USB-3500 Series Multifunctional Data Acquisition Devices

User 's Manual

Rev: B

Smacq

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Statement

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

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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

1. Getting Started

This chapter describes the basic functions of USB-3500 Series Data Acquisition Device, as well as product specifications and precautions in the process of product unpacking.

1.1. Product introduction

USB-3500 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 high-speed control signal output.

USB-3500 series can analog signal output,and periodic repetitive signal output, and high-speed uninterrupted non-repetitive signal output controlled by a computer.
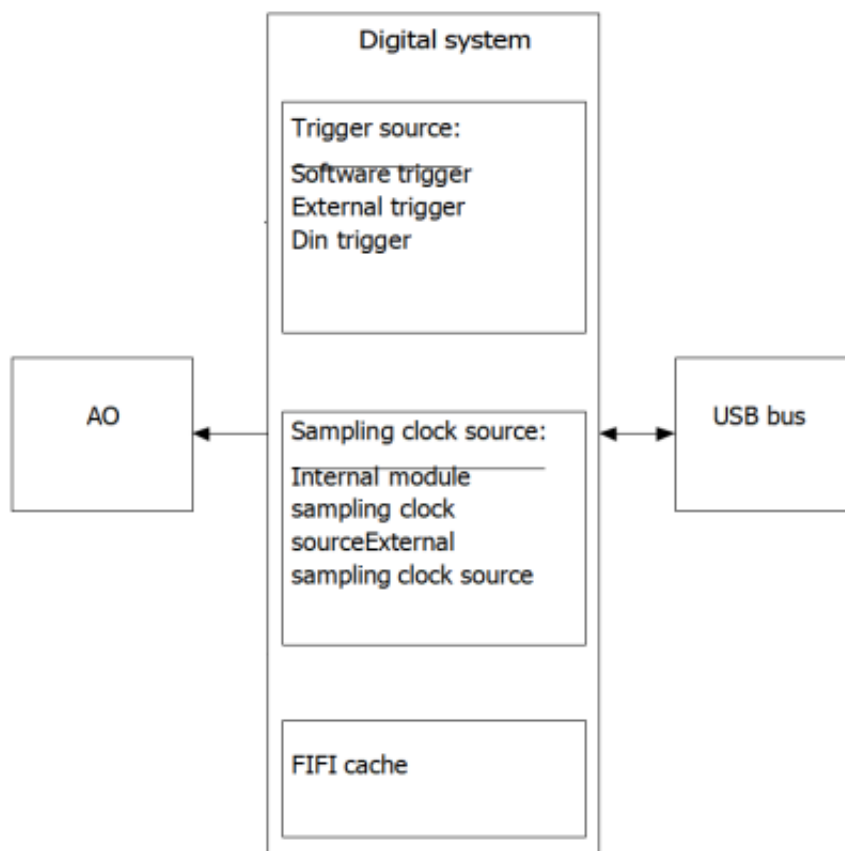
USB-3500 series data acquisition device supports operating in Windows OS, providing standard DLLs and support for mainstream development languages including VC++, VB, C#, LabVIEW, and MATLAB.

USB-3500 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 output resolution, with output range of ±10V
- Supports 4-channel synchronous analog output, up to 100kS/s sampling rate
- Supports continuous analog output of nonrepetitive arbitrary waveforms of infinite length
- Analog output waveforms supports proportional and offset operations

1.2. Function Diagram

USB-3500 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 output

Channel	4
Resolution	16-bit
DNL	±1 LSB
Update rate	100kHz/Ch
Timing resolution	10ns
Channel synchronization	Yes
Input range	±10V
Output coupling	DC
Output impedance	0.1Ω
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	4us
Edge slope	9.2V/us

Analog output accuracy

Analog output Range	±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)

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

External sampling clock I/O

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 frequency range(DC)	1MHz
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	USB 2.0 High Speed interface

Power supply requirements

USB interface power supply	4.5~5.5V
Typical current without load	400mA
Maximum Load	600mA

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	16~28 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-3500 Series	USB-3500 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	1

3. Installation

This chapter describes signal connection and drive installation of USB-3500 series.

