See the possibilities

User Manual

SP-20000M-CXP2

SP-20000C-CXP2

CMOS Digital Progressive Scan
Monochrome and Color Camera

Document Version: 2.0
Date: 2024-02-16

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

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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-CXP2 and SP-20000C-CXP2 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-CXP2
제조자 및 제조국가:	JAI Ltd., Japan / JAPAN

R-R-JAi-SP-20000M-CXP2

상 호:	JAI Ltd. Japan
기자재명칭:	Industrial Camera
모 델 명:	SP-20000C-CXP2
제조자 및 제조국가:	JAI Ltd., Japan / JAPAN

R-R-JAi-SP-20000M-CXP2

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-CXP2 SP-20000C-CXP2	×	○	○	○	○	○

○: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.

Interface

This camera employs CoaXPress as an interface system. In order to connect the camera to a PC, it requires the use of a Frame Graber board and the appropriate coaxial cable(s). The maximum video transfer rate per coaxial cable is 6.25 Gbps. In addition to video information, power and control signals can be transferred to the camera over this interface.

For detailed specifications, please refer to "JIIA-NTF-001-2010" published by Japan Industrial Imaging Association, http://www.jiia.org.

Frame Grabber Board

As this camera employs CoaXPress as an interface system, a CoaXPress-compliant frame grabber board is required. Both cameras have two CoaXPress interface connectors and it is recommended that a frame grabber board with more than two interface connectors be used in order to maximize camera performance.

Notes on Coaxial Cables

For the CoaXPress interface, coaxial cables are used. This camera uses 75Ω 1.0/2.3 DIN receptacles (Amphenol ACX1785-ND or equivalent). The coaxial cable used to connect the camera must have a 75Ω 1.0/2.3 DIN-type plug at the camera side. An ordinary BNC cable cannot be used.

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-CXP2 is a monochrome progressive scan CMOS camera and the SP-20000C-CXP2 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 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. A full pixel readout or partial scan readout mode can be selected depending on the applications.

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.

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.

Camera Composition

The standard camera composition is as follows.

- Camera body x1
- Sensor protection cap x1
- Dear Customer (sheet) x1

The following optional accessories are available.

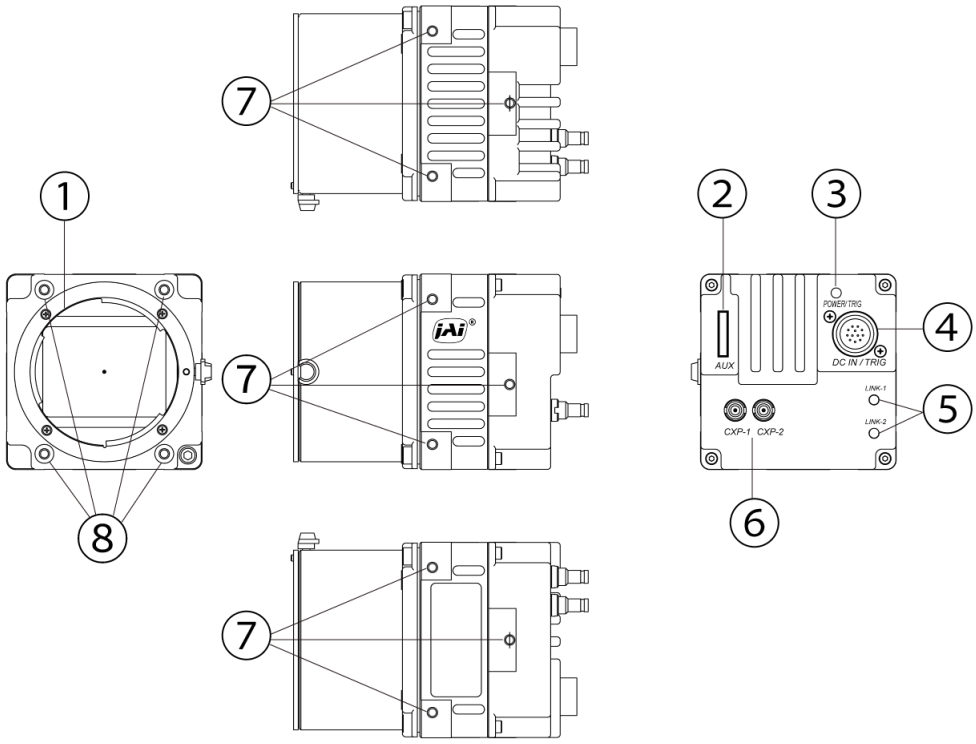
- MP-42 Tripod base

Main features

- New Spark Series, 35mm full size, CMOS 20-megapixel progressive scan camera with global shutter
- Utilizes CoaXPress interface with two cables configuration
- 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 color, plus 3 x 8-bit RGB for color with in-camera color interpolation
- 30 frames/second with full resolution in continuous operation for CXP6_X2 Link Configuration

- Vertical and horizontal binning on monochrome model
- Supports ROI (Region Of Interest) modes
- 0dB to +24dB gain control for both monochrome and color models.
- 299 μs (1/100,000) 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
- Lens communication control
- New Hirose 10P connector for TTL IN and OUT and LVDS IN interface
- Lens mount: F-mount or M42-mount
- Accepts power over Coaxial cable or via 12-pin connector

Parts Identification



> **Note:** The above is an external view of the F-mount model; for an external view of the M42 mount, see " M42-Mount Model".

① Lens Mount (F-Mount or M42-Mount)
② AUX connector (10-Pin)
③ POWER/TRIG LED
④ DC IN / Trigger IN Connector (12-pin Round)
⑤ LINK-1 / LINK-2 LED
⑥ CXP-1 / CXP-2 Connectors
⑦ ⑧ Mounting Holes (M3)

① Lens Mount (F-Mount or M42-Mount)

Mount an F-mount or M42-mount lens, microscope adapter, etc. here.

- **F-Mount**: F-mount lenses with lens mount protrusions of 40.0 mm or less can be attached.
- **M42-Mount**: M42-mount lenses with lens mount protrusions of 39.0 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 39.0 mm for the M42-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)

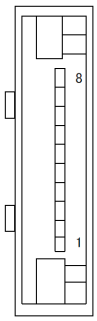
W: Width of object

w: Width of sensor (= 8.5mm)

② 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	

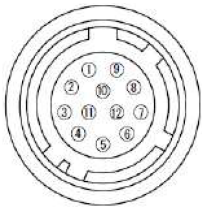
③ POWER/TRIG LED

Indicates the power or trigger input status.

LED		Status
	Lit amber	Camera initializing. The light blinks once after initialization. The light also blinks while changing the Link Configuration.
	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.



Hirose 12-pin Connector

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

No	Signal	Remarks
1	GND	
2	DC Input	+12V ~ +24V
3	GND	
4	NC	
5	OPTO IN -	Line 5
6	OPTO IN +	Line 5
7	OPTO OUT -	Line 2
8	OPTO OUT +	Line 2
9	TTL Out 1	Line1 (Note 1)
10	TTL In 1	Line4 (Note 2)
11	DC Input	+12V ~ +24V
12	GND	

Notes:

1. Factory default setting is Exposure Active and negative
2. Factory default setting is trigger input.

3. If power is supplied from both the 12-pin connector and CoaXPress, the power from the 12-pin is active. If power from the 12-pin is interrupted, the operation depends on how power was initially connected.

The order of power supply connections	If the power supply from 12-pin is interrupted
12Pin ⇒ CoaXPress	Stop power supply ⇒ Power from CoaXPress
CoaXPress ⇒ 12Pin	Power is suppled from CoaXPress, but the camera does not restart.

⑤ LINK-1 / LINK-2 LED

- LINK-1: LINK Status indication for CXP#1
- LINK-2: LINK Status indication for CXP#2

	Steady green	Acquisition Active, Outputting video
	Flashing green	Acquisition Wait

⑥ CXP-1 / CXP-2 Connectors

Digital Video Output (75Ω 1.0, 2.3 DIN Receptacle).

Type: CoaXPress Connector (ACX1785-ND Amphenol Connector or equivalent)

- CXP-1: CoaXPress No.1 Connector

  Note: PoCXP compliant

- CXP-2: CoaXPress No.2 Connector

Notes:

- Maximum Bit Rate per one coax: 6.25Gbps
- Maximum Bit Rate per two coaxes: 12.5Gbps
- If one coaxial cable is used, CXP#1 must be used.

⑦ ⑧ Mounting Holes (M3)

Use these holes when attaching an MP-42 tripod adapter plate (optional) or mounting the camera directly to a system. If you mount the tripod mounting plate, please use the provided screws.

- **Top, Side and Bottom**: M3, Depth 5 x 3
- **Front**: M3, Dept 3 x 4

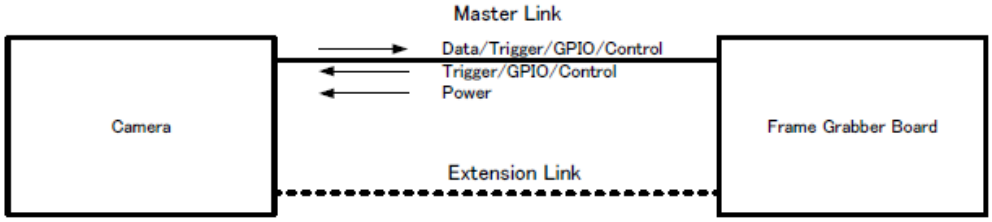
Main Functions

This chapter describes the camera's main functions.

CoaXPress Interface Standard

This camera uses CoaXPress as their interface. CoaXPress is a PLUG-AND-PLAY interface and connects the camera and the frame grabber board by coaxial cable(s). Its maximum transfer rate is 6.25 Gbps per one coaxial cable. Additionally, CoaXPress interface supports power supplied through the coaxial cable as well as communication signals. In the CoaXPress interface, multiple coaxial cables can be used in order to achieve a faster transfer rate or a reduced transfer rate can be used to extend the cable length.

On this camera, a 2-coaxial cable system is used.



The distance between camera and frame grabber board depends on the bit rate of the video and the cable used. Among the unique features of CoaXPress is its ability to supply DC power and provide trigger timing accuracy.

The maximum power supply per one cable is 13W with DC+24V voltage. If the system uses 2 cables, it will be 26W. The accuracy of the trigger is ±2 ns at 3.125 Gbps.

The CoaXPress compliance labeling is assigned to the following five cable types and the maximum bit rate and transmission length is indicated in the table below.

Compliance Labeling	Maximum Operational Bit Rate per coax (Gbps) and transmission length
CXP-1	1.250 (up to 212 m)
CXP-2	2.500 (up to 185 m)
CXP-3	3.125 (up to 169 m)
CXP-5	5.000 (up to 102 m)
CXP-6	6.250 (up to 68 m)

On this camera, the maximum bit rate is 6.25 Gbps per one cable and the power supply is available on the CXP#1 connector only.

The following link configurations with the reference to pixel format are use on this camera.

Model	Pixel format	Link configuration	Bit rate / cable	Used BNC cable
SP-20000M-CXP2	Mono 8/10/12	CXP6_X2	6.250 Gps	2
	Mono 8/10/12	CXP6_X1	6.250 Gps	1
	Mono 8/10/12	CXP3_X2	3.125 Gps	2
	Mono 8/10/12	CXP3_X1	3.125 Gps	1
SP-20000C-CXP	Bayer 8/10/12/RGB	CXP6_X2	6.250 Gps	2
	Bayer 8/10/12/RGB	CXP6_X1	6.250 Gps	1
	Bayer 8/10/12/RGB	CXP3_X2	3.125 Gps	2
	Bayer 8/10/12/RGB	CXP3_X1	3.125 Gps	1

For the details of the specifications, please refer to "JIIA-NTF-001-2010" published by Japan Industrial Imaging Association, www.jiia.org.

GPIO (Digital Input/Output Settings)

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

Line Selector

Line Selector	Description
Line 1 - TTL OUT 1	③ POWER/TRIG LED: Pin 9
Line 2 - OPT OUT 1	③ POWER/TRIG LED: Pin 7 & 8
Line4 - TTL In 1	③ POWER/TRIG LED: Pin 10
Line5 - Opt In 1	③ POWER/TRIG LED: Pin 5 & 6
Line7 - CXP In	⑥ CXP-1 / CXP-2 Connectors
Line8 - TTL Out 2(Option)	② AUX connector (10-Pin): Pin 1
Line9 - TTL Out 3 (Option)	② AUX connector (10-Pin): Pin 2
Line10 - TTL In 2 (Option)	② AUX connector (10-Pin): Pin 3
Line11 - LVDS In (Option)	② AUX connector (10-Pin): Pin 6 & 7
NAND 0 In 1	First input at first NAND gate in GPIO
NAND 0 in 2	Second input at first NAND gate in GPIO
NAND 1 In 1	First input at second NAND gate in GPIO
NAND 1 in 2	Second input at second NAND gate in GPIO

Note: In the line source, input interfaces besides those mentioned above will be shown but the line source setting is not available. The input interface can be configured in the trigger source and the pulse generator source.

Line Mode

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

GenICam Name	Access	Values
Line Selector	R/W	Line 1 - TTL OUT 1, Line 2 - OPT OUT 1, Line4 - TTL In 1, Line5 - Opt In 1, Line7 - CXP In, Line8 - TTL Out 2, Line9 - TTL Out 3, Line10 - TTL In 2, Line11 - LVDS In, NAND 0 In 1, NAND 0 in 2, NAND 1, In 1 NAND 1 in 2
Line Mode	RO	Output, Input
Line Inverter	R/W	False, True
Line Status	RO	False True
Line Source	R/W	Low, High, Acquisition Trigger Wait, Acquisition Active, Frame Trigger Wait, Frame Active, Exposure Active, FVAL, PulseGenerator0, PulseGenerator1, PulseGenerator2, PulseGenerator3, UserOutput0, UserOutput1, UserOutput2, UserOutput3, Line4 - TTLIn1, Line5 - OptIn1, Line7 - CXPIn, NAND0 Out, NAND1 Out, TTLIn2, LVDSIn1
Line Format	RO	No Connect, TTL, LVDS, Opto, CXP

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 Source

Controls the format of the line item selected in 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

Line Format

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

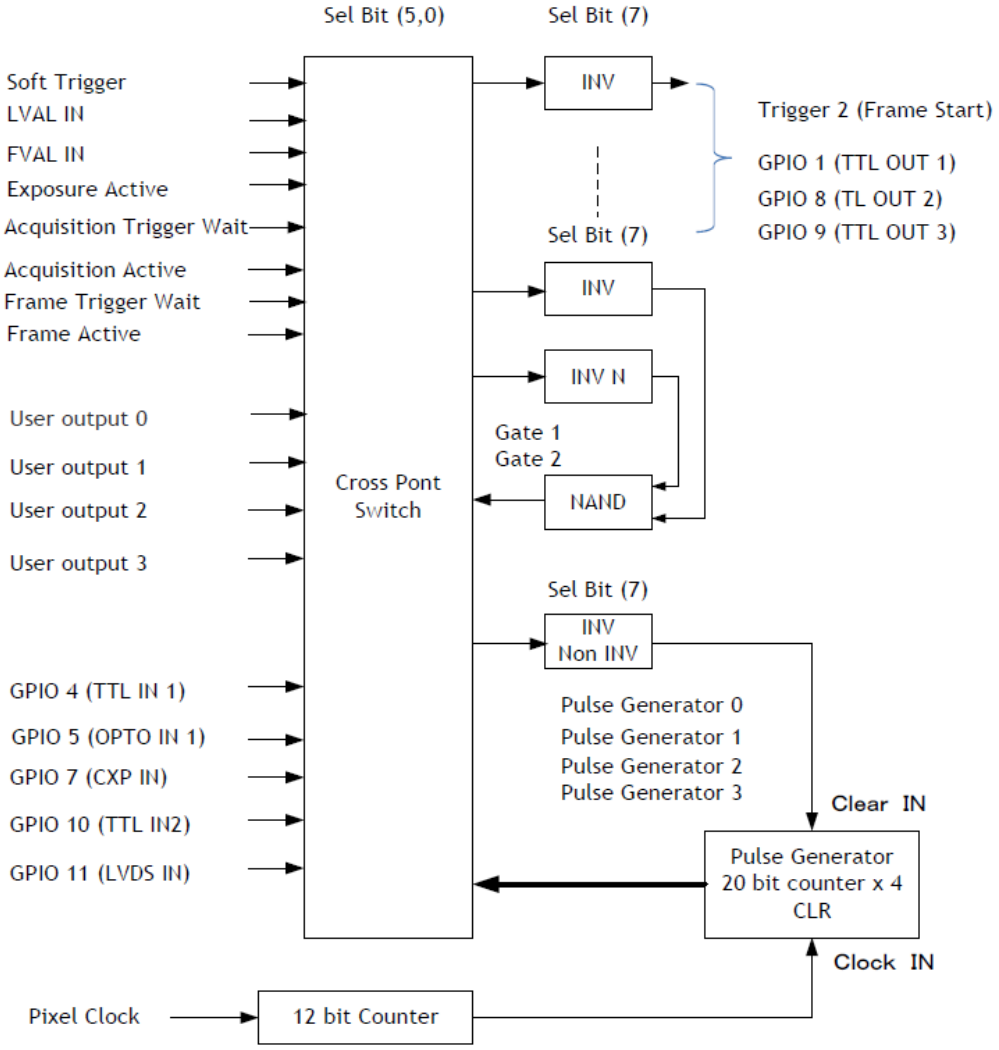
- No Connect, TTL, LVDS, Opto Coupled, CXP

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.

