

China Daheng Group, Inc. Beijing Image Vision Technology Branch

VENUS USB3 Vision Cameras

User Manual

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DAHENG | **大恒图像**
IMAGING

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Preface

We really appreciate your choosing of DAHENG IMAGING products.

The VENUS USB3.0 series camera is DAHENG IMAGING's latest board level industrial digital camera with large and high-quality sensor, featuring high resolution, high definition and extremely low noise. The camera is equipped with standard USB3.0 interface, is easy to install and use.

The VENUS family 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 series camera is DAHENG IMAGING's innovative board level industrial digital camera, featuring outstanding performance, powerful features, outstanding price/performance ratio. The VEN-U3 series 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 VEN-U3 series digital camera transmits image data through the USB3.0 data interface. Thanks to the locking screw connectors, the VENUS series cameras can secure the reliability of cameras deployed in harsh industrial environments. Featuring high reliability and high price/performance ratio, the VENUS series cameras are especially suitable for machine vision applications such as industrial inspection, medical, scientific research, education, security and so on.

1.2. Naming Rules

Details of the VENUS USB3 Vision series camera is given in the general specifications below. Each camera model name is determined by its sensor's maximum resolution, maximum frame rate at maximum resolution, the color/monochrome type of the sensor, etc.



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 GENiCAM 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. The relevant contents are as follows:

Document	VENUS USB3 Vision Cameras User Manual
CAD/Technical Drawing	DAHENG IMAGING VEN-U3 CAD/Technical Drawing
Software	Galaxy Windows SDK—USB3.0, GigE, MERCURY USB2.0 Cameras
	Galaxy Linux SDK—USB3.0, GigE, MERCURY USB2.0 Cameras
	Galaxy Android SDK—USB3.0 Cameras

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 screw and the camera should have a screw length between 2.5 and 2.7mm, and the M2 screw and the camera should have a screw length between 3 and 3.3mm
- 2) The M3 screw assembly torque $\leq 1\text{N.M}$, and the M2 screw assembly torque $\leq 0.5\text{N.M}$. If the screw assembly torque is too large, it may cause the camera thread stripping.

3. Installation Guideline

3.1. Host Preparation

3.1.1. Software Package

The software package of DAHENG IMAGING's MERCURY2 series is used to control the MERCURY2 and VENUS series 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 series 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 MERCURY2 series 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 GENCAM standard, DAHENG IMAGING follows the GENCAM 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 series USB3.0 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

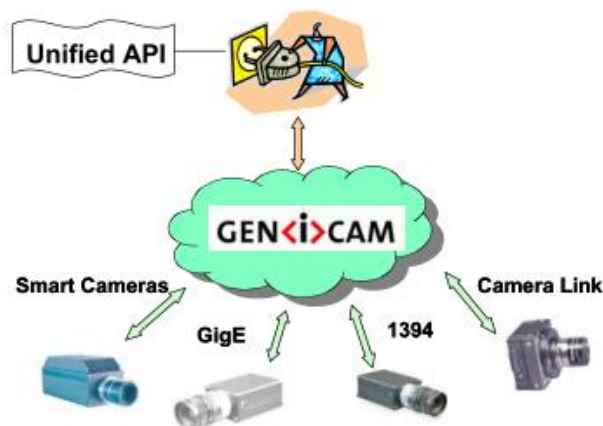


Figure 3-1 GEN<i>CAM standard schematic diagram

3.2. Camera Power

VEN-U3 series camera is powered by the USB 3.0 interface.

3.3. Camera Driver Installation

3.3.1. System Requirements

GalaxySDK is suitable for all cameras in the VENUS series. 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	<ul style="list-style-type: none">➤ Windows XP (32bit, 64bit)➤ Windows 7 (32bit, 64bit)➤ Windows 8 (32bit, 64bit)➤ Windows 8.1 (32bit, 64bit)➤ Windows 10 (32bit, 64bit)
Linux	<ul style="list-style-type: none">➤ Ubuntu 12.04 or above, kernel version 3.5.0.23 or above
Android	<ul style="list-style-type: none">➤ Android6 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 toolbar 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 toolbar to perform the Start Acquisition operation on the current device.

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 $V/((W/m^2) \cdot s)$, $V/lux \cdot s$, $e-/((W/m^2) \cdot s)$ or $DN/((W/m^2) \cdot s)$.

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-(M01/M05/M06)

4.2.1. Parameter

Specifications	VEN-161-61U3M-M06	VEN-161-61U3M-M01	VEN-161-61U3M-M05
Resolution	1440 × 1080		
Sensor Type	Sony IMX296 global shutter CMOS		
Optical Size	1/2.9 inch		
Pixel Size	3.45 μ m × 3.45 μ m		
Frame Rate	61.2fps@1440 × 1080		
ADC Bit Depth	10bit		
Pixel Bit Depth	8bit, 10bit		
Shutter Time	20 μ s~1s		
Gain	0dB~24dB		
Pixel Data Formats	Mono8/Mono10		
Signal Noise Ratio	40.6dB		
Synchronization	External 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×35 mm×15.1mm (without S-mount lens adapter or connectors)
Weight	7g	31g	32g
Software	Windows XP/Win7/Win8/Win10 32bit, 64bit OS		
Data Interface	USB3.0		
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity		
Conformity	CE, RoHS, FCC, USB3 Vision, GenICam		

