See the possibilities

User Manual

SP-20000M-PMCL
SP-20000C-PMCL

CMOS Digital Progressive Scan
Monochrome and Color Camera with Mini Camera Link Interface

Document Version: 3.1
Date: 2024-02-07

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.

Table of Contents

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.

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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 SP-20000M-PMCL and SP-20000C-PMCL 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

상 호:	JAI Ltd. Japan
기자재명칭:	Industrial Camera
모 델 명:	SP-20000M-PMCL
제조자 및 제조국가:	JAI Ltd., Japan / JAPAN

MSIP-REM-JAi-SP-20000M-PMCL

상 호:	JAI Ltd. Japan
기자재명칭:	Industrial Camera
모 델 명:	SP-20000C-PMCL
제조자 및 제조국가:	JAI Ltd., Japan / JAPAN

MSIP-REM-JAi-SP-20000M-PMCL

제조년월은 제품상자의 라벨을 참조하십시오.

China RoHS

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『电器电子产品有害物质限制使用管理办法』， 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)
SP-20000M-PMCL SP-20000C-PMCL	×	○	○	○	○	○

○: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

EMVA1288

With regard to signal-to-noise ratio in this manual, specifications measured by EMVA 1288 are used together with specifications by a traditional measurement method.

EMVA 1288 is a more complete measurement that considers multiple noise sources, including random noise, pattern noise, and shading. Additionally, EMVA 1288 incorporates temporal variances in pixel output by capturing 100 frames of data and computing the RMS variations over the captured frames. Because of the comprehensive nature of the noise analysis and the additional consideration for RMS variances over time, EMVA 1288 SNR measurements are inherently lower than the traditional SNR measurements given by manufacturers. However, the comprehensive nature combined with rigid test parameters, means that all manufacturers' are measuring their products equally and EMVA 1288 tested parameters can be compared among different manufacturers' products.

In order to learn more about EMVA 1288, please visit www.emva.org.

Frame Grabber Board

This camera complies with "Power over Camera Link" which enables power to be supplied to the camera through the Camera Link cable(s). Because the power requirements of the camera exceed the amount of power which can be provided over a single PoCL connection, power must be supplied via both Camera Link cables in order to utilize the PoCL capabilities. If you plan to use this function, please be sure that the frame grabber board you are using also complies with this specification. Alternatively, the camera can be powered via a separate power supply connected to the 12-pin Hirose connector.

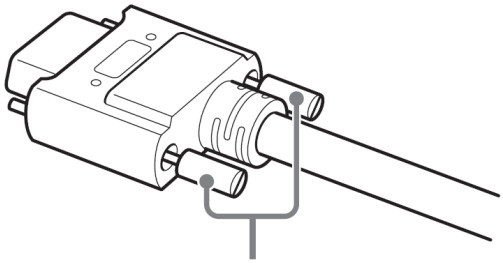
This camera employs output formats which comply with the GenICam® standard. They are 1X8-1Y (8-Tap output), 1X4–1Y (4-Tap output) and 1X2–1Y (2-Tap output). 1X8–1Y, 1X4-1Y and 1X2–1Y are available for 8-bit and 10-bit. Please check if the frame grabber used in the system complies with the mentioned formats.

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 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.

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.

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

This camera provides both high resolution and a high frame rate with excellent image quality for machine vision applications. The SP-20000M-PMCL is a monochrome progressive scan CMOS camera and the SP-20000C-PMCL is the equivalent Bayer mosaic progressive scan CMOS camera. Both are equipped with CMOS sensors offering a 35 mm full size image format, a resolution of 20 million pixels, and a 4:3 aspect ratio. They provide 30 frames per second for 1X8–1Y output format continuous scanning with 5120 x 3480 full pixel resolution for both monochrome and raw Bayer output.

8-bit, 10-bit or 12-bit output can be selected for both monochrome and raw Bayer formats. The new cameras feature a Mini Camera Link interface which is capable of supporting a “Power over Camera Link” capability. A full pixel readout or partial scan readout mode can be selected depending on applications. The readout format is available from 8-tap, 4-tap or 2-tap output.

This camera has 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. They also provide a new HDR (High Dynamic Range) function.

The latest version of this manual and Control Tool can be downloaded from: www.jai.com

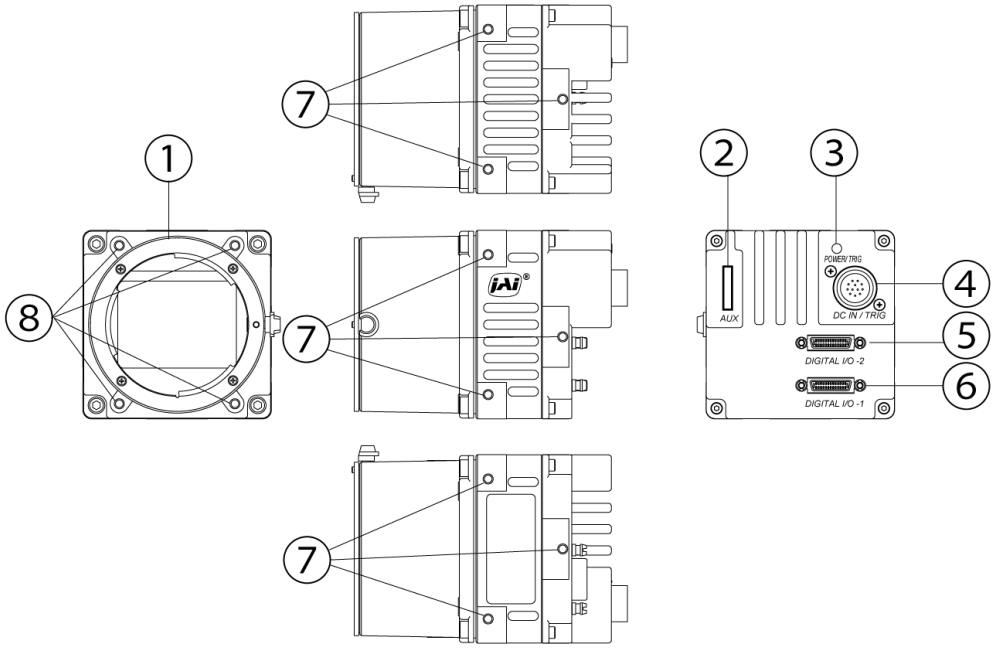
For camera revision history, please contact your local JAI distributor.

Main features

- New Spark Series, 35mm full size, CMOS 20-megapixel progressive scan camera with global shutter
- Utilizes Mini Camera Link interface in Medium or Full configurations
- Aspect ratio 4:3, 5120(H) x 3480(V) - 20 million effective pixels
- 6.4 µm square pixels
- S/N 53dB for monochrome and 51dB for color
- 8-bit, 10-bit or 12-bit output for monochrome and Bayer
- 30 frames/second with full resolution in continuous operation for 8-tap output,
- 15 frames/second for 4-tap output and 7.5 fps for 2-tap output for both monochrome and Bayer
- Vertical and horizontal binning on monochrome model
- Supports ROI (Region Of Interest) modes for faster frame rate
- 0dB to +24dB gain control for both SP-20000M-PMCL and SP-20000C-PMCL
- 304 µs (1/3290) to 8 seconds exposure control in 1 µs step
- Auto exposure control

- Timed and trigger width exposure control
- PIV and sequential trigger modes for specific applications
- ALC control with combined function of AGC and auto exposure
- Various pre-processing circuits are provided: Programmable LUT, Gamma correction from 0.45 to 1.0, Shading correction, Bayer white balance with manual or one-push auto (color model only), Blemish compensation
- Auto iris lens video output with H-sync
- New Hirose 10P connector for TTL IN and OUT and LVDS IN interface
- F-mount for lens mount
- Accepts power over Mini Camera Link or via 12-pin connector

Parts Identification



① Lens Mount (F-Mount or M42A-Mount)
② AUX connector (10-Pin)
③ POWER/TRIG LED
④ DC IN / Trigger IN Connector (12-pin Round)
⑤ ⑥ Camera Link Connector 2 & 1
⑦ ⑧ Mounting Holes (M3)

① Lens Mount (F-Mount or M42A-Mount)

Mount an F-mount or M42A-mount lens, microscope adapter, etc. here.

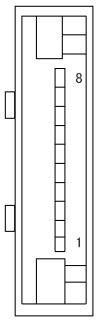
Notes:

- Before mounting a lens, be sure to refer to ① Lens and confirm the precautions for attaching a lens and the supported lens types.
- Rear protrusion on F-mount lens must be less than 40.0 mm. Rear protrusion on M42A-mount lens must be less than 9.0 mm.

② AUX connector (10-Pin)

AUX connector for TTL IN/OUT and LVDS IN.

Type: HIROSE 10-Pin Connector 3260-10S3(55)



No	I/O	Name	Note
1	O	TTL OUT2	Line8
2	O	TTL OUT3	Line9
3	I	TTL IN2	Line10
4		NC	
5		GND	
6	I	LVDS IN1+	Line11
7	I	LVDS IN1-	Line11
8		NC	
9		GND	
10		GND	

③ POWER/TRIG LED

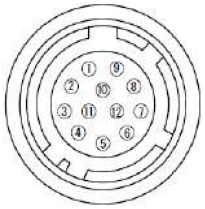
Indicates the power or trigger input status.

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

④ DC IN / Trigger IN Connector (12-pin Round)

Connect the cable for DC IN / Trigger IN here.

Type: HR-10A-10R-12PB(72) Hirose male or equivalent. Use the part number HR10A-10P-12S or equivalent for the cable side.



Hirose 12-pin Connector

No	Signal	Remarks
1	GND	
2	DC Input	+12V ~ +24V
3	GND	
4	Video Iris	For lens auto iris
5	NC	
6	NC	
7	NC	
8	NC	
9	TTL Out 1	Line1 (Note 1)
10	TTL In 1	Line4 (Note 2)
11	DC Input	+12V ~ +24V
12	GND	

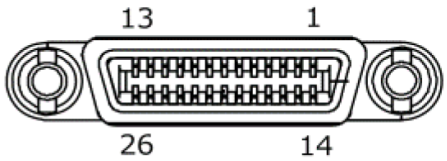
Notes:

- Factory default setting is Exposure Active and negative. Although Exposure Active is positive in the inside of the camera, it is output from TTL Out 1 after being inverted to negative.
- Factory default setting is trigger input.

⑤ ⑥ Camera Link Connector 2 & 1

⑤ Camera Link Connector 2: Digital video output (Medium and Full configuration)

⑥ Camera Link Connector 1: Digital video output (Base, Medium and Full config.)



Type: 26-pin Mini Camera Link connector (Honda HDR-EC26FYTG2-SL+)

Pin No.	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 (-)		CC2 (Reserved)	
11, 24		N.C	
12, 25		N.C	
13, 14		Shield	Power return

Pin	Input Output	Signal	Description
1, 26		Power	Power
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		N.C	
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	Power Return

Caution: This camera supports PoCL, but since the power consumption of the camera exceeds the allowable power consumption of a single cable, please connect two cables when using the camera with PoCL.

⑦ ⑧ Mounting Holes (M3)

Use these holes when attaching an MP-42 tripod adapter plate (optional) or mounting the camera directly to a wall or other structural system.

⑦ M3, Depth 5mm

⑧ M3, Depth 3mm

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 via Control Tool.
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: Configuring Various Other Settings** • Configure other settings as necessary.
7	**Step 7: Save the Settings** • Save the current setting configurations in user memory.

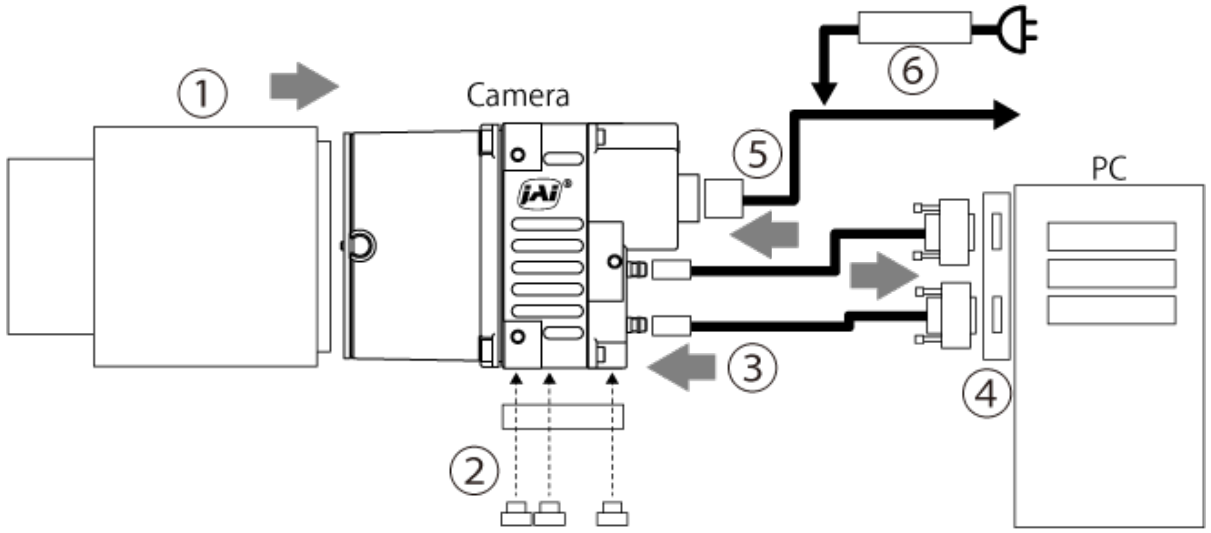
Short ASCII Commands

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 is included in the Short ASCII Command List chapter.

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 Mounting (or Use MP-42 Tripod Adapter Plate)

③ Camera Link Cable

④ Frame Grabber Board

⑤ DC IN / Trigger IN Connection Cable

⑥ AC adapter (Power Supply, If Necessary)

① Lens

- **F-Mount**: F-mount lenses with lens mount protrusions of 40.0 mm or less can be attached.
- **M42A-Mount**: M42A-mount lenses with lens mount protrusions of 9.0 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 (41.0 mm).

Cautions:

- The maximum performance of the camera may not be realized depending on the lens.
- Attaching a lens with a protrusion longer than 40.0 mm for the F-mount or 9.0 mm for the M42A-mount 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 (= 8.5mm)

② Mounting (or Use MP-42 Tripod Adapter Plate)

When mounting the camera directly to a wall or other device, use screws that match the mounting holes on the camera (see ⑦ ⑧ Mounting Holes (M3) for more information).

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 ⑤ ⑥ Camera Link Connector 2 & 1.

> **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 / Trigger IN Connection Cable

Performs external I/O such as power supply and trigger input.

⑥ AC adapter (Power Supply, If Necessary)

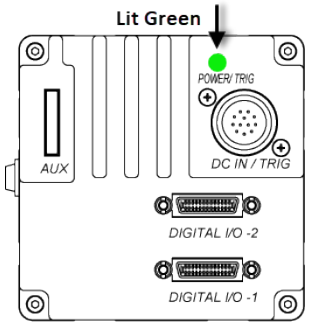
Connect the AC adapter and the round connector of the connection cable to the DC IN / trigger IN connector on the camera.

> **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.



> **Note:** For details on how to read the LEDs, see the ③ POWER/TRIG LED section.

Step 3: Verify the Connection Between the Camera and PC

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	1bit
Parity	None
Xon/Xoff Control	None

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

   If correctly connected, response **DVN = JAI Corporation** 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	5120
	1216	3840
	OffsetX (horizontal position)	0
	OffsetY (vertical position)	0
	PixelFormat	Mono8 (Monochrome model)
		BayerRG8 (Color model)

You can specify the image acquisition area. For details, see “ROI (Regional Scanning Function)”.

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 1200, enter **WTC=1200<CR><LF>**.
3. To change other setting items, please use the Short ASCII command below.

Item	Short ASCII Command	Value
Width	WTC	8 ~ 5120 (8 pixels/step)
Height	HTL	2 ~ 3840 (2 line/step)
OffsetX	OFC	0 ~ 5112 (8 pixels/step)
OffsetY	OFL	0 ~ 3838, 2 line / step
PixelFormat	BA	0: Mono8 (Default), 1: Mono10, 2: Mono12* 0: BayerRG8 (Default), 1: BayerRG10, 2: BayerRG12 **Note:** *Mono12: Geometry_1x4_1Y only.

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.

1. Display the image. Display the image captured by the camera. Please display the image with the viewer on the frame grabber board application.
2. Adjust the Gain. For more information, see Gain Control.
3. Adjust the White Balance. For more information, see Balance White Auto.
4. Adjsut the Black Level. For more information, see Black Level Control.

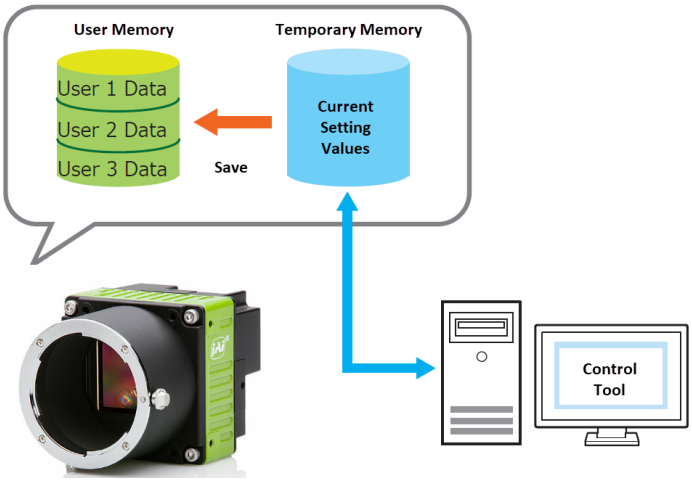
Step 6: Configuring Various Other Settings

See "Short ASCII Command List" and configure settings as necessary.

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

Digital I/O - 2 (1/2)

Camera Link Configuration		Base	Medium	Full	80bit
Camera Link port/bit		2Tap / 12bit	4Tap / 12bit	8 Tap / 8bit	8 Tap / 10bit
GenICam Tap Geometry		1X 2 - 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	Medium	Full	80bit
Camera Link port/bit		2Tap / 12bit	4Tap / 12bit	8 Tap / 8bit	8 Tap / 10bit
GenICam Tap Geometry		1X 2 - 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:

- In this table, all Tap Geometry items are not described. For instance, 1X2–1Y and 1X4–1Y show 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.
- Please check whether the frame grabber complies with those formats if you use 80-bit (8Tap/10-bit) camera configuration.

- If you use 80-bit (8Tap/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

Related Setting Items: JAI Custom

This camera uses the Camera Link pixel clock of 80 MHz as the default setting. It can be changed (SensorClockFrequency).

Camera Link Pixel Clock Frequency	Tap Geometry	Camera Link Configuration
80 MHz	1X8-1Y	80 bit, Full (Default)
	1X4-1Y	Medium
	1X2-1Y	Base
60 MHz	1X8-1Y	80 bit, Full
	1X4-1Y	Medium
	1X2-1Y	Base

Note: If the Camera Link pixel clock is changed, the output is immediately changed but it may take a few seconds for the output signal to be stable.

GPIO (Digital Input/Output Settings)

> **Related Setting Items:** Digital IO Control

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

Line Selector

Line Selector	Description
Line 1 TTL 1 Out	TTL output from # 9 pin of DC In/Trigger 12-Pin on the rear
Line 8 TTL 2 Out	TTL output from #1pin “AUX” HIROSE 10-Pin on the rear
Line 9 TTL 3 Out	TTL output from #2pin “AUX” HIROSE 10-Pin on the rear
NAND 0 In 1	First input at NAND first gate in GPIO
NAND 0 in 2	Second input at NAND first gate in GPIO
NAND 1 In 1	First input at NAND second gate in GPIO
NAND 1 in 2	Second input at NAND second gate in GPIO

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.

- 0: Low, 1: High, 3: FrameTrigger Wait, 4: FrameActive, 5: ExposureActive, 6: Fval, 8: PulseGenerator0, 9: PulseGenerator1, 10: PulseGenerator2, 11: PulseGenerator3, 12: TTL_In, 13: CL_CC1_In, 14: Nand0, 15: Nand1, 16:TTL_In2, 17:LVDS_In

> **Note:** As for LVAL, some line items cannot be connected. Refer to “Operation and Function Matrix.”

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)

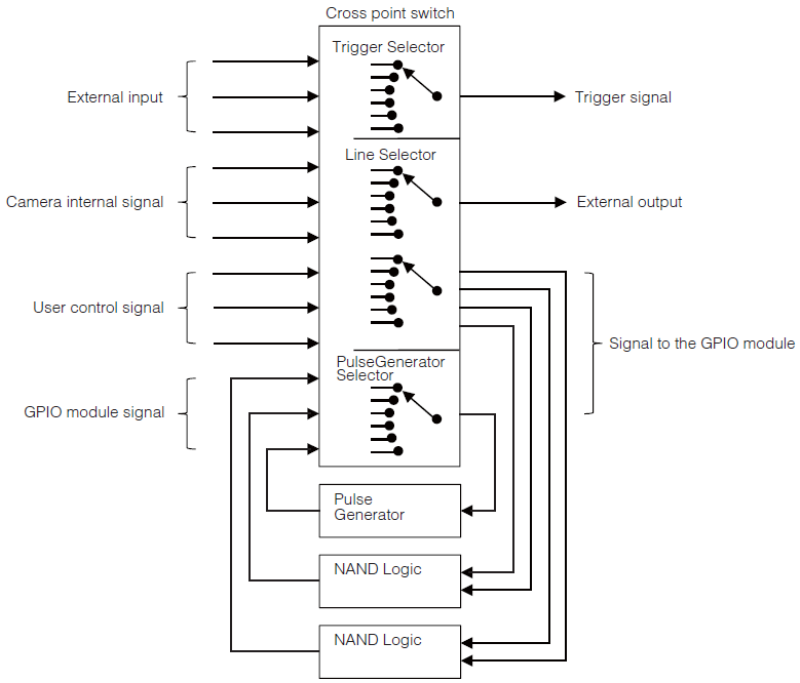
Line Format

Controls the format of the line item selected in Line Selector.

GPIO

GPIO is a general interface for input and output and 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.

GPIO Block Diagram



Input and Output Matrix Table

The relation between input and output is as follows.

		Selector (Cross point switch output)										
Source signal (Cross point switch input)	Trigger Selector	Line Selector							Pulse Generator Selector			
	Trigger Source (Frame Start)	Line 1 - 12P TTL Out	Line 8 - TTL 2 Out	Line 9 - TTL 3 Out	NAND 1 In 1	NAND 1 In 2	NAND 2 In 1	NAND 2 In 2	Pulse Generator 0	Pulse Generator 1	Pulse Generator 2	Pulse Generator 3
Low	●	●	●	●	●	●	●	●	●	●	●	●
High	●	●	●	●	●	●	●	●	●	●	●	●
Soft Trigger	●											
Exposure Active		●	●	●	●	●	●	●	●	●	●	●
Frame Trigger Wait		●	●	●	●	●	●	●	●	●	●	●
Frame Active		●	●	●	●	●	●	●	●	●	●	●
FVAL		●	●	●	●	●	●	●	●	●	●	●
LVAL		●	●	●	●	●	●	●	●	●	●	●
Pulse Generator 0	●	●	●	●	●	●	●	●		●	●	●
Pulse Generator 1	●	●	●	●	●	●	●	●	●		●	●
Pulse Generator 2	●	●	●	●	●	●	●	●	●	●		●
Pulse Generator 3	●	●	●	●	●	●	●	●	●	●	●	
Line 4 - TTL In1	●	●	●	●	●	●	●	●	●		●	●
Line 7 - CL CC1 in	●	●	●	●	●	●	●	●	●		●	●
NAND 0 Out	●	●	●	●			●	●	●	●	●	●
NAND 1 Out 1	●	●	●	●	●	●			●	●	●	●
Line 10 - TTL 2 In	●	●	●	●	●	●	●	●	●	●	●	●
Line 11 - LVDS 1 In	●	●	●	●	●	●	●	●	●	●	●	●
	Trigger Source	Line Source							Pulse Generator Clear Source			

●	Supported
	(Empty) Not Supported

Pulse Generator

Related Setting Items: JAI Custom

This camera has a frequency divider using the sensor clock as the basic clock and four pulse generators. In each Pulse Generator, various Clear settings are connected to GPIO.

The following shows Pulse Generator default settings.

Display Name	Value						
Clock Pre-scaler	1 (Divide Value)						
Pulse Generator Selector	Pulse Generator						
	Length	Start Point	End Point	Repeat Count	Clear Source	Clear Activation	Clear Sync Mode
Pulse Generator 0 ~ 3	1	0	1	0	Low	Free Run	Async Mode

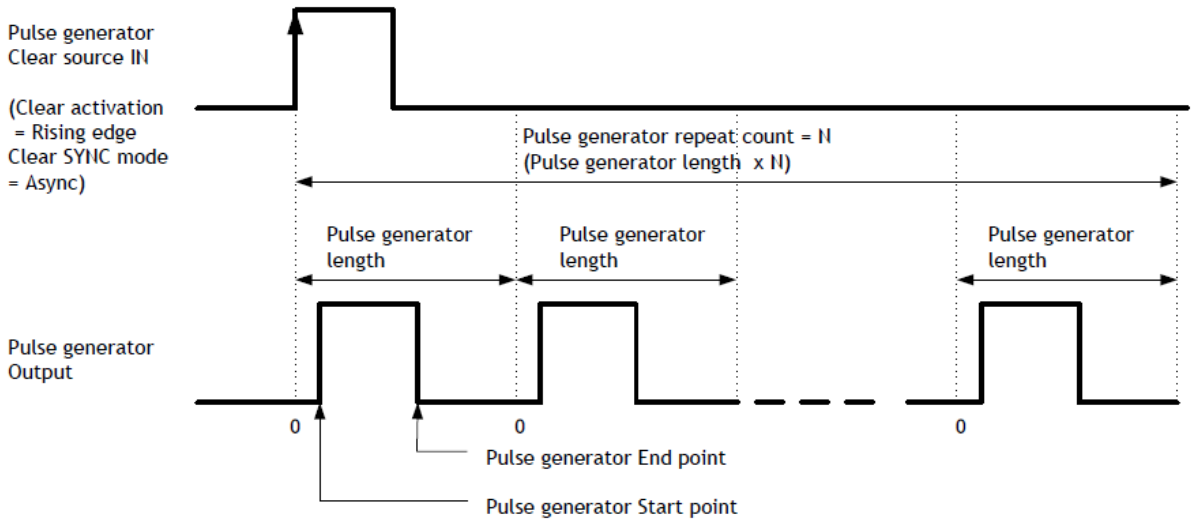
Note: When Pulse Generator Repeat Count is set to “0”, the camera is operating in free-running mode.

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. Four built-in pulse generators work by the same clock. On this camera, the sensor pixel clock is 39.16 MHz.

Pulse Generator Selector

This is where you select one of the 4 pulse generators in order to set or modify its parameters. When a Pulse Generator (Pulse Generator 0 ~ 3) is selected, Length, Start Point, End Point, Repeat Count, Clear Activation, and Sync Mode are displayed.



Pulse Generator Length

Set the counter up value for the selected 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 selected 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 selected pulse generator.

Pulse Generator Repeat Count

Set the repeating number of the pulse for the selected 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 free-running counter.

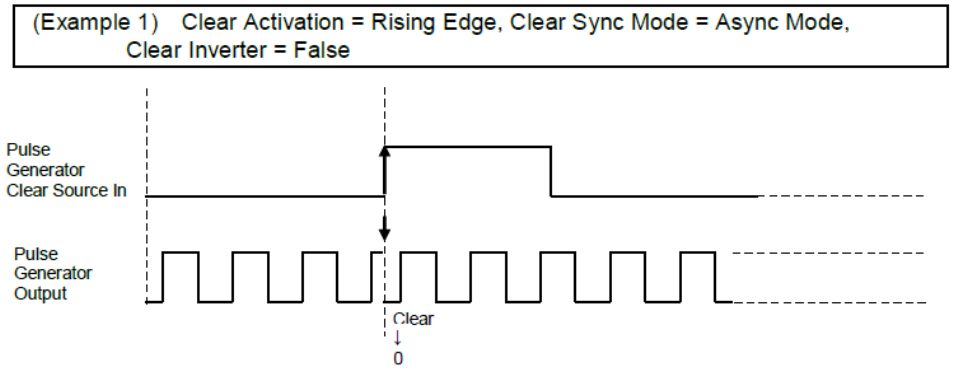
Pulse Generator Clear Activation

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

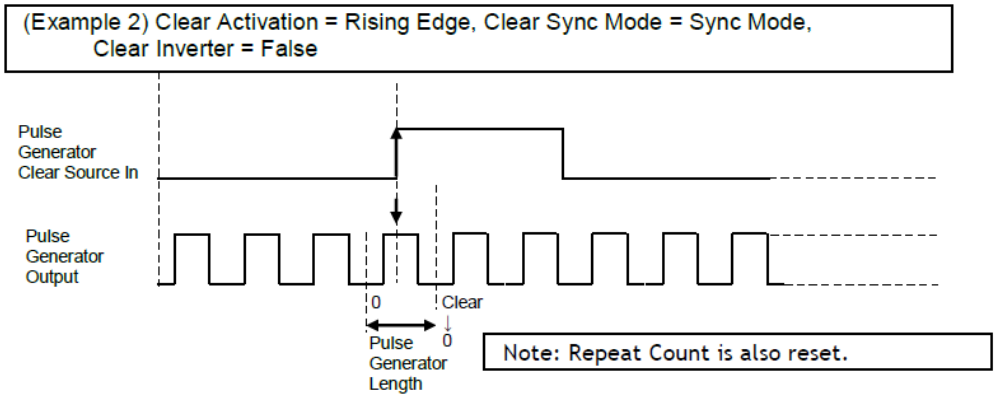
Pulse Generator Clear Sync Mode

Set the count clear method for the selected 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.

- 0:Low, 1:High, 3: FrameTriggerWait, 4: FrameActive, 5: ExposureActive, 6: Fval, 8: PulseGenerator0, 9: PulseGenerator1, 10: PulseGenerator2, 11: PulseGenerator3, 12: TTL_In1, 13: CL_CC1_In, 14: Nand0, 15: Nand1, 16: TTL_In2, 17: LVDS_In

> **Note:** The pulse generator output cannot be used as the clear input to the same pulse generator. Refer to "Input and Output Matrix Table".

Pulse Generator Inverter

Clear Source Signal can have polarity inverted.

