PCI-1316 Digital I/O Acquisition Devices

User Manual

Rev. B

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Safety Requirements

Warning

Only the voltage within the specified range can be connected. Voltage exceeding the specified range may cause damage to the device, and even present a negative impact on personal safety. Check the product specification for detailed reference to the range of voltages that can be connected by each port.

Warning

Do not attempt to operate the device in other ways that are not mentioned in this document. Incorrect use of the device may be dangerous. In the event of device damage, the internal security protection mechanism will also be affected.

Warning

Do not attempt to replace device components or change devices in other ways that are not mentioned in this document. Do not repair the device yourself in the event of a product failure.

Warning

Do not use the device in an environment where an explosion may occur or where flammable flue or gas is present. If you must use the device in this kind of environment, please fit it into a proper case.

Warning

While the device is running, all chassis covers and fill panels need to be closed.

Warning

For equipment with exhaust vents, do not insert foreign objects into the vents or block air circulation in the vents.

Measurement Categories

Warning For use in measurement category I (CAT I) only. Do not use in measurement category II/III/IV. Use this device to connect signals or make measurements.

Measurement categories Note

Measurement categories I (CAT I) means that measurements are made on a circuit that is not directly connected to the main power supply. For example, a circuit that is not exported from the main power supply, especially a circuit that is exported from a protected (internal) primary power supply, is measured. In the latter case, the instantaneous stress will change. Therefore, the user should be aware of the instantaneous affordability of the device.

Measurement categories II (CAT II) means that measurements are made on a circuit that is directly connected to a low-voltage device. For example, a measurement on household appliances, portable tools and similar equipment.

Measurement categories III (CAT III) means that measurements are made in construction equipment. For example, a measurement on the distribution boards, circuit breakers, wiring (including cables, Busbars, junction boxes, switches, sockets) in fixed equipment and equipment for industrial use and certain other equipment (for example, fixed motors that are permanently connected to fixtures).

Measurement categories IV (CAT IV) means that measurements are made on the source of low-voltage equipment. For example, a measurement on a meter, a major overcurrent protection device, and a pulse control unit.

Environment

Temperature	
Operating	0℃ ~ 55℃
Storage	-40℃ ~ 85℃
Humidity	
Operating	5%RH ~ 95%RH, no condensation
Storage	5%RH ~ 95%RH, no condensation
Pollution degree	2
Highest elevation	2000 m

Pollution degree description

Pollution degree 1: No pollution, or only dry non-conductive pollution. This pollution degree has no effect. For example: a clean room or an air-conditioned office environment.

Pollution degree 2: Generally only dry non-conductive pollution occurs. Temporary conduction can sometimes occur due to condensation. For example: General indoor environment.

Pollution degree 3: Conductive pollution occurs, or dry non-conductive pollution becomes conductive due to condensation. For example, an outdoor sheltered environment.

Pollution degree 4: Permanent conductive pollution caused by conductive dust, rain, or snow. For example: Outdoor places.

Recycle precautions

Warning Some of the substances contained in this product may be harmful to the environment or human health. In order to avoid releasing harmful substances into the environment or endangering human health, it is recommended that appropriate methods be used to recover this product to ensure that most materials can be properly reused or recycled. For information about processing or recycling, please contact your local professional organizations.

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1. Getting Started

This chapter describes the basic functions of PCI-1316 Data Acquisition Devices, as well as product specifications and precautions in the process of product unpacking.

1.1. Product introduction

PCI-1316 data acquisition device is a digital I/O acquisition device based on PCI bus, which can be used for digital signal input and digital switch signal output control when loaded into a computer.All digital inputs of are isolated from the computer system by optocouplers.

All digital input channels of can be set to interrupt input and execute user-defined programs.

PCI-1316 data acquisition device supports operating in Windows OS, providing standard DLLs and support for mainstream development languages including VC++, VB, C#, LabVIEW, and MATLAB.

Key Features

- 16-channel isolated digital input, supporting continuous and uninterrupted acquisition
- Digital input supports up to 500kS/s sampling rate.
- All digital input channels can be set as interrupt sources.
- The digital input voltage is up to 70VDC
- The isolated power supply voltage is 5~50VDC, and the maximum load current is 500mA.
- 16-channel isolated digital output
- Digital output supports custom waveform output, with a maximum of 2048 points and a maximum sampling rate of 500ks/s.
- Digital output supports infinite length waveform output, and the highest sampling rate is 10ks/s.
- Digital output supports power-on default state customization.
- Compatible with 32-bit 3.3V/5VPCI bus

1.2. Function Diagram

Figure 1.1 shows the schematic diagram of PCI-1316 series data acquisition device.

