

# **PCI-3000 Series Multifunctional Data Acquisition Devices**

## **User 's Manual**

Rev: A

**Smacq**

**Smacq Technologies. Co., Ltd**

**Smacq.com**

**Smacq.cn**

# Statement

## Copyright

© 2019 Smacq Technologies. Co., Ltd. All rights reserved.

Without prior consent and written permission, no content of this manual may be copied, modified, or deleted.

## Trademark information

**Smaq** It is a registered trademark of Smacq Technologies. Co., Ltd.

The other products and company names mentioned in this document are trademarks or business names of their respective companies.

## Other statements

- The information provided in this document may be modified and updated in subsequent versions without prior notice.
- Smacq Technologies. Co., Ltd. does not provide any express or implied warranties with respect to this document and the information contained therein, including but limited to implied warranties of the marketability and suitability for a particular purpose of the product.
- Smacq Technologies. Co., Ltd. shall not be liable for any errors or inaccurate descriptions that may be contained in this document, or for any incidental or consequential damages resulting from the information and functions provided in the manual, or from the use of this document.
- Smacq Technologies. Co., Ltd. reserves the right to change product specifications, prices, and decide whether to discontinue production.

## Contact us

If you have any questions or need assistance while using this product or this document, please contact us via:

Phone: (86-10) 52482802

E-mail: [service@smacq.com](mailto:service@smacq.com)

Website: <http://www.smaq.com>  
<http://www.smaq.cn>

# Safety requirements



Warning: Only connect voltage within the specified range. If the voltage exceeds the specified range, it may cause equipment damage and even affect personal safety. The voltage range that can be connected to each port is detailed in the product specification section.



Warning: Do not attempt to operate the device in any other way not mentioned in this document. Incorrect operation of equipment may pose a danger. When the equipment is damaged, the internal security protection mechanism will also be affected.



Warning: Do not attempt to replace device components or modify the device using other methods not mentioned in this document. Do not repair the product yourself when it malfunctions.



Warning: Do not use the equipment in environments where explosions may occur or in the presence of flammable smoke. If necessary for such environments, please place the device in a suitable enclosure.



Warning: During the operation of the warning device, all chassis covers and filling panels must be closed.



Warning: For equipment with exhaust vents, do not insert foreign objects into the vents or block the air flow through the vents.

# Measurement category



**Warning:** This device can only be used in measurement category I (CAT I). Do not use this device to connect signals or perform measurements in measurement categories II/III/IV.

## Measurement category description

Measurement Category I (CAT I) refers to measurements taken on circuits that are not directly connected to the main power supply. For example, measuring circuits that are not derived from the main power source, especially circuits derived from protected (internal) main power sources. In the latter case, the instantaneous stress will change. Therefore, users should understand the instantaneous tolerance of the device.

Measurement Category II (CAT II) refers to measurements taken on circuits directly connected to low-voltage equipment. For example, measuring household appliances, portable tools, and similar devices.

Measurement Category III (CAT III) refers to measurements conducted in building equipment. For example, measurements are taken on distribution boards, circuit breakers, circuits (including cables, busbars, junction boxes, switches, sockets) in fixed equipment, as well as industrial equipment and certain other devices (such as fixed motors permanently connected to fixed installations).

Measurement category IV (CAT IV) refers to measurements taken at the source of low-voltage equipment. For example, measurements taken on electricity meters, primary over Current protection equipment, and pulse control units.

# Environment

Temperature	
Operation	0°C~55°C
Storage	-40°C~85°C
Humidity	
Operation	5% RH~95% RH, non-condensing
Storage	5% RH~95% RH, non-condensing
Pollution level	2
Highest altitude	2000m

## Pollution level description

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

Pollution level 2: Generally only dry non-conductive pollution occurs. Sometimes temporary conduction may occur due to condensation. For example: general indoor environment.

Pollution level 3: Conductive pollution occurs, or dry non-conductive pollution becomes conductive due to condensation. For example, an outdoor environment with a canopy.

Pollution Level 4: Permanent conductive pollution caused by conductive dust, rainwater, or snow. For example: outdoor places.

## Recycling precautions



**Warning:** Some substances contained in this product may be harmful to the environment or human health. To avoid releasing harmful substances into the environment or endangering human health, it is recommended to recycle this product using appropriate methods to ensure that most materials can be reused or recycled correctly. For information on handling or recycling, please contact local professional organizations.

# CONTENT

<b>Statement .....</b>	<b>1</b>
<b>Safety requirements.....</b>	<b>2</b>
<b>Measurement category .....</b>	<b>3</b>
Measurement category description .....	3
<b>Environment.....</b>	<b>4</b>
Pollution level description.....	4
Recycling precautions.....	4
<b>1. Getting Started.....</b>	<b>7</b>
<b>1.1. Product introduction .....</b>	<b>7</b>
<b>1.2. Function Diagram.....</b>	<b>9</b>
<b>1.3. Product specifications.....</b>	<b>9</b>
<b>2. Product unpacking and packing list.....</b>	<b>12</b>
<b>2.1. Product unboxing.....</b>	<b>12</b>
<b>2.2. Check the packing list.....</b>	<b>12</b>
<b>2.3. Packing list.....</b>	<b>12</b>
<b>3. Installation.....</b>	<b>13</b>
<b>3.1. Connector signal pins distribution .....</b>	<b>13</b>
<b>3.2. Drive installation.....</b>	<b>15</b>
<b>4. Analog Input (AI).....</b>	<b>17</b>
<b>4.1. Signal Connection Mode.....</b>	<b>17</b>
<b>4.2. Floating grounded signal source.....</b>	<b>18</b>
● Using differential mode (DIFF) connection.....	18
● Non-grounding reference single-ended mode (RSE) connection .....	20
<b>4.3. Grounded Signal Source.....</b>	<b>20</b>
● Use a differential mode (DIFF) .....	20
● Use a non-grounded reference single-ended mode (NRSE) .....	21
<b>4.4. Signal acquisition mode .....</b>	<b>22</b>
● Hardware timing mode .....	22
● Continuous acquisition mode.....	22
● Limited number acquisition mode.....	22
● Single read .....	22
<b>4.5. Sampling rate setting.....</b>	<b>22</b>
<b>4.6. Trigger.....</b>	<b>23</b>

● Clear trigger .....	23
5. Analog Output (AO).....	24
5.1. Signal output mode.....	24
● DC immediate output .....	24
● Finite number output mode .....	24
● Infinite loop output mode.....	24
● Infinite non-loop output mode .....	24
5.2. Output update rate .....	25
5.3. Trigger.....	25
● Clear trigger .....	25
6. Digital Input (DI) .....	26
6.1. Signal acquisition mode .....	26
● Hardware timing .....	26
● Continuous acquisition mode.....	26
● Limited number acquisition mode.....	26
6.2. Trigger.....	27
● Clear Trigger.....	27
7. Digital Output (DO).....	28
7.1. Signal output mode.....	28
● Immediate output .....	28
● Hardware timing .....	28
● Finite number output mode .....	28
● Infinite loop output mode.....	28
● Infinite non-loop output mode .....	29
7.2. Output update rate .....	29
7.3. Trigger.....	29
● Clear trigger .....	29
8. Synchronization System.....	30
8.1. Synchronous clock .....	30
8.2. External trigger input.....	30
8.3. Trigger output .....	30
9. After sales service and warranty.....	31
10. Ordering Information.....	32
11. Document Revision History.....	33

# 1. Getting Started

This chapter describes the basic functions of PCI-3000 Series Data Acquisition Device, as well as product specifications and precautions in the process of product unpacking.

## 1.1. Product introduction

PCI-3000 Series data acquisition device is based on PCI bus interface. When connected to the computer, it can be used for continuous high-speed signal acquisition and high-speed control signal output.

PCI-3000 series of data acquisition devices can measure analog and digital signals continuously and save the data to the computer hard drive without interruption. It can also provide digital signal output, periodic repetitive signal output, and high-speed uninterrupted non-repetitive signal output controlled by a computer.

