PC-HELPER

Digital I/O Board with Opto-Isolation for PCI Express
Low Profile

DIO-1616B-LPE
User’s Guide

CONTEC CO., LTD.
Check Your Package

Thank you for purchasing the CONTEC product.
The product consists of the items listed below.
Check, with the following list, that your package is complete. If you discover damaged or missing items, contact your retailer.

Product Configuration List
- Board [DIO-1616B-LPE] …1
- Standard-sized bracket …1
- First step guide …1
- Disk *1 [API-PAC(W32)] …1
- Warranty Certificate …1
- Serial number label …1
*1 Driver software (API-PAC(W32)), User’s Guide (this guide)
Copyright

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1. Before Using the Product

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

About the Board

This product is a PCI Express bus-compliant interface board that extends the digital signal I/O functions of a PC.

This product is a 12 - 24VDC opto-coupler isolated type with opto-coupler isolated input 16ch and opto-coupler isolated open-collector output 16ch. You can use all of the input signals as interrupt inputs. Equipped with the power for opto-coupler operation (12VDC) supplied and the digital filter function and output transistor protection circuit (surge voltage protection and overcurrent protection).

This product supports a Low Profile size slot and, if replaced with the supplied bracket, supports a standard size slot, too.

Windows/Linux driver is bundled with this product.

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

Features

Opto-coupler isolated input (supporting current sink output) and opto-coupler isolated open-collector output (current sink type)

This product has the opto-coupler isolated input 16ch (supporting current sink output) whose response speed is 200μsec and opto-coupler isolated open-collector output 16ch (current sink type).

Common terminal provided per 16ch, capable of supporting a different external power supply.

Supporting driver voltages of 12 - 24 VDC for I/O

Opto-coupler bus isolation

As the PCI Express bus (PC) is isolated from the input and output interfaces by opto-couplers, this product has excellent noise performance.

Power for opto-coupler operation (12VDC 240mA) supplied internally

As the power to run the opto-couplers is supplied internally, no external power supply is required. The use of jumpers allows you to decide whether you want to use the internal or external power supply for every 16 points.

You can use all of the input signals as interrupt events.

You can use all of the input signals as interrupt events and also disable or enable the interrupt in bit units and select the interrupt edge.
Windows/Linux compatible driver libraries are attached.

Using the attached driver library API-PAC(W32) makes it possible to create applications of Windows/Linux. In addition, a diagnostic program by which the operations of hardware can be checked is provided.

This product has a digital filter to prevent input signals from carrying noise or a chattering.

All input terminals can be added a digital filter, and the setting can be performed by software.

Output circuits include zener diodes for surge voltage protection and overcurrent protection circuit.
Zener diodes are connected to the output circuits to protect against surge voltages. Similarly, overcurrent protection circuits are fitted to each group of 8ch outputs.

Functions are compatible with PCI Express compatible board DIO-1616B-PE and PCI compatible board PIO-16/16B(PCI)H.
The functions same with PCI Express compatible board DIO-1616B-PE and PCI compatible board PIO-16/16B(PCI)H are provided.

Functions and connectors are compatible with PCI compatible board PIO-16/16B(LPCI)H series.
The functions same with PCI compatible board PIO-16/16B(LPCI)H are provided.
In addition, as there is compatibility in terms of connector shape and pin assignments, it is easy to migrate from the existing system.

LabVIEW is supported by a plug-in of dedicated library VI-DAQ.
Using the dedicated library VI-DAQ makes it possible to create each application for LabVIEW.
Support Software

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

Windows version of digital I/O driver **API-DIO(WDM)/API-DIO(98/PC)**
[Stored on the bundled media driver library API-PAC(W32)]

The API-DIO(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 *1useful for checking operation is provided.

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/apipac/).

Linux version of digital I/O driver **API-DIO(LNX)**
[Stored on the bundled media driver library API-PAC(W32)]

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

For more details on the supported OS, applicable language and how to download the updated version, please visit the CONTEC’s Web site (http://www.contec.com/apipac/).

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. Before Using the Product

**Cable & Connector (Option)**

Shield Cable with Two 50-Pin Mini-Ribbon Connector
- : PCB50PS-0.5P(0.5m)
- : PCB50PS-1.5P(1.5m)
- : PCB50PS-3P(3m)
- : PCB50PS-5P(5m)

Shield Cable with One 50-Pin Mini-Ribbon Connector
- : PCA50PS-0.5P(0.5m)
- : PCA50PS-1.5P(1.5m)
- : PCA50PS-3P(3m)
- : PCA50PS-5P(5m)

Connection Conversion 0.5m Shield Cable (50-Pin Ribbon->37-Pin D-SUB)
- : PCE50/37PS-0.5P(0.5m)

**Accessories (Option)**

- Screw Terminal Unit (M3 terminal block, 50 points) : EPD-50A *1 *2
- Screw Terminal Unit (M3 terminal block, 37 points) : EPD-37A *1 *3
- Screw Terminal Unit (M3.5 terminal block, 37 points) : EPD-37 *3
- Termination Panel (M3) : DTP-3A *3
- Termination Panel : DTP-4C *3
- Signal Monitor for Digital I/O : CM-32L *3

*1 "Spring-up" type terminal is used to prevent terminal screws from falling off.
*2 PCB50PS-*P optional cable is required separately.
*3 PCE50/37PS-0.5P and PCB37P or PCB37PS optional cable is required separately.

