

# USER'S MANUAL

## **AX92352**

2-CH Encoder Card with Real-time  
Trigger I/O

## **AX92353**

4-CH Lighting Control Module

User's Manual



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## ESD Precautions

The boards have integrated circuits sensitive to static electricity. To avoid damaging chipsets from electrostatic discharge, observe the following precautions:

- Do not remove boards or integrated circuits from their anti-static packaging until you are ready to install them.
- Before handling a board or integrated circuit, touch an unpainted portion of the system unit chassis for a few seconds. This will help to discharge any static electricity on a human body.
- When handling boards and components, wear a grounding wrist strap available from most electronic component stores.

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# Table of Contents

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Disclaimers.....	ii
ESD Precautions.....	iii
<b>Section 1 Introduction.....</b>	<b>1</b>
1.1 General Description .....	1
1.2 Features .....	1
1.3 Specifications (AX92352).....	2
1.4 Specifications (AX92353).....	4
1.5 Dimensions.....	5
<b>Section 2 Connectors.....</b>	<b>7</b>
2.1 Connectors .....	7
2.1.1 44-Pin Female I/O Connector (CN 1).....	7
2.1.2 Communication Connector (CN3).....	8
2.1.3 Board ID (SW1).....	8
2.1.4 6-pin ATX Power Connector (CN1) .....	8
2.1.5 8-Pin Terminal Connector for LED Lighting Control (CN2) .....	9
2.1.6 Communication Connector (CN3).....	9
<b>Section 3 I/O Connection.....</b>	<b>11</b>
3.1 I/O Connection.....	11
3.1.1 Isolated Digital Input.....	11
3.1.2 Isolated Digital Output.....	12
3.1.3 Isolated Trigger/Latch Input.....	12
3.1.4 Isolated Trigger Output.....	13
3.1.5 Isolated Encoder Input .....	13
3.1.6 LED Lighting Control (AX92353).....	14
<b>Section 4 Operating.....</b>	<b>15</b>
4.1 Operating of AX92352 .....	15
4.1.1 Encoder function .....	15
4.1.2 De-bounce filter .....	16
4.1.3 Encoder Homing.....	17
4.1.4 Encoder Linear Trigger.....	17
4.1.5 Encoder FIFO Trigger .....	17
4.1.6 Encoder Counter Value Latch .....	17
4.1.7 Trigger Input/ Output .....	18
4.1.8 Interrupt.....	19
4.2 Operating of AX92353 .....	19

<b>4.3</b>	<b>Application.....</b>	<b>21</b>
4.3.1	Scenario 1 .....	21
4.3.2	Scenario 2 .....	21
<b>APPENDIX A    HARDWARE INSTALLATION .....</b>		<b>23</b>



# Section 1

## Introduction

This section contains general information and detailed specifications of the AX92352 Encoder Card with trigger I/O, including the following sections:

- General Description
- Features
- Specifications
- Dimensions

### 1.1 General Description

The AX92352 integrates advanced vision I/O capabilities for machine vision applications, such as synchronizing multiple frame grabbers in line scan and multiple cameras in area scan. It provides 2-CH encoder input with the FIFO function to achieve the tasks of position comparison and linear trigger. It also supports trigger I/O with a microsecond-scale real-time control camera to capture images, as well as isolated DIO that can be used with other devices for your vision cases. The AX92352 vision I/O card can fit in the PCI Express slot of any vision control system. It can also be used with an optional add-on module AX92353, which provides LED output support to meet further application needs. These functions can simplify the deployment of your machine vision platform.

### 1.2 Features

- Synchronizes devices via real-time I/O
- Applied to area scan and line scan applications
- Integrates multiple I/O
  - 2-CH 32-bit incremental quadrature encoder input
  - 4-CH trigger input
  - 4-CH trigger output
  - 8-CH isolated DI, 8-CH isolated DO
  - 4-CH LED output (optional module, AX92353)
- Programmable interrupt functions
- **PCI Express x1 compliant**

## 1.3 Specifications (AX92352)

- **Isolated encoder input**
  - Number of channels: 2
  - Support mode: incremental quadrature encoder input (A/B/Z phase, x1/4 x1/3 x1/2 x1 x2 x4 mode)
  - Type of wiring: differential or single-ended 5V, 12V open collector
  - Frequency input: Max. 1MHz
  - Data length: 32-bit
  - Digital filter: supports programmable de-bounce filter (disable, 500ns, 1us, 2us, 4us)
  - Operating mode: Linear function, FIFO, Position latch
- **Encoder FIFO**
  - Number of channels: 2
  - FIFO depth: 1024x32-bit
  - Interrupt type: Empty/ Almost Empty  
(Almost empty: FIFO data number is less than 1/3)
  - Auto reload: Yes. After compared, the next FIFO data will reload to FIFO storage.
- **Encoder Linear Function**
  - Number of linear functions: 4  
Two linear functions per encoder channel
  - Start point: 32-bit
  - Repeat Times: Trigger repeat times. (31-bit)
  - Interval: The linear interval (15-bit)
  - Direction: 1-bit
  - Auto reload: Yes. After compared, the next data will reload to linear storage.
- **Isolated trigger input**
  - Number of channels: 4
  - Type: sink
  - Input voltage: on (logic 1): 3.3~30VDC, off (logic 0): 0~2VDC
  - Response time: <1us (from trigger input to trigger output)
  - Input filter: supports programmable de-bounce filter (disable, 100us, 500us, 1ms, 5ms)
- **Isolated trigger output**
  - Number of channels: 4
  - Output voltage: 0-30VDC, sink, open collector
  - Output current: Max. 100mA per channel
  - Response time: <1us (from trigger input to trigger output)



