China Daheng Group, Inc. Beijing Image Vision Technology Branch

VENUS USB3 Vision Cameras

User Manual

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DAHENG IMAGING 大恒图像

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Preface

We really appreciate your choosing of DAHENG IMAGING products.

The VENUS USB3 Vision camera is DAHENG IMAGING's mature board level industrial digital camera with large and high-quality sensor, featuring high resolution, high definition and extremely low noise. The VENUS USB3 Vision cameras are include split USB3.0 cameras and all-in-one USB3.0 cameras. The camera is equipped with standard USB3.0/FPC connector, which is easy to install and use.

The VENUS USB3 Vision cameras are especially suitable for machine vision applications such as industrial inspection, medical, scientific research, education, security and so on.

This manual describes in detail on how to install and use the VENUS USB3 Vision digital cameras.

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1. Introduction

1.1. Series Introduction

The VENUS USB3 Vision camera is DAHENG IMAGING's innovative board level industrial digital camera, featuring outstanding performance, powerful features, and outstanding price/performance ratio. The VENUS board level cameras include split USB3.0 cameras and all-in-one USB3.0 cameras. The cameras are available in a variety of resolutions and frame rates, and are available with CMOS sensors from leading chip manufacturers, which is easy to install and use.

The VENUS board level cameras transmit image data through the USB3.0 data interface. Featuring high reliability and high price/performance ratio, the VENUS USB3 Vision cameras are especially suitable for machine vision applications such as industrial inspection, medical, scientific research, education, security and so on.

1.2. Naming Rules

The naming rules of the VENUS board level cameras are as follows, through which users can know main features of the camera, see more details in 4.General Specification.

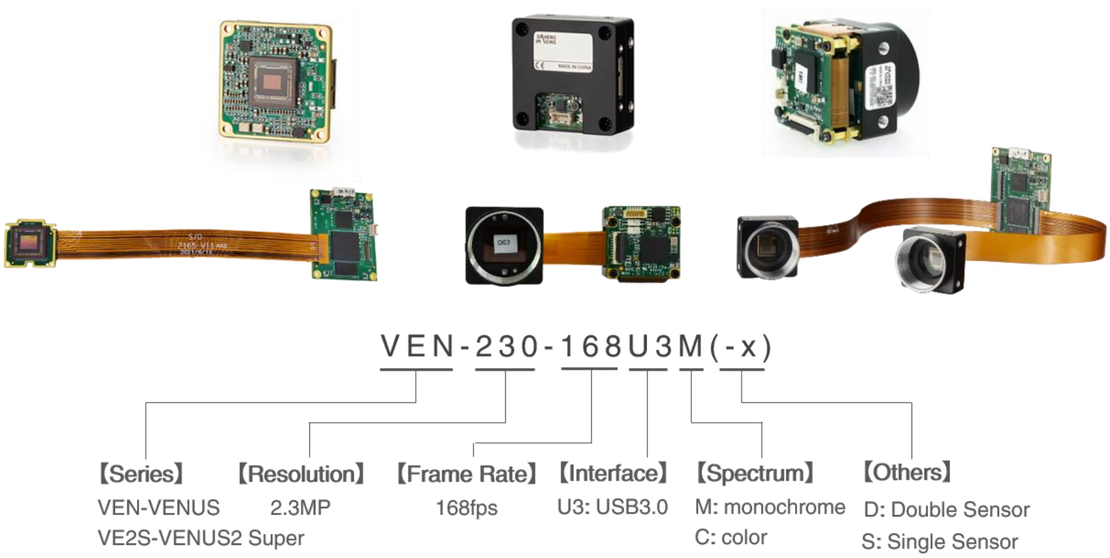


Figure 1-1 Naming rules

1.3. Standards

The camera follows the USB3 Vision1.0 standard, and its development interface GalaxySDK is implemented based on the GEN<i>CAM standard.

1.4. Document, CAD/Technical Drawing and Software Downloads

Product related document, CAD/Technical drawing and software can be downloaded from the Downloads of DAHENG IMAGING website.

2. Precautions

2.1. Guideline for Avoiding EMI and ESD

You should consider the EMI (Electro Magnetic Interference) and ESD (Electro-Static discharge) problem in the process of using the camera, to guarantee the camera to work in a relatively good electromagnetic environment. The main measures are as follows:

1) USB cables certificated by USB IF with lock screw are recommended.

2) Using shielded cable can avoid electro-magnetic interface. Shielding layer of the cable should conduct to ground nearby and not until stretched too long. When many devices need conduct to ground, using single point grounding to avoid earth loop.

3) Keep your cameras away from equipment with high voltage, or high current (such as motor, inverter, relay, etc.). If necessary, use additional shielding.

4) ESD (electro-static discharge) may damage cameras permanently, so use suitable clothing (cotton) and shoes, and touch the metal to discharge the electro-static before operating cameras.

2.2. Environmental Requirements

1) Housing temperature during operation: 0°C ~ 45°C, humidity during operation: 10% ~ 80%.

   Storage temperature: -20°C ~ 70°C.

2) To avoid collecting dust in the optical filter, always keep the plastic cap on cameras when no lens is mounted.

3) PC requirement: Intel Core 2 Duo, 2.4GHz or above, and 2GB memory or above.

4) USB3.0 host controller requirement: Intel controller integrated in mainboard is recommend. Select Renesas controller if external frame grabber is needed.

5) The cable must have a locking screw at the end of the device.

6) Make sure that cameras are transported in the original factory packages.

2.3. Camera Mechanical Installation Precautions

Camera installation requirements:

1) The M3/M2's screwing length with the cameras while mounting can reference to the 5.Dimensions section. If the length of the screw exceeds the length indicated on the drawing, the camera may be damaged.

2) The M3 screw assembly torque ≤ 1N·M, and the M2 screw assembly torque ≤ 0.5N·M. If the screw assembly torque is too large, it may cause the camera thread stripping.

2.4. Certification and Declaration

1) CE, RoHS

We declare that DAHENG IMAGING VENUS USB3 Vision cameras have passed the following EU certifications:

- 2014/30/EU—Electromagnetic Compatibility Restriction
- 2011/65/EU—Restriction of Hazardous Substances (RoHS) and its revised directive 2015/863/EU

Equipment meeting Class A requirements may not offer adequate protection to broadcast services within a residential environment.

3. Installation Guideline

3.1. Host Preparation

3.1.1. Software Package

The software package of DAHENG IMAGING's is used to control the camera to provide stable, real-time image transmission, and provides multiple samples and easy-to-integrate SDKs for various programming tools. The package is composed of the following modules:

1) Driver Package (Driver): This package provides the VENUS USB3 Vision camera driver program, such as: the USB3.0 cameras' driver program.

2) Interface Library (API): This package provides the camera control interface library and the image processing interface library, supports the user for secondary development.

3) Demonstration Program (GalaxyView.exe): This demonstration program is used to display the camera control, image acquisition and image processing functions, the user can control the camera directly by the demonstration program, and the user can develop their own control program based on the camera interface library.

4) Sample: These samples demonstrate cameras' functions, the user can easily use these samples to control cameras, or refer to the samples to develop their own control programs.

5) Programmer's Manual: This manual is the users programming guide that instructs the users how to configure the programming environment and how to control cameras and acquire images through the camera interface library.

You can download the latest software package from the website: www.daheng-imaging.com/en/Downloads.

3.1.2. User Software Interface

After installing the camera software package, the user can use the demonstration program and the samples to control the camera, also the user can control the camera by the program which is written by the user themselves. The software package provides three kinds of program interface, the user can select the suitable one for use according to their own requirements:

1) API Interface

In order to simplify the users' programming complexity, the package provides the general C programming interface GxIAPI.dll and image processing algorithm interface DxImageProc.dll for the user to control the camera, and provides the samples and software development manual which are based on these interfaces. The API interface supports C/C++/C#/Python, etc.

2) GenTL Interface

This interface is developed according to the standard of general transport layer in GEN<i>CAM standard, DAHENG IMAGING follows the GEN<i>CAM standard and provides the GenTL interface for the user, the user can use the GenTL interface directly to develop their own control program.

In addition, users can use some third-party software that supports GEN<i>CAM standard to control the camera, such as HALCON.

3) USB3 Vision interface

The VENUS USB3 Vision camera is compatible with the USB3 Vision protocol, which allows the user to control the camera directly through the USB3 Vision protocol. In addition, the user can use some third-party software that supports the USB3 Vision protocol to control the camera, such as HALCON.

- **Note**

GEN<i>CAM standard: GEN<i>CAM is administered by the European Machine Vision Association (EMVA). GenICam provides a generic programming interface for all kinds of cameras and devices. It provides a standard application programming interface (API), no matter what interface technology is being used. It mainly includes the following modules:

- GenAPI: an XML description file format defining how to capture the features of a device and how to access and control these features in a standard way
- GenTL: a generic Transport Layer Interface, between software drivers and libraries, that transports the image data from the camera to the application running on a PC
- SFNC: common naming convention for camera features, which promotes interoperability between products from different manufacturers

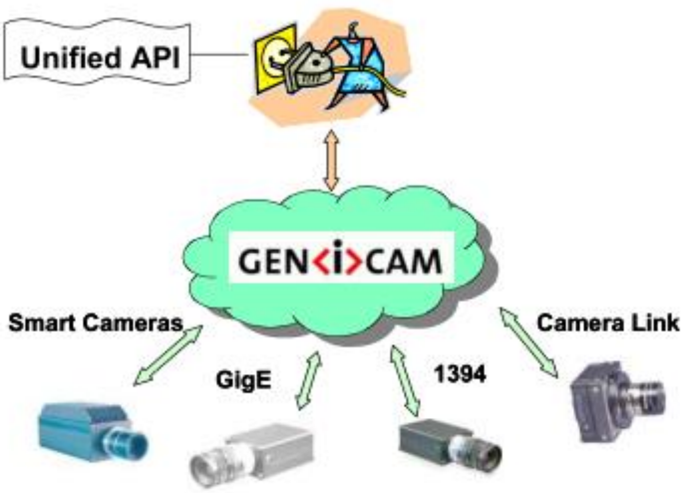


Figure 3-1 GEN<i>CAM standard schematic diagram

3.2. Camera Power

VENUS USB3 Vision camera is powered by the USB 3.0 bus.

3.3. Camera Driver Installation

3.3.1. System Requirements

GalaxySDK is suitable for all VENUS USB3 Vision cameras. The GalaxySDK contains various operating systems such as Windows, Android and Linux. The requirements for the operating system and version of the installation package are as follows:

Operating Systems	Applicable Version
Windows	➢ Windows 7 (32bit, 64bit) ➢ Windows 10 (32bit, 64bit) ➢ Windows 11 (64bit)
Linux	➢ Ubuntu 12.04 or above, kernel version 3.5.0.23 or above
Android	➢ Android 6 or above

3.3.2. Driver Installation

The steps to install the Galaxy SDK under Windows are as follows:

1) Download the corresponding version of the installation package from www.daheng-imaging.com/en/Downloads.

2) Run the installer.

3) Follow the instructions of the installation wizard to complete the installation process. During the installation process, you can choose the camera interface you need (USB2.0, USB3 Vision, GigE Vision, etc.).

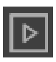
During the installation process, especially when installing the *.sys file, you must always pay attention to whether the anti-virus software intercepts the driver. If intercepted, it may cause the driver installation to fail.

3.4. Open Device and Start Acquisition

After powering the device, connecting the device to the USB3.0 interface of the host. Double-click the GalaxyView software to acquire image. The steps are as follows:

1) Click the  icon on the Device Tree in the GalaxyView to refresh device list.

2) After the device is enumerated, double-click the device enumerated in the device list.

3) Click the  icon on the Device Tree to perform the Start Acquisition operation on the current device.

3.5. Hardware System and Installation

During installation and debugging, human bodies may discharge components on the PCB board and causing permanent damage to the camera. So, before touching the camera, wear an anti-static bracelet or touch the metal frame to release the accumulated electric charge from the human body.

There is a limit to the number of times that connectors (gold finger or board to board) can be inserted and opened (typically 20 times), and electrical performance may be reduced after exceeding this limit. Please avoid repeated plugging and unplugging operations during use.

3.5.1. Split USB3.0 camera's hardware composition

The composition of the split USB3.0 camera is composed of acquisition board, imaging board and FPC cable. The complete machine composition diagram are as follows.

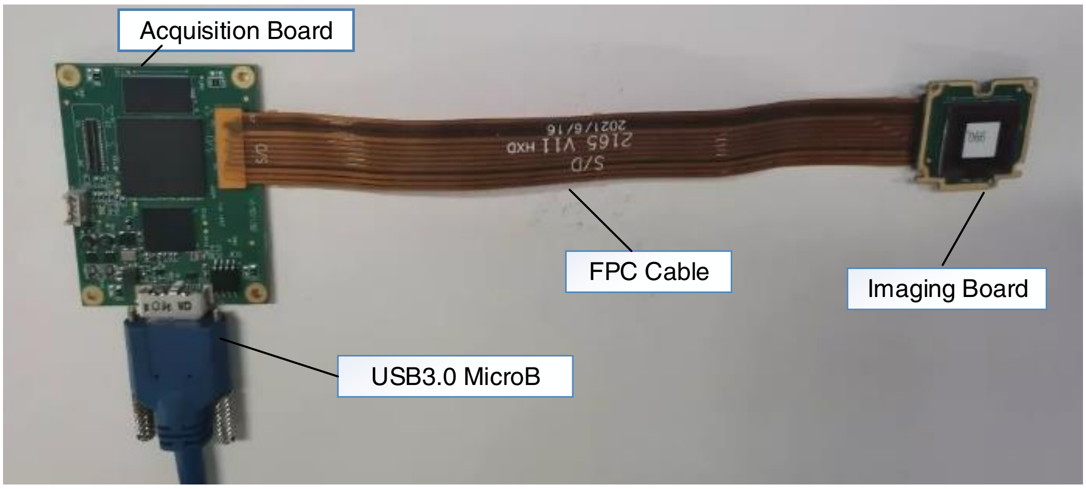


Figure 3-2 Split USB3.0 camera composition diagram (without C-Mount)

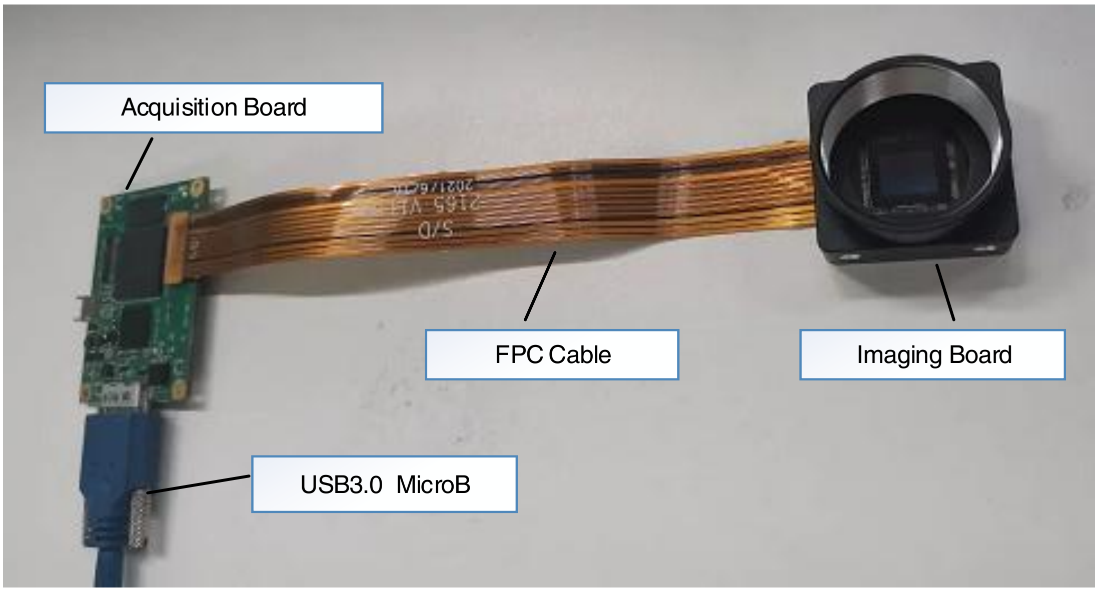


Figure 3-3 Split USB3.0 camera composition diagram (C-Mount)

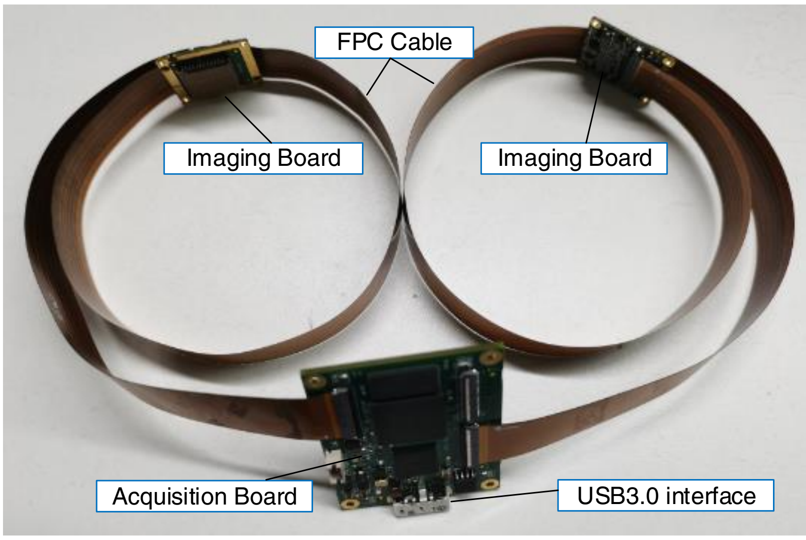


Figure 3-4 Split binocular USB3.0 interface camera composition diagram (without C-Mount)

3.5.1.1. Split USB3.0 camera’s hardware assembly

The split USB3.0 camera is a board camera. The user may need to disassemble and assemble each camera unit during integration into the application system. The following issues should be paid attention to when using the camera:

1) Camera assembly

VEN-302-56U3M/C-S camera’s acquisition board and imaging board connect corresponding interface through the FPC cable. The single imaging board camera can only be connected to the interface with the "S/D" mark on the acquisition board, and it must be used the FPC cable with the "S/D" mark. The other imaging board of the double imaging board camera can only be connected to the interface with the "D" mark on the acquisition board, and it must be used the FPC cable with the "Double" mark.

Corresponding identification through the "S/D" or "D" mark next to the connector of the acquisition board and the "S/D" or Doubled" mark of the FPC cable. Alignment recognition of the connector through the FPC cable and the "△" mark on the acquisition board, as shown in Figure 3-5.

The connection between the imaging board and the FPC cable is aligning and identifying the edge of the imaging board through the screen printing line at the connector of the FPC cord. The FPC cable is connected to the acquisition board, as shown in Figure 3-6.

Figure 3-5 The mark of the FPC cable and the connector of the acquisition board

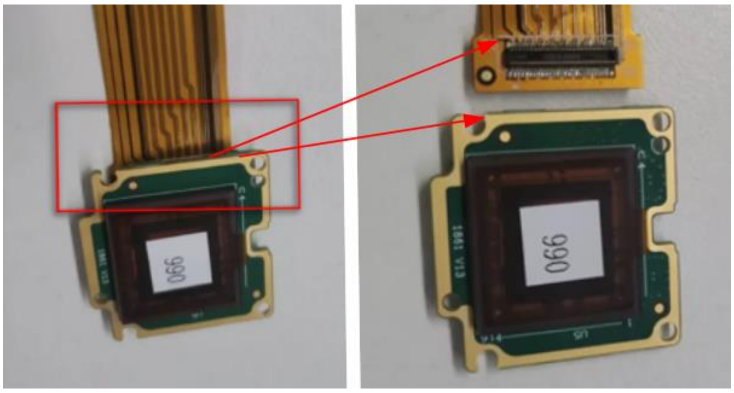


Figure 3-6 The connection between the imaging board connector and the FPC cable connector

2) FPC cable folding

The acquisition board and imaging board are connected with FPC cable. When the camera and the user structure are installed, the FPC cable should be free for external force. The FPC cable and other structural parts are prohibited from contact.

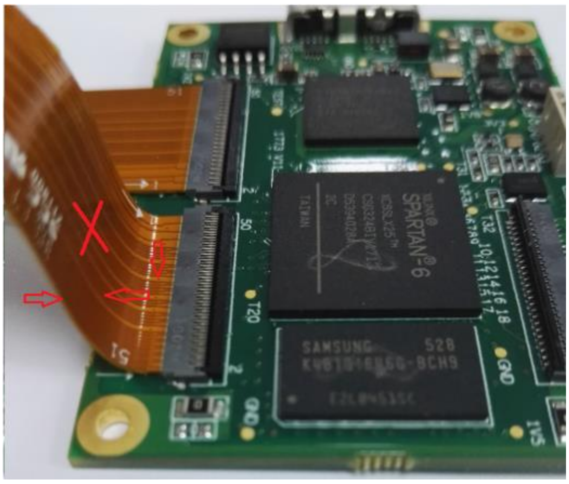


Figure 3-7 Schematic diagram of external force prohibition near FPC connector and FPC cable of acquisition board

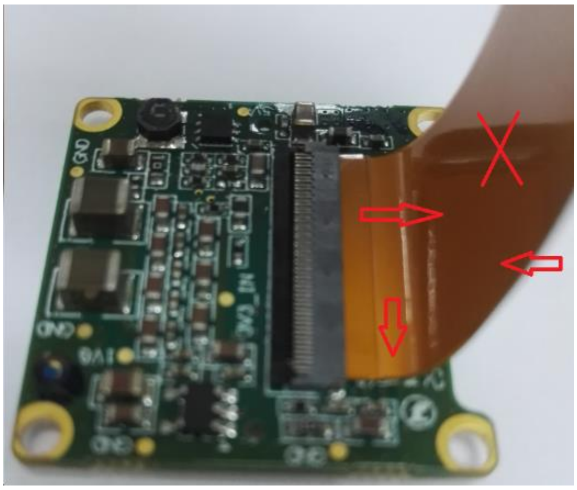


Figure 3-8 Schematic diagram of external force prohibition near FPC connector and FPC cable of imaging board

When the camera is installed into a specific position, the acquisition board and imaging board will have various relative positions of space. At this point, the FPC cable may be rotated or bent. In order to ensure that the FPC cable is in a free state, the FPC cable can be folded in advance according to the space position (avoiding the death fold, the turning radius above 6mm), and reducing the distortion and rotation of the stress to the FPC connector. The following figure is an example.

Figure 3-9 FPC cable folding

3) Heat dissipation of imaging board

The image sensor is sensitive to temperature. In order to ensure good imaging quality, the structure of the user optical path system should use thermally conductive materials, and the mounting surface of the structure should be in good contact with the heat conduction region of the imaging board. The following is the heat conduction region of the imaging board:

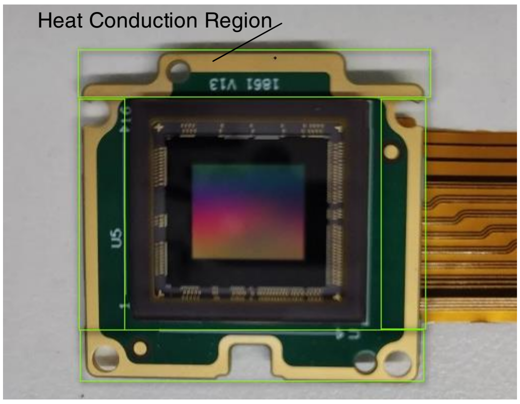


Figure 3-10 The heat conduction region of the imaging board (split monocular camera)

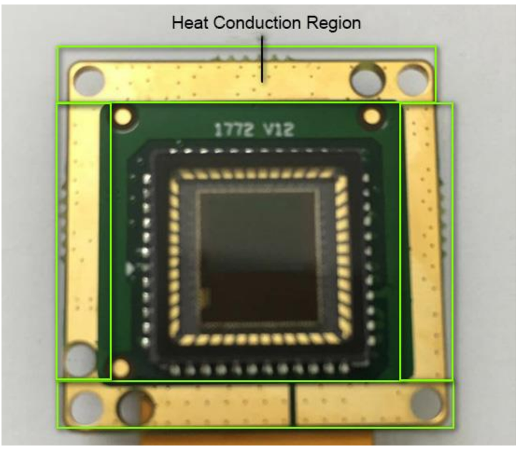


Figure 3-11 The heat conduction region of the imaging board (split binocular camera)

4) Heat dissipation of acquisition board

When the temperature around the acquisition board exceeds 45 degrees, it is recommended that the user dissipate heat on the main chip. Thermally conductive materials is used to transfer the heat of the main chip to the housing / radiator with good thermal conductivity. The following is the heat conduction region of the imaging board with the thermally conductive material:

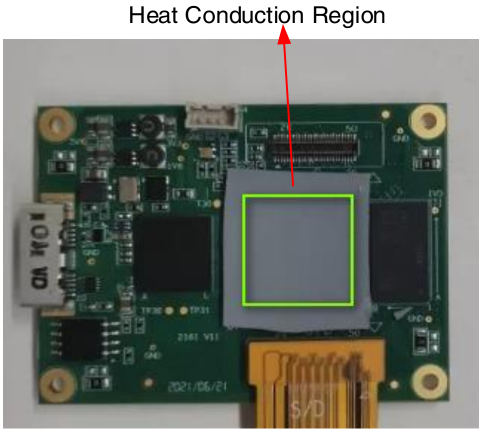


Figure 3-12 The heat conduction region of the imaging board (split monocular camera)

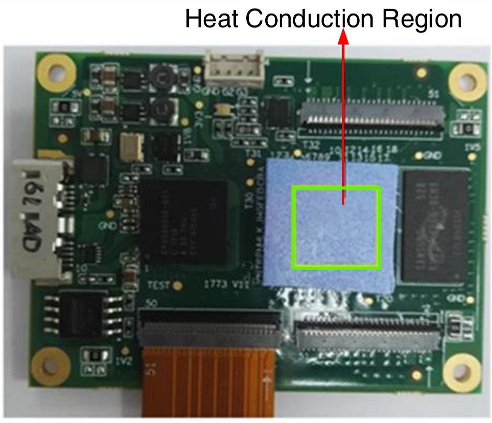


Figure 3-13 The heat conduction region of the imaging board (split binocular camera)

3.5.2. All-in-one vertical FPC camera's hardware composition

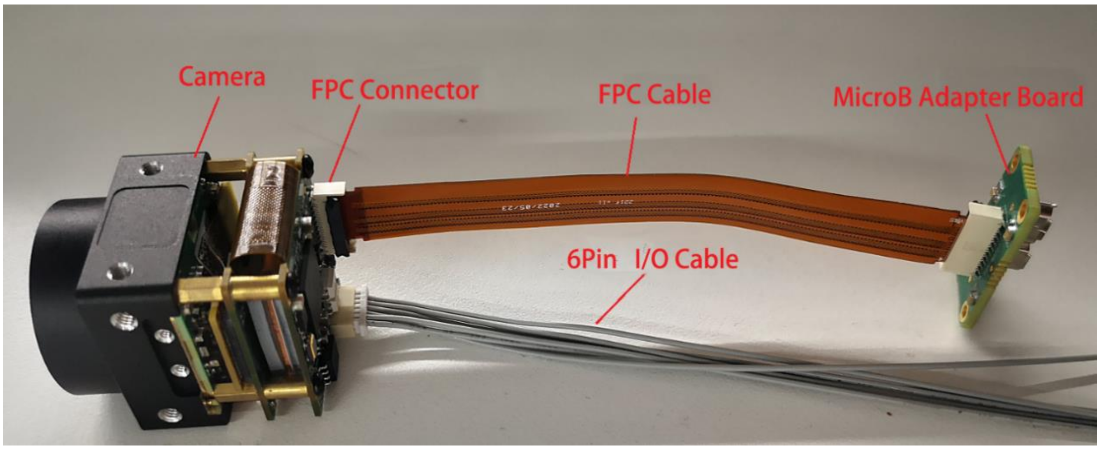


Figure 3-14 All-in-one vertical FPC camera's hardware composition

3.5.2.1. All-in-one vertical FPC camera’s installation

Step1: Connect the FPC cable to the camera according to the following picture’s red box part: the FPC cable’s connecting finger facing up, insert it into the white FPC card holder and rotate the black locking mechanism 90 degrees downward to lock the FPC cable.

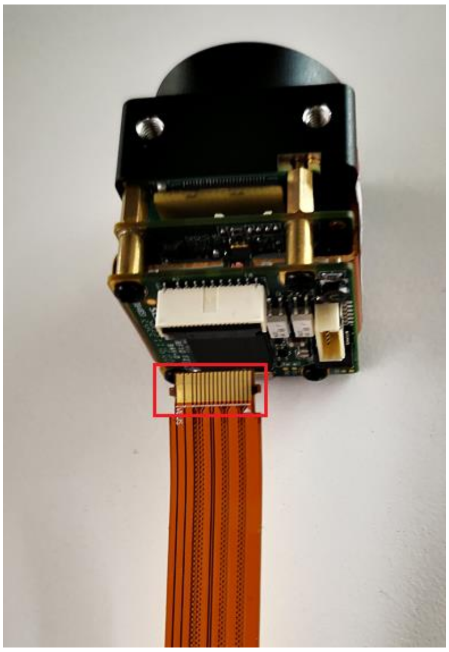


Figure 3-15 FPC cable connect to the camera

Step2: PFC cable connecting to the Micro-B adapter board according to the following picture’s red box part: the FPC cable’s connecting finger facing up, insert it into the white FPC card holder and rotate the black locking mechanism 90 degrees downward to lock the FPC cable.

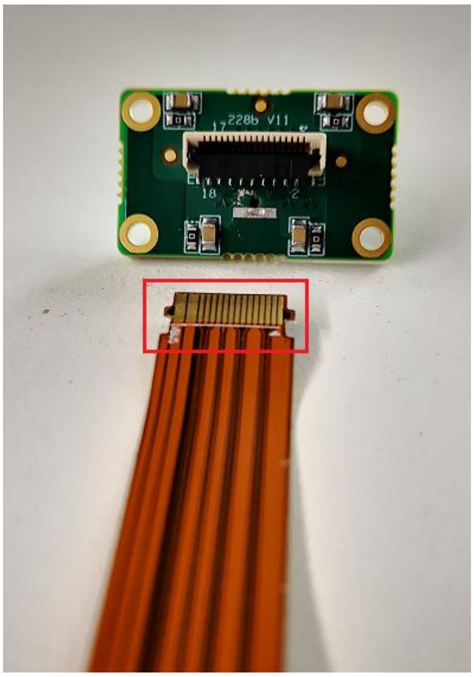


Figure 3-16 FPC cable connect to the Micro-B adapter board

3.5.3. Split vertical FPC camera's hardware composition

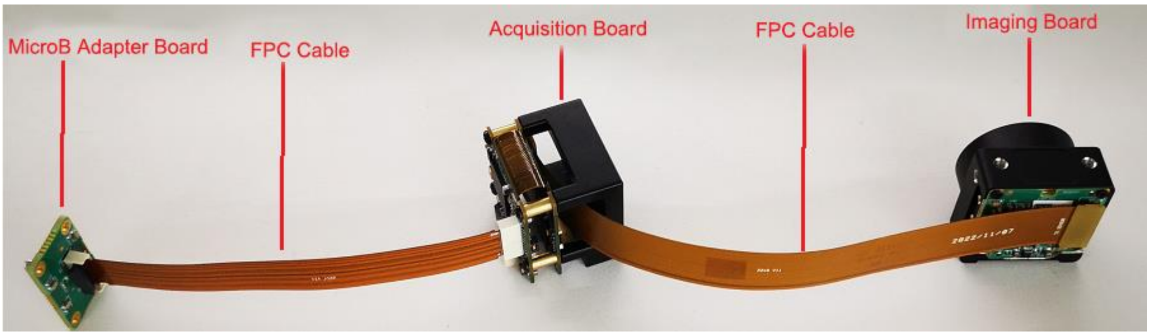


Figure 3-17 Split vertical FPC camera's hardware composition

⚠ The left side FPC cable is the connection method of connecting finger, which is used to transfer USB3 signal. And the right side FPC cable is the connection method of board to board, which is used to transfer image signal. The appearance and connection methods above are different, so they cannot be installed after being interchanged.

3.5.3.1. Split vertical FPC camera's installation

Step1: FPC cable connect to the image board, according to the following figure: the side marked with " TO SENSOR " connect to the image board.

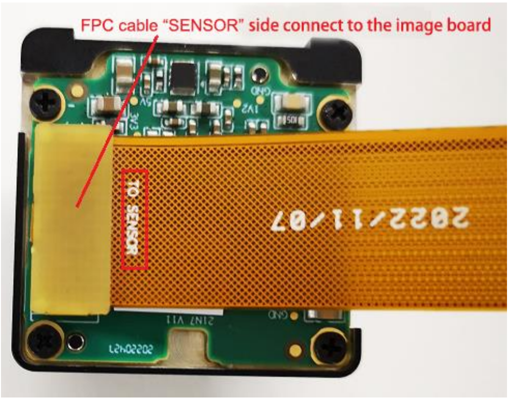


Figure 3-18 FPC cable connect to the image board

Step2: FPC cable with "TO BE" connect to the acquisition board.

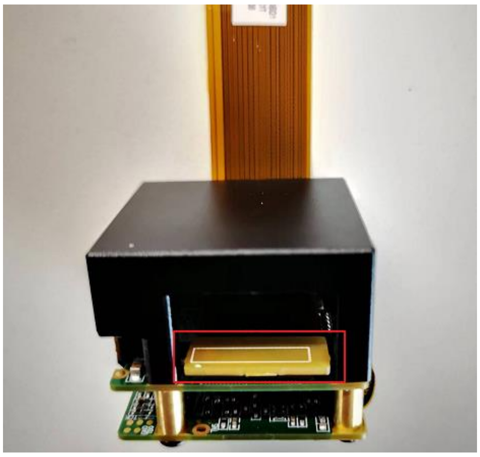


Figure 3-19 FPC cable connect to the acquisition board

Step3: Connect the FPC cable to the camera according to the following picture's red box part: the FPC cable's connecting finger facing up, insert it into the white FPC card holder and rotate the black locking mechanism 90 degrees downward to lock the FPC cable.

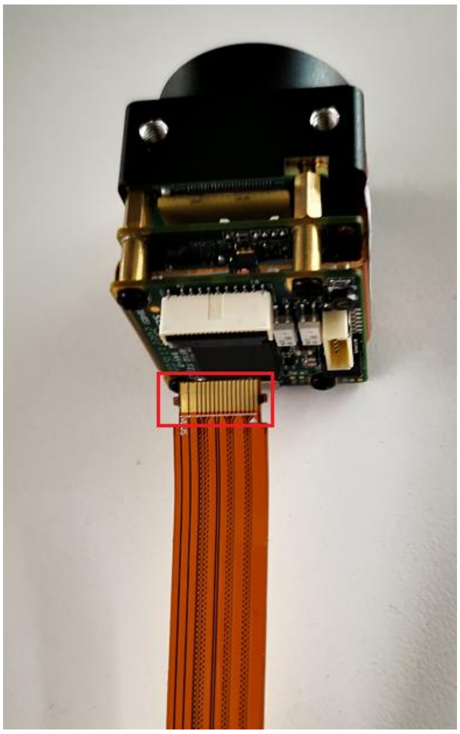


Figure 3-20 FPC cable connect to the FPC holder

Step4: PFC cable connecting to the Micro-B adapter board according to the following picture's red box part: the FPC cable's connecting finger facing up, insert it into the white FPC card holder and rotate the black locking mechanism 90 degrees downward to lock the FPC cable.

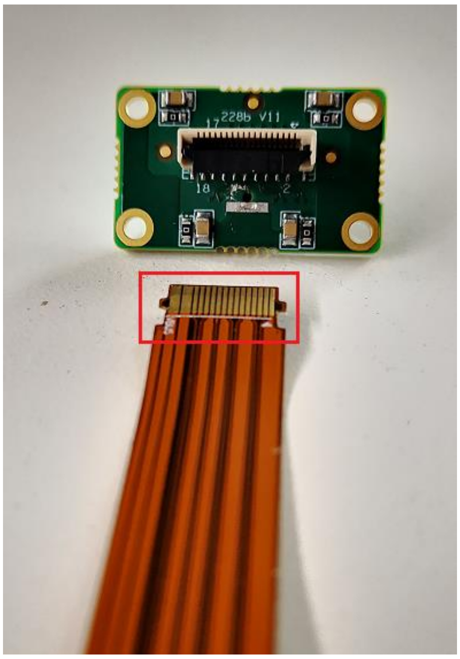


Figure 3-21 FPC cable connect to the Micro-B adapter board

4. General Specification

4.1. Explanation of Important Parameters

4.1.1. About Spectral Response

QE: Quantum efficiency, which is the ratio of the average number of photoelectrons produced per unit time to the number of incident photons at a given wavelength.

Sensitivity: The change of the sensor output signal relative to the incident light energy. The commonly used sensitivity units are V/((W/m2)·s), V/lux·s, e-/((W/m2)·s) or DN/ ((W/m2)·s).

The spectral response graphs given by different manufacturers are different. Some graphs' ordinate is relative sensitivity response, and abscissa is wavelength. Some graphs' ordinate is QE, and abscissa is wavelength.

4.2. VEN-161-61U3M/C-(M01/M05/M06)

4.2.1. Parameter

Specifications	VEN-161-61U3C-M06	VEN-161-61U3C-M01	VEN-161-61U3C-M05
Camera Type	All-in-one USB3.0 camera		
Resolution	1440 × 1080		
Sensor Type	Sony IMX296 global shutter CMOS		
Max. Image Circle	1/2.9 inch		
Pixel Size	3.45μm × 3.45μm		
Frame Rate	61.2fps@1440 × 1080		
ADC Bit Depth	10bit		
Pixel Bit Depth	8bit, 10bit		
Shutter Time	20μs~1s		
Gain	0dB~24dB		
Pixel Formats	Bayer RG8/Bayer RG10		
Signal Noise Ratio	40.6dB		
Synchronization	Hardware trigger, software trigger		
I/O	1 input with opto-isolated, 1 programmable GPIO		
Operating Temp	0°C~45°C		
Storage Temp	-20°C~70°C		
Operating Humidity	10%~80%		

Power Consumption	< 2.7W@5V		
Lens Mount	-	CS	S
Dimensions	32.5mm×32.5mm×8.1mm (PCB thickness is 1.6mm)	35mm×35mm×15.8mm (without CS-mount lens adapter or connectors)	35mm×35mm×15.1mm (without S-mount lens adapter or connectors)
Weight	7g	31g	32g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8		
Data Interface	USB3.0 (Micro-B)		
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity		
Conformity	CE, RoHS, USB3 Vision, GenICam		

Table 4-1 VEN-161-61U3C-(M01/M05/M06) camera specifications

Specifications	VEN-161-61U3M-M06	VEN-161-61U3M-M01	VEN-161-61U3M-M05
Camera Type	All-in-one USB3.0 camera		
Resolution	1440 × 1080		
Sensor Type	Sony IMX296 global shutter CMOS		
Max. Image Circle	1/2.9 inch		
Pixel Size	3.45μm × 3.45μm		
Frame Rate	61.2fps@1440 × 1080		
ADC Bit Depth	10bit		
Pixel Bit Depth	8bit, 10bit		
Shutter Time	20μs~1s		
Gain	0dB~24dB		
Pixel Formats	Mono8/Mono10		
Signal Noise Ratio	40.6dB		
Synchronization	Hardware trigger, software trigger		
I/O	1 input with opto-isolated, 1 programmable GPIO		
Operating Temp	0°C~45°C		
Storage Temp	-20°C~70°C		
Operating Humidity	10%~80%		
Power Consumption	< 2.7W@5V		

Lens Mount	-	CS	S
Dimensions	32.5mm×32.5mm×8.1mm (PCB thickness is 1.6mm)	35mm×35mm×15.8mm (without CS-mount lens adapter or connectors)	35mm×35mm×15.1mm (without S-mount lens adapter or connectors)
Weight	7g	31g	32g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8		
Data Interface	USB3.0 (Micro-B)		
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity		
Conformity	CE, RoHS, USB3 Vision, GenICam		

Table 4-2 VEN-161-61U3M-(M01/M05/M06) camera specifications

4.2.2. Spectral Response

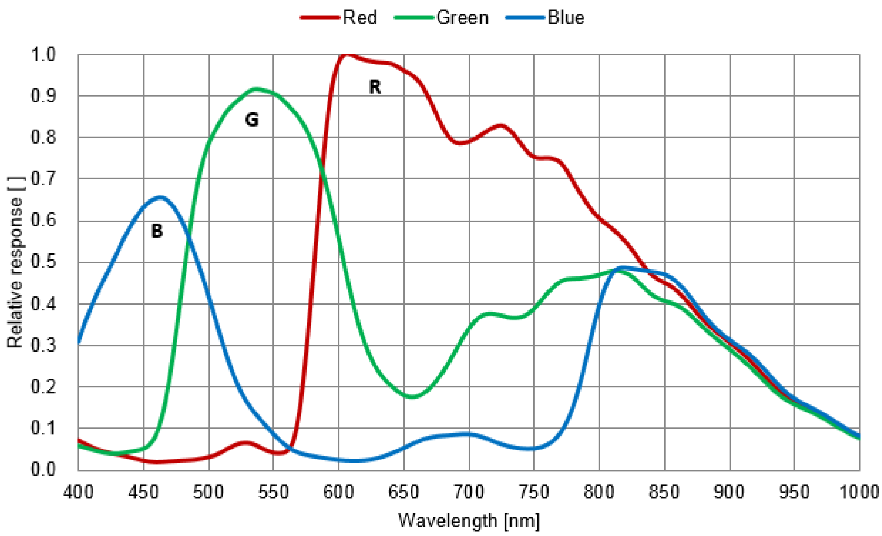


Figure 4-1 VEN-161-61U3C-(M01/M05/M06) sensor spectral response

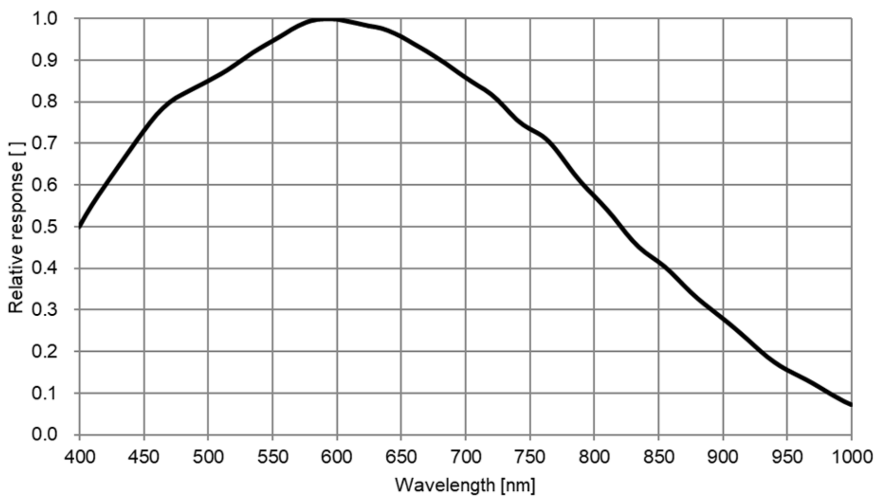


Figure 4-2 VEN-161-61U3M-(M01/M05/M06) sensor spectral response

4.3. VEN-505-36U3M/C-(M01/M05/M06)

4.3.1. Parameter

Specifications	VEN-505-36U3C-M06	VEN-505-36U3C-M01	VEN-505-36U3C-M05
Camera Type	All-in-one USB3.0 camera		
Resolution	2592 × 1944		
Sensor Type	Sony IMX335 rolling shutter CMOS		
Max. Image Circle	1/2.8 inch		
Pixel Size	2.0μm × 2.0μm		
Frame Rate	36.9fps@2592 × 1944		
ADC Bit Depth	10bit		
Pixel Bit Depth	8bit, 10bit		
Shutter Time	20μs~1s		
Gain	0dB~24dB		
Pixel Formats	Bayer GB8/Bayer GB10		
Signal Noise Ratio	39.29dB		
Synchronization	Hardware trigger, software trigger		
I/O	1 input with opto-isolated, 1 programmable GPIO		
Operating Temp	0°C~45°C		
Storage Temp	-20°C~70°C		
Operating Humidity	10%~80%		
Power Consumption	< 2.7W@5V		
Lens Mount	-	CS	S
Dimensions	32.5mm×32.5mm×8.1mm (PCB thickness is 1.6mm)	35mm×35mm×15.2mm (without CS-mount lens adapter or connectors)	35mm×35mm×15.1mm (without S-mount lens adapter or connectors)
Weight	7g	31g	32g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8		
Data Interface	USB3.0 (Micro-B)		
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity		

Conformity	CE, RoHS, USB3 Vision, GenICam

Table 4-3 VEN-505-36U3C-(M01/M05/M06) camera specifications

Specifications	VEN-505-36U3M-M06	VEN-505-36U3M-M01	VEN-505-36U3M-M05
Camera Type	All-in-one USB3.0 camera		
Resolution	2592 × 1944		
Sensor Type	Sony IMX335 rolling shutter CMOS		
Max. Image Circle	1/2.8 inch		
Pixel Size	2.0μm × 2.0μm		
Frame Rate	36.9fps@2592 × 1944		
ADC Bit Depth	10bit		
Pixel Size	8bit, 10bit		
Shutter Time	20μs~1s		
Gain	0dB~24dB		
Pixel Formats	Mono8/Mono10		
Signal Noise Ratio	39.43dB		
Synchronization	Hardware trigger, software trigger		
I/O	1 input with opto-isolated, 1 programmable GPIO		
Operating Temp	0°C~45°C		
Storage Temp	-20°C~70°C		
Operating Humidity	10%~80%		
Power Consumption	< 2.7W@5V		
Lens Mount	-	CS	S
Dimensions	32.5mm×32.5mm×8.1mm (PCB thickness is 1.6mm)	35mm×35mm×15.2mm (without CS-mount lens adapter or connectors)	35mm×35 mm×15.1mm (without S-mount lens adapter or connectors)
Weight	7g	31g	32g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8		

Data Interface	USB3.0 (Micro-B)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, USB3 Vision, GenICam

Table 4-4 VEN-505-36U3M-(M01/M05/M06) camera specifications

4.3.2. Spectral Response

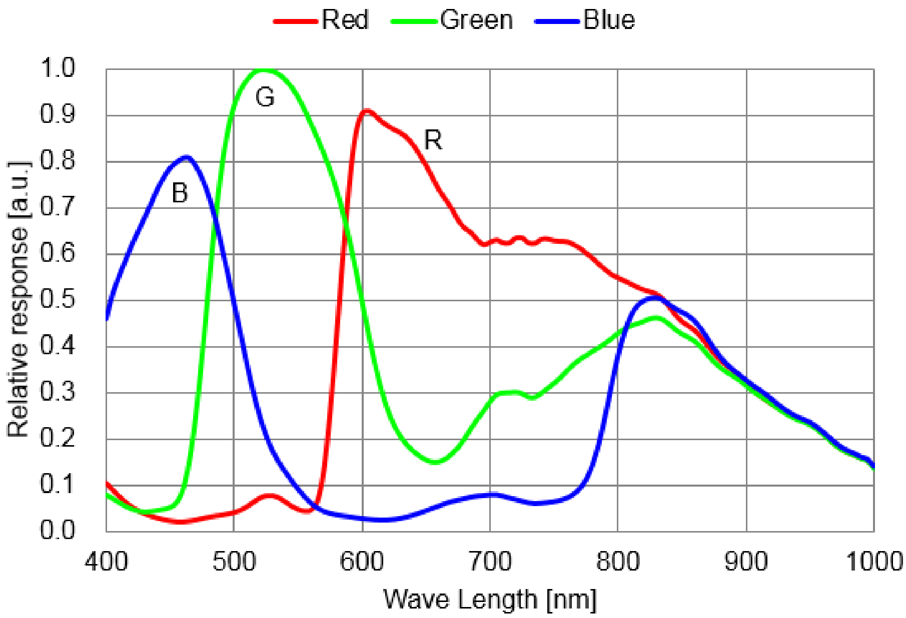


Figure 4-3 VEN-505-36U3C-(M01/M05/M06) sensor spectral response

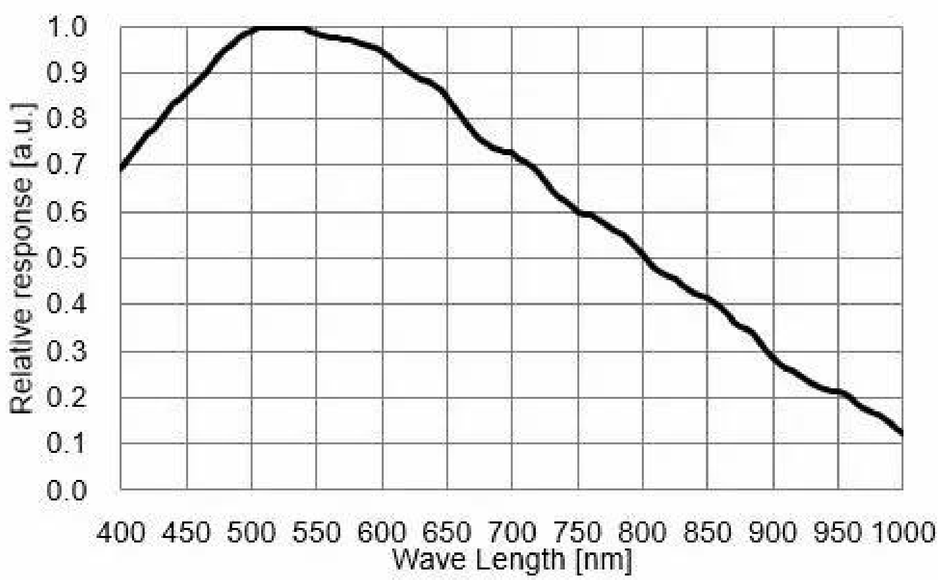


Figure 4-4 VEN-505-36U3M-(M01/M05/M06) sensor spectral response

4.4. VEN-830-22U3M/C-(M01/M05/M06)

4.4.1. Parameter

Specifications	VEN-830-22U3C-M06	VEN-830-22U3C-M01	VEN-830-22U3C-M05
Camera Type	All-in-one USB3.0 camera		
Resolution	3840 × 2160		
Sensor Type	Sony IMX334 rolling shutter CMOS		
Max. Image Circle	1/1.8 inch		
Pixel Size	2.0μm × 2.0μm		
Frame Rate	22fps@3840 × 2160		
ADC Bit Depth	12bit		
Pixel Bit Depth	8bit, 10bit		
Shutter Time	20μs~1s		
Gain	0dB~24dB		
Pixel Formats	Bayer RG8/Bayer RG10		
Signal Noise Ratio	39.41dB		
Synchronization	Hardware trigger, software trigger		
I/O	1 input with opto-isolated, 1 programmable GPIO		
Operating Temp	0°C~45°C		
Storage Temp	-20°C~70°C		
Operating Humidity	10%~80%		
Power Consumption	< 2.7W@5V		
Lens Mount	-	CS	S
Dimensions	32.5mm×32.5mm×8.1mm (PCB thickness is 1.6mm)	35mm×35mm×15.7mm (without CS-mount lens adapter or connectors)	35mm×35mm×15.1mm (without S-mount lens adapter or connectors)
Weight	7g	31g	32g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8		
Data Interface	USB3.0 (Micro-B)		
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity		
Conformity	CE, RoHS, USB3 Vision, GenICam		

Table 4-5 VEN-830-22U3C-(M01/M05/M06) camera specifications

Specifications	VEN-830-22U3M-M06	VEN-830-22U3M-M01	VEN-830-22U3M -M05
Camera Type	All-in-one USB3.0 camera		
Resolution	3840 × 2160		
Sensor Type	Sony IMX334 rolling shutter CMOS		
Max. Image Circle	1/1.8 inch		
Pixel Size	2.0μm × 2.0μm		
Frame Rate	22fps@3840 × 2160		
ADC Bit Depth	10bit		
Pixel Bit Depth	8bit, 10bit		
Shutter Time	20μs~1s		
Gain	0dB~24dB		
Pixel Formats	Mono8/Mono10		
Signal Noise Ratio	39.36dB		
Synchronization	Hardware trigger, software trigger		
I/O	1 input with opto-isolated, 1 programmable GPIO		
Operating Temp	0°C~45°C		
Storage Temp	-20°C~70°C		
Operating Humidity	10%~80%		
Power Consumption	< 2.7W@5V		
Lens Mount	-	CS	S
Dimensions	32.5mm×32.5mm×8.1mm (PCB thickness is 1.6mm)	35mm×35mm×15.7mm (without CS-mount lens adapter or connectors)	35mm×35mm×15.1mm (without S-mount lens adapter or connectors)
Weight	7g	31g	32g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8		
Data Interface	USB3.0 (Micro-B)		
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity		
Conformity	CE, RoHS, USB3 Vision, GenICam		

