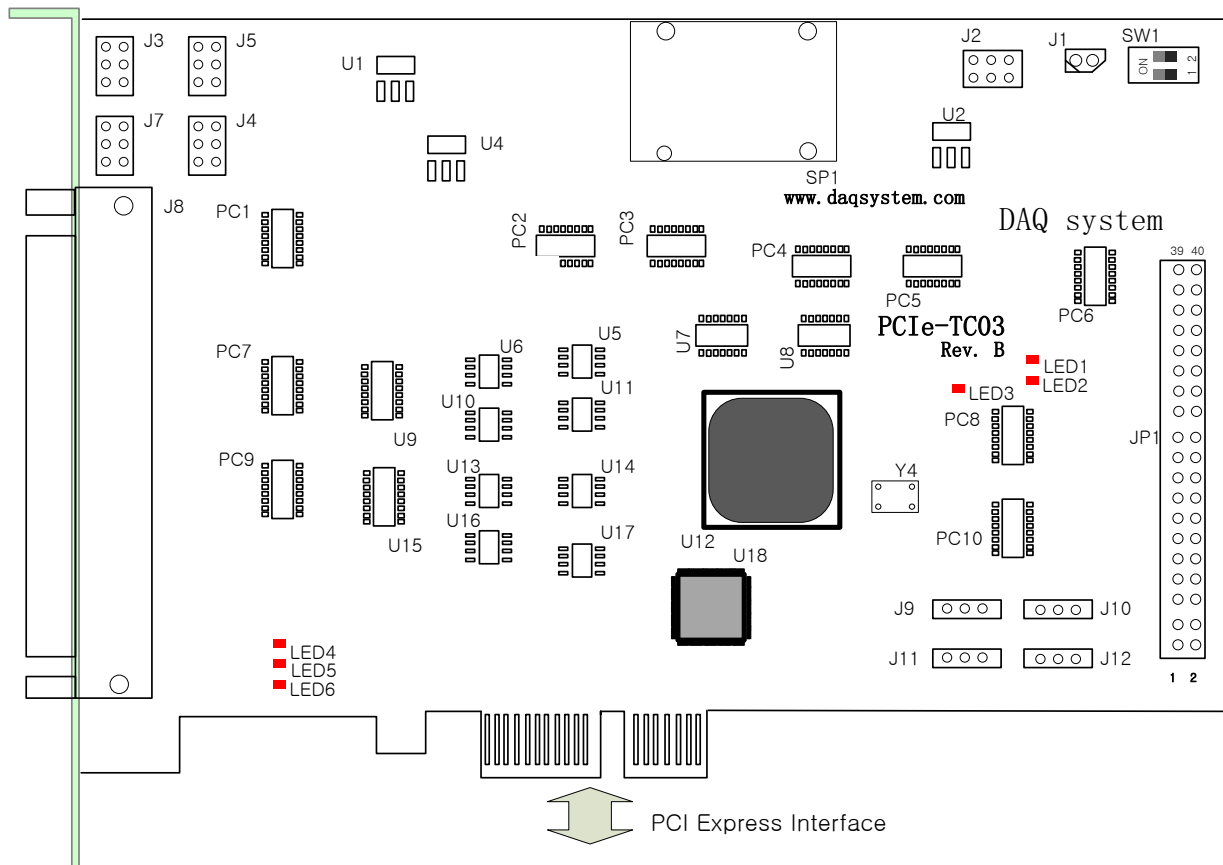
[Figure 3-1.   PCIe-TC03 Layout]

There are 6 LEDs on the board, and the description of each is as follows.

LED1 : Blinks according to PCI Express clock change.

LED2 : Blinks when there is a change in the COUNT0 or COUNT1 input signal.

LED3 : Lights up when FPGA fusing is complete.

LED4 : Blinks when the PCI Express connection is active.

LED5 : Indicates the PCI Express Reset signal status.

LED6: Indicates PCI Express power input.

3-2 Device Features

(1) **FPGA : U12**

All functions of the board are controlled through this FPGA Logic.

(2) **Photo-coupler : PC1 ~ PC10**

Photo-coupler chipset.

(3) **Regulator : U1, U2, U4, SP1**

It supplies the power used by the board.

(4) **PCI Express Chipset : U18**

PCI Express to PCI translation bridge
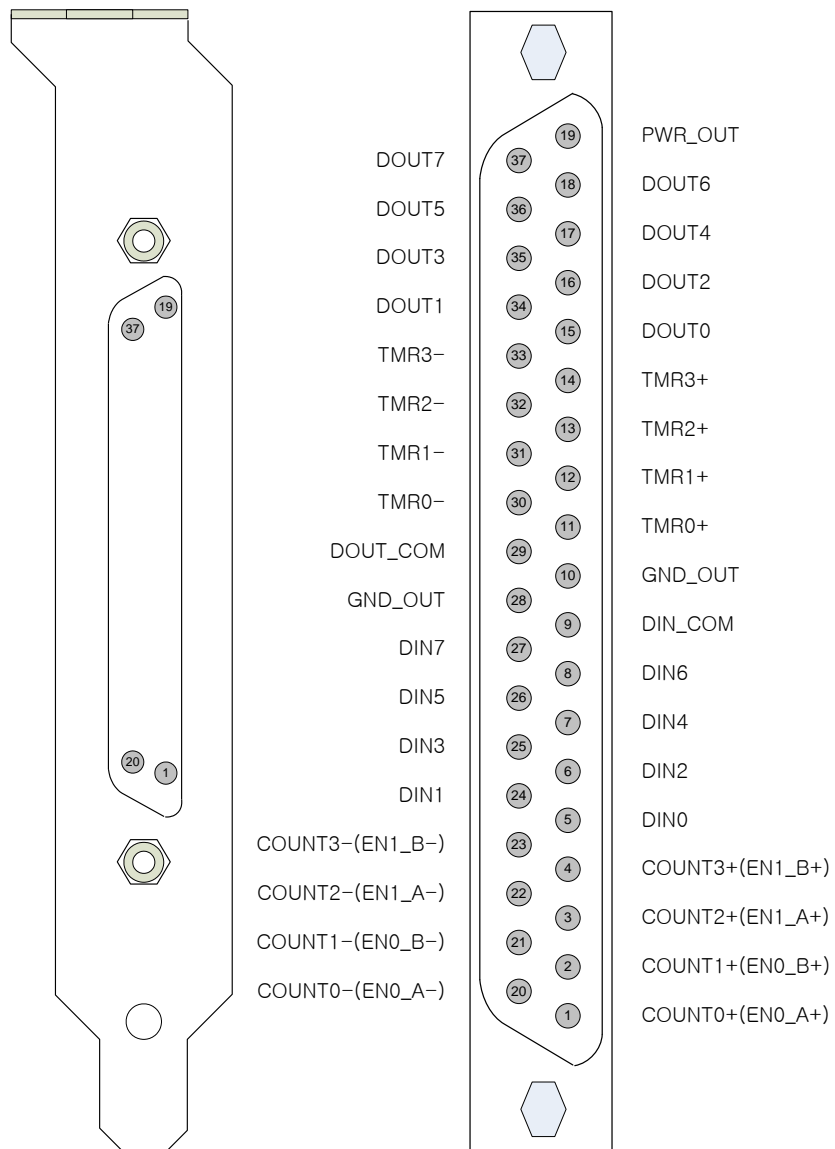
(5) **Oscillator : Y1**

Clock for local bus.

(6) **Selector : SW1**

Board Select Switch

3-3 Connector Pin Map

PCIe-TC03 receives counter, timer and digital I/O in two parts: D-Sub37 Pin (external connector) 82 and BOX 40 Pin header (internal connector) JP1.
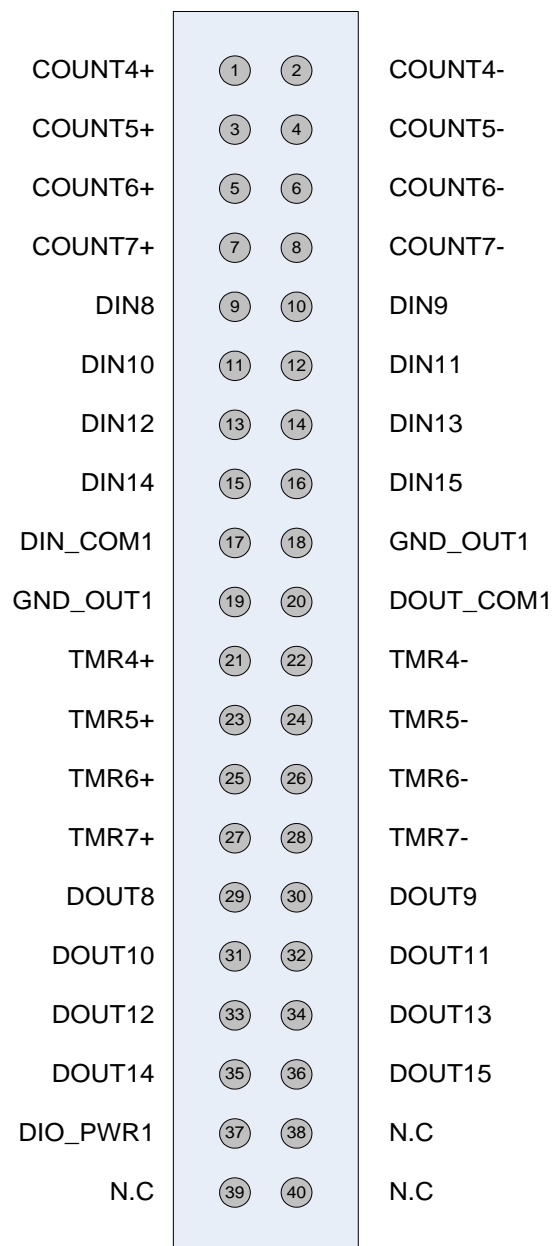
3-3-1 External DSub-37Pin (J8)

