

USB-3500 Series of Multifunctional Data Acquisition Devices

User Manual

Rev. B

Smacq

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Statement

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Safety Requirements



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



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



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



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



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



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

Measurement Categories



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

Measurement categories Note

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

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

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

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

Environment

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

Pollution degree description

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

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

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

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

Recycle precautions



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

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1. Getting Started

This chapter describes the basic functions of 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 continuous high-speed signal acquisition and high-speed control signal output.

USB-3500 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-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 $\pm 10V$
- Support 4 channel synchronous analog output, up to 100kS/s sampling rate
- Support continuous analog output of nonrepetitive arbitrary waveforms of infinite length

1.2. Function Diagram

Figure 1.1 shows the schematic diagram of USB-3500 series data acquisition device.

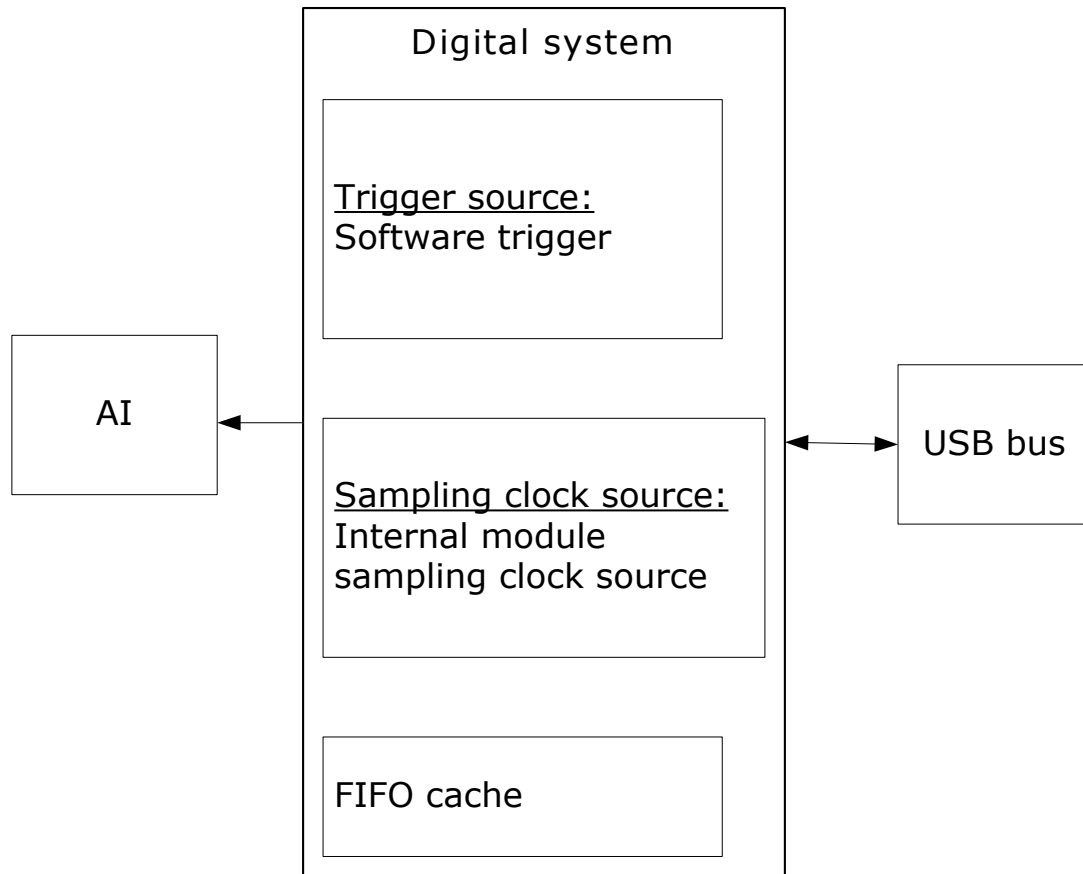


Figure 1.1 USB-3500 series data acquisition device functions

1.3. Product specifications

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

Analog output

Number of channels	4
Resolution	16-bit
DNL	±1 LSB
Highest update rate	100 kHz/Ch
Timing resolution	10 ns

Channel synchronization	Yes
Input range	± 10 V
Output coupling	DC
Output impedance	0.1 Ω
Output drive current	10 mA
Power-on status	Within ± 50 mV
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 establishment time	4 μ s
Edge slope	9.2 V/ μ s

Analog output accuracy

Range (V)	-10 ~ 10
Gain error (reading's ppm)	30
Gain temperature coefficient (reading's ppm/ $^{\circ}$ C)	5
Offset error (range's ppm)	50
Offset temperature coefficient (range's ppm/ $^{\circ}$ C)	5
Full range absolute precision (mV)	5
Reference temperature coefficient (ppm/ $^{\circ}$ C)	5
INL error (range's ppm)	120

