



*See the possibilities*

# User Manual

## ***SW-4000M-PMCL***

*Monochrome Line Scan Camera*

*Document Version: 1.1*

*SW-4000M-PMCL\_Ver.1.1\_May 2017*

Thank you for purchasing this product.



Be sure to read this manual before use.

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

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## **Notice**

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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 SW-4000M-PMCL complies with the following provisions applying to its standards.

EN 61000-6-3 (Generic emission standard part 1)

EN 61000-6-2 (Generic immunity standard part 1)

### **FCC**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:


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

## **Warning**

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

# 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.

## 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)
连接插头	×	○	○	○	○	○
电路板	×	○	○	○	○	○
光学滤镜	×	○	×	○	○	○
棱镜	×	○	○	○	○	○
螺丝固定座	×	○	○	○	○	○
机体外壳	×	○	○	○	○	○
○：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SJ/T11363-2006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SJ/T11363-2006规定的限量要求。 (企业可在此处、根据实际情况对上表中打“×”的技术原因进行进一步说明。)						



### 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基人身、财产造成严重损害的期限。  
数字「15」为期限15年。

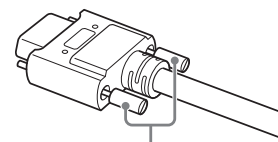
## Usage Precautions

### Notes on cable configurations

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

### 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:  $0.291 \pm 0.049$  N·m or less)



Secure manually.  
Do not secure too tightly.

### Notes on attaching the lens

#### 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.

### 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

The SW-4000M-PMCL is a line scan camera equipped with a 4096-pixel CMOS linear sensor. The camera has a Camera Link clock of 84.82 MHz and is capable of high-speed scanning at up to 199.5 kHz (Line Rate). 8-bit and 10-bit video output is possible via Camera Link. Camera and external trigger settings are configured via the Camera Link interface or the 12-pin connector.

### Camera Link compatible interface

- Video outputs can be used as trigger inputs.

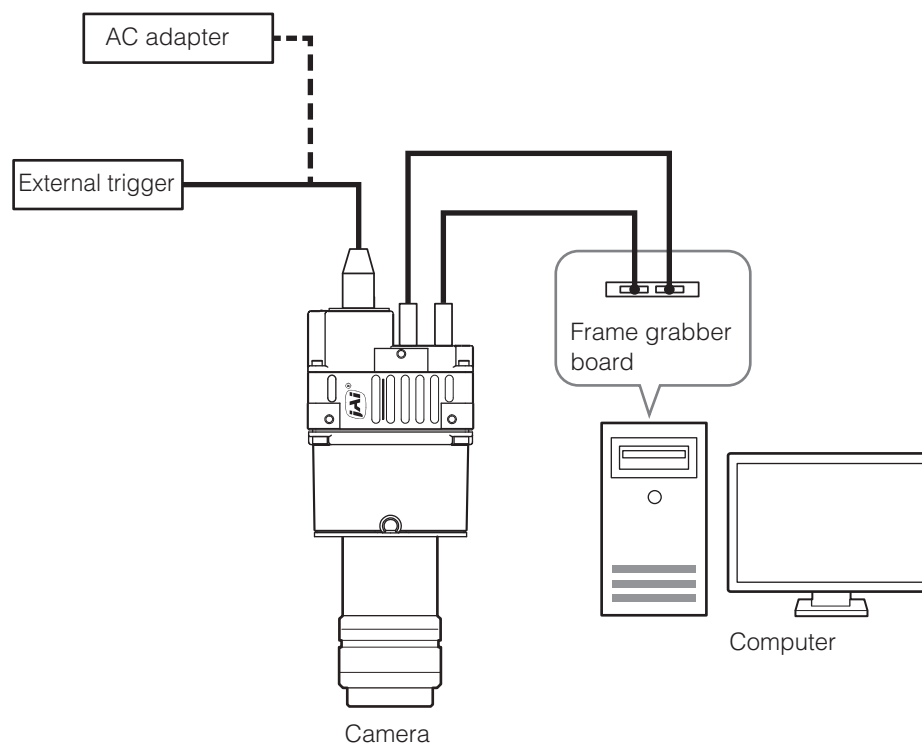
### Output formats

You can choose from 8-bit, and 10-bit output.

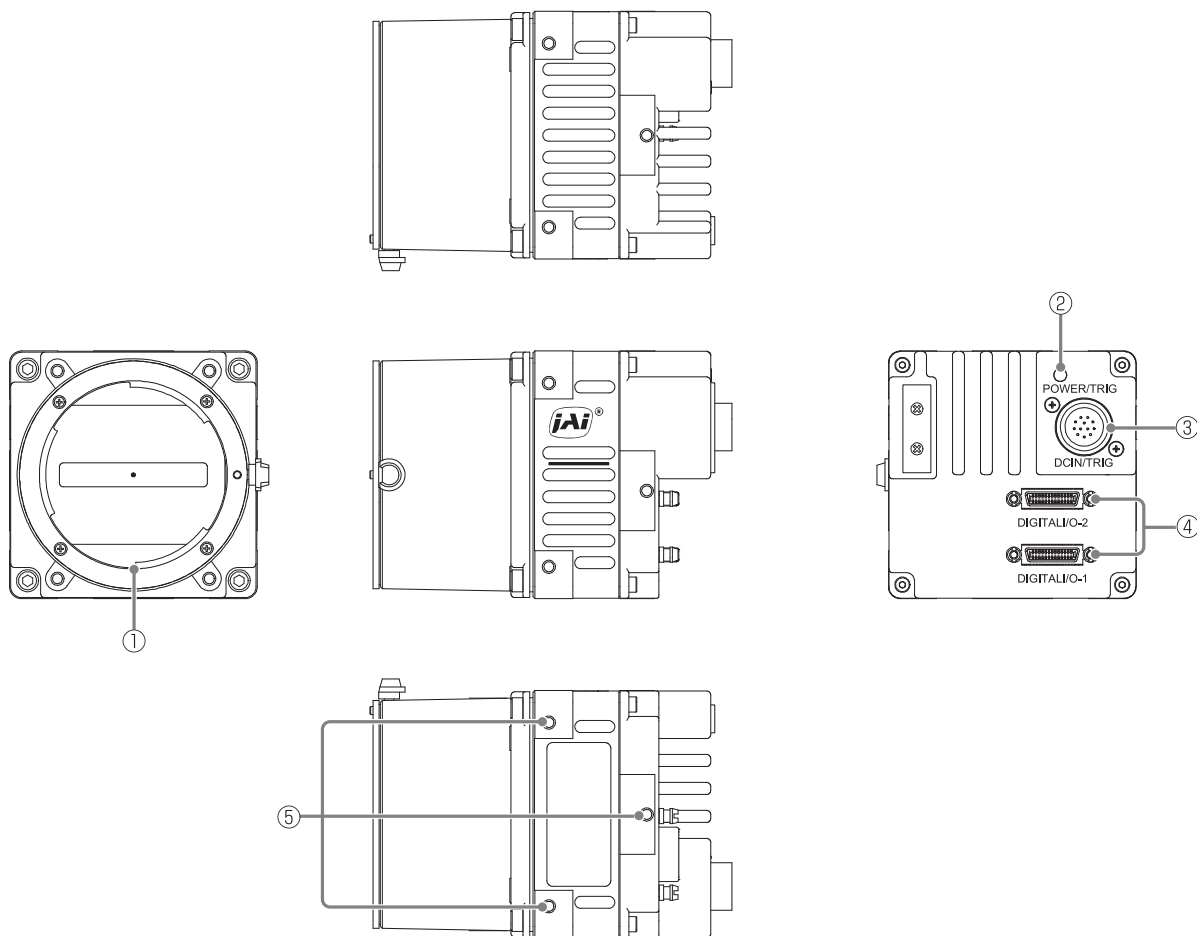
### Variety of pre-process functions

- **Variable pixel size**  
The pixel size can be changed by switching between the  $7.5 \times 7.5 \mu\text{m}$  (default) and  $7.5 \times 10.5 \mu\text{m}$  operation modes.
- **LUT (Lookup Table)**  
Programmable control over gamma and contrast is possible.
- **Gamma correction**  
Gamma can be set to 1.0, 0.9, 0.8, 0.75, 0.65, 0.6, 0.55, 0.5, or 0.45.
- **Shading correction (flat field)**  
Non-uniformity (i.e., shading) in the amount of light generated by the lens and lighting equipment can be corrected.
- **Variable line rate**  
By varying the line rate, the scanning speed of the camera can be matched to the feeding speed of the object, and the accumulation time can be lengthened to increase sensitivity.

### Connection example:



## Parts Identification



### ① Lens mount (M42 mount or F mount)

Mount an M42-mount lens or F-mount lens here.

- ❖ Before mounting a lens, be sure to refer to “Step 2: Connecting Devices” (page 12) and confirm the precautions for attaching a lens and the supported lens types.
- ❖ Lenses without the aperture ring on the lens side are not supported.

### ② POWER/TRIG LED

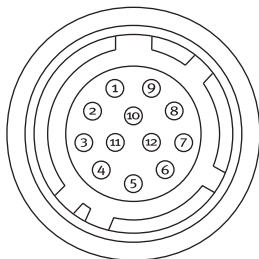
Indicates the power and trigger input status.

#### LED status and camera status

LED	Light	Status
POWER/TRIG LED	● Lit amber	Camera initializing.
	● Lit green	Operational and no triggers being input.
	✱ Blinking green	Operational and triggers being input. ❖ The blinking interval is not related to the actual input interval of the external trigger.

### ③ DC IN / trigger IN connector (12-pin round)

Connect the cable for a power supply (sold separately) or for DC IN /trigger IN here.



HR-10A-10R-12PB (71) (Hirose Electric or equivalent)

Pin No.	Input/output	Signal	Description
1		GND	
2	Power In	DC IN	DC 12 V to 24 V $\pm$ 10%
3		GND	
4		Reserved	External connection not possible
5		GND	
6	In	RxD In	RS-232C
7	Out	TxD Out	RS-232C
8		GND	
9	Out	TTL Out 1	Line1
10	In	TTL In 1	Line4
11	Power In	DC In	DC 12 V to 24 V $\pm$ 10%
12		GND	

#### Caution

The DC IN / trigger IN connector or the CC1 of the DIGITAL I/O 1 video output connector will be used for external trigger inputs. You can switch which of these two are used via a command.

#### Compatible connectors

Camera side: HR10A-10R-12PB (71) (Hirose Electric or equivalent)

Cable side: HR-10A-10P-12S (plug) (Hirose Electric or equivalent)

### ④ DIGITAL I/O 1 and DIGITAL I/O 2 video output connectors

Connect a Cable Link compatible cable here.

#### Connector 1 (used during Base, Medium, Full, 8/10 bit output)

Pin No.	Input/output	Signal	Description
1, 26		Power	Power
2 (-), 15 (+)	Out	TxOUT0	Data output
3 (-), 16 (+)	Out	TxOUT1	Data output
4 (-), 17 (+)	Out	TxOUT2	Data output
5 (-), 18 (+)	Out	TxCk	CL Clock
6 (-), 19 (+)	Out	TxOUT3	Data output
7 (+), 20 (-)	In	SerTC (RxD)	LVDS serial control
8 (-), 21 (+)	Out	SerTFG (TxD)	LVDS serial control
9 (-), 22 (+)	In	CC1	Trigger
10 (-), 23 (+)		CC2	Reserved
11, 24		N.C	
12, 25		N.C	
13, 14		Shield	GND



**Channel 2 (used during Medium, Full, 8/10 bit output)**

Pin No.	Input/ output	Signal	Description
1, 26		Power	Power
2 (-), 15 (+)	Out	TxOUT0	Data output
3 (-), 16 (+)	Out	TxOUT1	Data output
4 (-), 17 (+)	Out	TxOUT2	Data output
5 (-), 18 (+)	Out	TxCk	CL Clock
6 (-), 19 (+)	Out	TxOUT3	Data output
7 (+), 20 (-)		Reserved	
8 (-), 21 (+)	Out	TxOut0	Data output
9 (-), 22 (+)	Out	TxOut1	Data output
10 (-), 23 (+)	Out	TxOut2	Data output
11 (-), 24 (+)	Out	TxCk	CL Clock
12 (-), 25 (+)	Out	TxOut3	Data output
13, 14		Shield	GND