Table 4-6 VEN-830-22U3M-(M01/M05/M06) camera specifications

4.4.2. Spectral Response

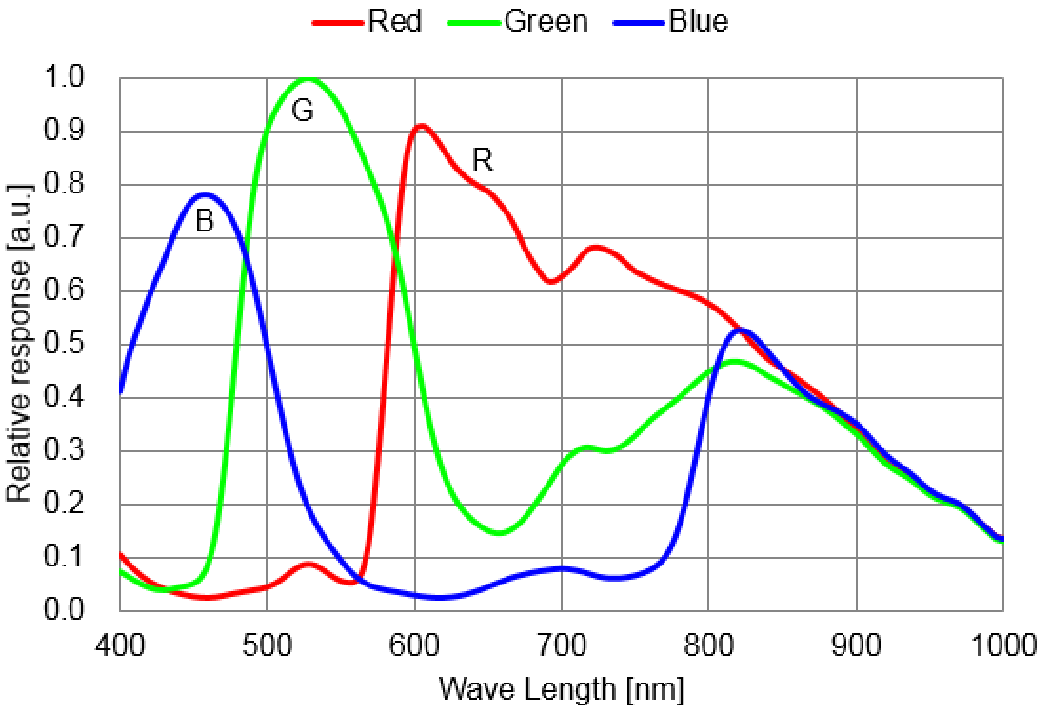


Figure 4-5 VEN-830-22U3C-(M01/M05/M06) sensor spectral response

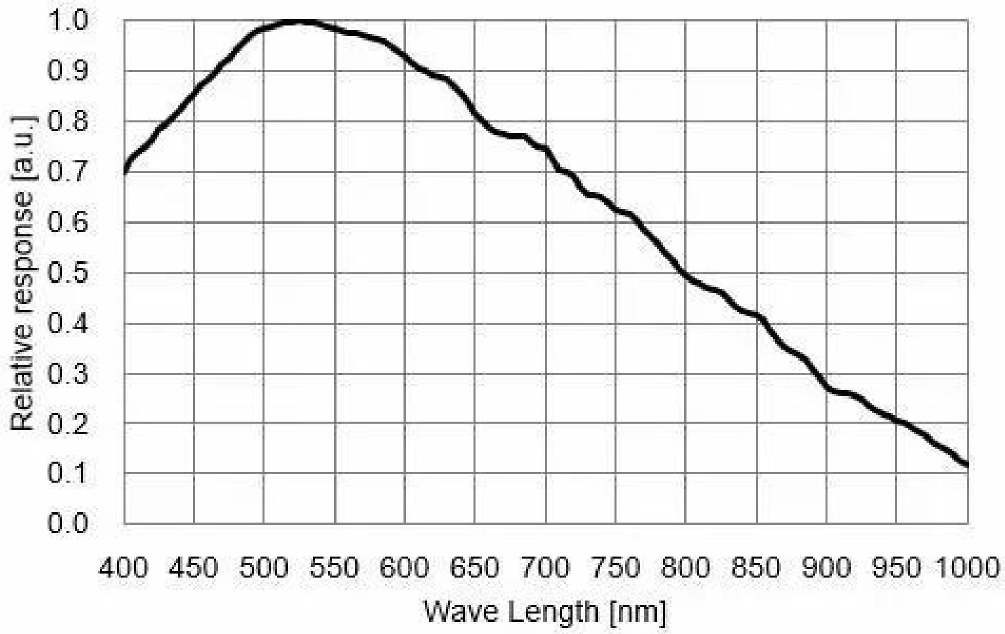


Figure 4-6 VEN-830-22U3M-(M01/M05/M06) sensor spectral response

4.5. VEN-302-56U3M/C-S

4.5.1. Parameter

Specifications	VEN-302-56U3C-S
Camera Type	Split USB3.0 camera
Resolution	2048 × 1536
Sensor Type	Sony IMX265 global shutter CMOS
Max. Image Circle	1/1.8 inch
Pixel Size	3.45μm × 3.45μm
Frame Rate	56fps@2048 × 1536
ADC Bit Depth	12bit
Pixel Bit Depth	8bit, 10bit
Shutter Time	20μs~1s
Gain	0dB~24dB
Pixel Formats	Bayer RG8/Bayer RG10
Signal Noise Ratio	40.09dB
Synchronization	Hardware trigger, software trigger
I/O	2 GPIOs
Operating Temp	0°C~45°C
Storage Temp	-20°C~70°C
Operating Humidity	10%~80%
Power Consumption	< 2.7W@5V
Lens Mount	C, NO-Mount
Dimensions	29mm×29mm×20.2mm (C-Mount) 40mm×54mm (acquisition board dimensions) 27mm×26.2mm (imaging board dimensions)
Weight	32g (C-mount) 18g (NO-Mount)
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8
Data Interface	USB3.0 (Micro-B)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	RoHS, USB3 Vision, GenICam

Table 4-7 VEN-302-56U3C-S camera specifications

Specifications	VEN-302-56U3M-S
Camera Type	Split USB3.0 camera
Resolution	2048 × 1536
Sensor Type	Sony IMX265 global shutter CMOS
Max. Image Circle	1/1.8 inch
Pixel Size	3.45μm × 3.45μm
Frame Rate	56fps@2048 × 1536
ADC Bit Depth	12bit
Pixel Bit Depth	8bit, 10bit
Shutter Time	20μs~1s
Gain	0dB~24dB
Pixel Formats	Mono8/Mono10
Signal Noise Ratio	40.76dB
Synchronization	Hardware trigger, software trigger
I/O	2 GPIOs
Operating Temp	0°C~45°C
Storage Temp	-20°C~70°C
Operating Humidity	10%~80%
Power Consumption	< 2.7W@5V
Lens Mount	C, NO-Mount
Dimensions	29mm×29mm×20.2mm (C-Mount) 40mm×54mm (acquisition board dimensions) 27mm×26.2mm (imaging board dimensions)
Weight	32g (C-mount) 18g (NO-Mount)
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8
Data Interface	USB3.0 (Micro-B)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	RoHS, USB3 Vision, GenICam

Table 4-8 VEN-302-56U3M-S camera specifications

4.5.2. Spectral Response

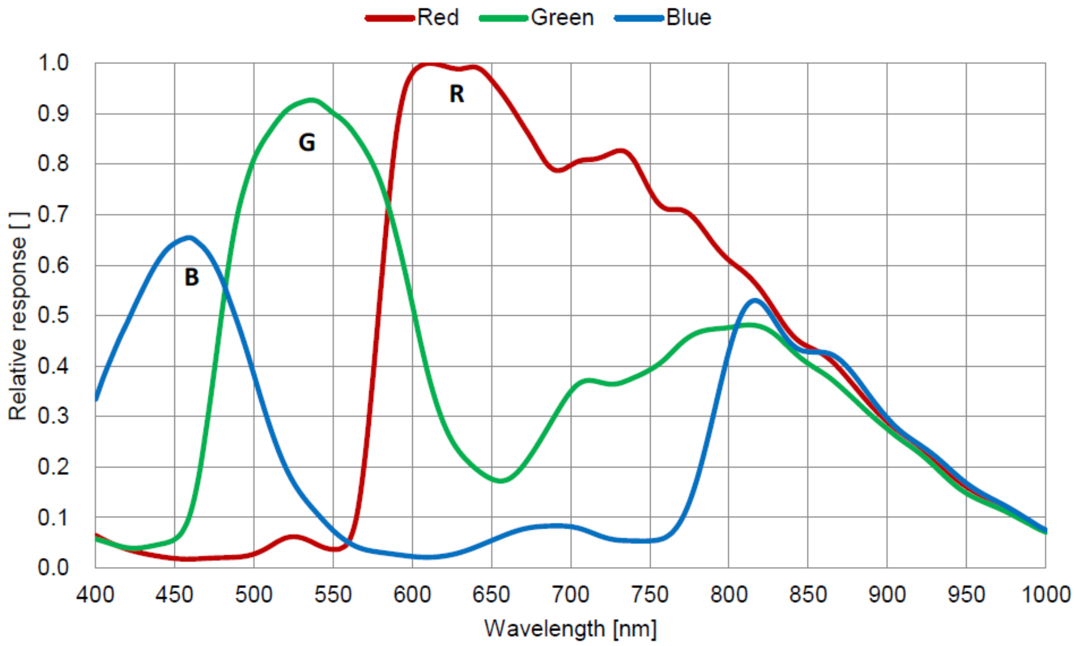


Figure 4-7 VEN-302-56U3C-S sensor spectral response

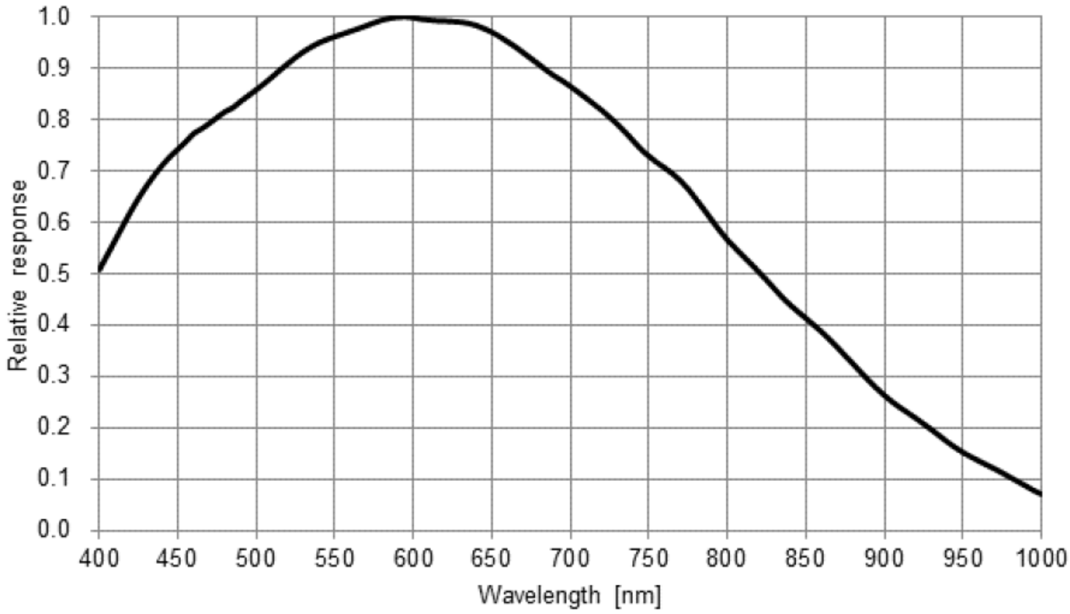


Figure 4-8 VEN-302-56U3M-S sensor spectral response

4.6. VEN-134-90U3M/C-D

4.6.1. Parameter

Specifications	VEN-134-90U3C-D
Camera Type	Split USB3.0 binocular camera
Resolution	1280 × 1024 × 2
Sensor Type	Onsemi PYTHON 1300 global shutter CMOS
Max. Image Circle	1/2 inch
Pixel Size	4.8μm × 4.8μm
Frame Rate	90fps@1280 × 1024 × 2
ADC Bit Depth	10bit
Pixel Bit Depth	8bit, 10bit
Shutter Time	5μs~1s
Gain	0dB~16dB
Pixel Formats	Bayer RG8/Bayer RG10
Signal Noise Ratio	41dB
Synchronization	Hardware trigger, software trigger
I/O	2 GPIOs
Operating Temp	0°C~45°C
Storage Temp	-20°C~70°C
Operating Humidity	10%~80%
Power Consumption	< 3.5W@5V
Lens Mount	C, CS, S, NO-Mount
Dimensions	C-Mount: 29mm×29mm×20.2mm, CS-Mount : 29mm×29mm×15.2mm, S-Mount: 29mm×29mm×16.1mm, NO-Mount : 29mm×29mm×2.28mm, acquisition board: 40mm×54mm, imaging board : 25.4mm×25.4mm
Weight	C-Mount: 39g, CS-Mount : 49g, S-Mount: 50g, NO-Mount : 25g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8
Data Interface	USB3.0 (Micro-B)
Programmable Control	Image size, gain (auto gain not support), exposure time (auto exposure not support), trigger polarity, flash polarity
Conformity	CE, RoHS, USB3 Vision, GenICam

Table 4-9 VEN-134-90U3C-D camera specifications

Specifications	VEN-134-90U3M-D
Camera Type	Split USB3.0 binocular camera
Resolution	1280 × 1024 × 2
Sensor Type	Onsemi PYTHON 1300 global shutter CMOS
Max. Image Circle	1/2 inch
Pixel Size	4.8μm × 4.8μm
Frame Rate	90fps@1280 × 1024 × 2
ADC Bit Depth	10bit
Pixel Bit Depth	8bit, 10bit
Shutter Time	5μs~1s
Gain	0dB~16dB
Pixel Formats	Mono8/Mono10
Signal Noise Ratio	41dB
Synchronization	Hardware trigger, software trigger
I/O	2 GPIOs
Operating Temp	0°C~45°C
Storage Temp	-20°C~70°C
Operating Humidity	10%~80%
Power Consumption	< 3.5W@5V
Lens Mount	C, CS, S, NO-Mount
Dimensions	C-Mount: 29mm×29mm×20.2mm, CS-Mount : 29mm×29mm×15.2mm, S-Mount: 29mm×29mm×16.1mm, NO-Mount : 29mm×29mm×2.28mm, acquisition board: 40mm×54mm, imaging board : 25.4mm×25.4mm
Weight	C-Mount: 39g, CS-Mount : 49g, S-Mount: 50g, NO-Mount : 25g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8
Data Interface	USB3.0 (Micro-B)
Programmable Control	Image size, gain (auto gain not support), exposure time (auto exposure not support), trigger polarity, flash polarity
Conformity	CE, RoHS, USB3 Vision, GenICam

Table 4-10 VEN-134-90U3M-D camera specifications

4.6.2. Spectral Response

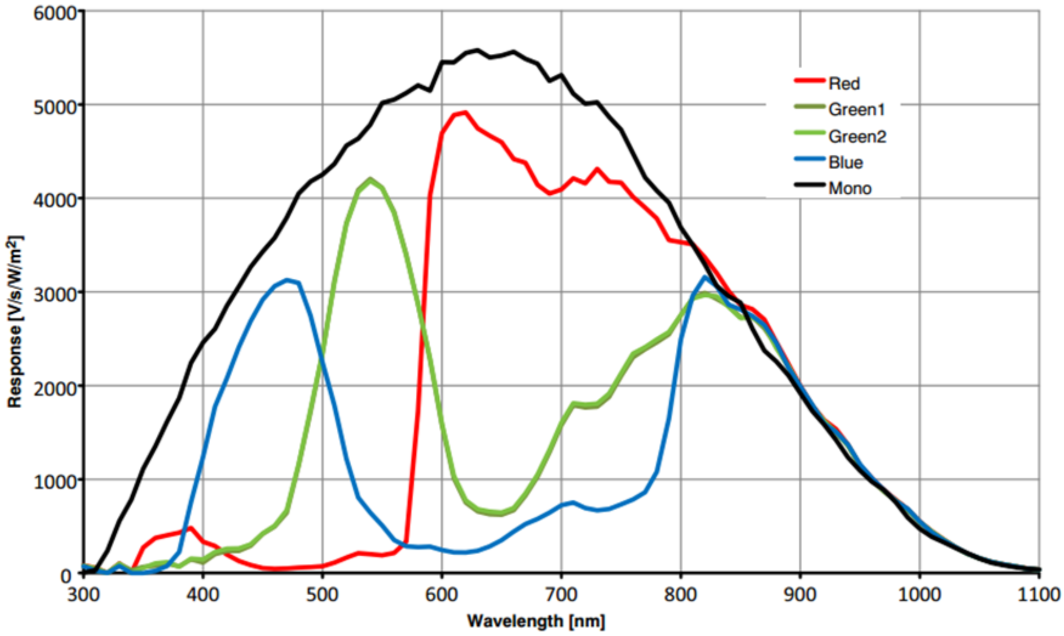


Figure 4-9 VEN-134-90U3M/C-D sensor spectral response

4.7. VEN-134-90U3M-D NIR

4.7.1. Parameter

Specifications	VEN-134-90U3M-D NIR
Camera Type	Split USB3.0 binocular camera
Resolution	1280 × 1024 × 2
Sensor Type	Onsemi PYTHON 1300 global shutter CMOS
Max. Image Circle	1/2 inch
Pixel Size	4.8μm × 4.8μm
Frame Rate	90fps@1024 × 1024 × 2
ADC Bit Depth	10bit
Pixel Bit Depth	8bit, 10bit
Shutter Time	5μs~1s
Gain	0dB~16dB
Pixel Formats	Mono8/Mono10
Signal Noise Ratio	41dB
Synchronization	Hardware trigger, software trigger

I/O	2 GPIOs
Operating Temp	0°C~45°C
Storage Temp	-20°C~70°C
Operating Humidity	10%~80%
Power Consumption	< 3.5W@5V
Lens Mount	C, CS, S, NO-Mount
Dimensions	C-Mount: 29mm×29mm×20.2mm, CS-Mount : 29mm×29mm×15.2mm, S-Mount: 29mm×29mm×16.1mm, NO-Mount : 29mm×29mm×2.28mm, acquisition board: 40mm×54mm, imaging board : 25.4mm×25.4mm
Weight	C-Mount: 39g, CS-Mount : 49g, S-Mount: 50g, NO-Mount : 25g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8
Data Interface	USB3.0 (Micro-B)
Programmable Control	Image size, gain (auto gain not support), exposure time (auto exposure not support), trigger polarity, flash polarity
Conformity	CE, RoHS, USB3 Vision, GenICam

Table 4-11 VEN-134-90U3M-D NIR camera specifications

4.7.2. Spectral Response

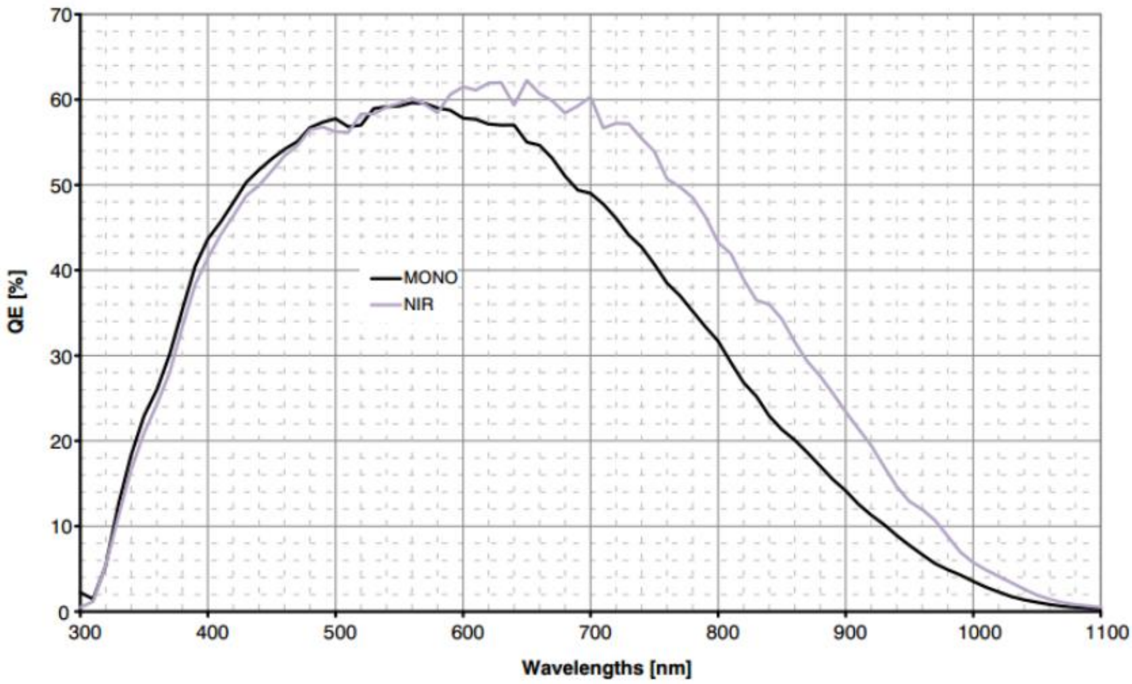


Figure 4-10 VEN-134-90U3M-D NIR sensor spectral response

4.8. VEN-160-227U3M/C-FPC-(M00/M05)

4.8.1. Parameter

Specifications	VEN-160-227U3C-FPC-M00	VEN-160-227U3C-FPC-M05
Camera Type	All-in-one horizontal FPC camera	
Resolution	1440 × 1080	
Sensor Type	Sony IMX273 global shutter CMOS	
Max. Image Circle	1/2.9 inch	
Pixel Size	3.45μm × 3.45μm	
Frame Rate	227fps@1440 × 1080	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB~24dB	
Pixel Formats	Bayer RG8/Bayer RG10	
Signal Noise Ratio	41dB	
Synchronization	Hardware trigger, software trigger	
I/O	1 Bidirectional GPIO	
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	< 2.7W@5V	
Lens Mount	C Mount	S Mount
Dimensions	29mm×29mm×25.1(±1)mm (without C Mount)	29mm×29mm×24.5(±1)mm (without S Mount)
Weight	36g	38g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8	
Data Interface	USB3.0 (horizontal FPC)	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity	
Conformity	CE, RoHS, USB3 Vision, GenICam	

Table 4-12 VEN-160-227U3C-FPC-(M00/M05) camera specifications

Specifications	VEN-160-227U3M-FPC-M00	VEN-160-227U3M-FPC-M05
Camera Type	All-in-one horizontal FPC camera	
Resolution	1440 × 1080	
Sensor Type	Sony IMX273 global shutter CMOS	
Max. Image Circle	1/2.9 inch	
Pixel Size	3.45μm × 3.45μm	
Frame Rate	227fps@1440 × 1080	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB~24dB	
Pixel Formats	Mono8/Mono10	
Signal Noise Ratio	41dB	
Synchronization	Hardware trigger, software trigger	
I/O	1 Bidirectional GPIO	
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	< 2.7W@5V	
Lens Mount	C Mount	S Mount
Dimensions	29mm × 29mm × 25.1(±1)mm (without C Mount)	29mm × 29mm × 24.5(±1)mm (without S Mount)
Weight	36g	38g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8	
Data Interface	USB3.0 (horizontal FPC)	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity	
Conformity	CE, RoHS, USB3 Vision, GenICam	

Table 4-13 VEN-160-227U3M-FPC-(M00/M05) camera specifications

4.8.2. Spectral Response

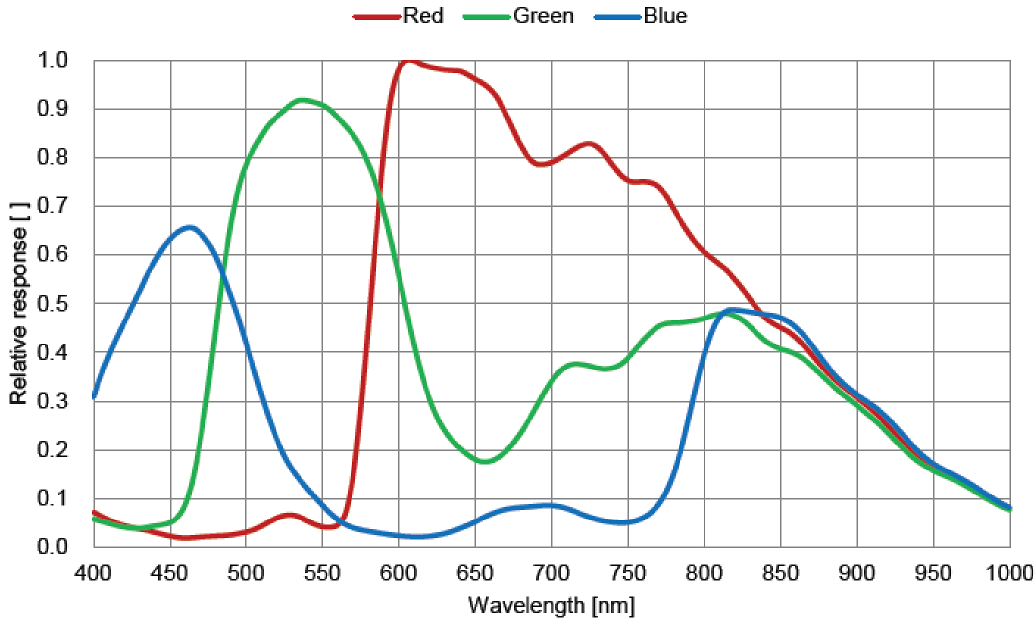


Figure 4-11 VEN-160-227U3C-FPC-(M00/M05) sensor spectral response

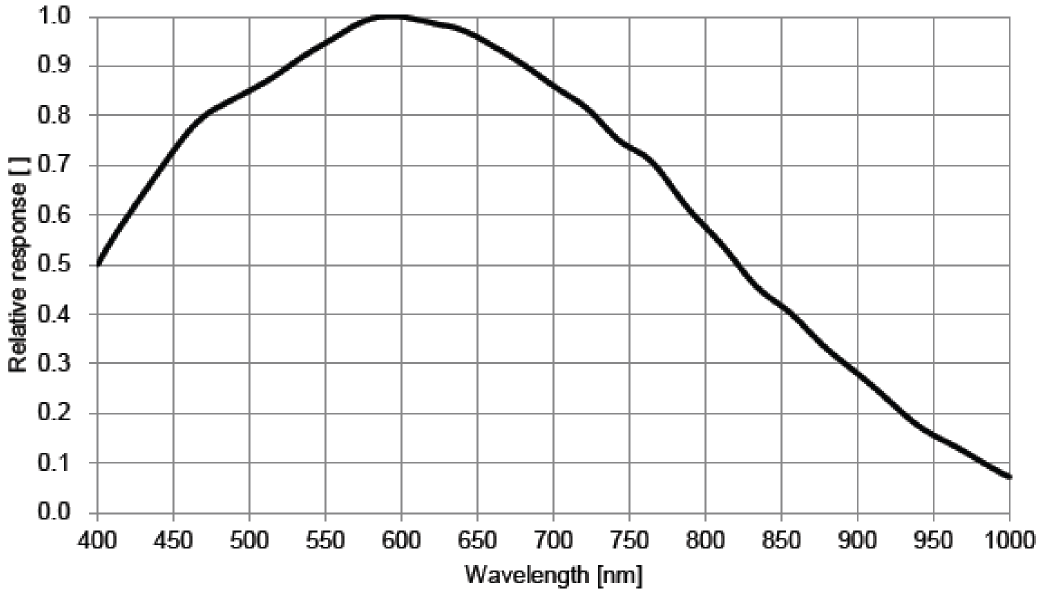


Figure 4-12 VEN-160-227U3M-FPC-(M00/M05) sensor spectral response

4.9. VEN-230-168U3M/C-FPC

4.9.1. Parameter

Specifications	VEN-230-168U3C-FPC
Camera Type	All-in-one horizontal FPC camera
Resolution	1920 × 1200
Sensor Type	Sony IMX174 global shutter CMOS
Max. Image Circle	1/1.2 inch
Pixel Size	5.86μm × 5.86μm
Frame Rate	168fps@1920 × 1200
ADC Bit Depth	10bit
Pixel Bit Depth	8bit, 10bit
Shutter Time	20μs~1s
Gain	0dB~24dB
Pixel Formats	Bayer RG8/Bayer RG10
Signal Noise Ratio	45.32dB
Synchronization	Hardware trigger, software trigger
I/O	1 Bidirectional GPIO
Operating Temp	0°C~45°C
Storage Temp	-20°C~70°C
Operating Humidity	10%~80%
Power Consumption	< 2.7W@5V
Lens Mount	C Mount
Dimensions	29mm × 29mm × 25.1(±1)mm (without C-Mount)
Weight	36g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8
Data Interface	USB3.0 (horizontal FPC)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, USB3 Vision, GenICam

Table 4-14 VEN-230-168U3C-FPC camera specifications

Specifications	VEN-230-168U3M-FPC
Camera Type	All-in-one horizontal FPC camera
Resolution	1920 × 1200
Sensor Type	Sony IMX174 global shutter CMOS
Max. Image Circle	1/1.2 inch
Pixel Size	5.86μm × 5.86μm
Frame Rate	168fps@1920 × 1200
ADC Bit Depth	10bit
Pixel Bit Depth	8bit, 10bit
Shutter Time	20μs~1s
Gain	0dB~24dB
Pixel Formats	Mono8/ Mono10
Signal Noise Ratio	45.32dB
Synchronization	Hardware trigger, software trigger
I/O	1 Bidirectional GPIO
Operating Temp	0°C~45°C
Storage Temp	-20°C~70°C
Operating Humidity	10%~80%
Power Consumption	< 2.7W@5V
Lens Mount	C Mount
Dimensions	29mm×29mm×25.1(±1)mm (without C-Mount)
Weight	36g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8
Data Interface	USB3.0 (horizontal FPC)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, USB3 Vision, GenICam

Table 4-15 VEN-230-168U3M-FPC camera specifications

4.9.2. Spectral Response

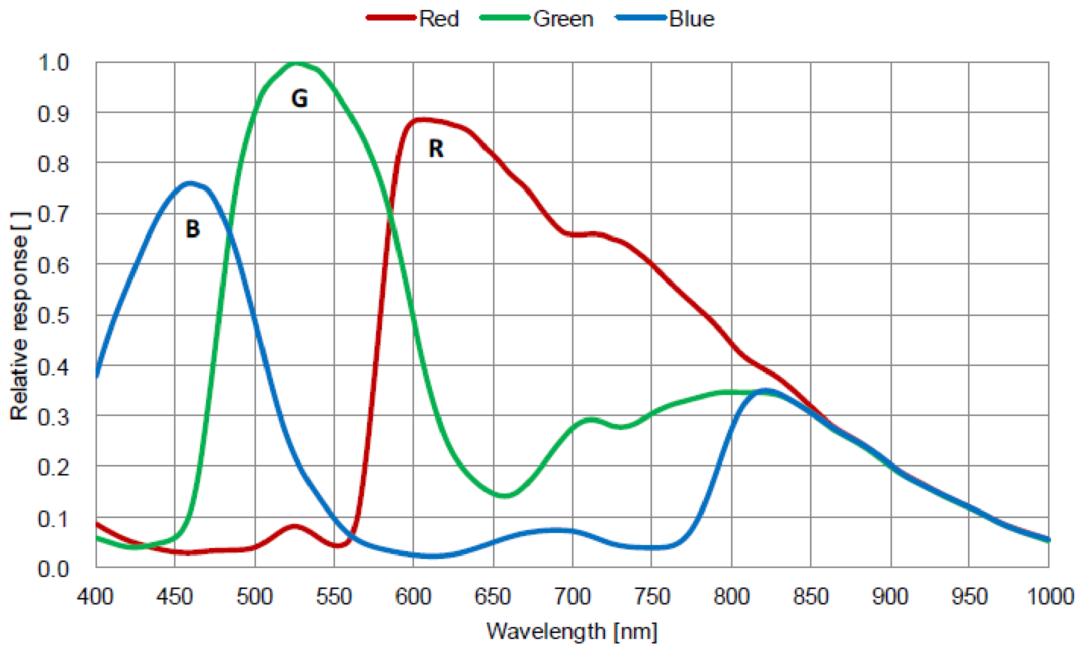


Figure 4-13 VEN-230-168U3C-FPC sensor spectral response

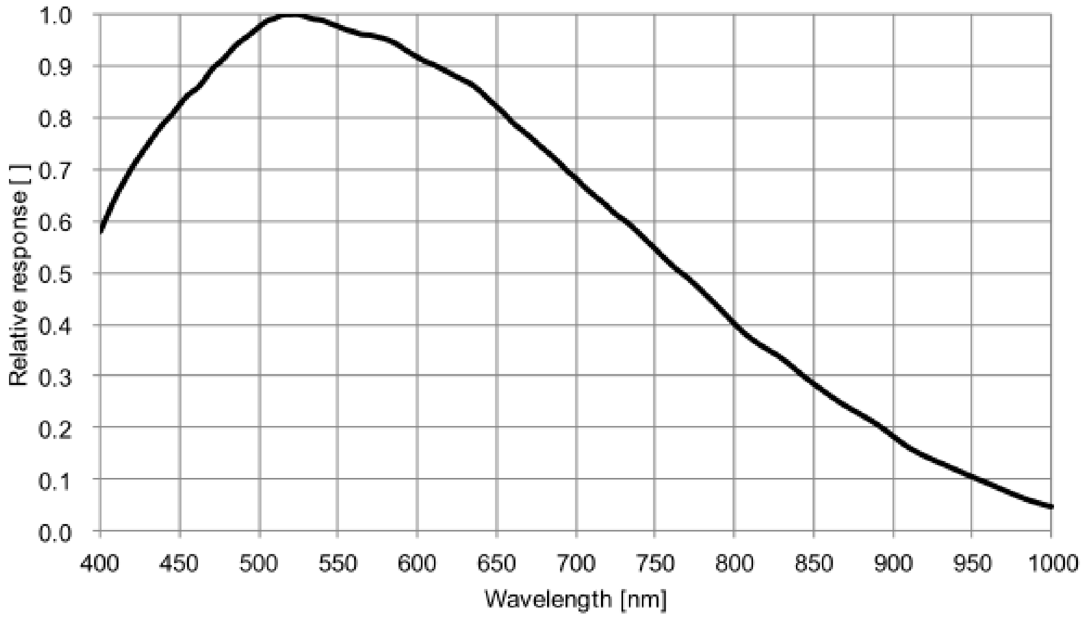


Figure 4-14 VEN-230-168U3M-FPC sensor spectral response

4.10. VEN-301-125U3M/C-FPC

4.10.1. Parameter

Specifications	VEN-301-125U3C-FPC
Camera Type	All-in-one horizontal FPC camera
Resolution	2048 × 1536
Sensor Type	Sony IMX252 global shutter CMOS
Max. Image Circle	1/1.8 inch
Pixel Size	3.45μm × 3.45μm
Frame Rate	125fps@2048 × 1536
ADC Bit Depth	10bit
Pixel Bit Depth	8bit, 10bit
Shutter Time	20μs~1s
Gain	0dB~24dB
Pixel Formats	Bayer RG8/Bayer RG10
Signal Noise Ratio	40.63dB
Synchronization	Hardware trigger, software trigger
I/O	1 Bidirectional GPIO
Operating Temp	0°C~45°C
Storage Temp	-20°C~70°C
Operating Humidity	10%~80%
Power Consumption	< 2.7W@5V
Lens Mount	C Mount
Dimensions	29mm×29mm×25.1(±1)mm (without C-Mount)
Weight	36g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8
Data Interface	USB3.0 (horizontal FPC)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, USB3 Vision, GenICam

Table 4-16 VEN-301-125U3C-FPC camera specifications

Specifications	VEN-301-125U3M-FPC
Camera Type	All-in-one horizontal FPC camera
Resolution	2048 × 1536
Sensor Type	Sony IMX252 global shutter CMOS
Max. Image Circle	1/1.8 inch
Pixel Size	3.45μm × 3.45μm
Frame Rate	125fps@2048 × 1536
ADC Bit Depth	10bit
Pixel Bit Depth	8bit, 10bit
Shutter Time	20μs~1s
Gain	0dB~24dB
Pixel Formats	Mono8/Mono10
Signal Noise Ratio	40.63dB
Synchronization	Hardware trigger, software trigger
I/O	1 Bidirectional GPIO
Operating Temp	0°C~45°C
Storage Temp	-20°C~70°C
Operating Humidity	10%~80%
Power Consumption	< 2.7W@5V
Lens Mount	C Mount
Dimensions	29mm×29mm×25.1(±1)mm (without C-Mount)
Weight	36g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8
Data Interface	USB3.0 (horizontal FPC)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, USB3 Vision, GenICam

Table 4-17 VEN-301-125U3M-FPC camera specifications

4.10.2. Spectral Response

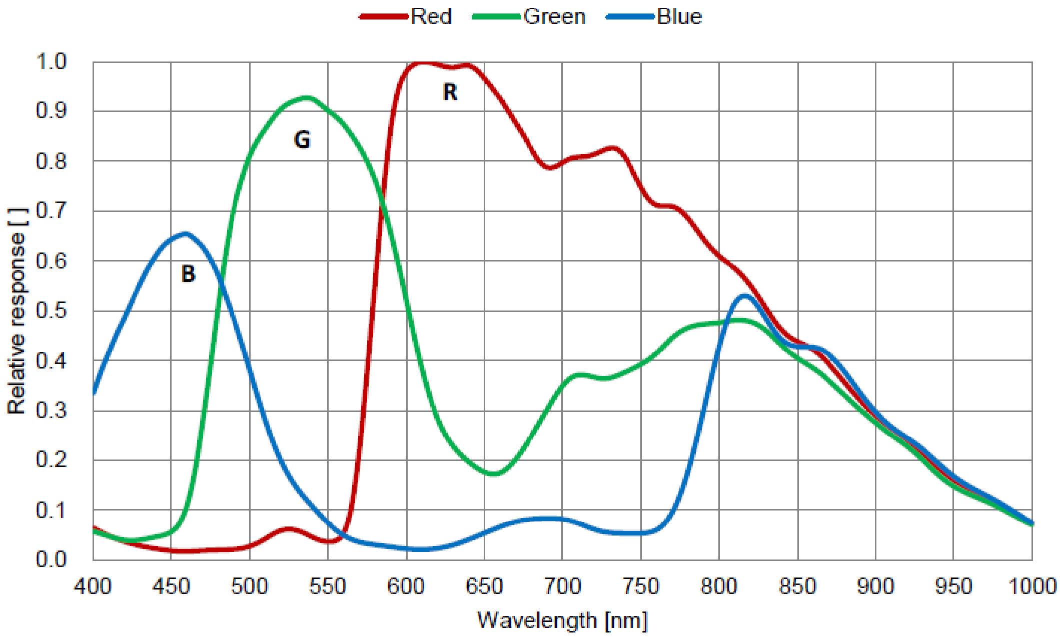


Figure 4-15 VEN-301-125U3C-FPC sensor spectral response

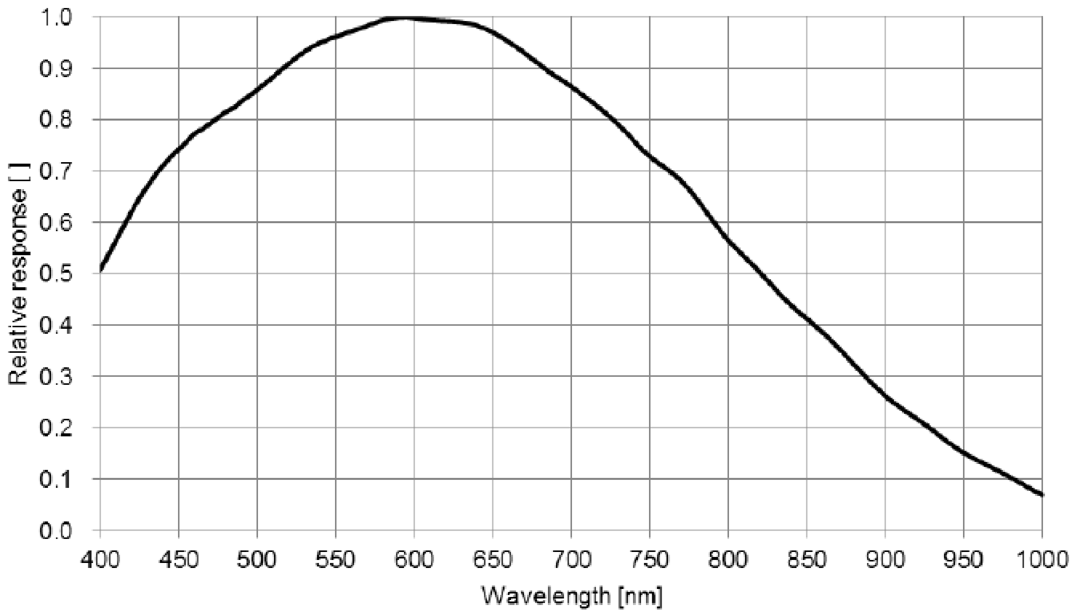


Figure 4-16 VEN-301-125U3M-FPC sensor spectral response

4.11. VEN-1220-32U3M/C-FPC-(M00/M05)

4.11.1. Parameter

Specifications	VEN-1220-32U3C-FPC-M00	VEN-1220-32U3C-FPC-M05
Camera Type	All-in-one horizontal FPC camera	
Resolution	4024 × 3036	
Sensor Type	Sony IMX226 rolling shutter CMOS	
Max. Image Circle	1/1.7 inch	
Pixel Size	1.85μm × 1.85μm	
Frame Rate	32.3fps@4024 × 3036	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	10μs~1s	
Gain	0dB~24dB	
Pixel Formats	Bayer RG8/Bayer RG12	
Signal Noise Ratio	40.61dB	
Synchronization	Hardware trigger, software trigger	
I/O	1 Bidirectional GPIO	
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	< 2.7W@5V	
Lens Mount	C Mount	S Mount
Dimensions	29mm×29mm×25.1(±1)mm (without C Mount)	29mm×29mm×24.5(±1)mm (without S Mount)
Weight	36g	38g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8	
Data Interface	USB3.0 (horizontal FPC)	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity	
Conformity	CE, RoHS, USB3 Vision, GenICam	

Table 4-18 VEN-1220-32U3C-FPC(M00/M05) camera specifications

Specifications	VEN-1220-32U3M-FPC-M00	VEN-1220-32U3M-FPC-M05
Camera Type	All-in-one horizontal FPC camera	
Resolution	4024 × 3036	
Sensor Type	Sony IMX226 rolling shutter CMOS	
Max. Image Circle	1/1.7 inch	
Pixel Size	1.85μm × 1.85μm	
Frame Rate	32.3fps@4024 × 3036	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	10μs~1s	
Gain	0dB~24dB	
Pixel Formats	Mono8/Mono12	
Signal Noise Ratio	40.77dB	
Synchronization	Hardware trigger, software trigger	
I/O	1 Bidirectional GPIO	
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	< 2.7W@5V	
Lens Mount	C Mount	S Mount
Dimensions	29mm×29mm×25.1(±1)mm (without C Mount)	29mm×29mm×24.5(±1)mm (without S Mount)
Weight	36g	38g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8	
Data Interface	USB3.0 (horizontal FPC)	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity	Image size, gain, exposure time
Conformity	CE, RoHS, USB3 Vision, GenICam	

Table 4-19 VEN-1220-32U3M-FPC(M00/M05) camera specifications

4.11.2. Spectral Response

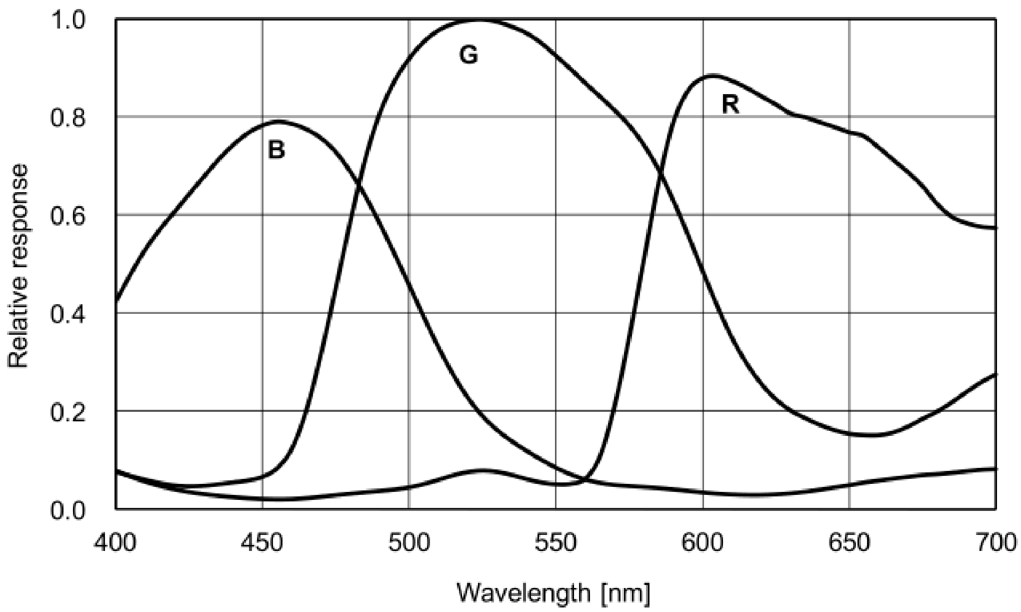


Figure 4-17VEN-1220-32U3C-FPC sensor spectral response

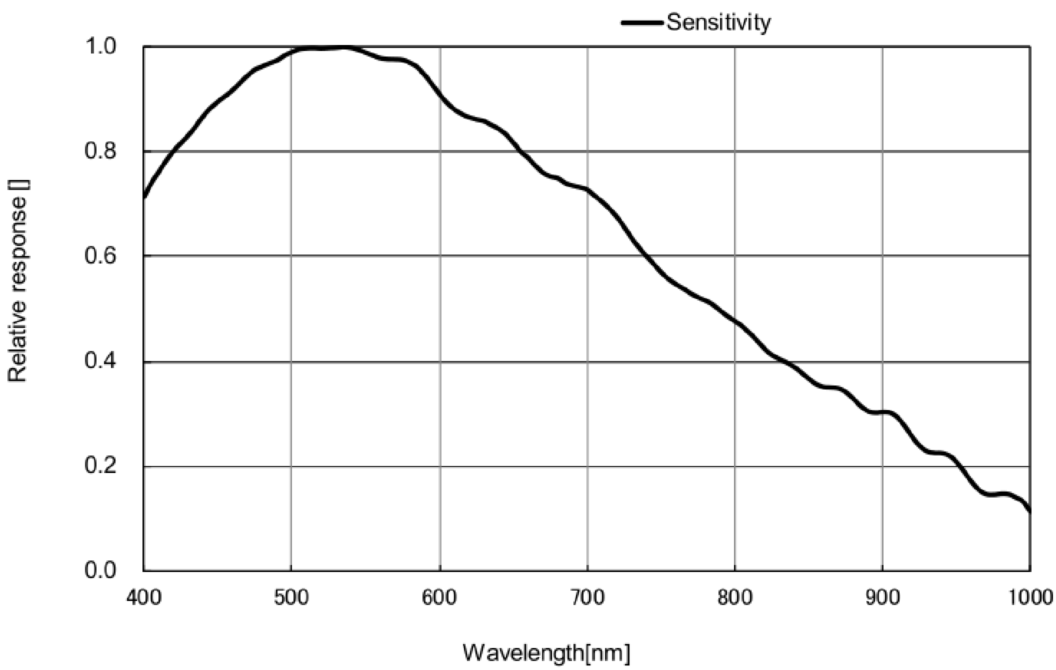


Figure 4-18 VEN-1220-32U3M-FPC sensor spectral response

4.12. VE2S-301-125U3M/C-S (J150)

4.12.1. Parameter

Specifications	VE2S-301-125U3C-S	VE2S-301-125U3C-S (J150)
Camera Type	All-in-one vertical FPC camera	Split vertical FPC camera
Resolution	2048 × 1536	
Sensor Type	Sony IMX252 global shutter CMOS	
Max. Image Circle	1/1.8 inch	
Pixel Size	3.45μm × 3.45μm	
Frame Rate	125fps@2048 × 1536	
ADC Bit Depth	8bit, 10bit, 12bit	
Pixel Bit Depth	8bit, 10bit, 12bit	
Shutter Time	20μs~1s	
Gain	0dB~24dB	
Pixel Formats	Bayer RG8/Bayer RG10/Bayer RG12	
Signal Noise Ratio	41.0dB	
Synchronization	Hardware trigger, software trigger	
I/O	1 optical isolation input, 1 optical isolation output 2 Bidirectional GPIO, 1 UART (multiplexing GPIO signal)	
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	< 2.8W@5V	
Lens Mount	C Mount	
Dimensions	31mm×29mm×39.3mm	C-Mount: 31mm×29mm×22.4mm Acquisition Board: 29mm×30mm×29.4mm
Weight	30g	30g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8	
Data Interface	USB3.0 (vertical FPC)	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity	Image size, gain, exposure time
Conformity	CE, RoHS, USB3 Vision, GenICam	

Table 4-20 VE2S-301-125U3C-S (J150) camera specifications

Specifications	VE2S-301-125U3M-S	VE2S-301-125U3M-S (J150)
Camera Type	All-in-one vertical FPC camera	Split vertical FPC camera
Resolution	2048 × 1536	
Sensor Type	Sony IMX252 global shutter CMOS	
Max. Image Circle	1/1.8 inch	
Pixel Size	3.45μm × 3.45μm	
Frame Rate	125fps@2048 × 1536	
ADC Bit Depth	8bit, 10bit, 12bit	
Pixel Bit Depth	8bit, 10bit, 12bit	
Shutter Time	20μs~1s	
Gain	0dB~24dB	
Pixel Formats	Mono8/Mono10/Mono12	
Signal Noise Ratio	40.8dB	
Synchronization	Hardware trigger, software trigger	
I/O	1 optical isolation input, 1 optical isolation output 2 Bidirectional GPIO, 1 UART serial port (Also GPIO)	
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	< 2.8W@5V	
Lens Mount	C Mount	
Dimensions	31mm×29mm×39.3mm	C-Mount: 31mm×29mm×22.4mm Acquisition Board: 29mm×30mm×29.4mm
Weight	30g	30g
Operating System	Windows 7/10/11 32bit/64bit, Linux, Android, ARMv7, ARMv8	
Data Interface	USB3.0 (vertical FPC)	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity	Image size, gain, exposure time
Conformity	CE, RoHS, USB3 Vision, GenICam	

Table 4-21 VE2S-301-125U3M-S (J150) camera specifications

4.12.2. Spectral Response

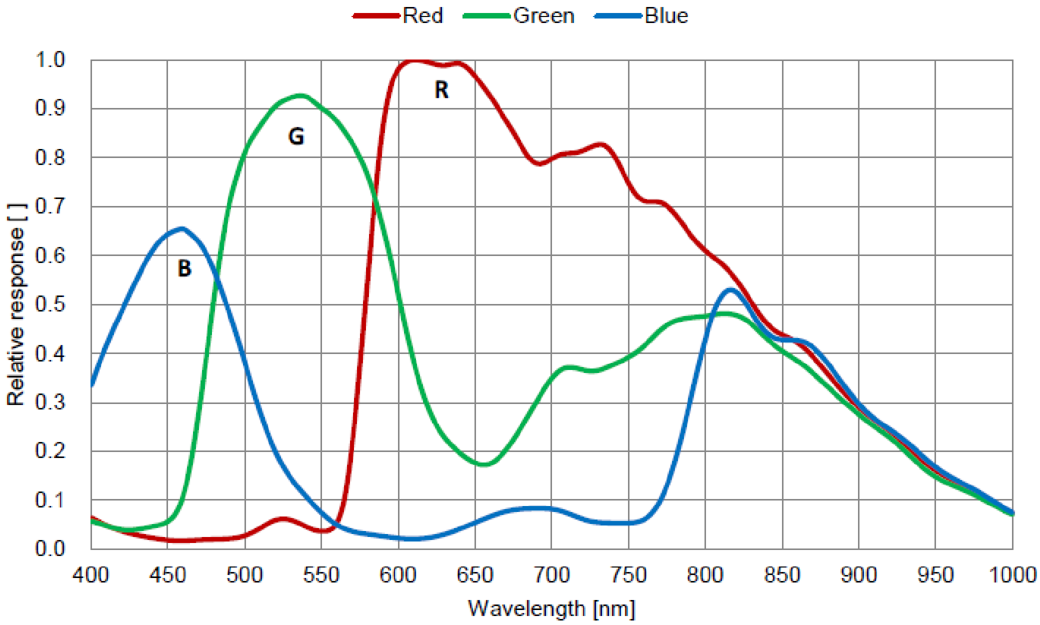


Figure 4-19 VE2S-301-125U3C-S (J150) sensor spectral response

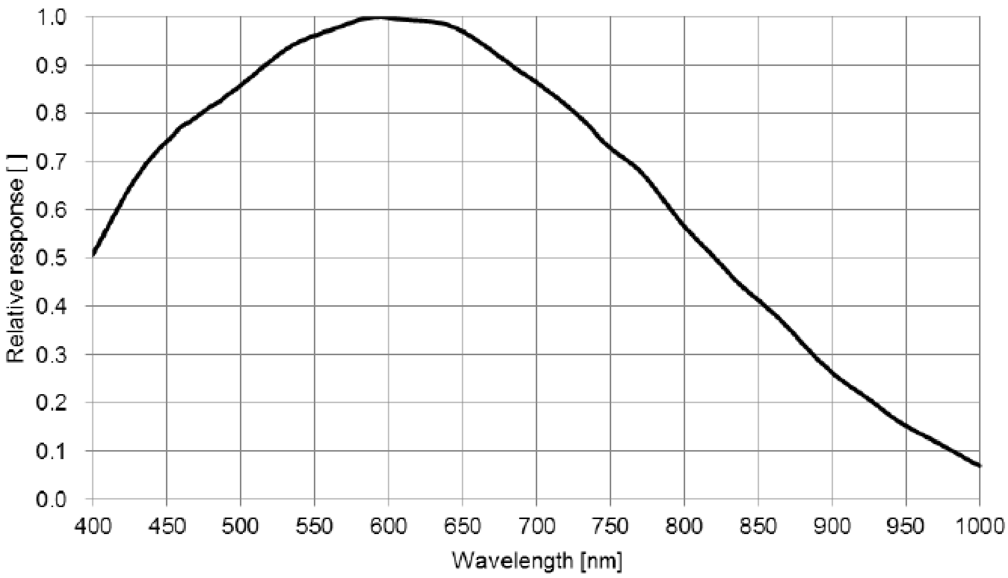


Figure 4-20 VE2S-301-125U3M-S (J150) sensor spectral response

5. Dimensions

5.1. Camera Dimensions

5.1.1. All-in-one USB3.0 Camera Dimensions

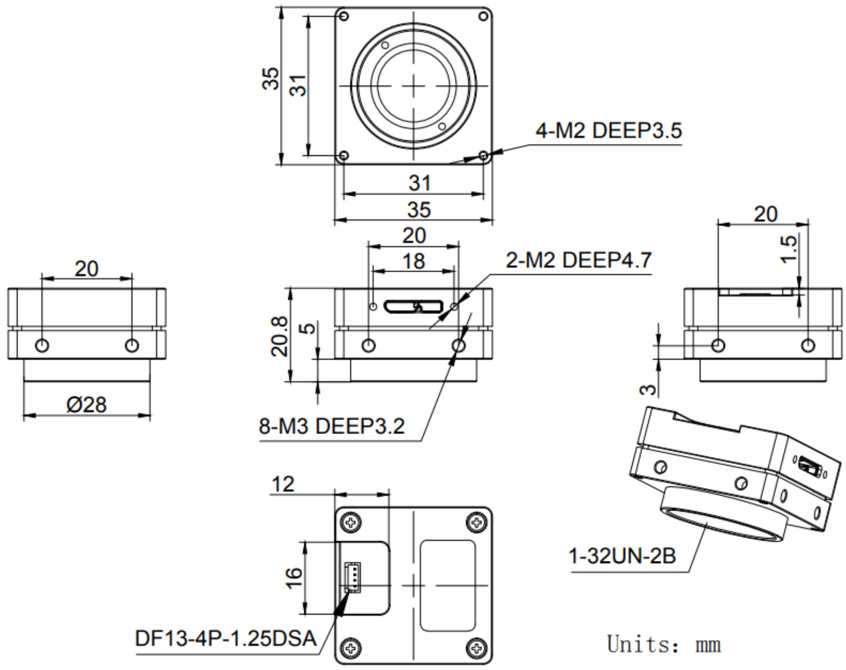


Figure 5-1 All-in-one USB3.0 camera mechanical dimensions (CS-Mount)