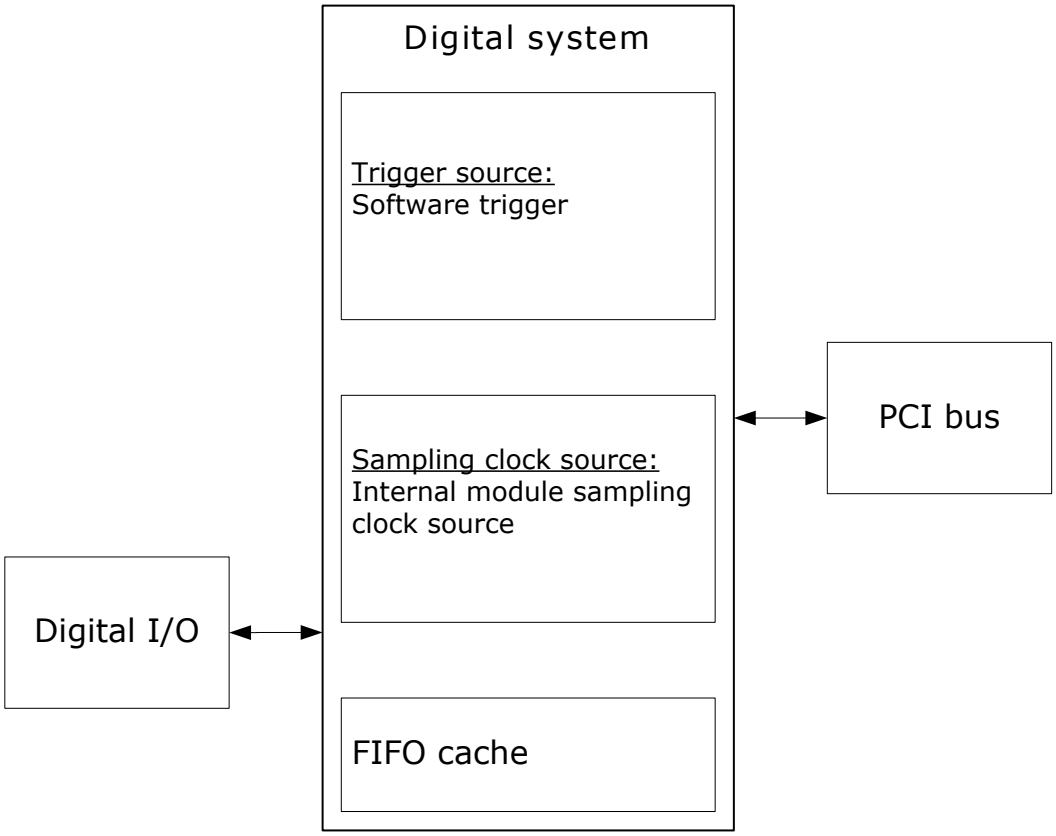

Figure 1.1 PCI-1316 data acquisition device functions

1.3. Product specifications

The following product specification parameters, unless otherwise stated, are acquired at the temperature of 25°C and the humidity of 40%, while the device is turned on for 20 minutes.

Digital Input

Number of channels	16
Ground reference	ISOGND,Isolate from computer
Digital input photoelectric isolation	photoelectric isolation
Isolation voltage	$1000V_{DC}$
Digital input voltage	High level:3V ~ 70V Low level: 0V ~ 3V
Highest sampling rate	50kS/s
Timing resolution	20 ns
Channel synchronization	Yes
Software FIFO	2MPts
Onboard FIFO	8192 Pts
Capture mode	Continuous acquisition mode/ Limited collection mode / Single read

Digital Output

Number of channels	16
Ground reference	ISOGND,Isolate from computer
Output type	Darlington transistor
Output voltage	5 ~ 50 V_{DC}
Output current	single channel conduction: 500mA max All channels conduction: 150mA max.
Output power-on status	Support customization
Output mode	Direct output / finite length waveform output / infinite non-cyclic waveform output
Highest sampling rate	50kS/s
Timing resolution	20 ns

Bus power requirements

PCI bus	compatible with 5V and 3.3V
Power supply	PCI bus power supply
Typical current without load	160mA@+5V,typical
Maximum Load	400mA@+5V

1.4. Product unpacking

Precautions

To prevent electrostatic discharge (ESD) from damaging the device, please note the following:

- Please wear a grounding wristband or touch a grounded object first to ensure being grounded.
- Before removing the equipment from the packaging, please first connect the anti-static packaging to the grounded object.
- Do not touch the exposed pins of the connector.
- Place your device in anti-static packaging when you are not using the device.

Check the packing list

After unpacking the product, follow the packing list in the box, check the host and each attachment individually to ensure that the items in the box are consistent with the packing list.

If you find that any item is missing, please get in touch with us for help as soon as possible.

If you find that the product comes in damaged after unpacking, please get in touch with us as soon as possible. Do not install damaged equipment on your devices.

2. Installation

This chapter describes signal connection and drive installation of PCI-1316 data acquisition device.