- Configuration: Derived from 4CH trigger input or encoder input. The user can set the pulse delay time and duration time.
- Trigger sources: 4CH trigger input/ encoder: 4x Linear function, 2x FIFO  
(Each channel supports two sources.)
- **Isolated digital input**
  - Number of channels: 8
  - Input type: sink/source
  - Input voltage: on (logic 1): 10~30VDC, off (logic 0): 0~3VDC
  - Impedance: 7.5k $\Omega$
- **Isolated digital output**
  - Number of channels: 8
  - Output type: sink, open collector
  - Supply voltage: 5-30VDC
  - Sink current: Max. 200mA per channel
- **Interrupt**
  - Sources: Provides two interrupt sources from DI 0~1, trigger/Latch input 0~1, encoder Z phase 0~1, FIFO empty 0~1, almost empty 0~1, encoder overflow 0~1 and encoder linear function 0~3 (when repeat times count to 0),
- **General specifications**
  - Bus type: PCI Express x1
  - I/O connector: D-sub 44-pin female connector
  - Isolation voltage: 2kVDC
  - Power requirement: +3.3V @ 180mA (Max.), +12V @ 120mA (Max.)
  - Dimensions: W 168 mm x D 100 mm
  - Board ID: Yes, 4-bit
  - Operating temperature: 0°C ~ +70°C (32°F ~ +158°F)
  - Storage temperature: -20°C ~ +80°C (-4°F ~+176°F)
  - Operating Humidity: 10 ~95% RH, non-condensing
- **OS support**
  - Windows® 7, Windows® 10 (32/64-bit)
  - Software compatibility: C#, C/C++

## 1.4 Specifications (AX92353)

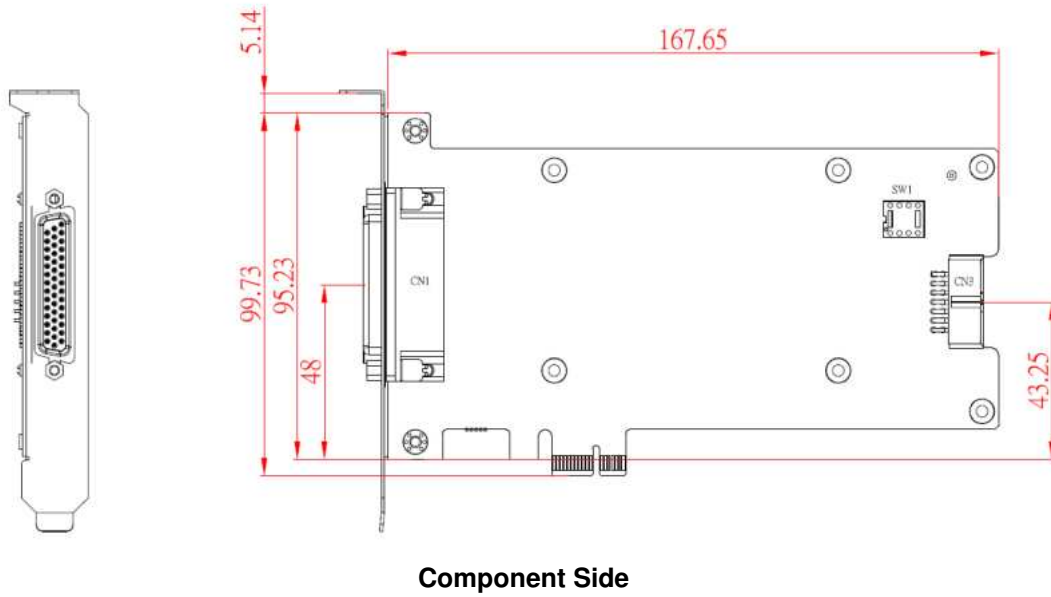


**Note:** *This optional add-on module cannot be operating independently and must be used in conjunction with the AX92352.*

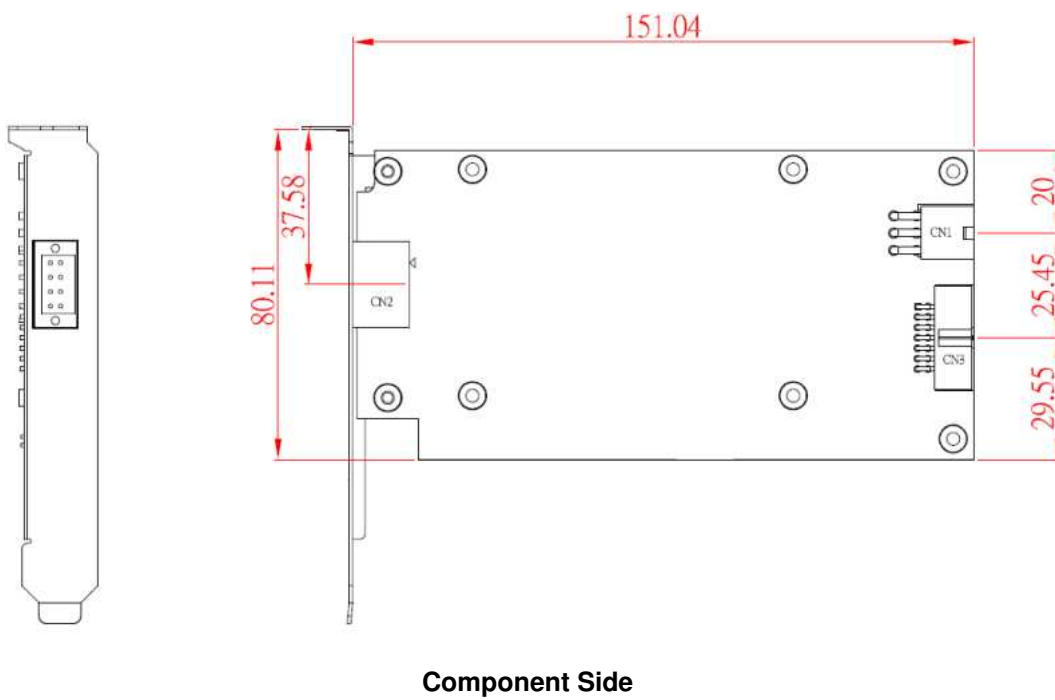
- **LED lighting control module**
  - Number of channels: 4
  - Constant current control
  - Operating mode: strobe; trigger
  - Strobe mode: 24VDC; Max. 1A per channel  
Delay time: 1  $\mu$ s to 65ms; 1ms to 65s (time unit: 1us, 16bit/ 1ms, 16bit)  
Duration time: 10  $\mu$ s to 10ms (time unit: 1us)
  - Trigger mode: 24VDC; Max. 0.5A per channel  
Delay time: 1  $\mu$ s to 65ms; 1ms to 65s (time unit: 1us, 16bit/ 1ms, 16bit)  
Duration time: 10  $\mu$ s to 65ms; 1ms to 65s (time unit: 1us, 16bit/ 1ms, 16bit)
  - Output current step size: 50mA by software
- **General specifications**
  - I/O connector: 8-pin terminal connector (Black)
  - Power connector: 6-pin ATX power connector
  - Power requirements: Trigger mode 60W @ 12VDC; strobe mode 120W @ 12VDC
  - Dimensions: W 151 mm x D 80 mm