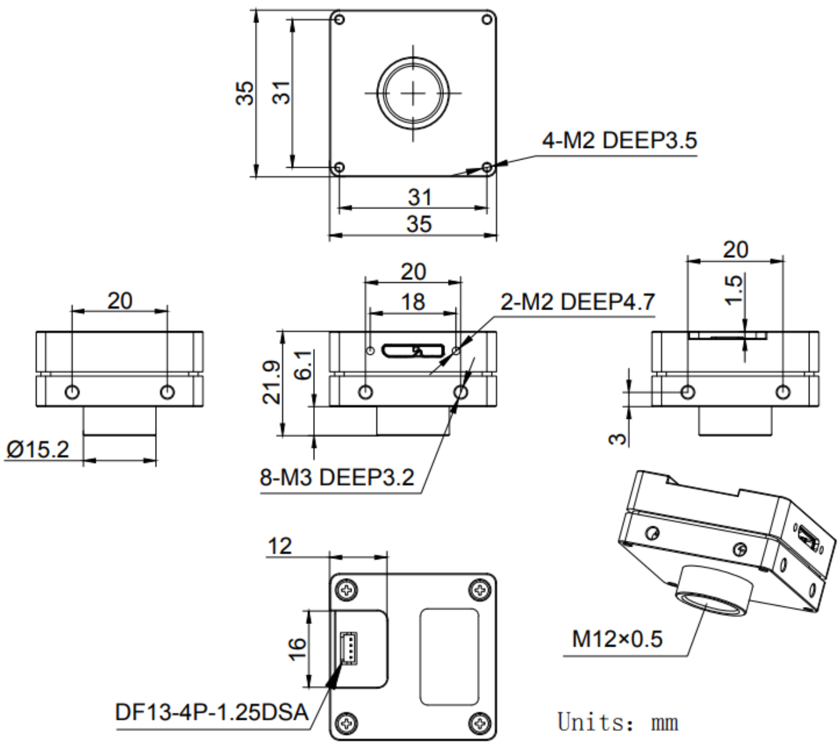


Figure 5-2 All-in-one USB3.0 camera mechanical dimensions (S-Mount)

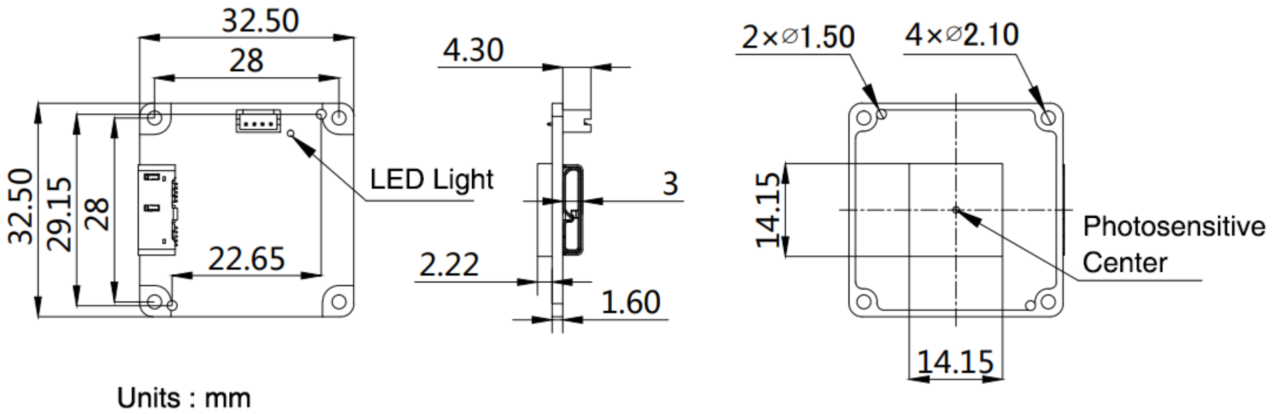


Figure 5-3 VEN-161-61U3M/C-M06 mechanical dimensions

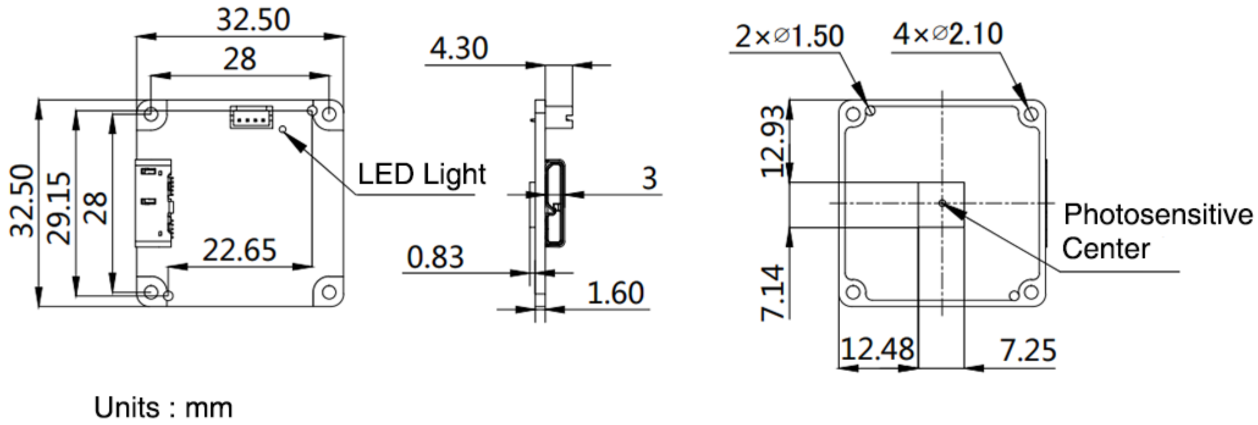


Figure 5-4 VEN-505-36U3M/C-M06 mechanical dimensions

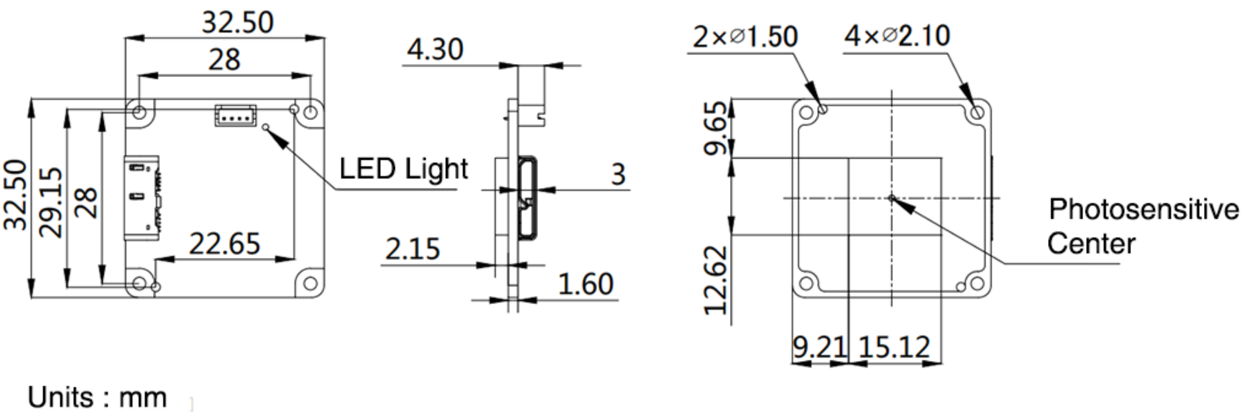


Figure 5-5 VEN-830-22U3M/C-M06 mechanical dimensions

5.1.2. All-in-one FPC Camera Dimensions

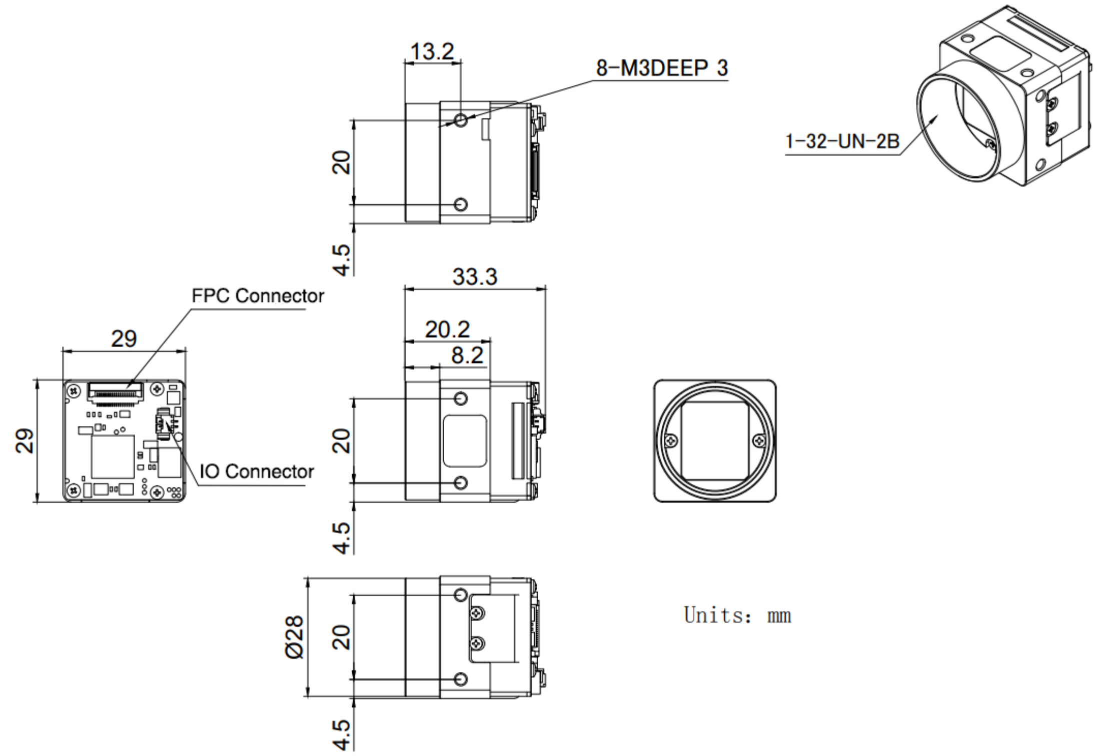


Figure 5-6 All-in-one horizontal FPC camera mechanical dimensions (C-Mount)

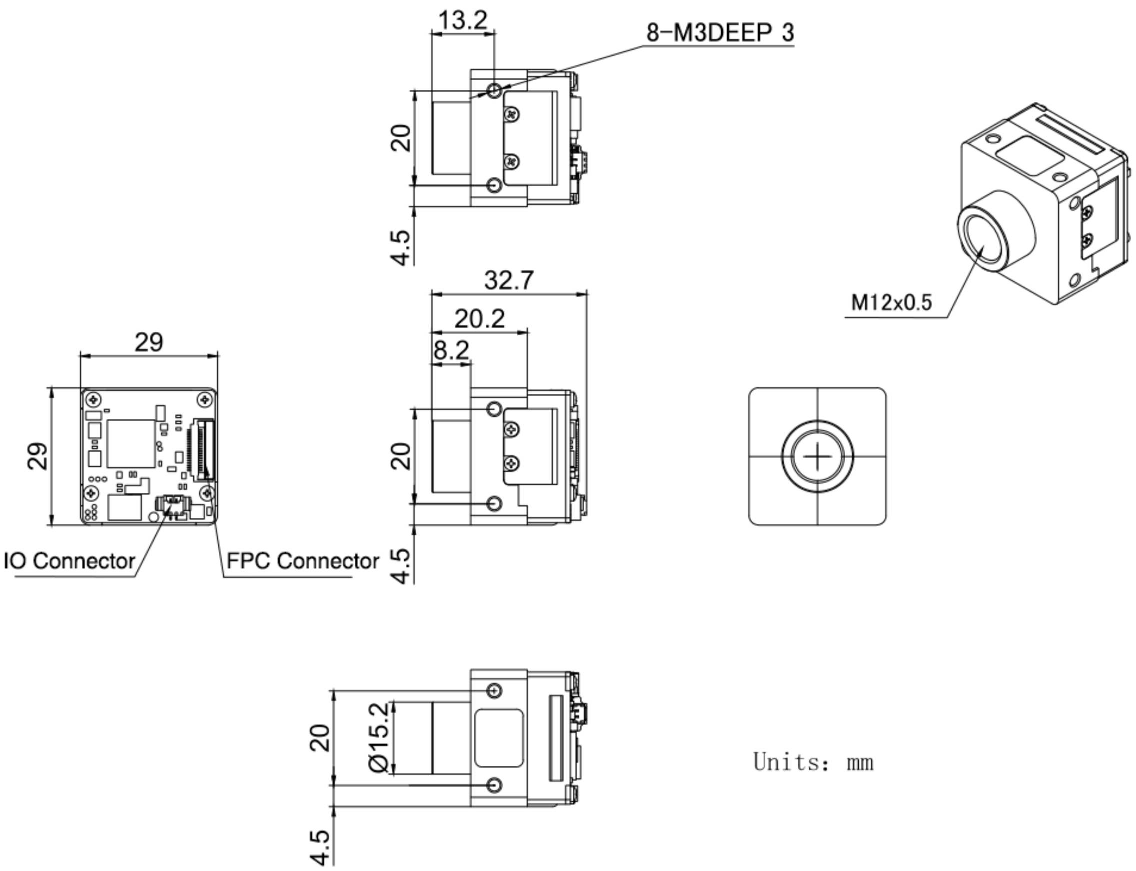


Figure 5-7 All-in-one horizontal FPC camera mechanical dimensions (S-Mount)

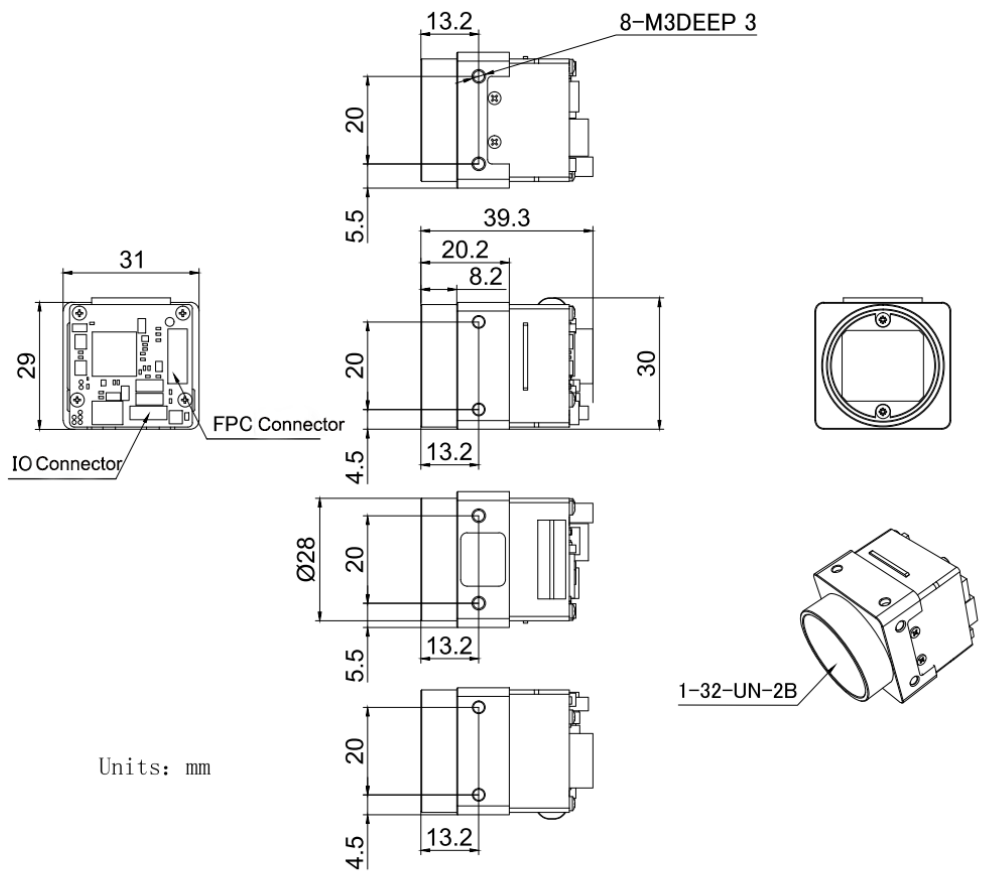


Figure 5-8 All-in-one vertical FPC camera mechanical dimensions

5.1.3. Split USB3.0 Camera Mechanical Dimensions

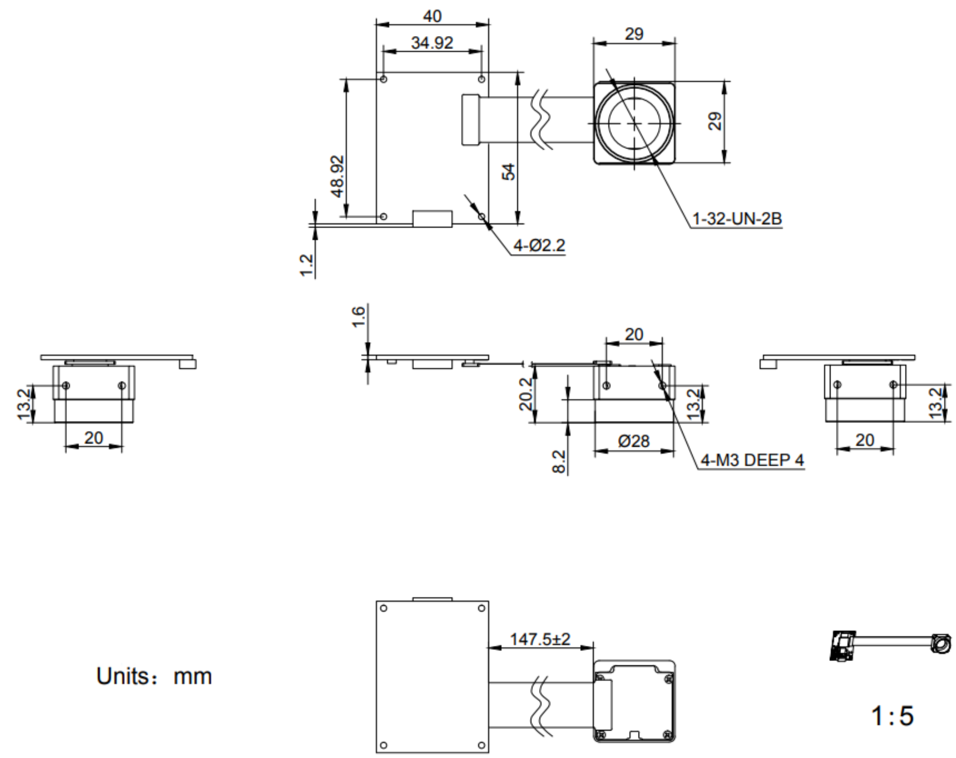


Figure 5-9 Split USB3.0 camera mechanical dimensions (C-Mount)

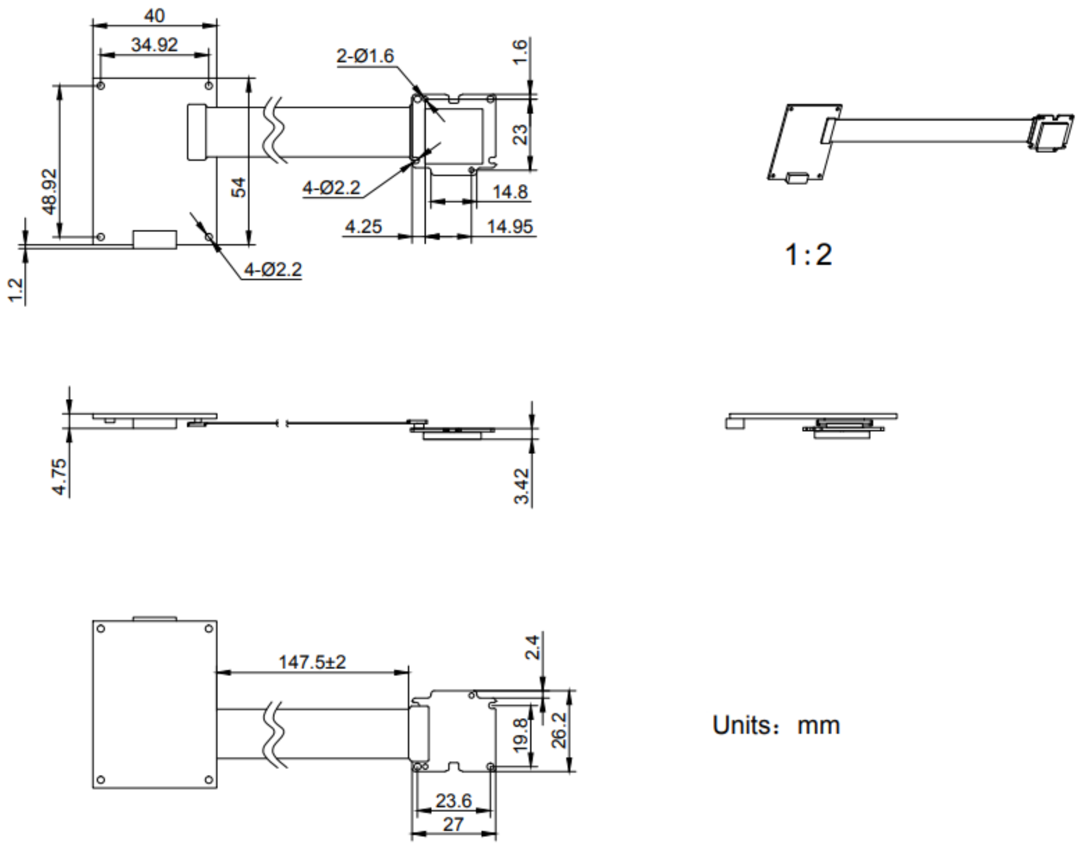


Figure 5-10 Split USB3.0 camera mechanical dimensions (No-Mount)

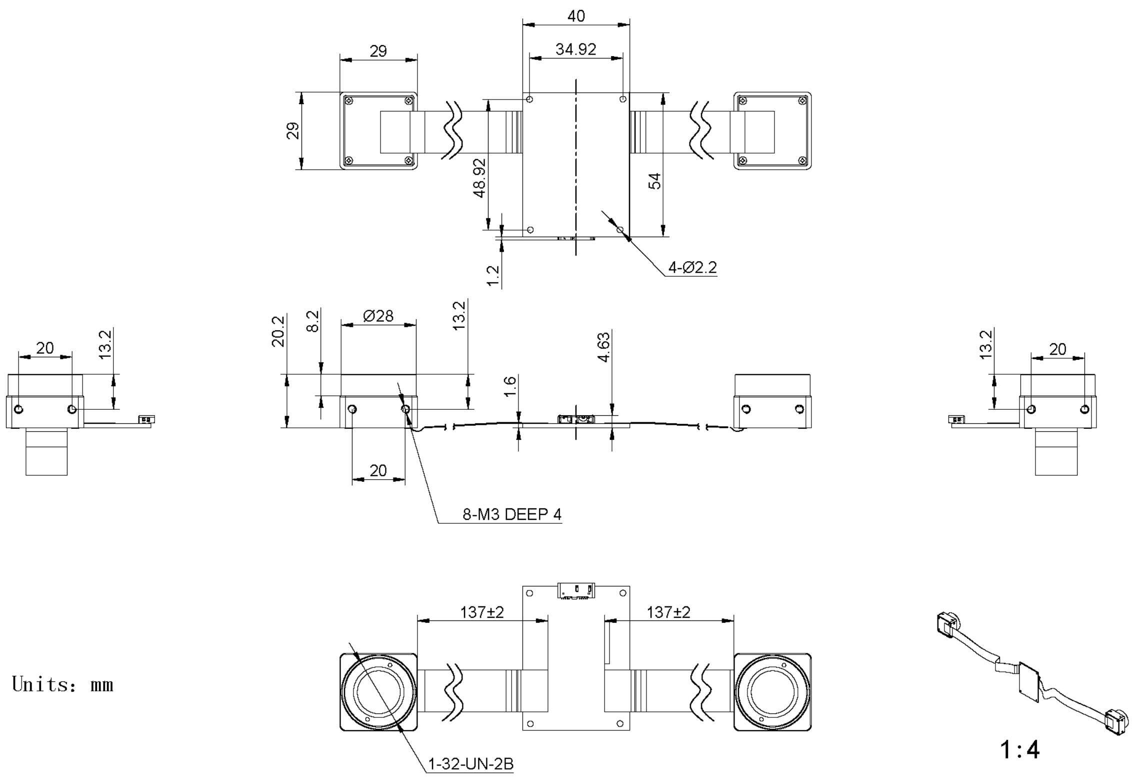


Figure 5-11 Split USB3.0 binocular camera mechanical dimensions (C-Mount)

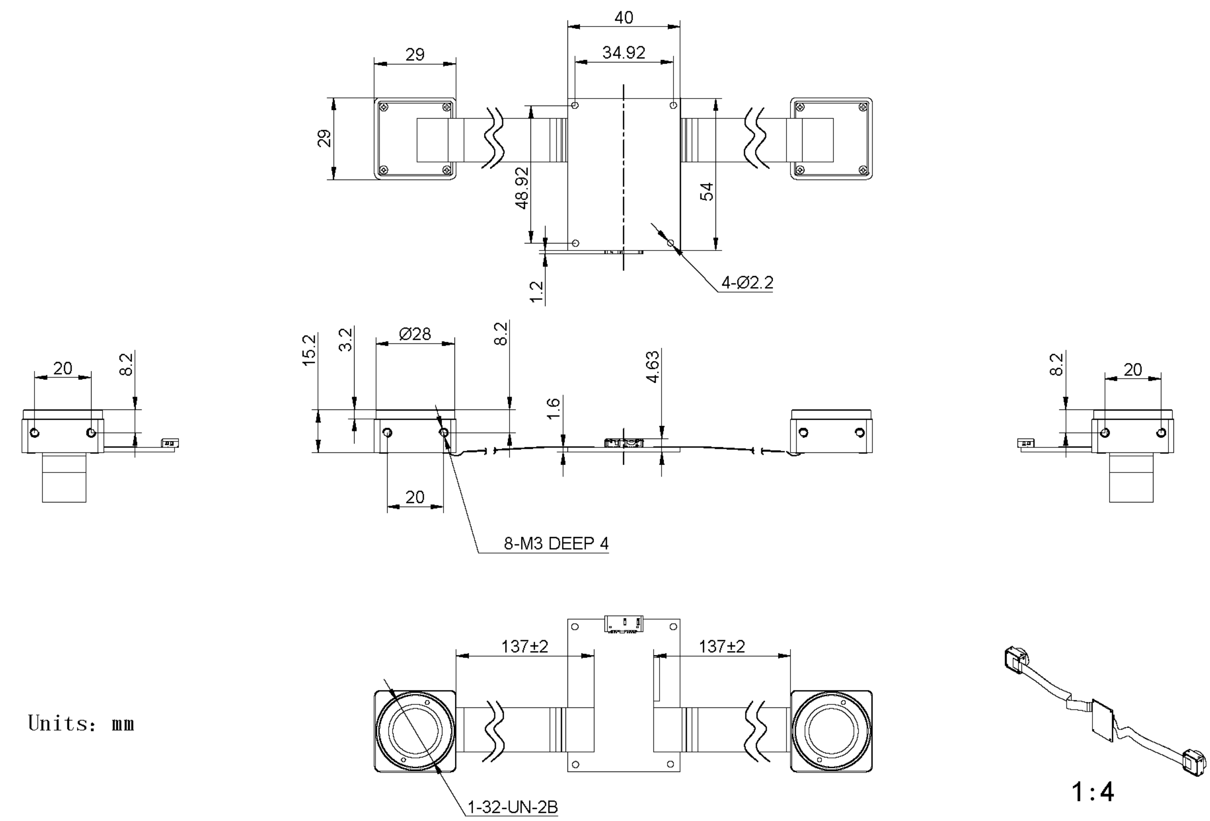


Figure 5-12 Split USB3.0 binocular camera mechanical dimensions (CS-Mount)

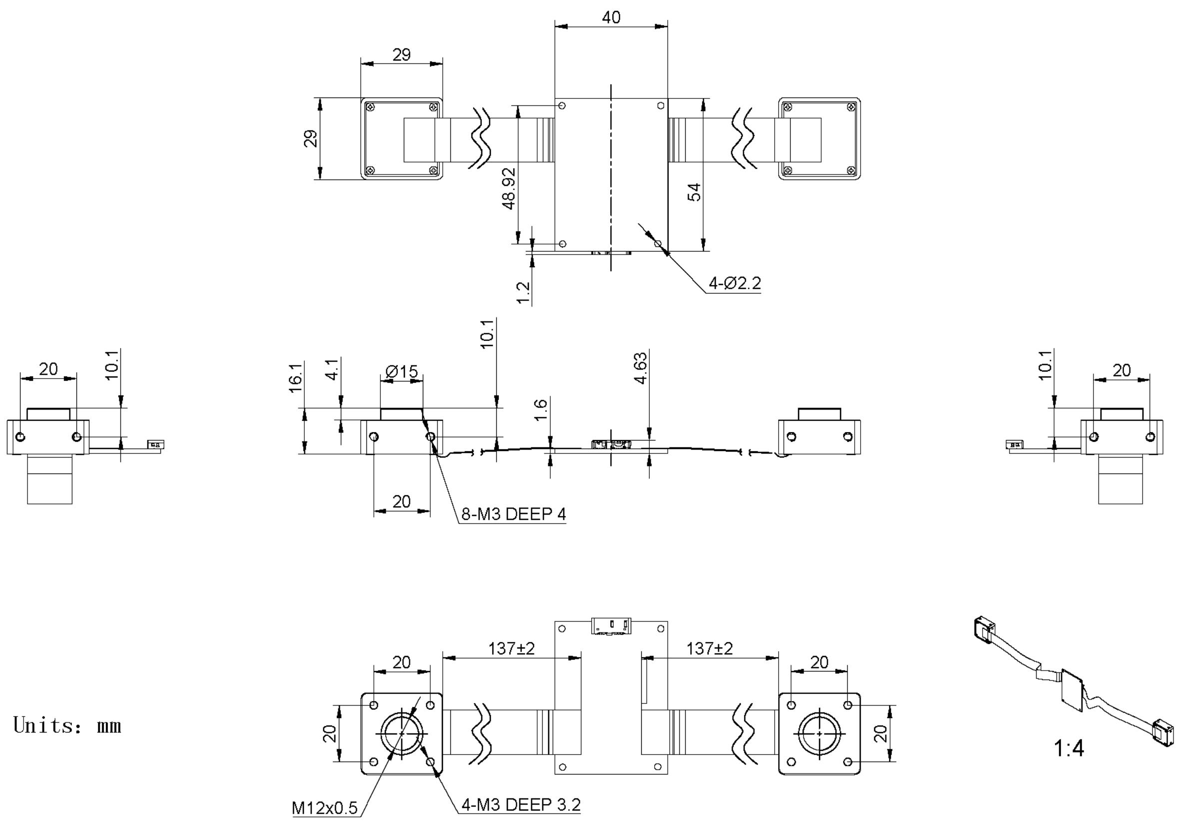


Figure 5-13 Split USB3.0 binocular camera mechanical dimensions (S-Mount)

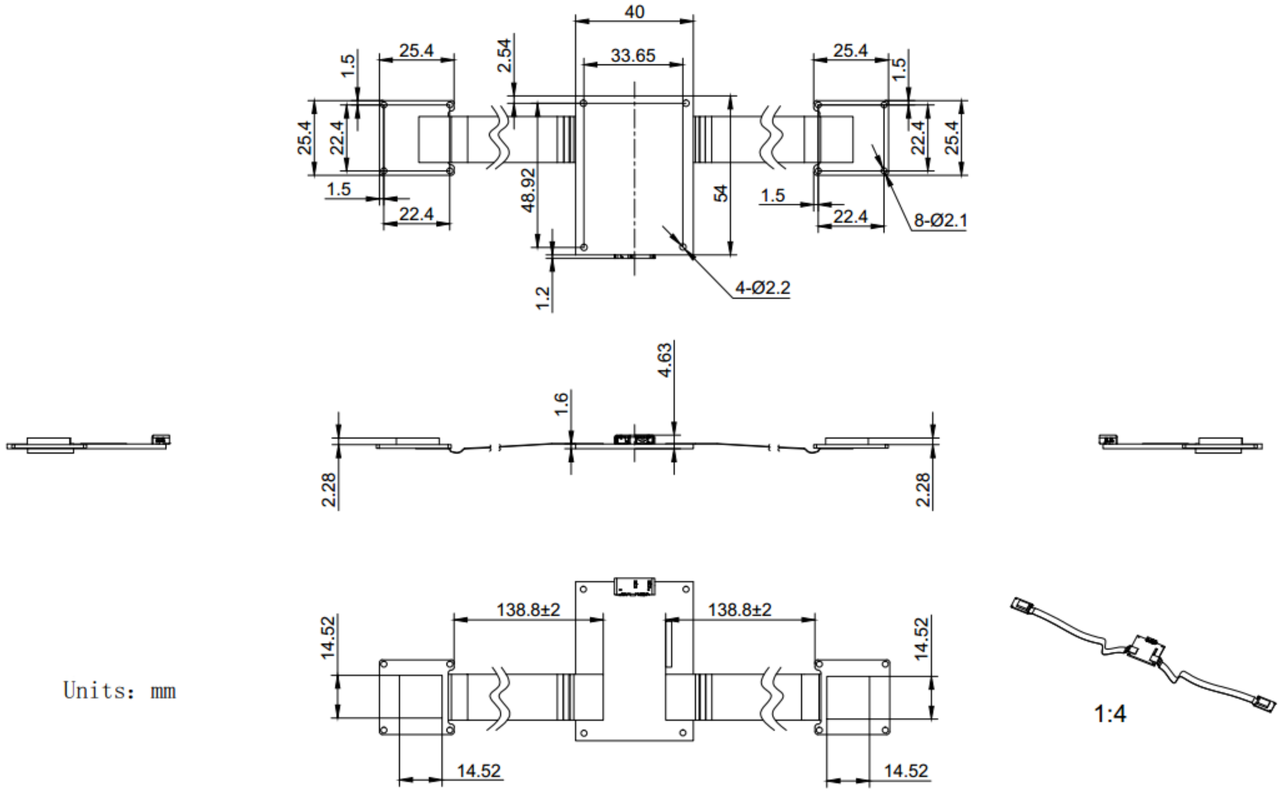


Figure 5-14 Split USB3.0 binocular camera mechanical dimensions (No-Mount)

5.1.4. Split FPC Camera Mechanical Dimensions

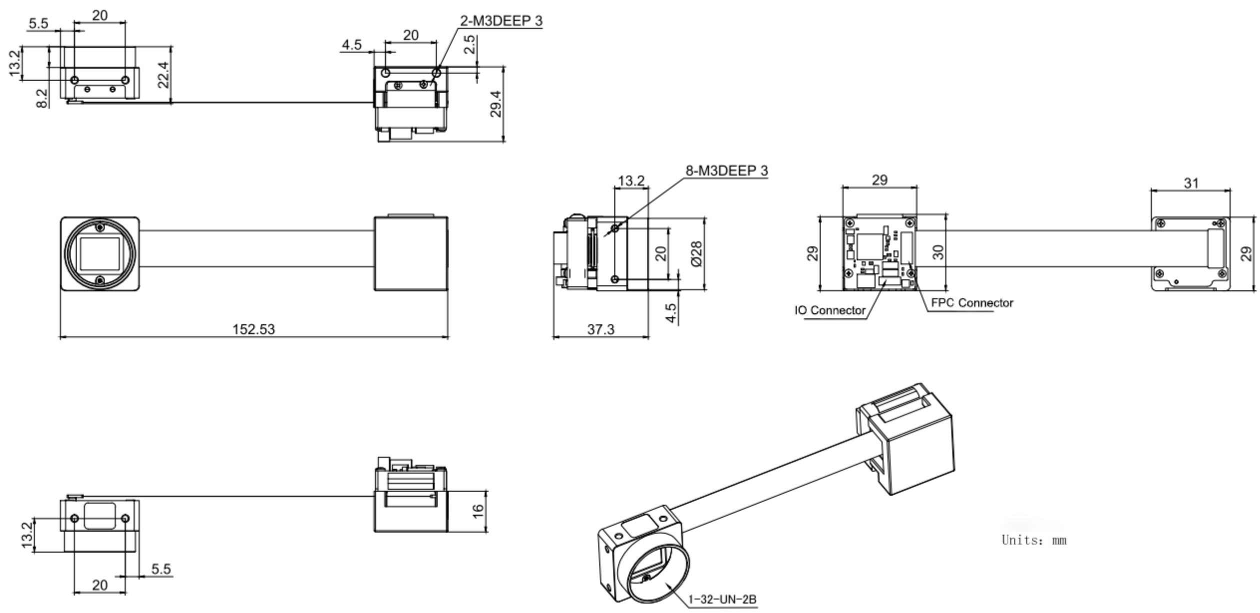


Figure 5-15 Split vertical FPC camera mechanical dimensions

5.1.5. Micro-B Adapter Board Mechanical Dimensions

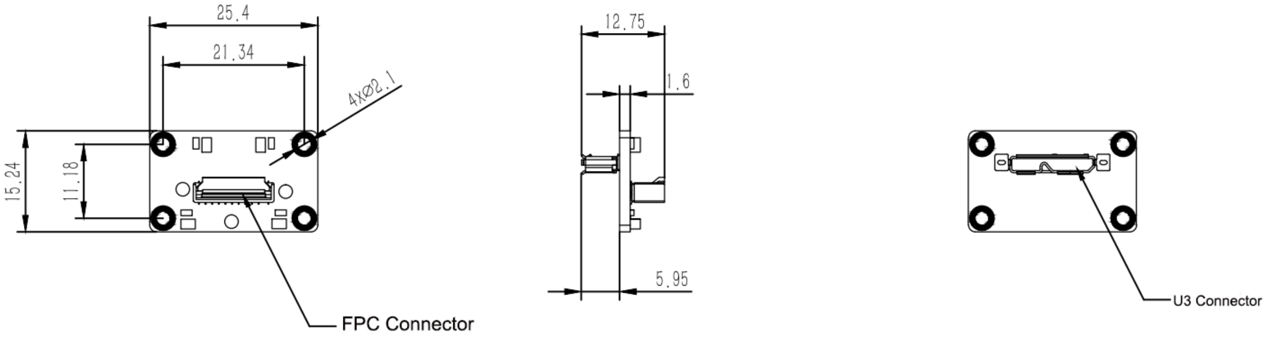


Figure 5-16 Micro-B adapter board mechanical dimensions

5.2. Optical Interface

Cameras are equipped with C-mount, CS-mount and S-mount lens adapters. The back-flange distance of C-mount is 17.526 mm (in the air), and the maximum lens allowed thread length should be less than 11.3mm, as shown in Figure 5-17.The back-flange distance of CS-mount is 12.526 mm (in the air), and the maximum lens allowed thread length should be less than 6.3mm, as shown in Figure 5-18. The maximum screw-in depth of the S-mount lens should be less than 11.6mm, as shown in Figure 5-19. The maximum screw-in depth of the all-in-one FPC camera S-mount lens should be less than 13.2mm, as shown in Figure 5-20.

The CS-mount color models are equipped with an IR filter and the cut-off frequency is 700nm. The mono models are equipped with a transparent glass. Remove IR-filter or transparent glass will defocus the image plane.

Contact our technical support when the glass needed to be removed.

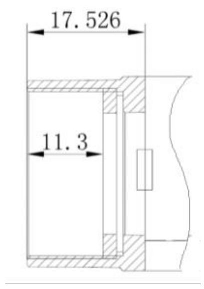


Figure 5-17 C-mount optical interface of VENUS USB3 Vision camera

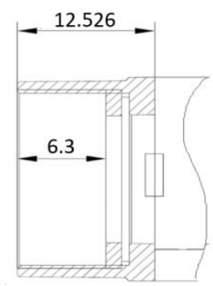


Figure 5-18 CS-mount optical interface of VENUS USB3 Vision camera

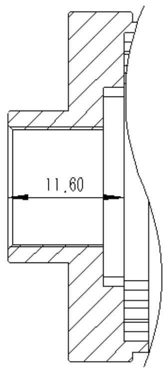


Figure 5-19 S-mount optical interface of VENUS USB3 Vision camera (except FPC camera)

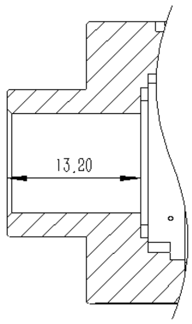


Figure 5-20 S-mount optical interface of VENUS all-in-one FPC camera

6. Filters and Lenses

6.1. Filters

The VENUS USB3 Vision color models of C-mount and CS-mount are equipped with IR filters. The monochrome models are equipped with transparent glasses.

Contact our technical support when the glass needed to be removed.

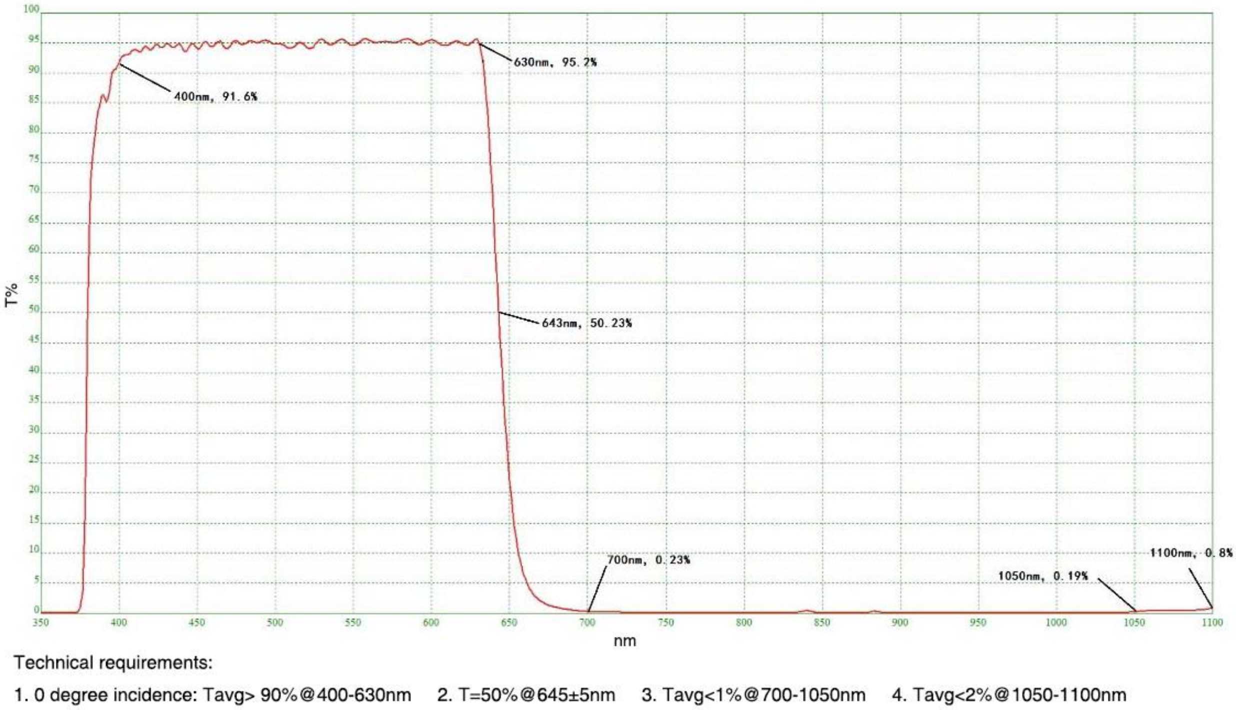


Figure 6-1 Infrared cut-off filter transmittance curve for VENUS USB3 Vision series color camera

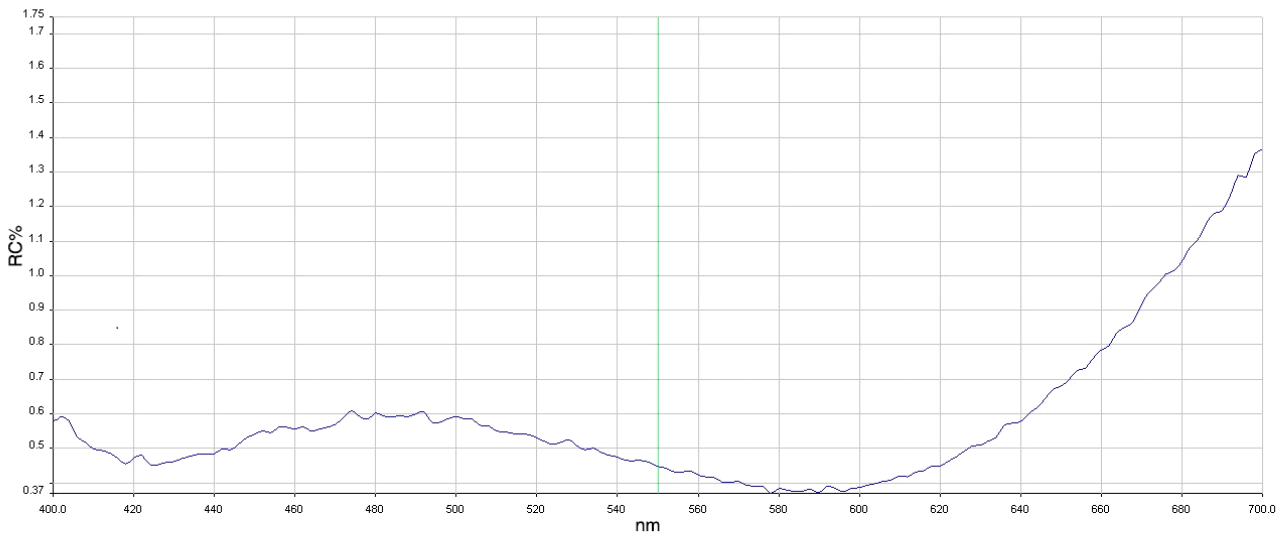


Figure 6-2 Transparent glass reflectance curve for VENUS USB3 Vision series mono camera

6.2. Lens Selection Reference

DAHENG IMAGING is a professional supplier for images and machine vision devices in China. In addition to industrial cameras, it also provides high-resolution, high-optical machine vision lenses for a wide range of industrial cameras on the market.

In order to meet the requirements of machine vision for high resolution and low distortion, DAHENG IMAGING released seven series of lenses, resolution from 2 megapixels to 25 megapixels, with small size, light weight, high resolution and low distortion rate, etc.

When choosing a lens, there are several factors to consider:

1) Mount

- The lens and camera connection methods, commonly used mounts include C, CS, S, and so on
- The VENUS series USB3.0 digital camera is equipped with standard C-mount, CS-mount and S-mount. When selecting a lens, select the lens of the same mount as the camera. The CS-mount can use the C-mount lens by matching the CS-mount to C-mount adapter ring.

2) Max. Image Circle

- The maximum sensor size that the lens image can cover. There are mainly 1/2", 2/3", 1/1.2", 1 ", 1.1", 4/3" and so on
- When selecting a lens, make sure that the Max. Image Circle of the lens is not smaller than the sensor size of the digital camera

3) Resolution

- The resolution represents the ability of the lens to record the details of the object, usually in units of line pairs that can be resolved per millimeter: line pair/mm (lp/mm). The higher the resolution of the lens, the sharper the image
- When selecting a lens, make sure that the accuracy required by the system is less than the resolution of the lens

4) Working distance

- The distance from the first working surface of the lens to the object being measured
- When selecting a lens, make sure that the working distance is larger than the lens parameter "minimum object distance"

5) Focal length

- The focal length is the distance from the center point of the lens to the clear image formed on the focal plane. The smaller the focal length, the larger the field of view of the digital camera

- For focal length calculation, we need to confirm three parameters: the field of view, the sensor size of the digital camera and the working distance. The focal length (f) of the expected lens can be calculated by the following formula

f = sensor size (horizontal or vertical) * Working distance / Field of View (corresponding to the horizontal or vertical direction of the sensor size)

The corresponding lens is selected by the calculated focal length.

6.2.1. HN-2M Series

The HN-2M series lenses are 2 megapixels lenses for industrial, suitable for sensors with max. image circle of 1/2" ~ 2/3". This series of lenses has the following features:

- High optical performance with optical design supporting up to 2/3" sensor size, 6.2μm pixel size (up to 2 megapixels) sensor. 8 models with F values below 2.8, clear images can be obtained even in low light environment
- Excellent anti-shock and anti-vibration performance, with a unique mechanical structure, the optical axis fluctuates below 10μm
- The housing is small and compact, the minimum outer diameter is only φ29.5mm, and it can be installed in various limited spaces
- Easy to install, there are 3 fixing holes on the lens barrel for fixing the iris and focusing. The best fixing hole can be selected according to the installation environment

Models:

- HN-0612-2M-C1/2X
- HN-0914-2M-C2/3X
- HN-12.514-2M-C2/3X
- HN-1614-2M-C2/3X
- HN-2514-2M-C2/3X
- HN-3516-2M-C2/3X
- HN-5023-2M-C2/3X
- HN-7528-2M-C2/3X

6.2.2. HN-5M Series

The HN-5M series lenses are 5 megapixels lenses for industrial, suitable for sensors with max. image circle of 2/3" ~ 1.1". This series of lenses has the following features:

- 5 megapixels resolution, the definition is consistent from the center to the periphery, greatly improving the distance between iris and photography

- The housing is small and compact, the minimum outer diameter is only φ29.5mm, and it can be installed in various limited spaces
- Easy to install, there are 3 fixing holes on the lens barrel for fixing the iris and focusing. The best fixing hole can be selected according to the installation environment

Models:

- HN-0619-5M-C2/3X
- HN-0816-5M-C2/3X
- HN-1216-5M-C2/3X
- HN-1616-5M-C2/3X
- HN-2516-5M-C2/3X
- HN-3519-5M-C2/3X
- HN-5024-5M-C2/3X

6.2.3. HN-6M Series

The HN-6M series lenses are 6 megapixels lenses for industrial, suitable for sensors with max. image circle of 2/3". This series of lenses has the following features:

- 6 megapixels resolution, 5~75mm focal length available
- Stable performance at long working distance
- Compact and robust
- Up to 5G of anti-vibration performance

Models:

- HN-0528-6M-C2/3B
- HN-0828-6M-C2/3B
- HN-1228-6M-C2/3B
- HN-1628-6M-C2/3B
- HN-2528-6M-C2/3B
- HN-3528-6M-C2/3B
- HN-5028-6M-C2/3B
- HN-7528-6M-C2/3B

6.2.4. HN-20M Series

The HN-20M series lenses are 20 megapixels lenses for industrial, suitable for sensors with max. image circle of 1". This series of lenses has the following features:

- 20 megapixels resolution, 8~75mm focal length available
- Ultra-low optical distortion and excellent uniformity of brightness
- Stable performance at different working distance by floating design
- The housing is small and compact, up to 5G of anti-vibration performance
- the definition is consistent from the center to the periphery, greatly improving the distance between iris and photography

Models:

- HN-0826-20M-C1/1X
- HN-1226-20M-C1/1X
- HN-1624-20M-C1/1X
- HN-2520-20M-C1/1X
- HN-3522-20M-C1/1X
- HN-5024-20M-C1/1X
- HN-7531-20M-C1/1X

6.2.5. HN-P-6M Series

The HN-P-6M series lenses are 6 megapixels lenses for industrial, suitable for sensors with max. image circle of 1/1.8" ~ 2/3". This series of lenses has the following features:

- 6 megapixels resolution, 6~50mm focal length available
- The housing is small and compact, the minimum outer diameter is only φ33.0mm, and it can be installed in various limited spaces
- Ultra-low optical distortion, greatly improving the accuracy and stability

Models:

- HN-P-0628-6M-C1/1.8
- HN-P-0828-6M-C1/1.8
- HN-P-1228-6M-C1/1.8
- HN-P-1628-6M-C1/1.8

- HN-P-2528-6M-C1/1.8
- HN-P-3528-6M-C1/1.8
- HN-P-5028-6M-C1/1.8
- HN-P-0828-6M-C2/3
- HN-P-1228-6M-C2/3
- HN-P-1628-6M-C2/3
- HN-P-2528-6M-C2/3
- HN-P-3528-6M-C2/3

6.2.6. HN-P-10M Series

The HN-P-10M series lenses are 10 megapixels lenses for industrial, suitable for sensors with max. image circle of 2/3". This series of lenses has the following features:

- 10 megapixels resolution, 8~50mm focal length available
- 2.4μm small pixel size, F1.8 large aperture design
- The housing is small and compact, the minimum outer diameter is only φ32.0mm, and it can be installed in various limited spaces
- Ultra-low optical distortion

Models:

- HN-P-0824-10M-C2/3
- HN-P-1220-10M-C2/3
- HN-P-1618-10M-C2/3
- HN-P-2518-10M-C2/3
- HN-P-3520-10M-C2/3
- HN-P-5028-10M-C2/3

6.2.7. HN-P-25M Series

The HN-P-25M series lenses are 25 megapixels lenses for industrial, suitable for sensors with max. image circle of 1.2". This series of lenses has the following features:

- 25 megapixels resolution, 12~50mm focal length available
- 2.74μm small pixel size, F2.4 large aperture design

- Small and compact
- Ultra-low optical distortion

Models:

- HN-P-1224-25M-C1.2/1
- HN-P-1624-25M-C1.2/1
- HN-P-2524-25M-C1.2/1
- HN-P-3524-25M-C1.2/1
- HN-P-5024-25M-C1.2/1

7. Electrical Interface

7.1. LED Light

An LED light is set on the back cover of camera which indicates camera's status, as shown in Table 7-1. LED light can display 3 colors: red, yellow and green.

