China Daheng Group, Inc. Beijing Image Vision Technology Branch

MARS 5GigE Cameras

User Manual

Version: V1.0.6

Date: 2023-09-09

DAHENG IMAGING 大恒图像

Web: www.daheng-imaging.com/en

Sales Email: isales@daheng-imaging.com

Sales Tel: +86 10 8282 8878-8081

Support Email: isupport@daheng-imaging.com

Preface

We really appreciate your choosing of DAHENG IMAGING products.

The MARS 5GigE series (MARS-G5-P) camera is DAHENG IMAGING's latest area scan industrial digital camera, featuring high resolution, high definition, high transmission bandwidth and extremely low noise. The camera is equipped with 5GigE interface, which is backward compatible with GigE network cards and supports Power over Ethernet (PoE, IEEE802.3af compliant).

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

This manual describes in detail on how to install and use the MARS 5GigE digital cameras.

Contents

1. Introduction

1.1. Series Introduction

The MARS 5GigE series (MARS-G5-P) camera is DAHENG IMAGING's latest area scan industrial digital camera, featuring outstanding performance, powerful features, outstanding price/performance ratio. The camera supports Power over Ethernet (PoE, IEEE802.3af compliant), which is easy to install and use. The MARS-G5-P series cameras are available in a variety of resolutions and frame rates, and are available with CMOS sensors from leading chip manufacturers.

The MARS-G5-P series digital camera transmits image data through the Ethernet interface, with a transmission link speed up to 5Gbit/s, which significantly increases the transmission bandwidth of traditional network cameras. Thanks to the locking screw connectors, the MARS series cameras can secure the reliability of cameras deployed in harsh industrial environments. Featuring high reliability and high price/performance ratio, the MARS 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 MARS 5GigE series (MARS-G5-P) 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.

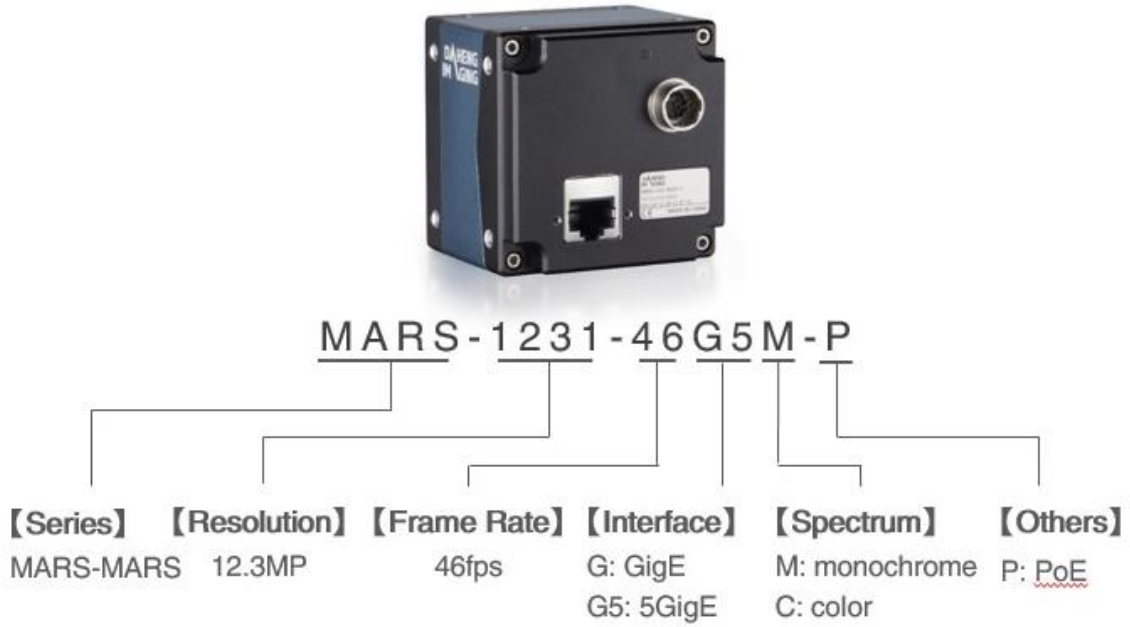


Figure 1-1 Naming rules

1.3. About 5GigE

The new MARS 5GigE model features the brand new 5Gbps (5GBASE-T) link speed. 5GBASE-T is one of the two speeds supported by NBASE-T technology, and the other is 2.5GBASE-T. NBASE-T technology has now become the basis of the IEEE 802.3bz standard.

GigE Vision has been using Gigabit Ethernet as the transmission interface since its release in 2006. With the increase of sensor resolution and frame rate, the transmission link speed of Gigabit Ethernet has gradually limited the GigE Vision camera. The transmission of MARS-G5-P camera is based on NBASE-T technology, the maximum transmission link speed can up to 5Gbit/s, and supports link speed switching to 1Gbit/s and 2.5Gbit/s, which greatly improves the transmission link speed of network cameras and expands the application field of cameras.

Due to the greatly improved transmission link speed, the power consumption of the 5GigE camera is significantly increased compared with the GigE camera. The MARS-G5-P camera uses a unique heat removal technology (passive heat removal technology), which maximizes the transmission capacity of the camera in a limited volume, and makes the camera highly reliable and environmentally adaptable.

5GBASE-T supports cable lengths up to 100 m (CAT-5e cables or above), which is not different from the traditional GigE, so users do not need to buy new cables.

Currently, PCs generally do not support 5GigE transmission interfaces, so users need to purchase 5GigE network cards separately. The recommended models are Intel X550 and IOI GE10-PCIE4XG301. The network card generally requires the PCIE slot of the PC to be x4 gen3. And the Intel X550 network card supports 5GigE and 2.5GigE only under Win10 64bit operating system. In order to achieve better acquisition results, the following settings are recommended:

1) Support jumbo frames, the length of jumbo frame is at least 9014.
2) Set the network link speed to Auto Negotiation.
3) Set the receive buffer and send buffer to maximum.
4) Set the stream control of RX and TX to on.

1.4. Standards

The camera follows the GigE Vision 1.2 standard, the GEN<i>CAM3.0 standard and the IEEE802.3af standard.

1.5. Document, CAD/Technical Drawing and Software Downloads

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

2. Precautions

2.1. Safety Claim

Before installing and using DAHENG IMAGING products, please carefully read this manual and strictly comply with the usage requirements. And ensure to use the product in specified conditions, otherwise it may cause equipment malfunction. Our company will not bear any legal responsibility for any damage or injury caused by improper use of this product and disregard of safety instructions.

The symbols that may be found in this document are defined as follows:

Symbol	Description
	Note: Provides additional information to emphasize or supplement important points of the main text
	Caution: Indicates a potentially hazardous situation which, if not avoided, could result in equipment damage, data loss, performance degradation, or unexpected results
	Warning: Indicates a potential risk that, if not avoided, could result in injury accidents, equipment damage, or business interruption
	Danger: Indicates a hazard with a high level of risk, which if not avoided, will result in death or serious injury

2.2. Safety Instruction

Usage	
 Warning	1) Do not install and operate the product in extreme environments with vibration, high temperature, humidity, dust, strong magnetic fields, explosive/corrosive smoke or gases, as it may damage the camera, cause a fire or electric shock. 2) Do not aim at the product with high intensity light sources directly, as it may damage the sensor. 3) If the device damaged, emits smoke, odor or noise, please turn off the power and unplug the power cord immediately, and contact our technical support engineer. 4) Unauthorized disassembly, repair, or modification of products is prohibited as it may damage the camera or cause a risk of electric shock. 5) In the use of the device, you must be in strict compliance with the electrical safety regulations of the nation and region. 6) Please use the power supply provided by reputable manufacturers that meets the camera power limit requirements, otherwise, it will damage the camera.
 Caution	1) Check whether the device's package is in good condition, whether there is damage, deformation, etc. before unpacking. 2) After unpacking, please carefully inspect the quantity and appearance of the product and accessories for any abnormalities. 3) Please store and transport the product according to the specified storage and transportation conditions, ensure that the storage temperature and humidity meet the requirements.

Personal Safety	
Warning	1) It is strictly prohibited to perform device wiring, dismantling, maintenance and other operations while powered on, otherwise there may be a risk of electric shock. 2) It is prohibited to touch the camera directly during using, otherwise there may be a risk of burns. 3) Please install and use the camera in accordance with regulations, otherwise there may be a risk of falling and get injured. 4) The edges of the lens mount and fan are relatively sharp, so pay attention to the risk of scratches during installation or use.

2.3. 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.

2.4. 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 i5 or above, 8GB memory or above, Win7 64bit OS or above.

4) NIC requirement: 5GigE NIC confirming to IEEE802.3af standard or higher performance 10GigE NIC with 5Gbps link speed, CAT-5e cables or above, length less than 100m, switch confirming to IEEE802.3af standard.

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

2.5. Camera Mechanical Installation Precautions

Camera installation requirements:

1) The screw and camera have a screw length between 3 and 4.8 mm.

2) Screw assembly torque ≤ 5N.M. If the screw assembly torque is too large, it may cause the camera thread stripping.

2.6. Certification and Declaration

1. CE, RoHS

We declare that DAHENG IMAGING MARS 5GigE 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

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference
- This device must accept any interference received, including interference that may cause undesired operation

 Note: This equipment 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 in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

3. Installation Guidelines

3.1. Host Preparation

3.1.1. Software Package

The Software package of DAHENG IMAGING's MARS series is used to control the MARS 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 MARS 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 MARS 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. The definition and usage of GenTL interfaces can be downloaded from the website of EMVA.

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 MARS series GigE Vision camera is compatible with the GigE Vision protocol, which allows the user to control the camera directly through 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

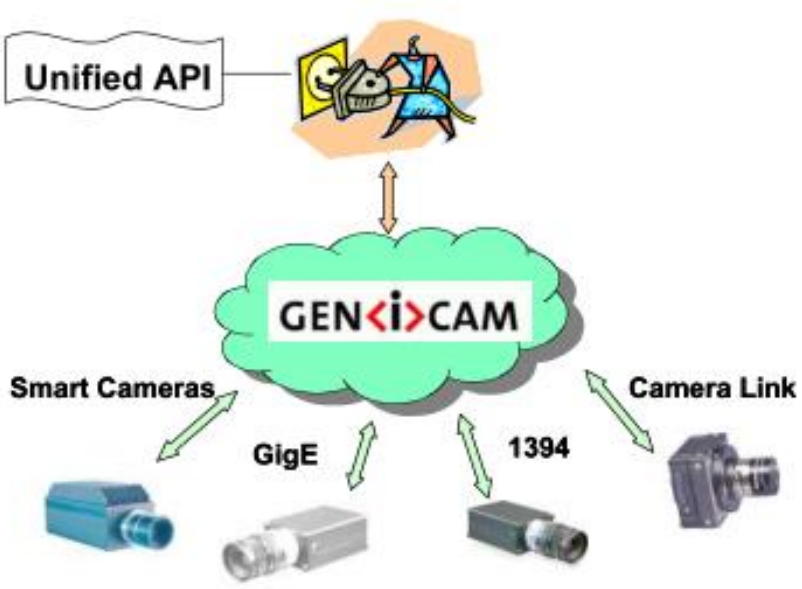


Figure 3-1 GEN<i>CAM standard schematic diagram

3.2. Camera Power

MARS-G5-P series camera can get power in either of two different ways: via PoE (Power over Ethernet) or via Hirose I/O port.

1) Via PoE (Power over Ethernet)

Via PoE (Power over Ethernet), i.e., via the Ethernet cable plugged into the camera's RJ-45 jack. Use the IEEE 802.3af compliant PSE (Power sourcing equipment) to power the MARS-G5-P camera.

2) Via the Hirose I/O port

Camera can get power from the 12-pin Hirose I/O port via a standard I/O cable.

Nominal operating voltage is +12V (± 10%) ~ +24VDC (± 10%).

When you supply power to the camera both via the camera's RJ-45 jack and via the 12-pin Hirose I/O port, the camera will get power via the Hirose I/O port. And if you cut off the Hirose I/O port, the camera will get power via PoE and may restart.


Note:

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

2) The plug on the cable that you attach to the 12-pin Hirose I/O port must have 8 female pins. Using a plug designed for a smaller or a larger number of pins can damage the connector. See 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 MARS series. The GalaxySDK contains various operating systems such as Windows and Linux. The requirements for the operating system and version of the installation package are as follows:

Operating Systems	Applicable Version
Windows	➢ Windows 7 (32bit, 64bit) ➢ Windows 10 (32bit, 64bit) ➢ Windows 11 (64bit)
Linux	➢ Ubuntu 12.04 or above, kernel version 3.5.0.23 or above
Android	➢ Android6 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, 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 5GigE camera to the network port of the current host.

2) Open the 5GigE IP Configurator of the installation package.

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

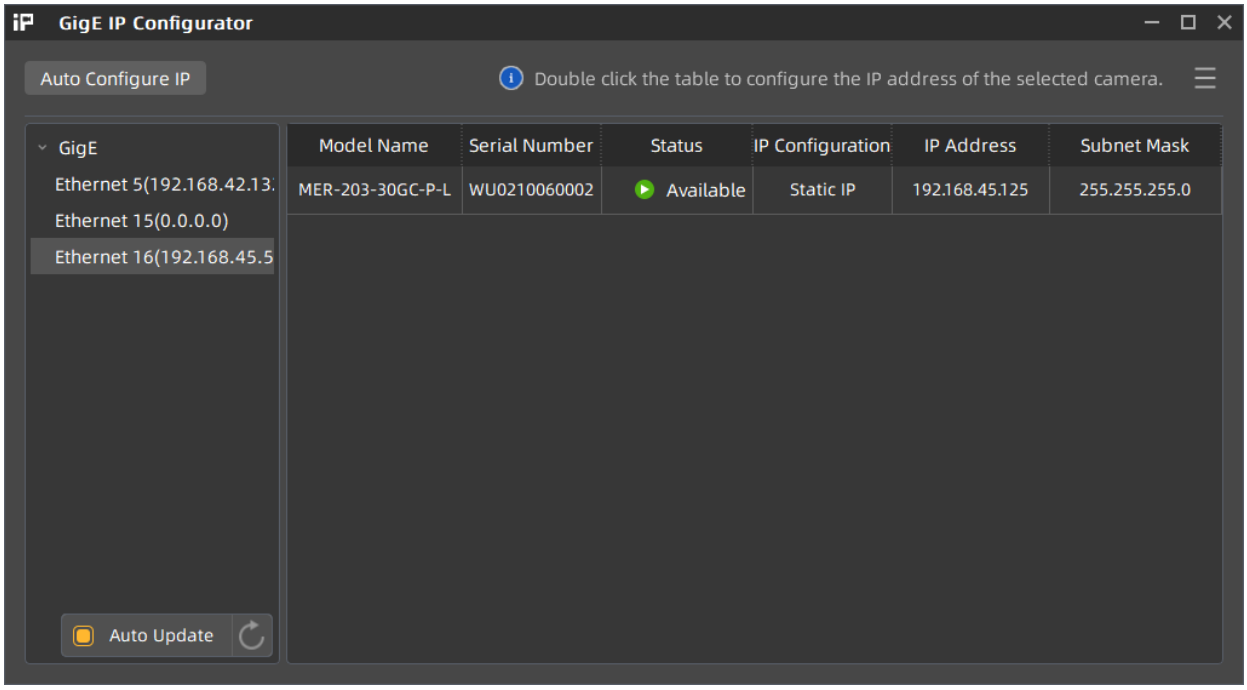


Figure 3-2 GigE IP Configurator

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:

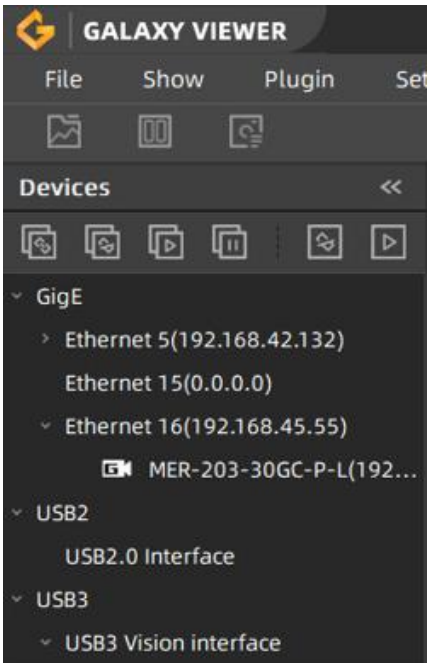


Figure 3-3 GalaxyView

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

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

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

4. General Specifications

4.1. Explanation of Important Parameters

4.1.1. About Spectral Response

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

Sensitivity: The change of the sensor output signal relative to the incident light energy. The commonly used sensitivity units are V/((W/m^2) •s), V/lux •s, e-/((W/m^2) •s) or DN/ ((W/m^2) •s).