## 1.5 Dimensions

AX92352



AX92353



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# Section 2

## Connectors

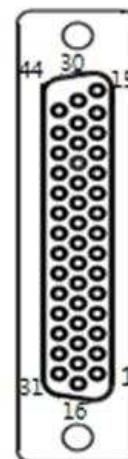
### 2.1 Connectors

Connectors connect the board with other parts of the system. Loose or improper connection might cause malfunctions. Make sure all connectors are properly and firmly connected. The following table lists the function of each connector on the cards.

Model Name	Connectors	Label
AX92352	CN1	2.1.1
	CN3	2.1.2
	SW1	2.1.3
AX92353	CN1	2.1.4
	CN2	2.1.5
	CN3	2.1.6

#### 2.1.1 44-Pin Female I/O Connector (CN 1)

Pin	Description	Pin	Description	Pin	Description
1	I_GND	16	DI_COM	31	I_GND
2	Encoder0_A+	17	DI 0	32	DO 0
3	Encoder0_A-	18	DI 1	33	DO 1
4	Encoder0_B+	19	DI 2	34	DO 2
5	Encoder0_B-	20	DI 3	35	DO 3
6	Encoder0_Z+	21	DI 4	36	DO 4
7	Encoder0_Z-	22	DI 5	37	DO 5
8	I_GND	23	DI 6	38	DO 6
9	Encoder1_A+	24	DI 7	39	DO 7
10	Encoder1_A-	25	I_GND	40	I_GND
11	Encoder1_B+	26	Trigger / Latch input 0	41	Trigger output 0
12	Encoder1_B-	27	Trigger / Latch input 1	42	Trigger output 1
13	Encoder1_Z+	28	Trigger input 2	43	Trigger output 2
14	Encoder1_Z-	29	Trigger input 3	44	Trigger output 3
15	I_GND	30	I_GND		



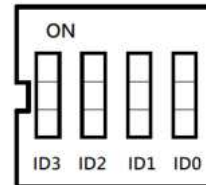
### 2.1.2 Communication Connector (CN3)

The communication connector allows the user to synchronize AX92352 and AX92353 via the communication cable to control LED functions.

### 2.1.3 Board ID (SW1)

Default board ID setting is 0 (0x0000)

ID3	ID2	ID1	ID0	Board ID
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

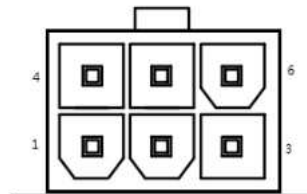


**Note:** On: 1, Off: 0

### 2.1.4 6-pin ATX Power Connector (CN1)

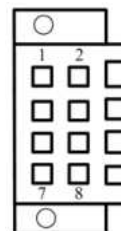
The 6-pin ATX connector is used for power requirements of LED output.

Pin	Signal
1	+12V
2	+12V
3	+12V
4	Ground (GND)
5	Ground (GND)
6	Ground (GND)



### 2.1.5 8-Pin Terminal Connector for LED Lighting Control (CN2)

Pin	Description	Pin	Description
1	LED1 -	2	LED1 +
3	LED2 -	4	LED2 +
5	LED3 -	6	LED3 +
7	LED4 -	8	LED4 +



### 2.1.6 Communication Connector (CN3)

When using the AX92353, please plug the communication cable into this connector to link to AX92352.

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# Section 3

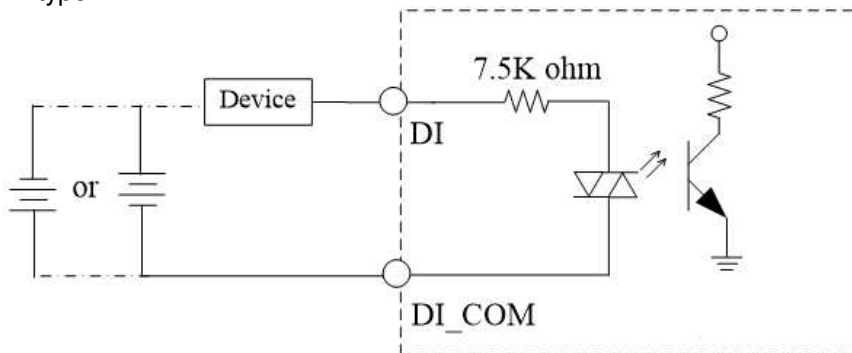
## I/O Connection

### 3.1 I/O Connection

Refer to this section to connect any cables between the cards and the device.  
Each of the following I/O figures illustrates their respective connection on the AX92352 and AX92353.

