See the possibilities

User Manual

GO-5000M-PGE
GO-5000C-PGE

5M Digital Progressive Scan Monochrome and Color Camera

Document Version: 1.4
GO-5000-PGE_Ver.1.4_August2018

1056E-1408

Notice

Warranty

For information about the warranty, please contact your factory representative.

Certifications

CE compliance

As defined by the Directive 2004/108/EC of the European Parliament and of the Council, EMC (Electromagnetic compatibility), JAI Ltd., Japan declares that GO-5000M-PGE and GO-5000C-PGE comply with the following provisions applying to its standards.
EN 61000-6-3 (Generic emission standard part 1)
EN 61000-6-2 (Generic immunity standard part 1)

FCC

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.

Warning

Changes or modifications to this unit not expressly approved by the party responsible for FCC compliance could void the user's authority to operate the equipment.

KC

상 호 : JAI Ltd.,Japan
기자재 명칭 : Industrial camera
모 델 명 : GO-5000M-PGE
제조자 및 제조국가: JAI Ltd.,Japan / JAPAN
MSIP-REM-Jai-GO-5000M-PGE

상 호 : JAI Ltd.,Japan
기자재 명칭 : Industrial camera
모 델 명 : GO-5000C-PGE
제조자 및 제조국가: JAI Ltd.,Japan / JAPAN
MSIP-REM-Jai-GO-5000M-PGE

제조년월은 제품상자의 라벨을 참조하십시요

- Contents -

Introduction

Before using GigE Vision® camera

All software products described in this manual pertain to the proper use of JAI GigE Vision® cameras. Product names mentioned in this manual are used only for the explanation of operation. Registered trademarks or trademarks belong to their manufacturers.
To use the JAI SDK, it is necessary to accept the "Software license agreement" first.

This manual describes necessary equipment and the details of camera functions.

1 JAI GigE Vision® camera operation manuals

To understand and operate this JAI GigE Vision camera properly, JAI provides the following manuals.

User's manual (this booklet)	Describes functions and operation of the hardware
JAI SDK & Control Tool User Guide	Describes functions and operation of the Control Tool
JAI SDK Getting Started Guide	Describes the network interface

User's manual is available at **www.jai.com**

2 Software installation

The JAI GigE Vision SDK & Control Tool can be downloaded from the JAI web site at www.jai.com.
The JAI SDK is available for Windows XP, Vista, and Windows 7, 32-bit and 64-bit.
For the details of software installation, please refer to the "Getting Started Guide" supplied on the JAI SDK download page.

3 About GigE Vision Ver1.1

The GO-5000-PGE complies with the latest GigE Vision version 1.1. GigE Vision is the new standard interface using Gigabit Ethernet for machine vision applications and it was mainly set up by AIA (Automated Imaging Association) members. GigE Vision is capable of transmitting large amounts of uncompressed image data through an inexpensive general purpose LAN cable for a long distance.

GigE Vision also supports the GenICam™ standard which is mainly set up by the EMVA (European Machine Vision Association). The purpose of the GenICam standard is to provide a common program interface for various machine vision cameras. By using GenICam, cameras from different manufactures can seamlessly connect in one platform.

For details about the GigE Vision standard, please visit the AIA web site,
www.machinevisiononline.org and for GenICam, the EMVA web site, www.genicam.org.

4 EMVA 1288

With regard to signal to noise ratio in this manual, specifications measured by EMVA 1288 are used together with specifications by a traditional measurement method.
EMVA 1288 is a more complete measurement that considers multiple noise sources, including random noise, pattern noise, and shading. Additionally, EMVA 1288 incorporates temporal variances in pixel output by capturing 100 frames of data and computing the RMS variations over the captured frames. Because of the comprehensive nature of the noise analysis and the additional consideration for RMS variances over time, EMVA 1288 SNR measurements are inherently lower than the traditional SNR measurements given by manufacturers. However, the comprehensive nature combined with rigid test parameters, means that all manufacturers are measuring their products equally and EMVA 1288 tested parameters can be compared among different manufacturers' products.
In order to learn more about EMVA 1288, please visit http://www.emva.org

Camera Operation Manual

1. General

The GO-5000M-PGE and GO-5000C-PGE are members of JAI's Go Series, offering users small yet rugged cameras equipped with fundamental functions for machine vision. They are high performance cameras with high resolution and a frame rate suitable for a range of applications. The GO-5000M-PGE is a monochrome progressive scan CMOS camera and the GO-5000C-PGE is the equivalent Bayer mosaic progressive scan CMOS camera. Both are equipped with a CMOS sensor offering a 1-inch optical format, a resolution of 5.24 million pixels, and a 5:4 aspect ratio. They provide up to 22.3 frames per second for continuous scanning with 2560 x 2048 full pixel resolution for both monochrome and raw Bayer 8-bit outputs.

8-bit, 10-bit or 12-bit output can be selected for both monochrome and raw Bayer formats. The new cameras feature a GigE Vision Ver. 2.0 interface and also a Power Over Ethernet function.

The GO-5000M-PGE and GO-5000C-PGE have various comprehensive functions needed for automated optical inspection applications, such as solid state device inspection or material surface inspection. They incorporate video processing functions such as a look-up table, shading compensation and blemish compensation in addition to fundamental functions such as trigger, exposure setting, and video level control.

The latest version of this manual can be downloaded from: www.jai.com
The latest version of the Camera Control Tool for the GO-5000M-PGE and GO-5000C-PGE can be downloaded from: www.jai.com
For camera revision history, please contact your local JAI distributor.

2. Camera composition

The standard camera composition is as follows.

Camera body	1
Sensor protection cap	1
Dear Customer (sheet)	1

The following optional accessories are available.

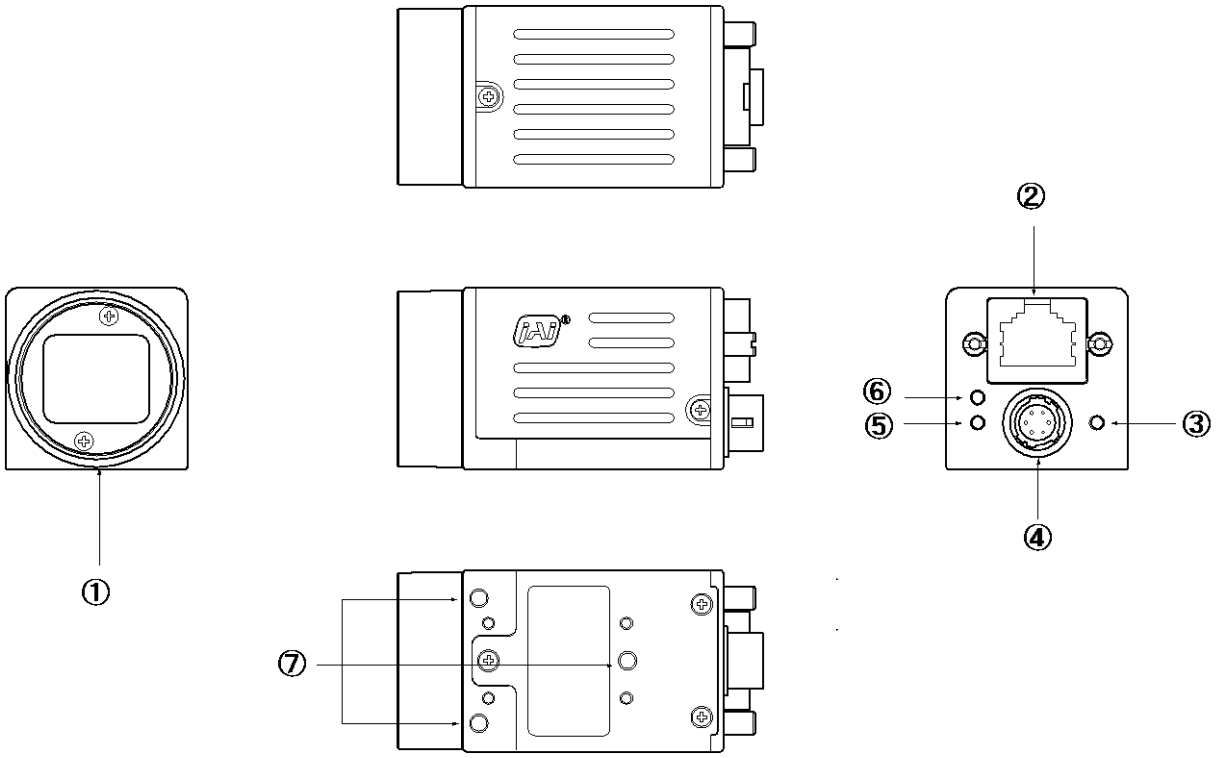
Tripod base	MP-43
Power supply unit	PD-12 series

3. Main features

- New Compact and Rugged housing Series, 1” progressive scan camera
- Intelligent body design for easy and flexible installation
- Utilizes new GigE Vision ver.2.0 and IEEE802.3af PoE
- Aspect ratio 5:4, 2560(H) x 2048(V) - 5.2 million effective pixels
- 5 µm square pixels
- S/N 55 dB for monochrome and 50 dB for color with Dark Compression ON
- 8-bit, 10-bit or 12-bit output for monochrome and Bayer
- 22.3 frames/second with full resolution in continuous operation (8-bit)
- Various readout modes, including horizontal and vertical binning (GO-5000M-PGE only), and ROI (Region Of Interest) for faster frame rates
- 0 dB to +24 dB gain control for both GO-5000M-PGE and GO-5000C-PGE
- 10 µs (1/100,000) to 8 seconds exposure control in 1 µs step
- Auto exposure control
- Timed and trigger width exposure control
- RCT trigger mode for specific applications
- ALC control with combined function of AGC and auto exposure
- HDR (High Dynamic Range) function is available (GO-5000M-PGE only)
- Various pre-processing circuits are provided
  Programmable LUT
  Gamma correction (0.45, 0.6 and 1.0 3 steps)
  Bayer white balance with manual or continuous auto (GO-5000C-PGE only)
  Blemish compensation
- C-mount for lens mount
- Setup by Windows XP/Vista/7/8 via serial communication

4. Locations and functions

4.1 Locations and functions



①	Lens mount	C-mount (Note *1)
②	RJ45 connector	Gigabit Ethernet connection
③	LED	Indicator for power and trigger input
④	6-pin connector	DC and trigger input
⑤	LED (ACT)	GigE network indication (ACT)
⑥	LED (LINK)	GigE network indication (LINK)
⑦	Mounting holes	Holes for mounting tripod base or direct installation. Depth 3 mm (Note*3)

Note1: Rear protrusion on C-mount lens must be less than 10.0 mm.
Note2: When an RJ-45 cable with thumbscrews is connected to the camera, please do not Excessively tighten screws by using a screw driver. The RJ-45 receptacle on the camera might be damaged. For security, the strength to tighten screws is less than 0.147 Newton meter (Nm). Tightening by hand is sufficient in order to achieve this.
Note3: The part number for the tripod adapter plate (with 1/4"-20 thread) is MP-43 (option).

Fig. 1 Locations

4.2 Rear panel

The rear panel mounted LEDs provide the following information:

① POWER/TRIG

- Amber: Power connected – initiating
  This light goes OFF after initiating.
- Steady green: Camera is operating in Continuous mode
- Flashing green: The camera is receiving external triggering

Note: The interval of flashing does not correspond with external trigger duration.

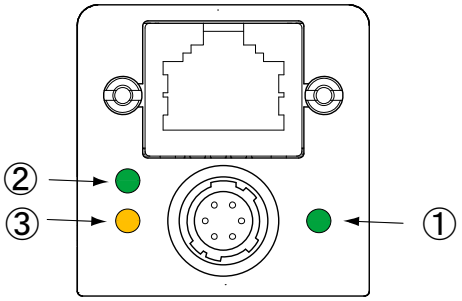


Fig. 2 Rear panel

② LINK

- Steady green: Connecting in 1000BASE-T
- Flashing green: Connecting in 100BASE-T

③ ACT

- Flashing amber: GigE Network indication

5. Installation and preparation

Before starting operation, check to make sure that all equipment is appropriate and is connected in the right manner.

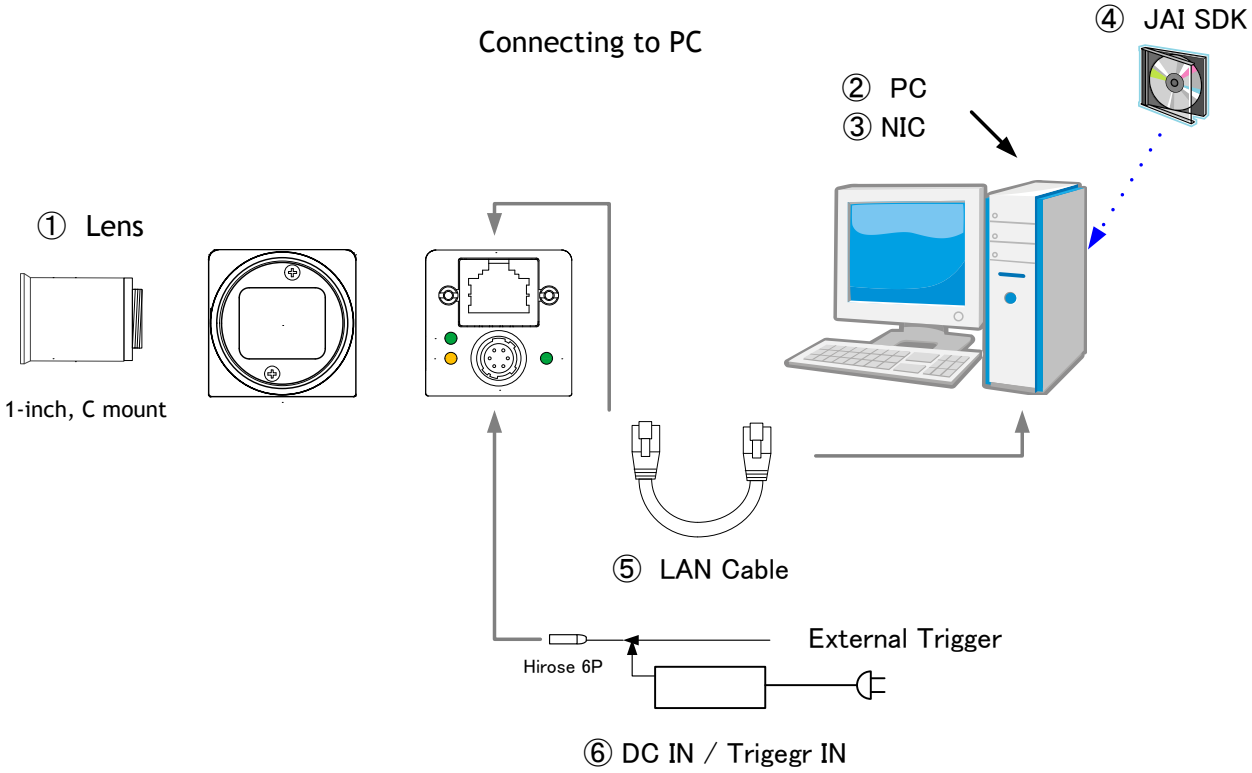


Fig3 Basic system

5.1 Lens used

The GO-5000-PGE employs a 1-inch CMOS imager. It is necessary to select a 1-inch C mount lens if the full resolution of the camera is to be utilized. The imager used in the GO-5000-PGE measures 16.392 mm diagonally, which is slightly larger than the standard 16 mm diagonal of the 1-inch format. Please consult with your lens provider to select a 1-inch lens able to cover 16.392 mm diagonally, otherwise the image captured may show vignetting.

It is possible to use C mount lenses with an optical format smaller than 1-inch, provided a less-than full-resolution ROI is going to be used. For example, a centered ROI of 1920 x 1080 pixels (HD format) will fit inside the image circle of most standard 2/3-inch C mount lenses. Likewise, a centered VGA ROI (640 x 480 pixels) can be accommodated by a standard 1/3-inch C mount lens.

The rear protrusion on any lens used must be less than 10 mm.

The focal length of lens used is estimated by the following formula.

Focal length = $WD/(1 + W/w)$

Here, WD: Working distance (the distance between lens and object)
W: Width of object
w: Width of sensor (the GO-5000-PGE is 12.8 mm)

5.2 Recommended PC to be used

The PC used should have the following performance or better

1) Recommended CPU : Core i3 or better,
2) Recommended memory: DDR3, 4GB fully equipped (Windows 7 32-bit)
   DDR3, 8GB fully equipped (Windows 7 64-bit)
3) Graphics card : Should apply with PCI Express Generation 3.0 or better
4) NIC : Use Intel NIC
   PCI-Express Bus to install Intel NIC should be better than Generation 2.0.
   Generation 1.0 cannot be used.
5) Other: If the picture is always displayed on the monitor, it is not recommended to use the CPU in the PC.

5.3 About the network card to be used

The network card should comply with 1000BASE-T and also have the capability of JUMBO FRAMES. When the jumbo frame size is set at a larger number, the load on the CPU will be decreased. Additionally, as the overhead of the packet is decreased, the transmission will have more redundancy.

Table-1 JAI confirms the following network cards.

NIC Manufacture	Type	PCI-X Bus	PCI-Express Bus	
Intel	PRO/1000MT Server Adapter	√	–	32bit or 64bit 33/66/100/133 MHz
Intel	PRO/1000MT Dual Port Server Adapter	√	–	32bit or 64bit 33/66/100/133 MHz
Intel	PRO/1000GT Quad Port Server Adapter	√	–	32bit or 64bit 66/100/133 MHz
Intel	PRO/1000PT Server Adapter	—	√ (x1)	2.5Gbps uni-directional 5Gbps bi-directional
Intel	Pro/1000 CT Desktop adaptor	—	√ (x1)	2.5Gbps uni-directional 5Gbps bi-directional
Intel	Gigabit ET2 Quad port Server Adapter	—	√ (x4)	10Gbps uni-directional 20Gbps bi-directional
Intel	Gigabit ET Dual port Server Adapter	—	√ (x4)	10Gbps uni-directional 20Gbps bi-directional
Intel	Gigabit EF Dual port Server Adapter	—	√ (x4)	10Gbps uni-directional 20Gbps bi-directional

Notes for connecting 100BASE-TX

- In order to use 100 Mbps network, 100BASE-TX and Full Duplex are available. Half Duplex cannot be used.
- In the case of connecting on 100BASE-TX, the maximum packet size should be 1500 bytes.
- In the case of connecting on 100BASE-TX, the specifications such as frame rate, trigger interval and so on described in this manual cannot be satisfied.

5.4 JAI SDK and Control Tool software

The GO-5000M-PGE and GO-5000C-PGE are designed to use the JAI SDK and Control Tool software to control camera functions. All controllable functions are stored in the camera's XML file. The JAI SDK can be downloaded from www.jai.com. Third-party software can also be used with the camera provided it is compliant with the GenICam® standard.