The spectral response graph 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. MARS-1231-46G5C-P / MARS-1231-46G5M-P

4.2.1. Parameters

Specifications	MARS-1231-46G5C-P	MARS-1231-46G5M-P
Resolution	4096 × 3000	
Sensor Type	Sony IMX253 global shutter CMOS	
Max. Image Circle	1.1 inch	
Pixel Size	3.45μm × 3.45μm	
Frame Rate	43.3fps @ 4096 × 3000 (default) >47fps @ 4096 × 3000 (adjust the packet size to 8192 and reserved bandwidth to 5)	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	21μs~1s	
Gain	0dB~24dB	
Pixel Formats	Bayer RG8/Bayer RG10	Mono8/Mono10
Signal Noise Ratio	40.79dB	40.68dB
Synchronization	Hardware 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 12-pin Hirose connector
Power Consumption	< 9W @ 12VDC, < 10.5W @ PoE
Lens Mount	C
Dimensions	53.2mm×62mm×62 mm (without lens adapter or connectors)
Weight	305g
Operating System	Win7/Win10/Win11 32bit, 64bit OS, 64bit OS is recommended
Data Interface	Gigabit Ethernet (1000Mbit/s), 2.5G Ethernet (2500Mbit/s) or 5G Ethernet (5000Mbit/s)
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity
Conformity	CE, RoHS, FCC, GigE Vision, GenICam, IEEE802.3af

4.2.2. Spectral Response

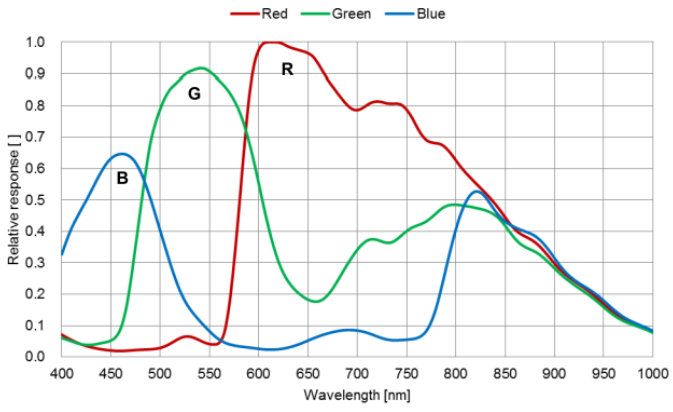


Figure 4-1 MARS-1231-46G5C-P sensor spectral response

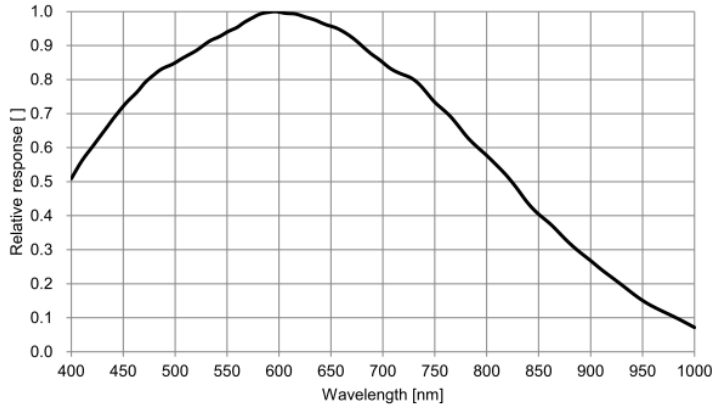


Figure 4-2 MARS-1231-46G5M-P sensor spectral response

5. Dimensions

5.1. Camera Dimensions

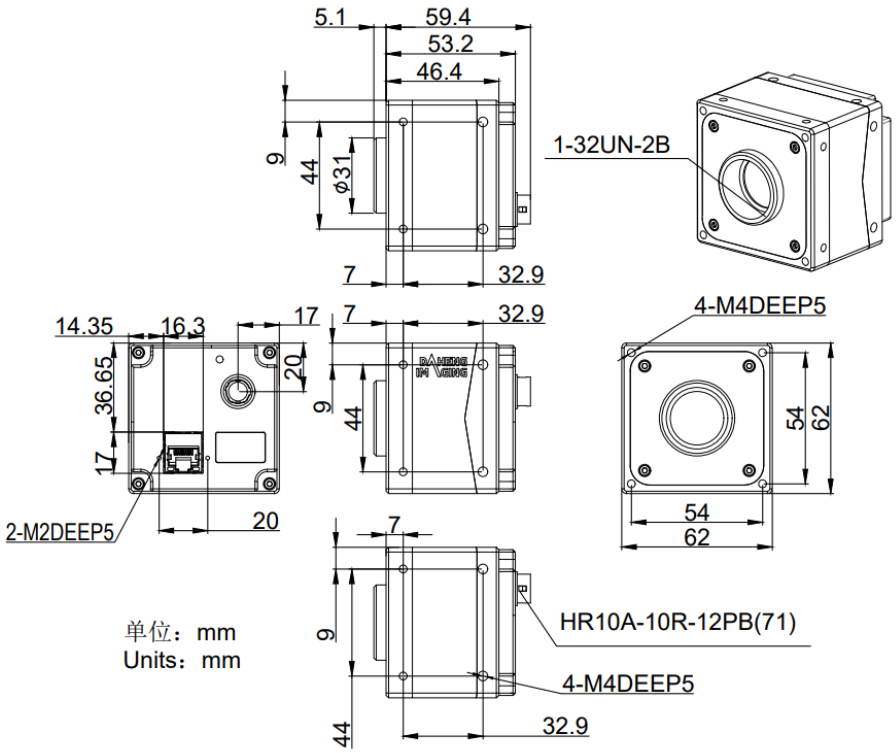


Figure 5-1 MARS-G5-P mechanical dimensions

5.2. Optical Interface

MARS-G5-P 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 11.1mm, as shown in Figure 5-2. A longer lens thread will damage camera.

The color models are equipped with IR filters 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.

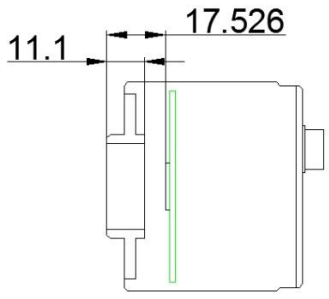


Figure 5-2 Optical interface of C-mount

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

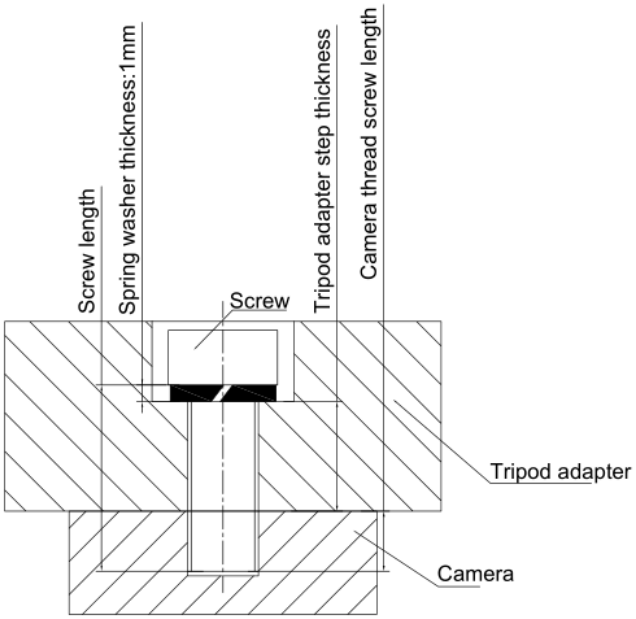


Figure 5-3 Schematic diagram of screw specification, tripod adapter step thickness and spring washer thickness

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)
M4*8 screw	2.8	1	4.2
M4*10 screw	4.8	1	4.2

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 MARS 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.

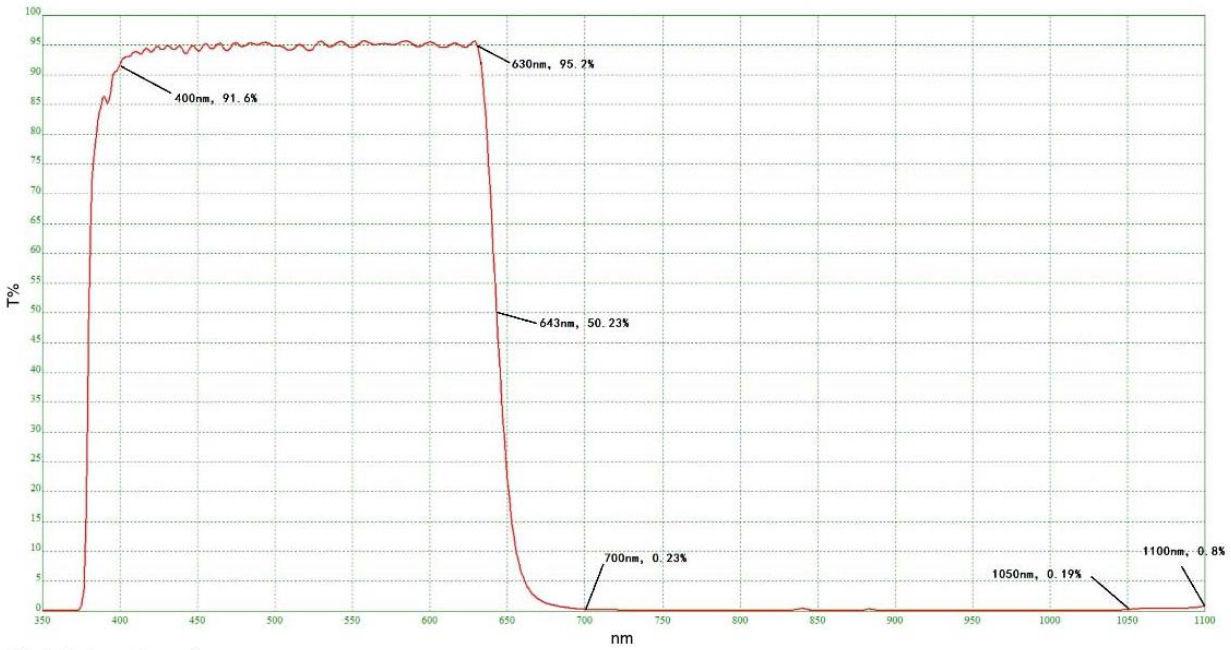


Figure 6-1 Infrared cut-off filter transmittance curve for MARS series color camera

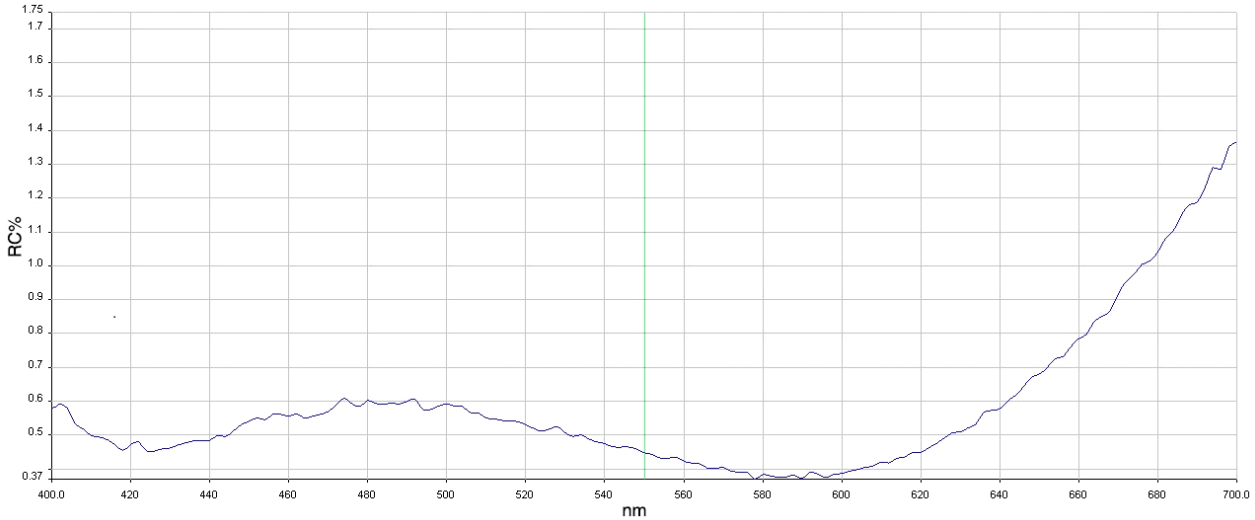


Figure 6-2 Transparent glass reflectance curve for MARS series mono camera

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 nine series of industrial lenses, resolution from 2 megapixels to 25 megapixels, with small size, light weight, high resolution and low distortion rate, etc.

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

1) 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 MARS series 5GigE digital camera is equipped with a standard C-Mount. When selecting a lens, select the lens of the same mount as the camera

2) Max. Image Circle

- The maximum sensor size that the lens image can cover. There are mainly 1/2", 2/3", 1/1.2", 1", 1.1", 4/3", and so on
- When selecting a lens, make sure that the lens max. image circle 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 lenses for industrial, suitable for sensors with max. image circle of 1/2" ~ 2/3". This series of lenses has the following features:

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

Models:

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

6.2.2. HN-5M Series

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

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

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

Models:

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

6.2.3. HN-6M Series

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

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

Models:

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

6.2.4. HN-20M Series

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

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

Models:

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

6.2.5. HN-P-6M Series

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

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

Models:

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

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

6.2.6. HN-P-10M Series

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

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

Models:

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

6.2.7. HN-P-20M Series Prime Lenses

The HN-P-20M series lenses are 20 megapixels lenses for industrial, with max. image circle of 1.1". This series of lenses has the following features:

- 20 megapixels resolution, 12~50mm focal length available
- 2.4μm small pixel size, F2.4 large aperture design
- Miniaturized structure

- Ultra-low optical distortion

Models:

- HN-P-1224-20M-C1.1/1
- HN-P-1624-20M-C1.1/1
- HN-P-2524-20M-C1.1/1
- HN-P-3524-20M-C1.1/1
- HN-P-5024-20M-C1.1/1

6.2.8. HN-P-25M Series

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

- 25 megapixels resolution, 12~50mm focal length available
- 2.74μm small pixel size, F2.4 large aperture design
- Small and compact
- Ultra-low optical distortion

Models:

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

6.2.9. HN-P Series 8K ~ 16K Line Scan Lenses

Features of this series lenses are as follows:

- 8K ~ 16K resolution
- Focal length of 60mm
- 3.7μm ~ 7μm pixel size
- Magnification from 0.04× to 0.05

Models:

- HN-P-6040-H
- HN-P-6040-L

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-green	The camera starts properly, but the network connection is not established, the other party's device is 10M/100M/10G and other unsupported link speed levels
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 red-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 MARS-G5-P camera 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 12-pin Hirose connector (No. HR10A-10R-12PB(71)), and the corresponding plug is HR10A-10P-12S(73).

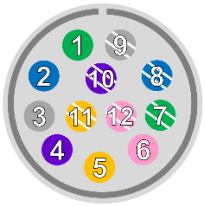
Diagram	Pin	Definition	Core Color	Description
	1	Line0+	Green	Opto-isolated input +
	2	GND	Blue	PWR GND & GPIO GND
	3	Line0-	Grey	Opto-isolated input -
	4	POWER_IN	Purple	Camera external power, +12V DC~+24V DC
	5	Line2	Orange	GPIO input/output
	6	Line3	Pink	GPIO input/output
	7	Line1-	White Green	Opto-isolated output -
	8	Line1+	White Blue	Opto-isolated output +
	9	NC1	White Grey	Not Connected, reserved
	10	GND	White Purple	PWR GND & GPIO GND
	11	NC2	White Orange	Not Connected, reserved
	12	NC3	White Pink	Not Connected, reserved

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

The input power of MARS-G5-P series digital camera must be +12V (±10%) ~ +24VDC (±10%) when powered by I/O port.

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

2) The polarity of GPIO pins 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.

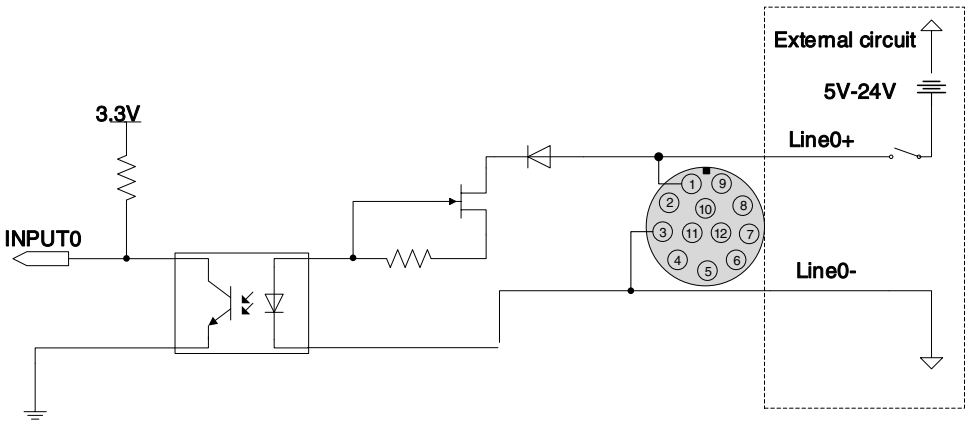


Figure 7-1 Opto-isolated input circuit

- 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 the external input voltage is 5V, there is no need for circuit-limiting resistance in the external input. But if there is a series resistance, please ensure the value is less than 90Ω. In order to protect the Line0+ while the external input voltage is higher than 9V, a circuit-limiting resistance is needed in the external input. The recommended resistance is shown in Table 7-3

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

Table 7-3 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.