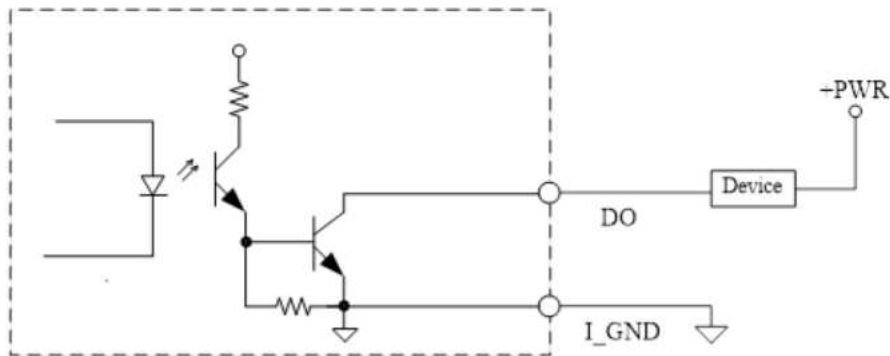
#### 3.1.1 Isolated Digital Input

The figure shows how to connect between external input source and the AX92352.  
Each of the isolated digital input channels accepts 0~30 VDC with sink type and source type.



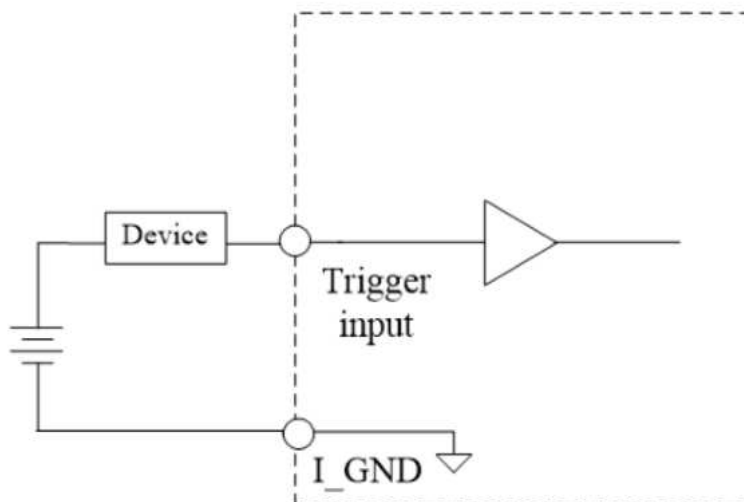
### 3.1.2 Isolated Digital Output

The figure shows how to connect between an output channel and the AX92352. If an external voltage 5~30 VDC is applied to an isolated output channel, the current will flow from the external voltage source to the system. Please note that the current through each DO channel should not exceed 200 mA.



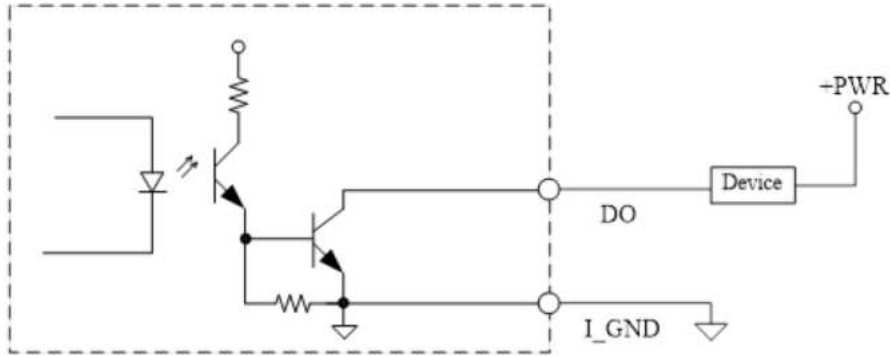
### 3.1.3 Isolated Trigger/Latch Input

The figure shows how to connect between external input source and the system. Each of the isolated trigger input channels accepts 0~30 VDC with sink type.



### 3.1.4 Isolated Trigger Output

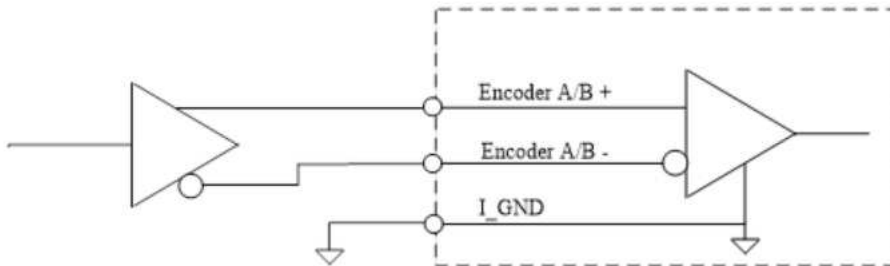
The figure shows how to connect between an output channel and the system. If an external voltage 5~30 VDC is applied to an isolated output channel, the current will flow from the external voltage source to the system. Please note that the current through each trigger output channel should not exceed 100 mA.