5.5 Cables to be used

GigEVision configures the system by using 1000BASE-T.
In the market, CAT5e (125MHz), CAT6 (250MHz) and CAT7 (600MHz) cables are available for 1000BASE-T. There are crossover cables and straight through cables available. Currently, as most equipment complies with Auto MDI/MDI-X, please use straight through cables. (Among crossover cables, a half crossover type exists, which the Ethernet will recognize as 100BASE-T).
The GO-5000-PGE also has PoE (Power Over Ethernet) capability and DC power is supplied through LAN cable.

5.6 DC IN / Trigger IN

The GO-5000-PGE supports a PoE (Power over Ethernet) function which complies with IEEE 802.3af. Therefore, the Gigabit Ethernet interface card used in the PC needs to have this capability too. However, if the Gigabit Ethernet network card does not have this capability, GO-5000-PGE provides a 6P connector to receive +12 to +24V DC to operate the camera. The 6P connector is also used to provide external trigger input.

5.7 Camera Default Settings

When the camera is connected to a PC and JAI SDK 2.0 is started up, an XML file which stores default settings of the camera is downloaded to the JAI_SDK camera control tool.

The default settings of the GO-5000-PGE are as follows.

Table – 2 Default settings

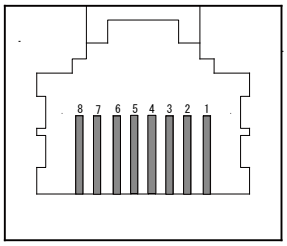
Image Format	Bit allocation	8-bit
	Height	2048
	Binning Horizontal (Note)	OFF
	Binning Vertical (Note)	OFF
Trigger Operation	Trigger Mode	OFF
Exposure Control	Exposure Mode	OFF
Gain	Gain Auto	OFF
	Manual Gain all	0
	Manual Fine Gain all	0
	Analogue Base Gain	0dB

Note: GO-5000M-PGE only.

6. Input and output

6.1 Connectors and pin assignment

6.1.1 Output connector for Gigabit Ethernet



Type : RJ-45

Fig.4 RJ-45 connector (View from outside)

The digital output signals follow the Gigabit Ethernet interface using an RJ-45 conforming connector. The following table shows pin configuration.

Table-3 RJ-45 pin configuration

Pin No.	Input /Output	Description
1	In/Out	MX1+ (DA+)
2	In/Out	MX1- (DA-)
3	In/Out	MX2+ (DB+)
4	In/Out	MX3+ (DC+)
5	In/Out	MX3- (DC-)
6	In/Out	MX2- (DB-)
7	In/Out	MX4+ (DD+)
8	In/Out	MX4- (DD-)

6.1.2 Hirose 6-Pin connector

Type: HR-10A-7R-6PB(73) Hirose or equivalent

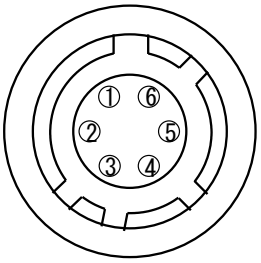


Fig.5 6-pin connector (view from outside)

Table-4 Hirose 6P pin assignment

Pin no.	I/O	Signal	Remarks
1		DC in	+12V ～ +24V
2	I	Opto in1	GPIO 5
3	O	Opto out1	GPIO 1
4	O	Opto out2	GPIO 2
5		Opto Common	
6		GND	

6.2 Digital IN/OUT interface

In the GO-5000M-PGE and GO-5000C-PGE, the digital IN/OUT capability in the software control tool can assign the necessary signals needed for the system.

6.2.1 Line Selector

In the Line Selector, the following input and output signals can be assigned.

Table-5 Line selector

Line Selector item	Description
Line 1 Opt 1 Out	Opt 1 output from # 3 of DC In/Trigger 6-Pin on the rear
Line 2 Opt 2 Out	Opt 2 output from #4 of DC In/Trigger 6-Pin on the rear
NAND 0 In 1	No. 1 input to NAND 0 gate in GPIO
NAND 0 In 2	No. 2 input to NAND 0 gate in GPIO
NAND 1 In 1	No. 1 input to NAND 1 gate in GPIO
NAND 1 in 2	No. 2 input to NAND 1 gate in GPIO

Note1: Select and connect the line source signal against the item selected in the line selector.

6.2.2 Line Source

Line source signal can be selected from the following table to connect it to the line item which is selected in the line selector.

Table-6 Line Source

Line Source item	Description
Low	Connect Low Level signal to line item selected in Line Selector, **Default setting**
High	Connect High Level signal to line item selected in Line Selector
Acquisition Trigger Wait	Connect Acquisition Trigger Wait signal to line item selected in Line Selector
Frame Trigger Wait	Connect Frame Trigger Wait signal to line item selected in Line Selector
Frame Active	Connect Frame Active signal to line item selected in Line Selector
Exposure Active	Connect Exposure Active signal to line item selected in Line Selector
FVAL	Connect FVAL signal to line item selected in Line Selector
PulseGenerator0 Out	Connect Pulse Generator 0 signal to line item selected in Line Selector
User Out 0	Connect User Out 0 signal to line item selected in Line Selector
User Out 1	Connect User Out 1 signal to line item selected in Line Selector
Line 5 Opt In	Connect Opt In signal to line 6 in Line Selector
NAND 0 Out	Connect NAND 0 signal to line item selected in Line Selector
NAND 1 Out	Connect NAND 1 signal to line item selected in Line Selector

6.2.3 Line Mode

Indicates the status of the interface. (Input, Output or Internal)

6.2.4 Line Inverter

Sets the polarity of the selected input or output. (False or True)

6.2.5 Line Status

Indicates the status of the selected signal, input or output (True=High or False=Low)

6.2.6 Line Format

Indicates the format of the line item selected in Line Selector.
(No Connect, TTL, LVDS, Opt Coupled or Internal Signal)

Note: In the GO-5000-PGE, TTL and LVDS interface are not equipped.

6.2.7 Action Control

Action control settings allow the use of unicast or broadcast Action Commands as defined in the GigE Vision 2.0 specification. ACTION_CMD messages received via the GVCP port can control the camera's internal action signals provided the camera's action control settings match the settings of the message received. This function is useful for triggering an action in multiple cameras at roughly the same time. There are two action control inputs on the GO-5000-PGE and they are connected to four triggers, counter reset, counter, and timer.
When action control is used, the trigger input source should be set to Action 1 or Action 2 in advance.

6.2.7.1 ActionDeviceKey

Sets the device key value for the camera in a 32-bit register. This value must match the device_key value of the ACTION_CMD message in order for the message to be acted upon. .

6.2.7.2 ActionSelector

Selects Action 1 or Action 2 for setting the action control values.

6.2.7.3 ActionGroupKey

Sets the group key value for the selected action signal in a 32-bit register. This value must match the group_key value of the ACTION_CMD message in order for the message to be acted upon.

6.2.7.4 ActionGroupMask

Sets the mask value for the selected action signal in a 32-bit register. This value is compared against the group mask value of the ACTION_CMD message to determine if the message should be ignored or acted upon. A logical AND operation is used and must produce a non-zero result or else the message is ignored..

6.2.8 GPIO

This is a general interface for input and output and controls input and output for trigger signals or valid signals and pulse generator. By using this interface, you can control an external light source, make a delayed function to input a trigger signal or make a precise exposure control with PWC trigger.

6.2.8.1 Basic block diagram

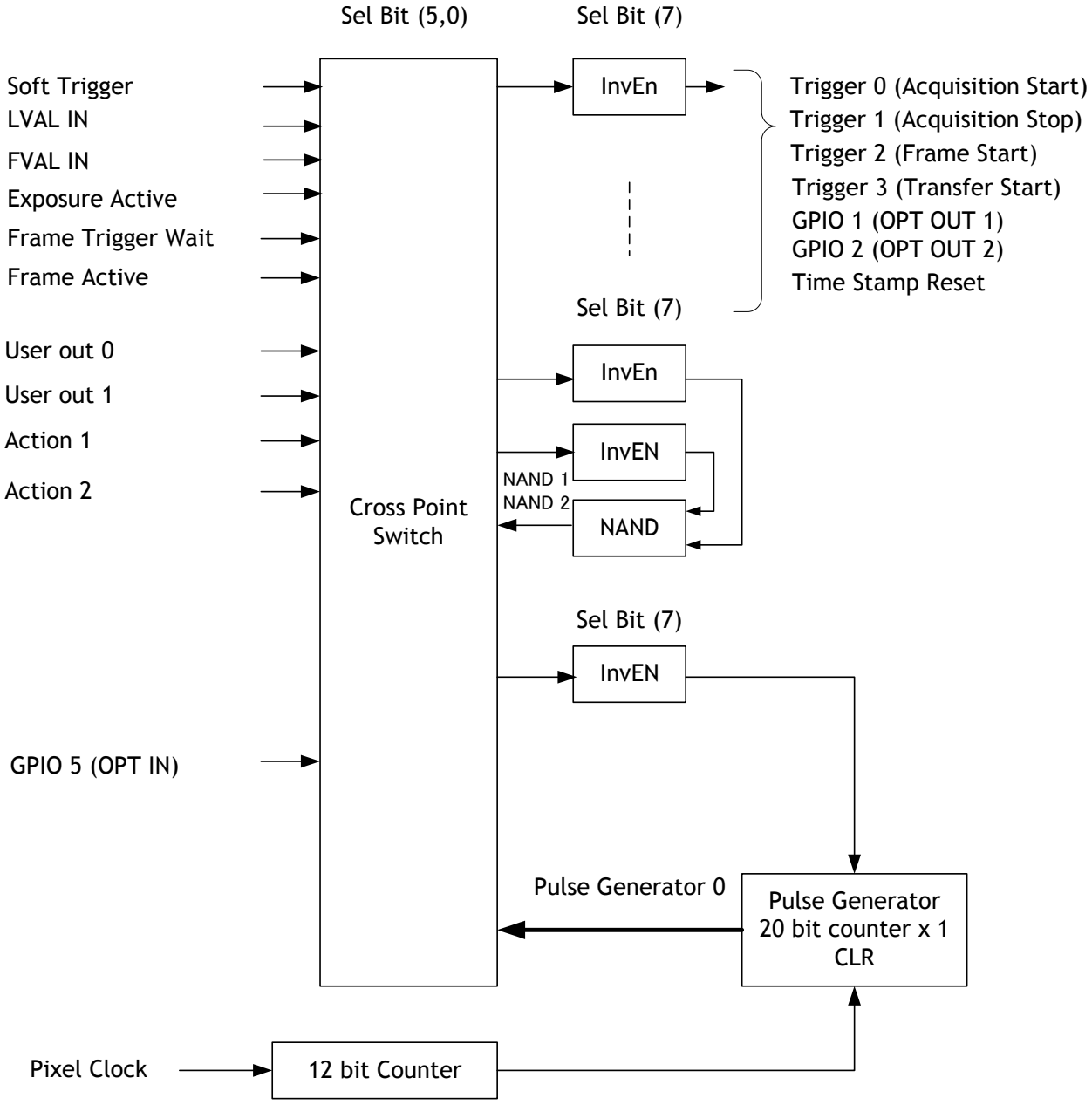


Fig. 6 GPIO

6.2.8.2 IN and OUT matrix table

The following table shows the input and output matrix table.
Table-7 GPIO IN and OUT matrix table

Selector (Cross point switch output) / Source signal (Cross point switch input)	Trigger Selector				Line Selector						Pulse Generator Selector
	Acquisition Start	Acquisition Stop	Frame Start	Transfer Start	GPIO 1 - 12P OPT Out 1	GPIO 2 - 12P Opt Out 2	NAND 1 In 1	NAND 1 In 2	NAND 2 In 1	NAND 2 In 2	Pulse Generator 0
LOW	o	o	o	o	o	o	o	o	o	o	o
HIGH	o	o	o	o	o	o	o	o	o	o	o
GPIO 5 - 6P OPT 1 In	o	o	o	o	o	o	o	o	o	o	o
NAND 1 Out 1	o	o	o	o	o	o	×	×	o	o	o
NAND 2 Out 1	o	o	o	o	o	o	o	o	×	×	o
Pulse Generator 0	o	o	o	o	o	o	o	o	o	o	×
User Output 0	o	o	o	o	o	o	o	o	o	o	o
User Output 1	o	o	o	o	o	o	o	o	o	o	o
Software Trigger	o	o	o	o	×	×	×	×	×	×	o
Action 1	o	o	o	o	×	×	×	×	×	×	o
Action 2	o	o	o	o	×	×	×	×	×	×	o
FVAL	×	×	×	×	o	o	o	o	o	o	o
LVAL	×	×	×	×	×	×	×	×	×	×	o
Exposure Active	×	×	×	×	o	o	o	o	o	o	o
Frame Trigger Wait	×	×	×	×	o	o	o	o	o	o	o
Frame Active	×	×	×	×	o	o	o	o	o	o	o
	Trigger Source				Line Source						Pulse Generator Clear Source

6.3 Optical Interface

The GO-5000-PGE is equipped with opto-isolated inputs and outputs, providing galvanic separation between the camera's inputs/outputs and peripheral equipment.
In addition to galvanic separation, the opto-isolated inputs and outputs can cope with a wide range of voltages; the voltage range for inputs is +3.3V to +24V DC whereas outputs will handle +5V to +24V DC.

The following drawing is the concept of photo coupler

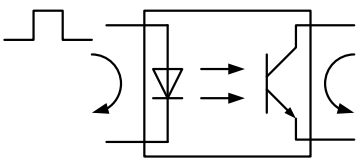


Fig.7 Photo coupler

6.3.1 Recommended External Input circuit diagram for customer

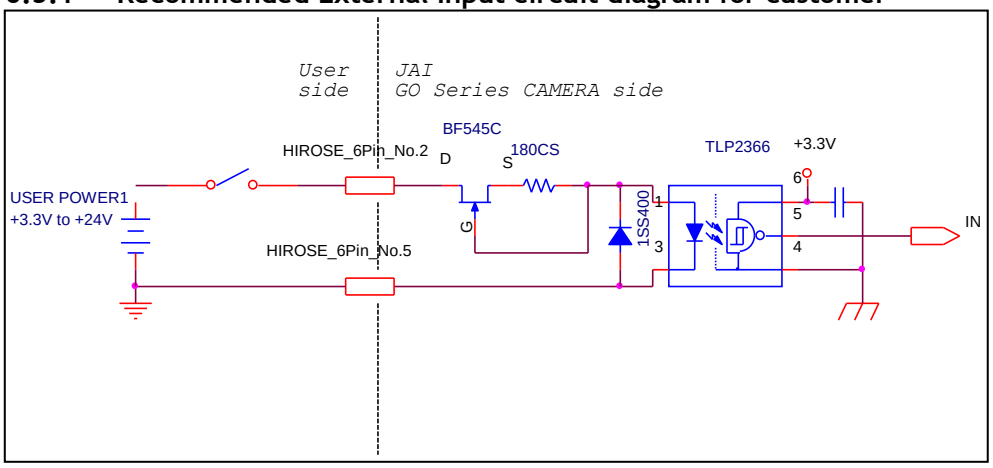


Fig.8 Example of external input circuit

6.3.2 Recommended External Output circuit diagram for customer

Standard circuit

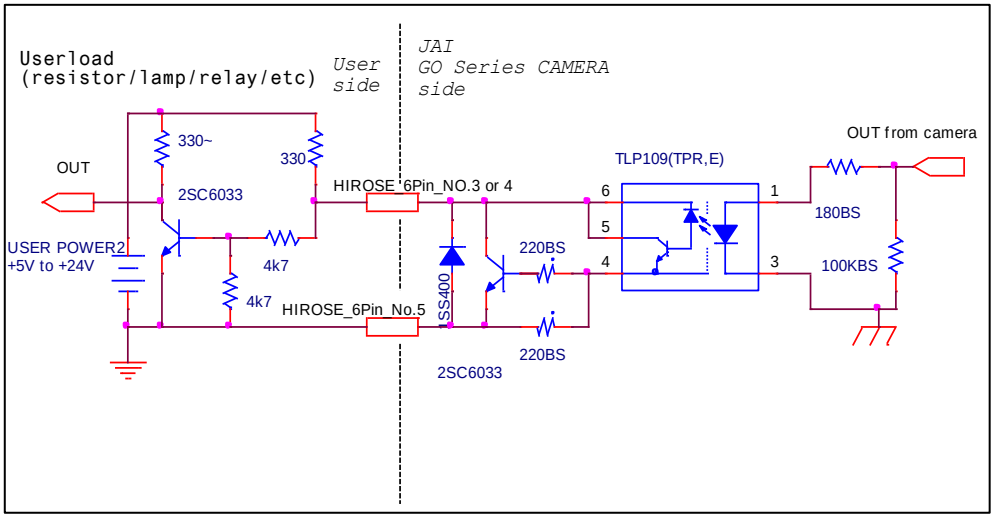


Fig.9 Example of external output circuit(Standard)

Simple circuit

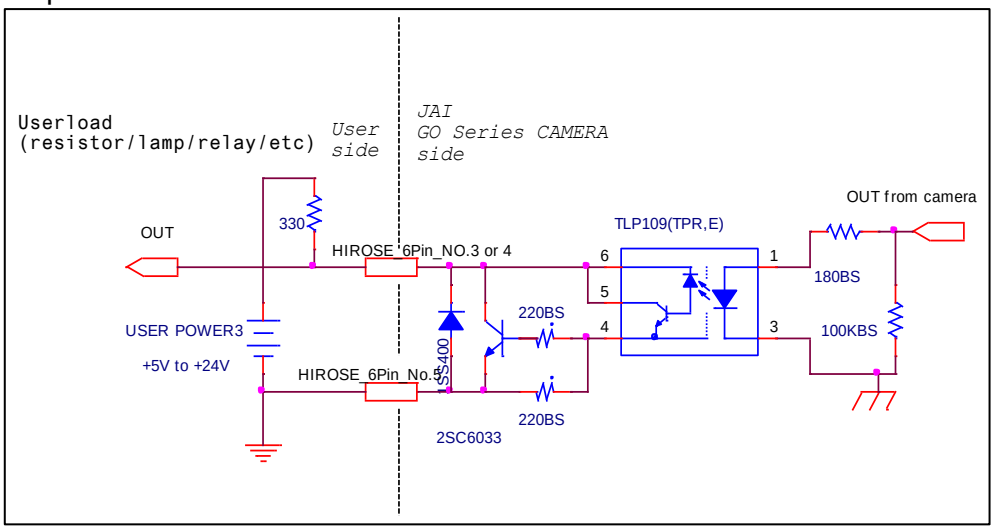


Fig.10 Example of external output circuit(Simple)

330Ω

6.3.3 Characteristics of optical interface

The relationship of the input signal to the output signal through the optical interface is as follows.

