PC-HELPER

64/16 Channel Analog to Digital Input
Board for PCI

AD12-64(PCI)
AD12-16(PCI)
User's Guide

CONTEC CO., LTD.

Check Your Package

Thank you for purchasing the CONTEC product.

The product consists of the items listed below.

Check, with the following list, that your package is complete.   If you discover damaged or missing items, contact your retailer.

Product Configuration List

- Board (One of the following) …1
    [AD12-64(PCI), AD12-16(PCI)] …1

- First step guide …1

- CD-ROM *1 [API-PAC(W32)]…1

- Warranty Certificate …1

- Serial number label…1

*1 The CD-ROM contains the driver software and User's Guide (this guide)

Board   First step guide   CD-ROM
                                        [API-PAC(W32)]

Warranty Certificate   Serial number label
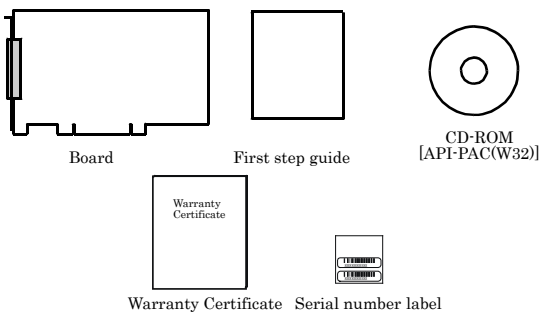
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Table of Contents

6.	ABOUT HARDWARE	75

1. Before Using the Product

About the Board

AD12-64(PCI) and AD12-16(PCI) are PCI-compliant interface boards that convert analog input signals to digital equivalents (performing analog-to-digital conversion).

AD12-64(PCI) and AD12-16(PCI) can perform A-D conversion at a conversion speed of 10μsec [100KSPS] per channel and a resolution of 12bit.

Using the dedicated library VI-DAQ makes it possible to create each application for LabVIEW.

Features

Multi-channel analog input

< AD12-64(PCI) > can perform an analog input of single-ended input 64 channels and differential input 32 channels.   < AD12-16(PCI) > can perform an analog input of single-ended input 16 channels and differential input 8 channels.
Selection of single-ended input and differential input can be set up by the software.

Input range setup by software

Input range can be selected for each channel from the following ranges and can be set up by the software.

±10V, ±5V, ±2.5V, ±1.25V, 0 - +10V, 0 - +5V, 0 - +2.5V, 0 - +1.25V

Sampling control function

The board can perform sampling either at arbitrary timings under control of software or periodically in synchronization with a sampling clock signal.

The sampling clock signal can be selected between the internal one based on the on-board clock generator and the external one using a digital signal input from an external source.

Digital input/output function

The board has four digital input and four digital output pins for TTL-level signals, allowing an external device to be monitored and controlled.

Optional units

Using optional units facilitates connections.
For more details on the option, please refer to this chapter "Cable & Connector" or "Accessories   (Option)".

Support Software

You should use CONTEC support software according to your purpose and development environment.

Windows version of analog I/O driver   **API-AIO(WDM)/API-AIO(98/PC)**
  [Stored on the bundled CD-ROM driver library API-PAC(W32)]

These drivers are 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 *1useful 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 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.

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**
(Available for downloading (free of charge) from the CONTEC web site.)

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.

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Cable & Connector   (Option)

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 Both Ends	:	PCB96PS-0.5P (0.5m)
	:	PCB96PS-1.5P (1.5m)
Flat Cable with 96-Pin Half-Pitch Connectors at One End	:	PCA96P-1.5 (1.5m)
Shield Cable with 96-Pin D-SUB Connector at One End	:	PCA96PS-0.5P (0.5m)
	:	PCA96PS-1.5P (1.5m)
Half Pitch 96P Female Connector Set(5 Pieces)	:	CN5-H96F

Accessories   (Option)

Screw Terminal (M3 x 96P)	:	EPD-96A *1 *2
Screw Terminal (M3.5 x 96P)	:	EPD-96 *1
Screw Terminal (M3 x 96P)	:	DTP-64A *1

1 PCB96P- or PCB96PS-* optional cable is required separately.

*2 "Spring-up" type terminal is used to prevent terminal screws from falling off.

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

Customer Support

CONTEC provides the following support services for you to use CONTEC products more efficiently and comfortably.

Web Site

https://www.contec.com/

Latest product information

CONTEC provides up-to-date information on products.
CONTEC also provides product manuals and various technical documents in the PDF.

Free download

You can download updated driver software and differential files as well as sample programs available in several languages.

Note!   For product information

Contact your retailer if you have any technical question about a CONTEC product or need its price, delivery time, or estimate information.

Limited Three-Years Warranty

CONTEC products are warranted by CONTEC CO., LTD. to be free from defects in material and workmanship for up to three years from the date of purchase by the original purchaser.

Repair will be free of charge only when this device is returned freight prepaid with a copy of the original invoice and a Return Merchandise Authorization to the distributor or the CONTEC group office, from which it was purchased.

This warranty is not applicable for scratches or normal wear, but only for the electronic circuitry and original products.   The warranty is not applicable if the device has been tampered with or damaged through abuse, mistreatment, neglect, or unreasonable use, or if the original invoice is not included, in which case repairs will be considered beyond the warranty policy.

How to Obtain Service

For replacement or repair, return the device freight prepaid, with a copy of the original invoice.   Please obtain a Return Merchandise Authorization number (RMA) from the CONTEC group office where you purchased before returning any product.

*   No product will be accepted by CONTEC group without the RMA number.

Liability

The obligation of the warrantor is solely to repair or replace the product.   In no event will the warrantor be liable for any incidental or consequential damages due to such defect or consequences that arise from inexperienced usage, misuse, or malfunction of this device.

Safety Precautions

Understand the following definitions and precautions to use the product safely.

Safety Information

This document provides safety information using the following symbols to prevent accidents resulting in injury or death and the destruction of equipment and resources.   Understand the meanings of these labels to operate the equipment safely.

⚠ DANGER	DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or in property damage.

Handling Precautions

⚠ DANGER

Do not use the product where it is exposed to flammable or corrosive gas.   Doing so may result in an explosion, fire, electric shock, or failure.

⚠ CAUTION

- There are switches and jumpers on this product that need to be set in advance.
  Be sure to check these before installing to the expansion slot.

- Only set the switches and jumpers on this product to the specified settings.
  Otherwise, this product may malfunction, overheat, or cause a failure.

- Do not strike or bend this product.
  Otherwise, this product may malfunction, overheat, cause a failure or breakage.

- Do not touch this product's metal plated terminals (edge connector) with your hands.
  Otherwise, this product may malfunction, overheat, or cause a failure.
  If the terminals are touched by someone's hands, clean the terminals with industrial alcohol.

- Do not install this product to the expansion slot and do not plug or unplug the cables which are connected to this product while the PC or expansion unit is still turned on.
  Otherwise, this product may malfunction, overheat, or cause a failure.
  Be sure that the personal computer power is turned off.

- Make sure that your PC or expansion unit can supply ample power to all the product installed.
  Insufficiently energized products could malfunction, overheat, or cause a failure.

- The specifications of this product are subject to change without notice for enhancement and quality improvement.
  Even when using the product continuously, be sure to read the user's guide and understand the contents.

- Do not modify the product.   CONTEC will bear no responsibility for any problems, etc., resulting from modifying this product.

- Regardless of the foregoing statements, CONTEC is not liable for any damages whatsoever (including damages for loss of business profits) arising out of the use or inability to use this CONTEC product or the information contained herein.

- Regarding "CE EMC Directive Notice".
  Please connect the Interface Connector with a shielded cable to meet the mentioned standard above.

Environment

Use this product in the following environment.   If used in an unauthorized environment, the product may overheat, malfunction, or cause a failure.

Operating temperature

0 - 50°C

Operating humidity

10 - 90%RH (No condensation)

Corrosive gases

None

Floating dust particles

Not to be excessive

Inspection

Inspect the product periodically as follows to use it safely.

- Check that the bus connector of the board and its cable have been plugged correctly.

- Check that the board has no dust or foreign matter adhering.

- The gold-plated leads of the bus connector have no stain or corrosion.
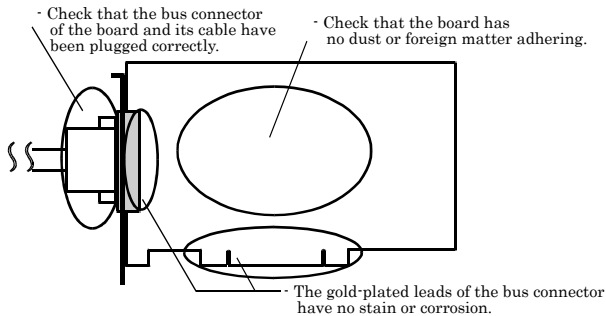
Storage

When storing this product, keep it in its original packing form.

(1) Put the product in the storage bag.

(2) Wrap it in the packing material, then put it in the box.

(3) Store the package at room temperature at a place free from direct sunlight, moisture, shock, vibration, magnetism, and static electricity.

Disposal

When disposing of the product, follow the disposal procedures stipulated under the relevant laws and municipal ordinances.

2. Setup

This chapter explains how to set up the board.

What is Setup?

Setup means a series of steps to take before the product can be used.
Different steps are required for software and hardware.
The setup procedure varies with the OS and software used.

Using the Board under Windows

Using the Driver Library API-PAC(W32)

This section describes the setup procedure to be performed before you can start developing application programs for the board using the bundled CD-ROM "Driver Library API-PAC(W32)".

Taking the following steps sets up the software and hardware.   You can use the diagnosis program later to check whether the software and hardware function normally.

   Step 1 Installing the Software

   Step 2 Setting the Hardware

   Step 3 Installing the Hardware

   Step 4 Initializing the Software

   Step 5 Checking Operations with the Diagnosis Program

If Setup fails to be performed normally, see the "Setup Troubleshooting" section at the end of this chapter.

Using the Board under Windows

Using Software Other than the Driver Library

API-PAC(W32)

For setting up software other than API-PAC(W32), refer to the user's guide for that software.   See also the following parts of this user's guide as required.

   This chapter Step 2 Setting the Hardware

   This chapter Step 3 Installing the Hardware

   Chapter 3 External Connection

   Chapter 6 About Hardware

Using the Board under an OS Other than Windows

For using the board under an OS other than Windows, see the following parts of this user's guide.

This chapter Step 2 Setting the Hardware

Chapter 3 External Connection

Chapter 6 About Hardware

Step 1 Installing the Software

This section describes how to install the Driver libraries.

Before installing the hardware on your PC, install the Driver libraries from the bundled API-PAC(W32) CD-ROM.

The following description assumes the operating system as Windows XP.   Although some user interfaces are different depending on the OS used, the basic procedure is the same.

About the driver to be used

Two Analog I/O drivers are available : API-AIO(WDM) and API-AIO(98/PC).

API-AIO(WDM) is a new driver to perform analog I/O under Windows.

API-AIO(WDM) was developed to improve the conventional product version of API-AIO(98/PC) in the ease of use and functionality.

It is advisable to use API-AIO(WDM) for you to use an analog I/O device.   API-AIO(WDM) will support new OS and devices in the future but will not support Windows NT 4.0, Windows 95, ISA bus. Use API-AIO(98/PC) if your operating environment contains such an unsupported piece of software or hardware.

Check the following selection guide to easily select the driver to be used.
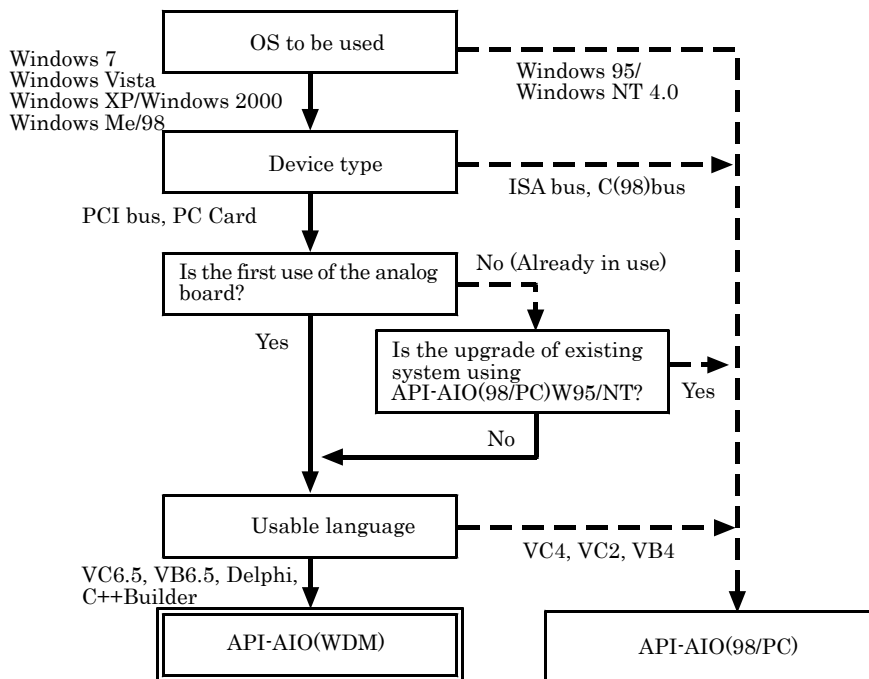
Starting the Install Program

(1) **Load the CD-ROM [API-PAC(W32)] on your PC.**

(2) **The API-PAC(W32) Installer window appears automatically.**
If the panel does not appear, run (CD-ROM drive letter):\AUTORUN.exe.

(3) **Click on the [Install Development or Execution Environment] button.**
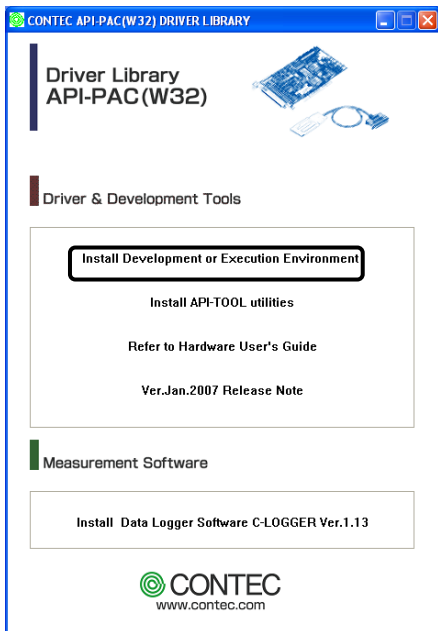
* When using the Windows Vista, driver is automatically installed.

⚠ CAUTION

Before installing the software in Windows 7, Server 2008, Vista, XP, Server 2003, 2000, log in as a user with administrator privileges.