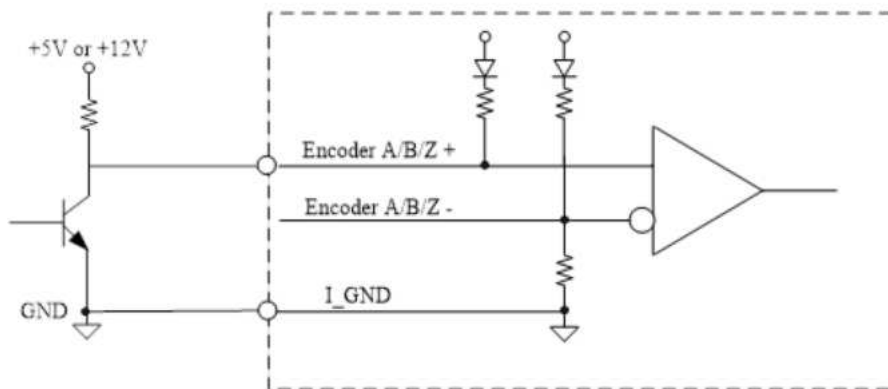
### 3.1.5 Isolated Encoder Input

The figure shows how to connect between an input channel and the system.

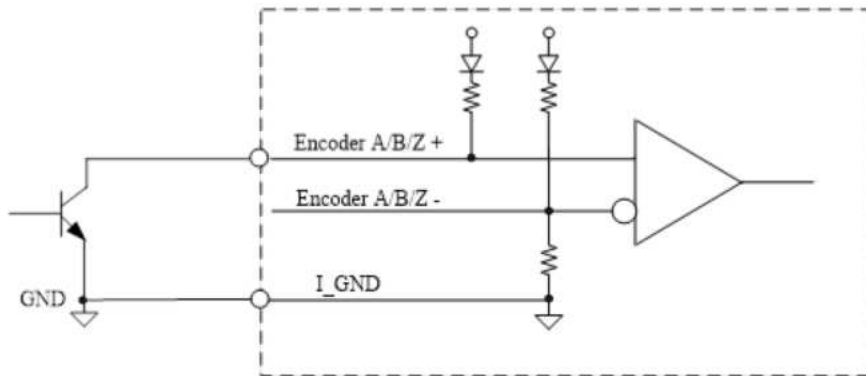
Differential type:



5V or 12V Voltage Type:

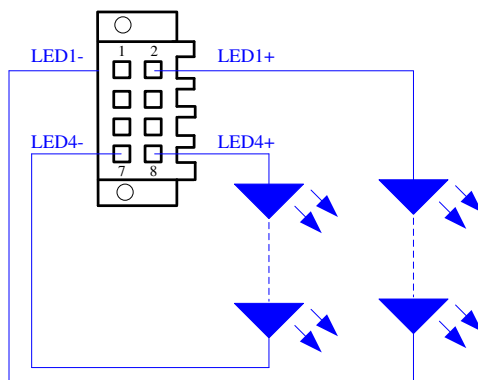


Open Collector Type:



### 3.1.6 LED Lighting Control (AX92353)

The figure shows how to connect between lighting output channel and LED.



# Section 4

## Operating

### 4.1 Operating of AX92352

This section details the operations of the AX92352 2-CH Encoder Card with Real-time Trigger I/O and how it works with the AX92353 4-CH LED lighting control module.

#### 4.1.1 Encoder function

The AX92352 supports 2CH 32-bit incremental quadrature encoder input for the ABZ signal in different modes, which is used for applications where direction sensing is required. This mode consists of two square-wave pulse signals known as Phase A and Phase B, which are generated by a rotating encoder. Phase A and Phase B signals are coded 90° out of phase from each other: Phase A is either 90° phase leading or lagging behind Phase B. The AX92352 supports 2CH 32-bit incremental quadrature encoder input for the ABZ signal. It is able to count square-wave pulses of Phase A and Phase B, and then determine the rotating direction of motor movement by comparing the phase relationship between Phase A and B:

- When the quadrature encoder is rotating in a clockwise direction, its signal will show a positive direction of Phase A leading Phase B.
- When the quadrature encoder rotates counterclockwise, its signal will show a negative direction of Phase A lagging behind Phase B.

Besides direction, the quadrature encoder can generate another signal named Phase Z, which is produced once per complete rotation of the quadrature encoder. Phase Z is used by the AX92352 to locate a position of the motor when the quadrature encoder completes a 360° rotation, so that the counter value of Phase Z can reset to zero if the configuration sets the homing conditions.

- Counter mode

x1 mode: The counter value will increment or decrement when a rising edge happens on Phase A.

x2 mode: The counter value will increment or decrement when a rising edge or a falling edge happens on Phase A.

x4 mode: The counter value will increment or decrement when a rising edge or a falling edge happens on Phase A or B.

