USB-3300 Series Multifunctional Data Acquisition Devices

User 's Manual

Rev: F

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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-3300 Series Data Acquisition Device, as well as product specifications and precautions in the process of product unpacking.

1.1. Product introduction

USB-3300 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-3300 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.It also has the counter function, which can count the pulse, make the PWM waveform output, measure the encoder signal, and realize the position measurement function

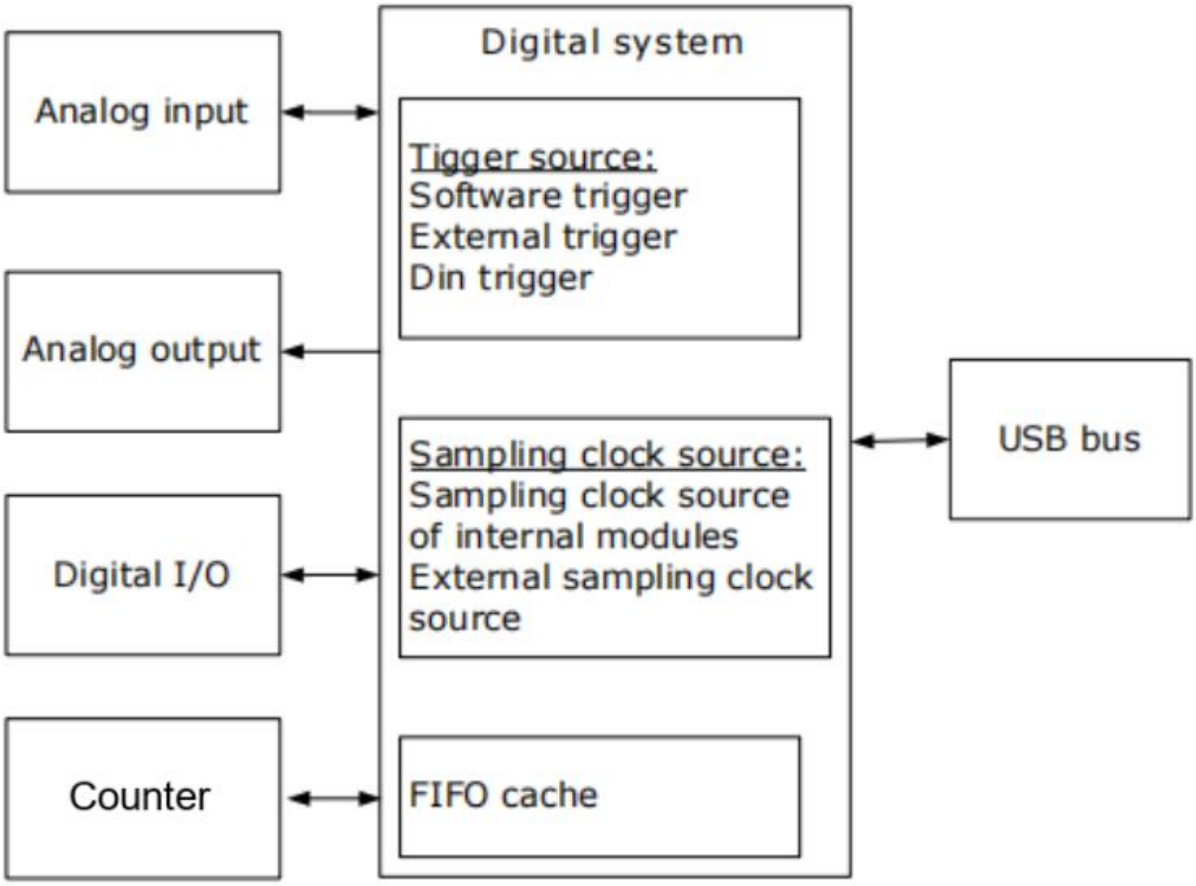
USB-3300 series data acquisition device supports operating in Windows OS, providing standard DLLs and support for mainstream development languages including VC++, VB, C#, LabVIEW, and MATLAB.

USB-3300 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-channel and up to 1MS/s/Ch
- Each analog input channel supports alone range setting
- Analog input mode supports Difference and Single end
- 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
- Up to 10MS/s/Ch sampling rate for digital I/O
- 32-bit counter supports high-speed pulse counting
- Encoder measurement supports A, B and Z inputs, supports setting of X1/2/4 and two pulse encoder

1.2. Function Diagram



USB-3300 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	USB-3320/3321/3322/3323: 16-CH Single End / 8-CH Difference USB-3310/3311/3312/3313: 8-CH Single End / 4-CH Difference
ADC type	SAR
Resolution	16-Bit
Sampling rate (Use channel equal allocation)	USB-3313/3323: 1MS/s, Continuous USB-3312/3322: 500kS/s, Continuous USB-3311/3321: 250kS/s, Continuous USB-3310/3320: 125kS/s, Continuous
Timing resolution	10ns
Channel synchronization	No
Range	±10.24V / ±5.12V / ±2.56V / ±1.28V / ±0.64V
Input coupling mode	DC
Input impedance	500MΩ
Small signal bandwidth(-3dB)	450kHz
Input bias current	0.7uA
Analog input max voltage	±12V
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)
±10.24V	20	10	195	820
±5.12V	50	15	110	550
±2.56V	55	30	70	315
±1.28V	100	60	60	220
±0.64V	200	120	50	100

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)

Digital I/O

Channel	4 input, 4 output
Ground reference	DGND
Digital input pull-up resistance	10kΩ
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	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	2MPts/Ch
DIN pre-trigger FIFO	2048Pts/Ch
DOUT hardware FIFO	2048Pts/Ch
DIN capture mode	Continuous acquisition mode and OneShot mode (When sampling rate exceed 4MS/s/CH only support OneShot mode and sampling point number limit of 15000)
DOUT output mode	Direct output; onboard FIFO waveform periodic generation; onboard FIFO waveform trigger N loop; Uninterrupted non-repetitive signals for computer caches
DOUT edge time	Ascending edge: 6ns Descending edge: 8ns

Counter

Channel	3
Counter resolution	32-bit
Reference ground	DGND
Input interface pull-up resistor	10kQ
Input voltage(Src/Gate/Z)	High level: 1.95~5V Low level: 0~1.2V
Output voltage(Out)	High level: 3.3V Low level: 0~0.003V
Output power-on state	Low level
Function	Counting edge, Frequency measurement, Pulse measurement, Pulse width measurement, Quadrature encoder measurement (X1/X2/X4/reset channel z), Two pulse encoder measurement.

Internal reference clock	100MHz
Internal Src period setting	20ns minimum, with 10ns increments
External Src input	Up to 25MHz
Reference clock accuracy	25 ppm
Hardware FIFO	256 Pts /Ch
Acquisition mode	Single point measurement, Sampling clock timing acquisition, Implicit buffer acquisition.

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.

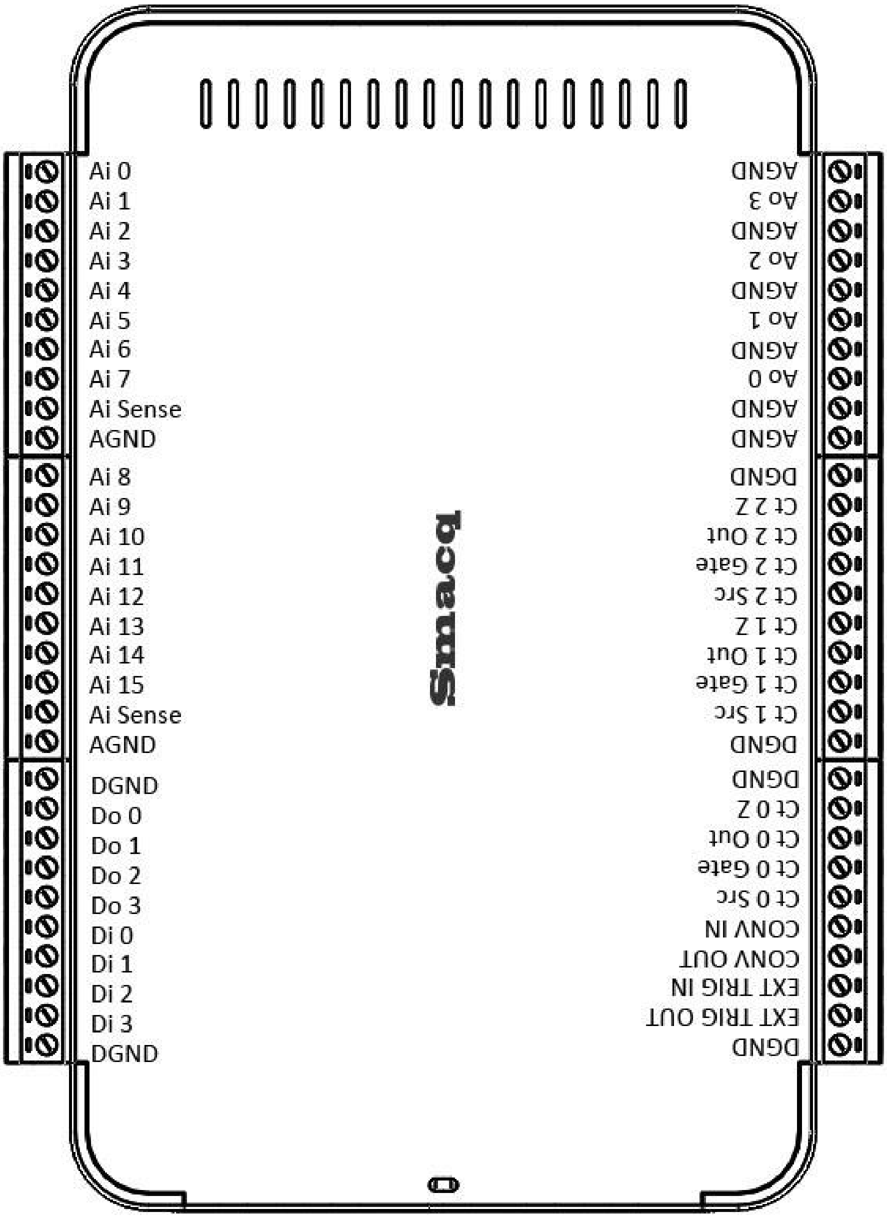
2.3. Packing list

Name	Specification Description	Quantity
USB-3300 Series	USB-3300 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-3300 series.

3.1. Connector signal pins distribution



USB-3300 series signal pins distribution

Attention：

Single-end acquisition analog input, AISENSE should only be connected to the terminal of the group in which the channel is located that is, the positive and negative ends of the measured analog signal should be connected to the same terminal, otherwise it will cause a measurement error.

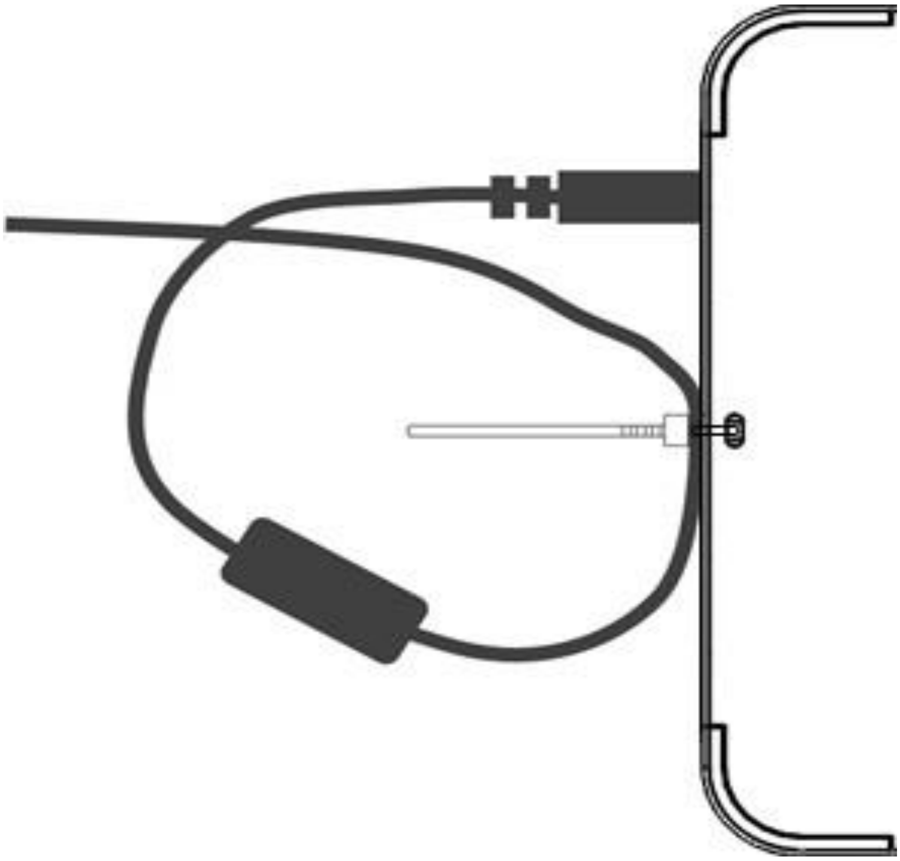
Signal pin allocation list

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

Signal name	NOTE
AISENSE	Analog input reference
AGND	Simulated ground
AO0	Analog output 0
AO1	Analog output 1
AO2	Analog output 2
AO3	Analog output 3
AGND	Simulated ground
DI0	Digital input 0
DI1	Digital input 1
DI2	Digital input 2
DI3	Digital input 3
DO0	Digital output 0
DO1	Digital output 1
DO2	Digital output 2
DO3	Digital output 3
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
Ct 0 Src	Counter 0 Source input
Ct 0 Gate	Counter 0 Gate input
Ct 0 Out	Counter 0 Out output
Ct 0 Z	Counter 0 Z input
Ct 1 Src	Counter 1 Source input
Ct 1 Gate	Counter 1 Gate input
Ct 1 Out	Counter 1 Out output
Ct 1 Z	Counter 1 Z input
Ct 2 Src	Counter 2 Source
Ct 2 Gate	Counter 2 Gate
Ct 2 Out	Counter 2 Out output
Ct 2 Z	Counter 2 Z input