Input Line Voltage Range : +3.3v～+24V
Input Current : 6mA～30mA
Output Load(Maximum Current) : 100mA
Minimum Input Pulse Width to Turn ON : 0.5us
Minimum Output Pulse Width : 20us

Table-8 Optical interface

Characteristic on User Output circuit

R1, R4 (in Fig.9)= 330ΩPULL_UP	User Power (Vcc)			
	3.3v	5.0v	12v	24v
Time Delay Rise TDR(us)	0.78	0.82	1.8	2.65
Rise Time RT(us)	4.1	4.7	6.1	9.1
Time Delay Fall TDF(us)	0.26	0.48	0.56	0.78
Fall Time FT(us)	1.3	1.6	3.1	4.8

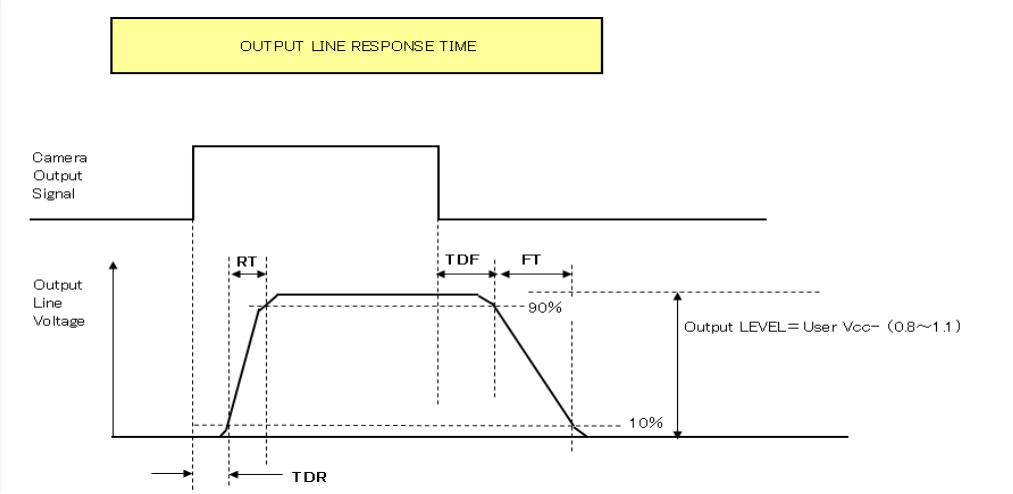


Fig.11 Optical interface characteristics

6.3.4 Opt In Filter Selector function

As for the surge protection of the optical input, the filter can be selected from 5 steps which are 10 µs (Typical), 100 µs, 500 µs, 1 ms and 10 ms. If the filter is set, a pulse with a shorter width than the filter setting value cannot be accepted.

6.4 Pulse Generator

The GO-5000-PGE has a frequency divider using the pixel clock as the basic clock and a pulse generator. In the Pulse Generator, various Clear settings are connected to GPIO.
The following shows the Pulse Generator default settings.

Table-9 Pulse Generator default settings

Display Name	Value							
Clock Pre-scaler	1							
	Pulse Generator							
Pulse Generator Selector	Length	Start Point	End Point	Repeat Count	Clear Source	Clear Inverter	Clear Activation	Clear Sync Mode
- Pulse Generator 0	1	0	1	0	Off	True	Off	Async Mode

Note: When Pulse Generator Repeat Count is set to "0", the camera is operating in free-running mode.
However, based on the above default setting, Length=1, Start Point=0 and End Point=1, Pulse Generator stops at High output. Therefore, if Start Point=0 and End Point=1 are configured, Length should be "2" as the minimum active width.

6.4.1 Clock Pre-scaler

Clock pre-scaler (Divide Value) can set the dividing value of the frequency divider –(12-bit length) and the pixel clock is used for this. In the GO-5000-PGE, the pixel clock is set at 48 MHz.

6.4.2 Pulse Generator Selector

This is where you select a pulse generator. In the GO-5000-PGE, it is fixed to Pulse Generator 0.

Table-10 Pulse Generator setting

Trigger Selector item	Description
Pulse Generator 0	If Pulse Generator 0 is selected, Length Start Point, End Point, Repeat Count, Clear Source, Clear Inverter Clear Activation and Clear Sync Mode of pulse generator 0 are displayed under the selector.

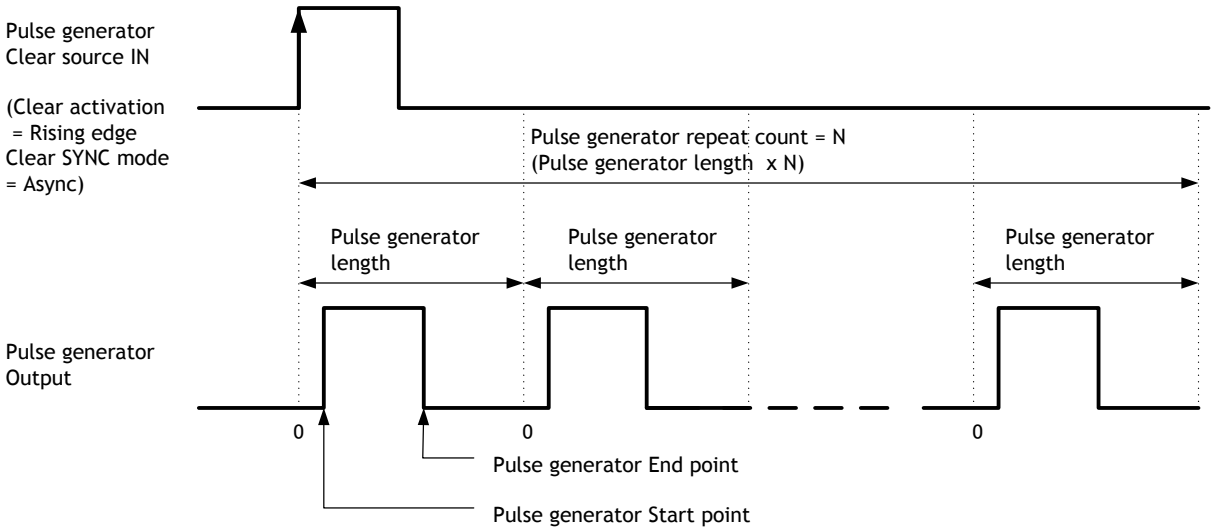


Fig.12 Pulse Generator pulse construction

6.4.3 Pulse Generator Length

Set the counter up value (number of clocks, refer to Table 11) for the pulse generator.
If Repeat Count value is “0”, and if Pulse Generator Clear signal is not input, the pulse generator generates the pulse repeatedly until reaching this counter up value.

6.4.4 Pulse Generator Start Point

Set the active output start count value for the pulse generator.
However, please note that a maximum 1 clock jitter for the clock which is divided in the clock pre-scaler can occur.

6.4.5 Pulse Generator End Point

Set the active output ending count value for the pulse generator.

6.4.6 Pulse Generator Repeat Count

Set the repeating number of the pulse for the pulse generator. After Trigger Clear signal is input, the pulse generator starts the count set in Repeat Count. Accordingly, an active pulse which has a start point and end point can be output repeatedly.
However, if Repeat Count is set to “0”, it works as a free-running counter.

6.4.7 Pulse Generator Clear Activation

Set the clear conditions of clear count pulse for the pulse generator.

6.4.8 Pulse Generator Clear Sync Mode

Set the count clear method for the pulse generator. In the case of Async Mode, if the clear signal is input during the length setting value, the counter will stop counting according to the clear signal input. In the case of Sync Mode, if the clear signal is input during the length setting value, the counter will continue to count until the end of the length setting value and then clear the count. Both modes clear the repeat count when the counter is cleared.

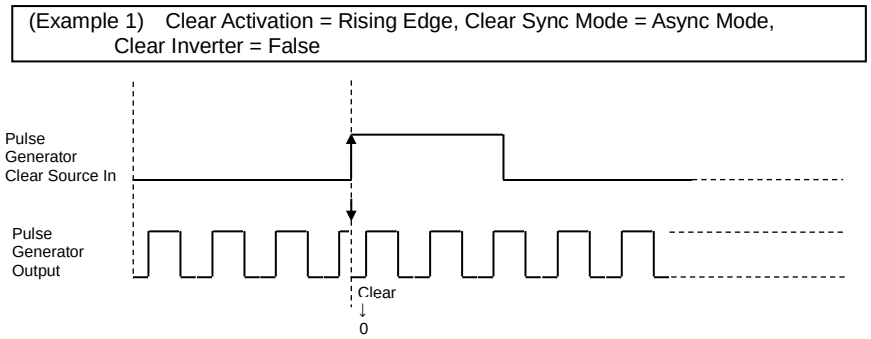


Fig.13 Counter clear in Async mode

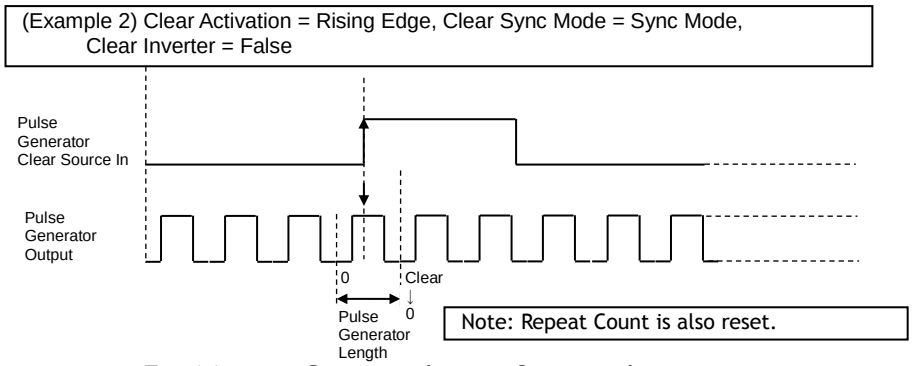


Fig.14 Counter clear in Sync mode

6.4.9 Pulse Generator Clear Source

The following clear source can be selected as the pulse generator clear signal.

Table-11 Pulse generator clear source

Pulse Generator Clear Source item	Description
Low	Connect Low level signal to Clear Source for the selected pulse generator. **Default setting**
High	Connect High level signal to Clear Source for the selected pulse generator.
Frame Trigger Wait	Connect Frame Trigger Wait signal to Clear Source for the selected pulse generator.
Frame Active	Connect Frame Active signal to Clear Source for the selected pulse generator.
Exposure Active	Connect Exposure Active signal to Clear Source for the selected pulse generator.
FVAL	Connect FVAL signal to Clear Source for the selected pulse generator.
LVAL	Connect LVAL signal to Clear Source for the selected pulse generator.
Action 0 Out	Connect Action 0 output to Clear Source for the selected pulse generator.
Action 1 Out	Connect Action 1 output to Clear Source for the selected pulse generator.
User 0 Out	Connect User 0 output to Clear Source for the selected pulse generator.
User 1 Out	Connect User 1 output to Clear Source for the selected pulse generator.
Line 5 Opt 1 In	Connect Opt 1 In signal to Clear Source for the selected pulse generator.
Nand 0 Out	Connect NAND 0 output signal to Clear Source for the selected pulse generator.
Nand 1 Out	Connect NAND 1 output signal to Clear Source for the selected pulse generator.

6.4.10 Pulse Generator Inverter

Clear Source Signal can have polarity inverted.

6.4.11 Pulse Generator Setting Parameters

Table-12 Pulse Generator setting parameters

Display Name	Value
Clock Pre-scaler	1 to 4096
Pulse Generator Clock (MHz)	[Pixel Clock:48 MHz]÷[Clock Pre-scaler]
Pulse Generator Selector	- Pulse Generator0
	- Pulse Generator1
- Pulse Generator Length	1 to 1048575
- Pulse Generator Length (ms)	([Clock Source]÷[Clock Pre-scaler]) $^{-1}$ x [Pulse Generator Length]
- Pulse Generator Frequency (Hz)	[Pulse Generator Length (ms)] $^{-1}$
- Pulse Generator Start Point	0 to 1048574
- Pulse Generator Start Point (ms)	([Clock Source]÷[Clock Pre-scaler]) $^{-1}$ x [Pulse Generator Start Point]
- Pulse Generator End Point	1 to 1048575
- Pulse Generator End Point (ms)	([Clock Source]÷[Clock Pre-scaler]) $^{-1}$ x [Pulse Generator End Point]
- Pulse Generator pulse-width (ms)	[Pulse Generator End Point (ms)]－[Pulse Generator Start Point (ms)]
- Pulse Generator Repeat Count	0 to 255
- Pulse Generator Clear Activation Clear Mode for the Pulse Generators	- Off
	- High Level
	- Low level
	- Rising Edge
	- Falling Edge
- Pulse Generator Clear Sync Mode	- Async mode
	- Sync mode
- Pulse Generator Clear Source-UserOutput3	- Low
	- High
	- Frame Trigger Wait
	- Frame Active
	- Exposure Active
	- Fval
	- Lval
	- User output 0
	- User output1
	- Action In 0
	- Action In 1
	- Opt_In1
	- Nand0 Out
	- Nand1 Out
- Pulse Generator Inverter(Polarity) Pulse Generator Clear Inverter	- False
	- True

Note:
1. If Pulse Generator Repeat Count is set to “0”, the pulse generator works in Free Running mode.

7. Sensor layout, output format and timing

7.1 Sensor layout

CMOS sensors used in the GO-5000M-PGE and GO-5000C-PGE have the following tap and pixel layout.

7.1.1 Monochrome sensor

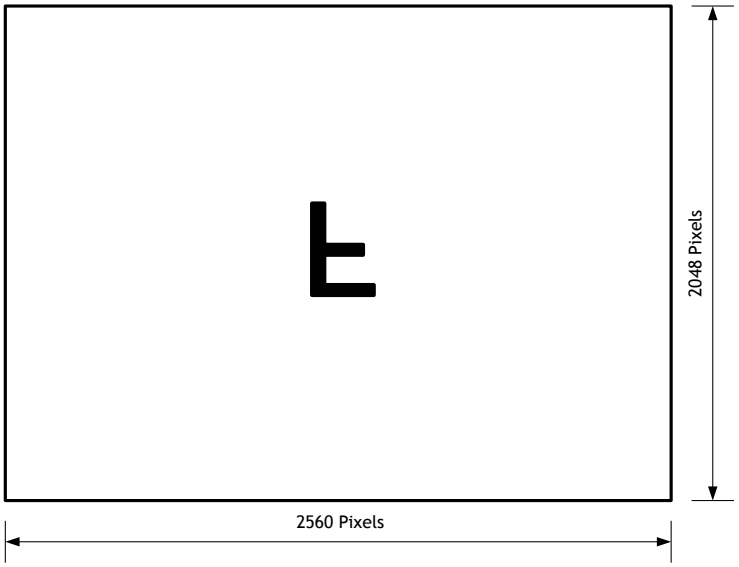


Fig.15 Monochrome sensor layout

7.1.2 Bayer color sensor

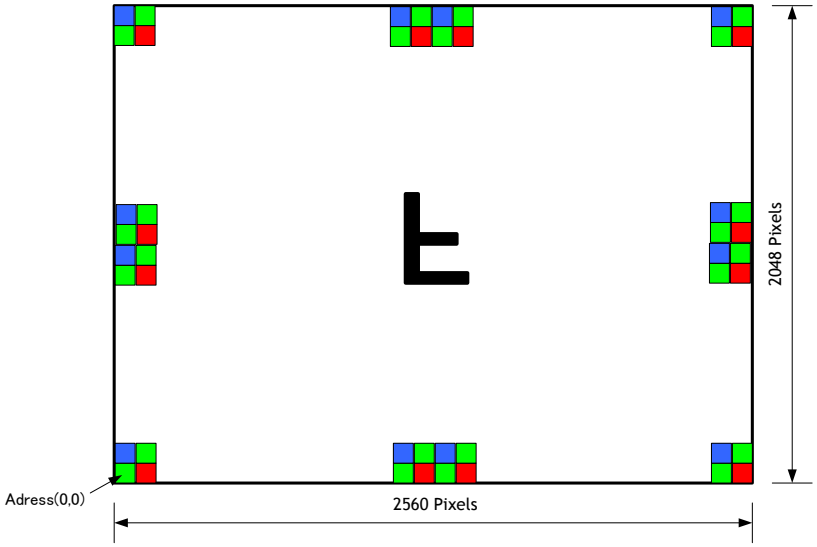


Fig.16 Bayer color sensor layout

7.2. Camera output format

The following table shows the relationship between camera output and sensor readout system.

Camera output format	Sensor readout system	Reference figure
1X-1Y	1-tap readout	7.2.1

Note: The description of camera output format is based on GenICam SFNC Ver.1.5.1.

7.2.1 1X-1Y

1X-1Y is defined in GenICam SFNC Ver.1.5.1 for 1-tap readout and the readout system is the following.

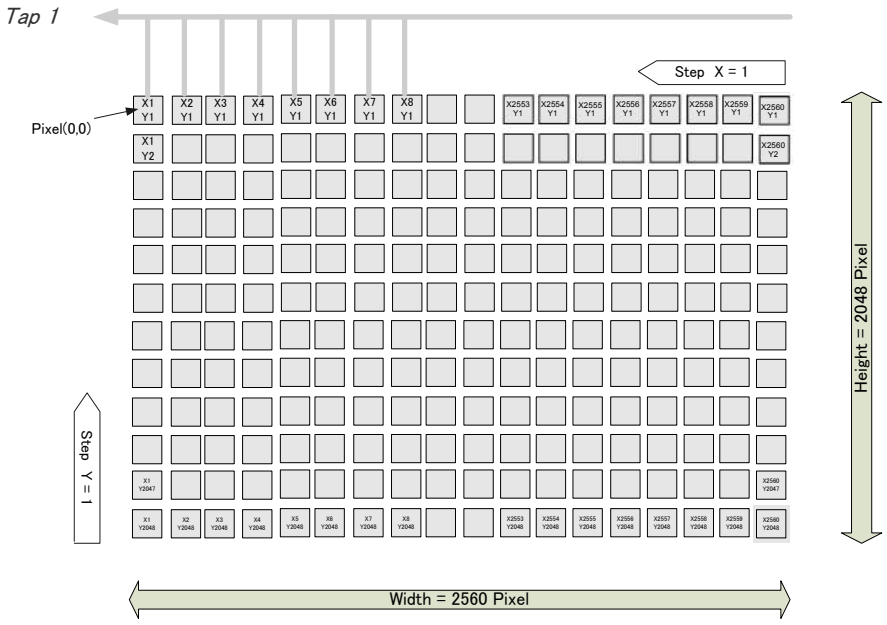


Fig.17 1X – 1Y readout

7.3 GigE Vision Pixel Format

7.3.1 Pixel Format

Model	Supported Pixel Formats
GO-5000M-PGE	Mono8, Mono10, Mono10_Packed, Mono12, Mono12_Packed
GO-5000C-PGE	BayGR8, BayGR10, BayGR10_Packed, BayerGR12, BayerGR12_Packed

7.3.2 GO-5000M-PGE Pixel Type

7.3.2.1 GVSP_PIX_MONO8 8-bit output

Y0								Y1								Y2							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

7.3.2.2 GVSP_PIX_MONO10 16-bit output

Y0								Y0								Y1								Y1							
0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X	0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X

7.3.2.3 GVSP_PIX_MONO10PACKED 12-bit output

								Y0				Y1				Y1							
2	3	4	5	6	7	8	9	0	1	X	X	0	1	X	X	2	3	4	5	6	7	8	9

7.3.2.4 GVSP_PIX_MONO12 16-bit output

Y0								Y0								Y1								Y1							
0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X	0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X

7.3.2.5 GVSP_PIX_MONO12PACKED 12-bit output

Y0								Y0				Y1				Y1							
4	5	6	7	8	9	10	11	0	1	2	3	0	1	2	3	4	5	6	7	8	9	10	11

7.3.3 GO-5000C-PGE Pixel Type

7.3.3.1 GVSP_PIX_BAYGR8 8-bit output

Odd Line

G0								R1								G2							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

Even Line

B0								G1								B2							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

7.3.3.2 GVSP_PIX_BAYGR10 16-bit output

Odd Line

G0								G0								R1								R1							
0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X	0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X

Even Line

B0								B0								G1								G1							
0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X	0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X

7.3.3.3 GVSP_PIX_BAYGR10PACKED 12-bit output

Odd Line

G0								G0				R1				R1							
2	3	4	5	6	7	8	9	0	1	X	X	0	1	X	X	2	3	4	5	6	7	8	9

Even Line

B0								B0				G1				G1							
2	3	4	5	6	7	8	9	0	1	X	X	0	1	X	X	2	3	4	5	6	7	8	9

7.3.3.4 GVSP_PIX_BAYER12 16-bit output

Odd Line

G0								G0								R1								R1							
0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X	0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X

Even line

B0								B0								G1								G1							
0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X	0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X

7.3.3.5 GVSP_PIX_BAYER12PACKED 12-bit output

Odd line

G0								G0				R1				R1							
4	5	6	7	8	9	10	11	0	1	2	3	4	5	6	7	8	9	10	11	0	1	2	3

Even line

B0								B0				G1				G1							
4	5	6	7	8	9	10	11	0	1	2	3	4	5	6	7	8	9	10	11	0	1	2	3

7.3.4 Packet data

The following table shows a guide of packet data for each pixel format.