2.1. Connector signal pins distribution

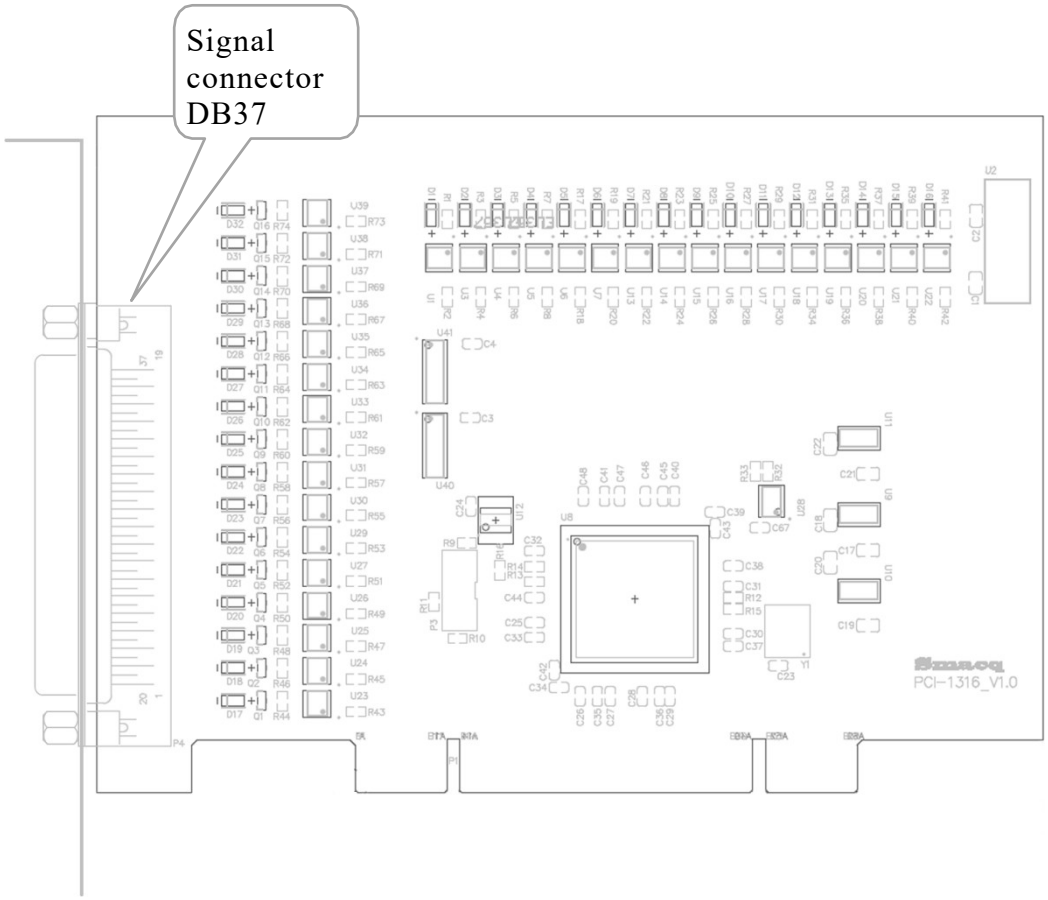

Figure 2.1 Schematic diagram of PCI-1316 digital I/O acquisition device

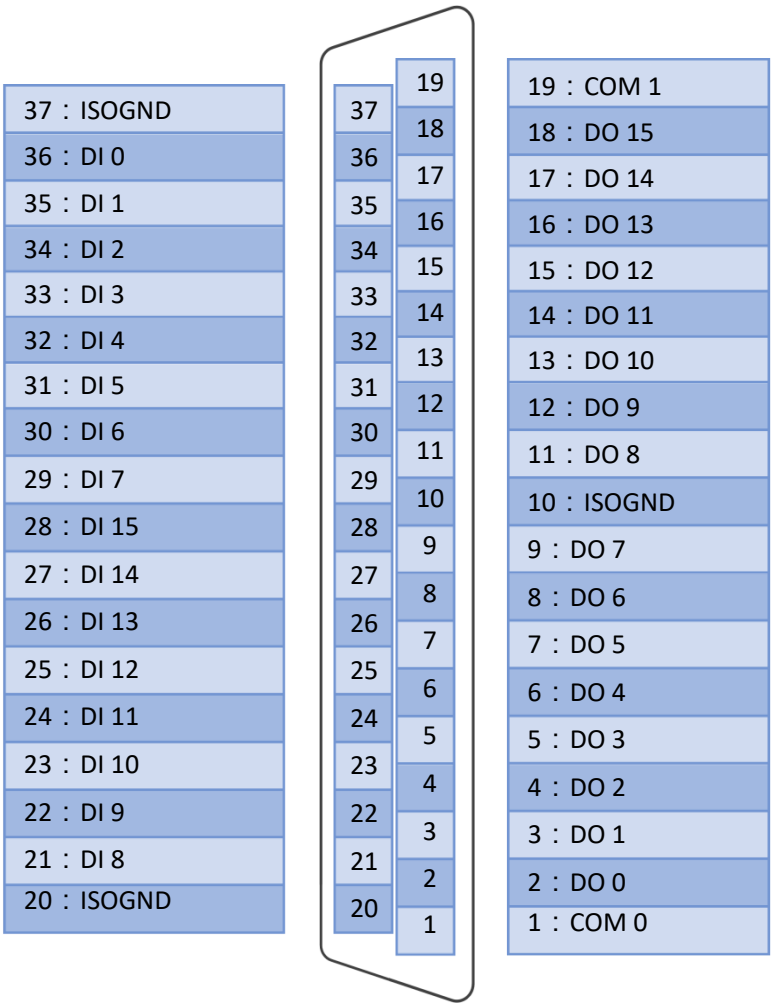

Figure 2.2 Signal connector distribution diagram

Table 2.1, Signal pin allocation

Signal name	Notes
DI x	Number input x
DO x	Number output x
ISOGND	The reference ground of digital I/O is isolated from the computer.
COM 0	Common end of DO 0 ~ DO 7
COM 1	Common end of DO 8 ~ DO 15

2.2. Drive installation

PCI-1316 data acquisition device can be used in Windows 7 and Windows 10, including 32-bit and 64-bit. Here, taking the driver installation in Windows 10 environment as an example, we will introduce how to install the driver of PCI-1316 data acquisition device step by step. The steps of installing drivers in Windows 7 environment are the same as those in Windows 10 environment.

1) Open the device manager of Windows operating system, and when the driver is not installed, it is displayed as "PCI Data Capture and Signal Processing Controller", as shown in Figure 2.3 below.

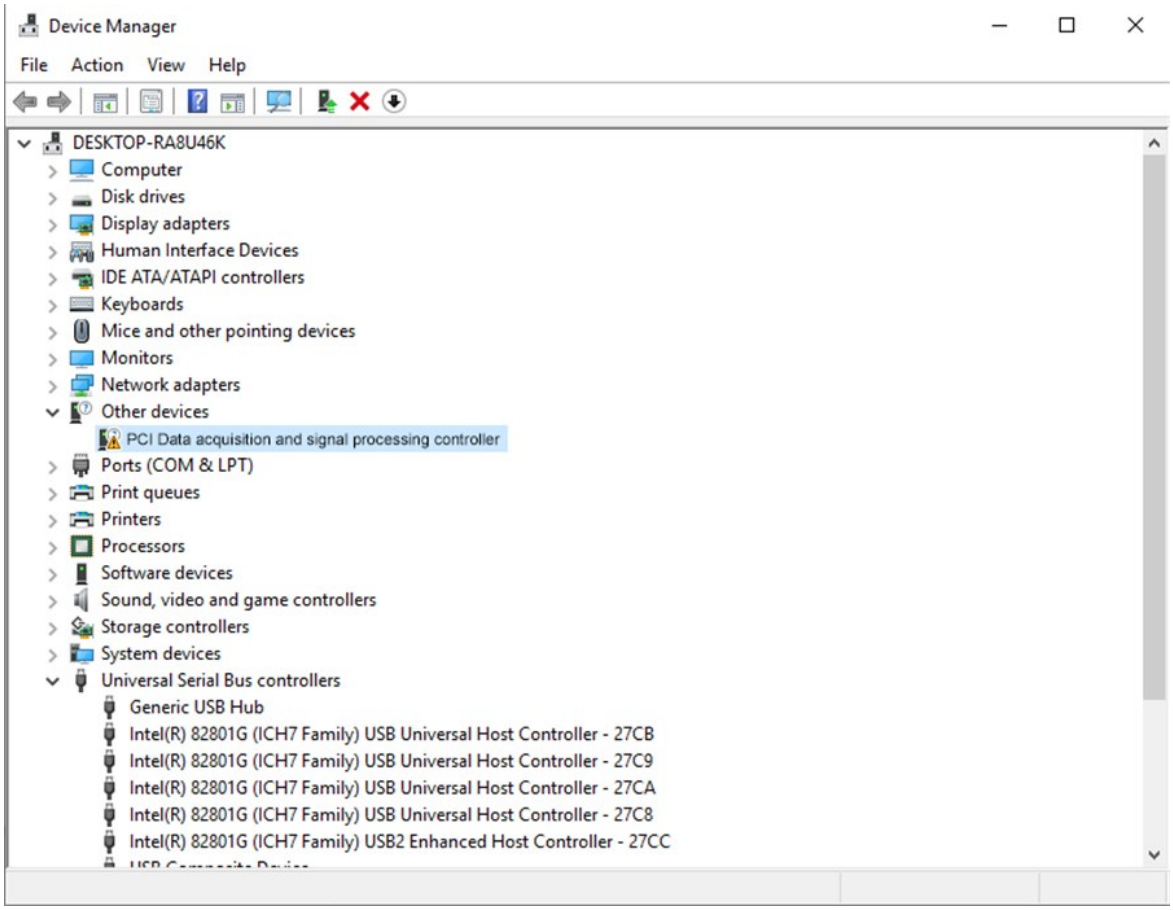

Figure 2.3 Before the driver is installed

2) Select "PCI Data Capture and Signal Processing Controller", right-click and select "Update Driver". Select "Browse my computer to find driver software" in the pop-up dialog box, as shown in Figure 2.4 below.

