China Daheng Group, Inc. Beijing Image Vision Technology Branch

MERCURY2 GigE 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 MERCURY2 GigE series (MER2-G) camera is DAHENG IMAGING's mature area scan industrial digital camera. The MERCURY2 cameras are the second generation of MERCURY cameras, which provide more features and improved structures. The camera is equipped with standard GigE interface, which is easy to install and use.

The MERCURY2 family cameras have small size, which are a good choice for users who have dimension requirements, and the camera is 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 MERCURY2 GigE digital cameras.

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1. Introduction

1.1. Series Introduction

The MERCURY2 GigE series (MER2-G) camera is DAHENG IMAGING's mature area scan industrial digital camera, featuring outstanding performance, powerful features, small size, outstanding price/performance ratio and ease of use. The MER2-G series cameras are available in a variety of resolutions and frame rates, and are available with CMOS sensors from leading chip manufacturers.

The MER2-G series digital camera transmits image data through the GigE data interface. Thanks to the locking screw connectors, the MERCURY2 series cameras can secure the reliability of cameras deployed in harsh industrial environments. Featuring high reliability and high price/performance ratio, the MERCURY2 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 MERCURY2 GigE series (MER2-G) camera are 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.

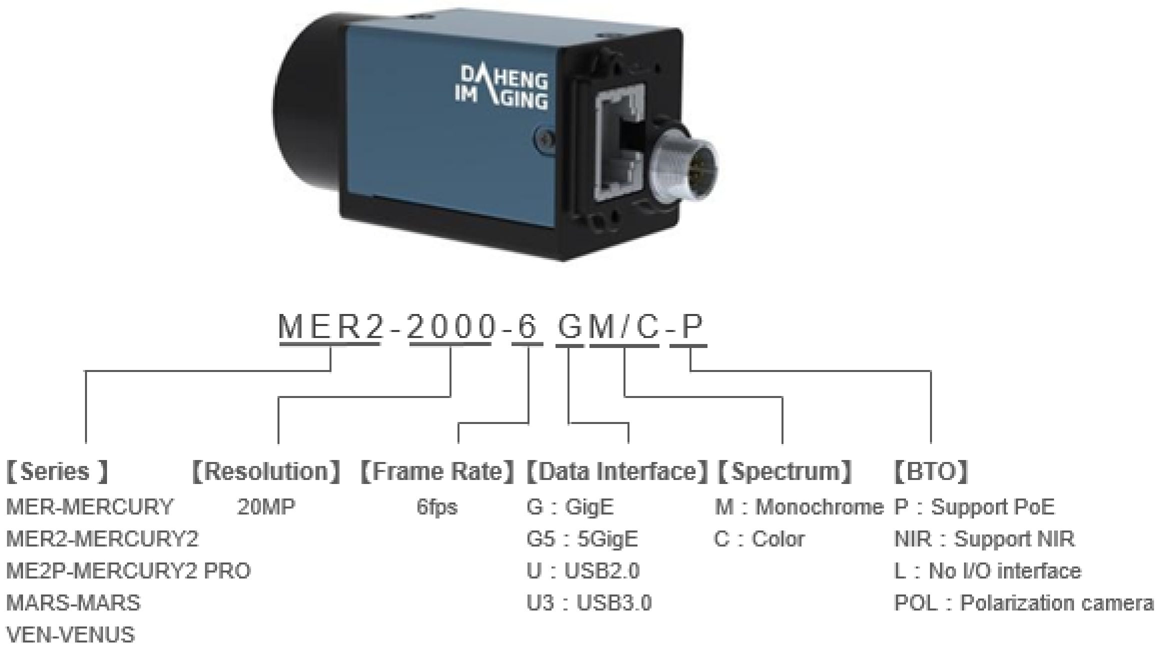

Figure 1-1 Naming rules

1.3. Standards

The camera follows the GigE Vision 1.2 standard, the GEN<i>CAM3.0 standard and the IEEE802.3af 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	MERCURY2 GigE Cameras User Manual
CAD/Technical Drawing	DAHENG IMAGING MER2-G 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. Guidelines for Avoiding EMI and ESD

1) CAT-5e cables or above with S/STP shielding 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) Try to use camera cables that are the correct length. Avoid coiling camera cables. If the cables are too long, use a meandering path rather than coiling the cables.

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

5) 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) NIC requirement: Intel Pro 1000 NIC or higher performance Gigabit LAN confirming to IEEE802.3af standard, CAT-5e or CAT-6 cables, less than 100m, Gigabit Switch confirming to IEEE802.3af standard.

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

2.3. Camera Mechanical Installation Precautions

1. Camera installation requirements

1) The screw and camera have a screw length between 2.5 and 2.7 mm.

2) Screw assembly torque ≤ 1N.M. If the screw assembly torque is too large, it may cause the camera thread stripping.

2. DAHENG tripod adapter instructions

1) M3 * 6 cross recessed cheese head screws are required.

2) After the screws pass through the tripod adapter, they are directly assembled with the camera threads.

3) DAHENG tripod adapter does not need to use spring washer.

2.4. Certification and Declaration

1. CE, RoHS

We declare that DAHENG IMAGING MERCURY2 GigE digital 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

2. FCC

The MERCURY2 GigE digital camera has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential area. This equipment may generate or radiate radio frequency energy. If it is not installed and used in accordance with the instructions, it may cause harmful interference to radio communications, but there is no guarantee that interference will not occur in a particular installation environment. If the equipment does cause harmful interference to radio or television reception, which can be determined by opening or closing the equipment, the user is recommended to take one or more of the following measures to eliminate interference:

- Adjust the direction or position of the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment and receiver to different circuits
- Consult dealers or experienced engineers for help

Changes or modifications to the product without the authorization from DAHENG IMAGING may invalidate the FCC certification and lose the warranty qualification of the product.

3. Installation Guidelines

3.1. Host Preparation

3.1.1. Software Package

The software package of DAHENG IMAGING's MERCURY2 series is used to control the MERCURY2 series camera to provide stable, real-time image transmission, and provides a free SDK and abundant development sample source code. The package is composed of the following modules:

1) Driver Package (Driver): This package provides the MERCURY2 series camera driver program, such as: the GigE Vision cameras' Filter 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) IP configurator (GxGigeIPConfig.exe): The tool is used to configure the camera IP address and to set the IP mode when the camera is powered on.

5) 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.

6) 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 acquisition 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 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) GigE Vision interface

The MERCURY2 series GigE Vision camera is compatible with the GigE Vision protocol, which allows the user to control the camera directly through the PC software based on the GigE Vision protocol.

In addition, the user can use some third-party software that supports the GigE 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

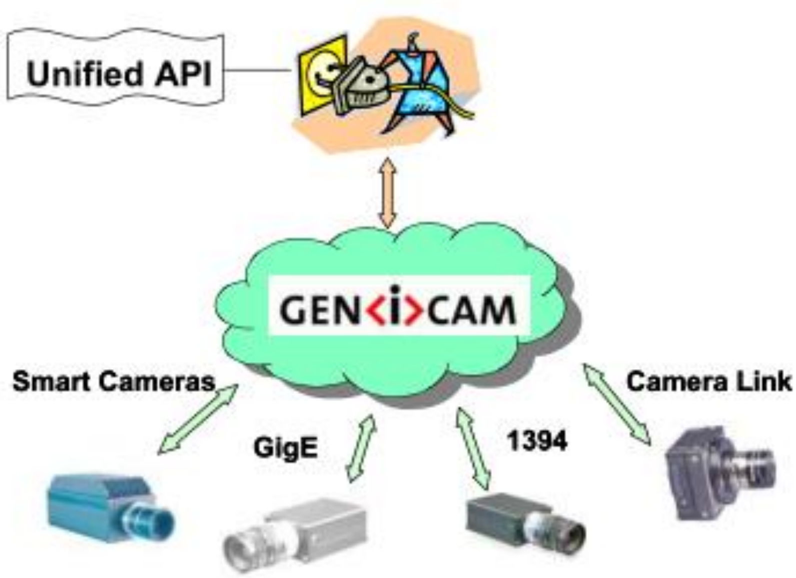

Figure 3-1 GEN<i>CAM standard schematic diagram

3.2. Camera Power

MER2-G series camera can get power via Hirose I/O port.

Camera can get power from the 8-pin Hirose I/O port via a standard I/O cable.

Nominal operating voltage is +12V (± 10%).

1) Voltage outside of the specified range can cause damage.

2) The plug on the cable that you attach to the Hirose 8-pin receptacle must have 8 female pins. Using a plug designed for a smaller or a larger number of pins can damage the connector. See the Figure 7-1 of section 7.3 for the definition of IO port.

3.3. Camera Driver Installation

3.3.1. System Requirements

GalaxySDK is suitable for all cameras in the MERCURY2 series. The GalaxySDK contains various operating systems such as Windows, Linux and Android. The requirements for the operating system and version of the installation package are as follows:

Operating Systems	Applicable Version
Windows	➢ Windows XP (32bit, 64bit) ➢ Windows 7 (32bit, 64bit) ➢ Windows 8 (32bit, 64bit) ➢ Windows 8.1 (32bit, 64bit) ➢ Windows 10 (32bit, 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 GalaxySDK 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 the anti-virus software to intercept the driver. If intercepted, it may cause the driver installation to fail.

3.4. Camera IP Configuration

The IP Configurator provided by GalaxySDK eliminates the need for users to configure IP for hosts and devices. Implement one-click configuration IP. You only need to follow the steps below to configure the camera IP. For details on how to use the tool, please refer to section 9.1.

1) Connect the GigE camera to the network port of the current host.

2) Open the GigE IP Configurator of the installation package.

3) Click "Auto Config" on the right side of the GigE IP Configurator to automatically configure the IP.

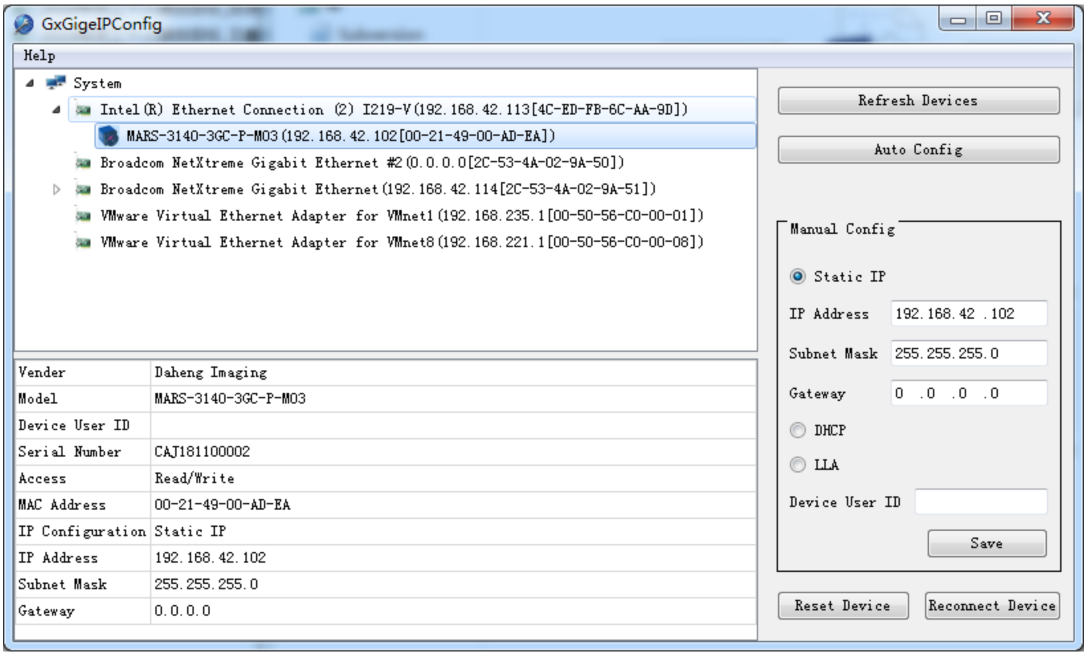

Figure 3-2 GigE IP Configurator

3.5. Open Device and Start Acquisition

After powering the device, connecting the device to the host, and configuring the IP, you can 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 Specifications

4.1. Explanation of Important Parameters

4.1.1. About Spectral Response

QE: 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. MER2-041-302GM/C

4.2.1. Parameters

Specifications	MER2-041-302GC	MER2-041-302GM
Resolution	720 × 540	
Sensor Type	Sony IMX287 global shutter CMOS	
Optical Size	1/2.9 inch	
Pixel Size	6.9μm × 6.9μm	
Frame Rate	302.3fps @ 720 × 540	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 12bit	
Shutter Time	20μs~1s	
Gain	0dB~24dB	
Pixel Data Formats	Bayer RG8/Bayer RG12	Mono8/Mono12
Signal Noise Ratio	43.0dB	43.1dB
Synchronization	External trigger, software trigger	

I/O	1 input and 1 output with opto-isolated, 2 programmable GPIOs
Operating Temp.	0°C~45°C
Storage Temp.	-20°C~70°C
Operating Humidity	10%~80%
Power Consumption	< 3W@24VDC
Lens Mount	C
Dimensions	29mm×29mm×29mm (without lens adapter or connectors)
Weight	65g
Software	Windows XP / Win7 / Win8 / Win8.1 / Win10 / Windows Embedded 32bit and 64bit OS, Ubuntu14.04 / Ubuntu16.04 Linux OS
Data Interface	Fast Ethernet(100Mbit/s) or Gigabit Ethernet(1000Mbit/s)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, FCC, GigE Vision, GenICam

Table 4-1 MER2-041-302GM/C camera parameter

4.2.2. Spectral Response

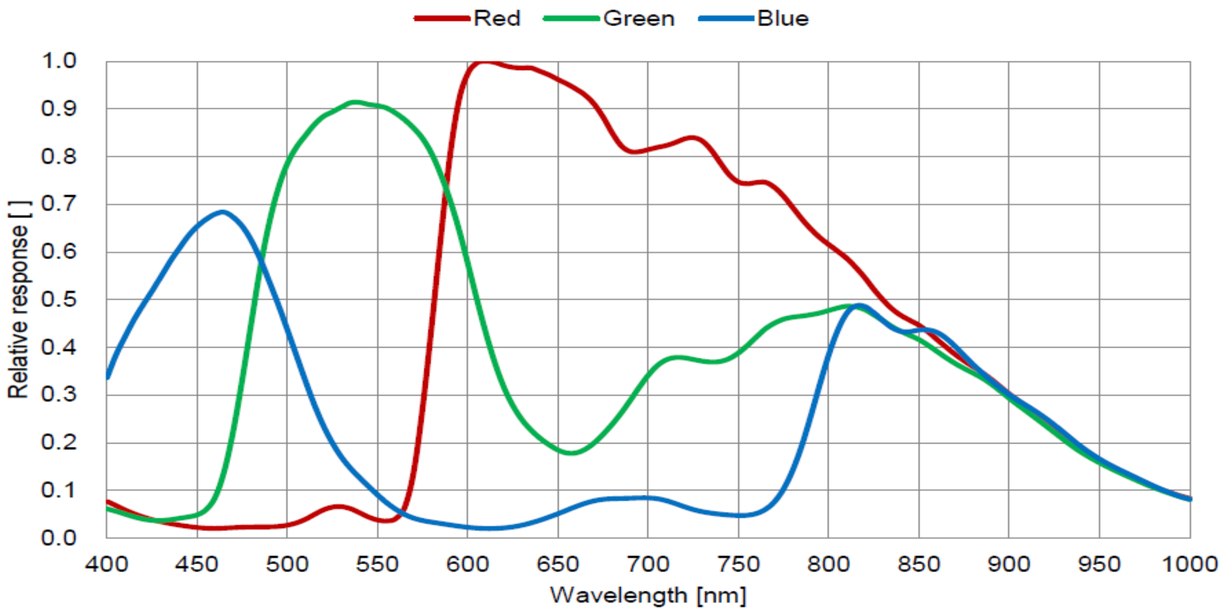

Figure 4-1 MER2-041-302GC sensor spectral response

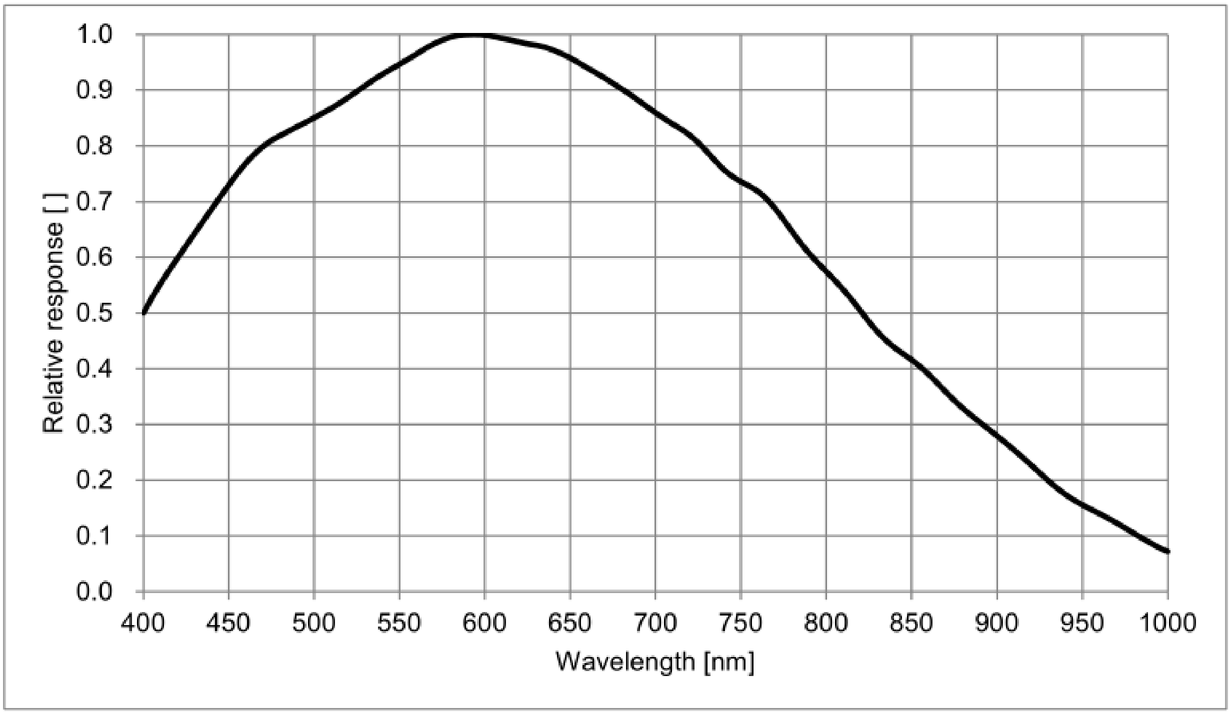

Figure 4-2 MER2-041-302GM sensor spectral response

4.3. MER2-160-75GM/C

4.3.1. Parameters

Specifications	MER2-160-75GC	MER2-160-75GM
Resolution	1440 × 1080	
Sensor Type	Sony IMX273 global shutter CMOS	
Optical Size	1/2.9 inch	
Pixel Size	3.45μm × 3.45μm	
Frame Rate	75.6fps @ 1440 × 1080 (adjust the packet size to 8192 and reserved bandwidth to 5)	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 12bit	
Shutter Time	20μs~1s	
Gain	0dB~24dB	

Pixel Data Formats	Bayer RG8/Bayer RG12	Mono8/Mono12
Signal Noise Ratio	40.75dB	40.66dB
Synchronization	External trigger, software trigger	
I/O	1 input and 1 output with opto-isolated, 2 programmable GPIOs	
Operating Temp.	0°C~45°C	
Storage Temp.	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	< 3W@24VDC	
Lens Mount	C	
Dimensions	29mm×29mm×29mm (without lens adapter or connectors)	
Weight	65g	
Software	Windows XP / Win7 / Win8 / Win8.1 / Win10 / Windows Embedded 32bit and 64bit OS, Ubuntu14.04 / Ubuntu16.04 Linux OS	
Data Interface	Fast Ethernet(100Mbit/s) or Gigabit Ethernet(1000Mbit/s)	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity	
Conformity	CE, RoHS, FCC, GigE Vision, GenICam	

Table 4-2 MER2-160-75GM/C camera parameter

4.3.2. Spectral Response

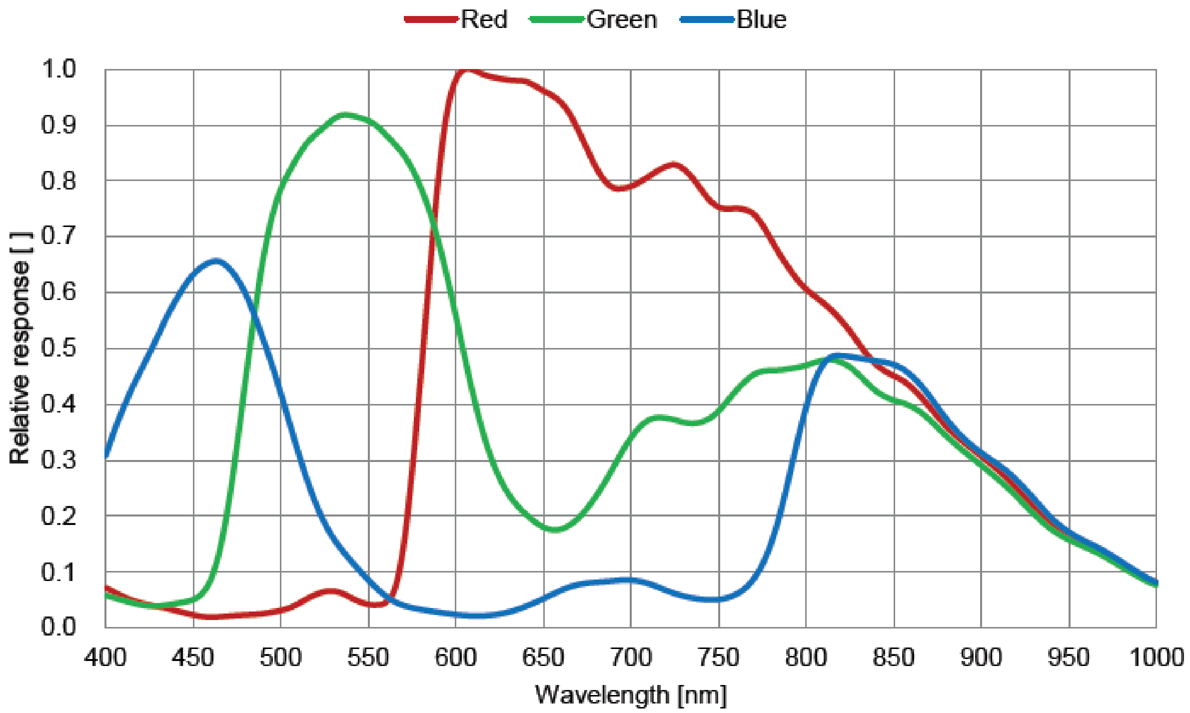

Figure 4-3 MER2-160-75GC sensor spectral response

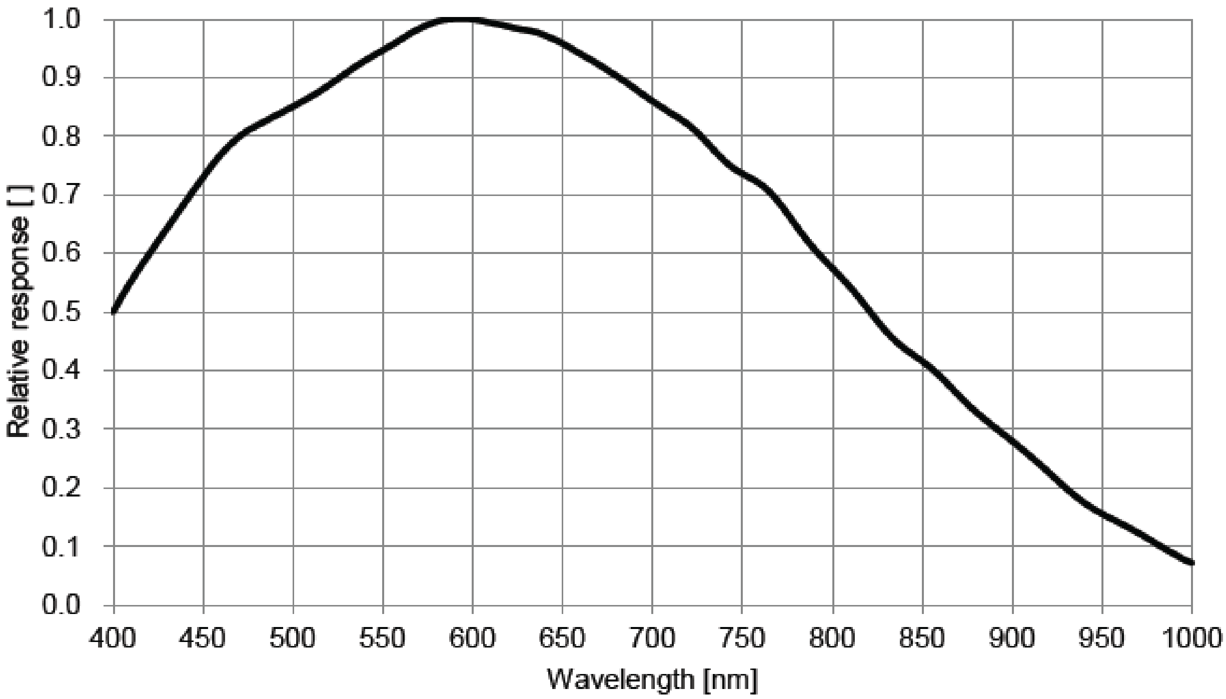

Figure 4-4 MER2-160-75GM sensor spectral response

4.4. MER2-202-60GM/C

4.4.1. Parameters

Specifications	MER2-202-60GC	MER2-202-60GM
Resolution	1600 × 1200	
Sensor Type	EV76C570 global shutter CMOS	
Optical Size	1/1.8 inch	
Pixel Size	4.5μm × 4.5μm	
Frame Rate	60fps @ 1600 × 1200 (adjust the packet size to 8192 and reserved bandwidth to 5)	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	14μs~0.86s	
Gain	0dB~24dB	
Pixel Data Formats	Bayer BG8/Bayer BG10	Mono8/Mono10
Signal Noise Ratio	39.46dB	38.41dB
Synchronization	External trigger, software trigger	
I/O	1 input and 1 output with opto-isolated, 2 programmable GPIOs	
Operating Temp.	0°C~45°C	
Storage Temp.	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	< 3W@24VDC	
Lens Mount	C	
Dimensions	29mm×29mm×29mm (without lens adapter or connectors)	

Weight	62g
Software	Windows XP / Win7 / Win8 / Win10 32bit and 64bit OS
Data Interface	Fast Ethernet(100Mbit/s) or Gigabit Ethernet(1000Mbit/s)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, FCC, GigE Vision, GenICam

Table 4-3 MER2-202-60GM/C camera parameter

4.4.2. Spectral Response

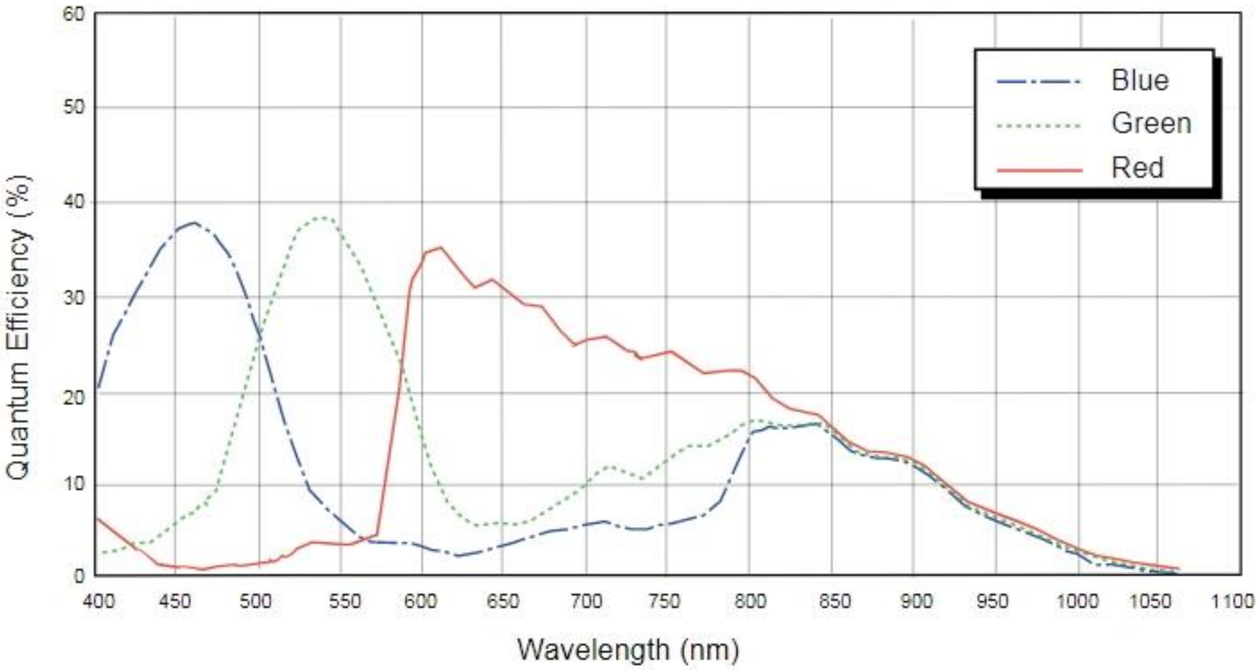

Figure 4-5 MER2-202-60GC sensor spectral response

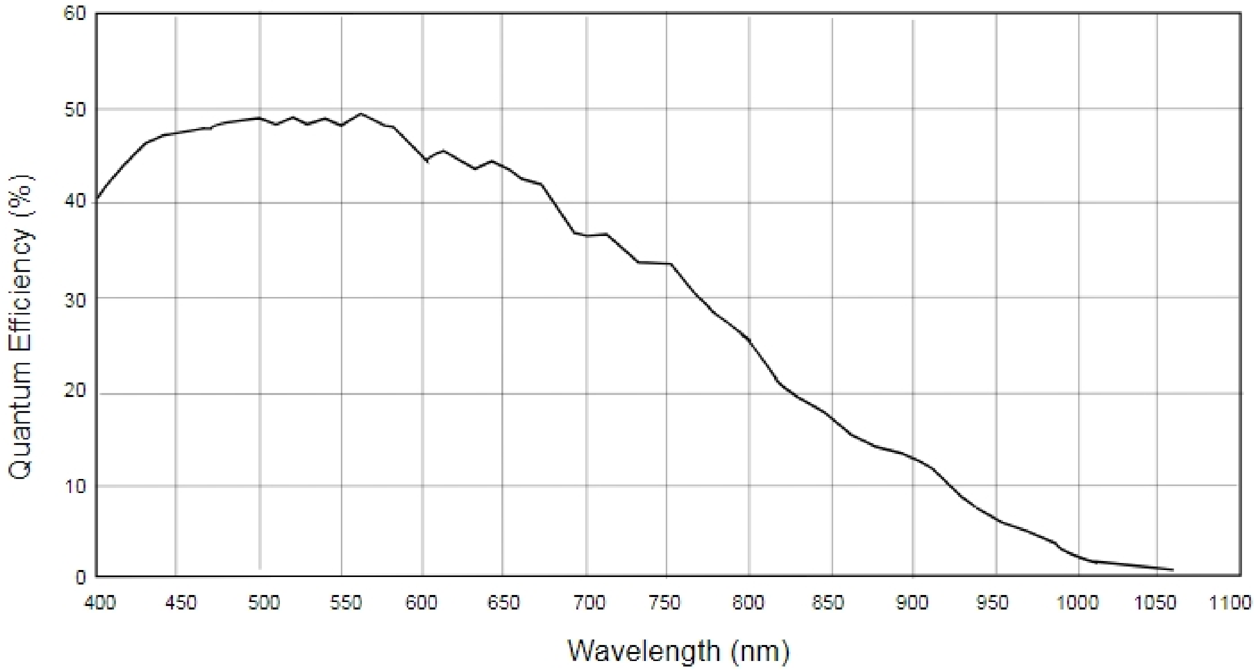

Figure 4-6 MER2-202-60GM sensor spectral response

4.5. MER2-231-41GM/C

4.5.1. Parameters

Specifications	MER2-231-41GC	MER2-231-41GM
Resolution	1920 × 1200	
Sensor Type	Sony IMX249 LQJ global shutter CMOS	
Optical Size	1/1.2 inch	
Pixel Size	5.86μm × 5.86μm	
Frame Rate	41fps @ 1920 × 1200	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB~24dB	