LED status	Camera status
Off	The camera is powered off
Solid red	The camera is not boot-loaded
Flashing red	The camera is in low power consumption mode
Solid green	The camera has been boot-loaded, but no data is being transmitted
Flashing green	Data is being transmitted
Flashing yellow	The camera's initialization failed

Table 7-1 Camera status

7.2. USB Port

7.2.1. USB3.0 Connector

Some of the VENUS models use USB3.0 Micro-B connector to transfer USB3 signal (see the specific parameters in 4.General Specification), use standard USB3 cable to connect to the host. USB3 is a high-speed bus, and the cable's quality has a significant impact on data transmission, please contact our technical support when you need help in cable selection or we recommend you to use the cables recognized by USB IF.

7.2.2. FPC Connector

In order to facilitate embedded visual applications, some of the VENUS models use FPC to transfer USB3 signal (see the specific parameters in 4.General Specification, there are two types of FPC connectors: horizontal and vertical).

There are two connection methods of camera and host. Method1: An FPC card holder is designed on the chassis of the host computer. Use FPC flexible cables to connect the camera to the chassis. Method2: Connect the FPC cable and Micro-B adapter to the camera, and then connect the Micro-B adapter to the host using a standard USB3 cable.

When using the second method, due to the attenuation of the USB signal after multiple transfers, and in order to ensure stable signal transmission, the length of the standard USB3 cable cannot exceed 1m. For details, please consult our technical support.

When designing an FPC cable or host board FPC PCB, the size of the connecting finger should comply with the card holder requirements.

When designing the installation structure of the Micro-B adapter board, the cable locking thread, the protruding height of the receptacle, etc., should meet the dimensional requirements specified in USB3 Vision, or ask help for our technical support.

FPC Signal definition as follows:

Pin	Definition	Description	Pin	Definition	Description
1	GND	Ground	10	NC	NC
2	SSRX_P	USB3.0 Differential data	11	GND	Ground
3	GND	Ground	12	USB2D_P	USB2.0 Differential data
4	SSRX_N	USB3.0 Differential data	13	GND	Ground
5	GND	Ground	14	USB2D_N	USB2.0 Differential data
6	SSTX_P	USB3.0 Differential data	15	GND	Ground
7	GND	Ground	16	GND	Ground
8	SSTX_N	USB3.0 Differential data	17	Vbus	VBUS Power
9	GND	Ground	18	Vbus	VBUS Power

Table 7-2 FPC Connector Signal Definition of FPC camera

7.3. I/O Port

7.3.1. All-in-one USB3.0 Camera

I/O port is implemented by Hirose 4-pin anti-plug reverse receptacle (No. DF13-4P-1.25DSA(**)), and the corresponding plug plastic shell model is DF13-4S-1.25C, and the contact core model is DF13-2630SCF.

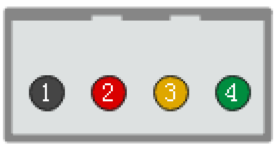
Diagram	Pin	Definition	Description
	1	GND	GPIO GND
	2	Line2	GPIO input/output
	3	Line0+	Opto-isolated input +
	4	Line0-	Opto-isolated input -

Table 7-3 I/O port definition

Figure 7-1 I/O interface

The polarity of GPIO pins cannot be reversed, otherwise, camera or other peripherals could burn out.

7.3.1.1. Line0 (Opto-isolated Input) Circuit

Hardware schematics of opto-isolated input circuit is shown as Figure 7-2

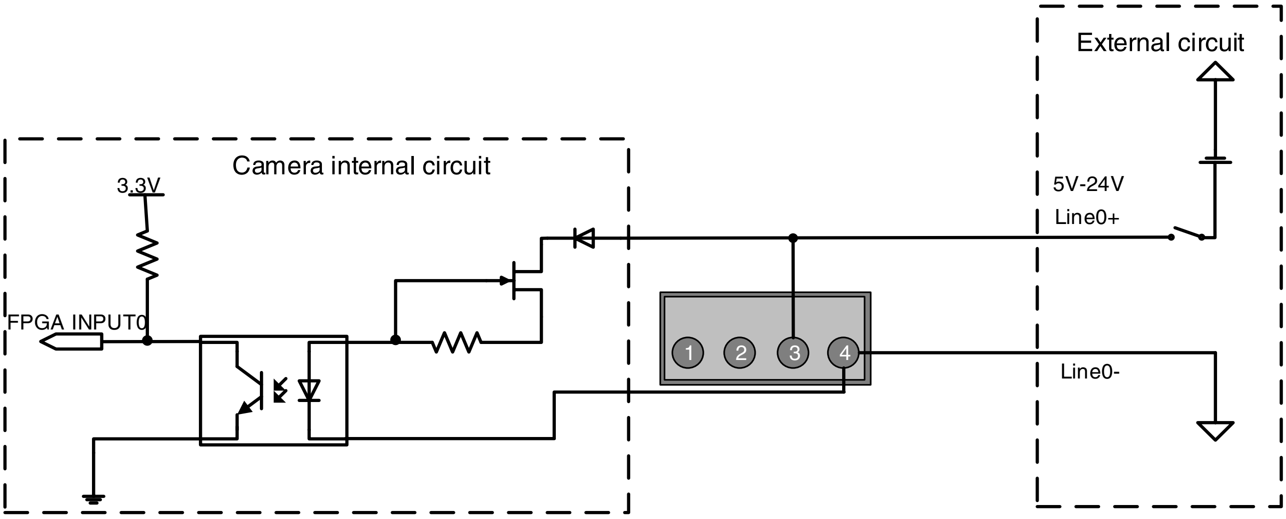


Figure 7-2 Opto-isolated input circuit

- Logic 0 input voltage: 0V~+2.5V (Line0+ voltage)
- Logic 1 input voltage: +5V~+24V (Line0+ voltage)
- Minimum input current: 7mA
- The status is unstable when input voltage is between 2.5V and 5V, which should be avoided
- When the external input voltage is 5V, there is no need for circuit-limiting resistance in the external input. But if there is a series resistance, please ensure the value is less than 90Ω. In order to protect the Line0+ while the external input voltage is higher than 9V, a circuit-limiting resistance is needed in the external input. The recommended resistance is shown in Table 7-4

External input voltage	Circuit-limiting resistance Rlimit	Line0+ input voltage
5V	Non or <90Ω	About 5V
9V	680Ω	About 5.5V
12V	1kΩ	About 6V
24V	2kΩ	About 10V

Table 7-4 Circuit-limiting resistor value

The connection method of the opto-isolated input circuit and the NPN and PNP photosensor is shown in Figure 7-3 and Figure 7-4. The relationship between the pull-up resistor and the external power supply voltage is shown in Table 7-4.

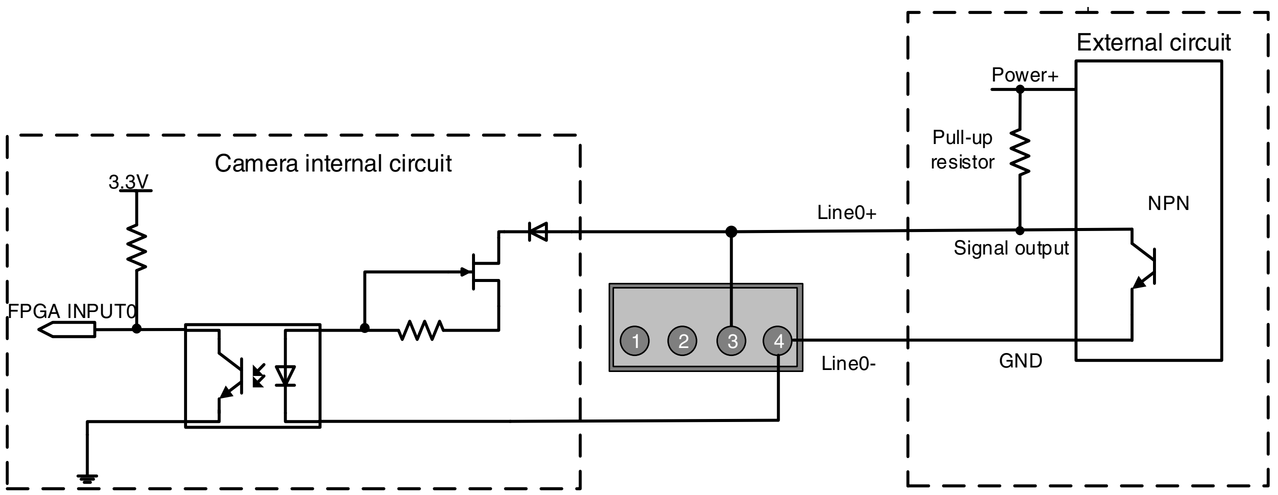


Figure 7-3 NPN photosensor connected to opto-isolated input circuit

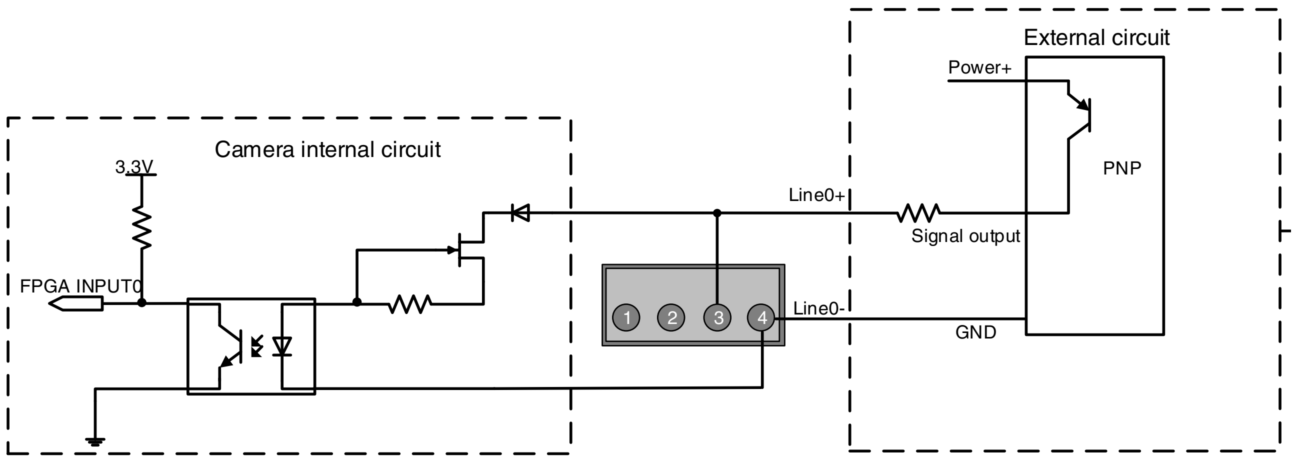


Figure 7-4 PNP photosensor connected to opto-isolated input circuit

- Rising edge delay: <50μs (0°C~45°C), parameter description as shown in Figure 7-5
- Falling edge delay: <50μs (0°C~45°C), parameter description as shown in Figure 7-5
- Different environment temperature and input voltage have influence on delay time of opto-isolated input circuit. Delay times in typical application environment (temperature is 25°C) is as shown in Table 7-5

Parameter	Test condition	Value (μs)		
Rising edge delay	VIN=5V	3.02	~	6.96
	VIN=12V	2.46	~	5.14
Falling edge delay	VIN=5V	6.12	~	17.71
	VIN=12V	8.93	~	19.73

Table 7-5 Delay time of opto-isolated input circuit in typical application environment

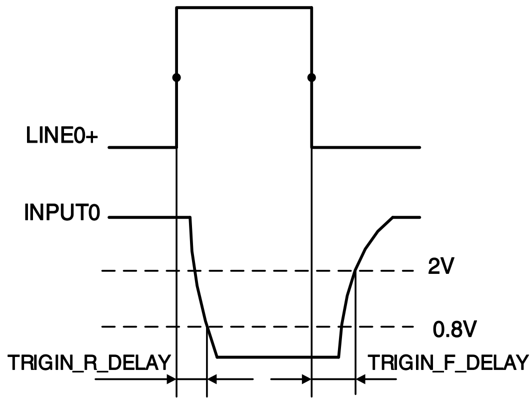


Figure 7-5 Parameter of opto-isolated input circuit

- Rising time delay (TRIGIN_R_DELAY): the time required for the response to the decrease to 0.8V of INPUT0 from 50% rising of LINE0+
- Falling time delay (TRIGIN_F_DELAY): the time required for the response to the rise to 2V of INPUT0 from 50% falling of LINE0+

7.3.1.2. Line2 (Bidirectional) Circuit

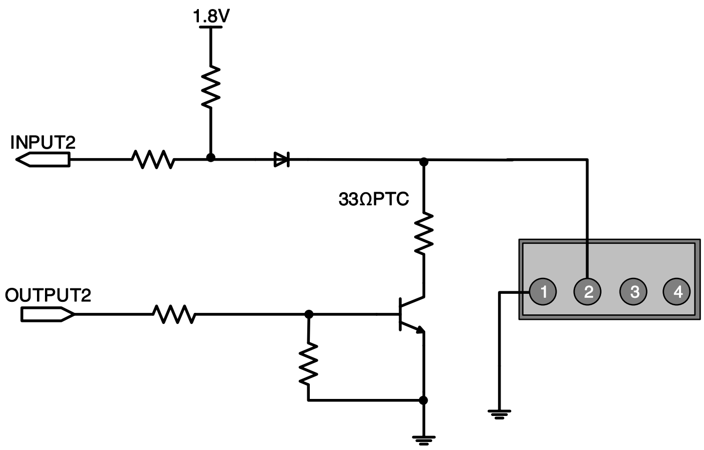


Figure 7-6 Line2 (bidirectional) circuit

7.3.1.2.1. Line2 is Configured as Input

- When Line2 is configured as input, the internal equivalent circuit of camera is shown in Figure 7-7

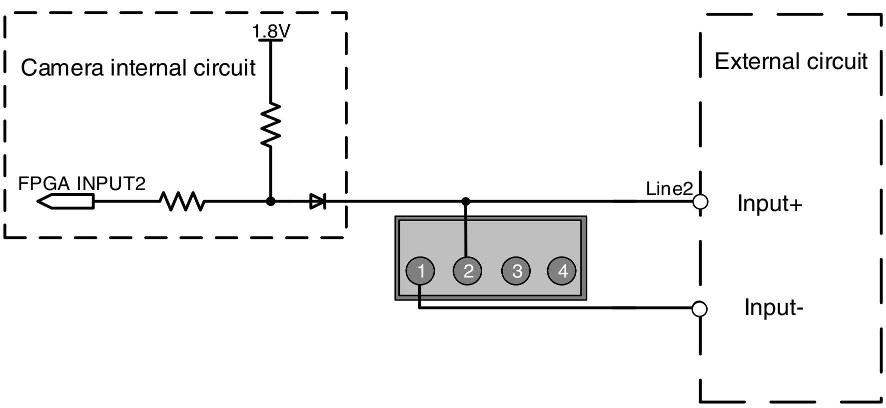


Figure 7-7 Internal equivalent circuit of camera when Line2 is configured as input

To avoid the damage of GPIO pins, please connect GND pin before supplying power to Line2.

- Logic 0 input voltage: 0V~+0.6V (GPIO1 voltage)
- Logic 1 input voltage: +1.9V~+24V (GPIO1 voltage)
- The status is unstable when input voltage is between 0.6V and 1.9V, which should be avoided
- When input of Line2 is high, input current is lower than 100μA. When input of Line2 is low, input current is lower than -1mA. The connection method between Line2 and NPN/PNP photoelectric sensors is shown in Figure 7-8 and Figure 7-9. The relationship between the pull-up resistor value and the external input voltage is shown in Table 7-6.

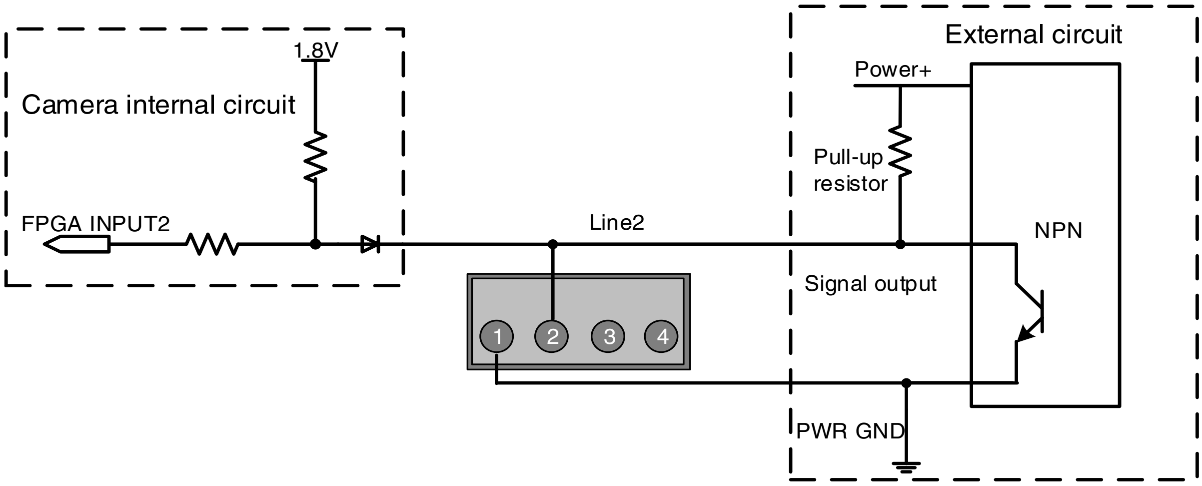


Figure 7-8 NPN photoelectric sensor connected to Line2 input circuit

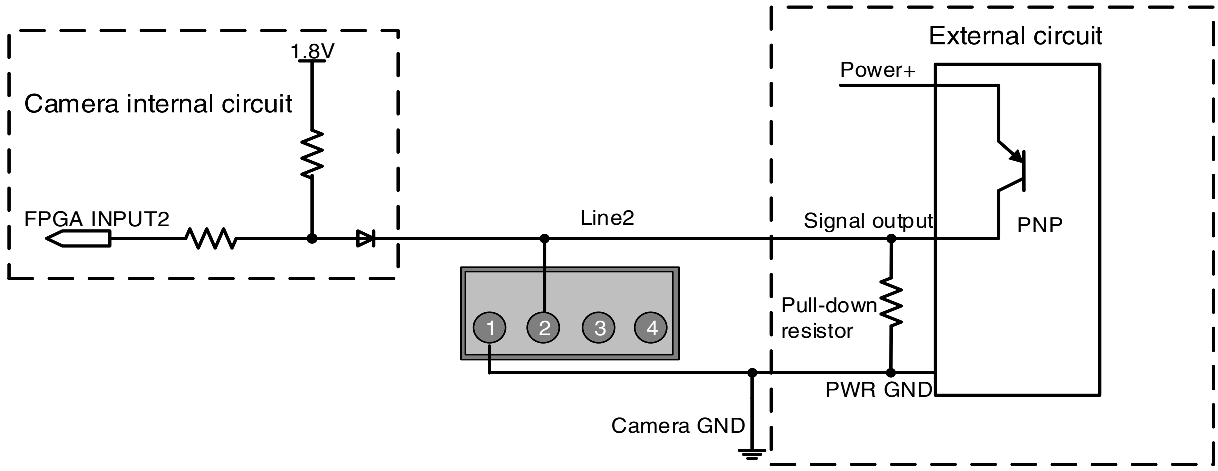


Figure 7-9 PNP photoelectric sensor connected to Line2 input circuit

- When Lline2 is configured as input, pull-down resistor over 1K should not be used, otherwise the input voltage of Line2 will be over 0.6V and logic 0 cannot be recognized stably
- Input rising time delay: <2μs (0°C~45°C), parameter description as shown in Figure 7-5
- Input falling time delay: <2μs (0°C~45°C), parameter description as shown in Figure 7-5

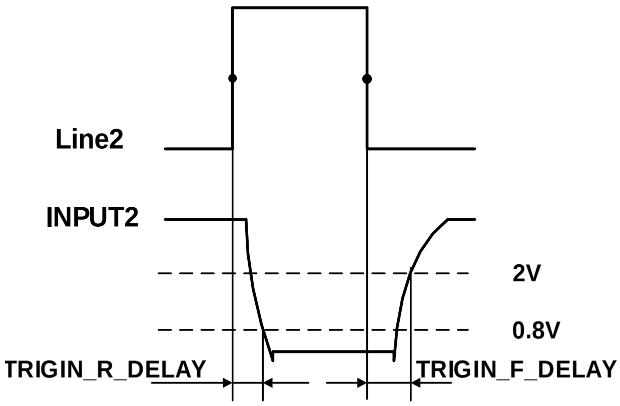


Figure 7-10 Parameter of Line2 input circuit

7.3.1.2.2. Line2 is Configured as Output

- Range of external voltage (EXVCC) is 5~24V
- Maximum output current of Line2 is 25mA, output impedance is 40Ω
- Transistor voltage drop and output current in typical application conditions (temperature is 25°C) are shown in Table 7-6

External voltage EXVCC	External resistance Rexternal	Transistor voltage drop (turn on, unit V)	Output current (mA)
5V	1kΩ	0.19	4.8
12V		0.46	11.6
24V		0.92	23.1

Table 7-6 Voltage and output current of Line2 in typical conditions

- Rising time delay = tr+td: <20μs (0°C~45°C) (parameter description as shown in Figure 7-11
- Falling time delay = ts+tf: <20μs (0°C~45°C) (parameter description as shown in Figure 7-11

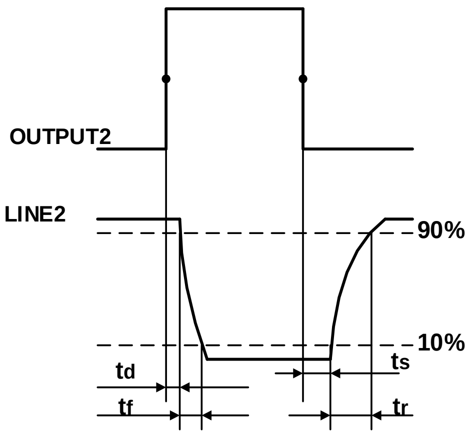


Figure 7-11 Parameter of opto-isolated output circuit

- Delay time (td): the time required from 50% rising of OUTPUT2 to the decrease to 90% of the maximum value of LINE2

- Falling time (tf): the time taken for the amplitude of LINE2 to decrease from 90% to 10% of the maximum value
- Storage time (ts): the time required from 50% falling of OUTPUT2 to the rise to 10% of the maximum value of LINE2
- Rising time (tr): the time for the response of LINE2 to rise from 10% to 90% of its final value
- Delay parameters are affected greatly by external voltage and external pull-up resistor, but little by temperature. Output delay time in typical application conditions (temperature is 25°C) are shown in Table 7-7

Parameter	Test Conditions	Value (μs)		
Storage time (ts)	External power is 5V, pull-up resistor is 1kΩ	0.17	~	0.18
Delay time (td)		0.08	~	0.09
Rising time (tr)		0.11	~	0.16
Falling time (tf)		1.82	~	1.94
Rising time delay = tr+td		0.19	~	0.26
Falling time delay = tf+ts		1.97	~	2.09

Table 7-7 Delay time when GPIO is configured as output in typical conditions

- When Line2 is configured as output, the internal equivalent circuit of camera is shown in Figure 7-12, take Line2 as an example

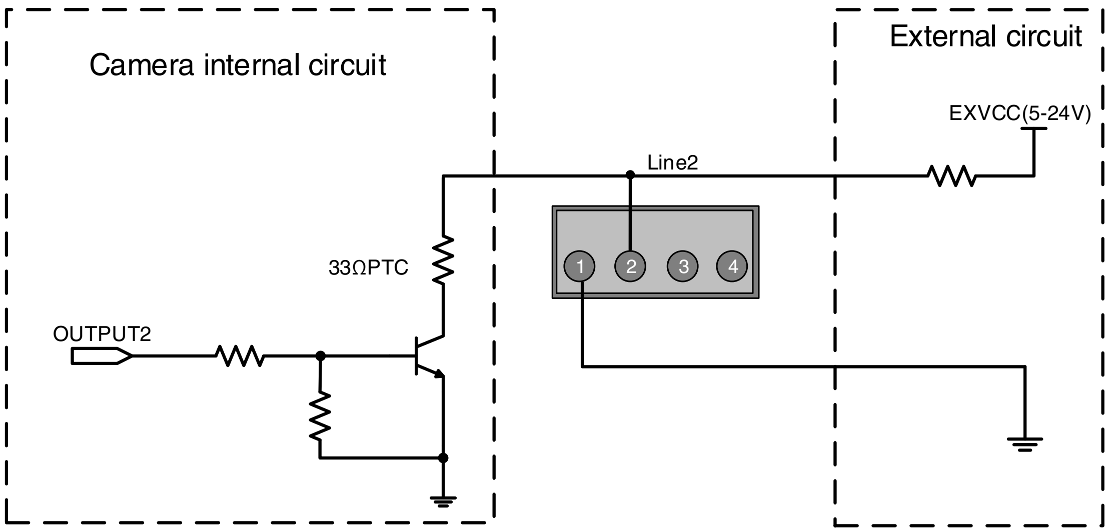


Figure 7-12 Internal equivalent circuit of camera when Line2 is configured as output

7.3.2. Split USB3.0 Camera

I/O port is implemented by Hirose 4-pin anti-plug reverse receptacle (No. DF13-4P-1.25DSA(**)), and the corresponding plug plastic shell model is DF13-4S-1.25C, and the contact core model is DF13-2630SCF.

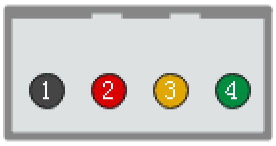
Diagram	Pin	Definition	Description
	1	GND	GPIO GND
	2	Line2	GPIO input/output
	3	Line3	GPIO input/output
	4	NC	NC

Table 7-8 I/O port definition

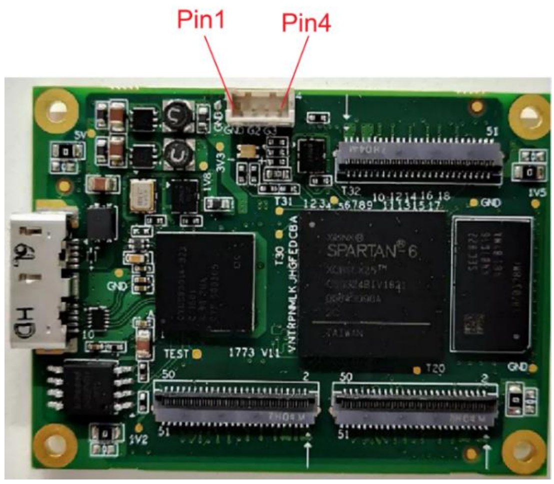


Figure 7-13 I/O interface

⚠ The polarity of GPIO pins cannot be reversed, otherwise, camera or other peripherals could burn out.

7.3.2.1. Line2/3 (Bidirectional) Circuit

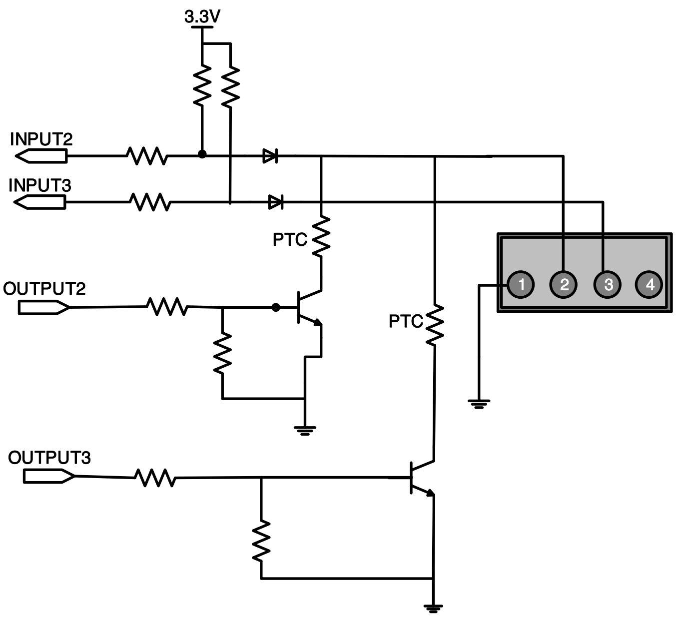


Figure 7-14 Line2/3 (bidirectional) circuit

7.3.2.1.1. Line2/3 is Configured as Input

- When Line2/3 is configured as input, the internal equivalent circuit of camera is shown in Figure 7-15, take Line2 as an example

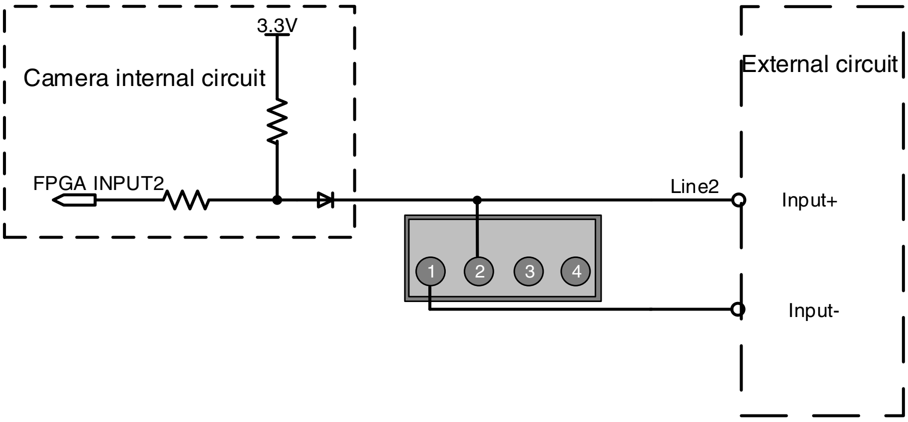


Figure 7-15 Internal equivalent circuit of camera when Line2/3 is configured as input

To avoid the damage of GPIO pins, please connect GND pin before supplying power to Line2.

- Logic 0 input voltage: 0V~+0.6V (GPIO1 voltage)
- Logic 1 input voltage: +1.9V~+24V (GPIO1 voltage)
- The status is unstable when input voltage is between 0.6V and 1.9V, which should be avoided
- When input of Line2/3 is high, input current is lower than 100μA. When input of Line2 is low, input current is lower than -1mA. The connection method between Line2/3 input circuit and NPN/PNP photoelectric sensors is shown in Figure 7-16 and Figure 7-17. The relationship between the pull-up resistor value and the external input voltage is shown in Table 7-9

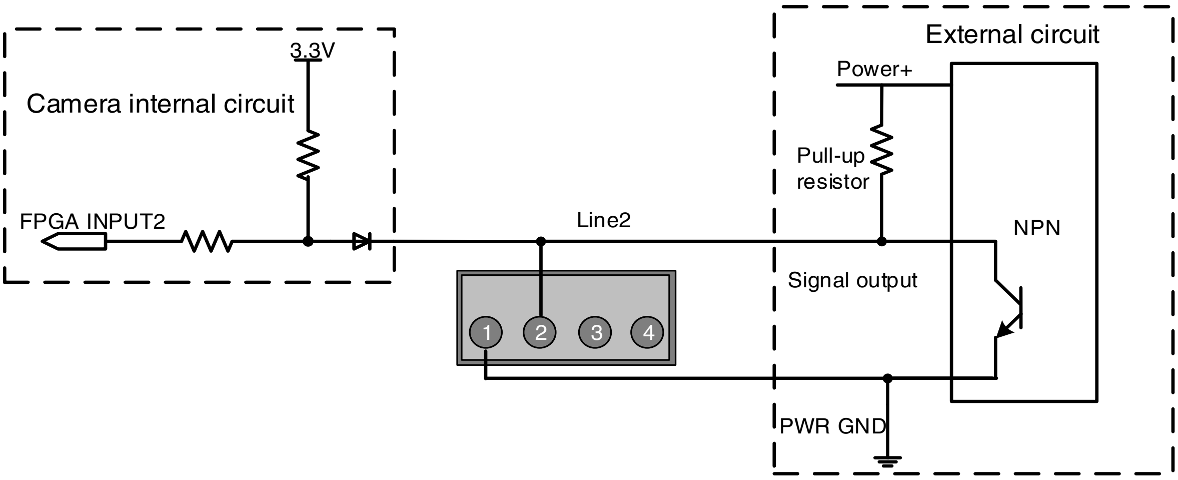


Figure 7-16 NPN photoelectric sensor connected to Line2 input circuit

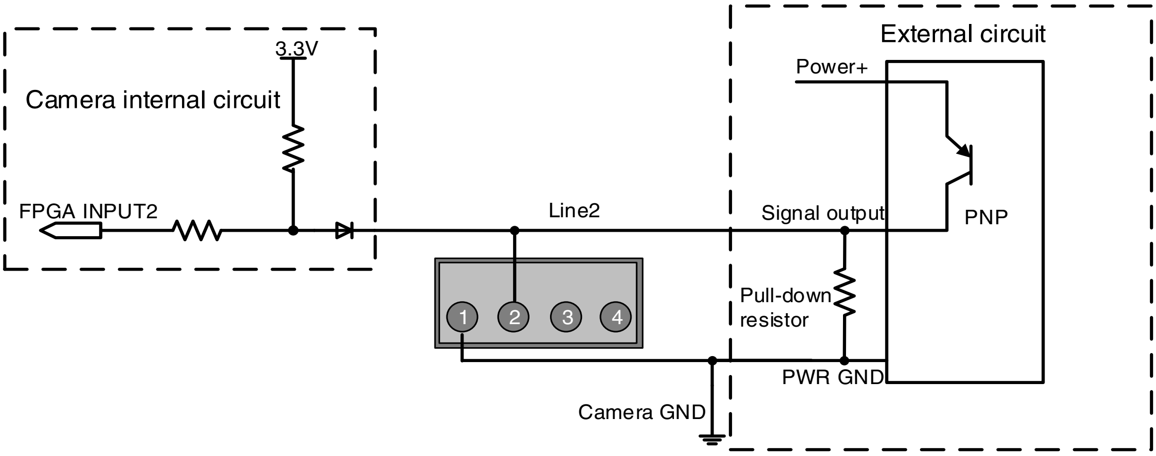


Figure 7-17 PNP photoelectric sensor connected to Line2 input circuit

- When LIine2/3 is configured as input, pull-down resistor over 1K should not be used, otherwise the input voltage of Line2/3 will be over 0.6V and logic 0 cannot be recognized stably
- Input rising time delay: <2μs (0°C~45°C), parameter description as shown in Figure 7-18
- Input falling time delay: <2μs (0°C~45°C), parameter description as shown in Figure 7-18

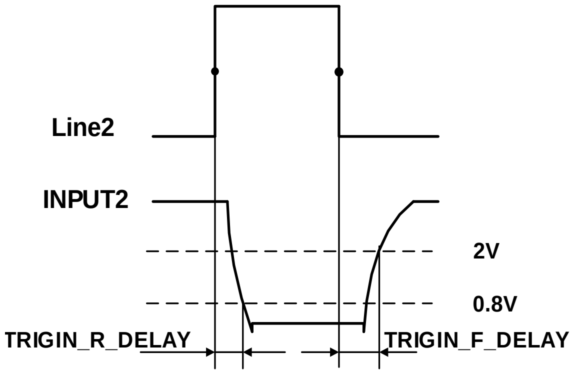


Figure 7-18 Parameter of Line2 input circuit

7.3.2.1.2. Line2/3 is Configured as Output

- Range of external voltage (EXVCC) is 5~24V
- Maximum output current of Line2/3 is 25mA, output impedance is 40Ω
- Transistor voltage drop and output current in typical application conditions (temperature is 25°C) are shown in Table 7-9

External voltage EXVCC	External resistance Rexternal	Transistor voltage drop (turn on, unit V)	Output current (mA)
5V	1kΩ	0.19	4.8
12V		0.46	11.6
24V		0.92	23.1

Table 7-9 Voltage and output current of Line2 in typical conditions

- Rising time delay = tr+td: <20μs (0°C~45°C) (parameter description as shown in Figure 7-11)
- Falling time delay = ts+tf: <20μs (0°C~45°C) (parameter description as shown in Figure 7-11)
- Delay parameters are affected greatly by external voltage and external pull-up resistor, but little by temperature. Output delay time in typical application conditions (temperature is 25°C) are shown in Table 7-10

Parameter	Test Conditions	Value (μs)		
Storage time (ts)	External power is 5V, pull-up resistor is 1kΩ	0.17	~	0.18
Delay time (td)		0.08	~	0.09
Rising time (tr)		0.11	~	0.16
Falling time (tf)		1.82	~	1.94
Rising time delay = tr+td		0.19	~	0.26
Falling time delay = tf+ts		1.97	~	2.09

Table 7-10 Delay time when GPIO is configured as output in typical conditions

- When Line2/3 is configured as output, the internal equivalent circuit of camera is shown in Figure 7-19, take Line2 as an example

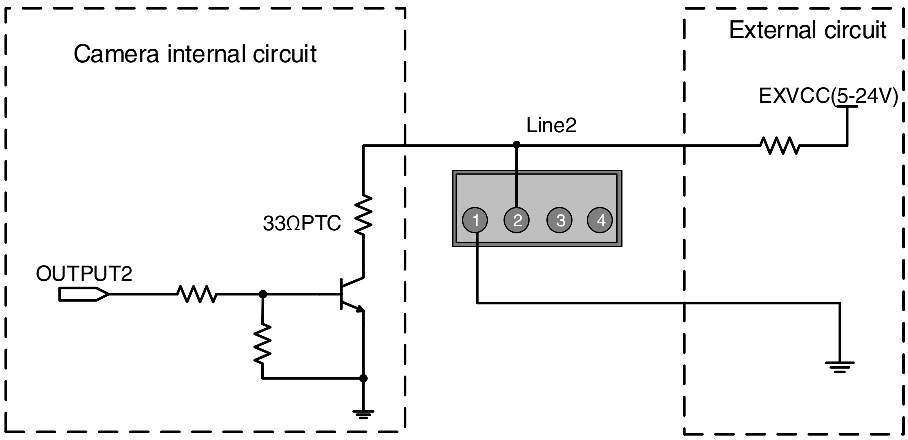


Figure 7-19 Internal equivalent circuit of camera when Line2 is configured as output

7.3.3. All-in-one Horizontal FPC Camera

The IO interface uses Molex's 2-pin anti reverse plug socket, model 532610271. The matched plug molded case model is 510210200.

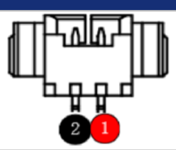
Diagram	Pin	Definition	Description
	1	Line2	GPIO Input/Output
	2	GND	GPIO Ground

Table 7-11 I/O port definition

The positive and negative polarity of GPIO cannot be reversed, otherwise the camera or other devices connected to the camera may be burned.

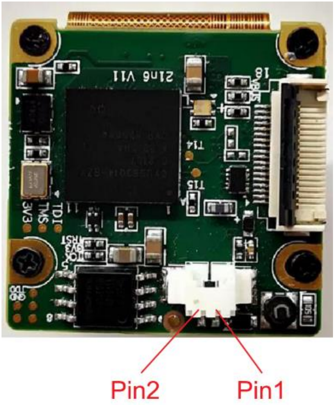


Figure 7-20 I/O interface

7.3.3.1. Line2 (Bidirectional) Circuit

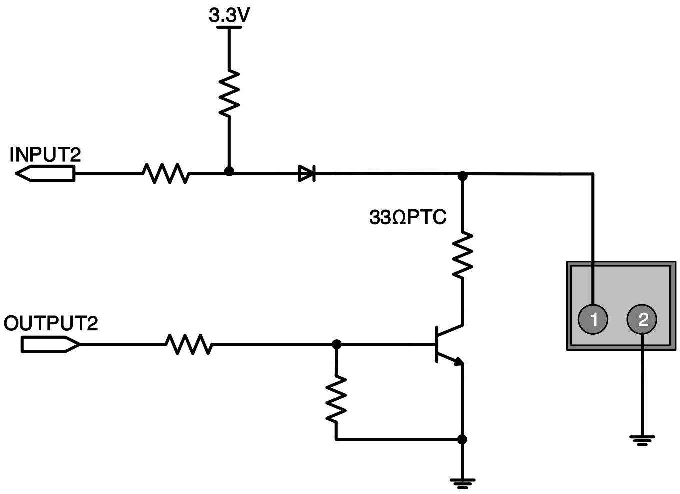


Figure 7-21 Line2 (bidirectional) circuit

7.3.3.1.1. Configure Line2 as Input Pin

- When configuring Line2 as input pin, the internal equivalent circuit of the camera is shown in Figure 7-22

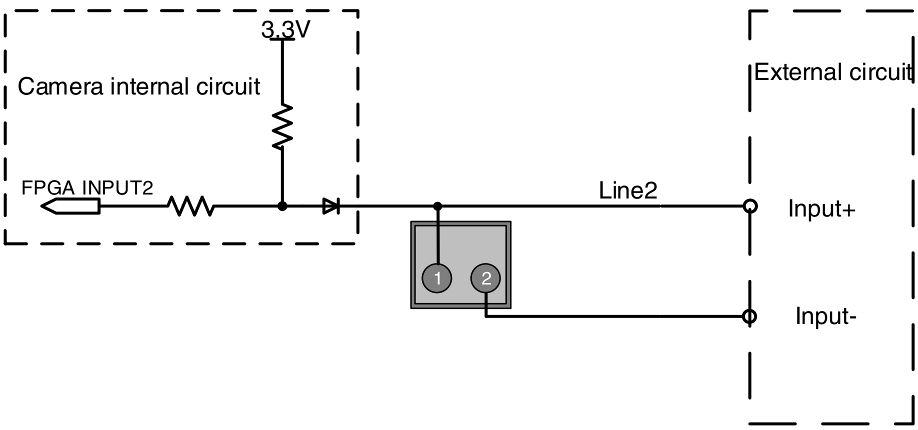


Figure 7-22 Internal equivalent circuit when Line2 configured as input

⚠ In order to prevent the GPIO pin from damaging, please connect the GND pin firstly, and then give voltage to the Line2 pin.

- Logic 0 input voltage: 0V~+0.6V (GPIO1 voltage)
- Logic 1 input voltage: +1.9V~+24V (GPIO1 voltage)
- The status is unstable when input voltage is between 0.6V and 1.9V, which should be avoided
- When input of Line2 is high, input current is lower than 100μA. When input of Line2 is low, input current is lower than -1mA. The connection method between Line2 and NPN/PNP photoelectric sensors is shown in Figure 7-23 and Figure 7-24. The relationship between the pull-up resistor value and the external input voltage is shown in Table 7-6

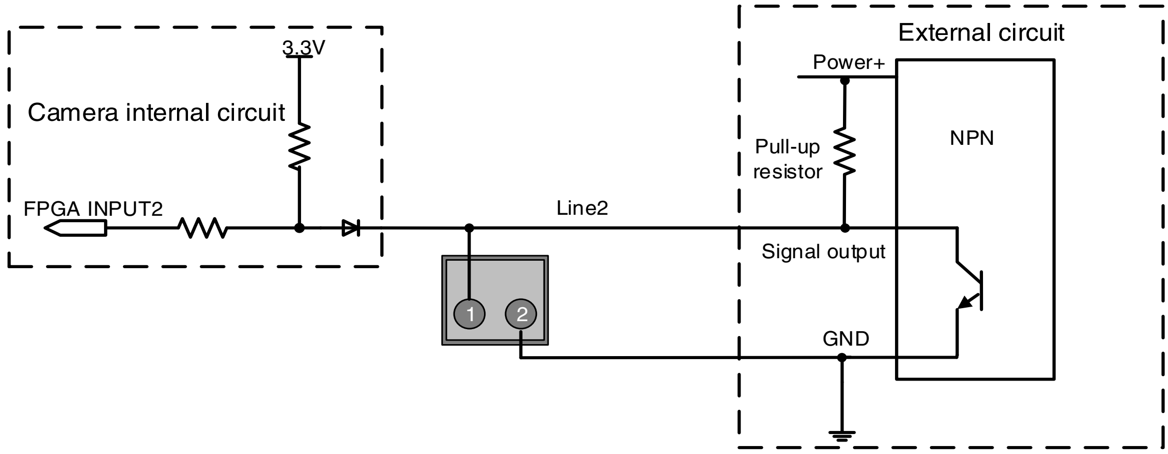


Figure 7-23 NPN photoelectric sensor connected to Line2 input circuit

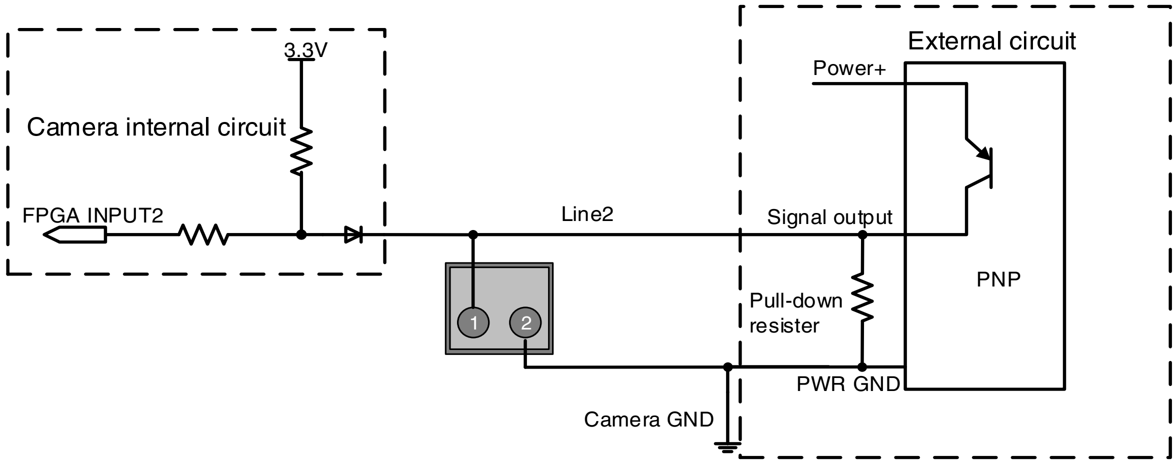


Figure 7-24 PNP photoelectric sensor connected to Line2 input circuit

- When Line2 is used as input, its pull-down resistance should not exceed 1K, otherwise the GPIO input voltage will exceed 0.6V and cannot be stably identified as logic 0
- Input rising time delay: <2μs (0°C ~45°C), see Figure 7-25 for parameter description
- Input falling time delay: <2μs (0°C ~45°C), see Figure 7-25 for parameter description

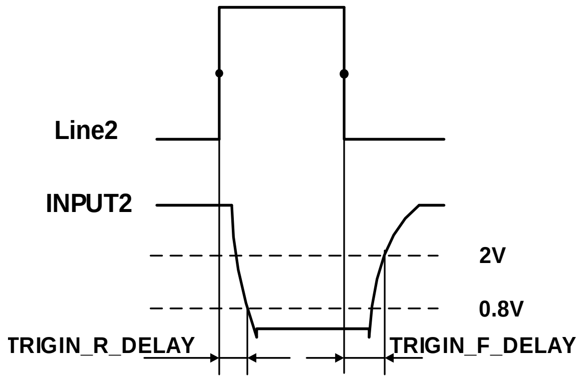


Figure 7-25 Parameter of Line2 input circuit

7.3.3.1.2. Line2 is configured as Output

- External voltage EXVCC range is 5 ~ 24V
- Maximum output current of Line2 is 25mA, and the output impedance is 40 Ω
- Transistor voltage drop and output current in typical application conditions (temperature is 25°C) are shown in Table 7-12

External voltage EXVCC	External resistance Rexternal	Transistor voltage drop (turn on, unit V)	Output current（mA）
5V	1kΩ	0.19	4.8
12V		0.46	11.6
24V		0.92	23.1

Table 7-12 Voltage and output current of Line2 in typical conditions

- Rising time delay =tr+td: <20μs (0°C~45°C) (parameter description as shown in Figure 7-26)
- Falling time delay =ts+tf: <20μs (0°C~45°C) (parameter description as shown in Figure 7-26)

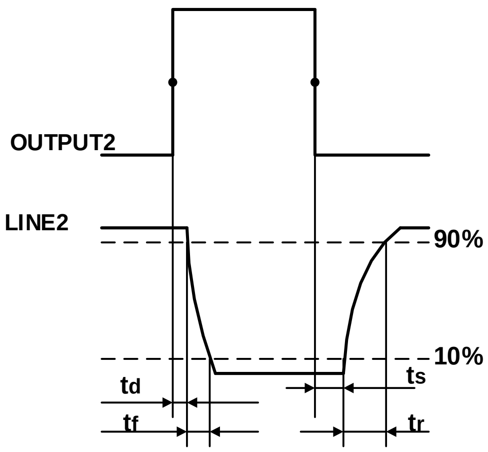


Figure 7-26 Output Circuit Parameter of Line2

- Delay time (td): the time required from 50% rising of OUTPUT2 to the decrease to 90% of the maximum value of Line2

- Falling time (tf): the time taken for the amplitude of Line2 to decrease from 90% to 10% of the maximum value
- Storage time (ts): the time required from 50% falling of OUTPUT2 to the rise to 10% of the maximum value of Line2
- Rising time (tr): the time for the response of Line2 to rise from 10% to 90% of its final value
- Delay parameters are affected greatly by external voltage and external pull-up resistor, but little by temperature. Output delay time in typical application conditions (temperature is 25°C) are shown in Table 7-13

Parameter	Test Conditions	Value (μs)		
Storage time(ts)	External power is 5V, pull-up resistor is 1kΩ	0.17	~	0.18
Delay time(td)		0.08	~	0.09
Rising time(tr)		0.11	~	0.16
Falling time(tf)		1.82	~	1.94
Rising time delay = tr+td		0.19	~	0.26
Falling time delay = tf+ts		1.97	~	2.09

Table 7-13 Delay time when GPIO is configured as output in typical conditions

- When Line2 is configured as output, the internal equivalent circuit of camera is shown in Figure 7-27, take Line2 as an example

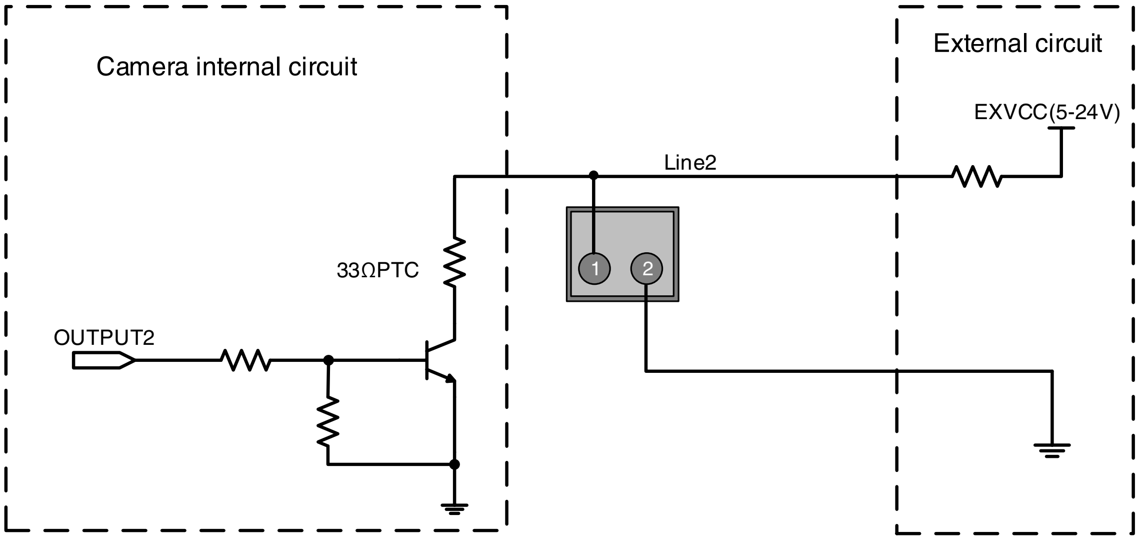


Figure 7-27 Internal equivalent circuit of camera when Line2 is configured as output

7.3.4. All-in-one/Split Vertical FPC Camera

I/O port is implemented by TXGA 6-pin anti-plug reverse receptacle (No.FWF10002-S06S24W5M), and the corresponding plug plastic shell model is FT10001-F2H.

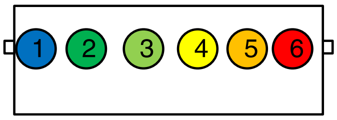
Diagram	Pin	Definition	Description
	1	Line3	GPIO Input/Output UART Tx/Rx
	2	Line0+	Opto-isolated input +
	3	Line2	GPIO Input/Output UART Tx/Rx
	4	Line1+	Opto-isolated output +
	5	Line0/1-	Opto-isolated input/output -
	6	GND	GPIO Ground

Table 7-14 I/O port definition

⚠ The positive and negative polarity of GPIO cannot be reversed, otherwise the camera or other devices connected to the camera may be burned.