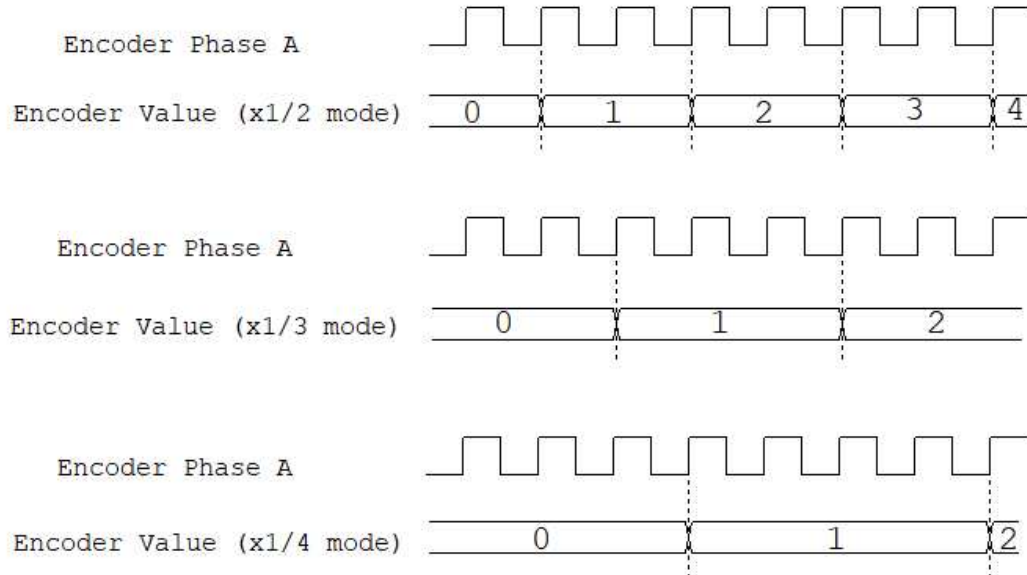
In most cases, the x4 Phase AB signal mode is applied to incremental encoder devices. For example, when a motor completes a 360° rotation, an incremental encoder will generate 1000 pulses per phase (A or B phase), but the count will show 4000 pulses.

1/2 mode: The counter value will increment or decrement when a rising edge happens twice on phase A.

1/3 mode: The counter value will increment or decrement when a rising edge happens three times on phase A.

1/4 mode: The counter value will increment or decrement when a rising edge happens four times on phase A

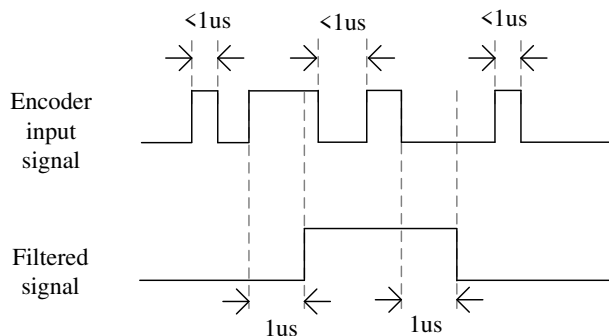
The figure below depicts a case where a valid encoder value is pulse edge from phase A encoder signal. The 1/2, 1/3 or 1/4 mode defines the number of pulses to skip between valid acquisition. After the following pulses meet mode setting, the encoder value will be increasing (As defined by the selection of 1/2, 1/3 or 1/4 mode).



#### 4.1.2 De-bounce filter

Each encoder channel supports de-bounce filter function to reject noise. The de-bounce filter can define the interval width for high/low signals. Signals with interval width less than the defined value will be filtered out.

Below is a diagram illustrating the case of a filter timer set with a duration time of 1 microsecond:



### 4.1.3 Encoder Homing

This function can clear the counter value when Phase Z has a rising edge or when the user gives the command. Further, the user can configure a specific value by software. When a current value equals a value of setting, the counter value will reset zero.

### 4.1.4 Encoder Linear Trigger

This function allows the user to compare counter values using the encoder linear function. Each encoder supports two linear functions and has four parameters of configuration as below: Start Point, Repeat Times, Interval and Direction.

- Trigger Point (N+1) = Trigger Point N + Interval  
(N = Repeat Times; the first trigger condition is the start point.)

Trigger output will generate an output signal when Trigger Point equals the current counter value of a selected encoder channel.

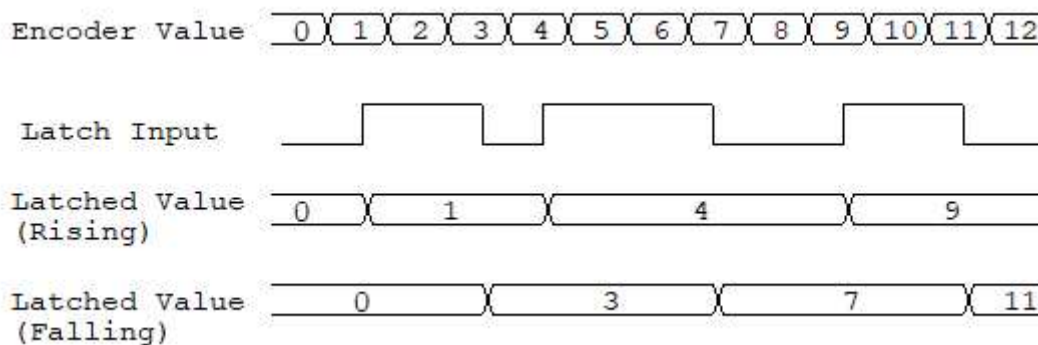
### 4.1.5 Encoder FIFO Trigger

The encoder FIFO trigger function utilizes FIFO (first-in first-out) storage to process preset position data. Furthermore, each encoder supports one encoder FIFO trigger function. After the preset position is compared, trigger output will generate an output signal. Meanwhile, the user also can input new data into FIFO.

### 4.1.6 Encoder Counter Value Latch

The encoder counter value latch function is used for handling latch input signals. The user can set rising or falling trigger. When the signal is triggered, the encoder counter value will be saved to latch register. Further, the user can read this value and apply it to different cases.