Pixel Data Formats	Bayer RG8/Bayer RG10	Mono8/Mono10
Signal Noise Ratio	45.22dB	45.38dB
Synchronization	External trigger, software trigger	
I/O	1 input and 1 output with opto-isolated, 2 programmable GPIOs	
Operating Temp.	0°C~45°C	
Storage Temp.	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	< 3W@24VDC	
Lens Mount	C	
Dimensions	29mm×29mm×29mm (without lens adapter or connectors)	
Weight	62g	
Software	Windows XP / Win7 / Win8 / Win8.1 / Win10 / Windows Embedded 32bit and 64bit OS, Ubuntu14.04 / Ubuntu16.04 Linux OS	
Data Interface	Fast Ethernet(100Mbit/s) or Gigabit Ethernet(1000Mbit/s)	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity	
Conformity	CE, RoHS, FCC, GigE Vision, GenICam	

Table 4-4 MER2-231-41GM/C camera parameter

4.5.2. Spectral Response

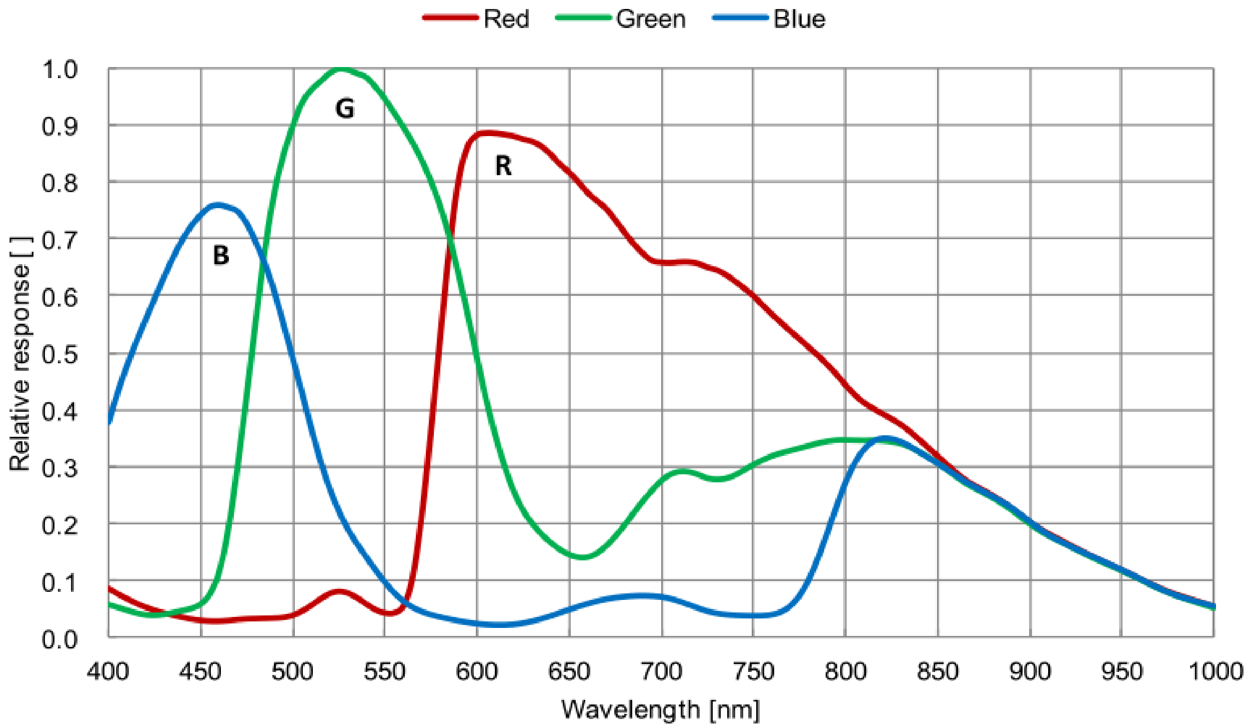

Figure 4-7 MER2-231-41GC sensor spectral response

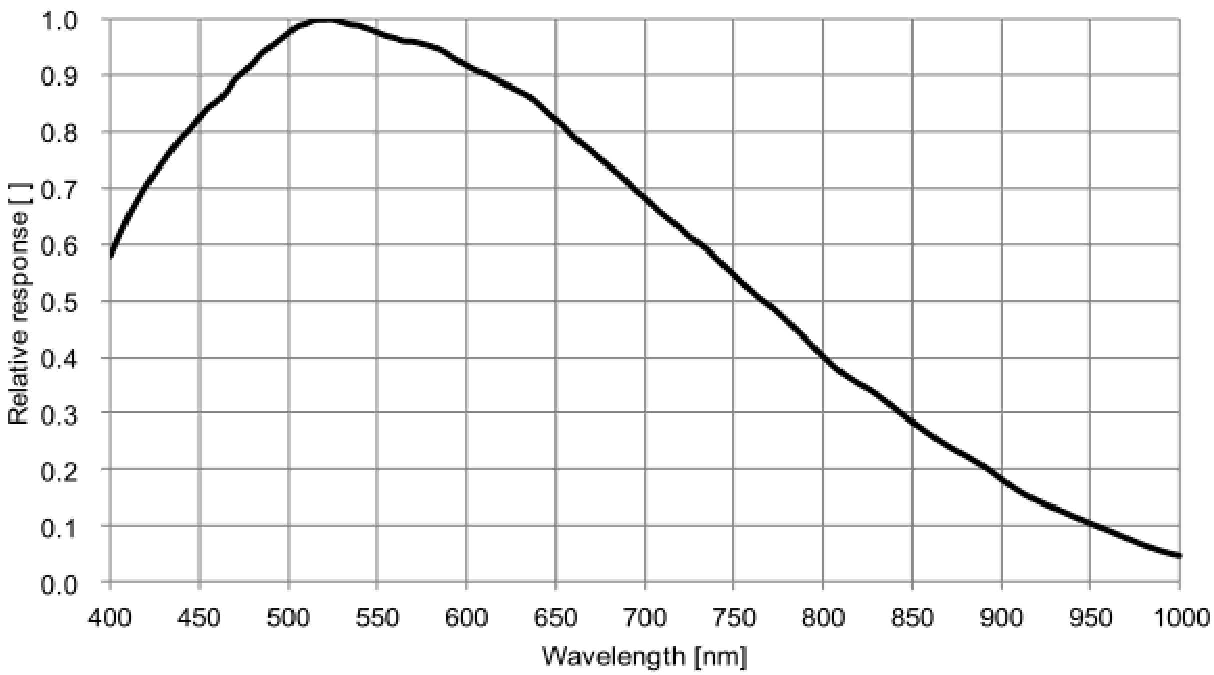

Figure 4-8 MER2-231-41GM sensor spectral response

4.6. MER2-302-37GM/C

4.6.1. Parameter

Specifications	MER2-302-37GC	MER2-302-37GM
Resolution	2048 × 1536	
Sensor Type	Sony IMX265 global shutter CMOS	
Optical Size	1/1.8 inch	
Pixel Size	3.45μm × 3.45μm	
Frame Rate	37.4fps @ 2048 × 1536 (adjust the packet size to 8192 and reserved bandwidth to 5)	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit、10bit	
Shutter Time	20μs ~ 1s	
Gain	0dB ~ 24dB	
Pixel Data Formats	Bayer RG8/Bayer RG10	Mono8/Mono10
Signal Noise Ratio	40.09dB	40.76dB
Synchronization	External trigger, software trigger	
I/O	1 input and 1 output with opto-isolated, 2 programmable GPIOs	
Operating Temp.	0°C~45°C	
Storage Temp.	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	< 3W @ 24V	
Lens Mount	C	
Dimensions	29mm×29mm×29mm (without lens adapter or connectors)	
Weight	62g	

Software	Windows XP / Win7 / Win8 / Win8.1 / Win10 / Windows Embedded 32bit and 64bit OS, Ubuntu14.04 / Ubuntu16.04 Linux OS
Data Interface	Fast Ethernet(100Mbit/s) or Gigabit Ethernet(1000Mbit/s)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, FCC, GigE Vision, GenICam

Table 4-5 MER2--302-37GM/C camera parameter

4.6.2. Spectral Response

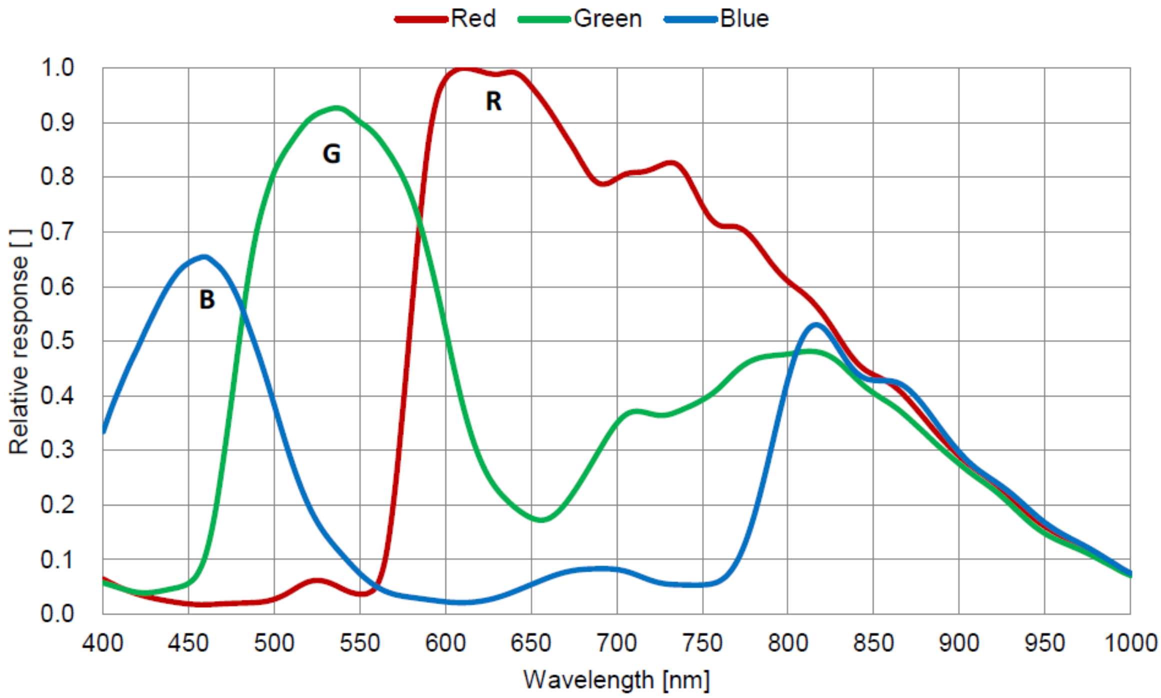

Figure 4-9 MER2-302-37GC sensor spectral response

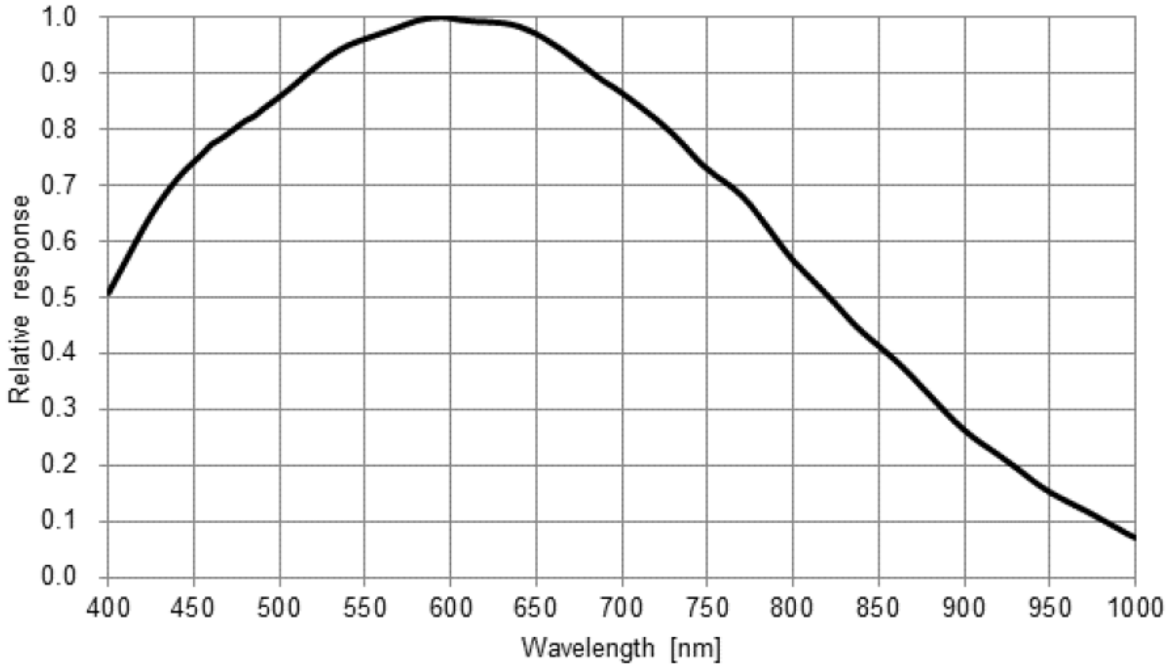

Figure 4-10 MER2-302-37GM sensor spectral response

4.7. MER2-503-23GM/C

4.7.1. Parameter

Specifications	MER2-503-23GC	MER2-503-23GM
Resolution	2448 × 2048	
Sensor Type	Sony IMX264 global shutter CMOS	
Optical Size	Diagonal 11.1 mm (2/3-type)	
Pixel Size	3.45μm × 3.45μm	
Frame Rate	23.5fps @ 2448 × 2048 (adjust the packet size to 8192 and reserved bandwidth to 5)	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit、10bit	
Shutter Time	20μs ~ 1s	
Gain	0dB ~ 24dB	
Pixel Data Formats	Bayer RG8/Bayer RG10	Mono8/Mono10

Signal Noise Ratio	40.77dB	40.59dB
Synchronization	External trigger, software trigger	
I/O	1 input and 1 output with opto-isolated, 2 programmable GPIOs	
Operating Temp.	0°C~45°C	
Storage Temp.	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	< 3W @ 24V	
Lens Mount	C	
Dimensions	29mm×29mm×29mm (without lens adapter or connectors)	
Weight	62g	
Software	Windows XP / Win7 / Win8 / Win8.1 / Win10 / Windows Embedded 32bit and 64bit OS, Ubuntu14.04 / Ubuntu16.04 Linux OS	
Data Interface	Fast Ethernet(100Mbit/s) or Gigabit Ethernet(1000Mbit/s)	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity	
Conformity	CE, RoHS, FCC, GigE Vision, GenICam	

Table 4-6 MER2-503-23GM/C camera parameter

4.7.2. Spectral Response

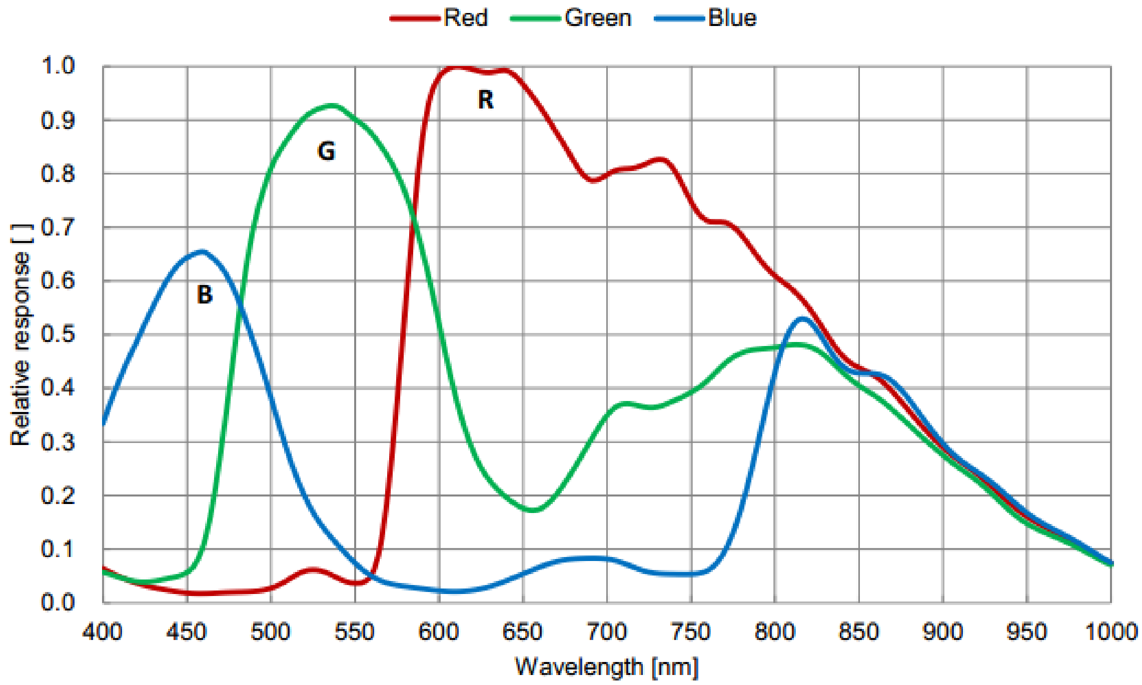

Figure 4-11 MER2-503-23GC sensor spectral response

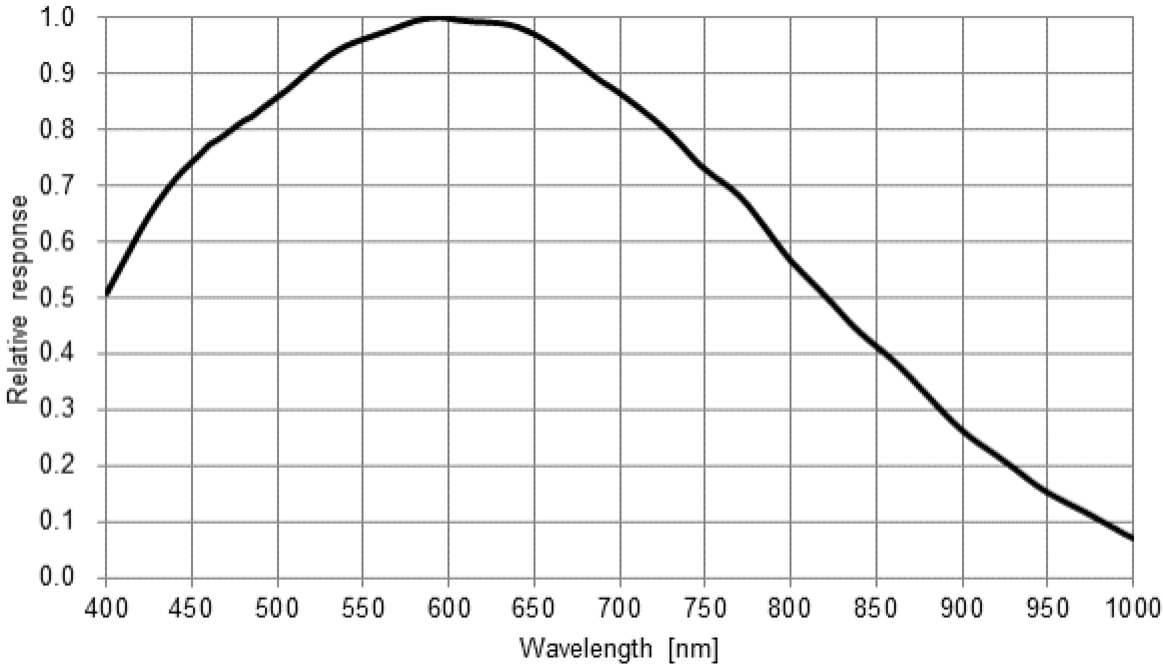

Figure 4-12 MER2-503-23GM sensor spectral response

4.8. MER2-630-16GM/C

4.8.1. Parameter

Specifications	MER2-630-16GC	MER2-630-16GM
Resolution	3088 × 2064	
Sensor Type	Sony IMX178 rolling shutter CMOS	
Optical Size	1/1.8 inch	
Pixel Size	2.4μm × 2.4μm	
Frame Rate	Default: 16.8fps @ 3088 x 2064	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit、12bit	
Shutter Time	19μs ~ 1s	
Gain	0dB ~ 24dB	
Pixel Data Formats	Bayer RG8/Bayer RG12	Mono8/Mono12
Signal Noise Ratio	40.25dB	40.28dB
Synchronization	External trigger, software trigger	
I/O	1 input and 1 output with opto-isolated, 2 programmable GPIOs	
Operating Temp.	0°C~45°C	
Storage Temp.	-20°C~70°C	
Operating Humidity	10%~80%	
Camera Power Requirements	PoE (Power over Ethernet, IEEE802.3af compliant) or +12VDC (±10%) supplied via the camera's 8-pin Hirose connector	
Power Consumption	< 3W @ 24V	
Lens Mount	C	
Dimensions	29mm×29mm×29mm (without lens adapter or connectors)	

Weight	65g
Software	Windows XP / Win7 / Win8 / Win8.1 / Win10 / Windows Embedded 32bit and 64bit OS, Ubuntu14.04 / Ubuntu16.04 Linux OS
Data Interface	Fast Ethernet(100Mbit/s) or Gigabit Ethernet(1000Mbit/s)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, FCC, GigE Vision, GenICam

Table 4-7 MER2-630-16GM/C camera parameter

4.8.2. Spectral Response

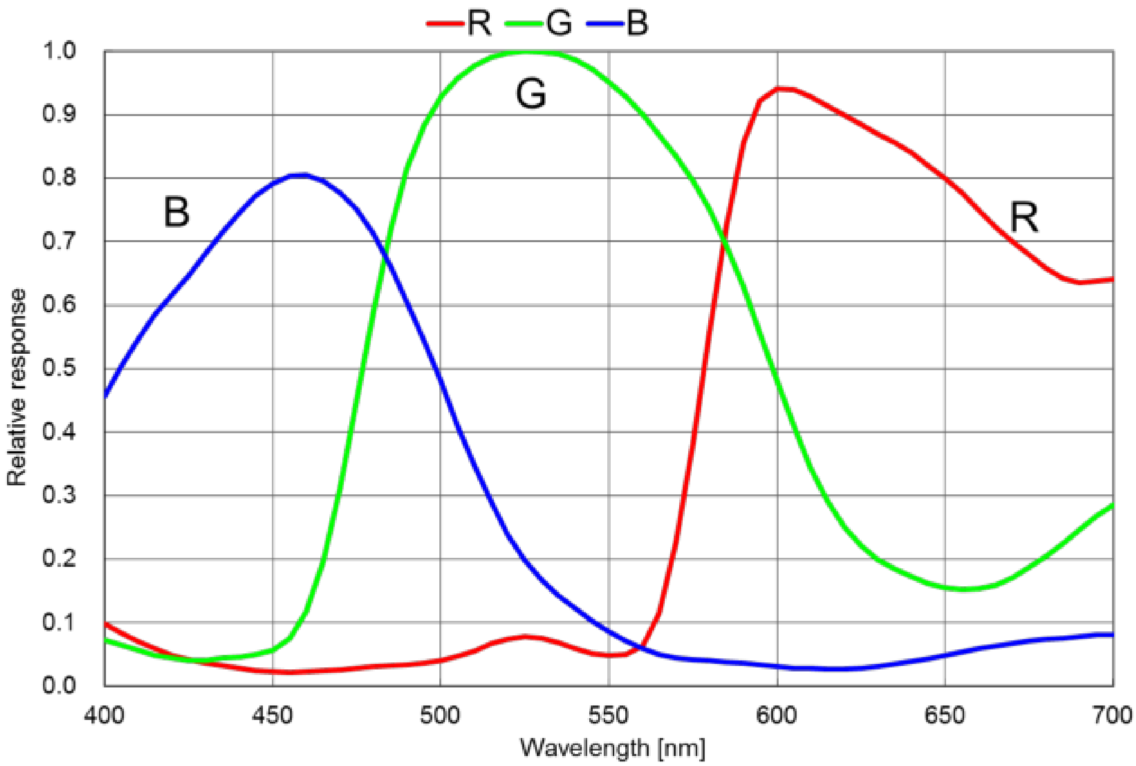

Figure 4-13 MER2-630-16GC sensor spectral response

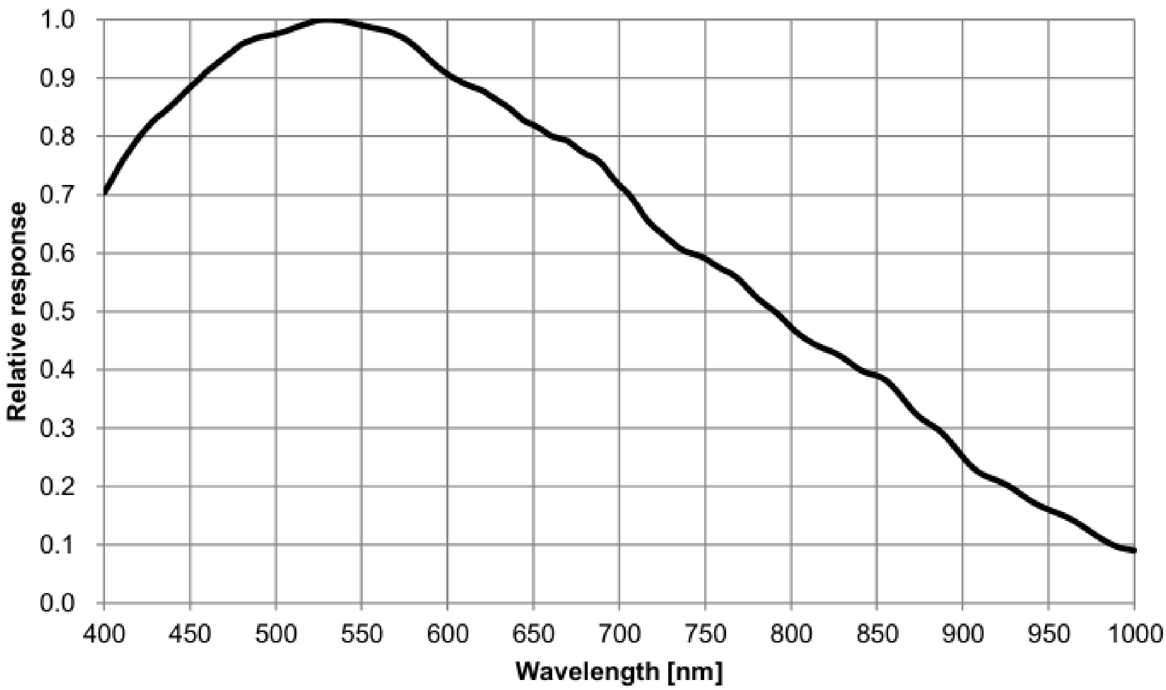

Figure 4-14 MER2-630-16GM sensor spectral response

4.9. MER2-1220-9GM/C

4.9.1. Parameter

Specifications	MER2-1220-9GC	MER2-1220-9GM
Resolution	4024 x 3036	
Sensor Type	Sony IMX226 rolling shutter CMOS	
Optical Size	1/1.7 inch	
Pixel Size	1.85μm × 1.85μm	
Frame Rate	Default: 9.6fps @ 4024 x 3036 Trigger mode: 7.5fps@4024x3036	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit、12bit	
Shutter Time	23μs ~ 1s	
Gain	0dB ~ 24dB	
Pixel Data Formats	Bayer RG8/Bayer RG12	Mono8/Mono12