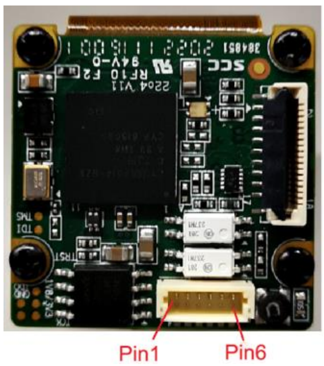


Figure 7-28 I/O interface

7.3.4.1. Line0 (Opto-isolated Input) Circuit

Hardware schematics of opto-isolated input circuit is shown as Figure 7-29

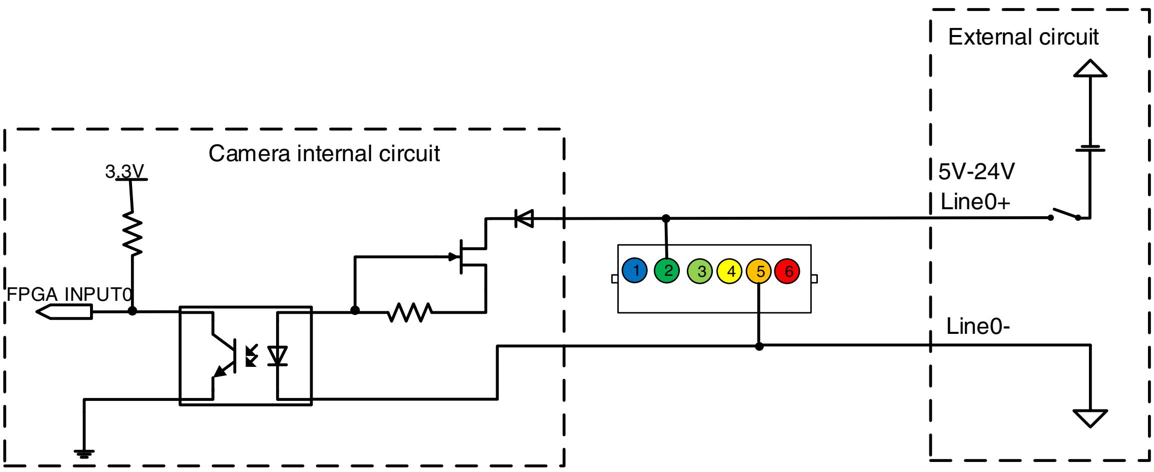


Figure 7-29 Opto-isolated input circuit

- Logic 0 input voltage: 0V~+2.5V (Line0+ voltage)
- Logic 1 input voltage: +5V~+24V (Line0+ voltage)
- Minimum input current: 7mA
- The status is unstable when input voltage is between 2.5V and 5V, which should be avoided
- When the external input voltage is 5V, there is no need for circuit-limiting resistance in the external input. But if there is a series resistance, please ensure the value is less than 90Ω. In order to protect the Line0+ while the external input voltage is higher than 9V, a circuit-limiting resistance is needed in the external input. The recommended resistance is shown in Table 7-15

External input voltage	Circuit-limiting resistance Rlimit	Line0+ input voltage
5V	Non or <90Ω	About 5V
9V	680Ω	About 5.5V
12V	1kΩ	About 6V
24V	2kΩ	About 10V

Table 7-15 Circuit-limiting resistance value

The connection method of the opto-isolated input circuit and the NPN and PNP photosensor is shown in Figure 7-30 and Figure 7-31 The relationship between the pull-up resistor and the external power supply voltage is shown in Table 7-15

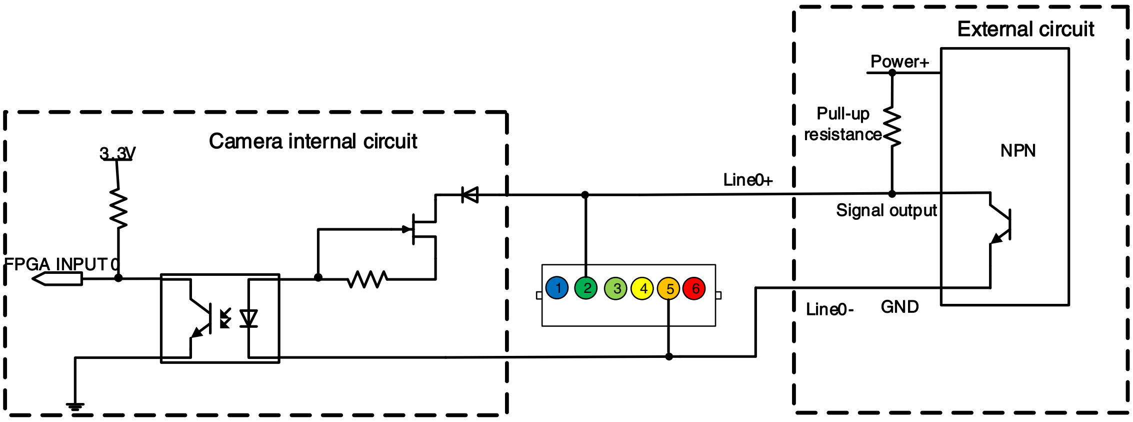


Figure 7-30 NPN photosensor connected to opto-isolated input circuit

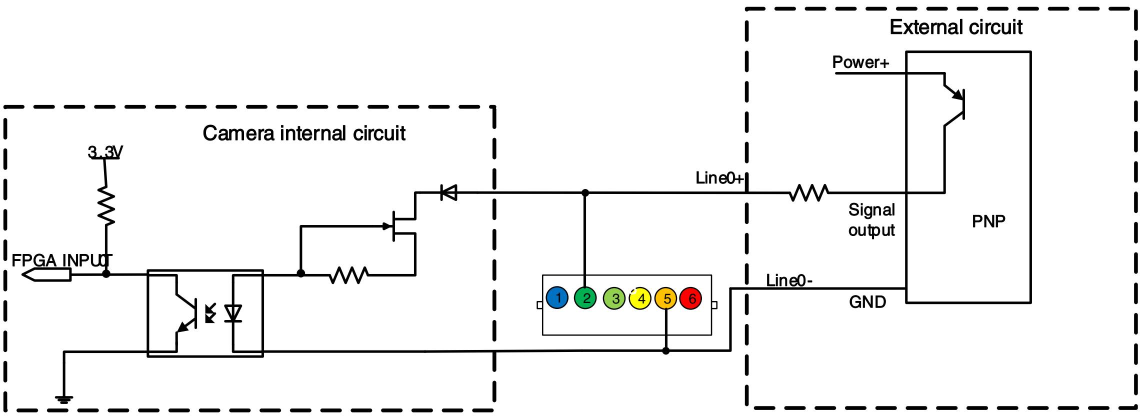


Figure 7-31 PNP photosensor connected to opto-isolated input circuit

- Rising edge delay: <50μs (0°C~45°C), parameter description as shown in Figure 7-32
- Falling edge delay: <50μs (0°C~45°C), parameter description as shown in Figure 7-32
- Different environment temperature and input voltage have influence on delay time of opto-isolated input circuit. Delay times in typical application environment (temperature is 25°C) is as shown in Table 7-16

Parameter	Test condition	Value (μs)		
Rising edge delay	VIN=5V	3.02	~	6.96
	VIN=12V	2.46	~	5.14
Falling edge delay	VIN=5V	6.12	~	17.71
	VIN=12V	8.93	~	19.73

Table 7-16 Delay time of opto-isolated input circuit in typical application environment

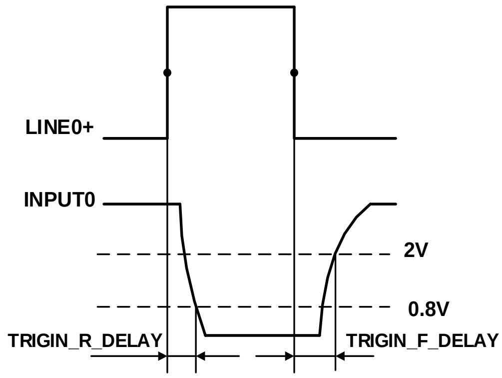


Figure 7-32 Parameter of opto-isolated input circuit

- Rising time delay (TRIGIN_R_DELAY): the time required for the response to the decrease to 0.8V of INPUT0 from 50% rising of LINE0+
- Falling time delay (TRIGIN_F_DELAY): the time required for the response to the rise to 2V of INPUT0 from 50% falling of LINE0+

7.3.4.2. Line1 (Opto-isolated Output) Circuit

Hardware schematics of opto-isolated output circuit is shown as Figure 7-33.

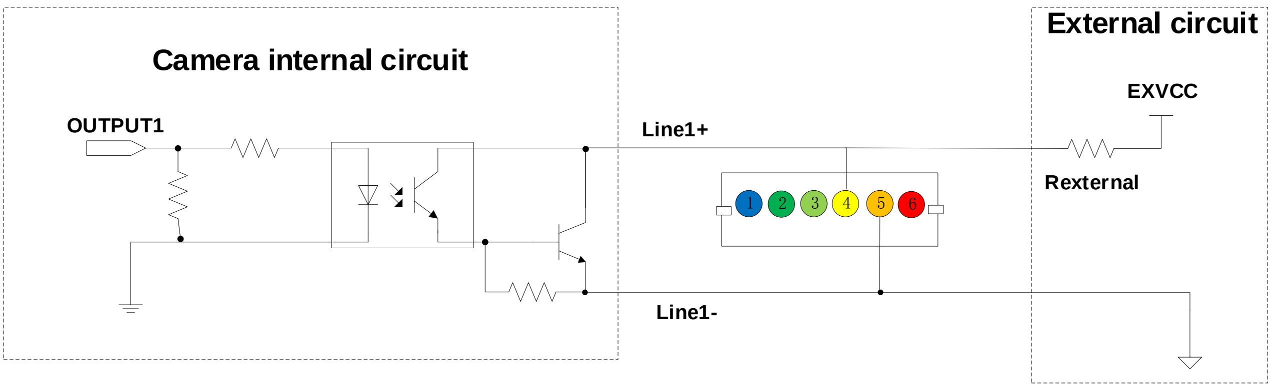


Figure 7-33 Opto-isolated output circuit

- Range of external voltage (EXVCC) is 5~24V
- Maximum output current of Line1 is 25mA
- Transistor voltage drop and output current of opto-isolated output circuit in typical application environment (temperature is 25°C) is as shown in Table 7-17

External voltage EXVCC	External resistance Rexternal	Transistor voltage drop (V)	Output current (mA)
5V	1kΩ	0.90	4.16
12V	1kΩ	0.97	11.11
24V	1kΩ	1.04	23.08

Table 7-17 Transistor voltage drop and output current of opto-isolated output circuit in typical application environment

- Rising time delay = tr+td: <50μs (0°C~45°C) (parameter description is shown in Figure 7-34)
- Falling time delay = ts+tf: <50μs (0°C~45°C) (parameter description is shown in Figure 7-34)
- Delay time in typical application conditions (environment temperature is 25°C) are shown in Table 7-18

Parameter	Test Condition	Value (μs)		
Storage time (ts)	External power is 5V, pull-up resistor is 1kΩ	6.16	~	13.26
Delay time (td)		1.90	~	3.16
Rising time (tr)		2.77	~	10.60
Falling time (tf)		7.60	~	11.12
Rising time delay = tr+td		4.70	~	13.76
Falling time delay = tf+ts		14.41	~	24.38

Table 7-18 Delay time of opto-isolated output circuit in typical application environment

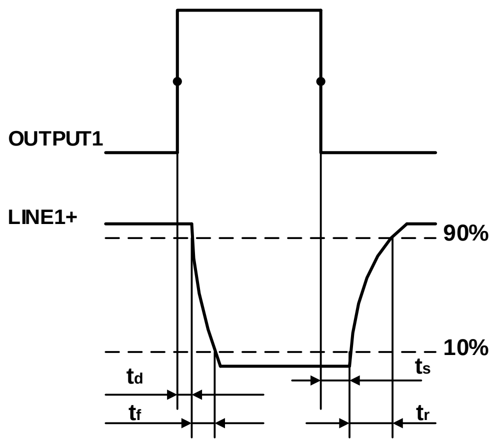


Figure 7-34 Parameter of opto-isolated output circuit

- Delay time (td): the time required from 50% rising of OUTPUT1 to the decrease to 90% of the maximum value of LINE1+
- Falling time (tf): the time taken for the amplitude of LINE1+ to decrease from 90% to 10% of the maximum value
- Storage time (ts): the time required from 50% falling of OUTPUT1 to the rise to 10% of the maximum value of LINE1+
- Rising time (tr): the time for the response of LINE1+ to rise from 10% to 90% of its final value

7.3.4.3. Line2/3 (Bidirectional) Circuit

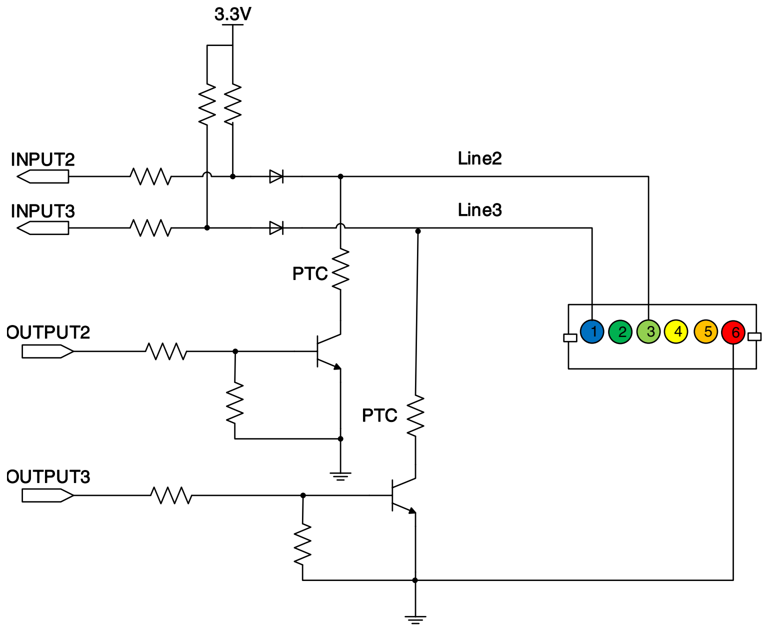


Figure 7-35 Line2/3 (bidirectional) circuit

7.3.4.3.1. Line2/3 is Configured as Input

- When Line2/3 is configured as input, the internal equivalent circuit of camera is shown in Figure 7-36

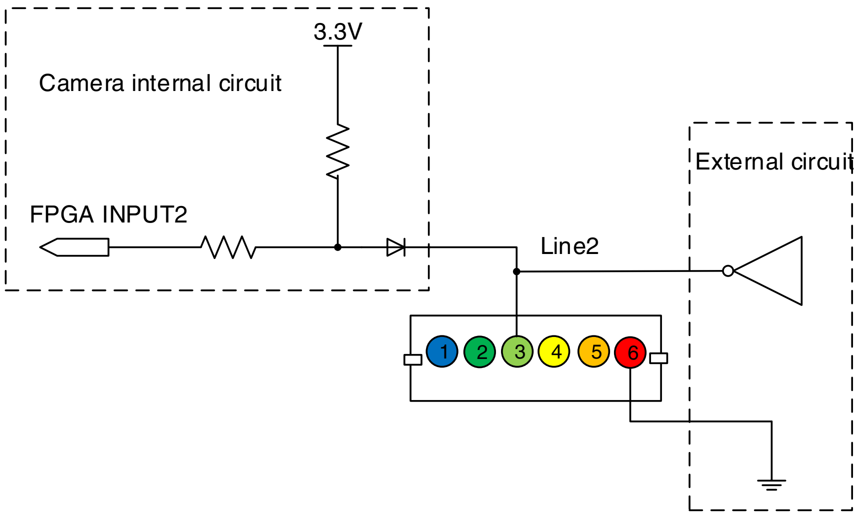


Figure 7-36 Internal equivalent circuit of camera when Line2 is configured as input

To avoid the damage of GPIO pins, please connect GND pin before supplying power to Line2.

- Logic 0 input voltage: 0V~+0.6V (GPIO1 voltage)
- Logic 1 input voltage: +1.9V~+24V (GPIO1 voltage)
- The status is unstable when input voltage is between 0.6V and 1.9V, which should be avoided
- When input of Line2 is high, input current is lower than 100uA. When input of Line2 is low, input current is lower than -1mA. The connection method between Line2 and NPN/PNP photoelectric sensors is shown in Figure 7-37 and Figure 7-38. The relationship between the pull-up resistor value and the external input voltage is shown in Table 7-19.

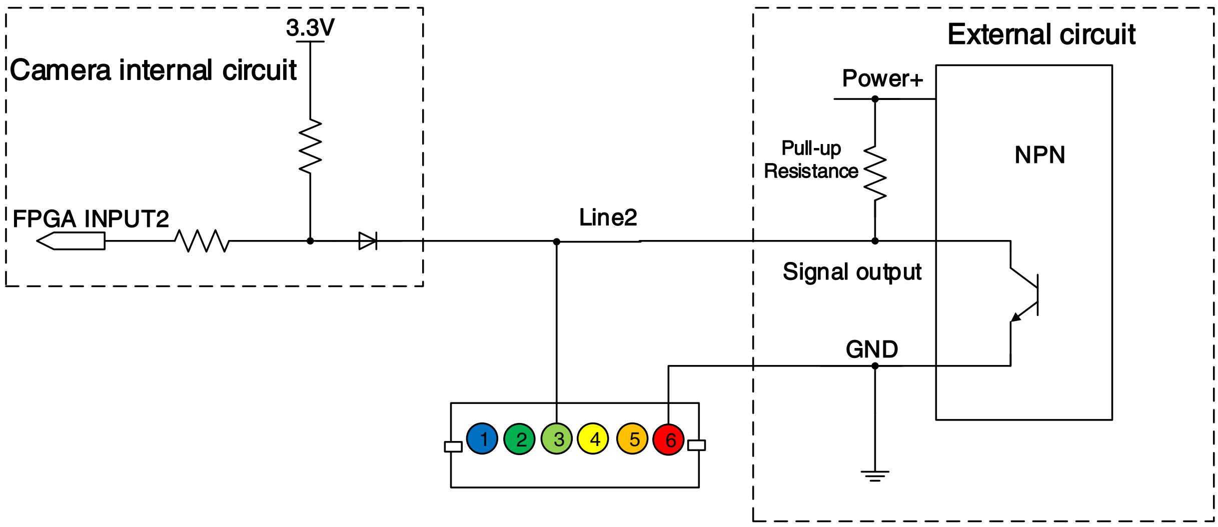


Figure 7-37 NPN photoelectric sensor connected to Line2 input circuit

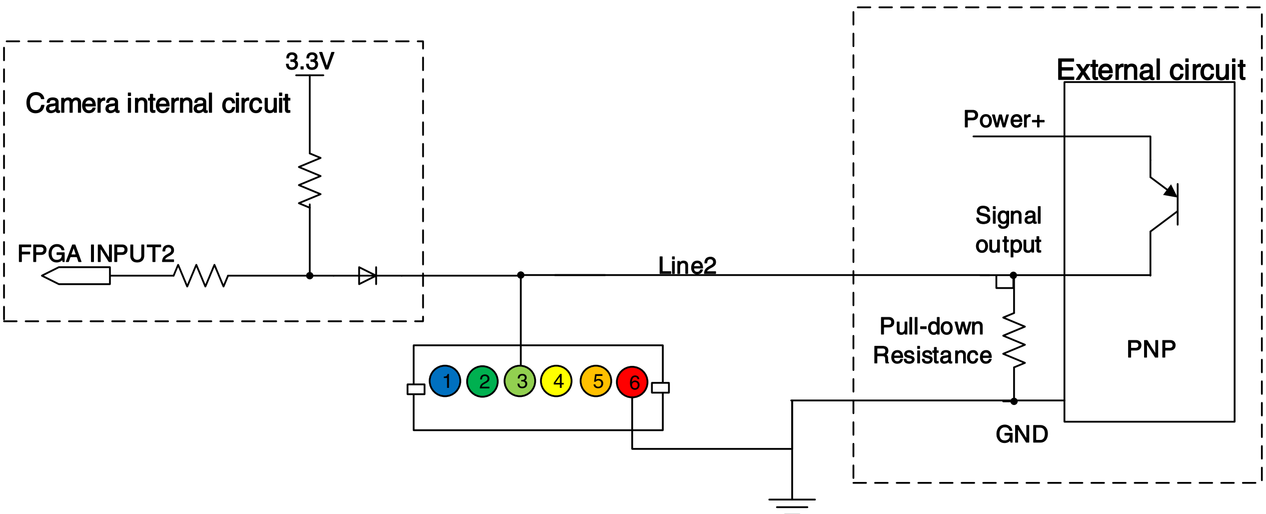


Figure 7-38 PNP photoelectric sensor connected to Line2 input circuit

- When LIine2 is configured as input, pull-down resistor over 1K should not be used, otherwise the input voltage of Line2 will be over 0.6V and logic 0 cannot be recognized stably
- Input rising time delay: <2μs (0°C~45°C), parameter description as shown in Figure 7-39

- Input falling time delay: <2μs (0°C~45°C), parameter description as shown in Figure 7-39

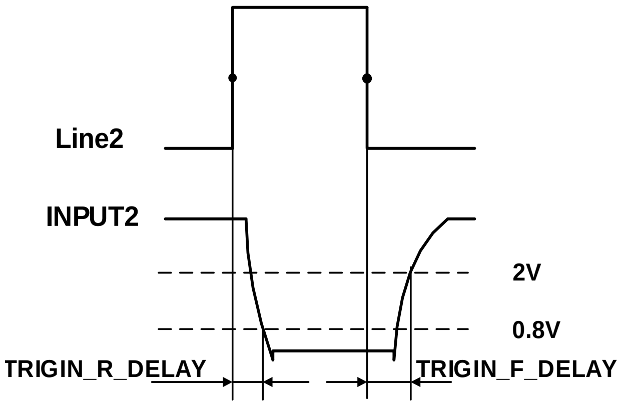


Figure 7-39 Parameter of Line2 input circuit

7.3.4.3.2. Line2/3 is Configured as Output

- Range of external voltage (EXVCC) is 5~24V
- Maximum output current of Line2 is 25mA, output impedance is 40Ω
- Transistor voltage drop and output current in typical application conditions (temperature is 25°C) are shown in Table 7-19

External voltage EXVCC	External resistance Rexternal	Transistor voltage drop (turn on, unit V)	Output current (mA)
5V	1kΩ	0.19	4.8
12V		0.46	11.6
24V		0.92	23.1

Table 7-19 Voltage and output current of Line2 in typical conditions

- Rising time delay = tr+td: <20μs (0°C~45°C) (parameter description as shown in Figure 7-40
- Falling time delay = ts+tf: <20μs (0°C~45°C) (parameter description as shown in Figure 7-40

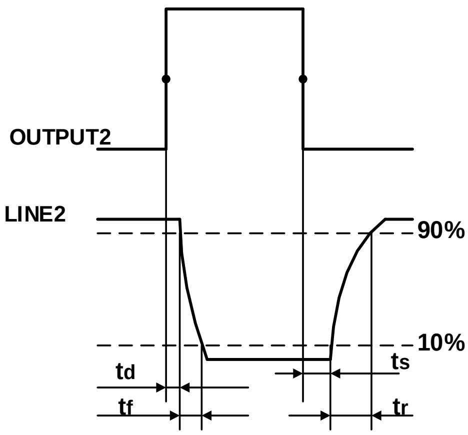


Figure 7-40 Parameter of opto-isolated output circuit

- Delay time (td): the time required from 50% rising of OUTPUT2 to the decrease to 90% of the maximum value of LINE2/3

- Falling time (tf): the time taken for the amplitude of LINE2/3 to decrease from 90% to 10% of the maximum value
- Storage time (ts): the time required from 50% falling of OUTPUT2 to the rise to 10% of the maximum value of LINE2/3
- Rising time (tr): the time for the response of LINE2/3 to rise from 10% to 90% of its final value
- Delay parameters are affected greatly by external voltage and external pull-up resistor, but little by temperature. Output delay time in typical application conditions (temperature is 25°C) are shown in Table 7-20

Parameter	Test Conditions	Value (μs)		
Storage time (ts)	External power is 5V, pull-up resistor is 1kΩ	0.17	~	0.18
Delay time (td)		0.08	~	0.09
Rising time (tr)		0.11	~	0.16
Falling time (tf)		1.82	~	1.94
Rising time delay = tr+td		0.19	~	0.26
Falling time delay = tf+ts		1.97	~	2.09

Table 7-20 Delay time when GPIO is configured as output in typical conditions

- When Line2/3 is configured as output, the internal equivalent circuit of camera is shown in Figure 7-41, take Line2 as an example

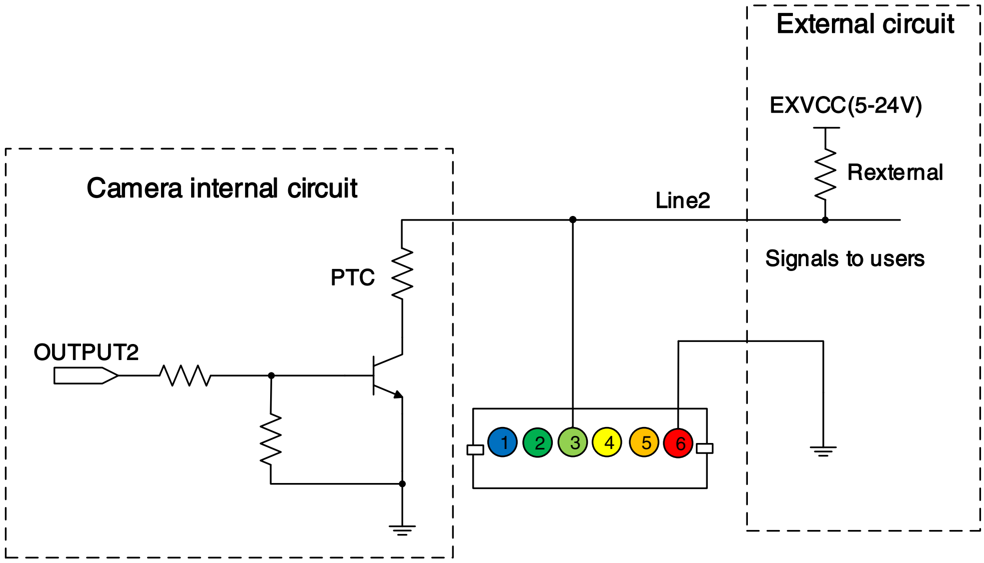


Figure 7-41 Internal equivalent circuit of camera when Line2 is configured as output

8. Features

8.1. I/O Control

For the VENUS USB3.0 cameras, different models have different available I/O numbers and types, see details in 4. General Specification and 7.3. I/O Port. I/O with the same signal definition are also have the same functions. For example, Line2 is GPIO, among all VENUS models (if supported Line2's electrical characteristics), the functions of these models are identical. Line0+/Line0- is opto-isolated input, if the models support Line0+/Line0-, then their functions are also identical.

The following are the descriptions of all IO functions, if models only support Line2, then the following mentioned Line0, Line1, Line3 functions are not supported for these models.

8.1.1. Input Mode Operation

1) Configuring Line as Input

The VENUS USB3.0 camera has three input signals: Line0, Line2 and Line3. In which the Line0 is uni-directional opto-isolated input, Line2 and Line3 are bi-directional line which can be configured as input or output.

The camera's default input is Line0 when the camera is powered on. Line2 and Line3 are input by default, which can be configured to be input or output by LineMode.

2) Input Debouncer

In order to suppress the interference signals from hardware trigger, the camera has the hardware trigger filtering feature, including rising edge filtering and falling edge filtering. The user can set the trigger filter feature by setting the " TriggerFilterRaisingEdge " and the " TriggerFilterFallingEdge ". The range of the trigger filter feature is [0, 5000] μs, step: 1μs.

Example 1: Setting the rising edge filter width to 1ms, the pulse width less than 1ms in the rising edge will be filtered out, as shown in Figure 8-1:

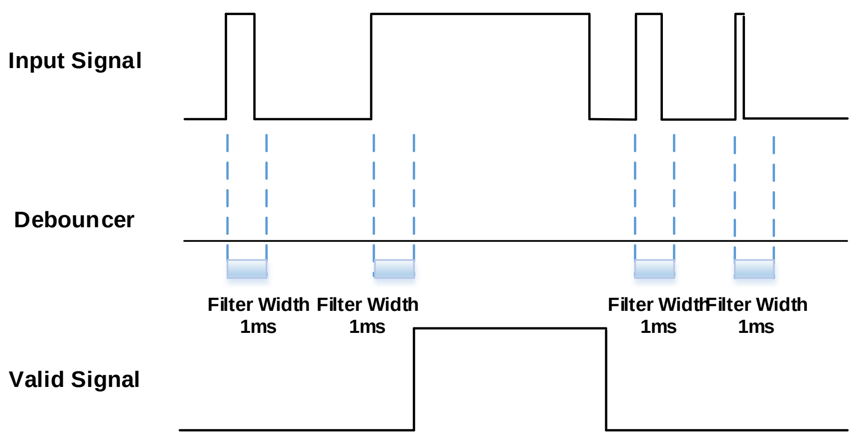


Figure 8-1 Input debouncer schematic diagram

3) Trigger Delay

The VENUS USB3.0 camera has trigger delay feature. The user can set the trigger delay feature by setting "TriggerDelay". The range of the trigger delay feature is [0, 3000000] μs, step: 1μs.

Example 1: Setting the trigger delay value to 1000ms, and the trigger signal will be valid after 1000ms delay, as shown in Figure 8-2.

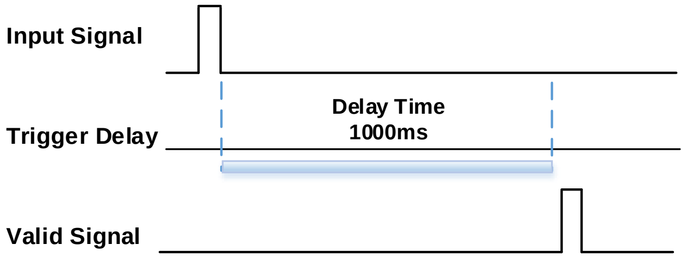


Figure 8-2 Trigger delay schematic diagram

4) Input Inverter

The signal level of input lines is configurable for the VENUS USB3.0 camera. The user can select whether the input level is reverse or not by setting "LineInverter".

For the camera, the default input line level is false when the camera is powered on, indicating that the input line level is not reversed. If it is set as true, indicating that the input line level is reversed. As shown in the Figure 8-3:

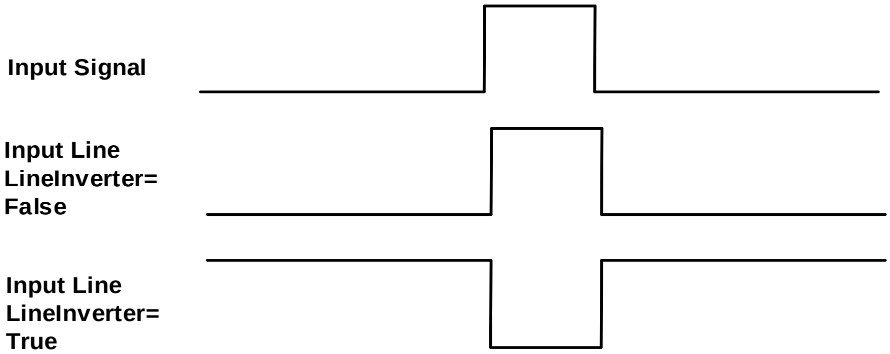


Figure 8-3 Setting input line to reverse

8.1.2. Output Mode Operation

1) Configuring Line as output

The VENUS USB3.0 camera has three output signal: Line1, Line2 and Line3. In which Line1 is the unidirectional opto-isolated output, Line2 and Line3 are bi-direction configurable I/O.

The camera's default intput is Line1 when the camera is powered on. Line2 and Line3 can be configured to be output by changing the "LineMode" of this line.

Each output source of the output line is configurable, and the output source includes: Strobe, UserOutput0, UserOutput1, UserOutput2, ExposureActive, FrameTriggerWait, AcquisitionTriggerWait, Timer1Active. And ExposureActive, FrameTriggerWait and AcquisitionTriggerWait are supported by partial models only.

The default output source of the camera is UserOutput0 when the camera is powered on.

What status (high or low level) of the output signal is valid depends on the specific external circuit. The following signal diagrams are described as examples of active low.

- Strobe

In this mode the camera sends a trigger signal to activate the strobe. The strobe signal is active low. After receiving the trigger signal, the strobe signal level is pulled low, and the pull-low time is the sum of the exposure delay time and the exposure time.

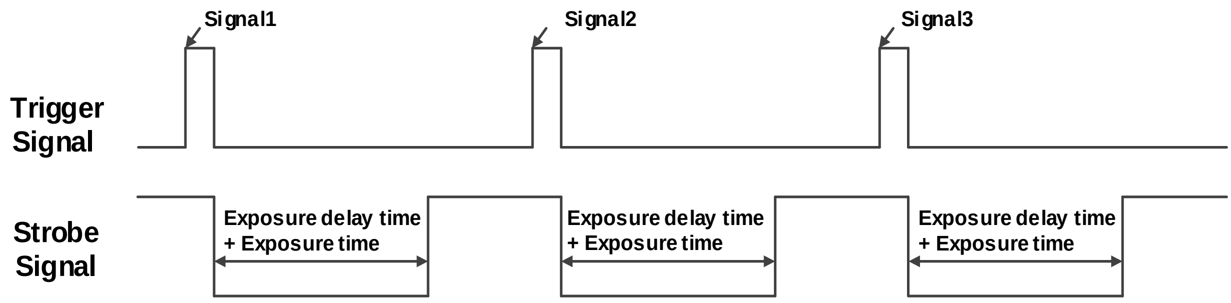


Figure 8-4 Strobe signal schematic diagram

- UserOutput

In this mode, the user can set the camera's constant output level for special processing, such as controlling the constant light source or the alarm light (two level types are available: high level or low level).

For example: select line2 as the output line, the output source is selected as UserOutput1, and the output value is defined as true.

"LineSelector" is selected as "line2", "LineMode" is set to "Output", "LineSource" is set to "UserOutput1", "UserOutputSelector" is selected as "UserOutput1", and "UserOutputValue" is set to "true".

- ExposureActive

You can use the "ExposureActive" signal to check whether the camera is currently exposing. The signal goes low at the beginning of the exposure and the signal goes high at the end of the exposure. For electronic rolling shutter cameras, the signal goes low when the exposure of the last line ends.

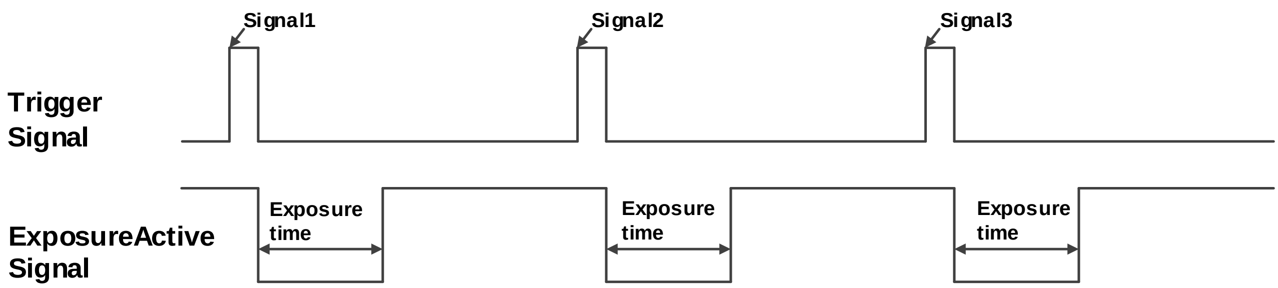


Figure 8-5 Global shutter "ExposureActive" signal schematic diagram

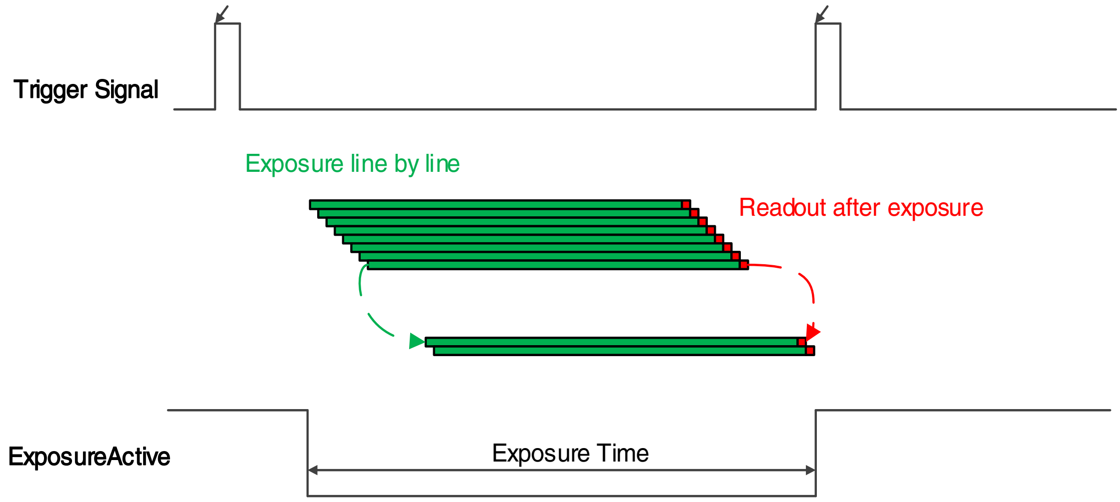


Figure 8-6 Electronic rolling shutter "ExposureActive" signal schematic diagram

This signal is useful when the camera or target object is moving. For example, suppose the camera is mounted on a robotic arm that can move the camera to different position. Generally, it is not desirable for the camera to move during the exposure. In this case, you can check the exposure activity signal to know the exposure time so you can avoid moving the camera during this time.

- TriggerWait

The "TriggerWait" signal can be used to optimize the acquisition of the trigger image and to avoid excessive triggering.

It is recommended to use the "TriggerWait" signal only when the camera is configured for hardware trigger. For software trigger, please use the "AcquisitionStatus". When the camera is ready to receive a trigger signal of the corresponding trigger mode, the "TriggerWait" signal goes low. When the corresponding trigger signal is used, the "TriggerWait" signal goes high. It remains high until the camera is ready to receive the next trigger.

When the trigger mode is "FrameStart", the camera acquires only one frame of image when it receives the trigger signal. After receiving the trigger signal, the "FrameTriggerWait" signal is pulled low and the camera starts exposure transmission. After the transfer is complete, the "FrameTriggerWait" signal is pulled high.

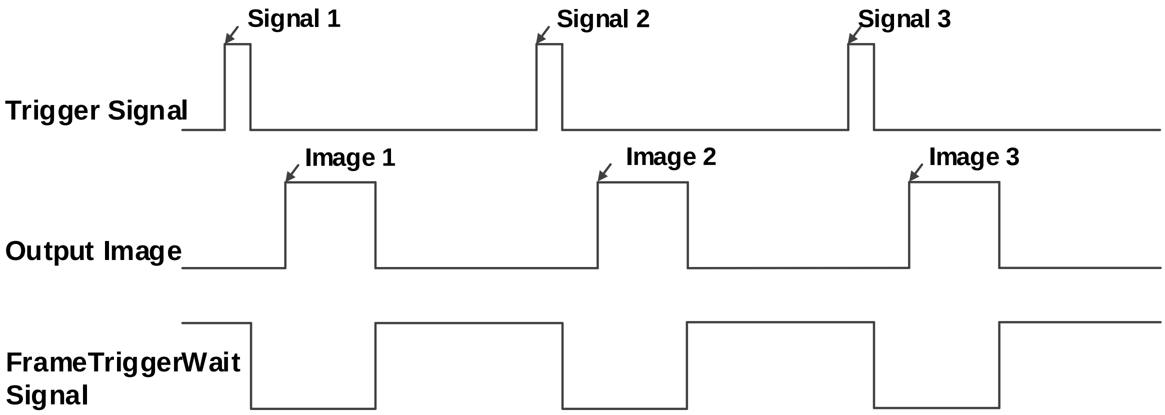


Figure 8-7 "FrameTriggerWait" signal schematic diagram

When the trigger mode is "FrameBurstStart", each time the camera receives a trigger signal, it will acquire the set AcquisitionFrameCount frames of image. After receiving the trigger signal, the "AcquisitionTriggerWait" signal is pulled low and the camera starts the exposure transmission. When the transmission is completed and images are transferred, the "AcquisitionTriggerWait" signal will be pulled high.

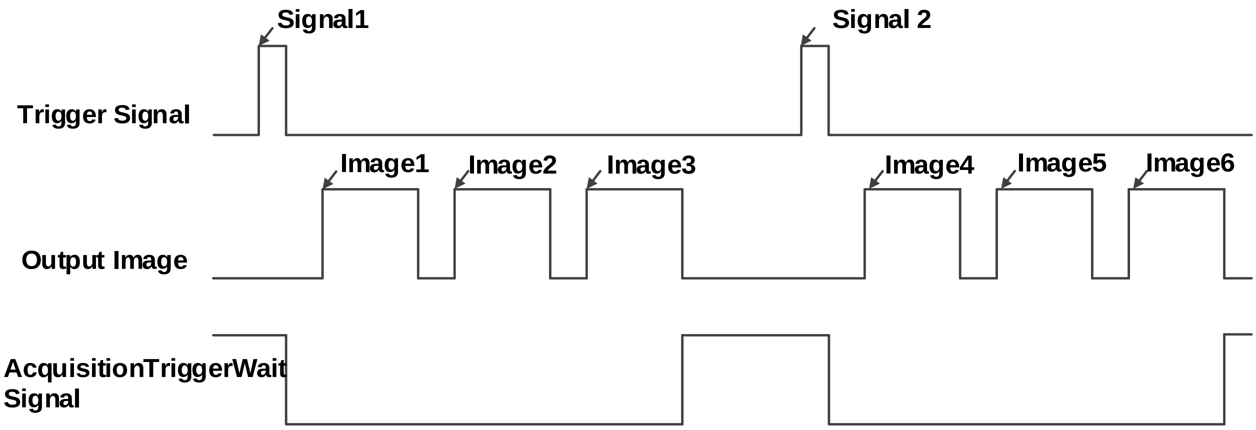


Figure 8-8 "AcquisitionTriggerWait" signal schematic diagram

2) Setting the user-defined status for the output lines

The VENUS USB3.0 camera can select the user-defined output by setting "LineSource", by setting "UserOutputValue" to configure the output signal.

By setting "UserOutputSelector" to select UserOutput0, UserOutput1 or UserOutput2.

By setting "UserOutputValue" to set the user-defined output value, and the default value is false when the camera is powered on.

3) Output Inverter

In order to facilitate the camera IO configuration and connection, the camera can configure output signal level. The user can select whether the output level is reverse or not by setting "LineInverter".

The default output signal level is false when the camera is powered on, indicating that the output line level is not reversed. If it is set as true, indicating that the output line level is reversed. As shown in the Figure 8-3 and Figure 8-9.

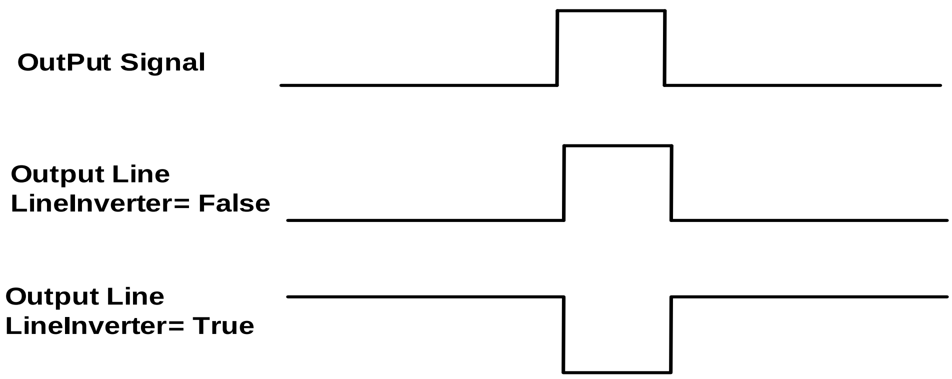


Figure 8-9 Set output line reversion

8.1.3. Read the LineStatus

1) Read the level of single line

The VENUS USB3.0 camera can get the line's signal status. When the device is powered on, the default status of Line0 and Line1 are false, and the default status of Line2 and Line3 are true.

2) Read all the lines level

The VENUS USB3.0 camera can get the current status of all lines. On the one hand, the signal status is the status of the external IO after the reversal of the polarity. On the other hand, signal status level can reflect the external IO level.

All the lines level status bit of the VENUS USB3.0 camera are shown in Table 8-1. The default value is 0xC.

Line3	Line2	Line1	Line0
1	1	0	0

Table 8-1 Camera line status bit

8.2. Image Acquisition Control

8.2.1. Acquisition Start and Stop

8.2.1.1. Acquisition Start

It can send **AcquisitionStart** command immediately after opening the camera. The acquisition process in continuous mode is illustrated in Figure 8-10, and the acquisition process in trigger mode is illustrated in Figure 8-11.

- **Continuous Acquisition**

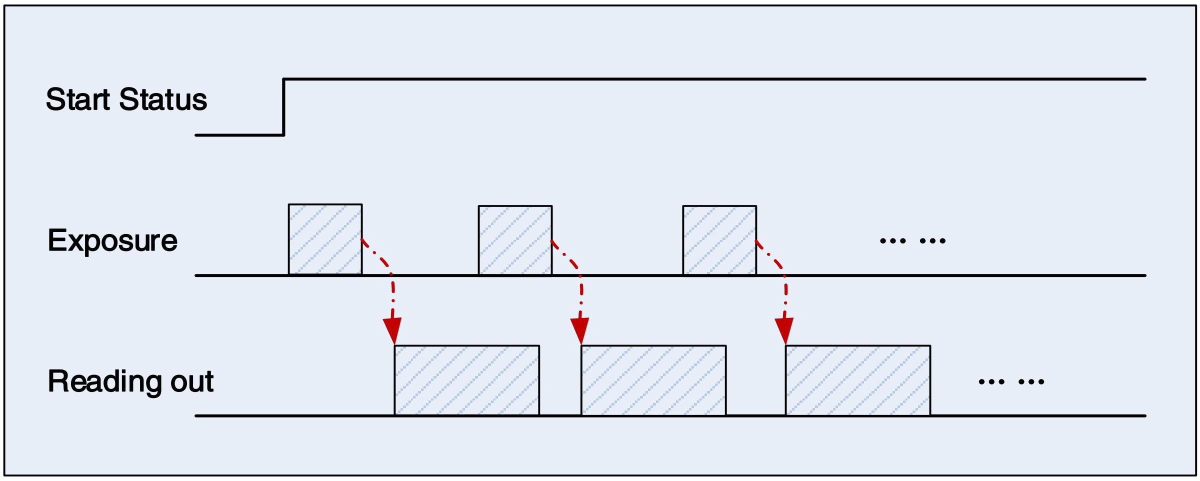


Figure 8-10 Continuous acquisition process

In continuous mode, a camera starts to expose and read out after receiving the **AcquisitionStart** command. The frame rate is determined by the exposure time, ROI and some other parameters.

- **Trigger Acquisition**

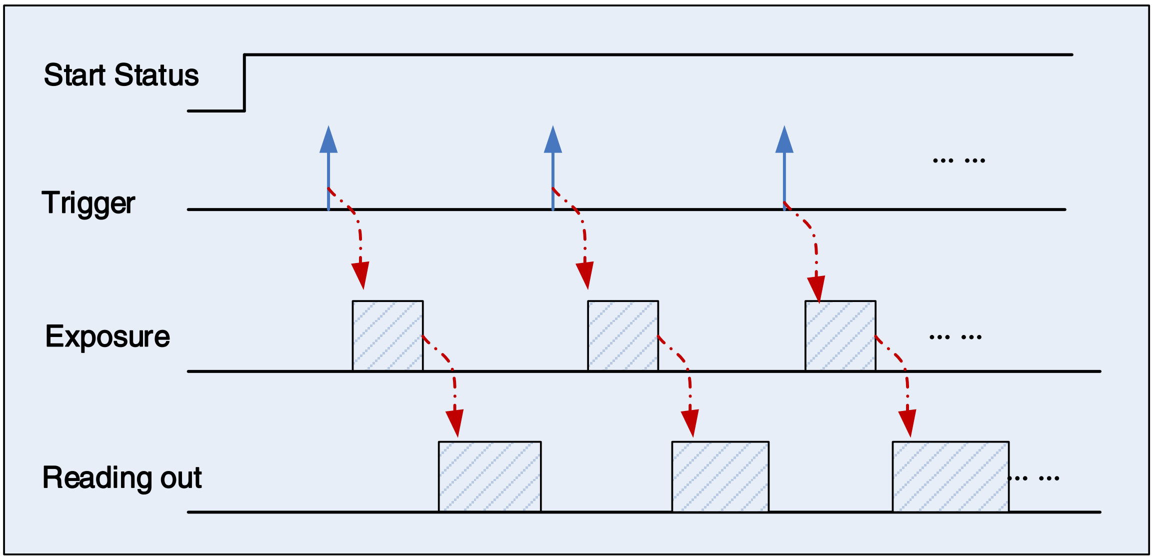


Figure 8-11 Trigger acquisition process

In trigger mode, sending **AcquisitionStart** command is not enough, a trigger signal is also needed. Each time a frame trigger is applied (including software trigger and hardware trigger), the camera will acquire and transmit a frame of image.

8.2.1.2. Acquisition Stop

It can send **AcquisitionStop** command to camera at any time. The acquisition stop process is irrelevant to acquisition mode. But different stop time will result in different process, as shown in Figure 8-12 and Figure 8-13.

- **Acquisition stop during reading out**

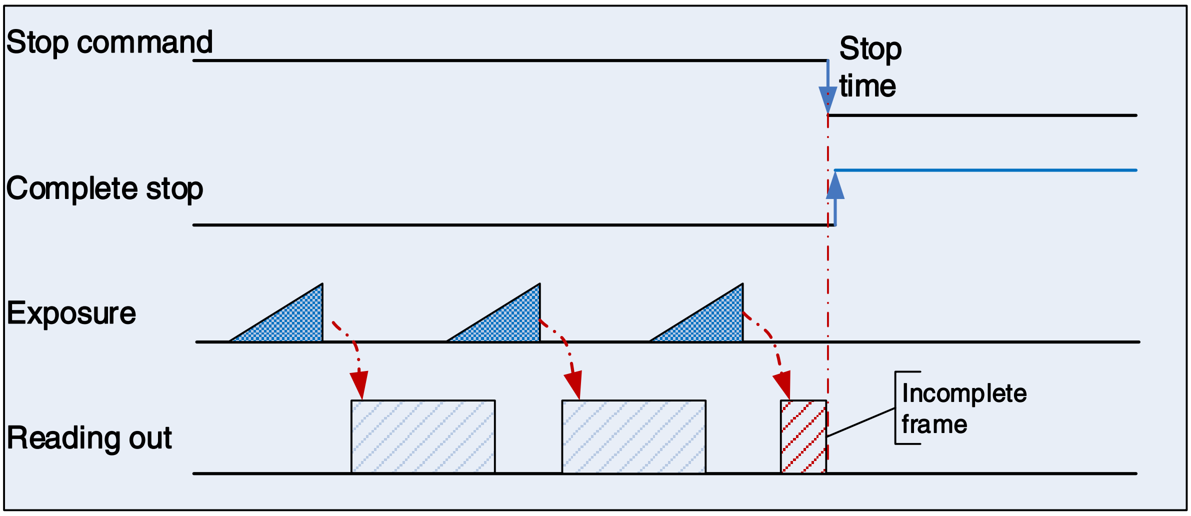


Figure 8-12 Acquisition stop during reading out

As shown in Figure 8-12, when the camera receives an **AcquisitionStop** command during reading out, it stops transferring frame data immediately. The currently transferred frame data is regarded as incomplete frame and will be discarded.

- **Acquisition stop during blanking**

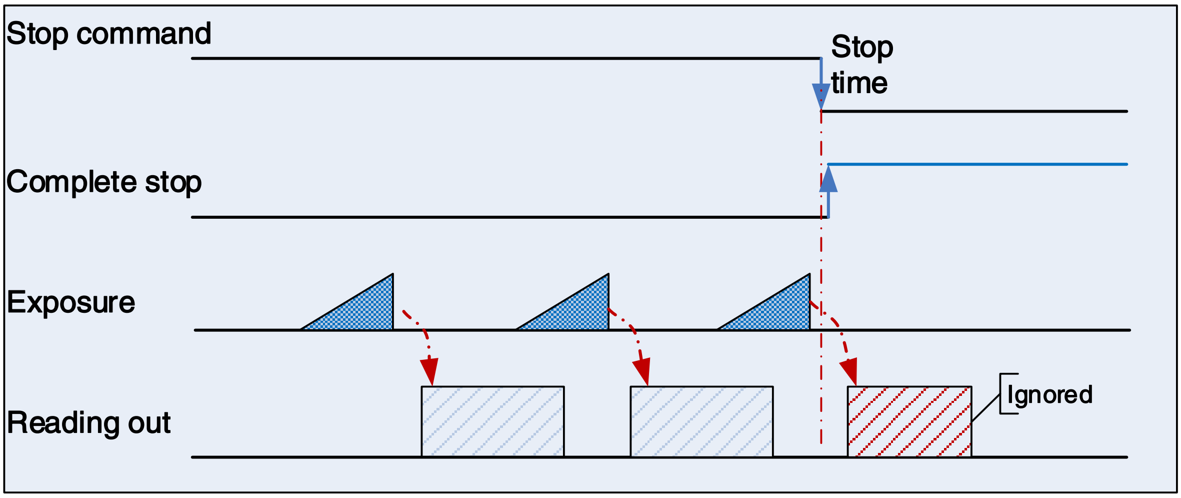


Figure 8-13 Acquisition stop during blanking

After the camera transferred a whole frame, the camera goes into wait state. When user sends an **AcquisitionStop** command in wait state, the camera will return to stop acquisition state. The camera will not send any frames even if it is just going to start the next exposing.

8.2.2. Acquisition Mode

The VENUS USB3.0 camera support continuous acquisition mode.

In continuous acquisition mode, the camera continuously acquires and transmits images until the acquisition is stopped.

1) When the trigger mode is set to On, the trigger type is **FrameStart**

After executing the **AcquisitionStart** command, the camera waits for a trigger signal, which may be a software trigger or a hardware trigger of the camera. Each time the camera receives a trigger signal, it can acquire a frame of image until the **AcquisitionStop** command is executed. It is not necessary to execute the **AcquisitionStart** command every time.

2) When the trigger mode is set to Off

After executing the **AcquisitionStart** command, the camera will continuously acquire images until it receives the **AcquisitionStop** command.

⚠ You can check if the camera is in the waiting trigger status by the camera's trigger wait signal or by using the acquisition status function.

8.2.3. Trigger Type Selection

Two camera trigger types are available: **FrameStart** and **FrameBurstStart**. Different trigger types correspond to their respective set of trigger configurations, including trigger mode, trigger delay, trigger source, trigger polarity, and software trigger commands.

- FrameStart trigger mode

The **FrameStart** trigger is used to acquire one image. Each time the camera receives a **FrameStart** trigger signal, the camera begins to acquire an image.

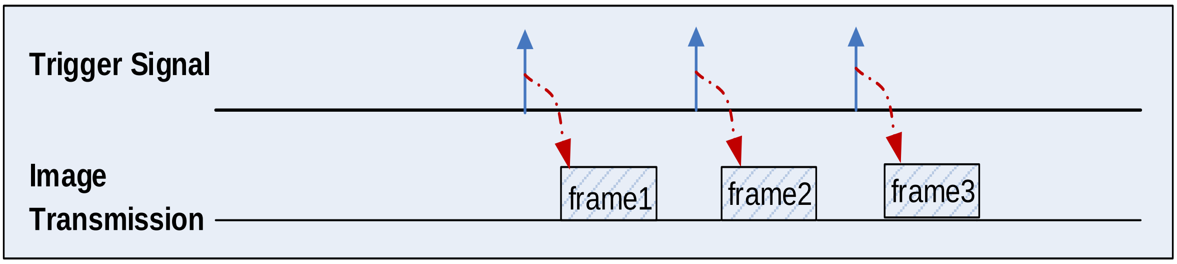


Figure 8-14 FrameStart trigger

- FrameBurstStart trigger mode

You can use the **FrameBurstStart** trigger signal to acquire a series of images ("continuous shooting" of the image). Each time the camera receives a **FrameBurstStart** trigger signal, the camera will start acquiring a series of images. The number of acquired image frames is specified by the "Acquisition burst frame count" parameter. The range of "Acquisition burst frame count" is 1~255, and the default value is 1.