3.2. USB cable reinforcement design

USB cable connectors are prone to be pulled off during operation. USB-3300 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-3300 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-3300 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-3300 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"

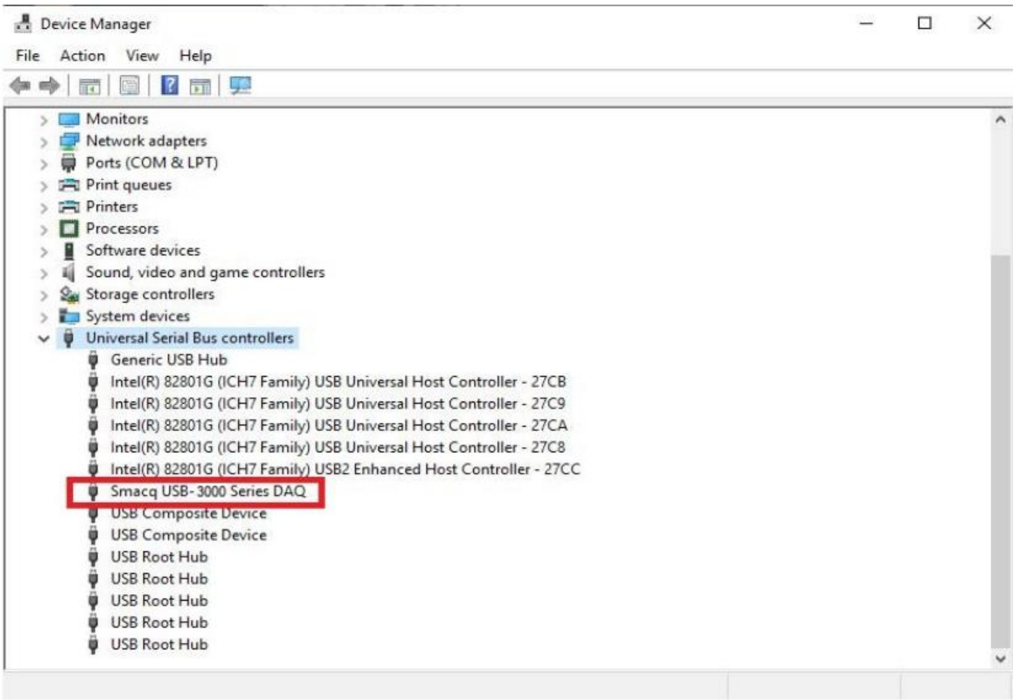
6. Click on "Next" and then select "Have disk"

7. Click Browse in the pop-up dialog box, then enter the \USB-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.

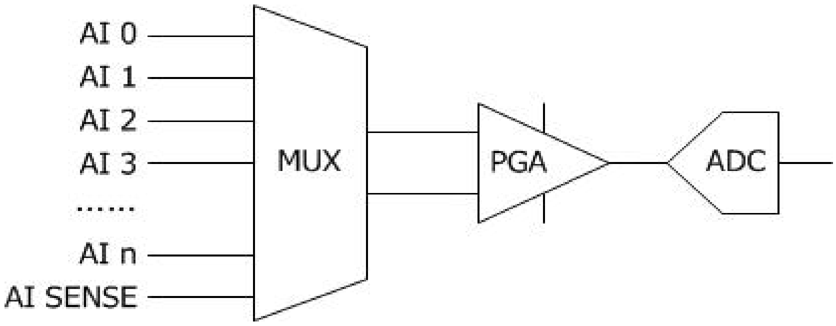


Device Manager after the driver is correctly installed

4. Analog Input (AI)

This chapter describes measuring the relevant content of analog input signals on USB-3300 series data acquisition cards. AI here is short for Analog Input.

4.1. Circuit diagram

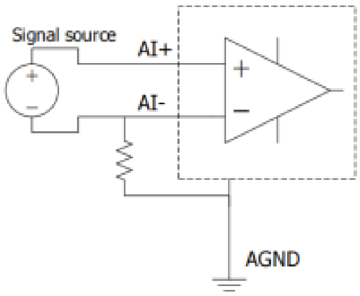
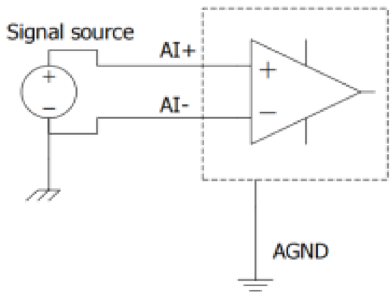
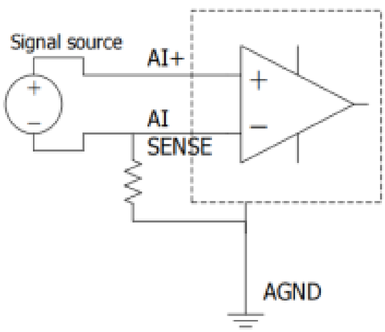
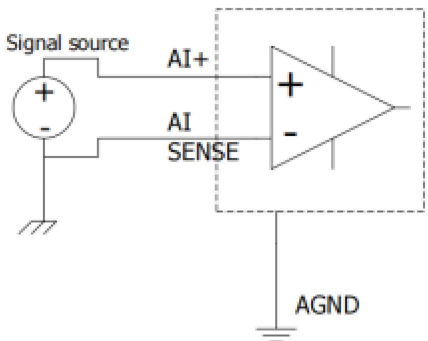


Analog input circuit

4.2. Signal Connection Mode

USB-3300 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	● Ungrounded thermocouples ● Signals that are isolated ● Battery-powered devices	● Signals that are not isolated
DIFF		
NRSE		

4.3. 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 AGND.

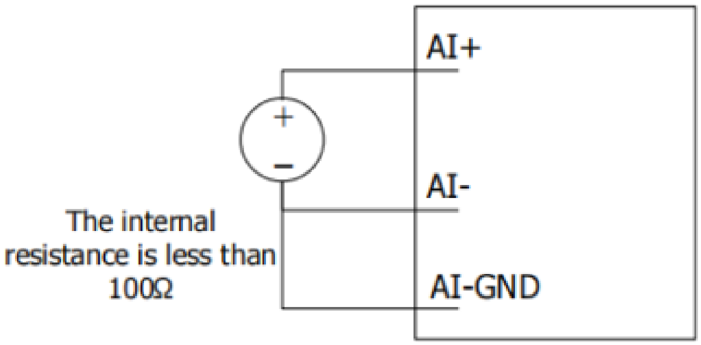
● Using differential mode (DIFF) connection

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.

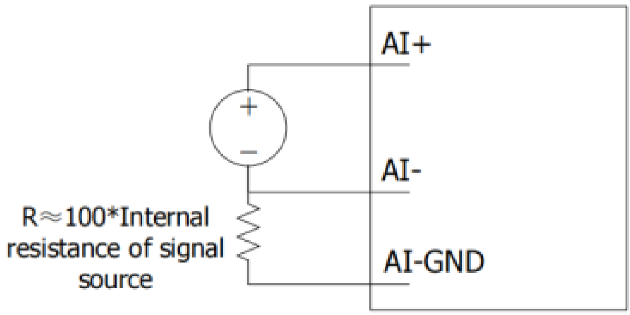
For a floating signal source with less than 100ΩF internal resistance, you can directly connect the negative end of the signal to AI- and AGND ports and connect the positive end of the signal to AI+ ports, as shown below.



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.

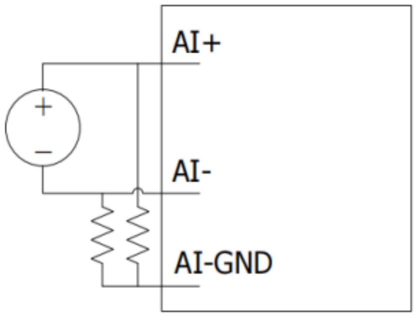
Therefore, for such a signal source, you can use a bias resistor approximately 100 times the internal resistance of the signal source to connect to AI- and AGND ports.
This can make the differential signal close to equilibrium, hence couple the same amount of noise at both ends of the signal to enable better common-mode noise suppression.



Differential input mode with single bias resistor

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 2kΩ, and two equilibrium resistors are 100kΩ each, then the signal source load is 200kΩ, which results in a 1% gain error.

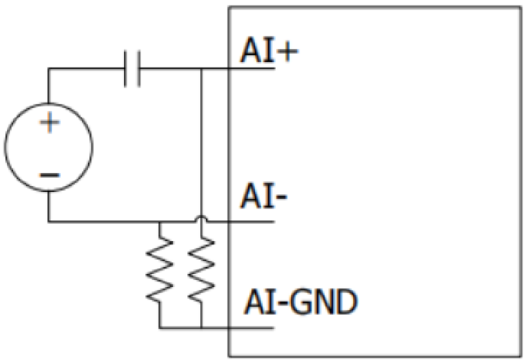


Balanced bias resistor differential input mode

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 AGND connection resistance values should be generally set as 100kΩ to 1MΩ. 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 AGND.

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.



Differential input method for AC coupled floating signal source

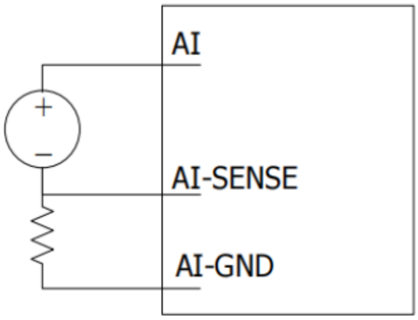
● Non-grounded reference single-ended mode (NRSE) connection

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

- 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 are more than that in differential mode.

Non-grounded reference single-ended mode (NRSE) connection methods.
Note that the resistance value setting of the grounded resistance is consistent with the that in difference mode.



Floating-grounded signal source NRSE input

4.4. 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.

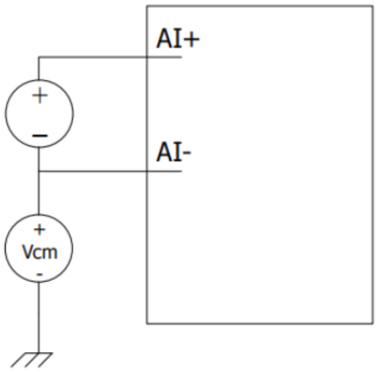
● Use a differential mode (DIFF)

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

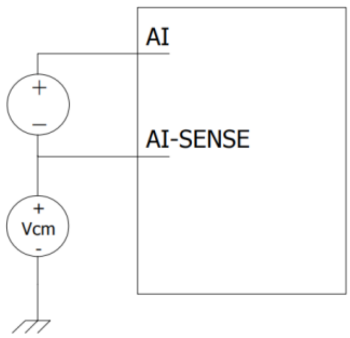
● Use a non-grounded reference single-ended mode (NRSE)

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

4.5. Signal acquisition mode

When the USB-3300 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.

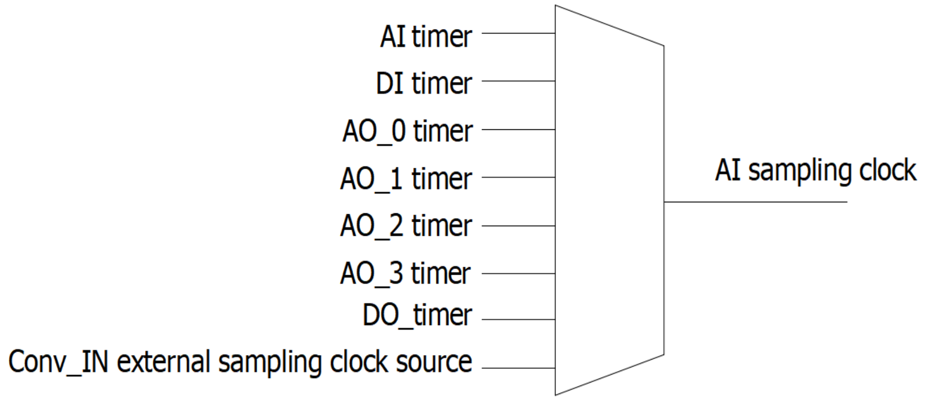
4.6. Sampling rate setting

When the USB-3300 series data acquisition device is used for single channel acquisition, the channel can achieve the maximum sampling rate.

