USB-5100 Series Multifunctional Data Acquisition Devices

User 's Manual

Rev: C

Smacq Technologies. Co., Ltd
Smacq.com
Smacq.cn

Statement

Copyright

Trademark information

Smacq 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
Website: http://www.smacq.com
http://www.smacq.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

Statement **1**
Copyright 1
Trademark information 1
Other statements 1
Contact us 1
Safety requirements **2**
Measurement category **2**
Environment **4**
1. Getting Started **7**
1.1. Product introduction 7
1.2. Function Diagram 8
1.3. Product specifications 8
2. Product unpacking and packing list **12**
2.1. Product unboxing 12
2.2. Check the packing list 12
2.3. Packing list 12
3. Installation **13**
3.1. Connector signal pins distribution 13
3.2. USB cable reinforcement design 14
3.3. Drive installation 15
4. Analog Input (AI) **16**
4.1. Circuit diagram 16
4.2. Signal Connection Mode 16
4.3. Signal acquisition mode 16
- Hardware timing mode 16
- Continuous acquisition mode 16
- Limited number acquisition mode 17

4.4. AI sampling clock 17
4.5. Trigger 18
- Clear trigger 19
- Pre-trigger 19

5. Analog Output (AO) **20**
5.1. Circuit diagram 20
5.2. Signal output mode 20
- DC immediate output 20
- Hardware timing 20
- Finite number output mode 20
- Infinite loop output mode 21
- Infinite non-loop output mode 21

5.3. Output update rate 21
- Synchronous update 21

5.4. AO sampling clock 21
5.5. Trigger 22
- Clear trigger 22

6. Digital Input (DI) 23
6.1. Signal acquisition mode 23
- Hardware timing 23
- Continuous acquisition mode 23
- Limited number acquisition mode 23

6.2. Sampling rate 24
6.3. DI sampling clock 24
6.4. Trigger 25
- Clear Trigger 25
- Pre-Trigger 26

7. Digital Output (DO) 27
7.1. Signal output mode 27
- Immediate output 27
- Hardware timing 27
- Finite number output mode 27
- Infinite loop output mode 27
- Infinite non-loop output mode 28

7.2. Output update rate 28
7.3. DO sampling clock 28
7.4. Trigger 29
- Clear trigger 29

8. Synchronization System 30
8.1. Sampling clock 30
8.2. External trigger 31

9. After sales service and warranty 32

10. Ordering Information 33

11. Document Revision History 34

1. Getting Started

This chapter describes the basic functions of USB-5100 Series Data Acquisition Device, as well as product specifications and precautions in the process of product unpacking.

1.1. Product introduction

USB-5100 Series data acquisition device is the multifunctional data acquisition device based on high-speed USB2.0 interface. When connected to the computer, it can be used for continuous high-speed signal acquisition and high-speed control signal output.

USB-5100 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.

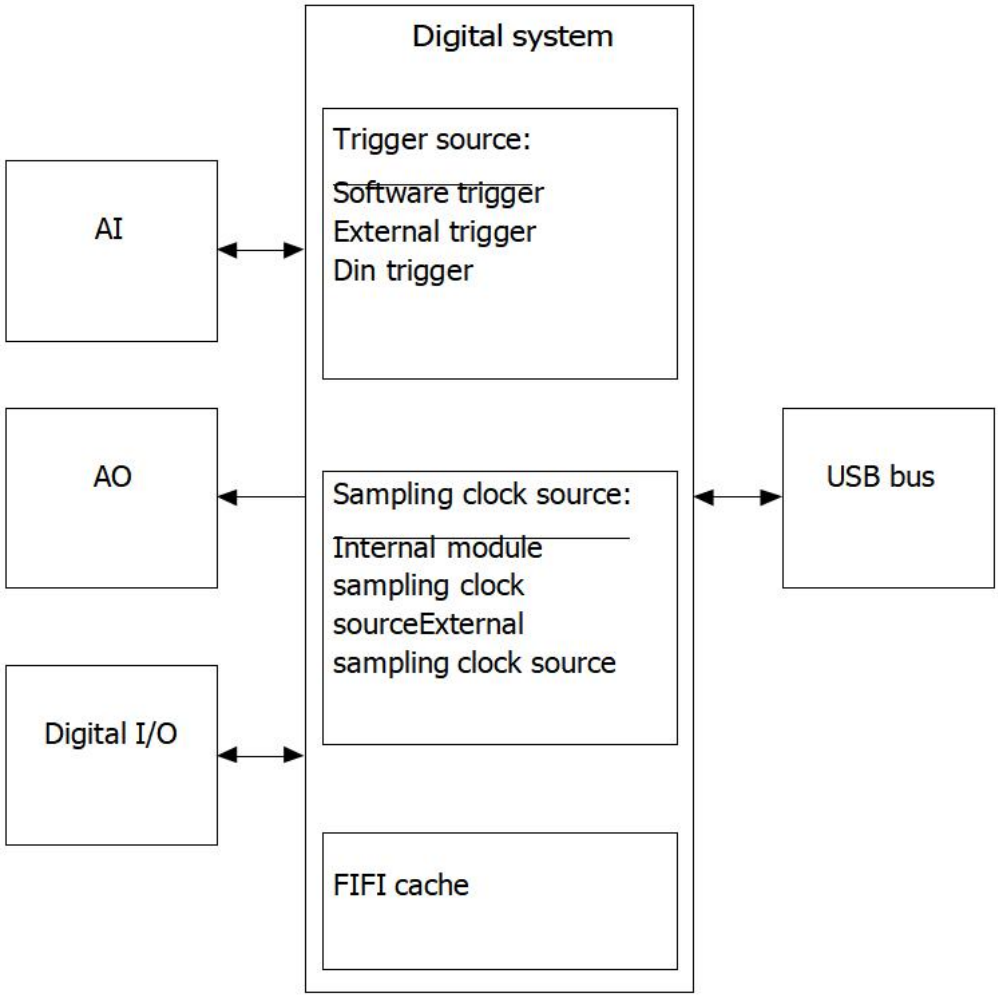
USB-5100 series data acquisition device supports operating in Windows OS, providing standard DLLs and support for mainstream development languages including VC++, VB, C#, LabVIEW, and MATLAB.

USB-5100 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

- High speed USB interface, Plug and Play, USB powered
- 16-bit analog input resolution, support continuous uninterrupted acquisition
- Analog input supports up to 16 channels of synchronous sampling and up to 500kS/s/Ch
- 16-bit analog output resolution, with output range of ±10V
- Support 4 channel synchronous analog output, up to 100kS/s sampling rate
- Support continuous analog output of nonrepetitive arbitrary waveforms of infinite length
- Up to 10MS/s/Ch sampling rate for digital I/O

1.2. Function Diagram



USB-5100 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(Single End)	USB-5120/5121/5120/5521/5320/5321: 16-CH USB-5110/5111/5510/5511/5310/5311: 8-CH
ADC type	SAR
Resolution	USB-5120/5121/5510/5111: 16-Bit USB-5510/5521/5511/5520: 14-Bit USB-5320/5321/5310/5311: 12-Bit
Sampling rate	USB-5311/5321/5511/5521/5111/5121: 500kS/s/Ch, continuous USB-5120/5110/5520/5510/5320/5310: 250kS/s/Ch, continuous
Timing resolution	10ns
Channel synchronization	Yes
Range	±10V / ±5V
Input coupling mode	DC
Input impedance	AI+ to AI- : 10GΩ AI- to AGND : 1MΩ
Small signal bandwidth(-3dB)	450kHz
Input bias current	1uA
Analog input max voltage	±15 V
Software FIFO	2 MPts/Ch
Pre-trigger FIFO	4096 Pts
Analog input mode	Continuous mode and limited number acquisition mode