Basic block diagram

The basic block diagram is as follows. On this camera, the pixel clock is fixed at 40 MHz, even though the sensor clock is selectable in the Link Configuration setting.



Input and Output Matrix Table

The relation between input and output is as follows.

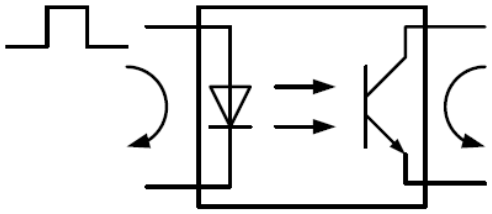
	Trigger Selector			Line Selector								Pulse Generator Selector			
Source Signal	Frame Start	Acq. Start	Acq.End	TTL OUT 1	OPTO OUT 1	TTL OUT 2	TTL OUT 3	NAND 1 In 1	NAND 1 In 2	NAND 2 In 1	NAND 2 In 2	Pulse Gen.0	Pulse Gen. 1	Pulse Gen. 2	Pulse Gen. 3
Low	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
High	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Soft Trigger	●	●	●												
Acquisition Trigger Wait				●	●	●	●	●	●	●	●	●	●	●	●
Acquisition Active				●	●	●	●	●	●	●	●	●	●	●	●
Exposure Active				●	●	●	●	●	●	●	●	●	●	●	●
Frame Trigger Wait				●	●	●	●	●	●	●	●	●	●	●	●
Frame Active				●	●	●	●	●	●	●	●	●	●	●	●
FVAL				●	●	●	●	●	●	●	●	●	●	●	●
LVAL												●	●	●	●
Pulse Gen. 0	●	●	●	●	●	●	●	●	●	●	●		●	●	●
Pulse Gen. 1	●	●	●	●	●	●	●	●	●	●	●	●		●	●
Pulse Gen. 2	●	●	●	●	●	●	●	●	●	●	●	●	●		●
Pulse Gen. 3	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
TTL In1	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
OPTO IN 1	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CXP IN	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
NAND 0 Out	●	●	●	●	●	●	●			●	●	●	●	●	●
NAND 1 Out 1	●	●	●	●	●	●	●	●	●			●	●	●	●
User Output 0	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
User Output 1	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
User Output 2	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
User Output 3	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
TTL IN 2	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
LVDS IN	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Trigger Source			Line Source								Pulse Generator Clear Source			

●	Supported
	(Empty) Not Supported

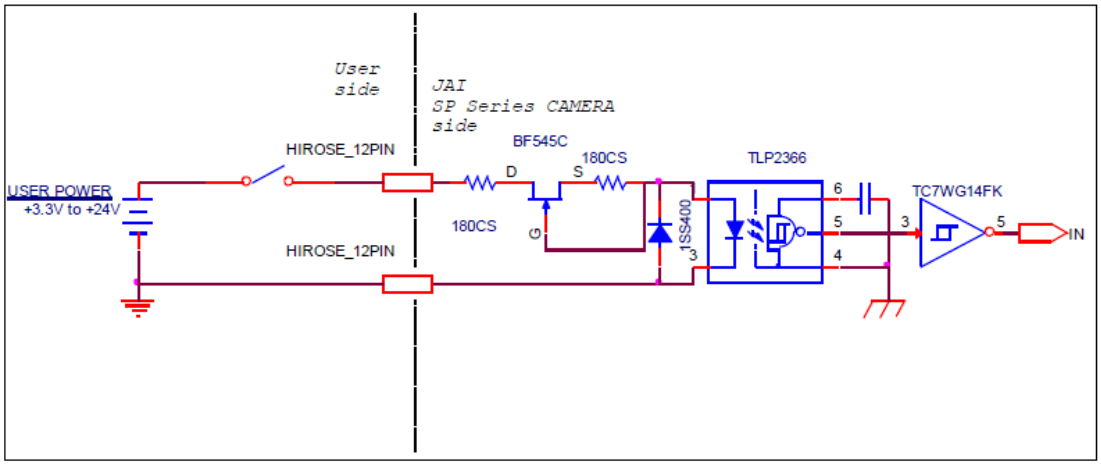
Optical Interface

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

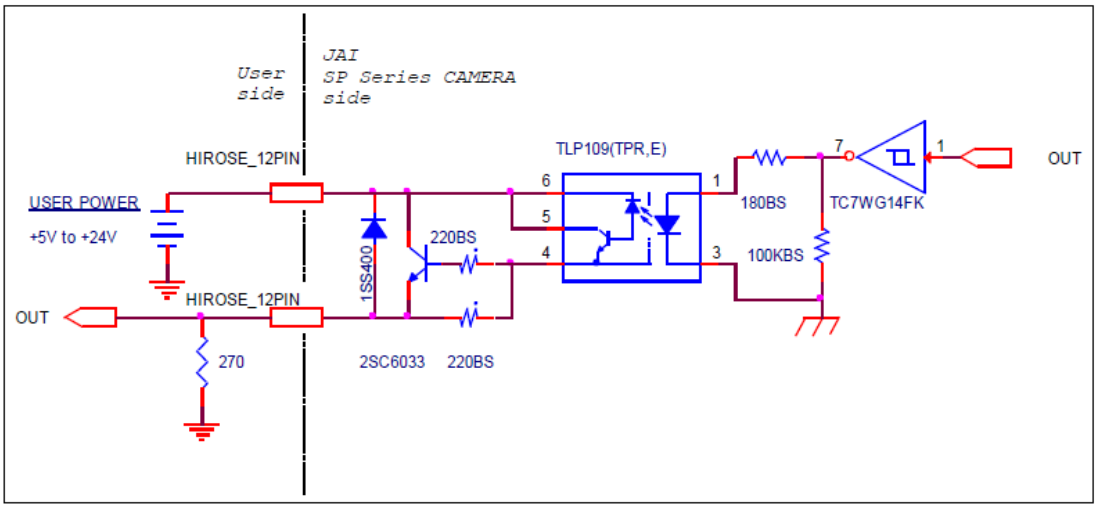
The following drawing is the concept of photo coupler.



Recommended External Input Circuit Diagram

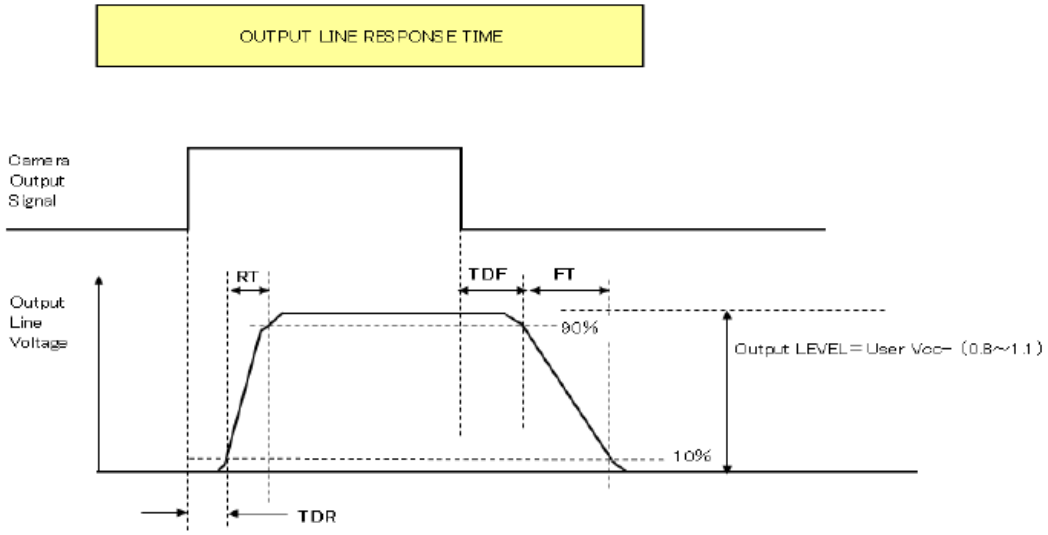


Recommended External Output Circuit Diagram

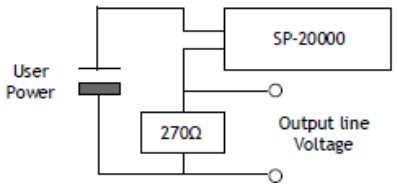


Characteristics of optical interface

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



270Ω	User Power (VCC)			
	3.3V	5V	12V	24V
Time Delay Rise TDR (us)	0.54	0.54	0.62	0.68
Rise Time RT (us)	1.2	1.2	2	3
Time Delay Fall TDF (us)	1.5	1.5	2.4	2.1
Fall Time FT (us)	3.6	3.4	4.5	6.8



Pulse Generator

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

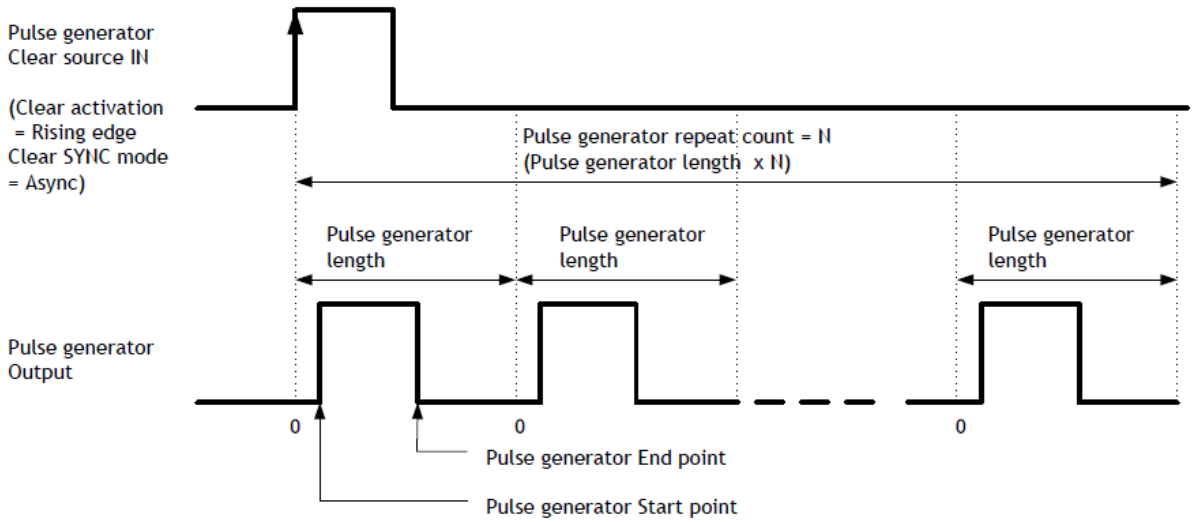
> **Note:** When Pulse Generator Repeat Count is set to “0”, the camera is operating in free-running mode.

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 40 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 count 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.

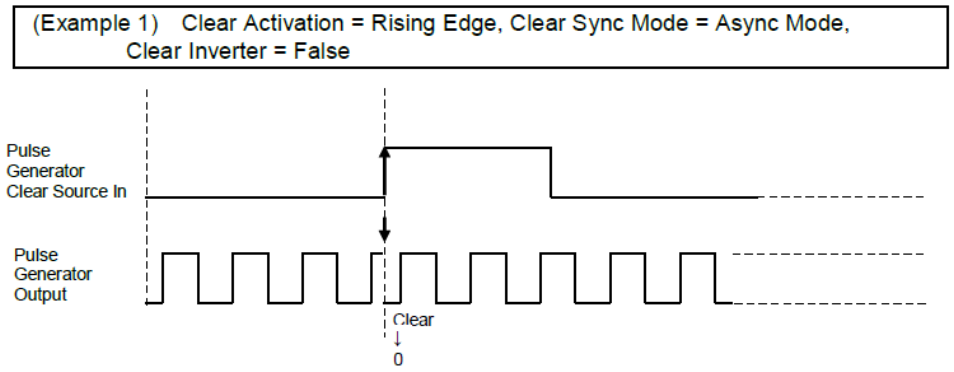
Pulse Generator Clear Activation

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

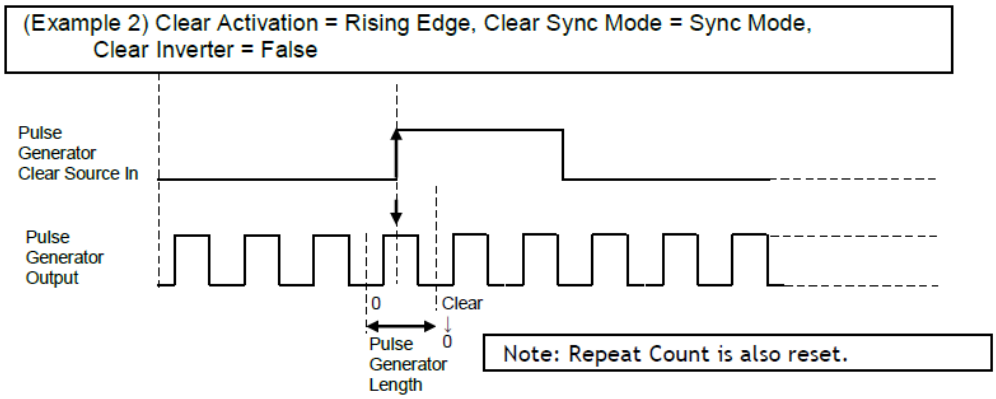
Pulse Generator Clear Sync Mode

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.

- Low, High, AcquisitionTriggerWait, AcquisitionActive, FrameTriggerWait, FrameActive, ExposureActive, FVAL, LVAL, PulseGenerator0, PulseGenerator1, PulseGenerator2, PulseGenerator3, UserOutput0, UserOutput1, UserOutput2, UserOutput3, Line4, Line5, CXPin, Nand0, Nand1, Line10, Line11

> **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: Off, 1: Level High, 2: Level Low, 4: Rising Edge, 8: Falling Edge
Pulse Generator Clear Sync Mode	0: Async Mode, 1: Sync Mode
Pulse Generator Clear Source	Low, High, AcquisitionTriggerWait, AcquisitionActive, FrameTriggerWait, FrameActive, ExposureActive, FVAL, LVAL, PulseGenerator0, PulseGenerator1, PulseGenerator2, PulseGenerator3, UserOutput0, UserOutput1, UserOutput2, UserOutput3, Line4, Line5, CXPin, Nand0, Nand1, Line10, Line11
- Pulse Generator Inverter (Polarity) Pulse Generator Clear Inverter	0:Non-Inv, 1:Inv

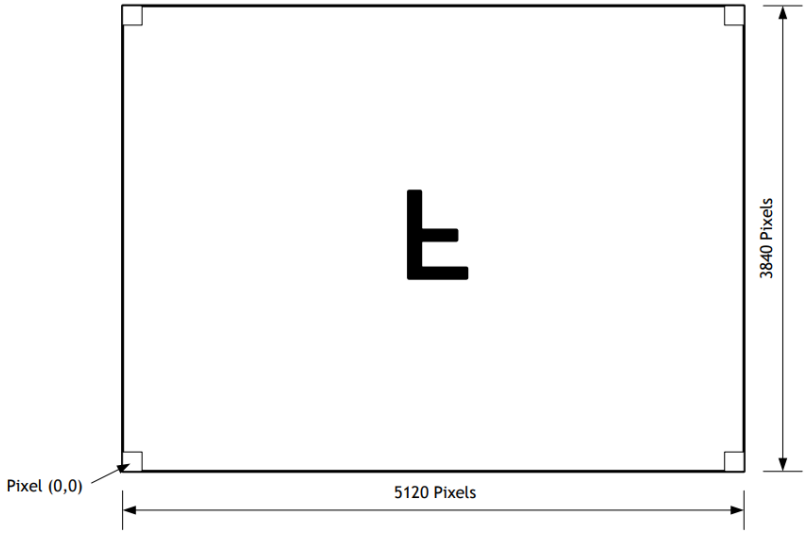
Notes:

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.