PCI-3000 series data acquisition device supports operating in Windows OS, providing standard DLLs and support for mainstream development languages including VC++, VB, C#, LabVIEW.

PCI-3000 series data acquisition device provides multiple models, in terms of function and performance. For detailed reference, please turn to Chapter 1.3 for specification description of each model.

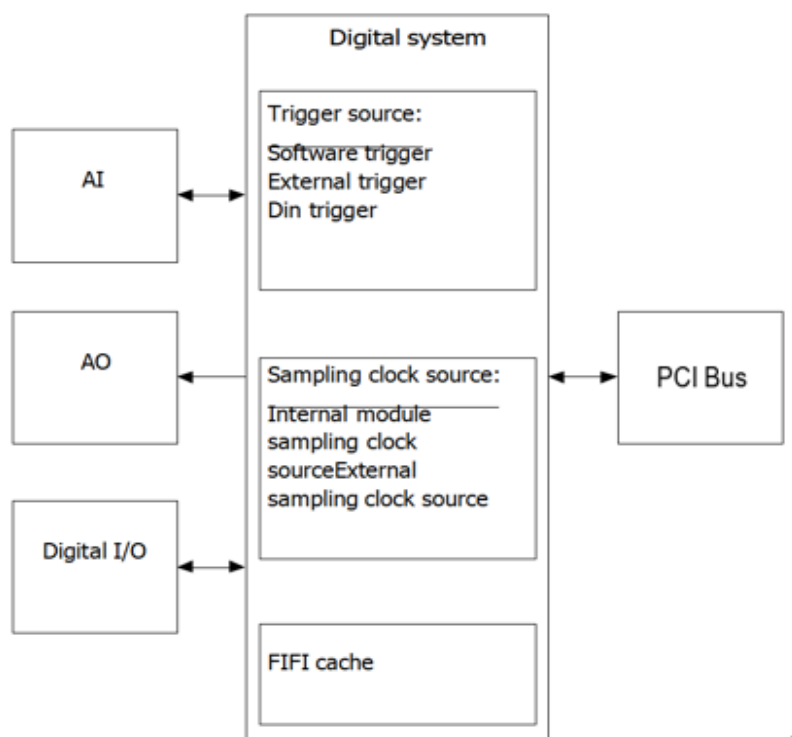
## Key Features

- 16-bit analog input resolution, support continuous uninterrupted acquisition
- Analog input sampling rate up to 1MS/s/
- Analog input channel supports range setting  $\pm 10V/\pm 5V/\pm 2.5V/\pm 1.25V/\pm 0.6V$
- Analog input mode supports Difference and Single end
- 16-bit analog output resolution, with output range of  $\pm 10V$
- Analog output sampling rate up to 1MS/s/
- Up to 10MS/s/Ch sampling rate for digital I/O

PCI-3000 series data acquisition device contains several models, and the main differences of each models are as follows:

Model	Resolution	Sampling rate	AI	AO	DI	DO
PCI-3210	16-bit	125kSa/s	8-RSE   4-DIFF	-	8-ch	8-ch
PCI-3211	16-bit	250kSa/s	8-RSE   4-DIFF	-	8-ch	8-ch
PCI-3212	16-bit	500kSa/s	8-RSE   4-DIFF	-	8-ch	8-ch
PCI-3213	16-bit	1MSa/s	8-RSE   4-DIFF	-	8-ch	8-ch
PCI-3220	16-bit	125kSa/s	16-RSE   8-DIFF	-	8-ch	8-ch
PCI-3221	16-bit	250kSa/s	16-RSE   8-DIFF	-	8-ch	8-ch
PCI-3222	16-bit	500kSa/s	16-RSE   8-DIFF	-	8-ch	8-ch
PCI-3223	16-bit	1MSa/s	16-RSE   8-DIFF	-	8-ch	8-ch
PCI-3110	16-bit	125kSa/s (AO: 1MSa/s)	8-RSE   4-DIFF	2-ch	8-ch	8-ch
PCI-3111	16-bit	250kSa/s (AO: 1MSa/s)	8-RSE   4-DIFF	2-ch	8-ch	8-ch
PCI-3112	16-bit	500kSa/s (AO: 1MSa/s)	8-RSE   4-DIFF	2-ch	8-ch	8-ch
PCI-3113	16-bit	1MSa/s (AO: 1MSa/s)	8-RSE   4-DIFF	2-ch	8-ch	8-ch
PCI-3120	16-bit	125kSa/s (AO: 1MSa/s)	16-RSE   8-DIFF	2-ch	8-ch	8-ch
PCI-3121	16-bit	250kSa/s (AO: 1MSa/s)	16-RSE   8-DIFF	2-ch	8-ch	8-ch
PCI-3122	16-bit	500kSa/s (AO: 1MSa/s)	16-RSE   8-DIFF	2-ch	8-ch	8-ch
PCI-3123	16-bit	1MSa/s (AO: 1MSa/s)	16-RSE   8-DIFF	2-ch	8-ch	8-ch

## 1.2. Function Diagram



PCI-3000 series data acquisition device functions schematic

## 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.

### Analog input

Channel	PCI-3210/3211/3212/3213/3110/3111/3112/3113: 8 Single-Ended / 4 Difference PCI-3220/3221/3222/3223/3120/3121/3122/3123: 16 Single-Ended / 8 Difference
ADC type	SAR
Resolution	16-Bit
Sampling rate (Use channel equal allocation)	PCI-3213/3223/3113/3123: 1MS/s, continuous PCI-3212/3222/3112/3122: 500kS/s, continuous PCI-3211/3221/3111/3121: 250kS/s, continuous PCI-3210/3220/3110/3120: 125kS/s, continuous
Timing resolution	10ns
Channel synchronization	No
Range	$\pm 10.24V/\pm 5.12V/\pm 2.56V/\pm 1.28V/\pm 0.64V$
Input coupling mode	DC
Input impedance	Single end: 1M $\Omega$ Different: 500k $\Omega$
Small signal bandwidth(-3dB)	1MHz
Input bias current	200mA
Analog input max voltage	$\pm 12V$

Software FIFO	2 MPts/Ch
Hardware FIFO	4096 Pts
Analog input mode	Continuous / Oneshot / Single read

#### **Analog input accuracy** (With temperature coefficient of 5 ppm/°C)

Range	Gain error (ppm of reading)	Zero offset (ppm of range)	Random noise ( $\mu$ V rms)	Full range absolute accuracy ( $\mu$ V)
$\pm 10.24$ V	20	10	195	820
$\pm 5.12$ V	50	15	110	550
$\pm 2.56$ V	55	30	70	215
$\pm 1.28$ V	100	60	60	220
$\pm 0.64$ V	200	120	50	100

#### **Analog output**

Channel	2
Resolution	16-bit
DNL	$\pm 1$ LSB
Update rate	1Mpts/s
Channel synchronization	Yes
Output range	$\pm 10$ V
Output coupling	DC
Output impedance	50 $\Omega$
Output drive current	10mA
Power-on status (Within)	Software configurable
AO output mode	DC direct output Limited waveform output non-repetitive loop signals
Output voltage delay	1 $\mu$ s
Edge slope	0.7V/ $\mu$ s

#### **Analog output accuracy**

Analog output Range	$\pm 10$ V
Gain error	30 (reading's ppm)
Gain temperature coefficient	5 (reading's ppm/°C)
Offset error	50 (range's ppm)
Offset temperature coefficient	5 (range's ppm/°C)
Full range absolute precision	5 (mV)
Reference temperature coefficient	5 (ppm/°C)
INL error	120 (range's ppm)

## Digital I/O

Channel	8-channel (Software configurable DI/DO)
Ground reference	DGND
Digital input voltage	High level: 1.95~5V Low level: 0~1.2V
Digital output voltage	High level: 3.3V Low level: 0~0.003V
Digital output power-on status	Software configurable
Sampling rate	10MS/s/Ch
Timing resolution	10ns
Channel synchronization	Yes
DI software FIFO	2MPts/Ch
DI hardware FIFO	4096Pts/Ch
DI acquisition mode	Continuous / Oneshot / Single read
DOUT output mode	DC direct output Limited waveform output non-repetitive loop signals

## External trigger

Channel	1 input, 1 output
Input voltage	High level: 1.95~5V Low level: 0~1.2V
Output voltage	High level: 3.3V Low level: 0~0.003V
Output power-on status	Low level
Output edge time	Ascending edge: 6ns Descending edge: 8ns

## Calibration

Warm-up time	No less than 20Minutes (Recommended)
Calibration interval	1 year (Recommended)

## Bus interface

PCI	PCI interface
-----	---------------

## Power supply requirements

PCI interface power supply	5V / 3.3V
Typical current without load	400mA
Maximum Load	600mA

## 2. Product unpacking and packing list

### 2.1. Product unboxing

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.