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

Range	Gain error (ppm of reading)	Zero offset (ppm of range)	Random noise (μV rms)	Full range absolute accuracy (μV)
±10 V	90	4	180	1100
±5 V	80	10	90	500

Analog output

Channel	4
Resolution	16-bit
DNL	±1 LSB
Update rate	100 kHz/Ch
Timing resolution	10ns
Channel synchronization	Yes
Input range	±10 V
Output coupling	DC
Output impedance	0.1 Ω
Output drive current	10mA
Power-on status	Within ±50mV
Hardware FIFO	2048 Pts/Ch
AO output mode	DC direct output, Onboard FIFO waveform periodic output, onboard FIFO waveform trigger N loop, non-repetitive loop signals to computer caches
Output voltage delay	4 us
Edge slope	9.2 V/us

Analog output accuracy

Analog output Range	-10V~10V
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	2 input, 2 output
Ground reference	DGND
Digital input pull-up resistance	10kΩ
Digital input voltage	High level: 1.95 V~5 V Low level: 0 V~1.2 V
Digital output voltage	High level: 3.3 V Low level: 0 V~0.003V
Digital output power-on status	Low level
DIN highest sampling rate	10MS/s/Ch
DOUT highest update rate	10MS/s/Ch
Timing resolution	10ns
Channel synchronization	Yes
DIN software FIFO	2 MPts/Ch
DIN pre-trigger FIFO	2048 Pts/Ch
DOUT hardware FIFO	2048 Pts/Ch
DIN capture mode	Continuous acquisition mode and OneShot mode
DOUT output mode	Direct output; onboard FIFO waveform periodic generation; onboard FIFO waveform trigger N loop; Uninterrupted nonrepetitive signals for computer caches
DOUT edge time	Ascending edge: 6ns Descending edge: 8ns

External trigger

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

External sampling clock I/O

Channel	1 input、1 output
Input voltage	High level: 1.95 V~5 V Low level: 0 V~1.2 V
Output voltage	High level: 3.3 V Low level: 0 V ~ 0.003 V
Output power-on status	Low level
Output frequency range	DC ~ 1 MHz
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

USB	USB2.0 High Speed interface

Power supply requirements

USB interface power supply	4.5 V ~ 5.5 V
Typical current without load	420mA
Maximum Load	620mA

Physical properties

Size (mm)	Without connectors: 150*96*28 Connectors included: 150*112*28
Weight (g)	Without connectors: about 185g Connectors included: about 230g
I/O connectors	Bolt terminals
Bolt terminal connection	16 AWG ~ 28 AWG
USB connectors	USB Type B

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
USB-5100 Series	USB-5100 Series Multifunctional Data Acquisition Devices	1
Include Attachments		
USB cable	USB cable/black/1.5 meters	1
Wiring terminals	10Pin/Green/3.81mm pitch terminal block	6

3. Installation

This chapter describes signal connection and drive installation of USB-5100 series.

3.1. Connector signal pins distribution

USB-5100 series signal pins distribution

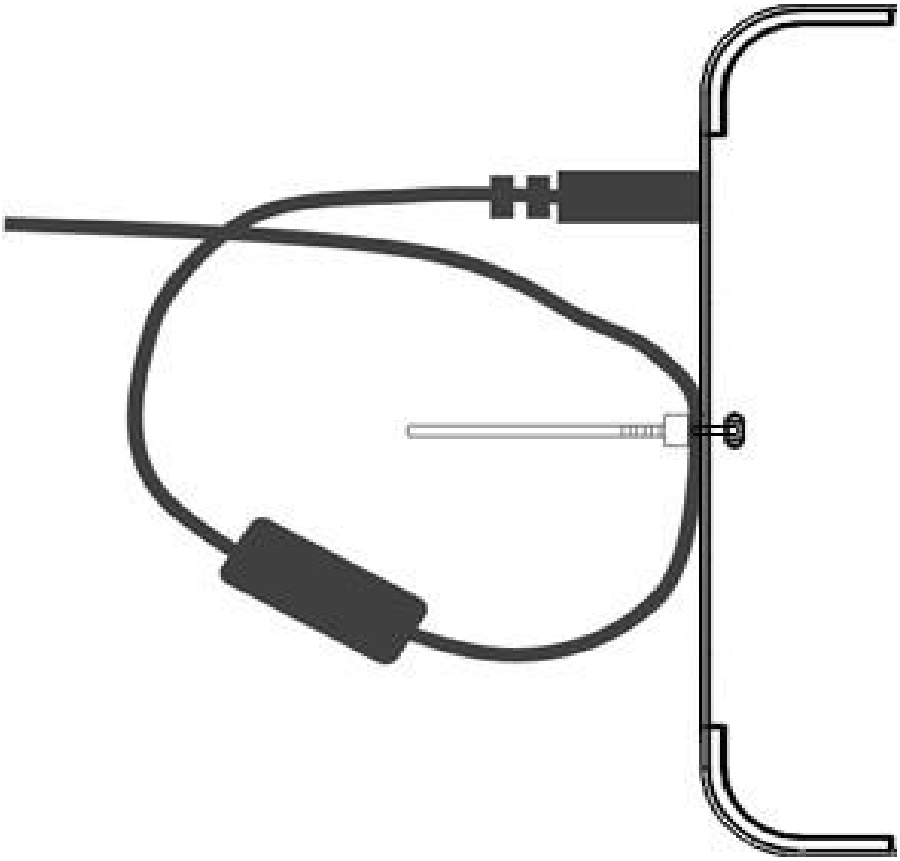
Signal pin allocation list

Signal name	Notes
AI 0	Analog input 0
AI 1	Analog input 1
AI 2	Analog input 2
AI 3	Analog input 3
AI 4	Analog input 4
AI 5	Analog input 5
AI 6	Analog input 6
AI 7	Analog input 7
AI 8	Analog input 8
AI 9	Analog input 9
AI 10	Analog input 10
AI 11	Analog input 11
AI 12	Analog input 12
AI 13	Analog input 13
AI 14	Analog input 14
AI 15	Analog input 15

Signal name	Notes
AGND	Simulated ground
AO 0	Analog output 0
AO 1	Analog output 1
AO 2	Analog output 2
AO 3	Analog output 3
AGND	Simulated ground
DI 0	Digital input 0
DI 1	Digital input 1
DO 0	Digital input 0
DO 1	Digital input.1
DGND	Digital ground
EXT TRIG OUT	Trigger signal output
EXT TRIG IN	External trigger signal input
CONV OUT	Sampling clock output
CONV IN	External sampling clock input
DGND	Digital ground

3.2. USB cable reinforcement design

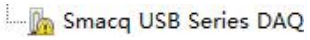
USB cable connectors are prone to be pulled off during operation. USB-5100 series data acquisition devices provide a cable reinforcement design, with which a strap can be used to fix the USB cable to the device to prevent the accidents.



