See the possibilities

User Manual

GO-5000M-PMCL
GO-5000M-PMCL-EP
GO-5000M-PMCL-UV

CMOS Digital Progressive Scan
Monochrome Camera with Mini Camera Link Interface

Document Version: 2.2
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Thank you for purchasing this product.

⚠Be sure to read this documentation before use.

This documentation includes important safety precautions and instructions on how to operate the unit. Be sure to read this documentation to ensure proper operation.

The contents of this documentation are subject to change without notice for the purpose of improvement.

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About Technical Note

Some additional technical information is provided on the JAI website as Technical Notes. In this manual, if a technical note is available for a particular topic, the above icon is shown. Please refer to the following URL for Technical notes.

https://www.jai.com/support-software/technical-notes

Notice/Warranty

Notice

The material contained in this manual consists of information that is proprietary to JAI Ltd., Japan, and may only be used by the purchasers of the product. JAI Ltd., Japan makes no warranty for the use of its product and assumes no responsibility for any errors which may appear or for damages resulting from the use of the information contained herein. JAI Ltd., Japan reserves the right to make changes without notice.

Company and product names mentioned in this manual are trademarks or registered trademarks of their respective owners.

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-PMCL, GO-5000M-PMCL-EP and GO-5000M-PMCL-UV comply with the following provisions applying to their 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

제조년월은 제품상자의 라벨을 참조하십시오.

Supplement

The following statement is related to the regulation on “Measures for the Administration of the Control of Pollution by Electronic Information Products “, known as “China RoHS“. The table shows contained Hazardous Substances in this camera.

mark shows that the environment-friendly use period of contained Hazardous Substances is 15 years.

Applicable Model: GO-5000M-PMCL

重 要 注 意 事 项

有毒，有害物质或元素名称及含量表

根据中华人民共和国信息产业部『电子信息产品污染控制管理办法』， 本产品《 有毒，有害物质或元素名称及含量表》如下.

部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
螺丝固定座	×	○	○	○	○	○
连接插头	×	○	○	○	○	○
电路板	×	○	○	○	○	○
.....	.....	.....	.....	.....	.....	.....

○:表示该有毒有害物质在该部件所有均质材料中的含量均在GB/T 26572-2011规定的限量要求以下。

×:表示该有毒有害物质至少在该部件的某一均质材料中的含量超出GB/T 26572-2011规定的限量要求。

环保使用期限

电子信息产品中含有的有毒有害物质或元素在正常使用的条件下不会发生外 泄或突变、电子信息产品用户使用该电子信息产品不会对环境造成严重污染 或对其人身、财产造成严重损害的期限。

数字「15」为期限15年。

Supplement

The following statement is related to the regulation on “Measures for the Administration of the Control of Pollution by Electronic Information Products “, known as “China RoHS“. The table shows contained Hazardous Substances in this camera.

mark shows that the environment-friendly use period of contained Hazardous Substances is 15 years.

Applicable Models: GO-5000M-PMCL-EP and GO-5000M-PMCL-UV

重 要 注 意 事 项

有毒，有害物质或元素名称及含量表

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部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
电路板	×	○	○	○	○	○
螺丝	×	○	○	○	○	○
插座	×	○	○	○	○	○
.....	.....	.....	.....	.....	.....	.....

○:表示该有毒有害物质在该部件所有均质材料中的含量均在GB/T 26572-2011规定的限量要求以下。

×:表示该有毒有害物质至少在该部件的某一均质材料中的含量超出GB/T 26572-2011规定的限量要求。

环保使用期限

电子信息产品中含有的有毒有害物质或元素在正常使用的条件下不会发生外 泄或突变、电子信息产品用户使用该电子信息产品不会对环境造成严重污染 或对其人身、财产造成严重损害的期限。

数字「15」为期限15年。

Usage Precautions

Notes on Cable Configurations

The presence of lighting equipment and television receivers nearby may result in video noise. In such cases, change the cable configurations or placement.

Notes on Attaching the Lens

Technical Notes How to Clean a Sensor

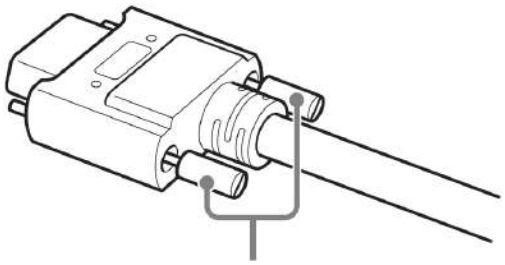
Avoiding Dust Particles

When attaching the lens to the camera, stray dust and other particles may adhere to the sensor surface and rear surface of the lens. Be careful of the following when attaching the lens.

- Work in a clean environment.
- Do not remove the caps from the camera and lens until immediately before you attach the lens.
- To prevent dust from adhering to surfaces, point the camera and lens downward and do not allow the lens surface to come into contact with your hands or other objects.
- Always use a blower brush to remove any dust that adheres.
- Never use your hands or cloth, blow with your mouth, or use other methods to remove dust.

Notes on Camera Link Cable Connections

Secure the locking screws on the connector manually, and do not use a driver. Do not secure the screws too tightly. Doing so may wear down the screw threads on the camera. (Tightening torque: 0.15 N·m or less)



Caution: Secure manually. Do not secure too tightly.

Phenomena Specific to CMOS Image Sensors

The following phenomena are known to occur on cameras equipped with CMOS image sensors. These do not indicate malfunctions.

- **Aliasing**: When shooting straight lines, stripes, and similar patterns, vertical aliasing (zigzag distortion) may appear on the monitor.
- **Blooming**: When strong light enters the camera, some pixels on the CMOS image sensor may receive much more light than they are designed to hold, causing the accumulated signal charge to overflow into surrounding pixels. This “blooming” phenomenon can be seen in the image but does not affect the operation of the camera.
- **Fixed pattern noise**: When shooting dark objects in high-temperature conditions, fixed pattern noise may occur throughout the entire video monitor screen.
- **Defective pixels**: Defective pixels (white and black pixels) of the CMOS image sensor are minimized at the factory according to shipping standards. However, as this phenomenon can be affected by the ambient temperature, camera settings (e.g., high sensitivity and long exposure), and other factors, be sure to operate within the camera’s specified operating environment.

Notes on Exportation

When exporting this product, please follow the export regulations of your country or region.

Features

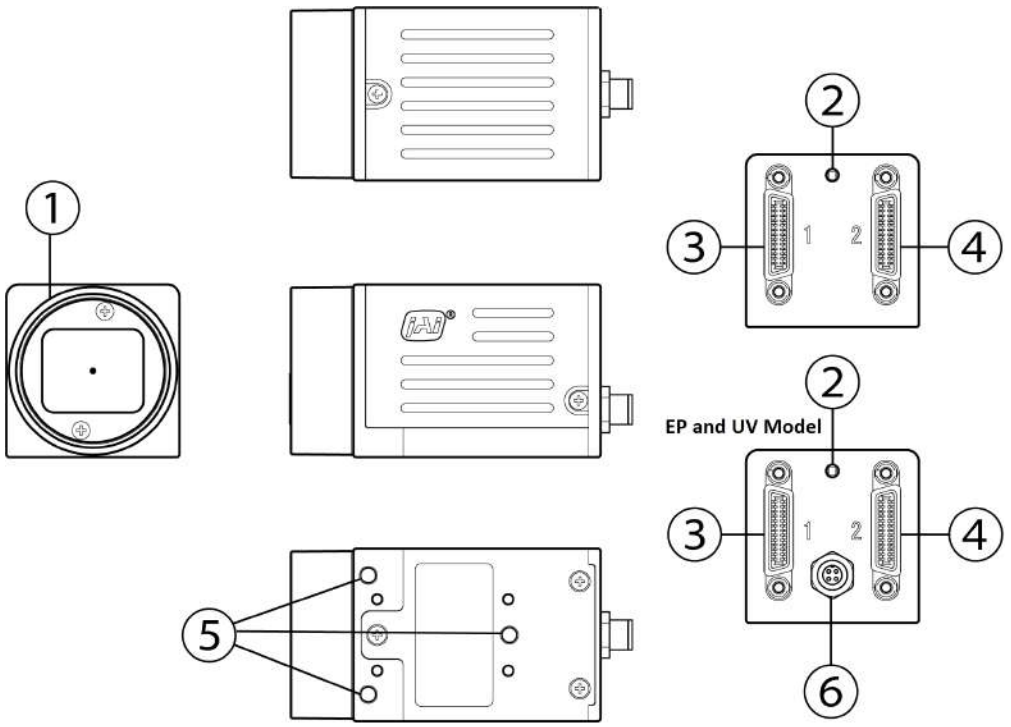
GO-5000M-PMCL, GO-5000M-PMCL-EP and GO-5000M-PMCL-UV are small-in-size cameras providing both high resolution and a high frame rate with excellent image quality for machine vision applications. They are monochrome progressive scan COMS cameras equipped with CMOS sensors offering a 1-inch image format, a resolution of 5 million pixels, and a 5:4 aspect ratio. They provide a maximum of 107.2 frames per second for continuous scanning with 2560 x 2048 full pixel resolution in 1x8-1Y, 8-bit output format. The UV model has sensitivity in the UV region. The EP and UV models has 4-pin connector for external power supplies.

These cameras 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, flat field shading compensation, and blemish compensation in addition to fundamental functions such as trigger, exposure setting, and video level control.

Feature Overview

- Compact and Rugged housing Series, 1” progressive scan camera
- Intelligent body design for easy and flexible installation
- Aspect ratio 5:4, 2560(H) x 2048(V) - 5.2 million effective pixels (5 µm square pixels)
- S/N 55 dB with Dark Compression ON
- 8-bit, 10-bit or 12-bit output
- Various readout modes, including horizontal and vertical binning, and ROI (Region Of Interest) for faster frame rates
- 0dB to +24dB gain control
- 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
- Various pre-processing circuits are provided: Programmable LUT, Gamma correction (0.45, 0.6 and 1.0 3 steps), Blemish compensation
- C-mount for lens mount

Parts Identification



① Lens Mount (C-Mount)

② POWER/TRIG LED

③ ④ Camera Link Connector 1 and 2

⑤ Mounting Holes (M3, 3mm depth)

⑥ DC IN Connector (UV Model Only)

① Lens Mount (C-Mount)

Mount a C-mount lens, microscope adapter, etc. here.

> **Note:** Before mounting a lens, be sure to refer to ① Lens and confirm the precautions for attaching a lens and the supported lens types.

② POWER/TRIG LED

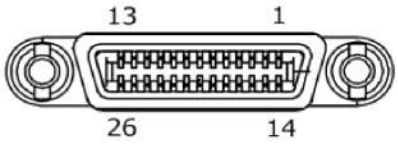
Indicates the power or trigger input status.

LED		Status
	Lit amber	Camera initializing. The light goes off after initiating
	Lit green	Camera in operation in Continuous mode
	Blinking green	During operation in trigger mode, trigger signals are being input. **Note:** The blinking interval is not related to the actual input interval of the external trigger.

③ ④ Camera Link Connector 1 and 2

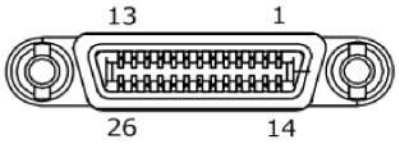
Connect a cable that is compatible with Mini Camera Link (SDR) connectors here.

Note: The cable length at which communication will be possible will be limited when using a cable that is not compatible with Camera Link, a small diameter type cable, or a high flex type cable.



Camera Link Connector 1

Pin	Input Output	Signal	Description
1, 26		Power	Power
2 (-), 15 (+)	Out	X_OUT0	Data out
3 (-), 16 (+)	Out	X_OUT1	Data out
4 (-), 17 (+)	Out	X_OUT2	Data out
5 (-), 18 (+)	Out	X_Clk	CL Clock
6 (-), 19 (+)	Out	X_OUT3	Data output
7 (+), 20 (-)	In	SerTC (RxD)	LVDS Serial Control
8 (-), 21 (+)	Out	SerTFG (TxD)	
9 (-), 22 (+)	In	CC1 (Trigger)	JAI standard trigger
10 (+), 23 (-)	In	CC2 (Reserved)	
11, 24		N.C	
12, 25		N.C	
13, 14		Shield	GND



Camera Link Connector 2

Pin	Input Output	Signal	Description
1, 26		Shield	GND
2 (-), 15 (+)	Out	Y_OUT0	Data out
3 (-), 16 (+)	Out	Y_OUT1	Data out
4 (-), 17 (+)	Out	Y_OUT2	Data out
5 (-), 18 (+)	Out	Y_Clk	CL Clock
6 (-), 19 (+)	Out	Y_OUT3	Data out
7, 20			Terminal (100Ω)
8 (-), 21 (+)	Out	Z_OUT0	Data out
9 (-), 22 (+)	Out	Z_OUT1	Data out
10 (-), 23 (+)	Out	Z_OUT2	Data out
11 (-), 24 (+)	Out	Z_Clk	CL Clock
12 (+), 25 (-)	Out	Z_OUT3	Data out
13, 14		Shield	GND

Connectors

Camera Side: HDR-EC26FYTG2-SL+ (HONDA)

Cable Side: SDR connector cable for PoCL

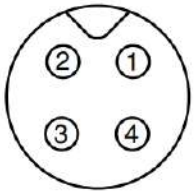
⑤ Mounting Holes (M3, 3mm depth)

Use these holes when attaching an MP-43 tripod adapter plate (optional) or mounting the camera directly to a wall or other structural system.

⑥ DC IN Connector (UV Model Only)

> **Note:** This connector is available only on the EP and UV camera.

Connect the cable for DC IN here.



Compatible Connectors

- Camera side: 09-3111-81-04 (Binder)
- Cable side: 79-3108-52-04 (Binder) AWG 26
  or
  79-3108-32-04 (Binder) AWG 24

Pin No.	Input/Output	Signal	Description
1	Power In	DC (+12 V) In	DC 12 V to 24V +/- 10%
2	NC		
3			
4	Out	Power GND	COMMON GND

Preparation

Read this section to learn how the camera connects to devices and accessories. The preparation process is described below.

1	**Step 1: Connect Devices** • Connect the lens, Camera Link cable, AC adapter, computer, and other devices.
2	**Step 2: Verify Camera Operation** • Verify whether the camera is turned on and ready for use.
3	**Step 3: Verify the Connection Between the Camera and PC** • Verify whether the camera is properly recognized.
4	**Step 4: Change the Camera Settings** • Refer to the procedure for changing the output format setting as an example and change various settings as necessary.
5	**Step 5: Adjust the Image Quality** • Refer to the procedures for adjusting the gain and black level as examples and adjust the image quality.
6	**Step 6: Save the Settings** • Save the current setting configurations in user memory.

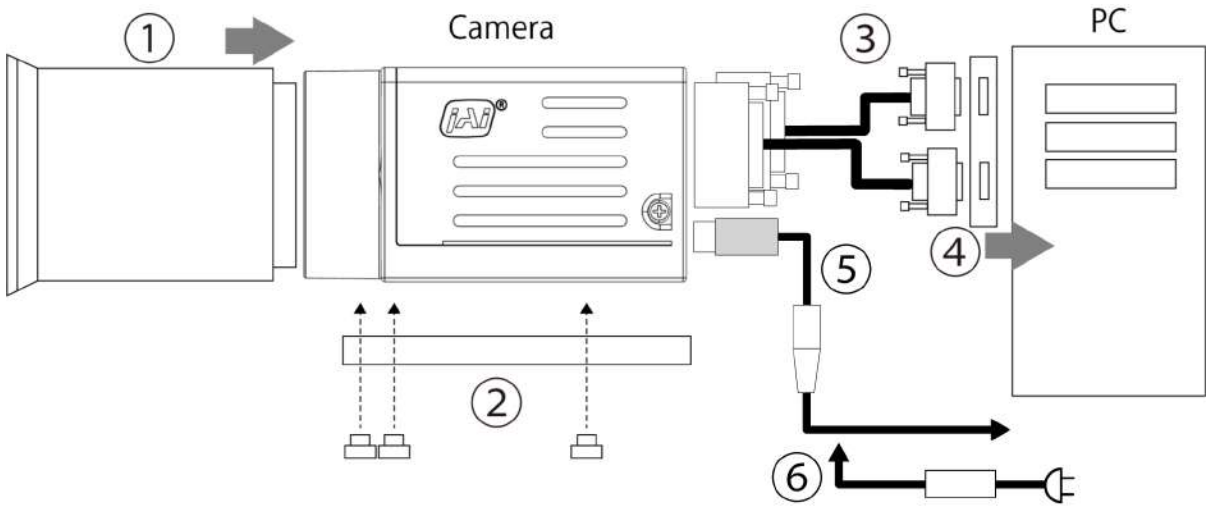
Short ASCII Commands

The most universal method for controlling a Camera Link camera such as this camera is by the use of short ASCII commands sent via serial communications. All Camera Link frame grabber boards support the use of these short ASCII commands. SDKs that utilize these ASCII commands for developing machine vision applications are typically available from the grabber manufacturer, as well as from third-party vendors.

This section describes how to configure various camera settings using serial communication and specific short ASCII commands. A complete list of all available ASCII commands for this camera can be found at the end of this manual (Short ASCII Command List).

This camera fully supports applications written using GenICam-based SDKs. The advantage of this is that programs written using GenICam names can be applied with little or no modification to control cameras with other GenICam-compliant interfaces and even GenICam-compliant cameras from different vendors.

Step 1: Connect Devices



① Lens

② Direct Mounting (or Use MP-43 Tripod Adapter Plate)

③ Camera Link Cable

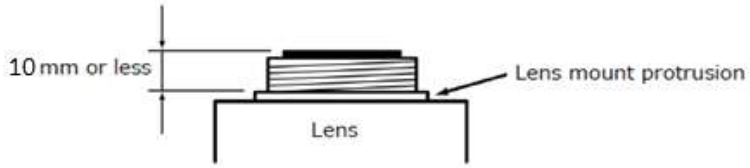
④ Frame Grabber Board

⑤ DC IN Connection Cable (Option, EV and UV Models Only)

⑥ AC Adapter (Power Supply, Option, EV and UV Models Only)

① Lens

C-mount lenses with lens mount protrusions of 10 mm or less can be attached.



To prevent vignetting and to obtain the optimal resolution, use a lens that will cover the image sensor size.

- Type 1, 12.8mm x 10.24mm (16.392mm diagonal)

Cautions:

- The maximum performance of the camera may not be realized depending on the lens.
- Attaching a lens with a mount protrusion of 10 mm or longer may damage the lens or camera.

Notes:
The following formula can be used to estimate the focal length.

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

WD: Working distance (distance between lens and object)

W: Width of object

w: Width of sensor (=12.8mm)

② Direct Mounting (or Use MP-43 Tripod Adapter Plate)

When mounting the camera directly to a wall or other device, use screws that match the mounting holes on the camera. (Large: M3, small: M2, depth: 3 mm)

Use the supplied screws to attach the tripod adapter plate.

Caution: For heavy lenses, be sure to support the lens itself. Do not use configurations in which its weight is supported by the camera.

③ Camera Link Cable

Connect the Camera Link cable to the Mini Camera Link connector.

- Use a cable that supports the Camera Link standard and is compatible with Mini Camera Link (SDR) connectors.
- Refer to the specifications of the cable for details on its bend radius.
- For details on the cable, see ③ ④ Camera Link Connector 1 and 2.

> **Caution:** Refer to Notes on Camera Link Cable Connections when connecting the cables to the connectors.

④ Frame Grabber Board

Refer to the operating instructions of the frame grabber board and configure settings on the computer as necessary. (Use a computer that meets the requirements of your frame grabber board).

⑤ DC IN Connection Cable (Option, EV and UV Models Only)

Provides the power supply to the camera.

> **Notes:**
> - The DC In connector is available only on the EV and UV camera.
> - A power supply is not required when using PoCL.

⑥ AC Adapter (Power Supply, Option, EV and UV Models Only)

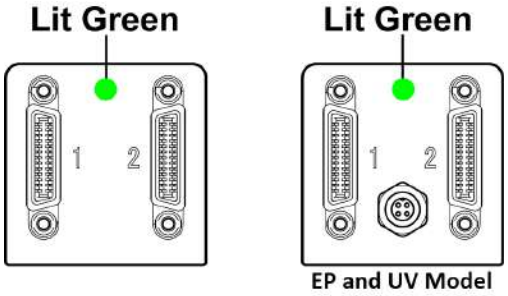
Connect the AC adapter and the round connector of the connection cable to the DC IN connector on the camera.

> **Note:** The AC adapter is not required when using PoCL.

Step 2: Verify Camera Operation

When power is supplied to the camera while the necessary equipment is connected, the POWER/TRIG LED at the rear of the camera lights amber, and initialization of the camera starts. When initialization is complete, the POWER/TRIG LED lights green.

Verify whether power is being supplied to the camera by checking the rear LED. When properly turned on, the power LED is lit green.



For details on how to read the LEDs, see the ② POWER/TRIG LED section.

Step 3: Verify the Connection Between the Camera and PC

> **Related Topic:** Short ASCII Command List

Use a short ASCII command to verify whether the camera is properly recognized in your setup.

1. Install terminal emulator software capable of serial communication to the PC connected to the camera via the frame grabber board.

   Set the following serial communication.

   - Baud Rate: 9600
   - Data Length: 8bit
   - Start Bit: 1bit
   - Stop Bit: 1 bit
   - Parity: None
   - Xon/Xoff Control: None

2. Enter the command **DVN? <CR><LF>** from the terminal emulator software.

   If correctly connected, response **DVN = JAI Ltd., Japan** will be displayed.

Item	Short ASCII Command	Description
DeviceVendorName	DVN	DVN? <CR><LF> Display the device vendor name: "JAI Ltd., Japan"

Step 4: Change the Camera Settings

> **Related Setting Items:** Image Format Control

This section explains how to change settings by describing the procedure for changing the output format as an example.

Configure the Output Format

Configure the size, position, and pixel format of the images to be acquired. The factory settings are as follows. Change the settings as necessary.

Factory Default Values

Item		Default Value
ImageFormatControl	Width	2560
	Height	2048
	OffsetX (horizontal position)	0
	OffsetY (vertical position)	0
	PixelFormat	Mono8

You can specify the image acquisition area. For details, see "ROI (Region of Interest) Settings".

Example: Change the Width setting (ImageFormatControl)

1. To check the current Width setting, enter the command **WTC?<CR><LF>** from the terminal emulator software.
2. To change the Width setting to 2480, enter **WTC=2480<CR><LF>**.
3. To change other setting items, please use the Short ASCII command below.

Item	Short ASCII Command	Values
Width	WTC	8 ~ 2560, 8 pixels / step
Height	HTL	1 ~ 2048, 1 line / step
OffsetX	OFC	0 ~ 2552, 8 pixels / step
OffsetY	OFL	0 ~ 2047, 1 line / step
PixelFormat	BA	0: Mono8, 1: Mono10, 2: Mono12

Example: Change the PixelFormat setting (ImageFormatControl)

1. To check the current PixelFormat setting, enter the command **BA?<CR><LF>** from the terminal emulator software.
2. To change the PixelFormat setting to Mono10, enter **BA=1<CR><LF>**.

Step 5: Adjust the Image Quality

> **Related Setting Items:** Analog Control

Display the camera image and adjust the image quality.

Display the Image

Display the image captured by the camera. Please display the image with the viewer on the frame grabber board application.

Adjust the Gain

The gain control uses Analog Base Gain and Digital Gain.

For setting the gain manually,

1. Set Analog Gain (select from 0dB, +6dB and +12dB).
2. Set Digital Gain.

   The master gain (DigitalAll) 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.