If two channels are enabled, the sample rate for each channel need less than or equal max sampling rate half. if three channels are enabled, the sampling rate for each channel need less than or equal max sampling rate one third. When set sampling rate for more channels the calculation method is like above.

4.7. AI sampling clock

The USB-3300 series data acquisition device has a rich collection timing option. The schematic diagram of the AI sampling clock.



AI sampling clock options

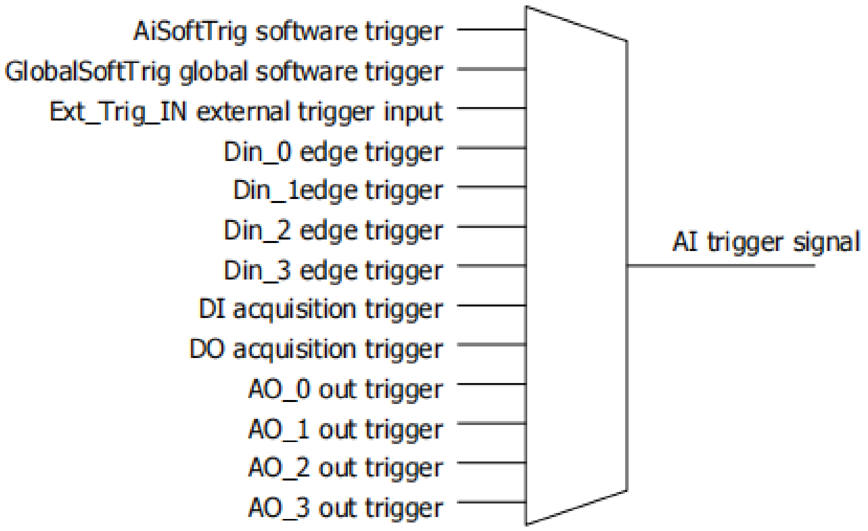
The AI acquisition uses the AI timer signal as the AI sampling clock by default. The AI acquisition can be set via software to use other sampling clock sources to achieve the synchronization of each function.

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.

4.8. Trigger

The USB-3300 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.

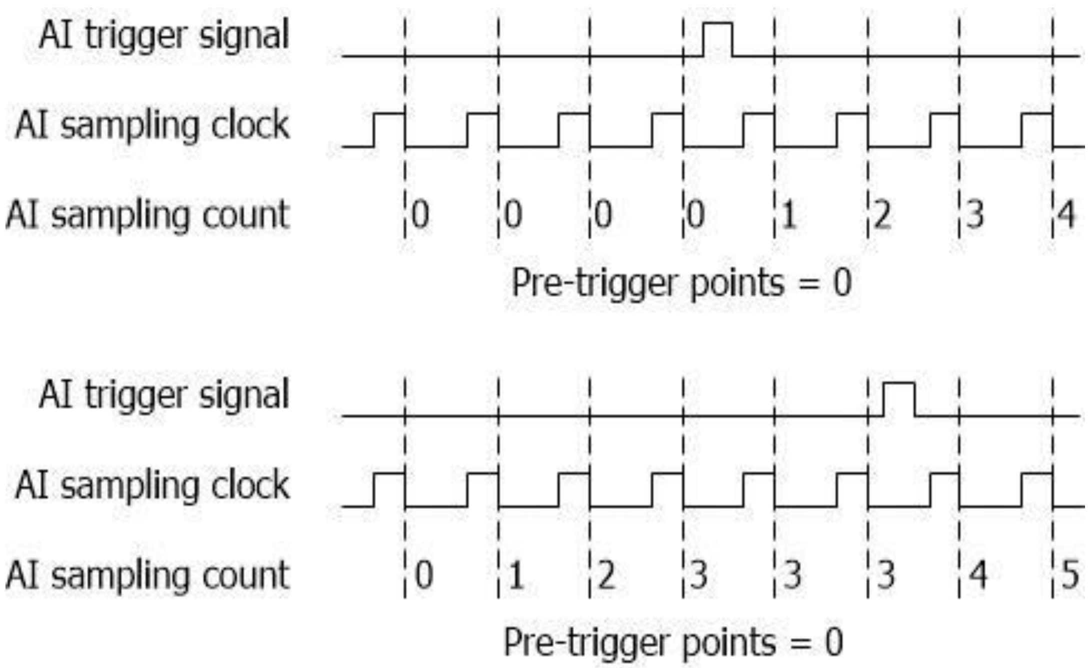
DI acquisition trigger, DO acquisition trigger, AO_0 output trigger, AO_1 output trigger, AO_2 output trigger, and AO_3 output trigger can be used to trigger the AI function alongside their own functions to achieve the synchronization of each function.

● 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.

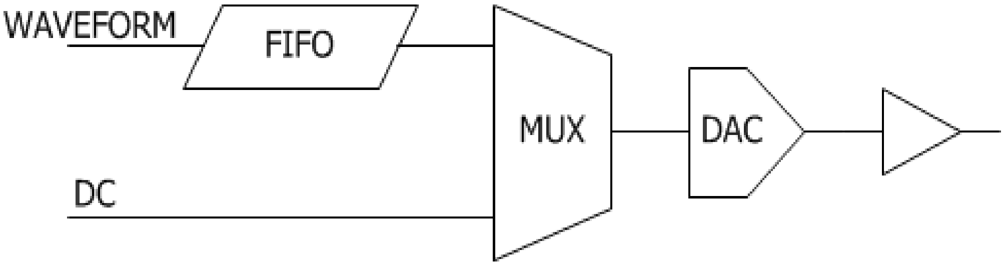
When the pre-trigger signal is set to be larger than 0, for example, in AI pre-trigger function diagram, the number of pre-trigger points is set to 3, then the data before the trigger signal will be stored, and when the stored quantity reaches 3, the newly acquired data will automatically remove the 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-3300 series data acquisition devices. AO is the abbreviation of Analog Output here.

5.1. Circuit diagram

The AO output circuit of the USB-3300 series data acquisition device, which supports the ground reference single-ended output.



Analog output circuit diagram

5.2. Signal output mode

When the USB-3300 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.

5.3. Output update rate

USB-3300 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.

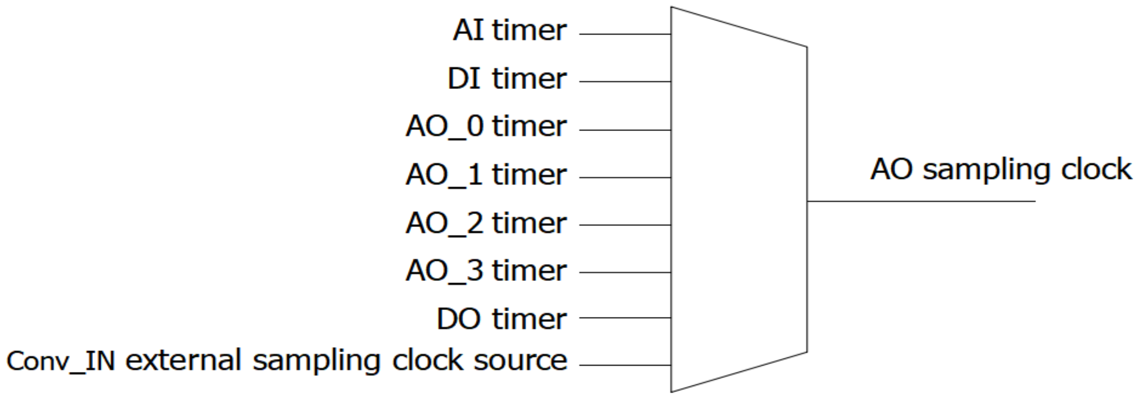
● Synchronous update

The four AO channels of the USB-3300 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-3300 series data acquisition device has rich AO acquisition timing options. The AO sampling clock is below.



AO output sampling clock option

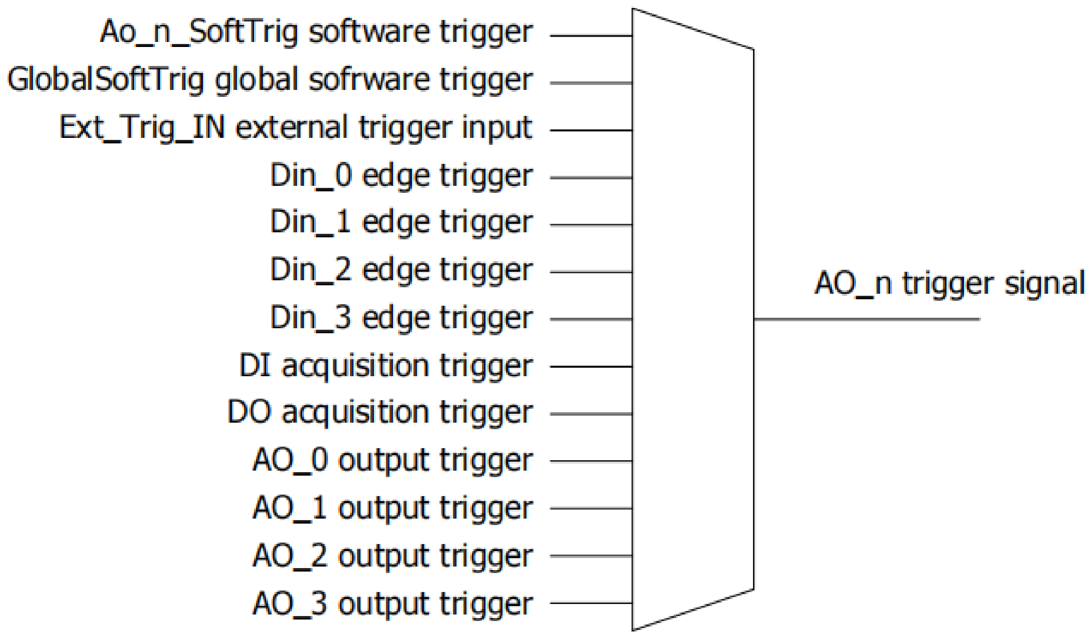
The AO acquisition uses the AO_n timer signal as the AO sampling clock by default. You can set AO acquisition to use other sampling clock sources to achieve the synchronization of each function via software settings.

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.

5.5. Trigger

The USB-3300 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.

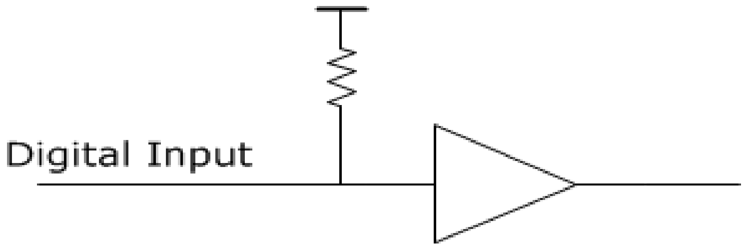
DI acquisition trigger, DO acquisition trigger, AO_0 output trigger, AO_1 output trigger, AO_2 output trigger, and AO_3 output trigger can be used to trigger the AO function alongside their own functions to achieve the synchronization of each function.

● 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-3300 series data acquisition cards. DI is the abbreviation of Digital Input here.



Digital input circuit

6.1. Signal acquisition mode

When the USB-3300 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.

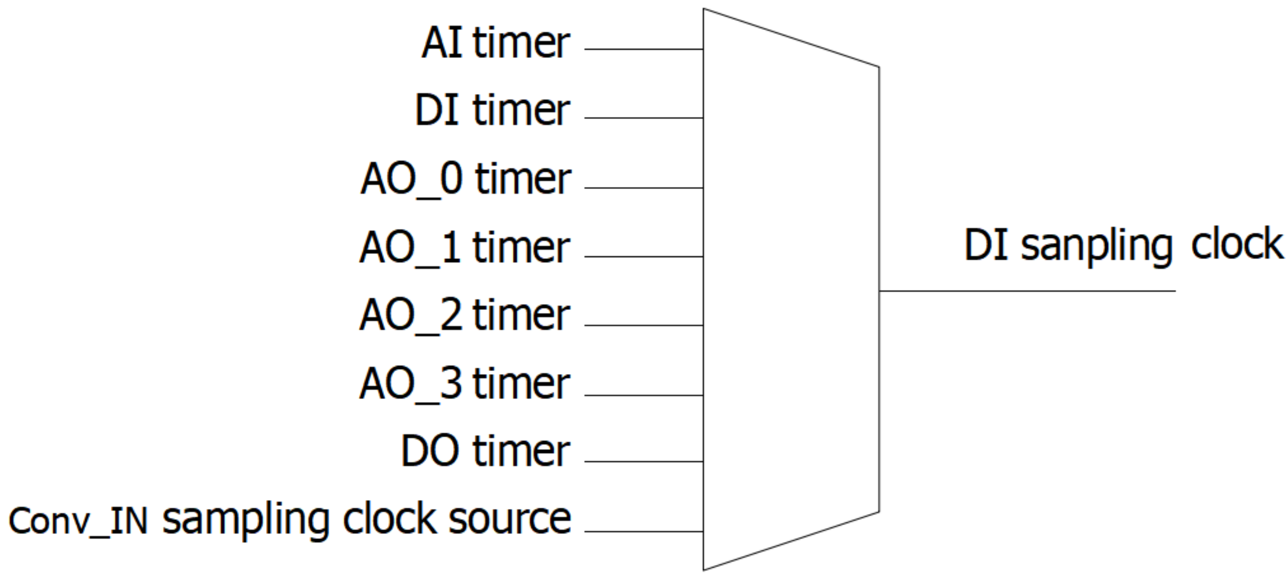
Attention: The number of set collection points cannot exceed 2MPts.

