

Bus master transfer/multi-functions  
Analog I/O board for PCI Express  
**AIO-163202F-PE**

Drive Library [API-PAC]: Included



\* Specifications, color and design of the products are subject to change without notice.

This product is a multi-function, PCI Express bus-compliant interface board that incorporates high-precision 16-bit analog inputs (32ch), high-precision 16-bit analog outputs (2ch), digital inputs/outputs (LVTTTL level each 8ch), and a counter (32-bit, 2ch) function.

The board includes an event controller for integrated management of control signals by hardware and a bus master data transfer function for transferring large volumes of data at high speed. Together, these features provide all you need to build a high-performance PC-based measurement and control system.

You can use the driver library (API-PAC(W32)) supplied with the board to write Windows application programs in any programming language (such as Visual Basic, Visual C++, etc.) that supports the calling of Win32 API functions.

It can also collect data easily without a program when the data logger software [C-LOGGER] stored on the attached CD-ROM is used. With plug-ins for the dedicated libraries, the board also supports MATLAB and LabVIEW.

**Features**

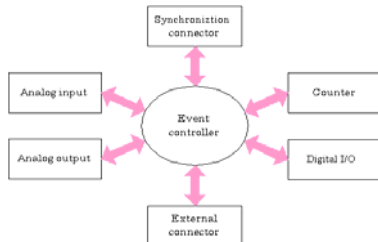
**Multi-function**

The board contains analog inputs (16-bit, 32ch), analog outputs (16-bit, 2ch), digital inputs (LVTTTL level 8ch), digital outputs (LVTTTL level 8ch), and counters (32-bit binary, LVTTTL level 2ch). Combining all these features on one board allows complex systems to be implemented even on PCs with few spare extension slots.

**The event controller can be used to implement a wide range of different sampling control schemes**

The board incorporates an event controller for integrated hardware control. The event controller can use the external control signals and the events generated by the board functions to start and stop analog input operation and perform clock control. This enables high-precision synchronization of the various board functions without requiring software. Also, each function can be operated separately.

Overview of event controller



Each I/O function can be synchronized by the operation starting/stopping signal and the clock signal etc. of each I/O function.

Example 1: Synchronize the timing of analog input and analog output based on an external clock signal.

Example 2: Start analog input operation each time the counter value reaches a constant one.

**Bus master transfer function and combined data I/O function**

Bus master data transfer can be used for the analog inputs and outputs either separately or at the same time. This can be used to transfer large volumes of data to the PC without placing a load on the CPU.

When using bus master data transfer for analog input data, you can transfer the analog output, digital input, digital output, and counter data at the same time synchronized with the analog input clock signal.

**Buffer memory available for background processing independent of software**

The analog inputs and outputs each have their own buffer memory (64k Word) which can be used when not using bus master transfer. The buffer memory can be used as FIFO or RING form.

You can also perform analog input and output in the background, independent of software and the current status of the PC.

**Software-based calibration function**

Calibration of analog input/output can be all performed by software. Apart from the adjustment information prepared before shipment, additional adjustment information can be stored according to the use environment.

**Equipped with the synchronization control function**

The operation of each I/O function can be synchronized with two or more (Max. 16 pieces) boards equipped with the synchronous control function as the analog input is started at the same time.

**Filter function for easy connection of external signals**

The digital input signals, counter input signals, and the external control signals for analog I/O incorporate a digital filter to prevent problems such as chattering.

**Supported to the data logger software [C-LOGGER]**

Supporting the data logger software [C-LOGGER] that enables the graph display of recorded signal data, file saving, and dynamic transfer to the spreadsheet software program "Excel"

**Plug-ins for the dedicated libraries, the board also supports MATLAB and LabVIEW.**

We offer a dedicated library [ML-DAQ], which allows you to use this product on MATLAB by The MathWorks as well as another dedicated library [VI-DAQ], which allows you to use the product on LabVIEW.

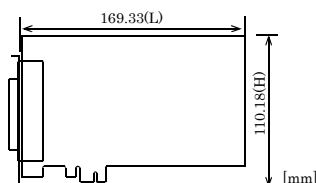
These dedicated libraries are available, free of charge (downloadable), on our web site.