Signal Noise Ratio	44dB	40.73dB
Synchronization	External trigger, software trigger	
I/O	1 input and 1 output with opto-isolated, 2 programmable GPIOs	
Operating Temp.	0°C~45°C	
Storage Temp.	-20°C~70°C	
Operating Humidity	10%~80%	
Camera Power Requirements	PoE (Power over Ethernet, IEEE802.3af compliant) or +12~24VDC (±10%) supplied via the camera's 8-pin Hirose connector	
Power Consumption	< 3W@24VDC	
Lens Mount	C	
Dimensions	29mm×29mm×29mm (without lens adapter or connectors)	
Weight	65g	
Software	Windows XP / Win7 / Win8 / Win8.1 / Win10 / Windows Embedded 32bit and 64bit OS, Ubuntu14.04 / Ubuntu16.04 Linux OS	
Data Interface	Fast Ethernet(100Mbit/s) or Gigabit Ethernet(1000Mbit/s)	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity	
Conformity	CE, RoHS, FCC, GigE Vision, GenICam	

Table 4-8 MER2-1220-9GM/C camera parameter

4.9.2. Spectral Response

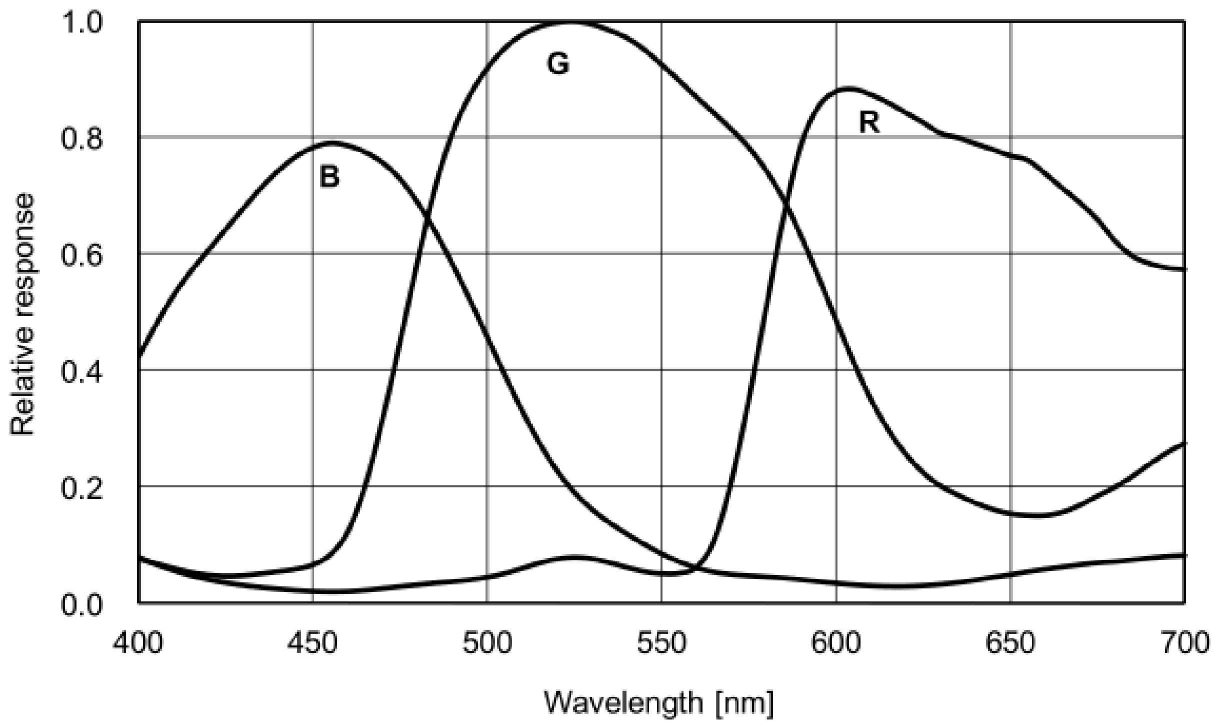

Figure 4-15 MER2-1220-9GC sensor spectral response

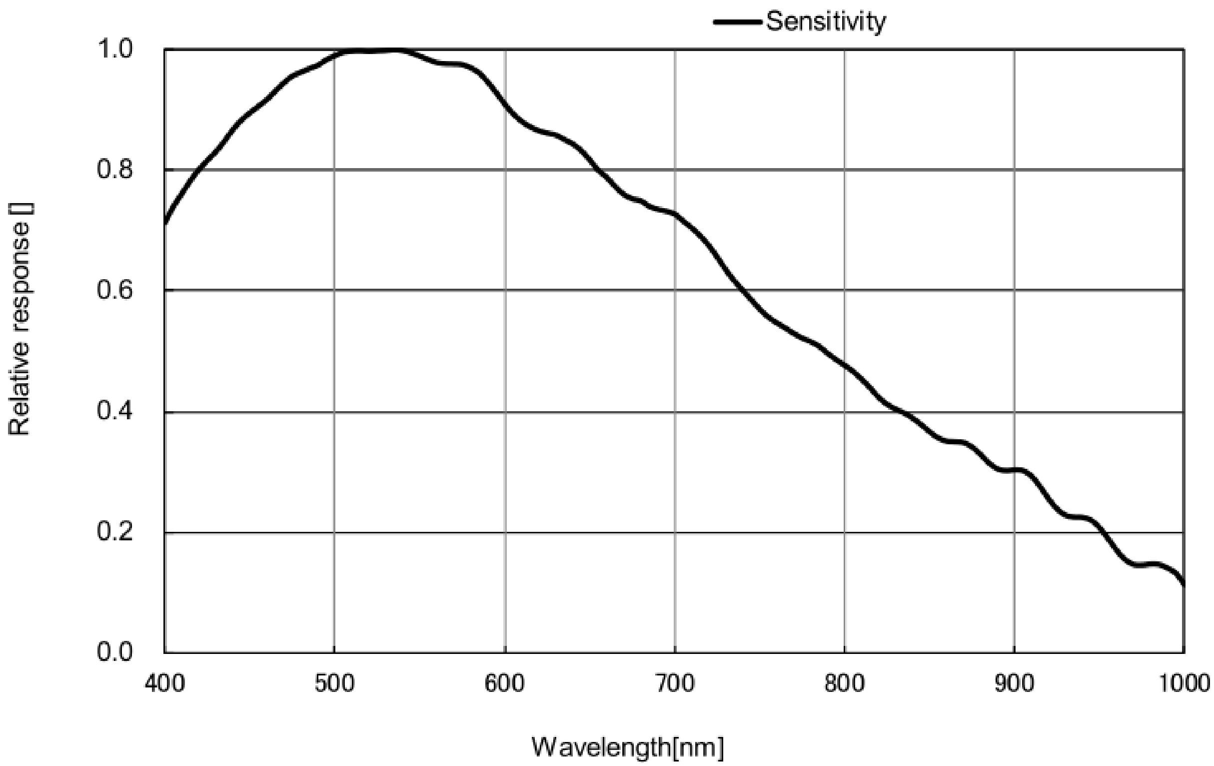

Figure 4-16 MER2-1220-9GM sensor spectral response

4.10. ME2P-1230-9GM/C-P

4.10.1. Parameter

Specifications	ME2P-1230-9GC-P	ME2P-1230-9GM-P
Resolution	4096 × 3000	
Sensor Type	Sony IMX304 global shutter CMOS	
Optical Size	1.1 inch	
Pixel Size	3.45μm × 3.45μm	
Frame Rate	Default: 8.7fps @ 4096 × 3000 (adjust the packet size to 8192 and reserved bandwidth to 5, frame rate to 9fps)	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit、12bit	
Shutter Time	36μs ~ 1s	
Gain	0dB ~ 23.9dB	
Pixel Data Formats	Bayer RG8/Bayer RG12	Mono8/Mono12
Signal Noise Ratio	40.48dB	40.66dB
Synchronization	External trigger, software trigger	
I/O	1 input and 1 output with opto-isolated, 2 programmable GPIOs	
Operating Temp.	0°C~45°C	
Storage Temp.	-20°C~70°C	
Operating Humidity	10%~80%	
Camera Power Requirements	PoE (Power over Ethernet, IEEE802.3af compliant) or 12VDC -10% ~ 24VDC+10% supplied via the camera's 8-pin Hirose connector	
Power Consumption	< 3W@24VDC, <3.75W@ PoE	
Lens Mount	C	

Dimensions	36mm × 31mm × 50.6mm (without lens adapter or connectors)
Weight	75g
Software	Windows XP / Win7 / Win8 / Win8.1 / Win10 32bit and 64bit OS
Data Interface	Fast Ethernet(100Mbit/s) or Gigabit Ethernet(1000Mbit/s)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, GigE Vision, GenICam, IEEE802.3af

Table 4-9 ME2P-1230-9GM/C-P camera parameter

4.10.2. Spectral Response

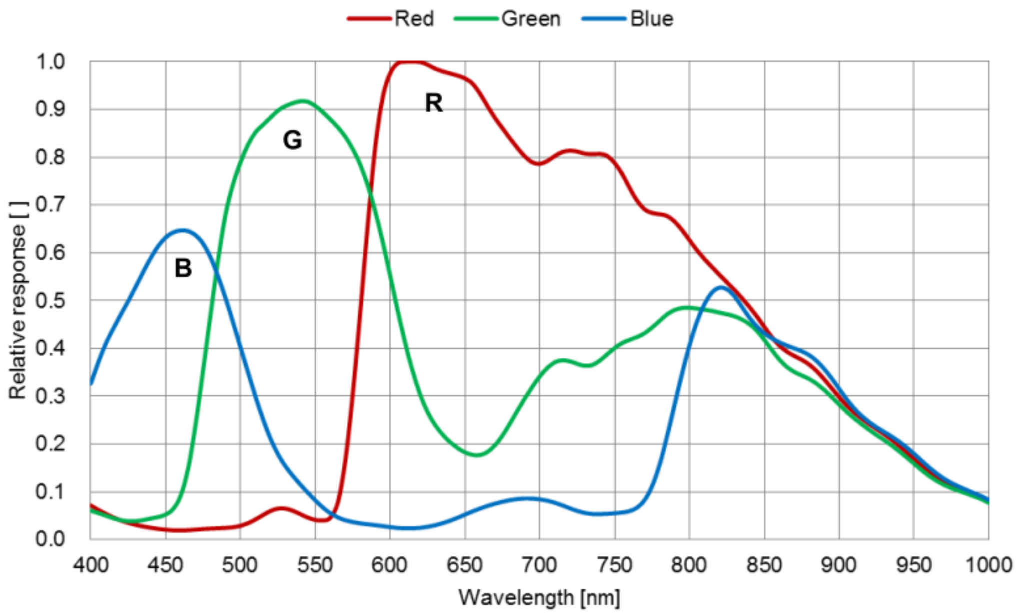

Figure 4-17 ME2P-1230-9GC-P sensor spectral response

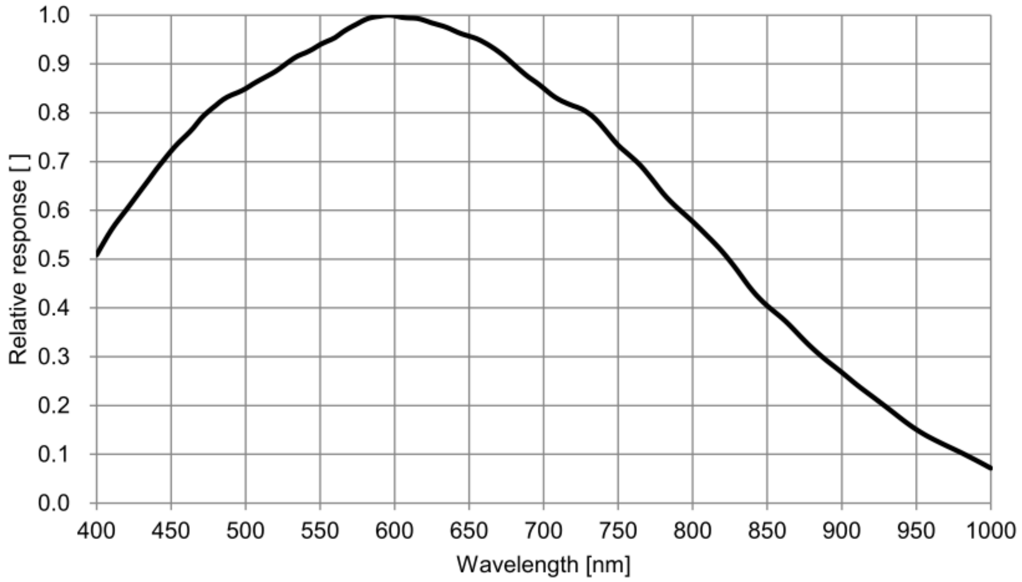

Figure 4-18 ME2P-1230-9GM-P sensor spectral response

4.11. MER2-2000-6GM/C

4.11.1. Parameter

Specifications	MER2-2000-6GC	MER2-2000-6GM
Resolution	5496 × 3672	
Sensor Type	Sony IMX183 rolling shutter CMOS	
Optical Size	1 inch	
Pixel Size	2.4μm × 2.4μm	
Frame Rate	5.8fps @ 5496 x 3672 (adjust the packet size to 8192 and reserved bandwidth to 5)	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit、12bit	
Shutter Time	31μs ~ 1s	
Gain	0dB ~ 24dB	
Pixel Data Formats	Bayer RG8/Bayer RG12	Mono8/Mono12
Signal Noise Ratio	45dB	41.16dB

Synchronization	External trigger, software trigger
I/O	1 input and 1 output with opto-isolated, 2 programmable GPIOs
Operating Temp.	0°C~45°C
Storage Temp.	-20°C~70°C
Operating Humidity	10%~80%
Power Consumption	< 3W@24VDC
Lens Mount	C
Dimensions	29mm×29mm×29mm (without lens adapter or connectors)
Weight	65g
Software	Windows XP / Win7 / Win8 32bit, 64bit OS
Data Interface	Fast Ethernet(100Mbit/s) or Gigabit Ethernet(1000Mbit/s)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, FCC, GigE Vision, GenICam

Table 4-10 MER2-2000-6GM/C camera parameter

4.11.2. Spectral Response

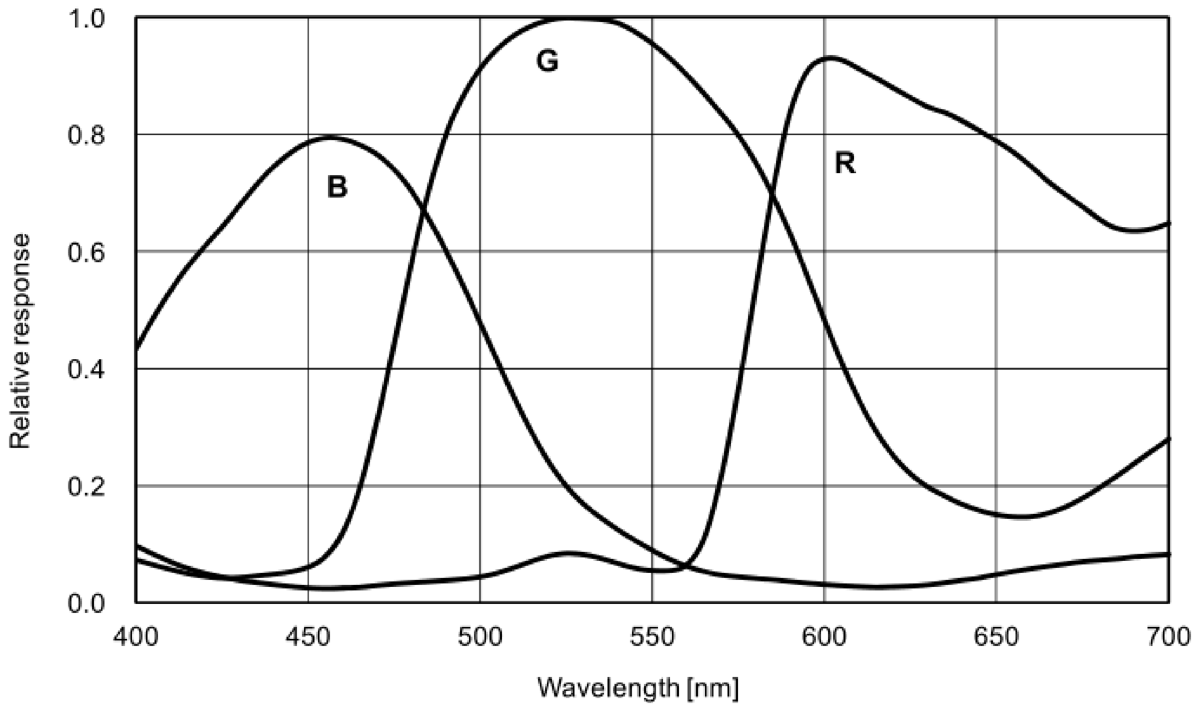

Figure 4-19 MER2-2000-6GC sensor spectral response

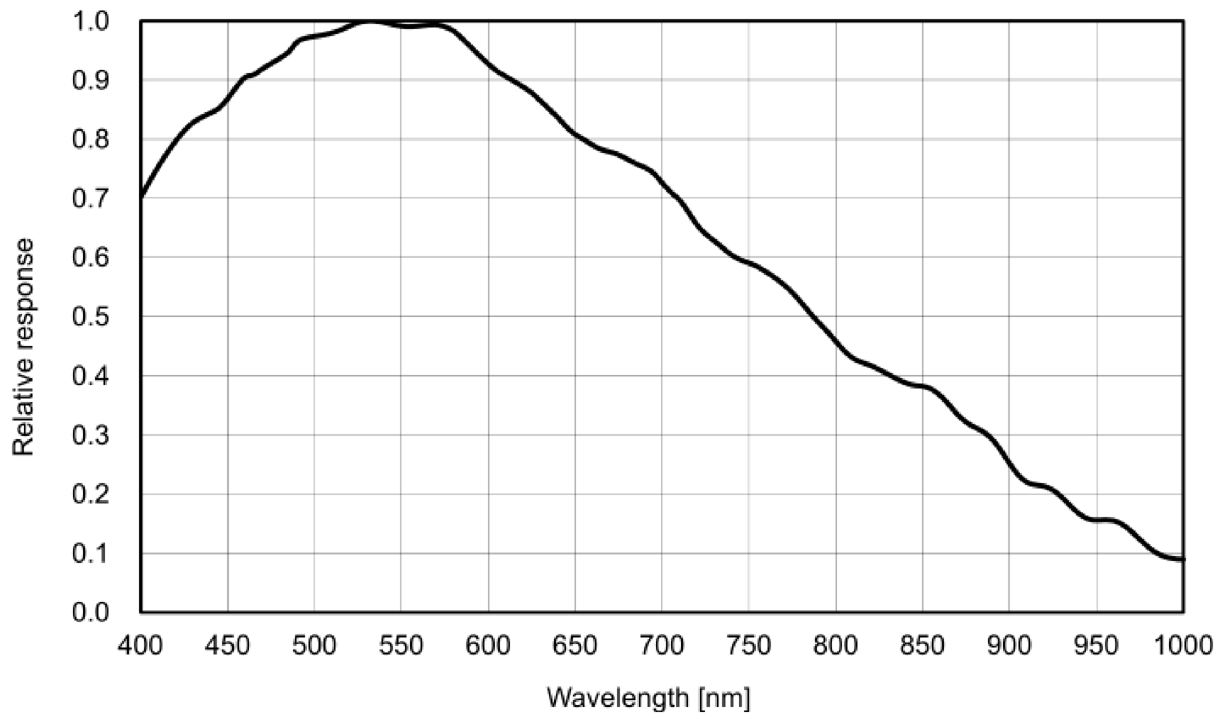

Figure 4-20 MER2-2000-6GM sensor spectral response

5. Dimensions

5.1. Camera Dimensions

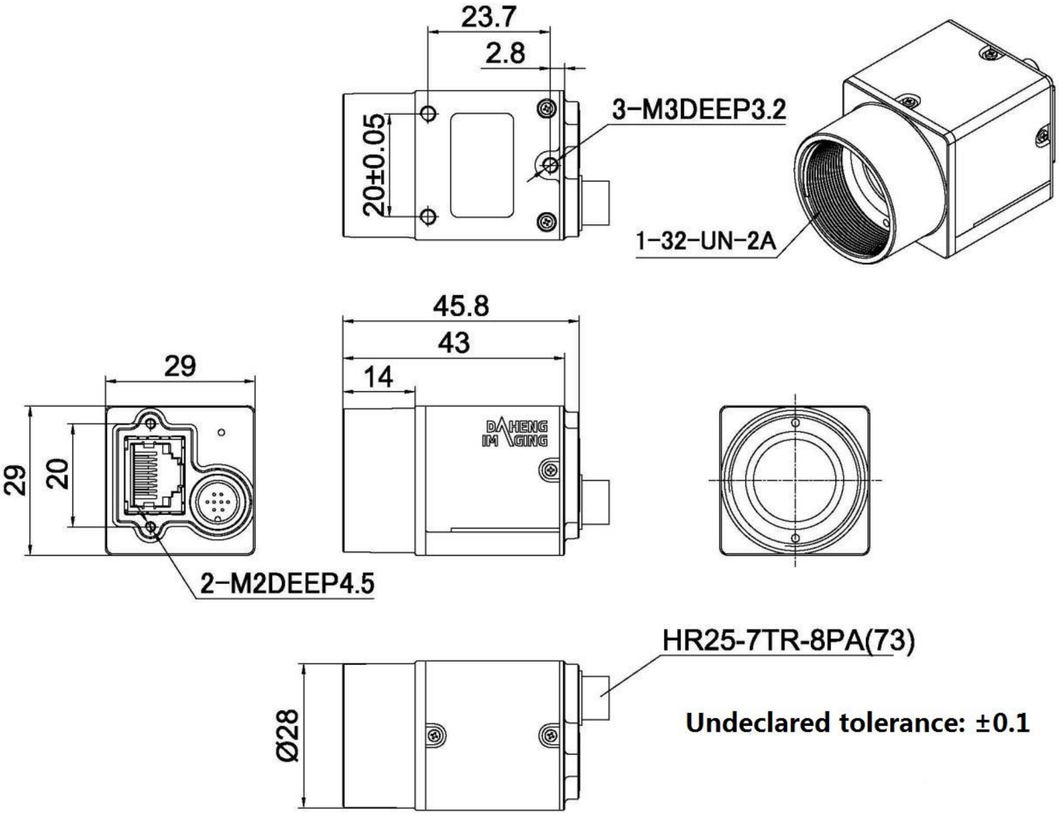

Figure 5-1 MER2-G mechanical dimensions

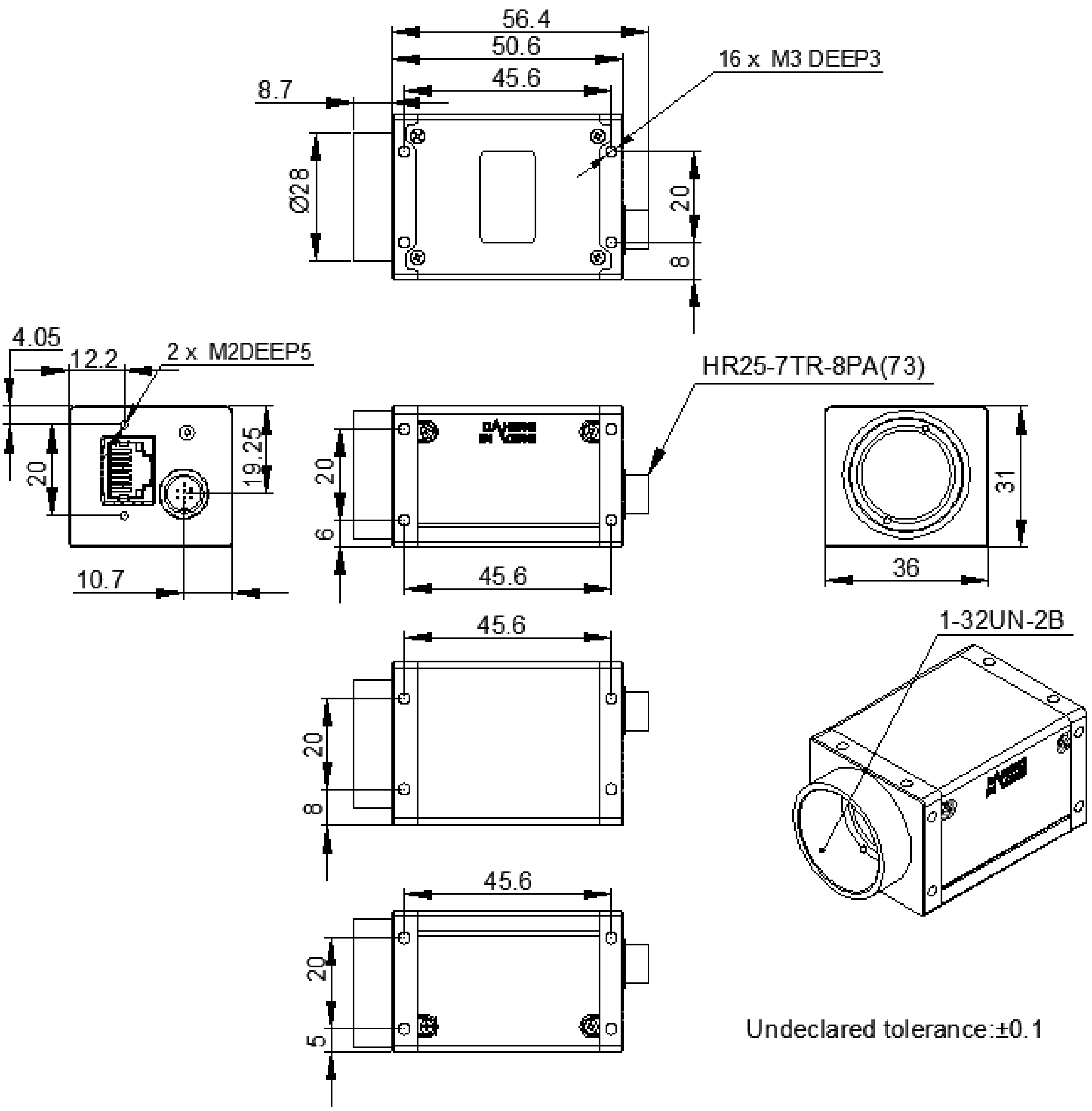

Figure 5-2 ME2P-G-P mechanical dimensions

5.2. Optical Interface

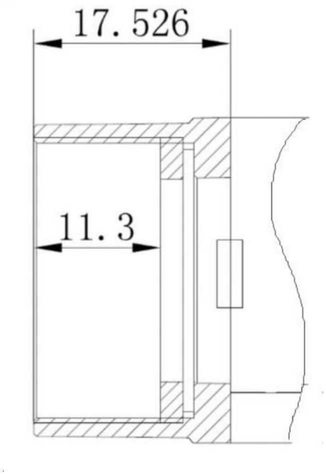

Figure 5-3 Optical interface of C-mount

MER2-G cameras are equipped with C-mount lens adapters. The back-flange distance is 17.526 mm (in the air). The maximum allowed thread length of lens should be less than 11.3mm, as shown in Figure 5-3. A longer lens thread will damage camera.

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

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

5.3. Tripod Adapter Dimensions

When customizing the tripod adapter, you need to consider the relationship between tripod adapter, screw length and step thickness of tripod adapter.

1) Screw length = tripod adapter step thickness + spring washer thickness + Screwing length of camera screw thread

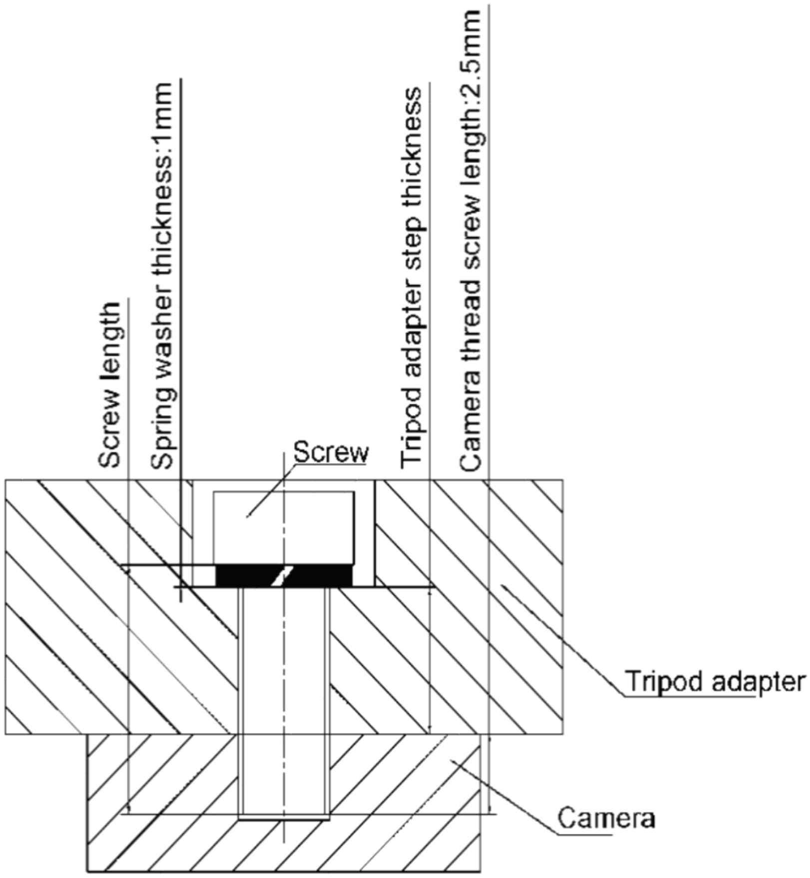

Figure 5-4 Schematic diagram of screw specification, tripod adapter step thickness and spring washer thickness

2) It is recommended that you select the screw specifications and the tripod adapter step thickness from the table below:

Screw specification	Tripod adapter step thickness (mm)	Spring washer thickness (mm)	Screwing length of camera screw thread (mm)
M3*6 screw	2.5	0.8	2.7
M3*8 screw	4.5	0.8	2.7
M3*10 screw	6.5	0.8	2.7

If the screw specification and the thickness of the tripod adapter do not conform to the requirement above, it may cause the camera thread hole through or thread stripping.