6.2. Sampling rate

For USB-3300 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-3300 series data acquisition device has a rich DI acquisition timing option. The DI sampling clock is shown in below.



DI sampling clock option

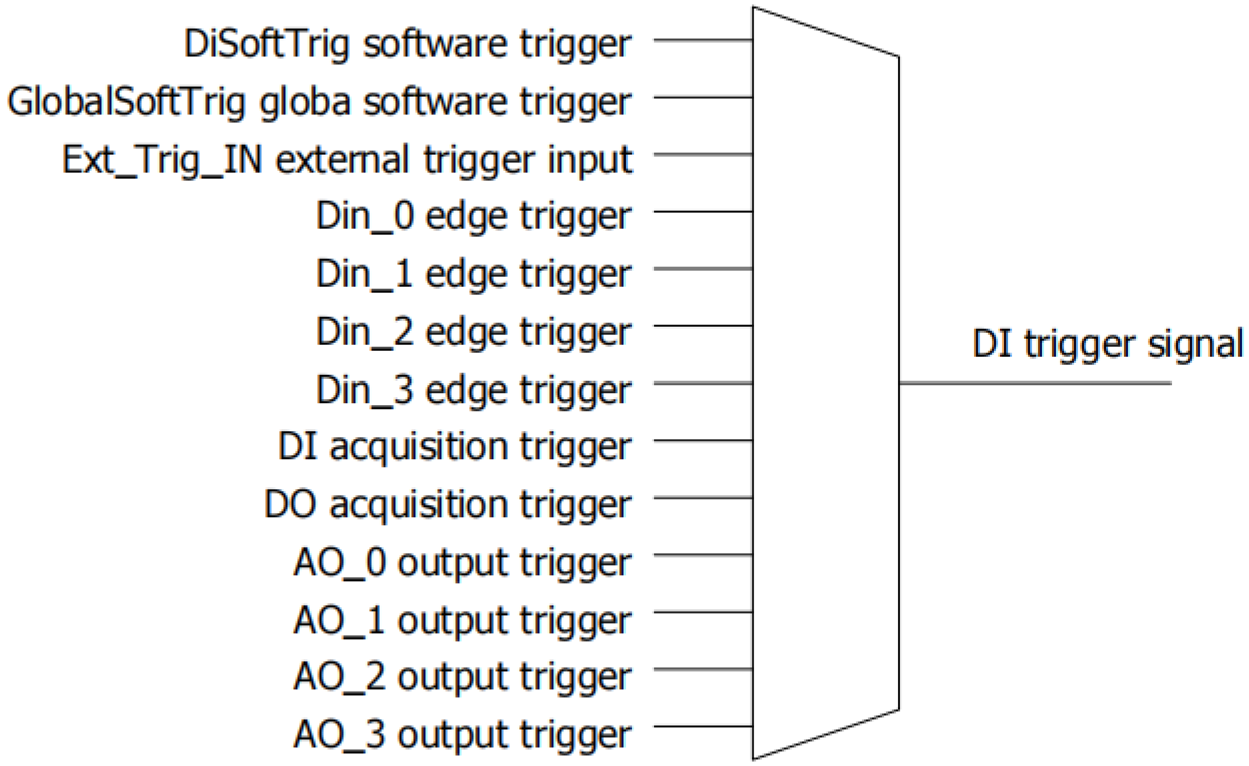
The DI acquisition uses the DI timer signal as the DI sampling clock by default. The DI acquisition can be set via software to use other sampling clock sources to achieve the synchronization of each function.

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-3300 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.

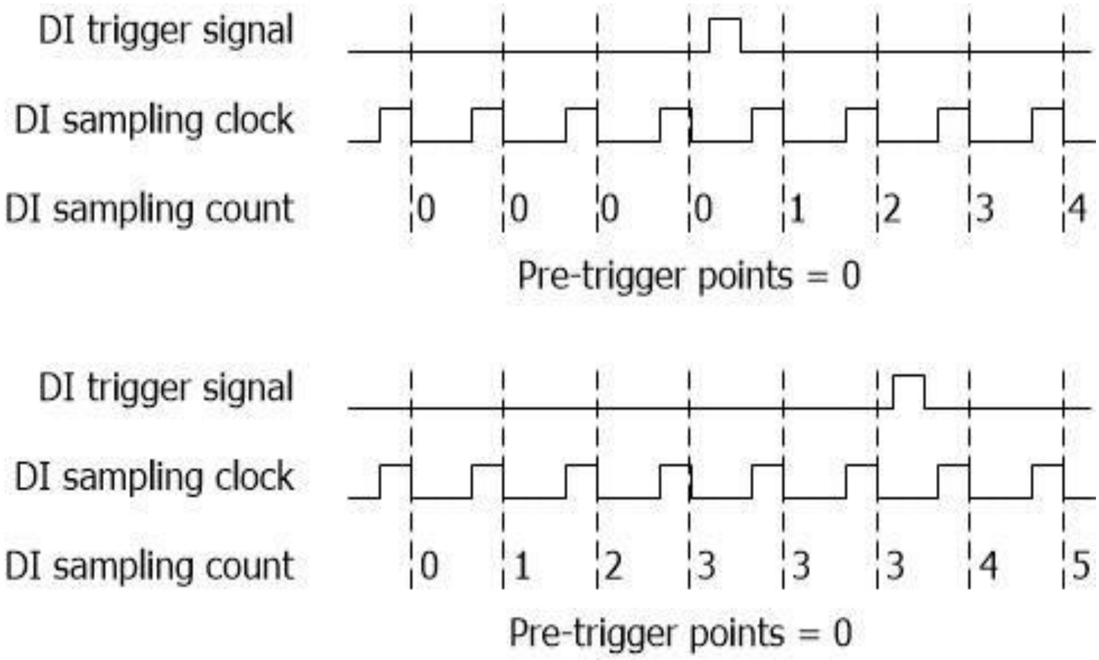
DI acquisition trigger, DO acquisition trigger, AO_0 output trigger, AO_1 output trigger, AO_2 output trigger, and AO_3 output trigger can be used to trigger the DI function alongside their own functions to achieve the synchronization of each function.

- **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.



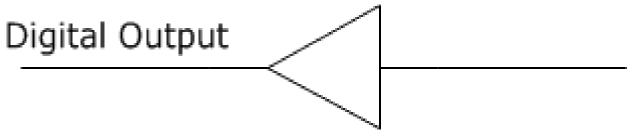
DI pre-trigger function

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-3300 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-3300 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.

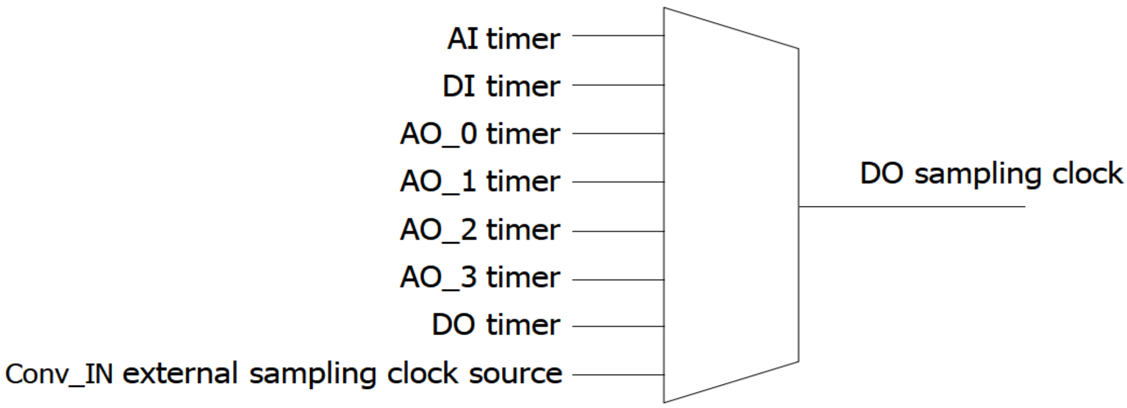
When the waveform output in the hardware FIFO is complete and no new data arrives, the DO output level state will remain at the level defined by the last point.

7.2. Output update rate

USB-3300 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-3300 series data acquisition device has rich DO acquisition timing options. The DO sampling clock is below.



DO sampling clock option

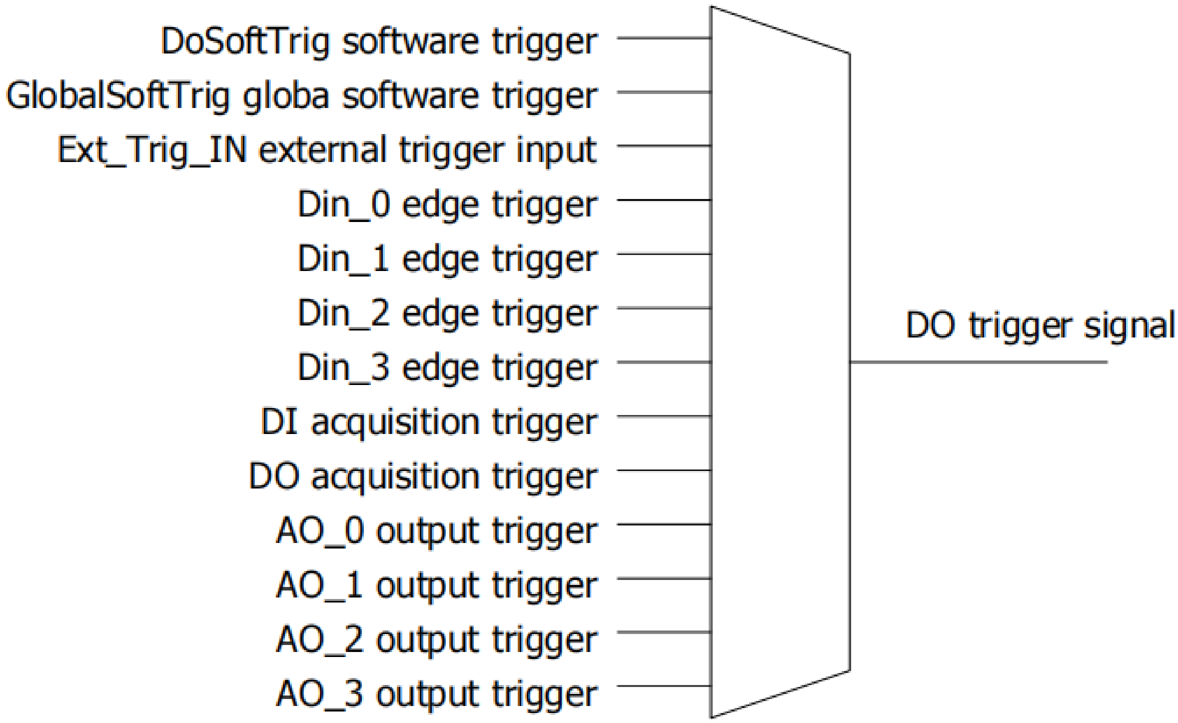
The DO acquisition uses the DO timer signal as the DO sampling clock by default. You can set DO acquisition to use other sampling clock sources to achieve the synchronization of each function via software settings.

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-3300 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.