Item	Short ASCII Command	Values
GainRawDigitalAll	FGA	Setting Range: 100 ~ 1600
AnalogBaseGainAll	ABALL	0: 0dB, 1: 6dB, 2: 12dB
GainAuto	AGC	0: Off, 1: Continuous

Adjust the Black Level

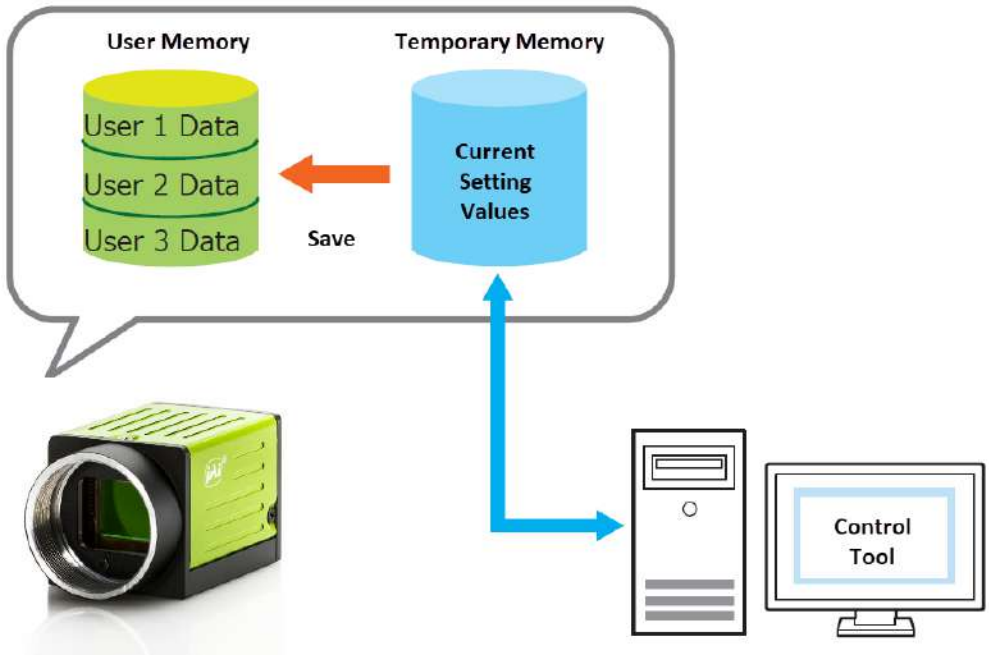
The black level can be set in the following range.

Item	Short ASCII Command	Values
BlackLevelRawAll	BL	-256 ~ 255.

Step 6: Save the Settings

> **Related Setting Items:** User Set Control

The configured setting values will be deleted when the camera is turned off. By saving current setting values to user memory, you can load and recall them whenever necessary. You can save up to three sets of user settings in the camera. (User Set1 to 3)



Save the User Settings

1. Stop image acquisition. Settings can only be saved when image acquisition on the camera is stopped.
2. Specify the storage location (UserSet1 - UserSet3) using the **UserSetSave** command and save the current camera settings.

Item	Short ASCII Command	Values	Command Examples
UserSetSave	SA	1: User1 2: User2 3: User3	SA=[Param.]<CR><LF> SA?<CR><LF>

Load the User Settings

1. Stop image acquisition. User settings can only be loaded when image capture on the camera is stopped.
2. Specify the storage location (UserSet1 - UserSet3) using the **UserSetLoad** command and read the settings of the camera.

> **Note:** When selecting **Default**, the factory settings are loaded.

Item	Short ASCII Command	Values	Command Examples
UserSetLoad	LD	0: Default (Default) 1: User1 2: User2 3: User3	LD=[Param.]<CR><LF> LD?<CR><LF>

Main Functions

This chapter describes the camera's main functions.

Camera Link Interface

Digital I/O 1

Camera Link Configuration		**Base**	**Base**	**Medium**	**Full**	**80bit**
Camera Link port/bit		**2Tap / 12bit**	**3Tap/8bit**	**4Tap / 12bit**	**8 Tap / 8bit**	**8 Tap / 10bit**
GenICam Tap Geometry		**1X 2 - 1Y**	**1X 3 - 1Y**	**1X 4 - 1Y**	**1x8 - 1Y**	**1X 8 - 1Y**
Port A0	TxIN 0	Tap1 D0	Tap 1 D0	Tap 1 D0	Tap 1 D0	Tap 1 D2
Port A1	TxIN 1	Tap1 D1	Tap 1 D1	Tap 1 D1	Tap 1 D1	Tap 1 D3
Port A2	TxIN 2	Tap1 D2	Tap 1 D2	Tap 1 D2	Tap 1 D2	Tap 1 D4
Port A3	TxIN 3	Tap1 D3	Tap 1 D3	Tap 1 D3	Tap 1 D3	Tap 1 D5
Port A4	TxIN 4	Tap1 D4	Tap 1 D4	Tap 1 D4	Tap 1 D4	Tap 1 D6
Port A5	TxIN 6	Tap1 D5	Tap 1 D5	Tap 1 D5	Tap 1 D5	Tap 1 D7
Port A6	TxIN 27	Tap1 D6	Tap 1 D6	Tap 1 D6	Tap 1 D6	Tap 1 D8
Port A7	TxIN 5	Tap1 D7	Tap 1 D7	Tap 1 D7	Tap 1 D7	Tap 1 D9
Port B0	TxIN 7	Tap1 D8	Tap 2 D0	Tap 1 D8	Tap 2 D0	Tap 2 D2
Port B1	TxIN 8	Tap1 D9	Tap 2 D1	Tap 1 D9	Tap 2 D1	Tap 2 D3
Port B2	TxIN 9	Tap1 D10	Tap 2 D2	Tap 1 D10	Tap 2 D2	Tap 2 D4
Port B3	TxIN 12	Tap1 D11	Tap 2 D3	Tap 1 D11	Tap 2 D3	Tap 2 D5
Port B4	TxIN 13	Tap2 D8	Tap 2 D4	Tap 2 D8	Tap 2 D4	Tap 2 D6
Port B5	TxIN 14	Tap2 D9	Tap 2 D5	Tap 2 D9	Tap 2 D5	Tap 2 D7
Port B6	TxIN 10	Tap2 D10	Tap 2 D6	Tap 2 D10	Tap 2 D6	Tap 2 D8
Port B7	TxIN 11	Tap2 D11	Tap 2 D7	Tap 2 D11	Tap 2 D7	Tap 2 D9
Port C0	TxIN 15	Tap2 D0	Tap 3 D0	Tap 2 D0	Tap 3 D0	Tap 3 D2
Port C1	TxIN 18	Tap2 D1	Tap 3 D1	Tap 2 D1	Tap 3 D1	Tap 3 D3
Port C2	TxIN 19	Tap2 D2	Tap 3 D2	Tap 2 D2	Tap 3 D2	Tap 3 D4
Port C3	TxIN 20	Tap2 D3	Tap 3 D3	Tap 2 D3	Tap 3 D3	Tap 3 D5
Port C4	TxIN 21	Tap2 D4	Tap 3 D4	Tap 2 D4	Tap 3 D4	Tap 3 D6
Port C5	TxIN 22	Tap2 D5	Tap 3 D5	Tap 2 D5	Tap 3 D5	Tap 3 D7
Port C6	TxIN 16	Tap2 D6	Tap 3 D6	Tap 2 D6	Tap 3 D6	Tap 3 D8
Port C7	TxIN 17	Tap2 D7	Tap 3 D7	Tap 2 D7	Tap 3 D7	Tap 3 D9
-	TxIN 24	LVAL	LVAL	LVAL	LVAL	LVAL
-	TxIN 25	FVAL	FVAL	FVAL	FVAL	FVAL
(Port I0)	TxIN 26	DVAL	DVAL	DVAL	DVAL	Tap 1 D0
(Port I1)	TxIN 23	Exposure Active	Exposure Active	Exposure Active	Exposure Active	Tap 1 D1

Digital I/O 2 (1/2)

Camera Link Configuration		**Base**	**Base**	**Medium**	**Full**	**80bit**
Camera Link port/bit		**2Tap / 12bit**	**3Tap/8bit**	**4Tap / 12bit**	**8 Tap / 8bit**	**8 Tap / 10bit**
GenICam Tap Geometry		**1X 2 - 1Y**	**1X 3 - 1Y**	**1X 4 - 1Y**	**1x8 - 1Y**	**1X 8 - 1Y**
Port D0	TxIN 0	—	—	Tap 4 D0	Tap 4 D0	Tap 4 D2
Port D1	TxIN 1	—	—	Tap 4 D1	Tap 4 D1	Tap 4 D3
Port D2	TxIN 2	—	—	Tap 4 D2	Tap 4 D2	Tap 4 D4
Port D3	TxIN 3	—	—	Tap 4 D3	Tap 4 D3	Tap 4 D5
Port D4	TxIN 4	—	—	Tap 4 D4	Tap 4 D4	Tap 4 D6
Port D5	TxIN 6	—	—	Tap 4 D5	Tap 4 D5	Tap 4 D7
Port D6	TxIN 27	—	—	Tap 4 D6	Tap 4 D6	Tap 4 D8
Port D7	TxIN 5	—	—	Tap 4 D7	Tap 4 D7	Tap 4 D9
Port E0	TxIN 7	—	—	Tap 3 D0	Tap 5 D0	Tap 5 D2
Port E1	TxIN 8	—	—	Tap 3 D1	Tap 5 D1	Tap 5 D3
Port E2	TxIN 9	—	—	Tap 3 D2	Tap 5 D2	Tap 5 D4
Port E3	TxIN 12	—	—	Tap 3 D3	Tap 5 D3	Tap 5 D5
Port E4	TxIN 13	—	—	Tap 3 D4	Tap 5 D4	Tap 5 D6
Port E5	TxIN 14	—	—	Tap 3 D5	Tap 5 D5	Tap 5 D7
Port E6	TxIN 10	—	—	Tap 3 D6	Tap 5 D6	Tap 5 D8
Port E7	TxIN 11	—	—	Tap 3 D7	Tap 5 D7	Tap 5 D9
Port F0	TxIN 15	—	—	Tap 3 D8	Tap6 D0	Tap 6 D2
Port F1	TxIN 18	—	—	Tap 3 D9	Tap6 D1	Tap 6 D3
Port F2	TxIN 19	—	—	Tap 3 D10	Tap6 D2	Tap 6 D4
Port F3	TxIN 20	—	—	Tap 3 D11	Tap6 D3	Tap 6 D5
Port F4	TxIN 21	—	—	Tap 4 D8	Tap6 D4	Tap 6 D6
Port F5	TxIN 22	—	—	Tap 4 D9	Tap6 D5	Tap 6 D7
Port F6	TxIN 16	—	—	Tap 4 D10	Tap6 D6	Tap 6 D8
Port F7	TxIN 17	—	—	Tap 4 D11	Tap6 D7	Tap 6 D9
-	TxIN 24	—	—	LVAL	LVAL	LVAL
(Port I2)	TxIN 25	—	—	FVAL	FVAL	Tap 2 D0
(Port I3)	TxIN 26	—	—	DVAL	DVAL	Tap 2 D1
(Port I4)	TxIN 23	—	—	Exposure Active	Exposure Active	Tap 3 D0

Digital I/O 2 (2/2)

Camera Link Configuration		Base	Base	Medium	Full	80bit
Camera Link port/bit		2Tap / 12bit	3Tap/8bit	4Tap / 12bit	8 Tap / 8bit	8 Tap / 10bit
GenICam Tap Geometry		1X 2 - 1Y	1X 3 - 1Y	1X 4 - 1Y	1x8 - 1Y	1X 8 - 1Y
Port G0	TxIN 0	—	—	—	Tap 7 D0	Tap 7 D2
Port G1	TxIN 1	—	—	—	Tap 7 D1	Tap 7 D3
Port G2	TxIN 2	—	—	—	Tap 7 D2	Tap 7 D4
Port G3	TxIN 3	—	—	—	Tap 7 D3	Tap 7 D5
Port G4	TxIN 4	—	—	—	Tap 7 D4	Tap 7 D6
Port G5	TxIN 6	—	—	—	Tap 7 D5	Tap 7 D7
Port G6	TxIN 27	—	—	—	Tap 7 D6	Tap 7 D8
Port G7	TxIN 5	—	—	—	Tap 7 D7	Tap 7 D9
Port H0	TxIN 7	—	—	—	Tap 8 D0	Tap 8 D2
Port H1	TxIN 8	—	—	—	Tap 8 D1	Tap 8 D3
Port H2	TxIN 9	—	—	—	Tap 8 D2	Tap 8 D4
Port H3	TxIN 12	—	—	—	Tap 8 D3	Tap 8 D5
Port H4	TxIN 13	—	—	—	Tap 8 D4	Tap 8 D6
Port H5	TxIN 14	—	—	—	Tap 8 D5	Tap 8 D7
Port H6	TxIN 10	—	—	—	Tap 8 D6	Tap 8 D8
Port H7	TxIN 11	—	—	—	Tap 8 D7	Tap 8 D9
(Port I5)	TxIN 15	—	—	—		Tap 3 D1
(Port I6)	TxIN 18	—	—	—		Tap 4 D0
(Port I7)	TxIN 19	—	—	—		Tap 4 D1
(Port K0)	TxIN 20	—	—	—		Tap 5 D0
(Port K1)	TxIN 21	—	—	—		Tap 5 D1
(Port K2)	TxIN 22	—	—	—		Tap 6 D0
(Port K3)	TxIN 16	—	—	—		Tap 6 D1
(Port K4)	TxIN 17	—	—	—		Tap 7 D0
-	TxIN 24	—	—	—	LVAL	LVAL
(Port K5)	TxIN 25	—	—	—	FVAL	Tap 7 D1
(Port K6)	TxIN 26	—	—	—	DVAL	Tap 8 D0
(Port K7)	TxIN 23	—	—	—	Exposure Active	Tap 8 D1

Notes:

1. In this table, not all tap geometry items are described. For instance, 1X4–1Y shows only 12-bit. In case of 10-bit, upper 2 bits (D10 and D11) are not used and in case of 8-bit, upper 4 bits (D8 through D11) are not used.
2. Please check whether the frame grabber complies with those formats if you use 80-bit (8-tap/10-bit) camera configuration.

3. If you use 80-bit (8-tap/10-bit) camera configuration, DVAL and Exposure Active (JAI custom) are not output through the Camera Link interface. FVAL is only output via Digital I/O-1 connector.

Camera Link Pixel Clock Frequency

Related Setting Items: JAI Custom

On this camera, the Camera Link pixel clock can be selected from 84.99 MHz, 72.85 MHz, 58.28 MHz, and 48.57 MHz. If the 48.57MHz clock is used, the transfer length through the camera link cable will be extended to 10m for all tap geometries. On the other hand, the frame rate will be reduced (see table). The default setting is 72.85 MHz.

Camera Link Pixel Clock	Maximum Length	1X2-1Y	1X3-1Y	1X4-1Y	1X8-1Y	
		8 / 10 / 12bit	8bit	8 / 10 / 12bit	8bit	10bit
High (84.99 MHz)	5m	31.9 fps	47.8 fps	63.6 fps	-	-
Mid (72.85 MHz)	5m	27.4 fps	41.0 fps	54.7 fps	-	-
High (72.85 MHz)	10m	-	-	-	107.2 fps	-
Mid (58.28 MHz)	10m	-	-	-	-	84.9 fps
Low (48.57 MHz)	10m	18.3 fps	27.4 fps	36.4 ssfps	70.8 fps	70.8 fps

Note: The maximum lengths shown in the above table are guidelines. Operating at these lengths may generate bit noise, depending on the cable used.

Digital IN/OUT Interface

> **Related Setting Items:** JAI Custom

On this camera, the software control tool can assign the necessary signals used in the system to digital inputs and outputs.

Line Selector

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

Line Selector Item	Description
NAND 0 IN 1	No. 1 input to the first NAND gate
NAND 0 IN 2	No. 2 input to the first NAND gate
NAND 1 IN 1	No. 1 input to the second NAND gate
NAND 1 IN 2	No. 2 input to the second NAND gate

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.

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
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
LVAL	Connect LVAL signal to line item selected in Line Selector **Note:** Some line items cannot be connected. Refer to “GPIO Matrix Table”.
Pulse Generator 0 Out	Connect Pulse Generator 0 signal to line item selected in Line Selector
CL CC1 In	Connect CL CC1 IN signal to line item selected 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

Line Mode

Indicates the status of the item selected in Line Selector. (INPUT or OUTPUT)

Line Inverter

Inverts the signal polarity for the item selected in Line Selector. (False=Positive, True=Negative)

Line Status

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

Line Format

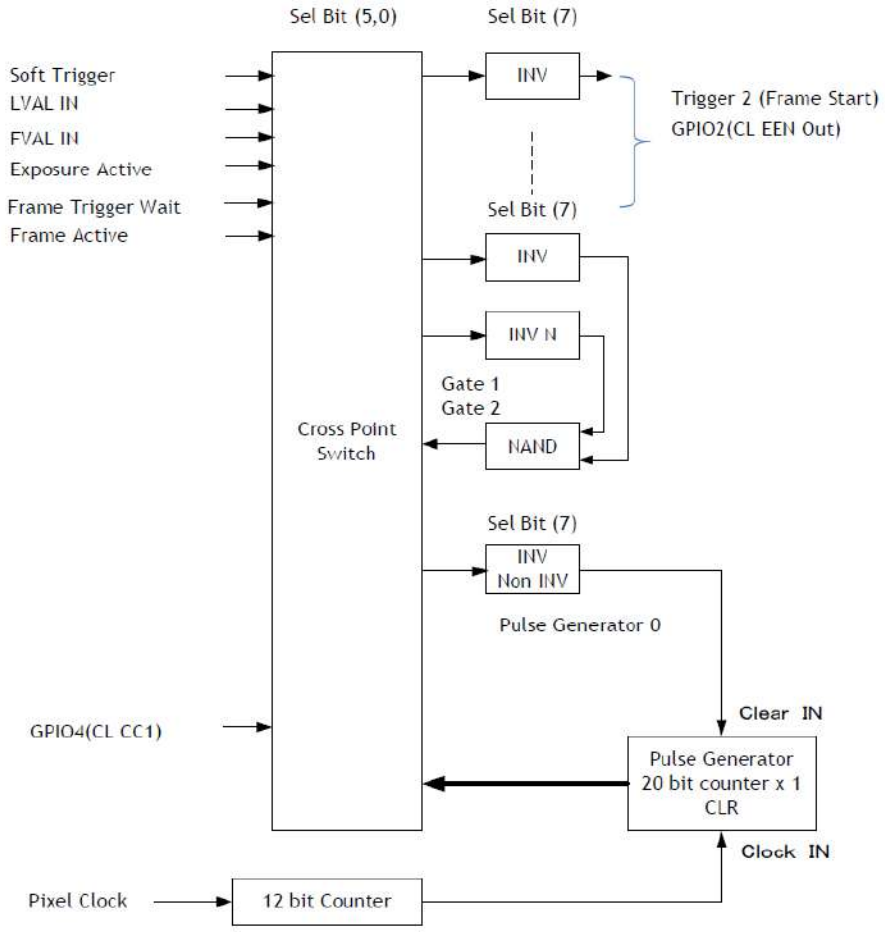
Indicates the interface information of the input and output lines (Internal Signal and LVDS)

> **Note:** On this camera, Opto-coupled interface is not available.

GPIO

GPIO is a general interface for input and output which controls the I/O for trigger signals and other valid signals and pulse generators. By using this interface, you can control an external light source, make a delay function for an external trigger signal, or make a precise exposure setting together with a PWC trigger.

Basic Block Diagram



GPIO IN/OUT Matrix

Source Signal	Trigger Selector	Line Selector				Pulse Generator Selector
	Trigger Source (Frame Start)	NAND 1 In 1	NAND 1 In 2	NAND 2 In 1	NAND 2 In 2	Pulse Generator 0
Low	✓	✓	✓	✓	✓	✓
High	✓	✓	✓	✓	✓	✓
Soft Trigger	✓					
Exposure Active		✓	✓	✓	✓	✓
Frame Trigger Wait		✓	✓	✓	✓	✓
Frame Active		✓	✓	✓	✓	✓
FVAL		✓	✓	✓	✓	✓
LVAL						✓
Pulse Generator 0	✓	✓	✓	✓	✓	
CL CC1 in	✓	✓	✓	✓	✓	✓
NAND 0 Out	✓			✓	✓	✓
NAND 1 Out 1	✓	✓	✓			✓

✓ : Supported
Empty: Not Supported

Pulse Generator

Related Setting Items: JAI Custom

Technical Notes Tips for using the Pulse Generator

This camera has a frequency divider using the sensor clock as the basic clock and one pulse generator. In the Pulse Generator, various Clear settings are connected to GPIO. The following shows the Pulse Generator default settings.

The sensor pixel clock is 36 MHz for 8-bit, 28.8MHZ for 10-bit and 24 MHZ for 12-bit.

Pulse Generator Default Settings

Display Name	Value						
Clock Pre-scaler	107						
Pulse Generator Scaler	Pulse Generator						
	Length	Start Point	End Point	Repeat Count	Clear Source	Clear Activation	Clear Sync Mode
Pulse Generator 0	30000	0	15000	0	Low	Free Run	Async Mode

Note: When Pulse Generator Repeat Count is set to “0”, the camera is operating in free-running mode.

Clock Pre-scaler

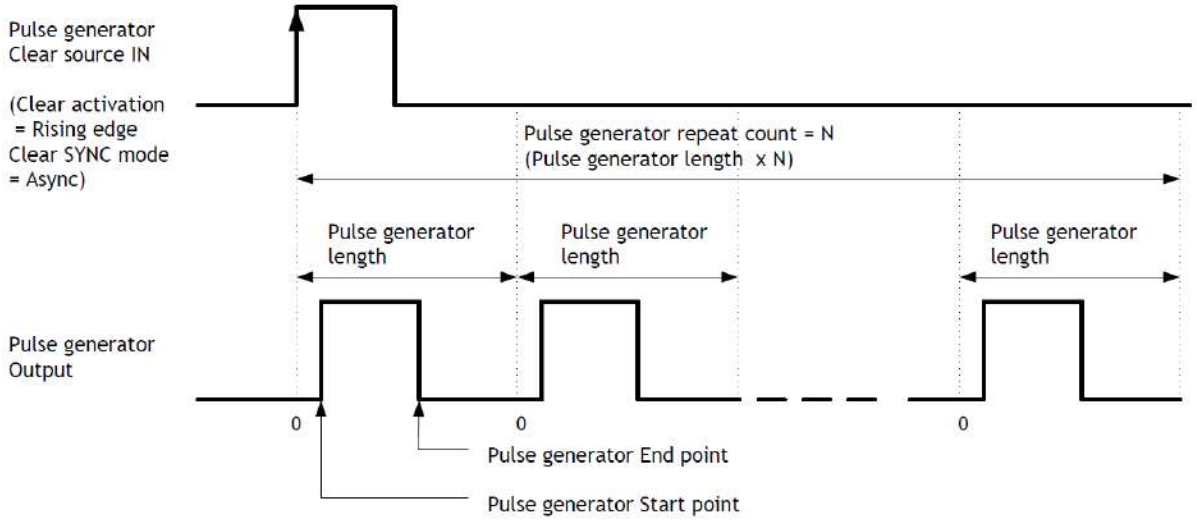
Clock pre-scaler (Divide Value) can set the dividing value of the frequency divider (12-bit length) and the sensor clock is used for this. This camera's Pixel Clock is 48.5714MHz.

Pulse Generator Selector

This is where you select a pulse generator. On this camera, it is fixed to Pulse Generator 0.

Pulse Generator setting / Pulse Generator pulse construction

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.



Pulse Generator Length

Set the counter up value 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.

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.

Pulse Generator End Point

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

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.

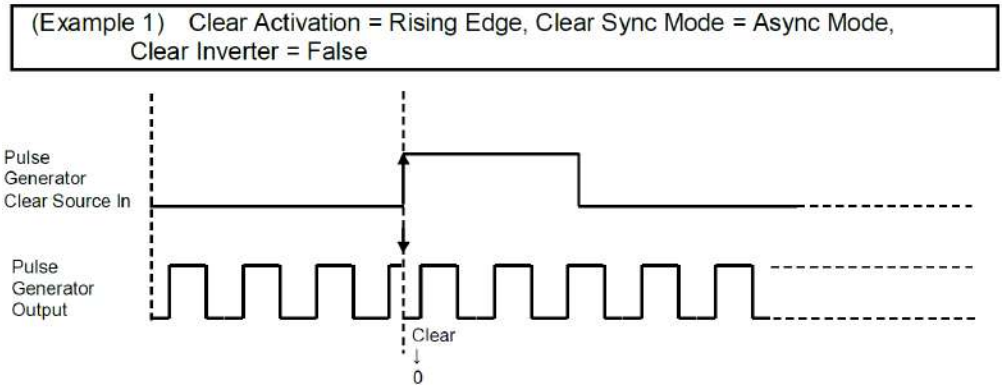
Pulse Generator Clear Activation

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

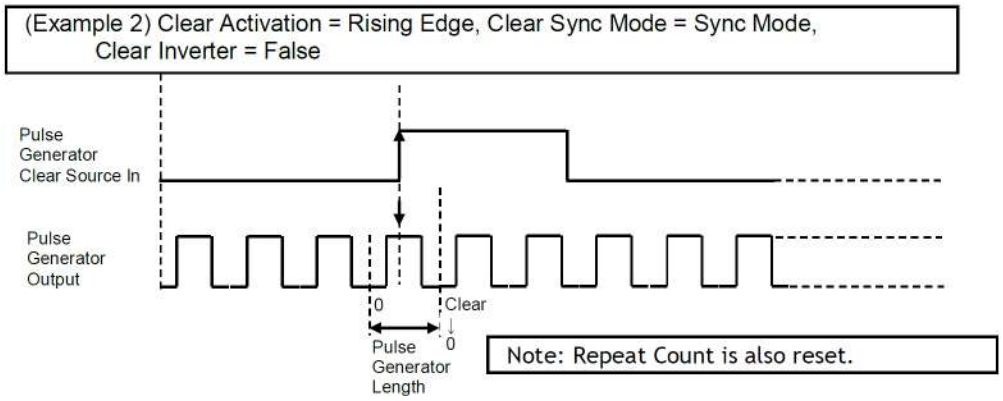
Pulse Generator Clear Sync Mode

Set the count clear method for the pulse generator. In 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 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.