* 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

- There are switches and jumpers on this product that need to be set in advance. Be sure to check these before installing to the expansion slot.
- Only set the switches and jumpers on this product to the specified settings. Otherwise, this product may malfunction, overheat, or cause a failure.
- Do not strike or bend this product. Otherwise, this product may malfunction, overheat, cause a failure or breakage.
- Do not touch this product's metal plated terminals (edge connector) with your hands. Otherwise, this product may malfunction, overheat, or cause a failure. If the terminals are touched by someone's hands, clean the terminals with industrial alcohol.
- Do not install or remove this product to or from the expansion slot while the computer's power or expansion unit is turned on. Otherwise, this product may malfunction, overheat, or cause a failure. Be sure that the personal computer power is turned off.
- Make sure that your PC or expansion unit can supply ample power to all the products installed. Insufficiently energized products could malfunction, overheat, or cause a failure.
- The specifications of this product are subject to change without notice for enhancement and quality improvement. Even when using this product continuously, be sure to read the user’s guide 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

**Environment**

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

Operating temperature
0 - 50°C

Operating Humidity
10 - 90%RH (No condensation)

Corrosive gases
None

Floating dust particles
Not to be excessive

**Inspection**

Inspect the product periodically as follows to use it safely.

- Check that the bus connector of the board and its cable have been plugged correctly.
- Check that the board has no dust or foreign matter adhering.
- The gold-plated leads of the bus connector.

**Storage**

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

1. Put the product in the storage bag.
2. Wrap it in the packing material, then put it in the box.
3. Store the package at room temperature at a place free from direct sunlight, moisture, shock, vibration, magnetism, and static electricity.

**Disposal**

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

This chapter explains how to set up the board.

What is Setup?

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

Using the Board under Windows

Using the Driver Library API-PAC(W32)

This section describes the setup procedure to be performed before you can start developing application programs for the board using the bundled media “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 Operation Checks

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

Using the Board under an OS Other than Windows

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

- This chapter Step 2 Setting the Hardware
- Chapter 3 External Connection
- Chapter 6 About Hardware
Step 1 Installing the Software

This section describes how to install the Driver libraries.

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

Although some user interfaces are different depending on the OS used, the basic procedure is the same.

**About the driver to be used**

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

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

When this product is used, digital input/output high performance driver "API-DIO(WDM)" is used.

If you use this product with digital input and output high-performance driver API-DIO (WDM).

If API-DIO (98 / PC) using existing systems continue to use API-DIO (98 / PC).

Please note that the API-DIO 98 (PC) does not support Windows 8 or later, and the 64-bit OS.

Use the API-DIO(98/PC)

If you are installing from media attachments, select "all" from the "Installer" later in this chapter and starts the execution environment and development environment packages installer.

Please see the Help folder in the installed hardware installation instructions please see reference in help media attachments or downloaded from CONTEC’s Web site development environment.

Furthermore, that applies to the default step 4 software described below, see config.chm folder installed execution environment.
Starting the Install Program

1. Load the bundled media [API-PAC(W32)] on your PC.
2. The API-PAC(W32) Installer window appears automatically.
   If the panel does not appear, run (drive letter):\AUTORUN.exe.
3. Click on the [Install Development or Execution Environment] button.

* When using the Windows Vista, driver is automatically installed.

⚠️ CAUTION

Before installing the software in Windows Vista, Windows XP, Server 2003 and 2000, log in as a user with administrator privileges.
Select API-DIO(WDM)

Selecting API-DIO(WDM)

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

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

(3) Click on the [Install] button.

* Clicking the [API-DIO] button under the “Detail” displays detailed information about API-DIO(WDM) and API-DIO(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.
Step 2 Setting the Hardware

This section describes how to set the board and plug it on your PC.

The board has some switches to be preset.

Check the on-board switches before plugging the board into an extension slot.

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

Replacing the Bracket

This board is shipped with a Low Profile size bracket mounted. To plug the board into a standard size slot, replace the bracket with the bundled standard size bracket. The replacing method is as follows:

- Remove the screws and replace it with the Standard size bracket.

Use a flathead screwdriver or hexagonal spanner to undo and tighten the screws.

Figure 2.1. Replacing the Bracket
Parts of the Board and Factory Defaults

Figure 2.2 shows the names of major parts on the board.

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

![Component Locations Diagram]

**Setting the Board ID**

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

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

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

Setting Procedure

To set the board ID, use the rotary switch on the board. Turn the SW1 knob to set the board ID as shown below.