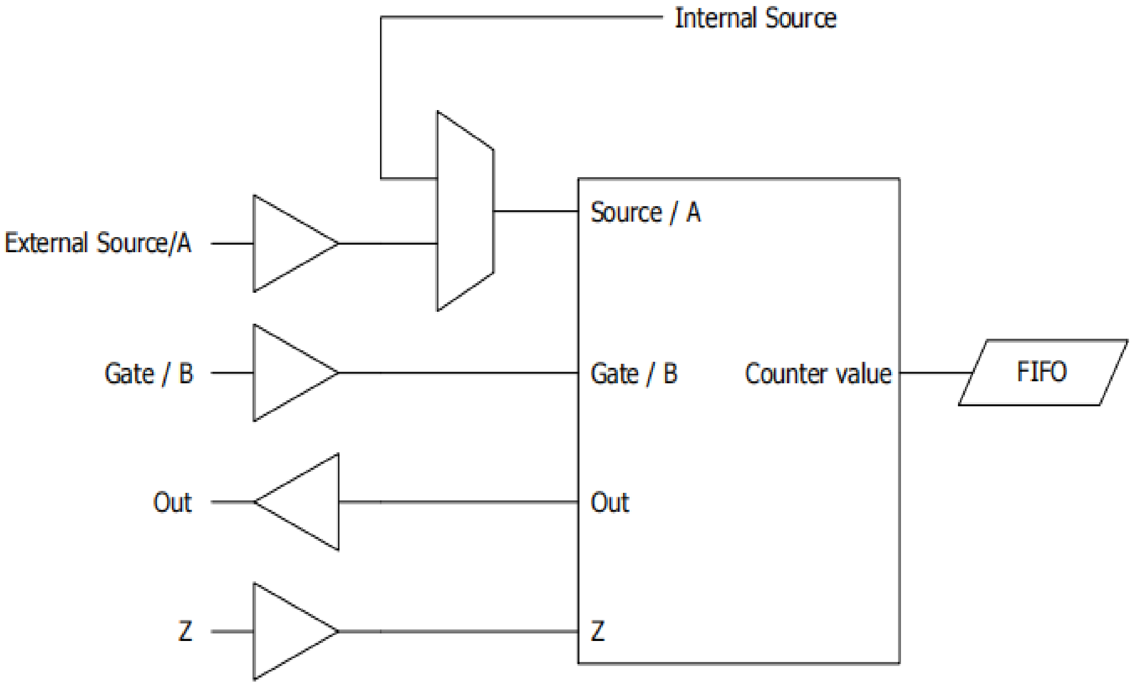
DI acquisition trigger, DO acquisition trigger, AO_0 output trigger, AO_1 output trigger, AO_2 output trigger, and AO_3 output trigger can be used to trigger the DO function alongside their own functions to achieve the synchronization of each function.

- **Clear trigger**

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

8. Counter (CT)

This chapter introduces the related contents of USB-3300 series data acquisition device when using counters. Later, the Counter is expressed by CT, which is the abbreviation of counter.



Block Diagram of counter circuit

The counter of USB-3300 series is a 32-bit counter, in which the frequency of the internal Source signal can be set by software, and its period is set in steps of 10ns, with a minimum setting of 20ns.

The supported working modes of the counter are as follows:

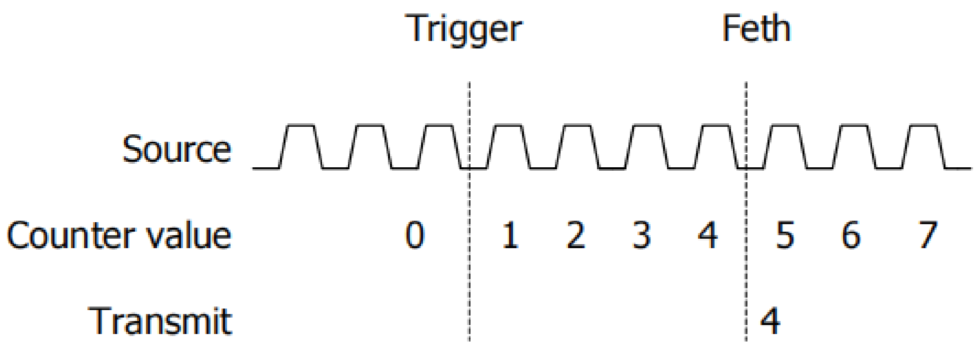
- Counting edge (PWM output)
- Pulse width measurement
- Pulse measurement
- Frequency measurement (period measurement)
- Position measurement (encoder input, supports quadrature encoder and two pulse encoder)

8.1. Counting edge and PWM output

Counting edge means that the counter starts counting edge of the signal input to the Source port after triggering. The Source can be set as an external Source port input or an internal Source signal. When set to external Source port input, the counter can be set to count rising edges or falling edges. You can also control the direction of counting, and the counting value increases or decreases.

● software controls single point reading.

Software-controlled single-point reading means that after the counter triggers to start counting edge of the Source signal, the counter value is not directly uploaded to the computer, but the latest counter value is sent back to the computer when the computer reading demand is received, which does not interfere with counting

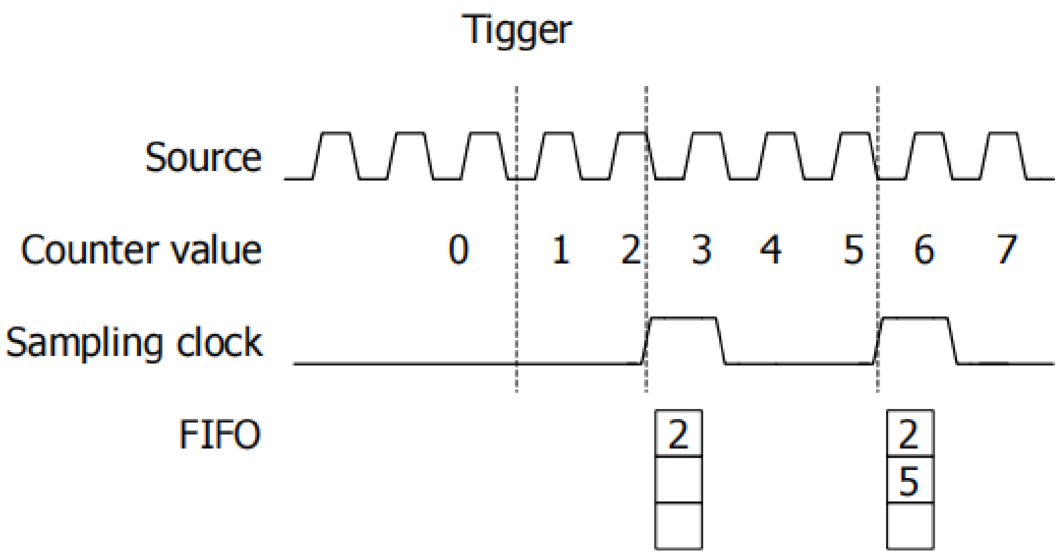


Example of Software Controlled Single Point Reading

● Sampling Clock Timing Continuous acquisition

Sampling clock timing continuous acquisition means that after the counter triggers to start counting edge of the Source signal, the counter value is stored in the FIFO according to the set sampling rate, and the data in the FIFO is continuously uploaded to the computer memory buffer, so that the user program can realize continuous and uninterrupted data acquisition only by continuously processing the data in the memory.

If the data processing speed of user program is not fast enough, the data will gradually fill the memory space of 2M points in the computer memory buffer, and after filling, the new data cannot be written correctly, resulting in data discontinuity.



Sample of Sampling Clock Timing Continuous Acquisition

● Control counting enable

The enable of the control counter can be realized by inputting the high and low levels of the Gate port.

- Gate port input high level, the counter counts normally.
- Gate port input low level, counter stops counting.
- Because there is a pull-up resistor inside the Gate port, the counter can count normally when the input is suspended.

● Control the counting direction

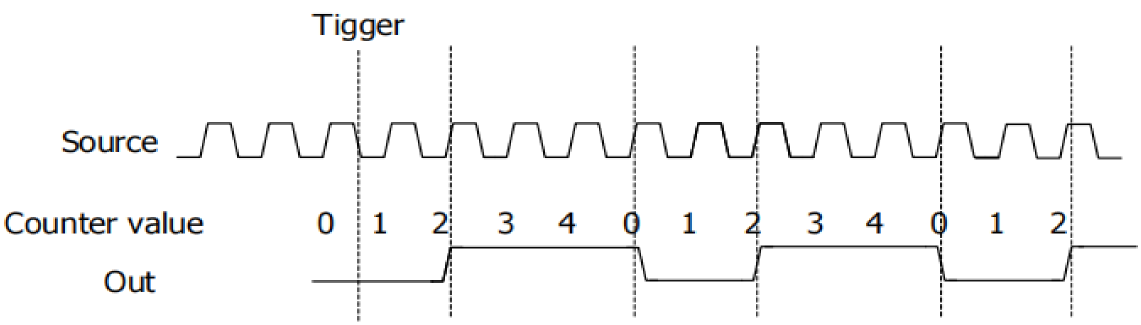
Control the counting direction of the counter, which can be jointly controlled by software setting and Z port.

- When the software is set to increment, the Z port input is high and the counter is incremented; The Z port input is low and the counter is decremented.
- When the software is set to decrement, the Z port input is high and the counter decrements;The Z port input is low and the counter is incremented.
- Because there is a pull-up resistor in the Z port, the counter can count normally when the input is suspended.

● PWM output

When counting edge, the Out port can output PWM waveform with specified duty cycle by setting. When the counter triggers to start counting, the output of the Out port is low; When the count value reaches the median count value (Front Part Value), the output of the Out port is pulled high; When the count value reaches the overflow value (Overflow Value), the Out port is pulled low and the count value is reset to the reset value (Reload Value).

Below is shows the working mode of PWM output during counting edge. In this example, the initial value is set to 0, the overflow value is set to 5, the counting median value is set to 2, and the reset value is set to 0. When the count value reaches 5, the counter overflows and the count value is reset to 0. At this time, the positive pulse width duty ratio of the PWM waveform Output from the out port is 60%.



Example of PWM output during counting edge

8.2. Pulse width measurement

Pulse width measurement refers to measuring the width of the input signal pulse at the Gate port. The width of positive pulse or negative pulse can be measured by software setting.

- When measuring positive pulse width, count from the first rising edge after triggering.
- When measuring negative pulse width, count from the first falling edge after triggering.

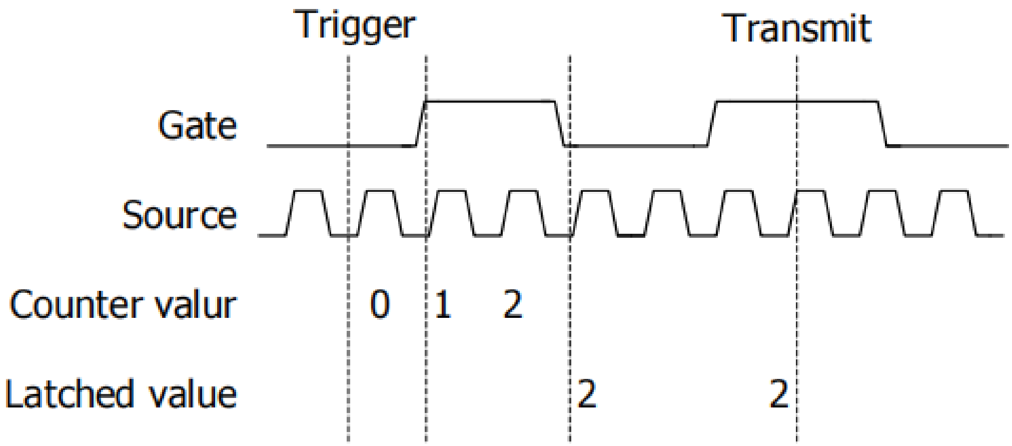
When measuring pulse width, the Source signal used for counting can be set as the input signal of external Source port or internal Source signal. Multiply the period of the Source signal by the counter value to get the pulse width.

The frequency of the internal Source signal can be set by software, and its period is set in steps of 10ns to adapt to the measurement of Gate signals in different frequency ranges.

There are three ways to output the pulse width measurement:

● Software controlled single point measurement

Software-controlled single-point measurement means that after the counter triggers and starts counting edge of the Source signal, the counter value is not directly uploaded to the computer, but the latched counter value is sent back to the computer when the computer reads the request. In this process, no new pulse width measurement is carried out, and only the width of the first pulse after triggering is latched.