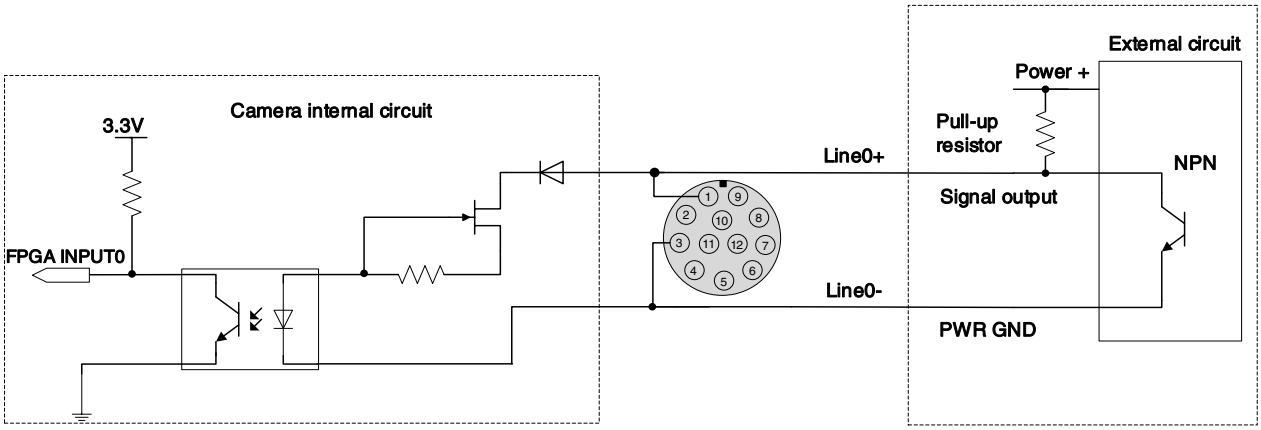


Figure 7-2 NPN photosensor connected to opto-isolated input circuit

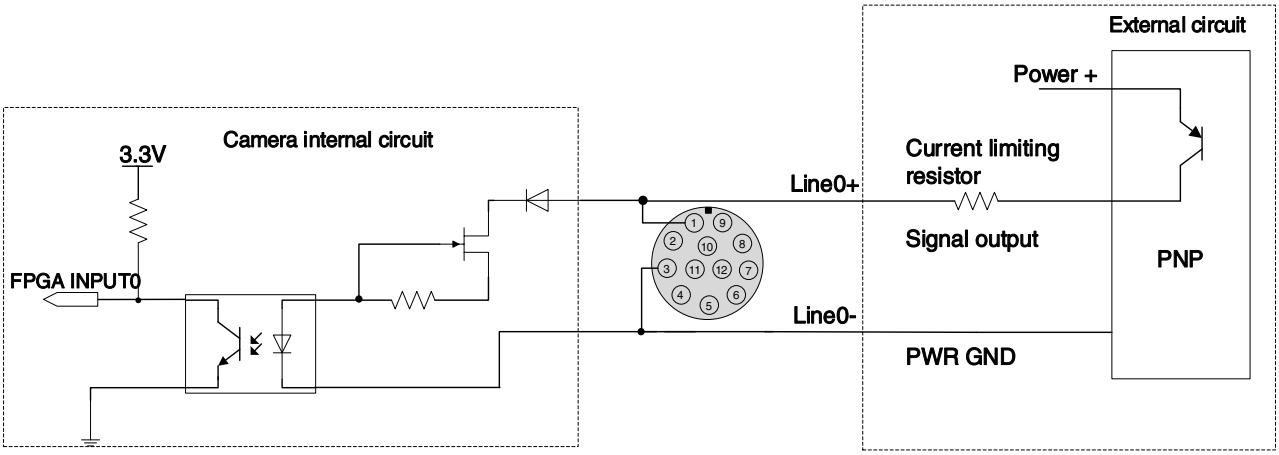


Figure 7-3 PNP photosensor connected to opto-isolated input circuit

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

Table 7-4 Delay time of opto-isolated input circuit in typical application environment

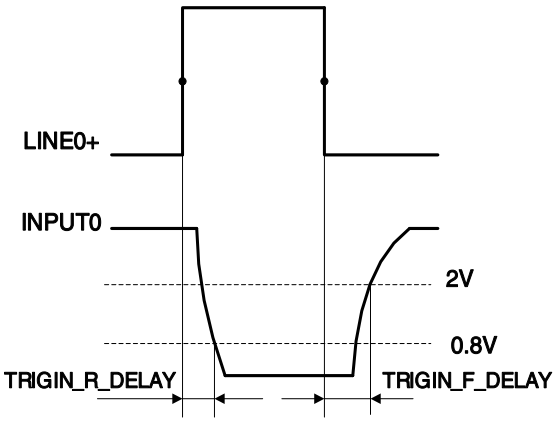


Figure 7-4 Parameter of opto-isolated input circuit

- 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.

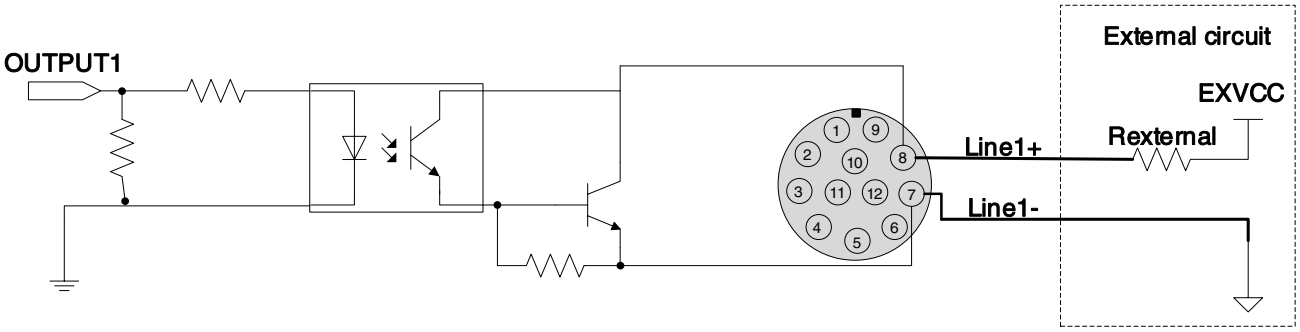


Figure 7-5 Opto-isolated output circuit

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

External voltage EXVCC	External resistance Rexternal	Transistor voltage drop (turn on, unit 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 ansistor voltage drop and output current of opto-isolated output circuit in typical application environment

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

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

Table 7-6 Delay time of opto-isolated output circuit in typical application environment

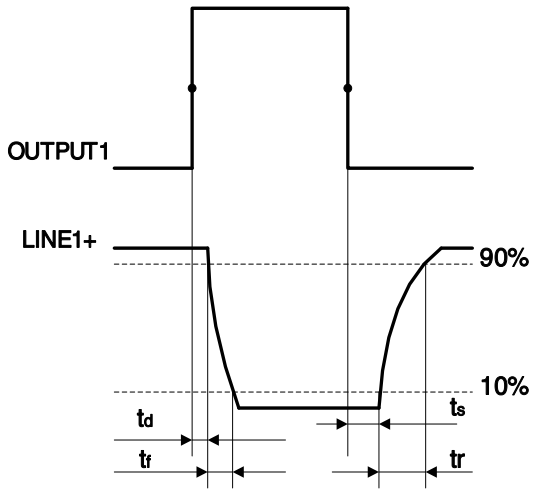


Figure 7-6 Parameter of opto-isolated output circuit

- 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

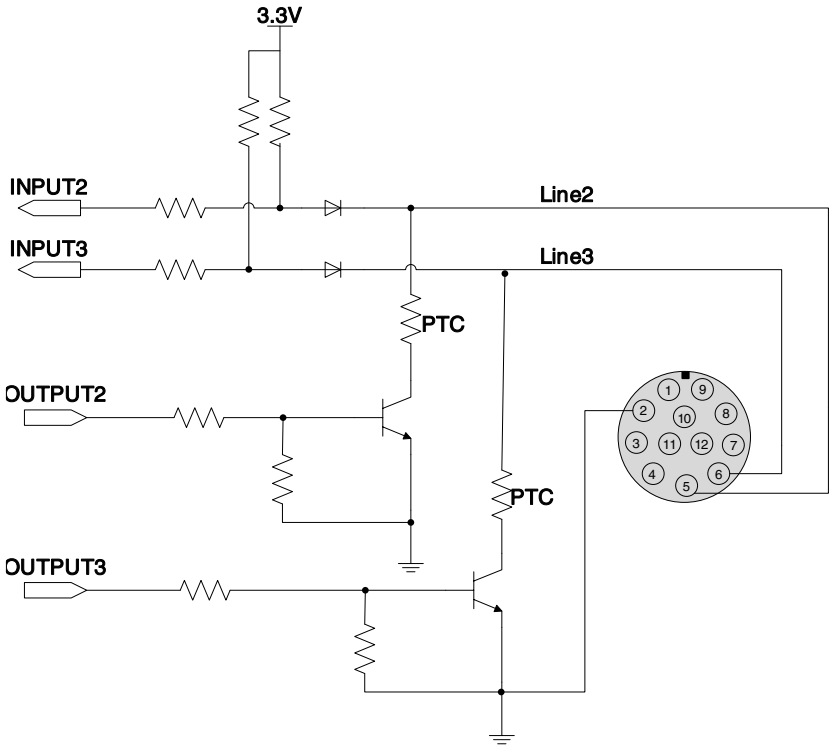


Figure 7-7 GPIO 2/3 (bidirectional) circuit

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:

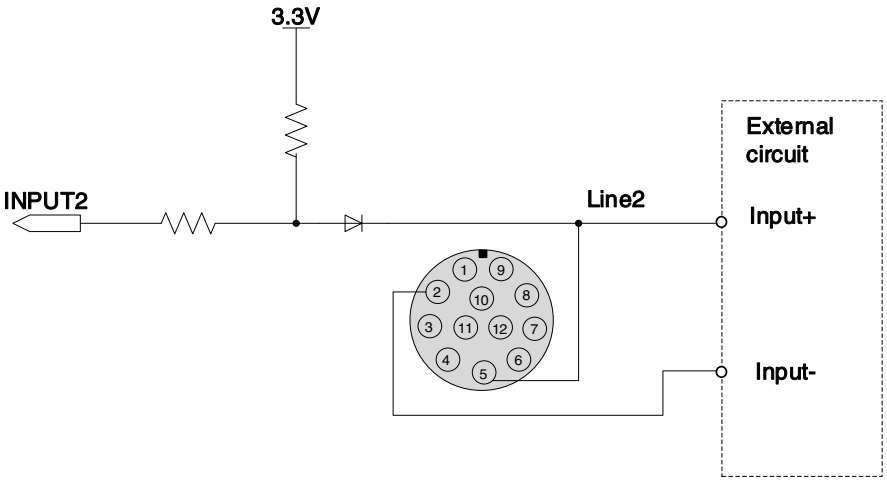


Figure 7-8 Internal equivalent circuit of camera when Line2 is configured as input

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

When Line2/3 is configured as input. The connection method between them and NPN and PNP photoelectric sensors is shown in Figure 7-9 and Figure 7-10. The relationship between the pull-up resistor value and the external input voltage is shown in Table 7-3.

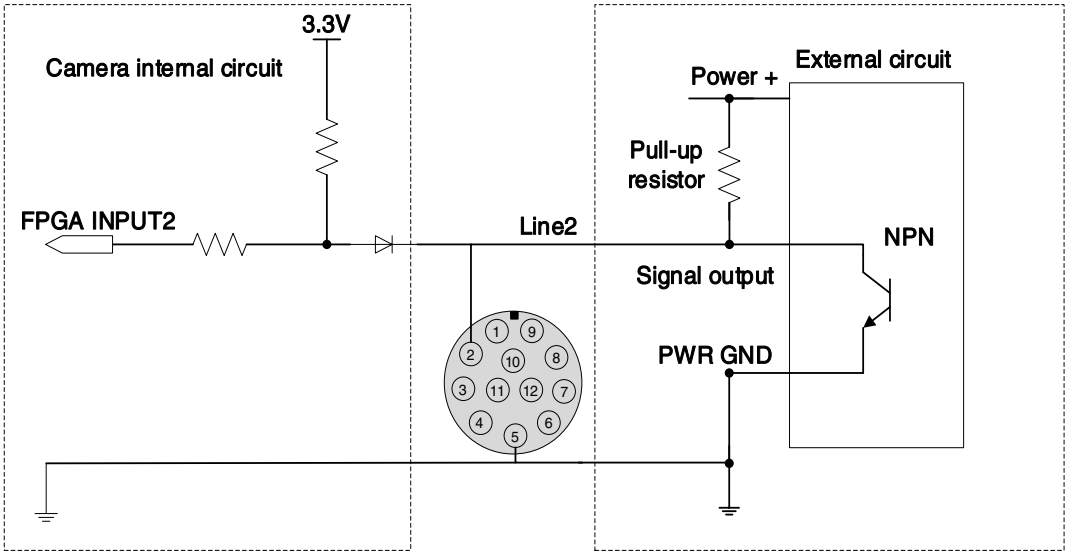


Figure 7-9 NPN photoelectric sensor connected to Line2 input circuit

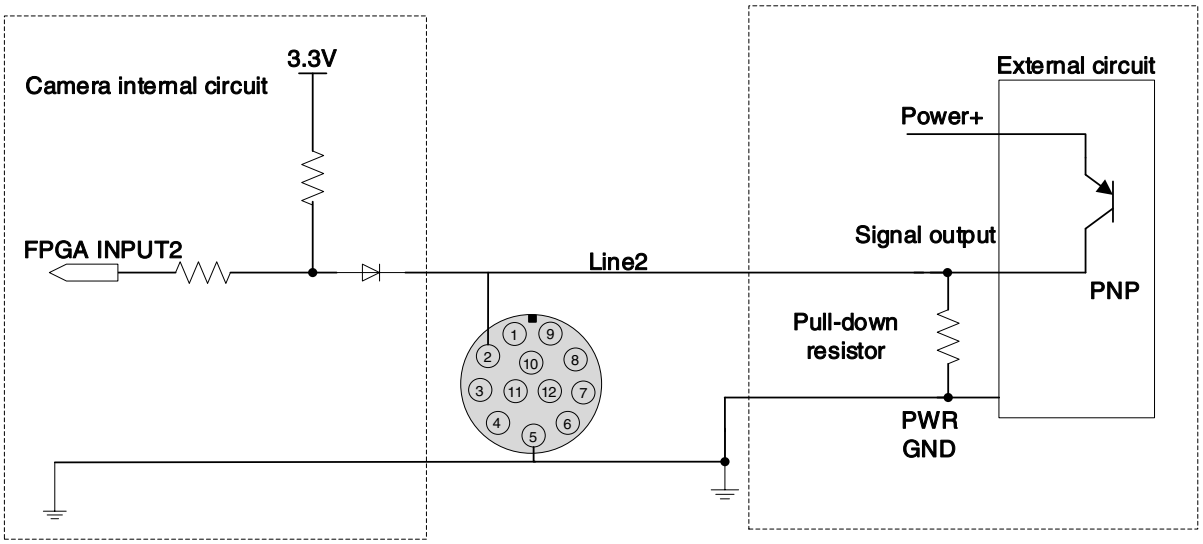


Figure 7-10 PNP photoelectric sensor connected to Line2 input circuit

When LIine2/3 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

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

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

Table 7-7 Transistor voltage drop (turn on, unit V) 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 (μs)		
Storage time (ts)	External power is 5V, pull-up resistor is 1kΩ	0.17	~	0.18
Delay time (td)		0.08	~	0.09
Rising time (tr)		0.11	~	0.16
Falling time (tf)		1.82	~	1.94
Rising time delay = tr+td		0.19	~	0.26
Falling time delay = tf+ts		1.97	~	2.09

Table 7-8 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.