For example, if the "Acquisition burst frame count" parameter is set to 3, the camera automatically acquires 3 images. Then, the camera waits for the next **FrameBurstStart** trigger signal. After receiving the next trigger signal, the camera will take another 3 images, and so on.

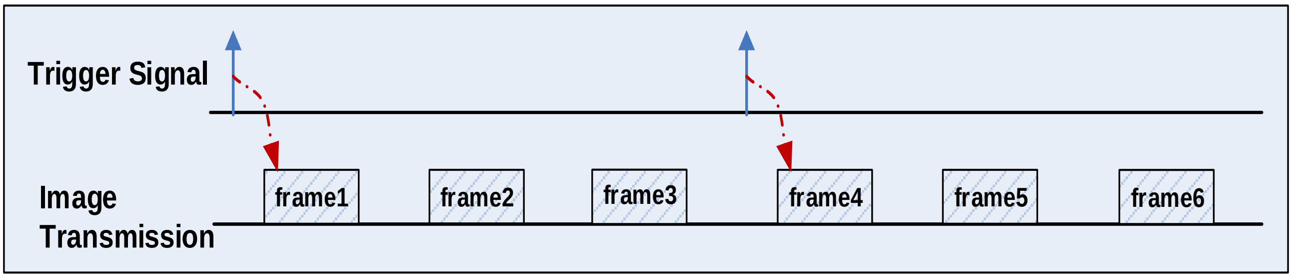


Figure 8-15 FrameBurstStart trigger

- FrameStart trigger mode and FrameBurstStart trigger mode are selected at the same time

If the **FrameStart** trigger mode and the **FrameBurstStart** trigger mode are selected at the same time, the trigger sequence is: first send the **FrameBurstStart** trigger signal, then send the **FrameStart** trigger signal. Each time a **FrameStart** trigger signal is sent, an image is acquired until the value of the "Acquisition burst frame count" parameter is reached.

For example, the **FrameStart** trigger mode and the **FrameBurstStart** trigger mode are selected at the same time. If the "Acquisition burst frame count" parameter is set to 3, when the camera receives a **FrameBurstStart** trigger signal, no image will be acquired. When the **FrameStart** trigger signal is received, the camera will acquire1 image, each time a **FrameStart** trigger signal is received, the camera will acquire 1 image. When 3 images are acquired, the camera will wait for the next **FrameBurstStart** trigger signal, and so on.

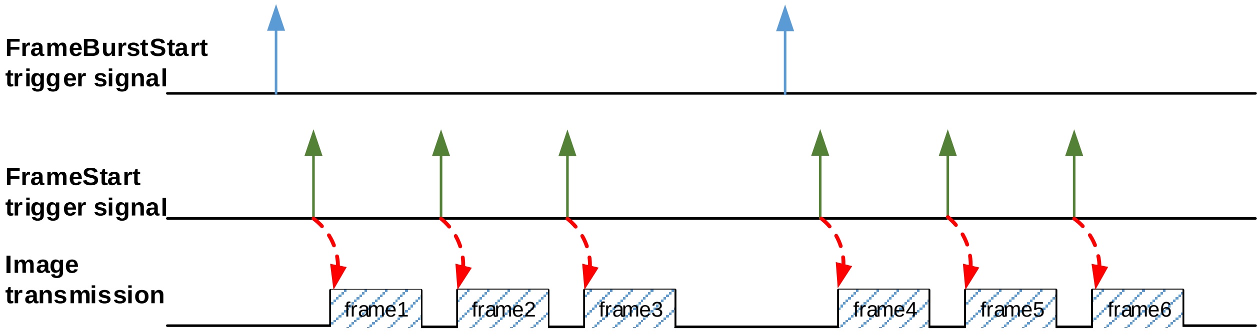


Figure 8-16 Two trigger modes are selected at the same time

- Burst Mode

For cameras that do not support **Burst** mode, the maximum frame rate output by the camera is limited by the physical bandwidth of the USB 3.0 interface, which means that the effective bandwidth output by the sensor cannot exceed 400MBps.

In order to maximize the performance of the sensor, some cameras support **Burst** function. Even if the sensor outputs a certain number of images at the maximum frame rate, the images output by the sensor are cached in the camera's DDR3 chip, and they are also not limited by the bandwidth of 400MBps during outputting.

Because the effective bandwidth output by the sensor exceeds 400MBps, but the bandwidth of camera's image transmission is still 400MBps, the sensor cannot always output images at the maximum frame rate, otherwise frames may be lost.

Suggested method:

1) Query whether the camera supports **Burst** mode and the number of frames, see details in Table 8-2.

2) If camera support Burst mode, then use the **FrameBurstStart** trigger type to implement the **Burst** function. The specific steps are as follows, take VE2S-301-125U3M/C-S as an example:

   a) Set **Trigger Type** as **FrameBurstStart**, **Trigger Mode** as ON, **Acquisition burst frame count** as 64 (the range is 1~64), it may cause frame loss if exceeds the maximum burst acquisition frames.

   b) While using the software trigger or hardware trigger camera, the camera outputs 64 images at the maximum frame rate supported by the sensor.

   c) The user cannot send the next trigger signal until they receive 64 images.

Model	Maximum Burst Acquisition Frame	Maximum Burst Acquisition Frame Rate
VE2S-301-125U3M/C-S (J150)	64	153.09

Table 8-2 Frame/frame rate for burst mode supported cameras

VE2S-301-125U3M/C-S (J150) camera's Burst Mode only effective when the sensor bit depth is 8bit. When the sensor bit depth is 10bit or 12bit, due to sensor performance constraints, the effective bandwidth of the sensor output does not exceed 400 MBps, so there is no Burst effect.

8.2.4. Switching Trigger Mode

During the stream acquisition process, the user can switch the trigger mode of the camera without the **AcquisitionStop** command.

As shown below, switching the trigger mode at different positions will have different results.

- **Switch trigger mode during frame reading out**

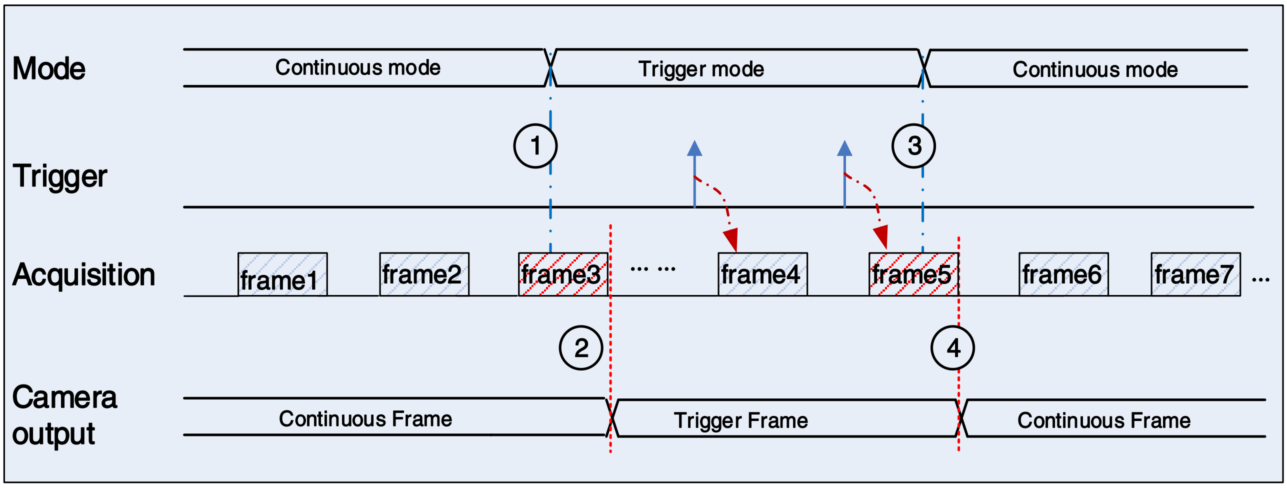


Figure 8-17 Switch trigger mode during frame reading out

As shown in Figure 8-17, the camera starts with trigger mode **OFF** after receiving acquisition start command.

At point 1, the camera gets a command of setting trigger mode **ON** while transferring the 3rd frame in trigger mode **OFF**. The trigger mode is not active until the 3rd frame is finished, at point 2, and then the trigger signal will be accepted. At point 3, the camera gets a command of switching back to **OFF**. It is also not active until the 5th frame is finished, it should wait a complete reading out. The camera switches from trigger mode to continuous mode at point 4, and then the camera works in continuous mode.

- **Switch trigger mode during blanking**

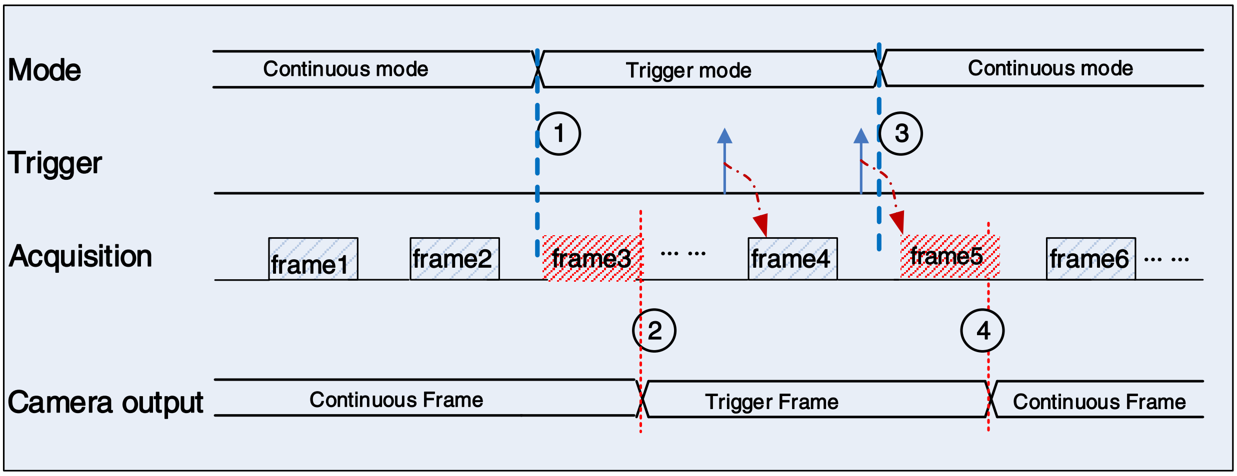


Figure 8-18 Switch trigger mode during blanking

As shown in Figure 8-18, the camera with trigger mode **OFF** begins after receiving an **AcquisitionStart** command.

At point 1, the camera gets a command of setting trigger mode **ON** while it is in wait state. The trigger mode is not active until the 3rd frame is finished, i.e., point 2. Please note that the 3rd frame does not belong to trigger mode. All trigger frames need trigger signals or software trigger commands. At point 3, the camera gets a command of switching back to continuous mode. It is also not active until the 5th frame is finished, it should wait a complete frame. The camera switches from trigger mode to continuous mode at point 4, and then the camera works in continuous mode.

8.2.5. Continuous Mode and Configuration

- **Continuous mode configuration**

The default value of **Trigger Mode** is **OFF** in default user set. If the camera is opened with default user set, the camera works in continuous mode directly. Otherwise, user can set **Trigger Mode** to **OFF** to work in continuous mode.

Other parameters also can be changed in **Trigger Mode OFF**.

- **Continuous mode features**

In continuous acquisition mode, the camera acquires and transmits images according to camera parameter set.

⚠ In continuous mode, ROI size may have effects on frame rate.

8.2.6. Software Trigger Acquisition and Configuration

- **Software trigger acquisition configuration**

The camera supports software trigger acquisition mode. Three steps followed should be ensured.

1) Set the Trigger Mode to ON.

2) Set the Trigger Source to Software.

3) Send Software Trigger command.

All the software trigger commands are sent by the host through the USB3.0 bus, to trigger the camera to acquire and transmit images.

- **Software trigger acquisition features**

In software trigger acquisition mode, the camera begins to acquire one image after receiving software trigger commands. In general, the number of frames is equal to the number of software trigger commands. The relative features are illustrated below:

1) In software trigger acquisition mode, if the trigger frequency is lower than permissible maximal FPS (Frame per Second) of the camera, the current frame rate is trigger frequency. If the trigger frequency

is higher than permissible maximal FPS (Frame per Second) of the camera, some software triggers are ignored and the current frame rate is lower than trigger frequency.

2) The trigger delay feature can control the camera delay interval between your triggers and the camera acquiring frames. The default value of trigger delay time is zero.

8.2.7. Hardware Trigger Acquisition and Configuration

- **Hardware trigger acquisition configuration**

The VENUS USB3.0 camera supports hardware trigger acquisition mode. First， set the Trigger Mode to ON. At the same time, make sure that the physical connection of the external trigger is completed for the camera's aviation connector.

Different models have different IO quantities and types, please see details in 4.General Specification section.

- **Hardware trigger acquisition features**

The relative features about the camera's trigger signal process are illustrated below:

1) The polarity of lines can be set to inverted or not inverted, and the default setting is not inverted.

2) Improper signal can be filtered by setting appropriate value to trigger filter. Raising edge filter and falling edge can be set separately. The range is from 0 to 5000 μs. The default configuration is not use trigger filter.

3) The time interval between trigger and exposure can be set through the trigger delay feature. The range of time interval covers from 0 to 3000000μs. The default value of trigger delay time is zero.

The features, like trigger polarity, trigger delay and trigger filter, can be select in the GalaxyView.

The camera's trigger source Line0 uses opto-isolated circuit to isolate signal. Its internal circuit delay trigger signal and rising edge's delay time is less than falling edge's. There are a dozen clock cycles delay of rising edge and dozens clock cycles delay of falling edge. If you use Line0 to trigger the camera, the positive pulse signal's positive width will be wider (about 20-40μs) and the negative pulse signal's negative width will be narrower (about 20-40μs). You can adjust filter parameter to accurately filter trigger signal.

- **Exposure delay**

When a hardware trigger signal is received to the sensor to start exposure, there is a small delay, which is called the exposure delay and consists of four parts of time.

T1: The delay introduced by the hardware circuit when the external signal passes through the optocoupler or GPIO. The value is generally in the range of several to several tens of μs. The delay is mainly affected by the connection mode, trigger signal intensity and temperature. When the external environment is constant, the delay is generally stable.

T2: Delay introduced by the trigger filter. For example, if the trigger filter time is set to 50μs, T2 is 50μs.

T3: Trigger delay (trigger_delay), the camera supports trigger delay feature. If the trigger delay is set to 200μs, T3 is 200μs.

T4: The sensor timing sequence delay, the internal exposure of the sensor is aligned with the row timing sequence, so T4 has a maximum of several row period jitter. Each sensor has a different value, and some products with high latency (hundreds of μs or more) have additional configuration time counted in T4.

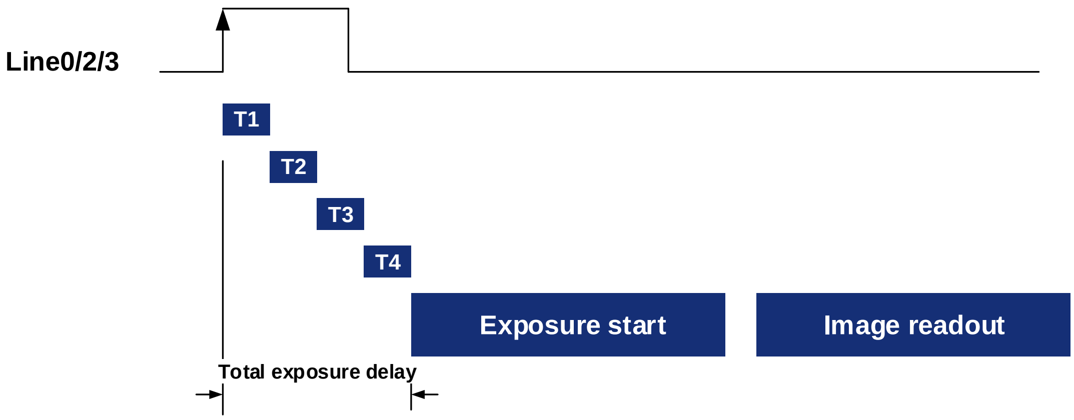


Figure 8-19 Exposure delay

The following table shows the total exposure delay time for each sensor.

T1 is calculated according to the typical delay (5μs) of line0. If it is line2/3, T1 can be ignored.

T2 is calculated as 0μs.

T3 is calculated as 0μs.

T4 is calculated according to the ROI settings and features of each sensor.

The exposure delay data for each model is as follows:

Model	Exposure delay (μs)
VEN-161-61U3M/C-(M01/M05/M06)	N/A
VEN-505-36U3M/C-(M01/M05/M06)	BayerRG8/Mono8: 27254 BayerRG10/Mono10: 27567
VEN-830-22U3M/C-(M01/M05/M06)	BayerRG8/Mono8: 32483 BayerRG10/Mono10: 32729
VEN-302-56U3M/C-S	33.8~45.1
VEN-134-90U3M/C-D	17.861~38.307
VEN-134-90U3M-D NIR	17.861~38.307
VEN-160-227U3M/C-FPC-(M00/M05)	BayerRG8/Mono8: 13~17 BayerRG10/Mono10: 20.6~28.5

VEN-230-168U3M/C-FPC	Mono8/BayerRG8: 15~20 Mono10/BayerRG10: 24.2~33.8
VEN-301-125U3M/C-FPC	Mono8/BayerRG8: 15~20 Mono10/BayerRG10: 29.2~36.3
VEN-1220-32U3M/C-FPC-(M00/M05)	BayerRG8/Mono8: 650 BayerRG12/Mono12: 1260
VE2S-301-125U3M/C-S (J150)	Mono8/BayerRG8: 15~20 Mono10/BayerRG10: 29.2~36.3 Mono12/BayerRG12: 23.7~33.55

Table 8-3 Camera exposure delay range

8.2.8. Set Exposure

8.2.8.1. Set Exposure Mode

Two Exposure Mode are available: Timed exposure mode and TriggerWidth exposure mode. Among them, the TriggerWidth exposure mode determines the exposure time when the camera is configured for hardware triggering. And the exposure time depends on the width of the trigger signal, which is triggered by the rising edge (falling edge) set by the Trigger Activation.

1) Available exposure mode

a) Timed exposure mode

Timed exposure mode is available on all camera models. In this mode, the exposure time is determined by the camera's Exposure Time setting. If the camera is configured for software triggering, exposure starts when the software trigger signal is received and continues until the exposure time has expired.

If the camera is configured for hardware trigger:

- If rising edge triggering is enabled, exposure starts when the trigger signal rises and continues until the exposure time has expired, as shown in Figure 8-20

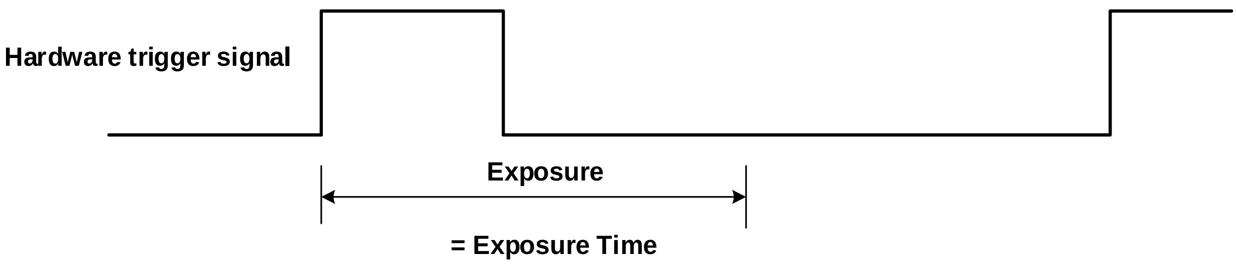


Figure 8-20 The sequence diagram in rising edge trigger of Timed exposure mode

- If falling edge triggering is enabled, exposure starts when the trigger signal falls and continue until the exposure time has expired, as shown in Figure 8-21

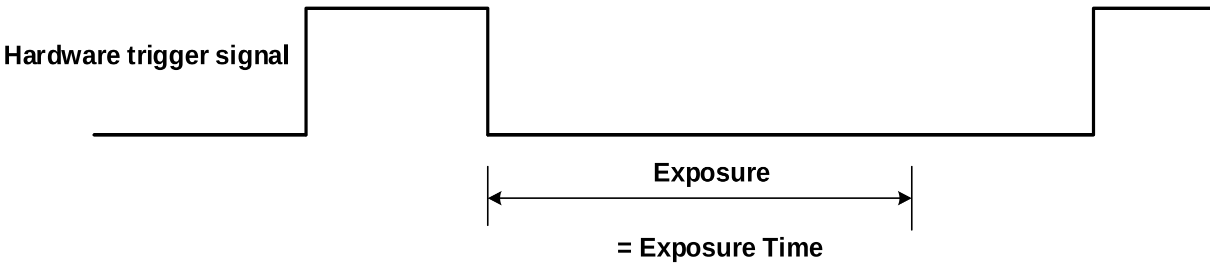


Figure 8-21 The sequence diagram in falling edge trigger of Timed exposure mode

Avoid overtriggering in Timed exposure mode. If the Timed exposure mode is enabled, do not attempt to send a new trigger signal while the previous exposure is still in progress. Otherwise, the trigger signal will be ignored, and a FrameStartOvertrigger event will be generated.

b) TriggerWidth exposure mode

In TriggerWidth exposure mode, the length of exposure is determined by the width of the hardware trigger signal. This function can meet the needs of users to change the exposure time of each frame of image.

- If rising edge triggering is enabled, exposure starts when the trigger signal rises and continue until the trigger signal falls, as shown in Figure 8-22

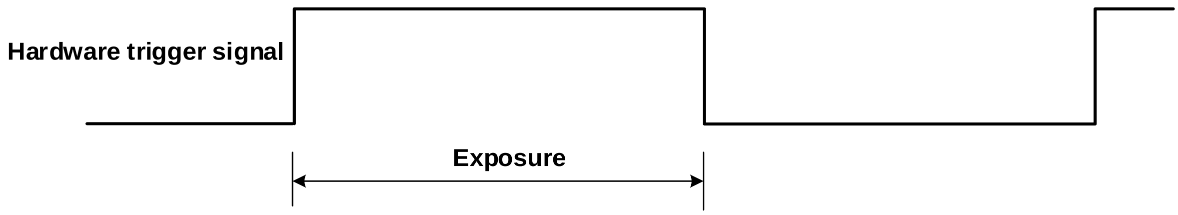


Figure 8-22 The sequence diagram in rising edge trigger of TriggerWidth exposure mode

- If falling edge triggering is enabled, exposure starts when the trigger signal falls and continue until the trigger signal rises, as shown in Figure 8-23

Figure 8-23 The sequence diagram in falling edge trigger of TriggerWidth exposure mode

Avoid overtriggering in TriggerWidth exposure mode. If the TriggerWidth exposure mode is enabled, do not send trigger signals at too high a rate. Otherwise, trigger signals will be ignored, and a FrameStartOvertrigger event will be generated.

⚠ The trigger signal width of the hardware triggering should not be shorter than the value of the entered ExposureOverlapTimeMax parameter.

8.2.8.2. Set Exposure Value

- **Global Shutter**

The VEN-161-61U3M/C-(M01/M05/M06), VEN-302-56U3M/C-S, VEN-134-90U3M/C-D, VEN-134-90U3M-D NIR, VEN-160-227U3M/C-FPC-(M00/M05), VEN-230-168U3M/C-FPC, VEN-301-125U3M/C-FPC use global shutter sensors. The implementation process of global shutter is as shown in Figure 8-24, all the lines of the sensor are exposed at the same time, and then the sensor will read out the image date one by one.

The advantage of the global shutter is that all the lines are exposed at the same time, and the images do not appear offset and distortion when capturing moving objects.

The time width of the flash signal can be got by the following formula:

$$T_{strobe} = T_{exposure}$$

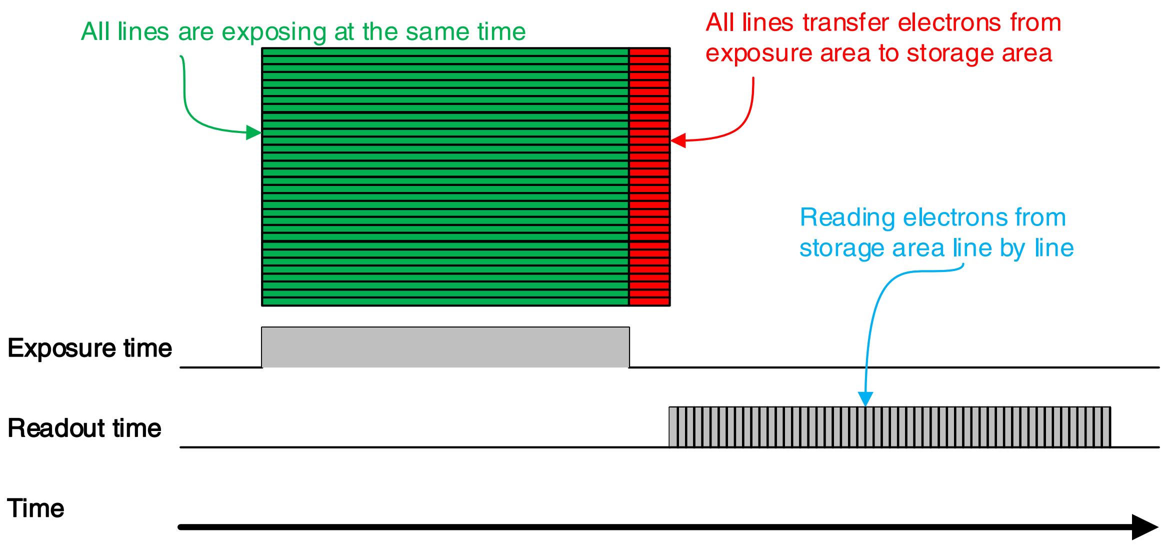


Figure 8-24 Global shutter

- **Electronic Rolling Shutter**

VEN-505-36U3M/C-(M01/M05/M06), VEN-830-22U3M/C-(M01/M05/M06), VEN-1220-32U3M/C-FPC-(M00/M05) cameras use electronic rolling shutter sensors. The implementation process of electronic rolling shutter is as shown in Figure 8-25. Different from the global shutter, electronic rolling shutter exposures from the first line, and starts the second line exposure after a row period. And so on, after N-1 line, the N line starts exposing. When the first line exposure ends, it begins to read out the data, and it need a row period time to read out one line (including the line blanking time). When the first line reads out completely, the second line just begins to read out, and so on, when the N-1 line is read out, the N line begins to read out, until the whole image is read out completely.

The electronic rolling shutter has low price and high resolution, which is a good choice for some static image acquisition.

The time width of the flash signal can be calculated by the following formula:

$$T_{strobe} = T_{exposure} - (N - 1) \times T_{row}$$

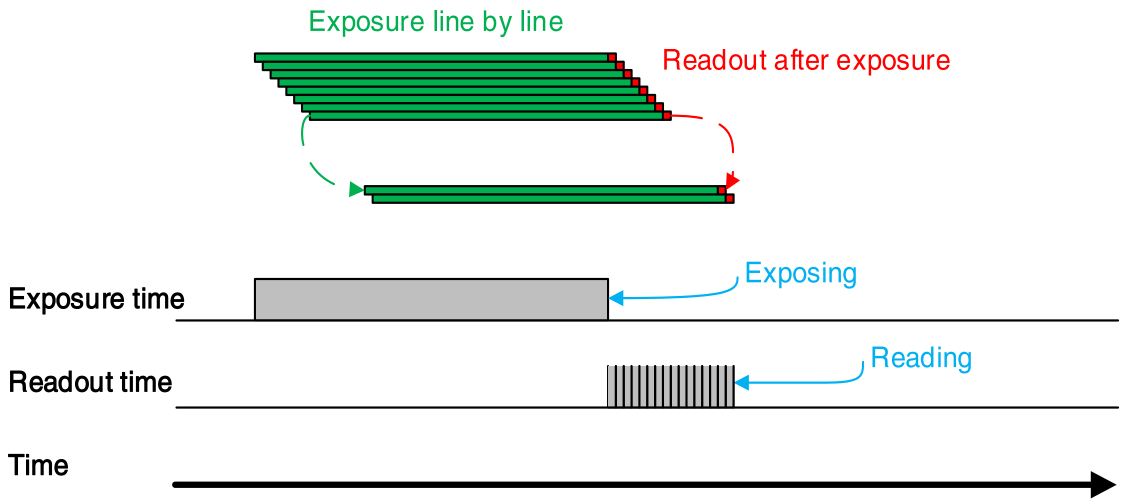


Figure 8-25 Electronic rolling shutter

- **Global Reset Release Shutter**

The implementation process of global reset rolling shutter is as shown in Figure 8-26. When using rolling shutter sensor taking photos of fast-moving objects, the upper and lower exposure start and end points of the same frame of image are different which will occur smear phenomenon. The Global Reset Release exposure method can effectively avoid smear, and it must be used with flash.

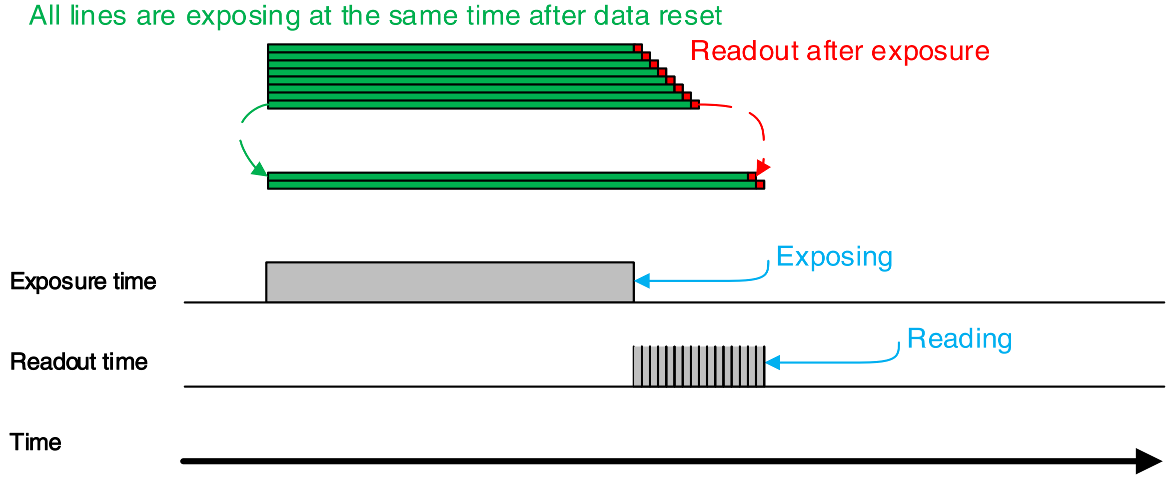


Figure 8-26 Global reset rolling shutter

All the lines of the electronic rolling shutter sensor are exposed at the same time in GRR mode, and end the exposure sequentially from top to bottom. The flash need turn on during the exposure interval, and turn off beyond the exposure interval to avoid the smear and ununiformed brightness of the image.

The camera support exposure delay in GRR mode, and there is a delay when the flash turn on, so the actual flash time is as follows:

$$T_{strobe} = T_{ahead} + T_{exp\_delay} + T_{exposure}$$

Set conditions:

1) Set the "SensorShutterMode" to "Global Reset"

2) External camera flash

Camera model that support Global Reset Release Shutter mode:

Model	T_{ahead} (row period time)
VEN-1220-32U3M/C-FPC-(M00/M05)	18

- **Setting the exposure time**

The VENUS USB3 Vision camera supports setting the exposure time, step: 1μs. The exposure time is shown as follows:

Model	Exposure Mode	Adjustment Range (μs)	Steps (μs)	Actual Steps
VEN-161-61U3M/C-(M01/M05/M06)	Global Shutter	20-1000000	1	1 row period*
VEN-505-36U3M/C-(M01/M05/M06)	Rolling Shutter	20-1000000	1	1 row period*
VEN-830-22U3M/C-(M01/M05/M06)	Rolling Shutter	20-1000000	1	1 row period*
VEN-302-56U3M/C-S	Global Shutter	20-1000000	1	1 row period*
VEN-134-90U3M/C-D	Global Shutter	5-1000000	1	1 row period
VEN-134-90U3M-D NIR	Global Shutter	5-1000000	1	1 row period
VEN-160-227U3M/C-FPC-(M00/M05)	Global Shutter	20-1000000	1	1 row period*
VEN-230-168U3M/C-FPC	Global Shutter	20-1000000	1	1 row period*
VEN-301-125U3M/C-FPC	Global Shutter	20-1000000	1	1 row period*
VEN-1220-32U3M/C-FPC-(M00/M05)	Rolling Shutter	10-1000000	1	1 row period*
VE2S-301-125U3M/C-S (J150)	Global Shutter	20-1000000	1	1 row period*

Table 8-4 VENUS USB3 Vision camera exposure time setting range

*The exposure precision of the camera is limited by the sensor, when the steps in the user's interface and the demo display as 1μs, actually the steps are one row period. When the value of the ExposureTime cannot be divisible by the row period, round up to an integer should be taken, such as the row period is 36μs, setting exposure time to 80μs, and the actual exposure time is 108μs.

When the external light source is sunlight or direct current (DC), the camera has no special requirements for the exposure time. When the external light source is alternating current (AC), the exposure time must synchronize with the external light source (under 50Hz light source, the exposure time must be a multiple of 1/100s, under 60Hz light source, the exposure time must be a multiple of 1/120s), to ensure better image quality. You can set the exposure time that is synchronized with the external light source by using the demo or interface function.

The VENUS USB3 Vision camera supports Auto Exposure feature. If the Auto Exposure feature is enabled, the camera can adjust the exposure time automatically according to the environment brightness. See section 8.3.4 for more details.

8.2.9. Overlapping Exposure

There are two stages in image acquisition of the VENUS USB3 Vision camera: exposure and readout. Once the camera is triggered, it begins to integrate and when the integration is over, the image data will be read out immediately.

The VENUS USB3 Vision camera only supports two exposure modes. The user cannot assign the overlapping exposure or non-overlapping exposure directly, it depends on the frequency of trigger signal and the exposure time. The two exposure mode are described as below.

- Non-overlapping exposure

In non-overlapping exposure mode, after the exposure and readout of the current frame are completed, then the next frame will expose and read out. As shown in the Figure 8-27, the Nth frame is read out, after a period of time, the N+1th frame to be exposed.

The formula of non-overlapping exposure frame period:

non-overlapping exposure frame period > exposure time + readout time

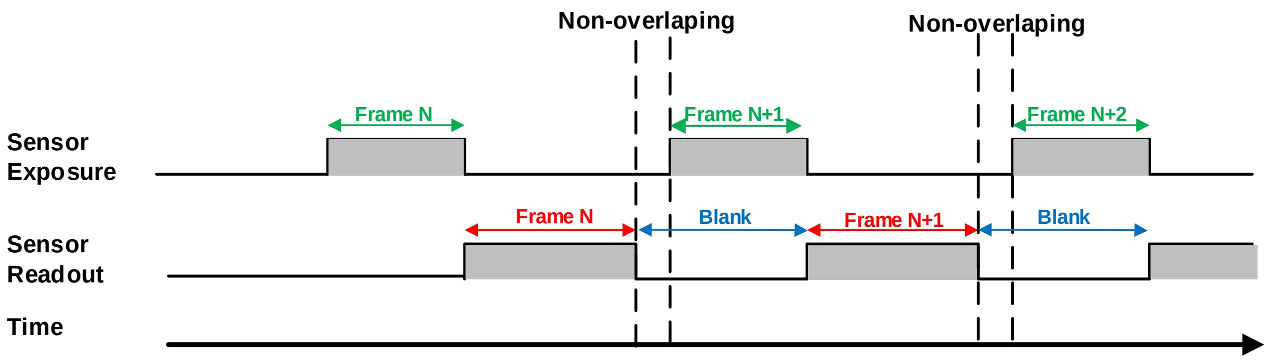


Figure 8-27 The exposure sequence diagram in non-overlapping exposure mode

- **Trigger acquisition mode**

If the interval between two triggers is greater than the sum of the exposure time and readout time, overlapping exposure will not occur, as shown in Figure 8-28.

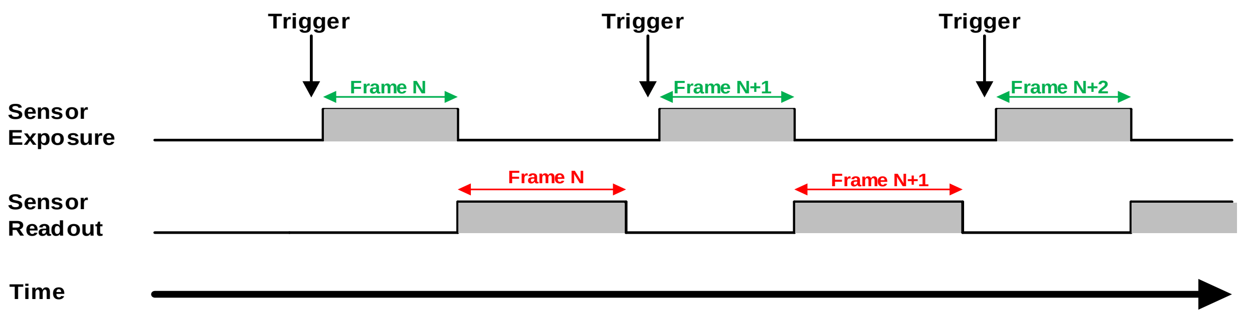


Figure 8-28 The trigger acquisition exposure sequence diagram in non-overlapping exposure mode

- **Overlapping exposure**

In overlapping exposure mode, the current frame image exposure process is overlap with the readout of the previous frame. That is, when the previous frame is reading out, the next frame image has been started exposure. As shown in the Figure 8-29, when the N^{th} frame image is reading out, the $N+1^{th}$ frame image has been started exposure.

The formula of overlapping exposure frame period:

overlapping exposure frame period ≤ exposure time + readout time

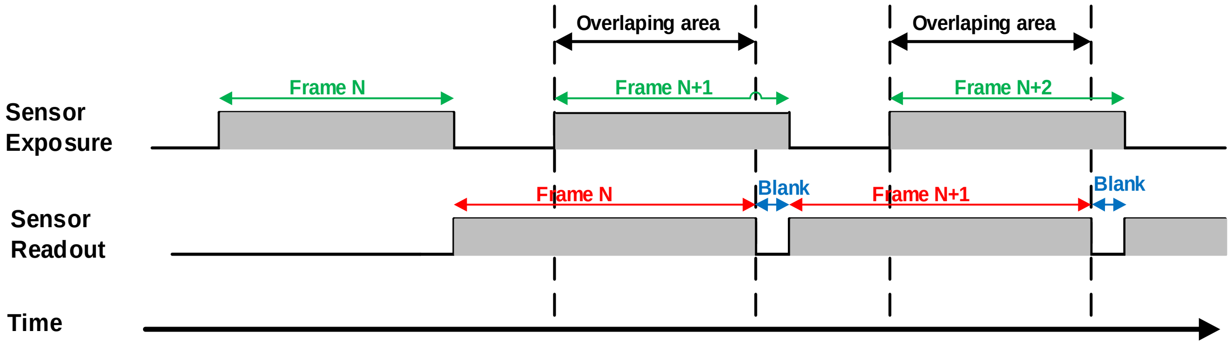


Figure 8-29 The exposure sequence diagram in overlapping exposure mode

- **Continuous acquisition mode**

If the exposure time is greater than the frame blanking time, the exposure time and the readout time will be overlapped. As shown in the Figure 8-29.

- **Trigger acquisition mode**

When the interval between two triggers is less than the sum of exposure time and the readout time, overlapping exposure will occur, as shown in Figure 8-30.

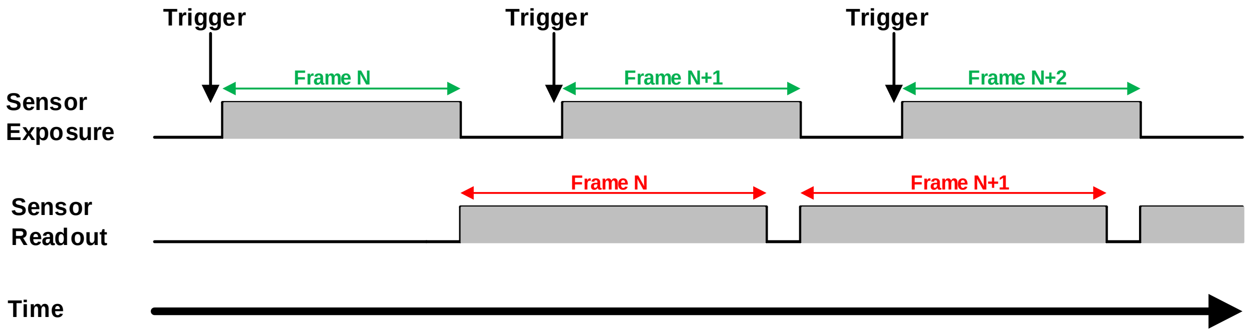


Figure 8-30 The trigger acquisition exposure sequence diagram in overlapping exposure mode

Compared with non-overlapping exposure mode, in overlapping exposure mode, the camera can obtain higher frame rate.

8.3. Basic Features

8.3.1. Gain

The VENUS USB3 Vision camera can adjust the analog gain, and the range of analog gain is as follows:

Model	Adjustment Range	Default/Steps
VEN-161-61U3M/C-(M01/M05/M06)	0-24dB	0dB, 0.1dB
VEN-505-36U3M/C-(M01/M05/M06)	0-24dB	0dB, 0.1dB
VEN-830-22U3M/C-(M01/M05/M06)	0-24dB	0dB, 0.1dB
VEN-302-56U3M/C-S	0-24dB	0dB, 0.1dB
VEN-134-90U3M/C-D	0-16dB	0dB, 0.1dB
VEN-134-90U3M-D NIR	0-16dB	0dB, 0.1dB
VEN-160-227U3M/C-FPC-(M00/M05)	0-24dB	0dB, 0.1dB
VEN-230-168U3M/C-FPC	0-24dB	0dB, 0.1dB
VEN-301-125U3M/C-FPC	0-24dB	0dB, 0.1dB
VEN-1220-32U3M/C-FPC-(M00/M05)	0-24dB	0dB, 0.1dB
VE2S-301-125U3M/C-S (J150)	0-24dB	0dB, 0.1dB

Table 8-5 VENUS USB3 Vision camera analog gain adjustment range

When the analog gain changes, the response curve of the camera changes, as shown in Figure 8-31. The horizontal axis represents the output signal of the sensor in the camera, and the vertical axis represents the gray value of the output image. When the amplitude of the sensor output signal remains constant, increasing the gain makes the response curve steeper, and that makes the image brighter. For every 6dB increases of the gain, the gray value of the image will double. For example, when the camera has a gain of 0dB, the image gray value is 126, and if the gain is increased to 6dB, the image gray will increase to 252. Thus, increasing gain can be used to increase image brightness.

Note that increasing the analog gain or digital gain will amplify the image noise.

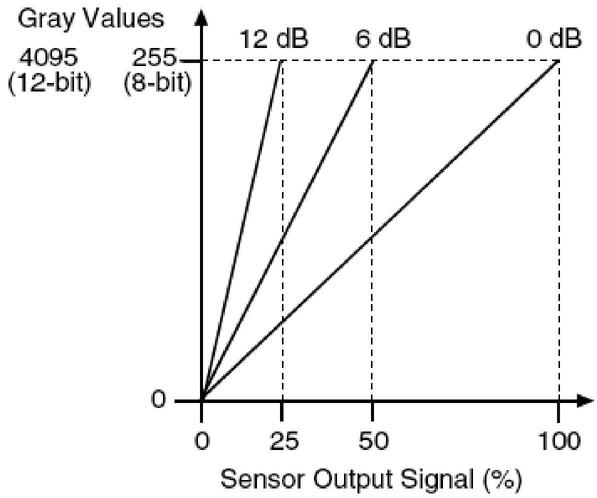


Figure 8-31 The cameras response curve

8.3.2. Pixel Format

By setting the pixel format, the user can select the format of output image. The available pixel formats depend on the camera model and whether the camera is monochrome or color. The following table shows the pixel format supported by the camera.

Model	Pixel Format
VEN-161-61U3M/C-(M01/M05/M06)	Mono8, Mono10, BayerRG8, BayerRG10
VEN-505-36U3M/C-(M01/M05/M06)	Mono8, Mono10, BayerRG8, BayerRG10
VEN-830-22U3M/C-(M01/M05/M06)	Mono8, Mono10, BayerRG8, BayerRG10
VEN-302-56U3M/C-S	Mono8, Mono10, BayerRG8, BayerRG10
VEN-134-90U3M/C-D	Mono8, Mono10, BayerRG8, BayerRG10
VEN-134-90U3M-D NIR	Mono8, Mono10
VEN-160-227U3M/C-FPC-(M00/M05)	Mono8, Mono10, BayerRG8, BayerRG10
VEN-230-168U3M/C-FPC	Mono8, Mono10, BayerRG8, BayerRG10
VEN-301-125U3M/C-FPC	Mono8, Mono10, BayerRG8, BayerRG10
VEN-1220-32U3M/C-FPC-(M00/M05)	Mono8, Mono12, BayerRG8, BayerRG12
VE2S-301-125U3M/C-S (J150)	Mono8, Mono10, Mono12 BayerRG8, BayerRG10, BayerRG12

Table 8-6 Pixel format that the VENUS USB3 Vision camera supported

The image data starts from the upper left corner, and each pixel is output brightness value of each pixel line from left to right and from top to bottom.

- **Mono8**

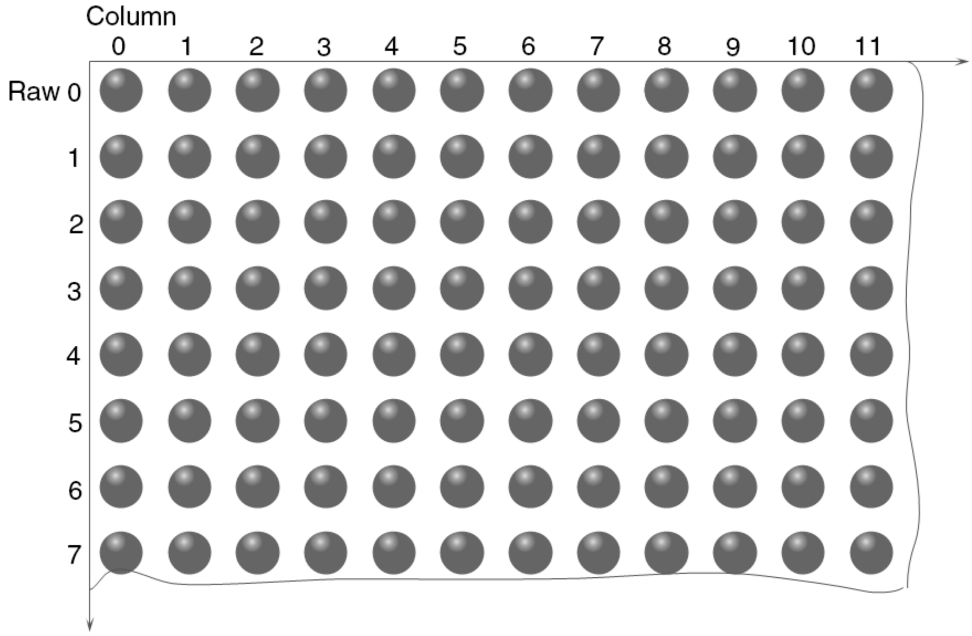


Figure 8-32 Mono8 pixel format

When the pixel format is set to Mono8, the brightness value of each pixel is 8 bits. The format in the memory is as follows:

Y00	Y01	Y02	Y03	Y04	……
Y10	Y11	Y12	Y13	Y14	……
……					

Among them Y00, Y01, Y02 … are the gray value of each pixel that starts from the first row of the image. Then the gray value of the second row pixels of the images is Y10, Y11, and Y12…

- **Mono10/Mono12**

When the pixel format is set to mono10 or Mono12, each pixel is 16 bits. When Mono10 is selected, the effective data is only 10 bits, the six unused most significant bits are filled with zero. When Mono12 is selected, the effective data is only 12 bits, the 4 of the MSB 16 bits data are set to zero. Note that the brightness value of each pixel contains two bytes, arranged in little-endian mode. The format is as follows:

Y00	Y01	Y02	Y03	Y04	……
Y10	Y11	Y12	Y13	Y14	……
……					

Among them Y00, Y01, Y02…are the gray value of each pixel that start with the first row of the image. The first byte of each pixel is low 8 bits of brightness, and the second byte of each pixel is high 8 bits of brightness.

- **BayerRG8**

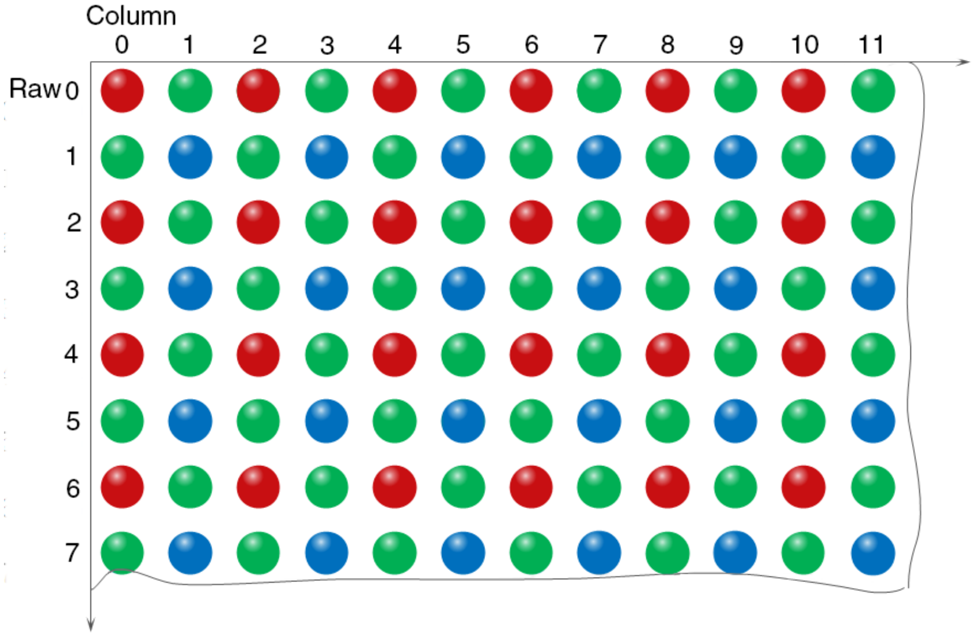


Figure 8-33 BayerRG8 pixel format

When the pixel format is set to BayerRG8, the value of each pixel in the output image of the camera is 8 bits. According to the location difference, the three components of red, green and blue are respectively represented. The format in the memory is as follows:

R00	G01	R02	G03	R04	……
G10	B11	G12	B13	G14	……
……					

Where R00 is the first pixel value of the first row (for the red component), G01 represents the second pixel value (for the green component), and so on, so that the first row pixel values are arranged. G10 is the first pixel value of the second row (for the green component), the B11 is the second pixel value (for the blue component), and so on, and the second row of pixel values are arranged.

- **BayerRG10/BayerRG12**

When the pixel format is set to BayerRG10 or BayerRG12, the value of each pixel in the output image of the camera is 16 bits. According to the location difference, the three components of red, green and blue are respectively represented. The format in the memory is as follows:

R00	G01	R02	G03	R04	……
G10	B11	G12	B13	G14	……
……					

Each pixel is the same as BayerRG8, the difference is that each pixel is made up of two bytes, the first byte is the low 8 bits of the pixel value, and the second byte is the high 8 bits of the pixel value.

8.3.3. ROI

By setting the ROI of the image, the camera can transmit the specific region of the image, and the output region's parameters include OffsetX, OffsetY, width and height of the output image. The camera only reads the image data from the sensor's designated region to the memory, and transfer it to the host, and the other regions' image of the sensor will be discarded.

By default, the image ROI of the camera is the full resolution region of the sensor. By changing the OffsetX, OffsetY, width and height, the location and size of the image ROI can be changed. The OffsetX refers to the starting column of the ROI, and the OffsetY refers to the starting row of the ROI. Among them, the step of OffsetX and width is 4, and the step of OffsetY and height is 2.

The coordinates of the ROI of the image are defined the 0th raw and 0th column as the origin of the upper left corner of the sensor. As shown in the figure, the OffsetX of the ROI is 4, the OffsetY is 4, the height is 8 and the width is 12.