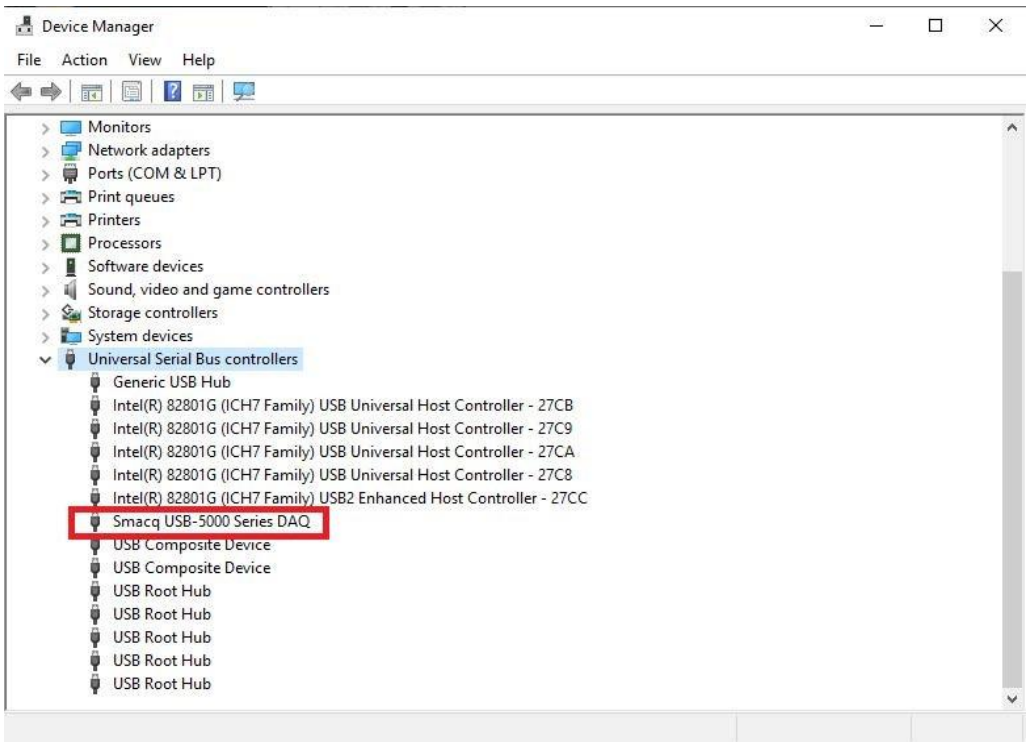
USB cable reinforcement design

3.3. Drive installation

Smacq USB-5100 series data acquisition device support Microsoft Windows XP, Windows 7, Windows 8/8.1, and Windows 10, including all the 32-bit and 64-bit versions. To install the driver for USB-5100 devices, you need to turn off driver signature enforcement first. Here is an example step-by-step tutorial on how to install the driver in Windows 7.

1. Connect your USB-5100 card to the computer and launch the Device Manager in Windows.
2. There should be a device with an exclamation point. 

3. Right-click it, select "Update driver".
4. In the pop-up dialog box, select "Browse my computer for driver software"
5. And then select "Let me pick from a list of device drivers on my computer"
6. Click on "Next" and then select "Have disk"
7. Click Browse in the pop-up dialog box, then enter the \USB-5000SeriesDAQ \driver folder in the CD-ROM, then enter the "win7" folder, then the 32-bit operating system enters the "x86" folder, the 64-bit operating system enters the "x64" folder, select the "susb.inf" file, and then click "Open". (The drivers of Windows8/8.1 and Windows10 are the same as those of Windows7, using the same file.)
8. Then in the dialogue of "Install from disk", click on "Yes".
9. Click "Next", if the Windows security warning pops up, you need to select "Install this driver software anyway" to finish the installation.
10. After these steps, the operating system will start installing the driver, which usually takes about 30 seconds. After the driver is installed, the exclamation point in Device Manager will disappear.

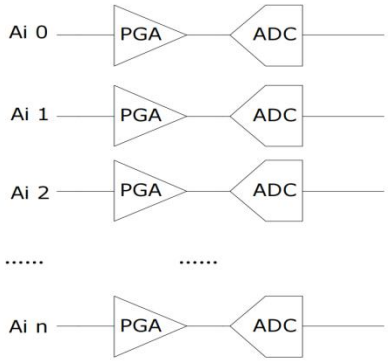


Device Manager after the driver is correctly installed

4. Analog Input (AI)

This chapter describes measuring the relevant content of analog input signals on USB-5100 series data acquisition cards. AI here is short for Analog Input.

4.1. Circuit diagram



analog input circuit

4.2. Signal Connection Mode

The AI acquisition connection mode of the USB-5100 series data acquisition device supports grounding reference single-ended input. The positive end of the analog input signal is connected to the Ain port of the analog input port, and the negative end of the input signal is linked to the AGND port.

4.3. Signal acquisition mode

When the USB-5100 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**

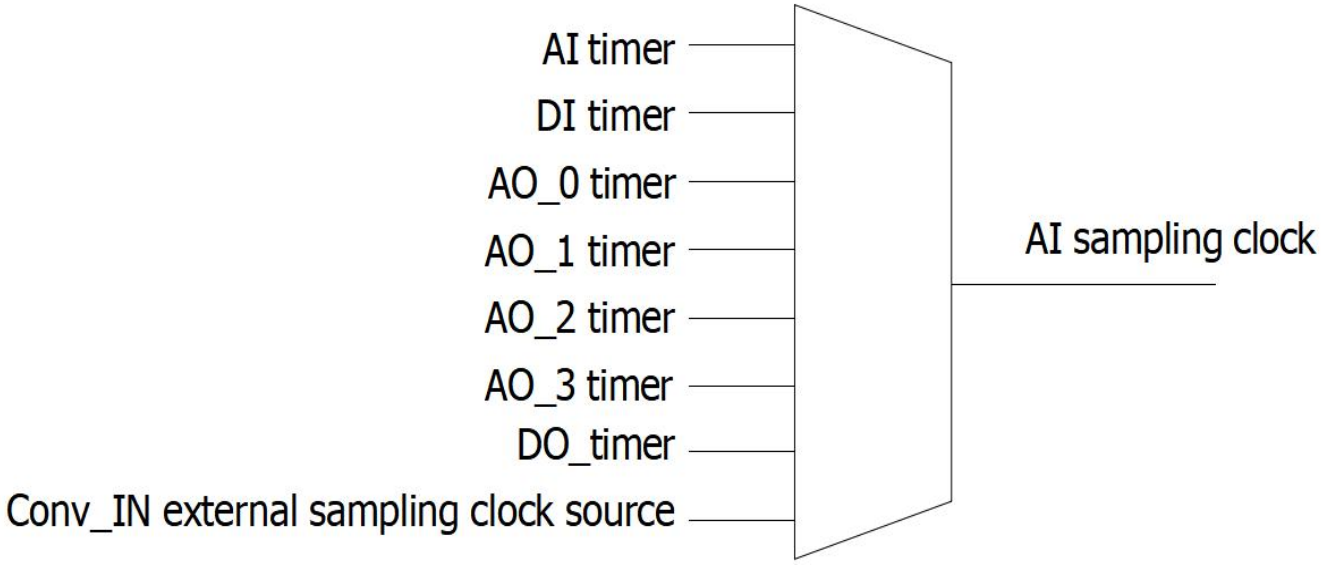
Limited number acquisition mode (OneShot mode) refers to one time acquisition to get the set number of collection points at the set sampling speed

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.

4.4. AI sampling clock

The USB-5100 series data acquisition device has a rich collection timing option. The schematic diagram of the AI sampling clock.