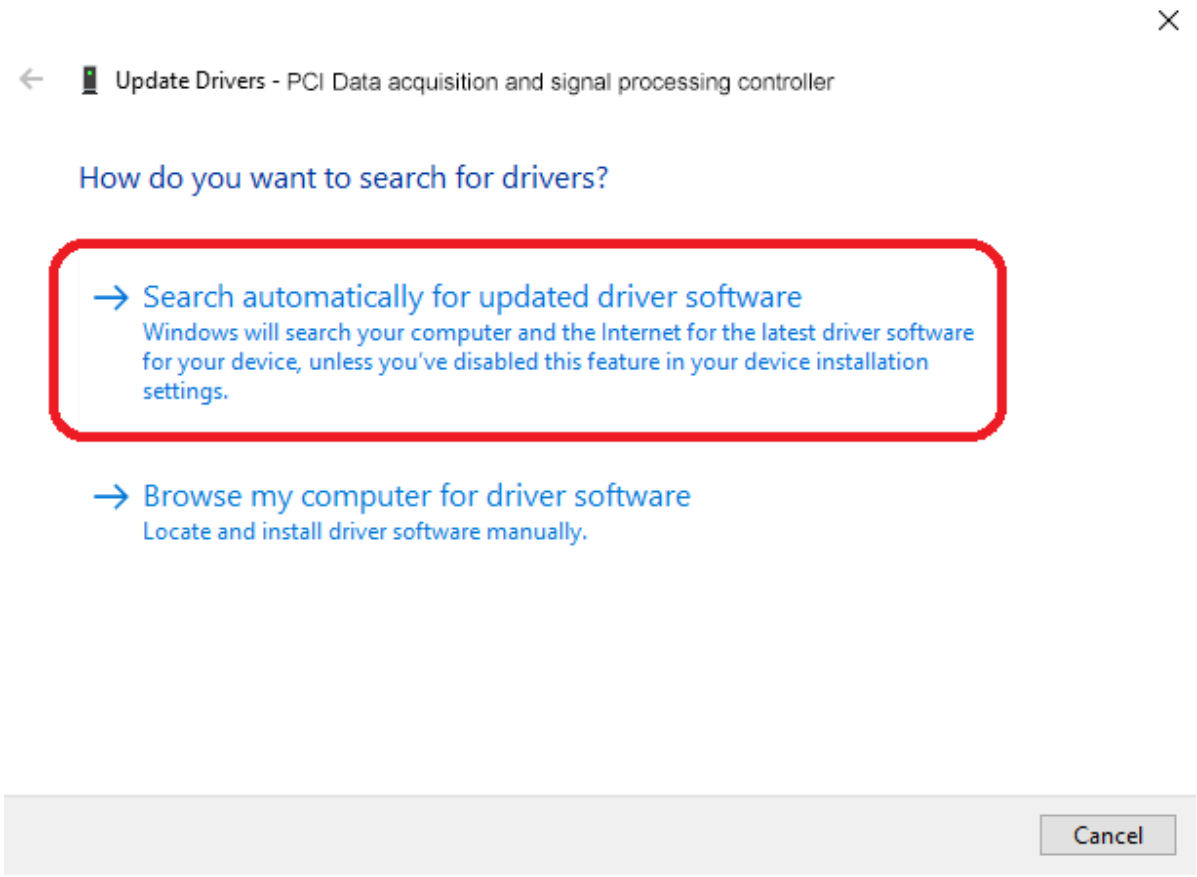

Figure 2.4 Browse my computer for driver software.

3) Then in the pop-up dialog box, click "Browse" button, locate the operating system version folder corresponding to the driver, and then click "Next", as shown in Figure 2.5.