		19	PWR_OUT
DOUT7	37		
		18	DOUT6
DOUT5	36		
		17	DOUT4
DOUT3	35		
		16	DOUT2
DOUT1	34		
		15	DOUT0
TMR3−	33		
		14	TMR3+
TMR2−	32		
		13	TMR2+
TMR1−	31		
		12	TMR1+
TMR0−	30		
		11	TMR0+
DOUT_COM	29		
		10	GND_OUT
GND_OUT	28		
		9	DIN_COM
DIN7	27		
		8	DIN6
DIN5	26		
		7	DIN4
DIN3	25		
		6	DIN2
DIN1	24		
		5	DIN0
COUNT3−(EN1_B−)	23		
		4	COUNT3+(EN1_B+)
COUNT2−(EN1_A−)	22		
		3	COUNT2+(EN1_A+)
COUNT1−(EN0_B−)	21		
		2	COUNT1+(EN0_B+)
COUNT0−(EN0_A−)	20		
		1	COUNT0+(EN0_A+)

[Figure 3-2. PCIe-TC03 J8 Connector]

[Table 1.   PCIe-TC03 J8 Connector]

Pin No.	Pin Name	Description	Remark
1	COUNT0+(EN0_A+)	Counter 0 +Input, Encoder 0 A-Phase (+) Signal	
2	COUNT1+(EN0_B+)	Counter1 + Input, Encoder 0 B-Phase (+) Signal	
3	COUNT2+(EN1_A+)	Counter2 + Input, Encoder 1 A-Phase (+) Signal	
4	COUNT3+(EN1_B+)	Counter3 + Input, Encoder 1 B-Phase (+) Signal	
5	DIN0	Digital Input 0	
6	DIN2	Digital Input 2	
7	DIN4	Digital Input 4	
8	DIN6	Digital Input 6	
9	DIN_COM	Digital Input Common, Anode	DIN0~7 Common Input
10	GND OUT	Board Ground Output	
11	TMR0 +	Timer0 + Output	
12	TMR1 +	Timer1 + Output	
13	TMR2 +	Timer2 + Output	
14	TMR3 +	Timer3 + Output	
15	DOUT0	Digital Output 0	
16	DOUT2	Digital Output 2	
17	DOUT4	Digital Output 4	
18	DOUT6	Digital Output 6	
19	PWR_OUT	Board Power Output	Refer 3.7
20	COUNT0-(EN0_A-)	Counter0 - Input, Encoder 0 A-Phase (-) Signal	
21	COUNT1-(EN0_B-)	Counter1 - Input, Encoder 0 B-Phase (-) Signal	
22	COUNT2-(EN0_A-)	Counter2 - Input, Encoder 1 A-Phase (-) Signal	
23	COUNT3-(EN0_B-)	Counter3 - Input, Encoder 1 B-Phase (-) Signal	
24	DIN1	Digital Input 1	
25	DIN3	Digital Input 3	
26	DIN5	Digital Input 5	
27	DIN7	Digital Input 7	
28	GND OUT	Board Ground Output	
29	DOUT_COM	Digital Output Common	DOUT0~7 Common Output

30	TMR0 -	Timer0 - Output	
31	TMR1 -	Timer1 - Output	
32	TMR2 -	Timer2 - Output	
33	TMR3 -	Timer3 - Output	
34	DOUT1	Digital Output 1	
35	DOUT3	Digital Output 3	
36	DOUT5	Digital Output 5	
37	DOUT7	Digital Output 7	

3-3-2 Internal BOX 40Pin (JP1)

COUNT4+	1	2	COUNT4-
COUNT5+	3	4	COUNT5-
COUNT6+	5	6	COUNT6-
COUNT7+	7	8	COUNT7-
DIN8	9	10	DIN9
DIN10	11	12	DIN11
DIN12	13	14	DIN13
DIN14	15	16	DIN15
DIN_COM1	17	18	GND_OUT1
GND_OUT1	19	20	DOUT_COM1
TMR4+	21	22	TMR4-
TMR5+	23	24	TMR5-
TMR6+	25	26	TMR6-
TMR7+	27	28	TMR7-
DOUT8	29	30	DOUT9
DOUT10	31	32	DOUT11
DOUT12	33	34	DOUT13
DOUT14	35	36	DOUT15
DIO_PWR1	37	38	N.C
N.C	39	40	N.C

[Figure 3-3. PCIe-TC03 BOX 40 Pin JP1 Connector]

[Table 2.   PCIe-TC03 BOX40 PIN JP1 Connector (HIROSE HIF3F-40PA-2.54DS)]

Pin No.	Pin Name	Description	Remark
1	COUNT4+(EN2_A+)	Counter4 + Input, Encoder 2 A-Phase (+) Signal	
2	COUNT4-(EN2_A-)	Counter4 – Input, Encoder 2 A-Phase (-) Signal	
3	COUNT5+(EN2_B+)	Counter5 + Input, Encoder 2 B-Phase (+) Signal	
4	COUNT5-(EN2_B-)	Counter5 - Input, Encoder 2 B-Phase (-) Signal	
5	COUNT6+(EN3_A+)	Counter6 + Input, Encoder 3 A-Phase (+) Signal	
6	COUNT6-(EN3_A-)	Counter6 - Input, Encoder 3 A-Phase (-) Signal	
7	COUNT7+(EN3_B+)	Counter7 + Input, Encoder 3 B-Phase (+) Signal	
8	COUNT7-(EN3_B-)	Counter7 - Input, Encoder 3 B-Phase (-) Signal	
9	DIN8	Digital Input 8	
10	DIN9	Digital Input 9	
11	DIN10	Digital Input 10	
12	DIN11	Digital Input 11	
13	DIN12	Digital Input 12	
14	DIN13	Digital Input 13	
15	DIN14	Digital Input 14	
16	DIN15	Digital Input 15	
17	DIN_COM1	Digital Input Common 1, Anode	DIN8~15 Common Input
18	GND OUT1	Board Ground Output	
19	GND OUT1	Board Ground Output	
20	DOUT_COM1	Digital Output Common 1	DOUT8~15 Common Output
21	TMR4 +	Timer4 + Output	
22	TMR4 -	Timer4 - Output	
23	TMR5 +	Timer5 + Output	
24	TMR5 -	Timer5 - Output	
25	TMR6 +	Timer6 + Output	
26	TMR6 -	Timer6 - Output	
27	TMR7 +	Timer7 + Output	
28	TMR7 -	Timer7 - Output	
29	DOUT8	Digital Output 8	

30	DOUT9	Digital Output 9	
31	DOUT10	Digital Output 10	
32	DOUT11	Digital Output 11	
33	DOUT12	Digital Output 12	
34	DOUT13	Digital Output 13	
35	DOUT14	Digital Output 14	
36	DOUT15	Digital Output 15	
37	DIO_PWR1	Board Power Output	Refer 3.7
38	N.C	NO CONNECTION	
39	N.C	NO CONNECTION	
40	N.C	NO CONNECTION	

3-3-3 Output Power Jumper (J3, J4, J5, J7)

It is an external output power and ground selection switch. J4 and J7 select the power and ground of the J8 DSUB-37 connector, and J5 and J3 are the power and ground select switches of the BOX header connector.
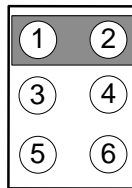
[Figure 3-4. Jumper (Top View)]

[Table 3. J4, J5 Power]

Pin No.	Pin Name	Description	Remark
1	+5V	+5V	500mA(max)
2	DIO_PWR	Output Power	
3	+12VPCI	+12V	250mA(max)
4	DIO_PWR	Output Power	
5	ISO_PWR	Separate +24V Board Power	250mA(max)
6	DIO_PWR	Output Power	

[Table 4. J3, J7 Power]

Pin No.	Pin Name	Description	Remark
1	EGND	+5V Ground	
2	GND_OUT	Output Ground	
3	+12VPCI	+12V Ground	