AI sampling clock options

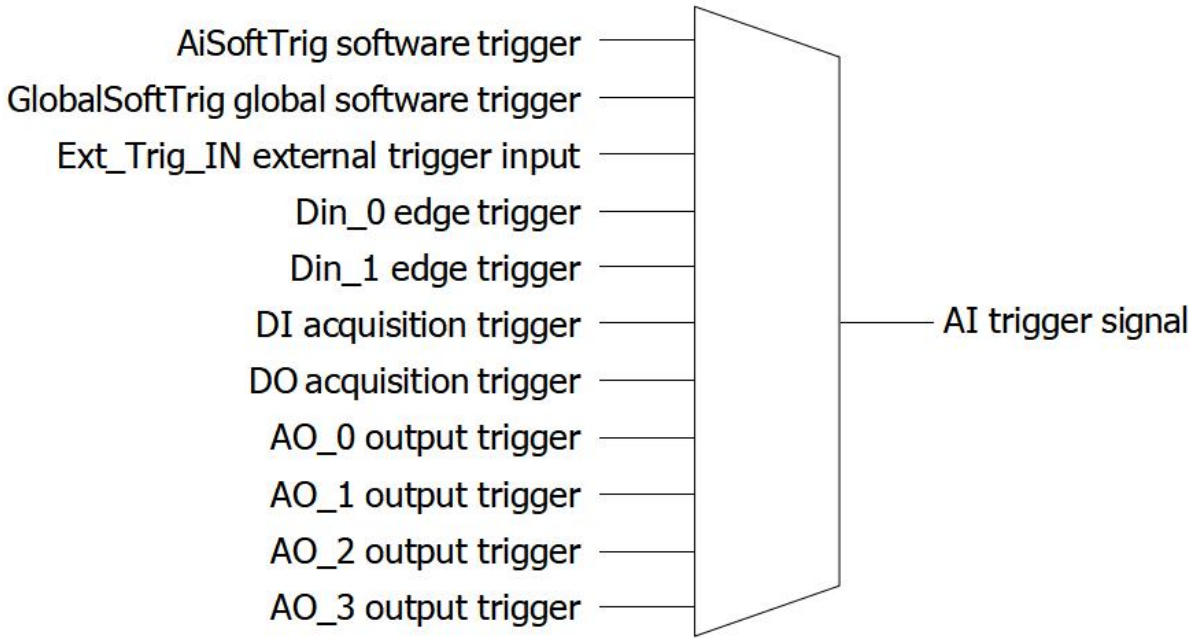
The AI acquisition uses the AI timer signal as the AI sampling clock by default. The AI acquisition can be set via software to use other sampling clock sources to achieve the synchronization of each function.

All timers can be set in steps of 10ns, but the set sampling rate cannot exceed the maximum sampling rate supported by the device.

The external sampling clock source input from Conv_IN cannot be set to divide or multiply. It can only be used directly as the sampling clock. The AI timer output signal can be set to the Conv_OUT pin via software for simultaneous synchronization of multiple device.See the "Synchronization System" chapter for details on the external clock.

4.5. Trigger

The USB-5100 series data acquisition device provides rich trigger options. The schematic diagram of the AI acquisition trigger options.



AI 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. The AI trigger signal can be set to the Ext_Trig_OUT pin via software for multiple device synchronization. See the "Synchronization System" chapter for details on the external trigger.

The Din_0 ~ Din_1 edge trigger means that when the DIO is configured as an input, the DIO pin receives a rising edge and the device triggers.

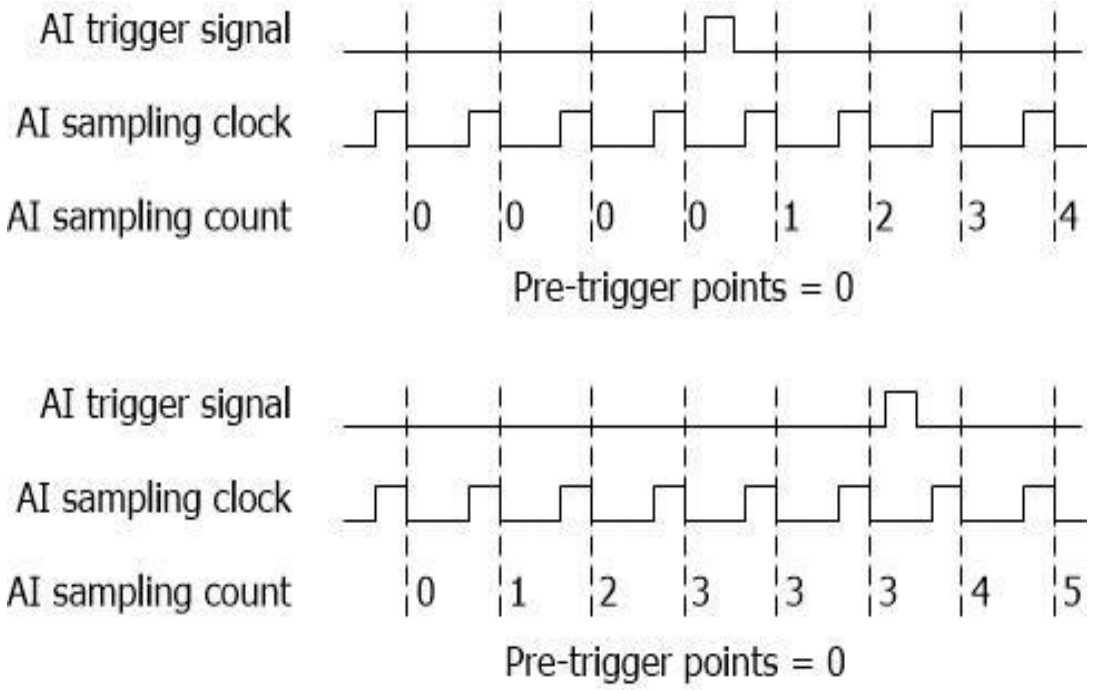
DI acquisition trigger, DO acquisition trigger, AO_0 output trigger, AO_1 output trigger, AO_2 output trigger, and AO_3 output trigger can be used to trigger the AI function alongside their own functions to achieve the synchronization of each function.

● Clear trigger

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

● Pre-trigger

The pre-trigger function is used to record the pre-trigger signal. The pre-trigger function relies on the hardware FIFO to store the data of the pre-trigger signal, so the number of pre-triggered points is limited and cannot exceed 4kPts.



AI pre-trigger function diagram

When the pre-trigger point is set to 0, the data before the trigger signal is not stored, and the user will not be able to obtain the signal state before the trigger signal.

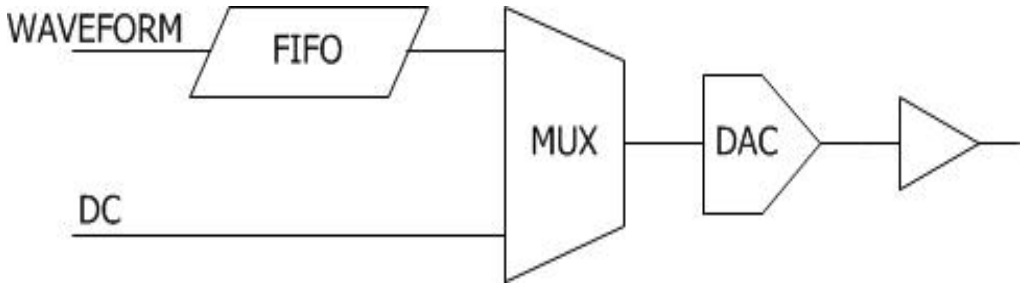
When the pre-trigger signal is set to be larger than 0, for example, in AI pre-trigger function diagram, the number of pre-trigger points is set to 3, then the data before the trigger signal will be stored, and when the stored quantity reaches 3, the newly acquired data will automatically remove the oldest data in the FIFO to ensure that the latest 3 data is saved in the FIFO before the trigger.