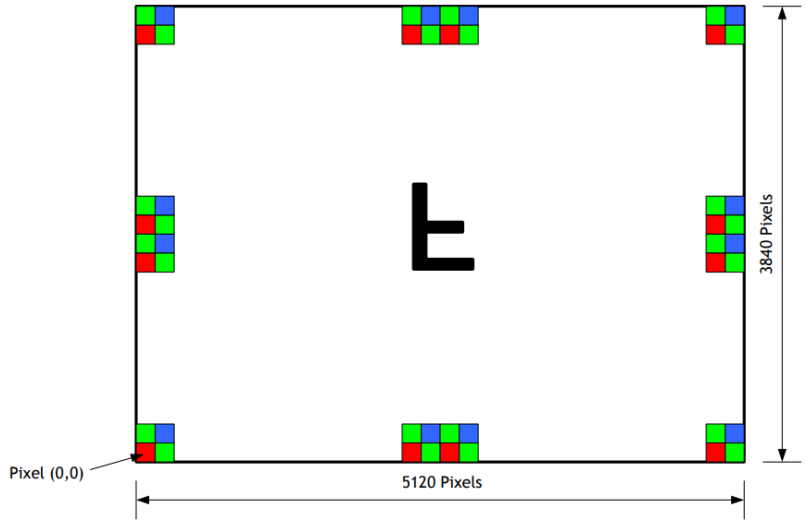
Sensor Layout

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

Monochrome Sensor



Bayer Sensor



Camera Output Format (Tap Geometry)

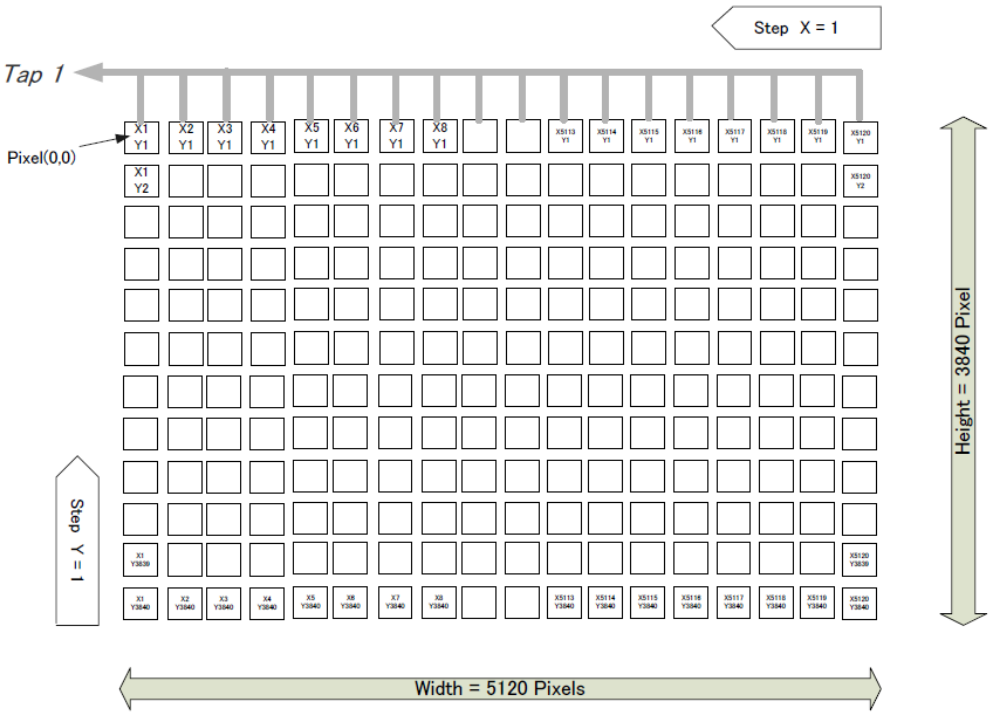
This camera supports the following output format.

Camera Output Format	Pixel Format
1X–1Y	8 bit, 10 bit, 12 bit, RGB 8-bit

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

1X–1Y

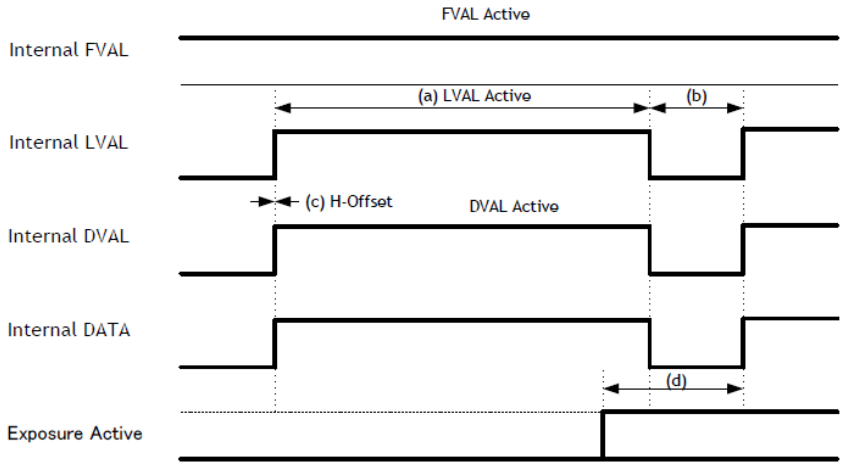
1X–1Y is 1-tap readout system specified in GenICam Tap Geometry and it outputs as the following.



Output Timing

Horizontal Timing

The horizontal frequency depends on the link configuration. The following chart and tables explain the details. On this camera, the horizontal frequency does not change when horizontal binning is effective, and therefore, the frame rate is not increased.



Horizontal Formats in Continuous Trigger

Horizontal Formats (1/2)

Note: Binning 1 = Off, 2 = On

	ROI				Binning		(a) LVAL Active	(b) LVAL Non-Active	(c) H-Offset	(d) Exposure Active Start to LVAL Active Start			Step
	Width	Offset X	Height	Offset Y	H	V	Unit: Clock]	Unit: Clock]	Unit: Clock]	[Unit: us]			(Typ.)
CXP6 _ X2	5120	0	3840	0	1	1	320	0.5	0	0.512			8
	5120	0	1920	0	1	2	320	321	0	0.512	or	8.523	8
	2560	0	3840	0	2	1	160	160.5	0	0.512			8
	2560	0	1920	0	2	2	160	481	0	0.512	or	8.523	8
CXP6 _ X1 CXP3 _ X2	5120	0	3840	0	1	1	640	1	0	7.815			16
	5120	0	1920	0	1	2	640	642	0	7.815	or	23.838	16
	2560	0	3840	0	2	1	320	321	0	7.815			16
	2560	0	1920	0	2	2	320	962	0	7.815	or	23.838	16
CXP3 _ X1	5120	0	3840	0	1	1	640	1	0	15.630			16
	5120	0	1920	0	1	2	640	642	0	15.63	or	47.676	16
	2560	0	3840	0	2	1	320	321	0	15.63			16
	2560	0	1920	0	2	2	320	962	0	15.63	or	47.676	16

Notes:

- The horizontal frequency is not doubled if horizontal binning is ON.
- If vertical binning is ON, the horizontal frequency becomes half.
- H-Offset: The period from the LVAL Active start to DATA Active start
- If the next frame is exposed while the image is read out in the vertical binning mode, the exposure control is controlled by 0.5 line.
- (d) "Exposure Active Start to LVAL Active Start" has 1 clock difference due to the jitter in LVAL Non Active period.

Horizontal Formats (2/2)

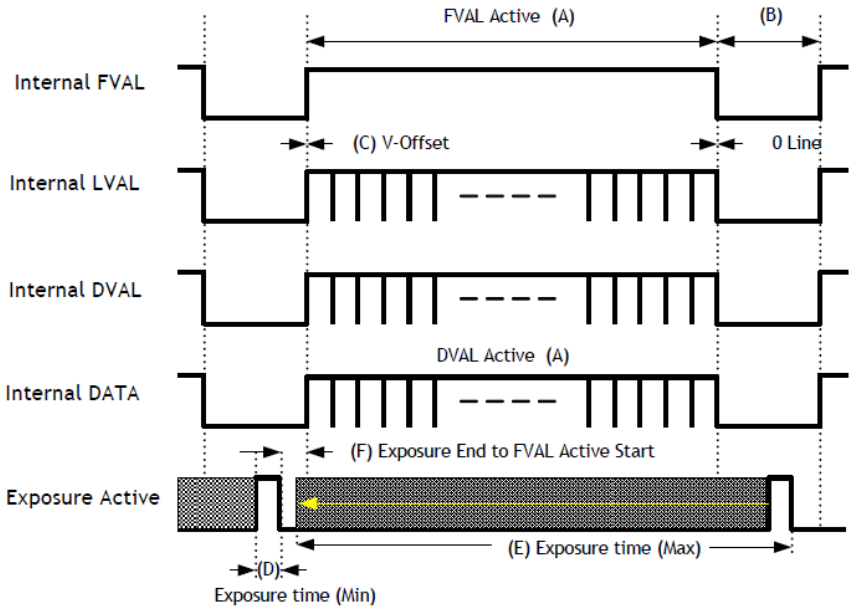
> **Note:** Binning 1 = Off, 2 = On

	ROI				Binning		1Line Total Clock	Horizontal Frequency	Horizontal Period
	Width	Offset X	Height	Offset Y	H	V	[Unit: Clock]	[Unit: kHz]	[Unit: us]
CXP6 _X2	5120	0	3840	0	1	1	320.5	124.805	8.013
	5120	0	1920	0	1	2	641	62.402	16.025
	2560	0	3840	0	2	1	320.5	124.805	8.013
	2560	0	1920	0	2	2	641	62.402	16.025
CXP6 _X1 CXP3 _X2	5120	0	3840	0	1	1	641	62.402	16.025
	5120	0	1920	0	1	2	1282	31.201	32.050
	2560	0	3840	0	2	1	641	62.402	16.025
	2560	0	1920	0	2	2	1282	31.201	32.050
CXP3 _X1	5120	0	3840	0	1	1	641	31.201	32.050
	5120	0	1920	0	1	2	1282	15.601	64.100
	2560	0	3840	0	2	1	641	31.201	32.050
	2560	0	1920	0	2	2	1282	15.601	64.100

Vertical Timing

In Continuous Trigger operation, the output timing relation is as follows.

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



Continuous Trigger Vertical Timing

Vertical formats in Continuous Trigger (1/2)

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

	Acquisition Frame Rate	ROI				Binning		(A) FVAL Active	(B) FVAL Non-Active	(C) V-Offset	(D) Exposure Time (Min)
		Width	Offset X	Height	Offset Y	H	V	Unit: Line	Unit: Line	Unit: Line	Unit: us
CXP6_X2	30.0	5120	0	3840	0	1	1	3840	321.1	0	10.0
		5120	0	1920	0	1	2	1920	160.6		
		2560	0	3840	0	2	1	3840	321.1		
		2560	0	1920	0	2	2	1920	160.6		
CXP6_X1 CXP3_X2	15.0	5120	0	3840	0	1	1	3840	320.6	0	10.0
		5120	0	1920	0	1	2	1920	160.3		
		2560	0	3840	0	2	1	3840	320.6		
		2560	0	1920	0	2	2	1920	160.3		
CXP3_X1	7.5	5120	0	3840	0	1	1	3840	320.6	0	10.0
		5120	0	1920	0	1	2	1920	160.3		
		2560	0	3840	0	2	1	3840	320.6		
		2560	0	1920	0	2	2	1920	160.3		

Vertical formats in Continuous Trigger (2/2)

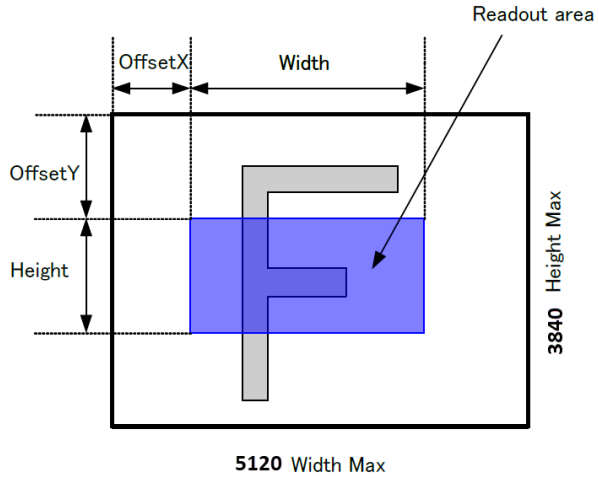
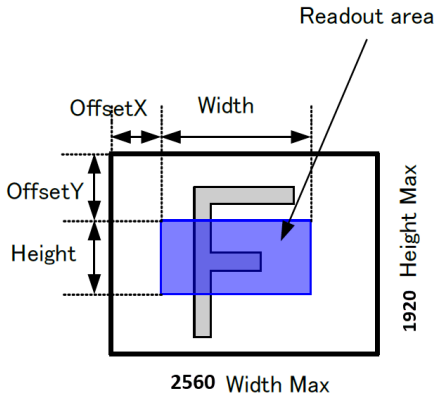
	Acquisition Frame Rate	ROI				Binning	ROI	Frame Rate	(E) Exposure Time (Max.)	(F) Exposure End to FVAL Active Start	
		Width	Offset X	Height	Offset Y	H	V	Unit: Hz	Unit: us	Unit: Line	Unit: us
CXP6_X2	30.0	5120	0	3840	0	1	1	30.000	[Acquisition Frame Rate Raw] - 250us = 33333-250 = 33083	38.1	305.225
		5120	0	1920	0	1	2			19.0	305.225
		2560	0	3840	0	2	1			38.1	305.225
		2560	0	1920	0	2	2			19.0	305.225
CXP6_X1 CXP3_X2	15.0	5120	0	3840	0	1	1	15.000	ROUNDDOWN([Acquisition Frame Rate Raw] - 250us = 66667-250 = 66417	19.0	305.225
		5120	0	1920	0	1	2			9.5	305.225
		2560	0	3840	0	2	1			19.0	305.225
		2560	0	1920	0	2	2			9.5	305.225
CXP3_X1	7.5	5120	0	3840	0	1	1	7.500	[Acquisition Frame Rate Raw] - 500us = 133333-500 = 132833	19.0	610.424
		5120	0	1920	0	1	2			9.5	610.424
		2560	0	3840	0	2	1			19.0	610.424
		2560	0	1920	0	2	2			9.5	610.424

Notes:

- In the SP-20000-CXP2, the frame rate control is done in steps of 1 µs unit. Therefore, FVAL Non Active conversion has tolerance.
- Even if the horizontal binning is ON, the horizontal frequency is not doubled. Therefore, the vertical frequency is not increased.
- If the vertical binning is ON, the horizontal frequency becomes half. Therefore, if the height is half, the vertical frequency is not doubled.
- On this camera, the frame rate can be varied in steps of 1 µs. (B) FVAL NON Active in the table XX will be varied.
- (5) V-Offset: The period from FVAL Active Start to 1st LVAL Active Start

ROI (Regional Scanning Function)

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

> **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				CXP6 _X2	CXP6 _X1 or CXP3 _X2	CXP3 _X2			
Full Line	5120	0	3840	0	1	1	5120	3840	0	8	8	8	0	2	2
2/3 Screen - Center	3408	856	2560	640	1	1	5120	3840	1712	8	8	8	1280	2	2
1/2 Screen - Center	2560	1280	1920	960	1	1	5120	3840	2560	8	8	8	1920	2	2
1/4 Screen - Center	1280	1920	960	1440	1	1	5120	3840	3840	8	8	8	2880	2	2
1/8 Screen - Center	640	2240	480	1680	1	1	5120	3840	4480	8	8	8	3360	2	2
Full Line	2560	0	1920	0	2	2	2560	1920	0	8	8	8	0	1	2
2/3 Screen - Center	1704	428	1280	320	2	2	2560	1920	856	8	8	8	640	1	2
1/2 Screen - Center	1280	640	960	480	2	2	2560	1920	1280	8	8	8	960	1	2
1/4 Screen - Center	640	960	480	720	2	2	2560	1920	1920	8	8	8	1440	1	2
1/8 Screen - Center	320	1120	240	840	2	2	2560	1920	2240	8	8	8	1680	1	2

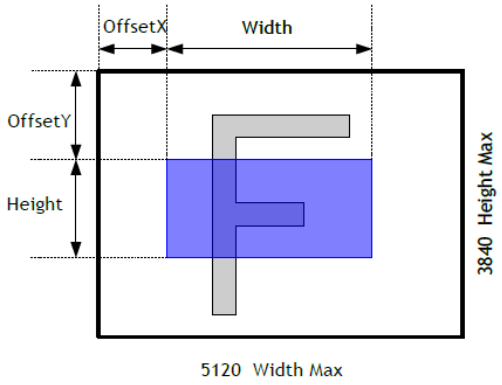
> **Note: Setting restrictions**
>
> 1. Width Max = 5120, Height Max = 3840 (H and V Binning Off) (If it is On, the value is 1/2)
> 2.Max Offset X Value = Width Max - Width: Maximum value which Offset X can be set
> 3.Max Offset Y Value = Height Max - Height: Maximum value which Offset Y can be set
>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

Mirroring Function

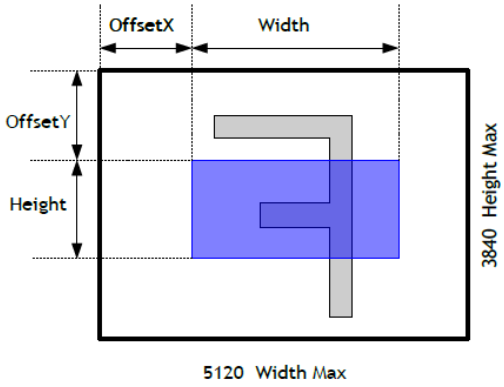
This camera has the ability to reverse the image vertically, horizontally, or both vertically and horizontally. If ROI readout is used, ROI image can be read out after the image is reversed.