Counter Clear in Async Mode



Counter Clear in Sync Mode



Pulse Generator Clear Source

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

Pulse Generator Clear Source Item	Description
Low	Connect Low level signal to Clear Source for the pulse generator. **Default setting**
High	Connect High level signal to Clear Source for the pulse generator.
Frame Trigger Wait	Connect Frame Trigger Wait signal to Clear Source for the pulse generator.
Frame Active	Connect Frame Active signal to Clear Source for the pulse generator.
Exposure Active	Connect Exposure Active signal to Clear Source for the pulse generator.
FVAL	Connect FVAL signal to Clear Source for the pulse generator.
LVAL	Connect LVAL signal to Clear Source for the pulse generator.
CL CC1 In	Connect CL CC1 IN signal to Clear Source for the pulse generator.
Nand0 Out	Connect NAND 0 output signal to Clear Source for the pulse generator.
Nand1 Out	Connect NAND 1 output signal to Clear Source for the pulse generator.

Pulse Generator Setting Table

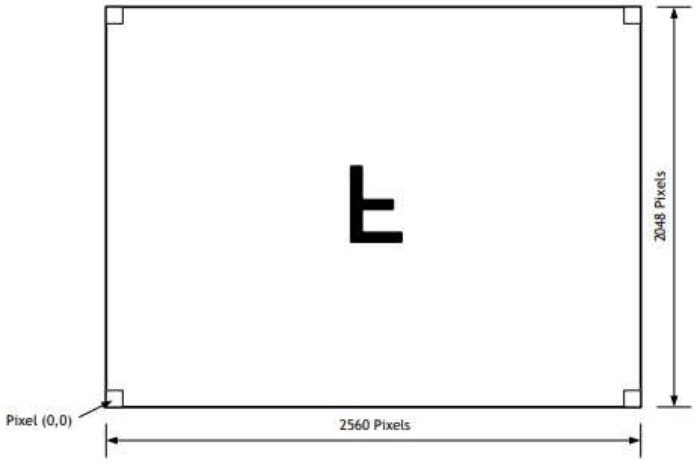
Display Name	Value
Clock Pre-scaler	1 to 4096
Pulse Generator Clock (MHZ)	[Pixel Clock:48.5714MHz]÷[Clock Pre-scaler]
Pulse Generator Selector	- Pulse Generator 0
- Pulse Generator Length	1 to 1048575
- Pulse Generator Length (ms)	([Clock Source]÷[Clock Pre-scaler]) $^{-1}$ x [Pulse Generator Length]
- 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	- Free Run
	- High Level
	- Low level
	- Rising Edge
	- Falling Edge
- Pulse Generator Clear Sync Mode	- Async mode
	- Sync mode

Display Name	Value
- Pulse Generator Clear Source	- Low
	- High
	- Frame Trigger Wait
	- Frame Active
	- Exposure Active
	- Fval
	- Lval
	- CL_CC1_In
	- Nand0 Out
	- Nand1 Out

> **Note:** If Pulse Generator Repeat Count is set to “0”, the pulse generator works in free-running mode.

Sensor Layout

The CMOS sensor used on this camera have the following tap and pixel layout.



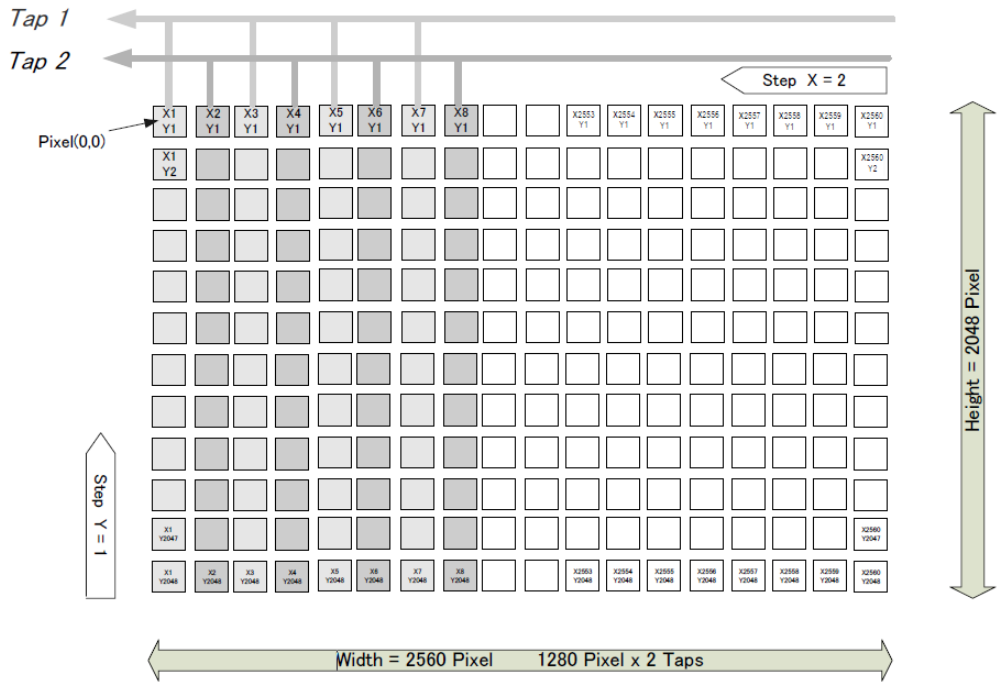
Camera Output Format (Tap Geometry)

Camera Output Format	Bit Assignment
1X2–1Y	8-bit, 10-bit, 12-bit
1X3-1Y	8-bit
1X4–1Y	8-bit, 10-bit, 12-bit
1X8–1Y	8-bit, 10-bit

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

1X2–1Y

1X2–1Y is a 2-tap readout system specified in GenICam Tap Geometry and it outputs as the following.

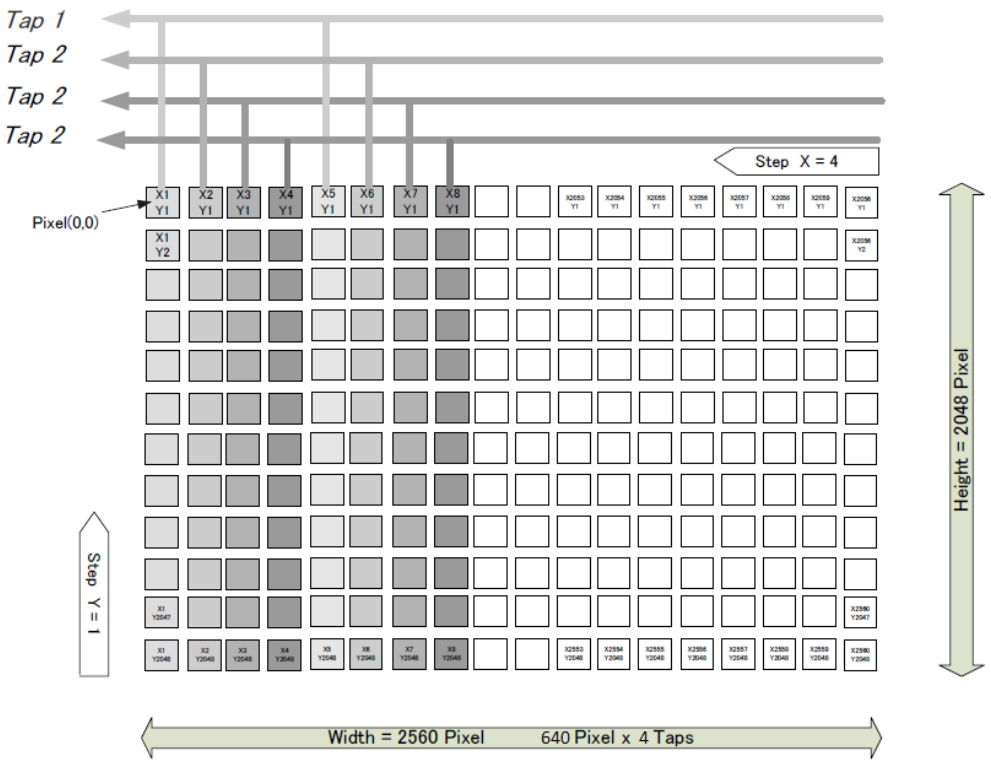


1X3-1Y

1X3–1Y is a 3-tap readout system specified in GenICam Tap Geometry.

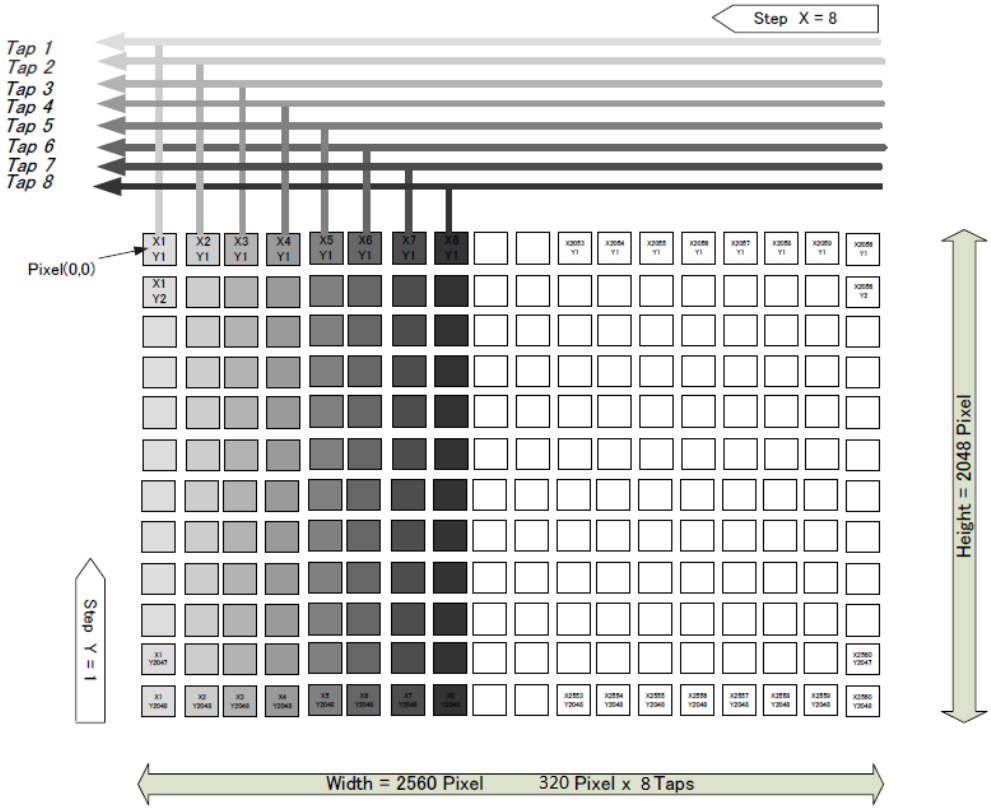
1X4–1Y

1X4–1Y is a 4-tap readout system specified in GenICam Tap Geometry.



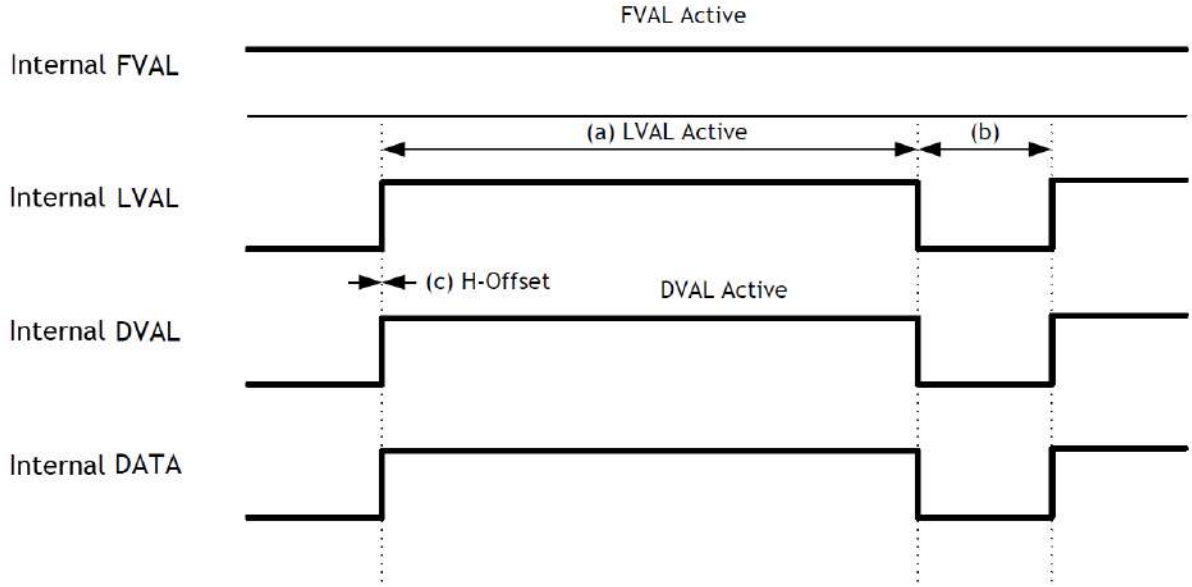
1X8–1Y

1X8–1Y is an 8-tap readout system and outputs as follows.



Output Timing (Horizontal)

The horizontal frequency is changed by setting the Tap Geometry.



Horizontal timing per 1 tap in Camera Link output

1x8-1Y (LVAL Active/Non-Active, H Total)

Horizontal Timing (Continuous Trigger Mode) (1/2)

Camera Settings								(a)	(b)	(c)
Tap Geometry	Camera Link Pixel Clock	ROI				Binning		LVAL Active	LVAL Non Active	H Total
		Width	Offset X	Height	Offset Y	Horizontal	Vertical	(Unit clock)	(Unit clock)	(Unit clock)
1X8 - 1Y 8-bit	72.85 MHz	2560	0	2048	0	Off	Off	320	10	330
		1280	0	2048	0	x2	Off	160	170	330
		640	0	2048	0	x4	Off	80	250	330
		2560	0	1024	0	Off	x2	320	10	330
		1280	0	1024	0	x2	x2	160	170	330
		640	0	1024	0	x4	x2	80	250	330
		2560	0	512	0	Off	Off	320	10	330
		1280	0	512	0	x2	x4	160	170	330
		640	0	512	0	x4	x4	80	250	330
	48.57 MHz	2560	0	2048	0	Off	Off	320	14	334
		1280	0	2048	0	x2	Off	160	170	330
		640	0	2048	0	x4	Off	80	250	330
		2560	0	1024	0	Off	x2	320	14	334
		1280	0	1024	0	x2	x2	160	170	330
		640	0	1024	0	x4	x2	80	250	330
		2560	0	512	0	Off	Off	320	14	334
		1280	0	512	0	x2	x4	160	170	330
		640	0	512	0	x4	x4	80	250	330
1X8 - 1Y 10-bit	58.28 MHz	2560	0	2048	0	Off	Off	320	14	334
		1280	0	2048	0	x2	Off	160	170	330
		640	0	2048	0	x4	Off	80	250	330
		2560	0	1024	0	Off	x2	320	14	334
		1280	0	1024	0	x2	x2	160	170	330
		640	0	1024	0	x4	x2	80	250	330
		2560	0	512	0	Off	Off	320	14	334
		1280	0	512	0	x2	x4	160	170	330
		640	0	512	0	x4	x4	80	250	330

1x4-1Y (LVAL Active/Non-Active, H Total)

Horizontal Timing (Continuous Trigger Mode) (1/2)

Camera Settings								(a)	(b)	(c)
Tap Geometry	Camera Link Pixel Clock	ROI				Binning		LVAL Active	LVAL Non Active	H Total
		Width	Offset X	Height	Offset Y	Horizontal	Vertical	(Unit clock)	(Unit clock)	(Unit clock)
1X4 - 1Y	84.99 MHZ	2560	0	2048	0	Off	Off	640	14	654
		1280	0	2048	0	x2	Off	320	253	573
		640	0	2048	0	x4	Off	160	413	573
		2560	0	1024	0	Off	x2	640	14	654
		1280	0	1024	0	x2	x2	320	253	573
		640	0	1024	0	x4	x2	160	413	573
		2560	0	512	0	Off	Off	640	14	654
		1280	0	512	0	x2	x4	320	253	573
		640	0	512	0	x4	x4	160	413	573
	72.85 MHz	2560	0	2048	0	Off	Off	640	12	652
		1280	0	2048	0	x2	Off	320	179	499
		640	0	2048	0	x4	Off	160	339	499
		2560	0	1024	0	Off	x2	640	12	652
		1280	0	1024	0	x2	x2	320	179	499
		640	0	1024	0	x4	x2	160	339	499
		2560	0	512	0	Off	Off	640	12	652
		1280	0	512	0	x2	x4	320	179	499
		640	0	512	0	x4	x4	160	339	499
	48.57 MHz	2560	0	2048	0	Off	Off	640	12	652
		1280	0	2048	0	x2	Off	320	173	493
		640	0	2048	0	x4	Off	160	333	493
		2560	0	1024	0	Off	x2	640	12	652
		1280	0	1024	0	x2	x2	320	173	493
		640	0	1024	0	x4	x2	160	333	493
		2560	0	512	0	Off	Off	640	12	652
		1280	0	512	0	x2	x4	320	173	493
		640	0	512	0	x4	x4	160	333	493

1x3-1Y (LVAL Active/Non-Active, H Total)

Horizontal Timing (Continuous Trigger Mode) (1/2)

Camera Settings								(a)	(b)	(c)
Tap Geometry	Camera Link Pixel Clock	ROI				Binning		LVAL Active	LVAL Non Active	H Total
		Width	Offset X	Height	Offset Y	Horizontal	Vertical	(Unit clock)	(Unit clock)	(Unit clock)
1X3 - 1Y	84.99 MHZ	2559	0	2048	0	Off	Off	853	12	865
		1278	0	2048	0	x2	Off	426	149	575
		639	0	2048	0	x4	Off	213	365	578
		2559	0	1024	0	Off	x2	853	12	865
		1280	0	1024	0	x2	x2	426	149	575
		639	0	1024	0	x4	x2	213	365	578
		2559	0	512	0	Off	Off	853	12	865
		1278	0	512	0	x2	x4	426	149	575
		639	0	512	0	x4	x4	213	365	578

1x2-1Y (LVAL Active/Non-Active, H Total)

Horizontal Timing (Continuous Trigger Mode) (1/2)

Camera Settings								(a)	(b)	(c)
Tap Geometry	Camera Link Pixel Clock	ROI				Binning		LVAL Active	LVAL Non Active	H Total
		Width	Offset X	Height	Offset Y	Horizontal	Vertical	(Unit clock)	(Unit clock)	(Unit clock)
1X2 - 1Y	84.99 MHz	2560	0	2048	0	Off	Off	1280	14	1294
		1280	0	2048	0	x2	Off	640	17	657
		640	0	2048	0	x4	Off	320	155	575
		2560	0	1024	0	Off	x2	1280	14	1294
		1280	0	1024	0	x2	x2	640	17	657
		640	0	1024	0	x4	x2	320	155	575
		2560	0	512	0	Off	Off	1280	14	1294
		1280	0	512	0	x2	x4	640	17	657
		640	0	512	0	x4	x4	320	155	575
	72.85 MHz	2560	0	2048	0	Off	Off	1280	14	1294
		1280	0	2048	0	x2	Off	640	13	653
		640	0	2048	0	x4	Off	320	173	493
		2560	0	1024	0	Off	x2	1280	14	1294
		1280	0	1024	0	x2	x2	640	13	653
		640	0	1024	0	x4	x2	320	173	493
		2560	0	512	0	Off	Off	1280	14	1294
		1280	0	512	0	x2	x4	640	13	653
		640	0	512	0	x4	x4	320	173	493
	48.57 MHz	2560	0	2048	0	Off	Off	1280	16	1296
		1280	0	2048	0	x2	Off	640	21	651
		640	0	2048	0	x4	Off	320	15	335
		2560	0	1024	0	Off	x2	1280	16	1296
		1280	0	1024	0	x2	x2	640	21	651
		640	0	1024	0	x4	x2	320	15	335
		2560	0	512	0	Off	Off	1280	16	1296
		1280	0	512	0	x2	x4	640	21	651
		640	0	512	0	x4	x4	320	15	335

1x8-1Y (1 Line Clock, Horizontal Frequency/Period)

Horizontal Timing (Continuous Trigger Mode) (2/2)

> **Note:** A: Operation Value; B = Calculation Value

Camera Settings								A: Operation value B: Calculation value			
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1 line Total clock (Unit: clock)	Horizontal Frequency (Unit: kHz)	Horizontal Period (Unit: us)
		Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X8 - 1Y 8bit	72.85 MHz	2560	0	2048	0	Off	Off	A	330	220.751	4.53
								B	330	220.779	4.529
		1280	0	2048	0	x2	Off	A	330	220.751	4.53
								B	330	220.779	4.529
		640	0	2048	0	x4	Off	A	330	220.751	4.53
								B	330	220.779	4.529
		2560	0	1024	0	Off	x2	A	330	220.751	4.53
								B	330	220.779	4.529
		1280	0	1024	0	x2	x2	A	330	220.751	4.53
								B	330	220.779	4.529
		640	0	1024	0	x4	x2	A	330	220.751	4.53
								B	330	220.779	4.529
		2560	0	512	0	Off	x4	A	330	220.751	4.53
								B	330	220.779	4.529
		1280	0	512	0	x2	x4	A	330	220.751	4.53
								B	330	220.779	4.529
		640	0	512	0	x4	x4	A	330	220.751	4.53
								B	330	220.779	4.529

Camera Settings								A: Operation value B: Calculation value			
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1 line Total clock (Unit: clock)	Horizontal Frequency (Unit: kHz)	Horizontal Period (Unit: us)
		Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X8 - 1Y 8bit	48.57 MHz	2560	0	2048	0	Off	Off	A	333.7	145.56	6.87
								B	334	145.423	6.876
		1280	0	2048	0	x2	Off	A	329.3	147.493	6.78
								B	330	147.186	6.794
		640	0	2048	0	x4	Off	A	329.3	147.493	6.78
								B	330	147.186	6.794
		2560	0	1024	0	Off	x2	A	333.7	145.56	6.87
								B	334	145.423	6.876
		1280	0	1024	0	x2	x2	A	329.3	147.493	6.78
								B	330	147.186	6.794
		640	0	1024	0	x4	x2	A	329.3	147.493	6.78
								B	330	147.186	6.794
		2560	0	512	0	Off	x4	A	333.7	145.56	6.87
								B	334	145.423	6.8764
		1280	0	512	0	x2	x4	A	329.3	147.493	6.78
								B	330	147.186	6.794
		640	0	512	0	x4	x4	A	329.3	147.493	6.78
								B	330	147.186	6.794

Camera Settings								A: Operation value B: Calculation value			
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1 line Total clock (Unit: clock)	Horizontal Frequency (Unit: kHz)	Horizontal Period (Unit: us)
		Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X8 - 1Y 10 bit	58.28 MHz	2560	0	2048	0	Off	Off	A	333.4	174.825	5.72
								B	334	174.508	5.73
		1280	0	2048	0	x2	Off	A	329.9	176.687	5.66
								B	330	176.623	5.662
		640	0	2048	0	x4	Off	A	329.9	176.687	5.66
								B	330	176.623	5.662
		2560	0	1024	0	Off	x2	A	333.4	174.825	5.72
								B	334	174.508	5.73
		1280	0	1024	0	x2	x2	A	329.9	176.687	5.66
								B	330	176.623	5.662
		640	0	1024	0	x4	x2	A	329.9	176.687	5.66
								B	330	176.623	5.662
		2560	0	512	0	Off	x4	A	333.4	174.825	5.72
								B	334	174.508	5.73
		1280	0	512	0	x2	x4	A	329.9	176.687	5.66
								B	330	176.623	5.662
		640	0	512	0	x4	x4	A	329.9	176.687	5.66
								B	330	176.623	5.662