5. Analog Output (AO)

This chapter introduces the analog signal output on USB-5100 series data acquisition devices. AO is the abbreviation of Analog Output here.

5.1. Circuit diagram

The AO output circuit of the USB-5100 series data acquisition device, which supports the ground reference single-ended output.



analog output circuit diagram

5.2. Signal output mode

When the USB-5100 series data acquisition device is utilized for analog output, the following four output modes are supported:

● 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.

● Hardware timing

The three output modes mentioned below refer to the mode of outputting analog waveforms, so the sampling rate of the output waveform is an important parameter. When the acquisition device is in AO mode, the AO 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 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.

5.3. Output update rate

USB-5100 series data acquisition device can reach an AO output update rate up to 100 kSa/s/Ch, which is also the DAC output sampling rate. This is the independent sampling rate for each channel.

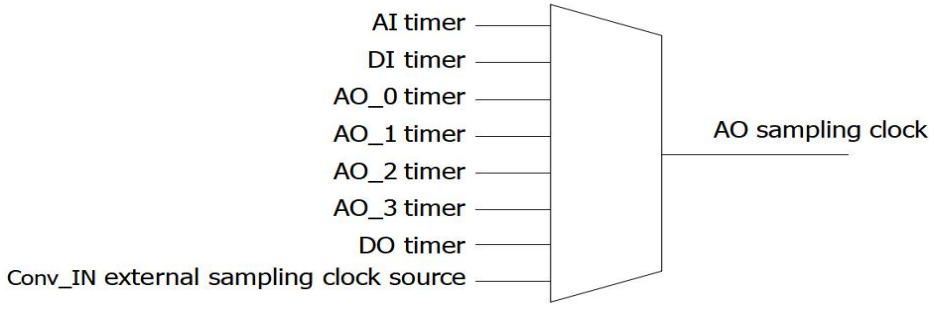
- **Synchronous update**

The four AO channels of the USB-5100 series data acquisition device support the selection of any two, three or four channels to synchronize the output when outputting waveforms.

Attention When several channels of synchronous output are selected, the selected channels must be set to the same sampling rate, otherwise it will cause an error.

5.4. AO sampling clock

The USB-5100 series data acquisition device has rich AO acquisition timing options. The AO sampling clock.



AO output sampling clock option

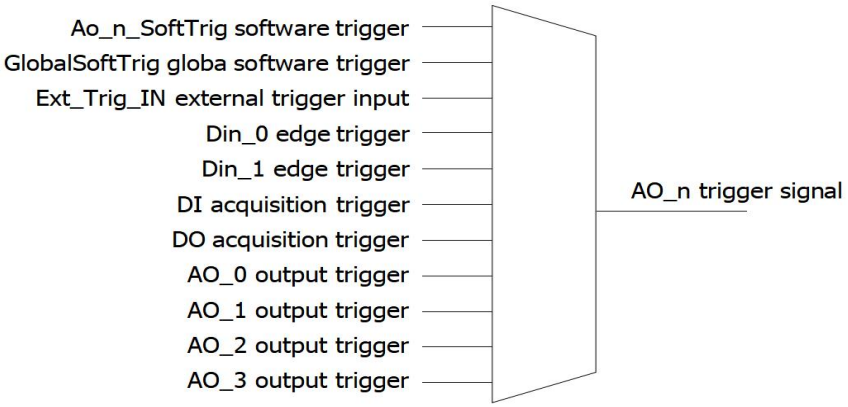
The AO acquisition uses the AO_n timer signal as the AO sampling clock by default. You can set AO acquisition to use other sampling clock sources to achieve the synchronization of each function via software settings.

All timers can be set in steps of 10ns, but the set sampling rate cannot exceed the maximum sample rate supported by the device.

The external sampling clock source input from Conv_IN cannot be set to divide or multiply. It can only be used directly as the sampling clock. The AO_n timer output signal can be set to the Conv_OUT pin via software for simultaneous synchronization of multiple devices. See the "Synchronization System" chapter for details on the external clock.

5.5. Trigger

The USB-5100 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 Ao_nSoftTrig 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.

The Ao_n_SoftTrig 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. The AO trigger signal can be set to the Ext_Trig_OUT pin via software for multiple device synchronization. See the "Synchronization System" chapter for details on external triggering.

The Din_0 ~ Din_1 edge trigger means that when the DIO pin is configured as an input, and the DIO pin receives a rising edge, the device triggers.

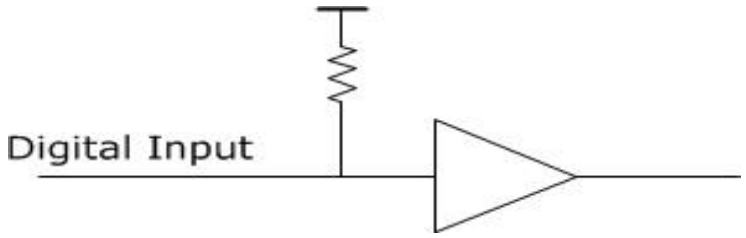
DI acquisition trigger, DO acquisition trigger, AO_0 output trigger, AO_1 output trigger, AO_2 output trigger, and AO_3 output trigger can be used to trigger the AO function alongside their own functions to achieve the synchronization of each function.

- **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 USB-5100 series data acquisition cards. DI is the abbreviation of Digital Input here.



digital input circuit

6.1. Signal acquisition mode

When the USB-5100 series data acquisition device performs DI acquisition, 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**

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 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.

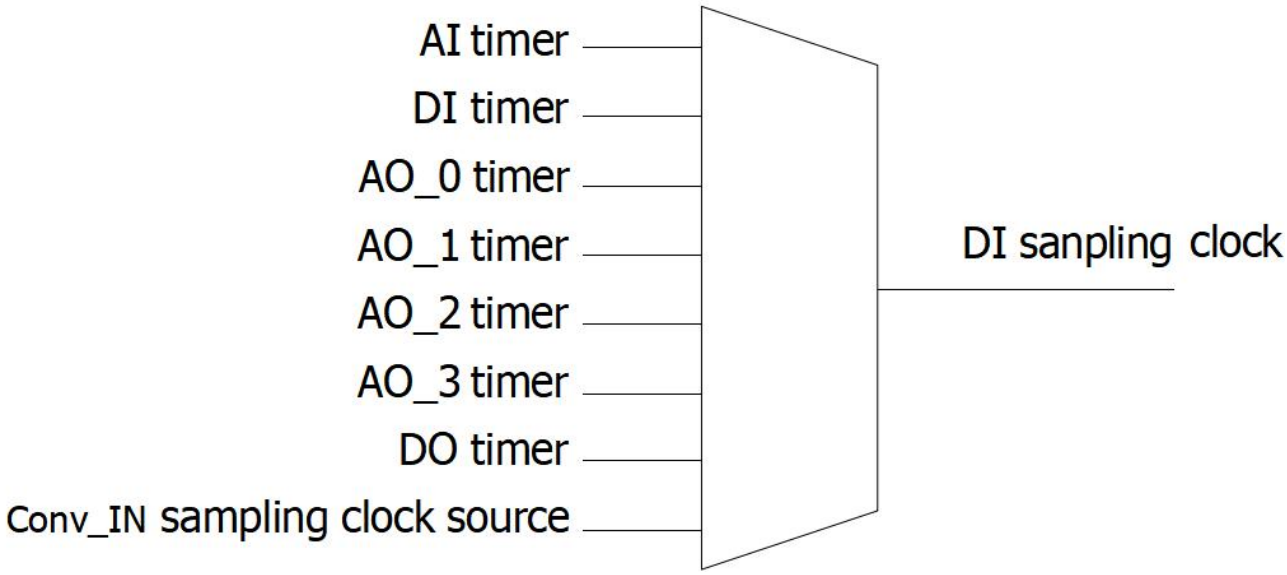
Attention: The number of set collection points cannot exceed 2MPts.