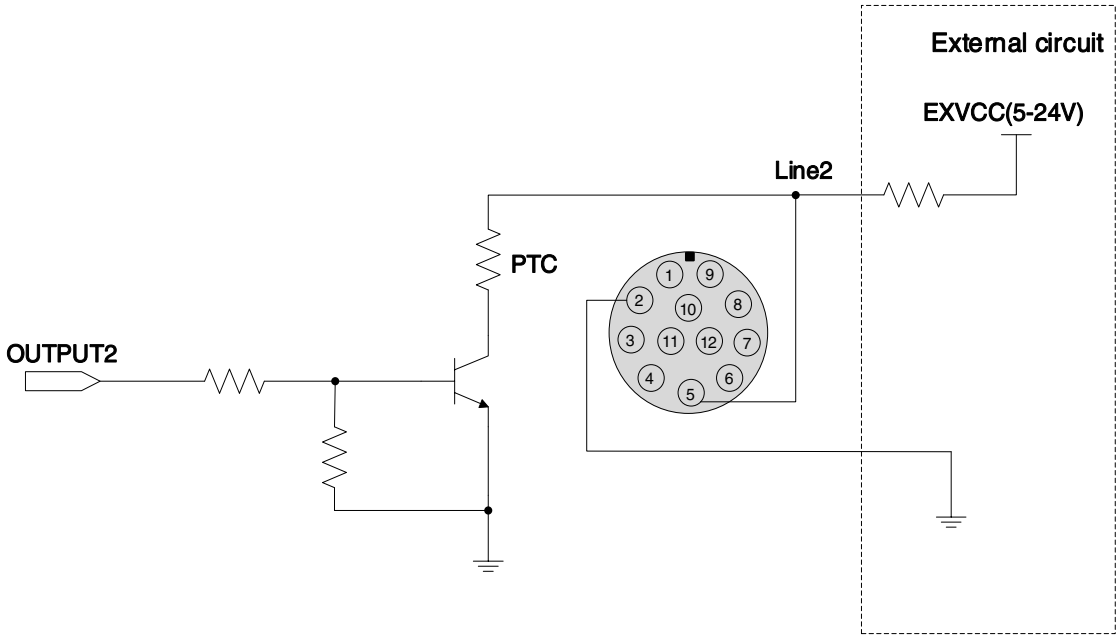


Figure 7-11 Internal equivalent circuit of camera when Line2 is configured as output

8. Features

8.1. I/O Control

8.1.1. Input Mode Operation

1) Configuring Line as input

The MARS-G5-P 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 hardware trigger, the MARS-G5-P series camera has the hardware trigger filtering feature, including rising edge filtering and falling edge filtering. The user can set the trigger filter feature by setting the " TriggerFilterRaisingEdge " and the " TriggerFilterFallingEdge ". The range of the trigger filter feature is [0, 5000] μs, step: 1μs.

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

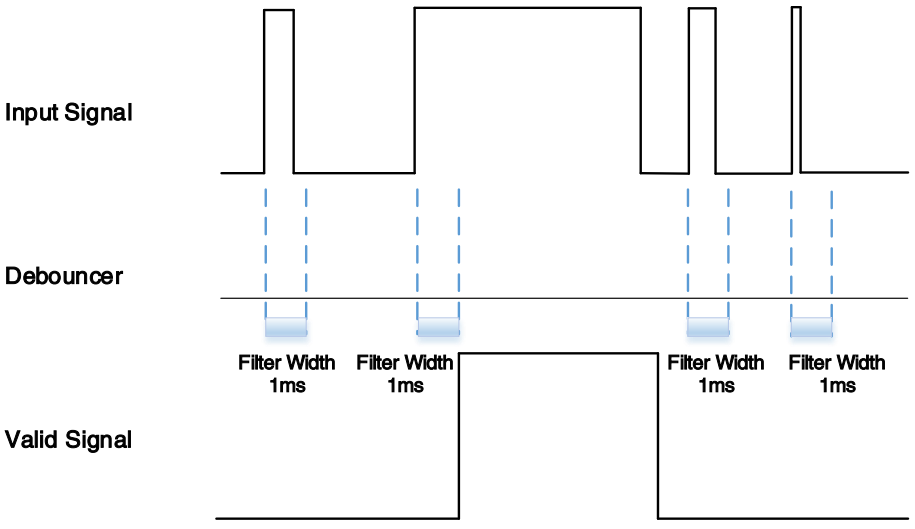


Figure 8-1 Input debouncer schematic diagram

3) Trigger Delay

The MARS-G5-P 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 1: Setting the trigger delay value to 1000ms, and the trigger signal will be valid after 1000ms delay, as shown in Figure 8-2.

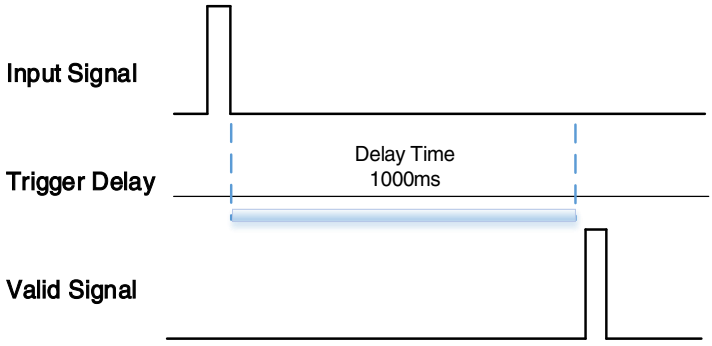


Figure 8-2 Trigger delay schematic diagram

4) Input Inverter

The signal level of input lines is configurable for the MARS-G5-P series camera. The user can select whether the input level is reverse or not by setting "LineInverter".

For the MARS-G5-P 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:

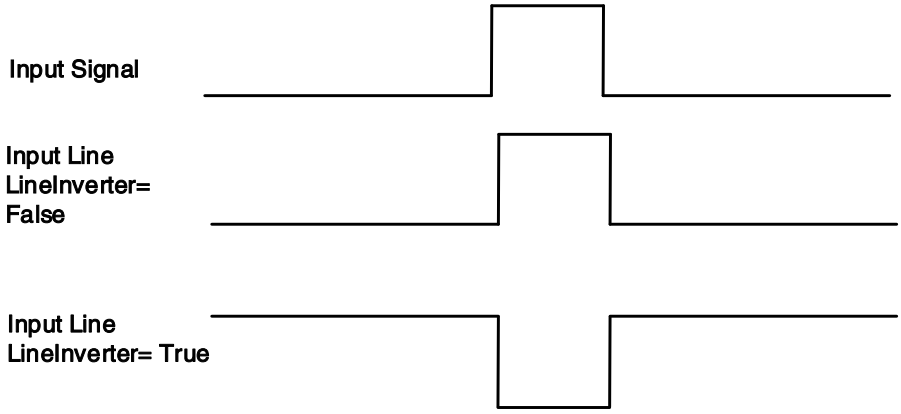


Figure 8-3 Setting input line reverse

8.1.2. Output Mode Operation

1) Configuring Line as output

The MARS-G5-P 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.

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

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

- Strobe

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

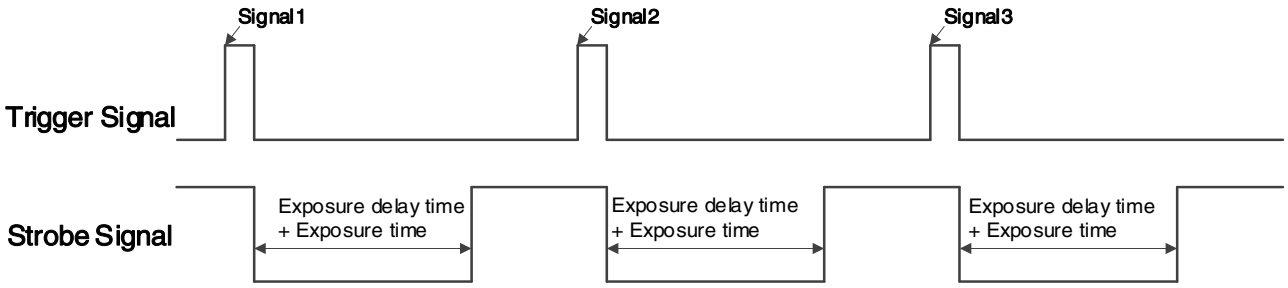


Figure 8-4 Strobe signal schematic diagram

- UserOutput

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

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

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

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

The MARS-G5-P 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 MARS-G5-P 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 8-5.

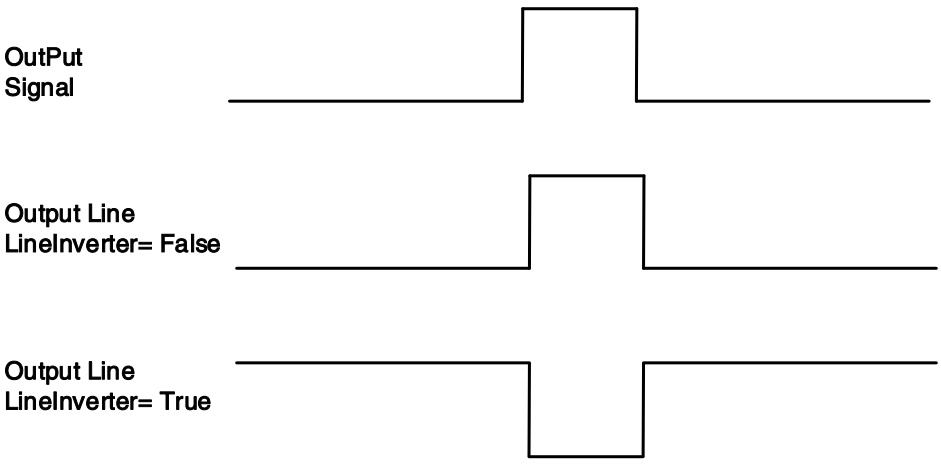


Figure 8-5 Set output line reversion

8.1.3. Read the LineStatus

1) Read the level of single line

The MARS-G5-P 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 MARS-G5-P 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 MARS-G5-P series camera are 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 8-6, and the acquisition process in trigger mode is illustrated in Figure 8-7.

- **Continuous Acquisition**

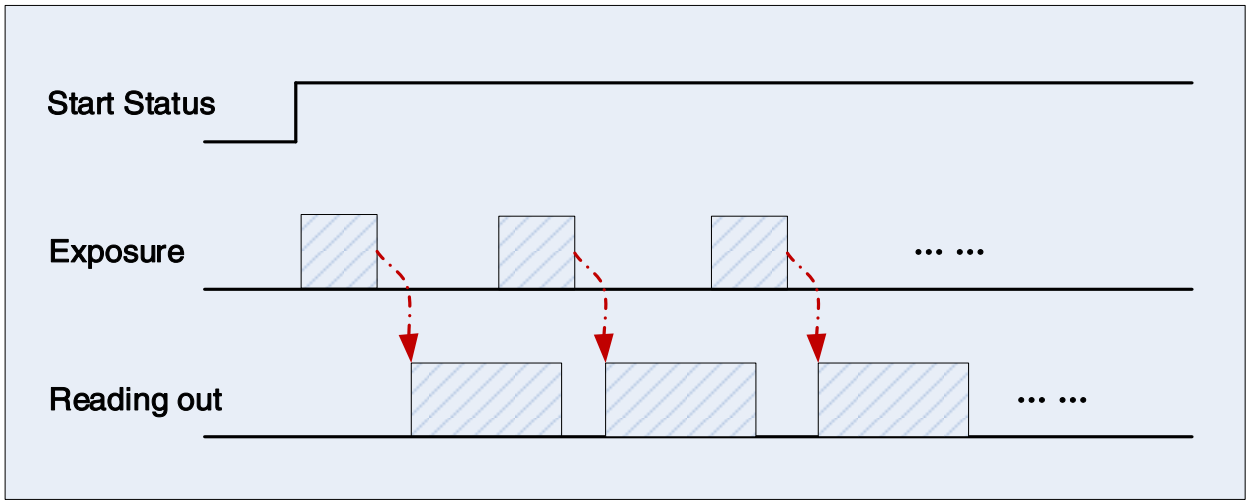


Figure 8-6 Continuous acquisition process

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

- **Trigger Acquisition**

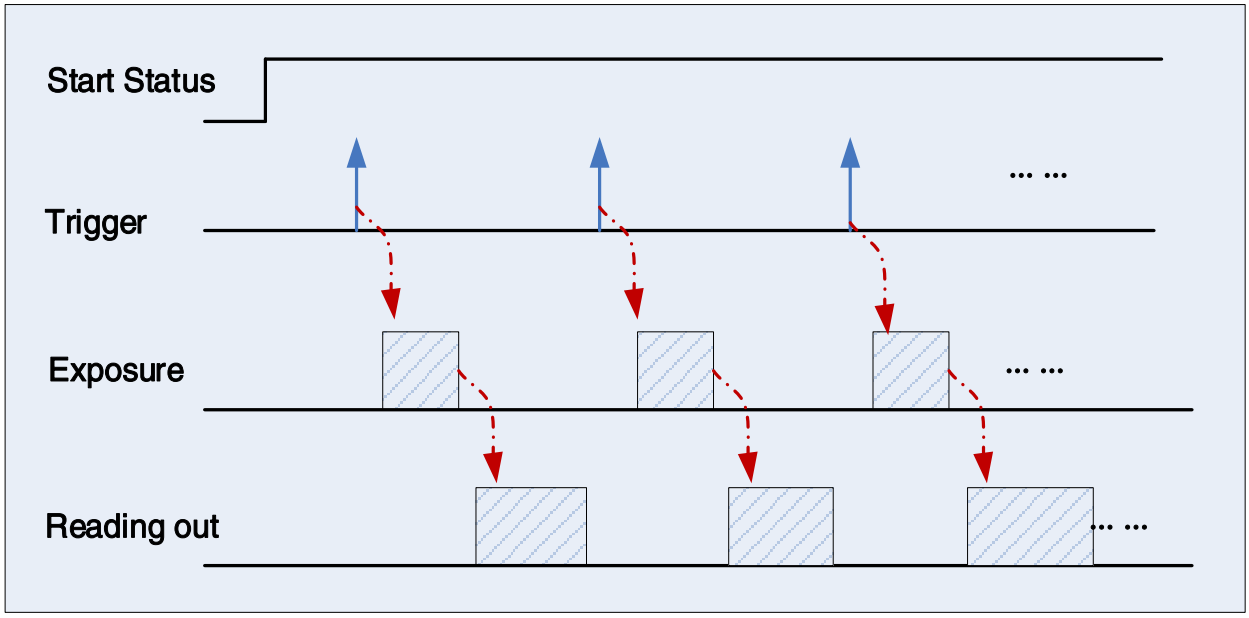


Figure 8-7 Trigger acquisition process

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

8.2.1.2. Acquisition Stop

It can send **AcquisitionStop** command to camera at any time. The acquisition stop process is irrelevant to acquisition mode. But different stop time will result in different process, as shown in Figure 8-8 and Figure 8-9.

- **Acquisition stop during reading out**

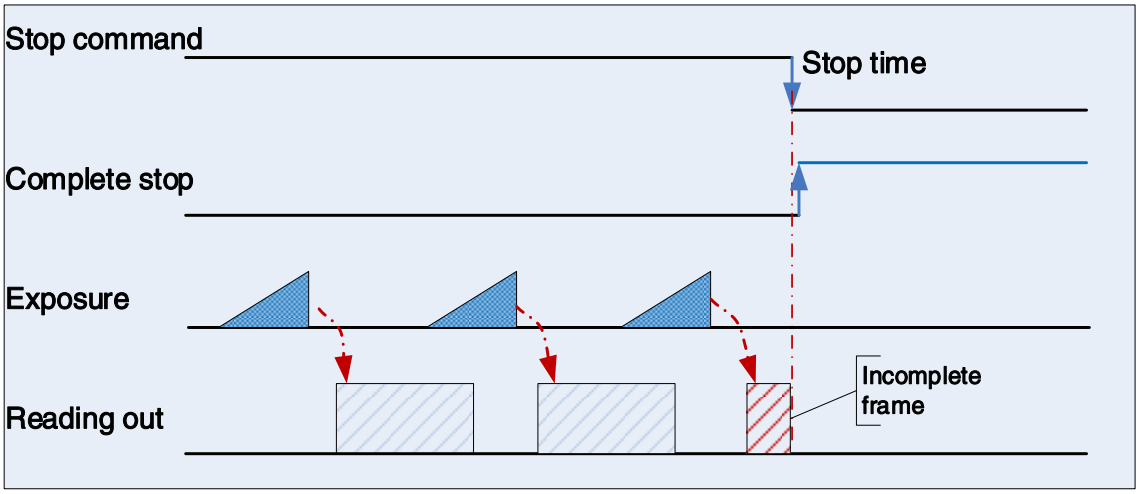


Figure 8-8 Acquisition stop during reading out

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

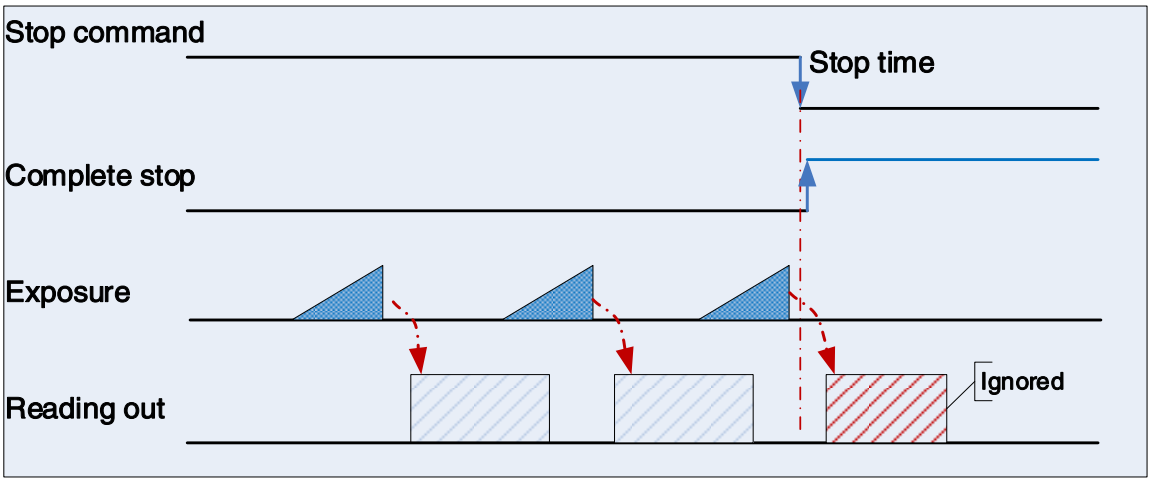


Figure 8-9 Acquisition stop during blanking

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

8.2.2. Acquisition Mode

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 hardware 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.