![Board ID Settings (SW1) Diagram]

**Figure 2.3.** Board ID Settings (SW1)
Selecting Power Supply

This board equips an on board isolated power supply (12VDC, 240mA) for driving opto-isolation circuits. You can select to use this internal power supply or use an external power supply for driving the opto-isolation circuits in unit of two ports (16channels) per common.

⚠️ CAUTION ⚠️
- When the internal power supply is used, the input section of this board consumes up to 40mA current maximum and the output channel switching section consumes up to 30mA current maximum. Note, in this case, that the board can supply the following output current:
  DIO-1616B-LPE: 170 mA
- The both internal and external supply must not be used simultaneously. Or the supply will be broken down.

Setting method
Jumpers JP1 - JP4 on the board are used to select the internal or external power supply.

<table>
<thead>
<tr>
<th>Use internal power*</th>
<th>Use external power</th>
</tr>
</thead>
<tbody>
<tr>
<td>+0 port (Input)</td>
<td>JP1 1 2 3</td>
</tr>
<tr>
<td>+1 port (Input)</td>
<td>JP3 1 2 3</td>
</tr>
<tr>
<td>+2 port (output)</td>
<td>JP2 1 2 3</td>
</tr>
<tr>
<td>+3 port (output)</td>
<td>JP4 1 2 3</td>
</tr>
</tbody>
</table>

*Factory setting
Notes: These jumpers must be set in pairs.
Ports +0 and +1 serve as inputs and ports +2 and +3 serve as outputs.

Figure 2.4. Power supply setting for driving the opto-coupler
Plugging the Board

(1) Before plugging the board, shut down the system, unplug the power code of your PC.
(2) Remove the cover from the PC so that the board can be mounted.
(3) Plug the board into an extension slot.
(4) Attach the board bracket to the PC.
(5) Put the cover back into place.

⚠️ CAUTION

- Do not touch the board's metal plated terminals (edge connector) with your hands. Otherwise, the board may malfunction, overheat, or cause a failure.
  If the terminals are touched by someone's hands, clean the terminals with industrial alcohol.
- Do not install or remove the board to or from the slot while the computer's or extension unit’s power is turned on.
  Otherwise, the board may malfunction, overheat, or cause a failure.
  Be sure that the personal computer power is turned off.
- Make sure that your PC or extension unit can supply ample power to all the boards installed.
  Insufficiently energized boards could malfunction, overheat, or cause a failure.
Step 3 Installing the Hardware

For using an expansion board under Windows, you have to let the OS detect the I/O addresses and interrupt level to be used by the board. The process is referred to as installing the hardware.

In the case of using two or more boards, make sure you install one by one with the Add New Hardware Wizard.

Turning on the PC

Turn on the power to your PC.

⚠️ CAUTION

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

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

Depending on the OS that you use, the installation process may start automatically without starting the wizard. In this situation, proceed to "Step 4 Initializing the Software".

Performing installations on various operating systems

Help files containing the methods to follow in performing installations on different Windows operating systems are included on the bundled media, so refer to the files in the following folder. ¥Help¥Hwinst¥Eng¥ApiTool.chm

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

Select “No, not this time” and then click the “Next” button.

(2) When the model name of hardware is displayed, select “Install the software automatically [Recommended]” and then click on the “Next” button.

The device is automatically installed, and processing is completed.
You have now finished installing the initial setting of Hardware.
Step 4 Initializing the Software

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

This software is initialized automatically during hardware installation. Therefore, if you want to use it with its initial settings, you can skip the setting procedure described in Step 4. To change the device name, follow the setting procedure shown below.

Setting the device name

(1) Run Device Manager. From [My Computer] - [Control Panel], select [System] and then select the [Device Manager] tab. (You can also open Device Manager by right clicking on My Computer and selecting Properties.)

When you install this product, the displayed board name is "DIO-1616B-PE DIO-1616B-LPE "DIO000".

* The name of the board you have just added is displayed.

(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].

⚠️ CAUTION
When you install this product, the displayed board name is "DIO-1616B-PE DIO-1616B-LPE".
(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.

⚠️ CAUTION

When you install this product, the displayed board name is "DIO-1616B-PE DIO-1616B-LPE".

You have now finished installing the initial setting of Software.
Step 5 Operation Checks

You must make sure that the board and driver software operate normally. By taking this step, you can make sure that the board has been set up correctly.

Check Method

Connect the board to a remote device to test the input/output and check the execution environment. The Check Mate (CM-32L) comes in handy when you check digital I/O boards. Check the board with the factor defaults untouched.

Connection diagram

To connect a device other than the Check Mate, see Chapter 3 “External Connection”.
Using the Diagnosis Program

Starting the Diagnosis Program

Open the “Properties” page of the device that was used for the software initialization, and press the [Diagnosis] button.
Checking Digital Inputs and Outputs

The main panel of the Diagnosis Program appears.