Camera Settings								A: Operation value B: Calculation value			
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1 line Total clock (Unit: clock)	Horizontal Frequency (Unit: kHz)	Horizontal Period (Unit: us)
		Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X8 - 1Y 10 bit	48.57 MHz	2560	0	2048	0	Off	Off	A	333.7	145.56	6.87
								B	334	145.423	6.876
		1280	0	2048	0	x2	Off	A	329.3	147.493	6.78
								B	330	147.186	6.794
		640	0	2048	0	x4	Off	A	329.3	147.493	6.78
								B	330	147.186	6.794
		2560	0	1024	0	Off	x2	A	333.7	145.56	6.87
								B	334	145.423	6.876
		1280	0	1024	0	x2	x2	A	329.3	147.493	6.78
								B	330	147.186	6.794
		640	0	1024	0	x4	x2	A	329.3	147.493	6.78
								B	330	147.186	6.794
		2560	0	512	0	Off	x4	A	333.7	145.56	6.87
								B	334	145.423	6.876
		1280	0	512	0	x2	x4	A	329.3	147.493	6.78
								B	330	147.186	6.794
		640	0	512	0	x4	x4	A	329.3	147.493	6.78
								B	330	147.186	6.794

1x4-1Y (1 Line Clock, Horizontal Frequency/Period)

Horizontal Timing (Continuous Trigger Mode) (2/2)

> **Note:** A: Operation Value; B = Calculation Value

Camera Settings								A: Operation value B: Calculation value			
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1 line Total clock (Unit: clock)	Horizontal Frequency (Unit: kHz)	Horizontal Period (Unit: us)
		Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X4 - 1Y	84.99 MHz	2560	0	2048	0	Off	Off	A	653.6	130.039	7.69
								B	654	129.969	7.694
		1280	0	2048	0	x2	Off	A	572.9	148.368	6.74
								B	573	148.342	6.741
		640	0	2048	0	x4	Off	A	572.9	148.368	6.74
								B	573	148.342	6.741
		2560	0	1024	0	Off	x2	A	653.6	130.039	7.69
								B	654	129.969	7.694
		1280	0	1024	0	x2	x2	A	572.9	148.368	6.74
								B	573	148.342	6.741
		640	0	1024	0	x4	x2	A	572.9	148.368	6.74
								B	573	148.342	6.741
		2560	0	512	0	Off	x4	A	653.6	130.039	7.69
								B	654	129.969	7.694
		1280	0	512	0	x2	x4	A	572.9	148.368	6.74
								B	573	148.342	6.741
		640	0	512	0	x4	x4	A	572.9	148.368	6.74
								B	573	148.342	6.741

Camera Settings								A: Operation value B: Calculation value			
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1 line Total clock (Unit: clock)	Horizontal Frequency (Unit: kHz)	Horizontal Period (Unit: us)
		Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X4 - 1Y	72.85 MHz	2560	0	2048	0	Off	Off	A	651.2	111.857	8.94
								B	652	111.916	8.935
		1280	0	2048	0	x2	Off	A	498.3	146.199	6.84
								B	499	146.006	6.849
		640	0	2048	0	x4	Off	A	492.5	147.929	6.76
								B	493	147.059	6.767
		2560	0	1024	0	Off	x2	A	651.2	111.857	8.94
								B	652	111.916	8.935
		1280	0	1024	0	x2	x2	A	498.3	146.199	6.84
								B	499	146.006	6.849
		640	0	1024	0	x4	x2	A	492.5	147.929	6.76
								B	493	147.059	6.767
		2560	0	512	0	Off	x4	A	651.2	111.857	8.94
								B	652	111.916	8.935
		1280	0	512	0	x2	x4	A	498.3	146.199	6.84
								B	499	146.006	6.849
		640	0	512	0	x4	x4	A	492.5	147.929	6.76
								B	493	147.059	6.767

Camera Settings								A: Operation value B: Calculation value			
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1 line Total clock (Unit: clock)	Horizontal Frequency (Unit: kHz)	Horizontal Period (Unit: us)
		Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X4 - 1Y	48.57 MHz	2560	0	2048	0	Off	Off	A	651.2	74.571	13.41
								B	652	75.421	13.259
		1280	0	2048	0	x2	Off	A	334.2	154.349	6.88
								B	335	144.989	6.897
		640	0	2048	0	x4	Off	A	329.3	147.493	6.78
								B	330	147.186	6.794
		2560	0	1024	0	Off	x2	A	651.2	74.571	13.41
								B	652	75.42	13.259
		1280	0	1024	0	x2	x2	A	334.2	154.349	6.88
								B	335	144.989	6.897
		640	0	1024	0	x4	x2	A	651.2	74.571	13.41
								B	652	75.421	13.259
		2560	0	512	0	Off	x4	A	334.2	154.349	6.88
								B	335	144.989	6.897
		1280	0	512	0	x2	x4	A	651.2	74.571	13.41
								B	652	75.421	13.259
		640	0	512	0	x4	x4	A	334.2	154.349	6.88
								B	335	144.989	6.897

1x3-1Y (1 Line Clock, Horizontal Frequency/Period)

Horizontal Timing (Continuous Trigger Mode) (2/2)

> **Note:** A: Operation Value; B = Calculation Value

Camera Settings								A: Operation value B: Calculation value			
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1 line Total clock (Unit: clock)	Horizontal Frequency (Unit: kHz)	Horizontal Period (Unit: us)
		Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X3 - 1Y	84.99 MHz	2560	0	2048	0	Off	Off	A	864.4	98.328	10.17
								B	865	98.266	10.176
		1280	0	2048	0	x2	Off	A	578	147.059	6.8
								B	578	147.059	6.8
		640	0	2048	0	x4	Off	A	578	147.059	6.8
								B	578	147.059	6.8
		2560	0	1024	0	Off	x2	A	864.4	98.328	10.17
								B	865	98.266	10.176
		1280	0	1024	0	x2	x2	A	578	147.059	6.8
								B	578	147.059	6.8
		640	0	1024	0	x4	x2	A	578	147.059	6.8
								B	578	147.059	6.8
		2560	0	512	0	Off	x4	A	864.4	98.32	10.17
								B	865	98.266	10.176
		1280	0	512	0	x2	x4	A	578	147.059	6.8
								B	578	147.059	6.8
		640	0	512	0	x4	x4	A	578	147.059	6.8
								B	578	147.059	6.8

1x2-1Y (1 Line Clock, Horizontal Frequency/Period)

Horizontal Timing (Continuous Trigger Mode) (2/2)

> **Note:** A: Operation Value; B = Calculation Value

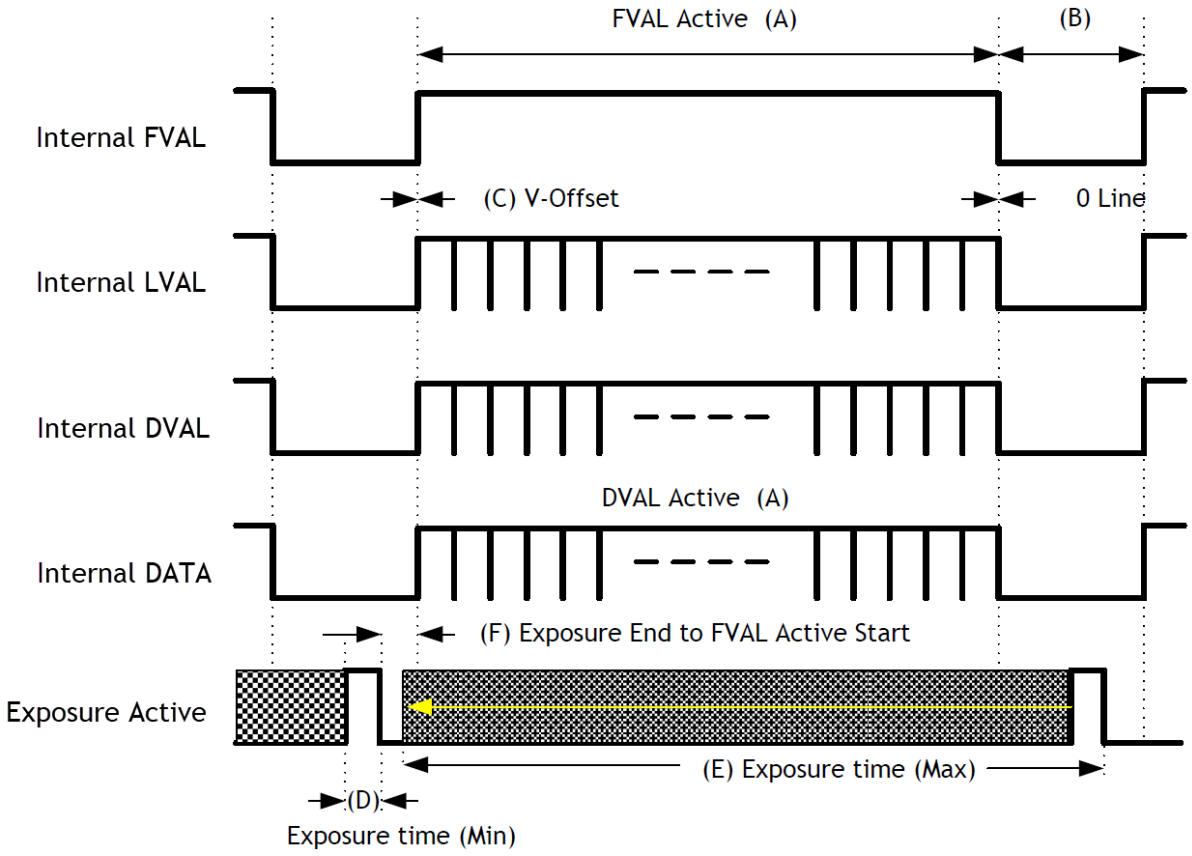
Camera Settings								A: Operation value B: Calculation value			
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1 line Total clock (Unit: clock)	Horizontal Frequency (Unit: kHz)	Horizontal Period (Unit: us)
		Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X2 - 1Y	84.99 MHz	2560	0	2048	0	Off	Off	A	1293.7	65.703	15.22
								B	1294	65.668	15.224
		1280	0	2048	0	x2	Off	A	656.2	129.534	7.72
								B	657	129.376	7.729
		640	0	2048	0	x4	Off	A	574.6	147.929	6.76
								B	575	147.826	6.765
		2560	0	1024	0	Off	x2	A	1293.7	65.703	15.22
								B	1294	65.668	15.224
		1280	0	1024	0	x2	x2	A	656.2	129.534	7.72
								B	657	129.376	7.729
		640	0	1024	0	x4	x2	A	574.6	147.929	6.76
								B	575	147.826	6.765
		2560	0	512	0	Off	x4	A	1293.7	65.703	15.22
								B	1294	65.668	15.224
		1280	0	512	0	x2	x4	A	656.2	129.534	7.72
								B	657	129.376	7.729
		640	0	512	0	x4	x4	A	574.6	147.929	6.76
								B	575	147.826	6.765

Camera Settings								A: Operation value B: Calculation value			
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1 line Total clock (Unit: clock)	Horizontal Frequency (Unit: kHz)	Horizontal Period (Unit: us)
		Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X2 - 1Y	72.85 MHz	2560	0	2048	0	Off	Off	A	1293.2	56.338	17.75
								B	1294	56.304	17.761
		1280	0	2048	0	x2	Off	A	652.8	111.607	8.960
								B	653	111.573	8.963
		640	0	2048	0	x4	Off	A	492.5	147.929	6.76
								B	493	147.783	6.767
		2560	0	1024	0	Off	x2	A	1293.2	56.338	17.75
								B	1294	56.304	17.761
		1280	0	1024	0	x2	x2	A	652.8	111.607	8.960
								B	653	111.573	8.963
		640	0	1024	0	x4	x2	A	492.5	147.929	6.76
								B	493	147.783	6.767
		2560	0	512	0	Off	x4	A	1293.2	56.338	17.75
								B	1294	56.304	17.761
		1280	0	512	0	x2	x4	A	652.8	111.607	8.960
								B	653	111.573	8.963
		640	0	512	0	x4	x4	A	492.5	147.929	6.76
								B	493	147.783	6.767

Camera Settings								A: Operation value B: Calculation value			
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1 line Total clock (Unit: clock)	Horizontal Frequency (Unit: kHz)	Horizontal Period (Unit: us)
		Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X2 - 1Y	48.57 MHz	2560	0	2048	0	Off	Off	A	1294.9	37.509	26.66
								B	1296	37.478	26.682
		1280	0	2048	0	x2	Off	A	650.9	74.627	13.4
								B	651	74.61	13.403
		640	0	2048	0	x4	Off	A	334.2	145.349	6.88
								B	335	144.989	6.897
		2560	0	1024	0	Off	x2	A	1294.9	37.509	26.66
								B	1296	37.478	26.682
		1280	0	1024	0	x2	x2	A	650.9	74.627	13.4
								B	651	74.61	13.403
		640	0	1024	0	x4	x2	A	334.2	145.349	6.88
								B	335	144.989	6.897
		2560	0	512	0	Off	x4	A	1294.9	37.509	26.66
								B	1296	37.478	26.682
		1280	0	512	0	x2	x4	A	650.9	74.627	13.4
								B	651	74.61	13.403
		640	0	512	0	x4	x4	A	334.2	145.349	6.88
								B	335	144.989	6.897

Output Timing (Vertical)

The below figure shows the vertical timing of Camera Link output during continuous trigger operation. However, with 1X8-1Y 10-bit geometry, which is 80-bit configuration, DVAL and Exposure Active, which are normally output to Camera Link spare bits, are not output through the Camera Link interface as data bits are applied to those bits.



Vertical Timing

1x8-1Y (FVAL, DVAL, V-Offset, Exposure Time)

Vertical Timing (Continuous Trigger Mode) (1/2)

Camera Settings									(A)	(B)	(C)	(D)
Tap Geometry	Pixel Clock	Frame Period (Typ)	ROI				Binning		FVAL & DVAL Active (Unit: line)	FVAL Non Active (Unit: line)	V-Offset (Unit: line)	Exposure Time (min) (Unit:µs)
			Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X8 - 1Y 8-bit	72.85 MHz	9328 us	2560	0	2048	0	Off	Off	2048	10	0	10
			2560	0	1024	0	Off	x2	1024	10		
			2560	0	512	0	Off	x4	512	10		
			1280	0	2048	0	x2	Off	2048	10		
			1280	0	1024	0	x2	x2	1024	10		
			1280	0	512	0	x2	x4	512	10		
			512	0	2048	0	x4	Off	2048	10		
			512	0	1024	0	x4	x2	1024	10		
			512	0	512	0	x4	x4	512	10		
	48.57 MHz	14117 us	2560	0	2048	0	Off	Off	2048	14	0	10
			2560	0	1024	0	Off	x2	1024	14		
			2560	0	512	0	Off	x4	512	14		
			1280	0	2048	0	x2	Off	2048	14		
			1280	0	1024	0	x2	x2	1024	14		
			1280	0	512	0	x2	x4	512	14		
			512	0	2048	0	x4	Off	2048	14		
			512	0	1024	0	x4	x2	1024	14		
			512	0	512	0	x4	x4	512	14		
1X8 - 1Y 10-bit	58.28 MHz	11765 us	2560	0	2048	0	Off	Off	2048	14	0	10
			2560	0	1024	0	Off	x2	1024	14		
			2560	0	512	0	Off	x4	512	14		
			1280	0	2048	0	x2	Off	2048	14		
			1280	0	1024	0	x2	x2	1024	14		
			1280	0	512	0	x2	x4	512	14		
			512	0	2048	0	x4	Off	2048	14		
			512	0	1024	0	x4	x2	1024	14		
			512	0	512	0	x4	x4	512	14		

1x4-1Y (FVAL, DVAL, V-Offset, Exposure Time)

Vertical Timing (Continuous Trigger Mode) (1/2)

Camera Settings									(A)	(B)	(C)	(D)
Tap Geometry	Pixel Clock	Frame Period (Typ)	ROI				Binning		FVAL & DVAL Active (Unit: line)	FVAL Non Active (Unit: line)	V-Offset (Unit: line)	Exposure Time (min) (Unit:µs)
			Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X4 - 1Y	84.99 MHz	15719 us	2560	0	2048	0	Off	Off	2048	14	0	10
			2560	0	1024	0	Off	x2	1024	14		
			2560	0	512	0	Off	x4	512	14		
			1280	0	2048	0	x2	Off	2048	14		
			1280	0	1024	0	x2	x2	1024	14		
			1280	0	512	0	x2	x4	512	14		
			512	0	2048	0	x4	Off	2048	14		
			512	0	1024	0	x4	x2	1024	14		
			512	0	512	0	x4	x4	512	14		
	72.85 MHz	18268 us	2560	0	2048	0	Off	Off	2048	12	0	10
			2560	0	1024	0	Off	x2	1024	12		
			2560	0	512	0	Off	x4	512	12		
			1280	0	2048	0	x2	Off	2048	12		
			1280	0	1024	0	x2	x2	1024	12		
			1280	0	512	0	x2	x4	512	12		
			512	0	2048	0	x4	Off	2048	12		
			512	0	1024	0	x4	x2	1024	12		
			512	0	512	0	x4	x4	512	12		
	48.57 MHz	27778 us	2560	0	2048	0	Off	Off	2048	12	0	10
			2560	0	1024	0	Off	x2	1024	12		
			2560	0	512	0	Off	x4	512	12		
			1280	0	2048	0	x2	Off	2048	12		
			1280	0	1024	0	x2	x2	1024	12		
			1280	0	512	0	x2	x4	512	12		
			512	0	2048	0	x4	Off	2048	12		
			512	0	1024	0	x4	x2	1024	12		
			512	0	512	0	x4	x4	512	12		

1x3-1Y (FVAL, DVAL, V-Offset, Exposure Time)

Vertical Timing (Continuous Trigger Mode) (1/2)

Camera Settings									(A)	(B)	(C)	(D)
Tap Geometry	Pixel Clock	Frame Period (Typ)	ROI				Binning		FVAL & DVAL Active (Unit: line)	FVAL Non Active (Unit: line)	V-Offset (Unit: line)	Exposure Time (min) (Unit:µs)
			Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X3 - 1Y 8-bit	84.99 MHz	20796 us	2559	0	2048	0	Off	Off	2048	14	0	10
			2559	0	1024	0	Off	x2	1024	14		
			2559	0	512	0	Off	x4	512	14		
			1278	0	2048	0	x2	Off	2048	14		
			1278	0	1024	0	x2	x2	1024	14		
			1278	0	512	0	x2	x4	512	14		
			510	0	2048	0	x4	Off	2048	14		
			510	0	1024	0	x4	x2	1024	14		
			510	0	512	0	x4	x4	512	14		

1x2-1Y (FVAL, DVAL, V-Offset, Exposure Time)

Vertical Timing (Continuous Trigger Mode) (1/2)

Camera Settings									(A)	(B)	(C)	(D)
Tap Geometry	Pixel Clock	Frame Period (Typ)	ROI				Binning		FVAL & DVAL Active (Unit: line)	FVAL Non Active (Unit: line)	V-Offset (Unit: line)	Exposure Time (min) (Unit:µs)
			Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X2 - 1Y	84.99 MHz	31268 us	2560	0	2048	0	Off	Off	2048	14	0	10
			2560	0	1024	0	Off	x2	1024	14		
			2560	0	512	0	Off	x4	512	14		
			1280	0	2048	0	x2	Off	2048	14		
			1280	0	1024	0	x2	x2	1024	14		
			1280	0	512	0	x2	x4	512	14		
			512	0	2048	0	x4	Off	2048	14		
			512	0	1024	0	x4	x2	1024	14		
			512	0	512	0	x4	x4	512	14		
	72.85 MHz	36366 us	2560	0	2048	0	Off	Off	2048	14	0	10
			2560	0	1024	0	Off	x2	1024	14		
			2560	0	512	0	Off	x4	512	14		
			1280	0	2048	0	x2	Off	2048	14		
			1280	0	1024	0	x2	x2	1024	14		
			1280	0	512	0	x2	x4	512	14		
			512	0	2048	0	x4	Off	2048	14		
			512	0	1024	0	x4	x2	1024	14		
			512	0	512	0	x4	x4	512	14		
	48.57 MHz	55126 us	2560	0	2048	0	Off	Off	2048	16	0	10
			2560	0	1024	0	Off	x2	1024	16		
			2560	0	512	0	Off	x4	512	16		
			1280	0	2048	0	x2	Off	2048	16		
			1280	0	1024	0	x2	x2	1024	16		
			1280	0	512	0	x2	x4	512	16		
			512	0	2048	0	x4	Off	2048	16		
			512	0	1024	0	x4	x2	1024	16		
			512	0	512	0	x4	x4	512	16		

1x8-1Y (Frame Period, Exposure Time, Exposure End to FVAL Active Start)

Vertical Timing (Continuous Trigger Mode) (2/2)

Camera Settings											(E)	(F)
Tap Geometry	Pixel Clock	Frame Period (Typ)	ROI				Binning		Frame Period (min) (Unit: us)	Exposure Time (max) (Unit: us)	Exposure End to FVAL Active Start (Unit: us)	
			Width	Offset X	Height	Offset Y	Horizontal	Vertical				
1X8 - 1Y 8-bit	72.85 MHz	9328 us	2560	0	2048	0	Off	Off	9328	9222	29.6	
			2560	0	1024	0	Off	x2	4709	4657		
			2560	0	512	0	Off	x4	2397	2317		
			1280	0	2048	0	x2	Off	9272	9228		
			1280	0	1024	0	x2	x2	4681	4628		
			1280	0	512	0	x2	x4	2383	2302		
			512	0	2048	0	x4	Off	9272	9280		
			512	0	1024	0	x4	x2	4681	4628		
			512	0	512	0	x4	x4	2383	2302		
	48.57 MHz	14117 us	2560	0	2048	0	Off	Off	14117	14184	40.4	
			2560	0	1024	0	Off	x2	7127	7102		
			2560	0	512	0	Off	x4	3627	3560		
			1280	0	2048	0	x2	Off	13947	14012		
			1280	0	1024	0	x2	x2	7041	7015		
			1280	0	512	0	x2	x4	3584	3516		
			512	0	2048	0	x4	Off	13947	14012		
			512	0	1024	0	x4	x2	7041	7015		
			512	0	512	0	x4	x4	3584	3516		
1X8 - 1Y 10-bit	58.28 MHz	11765 us	2560	0	2048	0	Off	Off	11765	11803	35.2	
			2560	0	1024	0	Off	x2	5938	5900		
			2560	0	512	0	Off	x4	3023	2949		
			1280	0	2048	0	x2	Off	11622	11659		
			1280	0	1024	0	x2	x2	5867	5828		
			1280	0	512	0	x2	x4	2986	2913		
			512	0	2048	0	x4	Off	11622	11659		
			512	0	1024	0	x4	x2	5867	5828		
			512	0	512	0	x4	x4	2986	2913		

1x4-1Y (Frame Period, Exposure Time, Exposure End to FVAL Active Start)

Vertical Timing (Continuous Trigger Mode) (2/2)

Camera Settings											(E)	(F)
Tap Geometry	Pixel Clock	Frame Period (Typ)	ROI				Binning		Frame Period (min) (Unit:us)	Exposure Time (max) (Unit:us)	Exposure End to FVAL Active Start (Unit:us)
			Width	Offset X	Height	Offset Y	Horizontal	Vertical			
1X4 - 1Y	84.99 MHz	15719 us	2560	0	2048	0	Off	Off	15719	15804	41.6
			2560	0	1024	0	Off	x2	7927	7911	
			2560	0	512	0	Off	x4	4028	3964	
			1280	0	2048	0	x2	Off	13934	13998	
			1280	0	1024	0	x2	x2	7027	7001	
			1280	0	512	0	x2	x4	3570	3502	
			512	0	2048	0	x4	Off	13934	13998	
			512	0	1024	0	x4	x2	7027	7001	
			512	0	512	0	x4	x4	3570	3502	
	72.85 MHz	18268 us	2560	0	2048	0	Off	Off	18268	18384	43.2
			2560	0	1024	0	Off	x2	9213	9211	
			2560	0	512	0	Off	x4	4681	4624	
			1280	0	2048	0	x2	Off	13934	13998	
			1280	0	1024	0	x2	x2	7027	7001	
			1280	0	512	0	x2	x4	3570	3502	
			512	0	2048	0	x4	Off	13934	13998	
			512	0	1024	0	x4	x2	7027	7001	
			512	0	512	0	x4	x4	3570	3502	
	48.57 MHz	27444 us	2560	0	2048	0	Off	Off	27444	27672	52.4
			2560	0	1024	0	Off	x2	13841	13891	
			2560	0	512	0	Off	x4	7033	7000	
			1280	0	2048	0	x2	Off	14019	14084	
			1280	0	1024	0	x2	x2	7070	7044	
			1280	0	512	0	x2	x4	3592	3524	
			512	0	2048	0	x4	Off	13934	13998	
			512	0	1024	0	x4	x2	7027	7001	
			512	0	512	0	x4	x4	3608	3502	

1x3-1Y (Frame Period, Exposure Time, Exposure End to FVAL Active Start)

Vertical Timing (Continuous Trigger Mode) (2/2)