3.1. Connector signal pins distribution
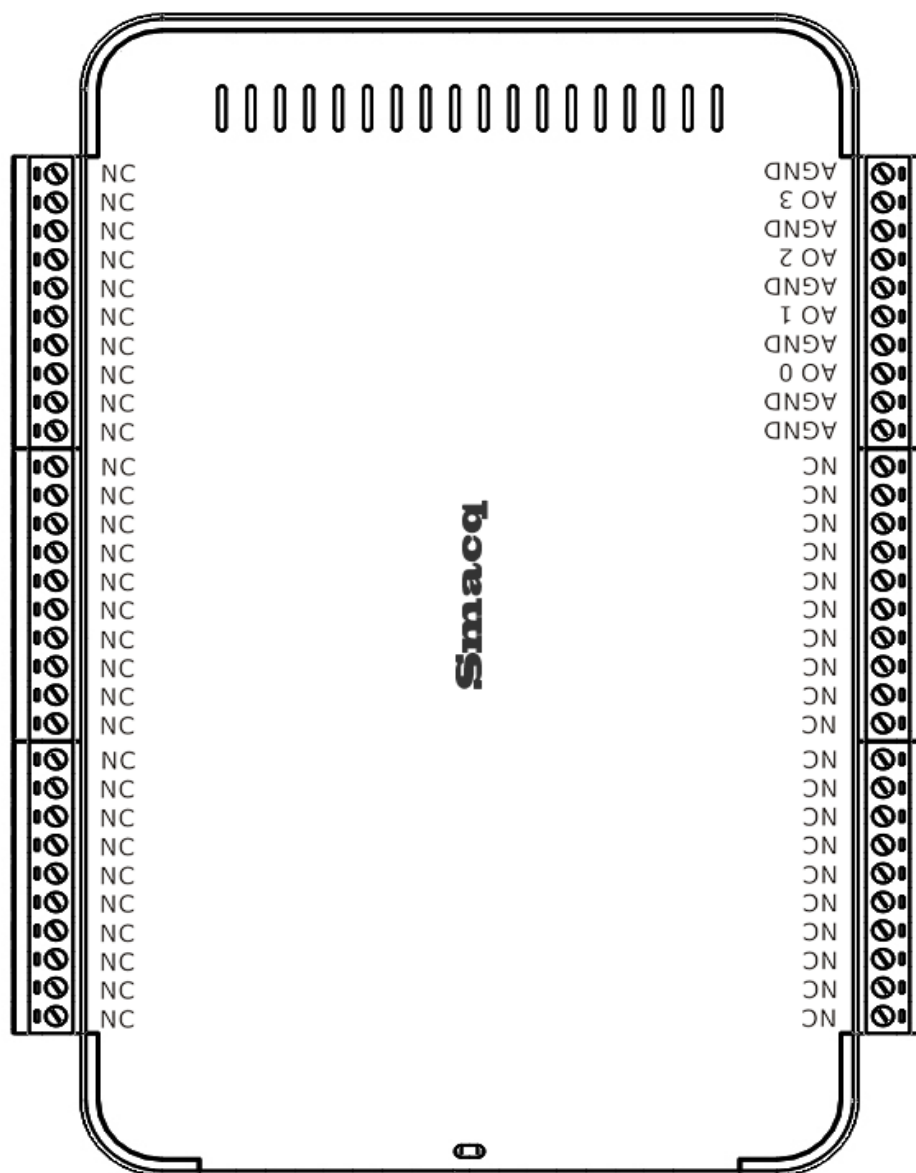
USB-3500 series signal pins distribution

Signal pin allocation list

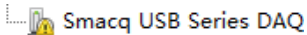| Signal name	NOTE
AO0	Analog output 0
AO1	Analog output 1
AO2	Analog output 2
AO3	Analog output 3
AGND	Simulated ground
NC	Not connected