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

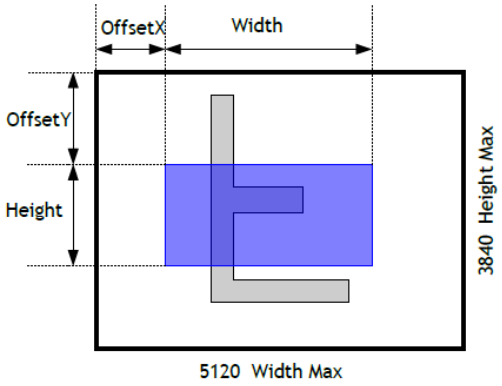
Mirroring = Off



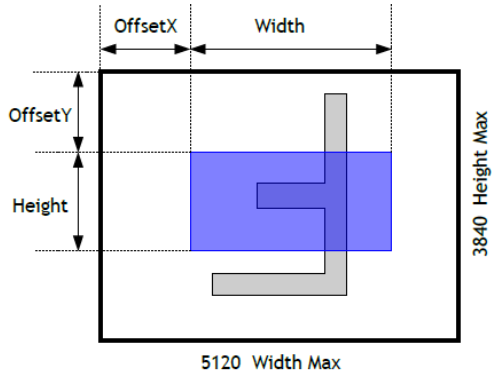
Mirroring = Horizontal



Mirroring = Vertical



Mirroring = Horizontal & Vertical



The Start Pixel and Line

	Start Line	Start Pixel
OFF	R & G	R
Horizontal	R & G	G
Vertical	R & G	G
Horizontal & Vertical	R & G	B

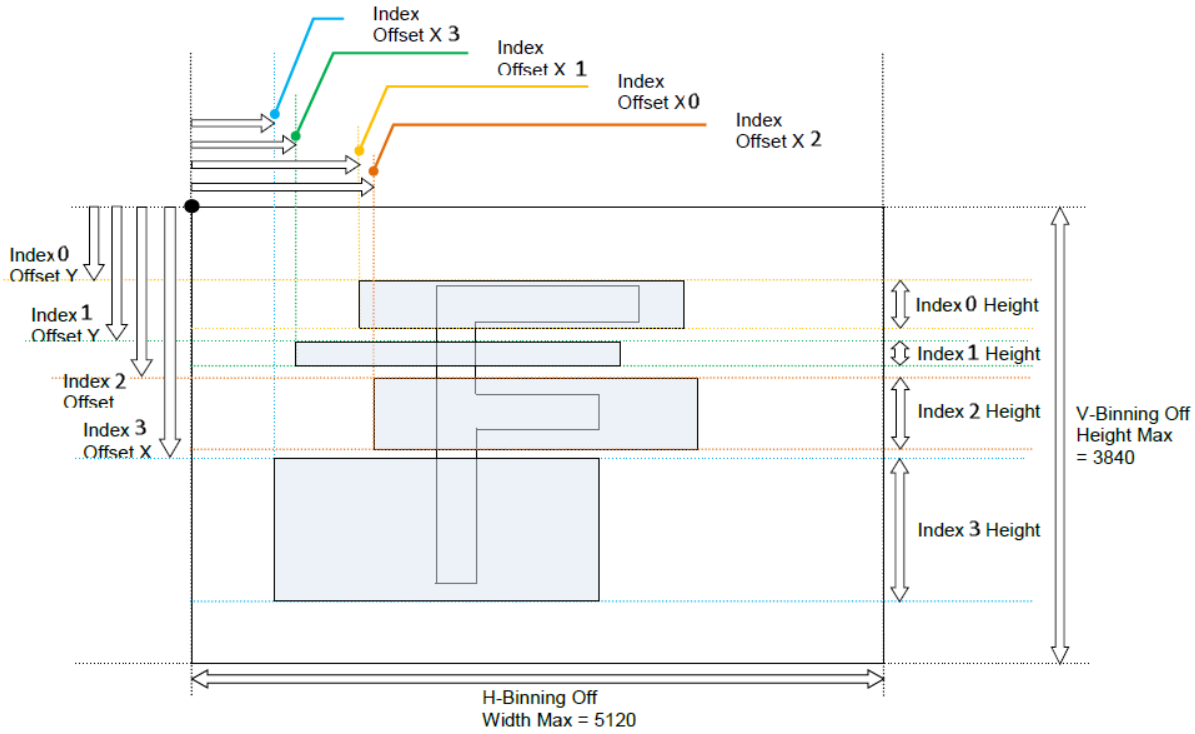
Multi ROI Function

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

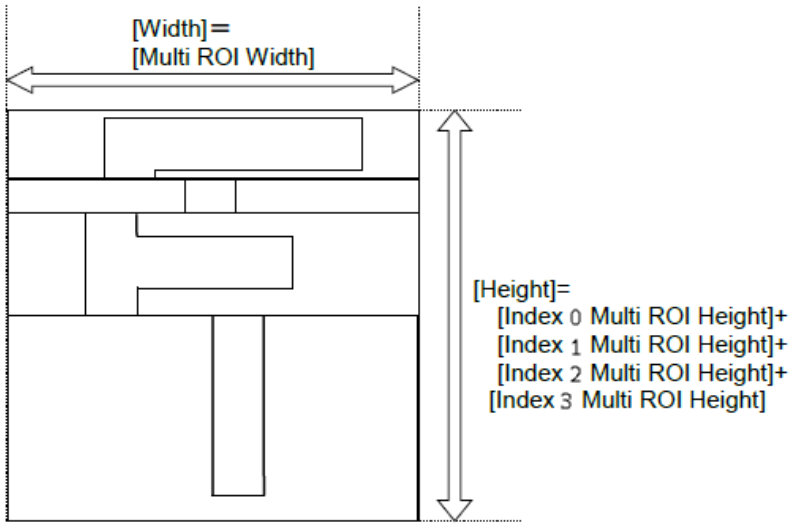
Item	Setting Range	Default	Description
Video Send Mode Selector	NormalMode TriggerSequence MultiMode CommandSequence	NormalMode	Configure Video Send Mode. To use the Multi ROI function, select **MultiMode**.
Multi ROI Index Selector	0 ~ 7	-	Index 0 to 7 can be selected. Height], [Offset X], and [Offset Y] of the selected Multi ROI Index are displayed and can be set.
Multi ROI Width	8 ~ 5120	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 Offset X	0 ~ 5120 – Multi ROI Width	0	Offset X can be set for each ROI area of Multi ROI Index 0 to 7. 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 0 to 7.
Multi ROI Height	2 ~ 3840	2	Height can be set for each ROI area of Multi ROI Index 0 to 7. The restriction for setting Step and other factors are the same as the normal ROI setting.
Multi ROI Offset Y	0 ~ 3840 – Multi ROI Height	0	Offset Y can be set for each ROI area of Multi ROI Index 0 to 7. The restriction for setting Step and other factors is the same as the normal ROI setting. The summary of Multi ROI Height value of index 1 to 8 should be less than Height Max.
Multi ROI Index Max	0 ~ 7	-	Maximum 8 ROI settings are possible in a frame. Set Index 1 through 8 in Multi ROI Index table as an application requires.

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

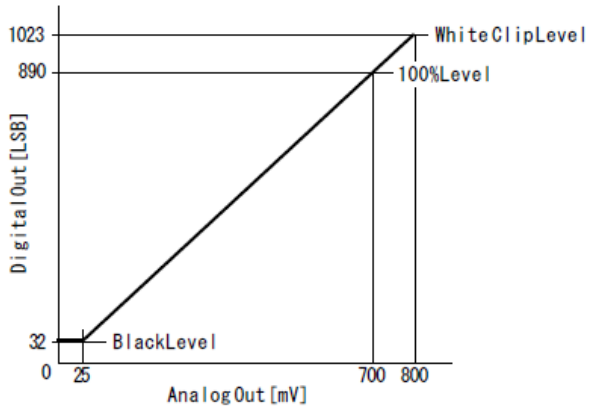


Caution: If Multi ROI function is used, the frame grabber board that is used should be set as follows. The Horizontal pixel number is [Multi ROI Width]. The Vertical pixel number is the aggregate of [Multi ROI Height] as configured.

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)

With Trigger OFF and in free-running mode, the default frame rate of the camera is based on the specified ROI. The smaller the ROI, the faster the default frame rate. However, it is possible to specify a free-running frame rate that is slower than the default rate. This can be useful when a longer exposure time is needed for a specific ROI.

Modification of the frame rate is done by entering a value in the AcquisitionFrameRate control corresponding to the frequency to be allocated to each frame period. Allowed values range from the frequency required for the default frame rate to a maximum of 0.125Hz (8 seconds).

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:

- If the trigger is set to ON, this function is not available.
- The value for setting is the frequency (Hz).
- The minimum interval of a frame depends on reading out time. If the setting value is less than time required for the minimum period, this setting is ignored and camera automatically operates at the minimum period (frequency).

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).

Self-running (Trigger OFF) works under the following conditions.

- Exposure Mode: OFF
- Exposure Mode: Timed and Frame start OFF
- Exposure mode: Trigger width and Frame start OFF.

Relationship between Link Configuration and Acquisition Frame Rate

Model	Image Size	Link Configuration	Pixel Format	Acquisition Frame Rate (Max. Value)
SP-20000M-CXP2	5120 x 3480	CXP6_X2	Mono 8/10/12	30
		CXP6_X1		15
		CXP3_X2		15
		CXP3_X1		7.5
SP-20000C-CXP2	5120 x 3480	CXP6_X2	Bayer RG 8/10/12	30
			RGB8	15
		CXP6_X1	Bayer RG 8/10/12	15
			RGB8	7.5
		CXP3_X2	Bayer RG 8/10/12	15
			RGB8	7.5
		CXP3_X1	Bayer RG 8/10/12	7.5

Note: When the link configuration is changed, it will take a maximum of 10 seconds. While changing the link configuration, the camera LED lights in amber and after changed, it will turn to green.

Calculation of Frame Rate (In Continuous Trigger mode)

Link Configuration	Sensor Clock	Binning Vertical	Acquisition Frame Rate Minimum Value setting formula (unit: us)
CXP6_X2	40MHz	1 (Off)	ROUNDDOWN((([Height] x 320.5) + 102600) ÷ 40MHz x 10^6)
		2 (On)	ROUNDDOWN((([Height] x 641) + 102600) ÷ 40MHz x 10^6)
CXP3_X2 or CXP6_X1	40MHz	1 (Off)	ROUNDDOWN((([Height] x 641) + 205240) ÷ 40MHz x 10^6)
		2 (On)	ROUNDDOWN((([Height] x 1282) + 205240) ÷ 40MHz x 10^6)
CXP3_X1	20MHz	1 (Off)	ROUNDDOWN((([Height] x 641) + 205220) ÷ 20MHz x 10^6)
		2 (On)	ROUNDDOWN((([Height] x 1282) + 205220) ÷ 20MHz x 10^6)

Notes:

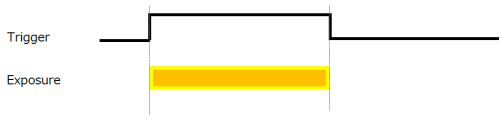
- As the horizontal frequency is doubled with Binning Vertical ON, even though the height becomes 1/2, the frame rate is not changed.
- If Binning Horizontal is set to ON, the horizontal frequency is not changed and therefore, the frame rate is not changed.

Associated GenICam Register Information

GenICam Name	Access	Values	Category
Acquisition Frame Rate	R/W	0.125 to 30	Acquisition Control
Acquisition Frame Rate Raw	R/W	33333 to 8000000	Acquisition Control

Exposure Mode

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

Exposure Mode	Operation
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.
Timed	Exposure operation at the value set in Exposure Time. Setting value is usec unit. • If Trigger Mode setting is OFF, the camera is in free-running operation. • If Trigger Mode setting is ON, the exposure operation depends on the setting of Trigger Option.
TriggerWidth	The exposure is controlled by the pulse width of the external trigger. Trigger Mode is forced to ON. 

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

Trigger Option	Exposure Operation
OFF	Timed (EPS) mode
PIV	PIV (Particle Image Velocimetry) mode

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

Exposure Mode	Trigger Option	Trigger Mode (Frame Start)	Operation
OFF	Invalid	Invalid	Self-running operation. Exposure control by Exposure Time is not possible.
Timed	OFF	OFF	Self-running operation. Exposure control by Exposure Time is not possible.
		ON	Timed (EPS) Operation. Exposure can be controlled by Exposure Time.
	PIV	Forced to ON	PIV Operation. Exposure can be controlled by Exposure Time.
TriggerWidth	Invalid	Forced to ON	Exposure is controlled by the pulse width of the external trigger

Associated GenICam Register Information

GenICam Name	Access	Values	Category
Exposure Mode	R/W	Off, Timed, TriggerWidth	Acquisition Control
Trigger Mode	R/W	Off, On	Acquisition Control
Trigger Option	R/W	Off, PIV	JAI Custom

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: 10us

  > **Note:** Actual Exposure Time: 299us

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

The actual exposure time is added the values listed in the following table against the setting exposure time due to the sensor characteristics. However, Exposure Active signal is not the actual exposure time, but the setting exposure time.

Link Configuration	Sensor actual exposure time
CXP6_X2, CXP6_X1, CXP3_X2	Exposure Time + 289us
CXP3_X1	Exposure Time + 577us

Cautions:
In free-running mode with the frame start trigger set to OFF, the maximum setting value of the exposure time is limited by the frame rate setting. Although 8 seconds is the maximum frame rate setting, the upper limit of the exposure time setting value (for all configurations except CXP3_X1) is 7,999,750 µsec., which is 250 µsec. shorter than the maximum. In the case of CXP_X3, it is 500 µsec. shorter. In EPS trigger operation, where Exposure Time is not influenced by the frame rate setting, the upper limit is 8 seconds. However, please note the following:

As a characteristic of this camera, the black level tends to increase depending on the exposure time and the temperature of the sensor. SP-20000-CXP2 compensates for the black shift inside the camera but the following are the maximum ambient temperatures at which camera performance can be guaranteed for 8 secs of exposure time.