6. Filters and Lenses

6.1. Filters

The MERCURY2 color models are equipped with IR filters. The thickness of the filter is 0.7±0.05mm, and the cut-off frequency is 700nm, which reduces the influence of invisible light on the image. The monochrome models are equipped with transparent glasses. Remove IR-filters or transparent glasses will defocus the image plane.

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

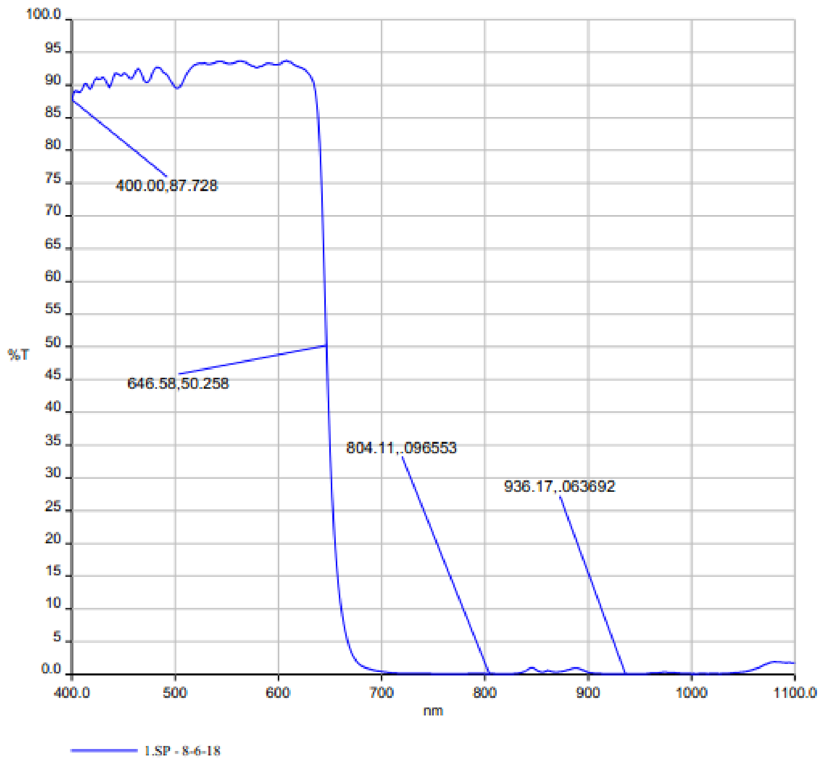

Figure 6-1 Infrared cut-off filter transmittance curve for MERCURY2 series color camera

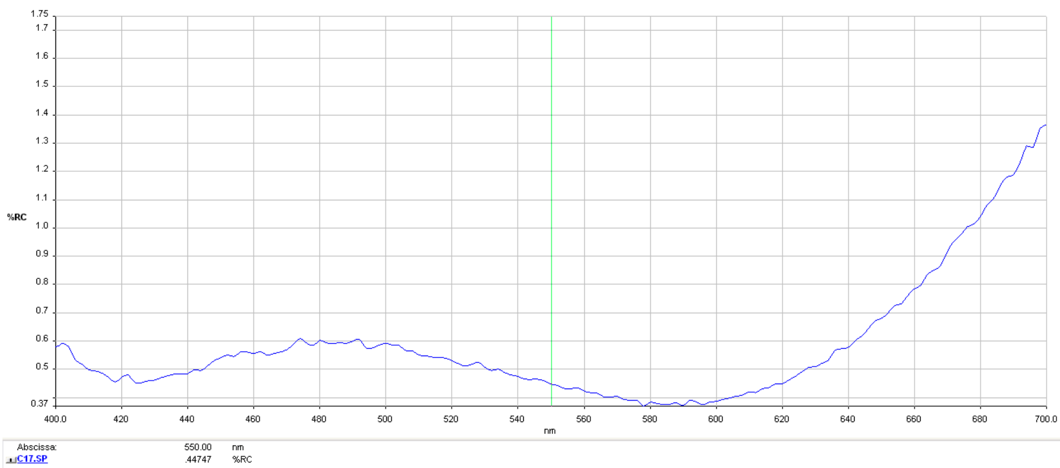

Figure 6-2 Transparent glass reflectance curve for MERCURY2 series mono camera

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) Lens mount

- According to the connection methods of the lens and the camera, the commonly used mounts are C, CS, F, V, Leica, M42, M58, M72, M90, and so on
- The MERCURY2 series GigE digital camera is equipped with a standard C-Mount. When selecting a lens, select the lens of the same mount as the camera

2) Optical size

- 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 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 value, 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 for industrial, suitable for sensors with optical size 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 for industrial, suitable for sensors with optical size 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

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	No power
Solid red	The camera is powered on, but the program does not start properly
Solid green	Ethernet is connected, but no data is being transmitted
Solid yellow	The camera starts properly, but the network connection is not established
Flashing yellow	The camera's permanent IP address and other real-time save parameters are incorrect or the camera is started in the userset mode, the parameter set is wrong, and the camera is switched to the default mode to start. Use the IP Configurator to save the camera IP or re-save the userset. After the camera is powered on, the LED status returns to green
Flashing green	Data is being transmitted through Ethernet
Flashing yellow-green	Camera initialization failed

Table 7-1 Camera status

7.2. Ethernet Port

Ethernet connector is a standard RJ45 jack, and the pin definition follows the Ethernet standard.

Ethernet port supports CAT-5e cables or above, and the cable length can be up to 100m.

Power can be supplied to the camera (MER2-G-P series) via Power over Ethernet (IEEE802.3af compatible), i.e., via the Ethernet cable plugged into the camera's RJ45 jack.

7.3. I/O Port

I/O port is implemented by 8-pin Hirose connector (No. HR25-7TR-8PA(73)), and the corresponding plug is HR25-7TP-8S.

Diagram	Pin	Definition	Core Color	Description
	1	Line0+	Green	Opto-isolated input +
	2	GND	Blue	PWR GND & GPIO GND
	3	Line0-	Grey	Opto-isolated input -
	4	POWER_IN	Purple	Camera external power, +12V DC
	5	Line2	Orange	GPIO input/output
	6	Line3	Pink	GPIO input/output
	7	Line1-	White Green	Opto-isolated output -
	8	Line1+	White Blue	Opto-isolated output +

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

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

7.3.1. Line0 (Opto-isolated Input) Circuit

Hardware schematics of opto-isolated input circuit is shown as Figure 7-1.

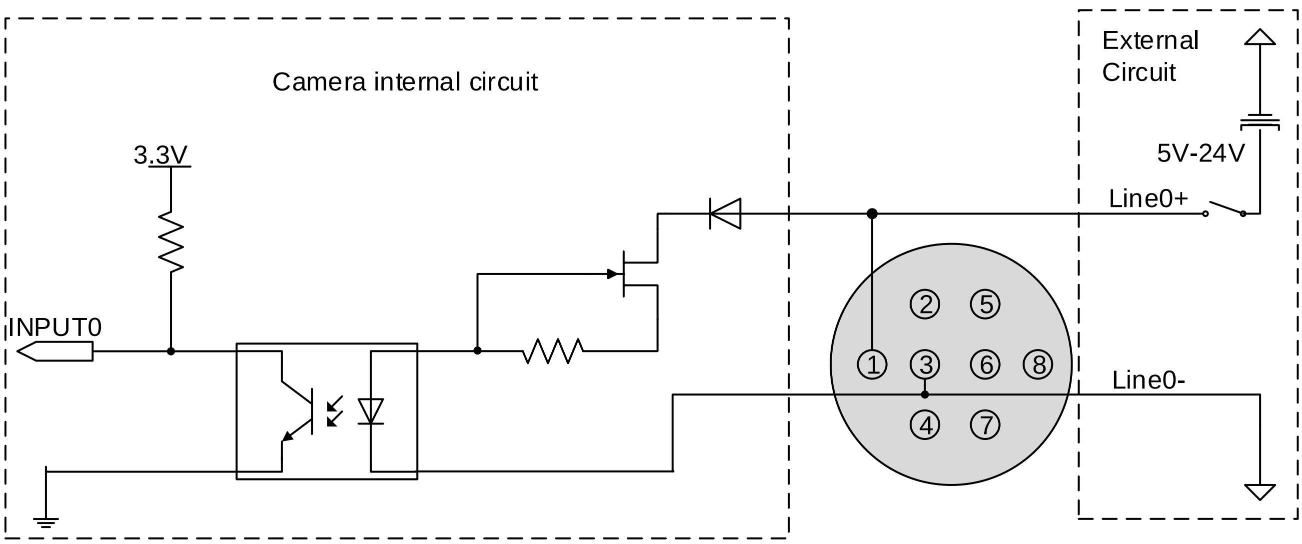

Figure 7-1 Opto-isolated input circuit

- 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 line. The recommended resistance is shown in Table 7-3

External input voltage	Circuit-limiting resistance Rlimit	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 value and the external power supply voltage is shown in Table 7-3.

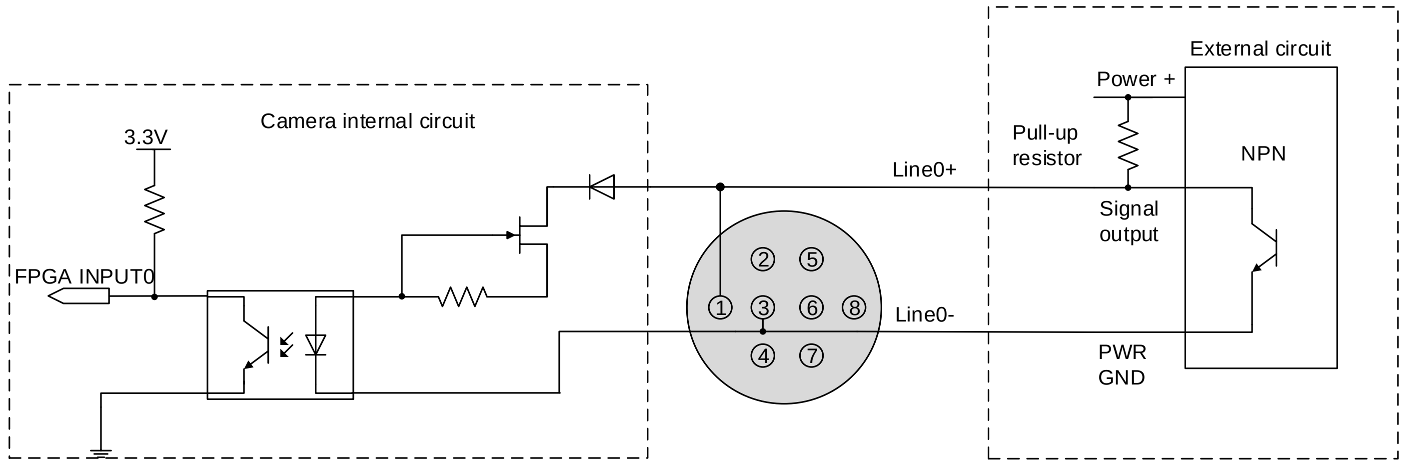

Figure 7-2 NPN photosensor connected to opto-isolated input circuit

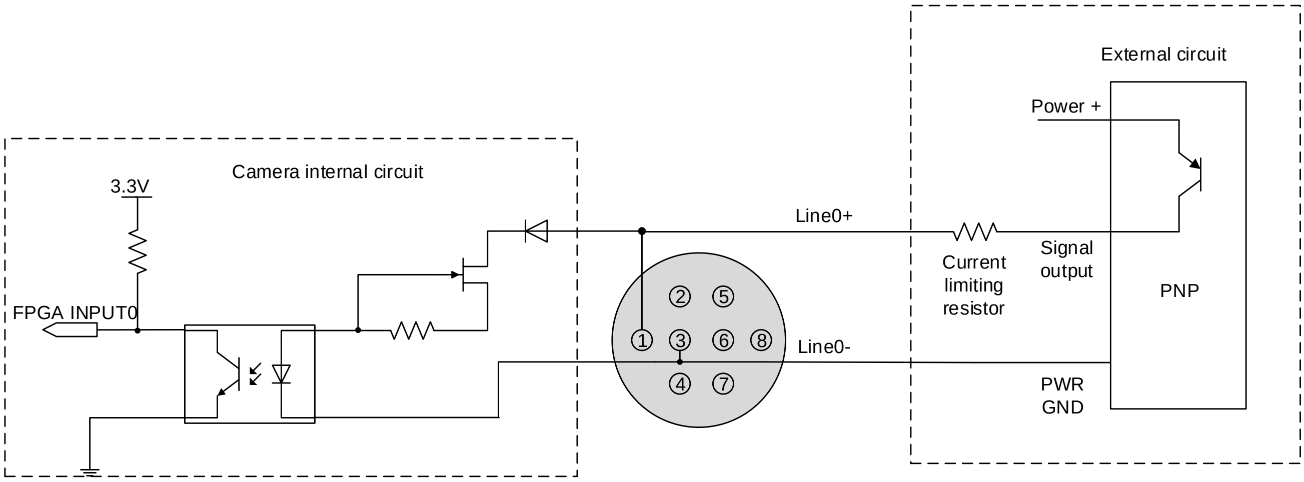

Figure 7-3 PNP photosensor connected to opto-isolated input circuit

- Rising edge delay: <50μs (0°C~45°C), parameter description as shown in Figure 7-4
- Falling edge delay: <50μs (0°C~45°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 time 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

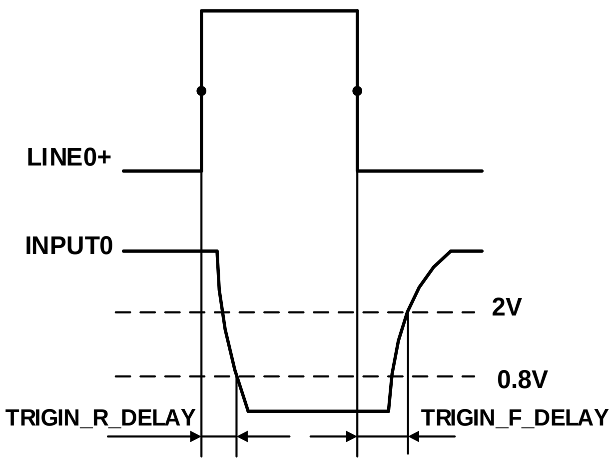

Figure 7-4 Parameter of opto-isolated input circuit

- Rising time delay (TRIGIN_R_DELAY): the response time from LINE0+ rises to 50% of amplitude to INPUT0 decreases to 0.8V
- Falling time delay (TRIGIN_F_DELAY): the response time from LINE0+ decreases to 50% of amplitude to INPUT0 rises to 2V

7.3.2. Line1 (Opto-isolated Output) Circuit

Hardware schematics of opto-isolated output circuit is shown as Figure 7-5.

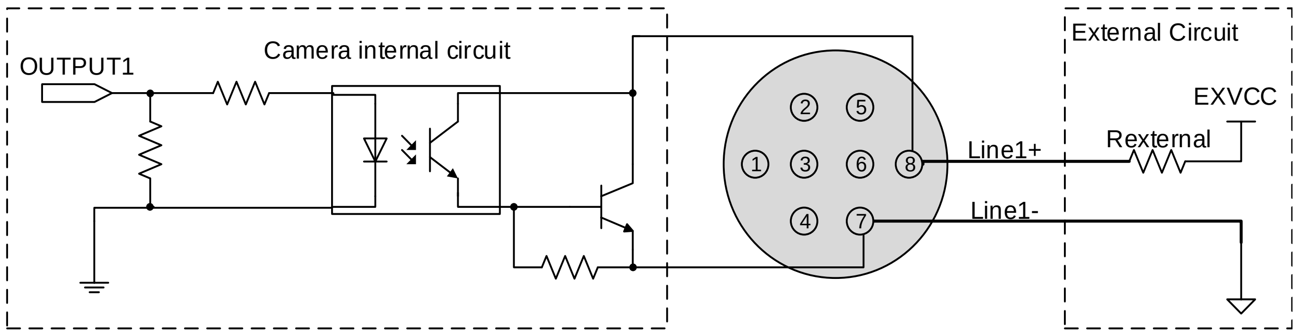

Figure 7-5 Opto-isolated output circuit

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

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

Table 7-5 Output voltage 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 7-6)
- Falling time delay = ts+tf: <50μs (0°C~45°C) (parameter description is shown in Figure 7-6)
- Delay times in typical application conditions (environment temperature is 25°C) are shown in Table 7-6

Parameter	Test Condition	Value (us)		
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 7-6 Delay time of opto-isolated output circuit in typical application environment

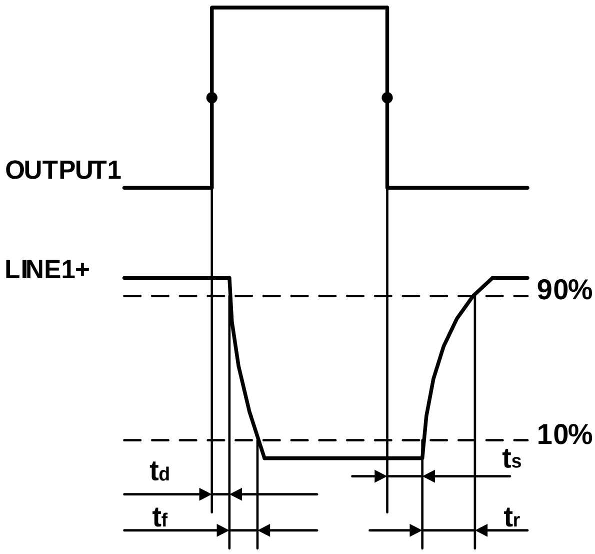

Figure 7-6 Parameter of opto-isolated output circuit

- Delay time (td): the response time from OUTPUT1 rises to 50% of amplitude to LINE1+ decreases to 90% of amplitude
- Falling time (tf): the response time for LINE1+ to decrease from 90% of the amplitude to 10%
- Storage time (ts): the response time from OUTPUT1 decreases to 50% of amplitude to LINE1+ rises to 10% of amplitude
- Rising time (tr): the response time for LINE1+ to rise from 10% of the amplitude to 90%

7.3.3. GPIO 2/3 (Bidirectional) Circuit

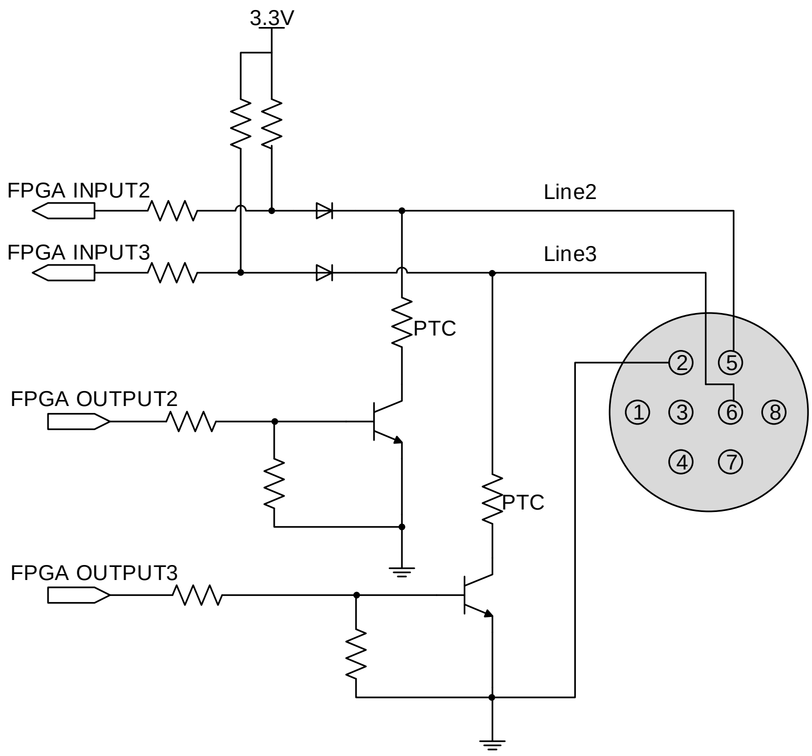

Figure 7-7 GPIO 2/3 (bidirectional) circuit

7.3.3.1. Line2/3 is Configured as Input

When Line2/3 is configured as input, the internal equivalent circuit of camera is shown in Figure 7-8, taking Line2 as an example:

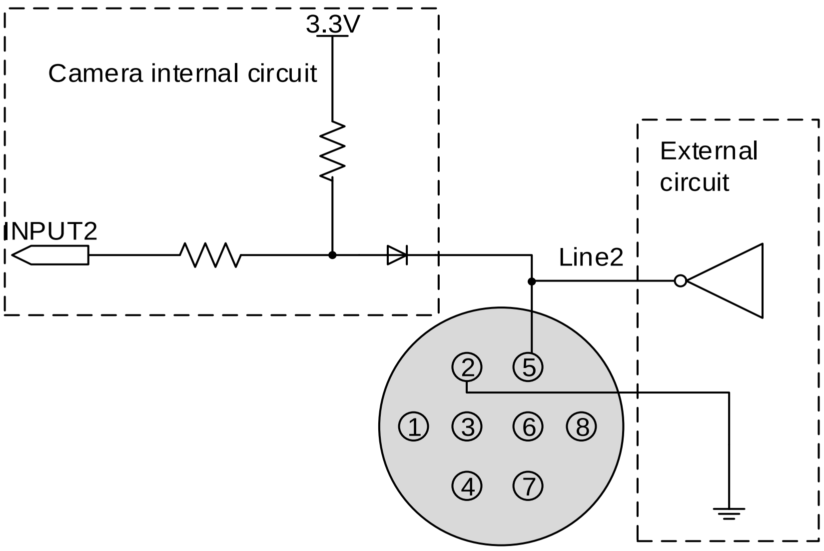

Figure 7-8 Internal equivalent circuit of camera when Line2 is configured as input

To avoid the damage of GPIO pins, please connect GND pin before supplying power to Line2/3.

- Logic 0 input voltage: 0V~+0.6V(Line2/3 voltage)
- Logic 1 input voltage: +1.9V~+24V(Line2/3 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 100uA. When input of Line2/3 is low, input current is lower than -1mA

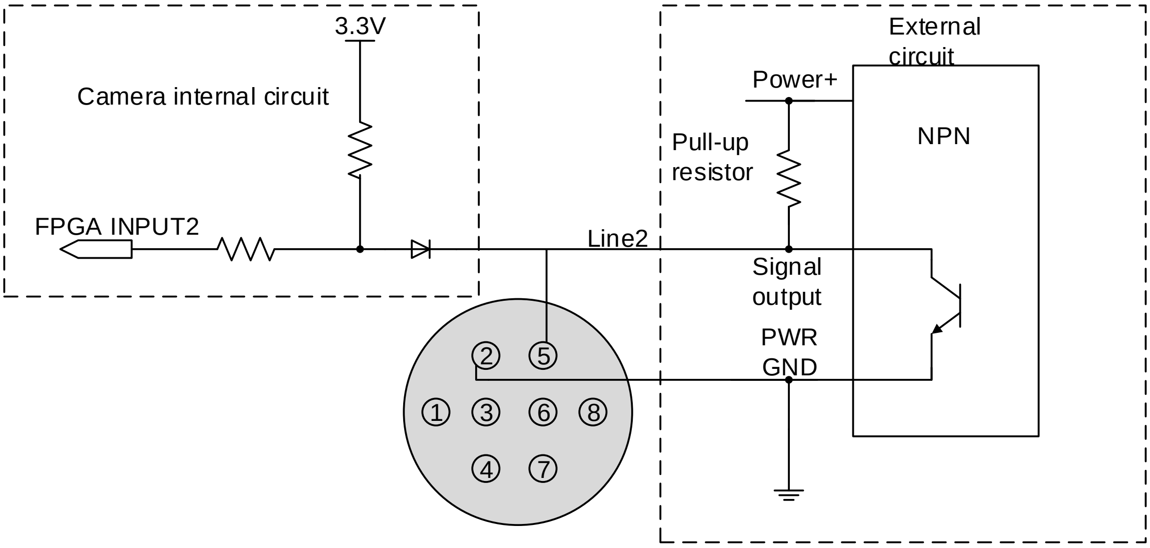

Figure 7-9 NPN photoelectric sensor connected to Line2 input circuit

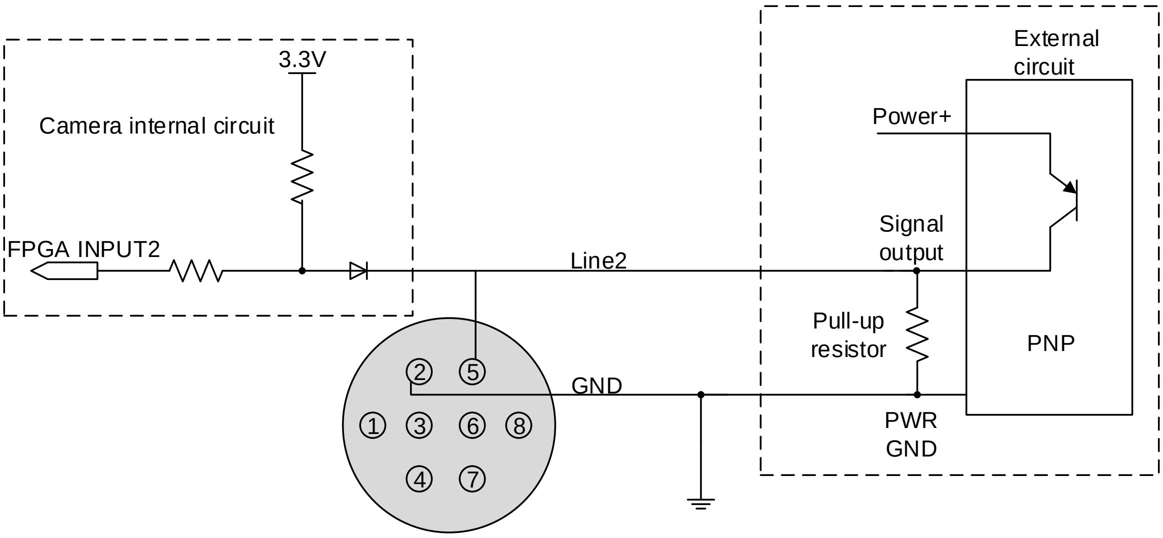

Figure 7-10 PNP photoelectric sensor connected to Line2 input circuit

- When Line2/3 is configured as input, if the corresponding output device is common-anode connected, 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 7-4
- Input falling time delay: <2μs (0°C~45°C), parameter description as shown in Figure 7-4

7.3.3.2. 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

Output voltage and output current in typical application conditions (temperature is 25℃) are shown in Table 7-7.

External voltage EXVCC	External resistance Rexternal	Line2/3 voltage (V)	Output current (mA)
5V	1kΩ	0.19	4.8
12V		0.46	11.6
24V		0.92	23.1

Table 7-7 Voltage and output current of Line2/3 in typical conditions

- Rising time delay = tr+td: <20μs (0°C~45°C) (parameter description as shown in Figure 7-6)
- Falling time delay = ts+tf: <20μs (0°C~45°C) (parameter description as shown in Figure 7-6)
- Delay parameters are affected greatly by external voltage and external pull-up resistor, but little by temperature. Output delays in typical application conditions (temperature is 25°C) are shown in Table 7-8

Parameter	Test Conditions	Value (us)		
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 7-8 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 7-11, taking Line2 as an example.

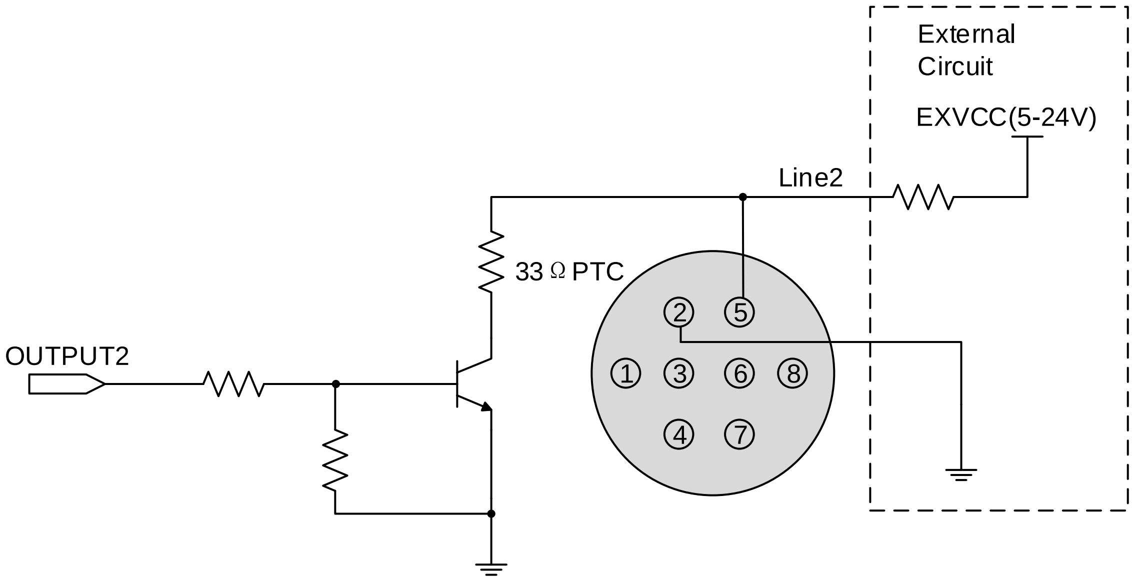

Figure 7-11 Internal equivalent circuit of camera when Line2 is configured as output

8. Features

8.1. I/O Control

8.1.1. Input Mode Operation

1) Configuring Line as input

The MER2-G series 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 lines 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 external trigger, the MER2-G 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] 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:

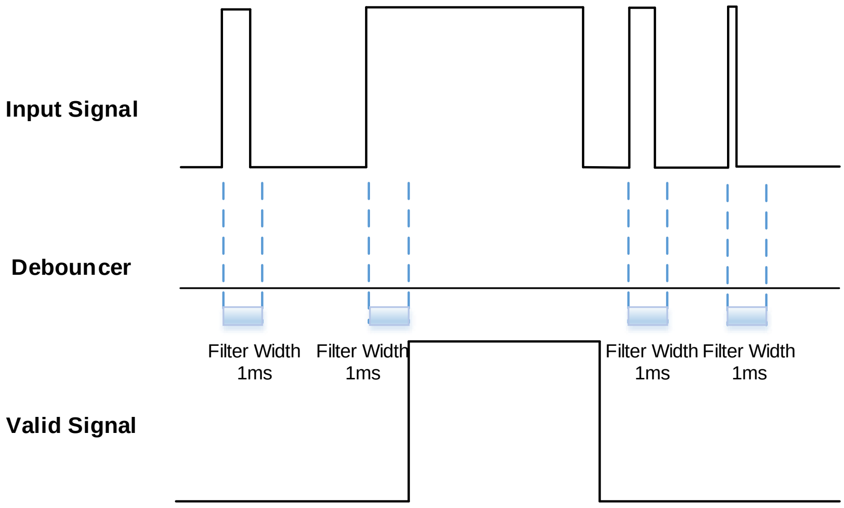

Figure 8-1 Input debouncer schematic diagram

3) Trigger Delay

The MER2-G 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] μs, step: 1μs.