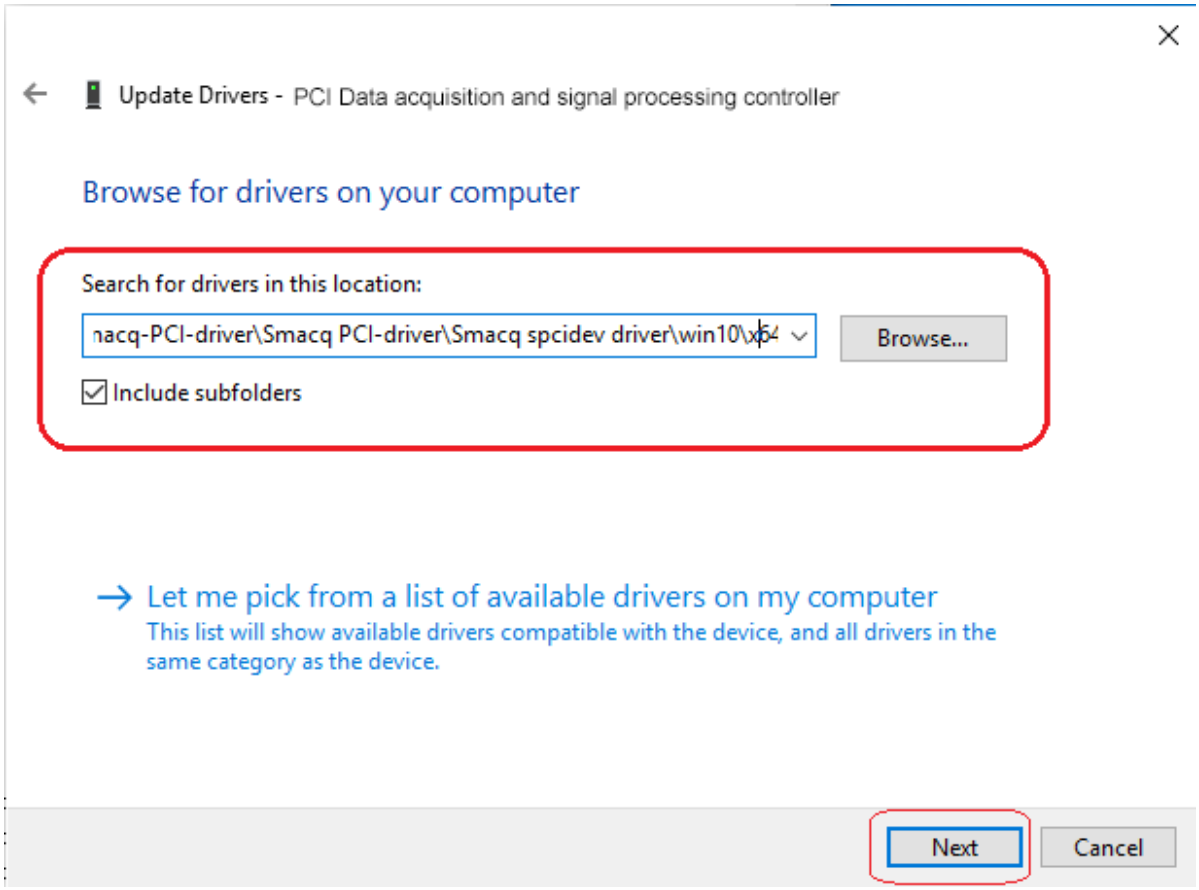

Figure 2.5 Locate the folder where the driver is located.

4) The computer starts to enter the driver installation process. After the installation is successful, the dialog box shown in Figure 2.6 below pops up, and the driver installation is completed.

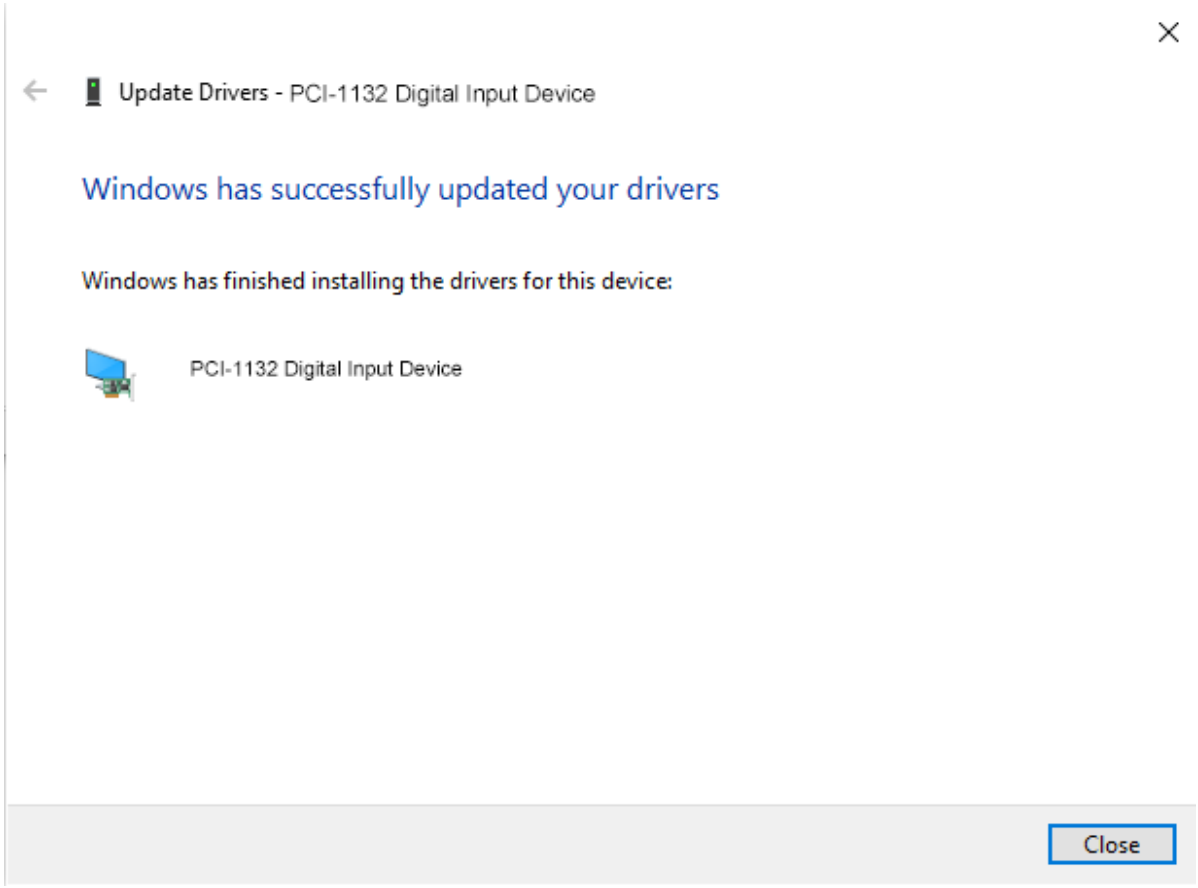

Figure 2.6 Driver installation is complete.

