PC-HELPER

High-Resolution
Analog Output Unit for USB

AO-1604LX-USB
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
- Unit [AO-1604LX-USB] …1
- AC adaptor …1
- AC Cable (for 125VAC)…1
- USB cable (1.8m) …1
- USB cable attachment on the main unit’s side (For Mini B connector side) …1
- Clamps for prevention of cable on the main unit’s side …1
- CD-ROM *1 [API-USBP(WDM)] …1
- First step guide … 1
- Power connector MC1,5/3-ST-3,5 …1
- Ferrite core …1

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

Copyright 2010 CONTEC CO., LTD. ALL RIGHTS RESERVED.

No part of this document may be copied or reproduced in any form by any means without prior written consent of CONTEC CO., LTD.

CONTEC CO., LTD. makes no commitment to update or keep current the information contained in this document. The information in this document is subject to change without notice.

All relevant issues have been considered in the preparation of this document. Should you notice an omission or any questionable item in this document, please feel free to notify CONTEC CO., LTD.

Regardless of the foregoing statement, CONTEC assumes no responsibility for any errors that may appear in this document or for results obtained by the user as a result of using this product.

Trademarks

MS, Microsoft, Windows and Windows NT are trademarks of Microsoft Corporation. Other brand and product names are trademarks of their respective holder.
## Table of Contents

Check Your Package ................................................................................................................................. i
Copyright ................................................................................................................................................ ii
Trademarks ........................................................................................................................................... ii
Table of Contents ................................................................................................................................. iii

### 1. BEFORE USING THE PRODUCT

- About the Unit ........................................................................................................................................ 1
- Features ................................................................................................................................................ 1
- Support Software ................................................................................................................................. 3
- Cable & Connector (Option) ............................................................................................................. 4
- Accessories (Option) ........................................................................................................................ 4
- Customer Support ............................................................................................................................. 5
- Web Site ............................................................................................................................................... 5
- Limited One-Year Warranty ................................................................................................................ 5
- How to Obtain Service ....................................................................................................................... 5
- Liability ................................................................................................................................................ 5
- Safety Precautions ............................................................................................................................. 6
  - Safety Information ........................................................................................................................... 6
  - Handling Precautions ...................................................................................................................... 6
  - Environment ..................................................................................................................................... 8
  - Inspection ......................................................................................................................................... 8
  - Storage ............................................................................................................................................. 8
  - Disposal ........................................................................................................................................... 8

### 2. SETUP

- What is Setup? ....................................................................................................................................... 9
- Step 1 Setting the Hardware ............................................................................................................... 10
  - Name of each parts .......................................................................................................................... 10
- Step 2 Installing the Software ........................................................................................................... 11
  - Illustration of Menu Screen .......................................................................................................... 11
  - Installation of API-USBP(WDM) Development Environment ....................................................... 12
- Step 3 Installing the Hardware .......................................................................................................... 13
  - Connection with 5VDC Power Supply for Self-power ................................................................ 13
  - Connecting the Product .................................................................................................................. 14
  - Setting with the Found New Hardware Wizard .......................................................................... 16
  - Setting Properties Using Device Manager .................................................................................... 17
- Step 4 Checking Operations with the Diagnosis Program ................................................................. 19
  - What is the Diagnosis Program? ................................................................................................... 19
  - Check Method ................................................................................................................................. 19
Using the Diagnosis Program ................................................................. 20
Setup Troubleshooting .............................................................................. 23
Symptoms and Actions.............................................................................. 23
If your problem cannot be resolved ....................................................... 23

3. EXTERNAL CONNECTION .................................................................. 25

How to connect the connectors ................................................................. 25
Connector shape ......................................................................................... 25
Connector Pin Assignment .......................................................................... 26
Analog Output Signal Connection ............................................................. 27
Digital I/O signals, Counter signals and Control signals Connection ......... 28

4. APPLICATION DEVELOPMENT ......................................................... 29

Reference to Online Help ........................................................................... 29
Printing Function Reference ....................................................................... 29
Sample Program ........................................................................................ 30
Distributing Developed Application ......................................................... 30
Use of utility program ................................................................................ 31
Returning to Initial State ............................................................................ 34

5. FUNCTIONS ......................................................................................... 35

Analog Output Function ........................................................................... 35
1. Setting the Conversion Conditions ..................................................... 36
2. Starting/Stopping Operation ................................................................. 43
3. Monitoring the Status and Acquiring Data ........................................ 44
4. Reset ..................................................................................................... 45

Counter Function ....................................................................................... 46
1. Setting the Operating Conditions ....................................................... 46
2. Starting/Stopping Operation ................................................................. 47
3. Monitoring the Status and Acquiring Data ........................................ 47
4. Reset ..................................................................................................... 48

Digital Input Function ............................................................................... 49

Digital Output Function ............................................................................ 50

6. ABOUT HARDWARE ........................................................................... 51

Hardware specification ............................................................................. 51
Physical dimensions .................................................................................. 53
Block Diagram .......................................................................................... 54
Control Signal Timings ............................................................................. 55
Control Signal Timings for Analog Output ............................................... 55
1. Before Using the Product

This chapter provides information you should know before using the product.

About the Unit

This product is a USB2.0-compliant analog output unit that extends the analog output function of USB port of PCs. This product features high-precision analog outputs, digital inputs, digital outputs, and a counter function.