**Compatible connectors / cable assembly**

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

Cable: SDR connector cable for PoCL

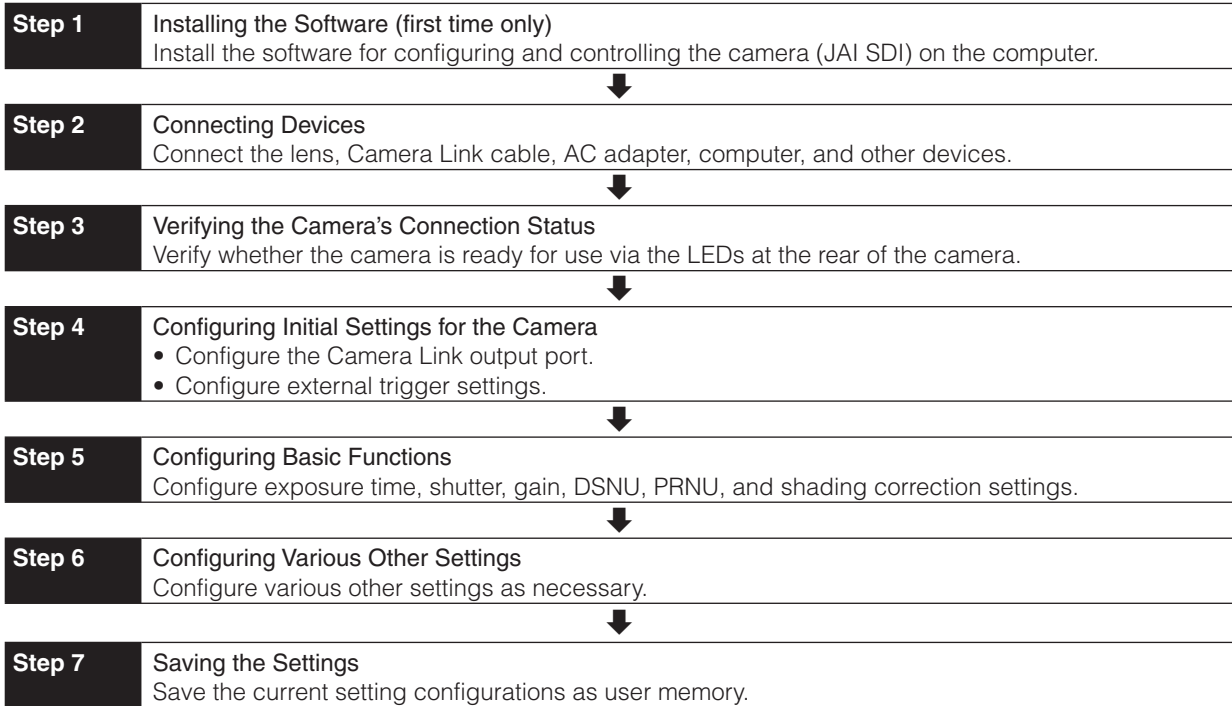
- ❖ Compatible cable length is 0.5 to 10 m.
- ❖ The cable length at which communication will be possible will be limited when using a cable that is not compatible with Camera Link, a small diameter type cable or a high flex type cable.

⑤ **Camera locking screw holes (M4, 6 mm depth)**

Use this to connect the camera to the system.

# Preparation

## Preparation Flow



## Step 1: Installing the Software (first time only)

When using the camera for the first time, install the software for configuring and controlling the camera (JAI SDK) on the computer.

❖ When you install JAI SDK, JAI Camera Control Tool will also be installed.

### 1 Download the “JAI - Getting Started Guide” and JAI SDK from the JAI website.

URL <http://www.jai.com/jp/camerasolutions/download/software>

### 2 Refer to the “JAI - Getting Started Guide,” and install JAI SDK on the computer.

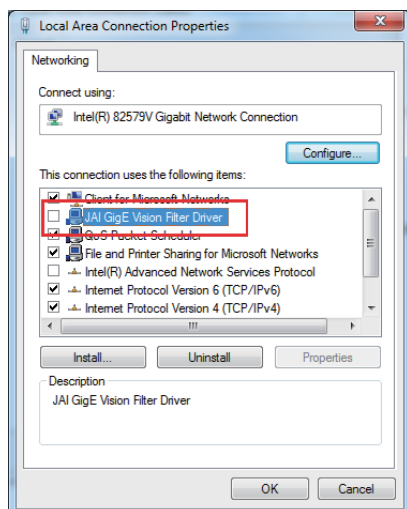
The computer will restart when installation is complete.

#### Note

When the JAI SDK is installed, a camera driver for the interface is also part of the default installation. This Vision Filter Driver is added to every NIC/port on the host computer. As the driver is also added to the NIC/port for Internet connection, it may affect Internet access speed on some systems. If you think your Internet speed is affected, configure the following settings to disable the filter driver on that port.

- ① Open [Control Panel] → [Network and Internet] → [Connect to a network], and right-click the port used for Internet connection to open the properties dialog box.

- 2 Clear the [JAI GigE Vision Filter Driver] checkbox, and save.



### 3 Verify the settings for using Camera Link.

The SW-4000M-PMCL supports GenIcam and Gen-CP. Check the following settings when controlling the camera via JAI SDK.

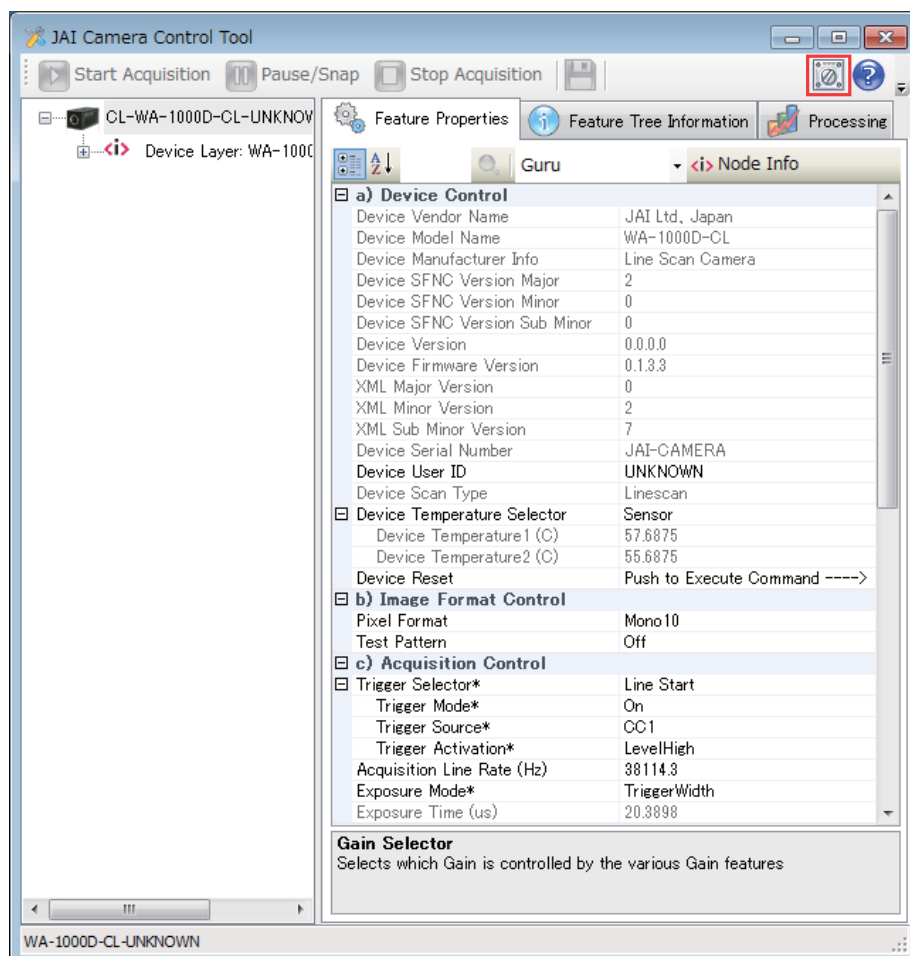
#### Checking the frame grabber board's settings

Settings must be configured on the frame grabber board to enable Gen-CP support.

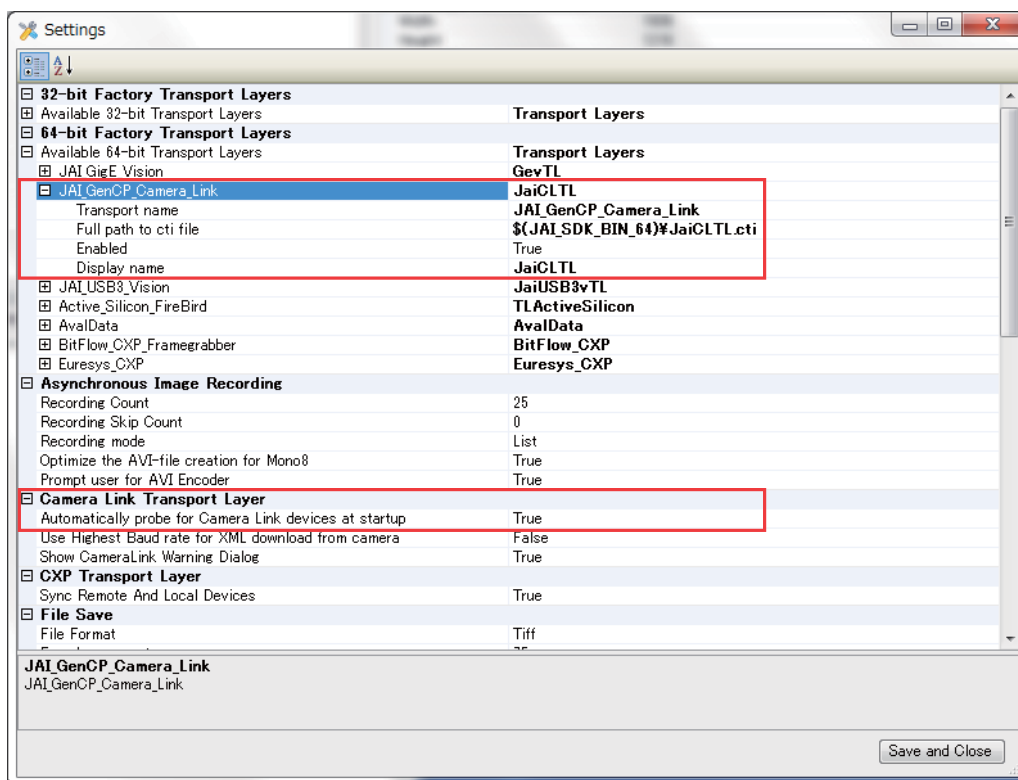
For details, refer to the operating instructions for each board.

#### Checking JAI SDK's settings

- 1 Start JAI Control Tool, and click the  (Settings) icon at the top right.

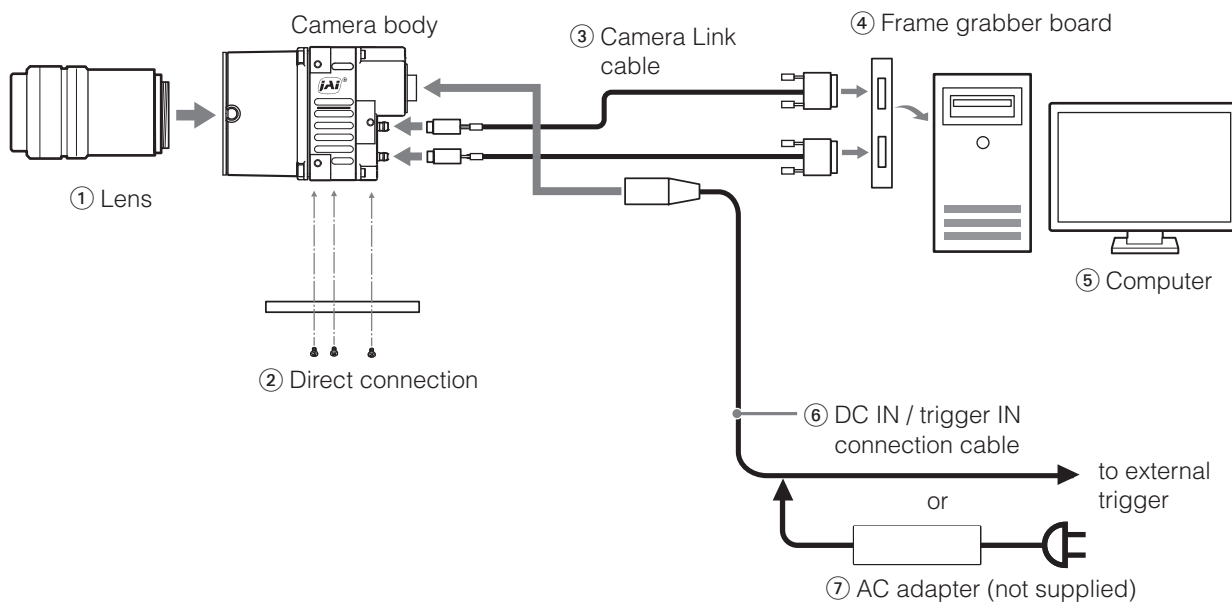


- ② Check that the [JAI\_GenCP\_Camera\_Link] and [Camera Link Transport Layer] settings are configured as follows.