Table-13 Packet data

Model	Pixel Format	Frame Rate	Packet data (Packet size is at 1500)
GO-5000M-PGE	MONO8	22.3Frame/s	940Mbit/s
	MONO10_PACKED MONO12_PACKED	14.86Frame/s	940Mbit/s
	MONO10 MONO12	11.15Frame/s	940Mbit/s
GO-50000C-PGE	BAYGR8,	22.3Frame/s	940Mbit/s
	BAYGR10_PACKED, BAYGR12_PACKED,	14.86Frame/s	940Mbit/s
	BAYGR10, BAYGR12,	11.15Frame/s	940Mbit/s

7.4 Output timing

7.4.1 Horizontal timing

The horizontal timing of the GO-5000-PGE is described below. Although the GO-5000M-PGE has a horizontal binning function, its horizontal frequency does not change if it is ON. So, the frame rate is not increased.

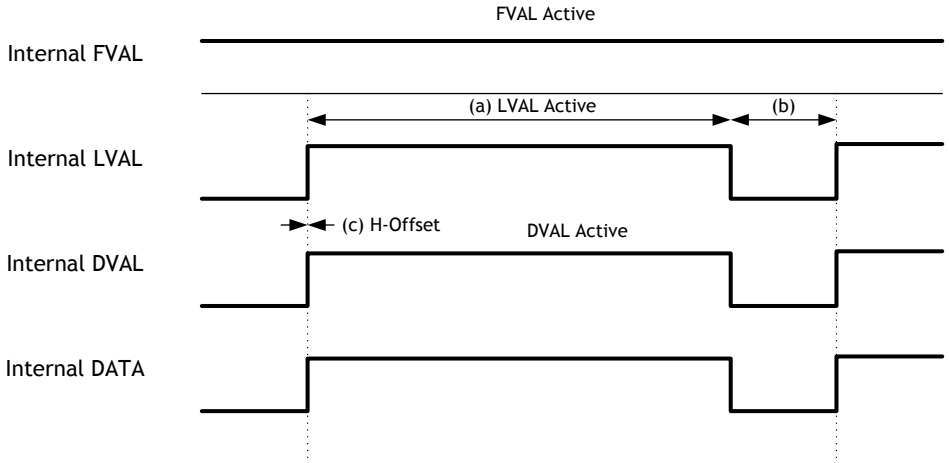


Fig.18 Horizontal Timing (Vertical timing OFF)

Table-14 Timing parameters in Continuous Trigger mode

			(c)		(a)		(b)	
		Horizontal Frequency		H-Offset	LVAL Active		LVAL Non-Active	
H Binning	Pixel Type	kHz	Interval(µ)	clk	µS	clk	clk	Freme Rate(fps)
H1	8Bit	72.727	13.75	660	6.667	320	340	22.3025
	10Bit Packed	47.998	20.834	1000	13.334	640	360	14.8683
	12Bit Packed	47.998	20.834	1000	13.334	640	360	14.8683
	10Bit	47.998	20.834	1000	13.334	640	360	11.1513
	12Bit	47.998	20.834	1000	13.334	640	360	11.1513
H2	8Bit	56.338	17.75	852	3.334	160	692	27.3748
	10Bit Packed	47.998	20.834	1000	6.667	320	680	23.3231
	12Bit Packed	47.998	20.834	1000	6.667	320	680	23.3231
	10Bit	47.998	20.834	1000	6.667	320	680	22.3025
	12Bit	47.998	20.834	1000	6.667	320	680	22.3025
H4	8Bit	56.338	17.75	852	1.668	80	772	27.3748
	10Bit Packed	47.998	20.834	1000	3.335	160	840	23.3231
	12Bit Packed	47.998	20.834	1000	3.335	160	840	23.3231
	10Bit	47.998	20.834	1000	3.334	160	840	23.3231
	12Bit	47.998	20.834	1000	3.334	160	840	23.3231

* Binning available on GO-5000M-PGE only.

7.4.2 Vertical timing

The vertical timing of the GO-5000-PGE is described below.

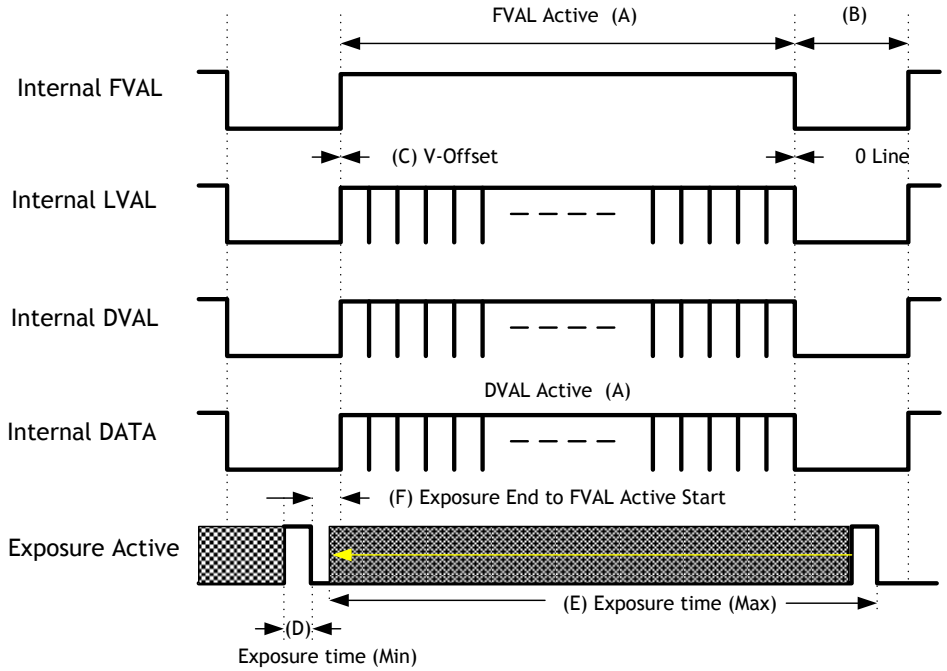


Fig.19 Vertical Timing (Vertical binning OFF)

Table-15 Timing parameters in Continuous Trigger mode

				(A)	(B)	(C)
		Frame Rate	1Line Total clock	FVAL & DVAL Active	FVAL Non-Active	V -Offset
Binning		Interval(fps)	L	L	L	L
V1, H1	8Bit	22.3025	3261	2048	1213	0
	10Bit Packed	14.8683	3228	2048	1180	0
	12Bit Packed	14.8683	3228	2048	1180	0
	10Bit	11.1513	4304	2048	2256	0
	12Bit	11.1513	4304	2048	2256	0
V1, H2	8Bit	27.3748	2058	2048	10	0
	10Bit Packed	23.3231	2058	2048	10	0
	12Bit Packed	23.3231	2058	2048	10	0
	10Bit	22.3025	2152	2048	104	0
	12Bit	22.3025	2152	2048	104	0
V1, H4	8Bit	27.3748	2058	2048	10	0
	10Bit Packed	23.3231	2058	2048	10	0
	12Bit Packed	23.3231	2058	2048	10	0
	10Bit	23.3231	2058	2048	10	0
	12Bit	23.3231	2058	2048	10	0
V2, H1	8Bit	44.3912	1638	1024	614	0
	10Bit Packed	29.5937	1622	1024	598	0
	12Bit Packed	29.5937	1622	1024	598	0
	10Bit	22.1951	2163	1024	1139	0
	12Bit	22.1951	2163	1024	1139	0
V2, H2	8Bit	54.484	1034	1024	10	0
	10Bit Packed	46.4188	1034	1024	10	0
	12Bit Packed	46.4188	1034	1024	10	0
	10Bit	44.3912	1081	1024	57	0
	12Bit	44.3912	1081	1024	57	0
V2, H4	8Bit	54.484	1034	1024	10	0
	10Bit Packed	46.4188	1034	1024	10	0
	12Bit Packed	46.4188	1034	1024	10	0
	10Bit	46.4188	1034	1024	10	0
	12Bit	46.4188	1034	1024	10	0
V4, H1	8Bit	87.9353	827	512	315	0
	10Bit Packed	58.6201	819	512	307	0
	12Bit Packed	58.6201	819	512	307	0
	10Bit	43.9657	1092	512	580	0
	12Bit	43.9657	1092	512	580	0
V4, H2	8Bit	107.93	522	512	10	0
	10Bit Packed	91.653	524	512	12	0
	12Bit Packed	91.653	524	512	12	0
	10Bit	87.911	546	512	34	0
	12Bit	87.911	546	512	34	0
V4, H4	8Bit	107.921	522	512	10	0
	10Bit Packed	91.9456	522	512	10	0
	12Bit Packed	91.9456	522	512	10	0
	10Bit	91.9456	522	512	10	0
	12Bit	91.9456	522	512	10	0

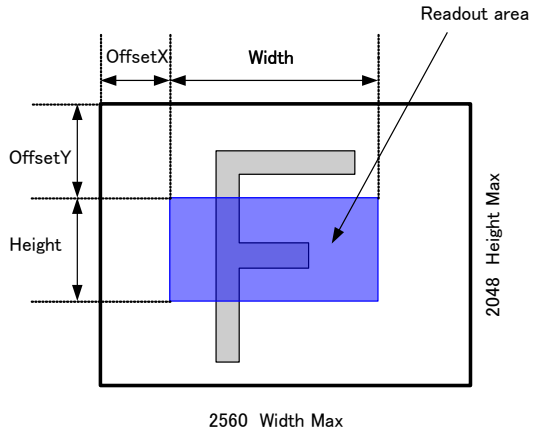
* Binning available on GO-5000M-PGE only.

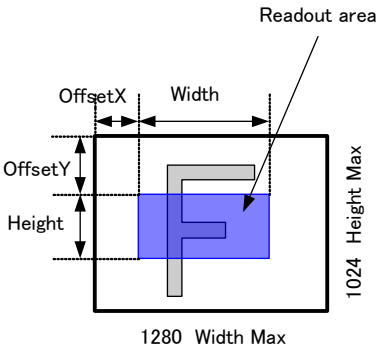
7.4.3 ROI (Region Of Interest) setting

In the GO-5000-PGE, a subset of the image can be output by setting Width, Height, Offset-X, and Offset-Y. If the height is decreased, the number of lines read out is decreased and as the result, the frame rate is increased. In the GO-5000-PGE, the minimum width is “16” and minimum height for GO-5000M-PGE is “1” and for GO-5000C-PGE is “2”.

Setting example (1)	Setting example (2)
Binning* Horizontal = 1	Binning* Horizontal = 2
Binning* Vertical = 1	Binning* Vertical = 2

* GO-5000M-PGE only.



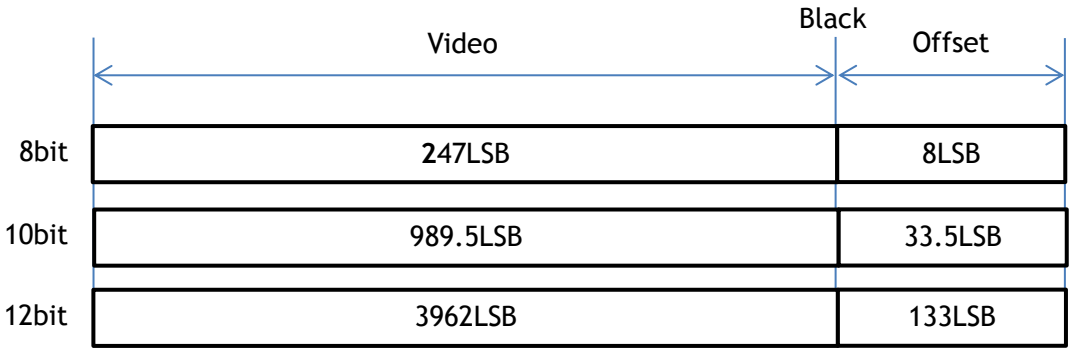


Note: Binning is available for GO-5000M-PGE only.

Fig.20 Setting example (No binning) Fig.21 Setting example (Binning)

7.5 Digital output Bit allocation

The following drawing shows Bit allocation of Digital output.



Note: Above figures are the average value of 100 x 100 pixels in the center.

Fig.22 Bit allocation (10-bit)

8. Operating modes

8.1. Acquisition control

Acquisition control contains the following commands.

Table-16 Acquisition control command

Command	Parameter	Desctiption
Acquisition Mode	Single Frame	One frame can be output by AcqusitionStart command
	Multi Frame	The number of frames which is specified in Acquistion Frame Count, are output by AcquisitionStart command
	Continuous	Images are continuously output by AcquisitionStart command until AcqusitionStop command is input.
Acquisition Start	No(EXE command)	Start Acquisition
Acquisition Stop	No(EXE command)	Stop Acquisition
Acquisition Frame Count	1～255	Set the number of frames to be used in Multi Frame mode.
Acquisition Frame Rate	0.125 to Maximum FrameRate	Set the frame rate in fps value
Acquisition Frame Rate Raw	8sec to Minimum FramePeriod	Set the frame rate in Frame period (μs)

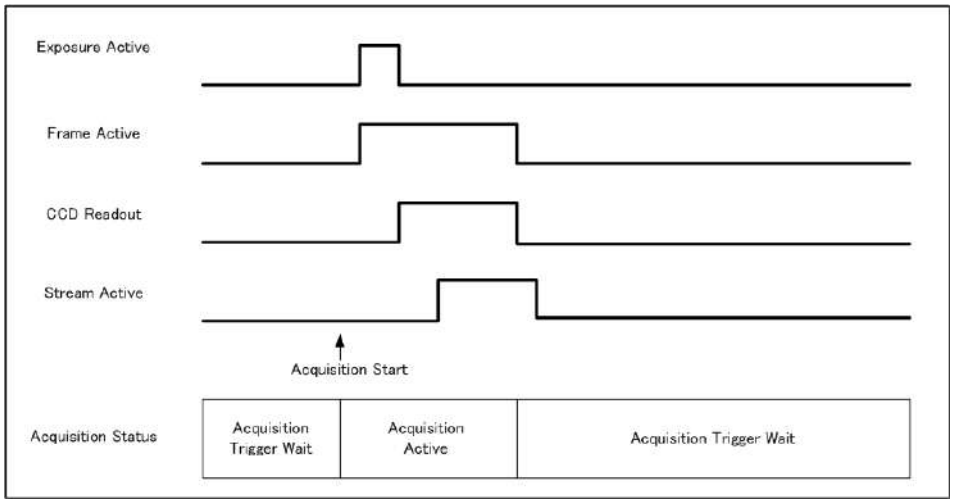
8.1.1 Acquisition Mode

In the GO-5000-PGE, the following three acquisition modes are available.

8.1.1.1 Single Frame

In single frame mode, executing the AcquisitionStart command causes one frame to be captured. After one frame is captured, this operation is automatically stopped.
In order to restart the capture, it is necessary to input the AcquisitionStart command again. BlockID is not reset until AcquisitionStop is input and is incremented when the AcquisitionStart command is called.

◆ Normal single frame operation
1) AcquisitionStart command is input
2) AcquisitionActive becomes “TRUE” (accepts capture)
3) 1 frame is output
4) AcquisitionActive becomes “FALSE” (stop capturing)
5) Output is stopped



Note: This figure is if the trigger mode is OFF. When the trigger mode is ON, FrameActive becomes True at different AcquisitionActive timing.

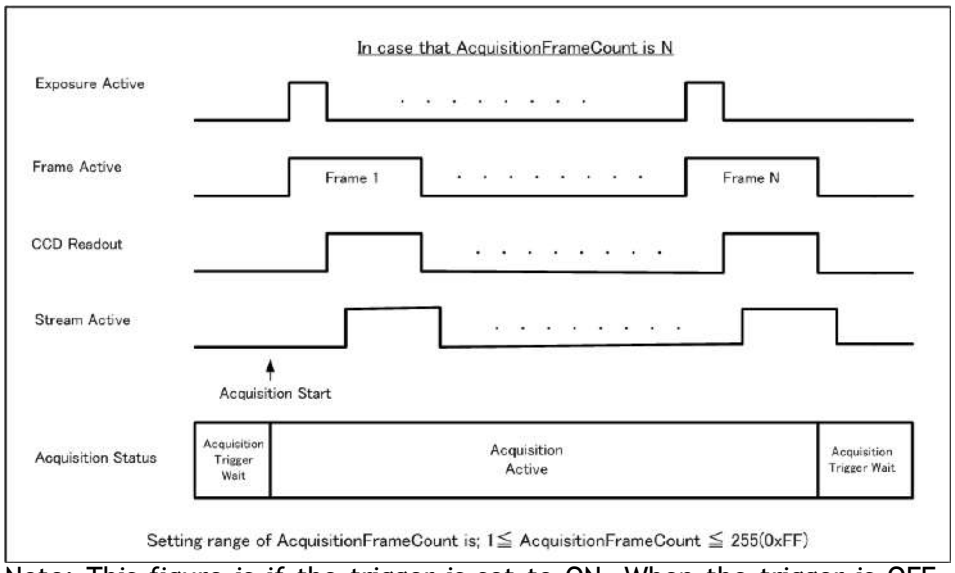
Fig.23 Single Frame operation

◆ Forcing acquisition to stop
While AcquisitionActive is “TRUE”, if AcquisitionStop or AcquisitionAbort is initiated, AcquisitionActive becomes “FALSE” (stop capturing).
However, if AcqusitionStop command is initiated during image output period, AcqusitionActive becomes “FALSE” (stop capturing) after image output is completed.

8.1.1.2 Multi Frames

In this mode, the AcquisitionStart command captures the number of frames which are specified by AcquisitionFrameCount.