Table 4-1 VEN-161-61U3M-(M01/M05/M06) camera specifications

4.2.2. Spectral Response

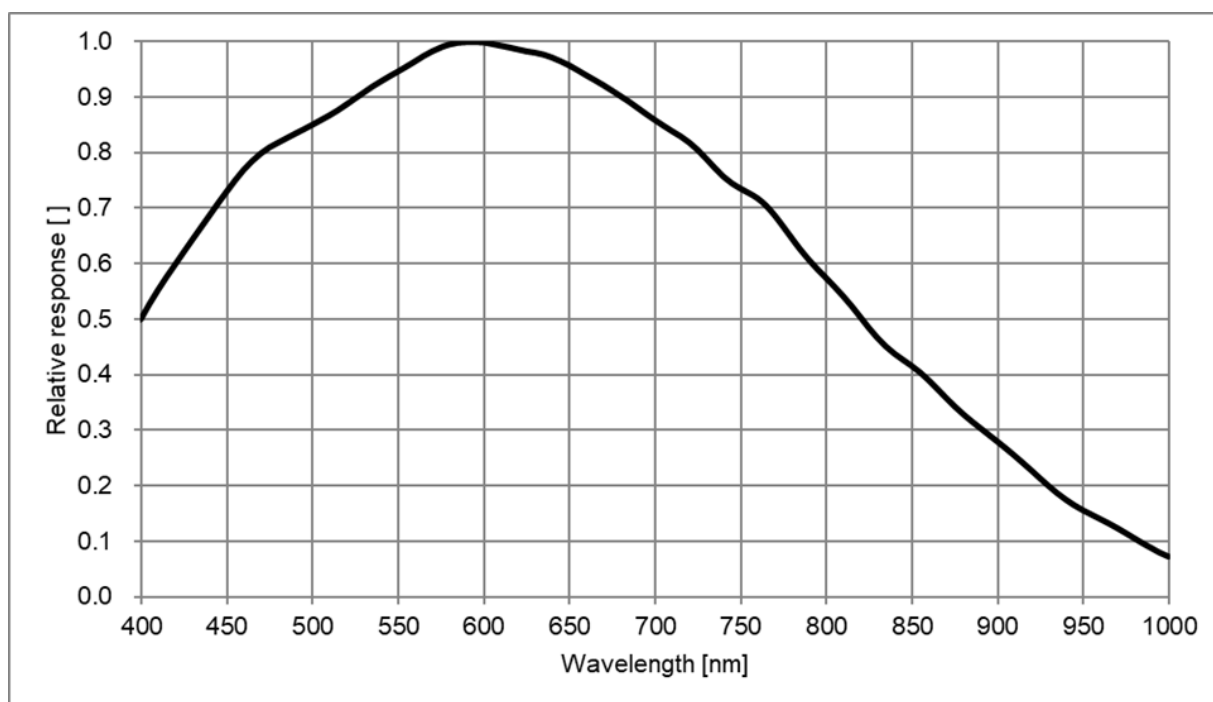


Figure 4-1 VEN-161-61U3M-(M01/M05/M06) sensor spectral response

5. Dimensions

5.1. Camera Dimensions

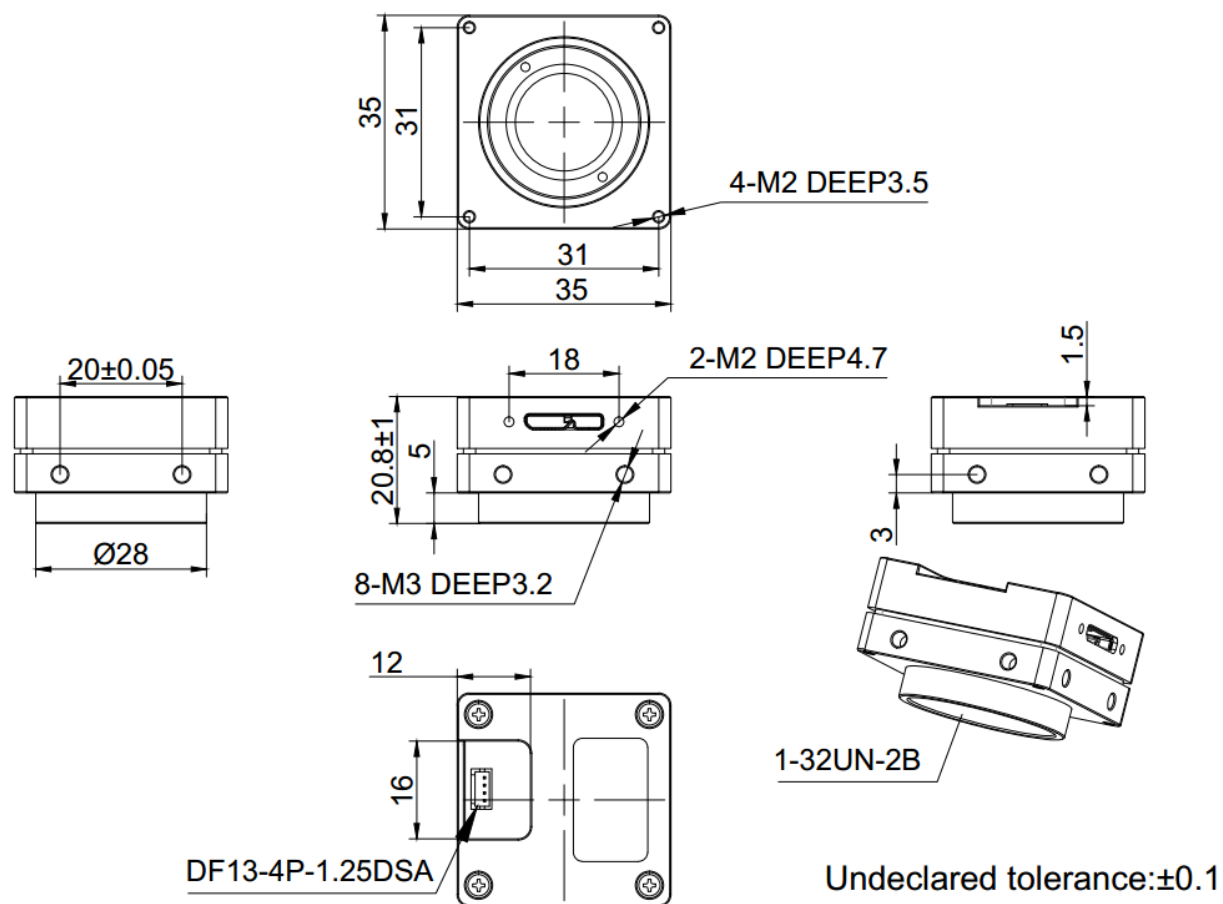


Figure 5-1 VEN-U3-M01 mechanical dimensions

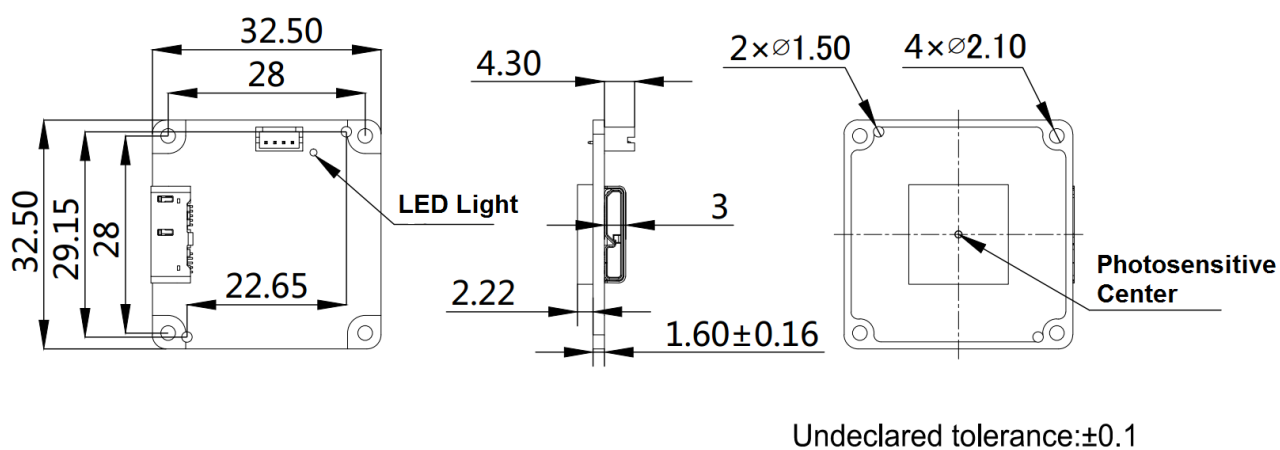


Figure 5-2 VEN-U3-M06 mechanical dimensions

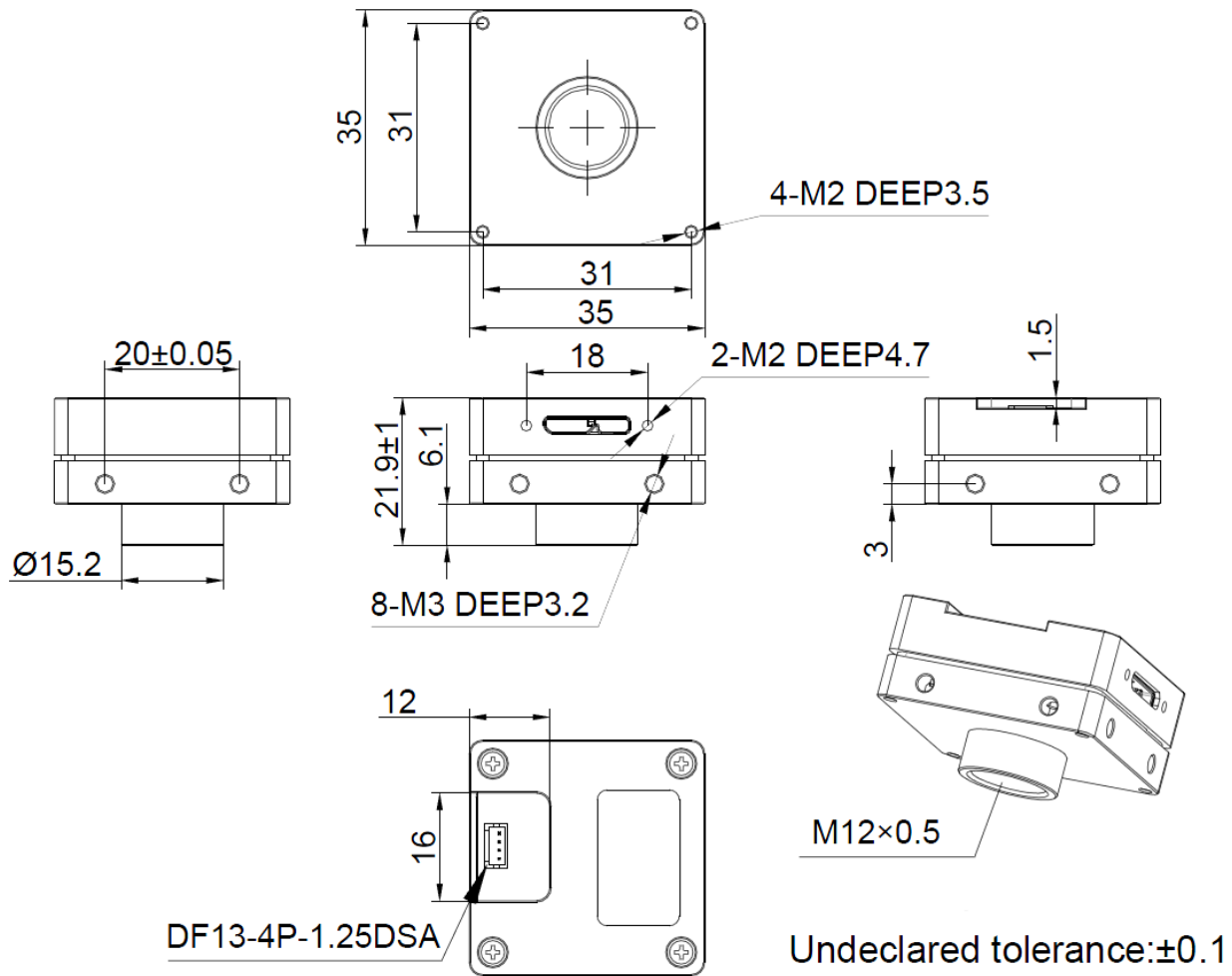


Figure 5-3 VEN-U3-M05 mechanical dimensions

5.2. Optical Interface

VEN-U3 cameras are equipped with CS-mount and S-mount lens adapters. 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 5-4. The back-flange distance of S-mount is 13.18 mm (in the air), and the maximum screw-in depth of the S-mount lens should be less than 11.6mm, as shown in Figure 5-5.

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.

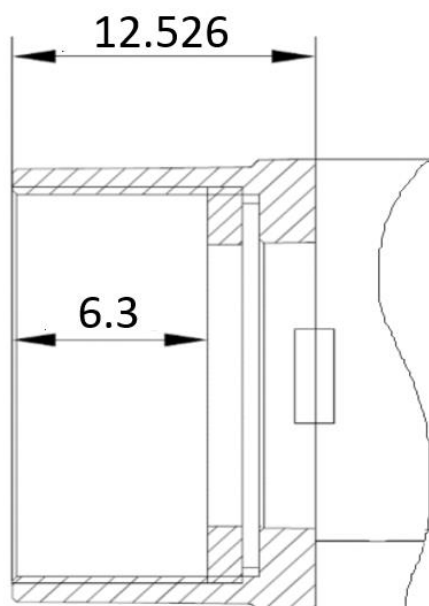


Figure 5-4 CS-mount optical interface of VENUS

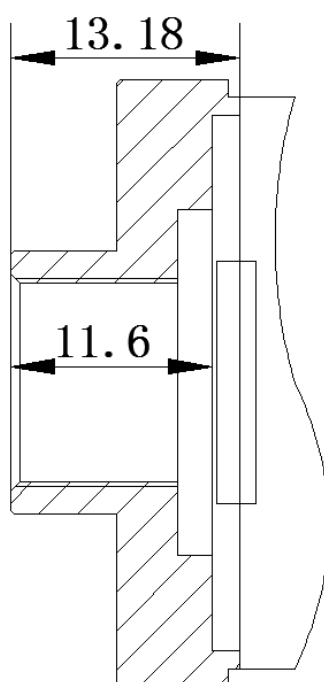


Figure 5-5 S-mount optical interface of VENUS

6. Filters and Lenses

6.1. Filters

The VENUS color models of 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.

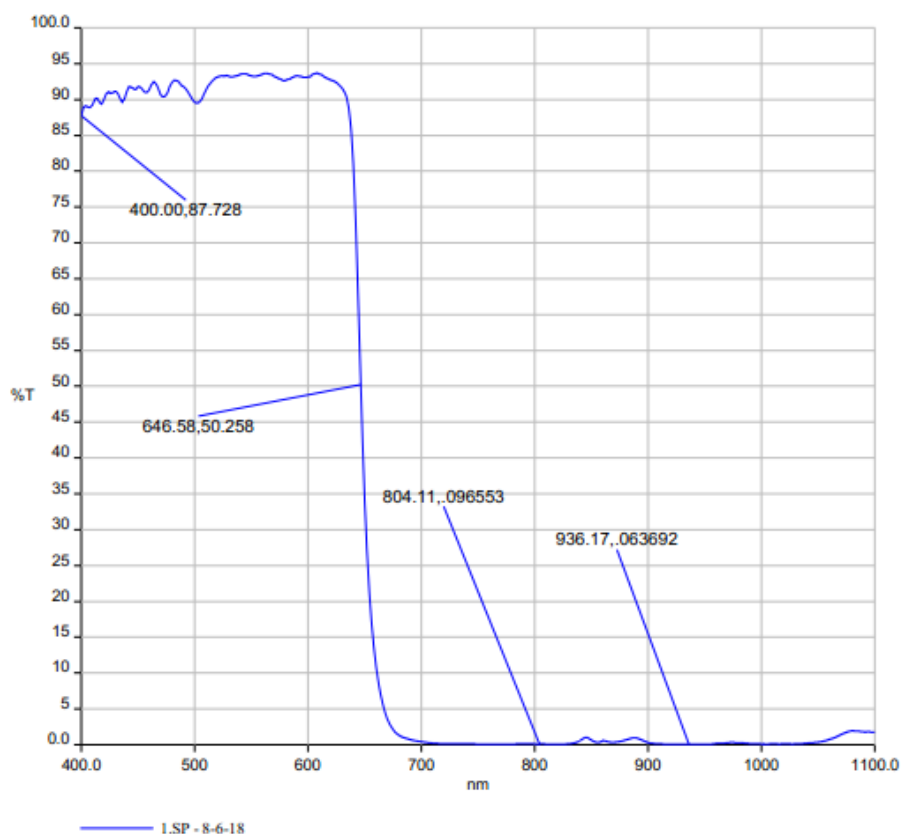


Figure 6-1 Infrared cut-off filter transmittance curve for VENUS series color camera

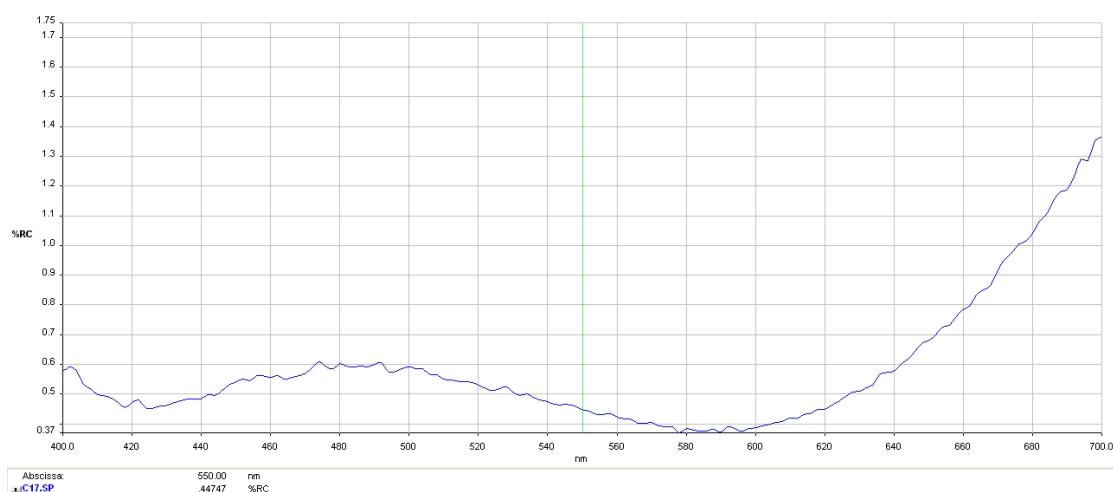


Figure 6-2 Transparent glass reflectance curve for VENUS series mono camera

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 two series of lenses, including industrial lenses of 2 megapixels and 5 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 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) Optical size

- The maximum sensor size that the lens image can cover. There are mainly 1/2", 2/3", 1/1.2", 1", and so on
- When selecting a lens, make sure that the optical size 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

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

The corresponding lens is selected by the calculated focal length.

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

Recommend to use the cables officially recognized by USB IF.

7.3. I/O Port

7.3.1. VEN-U3 Series

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 7-2 I/O port definition (back sight of the camera)



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 7-1.

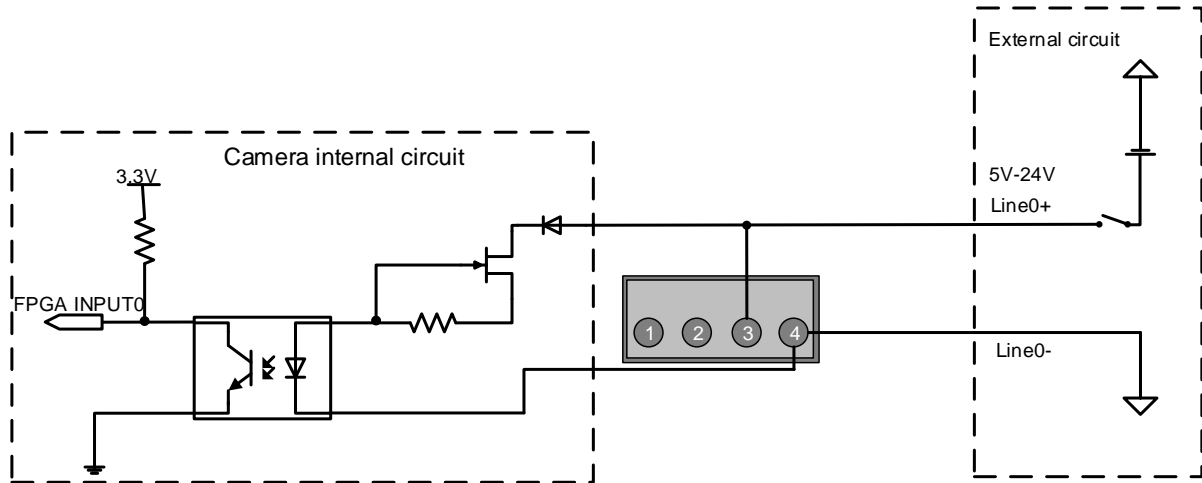


Figure 7-1 Opto-isolated input circuit

- 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 peak voltage of input signal over 9V, a current limiting resistor is recommended to protect the input Line0+. The recommended resistance is shown in Table 7-3

External input voltage	Circuit-limiting resistance R_{limit}	Line0+ input voltage
9V	680Ω	About 5.5V
12V	1kΩ	About 6V
24V	2kΩ	About 10V

Table 7-3 Circuit-limiting resistor value

The connection method of the opto-isolated input circuit and the NPN and PNP photosensor is shown in Figure 7-2 and Figure 7-3. The relationship between the pull-up resistor and the external power supply voltage is shown in Table 7-3.