As there is compatible with PCI bus-compatible board DA16-4(LPCI)L and PCI Express bus-compatible board AO-1604L-LPE in terms of connector shape and pin assignments, it is easy to migrate from the existing system.

Using the bundled API function library package [API-USBP(WDM)], you can create Windows application software for this board in your favorite programming language supporting Win32 API functions, such as Visual Basic or Visual C/C++.

With plug-ins for the dedicated libraries, this product also supports MATLAB and LabVIEW.

Features

- Multi-function

The unit contains analog outputs (16bit, 4channels), control signal(3 points) of analog output, digital inputs (LVTTL level 4channels), digital outputs (LVTTL level 4channels), and counters (32bit binary, LVTTL level 1channels). Combining all these features on one unit allows complex systems to be implemented even on PCs with USB port only.

Buffer memory

The analog outputs have their own buffer memory. You can also perform analog output in the background, independent of software and the current status of the PC.

- Filter function for easy connection of external signals

The digital input signals, counter input signals, and the external control signals for analog output incorporate a digital filter to prevent wrong recognition of input signals from carrying noise or a chattering.

- Compatible with PCI / PCI Express bus board in it’s design.

Common connector shape and pin assignment with PCI / PCI Express bus board

This product has the common connector shape and pin assignment with PCI bus board DA16-4(LPCI)L, PCI Express bus board AO-1604L-LPE so you can use the common cables and accessories, it is easy to migrate from the existing system *1.

- Compatible to USB1.1/USB2.0

Compatible to USB1.1/USB2.0 and capable to achieve high speed transfer at HighSpeed (480 Mbps).
1. Before Using the Product

- USB HUB function, the CONTEC’s USB supported products (Max. 4) can be used.

This product has the USB HUB function. *2 Max. 4 AO-1604LX-USB can be used in 1 USB port of PC. When you use 4 or more AO-1604LX-USB, you can do by connecting AO-1604LX-USB to the another USB port of PC side.

Also, you can connect the CONTEC’s USB supported products other than AO-1604LX-USB to the USB port of AO-1604LX-USB. *3*4

- Software-based calibration function

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

- Windows compatible driver libraries are attached.

Driver library API-USBP(WDM) that makes it possible to create applications of Windows is attached.

- Plug-ins for the dedicated libraries, this product 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 by National Instruments.

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

*1 There are some differences of the specifications between this product and AO-1604L-LPE, DA16-4L(LPCI)L. For more details on this, refer to “Chapter7, Difference from AO-1604L-LPE, DA16-4(LPCI)L”

*2 This product cannot be stacked up for installation.

*3 Do not connect the device other than that of CONTEC’s USB to the USB port included on the AO-1604LX-USB. Otherwise, this may cause a failure or malfunction.

*4 When connecting multiple units with USB HUB function and set up them, do one at a time and complete setup for the previous unit before starting to do the next unit.
Support Software

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

Windows version of analog I/O driver **API-AIO(WDM)**
[Stored on the bundled CD-ROM driver library API-USBP(WDM)]
The API-AIO(WDM) is the Windows version driver library software that provides products in the form of Win32 API functions (DLL). Various sample programs such as Visual Basic and Visual C++, etc and diagnostic program useful for checking operation is provided.

< Operating environment >
Adaptation language Visual Basic, Visual C++, Visual C#, Delphi, C++ Builder
For more details on the supported OS, applicable language and how to download the updated version, please visit the CONTEC’s Web site (http://www.contec.com/apiusb/).

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.
Cable & Connector  (Option)

Shield Cable with 50-Pin Mini-Ribbon Connectors at either Ends  : PCB50PS-0.5P (0.5m)
: PCB50PS-1.5P (1.5m)

Shield Cable with 50-Pin Mini-Ribbon Connector at one End  : PCA50PS-0.5P (0.5m)
: PCA50PS-1.5P (1.5m)

Accessories  (Option)

Screw Terminal Unit (M3 x 50P)  : EPD-50A *1*2
BNC Terminal Unit (for analog input 8ch)  : ATP-8L *1*3
USB I/O Unit Bracket for X Series  : BRK-USB-X
AC adaptor (input : 90 - 264VAC, output : 5VDC 2.0A)  : POA200-20-2 *4
AC-DC power supply unit (input: 85 - 132VAC, output: 5VDC 3.0A)  : POW-AC13GY
AC-DC power supply unit (input: 85 - 264VAC, output: 5VDC 2.0A)  : POW-AD22GY
DC-DC power supply unit (input: 10 - 30VDC, output: 5VDC 3.0A)  : POW-DD10GY
DC-DC power supply unit (input: 30 - 50VDC, output: 5VDC 3.0A)  : POW-DD43GY

*1 PCB50PS-0.5P or PCB50PS-1.5P optional cable is required separately.
*2 “Spring-up” type terminal is used to prevent terminal screws from falling off.
*3 Capable of using the analog output of up to 2ch.
*4 It is the same as the one appended to the product. Please buy it necessary for maintenance.

* 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 One-Year Warranty

CONTEC products are warranted by CONTEC CO., LTD. to be free from defects in material and workmanship for up to one year 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.
1. Before Using the Product

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.