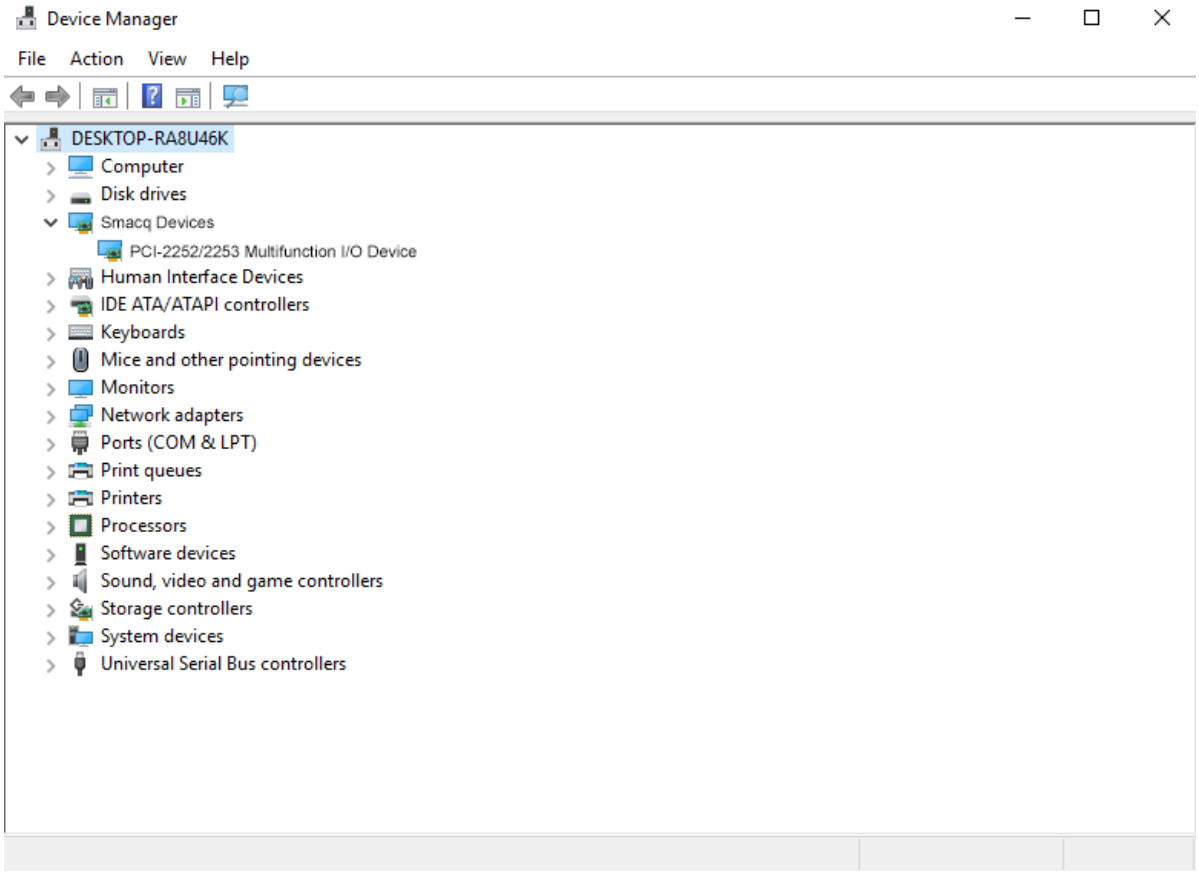

Figure 2.7 Device Manager after successful driver installation

3. Digital Input（DI）

This chapter introduces the digital input signal acquisition on PCI-1316 data acquisition devices. DI is the abbreviation of Digital Input here.

3.1. Schematic diagram of digital input circuit

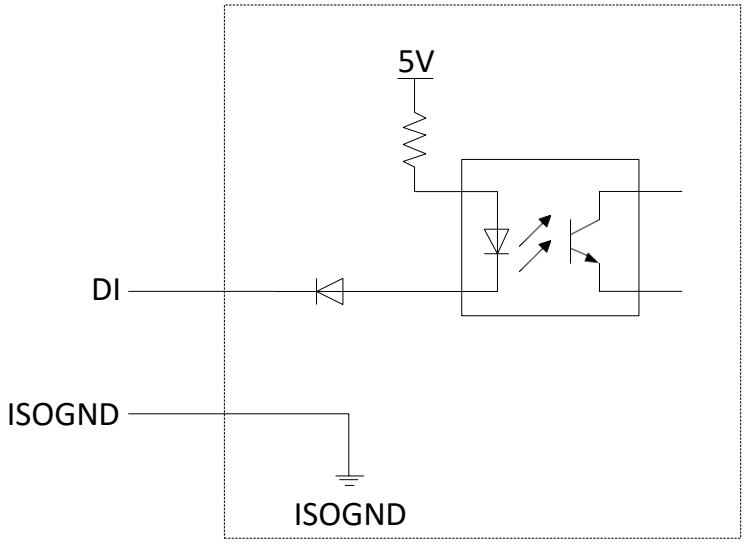

Figure 3.1 Schematic diagram of digital input circuit

3.2. Digital sensitivity

The setting of digital input sensitivity is to filter the input level jitter of unpredictable length, such as the jitter caused by button switch. Sensitivity is set in time units. For example, the default value of digital input sensitivity of PCI-1316 is 20ms, and its function mode is shown in Figure 3.2 below.

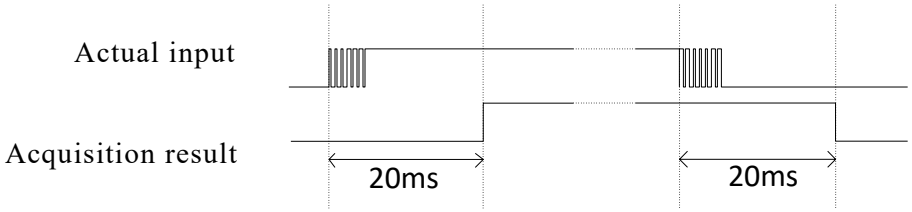

Figure 3.2 Schematic diagram of function mode of digital sensitivity

Take the default value of 20ms as an example. When PCI-1316 detects that the level of the actual input port changes, it starts timing. When it reaches 20ms, it takes the current level state of the actual input port as the acquisition result.

3.3. Signal acquisition mode

PCI-1316 data acquisition device supports the following three acquisition modes when performing DI acquisition:

- Continuous acquisition mode
- Limited collection mode (OneShot mode)
- Single read

The sampling rate of the first two modes adopts hardware timing.The limited number acquisition mode is called OneShot mode.

Hardware timing

Hardware timing refers to the sampling rate of the sample acquired by DI. It is controlled by the hardware digital signal (DI sampling clock). This signal can be generated internally.

Continuous acquisition mode

The continuous acquisition mode refers to continuous and uninterrupted data acquisition at a set sampling speed.

In the continuous acquisition mode, after the DI acquisition triggers, the acquisition device collects the signal at a fixed sampling speed, buffers it in the FIFO, and continuously uploads the data in the FIFO to the computer memory buffer. The user program only needs to continuously process the data in memory to achieve continuous uninterrupted data collection.

If the user program could not process the data fast enough, the data will gradually fill up the 2M points of storage space in the computer's memory buffer. After filling it up, the new data cannot be written into memory buffer correctly, resulting in data discontinuity.

Limited number acquisition mode

Limited number of acquisition modes (OneShotmode) refers to one-time acquisition of the set number of collection points at the set sampling speed.

In OneShot mode, after the DI acquisition triggers, the acquisition device will start acquiring set number of data at the set sampling speed and stop the acquisition automatically after. The user program only needs to read the set data amount from the computer memory buffer.

Attention The number of set collection points cannot exceed 2MPts.

Single read

Single read refers to reading the status of the current digital input port once. No trigger is required for a single read.

3.4. Trigger

The PCI-1316 series data acquisition device provides rich trigger options. The DI acquisition trigger options are shown in Figure 3.3.