SP-20000M-CXP2: Up to 15 ºC of ambient temperature

SP-20000C-CXP2: Up to 5ºC of ambient temperature

Associated GenICam Register Information

GenICam Name	Access	Values	Category
Exposure Mode	R/W	Off, Timed, TriggerWidth	Acquisition Control
Exposure Time	R/W	10 to 8000000 [us]	Acquisition Control
Exposure Time Raw	R/W	10 to 8000000 [us]	Acquisition Control

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.

However, the shutter noise at the exposure start period will appear on images. It is approximately 70LSB/10-bit as the maximum.

Modes where the exposure control becomes 1L if overlap occurs

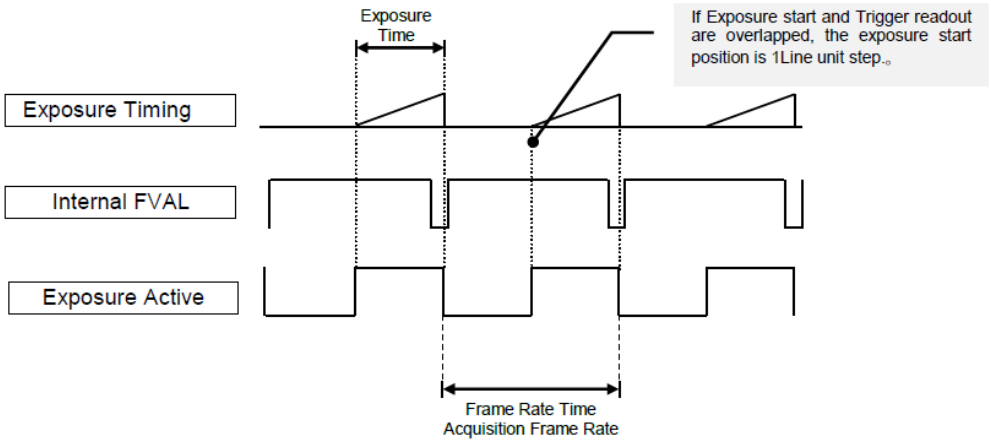
JAI Custom Naming	Trigger Mode	Trigger Overlap
Continuous Trigger	Off	Invalid
EPS Trigger / LVAL SYNC Reset	On	Readout

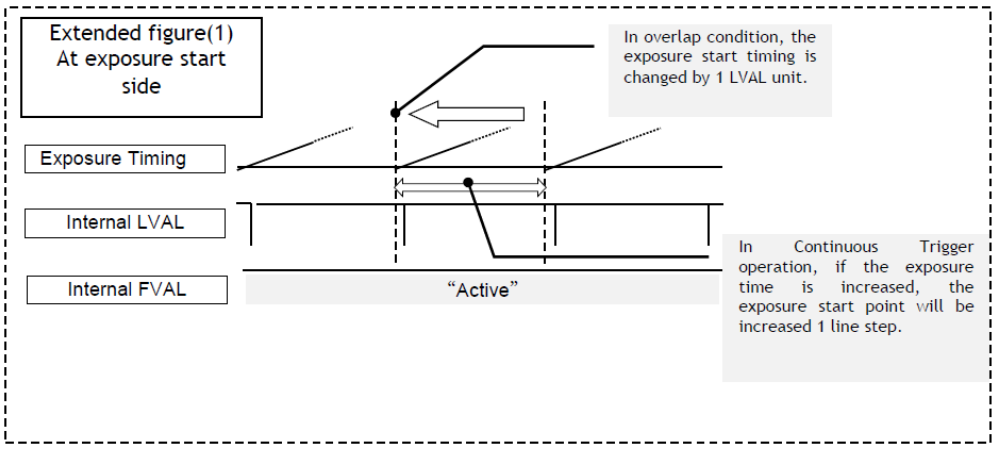
Formula of the exposure time maximum value at the continuous trigger

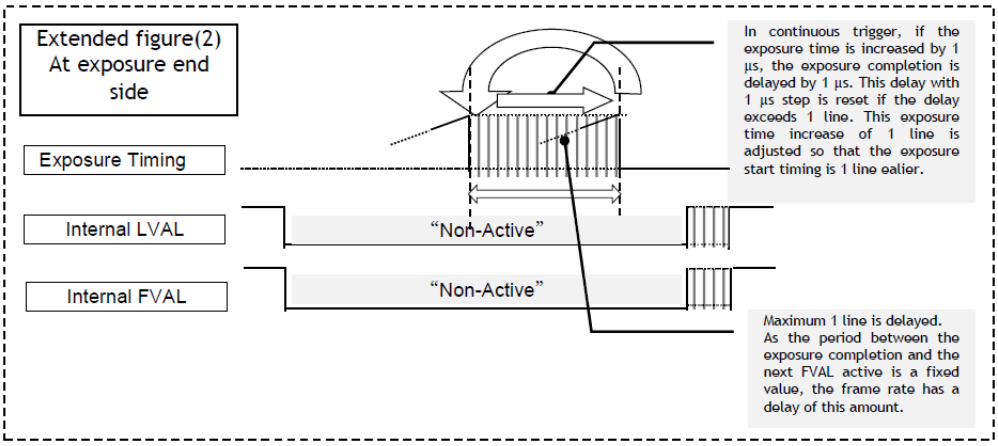
> **Note:** Acquisition Frame Rate Raw is configured by the frame interval [Unit: us].

Link Configuration	Sensor Clock	Binning Vertical	Exposure Time Max setting formula [Unit: us]
CXP6_X2	40MHz	1 (Off)	= [Acquisition Frame Rate Raw] - 250
		2 (On)	= [Acquisition Frame Rate Raw] - 250
CXP6_X1 or CXP3_X2	40MHz	1 (Off)	= [Acquisition Frame Rate Raw] - 250
		2 (On)	= [Acquisition Frame Rate Raw] - 250
XP3_X1	20MHz	1 (Off)	= [Acquisition Frame Rate Raw] - 500
		2 (On)	= [Acquisition Frame Rate Raw] - 500

As an example, the following is for the continuous trigger operation.







ExposureAuto

An automatic exposure control function using Exposure. This function works only when Exposure Mode is Timed (EPS), and brightness can be controlled by ALC Reference.

There are three modes: OFF, Once and Continuous.

ExposureAuto	Description
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.

Setting Item	Description
ALC speed	Rate of adjustment can be set (Common with Gain Auto)
AutoShutterControlExposureMax	The maximum value for the exposure time to be controlled can be set
AutoShutterControlExposureMin	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 Area	The measurement area of the exposure control can be set

Associated GenICam Register Information

GenICam Name	Access	Values	Category
Exposure Auto	R/W	Off, Continuous, Once	Acquisition Control
Exposure Auto Max	R/W	100 to 8000000	JAI-Custom
Exposure Auto Min	R/W	100 to 8000000	JAI-Custom

Trigger Control

Trigger Source can be selected in Trigger Selector. On this camera, the trigger source can be selected from Frame Start, Acquisition Start, and Acquisition End.

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, the following trigger operation can be selected as the trigger: **Frame Start**, **Acquisition Start**, **Acquisition End**

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.

- Low, High, Software, PulseGenerator0 ~ 3, UserOutput0 ~ 3, Line4, Line5, CXPIn, Nand1, Nand2, Line10, Line11

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.

Associated GenICam Register Information

GenICam Name	Access	Values
Trigger Selector	R/W	AcquisitionStart, AcquisitionEnd, FrameStart
Trigger Mode	R/W	Off, On
Trigger Software	W	
Trigger Source	R/W	Low, High, Software, PulseGenerator0 ~ 3, UserOutput0 ~ 3, Line4, Line5, CXPin, Nand1, Nand2, Line10, Line11
Trigger Activation	R/W	RisingEdge, FallingEdge, LevelHigh, LevelLow
Trigger Over Lap	R/W	Off, ReadOut

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

This is used for applications which do not require triggering. For the video timing, refer to "Output Timing".

Typical Minimum interval

Readout Mode	Time (Min. Trigger Period)		
	CXP6_X2	CXP6_X1, CXP3_X2	CXP3_X1
Full	33.333ms	66.666ms	133.333ms
ROI Center 2/3	22.222ms	44.444ms	88.889ms
ROI Center 1/2	16.667ms	22.222ms	66.667ms
ROI Center 1/4	8.428ms	16.826ms	33.713ms
ROI Center 1/8	4.500ms	9.001ms	18.002ms
V Binning ON*	33.333ms	66.666ms	133.333ms
*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:

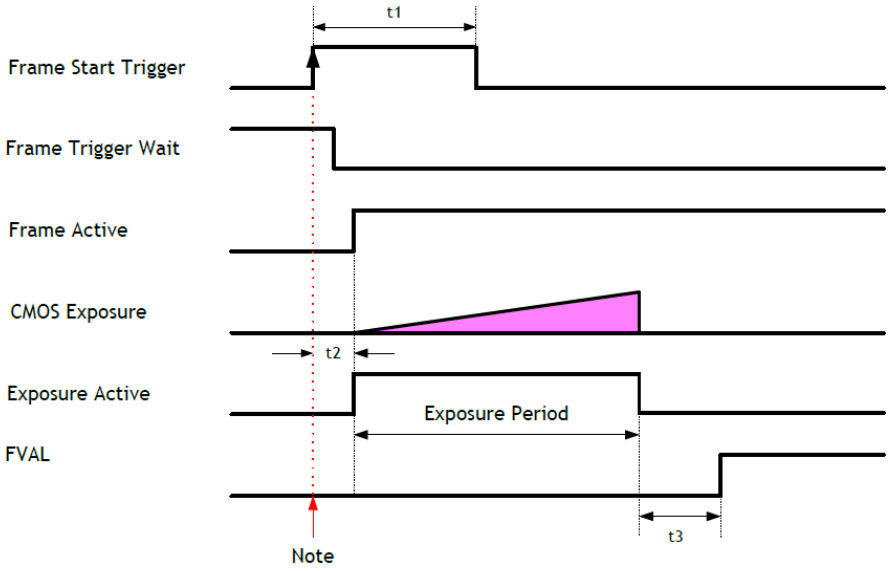
- Trigger Mode: ON
- Exposure Mode: Timed
- Trigger Option: OFF
- Trigger Overlap: OFF

Typical Trigger Minimum Interval (Pixel format: 8-bit)

Readout Mode	Time (Min. Trigger Period)		
	CXP6_X2	CXP6_X1, CXP3_X2	80 MHz
Full	≧ 31.761ms	≧ 63.200ms	≧ 126.389ms
ROI Center 2/3	≧ 21.287ms	≧ 42.252ms	≧ 84.492ms
ROI Center 1/2	≧ 16.050ms	≧ 31.777ms	≧ 63.544ms
ROI Center 1/4	≧ 8.195ms	≧ 16.066ms	≧ 32.121ms
ROI Center 1/8	≧ 4.267ms	≧ 8.211ms	≧ 16.410ms
V Binning ON* (Full)	≧ 31.770ms	≧ 63.216ms	≧ 126.423ms
*Monochrome model only			

> **Note:** The above table is if Trigger Overlap is set to Readout.

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.

	Tap Geometry	Vertical Binning	Exposure Active Signal source	CXP6_X2	CXP6_X1, CXP3_X2	CXP3_X1
t1	1X – 1Y	—		2L(mini)	2L(mini)	2L(mini)
t2	1X - 1Y	—	TTL Out	2.120 us	2.120 us	2.370 us
			Inside Camera	450 ns ~ 480 ns	450 ns ~ 480 ns	700 ns ~ 750 ns
t3	1X -1Y	1 (Off)	TTL Out	304.980 us	304.980 us	610.170 us
			Inside Camera	305.240 us	305.240 us	610.400 us
		2 (On)	TTL Out	305.240 us	305.240 us	610.170 us
			Inside Camera	304.980 us	304.980 us	610.400 us

Notes:

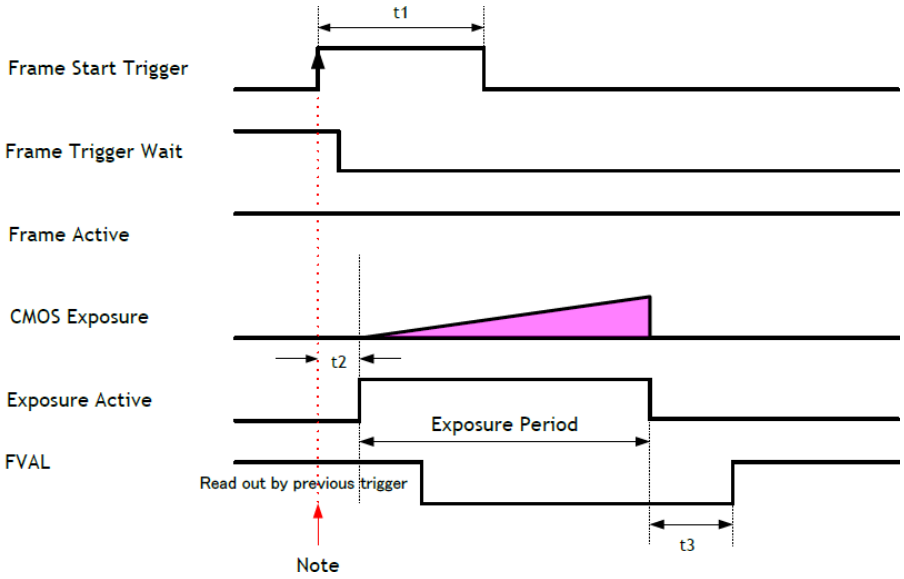
- Because jitter occurs during triggering, t2 has tolerance in time.
- If the exposure signal is used as TTL OUT, the timing is delayed against the timing inside camera. Especially, the phase delay is large at the rising edge.

Minimum trigger interval calculation formula (Trigger Overlap: OFF)

Link Configuration	Tap Geometry	Binning Vertical	Trigger Mode="On", Exposure Mode="Timed", Trigger Overlap="Off" [Unit: us]
CXP6_X2	1X – 1Y	1 (Off)	ROUNDDOWN(((([Height]+1) x 320.5) + 12205) ÷ 40MHz x 10^6) + 10us
		2 (On)	ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) + 10us
CXP6_X1, CXP3_X2	1X – 1Y	1 (Off)	ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) + 10 us
		2 (On)	ROUNDDOWN(((([Height]+1) x 1282) + 12205) ÷ 40MHz x 10^6) + 10us
CXP3_X1	1X – 1Y	1 (Off)	ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 20MHz x 10^6) + 10us
		2 (On)	ROUNDDOWN(((([Height]+1) x 1282) +12205) ÷ 20MHz x 10^6) + 10us

Note: If Trigger Overlap is set at OFF and the trigger period is less than value described in the above table, the trigger mask becomes effective and the trigger might be ignored.

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.