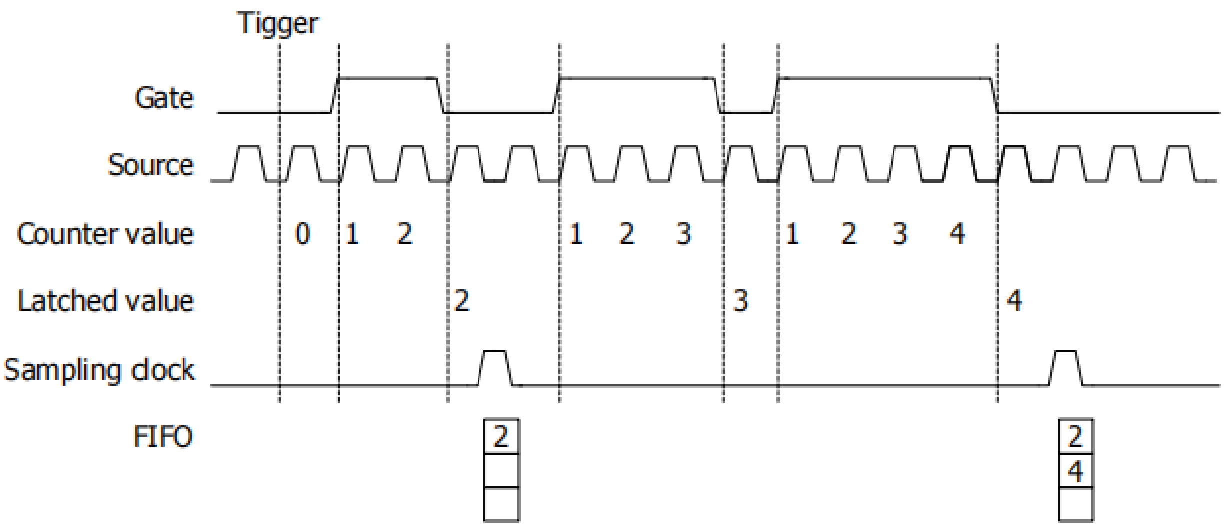


Examples of software controlling single-point measurement

● Sampling clock timing continuous acquisition

Sampling clock timing continuous acquisition means that after the counter triggers to start counting edge of the Source signal, the counter value is stored in the FIFO according to the set sampling rate, and the data in the FIFO is continuously uploaded to the computer memory buffer, so that the user program can realize continuous and uninterrupted data acquisition only by continuously processing the data in the memory.

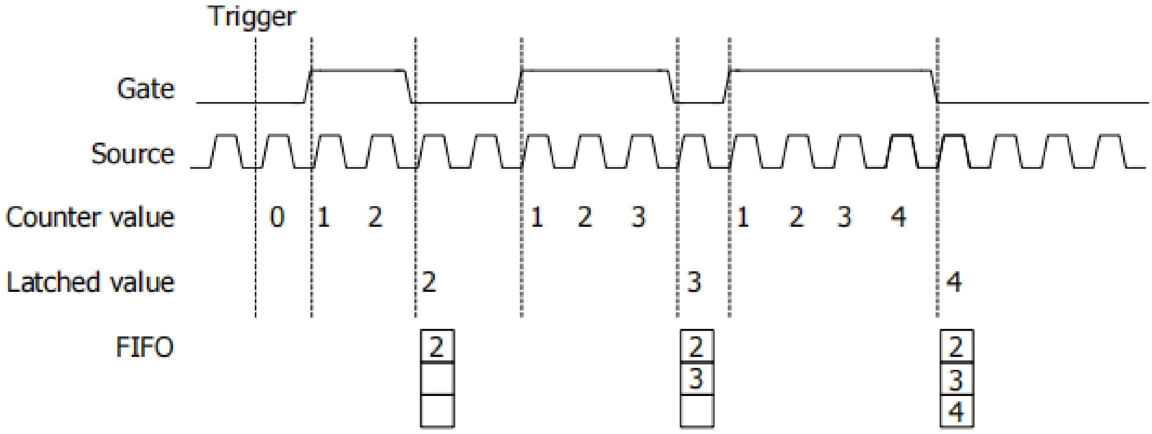
If the data processing speed of user program is not fast enough, the data will gradually fill the memory space of 2M points in the computer memory buffer, and after filling, the new data cannot be written correctly, resulting in data discontinuity.



Example of sampling clock timing continuous acquisition

● Implicit buffer pulse width acquisition

Implicit pulse width acquisition means that when the pulse width is measured by the counter value, the measured value will be automatically stored in the FIFO every time the pulse width measurement is completed, and the data in the FIFO will be continuously uploaded to the computer memory buffer. The sequence of all pulse width data read by the user program.



Example of implicit buffer pulse width acquisition

8.3. Pulse Measurement

Pulse measurement refers to the measurement of the high and low level time of the input pulse signal at the Gate port. The high-level measurement value is stored in the upper 16-bit of the result, and the low-level measurement value is stored in the lower 16-bit of the result.

The first rising edge of the Gate input pulse signal starts counting, measurements the high-level time until the next falling edge, ends the high-level measurement, starts counting again, measurements the low-level time until the next rising edge, ends the low-level measurement, latches the data and starts the next measurement.

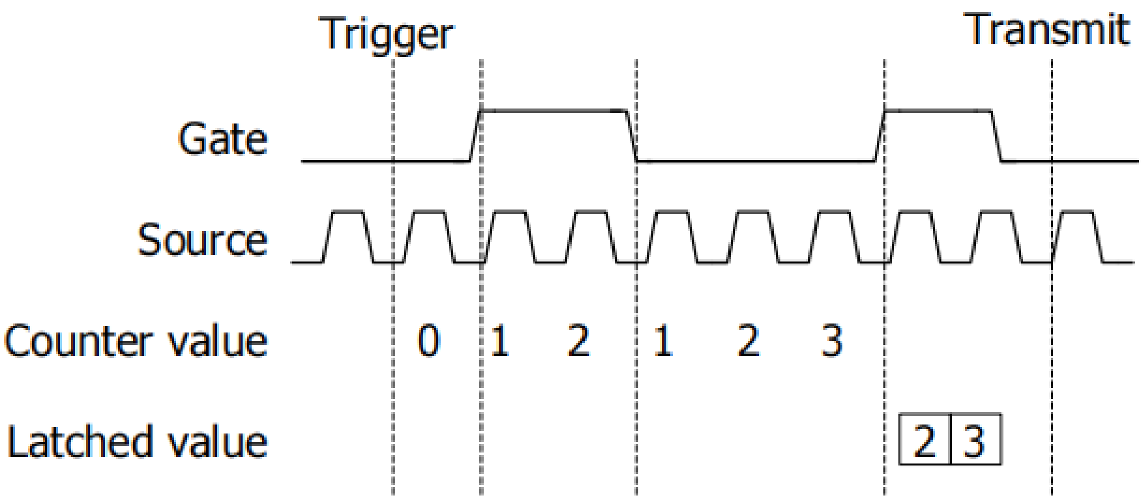
When measuring pulses, the Source signal used for counting can be set as the signal input from the external Source port or the internal Source signal. Multiply the period of the Source signal by the counter value to get the high level and low level time of the pulse respectively.

The frequency of the internal Source signal can be set by software, and its period is set in steps of 10ns to adapt to the measurement of Gate signals in different frequency ranges.

There are three ways to output the pulse measurement value:

● Software controlled single point measurement

Software-controlled single-point measurement means that after the counter triggers and starts counting edge of the Source signal, the counter value is not directly uploaded to the computer, but the latched counter value is sent back to the computer when the computer reads the request. In this process, no new pulse measurement is carried out, and only the first pulse after triggering is latched.

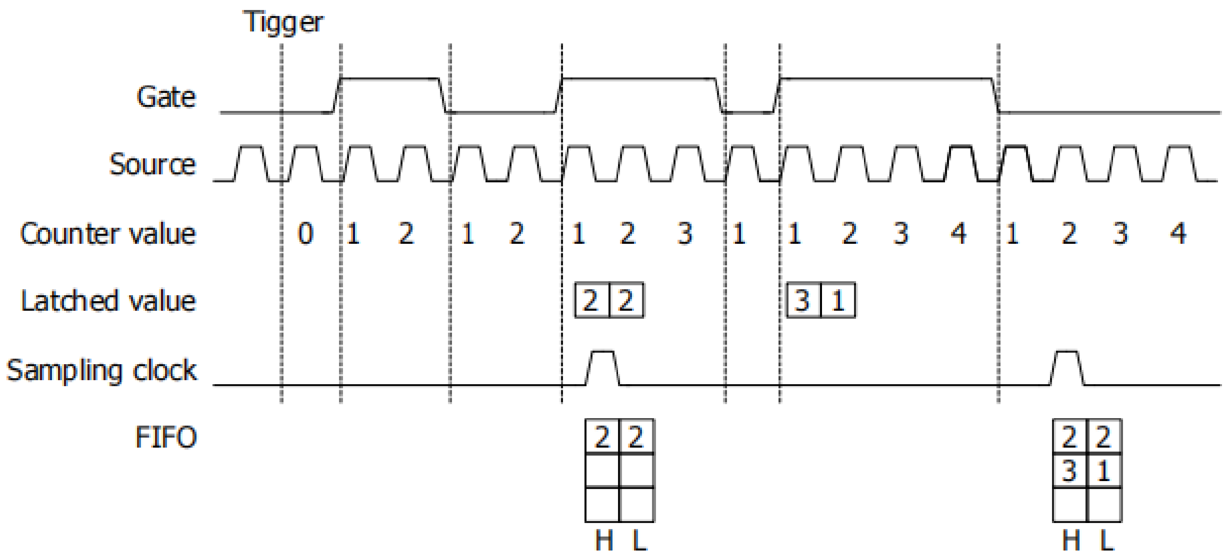


Examples of software controlling single-point measurement

● Sampling clock timing continuous acquisition

Sampling clock timing continuous acquisition means that after the counter triggers to start counting edge of the Source signal, the counter value is stored in the FIFO according to the set sampling rate, and the data in the FIFO is continuously uploaded to the computer memory buffer, so that the user program can realize continuous and uninterrupted data acquisition only by continuously processing the data in the memory.

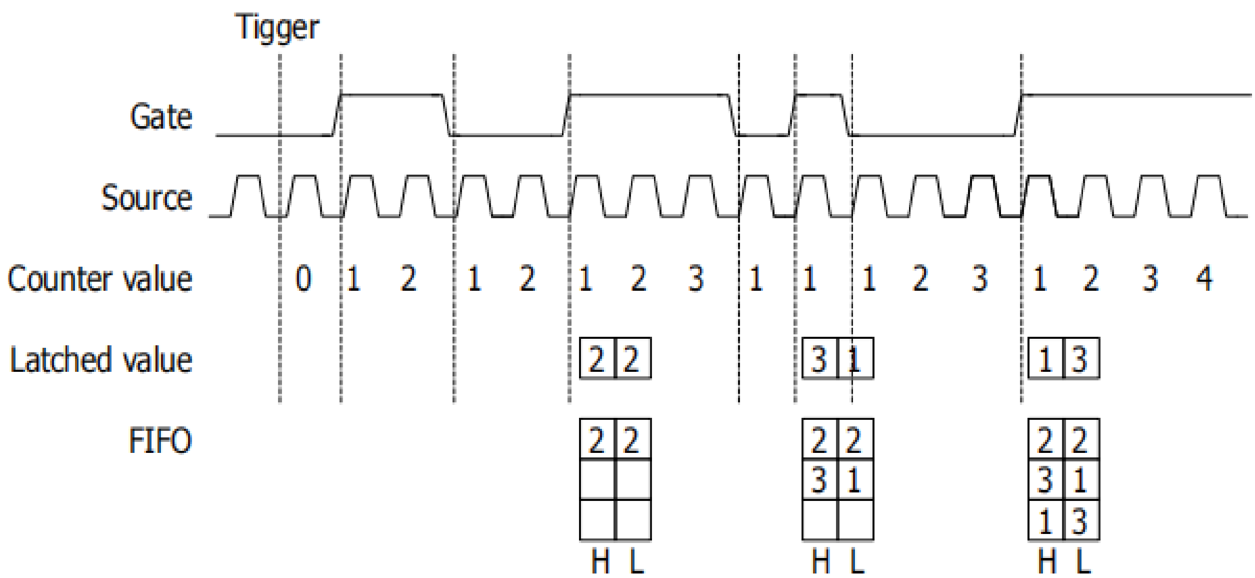
If the data processing speed of user program is not fast enough, the data will gradually fill the memory space of 2M points in the computer memory buffer, and after filling, the new data cannot be written correctly, resulting in data discontinuity.



Example of sampling clock timing continuous acquisition

● Implicit buffered pulse acquisition

Implicit buffer pulse acquisition means that when counting values measurement pulses, the measured values are automatically stored in FIFO every time the pulse measurement is completed, and the data in FIFO are continuously uploaded to the computer memory buffer. The sequence of all pulse data read by the user program.