### 2.2. 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.

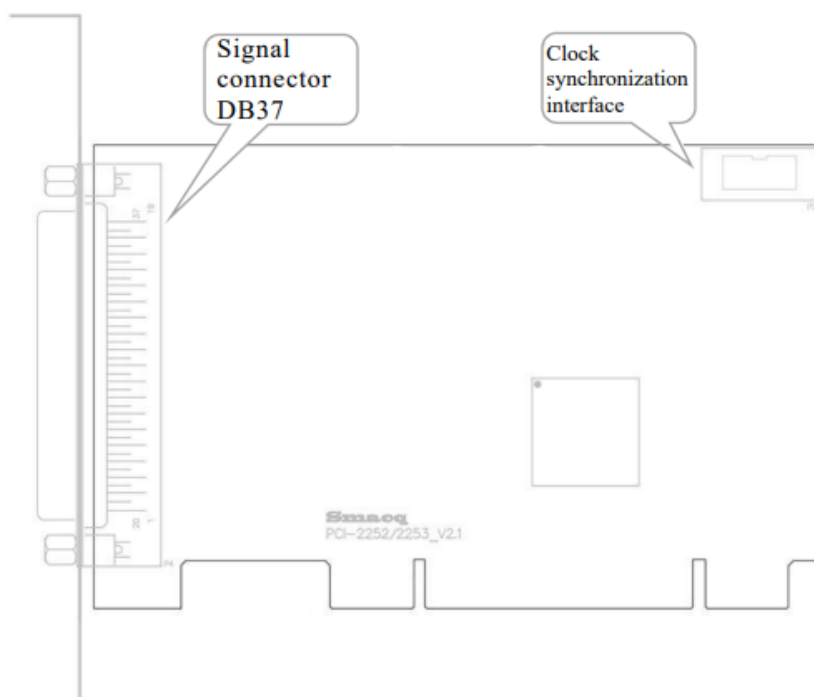
### 2.3. Packing list

Name	Specification Description	Quantity
PCI-3000 Series	PCI-3000 Series Multifunctional Data Acquisition Devices	1

# 3. Installation

This chapter describes signal connection and drive installation of PCI-3000 series.

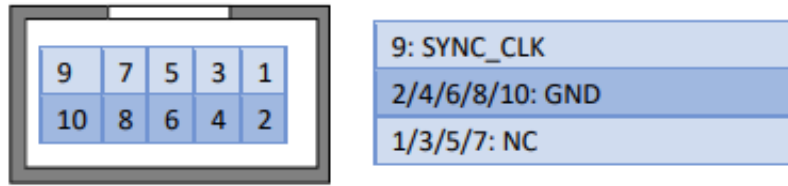
## 3.1. Connector signal pins distribution



PCI-3000 series signal pins distribution

37 : AI 7	19	19 : AI 8
36 : AI 6	18	18 : AI 9
35 : AI 5	17	17 : AI 10
34 : AI 4	16	16 : AI 11
33 : AI 3	15	15 : AI 12
32 : AI 2	14	14 : AI 13
31 : AI 1	13	13 : AI 14
30 : AI 0	12	12 : AI 15
29 : AI SENSE 0	11	11 : AI SENSE 1
28 : GND	10	10 : GND
27 : AO 1	9	9 : AO 0
26 : GND	8	8 : GND
25 : GND	7	7 : GND
24 : DIO 6	6	6 : DIO 7
23 : DIO 4	5	5 : DIO 5
22 : DIO 2	4	4 : DIO 3
21 : TRIG OUT	3	3 : DIO 1
20 : TRIG IN	2	2 : DIO 0
	1	1 : GND

Signal connector distribution diagram



Clock interface signal distribution diagram

#### Signal pin allocation list

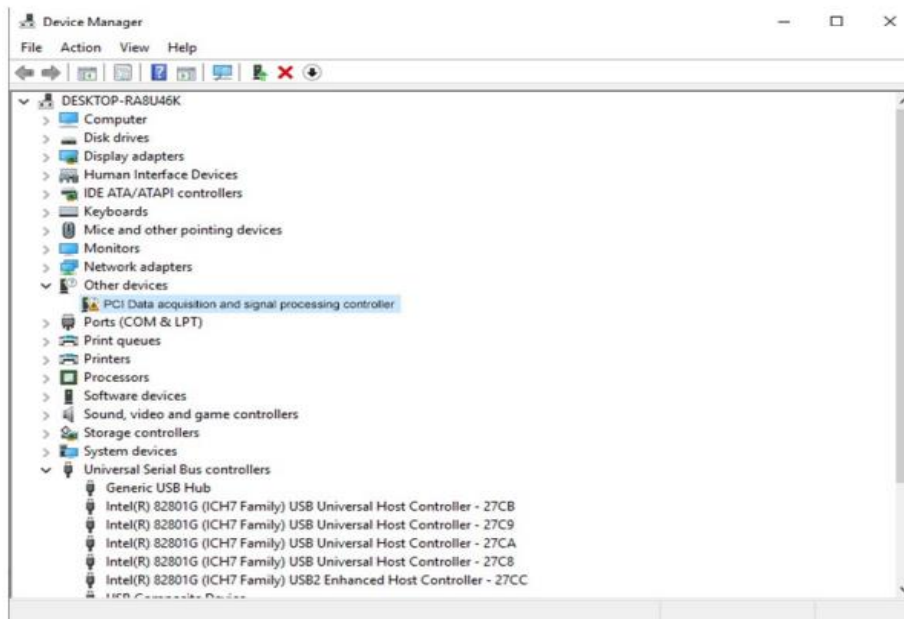
Signal name	NOTE(Single end)	NOTE(Difference)
AI0	Analog input 0	Analog input 0 +
AI1	Analog input 1	Analog input 1 +
AI2	Analog input 2	Analog input 2 +
AI3	Analog input 3	Analog input 3 +
AI4	Analog input 4	Analog input 4 +
AI5	Analog input 5	Analog input 5 +
AI6	Analog input 6	Analog input 6 +
AI7	Analog input 7	Analog input 7 +
AI8	Analog input 8	Analog input 0 -
AI9	Analog input 9	Analog input 1 -
AI10	Analog input 10	Analog input 2 -
AI11	Analog input 11	Analog input 3 -
AI12	Analog input 12	Analog input 4 -
AI13	Analog input 13	Analog input 5 -
AI14	Analog input 14	Analog input 6 -
AI15	Analog input 15	Analog input 7 -

Signal name	NOTE
AI SENSE 0	Signal negative pole of AI 0~ 7 single-ended input
AI SENSE 1	Signal negative pole of AI 8~ 15 single-ended input
AO0	Analog output 0
AO1	Analog output 1
DI/O 0	Digital input/output 0
DI/O 1	Digital input/output 1
DI/O 2	Digital input/output 2
DI/O 3	Digital input/output 3
DI/O 4	Digital input/output 4
DI/O 5	Digital input/output 5
DI/O 6	Digital input/output 6
DI/O 7	Digital input/output 7
GND	Reference ground
EXT TRIG OUT	Trigger signal output
EXT TRIG IN	External trigger signal input
SYNC_CLK	System synchronous clock input/output
NC	Not connected