<table>
<thead>
<tr>
<th>Danger Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DANGER</td>
<td>DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.</td>
</tr>
<tr>
<td>WARNING</td>
<td>WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.</td>
</tr>
<tr>
<td>CAUTION</td>
<td>CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or in property damage.</td>
</tr>
</tbody>
</table>

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

- Do not strike or bend this product. Otherwise, this may malfunction, overheat, cause a failure or breakage.
- Do not touch this product's terminals (edge connector) with your hands. Otherwise, this may malfunction, overheat, or cause a failure.
- If the terminals are touched by someone's hands, clean the terminals with industrial alcohol.
- Do not close the ventilation hole(s) of this product by, for example, placing an object. This may cause overheating, malfunction, and/or failure of the product.
- Make sure that your PC can supply ample power to all this product installed. Insufficiently energized products could malfunction, overheat, or cause a failure.
- Do not connect the device other than that of CONTEC’s USB to the USB port included on the AO-1604LX-USB. Otherwise, this may cause a failure or malfunction.
- When connecting multiple units and set up them, do one at a time and complete setup for the previous unit before starting to do the next unit.
- The specifications of this product are subject to change without notice for enhancement and quality improvement. Even when using this product continuously, be sure to read the manual and understand the contents.
- Do not modify this 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.
1. Before Using the Product

- If you use this product in a environment of noisy AC line, attach the ferrite core near the +5VDC input terminal to stabilize the operation.

- If you use this product in a noisy environment, attach the bundled ferrite core to stabilize the operation.

When attaching a ferrite core to the USB cable, coil it around once near the connector while leaving it open, and then close it.

FCC PART 15 Class A Notice

NOTE
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WARNING TO USER
Change or modifications not expressly approved the manufacturer can void the user's authority to operate this equipment.
1. Before Using the Product

Environment

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

Operating temperature
0 - 50°C

Operating humidity
10 - 90%RH (No condensation)

Corrosive gases
None

Floating dust particles
Not to be excessive

Inspection

Inspect the product periodically as follows to use it safely.

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

Storage

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

(1) Put this product in the storage bag.
(2) Wrap it in the packing material and 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 product.

What is Setup?

Setup means a series of steps to take before the product can be used. This section enables you to prepare the software and hardware by operating in accordance with each step in this chapter using the bundled CD-ROM. 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 Setting the Hardware**
- **Step 2 Installing the Software**
- **Step 3 Installing the Hardware**
- **Step 4 Checking Operations with the Diagnosis Program**

Uninstall the driver and then set it up again if it cannot be set up properly.

The following shows the basic flow for installing product.
2. Setup

Step 1 Setting the Hardware

This section describes how to set up the product and how to connect it to a PC.

When using the AO-1604LX-USB, you do not have to set with SW. Connect it to the USB interface connector of PC that you use.

Name of each parts

LED indicator

The above figure has already attached the USB cable attachment.

Figure 2.1. Name of each parts (Front side)
Step 2 Installing the Software

Install software.
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.

Points
- If you are using Windows XP or Windows 2000, please log on as Administrator (authorized account) before proceeding to the following steps.

Illustration of Menu Screen

- Please set up the supplied CD-ROM if it has not been set up. The menu starts automatically.
- If the menu do not start, launch X:AUTORUN.EXE(X:CD-ROM drive) from [Run…] in Start menu.
- The screen design may be different.
Installation of API-USBP(WDM) Development Environment

Installation of development environment is namely installing supplied online help and sample program in all language in order to use API function.

1. Clicking on “Install Development or Execution Environment”.
   [API-USBP(WDM) Installer] dialog box displays.

2. Selecting “Advanced Digital I/O driver”.

3. Clicking on “Install” button.
   Please perform installation following the directions on the screen. And thus the installation is completed.
   * The screen design may be different.
Step 3 Installing the Hardware

Under Windows, information about the converter needs to be detected by the OS. This is called hardware installation.

To use more than one of USB product with HUB function, make sure to install them one by one, setting each unit after completing the previous one.

Connection with 5VDC Power Supply for Self-power

This product must be connected with 5VDC power supply (in a self-powered state).

Connect with 5VDC power supply by using +5VDC input pin.

![Figure 2.2. +5 VDC Input Terminal Pinouts](image)

When using the attached AC adaptor [POA200-20-2], please connect directly to the input terminals.

When the accompanying power connector (MC1,5/3-ST-3.5, suitable cable: AWG28 - 16) is used to supply power to this unit, strip the end of the suitable cable and insert it to the power connector before firmly securing it using a screw.

![Figure 2.3. Connecting the AC Adapter POA200-20-2](image)

Beside the AC adaptor, a power supply for installation on a DIN rail is also available (as an option).

Use the appropriate power supply depending on the operating environment and application. When a power supply for installation on a DIN rail is used, connect the unit using the accompanying power connector MC1,5/-ST-3.5.

⚠️ CAUTION

- Connect 5VDC power supply to the main unit. Next, connect the USB cable to the PC. Do not turn it on or off when using. If you remove, USB cable is first and then 5VDC power supply.
- When the USB module is not used, leave the AC adaptor unplugged.
- Continuously using the AC adaptor heated affects its life.
- Use the AC adaptor not in a closed place but in a well-ventilated place not to be heated.
- Do not remove the power connector [MC1,5/3-ST-3.5] attached to the AC adapter.
Connecting the Product

(1) Turn on the power to the PC before connecting this product.

(2) When the PC has been up and running, plug the USB interface connector to a USB port in the PC. The converter can also be connected to the PC via a USB hub of this product.

![Figure 2.4. Connecting the PC](image)

(3) USB cable can be attached firmly to the main unit by using a USB cable attachment.