You can check the current operation states of the board in the following boxes:

"Input Port" : Displays input values bit by bit at fixed time intervals.
"Output Port" : Mouse operation allows the data to output or display.
"Interrupt" : Displays the number of interrupts detected bit by bit.

When you install this product, the displayed board name is "DIO-1616B-LPE".

⚠️ CAUTION

When you install this product, the displayed board name is "DIO-1616B-LPE".

To use the function execution time measurement feature, click on the [Measurement Time] button. Enter the I/O start port and the number of ports, then press the measurement button. The time for each execution of a function will be measured.
2. Setup

Diagnosis Report

(1) Clicking on the [Show Diagnosis Report] button displays detailed data such as board settings and the diagnosis results while saving them in text format.

The Diagnosis Program performs “board presence/absence check”, “driver file test”, “board setting test”, and so on.

⚠️ CAUTION

Before executing diagnosis report output, unplug the cable from the board.

* The name of the board you have just added is displayed.
   DIO-1616B-LPE

⚠️ CAUTION

When you install this product, the displayed board name is "DIO-1616B-LPE".
(2) A diagnosis report is displayed as shown below.

![Diagnosis Report]

* The name of the board you have just added is displayed. DIO-1616B-LPE

⚠️ CAUTION
When you install this product, the displayed board name is "DIO-1616B-LPE".

## Setup Troubleshooting

### Symptoms and Actions

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

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

- Check the return values of functions.
- Refer to the source code of sample program.

Refer to the “Troubleshooting” in API-TOOL(WDM) HELP (APITOOL.chm)
3. External Connection

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

How to connect the connectors

Connector shape

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

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

Figure 3.1. Interface Connector and Applicable Cable Connector
## Connector Pin Assignment

### Pin Assignments of Interface Connector

<table>
<thead>
<tr>
<th>Common minus pin for +2/+3 output</th>
<th>ON 2/3</th>
<th>50</th>
<th>ON 2/3</th>
<th>49</th>
<th>Common minus pin for +2/+3 output ports</th>
<th>ON 2/3</th>
<th>25</th>
<th>ON 2/3</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>+2 port (output)</td>
<td>O-20</td>
<td>48</td>
<td>O-21</td>
<td>47</td>
<td>+3 port (output)</td>
<td>O-23</td>
<td>45</td>
<td>O-24</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>O-22</td>
<td>46</td>
<td>O-23</td>
<td>45</td>
<td></td>
<td>O-25</td>
<td>43</td>
<td>O-26</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>O-27</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common plus pin for +2/+3 output ports</td>
<td>OP 2/3</td>
<td>40</td>
<td>OP 2/3</td>
<td>39</td>
<td></td>
<td></td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common minus pin for +0/+1 input ports</td>
<td>IN 0/1</td>
<td>37</td>
<td>IN 0/1</td>
<td>36</td>
<td></td>
<td></td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+0 port (input)</td>
<td>I-00</td>
<td>35</td>
<td>I-01</td>
<td>34</td>
<td></td>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I-02</td>
<td>33</td>
<td>I-03</td>
<td>32</td>
<td></td>
<td></td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I-04</td>
<td>31</td>
<td>I-05</td>
<td>30</td>
<td></td>
<td></td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I-06</td>
<td>29</td>
<td>I-07</td>
<td>28</td>
<td></td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common plus pin for +0/+1 input ports</td>
<td>IP 0/1</td>
<td>27</td>
<td>IP 0/1</td>
<td>26</td>
<td></td>
<td></td>
<td>11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**I00 - I17**  16 input signal pins. Connect output signals from the external device to these pins.

**O20 - O37**  16 output signal pins. Connect these pins to the input signal pins of the external device.

**IP 0/1**  When the external power supply is selected, its positive side is connected to this pin. When the internal power supply is used, this pin outputs power at +12 V. These pins are common to 16 input signal pins.

**OP 2/3**  When the external power supply is selected, its positive side is connected to this pin. When the internal power supply is used, this pin outputs power at +12 V. These pins are common to 16 output signal pins.

**IN 0/1**  When the external power supply is selected, its negative side is connected to this pin. When the internal power supply is used, this pin serves as the ground. These pins are common to 16 input signal pins.

**ON 2/3**  When the external power supply is selected, its negative side is connected to this pin. When the internal power supply is selected, this pin serves as the ground. These pins are common to 16 output signal pins.

**N.C.**  This pin is left unconnected.

---

![Diagram of Connector Pin Assignment](image.png)

**Figure 3.2. Pin Assignments of Interface Connector**
Relationships between API-PAC(W32) Logical Ports/Bits and Connector Signal Pins

The following table lists the relationships between the connector signal pins and the logical port/bit numbers used for I/O functions when applications are written with API-PAC(W32).

⚠️ CAUTION

The logical port and logical bit numbers are virtual port and bit numbers that enable programming independent of board I/O addresses or board types.