6.2. Sampling rate

For USB-5100 series of data acquisition devices, the DI sampling rate is up to10MSa/s/ch. This is parallel simultaneous sampling of all channels, with each channel able to achieve this highest sampling rate.

6.3. DI sampling clock

The USB-5100 series data acquisition device has a rich DI acquisition timing option. The DI sampling clock is shown in below.



DI sampling clock option

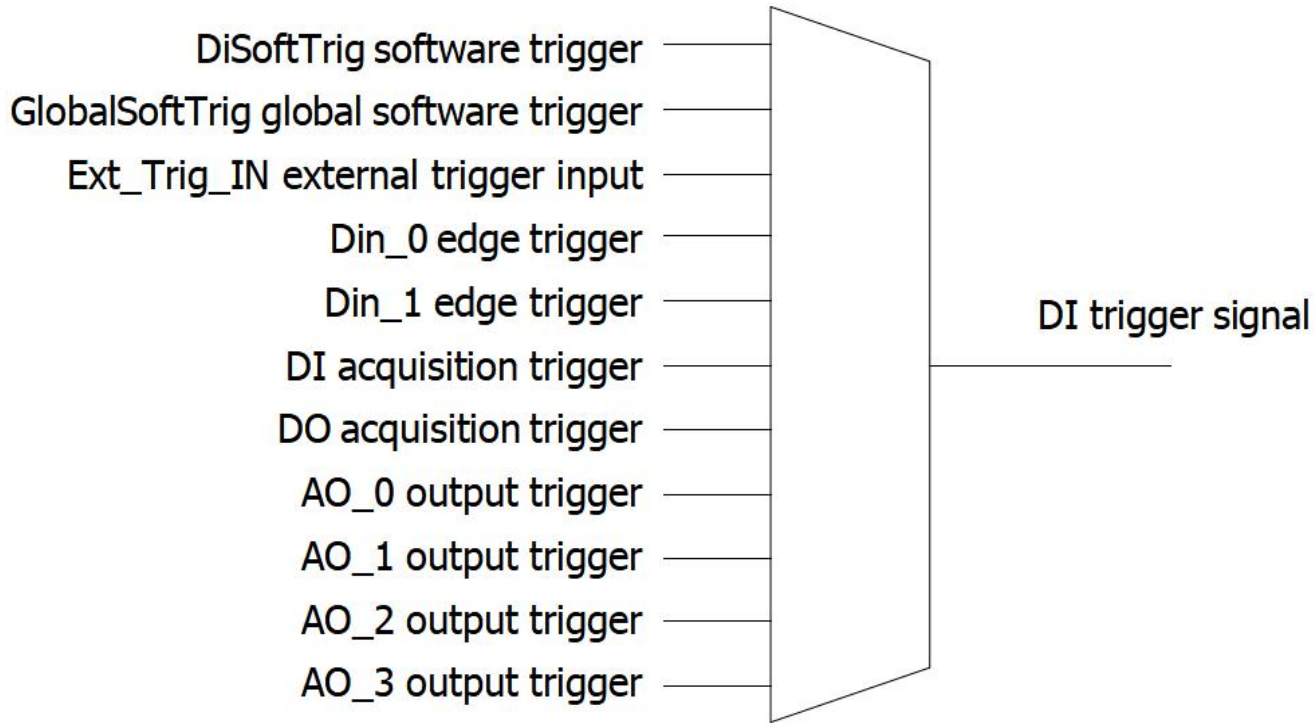
The DI acquisition uses the DI timer signal as the DI sampling clock by default. The DI acquisition can be set via software to use other sampling clock sources to achieve the synchronization of each function.

All timers can be set in steps of 10ns, but the set sampling rate cannot exceed the maximum sampling rate supported by the device.

The external sampling clock source input from Conv_IN cannot be set to divide or multiply. It can only be used directly as the sampling clock. The DI timer output signal can be set to the Conv_OUT pin via software for simultaneous synchronization of multiple devices. See the "Synchronization System" chapter for details on the external clock.

6.4. Trigger

The USB-5100 series data acquisition device provides rich trigger options. The DI acquisition trigger options are shown in below.



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 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. The AI trigger signal can be set to the Ext_Trig_OUT pin via software for multiple device synchronization. See the "Synchronization System" chapter for details on the external trigger.

The Din_0 ~ Din_1 edge trigger means that when the DIO is configured as an input, the DIO pin receives a rising edge and the device triggers.

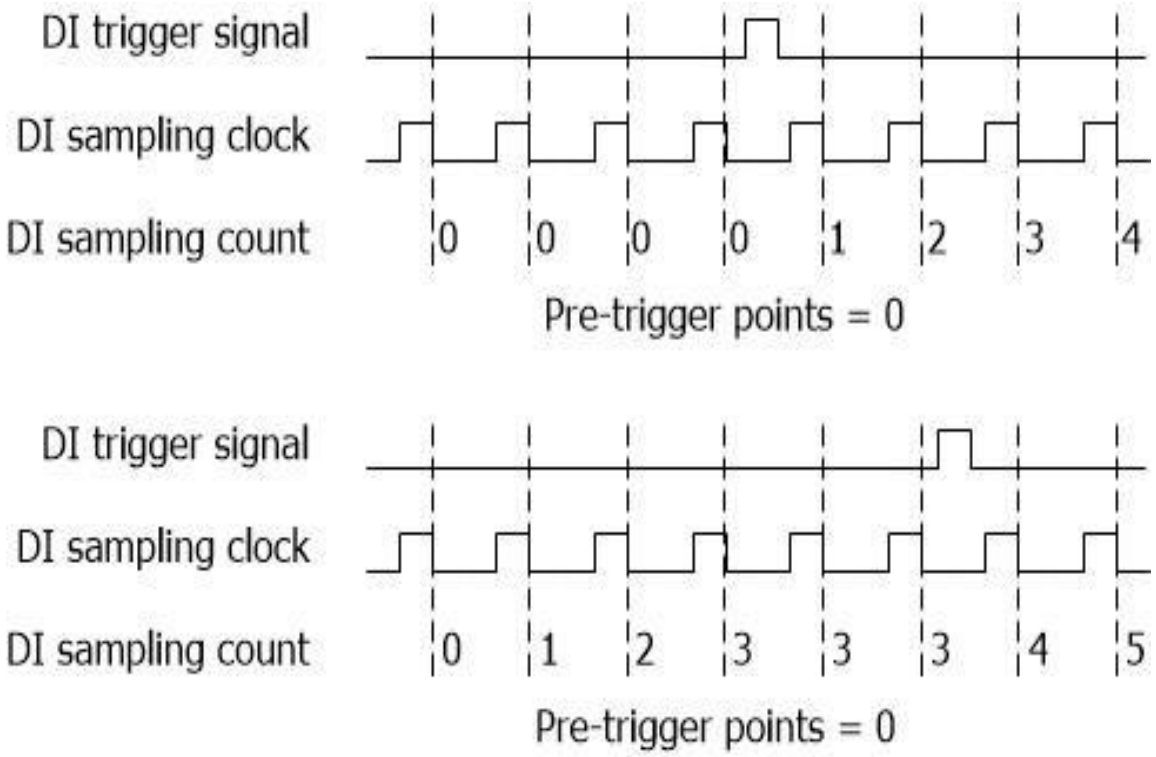
DI acquisition trigger, DO acquisition trigger, AO_0 output trigger, AO_1 output trigger, AO_2 output trigger, and AO_3 output trigger can be used to trigger the DI function alongside their own functions to achieve the synchronization of each function.