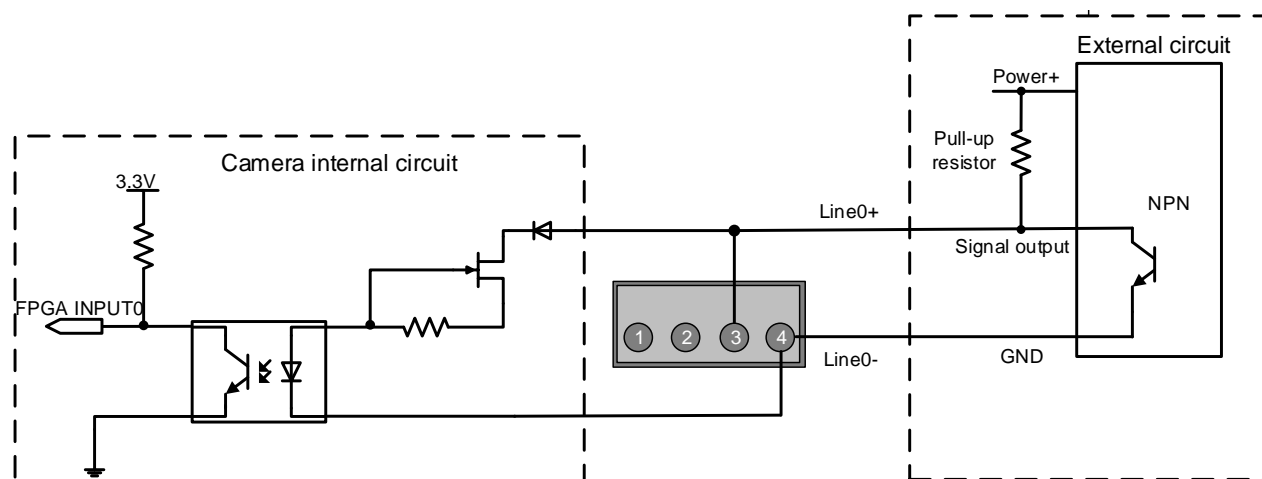


Figure 7-2 NPN photosensor connected to opto-isolated input circuit

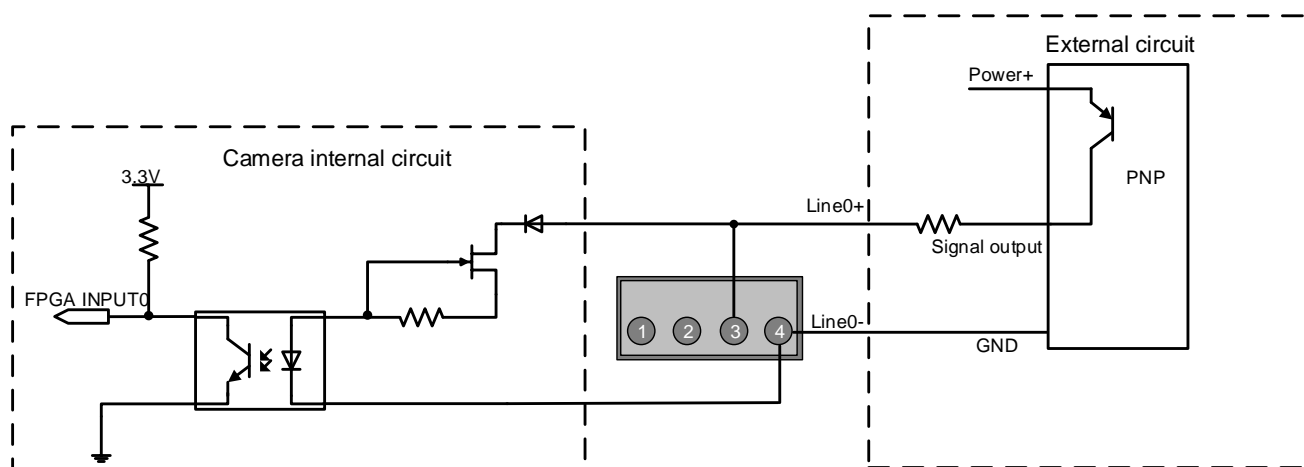


Figure 7-3 PNP photosensor connected to opto-isolated input circuit

- Rising edge delay: $<50\mu\text{s}$ ($0^{\circ}\text{C}\sim 45^{\circ}\text{C}$), parameter description as shown in Figure 7-4
- Falling edge delay: $<50\mu\text{s}$ ($0^{\circ}\text{C}\sim 45^{\circ}\text{C}$), parameter description as shown in Figure 7-4
- 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 7-4

Parameter	Test condition	Value (us)		
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 7-4 Delay time of opto-isolated input circuit in typical application environment

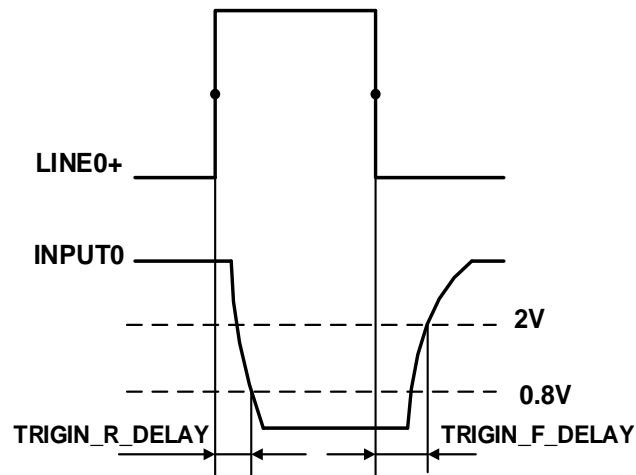


Figure 7-4 Parameter of opto-isolated input circuit

- 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

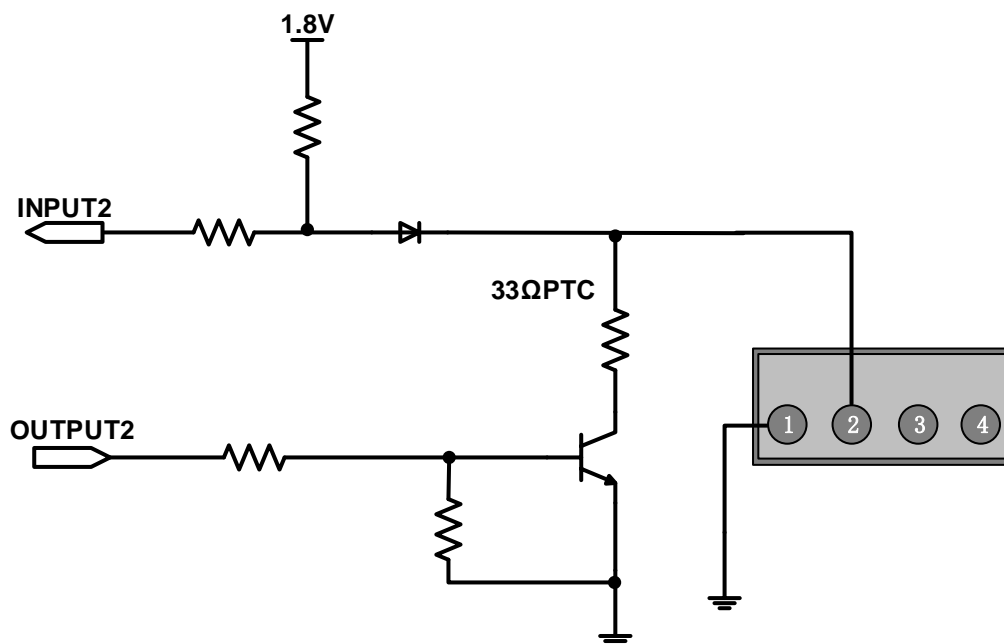


Figure 7-5 Line2 (bidirectional) circuit

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 7-6

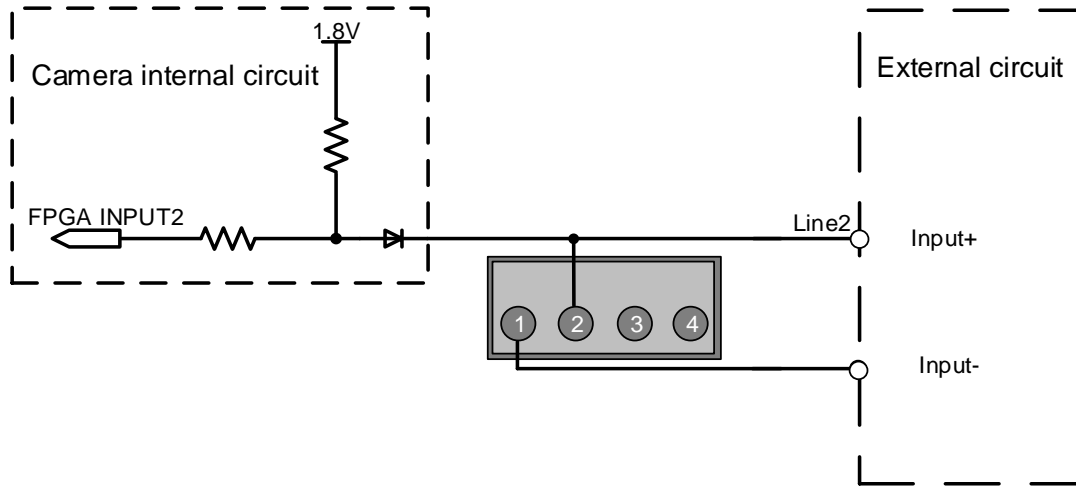


Figure 7-6 Internal equivalent circuit of camera when Line2 is configured as input



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 7-7 and Figure 7-8. The relationship between the pull-up resistor value and the external input voltage is shown in Table 7-3

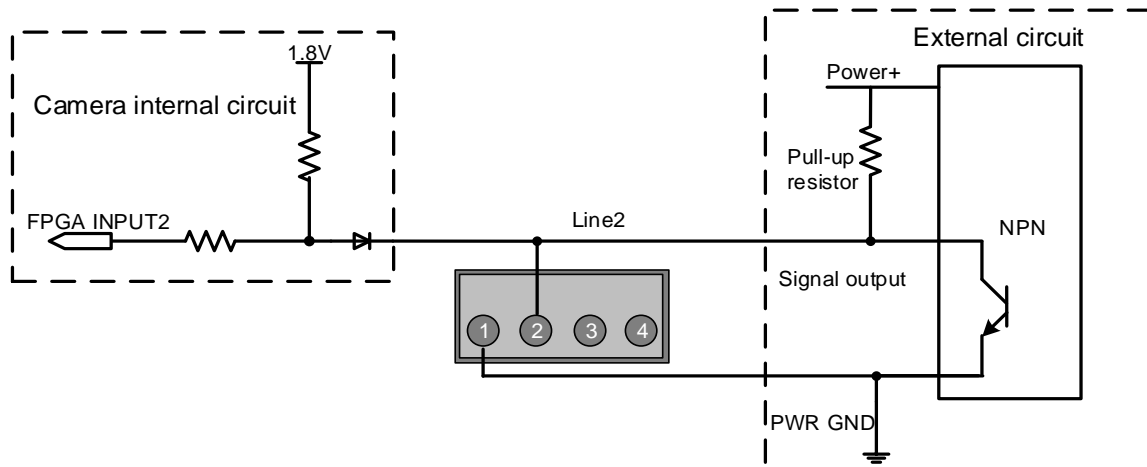


Figure 7-7 NPN photoelectric sensor connected to Line2 input circuit

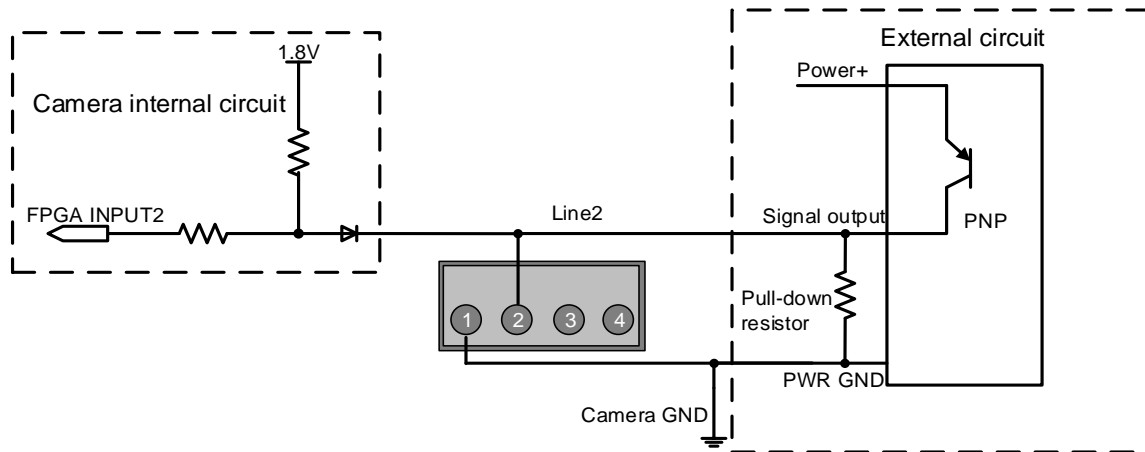


Figure 7-8 PNP photoelectric sensor connected to Line2 input circuit

- When Line2 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: $<2\mu\text{s}$ ($0^{\circ}\text{C}\sim 45^{\circ}\text{C}$), parameter description as shown in Figure 7-4
- Input falling time delay: $<2\mu\text{s}$ ($0^{\circ}\text{C}\sim 45^{\circ}\text{C}$), parameter description as shown in Figure 7-4