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

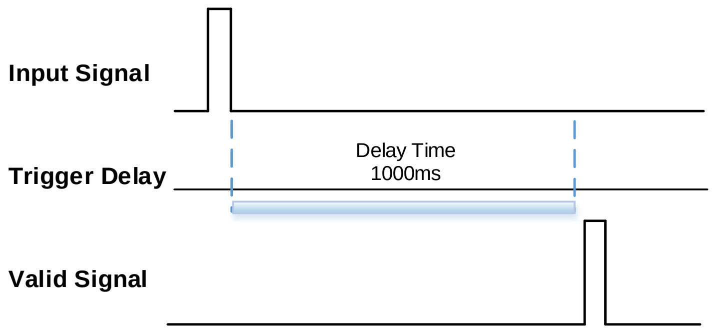

Figure 8-2 Trigger delay schematic diagram

4) Input Inverter

The signal level of input lines is configurable for the MER2-G series camera. The user can select whether the input level is reverse or not by setting "LineInverter".

For the MER2-G 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:

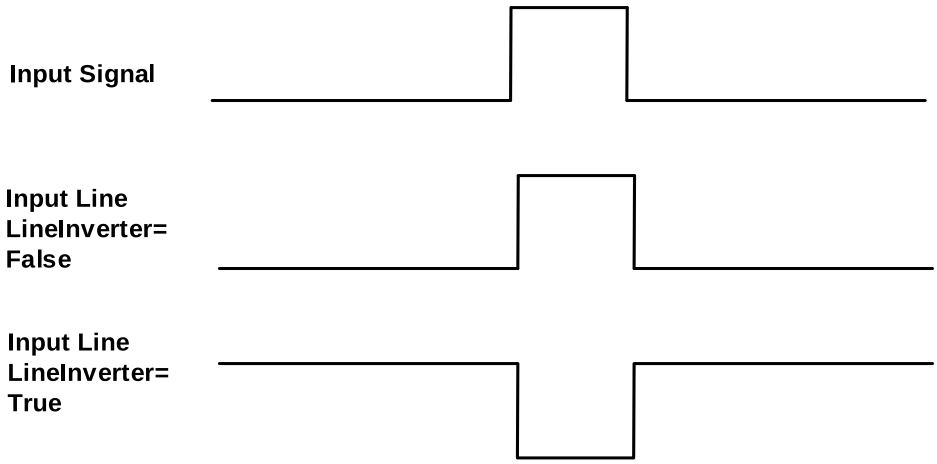

Figure 8-3 Setting input line reverse

8.1.2. Output Mode Operation

1) Configuring Line as output

The MER2-G series camera has three output signals: Line1, Line2, and Line3. In which the Line1 is a uni-directional opto-isolated output I/O, Line2 and Line3 are bi-direction configurable I/Os.

The camera's default output 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 three output lines can be configurable, and the output source includes: Strobe, UserOutput0, UserOutput1, UserOutput2, ExposureActive, FrameTriggerWait, AcquisitionTriggerWait.

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.

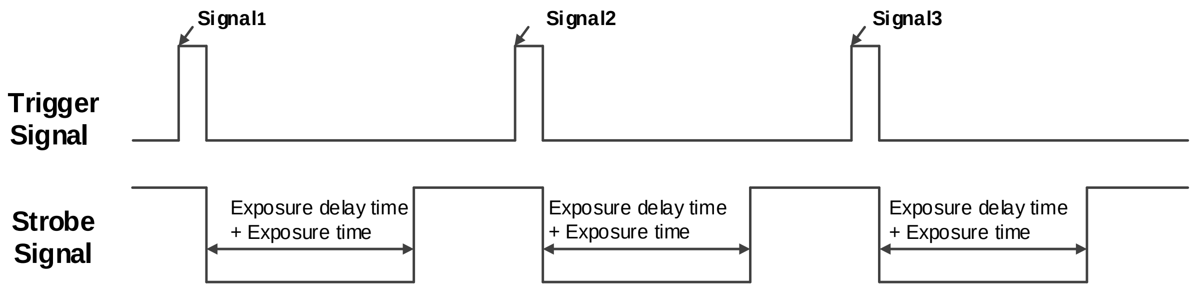

Figure 8-4 Strobe signal schematic diagram

- 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.

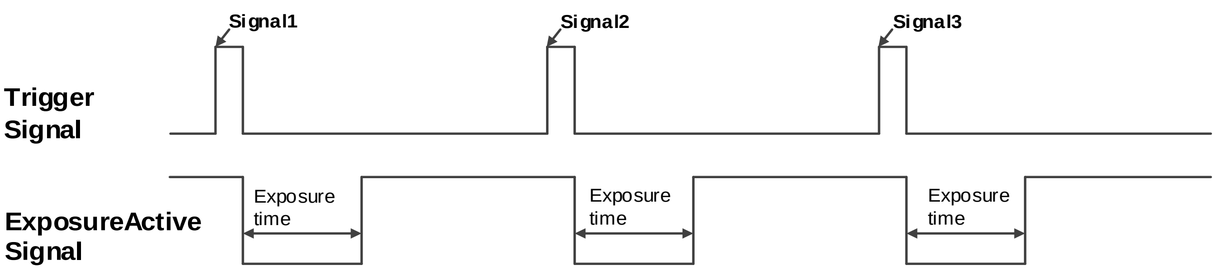

Figure 8-5 Global shutter "ExposureActive" signal schematic diagram

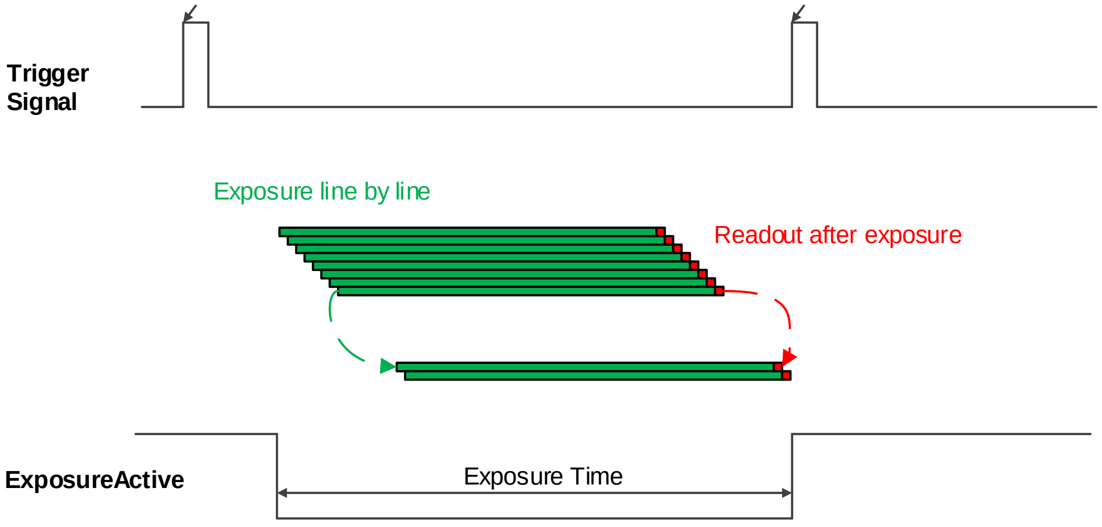

Figure 8-6 Electronic rolling shutter "ExposureActive" signal schematic diagram

This signal is also 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 external 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.

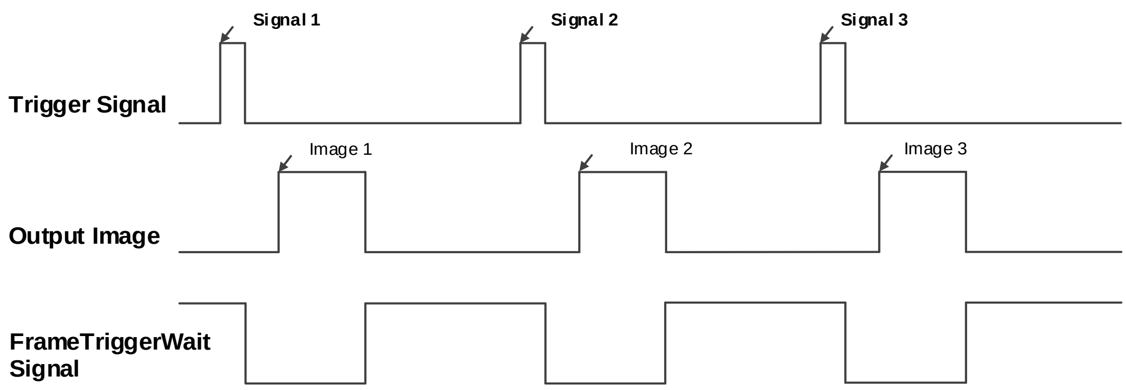

Figure 8-7 "FrameTriggerWait" signal schematic diagram

When the trigger mode is "FrameBurstStart", each time the camera receives a trigger signal, it will acquire multiple frames of image (the number of frames can be obtained by the function "AcquisitionFrameCount"). After receiving the trigger signal, the "AcquisitionTriggerWait" signal is pulled low and the camera starts the exposure transmission. When the transfer is completed, the "AcquisitionTriggerWait" signal will be pulled high.

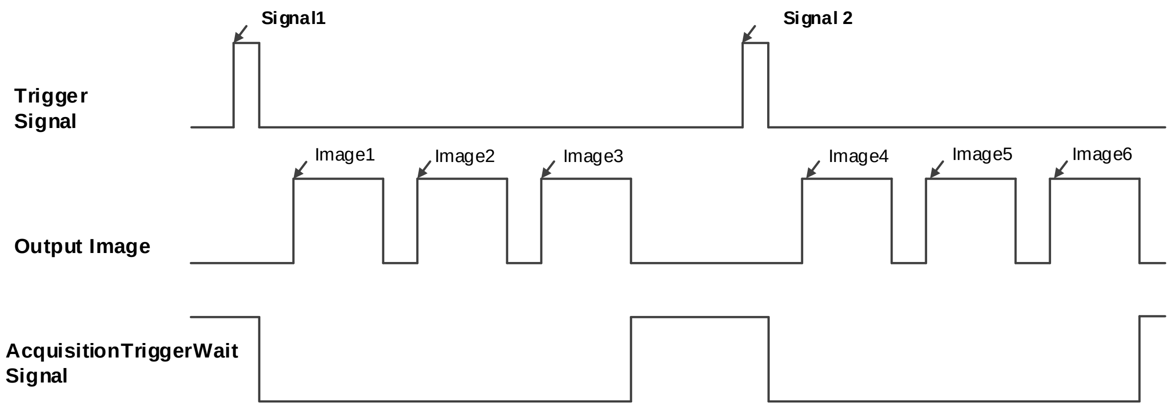

Figure 8-8 " AcquisitionTriggerWait " signal schematic diagram

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

The MER2-G 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 MER2-G series camera has the function of configurable 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 8-9.

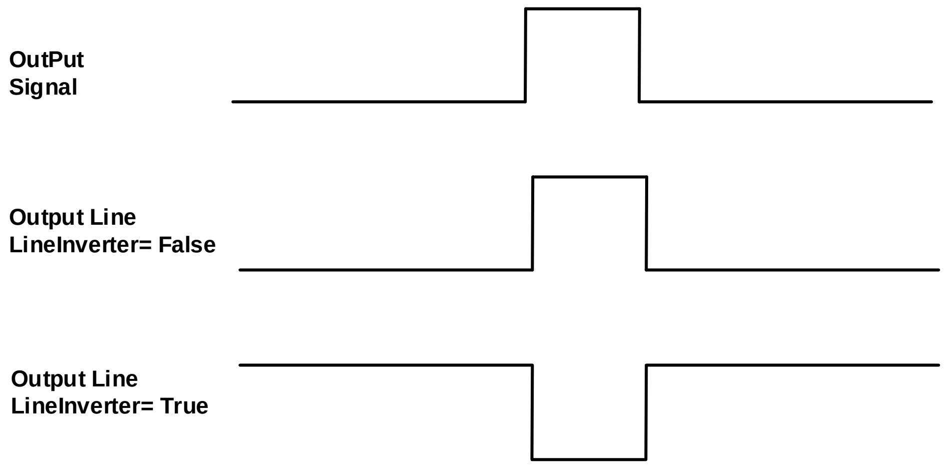

Figure 8-9 Set output line reversion

8.1.3. Read the LineStatus

1) Read the level of single line

The MER2-G series camera can get the line's signal status. When the device is powered on, the default status of Line0 and Line1 is false, and the default status of Line2 and Line3 is true.

2) Read all the lines level

The MER2-G 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 MER2-G series camera is shown in Table 8-1. The default polarity does not reverse, and 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 **Acquisition Start** 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**

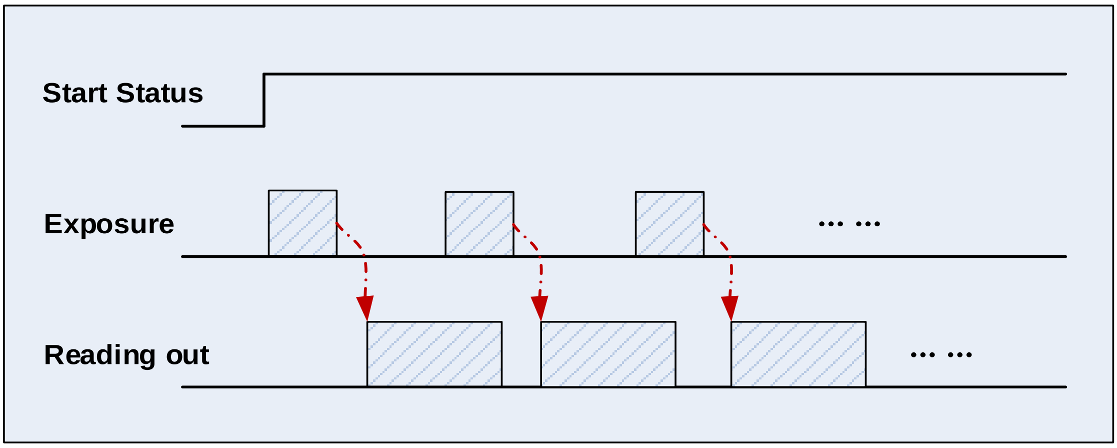

Figure 8-10 Continuous acquisition process

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**

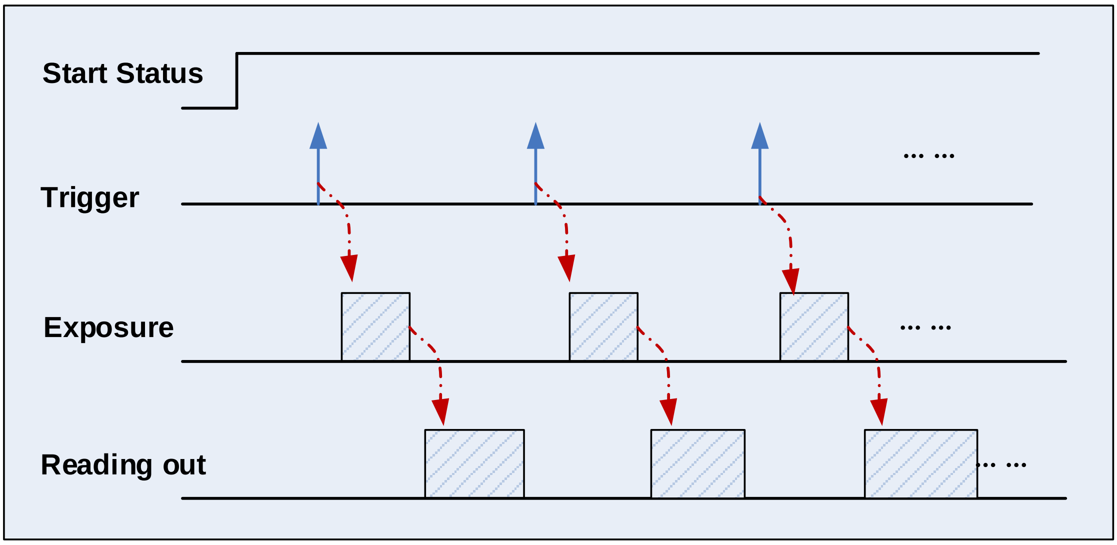

Figure 8-11 Trigger acquisition process

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 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 8-12 and Figure 8-13.

- **Acquisition stop during reading out**

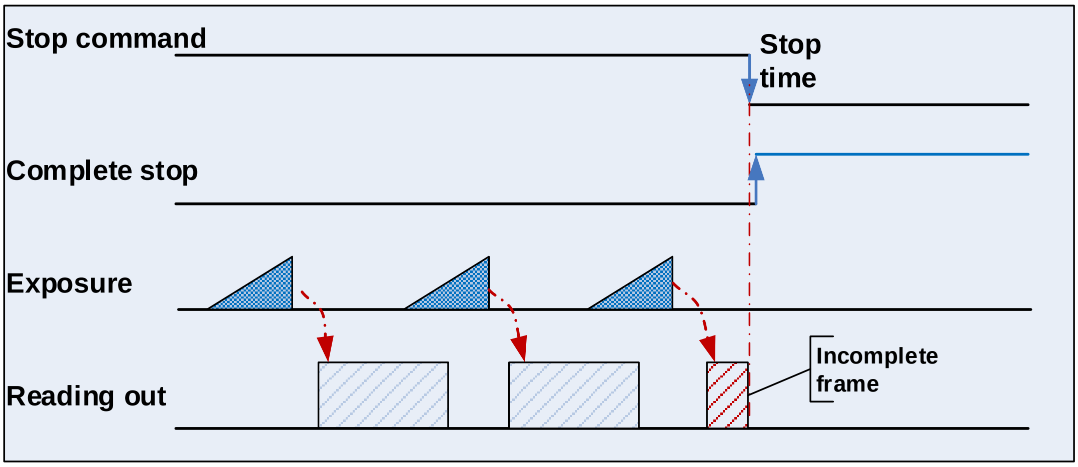

Figure 8-12 Acquisition stop during reading out

As shown in Figure 8-12, when the camera receives an acquisition stop 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**

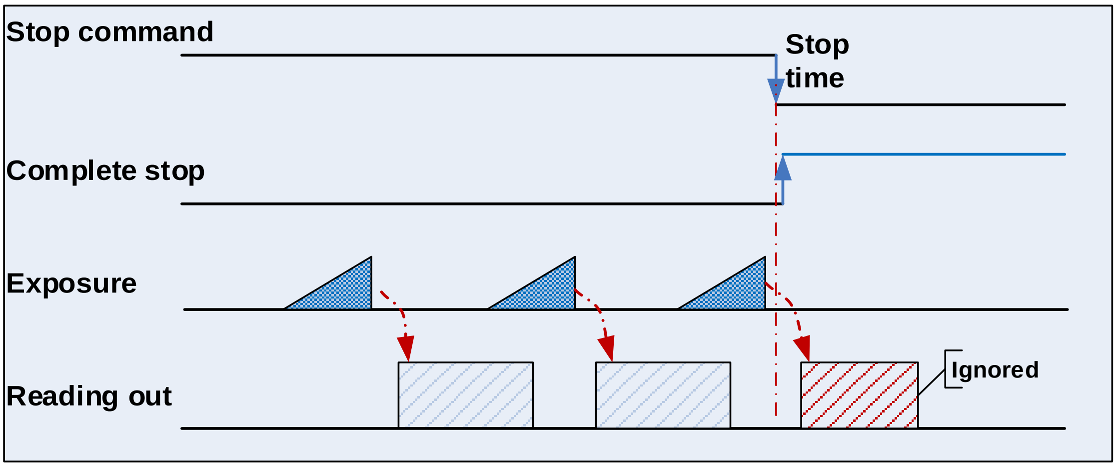

Figure 8-13 Acquisition stop during blanking

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-finished state. The camera will not send any frames even if it is just going to start the next exposing.

8.2.2. Acquisition Mode

Two camera acquisition modes are available: single frame acquisition mode and continuous acquisition mode.

- Single frame acquisition mode: In single frame acquisition mode, the camera will only acquire one frame of image at a time

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

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. When the camera receives the trigger signal and acquires an image, the camera will automatically stop image acquisition. If you want to acquire another frame of image, you must execute the **AcquisitionStart** command again.

2) When the trigger mode is set to Off

After executing the **AcquisitionStart** command, the camera acquires one frame of image and then automatically stops image acquisition. If you want to acquire another frame of image, you must execute the **AcquisitionStart** command again.

In single frame acquisition mode, you must execute the **AcquisitionStop** command to set the functions that cannot be set in the acquisition status, such as ROI, package size, etc.

- 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 On, the trigger type is **FrameBurstStart**

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 continuously acquire the set **AcquisitionFrameCount** frames of image. If the **AcquisitionStop** command is received during the acquisition process, the image being transmitted may be interrupted, resulting in the number of images acquired this time not reaching the **AcquisitionFrameCount** frames of image.

3) 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.

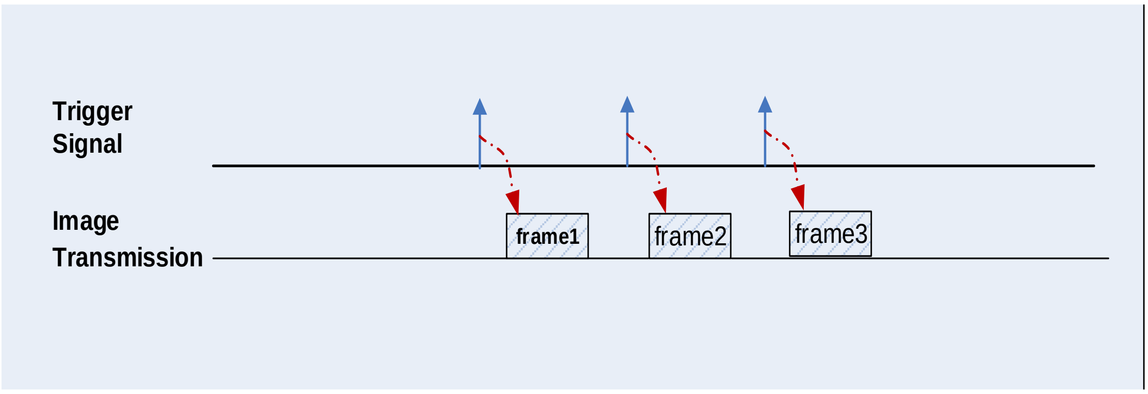

Figure 8-14 FrameStart trigger

- FrameBurstStart trigger mode

You can use the frame burst trigger 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.

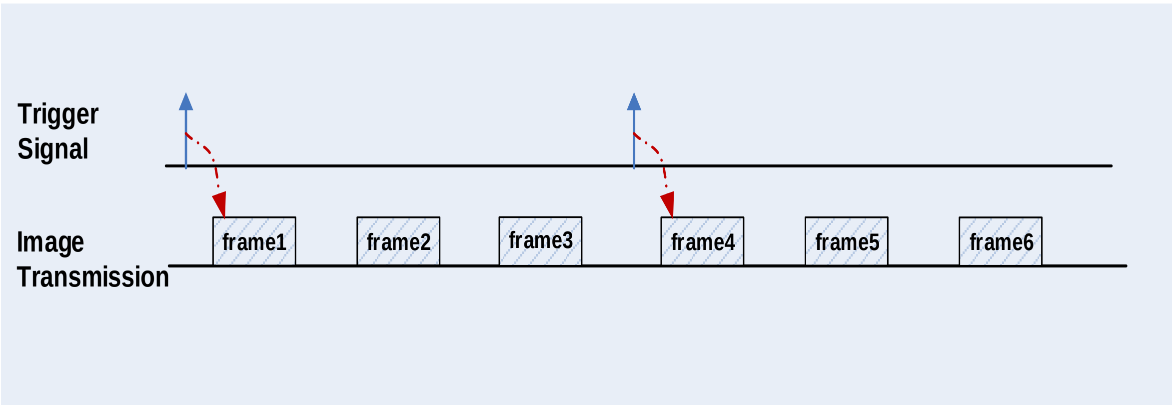

Figure 8-15 FrameBurstStart trigger

The switches of **FrameBurstStart** trigger and **FrameStart** trigger are mutually exclusive. When the **FrameBurstStart** trigger is set to ON, the **FrameStart** trigger is automatically set to OFF. When the **FrameStart** trigger is set to ON, the **FrameBurstStart** trigger is automatically set to OFF.

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**

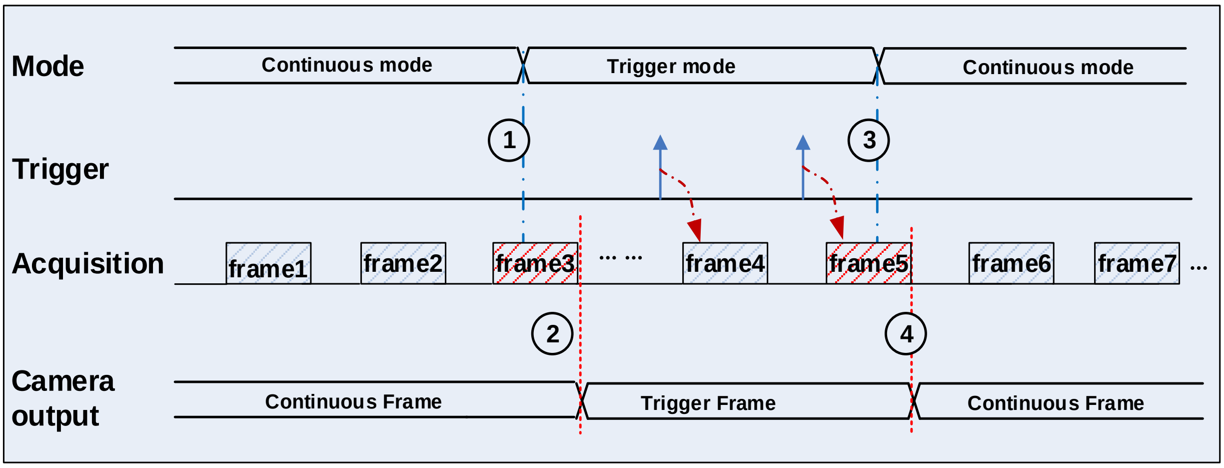

Figure 8-16 Switch trigger mode during frame reading out

As shown in Figure 8-16, 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 (or exposure)**

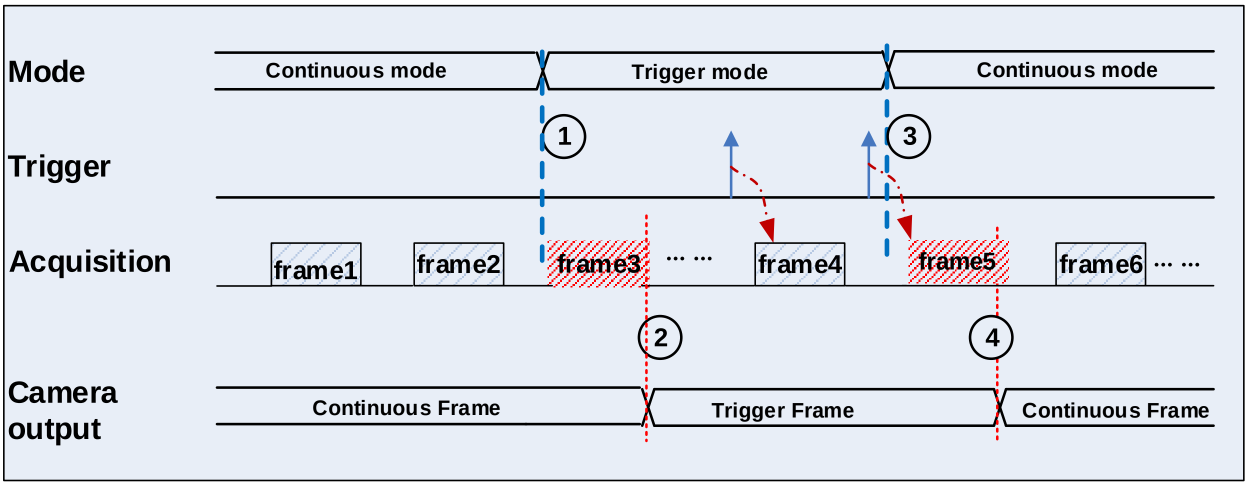

Figure 8-17 Switch trigger mode during blanking (or exposure)

As shown in Figure 8-17, 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 (including exposure and reading out), i.e., point 2. Please note that the 3rd frame does not belong to trigger mode. All trigger frames need trigger signals or soft-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 OFF** to use continuous mode.

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

- **Continuous mode features**

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

In continuous mode, ROI size, packet delay 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 TriggerSoftware command.

All the software trigger commands are sent by the host through the Gigabit Ethernet bus, to trigger the camera to capture and transmission 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. External Trigger Acquisition and Configuration

- **External trigger acquisition configuration**

The 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, Line2 or Line3.

3) Connect external trigger signal to Line0.