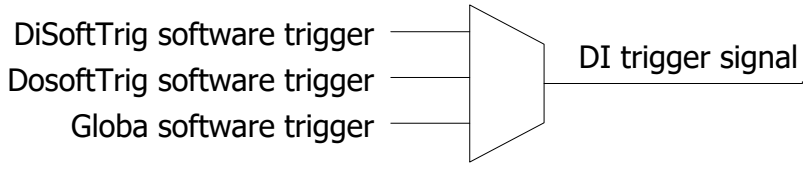

Figure 3.3 DI trigger options

The DI acquisition uses the DiSoftTrig software trigger as the trigger source by default. The DI acquisition can use other trigger sources via software settings to achieve the synchronization of each function.

DiSoftTrig software trigger and DosoftTrig software trigger are software triggers, which are used to send a command to the acquisition device to initiate device triggering.

Clear Trigger

Trigger status can be reset to an untriggered state via software settings.

3.5. Counting edge

Counting edge means that every DI channel can count the edges on the DI input port, each DI channel has a 32-bit counter, and each channel can independently set whether to count the rising edge or the falling edge.

The schematic diagram of rising edge counting principle is shown in Figure 3.4.

Attention Counting edge function is to make counting edge for the collected results after digital input sensitivity filtering.

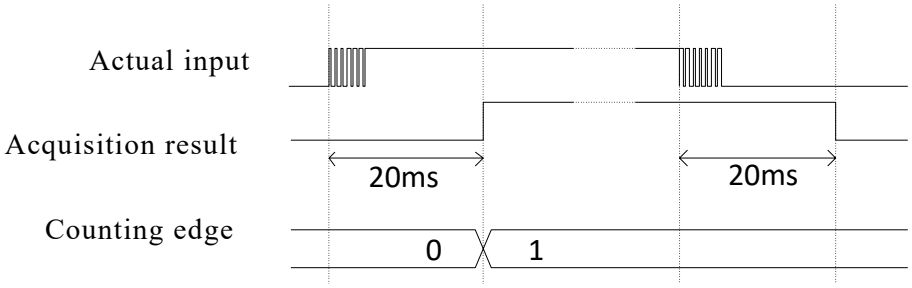

Figure 3.4 The schematic diagram of rising edge counting principle

3.6. Interrupt

All DI input channels of PCI-1316 can be set as bit interrupt sources, and can also be set as high-level interrupt or low-level interrupt at will.

Through the dll and functions provided by us, users can implement custom interrupt service functions. Please refer to the corresponding routine for detailed usage methods.

4. Digital Output（DO）

This chapter introduces the digital signal output for the PCI-1316 data acquisition device. The digital input is referred to as DO here, the abbreviation of Digital Output.

4.1. Schematic diagram of digital output circuit

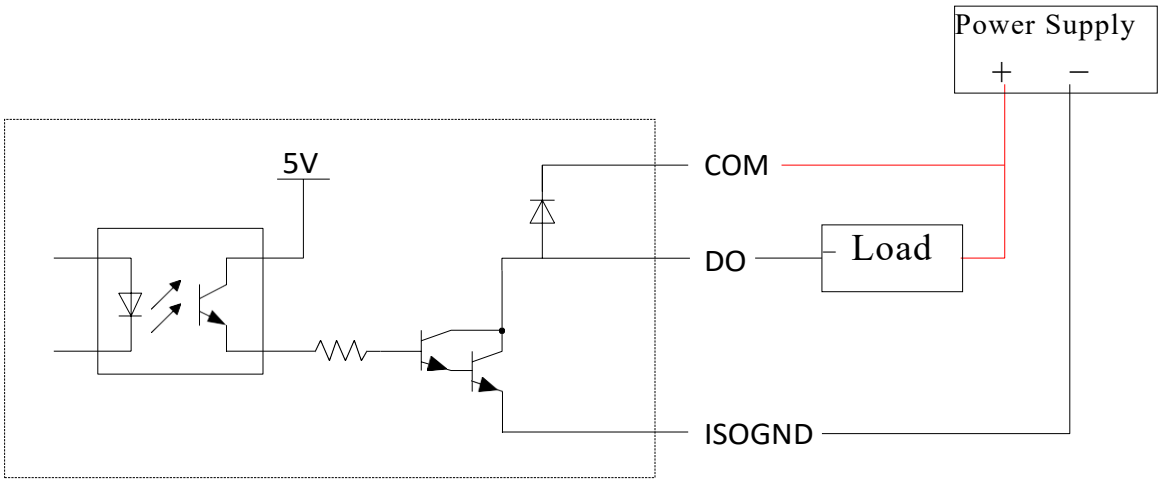

Figure 4.1 Schematic diagram of digital output circuit

4.2. Signal output mode

When the PCI-1316 data acquisition device is utilized for digital output, the following three output modes are supported:

- Immediate output
- Finite length waveform output
- Infinite loop waveform output

The sampling rate of the latter two modes adopts hardware timing.

Immediate output

Immediate output refers to the output state without buffer and no waveform. The computer sends a command to the acquisition device, and it immediately outputs the specified level state.

Hardware timing

Hardware timing means that the sampling rate of DO output is controlled by hardware digital signal (DO sampling clock), which is generated internally by the acquisition device.

Finite length waveform output

Limited-length waveform output means that the computer first sends the specified length of waveform points to the acquisition device. When DO acquisition is triggered, the acquisition device starts to output waveforms according to the set sampling speed. When the output waveform cycle number reaches the set cycle number, the acquisition device automatically stops outputting.

Attention

- The length of the number of waveform points cannot exceed 2048 points.
- WWhen the number of waveform cycles is set to bit 0, the acquisition device will always output the waveform cyclically.

Infinite loop waveform output

Unlimited waveform output refers to the output of waveforms of infinite length. At this time, the computer is required to send the latest waveform points to the acquisition device at the set speed, and the acquisition device will output the latest waveform points at the set sampling speed. Please refer to the response routine for details.

4.3. Trigger

The PCI-1316 of data acquisition devices provide a rich set of trigger options, as shown in Figure 4.2, which describes trigger options for the DO output.

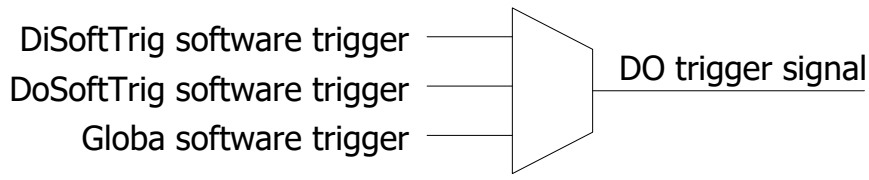

Figure 4.2 DO trigger options

The DI acquisition uses the DiSoftTrig software trigger as the trigger source by default..You can set DO output to use other trigger sources to achieve the synchronization of each function via software settings.

