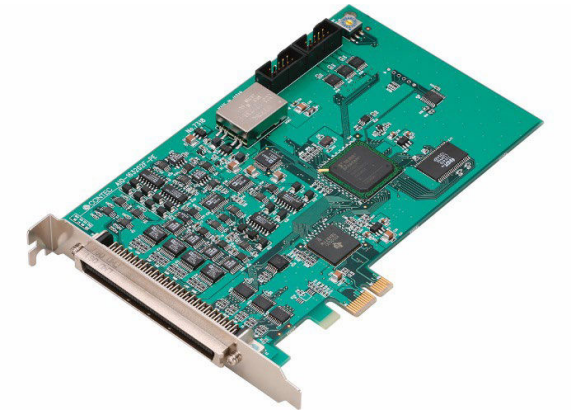
Bus master transfer/multi-functions
Analog I/O board for PCI Express

# AIO-163202F-PE



* 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 (LVTTL 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.

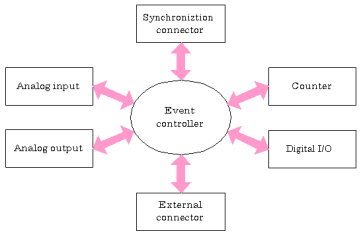
You can use the driver library (API-PAC(W32)) supplied with the board to write Windows application programs in any programming language (such as Visual Basic, Visual C++, etc.) that supports the calling of Win32 API functions. It can also collect data easily without a program when the data logger software [C-LOGGER] stored on the attached Disk 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 (LVTTL level 8ch), digital outputs (LVTTL level 8ch), and counters (32-bit binary, LVTTL 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.



PLUG-IN Electronic GmbH • Am Sonnenlicht 5 • 82239 Alling • Tel.: +49 (0) 8141 3697-0 • info@plug-in.de • www.plug-in.de

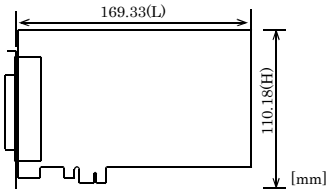
## Specifications

| Item | Specifications |
|---|---|
| Analog input | |
| 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 ±10V, ±5V, ±2.5V or Unipolar 0 - +10V, 0 - +5V, 0 - +2.5V |
| Absolute max. input voltage | ±15V |
| Input impedance | 1MΩ or more |
| Resolution | 16bit |
| Non-Linearity error *1*2 | ±5LSB |
| Conversion speed | 2μsec/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<br>Sampling clock output |
| Analog output | |
| Isolated specification | Un-Isolated |
| Number of output channels | 2ch |
| Output range | Bipolar ±10V, ±5V, ±2.5V, ±1.25V or Unipolar 0 - +10V, 0 - +5V, 0 - +2.5V |
| Output current ability | ±5mA |
| Output impedance | 1Ω or less |
| Resolution | 16bit |
| Non-Linearity error *1 | ±3LSB |
| Conversion speed | 10μsec (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 |
| Digital I/O | |
| Number of input channels | Un-Isolated input 8ch (LVTTL level positive logic) |
| Number of output channels | Un-Isolated output 8ch (LVTTL level positive logic) |
| Counter | |
| Number of channels | 2ch |
| Counting system | Up count |
| Max. count | FFFFFFFFh (Binary data, 32bit) |
| Number of external inputs | 2 LVTTL level (Gate/Up)/ch,<br>Gate (High level), Up (Rising edge) |
| Number of external outputs | LVTTL level output/ch,<br>Count match output (positive logic, pulse output) |
| Frequency response | 10MHz (Max.) |
| Bus master section | |
| 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 |
| Synchronization bus section | |
| 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 |
| Common section | |
| I/O address | 64 ports x 1, 256 ports x 1 region |
| Interruption level | Errors and various factors, One interrupt request line as INTA |
| Connector | 96-pin half pitch connector [M(male)type]<br>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 |
| Standard | VCCI Class A, CE Marking (EMC Directive Class A, RoHS Directive), UKCA |

*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.

*2 At the time of the source use of a signal which built in the high-speed operational amplifier.

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 digital I/O driver API-AIO(WDM)**

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.
For more details on the supported OS, applicable language and new information, please visit the CONTEC's Web site.

**Linux version of digital I/O driver API-AIO(LNX)**

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.
For more details on the supported OS, applicable language and new information, please visit the CONTEC's Web site.

**Data Logger Software C-LOGGER**

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.
For more details on the supported OS, applicable language and new information, please visit the CONTEC's Web site.

**Data Acquisition library for MATLAB ML-DAQ**

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.
For more details on the supported OS, applicable language and new information, please visit the CONTEC's Web site.

**Data acquisition VI library for LabVIEW VI-DAQ *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.
For more details on the library and download of VI-DAQ, please visit the CONTEC's Web site.

*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)**

Shield Cable with 96-Pin Half-Pitch Connectors at Both Ends
: PCB96PS-0.5P (0.5m), PCB96PS-1.5P (1.5m)

Flat Cable with 96-Pin Half-Pitch Connectors at Both Ends
: PCB96P-1.5 (1.5m)

Shield Cable with 96-Pin Half-Pitch Connectors at One End
: PCA96PS-0.5P (0.5m), PCA96PS-1.5P (1.5m)

Flat Cable with 96-Pin Half-Pitch Connectors at One End
: PCA96P-1.5 (1.5m)

## 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 (M3 x 96P) | : DTP-64A *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.

