

PC-HELPER

High-Resolution Analog I/O Card
for CardBus

ADA16-8/2(CB)L

User's Guide

CONTEC CO.,LTD.

Check Your Package

Thank you for purchasing the CONTEC product.

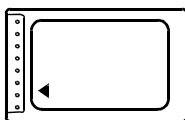
The product consists of the items listed below.

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

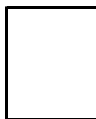
Product Configuration List

- PC Card [ADA16-8/2(CB)L] ...1
- First step guide ...1
- CD-ROM *1 [API-PAC(W32)] ...1

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



PC Card



First step guide



CD-ROM
[API-PAC(W32)]

Copyright

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Regardless of the foregoing statement, CONTEC assumes no responsibility for any errors that may appear in this document nor for results obtained by the user as a result of using this product.

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1. Before Using the Product

About the PC Card

This card is a multi-function PC card containing high-precision analog inputs/outputs, digital inputs, digital outputs, and counters. The card is a Type II size PC Card Standard CardBus card.

This card provides all you need to build a high-performance PC-based measurement and control system.

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

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

Features

Rich set of basic functions

Compact system providing high-precision analog inputs/outputs.

ADA16-8/2(CB)L contains analog inputs (16-bit, 8ch), analog outputs (16-bit, 2ch), analog I/O control signals (6ch), digital inputs (4ch), digital outputs (4ch), and counters (32-bit binary, 1ch).

Substantial control functions

Capable of analog input/output in either time-based mode or external-signal synchronous mode.

Filter function for easy connection of external signals

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

Containing the Buffer memory

The analog inputs and outputs each have their own buffer.

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

Software-based calibration

Setting and calibrating the analog input and output ranges can be performed completely by software. No tricky jumper settings are required. You can also set your own calibration data in place of the default data set at the factory and use different calibration data depending on the operating conditions.

The same systems can be implemented on either desktop or notebook PCs

The "Analog L Series" PC cards (ADA16-8/2(LPCI)L and ADA16-8/2(CB)L) have equivalent functionality.

Systems developed on a desktop PC can be ported directly to a notebook PC with minimal changes

Supported to the data logger software [C-LOGGER]

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

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

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

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

Support Software

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

Driver Library **API-PAC(W32)** (Bundled)

API-PAC(W32) is the library software that provides the commands for CONTEC hardware products in the form of Windows standard Win32 API functions (DLL). It makes it easy to create high-speed application software taking advantage of the CONTEC hardware using various programming languages that support Win32 API functions, such as Visual Basic and Visual C++.

It can also be used by the installed diagnosis program to check hardware operations.

CONTEC provides download services (at <http://www.contec.com/apipac/>) to supply the updated drivers and differential files.

For details, read Help on the bundled CD-ROM or visit the CONTEC’s Web site.

< Operating environment >

OS	Windows XP, Server 2003, 2000, Me, 98, etc..
Adaptation language	Visual C++ .NET, Visual C# .NET, Visual Basic .NET, Visual C++, Visual Basic, Delphi, C++Builder, etc..

Linux version of analog I/O driver **API-AIO(LNX)** (Supplied: Stored on the API-PAC(W32) CD-ROM)

This driver is used to control CONTEC analog I/O boards (cards) from within Linux.

You can control CONTEC I/O boards easily using the shared library used by gcc, the device driver (module) for each kernel version, and the board (card) configuration program (config).

CONTEC provides download services (at <http://www.contec.co.jp/en/>) to supply the updated drivers and differential files.

For details, read Help on the bundled CD-ROM or visit the CONTEC’s Web site.

< Operating environment >

OS	RedHatLinux, TurboLinux, etc.. (For details on supported distributions, refer to Help available after installation.)
Adaptation language	gcc
Others	Each piece of library software requires 20 megabytes of free hard disk space.

Data Logger Software **C-LOGGER** (Supplied: Stored on the API-PAC(W32) CD-ROM)

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

CONTEC provides download services (at <http://www.contec.com/clogger>) to supply the updated drivers.

For details, refer to the C-LOGGER Users Guide or our website.

< Operating Environment >

OS Windows XP, Server 2003, 2000

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

This is the library software which allows you to use our analog I/O device products on MATLAB by The MathWorks. Each function is offered in accordance with the interface which is integrated in MATLAB's Data Acquisition Toolbox.

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

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

This is a VI library to use in National Instruments LabVIEW.

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

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

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

Cables (Option)

Shielded cables with single-ended connector for 68-pin half-pitch connector

: PCA68PS-0.5 (0.5m)

: PCA68PS-1.5 (1.5m)

68/50-pin conversion shielded cable for analog input/output

: ADC-68M/50M (0.5m)

Accessories (Option)

Screw Terminal : EPD-50A *1

Buffer Amplifier Box for Analog Input Boards : ATBA-8L *1*3

Buffer Amplifier Box for Analog Input Boards : ATBA-16L *1*2*3

Termination Panel with BNC connectors for Analog I/O Boards : ATP-8L *1

*1 ADC-68M/50M optional cable is required separately.

*2 The analog input could have 8 channels to be used.

*3 An external power supply is necessary (optional AC adaptor POA200-20 prepared.)

* 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

Japanese <http://www.contec.co.jp/>
English <http://www.contec.com/>
Chinese <http://www.contec.com.cn/>

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

- Please use a PC card, mounting in the PC card slot dealing with PC Card Standard conformity CardBus of a personal computer.
 - Do not impact or bend the PC Card.
Doing so may result in a malfunction, overheating, fault, or damage.
 - Do not plug or unplug the cables which are connected to the PC Card the PC is still turned on.
Otherwise, the PC Card may malfunction, overheat, or cause a failure.
Be sure that the personal computer power is turned off.
 - Do not plug or unplug the PC Card into or from the expansion slot with the PC powered. Doing so may result in a malfunction, overheating, fault.
Be sure to turn off the PC before plugging or unplugging the PC Card.
 - 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 manual 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.
 - Power saving mode (standby mode) is not supported.
-

Environment

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

Operating temperature

0 - 50°C

Humidity

10 - 90%RH (No condensation)

Corrosive gases

None

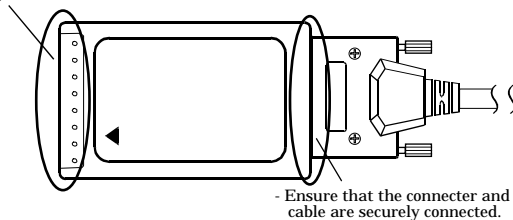
Floating dust particles

Not to be excessive

Inspection

Inspect the product periodically as follows to use it safely.

- Check for any dirt or corrosion on the metal-plated terminals in the connector.



Storage

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

- (1) Put the PC Card 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 PC card.

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 applications used.

Using the PC card 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 PC card 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 PC card under Windows

Using Software Other than the Driver Library

API-PAC(W32)

For setting up software other than API-PAC(W32), refer to the manual for that software. See also the following parts of this manual 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 PC card under an OS Other than Windows

For using the board under Linux, see the following parts of this manual.

This chapter Step 2 Setting the Hardware

Chapter 3 External Connection

Chapter 5 About Software

Chapter 6 About Hardware

For using the board under an OS other than Windows and Linux, see the following parts of this manual.

This chapter Step 2 Setting the Hardware

Chapter 3 External Connection

Chapter 6 About Hardware

Step 1 Installing the Software

This explains how to install the driver library.

Before installing the hardware on the PC, install the driver library from the API-PAC(W32) CD-ROM provided with the PC card.

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.

Which Driver to Use

CONTEC has two analog I/O drivers: API-AIO(WDM) and API-AIO(98/PC).

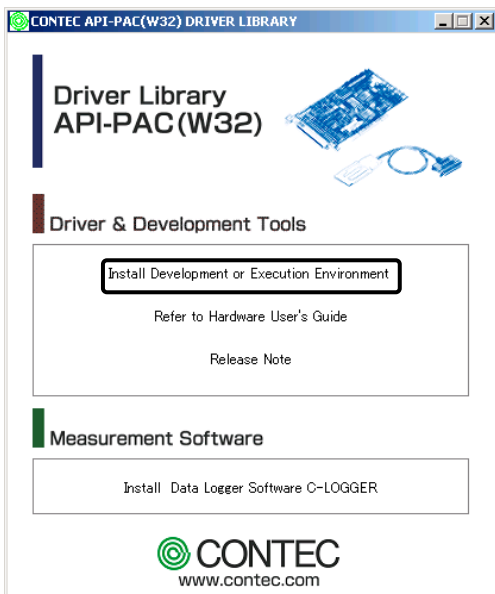
API-AIO(WDM) is a new driver for analog I/O under Windows.

This driver was developed to be easier to use and to provide additional functions above those provided by the previous API-AIO(98/PC) driver.

Please use the API-AIO(WDM) with this PC card. API-AIO(98/PC) is not supported.

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 the drivers] button.**

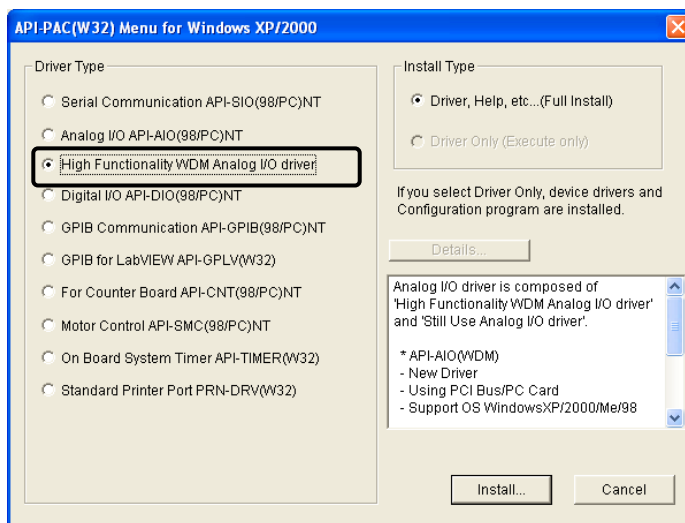


CAUTION

Before installing the software in Windows XP, 2000, log in as a user with administrator privileges.

Selecting API-AIO(WDM)

- (1) **The following dialog box appears to select “Driver Type” and “Install Type”.**
- (2) **Select the "High Functionality WDM Analog I/O driver"**
- (3) **Click on the [Install] button.**



- * Clicking the [Details] button 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.

You have now finished installing the software.

Step 2 Setting the Hardware

Connecting the PC Card to the Connector Cable

Plug the PC card connector of the optional cable ADC-68M/50M or PCA68PS-** into the ADA16-8/2(CB)L PC card. The flat side of the connector should face the same way as the topside of the card as shown in Figure 2.1.

CAUTION

When plugging in the cable, align the cable connector with the PC card socket and push firmly into place. Do not apply any excessive force to the socket on the PC card as this may damage the socket or result in a bad connection.

Also, never insert or unplug the connector while the PC power is turned on.

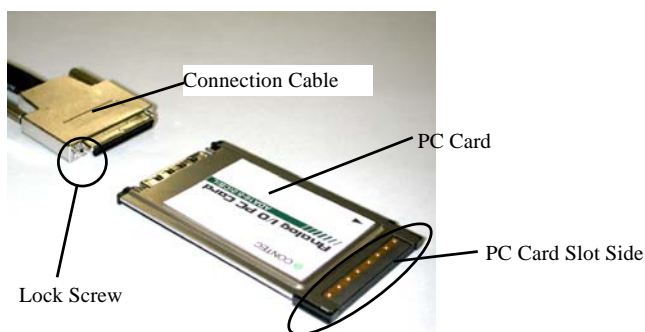


Figure 2.1. Connecting the PC Card to the Connection Cable

Insert the PC Card

Check that the power to the PC is turned off and insert the card into the PC card slot on the PC.

Firmly insert the card into the slot with the orientation indicated by the arrow symbol on the card, as shown in Figure 2.2.

The PC card has a key to prevent it from being inserted incorrectly. Do not try to force the card into the slot the wrong way around as this may damage the card or the slot on the PC. Also, check the card slot on your PC as the slots on some PCs are oriented so that cards are inserted with the topside facing down.

Refer to the manual for your PC for instructions on how to remove the card.

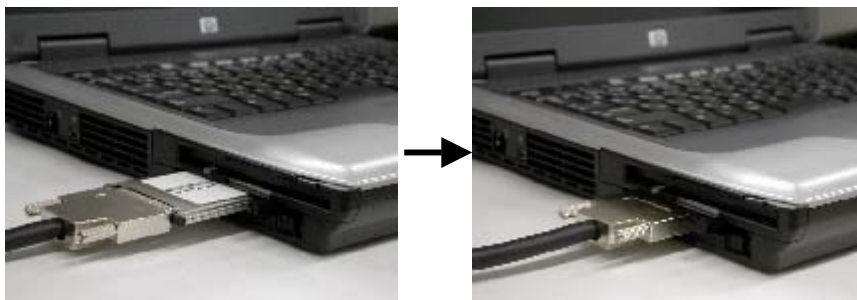


Figure 2.2. Insert the PC Card



CAUTION

Take note of the following points as inappropriate handling of the PC card may damage the card or connector socket and may result in a bad connection.