3.2. USB cable reinforcement design

USB cable connectors are prone to be pulled off during operation. USB-3500 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.
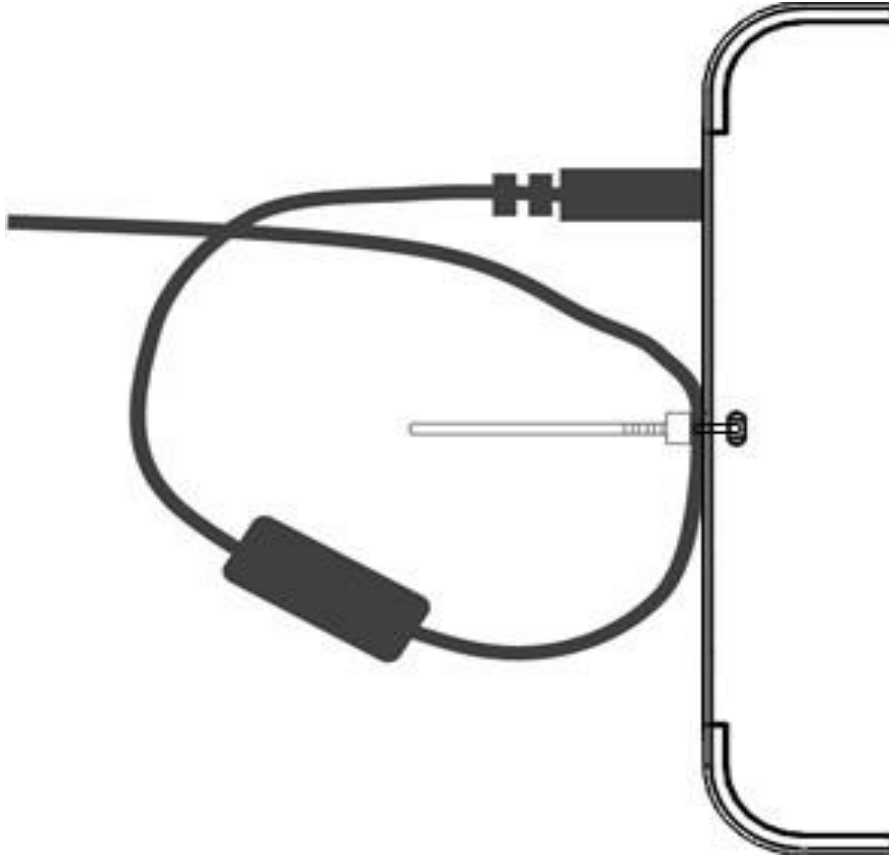

USB cable reinforcement design

3.3. Drive installation

Smacq USB-3500 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-3500 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-3500 card to the computer and launch the Device Manager in Windows.

2. There should be a device with an exclamation point. Smacq USB Series DAQ

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-3000 Series DAQ \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.
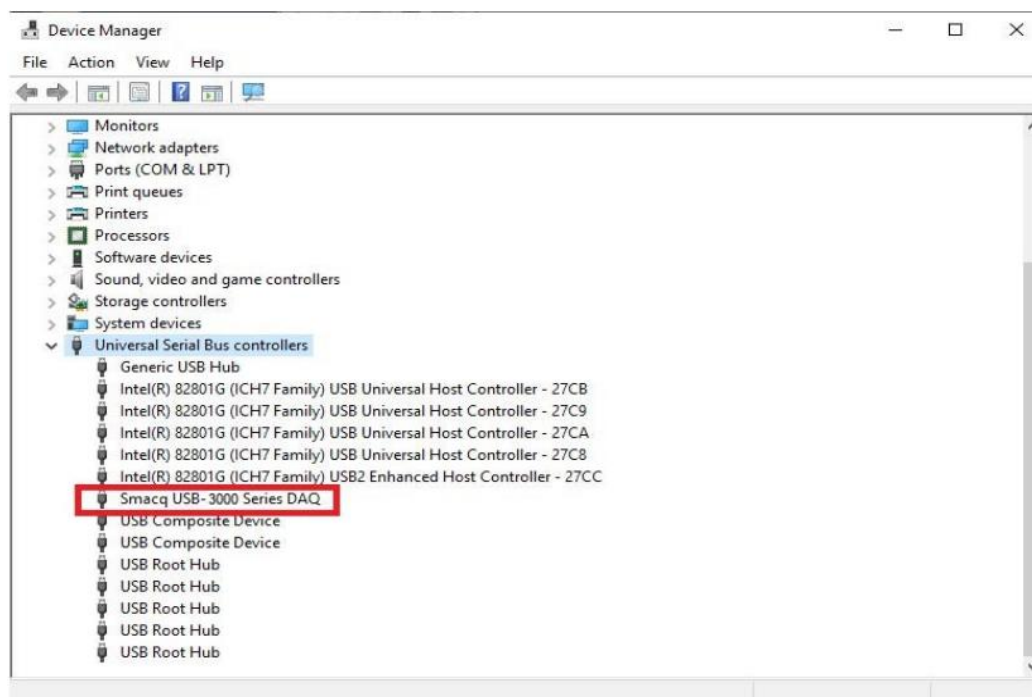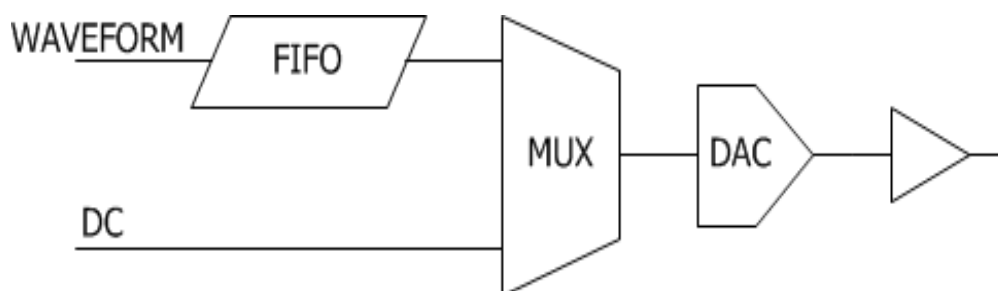