When Using API-AIO(WDM)

Selecting API-AIO(WDM)

(1) **The following dialog box appears to select "Driver to install" and "Install option", "Usage of driver library".**

(2) **Select the "Advanced Analog I/O driver".**

(3) **Click on the [Install] button.**
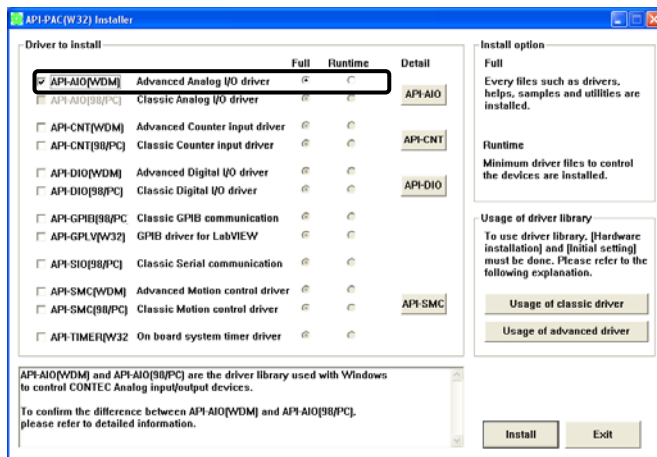
* Clicking the [API-AIO] button under the "Detail" displays detailed information about API-AIO(WDM) and API-AIO(98/PC).

Run the installation

(1) **Complete the installation by following the instructions on the screen.**

(2) **The Readme file appears when the installation is complete.**

When Using API-AIO(98/PC)

Selecting API-AIO(98/PC)

(1) **The following dialog box appears to select "Driver to install" and "Install option", "Usage of driver library".**

(2) **Select "Classic Analog I/O driver".**

(3) **Click on the [Install] button.**

* Clicking the [API-AIO] button under the "Detail" displays detailed information about API-AIO(WDM) and API-AIO(98/PC).
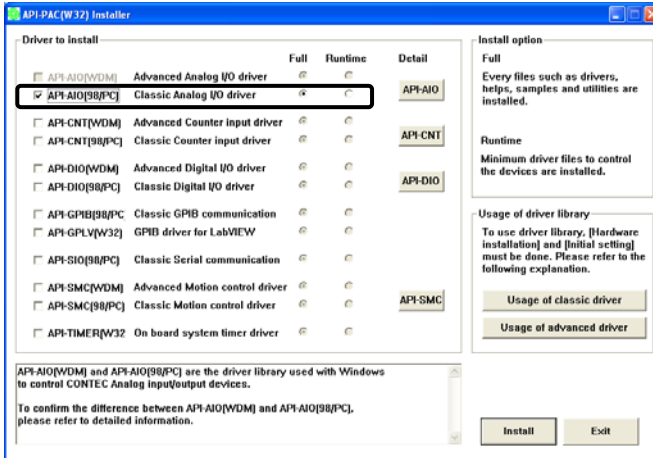
Executing the Installation

(1) **Follow the on-screen instructions to proceed to install.**

(2) When the required files have been copied, the "Perform a hardware setup now(API-TOOL Configuration)" and "Show readme file" check boxes are displayed.
When you are installing the software or hardware for the first time:
1) Uncheck "Perform a hardware setup now".
2) Click on the [Finish] button.
　Go to Step 2 to set and plug the hardware.

　* When the hardware has already been installed:
　Check "Perform a hardware setup now(API-TOOL Configuration)", then go to Step 4
　"Initializing the Software".
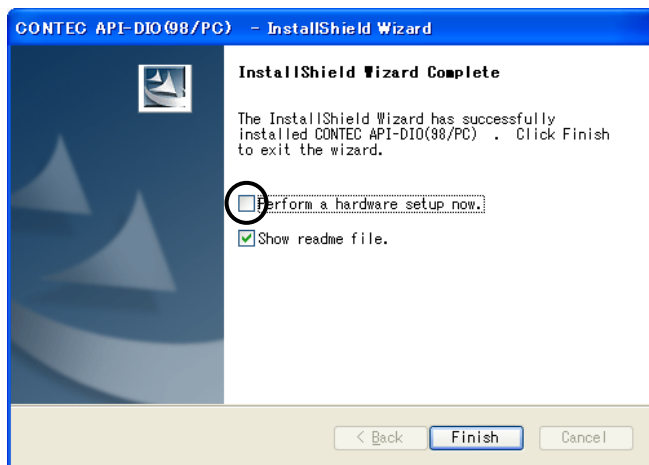
You have now finished installing the software.

Step 2 Setting the Hardware

This section describes how to set this product and plug it on your PC.

This product has some switches and jumper to be preset.
Check the on-board switches and jumpers before plugging this product into an expansion slot.

This product can be set up even with the factory defaults untouched.   You can change board settings later.

Parts of the Board and Factory Defaults
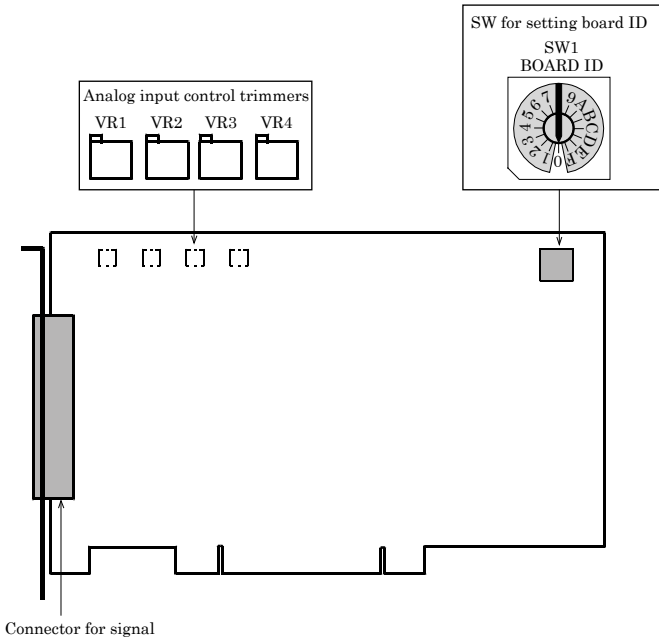
Figure 2.1.   Part Names

Note that the switch setting shown below is the factory default.

Setting the Board ID

If you install two or more boards on one personal computer, assign a different ID value to each of the boards to distinguish them.

The board IDs can be set from 0 to Fh to identify up to sixteen boards.

If only one board is used, the original factory setting (Board ID = 0) should be used.

Setting Procedure

To set the board ID, use the rotary switch on the board.   Turn the SW1 knob to set the board ID as shown below.
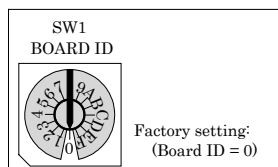
Figure 2.2.   Board ID Settings (SW1)

Plugging the Board

(1) Before plugging the board, shut down the system, unplug the power code of your PC.

(2) Remove the cover from the PC so that the board can be mounted.

(3) Plug the board into an expansion slot.

(4) Attach the board bracket to the PC with a screw.

(5) Put the cover back into place.

Applicable PCI bus slots

PCI bus slots used in PCs have keys to prevent 5V and 3.3V PCI bus boards from being accidentally plugged into wrong bus slots.   This board can be plugged into both of the 5V and 3.3V PCI bus slots.

<PCI bus slot>

5-V PCI bus slot

3.3-V PCI bus slot   5V key

3.3V key

<PCI bus board>

B   A
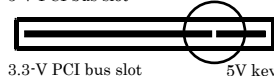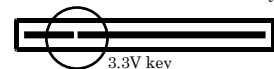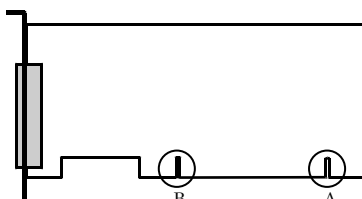
A : Slit for 5-V PCI bus slot
B : Slit for 3.3-V PCI bus slot

⚠ CAUTION

-   Do not touch the board's metal plated terminals (edge connector) with your hands.
    Otherwise, the board may malfunction, overheat, or cause a failure.
    If the terminals are touched by someone's hands, clean the terminals with industrial alcohol.

-   Do not install or remove the board to or from the slot while the computer's power is turned on.
    Otherwise, the board may malfunction, overheat, or cause a failure.
    Doing so could cause trouble. Be sure that the personal computer or the I/O expansion unit power is turned off.

-   Make sure that your PC or expansion unit can supply ample power to all the boards installed.
    Insufficiently energized boards could malfunction, overheat, or cause a failure.

-   Power supply from the PCI bus slot at +5V is required.

Step 3 Installing the Hardware

Windows needs to detect the I/O address and interrupt used by the board.   This is called hardware installation.

When using more than one board, install the boards one at a time and do not install the next board until setup is complete for the previous board.

Turning on the PC

Turn on the power to your PC.

⚠ CAUTION ─────────────────────

- The board cannot be properly installed unless the resources (I/O addresses and interrupt level) for the board can be allocated.   Before attempting to install the board, first determine what PC resources are free to use.

- The resources used by each board do not depend on the location of the PCI bus slot or the board itself.   If you remove two or more boards that have already been installed and then remount one of them on the computer, it is unknown that which one of the sets of resources previously assigned to the two boards is assigned to the remounted board.   In this case, you must check the resource settings.

When Using API-AIO(WDM)

(1) The "Found New Hardware Wizard" will be started.
    Select "Install from a list or specific location[Advanced]", then click on the [Next] button.

(2) Specify that folder on the CD-ROM which contains the setup information (INF) file to register the board.

Source folder

The setup information (INF) file is contained in the following folder on the bundled CD-ROM.

\INF\WDM\AIO
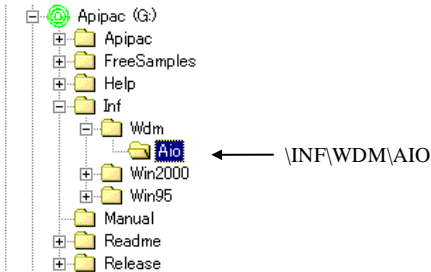
You have now finished installing the hardware.

When Using API-AIO(98/PC)

(1) The "Found New Hardware Wizard" will be started.
Select "Install from a list or specific location[Advanced]", then click on the [Next] button.
If you are using Windows NT 4.0, the "Found New Hardware Wizard" is not started.
Go to Step 4 "Initializing the Software".

(2) Specify that folder on the CD-ROM which contains the setup information (INF) file to register the board.

Source folder

The setup information (INF) file is contained in the following folder on the bundled CD-ROM.

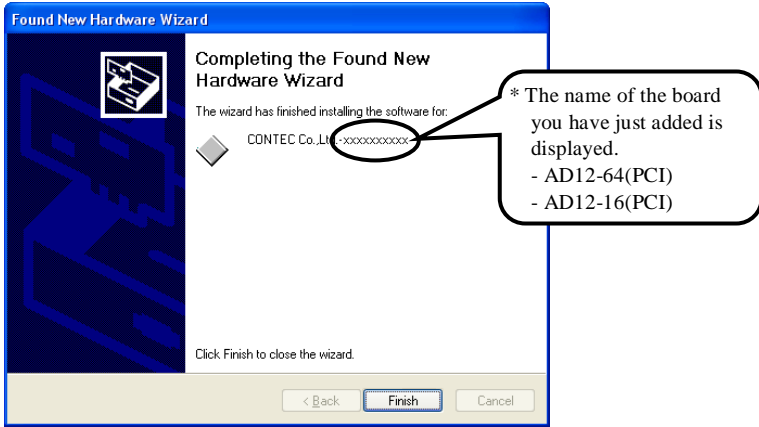|	
Windows Vista	\INF\WinVista\Aio\PCI
Windows XP, Server 2003, 2000	\INF\Win2000\Aio\PCI
Windows Me, 98, 95	\INF\Win95\Aio\PCI

Example of specifying the folder for use under Windows XP
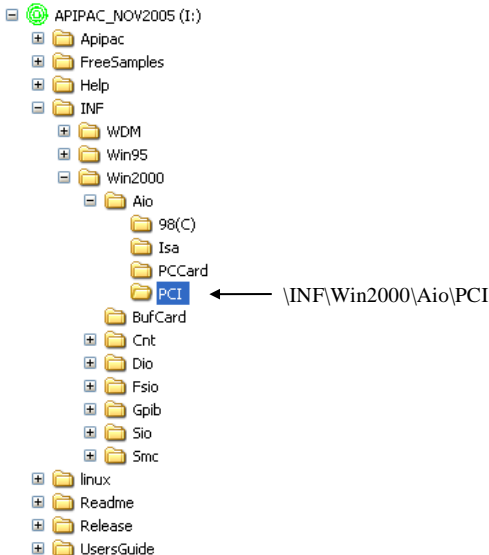
⚠ CAUTION

In Windows XP, the Hardware Wizard displays the following alert dialog box when you have located the INF file. This dialog box appears, only indicating that the relevant driver has not passed Windows Logo testing, and it can be ignored without developing any problem with the operation of the board.

In this case, click on the [Continue Anyway] button.

Hardware Installation

The software you are installing for this hardware:

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has not passed Windows Logo testing to verify its compatibility with Windows XP. (Tell me why this testing is important.)

Continuing your installation of this software may impair or destabilize the correct operation of your system either immediately or in the future. Microsoft strongly recommends that you stop this installation now and contact the hardware vendor for software that has passed Windows Logo testing.

[Continue Anyway] [STOP Installation]

* The name of the board you have just added is displayed.
- AD12-64(PCI)
- AD12-16(PCI)

You have now finished installing the hardware.

Step 4 Initializing the Software

The driver library requires the initial setting to recognize the execution environment.   It is called the initialization of the driver library.