- Always insert the PC card with the correct orientation and in accordance with the instructions.
- Do not hold the card by the cable or connector when inserting the card into the slot
- Do not move the PC with the cable still plugged in.
- Do not apply any excessive force to the cable socket on the PC card such as by pulling on the cable connector.
- Do not place any objects on top of the cable connector.

Cautions When Using Two or More ADA16-8/2(CB)L Cards

If your PC has two TYPE II size PC card slots one on top of the other, you cannot use the ADA16-8/2(CB)L cards in both slots at the same time. This is because of the shape of the cable connector.

However, you can use the ADA16-8/2(CB)L together with another PC card that does not require an external connector such as a memory card.

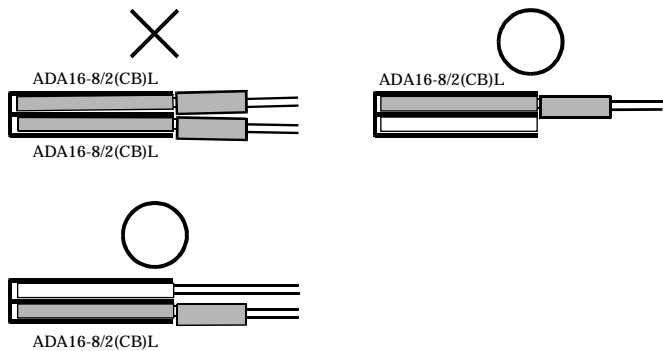


Figure 2.3. Cautions When Using Two or More ADA16-8/2(CB)L Cards

Step 3 Installing the Hardware

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

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

Turning on the PC

Turn on the power to your PC.



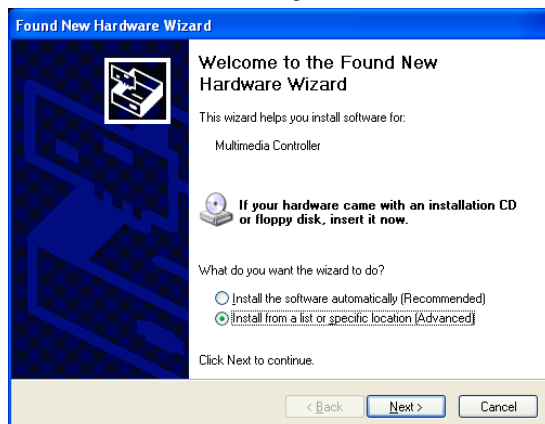
CAUTION

- The PC card cannot be properly installed unless the resources (I/O addresses and interrupt level) for the PC card can be allocated. Before attempting to install the PC card, first determine what PC resources are free to use.
- The resources used by each PC card do not depend on the location of the PCI bus slot or the PC card itself. If you remove two or more PC cards 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 PC cards is assigned to the remounted PC card. In this case, you must check the resource settings.

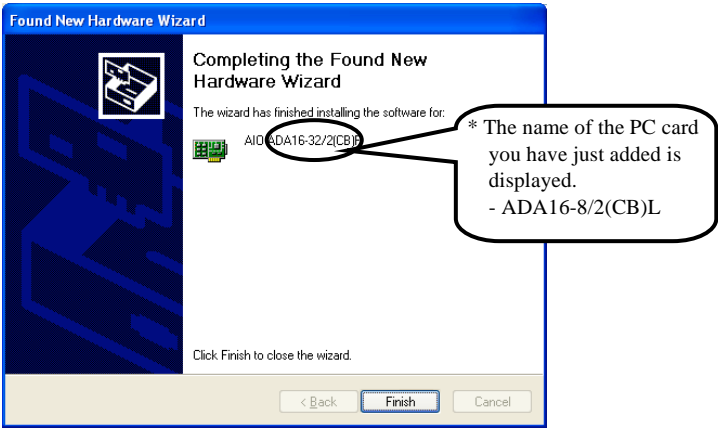
When Using API-AIO(WDM)

- (1) The “Found New Hardware Wizard” will be started.

Select the “Install from a list or specific location [Advanced]”, then click on the [Next] button.



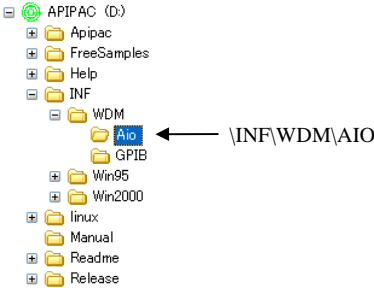
- (2) Specify that folder on the CD-ROM which contains the setup information (INF) file to register the PC card.



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.

Step 4 Initializing the Software

The driver library requires initial settings to determine the execution environment. This is called driver library initialization.



CAUTION

The device name must be set with the PC on. It must also be set after the card is plugged or unplugged.

Setting the device name

(1) Run Device Manager.

< In Windows XP in Normal View >

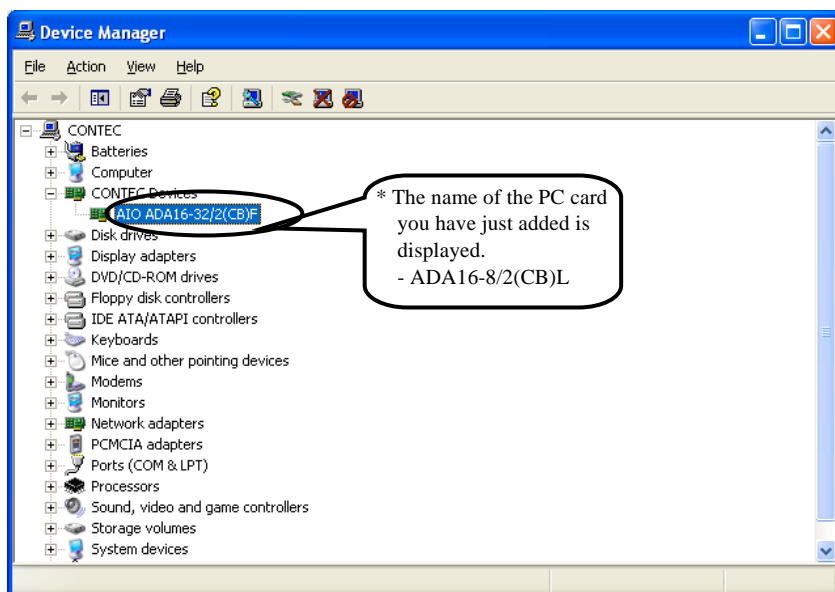
From [My Computer] – [Performance and maintenance] in [Control Panel], select [System] and then select the [Device Manager] in the [Hardware] tab.

< In Windows XP in Classic View >

From [My Computer] - [Control Panel], select [System] and then select the [Device Manager] in the [Hardware] tab.

< Other Windows OS >

From [My Computer] - [Control Panel], select [System] and then select the [Device Manager] tab.

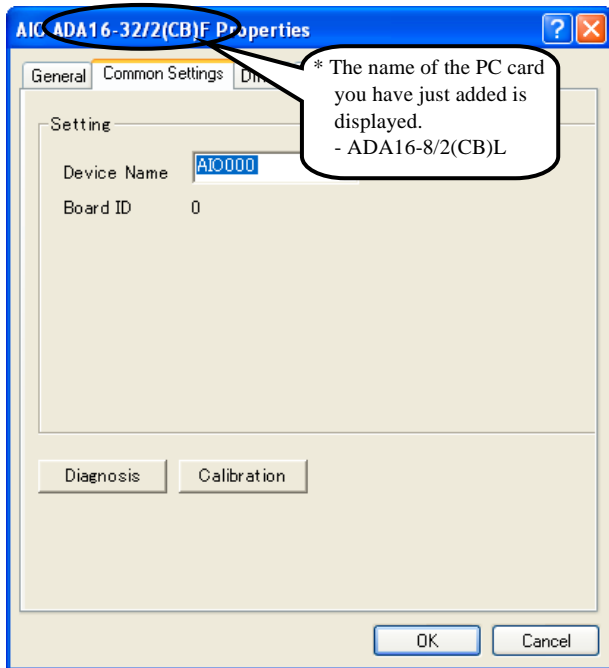


(2) The installed hardware appears under the CONTEC Devices node. Open the CONTEC Devices node and select the device you want to setup (the device name should appear highlighted). Click [Properties].

(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.

Step 5 Checking Operations with the Diagnosis Program

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

What is the Diagnosis Program?

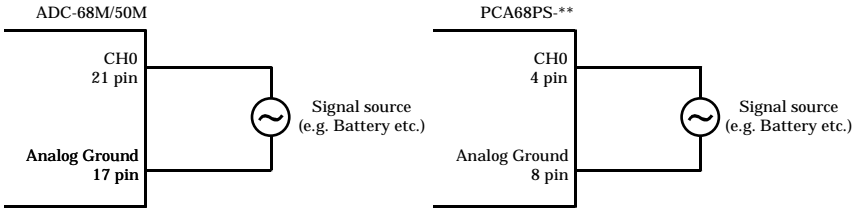
The diagnosis program diagnoses the states of the PC card and driver software. It can also be used as a simple checker when an external device is actually connected. Using the “Diagnosis Report” feature reports the driver settings, the presence or absence of the PC card, I/O status, and interrupt status.

Check Method

To check the analog I/O data, use the loopback connection on the PC card to directly connect the analog output (channel 0) to an analog input, or connect to an external signal source. No external connection is required if using loopback to check the I/O. The figure below shows an example of checking by connecting to an external signal. The example is for channel 0 on the ADA16-8/2(CB)L. See "Chapter 3 Connecting to External Devices" for details on how to make the connection.

Wiring Diagram

< Analog input >



⚠ 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”.

< Analog output >

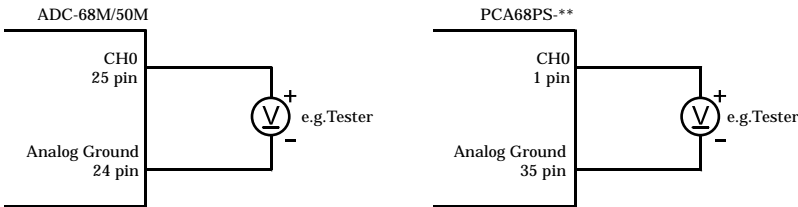
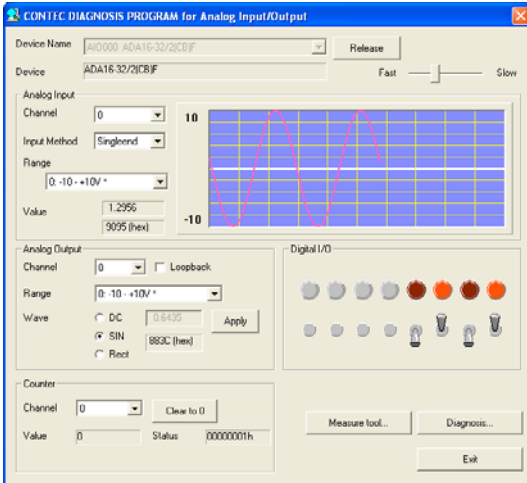
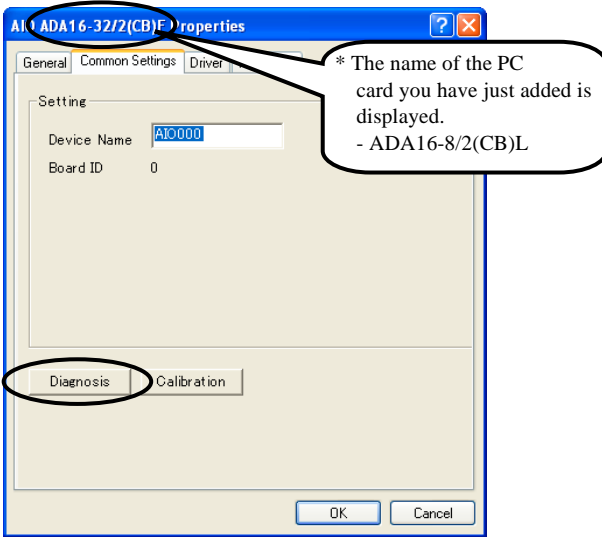


Figure 2.4. Wiring Diagram

Using the Diagnosis Program

Starting the Diagnosis Program

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



Analog input

Select the input channel, input type, and input range from the lists.

Input data is plotted on a graph.

Analog output

You can select the desired output channel and output range from the lists.