Camera Settings											(E)	(F)
Tap Geometry	Pixel Clock	Frame Period (Typ)	ROI				Binning		Frame Period (min) (Unit:us)	Exposure Time (max) (Unit:us)	Exposure End to FVAL Active Start (Unit:us)
			Width	Offset X	Height	Offset Y	Horizontal	Vertical			
1X3 - 1Y 8-bit	84.99 MHz	20796 us	2559	0	2048	0	Off	Off	20881	20944	46
			2559	0	1024	0	Off	x2	10521	10491	
			2559	0	512	0	Off	x4	5336	5264	
			1278	0	2048	0	x2	Off	13920	13985	
			1278	0	1024	0	x2	x2	7013	6987	
			1278	0	512	0	x2	x4	3557	3489	
			510	0	2048	0	x4	Off	13920	13985	
			510	0	1024	0	x4	x2	7013	6987	
			510	0	512	0	x4	x4	3557	3489	

1x2-1Y (Frame Period, Exposure Time, Exposure End to FVAL Active Start)

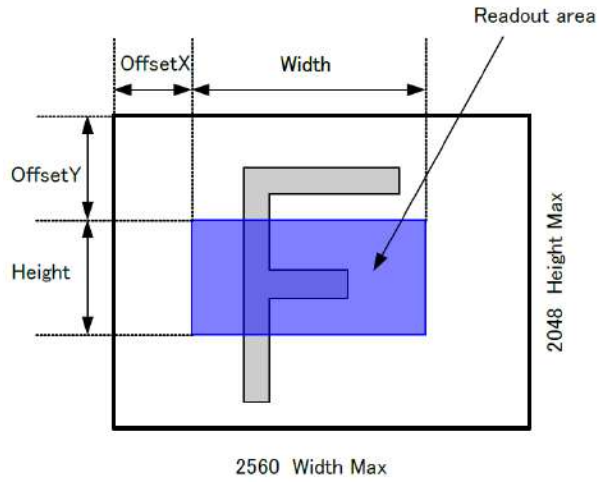
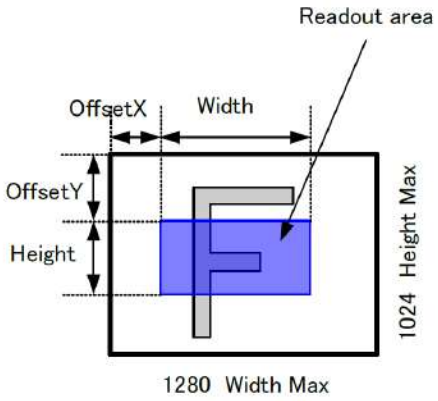
Vertical Timing (Continuous Trigger Mode) (2/2)

Camera Settings											(E)	(F)
Tap Geometry	Pixel Clock	Frame Period (Typ)	ROI				Binning		Frame Period (min) (Unit:us)	Exposure Time (max) (Unit:us)	Exposure End to FVAL Active Start (Unit:us)
			Width	Offset X	Height	Offset Y	Horizontal	Vertical			
1X2 - 1Y	84.99 MHz	31268 us	2560	0	2048	0	Off	Off	31268	31542	58
			2560	0	1024	0	Off	x2	15770	15841	
			2560	0	512	0	Off	x4	8013	7990	
			1280	0	2048	0	x2	Off	15889	15976	
			1280	0	1024	0	x2	x2	8013	7998	
			1280	0	512	0	x2	x4	4071	4008	
			512	0	2048	0	x4	Off	13934	13998	
			512	0	1024	0	x4	x2	7027	7001	
			512	0	512	0	x4	x4	3570	3502	
	72.85 MHz	36366 us	2560	0	2048	0	Off	Off	36366	36702	70
			2560	0	1024	0	Off	x2	18341	18441	
			2560	0	512	0	Off	x4	9319	9310	
			1280	0	2048	0	x2	Off	18438	18556	
			1280	0	1024	0	x2	x2	9299	9298	
			1280	0	512	0	x2	x4	4725	4668	
			512	0	2048	0	x4	Off	13934	13998	
			512	0	1024	0	x4	x2	7027	7001	
			512	0	512	0	x4	x4	3570	3502	
	48.57 MHz	55126 us	2560	0	2048	0	Off	Off	54464	55020	82.8
			2560	0	1024	0	Off	x2	27469	27671	
			2560	0	512	0	Off	x4	13958	13996	
			1280	0	2048	0	x2	Off	27614	27844	
			1280	0	1024	0	x2	x2	13926	13978	
			1280	0	512	0	x2	x4	7077	7044	
			512	0	2048	0	x4	Off	14189	14256	
			512	0	1024	0	x4	x2	7156	7131	
			512	0	512	0	x4	x4	3635	3568	

ROI (Region of Interest) Settings

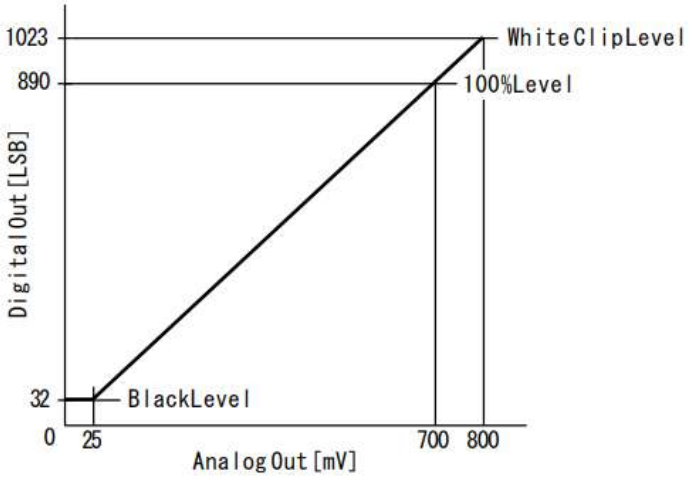
Related Setting Items: Image Format Control

On this camera, 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. However, in the horizontal direction, the horizontal frequency is not changed if the width is decreased. On this camera, the minimum width is “8” and minimum height is “1”.

Setting Example: 1	**Setting Example: 2**
Binning Horizontal = 1 Binning Vertical = 1	Binning Horizontal = 2 Binning Vertical = 2
	

Digital Output Bit Allocation

CMOS Out		Offset -100@120-bit	Setup +133@12-bit	Digital Output		
				8-bit	10-bit	12-bit
Black	100	0LSB	133LSB	8LSB	32LSB	128LSB
100%	3527	3427LSB	3560LSB	222LSB	890LSB	3560LSB
Full (115%)	4062	3962LSB	4095LSB	255LSB	1023LSB	4095LSB



Acquisition Control

With Trigger OFF (free running mode), 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 (Hz). Allowed values range from the shortest frame rate to 0.125Hz (fps), 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.

The setting range in Acquisition Frame Rate is:

Shortest Acquisition Frame Rate	to	Longest
Inverse number of time required to drive all pixels in the area set by ROI command	to	0.125 Hz (fps) = 8 seconds

Calculation of the Frame Rate

> **Note:** The Frame Rate Calculator is available for download from the product page on the JAI website (www.jai.com).

The frame rate depends on the tap geometry and is calculated in the following formula.

Maximum Frame Rate (fps) = 1/(Rounddown*3([Trow]x16/C) x ([H]+E) x 0.988*4) x 1000000

Where,

[Trow]=Roundup*1((Roundup*1(2560 /A*2) x [W] /2560 + B) x A*2) x C /(Dx16)

If the result of the calculation is equal or less to 164, [Trow] is fixed to 164.

- Binning OFF: [W] = [Width*5] / [H] = [Height*6]
- Binning ON: [W] = [Width*5] + 1 / [H] = [Height*6] + 1

Notes:
*1 Roundup after the decimal point

*2 Number of TAP

*3 Round down after the decimal point

*4 Compensation coefficient

*5 Refer to the Width value on the below table.

*6 Refer to the Height value on the below table.

Figures for A to E by the Tap Geometry

Tap Geometry	CL Clock Frequency (MHz)	A	B	C	D	E	Max. Frame Rate (fps)*7
1X2-1Y	84.99(High)	2	20	384	169.9999	16	31.9
	72.85(Mid)		18		145.7142		27.4
	48.57(Low)		16		97.1428		18.3
1X3-1Y	84.99(High)	3	15		254.99985	14	47.8
	72.85(Mid)		16		218.5713		41.0
	48.57(Low)		14		145.7142		27.4
1X4-1Y	84.99(High)	4	12		339.9998	16	63.6
	72.85(Mid)				291.4284		54.7
	48.57(Low)				194.2856		36.4
1X8-1Y (8bit)	72.85(High)	8	12	577.6	582.8568	18	107.1
	48.57(Low)		14	384	388.5712		70.8
1X8-1Y (10bit)	58.28(Mid)			460.8	466.28544		84.9
	48.57(Low)			384	388.5712		70.8

Note: *7 Maximum frame rate at the full image size

The following table shows Width and Height in the binning modes.

	Width*5	Height*6
Binning OFF 1	8 ~ 2560	1 ~ 2048
Binning ON 2	4 ~ 1280	1 ~ 1024
Binning ON 4	2 ~ 640	1 ~ 512

Exposure Settings

Related Setting Items: Acquisition Control, JAI Custom

This section describes how to set the exposure settings.

Command Name	Parameter	Description
Exposure Mode	Off	Shutter control is not available. The exposure time depends on the frame rate.
	Timed	The exposure is set by ExposureTime.
	Trigger Width	The exposure is controlled by the input trigger pulse width.
Exposure Time	10 ~ Max. Exposure time[us]	Exposure time(float)
Exposure Time Raw	Raw 10 ~ Max. exposure time [us]	Exposure time(integer)
Exposure Auto	Off	Disable the exposure auto
	Continuous	Enable the exposure auto

Exposure Mode

The exposure mode set the way of the exposure. There are three ways.

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 usec 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. • Trigger Mode is forced to ON.

If Exposure Mode is set at Timed, the exposure operation can be selected as follows by setting Trigger Option.

Trigger Option Setting	Exposure Operation
OFF	Timed (EPS) mode
RCT	RCT mode

If the trigger is used, it uses “Frame Start”.

The procedure is;

1. Select “Frame Start” in “Trigger Selector”

   > **Note:** Only “Frame Start” is available on this camera.

2. Select “Timed” or “Trigger Width” in “Exposure Mode”.
3. Set “ON” in “Trigger Mode”.

> **Caution:** For trigger operation, Exposure Mode must first be set to something other than OFF and then Trigger Mode of Frame Start must be ON. If the exposure mode is set to OFF, the trigger mode cannot be set.

Operational mode by the combination of the exposure mode and the trigger control.

	Trigger Control	
Exposure Mode Setting	**Frame Start Trigger Mode (ON/OFF)**	**Exposure Control**
OFF	OFF	Not available
Timed (ESP, RCT)	OFF or ON	Preset exposure time
Trigger Width	OFF	Not available
	ON	The pulse width of the input trigger pulse

- **Frame Start Trigger**: The start of image capturing of a frame is controlled by the external trigger.
- **Trigger Mode ON**: Start the exposure by the selected signal for the frame start
- **Trigger OFF**: The camera is in free-running mode

ExposureTime

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.

ExposureAuto

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
  a. **ASC Max**: The maximum value for the exposure time to be controlled can be set.
  b. **ASC Min**: The minimum value for the exposure time to be controlled can be set.
  c. **ALC Reference**: The reference level of the exposure control can be set
  d. **ALC Channel Area**: This can Enable or Disable the area selected by ALC Custom Area Selector

ALC Area Type

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

Trigger Control

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

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

Trigger Selector

Selects the trigger operation. On this camera, only Frame Start is available.

Trigger Mode

Select either free-running operation or external trigger operation.

- **OFF**: Free-running operation
- **ON**: External trigger operation

> **Caution:** For trigger operation, Exposure Mode must first be set to something other than OFF and the Trigger Mode of Frame Start must be ON. If the exposure mode is set to OFF, the trigger mode cannot be set.

Trigger Source

Select the trigger source to be used for trigger operation (Frame Start) from the following:

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	Connect Pulse generator 0 signal to the selected trigger operation
Line 7 – CC1	Connect Trigger In signal through CC1 in Camera Link Interface to the selected trigger operation
NAND 0 Out	Connect NAND 0 OUT signal to the selected trigger operation
NAND 1 Out	Connect NAND1 OUT signal to the selected trigger operation

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.

	Trigger Activation Setting			
Exposure Mode	Rising Edge	Falling Edge	Level High	Level Low
Timed	✓	✓		
Trigger Width			✓	✓
Timed RCT	✓	✓		

✓ : Supported
Empty: Not Supported

Normal Continuous Operation

This is used for applications which do not require triggering.

Minimum interval (1X8–1Y, 8-bit, CL Clock =72.85MHz)

Trigger Mode	Readout Mode	Time (Min. Frame Period)
Timed Exposure Mode Trigger Mode OFF*	Full	9435us
	ROI Center 2/3	6281us
	ROI Center 1/2	4740us
	ROI Center 1/4	2393us
	ROI Center 1/8	1219us
	V Binning ON (Full)	4740us

Note: *Readout setting in Trigger Overlap is not available.

Timed Mode

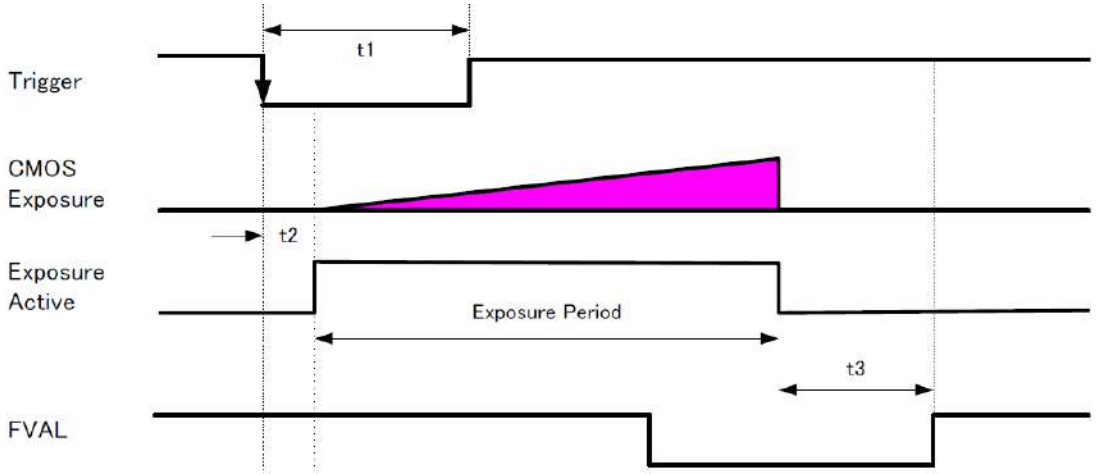
This mode captures image(s) with a preset exposure time by using the external trigger. An additional setting determines if the trigger pulse can be accepted during the exposure period.

Primary settings to use this mode

- Trigger Mode = ON
- Exposure Mode = Timed

Trigger minimum interval (Trigger Overlap = Readout) (1X8–1Y, 8-bit, CL Clock=72.85 MHz)

Trigger Mode	Readout Mode	Time (Min. Trigger Period)
Timed Exposure Mode Trigger Mode ON	Full	9435us + 8.01 µs
	ROI Center 2/3	6281us + 8.01 µs
	ROI Center 1/2	4740us + 8.01 µs
	ROI Center 1/4	2393us + 8.01 µs
	ROI Center 1/8	1219us + 8.01 µs
	V Binning ON (Full)	4740us+ 8.01 µs



t1	t2	t3
10µ (Min.)	18µ	6L to 7L

Trigger Width Mode

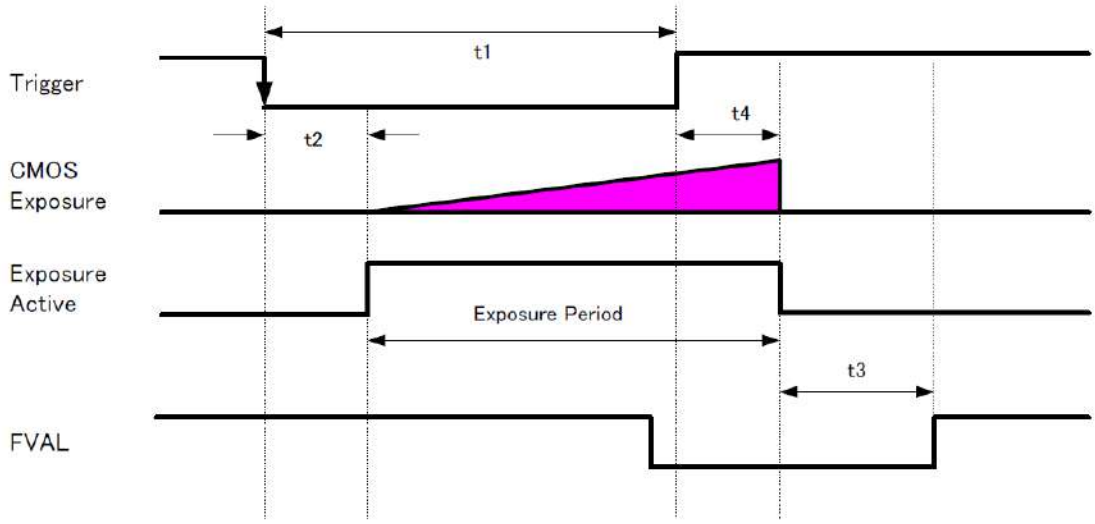
In this mode, the exposure time is equal to the trigger pulse width. Accordingly, longer exposure times are supported. Additional settings determine if the trigger pulse can be accepted during the exposure period.

Primary settings to use this mode

- Trigger Mode = ON
- Exposure Mode = Trigger Width

Minimum trigger interval (Trigger Overlap = Readout) (1X8–1Y, 8-bit, CL Clock=72.85 MHz)

Trigger Mode	Readout Mode	Time (Min. Trigger Period)
TriggerWidth Exposure Mode	Full	9435us + 8.01 µs
	ROI Center 2/3	6281us + 8.01 µs
	ROI Center 1/2	4740us + 8.01 µs
	ROI Center 1/4	2393us + 8.01 µs
	ROI Center 1/8	1219us + 8.01 µs
	V Binning ON (Full)	4740us+ 8.01 µs



t1	t2	t3	t4
10µ(Min.)	18µs	6L to 7L	14.2 µs

RCT Mode

Related Setting Items: JAI Custom

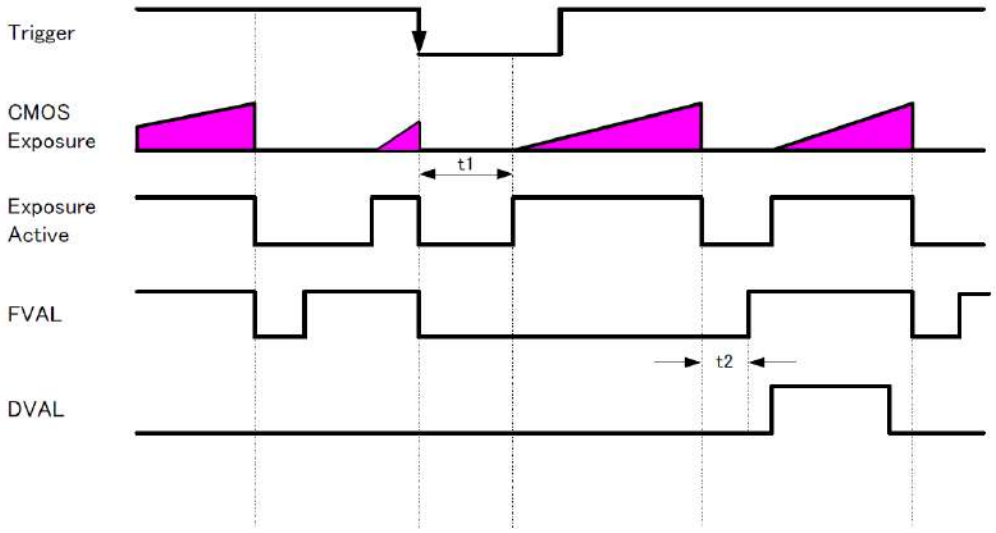
Until the trigger is input, the camera operates continuously and can use auto-gain, if necessary, to control the exposure setting. During this time, FVAL and LVAL are output but DVAL is not output. When the trigger is input, the fast dump is activated to read out the electronic charge very quickly, after which the accumulation and the readout are performed. When the accumulated signal against the trigger is read out, FVAL, LVAL and DVAL are output too.

Primary settings to use this mode

- Trigger Mode: ON
- Exposure Mode: Timed
- Trigger Option: RCT

Minimum trigger interval (1X8–1Y)

Trigger Mode	Readout Mode	Time (Min. Trigger Period)
Reset Continuous Trigger Mode (Note2)	Full	9435us + Exposure time + 1.562 ms
	ROI Center 2/3	6281us + Exposure time + 1.562 ms
	ROI Center 1/2	4740us + Exposure time + 1.562 ms
	ROI Center 1/4	2393us + Exposure time + 1.562 ms
	ROI Center 1/8	1219us + Exposure time + 1.562 ms
	V Binning ON (Full)	4740us+ Exposure time + 1.562 ms



t1	t2
28L	9L ~ 10L

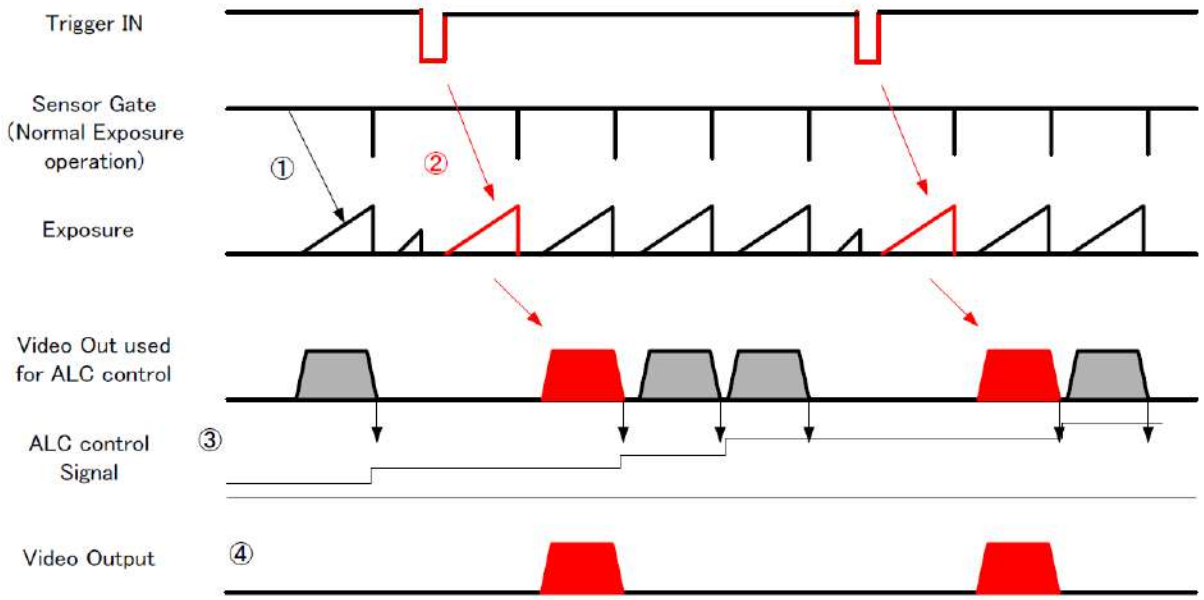
RCT Mode Together with ALC Function

The RCT mode can be used in conjunction with the ALC control so that the exposure is always set to the appropriate state when the trigger pulse is input. In this case, the following settings are additionally required to RCT mode settings.

1. **Exposure Auto**: Continuous
2. **Gain Auto**: Continuous

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	Frame grabber board video output is only the signal after the trigger is input.



Sequence Mode

Related Setting Items: JAI Custom

This is a function to capture images in sequence based on preset ROI, Exposure Time, Gain and other parameters in the sequence index table. To use sequence mode, configure VideoSendMode (Trigger Sequence or Command Sequence).