## Step 2: Connecting Devices

Connect the lens, Camera Link cable, AC adapter, and other necessary devices.  
Attach the lens in a clean environment to prevent dust from adhering to the unit.



① **Lens**

Attach an M42-mount lens or F-mount lens.

**Caution**

The maximum performance of the camera may not be realized depending on the lens.

**Note**

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

$$\text{focal length} = \text{WD} / (1 + \text{W}/\text{w})$$

WD: Working distance (distance between lens and object)

W: Width of object

w: Width of sensor 30.72 mm on this camera.

② **Direct connection**

When mounting the camera directly to another device, for example, use screws that match the camera locking screw holes on the camera. (M4, 6 mm depth)

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 cables to the DIGITAL I/O 1 and DIGITAL I/O 2 video output connectors.

- Use Cable Link compatible cables.
- Refer to the specifications of the cable for details on its bend radius.
- ❖ For details on the cable, see "4 DIGITAL I/O 1 and DIGITAL I/O 2 video output connectors" (page 8).

**Caution**

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:  $0.291 \pm 0.049$  N·m or less)

④ **Frame grabber board**

Refer to the operating instructions of the frame grabber board, and configure settings on the computer as necessary.

⑤ **Computer**

Use a computer that meets the requirements of your frame grabber board.

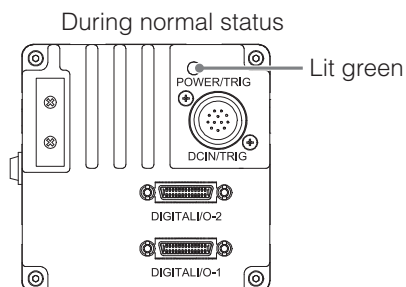
⑥ **DC IN / trigger IN connection cable**⑦ **AC adapter (if necessary)**

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

## Step 3: Verifying the Camera Connection Status

When the necessary devices are connected and power is supplied to the camera, 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 and whether the camera is operational by checking the rear LED.



❖ For details on how to read the LED, see “LED status and camera status” (page 7) in the “Parts Identification” section.

### Note

If the POWER/TRIG LED does not switch to green within minutes of supplying power, check the DC IN/TRIG cable, the Camera Link cable and other connections.

## Step 4: Configuring Basic Settings for the Camera

Start Control Tool, connect the camera to the frame grabber board, and configure initial settings for the output format.

### Connecting the Camera to the Control Tool

- 1** Start JAI Control Tool.  
Cameras connected to the frame grabber board are detected, and a window appears. If they do not appear, right-click inside the window and select [Search for Cameras].
- 2** Select the camera you want to configure.
- 3** Check that the settings of the selected camera are displayed.

### Configuring the operation modes

The pixel size can be changed by switching between the  $7.5 \times 7.5 \mu\text{m}$  (Mode A) and  $7.5 \times 10.5 \mu\text{m}$  (Mode B) operation modes. Mode A has a saturation capacity of 19,500 electrons per pixel while the pixel wells in Mode B can hold 36,000 electrons.

To configure the operation modes.

Select [Sensor select]

4K-A : Mode A

4K-B : Mode B

### Note

DSNU and PRNU may need to be recalibrated when switching between Sensor Select operation modes. See page

17 for additional details.

Also, [Binning Vertical] must be set independently in each operation mode.

## Configuring the Output Format

Configure the pixel format for images.

Item		Default value
Image Format Control	Pixel Format	mono8 (8-bit monochrome)

## Control via External Triggers

### When Controlling the Exposure Time Using Specified Exposure Times

Configure the settings as follows.

Item		Setting value / selectable range
Trigger Selector (trigger operation)		Line Start
	Trigger Mode	On
	Trigger Source (trigger signal source)	Any
	Trigger Activation (trigger polarity)	Rising Edge (rising edge of input signal), Falling Edge (falling edge of input signal)
Exposure Mode		Timed (control via exposure time)
Exposure Time		Varies depending on the Tap Geometry and CL Pixel Clock settings.

- 1** Set [Exposure Mode] to [Timed].  
([Timed] is the default setting.)
- 2** Specify the exposure time in [Exposure Time].
- 3** Set [Trigger Mode] to [On].
- 4** If necessary, change the [Trigger Source], and [Trigger Activation] settings.

### When Controlling the Exposure Time Using the Pulse Width of the Trigger Input Signal

Configure the settings as follows.

Item		Setting value / selectable range
Trigger Selector (trigger operation)		Line Start
	Trigger Mode	On
	Trigger Source (trigger signal source)	Any
	Trigger Activation (trigger polarity)	Level High (high-level duration), Level Low (low-level duration)
Exposure Mode		Trigger Width (control via trigger width)

- 1** Set [Trigger Mode] to [On] .

- 2** Set [Exposure Mode] to [Trigger Width] .
- 3** If necessary, change the [Trigger Source] and [Trigger Activation] settings.

## Control Without External Triggers

### When Controlling the Exposure Time Using Specified Exposure Times

Configure the settings as follows.

Item	Setting value / selectable range
Trigger Selector (trigger operation)	Line Start
Trigger Mode	Off
Exposure Mode	Timed (control via exposure time)
Exposure Time	Varies depending on the Tap Geometry and CL Pixel Clock settings.

- 1** Set [Exposure Mode] to [Timed].  
([Timed] is the default setting.)
- 2** Set [Trigger Mode] to [On].
- 3** Specify a line period slower than the exposure time in [Acquisition Line rate].
- 4** Specify the exposure time in [Exposure Time].

### When Not Controlling the Exposure Time

Configure the settings as follows.

Item	Setting value / selectable range
Exposure Mode	Off

The exposure will be performed with an exposure time equal to Line Period minus 3.6  $\mu$ s.

## Step 5: Adjusting the Image Quality

To maximize the performance of the camera, configure its basic function in the following order.

\* For details on this setting, "Variable Line Rate" (page 34) and "Electronic Shutter" (page 35). The exposure times and line rates that can be set will vary depending on the CL clock and Tap Geometry settings for Camera Link.

- 1** Configure the gain.
  - ❖ For details on this setting, see "Gain Control" (page 32).



## 2 Adjust the black level.

- ❖ Open [Analog Control], and specify the black level in [Black Level] under [Black Level Selector].

## 3 Perform DSNU calibration.

- ❖ The camera is equipped with a DSNU correction function. The function allows you to reduce DSNU generated by the sensor. To use the function, calibration must be performed within the camera and correction data must be created beforehand.

### Procedure

- 1 Close the lens aperture.
- 2 Set [Pixel Black Correct] to [User].
- 3 Execute [Pixel Black Direct], and perform calibration.

## 4 Perform PRNU calibration.

- ❖ The camera is equipped with a PRNU correction function. The function allows you to reduce PRNU generated by the sensor. To use the function, calibration must be performed within the camera and correction data must be created beforehand.

### Procedure

- 1 Make the signal output level as flat as possible within a range of 50% to 95%.
- 2 Set [Pixel Gain Correct] to [User].
- 3 Execute [Pixel Gain Direct], and perform calibration.

### Note

Initial calibrations for DSNU and PRNU are performed at the factory. These can be accessed by changing [Pixel Black Select] and [Pixel Gain Select] to [Factory area]. These calibrations should only be used if the camera is being operated with default settings.

In most cases, it is recommended that the user perform DSNU and PRNU calibrations for the specific settings that will be used, and also when switching operation modes. Set [Pixel Black Select] and [Pixel Gain Select] to [User area] before running calibrations for the operation mode(s) that you will be using.

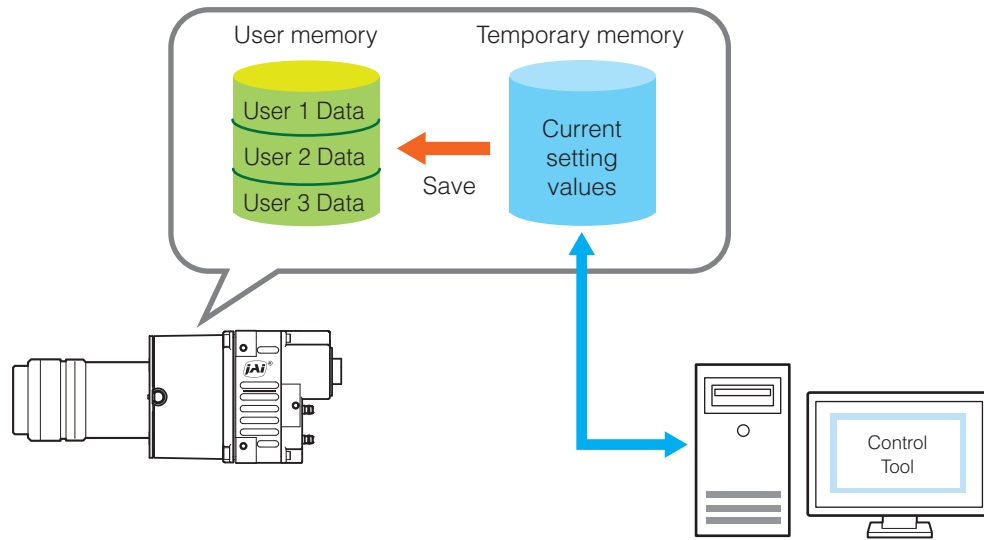
## Step 6: Configuring Various Other Settings

See “Settings List” (page 38), and configure settings as necessary.

\* We recommend performing DSNU and PRNU calibration again whenever the line rate setting is changed significantly.

## Step 7: Saving the Settings

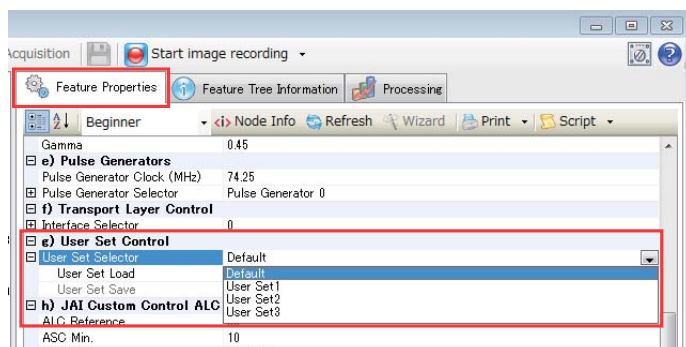
The setting values configured in Control Tool will be deleted when the camera is turned off. By storing current setting values to user memory, you can load and recall them whenever necessary. You can save up to three sets of user memory settings (User 1 Data to User 3 Data).

**Note**

The setting values are not saved to the computer (Control Tool).

## ■ To save user settings

- 1 Stop image capture.
- 2 Expand [User Set Control] and select the save destination ([User Set1] to [User Set3]) in [User Set Selector].



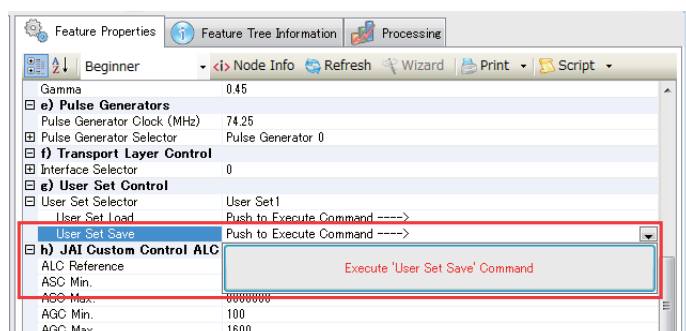
### Note

The factory default setting values are stored in [Default] and cannot be overwritten.

### Caution

Settings can only be saved when image capture on the camera is stopped.

- 3 Select [User Set Save], and click [Execute 'User Set Save' Command].



The current setting values are saved as user settings.

## ■ To load user settings

- 1 Stop image capture.  
User settings can only be loaded when image capture on the camera is stopped.
- 2 Select the settings to load (Default, and User Set1 to User Set3) in [User Set Selector].
- 3 Select [User Set Load], and click [Execute 'User Set Load' Command].  
The selected user settings are loaded.

❖ The next time the unit is started up, the settings selected in [User Set Selector] will be loaded automatically.

## Basic Function Matrix

### Valid Input/Output Combinations

The following signals can be used as sources for each output destination (Trigger Selector).

The combinations of source signals and output destinations are indicated in the following.

Source signal (Cross point switch input)		Output destination	
		Trigger Selector	Line Selector
		Line Start	Line 2 Output Source
Signals to use as output	Line4 TTL In	○	○
	Line7 CC1	○	○
	LVAL	×	○
	Exposure Active (EEN)	×	○
	Low	×	○
	High	×	○

# Main Functions

## GPIO (Digital Input/Output Settings)

The unit can input/output the following signals to and from external input/output connectors.

