

CoaXPress Area Scan Camera

User's Manual



Foreword

General

This manual introduces the functions and operations of the CoaXPress area scan camera (hereinafter referred to as "the camera").

Safety Instructions

The following signal words might appear in the manual.

Signal Words	Meaning
 DANGER	Indicates a high potential hazard which, if not avoided, will result in death or serious injury.
 WARNING	Indicates a medium or low potential hazard which, if not avoided, could result in slight or moderate injury.
 CAUTION	Indicates a potential risk which, if not avoided, could result in property damage, data loss, reductions in performance, or unpredictable results.
 TIPS	Provides methods to help you solve a problem or save time.
 NOTE	Provides additional information as a supplement to the text.

Revision History

Version	Revision Content	Release Time
V1.0.0	First release.	July 2021

Privacy Protection Notice

As the device user or data controller, you might collect the personal data of others such as their face, fingerprints, and car plate number. You need to be in compliance with your local privacy protection laws and regulations to protect the legitimate rights and interests of other people by implementing measures which include but are not limited: Providing clear and visible identification to inform people of the existence of the surveillance area and provide required contact information.

About the Manual

- The contents of this manual are for reference only, and timely update cannot be guaranteed. Slight differences might be found between the manual and the product. If you have any questions, please contact the technical support of the corresponding area.

- We are not liable for losses incurred due to operating the product in ways that are not in compliance with the manual.
- The manual will be updated according to the latest laws and regulations of related jurisdictions. For detailed information, see the paper user's manual, use our CD-ROM, scan the QR code or visit our official website. The manual is for reference only. Slight differences might be found between the electronic version and the paper version.
- All designs and software are subject to change without prior written notice. Product updates might result in some differences appearing between the actual product and the manual. Please contact customer service for the latest program and supplementary documentation.
- There might be errors in the print or deviations in the description of the functions, operations and technical data. If there is any doubt or dispute, we reserve the right of final explanation.
- Upgrade the reader software or try other mainstream reader software if the manual (in PDF format) cannot be opened.
- All trademarks, registered trademarks and company names in the manual are properties of their respective owners.
- Please visit our website, contact the supplier or customer service if any problems occur while using the device.
- If there is any uncertainty or controversy, we reserve the right of final explanation.

Important Safeguards and Warnings

This section describes the contents covering proper handling of the device, hazard prevention, and prevention of property damage. Read these contents carefully before using the device, comply with them when using, and keep the manual well for future reference.

Operation Requirements

- Transport, use and store the device under allowed humidity and temperature conditions.
- Prevent liquids from splashing or dripping on the device. Make sure that there are no objects filled with liquids on top to avoid liquids flowing into the device.
- Do not disassemble the device.
- Only use the device within the rated power range.
- Make sure that the power supply of the device works properly before use.
- Do not pull out the power cable of the device while it is powered on.

Installation Requirements

- Observe all safety procedures and wear required protective equipment provided for your use while working at height.
- Do not expose the device to direct sunlight or heat source.
- Do not install the device in humid, dusty or smoky places.
- Install the device in a well-ventilated place, and do not block the ventilator of the device.
- Strictly abide by local electrical safety standards, and make sure that the voltage in the area is steady and conforms to power requirements of the device.
- Use the power adapter or case power supply provided by the device manufacturer.
- Connect the device with the adapter before power on.
- Do not connect the device to more than one power supply. Otherwise, the device might be damaged.
- The power supply must conform to the requirements of ES1 in IEC 62368-1 standard and no higher than PS2. Note that power supply requirements are subject to the device label.
- Connect the class I electrical appliance to a power socket with protective earthing.

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1 Product Information

1.1 Overview

The CoaXPress large area scan industrial camera adopts high performance photosensitive chip and transmits image data through CoaXPress port. Up to 4×6.25 Gbps or 4×12.5 Gbps transmission speed meets the requirements of most industrial applications. It can work stably in various poor environments, which makes it an industrial camera with high stability at low cost.

1.2 Features

- Multiple trigger modes such as external trigger and free run mode.
- Outputs multiple image data formats and supports ROI.
- Compatible with CoaXPress and GenICam.
- Supports PoCXP and external 24 VDC power supply.
- Conform to CE, FCC, UL and RoHS certification standards.

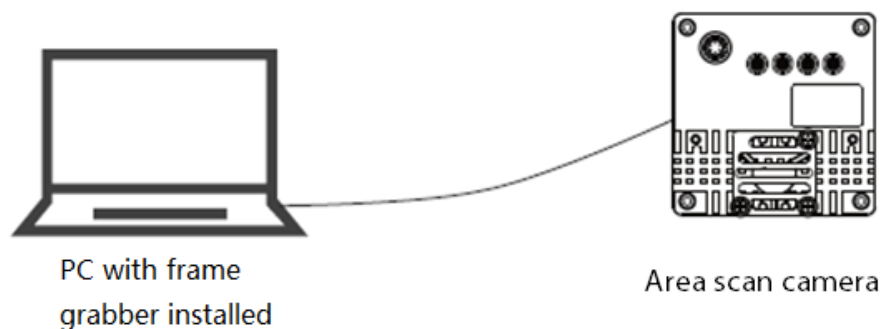


- Functions above are for reference only, and might be different from actual models.
- For detailed parameters, see the corresponding technical specifications.

1.3 Typical Networking Topology

Install the CoaXPress frame grabber on local PC, connect the camera to the frame grabber by CoaXPress cable, and then frame grabber SDK on PC detects and connects to the camera to operate.

Figure 1-1 Networking



1.4 Operating Environment

The requirements for the camera operating environment are as follows.

- Temperature and humidity.
Environment temperature cannot exceed 50°C (122°F), and air conditioner preferred.
 - ◇ Operating temperature: -30°C to $+50^{\circ}\text{C}$ (-22°F to $+122^{\circ}\text{F}$).
 - ◇ Operating humidity: 20%–80% (non-condensing).
 - ◇ Storage temperature: -30°C to $+80^{\circ}\text{C}$ (-22°F to 176°F).
 - ◇ Storage humidity: 20%–80% (non-condensing).

- Install the camera indoor on stable surface with reasonable dissipation space around it.
- Air circulation ensured.

2 Function Parameter

This section takes on the functions of the industrial camera.



- Industrial cameras support 3 user levels, including **Beginner**, **Expert** and **Guru**. Each corresponds to slightly different sets of parameters.
- Grayed out parameters cannot be changed under the current running mode.

2.1 Frame Rate

The number of images the camera outputs every second.

2.1.1 Influential Facts for Frame Rate

- Single frame reading time: The shorter the time period of reading one frame, the higher the frame rate.
- Exposure time: The shorter the exposure time of one frame, the higher the upper limit of frame rate.
- Bandwidth: The bigger the bandwidth, the bigger the transmission data volume and the higher the frame rate.

2.1.2 Operation

Step 1 Connect the camera.

Step 2 Open the client.

Step 3 Display the **AcquisitionControl** menu and set a reasonable frequency for **AcquisitionFrameRate**.

Step 4 Starts image acquisition.

2.2 Acquisition mode

Acquisition mode of the camera includes **Continuous**, **Single Frame** and **MultiFrame**. Configurations are as follows.

Table 2-1 Description of acquisition mode parameters

Parameter	Working Principle
Single Frame	The camera starts capturing and stops after one capture.
Continuous	• The camera starts and keeps capturing. • Manual operation is required for stopping the capture.
MultiFrame	Set the number of frames to be captured in AcquisitionFrameCount (1–255). • The camera starts and keeps capturing. • Manually stop capturing before the set volume is reached.

AcquisitionFrameCount needs to be configured for **MultiFrame**. Enter a reasonable number as needed.

2.3 Trigger Mode

The trigger mode of the camera includes **SoftwareTrigger** (software trigger), **LineN** (hardware trigger) and custom trigger.

2.3.1 Trigger Type

Select **FrameStart**(frame trigger) or **AcquisitionStart**(image capture trigger) under **TriggerSelector**.

- **FrameStart**: Single frame capture. One trigger signal captures one frame.
- **AcquisitionStart**: Continuous capture. One signal triggers continuous captures.

2.3.2 Trigger Source

- Software trigger: Trigger signal comes from software.
- Hardware trigger: Trigger signal comes from external devices through I/O port. For the detailed number of signal channels for each camera I/O port, refer to the electrical specifications of the camera.
- Frame grabber trigger: Only available for CXP cameras. The capture card transmits the external signals to the camera to trigger image capture.

2.3.3 Trigger Operation

Step 1 Enable **TriggerMode**.

Step 2 Set **TriggerSource** to **Software**.

Each click on **TriggerSoftware** gets a frame.

Step 3 (Optional) Set **TriggerSource** to **LineN**, namely, hardware trigger.

Each trigger signal from external devices gets a frame.

Step 4 When hardware trigger is enabled, select trigger signal through **TriggerActivation**.

- **RisingEdge**: Press the trigger board to send trigger signal.
- **FallingEdge**: Release the trigger board to send the signal.

Step 5 You can send the trigger signal as needed after setting the trigger source.