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
- Output voltage and output current in typical application conditions (temperature is 25°C) are shown in Table 7-5

External voltage EXVCC	External resistance R_{external}	Line2 voltage (V)	Output current (mA)
5V	1k Ω	0.19	4.8
12V		0.46	11.6
24V		0.92	23.1

Table 7-5 Voltage and output current of Line2 in typical conditions

- Rising time delay = t_r+t_d : $<20\mu\text{s}$ ($0^{\circ}\text{C}\sim 45^{\circ}\text{C}$) (parameter description as shown in Figure 7-9)
- Falling time delay = t_s+t_f : $<20\mu\text{s}$ ($0^{\circ}\text{C}\sim 45^{\circ}\text{C}$) (parameter description as shown in Figure 7-9)

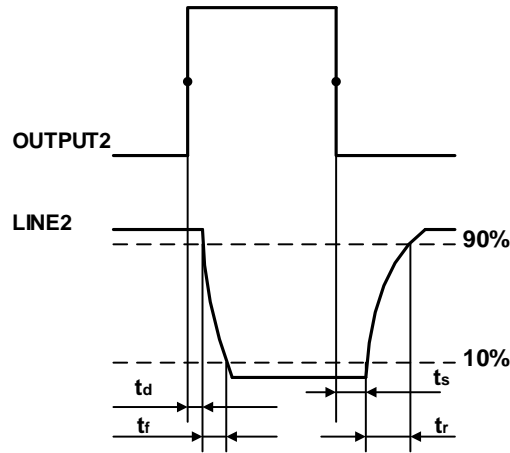


Figure 7-9 Parameter of opto-isolated output circuit

- Delay time (t_d): the time required from 50% rising of OUTPUT2 to the decrease to 90% of the maximum value of LINE2
- Falling time (t_f): the time taken for the amplitude of LINE2 to decrease from 90% to 10% of the maximum value
- Storage time (t_s): the time required from 50% falling of OUTPUT2 to the rise to 10% of the maximum value of LINE2
- Rising time (t_r): 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 7-6

Parameter	Test Conditions	Value (us)		
Storage time (t_s)	External power is 5V, pull-up resistor is 1kΩ	0.17	~	0.18
Delay time (t_d)		0.08	~	0.09
Rising time (t_r)		0.11	~	0.16
Falling time (t_f)		1.82	~	1.94
Rising time delay = t_r+t_d		0.19	~	0.26
Falling time delay = t_f+t_s		1.97	~	2.09

Table 7-6 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 7-10

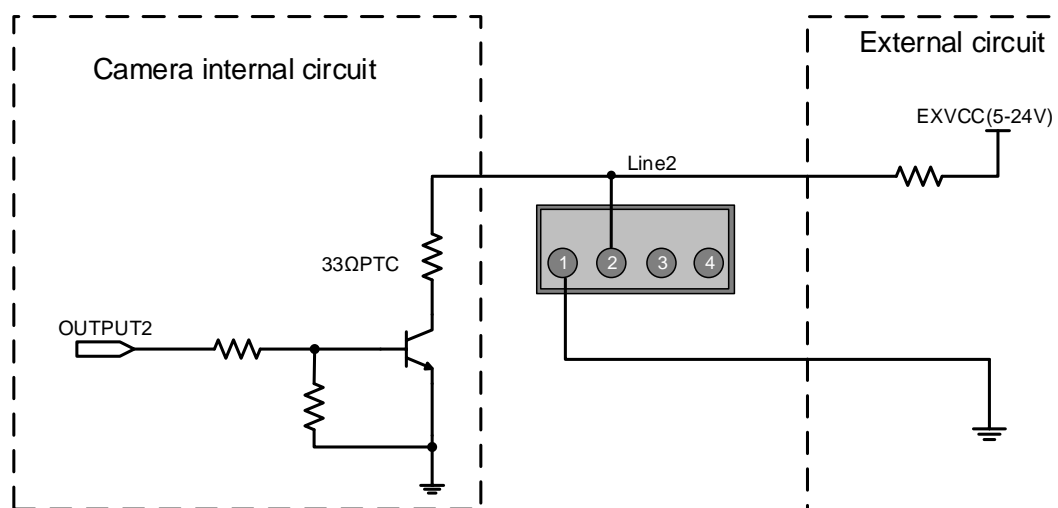


Figure 7-10 Internal equivalent circuit of camera when Line2 is configured as output

8. Features

8.1. I/O Control

8.1.1. VEN-U3 Series

8.1.1.1. Input Mode Operation

1) Configuring Line as input

The VEN-U3 series camera has two input signals: Line0 and Line2. In which the Line0 is uni-directional opto-isolated input, Line2 is 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 is 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 external trigger, the VEN-U3 series camera has the external 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] μ s, step: 1 μ s.

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:

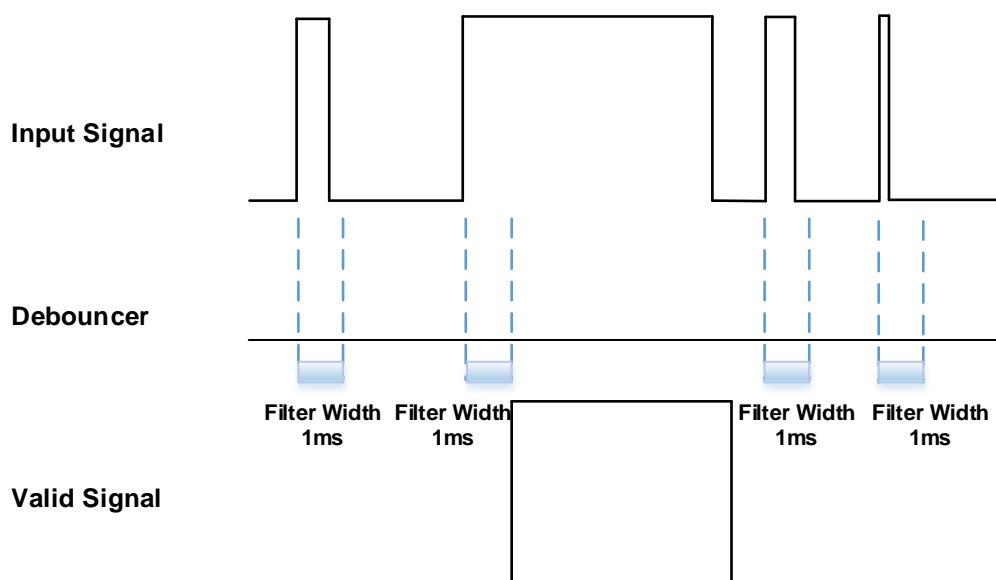


Figure 8-1 Input debouncer schematic diagram

3) Trigger Delay

The VEN-U3 series 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] μ s, step: 1 μ s.

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.

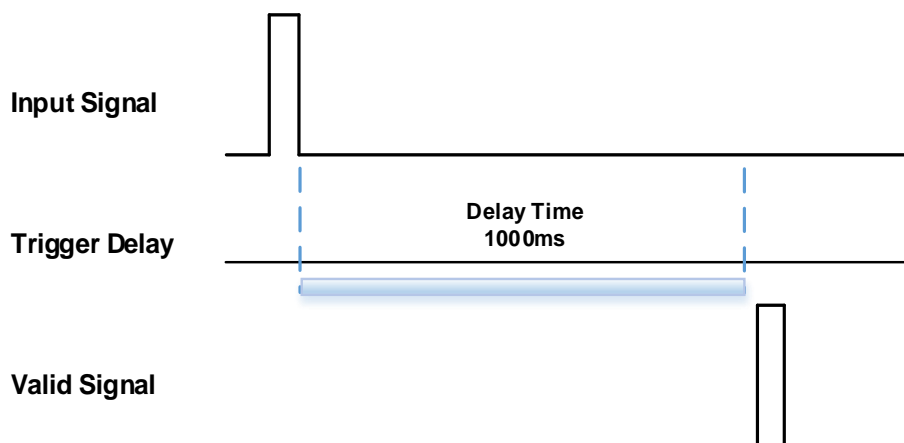


Figure 8-2 Trigger delay schematic diagram

4) Input Inverter

The signal level of input lines is configurable for the VEN-U3 series camera. The user can select whether the input level is reverse or not by setting "LineInverter".

For the VEN-U3 series 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:

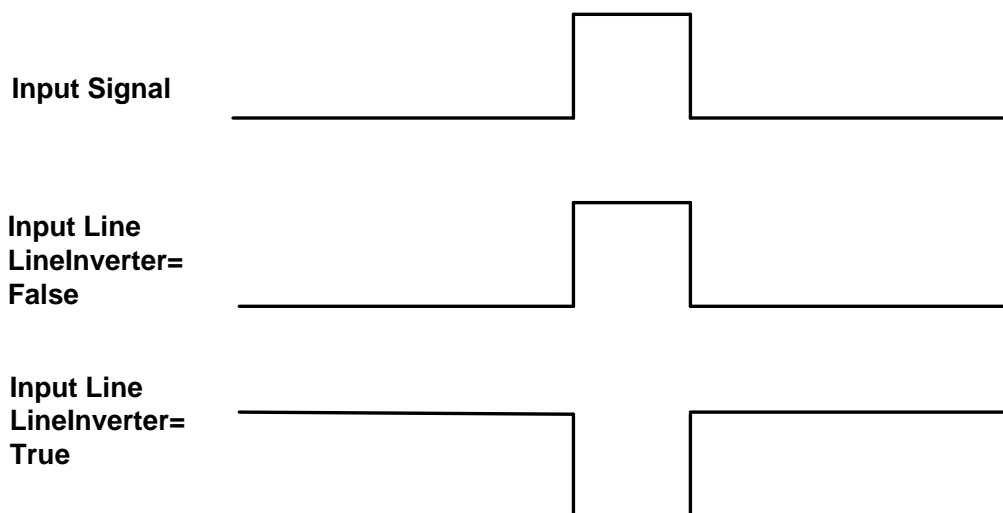


Figure 8-3 Setting input line to reverse

8.1.1.2. Output Mode Operation

1) Configuring Line as output

The VEN-U3 series camera has one output signal: Line2. Line2 is bi-direction configurable I/O.

The camera's default input is Line2 when the camera is powered on. Line2 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.

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.

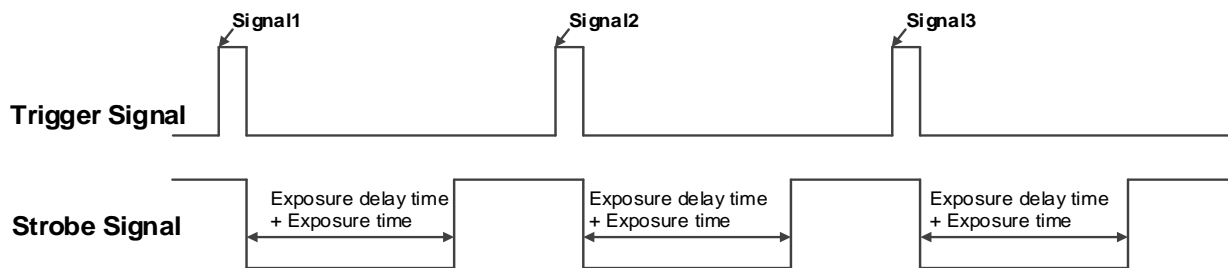


Figure 8-4 Strobe signal schematic diagram

- 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".

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

The VEN-U3 series 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 VEN-U3 series 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 8-5.