Pulse Generator Setting Parameters

Display Name	Value
Clock Pre-scaler	1 to 4096
Pulse Generator Clock (MHz)	[Pixel Clock:39.16MHz] ÷ [Clock Per-scaler]
Pulse Generator Selector	Pulse Generator 0 ~ 3
Pulse Generator Length	1 to 1048575
Pulse Generator Length (ms)	([Clock Source] ÷ [Clock Per-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 Per-scaler]) $^{-1}$ x [Pulse Generator Start Point]
Pulse Generator End Point	1 to 1048575
Pulse Generator End Point (ms)	([Clock Source] ÷ [Clock Per-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	0: Free Run, 1: Level High, 2: Level Low, 3: Rising Edge, 4: Falling Edge
Pulse Generator Clear Sync Mode	0: Async Mode, 1: Sync Mode
Pulse Generator Clear Source	0: Low, 1: High, 3: Acquisition Trigger Wait, 4: FrameActive, 5: ExposureActive, 6: FVAL, 7: LVAL, 8: PulseGenerator0*, 9: PulseGenerator1*, 10: PulseGenerator2*, 11: PulseGenerator3*, 12: TTL_In1, 13: CL_CC1_In, 14: nand0, 15: nand1, 16: OPTTL in2, 17: OPLVDS in
- Pulse Generator Inverter (Polarity) Pulse Generator Clear Inverter	0: Non-Inv, 1:Inv

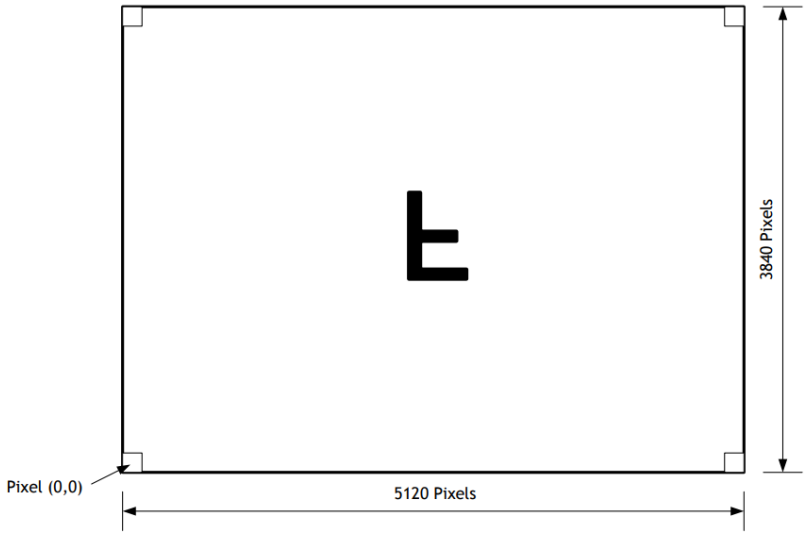
Notes:

1. If Pulse Generator Repeat Count is set to “0”, the pulse generator works in free-running mode.
2. The output of the same pulse generator cannot be connected to Clear input.
3. If the Camera Link pixel clock is changed, the pixel clock of the pulse generator remains 39.16 MHz.

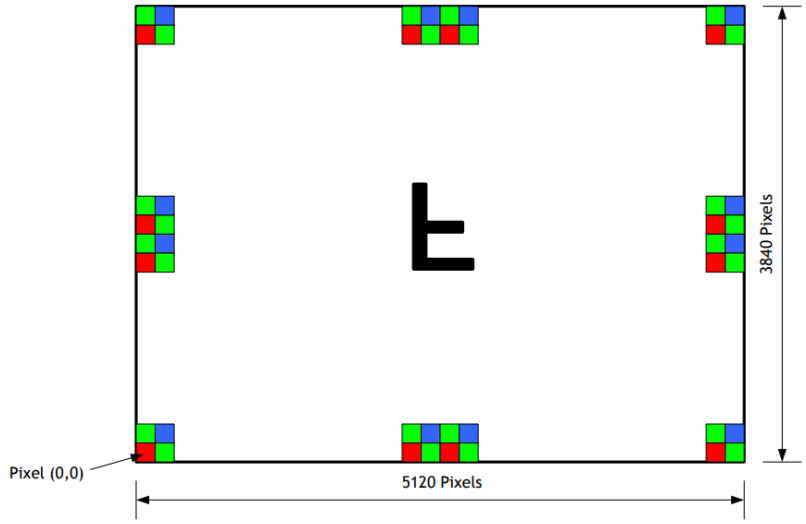
Sensor Layout

The CMOS sensors used on this camera have the following pixel layout.

Monochrome Sensor



Bayer sensor



Camera Output Format (Tap Geometry)

Related Setting Items: Transport Layer Control

This camera supports the following output format.

Camera Output Format	Pixel Format
1X2 – 1Y	8 bit, 10 bit, 12 bit
1X4 – 1Y	8 bit, 10 bit, 12 bit
1X8 – 1Y	8 bit, 10 bit

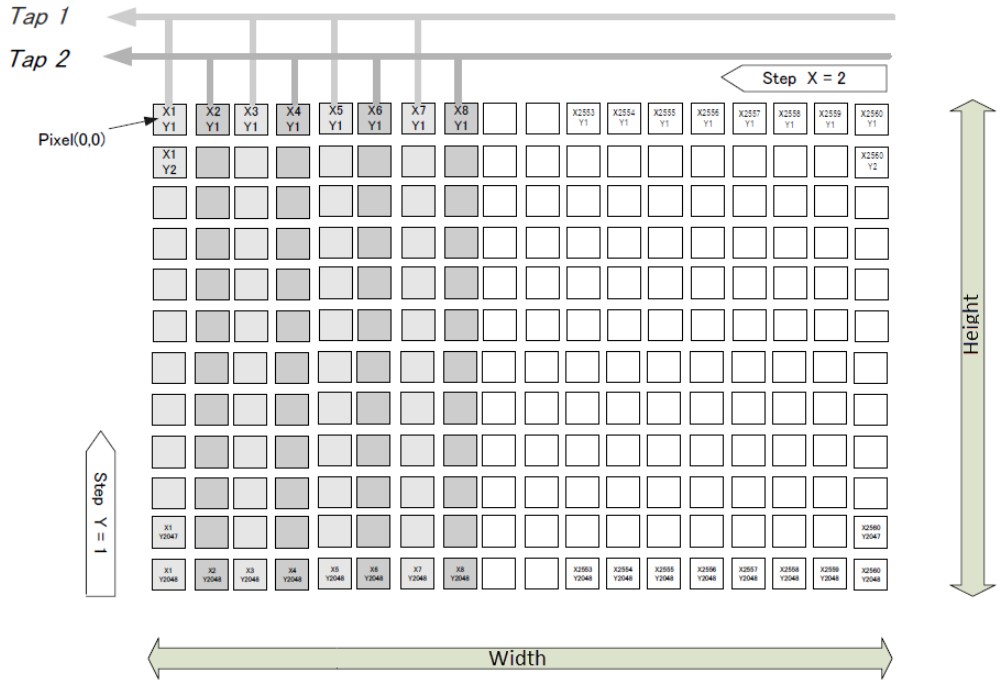
Note: The camera output description is based on GenICam SFNC Ver.1.5.1.

1X2–1Y

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

Width: 5120 pixels, 2560 pixels x 2 Taps

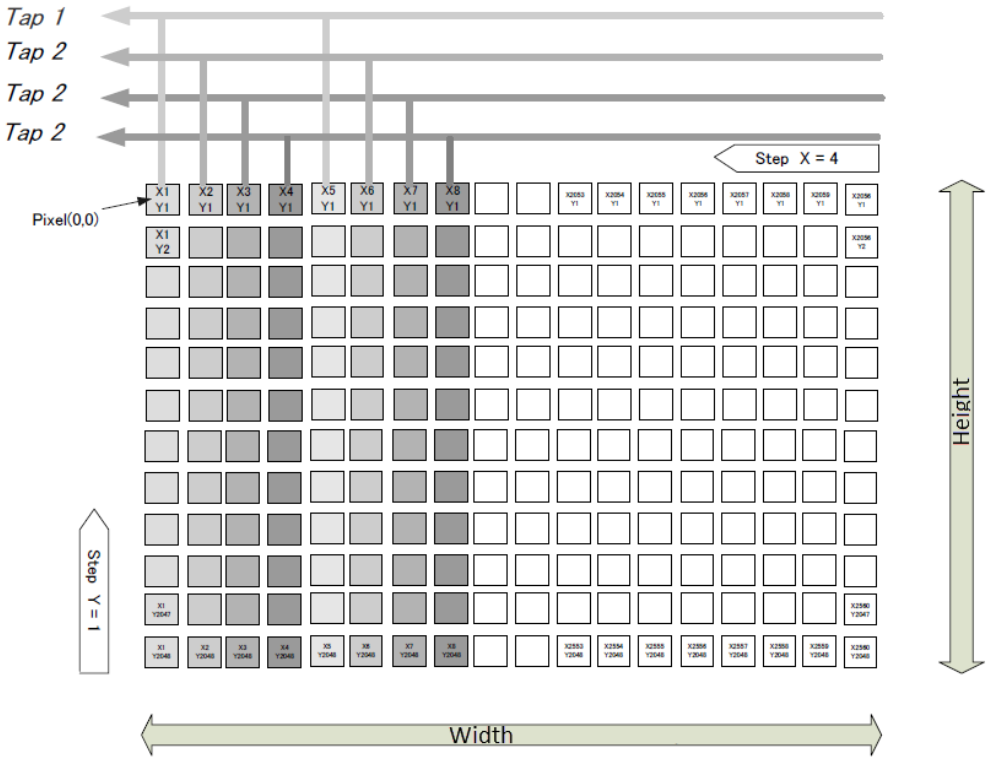
Height: 3840 pixels



1X4–1Y

1X4–1Y is a 2-tap readout system specified in GenICam Tap Geometry and it outputs as follows.

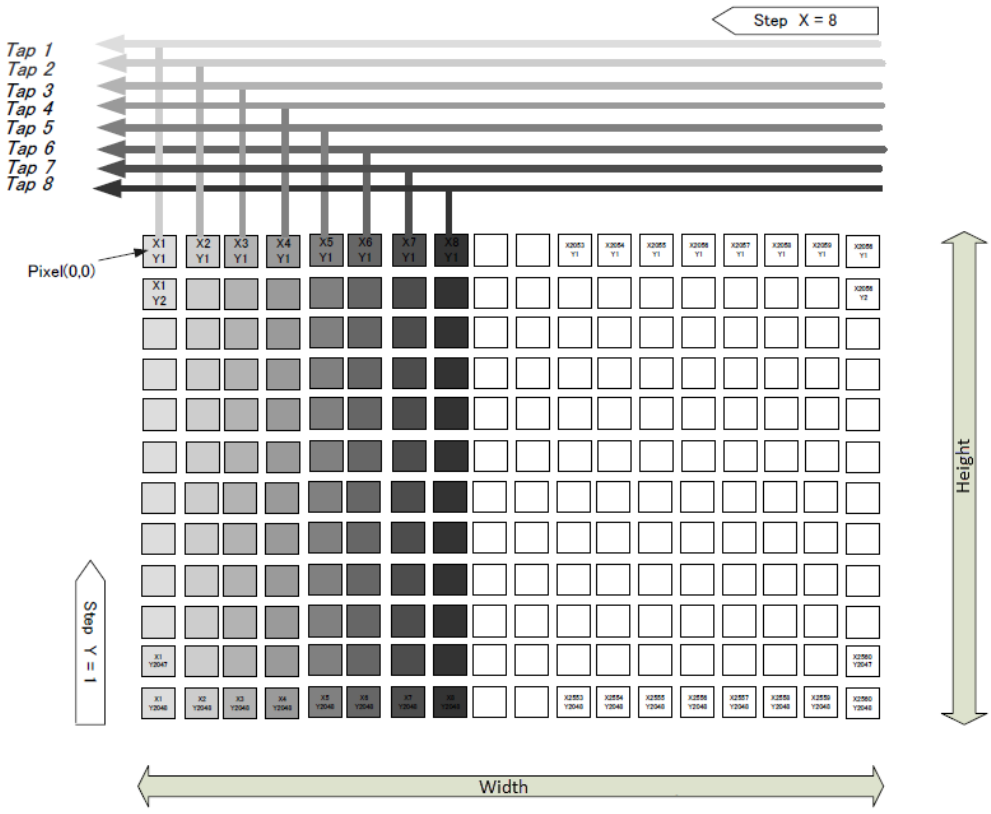
> **Width**: 5120 pixels, 1280 pixels x 4 Taps
>
> **Height**: 3840 pixels



1X8–1Y

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

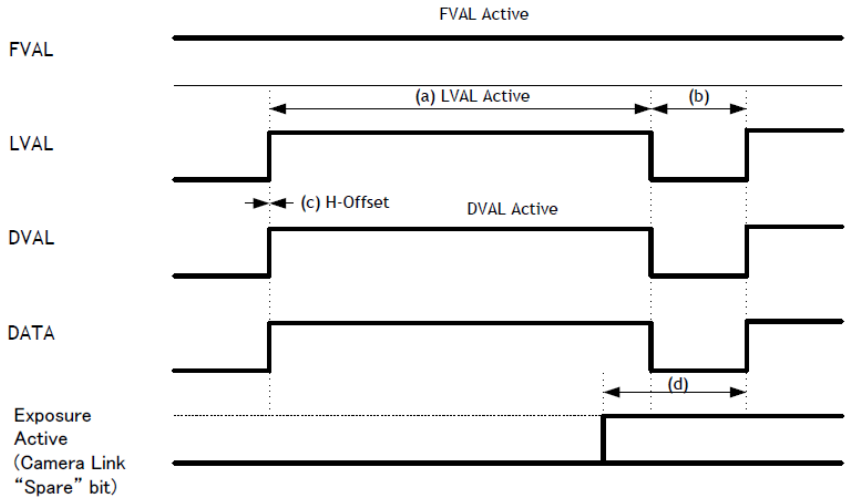
> **Width**: 5120 pixels, 640 pixels x 8 Taps
>
> **Height**: 3840 pixels



Output Timing

Horizontal Timing

This timing is for the continuous trigger. The horizontal frequency is changed by the setting of Tap Geometry. The monochrome model supports horizontal and vertical binning. However, the horizontal frequency does not change when horizontal binning is effective, and therefore, the frame rate is not increased.



Continuous Trigger Horizontal Timing

Note: Binning 1 = Off, 2 = On

Tap Geometry	Camera Link Pixel Clock	ROI				Binning		LVAL [Unit: Clock]	LVAL [Unit: Clock]	H-Offset [Unit: Clock]	Exposure Active Start to LVAL Active Start [Unit: Camera Link Clock]	Step (Typ.)
		Width	Offset X	Height	OffsetY	H	V					
1X8 -1Y	80M Hz	5120	0	3840	0	1	1	640	14~15	0	53	8
		5120	0	1920	0	1	2	640	669~670	0	53 or 707	8
		2560	0	3840	0	2	1	320	334~335	0	53	8
		2560	0	1920	0	2	2	320	989~990	0	53 or 707	8
	60M Hz	5120	0	3840	0	1	1	640	19~20	0	53	10
		5120	0	1920	0	1	2	640	678~679	0	53 or 713	10
		2560	0	3840	0	2	1	320	339~340	0	53	10
		2560	0	1920	0	2	2	320	998~999	0	53 or 713	10
1X4 -1Y	80M Hz	5120	0	3840	0	1	1	1280	29~30	0	650	16
		5120	0	1920	0	1	2	1280	1339~1340	0	650 or 1959	16
		2560	0	3840	0	2	1	640	669~670	0	650	16
		2560	0	1920	0	2	2	640	1979~1980	0	650 or 1959	16
	60M Hz	5120	0	3840	0	1	1	1280	38~39	0	653	22
		5120	0	1920	0	1	2	1280	1357~1358	0	653 or 1972	22
		2560	0	3840	0	2	1	640	678~679	0	653	22
		2560	0	1920	0	2	2	640	1997~1998	0	653 or 1972	22
1X2 -1Y	80M Hz	5120	0	3840	0	1	1	2560	58~59	0	1290	33
		5120	0	1920	0	1	2	2560	2677~2678	0	1290 or 3909	33
		2560	0	3840	0	2	1	1280	1339~1340	0	1290	33
		2560	0	1920	0	2	2	1280	3957~3958	0	1290 or 3909	33
	60M Hz	5120	0	3840	0	1	1	2560	77~78	0	1301	44
		5120	0	1920	0	1	2	2560	2714~2715	0	1301 or 3939	44
		2560	0	3840	0	2	1	1280	1357~1358	0	1301	44
		2560	0	1920	0	2	2	1280	3994~3995	0	1301 or 3939	44

Notes:

- In 1X8-1Y, 10-bit setting (80-bit Configuration), DVAL output port is used for data output and therefore, DVAL is not output through Camera Link interface.
- On this camera, the horizontal frequency is not doubled even if horizontal binning is ON.

- On this camera, the horizontal frequency is 1/2 if vertical binning is ON. And if vertical binning is ON, the invalid data is output in non-active range (H-offset range) of DVAL during LVAL being active.
- H-Offset: Duration between LVAL Active Start and DVAL Active Start.
- The phase of Exposure Active is described based on using the output at Camera Link Spare bit as the reference.
- If the next exposure is done while the image of V-Binnig On is read out, the exposure control is increased or decreased by 0.5 line unit.
- “d” ExposureActive Start to LVALActiveStart may have 1 clock difference due to the jitter in LVALNonActive period.

Continuous Trigger Horizontal Frequency (1X8 – 1Y, 1X4 – 1Y)

In the following table, values in “Actual operation” are real operating values. However, “1 Line Total Clock” values in “Calculation” are used to calculate the frame rate and other. This is because jitter occurs in “LVAL Non Active” period.

Notes:

- Binning 1 = Off, 2 = On
- Op. = Actual Operation, Calc. =Calculation

Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1Line Total Clock [Unit: Clock]	Horizontal Frequency [Unit: kHz]	Horizontal Period [Unit: us]
		Width	OffsetX	Height	OffsetY	H	V				
1X8 -1Y	80M Hz	5120	0	3840	0	1	1	Op.	654 or 655	122.324 or 122.137	8.175 or 8.188
								Calc.	654.63	122.206	8.183
		5120	0	1920	0	1	2	Op.	1309 or 1310	61.115 or 61.068	16.363 or 16.375
								Calc.	1309.27	61.103	16.366
		2560	0	3840	0	2	1	Op.	654 or 655	122.324 or 122.137	8.175 or 8.188
								Calc.	654.63	122.206	8.183
		2560	0	1920	0	2	2	Op.	1309 or 1310	61.115 or 61.068	16.363 or 16.375
								Calc.	1309.27	61.103	16.366

Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1Line Total Clock [Unit: Clock]	Horizontal Frequency [Unit: kHz]	Horizontal Period [Unit: us]
		Width	OffsetX	Height	OffsetY	H	V				
1X8 -1Y	60M Hz	5120	0	3840	0	1	1	Op.	659 or 660	91.047 or 90.909	10.983 or 11
								Calc.	659.31	91.004	10.989
		5120	0	1920	0	1	2	Op.	1318 or 1319	45.523 or 45.489	21.967 or 21.983
								Calc.	1318.61	45.502	21.977
		2560	0	3840	0	2	1	Op.	659 or 660	91.047 or 90.909	10.983 or 11
								Calc.	659.31	91.004	10.989
		2560	0	1920	0	2	2	Op.	1318 or 1319	45.523 or 45.489	21.967 or 21.983
								Calc.	1318.61	45.502	21.977
1X4 -1Y	80M Hz	5120	0	3840	0	1	1	Op.	1309 or 1310	61.115 or 61.069	16.363 or 16.375
								Calc.	1309.27	61.103	16.366
		5120	0	1920	0	1	2	Op.	2618 or 2619	30.558 or 30.546	32.725 or 32.738
								Calc.	2618.530	30.551	32.732
		2560	0	3840	0	2	1	Op.	1309 or 1310	61.115 or 61.070	16.363 or 16.375
								Calc.	1309.27	61.103	16.366
		2560	0	1920	0	2	2	Op.	2618 or 2619	30.558 or 30.546	32.725 or 32.738
								Calc.	2618.530	30.551	32.732
1X4 -1Y	60M Hz	5120	0	3840	0	1	1	Op.	1318 or 1319	45.524 or 45.489	21.967 or 21.983
								Calc.	1318.61	45.502	21.977
		5120	0	1920	0	1	2	Op.	2637 or 2638	22.753 or 22.745	43.950 or 43.967
								Calc.	2637.23		
		2560	0	3840	0	2	1	Op.	1318 or 1319	45.524 or 45.489	21.967 or 21.983
								Calc.	1318.61	45.502	21.977
		2560	0	1920	0	2	2	Op.	2637 or 2638	22.753 or 22.745	43.950 or 43.967
								Calc.	2637.23	22.751	43.954

Continuous Trigger Horizontal Frequency (1X2 – 1Y)

In the following table, values in “Actual operation” are real operating values. However, “1 Line Total Clock” values in “Calculation” are used to calculate the frame rate and other. This is because jitter occurs in “LVAL Non Active” period.

Notes:

- Binning 1 = Off, 2 = On
- Op. = Actual Operation, Calc. =Calculation

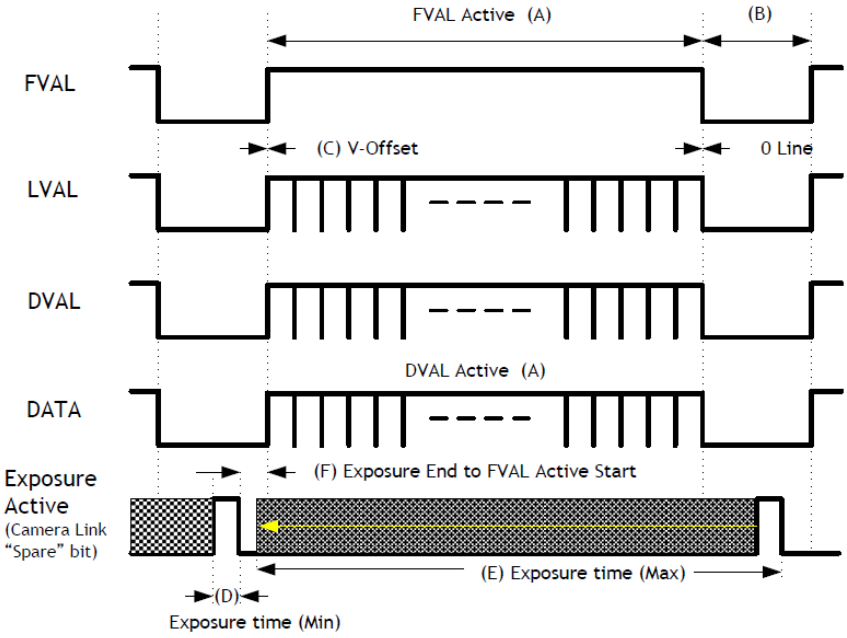
Tap Geometry	Camera Link Pixel Clock	ROI				Binning			1Line Total Clock [Unit: Clock]	Horizontal Frequency [Unit: kHz]	Horizontal Period [Unit: us]
		Width	OffsetX	Height	OffsetY	H	V				
1X2 -1Y	80M Hz	5120	0	3840	0	1	1	Op.	2618 or 2619	30.558 or 30.546	32.725 or 32.738
								Calc.	2618.54	30.551	32.732
		5120	0	1920	0	1	2	Op.	5237 or 5238	15.276 or 15.273	65.463 or 65.475
								Calc.	5237.09	15.276	65.46
		2560	0	3840	0	2	1	Op.	2618 or 2619	30.558 or 30.546	32.725 or 32.738
								Calc.	2618.54	30.551	32.732
		2560	0	1920	0	2	2	Op.	5237 or 5238	15.276 or 15.273	65.463 or 65.475
								Calc.	5237.09	15.276	65.464
	60M Hz	5120	0	3840	0	1	1	Op.	2637 or 2638	25.349 or 22.745	39.450 or 43.967
								Calc.	2637.25	22.751	43.954
		5120	0	1920	0	1	2	Op.	5274 or 5275	11.377 or 11.374	87.900 or 87.917
								Calc.	5274.49	11.376	87.908
		2560	0	3840	0	2	1	Op.	2637 or 2638	25.349 or 22.745	39.450 or 43.967
								Calc.	2637.25	22.751	43.954
		2560	0	1920	0	2	2	Op.	5274 or 5275	11.377 or 11.374	87.900 or 87.917
								Calc.	5274.49	11.376	87.908

Vertical Timing

In Continuous Trigger operation, the output through the Camera Link interface is as follows.

However, if 80-bit (1X8-1Y, 10-bits) configuration is set, DVAL and Exposure Active (JAI CUSTOM) are not output through Camera Link “Spare” bit because this port is used for data output.

This camera supports the H-Binning and V-Binning functions, but the frame rate is not increased.



Continuous Trigger vertical Timing (1/2)

> **Note:** Binning 1 = Off, 2 = On

Tap Geometry	Camera Link Pixel Clock	Frame Rate (Typ.) Time	ROI				Binning		[A] FVAL & DVAL Active [Unit: Line]	[B] FVAL Non-Active [Unit: Line]	[C] V-Offset [Unit: Line]	[D] Exposure Time (Min) [Unit: us]
			Width	Offset X	Height	Offset Y	H	V				
1X8 -1Y	80M Hz	33333	5120	0	3840	0	1	1	3840	233.53	0	10.0
			5120	0	1920	0	1	2	1920	117.27		
			2560	0	3840	0	2	1	3840	234.02		
			2560	0	1920	0	2	2	1920	117.51		
	60M Hz	44444	5120	0	3840	0	1	1	3840	204.65	0	10.0
			5120	0	1920	0	1	2	1920	102.82		
			2560	0	3840	0	2	1	3840	205.13		
			2560	0	1920	0	2	2	1920	103.07		
1X4 -1Y	80M Hz	66666	5120	0	3840	0	1	1	3840	233.53	0	10.0
			5120	0	1920	0	1	2	1920	117.27		
			2560	0	3840	0	2	1	3840	234.02		
			2560	0	1920	0	2	2	1920	117.51		
	60M Hz	88888	5120	0	3840	0	1	1	3840	204.6	0	10.0
			5120	0	1920	0	1	2	1920	102.8		
			2560	0	3840	0	2	1	3840	205.09		
			2560	0	1920	0	2	2	1920	103.04		
1X2 -1Y	80M Hz	133333	5120	0	3840	0	1	1	3840	233.53	0	10.0
			5120	0	1920	0	1	2	1920	117.27		
			2560	0	3840	0	2	1	3840	234.02		
			2560	0	1920	0	2	1	1920	117.51		
	60M Hz	177777	5120	0	3840	0	1	1	3840	204.62	0	10.0
			5120	0	1920	0	1	2	1920	102.81		
			2560	0	3840	0	2	1	3840	205.11		
			2560	0	1920	0	2	2	1920	103.05		

Continuous Trigger Vertical Timing (2/2)

Note: Binning 1 = Off, 2 = On

Tap Geometry	Camera Link Pixel Clock	Frame Rate (Typ.) Time	ROI				Binning		Frame Rate	[E] Exposure Time (Max) [Unit: us]	(F) Exposure End to FVAL Active Start	
			Width	Offset X	Height	Offset Y	H	V			Unit: Line	Unit: us
1X8 -1Y	80M Hz	33333	5120	0	3840	0	1	1	30.000	ROUNDDOWN([Frame Rate (Time)] - (20600clk ÷ 80)) = 33075	39.1	319.96
			5120	0	1920	0	1	2			20.05	328.15
			2560	0	3840	0	2	1			39.1	319.96
			2560	0	1920	0	2	2			20.05	328.15
	60M Hz	44444	5120	0	3840	0	1	1	22.500	ROUNDDOWN([Frame Rate (Time)] - (20600clk ÷ 60)) = 44100	39.1	429.68
			5120	0	1920	0	1	2			20.05	440.68
			2560	0	3840	0	2	1			39.1	429.68
			2560	0	1920	0	2	2			20.05	440.68
1X4 -1Y	80M Hz	66666	5120	0	3840	0	1	1	15.000	ROUNDDOWN([Frame Rate (Time)] - (20600clk ÷ 80)) = 66408	20.05	328.15
			5120	0	1920	0	1	2			10.53	344.51
			2560	0	3840	0	2	1			20.05	328.15
			2560	0	1920	0	2	2			10.53	344.51
	60M Hz	88888	5120	0	3840	0	1	1	11.250	ROUNDDOWN([Frame Rate (Time)] - (20600clk ÷ 60)) = 88544	20.05	440.67
			5120	0	1920	0	1	2			10.53	462.63
			2560	0	3840	0	2	1			20.05	440.67
			2560	0	1920	0	2	2			10.53	462.63
1X2 -1Y	80M Hz	133333	5120	0	3840	0	1	1	7.500	ROUNDDOWN([Frame Rate (Time)] - (41200clk ÷ 80)) = 132818	20.05	656.2
			5120	0	1920	0	1	2			10.52	688.93
			2560	0	3840	0	2	1			20.05	656.2
			2560	0	1920	0	2	1			10.52	688.93
	60M Hz	177777	5120	0	3840	0	1	1	5.625	ROUNDDOWN([Frame Rate (Time)] - (41200clk ÷ 60)) = 177090	20.05	881.22
			5120	0	1920	0	1	2			10.52	925.17
			2560	0	3840	0	2	1			20.05	881.22
			2560	0	1920	0	2	2			10.52	925.17

Notes:

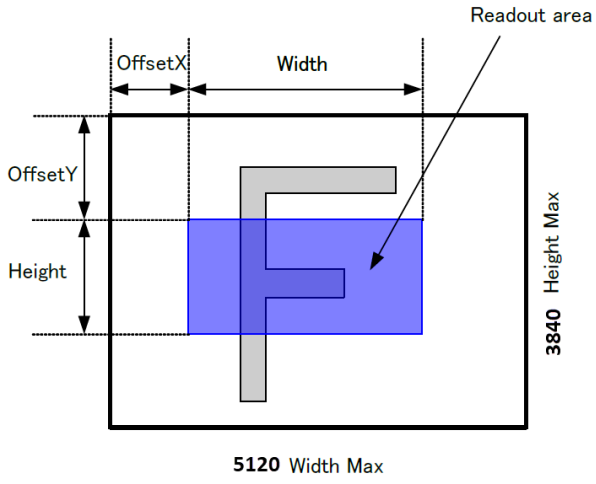
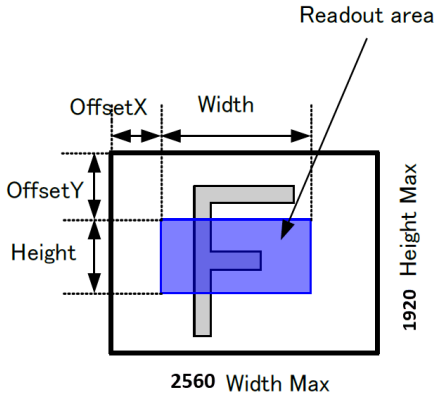
- As the frame rate of the SP-20000-PMCL is 1 µs duration per 1 step, the above FVAL Non-Active conversion may have certain tolerance.
- On this camera, the horizontal frequency is not doubled even if horizontal binning is used. The frame rate is not increased.