If the Trigger Source is set by Line2 or Line3, it should be ensured that the corresponding Line is set as Input.

Please refer to section 8.1.1 for more information of the programmable GPIO interfaces.

- **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 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 use 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.

8.2.8. Exposure Time Mode

According to the length of the exposure time, two exposure time modes of the MER2-G camera are available: Standard exposure time mode and UltraShort exposure time mode.

8.2.8.1. 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 8.2.9. For the automatic adjustment and continuous automatic adjustment, please refer to section 8.3.4.3.

8.2.8.2. UltraShort exposure time mode

In UltraShort exposure time mode, the MER2-G 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, as shown in Figure 8-18.

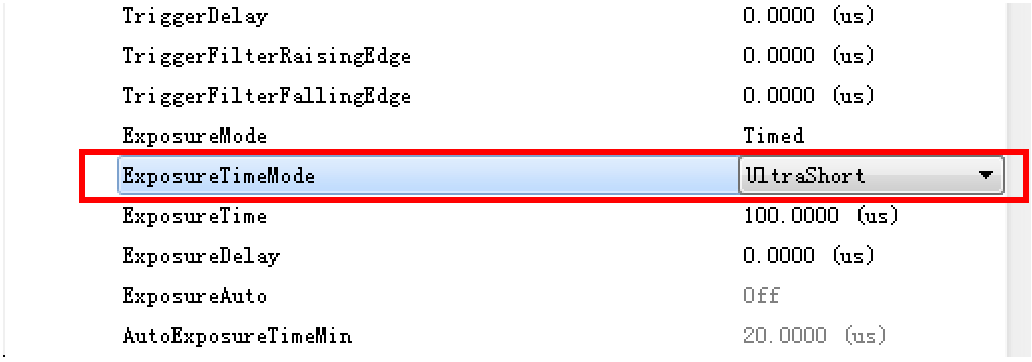

Figure 8-18 UltraShort exposure time mode

Camera model that support UltraShort exposure time mode:

Model
MER2-503-23GM/C
MER2-160-75GM/C
MER2-041-302GM/C

In UltraShort exposure time mode, the MER2-G camera does not support automatic adjustment of the exposure time, only support manual adjustment of the exposure time.

8.2.9. Set Exposure

- **Global Shutter**

The implementation process of global shutter is as shown in Figure 8-19, 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.

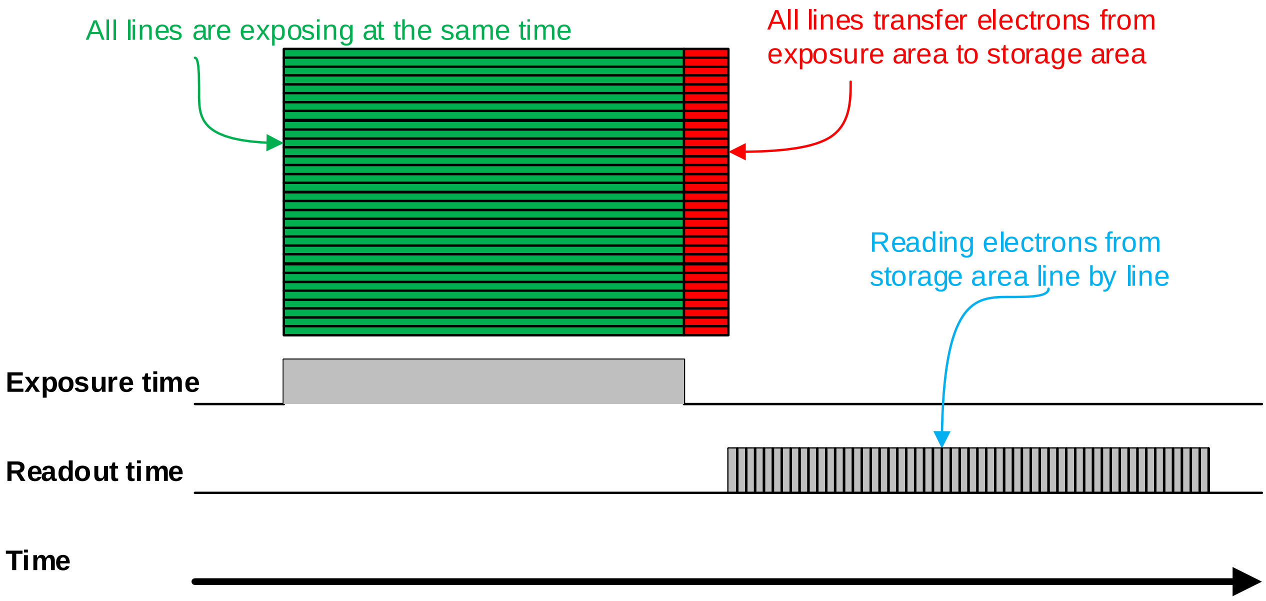

Figure 8-19 Global Shutter

- **Electronic Rolling Shutter**

The implementation process of electronic rolling shutter is as shown in Figure 8-20, 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.

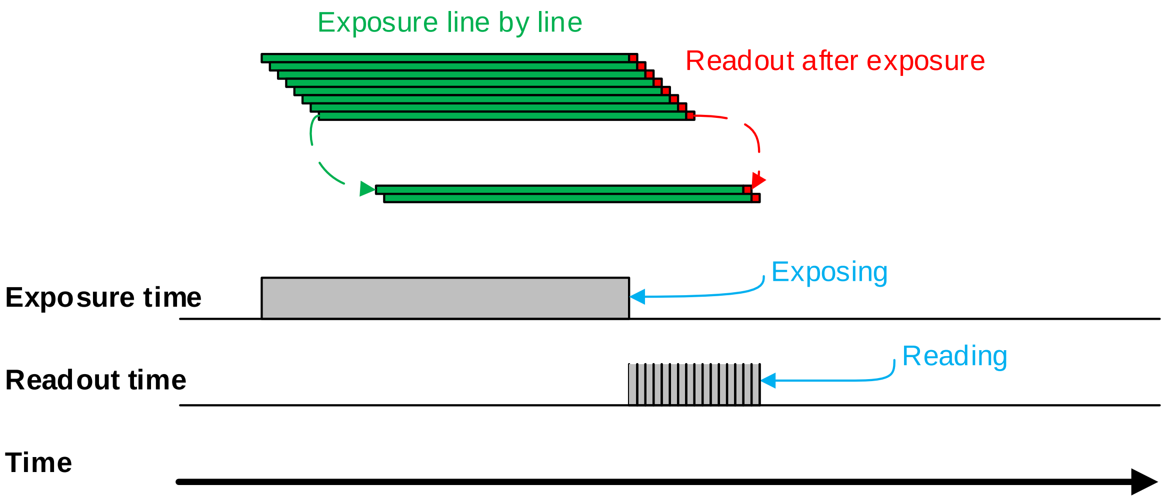

Figure 8-20 Electronic rolling shutter

- **Setting the exposure time**

The MER2-G series camera supports setting the exposure time in UltraShort exposure time mode. The exposure time is shown as follows:

Exposure Range (μs)	Steps (μs)	Actual Steps (μs)
1-100	1	1

Table 8-2 MER2-G series camera exposure time setting range in UltraShort exposure time mode

The MER2-G series camera supports setting the exposure time in Standard exposure time mode. The exposure time is shown as follows:

Model	Exposure Mode	Adjustment Range (μs)	Steps (μs)	Actual Steps
MER2-041-302GM/C	Global Shutter	20-1000000	1	1 row period
MER2-160-75GM/C	Global Shutter	20-1000000	1	1 row period
MER2-202-60GM/C	Global Shutter	14-860000	1	1 row period
MER2-231-41GM/C	Global Shutter	20-1000000	1	1 row period*
MER2-302-37GM/C	Global Shutter	20-1000000	1	1 row period
MER2-503-23GM/C	Global Shutter	20-1000000	1	1 row period
MER2-630-16GM/C	Global Shutter	19-1000000	1	1 row period
MER2-1220-9GM/C	Rolling Shutter	23-1000000	1	1 row period
ME2P-1230-9GM/C-P	Global Shutter	36-1000000	1	1 row period
MER2-2000-6GM/C	Rolling Shutter	31-1000000	1	1 row period

Table 8-3 MER2-G series camera exposure time setting range in Standard exposure time mode

*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 is 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 80us exposure time, 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.

The MER2-G 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.

8.2.10. Overlaping Exposure and Non-overlaping Exposure

There are two stages in image acquisition of the MER2-G 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 MER2-G series camera supports two exposure modes: overlaping exposure and non-overlaping exposure. The user cannot assign the overlaping exposure or non-overlaping exposure directly, it depends on the frequency of trigger signal and the exposure time. The two exposure mode are described as below.

- **Non-overlaping exposure**

In non-overlaping 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 8-21, the N^{th} frame is read out, after a period of time, the $N+1^{th}$ frame to be exposed.

The formula of non-overlaping exposure frame period:

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

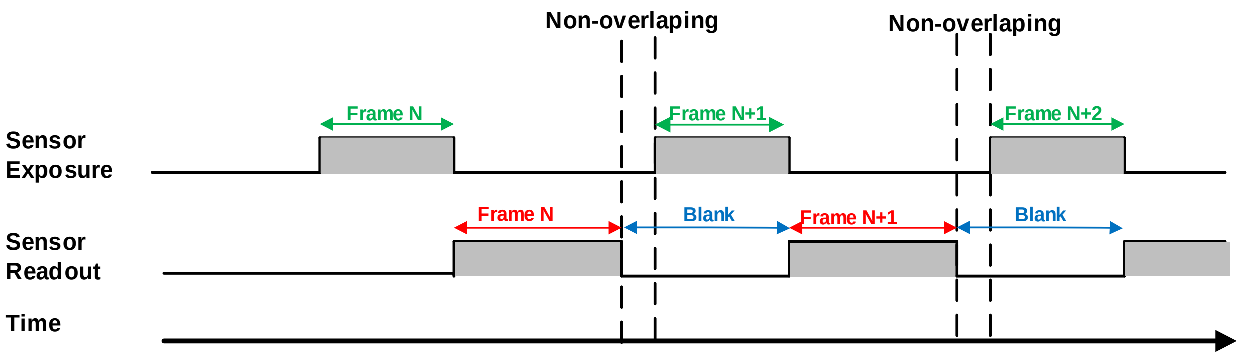

Figure 8-21 The exposure sequence diagram in non-overlaping exposure mode

- **Trigger acquisition mode**

If the interval between two triggers is greater than the sum of the exposure time and readout time, it will not occur overlaping exposure, as shown in Figure 8-22.

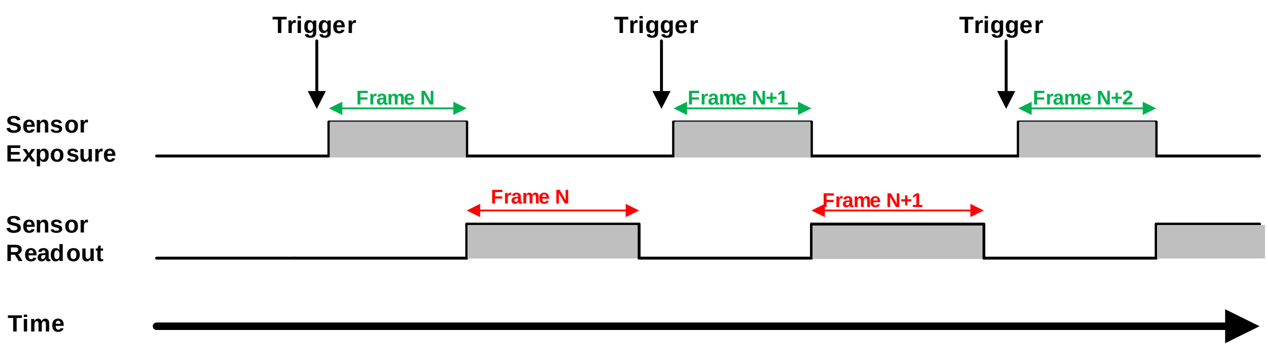

Figure 8-22 The trigger acquisition exposure sequence diagram in non-overlaping exposure mode

- **Overlaping exposure**

In overlaping exposure mode, the current frame image exposure process is overlaping 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 8-23, when the N^{th} frame image is reading out, the $N+1^{th}$ frame image has been started exposure.

The formula of overlaping exposure frame period:

overlaping exposure frame period ≤ exposure time + readout time

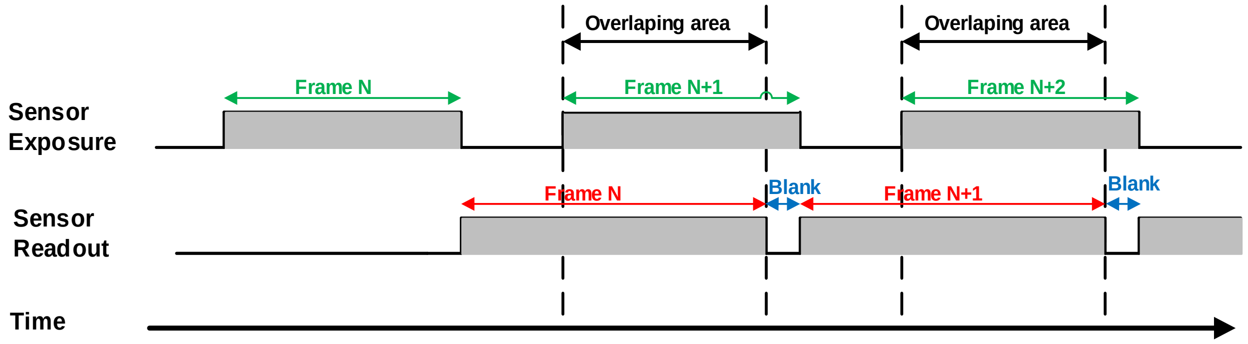

Figure 8-23 The exposure sequence diagram in overlaping exposure mode

- **Trigger_mode OFF**

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 8-23.

- **Trigger_mode ON**

When the interval between two triggers is less than the sum of exposure time and the readout time, it will occur overlaping exposure, as shown in Figure 8-24.

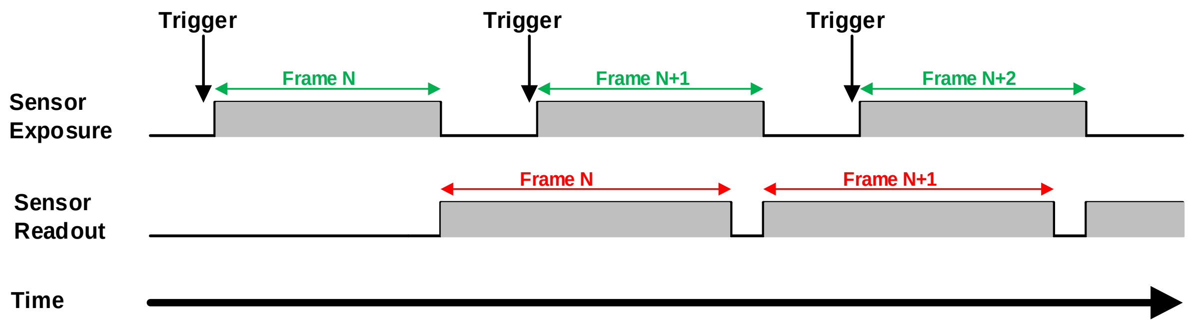

Figure 8-24 The trigger acquisition exposure sequence diagram in overlaping exposure mode

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

8.2.11. Exposure Delay

The exposure delay function can effectively solve the strobe delay problem. Most strobes have a delay of at least tens of microseconds from trigger to light. When the camera is working in a small exposure mode, the fill light effect of the strobe will be affected. The exposure delay is achieved by the strobe signal and the delay of the actual exposure starting.

The unit of exposure delay is us, the range is 0 ~ 5000us, and the minimum value is 0.

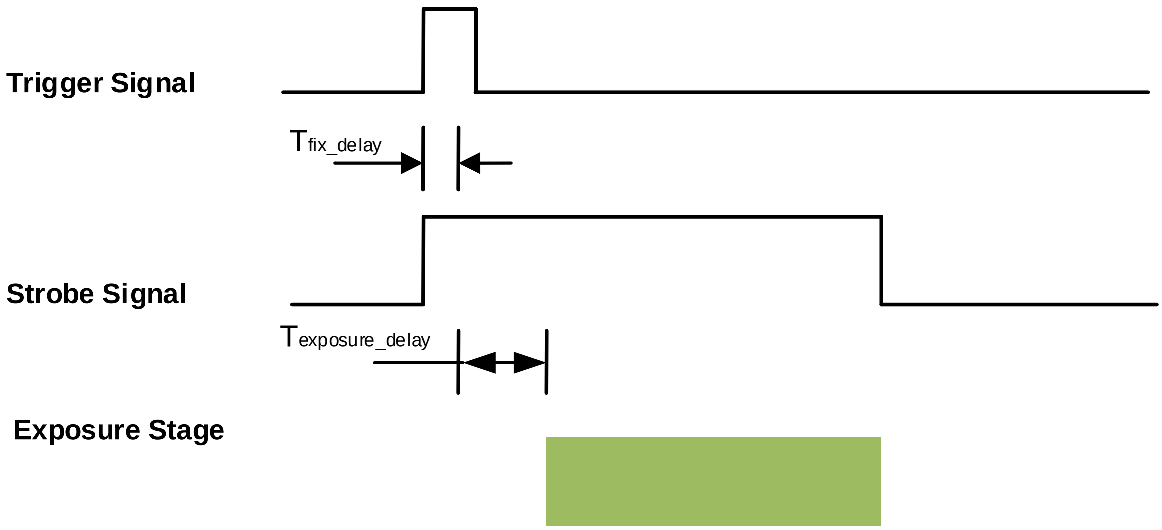

Figure 8-25 The exposure delay sequence diagram in overlaping exposure mode

8.3. Basic Features

8.3.1. Gain

The MER2-G series camera can adjust the analog gain, and the range of analog gain is as follows:

Model	Adjustment Range	Default/Steps
MER2-041-302GM/C	0-24dB	0dB, 0.1dB
MER2-160-75GM/C	0-24dB	0dB, 0.1dB
MER2-202-60GM/C	0-24dB	0dB, 0.1dB
MER2-231-41GM/C	0-24dB	0dB, 0.1dB
MER2-302-37GM/C	0-24dB	0dB, 0.1dB
MER2-503-23GM/C	0-24dB	0dB, 0.1dB
MER2-630-16GM/C	0-24dB	0dB, 0.1dB
MER2-1220-9GM/C	0-24dB	0dB, 0.1dB

ME2P-1230-9GM/C-P	0-23.9dB	0dB, 0.1dB
MER2-2000-6GM/C	0-24dB	0dB, 0.1dB

Table 8-4 MER2-G series camera analog gain adjustment range

When the analog gain changes, the response curve of the camera changes, as shown in Figure 8-26. 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. When the environment brightness and exposure time keep constant, another way to increase the image brightness is to change the camera's digital gain by modifying the lookup table.

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

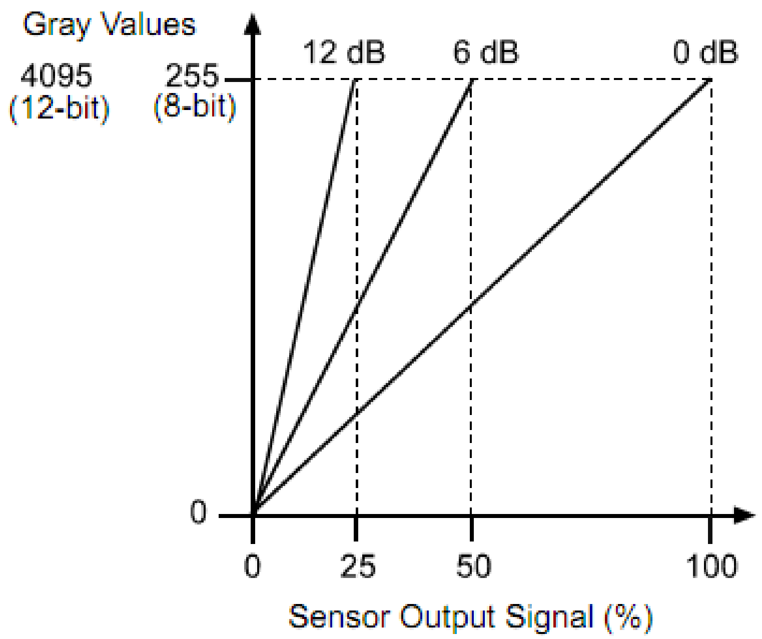

Figure 8-26 The cameras response curve

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
MER2-041-302GM/C	Mono8, Mono12, BayerRG8, BayerRG12
MER2-160-75GM/C	Mono8, Mono12, BayerRG8, BayerRG12

MER2-202-60GM/C	Mono8, Mono10, BayerBG8, BayerBG10
MER2-231-41GM/C	Mono8, Mono10, BayerRG8, BayerRG10
MER2-302-37GM/C	Mono8, Mono10, BayerRG8, BayerRG10
MER2-503-23GM/C	Mono8, Mono10, BayerRG8, BayerRG10
MER2-630-16GM/C	Mono8, Mono12, BayerRG8, BayerRG12
MER2-1220-9GM/C	Mono8, Mono12, BayerRG8, BayerRG12
ME2P-1230-9GM/C-P	Mono8, Mono12, BayerRG8, BayerRG12
MER2-2000-6GM/C	Mono8, Mono12, BayerRG8, BayerRG12

Table 8-5 Pixel format that the MER2-G 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

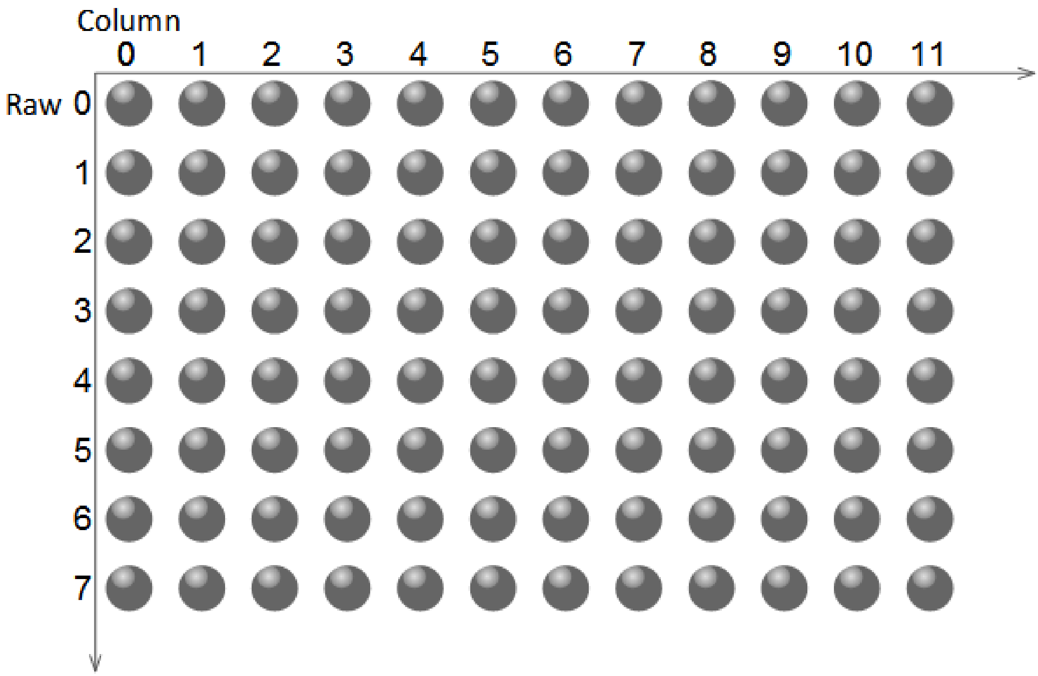

Figure 8-27 Mono8 pixel format

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**

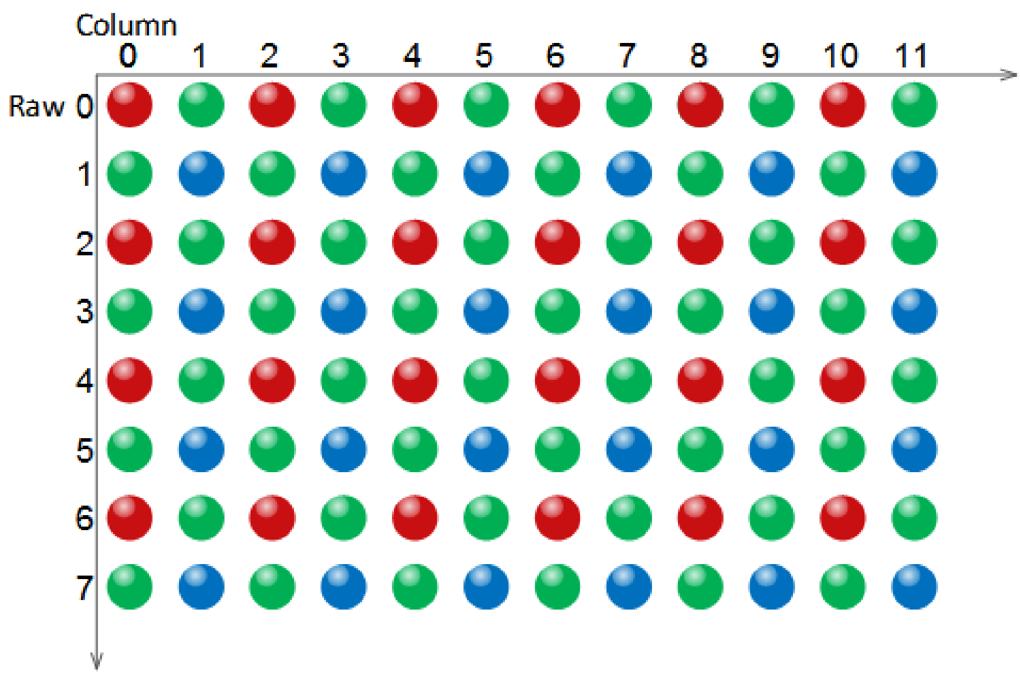

Figure 8-28 BayerRG8 pixel format

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.

The coordinates of the ROI of the image are defined the 0^{th} line and 0^{th} columns 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.

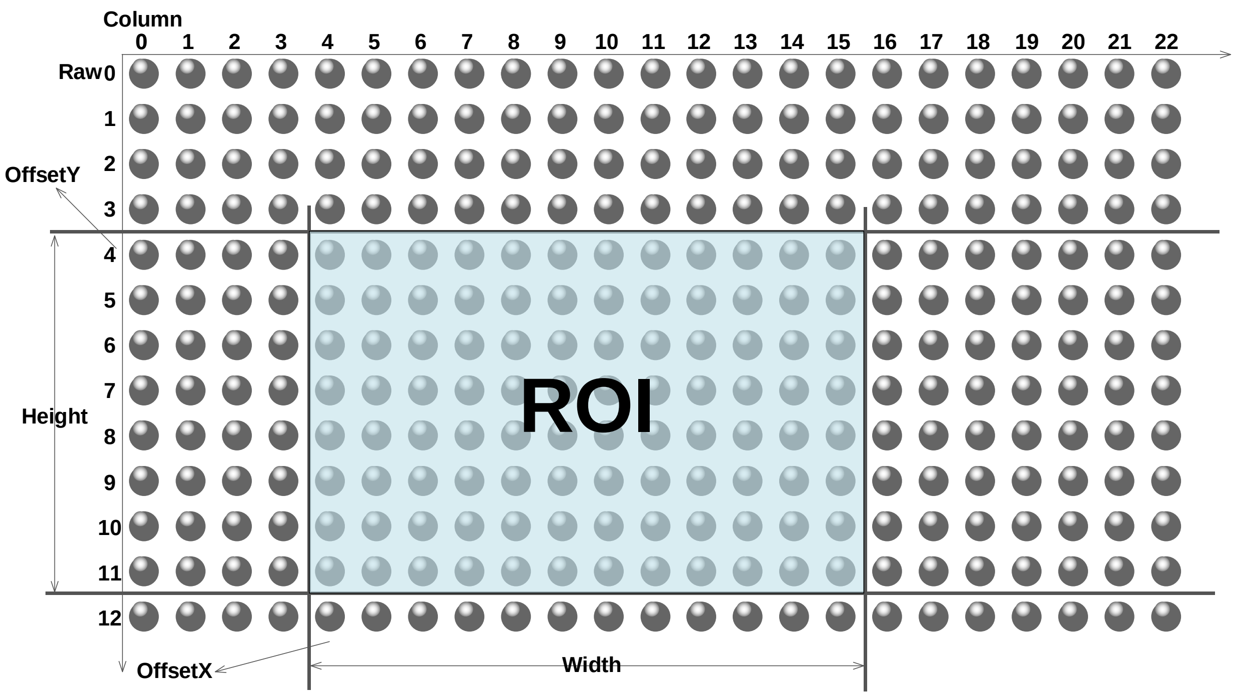

Figure 8-29 Mono8

When reducing the height of the ROI, the maximum frame rate of the camera will be raised. Please refer to section 8.5.1 for specific effects on the acquisition frame rate.

8.3.4. Auto Exposure / Auto Gain

8.3.4.1. 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:

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

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

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 8-30.

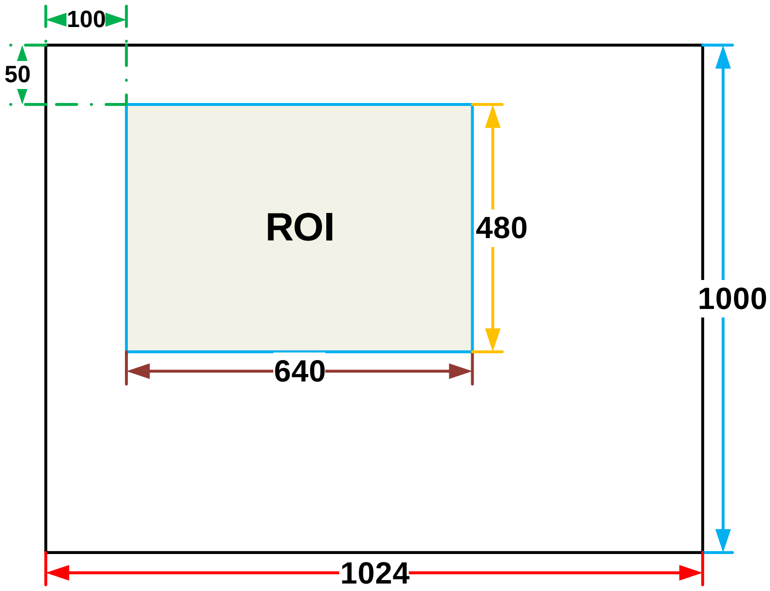

Figure 8-30 An example for the relative position between the ROI and the current image

8.3.4.2. 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.