Basic setting to use this function

- Trigger Mode: ON
- Exposure mode: Timed
- Video Send Mode: Sequence

Minimum Trigger Interval (1x8–1Y)

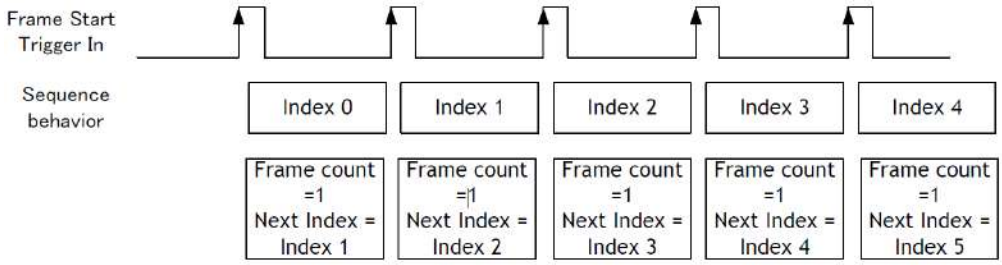
Trigger Mode	Readout Mode	Time (Min. Trigger Period)
Sequence mode	Full	9435us + Exposure time + 8.01µs
	ROI Center 2/3	6281us + Exposure time + 8.01µs
	ROI Center 1/2	4740us + Exposure time + 8.01µs
	ROI Center 1/4	2393us + Exposure time + 8.01µs
	ROI Center 1/8	1219us + Exposure time + 8.01µs
	V Binning ON (Full)	4740us+ Exposure time + 8.01µs

Notes:

- The minimum trigger interval assumes that the exposure time is the same for each index in the sequence. If the exposure time is different, the difference in period should be added to the interval calculation.
- If it is necessary to use different exposure times, it is recommended to arrange the exposure times from the shortest to the longest.
- In sequence mode, the exposure should be adjusted so that the operation is not in LVAL sync accumulation.

Trigger Sequence Mode Timing

The following drawing shows the sequence mode timing concept.



In this mode, it is not possible to overlap the next exposure while the previous trigger operation (Index table) is in progress.

Sequence Index Table (Default)

The following table shows the default settings.

	Sequence ROI											
			Offset		Gain Selector	Exposure Time	Black Level	Binning		LUT Enable	Frame Count	Next Index
Sequence ROI Index	Width	Height	X	Y	Gain (ALL)			Horizontal	Vertical			
- Index 1	2560	2048	0	0	100	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 2	2560	2048	0	0	100	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 3	2560	2048	0	0	100	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index (n)	2560	2048	0	0	100	180000	0	1 (Off)	1 (Off)	Off	1	Index 1
- Index 128	2560	2048	0	0	100	180000	0	1 (Off)	1 (Off)	Off	1	Index 1

Descriptions of Index Table Parameters

Sequence Mode Command

Command	Parameter	Description
Sequence ROI Index	Index 1 ~ 128	Select an index to be set
Sequence ROI Frame Count	1 ~ 255	<Set to each Index> Set fame number for display per a frame
SequenceROINextIndex	Index 1 ~ 128	<Set to each Index> The next Index to be executed after the currently executed Index table can be set.
Sequence ROI Width	8 ~ 2560*	<Set to each Index> Set the width value
Sequence ROI Height	1 ~ 2048*	<Set to each Index> Set the height value
Sequence ROI Offset X	0 ~ 2560*- [Sequence ROI Width]	<Set to each Index> Set the offset value.
Sequence ROI Offset Y	0 ~ 2048* – [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 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 the same value for all Indexes> 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	1, 2, 4 (3 is disable)	<Set the same value for all Indexes> Set the H Binning value.
Sequence ROI V Binning	1, 2, 4 (3 is disable)	<Set the same value for all Indexes> Set the V Binning value.
Command Sequence Index	Index 0 ~ 127	<For Command Sequence Mode> Set the performed index.
Current Sequence Index	Index 0~ 127	<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: *If the binning mode is used, the maximum value is changed.

Multi ROI Function

Related Setting Items: JAI Custom

This function divides one frame image into a maximum of 5 images vertically and reads out all areas in one frame. In this function, width is the same for all 5 images. In the GO-5000M-PMCLUV, image overlapping is not possible.

Multi ROI setting

- Video Send Mode: Set to Multi ROI

Multi ROI Index table default values

Multi ROI Index table default values

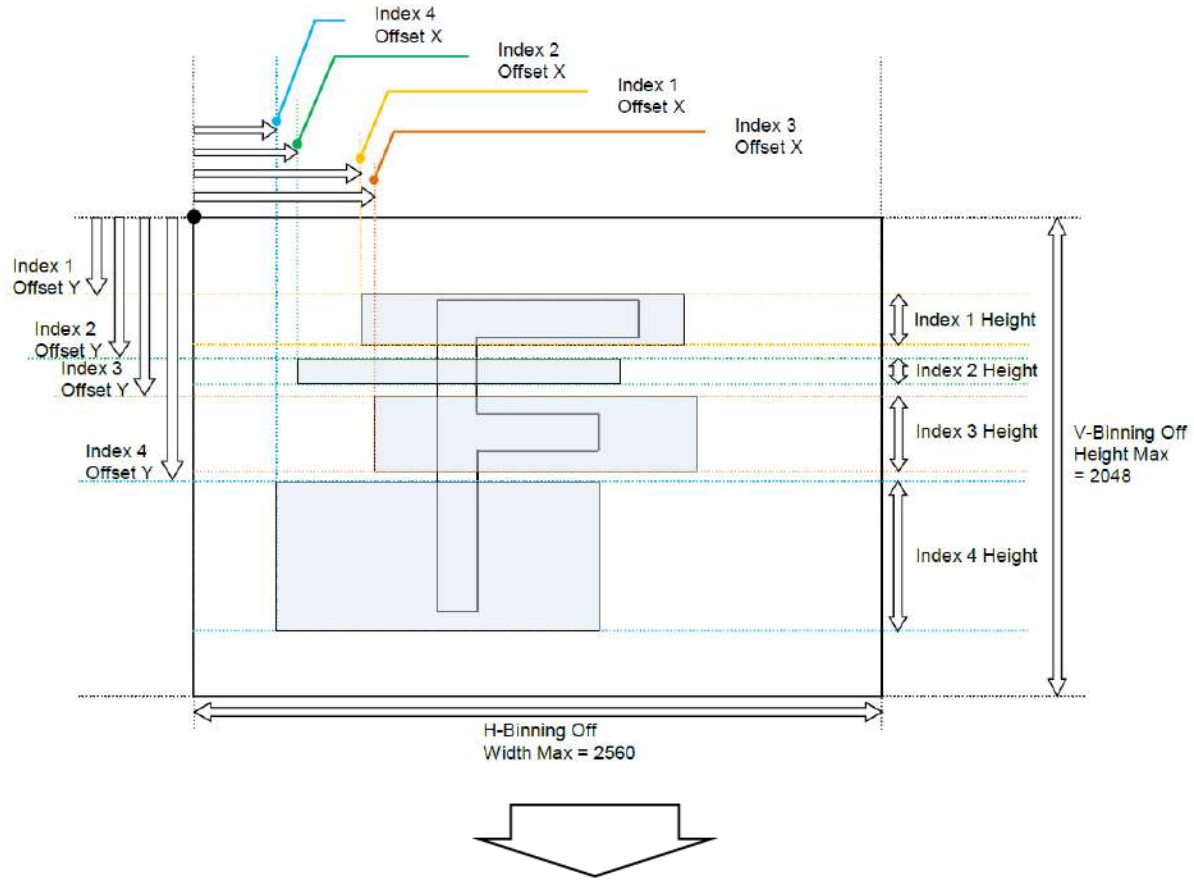
Multi ROI Index Max	5		
Multi ROI Width	2560		
Multi ROI Index Selector	Multi ROI		
	Height	Offset X	Offset Y
- Index 1	1024	0	0
- Index 2	2	0	0
- Index 3	2	0	0
- Index 4	2	0	0
- Index 5	2	0	0

Multi ROI Setting Command

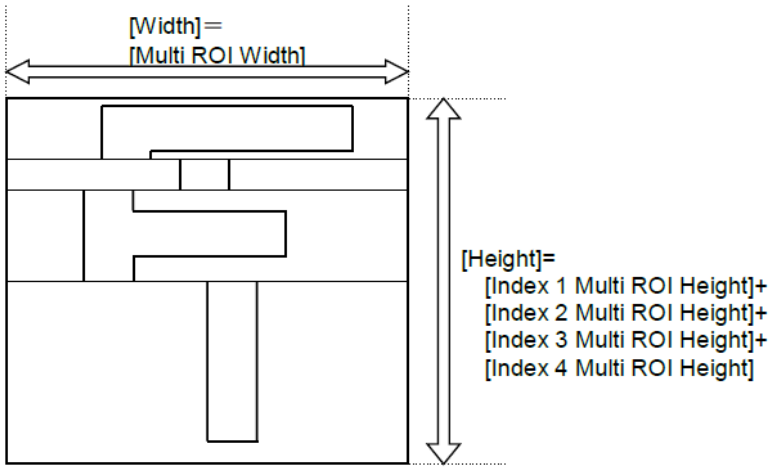
Command	Parameter	Description
Multi ROI Index	Index 1 ~ 5	Select index table to be set
Multi ROI Width	8 ~ 2560*	<Common for all indexes> Set the width value to be used in Multi ROI Mode
Multi ROI Height	1 ~ 2048*	<Set to each Index> Set the height value
Multi ROI Offset X	0 ~ 2552* - [Sequence ROI Width]	<Set to each Index> Set the offset X value
Multi ROI Offset Y	0 ~ 2047* - [Sequence ROI Height]	<Set to each Index> Set the offset Y value
Multi ROI Index Max	1 ~ 5	Set the index number to be used.

Note: *In the binning mode, the maximum value is changed.

ROI setting explanation if Multi ROI Index Max is set to 4



Video output of Multi ROI



Note: In this mode, the frame grabber board must set its horizontal pixel number to Multi ROI Width and its vertical pixels to Multi ROI Max and the sum of Multi ROI Height.

Operation and Function Matrix

Exposure Operation	Trigger Mode	Trigger Option	Binning Vertical	Binning Horizontal	Exposure Time	ROI	Auto Gain	Auto Exposure	Over lap	Vide Send Mode	
										Multi ROI	Sequence ROI
OFF	OFF	OFF	1	1		✓	✓			✓	
			2	2		✓	✓			✓	
Timed	OFF	OFF	1	1	✓	✓	✓	✓		✓	
			2	2	✓	✓	✓	✓		✓	
Timed	ON	OFF	1	1	✓	✓	✓	✓	✓	✓	✓
			2	2	✓	✓	✓	✓	✓	✓	✓
Trigger Width	ON	OFF	1	1		✓	✓		✓	✓	
			2	2		✓	✓		✓	✓	
Timed (RCT)	ON	RCT	1	1	✓	✓	✓	✓		✓	
			2	2							

✓ : Supported
Empty: Not Supported

Black Level Control

Related Topic: Adjust the Black Level

Related Setting Items: Analog Control

This function adjusts the setup level.

Reference Level	33.5LSB
Video Level Variable Range	0 ~ approx.100 LSB
Variable Range	-256 ~ 255 (Default: 0)
Resolution	1STEP=0.25LSB

Gain Control

> **Related Setting Items:** Analog Control

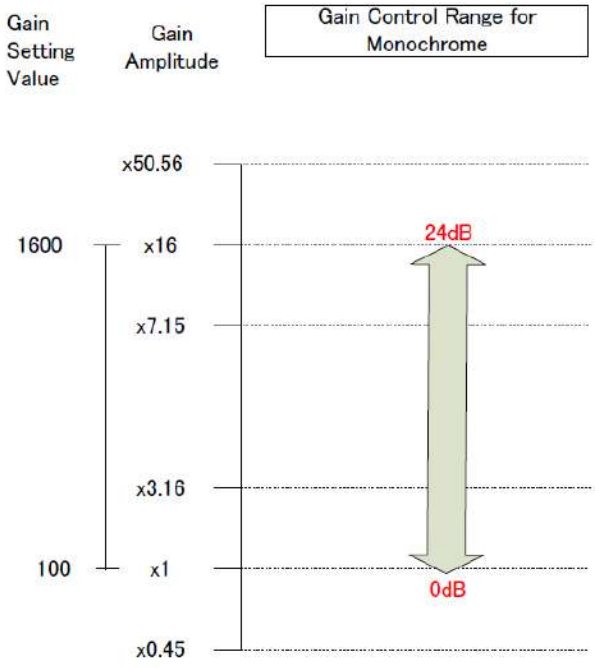
On this camera, the gain control uses Analog Base Gain and Digital Gain. Analog Base Gain can be set at 0dB, +6dB or +12dB. The digital gain is used for the master gain setting.

Analog base gain

Analog base gain can be selected from 0dB, 6dB and 12dB.

Gain

The master gain (DigitalAll) can be set x1 (0dB) to x16 (+24dB) against the analog base gain. The resolution for gain setting is 0.01%/step which is 0.05dB to 0.08dB, depending on the setting value.



Gain Selector

The following parameters can be set.

- Digital All

Gain

The range for adjustment: Digital All: 1 ~ 16 (x1 (0dB) ~ x16 (+24dB))

Gain Raw

The range for adjustment: Gain Raw Digital All: 100 ~ 1600 (0dB ~ 24dB)

This provides automatic control of the gain level.

Gain Auto

This provides automatic control of the gain level. This is controlled by the command JAI ALC Reference.

- OFF: Adjust manually.
- 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 Exposure Auto)
- 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 Exposure Auto)
- ALC Area Selector: The measurement area of GainAuto control can be set. (Common with Exposure Auto)
- ALC Area Enable: Determine the use of selected ALC area. This can enable its use area by area. If ALC Area Enable All is set to “True”, all areas are enabled. In this case, the setting area by area is disabled.

ALC Channel Area

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

LUT (Lookup Table)

> **Related Setting Items:** LUT Control

This function can be used to convert the input to the desired output characteristics. The Lookup Table (LUT) has 32 points for setup on this camera. The output level is created by applying gain to the input level to achieve the specified output level.

LUT Mode

Can be set to OFF, gamma, or Lookup Table. If Lookup Table is selected, the dark compression is forced to be OFF.

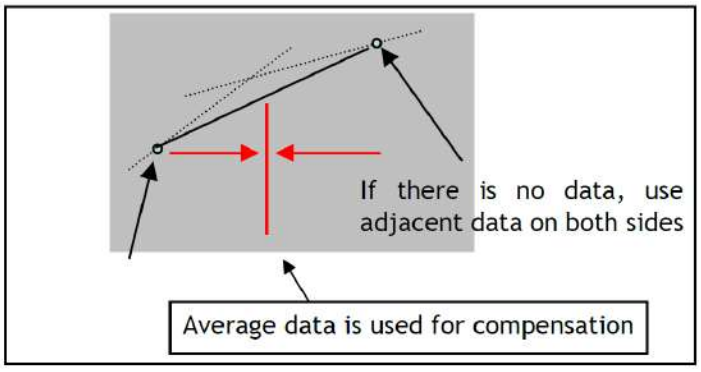
LUT Index

This represents the “starting” or “input” pixel value to be modified by the Lookup Table. This camera has a 32-point Lookup Table. Thus, on this camera, 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.

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.

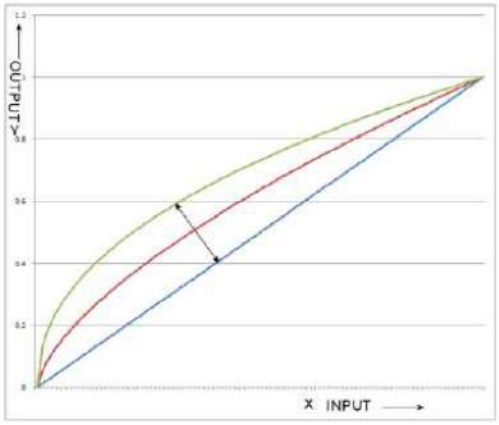
> **Note:** *The LUT must have a positive slope, i.e., the value for each index must be greater than the previous index. If the value for an index is set ≤ one or more previous indexes, those indexes will be automatically adjusted to maintain a positive slope.



Gamma

> **Note:** JAI Custom

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.

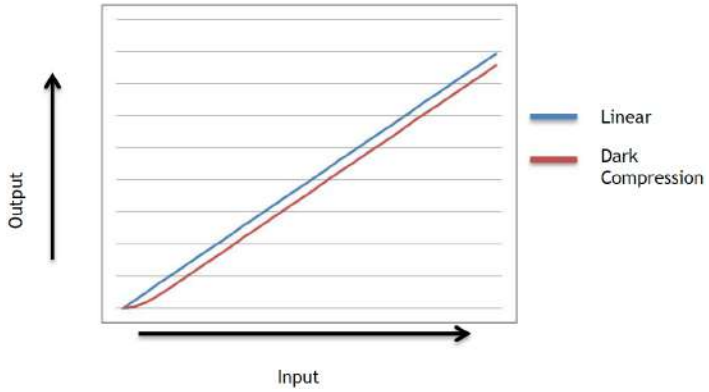


Linear and Dark Compression

This camera has a dark compression circuit to improve the signal-to-noise ratio in the dark portion of the image.

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.

The following drawing is characteristics of linear and dark compression.



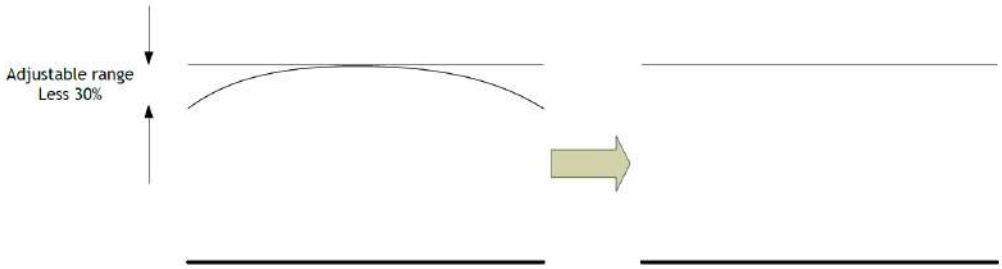
Shading Correction

Related Setting Items: JAI Custom

This function compensates for shading (non-uniformity) caused by the lens or the light source used. This compensation can be performed even if shading issues are not symmetrical in horizontal and/or vertical directions. There are two methods of correction.

Flat Shading Correction:

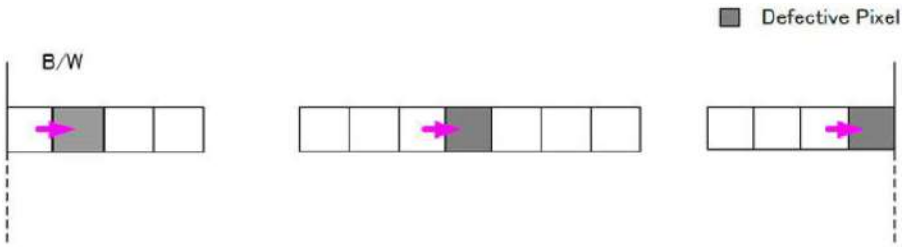
The method to compensate the shading is to measure the highest luminance level in the image and use that data as the reference. Luminance levels of other areas are then adjusted so that the level of the entire area is equal. The block grid for compensation is 20 (H) x 16(V) and each block contains 128 x 128 pixels. The complementary process is applied to produce the compensation data with less error.



Blemish Compensation

This camera has a blemish compensation circuit. This function compensates blemishes on the CMOS sensor (typically pixels with extremely high response or extremely low response). Pixels that fulfill the blemish criteria can be compensated by averaging the data from the pixel in the left adjacent column.

This camera has automatic blemish detection function. After setting the threshold, and then 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.

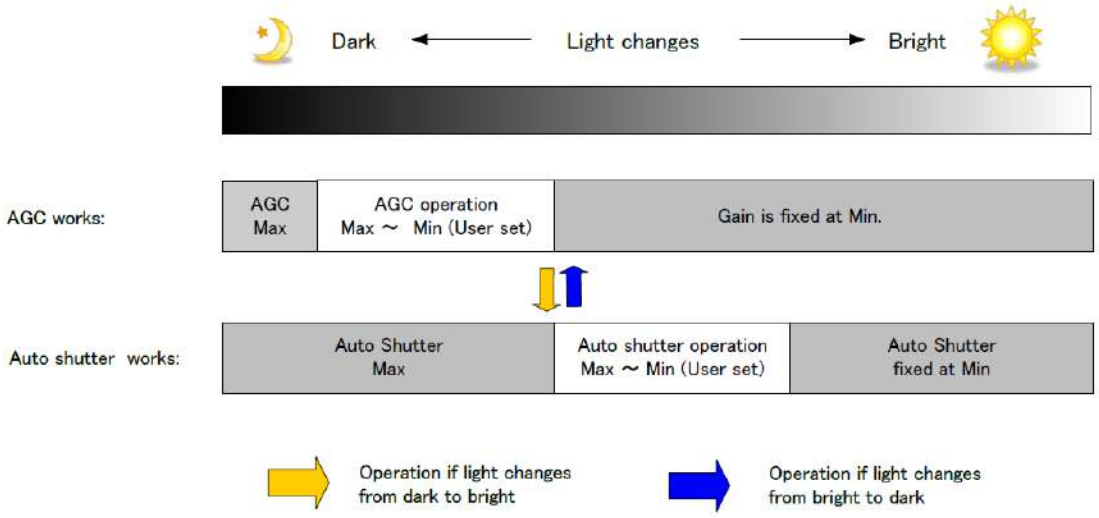


ALC (Automatic Level Control)

Related Setting Items: JAI Custom

On this camera, 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



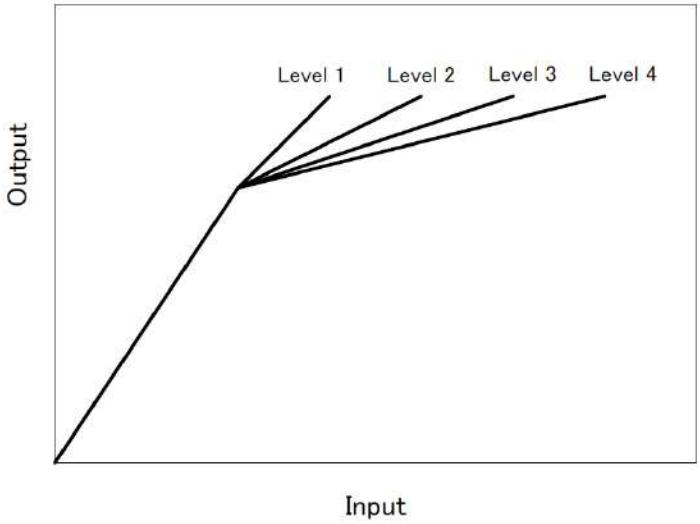
HDR (High Dynamic Range)

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:

- If the exposure mode is OFF and the HDR mode is set to ON, the exposure mode is automatically changed to Timed.
- 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.
- In this mode, exposure overlapped behavior is not available and the frame rate is slower than normal operation.
- 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.
- In this mode, Exposure Auto function is disabled.



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

Short ASCII Command List

This chapter describes the communication control protocol based on the short ASCII command as the reference.

Communication Setting

Baud Rate: 9600 (Default)

Data Length: 8bit

Start Bit: 1bit

Stop Bit: 1 bit

Parity: None

Xon/Xoff Control: None

Protocol (Short ASCII Command)

Transmit the setting command to camera

NN is any kind of the command.

NN=[Param.]<CR><LF>

Send to camera: GA=0 <CR><LF>

Camera response: COMPLETE<CR><LF>

When camera receives a valid command, camera will return 'COMPLETE'. If camera receives an invalid command, camera will return following:

Send to camera: GAX=0 <CR><LF>

Camera response: 01 Unknown Command!!<CR><LF>

Send to camera: GA=1000 <CR><LF>

Camera response: 02 Bad Parameters!!<CR><LF>

Transmit the request command to camera

The status of camera's settings can be queried by transmitting NN?<CR><LF>, where NN is any valid command.

The camera will return the current setting data.

Send to camera: GA? <CR><LF>

Camera response: GA=0<CR><LF>

Switching baud rate between PC and camera

Camera always starts up with 9600bps. This can be switched to higher baud rates after a communication has been established. When switching to other baud rate the procedure is as follows.

e.g. Change baud rate to 115200bps

1. Confirm baud rates camera supported
   Send to camera: SBDRT? <CR><LF>
   Camera response: SBDRT=31(0x1F)<CR><LF>
2. Request new baud rate 115200bps
   Send to camera: CBDRT=16(0x10) <CR><LF>
   Camera response: COMPLETE<CR><LF>
3. Rewrite new baud rate again with new baud rate (Confirmation command)
   Send to camera: CBDRT=16(0x10) <CR><LF>
   Camera response: COMPLETE<CR><LF>

In case the camera does not receive the confirming command with new baud rate within 250ms after sending the acknowledge it falls back to the original baud rate (9600bps).