Table 2-2 Description of trigger parameter

Parameter	Description
AcquisitionFrameRate	Image frame rate.
AcquisitionFrameRateEnable	The AcquisitionFrameRate value is only recognized when AcquisitionFrameRateEnable is set to True .  If the set frame rate exceeds the maximum limit, the value of ResultingframeRateAbs , the actual frame rate the camera outputs is ResultingframeRateAbs value.
AcquisitionStatusSelector	Check trigger status.
AcquisitionStatus	Set AcquisitionStatusSelector to AcquisitionTriggerWait (wait status of image capture trigger) or FrameTriggerWait (wait status of frame trigger), and then check AcquisitionStatus , True means waiting to trigger and False means already triggered.
TriggerSelector	Select trigger type.
TriggerActivation	Select FrameStart (frame trigger) or AcquisitionStart (image capture trigger) under TriggerSelector , and then set TriggerMode to On or Off to enable or disable the trigger mode. If both trigger modes are enabled at the same time, you can only get image captured when AcquisitionStart triggers first and FrameStart later.
TriggerDelay	Trigger delay. Refers to the time period from the camera receives the trigger signal to responses to the signal. Effective for both software and hardware trigger.

Parameter	Description
TriggerSoftware	Trigger mode.
TriggerSource	TriggerSource supports SoftwareTrigger (software trigger), LineN (hardware trigger) and frame grabber trigger CXPIn .
TriggerActivation	For software trigger, click TriggerSoftware or call API can both capture a frame. For hardware trigger, set TriggerActivation to RisingEdge or FallingEdge , and then when external cables generate rising or falling edge signals, the camera is triggered to capture a frame. For frame grabber trigger, the camera is triggered when the frame grabber sends out a trigger command.
	 You can select trigger source for AcquisitionStart or FrameStart separately.

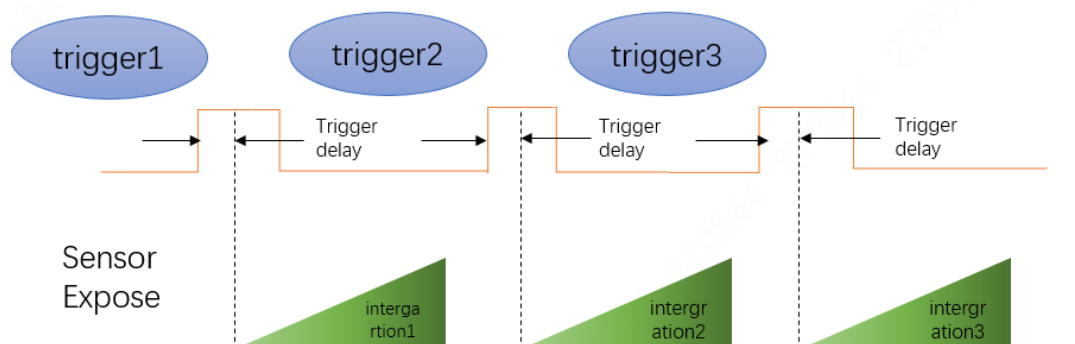


- For detailed trigger settings, see the user manual of the frame grabber.
- When the **LineDebouncerTimeAbs** value is higher than that of the high-low level, as the above example, the smoothing level is higher than 5000 us, the camera has no stream. Do not set the **LineDebouncerTimeAbs** value higher than that of the high-low level.

2.4 Trigger Delay

You can set delay time from the camera receiving the trigger signal to responding to the signal to capture.

Figure 2-1 Principle of trigger delay



The delay time is configured through Trigger Delay with μs as unit and ranges from 0 μs –10000000 μs , namely, 0 s–10 s.

2.5 Flat Field Correction

The image quality can be affected by uneven light, fixed-pattern noise of the sensor and noise of uneven responses during using the area scan cameras. FFC (Flat Field Correction) is applied in these situations.

It is mainly for ensuring image balance when applied to area scan cameras.

FFC works by combination of 3 corrections.

- In dark field, correct fixed-pattern noise.
- In bright field, correct uneven response.
- In bright field, correct uneven lens or light.



The ratio between the maximum and the minimum brightness of the image which needs FFC cannot exceed 2.

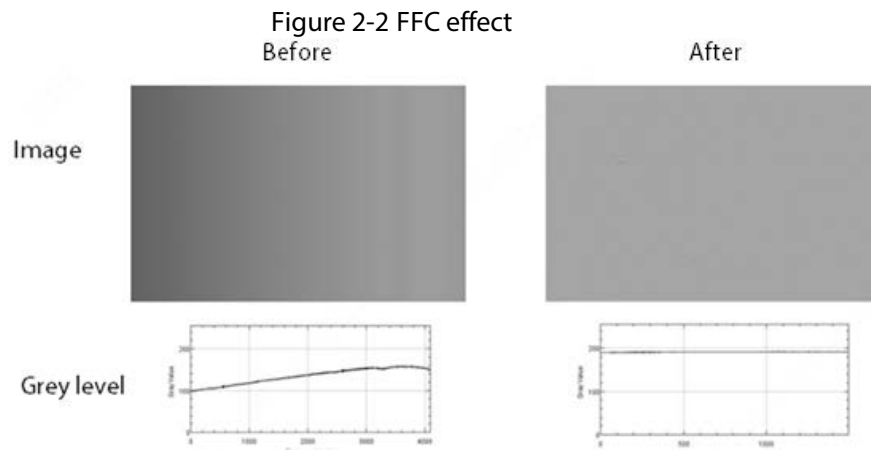


Table 2-3 FFC parameter description

Parameter	Description
FFCMode	Enable or disable FFC.
FFCStatus	Current FFC status. ● Working: Normal. ● Disabled: FFC disabled. ● ROINotMatch: The current ROI does not match with the parameter. Try loading the FFC coefficient again. ● NoParameter: No correction coefficients are saved in the camera. ● LoadingParameter: Loading correction coefficient. ● CroppedParameter: The current correction coefficient has been cropped. It happens when the set ROI does not match that of the correction coefficient. The cropped coefficient has a slight influence on image quality. If you require high quality, generate new FFC coefficient based on the indicated ROI.
FFCRefreshStatus	Refresh FFC status. For certain frame grabber clients on which the automatic refresh of register is not available, you need to click FFCRefreshStatus to refresh manually.
FFCReloadParameter	Load FFC coefficient again. Click it to load the coefficient again when the set ROI does not match that of the correction coefficient. FFCStatus shows Working or CroppedParameter after successful loading.

2.6 Output Signal

The camera contains 1 opto-isolated output **Line 0** and 1 **Line 2** which can be set to input or output.

Step 1 Under **Digital IO Control**, set **Line 2** as **Line Selector**.

Step 2 Set **Line Mode** to **Output**.



The output signal triggered by the camera can be used as switch on/off signal to control external devices such as alarm light, light source and PLC. Trigger signal can be sent out through electrical level reversal and **Output** signal. Configure parameters by **Digital IO Control**.

2.7 Black Level

The camera supports black level which can adjust the gray level deviation of the output data and decides the average gray level when the sensor is not photosensitive. Different ADC bit depth modes corresponds to different black level parameter range of the camera.

Configure black level.

Step 1 Select **Once** or **Continuous** under **Analog Control** > **Black Level Enable**.

Step 2 Enter the value in **Black Level** as needed.

2.8 Gain

Gain contains analog gain and digital gain. Analog gain can amplify the analog signal, and digital gain can amplify the signal after ADC (Analog to Digital Conversion).

Analog gain amplifies the signal, with higher value comes the stronger gain, higher brightness and more noises. Digital gain amplifies signals after ADC, same as analog gain, the higher the value, the stronger the gain, the higher the brightness and the more the noise. Compares to analog gain, the noise of digital gain is even more.

2.8.1 Analog Gain

Analog gain parameter settings include **Off**, **Once** and **Continuous**.

Table 2-4 Working principle of gain

Analog Mode	Gain	Parameter	Working Mode
Manual		Off	Adjusts analog gain based on the set value of GainRaw .
Automatic once		Once	Runs analog gain adjustment automatically for a period and then stops based on the current situation.
Continuous		Continuous	Runs analog gain adjustment continuously and automatically based on the current situation.

2.8.2 Digital Gain

Set the **DigitalShift** parameter among 0–4. The higher the value, the stronger the gain, the higher the brightness and the more the noise.

2.9 White Balance

White balance renders the intensities of colors on images captured under different lights through adjusting the corresponding R/G/B value. It keeps the white parts of the image white under different color temperature.

White balance supports **Off**, **Once** and **Continuous** mode.

Table 2-5 Configure white balance.

Parameter	Working Mode
Off	Manually set the value of Red, Green and Blue channels under BlackRatioSelector and BalanceRatio .
Once	Runs white balance adjustment automatically for a period and then stops based on the current situation.
Continuous	Runs white balance adjustment continuously and automatically based on the current situation.

Use white balance to correct the image when the color is much different from the actual objects.

Step 1 Set **BalanceWithAuto** to **Off**.