4	GND_OUT	Output Ground	
5	ISO_PWR	+24V Ground	
6	GND_OUT	Output Ground	

3-3-4 J9, J10, J11, J12 Connector

Encoder 0 ~ 3 is the selection selector switch. It is multiplied by x2 for 1-2 connections, x1 for 2-3 connections, and x4 when there is no connection.
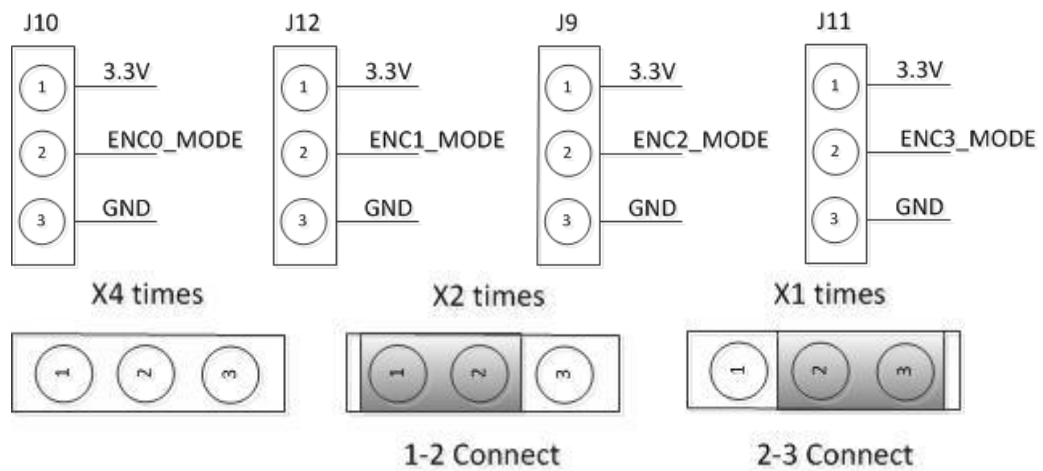
[Figure 3-5.   Jumper (Top View)]

3-3-5 SW1

PCIe-TC03 board is designed of four maximum PCIe-TC03 boards at the same time so as usable. Distribution of each board sets it up through 4 pin switch (SW1) in a board.
The total number of boards installed in one system is four.

SW1 Setup

1	2	Board No.
OFF	OFF	0
ON	OFF	1
OFF	ON	2
ON	ON	3
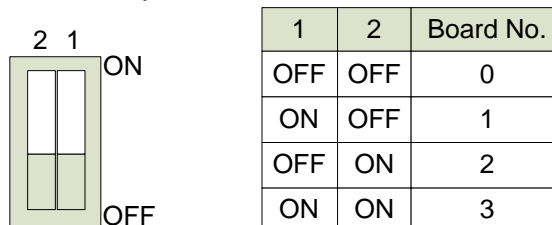
[Figure 3-6.   Board Address Setup

3-4 Counter Input Circuit
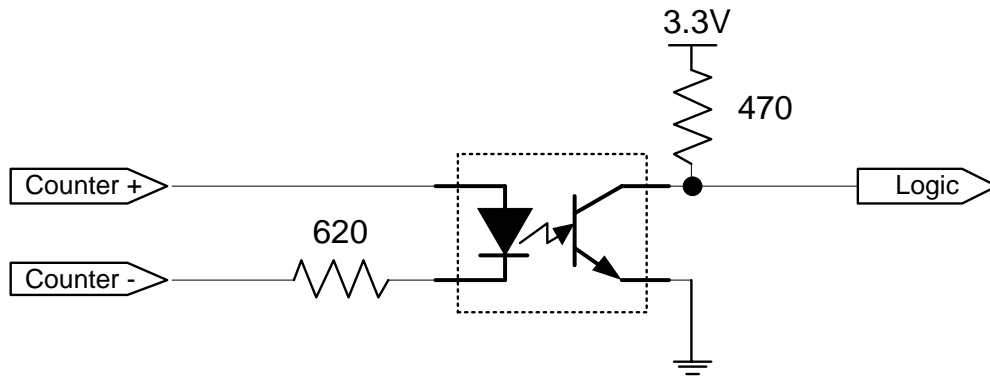
[Figure 3-7.   Counter Input Circuit]

The counter input circuit is insulated with a circuit protection and noise-resistant port coupler, and a maximum of 30mA input is possible.

A total of 8 optocoupler circuits are configured on the PCIe-TC03 board..

3-5 Timer Output Circuit
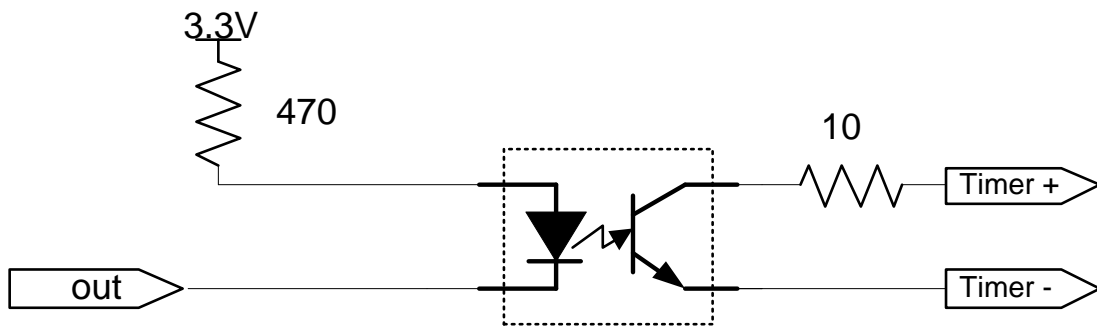
[Figure 3-8.   Timer Output Circuit]

The timer output circuit is insulated by a port coupler and outputs up to 50mA. And a current limiting resistor 10Ω (Ohm) is connected in series to the output for protection.
A total of 8 photo coupler circuits are configured on the PCIe-TC03 board.

3-6 Digital Input Circuit
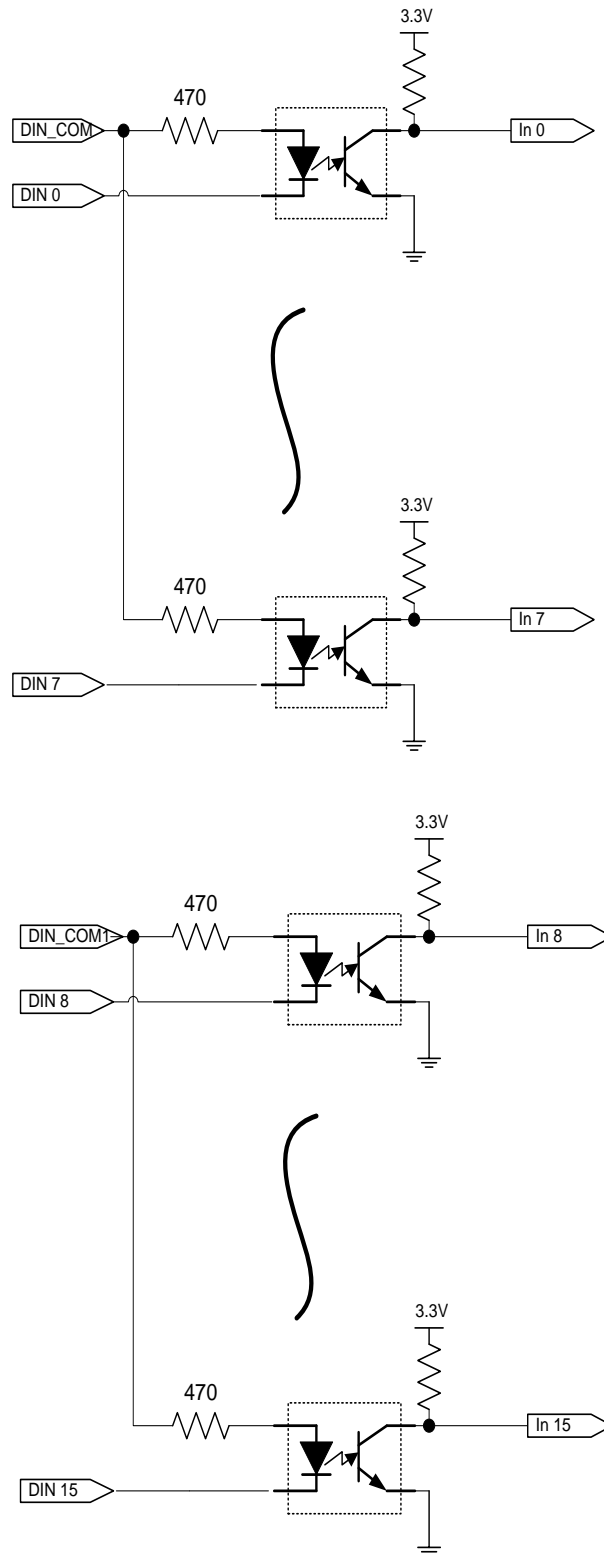
[Figure 3-9.   Digital Input Circuit]

In the figure above, the 16-bit digital input circuit is insulated by a port coupler, and is divided by 8 bits to use DIN_COM and DIN_COM1 in common.