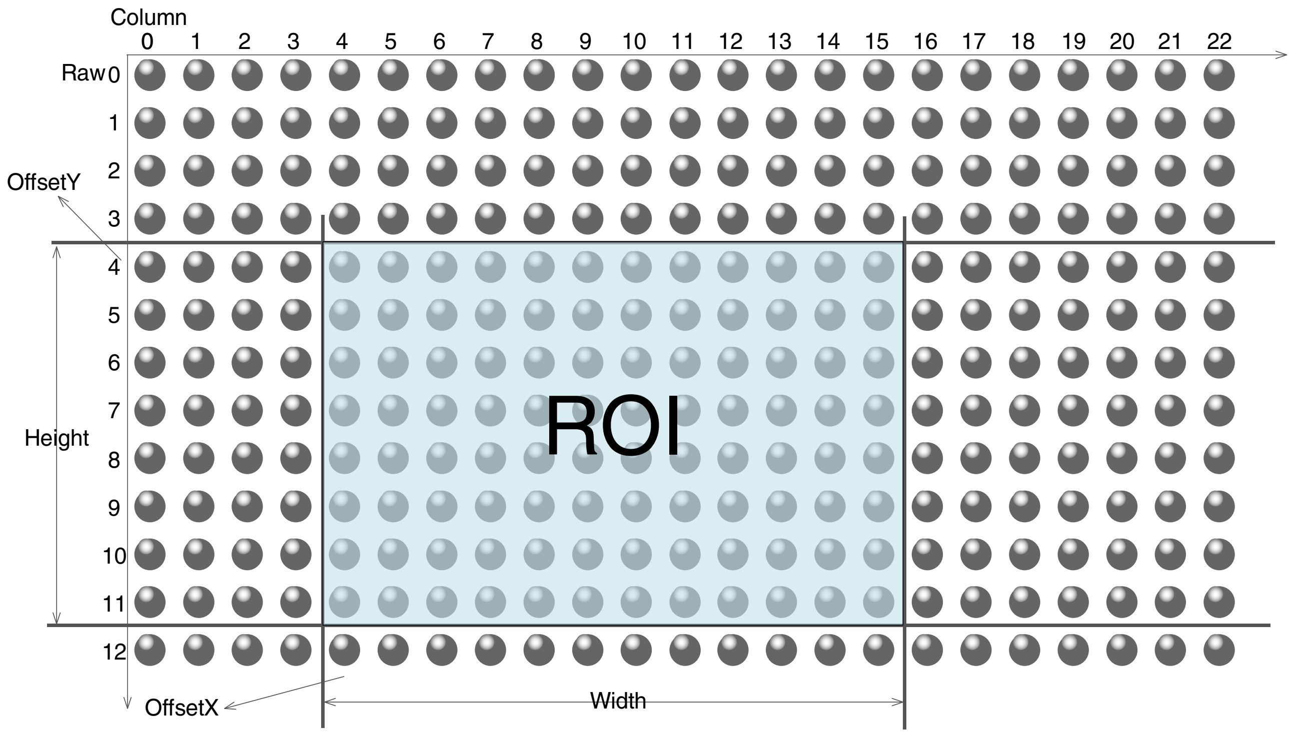


Figure 8-34 ROI

When reducing the height of the ROI, the maximum frame rate of the camera will be raised. Please refer to section 8.4.1 for specific effects on the acquisition frame rate.

8.3.4. Auto Exposure/Auto Gain

- **ROI Setting of Auto Exposure/ Auto Gain**

For Auto Exposure and Auto Gain, you can specify a portion of the sensor array and only the pixel data from the specified portion will be used for auto function control.

AAROI is defined by the following way:

AAROIOffsetX: The offset of the X axis direction.

AAROIOffsetY: The offset of the Y axis direction.

AAROIWidth: The width of ROI.

AAROIHeight: The height of ROI.

Offset is the offset value that relative to the upper left corner of the image. The step of AAROIOffsetX and AAROIWidth is 4. The step of AAROIOffsetY and AAROIHeight is 2. The setting of the AAROI depends on the size of the current image and cannot exceed the range of the current image. That is to say, assuming the Width and Height are parameters for users captured image, then the AAROI setting need to meet the condition 1:

$$AAROIWidth + AAROIOffsetX \leq Width$$

$$AAROIHeight + AAROIOffsetY \leq Height$$

If condition 1 is not met, the user cannot set the ROI.

The default value of ROI is the entire image, you can set the ROI according to your need. Where the minimum value of AAROIWidth can be set to 16, and the maximum value is equal to the current image width. The minimum value of AAROIHeight can be set to 16, and the maximum value is equal to the current image height, they are all need to meet the condition1.

For example: the current image width is 1024, the height is 1000, and then the ROI setting is:

AAROIOffsetX = 100

AAROIOffsetY = 50

AAROIWidth = 640

AAROIHeight = 480

The relative position of the ROI and the image is shown in Figure 8-35.

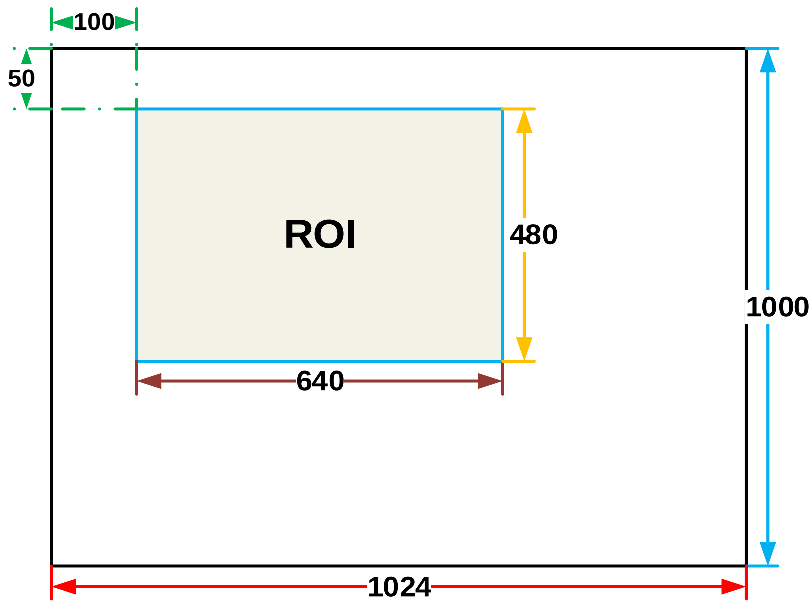


Figure 8-35 An example for the relative position between the ROI and the current image

- **Auto Gain**

The auto gain can adjust the camera's gain automatically, so that the average gray value in AAROI is achieved to the expected gray value. The auto gain can be controlled by "Once" and "Continuous" mode.

When using the "Once" mode, the camera adjusts the image data in the AAROI to the expected gray value once, then the camera will turn off the auto gain feature. When using the "Continuous" mode, the camera will continuous adjust the gain value according to the data of the AAROI, so that the data in the AAROI is kept near to the expected gray level.

The expected gray value is set by the user, and it is related to the data bit depth. For 8bit pixel data, the expected gray value range is 0-255, for 10bit pixel data, the expected gray value range is 0-1023, and for 12bit pixel data, the expected gray value range is 0-4095.

The camera adjusts the gain value within the range [minimum gain value, maximum gain value] which is set by the user.

The auto gain feature can be used with the auto exposure at the same time, when target grey is changed from dark to bright, the auto exposure adjust is prior to auto gain adjust. Vice versa, when target grey is changed from bright to dark, the auto gain adjust is prior to auto exposure adjust.

- **Auto Exposure**

The auto exposure can adjust the camera's exposure time automatically, so that the average gray value in AAROI can achieve to the expected gray value. The auto exposure can be controlled by "Once" and "Continuous" mode.

When using the "Once" mode, the camera adjusts the image data in the AAROI to the expected gray value once, then the camera will close the auto exposure feature. When using the "Continuous" mode, the camera will continuous adjusting the exposure time according to the data of the AAROI, so that the data in the AAROI is kept near to the expected gray level.

The expected gray value is set by the user and it is related to the data bit depth. For 8bit pixel data, the expected gray value range is 0-255, and for 12bit pixel data, the expected gray value range is 0-4095.

The camera adjusts the exposure time in the range [minimum exposure time, maximum exposure time] which is set by the user.

The auto exposure feature can be used with the auto gain at the same time, when target grey is changed from dark to bright, the auto exposure adjust is prior to auto gain adjust. Vice versa, when target grey is changed from bright to dark, the auto gain adjust is prior to auto exposure adjust.

8.3.5. Auto White Balance

8.3.5.1. Split VENUS USB3 Vision Camera

- **Auto White Balance ROI**

Auto White Balance feature use the image data from AWBROI to calculate the white balance ratio, and then the white balance ratio is used to adjust the components of the image.

ROI is defined in the following way:

AWBROIOffsetX:	The offset of the X axis direction.
AWBROIOffsetY:	The offset of the Y axis direction.
AWBROIWidth:	The width of ROI.
AWBROIHeight:	The height of ROI.

Offset is the offset value that relative to the upper left corner of the image. Where the step of AWBROIOffsetX and AWBROIWidth is 4, the step of AWBROIOffsetY and AWBROIHeight is 2. The ROI setting depends on the current image's size and cannot exceed the current image range. Assuming the current image width is Width, the image height is Height, then the ROI setting need to meet the following condition 2:

$$AWBROIWidth + AWBROIOffsetX \leq Width$$

$$AWBROIHeight + AWBROIOffsetY \leq Height$$

If condition 2 is not met, the user cannot set the ROI.

The default value of ROI is the entire image, you can set the "white dot" area (ROI) according to your need. Where the minimum value of AWBROIWidth can be set is 16, the maximum value is equal to the current image width. The minimum value of AWBROIHeight can be set is 16, the maximum value is equal to the current image height, they are all need to meet the condition 2.

Assuming the current image width is 1024, the height is 1000, and then the "white dot" area ROI setting is:

AWBROIOffsetX =	100
AWBROIOffsetX =	50
AWBROIWidth =	640
AWBROIHeight =	480

The relative position of the ROI and the image is shown in Figure 8-36.

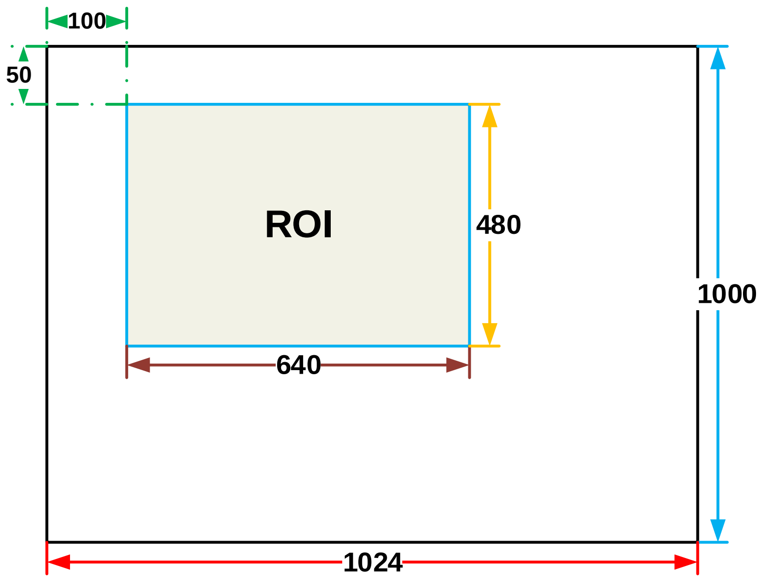


Figure 8-36 An example for the relative position between the ROI and the current image

- **Auto White Balance Adjustment**

Auto White Balance function calculates the white balance coefficient based on the data in ROI, and then use the coefficient to adjust the components of the image, in order to make the R/G/B component the same in the ROI. The Auto White Balance feature is only available on color sensors.

The auto white balance can be set to "Once" or "Continuous" mode. When using the "Once" mode, the camera just adjusts the white balance ratio once, when using the "Continuous" mode, the camera continuously adjusts the white balance ratio based on the data in AWBROI.

The auto white balance feature can also select the color temperature. When the color temperature of the selection is "Adaptive", the data in ROI always adjusting the red, green and blue to the same. When selecting the specific color temperature, the camera adjusts the factor according to the light source, so that the hue of the ROI is the same as the hue of the light source. That is: high temperature is cold, low color temperature is warm.

Models that support this function:

Model	Auto White Balance Function
VEN-161-61U3C-(M01/M05/M06)	once*
VEN-505-36U3C-(M01/M05/M06)	once*
VEN-830-22U3C-(M01/M05/M06)	once*
VEN-302-56U3C-S	Once, continous
VEN-160-227U3C-FPC-(M00/M05)	once, continous
VEN-230-168U3C-FPC	once, continous
VEN-301-125U3C-FPC	once, continous
VEN-1220-32U3C-FPC-(M00/M05)	once, continous
VE2S-301-125U3C-S (J150)	once, continous

* Auto White Balance Function is implemented by PC software

8.3.6. Light Source Preset

Some of the VENUS USB3.0 camera supports light source preset function, and provides Off, Custom mode and four specified common color temperature light source modes. Different models of cameras have difference about Light Source Preset function.

- **Off Mode**

By default, the camera does not perform white balance and color conversion processing on images.

- **Custom Mode**

By default, the camera does not perform white balance and color conversion processing on images.

Support for automatic white balance or manual input of white balance coefficients by users, as well as color conversion enable control and color conversion coefficients manually input.

- **Specified Color Temperature Modes (for example, Daylight-6500K)**

When the user selects **Daylight6500K** in the Light Source Preset, the camera performs white balance processing on the image by default. If the external environment light source used is D65, the image does not produce color bias.

Even if selected the current light source, the white balance factor can still be manually adjusted.

Turn on the color conversion enable switch and correct according to the color conversion coefficient of the **Daylight6500K** light source (manual input of color correction coefficients is not supported).

Daylight5000K, **CoolWhiteFluoresence**, and **INCA**'s operation is the same as **Daylight6500K.**

Models that support this function:

Model	Light Source Preset Function
VEN-161-61U3C-(M01/M05/M06)	Off, Specified color temperature (4 types)
VEN-505-36U3C-(M01/M05/M06)	Off, Specified color temperature (4 types)
VEN-830-22U3C-(M01/M05/M06)	Off, Specified color temperature (4 types)
VEN-160-227U3C-FPC-(M00/M05)	Off, Custom, Specified color temperature (4 types)
VEN-230-168U3C-FPC	Off, Custom, Specified color temperature (4 types)
VEN-301-125U3C-FPC	Off, Custom, Specified color temperature (4 types)
VEN-1220-32U3C-FPC-(M00/M05)	Off, Custom, Specified color temperature (4 types)
VE2S-301-125U3C-S (J150)	Off, Custom, Specified color temperature (4 types)

8.3.7. Test Pattern

The VENUS USB3 Vision camera supports three test images: gray gradient test image, static diagonal gray gradient test image, and moving diagonal gray gradient test image (All-in-one VENUS USB3 Vision camera VEN-161-61U3M/C only support gray gradient test image, VEN-505-36U3M/C and VEN-830-22U3M/C not support test image). When the camera captures in RAW10 mode, the gray value of test image is: the pixel gray value in RAW8 mode multiplies by 4, as the output of pixel gray value in RAW10 mode.

The following three test images are illustrated in the RAW8 mode.

- GrayFrameRampMoving

In the gray gradient test pattern, all the pixels' gray values are the same in the frame. In the adjacent frame, the gray value of the next frame increases by 1 compared to the previous frame, until to 255, and then the next frame gray value returns to 0, and so on. A printscreen of a single frame is shown in Figure 8-37.

Figure 8-37 Gray gradient test pattern

- SlantLineMoving

In the moving diagonal gray gradient test pattern, the first pixel value of adjacent row in each frame increases by 1, until the last row. When the pixel gray value increases to 255, the next pixel gray value returns to 0. The first pixel gray value of adjacent column increases by 1, until the last column. When the pixel gray value increases to 255, the next pixel gray value returns to 0.

In the moving diagonal gray gradient test image, in the adjacent frame, the first pixel gray value of the next frame increases by 1 compared to the previous frame. So, in the dynamic image, the image is scrolling to the left. A printscreen of the moving diagonal gray gradient test image is shown in Figure 8-38:

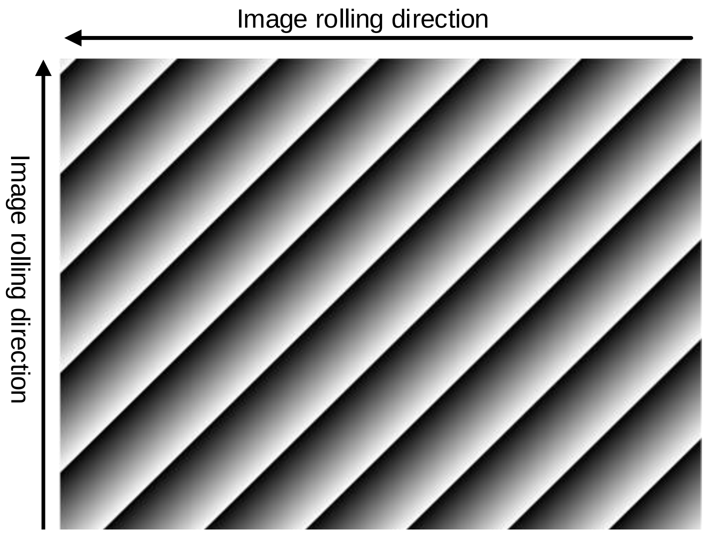


Figure 8-38 Moving diagonal gray gradient test pattern

- SlantLine

In the static diagonal gray gradient test pattern, the first pixel gray value is 0, the first pixel gray value of adjacent row increases by 1, until the last row. When the pixel gray value increases to 255, the next pixel gray value returns to 0. The first pixel gray value of adjacent column increases by 1, until the last column. When the pixel gray value increases to 255, the next pixel gray value returns to 0.

Compared to the moving diagonal gray gradient test pattern, in the adjacent image of the static diagonal gray gradient test pattern, the gray value in the same position remains unchanged. A printscreen of the static diagonal gray gradient test image is shown in Figure 8-39.

Figure 8-39 Static diagonal gray gradient test pattern

8.3.8. User Set Control

By setting various parameters of the camera, the camera can perform the best performance in different environments. There are two ways to set parameters: one is to modify the parameters manually, and the other is to load parameter set. In order to save the specific parameters of the users, avoiding to set the parameters every time when you open the camera, the VENUS USB3 Vision camera provides a function to save the parameter set, which can easily save the parameters that the user use, including the control parameters that the camera needed. There three types of configuration parameters: the currently effective configuration parameters, the vendor default configuration parameters (Default), and the user configuration parameters (UserSet).

Three operations can be performed on the configuration parameters, including save parameters (UserSetSave), load parameters (UserSetLoad), and set the startup parameter set (UserSetDefault). The UserSetSave is to save the effective configuration parameters to the user configuration parameter set which is set by the user. The UserSetLoad is to load the vendor default configuration parameters (Default) or the user configuration parameters (UserSet) to the current effective configuration parameters. The UserSetDefault is refer to the user can specify a set of parameters which to be loaded into the effective configuration parameters automatically when the camera is reset or powered on. And the camera can work under this set of parameters. This set of parameters can be vendor default configuration parameters or user configuration parameters.

- **The type of configuration parameters**

The type of configuration parameters includes: the current effective configuration parameters, vendor default configuration parameters, user configuration parameters.

The current effective configuration parameters: Refers to the current control parameters used by the camera. Using API function or Demo program to modify the current control parameters of the camera is to modify the effective configuration parameters. The effective parameters are stored in volatile memory of the camera, so when the camera is reset or powered on again, the effective configuration parameters will be lost.

The vendor default configuration parameters (Default): Before the camera leaves the factory, the camera manufacturer will test the camera to assess the camera's performance and optimize the configuration parameters of the camera. The vendor default configuration parameters are the camera configuration parameters optimized by the vendor in a particular environment, these parameters are stored in the non-volatile memory of the camera, so when the camera is reset or powered on again, the effective configuration parameters will not be lost, and these parameters cannot be modified.

The user configuration parameters (UserSet): The effective parameters are stored in volatile memory of the camera, so when the camera is reset or powered on again, the effective configuration parameters will be lost. You can store the effective configuration parameters to the user configuration parameters, the user configuration parameters are stored in the non-volatile memory of the camera, so when the camera is reset or powered on again, the user configuration parameters will not be lost. The VENUS USB3 Vision camera can store a set of user configuration parameters.

- **The operation of configuration parameters**

The operations for configuration parameters include the following three types: save parameters, load parameters and set the UserSetDefault.

Save parameters (UserSetSave): Save the current effective configuration parameters to the user configuration parameters. The storage steps are as follows:

1) Modify the camera's configuration parameters, until the camera runs to the user's requirements.

2) Use UserSetSelector to select UserSet0. Execute UserSetSave command.

The camera's configuration parameters which are saved in the user parameter set include:

- Gain
- ExposureTime
- PixelFormat
- OffsetX, OffsetY, ImageWidth, ImageHeight
- EventNotification
- TriggerMode, TriggerSource, TriggerPolarity, TriggerDelay
- TriggerFilterRaisingEdge, TriggerFilterFallingEdge
- LineMode, LineInverter, LineSource, UserOutputValue
- ChunkModeActive
- TestPattern
- ExpectedGrayValue
- ExposureAuto, AutoExposureTimeMax, AutoExposureTimeMin
- GainAuto, AutoGainMax, AutoGainMin
- AAROIOffsetX, AAROIOffsetY, AAROIWidth, AAROIHeight

- BalanceWhiteAuto, AWBLampHouse
- AWBROIOffsetX, AWBROIOffsetY, AWBROIWidth, AWBROIHeight
- BalanceRatio(R/G/B)
- LUT

Load parameters (UserSetLoad): Load the vendor default configuration parameters or the user configuration parameters into the effective configuration parameters. After this operation is performed, the effective configuration parameters will be covered by the loaded parameters which are selected by the user, and the new effective configuration parameters are generated. The operation steps are as follows:

1) Use UserSetSelector to select Default or UserSet0.

2) Execute UserSetLoad command to load the UserSet specified by UserSetSelector to the device and makes it active.

Change startup parameter set (UserSetDefault): The user can use UserSetDefault to select Default or UserSet0 as the UserSetDefault. When the camera is reset or powered on again, the parameters in the UserSetDefault will be loaded into the effective configuration parameters.

8.3.9. Device User ID

The VENUS USB3 Vision camera provides programmable device user ID function, the user can set a unique identification for the camera, and can open and control the camera by the unique identification.

The user-defined name is a string which maximum length is 16 bytes, the user can set it by the following ways:

1) Set by the GalaxyView, as shown in the Figure 8-40.

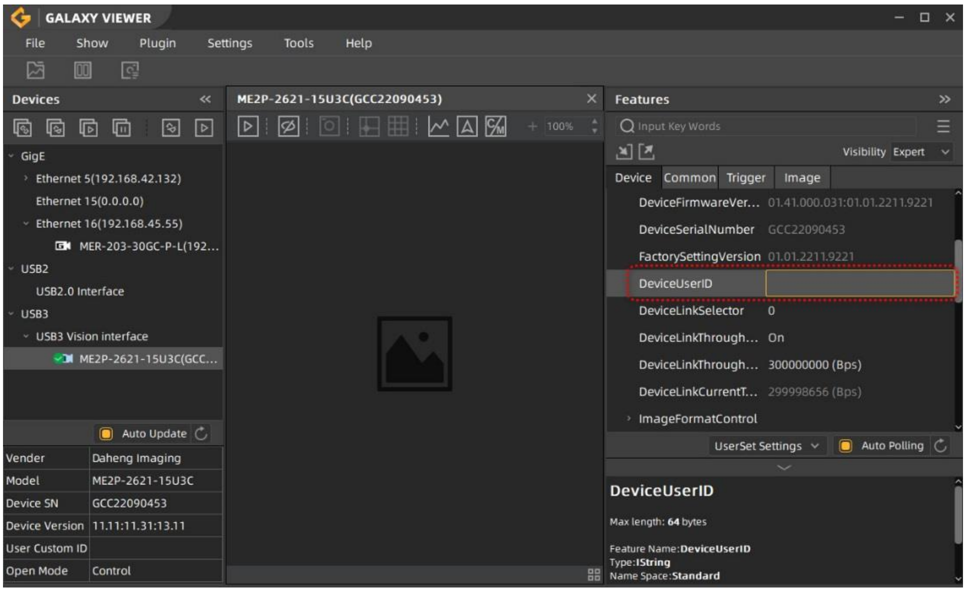


Figure 8-40 GalaxyView software

2) Set by calling the software interface, for details please see the Programmer's Guide.

When using multi-cameras at the same time, it is necessary to ensure the uniqueness of the user-defined name of each camera, otherwise, an exception will occur when the camera is opened.

8.3.10. Timestamp

The timestamp feature counts the number of ticks generated by the camera's internal device clock. As soon as the camera is powered on, it starts generating and counting clock ticks. The counter is reset to 0 whenever the camera is powered off and on again. Some of the camera's features use timestamp values, such as event, frame information, and timestamps can be used to test the time spent on some of the camera's operations.

The unit of timestamp is ns.

8.3.11. Binning

The feature of Binning is to combine multiple pixels adjacent to each other in the sensor into a single value, and process the average value of multiple pixels or sum the multiple pixel values, which may increase the signal-to-noise ratio or the camera's response to light.

- **How Binning Works**

On color cameras, the camera combines (sums or averages) the pixel values of adjacent pixels of the same color:

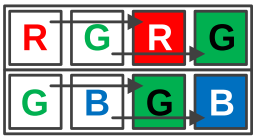


Figure 8-41 Horizontal color Binning by 2

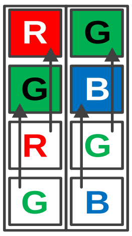


Figure 8-42 Vertical color Binning by 2

When the horizontal Binning factor and the vertical Binning factor are both set to 2, the camera combines the adjacent 4 sub-pixels of the same color according to the corresponding positions, and outputs the combined pixel values as one sub-pixel.

Figure 8-43 Horizontal and vertical color Binning by 2×2

On monochrome cameras, the camera combines (sums or averages) the pixel values of directly adjacent pixels:

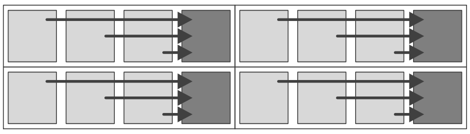


Figure 8-44 Horizontal mono Binning by 4

- **Binning Factors**

Two types of Binning are available: horizontal Binning and vertical Binning. You can set the Binning factor in one or two directions.

Horizontal Binning is the processing of pixels in adjacent rows.

Vertical Binning is the processing of pixels in adjacent columns.

Binning factor 1: Disable Binning.

Binning factor 2, 4: Indicate the number of rows or columns to be processed.

For example, the horizontal Binning factor 2 indicates that the Binning is enabled in the horizontal direction, and the pixels of two adjacent rows are processed.

- **Binning Modes**

The Binning mode defines how pixels are combined when Binning is enabled. Two types of the Binning mode are available: Sum and Average.

Sum: The values of the affected pixels are summed and then output as one pixel. This improves the signal-to-noise ratio, but also increases the camera's response to light.

Average: The values of the affected pixels are averaged. This greatly improves the signal-to-noise ratio without affecting the camera's response to light.

- **Considerations when Using Binning**

1) Effect on ROI settings

When Binning is used, the value of the current ROI of the image, the maximum ROI of the image, the auto function ROI, and the auto white balance ROI will change. The changed value is the original value (the value before the setting) divided by the Binning factor.

For example, assume that you are using a camera with a 1200 x 960 sensor. Horizontal Binning by 2 and vertical Binning by 2 are enabled. In this case, the maximum ROI width is 600 and the maximum ROI height is 480.

2) Increased response to light

Using Binning with the Binning mode set to **Sum** can significantly increase the camera's response to light. When pixel values are summed, the acquired images may look overexposed. If this is the case, you can reduce the lens aperture, the intensity of your illumination, the camera's exposure time setting, or the camera's gain setting.

3) Possible image distortion

Objects will only appear undistorted in the image if the numbers of binned rows and columns are equal. With all other combinations, objects will appear distorted. For example, if you combine vertical Binning by 2 with horizontal Binning by 4, the target objects will appear squashed.

4) Mutually exclusive with Decimation

Binning and Decimation cannot be used simultaneously in the same direction. When the horizontal Binning value is set to a value other than 1, the horizontal Decimation feature cannot be used. When the vertical Binning value is set to a value other than 1, the vertical Decimation feature cannot be used.

Camera models that support this feature:

Model
VEN-302-56U3M/C-S
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-230-125U3M/C-FPC
VEN-301-125U3M/C-FPC
VEN-1220-32U3M/C-FPC-(M00/M05)
VE2S-301-125U3M/C-S (J150)

8.3.12. Decimation

The Decimation can reduce the number of sensor pixel columns or rows that are transmitted by the camera, reducing the amount of data that needs to be transmitted and reducing bandwidth usage.

- **How Vertical Decimation Works**

On mono cameras, if you specify a vertical Decimation factor of n, the camera transmits only every n^th^ row. For example, when you specify a vertical Decimation factor of 2, the camera skips row 1, transmits row 2, skips row 3, and so on.

On color cameras, if you specify a vertical Decimation factor of n, the camera transmits only every n^th^ pair of rows. For example, when you specify a vertical Decimation factor of 2, the camera skips rows 1 and 2, transmits rows 3 and 4, skips rows 5 and 6, and so on.

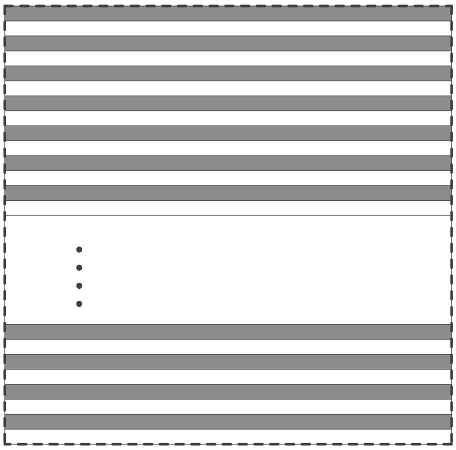


Figure 8-45 Mono camera vertical Decimation

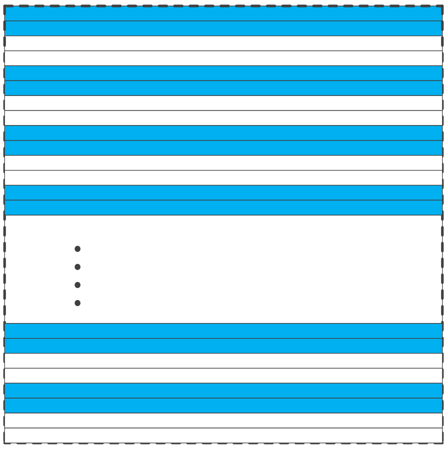


Figure 8-46 Color camera vertical Decimation

As a result, the image height is reduced. For example, enabling vertical Decimation by 2 halves the image height. The camera automatically adjusts the image ROI settings.

Vertical Decimation significantly increases the camera's frame rate. For details, please refer to the section 9.2 VENUS USB3 Vision Camera Frame Rate Calculation Tool.

- **How Horizontal Decimation Works**

On mono cameras, if you specify a horizontal Decimation factor of n, the camera transmits only every n^{th} column. For example, if specify set a horizontal Decimation factor of 2, the camera skips column 1, transmits column 2, skips column 3, and so on.

On color cameras, if you specify a horizontal Decimation factor of n, the camera transmits only every n^{th} pair of columns. For example, if you specify a horizontal Decimation factor of 2, the camera skips columns 1 and 2, transmits columns 3 and 4, skips columns 5 and 6, and so on.

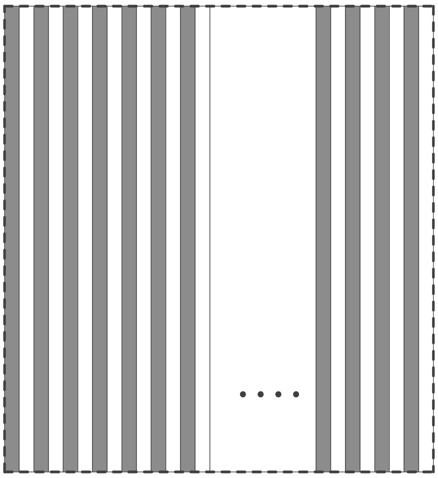


Figure 8-47 Mono camera horizontal Decimation

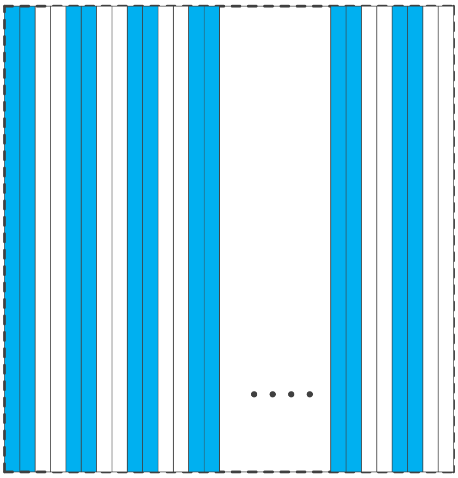


Figure 8-48 Color camera horizontal Decimation

As a result, the image width is reduced. For example, enabling horizontal Decimation by 2 halves the image width. The camera automatically adjusts the image ROI settings.

Horizontal Decimation does not (or only to a very small extent) increase the camera's frame rate.

- **Configuring Decimation**

To configure vertical Decimation, enter a value for the DecimationVertical parameter. To configure horizontal Decimation, enter a value for the DecimationHorizontal parameter.

The value of the parameters defines the Decimation factor. Depending on your camera model, the following values are available:

1: Disable Decimation.

2: Enable Decimation.

- **Considerations When Using Decimation**

1) Effect on ROI settings

When you are using Decimation, the settings for your image ROI refer to the resulting number of rows and columns. Taking VEN-1220-32U3M/C-FPC-(M00/M05) as an example, the camera's default resolution is 4024×3036. When horizontal Decimation by 4 and vertical Decimation by 4 are enabled, the maximum ROI width would be 1000 and the maximum ROI height would be 758.

2) Reduced resolution

Using Decimation effectively reduces the resolution of the camera's imaging sensor. Taking VEN-1220-32U3M/C-FPC-(M00/M05) as an example, the camera's default resolution is 4024×3036. When horizontal Decimation by 4 and vertical Decimation by 4 are enabled, the effective resolution of the sensor is reduced to 1000×758.

3) Possible image distortion

The displayed image will not be distorted if the vertical and horizontal Decimation factors are equal. When only horizontal Decimation or vertical Decimation is used, the displayed image will be reduced in width or height.

4) Mutually exclusive with Binning

Decimation and Binning cannot be used simultaneously in the same direction. When the horizontal Decimation value is set to a value other than 1, the horizontal Binning feature cannot be used. When the vertical Decimation value is set to a value other than 1, the vertical Binning feature cannot be used.

On some camera models, user can select to perform Sensor or FPGA decimation. The difference is that Sensor decimation may increase the camera's frame rate. Camera models that support this feature:

Model	Pattern
VEN-160-227U3M/C-FPC-(M00/M05)	Sensor decimation
VEN-230-168U3M/C-FPC	FPGA decimation
VEN-301-125U3M/C-FPC	Sensor decimation
VEN-1220-32U3M/C-FPC-(M00/M05)	FPGA decimation
VE2S-301-125U3M/C-S (J150)	Sensor decimation

8.3.13. Reverse X and Reverse Y

The Reverse X and Reverse Y features can mirror acquired images horizontally, vertically, or both.

- **Enabling Reverse X**

To enable Reverse X, set the **ReverseX** parameter to **true**. The camera mirrors the image horizontally.

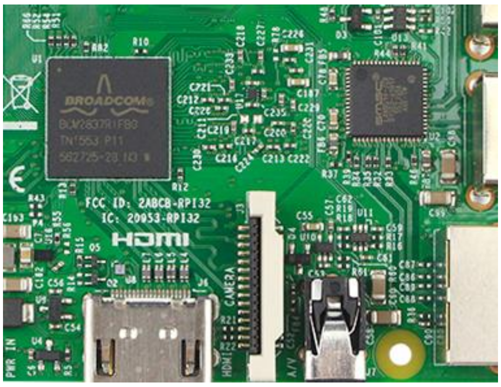


Figure 8-49 The original image

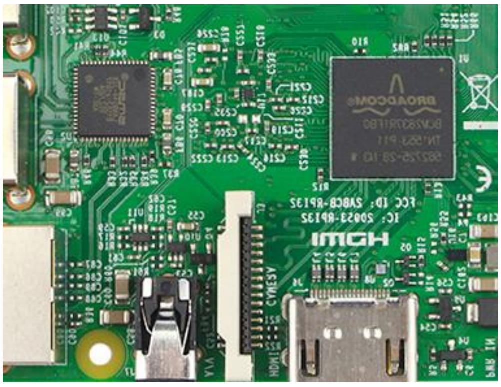


Figure 8-50 Reverse X enabled

- **Enabling Reverse Y**

To enable Reverse Y, set the **ReverseY** parameter to **true**. The camera mirrors the image vertically.

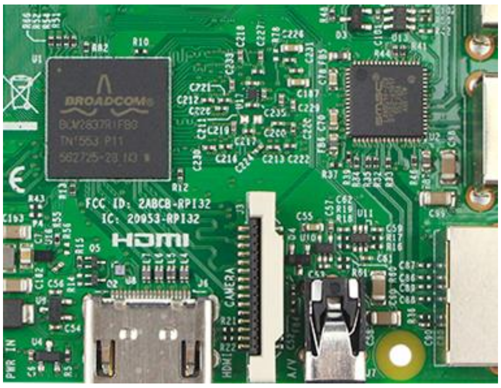


Figure 8-51 The original image

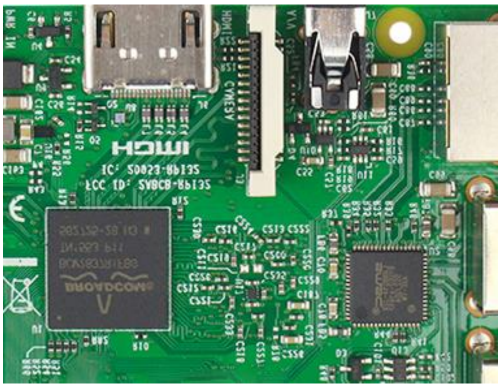


Figure 8-52 Reverse Y enabled

- **Enabling Reverse X and Y**

To enable Reverse X and Y, set the **ReverseX** and **ReverseY** parameters to **true**. The camera mirrors the image horizontally and vertically.

Figure 8-53 The original image

Figure 8-54 Reverse X and Y enabled

- **Using Image ROI with Reverse X or Reverse Y**

If you have specified an image ROI while using Reverse X or Reverse Y, you must bear in mind that the position of the ROI relative to the sensor remains the same. Therefore, the camera acquires different portions of the image depending on whether the Reverse X or the Reverse Y feature are enabled:

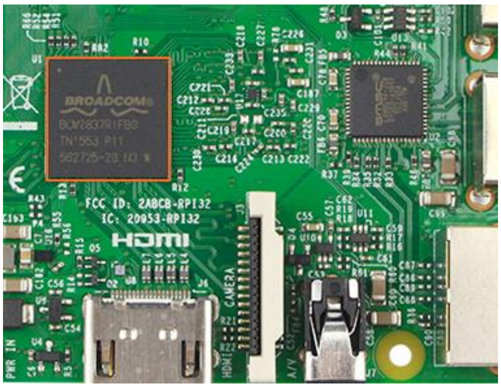


Figure 8-55 The original image

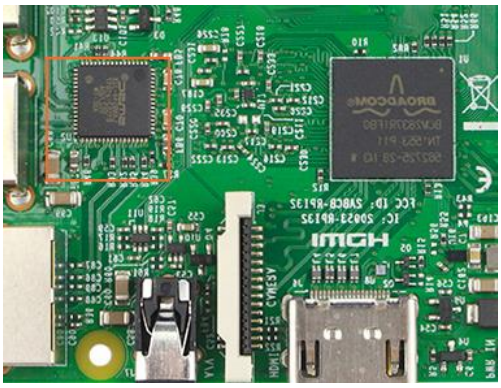


Figure 8-56 Reverse X enabled

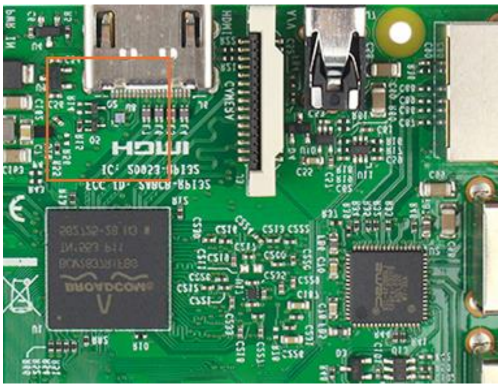


Figure 8-57 Reverse Y enabled

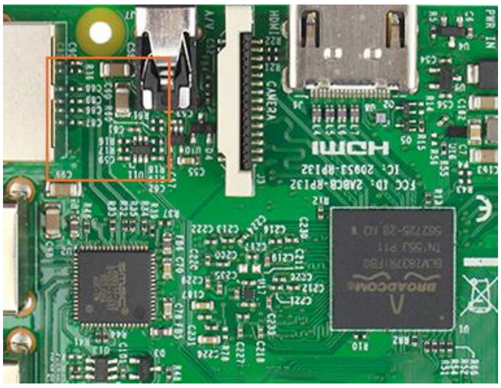


Figure 8-58 Reverse X and Y enabled

When camera is using the reverse feature, the alignment of the Bayer format of some cameras does not change, and the others is change. Camera models that the alignment of the Bayer format does not change after using the reverse feature are as follows:

Model
VEN-161-61U3M-(M01/M05/M06)
VEN-505-36U3M/C-(M01/M05/M06)
VEN-830-22U3M/C-(M01/M05/M06)
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-230-168U3M/C-FPC
VEN-301-125U3M/C-FPC
VEN-1220-32U3M/C-FPC-(M00/M05)
VE2S-301-125U3M/C-S (J150)

Camera models and changes in the alignment of the Bayer format after using the reverse feature are as follows:

Model	Reverse X and Reverse Y	Bayer format
VEN-161-61U3C-(M01/M05/M06)	Disable Reverse X and Reverse Y	BayerRG
	Enable Reverse X and disable Reverse Y	BayerGR
	Disable Reverse X and enable Reverse Y	BayerGB
	Enable Reverse X and Reverse Y	BayerBG

8.3.14. Digital Shift

The Digital Shift can multiply the pixel values by 2^n of the images.

This increases the brightness of the image. If your camera doesn't support the digital shift feature, you can use the Gain feature to achieve a similar effect.

- **How Digital Shift Works**

Configuring a digital shift factor of n results in a logical left shift by n on all pixel values. This has the effect of multiplying all pixel values by 2^n.

If the resulting pixel value is greater than the maximum value possible for the current pixel format (e.g., 255 for an 8-bit pixel format, 1023 for a 10-bit pixel format, and 4095 for a 12-bit pixel format), the value is set to the maximum value.

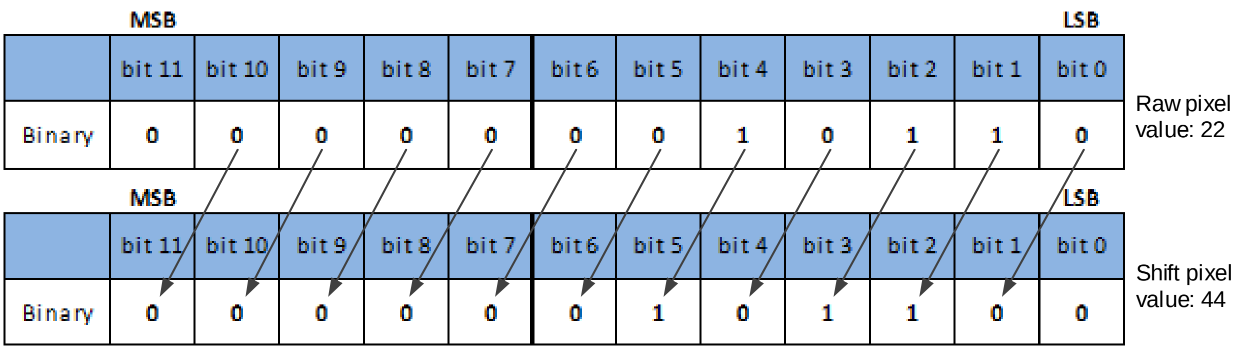
- **Configuring Digital Shift**

To configure the digital shift factor, enter the expected value for the **DigitalShift** parameter.

By default, the parameter is set to 0, i.e., digital shift is disabled. When the **DigitalShift** parameter is set to 1, the camera will shift the pixel value to the left by 1 bit. When the **DigitalShift** parameter is set to 2, the camera will shift the pixel value to the left by 2 bits.

- **Considerations When Using Digital Shift**

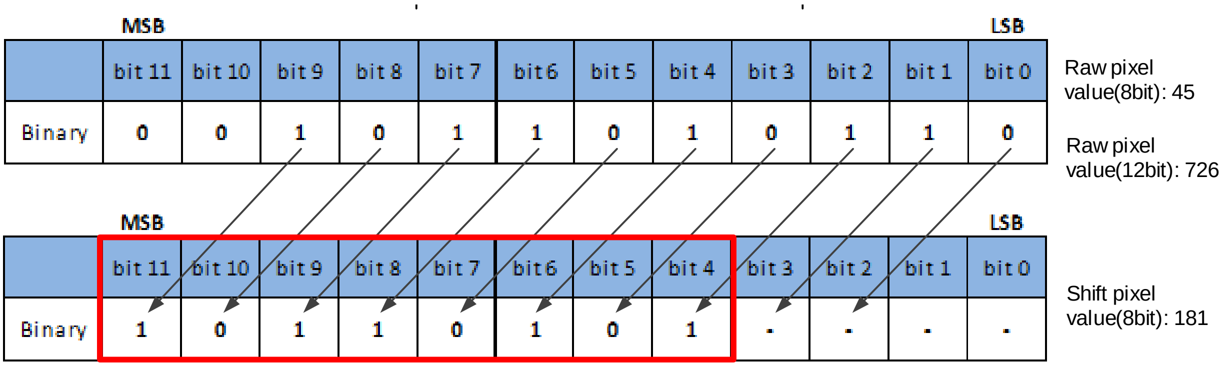
Example 1: Digital Shift by 1, 12-Bit Image Data



The least significant bit in each 12-bit image data is set to 0.

Example 2: Digital Shift by 2, 8-bit Image Data

Assume that your camera has a maximum pixel bit depth of 12-bit, but is currently using an 8-bit pixel format. In this case, the camera first performs the digital shift calculation on the 12-bit image data. Then, the camera transmits the 8 most significant bits.



Example 3: Digital Shift by 1, 12-bit Image Data, High Value

Assume that your camera is using a 12-bit pixel format. Also assume that one of your original pixel values is 2839.

	MSB bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	LSB bit 0	
Binary	1	0	1	1	0	0	0	1	0	1	1	1	Raw pixel value: 2839

	MSB bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	LSB bit 0	
Binary	1	1	1	1	1	1	1	1	1	1	1	1	Shift pixel value: 4095

If you apply digital shift by 1 to this pixel value, the resulting value is greater than the maximum possible value for 12-bit pixel formats. In this case, the value is set to the maximum value, i.e., all bits are set to 1.

Camera models that support this feature:

Model
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-230-168U3M/C-FPC
VEN-301-125U3M/C-FPC
VEN-1220-32U3M/C-FPC-(M00/M05)
VE2S-301-125U3M/C-S (J150)

8.3.15. Acquisition Status

The Acquisition Status feature can determine whether the camera is waiting for trigger signals. This is useful if you want to optimize triggered image acquisition and avoid over triggering.

To determine if the camera is currently waiting for trigger signals.

a) Set the **AcquisitionStatusSelector** parameter to the expected trigger type. Two trigger types are available: **FrameTriggerWait** and **AcquisitionTriggerWait**. For example, if you want to determine if the camera is waiting for **FrameStartTrigger** signals, set the **AcquisitionStatusSelector** to **FrameTriggerWait**. If you want to determine if the camera is waiting for **FrameBurstStartTrigger** signals, set the **AcquisitionStatusSelector** to **AcquisitionTriggerWait**.

b) If the **AcquisitionStatus** parameter is **true**, the camera is waiting for a trigger signal of the trigger type selected. If the **AcquisitionStatus** parameter is **false**, the camera is busy.

Camera models that support this feature:

Model
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-230-168U3M/C-FPC
VEN-301-125U3M/C-FPC
VE2S-301-125U3M/C-S (J150)

8.3.16. Black Level

The Black Level can change the overall brightness of an image by changing the gray values of the pixels by a specified amount. Currently, the application range of the black level value can only be selected as all pixels, and pixel selection is not supported.

The lower the black level, the darker the corresponding image, the higher the black level, the brighter the corresponding image.

Model	Adjustment range	Default value/Step
VEN-160-227U3M/C-FPC-(M00/M05)	0~255	15, 1
VEN-230-168U3M/C-FPC	0~511	4, 1
VEN-301-125U3M/C-FPC	0~1023	0, 1
VEN-1220-32U3M/C-FPC-(M00/M05)	0~255	4, 1
VE2S-301-125U3M/C-S (J150)	8bit Pixel Depth: 0~255 10bit Pixel Depth: 0~1023 12bit Pixel Depth: 0~4095	0, 1 0, 1 0, 1

Table 8-7 VENUS USB3 Vision camera black level adjustment range

8.3.17. Remove Parameter Limits

The range of camera parameters is usually limited, and these factory limits are designed to ensure the best camera performance and high image quality. However, for certain use cases, you may want to specify parameter values outside of the factory limits. You can use the remove parameter limits feature to expand the parameter range. The features of the extended range supported by different cameras may be different and the range may be different, as shown in Table 8-8.

Model	Features	Set the switch to off	Set the switch to on
VEN-160-227U3M/C-FPC-(M00/M05)	Exposure	20~1000000	20~15000000
	Auto Exposure	20~1000000	20~15000000
	Gain	0~24	0~48
	Auto Gain	0~24	0~48
	Black Level	0~255	0~255
	Sharpness	0~3	0~63
	White Balance component	0~15.996	0~63.996
	Auto White Balance	0~15.996	0~63.996
VEN-230-168U3M/C-FPC	Exposure	20~1000000	20~15000000
	Auto Exposure	20~1000000	20~15000000
	Gain	0~24	0~48
	Auto Gain	0~24	0~48
	Black Level	0~511	0~511
	Sharpness	0~3	0~63
	White Balance component	0~15.996	0~63.996
	Auto White Balance	0~15.996	0~63.996
VEN-301-125U3M/C-FPC	Exposure	20~1000000	20~15000000
	Auto Exposure	20~1000000	20~15000000
	Gain	0~24	0~48
	Auto Gain	0~24	0~48
	Black Level	0~1023	0~1023
	Sharpness	0~3	0~63
	White Balance component	0~15.996	0~63.996
	Auto White Balance	0~15.996	0~63.996

VEN-1220-32U3M/C-FPC-(M00/M05)	Exposure	10~1000000	10~15000000
	Auto Exposure	10~1000000	10~15000000
	Gain	0~24	0~27
	Auto Gain	0~24	0~27
	Black Level	0~255	0~255
	Sharpness	0~3	0~63
	White Balance component	0~15.996	0~63.996
	Auto White Balance	0~15.996	0~63.996
VE2S-301-125U3M/C-S (J150)	Exposure	20~1000000	20~15000000
	Auto Exposure	20~1000000	20~15000000
	Gain	0~24	0~48
	Auto Gain	0~24	0~48
	Black Level (8bit)	0~255	0~255
	Black Level (10bit)	0~1023	0~1023
	Black Level (12bit)	0~4095	0~4095
	Sharpness	0~3	0~63
	White Balance component	0~15.996	0~63.996
	Auto White Balance	0~15.996	0~63.996

Table 8-8 Parameter range of features supported before and after Remove Parameter Limits

8.3.18. User Data Area 16KB

The user data area is a FLASH data area reserved for the user, and the user can use the area to save algorithm factors, parameter configurations, etc.

The user data area is totally 16KB and is divided into 4 data segments, each of which is 4KB. The user can access the user data area through the API interface. The data is saved to the camera flash area immediately after being written, and the data will not disappear after the camera is powered off.

Camera models that support this feature:

Model
VEN-161-61U3M/C-(M01/M05/M06)
VEN-505-36U3M/C-(M01/M05/M06)

VEN-830-22U3M/C-(M01/M05/M06)
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-230-168U3M/C-FPC
VEN-301-125U3M/C-FPC
VEN-1220-32U3M/C-FPC-(M00/M05)
VE2S-301-125U3M/C-S (J150)

8.3.19. User Data Area 512KB

In addition to the above 16KB user data area, the camera also has a 512KB ROM area for storing large amounts of data and files. Users can access the user's data area through API. After writing, it will immediately saved into the camera's Flash area, and will not disappear after power down.

Camera models that support this feature:

Model
VE2S-301-125U3M/C-S (J150)

8.3.20. Timer

The camera only supports one timer (Timer1), which can be started by a specified event or signal (only ExposureStart signal is supported). The Timer can configure a timer output signal that goes high on a specific event or signal and goes low after a specific duration. And the timer is cleared when the output signal goes low. A schematic diagram of the timer working process is as follows:

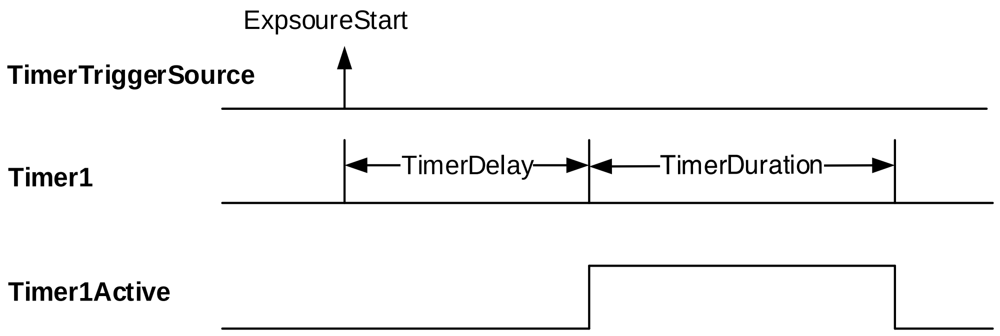


Figure 8-59 Timer1Active schematic diagram

The timer configuration process is as follows:

1. Set TimerSelector, currently only Timer1 supported.
2. Set LineSelector.
3. Set the LineSource to Timer1Active.
4. Set TimerTriggerSource, currently only ExposureStart supported.
5. Set TimerDelay, the range of TimerDelay is [0, 16777215], the unit is μs.

6. Set TimerDuration, the range of TimerDuration is [0, 16777215], the unit is μs.

   1) From the start of the timer to the full output of Timer1Active, this process will not be interrupted by the ExposureStart signal, and Timer1Active must be completely output to start timing according to the next ExposureStart signal. As shown in the figure below, the red ExposureStart signals are ignored.

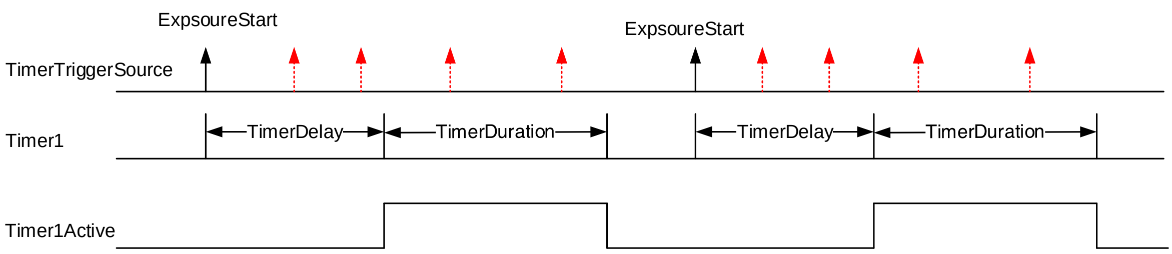


Figure 8-60 The relationship of Timer1Active and ExposureStart signal

   2) After the acquisition is stopped, the timer is immediately cleared and the Timer1Active signal goes low immediately.