When Using API-AIO(WDM)

Setting the device name

(1) Run Device Manager.   From [My Computer] - [Control Panel], select [System] and then select the [Device Manager] tab.
     (You can also open Device Manager by right clicking on My Computer and selecting Properties.)
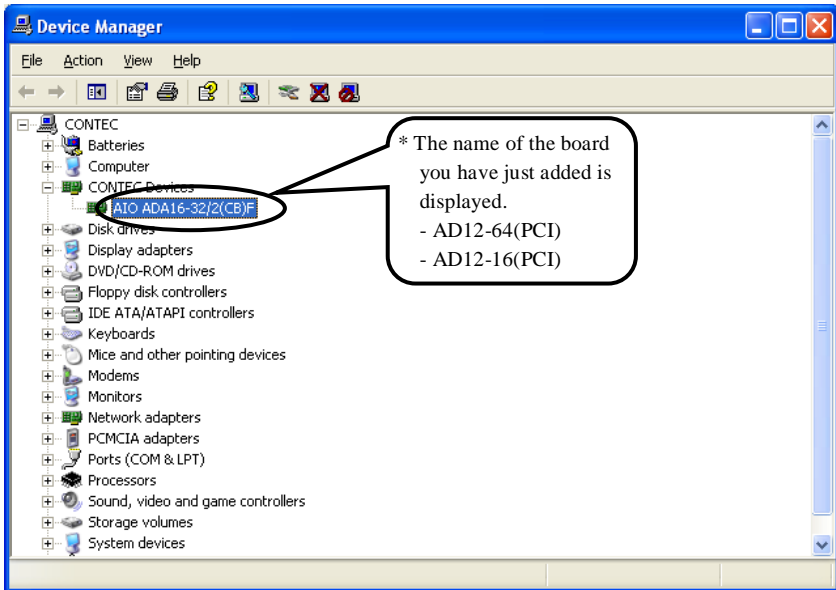
(2) The installed hardware appears under the CONTEC Devices node.   Open the CONTEC Devices node and select the device you want to setup (the device name should appear highlighted).   Click [Properties].

(3) The property page for the device opens.

Enter the device name in the common settings tab page and then click [OK].

The device name you set here is used later when programming.
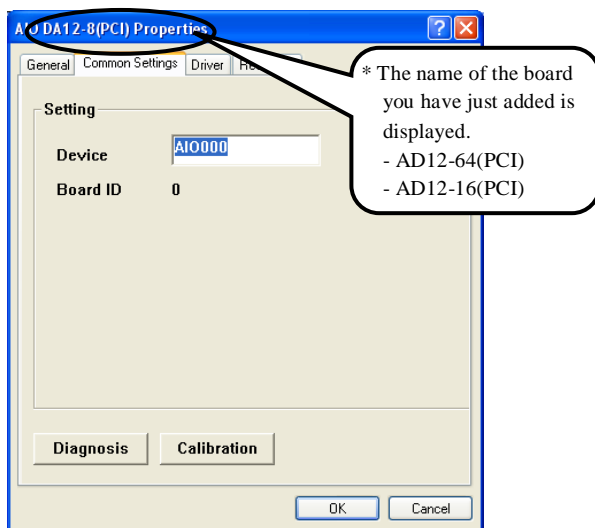
*   The initial device name that appears is a default value.   You can use this default name if you wish.

*   Make sure that you do not use the same name for more than one device

You have now finished installing the initial setting of Software.

When Using API-AIO(98/PC)

Invoking API-TOOL Configuration

(1) Open the Start Menu, then select "Programs" – "CONTEC API-PAC(W32)" – "API-TOOL Configuration".
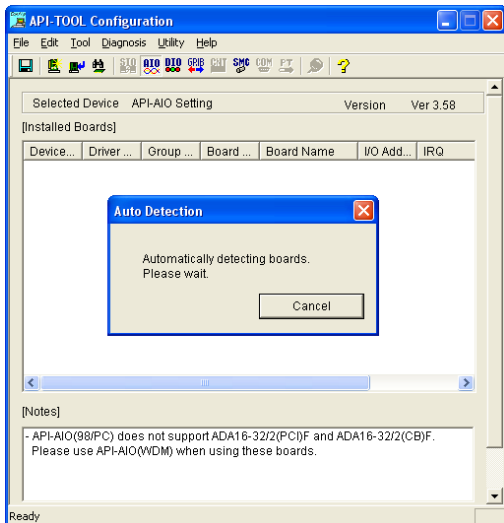
(2) API-TOOL Configuration detects boards automatically.
The detected boards are listed.

Updating the Settings

(1) Select "Save setting to registry…" from the "File" menu.

You have now finished installing the initial setting of Software.

Step 5 Checking Operations with the Diagnosis Program

Use the diagnosis program to check that the board and driver software work normally, thereby you can confirm that they have been set up correctly.

What is the Diagnosis Program?

The diagnosis program diagnoses the states of the board and driver software.
It can also be used as a simple checker when an external device is actually connected.
Using the "Diagnosis Report" feature reports the driver settings, the presence or absence of the board, I/O status, and interrupt status.

Check Method

To check analog input data, connect the signal.
The diagrams below show examples of using channel 0.   For details on the connections, see Chapter 3 "External Connection".   Check the board with the factory defaults untouched.

Wiring Diagram
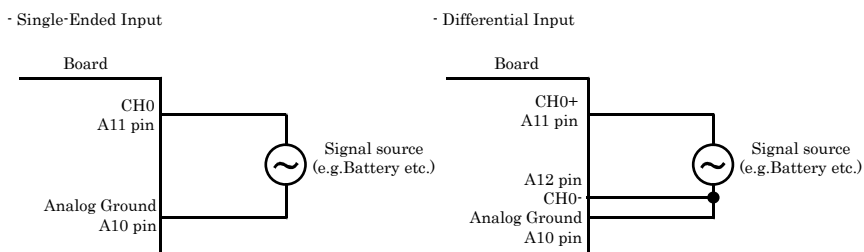
Figure 2.3. Wiring Diagram

⚠ CAUTION

Input data remains indeterminate when no input pin is connected.   The input pin for the channel not connected to the signal source must be connected to the analog ground.   For details, see "Chapter 3 External Connection".

Using the Diagnosis Program for Use of API-AIO(WDM)

Starting the Diagnosis Program

Click the [Diagnosis] button on the device property page to start the diagnosis program.

* The name of the board you have just added is displayed.
- AD12-64(PCI)
- AD12-16(PCI)

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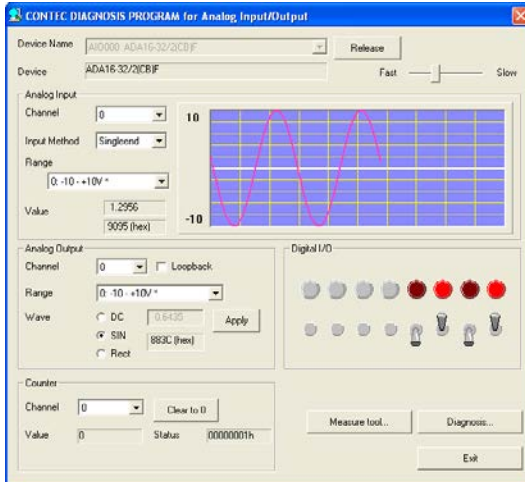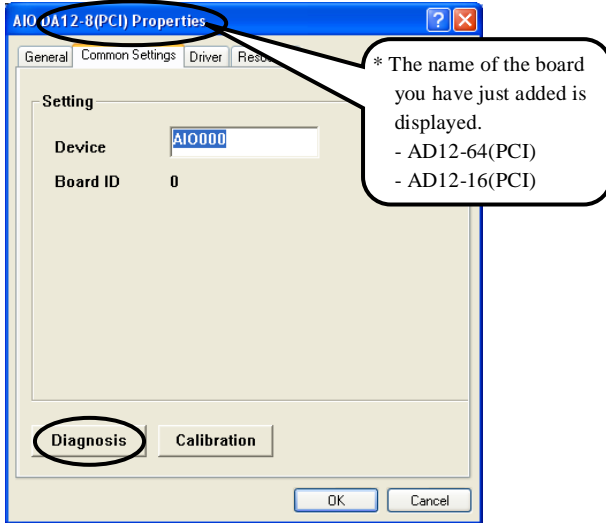
Analog input

You can select the desired input channel, input mode and input range from the lists.

Input data is plotted on a graph.

Digital input / output

The upper row of circular lamps indicates the digital input states.   Red indicates the bit is ON and brown indicates OFF.

Clicking the lower row of switches turns the digital output bits ON or OFF.

Diagnosis Report

(1) The diagnosis report saves detailed data, including the device settings and settings for each channel, to a text file and displays the file for you to view.

Clicking [Diagnosis Report] prompts you to specify where to save the report text file.

(2) The diagnosis report contains the following data.

- Version of OS
- Device Information
- File Information
- Diagnosis results for each input channel

Execution time measurement

Clicking [Execution Time Measurement] runs the program to measure API function execution speed. The operation of this program is explained in "API function Execution Speed Measurement Program" in Chapter 5.

Using the Diagnosis Program for Use of API-AIO(98/PC)

Starting the Diagnosis Program

After selecting the board in [API-TOOL Configuration], run the diagnosis program.   Follow the on-screen instructions.
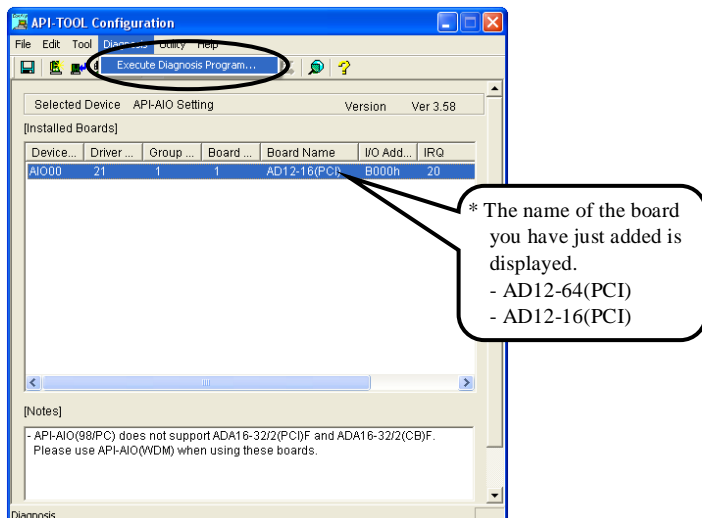
Checking the Analog Input
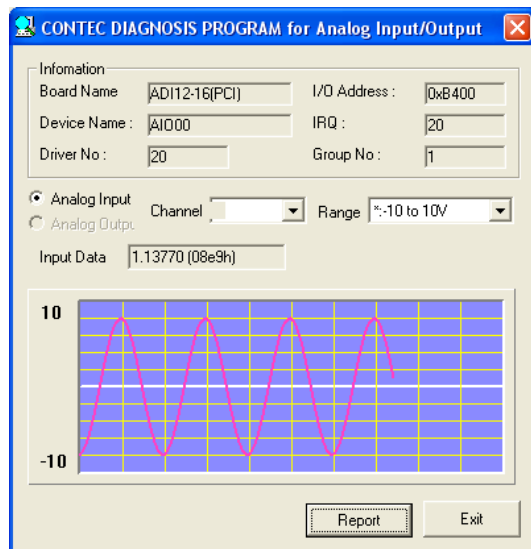
Analog input

You can select the input channel and input range from the lists.
Input data is plotted on a graph.

Diagnosis Report

(1) Clicking on the [Report] button displays detailed data such as a board, channel settings and the
diagnosis results while saving them in text format.
The results are saved and displayed as a text file (AioRep.txt) in the install folder
(CONTEC/CONTECW95).
The Diagnosis Program performs "board presence/absence check", "interrupt test", "driver file
test", "board setting test", and so on.
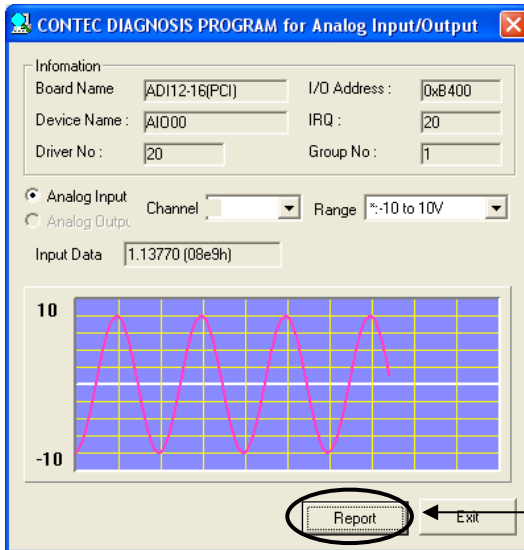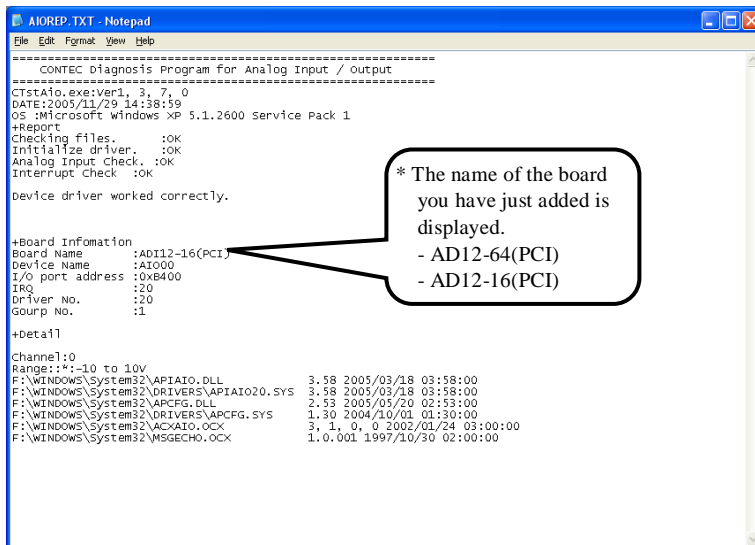
Click on [Report].

(2) A diagnosis report is displayed as shown below.

Setup Troubleshooting

Symptoms and Actions

The board cannot be initialized. [Windows NT4.0]

The driver may not yet be activated.   When your PC is running under Windows NT 4.0, set the PnP OS option in the BIOS Setup menu to "NO".

For details on BIOS settings, refer to the user's guide for your PC.

The board cannot input or output data normally

- Run the Diagnosis Program to check whether the board has been registered correctly and whether any initialization error has occurred.
- Check the settings and connections of the board.   Also check the input and output ranges.   When your board uses jumpers to set the input/output ranges, correct data cannot be obtained unless the ranges have been adjusted.   When no connection has been made, input data remains indeterminate. The channel to be used must be wired.   The channels not to be used must be connected to the analog ground.
- If there is no appropriate signal source available at voltage input, either connect a cell or connect the channel to the analog ground to check for 0V.

The board works with the Diagnosis Program but not with an application.

The Diagnosis Program is coded with API-TOOL functions.   As long as the board operates with the Diagnosis Program, it is to operate with other applications as well.   In such cases, review your program while paying attention to the following points:

- Check the return values of functions.
- Check the Driver No. and Board No.

The OS won't normally get started or detect the board.
[Windows Vista, XP, Server 2003, 2000]

Turn off the power to your PC, then unplug the board.   Restart the OS and delete the board settings of API-TOOL Configuration.   Turn off the PC again, plug the board, and restart the OS.   Let the OS detect the board and use API-TOOL Configuration to register board settings.

If your problem cannot be resolved

Contact your retailer.