- On this camera, the horizontal frequency is 1/2 if vertical binning is used. Therefore, if the height is 1/2, the vertical frequency is not doubled.
- On this camera, the frame rate can be changed by 1 µs unit. In the above table, “B” FVAL Non-Active duration is varied.
- V-Offset: The duration between FVAL Active Start and 1st LVAL Active Start.

ROI (Regional Scanning Function)

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. On this camera, the minimum width is “8” and minimum height is “2”.

Setting Example: 1 (Binning OFF)	**Setting Example: 2 (Binning On - Mono Model Only)**
Binning Horizontal = 1 Binning Vertical = 1 Mirroring = Off	Binning Horizontal = 2 Binning Vertical = 2 Mirroring = Off
	

Notes:

- Binning is available only for the monochrome model.
- Binning can be used in horizontal, vertical, or both directions.

ROI Setting Examples (1/2)

> **Note:** Binning 1 = Off, 2 = On

	ROI				Binning		Width Max	Height Max	Max Offset X Value	Width and Offset X Step			Max Offset Y Value	Height Step	Offset Y Step
	Width	Offset X	Height	Offset Y	H	V				1X8-1	1X4-1	1X2-1			
Full Line	5120	0	3840	0	1	1	5120	3840	0	8	8	8	0	2	1
2/3 Screen - Center	3408	856	2560	640	1	1	5120	3840	1712	8	8	8	1280	2	1
1/2 Screen - Center	2560	1280	1920	960	1	1	5120	3840	2560	8	8	8	1920	2	1
1/4 Screen - Center	1280	1920	960	1440	1	1	5120	3840	3840	8	8	8	2880	2	1
1/8 Screen - Center	640	2240	480	1680	1	1	5120	3840	4480	8	8	8	3360	2	1
Full Line	2560	0	1920	0	2	2	2560	1920	0	8	8	8	0	1	1
2/3 Screen - Center	1704	428	1280	320	2	2	2560	1920	856	8	8	8	640	1	1
1/2 Screen - Center	1280	640	960	480	2	2	2560	1920	1280	8	8	8	960	1	1
1/4 Screen - Center	640	960	480	720	2	2	2560	1920	1920	8	8	8	1440	1	1
1/8 Screen - Center	320	1120	240	840	2	2	2560	1920	2240	8	8	8	1680	1	1

> **Note: Setting restrictions**
>
> 1. Width Max = 5120, Height Max = 3840 (H and V Binning Off) (If it is On, the value is 1/2)
> 2.Max Offset X Value = Width Max - Width : Maximum value which Offset X can be set
> 3.Max Offset Y Value = Height Max - Height: Maximum value which Offset Y can be set
> 4.Width and Offset X Step: The step number which Width and horizontal offset can be shifted
> 5. Height and Offset Y Step: The step number which Height and vertical offset can be shifted

ROI Setting Examples (2/2) (Frame Rate)

Notes:

- Binning 1 = Off, 2 = On
- Tap Geometry: 1X8-1Y, 1X4-1Y, 1X2-1Y
- Camera Link Pixel Clock: 80Mz, 60Mz

	ROI				Binning			1X8-1Y		1X4-1Y		1X2-1Y	
	Width	Offset X	Height	Offset Y	H	V		80MHz	60MHz	80MHz	60MHz	80MHz	60MHz
Full Line	5120	0	3840	0	1	1	Setting Value [us]	33333	44444	66666	88888	133333	177777
							Output [Hz]	30.000	22.500	15.000	11.250	7.500	5.625
2/3 Screen - Center	3408	856	2560	640	1	1	Setting Value [us]	22222	29629	44444	59259	88889	118518
							Output [Hz]	44.998	33.751	22.500	16.875	11.250	8.4375
1/2 Screen - Center	2560	1280	1920	960	1	1	Setting Value [us]	16667	22222	33333	44444	66667	88889
							Output [Hz]	59.998	45.000	30.000	22.500	15.000	11.250
1/4 Screen - Center	1280	1920	960	1440	1	1	Setting Value [us]	8428	11318	16856	22636	33713	45272
							Output [Hz]	118.640	88.352	59.325	44.176	29.662	22.088
1/8 Screen - Center	640	2240	480	1680	1	1	Setting Value [us]	4500	6043	9001	12087	18002	24174
							Output [Hz]	222.180	165.460	111.090	82.728	55.549	41.366
Full Line	2560	0	1920	0	2	2	Setting Value [us]	33333	44444	66666	88888	133333	177777
							Output [Hz]	30.000	22.500	15.000	11.250	7.500	5.625
2/3 Screen - Center	1704	428	1280	320	2	2	Setting Value [us]	22222	29629	44444	59258	88889	118518
							Output [Hz]	44.998	33.751	22.500	16.875	11.250	8.4375
1/2 Screen - Center	1280	640	960	480	2	2	Setting Value [us]	16667	22222	33333	44444	66667	88889
							Output [Hz]	59.998	45.000	30.000	22.500	15.000	11.250
1/4 Screen - Center	640	960	480	720	2	2	Setting Value [us]	8412	11296	16824	22592	33648	45184
							Output [Hz]	118.87	88.521	59.437	44.262	29.719	22.132
1/8 Screen - Center	320	1120	240	840	2	2	Setting Value [us]	4484	6021	8968	12043	17937	24086
							Output [Hz]	222.99	166.08	111.5	83.032	55.748	41.518

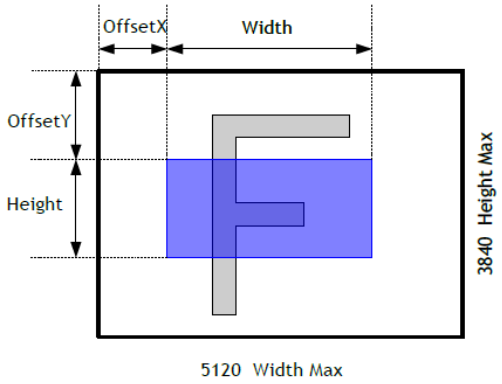
- This example is based on 1X8-1Y, Camera Link Pixel Clock =80MHz and 30 fps output.
- In case of 1/4 Partial and lower height, the maximum frame rate is described

Mirroring Function

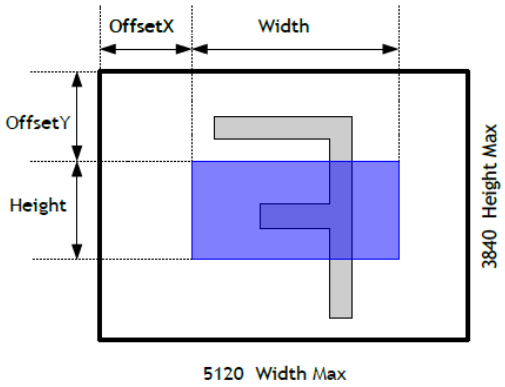
This camera has the ability to reverse the image vertically, horizontally, or both vertically and horizontally. If ROI readout is used, ROI image can be read out after the image is reversed.

Examples of Mirror function settings is shown below. In the examples below, BinningHorizontal and BinningVertical are set to 1.

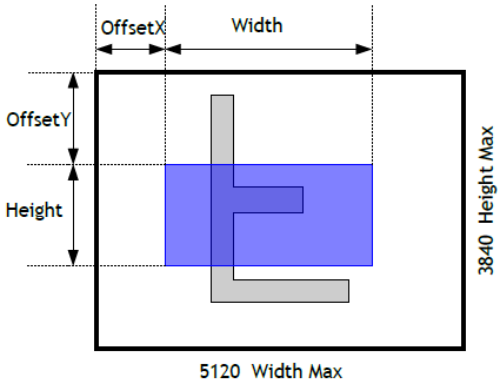
Mirroring = Off



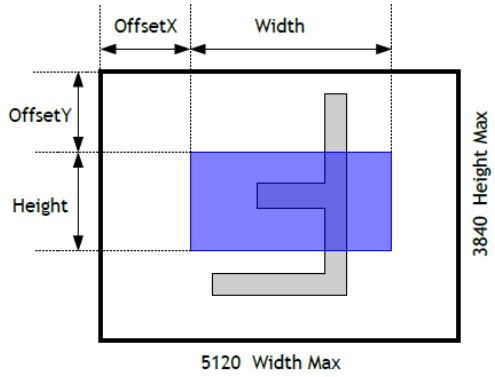
Mirroring = Horizontal



Mirroring = Vertical



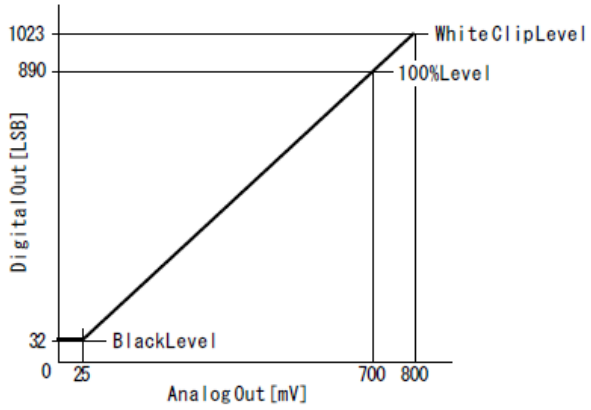
Mirroring = Horizontal & Vertical



Digital Output Bit Allocation

CMOS Out		Digital Out		
		8bit	10bit	12bit
Black	0%	8LSB	32LSB	128LSB
Mono / Color	100%	222LSB	890LSB	3560LSB
Mono / Color	115%	225LSB	1023LSB	4095LSB

Bit Allocation (10-bit)



Acquisition Control (Change the Frame Rate)

Related Setting Items: Acquisition Control, JAI Custom

With Trigger OFF (free-running mode), it is possible to specify a free-running frame rate (i.e., no trigger needed) that is slower than the default rate.

The setting range in Acquisition Frame Rate is:

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

Notes:

- When Trigger is set to Off, you cannot configure the Frame Rate setting.
- 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.

When using Control Tool, the frame rate setting is configured by Acquisition Frame Rate (Hz). When using ASCII Command (ART), the frame rate setting is configured by AcquisitionFrameTime (us).

For example, when Tap Geometry is set to 1X2-1Y and Camera Link Pixel Clock is set to 80Hz,

- Acquisition Frame Rate: 7.8136 Hz to 0.125 Hz
- AcquisitionFrameTime: 127982 µs to 8000000µs

For additional details, see Frame Rate Interval Setting Range (Typical Value) in Continuous Trigger Mode.

Note: It is possible to set, for instance 7.8136 fps for 1X2–1Y, full frame and 80 MHz of Camera Link pixel clock, but 7.8136 fps is the setting limit value. This value will vary depending on shutter settings which will cause 1 H delay in conditions. 7.5 fps is the performance guaranteed value.

How to Configure

1. ROI should be set first.
2. The available number shown in Acquisition Frame Rate will correspond to the maximum frame period for the specified ROI.
3. The value can be decreased up to 0.125Hz (fps).

If ROI is changed from a smaller size to a larger size, the default frame rate of the ROI is automatically recalculated inside the camera and changed to the slower frame rate of the larger ROI.

Interval Calculation of Frame Rate (In Continuous Trigger mode)

Camera Settings			ART Command Minimum Value Setting Calculation Formula Unit: us
Tap Geometry	Binning Vertical	Camera Link Pixel Clock	
1X8-1Y	1 (Off)	80MHz	ROUND(([Height] + 70 Line) x 654.63÷ [Camera Link Pixel Clock Frequency:80MHz] x 10^6)
		60MHz	ROUND(([Height] + 70 Line) x 659.31÷ [Camera Link Pixel Clock Frequency:60MHz] x 10^6)
	2 (On)	80MHz	ROUND(([Height] + 34 Line) x 1309.27÷ [Camera Link Pixel Clock Frequency:80MHz] x 10^6)
		60MHz	ROUND(([Height] + 34 Line) x 1318.61÷ [Camera Link Pixel Clock Frequency:60MHz] x 10^6)
1X4-1Y	1 (Off)	80MHz	ROUND(([Height] + 70 Line) x 1309.50÷ [Camera Link Pixel Clock Frequency:80MHz] x 10^6)
		60MHz	ROUND(([Height] + 70 Line) x 1318.93÷ [Camera Link Pixel Clock Frequency:60MHz] x 10^6)
	2 (On)	80MHz	ROUND(([Height] + 34 Line) x 2618.53÷ [Camera Link Pixel Clock Frequency:80MHz] x 10^6)
		60MHz	ROUND(([Height] + 34 Line) x 2637.23÷ [Camera Link Pixel Clock Frequency:60MHz] x 10^6)
1X2-1Y	1 (Off)	80MHz	ROUND(([Height] + 70 Line) x 2618.54÷ [Camera Link Pixel Clock Frequency:80MHz] x 10^6)
		60MHz	ROUND(([Height] + 70 Line) x 2637.25÷ [Camera Link Pixel Clock Frequency:60MHz] x 10^6)
	2 (On)	80MHz	ROUND(([Height] + 34 Line) x 5237.09÷ [Camera Link Pixel Clock Frequency:80MHz] x 10^6)
		60MHz	ROUND(([Height] + 34 Line) x 5274.49 ÷ [Camera Link Pixel Clock Frequency:60MHz] x 10^6)

Notes:

- If Tap Geometry is changed, the minimum value of the frame rate interval is limited automatically.
- If **Exposure Mode** is set to **Timed**, the maximum value of Exposure Time is changed automatically by the setting value of the frame rate.
- The Camera Link pixel clock is 80 MHz as the default setting.

Frame Rate Interval Setting Range (Typical Value) in Continuous Trigger Mode

Camera Settings				ART Command value (limited standard value)			
				Min.		Max.	
Tap Geometry	Camera Link Pixel Clock	Binning Vertical	Height	Setting Value	Actual operating time/Actual operating interval	Setting Value	Actual operating time/Actual operating interval
1X8-1Y	80 MHz	1 (Off)	3840	31995	31.996 ms / 31.254 Hz	8000000	8 sec / 0.125 Hz
		2 (On)	1920	31978	31.979 ms / 31.271 Hz		
	60 MHz	1 (Off)	3840	42965	42.966 ms / 23.274 Hz		
		2 (On)	1920	42942	42.942 ms / 23.287 Hz		
1X4-1Y	80 MHz	1 (Off)	3840	63990	63.992 ms / 15.627 Hz		
		2 (On)	1920	63957	63.959 ms / 15.635 Hz		
	60 MHz	1 (Off)	3840	85929	11.637 Hz 85.933 ms		
		2 (On)	1920	85885	85.889 ms / 11.643 Hz		
1X2-1Y	80 MHz	1 (Off)	3840	127981	127.982 ms / 7.8136 Hz		
		2 (On)	1920	127915	127.916 ms / 7.8176 Hz		
	60 MHz	1 (Off)	3840	171860	171.860 ms / 5.8187 Hz		
		2 (On)	1920	171772	171.771 ms / 5.8217 Hz		

Notes:

- The above reference value is the setting range to which frame interval is automatically changed if Height is set at Height Max. In vertical ROI operation, if Height is set at less than Height Max, the minimum setting value will be smaller.
- On this camera, the frame rate in 1X8-1Y and Full Line setting can be set at a maximum of 31.254 fps. However, it is only guaranteed up to 30 fps in terms of performance.

- On this camera, the frame rate has maximum 1 line longer or shorter depending on the exposure time. This happens, when the exposure executes for the next frame while the previous video is reading out, the increment or of 1 µs for the exposure time is completed at the exposure completion side.

Exposure Mode

Related Setting Items: Acquisition Control

This camera has three Exposure modes (Off, Timed, TriggerWidth). Use the AcquisitionControl settings to perform operations and settings for exposure.

ExposureMode = Off

Exposure control is not performed (free-running operation). The exposure time is the longest possible time within the operating conditions such as the frame rate.

ExposureMode = Timed

Mode in which control is performed using ExposureTime. Acquire images using an exposure time configured beforehand on an external trigger.

In this mode, the exposure time can be adjusted automatically by setting ExposureAuto. For details, refer to ALC (Automatic Level Control) Function.

ExposureMode = TriggerWidth

Mode in which control of the exposure time is performed using the pulse width of the trigger input signal. The exposure time will be the same as the pulse width of the trigger input signal.

Note: The settings for exposure control and triggers are related to each other. Be sure to configure the settings described in Trigger Control.

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: 10u

  > **Note:** Actual Exposure Time: 304μs

- Maximum: 8sec (When Frame Start Trigger Mode is ON)

Actual Exposure Time

The actual exposure time is shown in the following table due to the sensor characteristics. But the exposure active signal is same as the exposure time.

Tap Geometry	Camera Link Clock	Sensor Acual Exposure Time
1X8-1Y	80MHz	Exposure Time + 294us
1X4-1Y		
1X8-1Y	60MHz	Exposure Time + 395us
1X4-1Y		
1X2-1Y	80MHz	Exposure Time + 589us
1X2-1Y	60MHz	Exposure Time + 791us

> **Notes:**
> In Continuous Trigger operation with Frame Start Trigger Mode OFF, the maximum Exposure Time is limited by the frame rate setting. In 1X8–1Y camera output format and 80 MHz Camera Link pixel clock, the maximum setting value is 7.999742 sec which is 258 μs smaller than 8 seconds, the maximum value of frame rate setting.
>
> In EPS Trigger operation (Frame Start Trigger Mode set to On), the maximum exposure time is not influenced and therefore it is 8 seconds as the maximum. Due to the characteristics of the camera's sensor, the black level may rise if a long time exposure is used, or if the sensor temperature increases. Although this black level variance is compensated in the camera, the performance needed to maintain the dynamic range for a maximum exposure of 8 seconds is guaranteed only under the following conditions.
>
> SP-20000M-PMCL: The ambient temperature is up to 25°C.
>
> SP-20000C-PMCL: The ambient temperature is up to 15°C.

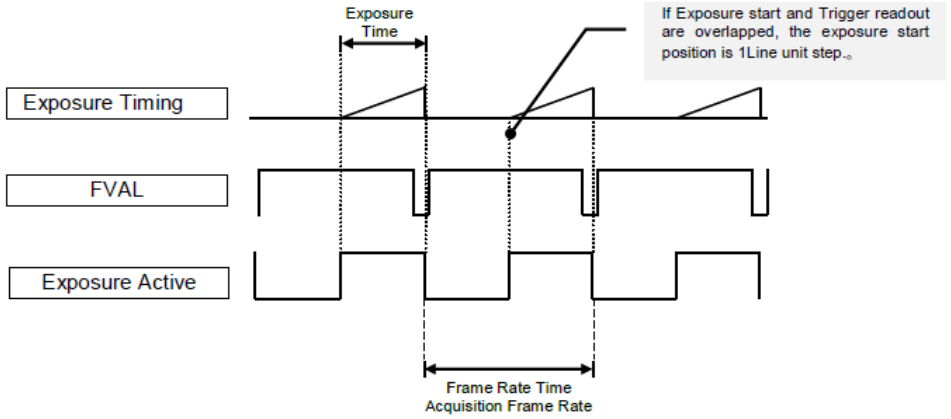
Behavior if Trigger Overlap is Set to Readout

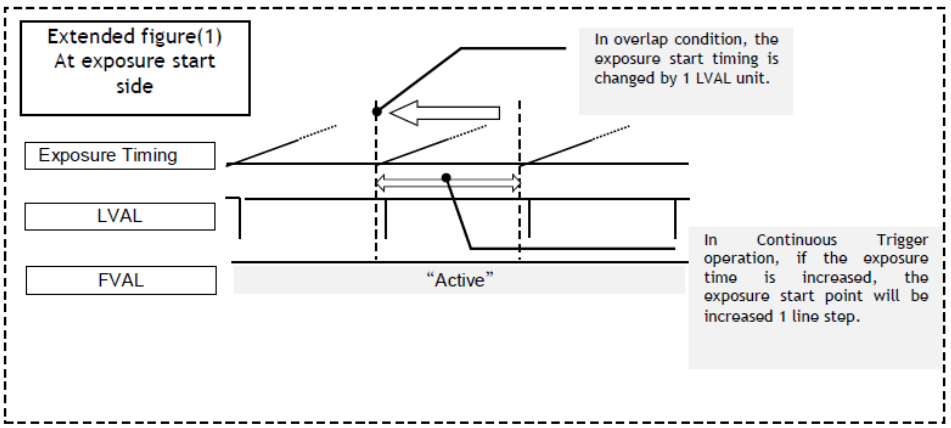
On this camera, if the accumulation of the next frame starts while the current image is read out, the varied value of accumulation time is changed to 1 Line period inside the camera. This is done so that the accumulation start signal will not affect the output signal while it is overlapped.

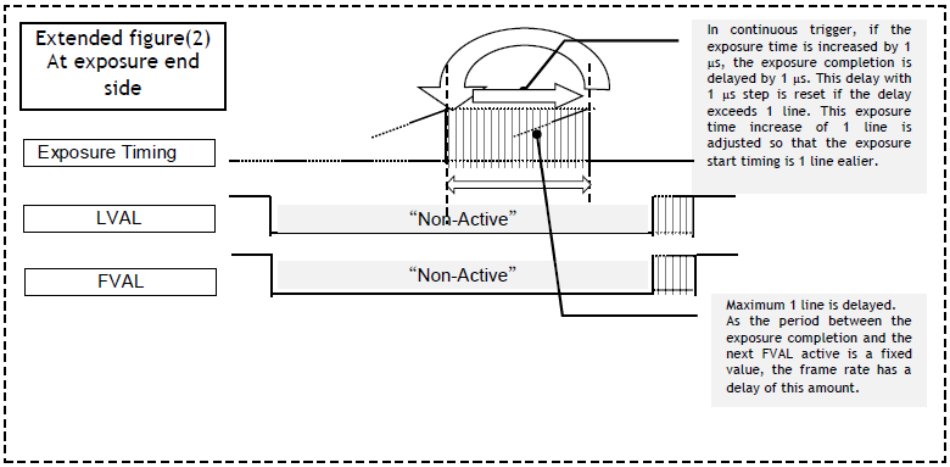
Modes where the exposure control becomes 1L if overlap occurs

JAI Custom Naming	Trigger Mode	Trigger Overlap
Continuous Trigger	Off	-
EPS Trigger / LVAL Sync Reset	On	Readout

As an example, the following is for Continuous Trigger.






Extended figure(2)
At exposure end side
Exposure Timing
LVAL
FVAL
"Non-Active"
"Non-Active"
In continuous trigger, if the exposure time is increased by 1 µs, the exposure completion is delayed by 1 µs. This delay with 1 µs step is reset if the delay exceeds 1 line. This exposure time increase of 1 line is adjusted so that the exposure start timing is 1 line ealier.
Maximum 1 line is delayed. As the period between the exposure completion and the next FVAL active is a fixed value, the frame rate has a delay of this amount.

Calculation for the Period Which the Exposure Time is Overlapped with Previous Trigger in Continuous Trigger Mode

Tap Geometry: 1X8-1Y

Exposure Start Position [Unit: Line]	Binning Vertical	Camera Link Pixel Clock	Continuous trigger readout / exposure overlapped period Exposure Time value calculation formula
1Line Control Start Exposure Time value [Unit: us]	1 (Off)	80MHz	ROUND([Frame Rate (Time)] - ((([Height]×654.63)+24901 -654.63+ ([Width]÷8)) ÷ [Camera Link Clock Frequency:80MHz]×(10^6)))
		60MHz	ROUND([Frame Rate (Time)] - ((([Height]×659.31)+25109 -654.63+ ([Width]÷8)) ÷ [Camera Link Clock Frequency:60MHz]×(10^6)))
	2 (On)	80MHz	ROUND([Frame Rate (Time)] - ((([Height]×1309.27)+24901 -640+ ([Width]÷8)) ÷ [Camera Link Clock Frequency:80MHz]×(10^6)))
		60MHz	ROUND([Frame Rate (Time)] - ((([Height]×1318.61)+25109 -640+ ([Width]÷8)) ÷ [Camera Link Clock Frequency:60MHz]×(10^6)))
1Line Control End Exposure Time value [Unit: us]	1 (Off), 2 (On)	80MHz	ROUND([Frame Rate (Time)] - (24901÷[Camera Link Clock Frequency:80MHz]×(10^6))
		60MHz	ROUND([Frame Rate (Time)] - (25109÷[Camera Link Clock Frequency:60MHz]×(10^6))
When overlapped, Exposure Time effective step value [Unit: us/step]	1 (Off)	80MHz	ROUNDDOWN(654.63÷[Camera Link Clock Frequency:80MHz]×10^6)
		60MHz	ROUNDDOWN(659.31÷[Camera Link Clock Frequency:60MHz]×10^6)
	2 (On)	80MHz	ROUNDDOWN(1309.27÷[Camera Link Clock Frequency:80MHz]×10^6÷ 2)
		60MHz	ROUNDDOWN(1318.61÷[Camera Link Clock Frequency:60MHz]×10^6÷ 2)

Exposure Start Position [Unit: Line]	Binning Vertical	Camera Link Pixel Clock	Continuous trigger readout / exposure overlapped period Exposure Time value calculation formula
Exposure Start Position [Unit: Line]	1 (Off)	80MHz	([Height] - 1 - (ROUNDOWN(([Exposure Time] - [1Line Control Start Exposure Time value])×(10^-6)×[Camera Link Clock Frequency:80MHz]÷654.63)))
		60MHz	[Height] - 1 - (ROUNDDOWN(([Exposure Time] - [1Line Control Start Exposure Time value]) ×(10^-6)×[Camera Link Clock Frequency:60MHz]÷659.31))
	2 (On)	80MHz	[Height] - 0.5 - (ROUNDDOWN(([Exposure Time] - [1Line Control Start Exposure Time value]÷1309.27)÷2)
		60MHz	[Height] - 0.5 - (ROUNDDOWN(([Exposure Time] - [1Line Control Start Exposure Time value]) ×(10^-6)×[Camera Link Clock Frequency:60MHz]÷1318.61)÷2)
Exposure Time Max value	1 (Off), 2 (On)	80MHz	ROUNDDOWN([Frame Rate (Time)] - (20600÷[Camera Link Clock Frequency:80MHz]×10^6))
		60MHz	ROUNDDOUWN([Frame Rate (Time)] - (20600÷[Camera Link Clock Frequency:60MHz]×10^6))

Notes:

- If V-Binning is set to On, the horizontal frequency is 1/2. However, as the effective image period is not changed, the Exposure Time setting step is approx. 8 steps for 1X8 –1Y and approx. 16 steps for 1X4 –1Y.
- The default setting for Camera Link Pixel Clock is 80MHz.
- The exposure start position calculate numbers of line which Exposure Active Start Edge passes, if the upper part of the previous video is 1 line. However, it the frame rate is overlapped with Exposure Start, maximum 1 line delay is occurred, and differences may be happened.
- The result of calculation and actual camera operation may differ by 1 to 2 μs.
- Exposure Time Effective Step value when overlapped is basic figure. It may be increased or decreased due to ROUND figures.
- In overlapped operation, shutter noise occurring at the start of the exposure period will appear in the video (Approx. 70LSB/10bit/24dB as the maximum)

Tap Geometry: 1X4-1Y

Item	Binning Vertical	Camera Link Pixel Clock	Continuous trigger readout / exposure overlapped period Exposure Time value calculation formula
1Line Control Start Exposure Time value [Unit: us]	1 (Off)	80MHz	ROUND([Frame Rate (Time)] - ((([Height]×1309.27) + 24931 - 1309.27 + ([Width]÷4) ÷[Camera Link Clock Frequency:80MHz]×(10^6)))
		60MHz	ROUND([Frame Rate (Time)] - ((([Height]×1318.61) + 25111 - 1318.61+ ([Width]÷4)) ÷[Camera Link Clock Frequency:60MHz]×(10^6)))
	2 (On)	80MHz	ROUND([Frame Rate (Time)] - ((([Height]×2618.53) + 24931 - 1280 + ([Width]÷4)) ÷[Camera Link Clock Frequency:80MHz]×(10^6)))
		60MHz	ROUND([Frame Rate (Time)] - ((([Height]×2637.23) + 25111−1280 + ([Width]÷4)) ÷[Camera Link Clock Frequency:60MHz]×(10^6)))
1Line Control End Exposure Time value [Unit: us]	1 (Off), 2 (On)	80MHz	ROUND([Frame Rate (Time)] - (24931÷[Camera Link Clock Frequency:80MHz]×(10^6))
		60MHz	ROUND([Frame Rate (Time)] - (25111÷[Camera Link Clock Frequency:60MHz]×(10^6))
When overlapped, Exposure Time effective step value [Unit: us/step]	1 (Off)	80MHz	ROUNDDOWN(1309.27÷[Camera Link Clock Frequency]×10^6)
		60MHz	ROUNDDOWN(1318.61÷[Camera Link Clock Frequency]×10^6)
	2 (On)	80MHz	ROUNDDOWN(2618.53÷[Camera Link Clock Frequency])×10^6÷2)
		60MHz	ROUNDDOWN(2637.23÷[Camera Link Clock Frequency])×10^6÷2)
Exposure Start Position [Unit: Line]	1 (Off)	80MHz	[Height] - 1 - (ROUNDOWN(([Exposure Time] - [1Line Control Start Exposure Time value]) ×(10^-6)×[Camera Link Clock Frequency:80MHz]÷1309.27))
		60MHz	[Height] - 1 - (ROUNDOWN(([Exposure Time] - [1Line Control Start Exposure Time value]) ×(10^-6)×[Camera Link Clock Frequency:80MHz]÷1318.61))
	2 (On)	80MHz	[Height] - 0.5 - (ROUNDOWN(([Exposure Time] - [1Line Control Start Exposure Time value]) ×(10^-6)×[Camera Link Clock Frequency:80MHz]÷2618.53)÷2)
		60MHz	[Height] - 0.5 - (ROUNDOWN(([Exposure Time] - [1Line Control Start Exposure Time value]) ×(10^-6)×[Camera Link Clock Frequency:60MHz]÷2637.23)÷2)
Exposure Time Max value	1 (Off), 2 (On)	80MHz	ROUNDDOWN([Frame Rate (Time)] - (20600÷[Camera Link Clock Frequency:80MHz]×10^6))
		60MHz	ROUNDDOWN([Frame Rate (Time)] - (20600÷[Camera Link Clock Frequency:60MHz]×10^6))

Tap Geometry: 1X2-1Y

Item	Binning Vertical	Camera Link Pixel Clock	Continuous trigger readout / exposure overlapped period Exposure Time value calculation formula
1Line Control Start Exposure Time value [Unit: us]	1 (Off)	80MHz	ROUND([Frame Rate (Time)] - ((([Height]×2618.54) + 49865 - 2618.54 + ([Width]÷2)) ÷[Camera Link Clock Frequency:80MHz]×(10^6)))
		60MHz	ROUND([Frame Rate (Time)] - ((([Height]×2637.25) + 50223 - 2637.25 + ([Width]÷2)) ÷[Camera Link Clock Frequency:60MHz]×(10^6)))
	2 (On)	80MHz	ROUND([Frame Rate (Time)] - ((([Height]×5237.09) + 49865 - 2560 + ([Width]÷2)) ÷[Camera Link Clock Frequency:80MHz]×(10^6)))
		60MHz	ROUND([Frame Rate (Time)] - ((([Height]×5274.49) + 50223 - 2560 + ([Width]÷2)) ÷[Camera Link Clock Frequency:60MHz]×(10^6)))
1Line Control End Exposure Time value [Unit: us]	1 (Off), 2 (On)	80MHz	ROUND([Frame Rate (Time)] - (49865÷[Camera Link Clock Frequency:80MHz]×(10^6))
		60MHz	ROUND([Frame Rate (Time)] - (50223÷[Camera Link Clock Frequency:60MHz]×(10^6))
When overlapped, Exposure Time effective step value [Unit: us/step]	1 (Off)	80MHz	ROUNDDOWN(2618.54÷[Camera Link Clock Frequency]×10^6)
		60MHz	ROUNDDOWN(2637.25÷[Camera Link Clock Frequency]×10^6)
	2 (On)	80MHz	ROUNDDOWN(5237.09÷[Camera Link Clock Frequency])×10^6÷2)
		60MHz	ROUNDDOWN(5274.49÷[Camera Link Clock Frequency])×10^6÷2)
Exposure Start Position [Unit: Line]	1 (Off)	80MHz	[Height] - 1 - (ROUNDDOWN(([Exposure Time] - [1Line Control Start Exposure Time value]) ×(10^-6)×[Camera Link Clock Frequency:80MHz]÷2618.54))
		60MHz	[Height] - 1 - (ROUNDDOWN(([Exposure Time] - [1Line Control Start Exposure Time value]) ×(10^-6)×[Camera Link Clock Frequency:80MHz]÷2637.25))
	2 (On)	80MHz	[Height] - 0.5 - (ROUNDDOWN(([Exposure Time] - [1Line Control Start Exposure Time value]) ×(10^-6)×[Camera Link Clock Frequency:80MHz]÷5237.09)÷2)
		60MHz	[Height] - 0.5 - (ROUNDDOWN(([Exposure Time] - [1Line Control Start Exposure Time value]) ×(10^-6)×[Camera Link Clock Frequency:60MHz]÷5274.49)÷2)
Exposure Time Max value	1 (Off), 2 (On)	80MHz	ROUNDDOWN([Frame Rate (Time)] - (41200÷[Camera Link Clock Frequency:80MHz]×10^6))
		60MHz	ROUNDDOWN([Frame Rate (Time)] - (41200÷[Camera Link Clock Frequency:60MHz]×10^6))

ExposureAuto

This is a function to control the exposure automatically. It is effective only for Timed.