## Specification

Item	Specification
<b>Analog input</b>	
Isolated specification	Un-Isolated
Input type	Single-Ended Input or Differential Input
Number of input channels	32ch (Single-Ended Input) 16ch (Differential Input)
Input range	Bipolar $\pm 10V, \pm 5V, \pm 2.5V$ or Unipolar $0 - +10V, 0 - +5V, 0 - +2.5V$
Absolute max. input voltage	$\pm 15V$
Input impedance	$1M\Omega$ or more
Resolution	16bit
Non-Linearity error *1	$\pm 5LSB$
Conversion speed	$2\mu\text{sec}/\text{ch}$ (Max.)
Buffer memory	64k Word FIFO or 64k Word RING
Conversion start trigger	Software, conversion data compare, external trigger, and event controller output.
Conversion stop trigger	Settings include data save complete, conversion data compare, external trigger, event controller output, and software.
External start signal	LVTTL level (Rising or falling edge can be selected by software)
External stop signal	LVTTL level (Rising or falling edge can be selected by software)
External clock signal	LVTTL level (Rising or falling edge can be selected by software)
External status output signal	2 LVTTL level Sampling clock output
<b>Analog output</b>	
Isolated specification	Un-Isolated
Number of output channels	2ch
Output range	Bipolar $\pm 10V, \pm 5V, \pm 2.5V, \pm 1.25V$ or Unipolar $0 - +10V, 0 - +5V, 0 - +2.5V$
Output current ability	$\pm 5\text{mA}$
Output impedance	$1\Omega$ or less
Resolution	16bit
Non-Linearity error *1	$\pm 3LSB$
Conversion speed	$10\mu\text{sec}$ (Max.)
Buffer memory	64k Word FIFO or 64k Word RING
Conversion start trigger	Software, external trigger, and event controller output.
Conversion stop trigger	Settings include data save complete, external trigger, event controller output, and software.
External start signal	LVTTL level (Rising or falling edge can be selected by software)
External stop signal	LVTTL level (Rising or falling edge can be selected by software)
External clock signal	LVTTL level (Rising or falling edge can be selected by software)
External status output signal	2 LVTTL level Sampling clock output
<b>Digital I/O</b>	
Number of input channels	Un-Isolated input 8ch (LVTTL level positive logic)
Number of output channels	Un-Isolated output 8ch (LVTTL level positive logic)
<b>Counter</b>	
Number of channels	2ch
Counting system	Up count
Max. count	FFFFFFFF (Binary data, 32bit)
Number of external inputs	2 LVTTL level (Gate/Up)/ch, Gate (High level), Up (Rising edge)
Number of external outputs	LVTTL level output/ch, Count match output (positive logic, pulse output)
Frequency response	10MHz (Max.)
<b>Bus master section</b>	
DMA channels	2ch (one each for input and output)
Transfer bus width	32bit
Transfer data length	8 PCI Words length (Max.)
FIFO	1K-Word/ch
Scatter/Gather function	64M-Byte/ch
<b>Synchronization bus section</b>	
Control output signal	Selection of output signal with the software when specifying a sync master board.
Control input signal	Selection of sync factor with the software when specifying sync slave boards.
Max. board count for connection	16 boards including the master board
Connector	PS-10PE-D4T1-B1 (JAE) or equivalent x 2
<b>Common section</b>	
I/O address	64 ports x 1, 256 ports x 1 region
Interrupt level	Errors and various factors, One interrupt request line as INTA
Connector	96-pin half pitch connector [M(male)type] PCR-96LMD [HONDA TSUSHIN KOGYO CO., LTD.] or equivalent
Power consumption (Max.)	3.3VDC 500mA 12VDC 300mA
Operating condition	0 - 50°C, 10 - 90%RH (No condensation)
Bus specification	PCI Express Base Specification Rev. 1.0a x 1
Dimension (mm)	169.33(L) x 110.18(H)
Weight	140g

\*1 The non-linearity error means an error of approximately 0.1% occurs over the maximum range at 0°C and 50°C ambient temperature.

## Board Dimensions



The standard outside dimension(L) is the distance from the end of the board to the outer surface of the slot cover.

## Support Software

### Windows version of analog I/O driver API-AIO(WDM) [Stored on the bundled CD-ROM driver library API-PAC(W32)]

The API-AIO(WDM) is the Windows version driver library software that provides products in the form of Win32 API functions (DLL). Various sample programs such as Visual Basic and Visual C++, etc and diagnostic program useful for checking operation is provided.