3. External Connection

This chapter describes the interface connectors on the product and the external I/O circuits.
Check the information available here when connecting an external device.

How to connect the connectors

Connector shape

To connect an external device to this product, plug the cable from the device into the interface
connector (CN1) shown below.

- Connector used
  PCR-E96LMD+ equivalence to it
  [mfd.by HONDA TSUSHIN KOGYO CO., LTD]

- Compatible connector
  PCR-E96FA or equivalence to it
  [mfd. by HONDA TSUSHIN KOGYO CO., LTD.]

  CN5-H96F (Set of 5 connectors)
  [CONTEC, M(male)type]]
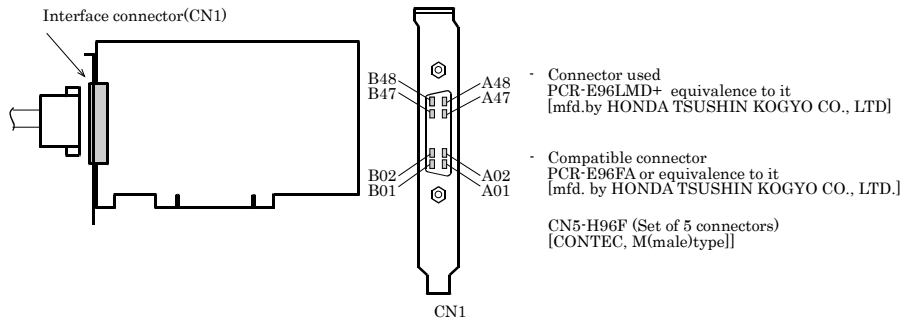
* Please refer to chapter 1 for more information on the supported cable and accessories.

Figure 3.1.   Interface Connector Shape
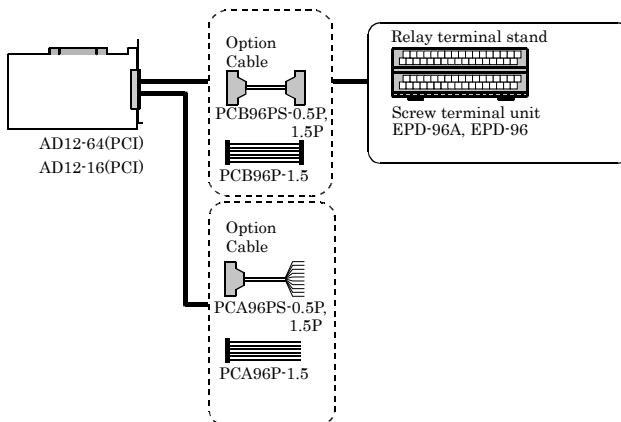
Figure 3.2.   Examples of Connecting Options

Connector Pin Assignment

Pin Assignments of AD12-64(PCI) Interface Connector (CN1) < Single-Ended Input >

Analog Input 63	B48		A48	Analog Input 59
Analog Input 55	B47		A47	Analog Input 51
Analog Input 62	B46		A46	Analog Input 58
Analog Input 54	B45		A45	Analog Input 50
Analog Input 61	B44		A44	Analog Input 57
Analog Input 53	B43		A43	Analog Input 49
Analog Input 60	B42		A42	Analog Input 56
Analog Input 52	B41		A41	Analog Input 48
Analog Ground	B40		A40	Analog Ground
Analog Ground	B39		A39	Analog Ground
Analog Input 47	B38		A38	Analog Input 43
Analog Input 39	B37		A37	Analog Input 35
Analog Input 46	B36		A36	Analog Input 42
Analog Input 38	B35		A35	Analog Input 34
Analog Input 45	B34		A34	Analog Input 41
Analog Input 37	B33		A33	Analog Input 33
Analog Input 44	B32		A32	Analog Input 40
Analog Input 36	B31		A31	Analog Input 32
Analog Ground	B30		A30	Analog Ground
Analog Ground	B29		A29	Analog Ground
Analog Input 31	B28		A28	Analog Input 27
Analog Input 23	B27		A27	Analog Input 19
Analog Input 30	B26		A26	Analog Input 26
Analog Input 22	B25		A25	Analog Input 18
Analog Input 29	B24		A24	Analog Input 25
Analog Input 21	B23		A23	Analog Input 17
Analog Input 28	B22		A22	Analog Input 24
Analog Input 20	B21		A21	Analog Input 16
Analog Ground	B20		A20	Analog Ground
Analog Ground	B19		A19	Analog Ground
Analog Input 15	B18		A18	Analog Input 11
Analog Input 7	B17		A17	Analog Input 3
Analog Input 14	B16		A16	Analog Input 10
Analog Input 6	B15		A15	Analog Input 2
Analog Input 13	B14		A14	Analog Input 9
Analog Input 5	B13		A13	Analog Input 1
Analog Input 12	B12		A12	Analog Input 8
Analog Input 4	B11		A11	Analog Input 0
Analog Ground	B10		A10	Analog Ground
Analog Ground	B09		A09	Analog Ground
+5VDC from PC	B08		A08	External Sampling Clock Input
+5VDC from PC	B07		A07	Digital Ground
Sampling Busy Output	B06		A06	External Trigger Input
Timer Output	B05		A05	Digital Ground
Digital Output 3	B04		A04	Digital Input 3
Digital Output 2	B03		A03	Digital Input 2
Digital Output 1	B02		A02	Digital Input 1
Digital Output 0	B01		A01	Digital Input 0

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

Analog Input 0 - Analog Input 63	Analog input signal at the time of Single-Ended Input. The numbers correspond to channel numbers.
Analog Ground	Common analog ground for analog input signals.
Digital Input 0 - Digital Input 3	Digital input signal.
Digital Output 0 - Digital Output 3	Digital output signal.
External Trigger Input	External trigger input signal.
External Sampling Clock Input	External Sampling Clock Input signal.
Timer Output	Programmable timer output signal.
Sampling Busy Output	Output signal indicating that the board is performing AD conversion
+5VDC from PC	Output +5V. The total current-carrying capacity that can be supplied from two pins is 1 A
Digital Ground	Digital ground common to those signals other than analog input signals, such as digital I/O signals and external sampling clock input signals, and "+5V DC from PC"

Figure 3.3. Pin Assignments of AD12-64(PCI) Interface Connector (CN1)
< Single-Ended Input >

⚠ 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.

Pin Assignments of AD12-64(PCI) Interface Connector (CN1)   < Differential Input >

Analog Input 31 [-]	B48			A48	Analog Input 27 [-]
Analog Input 31[+]	B47			A47	Analog Input 27 [+]
Analog Input 30 [-]	B46			A46	Analog Input 26 [-]
Analog Input 30[+]	B45			A45	Analog Input 26 [+]
Analog Input 29 [-]	B44			A44	Analog Input 25 [-]
Analog Input 29[+]	B43			A43	Analog Input 25 [+]
Analog Input 28 [-]	B42			A42	Analog Input 24 [-]
Analog Input 28[+]	B41			A41	Analog Input 24 [+]
Analog Ground	B40			A40	Analog Ground
Analog Ground	B39			A39	Analog Ground
Analog Input 23 [-]	B38			A38	Analog Input 19 [-]
Analog Input 23[+]	B37			A37	Analog Input 19 [+]
Analog Input 22 [-]	B36			A36	Analog Input 18 [-]
Analog Input 22[+]	B35	B48 [49] [1] A48		A35	Analog Input 18 [+]
Analog Input 21 [-]	B34			A34	Analog Input 17 [-]
Analog Input 21[+]	B33			A33	Analog Input 17 [+]
Analog Input 20 [-]	B32			A32	Analog Input 16 [-]
Analog Input 20[+]	B31			A31	Analog Input 16 [+]
Analog Ground	B30			A30	Analog Ground
Analog Ground	B29			A29	Analog Ground
Analog Input 15 [-]	B28			A28	Analog Input 11 [-]
Analog Input 15[+]	B27			A27	Analog Input 11 [+]
Analog Input 14 [-]	B26			A26	Analog Input 10 [-]
Analog Input 14[+]	B25			A25	Analog Input 10 [+]
Analog Input 13 [-]	B24			A24	Analog Input 9 [-]
Analog Input 13[+]	B23			A23	Analog Input 9 [+]
Analog Input 12 [-]	B22			A22	Analog Input 8 [-]
Analog Input 12[+]	B21			A21	Analog Input 8 [+]
Analog Ground	B20			A20	Analog Ground
Analog Ground	B19			A19	Analog Ground
Analog Input 7 [-]	B18			A18	Analog Input 3 [-]
Analog Input 7[+]	B17			A17	Analog Input 3 [+]
Analog Input 6 [-]	B16			A16	Analog Input 2 [-]
Analog Input 6[+]	B15	B01 [96] [48] A01		A15	Analog Input 2 [+]
Analog Input 5 [-]	B14			A14	Analog Input 1 [-]
Analog Input 5[+]	B13			A13	Analog Input 1 [+]
Analog Input 4 [-]	B12			A12	Analog Input 0 [-]
Analog Input 4[+]	B11			A11	Analog Input 0 [+]
Analog Ground	B10			A10	Analog Ground
Analog Ground	B09			A09	Analog Ground
+5VDC from PC	B08			A08	External Sampling Clock Input
+5VDC from PC	B07			A07	Digital Ground
Sampling Busy Output	B06			A06	External Trigger Input
Timer Output	B05			A05	Digital Ground
Digital Output 3	B04			A04	Digital Input 3
Digital Output 2	B03			A03	Digital Input 2
Digital Output 1	B02			A02	Digital Input 1
Digital Output 0	B01			A01	Digital Input 0

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

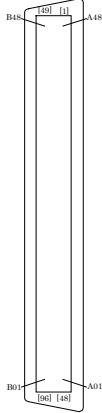|	
Analog Input 0[+] - Analog Input 31[+]	Analog input signal at the time of Differential Input. The numbers correspond to channel numbers.
Analog Input 0[-] - Analog Input 31[-]	Analog input signal at the time of Differential Input. The numbers correspond to channel numbers.
Analog Ground	Common analog ground for analog input signals.
Digital Input 0 - Digital Input 3	Digital input signal.
Digital Output 0 - Digital Output 3	Digital output signal.
External Trigger Input	External trigger input signal.
External Sampling Clock Input	External Sampling Clock Input signal.
Timer Output	Programmable timer output signal.
Sampling Busy Output	Output signal indicating that the board is performing AD conversion
+5VDC from PC	Output +5V. The total current-carrying capacity that can be supplied from two pins is 1 A
Digital Ground	Digital ground common to those signals other than analog input signals, such as digital I/O signals and external sampling clock input signals, and "+5V DC from PC"

Figure 3.4. Pin Assignments of AD12-64(PCI) Interface Connector (CN1)
< Differential Input >

⚠ 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.

Pin Assignments of AD12-16(PCI) Interface Connector (CN1)   < Single-Ended Input >

N.C.	B48		A48	N.C.
N.C.	B47		A47	N.C.
N.C.	B46		A46	N.C.
N.C.	B45		A45	N.C.
N.C.	B44		A44	N.C.
N.C.	B43		A43	N.C.
N.C.	B42		A42	N.C.
N.C.	B41		A41	N.C.
Analog Ground	B40		A40	Analog Ground
Analog Ground	B39		A39	Analog Ground
N.C.	B38		A38	N.C.
N.C.	B37		A37	N.C.
N.C.	B36		A36	N.C.
N.C.	B35		A35	N.C.
N.C.	B34		A34	N.C.
N.C.	B33		A33	N.C.
N.C.	B32		A32	N.C.
N.C.	B31		A31	N.C.
Analog Ground	B30		A30	Analog Ground
Analog Ground	B29		A29	Analog Ground
N.C.	B28		A28	N.C.
N.C.	B27		A27	N.C.
N.C.	B26		A26	N.C.
N.C.	B25		A25	N.C.
N.C.	B24		A24	N.C.
N.C.	B23		A23	N.C.
N.C.	B22		A22	N.C.
N.C.	B21		A21	N.C.
Analog Ground	B20		A20	Analog Ground
Analog Ground	B19		A19	Analog Ground
Analog Input 15	B18		A18	Analog Input 11
Analog Input 7	B17		A17	Analog Input 3
Analog Input 14	B16		A16	Analog Input 10
Analog Input 6	B15		A15	Analog Input 2
Analog Input 13	B14		A14	Analog Input 9
Analog Input 5	B13		A13	Analog Input 1
Analog Input 12	B12		A12	Analog Input 8
Analog Input 4	B11		A11	Analog Input 0
Analog Ground	B10		A10	Analog Ground
Analog Ground	B09		A09	Analog Ground
+5VDC from PC	B08		A08	External Sampling Clock Input
+5VDC from PC	B07		A07	Digital Ground
Sampling Busy Output	B06		A06	External Trigger Input
Timer Output	B05		A05	Digital Ground
Digital Output 3	B04		A04	Digital Input 3
Digital Output 2	B03		A03	Digital Input 2
Digital Output 1	B02		A02	Digital Input 1
Digital Output 0	B01		A01	Digital Input 0

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

Analog Input 0 - Analog Input 15	Analog input signal at the time of Single-Ended Input. The numbers correspond to channel numbers.
Analog Ground	Common analog ground for analog input signals.
Digital Input 0 - Digital Input 3	Digital input signal.
Digital Output 0 - Digital Output 3	Digital output signal.
External Trigger Input	External trigger input signal.
External Sampling Clock Input	External Sampling Clock Input signal.
Timer Output	Programmable timer output signal.
Sampling Busy Output	Output signal indicating that the board is performing AD conversion
+5VDC from PC	Output +5V. The total current-carrying capacity that can be supplied from two pins is 1 A
Digital Ground	Digital ground common to those signals other than analog input signals, such as digital I/O signals and external sampling clock input signals, and "+5V DC from PC"
N.C.	No connection to this pin.

Figure 3.5. Pin Assignments of AD12-16(PCI) Interface Connector (CN1)
< Single-Ended Input >

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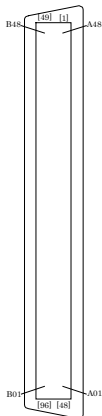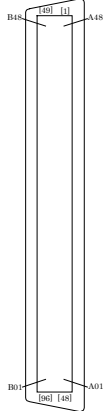Do not connect any of the outputs and power outputs to the analog or digital ground.
Neither connect outputs to each other.   Doing either can result in a fault.