![Figure 2.5. Attaching a USB Attachment](image)

⚠️ CAUTION

The USB cable attachment cannot be used excluding an attached cable.
- When the USB cable attachment is being used, do not perform removing and connecting the USB cable on the unit side repeatedly. This may damage the USB cable attachment or yourself.
(4) When connecting the USB cable through the USB hub of this product, it can be made easily not to come off by using clamps for prevention of cable on the main unit's side (Appended goods).

Figure 2.6. Usage of clamps for prevention of cable on the main unit's side
Setting with the Found New Hardware Wizard

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

*In Windows Vista, Because the driver's installation is completed by "Installing the Software", it is not necessary to operate it about the Hardware Wizard.

(2) Select “Install from a list or specific location”, then click on the [Next] button.
Detect setup information from supplied CD automatically for installing USB driver.

Point
Please specify the path for supplied CD as follows in the case of failure in detecting automatically.
X:\INF\WDM\AIO  (X: CD-ROM drive)

(3) Click on [Finish] button to complete the installation of USB driver.
Setting Properties Using Device Manager

After connecting product with a PC and completing driver installation, open Device Manager and set properties.

(1) Starting Device Manager.
   From [Start] menu, click on [Settings]-[Control Panel]-[System] and then click on [Device Manager] button in [Hardware] tab.

- In the case of Windows 98
  Right-click on [My Computer] and select [Properties] to start device manager.
(2) Setting the Device Name.
Right-clicking on the product name and selecting [Properties] displays [Product Properties].
Open [Common Settings] tab and enter arbitrary name in the editing box for device name.
(Default name also can be used.)

![Device Properties Configuration]

* The product-specific number will be displayed as the serial number.

⚠️ CAUTION
USB driver can not be used without settings. Settings must be performed.

(3) Clicking on [OK] button.
Device name is set by clicking [OK] button.
Step 4 Checking Operations with the Diagnosis Program

Use the diagnosis program to check that the product 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 product 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 product, I/O status, and interrupt status.

Check Method

To check the analog output data, connect the analog output to a Tester. The figure below shows an example of checking by connecting to a Tester. The example is for channel 0 on the AO-1604LX-USB.

< Analog Output >

![Diagram of Analog Output Connection](image-url)
Using the Diagnosis Program

Starting the Diagnosis Program
Click [Diagnosis] on the Properties page to start the diagnosis program.

* The name of the connected product will be displayed. AO-1604LX-USB
2. Setup

Analog input
Although this product of analog input function is not supported.

Analog output
You can select the desired output channel from the lists.
You can select the DC (constant voltage), sine wave, or square wave as the output data.

Digital I/O
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.

(2) The diagnosis report contains the following data.
- Version of OS
- Device Information
- File Information
- Initialization, interrupts, I/O state for each channel

Execution time measurement

Clicking [Execution Time Measurement] runs the program to measure API function execution speed. The operation of this program is explained in "API function Execution Speed Measurement Program" in Chapter 4.
Setup Troubleshooting

Symptoms and Actions

Data 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.

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 product. Check the information available here when connecting an external device.

How to connect the connectors

Connector shape

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

- Connector used
  50-pin mini-ribbon connector
  10250-52A2JL[mfd.by 3M] or equivalence to it

- Compatible connectors
  10150-6000EL[mfd. by 3M] or equivalence to it

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

Figure 3.1. Interface Connectors and Mating Connectors
## Connector Pin Assignment

### Pin Assignments of AO-1604LX-USB Interface Connector(CN1)

<table>
<thead>
<tr>
<th>Pin Assignment</th>
<th>Pin Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Output 02</td>
<td>AO 02</td>
<td>Analog output signal. The numbers correspond to channel numbers.</td>
</tr>
<tr>
<td>Analog Ground (for AO)</td>
<td>AGND</td>
<td>Common analog ground for analog output signals.</td>
</tr>
<tr>
<td>Analog Output 03</td>
<td>AO 03</td>
<td>Analog output signal. The numbers correspond to channel numbers.</td>
</tr>
<tr>
<td>Analog Ground (for AO)</td>
<td>AGND</td>
<td>Common analog ground for analog output signals.</td>
</tr>
<tr>
<td>Digital Output 00</td>
<td>DO 00</td>
<td>Digital input signal.</td>
</tr>
<tr>
<td>Digital Output 01</td>
<td>DO 01</td>
<td>Digital input signal.</td>
</tr>
<tr>
<td>Digital Output 02</td>
<td>DO 02</td>
<td>Digital output signal.</td>
</tr>
<tr>
<td>Digital Output 03</td>
<td>DO 03</td>
<td>Digital output signal.</td>
</tr>
<tr>
<td>Digital Ground</td>
<td>DGND</td>
<td>Digital ground for digital I/O signals, external trigger inputs, external sampling clock inputs, and counter I/O signals.</td>
</tr>
<tr>
<td>Counter UP Clock Input</td>
<td>CNT UPCLK</td>
<td>Count-up clock input signal for counter.</td>
</tr>
<tr>
<td>Reserved</td>
<td>Reserved</td>
<td>Reserved pin.</td>
</tr>
<tr>
<td>N.C.</td>
<td>N.C.</td>
<td>No connection to this pin.</td>
</tr>
</tbody>
</table>

![Figure 3.2. Pin Assignments of Interface Connector(CN1) <AO-1604LX-USB>](image)

### CAUTION

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

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

- Leave "Reserved" pins unconnected. Connecting these pins may cause a fault in the board.
### Analog Output Signal Connection

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

The following figure shows an example of flat cable connection.