GenCP Bootstrap Register

Name	Access	Short ASCII	Values	Default	Description
DeviceVendorName	R/O	DVN	"JAI Ltd., Japan"	-	DVN?<CR><LF>
DeviceModelName	R/O	MD		-	MD?<CR><LF>
DeviceVersion	R/O	DV	Indicate device version (e.g. “0.1.0.0”)	-	DV?<CR><LF>
DeviceID	R/O	ID	Serial Number	-	ID?<CR><LF>
DeviceUserID	R/W	UD	User can save and load free text. (12 or less characters)	-	UD= [Param.]<CR><LF> UD?<CR><LF>

Technology Specific Bootstrap Register

Related Topic: Short ASCII Command List

Name	Access	Short ASCII	Values	MIN	MAX	Default	Description
SupportedBaud rates	R/O	SBDRT	Indicate Support/Non-support status for each baud rate bit0: 9600bps bit1: 19200bps bit2: 38400bps bit3: 57600bps bit4: 115200bps	0x01	0xFF	0x1F	SBDRT?<CR><LF>
CurrentBaudrate	R/W	CBDRT	**READ**: Indicate current baud rate. **WRITE**: Set any bit of baud rate. bit0: 9600bps bit1: 19200bps bit2: 38400bps bit3: 57600bps bit4: 115200bps	0x01	0x80	1 (9600bps)	CBDRT=[Param.]<CR><LF> CBDRT?<CR><LF> In case of WRITE execution (change baud rate), it needs to control in the proper sequence between Host and Camera.

Device Control

Name	Interface Access	Short ASCII	Values	Default	Description
DeviceFirmware Version	R/O	VN	Firm Ver. No.	-	VN?<CR><LF>
DeviceReset	W/O	CRS00	1	-	CRS00=1<CR><LF>

Image Format Control

Related Topic: Configure the Output Format

Name	Access	Short ASCII	Values	Default	Description
Height	R/W	HTL	1 ~ (2048 - OffsetY)	2048	HTL=[Param.]<CR>< LF> HTL?<CR><LF>
Width	R/W	WTC	8 ~(2560 - OffsetY)	2560	WTC=[Param.]<CR><LF> WTC?<CR><LF>
Offset Y	R/W	OFL	0 ~ (2047 – Height)	0	OFL=[Param.]<CR><LF> OFL?<CR><LF>
Offset X	R/W	OFC	0 ~ (2552 – Width)	0	OFC=[Param.]<CR><LF> OFC?<CR><LF>
Binning Horizontal	R/W	HB	1: Normal 2: Binning 2 mode 4: Binning 4 mode	1	HB=[Param.]<CR><LF> HB?<CR><LF>
Binning Vertical	R/W	VB	1: Normal 2: Binning 2 mode 4: Binning 4 mode	1	VB=[Param.]<CR><LF> VB?<CR><LF>
PixelFormat	R/(W)	BA	0: Mono8 1: Mono10 2: Mono12	0	BA=[Param.]<CR><LF > BA?<CR><LF>
TestImage Selector	R/W	TPN	0: Off 1: GreyHorizontal Ramp 2: GreyVertical Ramp 3: GreyHorizontal RampMoving	0	TPN=[Param.]<CR><LF> TPN?<CR><LF>

Acquisition Control

Related Topic: Trigger Control,Exposure Settings

Name	Access	Short ASCII	Values	Default	Description
FrameStartTrig Mode	R/W	TM	0: Off 1: On	0	TM=[Param.]<CR><LF> TM?<CR><LF>
TriggerSoftware	(R)/W	STRG	0, 1	-	STRG=0<CR><LF>
FrameStartTrig Source	R/W	TI	0: Low 1: High 2: SoftTrigger 8: PulseGenerator0 13: CL_CC1_In 14: Nand0 15: Nand1	0	TI=[Param.]<CR><LF> TI?<CR><LF>
FrameStartTrig Activation	R/W	TA	0: RisingEdge 1: FallingEdge 2: LevelHigh 3: LevelLow	0	TA=[Param.]<CR><LF> TA?<CR><LF>
ExposureMode	R/W	EM	0: Off 1: Timed 2: TriggerWidth	0	EM=[Param.]<CR><LF> EM?<CR><LF>
ExposureTime Raw	R/W	PE	10 ~ 8000000[us]	18000	PE=[Param.]<CR><LF> PE?<CR><LF>
ExposureAuto	R/W	ASC	0: Off 1: Continuous	0	ASC=[Param.]<CR><LF> ASC?<CR><LF>

Analog Control

> **Related Topic:** Gain Control, Black Level Control

Name	Access	Short ASCII	Values	Default	Description
GainRawDigitalAll	R/W	FGA	100 ~1600	100	FGA=[Param.]<CR><L F> FGA?<CR><LF>
AnalogBaseGainAll	R/W	ABALL	0: 0dB 1: 6dB 2:12dB	0	ABALL=[Param.]<CR><L F> ABALL?<CR><LF>
GainAuto	R/W	AGC	0: Off 1: Continuous	0	AGC=[Param.]<CR><L F> AGC?<CR><LF>
BlackLevelRaw All	R/W	BL	-256 ~ 255	0	BL=[Param.]<CR><L F> BL?<CR><LF>

Digital IO Control

Related Topic: Digital IN/OUT Interface

Name	Access	Short ASCII	Values	Default	Description
LineInverter_Nand0In1	R/W	ND0INV1	0: False 1: True	0	ND0INV1=[Param.]<CR><LF> ND0INV1?<CR><LF>
LineInverter_Nand0In2	R/W	ND0INV2	0: False 1: True	0	ND0INV2=[Param.]<CR><LF> ND0INV2?<CR><LF>
LineInverter_Nand1In1	R/W	ND1INV1	0: False 1: True	0	ND1INV1=[Param.]<CR><LF> ND0INV1?<CR><LF>
LineInverter_Nand1In2	R/W	ND1INV2	0: False 1: True	0	ND1INV2=[Param.]<CR><LF> ND0INV2?<CR><LF>
LineSource_Line1	R/W	LS0	0: Low 1: High 3: Frame TriggerWait 4: Frame Active 5: Exposure Active 6: Fval 7: Lval 8: Pulse Generator0 13: CL_CC1_In 14: Nand0 15: Nand1	0	LS0=[Param.]<CR><LF> LS0?<CR><LF> For 12pin TTL out
LineSource_Nand0In1	R/W	ND0IN1	Same as for LS0	0	ND0IN1=[Param.]<CR><LF> ND0IN1?<CR><LF>
LineSource_Nand0In2	R/W	ND0IN2	Same as for LS0	0	ND0IN2=[Param.]<CR><LF> ND0IN2?<CR><LF>
LineSource_Nand1In1	R/W	ND1IN1	Same as for LS0	0	ND1IN1=[Param.]<CR><LF> ND1IN1?<CR><LF>
LineSource_Nand1In2	R/W	ND1IN2	Same as for LS0	0	ND1IN2=[Param.]<CR><LF> ND1IN2?<CR><LF>

LUT Control

Related Topic: LUT (Lookup Table)

Name	Access	Short ASCII	Values	Default	Description
LUTValueGreen (Mono)	R/W	LUTG	Param 1: LUT index (0 ~ 31) Param 2: LUTdata (0 ~ 4095)	γ=1 Equivalent	LUTG=[Param1],[Param2]<CR><LF> LUTG?[Param1]<CR>< LF>

Transport Layer Control

Related Topic: Camera Output Format (Tap Geometry)

Name	Access	Short ASCII	Values	Default	Description
DeviceTap Geometry	R/(W)	TAGM	1: Geometry_1X2_1Y 3: Geometry_1X4_1Y 5: Geometry_1X8_1Y 7: Geometry_1X3_1Y	5	TAGM=[Param.]<CR><LF> TAGM?<CR><LF>

User Set Control

> **Related Topic:** Step 6: Save the Settings

Name	Access	Short ASCII	Values	Default	Description
UserSetLoad	(R)/W	LD	0: Default 1: UserSet1 2: UserSet2 3: UserSet3	0	LD=[Param.]<CR><LF> LD?<CR><LF>
UserSetSave	(R)/W	SA	1: UserSet1 2: UserSet2 3: UserSet3	1	SA=[Param.]<CR><LF> SA?<CR><LF>

JAI Custom

Name	Access	Short ASCII	Values	Default	Description
AcquisitionFrame Period	R/W	AR	1 ~ 325786[us]	11961	AR=[Param.]<CR><LF> AR?<CR><LF> Maximum value is calcurated depending on Height and Offset Y settings
BlemishWhite Enable **Related Topic:** Blemish Compensation	R/W	BMW	0: False 1: True	0	BMW=[Param.]<CR><LF> BMW?<CR><LF>
BlemishWhite Detect	W/O	BMRCW	1	-	BMRCW=1<CR><LF>
BlemishWhite Detect Threshold	R/W	BMTHW	0 ~ 100 [%]	10	BMTHW=[Param.]<CR><LF> BMTHW?<CR><LF>
BlemishWhite DetectPositionX	R/W	BMPXW	Param 1: Blemish index Param 2: Y position (0 ~ 2559)	0	BMPXW=[Param1], [Param2] <CR><LF> BMPXW? [Param1]<CR><LF>
BlemishWhite DetectPositionY	R/W	BMPYW	Param 1: Blemish index Param 2: Y position (0 ~ 2047)	0	BMPYW=[Param1], [Param2] <CR><LF> BMPYW? [Param1]<CR><LF>

Name	Access	Short ASCII	Values	Default	Description
ShadingCorrection Mode **Related Topic:** Shading Correction	R/W	SDCM	0: Flat Shading	0	SDCM=[Param.]<CR><LF> SDCM?<CR><LF>
ShadingCorrect	W/O	RS		0	RS=0<CR><LF>
RequestShading DetectResult	R/O	SDRS	0=Complete. 1=Too Bright. 2=Too dark 3=Timeout Error 4=Busy. 5=Limit. 6= Trig is not set as Normal.	0	SDRS?<CR><LF>
ShadingMode	R/W	SDM	0: Off 1: UserSet1 2: UserSet2 3: UserSet3	0	SDM=[Param.]<CR>< LF> SDM?<CR><LF>
VideoSendMode **Related Topic:** Sequence Mode	R/W	VSM	0: Normal 1: Trigger Sequence 2: Command Sequence 3: Multi Roi Mode	0	VSM=[Param.]<CR><LF> VSM?<CR><LF>
SequenceROI FrameCount(n) (n) = 1 = 128	R/W	SQF(n)	1 ~ 255	1	SQF(n)=[Param.]<CR><LF> SQI(n)?<CR><LF>
SequenceROI NextIndex(n) (n)= 1 = 128	R/W	SQNI(n)	1 ~ 128	0	SQNI(n)=[Param.]<CR><LF> SQNI(n)?<CR><LF>
SequenceROI Width (n) (n) = 1 ~ 128	R/W	SQW(n)	8 ~ 2560	2560	SQW(n)=[Param.]<CR><LF> SQW(n)?<CR><LF>
SequenceROI OffsetX(n) (n) = 1 ~ 128	R/W	SQOXn	0 ~ 2552	0	SQOXn=[Param.]<CR><LF> SQOXn?<CR><LF>
SequenceROI Height (n) (n) = 1 ~ 128	R/W	SQH(n)	1 ~ 2048	2048	SQH(n)=[Param.]<CR><LF> SQH(n)?<CR><LF>

Name	Access	Short ASCII	Values	Default	Description
SequenceROI OffsetY(n) (n) = 1 ~ 128	R/W	SQOY(n)	0 ~ 2047	0	SQOY(n)=[Param.]<CR><LF> SQOY(n)?<CR><LF>
SequenceROI Gain (n) (n) = 1 ~ 128	R/W	SQGA(n)	100 ~1600	0	SQGA(n)=[Param.]<CR><LF> SQGA(n)?<CR><LF>
SequenceROI ExposureTime(n) (n) = 1 ~ 128	R/W	SQPE(n)	10 ~ 8000000	18000	SQPE(n)=[Param.]<CR> SQPE(n)?<CR><LF>
SequenceROI Hbinning(n) (n) = 1 ~ 128	R/W	SQHB(n)	1: Hbinning = OFF 2: Hbinning = x2 4: Hbinning = x4	1	SQHB(n)=[Param.]<CR><LF> SQHB(n)?<CR><LF>
SequenceROI Vbinning(n) (n) = 1 ~ 128	R/W	SQVB(n)	1: Vbinning = OFF 2: Vbinning = x2 4: Vbinning = x4	1	SQVB(n)=[Param.]<CR><LF> SQVB(n)?<CR><LF>
SequenceROI LutEnable(n) (n) = 1 ~ 128	R/W	SQLUT(n)	0: Off 1: On	0	SQLUT(n)=[Param.]<CR><LF> SQLUT(n)?<CR><LF>
SequenceROI BlackLevel(n) (n) = 1 ~ 128	R/W	SQBL(n)	-256 ~ 255	0	SQBL(n)=[Param.]<CR><LF> SQBL(n)?<CR><LF>
CommnadSequence Index	R/W	CSQI	0 ~ 127	0	CSQI=[Param.]<CR><LF> CSQI?<CR><LF>
CurrentSequence Index	R/O	SQIDX	0 ~ 127	0	SQIDX?<CR><LF>
SequenceReset	W/O	SQRST	0	0	SQRST=[Param.]<CR><LF>
SequenceLutMode	R/W	SQLUT	0: Gamma 1: LUT	0	SQLUT=[Param.]<CR><LF> SQLUT?<CR><LF>
MultiRoiIndexMax **Related Topic:** Multi ROI Function	R/W	MRIM	1 ~ 5	1	MRIM=[Param.]<CR><LF> MRIM?<CR><LF>
MultiRoiWidth	R/W	MRW	8 ~ 2560	2560	MRW=[Param.]<CR><LF> MRW?<CR><LF>
MultiRoiHeight1	R/W	MRH1	0 ~ 2048	2048	MRH1=[Param.]<CR><LF> MRH1?<CR><LF>

Name	Access	Short ASCII	Values	Default	Description
MultiRoiHeight2	R/W	MRH2	0 ~ 2048	2	MRH2=[Param.]<CR><LF> MRH2?<CR><LF>
MultiRoiHeight3	R/W	MRH3	0 ~ 2048	2	MRH3=[Param.]<CR><LF> MRH3?<CR><LF>
MultiRoiHeight4	R/W	MRH4	0 ~ 2048	2	MRH4=[Param.]<CR><LF> MRH4?<CR><LF>
MultiRoiHeight5	R/W	MRH5	0 ~ 2048	2	MRH5=[Param.]<CR><LF> MRH5?<CR><LF>
MultiRoiOffsetX1	R/W	MROX1	0 ~ 2559	0	MROX1=[Param.]<CR><LF> MROX1?<CR><LF>
MultiRoiOffsetX2	R/W	MROX2	0 ~ 2559	0	MROX2=[Param.]<CR><LF> MROX2?<CR><LF>
MultiRoiOffsetX3	R/W	MROX3	0 ~ 2559	0	MROX3=[Param.]<CR><LF> MROX3?<CR><LF>
MultiRoiOffsetX4	R/W	MROX4	0 ~ 2559	0	MROX4=[Param.]<CR><LF> MROX4?<CR><LF>
MultiRoiOffsetX5	R/W	MROX5	0 ~ 2559	0	MROX5=[Param.]<CR><LF> MROX5?<CR><LF>
MultiRoiOffsetY1	R/W	MROY1	0 ~ 2047	0	MROY1=[Param.]<CR><LF> MROY1?<CR><LF>
MultiRoiOffsetY2	R/W	MROY2	0 ~ 2047	0	MROY2=[Param.]<CR><LF> MROY2?<CR><LF>
MultiRoiOffsetY3	R/W	MROY3	0 ~ 2047	0	MROY3=[Param.]<CR><LF> MROY3?<CR><LF>
MultiRoiOffsetY4	R/W	MROY4	0 ~ 2047	0	MROY4=[Param.]<CR><LF> MROY4?<CR><LF>
MultiRoiOffsetY5	R/W	MROY5	0 ~ 2047	0	MROY5=[Param.]<CR><LF> MROY5?<CR><LF>
LUTMode **Related Topic:** LUT (Lookup Table)	R/W	LUTC	0: Off 1: Gamma 2: LUT	0	LUTC=[Param.]<CR><LF> LUTC?<CR><LF>
AlcSpeed **Related Topic:** ALC (Automatic Level Control)	R/W	ALCS	1 ~ 8	4	ALCS=[Param.]<CR><LF> ALCS?<CR><LF> for AGC and ASC

Name	Access	Short ASCII	Values	Default	Description
ExposureAutoMax **Related Topic:** Exposure Settings	R/W	ASCEA	101 ~ 8000000[us]	18000	ASCEA=[Param.]<CR><LF> ASCEA?<CR><LF> Maximum value is varied depending on frame rate.
ExposureAutoMin	R/W	ASCEI	100 ~ 7999999	100	ASCEI=[Param.]<CR>< LF> ASCEI?<CR><LF> Maximum value is varied depending on frame rate.
TriggerOption **Related Topic:** RCT Mode	R/W	TRGOP	0: Off 1: RCT	0	TRGOP=[Param.]<CR><LF> TRGOP?<CR><LF>
AlcReference **Related Topic:** ALC (Automatic Level Control)	R/W	AGCF	1 ~ 100[%]	50	AGCF=[Param.]<CR><LF> AGCF?<CR><LF>
GainAutoMax **Related Topic:** Gain Control	R/W	AGCGA	101 ~ 1600	1600	AGCGA=[Param.]<CR><LF> AGCGA?<CR><LF>
GainAutoMin	R/W	AGCGI	100 ~ 1599	100	AGCGI=[Param.]<CR>< LF> AGCGI?<CR><LF>
ALCChannelArea All **Related Topic:** ALC (Automatic Level Control)	R/W	ALCA	0: Off 1: On	0	ALCA=[Param.]<CR><LF> ALCA?<CR><LF>

<table>
<tr><th>Name</th><th>Access</th><th>Short ASCII</th><th>Values</th><th>Default</th><th>Description</th></tr>
<tr><td>ALCChannelArea</td><td>R/W</td><td>ALCLR
ALCLMR
ALCLML
ALCLL
ALCMLR
ALCMLMR
ALCMLML
ALMLL
ALCMHR
ALCMHMR
ALCMHML
ALMHL
ALCHR
ALCHMR
ALCHML
ALCHL</td><td>0: Off
1: On

Default: 1</td><td colspan="2">ALC***=[Param.]<CR><LF>
ALC***?<CR><LF>

16 Photometry Areas and Short ASCII Commands
<table><tr><td>ALCHL
(High Left)</td><td>ALCHML
(Hight Mid-Left)</td><td>ALCHMR
(High Mid-Right)</td><td>ALCHR
(High Right)</td></tr><tr><td>ALCMHL
(Mid-High Left)</td><td>ALCMHML
(Mid-Hight Mid-Left)</td><td>ALCMHMR
(Mid-High Mid-Right)</td><td>ALCMHR
(Mid-High Right)</td></tr><tr><td>ALCMLL
(Mid-Low Left)</td><td>ALCMLML
(Mid-Low Mid-Left)</td><td>ALCMLMR
(Mid-Low Mid-Right)</td><td>ALCMLR
(Mid-Low Right)</td></tr><tr><td>ALCLL
(Low Left)</td><td>ALCLML
(Low Mid-Left)</td><td>ALCLMR
(Low Mid-Right)</td><td>ALCLR
(Low Right)</td></tr></table></td></tr>
<tr><td>CurrentAreaNo Request</td><td>R/O</td><td>EA</td><td>0: Factory area
1: User 1 area
2: User 2 area
3: User 3 area</td><td>0</td><td>EA?<CR><LF>

The camera return the latest used DATA AREA.</td></tr>
<tr><td>GammaSelector

Related Topic:
Gamma</td><td>R/W</td><td>GMA</td><td>0(γ=0.45)
1(γ=0.6)
2(γ=1)</td><td>0</td><td>GMA=[Param.]<CR><LF>
GMA?<CR><LF></td></tr>
<tr><td>Temperature</td><td>R/O</td><td>TMP0</td><td>value</td><td>-</td><td>TMP0?<CR><LF>

(Value÷128)=Temperature[°C]</td></tr>
<tr><td>GpioPulseGen DivideValue

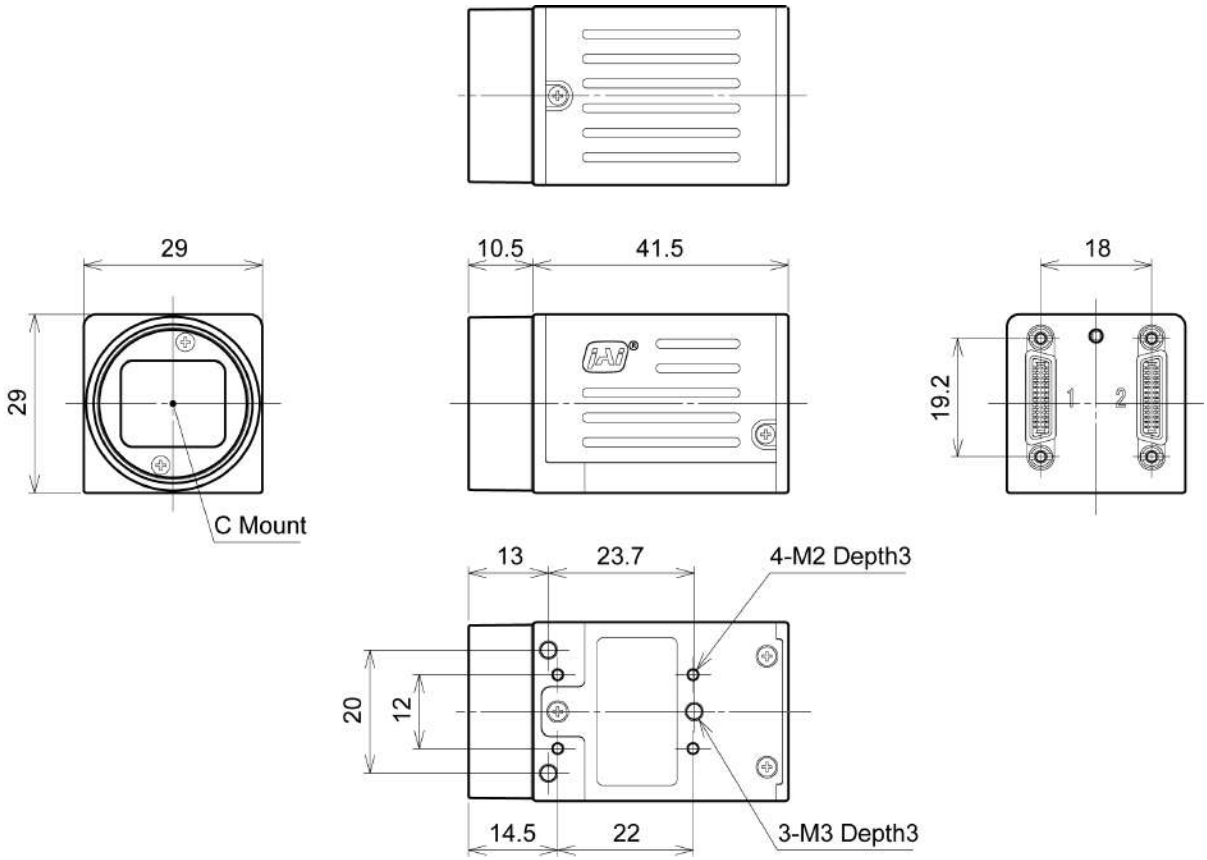
Related Topic:
Pulse Generator</td><td>R/W</td><td>PGDEV</td><td>1 ~ 4096</td><td>1</td><td>PGDEV=[Param.]<CR><LF>
PGDEV?<CR><LF></td></tr>
<tr><td>GpioPulseGen Length0</td><td>R/W</td><td>PGL</td><td>1 ~ 1048575</td><td>1</td><td>PGL=[Param.]<CR><LF>
PGL?<CR><LF></td></tr>
<tr><td>GpioPulseGen StartPoint0</td><td>R/W</td><td>PGST</td><td>0 ~ 1048575</td><td>0</td><td>PGST=[Param.]<CR><LF>
PGST?<CR><LF></td></tr>
<tr><td>GpioPulseGen EndPoint0</td><td>R/W</td><td>PGEN</td><td>1 ~ 1048575</td><td>1</td><td>PGEN=[Param.]<CR><LF>
PGEN?<CR><LF></td></tr>
<tr><td>GpioPulseGen RepeatCount0</td><td>R/W</td><td>PGRPT</td><td>0 ~ Max</td><td>0</td><td>PGRPT=[Param.]<CR><LF>
PGRPT?<CR><LF></td></tr>
</table>

Name	Access	Short ASCII	Values	Default	Description
GpioPulseGen ClearMode0	R/W	PGCM	0: Free Run 1: Level High 2: Level Low 3: Rising Edge 4: Falling Edge	0	PGCM=[Param.]<CR><LF> PGCM?<CR><LF>
GpioPulseGen SyncMode0	R/W	PGSM	0: Async Mode 1: Sync Mode	0	PGSM=[Param.]<CR><LF> PGSM?<CR><LF>
GpioPulseGenIn put0	R/W	PGIN	0: Low 1: High 2:Soft 3: AcquisitionTriggerWait 4: FrameTriggerWait 5: FrameActive 6: ExposureActive 7: Fval 8: Lval 15: Nand0 16: Nand1	0	PGIN=[Param.]<CR><LF> PGIN?<CR><LF>
GpioPulseGen Invert0	R/W	PGINV	0:Non-Inv 1:Inv	0	PGINV=[Param.]<CR><LF> PGINV?<CR><LF>
GpioNand0Input Source1 **Related Topic:** Digital IN/OUT Interface	R/W	IND0IN1	0: Low 1: High 2: FrameTriggerWait 3: FrameActive 4: ExposureActive 5: Fval 6: PulseGenerator0	0	IND0N1=[Param.]<CR><LF> IND0IN1?<CR><LF>
GpioNand1Input Source1	R/W	IND1IN1	Same as above.	0	IND1N1=[Param.]<CR><LF> IND1IN1?<CR><LF>
GpioNand0Input Source2	R/W	IND0IN2	0: Low 1: High 2: FrameTriggerWait 3: FrameActive 4: ExposureActive 5: Fval 6: PulseGenerator0	0	IND0N2=[Param.]<CR><LF> IND0IN2?<CR><LF>
GpioNand1Input Source2	R/W	IND1IN2	Same as above.	0	IND1N2=[Param.]<CR><LF> IND1IN2?<CR><LF>
GpioNand0Input Invert1	R/W	IND0INV1	0:Non-Inv 1:Inv	0	IND0INV1=[Param.]<CR><LF> IND0INV1?<CR><LF>

Name	Access	Short ASCII	Values	Default	Description
GpioNand1Input Invert1	R/W	IND1INV 1	Same as above.	0	IND1INV1=[Param.]<CR><LF> IND1INV1?<CR><LF>
GpioNand0Input Invert2	R/W	IND0INV 2	0:Non-Inv 1:Inv	0	IND0INV2=[Param.]<CR><LF> IND0INV2?<CR><LF>
GpioNand1Input Invert2	R/W	IND1INV 2	Same as above.	0	IND1INV2=[Param.]<CR><LF> IND1INV2?<CR><LF>
LUTSequencer	R/W	LUTSR	0 ~ 4095	0	LUTSR=[Param.]<CR>< LF> LUTSR?<CR><LF>
BlemishNum	R/O	BNUM	0 ~ 512	0	BNUM?<CR><LF>
CameraLink Cloc kFrequency **Related Topic:** Camera Link Interface	R/W	CLCF	0= 72.9MHz 1= 48.6MHz 2= 84.9MHz 3= 58.3MHz	0	CLCF=[Param.]<CR><LF> CLCF?<CR><LF>
DarkCompression **Related Topic:** Gamma	R/O	SBS	0: Linear 1: DarkCompression	0	SBS=[Param.]<CR><LF> SBS?<CR><LF>
BINNING_GAIN_ EN	R/W	BGOE	0: Off 1: On	0	BGOE =[Param.]<CR><LF> BGOE?<CR><LF>
HighDynamic RangeMode **Related Topic:** HDR (High Dynamic Range)	R/W	HES	0: Off 1: On	0	HES=[Param.]<CR><LF > HES?<CR><LF>
HighDynamic RangeSlope	R/W	HKS	0: Level1 1: Level2 2: Level3 3: Level4	0	HKS=[Param.]<CR><LF > HKS?<CR><LF>
VAB Low	R/W	VAB	96 ~ 191	163	VAB=[Param.]<CR><LF> VAB?<CR><LF> Decrease this value to improve brightness of image made darker despite increasing exposure time. **Caution:** When this value is decreased while **TapGeometry** is set to **1x2-1Y**, vertical stripes may appear in the lower half of the image.