	Vertical Binning	Exposure Active Signal Source	CXP6_X2	CXP6_X1, CXP3_X2	CXP3_X1
t1	—		2L(mini)	2L(mini)	2L(mini)
t2	—	TTL Out	1.680 us ~ 1.680 us + 1 Line	1.680 us ~ 1.680 us + 1 Line	2.330 us ~ 2.330 us + 1 Line
		Inside Camera	460 ns ~ 460 ns + 1 Line	460 ns ~ 460 ns + 1 Line	710 ns ~ 710 ns + 1 Line
t3	1 (Off)	TTL Out	305.240 us	305.240 us	610.170 us
		Inside Camera	307.990 us	307.990 us	610.400 us
	2 (On)	TTL Out	305.240 us	305.240 us	610.170 us
		Inside Camera	307.990 us	307.990 us	610.400 us

Minimum trigger interval calculation formula (Trigger Overlap: Readout)

Link Configuration	Binning Vertical	Conditions: Trigger Mode = "On", Exposure Mode = "Timed", Trigger Overlap = "Readout" (Unit: us)
CXP6_X2	1 (Off)	If ROUNDDOWN((((([Height]+1) x 320.5) + 12205) ÷ 40MHz x 10^6) + 10 - 260 ≧ [Exposure Time] Result= ROUNDDOWN((((([Height]+1) x 320.5) + 12205) ÷ 40MHz x 10^6) + 10 us
		If ROUNDDOWN((((([Height]+1) x 320.5) + 12205) ÷ 40MHz x 10^6) + 10 - 260 < [Exposure Time] Result = [Exposure Time] + 260 us
	2 (On)	If ROUNDDOWN((((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) + 10 - 260 ≧ [Exposure Time Result = ROUNDDOWN((((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) + 10us
		If ROUNDDOWN((((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) + 10 - 260 < [Exposure Time] Result = [Exposure Time] + 260 us
CXP6_X1, CXP3_X2	1 (Off)	If ROUNDDOWN((((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) + 10 - 260 ≧ [Exposure Time] Result = ROUNDDOWN((((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) +10us
		If ROUNDDOWN((((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) + 10 - 260 < [Exposure Time] Result = [Exposure Time] + 260 us
	1 (Off)	If ROUNDDOWN((((([Height]+1) x 1282) + 12205) ÷ 40MHz x 10^6) + 10 - 260 ≧ [Exposure Time] Result = ROUNDDOWN((((([Height]+1) x 1282) + 12205) ÷ 40MHz x 10^6) + 10us
		If ROUNDDOWN((((([Height]+1) x 1282) + 12205) ÷ 40MHz x 10^6) + 10 - 260 < [Exposure Time] Result = [Exposure Time] + 260 us
CXP3_X1	1 (Off)	If ROUNDDOWN((((([Height]+1) x 641) + 12205) ÷ 20MHz x 10^6) + 10 - 510 ≧ [Exposure Time] Result =ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 20MHz x 10^6) + 10us
		If ROUNDDOWN((((([Height]+1) x 641) + 12205) ÷ 20MHz x 10^6) + 10 - 510 < [Exposure Time] Result = [Exposure Time] + 510 us
	1 (Off)	If ROUNDDOWN((((([Height]+1) x 1282) +12205) ÷ 20MHz x 10^6)+ 10 - 510 ≧ [Exposure Time] Result = ROUNDDOWN(((([Height]+1) x 1282) +12205) ÷ 20MHz x 10^6) + 10us
		If ROUNDDOWN((((([Height]+1) x 1282) +12205) ÷ 20MHz x 10^6) + 10 - 510 < [Exposure Time] Result = [Exposure Time] + 510 us

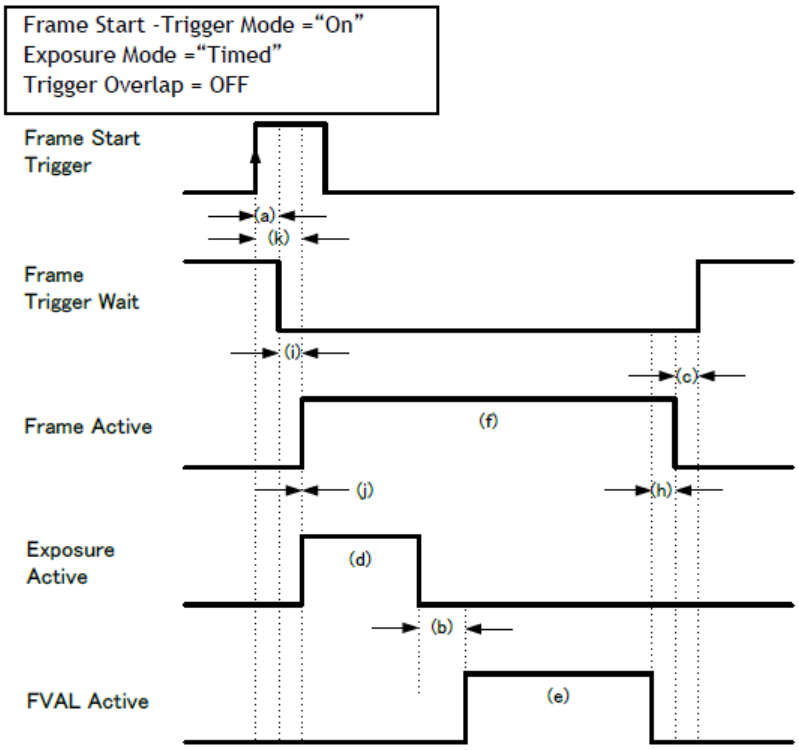
Notes:

- If Trigger Overlap is set at Readout and the trigger interval is set more than the value described in the above table, The exposure might not work properly and the proper image might not be output.

- If the trigger overlap is set at —Readoutll and the trigger period is set such that (the trigger period (µs) – 260µs) is shorter than the exposure time, the exposure operation does not work properly and as a result, the proper image is not displayed. In this case, it is required either to shorten the exposure time or to prolong the trigger period. If the link configuration CXP3_X1 is used, the figure 520µs must be used instead of 260µs.

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

GPIO TTL Out Timing



GPIO Out Timing (Reference) (Trigger Overlap= OFF)

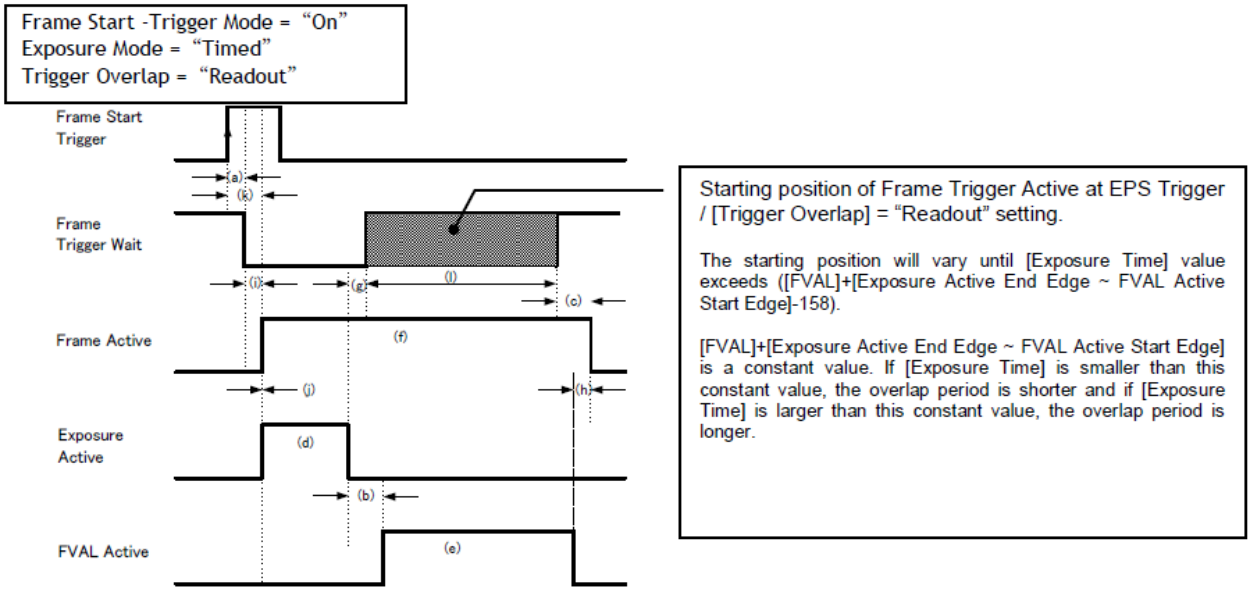
	Description	CXP6_X2	CXP6_X1 CXP3_X2	CXP3_X1	Note
(a)	Frame Start Trigger to Frame Trigger Wait Falling Edge	860 ns	860 ns	1.06 us	If Frame Start Trigger is input from TTL IN 1
(b)	Exposure Active Falling Edge to FVAL Rising Edge	304.97 us (305.22 us)	304.97 us (305.22 us)	610.19 us (610.24 us)	( ) is the phase relation between the exposure time and FVAL inside camera
(c)	Frame Active Falling Edge to Frame Trigger Wait Rising Edge	990 ns	990 ns	1.83 us	

	Description	CXP6_X2	CXP6_X1 CXP3_X2	CXP3_X1	Note
(d)	Exposure Active	8.61 us (10.03 us)	8.61 us (10.03 us)	8.68 us (10.05 us)	If Exposure Time = 10. ( ) is the exposure time inside camera
(e)	FVAL Active	30.74 ms (Internal: 30.77 ms)	61.53 ms (Internal: 61.54 ms)	123.07 ms (Internal: 123.07 ms)	If Binning off and Height=3840 (Varies by the vertical ROI)
(f)	Frame Active	31.08 ms	61.85 ms	123.69 ms	If Exposure Mode = Timed
(h)	FVAL Falling Edge to Frame Active Falling Edge	1.02 us	1.02 us	0.80 us	This may vary by binning setting and ROI setting. The phase of Frame Active End Edge may vary by 1us against FVAL Active End.
(i)	Frame Trigger wait Falling Edge to Frame Active Rising Edge	1.28 us	1.28 us	1.27 us	
(j)	Frame Active Rising Edge to Exposure Active Rising Edge	0.00 us	0.00 us	0.00 us	
(k)	Frame Start Trigger to Exposure Active Rising Edge	2.13 us ~ 2.16 us (450 ns~ 480 ns)	2.129 us~ 2.156 us (450 ns~ 480 ns)	2.312 us~ 2.360 us (704.00 ns~ 754.00 ns)	Exposure Active at TTL I/F output ( ) is the exposure phase relation inside camera
-	Exposure Active Start Edge : Internal / TTL Out Phase	1.67 us	1.67 us	1.61 us	If the polarity is Active High
-	Exposure Active End Edge: Internal / TTL Out Phase	260 ns	260 ns	230 ns	If the polarity is Active High

Note: The figure in ( ) is the comparison between the exposure time inside camera and Exposure Active.

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

GPIO Timing (Overlap = Readout)



	Description	CXP6_X2	CXP6_X1 CXP3_X2	CXP3_X1	Note
(a)	Frame Start Trigger to Frame Trigger Wait Falling Edge	860 ns	840.00 ns	1.063 us (±25ns)	
(b)	Exposure Active Falling Edge to FVAL Raising Edge	304.97 us (305.22 us)	304.97 us (305.21 us)	610.19 us (610.42 us)	This is changed by Link Configuration setting.
(c)	Frame Trigger Wait Rising Edge to Frame Active Falling Edge	6.98 us	6.97 us	6.97 us	Is Exposure Time=10 us
(d)	Exposure Active	8.61 us (10.03 us)	8.56 us (10.03 us)	8.68 us (10.05 us)	If Exposure Time=10 us ( ) is the exposure time inside camera
(e)	FVAL Active	30.77 ms (Internal: 30.77 ms)	61.53 ms (Internal: 61.54 ms)	123.07 ms (Internal: 123.07 ms)	If Binning off and Height = 3840 (Varies by the vertical ROI setting)
(f)	Frame Active	31.08 ms	61.85 ms	123.69 ms	If Exposure Mode = Timed
(g)	Exposure Active Falling Edge to Frame Trigger Wait Rising Edge	4.05 us	5.05 us	5.03 us	

	Description	CXP6_X2	CXP6_X1 CXP3_X2	CXP3_X1	Note
(h)	FVAL Falling Edge to Frame Active Falling Edge	1.02 us	1.03 us	270 ns	This may vary by binning setting and ROI setting. The phase of Frame Active End Edge may vary by 1us against FVAL Active End.
(i)	Frame Trigger Wait Falling Edge to Frame Active Rising Edge	1.32 us	1.33 us	1.29 us	
(j)	Frame Active Rising Edge to Exposure Active Rising Edge	0.00 us	0.00 us	0.00us	
(k)	Frame Start Trigger to Exposure Active Rising Edge	2.15 us ~ 2.17 us (450 ns~ 480 ns)	2.16 ~ 2.17 us (450 ~ 480 ns)	2.33 ~ 2.38 us (700 ~ 750 ns)	Exposure Active at TTL I/F output ( ) is the exposure phase relation inside camera
(l)	Frame Trigger Wait Rising Edge Variableness	31.06 ms	61.83 ms	123.67 ms	Varies by Exposure Time setting
-	Exposure Active Start Edge : Internal / TTL Out Phase	1.70 us	1.71 us	1.62 us	
-	Exposure Active End Edge: Internal /TTL Out Phase	250 ns	250 ns	230 ns	

Notes:

- In order to explain the phase relation of Frame Trigger Wait and Frame Active, the timing in this table reflects the condition that the trigger input is not overlapped in the previous video readout.
- Figures in ( ) are the comparison between the exposure time inside camera and Exposure 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

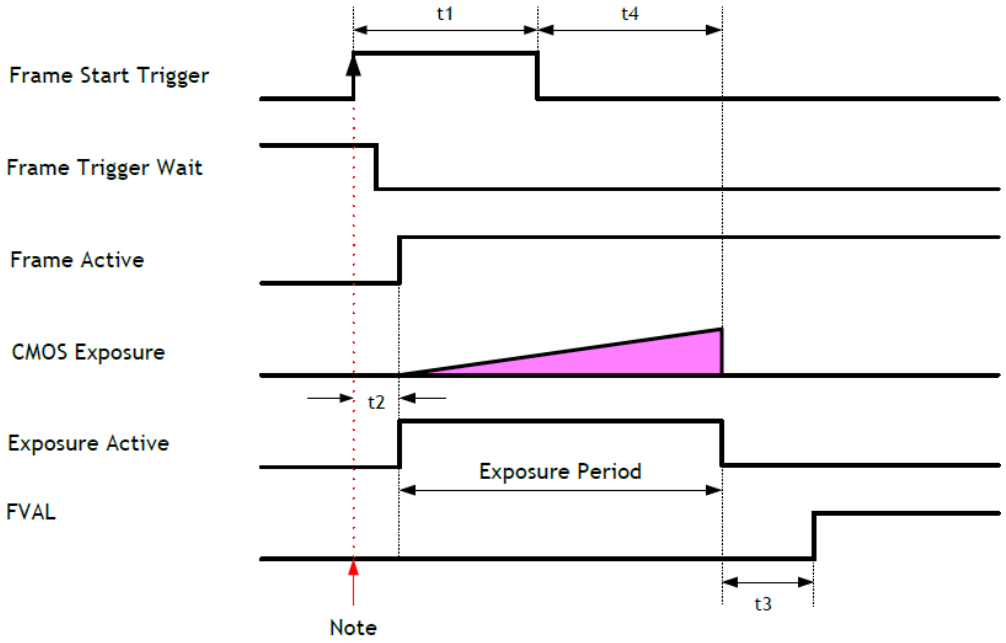
- Trigger Mode = ON
- Exposure Mode = Trigger Width

Typical Minimum Trigger Interval (Pixel Format: 8-bit)

Readout Mode	CXP6_X2	CXP6_X1, CXP3_X2	CXP3_X1
Full	≧ 31.761ms	≧ 63.200ms	≧ 126.389ms
ROI Center 2/3	≧ 21.287ms	≧ 42.252ms	≧ 84.492ms
ROI Center 1/2	≧ 16.050ms	≧ 31.777ms	≧ 63.544ms
ROI Center 1/4	≧ 8.195ms	≧ 16.066ms	≧ 32.121ms
ROI Center 1/8	≧ 4.267ms	≧ 8.211ms	≧ 16.410ms
V Binning ON* (Full)	≧ 31.770ms	≧ 63.216ms	≧ 126.423ms
*Monochrome model only			

Note: The above table is if Trigger Overlap is Readout.

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.