< Operating environment >

OS Windows Vista, XP, Server 2003, 2000

Adaptation language Visual Basic, Visual C++, Visual C#, Delphi, C++ Builder

You can download the updated version from the CONTEC's Web site (<http://www.contec.com/apipac/>). For more details on the supported OS, applicable language and new information, please visit the CONTEC's Web site.

### Linux version of analog I/O driver API-AIO(LNX) [Stored on the bundled CD-ROM driver library API-PAC(W32)]

The API-AIO(LNX) is the Linux version driver software which provides device drivers (modules) by shared library and kernel version. Various sample programs of gcc are provided.

< Operating environment >

OS RedHatLinux, TurboLinux

(For details on supported distributions, refer to Help available after installation.)

Adaptation language gcc

You can download the updated version from the CONTEC's Web site (<http://www.contec.com/apipac/>). For more details on the supported OS, applicable language and new information, please visit the CONTEC's Web site.

### Data Logger Software C-LOGGER [Stored on the bundled CD-ROM driver library API-PAC(W32)]

C-LOGGER is a data logger software program compatible with our analog I/O products. This program enables the graph display of recorded signal data, zoom observation, file saving, and dynamic transfer to the spreadsheet software "Excel". No troublesome programming is required.

CONTEC provides download services (at <http://www.contec.com/clogger>) to supply the updated drivers. For details, refer to the C-LOGGER Users Guide or our website.

< Operating environment >

OS Windows Vista, XP, Server 2003, 2000

### Data Acquisition library for MATLAB ML-DAQ (Available for downloading (free of charge) from the CONTEC web site.)

This is the library software which allows you to use our analog I/O device products on MATLAB by the MathWorks. Each function is offered in accordance with the interface which is integrated in MATLAB's Data Acquisition Toolbox. See <http://www.contec.com/mldaq/> for details and download of ML-DAQ.

### Data acquisition VI library for LabVIEW VI-DAQ (Available for downloading (free of charge) from the CONTEC web site.) \*1

This is a VI library to use in National Instruments LabVIEW. VI-DAQ is created with a function form similar to that of LabVIEW's Data Acquisition VI, allowing you to use various devices without complicated settings.

See <http://www.contec.com/vidaq/> for details and download of VI-DAQ.

\*1 The bus master transmission (analog input and output), the analog input in-range and out-range function and the event controller function of analog F series are not supported. It is impossible to synchronize the AIO-163202F-PE with another board only when the synchronous connector was used.

## Cable & Connector

### Cable (Option)

Shielded Cable with One 96-Pin Half-Pitch Connector

- : PCA96PS-0.5P (0.5m)
- : PCA96PS-1.5P (1.5m)

Shielded Cable with 96-Pin Half-Pitch Connectors at Both Ends

- : PCB96PS-0.5P (0.5m)
- : PCB96PS-1.5P (1.5m)

Flat Cable with One 96-Pin Half-Pitch Connector

- : PCA96P-1.5 (1.5m)

Flat Cable with 96-Pin Half-Pitch Connectors at Both Ends

- : PCB96P-1.5 (1.5m)

### Connector (Option)

Half Pitch 96-Pin Female Connector Set (5Pieces)

- : CN5-H96F

## Accessories

### Accessories (Option)

Buffer Amplifier Box for Analog Input Boards (32ch type)

- : ATBA-32F \*1\*2

Buffer Amplifier Box for Analog Input Boards (8ch type)

- : ATBA-8F \*1\*2\*3

Terminal Unit for Cables (M2.5 x 96P)

- : DTP-64(PC) \*1

Screw Terminal Unit (M3.5 x 96P)

- : EPD-96 \*1

Screw Terminal Unit (M3 x 96P)

- : EPD-96A \*1\*4

BNC Terminal Unit (for analog input 32ch)

- : ATP-32F \*1

BNC Terminal Unit (for analog input 8ch): ATP-8 \*1\*3\*5

- \*1 PCB96PS-\* optional cable is required separately (0.5mm is recommended).
- \*2 An external power supply is necessary (optional AC adaptor POA200-20 prepared.)
- \*3 The analog input could have 8 channels to be used.
- \*4 "Spring-up" type terminal is used to prevent terminal screws from falling off.
- \*5 The digital input can be used up to four points, the digital output up to four points and the counter I/O up to 1 channel.

\* Check the CONTEC's Web site for more information on these options.