Miscellaneous

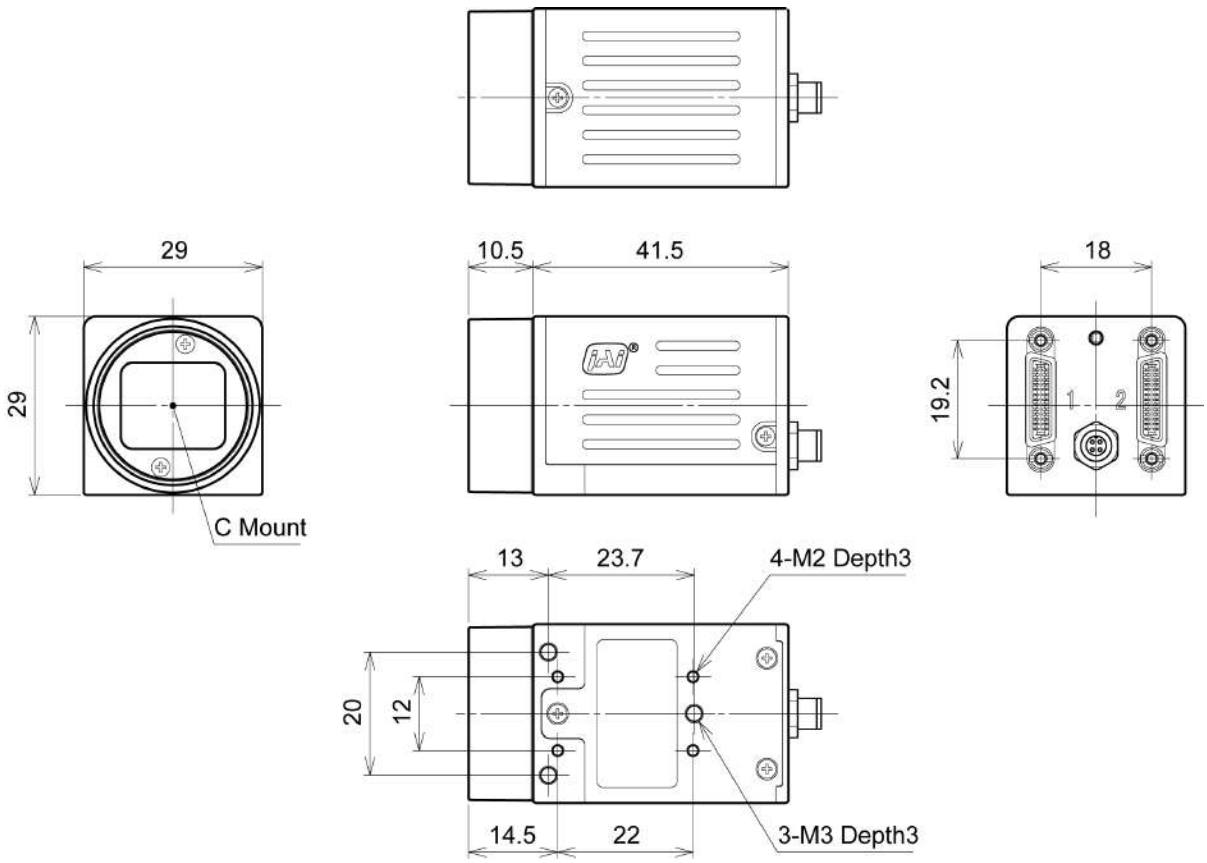
Dimensions: GO-5000M-PMCL



Notes:

- Dimensional tolerance: ± 0.3mm
- Unit: mm

Dimensions: GO-5000M-PMCL-EP and GO-5000M-PMCL-UV

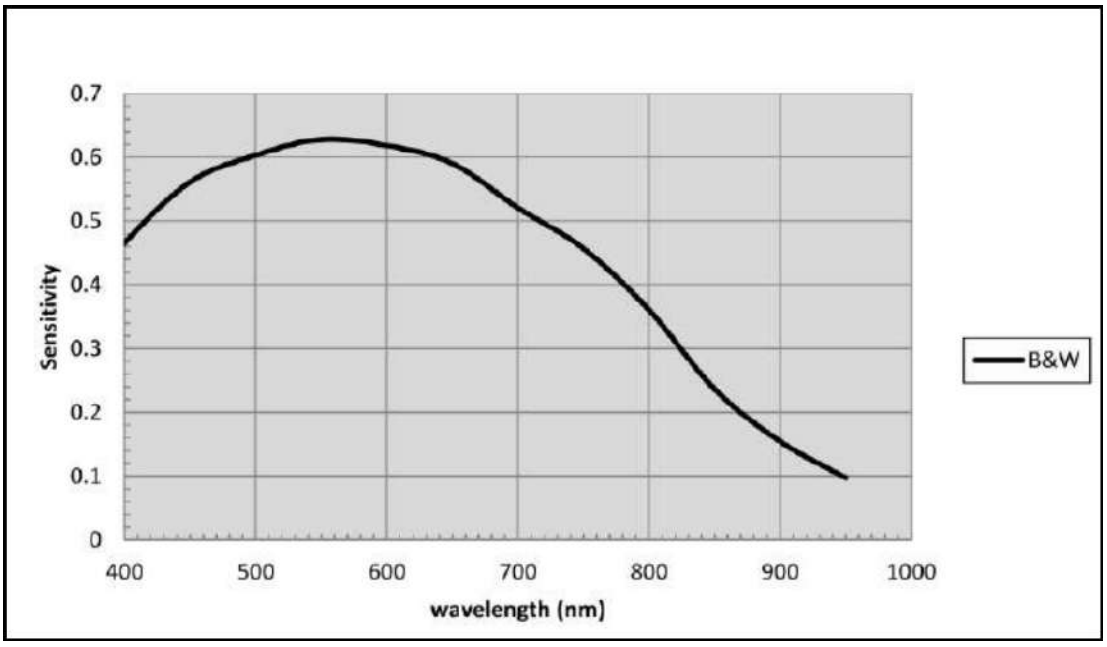


Notes:

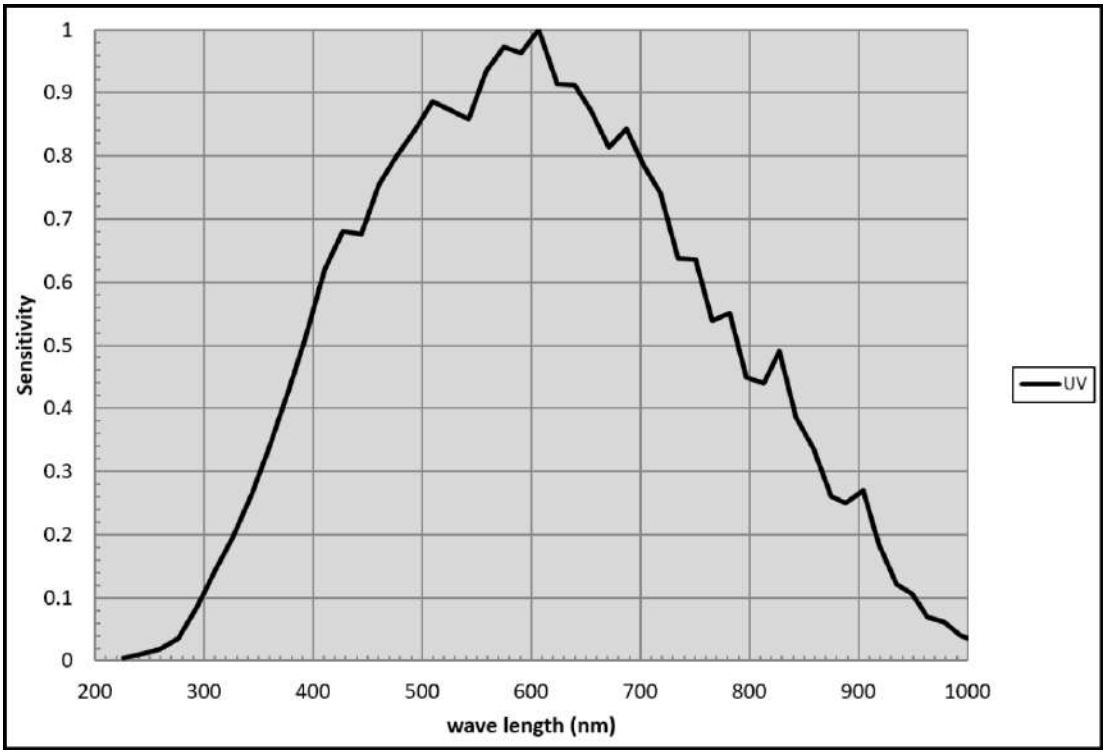
- Dimensional tolerance: ± 0.3mm
- Unit: mm

Spectral Response

GO-5000M-PMCL and GO-5000M-PMCL-EP



GO-5000M-PMCL-UV



Specifications

Specifications	Description		
Scanning system	Progressive scan		
Synchronization	Internal		
Interface	CameraLink Specifications (V.2.0), Conforming with PoCL specifications		
Image sensor	1-inch Monochrome 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)		
Sensor Pixel clock	8-bit: 36MHz, 10-bit: 2 8.8MHz, 12-bit: 24MHz		
Camera Link clock	48.57 MHz/8 Pixels (Camera Link Clock = Low) 58.28 MHz/8 Pixels (Camera Link Clock = Mid, only for X8-1Y-10bit) 72.85 MHz/8 Pixels (Camera Link Clock = Mid, High for 1X8-1Y-8bit) 84.99 MHz/8 Pixels (Camera Link Clock = High)		
Acquisition Frame Rate	Maximum frame rate shown. Minimum is 0.125fps in all instances.		
1X2–1Y 8/10/12-bit CL clock: HIGH	H1, V1		31.9fps
	Binning	H1, V2	63.4fps
		H1, V4	124.7fps
		H2, V1	62.9fps
		H2, V2	124.7fps
		H2, V4	245.6fps
		H4, V1	71.8fps
		H4, V2	245.6fps
		H4, V4	280.1fps
1X3–1Y 8-bit CL clock: HIGH	H1, V1		47.8fps
	Binning	H1, V2	95.0fps
		H1, V4	187.4fps
		H2, V1	71.8fps
		H2, V2	142.5fps
		H2, V4	281.1fps
		H4, V1	71.8fps
		H4, V2	142.5fps
		H4, V4	281.1fps

Specifications	Description		
1X4–1Y 8/10/12-bit CL clock: HIGH	H1, V1		63.6fps
	Binning	H1, V2	126.1fps
		H1, V4	248.2fps
		H2, V1	71.7fps
		H2, V2	142.3fps
		H2, V4	280.1fps
		H4, V1	71.7fps
		H4, V2	142.3fps
		H4, V4	280.1fps
1x8–1Y 8-bit CL Clock: HIGH	H1, V1		107.2fps
	Binning	H1, V2	212.3fps
		H1, V4	417.1fps
		H2, V1	107.1fps
		H2, V2	213.6fps
		H2, V4	417.0fps
		H4, V1	107.8fps
		H4, V2	213.6fps
		H4, V4	419.6fps
1x8–1Y 10-bit CL Clock: MID	H1, V1		84.9fps
	Binning	H1, V2	168.4fps
		H1, V4	330.7fps
		H2, V1	86.0fps
		H2, V2	170.4fps
		H2, V4	334.8fps
		H4, V1	86.0fps
		H4, V2	170.4fps
		H4, V4	334.8fps
SN ratio (traditional method)	Dark Compression:55dB (Typical) Linear:49dB (Typical) (0dB gain, Black))		
Image Output format Digital	Full pixels: 2560 (h) x 2048 (v)		

<table>
<tr><th>Specifications</th><th colspan="4">Description</th></tr>
<tr><td rowspan="8">Image Output Format Digital</td><td rowspan="4">ROI</td><td colspan="2">Width</td><td>8 ~ 2560 pixels, 8 pixels/step(1X2-1Y)
8 ~ 2560 pixels, 8 pixels/step(1X3-1Y)
8 ~ 2560 pixels, 8 pixels/step(1X4-1Y)
8 ~ 2560 pixels, 8 pixels/step(1X8-1Y)</td></tr>
<tr><td colspan="2">OFFSET X</td><td>0 ~ 2552 pixels, 8 pixels/step(1X2-1Y)
0 ~ 2552 pixels, 8 pixels/step(1X3-1Y)(Note1)
0 ~ 2552 pixels, 8 pixels/step(1X4-1Y)
0 ~ 2552 pixels, 8 pixels/step(1X8-1Y)</td></tr>
<tr><td colspan="2">Height</td><td>1 ~ 2047 lines,1 line/step</td></tr>
<tr><td colspan="2">OFFSET Y</td><td>0 ~ 2047 lines, 1 line/step</td></tr>
<tr><td rowspan="6">Binning</td><td rowspan="3">H</td><td>1</td><td>2560(H)</td></tr>
<tr><td>2</td><td>1280(H)</td></tr>
<tr><td>4</td><td>640(H)</td></tr>
<tr><td rowspan="3">V</td><td>1</td><td>2048(V)</td></tr>
<tr><td>2</td><td>1024(V)</td></tr>
<tr><td>4</td><td>512(V)</td></tr>
<tr><td colspan="3">Pixel Format</td><td>Mono8, Mono10, Mono12</td></tr>
<tr><td>Acquisition mode</td><td colspan="4">Continuous</td></tr>
<tr><td>Trigger selector</td><td colspan="4">Frame Start</td></tr>
<tr><td>Trigger mode</td><td colspan="4">Continuous, Timed (EPS), Trigger Width,</td></tr>
<tr><td>Trigger option</td><td colspan="4">RCT</td></tr>
<tr><td>Trigger Overlap</td><td colspan="4">Fixed to Readout</td></tr>
<tr><td>Trigger Input Signal</td><td colspan="4">Line7 (Camera link CC1), Pulse Generator 0, Soft Trigger, NAND0 (out), NAND1 (out)</td></tr>
<tr><td>Exposure Mode</td><td>Timed</td><td colspan="3">Auto Exposure OFF: 10 µs (Min) ~ 8 sec. (Max)(Note2), Step: 1µs</td></tr>
<tr><td></td><td>Trigger Width</td><td colspan="3">10 µs (Min) ~ ∞ (Max)(Note2)</td></tr>
<tr><td>Auto exposure</td><td colspan="4">OFF / Continuous</td></tr>
<tr><td>Auto Exposure Response Speed</td><td colspan="4">1 ~ 8</td></tr>
<tr><td>Video Send mode</td><td colspan="4">Normal, Multi ROI, Command Sequence</td></tr>
<tr><td>Digital I/O</td><td colspan="4">Line Selector: CC1 / NAND Gate 0 In1, In2 / NAND Gate 1 In1, In2</td></tr>
<tr><td>Black Level Adjust.</td><td colspan="2">Ref. level</td><td colspan="2">33.5LSB 10-bit</td></tr>
<tr><td></td><td colspan="2">Video level adj. range</td><td colspan="2">0 ~ approx. 100LSB</td></tr>
<tr><td></td><td colspan="2">Adj. range</td><td colspan="2">-256 ~ +255LSB 10-bit</td></tr>
<tr><td></td><td colspan="2">Resolution</td><td colspan="2">1 STEP = 0.25LSB</td></tr>
<tr><td>Analog Base Gain (For manual)</td><td colspan="4">x1 (0dB), x2 (+6dB), x4 (+12dB)</td></tr>
<tr><td>Gain Control</td><td colspan="4">Manual Adj. range: 0dB ~ +24dB, 1%/step (Note3)</td></tr>
<tr><td>Blemish Comp.</td><td>Detection</td><td colspan="3">Detect white blemish above the threshold value (Black blemish is detected only by factory)</td></tr>
<tr><td></td><td>Compensation</td><td colspan="3">Complement by adjacent pixels (Continuous blemishes are not compensated)</td></tr>
<tr><td></td><td>Numbers</td><td colspan="3">Up to 512 pixels</td></tr>
<tr><td>ALC</td><td colspan="4">AGC and Auto Shutter can be combined and automatically controlled</td></tr>
</table>

Specifications	Description		
Gamma	γ=0.45, 0.6, 1.0 (3 steps are available)		
LUT	OFF: γ=1.0, ON=32 points can be set		
Shading Compensation (Note1)	Flat field Block based (20 x 16 blocks)		
HDR	4 settings, Level 1, 2, 3 and 4		
Power supply	PoCL	Input range	DC+12V ± 1V (Complies with PoCL Standards)
		Current	250mA ± 20mA (12V input, full image)
		Power Consumption	3.0W (12V input, full image)
	4-pin Connector (EP/UV models only)	Input range	DC +12 V~ +24 V ± 10% (via input terminal)
		Power Consumption	2.88W (Typ) 12 V input
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		
Operating temperature/ Humidity Performance guaranteed	-5°C to +45°C / 20 to 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	GO-5000M-PMCL: 46g GO-5000M-PMCL-EP: 48g		

Notes:

- Note1) In 1X3-1Y type, if the width is set not to the multiple of 24, 1 or 2 pixels may not contain video data.
- Note 2) Performance guarantee is up to 1 second.
- Note 3) Gaps in histogram may occur if more than +12dB of gain is applied.
- Note 4) Approximately 5 minutes pre-heating is required to achieve these specifications.
- Note 5) The above specifications are subject to change without notice.

User's Record

Model name: ……

Revision: ……

Serial No: ……

Firmware version: ……

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

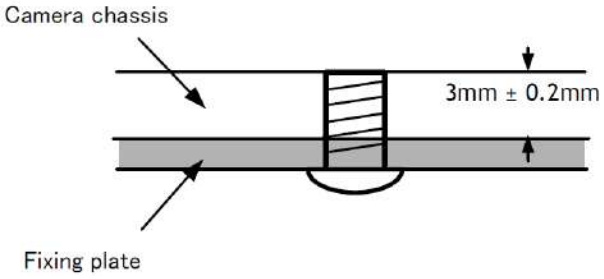
Appendix

Precautions

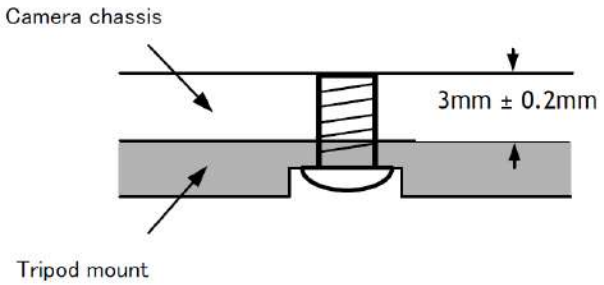
- Personnel not trained in dealing with similar electronic devices should not service this camera.
- The camera contains components sensitive to electrostatic discharge. The handling of these devices should follow the requirements of electrostatic sensitive components.
- Do not attempt to disassemble 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.

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.



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



Revision History

GO-5000M-PMCL, GO-5000M-PMCL-EP and GO-5000M-PMCL-UV (2023)

Revision	Date	Device Version	Changes
2.2	2023/06/19	0.2.1.6	Corrected/updated topics.
2.1	2023/05/08	0.2.1.6	• Added the VAB Low function. (JAI Custom) • Expanded CommandSequenceIndex's setting range. Changed the descriptions for Sequence ROI V/H Binning. (Descriptions of Index Table Parameters) • Corrected the image in the ① Lens topic.
2.0	2023/02/21	0.2.1.5	• Redesigned the user manual. • Combined the GO-5000M-PMCL and GO-5000M-PMCL-UV documentation, and added the GO-5000M-PMCL-EP model. • Corrected/updated topics, including the DC IN connector for GO-5000M-PMCL-UV. • Removed the GO-5000C-PMCL model and color-related information.

GO-5000M-PMCL (2014 ~ 2020)

The 1.x version user manual includes the GO-5000C-PMCL model.

Revision	Date	Changes
1.95	Nov. 2020	Updated "China RoHS" and others.
1.94	Feb. 2019	Updated Command List.
1.93	Aug. 2018	Added KC. Revised the LUT function.
1.92	July 2018	Added the LUT function.
1.91	Dec. 2017	Delete description of unsupported command (TRGOP)
1.90	Feb. 2015	Revised the GPIO block, Revised the Digital Output Bit allocation, Corrected Frame rate calculation, Add the description in Trigger mode/Exposure mode, Revised timing of Timed and Trigger width, Add the description to RCT mode, Revised Sequence trigger and Multi ROI sections, Revised Gain control section
1.8	Dec. 2014	Revised the frame rate calculation

Revision	Date	Changes
1.7	Nov. 2014	Changed the Binning & HDR function to monochrome only.
1.6	Nov. 2014	5mm Depth for mounting screw was wrong. Correct to 3mm
1.5	Oct. 2014	Added shading commands in communication protocol table, Added the restriction of HDR for color version
1.4	Oct. 2014	Revised the B/W spectral response, Add Dark compression on the protocol list
1.3	Sept. 2014	Revised Spectral Response, Update Command list, Deleted the Trigger Overlap (Readout) function
1.2	Aug. 2014	Revised Frame Rate, Frame Period and Calculation formulas.
1.1	July 2014	Revised the EMA1288 parameters
1.0	June 2014	New Release
Preliminary	May 2014	-

GO-5000M-PMCL-UV (2021 ~ 2022)

Revision	Date	Changes
1.1	Nov. 2022	Redesigned the User Manual
1.0	Feb. 2021	First Release

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