Camera models that support this feature:

Model
VEN-302-56U3M/C-S
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-230-168U3M/C-FPC
VEN-301-125U3M/C-FPC
VEN-1220-32U3M/C-FPC-(M00/M05)
VE2S-301-125U3M/C-S (J150)

8.3.21. Counter

The camera only supports one counter (Counter1), which can count the number of FrameTrigger, AcquisitionTrigger and FrameStart signals received by the camera. The counter starts counting from 0. You can select one of the above three signals to count by CounterEventSource. The FrameTrigger and AcquisitionTrigger signals of the counter statistics refer to the signals that have been triggered for filtering without a trigger delay.

If CounterValue is enabled, the statistical data can be inserted into the frame information and output with the image.

The counter can be reset by an external signal. The reset source is selected by CounterResetSource. Currently, the CounterResetSource option supports Off, SoftWare, Line0, Line2, and Line3. Among them, Off means no reset, SoftWare means software reset, Line0, Line2 or Line3 means reset through IO port input signal. The polarity of the reset signal only supports RisingEdge, which means reset the Counter on the rising edge of the reset signal.

Counter configuration:

1. Set CounterSelector, currently only Counter1 supported.
2. Set CounterEventSource, the values that can be set are FrameStart, FrameTrigger, AcquisitionTrigger.
3. Set CounterResetSource, the values that can be set are Off, SoftWare, Line0, Line2, Line3.
4. Set CounterResetActivation, currently only RisingEdge supported.

1) After the acquisition is stopped, the Counter continues to work, will not be cleared, and it will be cleared when the camera is powered off.
2) CounterReset is used to software reset the counter.

Camera models that support this feature:

Model
VEN-302-56U3M/C-S
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-230-168U3M/C-FPC
VEN-301-125U3M/C-FPC
VEN-1220-32U3M/C-FPC-(M00/M05)
VE2S-301-125U3M/C-S (J150)

8.3.22. Exposure Overlap Time Max

The Exposure Overlap Time Max feature can optimize the acquisition of overlapping images. This parameter is especially useful if the user wants to maximize the camera's frame rate, i.e., if the user wants to trigger at the highest rate possible.

1) Prerequisites

a) Set the TriggerMode parameter to On.

b) Set the TriggerSource parameter to one of the available hardware trigger source, e.g., Line0.

c) Set the ExposureMode parameter to TriggerWidth exposure mode.

2) How it works

The user can use overlapping image acquisition to increase the frame rate of the camera. With overlapping image acquisition, the exposure of a new image begins while the camera is still reading out the sensor data of the previous image.

In TriggerWidth exposure mode, the camera does not "know" how long the image will be exposed before the trigger period is complete. Therefore, the camera cannot fully optimize overlapping image acquisition. To avoid this problem, the user can enter a value for the ExposureOverlapTimeMax parameter, which represents the shortest exposure time the user intends to use (in μs). This helps the camera optimize the overlapping image acquisition.

The trigger signal width of the hardware triggering should not be shorter than the value of the entered ExposureOverlapTimeMax parameter.

3) Set ExposureOverlapTimeMax

To optimize the frame rate of the camera, the exposure mode should be set to TriggerWidth:

a) Set the ExposureMode parameter to TriggerWidth.

b) Enter a value for the ExposureOverlapTimeMax parameter, which represents the shortest exposure time the user intends to use (in μs).

Example: Assume that the user wants to trigger the camera to apply exposure times in the range of 3000 μs to 5500 μs, the user needs to set the ExposureOverlapTimeMax parameter of the camera to 3000.

Camera models that support this feature:

Model
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-230-168U3M/C-FPC
VEN-301-125U3M/C-FPC
VE2S-301-125U3M/C-S (J150)

8.3.23. Exposure Time Mode

According to the length of the exposure time, two exposure time modes of the VENUS USB3 Vision camera are available: Standard exposure time mode and UltraShort exposure time mode.

8.3.23.1. Standard Exposure Time Mode

In Standard exposure time mode, three exposure time adjustment modes are available: manual adjustment, one-time automatic adjustment and continuous automatic adjustment. The standard exposure time mode is the default setting. For the manual adjustment, please refer to section 8.2.8 Set Exposure. For the automatic adjustment and continuous automatic adjustment, please refer to section 8.3.4 Auto Exposure/Auto Gain.

VEN-134-90U3M/C-D, VEN-134-90U3M-D NIR cameras only support manual adjustment.

8.3.23.2. UltraShort Exposure Time Mode

In UltraShort exposure time mode, the VENUS USB3 Vision camera only supports manual adjustment of the exposure time. Since standard exposure time mode is the default setting, if you want to set the UltraShort exposure time mode, you first need to adjust the visibility level to guru and set the ExposureTimeMode to UltraShort under the acquisition control features window.

Camera model that support UltraShort exposure time mode:

Model
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-301-125U3M/C-FPC
VE2S-301-125U3M/C-S (J150)

⚠ In UltraShort exposure time mode, the VENUS USB3 Vision camera does not support automatic adjustment of the exposure time, only support manual adjustment of the exposure time.

8.4. Image Processing

8.4.1. Color Transformation Control

The Color Transformation is used to correct the color information delivered by the sensor, improve the color reproduction of the camera, and make the image closer to the human visual perception.

Figure 8-61 Color template

The user can use a color template containing 24 colors and shoot this color template with a camera, the RGB value of each color may be different from the standard RGB value of the standard color template, the vendor can use the software or hardware to convert the RGB value that is read to the standard RGB value. Because the color space is continuous, all the other RGB values that are read can be converted to the standard RGB values by using the mapping table created by the 24 colors.

1) Prerequisites

For the color transformation to work properly, the white balance must first be configured appropriately.

2) Configuring color transformation

There are two modes for configuring color transformation: default mode (RGBtoRGB), user-defined mode (User).

RGBtoRGB: Default color transformation parameters provided to the camera when it leaves the factory.

User:

a) Set the **ColorTransformationValueSelector** parameter to the expected position in the matrix, e.g., Gain00.

b) Enter the expected value for the **ColorTransformationValue** parameter to adjust the value at the selected position. The parameter's value range is -4.0 to +4.0.

In user mode, the user can input the color transformation value according to the actual situation to achieve the color transformation effect.

3) How it works

The color transformation feature uses a transformation matrix to deliver modified red, green, and blue pixel data for each pixel.

The transformation is performed by premultiplying a 3 x 1 matrix containing R, G, and B pixel values by a 3 x 3 matrix containing the color transformation values:

$$\begin{bmatrix} Gain00 & Gain01 & Gain02 \\ Gain10 & Gain11 & Gain12 \\ Gain20 & Gain21 & Gain22 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix}$$

4) Effect images

Figure 8-62 Before color transformation

Figure 8-63 After color transformation

8.4.2. Gamma

The Gamma can optimize the brightness of acquired images for display on a monitor.

1) Prerequisites

If the **GammaEnable** parameter is available, it must be set to **true**.

2) How it works

The camera applies a Gamma correction value (γ) to the brightness value of each pixel according to the following formula (red pixel value (R) of a color camera shown as an example):

$$R_{corrected} = \left(\frac{R_{uncorrected}}{R_{max}}\right)^{\gamma} \times R_{max}$$

The maximum pixel value (R_{max}) equals, e.g., 255 for 8-bit pixel formats, 1023 for 10-bit pixel formats or 4095 for 12-bit pixel formats.

3) Enabling Gamma correction

After enabling Gamma correction, set **GammaValue** to change the image brightness. The range of **GammaValue** is 0 to 4.00.

a) Gamma = 1.0: the overall brightness remains unchanged.

b) Gamma < 1.0: the overall brightness increases.

c) Gamma > 1.0: the overall brightness decreases.

In all cases, black pixels (gray value = 0) and white pixels (gray value = maximum) will not be adjusted.

If you enable Gamma correction and the pixel format is set to a 10-bit or 12-bit, some image information will be lost. Pixel data output will still be 10-bit or 12-bit, but the pixel values will be interpolated during the Gamma correction process, resulting in loss of accuracy and loss of image information. If the Gamma feature is required and no image information is lost, avoid using the Gamma feature in 10-bit or 12-bit pixel format.

4) Additional parameters

Depending on your camera model, the following additional parameters are available:

a) GammaEnable: Enable or disable Gamma correction.

b) GammaMode: You can select one of the following Gamma correction modes:

User: The Gamma correction value can be set as expected.

sRGB: The camera's internal default Gamma correction value. This feature is used with the color transformation feature to convert images from RGB to sRGB. It is recommended to adjust Gamma to sRGB mode after enabling the color transformation feature.

Camera models that support this feature:

Model
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-230-168U3M/C-FPC
VEN-301-125U3M/C-FPC
VEN-1220-32U3M/C-FPC-(M00/M05)
VE2S-301-125U3M/C-S (J150)

8.4.3. Lookup Table

When the analog signal that is read out by the sensor has been converted via ADC, generally, the raw data bit depth is larger than 8 bits, there are 12 bits, 10 bits, etc. The feature of lookup table is to replace some pixel values in the 8 bits, 10 bits, and 12 bits images by values defined by the user.

The lookup table can be a linear lookup table or a non-linear lookup table, created entirely by the user.

You can also use the **LutValueAll** function to create an entire lookup table.

1) How it works

a) LUT is short for "lookup table", which is basically an indexed list of numbers.

b) In the lookup table you can define replacement values for individual pixel values. For example, you can replace a gray value of 0 (= minimum gray value) by a gray value of 1023 (= maximum gray value for 10-bit pixel formats). This changes all black pixels in your images to white pixels.

c) Setting a user-defined LUT can optimize the luminance of images. By defining the replacement values in advance and storing them in the camera to avoid time-consuming calculations. The camera itself has a factory default lookup table, and the default lookup table does not affect image luminance.

2) Creating the user-defined LUT

To create a lookup table, you need to determine the range of **LUTIndex** and **LUTValue** parameters by the maximum pixel format supported by the currently used camera.

a) On cameras with a maximum pixel bit depth of 12 bits

The **LUTIndex** selectable item is 0-4095, each **LUTIndex** corresponds to a **LUTValue**, and the **LUTValue** range is [0,4095].

b) On cameras with a maximum pixel bit depth of 10 bits

The **LUTIndex** selectable item is 0-1023, each **LUTIndex** corresponds to a **LUTValue**, and the **LUTValue** range is [0,1023].

Create a user-defined lookup table with the following steps:

1) Select the lookup table to use. Since there is only one user-defined lookup table in the camera, there is no need to select it by default.

2) Set the **LUTIndex** parameter to the pixel value that you want to replace with a new value.

3) Set the **LUTValue** parameter to the new pixel value.

4) Repeat steps 1 and 2 for all pixel values that need to be changed to set the parameters to the target pixel values in turn.

5) Set the **LutEnable** parameter to **true** means that the lookup table feature is enabled. The default is disabled.

If you want to replace all pixel values, it is recommended to use the **LUTValueAll** function. See the **LutValueAll** sample code in the Development User Manual for details.

Camera models that support this feature:

Model
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-230-168U3M/C-FPC
VEN-301-125U3M/C-FPC
VEN-1220-32U3M/C-FPC-(M00/M05)
VE2S-301-125U3M/C-S (J150)

8.4.4. Sharpness

The sharpness algorithm integrated in the camera can significantly improve the definition of the edges of the image. The higher the definition, the clearer the contour corresponding to the image. This feature can improve the accuracy of image analysis, thus improving the recognition rate of edge detection and OCR.

- Enable sharpness

ON means that the sharpness feature is enabled.

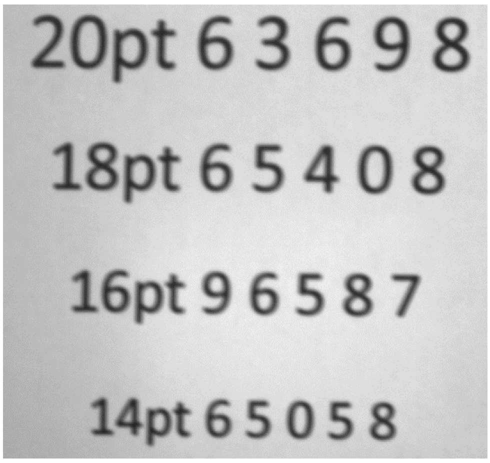


Figure 8-64 Before sharpness adjustment

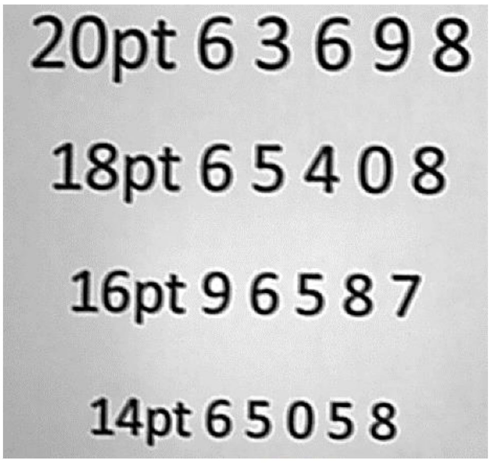


Figure 8-65 After sharpness adjustment

- Sharpness adjustment

Adjust the sharpness value can adjust the camera's sharpness to the image. The adjustment range is 0-3.0. The larger the value, the higher the sharpness.

Camera models that support this feature:

Model
VEN-160-227U3M-FPC-(M00/M05)
VEN-230-168U3M-FPC

VEN-301-125U3M-FPC
VEN-1220-32U3M-FPC-(M00/M05)
VE2S-301-125U3M-S (J150)

8.4.5. Noise Reduction

During the digitization and transmission of an image, it is often disturbed by the noise of the imaging device and the external environment, which will cause the image with noise. The process of reducing or suppressing the noise in the image is called image noise reduction.

Adjust the noise reduction value can adjust the noise reduction intensity of the camera on the image. The adjustment range is 0-4.0. The larger the value, the higher the degree of noise reduction.

Noise reduction feature: determine whether to enable noise reduction. ON means that the noise reduction feature is enabled. And OFF means that the noise reduction feature is disabled.

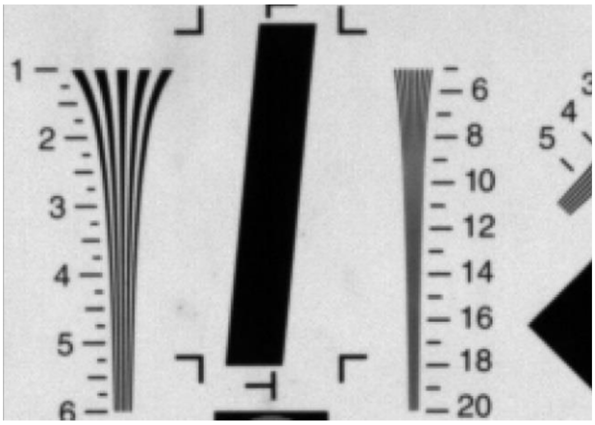


Figure 8-66 Before noise reduction

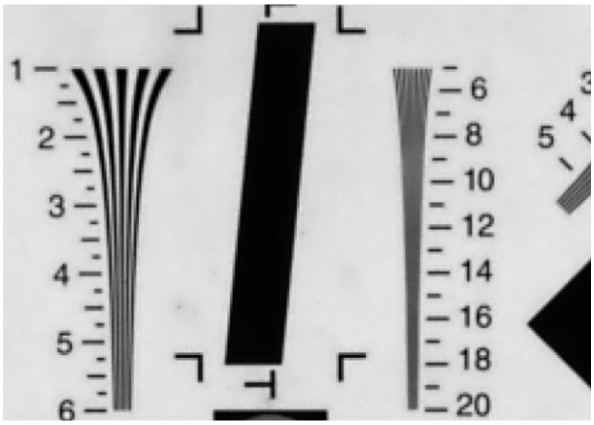


Figure 8-67 After noise reduction

Camera models that support this feature:

Model
VEN-160-227U3M-FPC-(M00/M05)
VEN-230-168U3M-FPC
VEN-301-125U3M-FPC
VEN-1220-32U3M-FPC-(M00/M05)
VE2S-301-125U3M-S (J150)

8.4.6. Saturation

Some VENUS USB3 Vision cameras support saturation function. Saturation function can changes the colorfulness (intensity) of the colors to achieve the goal image effect.

1) Prerequisites

If the **SaturationEnable** parameter is available, it must be set to **On**.

2) Configuring saturation

Enter the expected value for the Saturation parameter and the range is 0 to 128. By default, the parameter is set to 64 (no saturation perform)

3) How it works

The saturation adjustment is performed by a 3 × 3 matrix. When the saturation intensity is modified, the saturation can be changed by modifying the adjustment matrix A.

$$\begin{bmatrix} R_{out} \\ G_{out} \\ B_{out} \end{bmatrix} = \begin{bmatrix} RR & GR & BR \\ RG & GG & BG \\ RB & GB & BB \end{bmatrix} \begin{bmatrix} R_{in} \\ G_{in} \\ B_{in} \end{bmatrix} + \begin{bmatrix} R_{offset} \\ G_{offset} \\ B_{offset} \end{bmatrix} \quad A = \begin{bmatrix} RR & GR & BR \\ RG & GG & BG \\ RB & GB & BB \end{bmatrix}$$

Saturation adjustment and color correction adjustment both adopt the form of a matrix, so the saturation is adjusted at the same time after color correction is enabled.

4) Effect images

Figure 8-68 Before saturation

Figure 8-69 After saturation

Camera model that support this feature:

Model
VEN-160-227U3C-FPC-(M00/M05)
VEN-230-168U3C-FPC
VEN-301-125U3C-FPC
VEN-1220-32U3C-FPC-(M00/M05)
VE2S-301-125U3M/C-S (J150)

8.5. Image Transmission

8.5.1. Calculate Frame Rate

1) Frame Period

You can calculate the frame period of the VENUS USB3 Vision camera by the following formula:

$$T_f = \text{Max}(\frac{\text{ImageSize}\times 10^6}{\text{BandWidth}_{\text{USB}}}, \frac{\text{ImageSize}\times 10^6}{\text{DeviceLinkThroughputLimit}}, T_{acq}, T_{exp})$$

Among them:

$$\text{ImageSize} = \text{Width} \times \text{Height} \times \text{PixelSize} + 84$$

T_f: The camera's frame period, unit: μs.

Width: The current image width.

Height: The current image height.

PixelSize: The size of the pixel, in 8bit mode, the value is 1, and in 10bit/12bit mode, the value is 2.

$\text{BandWidth}_{\text{USB}}$: The bandwidth of the USB interface, unit: Bps.

DeviceLinkThroughputLimit: The limit of the device link throughput bandwidth, unit: Bps.

T_{acq}: The acquisition time of the camera, unit: μs.

T_{exp}: The exposure time of the camera, unit: μs.

2) Frame rate (Unit: fps)

$$F = \frac{10^6}{T_f}$$

It is recommended to use the frame rate calculation tool, the frame rate will be calculated automatically after the configuration parameters are filled.

8.5.2. USB Interface Bandwidth

The theoretical bandwidth of the USB interface of VENUS USB3 Vision camera is 400MBps, but actually the value will decrease with the type of the USB3.0 host controller, the version of the host controller driver, the wastage of the HUB and the host performance. The user can refer the test result of the interface bandwidth in <TN-USB3.0 host controller bandwidth and CPU utilization> document.

8.5.3. DeviceLinkThroughputLimit

The VENUS USB3 Vision camera provides bandwidth limit function, in order to control the upper limit bandwidth of single device. When the DeviceLinkThroughputLimit is greater than the current device acquisition bandwidth, the current device acquisition bandwidth will not change, when the DeviceLinkThroughputLimit is less than the current device acquisition bandwidth, the current device acquisition bandwidth will be reduced to the limit of the DeviceLinkThroughputLimit, the current device acquisition bandwidth can be read from the camera.

When the camera is working in trigger mode, the bandwidth limit will restrict the maximum trigger frequency.

Model	Min. of DeviceLinkThroughputLimit	Max. of DeviceLinkThroughputLimit	Step of DeviceLinkThroughputLimit
VEN-161-61U3M/C-(M01/M05/M06)	35000000Bps (8bit)	200000000Bps	1000000Bps
	70000000Bps (10bit)		
VEN-505-36U3M/C -(M01/M05/M06)	35000000Bps (8bit)	200000000Bps	1000000Bps
	70000000Bps (10bit)		
VEN-830-22U3M/C -(M01/M05/M06)	35000000Bps (8bit)	200000000Bps	1000000Bps
	70000000Bps (10bit)		
VEN-302-56U3M/C-S	35000000Bps (8bit)	400000000Bps	1000000Bps
	70000000Bps (10bit)		
VEN-134-90U3M/C-D	35000000Bps (8bit)	400000000Bps	1000000Bps
	70000000Bps (10bit)		
VEN-134-90U3M/C-D NIR	35000000Bps (8bit)	400000000Bps	1000000Bps
	70000000Bps (10bit)		
VEN-160-227U3M/C-FPC-(M00/M05)	35000000Bps (8bit)	400000000Bps	1000000Bps
	70000000Bps (10bit)		
VEN-230-168U3M/C-FPC	35000000Bps (8bit)	400000000Bps	1000000Bps
	70000000Bps (10bit)		
VEN-301-125U3M/C-FPC	35000000Bps (8bit)	400000000Bps	1000000Bps
	70000000Bps (10bit)		
VEN-1220-32U3M/C-FPC-(M00/M05)	35000000Bps (8bit)	400000000Bps	1000000Bps
	70000000Bps (10bit)		
VE2S -301-125U3M/C-S (J150)	35000000Bps (8bit)	400000000Bps	1000000Bps
	70000000Bps (10bit)		
	70000000Bps (12bit)		

Table 8-9 VENUS USB3 Vision camera bandwidth control

8.5.4. Camera Acquisition Time

The acquisition time of the camera is related to the OffsetY and height of the image ROI. When the OffsetY and height change in the ROI setting, it will affect the frame period captured by the camera front end, which will affect the acquisition frame rate.

The formulas are as follows:

- VEN-161-61U3M/C-(M01/M05/M06)

The row period (unit: μs):

$$T_{row} = \frac{552}{37.5} = 14.72$$

The camera acquisition time (unit: μs):

$$T_{acq} = (Height + 30) \times T_{row}$$

- VEN-505-36U3M/C-(M01/M05/M06)

The row period (unit: μs):

$$T_{row} = \frac{510}{37.5} = 13.6$$

The camera acquisition time (unit: μs):

$$T_{acq} = (Height + 96) \times T_{row}$$

- VEN-830-22U3M/C-(M01/M05/M06)

The row period (unit: μs):

$$T_{row} = \frac{768}{37.5} = 20.48$$

The camera acquisition time (unit: μs):

$$T_{acq} = (Height + 48) \times T_{row}$$

- VEN-302-56U3M/C-S

The row period (unit: μs):

$$T_{row} = \frac{423}{37.5} = 11.28$$

The camera acquisition time (unit: μs):

$$T_{acq} = (Height + 32) \times T_{row}$$

- VEN-134-90U3M/C-D, VEN-134-90U3M-D NIR

The row period (unit: μs):

$$T_{row} = \frac{736}{72} = 10.223$$

The camera acquisition time (unit: μs):

$$T_{acq} = \mathit{Height} \times T_{row} + 149.5$$

- VEN-160-227U3M/C-FPC-(M00/M05)

When the pixel format is Mono8 or BayerRG8, the row period (unit: μs):

$$T_{row} = \frac{147}{37.5} = 3.92$$

When the pixel format is Mono10 or BayerRG10, the row period (unit: μs):

$$T_{row} = \frac{147 \times 2}{37.5} = 7.84$$

The camera acquisition time (unit: μs):

$$T_{acq} = (\mathit{Height} + 32) \times T_{row}$$

- VEN-230-168U3M/C-FPC

When the pixel format is Mono8 or BayerRG8, the row period (unit: μs):

$$T_{row} = \frac{180}{37.5} = 4.8$$

When the pixel format is Mono10 or BayerRG10, the row period (unit: μs):

$$T_{row} = \frac{360}{37.5} = 9.6$$

The camera acquisition time (unit: μs):

$$T_{acq} = (\mathit{Height} + 38) \times T_{row}$$

- VEN-301-125U3M/C-FPC

When the pixel format is Mono8 or BayerRG8, the row period (unit: μs):

$$T_{row} = \frac{190}{37.5} = 5.07$$

When the pixel format is Mono10 or BayerRG10, the row period (unit: μs):

$$T_{row} = \frac{380}{37.5} = 10.13$$

The camera acquisition time (unit: μs):

$$T_{acq} = (\mathit{Height} + 38) \times T_{row}$$

- VEN-1220-32U3M/C-FPC-(M00/M05)

When the pixel format is BayerRG8, the row period (unit: μs):

$$T_{row} = \frac{720}{72} = 10$$

When the pixel format is BayerRG12, the row period (unit: μs):

$$T_{row} = \frac{720 \times 2}{72} = 20$$

The camera acquisition time (unit: μs):

$$T_{acq} = (Height + 38) \times T_{row}$$

- VE2S-301-125U3M/C-S (J150)

When the pixel depth is 8bit:

For the pixel format is Mono8 or BayerRG8, the row period (unit: μs):

$$T_{row} = \frac{166}{40} = 4.15$$

When the pixel depth is 10bit:

For the pixel format is Mono8 or BayerRG8, the row period (unit: μs):

$$T_{row} = \frac{203}{40} = 5.075$$

For the pixel format is Mono10 or BayerRG10, the row period (unit: μs):

$$T_{row} = \frac{406}{40} = 10.15$$

When the pixel depth is 12bit:

For the pixel format is Mono12 or BayerRG12, the row period (unit: μs):

$$T_{row} = \frac{474}{40} = 11.85$$

The camera acquisition time (unit: μs):

$$T_{acq} = (Height + D) \times T_{row}$$

8.6. Events

When event notification is set to "on", the camera can generate an "event" and transmit a related event message to the host whenever a specific situation has occurred. For VENUS USB3 Vision camera, the camera can generate and transmit events for the following situations:

- The camera has ended exposure (ExposureEnd)
- An image block is discarded (BlockDiscard)
- The trigger signal overflow (FrameStartOvertrigger)
- The image frame block is not empty (BlockNotEmpty)
- The burst trigger signal overflow (FrameBurstStartOvertrigger)
- The trigger signal wait (FrameStartWait)

- The burst trigger signal wait (FrameBurstStartWait)

Every event has a corresponding enable status, and in default all the events' enable status are disable.

When using the event feature, you need to enable the corresponding event. The effective information contained in each event is shown in Table 8-10:

No.	Event Type	Information
1	ExposureEnd Event	Event ID
		Frame ID
		Timestamp
2	BlockDiscard Event	Event ID
		Frame ID
		Timestamp
3	FrameStartOvertrigger Event	Event ID
		Frame ID
		Timestamp
4	BlockNotEmpty Event	Event ID
		Frame ID
		Timestamp
5	FrameBurstStartOvertrigger Event	Event ID
		Frame ID
		Timestamp
6	FrameStartWait Event	Event ID
		Frame ID
		Timestamp
7	FrameBurstStartWait Event	Event ID
		Frame ID
		Timestamp

Table 8-10 The effective information of each event

Among them: the timestamp is the time when the event occurs, and the timer starts when the camera is powered on or reset. The bit width of the timestamp is 64 bits, and the unit is ns.

8.6.1. ExposureEnd Event

If the ExposureEnd Event is enabled, when the camera's sensor has been exposed, the camera sends out an ExposureEnd Event to the host, indicating that the exposure has been completed.

8.6.2. BlockDiscard Event

When the average bandwidth of the write-in data is greater than the average bandwidth of the read-out data, the frame buffer may overflow. If the frame buffer is full and the camera continue to write image data to it, then the new data will overwrite the previous image data which has been in the frame buffer. At this moment, the camera sends a BlockDiscard event to the host, indicating that image discard event has occurred. So, when you read the next frame of image, the image is not continuous.

8.6.3. BlockNotEmpty Event

When the average bandwidth of the write-in data is greater than the average bandwidth of the readout data, if the frame buffer is not full, and there has image frame data in the frame buffer which has not been send out completely, then before the new image frame is written to the frame buffer, the camera will send a BlockNotEmpty event to the host, indicating that the previous image has not been send out completely when the new image is written in the frame buffer.

8.6.4. FrameStartOvertrigger Event

When the camera receives the FrameTrigger hardware trigger signal or software trigger signal, if the front-end sensor is exposing, it will not be able to respond to the new FrameTrigger signal, then the camera will send a FrameStartOvertrigger event to the host. Note that if multiple FrameTrigger signals are received within one frame acquisition period, the camera will send the corresponding number of FrameStartOvertrigger events.

8.6.5. FrameBurstStartOvertrigger Event

When the camera is in FrameBurstStart trigger mode, when it receives an AcquisitionTrigger hardware trigger or software trigger signal, if the front-end sensor is exposing, it will not be able to respond to the new AcquisitionTrigger signal, and the camera will send a FrameBurstStartOvertrigger event to the host. Note that the camera will send the corresponding number of FrameBurstStartOvertrigger events if it receives multiple AcquisitionTrigger signals during the acquisition period of one frame of image.

8.6.6. FrameStartWait Event

When the camera is in FrameTrigger mode, the camera starts acquiring images, and if it does not receive the FrameTrigger signal, the camera will send a FrameStartWait event to the host.

8.6.7. FrameBurstStartWait Event

When the camera is in the AcquisitionTrigger mode, the camera starts acquiring images. If the camera does not receive the AcquisitionTrigger signal, the camera sends a FrameBurstStartWait event to the host.

Note that if the FrameTrigger mode is set to on simultaneously with the AcquisitionTrigger mode, the FrameBurstStartWait event will be sent first. When the camera receives an AcquisitionTrigger signal, it will send a FrameBurstStartWait event.

Camera models that support this feature:

Model
VEN-160-227U3M/C-FPC-(M00/M05)
VEN-230-168U3M/C-FPC
VEN-301-125U3M/C-FPC
VEN-1220-32U3M/C-FPC-(M00/M05)
VE2S-301-125U3M/C-S (J150)

8.7. UART Port

The camera supports the TTL serial port function, and the Tx/Rx and GPIO pins are multiplexed. Through the software API interface, it can be configured as either the GPIO or the serial port. After being configured as a serial port, the serial port commands can be transmitted to the GPIO pin of the camera through the API interface to control other serial port devices.

The baud rate supported by the serial port is 9600, 19200, 38400, 76800, 115200, and the data bit width is 8bit, the maximum length for a single transmission or reception is 1004 bytes. For more details or the sample code, please contact our technical support.

The wiring diagram of the camera and external serial port device is shown below. Line3 can be configured as Tx or Rx, the same as Line2. When Line3 is configured as Tx, it should be connected to the Rx of the UART module; At this time, Line2 should be configured as Rx and connected to the Tx of the UART module.

Due to the open drain output of Line2/Line3, it is necessary to supply power to the UART module at +3.3V/+5V for normal communication.

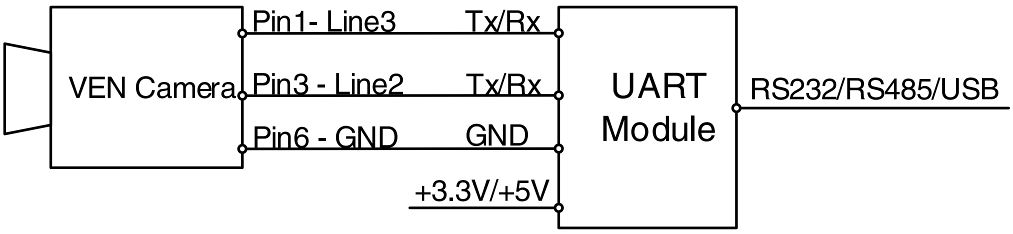


Figure 8-70 The wiring diagram of the camera and external serial port device

Camera models that support this feature:

Model
VE2S-301-125U3M/C-S (J150)

9. Software Tool

9.1. LUT Create Tool

9.1.1. GUI

LUT Create Tool, which supports all series of DAHENG IMAGING cameras. This plugin is integrated into GalaxyView.exe. After opening the device that you want to operate through this software, you can open LUT Create Tool from the menu bar plugin list. With the plugin you can achieve the following functions:

1) Adjust the image Gamma, brightness, and contrast.

2) Read the saved Lut from device.

3) Write the adjusted Lut to device.

4) Read the saved Lut from Lut/CSV file.

5) Save the adjusted Lut to file.

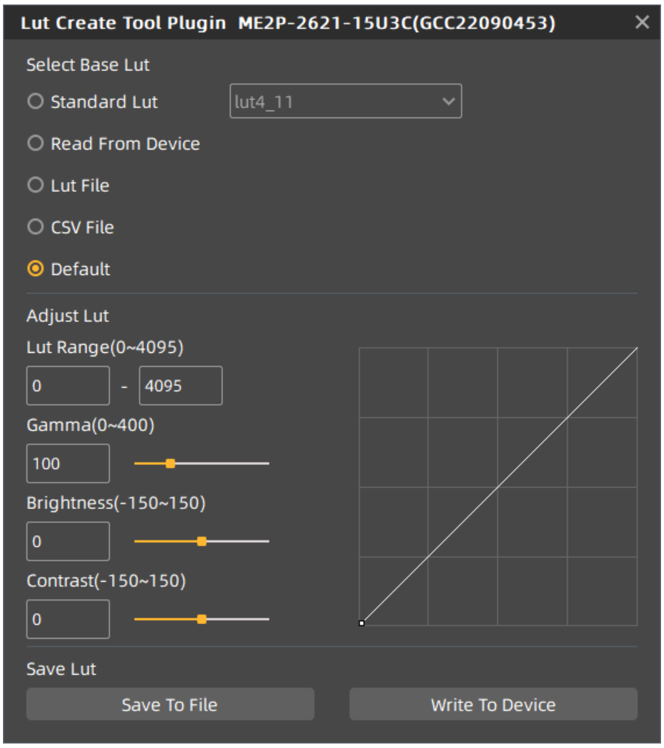


Figure 9-1 The GUI of LUT Create Tool

After opening the device and LUT Create Tool through GalaxyView.exe, the initial GUI is shown in Figure 9-1. The layout and function description of widgets are as follows:

[GroupBox] Select Lut from standard Lut, read from device, Lut file, CSV file and default. Among them, standard Lut is eight groups of factory standard Luts. Read from file is the Lut that can be read from device. Lut/CSV file can read the saved values. The default mode is the camera default value.

[Auto Create Lut] Adjust the Lut range, Gamma, brightness, and contrast to add effects on base Lut.

[Save Lut] Write the currently generated Lut to device or save to Lut/CSV file.

[Polyline Drawing Area] Represent the currently generated Lut in a curve form.

9.1.2. User Guide

9.1.2.1. User Case

After you select GroupBox and adjust the Lut parameter to a satisfactory effect, if you want to save the currently set parameters and you want to restore the parameters after the camera is powered on again, you need to select "Write To Device". The Lut parameter will be written to the UserSet0. After the device is powered on again, select the "Read From Device" in the GroupBox to load the UserSet0 and restore the parameter value.

If the device does not support reading/writing Lut, or does not support Lut to be used on other terminal devices after adjusting Lut effect through this terminal, then you can use the "Save To File" function. After adjusting Lut, select "Save To File" and choose the save format as lut. Then select the "Lut File" in GroupBox again and select the saved Lut file to restore the parameters. If you copy the file to another terminal and read it, you can still restore the parameters.

9.1.2.2. GroupBox

1. Standard Lut

When selecting standard Lut in GroupBox, the drop-down list box is enabled, which contains eight sets of optional standard Lut, as shown in Figure 9-2. These eight sets of values are factory set, which can achieve the optimal image effect. When you choose different standard Lut, the polyline and image effects change. You can modify the Lut range, Gamma, brightness, contrast values to add image effects until you are most satisfied.

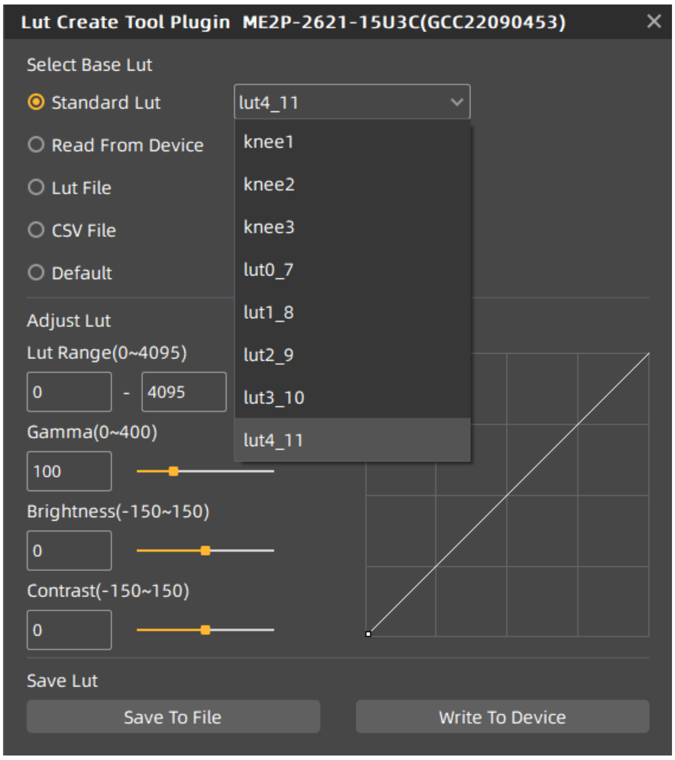


Figure 9-2 Standard Lut

2. Read From device

When you select read from device, the tool will automatically load UserSet0, and then load the Lut saved by the device. If the device supports LUTEnable, it will automatically set LUTEnable to true to display the image effect in real time, the GUI is as shown in Figure 9-3.

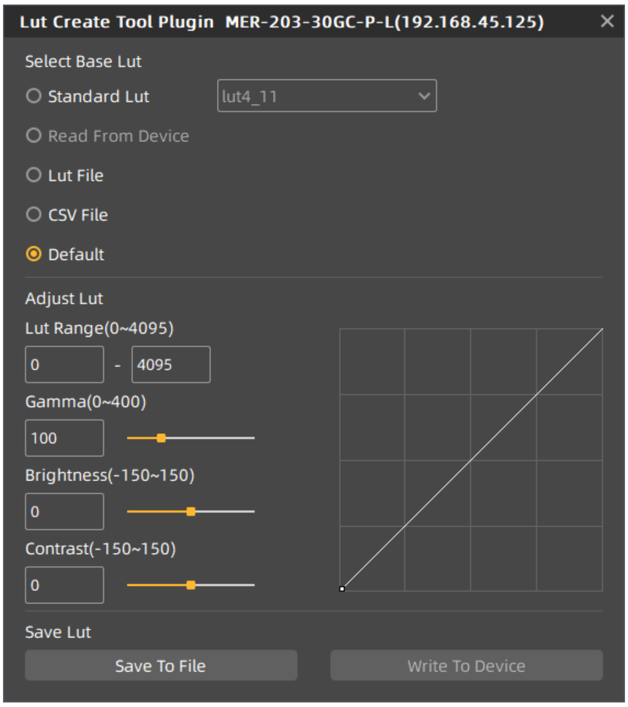


Figure 9-3 Do not support "Read From Device"

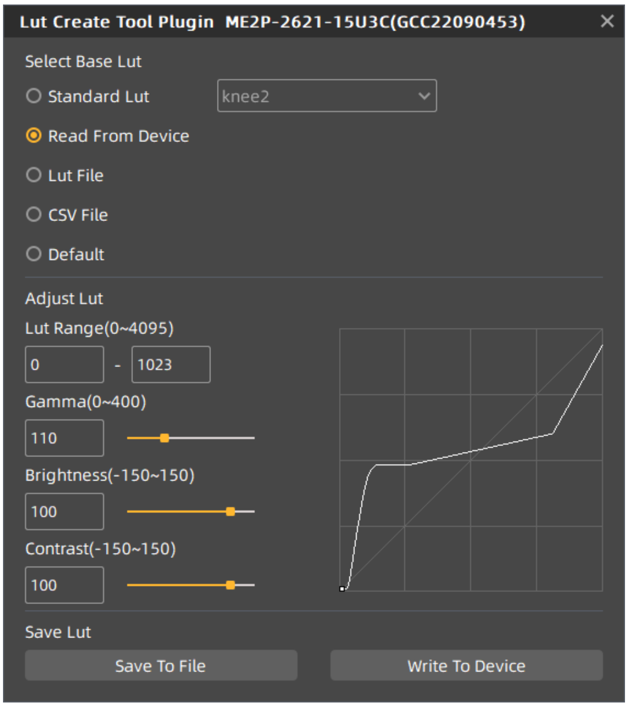


Figure 9-4 Select "Read From Device"

When selecting "Read From Device", the polyline graph and image effects are updated to the lookup table in the device.

When selecting the “Standard Lut” or “Default Lut” and selecting "Write To Device", then when reading, the written parameters will be updated to the GUI.

For example, standard Lut selects knee2, Lut range input 0-1023, Gamma input 110, brightness input 100, contrast input 100, and the GUI after selecting "Write To Device" is shown in Figure 9-4.

3. Lut file

After selecting the “Lut File”, a dialog box for selecting the file will pop up. You can select the file in the format of .lut, and update the polyline diagram and image acquisition effect of the device. If you select standard Lut or default Lut, and auto create Lut, the widget interface will update the parameters stored when saving Lut (the updated parameter values include Lut range, Gamma, brightness, contrast, and the values selected by the standard Lut drop-down box).

4. CSV file

After selecting “CSV File”, a dialog box for selecting the file will pop up. You can select the file in the format of .csv, and update the polyline diagram and image acquisition effect of the device. After selecting CSV file, all widgets of Auto Create Lut are disabled and unadjustable, as shown in Figure 9-5.

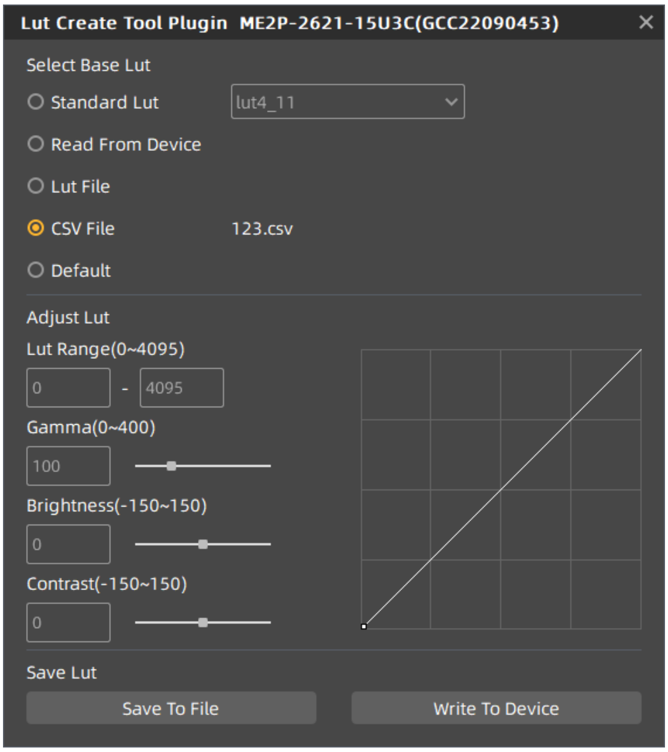


Figure 9-5 Select CSV file

CSV file can be manually modified by users. Currently, csv storage format saves decimal number of every four bytes to the first cell of each line in the file, and the maximum value of the number in each cell is 4095, a total of 4096 lines. The polyline graph of the GUI updates the curve according to the number of the first line of every 16 lines. Failure to follow the format when manually modifying will result in failure to read the file.

5. Default

The “Default” option is the Lut data when the device is shipped from the factory, and is the initial value in each situation. If there is an error in other situation, it will automatically switch to the default. The default polyline graph is diagonal.

9.1.2.3. Auto Create Lut

There are five sets of parameters in Auto Create Lut, the maximum Lut range (default value 4095, range 0~4095), minimum value (default value 0, range 0~4032), Gamma (default value 100, range 0~400), brightness (default value 0, range -150~150), contrast (default value 0, range -150~150), where the difference between the maximum and minimum values of the Lut range needs to be greater than or equal to 63.

After selecting the GroupBox, when the above parameters are modified, the generated Lut will be written to the device Flash in real time. At this time, the "Write To Device" is not selected. After the device is powered off and restarted, the modified parameters will be lost. The generated Lut cannot be restored by "Read From Device".

If the GroupBox is selected as default or standard Lut, then adjusting the parameter values in the Lut group to generate Lut and saving the lut file will save the parameter values together in the file. Reading the file again will restore the saved case. If written to the device, the VEN-U3 cameras will save and restore the parameter.

9.1.2.4. Save Lut

The group contains two widgets: Save To File and Write To Device.

1. When selecting "Save To File", the current Lut data can be saved to the file. The saved file contains two formats: Lut and csv: The save type can be changed when saving the file. The default save path is ".\resource\gxplugins\LookUpTable\Lut12", which is the directory where the GalaxyView.exe is installed.

2. When "Write To Device" is selected, the current Lut data is written to UserSet0, and UserSetDefault is modified to UserSet0. UserSet0 will be loaded when reading from the device again.

9.1.3. Precautions

9.1.3.1. Read From Device

When reading from device, UserSet0 will be loaded, which will cause the previously modified device feature information to be lost. Therefore, the information should be saved in time before reading from device.

9.1.3.2. Write To Device

In order to ensure that the device will restore the effect before power off after the device is power-on again. When writing to device, it will set the parameter set to UserSet0 and set the UserSetDefault to UserSet0. If you do not want to restore the case and the Lut in the flash after powering off and restarting the device, please use the "Write To Device" function with caution.

9.1.3.3. Directory Structure

When reading/writing Lut and Auto Creat Lut, you need to rely on some files in the installation package directory, so do not arbitrarily change the installation package directory structure to avoid read/write failure.

9.2. Frame Rate Calculation Tool

B	C
Width	1440
Height	1080
ExposureTime(us)	10000
PixelFormat(8/10)	8
DeviceLinkThroughputLimit(Bps)	200000000
MaxUSBControllerThroughput(Bps)	200000000
xtrig_low	679
N	1
ImageSize	1555284
Trow	14720
T_acq	16339200
AcquisitionFrameRateMode	off
AcquisitionFrameRate	61.2
Tf	16339200
FPS	61.20

Figure 9-6 Frame rate calculation tool

The frame rate calculation tool is currently provided in the form of Excel. When using it, firstly select the camera model in the table, and then achieve the expected frame rate by modifying the parameter of the camera. There are four major types of influencing factors, including image readout time (image width, image height, pixel format), exposure time, acquisition frame rate control, and device link throughput limit.

Table parameter explanation:

1) The Width and Height are the set ROI size.

2) The ExposureTime is the exposure time when the camera acquires one frame of image.

3) The PixelFormat is the pixel format corresponding to the camera output image, including 8 bits, 10 bits or 12 bits.

4) The DeviceLinkThroughputLimit represents the maximum bandwidth of the image transmitted by the camera.

5) The MaxUSBControllerThroughputLimit represents the recommended maximum transmission bandwidth of the camera. If this value is exceeded, frame losing may occur.

6) The AcquisitionFrameRate represents the maximum value of the frame rate control when the AcquisitionFrameRateMode is set to on, and whether the maximum value can be reached depends on whether the camera is affected by other acquisition parameters.

7) AcquisitionFrameRateMode indicates whether frame rate control is enabled, On means frame rate control is enabled, and Off means frame rate control is disabled. When frame rate control is enabled, the camera acquires images at a frame rate no higher than the AcquisitionFrameRate. When frame rate control is disabled, the camera acquires images without being affected by the AcquisitionFrameRate.

8) AcquisitionFrameRateMode indicates whether frame rate control is enabled, On means frame rate control is enabled, and Off means frame rate control is disabled. When frame rate control is enabled, the camera acquires images at a frame rate no higher than the AcquisitionFrameRate. When frame rate control is disabled, the camera acquires images without being affected by the AcquisitionFrameRate.

When using the frame rate calculation tool, please fill in the above information of the camera into the corresponding table. When the filled value exceeds the range or does not conform to the rules, the calculation tool will report an error. Please modify and fill in the value again according to the prompt information. When all parameters are correctly filled in, the FPS shown in the last column of the table is the theoretical frame rate currently acquired by the camera, and usually the error between this value and the actual frame rate acquired by the camera is no more than 1%.

10. FAQ

No.	General Question	Answer
1	On the unactivated Windows7 64bit system, the installation of Galaxy SDK has been successfully, but open the demo program failed.	1) Activate Windows7 64bit system, uninstall the package, restart the system, reinstall the package and reopen the demo program.
2	The cameras cannot be enumerated.	1) Please check whether the LED is green, and check whether the USB cable is connected properly, re-enumerate after re-plugging the camera. 2) Please check whether the driver of connected controller works well, reinstall the controller driver and enumerate repeatedly. 3) Please check whether the driver of host controller works well, and whether the camera displays as “USB3 Vision Digital Camera”, if not, try to reinstall the setup driver.
3	Fail to open device, it shows "Load XML failed".	1) Contact with the technical support to obtain upgrade program, and then upgrade your cameras.
4	Fail to open device, it shows that "The device has been opened".	1) Please close the software which has opened the camera.
5	Fail to open device, it shows that "This device can only be operated on an USB3.0 Port".	1) Please check whether the camera is connected to USB2.0 port or USB2.0 HUB. Be sure to connect the camera to USB3.0 port.
6	No images after acquisition start.	1) Please load the default parameter set, reopen the demo, execute the command AcquisitionStart again, and then check the frame rate. 2) Open the demo, switch to stream features page, and decrease the number of StreamTransferNumberUrb to 10. Then try to execute the command AcquisitionStart again and check the frame rate. 3) Open the demo, switch to stream features page, check the statistic information, and check if any packet has been received. If there are some incomplete frames, please refer to section 2.2.
7	The frame rate is not up to the nominal value.	1) Change another PC with high performance. 2) It's recommended to use Intel host controller. 3) Be sure the main board support PCI-E2.0 or above. 4) If you have any other questions, please contact us.

No.	General Question	Answer
8	Lose frames seriously in a multiple cameras' application.	1) The bandwidth of the camera is more than the bandwidth of the host controller. You can decrease the bandwidth through the DeviceLinkThroughputLimit function. 2) Connect the camera to the host controller separately.
9	Camera crashes on Advantech AIIS-1440 IPC.	1) Be sure the driver version of AMD USB controller is later than 2.20.
10	Brightness changes (flicker) or received incomplete frames in VEN-U3 series cameras' acquisition.	1) Be sure one USB3.0 controller can only be connected to one VEN-U3 series camera, and no other USB devices can be connected (Including keyboard/mouse/USB flash disk, etc.).

11. Revision History

No.	Version	Changes	Date
1	V1.0.0	1. Initial release	2020-09-14
2	V1.0.1	1. Add VEN-505-36U3M/C 2. Add VEN-830-22U3M/C 3. Add VEN-161-61U3C 4. Add the descriptions of auto white balance and light source preset 5. Modify some descriptions	2020-10-30
3	V1.0.2	1. Modify the frame rates of VEN-505-36U3M/C and VEN-830-22U3M/C	2020-12-10
4	V1.0.3	1. Modify some descriptions	2020-12-30
5	V1.0.4	1. Modify the exposure delay data	2021-03-11
6	V1.0.5	1. Add the descriptions in FAQ	2021-03-18
7	V1.0.6	1. Modify the frame rate of VEN-505-36U3M/C	2021-03-22
8	V1.0.7	1. Add VEN-302-56U3M-S 2. Add the descriptions of Certification and Hardware System and Installation 3. Add the descriptions of I/O port and I/O control about VEN–U3 binocular series camera 4. Add the descriptions of section 8.2.3, section 8.3.5.1, section 8.3.10, section 8.3.11, section 8.3.20 and section 8.3.21 5. Modify some descriptions in section 8.2.9 and section 8.3.7 6. Delete FCC description 7. Add HN-2M, HN-5M, HN-20M, HN-P-6M, HN-P-10M, HN-P-25M series of industrial lenses	2021-07-30
9	V1.0.8	1. Modify section 7.3.1.1 to add the series resistance requirement when the external voltage of Line0+ is 5V and modify Table 7-3 2. Add VEN-302-56U3C-S 3. Add HN-6M series of industrial lenses	2022-02-11
10	V1.0.9	1. Modify the mechanical dimensions of VEN-U3-M06: Figure 5-3, Figure 5-4 and Figure 5-5	2022-03-28
11	V1.0.10	1. Modify the mechanical dimensions of VEN-U3 monocular series: Figure 5-9 and Figure 5-10	2022-06-24

No.	Version	Changes	Date
12	V1.0.11	1. Add VEN-230-168U3M/C-FPC, VEN-301-125U3M/C-FPC, VEN-160-227U3M/C-FPC-(M00/M05), VEN-1220-32U3M/C-FPC-(M00/M05) cameras	2022-09-16
13	V1.0.12	1. Add FCC description 2. Update the operating system description in chapter 4 3. Modify the mechanical dimensions of Figure 5-6 4. Update the model of HN-P-6M series of industrial lenses	2022-10-20
14	V1.0.13	1. Add VEN-134-90U3M/C-D, VEN-134-90U3M-D NIR 2. Modify the descriptions in section 2.3, section 2.4 3. Add the descriptions of split bionuclar USB3.0 interface camera in section 3.5 4. Modify the mechanical dimensions in section 5.1 5. Update Figure 6-1 and Figure 6-2	2022-11-17
15	V1.0.14	1. Add VE2S-301-125U3M/C-S (J150) model 2. Update VEN-230-168U3M/C-FPC, VEN-301-125U3M/C-FPC model information 3. Add 8.2.3. High Speed Burst Mode, 8.3.19. User Data Area 512KB, 8.7. UART Port 4. Add 7.3. IO interface physical diagram 5. Update 8.3.5.Auto White Balance, 8.3.6.Light Source Preset descriptions 6. Delete FCC related certification description 7. Update Figure 1-1 Naming rules 8. Add industrial lens: HN-P-6M 1/1.8”	2023-03-31
16	V1.0.15	1. Update the UI interface and usage description related to the software	2023-09-09

12. Contact Us

12.1. Contact Sales

If you need to order products or inquire product information, please contact our sales:

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Email: isales@deheng-imaging.com

12.2. Contact Support

If you have any questions in using DAHENG IMAGING products, please contact the experts on our support team:

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