## Packing List

Board [AIO-163202F-PE] ...1

First step guide ... 1

CD-ROM \*1 [API-PAC(W32)] ...1

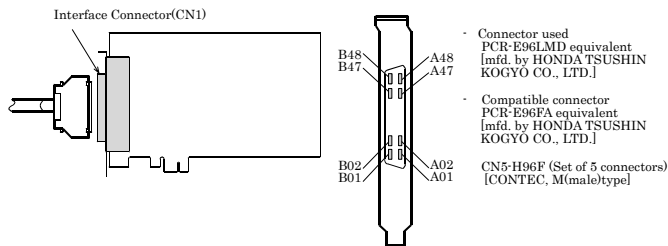
Synchronization Control Cable (10cm) ...1

\*1 The CD-ROM contains the driver software and User's Guide.

## How to connect the connectors

### Connector shape

The on-board interface connector (CN1) is used when connecting this product and the external devices.



\* Please refer to page 3 for more information on the supported cable and accessories.

## Connector Pin Assignment

### Pin Assignments of Interface Connector (CN1) < Single-Ended Input >

N.C.	B48	A48	Analog Output 00
N.C.	B47	A47	Analog Ground ( for AO )
N.C.	B46	A46	Analog Output 01
N.C.	B45	A45	Analog Ground ( for AO )
Analog Input 08	B44	A44	Analog Input 00
Analog Input 24	B43	A43	Analog Input 16
Analog Input 09	B42	A42	Analog Input 01
Analog Input 25	B41	A41	Analog Input 17
Analog Ground ( for AI )	B40	A40	Analog Ground ( for AI )
Analog Ground ( for AI )	B39	A39	Analog Ground ( for AI )
Analog Input 10	B38	A38	Analog Input 02
Analog Input 26	B37	A37	Analog Input 18
Analog Input 11	B36	A36	Analog Input 03
Analog Input 27	B35	A35	Analog Input 19
Analog Ground ( for AI )	B34	A34	Analog Ground ( for AI )
Analog Ground ( for AI )	B33	A33	Analog Ground ( for AI )
Analog Input 12	B32	A32	Analog Input 04
Analog Input 28	B31	A31	Analog Input 20
Analog Input 13	B30	A30	Analog Input 05
Analog Input 29	B29	A29	Analog Input 21
Analog Ground ( for AI )	B28	A28	Analog Ground ( for AI )
Analog Ground ( for AI )	B27	A27	Analog Ground ( for AI )
Analog Input 14	B26	A26	Analog Input 06
Analog Input 30	B25	A25	Analog Input 22
Analog Input 15	B24	A24	Analog Input 07
Analog Input 31	B23	A23	Analog Input 23
Analog Ground ( for AI )	B22	A22	Analog Ground ( for AI )
Analog Ground ( for AI )	B21	A21	Analog Ground ( for AI )
Digital Ground	B20	A20	Digital Ground
N.C.	B19	A19	N.C.
Digital Output 00	B18	A18	Digital Input 00
Digital Output 01	B17	A17	Digital Input 01
Digital Output 02	B16	A16	Digital Input 02
Digital Output 03	B15	A15	Digital Input 03
Digital Output 04	B14	A14	Digital Input 04
Digital Output 05	B13	A13	Digital Input 05
Digital Output 06	B12	A12	Digital Input 06
Digital Output 07	B11	A11	Digital Input 07
AO Control Signal Output 00	B10	A10	AI Control Signal Output 00
AO Control Signal Output 01	B09	A09	AI Control Signal Output 01
Digital Ground	B08	A08	Digital Ground
AO External Sampling Clock Input	B07	A07	AI External Sampling Clock Input
AO External Stop Trigger Input	B06	A06	AI External Stop Trigger Input
AO External Start Trigger Input	B05	A05	AI External Start Trigger Input
Counter UP Clock Input 01	B04	A04	Counter UP Clock Input 00
Reserved	B03	A03	Reserved
Counter Gate Control Input 01	B02	A02	Counter Gate Control Input 00
Control Output 01	B01	A01	Counter Output 00

The numbers in square brackets [ ] are pin numbers designated by HONDA TSUSHIN KOGYO CO., LTD.