3-7 Digital Output Circuit
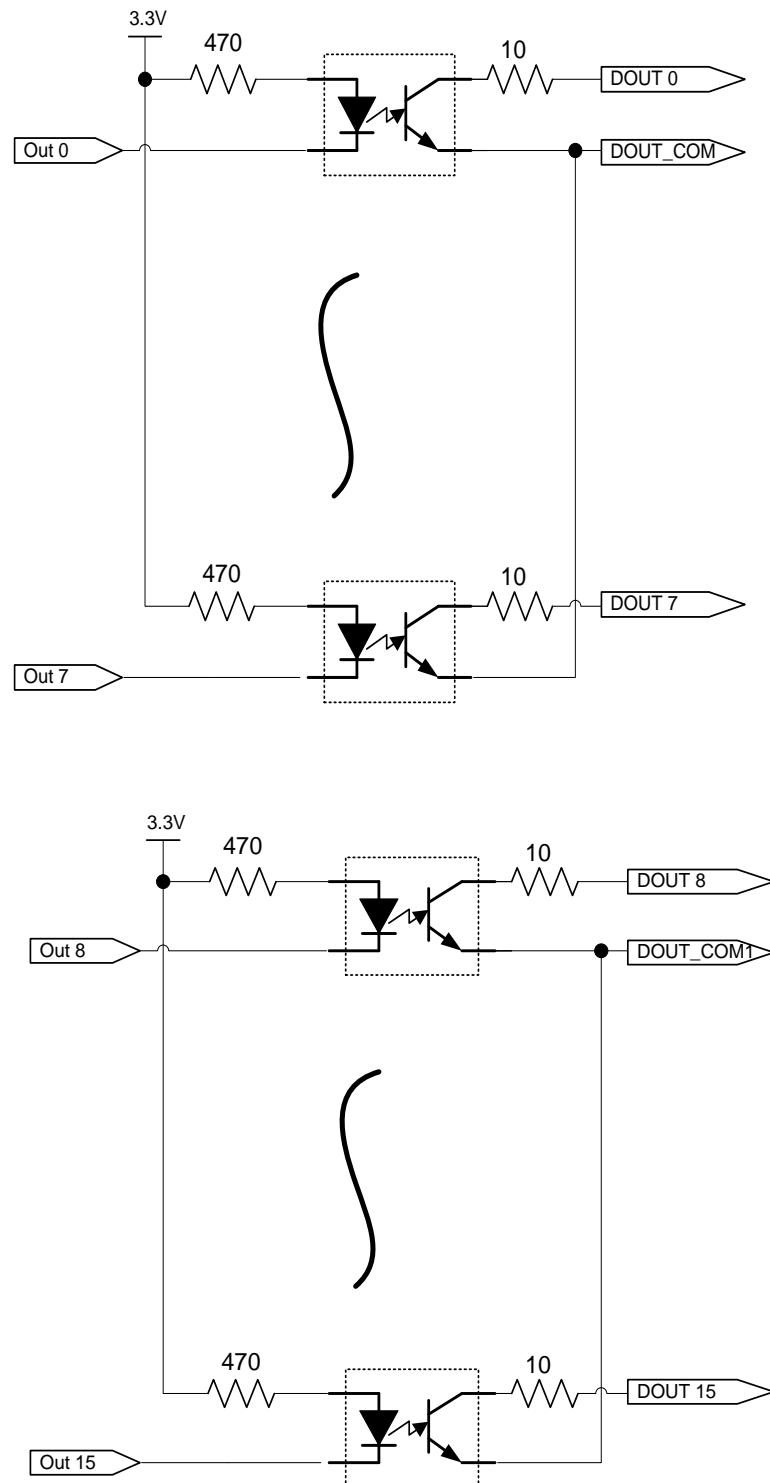
[Figure 3-10.   Digital Output Circuit]

As shown in the figure above, the output circuit is insulated by a port coupler, and it is divided by 8 channels to use DOUT_COM and DOUT_COM1 in common. And each output is connected in series with a current limiting resistor of 10Ω (Ohm) for protection.

4. Installation

Before installing the board, check that the contents of the package are intact.

4-1 Hardware Installation

4-1-1 Product Contents
1. PCIe-TC03 Board
2. CD (Driver/Manual/API/Sample Source etc.)

4-1-2 Installation Process
① Turn off the computer.
② Remove the computer cover according to the computer manual.
③ Insert the product into an empty PCI slot. If possible, insert the boards in the order closest to the CPU.
④ Remove the blocked part at the back of the computer case of the slot where the board is inserted. Tighten the screws between the bracket of the board and the connection part of the case.
⑤ In case of multi-board, repeat from step 3.
Connect the PCIe-TC03 board in the PC to an empty PCI slot.
When you turn on the power, a new hardware search window will appear.

4-2   Driver Installation

After mounting the board, install the driver and sample application program to run the board on the PC by referring to the contents of the provided CD.
The PCI-TC03 and PCIe-TC03 use the same driver and API, so they can share data.
The installation procedure is described based on Windows XP for PCIe-TC03 board.

The board environment must be Windows 2000 SP4 or higher and Windows XP SP1 or higher. First, turn off the PC's power, plug the PCIe-TC03 board into the PCI Slot, and turn on the PC's power. When the "Start New Hardware Wizard" window opens as shown below, select it as shown below and click the Next button.

As per Microsoft's authentication policy, if you have Window 7 or later, you must use the version with the KB3033929 update installed.