8.3.4.3. 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 continuously adjusting the exposure time according to the data of the AAROI, so that the data in the ROI 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. Auto White Balance ROI

Auto White Balance feature use the image data from AWBROI to calculate the white balance ratio, and then 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 length of X axis direction offset and width is 4, the step length of Y axis direction offset and height is 2. The ROI setting depends on the current image 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:

$$\mathrm{AWBROIWidth} + \mathrm{AWBROIOffsetX} \leq \mathrm{Width}$$

$$\mathrm{AWBROIHeight} + \mathrm{AWBROIOffsetY} \leq \mathrm{Height}$$

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:

$$\text{AWBROIOffsetX} = 100$$

$$\text{AWBROIOffsetY} = 50$$

$$\text{AWBROIWidth} = 640$$

$$\text{AWBROIHeight} = 480$$

The relative position of the ROI and the image is shown in Figure 8-31.

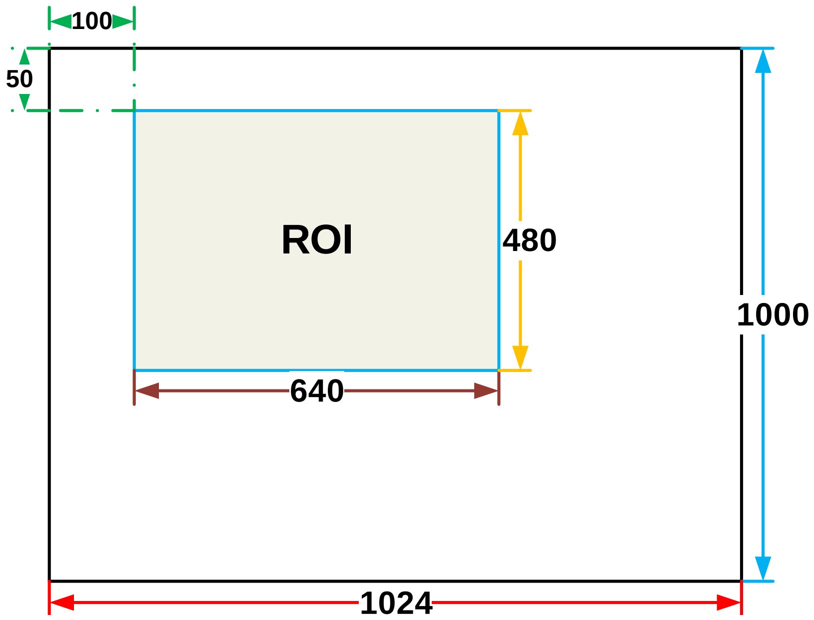

Figure 8-31 An example for the relative position between the ROI and the current image

8.3.5.2. Auto White Balance Adjustment

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 only 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.

The auto white balance feature is only available on color sensors.

8.3.6. Test Pattern

The MER2-G series camera supports three test images: gray gradient test image, static diagonal gray gradient test image, and moving diagonal gray gradient test image. When the camera captures in RAW12 mode, the gray value of test image is: the pixel gray value in RAW8 mode multiplies by 16, as the output of pixel gray value in RAW12 mode.

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

- **GrayFrameRampMoving**

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 8-32:

Figure 8-32 Gray gradient test image

- **SlantLineMoving**

In the moving diagonal gray gradient test image, 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 8-33:

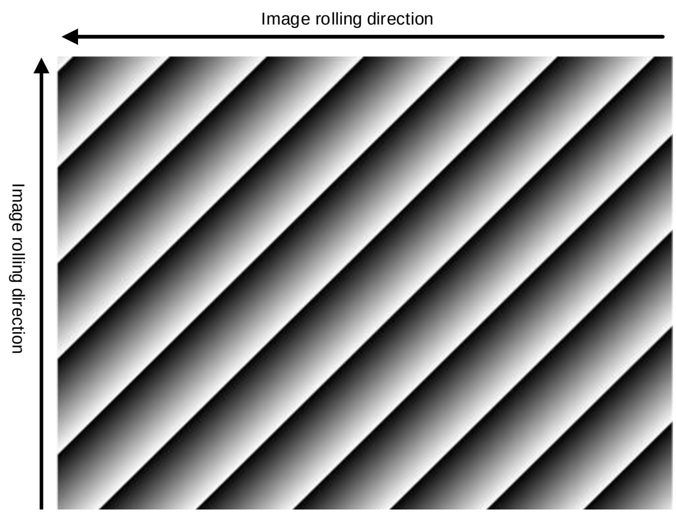

Figure 8-33 Moving diagonal gray gradient test image

- **SlantLine**

In the static diagonal gray gradient test image, 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 image, in the adjacent image of the static diagonal gray gradient test image, the gray value in the same position remains unchanged. A printscreen of the static diagonal gray gradient test image is shown in Figure 8-34.

Figure 8-34 Static diagonal gray gradient test image

8.3.7. 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 MER2-G 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. Three types of configuration parameters are available: 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.

1) 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 manufacturer's default configuration parameters are the camera configuration parameters optimized by the manufacture 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 MER2-G series camera can store a set of user configuration parameters.

2) 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
- TransferControlMode
- PixelFormat
- OffsetX, OffsetY, ImageWidth, ImageHeight
- GevSCPSPacketSize, GevSCPD
- EventNotification
- TriggerMode, TriggerSource, TriggerPolarity, TriggerDelay
- TriggerFilterRaisingEdge, TriggerFilterFallingEdge
- LineMode, LineInverter, LineSource, UserOutputValue
- FrameBufferOverwriteActive
- ChunkModeActive
- TestPattern
- ExpectedGrayValue
- ExposureAuto, AutoExposureTimeMax, AutoExposureTimeMin
- GainAuto, AutoGainMax, AutoGainMin
- AAROIOffsetX, AAROIOffsetY, AAROIWidth, AAROIHeight
- BalanceWhiteAuto, AWBLampHouse
- AWBROIOffsetX, AWBROIOffsetY, AWBROIWidth, AWBROIHeight
- BalanceRatio(R/G/B)
- LUT, Gamma, Color Correction
- Binning, Decimation
- AcquisitionMode
- Reverse X and Reverse Y
- Sharpness
- ExposureDelay

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 User Set 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.

8.3.8. Device User ID

The MER2-G 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 **IP Configurator**, for details please see section 9.1.2.5:

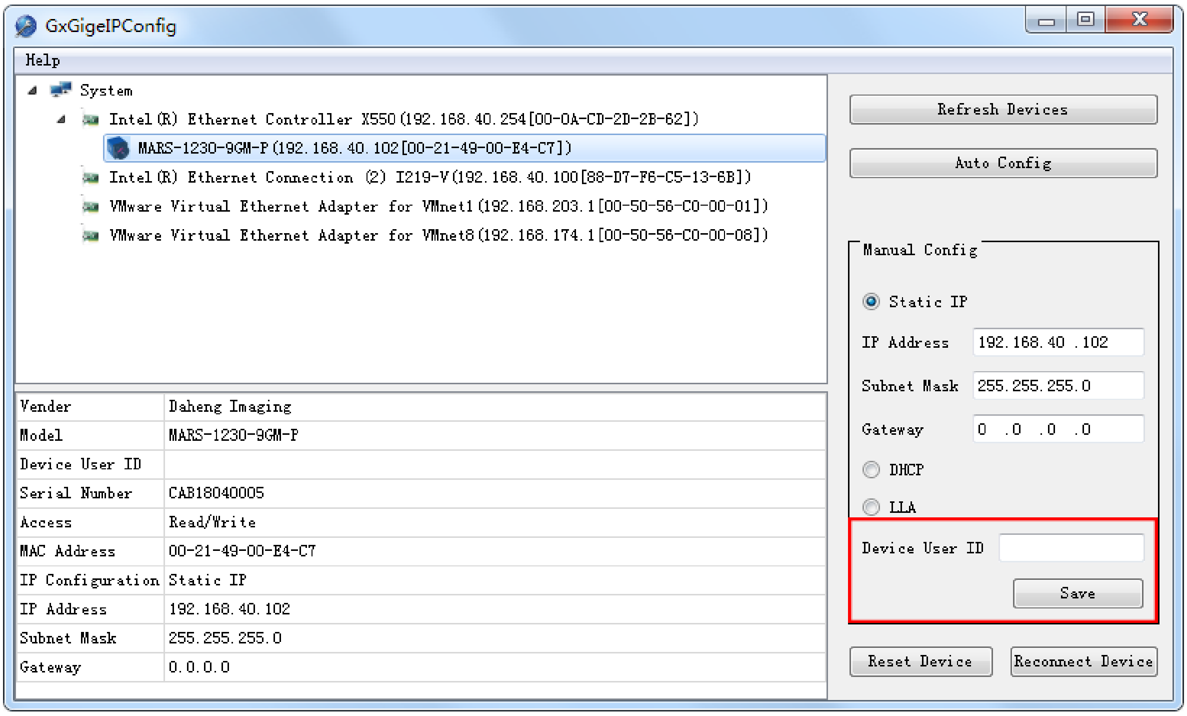

Figure 8-35 IP Configurator

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.

8.3.9. 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, and timestamps can be used to test the time spent on some of the camera's operations.

Timestamp clock frequency: The frequency of timestamp counter is obtained by reading the camera's "timestamp tick frequency". The unit is 8ns.

Timestamp latch: Latch the current timestamp value. The timestamp value needs to be read through the "timestamp latch value".

Timestamp reset: Reset the timestamp counter and recount from 0.

Timestamp latch reset: First latch the current timestamp value and then reset the timestamp counter.

Timestamp latched value: Save the value of the latched timestamp, and the specific time can be calculated based on the timestamp clock frequency.

8.3.10. 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:

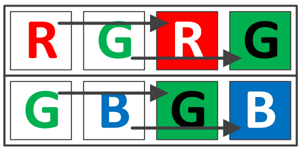

Figure 8-36 Horizontal color Binning by 2

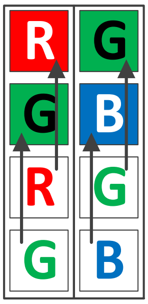

Figure 8-37 Vertical color Binning by 2

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 8-38 Horizontal and vertical color Binning by 2×2

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

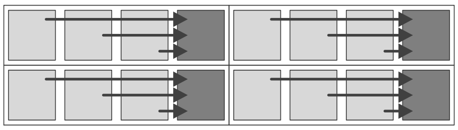

Figure 8-39 Horizontal mono Binning by 4

- **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.

8.3.11. 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 transferred 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.

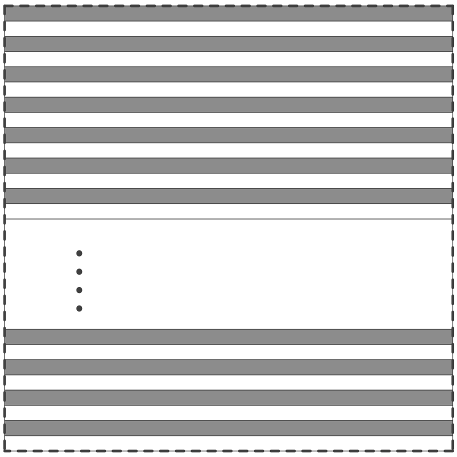

Figure 8-40 Mono camera vertical Decimation

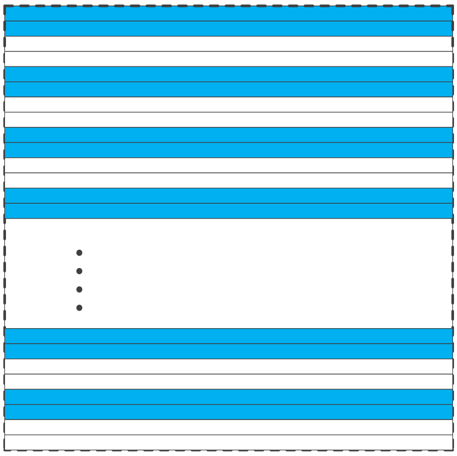

Figure 8-41 Color camera vertical Decimation

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.

- **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.

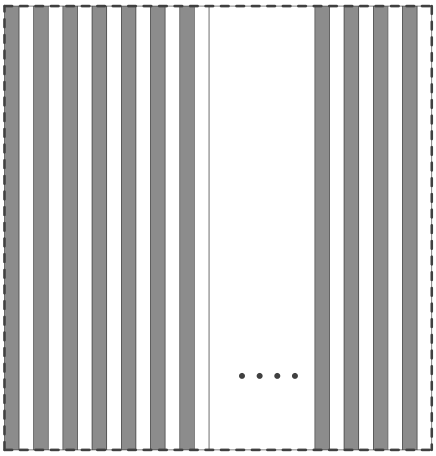

Figure 8-42 Mono camera horizontal Decimation

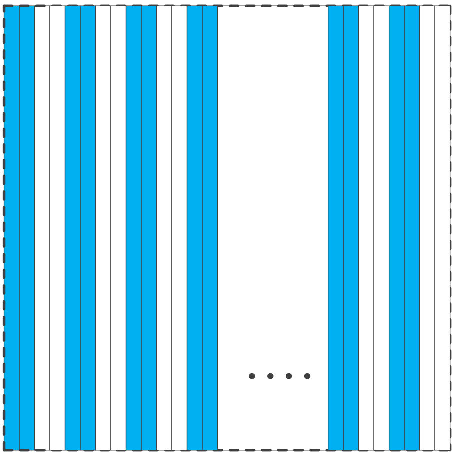

Figure 8-43 Color camera horizontal Decimation

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 MER2-231-41GM as an example, the camera's default resolution is 1920×1200. When horizontal Decimation by 2 and vertical Decimation by 2 are enabled, the maximum ROI width would be 960 and the maximum ROI height would be 600.

2) Reduced resolution

Using Decimation effectively reduces the resolution of the camera's imaging sensor. Taking MER2-231-41GM as an example, the camera's default resolution is 1920×1200. When horizontal Decimation by 2 and vertical Decimation by 2 are enabled, the effective resolution of the sensor is reduced to 960×600.

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.

8.3.12. 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.

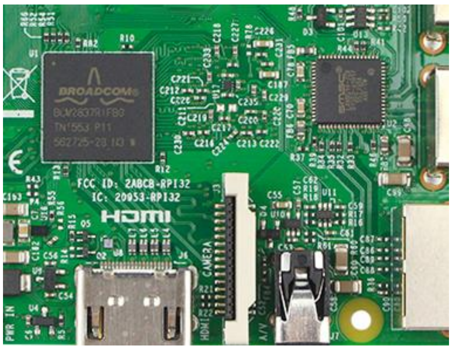

Figure 8-44 The original image

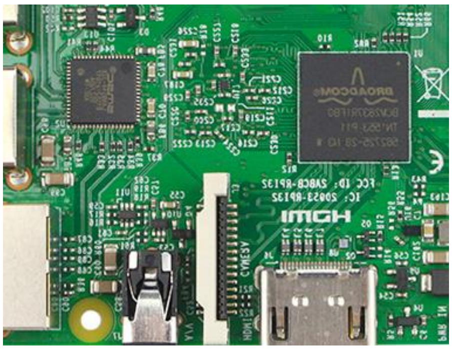

Figure 8-45 Reverse X enabled

- **Enabling Reverse Y**

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

Figure 8-46 The original image

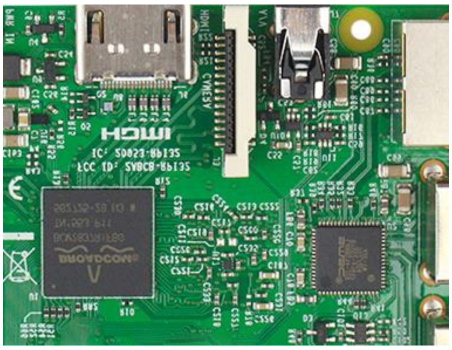

Figure 8-47 Reverse Y enabled

- **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.

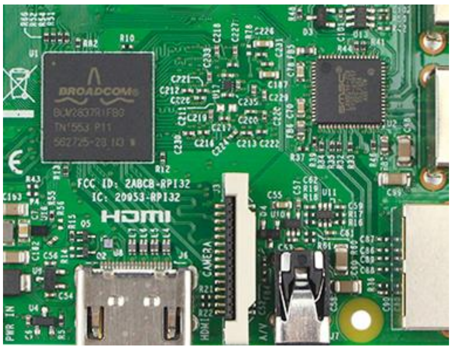

Figure 8-48 The original image

Figure 8-49 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 8-50 The original image

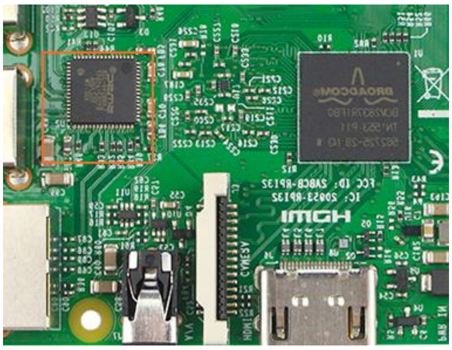

Figure 8-51 Reverse X enabled

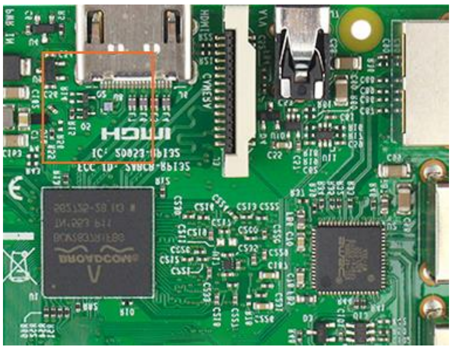

Figure 8-52 Reverse Y enabled

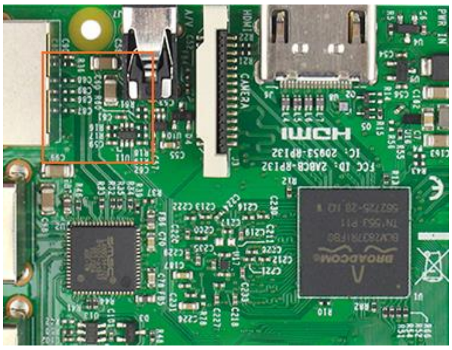

Figure 8-53 Reverse X and Y enabled

- **Pixel Format Alignment**

The alignment of the Bayer format does not change when the camera is using the reverse feature.

8.3.13. 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

	MSB											LSB	
	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	
Binary	0	0	0	0	0	0	0	1	0	1	1	0	Raw pixel value: 22

	MSB											LSB	
	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	
Binary	0	0	0	0	0	0	1	0	1	1	0	0	Shift pixel value: 44

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.

	MSB											LSB	
	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	
Binary	0	0	1	0	1	1	0	1	0	1	1	0	Raw pixel value(8bit): 45 Raw pixel value(12bit): 726

	MSB											LSB	
	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	
Binary	1	0	1	1	0	1	0	1	-	-	-	-	Shift pixel value(8bit): 181

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

	MSB											LSB	
	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	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.

8.3.14. 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.

8.3.15. 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
MER2-041-302GM/C	0-255	15
MER2-160-75GM/C	0-255	15
MER2-302-37GM/C	0-4084	15
MER2-503-23GM/C	0-511	15
MER2-1220-9GM/C	0-255	4
MER2-2000-6GM/C	0-255	4

Table 8-6 MERCURY2 GigE series camera black level adjustment range

8.3.16. 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 8-7.

Model	Features	Set the switch to off	Set the switch to on
MER2-041-302GM/C	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 factor	0~15.998	0~31.998
	Auto White Balance	1~15.998	1~31.998
MER2-160-75GM/C	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 factor	0~15.998	0~31.998
	Auto White Balance	1~15.998	1~31.998
MER2-302-37GM/C	Exposure	20~1000000	20~15000000
	Auto Exposure	20~1000000	20~15000000
	Gain	0~24	0~48
	Auto Gain	0~24	0~48

	Black Level	0-4084	0-4084
	White Balance component factor	0~15.998	0~31.998
	Auto White Balance	1~15.998	1~31.998
MER2-503-23GM/C	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 factor	0~15.998	0~31.998
	Auto White Balance	1~15.998	1~31.998
MER2-1220-9GM/C	Exposure	31~1000000	31~15000000
	Auto Exposure	31~1000000	31~15000000
	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 factor	0~15.998	0~31.998
	Auto White Balance	1~15.998	1~31.998
MER2-2000-6GM/C	Exposure	31~1000000	31c~15000000
	Auto Exposure	31~1000000	31~15000000
	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 factor	0~15.998	0~31.998
	Auto White Balance	1~15.998	1~31.998

Table 8-7 Parameter range of features supported before and after Remove Parameter Limits

8.3.17. 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.

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 8-54 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 8-55 Before color transformation

Figure 8-56 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 ® 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

To enable Gamma correction, use the **GammaValue** parameter. The **GammaValue** parameter's range 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 pixel format, 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: Enables or disables 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.

8.4.3. 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.

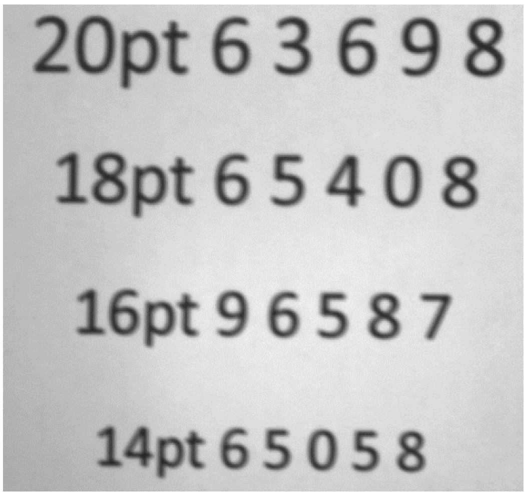

Figure 8-57 Before sharpness adjustment

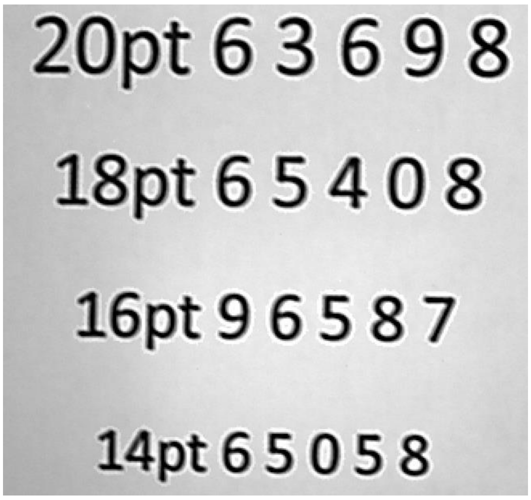

Figure 8-58 After sharpness adjustment

- Sharpness adjustment

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

8.4.4. 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 completely black pixels in your images to completely 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 tables do 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.

8.5. Image Transmission

8.5.1. Maximum Allowable Frame Rate

1) The maximum allowable frame rate of the network

The maximum allowable frame rate of the network is the camera's maximum transmission frame rate that the current network supports. The maximum frame rate that the MER2-G series camera network supports is determined by the camera's resolution, pixel format (Pixel Size), and the valid network bandwidth. It is can be expressed by the formula:

The maximum allowable frame rate of the network = the valid network bandwidth/ resolution/ Pixel Size

Example 1: The camera resolution is 1628*1236, the pixel format is BayerRG8, packet size is 1500 bytes, packet delay is 1000. The current valid network bandwidth is 468Mbps.

The maximum allowable frame rate of the network =468Mbps / (1628*1236)/8 = 29 fps

The maximum allowable frame rate of the network is 29fps, and the camera meets the front-end sensor's maximum acquisition frame rate of 29fps. In addition to the limitations of network bandwidth, the maximum working frame rate of the camera is affected by the following two factors:

- Usually, the camera front-end sensor readout time and the camera internal transfer time is called the camera acquisition time. The camera acquisition time is affected by the ROI which is set by the user

- The camera's exposure time

2) The calculation of the camera's acquisition time

The camera's acquisition time is related to the OffsetY and the height of the ROI. When the OffsetY and height of the ROI is changed, it will affect the front-end acquisition frame period of the camera, then affect the acquisition frame rate.

3) The camera's acquisition frame rate

In addition to the maximum allowable bandwidth of the network and the time limit for camera acquisition, the exposure time can also affect the frame rate. For example: when the exposure time is 100ms, the corresponding frame rate is 10fps.

In conclusion, the frame rate of the camera takes the minimum of the maximum allowable frame rate of the network, the acquisition frame rate and the exposure frame rate.

8.5.2. Stream Channel Packet Size

Stream channel packet size (SCPS) refers to the network packet's size of the stream channel data which is transferred to the host terminal by the camera, in bytes and the default value is 1500. It includes the IP header, UDP header and GVSP header which the total length is 36 bytes, so the payload in the default channel network packet is 1464 bytes. The recommended maximum packet size is 8192 bytes, which can improve the network transmission performance.

1) When the packet size is set to more than 1500, it needs the network equipment such as network card and switch to support the jumbo frames.
2) When changing the packet size, the packet size and the packet delay will affect the network transfer performance together.

8.5.3. Stream Channel Packet Delay

The stream channel packet delay (SCPD) is used to control the bandwidth of the image streaming data of the camera. The packet delay is the number of the idle clocks that inserted between adjacent network packets transmitted in the stream channel. Increase the packet delay can reduce the camera's bandwidth usage, and it may also reduce the camera's frame rate (the camera frame rate also depends on the exposure time, camera acquisition time).

The camera's packet size, packet delay and reserved bandwidth determine the effective network bandwidth. The effective network bandwidth is calculated as follows:

The time required to transmit a single stream packet:

$$\mathrm{T}_{data} = \left(Size_{pkt} \times 8bits\right)/Speed_{link}$$

The time of packet delay is:

$$T_{delay} = Delay_{pkt}/125{,}000{,}000$$

Among them: the $Size_{pkt}$ is packet size, $Delay_{pkt}$ is packet delay, $\mathrm{BandW}_{reserve}$ is reserved bandwidth, $Speed_{link}$ is link speed.

Effective network bandwidth:

$$\mathrm{Band}W_{avial} = (Size_{pkt} \times 8bits \times (1 - \mathrm{Band}W_{reserve})/(T_{data} + T_{delay})$$

Example 1: The packet size is 1500, the packet delay is 1000, the reserved bandwidth is 20%, and the link speed is 1Gbps.

The time to transport a single stream packet is:

$$T_{data} = (1500 \times 8)/1000{,}000{,}000 = 12us$$

The time of packet delay is:

$$T_{delay} = 1000/125{,}000{,}000 = 8us$$

The effective network bandwidth is:

$$\mathrm{Band}W_{avial} = (1464 \times 8 \times (1 - 0.2))/(12us + 8us) = 468Mbps$$

Note: Each stream packet contains 36 bytes of network header data, and a packet with the size of 1500 bytes contains only 1464 bytes of valid data.

Example 2: The packet size is 8192, the packet delay is 2000, the reserved bandwidth is 20%, and the link speed is 1Gbps.

The time to transport a single stream packet is:

$$T_{data} = (8192 \times 8)/1000{,}000{,}000 = 66us$$

The time of packet delay is:

$$T_{delay} = 2000/125{,}000{,}000 = 16us$$

The effective network bandwidth is:

$$\mathrm{Band}W_{avial} = (8156 \times 8 \times (1 - 0.2))/(66us + 16us) = 637Mbps$$

8.5.4. Bandwidth Reserve

The Bandwidth Reserve is used to reserve a part of bandwidth for packet retransmission and control data transfer between the camera and the host, and can be used for multiple cameras transmission, to limit the bandwidth allocation of each camera. For example, the network bandwidth is 1Gbps, setting the reserved bandwidth value to 20%, then the bandwidth will be reserved to 0.2Gbps. When the maximum bandwidth required for transmission is greater than the current bandwidth available, the camera reduces the frame rate to ensure the stability of the transmission.

8.5.5. Frame Transfer Control

When multiple cameras are connected to the host by switches, if trigger these cameras to acquire images at the same time, when transmitting the images, because of the instantaneous bandwidth of the switch is too large, and the storage capacity is limited, data loss will occur. Therefore, the user needs to use frame transfer delay to avoid this problem.

In trigger mode, by setting the Transfer Control Mode as “User Controlled”, when the camera receives software trigger command or external trigger signal and completes the image acquisition, the camera will save the images in the frame buffer which is internal the camera, waiting for the host to send the “Acquisition Start” command, the camera will transmit the images to the host. The transmission delay time is determined by the host. When multiple cameras are triggered simultaneously, different transmission delay can be set for each camera to avoid the instantaneous bandwidth of the switch is too large.

The Frame Transfer Control function is valid only in trigger mode.

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 MER2-G series 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 event queue is overflow (EventOverrun)

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 firstly and set the port of the event channel, the timeout of the event retransmission, and the number of times the event retransmission to the camera. When the retransmission timeout of the event is set to 0, the event sent by the camera will not require the host to return the reply packet. When the port value of the event channel is set to 0, the camera will not send the event to the host. In other cases, the camera needs to receive a host reply packet before sending the next event. When the event that the camera sends does not receive the reply packet, the camera will retransmit the event according to the retransmission timeout and retransmission times.

The effective information contained in each event is shown in Table 8-8:

No.	Event Type	Information
1	ExposureEnd Event	Event ID
		Frame ID
		Timestamp
2	BlockDiscard Event	Event ID
		Timestamp
3	EventOverrun Event	Event ID
		Timestamp
4	FrameStartOvertrigger Event	Event ID

		Frame ID
		Timestamp
5	BlockNotEmpty Event	Event ID
		Timestamp
6	FrameBurstStartOvertrigger Event	Event ID
		Frame ID
		Timestamp
7	FrameStartWait Event	Event ID
		Timestamp
8	FrameBurstStartWait Event	Event ID
		Timestamp

Table 8-8 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 64bits, and the unit is 8ns.