Analog Input00 - Analog Input31	Analog input signal. The numbers correspond to channel numbers.
Analog Output00 - Analog Output01	Analog output signal. The numbers correspond to channel numbers.
Analog Ground	Common analog ground for analog I/O signals.
AI External Start Trigger Input	External trigger input for starting analog input sampling.
AI External Stop Trigger Input	External trigger input for stopping analog input sampling.
AI External Sampling Clock Input	External sampling clock input for analog input.
AI Control Signal Output 00	External sampling clock output signal for analog input.
AI Control Signal Output 01	External output signal for analog input status. Not currently connected.
AO External Start Trigger Input	External trigger input for starting analog output sampling.
AO External Stop Trigger Input	External trigger input for stopping analog output sampling.
AO External Sampling Clock Input	External sampling clock input for analog output.
AO Control Signal Output 00	External sampling clock output signal for analog output.
AO Control Signal Output 01	External output signal for analog output status. Not currently connected.
Digital Input00 - Digital Input07	Digital input signal.
Digital Output00 - Digital Output07	Digital output signal.
Counter Gate Control Input00 - Counter Gate Control Input01	Gate control input signal for counter.
Counter Up Clock Input00 - Counter Up Clock Input01	Count-up clock input signal for counter.
Counter Output00 - Counter Output01	Count match output signal for counter.
Digital Ground	Common digital ground for digital I/O signals, external trigger inputs, external sampling clock inputs, and counter I/O signals.
Reserved	Reserved pin
N.C.	No connection to this pin.

### CAUTION

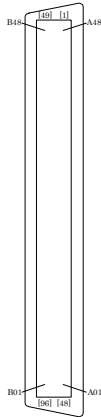
Do not connect any of the outputs and power outputs to the analog or digital ground. Neither connect outputs to each other. Doing either can result in a fault.

If analog and digital ground are shorted together, noise on the digital signals may affect the analog signals. Accordingly, analog and digital ground should be separated.

Leave "Reserved" pins unconnected. Connecting these pins may cause a fault in the board.

**Pin Assignments of Interface Connector (CN1)  
< Differential Input >**

N.C.	B48	A48	Analog Output 00
N.C.	B47	A47	Analog Ground ( for AO )
N.C.	B46	A46	Analog Output 01
N.C.	B45	A45	Analog Ground ( for AO )
Analog Input 08[+]	B44	A44	Analog Input 00[+]
Analog Input 08[-]	B43	A43	Analog Input 00[-]
Analog Input 09[+]	B42	A42	Analog Input 01[+]
Analog Input 09[-]	B41	A41	Analog Input 01[-]
Analog Ground ( for AI )	B40	A40	Analog Ground ( for AI )
Analog Ground ( for AI )	B39	A39	Analog Ground ( for AI )
Analog Input 10[+]	B38	A38	Analog Input 02[+]
Analog Input 10[-]	B37	A37	Analog Input 02[-]
Analog Input 11[+]	B36	A36	Analog Input 03[+]
Analog Input 11[-]	B35	A35	Analog Input 03[-]
Analog Ground ( for AI )	B34	A34	Analog Ground ( for AI )
Analog Ground ( for AI )	B33	A33	Analog Ground ( for AI )
Analog Input 12[+]	B32	A32	Analog Input 04[+]
Analog Input 12[-]	B31	A31	Analog Input 04[-]
Analog Input 13[+]	B30	A30	Analog Input 05[+]
Analog Input 13[-]	B29	A29	Analog Input 05[-]
Analog Ground ( for AI )	B28	A28	Analog Ground ( for AI )
Analog Ground ( for AI )	B27	A27	Analog Ground ( for AI )
Analog Input 14[+]	B26	A26	Analog Input 06[+]
Analog Input 14[-]	B25	A25	Analog Input 06[-]
Analog Input 15[+]	B24	A24	Analog Input 07[+]
Analog Input 15[-]	B23	A23	Analog Input 07[-]
Analog Ground ( for AI )	B22	A22	Analog Ground ( for AI )
Analog Ground ( for AI )	B21	A21	Analog Ground ( for AI )
Digital Ground	B20	A20	Digital Ground
N.C.	B19	A19	N.C.
Digital Output 00	B18	A18	Digital Input 00
Digital Output 01	B17	A17	Digital Input 01
Digital Output 02	B16	A16	Digital Input 02
Digital Output 03	B15	A15	Digital Input 03
Digital Output 04	B14	A14	Digital Input 04
Digital Output 05	B13	A13	Digital Input 05
Digital Output 06	B12	A12	Digital Input 06
Digital Output 07	B11	A11	Digital Input 07
AO Control Signal Output 00	B10	A10	AI Control Signal Output 00
AO Control Signal Output 01	B09	A09	AI Control Signal Output 01
Digital Ground	B08	A08	Digital Ground
AO External Sampling Clock Input	B07	A07	AI External Sampling Clock Input
AO External Stop Trigger Input	B06	A06	AI External Stop Trigger Input
AO External Start Trigger Input	B05	A05	AI External Start Trigger Input
Counter UP Clock Input 01	B04	A04	Counter UP Clock Input 00
Reserved	B03	A03	Reserved
Counter Gate Control Input 01	B02	A02	Counter Gate Control Input 00
Counter Output 01	B01	A01	Counter Output 00