Step 2 Select R/G/B channels to be adjusted under **BlackRatioSelector**.

Step 3 Adjust the **BalanceRatio** to a reasonable value among 0–15. Do the same for R/G/B.

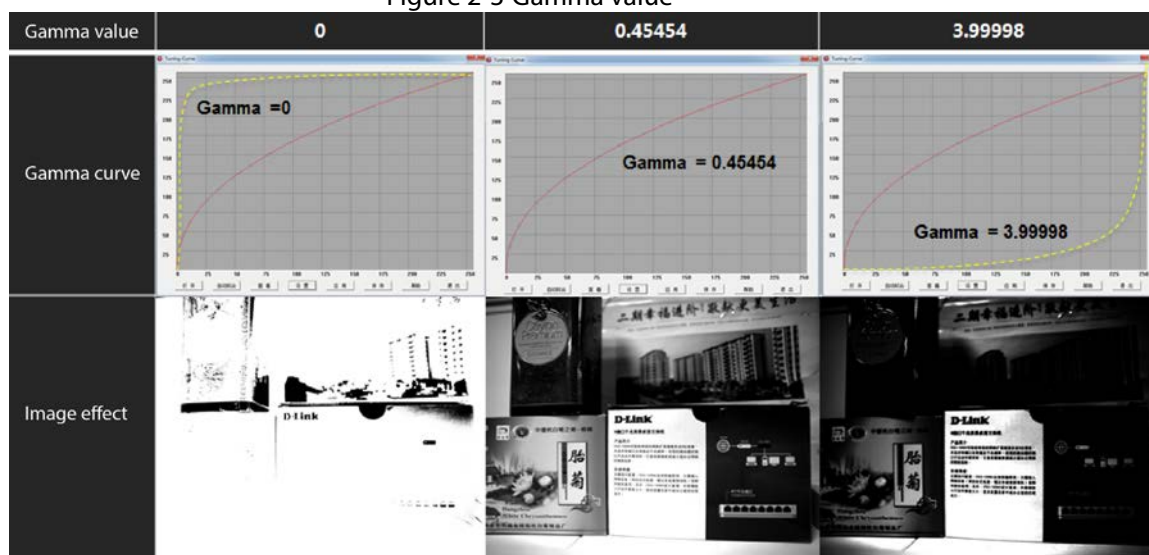


- Save the parameters after correction to avoid repeated configuration in case of unexpected occasions.
- You need to do white balance correction again if the light source or color temperature changes on the camera position.

2.10 Gamma

Gamma is used to correct the influence caused by nonlinear response of monitors on image. The smaller the value, the brighter the image. Gamma coefficient ranges from 0 to 3.99998.

Figure 2-3 Gamma value



Configure parameters.

Step 1 Set **GammaEnable** to **True**.

Step 2 Adjust Gamma value until the brightness meets the requirements.

Step 3 Gamma value is not valid when setting **GammaEnable** to **False**.



Gamma and **LookUpTable** are on opposite sides. When Gamma is enabled, LUT is unavailable. To make it available, set Gamma value to 1.

2.11 Transmission Management

You can configure related parameters in transmission protocol. For details about parameter configurations, see the table below.

Table 2-6 Description of transmission protocol parameters

Parameter	Description
Standard	The identification number of CoaXPress protocol. It is 0xC0A79AE5 (constant).
VersionMajor	Major version of CoaXPress protocol.
VersionMinor	Minor version of CoaXPress protocol.
XmlManifestSize	The number of XML files which describe the camera.
XmlManifestSelector	Select the XML files which describe the camera.
XmlVersionMajor	The major version of the XML files which describe the camera.
XmlVersionMinor	The minor version of the XML files which describe the camera.
XmlVersionSubMinor	The minor version of the XML files which describe the camera.
XmlSchemaVersionMajor	The major version number of the XMLSchema file.
XmlSchemaVersionMinor	The minor version number of the XMLSchema file.
XmlSchemaVersionSubMinor	The minor version number of the XMLSchema file.

Parameter	Description
XmlUrlAddress	The address of XMLURL register.
IidcAddress	The address of IIDC protocol. 0 Means that the IIDC protocol is not supported.
ConnectionReset	Reset connection.
DeviceConnectionID	The ID of the current connection.
MasterHostConnectionID	The ID of the host connection.
ControlPacketSizeMax	The maximum size of the control packet supported.
StreamPacketSizeMax	The maximum package size set by frame grabber.
NumberOfLink	The number of links currently connected.
LinkSpeed	The speed of the current link.
DefaultNumberOfLink	The default number of links.  This parameter is immediately saved after configuration. The frame grabber will set the number of links based on this set parameter for next connection.
DefaultLinkSpeed	Default link speed.  This parameter is immediately saved after configuration. The frame grabber will set the link speed based on this indicated parameter for next connection.
TapGeometry	The output image format.
Image1StreamID	The ID of image stream.
PayloadSize	The size of image load.

3 IO Electrical Specifications

This section describes the electrical specifications for the large area scan cameras, including electrical parameters for camera ports, connection method, and troubleshooting.



- The power supply should meet SELV and LPS specifications.
- 75 Ω coaxial cable conforming to the CoaXPress protocol must be used.

3.1 Electrical Specifications

Table 3-1 Electrical specifications for CXP-6 large area scan cameras

Module	Description
Data Ports	CoaXPress 1/2/4 channel(s); Single channel supports 2.5 Gbps/3.125 Gbps/5 Gbps/6.25 Gbps
Sync mode	Hardware trigger, software trigger and free run mode
Exposure control	Hardware trigger, set by camera API programming
Power supply	• +18 VDC to +26 VDC/1 A, < 1% ripple, powered by the Hirose 12-pin connector of the camera¹ • Powered by PoCXP²
Input/output port	• 3 opto-isolated inputs • 3 opto-isolated outputs • 1 RS-232 interface
Weight	TBD
Lens interface	Optional M58, adapter ring for F-mount interface
Certification	CE/FCC/RoHS

Table 3-2 Electrical specifications for CXP-12 large area scan cameras

Module	Description
Data Ports	CoaXPress 1/2/4 channel(s); Single channel supports 2.5 Gbps/3.125 Gbps/5 Gbps/6.25 Gbps
Sync mode	Hardware trigger, software trigger and free run mode
Exposure control	Hardware trigger, set by camera API programming
Power supply	• +18 VDC to +26 VDC/1 A, < 1% ripple, powered by the Hirose 12-pin connector of the camera¹ • Powered by PoCXP²
Input/output port	• 3 opto-isolated inputs • 3 opto-isolated outputs • 1 RS-232 interface
Weight	TBD
Lens interface	Optional M58, adapter ring for F-mount interface
Certification	CE/FCC/RoHS

3.2 External IO Ports

3.2.1 Port Description

Figure 3-1 CXP-6 port large area scan cameras

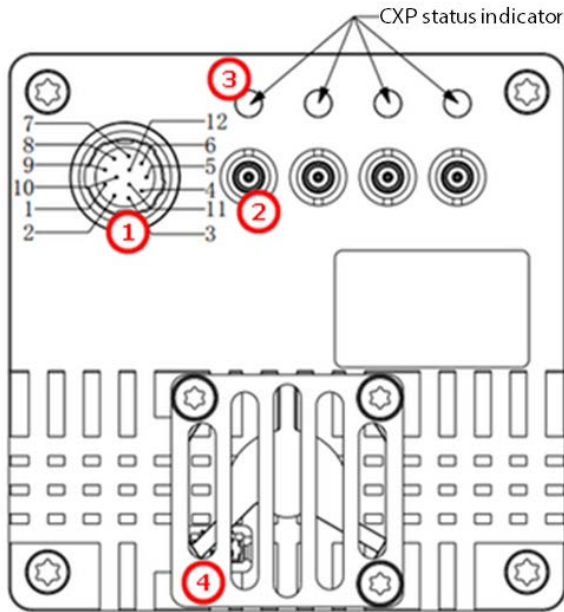


Table 3-3 CXP-6 port large area scan cameras description

No.	Description
1	Hirose 12-pin receptacle
2	CXP-6 port (4 sets)
3	Status indicator
4	Cooling fan

Figure 3-2 CXP-12 port large area scan cameras

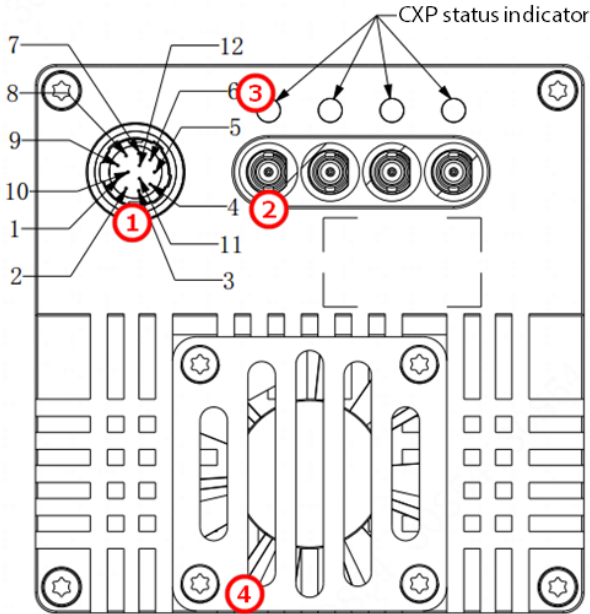


Table 3-4 CXP-12 port large area scan cameras description

No.	Description
1	Hirose 12-pin receptacle
2	CXP-12 port (4 sets)
3	Status indicator
4	Cooling fan