## 3.2. Drive installation

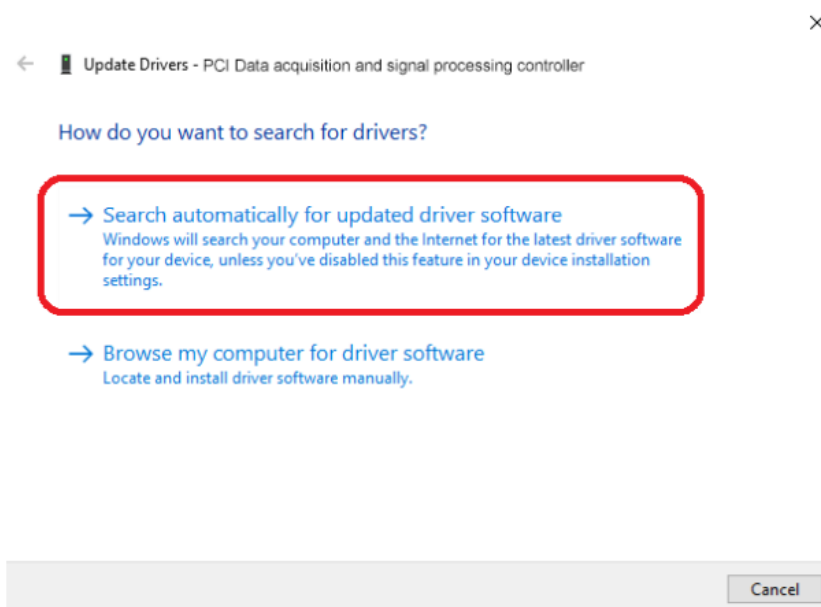
PCI-3000 series data acquisition device can be used in Windows 7 and Windows 10, including 32-bit and 64-bit. Here, taking the driver installation in Windows 10 environment as an example, we will introduce how to install the driver of PCI-1316 data acquisition device step by step. The steps of installing 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 below.



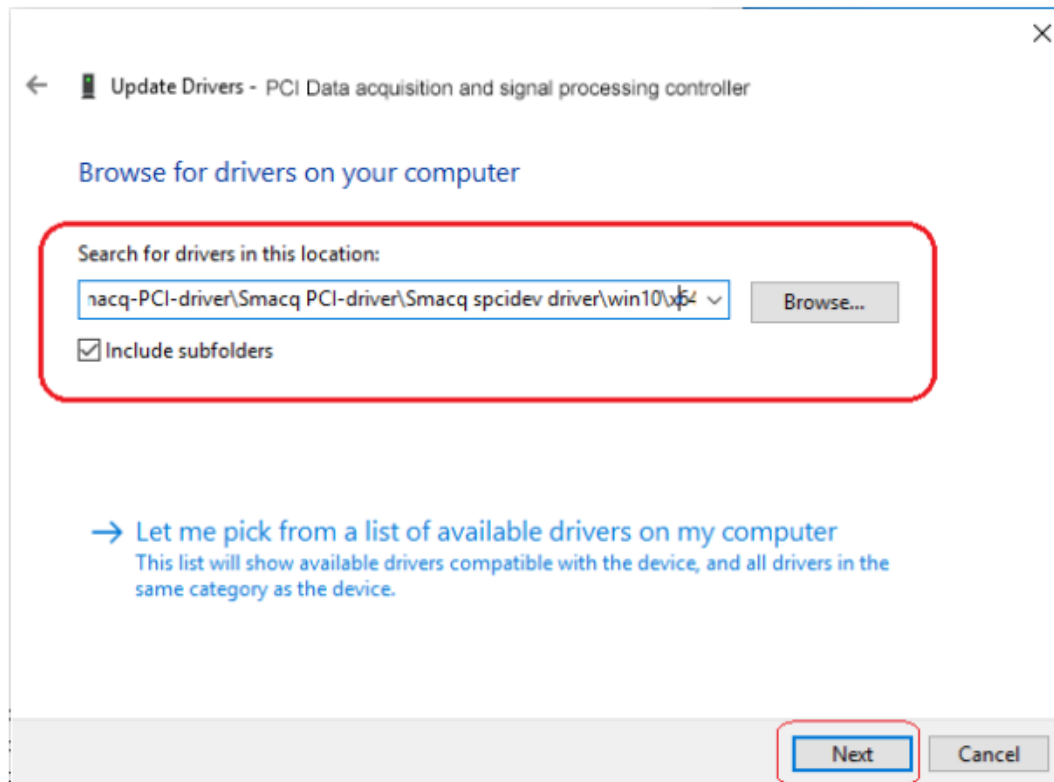
Before the driver is installed

- 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 below.



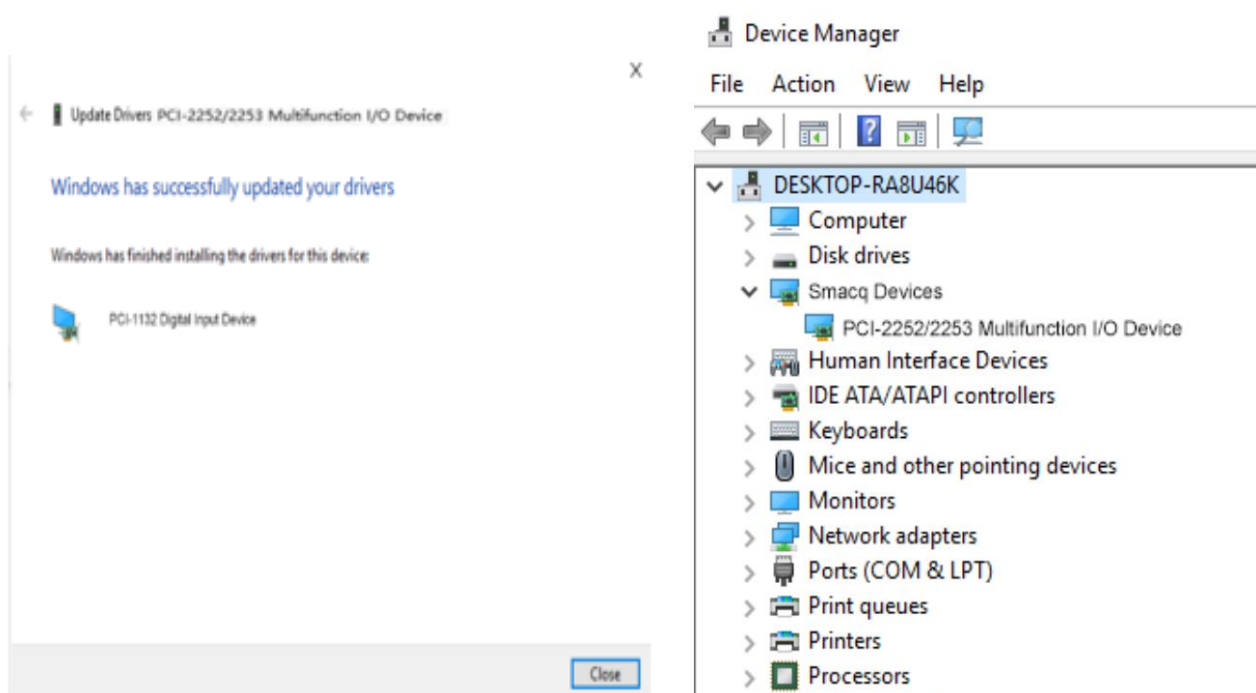
Browse my computer for driver software

- 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 below.



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 below pops up, and the driver installation is completed.