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

![Flat Cable Connection Diagram](image)

**Figure 3.3. Analog Output Connection (Flat Cable)**

The following figure shows an example of shield cable connection. Use shield cable if the distance between the signal source and this product 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.

![Shielded Cable Connection Diagram](image)

**Figure 3.4. Analog Output Connection (Shielded Cable)**

⚠️ **CAUTION**

- If this product or the connected wire receives noise, or the distance between this product and the target is long, data may not be outputted properly.
- For analog output signal, the current capacity is ±3mA (Max.). Check the specification of the connected device before connecting this product.
- Do not short the analog output signal to analog ground, digital ground, and/or power line. Doing so may damage this product.
- Do not connect an analog output signal to any other analog output, either on this product or on an external device, as this may cause a fault on this product.
- Analog output signal outputs hundreds of μ voltsages when USB cable is inserted.
Digital I/O signals, Counter signals and Control signals Connection

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

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

Figure 3.5. Digital Input Connection

Figure 3.6. 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 this product and remains "High". Therefore the external clock for the counter is effective when the counter gate control input is not connected.

⚠️ CAUTION

- Do not short the output signals to analog ground, digital ground, and/or power line. Doing so may damage the product.
- If connected to each output, a pull-up resistor must be about 10kΩ 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 “Control Signal Timings” in Chapter 6 “Hardware”.

© CONTEC

AO-1604LX-USB
4. Application Development

Please reference to online help and sample program when developing applications.

Reference to Online Help

Click on [Programs]-[CONTEC API-USBP(WDM)]-[API-USBP(WDM) Help] from [Start] menu. The information for application development, such as function reference is provided in [API-USBP(WDM) Help]. Detailed introduction to search method for help should be found from [How to navigate Help] in the help.

For basic usage, please reference to “Tutorial” for help.

Printing Function Reference

Clicking on Print button from online help prints the page being displayed. It can be printed entirely as follows in the case of referencing to printing function.

As figure shown on the right, selecting 📖 mark and clicking on Print button prints all the topics under the mark selected at a time.
Sample Program

Sample programs are copied in installation path. (The default path is Program Files\CONTEC~)

Sample programs in all language are provided here. To run a sample program, click on [Programs]- [CONTEC API-USBP(WDM)]-[AIO]-[Sample Name] from [Start] menu.

Distributing Developed Application

Please distribute the developed application with USB driver in supplied CD-ROM.

Created application (including driver) can be freely distributed.
Use of utility program

Program for Measuring the Executive Speed of Function

Program for measuring the executive speed of function is a program that can measure the executive time of some main functions.

To use the program for measuring the executive speed of function, please click the button "Measure tool..." from CONTEC DIAGNOSIS PROGRAM.

* The name of the connected product will be displayed. AO-1604LX-USB

Step to use

1. Select the device to be measured from the device list.
2. Measure the executive speed of a function by clicking the button with the function name.
   - Select the number of channels for conversion from the list for AioMultiAi and AioMultiAo.
   - Input the size of data to be transferred for AioGetAiSamplingData and AioSetAoSamplingData.
   - Set the transfer data in "kByte".
3. Terminate the application by clicking the button "Exit".
Measuring Analog Output tool

This is an analog output and measurement utility able to sample indefinitely using the FIFO memory. An event is triggered when the remaining conversion data in memory reaches a specified level and this causes the new output data to be loaded. The utility also shows a visual representation of the data in the FIFO memory.

The number of channels, whether to use an internal or external clock, conversion speed, number of times to sample before generating an event, and number of samples to load at each event can be specified. As an event is also generated if a sampling clock error occurs, you can use the utility to test the conversion operation under a range of different conditions.

Step to use

1. Use the combo box at the top left of the window to select the device name of the device to use, then click the [Set] button.

2. Specify the conversion conditions in the analog output setup window.
   An event is triggered and the next block of data is loaded after the number of samples specified in the settings have been output. Clicking the OK button saves the settings and returns to the previous window.
(3) The measuring is begun after clicked the button of [Start], the conversion's information is displayed.

The sampling number within FIFO:
This specifies the number of conversion data values remaining in memory (that have not yet been output). This is shown visually in the "Memory Image".

Sampling count for triggering event:
An event is triggered when the number of samples remaining in the FIFO reaches the specified value.

Number of samples to load:
The number of output data values (samples) to load at each event.

The Measuring will stop when this error as follows.

Sampling clock error:
When the application is measuring with internal clock, sampling clock is too fast to process.
When the application is measuring with External clock, clock cycle is too fast. Moreover, noise is being considered.

(4) The measuring is stopping after clicked the button of [Stop].
Returning to Initial State

This is the method of returning to initial state. It is suggested that you should return to initial state and perform installation again when the operation is losing stabilization.

1. Deleting Device form Device Manager.

   ![Device Manager](image)

   *The name of the connected product will be displayed. AO-1604LX-USB*

2. Drawing 5VDC power supply (the attached AC adaptor) from unit

3. Drawing USB cable from a PC

4. Uninstalling Driver
   
   Select [CONTEC API-AIO(WDM) driver] from [My Computer]-[Control Panel]-[Add/Remove Programs].

5. Restarting
5. 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).

* When data logger software (C-LOGGER) is used, a part of it's function can not be used.