JAI ALC Reference controls the brightness.

There are three modes: OFF, Once and Continuous.

Off	No exposure control
Once	Exposure adjusts when the function is set, then remains at that setting
Continuous	Exposure continues to be adjusted automatically

In this mode, the following settings are available.

ALC speed	Rate of adjustment can be set (Common with Gain Auto)
ExposureAuto Max	The maximum value for the exposure time to be controlled can be set
ExposureAuto Min	The minimum value for the exposure time to be controlled can be set
ALC Reference	The reference level of the exposure control can be set (Common with Gain Auto)
ALC Channel area	The measurement area of the exposure control can be set

Trigger Control

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

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

Trigger Mode can be selected in Trigger Selector. On this camera, the trigger mode is limited to Frame Start. However, it is possible to operate as shown below:

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

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

Trigger Source

Select the trigger source to be used for trigger operation.

- 0: Low (Default), 1: High, 2: SoftTrigger, 8: PulseGenerator0, 9: PulseGenerator1, 10: PulseGenerator02, 11: PulseGenerator03, 12: TTL_In1, 13: CL_CC1_In, 14: Nand0, 15: Nand1, 16: TTL_In2, 17: LVDS_In

> **Note:** On this camera, GPIO port is located on the AUX interface (Hirose 10P). In this GPIO. Line 10 and Line 11 are available.

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

> **Note:** If Exposure Mode is set to Trigger Width, Level High or Level Low must be used.

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

Trigger Overlap

This function defines whether or not a trigger pulse can be accepted while data is being read out.

- OFF: The trigger pulse is not accepted during CMOS readout.
- Read Out: The trigger pulse can be accepted during CMOS readout.

Normal Continuous Operation (Timed Exposure Mode/Trigger Mode OFF)

This is used for applications which do not require triggering. In this mode, the video signal for the auto-iris lens is available.

Minimum interval

Readout Mode	Time (Min. Trigger Period)					
	1x8 – 1Y		1x4 – 1Y		1X2 – 1Y	
	80 MHz	60 MHz	80 MHz	60 MHz	80 MHz	60 MHz
Full	33.333ms	44.444ms	66.666ms	88.888ms	133.333ms	177.777ms
ROI Center 2/3	22.222ms	29.629ms	44.444ms	59.259ms	88.889ms	118.518ms
ROI Center 1/2	16.667ms	22.222ms	22.222ms	44.444ms	66.667ms	88.889ms
ROI Center 1/4	8.428ms	11.318ms	16.826ms	22.636ms	33.713ms	45.272ms
ROI Center 1/8	4.500ms	6.043ms	9.001ms	12.087ms	18.002ms	24.174ms
V Binning ON*	33.333ms	44.444ms	66.666ms	88.888ms	133.333ms	177.777ms
*Monochrome Model only						

Timed (EPS) Mode

This mode allows a single image frame to be captured 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.

Basic settings to use this mode:

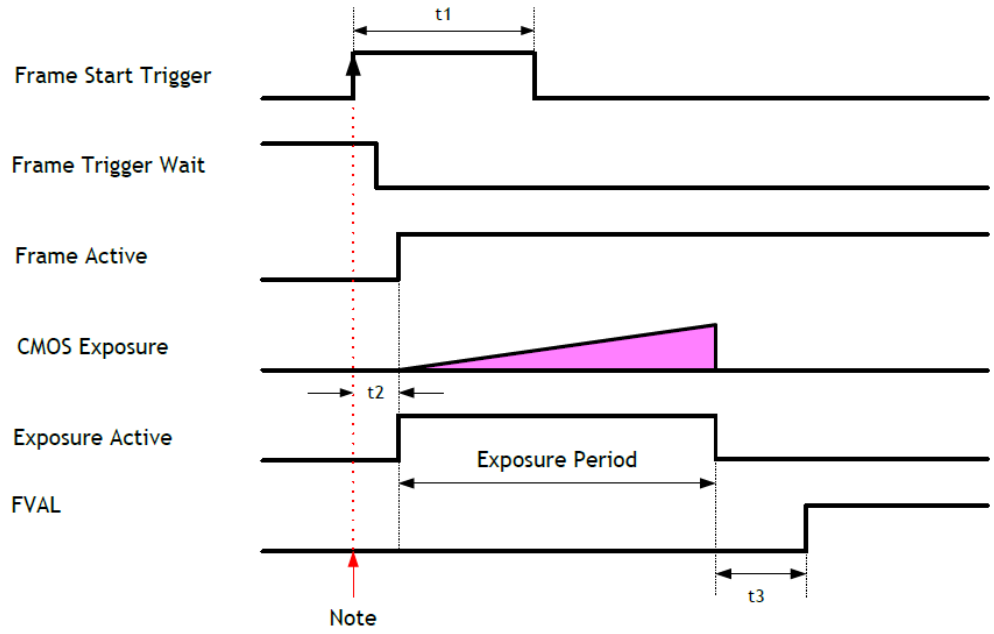
- Trigger Mode: ON
- Exposure Mode: Timed
- Trigger Option: OFF

Trigger Minimum interval (Trigger Overlap = Readout)

Readout Mode	Time (Min. Trigger Period)					
	1x8 – 1Y		1x4 – 1Y		1X2 – 1Y	
	80 MHz	60 MHz	80 MHz	60 MHz	80 MHz	60 MHz
Full	≧ 31.761ms	≧ 42.648ms	≧ 63.200ms	≧ 84.864ms	≧ 126.389ms	≧ 169.719ms
ROI Center 2/3	≧ 21.287ms	≧ 28.582ms	≧ 42.252ms	≧ 56.734ms	≧ 84.492ms	≧ 113.457ms
ROI Center 1/2	≧ 16.050ms	≧ 21.550ms	≧ 31.777ms	≧ 42.669ms	≧ 63.544ms	≧ 85.327ms
ROI Center 1/4	≧ 8.195ms	≧ 11.001ms	≧ 16.066ms	≧ 21.571ms	≧ 32.121ms	≧ 43.131ms
ROI Center 1/8	≧ 4.267ms	≧ 5.726ms	≧ 8.211ms	≧ 11.022ms	≧ 16.410ms	≧ 22.033ms
V Binning ON* (Full)	≧ 31.770ms	≧ 42.658ms	≧ 63.216ms	≧ 84.887ms	≧ 126.423ms	≧ 169.764ms
*Monochrome model only						

> **Note:** If Trigger Overlap is OFF, the accumulation time is added to the above table.

Trigger Overlap = Off (Timed Mode)



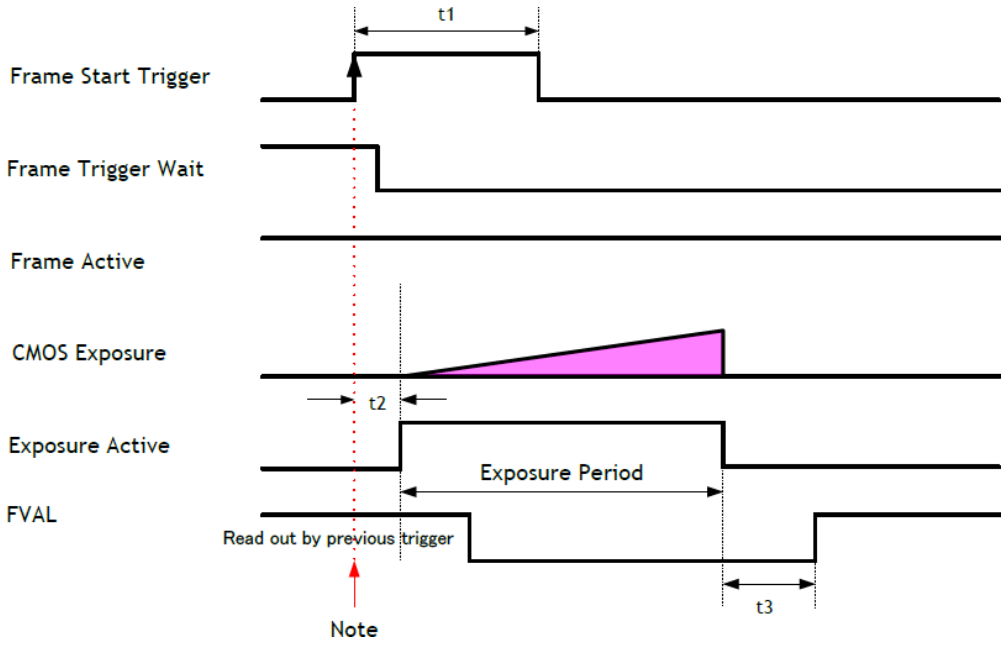
Note: The trigger pulse is accepted during Frame Trigger Wait being active if the trigger overlap is OFF. When the trigger is accepted, the trigger wait is inactive until the readout is completed.

EPS Trigger Mode, Trigger Overt Lap = Off

	Camera Link Pixel Clock	Vertical Binning	1X8-1Y	1X4-1Y	1X2-1Y
t1	80/60MHz	-	2L(min)	2L(min)	2L(min)
t2	80MHz	-	450 ns ~ 490 ns	460 ns ~ 490 ns	630 ns ~ 690 ns
	60MHz	-	530 ns ~ 580 ns	530 ns ~ 580 ns	770 ns ~ 860 ns
t3	80MHz	1 (Off)	320 us	328 us	656 us
		2 (On)	328 us	345 us	689 us
	60MHz	1 (Off)	430 us	441 us	881 us
		2 (On)	441 us	463 us	925 us

Note: Because jitter occurs during triggering, t2 has tolerance in time.

Trigger Overlap = Readout (Timed Mode)



Note: If the trigger overlap is Readout mode, Frame Trigger Wait is active on FVAL period of the previous trigger. In this period, the next trigger can be accepted. After receiving this trigger pulse, Frame Trigger Wait becomes inactive.

EPS Trigger Mode, Trigger Overt Lap = Readout

	Camera Link Pixel Clock	Vertical Binning	Tap Geometry Setting		
			1X8-1Y	1X4-1Y	1X2-1Y
t1	80/60 MHz	-	2L(min)	2L(min)	2L(min)
t2	80MHz	-	460 ns ~ 460ns + 1 Line	470 ns ~ 471 ns + 1 Line	655 ns ~ 655 ns + 1 Line
	60MHz	-	540 ns ~ 540 ns + 1 Line	540 ns ~ 540 ns +1 Line	780 ns ~ 780 ns + 1 Line
t3	80MHz	1 (Off)	320 us	328 us	656 us
		2 (On)	328 us	345 us	689 us
	60MHz	1 (Off)	430 us	441 us	881 us
		2 (On)	441 us	463 us	925 us

Calculation Formula for the Minimum Trigger Interval (Trigger Overlap = Off, Timed Mode)

Tap Geometry	Camera Link Pixel Clock	Binning Vertical	EPS Trigger / Trigger Overlap = Off Minimum Trigger Interval calculation formula [Unit: us]
1X8-1Y	80MHz	1 (Off)	= ROUND((((([Height]+1) ×654.63) − 654.63 + ([Width]÷8)) ÷ 80MHz x 10^6) +321+ [Exposure Time]
		2 (On)	= ROUND((((([Height]+1) ×1309.27) − 640 + ([Width]÷8)) ÷ 80MHz x 10^6) + 321 + [Exposure Time]
	60MHz	1 (Off)	= ROUND((((([Height]+1) ×659.31) − 659.31 + ([Width]÷8)) ÷ 60MHz x 10^6) + 431 + [Exposure Time]
		2 (On)	= ROUND((((([Height]+1) ×1318.61) − 640 + ([Width]÷8)) ÷ 60MHz x 10^6) + 431 + [Exposure Time]
1X4-1Y	80MHz	1 (Off)	= ROUND((((([Height]+1) ×1309.27) − 1309.27 + ([Width]÷4)) ÷ 80MHz x 10^6) + 329 + [Exposure Time]
		2 (On)	= ROUND((((([Height]+1) ×2618.53) − 1280 + ([Width]÷4)) ÷ 80MHz x 10^6) + 329 + [Exposure Time]
	60MHz	1 (Off)	= ROUND((((([Height]+1) ×1318.61) − 1318.61 + ([Width]÷4)) ÷ 60MHz x 10^6) + 442 + [Exposure Time]
		2 (On)	= ROUND((((([Height]+1) ×2637.23) − 1280 + ([Width]÷4)) ÷ 60MHz x 10^6) + 442 + [Exposure Time]
1X2-1Y	80MHz	1 (Off)	= ROUND((((([Height]+1) ×2618.54) − 2618.54 + ([Width]÷2)) ÷ 80MHz x 10^6) + 657 + [Exposure Time]
		2 (On)	= ROUND((((([Height]+1) ×5237.09) − 2560 + ([Width]÷2)) ÷ 80MHz x 10^6) + 657 + [Exposure Time]
	60MHz	1 (Off)	= ROUND((((([Height]+1) ×2637.25) − 2637.25 + ([Width]÷2)) ÷ 60MHz x 10^6) + 882 + [Exposure Time]
		2 (On)	= ROUND((((([Height]+1) ×5274.49) − 2560 + ([Width]÷2)) ÷ 60MHz x 10^6) + 882 + [Exposure Time]

Note: When Trigger Overlap is set to OFF, if the trigger pulse is input in shorter period than the period listed in the above trigger interval, this trigger input may be ignored by the trigger mask.

Calculation Formula for the Minimum Trigger Interval (Trigger Overlap = Readout, Timed Mode)

TapGeometry: 1X8-1Y

Camera Link Clock	Binning Vertical	EPS Trigger / Trigger Overlap = Readout Minimum Trigger Interval calculation formula [Unit: us]
80MHz	1 (Off)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 266 (1) If [Exposure Time] value is less than 1Frame = ROUND((((([Height] + 1) × 654.63) - 654.63 + ([Width]÷8))÷80MHz×10^6)+331
		2) If [Exposure Time] value is more than 1Frame = 266 + [Exposure Time]
	2 (On)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 266 (1) If [Exposure Time] value is less than 1Frame = ROUND((((([Height] + 1) ×1309.27) - 640 + ([Width]÷8))÷80MHz×10^6)+331
		(2) If [Exposure Time] valueis more than 1Frame = 266 + [Exposure Time]
60MHz	1 (Off)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 353 (1) If [Exposure Time] value is less than 1Frame = ROUND((((([Height] + 1) × 659.31) - 659.31 + ([Width]÷8))÷60MHz×10^6)+441
		(2) If [Exposure Time] value is more than 1Frame = 353 + [Exposure Time]
	2 (On)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 353 (1) If [Exposure Time] value is less than 1Frame = ROUND((((([Height] + 1) ×1318.61) - 1318.61 + ([Width]÷8))÷60MHz×10^6)+441
		(2) If [Exposure Time] value is more than 1Frame = 353 + [Exposure Time]

Note: When Trigger Overlap is set to Readout, if the trigger interval is set more than the period specified in the above table, the exposure operation may not be activated, and the video may be disturbed.

TapGeometry: 1X4-1Y

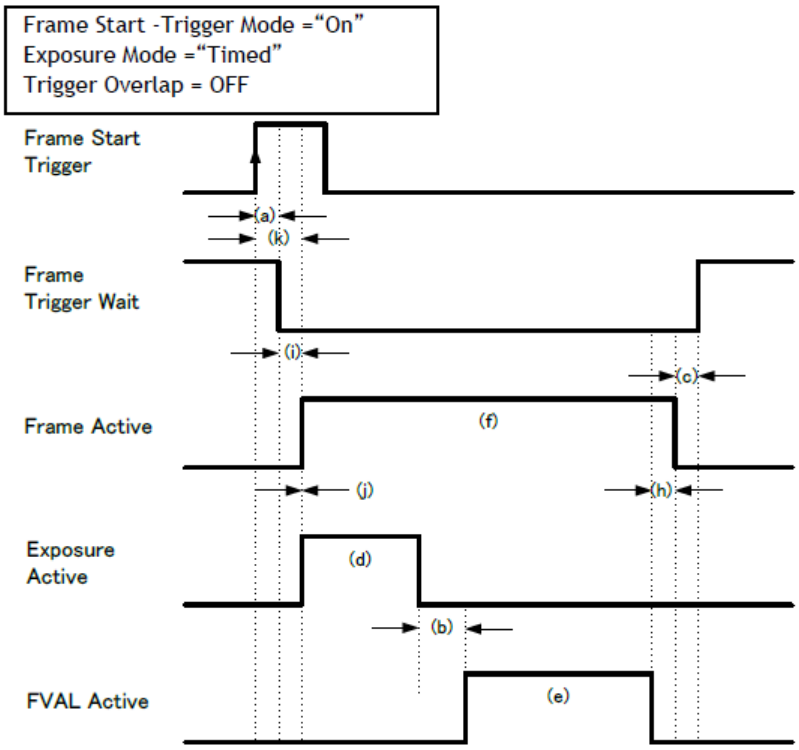
Camera Link Clock	Binning Vertical	EPS Trigger / Trigger Overlap = Readout Minimum Trigger Interval calculation formula [Unit: us]
80MHz	1 (Off)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 266 (1) If [Exposure Time] value is less than 1Frame = ROUND((([Height] + 1) ×1309.27) - 1309.27 + ([Width]÷4))÷80MHz×10^6)+339
		(2) If [Exposure Time] value is more than 1Frame = 266 + [Exposure Time]
	2 (On)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 266 (1) If [Exposure Time] value is less than 1Frame = ROUND((([Height] + 1) ×2618.53) - 1280 + ([Width]÷4))÷80MHz×10^6)+339
		(2) If [Exposure Time] value is more than 1Frame = 266 + [Exposure Time]
60MHz	1 (Off)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 353 (1) If [Exposure Time]value is less than 1Frame = ROUND((([Height] + 1) ×1318.61) - 1318.61 + ([Width]÷4))÷60MHz×10^6)+452
		(2) If [Exposure Time] value is more than 1Frame = 353 + [Exposure Time]
	2 (On)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 353 (1) If [Exposure Time] value is less than 1Frame = ROUND((([Height] + 1) ×2637.23) - 1280 + ([Width]÷4))÷60MHz×10^6)+452
		(2) If [Exposure Time] value is more than 1Frame = 353 + [Exposure Time]

TapGeometry: 1X2-1Y

Camera Link Clock	Binning Vertical	EPS Trigger / Trigger Overlap = Readout Minimum Trigger Interval calculation formula [Unit: us]
80MHz	1 (Off)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 521 (1) If [Exposure Time] value is less than 1Frame = ROUND((([Height] + 1) ×2618.54) - 2618.54 + ([Width]÷2))÷80MHz×10^6)+667
		(2) If [Exposure Time] value is more than 1Frame = 521 + [Exposure Time]
	2 (On)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 521 (1) If [Exposure Time] value is less than 1Frame = ROUND((([Height] + 1) ×5237.09) - 2560 + ([Width]÷2))÷80MHz×10^6)+667
		(2) If [Exposure Time] valueis more than 1Frame = 521 + [Exposure Time]
60MHz	1 (Off)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 696 (1) If [Exposure Time] value is less than 1Frame = ROUND((([Height] + 1) ×2637.25) - 2637.25 + ([Width]÷2))÷60MHz×10^6)+892
		(2) If [Exposure Time] valueis more than 1Frame = 696 + [Exposure Time]
	2 (On)	At the condition of [Exposure Time Max] ≦ [Trigger Period] - 696 (1) If [Exposure Time] value is less than 1Frame = ROUND((([Height] + 1) ×5274.49) - 2560 + ([Width]÷2))÷60MHz×10^6)+892
		(2) If [Exposure Time] value is more than 1Frame = 696 + [Exposure Time]

GPIO TTL Output Timing (Trigger Overlap = Off, Timed Mode)

GPIO TTL Out Timing



GPIO Out Timing (Reference) (80 MHz, EPS Trigger, Trigger Overlap= OFF)

	Description	Tap Geometry Setting			Note
		1X8-1Y	1X4-1Y	1X2-1Y	
(a)	Frame Start Trigger to Frame Trigger Wait Falling Edge	820 ns	820 ns	1.010 us	Frame Start Trigger is input through TTL IN 1
(b)	Exposure Active Falling Edge to FVAL Raising Edge	320 us (320 us)	328 us (328 us)	656 us (656 us)	Varies by Tap Geometry setting. ( ) is Exposure Active which is assigned to Camera Link Spare Bit
(c)	Frame Active Falling Edge to Frame Trigger Wait Raising Edge	1.00 us	1.00 us	1.00 us	
(d)	Exposure Active	8.91 us (10.26 us)	8.91 us (10.26 us)	8.98 us (10.31 us)	If Exposure Time is 10, ( ) is Exposure Active which is assigned to Camera Link Spare Bit
(e)	FVAL Active	31.42 ms	62.84 ms	125.69 ms	If Binning off and [Height]=3840, (Will be changed by Height setting)

	Description	Tap Geometry Setting			Note
		1X8-1Y	1X4-1Y	1X2-1Y	
(f)	Frame Active	31.75 ms	63.18 ms	126.36 ms	[Exposure Mode] = Timed
(h)	FVAL Falling Edge to Frame Active Falling Edge	1.110 us	1.110 us	410 ns	This will be different by Binning or ROI setting. Frame Active End Edge against FVAL Active End is shifted by approx. 1us.
(i)	Frame Trigger wait Falling Edge to Frame Active Raising Edge	1.19 us	1.19 us	1.19 us	
(j)	Frame Active Raising Edge to Exposure Active Raising Edge	0 ns	0 ns	0 ns	
(k)	Frame Start Trigger to Exposure Active Raising Edge	2.05 us (470 ns)	2.05 us (470 ns)	2.23 us (660 ns)	Exposure Active at TTL I/F ( ) is if comparing with Exposure Active which is assigned to Camera Link Spare Bit
-	Exposure Active Start Edge: CL / TTL Out phase difference	1.60 us	1.60 us	1.60 us	If the polarity is Active High
-	Exposure Active End Edge: CL / TTL Out phase difference	240 ns	240 ns	240 ns	If the polarity is Active High

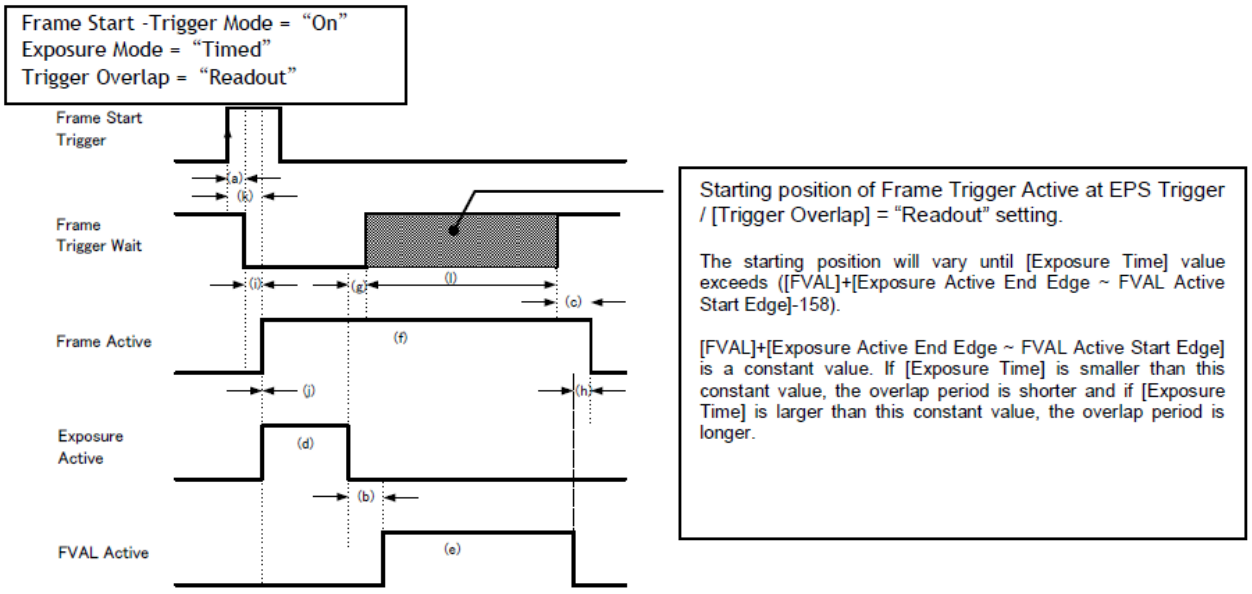
GPIO Out Timing (Reference) (60 MHz, EPS Trigger, Trigger Overlap= OFF)

	Description	Tap Geometry Setting			Note
		1X8-1Y	1X4-1Y	1X2-1Y	
(a)	Frame Start Trigger to Frame Trigger Wait Falling Edge	890 ns	890 ns	810 ns	Frame Start Trigger is input through TTL IN 1
(b)	Exposure Active Falling Edge to FVAL Raising Edge	429 us (430 us)	440us (441 us)	881 us (881 us)	Varies by Tap Geometry setting. ( ) is Exposure Active which is assigned to Camera Link Spare Bit
(c)	Frame Active Falling Edge to Frame Trigger Wait Raising Edge	975 ns	975 ns	1.028us	
(d)	Exposure Active	9.04 us (10.37 us)	9.04 us (10.37 us)	9.09 us (10.43 us)	Exposure Time = 10. ( ) is Exposure Active which is assigned to Camera Link Spare Bit.
(e)	FVAL Active	42.20 ms	84.39 ms	168.78 ms	If Binning off and [Height]=3840, (Will be changed by Height setting)

	Description	Tap Geometry Setting			Note
		1X8-1Y	1X4-1Y	1X2-1Y	
(f)	Frame Active	42.64 ms	84.84 ms	169.67 ms	[Exposure Mode] = Timed
(h)	FVAL Falling Edge to Frame Active Falling Edge	780 ns	390 ns	760 ns	This will be different by Binning or ROI setting. Frame Active End Edge against FVAL Active End is shifted by approx. 1us.
(i)	Frame Trigger wait Falling Edge to Frame Active Raising Edge	1.19 us	1.19 us	1.19 us	
(j)	Frame Active Raising Edge to Exposure Active Raising Edge	0 ns	0 ns	0 ns	
(k)	Frame Start Trigger to Exposure Active Raising Edge	2.08 us (560 ns)	2.08 us (560 ns)	2.35 us (800 ns)	Exposure Active at TTL I/F ( ) is if comparing with Exposure Active which is assigned to Camera Link Spare Bit
-	Exposure Active Start Edge: CL / TTL Out phase difference	1.53 us	1.53 us	1.53 us	If the polarity is Active High
-	Exposure Active End Edge: CL / TTL Out phase difference	220 ns	220 ns	220 ns	If the polarity is Active High

GPIO TTL Output Timing (Trigger Overlap = Readout, Timed Mode)

GPIO Timing (Overlap = Readout)



GPIO Output Timing (Reference) (80 MHz, EPS Trigger, Trigger Overlap = Readout)

	Description	Tap Geometry Setting			Note
		1X8-1Y	1X4-1Y	1X2-1Y	
(a)	Frame Start Trigger to Frame Trigger Waite Falling Edge	810 ns	810 ns	1.010 us	
(b)	Exposure Active Falling Edge to FVAL Raising Edge	320 us (320 us)	328 us (328 us)	656 us (656 us)	Varies by Tap Geometry setting.
(c)	Frame Trigger Wait Raising Edge to Frame Active Falling Edge	7.15 us	7.15 us	7.15 us	Phase if Exposure Time is set to 10us
(d)	Exposure Active	8.93 us (10.28 us)	8.93 us (10.28 us)	9.00 us (10.33 us)	Exposure Time=10us ( ) is Exposure Active which is assigned to Camera Link Spare Bit
(e)	FVAL Active	31.42 ms	62.84 ms	125.69 ms	If Binning off and [Height]=3840, (Will be changed by Height setting)
(f)	Frame Active	31.75 ms	63.18 ms	126.36 ms	Exposure Mode = Timed
(g)	Exposure Active Falling Edge to Frame Trigger Wait Raising Edge	241.03 us	231.84 us	470.81 us	

	Description	Tap Geometry Setting			Note
		1X8-1Y	1X4-1Y	1X2-1Y	
(h)	FVAL Falling Edge to Frame Active Falling Edge	1.10 us	1.27 us	370 ns	If Binning off and [Height]=3840, (Will be changed by Height setting)
(i)	Frame Trigger wait Falling Edge to Frame Active Raising Edge	1.22 us	1.22 us	1.22 us	
(j)	Frame Active Raising Edge to Exposure Active Raising Edge	0 ns	0 ns	0 ns	
(k)	Frame Start Trigger to Exposure Active Raising Edge	2.04 us (470 ns)	2.04 us (470 ns)	1.01 us (660 ns)	Exposure Active at TTL I/F ( ) is if comparing with Exposure Active which is assigned to Camera Link Spare Bit
(l)	Exposure Active Raising Edge Variableness	31.50 ms	62.93 ms	125.87 ms	Varies by Exposure Time setting
-	Exposure Active Start Edge: CL/TTL out phase difference	1.58 us	1.58 us	1.58 us	
-	Exposure Active End Edge: CL/TTL out phase difference	230 ns	230 ns	230 ns	

Note: The timing in this table is in the condition that the trigger pulse is not input during the video readout from the previous trigger. This is for the explanation of the phase relation between Frame Trigger Wait and Frame Active.