For details, refer to API-DIO HELP available after installing API-PAC(W32).

Table 3.1. Logical Ports, Logical Bits, and Connector Signal Pins

<table>
<thead>
<tr>
<th>Input logical port 0</th>
<th>D7</th>
<th>D6</th>
<th>D5</th>
<th>D4</th>
<th>D3</th>
<th>D2</th>
<th>D1</th>
<th>D0</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-07</td>
<td>[7]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-06</td>
<td>[6]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-05</td>
<td>[5]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-04</td>
<td>[4]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-03</td>
<td>[3]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-02</td>
<td>[2]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-01</td>
<td>[1]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-00</td>
<td>[0]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input logical port 1</td>
<td>I-17</td>
<td>I-16</td>
<td>I-15</td>
<td>I-14</td>
<td>I-13</td>
<td>I-12</td>
<td>I-11</td>
<td>I-10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output logical port 0</th>
<th>D7</th>
<th>D6</th>
<th>D5</th>
<th>D4</th>
<th>D3</th>
<th>D2</th>
<th>D1</th>
<th>D0</th>
</tr>
</thead>
<tbody>
<tr>
<td>O-27</td>
<td>[7]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O-26</td>
<td>[6]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O-25</td>
<td>[5]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O-24</td>
<td>[4]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O-23</td>
<td>[3]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O-22</td>
<td>[2]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O-21</td>
<td>[1]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O-20</td>
<td>[0]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output logical port 1</td>
<td>O-37</td>
<td>O-36</td>
<td>O-35</td>
<td>O-34</td>
<td>O-33</td>
<td>O-32</td>
<td>O-31</td>
<td>O-30</td>
</tr>
</tbody>
</table>

Notes: I-xx represents the input signal. O-xx represents the output signal. [xx] represents the logical bit.
Connecting Input Signals

Connect the input signals to a device which can be current-driven, such as a switch or transistor output device.

The connection requires an external power supply to feed currents.
The board inputs the ON/OFF state of the current-driven device as a digital value.

Input Circuit

* I\textsuperscript{xx} represents the input pin.

Figure 3.3. Input Circuit
The input circuits of interface is illustrated in Figure 3.3.
The signal inputs are isolated by opto-couplers (ready to accept current sinking output signals). The board therefore requires an external power supply to drive the inputs. The power requirement for each input pin is about 5.1mA at 24VDC (about 2.6mA at 12VDC).

⚠️ CAUTION

Please refer to Selecting Power Supply, and choose the proper supply by jumps.
Connecting a Switch

When the switch is ON, the corresponding bit contains 1.
When the switch is OFF, by contrast, the bit contains 0.

**Figure 3.4. An Example to use Input I-00**
Connecting Output Signals

Connect the output signals to a current-driven controlled device such as a relay or LED. The connection requires an external power supply to feed currents. The board controls turning on/off the current-driven controlled device using a digital value.

Output Circuit

* O·xx represents the output pin.

**Figure 3.5. Output Circuit**

The output circuits of interface is illustrated in Figure 3.5. The signal output section is an optocoupler isolated, open-collector output (current sink type). Driving the output section requires the on-board internal power supply or the external power supply.

The rated output current per channel is 100mA at maximum.

The output section can also be connected to a TTL level input as it uses a low-saturated transistor for output. The residual voltage (low-level voltage) between the collector and emitter with the output on is 0.5V or less at an output current within 50mA or at most 1.0V at an output current within 100mA.

A zener diode is connected to the output transistor for protection from surge voltages. A overcurrent protection circuit is provided for every 8 output transistors.
When the PC is turned on, all output are reset to OFF. Please refer to Selecting Power Supply, and choose the proper supply by jumps.

## Connection to the LED

When "1" is output to a relevant bit, the corresponding LED comes on. When "0" is output to the bit, in contrast, the LED goes out.

**Figure 3.6. An Example to use Output O-20**

## Example of Connection to TTL Level Input

**Figure 3.7. Connection Example of Output and TTL level Input Signal**
Connecting the Sink Type Output and Sink Output Support Input

The following example shows a connection between a sink type output (output board) and a sink output support input (input board). Refer to this connection example when you connect such boards to each other.

Figure 3.8. Example of Connecting the Sink Type Output and Sink Output Support Input
4. Function

This section describes the features of the board.

Each function described here can be easily set and executed by using the bundled API function library. For details, refer to API-DIO HELP available after installation.

Data I/O Function

Data Input

When input data is “ON”, “1” is input to the relevant bit.
When the input data is “OFF”, in contrast, “0” is input to the relevant bit.

Data Output

When “1” is output to the relevant bit, the corresponding transistor is set to “ON”.
When “0” is output to the relevant bit, in contrast, the corresponding transistor is set to “OFF”.

⚠️ CAUTION ⏤ When the PC is turned on, all output are reset to 0 (OFF).