Calibration

Recommended warm-up time	Not less than 20 minutes
Recommended calibration time interval	1 year

Bus interface

USB	USB 2.0 High-Speed interface
-----	------------------------------

Power supply requirements

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

Physical properties

Size (mm)	Connectors not included: 150*96*28 Connectors included: 150*112*28
Weight (g)	Connectors not included: about 185 grams Connectors included: about 230 grams
I/O connectors	Bolt terminals
Bolt terminal connection	16 AWG ~ 28 AWG
USB connectors	USB Type B

1.4. Product unpacking

Precautions

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

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

Check the packing list

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

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

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

AO 2	Analog output 2
AO 3	Analog output 3
AGND	Simulated ground
NC	Not connected

2.2. 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. Check Figure 2.2 for details.

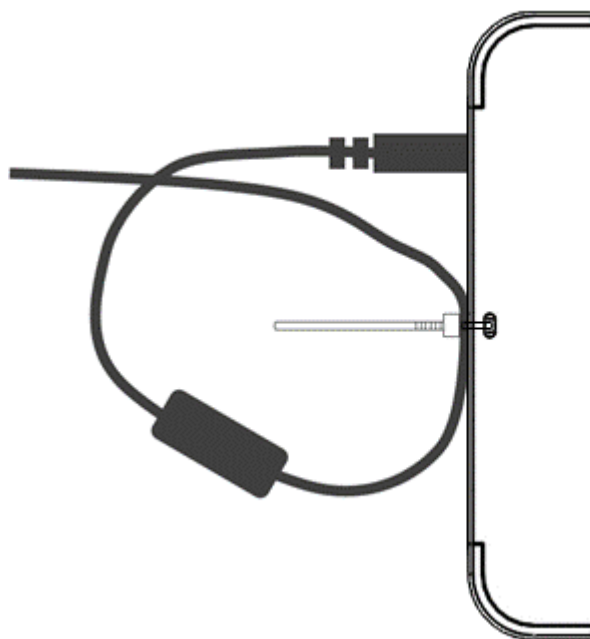



Figure 2.2 USB cable reinforcement design

2.3. Driver 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
Right-click it, select “Update driver”.
- 3) In the pop-up dialog box, select “Browse my computer for driver software”
- 4) And then select “Let me pick from a list of device drivers on my computer”
- 5) Click on “Next” and then select “Have disk”
- 6) Click Browse in the pop-up dialog box, then enter the \USB-3000SeriesDAQ\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 "sub.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.)
- 7) Then in the dialogue of “Install from disk”, click on “Yes”.
- 8) Click “Next”, if the Windows security warning pops up, you need to select “Install this driver software anyway” to finish the installation.

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, as shown in the following Figure 2.3.