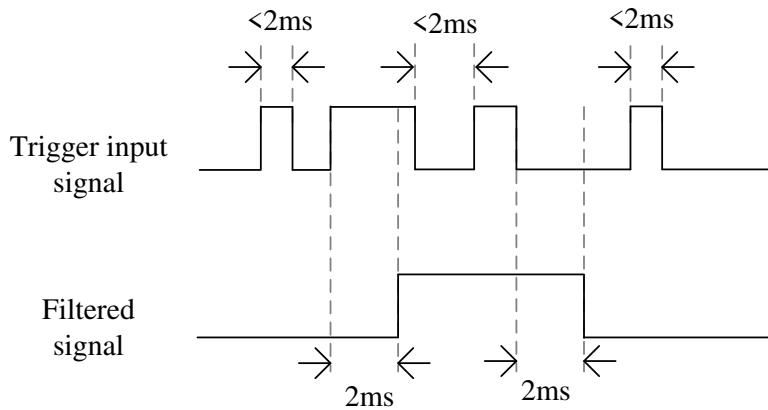
The diagram shows the case of position latch.



### 4.1.7 Trigger Input/ Output

Trigger input supports de-bounce filter function to help filter out environmental noise that can mix with normal encoder signals and affect the accuracy of the pulse count. The de-bounce filter defines the interval width for high/low signals. Signals with interval width less than the defined value will be filtered out.

Below is a diagram illustrating the case of filter timer set with a duration time of 2 milliseconds:



Trigger Output CH 0~4 provides the following parameters to configure:

- **Trigger source**

The user can select any of the following items as a triggering condition that prompts the AX92352 to generate a trigger output: Trigger Input CH 0~3, Encoder 0\_Linear 0, Encoder 0\_Linear 1, Encoder 0\_FIFO, Encoder 1\_Linear 0, Encoder 1\_Linear 1, Encoder 1\_FIFO

**Note:** One trigger source can be set to activate multiple trigger outputs.

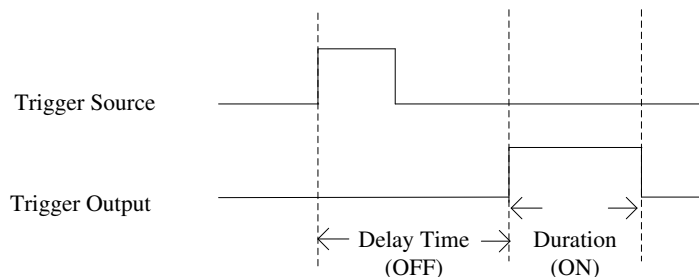
- **Delay time**

The user can set the delay time that the system waits before it sends a trigger output.

- **Duration time**

The user can adjust pulse width for the output signal.

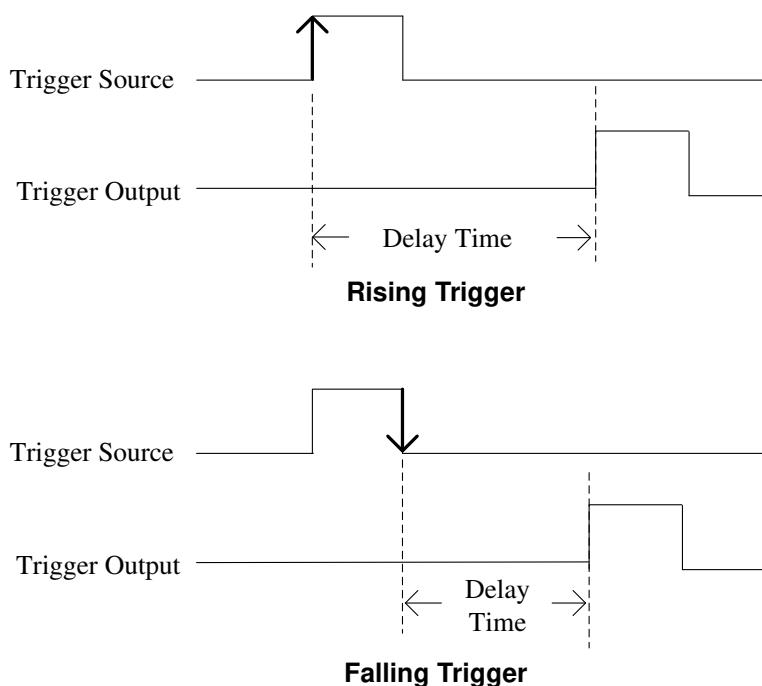
(Definitions of delay time and duration time are illustrated below):



- **Invert**

The condition of trigger source can be set as rising trigger or falling trigger.





#### 4.1.8 Interrupt

This function can send an interrupt signal to the host PC.

The user can select two conditions for the AX92352 to generate an interrupt signal.

## 4.2 Operating of AX92353

This section shows the operations of the AX92353 4-CH LED lighting control module. This module provides strobe and trigger operating modes suitable for various machine vision applications. In addition, the user can set trigger source, delay time, duration time, trigger methods and intensity (output current) to define the requirements for different vision tasks.

- **LED operating mode**

**Strobe mode:** Strobming is the technique of activating LEDs for a short period. This mode will increase brightness by overdriving an LED that allows for the passing of more current (up to 1A).

**Trigger mode:** In this mode, different lighting can be toggled on/off for a longer period. It supports current up to 500mA.

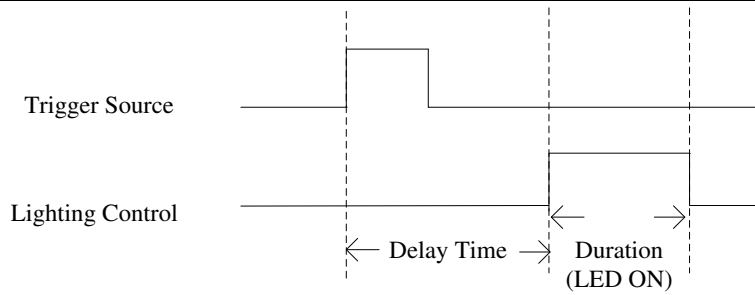
- **Trigger source**

Each LED output can use two trigger sources, and then one trigger source also can be set to activate multiple LED outputs.