The numbers in square brackets [ ] are pin numbers designated by HONDA TSUSHIN KOGYO CO., LTD.

Analog Input00 - Analog Input 15	Analog input signal. The numbers correspond to channel numbers.
Analog Output00 - Analog Output01	Analog output signal. The numbers correspond to channel numbers.
Analog Ground	Common analog ground for analog I/O signals.
AI External Start Trigger Input	External trigger input for starting analog input sampling.
AI External Stop Trigger Input	External trigger input for stopping analog input sampling.
AI External Sampling Clock Input	External sampling clock input for analog input.
AI Control Signal Output 00	External sampling clock output signal for analog input.
AI Control Signal Output 01	External output signal for analog input status. Not currently connected.
AO External Start Trigger Input	External trigger input for starting analog output sampling.
AO External Stop Trigger Input	External trigger input for stopping analog output sampling.
AO External Sampling Clock Input	External sampling clock input for analog output.
AO Control Signal Output 00	External sampling clock output signal for analog output.
AO Control Signal Output 01	External output signal for analog output status. Not currently connected.
Digital Input00 - Digital Input07	Digital input signal.
Digital Output00 - Digital Output07	Digital output signal.
Counter Gate Control Input00 - Counter Gate Control Input01	Gate control input signal for counter.
Counter Up Clock Input00 - Counter Up Clock Input01	Count-up clock input signal for counter.
Counter Output00 - Counter Output01	Count match output signal for counter.
Digital Ground	Common digital ground for digital I/O signals, external trigger inputs, external sampling clock inputs, and counter I/O signals.
Reserved	Reserved pin
N.C.	No connection to this pin.

**CAUTION**

Do not connect any of the outputs and power outputs to the analog or digital ground. Neither connect outputs to each other. Doing either can result in a fault.

If analog and digital ground are shorted together, noise on the digital signals may affect the analog signals. Accordingly, analog and digital ground should be separated.

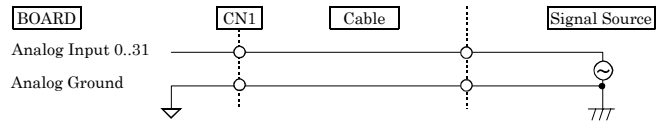
Leave "Reserved" pins unconnected. Connecting these pins may cause a fault in the board.

**Analog Input Signal Connection**

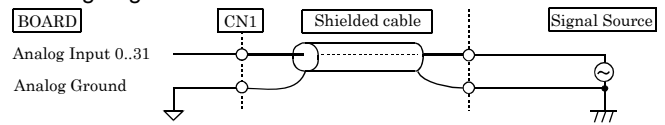
The procedure for connecting analog signals depends on whether the analog input signals are single-ended or differential. The sections below describe how to connect the signals using flat cable and shielded cable.

**Single-ended Input**

The following figure shows an example of flat cable connection. Connect separate signal and ground wires for each analog input channel on CN1.



The following figure shows an example of shielded cable connection. Use shielded cable if the distance between the signal source and board is long or if you want to provide better protection from noise. For each analog input channel on CN1, connect the core wire to the signal line and connect the shielding to ground.



**CAUTION**

If the signal source contains over 1MHz signals, the signal may effect the cross-talk noise between channels.

If the board and the signal source receive noise or the distance between the board and the signal source is too long, data may not be input properly.

An input analog signal should not exceed the maximum input voltage (relate to the board analog ground). If it exceeds the maximum voltage, the board may be damaged.

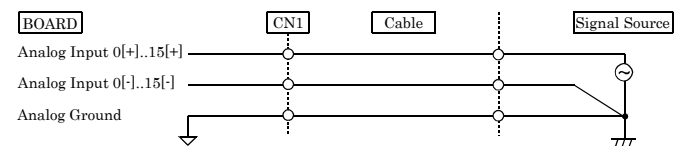
Connect all the unused analog input channels to analog ground.