Analog Output Function

This product 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
   - Resolution
   - Clock
   - Channel
   - Start Condition
   - Range
   - Stop Condition
   - Output data
   - Event
   - Data transfer method
   - Memory
   - Repeat
   - Setting data

2. Starting/Stopping Operation
   - Start
   - Stop

3. Monitoring the Status and Acquiring Data
   - Status
   - Sampling
   - Repeat

4. Reset
   - Status
   - Memory
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 12bit divides the range width into 4096 segments. When the device covers the range of 0 - 10V, the minimum unit of converted voltages is $10 \div 4096 \approx 2.44\text{mV}$.

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

Channel

"Channel" represents each point of analog output. For individual channel numbers, see "How to connect the 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 board uses a fixed range of voltages.

AO-1604LX-USB : The output range of the device is set by software.
Output data

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

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-V range.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Output data(16-bit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+9.99970V</td>
<td>65535</td>
</tr>
<tr>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>0.00030V</td>
<td>32769</td>
</tr>
<tr>
<td>0V</td>
<td>32768</td>
</tr>
<tr>
<td>-0.00030V</td>
<td>32767</td>
</tr>
<tr>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>-10.000V</td>
<td>0</td>
</tr>
</tbody>
</table>

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

\[
\text{Output data} = (3 - (-10)) \times 65536 / (10 - (-10))
\]

\[= 42598.4^*\]

* 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 "42599" converted to: 3.0001 V

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

Data transfer method
It is the device buffer mode, which uses memory for conversion data storage either on the device or in the driver.

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 retrieve conversion data directly as voltage values.
Memory format

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

- **FIFO (First In First Out) format**
  Use FIFO format if you wish to output a continuous arbitrary analog output like that shown below.

![FIFO Format Diagram](image1)

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.

![Ring Format Diagram](image2)
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 a analog output stop command by software.
Setting data

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.
5. Functions

Clock
The sampling clock controls the sampling frequency. You can select from among 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-product 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 stop of sampling can be selected from among the last sampling count, an external trigger, software.
The product stops sampling whenever an error occurs irrespective of the stop condition setting.

- Software
  The product starts sampling and storing input data to memory immediately after the operation start command is issued.

- External trigger
  The product 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, software.
The product stops sampling whenever an error occurs irrespective of the stop condition setting.

- Last sampling count
  The product stops sampling after storing input data to memory for the specified number of times of sampling.

- External trigger
  The product 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 product 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".
5. Functions

- "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.
- 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 a 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 product completes conversion, aborts operation due to an error, or stops sampling in response to the command.

- **Waiting for start trigger**
  This status remains ON, after the product 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 product 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.

<table>
<thead>
<tr>
<th>Time of count match</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>...</th>
<th>nth</th>
</tr>
</thead>
</table>

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).

Input signal

The external clock can be selected 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", 1 μs by software.

Event

The event function notifies the application when something occurs on the device.
The following events can be used as required.
5. Functions

- 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 - bit 3.

<table>
<thead>
<tr>
<th>Bit 3</th>
<th>Bit 2</th>
<th>Bit 1</th>
<th>Bit 0</th>
</tr>
</thead>
</table>

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)

<table>
<thead>
<tr>
<th>Bit 3</th>
<th>Bit 2</th>
<th>Bit 1</th>
<th>Bit 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0(OFF)</td>
<td>1(ON)</td>
<td>0(OFF)</td>
<td>1(ON)</td>
</tr>
</tbody>
</table>

Digital filter
A digital filter can be used on the 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 - bit 3.

<table>
<thead>
<tr>
<th>Bit 3</th>
<th>Bit 2</th>
<th>Bit 1</th>
<th>Bit 0</th>
</tr>
</thead>
</table>