## Packing List

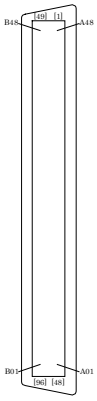
Board [AIO-163202F-PE] ...1
First step guide ... 1
Disk *1 [API-PAC(W32)] ...1
Synchronization Control Cable (10cm) ...1
Warranty Certificate ...1
Serial number label ...1

*1 The bundled disk contains the driver software and User's Guide

## Connector Pin Assignment

**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 |

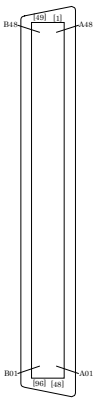



- The numbers in square brackets [ ] are pin numbers designated by HONDA TSUSHIN KOGYO CO., LTD.

| | |
|---|---|
| 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. |

### 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 Input15 | 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. |

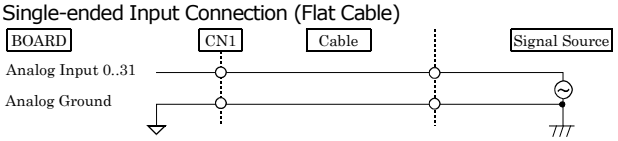
## Analog Input Signal Connection

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

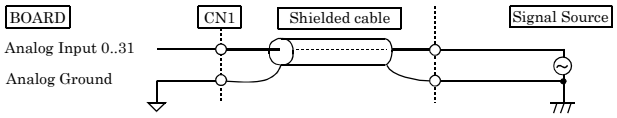
The following figure shows an example of flat cable connection.
Connect separate signal and ground wires for each analog input channel on CN1.

Single-ended Input Connection (Flat Cable)




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.

Single-ended Input Connection (Shielded Cable)



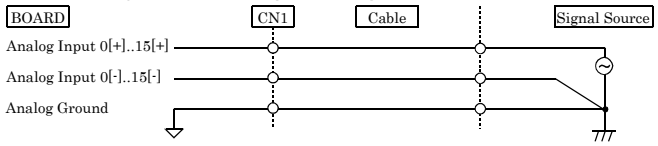

▼CAUTION

- 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

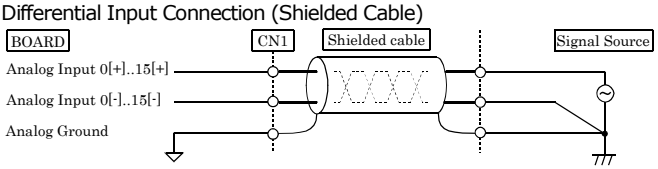
The following figure shows an example of flat cable connection.
For each analog input channel on CN1, connect the "+" input to the signal and connect the "-" input to the signal source ground. Also connect the analog ground on the board to the signal source ground.

Differential Input Connection (Flat Cable)




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.

Differential Input Connection (Shielded Cable)

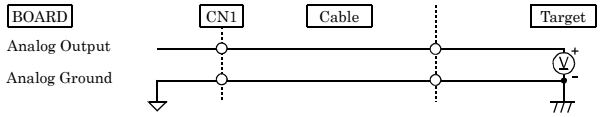


▼CAUTION
- If the signal source contains over 1MHz signals, the signal may effect the cross-talk noise between channels.
- When the analog ground is not connected, the conversion data is not determined.
- If the board and the signal source receive noise or the distance between the board and the signal 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

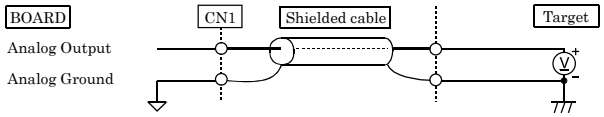
This section shows how to connect the analog output signal by using a flat cable or a shielded cable.
The following figure shows an example of flat cable connection.
Connect the signal source and ground to the CN1 analog output.

Analog Output Connection (Flat Cable)




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.

Analog Output Connection (Shielded Cable)

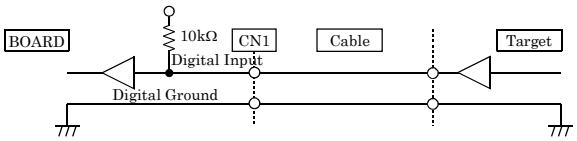



▼CAUTION
- When a frequency of 1MHz or higher is contained in the source signal, the cross talk between channels may occur.
- If the board or the connected wire receives noise, or the distance between the board and the target is long, data may not be outputted properly.
- For analog output signal, the current capacity is ±5mA (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.

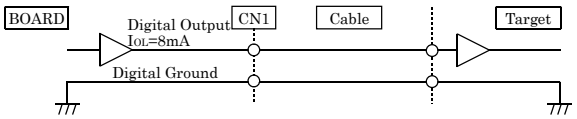
## Digital I/O signals, Counter signals and Control signals Connection

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 LVTTL 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.