◆ Normal multi-frame operation
1) AcquisitionStart command is input
2) AcquisitionTriggerWait becomes effective
3) AcquisitionActive becomes “TRUE” (accepts capture)
4) Output N frames as specified by AcquisitionFrameCount
5) AcquisitionActive becomes “FALSE”. Then the output stops. (See the following diagram)



Note: This figure is if the trigger is set to ON. When the trigger is OFF, FrameActive becomes True at the same timing of AcquisitionActive.

Fig.24 Multi Frame operation

◆ Forcing acquisition to stop
While AcquisitionActive is “TRUE”, if AcquisitionStop or AcquisitionAbort is initiated, AcquisitionActive becomes “FALSE” (stop capturing).
Once the operation is set to “FALSE”, the internal FrameCount is reset.
However, if AcqusitionStop command is initiated during image output period, AcqusitionActive becomes “FALSE” (stop capturing) after image output is completed.
Once, AcqusitionActive becomes “FALSE”, the internal count is reset.

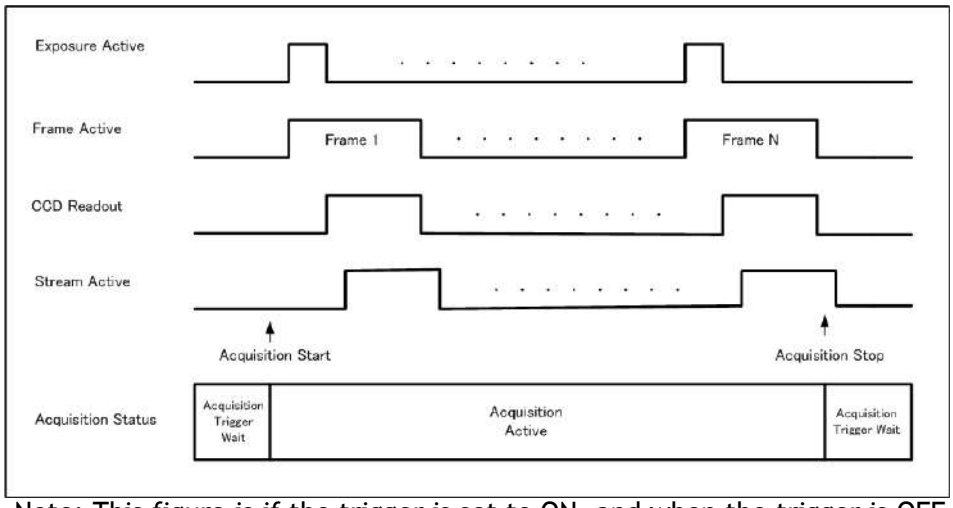
◆ Acqusition Frame Count : Can be set in the range of 1 to 255

8.1.1.3 Continuous

In this mode, when the AcquisitionStart command is set, the image is continuously output at the current frame rate. This is the default setting for the GO-5000M-PGE and GO-5000C-PGE.

◆ Normal continuous operation
1) AcquisitionStart command is input
2) AcquisitionTriggerWait becomes effective
3) AcquisitionActive becomes “TRUE”
4) Images begin outputting continuously
5) AcquisitionStop command is sent
6) AcquisitionActive becomes “FALSE”. At this moment, the output stops.

However, if AcqusitionStop command is initiated during image output period, AcqusitionActive becomes “FALSE” (stop capturing) after image output is completed.



Note: This figure is if the trigger is set to ON, and when the trigger is OFF, FrameActive becomes True at the same timing of AcquisitionActive.

Fig.25 Continuous operation

◆ Forcing acquisition to stop

If AcquisitionStop is executed and the video is already output when the camera receives the stop command, AcquisitionActive becomes False (disabling the capture) after the video output is completed.

8.1.2 Acquisition Start

This is the command to start the capture.

8.1.3 Acquisition Stop

This is the command to stop the capture.

8.1.4 Acquisition frame rate

With Trigger OFF, the default frame rate of the camera is based on the specified ROI. The smaller the ROI, the faster the default frame rate. However, it is possible to specify a free-running frame rate (i.e., no trigger needed) that is slower than the default rate. This can be useful when a longer exposure time is needed for a specific ROI.

Modification of the frame rate is done by entering a value in the AcquisitionFrameRate control corresponding to the frame frequency. Allowed values range from 4172 Hz to 0.125 Hz for GO-5000M-PGE, however if the value entered is less than the time required for the default frame rate, the setting is ignored and the default frame rate is used. For example, the minimum frame period for the smallest possible ROI (1 line) requires 4172 Hz (fps) in 8-bit mode, so any entry more than 4172 Hz (fps) will always be ignored.

The setting range in Acquisition Frame Rate is:

Shortest	to	Longest
Inverse number of time required to drive all pixels in the area set by ROI command or inverse number of time required to transmit one frame data	to	0.125 Hz (fps) = 8 seconds

For the above setting, Acquisition Frame Rate is used and its unit is Hz (fps).
Acquisition Frame Rate: 4172 Hz (fps) to 0.125 Hz (fps)

Note: The acquisition frame rate may be limited to the maximum value which will fit within the GigE bandwidth.

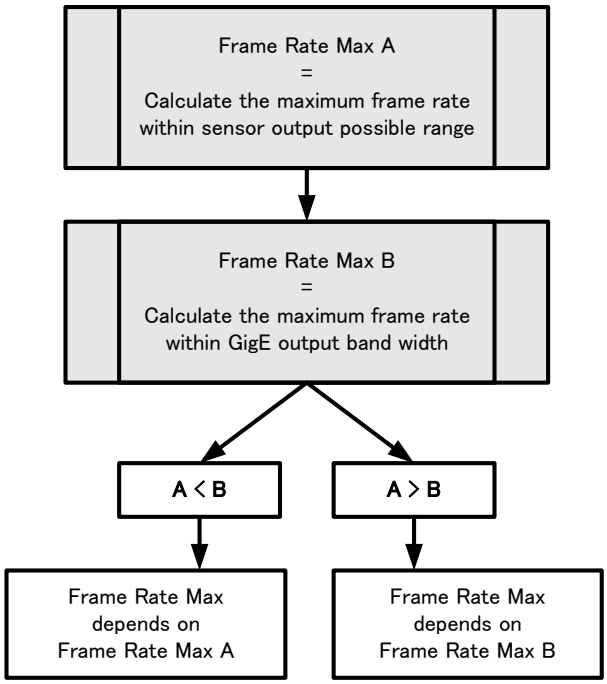


Fig.26 How to determine the maximum frame rate

8.1.5 Calculation of the maximum frame rate

As mentioned in the chapter 8.1.4, the maximum frame rate is limited by either the sensor frame rate or GigE bandwidth. The smaller value is the maximum frame rate of the camera.

(A) Calculation of sensor maximum frame rate (Frame Rate Max A)

[Sensor output maximum frame rate] = 1 / (((48000000/4)) x A) x ([Height [*1]] + 10))

(B) Calculation of GigE bandwidth maximum frame rate (Frame Rate Max B)

[GigE Bandwidth maximum frame rate] = 1000000/ [Frame period]
[Frame period] = round down[*2](1000000/round down[*3]((0.94 * 1000000000)/ [Total bit]))
[Total Bit] = [Width[*4]] x ([Height[*1]] + 10) x B

Maximum frame rate of camera output

As the result of calculation (A) and (B),
If (A) > (B), the maximum frame rate of GigE Bandwidth is the maximum frame rate
If (A) < (B), the maximum frame rate of the sensor output is the maximum frame rate.
If (A) = (B), the maximum frame rate of GigE Bandwidth or the sensor output is the maximum.

Pixel format	Binning Vertical *5	A	B	Maximum frame rate(fps) *6
8-bit	1 (OFF)	165	8	22.3
	2 (ON)	213		44.3
	4 (ON)			87.9
10-bit/12-bit	1 (OFF)	250	16	11.1
	2 (ON)			22.1
	4 (ON)			43.9
10-bit/12-bit Packed	1 (OFF)		12	14.8
	2 (ON)			29.5
	4 (ON)			58.6

	Width *4	Height *1	
		Mono	Color
Binning OFF 1	16 ～ 2560	1 ～ 2048	2 ～ 2048
Binning ON 2	16 ～ 1280	1 ～ 1024	–
Binning ON 4	16 ～ 640	1 ～ 512	–

Note:
*1: Refer to Height value on the above table. Max. value is changed in Binning ON.
*2: Round down after the decimal point
*3: Round down four decimal point
*4: Refer to Width value on the above table. Max. value is changed in Binning ON.
*5: Binning is available only for GO-5000M-PGE.
*6: The maximum frame rate of full pixels image size (2560 x 2048)

8.2. Exposure settings

This section describes how to set the exposure settings.

8.2.1 Exposure Mode

The exposure mode can be selected from the following three ways.

Table-17 Exposure mode

Exposure Mode setting	Exposure operation
OFF	No exposure control (free-running operation)
Timed	Exposure operation at the value set in Exposure Time. Setting value is μs unit. ・If Trigger Mode setting is OFF, the camera is in free-running operation. ・If Trigger Mode setting is ON, the exposure operation depends on the setting of Trigger Option.
Trigger Width	The exposure is controlled by the pulse width of the external trigger. ・If Trigger Mode setting is OFF, the camera is in free-running operation. ・If Trigger Mode setting is ON, the exposure time is controlled by the external trigger pulse width.

For trigger operation, Exposure Mode must be set to something other than OFF and Trigger Mode of Frame Start must be ON.
If Exposure Mode is set at Timed, the exposure operation can be selected as follows by setting Trigger Option

Table-18 Trigger option

Trigger Option setting	Exposure operation
OFF	Timed (EPS) mode
RCT	RCT mode

The effect of the combination of Exposure Mode, Trigger Option and Trigger Mode is as follows.

Table-19 The combination of Exposure Mode, Trigger Option and Trigger Mode

Exposure Mode	Trigger Option	Trigger Mode (Frame Start)	Operation
OFF	N/A	N/A	Free-running operation Exposure control by Exposure Time is not possible
Timed	OFF	OFF	Free-running operation Exposure control by Exposure Time is not possible
		ON	Timed (EPS) Operation Exposure can be controlled by Exposure Time
	RCT	ON	RCT Operation Exposure can be controlled by Exposure Time
Trigger Width	N/A	ON	Exposure is controlled by the pulse width of the external trigger

8.2.2 Exposure Time

This command is effective only when Exposure Mode is set to Timed. It is for setting exposure time. The setting step for exposure time is 1 μsec per step.

Minimum: 10 μsec
Maximum: 8 seconds (Note – noise may make image unusable after 1 second)

8.2.3 Exposure Auto

This is a function to control the exposure automatically. It is effective only for Timed.
JAI ALC Reference controls the brightness.

There are two modes, OFF and Continuous.

OFF: No exposure control
Continuous: Exposure continues to be adjusted automatically

In this mode, the following settings are available.
ALC Speed: Rate of adjustment can be set (Common with GainAuto)
ExpsoureAuto Max: The maximum value for the exposure time to be controlled can be set
ExposureAuto Min: The minimum value for the exposure time to be controlled can be set
ALC Reference: The reference level of the exposure control can be set (Common with GainAuto)
ALC Area Selector: The portion of the image used for controlling exposure can be set (Common with GainAuto)

High Left	High Mid-left	High Mid-right	High Right
Mid-High Left	Mid-High Mid-left	Mid-High Mid-right	Mid-High Right
Mid-Low Left	Mid-Low Mid-left	Mid-Low Mid-right	Mid-Low Right
Low Left	Low Mid-left	Low Mid-right	Low Right

Fig. 27 ALC Channel Area

8.3. Trigger Control

The following 5 types of Trigger Control are available by the combination of Trigger Selector, Trigger Mode, Exposure Mode and Trigger Option.

Table-20 Trigger control

Camera Settings				JAI Custom Trigger Mode Name	Description
Trigger Selector	Trigger Mode	Exposure Mode	Trigger Option		
Frame Start	Off	Off	Off	Continuous Trigger	Free-running operation with the maximum exposure time per the frame rate
	Off	Timed	Off	Continuous Trigger	Free-running operation with a user-set exposure time.
	On	Timed	Off	EPS Trigger	Externally triggered operation with a user-set exposure time
	On	Timed	RCT	RCT Trigger	Externally triggered operation for RCT
	On	Trigger Width	Off	PWC Trigger	Externally triggered operation with a pulse width exposure time

8.3.1 Trigger Selector

Selects the trigger operation. In the GO-5000-PGE, the following trigger operation can be selected as the trigger.

Table-21 Trigger selector

Trigger Selector Item	Description
Frame Start	Frame Start Trigger operation
Acquisition Start	Acquisition Start Trigger operation
Acquisition End	Acquisition End Trigger operation
Acquisition Transfer Start	Transfer Trigger operation

Each trigger has the following setting parameters and those parameters are configured on each trigger selector item.

Setting parameters: Trigger Mode, Trigger Software, Trigger Source, Trigger Activation

8.3.2 Trigger Mode

Select either free-running operation or external trigger operation.

OFF: Free-running operation
ON: External trigger operation
(Initiate the trigger operation selected in Trigger selector)

8.3.3 Trigger Source

The following signals can be used as the trigger source signal.

Table-22 Trigger source

Trigger Source item	Description
Low	Connect LOW level signal to the selected trigger operation **Default setting**
High	Connect HIGH level signal to the selected trigger operation
Soft Trigger	Connect Soft Trigger signal to the selected trigger operation Trigger can be input manually by the execution of the software trigger Trigger software is available on each trigger source.
PulseGenerator0 Out	Connect Pulse generator 0 signal to the selected trigger operation
User output 0	Connect User output 0 signal to the selected trigger operation
User output 1	Connect User output 1 signal to the selected trigger operation
Line 5 - OPT IN 1	Connect OPT IN 1 signal to the selected trigger operation
NAND 0 Out	Connect NAND 0 OUT signal to the selected trigger operation
NAND 1 Out	Connect NAND 1 OUT signal to the selected trigger operation
Action 1	Connect Action 1 OUT signal to the selected trigger operation
Action 2	Connect Action 2 OUT signal to the selected trigger operation

8.3.4 Trigger activation

This command can select how to activate the trigger.

Rising edge: At the rising edge of the pulse, the trigger is activated.
Falling edge: At the falling edge of the pulse, the trigger is activated.
Level High: During the high level of trigger, the accumulation is activated
Level Low: During the low level of trigger, the accumulation is activated
If Exposure Mode is set to Trigger Width, Level High or Level Low must be used.

Table-23 Trigger Activation

Camera Settings				JAI Custom Trigger Mode Name	Trigger Activation Setting			
Trigger Selector	Trigger Mode	Exposure Mode	Trigger Option		Rising Edge	Falling Edge	Level High	Level Low
Frame Start	On	Timed	Off	EPS Trigger	○	○	×	×
	On	Timed	RCT	RCT Trigger	○	○	×	×
	On	Trigger Width	Off	PWC Trigger	×	×	○	○

8.3.5 Trigger Overlap

In the GO-5000-PGE, the trigger overlap function is fixed to Read Out.

Read Out : The trigger pulse can be accepted during the sensor readout.

8.4. Normal continuous operation (Timed Exposure Mode/Trigger Mode OFF)

This is used for applications which do not require triggering.

Primary settings to use this mode

Trigger Mode: Off

Minimum interval of the trigger

Read out mode	Minimum trigger interval
Full	45.2 ms
ROI 2/3 (Height=1365)	30 ms
ROI 1/2 (Height=1024)	22.4 ms
ROI 1/4 (Height=512)	11.4 ms
ROI 1/8 (Height=256)	5.8 ms
1/2V Binning (Note)	22.4 ms

Note: GO-5000M-PGE only

8.5. Timed mode

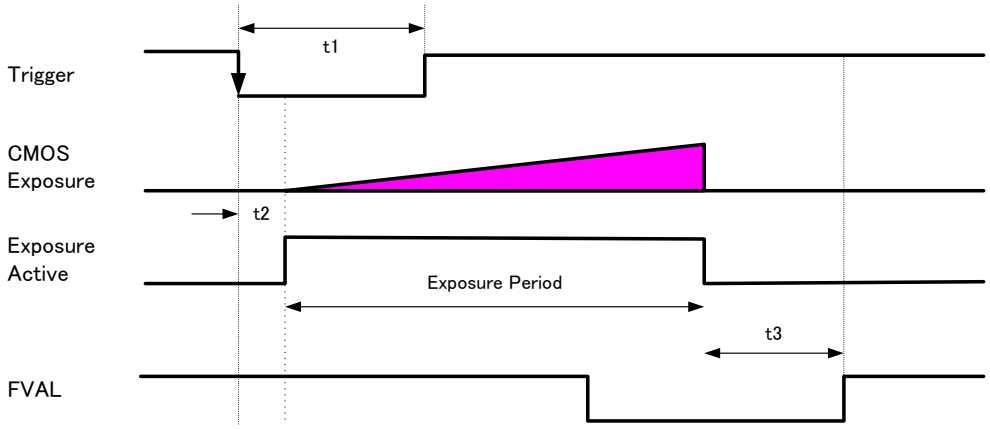
This mode allows a single image frame to be captured with a preset exposure time by using the external trigger. Additional settings determine if the trigger pulse can be accepted during the exposure period.

Primary settings to use this mode
Exposure Mode: Timed
Trigger Mode: ON
Trigger Source: Opt IN (6p connector)
Trigger Option: OFF
Optical Filter Selector: 10µs

Minimum interval of the trigger

Read out mode	Minimum trigger interval
Full	44.843 ms
ROI 2/3 (Height=1365)	29.962 ms
ROI 1/2 (Height=1024)	22.532 ms
ROI 1/4 (Height=512)	11.377 ms
ROI 1/8 (Height=256)	5.8 ms
1/2V Binning (Note 1)	22.532 ms

Note1 : GO-5000M-PGE only



t1	t2	t3
10 µs (Min)	61 µs	5L to 6L

Fig.28 Timed

8.6. Trigger width mode

In this mode, the exposure time is equal to the trigger pulse width. Accordingly, longer exposure times are supported. Additional settings determine if the trigger pulse can be accepted during the exposure period.

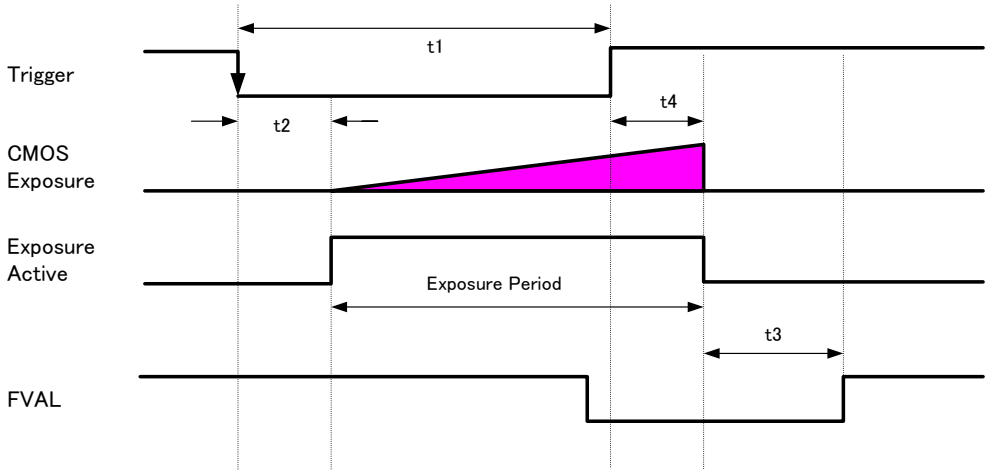
Note: As the exposure time is shortened against an input trigger width, the input trigger width should be "the necessary exposure time plus 8.2 µs".