	Vertical Binning	Exposure Active Signal Source	CXP6_X2	CXP6_X1, CXP3_X2	CXP3_X1
t1			10μs (min)	10μs (min)	10μs (min)
t2	-	TTL Out	2.050 us ~ 2.080 us	2.070 us ~ 2.090 us	2.120 us ~ 2.320 us
		Inside Camera	380 ns ~ 410 ns	380 ns ~ 400 ns	550 ns ~ 600 ns
t3	1 (Off)	TTL Out	304.990 us	304.990 us	610.170 us
		Inside Camera	305.240 us	305.240 us	610.400 us
	2 (On)	TTL Out	304.990 us	304.990 us	610.170 us
		Inside Camera	305.240 us	305.240 us	610.400 us
t4	-	TTL Out	2.860 us ~ 2.880 us	2.840 us ~ 2.870 us	3.060 us ~ 3.010 us
		Inside Camera	2.600 us ~ 2.630 us	2.560 us ~ 2.620 us	2.840 us ~ 2.790 us

	Vertical Binning	Exposure Active Signal Source	CXP6_X2	CXP6_X1, CXP3_X2	CXP3_X1
Actual Exposure time difference	-	TTL Out	0.780 us ~ 0.830 us	0.750 us ~ 0.800 us	0.740 us ~ 0.800 us
		Inside Camera	2.190 us ~ 2.250 us	2.160 us ~ 2.240 us	2.240 us ~ 2.260 us

Notes:

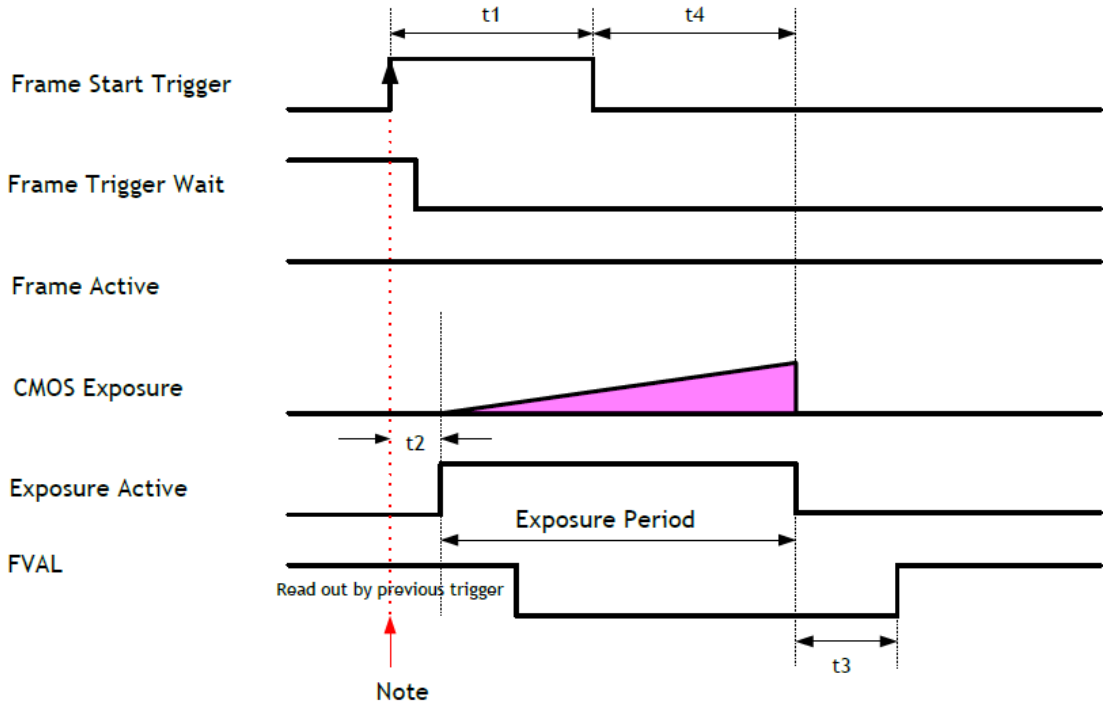
- The jitter from the trigger occurs at both the exposure start edge and exposure end edge.
- The actual exposure time difference is an additional period of exposure time against TTL trigger input. (t4) - (t2) ≒ The real exposure time difference

Shortest Trigger Cycle Formulas

Link Configuration	Binning Vertical	Shortest Trigger Cycle Formulas [Unit: us]
CXP6_X2	1 (Off)	ROUNDDOWN(((([Height]+1) x 320.5) + 12205) ÷ 40MHz x 10^6) + [Trigger Pulse Width: 10us~])
	2 (On)	ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) + [Trigger Pulse Width: 10us~])
CXP6_X1 CXP3_X2	1 (Off)	ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) + [Trigger Pulse Width: 10us~])
	2 (On)	ROUNDDOWN(((([Height]+1) x 1282) + 12205) ÷ 40MHz x 10^6) + [Trigger Pulse Width: 10us~])
CXP3_X1	1 (Off)	ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 20MHz x 10^6) + [Trigger Pulse Width: 10us~])
	2 (On)	ROUNDDOWN(((([Height]+1) x 1282) +12205) ÷ 20MHz x 10^6) + [Trigger Pulse Width: 10us~])

Note: If Trigger Overlap = "Non Overlap" and the trigger input is below the above trigger period, the trigger mask is applied and the trigger input may be ignored.

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.

	Vertical Binning	Exposure Active Signal source	CXP6_X2	CXP6_X1 CXP3_X2	CXP3_X1
t1			10μs (min)	10μs (min)	10μs (min)
t2	-	TTL Out	2.090 us ~ 2.090 us + 1Line	1.690 us ~ 1.690 us + 1Line	2.230 us ~ 2.230 us + 1Line
		Inside Camera	380 ns ~ 380 ns + 1Line	390 ns ~ 390 ns + 1Line	550 ns ~ 550 ns + 1Line
	1	TTL Out	304.990 us	304.990 us	610.200 us
t3	(Off)	Inside Camera	305.240 us	305.240 us	610.420 us
	2 (On)	TTL Out	304.990 us	304.990 us	610.200 us
		Inside Camera	305.240 us	305.240 us	610.420 us
t4	-	TTL Out	2.900 us ~ 2.920 us	2.880 us ~ 2.910 us	3.050 us ~ 3.100 us
		Inside Camera	2.650 us ~ 2.670 us	2.630 us ~ 2.660 us	2.820 us ~ 2.870 us

	Vertical Binning	Exposure Active Signal source	CXP6_X2	CXP6_X1 CXP3_X2	CXP3_X1
(b)-(a): Exposure Difference	-	TTL Out	-7.180 us ~ 0.840 us	-15.210 us ~ 1.220 us	-31.240 us ~ 0.870 us
		Inside Camera	-5.730 us ~ 2.290 us	-13.770 us ~ 2.270 us	-29.780 us ~ 2.320 us

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 = Readout)

Link Configuration	Binning Vertical	Conditions: PWC Trigger / Trigger Overlap = Readout [Unit: us]
CXP6_X2	1 (Off)	ROUNDDOWN(((([Height]+1) x 320.5) + 12205) ÷ 40MHz x 10^6) +10 - 260 ≧ [Trigger Pulse Width] Result = ROUNDDOWN(((([Height]+1) x 320.5) + 12205) ÷ 40MHz x 10^6)+ [Trigger Pulse Width: 10us~])
		ROUNDDOWN(((([Height]+1) x 320.5) + 12205) ÷ 40MHz x 10^6) +10 - 260 < [Trigger Pulse Width] Result = 260us + [Trigger Pulse Width]
	2 (On)	ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) +10 - 260 ≧ [Trigger Pulse Width] Result = ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6)+ [Trigger Pulse Width: 10us~])
		ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) +10 - 260 < [Trigger Pulse Width] Result = 260us + [Trigger Pulse Width]

Link Configuration	Binning Vertical	Conditions: PWC Trigger / Trigger Overlap = Readout [Unit: us]
CXP6_X1, CXP3_X2	1 (Off)	ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) +10 - 260 ≧ [Trigger Pulse Width] Result = ROUNDDOWN((((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6)+ [Trigger Pulse Width: 10us~])
		ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 40MHz x 10^6) +10 - 260 < [Trigger Pulse Width] Result = 260us + [Trigger Pulse Width]
	1 (Off)	ROUNDDOWN(((([Height]+1) x 1282) + 12205) ÷ 40MHz x 10^6) +10 - 260 ≧ [Trigger Pulse Width] Result = ROUNDDOWN(((([Height]+1) x 320.5) + 12205) ÷ 40MHz x 10^6)+ [Trigger Pulse Width: 10us~])
		ROUNDDOWN(((([Height]+1) x 1282) + 12205) ÷ 40MHz x 10^6)+10 - 260 < [Trigger Pulse Width] Result = 260us + [Trigger Pulse Width]
CXP3_X1	1 (Off)	ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 20MHz x 10^6) +10 - 520 ≧ [Trigger Pulse Width] Result = ROUNDDOWN((((([Height]+1) x 641) + 12205) ÷ 20MHz x 10^6) + [Trigger Pulse Width: 10us~])
		ROUNDDOWN(((([Height]+1) x 641) + 12205) ÷ 20MHz x 10^6) +10 - 520 < [Trigger Pulse Width] Result = 520us + [Trigger Pulse Width]
	1 (Off)	ROUNDDOWN(((([Height]+1) x 1282) + 12205) ÷ 20MHz x 10^6) +10 - 520 ≧ [Trigger Pulse Width] Result = ROUNDDOWN((((([Height]+1) x 1282) + 12205) ÷ 20MHz x 10^6)+ [Trigger Pulse Width: 10us~])
		ROUNDDOWN(((([Height]+1) x 1282) + 12205) ÷ 20MHz x 10^6) +10 - 520 < [Trigger Pulse Width] Result = 520us + [Trigger Pulse Width]

Note: For [Trigger Overlap]=Readout setting, if the trigger interval is set longer than the interval described in this table or the same as the trigger width, the exposure operation might not work properly and as a result, the normal image might not be output.

PIV (Particle Image Velocimetry)

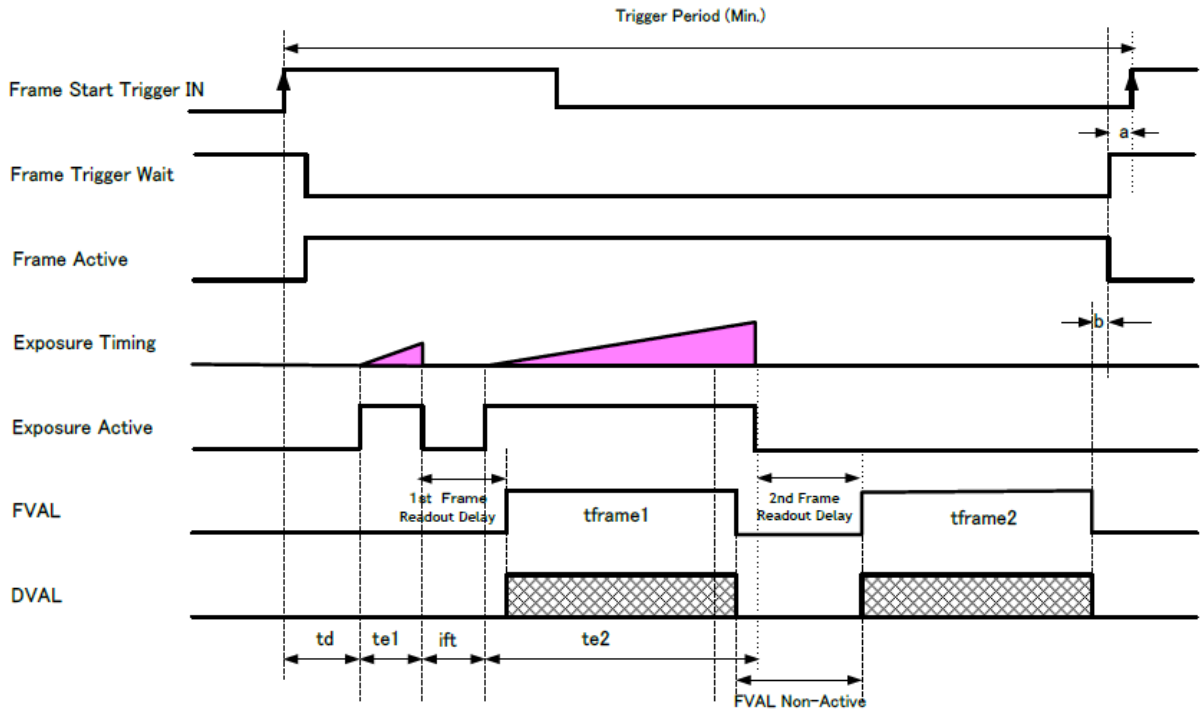
The Particle Image Velocimetry mode can be used in applications where 2 images need to be taken with a very short time interval. It can only be used with strobe flash as illumination. The first accumulation time is 10 us to 2 sec. Then, the second exposure will be taken. The first strobe is activated 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
- Trigger Overlap = OFF. Trigger Overlap mode=Readout is not available.

Typical Minimum Trigger Intervals (Pixel Format: 8-bit)

Readout Mode	Time (Min. Trigger Period)		
	CXP6_X2	CXP6_X1, CXP3_X2	CXP3_X1
Full	≧ 63.625ms	≧ 126.489ms	≧ 252.834ms
ROI Center 2/3	≧ 42.677ms	≧ 84.592ms	≧ 169.041ms
ROI Center 1/2	≧ 32.203ms	≧ 63.644ms	≧ 127.144ms
ROI Center 1/4	≧ 16.492ms	≧ 32.221ms	≧ 64.299ms
ROI Center 1/8	≧ 8.636ms	≧ 16.510ms	≧ 32.877ms
V Binning* ON (Full)	≧ 63.635ms	≧ 126.504ms	≧ 252.868ms
*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 (CXP-6_X2)

	Description	Exposure Active Signal Source	Time (CXP6_X2)
td	Exposure Beginning delay	TTL Out	2.11 us
		Internal	400 ns~ 430 ns
te1	First exposure time period	-	10us ~ ≒ 1 Frame ([Height]=3840: 33083us Max) = [Exposure Time Settings]
		TTL Out	8.62 us ~ 33.08 ms
		Internal	10.05 us ~ 33.08 ms
itf	Inter framing time	TTL Out	307.01 us
		Internal	305.58 us

	Description	Exposure Active Signal Source	Time (CXP6_X2)
te2	Second exposure time	TTL Out	≒ 1 frame (1) V-Binning Off = ((([Height]×320.5) - 0.5) ÷ 40MHz) - 2.05 us + 128.77 us
		Internal	= ((([Height]×320.5) - 0.5) ÷ 40MHz) - 0.35 us + 128.78 us
		TTL Out	(2) V-Binning On = ((([Height]×641) - 1) ÷ 40MHz) - 2.05 us + 128.77 us
		Internal	= ((([Height]×641) - 1) ÷ 40MHz) - 0.350 us + 128.78 us
tframe1	First Frame read out	-	(1) V-Binning Off [FVAL Active] = ((([Height]×320.5) - 0.5) ÷ 40MHz
		-	(2) V-Binning On [FVAL Active] = ((([Height]×641) - 1) ÷ 40MHz
tframe2	Second Frame read out	Internal	[FVAL Active] (the same as tframe1)
	1st Frame Readout Delay	TTL Out	V-Binning Off / V-Binning On = 304.97 us
		Internal	V-Binning Off / V-Binning On = 305.22 us
	2nd Frame Readout Delay	TTL Out	V-Binning Off / V-Binning On = 304.97 us
		Internal	V-Binning Off / V-Binning On = 305.224 us
	FVAL Non-Active	-	V-Binning Off / V-Binning On = 434.00 us (1) V-Binning Off = 54.2 Line (2) V-Binning On = 27.1 Line
	Trigger Period (Min.)	-	(1) V-Binning Off = (((([Height]+0.5)×320.5)-0.5) x 2Frame ÷ 40MHz) + [Exposure Time] + 305.22 us + 434.00 us
		-	(2) V-Binning On = (((([Height]+0.5)×641)-0.5) x 2Frame ÷ 40MHz) + [Exposure Time] + 305.22 us + 434.00 us
	2nd FVAL Active End ~ Frame Active End	-	0 Line

PIV trigger mode specifications (CXP-6_X1, CXP3_X2)

	Description	Exposure Active Signal Source	Time (CXP6_X1, CXP3_X2)
td	Exposure Beginning delay	TTL Out	2.11 us
		Internal	400 ns~ 430 ns
te1	First exposure time period	-	10us ~ ≒ 1 Frame ([Height]=3840 : 66417us Max) = [Exposure Time Settings]
		TTL Out	8.62 us ~ 66.42 ms
		Internal	10.05 us ~ 66.42 ms
itf	Inter framing time	TTL Out	307.01 us
		Internal	305.58 us
te2	Second exposure time	TTL Out	≒ 1 frame (1) V-Binning Off = ((([Height]×641) - 1) ÷ 40MHz) - 2.05 us + 128.77 us
		Internal	= ((([Height]×641) - 1) ÷ 40MHz) - 0.35 us + 128.78 us
		TTL Out	(2) V-Binning On = ((([Height]×1282) - 2) ÷ 40MHz) - 2.05 us + 128.77 us
		Internal	= ((([Height]×1282) - 2) ÷ 40MHz) - 0.35 us + 128.78 us
tframe1	First Frame read out	-	(1) V-Binning Off [FVAL Active] = ((([Height]×641) - 1) ÷ 40MHz
		-	(2) V-Binning On [FVAL Active] = ((([Height]×1281) - 2) ÷ 40MHz
tframe2	Second Frame read out	Internal	[FVAL Active] (the same as tframe1)
	1st Frame Readout Delay	TTL Out	V-Binning Off / V-Binning On = 304.97 us
		Internal	V-Binning Off / V-Binning On = 305.22 us
	2nd Frame Readout Delay	TTL Out	V-Binning Off / V-Binning On = 304.97 us
		Internal	V-Binning Off / V-Binning On = 305.22 us
	FVAL Non-Active	-	V-Binning Off / V-Binning On = 434.00 us (1) V-Binning Off = 27.1 Line (2) V-Binning On = 13.5 Line