──

Pin Assignments of AD12-16(PCI) Interface Connector (CN1)   < Differential Input >

N.C.	B48		A48	N.C.
N.C.	B47		A47	N.C.
N.C.	B46		A46	N.C.
N.C.	B45		A45	N.C.
N.C.	B44		A44	N.C.
N.C.	B43		A43	N.C.
N.C.	B42		A42	N.C.
N.C.	B41		A41	N.C.
Analog Ground	B40		A40	Analog Ground
Analog Ground	B39		A39	Analog Ground
N.C.	B38		A38	N.C.
N.C.	B37		A37	N.C.
N.C.	B36		A36	N.C.
N.C.	B35		A35	N.C.
N.C.	B34		A34	N.C.
N.C.	B33		A33	N.C.
N.C.	B32		A32	N.C.
N.C.	B31		A31	N.C.
Analog Ground	B30		A30	Analog Ground
Analog Ground	B29		A29	Analog Ground
N.C.	B28		A28	N.C.
N.C.	B27		A27	N.C.
N.C.	B26		A26	N.C.
N.C.	B25		A25	N.C.
N.C.	B24		A24	N.C.
N.C.	B23		A23	N.C.
N.C.	B22		A22	N.C.
N.C.	B21		A21	N.C.
Analog Ground	B20		A20	Analog Ground
Analog Ground	B19		A19	Analog Ground
Analog Input 7 [-]	B18		A18	Analog Input 3 [-]
Analog Input 7[+]	B17		A17	Analog Input 3 [+]
Analog Input 6 [-]	B16		A16	Analog Input 2 [-]
Analog Input 6[+]	B15		A15	Analog Input 2 [+]
Analog Input 5 [-]	B14		A14	Analog Input 1 [-]
Analog Input 5[+]	B13		A13	Analog Input 1 [+]
Analog Input 4 [-]	B12		A12	Analog Input 0 [-]
Analog Input 4[+]	B11		A11	Analog Input 0 [+]
Analog Ground	B10		A10	Analog Ground
Analog Ground	B09		A09	Analog Ground
+5VDC from PC	B08		A08	External Sampling Clock Input
+5VDC from PC	B07		A07	Digital Ground
Sampling Busy Output	B06		A06	External Trigger Input
Timer Output	B05		A05	Digital Ground
Digital Output 3	B04		A04	Digital Input3
Digital Output 2	B03		A03	Digital Input2
Digital Output 1	B02		A02	Digital Input1
Digital Output 0	B01		A01	Digital Input0

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

Analog Input 0[+] - Analog Input 7[+]	Analog input signal at the time of Differential Input. The numbers correspond to channel numbers.
Analog Input 0[-] - Analog Input 7[-]	Analog input signal at the time of Differential Input. The numbers correspond to channel numbers.
Analog Ground	Common analog ground for analog input signals.
Digital Input 0 - Digital Input 3	Digital input signal.
Digital Output 0 - Digital Output 3	Digital output signal.
External Trigger Input	External trigger input signal.
External Sampling Clock Input	External Sampling Clock Input signal.
Timer Output	Programmable timer output signal.
Sampling Busy Output	Output signal indicating that the board is performing AD conversion
+5VDC from PC	Output +5V. The total current-carrying capacity that can be supplied from two pins is 1 A
Digital Ground	Digital ground common to those signals other than analog input signals, such as digital I/O signals and external sampling clock input signals, and "+5V DC from PC"
N.C.	No connection to this pin.

Figure 3.6. Pin Assignments of AD12-16(PCI) Interface Connector (CN1)
< Differential Input >

⚠ 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.

Connecting the Analog Input Signal

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.

Connection Example of 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.

Figure 3.7. Connecting the Single-ended Input (Flat Cable)

The following example connects a signal source to this product using a shielded cable.   Use shielded cable if the distance between the signal source and this product 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.

Figure 3.8. Connecting the Single-ended Input (Shield Cable)

⚠ CAUTION

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

- If this product and the signal source receive noise or the distance between this product 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 this product analog ground).   If it exceeds the maximum voltage, this product may be damaged.

- Connect all the unused analog input channels to analog ground.

©CONTEC

Connection Example of 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 this product to the signal source ground.

* 0[+] to 7[+] and 0[-] to 7[-] for AD12-16(PCI), respectively.
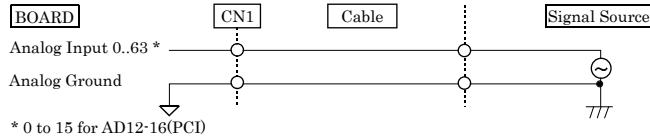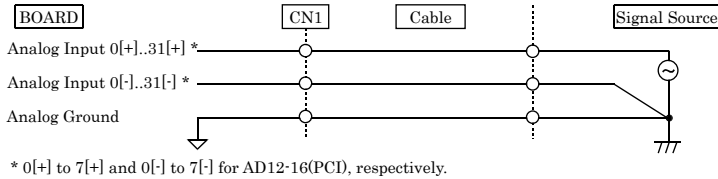
Figure 3.9.   Connecting the Differential Input (Flat Cable)

The following example connects a signal source to this product using a shielded cable.   Use shielded cable if the distance between the signal source and this product 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 this product and the signal source ground to the shielding.

* 0[+] to 7[+] and 0[-] to 7[-] for AD12-16(PCI), respectively.
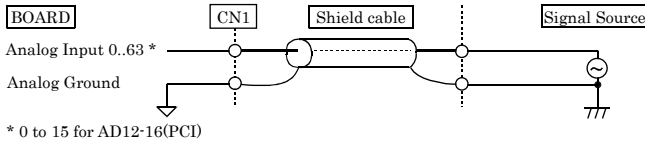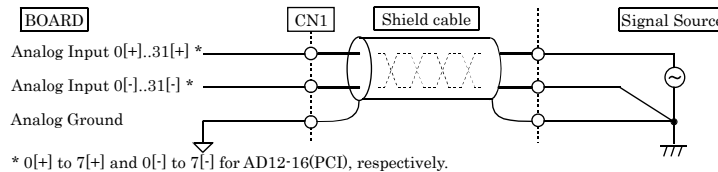
Figure 3.10. Connecting the Differential Input (Shield Cable)

⚠ 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, input data comes to be undetermined.

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

- An input analog signal to both [+] and [-] input should not exceed the maximum input voltage (relate to analog ground of this product).   If it exceeds the maximum voltage, this product may be damaged.

- Connect all the unused analog [+] and [-] input channels to analog ground.

Connecting the Digital I/O and Control Signal

This section shows how to connect the digital I/O signal and control signal ("External Sampling Clock Input", "External Trigger Input" and so on) by using a flat cable.

Connect CN1 to the external device by using the optional flat cable (PCA96P-1.5).
All the digital I/O signals and control signals are TTL level signals.

Figure 3.11. Connecting the Digital Input

Figure 3.12. Connecting the Digital Output

⚠ CAUTION

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

Reference

For the operation timings for control signal input, see "Timing of External Control Signals" in Chapter 6 "Hardware".

4. Functions

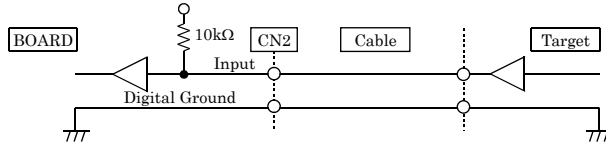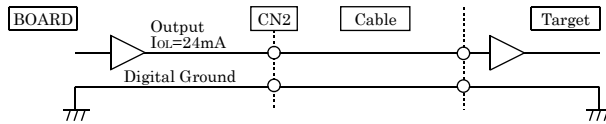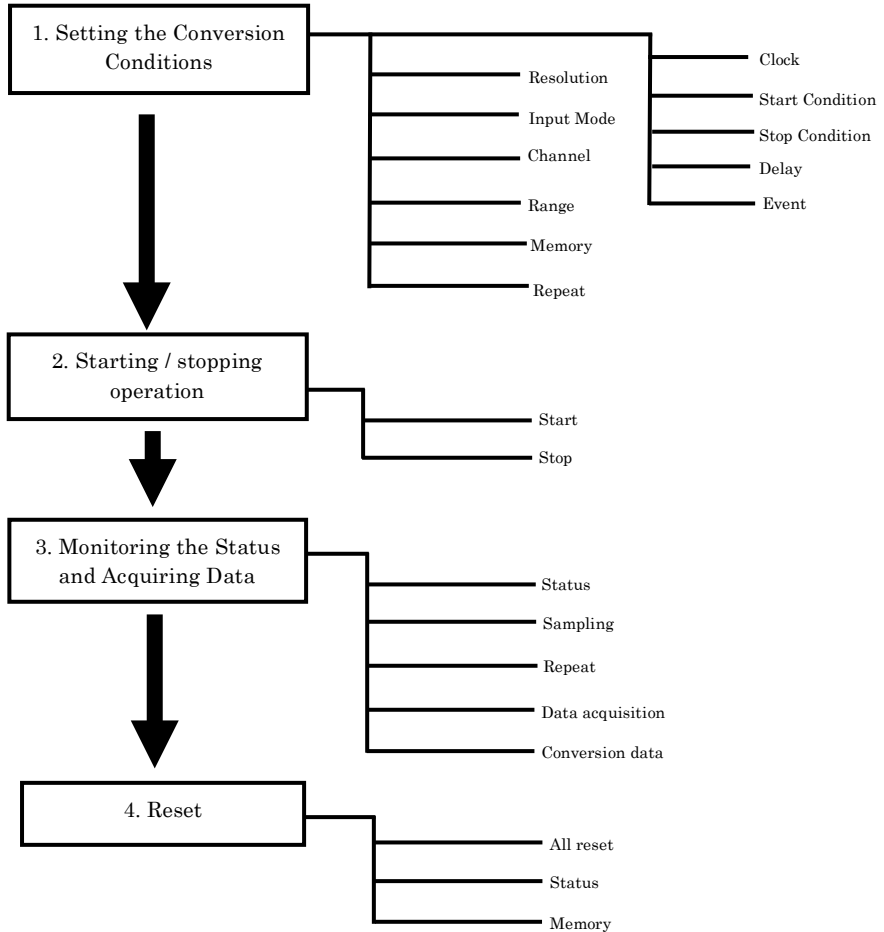This chapter describes the different functions that can be implemented using the hardware and driver together. Unless stated otherwise, the driver is assumed to be API-AIO(WDM).

Analog Input Function

This product converts analog signals to digital data according to the resolution and stores it in memory. You can set a variety of conditions for analog input, including the input channel, sampling period, and sampling start/stop conditions.

Analog input processes are classified as follows:

```
┌──────────────────────────┐
│  1. Setting the Conversion│─────────────────────┬──────── Clock
│       Conditions         │                       │
└──────────────────────────┘           Resolution  ├──────── Start Condition
           │                                        │
           │                           Input Mode   ├──────── Stop Condition
           │                                        │
           │                           Channel      ├──────── Delay
           │                                        │
           ▼                           Range        └──────── Event
                                       Memory
                                       Repeat
┌──────────────────────────┐
│  2. Starting / stopping   │───────── Start
│       operation          │
└──────────────────────────┘───────── Stop
           │
           ▼
┌──────────────────────────┐
│  3. Monitoring the Status │───────── Status
│     and Acquiring Data    │───────── Sampling
└──────────────────────────┘───────── Repeat
           │                 ───────── Data acquisition
           │                 ───────── Conversion data
           ▼
┌──────────────────────────┐
│      4. Reset             │───────── All reset
└──────────────────────────┘───────── Status
                             ───────── Memory
```

1. Setting the Conversion Conditions

First, set the conditions for executing analog input.

Resolution

"Resolution" signifies the number of bits used by an analog input device to represent analog signals.
The higher the resolution, the more finely the voltage range is segmented, allowing the device to convert analog values to digital equivalents more precisely.
A device with a resolution of 12bit divides the range width into 4096 segments.
When the device covers the range of 0 - 10V, the minimum unit of converted voltages is $10 \div 4096 = 2.44mV$.
If the device has a resolution of 16bit, it is $10 \div 65536 = 0.153mV$ instead.

Analog Voltage before Conversion   Low Resolution Board

High Resolution Board
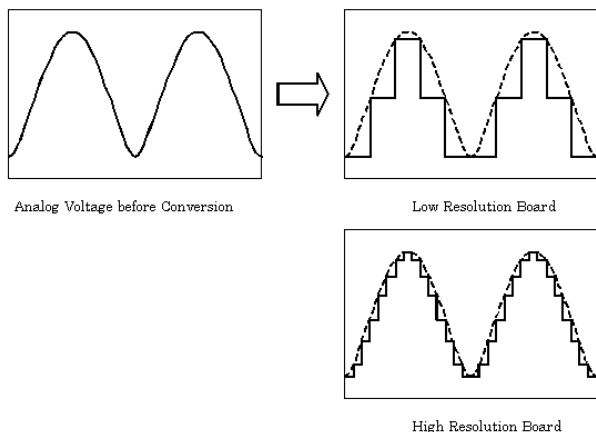
AD12-64(PCI)   : The resolution is 12bit.

AD12-16(PCI)   : The resolution is 12bit.

Input Mode

"Input Mode" indicates the method of connecting analog input signals.
The input modes available are single-ended input and differential input.
The single-ended input mode is suitable for the environment in which the potential difference between the signal source and ground and noise components can be ignored.   For the environment in which they cannot be ignored, the differential input mode is suitable.
The number of channels available in differential input mode is half that in single-ended input mode.

Channel

"Channel" represents each point of analog input.
For individual channel numbers, see "Connector Pin Assignment" in Chapter 3.
You can specify an arbitrary number of points of analog input by setting the channels by means of software.

Range

"Range" means the range of voltages at which analog input can be performed.
The input range can be selected by setting the upper and lower input signals.

AD12-64(PCI)   : The range is specified by setting the software.
AD12-16(PCI)   : The range is specified by setting the software.

Memory

Device's or driver's input data storage memory is used to enable advanced analog input processing at high speed.   For the memory, the FIFO or ring format can be selected by means of software.