In the channel switching, the multiplexer does the electrical charge and discharge on the internal capacitor according to the signal voltage. Therefore, the voltage from the previous switching state may go into the next channel. It might cause the error of the signal source action. If this occurs, insert a high-speed amplifier as a buffer between the signal source and the analog input pin to reduce the fluctuation.

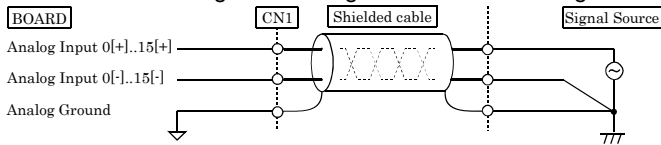
An input pin may fail to obtain input data normally when the signal source connected to the pin has high impedance. If this is the case, change the signal source to one with lower output impedance or insert a high-speed amplifier buffer between the signal source and the analog input pin to reduce the effect.

**Differential Input**

The following figure shows an example of flat cable connection. For each analog input channel on CN1, connect the "+" input to the signal and connect the "-" input to the signal source ground. Also connect the analog ground on the board to the signal source ground.



The following figure shows an example of shielded cable connection. Use shielded cable if the distance between the signal source and board is long or if you want to provide better protection from noise. For each analog input channel on CN1, connect the "+" input to the signal and connect the "-" input to the signal source ground. Also connect the analog ground on the board and the signal source ground to the shielding.



**CAUTION**

If the signal source contains over 1MHz signals, the signal may effect the cross-talk noise between channels.

When the analog ground is not connected, the conversion data is not determined.

If the board and the signal source receive noise or the distance between the board and the signal source is too long, data may not be input properly.

An input analog signal should not exceed the maximum input voltage (relate to the board analog ground). If it exceeds the maximum voltage, the board may be damaged.

Connect all the unused analog input channels to analog ground.

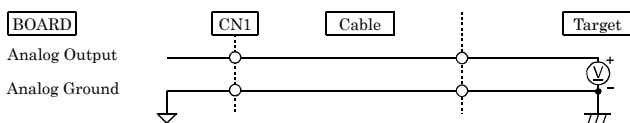
In the channel switching, the multiplexer does the electrical charge and discharge on the internal capacitor according to the signal voltage. Therefore, the voltage from the previous switching state may go into the next channel. It might cause the error of the signal source action. If this occurs, insert a high-speed amplifier as a buffer between the signal source and the analog input pin to reduce the fluctuation.

An input pin may fail to obtain input data normally when the signal source connected to the pin has high impedance. If this is the case, change the signal source to one with lower output impedance or insert a high-speed amplifier buffer between the signal source and the analog input pin to reduce the effect.

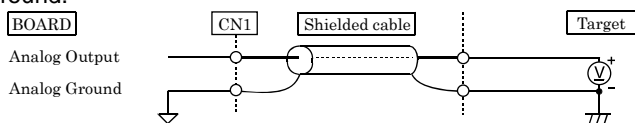
**Analog Output Signal Connection**

This section shows how to connect the analog output signal by using a flat cable or a shielded cable.

The following figure shows an example of flat cable connection. Connect the signal source and ground to the CN1 analog output.



The following figure shows an example of shielded cable connection. Use shielded cable if the distance between the signal source and board is long or if you want to provide better protection from noise. For the CN1 analog output, connect the core wire to the signal line and connect the shielding to ground.



**CAUTION**

When a frequency of 1MHz or higher is contained in the source signal, the cross talk between channels may occur.

If the board or the connected wire receives noise, or the distance between the board and the target is long, data may not be outputted properly.

For analog output signal, the current capacity is  $\pm 5\text{mA}$  (Max.). Check the specification of the connected device before connecting the board.

Do not short the analog output signal to analog ground, digital ground, and/or power line. Doing so may damage the board.

Do not connect an analog output signal to any other analog output, either on the board or on an external device, as this may cause a fault on the board.

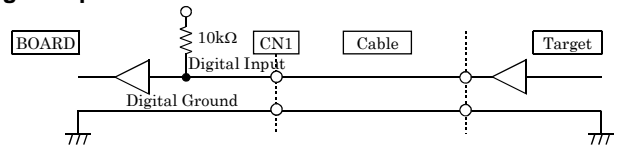
The signal connected to an input terminal may shake after a multiplexer change. In this case, a shake can be lessened by shortening the cable between the source signal and an analog input board, or inserting high-speed buffer amplifier between the source signal and an analog input board.