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

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

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

### Hardware specification

#### Table 6.1. Specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analog output</strong></td>
<td></td>
</tr>
<tr>
<td>Isolated specification</td>
<td>Non-isolated</td>
</tr>
<tr>
<td>Number of output channels</td>
<td>4 channels</td>
</tr>
<tr>
<td>Output range</td>
<td>Bipolar ±10V</td>
</tr>
<tr>
<td>Absolute max. output current</td>
<td>±3mA</td>
</tr>
<tr>
<td>Output impedance</td>
<td>1Ω or less</td>
</tr>
<tr>
<td>Resolution</td>
<td>16bit</td>
</tr>
<tr>
<td>Non-Linearity error *1</td>
<td>±5LSB</td>
</tr>
<tr>
<td>Conversion speed</td>
<td>10μsec</td>
</tr>
<tr>
<td>Buffer memory</td>
<td>1k Word</td>
</tr>
<tr>
<td>Conversion start trigger</td>
<td>Software / external trigger</td>
</tr>
<tr>
<td>Conversion stop trigger</td>
<td>Number of sampling times / external trigger/software</td>
</tr>
<tr>
<td>External start signal</td>
<td>LVTTTL level (Rising or falling edge can be selected by software) Digital filter (1μsec can be selected by software)</td>
</tr>
<tr>
<td>External stop signal</td>
<td>LVTTTL level (Rising or falling edge can be selected by software) Digital filter (1μsec can be selected by software)</td>
</tr>
<tr>
<td>External clock signal</td>
<td>LVTTTL level (Rising or falling edge can be selected by software) Digital filter (1μsec can be selected by software)</td>
</tr>
<tr>
<td><strong>Digital I/O</strong></td>
<td></td>
</tr>
<tr>
<td>Number of input channels</td>
<td>Non-isolated input 8 channels (LVTTTL level positive logic)</td>
</tr>
<tr>
<td>Number of output channels</td>
<td>Non-isolated output 8 channels (LVTTTL level positive logic)</td>
</tr>
<tr>
<td><strong>Counter</strong></td>
<td></td>
</tr>
<tr>
<td>Number of channels</td>
<td>1channel</td>
</tr>
<tr>
<td>Counting system</td>
<td>Up count</td>
</tr>
<tr>
<td>Max. count</td>
<td>FFFFFFFFFFh (Binary data, 32bit)</td>
</tr>
<tr>
<td>Number of external inputs</td>
<td>LVTTTL level : 2 (Gate/Up)/ch, Gate (High level), Up (Rising edge)</td>
</tr>
<tr>
<td>Number of external outputs</td>
<td>LVTTTL level : 1/ch, Count match output (positive logic, pulse output)</td>
</tr>
<tr>
<td>Frequency response</td>
<td>10MHz (Max.)</td>
</tr>
<tr>
<td><strong>USB</strong></td>
<td></td>
</tr>
<tr>
<td>Bus specification</td>
<td>USB Specification 2.0/1.1 standard</td>
</tr>
<tr>
<td>USB transfer rate</td>
<td>12Mbps (Full-speed), 480Mbps (High-speed) *2</td>
</tr>
<tr>
<td>Power supply</td>
<td>Self power *3</td>
</tr>
<tr>
<td><strong>Common section</strong></td>
<td></td>
</tr>
<tr>
<td>Number of terminals used at the same time</td>
<td>127 terminals (Max.) *4</td>
</tr>
<tr>
<td>Power consumption (Max.)</td>
<td>5VDC 700mA</td>
</tr>
<tr>
<td>Operating condition<em>5</em>6</td>
<td>0 · 50°C, 10 · 90%RH (No condensation)</td>
</tr>
<tr>
<td>Physical dimensions (mm)</td>
<td>180(L) x 140(D) x 34(H) (No protrusions)</td>
</tr>
<tr>
<td>Weight</td>
<td>400g (Not including the USB cable, attachment)</td>
</tr>
<tr>
<td>Connector</td>
<td>10250-52A2JL[3M] or equivalent to it</td>
</tr>
<tr>
<td>Attached cable length</td>
<td>USB Cable 1.8m</td>
</tr>
</tbody>
</table>

© CONTEC

AO-1604LX-USB

51
6. About Hardware

*1: A linearity error approximately 0.1% of full-range may occur when operated at 0°C or 50°C ambient temperature.

*2: The USB transfer speed depends on the host PC environment used (OS and USB host controller).

*3: The supplied current is insufficient in the bus power. Please use the attached AC adaptor (POA200-20-2).

*4: As a USB hub is also counted as one device, you cannot just connect 127 USB terminals.

*5: To suppress the heating, ensure that there are spaces for ventilation (about 5cm) around this product.

*6: When using the attached AC adaptor POA200-20-2, it is 0°C - 40°C

Table 6.2. AC adaptor environmental condition (environmental specification)

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage range</td>
<td>90 - 264VAC</td>
</tr>
<tr>
<td>Rated input current</td>
<td>300mA</td>
</tr>
<tr>
<td>Number of frequency</td>
<td>50 - 60Hz</td>
</tr>
<tr>
<td>Rated output voltage</td>
<td>5.0VDC</td>
</tr>
<tr>
<td>Rated output current</td>
<td>2.0A (Max.)</td>
</tr>
<tr>
<td>Dimension (mm)</td>
<td>47.5(W) x 75(D) x 27.3(H) (No protrusions)</td>
</tr>
<tr>
<td>Weight</td>
<td>175g</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>0°C - 40°C</td>
</tr>
<tr>
<td>Operating humidity</td>
<td>20% - 80%RH (No condensation)</td>
</tr>
<tr>
<td>Life expectancy</td>
<td>4 years at the ambient temperature 40°C (When 100VAC is input and 1.3A is output)</td>
</tr>
<tr>
<td>Allowable time of short interruption</td>
<td>15ms (Max.) (When 100VAC is input and 1.3A is output) *1</td>
</tr>
<tr>
<td>Floating dust particles</td>
<td>Not to be excessive</td>
</tr>
<tr>
<td>Corrosive gases</td>
<td>None</td>
</tr>
<tr>
<td>Voltage corresponding to the attached AC cable</td>
<td>125VAC 7A</td>
</tr>
</tbody>
</table>

*1 When the short interruption occurs and the defective operation of the equipment is generated, please insert the power supply of the equipment after pulling out it.
Physical dimensions

Figure 6.1. Physical dimensions

Figure 6.2. Physical dimensions of attached AC adaptor (POA200-20-2)
Block Diagram

Figure 6.3 is a circuit block diagram of this product.

![Block Diagram](image)

Figure 6.3. Block Diagram
Control Signal Timings

Control Signal Timings for Analog Output

Figures 6.4, 6.5, 6.6 and Table 6.3 show the control signal timings for the analog input function.