GPIO Output Timing (Reference) (60 MHz, EPS Trigger, Trigger Overlap = Readout)

	Description	Tap Geometry Setting			Note
		1X8-1Y	1X4-1Y	1X2-1Y	
(a)	Frame Start Trigger to Frame Trigger Waite Falling Edge	890 ns	890 ns	1.160 us	
(b)	Frame Start Trigger to Frame Trigger Waite Falling Edge	429 us (430 us)	440 us (441 us)	881 us (882us)	Varies by Tap Geometry setting.
(c)	Exposure Active Falling Edge to FVAL Raising Edge	7.21 us	7.21 us	7.21 us	Exposure Time=10us
(d)	Frame Trigger Wait Raising Edge to Frame Active Falling Edge	9.04 us (10.37 us)	9.04 us (10.37 us)	9.09 us (10.44 us)	Exposure Time=10us ( ) is Exposure Active which is assigned to Camera Link Spare Bit
(e)	Exposure Active	42.20 ms	84.39 ms	125.69 ms	If Binning off and Height =3840, (Will be changed by Height setting)

	Description	Tap Geometry Setting			Note
		1X8-1Y	1X4-1Y	1X2-1Y	
(f)	FVAL Active	42.64 ms	84.84 ms	168.78 ms	Exposure Mode = Timed
(g)	Frame Active	323.97 us	314.73 us	634.65 us	
(h)	Exposure Active Falling Edge to Frame Trigger Wait Raising Edge	790 ns	410 ns	730 ns	This will be different by Binning or ROI setting. Frame Active End Edge against FVAL Active End is shifted by approx. 2us.
(i)	FVAL Falling Edge to Frame Active Falling Edge	1.20 us	1.20 us	1.20 us	
(j)	Frame Trigger wait Falling Edge to Frame Active Raising Edge	0 ns	0 ns	0 ns	
(k)	Frame Active Raising Edge to Exposure Active Raising Edge	2.11 us	2.11 us	2.38 us	Exposure Active at TTL I/F ( ) is if comparing with Exposure Active which is assigned to Camera Link Spare Bit
(l)	Frame Start Trigger to Exposure Active Raising Edge	42.29 ms	84.51 ms	169.02 ms	Varies by Exposure Time setting
-	Exposure Active Raising Edge Variableness	1.53 us	1.53 us	1.53 us	
-	Exposure Active End Edge: CL/TTL out phase difference	220 ns	220 ns	220 ns	

Note: The timing in this table is in the condition that the trigger pulse is not input during the video readout from the previous trigger. This is for the explanation of the phase relation between Frame Trigger Wait and Frame Active.

TriggerWidth 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.

Basic settings to use this mode

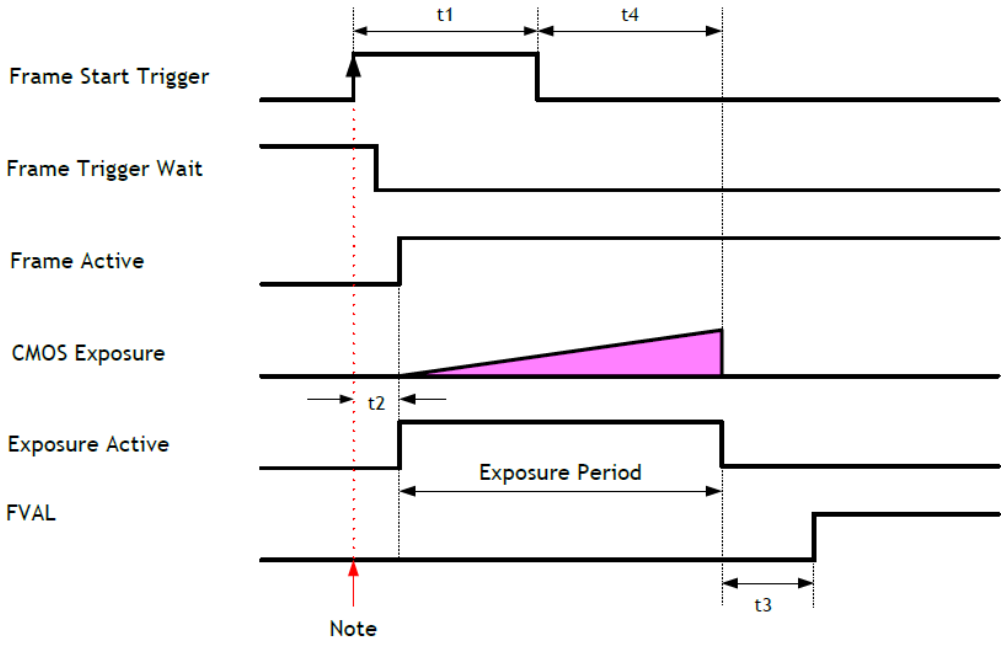
- Trigger Mode = ON
- Exposure Mode = Trigger Width

Minimum trigger interval (Trigger Overlap = Readout)

Readout Mode	1x8 – 1Y		1x4 – 1Y		1X2 – 1Y	
	80 MHz	60 MHz	80 MHz	60 MHz	80 MHz	60 MHz
Full	≧ 31.761ms	≧ 42.648ms	≧ 63.200ms	≧ 84.864ms	≧ 126.389ms	≧ 169.719ms
ROI Center 2/3	≧ 21.287ms	≧ 28.582ms	≧ 42.252ms	≧ 56.734ms	≧ 84.492ms	≧ 113.457ms
ROI Center 1/2	≧ 16.050ms	≧ 21.550ms	≧ 31.777ms	≧ 42.669ms	≧ 63.544ms	≧ 85.327ms
ROI Center 1/4	≧ 8.195ms	≧ 11.001ms	≧ 16.066ms	≧ 21.571ms	≧ 32.121ms	≧ 43.131ms
ROI Center 1/8	≧ 4.267ms	≧ 5.726ms	≧ 8.211ms	≧ 11.022ms	≧ 16.410ms	≧ 22.033ms
V Binning ON* (Full)	≧ 31.770ms	≧ 42.658ms	≧ 63.216ms	≧ 84.887ms	≧ 126.423ms	≧ 169.764ms
*Monochrome model only						

> **Note:** If Trigger Overlap is OFF, the accumulation time is added to the above table.

Trigger Overlap = OFF (TriggerWidth Mode)



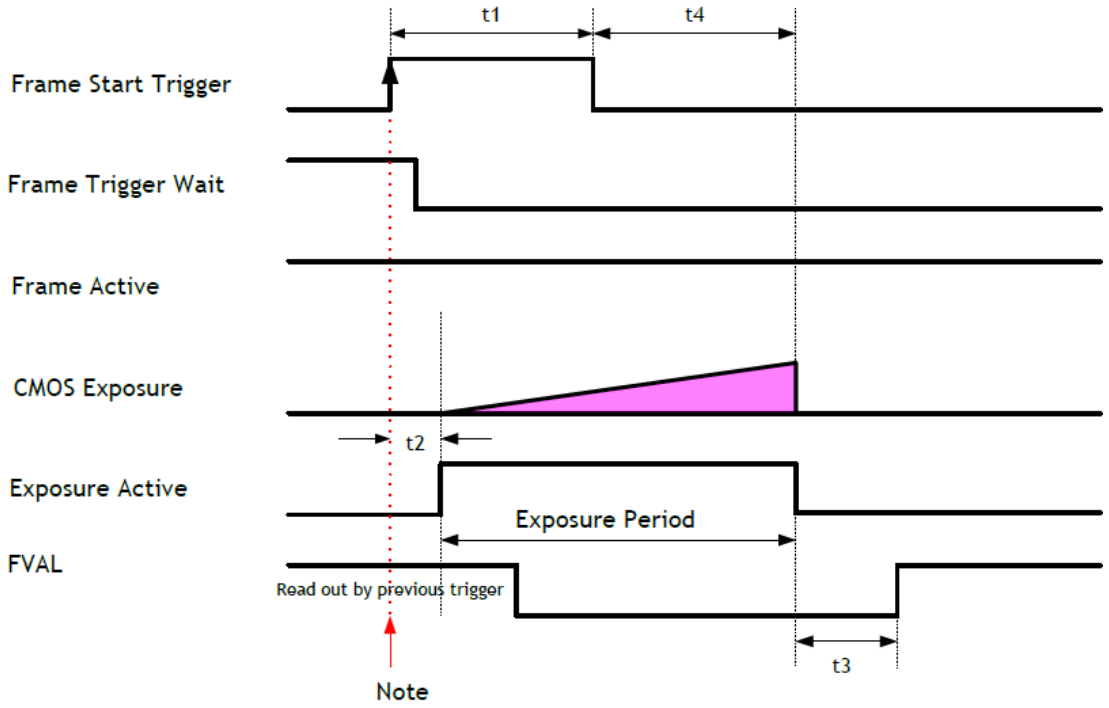
Note: The trigger pulse is accepted during Frame Trigger Wait being active if the trigger overlap is OFF. When the trigger is accepted, the trigger wait is inactive until the readout is completed.

	Camera Link Pixel Clock	Vertical Binning	Tap Geometry Setting		
			1X8-1Y	1X4-1Y	1X2-1Y
t1	80/60 MHz	—	10 µs (Min)	10 µs (Min)	10 µs (Min)
t2	80MHz	-	400 ns ~ 440 ns	400 ns ~ 440 ns	520 ns ~ 590 ns
	60MHz	-	460 ns ~ 510 ns	460 ns ~ 510 ns	630 ns ~ 720 ns
t3	80MHz	1 (Off)	320 us	328 us	656 us
		2 (On)	328 us	345 us	689 us
	60MHz	1 (Off)	430 us	441 us	881 us
		2 (On)	441 us	643 us	925 us
t4	80MHz	-	2.42 us ~ 2.45 us	2.42 us ~ 2.46 us	2.55 us ~ 2.62 us
	60MHz	-	2.48 us ~ 2.53 us	2.48 us ~ 2.53 us	2.67us ~ 2.75 us
Actual Exposure time difference	80MHz	-	2.00 us ~ 2.06 us	2.00 us ~ 2.04 us	12.00us ~ 12.63 us
	60MHz	-	2.00 us ~ 2.05 us	2.00 us ~ 2.52 us	12.00us ~ 12.08 us

Notes:

- The jitter from the trigger occurs at both the exposure start edge and exposure end edge.
- The actual exposure time difference is an additional period of exposure time against TTL trigger input. (t4) - (t2) ≒ The real exposure time difference

Trigger Overlap = Readout (TriggerWidth Mode)



Note: If the trigger overlap is Readout mode, Frame Trigger Wait is active during FVAL period of the previous trigger. In this period, the next trigger can be accepted. After receiving this trigger pulse, Frame Trigger Wait becomes inactive.

	Camera Link Pixel Clock	Vertical Binning	Tap Geometry Setting		
			1X8-1Y	1X4-1Y	1X2-1Y
t1	80/60 MHz	—	10 µs (Min)	10 µs (Min)	10 µs (Min)
t2	80MHz	-	440 ns ~ 440 ns + 1Line	420 ns ~ 420 ns + 1Line	550 ns ~ 550 ns + 1Line
	60MHz	-	490 ns ~ 490 ns + 1Line	500 ns ~ 500 ns + 1Line	700 ns ~ 700 ns + 1Line

	Camera Link Pixel Clock	Vertical Binning	Tap Geometry Setting		
			1X8-1Y	1X4-1Y	1X2-1Y
t3	80MHz	1 (Off)	320 us	328 us	656 us
		2 (On)	328 us	345 us	689 us
	60MHz	1 (Off)	430 us	441 us	881 us
		2 (On)	441 us	463 us	925 us
t4	80MHz	-	2.46 us ~ 2.50 us	2.49 us ~ 2.53 us	2.61 us ~ 2.67 us
	60MHz	-	2.53 us ~ 2.58 us	2.53 us ~ 2.59 us	2.70 us ~ 2.78 us
(t4)-(t2): Exposure time difference	80MHz	-	-6.16us ~ +2.01us	-13.46us ~ +2.11us	-35.26 us ~ +2.12 us
	60MHz	-	-7.97us ~ +2.09us	-18.95us ~ +2.09us	-41.95us ~ +2.08us

Notes:

- The jitter from the trigger occurs at both the exposure start edge and exposure end edge.
- The exposure start edge has 1 line jitter at receiving trigger in order not to influence the video signal.

Minimum Trigger Interval Calculation Formula (Trigger Overlap = Off, TrigerWidth Mode)

Tap Geometry	Camera Link Pixel Clock	Binning Vertical	Trigger Width / Trigger Overlap = Off Minimum Trigger interval calculation formula [Unit: us]
1X8-1Y	80MHz	1 (Off)	= ROUND(((([Height]+1) ×654.63) − 654.63 + ([Width]÷8)) ÷ 80MHz x 10^6) +321+ [Trigger Pulse Width:10us ~]
		2 (On)	= ROUND(((([Height]+1) ×1309.27) − 640 + ([Width]÷8)) ÷ 80MHz x 10^6) + 321 + [Trigger Pulse Width:10us ~]
	60MHz	1 (Off)	= ROUND(((([Height]+1) ×659.31) − 659.31 + ([Width]÷8)) ÷ 60MHz x 10^6) + 431 + [Trigger Pulse Width:10us ~]
		2 (On)	= ROUND(((([Height]+1) ×1318.61) − 640 + ([Width]÷8)) ÷ 60MHz x 10^6) + 431 + [Trigger Pulse Width:10us ~]
1X4-1Y	80MHz	1 (Off)	= ROUND(((([Height]+1) ×1309.27) − 1309.27 + ([Width]÷4)) ÷ 80MHz x 10^6) + 329 + [Trigger Pulse Width:10us ~]
		2 (On)	= ROUND(((([Height]+1) ×2618.53) − 1280 + ([Width]÷4)) ÷ 80MHz x 10^6) + 329 + [Trigger Pulse Width:10us ~]
	60MHz	1 (Off)	= ROUND(((([Height]+1) ×1318.61) − 1318.61 + ([Width]÷4)) ÷ 60MHz x 10^6) + 442 + [Trigger Pulse Width:10us ~]
		2 (On)	= ROUND(((([Height]+1) ×2637.23) − 1280 + ([Width]÷4)) ÷ 60MHz x 10^6) + 442 + [Trigger Pulse Width:10us ~]
1X2-1Y	80MHz	1 (Off)	= ROUND(((([Height]+1) ×2618.54) − 2618.54 + ([Width]÷2)) ÷ 80MHz x 10^6) + 657 + [Trigger Pulse Width:10us ~]
		2 (On)	= ROUND(((([Height]+1) ×5237.09) − 2560 + ([Width]÷2)) ÷ 80MHz x 10^6) + 657 + [Trigger Pulse Width:10us ~]
	60MHz	1 (Off)	= ROUND(((([Height]+1) ×2637.25) − 2637.25 + ([Width]÷2)) ÷ 60MHz x 10^6) + 882 + [Trigger Pulse Width:10us ~]
		2 (On)	= ROUND(((([Height]+1) ×5274.49) − 2560 + ([Width]÷2)) ÷ 60MHz x 10^6) + 882 + [Trigger Pulse Width:10us ~]

Note: When Trigger Overlap is set to OFF, if the trigger pulse is input in shorter period than the period listed in the above trigger interval, this trigger input may be ignored by the trigger mask.

Minimum Trigger Interval Calculation Formula (Trigger Overlap = Readout, TriggerWidth Mode)

TapGeometry: 1X8-1Y

Camera Link Clock	Binning Vertical	Trigger Width/ Trigger Overlap = Readout Minimum Trigger Interval calculation formula [Unit: us]
80MHz	1 (Off)	At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 266us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND(((([Height] + 1) × 654.63) - 654.63 + ([Width]÷8))÷80MHz×10^6)+331
		(2) If [Trigger Pulse Width] is more than 1Frame = 266 + [Trigger Pulse Width]
	2 (On)	At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 266us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND(((([Height] + 1) ×1309.27) - 640 + ([Width]÷8))÷80MHz×10^6)+331
		(2) If [Trigger Pulse Width] is more than 1Frame = 266 + [Trigger Pulse Width]
60MHz	1 (Off)	At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 353us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND(((([Height] + 1) × 659.31) - 659.31 + ([Width]÷8))÷60MHz×10^6)+441
		(2) If [Trigger Pulse Width] is more than 1Frame = 353 + [Trigger Pulse Width]
	2 (On)	At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 353us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND(((([Height] + 1) ×1318.61) - 1318.61 + ([Width]÷8))÷60MHz×10^6)+441
		(2) If [Trigger Pulse Width] is more than 1Frame = 353 + [Trigger Pulse Width]

Note: When Trigger Overlap is set to Readout, if the trigger interval is set at more than the period specified in the above table or Trigger Pulse width, the exposure operation may not work properly and the video image may be deteriorated.

TapGeometry: 1X4-1Y

Camera Link Clock	Binning Vertical	Trigger Width/ Trigger Overlap = Readout Minimum Trigger Interval calculation formula [Unit: us]
80MHz	1 (Off)	At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 266us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND((((([Height] + 1) ×1309.27) - 1309.27 + ([Width]÷4))÷80MHz×10^6)+339
		(2) If [Trigger Pulse Width] is more than 1Frame = 266 + [Trigger Pulse Width]
	2 (On)	At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 266us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND((((([Height] + 1) ×2618.53) - 1280 + ([Width]÷4))÷80MHz×10^6)+339
		(2) If [Trigger Pulse Width] is more than 1Frame = 266 + [Trigger Pulse Width]
60MHz	1 (Off)	= 266 + [Trigger Pulse Width] 60 MHz 1 (Off) At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 353us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND((((([Height] + 1) ×1318.61) - 1318.61 + ([Width]÷4))÷60MHz×10^6)+452
		(2) If [Trigger Pulse Width] is more than 1Frame = 353 + [Trigger Pulse Width]
	2 (On)	At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 353us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND((((([Height] + 1) ×2637.23) - 1280 + ([Width]÷4))÷60MHz×10^6)+452
		(2) If [Trigger Pulse Width] is more than 1Frame = 353 + [Trigger Pulse Width]

Tap Geometry: 1X2-1Y

Camera Link Clock	Binning Vertical	Trigger Width/ Trigger Overlap = Readout Minimum Trigger Interval calculation formula [Unit: us]
80MHz	1 (Off)	At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 521us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND(((([Height] + 1) ×2618.54) - 2618.54 + ([Width]÷2))÷80MHz×10^6)+667
		(2) If [Trigger Pulse Width] is more than 1Frame = 521 + [Trigger Pulse Width]
	2 (On)	At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 521us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND(((([Height] + 1) ×5237.09) - 2560 + ([Width]÷2))÷80MHz×10^6)+667
		(2) If [Exposure Time] is more than 1Frame = 521 + [Trigger Pulse Width]
60MHz	1 (Off)	At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 696us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND(((([Height] + 1) ×2637.25) - 2637.25 + ([Width]÷2))÷60MHz×10^6)+892
		(2) If [Exposure Time] is more than 1Frame = 696 + [Trigger Pulse Width]
	2 (On)	At the condition of [Trigger Pulse Width] ≦ [Trigger Period: us] - 696us (1) If [Trigger Pulse Width] is less than 1Frame = ROUND(((([Height] + 1) ×5274.49) - 2560 + ([Width]÷2))÷60MHz×10^6)+892
		(2) If [Exposure Time] is more than 1Frame = 696 + [Trigger Pulse Width]

PIV (Particle Image Velocimetry)

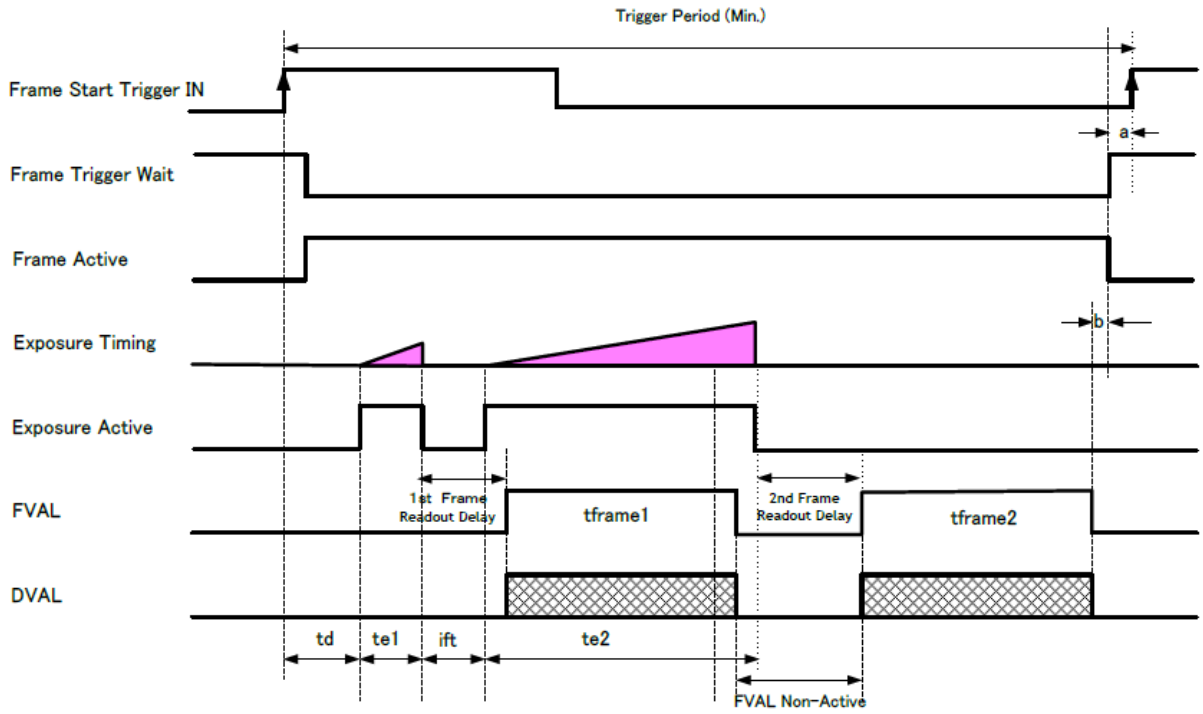
The Particle Image Velocimetry mode can be used in applications where 2 images need to be taken with a very short time interval. It can only be used with strobe flash as illumination. The first accumulation time is 10 us to 2 sec. Then, the second exposure will be taken. The first strobe is activated during the first exposure duration and the second strobe is pulsed while the first frame is being read out. In this way, two strobe flashes generate two video outputs.

Basic settings to use this mode

- Trigger Mode: ON
- Exposure mode: Timed
- Trigger Option: PIV

Minimum trigger interval (Trigger overlap = Off)

Readout Mode	Time (Min. Trigger Period)					
	1x8 – 1Y		1x4 – 1Y		1X2 – 1Y	
	80 MHz	60 MHz	80 MHz	60 MHz	80 MHz	60 MHz
Full	≧ 63.625ms	≧ 85.394ms	≧ 126.489ms	≧ 169.807ms	≧ 252.834ms	≧ 339.472ms
ROI Center 2/3	≧ 42.677ms	≧ 57.263ms	≧ 84.592ms	≧ 113.546ms	≧ 169.041ms	≧ 226.950ms
ROI Center 1/2	≧ 32.203ms	≧ 43.198ms	≧ 63.644ms	≧ 85.416ms	≧ 127.144ms	≧ 170.688ms
ROI Center 1/4	≧ 16.492ms	≧ 22.100ms	≧ 32.221ms	≧ 43.220ms	≧ 64.299ms	≧ 88.055ms
ROI Center 1/8	≧ 8.636ms	≧ 11.551ms	≧ 16.510ms	≧ 22.122ms	≧ 32.877ms	≧ 44.110ms
V Binning* ON (Full)	≧ 63.635ms	≧ 85.404 ms	≧ 126.504ms	≧ 169.831ms	≧ 252.868ms	≧ 339.518ms
*Monochrome model only						



Notes:

- The exposure time for the first frame (te1) can be set by [Exposure Time].
- The second exposure time (te2) varies by ROI setting and Binning setting but is not affected by [Exposure Time] setting.

PIV Trigger Mode Specifications (1X8 – 1Y)

	Description	Camera Link Pixel Clock = 80MHz	Camera Link Pixel Clock = 60MHz
td	Exposure Beginning delay	430 ns~470 ns	500 ns ~ 540 ns
te1	First exposure time period	10us ~ ≒ 1 Frame ([Height]=3840 : 31737us Max) = [Exposure Time Settings]	10us ~ ≒ 1 Frame ([Height]=3840: 42619us Max) = [Exposure Time Settings]
itf	Inter framing time	312 us	419 us
te2	Second exposure time	≒ 1 frame (1) V-Binning Off = ([Height]×654.63÷80MHz) + 131 us	≒ 1 frame (1) V-Binning Off = ([Height]×659.31÷60MHz) + 132 us
		(2) V-Binning On = ([Height]×1309.27÷80MHz) + 131 us	(2) V-Binning On = ([Height]×1318.61÷60MHz) + 132 us

	Description	Camera Link Pixel Clock = 80MHz	Camera Link Pixel Clock = 60MHz
tframe 1	First Frame read out	[FVAL Active] (1) V-Binning Off [FVAL Active] = (([Height]×654.63)-654.63+([Width]÷8))÷80 MHz	[FVAL Active] (1) V-Binning Off [FVAL Active] = (([Height]×659.31)-659.31+([Width]÷8))÷60MHz
		(2) V-Binning On [FVAL Active] = ((([Height]-0.5)×1309.27)-640+([Width] ÷ 8))÷80MHz	(2) V-Binning On [FVAL Active] = ((([Height]-0.5)×1318.61)-640+([Width] ÷ 8))÷60MHz
tframe 2	Second Frame read out	[FVAL Active] (the same as tframe1)	[FVAL Active] (the same as tframe1)
-	1st Frame Readout Delay	(1) V-Binning Off = 320 us (2) V-Binning On = 328 us	1) V-Binning Off = 430 us (2) V-Binning On = 441 us
-	2nd Frame Readout Delay	(1) V-Binning Off = 320 us (2) V-Binning Off = 328 us	(1) V-Binning Off = 551 us (2) V-Binning On = 562 us
-	FVAL Non-Active	(1) V-Binning Off , H-Binning Off = 443 us (2) V-Binning On , H-Binning Off = 452 us (3) V-Binning Off , H-Binning On = 447 us (4) V-Binning On , H-Binning On = 456 us	(1) V-Binning Off , H-Binning Off = 551 us (2) V-Binning On , H-Binning Off = 562 us (3) V-Binning Off , H-Binning On = 556 us (4) V-Binning On , H-Binning On = 567 us
-	Trigger Period (Min.)	(1) V-Binning Off = (((([Height]+0.5)×654.63)-654.63+([Width]÷ 8)) x 2Frame÷80MHz) +[Exposure Time] +763us	(1) V-Binning Off = (((([Height]+0.5)×659.31)-659.31+([Width]÷8)) x 2Frame÷60MHz) +[Exposure Time] + 982us
		(2) V-Binning On = ((([Height]×1309.27)-640+([Width÷8]))x 2Frame÷80MHz) +[Exposure Time] +780us	(2) V-Binning On = ((([Height]×1318.61)-640+([Width÷8]))x 2Frame ÷60MHz) +[Exposure Time] +1003us
-	2nd FrameActive End ~ Frame Active End	0us	1.8us
a		More than 1 Line	More than 1 Line
b		Less than 1 Line	Less than 1 Line

PIV Trigger Mode Specifications (1X4 – 1Y)

	Description	Camera Link Pixel Clock = 80MHz	Camera Link Pixel Clock = 60MHz
td	Exposure Beginning delay	430 ns~470 ns	490 ns ~540 ns
te1	First exposure time period	10us ~ ≒ 1 Frame ([Height]=3840 : 63164us Max) = [Exposure Time Settings]	10us ~ ≒ 1 Frame ([Height]=3840: 84819us Max) = [Exposure Time Settings]
itf	Inter framing time	312 us	419 us
te2	Second exposure time	≒ 1 frame (1) V-Binning Off = ([Height]×1309.27÷80MHz) + 132 us	≒ 1 frame (1) V-Binning Off = ([Height]×1318.61÷60MHz) + 133 us
		(2) V-Binning On = ([Height]×2618.53÷80MHz) + 132 us	(2) V-Binning On = ([Height]×2637.23÷60MHz) + 133 us
tframe 1	First Frame read out	[FVAL Active] (1) V-Binning Off [FVAL Active] = (([Height]×1309.27)-1309.27+([Width]÷4))÷ 80MHz	[FVAL Active] (1) V-Binning Off [FVAL Active] = (([Height]×1318.61)-1318.61+ ([Width]÷4))÷60MHz
		(2) V-Binning On [FVAL Active] = ((([Height]-0.5)×2618.53)-1280+([Width] ÷4))÷80MHz	(2) V-Binning On [FVAL Active] = ((([Height]-0.5)×2637.23)-1280+ ([Width]÷4))÷60MHz
tframe 2	Second Frame read out	[FVAL Active] (the same as tframe1)	[FVAL Active] (the same as tframe1)
-	1st Frame Readout Delay	(1) V-Binning Off = 328 us (2) V-Binning On = 345 us	1) V-Binning Off = 441 us (2) V-Binning On = 463 us
-	2nd Frame Readout Delay	(1) V-Binning Off = 328 us (2) V-Binning Off = 345 us	1) V-Binning Off = 441 us (2) V-Binning On = 463 us
-	FVAL Non-Active	(1) V-Binning Off , H-Binning Off = 444 us (2) V-Binning On , H-Binning Off = 460 us (3) V-Binning Off , H-Binning On = 452 us (4) V-Binning On , H-Binning On = 468 us	(1) V-Binning Off , H-Binning Off = 552 us (2) V-Binning On , H-Binning Off = 574 us (3) V-Binning Off , H-Binning On = 563 us (4) V-Binning On , H-Binning On = 585 us
-	Trigger Period (Min.)	(1) V-Binning Off = (((([Height]+0.5)×1309.27)-1309.27+([Width]÷4)) x 2Frame÷80MHz) +[Exposure Time] + 773 us	(1) V-Binning Off = (((([Height]+0.5)×659.31)-659.31+([Width]÷8)) x 2Frame÷60MHz) +[Exposure Time] + 982us
		(2) V-Binning On = ((([Height]×2618.53)-1280+([Width÷4]))x 2Frame÷80MHz) +[Exposure Time] + 805	(2) V-Binning On = ((([Height]×2637.23)-1280+([Width÷4]))x 2Frame ÷60MHz) +[Exposure Time] + 1038 us
-	2nd FrameActive End ~ Frame Active End	8.2us	11.8 us