Primary settings to use this mode
Exposure Mode: Trigger Width
Trigger Mode: ON
Trigger Source: Opt IN (6p connector)
Trigger Option: OFF
Optical Filter Selector: 10µs

Minimum interval of the trigger

Read out mode	Minimum trigger interval
Full	45.2 ms – 3 µs
ROI 2/3 (Height=1365)	30 ms – 3 µs
ROI 1/2 (Height=1024)	22.4 ms – 3 µs
ROI 1/4 (Height=512)	11.4 ms – 3 µs
ROI 1/8 (Height=256)	5.8 ms – 3 µs
1/2V Binning (Note)	22.4 ms – 3 µs

Note : GO-5000M-PGE only



t1	t2	t3	t4
10 µs (Min)	61 µs	53 µs	5L to 6L

Fig.29 Pulse width

8.7. RCT (Reset Continuous Trigger) mode

RCT mode can use ALC control to ensure that the proper exposure is set when the trigger pulse is input. In the following drawing, the steps to achieve this combination are explained.

① The exposure control is the same as in continuous mode.
② When the trigger signal is input, the charge that has already been accumulated during the current exposure period is read out very quickly and a new exposure period starts. The exposure continues as in continuous mode.
③ All video level data from every exposure is transferred to ALC control.
④ The video output sent to the GigE interface is only the signal after the trigger is input.

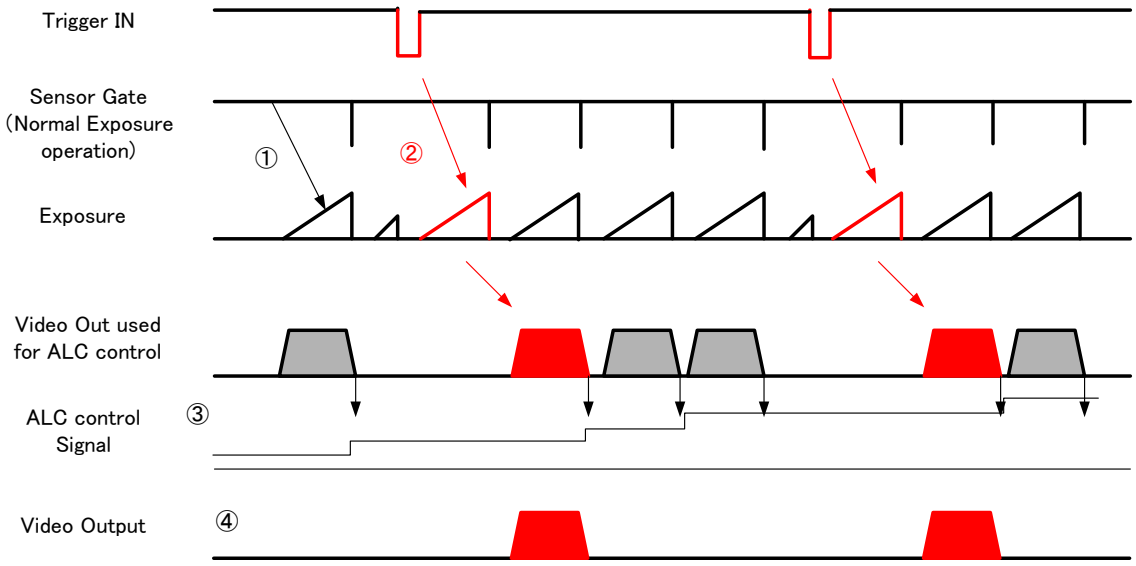


Fig.30 RCT mode timing for ALC operation (Example)

Primary settings to use this mode

Exposure Mode: Timed
Trigger Selector: Frame Start
Trigger Mode: ON
Trigger Option: RCT

If ALC control is used together with RCT mode, then
Exposure auto: Continuous
Gain Auto: Continuous

Minimum interval of the trigger

Read out mode	Minimum trigger interval
Full	45.2 ms + Exposure time + 271 µs
ROI 2/3 (Height=1365)	30 ms + Exposure time + 271 µs
ROI 1/2 (Height=1024)	22.4 ms + Exposure time + 271 µs
ROI 1/4 (Height=512)	11.4 ms + Exposure time + 271 µs
ROI 1/8 (Height=256)	5.8 ms + Exposure time + 271 µs
1/2V Binning (Note 1)	22.4 ms + Exposure time + 271 µs

Note1 : GO-5000M-PGE only

8.8 Video Send Mode

The GO-5000-PGE has a Video Send Mode and it includes the following operations.

Table-24 Video send mode

Mode selected	Index selection method
Normal	Normal operation
Multi ROI	Up to 5 ROI images can be set up. Each image is output independently.
Trigger Sequence	Up to 10 indexes can be set for ROI, Exposure Time and Gain. Select the index by using the Frame Start trigger signal.
Command Sequence	Up to 10 indexes can be set for ROI, Exposure time and Gain. Select the index number to assign directly by using the Command Sequence Index command.
Delayed Readout	Up to 7 frames can be stored (8-bit). Each image can be output by Acquisition Transfer Start trigger timing.

8.8.1 Sequence Mode

This mode allows the user to define a preset sequence of up to 10 images, each with its own ROI, exposure time and gain values. This mode has two operation modes.

Mode selected	Index selection method
Trigger Sequence	Select the index by using the Frame Start trigger signal. (The setting index can be determined by the Next Index setting.)
Command Sequence	Select the index number to assign directly by using the Command Sequence Index command.

Primary settings to use this mode

Exposure Mode: Timed
Trigger Mode: ON
Video Send Mode: Trigger Sequence or Command Sequence

Minimum interval of the trigger

Read out mode	Minimum trigger interval
Full	45.2 ms + Exposure time
ROI 2/3 (Height=1365)	30 ms + Exposure time
ROI 1/2 (Height=1024)	22.4 ms + Exposure time
ROI 1/4 (Height=512)	11.4 ms + Exposure time
ROI 1/8 (Height=256)	5.8 ms + Exposure time
1/2V Binning (Note 1)	22.4 ms + Exposure time

Note1 : GO-5000M-PGE only

8.8.1.1 Trigger Sequence mode basic timing

In this mode, as each trigger input is received, the image data associated with the next index within the preset sequence is output.
In the trigger sequence mode, it is not possible to input the trigger while the current index is executing.
The sequence index table always starts at Index 1 and changes to next index which is preset in the next index setting after the current index is completed.

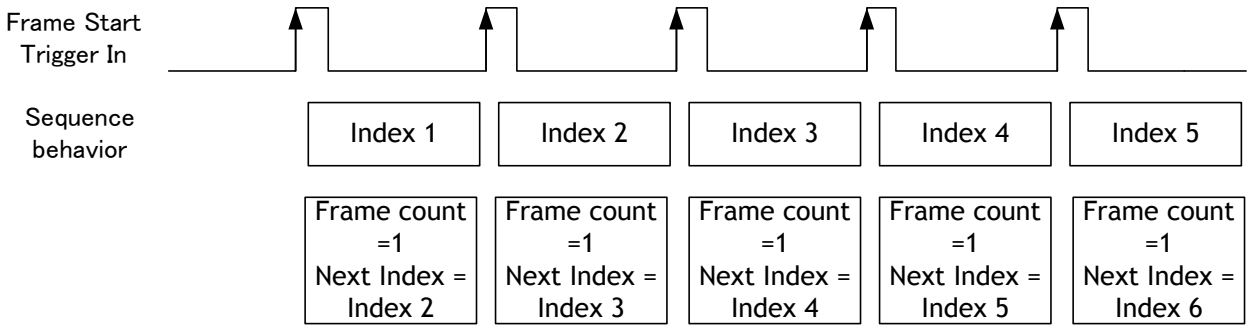


Fig. 31 Behavior of Sequence trigger

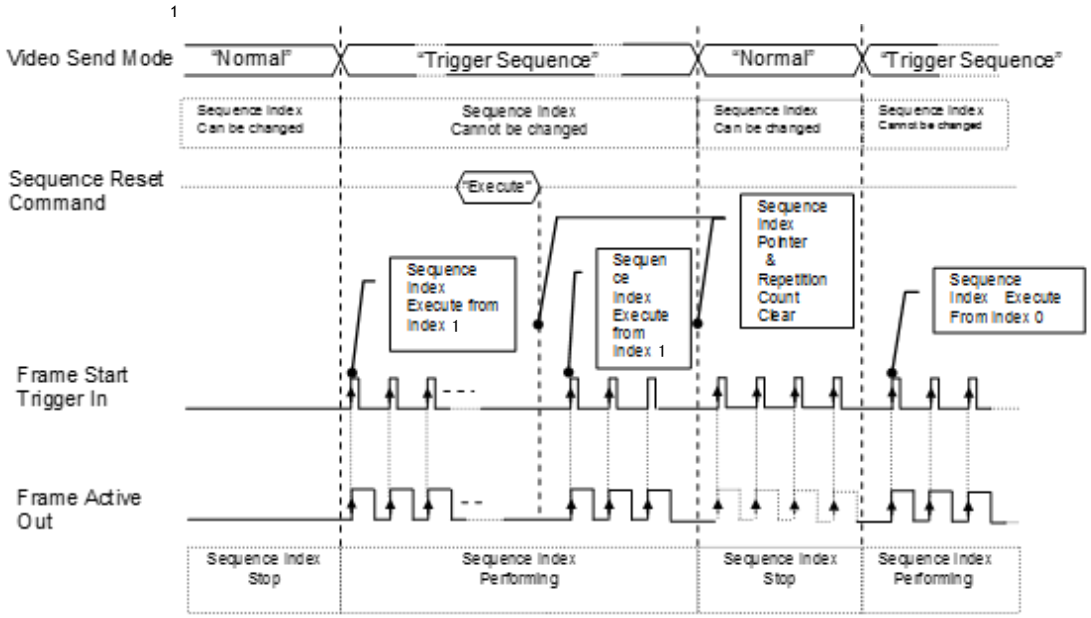


Fig. 32 Behavior if Video Send Mode is set to Trigger Sequence

8.8.1.2 Sequence index table (Default)

The following table shows the default settings.

Table-25 Sequence Index table (Default)

Sequence ROI Index	Sequence ROI													
	Width	Height	Offset		Gain Selector			Exposure Time	Black Level	Binning (Note 1)		LUT Enable	Frame Count	Next Index
			X	Y	Gain (ALL)	Red	Blue			Horizontal	Vertical			
- Index 1	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 2	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 3	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 4	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 5	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 6	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 7	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 8	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 9	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 10	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 1

Note1 : GO-5000M-PGE only

8.8.1.3 Descriptions of index table parameters

Table-26 Sequence mode command

Command	Parameter	Description
Sequence ROI Index	Index 1～10	Select an index to be set
Sequence ROI Frame Count	1～255	<Set to each Index> Set fame number for display per a frame
Sequence ROI Next Index	Index 1～10 Off	<Set to each Index> <Used for Trigger Sequence Mode> Set the index to be active at the next Off: Stop a sequence operation at the current index.
Sequence ROI Width	16～2560 (Note 1)	<Set to each Index> Set the width value
Sequence ROI Height	1～2048 (Note 1, Note3) 2～2048 (Note 2)	<Set to each Index> Set the height value
Sequence ROI Offset X	0～2560 (Note 1)- [Sequence ROI Width]	<Set to each Index> Set the offset value.
Sequence ROI Offset Y	0～2048(Note1) - [Sequence ROI Height]	<Set to each Index> Set the offset Y.
Sequence ROI Gain All	100～1600	<Set to each index> Set the gain value.
Sequence ROI Gain Red*2	-4533～37876	<Set to each Index> Set the Gain Red value.
Sequence ROI Gain Blue*2	-4533～37876	<Set to each Index> Set the Gain Blue value.
Sequence ROI Exposure Time	10～8000000	<Set to each Index> Set the exposure time value.
Sequence ROI Black Level	-256～255	<Set to each index> Set the black level value.
Sequence ROI LUT enable	0 (Disable) 1 (Enable)	<Set to each Index> Set the disable or enable of LUT. If it is set to enable, the function is selected in the Sequence LUT mode.

Sequence ROI H Binning[*3]	1, 2, 4 (3 is disable)	<Set to each Index> Set the H Binning value.
Sequence ROI V Binning[*3]	1, 2, 4 (3 is disable)	<Set to each Index> Set the V Binning value.
Sequence Repetition	1～255	<For Trigger Sequence Mode> Set the repeat number of the sequence.
Command Sequence Index	Index 1～10	<For Command Sequence Mode> Set the performed index.
Current Sequence Index	Index 1～10	<READ only> Refer to the current Sequence Index.
Sequence LUT Mode	Gamma LUT	Set the function if Sequence ROI LUT is set to enable. Set the value on Gamma or LUT control.
Reset Sequence Index	No (EXE command)	Reset the Sequence Index to 0. At the same time, the Frame Count is also initialized.

Note 1: If the binning mode is used, the maximum value is changed.
Note 2: Only Bayer model
Note 3: Only Monochrome model

8.9 Multi ROI mode

In the GO-5000-PGE, the width and height of 5 separate ROIs within the full image area can be set as required. Each image can be overlapped. The location of each ROI can also be set as required. The Multi ROI data is output as an independent frame.

The multi ROI mode is enabled if [Video Sending Mode] is set to “Multi ROI”.

Table-27 Multi ROI Index table default values

Multi ROI Index Selector	Multi ROI			
	Width	Height	Offset	
			X	Y
- Index 1	2560	2048	0	0
- Index 2	2560	2048	0	0
- Index 3	2560	2048	0	0
- Index 4	2560	2048	0	0
- Index 5	2560	2048	0	0

Fig.33 Multi ROI setting example

8.9.1 Multi ROI setting parameters

Table-28 Multi ROI command

Command	Parameter	Description
Multi ROI Index	Index 1～5	Select the index to be configured.
Multi ROI Width	16～2560 (Note 1)	<Set to each Index> Set the width value.
Multi ROI Height	1～2048 (Note 1, Note2) 2～2048 (Note 3)	<Set to each Index> Set the Height value.
Multi ROI Offset X	0～2560(Note 1) - [Sequence ROI Width]	<Set to each Index> Set the Offset X value.
Multi ROI Offset Y	0～2048 (Note 1) - [Sequence ROI Height]	<Set to each Index> Set the Offset Y value.
Multi ROI Index Max	1～5	Set the number of index to be used.

Note 1: If binning mode is used, the maximum values are adjusted accordingly.
Note 2: Only for GO-5000M-PGE
Note 3: Only for GO-5000C-PGE

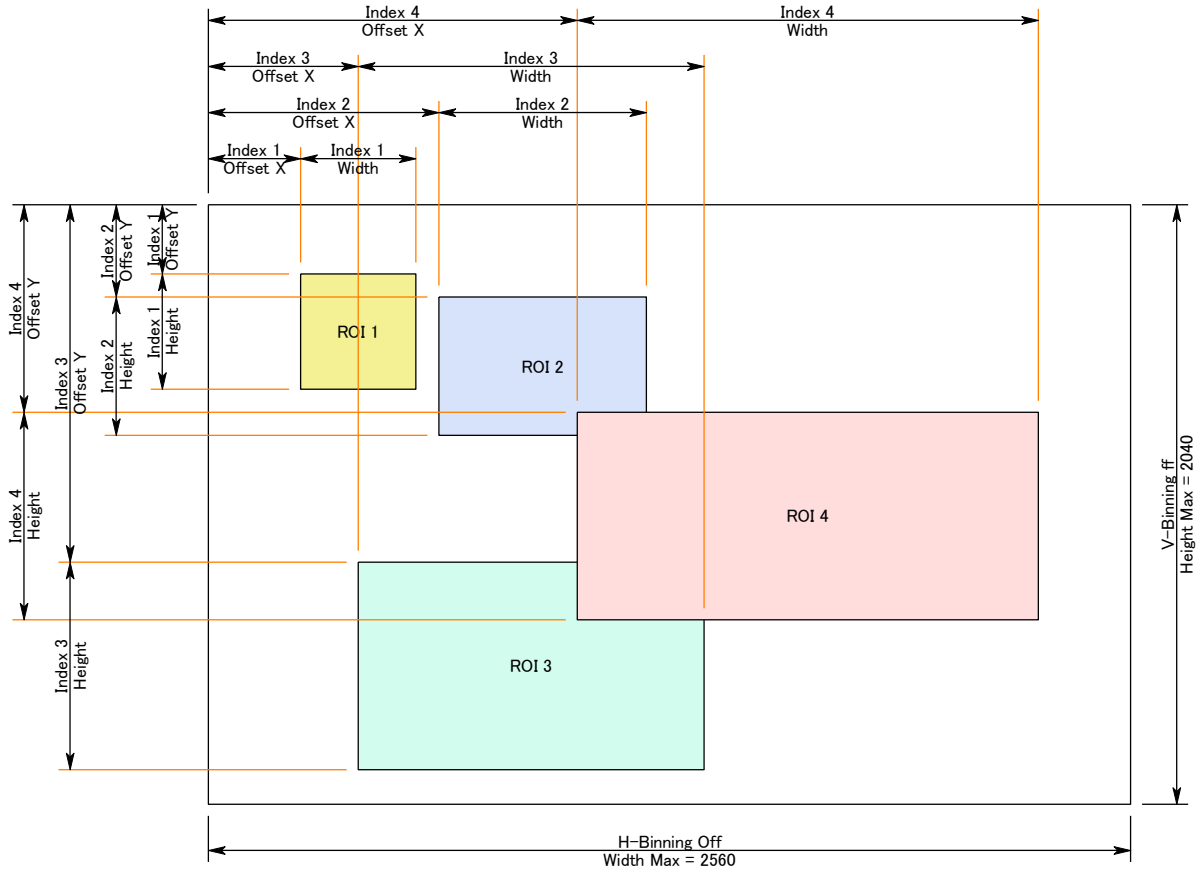


Fig.34 Multi ROI setting example

8.10 Delayed Readout function

The images captured by Frame Start trigger can be stored inside the camera and read out by Acquisition Transfer Start trigger. Up to 7 frames at 8-bit operation can be stored. For 10-bit/12-bit operation, it is 3 frames.

Table-29 Delayed readout command

Command	Setting	Description
Trigger Selector	Acquisition Transfer Start	Select the Trigger Selector at Acquisition Transfer Start to operate this function.
Trigger Mode	On	Refer to Chapter 8.3
Trigger Source	Select the source to be used	
Trigger Activation	Select the polarity of the source to be used.	