Driver installation is complete and successful

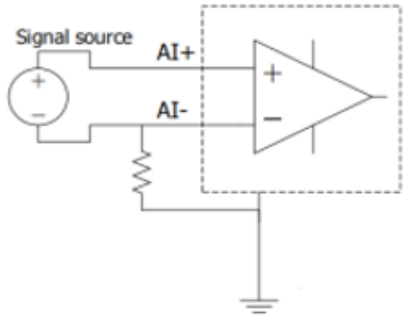
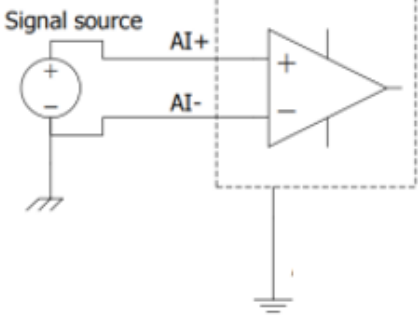
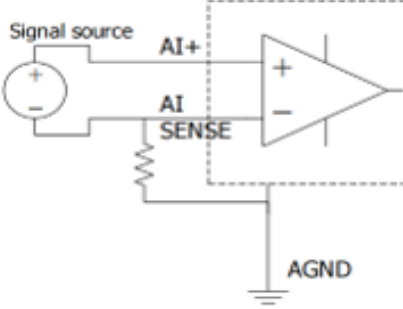
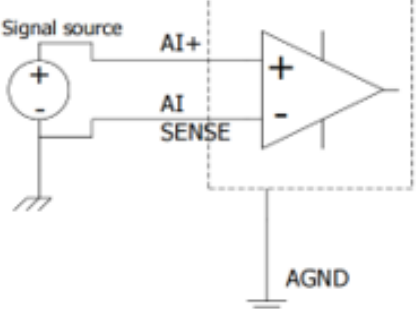
## 4. Analog Input (AI)

This chapter describes measuring the relevant content of analog input signals on PCI-3000 series data acquisition cards. AI here is short for Analog Input.

### 4.1. Signal Connection Mode

PCI-3000 series data acquisition devices support analog input acquisition connection methods of non-grounding reference single-ended input (NRSE) and differential input (DIFF).

The recommended connection methods for floating-ground and grounding signal sources list

Input mode	Floating grounded signal source (not connected to GND of the building)	Grounded signal source
Example	<ul style="list-style-type: none"> <li>• Ungrounded thermocouples</li> <li>• Signals that are isolated</li> <li>• Battery-powered devices</li> </ul>	<ul style="list-style-type: none"> <li>• Signals that are not isolated</li> </ul>
DIFF		
NRSE		

## 4.2. Floating grounded signal source

A floating grounded signal source is not connected in any way to the building ground system but, it has an isolated ground-reference point. Common floating grounded signal sources are transformers, thermocouples, battery equipment, optical isolate, and isolation amplifier output. An instrument or device with isolated output is a floating-ground signal source.

**Attention: When measuring the floating grounded signal source, it is important to connect the negative end of the signal source directly or indirectly through the resistor to the GND.**

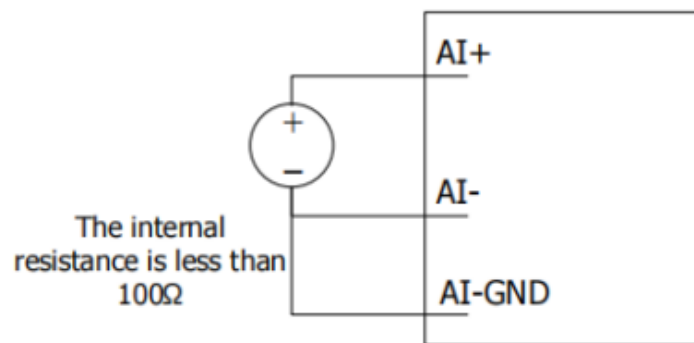
### ● Using differential mode (DIFF) connection

When any of the following conditions are true, a differential mode should be used to connect the floating signal:

- Analog input AI+ and AI- are all valid signals.
- Low input signal voltage while higher accuracy demanded
- The cable length of the connection signal to the acquisition device exceeds 3 Meters
- The input signal requires a separate ground-reference point or a return signal
- There is obvious noise in the environment of the connection wire

Differential connection mode can reduce noise interference and improve the common mode suppression ability of acquisition device.

For a floating signal source with less than  $100\Omega$  internal resistance, you can directly connect the negative end of the signal to AI- and GND ports and connect the positive end of the signal to AI+ ports, as shown below.

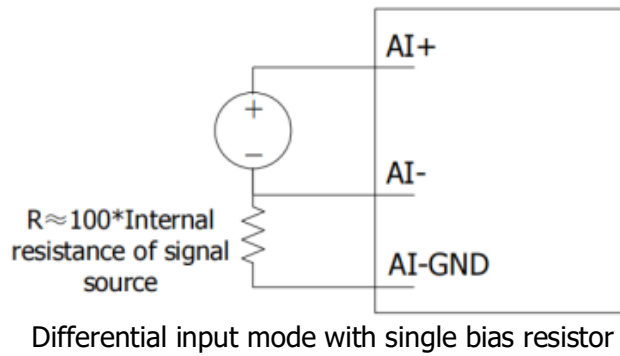


Differential input mode for direct connection

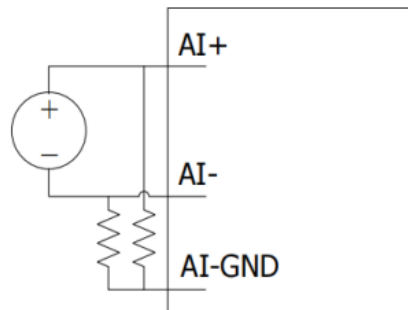
However, for a floating signal source with large internal resistance, the above connection will lead to the imbalance of differential signal, and the common-mode noise will be coupled to the signal of AI+ while not to AI-, so that the common-mode noise will appear in the measured results.

Therefore, for such a signal source, you can use a bias resistor approximately 100 times the internal resistance of the signal source to connect to AI- and GND ports.

This can make the differential signal close to equilibrium, hence couple the same amount of noise at both ends of the signal to enable better common-mode noise suppression.



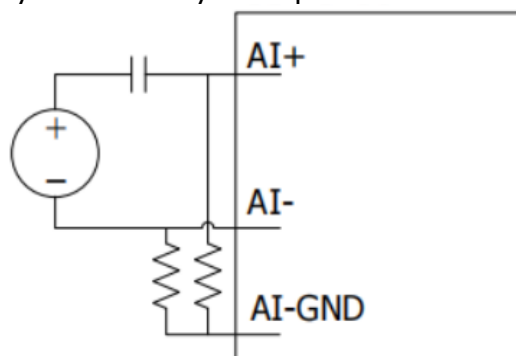
For a floating signal source with a large internal resistance, you can use the differential input mode with two bias resistors. The fully balanced bias resistor connection in this way can provide a slightly better noise suppression, but it can reduce the load on the signal source and result in gain errors. For example, suppose the internal resistance of the signal source is  $2\text{k}\Omega$ , and two equilibrium resistors are  $100\text{k}\Omega$  each, then the signal source load is  $200\text{k}\Omega$ , which results in a 1% gain error.



For AC-coupled floating signal sources, a resistor is required to provide DC loops for the positive input of instrument amplifier, AI+.

If the AC coupled float signal source has a smaller internal resistance, the AI+ and GND connection resistance values should be generally set as  $100\text{k}\Omega$  to  $1\text{M}\Omega$ . Hence, it does not aggravate the load of the signal source, nor does it generate an offset voltage due to the bias current of the instrument amplifier. In this case, you can directly connect AI- and GND.

If the internal resistance of the AC coupled floating source signal is large, the differential input mode utilizing the equilibrium bias resistor described earlier should be used, and it is important to note the gain error that may be caused by the equilibrium bias resistor.



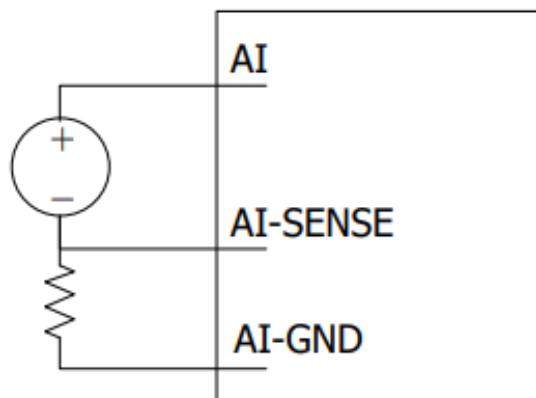
## ● Non-grounding reference single-ended mode (RSE) connection

No-Ground reference single-ended mode can be used to connect floating ground signals when all the following conditions are met:

- The input signal voltage is higher than 1V
- The length of the cable connecting signals to the acquisition device is lower than 3 meters

If the signal does not meet the above conditions, it is recommended to use a differential mode connection to ensure better signal integrity. In single-ended mode, the electrostatic noise and electromagnetic noise of the coupled input signal connection is more than that in differential mode.