	Description	Camera Link Pixel Clock = 80MHz	Camera Link Pixel Clock = 60MHz
a		More than 1 Line	More than 1 Line
b		Less than 1 Line	Less than 1 Line

PIV Trigger Mode Specifications (1X2 – 1Y)

	Description	Camera Link Pixel Clock = 80MHz	Camera Link Pixel Clock = 60MHz
td	Exposure Beginning delay	580 ns~640 ns	700 ns ~780 ns
te1	First exposure time period	10us ~ ≒ 1 Frame ([Height]=3840 : 126328us Max) = [Exposure Time Settings]	10us ~ ≒ 1 Frame ([Height]=3840 : 169641us Max) = [Exposure Time Settings]
itf	Inter framing time	624 us	838 us
te2	Second exposure time	≒ 1 frame (1) V-Binning Off = ([Height]×2618.54÷80MHz) + 131us	≒ 1 frame (1) V-Binning Off = ([Height]×2637.25÷60MHz) + 133us = 168.9165000 ms
		(2) V-Binning On = ([Height]×5237.09÷80MHz) + 131us	(2) V-Binning On = ([Height]×5274.49÷60MHz) + 133us
tframe 1	First Frame read out	[FVAL Active] (1) V-Binning Off [FVAL Active] = (([Height]×2618.54)-2618.54+([Width]÷2))÷ 80MHz	[FVAL Active] (1) V-Binning Off [FVAL Active] = (([Height]×2637.25)-2637.25+ ([Width]÷2))÷60MHz
		(2) V-Binning On [FVAL Active] = ((([Height]-0.5)×5237.09)-2560+([Width] ÷2))÷80MHz	(2) V-Binning On [FVAL Active] = ((([Height]-0.5)×5274.49)-2560+ ([Width]÷2))÷60MHz
tframe 2	Second Frame read out	[FVAL Active] (the same as tframe1)	[FVAL Active] (the same as tframe1)
-	1st Frame Readout Delay	(1) V-Binning Off = 656 us (2) V-Binning On = 689 us	(1) V-Binning Off = 881 us (2) V-Binning On = 925 us
-	2nd Frame Readout Delay	(1) V-Binning Off = 656 us (2) V-Binning Off = 656 us	(1) V-Binning Off = 881 us (2) V-Binning On = 925 us
-	FVAL Non-Active	(1) V-Binning Off , H-Binning Off = 755 us (2) V-Binning On , H-Binning Off = 788 us (3) V-Binning Off , H-Binning On = 771 us (4) V-Binning On , H-Binning On = 804 us	(1) V-Binning Off , H-Binning Off = 971 us (2) V-Binning On , H-Binning Off = 1.015 ms (3) V-Binning Off , H-Binning On = 993 us (4) V-Binning On , H-Binning On = 1.037 ms

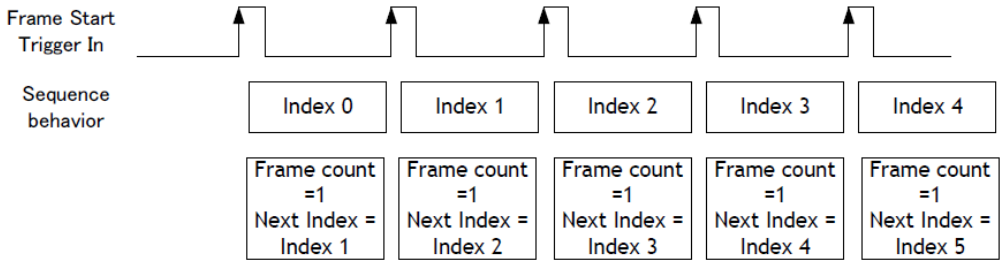
	Description	Camera Link Pixel Clock = 80MHz	Camera Link Pixel Clock = 60MHz
-	Trigger Period (Min.)	(1) V-Binning Off = (((([Height]+0.5)×2618.54)-2618.54+([Width]÷2)) x 2Frame÷80MHz) +[Exposure Time] + 1413 us	(1) V-Binning Off = (((([Height]+0.5)×2637.25)-2637.25+([Width]÷2)) x 2Frame÷60MHz) +[Exposure Time] + 1853 us
		(2) V-Binning On = ((([Height]×5237.09)-2560+([Width÷2]))x 2Frame÷80MHz) +[Exposure Time] + 1478 us	(2) V-Binning On = ((([Height]×5274.49)-2560+([Width÷2]))x 2Frame ÷60MHz) +[Exposure Time] + 1941 us
-	2nd FrameActive End ~ Frame Active End	22.9us	33.7 us
a		More than 1 Line	More than 1 Line
b		Less than 1 Line	Less than 1 Line

Sequential Timed Exposure Mode

This is a function to capture images in sequence based preset ROI, Exposure Time, Gain and other parameters in the sequence index table.

Video Send Mode

In order activate this function, Video Send Mode should be set to **Trigger Sequence**.



Minimum Trigger Interval (Trigger Overlap = Off)

Readout Mode	Time (Min. Trigger Period)					
	1x8 – 1Y		1x4 – 1Y		1X2 – 1Y	
	1x8 – 1Y	1x4 – 1Y	1X2 – 1Y	1x8 – 1Y	1x4 – 1Y	1X2 – 1Y
Full	≧ 31.761ms	≧ 42.648ms	≧ 63.200ms	≧ 84.864ms	≧ 126.389ms	≧ 169.719ms
ROI Center 2/3	≧ 21.287ms	≧ 28.582ms	≧ 42.252ms	≧ 56.734ms	≧ 84.492ms	≧ 113.457ms
ROI Center 1/2	≧ 16.050ms	≧ 21.550ms	≧ 31.777ms	≧ 42.669ms	≧ 63.544ms	≧ 85.327ms
ROI Center 1/4	≧ 8.195ms	≧ 11.001ms	≧ 16.066ms	≧ 21.571ms	≧ 32.121ms	≧ 43.131ms
ROI Center 1/8	≧ 4.267ms	≧ 5.726ms	≧ 8.211ms	≧ 11.022ms	≧ 16.410ms	≧ 22.033ms
V Binning ON (Full)	≧ 31.770ms	≧ 42.658ms	≧ 63.216ms	≧ 84.887ms	≧ 126.423ms	≧ 169.764ms
*Monochrome model only						

Notes:

- Overlap mode=Readout is not available.
- The minimum interval calculation assumes that the exposure time for all sequences are equal. If there are differences, it is necessary to add the difference to the calculation. If the exposure times are different, it is recommended to organize the exposure times from the shortest exposure to the longest

one.

- The sequence must start with Index 0. After Index 0 is executed, the sequence proceeds to the next setting index.

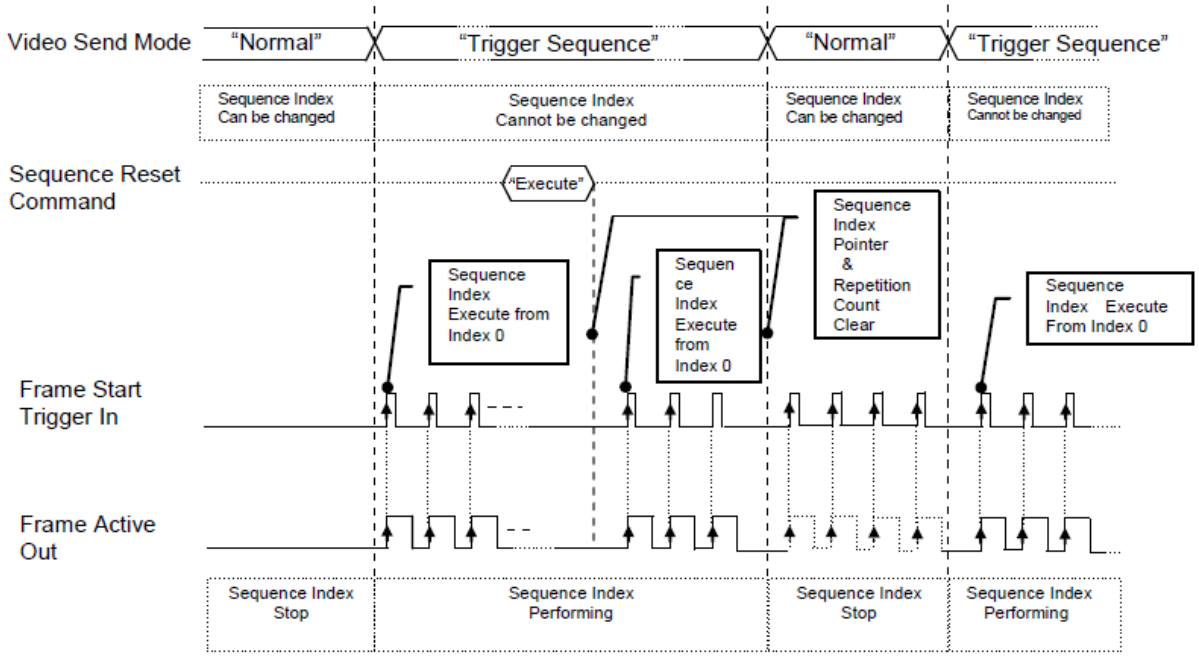
In this mode, while the previous trigger operation (Index table) is activating, the next trigger cannot be overlapped. Sequence index table must be through index 0 and after index 0 is performed, the next index can be operated.

Sequence ROI Setting Parameters

Setting parameters for Sequence ROI are as follows. (The Default shows the default value for Index 1 ~ 10, except Sequence ROI Next Index)

Item	Default	Description
Sequence ROI Index Selector	-	In Sequence ROI Index Selector, Index 1 to 10 can be selected. Sequence ROI – Width, Height, Offset X, Offset Y, Gain Selector - Gain/Red/Blue, Exposure Time, Black Level, Binning Horizontal, Binning Vertical, LUT Enable, Frame Count, Next Index for the selected index are displayed.
Sequence ROI Frame Count	1	This can set how many times the selected index is repeated. This is applied to each index. Triggers are input according to numbers set in Frame Count and index is repeated and moves to the next index. Therefore, the same number of triggers as Frame Count must be input.
Sequence ROI Next Index	Index 0	The number of the index that will follow the current index can be set. If [Video Send Mode] is set to “Trigger Sequence” and the trigger pulse is input in EPS trigger, the sequence is executed from index 0.
Sequence ROI Width	5120	Set the width of sequence ROI. The setting range is 8 to 5120 Pixels. Rules for setting area and step number are the same as the normal ROI mode set by [Video Send Mode] =“Normal”.
Sequence ROI Height	3840	Set the height of sequence ROI. The setting range is 2 to 3840 lines. Rules for setting area and step number are the same as the normal ROI mode set by [Video Send Mode] =“Normal”.
Sequence ROI Offset X	0	Set Offset X of sequence ROI. • Sequence ROI Binning Horizontal =1 (Off): Setting range is 0 to (5120 - [Sequence ROI Width]) • Sequence ROI Binning Horizontal =2 (On): Setting range is 0 to (2560 - [Sequence ROI Width]) The limitations of step number and other factors are the same as the normal ROI mode set by [Video Send Mode] =“Normal”.
Sequence ROI Offset Y	0	Set Offset Y of sequence ROI. • Sequence ROI Binning Vertical =1 (Off): Setting range is 0 to (3840 - [Sequence ROI Height]) • Sequence ROI Binning Vertical =2 (On): Setting range is 0 to (1920 - [Sequence ROI Height]) The limitations of step number and other factors are the same as the normal ROI mode set by [Video Send Mode] =“Normal”.

Item	Default	Description
Sequence ROI Gain Selector	-	In Sequence ROI Gain Selector, the gain settings for each index are available. Color model: Gain (ALL), Red, and Blue can be set. Monochrome model: Only Gain is displayed and can be set.
Sequence ROI Exposure Time	180000	Exposure Time setting is available for each index.
Sequence ROI Black Level	0	Black Level setting is available for each index.
Sequence ROI LUT Enable	Off	Enable or disable of LUT function for each index 0 to 9 can be set.
Sequence ROI Binning Horizontal	1 (On)	ON or OFF of Horizontal Binning for each index can be set.
Sequence ROI Binning Vertical	1 (On)	ON or OFF of Vertical Binning for each index can be set.
Sequence ROI Reset Command		This command resets the current index pointer and reverts to index 0 in the table. Frame Count is also re-initialized.
Sequence ROI Index Read Command		When this command is executed, the index executed by the trigger input is displayed. However, in the following scenarios, Index0 is returned: 1) The first time the mode is switched to VideoSendMode = TriggerSequence; 2) After executing Sequence ROI Index Read Command. Index 0 is returned when the Sequence ROI Index Read Command is executed before or after trigger input.


Video Send Mode
"Normal"
"Trigger Sequence"
"Normal"
"Trigger Sequence"
Sequence Index Can be changed
Sequence Index Cannot be changed
Sequence Index Can be changed
Sequence Index Cannot be changed
Sequence Reset Command
"Execute"
Sequence Index Execute from Index 0
Sequen ce Index Execute from Index 0
Sequence Index Pointer & Repetition Count Clear
Sequence Index Execute From Index 0
Frame Start Trigger In
Frame Active Out
Sequence Index Stop
Sequence Index Performing
Sequence Index Stop
Sequence Index Performing

Multi ROI Function

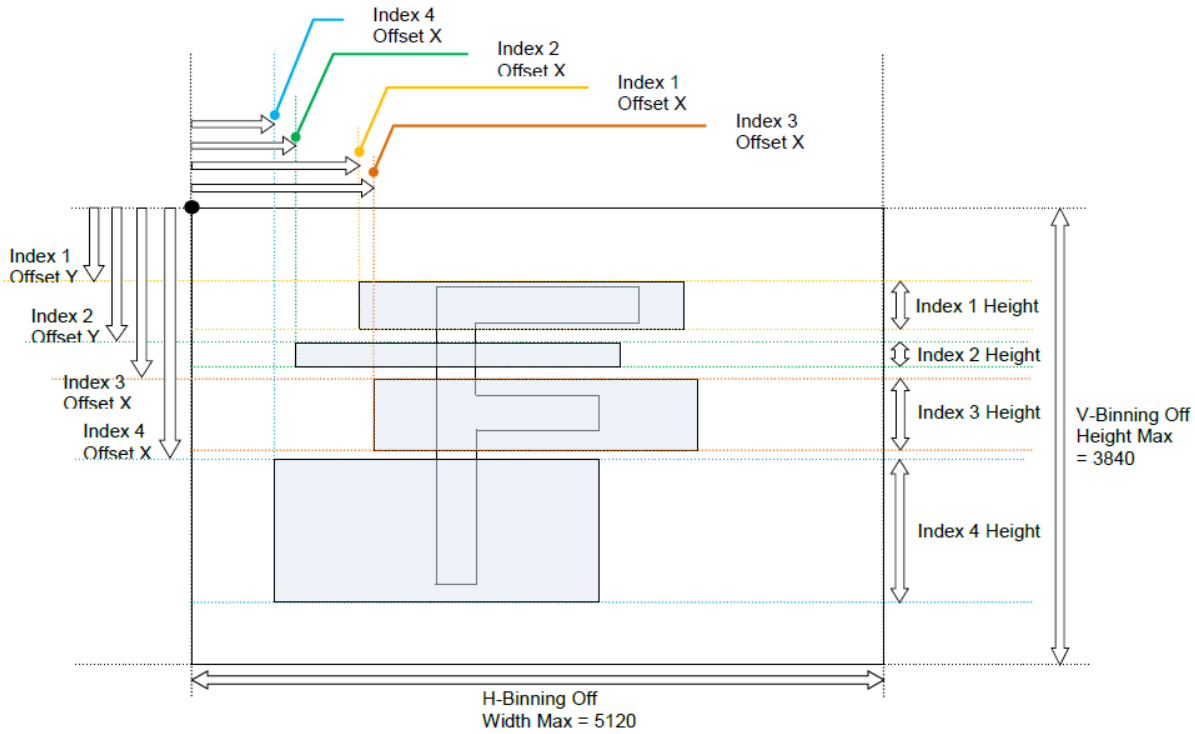
Related Topic: JAI Custom

This function divides one frame image into a maximum of 8 images vertically and reads out all areas in one frame. In this function, width is the same for all 8 images. The Multi ROI function is enabled if [Video Sending Mode] is set to "**Multi ROI**".

Multi ROI Setting Parameters

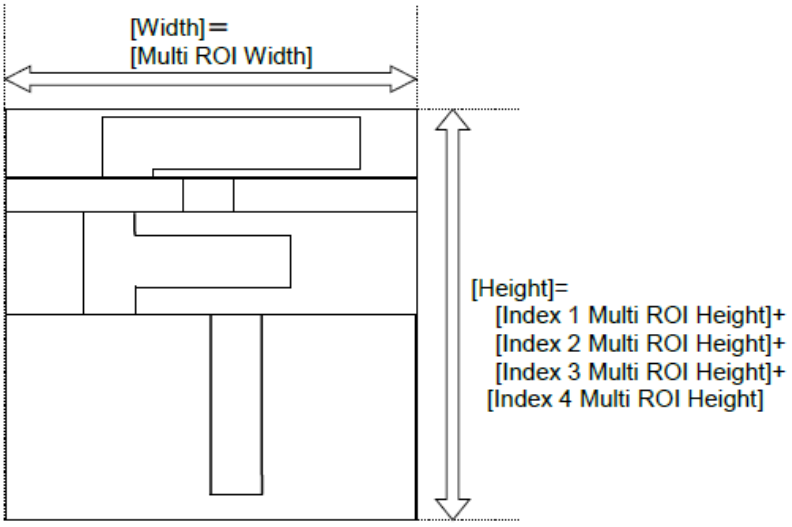
Item	Default	Description
Multi ROI Index Max	1	Setting value 1 ~ 8. Maximum 8 ROI settings are possible in a frame. Set Index 1 through 8 in Multi ROI Index table as an application requires.
Multi ROI Index Selector	-	Index 1 to 8 can be selected. [Height], [Offset X], and [Offset Y] of the selected Multi ROI Index are displayed and can be set.
Multi ROI Width	5120	The setting range and Step number are the same as the normal ROI setting in which [Width] plus [Offset X] should be equal to [Width Max]. In Multi ROI operation, the maximum offset value in index 1 to index 8 is the object in this calculation.
Multi ROI Height	1	Height can be set for each ROI area of Multi ROI Index 1 to 8. The restriction for setting Step and other factors are the same as the normal ROI setting.
Multi ROI Offset X	0	Offset X can be set for each ROI area of Multi ROI Index 1 to 8. The restriction for setting Step and other factors are the same as the normal ROI setting. As described before, in Multi ROI operation, Multi ROI Width is a common width setting for Multi ROI Index 1 to 8.
Multi ROI Offset Y	0	Offset Y can be set for each ROI area of Multi ROI Index 1 to 8. The restriction for setting Step and other factors is the same as the normal ROI setting. The summary of Muliti ROI Height value of index 1 to 8 should be less than Height Max.

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



The figure below shows the video output with the above example settings.

Video output of Multi ROI



Caution: If Multi ROI function is used, the Camera Link frame grabber board that is used should be set as follows. Horizontal pixel number is [Multi ROI Width]. Vertical pixel number is the aggregate of [Multi ROI Height] as configured.

Operation and Function Matrix

Exposure	Trigger Mode	H-Binning*	V-Binning**	Exposure Control	Single ROI	Auto White Balance**	Auto Gain	Auto Exposure	Trigger Overlap	Video Sending Mode	
										Multi ROI	Sequence ROI
OFF	OFF	1	1		●	●	●			●	
		2	2		●	●	●			●	
Timed	OFF	1	1	●	●	●	●	●		●	
		2	2	●	●	●	●	●		●	
Timed	ON	1	1	●	●	●	●	●	●	●	●
		2	2	●	●	●	●	●	●	●	●
Trigger Width	ON	1	1		●				●	●	
		2	2		●				●	●	
Timed PIV	ON	1	1	●	●					●	
		2	2	●	●					●	

*Binning: Monochrome model only

**AutoWhiteBalance: Color model only

Black Level Control

This function adjusts the setup level.

Variable range: -256 to 255 LSB (at 12-bit output)

Model	Black Level Selector	Black Level
Monochrome	Black Level All	-256 ~ +255
Color	Black Level All	-256 ~ +255
	Black Level Red	-512 ~ +511
	Black Level Blue	-512 ~ +511

Auto Black Control

The auto black control function is used to automatically adjust the black level of the sensor, which may vary due to temperature changes and/or the exposure time. It can adjust up to 30% of the video output level.

It has three modes which have different compensation values and the user can choose an appropriate mode depending on the application. As the dynamic range of the sensor depends on the compensation value of the black level, for best results, it is recommended that the camera be used under low temperature conditions, i.e., less than 30°C and with exposure times of less 1 frame, in order to maintain an appropriate dynamic range.

Auto	The compensation value can be automatically varied up to 30%. In this mode, the dynamic range is the smallest.
Limit	In this mode, the limit of the black level compensation value can be set in the range of 0% to 30% by 1% steps. If the camera is used in an environment with little temperature change or short exposure time, this mode can automatically provide an appropriate balance between black level compensation and dynamic range by setting the upper limit of the black level compensation.
Fix	In this mode, the camera automatically saves the temperature and the status of the exposure time just before this mode is set. Then, it sets the appropriate black level compensation value and the maximum dynamic range in accordance with the saved conditions. After this automatic adjustment, the compensation value, which is indicated by percentage, can be read out. In this mode, the black level compensation value is fixed. It is recommended to use this mode if the temperature and exposure time are stable. If the black level varies due to temperature change and/or exposure time variation, it is necessary to set this mode again in order to learn the new environmental conditions. If the environmental conditions are expected to be varied, it is recommended to use Auto or Limit mode.

Gain Control

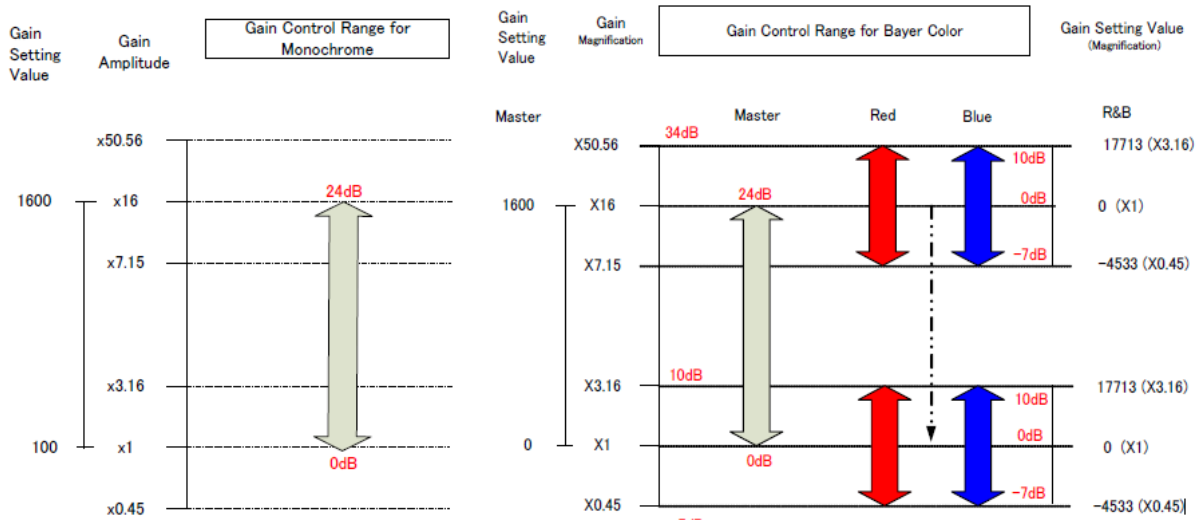
Related Setting Items: Analog Control

This camera can adjust the gain level from x1 (0dB) to 16 times (+24dB) using x1 (0dB) as the reference (Factory default). The master gain can be adjusted from x1 (0dB) to 16 times (+24dB) and R and B gains can be adjusted in the range of 0.45 times (-7dB) to 7.15 times (+10dB) using the master gain as the reference.

Resolution:

- Master Gain: x0.01 (0.035dB)/Step
- Blue/Red Gain: x0.00017 /Step

The master gain uses digital gain. All digital gain has the resolution of x0.01 /Step and provides more precise gain setting. However, as it uses only digital gain, please note that if high gain is set, breaks in the histogram may occur.



Model	Gain Selector	Gain
Monochrome	Digital All	100 ~ 1600 (0dB ~ 24dB)
Color	Digital All	100 ~ 1600 (0dB ~ 24dB)
	Digital Red	-4533 ~ +17713 (-7dB ~ +10dB)
	Digital Blue	-4533 ~ +17713 (-7dB ~ +10dB)

Gain Auto

This provides automatic control of the gain level. There are three modes.

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

The following detailed settings are also available.

- ALC Speed: The rate of adjustment of GainAuto can be set (Common with Exposure Auto)
- GainAuto Max: The maximum value of GainAuto control range can be set
- GainAuto 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 Channel Area: The measurement area of GainAuto control can be set, either entire area or individual section

Detection Area

HighLeft	High MidLeft	High MidRight	HighRight
MidHigh Left	MidHigh MidLeft	MidHigh MidRight	MidHigh Right
MidLow Left	MidLow MidLeft	MidLow MidRight	MidLow Right
LowLeft	Low MidLeft	Low MidRight	LowRight

Balance White Auto

This is a function to enable the auto white balance by using R and B gain controls.

- OFF: Set the white balance manually
- Once: Control the auto white balance only one time when it is set
- Continuous: Continuing control of the auto white balance
- AWB Channel Area: Can set the area to control the auto white balance.

Detection Area

HighLeft	High MidLeft	High MidRight	HighRight
MidHigh Left	MidHigh MidLeft	MidHigh MidRight	MidHigh Right
MidLow Left	MidLow MidLeft	MidLow MidRight	MidLow Right
LowLeft	Low MidLeft	Low MidRight	LowRight

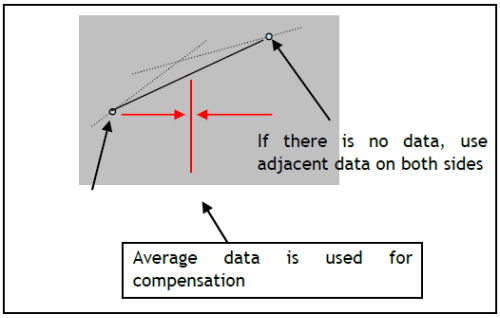
LUT (Lookup Table)

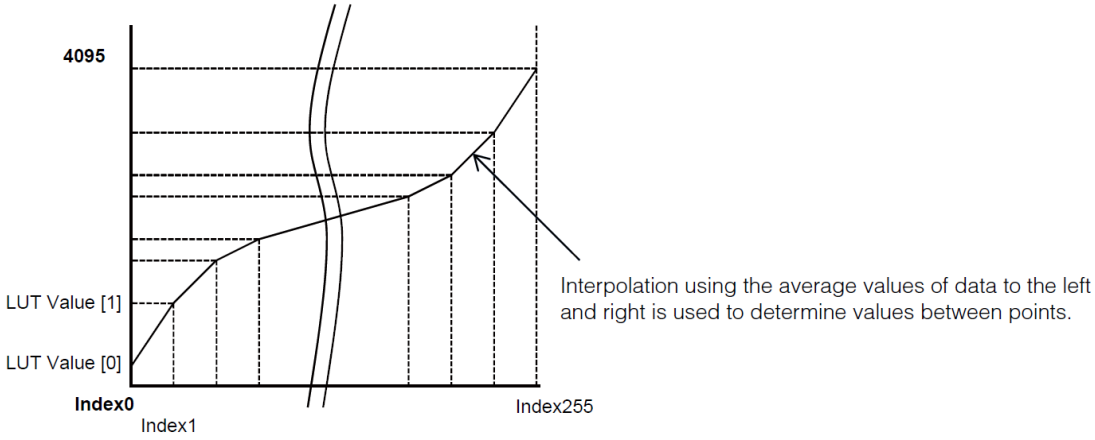
Related Setting Items: LUT Control

This function can be used to convert the input to the desired output characteristics. The Look-Up Table (LUT) has 256 points for setup. The output level can be created by multiplying the gain data by the input level.

To Use the LUT function

Configure the settings as follows.

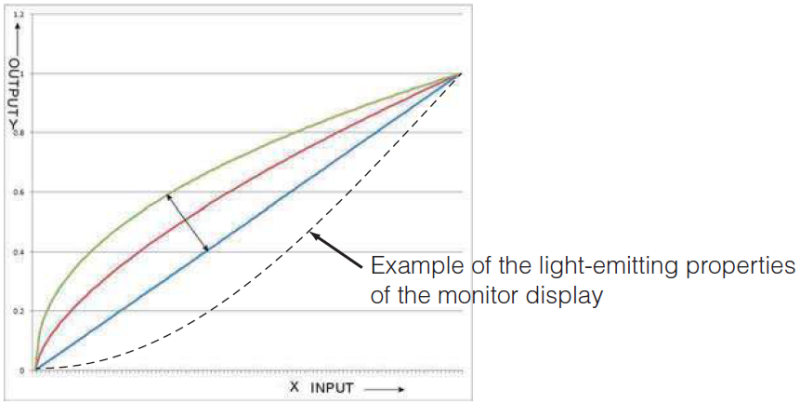
Item	Setting Value / Selectable Range	Description
JAI LUT Mode	LUT	Can be selected from OFF, Gamma or LUT Table.
LUT Index	0 ~ 255	This camera has a 256-point Lookup Table, meaning the index points are treated like an 8bit image with 0 representing a full black pixel and 255 representing a full white pixel.
LUT Value	0 ~ 4095	LUT values range from 0 at the lowest to 4095 at the highest. Linear interpolation is used to calculate LUT values between the index points.  • Output Data = Video IN x LUT data



Gamma Function

> **Note:** Analog Control

This command is used to set gamma between gamma 0.45 and gamma 1.0 (OFF). 8 steps are provided. The gamma value is an approximate value.