- **Clear Trigger**

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

● Pre-Trigger

The pre-trigger function is used to record the pre-trigger signal. The pre-trigger function relies on the hardware FIFO to store the data of the pre-trigger signal, so the number of pre-triggered points is limited and cannot exceed 4kPts. The pre-trigger function diagram is shown in below.



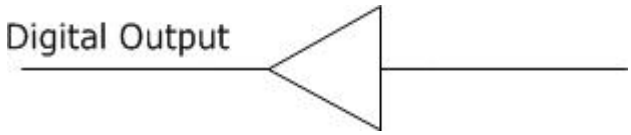
DI pre-trigger function

When the pre-trigger point is set to 0, the data before the trigger signal is not stored, and the user will not be able to obtain the signal state before the trigger signal.

When the pre-trigger signal is set to be larger than 0, for example, the number of pre-trigger points is set to 3, then the data before the trigger signal will be stored, and when the stored quantity reaches 3, the newly acquired data will automatically remove the oldest data in the FIFO to ensure that the latest 3 data is saved in the FIFO before the trigger.

7. Digital Output (DO)

This chapter introduces the digital signal output for the USB-5100 series data acquisition device. The digital input is referred to as DO here, the abbreviation of Digital Output. below is a schematic diagram of the digital output circuit.



Digital output circuit

7.1. Signal output mode

When the USB-5100 series data acquisition card is utilized for digital output, the following four output modes are supported:

- **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 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 DO output waveform.

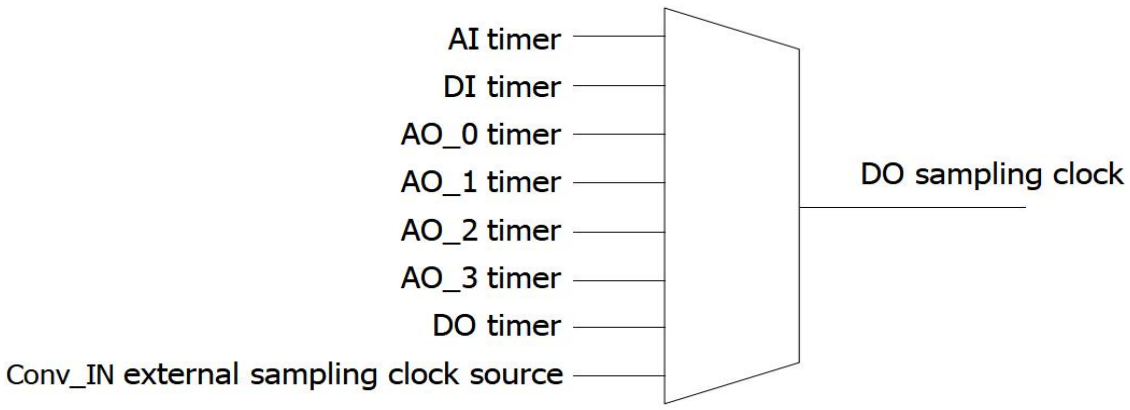
When the waveform output in the hardware FIFO is complete and no new data arrives, the DO output level state will remain at the level defined by the last point.

7.2. Output update rate

USB-5100 series data acquisition device DO output update rate can reach up to 10MSa/ s/Ch. This means parallel simultaneous sampling of all channels, while each channel can achieve this highest sampling rate.

7.3. DO sampling clock

The USB-5100 series data acquisition device has rich DO acquisition timing options. The DO sampling clock is below.



DO sampling clock option

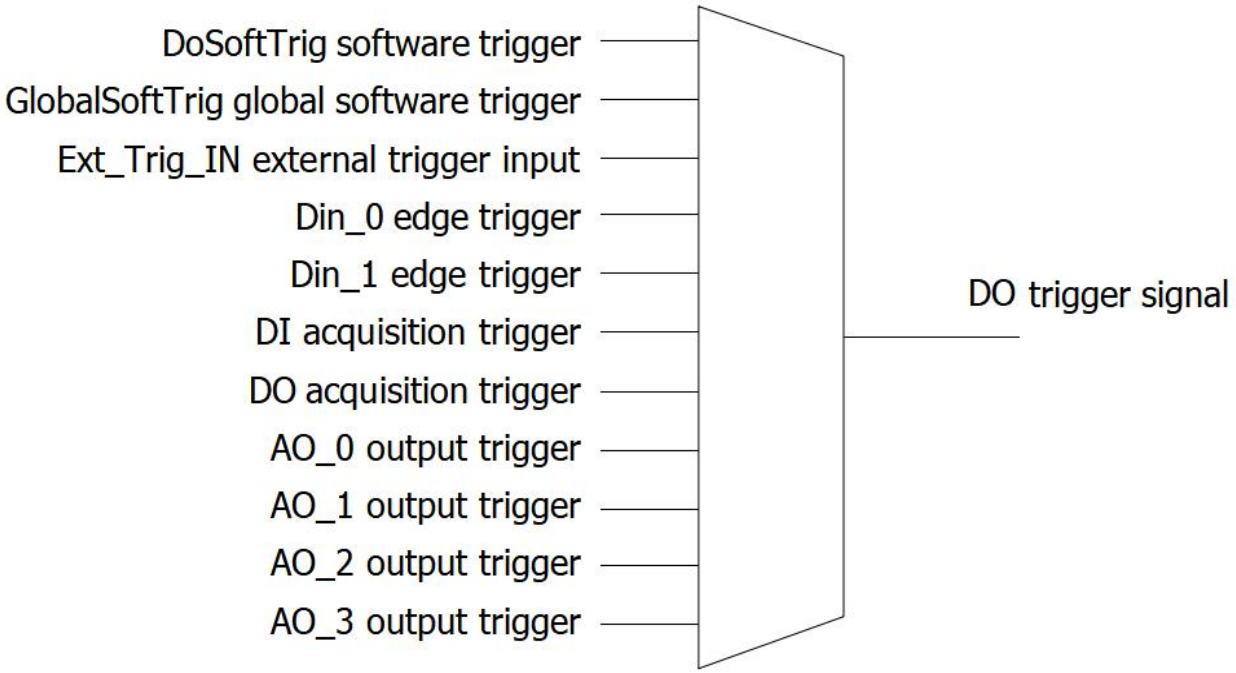
The DO acquisition uses the DO timer signal as the DO sampling clock by default. You can set DO acquisition to use other sampling clock sources to achieve the synchronization of each function via software settings.

All timers can be set in steps of 10ns, but the set sampling rate cannot exceed the maximum sample rate supported by the device.

The external sampling clock source input from Conv_IN cannot be set to divide or multiply. It can only be used directly as the sampling clock. The DO timer output signal can be set to the Conv_OUT pin via software for simultaneous synchronization of multiple devices. See the "Synchronization System" chapter for details on the external clock.

7.4. Trigger

The USB-5100 series of data acquisition devices provide a rich set of trigger options, as shown in below, which describes trigger options for the DO output.



DO trigger options

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. The DO trigger signal can be set to the Ext_Trig_OUT pin via software for multiple device synchronization. See the "Synchronization System" chapter for details on external triggering.

The Din_0 ~ Din_1 edge trigger means that when the DIO pin is configured as an input, and the DIO pin receives a rising edge, the device triggers.