You can set the output data to DC (constant voltage), sine wave, or square wave.

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.

Counter input

Selecting a counter channel displays the count value and state of that counter channel.

Clicking the zero clear button resets the count to zero.

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.

```

CAioRep.txt - Notepad
File Edit Format View Help
-----
CONTEC Analog I/O diagnostic report
-----
** CAioDiag.exe program **
Date:2004/05/06 07:08:09
OS :Microsoft windows XP 5.1.2600 Service Pack 1

[Device information]
  Device Name  AI0000
  Device       ADA16-8/2(CB)L

[File Information]
  G:\WINDOWS\SYSTEM32\CAIO.DLL      1, 3, 0, 0 2003/05/29 01:13
  G:\WINDOWS\SYSTEM32\CMESSEAGE.OCX 1, 0, 0, 1 2003/05/29 01:13
  G:\WINDOWS\SYSTEM32\CAIODEL.EXE   1, 1, 3, 0 2003/05/29 01:13
  G:\WINDOWS\SYSTEM32\CAIOPP32.DLL  1, 1, 2, 0 2003/08/27 01:12
  G:\WINDOWS\SYSTEM32\DRIVERS\CAIO.SYS 1, 1, 2, 0 2003/10/31 01:30
  G:\WINDOWS\SYSTEM32\CAIODIAG.EXE  1, 1, 4, 0 2003/10/31 01:14

[diagnosis]
  Initial result  [0] Normality completion
  Interrupt       [0] Normality completion

  Analog input 32CH
  Input method:Singleend
  CH00 [0] Normality completion DATA: 3.74(AFE4hex) RANGE:-10 - +10V
  CH01 [0] Normality completion DATA: 0.16(8200hex) RANGE:-10 - +10V
  CH02 [0] Normality completion DATA: -0.70(7701hex) RANGE:-10 - +10V
  CH03 [0] Normality completion DATA: -0.53(793Dhex) RANGE:-10 - +10V
  CH04 [0] Normality completion DATA: -0.93(7416hex) RANGE:-10 - +10V
  CH05 [0] Normality completion DATA: -0.75(7659hex) RANGE:-10 - +10V
  CH06 [0] Normality completion DATA: -0.63(77FChex) RANGE:-10 - +10V
  CH07 [0] Normality completion DATA: -0.28(7C6Dhex) RANGE:-10 - +10V
  CH08 [0] Normality completion DATA: -0.86(7506hex) RANGE:-10 - +10V
  CH09 [0] Normality completion DATA: -0.77(7623hex) RANGE:-10 - +10V
  CH10 [0] Normality completion DATA: -0.43(7A84hex) RANGE:-10 - +10V
  CH11 [0] Normality completion DATA: -0.21(7D50hex) RANGE:-10 - +10V
  CH12 [0] Normality completion DATA: -0.38(7B32hex) RANGE:-10 - +10V
  CH13 [0] Normality completion DATA: -0.16(7DF6hex) RANGE:-10 - +10V
  CH14 [0] Normality completion DATA: -0.12(7E77hex) RANGE:-10 - +10V
  CH15 [0] Normality completion DATA: -0.34(7BA1hex) RANGE:-10 - +10V
  CH16 [0] Normality completion DATA: -0.54(7914hex) RANGE:-10 - +10V
  CH17 [0] Normality completion DATA: -0.44(7A52hex) RANGE:-10 - +10V
  CH18 [0] Normality completion DATA: -0.52(794Chex) RANGE:-10 - +10V
  CH19 [0] Normality completion DATA: -0.41(7ACAhex) RANGE:-10 - +10V
  CH20 [0] Normality completion DATA: -0.68(7747hex) RANGE:-10 - +10V
  CH21 [0] Normality completion DATA: -0.39(7AF6hex) RANGE:-10 - +10V
  
```

(2) The diagnosis report contains the following data.

- Version of OS
- Device Information
- File Information
- Initialization, interrupts, current input or output state for each channel

Execution time measurement

Clicking [Measure Execution Time] starts the function execution speed measurement program.

Setup Troubleshooting

Symptoms and Actions

Data input or output does not operate correctly

- Run the diagnosis program to check that the device is registered and whether any initialization errors have occurred.
- Is there a problem with the device settings, wiring, or similar? Check the I/O range setting. Also, the input data will be undefined if the wiring terminals are not connected. Ensure that the channels you are using are correctly connected. Connect unused channels to analog ground.
- For voltage input, check by connecting a battery or similar if you do not have any other suitable signal source. Also check that connecting to analog ground reads correctly as 0V.

The diagnostic program works correctly but the application program does not.

The diagnostic program uses the API-TOOL functions. If the diagnostic program works correctly, other applications should work correctly also. If you have a problem, recheck your program taking note of the following points.

- Check the return values of the API functions.
- Refer to the source code for the sample programs.

The OS does not boot correctly or does not detect the device correctly.

Refer to the "Troubleshooting" section of API-AIO(WDM) HELP.

If your problem cannot be resolved

Contact your retailer.

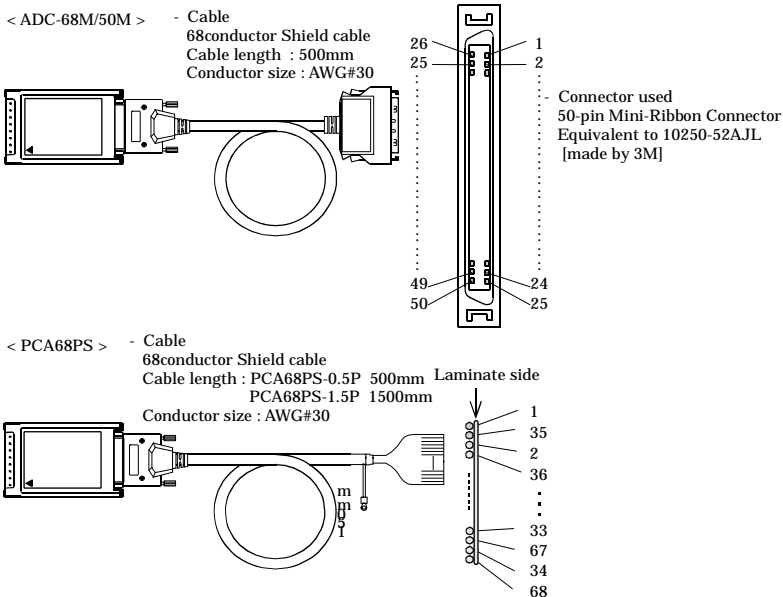
3. External Connection

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

How to connect the connectors

Connector shape

An optional cable (ADC-68M/50M) is used to connect the PC card to external devices. Use this cable in conjunction with a terminal block to connect external devices.



* Please refer to chapter 1 for more information on the supported cable and accessories.

Figure 3.1. Interface Connector Shape

Connector Pin Assignment

Pin Assignment of ADA16-8/2(CB)L interface connector

Analog Output 00	AO 00	1	35	- AGND	Analog Ground (for AO)
Analog Output 01	AO 01	2	36	- AGND	Analog Ground (for AO)
Analog Ground (for AO)	AGND	3	37	- AGND	Analog Ground (for AO)
Analog Input 00	AI 00	4	38	- N.C.	Non Connect
Analog Input 01	AI 01	5	39	- N.C.	Non Connect
Analog Input 02	AI 02	6	40	- N.C.	Non Connect
Analog Input 03	AI 03	7	41	- N.C.	Non Connect
Analog Ground (for AI)	AGND	8	42	- AGND	Analog Ground (for AI)
Analog Input 04	AI 04	9	43	- N.C.	Non Connect
Analog Input 05	AI 05	10	44	- N.C.	Non Connect
Analog Input 06	AI 06	11	45	- N.C.	Non Connect
Analog Input 07	AI 07	12	46	- N.C.	Non Connect
Analog Ground (for AI)	AGND	13	47	- AGND	Analog Ground (for AI)
Non Connect	N.C.	14	48	- N.C.	Non Connect
Non Connect	N.C.	15	49	- N.C.	Non Connect
Non Connect	N.C.	16	50	- N.C.	Non Connect
Non Connect	N.C.	17	51	- N.C.	Non Connect
Analog Ground (for AI)	AGND	18	52	- AGND	Analog Ground (for AI)
Non Connect	N.C.	19	53	- N.C.	Non Connect
Non Connect	N.C.	20	54	- N.C.	Non Connect
Non Connect	N.C.	21	55	- N.C.	Non Connect
Non Connect	N.C.	22	56	- N.C.	Non Connect
AI External Start Trigger Input	AI START	23	57	- AI STOP	AI External Stop Trigger Input
AI External Sampling Clock Input	AI EXCLK	24	58	- DGND	Digital Ground
Non Connect	N.C.	25	59	- N.C.	Non Connect
AO External Start Trigger Input	AO START	26	60	- AO STOP	AO External Stop Trigger Input
AO External Sampling Clock Input	AO EXCLK	27	61	- DGND	Digital Ground
Non Connect	N.C.	28	62	- N.C.	Non Connect
Digital Input 00	DI 00	29	63	- DI 01	Digital Input 01
Digital Input 02	DI 02	30	64	- DI 03	Digital Input 03
Digital Output 00	DO 00	31	65	- DO 01	Digital Output 01
Digital Output 02	DO 02	32	66	- DO 03	Digital Output 03
Counter Gate Control Input	CNT GATE	33	67	- CNT OUT	Counter Output
Counter UP Clock Input	CNT UPCLK	34	68	- Reserved	Reserved

Analog Input00 - Analog Input07	Analog input signal. The numbers correspond to channel numbers.
Analog Output00 - Analog Output01	Analog output signal. The numbers correspond to channel numbers.
Analog Ground	Common analog ground for analog I/O signals.
AI External Start Trigger Input	External trigger input signal for starting analog input sampling.
AI External Stop Trigger Input	External trigger input signal for stopping analog input sampling.
AI External Sampling Clock Input	External sampling clock input signal for analog input.
AO External Start Trigger Input	External trigger input signal for starting analog output sampling.
AO External Stop Trigger Input	External trigger input signal for stopping analog output sampling.
AO External Sampling Clock Input	External sampling clock input signal for analog output.
Digital Input00 - Digital Input03	Digital input signal.
Digital Output00 - Digital Output03	Digital output signal.
Counter Gate Control Input	Gate control input signal for counter.
Counter Up Clock Input	Count-up clock input signal for counter.
Counter Output	Counter output signal.
Digital Ground	Common digital ground for digital I/O signal, external trigger input, external sampling clock input signal, and counter I/O signal.
Reserved	Reserved pin
N.C.	No connection to this pin.

Figure 3.2. Pin Assignment of interface connector

Signal assignment with the ADC-68M/50M used

Analog Output 00	AO 00	-- 25	50	- N.C.	Non Connect
Analog Ground (for AO)	AGND	-- 24	49	- AGND	Analog Ground (for AO)
Analog Output 01	AO 01	-- 23	48	- N.C.	Non Connect
Analog Ground (for AO)	AGND	-- 22	47	- AGND	Analog Ground (for AO)
Analog Input 00	AI 00	-- 21	46	- AI 04	Analog Input 04
Non Connect	N.C.	-- 20	45	- N.C.	Non Connect
Analog Input 01	AI 01	-- 19	44	- AI 05	Analog Input 05
Non Connect	N.C.	-- 18	43	- N.C.	Non Connect
Analog Ground (for AI)	AGND	-- 17	42	- AGND	Analog Ground (for AI)
Analog Ground (for AI)	AGND	-- 16	41	- AGND	Analog Ground (for AI)
Analog Input 02	AI 02	-- 15	40	- AI 06	Analog Input 06
Non Connect	N.C.	-- 14	39	- N.C.	Non Connect
Analog Input 03	AI 03	-- 13	38	- AI 07	Analog Input 07
Non Connect	N.C.	-- 12	37	- N.C.	Non Connect
AI External Start Trigger Input	AI START	-- 11	36	- AO START	AO External Start Trigger Input
AI External Stop Trigger Input	AI STOP	-- 10	35	- AO STOP	AO External Stop Trigger Input
AI External Sampling Clock Input	AI EXCLK	-- 9	34	- AO EXCLK	AO External Sampling Clock Input
Digital Ground	DGND	-- 8	33	- DGND	Digital Ground
Digital Input 00	DI 00	-- 7	32	- DO 00	Digital Output 00
Digital Input 01	DI 01	-- 6	31	- DO 01	Digital Output 01
Digital Input 02	DI 02	-- 5	30	- DO 02	Digital Output 02
Digital Input 03	DI 03	-- 4	29	- DO 03	Digital Output 03
Digital Ground	DGND	-- 3	28	- DGND	Digital Ground
Counter Gate Control Input	CNT GATE	-- 2	27	- CNT UPCLK	Counter UP Clock Input
Counter Output	CNT OUT	-- 1	26	- Reserved	Reserved

Analog Input00 - Analog Input07	Analog input signal. The numbers correspond to channel numbers.
Analog Output00 - Analog Output01	Analog output signal. The numbers correspond to channel numbers.
Analog Ground	Common analog ground for analog I/O signals.
AI External Start Trigger Input	External trigger input signal for starting analog input sampling.
AI External Stop Trigger Input	External trigger input signal for stopping analog input sampling.
AI External Sampling Clock Input	External sampling clock input signal for analog input.
AO External Start Trigger Input	External trigger input signal for starting analog output sampling.
AO External Stop Trigger Input	External trigger input signal for stopping analog output sampling.
AO External Sampling Clock Input	External sampling clock input signal for analog output.
Digital Input00 - Digital Input03	Digital input signal.
Digital Output00 - Digital Output03	Digital output signal.
Counter Gate Control Input	Gate control input signal for counter.
Counter Up Clock Input	Count-up clock input signal for counter.
Counter Output	Counter output signal.
Digital Ground	Common digital ground for digital I/O signal, external trigger input signal, external sampling clock input signal, and counter I/O signal.
Reserved	Reserved pin
N.C.	No connection to this pin.