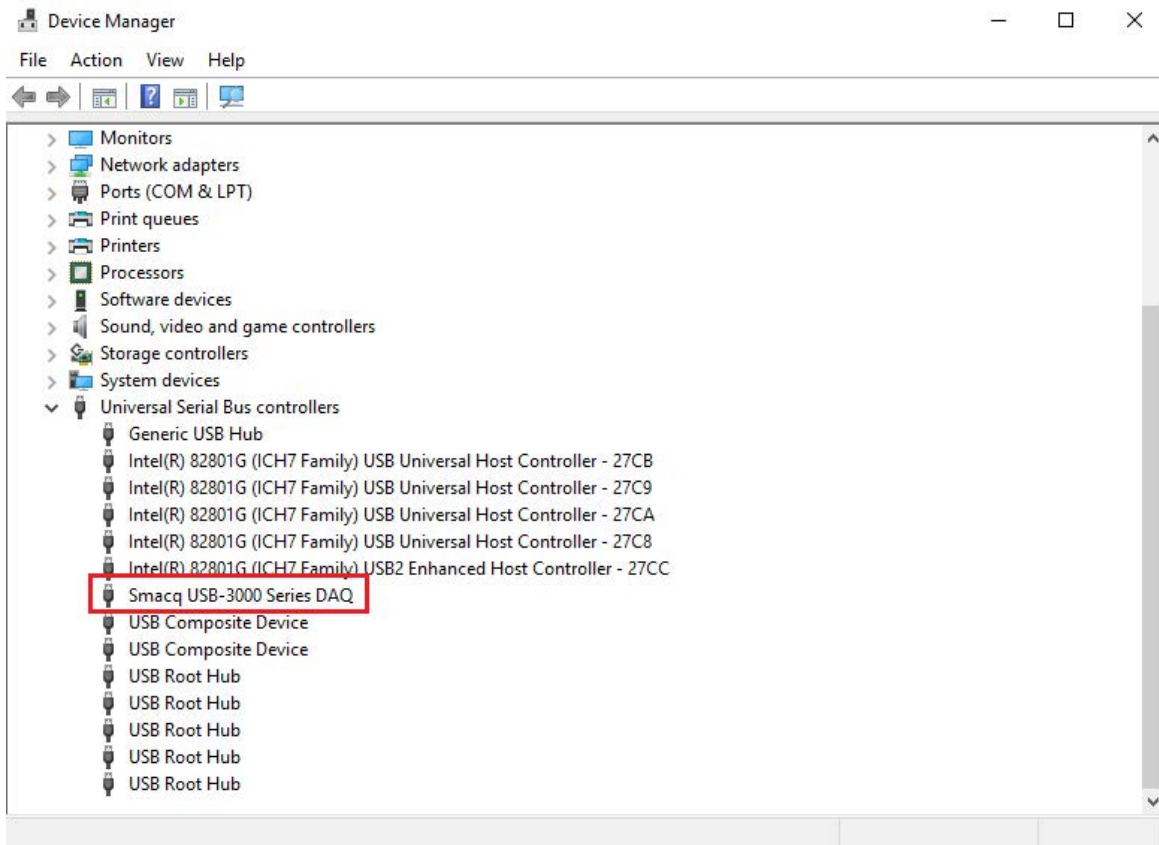


Figure 2.3 the Device Manager after the driver is correctly installed

3. 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.

3.1. Circuit diagram

Figure 3.1 shows the schematic diagram of the AO output circuit of the USB-3500 series data acquisition device, which supports the ground reference single-ended output.

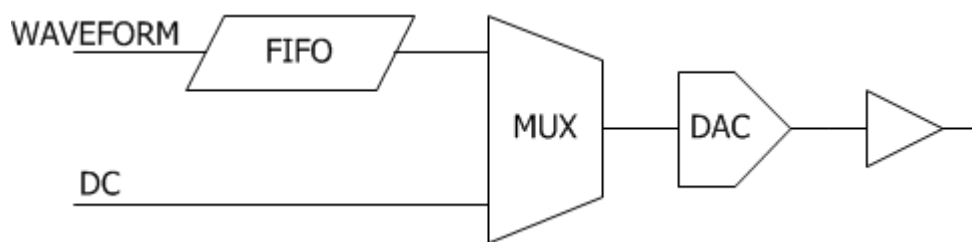


Figure 3.1 analog output circuit diagram

3.2. 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
- Finite number output
- Infinite number of loop output
- Infinite non-loop output

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.

3.3. 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.

3.4. AO sampling clock

The USB-3500 series data acquisition device has rich AO acquisition timing options. The AO sampling clock is shown in Figure 3.2.

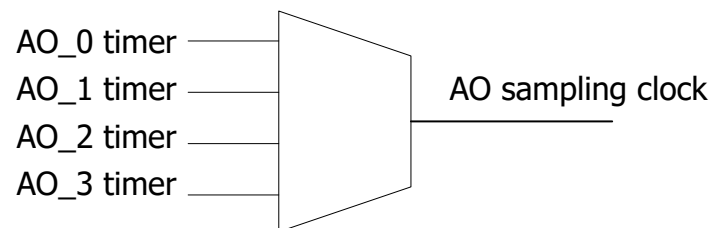


Figure 3.2 AO output sampling clock option

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.

3.5. Trigger

The USB-3500 series of data acquisition devices provide a rich set of trigger options, as shown in

Figure 3.3, which describes trigger options for an AO output channel.

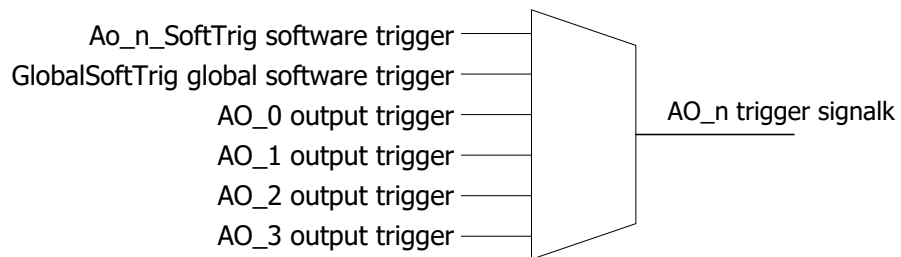


Figure 3.3 Trigger options for an AO output channel

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_nSoftTrig` 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.

4. Service and Warranty

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

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

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

Phone: (+86)10-52482802

E-mail: service@smacq.com

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

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5. Ordering Information

Host

Model	Notes
USB-3501	4-AO, 100kSa/s/Ch, $\pm 10V$

Standard accessories

Model	Notes
USB-A-B	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 $\pm 4v$
CHV-600VD	Voltage sensor, 600V, DC~20kHz, isolated differential input, output $\pm 5v$