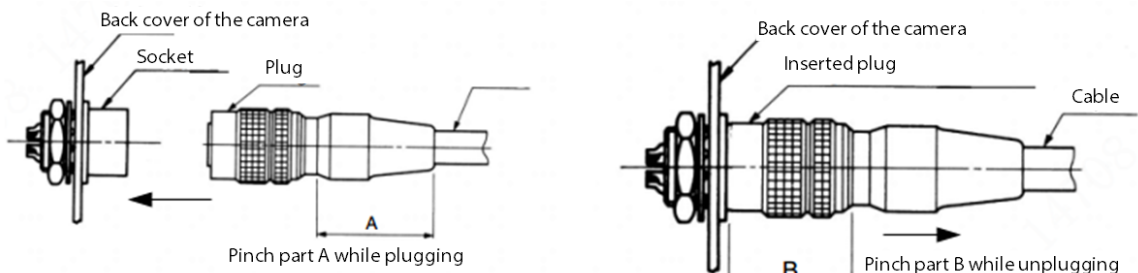


The 12-pin port connector is the equivalent product of HR10A-10R-12PB(71). Please use the equivalent product of HR10A-10P-12S (73) at the cable end. The use of improper cable connector may cause damage to camera port.

3.2.2 Plugging Operation

- Step 1** Align with the guide way of the connector before plugging, then pinch the black rubber part (A) at the rear end of the plug and push it in vertically. It is plugged in place after the "click" sound is heard.
- Step 2** To unplug the cable, pinch the metal part (B) at the front end of the plug and pull it out vertically.

Figure 3-3 12-pin port plugging operation



- Step 3** Before plugging or unplugging the 12-pin power supply and I/O connector, please cut off the power supply first to avoid hot plugging.



- Cord sets (power cords) recommended for your local region must be used for the product within their ratings.
- Use the standard power adapter that comes with the device. Otherwise, any personal injury or device damage will be the liability of the user.
- Use the power supply compliant with SELV (safety extra low voltage) requirements, and use the rated supply voltage compatible with Limited Power Source in accordance with IEC60950-1. For detailed power supply requirements, the label on the equipment shall prevail.

3.2.3 Pin Assignment

Figure 3-4 Pin assignment of 6-pin power supply/trigger port

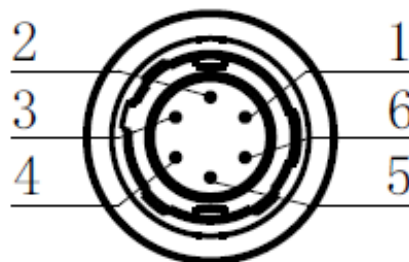


Table 3-5 Pin signal description (1)

Pin	Signal	Description
1	Power	Power
2	Line0	Input/output port
3	Line1	
4	Line2	
5	Signal GND	Signal ground
6	GND	Ground

Figure 3-5 Pin assignment of 12-pin power supply/trigger port

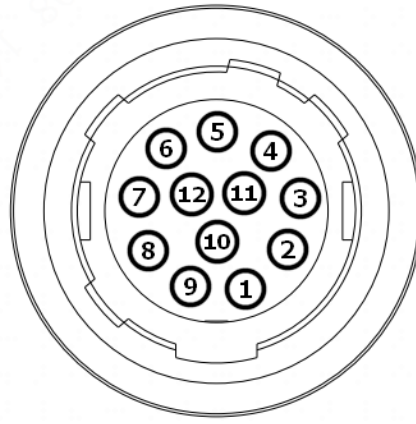


Table 3-6 Pin signal description (2)

Color	Pin	Signal	Description
Black	1	—	Camera power ground and RS-232 signal ground
Red	2	—	+18 VDC to +26 VDC camera power supply
White/blue	3	RXD RS232	Serial port receive
White/green	4	TXD RS232	Serial port transmit
Gray	5	Line3	Opto-isolated input
White	6	Line4	Opto-isolated input
Brown	7	Line5	Opto-isolated input
Orange	8	OPT_IN_GND	Opto-isolated input ground, not to connect to the power GND
Blue	9	Line0	Opto-isolated output
Green	10	Line1	Opto-isolated output
Purple	11	Line2	Opto-isolated output
Yellow	12	OPT_OUT_GND	Opto-isolated output ground, not to connect to the power GND

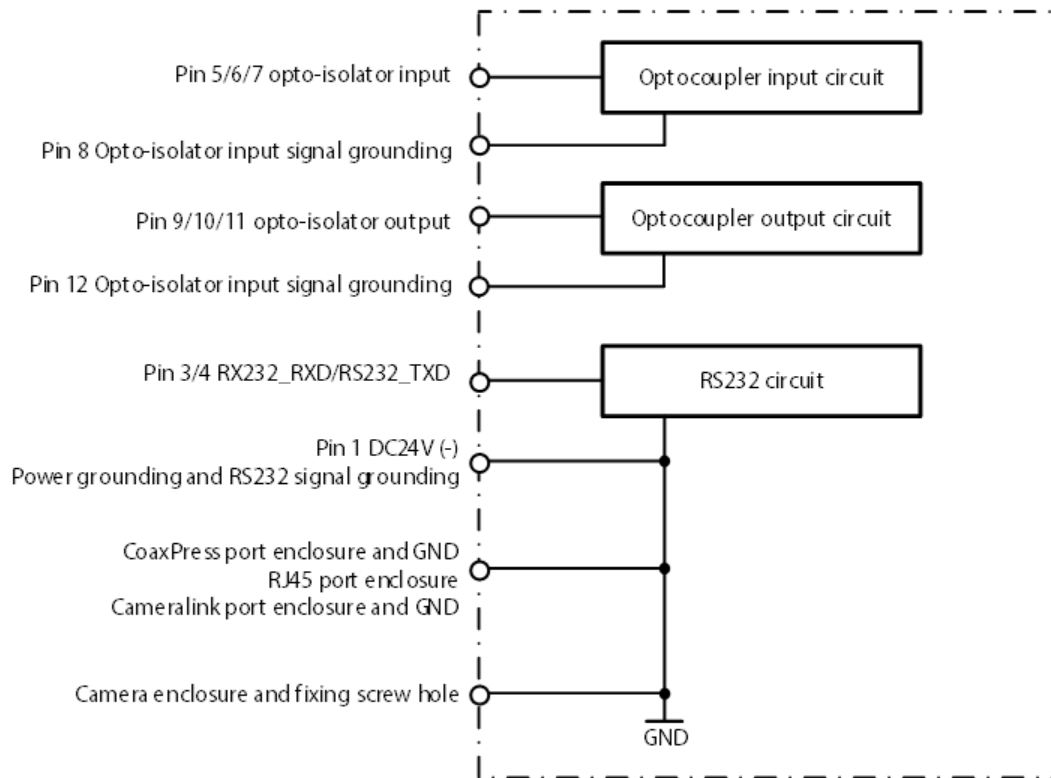


The color coding given in the table is the definition of the I/O cables of Huaray cameras, and may be different for other cables.

3.3 Insulation Status

Applicable for GIGE, Cameralink and CXP cameras.

Figure 3-6 Circuit insulation status



The signal cable of the Ethernet port couples with the internal GND through pressure-sensitive resistor, which can sustain voltage up to 65 VDC.



The metal shielding case for the DC power ground, USB port, RJ45 network port, CameraLink port, and CoaxPress port is not insulated from the camera enclosure, unless otherwise specified. Please be careful not to cause the potential difference between internal common terminals due to the positive grounding environment or the potential difference between devices; otherwise, this will lead to the failure of peripheral equipment such as the connected computer, the acquisition board, or the host computer.