Figure 3.3. Signal assignment with the ADC-68M/50M used



CAUTION

- Do not connect any of the outputs and power outputs to the analog or digital ground. Neither connect outputs to each other. Doing either can result in a fault.
 - If analog and digital ground are shorted together, noise on the digital signals may affect the analog signals. Accordingly, analog and digital ground should be separated.
 - Leave "Reserved" pins unconnected. Connecting these pins may cause a fault in the PC card.
-

Analog Input Signal Connection

Analog signal input types are divided into single-ended input and differential input. This card uses single-ended input fixed. The sections below describe how to connect the signals using flat cable and shielded cable.

Single-ended Input

The following figure shows an example of flat cable connection.

Connect separate signal and ground wires for each analog input channel on CN1.

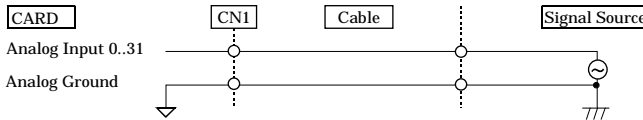


Figure 3.4. Single-ended Input Connection (Flat Cable)

The following figure shows an example of shield cable connection. Use shielded cable if the distance between the signal source and PC card 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.

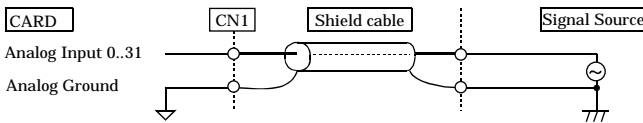


Figure 3.5. Single-ended Input Connection (Shield Cable)



CAUTION

- If the signal source contains over 1MHz signals, the signal may effect the cross-talk noise between channels.
- If the PC card and the signal source receive noise or the distance between the PC card and the signal source is too long, data may not be input properly.
- An input analog signal should not exceed the maximum input voltage (relate to the PC card analog ground). If it exceeds the maximum voltage, the PC card may be damaged.
- Connect all the unused analog input channels to analog ground. Failure to do so may affect input data to other channels.
- The signal connected to an input pin may fluctuate after switching of the multiplexer. If this occurs, shorten the cable between the signal source and the analog input pin or insert a high-speed amplifier as a buffer between the two to reduce the fluctuation.
- An input pin may fail to obtain input data normally when the signal source connected to the pin has high impedance. If this is the case, change the signal source to one with lower output impedance or insert a high-speed amplifier buffer between the signal source and the analog input pin to reduce the effect.

Analog Output Signal Connection

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

The following figure shows an example of flat cable connection.

Connect the signal source and ground to the CN1 analog output.

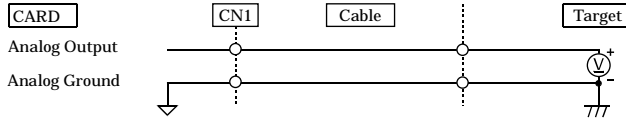


Figure 3.6. Analog Output Connection (Flat Cable)

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

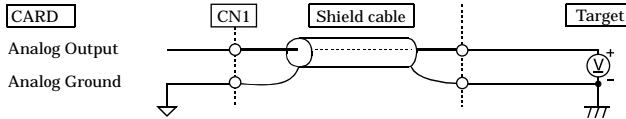


Figure 3.7. Analog Output Connection (Shield Cable)

⚠ CAUTION

- If the PC card or the target receives noise, or the distance between the PC card and the target is long, data may not be outputted properly.
- For analog output signal, the current capacity is $\pm 5\text{mA}$ (Max.). Check the specification of the connected device before connecting the PC card.
- Do not short the analog output signal to analog ground, digital ground. Doing so may cause a fault on the PC card.
- Do not connect an analog output signal to any other analog output, either on the PC card or on an external device, as this may cause a fault on the PC card.
- The voltage output when the PC is turned on is indeterminate.

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

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

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

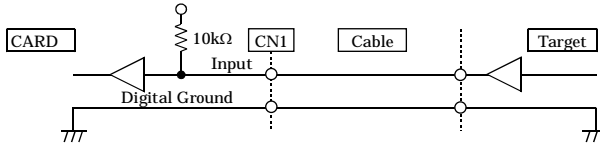


Figure 3.8. Digital Input Connection

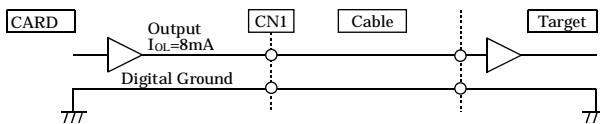


Figure 3.9. Digital Output Connection

About the counter input control signal

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



CAUTION

- Do not short the output signals to analog ground, digital ground, and/or power line. Doing so may cause a fault on the PC card.
- If connected to each output, a pull-up resistor must be about 10 kΩ to pull up with a 3.3V power source.
- Each input accepts 5V TTL signals.

Reference

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

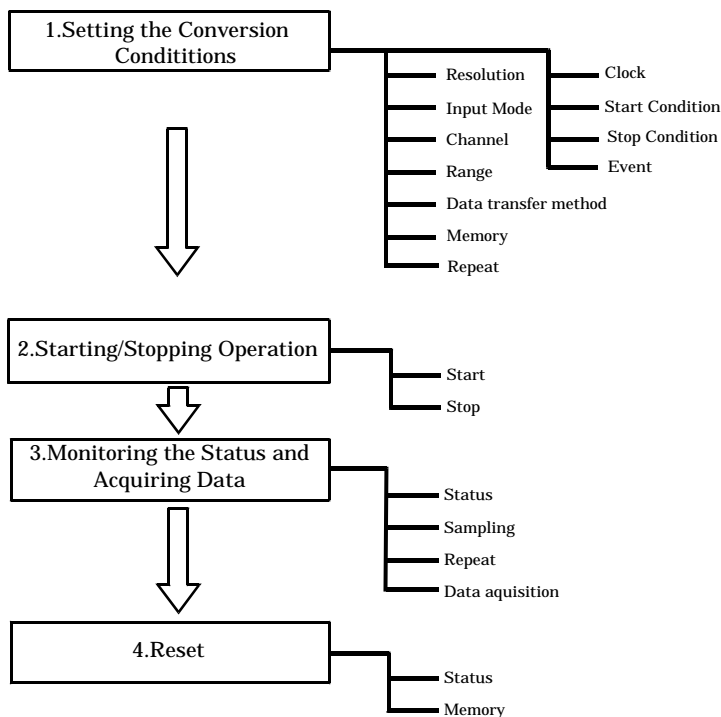
4. Functions

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

The PC card 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 Conditions

First, set the conditions for executing analog input.

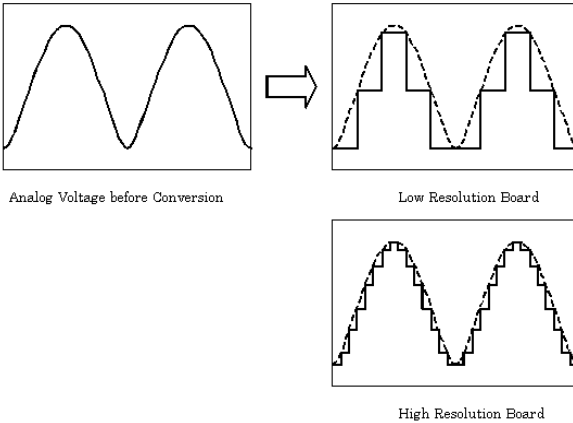
Resolution

“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 12-bit divides the range width into 4096 segments.

When the device covers the range of 0 to 10 volts, the minimum unit of converted voltages is $10 \div 4096 = 2.44\text{mV}$.

If the device has a resolution of 16-bit, it is $10 \div 65536 = 0.153\text{mV}$ instead.



ADA16-8/2(CB)L : The resolution is 16-bit.

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.

Software setup of the input mode is not required as this card uses the single-ended input mode fixed.

Channel

“Channel” represents each point of analog input.

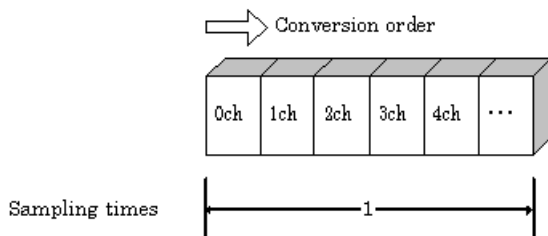
For individual channel numbers, see “Using the On-board Connectors” to “Connector Pin Assignment” in Chapter 3 "External Connection".

You can specify an arbitrary number of points of analog input by setting the channels by means of software.

Channel conversion order

Normally, when performing conversion for more than one channel at each sampling, conversion is performed consecutively starting from channel 0.

Software setup is not required as this card uses a fixed channel conversion priority.



Range

“Range” means the range of voltages at which analog input can be performed.

Software setup of the range is not required as this card uses a fixed range of voltages.

ADA16-8/2(CB)L : $\pm 10V$

Data transfer method

You can select the device buffer mode which saves conversion data in a conversion data memory area either on the device or in the driver.

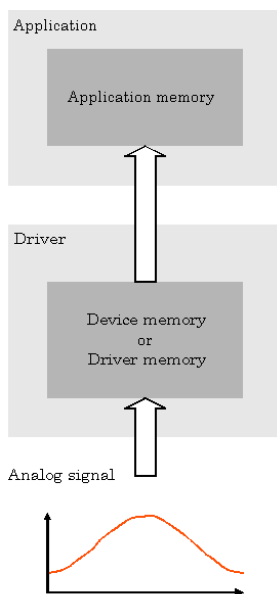
- Device buffer mode

When conversion starts, data is saved in the device buffer (memory on the device itself or in the driver).

The device buffer can operate as FIFO or ring memory.

The application calls an API function at an appropriate timing and fetches the conversion data from the device buffer.

Device buffer mode handles data by sampling count and API functions are provided to retrieve conversion data directly as voltage values.



Device buffer mode

Memory format

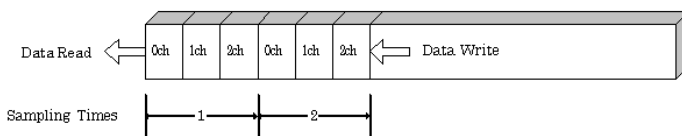
This card uses device buffer transfer mode; it does not require software setup of the memory format.

Device buffer mode

- 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.

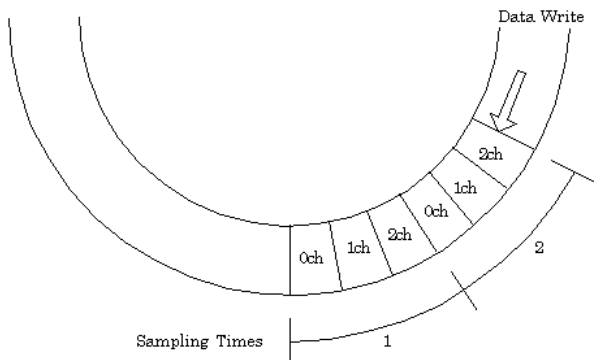
The FIFO memory is used to obtain all input data from analog input in a short or infinite period of time.



- 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.

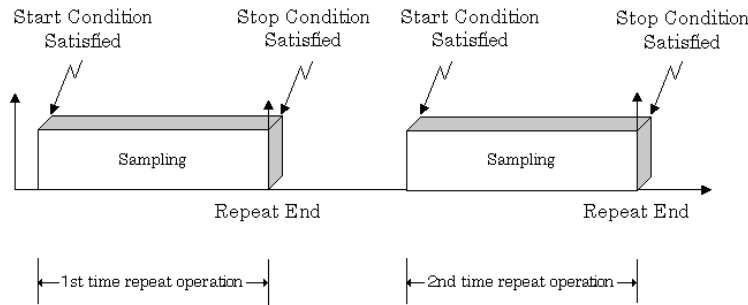


Repeat

“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.