External output	TTL Out (Line1)	DC IN / trigger IN connector (12-pin round)
External input	TTL IN (Line4)	DC IN / trigger IN connector (12-pin round)
	CC1 (Line7)	Camera Link cable

These signals can be used as triggers and other necessary signals within the camera or as signals output from the camera to the system, such as those used for lighting equipment control.

Signals are selected as follows.

- When using external signals or the signals of each GPIO module as trigger signals:  
Select in [Trigger Selector] > [Trigger Source].
- When selecting the signals to use for external outputs:  
Select in [Line Selector] > [Line Source].

## Camera Output Formats

The SW-4000M-PMCL supports a variety of output formats.

The supported tap geometries are as follows.

The tap geometry settings on the camera side and the frame grabber board side must match. For details on frame grabber board settings, refer to the instruction manual of the board.

Tap geometry	CL configuration	
1X2	Base	bit: 8/10
1X3	Base	bit: 8
1X4	Medium	bit: 8/10
1X8	Full	bit: 8
1X8	80 bit (Deca)	bit: 10
1X10	80 bit (Deca)	bit: 8

\*1 Effective pixels are restricted to 4092.

\*2 Effective pixels are restricted to 4090.

### ■ Cable length reference

The Camera Link cable length is 10 m or less, regardless of the Camera Link clock.\*3

\*3 The length of cable you can use will also vary depending on type and maker.

## Exposure Mode

The following operation modes are available on the camera.

Operation mode		Command	
Exposure Mode	Trigger Mode	TR	TG
OFF	OFF	0	0
	ON		1
Timed	OFF	1	0
	ON		1
PWC	ON	2	1

❖ For details on operation mode and function combinations, see "Basic Function Matrix" (page 20).

## Image Output Timing

### ■ Trigger Control

The camera allows Line Start trigger controls to be performed via external trigger signals.

The Line Start trigger allows exposure control via the trigger signal inputs.

- ❖ The settings for exposure control and triggers are related to each other. Be sure to configure the settings described in “Connecting to the Camera to Control Tool” (page 14).

---

### Shortest Repetition Period for Triggers

#### Trigger Mode ON, full resolution

		Shortest period (μs)
Exposure Mode OFF	Camera Link	Varies depending on the Tap Geometry and CL Clock settings.
	12-pin	
Exposure Mode Timed	Camera Link	
	12-pin	
PWC	Camera Link	
	12-pin	

---

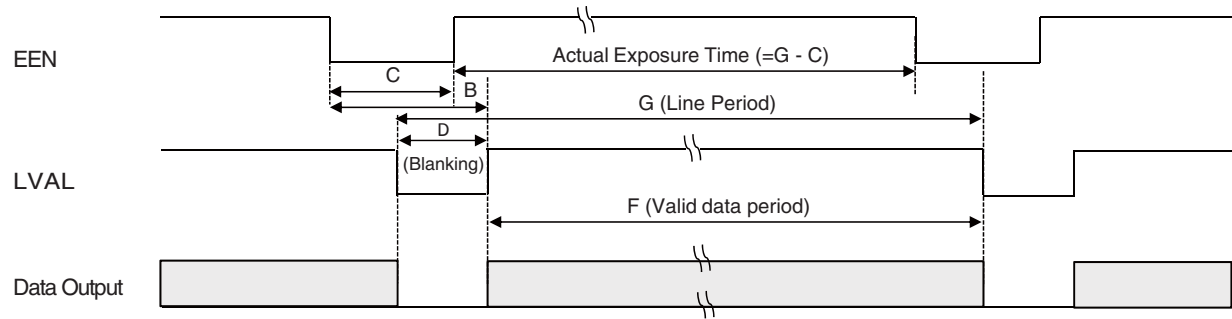
### Shortest Trigger Pulse Width

#### Trigger Mode ON

	Camera Link	12-pin
Exposure Mode OFF	3 μs	50 μs
Exposure Mode Timed	3 μs	50 μs
PWC	3 μs	50 μs

## ■ When [Exposure Mode] is [Off]

- Line Start Trigger Off



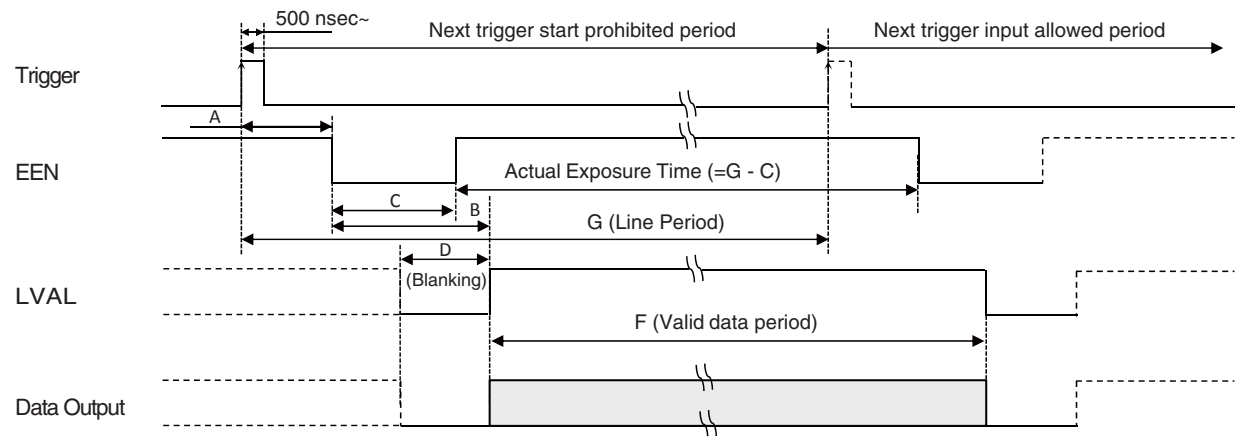
### [Binning Off]

Tap Geometry	Bit/ Pixel	CL Pixel Clock [MHz]	Period From EEN Falling to LVAL rising [B](usec)	EEN invalid time [C](usec)	Data invalid time [D](CLK)	Data valid time [F] (CLK)	Line Period [G](CLK)
1X2	8/10	31.70	13.4	3.6	10	2048	2058
		42.41	13.3	3.6	17	2048	2060
		63.39	13.2	3.6	10	2048	2058
		84.82	13.2	3.6	18	2048	2066
1X3	8	31.70	13.4	3.6	7	1364	1371
		42.41	13.3	3.6	12	1364	1376
		63.39	13.2	3.6	8	1364	1372
		84.82	13.2	3.6	12	1364	1376
1X4	8/10	31.70	13.4	3.6	5	1024	1029
		42.41	13.3	3.6	9	1024	1033
		63.39	13.2	3.6	6	1024	1030
		84.82	13.2	3.6	10	1024	1034
1X8	8/10	31.70	13.4	3.6	3	512	515
		42.41	13.3	3.6	5	512	517
		63.39	13.2	3.6	4	512	516
		84.82	13.2	3.6	6	512	518
1X10	8	31.70	13.4	3.6	3	409	412
		42.41	13.3	3.6	4	409	413
		63.39	13.2	3.6	3	409	412
		84.82	13.2	3.6	16	409	425

### [Binning On]

Tap Geometry	Bit/ Pixel	CL Pixel Clock [MHz]	Period From EEN Falling to LVAL rising [B](usec)	EEN invalid time [C](usec)	Data invalid time [D](CLK)	Data valid time [F] (CLK)	Line Period [G](CLK)
1X2	8/10	31.70	13.9	7.8	10	2048	2065
		42.41	13.8	7.8	17	2048	2058
		63.39	13.7	7.8	10	2048	2059
		84.82	13.7	7.8	18	2048	2066
1X3	8	31.70	13.9	7.8	7	1364	1371
		42.41	13.8	7.8	12	1364	1376
		63.39	13.7	7.8	8	1364	1372
		84.82	13.7	7.8	183	1364	1547
1X4	8/10	31.70	13.9	7.8	5	1024	1029
		42.41	13.8	7.8	9	1024	1033
		63.39	13.7	7.8	132	1024	1156
		84.82	13.7	7.8	523	1024	1547
1X8	8/10	31.70	13.9	7.8	66	512	578
		42.41	13.8	7.8	262	512	774
		63.39	13.7	7.8	644	512	1156
		84.82	13.7	7.8	1035	512	1547
1X10	8	31.70	13.9	7.8	169	409	578
		42.41	13.8	7.8	365	409	774
		63.39	13.7	7.8	747	409	1156
		84.82	13.7	7.8	1138	409	1547

- Line Start Trigger On



### [Binning Off]

Tap Geometry	Bit/ Pixel	CL Pixel Clock [MHz]	Delay time From Trigger to EEN falling [A] (usec)	Period From EEN Falling to LVAL rising [B](usec)	EEN invalid time [C](usec)	Data invalid time [D](CLK)	Data valid time [F] (CLK)	Line Period [G](CLK)
1X2	8/10	31.70	1.1	13.4	3.6	10	2048	2058
		42.41	1.1	13.3	3.6	17	2048	2065
		63.39	1.1	13.2	3.6	10	2048	2058
		84.82	1.1	13.2	3.6	18	2048	2066
1X3	8	31.70	1.1	13.4	3.6	7	1364	1371
		42.41	1.1	13.3	3.6	12	1364	1376
		63.39	1.1	13.2	3.6	8	1364	1372
		84.82	1.1	13.2	3.6	12	1364	1376
1X4	8/10	31.70	1.1	13.4	3.6	5	1024	1029
		42.41	1.1	13.3	3.6	9	1024	1033
		63.39	1.1	13.2	3.6	6	1024	1030
		84.82	1.1	13.2	3.6	10	1024	1034
1X8	8/10	31.70	1.1	13.4	3.6	3	512	515
		42.41	1.1	13.3	3.6	5	512	517
		63.39	1.1	13.2	3.6	4	512	516
		84.82	1.1	13.2	3.6	6	512	518
1X10	8	31.70	1.1	13.4	3.6	3	409	412
		42.41	1.1	13.3	3.6	4	409	413
		63.39	1.1	13.2	3.6	3	409	412
		84.82	1.1	13.2	3.6	16	409	425

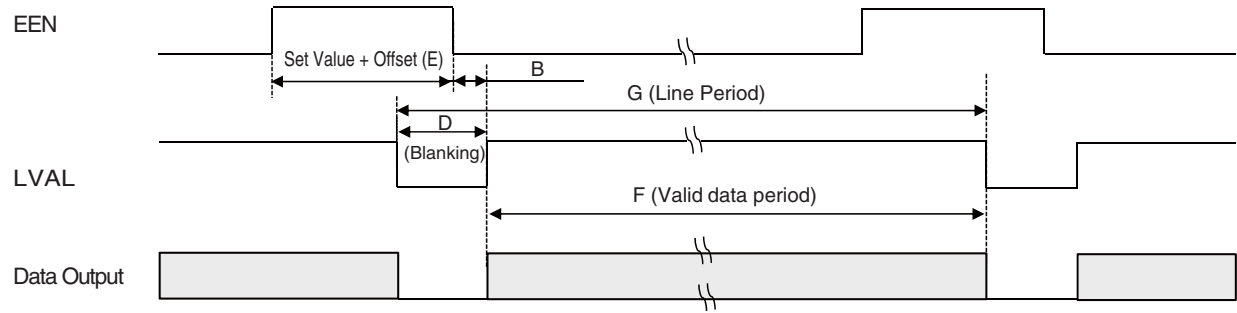


**[Binning On]**

Tap Geometry	Bit/ Pixel	CL Pixel Clock [MHz]	Delay time From Trigger to EEN falling [A] (usec)	Period From EEN Falling to LVAL rising [B](usec)	EEN invalid time [C](usec)	Data invalid time [D](CLK)	Data valid time [F] (CLK)	Line Period [G](CLK)
1X2	8/10	31.70	7.8	13.9	7.8	10	2048	2058
		42.41	7.8	13.8	7.8	17	2048	2065
		63.39	7.8	13.7	7.8	10	2048	2058
		84.82	7.8	13.7	7.8	18	2048	2066
1X3	8	31.70	7.8	13.9	7.8	7	1364	1371
		42.41	7.8	13.8	7.8	12	1364	1376
		63.39	7.8	13.7	7.8	8	1364	1372
		84.82	7.8	13.7	7.8	183	1364	1547
1X4	8/10	31.70	7.8	13.9	7.8	5	1024	1029
		42.41	7.8	13.8	7.8	9	1024	1033
		63.39	7.8	13.7	7.8	132	1024	1156
		84.82	7.8	13.7	7.8	523	1024	1547
1X8	8/10	31.70	7.8	13.9	7.8	66	512	578
		42.41	7.8	13.8	7.8	262	512	774
		63.39	7.8	13.7	7.8	644	512	1156
		84.82	7.8	13.7	7.8	1035	512	1547
1X10	8	31.70	7.8	13.9	7.8	169	409	578
		42.41	7.8	13.8	7.8	365	409	774
		63.39	7.8	13.7	7.8	747	409	1156
		84.82	7.8	13.7	7.8	1138	409	1547