- FIFO format
  In the FIFO (First In First Out) format, input data items are read from memory in the same order in which they were written to the memory.   Input data items are fed out of the memory sequentially, where the oldest one is always read from the memory.   The status monitor and application notification functions are provided, which check and report the state in which the memory has stored a fixed amount of data or in which the memory has become full.
 The FIFO memory is used to obtain all input data from analog input in a short or infinite period of time.
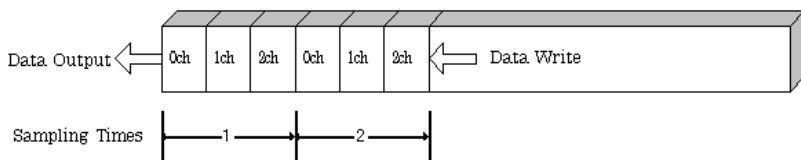
- Ring format
  In the ring format, the memory contains storage areas arranged in a ring.   Input data items are written to the memory sequentially.   When it stores data exceeding the limit, it overwrites the area storing the previous item of input data.   The status monitor and application notification functions are provided, which check and report the state in which data has been written to certain areas of memory.
  The ring memory is used to obtain data where conversion has stopped due to some event, usually without obtaining data in the normal state.
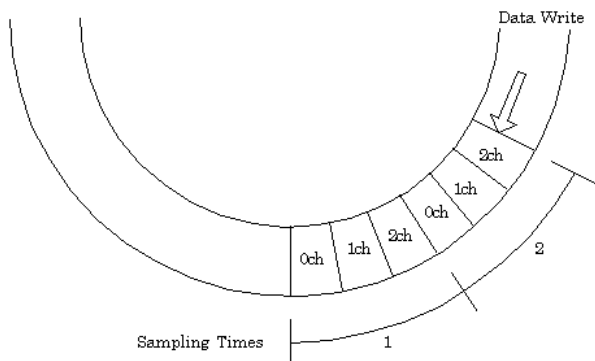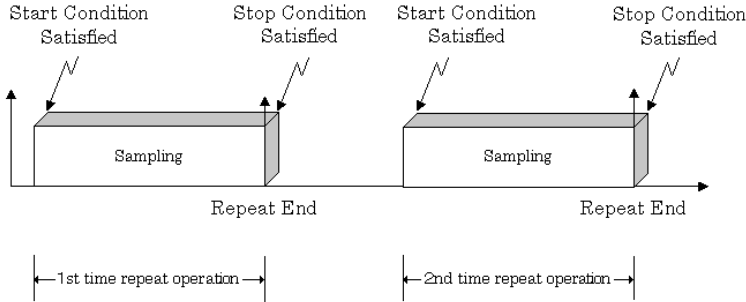
Repeat

"Repeat" indicates the number of repetitions of sampling to be executed, from when the sampling start condition is satisfied until the end of sampling, including delayed sampling.
The number of repetitions is set by means of software, for which conversion is repeated.   You can set an infinite number of repetitions, in which case the conversion is terminated by the software abort command.
Input data items are stored to the memory sequentially.   The repetition state can be subject to status monitoring and application notification.

This product does not support the Repeat feature when the sampling start condition is "software".

Clock

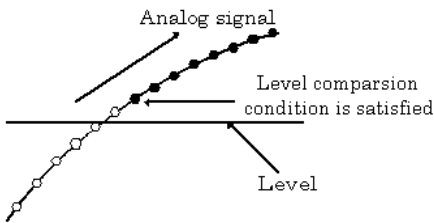The sampling clock controls the sampling frequency.   You can select both the internal sampling clock and the external sampling clock.   The sampling clock is selected by means of software.

- Internal sampling clock
  The clock signal from the on-board clock generator is used.

- External sampling clock
  The edge of the digital signal input from an external device is used for the sampling clock.
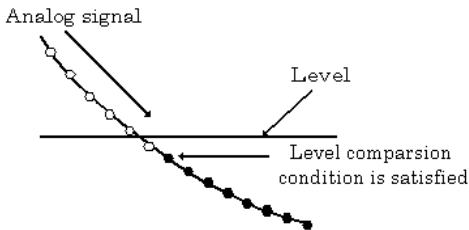
Start Condition

The condition for controlling the start of sampling can be selected from among software, input data comparison and an external trigger. The conditions for controlling the start and stop of sampling are completely independent of each other; they can be set separately.

- Software
  This product starts sampling and storing input data to memory immediately after the operation start command is issued.
- Input data comparison
  When the operation start command is issued, this product compares the analog signal input through a specified channel to the value of the preset comparison level. If the analog signal satisfies the condition, this product starts storing input data.
  Level comparison conditions are set as two conditions: level and direction.

The above sketch shows that the level comparison condition is satisfied in the rising direction. The start condition is satisfied when the analog signal at the specified channel passes the comparison level in the rising direction. Input data items are stored to memory, starting with those at solid dots.

The above sketch shows that the level comparison condition is satisfied in the falling direction. The start condition is satisfied when the analog signal at the specified channel passes the comparison level in the falling direction. Input data items are stored to memory, starting with those at solid dots.
If you set the level comparison directions to both directions, the start condition is satisfied when the analog signal passes the level both in the rising and falling directions.
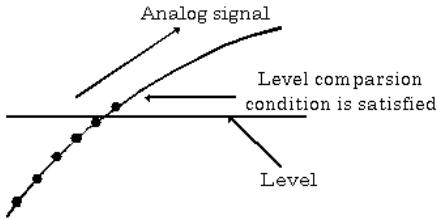- External trigger
  This product starts waiting for an external control signal as soon as the operation start command is output.
  Sampling and data transfer to memory start when the external control signal (falling edge) is input.
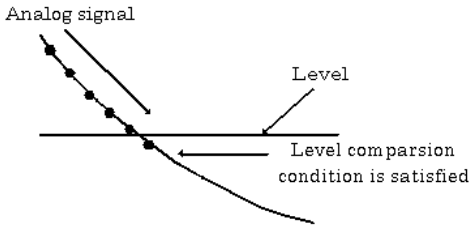
Stop Condition
The condition for controlling the stop of sampling can be selected from among the last sampling count, input data comparison, an external trigger, and software abort.
This product stops sampling whenever an error occurs irrespective of the stop condition setting.
- Last sampling count
  This product stops sampling after storing input data to memory for the specified number of times of sampling.
- Input data comparison
  Once this product has started sampling, it compares the analog signal input through a specified channel to the value of the preset comparison level.   If the analog signal satisfies the condition, this product stops sampling.
  Level comparison conditions are set as two conditions: level and direction.

The above sketch shows that the level comparison condition is satisfied in the rising direction. The stop condition is satisfied when the analog signal at the specified channel passes the comparison level in the rising direction.   Input data items are stored to memory, ending until those at solid dots.

The above sketch shows that the level comparison condition is satisfied in the falling direction. The stop condition is satisfied when the analog signal at the specified channel passes the comparison level in the falling direction.   Input data items are stored to memory, ending until those at solid dots.
  If you set the level comparison directions to both directions, the start condition is satisfied when the analog signal passes the level both in the rising and falling directions.
- External trigger
  This product starts waiting for an external control signal after the specified number of samples have been performed.   Sampling stops when the external control signal (falling edge) is input.
- Software
  Sampling continues indefinitely in this mode.   Sampling only stops in response to a software command or an error.

Delay

Delayed sampling is performed after the sampling stop condition is satisfied.
When a sampling stop condition other than the software abort command is satisfied, this product performs sampling for the specified number of times of delayed sampling to store input data to memory. If you set the number of times of delayed sampling to 0, this product stops sampling the moment the sampling stop condition is satisfied.
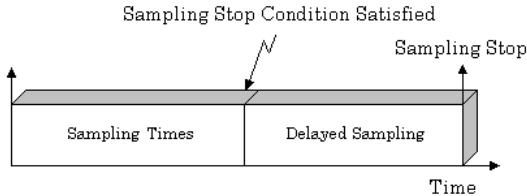
Event

"Event" works as a function for reporting the occurrence of a certain product state to the application. The following events can be used in combination depending on the specifications and purpose of the application.

- "AD conversion start condition satisfied" event
  This event occurs when the AD conversion start condition is satisfied.   The event is nullified when the conversion start condition is "software".

- "Repeat end" event
  This even occurs whenever a repetition is completed.

- "End of device operation" event
  This event occurs when the entire operation including repetitions is completed.

- "Stored specified sampling times" event
  This event occurs when sampling has been performed for the number of times set by software.

- Overflow event
  This event occurs at an attempt to store input data with the memory full.

- Sampling clock error event
  This event occurs when conversion stops as an error occurs due to a sampling clock period that is too short.

- AD conversion error event
  This event occurs when conversion stops due to an AD conversion error.

2. Starting/Stopping Operation

Sampling is started by the software command.
Once started, sampling can be stopped by the software command at any timing.

3. Monitoring the Status and Acquiring Data

Software commands are used to monitor the operation status of the device and to acquire input data from memory. Status monitoring and data acquisition can be performed even during sampling.

Status

The current state of the device can be checked by obtaining the device status.
The following types of device status are available:

- Device operating
  The "device operating" status remains ON, after the execution of the sampling start command until this product completes conversion, aborts operation due to an error, or stops sampling in response to the command.

- Waiting for start trigger
  This status remains ON, after this product starts sampling until the start trigger is input, if the conversion start condition is an external trigger or level comparison. The status is set to OFF when the input trigger is input to start conversion.
  The status is set to ON whenever this product enters the conversion start wait status even when repeated operation has been set.

- Specified sampling data stored
  This status is set to ON when input data stored in memory has reached the amount corresponding to the preset number of times of sampling.
  If the memory format is FIFO, the status is set to OFF when the amount of input data in the memory falls below the value corresponding to the preset number of times of sampling as data is acquired.
  Once the status is set to ON when the memory format is ring, it remains ON until it is reset.

- Overflow
  An overflow error occurs when an attempt is made to store input data to memory while it has been full of input data.
  When the memory format is FIFO, this product stops conversion.
  When the memory format is ring, this product continues conversion while overwriting existing data with new one.

- Sampling clock error
  This error occurs when the sampling clock period is too short.

- AD conversion error
  If the "device operating" status remains ON (without terminating conversion) for an extended period of time, the driver regards that state as an operation error and sets this status to ON. This error stops sampling.

Sampling

The number of sampled items of input data stored in memory can be obtained by the software command.

Repeat

The current repeat count can be obtained by the software command.

Data acquisition

The conversion data stored in memory can be retrieved using a software command.
The figure below shows the correspondence between the sampling count and the conversion channel for the conversion data stored in memory.
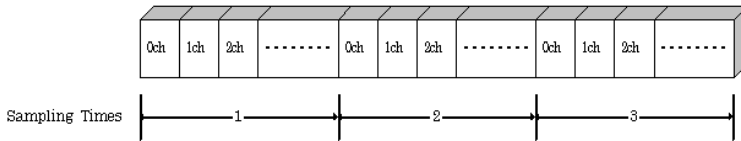
Input data is acquired differently depending on the memory format used.

- Data acquisition in FIFO format
 When FIFO memory is used, the oldest data is always read first.
  The following sketch shows an image of data acquisition in FIFO format.
  When data is acquired from the memory, the free memory space increases by that data size.   When data is acquired next, the oldest one of the existing data items is taken from the memory in the same way.
  The FIFO memory deletes data once that data is acquired.
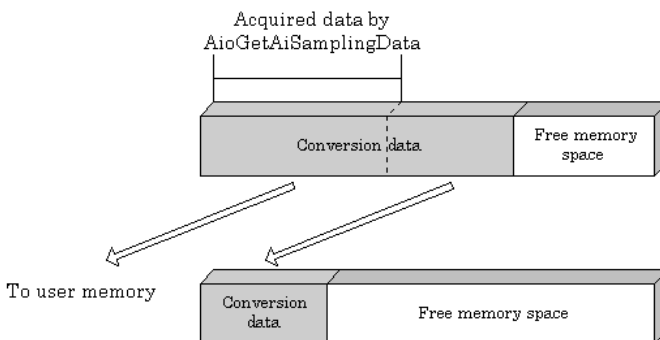
- Data acquisition in ring format

  When ring memory is used, data is read always with respect to the current input data write position. The following sketch shows an image of data acquisition in ring format. The sampling count obtained is always the number of times of sampling for up to the latest data (shaded portion below).

  The larger the number of samples taken, the older the data item acquired first.

  As the ring memory retains data even after that data is acquired, you can fetch the same data any number of times.

Conversion data write position

Conversion data write position

Acquired data by AioGetAiSamplingData

To user memory
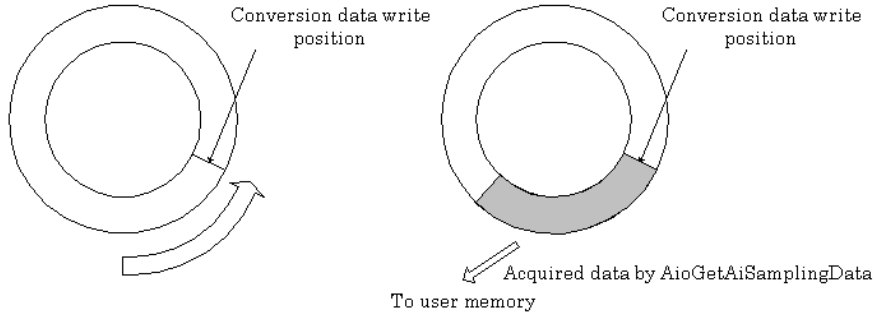
Conversion data

The following equation represents the relationship between input data and voltage.

Voltage = Input data x (Max. range value – Min. range value) ÷ Resolution + Min. range value

The value of resolution for the 12bit device is 4096; that for the 16bit device is 65536.
The table below shows the relationship between input data and voltage in the ±10-V range.

Voltage	Conversion data (12bit)
+9.995V	4095
:	:
0.005V	2049
0V	2048
-0.005V	2047
:	:
-10.000V	0

Voltage	Conversion data (16bit)
+9.99970V	65535
:	:
0.00030V	32769
0V	32768
-0.00030V	32767
:	:
-10.000V	0

Ex.: When input data 3072 is input at a resolution of 12bit in the ± 10-V range

Voltage = 3072 x (10 - (-10)) ÷ 4096 + (-10)

= 5.0

4. Reset

Various states can be reset by executing the following reset commands:

All reset

This command resets the entire device, thereby initializing the device.

Status

This command resets the sampling clock error status and AD conversion error status.

Memory

This command resets the following memory related states.

-    Resets the sampling count to 0.
-    Resets the status for the specified sampling count to OFF.
-    Resets the buffer overflow status to OFF.
-    Resets the repeat count to 0.

Digital Input Function

Input bit

Individual digital input points are called input bits.
When the number of input points of a device is 4, the bits are determined as bit 0 to bit 3.

	bit3	bit2	bit1	bit0

Input in Bits

The state 1 (ON) or 0 (OFF) of each input bit can be obtained by specifying the bit.

Input in Bytes

Individual input bits can be input in byte units.
When the number of input points of the device is 4, the individual input bits are arranged as shown below and the byte data to be input is a value between 0 and 15 depending on the states of the bits.

EX. Input of bit 3 (OFF), bit 2 (ON), bit 1 (OFF) and bit 0 (ON)
    Byte data = 5(5H)

	Bit 3	Bit 2	Bit 1	Bit 0
	0(OFF)	1(ON)	0(OFF)	1(ON)

Digital Output Function

Output bit

Individual digital output points are called output bits.
When the number of output points of a device is 4, the bits are determined as bit 0 to bit 3.

		bit3	bit2	bit1	bit0

Output in Bits

The state of each output bit can be changed to ON or OFF by specifying the bit and setting it to 1 or 0.