Clock

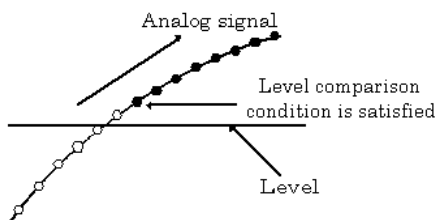
The sampling clock controls the sampling frequency. You can select either the internal sampling clock, external sampling clock.

- 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.

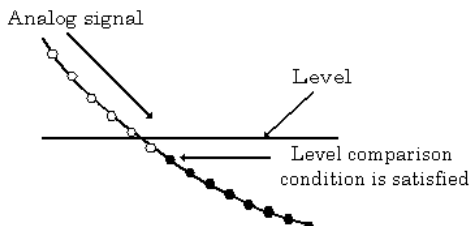
Start Condition

The condition for controlling the start of sampling can be selected from among software, input data comparison, 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
The PC card starts sampling and storing input data to memory immediately after the operation start command is issued.
- Input data level comparison
When the operation start command is issued, the PC card compares the analog signal input through a specified channel to the value of the preset comparison level. If the analog signal satisfies the condition, the PC card 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
The PC card 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 specified edge (rising edge or falling edge) is input from the external control signal.

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, software.

The PC card stops sampling whenever an error occurs irrespective of the stop condition setting.

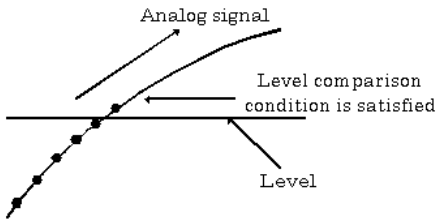
- Last sampling count

The PC card stops sampling after storing input data to memory for the specified number of times of sampling.

- Input data level comparison

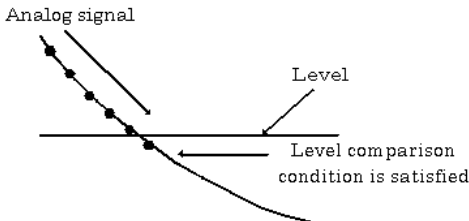
Once the PC card has started sampling, it compares the analog signal input through a specified channel to the value of the preset comparison level. If the analog signal satisfies the condition, the PC card stops sampling.

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.

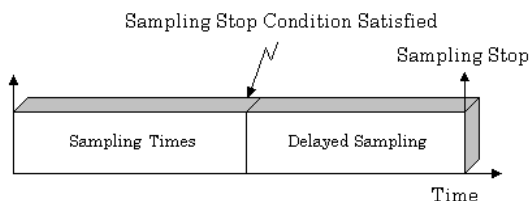
- External trigger

The PC card starts waiting for an external control signal after the specified number of samples have been performed. Sampling stops when the specified edge (rising edge or falling edge) is input from the external control signal.

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, the PC card 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, the PC card stops sampling the moment the sampling stop condition is satisfied.



Event

“Event” works as a function for reporting the occurrence of a certain PC card 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 event 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. This event can only be used in device buffer mode.
- “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 the PC card 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 the PC card 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 the PC card 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, the PC card stops conversion.
When the memory format is ring, the PC card 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.

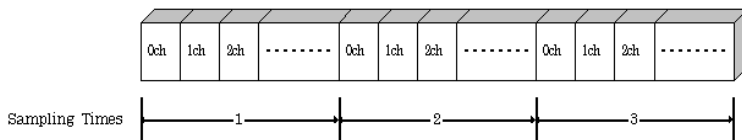
Repeat

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

Data acquisition

When using the device buffer, 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.

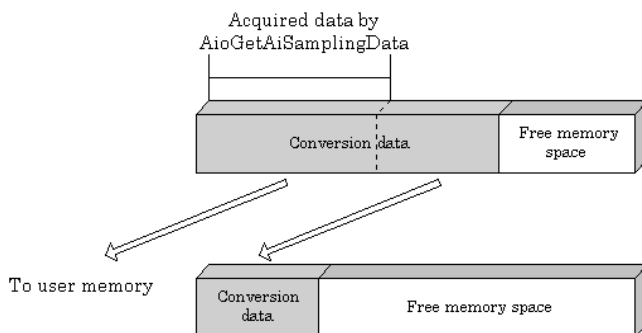
- Data acquisition in FIFO format

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

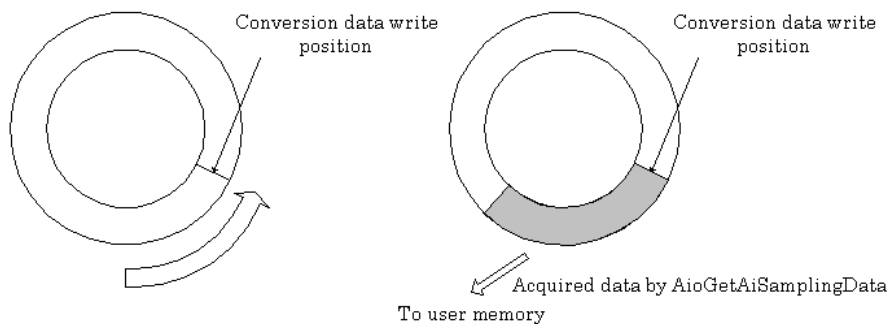
When ring memory is used, data is read always with respect to the current input data write position.

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

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

$$\text{Voltage} = \text{Input data} \times (\text{Max. range value} - \text{Min. range value}) / \text{Resolution} + \text{Min. range value}$$

The value of resolution for the 16-bit device is 65536.

The table below shows the relationship between input data and voltage in the ± 10 -volt range.

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

Ex.: When input data 49152 is input at a resolution of 16-bit in the ± 10 -volt range

$$\begin{aligned} \text{Voltage} &= 49152 \times (10 - (-10)) \div 65536 + (-10) \\ &= 5.0 \end{aligned}$$

4. Reset

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

Status

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

Memory

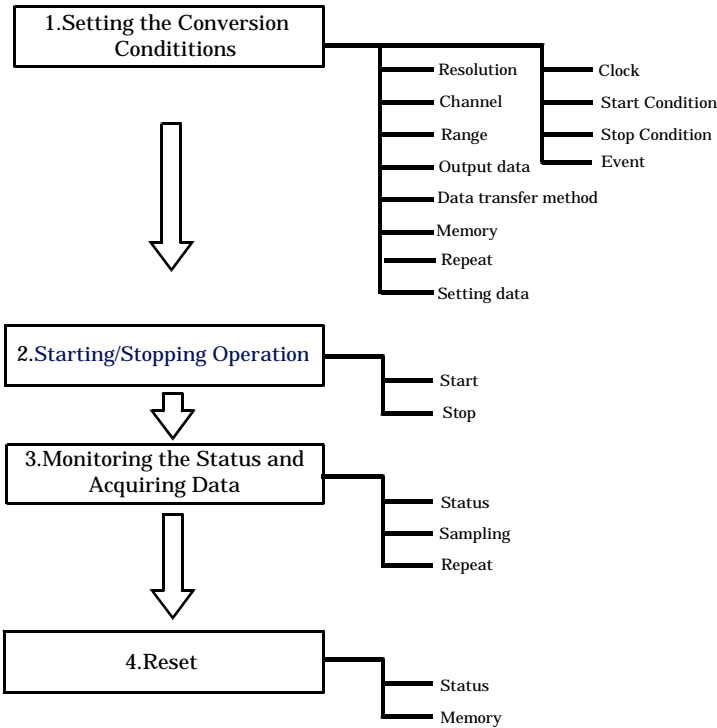
This can only be used when the transfer mode is set to device buffer mode.

This command resets the following memory related states.

- Resets the conversion data in memory.
- Resets the repeat count to 0.
- Resets the sampling count to 0 when a stop trigger is input.
- Resets the buffer overflow status.
- Resets the status information for the specified data save count.

Analog Output Function

The PC card converts digital data to analog signals according to the resolution.
You can set a variety of conditions for analog output, including the output channel, sampling period, and sampling start/stop conditions.
Analog output processes are classified as follows:



1. Setting the Conversion Conditions

First, set the conditions for executing analog output.

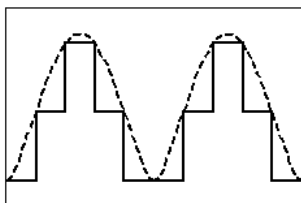
Resolution

"Resolution" signifies the number of bits used by an analog output device to represent analog signals. The higher the resolution, the more finely the voltage range is segmented, allowing the device to convert digital values to analog equivalents more precisely.

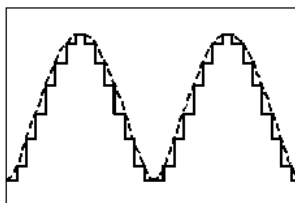
A device with a resolution of 12-bit divides the range width into 4096 segments.

When the device covers the range of 0 to 10 volts, the minimum unit of converted voltages is $10 \div 4096 = 2.44\text{mV}$.

If the device has a resolution of 16-bit, it is $10 \div 65536 = 0.153\text{mV}$ instead.



Low Resolution Board



High Resolution Board

ADA16-8/2(CB)L : The resolution is 16-bit.

Channel

"Channel" represents each point of analog output.

For individual channel numbers, see "Using the On-board Connectors" to "Connector Pin Assignment" in Chapter 3 "External Connection".

You can specify an arbitrary number of points of analog output by setting the channels by means of software.

Range

"Range" means the range of voltages at which analog output can be performed.

Software setup of the range is not required as this card uses a fixed range of voltages.

ADA16-8/2(CB)L : $\pm 10\text{V}$

Output data

$$\text{Output data} = ((\text{Voltage} - \text{Min. range value}) \times \text{Resolution}) \div (\text{Max. range value} - \text{Min. range value})$$

The value of resolution for the 16-bit device is 65536.

The table below shows the relationship between output data and voltage in the ± 10 -volt range.

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

Ex.: When 3V is output at a resolution of 16-bit in the ± 10 -volt range

$$\begin{aligned}\text{Output data} &= (3 - (-10)) \times 65536 \div (10 - (-10)) \\ &= 42598.4^*\end{aligned}$$

* The value that can be set as output data at this time is an integer. Select "42598" or "42599" as the output data.

The analog signal corresponding to the output data contains an error as follows:

- Output data "42598" converted to: 2.9998 V

- Output data "42598" converted to: 3.0001 V

This error is a consequential error occurring when output data is obtained from an expected analog value.

Data transfer method

You can select the device buffer mode which saves conversion data in a conversion data memory area either on the device or in the driver.

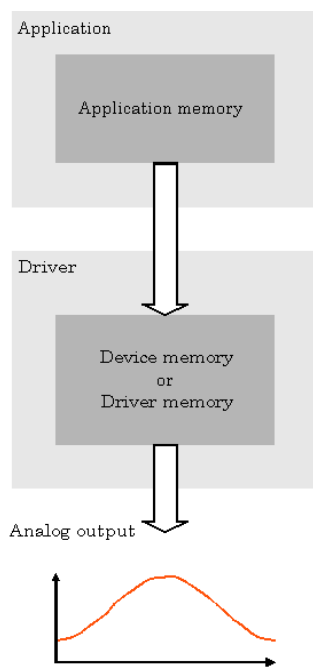
- Device buffer mode

The application output data is first stored in the device buffer (memory on the device itself or in the driver).

When conversion starts, the device starts outputting the output data.

The device buffer can operate as FIFO or RING memory.

Device buffer mode handles conversion data by sampling count and API functions are provided to set conversion data directly as voltage values.



Device buffer mode

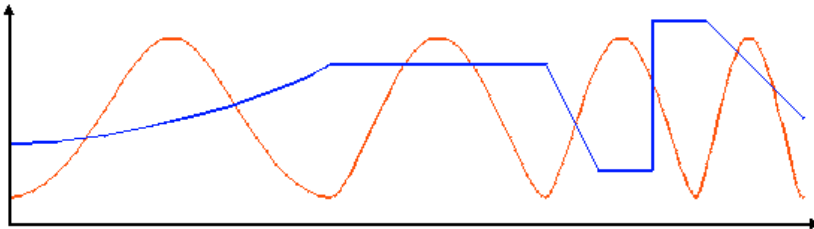
Memory format

This card uses device buffer transfer mode; it does not require software setup of the memory format.