(1) When the computer finishes booting, it searches for newly installed devices. If a new device is discovered, the operating system asks you to install a driver for the device.
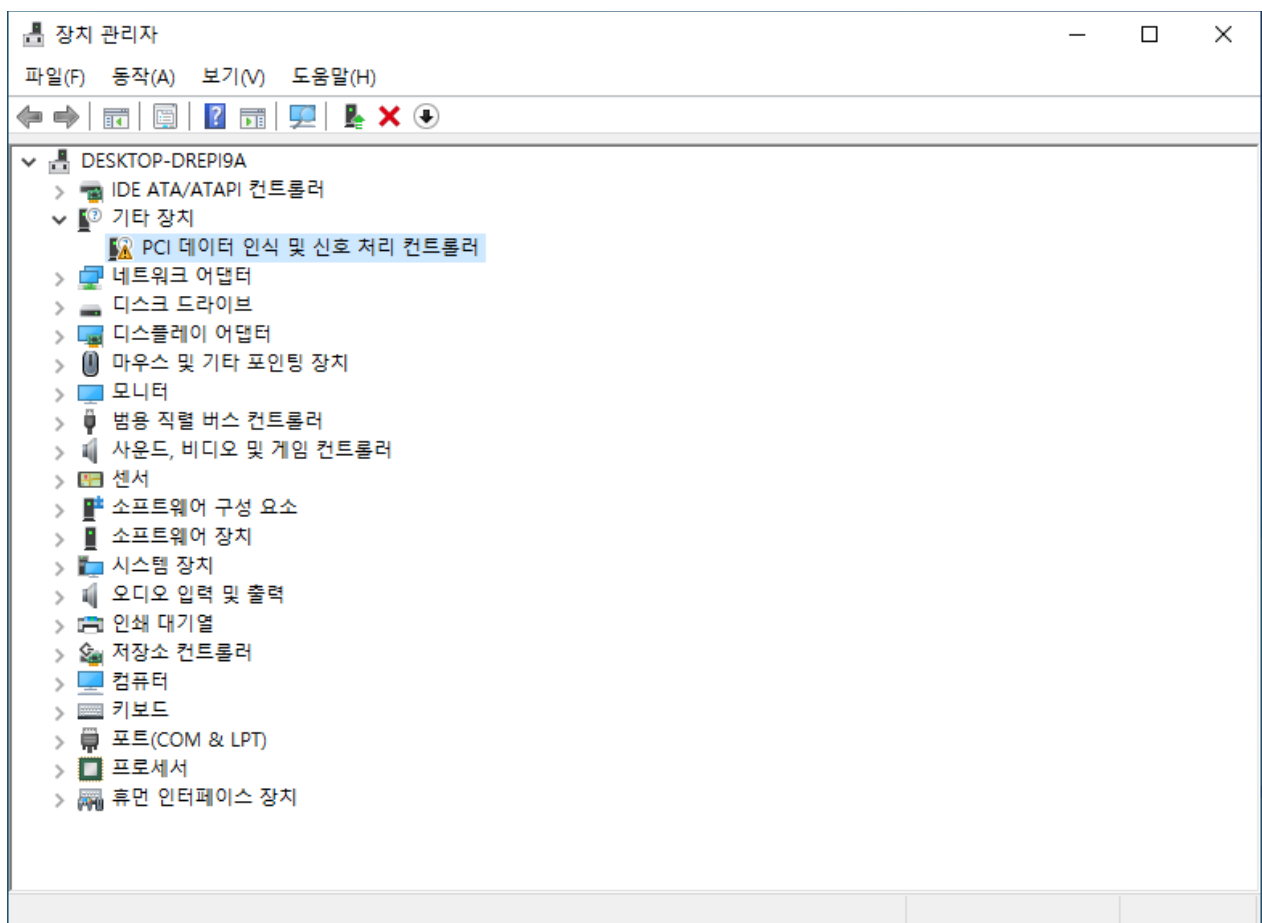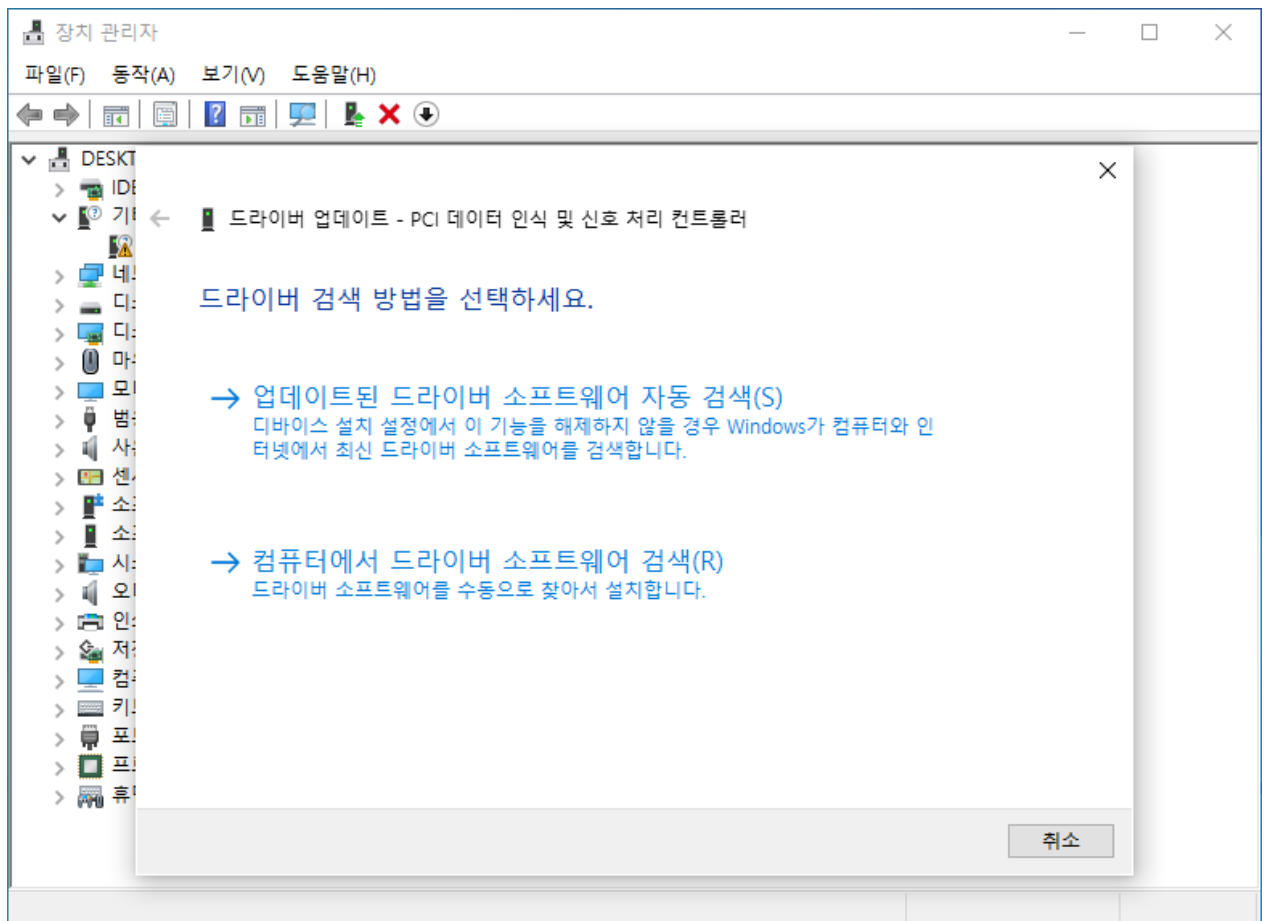
(2) In the figure above, if you press the "Search for driver software on your computer (R)" button to install the driver, the driver search screen appears. Designate the Driver folder on the CD that contains the driver.

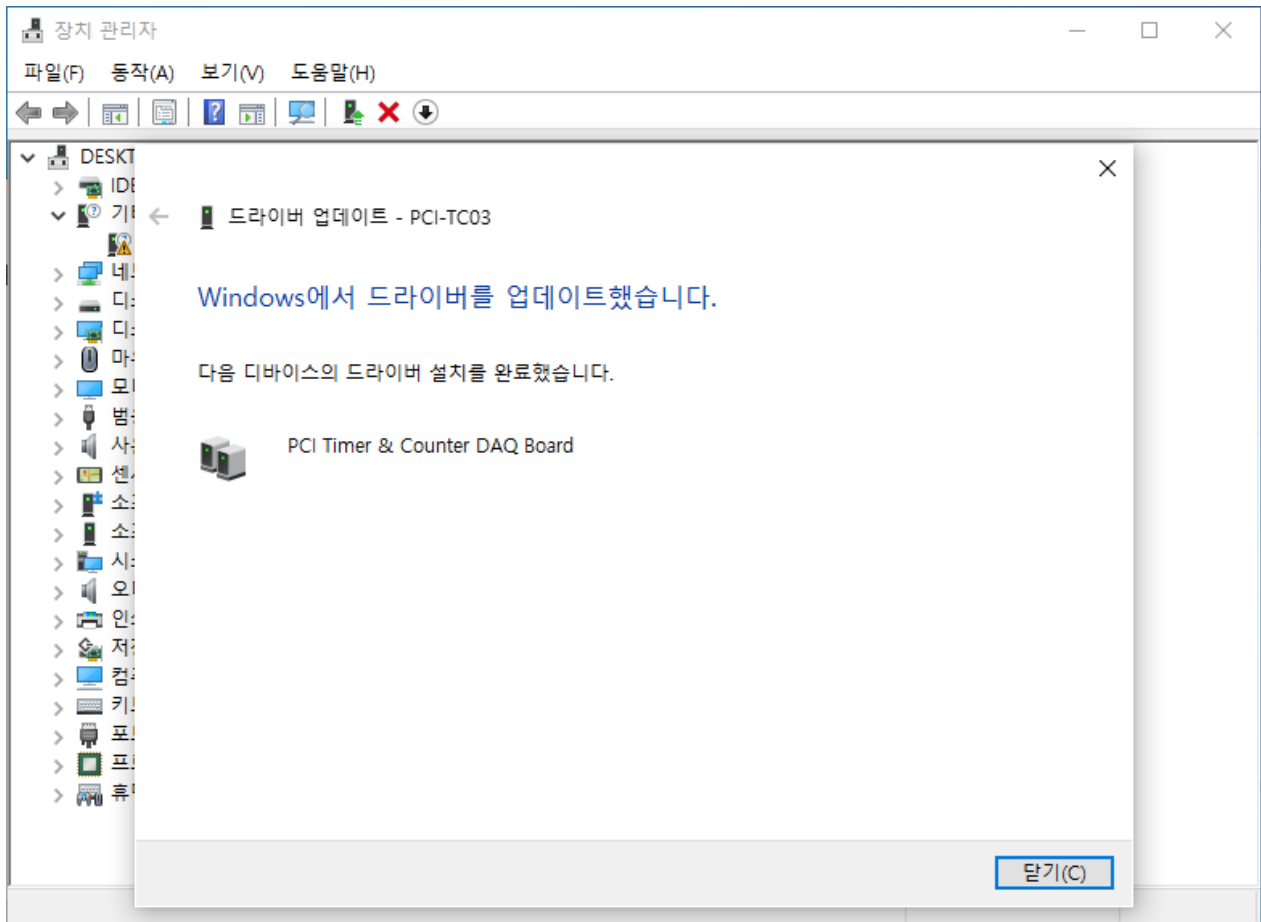(Select Install from a list or specific location)