## ■ When [Exposure Mode] is [Timed]

- Line Start Trigger Off  
Shutter select mode



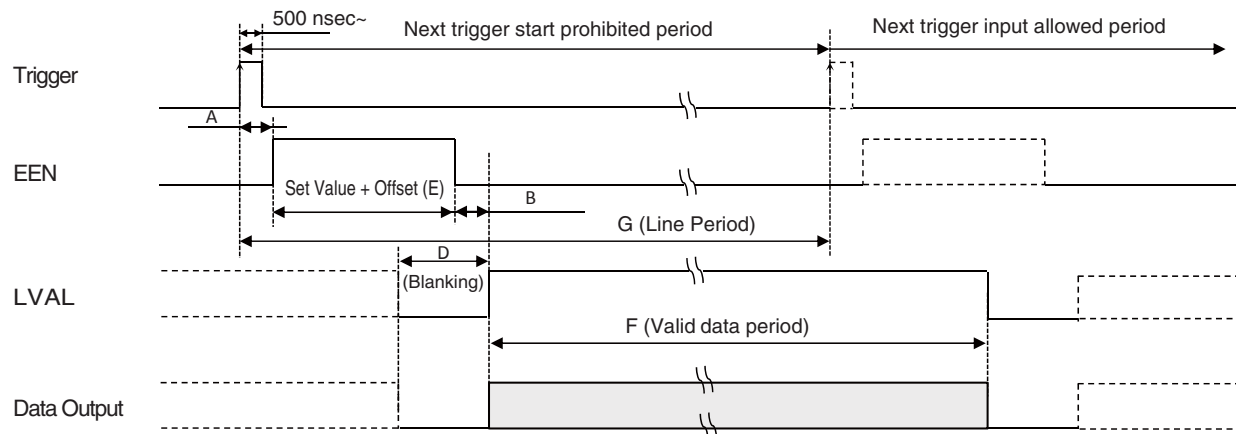
### [Binning Off]

Tap Geometry	Bit/ Pixel	CL Pixel Clock [MHz]	Period From EEN Falling to LVAL rising [B](usec)	Exposure offset time [E](usec)	Data invalid time [D](CLK)	Data valid time [F] (CLK)	Line Period [G](CLK)
1X2	8/10	31.70	13.4	-1.2	10	2048	2058
		42.41	13.3	-1.2	17	2048	2065
		63.39	13.2	-1.2	10	2048	2058
		84.82	13.2	-1.2	18	2048	2066
1X3	8	31.70	13.4	-1.2	7	1364	1371
		42.41	13.3	-1.2	12	1364	1376
		63.39	13.2	-1.2	8	1364	1372
		84.82	13.2	-1.2	12	1364	1376
1X4	8/10	31.70	13.4	-1.2	5	1024	1029
		42.41	13.3	-1.2	9	1024	1033
		63.39	13.2	-1.2	6	1024	1030
		84.82	13.2	-1.2	10	1024	1034
1X8	8/10	31.70	13.4	-1.2	3	512	515
		42.41	13.3	-1.2	5	512	517
		63.39	13.2	-1.2	4	512	516
		84.82	13.2	-1.2	6	512	518
1X10	8	31.70	13.4	-1.2	3	409	412
		42.41	13.3	-1.2	4	409	413
		63.39	13.2	-1.2	3	409	412
		84.82	13.2	-1.2	52	409	461

**[Binning On]**

Tap Geometry	Bit/ Pixel	CL Pixel Clock [MHz]	Period From EEN Falling to LVAL rising [B](usec)	Exposure offset time [E](usec)	Data invalid time [D](CLK)	Data valid time [F] (CLK)	Line Period [G](CLK)
1X2	8/10	31.70	13.9	-1.2	10	2048	2058
		42.41	13.8	-1.2	17	2048	2065
		63.39	13.7	-1.2	10	2048	2058
		84.82	13.7	-1.2	18	2048	2066
1X3	8	31.70	13.9	-1.2	7	1364	1371
		42.41	13.8	-1.2	12	1364	1376
		63.39	13.7	-1.2	8	1364	1372
		84.82	13.7	-1.2	265	1364	1629
1X4	8/10	31.70	13.9	-1.2	5	1024	1029
		42.41	13.8	-1.2	9	1024	1033
		63.39	13.7	-1.2	193	1024	1217
		84.82	13.7	-1.2	605	1024	1629
1X8	8/10	31.70	13.9	-1.2	97	512	609
		42.41	13.8	-1.2	302	512	814
		63.39	13.7	-1.2	705	512	1217
		84.82	13.7	-1.2	117	512	1629
1X10	8	31.70	13.9	-1.2	200	409	609
		42.41	13.8	-1.2	405	409	814
		63.39	13.7	-1.2	808	409	1217
		84.82	13.7	-1.2	1220	409	1629

- Line Start Trigger On  
Shutter select mode



### [Binning Off]

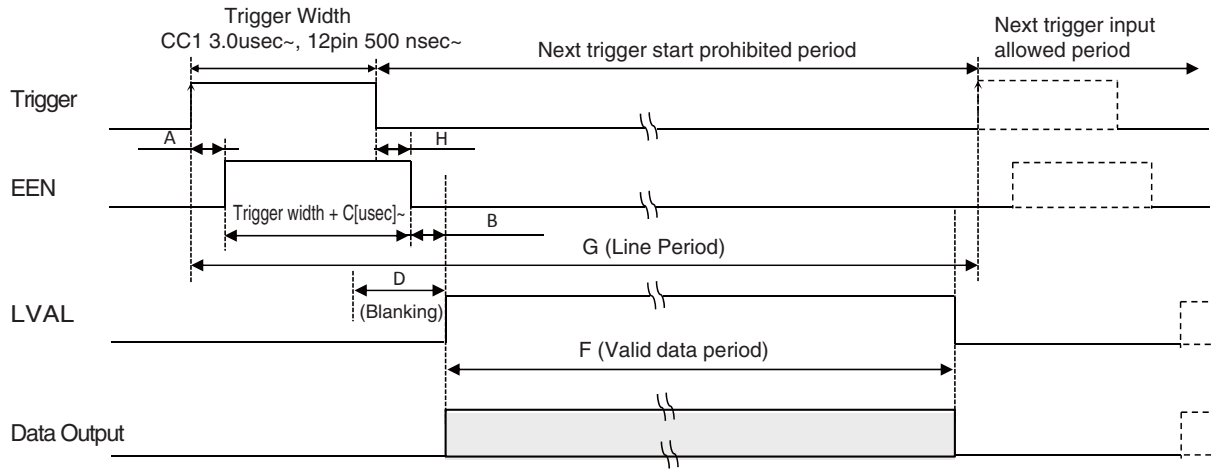
Tap Geometry	Bit/ Pixel	CL Pixel Clock [MHz]	Delay time From Trigger to EEN rising [A] (usec)	Period From EEN Falling to LVAL rising [B](usec)	Exposure offset time [E](usec)	Data invalid time [D](CLK)	Data valid time [F] (CLK)	Line Period [G](CLK)
1X2	8/10	31.70	1.5	13.4	-1.2	10	2048	2058
		42.41	1.5	13.3	-1.2	17	2048	2065
		63.39	1.5	13.2	-1.2	10	2048	2058
		84.82	1.5	13.2	-1.2	18	2048	2066
1X3	8	31.70	1.5	13.4	-1.2	7	1364	1371
		42.41	1.5	13.3	-1.2	12	1364	1376
		63.39	1.5	13.2	-1.2	8	1364	1372
		84.82	1.5	13.2	-1.2	12	1364	1376
1X4	8/10	31.70	1.5	13.4	-1.2	5	1024	1029
		42.41	1.5	13.3	-1.2	9	1024	1033
		63.39	1.5	13.2	-1.2	6	1024	1030
		84.82	1.5	13.2	-1.2	10	1024	1034
1X8	8/10	31.70	1.5	13.4	-1.2	3	512	515
		42.41	1.5	13.3	-1.2	5	512	517
		63.39	1.5	13.2	-1.2	4	512	516
		84.82	1.5	13.2	-1.2	6	512	518
1X10	8	31.70	1.5	13.4	-1.2	3	409	412
		42.41	1.5	13.3	-1.2	4	409	413
		63.39	1.5	13.2	-1.2	3	409	412
		84.82	1.5	13.2	-1.2	52	409	461

**[Binning On]**

Tap Geometry	Bit/ Pixel	CL Pixel Clock [MHz]	Delay time From Trigger to EEN rising [A] (usec)	Period From EEN Falling to LVAL rising [B](usec)	Exposure offset time [E](usec)	Data invalid time [D](CLK)	Data valid time [F] (CLK)	Line Period [G](CLK)
1X2	8/10	31.70	7.7	13.9	-1.2	10	2048	2058
		42.41	7.7	13.8	-1.2	17	2048	2065
		63.39	7.7	13.7	-1.2	10	2048	2058
		84.82	7.7	13.7	-1.2	18	2048	2066
1X3	8	31.70	7.7	13.9	-1.2	7	1364	1371
		42.41	7.7	13.8	-1.2	12	1364	1376
		63.39	7.7	13.7	-1.2	8	1364	1372
		84.82	7.7	13.7	-1.2	265	1364	1629
1X4	8/10	31.70	7.7	13.9	-1.2	5	1024	1029
		42.41	7.7	13.8	-1.2	9	1024	1033
		63.39	7.7	13.7	-1.2	193	1024	1217
		84.82	7.7	13.7	-1.2	605	1024	1629
1X8	8/10	31.70	7.7	13.9	-1.2	97	512	609
		42.41	7.7	13.8	-1.2	302	512	814
		63.39	7.7	13.7	-1.2	705	512	1217
		84.82	7.7	13.7	-1.2	1117	512	1629
1X10	8	31.70	7.7	13.9	-1.2	200	409	609
		42.41	7.7	13.8	-1.2	405	409	814
		63.39	7.7	13.7	-1.2	808	409	1217
		84.82	7.7	13.7	-1.2	1220	409	1629

## ■ When [Exposure Mode] is [Trigger Width]

- Line Start Trigger On  
PWC mode



### [Binning Off]

Tap Geometry	Bit/ Pixel	CL Pixel Clock [MHz]	Delay time From Trigger to EEN rising [A](u)sec	Period From EEN Falling to LVAL rising [B](u)sec	EEN invalid time [C] (u)sec	Data invalid time [D] (CLK)	Data valid time [F] (CLK)	Line Period [G] (CLK)	Delay time From Trigger falling to EEN falling [H](u)sec
1X2	8/10	31.70	1.5	13.4	-0.34	10	2048	2058	1.1
		42.41	1.5	13.3	-0.34	17	2048	2065	1.1
		63.39	1.5	13.2	-0.34	10	2048	2058	1.1
		84.82	1.5	13.2	-0.34	18	2048	2066	1.1
1X3	8	31.70	1.5	13.4	-0.34	7	1364	1371	1.1
		42.41	1.5	13.3	-0.34	12	1364	1376	1.1
		63.39	1.5	13.2	-0.34	8	1364	1372	1.1
		84.82	1.5	13.2	-0.34	12	1364	1376	1.1
1X4	8/10	31.70	1.5	13.4	-0.34	5	1024	1029	1.1
		42.41	1.5	13.3	-0.34	9	1024	1033	1.1
		63.39	1.5	13.2	-0.34	6	1024	1030	1.1
		84.82	1.5	13.2	-0.34	10	1024	1034	1.1
1X8	8/10	31.70	1.5	13.4	-0.34	3	512	515	1.1
		42.41	1.5	13.3	-0.34	5	512	517	1.1
		63.39	1.5	13.2	-0.34	4	512	516	1.1
		84.82	1.5	13.2	-0.34	6	512	518	1.1
1X10	8	31.70	1.5	13.4	-0.34	3	409	412	1.1
		42.41	1.5	13.3	-0.34	4	409	413	1.1
		63.39	1.5	13.2	-0.34	3	409	412	1.1
		84.82	1.5	13.2	-0.34	52	409	461	1.1