Device buffer mode

- FIFO (First In First Out) format

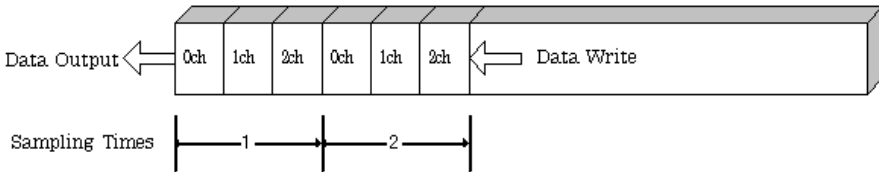
Use FIFO format if you wish to output a continuous arbitrary analog output like that shown below.



When using FIFO format, writing of conversion data to memory is always performed from after the most recent data and DA conversion is performed on the oldest data in memory.

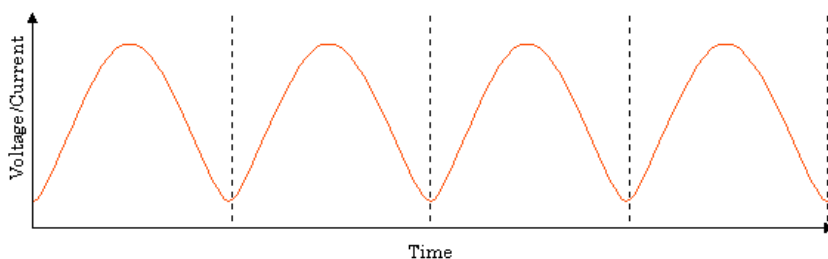
You can write to memory during analog output operation.

An error occurs if the volume of data exceeds the memory size. However, this error does not stop analog output if it is in progress.



- Ring format

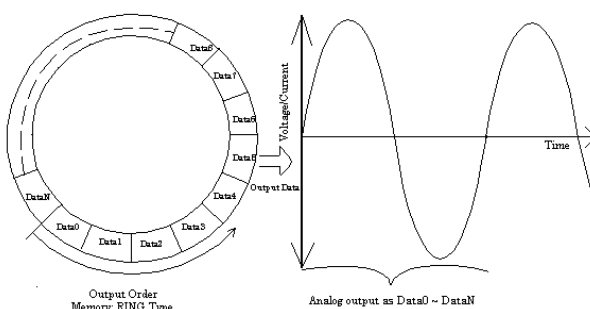
Use ring format if you wish to output a repeated pattern like that shown below.



When using ring format, write the data for one complete cycle of the output waveform before starting operation.

You cannot write to the memory during its operation of analog output.

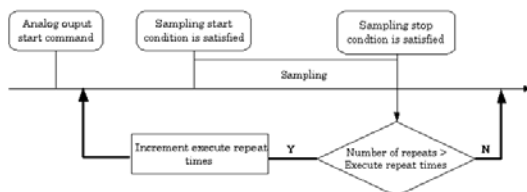
DA conversion data is output continuously in the sequence in which the ring format data is stored.



* Although the figure shows a single analog output channel, output from multiple channels is also possible.

Repeat

You can specify a repeat count to perform sampling for a specified number of times.



Memory must be set to ring format if a number of repetitions is to be specified.

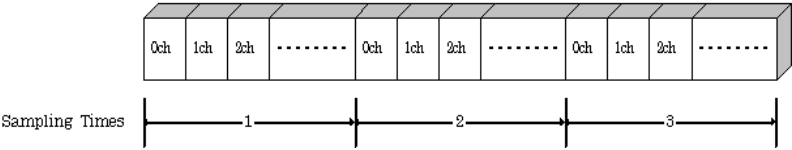
(The number of repetitions cannot be specified for FIFO memory format.)

The number of repetitions is set by software and sampling is repeated for the specified number of times.

You can also specify that operation continue indefinitely. If set to repeat indefinitely, analog output operation is stopped by outputting an analog output stop command by software.

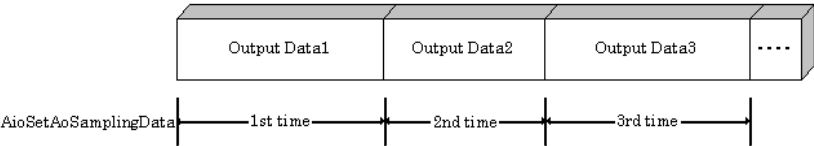
Setting data

You can use a software command to save the data in memory.
The figure below shows the relationship between the conversion data stored in memory and the sampling count and conversion channels.

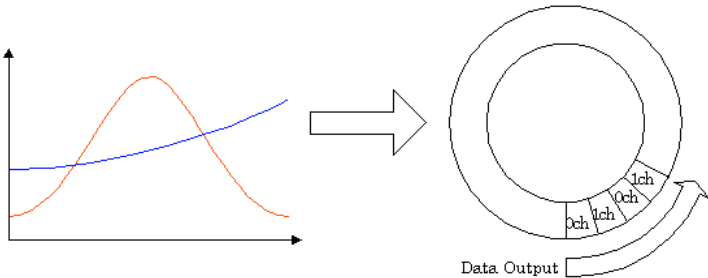


The procedure for setting the conversion data is different depending on the memory format being used.

- Procedure for FIFO format
When using FIFO format, setting data to memory is always performed from the most recent data.
New data can be added during conversion.



- Procedure for RING format
When using ring format, a ring memory area large enough for the data to be set is reserved.
Data cannot be modified during DA conversion.



Clock

The sampling clock controls the sampling frequency. You can select both the internal sampling clock or 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 both software 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
The PC card starts sampling and storing input data to memory immediately after the operation start command is issued.
- External trigger
The PC card starts waiting for an external control signal as soon as the operation start command is output.
Sampling and data transfer from memory start when the specified edge (rising edge or falling edge) is input from the external control signal.

Stop Condition

The condition for controlling the stop of sampling can be selected from among the last sampling count, an external trigger, and software abort.

The PC card stops sampling whenever an error occurs irrespective of the stop condition setting.

- Last sampling count
The PC card stops sampling after the setup data for the specified number of times of sampling is output from the memory.
- External trigger
The PC card starts waiting for an external control signal after the specified number of samples have been performed. Sampling stops when the specified edge (rising edge or falling edge) is input from the external control signal.
- Software
Sampling continues indefinitely in this mode. Sampling only stops in response to a software command or an error.

Event

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

- “DA conversion start condition satisfied” event
This event occurs when the DA 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.
- “Specified number of output samples complete” event
This event occurs when the number of output samples specified by software have been completed. This event is used when the device buffer mode is used for data transfer.
- Specified number of transfers event
This event occurs each time a specified number of samples (set by software) has been completed. When FIFO format is used, the event occurs when the remaining number of samples falls below a specified level. The event occurs repeatedly as long as this condition is satisfied. When ring memory format is used, the event occurs when the number of samples output from memory reaches a specified value. The event occurs for the specified number of repetitions. This event is used when the user buffer mode is used for data transfer.
- Sampling clock error event
This event occurs when conversion stops as an error occurs due to a sampling clock period that is too short.
- DA conversion error event
This event occurs when conversion stops due to an DA conversion error.

2. Starting/Stopping Operation

Analog output operation is started by a software command (the analog output start command). Similarly, you can stop analog output at any time using a software command (the analog output stop command).

3. Monitoring the Status and Acquiring Data

You can use a software command to check the status of analog output operation and of the output data stored in memory.

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 the card 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 the card starts sampling until the start trigger is input, if the conversion start condition is an external trigger. The status is set to OFF when the input trigger is input to start conversion.
The status is set to ON whenever the card enters the conversion start wait status even when repeated operation has been set.
- Specified number of data outputs
This status turns ON when the output data set in memory has reached a predefined number of samples.
- Sampling clock error
This error occurs when the sampling clock period is too short.
- DA 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 output data transferred from in memory can be obtained by the software command.

This command can only be used in device buffer mode.

4. Reset

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

Status

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

Memory

This can only be used when the transfer mode is set to device buffer mode.

This command resets the following memory related states.

- Resets the conversion data in memory.
- Resets the repeat count to 0.
- Resets the sampling count to 0 when a stop trigger is input.
- Resets the status information for the specified data save count.

Counter Function

1. Setting the Operating Conditions

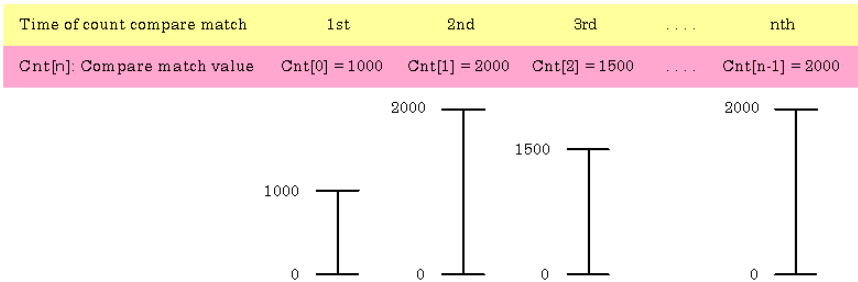
This specifies the conditions for counter operation.

Operating conditions

The basic operation of the counter is to count an external input signal.
The counter includes a function to detect a count match and perform a specified operation when the current count value reaches a preset count value.

Compare count values

The compare count load function automatically loads the next compare count value when a count match occurs.



The figure above shows an example of using the compare count load function.

After the counter starts, the first count match occurs when the count reaches 1000.

When the count reaches 1000, the counter value at which the second compare count match is to occur (2000) is set.

This continues with the next value from the array being set each time a count match occurs.

After the final value from the array is loaded, operation can start again from the beginning of the array.

Alternatively, loading can be halted (in which case, the compare count value remains at 2000).

Digital filter Input signal

The external clock can be used as the counter input signal.

Digital filter

A digital filter can be used on external input bits.

The filter time can be set to "don't use", 1μs by software.

Event

The event function notifies the application when something occurs on the device.

The following events can be used as required.

- Compare count match event
This event is triggered when a compare match occurs on the counter.
- Count overrun event
This event is triggered when a counter overrun occurs.
- Counter operation error
This event is triggered when a counter operation error causes the counter to stop.

2. Starting/Stopping Operation

Starting and stopping the counter are performed using software commands.

Once the counter has started, it can be stopped at any time by a software command.

3. Monitoring the Status and Acquiring Data

Software commands can be used to monitor the device operating status and read counter data. Status monitoring and data acquisition can both be performed while the counter is running.

Status

The current state of the device can be checked by obtaining the device status.

The following types of device status are available:

- Counter operating
The device operating status is ON from the time the operation start command is executed until operation stops due to a stop command or error.
- Compare count match
The compare count match status turns ON when a count match occurs after the counter is started. The status is turned OFF by the status reset command.
- Overrun
The overrun status turns ON if another count match occurs when the compare count match status is already ON. The status is turned OFF by the status reset command. Even if the overrun status turns ON, this does not stop the counter.
- Counter operation error
Execution of driver processing may not be able to keep up if multiple count match events occur within a short time period.
In this case, the counter operation error status turns ON and counter operation stops.

Data acquisition

The current count value can be read using a software command.

4. Reset

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

Counter reset

Resets the counter. This restores the counter to its state after power on.

Status

Resets the compare count match status and overrun status.

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.

Bit 3	Bit 2	Bit 1	Bit 0
-------	-------	-------	-------

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), bit 0 (ON)
Byte data = 05(5H)

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

Digital filter

A digital filter can be used on external input bits.
The filter time can be set to "don't use", 1μs by software.

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.

Bit 3	Bit 2	Bit 1	Bit 0
-------	-------	-------	-------

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), bit 0 (OFF)

Byte data = 10(AH)

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

About Software for Windows

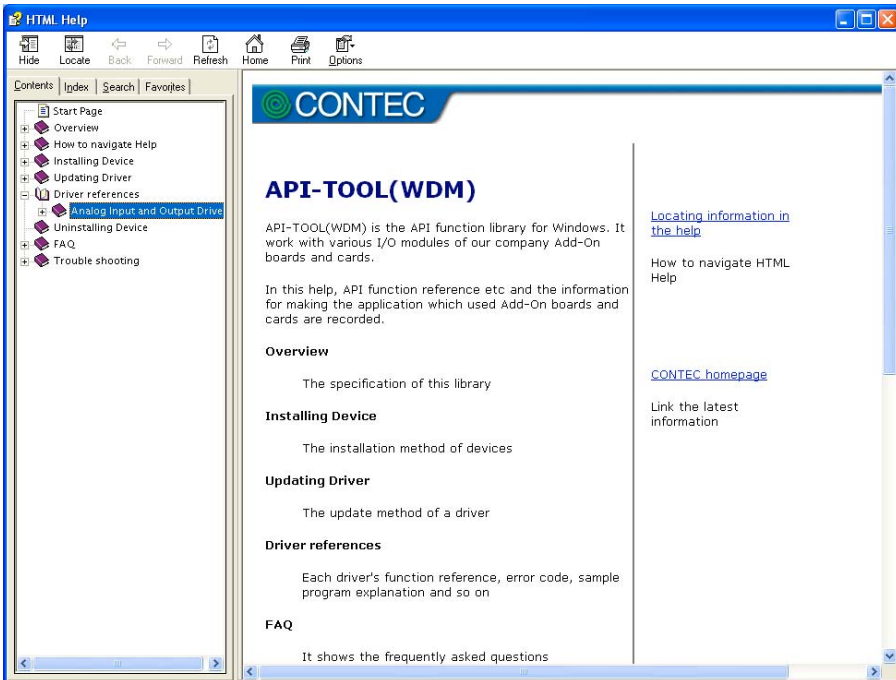
The bundled CD-ROM “Driver library API-PAC(W32)” contains the functions that provide the following features:

- 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 PC Card installed

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

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.