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 i.n horizontal and/or vertical directions.

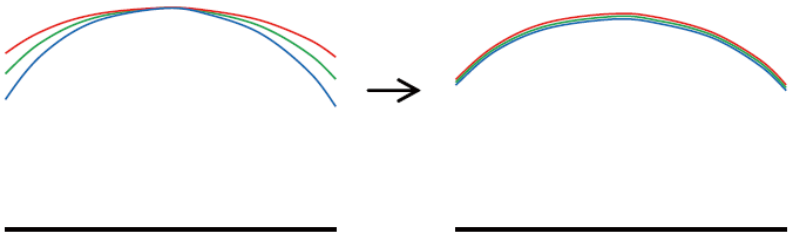
The following shading correction modes are available on the camera

Flat Shading

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 for compensation is 20 blocks (H) x 15 blocks (V) and each block contains 256 x 256 pixels. The complementary process is applied to produce the compensation data with less error.

Color Shading (Color model only)

R-channel and B-channel properties are adjusted by using the G-channel shading properties as a reference.



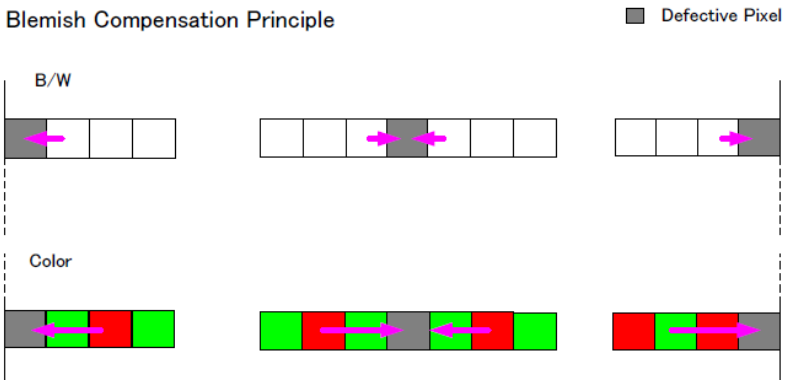
Cautions:
Proper correction is not possible under the following conditions.

- If there is some area in the image with a video level less than 70%
- If part of the image or the entire image is saturated
- If the highest video level in the image is less than 300LSB (at 10-bit output)

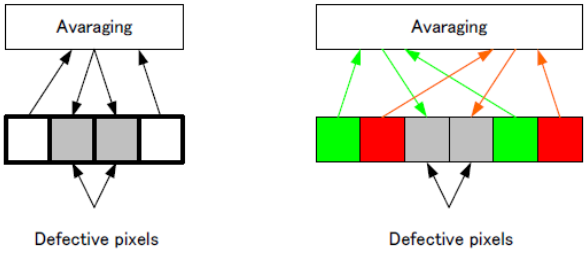
Blemish Compensation

Related Setting Items: JAI Custom

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). This applies to both monochrome and color versions. Pixels that fulfill the blemish criteria can be compensated by averaging the data from pixels in both adjacent columns and, in the case of the color model, the defective pixels can be compensated by averaging the data from the same Bayer color pixels in adjacent columns. The number of pixels that can be compensated is up to 1000 pixels.



If several defective pixels occur in series, 2 pixels in monochrome and 2 same color pixels in color can be compensated.

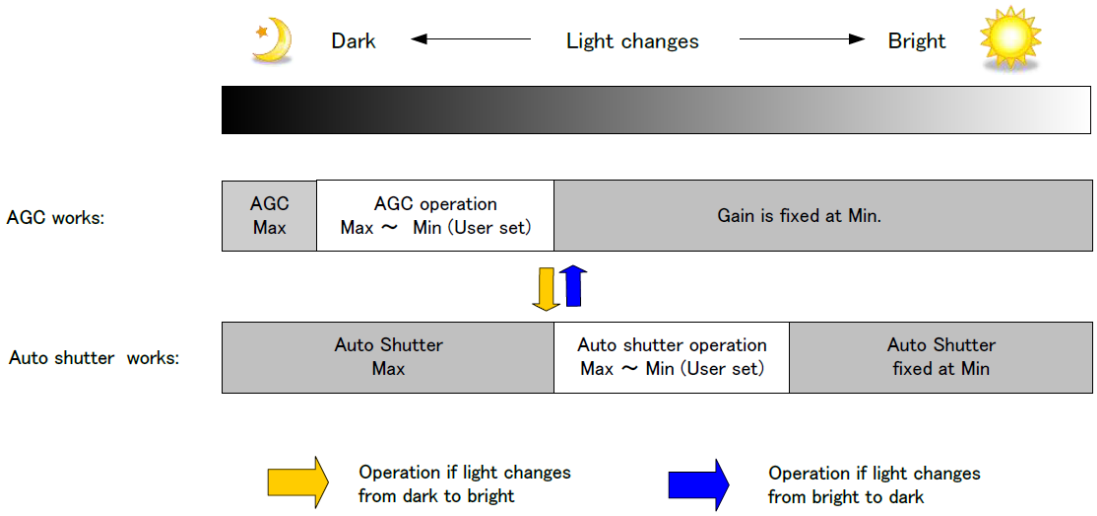


ALC (Automatic Level Control)

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.

- Change from bright to dark: ASC - AGC
- Change from dark to bright: AGC - ASC



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

Short ASCII Command List

All configuration of the camera is done via the RS-232C port. The camera can be set up from a PC running terminal emulator software.

Below is the description of the ASCII based short command protocol.

Communication Setting

Baud Rate	9600
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 a 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=10000 <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> Display the manufacture name.
DeviceModelName	R/O	MD	SP-20000C-PMCL	-	MD?<CR><LF> Display the model name.
DeviceVersion	R/O	DV	-	-	DV?<CR><LF> Display the camera version.
DeviceID	R/O	ID	-	-	ID?<CR><LF> Display the Serial Number.
DeviceUserID	R/W	UD	-	-	UD=[Param.]<CR><LF > UD?<CR><LF> User can save and load free text. (12 or less characters)

Technology Specific Bootstrap Register

Name	Access	Short ASCII	Values	MIN	MAX	Default	Description
Supported Baud rates	R/O	SBDRT	bit0: 9600bps bit1: 19200bps bit2: 38400bps bit3: 57600bps bit4: 115200bps	0x01	0x1F	0x1F	SBDRT?<CR><LF> Indicate Support/Non-support status for each baud rate.
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>

Device Control

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

Image Format Control

Name	Access	Short ASCII	Values	DEFAULT	Description
Width **Related Topic:** ROI (Regional Scanning Function)	R/W	WTC	8 ~ (5120 - OffsetX)	5120	WTC=[Param.]<CR><LF> WTC?<CR><LF> Set the image width. (The value will be set in configuration steps)
Height	R/W	HTL	1 ~ (3840 - OffsetY)	3840	HTL=[Param.]<CR><LF> HTL?<CR><LF> (2 line/ Step) Set the image height. (The value will be set in configuration steps)
OffsetX	R/W	OFC	0 ~ (5112 - Width)	0	OFC=[Param.]<CR><LF> OFC?<CR><LF> Set the horizontal offset. (The value will be set in configuration steps)
OffsetY	R/W	OFL	0 ~ (3838 - Height)	0	OFL=[Param.]<CR><LF> OFL?<CR><LF> Set the vertical offset. (The value will be set in configuration steps)
BinningHorizontal	R/W	HB	1: Normal 2: Binning mode	1	HB=[Param.]<CR><LF> HB?<CR><LF> Set the number of pixels in the horizontal direction for which to perform binning. (Mono model only)

Name	Access	Short ASCII	Values	DEFAULT	Description
BinningVertical	R/W	VB	1: Normal 2: Binning mode	1	VB=[Param.]<CR><LF> VB?<CR><LF> Set the number of pixels in the vertical direction for which to perform binning. (Mono model only)
PixelFormat	R/W	BA	**Mono Model** 0: Mono8 1: Mono10 2: Mono12* **Color Model** 0: BayerRG8 1: BayerRG10 2: BayerRG12	0	BA=[Param.]<CR><LF> BA?<CR><LF> *Mono12: Geometry_1x4_1Y Only.
TestImageSelector	R/W	TPN	0: Off 1: GreyHorizontalRamp 2: GreyVerticalRamp 3: GreyHorizontal RampMoving 4: Horizontal Colorbar* 5: Vertical Colorbar* 6: Moving Colorbar*	0	TPN=[Param.]<CR><LF> TPN?<CR><LF> Select the test image. **Note:** * Color Model Only.

Acquisition Control

Related Topic: Trigger Control, Exposure Mode, ExposureTime, ExposureAuto

Name	Access	Short ASCII	Values	DEFAULT	Description
FrameStartTrigMode	R/W	TM	0: Off 1: On	0	TM=[Param.]<CR><LF> TM?<CR><LF> Display the Trigger mode.
TriggerSoftware	W/O	STRG	0	-	STRG=0<CR><LF> Execute a software trigger.
FrameStartTrigSource	R/W	TI	0: Low 1: High 2: SoftTrigger 8: PulseGenerator0 9: PulseGenerator1 10: PulseGenerator02 11: PulseGenerator03 12: TTL_In1 13: CL_CC1_In 14: Nand0 15: Nand1 16: TTL_In2 17: LVDS_In	0	TI=[Param.]<CR><LF> TI?<CR><LF> Select the trigger signal source.
FrameStartTrigActivation	R/W	TA	0: RisingEdge 1: FallingEdge 2: LevelHigh 3: LevelLow	0	TA=[Param.]<CR><LF> TA?<CR><LF> Select the polarity of the trigger signal (i.e., location of signal at which trigger is applied).
FrameStartTrigOverlap	R/W	TO	0: Off 1: Readout	0	TO=[Param.]<CR><LF> TO?<CR><LF> Select the trigger overlap operation.
ExposureMode	R/W	EM	0: Off 1: Timed 2: TriggerWidth	0	EM=[Param.]<CR><LF> EM?<CR><LF> Select the exposure mode.

Name	Access	Short ASCII	Values	DEFAULT	Description
ExposureTimeRaw	R/W	PE	10 ~ 8000000 [us]	18000	PE=[Param.]<CR><LF> PE?<CR><LF> Set the exposure time.
ExposureAuto	R/W	ASC	0: Off 1: Continuous 2: Once	2	ASC=[Param.]<CR><LF> ASC?<CR><LF> Set whether to enable auto exposure.

Digital IO Control

Related Topic: GPIO (Digital Input/Output Settings)

Name	Access	Short ASCII	Values	DEFAULT	Description
LineInverter_0	R/W	LI0	0: False 1: True	0	LI0=[Param.]<CR><LF> LI0?<CR><LF> Enable/disable polarity inversion for the TTL1 output.
LineInverter_1	R/W	LI1	0: False 1: True	0	LI1=[Param.]<CR><LF> LI1?<CR><LF> Enable/disable polarity inversion for the TTL2 output.
LineInverter_2	R/W	LI2	0: False 1: True	0	LI2=[Param.]<CR><LF> LI2?<CR><LF> Enable/disable polarity inversion for the TTL3 output.
GpioNand0Input Invert1	R/W	ND0INV1	0: Non-Inv 1: Inv	0	ND0INV1=[Param.]<CR><LF> ND0INV1?<CR><LF> Enable/disable polarity inversion for the NAND0 In1 input.
GpioNand0Input Invert2	R/W	ND0INV2	0: Non-Inv 1: Inv	0	ND0INV2=[Param.]<CR><LF> ND0INV2?<CR><LF> Enable/disable polarity inversion for the NAND0 In2 input.

Name	Access	Short ASCII	Values	DEFAULT	Description
GpioNand1Input Invert1	R/W	ND1INV1	0: Non-Inv 1: Inv	0	ND1INV1=[Param.]<CR><LF> ND1INV1?<CR><LF> Enable/disable polarity inversion for the NAND1 In1 input.
GpioNand1Input Invert2	R/W	ND1INV2	0: Non-Inv 1: Inv	0	ND1INV2=[Param.]<CR><LF> ND1INV2?<CR><LF> Enable/disable polarity inversion for the NAND1 In2 input.
LineSource_0	R/W	LS0	0: Low 1: High 3: FrameTrigger Wait 4: FrameActive 5: ExposureActive 6: Fval 8: PulseGenerator0 9: PulseGenerator1 10: PulseGenerator2 11: PulseGenerator3 12: TTL_In 13: CL_CC1_In 14: Nand0 15: Nand1 16:TTL_In2 17:LVDS_In	0	LS0=[Param.]<CR><LF> LS0?<CR><LF> Select the line source signal for TTL1Out.
LineSource_1	R/W	LS1	Same as LS0	0	LS1=[Param.]<CR><LF> LS1?<CR><LF> Select the line source signal for TTL 2 Out.
LineSource_2	R/W	LS2	Same as LS0	0	LS2=[Param.]<CR><LF> LS2?<CR><LF> Select the line source signal for TTL3 Out.

Name	Access	Short ASCII	Values	DEFAULT	Description
GpioNand0Input Source1	R/W	ND0IN1	0: Low 1: High 3: FrameTrigger Wait 4: FrameActive 5: ExposureActive 6: Fval 8: PulseGenerator0 9: PulseGenerator1 10: PulseGenerator2 11: PulseGenerator3 12: TTL_In 13: CL_CC1_In 15: Nand1 16:TTL_In2 17:LVDS_In	0	ND0IN1=[Param.]<CR><LF> ND0IN1?<CR><LF> Select the line source signal for Nand0In1.
GpioNand0Input Source1	R/W	ND0IN2	Same as ND0IN1.	0	ND0IN2=[Param.]<CR><LF> ND0IN2?<CR><LF> Select the line source signal for Nand0In2.
GpioNand1Input Source1	R/W	ND1IN1	0: Low 1: High 3: FrameTrigger Wait 4: FrameActive 5: ExposureActive 6: Fval 7: Lval 8: PulseGenerator0 9: PulseGenerator1 10: PulseGenerator2 11: PulseGenerator3 12: TTL_In 13: CL_CC1_In 14: Nand0 16:TTL_In2 17:LVDS_In	0	ND1IN1=[Param.]<CR><LF> ND1IN1?<CR><LF> Select the line source signal for Nand1In1.
GpioNand1Input Source2	R/W	ND1IN2	Same as ND1IN1.	0	ND1IN2=[Param.]<CR><LF> ND1IN2?<CR><LF> Select the line source signal for Nand1In2.

Analog Control

Related Topic: Gain Control, Black Level Control, Balance White Auto

Name	Access	Short ASCII	Values	DEFAULT	Description
GainRawAnalogAll	R/W	FGA	100 ~ 1600	100	FGA=[Param.]<CR><LF> FGA?<CR><LF> Set the gain value.
GainRawDigitalRedAll	R/W	PGR	- 4533 ~ 17713	0	PGR=[Param.]<CR><LF> PGR?<CR><LF> Set the red gain value for white balance control.
GainRawDigitalBlueAll	R/W	PGB	- 4533 ~ 17713	0	PGB=[Param.]<CR><LF> PGB?<CR><LF> Set the blue gain value for white balance control.
GainAuto	R/W	AGC	0: Off 1: Continuous 2: Once	0	AGC=[Param.]<CR><LF> AGC?<CR><LF> Enable/disable gain auto adjustment.
BlackLevelRawAll	R/W	BL	- 256 ~ 255	0	BL=[Param.]<CR><LF> BL?<CR><LF> Set the black level value.
BlackLevelRaw Tap1All	R/W	BL1	- 512 ~ 511	0	BL1=[Param.]<CR><LF> BL1?<CR><LF> Set the black level Tap1 value.
BlackLevelRaw Tap1Red	R/W	BLR1	- 512 ~ 511	0	BLR1=[Param.]<CR><LF> BLR1?<CR><LF> Set the red gain value for black balance control.
BlackLevelRaw Tap1Blue	R/W	BLB1	- 512 ~ 511	0	BLB1=[Param.]<CR><LF> BLB1?<CR><LF> Set the blue gain value for black balance control.
BalanceWhiteAuto	R/W	AWB	0: Off 1: Continuous 2: Once	0	AWB=[Param.]<CR><LF> AWB?<CR><LF> Set the auto white balance mode.

LUT Control

Related Topic: LUT (Lookup Table)

Name	Access	Short ASCII	Values	DEFAULT	Description
LUTValueRed	R/W	LUTR	Param 1: LUT index (0 ~ 255) Param 2:LUTdata (0 ~ 4095)	γ=1 equivalent value	LUTR=[Param1],[Param2]<CR><LF> LUTR?[Param1]<CR><LF> Set the LUT value for the red output signal. Color model only.
LUTValueGreen	R/W	LUTG	Param 1: LUT index (0 ~ 255) Param 2:LUTdata (0 ~ 4095)	γ=1 equivalent value	LUTG=[Param1],[Param2]<CR><LF> LUTG?[Param1]<CR><LF> Set the LUT value for the green output signal.
LUTValueBlue	R/W	LUTB	Param 1: LUT index (0 ~ 255) Param 2:LUTdata (0 ~ 4095)	γ=1 equivalent value	LUTB=[Param1],[Param2]<CR><LF> LUTB?[Param1]<CR><LF> Set the LUT value for the red output signal. Color model only.

Transport Layer Control

Related Topic: Camera Output Format (Tap Geometry)

Name	Access	Short ASCII	Values	DEFAULT	Description
DeviceTapGeometry	R/W	TAGM	1: Geometry_1X2_1Y 3: Geometry_1X4_1Y 5: Geometry_1X8_1Y	5	TAGM=[Param.]<CR><LF> TAGM?<CR><LF> Set the transmission method for each time images are transmitted from the device (TAP structure).

User Set Control

Related Topic: Step 7: Save the Settings

Name	Access	Short ASCII	Values	Default	Description
UserSetLoad	W/O	LD	0: Default 1: UserSet1 2: UserSet2 3: UserSet3	0	LD=[Param.]<CR><LF> LD?<CR><LF> Load user settings.
UserSetSave	W/O	SA	1: UserSet1 2: UserSet2 3: UserSet3	1	SA=[Param.]<CR><LF> SA?<CR><LF> Save the current setting values as user settings.

JAI Custom

Blemish Compensation

Related Topic: Blemish Compensation

Name	Access	Short ASCII	Min ~ Max	Default	Description
BlemishWhiteEnable	R/W	BMW	0: False 1: True	0	BMW=[Param.]<CR><LF> BMW?<CR><LF> Enable/disable blemish correction.
BlemishWhiteDetect	W/O	BMRCW	0	-	BMRCW=0<CR><LF> Execute blemish detection.
BlemishWhiteDetect Threshold	R/W	BMTHW	0 ~ 100	10	BMTHW=[Param.]<CR><LF> BMTHW?<CR><LF> Set the blemish detection threshold.
BlemishWhiteDetect PositionX	R/W	BMPXW	0 ~ 1919	0	BMPXW=[Param.]<CR><LF> BMPXW? [Param.]<CR><LF> Display the X coordinate (horizontal pixel position) of the blemish selected in Blemish Data Index. You can also manually enter the X coordinate of the blemish you want to correct.

Name	Access	Short ASCII	Min ~ Max	Default	Description
BlemishWhiteDetect PositionY	R/W	BMPYW	0 ~ 1439	0	BMPYW=[Param1],[Param2]<CR><LF> BMPYW? [Param1]<CR><LF> Display the Y coordinate (vertical pixel position) of the blemish selected in Blemish Data Index. You can also manually enter the Y coordinate of the blemish you want to correct.

Shading Correction

Related Topic: Shading Correction

Name	Access	Short ASCII	Min ~ Max	Default	Description
ShadingCorrection Mode	R/W	SDCM	0: Flat Shading 1: Color Shading (Color model only)	0	SDCM=[Param.]<CR><LF> SDCM?<CR><LF> Select the shading correction mode.
ShadingCorrect	W/O	RS	-	-	RS=0<CR><LF> Execute shading correction.
RequestShadingDetect Result	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.	-	SDRS?<CR><LF> Display the shading correction results.
ShadingMode	R/W	SDM	0: OFF 1: User 1 2: User 2 3: User 3	0	SDM=[Param.]<CR><LF> SDM?<CR><LF> Set the storage area for the shading correction data. When this is set to **Off**, the shading correction data is not saved.

Sequencer Control

Related Topic: Sequence ROI Setting Parameters

Name	Access	Short ASCII	Min ~ Max	Default	Description
VideoSendMode **Related Topic:** Multi ROI Function	R/W	VSM	0: Normal 1: Trigger Sequence 2: Command Sequence 3: MultiROI	0	VSM=[Param.]<CR><LF> VSM?<CR><LF> Configure Video Send Mode.
SequenceRoiFrame Count *n* *n* = 1 ~ 10	R/W	SQF *n*	1 ~ 255	1	SQF *n*=[Param.]<CR><LF> SQF *n*?<CR><LF> Set the frame count of Sequence Roi Index *n*.
SequenceRoi NextIndex *n* *n* = 1 ~ 10	R/W	SQNI*n*	0: Index1 1: Index2 2: Index3 3: Index4 4: Index5 5: Index6 6: Index7 7: Index8 8: Index9 9: Index10	0	SQNI *n*=[Param.]<CR><LF> SQNI *n*?<CR><LF> Set the index to be executed after Sequence Roi Index *n*. (Only enabled during Trigger Sequence Mode.)
SequenceRoi Width *n* *n* = 1 ~ 10	R/W	SQW*n*	8 ~ (5120 - OffsetX)	5120	SQW *n*=[Param.]<CR><LF> SQW *n*?<CR><LF> Set the width of Sequence Roi Index *n*. See Width in Image Format Control.
SequenceRoi Height*n* *n* = 1 ~ 10	R/W	SQH*n*	1 ~ (3840 - OffsetY)	3840	SQH *n*=[Param.]<CR><LF> SQH *n*?<CR><LF> Set the height of Sequence Roi Index *n*.
SequenceRoi OffsetX *n* *n* = 1 ~ 10	R/W	SQOX*n*	0 ~ (5112 - Width)	0	SQOX *n*=[Param.]<CR><LF> SQOX *n*?<CR><LF> Set the Offset X of Sequence Roi Index *n*.
SequenceRoi OffsetY *n* *n* = 1 ~ 10	R/W	SQOY*n*	0 ~ (3839 - Height)	0	SQOY *n*=[Param.]<CR><LF> SQOY *n*?<CR><LF> Set the Offset Y of Sequence Roi Index *n*.

Name	Access	Short ASCII	Min ~ Max	Default	Description
SequenceRoi Gain*n* *n* = 1 ~ 10	R/W	SQGA*n*	100 ~1600	100	SQGA *n*=[Param.]<CR><LF> SQGA *n*?<CR><LF> Set the gain of Sequence Roi Index *n*.
SequenceRoi Hbinning*n* *n* = 1 ~ 10	R/W	SQHB*n*	1: Hbinning = OFF 2: Hbinning = x2	1	SQHB *n*=[Param.]<CR><LF> SQHB *n*?<CR><LF> Set the horizontal binning of Sequence Roi Index *n*.
SequenceRoi Vbinning*n* n = 1 ~ 10	R/W	SQVB*n*	1: Vbinning = OFF 2: Vbinning = x2	1	SQVB *n*=[Param.]<CR><LF> SQVB *n*?<CR><LF> Set the vertical binning of Sequence Roi Index *n*.
SequenceRoi LutEnable*n* *n* = 1 ~ 10	R/W	SQLUT*n*	0: Off 1: On	0	SQLUT *n*=[Param.]<CR><LF> SQLUT *n*?<CR><LF> Enable/disable the LUT setting for Sequence Roi Index *n*.
SequenceRoi BlackLevel*n* *n* = 1 ~ 10	R/W	SQBL*n*	- 256 ~ 255	0	SQBL *n*=[Param.]<CR><LF> SQBL *n*?<CR><LF> Set the black level of Sequence Roi Index *n*.
SequenceRoi GainRed*n* *n* = 1 ~ 10	R/W	SQPGR*n*	-4533 ~ 17713	0	SQPGR *n*=[Param.]<CR><LF> SQPGR *n*?<CR><LF> Set the Gain Red level of Sequence Roi Index *n*.
SequenceRoi GainBlue*n* *n* = 1 ~ 10	R/W	SQPGB*n*	-4533 ~ 17713	0	SQPGB *n*=[Param.]<CR><LF> SQPGB *n*?<CR><LF> Set the Gain Blue level of Sequence Roi Index *n*.
SequenceRoi Indexread	R/O	SQIDX	0: Index0 1: Index1 2: Index2 3: Index3 4: Index4 5: Index5 6: Index6 7: Index7 8: Index8 9: Index9	-	SQIDX?<CR><LF> Dispaly the index number of the current Command Sequence Index.
SequenceReset	W/O	SQRST	0	0	SQRST=0<CR><LF> Reset the current index number for Trigger Sequence Mode and Command Sequence Mode to ”Index 1”.

Name	Access	Short ASCII	Min ~ Max	Default	Description
CommandSequence Index	R/W	CSQI	0: Index0 1: Index1 2: Index2 3: Index3 4: Index4 5: Index5 6: Index6 7: Index7 8: Index8 9: Index9	0	CSQI=[Param.]<CR><LF> CSQI?<CR><LF> Set the inidex to execute during Command Sequence Mode.

Multi ROI Mode

Related Topic: Multi ROI Function

Name	Access	Short ASCII	Min ~ Max	Default	Description
MultiRoiIndexMax	R/W	MRIM	1 ~ 8	1	MRIM=[Param.]<CR><LF> MRIM?<CR><LF>
MultiRoiWidth	R/W	MRW	8 ~ 5120	8	MRW=[Param.]<CR><LF> MRW?<CR><LF> Set the width for the selected Multi Roi index.
MultiRoiHeight*n* n = 1 ~ 8	R/W	MRH*n*	0 ~ 3840	1	MRH*n*=[Param.]<CR><LF> MRH*n*?<CR><LF>
MultiRoiOffsetX*n* n = 1 ~ 8	R/W	MROX*n*	0 ~ 5118	0	MROX*n*=[Param.]<CR><LF> MROX*n*?<CR><LF>
MultiRoiOffsetY*n* n = 1 ~ 8	R/W	MROY*n*	0 ~ 3839	0	MROY*n*=[Param.]<CR><LF> MROY*n*?<CR><LF>

LUT Mode

Related Topic: LUT (Lookup Table)

Name	Access	Short ASCII	Min ~ Max	Default	Description
LUTMode	R/W	LUTC	0: Off 1: Gamma 2: LUT	0	LUTC=[Param.]<CR><LF> LUTC?<CR><LF> Select the JAI LUT mode.

Color Matrix

Name	Access	Short ASCII	Min ~ Max	Default	Description
ColorMatrixMode	R/W	MTX	0: Off 1: On	0	MTX=[Param.]<CR><LF> MTX?<CR><LF> Enable/disable Color Matrix Mode.

ALC, Exposure, Trigger

Name	Access	Short ASCII	Min ~ Max	Default	Description
AlcSpeed **Related Topic:** ALC (Automatic Level Control)	R/W	AGCS	1 ~ 8	4	AGCS=[Param.]<CR><LF> AGCS?<CR><LF> Set the control speed for AGC and ASC. (8 is the fastest.)
ExposureAutoMax **Related Topic:** ExposureAuto	R/W	ASCEA	11 ~ 8000000 (us)	18000	ASCEA=[Param.]<CR><LF> ASCEA?<CR><LF> Set the maximum value for the Exposure Auto (ASC) control range. Maximum value is varied depending on frame rate.
ExposureAutoMin	R/W	ASCEI	10 ~ 7999999 (us)	100	ASCEI=[Param.]<CR><LF> ASCEI?<CR><LF> Set the minimum value for the Exposure Auto (ASC) control range. Maximum value is varied depending on frame rate.

Name	Access	Short ASCII	Min ~ Max	Default	Description
RequestExposure AutoResult	R/O	ASRS	0 = Complete. 1 = Too Bright. 2 = Too dark. 3 = Timeout Error. 4 = Busy. 5 = Limit. 6 = Trig is not set as Normal.	0	ASRS?<CR><LF> Display the Exposure Auto result.
TriggerOption **Related Topic:** Trigger Control	R/W	TRGOP	0 = Off 2 = PIV	0	TRGOP=[Param.]<CR><LF> TRGOP?<CR><LF> Configure the Trigger option.
AlcReference **Related Topic:** ALC (Automatic Level Control)	R/W	AGCF	1 ~ 100[%]	50	AGCF=[Param.]<CR><LF> AGCF?<CR><LF> Set the target level for ALC. (unit: %)
GainAutoMax **Related Topic:** Gain Auto	R/W	AGCGA	200 ~ 1600	1600	AGCGA=[Param.]<CR><LF> AGCGA?<CR><LF> Set the maximum value for the Gain Auto (AGC) control range.
GainAutoMin	R/W	AGCGI	100 ~ 1500	100	AGCGI=[Param.]<CR><LF> AGCGI?<CR><LF> Set the minimum value for the Gain Auto (AGC) control range.
RequestGainAuto Result	R/O	AGRS	0 = Complete. 1 = Too Bright. 2 = Too dark. 3 = Timeout Error. 4 = Busy. 5 = Limit. 6 = Trig is not set as Normal.	0	AGRS?<CR><LF> Display the GainAuto result.

<table>
<tr><th>Name</th><th>Access</th><th>Short ASCII</th><th>Min ~ Max</th><th>Default</th><th>Description</th></tr>
<tr><td>ALCChannelAreaAll

Related Topic:
ALC (Automatic Level Control)</td><td>R/W</td><td>ALCA</td><td>0: OFF
1: ON</td><td>0</td><td>ALCA=[Param.]<CR><LF>
ALCA?<CR><LF>

On: Specify all photometry areas for ALC, regardless of the enabled/disabled statuses configured individually for each photometry area with [ALC Area Selector].

Off: Specify areas for ALC based on the enabled/disabled statuses configured individually for each photometry area with [ALC Area Selector].</td></tr>
<tr><td>ALCChannelArea</td><td>R/W</td><td>ALCxxx</td><td>0: OFF
1: ON</td><td>0</td><td>ALCxxx=[Param.]<CR><LF>
ALCxxx?<CR><LF>

Enable/disable the specified photometry area. For example, when enable the Low Right photometry area,use the Short ASCII command "ALCLR".

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>ALMHL
(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>ALMLL
(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>AWBChannelAreaAll

Related Topic:
Balance White Auto</td><td>R/W</td><td>AWBA</td><td>0: OFF
1: ON</td><td>0</td><td>AWBA=[Param.]<CR><LF>
AWBA?<CR><LF>

On: Specify all photometry areas for AWB, regardless of the enabled/disabled statuses configured individually for each photometry area with [AWB Area Selector].