- 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 hardware trigger of the camera. Each time the camera receives a trigger signal, it can acquire a frame of image until the **AcquisitionStop** command is executed. It is not necessary to execute the **AcquisitionStart** command every time.

2) When the trigger mode is set to Off:

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

8.2.3. Switching Trigger Mode

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

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

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

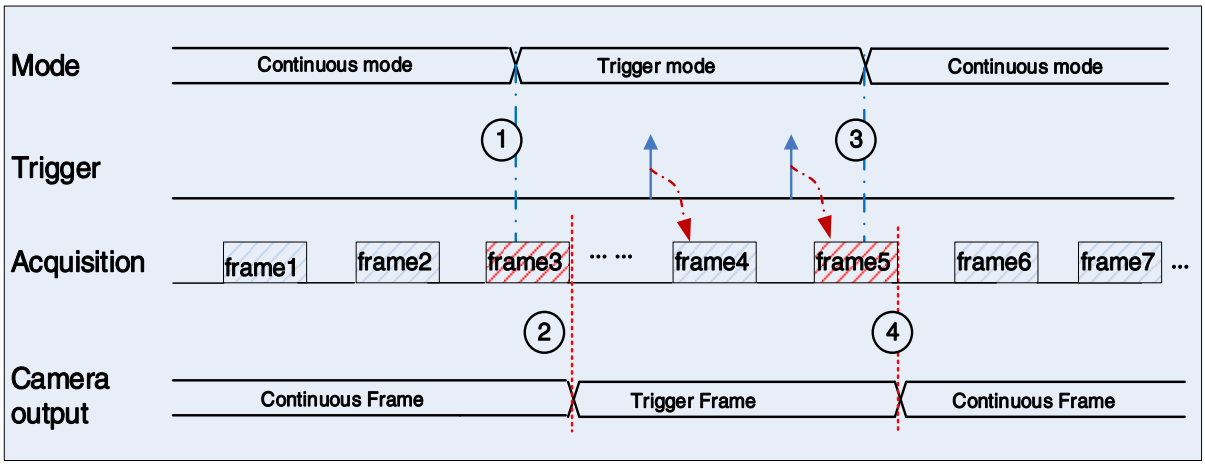


Figure 8-10 Switch trigger mode during frame reading out

As shown in Figure 8-10, the camera starts with trigger mode **OFF** after receiving acquisition start command.

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

- **Switch trigger mode during blanking (or exposure)**

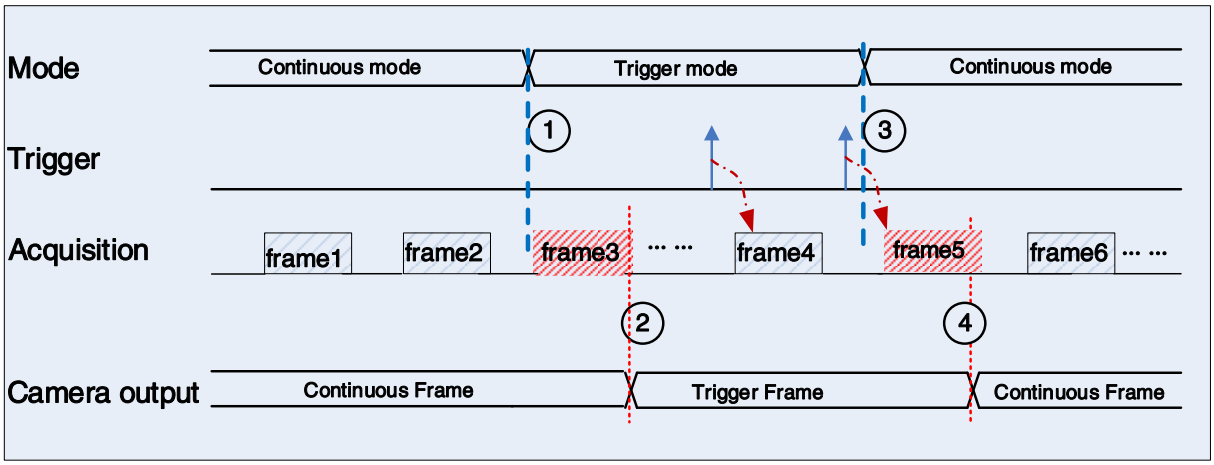


Figure 8-11 Switch trigger mode during blanking (or exposure)

As shown in Figure 8-11, the camera with trigger mode **OFF** begins after receiving an **AcquisitionStart** command.

At point 1, the camera gets a command of setting trigger mode **ON** while it is in wait state. The trigger mode is not active until the 3rd frame is finished (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.

8.2.4. Continuous Mode and Configuration

- **Continuous mode configuration**

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

8.2.5. Software Trigger Acquisition and Configuration

- **Software trigger acquisition configuration**

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

1) Set the Trigger Mode to ON.

2) Set the Trigger Source to Software.

3) Send Software Trigger command.

All the software trigger commands are sent by the host through the 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.

8.2.6. Hardware Trigger Acquisition and Configuration

- **Hardware trigger acquisition configuration**

The camera supports hardware 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 hardware 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.

- **Hardware trigger acquisition features**

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

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

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

3) The time interval between trigger and exposure can be 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.

- **Exposure delay**

When an hardware trigger signal is received to the sensor to start exposure, there is a small delay, which is called the exposure delay and consists of four parts of time, as shown in Figure 8-12.

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

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

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

T4: The sensor timing sequence delay, the internal exposure of the sensor is aligned with the row timing sequence, so T4 has a maximum row cycle jitter. The value of each sensor is different. Some products with large delay time (several hundred μs or more) have additional configuration time counted in T4.

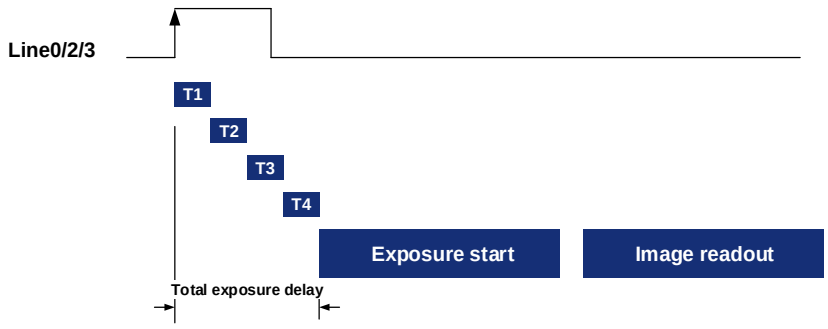


Figure 8-12 Exposure delay

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

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

T2 is calculated as 0μs.

T3 is calculated as 0μs.

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

The exposure delay data for each model is as follows:

Model	Exposure delay (μs)
MARS-1231-46G5M/C-P	17.8~24.2

Table 8-2 MARS-G5-P series camera exposure delay range

8.2.7. Set Exposure

- **Global Shutter**

The implementation process of global shutter is as shown in

Figure 8-13, all the lines of the sensor are exposed at the same time, and then the sensor will read out the image date one by one.

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

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

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

Figure 8-13 Global Shutter

- **Electronic Rolling Shutter**

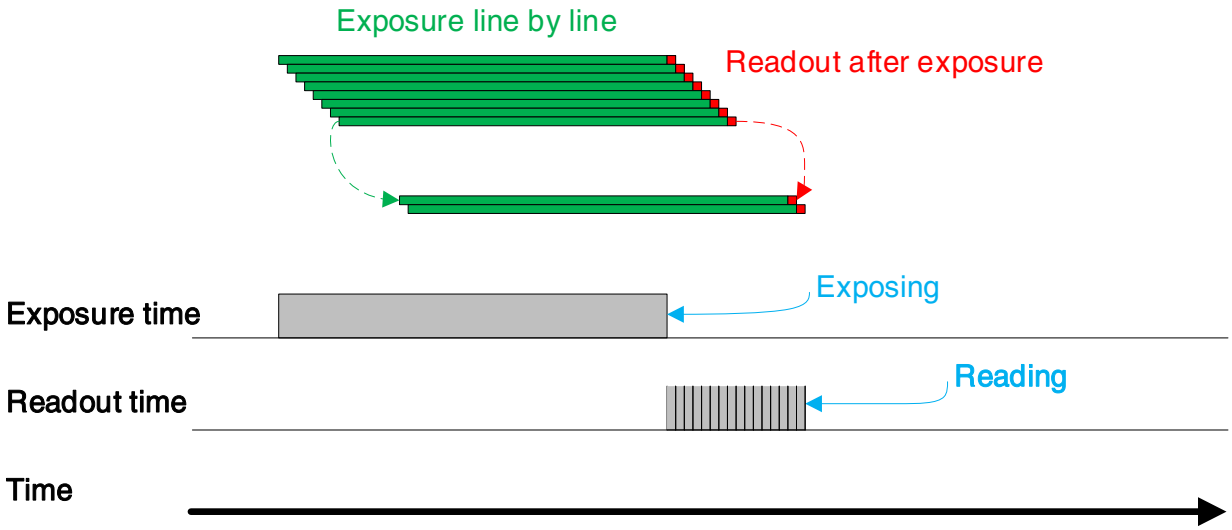


Figure 8-14 Electronic rolling shutter

The implementation process of electronic rolling shutter is as shown in Figure 8-14, different from the global shutter, electronic rolling shutter exposures from the first line, and starts the second line exposure after a row period. And so on, after N-1 line, the N line starts exposing. When the first line exposure ends, it begins to read out the data, and it need a row period time to read out one line (including the line blanking time). When the first line reads out completely, the second line just begins to read out, and so on, when the N-1 line is read out, the N line begins to read out, until the whole image is read out completely.

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

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

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

- **Setting the exposure time**

The MARS-G5-P series camera supports setting the exposure time, step: 1μs. The exposure time is shown as follows:

Model	Exposure Mode	Adjustment Range (μs)	Steps (μs)	Actual Steps
MARS-1231-46G5M/C-P	Global Shutter	21-1000000	1	1 row period*

Table 8-3 MARS-G5-P series camera exposure time setting range

The exposure precision of the camera is limited by the sensor, when the steps in the user's interface and the demo display as 1μs, actually the steps 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 21μs, setting 80μs exposure time, and the actual exposure time is 85μs.

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

quality. You can set the exposure time that is synchronized with the external light source by using the demo or interface function.

The MARS-G5-P series camera supports Auto Exposure feature. If the Auto Exposure feature is enabled, the camera can adjust the exposure time automatically according to the environment brightness. See section 8.3.4 for more details.

8.2.8. Overlap Exposure and Non-overlap Exposure

There are two stages in image acquisition of the MARS-G5-P 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 MARS-G5-P series camera supports two exposure modes: overlap exposure and non-overlap exposure. The user cannot assign the overlap exposure or non-overlap exposure directly, it depends on the frequency of trigger signal and the exposure time. The two exposure mode are described as below.

- **Non-overlap exposure**

In non-overlap 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 8-15, the N^{th} frame is read out, after a period of time, the $N+1^{th}$ frame to be exposed.

The formula of non-overlap exposure frame period:

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

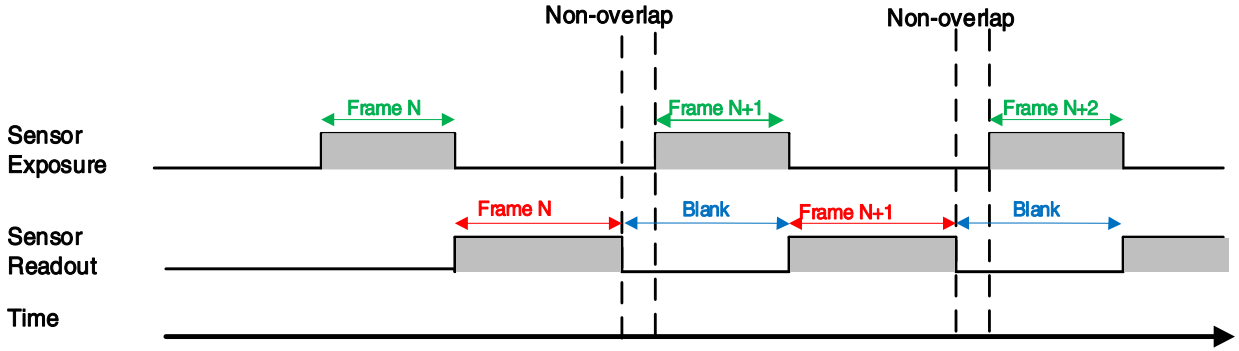


Figure 8-15 The exposure sequence diagram in non-overlap exposure mode

- **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 overlap exposure, as shown in Figure 8-16.

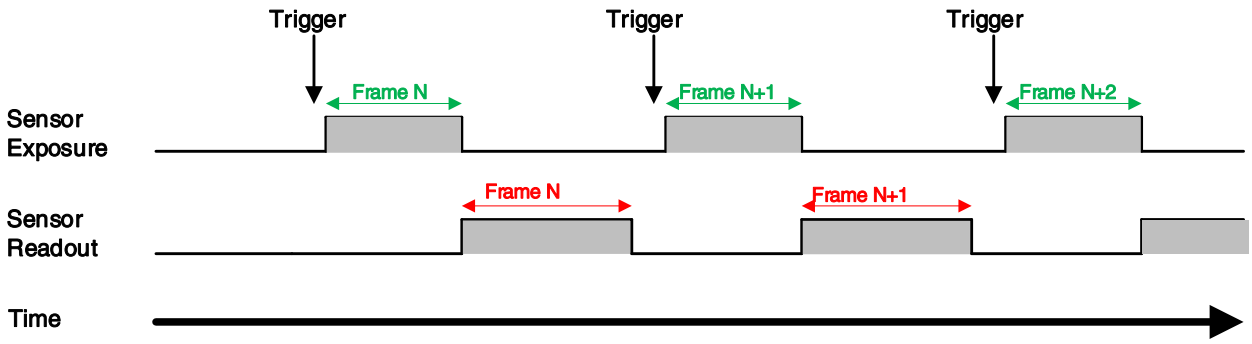


Figure 8-16 The trigger acquisition exposure sequence diagram in non-overlap exposure mode

- **Overlap exposure**

In overlap exposure mode, the current frame image exposure process is overlap with the readout of the previous frame. That is, when the previous frame is reading out, the next frame image has been started exposure. As shown in the Figure 8-17, when the N^{th} frame image is reading out, the $N+1^{th}$ frame image has been started exposure.