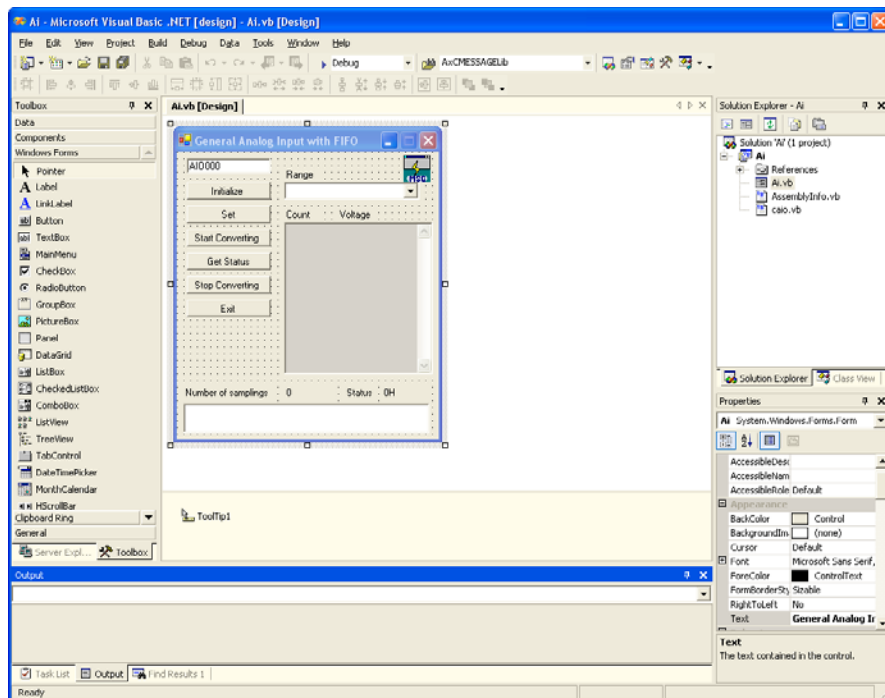


Using Sample Programs

Sample programs are provided for each of the basic operations. You can use these to check the operation of the card 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

Simple sample program

- SingleAi Perform single analog input from specified channel
- MultiAi Perform single analog input from multiple channels

Device buffer

- 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
- AiCall Perform analog input using a callback routine

Analog output

Simple sample program

- SingleAo Perform single analog output from specified channel
- MultiAo Perform single analog output from multiple channels

Device buffer

- 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
- AoCall Perform analog output using a callback routine

Digital input/output

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

Counter/Timer

- | | |
|------------|-------------------------|
| - Counter | General purpose counter |
| - Interval | Interval timer |
| - Watch | Stopwatch timer |

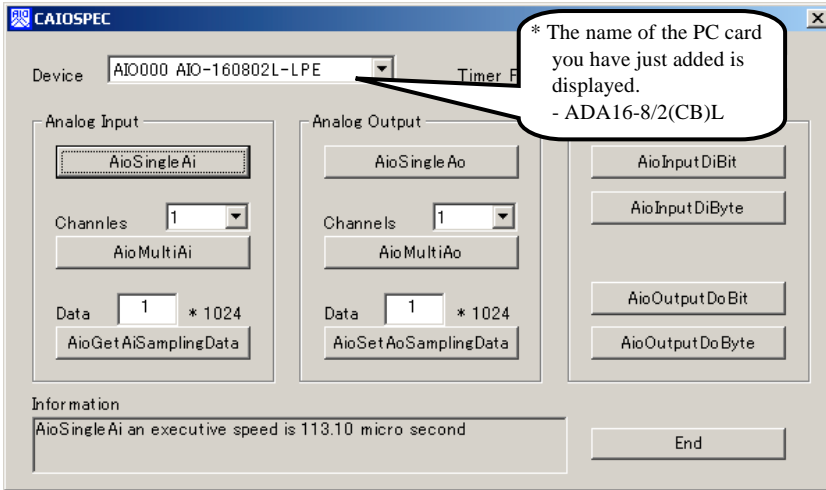
Others

- | | |
|-----------|-----------------|
| - Convert | Data conversion |
|-----------|-----------------|

Usage of Utility Program

Program for Measurement of Function Execution Speed

The execution time of some main functions can be measured in a function execution speed measurement program. To use a function execution speed measurement program, click the [execution time measurement] button in the diagnostic program.

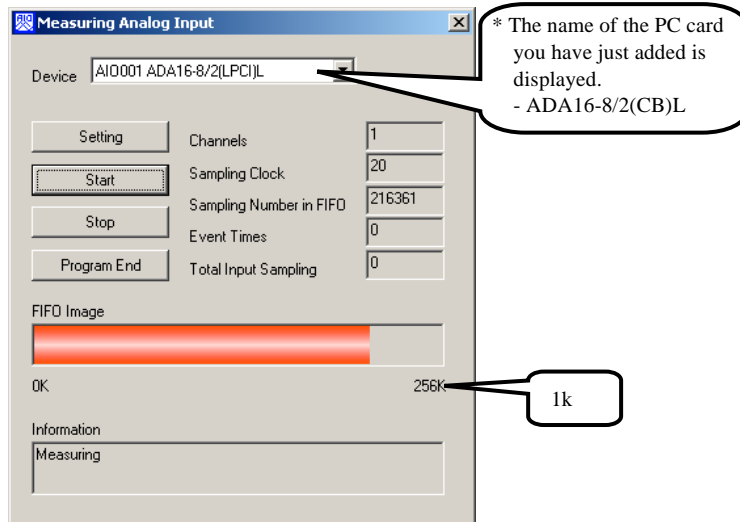


Procedure

- (1) Chose the measure device from device list.
- (2) Click the button written with the function name to measure the execution speed of the function.
Please choose from a list the number of channels used for conversion in function AioMultiAi and AioMultiAo. Input the transmission data size in function AioGetAiSamplingData and AioSetAoSamplingData. The transmission data is set by unit of kByte.
- (3) End the application with an [end] button.

Analog Input Measurement Tool

It is an analog input measurement utility to carry out infinity sample in the FIFO memory. Once the conversion data of memory accumulates to a certain quantity, the event occurs and data of the memory is acquired. Data in the FIFO memory can be confirmed visually.



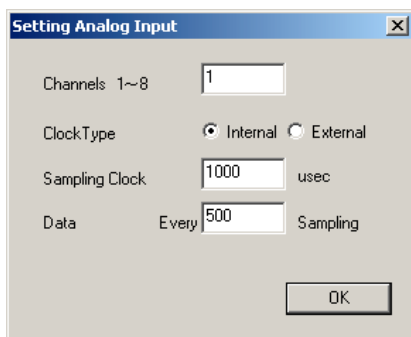
The number of channels used, the internal/external clock, the conversion speed, and the sampling frequency at which an event generates can be set. Since the notification of a sampling clock error event is sent, please make use of it for the conversion spec measurement under various conversion conditions.

Procedure

- (1) Chose the device name of the device to be used from the upper left combo box, and click the setting button.

- (2) The conversion conditions are set on the screen of the analog input setting.

Once an input is done at the sampling frequency specified as data taking-in sampling, an event occurs and data will be acquired. Click the OK button to finish setting the conditions, and returns to former screen.



- (3) Start the measurement with measurement start button. The various states during the conversion are displayed.

The number of the samplings in FIFO is :

It is conversion data taken in the memory. This can be visually checked in a "memory image".

Event generation sampling frequency :

When the number of input sampling in FIFO reaches this frequency, the event generates.

Total input sampling frequency :

It is the total number of samplings for application in the memory.

Measurement may stop by the following errors.

Sampling clock error :

It means that the conversion speed is too fast and the driver processing is not in time when converting at the internal clock.

The cycle of the clock is too fast when converting it at the external clock. Moreover, the cause by noise etc. is also concerned.

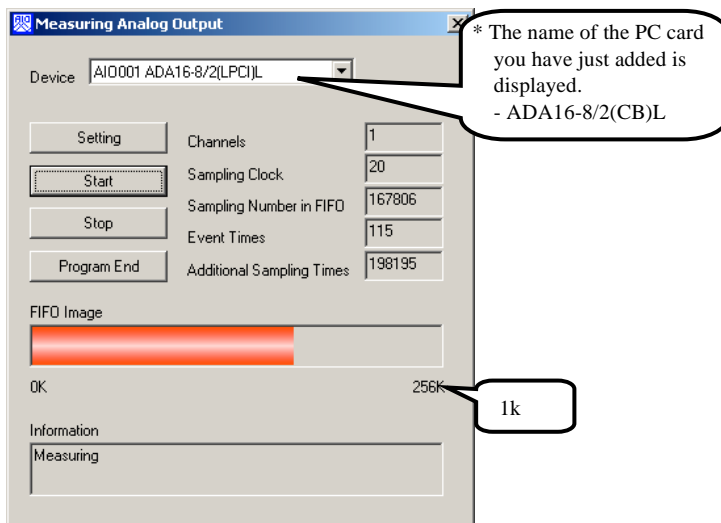
Buffer overflow :

The memory overflows since the conversion speed is too fast compared with the one at which data is inputted.

- (4) Click the "stop" button, and measurement stops.

Analog Output Measurement Tool

It is an analog output measurement utility to carry out infinity sample in the FIFO memory. Once the conversion data of memory accumulates to a certain quantity, the event occurs and new output data is added. Data in the FIFO memory can be confirmed visually.



The number of channels used, the internal/external clock, the conversion speed, the sampling frequency at which an event generates and number of the samplings to be added can be set. Since the notification of a sampling clock error event is sent, please make use of it for the conversion spec measurement under various conversion conditions.

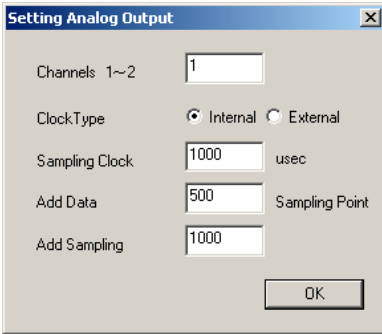
CAUTION

This program is made with Visual Basic. Therefore, it is not possible to execute it as it is in the environment in which Visual Basic is not installed. The program can be used by executing the following setup below the folder that installs the API-AIO(WDM).

AIOWDM\Utility\AoSpec\setup.exe

Procedure

- (1) Chose the device name of the device to be used from the upper left combo box, and click the setting button.
- (2) The conversion conditions are set on the screen of the setting analog output.



Once an output is done at the sampling frequency specified as data setting sampling frequency, an event occurs and data will be added. Click the OK button to finish setting the conditions, and returns to former screen.

- (3) Start the measurement with measurement start button. The various states during the conversion are displayed.

The number of the samplings in FIFO is :

It is conversion data set in the memory. This can be visually checked in a "memory image".

Event generation sampling frequency :

When the number of unoutput sampling in FIFO reaches this frequency, the event generates.

Adding sampling frequency :

It is the number of samplings of output data to be added during the event.

Measurement may stop by the following errors.

Sampling clock error :

It means that the conversion speed is too fast and the driver processing is not in time when converting at the internal clock.

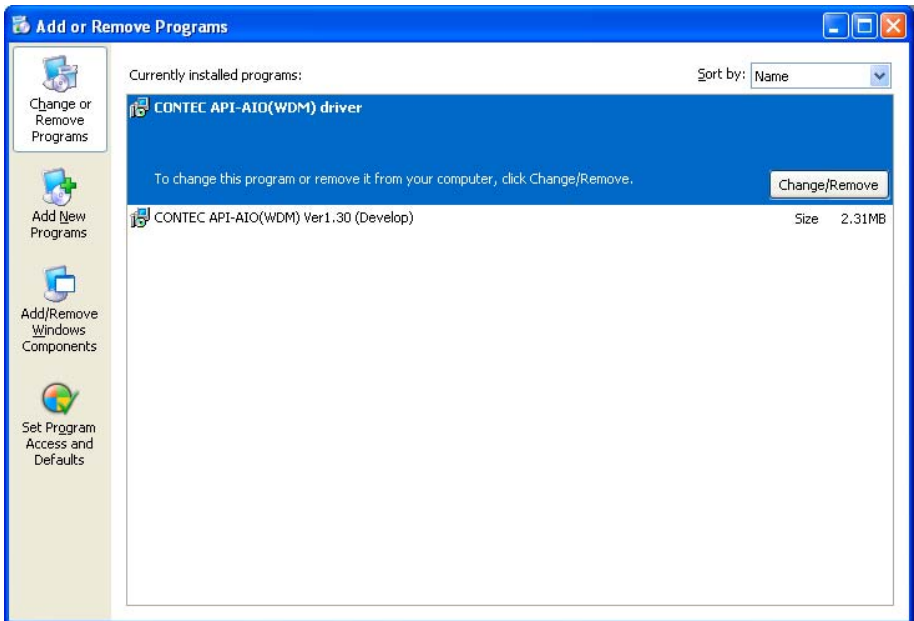
The cycle of the clock is too fast when converting it at the external clock. Moreover, the cause by noise etc. is also concerned.