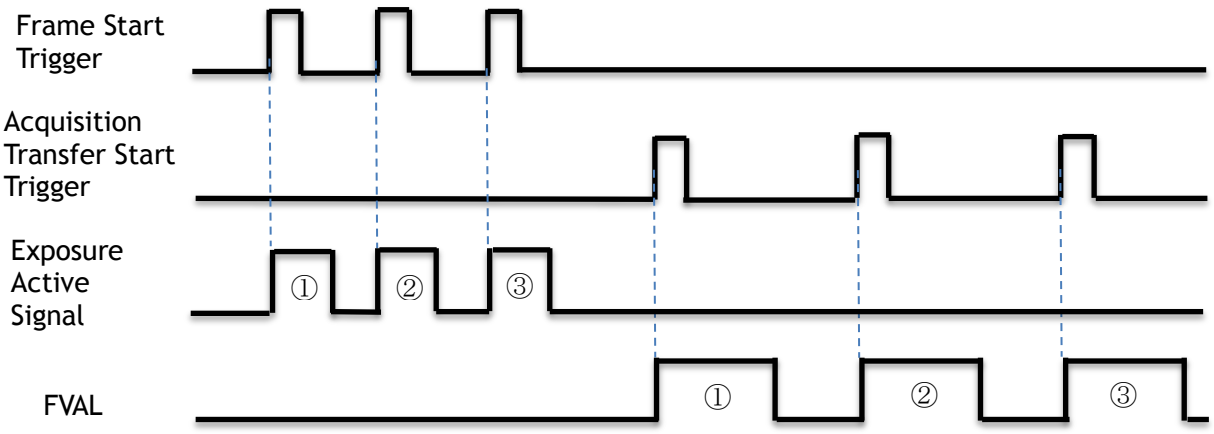


Fig. 35 Operating timing (Example)

8.11. Operation and function matrix

Table-30 Operation and function matrix

Exposure Operation	Trigger mode	Trigger Option	V-Binning Note1	H-Binning Note1	Exposure Time	ROI	AWB Note2	Auto Gain	Auto Exposure	Video Send Mode		HDR Note1
										Multi ROI	Sequence	
OFF	OFF	OFF	1	1	×	○	○	○	×	○	×	×
			2 / 4	2 / 4	×	○	×	○	×	○	×	×
Timed	OFF	OFF	1	1	○	○	×	○	○	○	×	○
			2 / 4	2 / 4	○	○	×	○	○	○	×	○
Timed (EPS)	ON	OFF	1	1	○	○	○	○	○	○	○	○
			2 / 4	2 / 4	○	○	×	○	○	○	○	○
Trigger Width	ON	OFF	1	1	×	○	○	○	×	○	×	×
			2 / 4	2 / 4	×	○	×	○	×	○	×	×
Timed (RCT)	ON	RCT	1	1	○	○	○	○	○	○	×	×
			2 / 4	2 / 4	×	×	×	×	×	×	×	×

Note 1. Only GO-5000M-PGE
Note 2: Only GO-5000C-PGE

9. Other functions

9.1 Black level control

This function adjusts the setup level.

Reference level	33.5LSB (Average of 100 x 100)
Video level adjusting range	0～approx. 100 LSB
Adjusting level	-256 to 255 (Default: 0)
Resolution of adjust	1STEP=0.25LSB

Note: the above figures are for 10-bit.

9.1.1 Black Level Selector

The following factors can be set.

GO-5000M-PGE: DigitalAll
GO-5000C-PGE: DigitalAll/DigitalRed/ DigitalBlue

9.1.2 Black Level

The black level can be set in the following range.

GO-5000M-PGE: DigitalAll : -256～ +255
GO-5000C-PGE: DigitalAll : -256～ +255
DigitalRed/DigitalBlue : -512～ +511

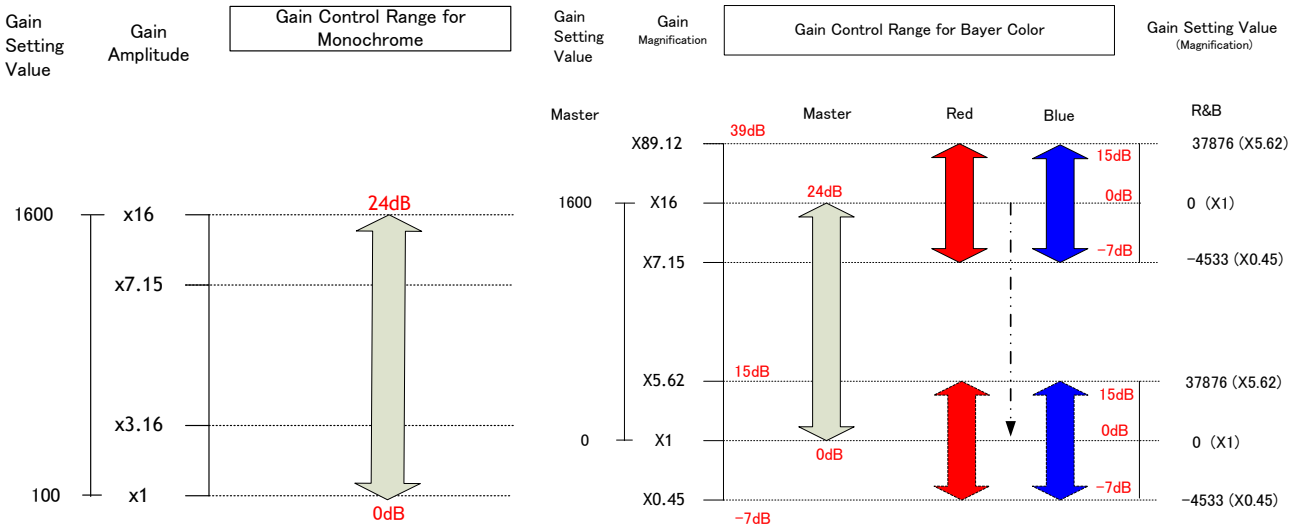
9.2 Gain control

In the GO-5000-PGE, the gain control uses Analog Base Gain and Digital Gain.
Analog Base Gain can be set at 0dB, +6dB or +12dB for both GO-5000M-PGE and GO-5000C-PGE. In the GO-5000C-PGE, R, G and B channels can be adjusted individually or simultaneously.
The digital gain is used for the master gain setting.

For setting the gain,

1. Set analog gain (Select from 0dB, +6dB and +12dB)
2. Set digital gain
   The master gain (DigitalAll) for both monochrome and color can be set x1 (0dB) to x16 (+24dB) against the analog base gain. The resolution for gain setting is x0.01/step which is 0.05dB to 0.08dB, depending on the setting value.
3. In the GO-5000C-PGE, blue and red gain can be set from x0.447 to x4 against the master gain setting and its resolution is x0.01/step.
4. In the GO-5000C-PGE, analog gain can be applied to R, G and B channel respectively in order to cover a wider range of color temperatures.

The master gain control uses Digital Gain Control. All digital gain can be set by x0.01/step. If the digital gain is set too high, gaps in the Histogram may occur.



The above drawing shows the relationship between gain setting value (command), gain amplitude, and dB indication. For example, the gain amplitude “x 5.62” equals 15dB.

Fig.36 Gain control

9.2.1 Gain Selector

The following parameters can be set.

GO-5000M-PGE: DigitalAll
GO-5000C-PGE: DigitalAll/Digital Red All/Digital Blue All

9.2.2 Gain

This is the reference value upon which gain adjustments are based. The operational adjustment is done in Gain Raw.

GO-5000M-PGE: DigitalAll : 1～16 (0dB to +24dB)
GO-5000C-PGE: DigitalAll : 1～16 (0dB to +24dB)
Digital Red :0.447 to 5.62
Digital Blue : 0.447 to 5.62

9.2.3 Gain RAW

Gain RAW can be set in the following range.

GO-5000M-PGE: Gain Raw Digital All : 100 ～ 1600 (0dB～24dB)

GO-5000C-PGE: Gain Raw Digital All : 100 ～ 1600(0dB～24dB)
Gain Raw Digital Red: -4533～37876
Gain Raw Digital Blue: -4533～37876

9.2.4 Gain Auto

This function automatically controls the gain level.
This is controlled by the command JAI ALC Reference.

There are three modes.

OFF: Adjust manually.
Once: Operate only one time when this command is set
Continuous: Operate the auto gain continuously

The following detailed settings are also available.

ALC Speed: The rate of adjustment of GainAuto can be set (Common with ExposureAuto).
Gain Auto Max: The maximum value of GainAuto control range can be set
Gain Auto Min: The minimum value of GainAuto control range can be set
ALC Reference: The reference level of Gain Auto control can be set (Common with ExposureAuto)
ALC Area Selector: The portion of the image used for auto gain control can be set(common with Exposure Auto)
ALC Area Enable: This command can make selected area(s) disabled or enabled. If ALC Area Selector selects ALC Area Enable ALL, and it is set to True, all areas are enabled and in this case, preset areas are all disabled.

High Left	High Mid-left	High Mid-right	High Right
Mid-High Left	Mid-High Mid-left	Mid-High Mid-right	Mid-High Right
Mid-Low Left	Mid-Low Mid-left	Mid-Low Mid-right	Mid-Low Right
Low Left	Low Mid-left	Low Mid-right	Low Right

Fig.37 ALC Area Selector

9.2.5 Balance White Auto

This is a function to achieve auto white balance by using R and B gain.
There are three operations.

OFF: Manual operation
Once: Only when this operation is set, the auto white balance is executed.
Continuous: The auto white balance is continuously executed.

The following details are also be set.

AWB Area Selector: The control area of BALANCE WHITE AUTO can be set.
AWB Area Enable: This command can make selected area(s) disabled or enabled. If AWB Area Selector selects AWB Area Enable ALL, and it is set to True, all areas are enabled and in this case, preset areas are all disabled.

Note: AWB Area Selector is the same as ALC Area Selector.

9.3. LUT

This function can be used to convert the input to the desired output characteristics.
The Look-Up Table (LUT) has 32 points for setup in the GO-5000M-PGE and 16 points for each R, G and B in GO-5000C-PGE. The output level can be created by multiplying the gain data by the input level.

9.3.1 LUT Enable

Can be selected from OFF, Gamma or LUT table.

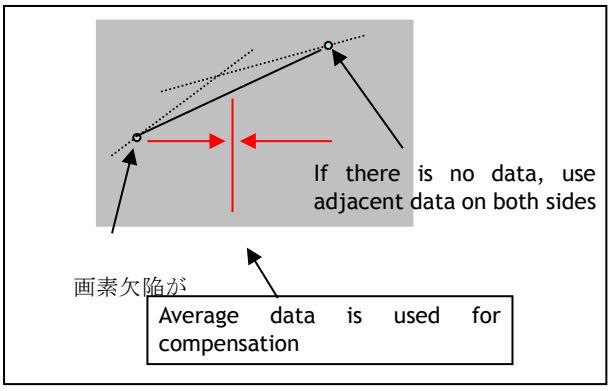
9.3.2 LUT Index

This represents the “starting” or “input” pixel value to be modified by the Lookup Table. The GO-5000M-PGE has a 32-point Lookup Table. Thus, in the GO-5000M-PGE, an index value of 0 represents a full black pixel and a value of 31 represents a full white pixel. The index point values are automatically scaled to fit the internal pixel format of the camera. This is common for all output configurations. In the GO-5000C-PGE, it is a 16-point Lookup Table.

9.3.3 LUT value

This is the "adjusted" or "output" pixel value for a given LUT index. It has a range of 0 to 4095 (12 bits) and is automatically scaled to the bit depth of the current output mode (8-bit, 10 bit, or 12-bit). Linear interpolation is used to calculate LUT values between index points. In the color model, the LUT function works the same regardless of the color of the pixel.

*Note: The LUT must have a positive slope, i.e., the value for each index must be greater than the previous index. If the value for an index is set ≤ one or more previous indexes, those indexes will be automatically adjusted to maintain a positive slope.



Output Data = Video IN x LUT data

Fig. 38 LUT value

9.4. Gamma

This command is used to set gamma 0.45, gamma 0.6 and gamma 1.0 (OFF) in 3 steps.
The gamma value is an approximate value.

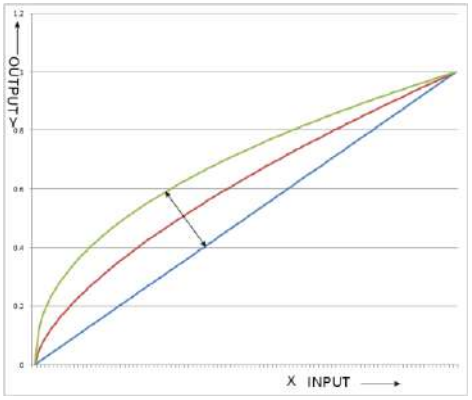


Fig. 39 Gamma compensation

9.4.1 Linear and Dark Compression

GO-5000-PGE has a dark compression circuit to improve the signal-to-noise ratio in the dark portion of the image. This function is OFF as factory default setting and can be ON according to applications.

Dark Compression	Function
Linear(Factory default)	No compression, Gamma=1.0
Dark Compression	Compress the signal level in the dark portion. It can improve the signal to noise ratio, but on the other hand, the linearity will be deteriorated.

9.5. Blemish compensation

The GO-5000-PGE has a blemish compensation circuit. This function compensates blemishes on the CMOS sensor (typically pixels with extremely high response or extremely low response). This applies to both monochrome and color versions. Pixels that fulfill the blemish criteria can be compensated by averaging the data from the pixel in the left adjacent column and, in the case of the GO-5000C-PGE, the defective pixels can be compensated by averaging the data from the same Bayer color pixel in left adjacent column. The number of pixels that can be compensated is up to 256pixels.
GO-5000-PGE has an automatic blemish detection function. After setting the threshold, when the blemish compensation is executed, blemishes are automatically detected and stored in the memory inside the camera. If the blemish compensation is set to ON, the stored data is loaded. The customer can adjust white blemishes but not black blemishes.

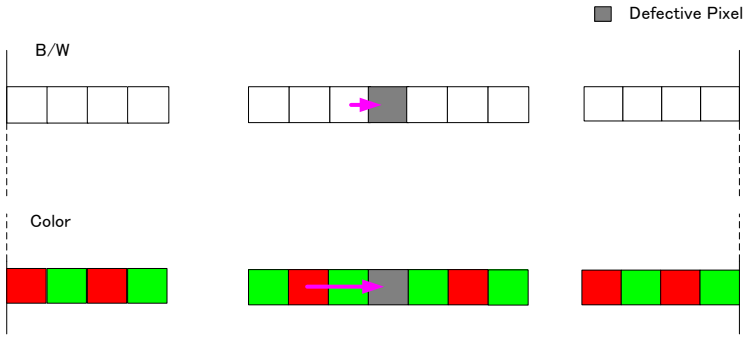


Fig.40 Blemish compensation

Note: If defective pixels are found consecutively in the horizontal direction, the blemish compensation circuit does not work.

9.6 ALC

In the GO-5000-PGE, auto gain and auto exposure can be combined to provide a wide ranging automatic exposure control from dark to bright or vice versa.
The functions are applied in the sequence shown below and if one function is disabled, the remaining function will work independently.

If the lighting condition is changed from bright to dark ASC → AGC
If the lighting condition is changed from dark to bright AGC → ASC

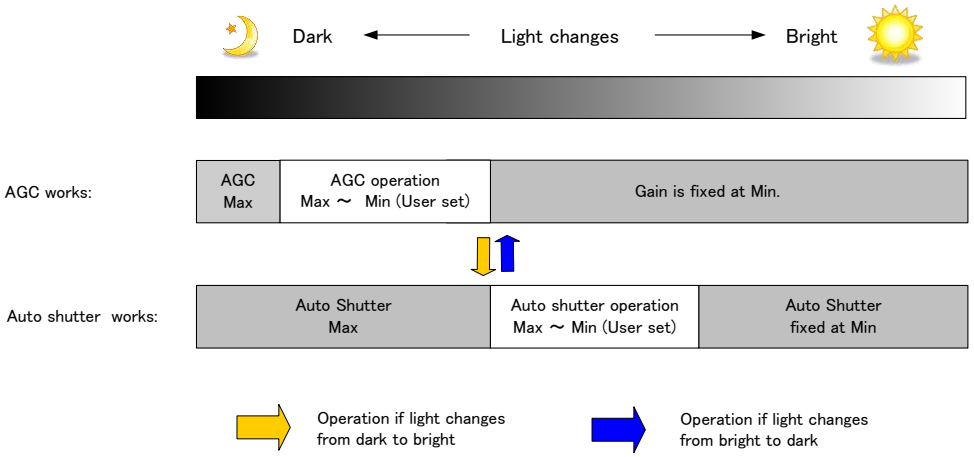


Fig.41 ALC function concept

ALC Reference will determine the target video level for AGC and Auto Shutter. For instance, if ALC Reference is set to 100% video level, AGC and Auto Shutter will function to maintain 100% video level.

■ Please note that ALC function is available only in continuous mode, as well as RCT mode.

9.7 HDR (High Dynamic Range)(GO-5000M-PGE only)

HDR sensing mode can be set when HDR Mode is set to ON while Exposure Mode is Timed.
The parameters to configure dynamic range are HDR_SLOPE Level 1, Level 2, Level 3 and Level 4.
The user can select any one of those parameters as required for their application.
In this mode, the timed exposure is used as the reference and the value selected in HDR_SLOPE will compensate to get an appropriate dynamic range by changing the exposure time.

Notes:

1. If the exposure mode is OFF and the HDR* mode is set to ON, the exposure mode is automatically changed to Timed.
2. If horizontal binning** and/or vertical binning** are set to ON, the HDR* mode cannot be set. In this case, the HDR* mode must be set first before H-Binning** and/or V-Binning** are set.
3. In this mode, exposure overlapped behavior is not available and the frame rate is slower than normal operation.
4. The exposure time value is fixed at the value when HDR* Mode is activated. When the exposure time is changed, HDR* Mode should be off. Once the exposure time is changed, HDR* Mode can be set to ON again.
5. In this mode, Exposure Auto function is disabled.