Non-grounding reference single-ended mode (NRSE) connection methods are shown below.



Floating-grounded signal source RSE input

**Attention: That the resistance value setting of the grounded resistance is consistent with the that in difference mode.**

## 4.3. Grounded Signal Source

The grounded signal source is a signal source connected to the building ground. If the computer is connected to the same power supply as the signal source, the source is already connected to a common ground point relative to the device. Instruments and equipment connected to the building power supply system while with non-isolated outputs belong to this type of signal source.

The potential difference between devices connected to the power supply system of the same building is usually 1mV to 100mV, but the potential difference may be larger if the distribution line is not properly connected. If the measurement method is improper, the potential difference may cause measurement errors. Follow the connection guide for the grounded signal source below to reduce the grounded potential difference of the measured signal.

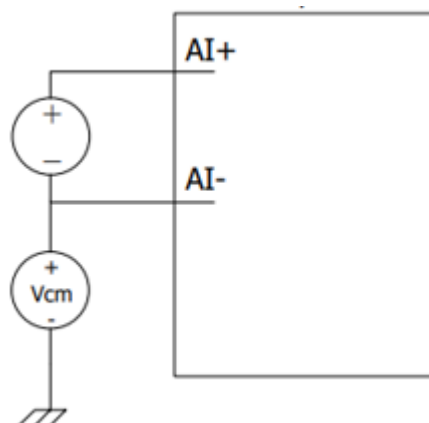
## ● Use a differential mode (DIFF)

Differential mode connection should be used when any of the following conditions is true:

- Analog input AI+ and AI- are all valid signals.
- Low input signal voltage while high accuracy demanded
- The cable connecting the signal to the acquisition device exceeds 3 meters
- The input signal requires a separate reference location or a return signal
- There is obvious noise in the environment of the signal wire

Differential connection mode can reduce noise interference and improve the common mode suppression of the acquisition device. Differential connection allows the input signal to float within the common-mode operating range of the instrument amplifier.

Shows how to use differential mode to connect the grounded signal source



Grounded signal source DIFF input

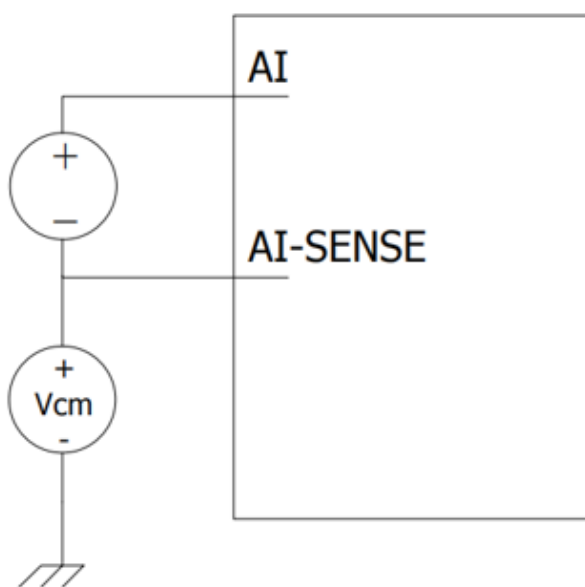
### ● Use a non-grounded reference single-ended mode (NRSE)

When all of the following conditions are true, you can connect the float signal using a non-grounded reference single-ended mode:

- The input signal voltage is higher than 1V
- The cable connecting the signal to the acquisition device is less than 3 meters
- The input signal shares a reference point whose voltage is not AGND.

If the signal does not meet the above conditions, it is recommended to use a differential mode connection to ensure better signal integrity. In single-ended mode, the electrostatic noise and electromagnetic noise of the coupled input signal connection are more than that in the difference mode.

The grounded signal source (NRSE) connection in non-grounded reference single-ended mode.



Grounded signal source NRSE input

## 4.4. Signal acquisition mode

When the PCI-3000 series data acquisition device performs analog input measurement, it supports continuous acquisition mode or limited number acquisition mode. The sampling rates of both modes are hardware timed. The limited number acquisition mode is called OneShot mode.

### ● Hardware timing mode

Hardware timing means that the sampling rate of AI acquisition is controlled by a hardware digital signal (AI sampling clock), which can be generated internally or externally.

Please refer to the chapter of "Synchronization system" for detailed settings for using externally provided sampling clocks.

### ● Continuous acquisition mode

Continuous acquisition mode refers to continuous and uninterrupted collection of data at defined sampling speed.

In continuous acquisition mode, after the AI acquisition is triggered, the acquisition device collects the signal at a fixed sampling speed, buffers data into 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 acquisition.

If the user program does not process the data fast enough, the data will gradually fill the 2M points of storage space in computer memory buffer. New data cannot be written correctly after the memory is filled up, resulting in discontinuous data.

### ● Limited number acquisition mode

Limited number acquisition mode (OneShot mode) refers to one time acquisition to get the set number of collection points at the set sampling speed

In OneShot mode, after the AI acquisition triggers, the acquisition device automatically stops the acquisition after the acquisition reaches the set number of times according to the set sampling speed. The user program only needs to read the set data amount from the computer memory buffer.

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

### ● Single read

Single point reading refers to the conversion of the selected channel and reading its conversion results.

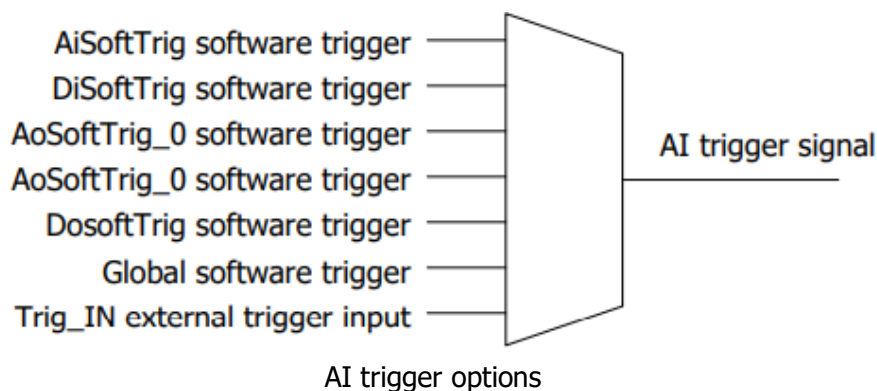
## 4.5. Sampling rate setting

When the PCI-3000 series data acquisition device collects in a single channel, the channel can achieve the maximum sampling rate.

If two channels are enabled for one acquisition, the sample rate for each channel is half the set sample rate; if three channels are enabled, the sample rate for each channel is one third of the set sample rate. When you have more channels, the calculation method is like this.

## 4.6. Trigger

The PCI-3000 series data acquisition device provides rich trigger options. The schematic diagram of the AI acquisition trigger options.



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

AiSoftTrig software trigger and GlobalSoftTrig global software trigger are software triggers, which are used to send a command to the acquisition device to initiate device triggering.

Ext\_Trig\_IN external trigger means that when Ext\_Trig\_IN receives a rising edge, the device triggers.

### ● Clear trigger

The AI trigger status can be reset to an untriggered state by software settings.

## 5. Analog Output (AO)

This chapter introduces the analog signal output on PCI-2253 series data acquisition devices. AO is the abbreviation of Analog Output here.