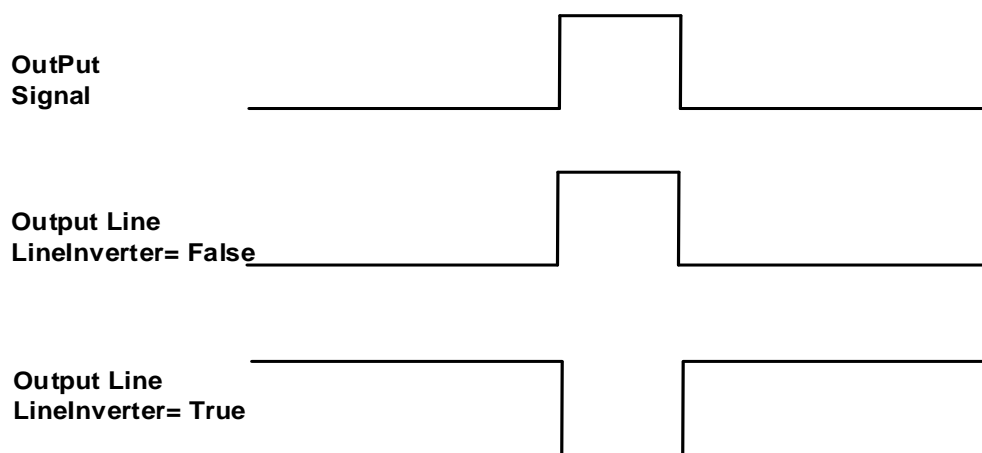


Figure 8-5 Set output line reversion

8.1.1.3. Read the LineStatus

1) Read the level of single line

The VEN-U3 series camera can get the line's signal status. When the device is powered on, the default status of Line0 is false, and the default status of Line2 is true.

2) Read all the lines level

The VEN-U3 series 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 VEN-U3 series camera are shown in Table 8-1. The default value is 0x4.

Line2	Line0
1	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 8-6, and the acquisition process in trigger mode is illustrated in Figure 8-7.

- **Continuous Acquisition**

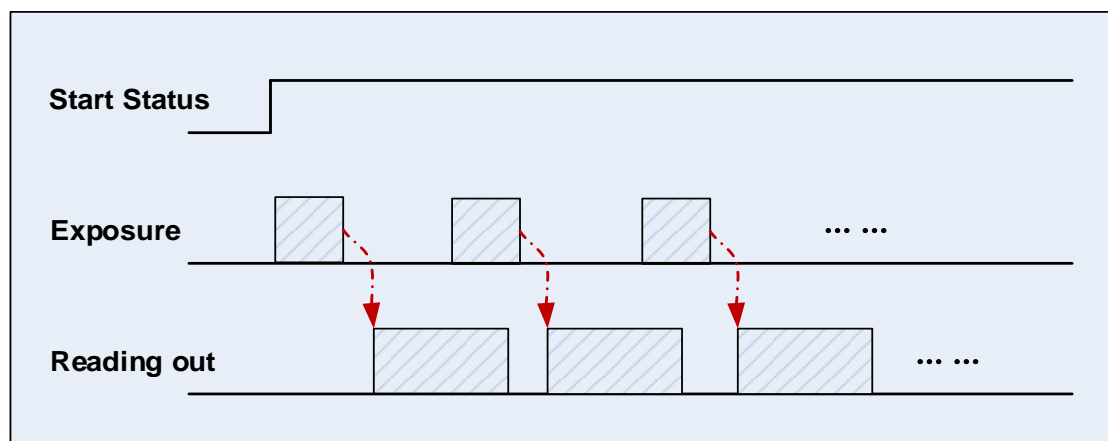


Figure 8-6 Continuous acquisition process

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**

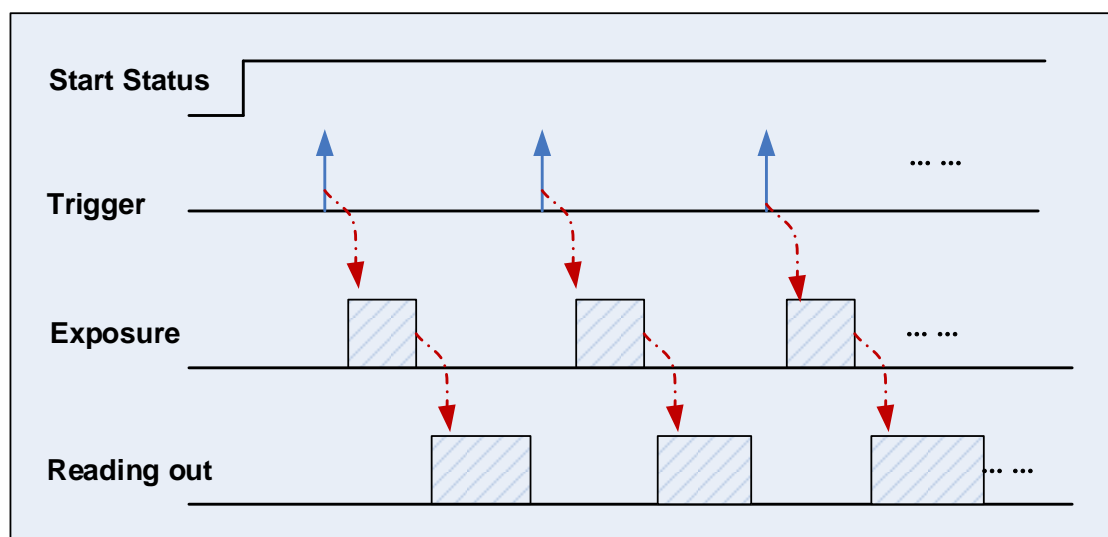


Figure 8-7 Trigger acquisition process

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 external 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 8-8 and Figure 8-9.

- **Acquisition stop during reading out**

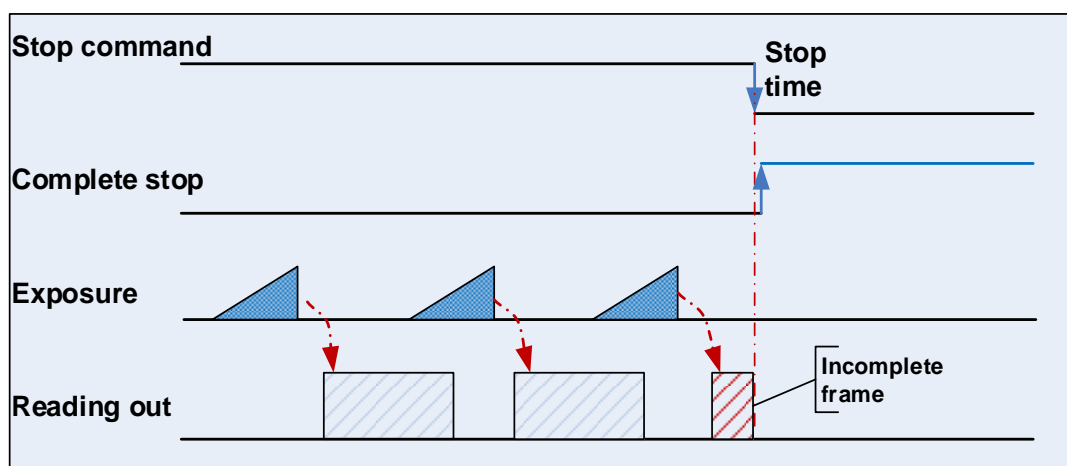


Figure 8-8 Acquisition stop during reading out

As shown in Figure 8-8, 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**

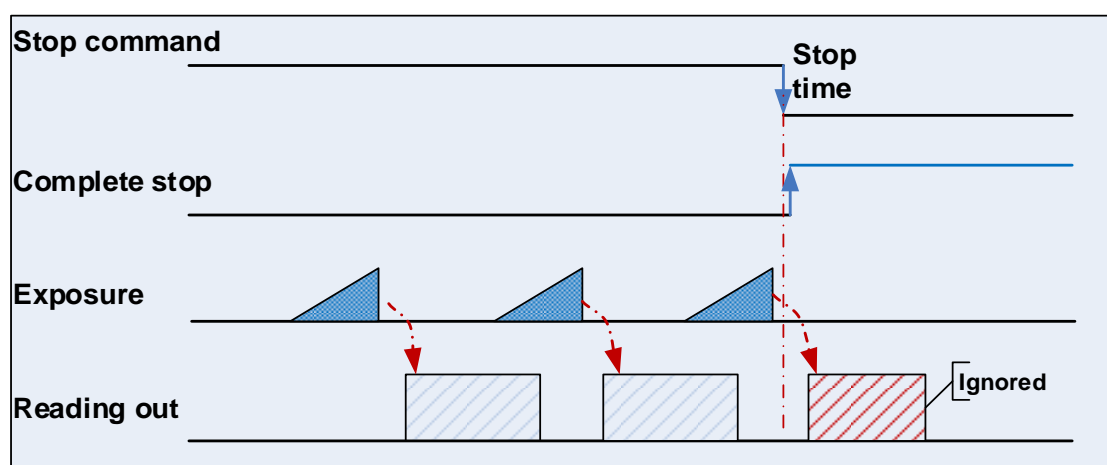


Figure 8-9 Acquisition stop during blanking

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

VEN-U3 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 an external 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. 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**

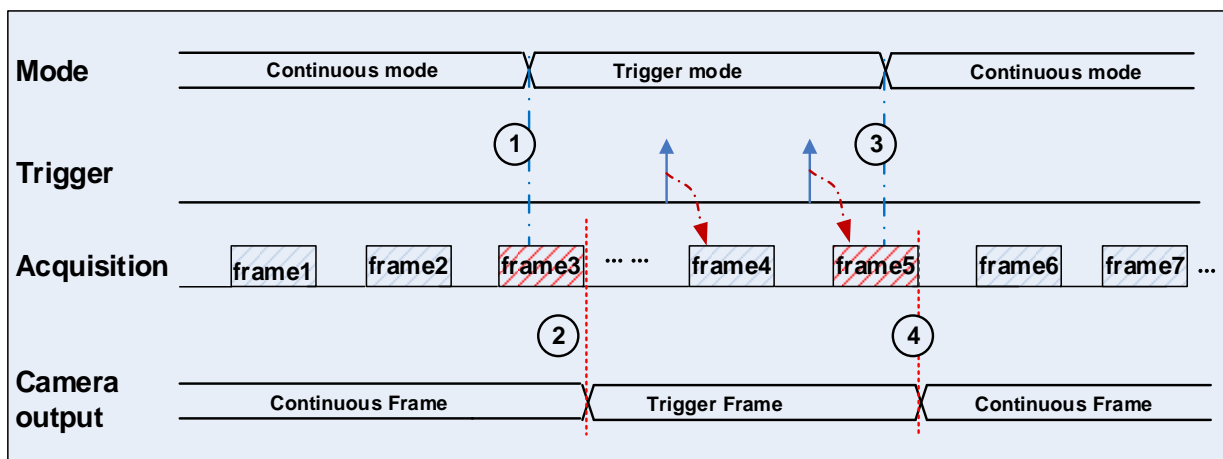


Figure 8-10 Switch trigger mode during frame reading out

As shown in Figure 8-10, 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**

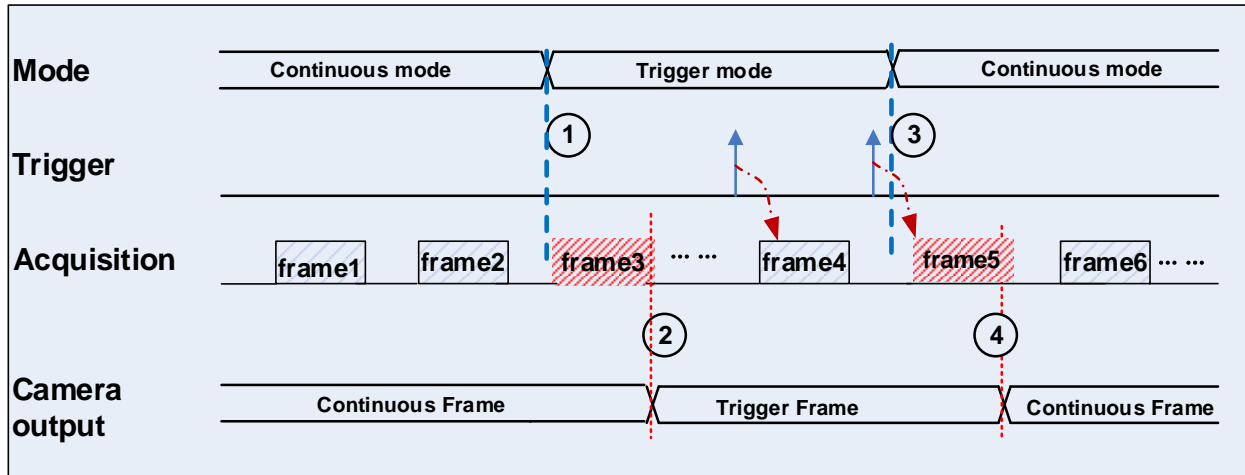


Figure 8-11 Switch trigger mode during blanking

As shown in Figure 8-11, 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.

8.2.4. 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.

8.2.5. 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.

8.2.6. External Trigger Acquisition and Configuration

● External trigger acquisition configuration

The VEN-U3 camera supports external trigger acquisition mode. Three steps followed should be ensured:

- 1) Set the Trigger Mode to ON.
- 2) Set the Trigger Source to Line0 or Line2.
- 3) Connect external trigger signal to Line0.

If the Trigger Source is set by Line2, it should be ensured that the corresponding Line is set as Input.

Please refer to [section 8.1.1](#) for more information of the VEN-U3 camera programmable GPIOs.

● External 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 us. 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 20-40 μ s) and the negative pulse signal's negative width will be narrower (about 20-40 μ s). You can adjust filter parameter to accurately filter trigger signal.