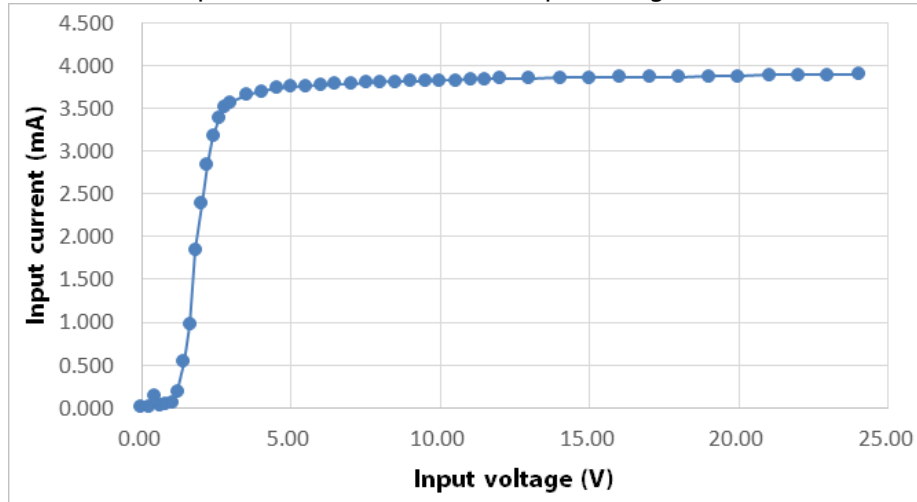
3.4 Opto-isolated Input

3.4.1 Current and Voltage

Table 3-7 Opto-isolated input voltage description

Input Voltage	Description
+26.0 VDC	Limit voltage input, which must be not exceeded; otherwise, the equipment may be damaged.
+0 to +24 VDC	Safe operating voltage input range.
+0 to +1.4 VDC	Represents logic 0.
> +1.4 to +2.2 VDC	The input status changes within this range, within which the logic status is unsteady.
>+2.2 VDC	Represents logic 1.

Figure 3-7 Relationship between sink current and input voltage of the isolator IN



- These are typical values measured at ambient temperature of 25°C, and may be different depending on camera models.
- The maximum sink current for the opto-isolated input is about 4 mA.

3.4.2 Signal Amplitude and Trigger Delay

Figure 3-8 Relationship between the input signal amplitude and trigger delay

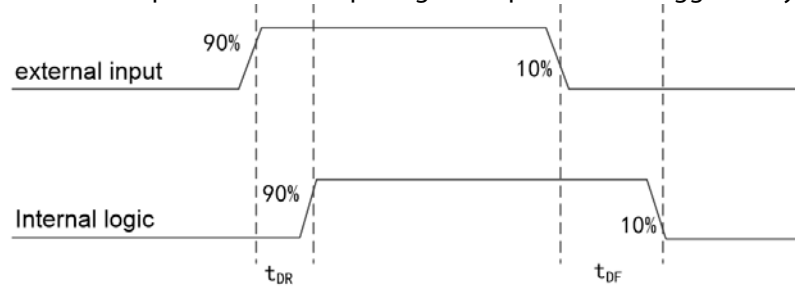


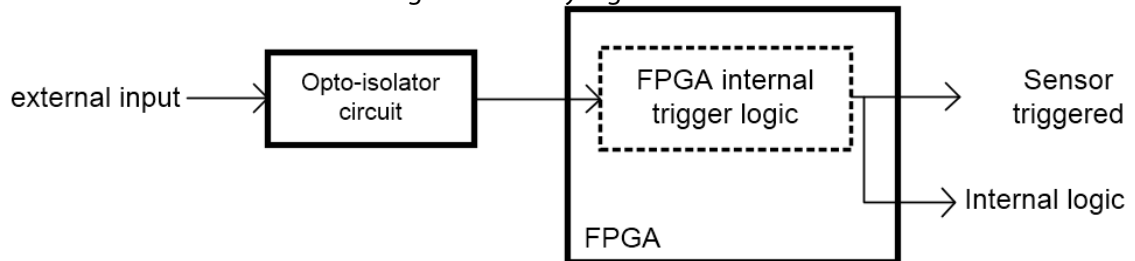
Table 3-8 Relationship between the input signal amplitude and trigger delay description

Input signal amplitude (Vp-p)	Rising edge trigger delay tDR (μs)	Falling edge trigger delay tDF (μs)
3.00	4.282	17.316
5.00	4.074	17.670
9.00	4.016	17.798
10.00	4.010	17.816



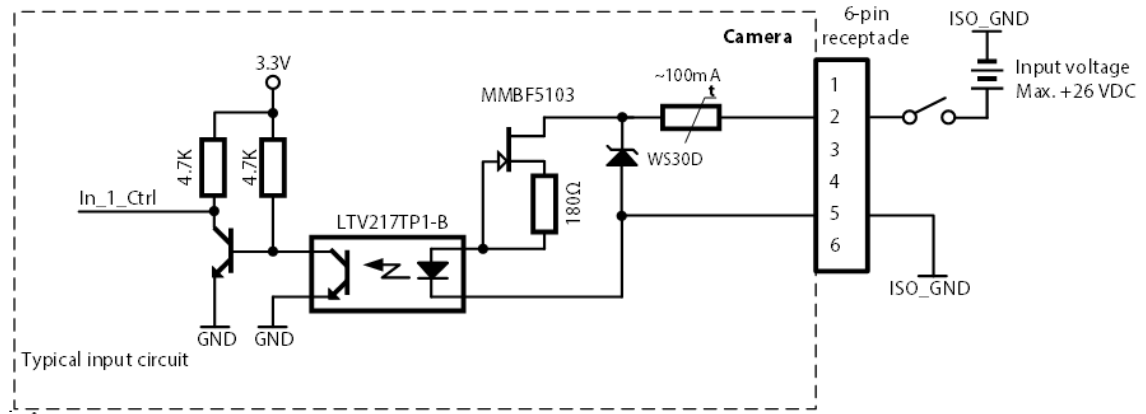
- The trigger delay refers to the delay from the external opto-isolated input to FPGA pin input, without taking into account the internal logic delay of FPGA.

Figure 3-9 Delay logic



- These are typical values measured at the ambient temperature of 25°C.
- The opto-isolated input supports the shortest input positive pulse of 3.2 μs (typical) and the shortest input negative pulse of 18.0 μs (typical).

Figure 3-10 Opto-isolated input circuit



- Do not apply voltage greater than the voltage rating to the input terminal.
- The port fuse is not a user-replaceable part. If the fuse is blown due to overcurrent such as short circuit, please contact the after-sales service.

3.4.3 Typical Application Connection Diagram

Figure 3-11

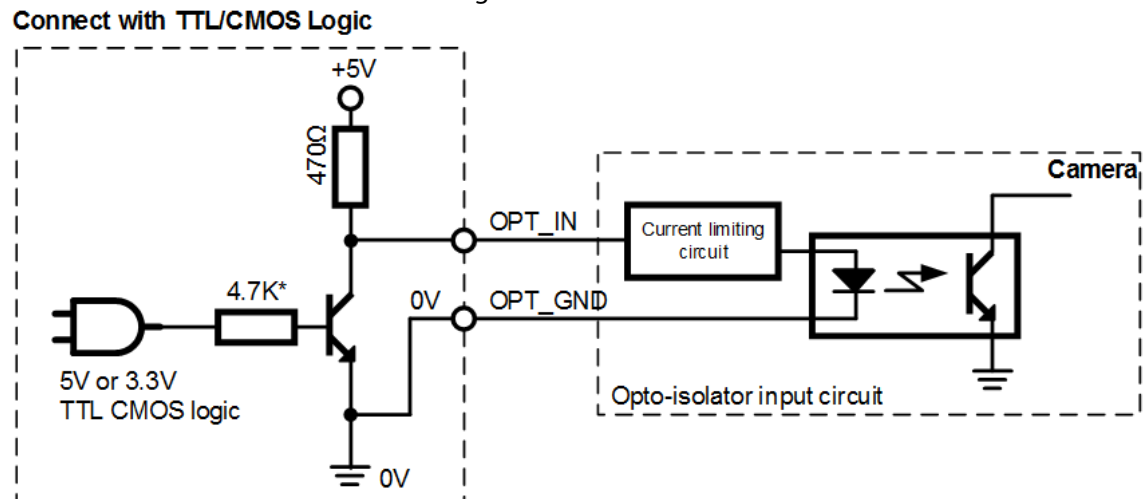
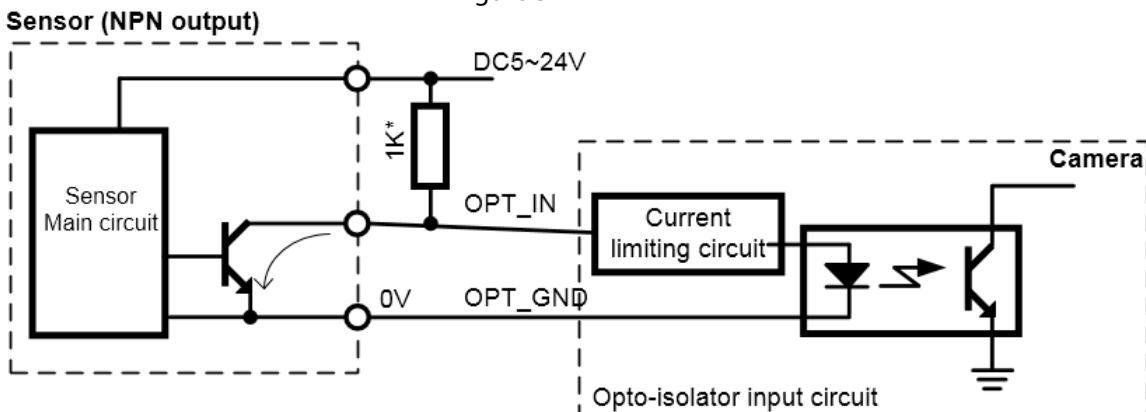


Figure 3-12



Note: For this connection method, the sensor output needs to be connected with a pull-up resistor in the sensor power supply. Select an appropriate resistance value to ensure that the high and low levels meet the input requirements of the opto-isolator interface of the camera.