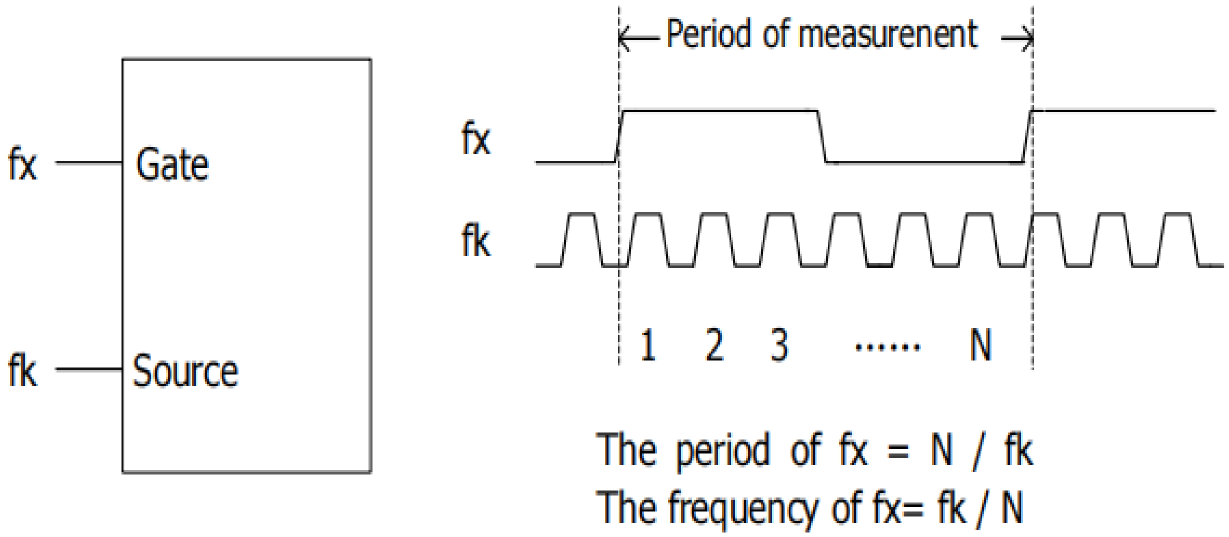
Example of implicit buffer pulse width acquisition

8.4. Frequency Measurement

Frequency measurement refers to measuring the time interval between two consecutive rising edges of the input pulse signal at the Gate port.

Frequency measurement refers to measuring the time interval between two consecutive rising edges of the input pulse signal at the Gate port. Frequency measurement refers to measuring the time interval between two consecutive rising edges of the input pulse signal at the Gate port. The measuring principle is shown in below.

The frequency of the internal Source signal can be set by software, and its period is set in steps of 10ns to adapt to the measurement of Gate signals in different frequency ranges.

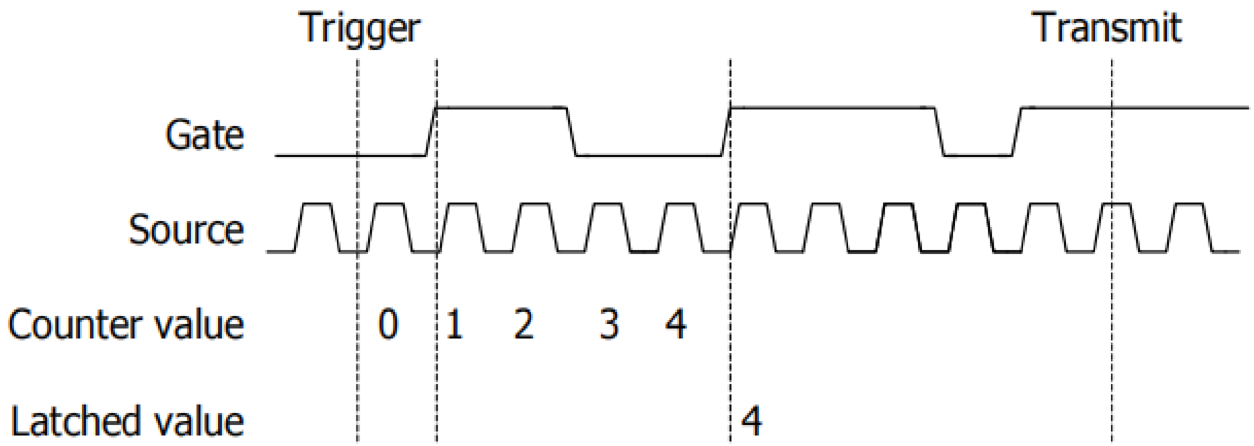


Principle of frequency (period) measurement

There are three ways to output the frequency measurement:

● Software controlled single point measurement

Software-controlled single-point measurement means that after the counter triggers and starts counting edge of the Source signal, the counter value is not directly uploaded to the computer, but the latched counter value is sent back to the computer after receiving the reading demand of the computer. In this process, no new frequency measurement is carried out, and only the first two rising edges after triggering are latched.

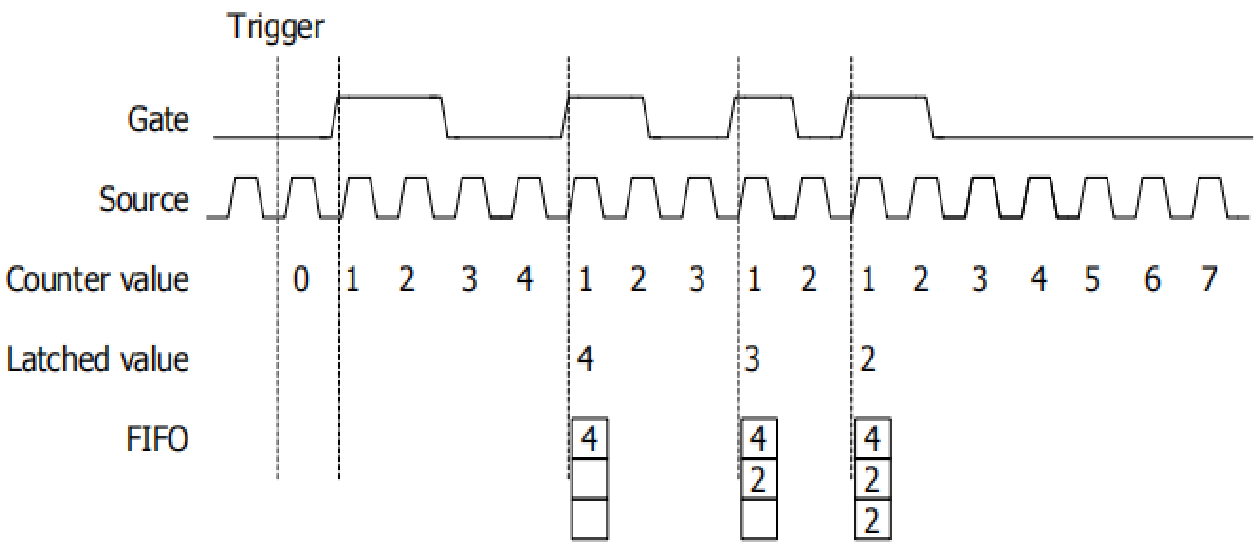


Example of Software Controlled Single Point Measurement

● Sampling clock timing continuous acquisition

Sampling clock timing continuous acquisition means that after the counter triggers to start counting edge of the Source signal, the counter value is stored in the FIFO according to the set sampling rate, and the data in the FIFO is continuously uploaded to the computer memory buffer, so that the user program can realize continuous and uninterrupted data acquisition only by continuously processing the data in the memory.

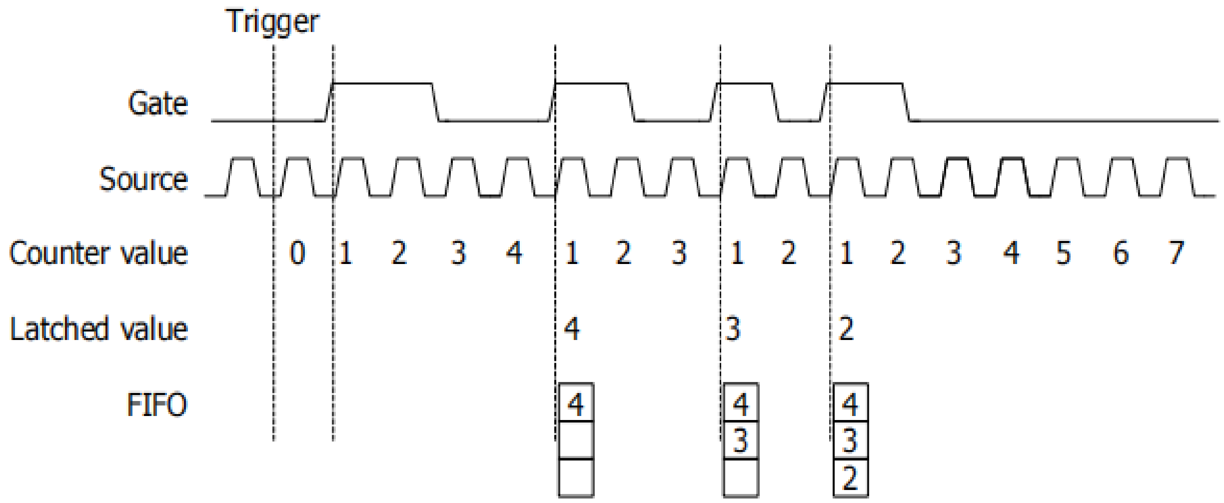
If the data processing speed of user program is not fast enough, the data will gradually fill the memory space of 2M points in the computer memory buffer, and after filling, the new data cannot be written correctly, resulting in data discontinuity.



Example of sampling clock timing continuous acquisition

● Implicit buffer frequency measurement and acquisition

Implicit buffer frequency measurement and acquisition means that every time the frequency measurement is completed, the measured value will be automatically stored in FIFO, and the data in FIFO will be continuously uploaded to the computer memory buffer. The sequence of all pulse data read by the user program.



Example of implicit buffer frequency measurement

8.5. Position Measurement

The counter can be used to measurement the position of quadrature encoder or two pulse encoder. X1, X2 and X4 angle encoders can be used for position measurement. The two pulse encoder can be used for line position measurement.

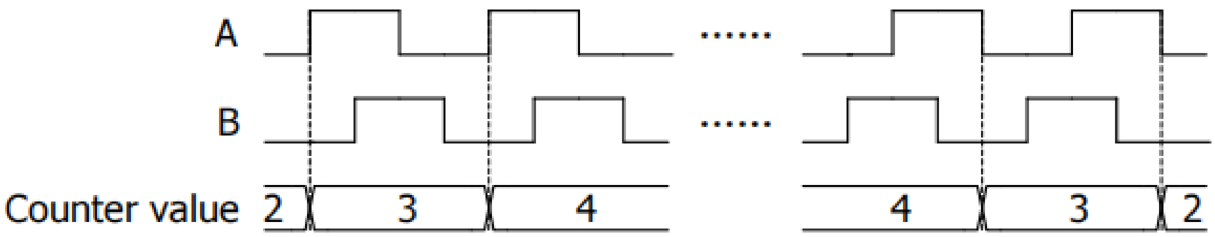
● Use quadrature encoder for measurement.

When quadrature encoder is used, X1, X2 or X4 encoding modes can be supported by software settings.

■ X1 coding

In one cycle, if the channel A phase leads the channel B phase, the counter value increases; If phase B of channel leads phase A, the counter value decreases. The increment and decrement in each cycle depends on the encoder type X1, X2 or X4.

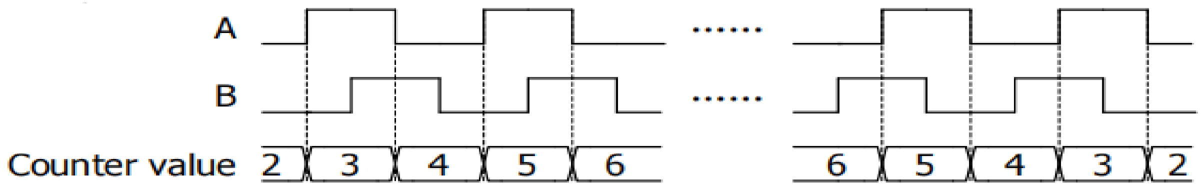
Below is shows the increment and decrement of X1 code in an integration period. If channel A phase leads channel B phase, the increment occurs at the rising edge of channel A; If the channel B phase leads the channel A phase, the decrement occurs at the falling edge of the channel A.



Quadrature encoder X1 coding counting mode

■ X2 coding

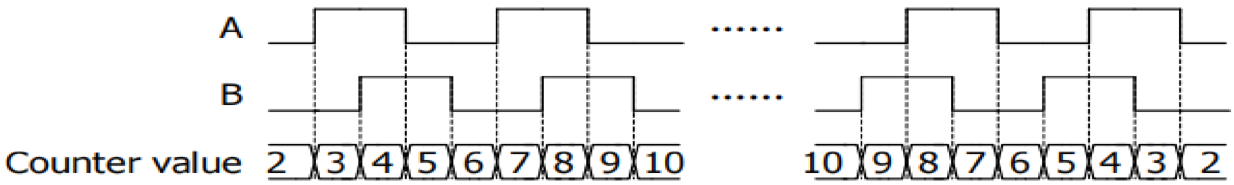
For X2 coding, according to the relative timing of two channels, the increment or decrement of the counter occurs at each edge of channel A.