The DiSoftTrig software trigger,DoSoftTrig software trigger and the Global software trigger are both software triggers, which means the computer sends a command to the data acquisition device to achieve device triggering.

Clear trigger

Trigger status can be reset to an untriggered state via software settings.

5. Register address mapping

Address mapping should be applied to lower-level programming development. Before that, developers should be familiar with the principles of computer system and PCI interface. Therefore, in the Windows system environment, we recommend developers to use the drivers and dll provided by us to develop the devices.

All registers in the device are 32-bit wide, some registers use all 32-bits, and some registers only use a part of them. The register addresses given in this paper are all offset addresses.

Later, by default, developers are already familiar with the principle of computer system and PCI interface, so the related terms and reading and writing methods will not be described in detail.

5.1. PCI register

Offset Address	Name	R/W	Explain
0x0000	Interrupt state	R/W	Bit-0: DMA completes the interrupt, 1 means an interrupt is generated, and 0 means no interrupt is generated. Bit-1:An interrupt is generated about the DI electrical level, 1 means an interrupt is generated, and 0 means no interrupt is generated.
0x0004	Interrupt enable	R/W	Bit-0: DMA completes the interrupt enable, 1 means an interrupt is generated, and 0 means no interrupt is generated. Bit-1:An interrupt enable is generated about the DI electrical level, 1 means an interrupt is generated, and 0 means no interrupt is generated.
0x0008	DMA transfer destination header address	R/W	When the device performs DMA transfer, it corresponds to the first address of the computer memory target.
0x000C	DMA transfer length	R/W	Actual DMA transfer length, in DWORD.
0x0010	DMA transfer counter	R/W	Actual DMA transfer length, in DWORD.

5.2. DI digital input register

Offset Address	Name	R/W	Explain
0x0200	DiReady	R/W	DI function configuration completion flag, 1 means to start waiting for triggering, and 0 means that the configuration has not been completed.
0x0204	Di acquisition mode	R/W	0: Software-initiated single point read 1. Hardware timing limited number of acquisitions 2. Hardware timing continuous acquisition
0x0208	Di sampling period	R/W	Di acquisition period, in 20ns. Di acquisition actual period = this register value * 20ns
0x020C	Di limited number of collection points	R/W	Di collects points for a limited number of times.
0x0210	Di acquisition clock source	R/W	0: external clock. 1: internal clock.
0x0214	Di trigger source	R/W	See the trigger source chapter later.
0x0218	Di single point reading	R	Read the current Di status.
0x021C	Di interrupt level	R/W	Set the level at which Di generates an interrupt. Each bit represents the interrupt level of the corresponding channel, 1 represents the high-level interrupt and 0 represents the low-level interrupt.
0x0220	Di interrupt channel	R/W	Channels that can generate interrupts. Each bit represents the corresponding channel, 1 means an interrupt is generated, and 0 means no interrupt is generated.
0x0224	Di sensitivity count value	R/W	Set the Di sensitivity in 20ns. Di actual sensitivity = this register value * 20ns

Offset Address	Name	R/W	Explain
0x0228	Di counter enable	R/W	1 means to start the counting function, and 0 means to turn it off.
0x022C	Di counting edge	R/W	Set whether the Di counter is rising edge counting or falling edge counting. Each bit represents the corresponding channel, 1 represents the rising edge count, and 0 represents the falling edge count.
0x0230	Di 0 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0234	Di 1 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0238	Di 2 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x023C	Di 3 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0240	Di 4 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0244	Di 5 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0248	Di 6 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x024C	Di 7 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0250	Di 8 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0254	Di 9 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0258	Di 10 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x025C	Di 11 counter value	R/W	R: read the current counter value. W: the counter is cleared.

Offset Address	Name	R/W	Explain
0x0260	Di 12 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0264	Di 13 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0268	Di 14 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x026C	Di 15 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0270	Di 16 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0274	Di 17 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0278	Di 18 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x027C	Di 19 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0280	Di 20 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0284	Di 21 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0288	Di 22 counter value	R/W	R: read the current counter value. W: the counter is cleared.

Offset Address	Name	R/W	Explain
0x028C	Di 23 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0290	Di 24 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0294	Di 25 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x0298	Di 26 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x029C	Di 27 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x02A0	Di 28 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x02A4	Di 29 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x02A8	Di 30 counter value	R/W	R: read the current counter value. W: the counter is cleared.
0x02AC	Di 31 counter value	R/W	R: read the current counter value. W: the counter is cleared.

5.3. DO digital output register

Offset Address	Name	R/W	Explain
0x1300	DoReady	R/W	DO function configuration completion flag, 1 means to start waiting for triggering, and 0 means that the configuration has not been completed
0x1304	Do output mode	R/W	0: Direct output. 1: waveform output ncycle 2: Infinite non-cyclic waveform output.
0x1308	Do sampling period	R/W	Do acquisition period, in 20ns. Do acquisition actual period = this register value * 20ns
0x130C	Do limited number of collection points	R/W	Do collects points for a limited number of times.
0x1310	Do acquisition clock source	R/W	0: external clock. 1: internal clock.
0x1314	Do trigger source	R/W	See the trigger source chapter later.
0x1318	Do direct output value	R/W	Do direct output value.
0x131C	Do wave table FIFO	W	writes a point into the Do wave table.
0x1320	Empty Do wave table	W	Empty Do wave table

6. Service and Warranty

Beijing Smacq Technology Co., Ltd. is committed to its products during the warranty period, if the product fails under normal use in warranty, we will repair or replace defected parts for free. Please refer to the warranty explanation in the box for detailed instructions.

In addition to the warranties mentioned in this manual and the warranty note, we do not provide any other warranties, express or implied, including, but not limited to, any implied warranties as to the tradable nature of the product and the suitability of the special purpose.

To get more technical support and service details, or if you have any questions about using this product and this document, you are welcome to contact us:

Phone: (+86)10 - 52482802
E-mail: service@smacq.com
Website: http://www.smacq.com
http://www.smacq.cn

7. Ordering Information

Host

Model	Notes
PCI-1316	16-DI, 16-DO, input and output are photoelectric isolated.

Optional accessories

Model	Notes
DB37CB-1.5M	DB37 connecting line, double male, 1.5m.
DB37TB	End board, DIN guide rail installation