The formula of overlap exposure frame period:

overlap exposure frame period ≤ exposure time + readout time

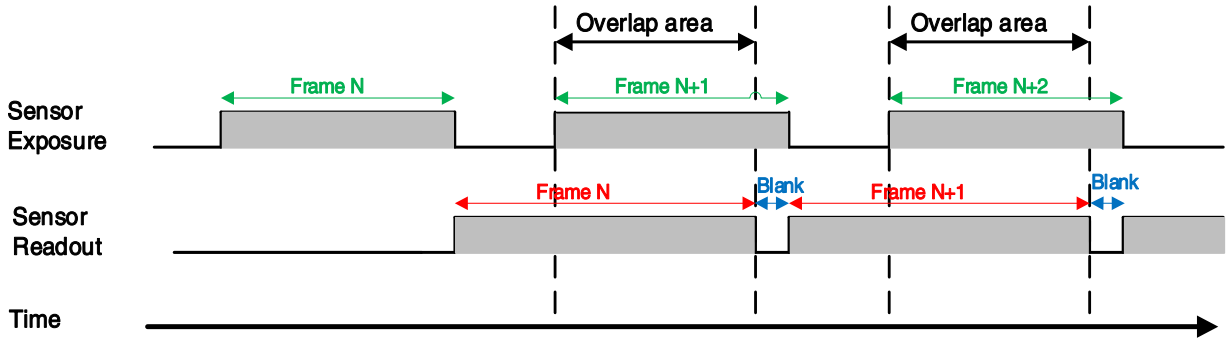


Figure 8-17 The exposure sequence diagram in overlap exposure mode

- **Continuous acquisition mode**

If the exposure time is greater than the frame blanking time, the exposure time and the readout time will be overlapped. As shown in the Figure 8-17.

- **Trigger acquisition mode**

When the interval between two triggers is less than the sum of exposure time and the readout time, it will occur overlap exposure, as shown in Figure 8-18.

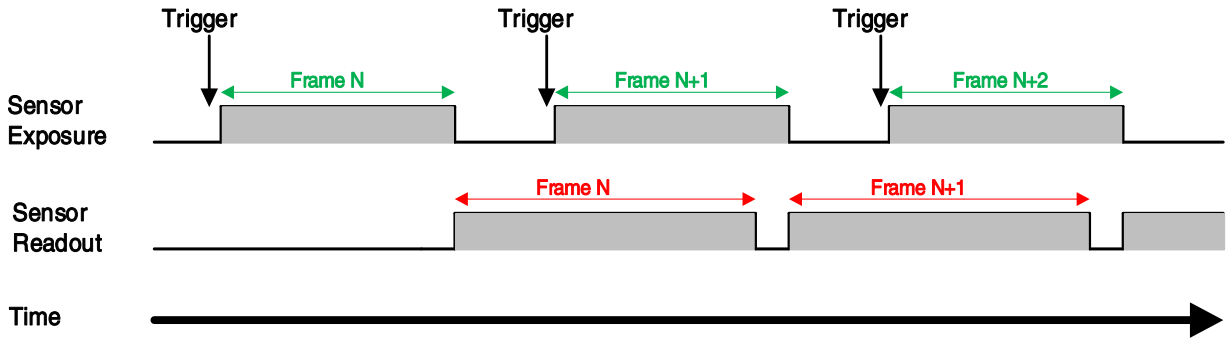


Figure 8-18 The trigger acquisition exposure sequence diagram in overlap exposure mode

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

8.3. Basic Features

8.3.1. Gain

The MARS-G5-P series camera can adjust the analog gain, and the range of analog gain is as follows:

Model	Adjustment Range	Default/Steps
MARS-1231-46G5M/C-P	0-24dB	0dB, 0.1dB

Table 8-4 MARS-G5-P series camera analog gain adjustment range

When the analog gain changes, the response curve of the camera changes, as shown in Figure 8-19. The horizontal axis represents the output signal of the sensor in the camera, and the vertical axis represents the gray value of the output image. When the amplitude of the sensor output signal remains constant, increasing the gain makes the response curve steeper, and that makes the image brighter. For every 6dB increases of the gain, the gray value of the image will double. For example, when the camera has a gain of 0dB, the image gray value is 126, and if the gain is increased to 6dB, the image gray will increase to 252. Thus, increasing gain can be used to increase image brightness. 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.

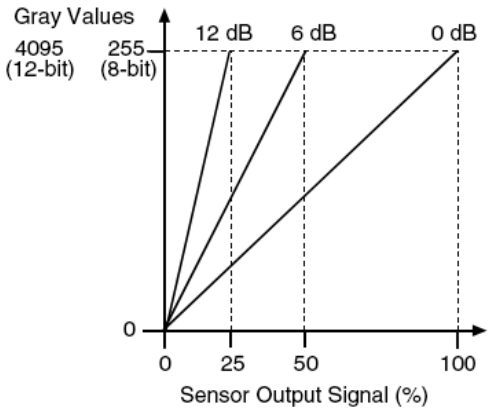


Figure 8-19 The cameras response curve

8.3.2. Pixel Format

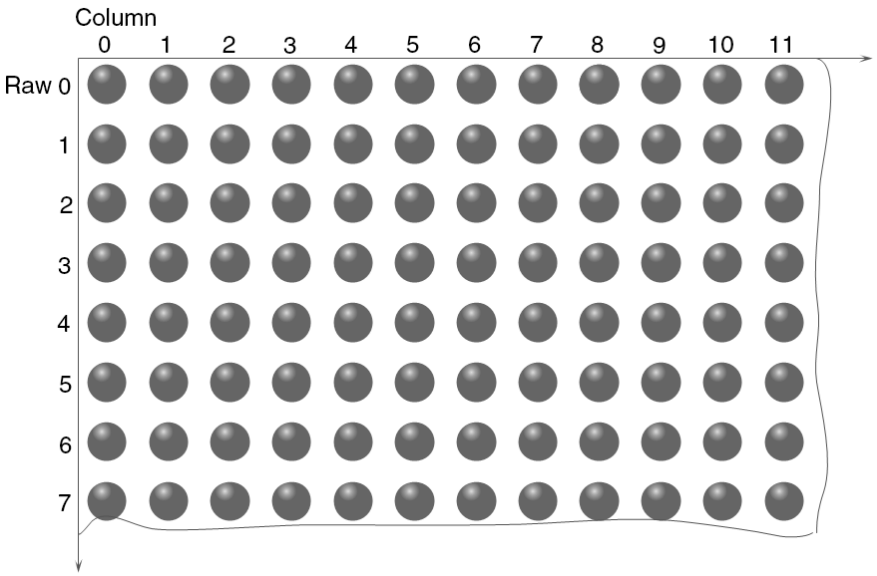
By setting the pixel format, the user can select the format of output image. The available pixel formats depend on the camera model and whether the camera is monochrome or color. The following table shows the pixel format supported by the camera.

Model	Pixel Format
MARS-1231-46G5M/C-P	Mono8, Mono10, BayerRG8, BayerRG10

Table 8-5 Pixel format that the MARS-G5-P 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



When the pixel format is set to Mono8, the brightness value of each pixel is 8bits. 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…

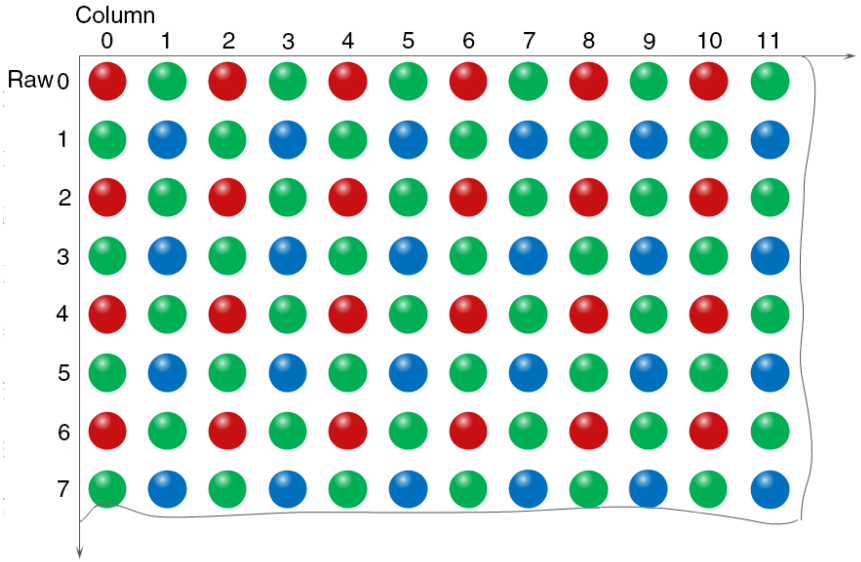
- **Mono10/Mono12**

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**



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**

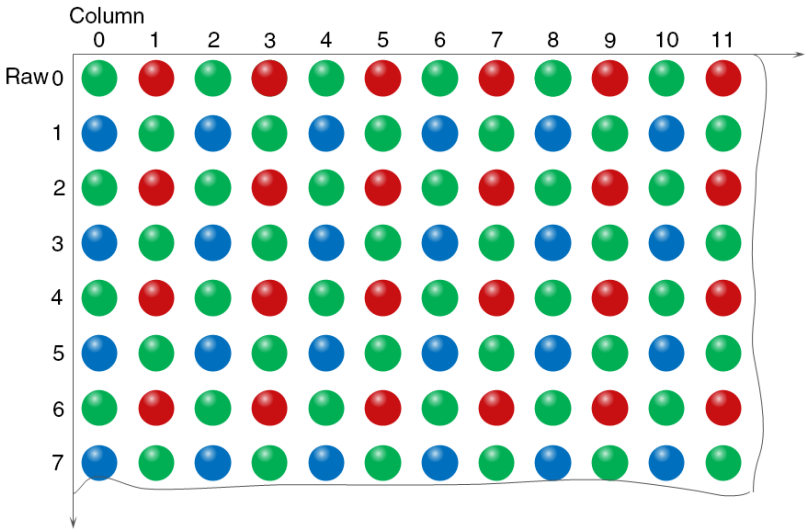
When the pixel format is set to BayerRG10 or BayerRG12, the value of each pixel in the output image of the camera is 16 bits. According to the location difference, the three components of red, green and blue are respectively represented. The format in the memory is as follows:

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.

- **BayerGR8**



When the pixel format is set to BayerGR8, 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:

G00	R01	G02	R03	G04	……
B10	G11	B12	G13	B14	……
……					

Where G00 is the first pixel value of the first row (for the green component), R01 represents the second pixel value (for the red component), and so on, so that the first row pixel values are arranged. B10 is the first pixel value of the second row (for the blue component), the G11 is the second pixel value (for the green component), and so on, and the second row of pixel values are arranged.

- **BayerGR10/BayerGR12**

When the pixel format is set to BayerGR10 or BayerGR12, 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:

G00	R01	G02	R03	G04	……
B10	G11	B12	G13	B14	……
……					

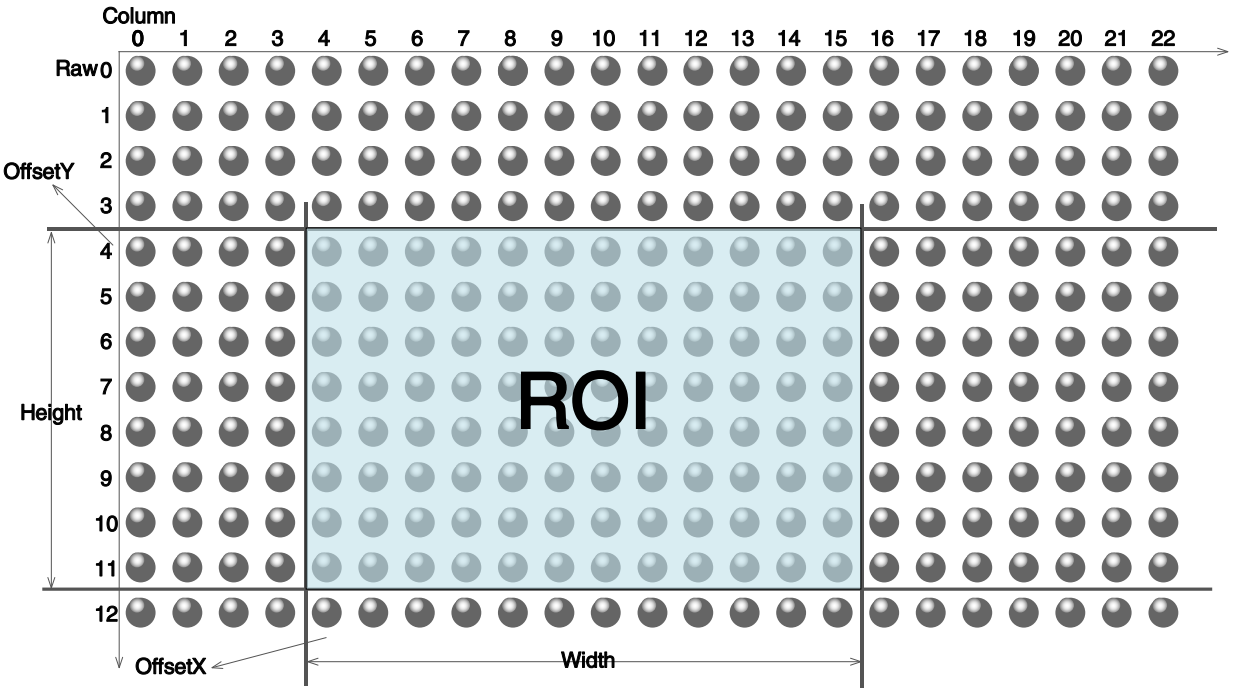
Each pixel is the same as BayerGR8, the difference is that each pixel is made up of two bytes, the first byte is the low 8 bits of the pixel value, and the second byte is the high 8 bits of the pixel value.

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.



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:

$$AAROIWidth + AAROIOffsetX \leq Width$$

$$AAROIHeight + AAROIOffsetY \leq Height$$

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

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

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

$$AAROIOffsetX = 100$$

$$AAROIOffsetY = 50$$

$$AAROIWidth = 640$$

$$AAROIHeight = 480$$

The relative position of the ROI and the image is shown in Figure 8-20.

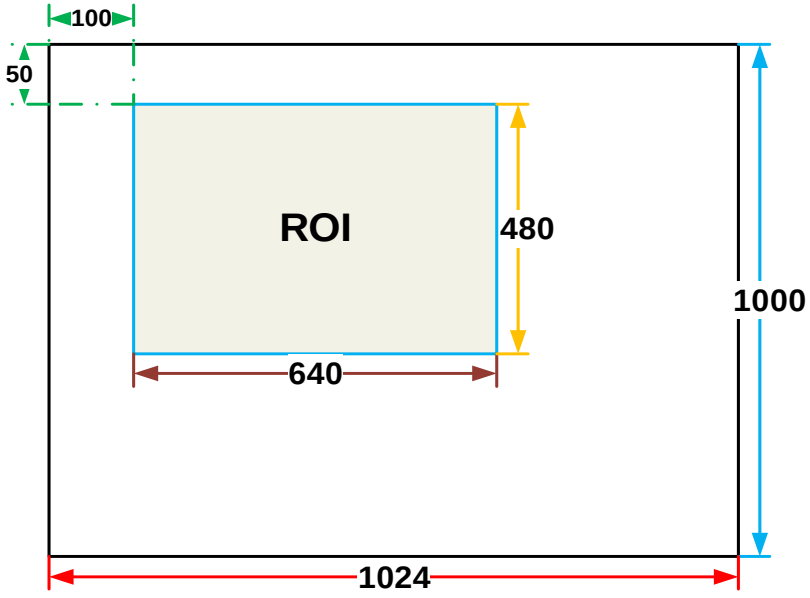


Figure 8-20 An example for the relative position between the ROI and the current image

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 continuous 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:

$$AAROIWidth+ AAROIOffsetX \leq Width$$

$$AAROIHeight+ AAROIOffsetY \leq Height$$

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

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

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

$$AAROIOffsetX = 100$$

$$AAROIOffsetY = 50$$

$$AAROIWidth = 640$$

$$AAROIHeight = 480$$

The relative position of the ROI and the image is shown in Figure 8-21.