Quadrature encoder X2 coding counting mode

■ X4 coding

For X4 coding, the increment or decrement of the counter occurs at two edges of channels A and B, and the increment or decrement is determined by the relative timing of channels. Four increments or decrements can occur in each cycle



Quadrature encoder X4 coding counting mode

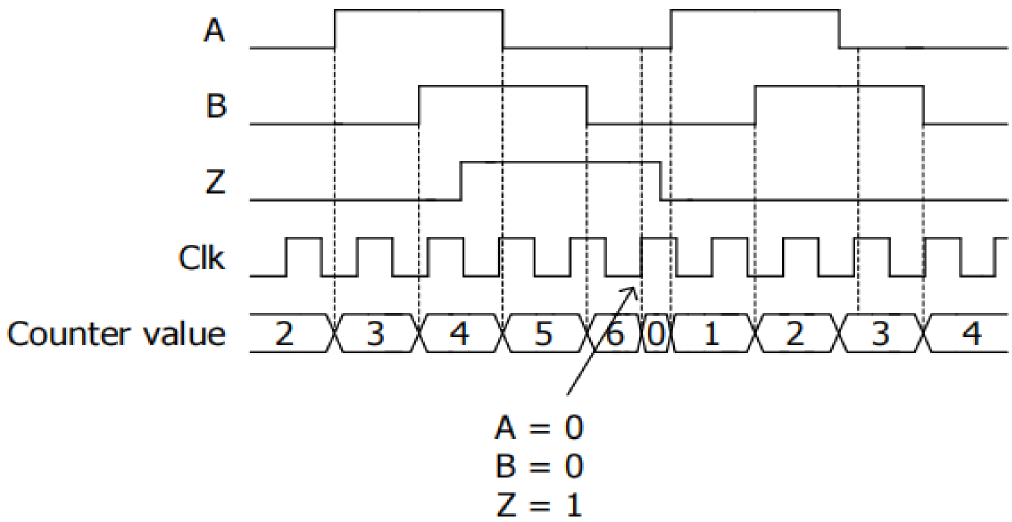
● Z channel characteristic

Some quadrature encoders have a third channel Z, which is usually used as an index channel. Setting channel Z to high level can reset the counter, and the value of the counter is reset to the specified value. By setting, the counter can be reset in any one of the four periods of a cycle.

Please refer to the relevant documents of the encoder used for the conditions for Z channel.

For the counter, the conditions for resetting channel Z can be set to the following four kinds by software:

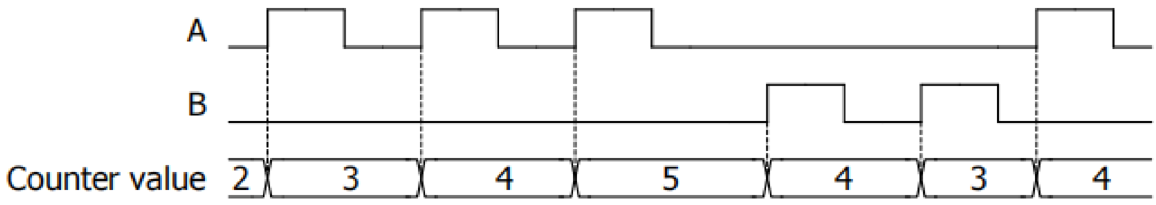
- ■ A=0, B=0, Z=1, the counter is reset.
- ■ A=0, B=1, Z=1, the counter is reset.
- ■ A=1, B=0, Z=1, the counter is reset.
- ■ A=1, B=1, Z=1, the counter is reset.



Example of Z channel reset

● Measurement with two pulse encoder

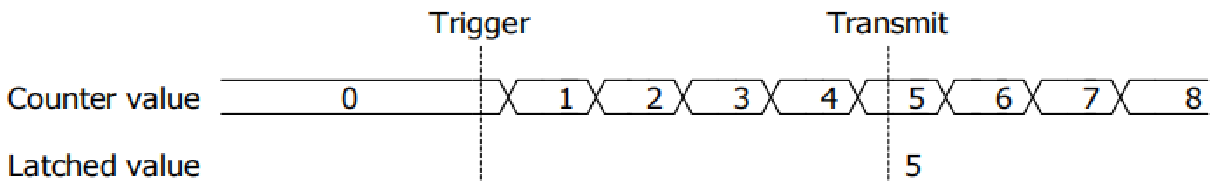
The counter supports two pulse encoder measurement with two channels, which are connected to channels A and B respectively. At each rising edge of channel A, the count value increases; At each rising edge of channel B, the counter value decreases as shown in below.



Measurement example of two pulse encoder

● Software controlled single point measurement

Software-controlled single-point measurement means that after the counter is triggered, the encoder is measured, and the measured value is not directly uploaded to the computer, but the latched measured value is sent back to the computer after receiving the computer reading request. Figure 7.20 is an example of software-controlled single-point measurement.

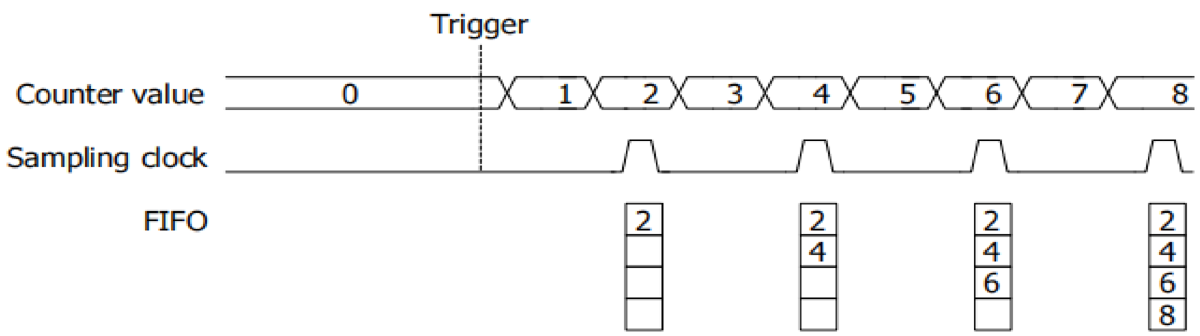


Example of software controlled single point measurement

● Sampling clock timing continuous acquisition

Sampling clock timing continuous acquisition means that after the counter triggers and begins to measurement the encoder, the counter value is stored in the FIFO according to the set sampling rate, and the data in the FIFO is continuously uploaded to the computer memory buffer, so that the user program can realize continuous and uninterrupted data acquisition only by continuously processing the data in the memory.

If the data processing speed of user program is not fast enough, the data will gradually fill the memory space of 2M points in the computer memory buffer, and after filling, the new data cannot be written correctly, resulting in data discontinuity



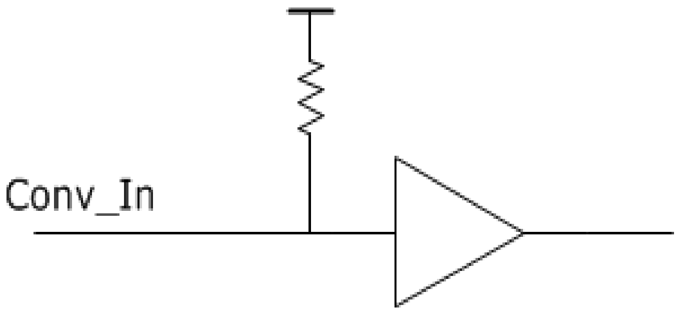
Example of sampling clock timing continuous acquisition

9. Synchronization System

This chapter introduces the multi-card synchronization system of the USB-3300 series data acquisition device. The synchronous system has 4 ports, sampling clock input, sampling clock output, external trigger input, and external trigger output.

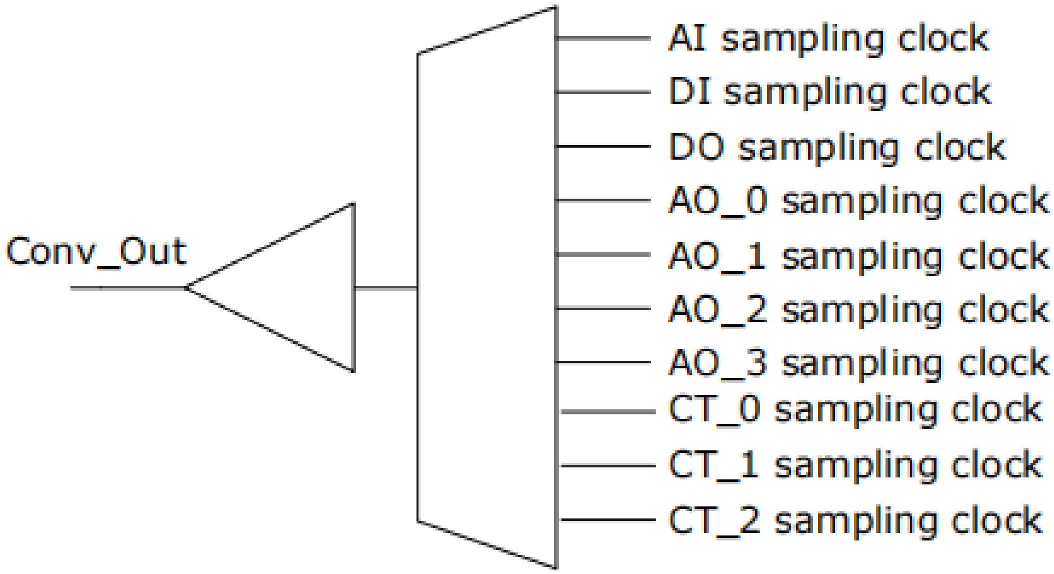
9.1. Sampling clock

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:

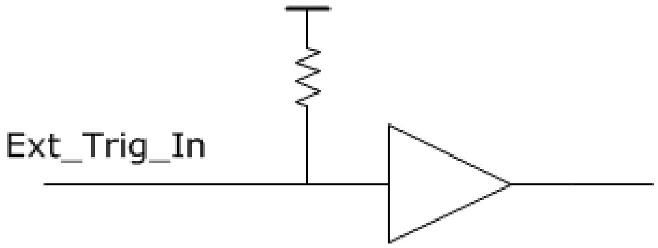


Sampling clock output circuit

9.2. External trigger

The pins of external trigger input and output are used to trigger the USB-3300 series acquisition card in synchronization with an external device.

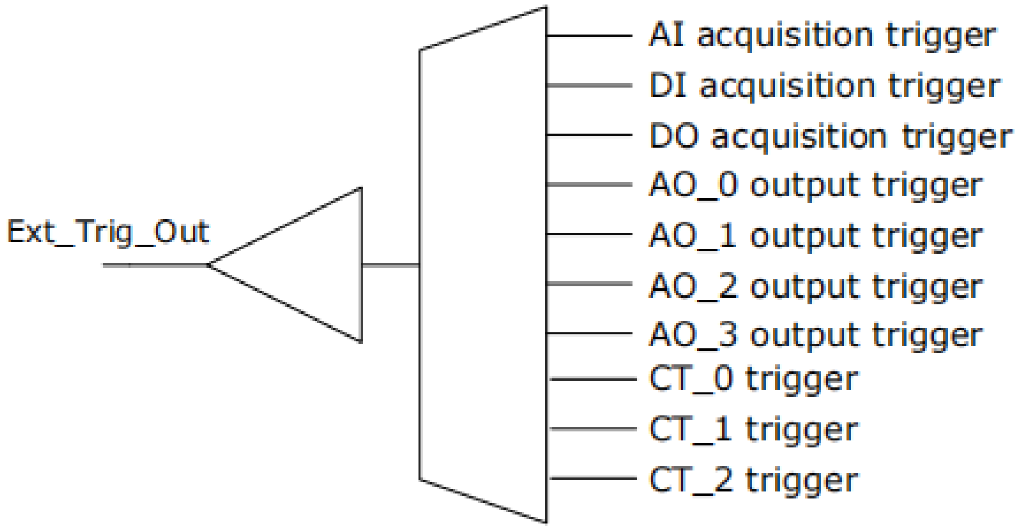
Each function trigger source of the acquisition device can select the external trigger input pin Ext_Trig_In as the trigger source. The external trigger input circuit diagram is shown in below.



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 circuit

10. 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

11. Ordering Information

Main Equipment

Model	Notes
USB-3323	16-AI(1MSa/s), 4-AO, 4-DI, 4-DO, 3-CT
USB-3322	16-AI(500kSa/s), 4-AO, 4-DI, 4-DO, 3-CT
USB-3321	16-AI(250kSa/s), 4-AO, 4-DI, 4-DO, 3-CT
USB-3320	16-AI(125kSa/s), 4-AO, 4-DI, 4-DO, 3-CT
USB-3313	8-AI (1MSa/s), 4-AO, 4-DI, 4-DO, 3-CT
USB-3312	8-AI (500kSa/s), 4-AO, 4-DI, 4-DO, 3-CT
USB-3311	8-AI (250kSa/s), 4-AO, 4-DI, 4-DO, 3-CT
USB-3310	8-AI (125kSa/s), 4-AO, 4-DI, 4-DO, 3-CT

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 Diff-input, output ±5v

12. Document Revision History

Date	Edition	Remarks
2019.01.11	Rev: A	First release
2019.02.27	Rev: B	Add PWM output information
2019.05.30	Rev: C	Add connector signal pin information
2019.12.09	Rev: D	Fix some wrong parameter
2020.06.20	Rev: E	Add Analog output KB operation information
2021.07.15	Rev: F	Fix about DIN acquisition mode