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 once 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 read-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 external 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 sends only one FrameStartOvertrigger event.

8.6.5. EventOverrun Event

Inside the camera, there has an event queue which is used for caching events. Usually, the event data packet which is sent to the host only contains one event. When there are multiple events occur simultaneously, or when the event transmission is delay, the user can use event queue inside the camera to cache the events. When an event can be sent, the camera will send all the events cached in the queue, at this time the event data packet which is sent to the host contains multiple events. But if the camera is running in a high frame rate mode, and send several events that exceed the camera cache, at this time, if the EventOverrun event is enable, the camera will send an EventOverrun event to the host, and discard all the events in the current cache.

8.6.6. FrameBurstStartOvertrigger Event

When the camera is in FrameBurstStart trigger mode, when it receives an AcquisitionTrigger external 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.

8.6.7. 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.

8.6.8. 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.

9. Software Tools

9.1. GigE IP Configurator

GxGigeIPConfig.exe is a matching tool of DAHENG IMAGING's MER2-G digital camera series software. Users can use this tool to implement the following functions.

1) This tool can enumerate all GigE Vision cameras attached to your network.

2) This tool can be used to change the IP address and the IP configuration.

3) This tool can be used to change the User ID of device.

4) This tool can reset device and reconnect device.

   a) Reset device: The effect is the same as powering Off-On. The program inside the device is reloaded.

   b) Reconnect device: The effect is the same as closing device using SDK. After this operation, the user can reconnect the device.

9.1.1. GUI

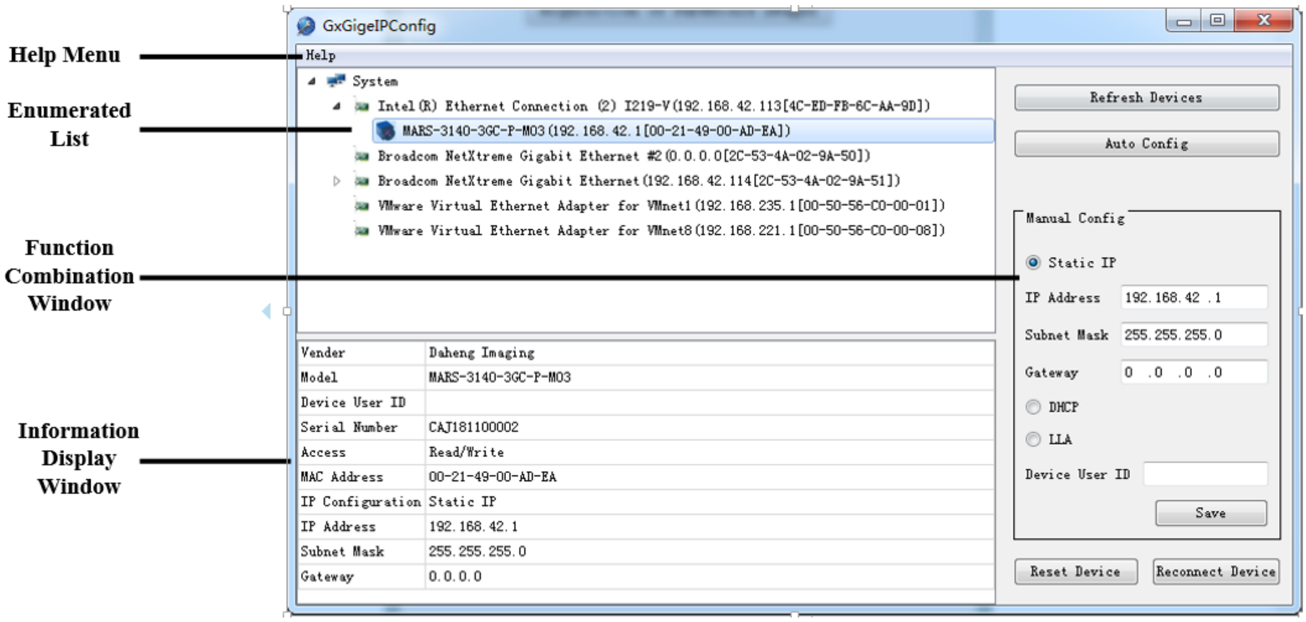

Figure 9-1 GUI

When you start up the GigE IP Configurator, the program will enumerate the GigE cameras connected to the current PC, and display the camera-related information on the GUI in the form of a tree list, as shown in Figure 9-1. The GUI layout and function descriptions are as follows:

[Help menu] Display the version and copyright of the GigE IP Configurator.

[Cameras list] List all GigE Vision enumerated cameras.

[Information display] It will display the information of selected feature which can be a camera or a network card. When the tree list root feature is selected, the information display window is empty.

[Refresh Devices] Update the network adapters list and the cameras list.

[Auto Config] Configurate the IP address of the current network card and all the devices under it. When no network card is selected, all device IPs under the network card are configured.

[Static IP] If this item is selected, it will use this static IP address.

[DHCP] If this item is selected, the camera is configured to use a Dynamic Host Configuration Protocol (DHCP) server to obtain an IP address.

[LLA] If this item is selected, the camera will assign itself an Auto IP address (LLA, Link-Local Address), and the Auto IP address ranges from 169.254.0.1 to 169.254.255.254.

[Device User ID] The user-defined identity for camera settings and the content is a character string.

[Save] Select the **Save** button, the tool will save the current configuration to the selected camera which takes a few seconds.

[Reset Device] The effect is the same as powering Off-On. The program inside the device is reloaded.

[Reconnect Device] The effect is the same as closing device using SDK. After this operation, the user can reconnect the device.

9.1.2. User Guide

9.1.2.1. Refresh Devices

If you select the **Refresh Devices** button, the tool will update the displayed network adapter and camera information. This way you can make sure that all displayed information is up to date. It will take one second to refresh devices, and during this period, all the buttons are disabled as the following figure shows.

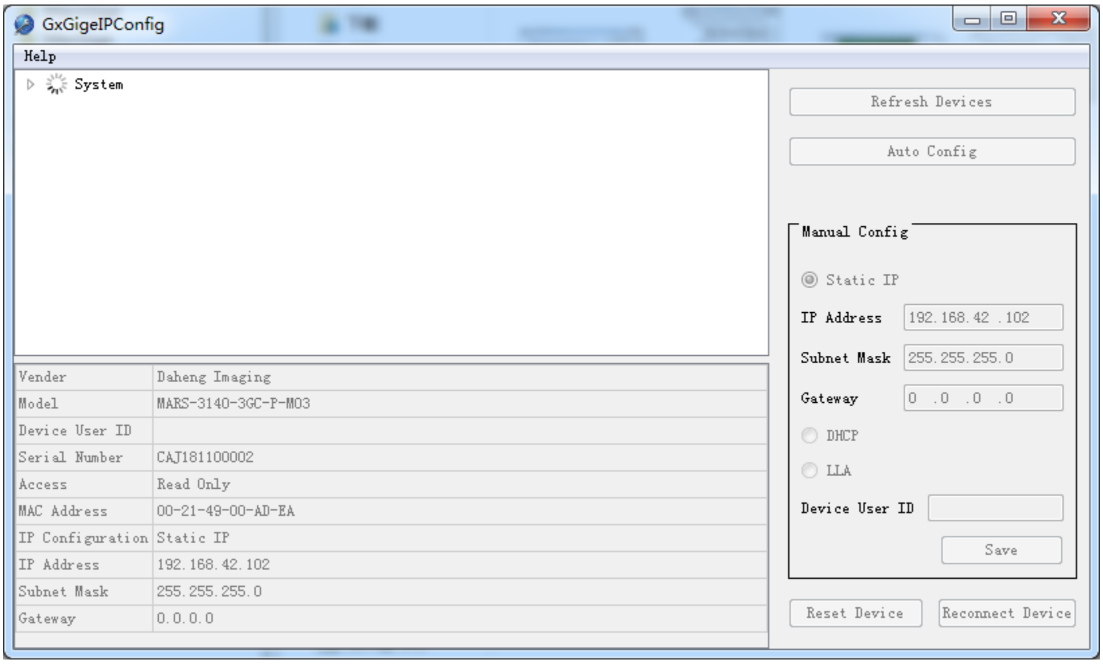

Figure 9-2 Refresh devices

9.1.2.2. Auto Config

You can configurate the device's IP address manually or automatically. In manual mode, the user is required to understand the basic network knowledge and to set the device one by one manually. In auto mode, the program will be executed automatically without the operator intervening.

If a user needs a batch of GigE cameras with no IP conflict between them, the user needs to connect all the cameras to the network and to make sure that all the cameras can be enumerated by IP configurator, then performs the IP config function automatically. If the user sets these cameras in two times, the IP conflict between them will be possibly caused. Please refer to precautions 3.

The auto config function can configure the IP address of the network card and devices which enumerated by the network card in bulk, with one push and no input needed. According to the network card's IP and device's IP, the program can configure IP automatically, under the premise of avoiding IP conflicts to the greatest extent and making minimum changes. After this function is executed, the starting mode of the GigE device is changed to static IP start mode, and the IP address is changed to permanent IP.

The auto config function has three modes:

1) According to the network card's IP address

If the current network card's IP is valid (Valid IP: non LLA type IP and 0.0.0.0, the same below), but the IP of devices enumerated by this network card is in the following cases: IP not in the same subnet, IP is invalid and IP conflicts with other devices, the program will modify the device's IP to the same subnet. After selecting the **[Auto Config]**.

2) According to device's IP address

If the current network card's IP is invalid, but at least one of the IP address of the devices that enumerated by the current network card is valid (let's say the device is A), please select **[Auto Config]**. According to the device's IP, the program will modify the current network card's IP to the same subnet with A, and also will modify all the devices with invalid IP under the current network card to the same subnet as device A.

3) According to the configuration file

If the current network card's IP and all the GigE devices' IP under the current network are invalid, the program will modify all the devices' IP under the network card and the network card's IP according to the configuration file (The configuration file is in the same directory as the tool). In the configuration file, the user only needs to specify the IP address segment and subnet mask that the network card is expected to be in. The user must input the private network address of A, B, and C. Otherwise, the program will set the network card's IP address and SubNetMask as 192.168.1/24 (IP:192.168.1.0, SubNetMask: 255.255.255.0).

1) This function will modify the network card's IP when the IP of the host network card is invalid. The network card's IP which is modified may be different from the IP of user work network.

2) The program will avoid IP conflict when modifying the IP of the device and the network card. But under the Windows system, the program is difficult to discover the IP conflict between GigE devices and other non-GigE devices on the network. In this case, the **[Auto Config]** operation may fail.

3) When the user configures the GigE cameras' IP in batches using the **[Auto Config]** function under the same environment (First, connect a batch of cameras to perform this function, then replace another batch after completion), in the two sets of cameras, the IP address may conflict.

9.1.2.3. Display Information

When you select a network adapter in the tree list, the following adapter information is displayed in the information display window below the left side of the main window.

[Display Name] The description of the network adapter.

[IP Address] The IP address of the network adapter.

[Subnet Mask] The subnet mask of the network adapter.

[Gateway] The gateway of the network adapter.

When you select a camera feature in the tree list, the following camera information is displayed in the information display window below the left side of the main window.

[Vendor] The name of the camera vendor.

[Model] The name of the camera model.

[Device User ID] A user-defined identifier for the camera (if a camera has been assigned).

[Serial Number] The serial number of the camera.

[Status] The connection status of the camera.

[MAC Address] The MAC address of the camera.

[IP Configuration] The method used for assigning the current IP address to the camera.

[IP Address] The current IP address of the camera.

[Subnet Mask] The subnet mask of the camera.

[Gateway] The gateway used by the camera.

9.1.2.4. Configure IP Address

You should select the camera feature which is to be modified in the camera list, select **Static IP**, and input the **IP Address**, **Subnet Mask**, and default **Gateway**, then select **Save** to complete the IP address setting, at the same time, setting the IP configuration mode as **Static IP**, see Figure 9-3:

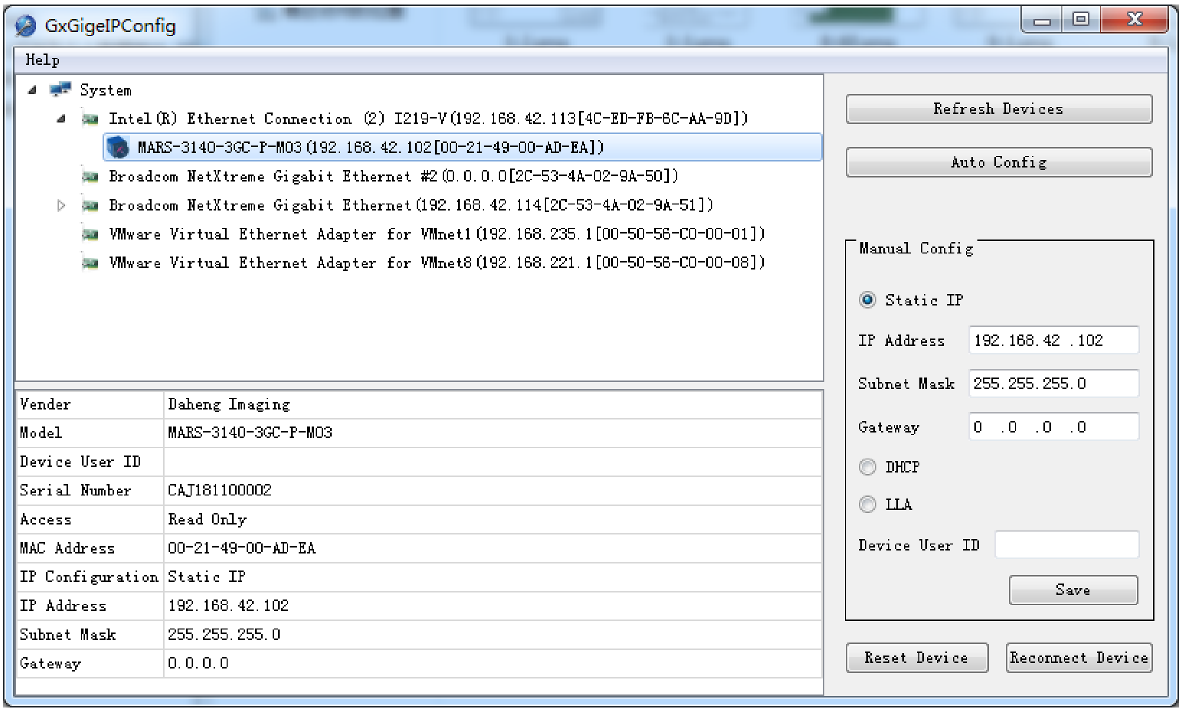

Figure 9-3 Configure IP address

9.1.2.5. IP Configuration Mode

You should select the camera feature which is to be modified in the camera list, select the **Static IP, DHCP,** or **LLA**, then select **Save**, the details are as follows:

1) To set a camera to a static IP address

See section 9.1.2.4. for details.

2) To set a camera to DHCP

Operation steps:

a) In the top pane of the tool, select the camera whose IP configuration you want to change.

b) In the right pane of the tool, select DHCP.

c) Select the **Save** button. When the tool has finished saving, the information in the top pane and the lower left area will be updated automatically.

Operation results:

a) Change the camera IP configuration mode as “DHCP”.

b) If operating successfully, the current IP address is the one which is allocated by the DHCP servers, if the DHCP servers is not exist, the camera’s IP will be configured with LLA.

3) To set a camera to AUTO IP (LLA)

Operation steps:

a) In the top pane of the tool, select the camera whose IP configuration you want to change.

b) In the right pane of the tool, select **Auto IP (LLA)**.

c) Select **Save**. When the tool has finished saving, the information in the top pane and the lower left area will have been updated automatically.

Operation results:

a) Change the camera IP configuration mode to “LLA”.

b) If operating successfully, the current IP address is allocated with the LLA mode.

9.1.2.6. Change the Device User ID

1) In the top pane of the tool, select the camera whose device user ID you want to change.

2) Enter a new device user ID for the camera in the **Device User ID** field. You can only enter **ASCII** characters. The maximum length allowable is 16 bytes.

3) Select **Save**. When the tool has finished saving, the information in the top pane and the lower left area will have been updated automatically.

9.1.2.7. Reset Device and Reconnect Device

The button is not available if the device does not support this feature.

Reset Device: When the device is not convenient to power down, but also need to reload the program, this feature can be used at this time.

Reconnect Device: This function is generally used debugging device using Visual Studio. In debug mode, the heartbeat timeout is 5 minutes. If the user exits the process without closing device, the device cannot be reset immediately and device cannot be reopened immediately. In this case, you can use this feature to release the device control, you can immediately open the device.

Carefully use these two features. The use of those two features during acquisition can cause acquisition stop immediately.

9.1.3. Precautions

9.1.3.1. Check IP Address Format

It's not allowed to enter the following IP address in the IP Address field.

1) The IP of Class D: 224.0.0.0 to 239.255.255.254.

2) The IP of Class E: 240.0.0.0~255.255.255.254.

3) The first paragraph of the IP address is 127 and 255.

If you enter one of these IP addresses, a red exclamation mark will be displayed in the right of the IP Address field and the Save button will be disabled as shown in the Figure 9-4.

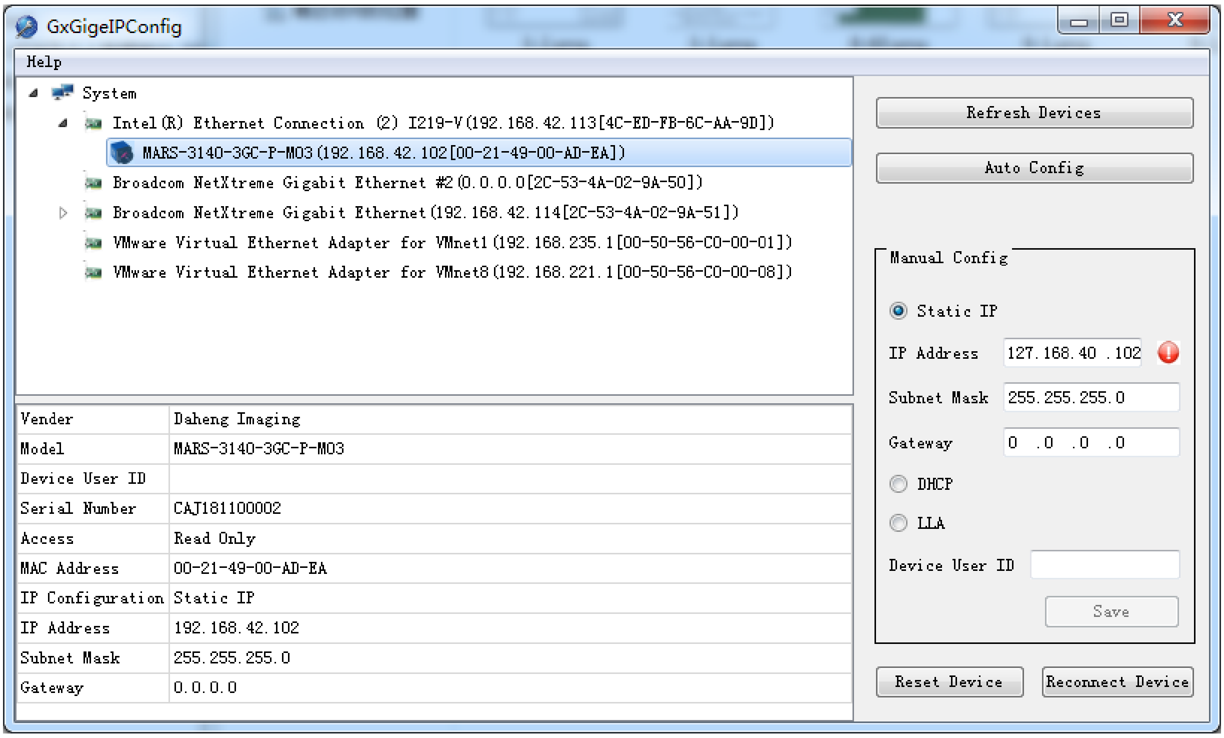

Figure 9-4 Check IP address format

9.1.3.2. Length Limitation of User-defined Name

The maximum allowable length of the user-defined name is 16 bytes.

9.1.3.3. Tips

1) The cameras' IP address are the same

If the cameras' IP address are the same, a red exclamation mark will be displayed in the right of the camera list, as shown in the Figure 9-5.

2) The camera's IP address and the network card are not in the same subnet

When the camera's IP address and the network card are not in the same subnet, the camera information in the enumeration list is marked in red, as shown in the Figure 9-5.

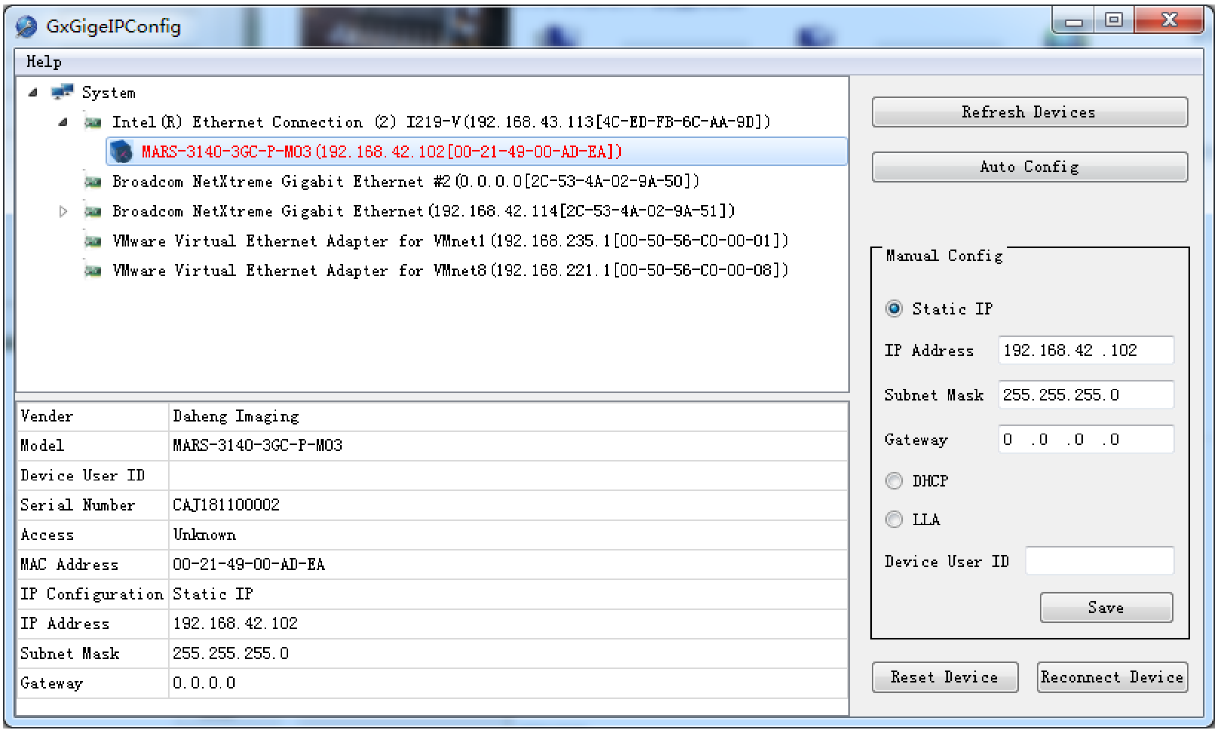

Figure 9-5 The tips of the IP configurator

9.2. Frame Rate Calculation Tool

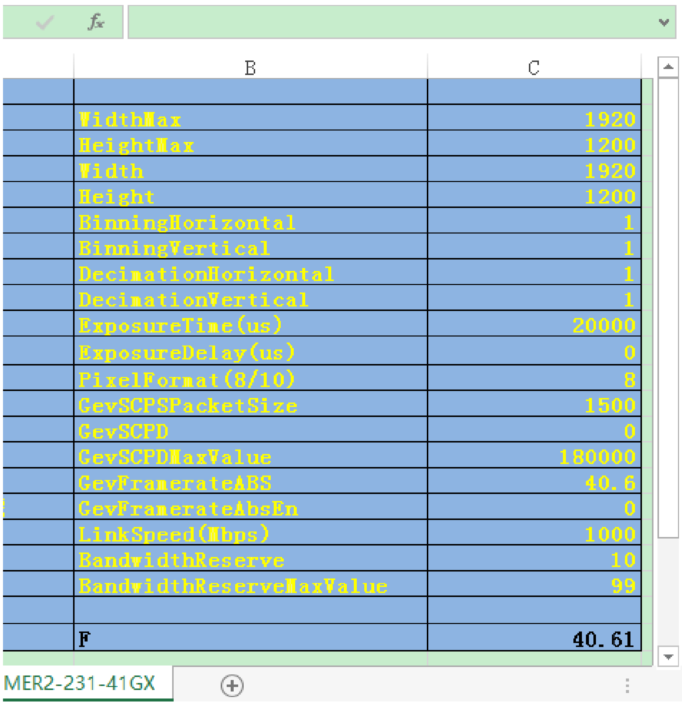

Figure 9-6 Frame rate calculation tool

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 setting value, and image transmission bandwidth influence.

The parameters in Figure 9-6 are explained as follows:

1) The Width and Height are the set ROI size.

2) The definitions of BinningHorizontal, BinningVertical, DecimationHorizontal, DecimationVertical can refer to section 8.3.10. and section 8.3.11. These four parameters will affect the transmission time of image data.

3) The ExposureTime is the exposure time when the camera acquires one frame of image.

4) The PixelFormat is the pixel format corresponding to the camera output image, including 8 bits, 10 bits or 12 bits.

5) The BandwidthReserveMaxValue represents the maximum reserved bandwidth when the camera transmits images.

6) The BandwidthReserve represents the recommended maximum reserved bandwidth of the camera. If this reserved bandwidth is exceeded, frame loss may occur.

7) The GevFramerateABS represents the maximum value of the GevFramerateAbsEn when GevFramerateAbsEn is enabled. Whether the maximum value can be reached depends on whether the camera is affected by other acquisition parameters.

8) The GevFramerateAbsEn indicates whether frame rate control is enabled, 1 means enable GevFramerateAbsEn, and 0 means disable GevFramerateAbsEn. When GevFramerateAbsEn is enabled, the camera acquires images at a frame rate that is no higher than the GevFramerateABS. When GevFramerateAbsEn is disabled, the camera acquires images without being affected by the GevFramerateABS.

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%.

Take the MER2-231-41GM/C camera as an example:

1) If you want to set the camera's acquisition frame rate to 40fps with the "GevFramerateABS" function, you can set "GevFramerateAbsEn" to 1, set "GevFramerateABS" to 40, and then you can check "F" as 40fps.

2) If you want to adjust "GevSCPSPacketSize" and "GevSCPD" to make the frame rate of the camera reach 40fps, you can select the "GevSCPSPacketSize" you want to use. If you set "GevSCPSPacketSize" to 8192, then gradually set the value of "GevSCPD" to make "F" approach 40fps. After several attempts, it can be concluded that when "GevSCPD" is set to 1710, the calculated result "F" is 40.02fps.

10. FAQ

No.	General Question	Answer
1	No images after starting acquisition.	1) Confirm that the camera packet size is greater than 1500, generally the packet size is set to be the maximum. If the host is not in jumbo frame mode, modify the maximum size of the IP packet to jumbo frame mode. 2) Load the default parameter set, reopen the application program, and then start acquisition again. 3) Run the demo program, and open the configuration page to confirm whether the data packet is received. If there are data packets, but they are all incomplete frames, please check your environment requirements in section 2.2.
2	The frame rate is not up to the nominal value.	1) Choose a better host. 2) Choose a recommended Intel series Gigabit Network card. 3) Contact with the technical support.
3	Lose frames seriously in a multiple cameras' application.	1) Adjust the packet size or packet delay, but frame rate reducing followed. 2) Using multiple network cards, and the cameras are connected separately to different network cards.
4	On the unactivated Windows7 64bit system, the installation of GalaxySDK has been successfully, but open the demo program failed.	1) Activate Windows7 64bit system, uninstall the package. Then, reinstall the package after restarting the system, and reopen the demo program.
5	Fail to open device, prompting the XML file parsing error.	1) Contact with the technical support to obtain upgrade program, and then upgrade your cameras.
6	Cannot receive any image after modifying the packet delay to a larger value.	1) Confirm the data block timeout settings in the configuration page, and adjust the timeout settings until the image data is received.
7	The cameras cannot be enumerated under Windows XP.	1) Check if the network is connected. 2) Enumerate repeatedly. 3) Modify the host IP address, and enumerate once again. Make sure that the host IP address is not the same as the camera.

8	The device fails to start acquisition, and the “Attach Buffer fails” error occurs.	1) Method 1: Modify the parameter of the stream layer **MaxNumQueueBuffer** (the maximum buffer number of acquisition queue) to be less than 9. The disadvantage of methods 1 is that the solution may reduce the acquisition performance, for the user who has low requirement of acquisition frame rate or the user who use trigger mode can select this way, but it is not recommended to the user who has high requirements of acquisition frame rate. 2) Method 3: increase the physical memory size and replacing the 32bit system with a 64bit system, it is recommended to use windows7 or above, it is a good solution to this problem.

11. Revision History

No.	Version	Changes	Date
1	V1.0.0	Initial release	2020-02-27
2	V1.0.1	Add section 8.2.8 Add ME2P-1230-9GM/C-P Modify the description of Figure 6-1 and Figure 6-2 Modify power consumption and weight of the camera	2020-06-22
3	V1.0.2	Modify the format of the manual	2020-06-28
4	V1.0.3	Modify Pixel Format of MER2-202-60GC	2020-07-27
5	V1.0.4	Update SNR of MER2-202-60GM/C	2020-08-11
6	V1.0.5	Add MER2-160-75GM/C and MER2-041-302GM/C	2020-09-08

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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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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