Monitoring Output Data

The DIO-1616B-LPE can read the state of the data currently being output without affecting the output data.
Digital Filter

Using this feature, the DIO-1616B-LPE can apply a digital filter to every input pin, thereby preventing the input signal from being affected by noise or chattering.

Digital Filter Function Principle

The digital filter checks the input signal level during the sampling time of the clock signal. When the signal level remains the same for the digital filter set time, the digital filter recognizes that signal as the input signal and changes the signal level of the PC.

If the signal level changes at a frequency shorter than the set time, therefore, the level change is ignored.

Figure 4.1. Digital Filter Function Principle
Set Digital Filter Time

Set the digital filter time to 0 - 20 (14h).

Setting the digital filter time to 0 disables digital filtering. It is set to 0 when the power is turned on.

Figure 4.2 shows the relationships between digital filter time settings and the actual digital filter times.

Digital Filter Time [sec.] = $2^n / (8 \times 10^6)$

$n$: setting data(0 - 20)

<table>
<thead>
<tr>
<th>Setting Data (n)</th>
<th>Digital Filter Time</th>
<th>Setting Data (n)</th>
<th>Digital Filter Time</th>
<th>Setting Data (n)</th>
<th>Digital Filter Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (00h)</td>
<td>The filter function is not used.</td>
<td>7 (07h)</td>
<td>16μsec</td>
<td>14 (0Eh)</td>
<td>2.048msec</td>
</tr>
<tr>
<td>1 (01h)</td>
<td>0.25μsec</td>
<td>8 (08h)</td>
<td>32μsec</td>
<td>15 (0Fh)</td>
<td>4.096msec</td>
</tr>
<tr>
<td>2 (02h)</td>
<td>0.5μsec</td>
<td>9 (09h)</td>
<td>64μsec</td>
<td>16 (10h)</td>
<td>8.192msec</td>
</tr>
<tr>
<td>3 (03h)</td>
<td>1μsec</td>
<td>10 (0Ah)</td>
<td>128μsec</td>
<td>17 (11h)</td>
<td>16.384msec</td>
</tr>
<tr>
<td>4 (04h)</td>
<td>2μsec</td>
<td>11 (0Bh)</td>
<td>256μsec</td>
<td>18 (12h)</td>
<td>32.768msec</td>
</tr>
<tr>
<td>5 (05h)</td>
<td>4μsec</td>
<td>12 (0Ch)</td>
<td>512μsec</td>
<td>19 (13h)</td>
<td>65.536msec</td>
</tr>
<tr>
<td>6 (06h)</td>
<td>8μsec</td>
<td>13 (0Dh)</td>
<td>1.024msec</td>
<td>20 (14h)</td>
<td>131.072msec</td>
</tr>
</tbody>
</table>

Figure 4.2. Digital Filter Time and Setting Data

⚠️ CAUTION

- If you set the digital filter time, the filter applies to all input pins. You cannot apply the filter only to a specific filter.
- Do not set Setting Data to a value outside the above range as doing so can cause the board to malfunction.
Interrupt Control Function

The DIO-1616B-LPE can use all of the input signals as interrupt request signals.

This product can generate an interrupt request signal to the PC when the input signal change from High to Low or from Low to High.

When the digital filter (described above) is used, interrupt requests are generated by input signals that have passed through the filter.

Disabling/enabling Interrupts

Interrupt mask bits can be used to disable or enable the individual bits for interruptions.

Once a certain bit has been interrupt-disabled, no interrupt occurs even when the corresponding input signal changes its level.

To let interrupts occur, enable the corresponding interrupt mask bit for interruptions.

⚠️ CAUTION  
All of the interrupt mask bits are interrupt-disabled when the power is turned on.

Selecting the Interrupt Edge

Interrupt edge select bits can be used to set the input logic for interruption bit by bit.

If you set an interrupt edge select bit to 0, an interrupt occurs when the input value to the corresponding bit changes from 0 to 1 (at the fall of the input signal from High to Low).

If you set an interrupt edge select bit to 1, an interrupt occurs when the input value to the corresponding bit changes from 1 to 0 (at the rise of the input signal from Low to High).

⚠️ CAUTION  
When the power is turned on, all of the interrupt edge select bits are set to 0 so that an interrupt occurs when the input value changes from 0 to 1 (at the fall of the input signal from High to Low).

Clearing the Interrupt Status and Interrupt Signal

Interrupt status bits are used to identify the input signal bit being used for requesting an interrupt.

When an interrupt status is input, the interrupt request signal and the interrupt status are cleared automatically.

⚠️ CAUTION  
- All of the interrupt status bits are set to 0 when the power is turned on.
- If an interrupt mask bit has been set to disable interrupts, the interrupt status bit is not set even when the input signal changes its level.
5. About Software

Bundled Media Directory Structure

\n  \- Autorun.exe   Installer Main Window
  | Readmej.html   Version information on each API-TOOL (Japanese)
  | Readmeu.html   Version information on each API-TOOL (English)
  
  \- APIPAC
      | AIO
      | | DISK1
      | | DISK2
      | | ......
      | | DISKN
      | | AioWdm
      | | CNT
      | | DIO
      | | ......