Ex) D:₩CDROM_PCIe_TC03₩Driver

The driver folder contains **"pci_tc03.inf"** and **"pci_tc03.sys"** files required for driver installation.
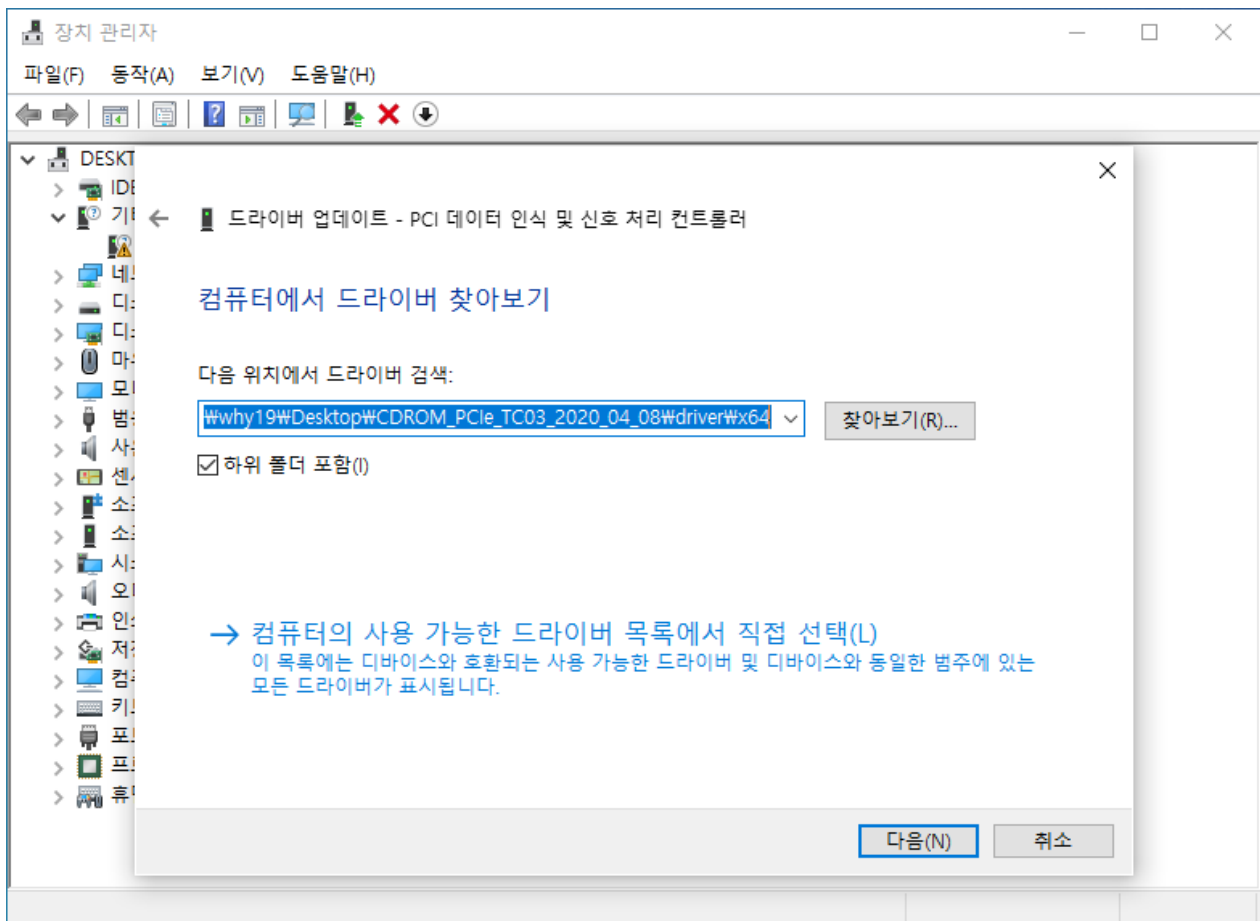
(3) Click Next to install the driver files.

(4) When the installation is completed normally, it is shown in the figure below.

(5) Once the installation is complete, you can use the PCIe-TC03 board immediately. Before using it, check if the driver is installed properly again in the following way.

On the My Computer -> Properties -> Hardware -> Device Manager screen, check if the **multifunction adapter -> "PCI-TC03"** is installed. When it appears as in [Figure 13], the installation has been completed normally.
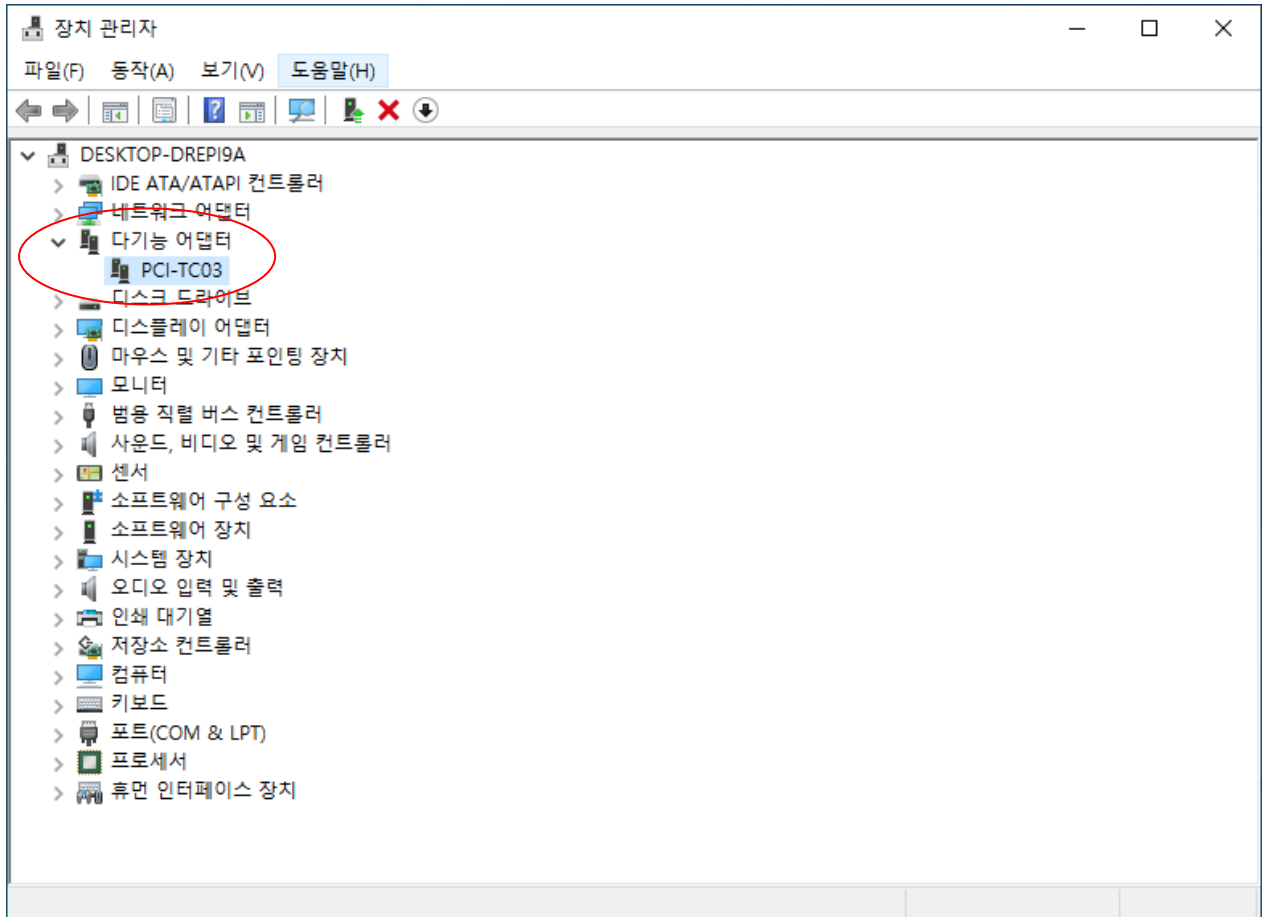
If you can see the "PCIe-TC03" at Multifunction Adaptors, the driver installation is to have been over. (Check the red circle)

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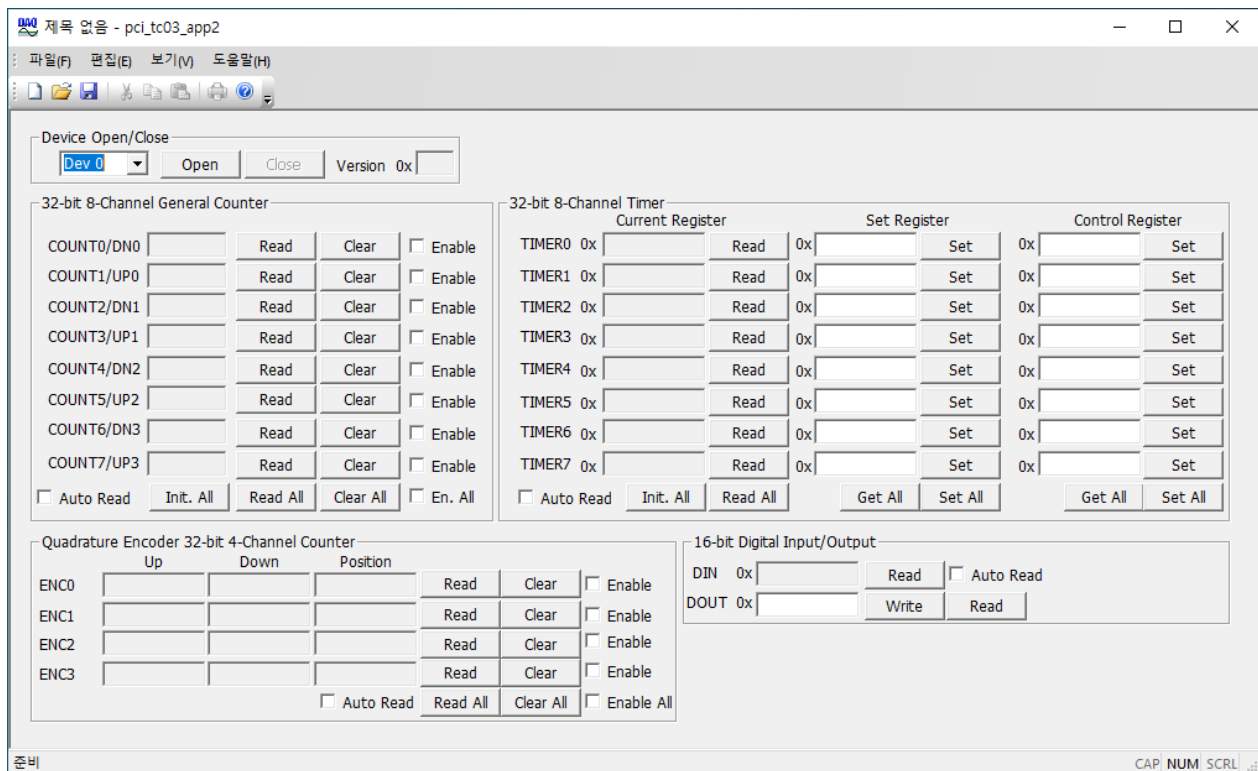
5. Sample Program