**[Binning On]**

Tap Geometry	Bit/ Pixel	CL Pixel Clock [MHz]	Delay time From Trigger to EEN rising [A](usec)	Period From EEN Falling to LVAL rising [B](usec)	EEN invalid time [C] (usec)	Data invalid time [D] (CLK)	Data valid time [F] (CLK)	Line Period [G] (CLK)	Delay time From Trigger falling to EEN falling [H](usec)
1X2	8/10	31.70	7.7	13.9	0.068	10	2048	2058	7.8
		42.41	7.7	13.8	0.068	7	2048	2065	7.8
		63.39	7.7	13.7	0.068	10	2048	2058	7.8
		84.82	7.7	13.7	0.068	18	2048	2066	7.8
1X3	8	31.70	7.7	13.9	0.068	7	1364	1371	7.8
		42.41	7.7	13.8	0.068	12	1364	1376	7.8
		63.39	7.7	13.7	0.068	8	1364	1372	7.8
		84.82	7.7	13.7	0.068	265	1364	1629	7.8
1X4	8/10	31.70	7.7	13.9	0.068	5	1024	1029	7.8
		42.41	7.7	13.8	0.068	9	1024	1033	7.8
		63.39	7.7	13.7	0.068	193	1024	1217	7.8
		84.82	7.7	13.7	0.068	605	1024	1629	7.8
1X8	8/10	31.70	7.7	13.9	0.068	97	512	609	7.8
		42.41	7.7	13.8	0.068	302	512	814	7.8
		63.39	7.7	13.7	0.068	705	512	1217	7.8
		84.82	7.7	13.7	0.068	1117	512	1629	7.8
1X10	8	31.70	7.7	13.9	0.068	200	409	609	7.8
		42.41	7.7	13.8	0.068	405	409	814	7.8
		63.39	7.7	13.7	0.068	808	409	1217	7.8
		84.82	7.7	13.7	0.068	1220	409	1629	7.8

## Pixel Sensitivity Correction

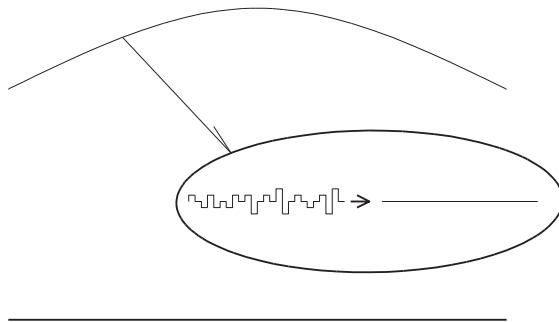
Correct variations between the sensor's pixels.

- ❖ Switching for this function is performed via serial communication.
- ❖ This function is dependent on the operation mode.

## PRNU Correction

Correct sensitivity variations between the sensor's pixels.

Level differences between taps will also be corrected simultaneously.



## DSNU Correction

Correct offset variations between the sensor's pixels.



## Gain Control

The following gain functions are available on the camera.

- Analog base gain
- Digital gain

### ■ Analog base gain

Analog base gain (ABG) is gain that is performed to the analog video signal output from the sensor. The gain steps can be configured to one of four levels.

AnalogBaseGain setting value	Scaling*
0	0 dB (×1)
1	6 dB (×2)
2	9.54 dB (×3)
3	12 dB (×4)

\* Sensitivity (all scaling values are TYP values)



## ■ Digital gain

- Manual  
0 to +24 dB ( $\times 1$  to  $\times 16$ ),  $\times 0.01/\text{steps}$

The following two gain values are added for the total gain value.

Total Gain = AnalogBaseGain (dB) + DigitalGain (dB)

## LUT (Lookup Table) / Gamma Function

The LUT function is used to generate a non-linear mapping between signal values captured on the sensor and those that are output from the camera.

The gamma function corrects the output signals from the camera beforehand (reverse correction), taking into consideration the light-emitting properties of the monitor display.

The Gamma, LUT, and OFF settings can be selected on this camera. When OFF is selected,  $\gamma 1$  (linear) sensitivity is applied.

The factory default setting is OFF.

## ■ Gamma

When [Gamma] is set, you can switch the curve characteristics by 9 steps.

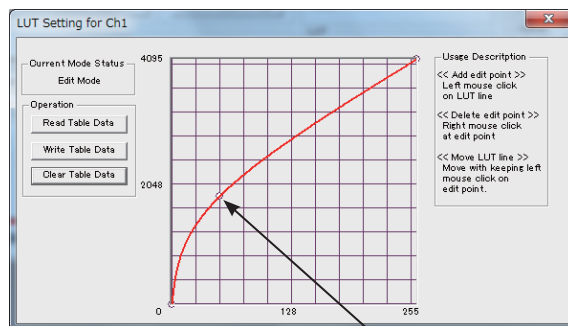
1.0, 0.9, 0.8, 0.75, 0.65, 0.6, 0.55, 0.5, 0.45

## ■ LUT

In this mode, the sensitivity curve can be configured.

Setting range: 0 to 4096LSB (100%)

Number of setting points: 256



Setting point

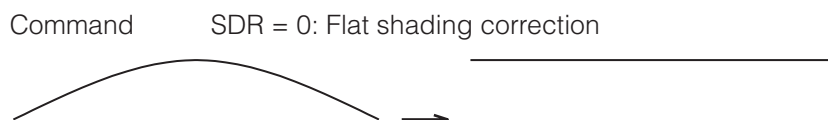
## Shading Correction

The shading correction is a function that corrects non-uniformity (i.e., shading) in the amount of light generated by the lens and lighting equipment.

The following shading correction modes are available on the camera.

### ■ Flat shading correction

The range of brightness that can be corrected is within  $\pm 30\%$  of the region with the highest signal level on one line.



- ❖ Complete correction may not be possible depending on the optical system and light source you are using.
- ❖ Data based on corrections performed under factory conditions is stored for this function.

### ■ To perform the shading function

The function is turned ON/OFF via serial communication.

This function is not dependent on the operation mode, but is effective when used during actual use.

- ❖ You can also save the setting and have it applied whenever the power is subsequently turned on. For details on saving the setting, see "Step 7: Saving the Settings" (page 17).

## Black Level Correction

Black level correction is a function for adjusting the setup level.

When this function is used, the following is performed for the gain mode setting.

-133 to +255 LSB@12-bit

## Variable Line Rate

You can set the line rate to 1L or more.

This function can be used to match the scanning speed of the camera to the feeding speed of the object or to lengthen the accumulation time to increase sensitivity.

- Variable range: 66 Hz to 199.5 kHz (5  $\mu$ s to 15.13 ms)
- Variable unit: 10 ns (1clk)
- Supported operation modes: Exposure Mode OFF / internal trigger  
Exposure Mode Timed / internal trigger

- ❖ You can also save the setting and have it applied whenever the power is subsequently turned on, but this requires additional operations.
- ❖ Switching and settings storage for this function is performed via serial communication.
- ❖ The black level will change depending on the line rate, so be sure to readjust the black level after changing the line rate or trigger period.

## ■ Auto line rate configuration function

You can automatically configure the optimal line rate when you want to prioritize sensitivity.

- Supported operation modes: When Trigger Mode OFF, Exposure Mode OFF.
- ❖ You can also save the setting and have it applied whenever the power is subsequently turned on. For details on saving the setting, see “Step 7: Saving the Settings” (page 17) .

## Electronic Shutter

When you use this function, you can set the exposure to a preconfigured accumulation time, regardless of the line rate.

- Variable range: 1.8  $\mu$ s to 15.148 ms
- Variable unit: 1.0  $\mu$ s (1clk)
- Supported operation modes: When Trigger Mode ON, Exposure Mode Timed
- ❖ Actual exposure time is the value set in [Exposure Time] minus 1.2 $\mu$ s.

### Caution

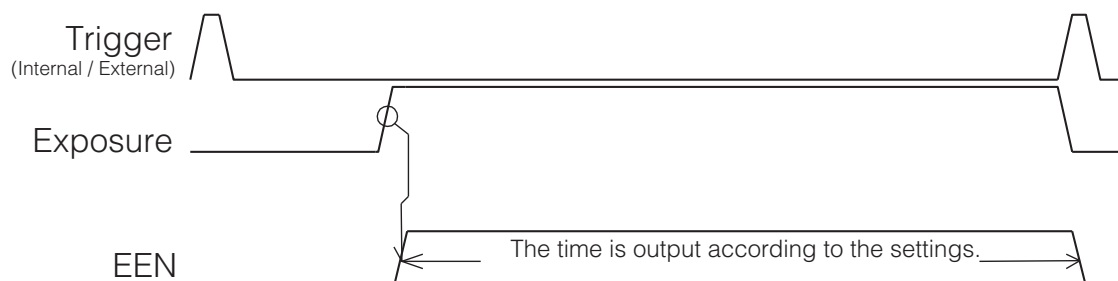
In “Trigger Mode OFF, Exposure Mode Timed” mode, the line rate configured will be the maximum value at which the shutter operates. However, in “Trigger Mode ON, Exposure Mode Timed” mode, the input trigger period will be the maximum value.

- ❖ You can also save the setting and have it applied whenever the power is subsequently turned on, but this requires addition operations.
- ❖ Switching and settings changing and storage for this function is performed via serial communication.

## EEN (Exposure Enable) Function

Perform external output for the timing at which video is accumulated to the sensor.  
The signal is output to the DC IN / trigger IN connector (12-pin round) and the DIGITAL I/O 1 video output connector (Camera Link).

### Example: Output to the DIGITAL I/O 1 video output connector (Camera Link)



- ❖ The negative polarity is output to the DC IN / trigger IN connector (12-pin round), and the positive polarity is output to the DIGITAL I/O 1 video output connector (Camera Link). The polarities cannot be changed.

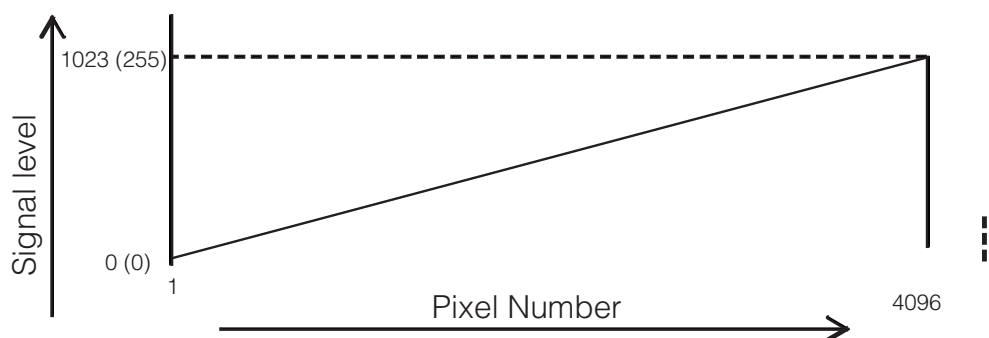
## Test Pattern Function

You can display the following types of test patterns. Video output is not possible while a test pattern is being executed.

This function is not dependent on gain and offset values that have already been configured, and output is performed in the following states.

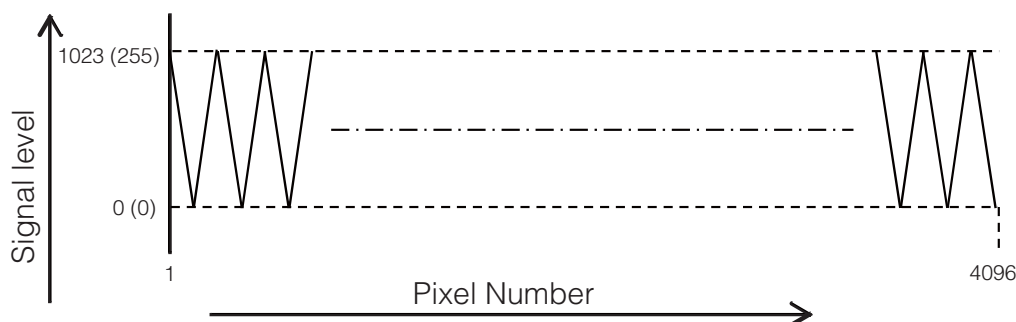
- ❖ Switching for this function is performed via serial communication.
- ❖ This function cannot be saved as the initial state of the camera.

### ■ 1: Gray 1



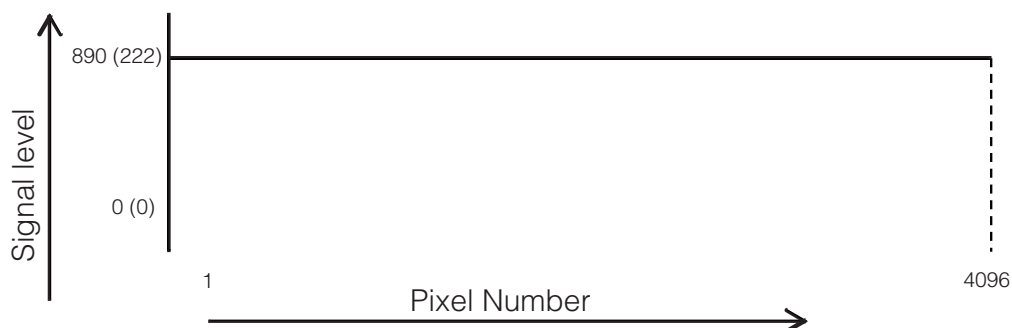
Values in parentheses indicate those during 8-bit output.