8.2.7. Set Exposure

8.2.7.1. 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 external 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 external 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 8-12

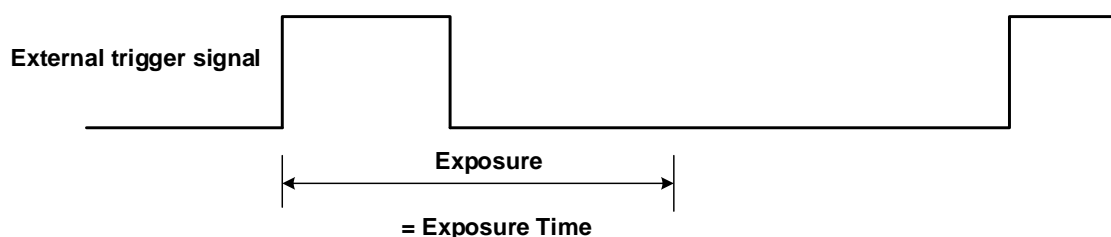


Figure 8-12 The sequence diagram in rising edge trigger of Timed exposure mode

- 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 8-13

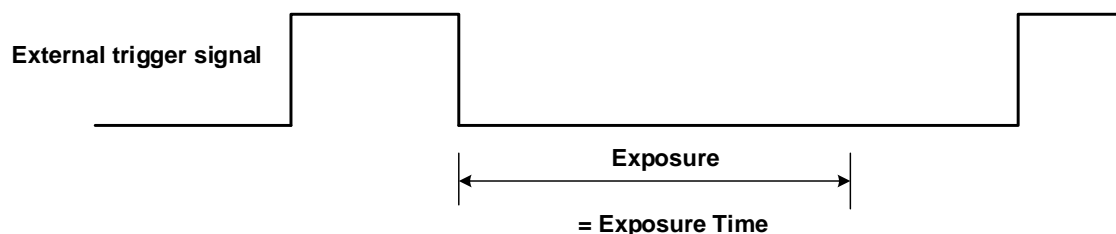


Figure 8-13 The sequence diagram in falling edge trigger of Timed exposure mode

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 external 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 8-14

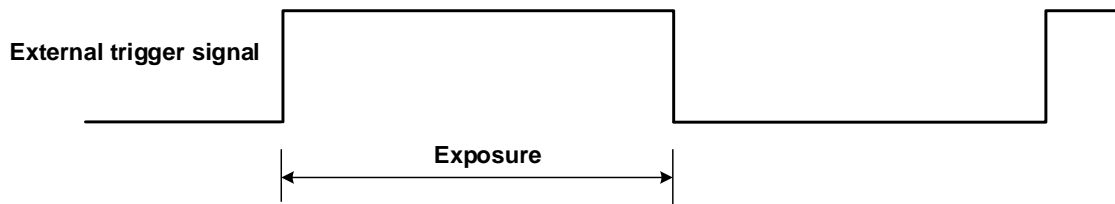


Figure 8-14 The sequence diagram in rising edge trigger of TriggerWidth exposure mode

- If falling edge triggering is enabled, exposure starts when the trigger signal falls and continue until the trigger signal rises, as shown in Figure 8-15



Figure 8-15 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 external triggering should not be shorter than the value of the entered ExposureOverlapTimeMax parameter.

8.2.7.2. Set Exposure Value

● Global Shutter

The VENUS camera (VEN-161-61U3M-(M01/M05/M06)) uses global shutter sensors. The implementation process of global shutter is as shown in Figure 8-16, all the lines of the sensor are exposed at the same time, and then the sensor will read out the image data 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:

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

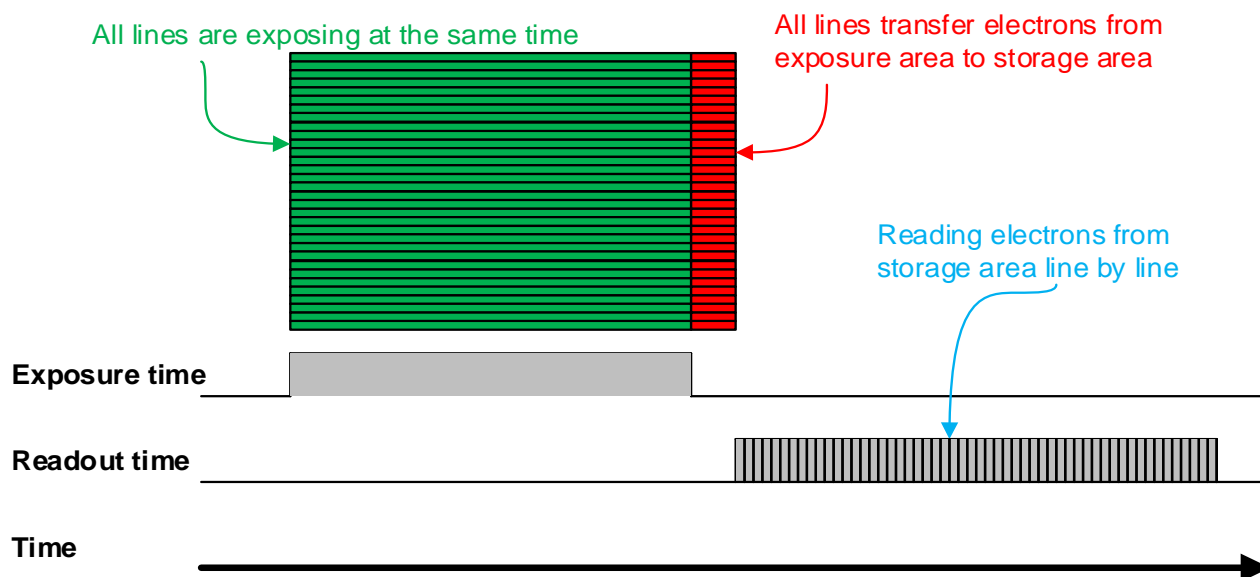


Figure 8-16 Global shutter

● Setting the exposure time

The VEN-U3 series 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-(M01/M05/M06)	Global Shutter	20-1000000	1	1 row period*

Table 8-2 VEN-U3 series 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 36us, setting exposure time to 80us, and the actual exposure time is 108us.

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 VEN-U3 series 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.

8.2.8. Overlapping Exposure

There are two stages in image acquisition of the VEN-U3 series 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 VEN-U3 series camera only support overlapping exposure.

- **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 8-17, when the Nth frame image is reading out, the N+1th frame image has been started exposure.

The formula of overlapping exposure frame period:

$$\text{overlapping exposure frame period} \leq \text{exposure time} + \text{readout time}$$

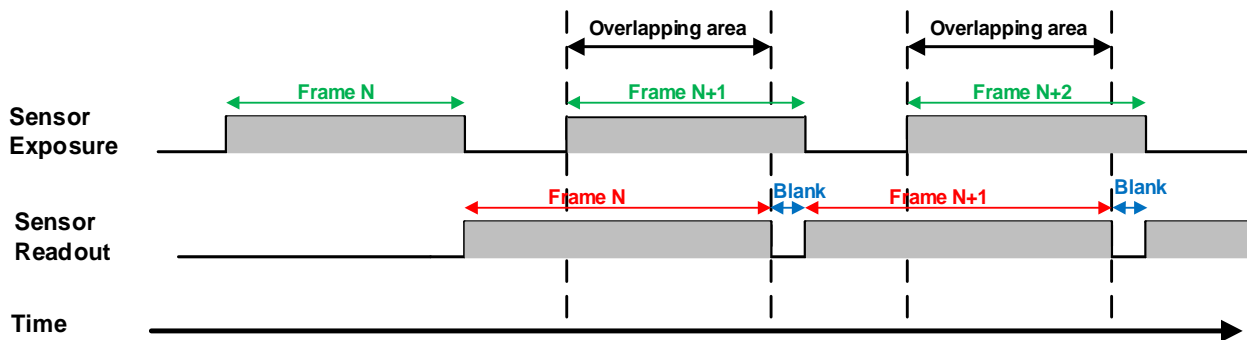


Figure 8-17 The exposure sequence diagram in overlapping exposure mode

- **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 8-17.

- **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 8-18.

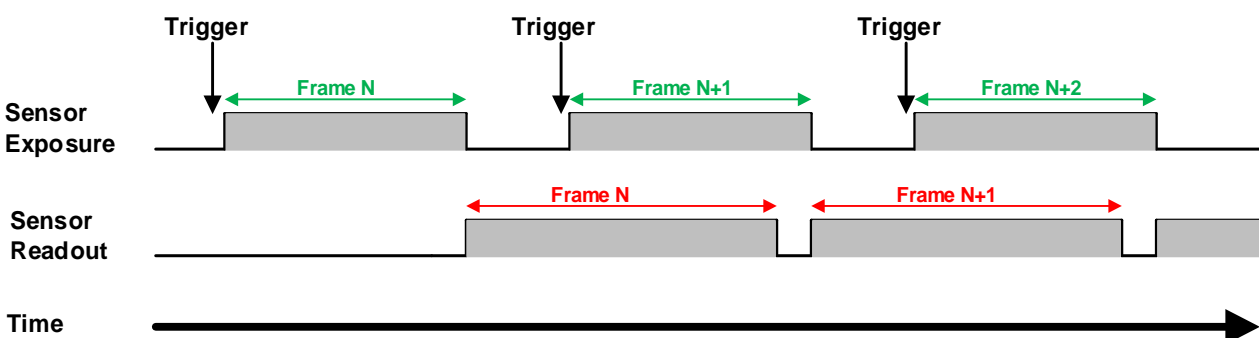


Figure 8-18 The trigger acquisition exposure sequence diagram in overlapping exposure mode

8.3. Basic Features

8.3.1. Gain

The VEN-U3 series camera can adjust the analog gain, and the range of analog gain is as follows:

Model	Adjustment Range	Default/Steps
VEN-161-61U3M-(M01/M05/M06)	0-24dB	0dB, 0.1dB

Table 8-3 VEN-U3 series camera analog gain adjustment range

When the analog gain changes, the response curve of the camera changes, as shown in Figure 8-19. 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.

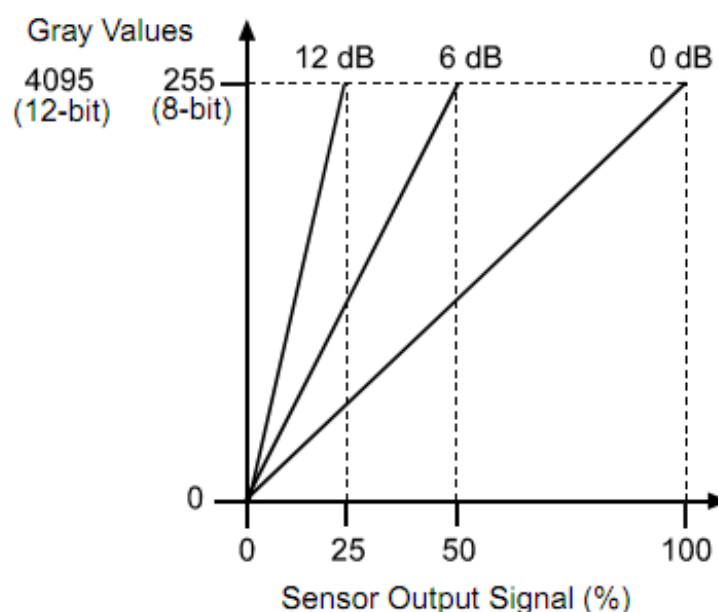


Figure 8-19 The camera's response curve

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-(M01/M05/M06)	Mono8, Mono10

Table 8-4 Pixel format that the VEN-U3 series 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