Output in Bytes

Individual output bits can be output in byte units.   When the number of output points of the device is 4, the individual output bits are arranged as shown below and byte data to be output is a value between 0 and 15.

Ex. Output of bit 3 (ON), bit 2 (OFF), bit 1 (ON) and bit 0 (OFF)
Byte data = 10(AH)

	Bit 3	Bit 2	Bit 1	Bit 0
	1(ON)	0(OFF)	1(ON)	0(OFF)

5. About Software

CD-ROM Directory Structure

```
\
|– Autorun.exe          Installer Main Window

|  Readmej.html         Version information on each driver (Japanese)
|  Readmeu.html         Version information on each driver (English)
   .
   .
|——APIPAC             Each installer
|     |—AIO
|     |    |—DISK1
|     |    |—DISK2
|     |    |—……
|     |    |—DISKN
|     |—AioWdm
|     |—CNT
|     |—DIO
|     |—……
   .
   .
|—HELP               HELP file
|     |—Aio
|     |—Cnt
|     |—……
   .
   .
|—INF                Each INF file for OS
|     |—WDM
|     |—WinVista
|     |—Win2000
|     |—Win95
   .
   .
|—linux              Linux driver file
|     |—cnt
|     |—dio
|     |—……
   .
   .
|—Readme             Readme file for each driver
   .
   .
|—Release            Driver file on each API-TOOL
|     |—API_NT         (For creation of a user-specific install program)
|     |—API_W95
   .
   .
|—UsersGuide         Hardware User's Guide(PDF files)
```

About Software for Windows

The bundled CD-ROM "Driver library API-PAC(W32)" contains the functions that provide the following features:

- Analog input or output through arbitrary channels

- Analog input at arbitrary intervals using the internal or external sampling clock

- Simultaneous monitoring of the termination of analog input sampling, buffer memory usage, and interrupt events such as occurrences of errors

- Driver option check using a demo driver even without the board installed

For details, refer to the help file.   The help file provides various items of information such as "Function Reference", "Sample Programs" and "Q&A".   Use them for program development and troubleshooting.

When using the API-AIO(WDM)

Accessing the Help File

(1) Click on the [Start] button on the Windows taskbar.

(2) From the Start Menu, select "Programs" – "CONTEC API-PAC(W32)" – "AIOWDM" – "API-AIO(WDM) HELP" to display help information.
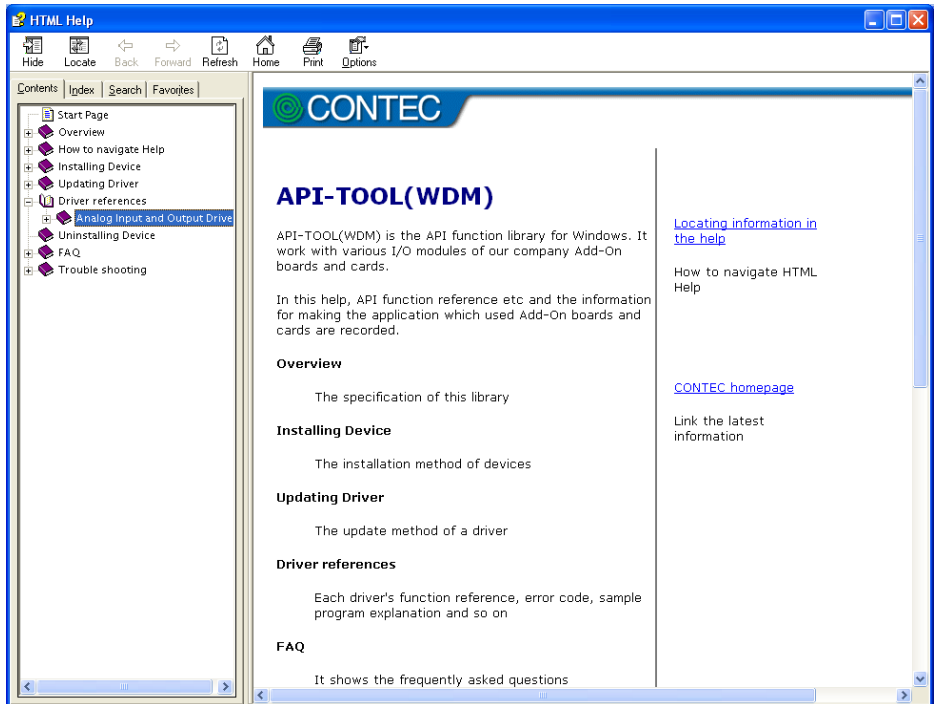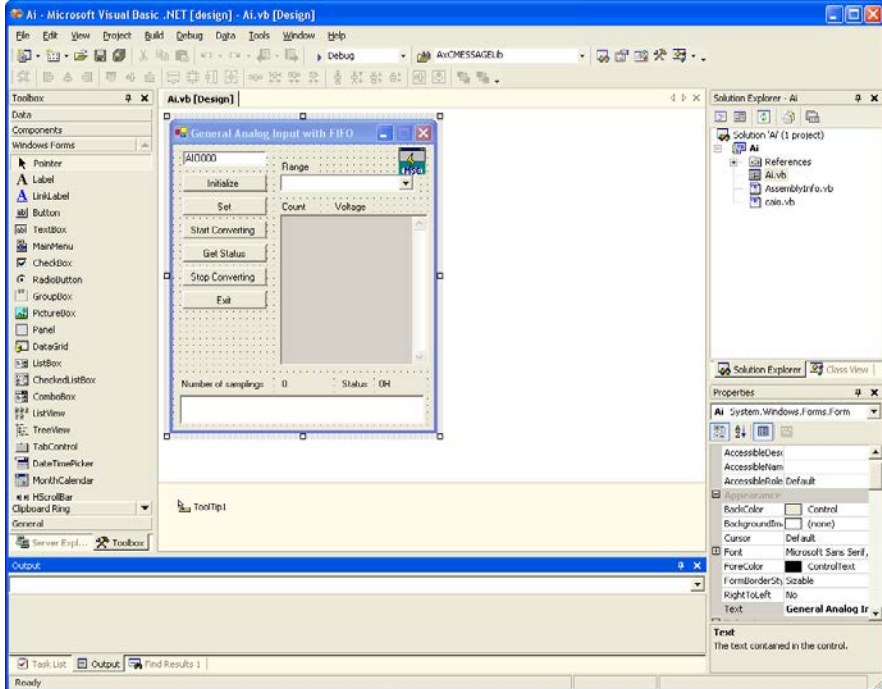
Using Sample Programs

Sample programs are provided for each of the basic operations.   You can use these to check the operation of the board and as a reference when writing your own programs.

To use the sample programs, specify the device name in the property page for the program.

The sample programs are stored in \Program Files\CONTEC\API-PAC(W32)\AIOWDM\Samples.

Running a Sample Program

(1) Click on the [Start] button on the Windows taskbar.

(2) From the Start Menu, select "Programs" – "CONTEC API-PAC(W32)" – "AIOWDM" – "SAMPLE…".

(3) A sample program is invoked.

Sample Programs - Examples

Analog input

- SingleAi	Perform single analog input from specified channel
- MultiAi	Perform single analog input from multiple channels
- Ai	Perform standard analog input using a FIFO buffer
- AiPoll	Perform standard analog input by polling
- AiEx	Perform analog input for multiple channels using a FIFO buffer
- AiLong	Perform long-duration analog input using a FIFO buffer
- AiExt	Perform analog input using an external clock
- AiTrg	Perform analog input using an external trigger to start and stop operation
- AiLevel1	Use a level trigger to start analog input
- AiLevel2	Use a level trigger to stop analog input
- Ai2	Perform standard analog input using more than one device

Analog output

|	
- SingleAo	Perform single analog output from specified channel
- MultiAo	Perform single analog output from multiple channels
- Ao	Perform standard analog output using a FIFO buffer
- AoPoll	Perform standard analog output by polling
- AoEx	Perform analog output for multiple channels using a FIFO buffer
- AoLong	Perform long-duration analog output using a FIFO buffer
- AoExt	Perform analog output using an external clock
- AoRing	Perform continuous analog output using a ring buffer
- AoTrg	Perform analog output using an external trigger to start and stop operation
- Ao2	Perform standard analog output using more than one device

Digital input/output

- DioBit	Perform digital I/O using bit values
- DioByte	Perform digital I/O using port values

* Sample programs executable vary with the functions of devices in use.

When using the API-AIO(98/PC)

Accessing the Help File

(1) Click on the [Start] button on the Windows taskbar.

(2) From the Start Menu, select "Programs" – "CONTEC API-PAC(W32)" – "Aio" – "API-AIO HELP" to display help information.
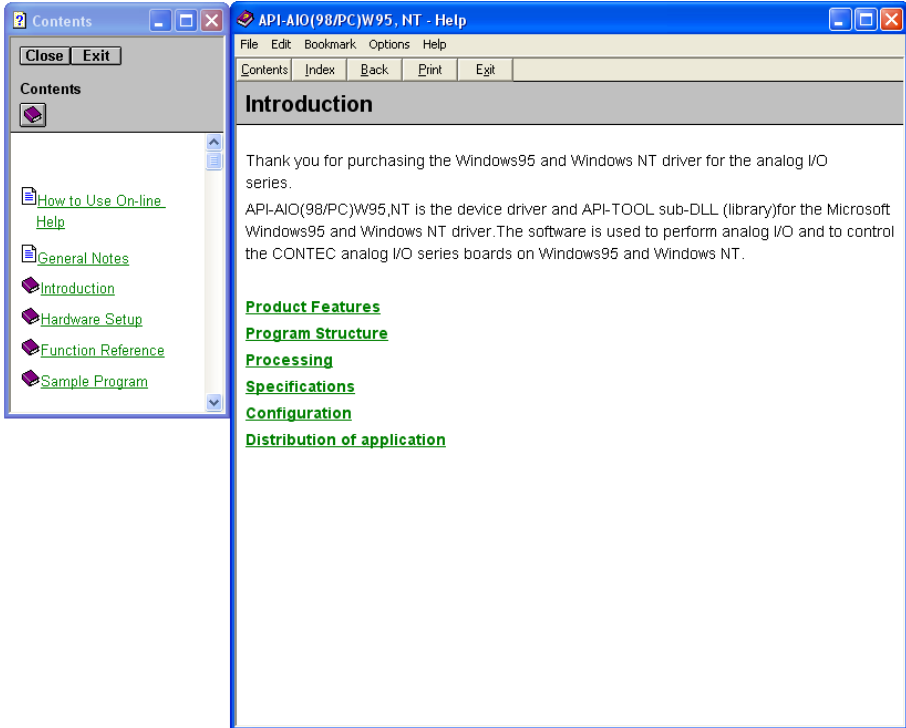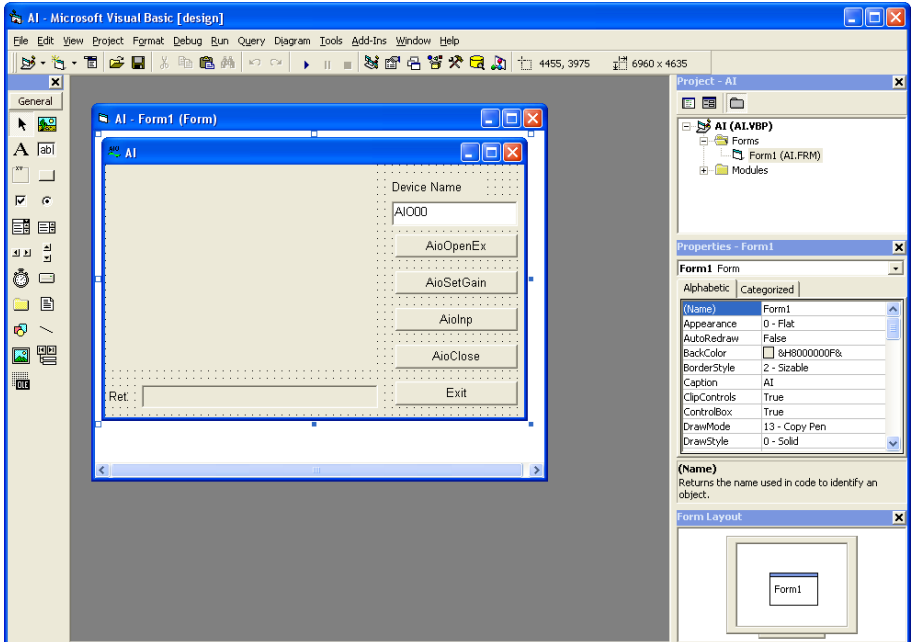
Using Sample Programs

Sample programs have been prepared for specific basic applications.
To use each sample program, enter its device name set by API-TOOL Configuration.

Use these sample programs as references for program development and operation check.
The sample programs are stored in \Program Files\CONTEC\API-PAC(W32)\Aio\Samples.

Running a Sample Program

(1) Click on the [Start] button on the Windows taskbar.

(2) From the Start Menu, select "Programs" – "CONTEC API-PAC(W32)" – "Aio" – "SAMPLE…".

(3) A sample program is invoked.

Sample Programs - Examples

Analog input

- AI	:	Uses AioInp to convert an analog signal only once and display the data.
- AIBack	:	Uses AioInpBack to perform memory-less board analog input.
- AIMemory	:	Uses AioInpBdMem to perform continuous conversion and AioReadBuf to acquire data from board memory (an example of using an external clock).
- AIInt	:	Infinite sampling example that uses AioInpBdMem for half/full interrupts and AioReadBuf to acquire data at interrupt events.
- AITimer	:	Infinite sampling example that uses AioInpBdMem to perform continuous conversion and AioReadBuf to acquire data at system timer events.
- AISync	:	Sample that uses AioInpBdMem and AioDO to perform simultaneous sampling of two memory-mounted boards.
- AioInp	:	Sample console application that uses AioOpenEx and AioInp.

Analog output

- AO	:	Uses AioOut to perform analog output once.
- AOBack	:	Uses AioOutBack to perform analog output at fixed intervals.
- AioOut	:	Sample console application that uses AioOpenEx and AioOut.

Digital input and output

- DIO	:	Uses AioDO and AioDI to perform digital input/output.

Counter

- Timer	:	Sample program using a timer. It uses the counter function to measure the lapse of time.
- Counter	:	Sample program using a counter. It uses the counter function to count external pulses.

The following sample program in Visual Basic is available.

- ANALOG	:	Versatile sample program using AioInp, AioInpBack, AioInpBdMem, AioOut, AioOutBack, AioDO, and AioDI

*   Sample programs executable vary with the functions of devices in use.