Figure 3-13

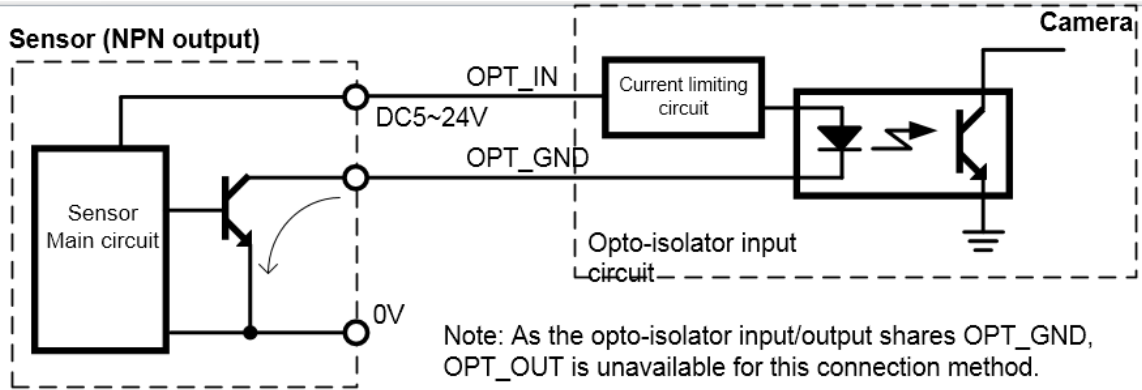


Figure 3-14

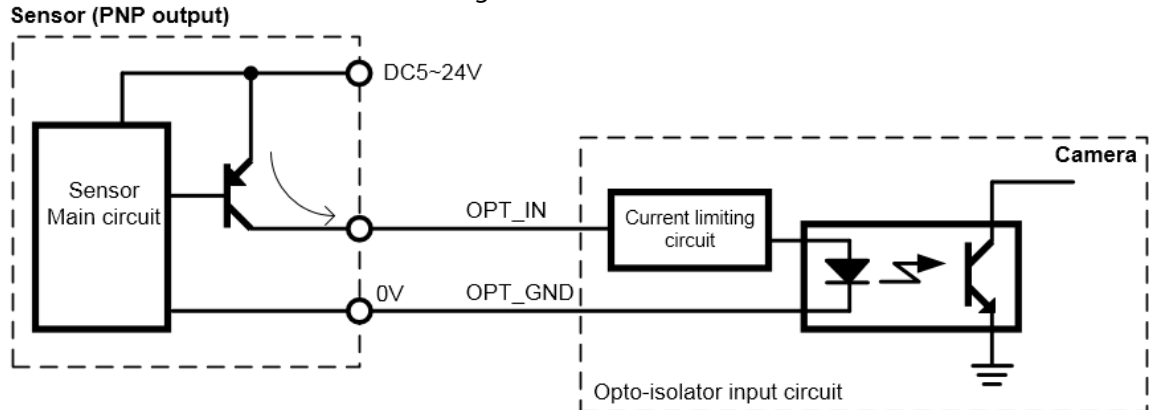


Figure 3-15

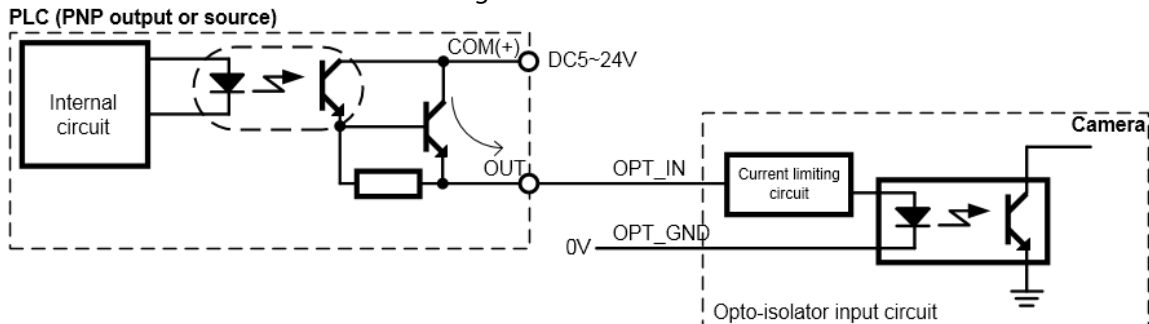
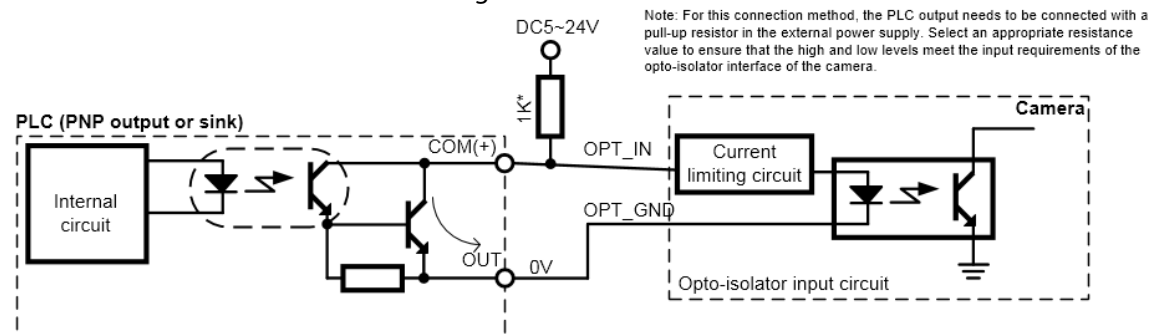


Figure 3-16



3.5 Opto-isolated Output

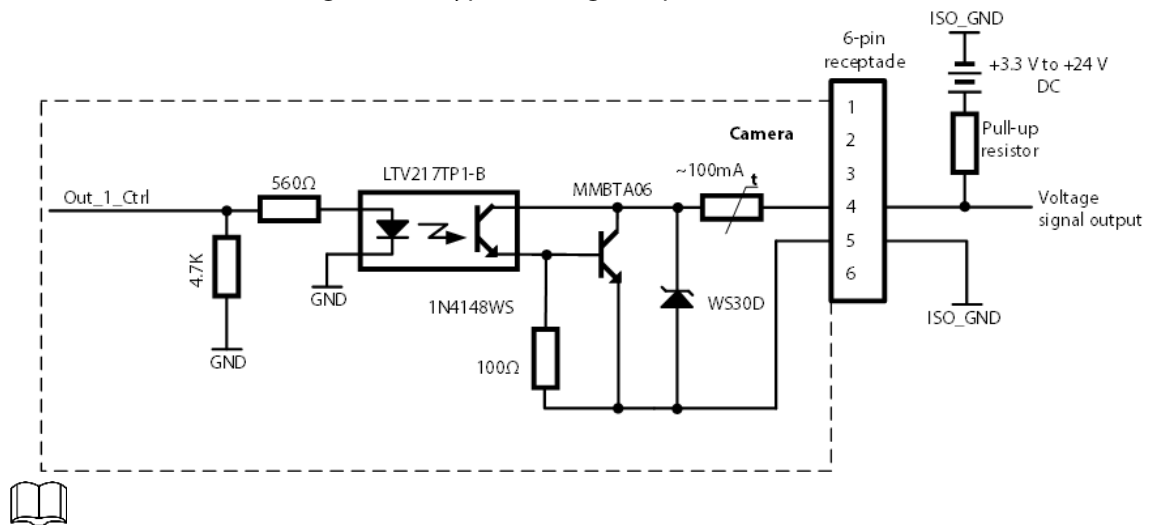
3.5.1 Current and Voltage

Table 3-9 Opto-isolated output voltage description

Voltage	Description
+26.0 VDC	Limit voltage input, which must be not exceeded; otherwise, the equipment may be damaged.

Voltage	Description
<+3.3 VDC	I/O output may be incorrect.
+3.3 to +24 VDC	Safe operating voltage output range.

Figure 3-17 Typical voltage output circuit



The opto-isolated output is sink (NPN) output, and ISO_GND is the common port of the optocoupler.

3.5.2 Trigger Delay

The pull-up resistance value in the figure shall not be greater than the maximum allowable current value at the opto-isolated output port under the given voltage. The larger the pull-up resistance is, the lower the voltage drop of the optocoupler will be, the longer the rise and fall time of the output waveform will be, and the lower the external driving capability will be. The recommended resistance for the optocoupler is 270 Ω at 5 V, 560 Ω at 12 V and 1 kΩ at 24 V.