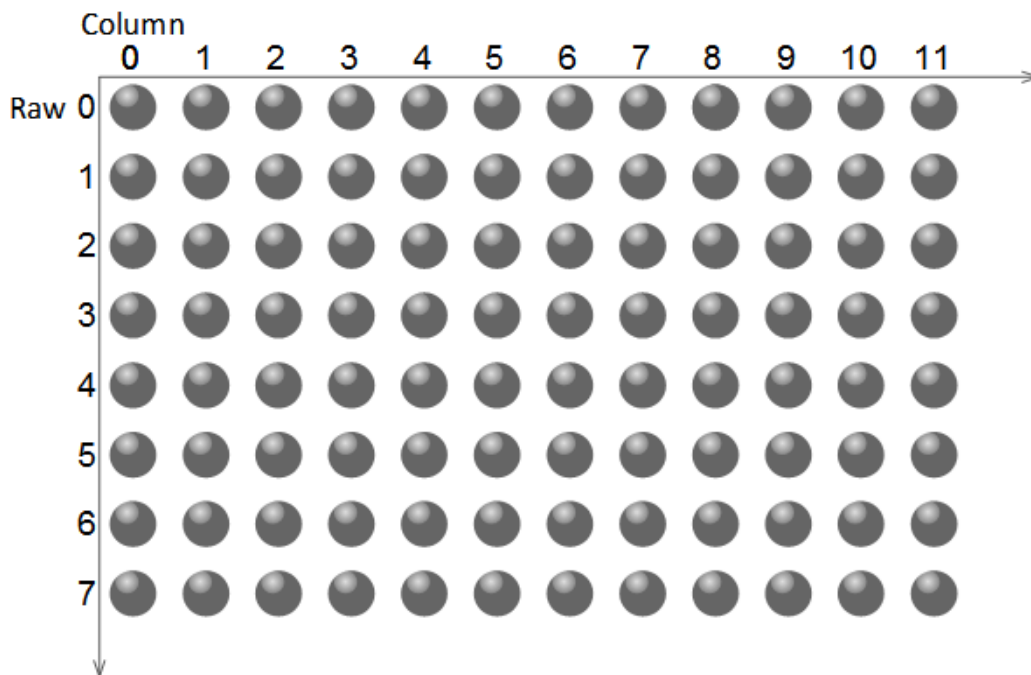


Figure 8-20 Mono8 pixel format

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

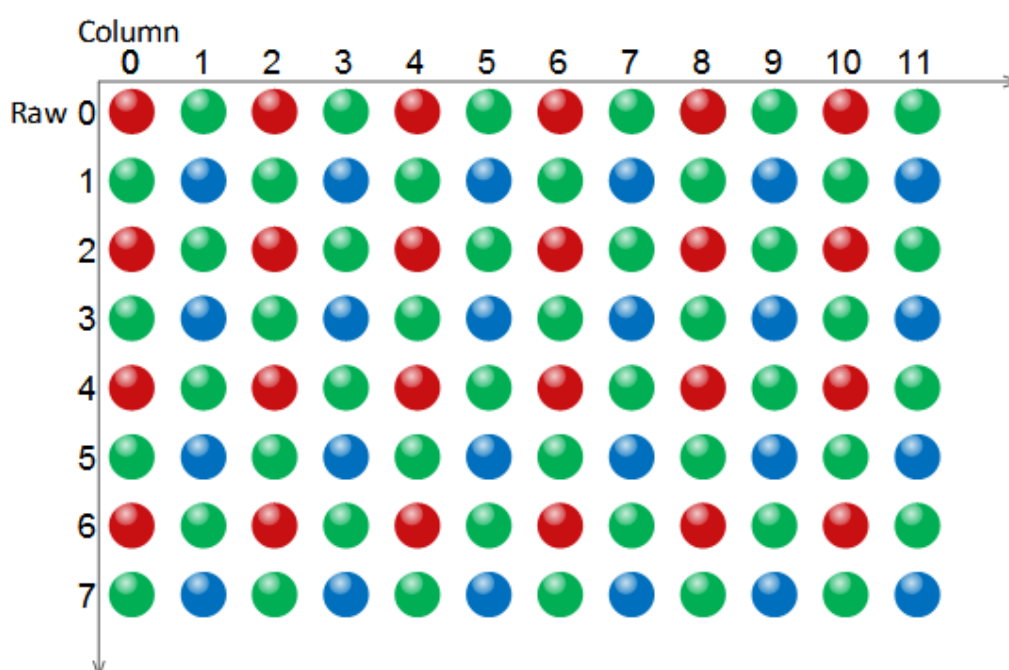


Figure 8-21 BayerRG8 pixel format

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.

VEN-161-61U3 cameras have no color models.

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.

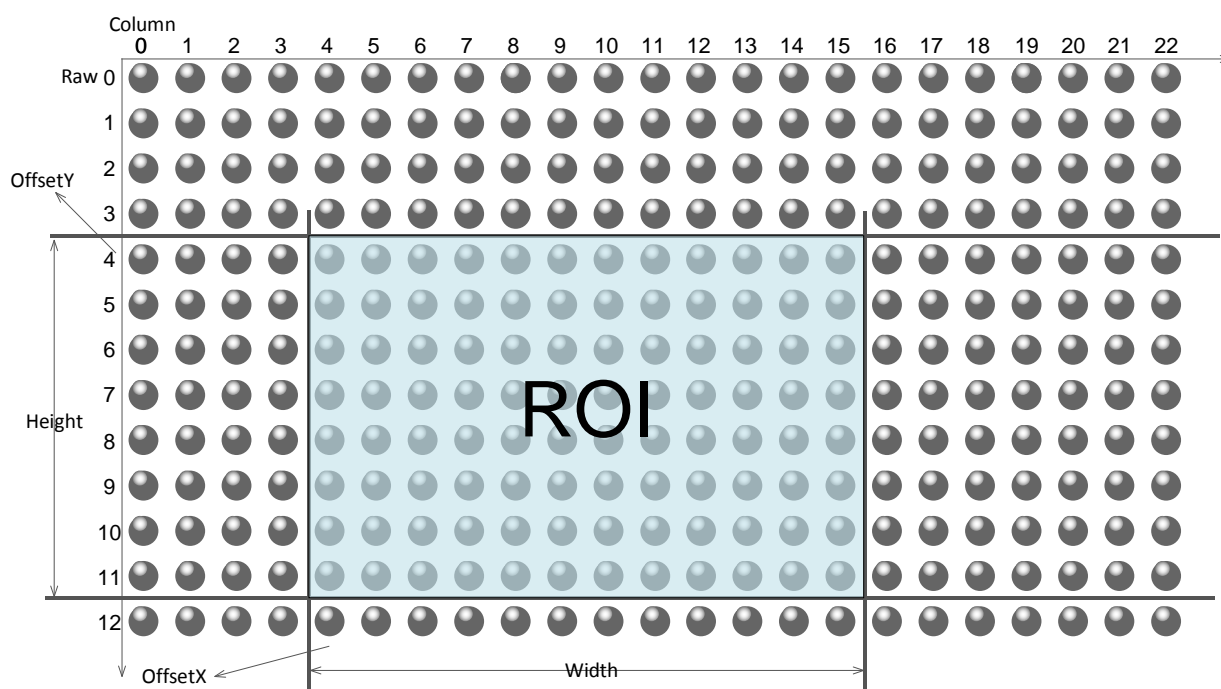


Figure 8-22 ROI

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:

$$\text{AAROIWidth} + \text{AAROIOffsetX} \leq \text{Width}$$

$$\text{AAROIHeight} + \text{AAROIOffsetY} \leq \text{Height}$$

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:

$$\text{AAROIOffsetX} = 100$$

$$\text{AAROIOffsetY} = 50$$

$$\text{AAROIWidth} = 640$$

$$\text{AAROIHeight} = 480$$

The relative position of the ROI and the image is shown in Figure 8-23.

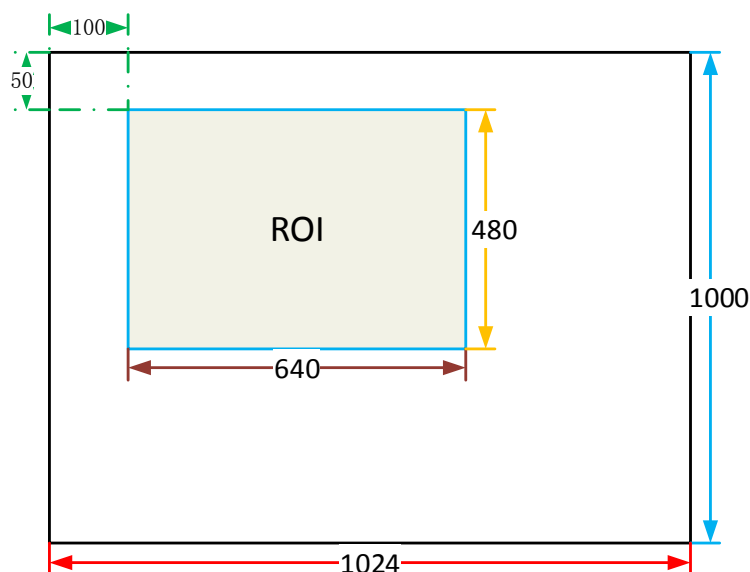


Figure 8-23 An example for the relative position between the ROI and the current image

● 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. Test Pattern

The VEN-U3 series camera supports gray gradient 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.

In the gray gradient test image, 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 8-24.



Figure 8-24 Gray gradient test image

8.3.6. 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 VEN-U3 series 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 VEN-U3 series 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.

8.3.7. Device User ID

The VEN-U3 series 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 GalxyView, as shown in the Figure 8-25.

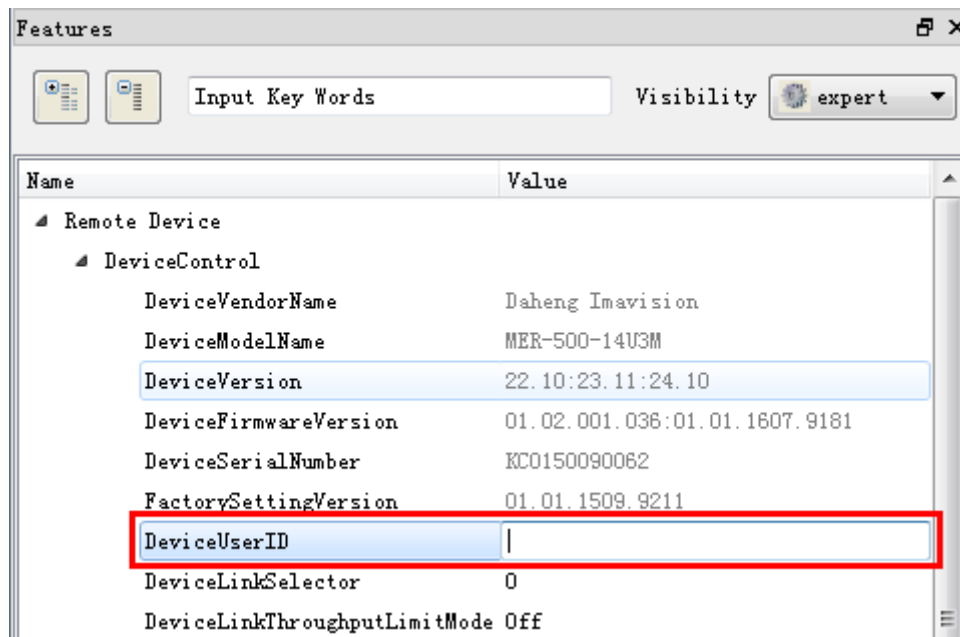


Figure 8-25 GalxyView software

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.

8.3.8. 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 8-26 The original image



Figure 8-27 Reverse X enabled

● Enabling Reverse Y

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

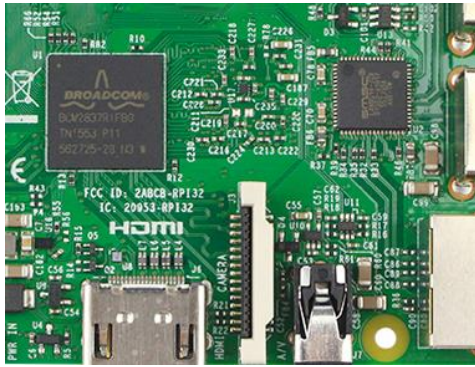


Figure 8-28 The original image



Figure 8-29 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 8-30 The original image

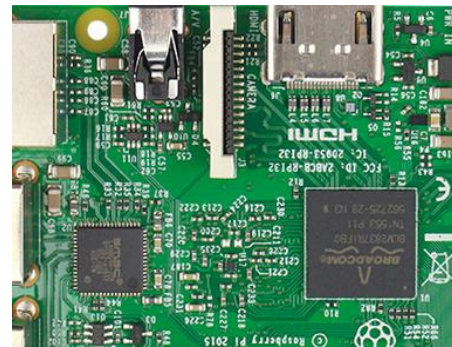


Figure 8-31 Reverse X and Y enabled

● 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 8-32 The original image



Figure 8-33 Reverse X enabled

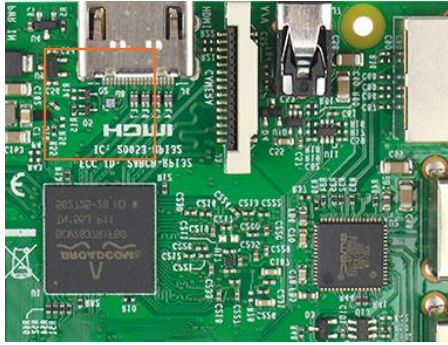


Figure 8-34 Reverse Y enabled

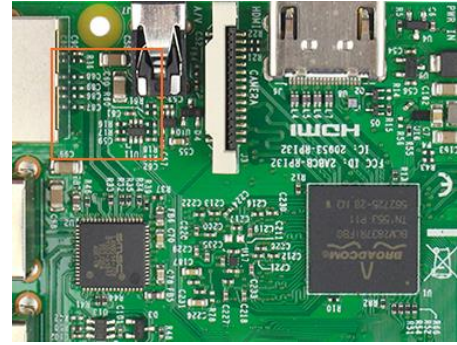


Figure 8-35 Reverse X and Y enabled

The alignment of the Bayer format does not change when the camera is using the reverse feature (VEN-161-61U3 cameras have no color models).

Camera models that support this feature:

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

8.3.9. User Data Area

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 16K bytes and is divided into 4 data segments, each of which is 4K bytes. 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-(M01/M05/M06)

8.4. Image Transmission

8.4.1. Calculate Frame Rate

1) Frame Period

You can calculate the frame period of the VEN-U3 series camera by the following formula:

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

Among them:

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

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.

BandWidth_{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.

8.4.2. USB Interface Bandwidth

The theoretical bandwidth of the USB interface of VEN-U3 series 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.