  \- HELP
      | Aio
      | Cnt
      | ......

  \- INF
      | WDM
      | | Win2000
      | | Win95
      | linux
      | | cnt
      | | dio
      | | ......

  \- Readme
      Readme file for each driver

  \- Release
      Driver file on each API-TOOL
      \- API_NT
         (For creation of a user-specific install program)
      \- API_W95

  \- UsersGuide
      Hardware User’s Guide(PDF files)
About Software for Windows

The bundled media “Driver Library Package API-PAC(W32)” contains the functions that provide the following features:
- Digital input/output of specified ports
- Hardware digital input/output of specified bits
- Hardware digital filtering that prevents chattering

For details, refer to the help file. The help file provides various items of information such as “Using procedure” and “Function Reference”. Use them for program development.

Accessing the Help File

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

(2) Using the “CONTEC API-PAC(W32)”, from the Start Menu, select “Programs” – “CONTEC API-PAC(W32)” - “API-DIO(WDM)” - “API-DIO(WDM) HELP” to display help information.
Using Sample Programs

Sample programs have been prepared for specific basic applications. For the API-DIO(WDM), the sample programs are stored in

```
¥Program Files¥CONTEC¥API-PAC(W32) ¥DIOWDM¥Sample
```

Use these sample programs as references for program development and operation check.

* When the installation folder is changed, the folder of the sample program is different.

Running a Sample Program

1. Click on the [Start] button on the Windows taskbar.
2. For the API-DIO(WDM), from the Start Menu, select “Programs” – “CONTEC API-PAC(W32)” – “API-DIO(WDM)” – “SAMPLE…”.
3. A sample program is invoked.

Sample list

| Simple I/O | Executes digital I/O processing of the specified port. |
| Multiple port/bit I/O ports/bits | Simultaneously executes digital I/O processing of multiple |
| Monitoring Trigger | Monitors rising-edge/falling-edge triggers. |
| Interrupt | Executes interrupt processing of the specified board. |
Uninstalling the Driver Libraries

< Uninstalling the device driver >

Run Device Manager. From [My Computer] - [Control Panel], select [System] and then select the [Device Manager] tab.
(You can also open Device Manager by right clicking on My Computer and selecting Properties.)
Select [Windows Driver Package - CONTEC (****)], and then click [Change/Remove].
* "****" contains the driver category name (caio, ccnt, cdio, csmc, etc.).

![Device Manager screenshot]

< Uninstall the development environment >

Use [My Computer] - [Control Panel] - [Programs and Features] to uninstall the development environment.
In case of API-***(WDM), select [CONTEC API-*** (WDM) VerXX (Develop)] and then click [Uninstall].
* "***" contains the driver category name (AIO, CNT, DIO, SMC, etc.).

![Programs and Features screenshot]
About Software for Linux

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

- Digital input/output of specified ports
- Digital input/output of specified bits
- Hardware digital filtering that prevents chattering

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

Driver Software Install Procedure

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

Mount the bundled media 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
# cp /mnt/cdrom/linux/dio/cdioXXX.tgz ./
# tar xvfz cdioXXX.tgz