### 5.1. Signal output mode

When the PCI-3000 series data acquisition device is utilized for analog output, the following four output modes are supported:

The limited output mode and infinite cycle output mode are collectively called n-cycle mode. When the output number n-cycle is set to 0, AO works in the infinite cycle output mode; When the output number n-cycle setting is greater than 0, AO works in the limited output mode.

#### ● DC immediate output

DC 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 voltage.

**Attention: The specified voltage cannot exceed the DAQ range of AO output. If exceeded, it will generate errors.**

#### ● Finite number output mode

The limited number of output modes means that the waveform data to be output is first stored in the hardware FIFO, then the output sampling rate is set, the number of times the waveform needs to be output is set, and the channel for outputting the digital waveform is set. After the AO output is triggered, the capture card begins to output a digital waveform in accordance with the set parameters. After the set number of outputs is reached, the capture card stops outputting the digital waveform.

**Attention: When the specified number of outputs is completed, the AO output level state stays at the level defined by the last point of the waveform data.**

#### ● Infinite loop output mode

Infinite loop output mode means that the digital waveform data to be output is first stored in the hardware FIFO, and then the output sampling rate is set. After the AO is triggered, the acquisition device starts to output the digital waveform according to the set parameters, and continuously loops the output until the AO triggers cleared to an untriggered state.

**Attention: After clearing the AO trigger to the untriggered state, the AO output level state stays at the level state at which the AO trigger is cleared.**

#### ● Infinite non-loop output mode

The infinite non-loop output mode refers to a waveform in which the AO output exceeds the length of the hardware FIFO space, and the computer transfers the data in batches to the AO hardware FIFO.

For example, a waveform with a length of 1M point needs to be output at a sampling rate of 10kSa/s, and the AO hardware FIFO space is only 2k points, so the waveform of 1M point length needs to be transferred to the AO hardware FIFO in 500 times. The 2k point data in the hardware

FIFO, with an output sampling rate of 10kSa/s, can be transmitted in 0.2 seconds. Therefore, the computer must start a new data transmission in less than 0.2 seconds to ensure the continuity of AO output waveform.

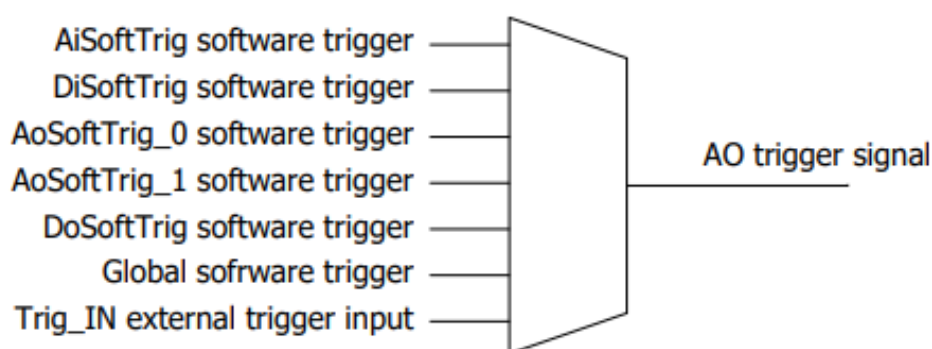
When the waveform output in the hardware FIFO is complete and no new data arrives, the AO output level state will remain at the level defined by the last point.

## 5.2. Output update rate

PCI-3000 series data acquisition device can reach an AO output update rate up to 1MSa/s/Ch, which is also the DAC output sampling rate.

## 5.3. Trigger

The PCI-3000 series of data acquisition devices provide a rich set of trigger options, which describes trigger options for the AO output.



Trigger options for an AO output channel

The AO output uses the channel exclusive software trigger signal AiSoftTrig as the trigger source by default. You can set AO output to use other trigger sources to achieve the synchronization of each function via software settings.

software triggers, which means the computer sends a command to the data acquisition device to achieve device triggering.

Ext\_Trig\_IN external trigger means that when Ext\_Trig\_IN receives a rising edge, the device triggers.

### ● Clear trigger

The AO trigger status can be reset to an untriggered state via software settings.

## 6. Digital Input (DI)

This chapter introduces the digital input signal acquisition on PCI-3000 series data acquisition cards. DI is the abbreviation of Digital Input here.

### 6.1. Signal acquisition mode

When the PCI-3000 series data acquisition device performs DI acquisition, it supports continuous acquisition mode or limited number acquisition mode:

- Continuous acquisition mode
- Limited collection 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 or externally.

For details on using an externally supplied sampling clock, refer to the "Synchronization System" chapter.

#### ● 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

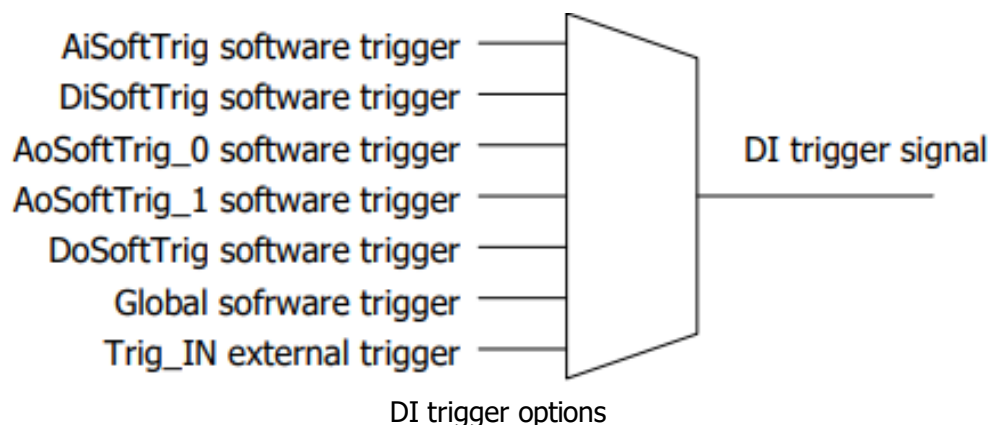
Limited number of acquisition modes (OneShot mode) refers to one-time acquisition of the set number of collection points at the set sampling speed.

In OneShot mode, after the DI acquisition triggers, the acquisition card will start acquiring set amount 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.**

## 6.2. Trigger

The PCI-3000 series data acquisition device provides rich trigger options. The DI acquisition trigger options are shown below.



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 GlobalSoftTrig global software trigger are software triggers, which are used to send a command to the acquisition device to initiate device triggering.

Ext\_Trig\_IN external trigger means that when Ext\_Trig\_IN receives a rising edge, the device triggers. T

### ● Clear Trigger

The DI trigger status can be reset to an untriggered state via software settings.

# 7. Digital Output (DO)

This chapter introduces the digital signal output for the PCI-3000 series data acquisition device. The digital input is referred to as DO here, the abbreviation of Digital Output.

## 7.1. Signal output mode

When the PCI-3000 series data acquisition card is utilized for digital output, the following four output modes are supported:

- Immediate output
- Finite number output
- Unlimited number of loop output
- Infinite non-loop output

The limited output mode and infinite cycle output mode are collectively called n-cycle mode. When the output number n-cycle is set to 0, DO works in the infinite cycle output mode; When the output number n-cycle setting is greater than 0, DO works in the limited output mode.

### ● 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

The three output modes mentioned below refer to the mode of outputting digital waveforms, so the sampling rate of the output waveform is an important parameter. When the acquisition device is in DO mode, the DO sampling clock is generated by hardware timing. The sampling clock signal can be generated internally or externally.

For details on using an externally supplied sampling clock, refer to the "Synchronization System" chapter.

### ● Finite number output mode

The limited number of output modes means that the digital waveform data to be output is first stored in the hardware FIFO, then the output sampling rate is set, the number of times the waveform needs to be output is set, and the channel for outputting the digital waveform is set.

After the DO output is triggered, the capture card begins to output a digital waveform in accordance with the set parameters. After the set number of outputs is reached, the capture card stops outputting the digital waveform.