8.4.3. DeviceLinkThroughputLimit

The VEN-U3 series 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-(M01/M05/M06)	35000000Bps (8bit)	200000000 Bps	1000000Bps
	70000000Bps (10bit)		

Table 8-5 VEN-U3 camera bandwidth control

8.4.4. 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-(M01/M05/M06)

The row period (unit: us):

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

The camera acquisition time (unit: μs):

$$T_{\text{acq}} = (\text{height} + 30) * T_{\text{row}}$$

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.

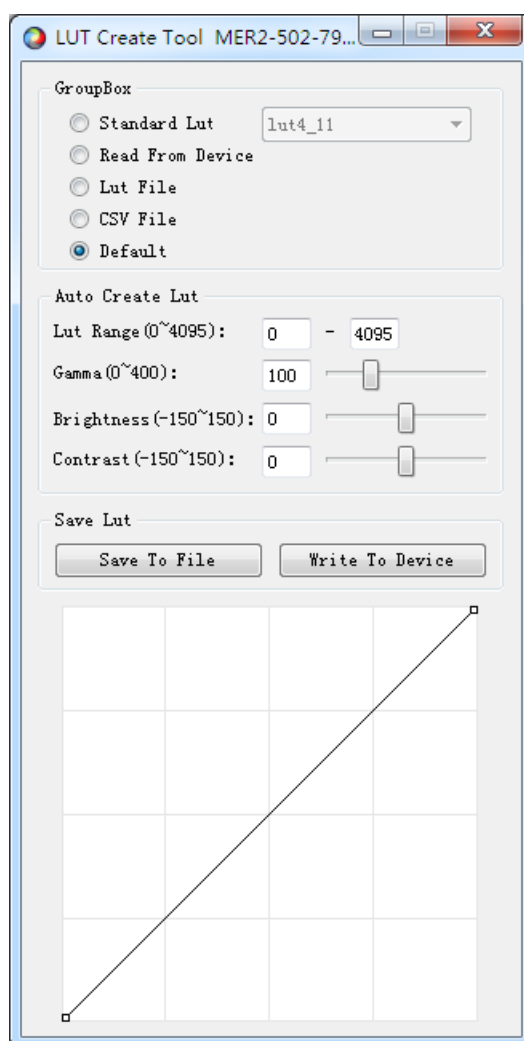


Figure 9-1 The GUI of LUT Create Tool

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.

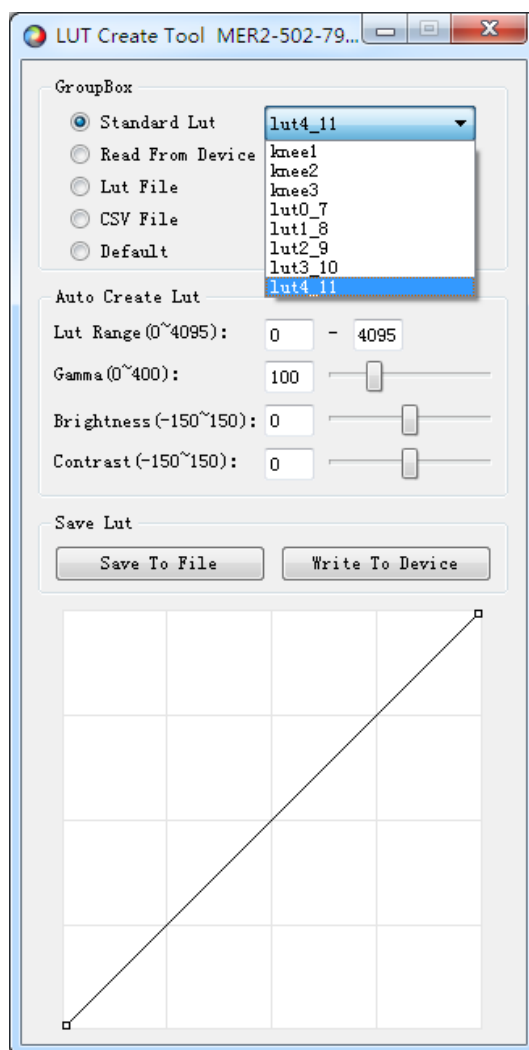


Figure 9-2 Standard Lut

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.

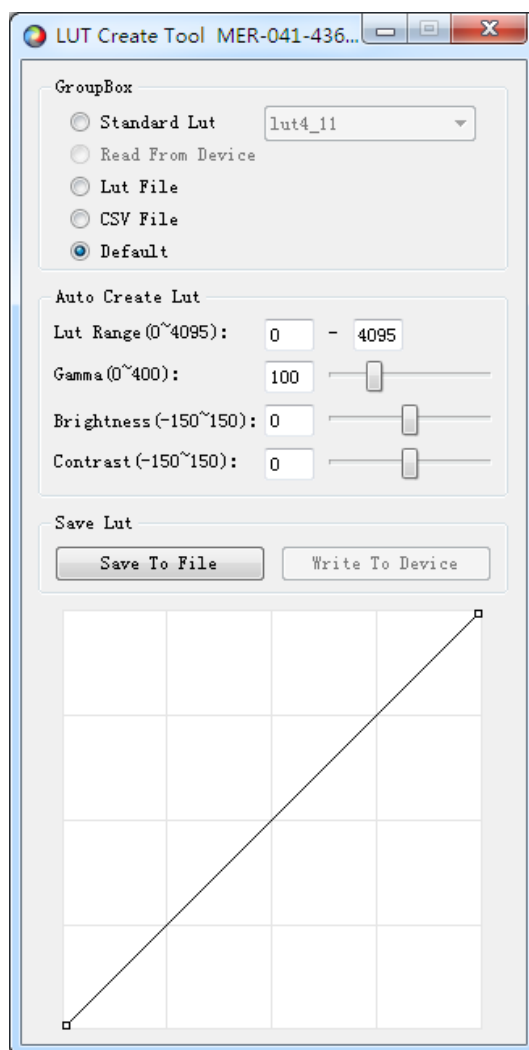


Figure 9-3 Do not support "Read From Device"

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.

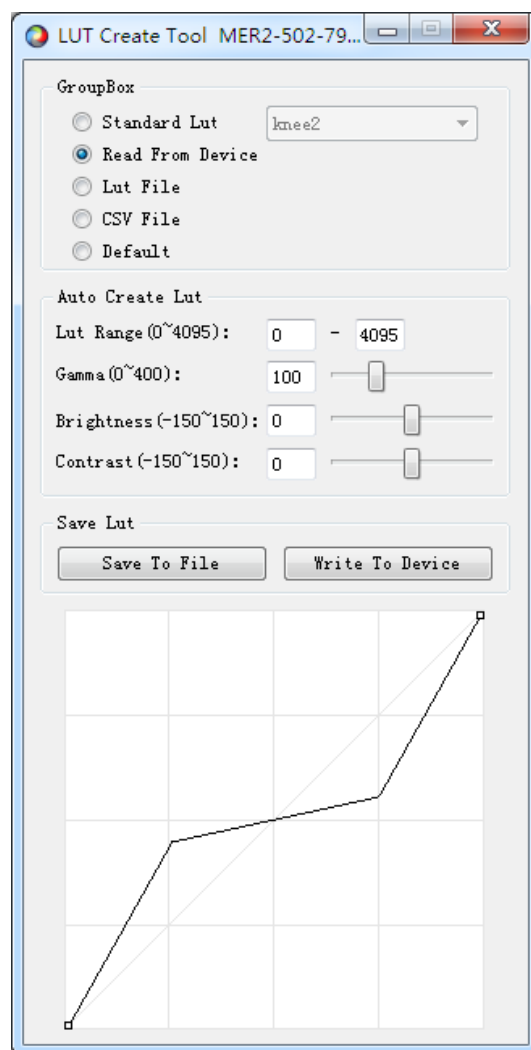


Figure 9-4 Select "Read From Device"

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.

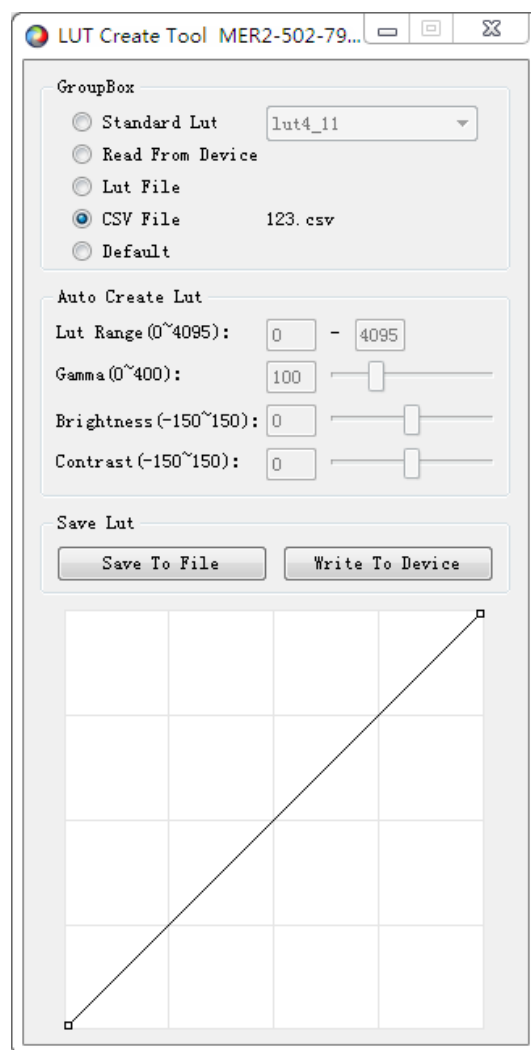


Figure 9-5 Select CSV file

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, as shown in Figure 9-6:

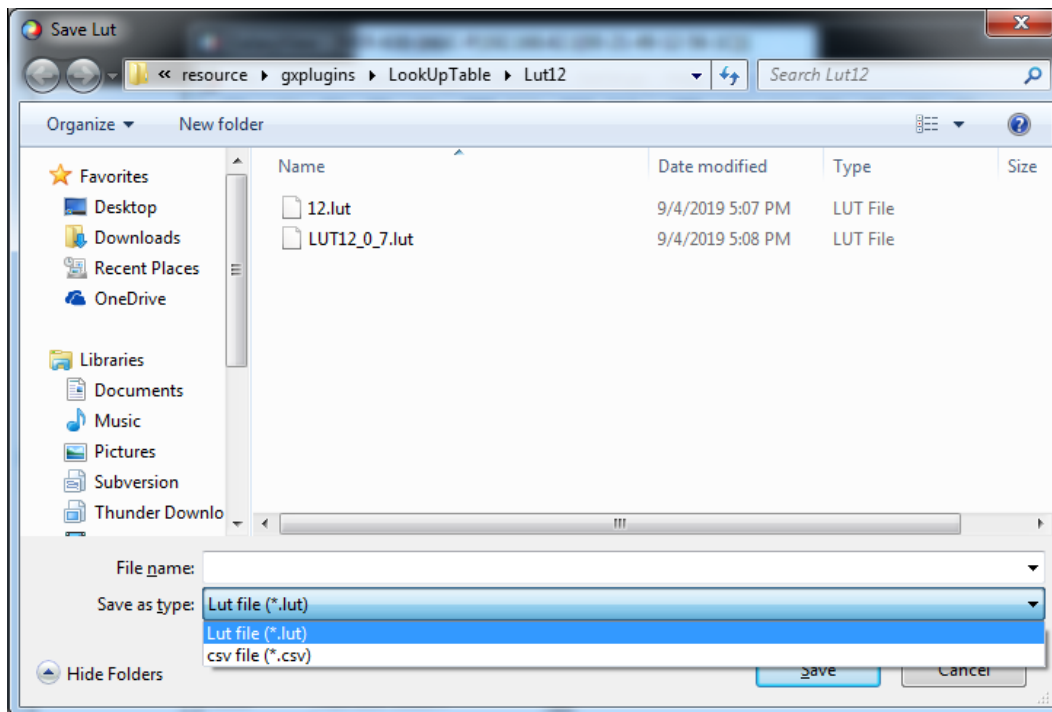


Figure 9-6 Save to file

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 9-7 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.

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.
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.
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11. Revision History

No.	Version	Changes	Date
1	V1.0.0	Initial release	2020-09-14

12. Contact Us

12.1. Contact Sales

If you need to order products or inquire product information, please contact our sales:

1) Beijing Headquarters

Tel: 010-82828878

Fax: 010-82563343

Email: isales@deheng-imaging.com

2) Shanghai Office

Tel: 021-35312826

Fax: 021-65201839-128

Email: shanghai@daheng-imaging.com

3) Shenzhen Office

Tel: 0755-83479565

Fax: 0755-82044020

E-mail: shenzhen@daheng-imaging.com

4) Wuhan Office

Tel: 027-87223690

Fax: 027-87223690

Email: wuhan@daheng-imaging.com

5) Chengdu Office

Tel: 028-63167707

Fax: 028-63167707

E-mail: chengdu@daheng-imaging.com

6) Xi'an Office

Tel: 029-84501012

Fax: 029-89588451

Email: xian@daheng-imaging.com

12.2. Contact Support

If you have any questions in using DAHENG IMAGING products, please contact the experts on our support team:

Tel: 400-999-7595

Email: isupport@daheng-imaging.com