![Timing Chart of External Sampling Clock (Analog output)](image)

**Figure 6.4. Timing Chart of External Sampling Clock (Analog output)**

![Timing Chart of Sampling Start Control Signal](image)

**Figure 6.5. Timing Chart of Sampling Start Control Signal**

![Timing Chart of Sampling Stop Control Signal](image)

**Figure 6.6. Timing Chart of Sampling Stop Control Signal**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Time</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay from external sampling clock to actual start</td>
<td>tDEC</td>
<td>100</td>
<td>nsec</td>
</tr>
<tr>
<td>Settling time</td>
<td>tWS</td>
<td>10000</td>
<td>nsec</td>
</tr>
<tr>
<td>Set up time of sampling start (Rising edge)</td>
<td>tSRS</td>
<td>100</td>
<td>nsec</td>
</tr>
<tr>
<td>Hold time of sampling start (Rising edge)</td>
<td>tHRS</td>
<td>100</td>
<td>nsec</td>
</tr>
<tr>
<td>Set up time of sampling start (Falling edge)</td>
<td>tSFS</td>
<td>100</td>
<td>nsec</td>
</tr>
<tr>
<td>Hold time of sampling start (Falling edge)</td>
<td>tHFS</td>
<td>100</td>
<td>nsec</td>
</tr>
<tr>
<td>Set up time of sampling stop (Rising edge)</td>
<td>tSRP</td>
<td>100</td>
<td>nsec</td>
</tr>
<tr>
<td>Hold time of sampling stop (Rising edge)</td>
<td>tHRP</td>
<td>100</td>
<td>nsec</td>
</tr>
<tr>
<td>Set up time of sampling stop (Falling edge)</td>
<td>tSFP</td>
<td>100</td>
<td>nsec</td>
</tr>
<tr>
<td>Hold time of sampling stop (Falling edge)</td>
<td>tHFP</td>
<td>100</td>
<td>nsec</td>
</tr>
</tbody>
</table>

⚠️ **CAUTION**

The times listed in Table 6.3 are for standard operating conditions.
Control Signal Timings for Counter

Figures 6.7, 6.8, and Table 6.4 show the control signal timings for the analog input function.

Counter Up Pulse Input

\[ t_{\text{SRC}} \quad t_{\text{HRC}} \]

Figure 6.7. Timing Chart of Counter Input Signal

Counter Compare Output

\[ t_{\text{PSC}} \]

Figure 6.8. Timing Chart of Counter Output Signal (Pulse output)

Table 6.4. Control Signal Timings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Time</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set up time of counter input (Rising edge)</td>
<td>t_{\text{SRC}}</td>
<td>100</td>
<td>nsec</td>
</tr>
<tr>
<td>Hold time of counter input (Rising edge)</td>
<td>t_{\text{HRC}}</td>
<td>100</td>
<td>nsec</td>
</tr>
<tr>
<td>Pulse width of counter output signal</td>
<td>t_{\text{PSC}}</td>
<td>1000</td>
<td>nsec</td>
</tr>
</tbody>
</table>

⚠️ CAUTION

The times listed in Table 6.4 are for standard operating conditions.
About Calibration

Although this product is calibrated before shipping, you can use the calibration program to calibrate analog output yourself.

Starting the calibration program

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

![Properties dialog box](image)

* The name of the product you have just added is displayed.
  - AO-1604LX-USB

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

Analog output calibration

Analog output calibration requires a digital multimeter.

As the analog output has 16bit 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.

If for some reason you are unable to achieve the rated accuracy, please contact the CONTEC information center.
Difference from AO-1604L-LPE and DA16-4(LPCI)L

Table 6.5. Difference from AO-1604L-LPE and DA16-4(LPCI)L

<table>
<thead>
<tr>
<th>Item</th>
<th>AO-1604LX-USB</th>
<th>AO-1604L-LPE</th>
<th>DA16-4(LPCI)L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog output</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External start signal,</td>
<td>LVTTL level</td>
<td></td>
<td>TTL level</td>
</tr>
<tr>
<td>External stop signal,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External clock signal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External status output signal</td>
<td>LVTTL level</td>
<td></td>
<td>TTL level</td>
</tr>
<tr>
<td>Digital I/O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of input channels</td>
<td>Non-isolated input 4 channels (LVTTL level positive logic)</td>
<td>Non-isolated input 4 channels (TTL level positive logic)</td>
<td></td>
</tr>
<tr>
<td>Number of output channels</td>
<td>Non-isolated output 4 channels (LVTTL level positive logic)</td>
<td>Non-isolated output 4 channels (TTL level positive logic)</td>
<td></td>
</tr>
<tr>
<td>Counter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of external inputs</td>
<td>LVTTL level</td>
<td></td>
<td>TTL level</td>
</tr>
<tr>
<td>Number of external outputs</td>
<td>LVTTL level</td>
<td></td>
<td>TTL level</td>
</tr>
<tr>
<td>Power consumption (Max.)</td>
<td>5VDC 700mA</td>
<td>3.3VDC 400mA,</td>
<td>5VDC 440mA (Max.)</td>
</tr>
<tr>
<td></td>
<td>12VDC 250mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus specification</td>
<td>USB Specification 2.0/1.1 standard</td>
<td>PCI Express Base Specification Rev. 1.0a x1</td>
<td>PCI(32bit, 33MHz, Universal key shapes supported)</td>
</tr>
<tr>
<td>Physical dimensions (mm)</td>
<td>180(L) x 140(D) x 34(H) (No protrusions)</td>
<td>121.69(L) x 67.90(H)</td>
<td>121.69(L) x 63.41(H)</td>
</tr>
<tr>
<td>Weight</td>
<td>400g (Not including the USB cable, attachment)</td>
<td>60g</td>
<td>130g</td>
</tr>
</tbody>
</table>