Off: Specify areas for AWB based on the enabled/disabled statuses configured individually for each photometry area with [AWB Area Selector].</td></tr>
</table>

<table>
<tr><th>Name</th><th>Access</th><th>Short ASCII</th><th>Min ~ Max</th><th>Default</th><th>Description</th></tr>
<tr><td>AWBChannelArea</td><td>R/W</td><td>AWBxxx</td><td>0: OFF
1: ON</td><td>0</td><td>AWBxxx=[Param.]<CR><LF>
AWBxxx?<CR><LF>

Enable/disable the specified photometry area. For example, when enable the Low Right photometry area,use the Short ASCII command "AWBLR".

16 Photometry Areas and Short ASCII Commands

<table>
<tr><td>AWBHL (High Left)</td><td>AWBHML (Hight Mid-Left)</td><td>AWBHMR (High Mid-Right)</td><td>AWBHR (High Right)</td></tr>
<tr><td>AWBHL (Mid-High Left)</td><td>AWBMHML (Mid-Hight Mid-Left)</td><td>AWBMHMR (Mid-High Mid-Right)</td><td>AWBMHR (Mid-High Right)</td></tr>
<tr><td>AWBMLL (Mid-Low Left)</td><td>AWBMLML (Mid-Low Mid-Left)</td><td>AWBMLMR (Mid-Low Mid-Right)</td><td>AWBMLR (Mid-Low Right)</td></tr>
<tr><td>AWBLL (Low Left)</td><td>AWBLML (Low Mid-Left)</td><td>AWBLMR (Low Mid-Right)</td><td>AWBLR (Low Right)</td></tr>
</table>
</td></tr>
<tr><td>RequestBalance White AutoResult</td><td>R/O</td><td>AWRS</td><td>0 = Complete.
1 = Too Bright.
2 = Too dark.
3 = Timeout Error.
4 = Busy.
5 = Limit.
6 = Trig is not set as Normal.</td><td>0</td><td>AWRS?<CR><LF>

Display the GainAuto result.</td></tr>
</table>

Data Area, Acquisition, Gamma, Temperature

Name	Access	Short ASCII	Min ~ Max	Default	
CurrentAreaNoRequest	R/O	EA	0: Factory area 1: User 1 area 2: User 2 area 3: User 3 area	0	EA?<CR><LF> Display the currently configured Use Set Selector status. (Start up with the state saved to this area.) The camera returns the latest used DATA AREA.
AcquisitionFrameTime **Related Topic:** Acquisition Control (Change the Frame Rate)	R/W	ART	1 ~ 8000000	32000	ART=[Param.]<CR><LF> ART?<CR><LF> Set the Acquisition Frame Time. Maximum value is calculated depending on Height and Offset Y settings
GammaSelector **Related Topic:** Gamma Function	R/W	GMA	0(γ=1) ~ 8 (γ=0.45) ~ 15 (γ=TBD)	8	GMA=[Param.]<CR><LF> GMA?<CR><LF> Set the gamma value.
Temperature	R/O	TMP0	-	-	TMP0?<CR><LF> Display the internal temperature (C°) of the camera.

Pulse Generator Control

Related Topic: Pulse Generator

Name	Access	Short ASCII	Min ~ Max	Default	
GpioPulseGenDivide Value	R/W	PGDEV	1 ~ 4095	1	PGDEV=[Param.]<CR><LF> PGDEV?<CR><LF> Set the division value for the prescaler (12-bit) using the pixel clock as the base clock.
GpioPulseGen Length*n* n = 0 ~ 3	R/W	PGL*n*	1 ~ 1048575	1	PGL*n*=[Param.]<CR><LF> PGL*n*?<CR><LF> Set the maximum count up value using clock value.
GpioPulseGen StartPoint*n* n = 0 ~ 3	R/W	PGST*n*	0 ~ 1048575	0	PGST*n*=[Param.]<CR><LF> PGST*n*?<CR><LF> Set the start point for the High interval using clock value. When the counter reaches this value, the output becomes 1.
GpioPulseGen EndPoint*n* n = 0 ~ 3	R/W	PGEN*n*	1 ~ 1048575	1	PGEN*n*=[Param.]<CR><LF> PGEN*n*?<CR><LF> Set the start point for the Low interval using clock value. When the counter reaches this value, the output becomes 0.
GpioPulseGen RepeatCount*n* n = 0 ~ 3	R/W	PGRPT*n*	0 ~ 255	0	PGRPT*n*=[Param.]<CR><LF> PGRPT*n*?<CR><LF> Set the repeat count for the counter. When this is set to 0, the counter will be free-running with limitless repeating.
GpioPulseGen ClearMode*n* n = 0 ~ 3	R/W	PGCM*n*	0: Free Run 1: Level High 2: Level Low 3: Rising Edge 4: Falling Edge	0	PGCM*n*=[Param.]<CR><LF> PGCM*n*?<CR><LF> Set the clear signal condition for the count clear input of the pulse generator.
GpioPulseGen SyncMode*n* n = 0 ~ 3	R/W	PGSM*n*	0: Async Mode 1: Sync Mode	0	PGSM*n*=[Param.]<CR><LF> PGSM*n*?<CR><LF> Select the sync mode for the count clear input signal.

Name	Access	Short ASCII	Min ~ Max	Default	
GpioPulseGen Input*n* n = 0 ~ 3	R/W	PGIN*n*	0: Low 1: High 3: Acquisition Trigger Wait 4: FrameActive 5: ExposureActive 6: FVAL 7: LVAL 8: PG0* 9: PG1* 10: PG2* 11: PG3* 12: TTL_In1 13: CL_CC1_In 14: nand0 15: nand1 16: OPTTL in2 17: OPLVDS in	0	PGIN*n*=[Param.]<CR><LF> PGIN*n*?<CR><LF> Select the count clear input signal source. * You cannot select the same Input. For example, 8: PG0 cannot be selected for PulseGeneratorInput0.
GpioPulseGen Invert*n* n = 0 ~ 3	R/W	PGINV*n*	0:Non-Inv 1:Inv	0	PGINV*n*=[Param.]<CR><LF> PGINV*n*?<CR><LF> Select whether to invert the polarity of the count clear input signal.
GpioNand0 InputSource1	R/W	ND0IN1	0:Low 1:High 3: FrameTriggerWait 4: FrameActive 5: ExposureActive 6: Fval 8: PulseGenerator0 9: PulseGenerator1 10: PulseGenerator2 11: PulseGenerator3 12: TTL_In1 13: CL_CC1_In 15: Nand1 16: TTL_In2 17: LVDS_In	0	ND0IN1=[Param.]<CR><LF> ND0IN1?<CR><LF> Select the input source signal for NAND0 In1.
GpioNand0 InputSource2	R/W	ND0IN2	Same as ND0IN1	0	ND0IN2=[Param.]<CR><LF> ND0IN2?<CR><LF> Select the input source signal for NAND0 In2.

Name	Access	Short ASCII	Min ~ Max	Default	
GpioNand1 InputSource1	R/W	ND1IN1	0:Low 1:High 3: FrameTriggerWait 4: FrameActive 5: ExposureActive 6: Fval 8: PulseGenerator0 9: PulseGenerator1 10: PulseGenerator2 11: PulseGenerator3 12: TTL_In1 13: CL_CC1_In 14: Nand0 16: TTL_In2 17: LVDS_In	0	ND1IN1=[Param.]<CR><LF> ND1IN11?<CR><LF> Select the input source signal for NAND1 In1.
GpioNand1 InputSource2	R/W	ND1IN2	Same as ND1IN1	0	ND1IN2=[Param.]<CR><LF> ND1IN2?<CR><LF> Select the input source signal for NAND1 In2.
GpioNand0 InputInvert1	R/W	ND0INV1	0: Non-Inv 1: Inv	0	ND0INV1=[Param.]<CR><LF> ND0INV1?<CR><LF>
GpioNand1 InputInvert1	R/W	ND1INV1	0: Non-Inv 1: Inv	0	ND1INV1=[Param.]<CR><LF> ND1INV1?<CR><LF>
GpioNand0 InputInvert2	R/W	ND0INV2	0: Non-Inv 1: Inv	0	ND0INV2=[Param.]<CR><LF> ND0INV2?<CR><LF>
GpioNand0 InputInvert2	R/W	ND1INV2	0: Non-Inv 1: Inv	0	ND0INV2=[Param.]<CR><LF> ND0INV2?<CR><LF>

Miscellaneous

Name	Access	Short ASCII	Min ~ Max	Default	
ImageFlipping **Related Topic:** Mirroring Function	R/W	FLIP	0: Off 1: Horizontal 2: Vertical 3: Horizontal & Vertical	0	FLIP=[Param.]<CR><LF> FLIP?<CR><LF> Outputs the image by inverting it horizontally and/or vertically.
SensorClock Frequency **Related Topic:** Camera Link Pixel Clock	R/W	SCF	0: 80MHz 1: 60MHz	0	SCF=[Param.]<CR><LF> SCF?<CR><LF> Configures the Sensor Clock Frequency.
BlackTempMode **Related Topic:** Black Level Control	R/W	BTM	0: Auto 1: Limit 2: Fix	0	BTM=[Param.]<CR><LF> BTM?<CR><LF> Auto adjusts the black level; when set to **Auto**, the compensation value can be automatically varied up to 30%.
BlackTempLimit	R/W	BTL	0 ~ 30	30	BTL=[Param.]<CR><LF> BTL?<CR><LF> The limit of the black level compensation value can be set in the range of 0% to 30% by 1% steps.
BlackTempFix	R/O	BTF	0 ~ 30	30	BTM?<CR><LF> The camera automatically saves the temperature and the status of the exposure time just before this mode is set.

Miscellaneous

Troubleshooting

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

Power Supply and Connections

Issue: The POWER/TRIG LED remains lit amber and does not turn green, even after power is supplied to the camera.

Cause and Solution: Camera initialization may not be complete. Check the Camera Link cable connection.

Image Display

Issue: Gradation in dark areas is not noticeable.

Cause and Solution: 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 Gamma Function.

Settings and Operations

Issue: Settings cannot be saved to user memory.

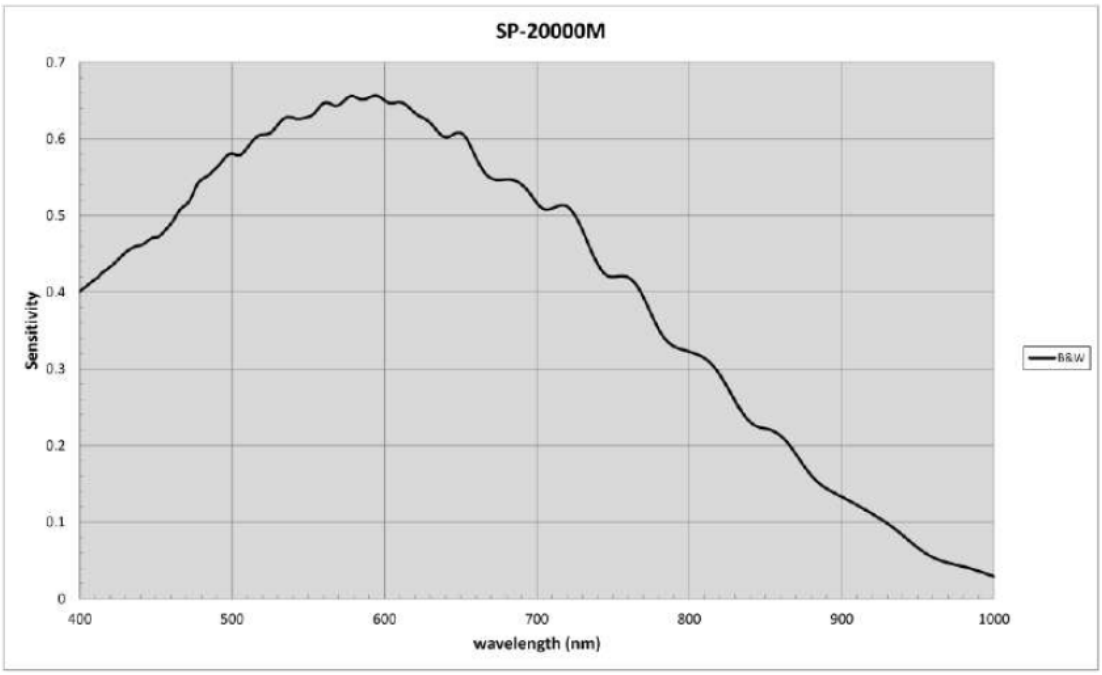
Cause and Solution: You cannot save to user memory while images are being captured by the camera. Stop image capture before performing the save operation.

Issue: I want to restore the factory default settings.

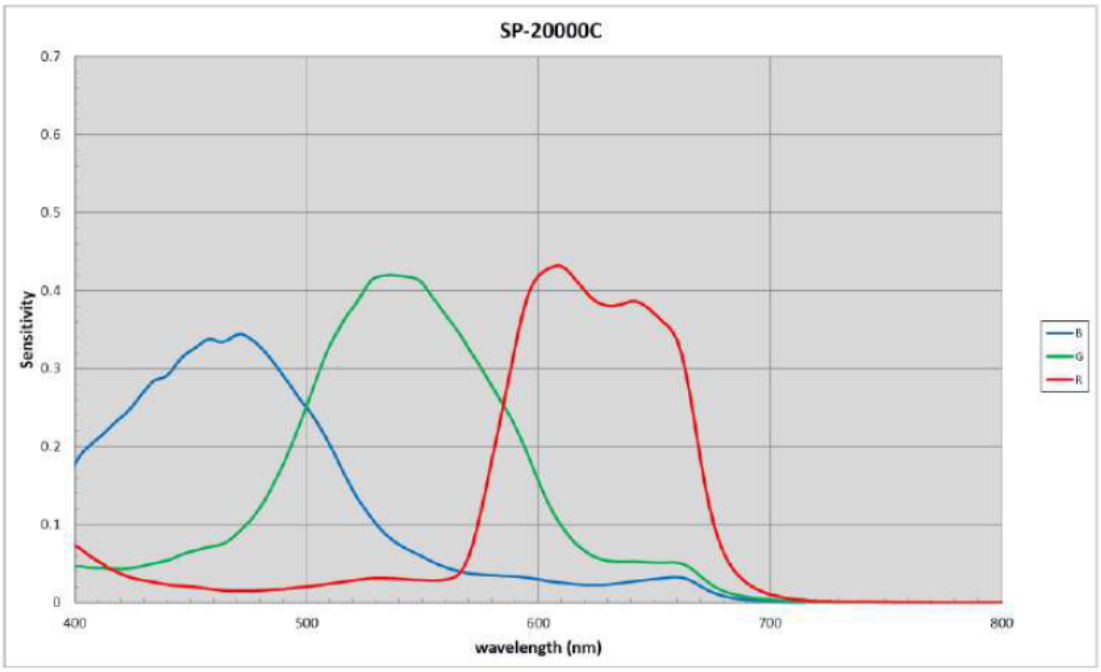
Cause and Solution: Load **Default** under User Set Selector in the Feature Properties tab to restore the factory default settings.

Spectral Response

SP-20000M-PMCL



SP-20000C-PMCL (With IR Cut Filter)



Specifications

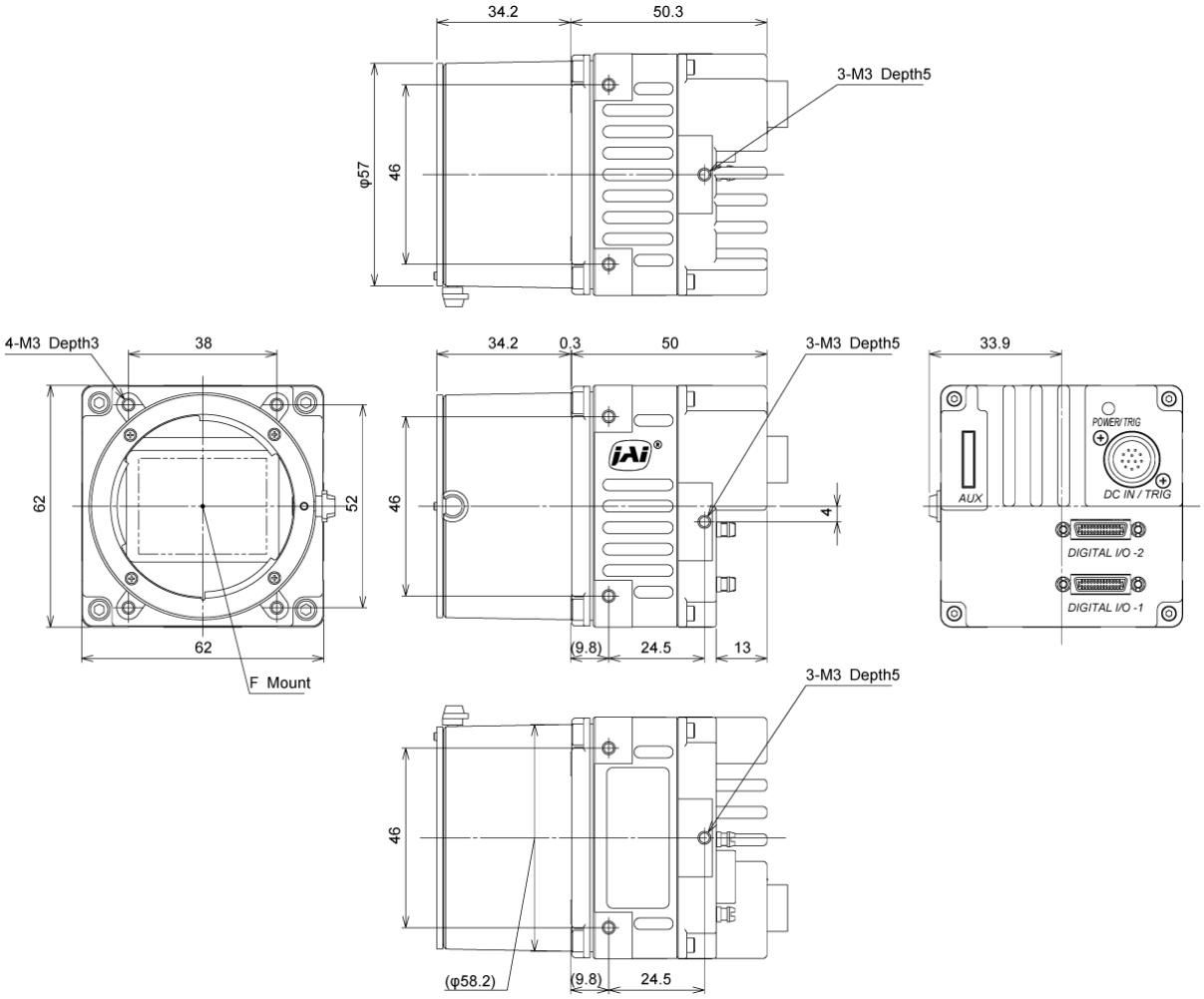
<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>Scanning System</td><td>Progressive scan, 1 tap</td></tr>
<tr><td>Synchronization</td><td>Internal</td></tr>
<tr><td>Interface</td><td>Camera Link Specfications (V.2.0 RC2) , Conforming with PoCL specifications,
Pixel clock: 80 MHz (Standard) or 60 MHz can be selected in conjunction with sensor clock</td></tr>
<tr><td>Image Sensor</td><td>Monochrome: 35mm Monochrome CMOS
Color: 35mm Bayer color CMOS</td></tr>
<tr><td>Aspect Ratio</td><td>32.77 (h) x 24.58 (v) mm 41mm diagonal</td></tr>
<tr><td>Pixel Size</td><td>6.4 (h) x 6.4 (v) um</td></tr>
<tr><td>Effective Image output pixel</td><td>5120 (h) x 3840 (v)</td></tr>
<tr><td>Sensor Pixel Clock</td><td>39.16 MHZ</td></tr>
<tr><td rowspan="3">Acquisition Frame rate</td><td>1X8 – 1Y: 30fps(Max) 80bit Configuration</td></tr>
<tr><td>1X4 – 1Y: 15fps(Max) Midium Configuration</td></tr>
<tr><td>1X2 – 1Y: 7.5 fps(Max) Base Configuration</td></tr>
<tr><td rowspan="2">SNR (traditional method)</td><td>Mono: 53 dB (Typical) (0dB gain, Black)</td></tr>
<tr><td>Color: 51 dB (Typical) (0dB gain, Green Pixel Black)</td></tr>
<tr><td rowspan="2">EMVA 1288 Parameters Absolute sensitivity Maximum SNR</td><td>Mono: 10-bit output format, 16.05 p (λ = 525 nm) 40.24dB</td></tr>
<tr><td>Color: 10-bit output format, 18.14 p (λ = 530 nm) 38.32dB</td></tr>
<tr><td>Image Output Format Digital</td><td>Full Image: 5120 (h) x 3840(v)</td></tr>
<tr><td rowspan="4">Image Output Format Digital: ROI</td><td>Height: 2 ~ 3840 line, 2 Line/step</td></tr>
<tr><td>Offset Y: 0 ~ 3838 line, 2 line/step</td></tr>
<tr><td>Width: 8 ~ 5120 pixel, 8 pixel/step</td></tr>
<tr><td>OffsetX: 0 ~ 5112 pixel, 8 pixel/step</td></tr>
<tr><td>Image Output Format Digital: Binning</td><td>
<table>
<tr><th>Binning</th><th>Horizontal</th><th>Vertical</th></tr>
<tr><td>1</td><td>5120 (h)</td><td>3840 (v)</td></tr>
<tr><td>2</td><td>2560 (h)</td><td>1920 (v)</td></tr>
</table>
Note: Monochrome model only. Frame rate does not change.
</td></tr>
<tr><td>Bit assignment</td><td>8bit , 10bit, 12bit</td></tr>
</table>

Item	Description
Video Send Mode (Sequence ROI)	ROI, Gain and Exposure time can be set for 10 indexes in sequence output by trigger
Video Send Mode (Multi ROI)	Maximum 8 ROIs can be set in one frame and are output as one video
Acquisition Mode	Continuous / Single Frame / Multi Frame
Acquisition Frame Rate	1X8 – 1Y: 30fps (Max) ~ 8s (Min)
	1X4 – 1Y: 15fps (Max) ~ 8s (Min)
	1X2 – 1Y: 7.5fps (Max) ~ 8s (Min)
Trigger Mode	Frame Start
Trigger Option	Overlap ON/OFF (only)、PIV
Trigger Input Signal	Line 4 (TTL 1),Line7(Camera Link) ,Pulse Generator 0/1/2/3, Soft Trigger Line 10(TTL2), Line 11(LVDS)
Exposure Mode	Timed: 304 μs(Min) ~ 8 sec (Max), Step:1μs
	Trigger Width: 304 μs (Min) ~ ∞ (Max)
Auto Exposure	OFF / Once / Continuous
Exposure Auto Speed	1 ~ 8
Digital I/O	Line Selector (Hirose 12P): GPIO IN / GPIO OUT
Black Level Adjustment	Reference: 33.5LSB 10bit (Average of 100*100)
	Setting Range: -256 ~ 255LSB 10bit
	Resolution: 1 STEP = 1LSB
Gain Adjustment **Note:** *Color model only	Manual Adjustment Range: 0dB ~ +24dB, 0.01dB/step
	WB Gain*: R / B : -7dB ~ +10dB, 0.01dB/step
	WBArea*: 4 x 4
	Color Temperature Preset*: 4600K, 5600K, 6500K
	WB Range* : 3000K ~ 9000K
	White Balance*: OFF, Once, Continuous
Auto Black	Mode: Auto / Limit / Fix
	Limit: 0% to 30%
Blemish Compensation	Detection: Detect white blemish above the threshold value (Black blemish is detected only by factory)
	Compensation: Complement by adjacent pixels (Continuous blemishes are not compensated)
	Correct Numbers: Up to 1000 pixels

Item	Description
ALC	AGC and Auto Exposure can be combined and automatically controlled
Gamma	0.45 ~ 1.0 (8 steps available)
LUT	OFF: γ = 1.0, ON = 256 points can be set
Shading Correction	Mono: Flat field Block based (20 x 15 blocks) Each block: 256 x 256 pixels
	Color: Flat field, Color shading Block based (20 x 15 blocks) Each block: 256 x 256 pixels
Vibration Resistance	10G (20 Hz ~ 200 Hz X-Y-Z direction)
Shock Resistance	80G
Power	Input: DC+12V to +24V ± 10% (at the input terminal)
	Current: 450mA ± 10% (12V input, full image), 480mA ± 10% (12V input, 8 lines ROI)
	Consumption: 5.4W ± 10% (12V input, full image), 5.6W ± 10% (12V input, 8 lines ROI)
Lens Mount	F mount, Rear protrusion of the lens is less than 40 mm.
	M42A mount, Rear protrusion of the lens is less than 9 mm.
Flange Back	F mount : 46.5 mm, Tolerance 0 to -0.05 mm
	M42A mount : 16.0 mm, Tolerance 0 to -0.05 mm
Optical Filter	Mono: Protection glass not provided
	Color: Optical Low Pass filter + IR cut filter (Half value is 670 nm)
Verified Performance Temperature / Humidity	- 5°C ~ + 45°C / 20% ~ 80% (non-condensing)
Operating temperature / Humidity (Performance guaranteed)	-45°C to +70°C / 20 – 80% (non-condensing)
Storage Temp. / Humidity	-45°C to +70°C / 20% - 80 % (non-condensing)
Regulations	CE (EN61000-6-2 and EN61000-6-3), FCC part 15 class B, RoHS, WEEE, KC
Dimensions (Housing)	F Mount: 62mm × 62mm × 84.5mm (Excluding Mount Protrusions)
	M42A Mount: 62mm x 62mm x 54mm (Excluding Mount Protrusions)
Weight	F Mount: 320g
	M42A Mount: 265g

Dimensions

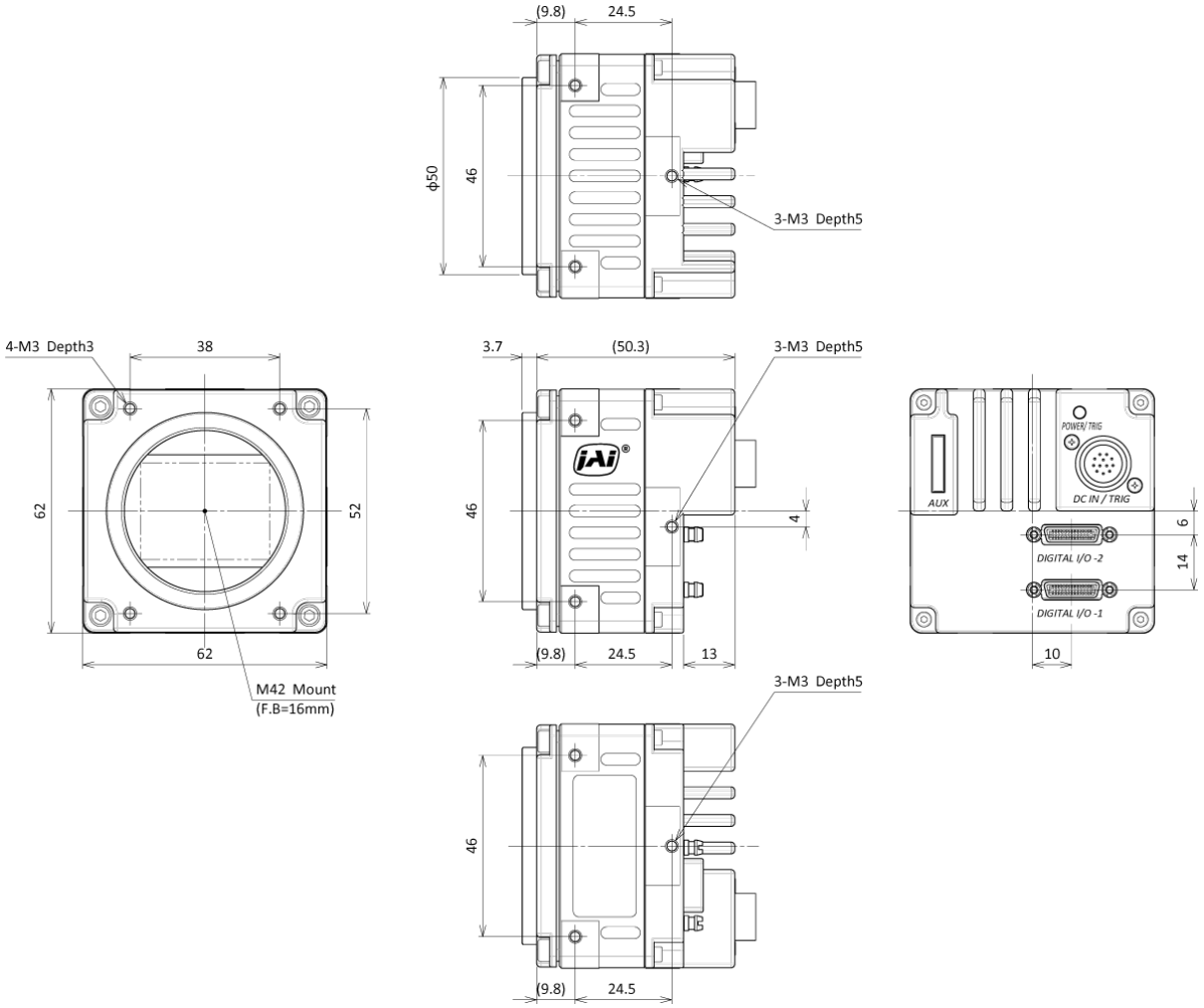
F-Mount Model



Notes:

- Dimensional tolerance: ± 0.3mm
- Unit: mm

M42A-Mount Model



Notes:

- Dimensional tolerance: ± 0.3mm
- Unit: mm

User's Record

Model name: ……

Revision: ……

Serial No: ……

Firmware version: ……

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

Revision History

Revision	Date	Device Version	Changes
3.1	2024/02/07	DV0401	Corrected errors.
3.0	2024/01/10	DV0401	Added the M42A-mount model information. Redesigned the user manual and corrected/updated topics.

Previous Revisions (1.0 ~ 2.2)

Revision	Date	Changes
2.2	Jan. 2021	China RoHS
2.1	Feb. 2018	Revised Variable range of Black Level
2.0	Nov. 2018	Add KC
1.9	Mar. 2015	Adde 12-bit function, HDR function is an optional function
1.8	Oct. 2014	Revise B/W spectral response with wider wave length range
1.7	Sept. 2014	Revise Spectral Response
1.6	June 2014	Review totally
1.5	Oct. 2013	Correct the timing chart of PIV.
1.4	Oct. 2013	Add EMVA spec. for SP-20000C-PMCL
1.3	Sept. 2013	Revised EMVA1288 parameter, Add Auto Black Control. Add the caution for Exposure time. Correct typo.
1.2	Sept. 2013	Add ASCII command list as Appendix 1
1.1	Aug. 2013	Add information for 1X2 – 1Y, Review all functionality
1.0	June 2013	New release

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