Device Manager after the driver is correctly installed

4. Analog Output (AO)

This chapter introduces the analog signal output on USB-3500 series data acquisition devices. AO is the abbreviation of Analog Output here.

4.1. Circuit diagram

The AO output circuit of the USB-3500 series data acquisition device, which supports the ground reference single-ended output.

Analog output circuit diagram

4.2. Signal output mode

When the USB-3500 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.

● Proportional and offset operation

Proportional and offset operation refers to fast transformation of output waveform. It is assumed that the voltage data in the wave table is x, and the current waveform data needs to be transformed into kx+b, where k is the scaling factor and b is the offset constant. The setting range of k is 0 to 10, and the default is 1; The setting range of b is -10 to 10, and the default is 0.

4.3. Output update rate

USB-3500 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-3500 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.

4.4. AO sampling clock

The USB-3500 series data acquisition device has rich AO acquisition timing options. The AO sampling clock is below.
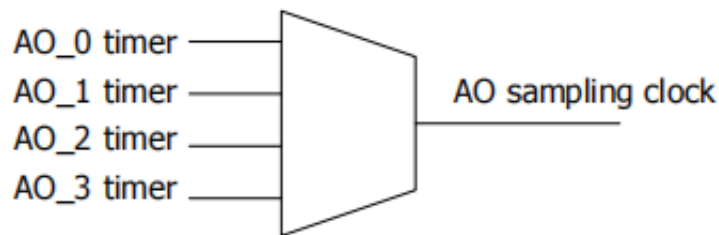

AO output sampling clock option

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.

4.5. Trigger

The USB-3500 series of data acquisition devices provide a rich set of trigger options, which describes trigger options for the AO output.
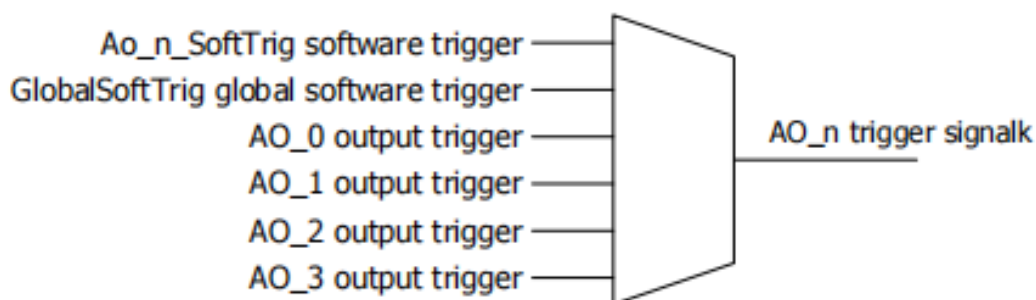
Trigger options for an AO output channel

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.

● Clear trigger

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

5. 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.

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6. Ordering Information

Main Equipment

Model	Notes
USB-3501	4-AO,100kSa/s/CH, ±10V

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

7. Document Revision History

Date	Edition	Remarks
2018.09.10	Rev: A	First release
2018.09.29	Rev: B	Fix some wrong parameter