- **Delay time and duration time function**

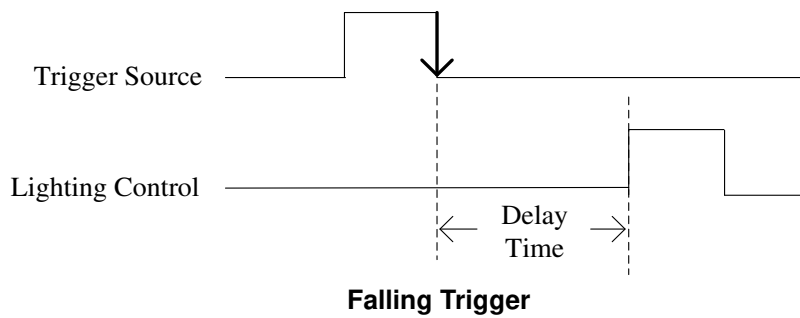
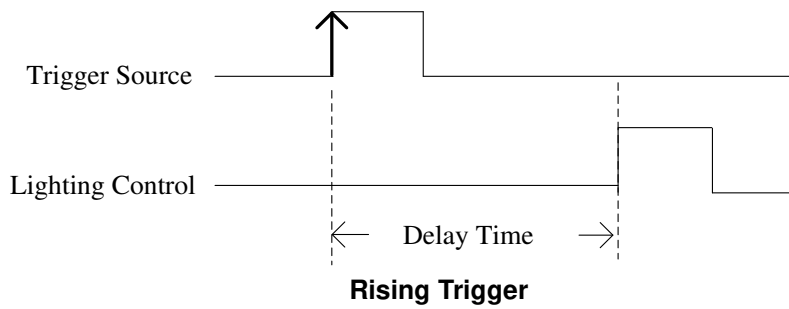
The user can set the delay time that the system waits before it sends a trigger output. The user can also define duration time in order to adjust pulse width for the LED output.

(Definitions of delay time and duration time are illustrated below):



■ **Invert**

The condition of trigger source can be set as rising trigger or falling trigger.

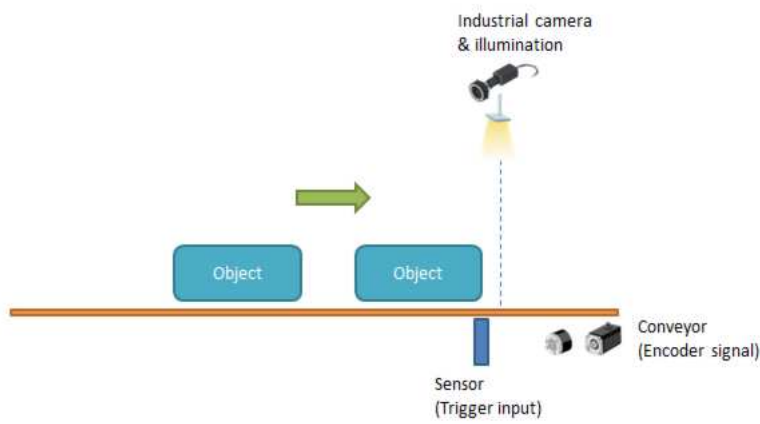


## 4.3 Application

This section shows the real cases in the machine vision field.

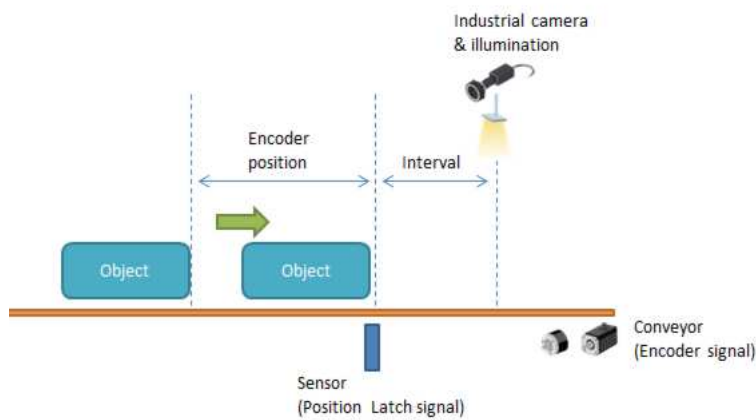
### 4.3.1 Scenario 1

In this scenario, when an optical sensor or encoder detects objects passing down the production line, it will send trigger signals to notify the system. These signals trigger a camera to capture images. Data from the camera is then used by a vision platform to identify features. Finally, should an object with defects be detected, it is rejected by a pneumatic actuator or robotic arm. These functions will provide real-time I/O with microsecond-scale control and lighting control to meet timing sequence requirements and ensure high quality image output.



### 4.3.2 Scenario 2

In this application, the system needs to record the encoder positions for camera trigger. The AX92352's hardware is specifically designed to store encoder positions. When the sensor produces an external latch input signal, the encoder position value will be recorded to the latch register. Users can get these position data by calling API and set value to the FIFO buffer. Further, trigger-out will output the FIFO data, which adds up both latch and interval values.



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# APPENDIX A

## HARDWARE INSTALLATION

This section will show you how to connect the AX92352 to the optional module AX92353 using the communication cable.

### Installation Procedure:

- Step 1** Align the AX92352 and AX92353 with the slots, and then press the AX92352 into the slot.
- Step 2** Fasten the two screws to fix the modules firmly to the system chassis.
- Step 3** Insert one end of the communication cable into the AX92352 connector and the other end of the cable into the AX92353 connector. Make sure both ends are firmly seated.