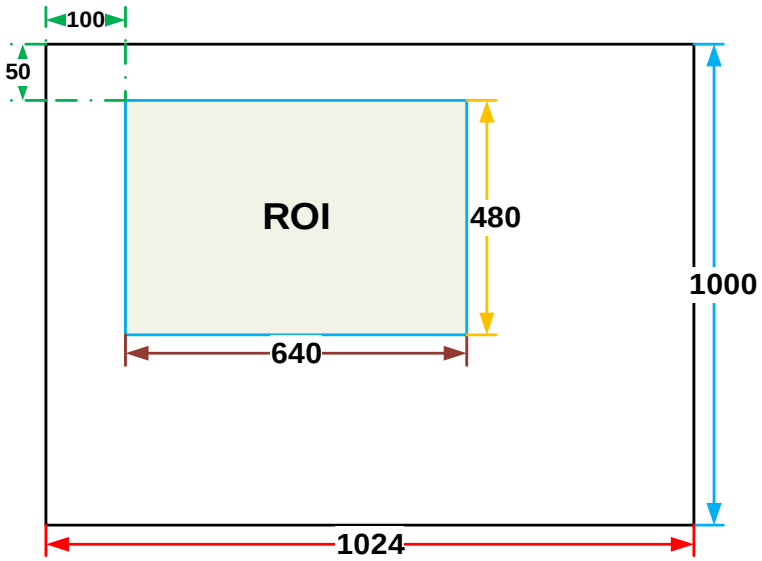


Figure 8-21 An example for the relative position between the ROI and the current image

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 MARS-G5-P 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 8-22:

Figure 8-22 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 8-23:

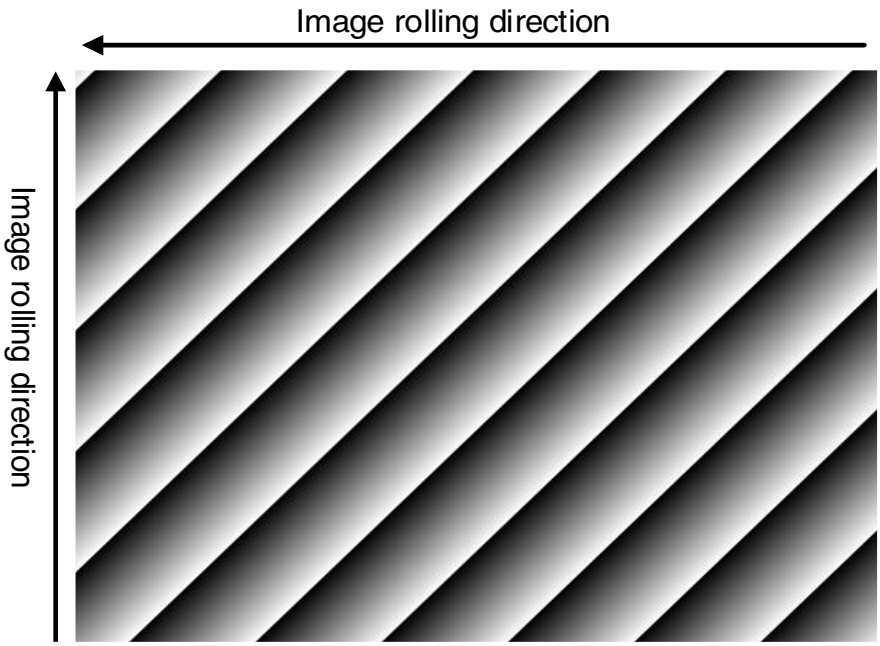


Figure 8-23 Moving diagonal gray gradient test image

- **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 8-24.

Figure 8-24 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 MARS-G5-P series camera provides a function to save the parameter set, which can easily save the parameters that the user use, including the control parameters that the camera needed. There three types of configuration parameters: the currently effective configuration parameters, the vendor default configuration parameters (Default), and the user configuration parameters (UserSet).

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

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 MARS-G5-P 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
- PixelFormat
- OffsetX, OffsetY, ImageWidth, ImageHeight
- GevSCPSPacketSize, GevSCPD
- TriggerMode, TriggerSource, TriggerPolarity, TriggerDelay
- TriggerFilterRaisingEdge, TriggerFilterFallingEdge
- LineMode, LineInverter, LineSource, UserOutputValue
- FrameBufferOverwriteActive
- TestPattern
- ExpectedGrayValue
- ExposureAuto, AutoExposureTimeMax, AutoExposureTimeMin
- GainAuto, AutoGainMax, AutoGainMin
- AAROIOffsetX, AAROIOffsetY, AAROIWidth, AAROIHeight
- BalanceWhiteAuto, AWBLampHouse
- AWBROIOffsetX, AWBROIOffsetY, AWBROIWidth, AWBROIHeight
- BalanceRatio(R/G/B)

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 MARS-G5-P 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 “GigE IP Configurator”:

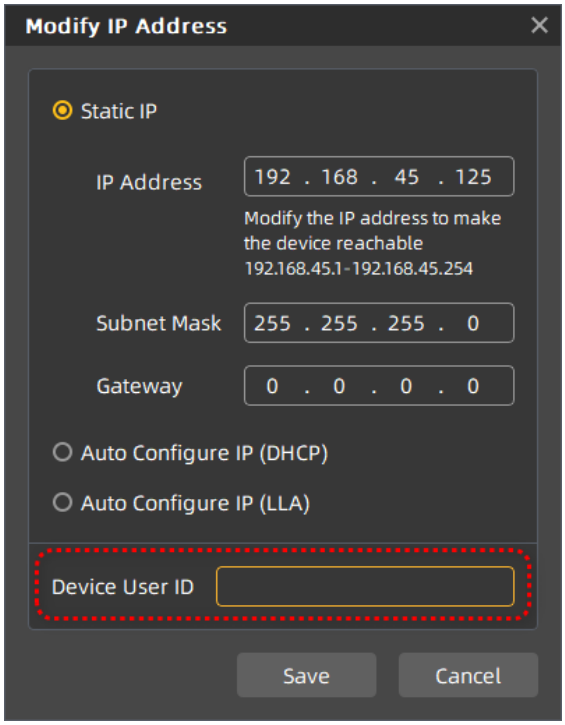


Figure 8-25 IP Configurator

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 1ns.

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. 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, reducing bandwidth usage, and increasing the frame rate.

- **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.

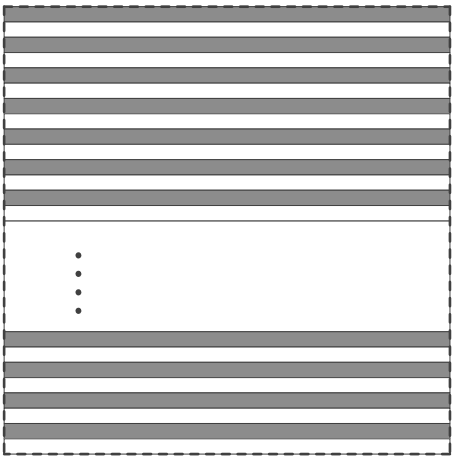


Figure 8-26 Mono camera vertical Decimation

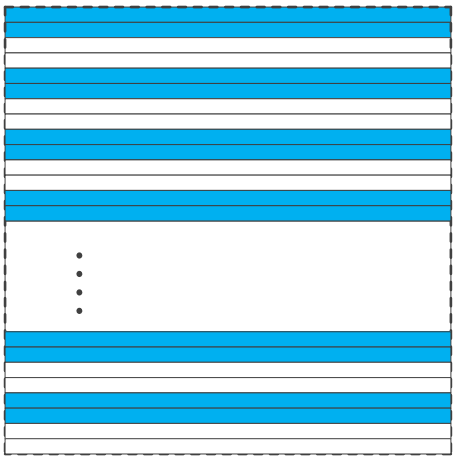


Figure 8-27 Color camera vertical Decimation

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.

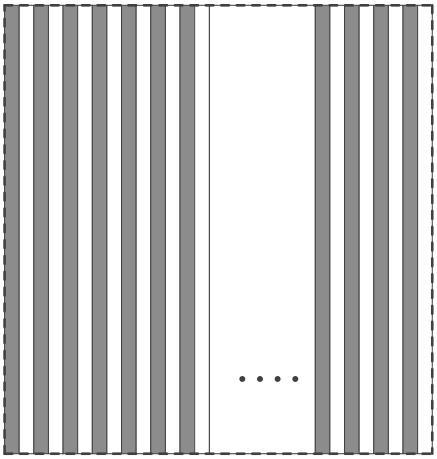


Figure 8-28 Mono camera horizontal Decimation

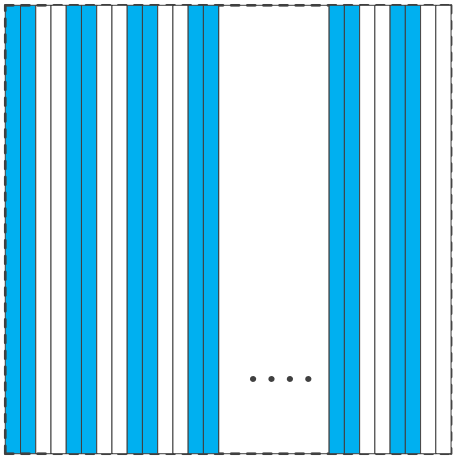


Figure 8-29 Color camera horizontal Decimation

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

The ROI feature and the Decimation feature cannot be used simultaneously. Taking MARS-1231-46G5M/C-P as an example, the camera's default resolution is 4096×3000. Regardless of the camera's ROI settings, when horizontal Decimation by 2 and vertical Decimation by 2 are enabled, the ROI size would be fixed to 2048×1500, which is the result of enable Decimation under the default resolution, and

the ROI cannot be set at this time. When horizontal Decimation by 1 and vertical Decimation by 1 are enabled, the effective resolution of the sensor is restored to 4096×3000. As shown in Figure 8-30.

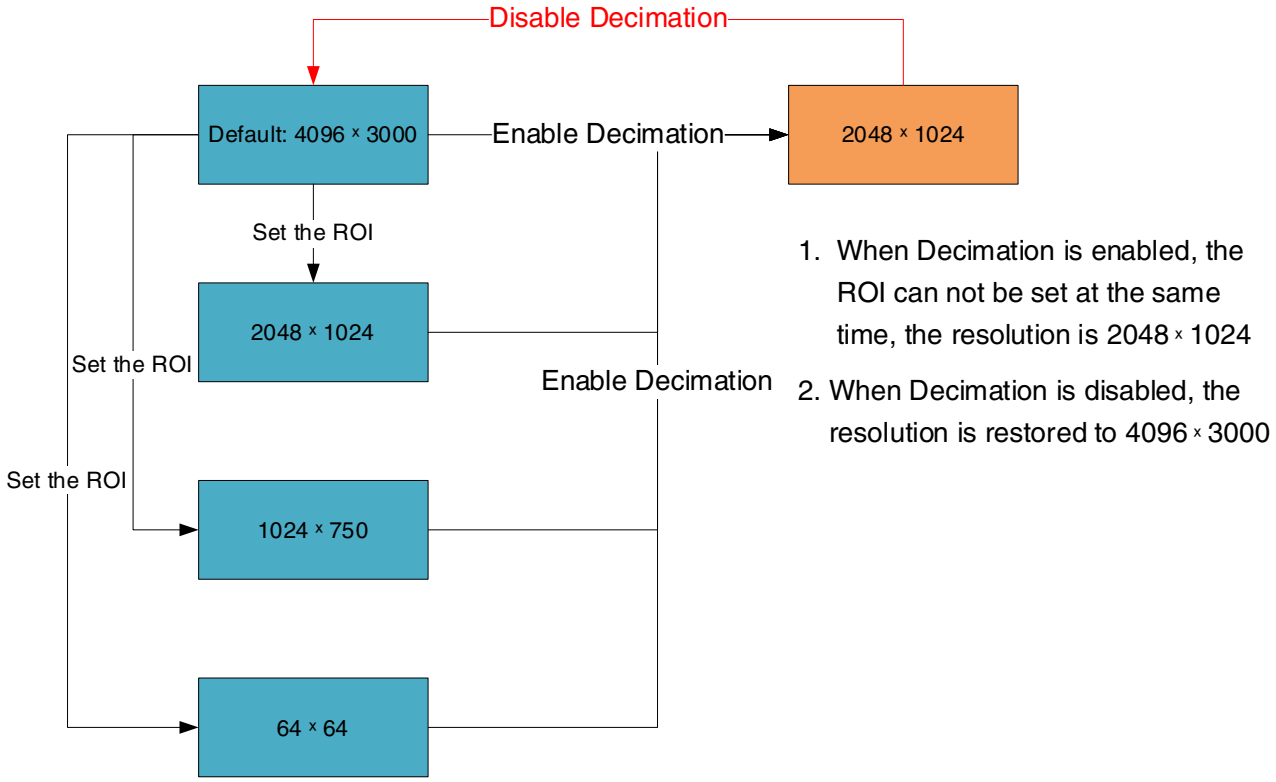


Figure 8-30 Schematic diagram of the relationship between ROI and Decimation

2) Simultaneous horizontal Decimation and vertical Decimation settings

Horizontal Decimation and vertical Decimation cannot be set separately. When one of them is modified, the other will change to the same value. That is, you can only set horizontal Decimation and vertical Decimation to ON or OFF at the same time.

3) Reduced resolution

Using Decimation effectively reduces the resolution of the camera's imaging sensor. Taking MARS-1231-46G5M/C-P as an example, the camera's default resolution is 4096×3000. When horizontal Decimation by 2 and vertical Decimation by 2 are enabled, the effective resolution of the sensor is reduced to 2048×1500.

4) Increased frame rate

The Decimation feature will increase the frame rate of the camera. Taking MARS-1231-46G5M/C-P as an example, the camera's default frame rate is 43.3fps. When horizontal Decimation by 2 and vertical Decimation by 2 are enabled, and the exposure time is less than 7ms, the frame rate of the camera is increased to 127.7fps.

5) 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.

8.3.11. 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
MARS-1231-46G5M/C-P	0-1023	3

Table 8-6 MARS 5GigE series camera black level adjustment range

8.4. Image Processing

8.4.1. Defect Pixel Correction

Due to the technical defects of the image sensor, the camera has defect pixels. Some of these defect pixels are fixed at the same gray value and do not change with the scene, which are called dead pixels. In acquired images, some pixels may appear significantly brighter or darker than the rest, even if uniform light is used, resulting in a significant difference between the gray value and the surrounding pixels, which is called dark pixels or bright pixels.

The defect pixel correction feature minimizes the influence of these sensitivity differences. The camera identifies pixels that have a significantly higher or lower intensity value than their neighboring pixels ("outlier pixels") and adjusts their intensity value.

The defect pixels affect the visual experience and further image processing. The MARS series cameras have very few defect pixels. The default switch status is off. If the gain is too large or a higher quality image is required, the defect pixels correction can be set to on.

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 MARS-G5-P 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 4096*3000, the pixel format is BayerRG8, packet size is 1500 bytes, packet delay is 0, and reserved bandwidth is 10%. The current valid network bandwidth is 4500Mbps.

The maximum allowable frame rate of the network = 4500Mbps / (4096×3000)/8 = 46 fps

The maximum allowable frame rate of the network is 46fps, and the MARS-1231-46G5M/C-P camera meets the front-end sensor's maximum acquisition frame rate of 46fps. In addition to the limitations of network bandwidth, the maximum working frame rate of the camera is affected by the following two factors:

- 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.

The specific calculation formulas are as follows:

- MARS-1231-46G5M/C-P

Row period (unit: μs):

$$T_{row}=\frac{240}{37.5}=6.4$$

Camera acquisition time (unit: μs):

$$T_{acq}=(height+54)\times T_{row}$$

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: for MARS-1231-46G5M/C-P camera, when the exposure time is 200ms, the corresponding frame rate is 5fps.

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. When the link speed is 5Gbps or 2.5Gbps, the recommended maximum SCPS can be set to 16384 bytes, which can improve the network transmission performance. And when the link speed is 1Gbps, the maximum SCPS can be set to 1500 bytes.

1) When the packet size is set to more than 1500 bytes, 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:

$$T_{data} = (Size_{pkt} \times 8\ bits) / Speed_{link}$$

The time of packet delay is:

$$T_{delay} = Delay_{pkt} / 1{,}000{,}000{,}000$$

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

Effective network bandwidth:

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

Example 1: The packet size is 1500, the packet delay is 1000, the reserved bandwidth is 20%, and the link speed is 5Gbps.

The time to transport a single stream packet is:

$$T_{data} = (1500 \times 8) / 5{,}000{,}000{,}000 = 2.4us$$

The time of packet delay is:

$$T_{delay} = 1000 / 1{,}000{,}000{,}000 = 1us$$

The effective network bandwidth is:

$$BandW_{avial} = (1464 \times 8 \times (1 - 0.2)) / (2.4us + 1us) = 2755Mbps$$

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 5Gbps.

The time to transport a single stream packet is:

$$T_{data} = (8192 \times 8) / 5{,}000{,}000{,}000 = 13us$$

The time of packet delay is:

$$T_{delay} = 2000 / 1{,}000{,}000{,}000 = 2us$$

The effective network bandwidth is:

$$BandW_{avial} = (8156 \times 8 \times (1\text{-}0.2)) / (13us + 2us) = 3479Mbps$$

1) The packet delay time cannot be greater than the packet timeout and the block timeout.
2) The packet delay time should be less than the packet timeout + 20(ms).
3) The packet delay time should be less than the block timeout + 20(ms).

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 5Gbps, setting the reserved bandwidth value to 20%, then the bandwidth will be reserved to 1Gbps. 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.