DI acquisition trigger, DO acquisition trigger, AO_0 output trigger, AO_1 output trigger, AO_2 output trigger, and AO_3 output trigger can be used to trigger the DO function alongside their own functions to achieve the synchronization of each function.

- **Clear trigger**

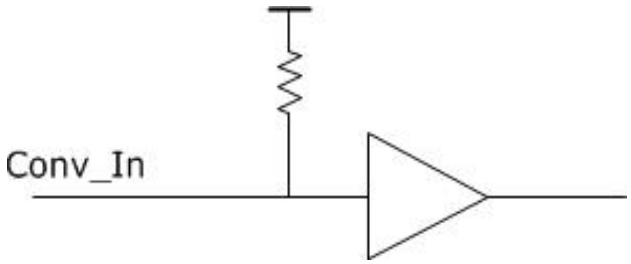
The DO trigger status can be reset to an untriggered state via software settings.

8. Synchronization System

This chapter introduces the multi-card synchronization system of the USB-5100 series data acquisition device. The synchronous system has 4 ports, sampling clock input, sampling clock output, external trigger input, and external trigger output.

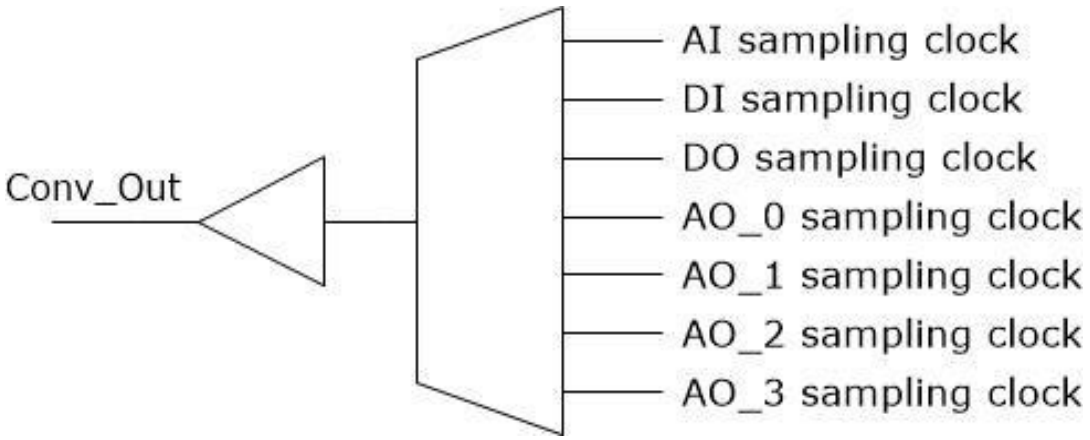
8.1. Sampling clock

The sampling clock is used to eliminate the error of the clock between multiple acquisition devices and achieve the synchronization of the sampling rate between multiple acquisition devices. At this time, the sampling clock output of one of the acquisition devices should be connected to the sampling clock input of other acquisition devices and use the appropriate software settings.
shows the sampling clock input circuit.



sampling clock input circuit

The sampling clock output circuit diagram is shown in below. The following sources can be selected as output options:

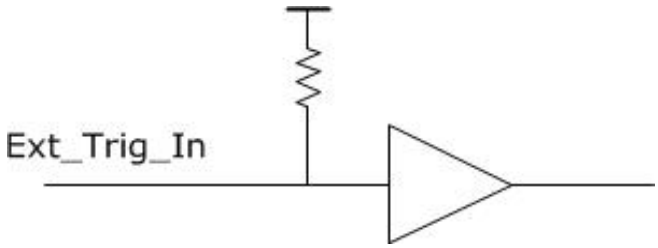


Sampling clock output circuit

8.2. External trigger

The pins of external trigger input and output are used to trigger the USB-5100 series acquisition card in synchronization with an external device.

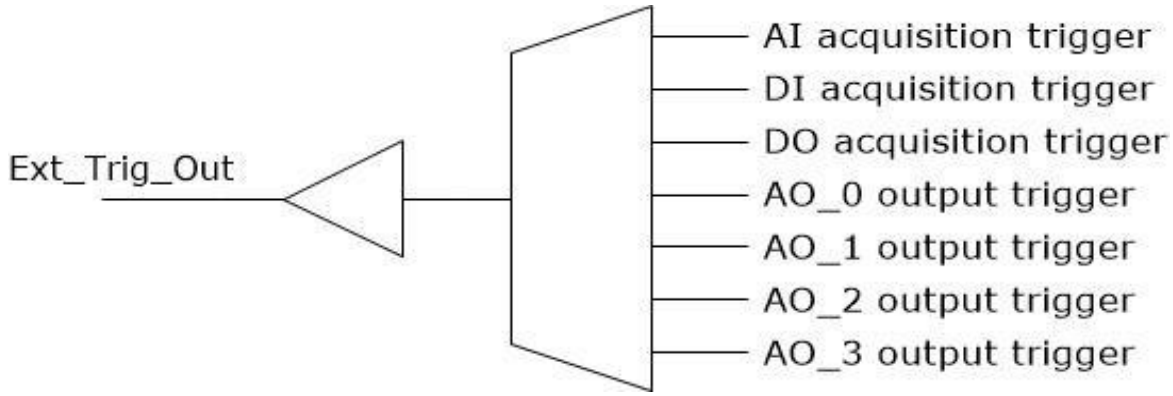
Each function trigger source of the acquisition device can select the external trigger input pin Ext_Trig_In as the trigger source. The external trigger input circuit diagram is shown in below.



External trigger input circuit

When the trigger signal of the specified function is set as the output source, the Ext_Trig_Out pin will output a high level pulse for 1us while the function is triggered.

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



External trigger output

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

10. Ordering Information

Main Equipment

Model	Notes
USB-5121	16-Bit, 16-AI(500 kSa/s)、4-AO、2-DI、2-DO
USB-5120	16-Bit, 16-AI(250 kSa/s)、4-AO、2-DI、2-DO
USB-5111	16-Bit, 8-AI (500 kSa/s)、4-AO、8-DI、8-DO
USB-5110	16-Bit, 8-AI (250 kSa/s)、4-AO、8-DI、8-DO
USB-5521	14-Bit, 16-AI(500 kSa/s)、4-AO、2-DI、2-DO
USB-5520	14-Bit, 16-AI(250 kSa/s)、4-AO、2-DI、2-DO
USB-5511	14-Bit, 8-AI (500 kSa/s)、4-AO、8-DI、8-DO
USB-5510	14-Bit, 8-AI (250 kSa/s)、4-AO、8-DI、8-DO
USB-5321	12-Bit, 16-AI(500 kSa/s)、4-AO、2-DI、2-DO
USB-5320	12-Bit, 16-AI(250 kSa/s)、4-AO、2-DI、2-DO
USB-5311	12-Bit, 8-AI (500 kSa/s)、4-AO、8-DI、8-DO
USB-5310	12-Bit, 8-AI (250 kSa/s)、4-AO、8-DI、8-DO

Standard accessories

Model	Notes
USB cable	USB connection cable, 1.5 meters, USB-A type to USB-B type
TB10-3.81	10-bit, 3.81mm pitch terminal block

Optional accessories

Model	Notes
SDIN	35mm DIN rail mounting bracket
CHF-100B	Current sensor, 100A, DC~20kHz, output ±4v
CHV-600VD	Voltage sensor, 600V, DC~20kHz, isolated differential input, output ±5v

11. Document Revision History

Date	Edition	Remarks
2018.11.07	Rev: A	First release.
2019.03.05	Rev: B	Update analog input sampling rate.
2021.11.25	Rev: C	Add new model USB-55xx/53xx and it parameter.