Using the Utility Program

Operation Check Tool

This program is a comprehensive operation check tool that can use all the features of the AioOpen, AioClose, AioSetRangeAioInp, AioInpBack, AioInpBdMem, AioOut, AioOutBack, AioDo, and AioDi functions.
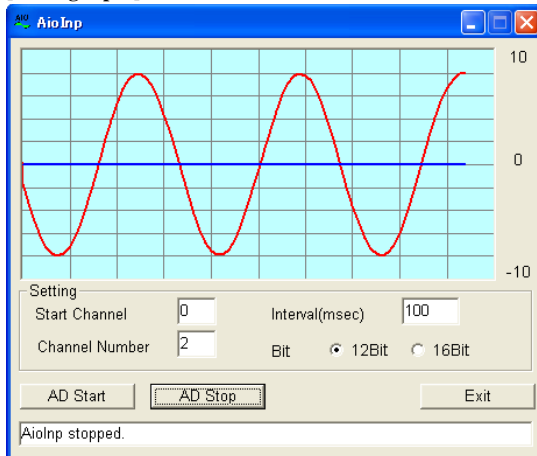
Invoke the tool by selecting the Start Menu – "CONTEC API-PAC(W32)" – "AIO" – "SAMPLE Analog".
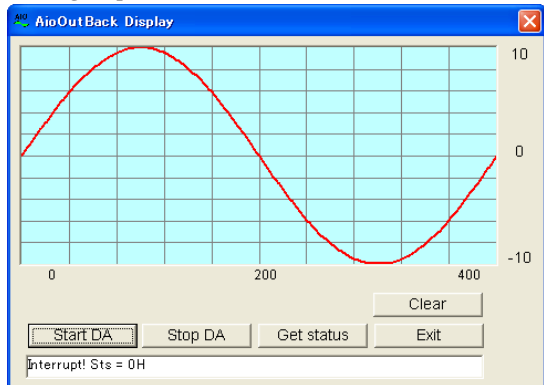
[Main screen]
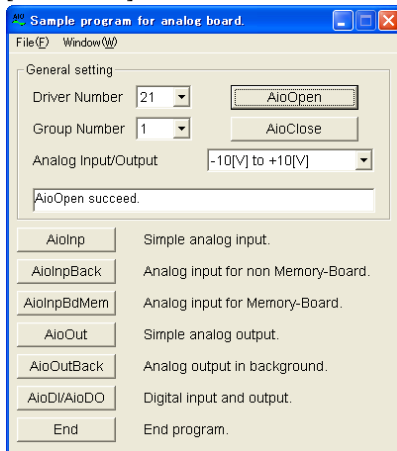
AioInp　　　　　: Simple analog input

AioInpBack　　　: Analog input for non Memory-Board

AioInpBdMem: Analog input for Memory-Board

AioOut　　　　　: Simple analog output

AioOutBack　　　: Analog output in background

AioDi/AioDo　: Digital input and output

[Analog input]

[Analog output]

[Digital input and output]

Uninstalling the Driver Libraries

The method used to uninstall API-PAC(W32) differs depending on which OS you are using.
Follow the procedure given below.

Uninstall procedure for Windows 7, Vista, Server 2008, XP and Server 2003

< Uninstall the device driver >

Use [My Computer] - [Control Panel] - [Programs and Features] to uninstall the device driver.
Select [Windows driver package - CONTEC (****)] and then click [Uninstall].

*   "***" contains the driver category name (caio, ccnt, cdio, csmc, etc.).

⚠ CAUTION
Uninstall procedure for XP and Server 2003, use [My Computer] - [Control Panel] - [Add and Remove Programs] to uninstall the device driver.

< Uninstall the development environment >

Use [My Computer] - [Control Panel] - [Programs and Features] to uninstall the development environment.
Select [CONTEC API-***(WDM) VerX.XX (development environment)] and then click [Uninstall].

*   "***" contains the driver category name (AIO, CNT, DIO, SMC, etc.).

⚠ CAUTION ───────────────────────────────
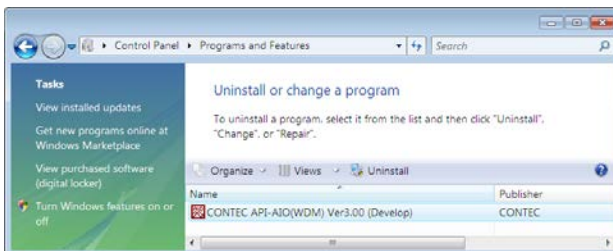
   Uninstall procedure for XP and Server 2003, use [My Computer] - [Control Panel] - [Add and
   Remove Programs] to uninstall the development environment.

───

Uninstall procedure for Windows Me

< Uninstall the device driver >

Use [My Computer] - [Control Panel] - [Add or Remove Programs] to uninstall the devevice driver.
Select [CONTEC API-***(WDM) driver] and then click [Change/Remove].

*   "***" contains the driver category name (caio, ccnt, cdio, csmc, etc.).

< Uninstall the development environment >

Use [My Computer] - [Control Panel] - [Add or Remove Programs] to uninstall the development
environment.
Select [CONTEC API-***(WDM) VerX.XX (development environment)] and then click
[Change/Remove].

*   "***" contains the driver category name (AIO, CNT, DIO, SMC, etc.).

Uninstall procedure for Windows 98, 98SecondEdition

< Uninstall the development environment >

Use [My Computer] - [Control Panel] - [Add or Remove Programs] to uninstall the device driver.
Select [CONTEC API-***(WDM) driver] and then click [Change/Remove].

*   "***" contains the driver category name (caio, ccnt, cdio, csmc, etc.).

< Uninstall the development environment >

Use [My Computer] - [Control Panel] - [Add or Remove Programs] to uninstall the development
environment.
Select [CONTEC API-***(WDM) VerX.XX (development environment)] and then click
[Change/Remove].

*   "***" contains the driver category name (AIO, CNT, DIO, SMC, etc.).

About Software for Linux

The Linux version of analog I/O function driver, API-AIO(LNX), provides functions that execute the following features:

- The analog input/output of a specified channel can be done.

- It is possible to operate as a set parameter to the analog input/output board is preserved by the default value, and the setting of the parameter doesn't exist.

For details, refer to the help file.   The help file provides various items of information such as "Function Reference", "Sample Programs", and "FAQs".   Use them for program development and troubleshooting.

Driver Software Install Procedure

The Linux version for digital I/O driver, API-AIO(LNX), is supplied as a compressed file /linux/aio/caioXXX.tgz on the bundled API-PAC(W32)CD-ROM.   (Note: XXX represents the driver version.)

Mount the CD-ROM as shown below, copy the file to an arbitrary directory, and decompress the file to install the driver.

For details on using the driver, refer to readme.txt and the help file in HTML format extracted by installation.

To install the driver, log in as a superuser.

Decompression and setup procedure

```
# cd
 # mount /dev/cdrom /mnt/cdrom                 Mount the CD-ROM.
 # cp /mnt/cdrom/linux/aio/caioXXX.tgz ./      Copy the compressed file.
 # tar xvfz caioXXX.tgz                        Decompress the compressed file.
 ................
 # cd contec/caio
 # make
                                               Compile the file.
 ................
 # make install                               Install.
 ................
 # cd config
 # ./config                                    Set up the board to be used.
 ..... Set as follows.........
 # ./contec_aio_start.sh                        Start the driver.
# cd
```

Accessing the Help File

(1) Invoke a web browser in your X-Window environment.

(2) In the browser, open diohelp.htm in the contec/caio/help directory.

Using Sample Programs

Sample programs have been prepared for specific basic applications.
Sample programs for each language are contained in the contec/caio/samples directory.   For compiling them, refer to the manual for the desired language.

Uninstalling the driver

To uninstall the driver, use the uninstall shell script contained in the contec/caio directory.   For details, check the contents of the script.

6. About Hardware

This chapter provides hardware specifications and hardware-related supplementary information.

For detailed technical information

For further detailed technical information ("Technical Reference" including the information such as an I/O map, configuration register, etc.), visit the Contec's web site (http://www.contec.com/support/) to call for it.

Hardware specification

Table 6.1.   Specification

Item	AD12-64(PCI)	AD12-16(PCI)
Analog input		
Isolated specification	Non-isolation	
Input Type	Single-Ended Input or Differential Input (Software setup)	
Number of input channels	64 channels (Single-Ended Input) 32 channels (Differential Input)	16 channels (Single-Ended Input) 8 channels (Differential Input)
Input range	Bipolar ±10V, ±5V, ±2.5V, ±1.25V, or Unipolar 0 - +10V, 0 - +5V, 0 - +2.5V, 0 - +1.25V (Software setup per channel)	
Absolute max. input voltage	±15V	
Input impedance	1MΩ or more	
Resolution	12bit	
Non-Linearity error *1	±2LSB(±10V, ±5V, 0 - 10V, 0 - 5V)4LSB(±2.5V, ±1.25V, 0 - 2.5V) ±8LSB(0 - 1.25V)	
Conversion speed	10μsec [100KSPS] /ch (Max.)	
Sampling clock	Internal sampling clock: 10,000 - 1,073,741,824,000nsec (Settable in 250 nanoseconds) External sampling clock: TTL level falling edge	
Digital I/O		
Number of output channels	4 TTL levels	
Number of input channels	4 TTL levels	
Programmable timer		
Setting period	500 - 1,073,741,824,000nsec (Settable in 250 nanoseconds)	
Status	Count up, count up over run	
Timer output signal	TTL-level 250nsec Low pulse, Low level output current I_{OL} = 24mA	
External trigger input		
External trigger input signal	Non-isolated input 1 channel (TTL-level falling edge)	
Status	Trigger input, trigger input overrun	
I/O address	32 ports boundary	
Interrupt level	1 level use	
Operating condition	0 - 50°C, 10 - 90%RH (No condensation)	
Current consumption *2	+5VDC 700mA (Max.)	
Bus specification	32bit, 33MHz, Universal key shapes supported *3*4	
Connector	96-pin half pitch connector [M(male)type] PCR-E96LMD+ [HONDA TSUSHIN KOGYO CO., LTD.] or equivalence to it	
Dimension (mm)	176.41(L) x 105.68(H) *5	
Weight	150g	

*1   A linearity error approximately 0.1% of full-range may occur when operated at 0ºC or 50ºC ambient temperature.
The error can be reduced by calibrating under the actual temperature conditions.

*2   If an external device requires this AD12-64(PCI), AD12-16(PCI) product to supply +5VDC from the CN1 or CN2
connectors, the power consumption of this product will be bigger than what this specification has defined.

*3   This product requires +5V power supply from expansion slots (it does not operate in the environment of only +3.3V
power supply).

*4   AD12-64(PCI): If the board No. is No.7149A, PCI bus specification is 32bit, 33MHz, 5V.
AD12-16(PCI): If the board No. is No.7150, PCI bus specification is 32bit, 33MHz, 5V

*5   Boards with different board numbers are different in these specifications.   See Table 6.3 "Different in the specification" at the end of this document.

Board dimension

176.41(L)

105.38(H)

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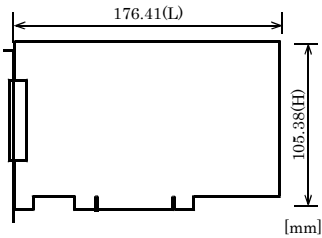
The standard outside dimension (L) is
the distance from the end of the board
to the outer surface of the slot cover.

Block Diagram

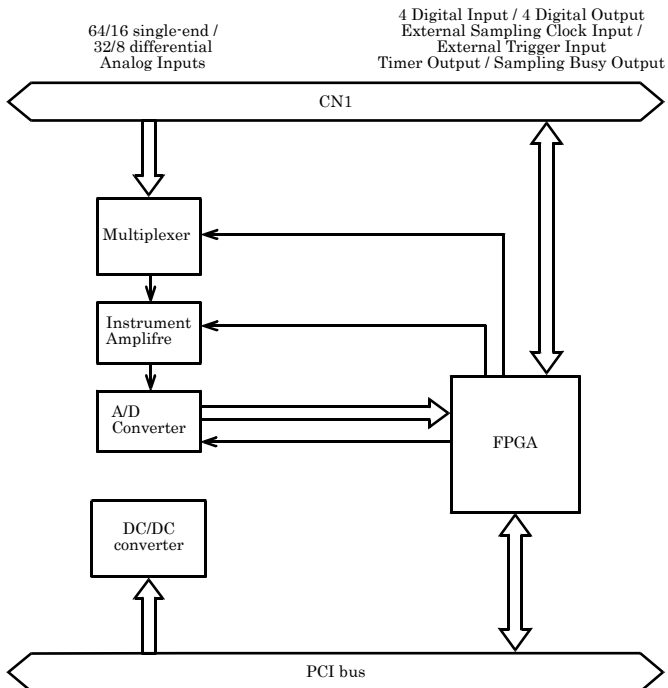Figure 6.1 is a circuit block diagram of this product.

64/16 single-end /
32/8 differential
Analog Inputs

4 Digital Input / 4 Digital Output
External Sampling Clock Input /
External Trigger Input
Timer Output / Sampling Busy Output

CN1

Multiplexer

Instrument
Amplifre

A/D
Converter

FPGA

DC/DC
converter

PCI bus

Figure 6.1. Block Diagram

Timing for Control Signal

Figures 6.2 and Table 6.2 shows the timing for external sampling clock.

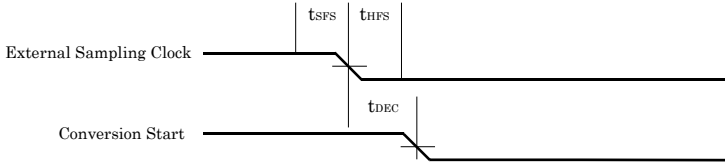**Figure 6.2. Timing for External Sampling Clock**

Table 6.2.   Description

Parameter	Symbol	Time(nsec)
External sampling clock signal falling setup time	tSFS	100nsec
External sampling clock signal falling hold time	tHFS	100nsec
Delay from the fall of external sampling clock signal to the AD conversion start pulse of the first channel	tDEC	200nsec

⚠ CAUTION
 All of the times in Table 6.2 are typical values.

About Calibration

This product is calibrated before shipment.

Contact your retailer if this product does not provide its prescribed performance.

Different in the specification

The AD12-64(PCI), and AD12-16(PCI) are different in specifications, depending on the board number as listed below.

Table 6.3.   Different in the specification

AD12-64(PCI)

Board No.	No.7149A	No.7149B	No.7149D
Dimension (mm)	176.41(L) x 106.68(H)	176.41(L) x 106.68(H)	176.41(L) x 105.68(H)

AD12-16(PCI)

Board No.	No.7150	No.7150A	No.7150C
Dimension (mm)	176.41(L) x 106.68(H)	176.41(L) x 106.68(H)	176.41(L) x 105.68(H)

AD12-64(PCI)
AD12-16(PCI)
User's Guide