5-1 Program Interface

In the APP folder of the CDROM provided with the board, sample programs **"PCI_TC03_APP.exe"** and **"pci_tc03_app2.exe"** are provided for easy use of the board. In order to test the sample program, the driver of the board must be installed first.

The sample program is provided in the form of a source so that the API provided to use the board can be tested briefly, so the user can modify it and use it.
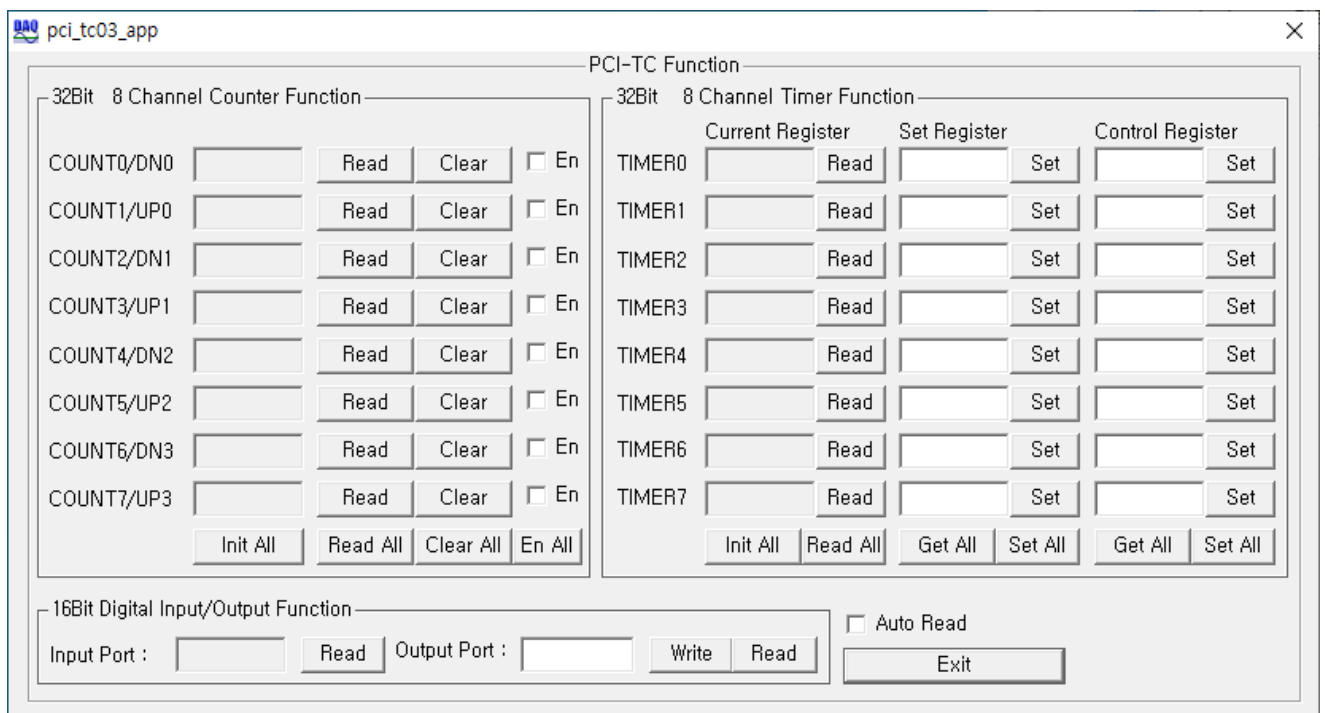
[Figure 5-1. Sample Program "PCI_TC03_APP.exe]

[Figure 5-2. Sample Program "pci_tc03_app2.exe"]

API (Application Programming Interface) is required to use the above sample program. API is provided in the form of "DLL", and import library and header file are required for compilation. In order to run the sample program normally, the API DLL **(PCI_TC03.DLL)** must be in the folder of the executable file, or in the Windows system folder or the folder specified by the Path environment variable.

5-2 Function Description

(1) **Device Open / Close**

Dev 0 ~ 3: Select the board number when using multi-board.

Open: Start using the device.

Close: Close all open devices.

Version: Version value of the internal logic.

(2) **32Bit 8 Channel Counter Function / 32Bit 8-Channel General Counter**

Enable the 8 channels Counter, and read the current Counter value.

Init (All) : (All) Counter initialize.

Read (All) : (All) Counter read the current value.

Clear (All) : (All) Counter value clear.

En (All) : (All) Counter enable.

(3) **32Bit 8 Channel Timer Function / 32Bit 8-Channel Timer**

Enable the 8 channels Timer, and control the Timer register.

Current Register

Read : Read the value of current Timer

Init (All) : (All) Timer initialize.

Read (All) : (All) Read the current value of Timer.

Set Register

Get (All) : (All) Get the value of Timer register. The default value is '0000ffff'.

Set (All) : (All) Set the value of wanted Timer. The default value is '000a0000'.

Ex.) In case of the value is '0000100', the Timer counts from '0' to 'ff'.

Control Register

Get (All) : (All) Get the value of Timer register.

Set (All) : (All) Enable the Timer. Ex.) Timer operation as '00000005'

Bit	Name	Description	Default
0	Enable	If it is '1', a timer operates. (Up-Counter)	'0'
1	Clear	If it is '1', it initialize current (TMR_CUR) value to "0x00000000"	'0'
2	Auto	If it is '1', it will occur time-out. It operates automatically as reload the timer value of "TMR_SET"	'0'

(4) **Quadrature Encoder 32bit 4-Channel Counter Function**

The counter of the 4-channel quadrature encoder is operated and the value is read. For basic operation, 2 channels are provided on the front panel of the board. 4 channels can be changed upon request.

Read (All) : Read the encoder counter value of multi-board system.

Clear (All) : Initialize the encoder counter value of multi-board system.