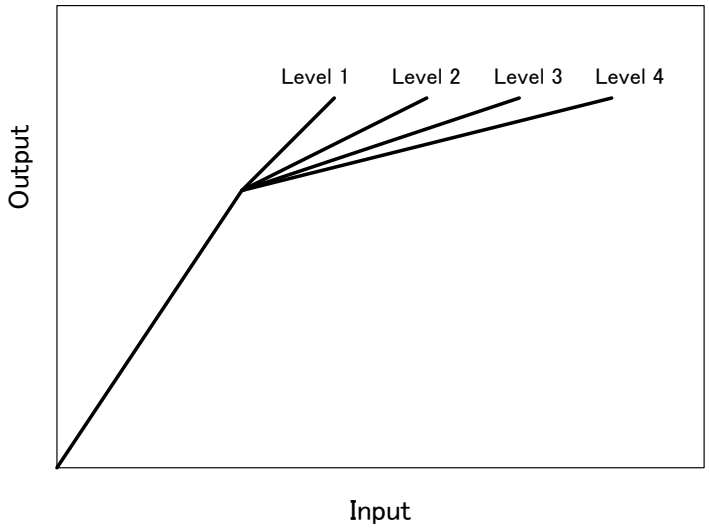


Fig.42 HDR characteristics

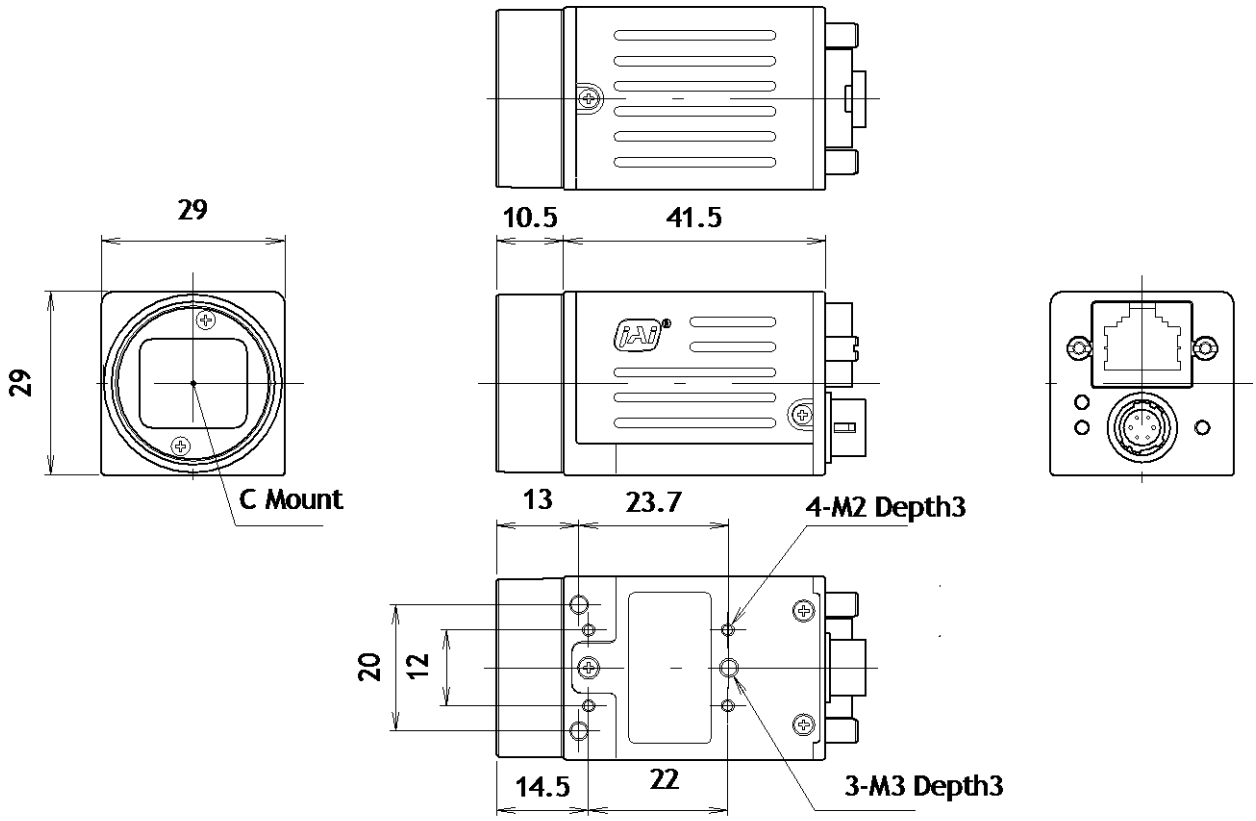
Knee Slope	Dynamic Range [%]
1	(200)
2	(400)
3	(800)
4	(1600)

10. Camera setting

10.1 Camera Control Tool

In the GO-5000M-PGE and GO-5000C-PGE, control of all camera functions is done by the JAI SDK and Control Tool software. All controllable camera functions are stored in an XML file inside of the camera. The JAI SDK and Control Tool software can be downloaded from www.jai.com.

11. External appearance and dimensions



Dimensions tolerance: ± 0.3mm
Unit: mm

Fig.43 Outside dimensions

12. Specifications

12.1 Spectral response

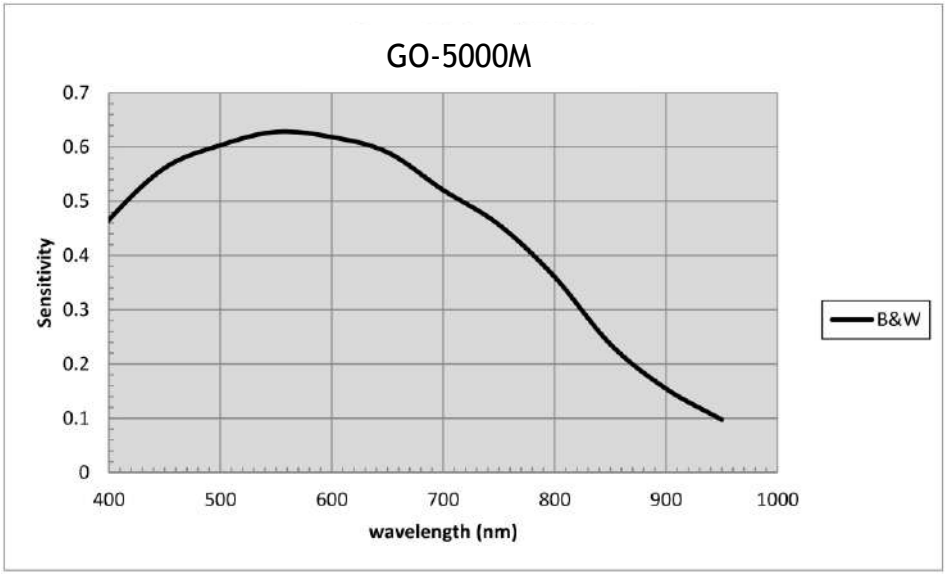


Fig.44 Spectral response (GO-5000M-PGE)

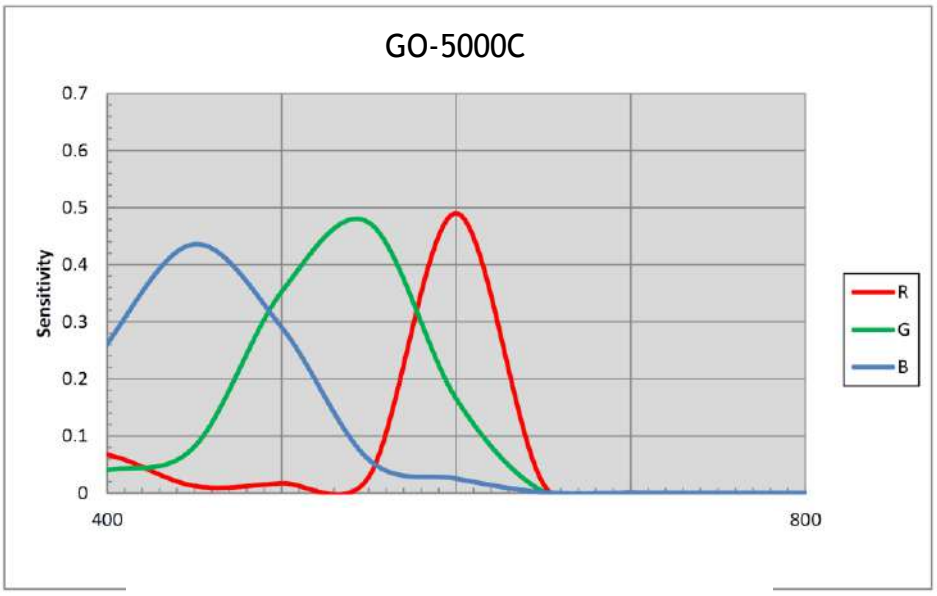


Fig.45 Spectral response (GO-5000C-PGE - with IR Cut Filter)

12.2 Specifications table

Specifications				GO-5000M-PGE	GO-5000C-PGE
Scanning system				Progressive scan, 1-tap	
Synchronization				Internal	
Interface				1000Base-T Ethernet (GigE Vision 2.0), IEEE 802.3af	
Image sensor				1-inch Monochrome CMOS	1-inch Bayer color CMOS
Aspect Ratio				5:4	
Image size(Effective Image)				12.8 (h) x 10.24 (v) mm, 16.39 mm diagonal	
Pixel size				5 (h) x 5 (v) μm	
Effective Image output Pixels				2560 (h) x 2048 (v)	2560 (h) x 2048 (v)
Pixel Clock				48 MHz	
Maximum Acquisition Frame Rate per Pixel Format (minimum is 0.125 fps for all formats)	8-bit	H1, V1		22.3 fps (Max)	22.3 fps (Max)
		Binning	H1, V2	44.39 fps (Max)	–
			H2, V1	27.37 fps (Max)	–
			H2, V2	54.48 fps (Max)	–
			H4, V4	107.92 fps (Max)	–
	10bit/ 12-bit Packed	H1, V1		14.86 fps (Max)	14.86 fps (Max)
		Binning	H1, V2	29.59 fps (Max)	–
			H2, V1	23.32 fps (Max)	–
			H2, V2	46.41 fps (Max)	–
			H4, V4	91.94 fps (Max)	–
	10-bit/ 12-bit	H1, V1		11.15 fps (Max)	11.15 fps (Max)
		Binning	H1, V2	22.19 fps (Max)	–
			H2, V1	22.3 fps (Max)	–
			H2, V2	44.39 fps (Max)	–
			H4, V4	91.94 fps (Max)	–
EMVA 1288 Parameters Absolute sensitivity Maximum SNR				At 10-bit output 20.17 p (λ = 525 nm) 41.30 dB	At 10-bit output 51.25 p (λ = 525 nm) 38.12 dB
SN ratio (traditional method)				49dB (Typical) (at Linear) 55dB (Typical) (at Dark compression ON) (0dB gain, Black)	44dB (Typical) (at Linear) 50dB (Typical) (at Dark compression ON) (0dB gain, Green Black)
Image Output format Digital	Full pixels			2560 (h) x 2048 (v)	Bayer 2560 (h) x 2048 (v)
	ROI	Width		16 ～2560, 16 pixels/step	16 ～2560, 16 pixels/step
		OFFSET X		0 ～2544, 16 pixels/step	0 ～2544, 16 pixels/step
		Height		1 ～2048 lines,1 line/step	2 ～2048 lines,2 line/step
		OFFSET Y		0 ～2047 lines, 1 line/step	0 ～2046 lines, 2 line/step
	Binning	H	1	2560 (H)	2560 (H)
			2	1280 (H)	–
			4	640 (H)	–
		V	1	2048 (V)	2048 (V)
			2	1024 (V)	–
			4	512 (V)	–
	Bit assignment			Mono8, Mono10, Mono10 Packed Mono12, Mono12 Packed	BayerGR, BayerGR10, BayerGR10 Packed, BayerGR12, BayerGR12 Packed

Acquisition mode			Continuous / Single Frame / Multi Frame (1 ～255)	
Trigger Selector		Acquisition	Acquisition Start/ Acquisition Stop	
		Exposure	Frame Start	
		Transfer	JAI Frame Transfer	
Exposure mode			OFF, Continuous, Timed (EPS), Trigger Width	
Trigger option			OFF / RCT (with ALC function)	
Trigger Overlap			Fixed (Readout)	
Trigger Input Signal			Line 6 (Opt In), Software, PG0, NAND Out 0/1, Action 1/2	
Opt. Filter			5 steps (10 µs (Typ), 100 µs, 500 µs, 1ms, 5ms, 10ms)	
Exposure Mode	Timed		Exposure Auto: OFF 10 µs (Min.)～ 8 second (Max.) (Note1), Variable unit: 1 µs Exposure Auto: Continuous 10 µs (Min.)～ 8 second (Max.)(Note1), Variable unit: 1 µs	
	Trigger Width		10 µs (Min.Note1) ～ ∞ (Max.) (Note1)	
Exposure Auto			OFF / Continuous	
Auto Exposure Response Speed			1 ～ 8	
Video Send mode			Normal ROI, Multi ROI (1 to 5), Trigger sequence, Command sequence, Delayed readout	
Digital I/O			Line Selector (6P): GPIO IN / GPIO OUT	
Black Level Adjust.	Ref. level		33.5LSB 10-bit (Average value of 100*100)	
	Video level adj. range		0 ～ 100 10-bit	
	Adj. range		±64LSB against Ref. level 10-bit	
	Resolution		1 STEP = 0.25LSB	
Analog Base Gain (For manual)			0dB, 6dB, 12dB	0dB, 6dB, 12dB (R/G/B individual setting)
Gain Control	Manual Adj. range		0dB ～+24dB (Note2) 1 step=x0.01 (0.005dB to 0.08dB) Varies by setting value	0dB ～+24dB (Note2) 1 step=x0.01 (0.005dB to 0.08dB) Varies by setting value
	Gain Auto		OFF / Continuous	OFF / Continuous
	WB Gain		—	R / B : -7dB to +15dB, 1 step = 0.01dB
	WB Area		—	4 x 4
	WB Range		—	3000K ～ 9000K
	White Balance		—	OFF, Continuous, Once
Blemish Comp.	Detection		Detect white blemish above the threshold value (Black blemish is detected only by factory)	
	Compensation		Complement by adjacent pixels (Continuous blemishes are not compensated)	
	Numbers		256 pixels	
ALC			AGC and auto exposure can be combined and automatically controlled	
Gamma			0.45, 0.6 and 1.0 (OFF) (3 steps are available)	
Dark compression			Choice of Linear or Dark compression ON	
LUT			OFF: γ=1.0, ON=32 points (Mono), 16 points (Bayer) can be set	
HDR			4 settings, Level 1, 2, 3 and 4	—
Power	6-Pin Connector	Input range	DC+12V to +24V ± 10% (At the input terminal)	
		Current	190mA ± 20mA (At 12V input, Full pixels) (Typical)	
		Power	2.5W (At 12V input, Full pixels) (Typical)	
	PoE	Input range	DC 35 ～ 57V	
		Current	58mA ±6mA (At 55V input, Full pixels) (Typical)	
		Power	3.0W (At 12V input, Full pixels) (Typical)	
Lens mount			C mount Rear protrusion of the lens is less than 10 mm	

Flange back	17.526 mm, Tolerance: 0 to -0.05 mm	
Optical filter	Protection glass: Not provided	IR cut filter (Half value is 670 nm)
Operating temperature/Humidity Performance guaranteed	-5°C to +45°C / 20 – 80% (No-condensing)	
Storage Temp. / Humidity	-25°C to +60°C/20% to 80 % (no-condensing)	
Regulation	CE (EN61000-6-2 and EN61000-6-3), FCC part 15 class B, RoHS, WEEE	
Housing Dimensions	29 x 29 x 52 mm (W x H x D) (excluding protrusion)	
Weight	46 g	

Note1): Usable performance will be up to 1 second.

Note2): A minimum of +12dB of gain can be applied without causing any breaks in the histogram.

Note3): Approximately 5 minutes pre-heating is required to achieve these specifications.

Note4): The above specifications are subject to change without notice.

Appendix

1. Precautions

Personnel not trained in dealing with similar electronic devices should not service this camera.
The camera contains components sensitive to electrostatic discharge. The handling of these devices should follow the requirements of electrostatic sensitive components.
Do not attempt to disassemble this camera.
Do not expose this camera to rain or moisture.
Do not face this camera towards the sun, extreme bright light or light reflecting objects.
When this camera is not in use, put the supplied lens cap on the lens mount.
Handle this camera with the maximum care.
Operate this camera only from the type of power source indicated on the camera.
Power off the camera during any modification such as changes of jumper and switch setting.

2. Typical Sensor Characteristics

The following effects may be observed on the video monitor screen. They do not indicate any fault of the camera, but are associated with typical sensor characteristics.

V. Aliasing
When the CMOS camera captures stripes, straight lines or similar sharp patterns, jagged edges may appear on the monitor.

Blemishes
All cameras are shipped without visible image sensor blemishes.
Over time some pixel defects can occur. This does not have a practical effect on the operation of the camera. These will show up as white spots (blemishes).
Exposure to cosmic rays can cause blemishes to appear on the image sensor. Please take care to avoid exposure to cosmic rays during transportation and storage. It is recommended using sea shipment instead of air flight in order to limit the influence of cosmic rays on the camera. Pixel defects/blemishes also may emerge due to prolonged operation at elevated ambient temperature, due to high gain setting, or during long time exposure. It is therefore recommended to operate the camera within its specifications.

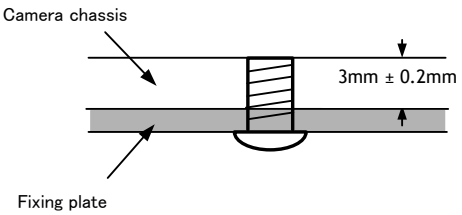
Patterned Noise
When the sensor captures a dark object at high temperature or is used for long time integration, fixed pattern noise may appear on the video monitor screen.

3. Caution when mounting a lens on the camera

When mounting a lens on the camera dust particles in the air may settle on the surface of the lens or the image sensor of the camera. It is therefore important to keep the protective caps on the lens and on the camera until the lens is mounted. Point the lens mount of the camera downward to prevent dust particles from landing on the optical surfaces of the camera. This work should be done in a dust free environment. Do not touch any of the optical surfaces of the camera or the lens.

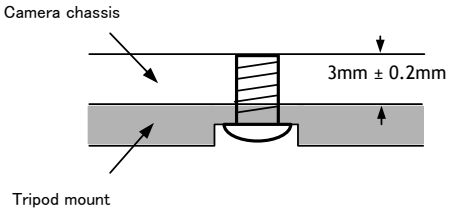
4. Caution when mounting the camera

When you mount the camera on your system, please make sure to use screws of the recommended length described in the following drawing. Longer screws may cause serious damage to the PCB inside the camera.



Mounting the camera to fixing plate

If you mount the tripod mounting plate, please use the provided screws.



Attaching the tripod mount

5. Exportation

When exporting this product, please follow the export regulation of your own country.

6. References

1. This manual can and datasheet for GO-5000M-PGE / GO-5000C-PGE can be downloaded from www.jai.com
2. Camera control software can be downloaded from www.jai.com

Manual change history

Date	Revision	Changes
August 2014	Preliminary	New Release
Nov. 2014	Ver.1.0	Release
Jan. 2015	Ver. 1.1	Review the frame rate calculation
May 2015	Ver. 1.2	Review the optical interface recommended circuits
Aug. 2015	Ver. 1.3	Revise a number of the Hirose 6Pin (page 20)
Aug. 2018	Ver. 1.4	Add KC, Revise LUT function

User's Record

Camera type: GO-5000M-PGE / GO-5000C-PGE

Revision: ……..

Serial No. ……..

Firmware version. ……..

For camera revision history, please contact your local JAI distributor.

User's Mode Settings.

User's Modifications.

Europe, Middle East & Africa	*Asia Pacific*	*Americas*
Phone +45 4457 8888 *Fax +45 4491 3252*	*Phone +81 45 440 0154* *Fax +81 45 440 0166*	*Phone (toll-free) +1 800 445 5444* *Phone +1 408 383 0300*

Visit our web site at www.jai.com

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