- (4) Click the "stop" button, and measurement stops.

Uninstalling the Driver Libraries

To uninstall API-PAC(W32), follow the procedure below.

- (1) Click on the [Start] button on the Windows taskbar. From the Start Menu, select “Settings” – “Control Panel”.
- (2) Double-click on “Add or Remove Programs” in the Control Panel.
- (3) Select "CONTEC API-AIO(WDM) driver" and "CONTEC API-AIO(WDM) VerX.XX (Development environment)" from the list of applications.
Click the [Change/Remove] button. Proceed with uninstalling by following the instructions that appear on the screen.



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 analog 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 (1/2)

Item	Specification
Analog input	
Isolated specification	Un-Isolated
Input type	Single-Ended Input
Number of input channels	8ch (Single-Ended Input)
Input range	Bipolar $\pm 10V$
Absolute max. input voltage	$\pm 20V$
Input impedance	$1M\Omega$ or more
Resolution	16bit
Non-Linearity error *1*2	$\pm 5LSB$
Conversion speed	$10\mu sec/ch$
Buffer memory	1k Word
Conversion start trigger	Software / external trigger
Conversion stop trigger	Number of sampling times / external trigger/software
External start signal	LVTTL (Rising or falling edge can be selected by software)
External stop signal	LVTTL (Rising or falling edge can be selected by software)
External clock input signal	LVTTL (Rising or falling edge can be selected by software)
External status output signal	2 LVTTL Sampling clock output
Analog output	
Isolated specification	Un-Isolated
Number of output channels	2ch
Output range	Bipolar $\pm 10V$
Absolute max. output current	$\pm 5mA$
Output impedance	1Ω or less
Resolution	16bit
Non-Linearity error *1	$\pm 3LSB$
Conversion speed	$10\mu sec$ (Max.)
Buffer memory	1k Word
Conversion start trigger	Software / external trigger
Conversion stop trigger	Number of sampling times / external trigger/software
External start signal	LVTTL (Rising or falling edge can be selected by software)
External stop signal	LVTTL (Rising or falling edge can be selected by software)
External clock input signal	LVTTL (Rising or falling edge can be selected by software)
External status output signal	2 LVTTL Sampling clock output

Table 6.1. Specification (2/2)

Item	Specification
Digital I/O	
Number of input channels	Un-Isolated input 4ch (LVTTTL positive logic)
Number of output channels	Un-Isolated output 4ch (LVTTTL positive logic)
Counter	
Number of channels	1ch
Counting system	Up count
Max. count	FFFFFFFFh (Binary data, 32bit)
Number of external inputs	2 LVTTTL (Gate/Up) Gate (High level), Up (Rising edge)
Number of external outputs	1 LVTTTL Count match output (positive logic, pulse output)
Response speed *3	10MHz (Max.)
Common section	
I/O address	64 ports
Interruption level	1 interruption level
Power consumption	3.3VDC 500mA (Max.)
Operating condition	0 - 50°C, 10 - 90%RH (No condensation)
Supported PC Card slot	PC Card Standard Compliant CardBus
Dimension (mm)	85.6 (W) x 54.0 (D) x 5.0 (H) TYPE II
Weight	70g

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

The error can be reduced by calibrating under the actual temperature conditions.

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

*3: Assuming that no digital filter is used.

Block Diagram

Figure 6.1 is a circuit block diagram of this PC Card.

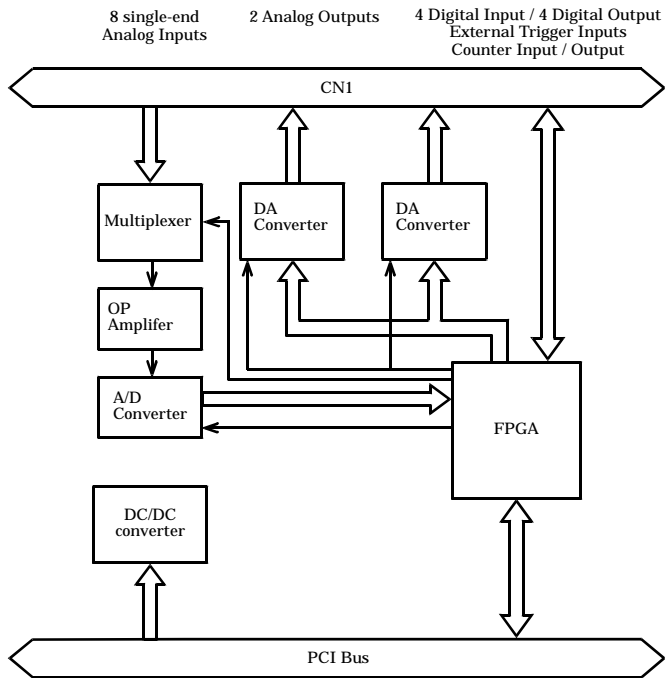


Figure 6.1. Block Diagram

Control Signal Timings

Control Signal Timings for Analog Input

Figures 6.2, 6.3, 6.4, and Table 6.2 show the control signal timings for the analog input function.

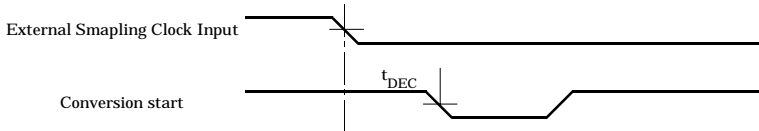


Figure 6.2. Timing Chart of External Sampling Clock

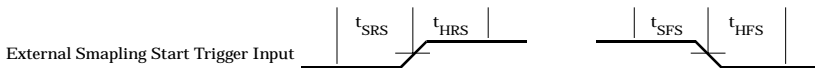


Figure 6.3. Timing Chart of Sampling Start Control Signal

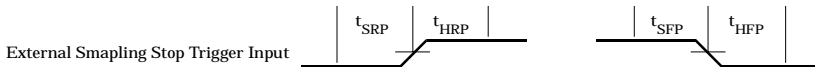


Figure 6.4. Timing Chart of Sampling Stop Control Signal

Table 6.2. Control Signal Timings

Parameter	Symbol	Time	Unit
Delay from external sampling clock cycle to first channel A/D conversion start pulse	t_{DEC}	100	nsec
Set up time of sampling start (Rising edge)	t_{SRS}	100	nsec
Hold time of sampling start (Rising edge)	t_{HRS}	100	nsec
Set up time of sampling start (Falling edge)	t_{SFS}	100	nsec
Hold time of sampling start (Falling edge)	t_{HFS}	100	nsec
Set up time of sampling stop (Rising edge)	t_{SRP}	100	nsec
Hold time of sampling stop (Rising edge)	t_{HRP}	100	nsec
Set up time of sampling stop (Falling edge)	t_{SFP}	100	nsec
Hold time of sampling stop (Falling edge)	t_{HFP}	100	nsec



CAUTION

The times listed in Table 6.2 are for standard operating conditions.

Control Signal Timings for Analog Output

Figures 6.5, 6.6, 6.7, and Table 6.3 show the control signal timings for the analog output function.

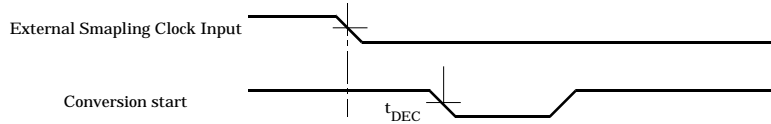


Figure 6.5. Timing Chart of External Sampling Clock (Analog output)

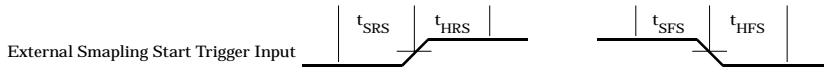


Figure 6.6. Timing Chart of Sampling Start Control Signal

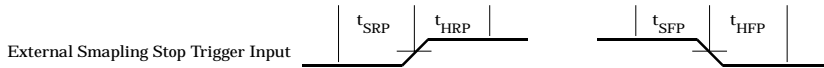


Figure 6.7. Timing Chart of Sampling Stop Control Signal

Table 6.3. Control Signal Timings

Parameter	Symbol	Time	Unit
Delay from external sampling clock to actual start	t_{DEC}	100	nsec
Settling time	t_{WS}	10000	nsec
Set up time of sampling start (Rising edge)	t_{SRS}	100	nsec
Hold time of sampling start (Rising edge)	t_{HRS}	100	nsec
Set up time of sampling start (Falling edge)	t_{SFS}	100	nsec
Hold time of sampling start (Falling edge)	t_{HFS}	100	nsec
Set up time of sampling stop (Rising edge)	t_{SRP}	100	nsec
Hold time of sampling stop (Rising edge)	t_{HRP}	100	nsec
Set up time of sampling stop (Falling edge)	t_{SFP}	100	nsec
Hold time of sampling stop (Falling edge)	t_{HFP}	100	nsec



CAUTION

The times listed in Table 6.3 are for standard operating conditions.

Control Signal Timings for Counter

Figures 6.8, 6.9, and Table 6.4 show the control signal timings for the analog input function.

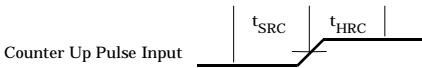


Figure 6.8. Timing Chart of Counter Input Signal

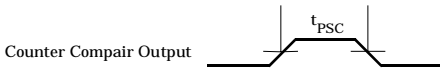



Figure 6.9. Timing Chart of Counter Output Signal (Pulse output)

Table 6.4. Control Signal Timings

Parameter	Symbol	Time	Unit
Set up time of counter input signal (Rising edge)	t_{SRC}	100	nsec
Hold time of counter input signal (Rising edge)	t_{HRC}	100	nsec
Pulse width of counter output signal	t_{PSC}	1000	nsec

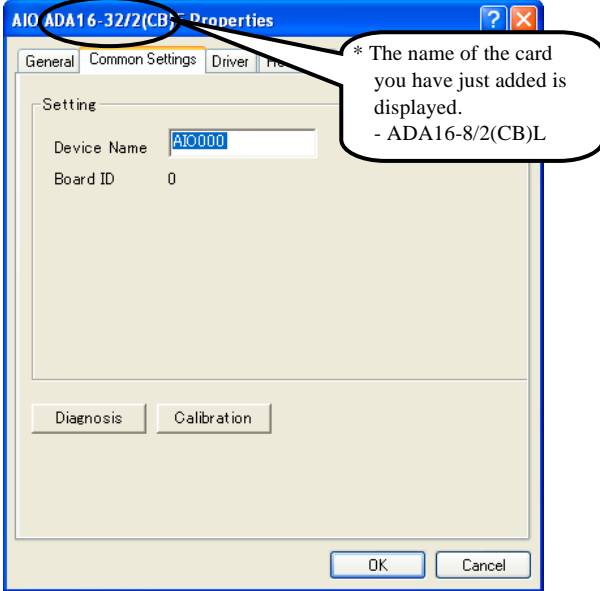
 **CAUTION** —————
The times listed in Table 6.4 are for standard operating conditions.

About Calibration

Although this PC Card is calibrated before shipping, you can use the calibration program to calibrate analog input and output yourself.

Starting the calibration program

Click the [Calibration] button on the property page for the device to start the calibration program.



Proceed with connecting the calibration equipment and performing the calibration in accordance with the instructions displayed by the calibration program.

Analog input calibration

Analog input calibration requires a reference voltage generator.

As the analog input has 16-bit resolution, use a reference voltage generator with a precision of at least 5 digits after the decimal point.

Calibrate one channel only for each range that you use.

Analog output calibration

Analog output calibration requires a digital multimeter.

As the analog output has 16-bit resolution, use a multimeter with a precision of at least 5 digits after the decimal point.

Calibrate each channel separately for each range that you use.

Factory setting

You can use the calibration program to restore the factory calibration settings.

ADA16-8/2(CB)L

User's Guide

CONTEC CO., LTD.

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