Enable (All) : Activate the encoder counter of multi-board system.4

(5) **32Bit Digital Input/Output Function**

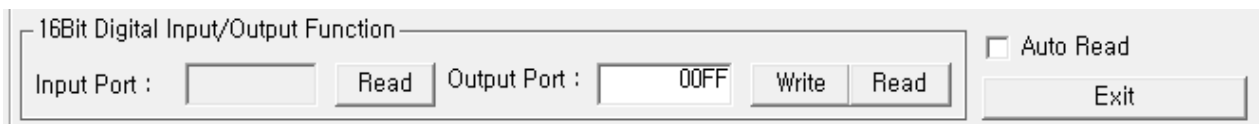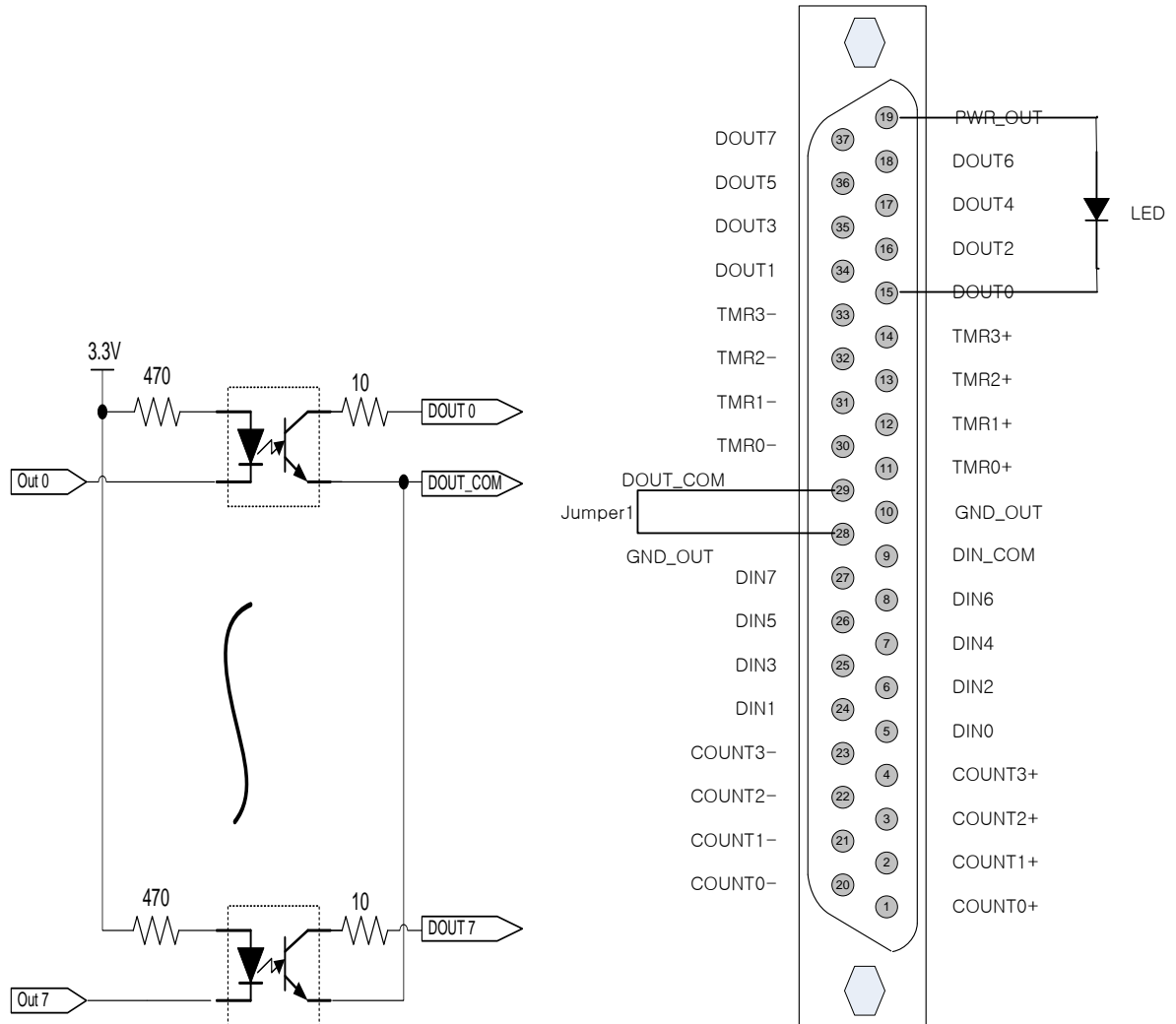DIN / Input Port **Read**: It reads the Digital value of the Input port.

DOUT / Output Port **Write**: It reads the Digital Input value of the Output port.

DOUT / Output Port **Read**: It outputs the Digital value of the Output port.

**Auto Read** : Data values are read automatically..

6. Test Method

6-1 DOUT 7..0 Test Connection

When connecting only port 7..0, write '00FF' to the output port. Connect both ends of Jumper1 to DOUT_COM and GND_OUT.

After connecting the anode of the LED to PWR_OUT, connect the cathode of the LED to the corresponding Output Port [DOUT7..0] and check the LED lighting.

6-2 DIN 7..0 Test Connection
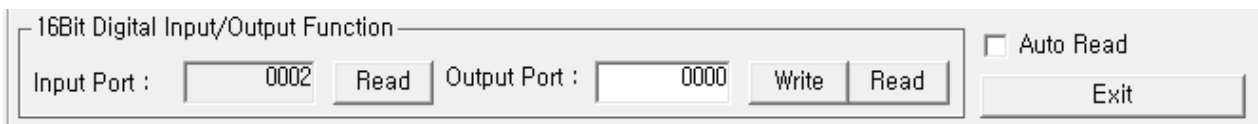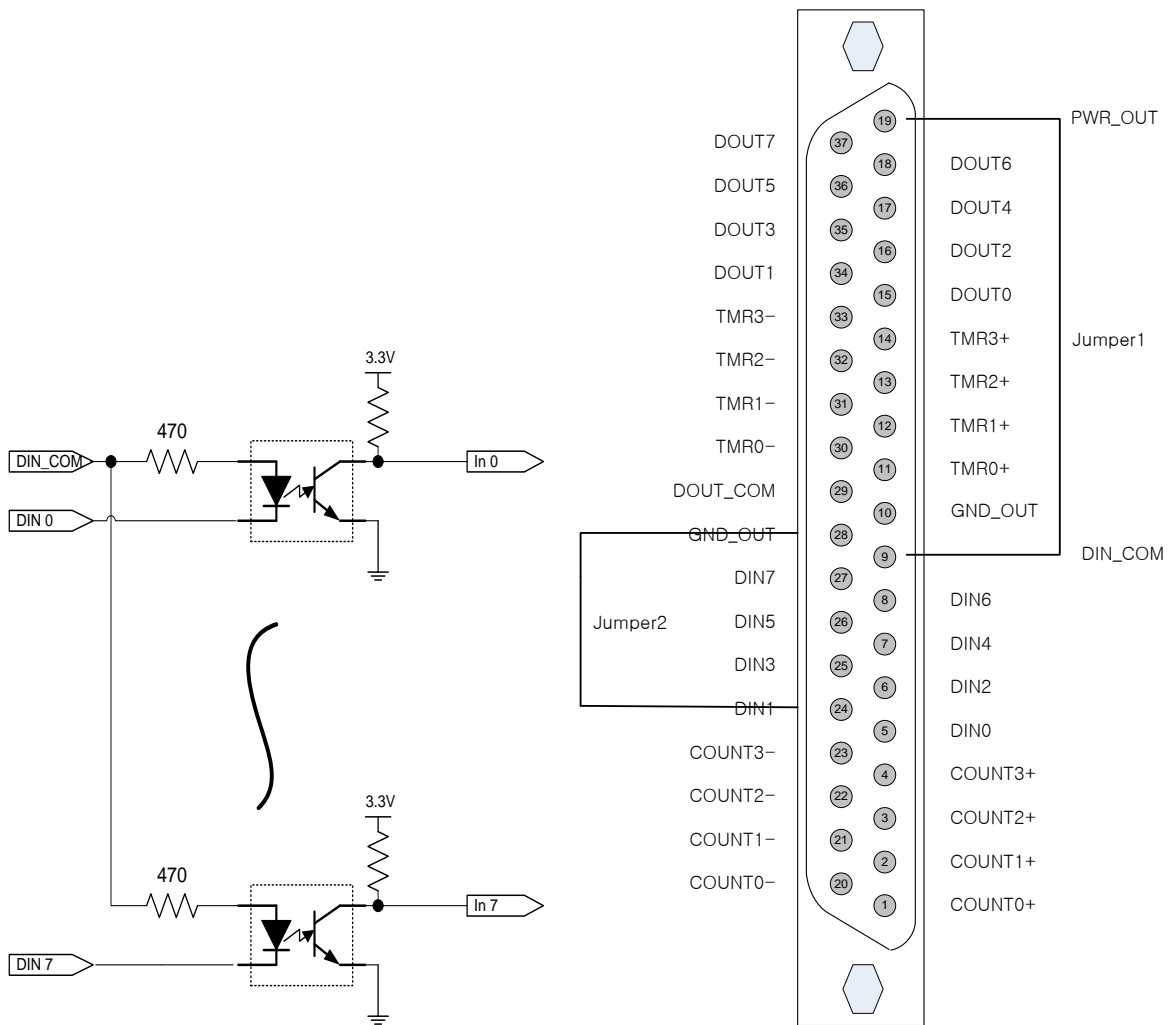
After connecting both ends of Jumper1 to DIN_COM and PWR_OUT, execute 'Auto Read'. After connecting one part of Jumper2 to GND_OUT and connecting the other part to Input Port DIN1, check if the value '02' is written to 'Input Port'. When connected to DIN7, the value '0080' is written to 'Input Port'.

6-3 Counter & Timer Test
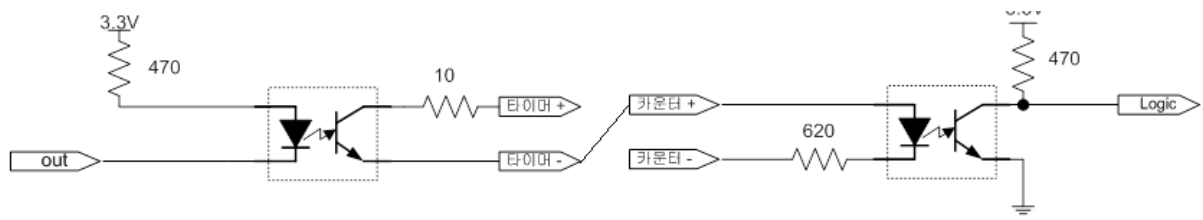
- Timer+   Pin19(PWR_OUT) Connection.

- Counter-   Pin28(GND_OUT) Connection.

- Timer-   to Counter + Connection

- APP)'**En ALL**' -> 'Control Register'   5   Input -> '**Set All**' -> Auto Read Check

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(e)-TC03 API Programming

    --DAQ system

<u>MEMO</u>

Contact Point

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