With the pull-up resistance of 1 kΩ, the output rise/fall time and rising/falling edge delay time at different external supply voltages are as follows:

Figure 3-18 Delay time at different power supply

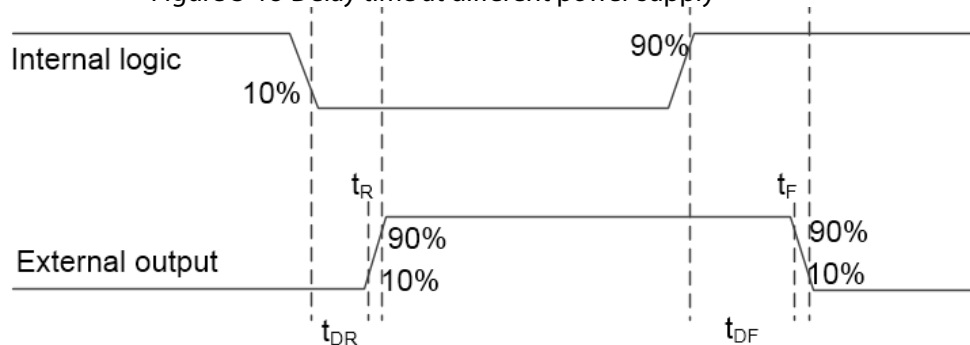


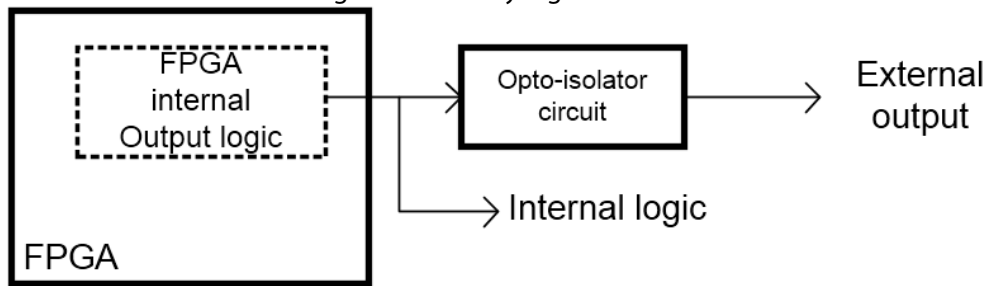
Table 3-10

External Power Supply Voltage (V)	Rise Time t_R (us)	Fall Time t_F (us)	Rising edge Trigger delay t_{DR} (μs)	Fall Edge trigger delay t_{DF} (μs)
5	19.70	3.20	39.9	8.06
12	24.06	5.22	44.8	11.8
24	30.11	8.10	44.8	53.2



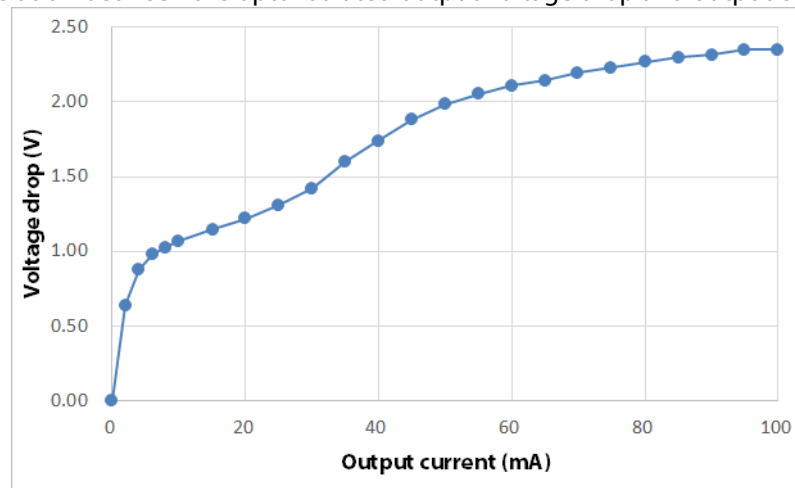
- The output delay refers to the delay from the internal logic output of the FPGA to the external opto-isolated output pin, without taking into account the internal logic delay of FPGA.
- These are typical values measured at ambient temperature of 25°C, and may be different depending on camera models.

Figure 3-19 Delay logic



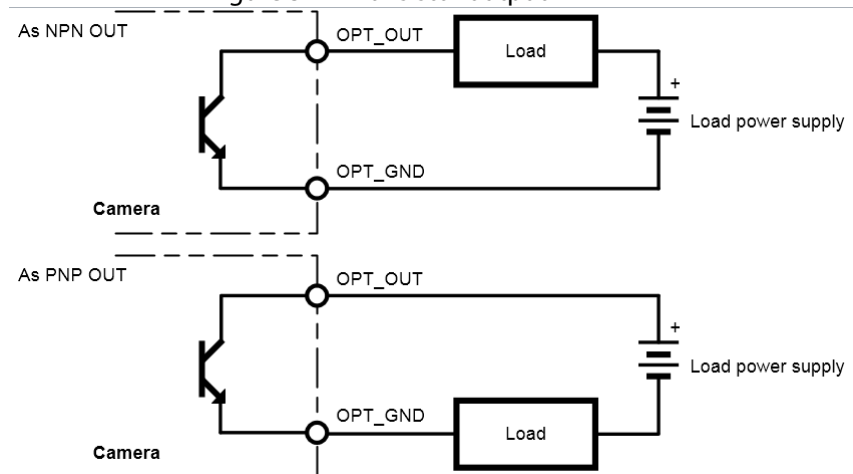
The following figure shows the relation between the opto-isolated output voltage drop (voltage drop between OPT_OUT and OPT_GND) and output current (current flowing into OPT_OUT pin). The maximum voltage drop at the opto-isolated output port is about 2.35 V (measured at the maximum output current of 100 mA).

Figure 3-20 Relation between the opto-isolated output voltage drop and output current

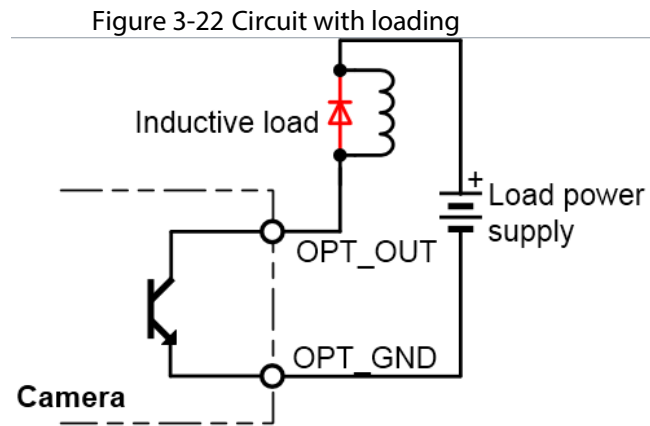


The camera's transistor output is separated from the internal loop by an opto-isolated. Therefore the transistor output can be used as either an NPN output or a PNP output.

Figure 3-21 Transistor output



- The maximum allowable sustained current at the opto-isolated output port is 100 mA. Please do not apply voltage that exceeds the maximum switching capacity to the output terminal or connect a load.
- The port fuse is not a user-replaceable part. If the fuse is blown due to overcurrent such as short circuit, please contact the after-sales service.
- If the output of the camera is connected to an inductive load such as an intermediate relay, the model with a built-in fly-wheel diode must be used (or an external fly-wheel diode, such as 1N4007); otherwise, this may lead to the damage of the output port due to instantaneous overvoltage.