**Digital I/O signals, Counter signals and Control signals Connection**

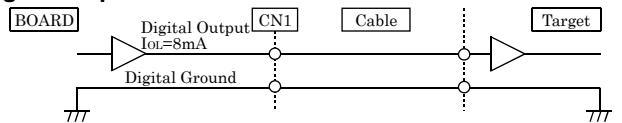
The following sections show examples of how to connect digital I/O signals, counter I/O signals, and other control I/O signals (external trigger input signals, sampling clock input signals, etc.).

All the digital I/O signals and control signals are LVTTTL level signals.

**Digital Input Connection**



**Digital Output Connection**



**About the counter input control signal**

Counter Gate Control Input (refer to the chapter 3 Connector Pin Assignment) acts as an input that validate or invalidate the input of an external clock for the counter. This function enables the control of an external clock input for the counter. The external clock for the counter is effective when input is "High", and invalid when input is "Low". If unconnected, it is a pull-up in the board (card) and remains "High". Therefore the external clock for the counter is effective when the counter gate control input is not connected.

**CAUTION**

Do not short the output signals to analog ground, digital ground, and/or power line. Doing so may damage the board.

If connected to each output, a pull-up resistor must be about 10 kΩ to pull up with a 3.3V power source.

Each input accepts 5V TTL signals.

## Synchronization Control Connectors

### SC Connectors

Controlling simultaneous operations between boards or controlling in sync with events is in part dependent on software performance. In order to enhance the reliability of the entire system and to solve these problems, the board is equipped with SC (Synchronization Control) connectors.

Connecting the SC connectors allows boards of the same or different models to operate in sync with one another. From the boards connected with the SC cable, select one master board and use others as slaves. On the master board, set the signal to be supplied to the slave boards with the software. On the slave boards, the signal from the master board can be set to either the pacer clock operation start or stop factor.

All board operations can also be stopped with a stop request from the master in case of an error, for example, or when requested from a slave board. A maximum of 16 boards can be connected including the master.

For more information on the setup procedure, see the driver software online help. When the SC is not connected, use the board with stand-alone settings.

#### Example 1: When clock start and stop requirements are set the same for multiple boards

In order to synchronize master clock start and stop with slave boards you can build a synchronous system which does not depend on software processing capabilities.

If the board model is the same, data remains synchronized among boards even when channels are expanded. When board models are different, data still remains compatible since operating clock start and stop are dependent on the master.

- (1) Connect the SC cable.
- (2) Designate master/slave with the software.
- (3) Assign to the connectors the clock start and stop signals to be output from the master.
- (4) Set up slave boards so they can utilize all signals.
- (5) Start in order of slave to master boards.

#### ⚠ CAUTION

When clock signals are assigned to the synchronization control connector, the maximum clock frequency is restricted to 5MHz.

When signals are assigned to the synchronization control connector, a delay of approximately 100ns occurs at the slave board.

#### Example 2: When controlling slave operations with master's internal events

By outputting an internal event (interrupt) occurring on the master board, the slaves can start operating in sync with that signal.

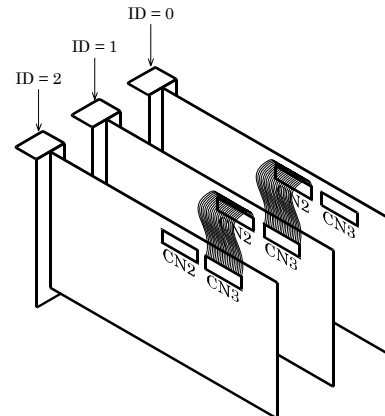
- (1) Connect the SC cable.
- (2) Designate master/slave with the software.
- (3) Assign to the connector the event signal to be output from the master.
- (4) Set signals from the master to the start requirements on the slave boards.
- (5) Start in order of slave to master boards.

### Connecting the SC Connectors (CN2 and CN3)

This board is equipped with sync signal control connectors (CN2 and CN3) for connecting a sync signal cable. When the cable is connected, multiple boards can operate in sync with one another.

### Connection Procedure

Connect the sync signal cable when two or more boards need to operate in sync with one another. Connect CN2 with a smaller ID number to CN3 with a greater ID number with the cable. You should only use the cable that came with the board.



### Block Diagram