### ■ 2: Gray 2



Values in parentheses indicate those during 8-bit output.

### ■ 3: White (890LSB)



Values in parentheses indicate those during 8-bit output.

## RS-232C Command Control

The basic control parameters are as follows.

Item	Control parameter
Scanning	Independent scanning for all pixels, binning
Electronic Shutter	Accumulation time
Gain	Gain Value
Black	Black offset value
Trigger	Mode, trigger polarity selection
Miscellaneous	Camera Link: 8- ⇔ 10-bit switching Test pattern: ON ⇔ OFF


## Field Upgrade Function

You can update the firmware using the dedicated update tool via Camera Link serial communication.

❖ Serial communication via the DC IN / trigger IN connector (12-pin round) is not supported for this function.

# Settings List

## Control Tool

: Settings that can only be configured when image capture on the camera is stopped.

Item		Setting range	Default value	Description
a) Device Control				
GenCP Version		—	—	Display/configure information related to the device.
Device Vendor Name		—	“JAI Ltd., Japan”	Display the manufacturer name.
Device Model Name		—	SW-4000M-PMCL	Display the model name.
Device Manufacturer Info		—	“See the possibilities”	Display the manufacturer information.
Device Version		—	—	Display the device version.
Device ID		—	—	Display the device ID.
Device User ID		Any	—	Set the user ID for the camera.
Device Scan Type		Linescan	Linescan	Display the scan type of the camera.
Device Temperature Selector		Sensor	Sensor, Sensor Board Bottom, Interface Board Bottom, FPGA	Display the location of the temperature sensor inside the camera.
Device Temperature (Celsius)		—	—	Display the internal temperature (°C) of the camera.
Device Clock Selector		Camera Link	Camera Link	Select the camera clock.
Device Clock Frequency		84.82MHz, 63.39MHz, 42.41MHz, 31.70MHz	42.41MHz	Select the clock frequency for the camera.
Device Serial Port BaudRate		Baud 9600, Baud 19200, Baud 38400, Baud 57600, Baud 115200	Baud 9600	Select the baud rate for the camera's serial board.
Device Reset		—	—	Reset the device.
b) Image Format Control				
Pixel Format		Mono8 Mono10	Mono8	Set the pixel format.
Test Pattern		Off, Monochrome, GrayPattern, White	Off	Select the test image.
Binning Vertical		1, 2	1	Set the number of pixels in the vertical direction for which to perform binning.
c) Acquisition Control				
Trigger Selector		Line Start	Line Start	Select the trigger operation.
	Trigger Mode	Off, On	Off	Select the trigger mode.
	Trigger Source	CC1(Camera Link), Hirose 12Pin(TTL)	—	Select the trigger signal source.
	Trigger Activation	Rising Edge, Falling Edge	Falling Edge (Falling edge of input signal)	Select the polarity of the trigger signal (i.e., location of signal at which trigger is applied).
	Trigger OverLap	Off, ReadOut	Off	Select the trigger overlap operation.
Acquisition Line Rate		66 to 10058 <sup>**</sup>	10000	Set the line rate as a frequency. (unit: Hz)
Exposure Mode		Off, Timed, Trigger Width	Timed (control via exposure time)	Select the exposure mode.
Exposure Time		3 to 97 <sup>**</sup>	97	Set the exposure time. The maximum value when [Trigger Mode] is set to [Off] varies depending on the [Acquisition Line Rate Raw] value.
d) Analog Control				
Configure analog control settings.				

<sup>\*1</sup> Setting range depending on the Tap Geometry and CL Pixel Clock settings..

Item	Setting range	Default value	Description
Black Level Selector	All	All	
Black Level	-133 to 255	0	Set the black level value.
Gain Selector	Digital All	Digital All	
Gain	1 to 16	1	Set the gain value by multipliers.
Analog Base Gain	0dB, 6dB, 9.54dB, 12dB	0dB	Set the analog base gain.
<b>e) LUT Control</b>			Configure LUT settings.
JAI LUT Enable	Off, LUT, Gamma	Off	Select the JAI LUT mode.
Gamma	0.45 to 1	0.45	Set the gamma value.
LUT Selector	Luminance	Luminance	Display the LUT data type.
LUT Index	0 to 256	0	Set the LUT index table number.
LUT Value	0 to 4096	4096	Set the LUT value.
<b>f) Transport Layer Control</b>			Display information on the transport layer.
Device Tap Geometry	Geometry_1X2, Geometry_1X3, Geometry_1X4, Geometry_1X8, Geometry_1X10	Geometry_1X2	Set the transfer method (tap configuration) of images transferred from the camera at one time.
CL Configuration	Base	Base	Display the Camera Link configuration.
CL Time Slots Count	One	One	Display the Camera Link time slot counter.
<b>g) Digital IO Control</b>			Configure settings for digital input/output.
Line Selector	Line1 - TTL Out	Line1 - TTL Out	Select the input/output to configure.
Line Mode	Output	Output	Display the input/output status (whether it is input or output).
Line Format	TTL	TTL	Display the current I/F type.
Line Source	Low, High, Exposure Active(XEEN), LVAL, Line4 - TTL In, Line7 - CC1	Exposure Active(XEEN)	Select the line source signal for the item selected in [Line Selector].
<b>h) User Set Control</b>			Configure user settings.
User Set Selector	Default, User Set1 to User Set3	Default (factory default values)	Select the user settings.
User Set Load	—	—	Load user settings.
User Set Save	—	—	Save the current setting values as user settings.
<b>i) JAI Custom Control</b>			Configure JAI proprietary function settings.
Auto Line Rate Reference			Set the reference value used when performing automatic level control using line periods.
Auto Line Rate	—	—	Adjust the line rate to achieve the brightness of the reference value. This functions only when [Exposure Mode] is set to [Off].
Auto Reset Mode	On, Off	Off	Set the Auto Reset Mode
Pixel Black Correct	Factory area, User area	User area	
Pixel Black Direct			
Pixel Gain Correct	Factory area, User area	User area	
Pixel Gain Direct			
Shading Correct	Off, Factory area, User area	Off	
Shading Direct			
Shading Direct Status	Succeeded		
Pixel Gain Direct Status	Succeeded		
Pixel Black Direct Status	Succeeded		
Sensor Select	4K-A, 4K-B	4K-A	Configure the operation modes. 4K-A: Mode A (Pixel size: 7.5 μm x 7.5 μm) 4K-B: Mode B (Pixel size: 7.5 μm x 10.5 μm)

# Miscellaneous

## Troubleshooting

Check the following before requesting help. If the problem persists, contact your local JAI distributor.

### ■ Power supply and connections

Problem	Cause and solution
The POWER/TRIG LED remains lit amber and does not turn green, even after power is supplied to the camera.	<ul style="list-style-type: none"> <li>• A drop in voltage may have occurred due to the length of the power cable. Check whether input voltage specification for the camera is being met.</li> <li>• Check that the sufficient power is being provided at the power supply in regards to the camera's power usage.</li> <li>• Check the power cable connection.</li> </ul>

### ■ Image display

Problem	Cause and solution
Gradation in dark areas is not noticeable.	Use the gamma function to correct the display. As the light-emitting properties of the monitor are not linear, the entire image may be darker or the gradation in the dark areas may be less noticeable when camera outputs are displayed without processing. Using the gamma function performs correction to produce a display that is close to linear. For details, see "LUT (Lookup Table) / Gamma Function" (page 33).

### ■ Settings and operations

Problem	Cause and solution
I want to restore the factory default settings.	To restore the factory default settings, select [Load settings] in the [Settings] menu of the [SW-4000M-PMCL Control Tool] window, select [Factory] in the dialog box that appears, and click [OK].



## Specifications

Image sensor	Model		ELITE 4K 1V2
	Effective pixels		4096(H)
	Pixel size		A: 7.5 μm × 7.5 μm B: 7.5 μm × 10.5 μm
Camera Link clock	31.70/42.41/63.39/84.82 MHz		
Line rate	66 Hz - 199.5 kHz		
Video S/N ratio	60 dB or more (when Gain = 0 dB) at 10-bit		
PRNU	Post-correction: Within ±5% (during 100% output)		
DSNU	Post-correction: Within ±5% (during 0% output)		
Gain	Analog Base Gain: 0 dB, 6 dB, 9.54 dB, 12 dB Digital: x1 to x16 (0 dB to +24 dB)		
Black level (user settings)	Manual -133 to +255 LSB (during 12-bit) Default setting: Output black level (33LSB at 12-bit)		
Image output	Digital video output (Camera Link) Base: 1 × 2, 1 × 3 Medium: 1 × 4 Full: 1 × 8 (8-bit) 80bit: 1 × 8 (10-bit), 1 × 10 (8-bit) ❖ Factory default values: 1 × 2, 8-bit		
Variable line rate	Supported (for Exposure Mode OFF mode / internal trigger mode or Shutter select mode / internal trigger mode) Variable range: 66 Hz to 200 kHz Variable unit: 10 ns ❖ The black level may vary with longer line rates, due to the increase in dark currents.		
Electronic shutter	Supported (during shutter select mode) Variable range: 1.8 μs to 15.148 ms Variable unit: 1.0 μs		
Test pattern	Available 1: Gray 1 2: Gray 2 3: White (890LSB)		
Synchronization	Internal		
Image processing	① Pixel sensitivity correction: Pixel correction (DSNU, PRNU) ② Shading correction: ON/OFF switchable Flat Field correction possible. ③ LUT/Gamma function: 1.00 (OFF) / 0.45 / User (LUT) selectable When set to User, table data can be applied from externally. Table data can be configured individually.		
Operation mode	<ul style="list-style-type: none"><li>Exposure Mode OFF mode (Internal/External trigger)</li><li>Shutter select mode (Internal/External trigger)</li><li>PWC (External trigger)</li></ul>		
Trigger inputs	12-pin: 3.5 ± 1.5 V (p-p) TTL input Camera Link: LVDS (CC1) Positive / negative logic switchable. Minimum trigger width: EPS 3 μs or more / PWC 3 μs or more ❖ Use either 12-pin or Camera Link for trigger inputs.		
Synchronous output (when the terminal is open)	Camera Link	<ul style="list-style-type: none"><li>LVAL (Camera Link Tx24)</li><li>DVAL (Camera Link Tx25)</li><li>EEN (Camera Link Tx26)</li></ul>	
	12-pin	<ul style="list-style-type: none"><li>XEEN (negative logic) 4.0 Vp-p (when there is no termination)</li></ul>	
Communication interface	EIA-644: Camera Link CC1 RS-232C: 12-pin Communication rate: 9600 bps (Default), 19200bps, 38400bps, 57600bps, 115200bps		
Field update	Supported		

Power supply voltage	DC input range: +12 V to 24 V $\pm$ 10% 5.22 W typical (current consumption at DC +12 V supply)	
Lens mount	M42 mount, F mount	
Flange back	M42 mount: 16 mm (in air), tolerance: 0 mm to -0.05 mm F mount: 46.5 mm, tolerance: 0 mm to -0.05 mm	
Optical axis accuracy	Center $\pm$ 0.5 mm (Max)	
Operating temperature / humidity	-5°C to +45°C / 20% to 80% (non-condensing)	
Storage temperature / humidity	-25°C to +60°C / 20% to 80% (non-condensing)	
Vibration resistance	10G (20 Hz to 200 Hz XYZ directions)	
Impact resistance	80G	
Standard compliance	CE (EN61000-6-2, EN61000-6-3) RoHS/WEEE FCC Part15 Class B	
Dimensions	62 x 62 x 84 mm (WHD) (F mount, excluding protrusions) 62 x 62 x 53.5 mm (WHD) (M42 mount, excluding protrusions)	
Weight	320 g	
Connectors / LEDs	Mini Camera Link (SDR Type)	Model: HDR-EC26FYTG2-SLT $\times$ 2 Function: video output / communication / external trigger / EEN ❖ Positive polarity for EEN (polarity switching not possible)
	12-pin	Model: HR10A-10R-12PB (71) Function: power supply input / communication / external trigger / EEN ❖ Negative polarity for EEN (polarity switching not possible)
	Rear panel LED	Model: SPR-39MVWF Function: operation display / trigger input display

❖ In this document, the "X" in the XEEN represents the negative polarity.