3.5.3 Typical Application Connection Diagram

Figure 3-23

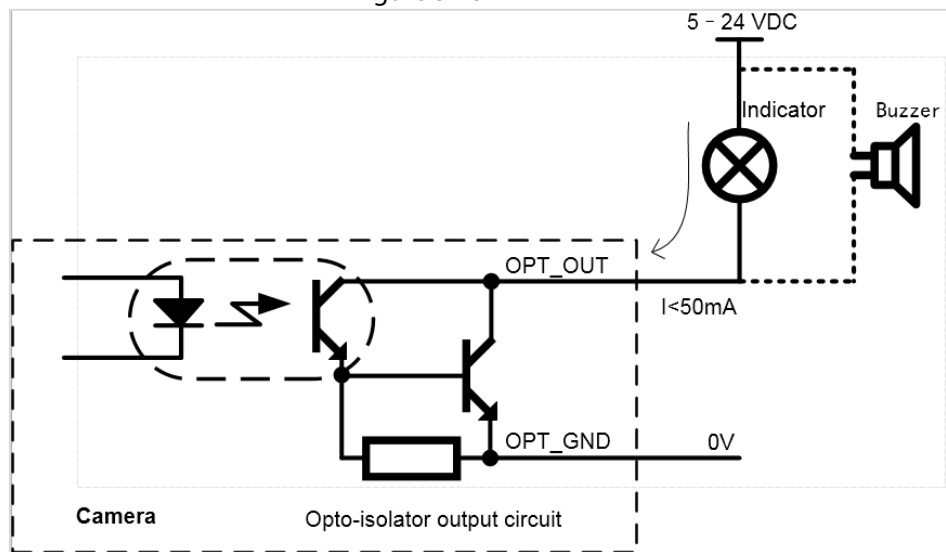


Figure 3-24

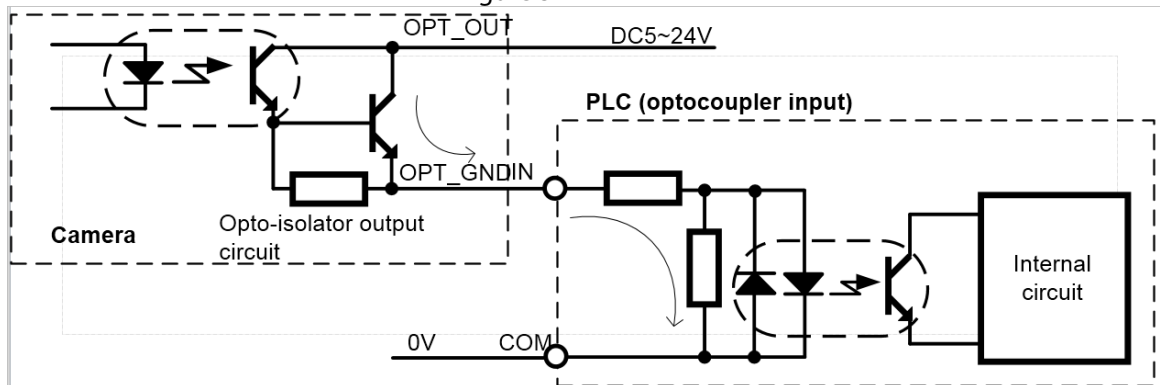


Figure 3-25

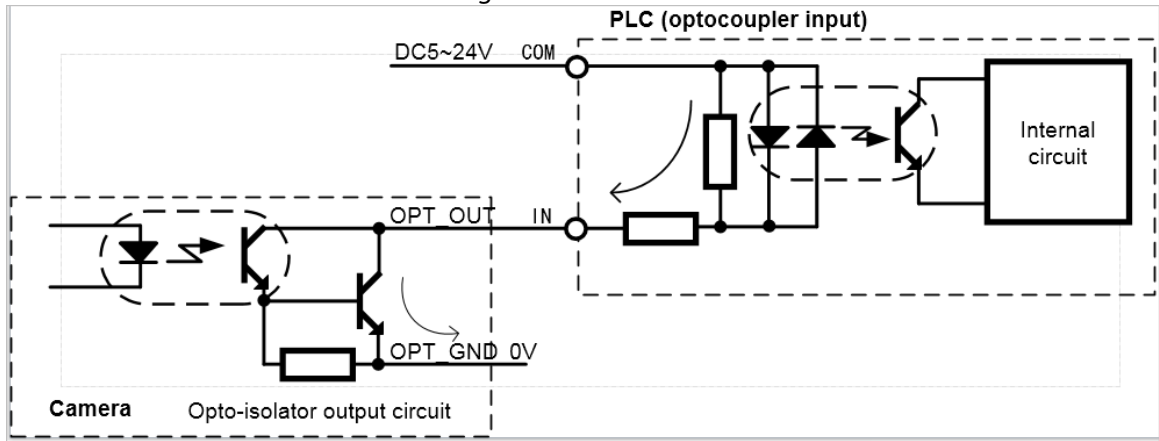
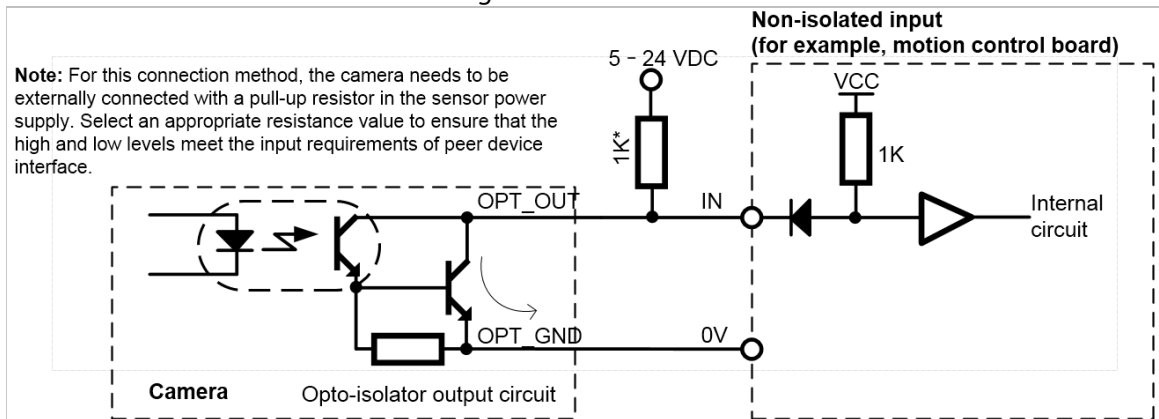


Figure 3-26



Appendix 1 Cybersecurity Recommendations

Cybersecurity is more than just a buzzword: it's something that pertains to every device that is connected to the internet. IP video surveillance is not immune to cyber risks, but taking basic steps toward protecting and strengthening networks and networked appliances will make them less susceptible to attacks. Below are some tips and recommendations on how to create a more secured security system.

Mandatory actions to be taken for basic device network security:

1. Use Strong Passwords

Please refer to the following suggestions to set passwords:

- The length should not be less than 8 characters;
- Include at least two types of characters; character types include upper and lower case letters, numbers and symbols;
- Do not contain the account name or the account name in reverse order;
- Do not use continuous characters, such as 123, abc, etc.;
- Do not use overlapped characters, such as 111, aaa, etc.;

2. Update Firmware and Client Software in Time

- According to the standard procedure in Tech-industry, we recommend to keep your device (such as NVR, DVR, IP camera, etc.) firmware up-to-date to ensure the system is equipped with the latest security patches and fixes. When the device is connected to the public network, it is recommended to enable the "auto-check for updates" function to obtain timely information of firmware updates released by the manufacturer.
- We suggest that you download and use the latest version of client software.

"Nice to have" recommendations to improve your device network security:

1. Physical Protection

We suggest that you perform physical protection to device, especially storage devices. For example, place the device in a special computer room and cabinet, and implement well-done access control permission and key management to prevent unauthorized personnel from carrying out physical contacts such as damaging hardware, unauthorized connection of removable device (such as USB flash disk, serial port), etc.

2. Change Passwords Regularly

We suggest that you change passwords regularly to reduce the risk of being guessed or cracked.

3. Set and Update Passwords Reset Information Timely

The device supports password reset function. Please set up related information for password reset in time, including the end user's mailbox and password protection questions. If the information changes, please modify it in time. When setting password protection questions, it is suggested not to use those that can be easily guessed.

4. Enable Account Lock

The account lock feature is enabled by default, and we recommend you to keep it on to guarantee the account security. If an attacker attempts to log in with the wrong password several times, the corresponding account and the source IP address will be locked.

5. Change Default HTTP and Other Service Ports

We suggest you to change default HTTP and other service ports into any set of numbers between 1024~65535, reducing the risk of outsiders being able to guess which ports you are using.

6. Enable HTTPS

We suggest you to enable HTTPS, so that you visit Web service through a secure communication channel.

7. MAC Address Binding

We recommend you to bind the IP and MAC address of the gateway to the device, thus reducing the risk of ARP spoofing.

8. Assign Accounts and Privileges Reasonably

According to business and management requirements, reasonably add users and assign a minimum set of permissions to them.

9. Disable Unnecessary Services and Choose Secure Modes

If not needed, it is recommended to turn off some services such as SNMP, SMTP, UPnP, etc., to reduce risks.

If necessary, it is highly recommended that you use safe modes, including but not limited to the following services:

- SNMP: Choose SNMP v3, and set up strong encryption passwords and authentication passwords.
- SMTP: Choose TLS to access mailbox server.
- FTP: Choose SFTP, and set up strong passwords.
- AP hotspot: Choose WPA2-PSK encryption mode, and set up strong passwords.

10. Audio and Video Encrypted Transmission

If your audio and video data contents are very important or sensitive, we recommend that you use encrypted transmission function, to reduce the risk of audio and video data being stolen during transmission.

Reminder: encrypted transmission will cause some loss in transmission efficiency.

11. Secure Auditing

- Check online users: we suggest that you check online users regularly to see if the device is logged in without authorization.
- Check device log: By viewing the logs, you can know the IP addresses that were used to log in to your devices and their key operations.

12. Network Log

Due to the limited storage capacity of the device, the stored log is limited. If you need to save the log for a long time, it is recommended that you enable the network log function to ensure that the critical logs are synchronized to the network log server for tracing.

13. Construct a Safe Network Environment

In order to better ensure the safety of device and reduce potential cyber risks, we recommend:

- Disable the port mapping function of the router to avoid direct access to the intranet devices from external network.
- The network should be partitioned and isolated according to the actual network needs. If there are no communication requirements between two sub networks, it is suggested to use VLAN, network GAP and other technologies to partition the network, so as to achieve the network isolation effect.
- Establish the 802.1x access authentication system to reduce the risk of unauthorized access to private networks.
- Enable IP/MAC address filtering function to limit the range of hosts allowed to access the device.