**Attention When the specified number of outputs is completed, the DO output level state stays at the level defined by the last point of the waveform data.**

### ● Infinite loop output mode

Infinite loop output mode means that the digital waveform data to be output is first stored in the hardware FIFO, and then the output sampling rate is set. After the DO is triggered, the acquisition device starts to output the digital waveform according to the set parameters, and continuously loops the output until the DO triggers cleared to an untriggered state.

**Attention After clearing the DO trigger to the untriggered state, the DO output level state stays at the level state at which the DO trigger is cleared.**

## ● Infinite non-loop output mode

The infinite loop output mode refers to a waveform in which the DO output exceeds the length of the hardware FIFO space, and the computer transfers the data in batches to the DO hardware FIFO.

For example, a waveform with a length of 1M point needs to be output at a sampling rate of 10kSa/s, and the DO hardware FIFO space is only 2k points, so the waveform of 1M point length needs to be transferred to the DO hardware FIFO 500 times. The 2k point data in the hardware FIFO, with an output sampling rate of 10kSa/s, can be transmitted in 0.2 seconds. Therefore, the computer must start a new data transmission in less than 0.2 seconds to ensure the continuity of DO output waveform.

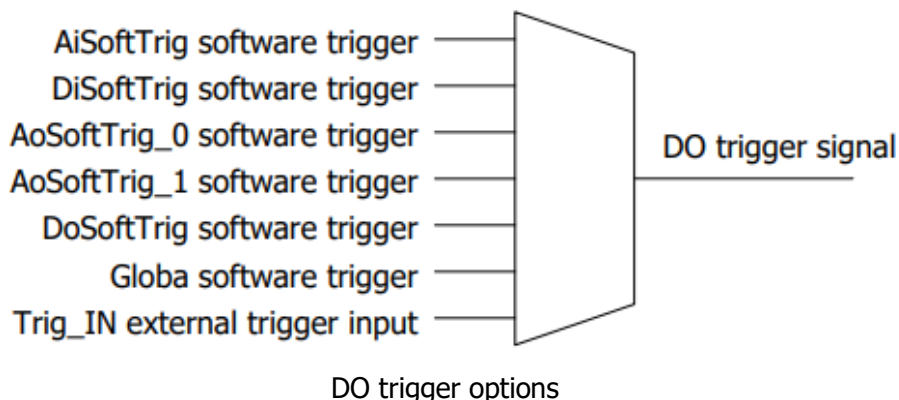
When the waveform output in the hardware FIFO is complete and no new data arrives, the DO output level state will remain at the level defined by the last point.

## 7.2. Output update rate

PCI-3000 series data acquisition device DO output update rate can reach up to 10MSa/ s/Ch.

## 7.3. Trigger

The PCI-3000 series of data acquisition devices provide a rich set of trigger options, as shown below, which describes trigger options for the DO output.



The DO output uses the channel exclusive software trigger signal DoSoftTrig 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 DoSoftTrig software trigger and the GlobalSoftTrig global software trigger are both software triggers, which means the computer sends a command to the data acquisition device to achieve device triggering.

Ext\_Trig\_IN external trigger means that when Ext\_Trig\_IN receives a rising edge, the device triggers.

## ● Clear trigger

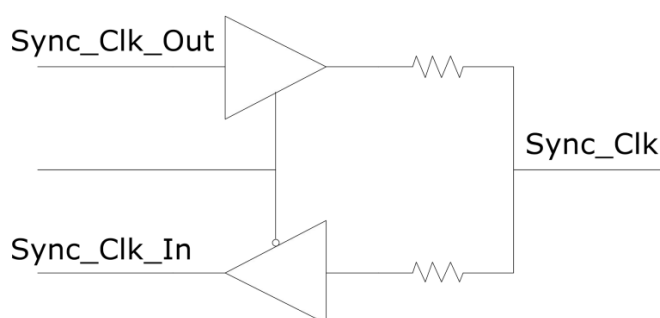
The DO trigger status can be reset to an untriggered state via software settings.

## 8. Synchronization System

This chapter introduces the multi-card synchronization system of the PCI-3000 series data acquisition device. The synchronous system has three ports, synchronous clock, external trigger input, and trigger output.

### 8.1. Synchronous clock

The synchronous clock is the key signal to ensure the synchronization of multiple devices, which is used to eliminate clock errors among multiple devices. The synchronous clock port of PCI-3000 data acquisition device can be set as input or output by software, and the default setting for power-on is input. The circuit diagram of the synchronous clock port is shown below.



The circuit diagram of the synchronous clock port

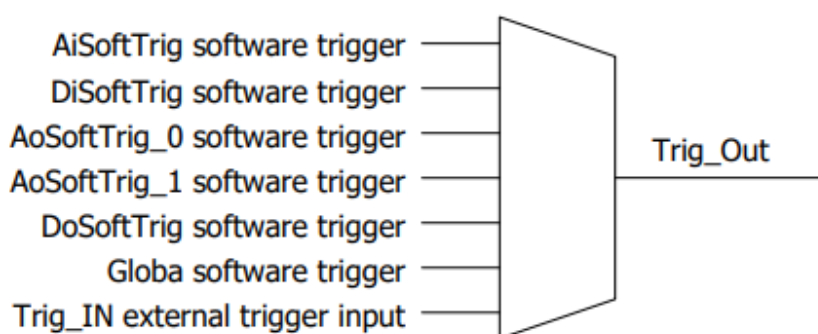
### 8.2. External trigger input

External trigger input can realize synchronous triggering of multiple devices. The trigger source of each function of the acquisition device can choose the external trigger input pin Trig\_In as the trigger source.

### 8.3. Trigger output

When the trigger signal of the specified function is set as the output source, the Trig\_Out pin will output a high-level pulse with a duration of 1us while the function is triggered.

The circuit diagram of the external trigger output Trig\_Out is shown below. The following sources can be selected as output options:



External trigger output circuit

## 9. After sales service and warranty

Smacq Technologies. Co., Ltd. promises that its products are under warranty. If the product malfunctions during normal use, we will provide free repair or replacement of parts for the user. For detailed warranty instructions, please refer to the warranty instructions inside the packaging box.

Except for the warranties mentioned in this manual and warranty instructions, our company does not provide any other express or implied warranties, including but not limited to any implied warranties regarding the merchant ability and fitness for a particular purpose of the product.

For more technical support and service details, or if you have any questions while using this product and this document, please feel free to contact us:

Phone: (86-10) 52482802

E-mail: [service@smacq.com](mailto:service@smacq.com)

Website: <http://www.smacq.com>  
<http://www.smacq.cn>

# 10. Ordering Information

## Main Equipment

Model	Notes
PCI-3210	8-AI (125kS/s), 8-DIO
PCI-3211	8-AI (250kS/s), 8-DIO
PCI-3212	8-AI (500kS/s), 8-DIO
PCI-3213	8-AI(1MS/s), 8-DIO
PCI-3220	16-AI (125kS/s), 8-DIO
PCI-3221	16-AI (250kS/s), 8-DIO
PCI-3222	16-AI (500kS/s), 8-DIO
PCI-3223	16-AI (1MS/s), 8-DIO
PCI-3110	8-AI (125kS/s), 2-AO, 8-DIO
PCI-3111	8-AI (250kS/s), 2-AO, 8-DIO
PCI-3112	8-AI (500kS/s), 2-AO, 8-DIO
PCI-3113	8-AI(1MS/s), 2-AO, 8-DIO
PCI-3120	16-AI (125kS/s), 2-AO, 8-DIO
PCI-3121	16-AI (250kS/s), 2-AO, 8-DIO
PCI-3122	16-AI (500kS/s), 2-AO, 8-DIO
PCI-3123	16-AI (1MS/s), 2-AO, 8-DIO

## Optional accessories

Model	Notes
DB37CB	DB37 connecting line, double male, 1.5m
DB37TB	End board, DIN guide rail installation
CHF-100B	Current sensor, 100A, DC~20kHz, output $\pm 4v$
CHV-600VD	Voltage sensor, 600V, DC~20kHz, isolated Diff-input, output $\pm 5v$

# 11. Document Revision History

Date	Edition	Remarks
2020.03.19	Rev: A	First release