9. Software Tools

9.1. GigE IP Configurator

You can set the IP Address and IP Configuration by **GxGigEIPConfig.**

- **Guidance**

Menu bar → Tools → GxGigEIPConfig, see Figure 9-1:

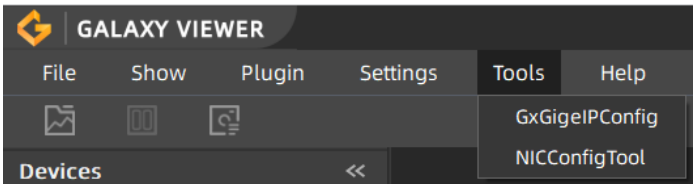


Figure 9-1

See GxGigEIPConfig interface as Figure 9-2:

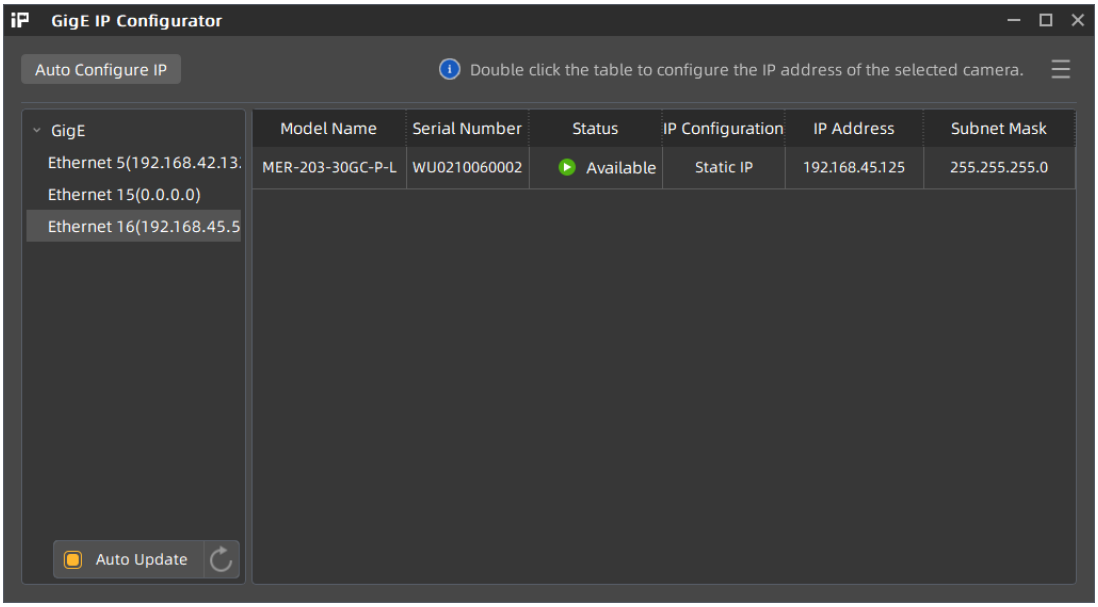


Figure 9-2 GxGigEIPConfig interface

The left side of the interface is device list, showing all searched GigE (Gigabit Ethernet)

1. When GigE is selected, all GigE cameras will be shown in the right side.
2. When selecting a certain GigE, the right side will only show the corresponding GigE cameras, and if you want to change the Ethernet attributes, just right click it.

Note:

1. **Auto Update** will enumerate devices automatically in every 2s, you can also click " " to update devices manually.

2. The essential information are listed in the right side, click “ ☰ ” in the top right-hand corner to set.

- **Status and operations**

Status: Available, Read Only, Occupy, Unreachable, Unknown.

Operations: Auto Configure IP, Modify IP Address, Release Occupation, Reset Device.

Icon	Status	Description	Operation
	Available	When the camera is not opened in Exclusive or Control mode by other processes. And the camera IP can be modified manually	1. Modify IP Address 2. Reset Device
	Read Only	When the camera is opened in Control mode by other processes. By this time, the Auto Configure IP and Modify IP Address will be forbidden	1. Release Occupation 2. Reset Device
	Occupy	When the camera is opened in Exclusive mode by other processes. By this time, the Auto Configure IP and Modify IP Address will be forbidden	1. Release Occupation 2. Reset Device
	Unreachable	Three conditions when in Unreachable status: 1. The current camera IP is same as other camera IP 2. The current camera IP is same as network card IP 3. The current camera IP and the connected network card are not in the same subnet	1. Modify IP Address 2. Auto Configure IP
	Unknown	Cannot get the current accessible state for some reason	1. Modify IP Address

Table 9-1 Device status description

Valid IP: Non LLA address, non 0.0.0.0.

- **Auto Configure IP**

By this function, all unreachable camera’s IP will be changed to the effective IP, which has the same network segment as the PC network port.

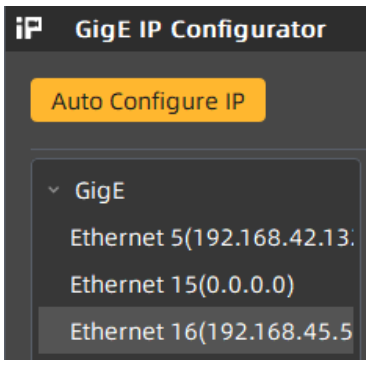


Figure 9-3

Note: If the host network card IP is invalid, then after Auto Configure IP operation, it will be valid.

- **Modify IP Address**

Users can double click the row of the camera in the list, the window as Figure 9-4:

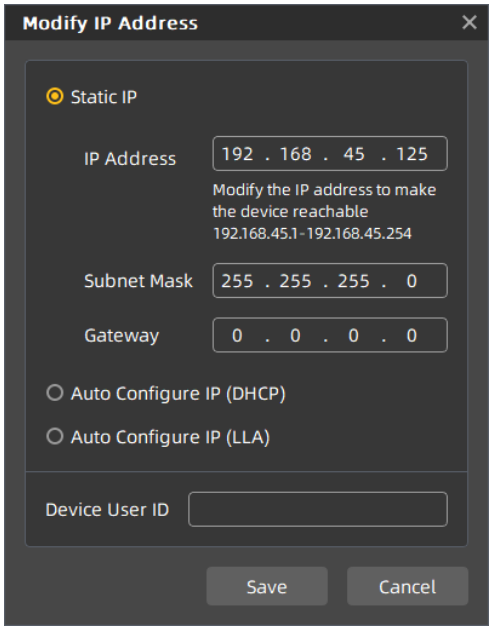


Figure 9-4 Modify IP Address

The default setting is **Static IP**, and in here, users can set **IP Address**, **Subnet Mask** and **Gateway**.

Note: It is restrict to set the IP as: class D (224~239), Class E (240~254), IP start with 127 or 255. There will be an error prompt if you set the restrict IP or wrong format IP, in this case, **Save** is not available. See Figure 9-5:

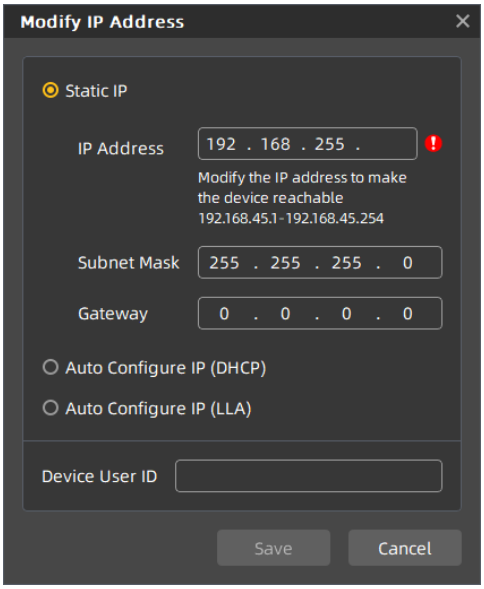


Figure 9-5 IP address format check

Users can set Static IP, DHCP or LLA according to their needs.

IP Configuring Type	Description
Static IP	Default configuration, which is saved in the camera Flash sensor and cannot be changed while power on/off
DHCP	When start with DHCP, please ensure that DHCP server is configured in your network environment, otherwise, the camera will restart in LLA address after waiting DHCP server assign IP overtime. But when DHCP server occurs, the camera IP will switch to DHCP assigned address, the default factory configuration of the camera is DHCP
LLA	Link-local address, which is used for local network communication, not forwarded through routing

Optional operation: Modify Device User ID, the maximum length of user-defined name is 16 characters.

Release Occupation: The camera heart beat time is 5min by default (VS develop, in debugging status). If users forcibly exits the process without closing the camera, then the camera cannot be resetting immediately, unless the 5min heart beat time is over, and by then, the camera is in Occupy or Unreachable status. Users can double click the row of the camera in the list to release the camera and open the camera again.

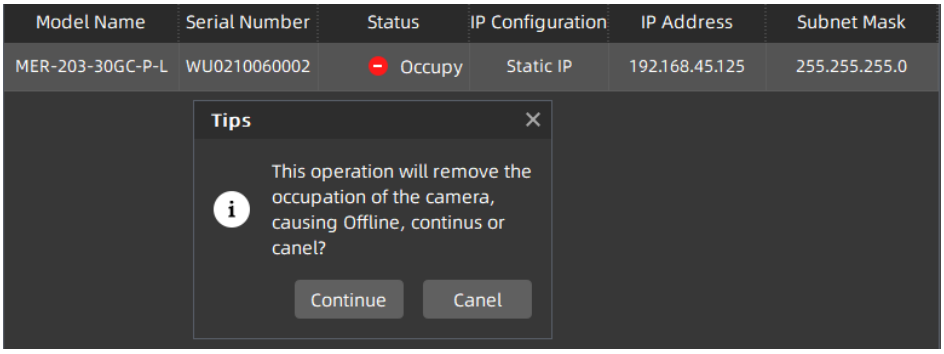


Figure 9-6

Reset Device: While users need to reload the camera and the device is not convenient to power off, then right click the row of the camera in the list and click Reset Device button.

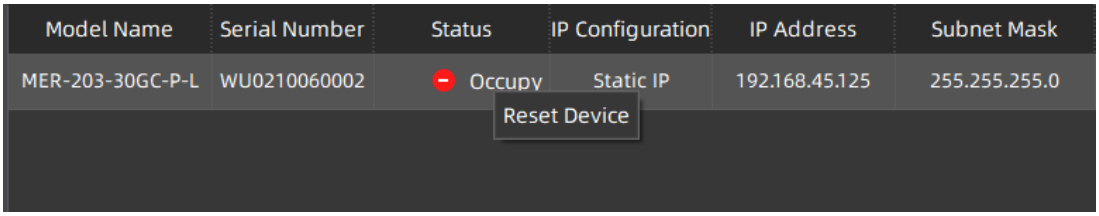


Figure 9-7

Note:

1. Be careful to use **Release Occupation** and **Reset Device**, they will cause the camera off-line while acquiring.
2. Require camera itself supports **Release Occupation** and **Reset Device**

9.2. Frame Rate Calculation Tool

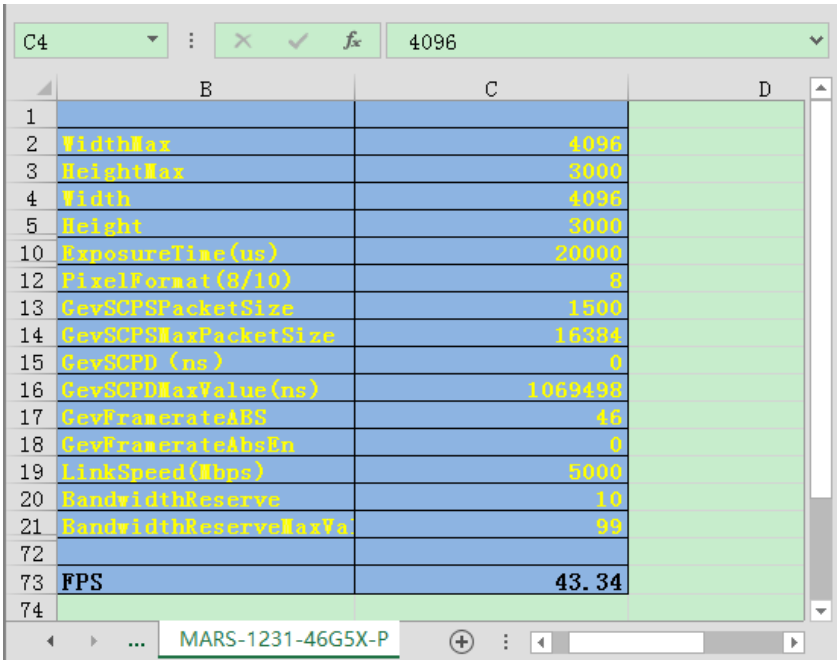


Figure 9-8 Frame rate calculation tool

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 (packet size, packet delay, reserved bandwidth, link speed, pixel format, image width, image height, pixel format).

The parameters in Figure 9-8 are explained as follows:

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

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

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

4) The GevSCPSPacketSize represents the packet size of the camera. The default value is 1500 bytes. When the LinkSpeed is 5000Mbps or 2500Mbps, the maximum GevSCPSPacketSize can be set to 16384 bytes. And it is necessary to ensure that the network card and the switch support jumbo frames. When the LinkSpeed is 1000Mbps, the maximum GevSCPSPacketSize can be set to 1500 bytes

5) The GevSCPD represents the packet delay between each frame of images.

6) The LinkSpeed refers to the network link speed between the camera and the host, which is divided into 1000Mbps/2500Mbps/5000Mbps.

7) The GevSCPDMaxValue represents maximum packet delay can be set under the current parameters.

8) The BandwidthReserve represents the percentage of network bandwidth reserved for other network transmission, which is 10% by default.

9) The BandwidthReserveMaxValue represents the maximum reserved bandwidth that can be set under the current parameters.

10) 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.

11) 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 MARS-1231-46G5M/C-P camera as an example:

If you want to set the camera's acquisition frame rate to 20fps with the "GevFramerateABS" function, you can set "GevFramerateAbsEn" to 1, set "GevFramerateABS" to 20, and then you can check "FPS" as 20fps.

If you want to adjust "GevSCPSPacketSize" and "GevSCPD" to make the frame rate of the camera to 20fps, you can select the "GevSCPSPacketSize" you want to use. If you set "GevSCPSPacketSize" to 8192, then gradually set the value of "GevSCPD" to make "FPS" approach 8fps. After several attempts, it can be concluded that when "GevSCPD" is set to 16690, the calculated result "FPS" is 20.00 fps.

10. FAQ

No.	General Question	Answer
1	The LED of the power is not on when the MARS-G5-P series camera is powered via PoE network card.	1) Confirm whether the power of the PoE network card is connected.
2	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.
3	The frame rate is not up to the nominal value.	1) Choose a better host. 2) Choose a recommended Intel series 10 Gigabit network card or IOI series 10 Gigabit network card. 3) Contact with the technical support.
4	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.
5	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.
6	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.
7	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.

No.	General Question	Answer
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). 2) Method 2: modify the size of the transmitted data block **StreamTransferSize** (the size of the data block divided by the acquisition queue Buffer). By default, Buffer needs a data block with a full image size, but when the system is used for a period of time, the continuity of memory is greatly affected by the current system environment, and the operation of some software may destroy the continuity of system memory, leading to the failure of image acquisition. If the size of the data block is reduced, for example, 120M memory is needed, and the size of the data block is set to 10M, then as long as the system has 12 consecutive memory sizes meeting 10M, the image can be successfully acquired. The disadvantage of methods 1 and 2 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. 3) 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.
9	The camera cannot be enumerated, and the LED light is in Yellow-Green flashing state.	1) Network card does not support 1000/2500/5000 Mbit/s, please replace the network card that supports this link speed. 2) Intel X550 series network card only supports Win10 64-bit OS, if you use Intel X550 series network card, please confirm the system.
10	The camera is not working at 5G, but working at 1G or 2.5G	1) Please confirm that the network card supporting 5G is used and the network card is inserted in the appropriate position. PCIE x4 gen3 is generally recommended. 2) Please confirm to use the latest network card driver. 3) Please confirm that the link speed settings of the network card are Auto Negotiation or 5G. 4) Please confirm to use CAT-5e or above, and the RJ interface cannot loose.

11. Revision History

No.	Version	Changes	Date
1	V1.0.0	1. Initial release	2019-12-24
2	V1.0.1	1. Modify the maximum packet size to 1500 bytes when the link speed is 1Gbps	2020-01-19
3	V1.0.2	1. Add section 8.3.10 Decimation	2020-04-02
4	V1.0.3	1. Modify the description of Figure 6-1 and Figure 6-2	2020-06-15
5	V1.0.4	1. Modify section 7.3.1 to add the series resistance requirement when the external voltage of Line0+ is 5V and modify Table 7-3 2. Modify Figure 1-1 3. Add section 2.6 Certification and Declaration 4. Modify some description in section 6.2. 5. Add HN-6M, HN-20M, HN-P-6M, HN-P-10M, HN-P-25M series of industrial lenses	2022-02-18
6	V1.0.5	1. Add 2.6 FCC 2. Modify Figure 5-1, Figure 6-1, Figure 6-2 3. Modify some model name of HN-P-6M	2022-11-11
7	V1.0.6	1. Update the UI interface and usage description related to the software	2022-09-09

12. Contact Us

12.1. Contact Sales

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

Tel: +86 10 8282 8878-8081

Email: isupport@daheng-imaging.com

12.2. Contact Support

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

Tel: +86 10 8282 8878

Email: isupport@daheng-imaging.com