**Package contents**

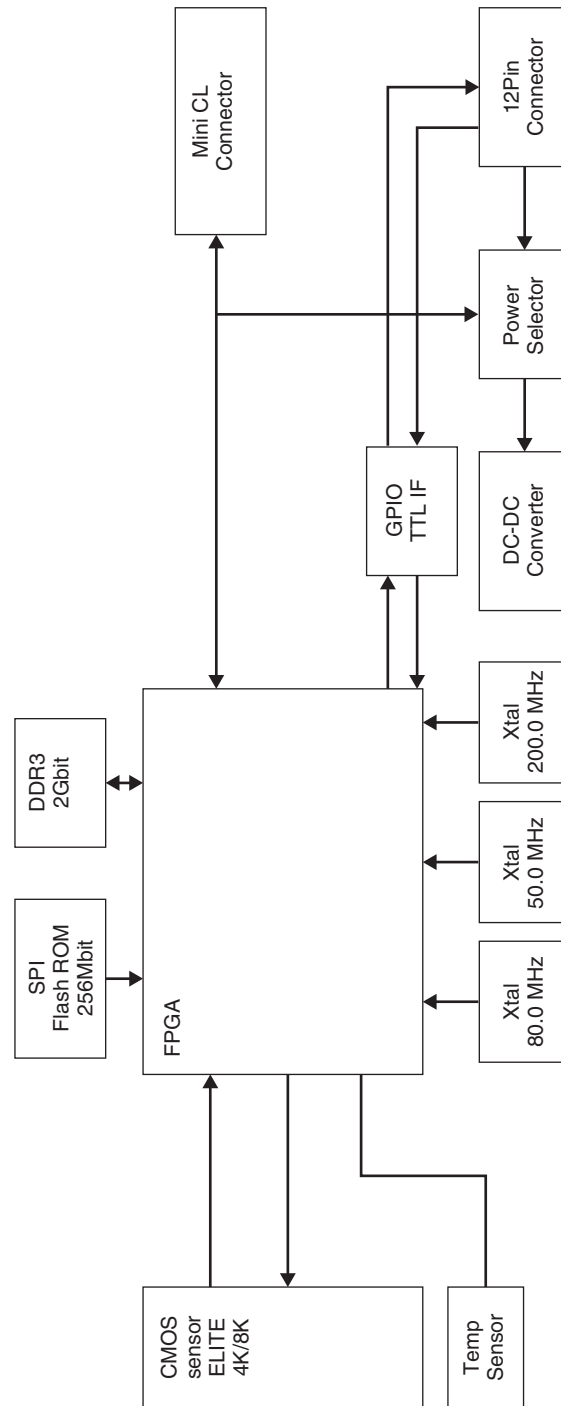
Camera body (1)

Sensor protection cap (1)

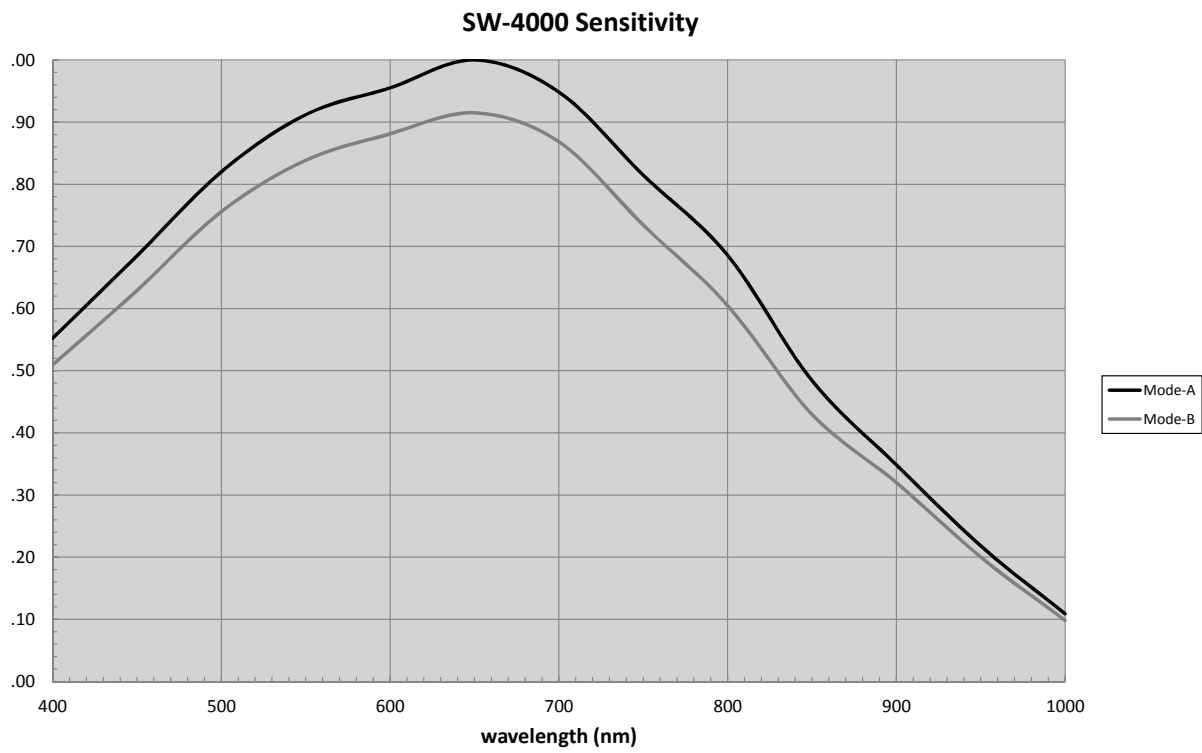
Dear Customer (sheet) (1)

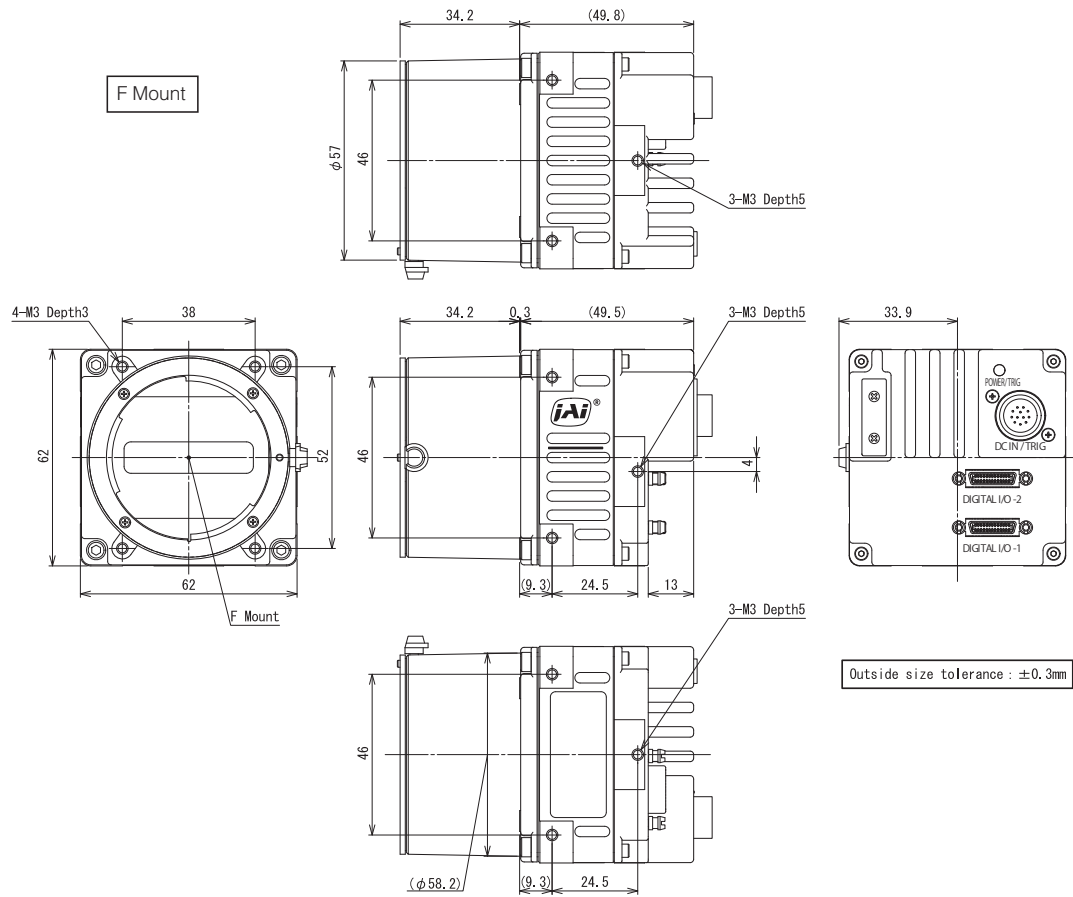
Design and specifications are subject to change without notice.

## Block Diagram



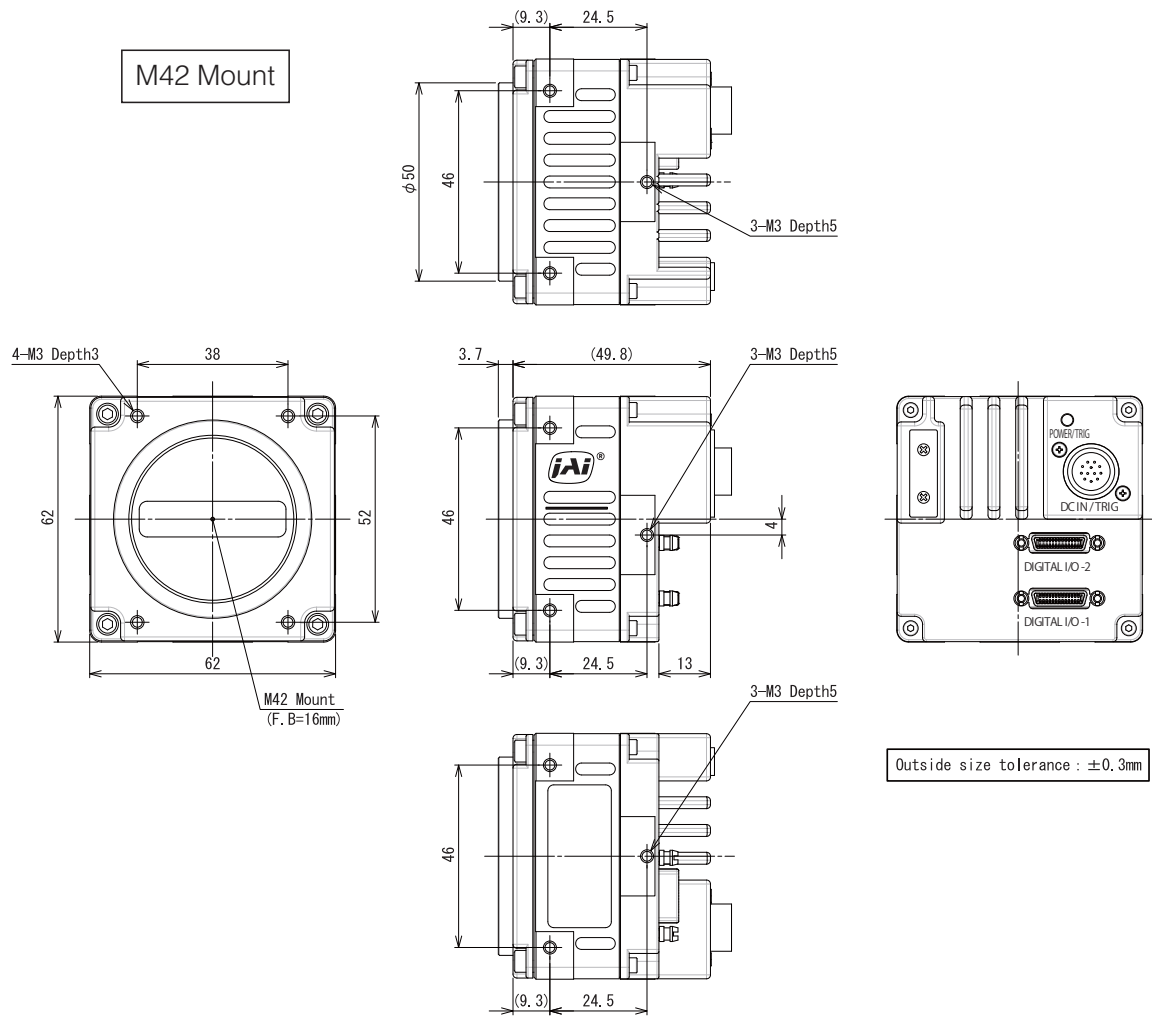
## Spectral Response





Dimensional tolerance:  $\pm 0.3\text{ mm}$   
Unit: mm

## Dimensions



Dimensional tolerance:  $\pm 0.3$  mm  
Unit: mm

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## Revision history

[illegible]