# cd contec/cdio
# make

# cd config
# ./config

# ./contec_dio_start.sh
```

© CONTEC

DIO-1616B-LPE
5. About Software

Accessing the Help File

(1) Invoke a web browser in your X-Window environment.
(2) In the browser, open diohelp.htm in the contec/cdio/help directory.

Using Sample Programs

Sample programs have been prepared for specific basic applications.
Sample programs for each language are contained in the contec/cdio/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/cdio 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>
<thead>
<tr>
<th>Table 6.1. Specification &lt; 1/2 &gt;</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
<td><strong>Specification</strong></td>
</tr>
</tbody>
</table>
| Input format | Opto-coupler isolated input  
(Compatible with current sink output) (Negative logic *1) |
| Number of input signal channels | 16ch (all available for interrupts) (1 common in 16ch) |
| Input resistance | 4.7kΩ |
| Input ON current | 2.0mA or more |
| Input OFF current | 0.16mA or less |
| Interrupt | 16 interrupt input signals are arranged into a single output of interrupt signal INTA.  
An interrupt is generated at the rising edge (HIGH-to-LOW transition) or falling edge (LOW-to-HIGH transition). |
| Response time | Within 200μsec |
| Output format | Opto-coupler isolated open collector output (current sink type) (Negative logic *1) |
| Number of output signal channels | 16ch (1 common) |
| Output rating |  |
| Output voltage | 35VDC (Max.) |
| Output current | 100mA (par channel) (Max.) |
| Residual voltage with output on | 0.5V or less (Output current≤50mA), 1.0V or less (Output current≤100mA) |
| Surge protector | Zener diode RD47FM(NEC) or equivalent to it |
| Response time | Within 200μsec |

*1 Data “0” and “1” correspond to the High and Low levels, respectively.
Table 6.1. Specification < 2 / 2 >

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Common</strong></td>
<td></td>
</tr>
<tr>
<td>Built-in power</td>
<td>120VDC 240mA*2</td>
</tr>
<tr>
<td>Allowable distance of</td>
<td>Approx. 50m (depending on wiring environment)</td>
</tr>
<tr>
<td>signal extension</td>
<td></td>
</tr>
<tr>
<td>I/O address</td>
<td>Any 32-byte boundary</td>
</tr>
<tr>
<td>Interruption level</td>
<td>1 level use</td>
</tr>
<tr>
<td>Max. board count for</td>
<td>16 boards including the master board</td>
</tr>
<tr>
<td>connection</td>
<td></td>
</tr>
<tr>
<td>Isolated Power</td>
<td>500Vrms</td>
</tr>
<tr>
<td>External circuit power</td>
<td>12VDC ±10%</td>
</tr>
<tr>
<td>supply</td>
<td></td>
</tr>
<tr>
<td>Power consumption</td>
<td>When using the internal power supply : 3.3VDC 350mA, 12VDC 350mA</td>
</tr>
<tr>
<td></td>
<td>When using the external power supply : 3.3VDC 350mA</td>
</tr>
<tr>
<td>Operating condition</td>
<td>0°C - 50°C, 10% RH (No condensation)</td>
</tr>
<tr>
<td>Bus specification</td>
<td>PCI Express Base Specification Rev. 1.0a x1</td>
</tr>
<tr>
<td>Dimension (mm)</td>
<td>121.69(L) × 67.90(H)</td>
</tr>
<tr>
<td>Connector</td>
<td>50-Pin Mini-Ribbon connector</td>
</tr>
<tr>
<td></td>
<td>1D250-52A2JE [mfd. by 3M]</td>
</tr>
<tr>
<td>Weight</td>
<td>55g</td>
</tr>
</tbody>
</table>

*2 When using the internal power supply, the input section consumes up to 40mA and the SW section of output channel consumes up to 30mA, so the output current that can be supplied to the external device is 170mA.

Board Dimensions

![Board Dimensions Diagram](image)

The standard outside dimension (L) is the distance from the end of the board to the outer surface of the slot cover.
Figure 6.1. Block Diagram
## Differences between DIO-1616B-LPE and PIO-16/16B(PCI)H, PIO-16/16B(LPCI)H, DIO-1616B-PE

### Table 6.2 Differences between DIO-1616B-LPE and PIO-16/16B(PCI)H, PIO-16/16B(LPCI)H, DIO-1616B-PE

<table>
<thead>
<tr>
<th></th>
<th>DIO-1616B-LPE</th>
<th>PIO-16/16B(PCI)H</th>
<th>PIO-16/16B(LPCI)H</th>
<th>DIO-1616B-PE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power consumption</strong></td>
<td>When using the internal power supply: 3.3VDC 350mA, 12VDC 350mA When using the external power supply: 3.3VDC 350mA</td>
<td>When using the internal power supply: 5VDC 1200mA When using the external power supply: 5VDC 300mA</td>
<td>When using the internal power supply: 5VDC 600mA When using the external power supply: 5VDC 150mA</td>
<td>When using the internal power supply: 3.3VDC 350mA, 12VDC 350mA When using the external power supply: 3.3VDC 350mA</td>
</tr>
<tr>
<td><strong>Bus specification</strong></td>
<td>PCI Express Base Specification Rev. 1.0a x1</td>
<td>PCI(32bit, 33MHz, Universal key shapes supported)</td>
<td>PCI(32bit, 33MHz, Universal key shapes supported)</td>
<td>PCI Express Base Specification Rev. 1.0a x1</td>
</tr>
<tr>
<td><strong>Dimension (mm)</strong></td>
<td>121.69(L)x67.90(H)</td>
<td>176.41(L)x105.68(H)</td>
<td>121.69(L)x63.41(H)</td>
<td>169.33(L)x110.18(H)</td>
</tr>
<tr>
<td><strong>Connector</strong></td>
<td>50-Pin Mini-Ribbon connector 10250-52A2JL[mfd by 3M] or equivalent to it</td>
<td>37 pin D-SUB connector [F (female) type] DCLC-J37SAF-20L9E [mfd by JAE] or equivalent to it</td>
<td>50-Pin Mini-Ribbon connector 10250-52A2JL[mfd by 3M] or equivalent to it</td>
<td>37 pin D-SUB connector [F (female) type] DCLC-J37SAF-20L9E [mfd by JAE] or equivalent to it</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>55g</td>
<td>150g</td>
<td>60g</td>
<td>130g</td>
</tr>
</tbody>
</table>