	Description	Exposure Active Signal Source	Time (CXP6_X1, CXP3_X2)
	Trigger Period (Min.)	-	(1) V-Binning Off = (((([Height]+0.5)×641)-0.5) x 2Frame ÷ 40MHz) +[Exposure Time] + 305.22 us + 434.00 us
		-	(2) V-Binning On = (((([Height]+0.5)×1282)-0.5) x 2Frame ÷ 40MHz) +[Exposure Time] + 305.22 us + 434.00 us
	2nd FVAL Active End ~ Frame Active End	-	0 Line

PIV trigger mode specifications (CXP3_X1)

	Description	Exposure Active Signal Source	Time (CXP3_X1)
td	Exposure Beginning delay	TTL Out	2.29 us
		Internal	600 ns~ 650 ns
te1	First exposure time period	-	10us ~ ≒ 1 Frame ([Height]=3840: 132833us Max) = [Exposure Time Settings]
		TTL Out	8.67 us ~ 123.68 ms
		Internal	10.10 us ~ 123.68 ms
itf	Inter framing time	TTL Out	612.53 us
		Internal	611.10 us
te2	Second exposure time	TTL Out	≒ 1 frame (1) V-Binning Off = ((([Height]×641) - 1) ÷ 20MHz) - 2.35 us + 128.80 us
		Internal	= ((([Height]×641) - 1) ÷ 20MHz) - 680 ns + 128.57 us
		TTL Out	(2) V-Binning On = ((([Height]×1282) - 2) ÷ 20MHz) - 2.35 us + 128.80 us
		Internal	= ((([Height]×1282) - 2) ÷ 20MHz) - 680 ns + 128.57 us
tframe1	First Frame read out	-	(1) V-Binning Off [FVAL Active] = ((([Height]×641) - 1) ÷ 20MHz
		-	(2) V-Binning On [FVAL Active] = ((([Height]×1282) - 2) ÷ 20MHz
tframe2	Second Frame read out	Internal	[FVAL Active] (the same as tframe1)
	1st Frame Readout Delay	TTL Out	V-Binning Off / V-Binning On = 610.19 us
		Internal	V-Binning Off / V-Binning On = 610.43 us

	Description	Exposure Active Signal Source	Time (CXP3_X1)
	2nd Frame Readout Delay	TTL Out	V-Binning Off / V-Binning On = 610.19 us
		Internal	V-Binning Off / V-Binning On = 610.43 us
	FVAL Non-Active	-	V-Binning Off / V-Binning On = 739.00 us (1) V-Binning Off = 23.1 Line (2) V-Binning On = 11.5 Line
	Trigger Period (Min.)	-	(1) V-Binning Off = (((([Height]+0.5)×641) -1) x 2Frame ÷ 20MHz) +[Exposure Time] + 610.43 us + 739.00 us
		-	(2) V-Binning On = (((([Height]+0.5)×1282) -2) x 2Frame ÷ 20MHz) +[Exposure Time] + 610.43 us + 739.00 us
	2nd FVAL Active End ~ Frame Active End	-	0 Line

Sequence ROI Trigger

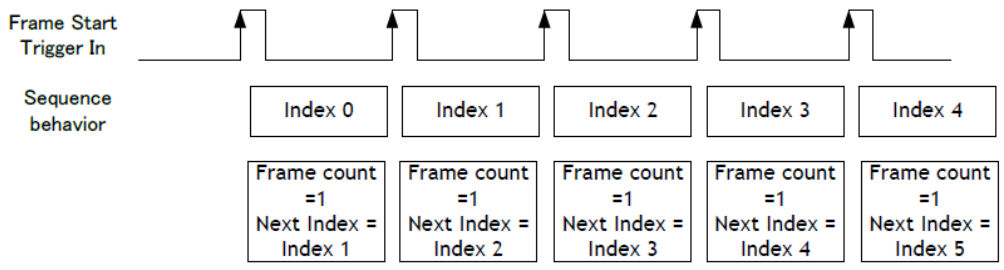
This is a function to capture images in sequence based preset ROI, Exposure Time, Gain and other parameters in the sequence index table.

Basic Settings

- Acquisition mode : Continuous
- Trigger selector : Frame Start
- Trigger mode : ON
- Exposure mode : Timed
- Video send mode selector : Trigger Sequence or Command Sequence

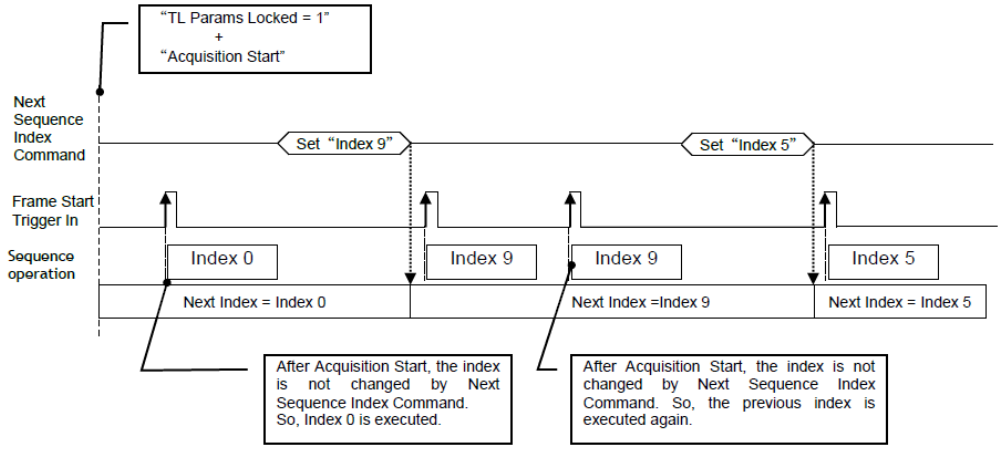
Trigger Sequence

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



Command Sequence

In this mode, after the acquisition starts, the index table is executed by the external trigger which sets the index according to the Next Sequence Index Command. In this case, Sequence ROI Frame Count and Sequence ROI Next Index commands in the index table are ignored.



Typical minimum trigger interval of Sequence ROI Trigger

Readout Mode	Time (Min. Trigger Period)		
	CXP6_X2	CXP6_X1, CXP3_X2	CXP3_X1
Full	≧ 31.761 ms	≧ 63.200 ms	≧ 126.389 ms
ROI Center 2/3	≧ 21.287 ms	≧ 42.252 ms	≧ 84.492 ms
ROI Center 1/2	≧ 16.050 ms	≧ 31.777 ms	≧ 63.544 ms
ROI Center 1/4	≧ 8.195 ms	≧ 16.066 ms	≧ 32.121 ms
ROI Center 1/8	≧ 4.267 ms	≧ 8.211 ms	≧ 16.410 ms
V Binning ON (Full)*	≧ 31.770 ms	≧ 63.216 ms	≧ 126.423 ms
*Monochrome only			

Notes:

- Overlap mode=Readout is not available. Please set the exposure time not to be Readout mode.
- The minimum interval calculation assumes that the exposure time for all sequences is 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 in order to operate faster.
- The above interval is if the exposure time is set to 10 µs.

Default Sequence Index Table

Sequence ROI Index	Width	Height	Offset X	Offset Y	Gain Selector			Exposure Time	Black Level	Binning		LUT Enable	Frame Count	Next Indes
					Gain (ALL)	Red	Blue			H	V			
Index 0 ~ 9	5120	3840	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0

Sequence ROI Setting Parameters

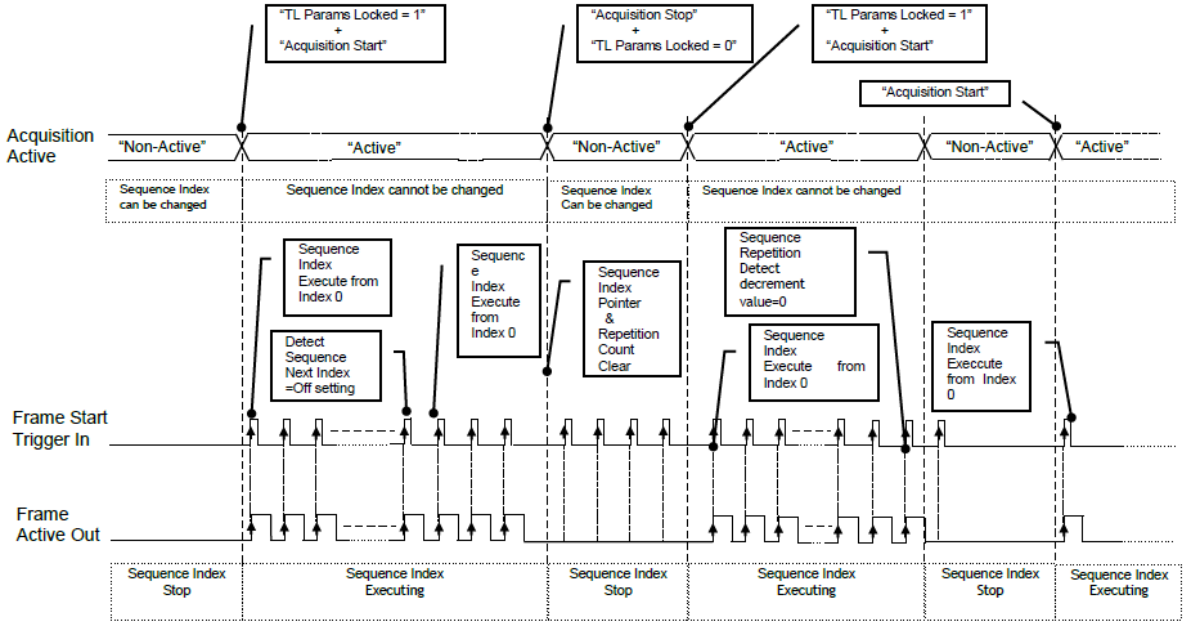
Setting parameters for Sequence ROI are as follows.

Setting Item	Setting Range	Description
Video Send Mode Selector	-	Options: Normal Mode, Trigger Sequence, Command Sequence, Multi Mode
Sequence ROI Index Selector	0 ~ 9	In Sequence ROI Index Selector, Index 0 to 9 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 ~ 255	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	0 ~ 9 Off	Only when Trigger Sequence is configured, it is possible to set the next index to the currently executing index. In this case, after the acquisition starts and the external trigger is input, the index table always starts from index 0. Accordingly, after the repeated cycle of index 0 set by Frame Count is completed, the next index can be set as required. However, if Sequence ROI Next Index is set to OFF, it refers to the setting of Sequence Repetition. **Note:** See "Sequence ROI trigger timing chart" below.
Sequence ROI Width	8 ~ 5120	Rules for setting area and step number are the same as the normal ROI mode set by Video Send Mode = "Normal".
Sequence ROI Height	2 ~ 3840	Rules for setting area and step number are the same as the normal ROI mode set by Video Send Mode = "Normal".

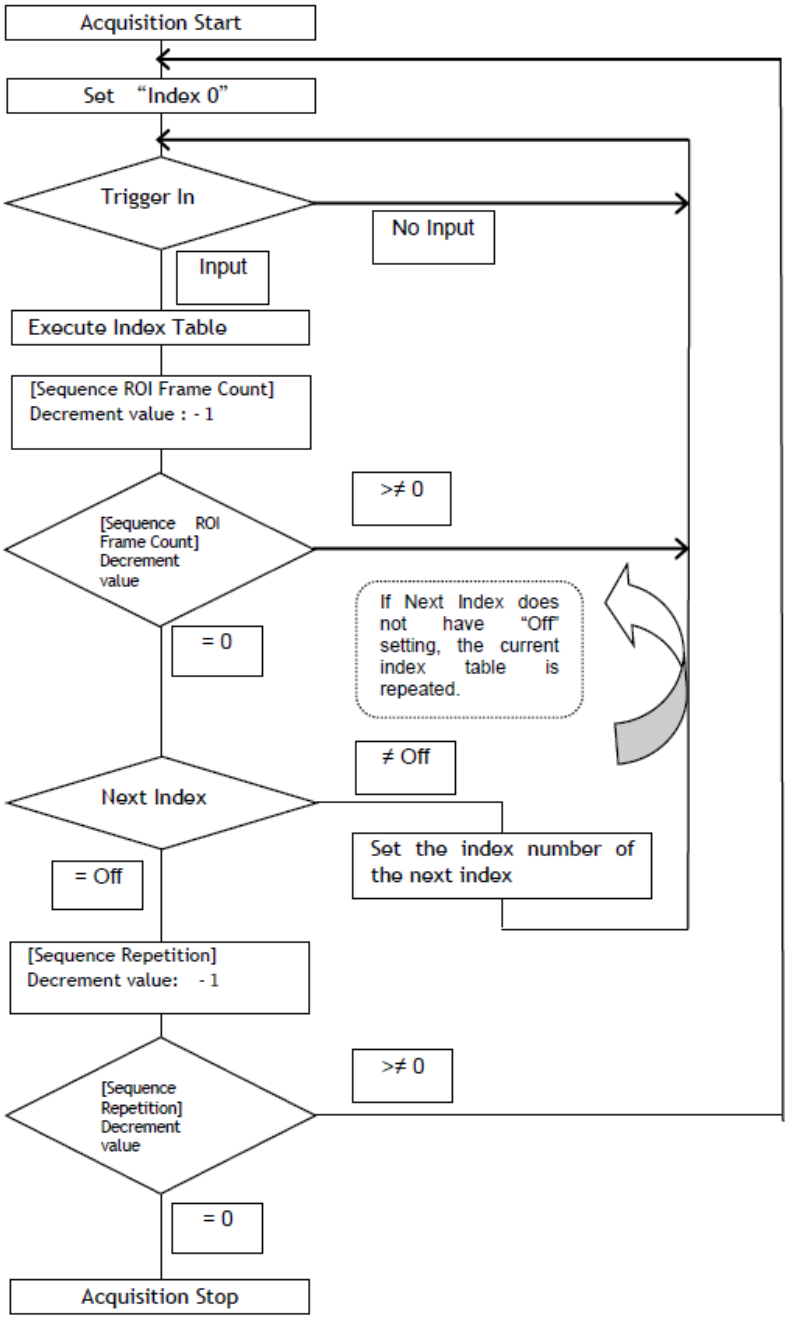
Setting Item	Setting Range	Description
Sequence ROI Offset X	-	Set Offset X of sequence ROI. Sequence ROI Binning Horizontal =1 (Off): Setting range is 0 to (5120 - [Sequence ROI Width]) Sequence ROI Binning Horizontal =2 (On): Setting range is 0 to (2560 - [Sequence ROI Width]) The limitations of step number and other factors are the same as the normal ROI mode set by Video Send Mode = "Normal".
Sequence ROI Offset Y	-	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".
Sequence ROI Gain Selector	-	In Sequence ROI Gain Selector, the gain settings for each index are available. SP-20000C-CXP2: Gain (ALL), Red, and Blue can be set. SP-20000M-CXP2: Only Gain is displayed and can be set.
Sequence ROI Exposure Time	10 ~ Acquisition Frame rate Raw	Exposure Time setting is available for each index.
Sequence ROI Black Level	-256 to 255	Black Level setting is available for each index.
Sequence ROI LUT Enable	0 (Off) or 1 (On)	Enable or disable of LUT function for each index 0 to 9 can be set.
Sequence ROI Binning Horizontal	1 (Off) or 2 (On)	ON or OFF of Horizontal Binning for each index can be set.
Sequence ROI Binning Vertical	1 (Off) or 2 (On)	ON or OFF of Vertical Binning for each index can be set. (11)

Setting Item	Setting Range	Description
Sequence Repetition	1 to 255	If Trigger Sequence is selected, and if there is an entry in the Index Table whose Sequence ROI Next Index is set to OFF, the value of Sequence Repetition is valid. Then, it becomes possible to repeat the Index Table as set in Sequence Repetition. After the acquisition starts, the index table is executed from Index 0 by the external trigger. And when the index table whose Sequence ROI Next Index is set to OFF is finished, the value of Sequence Repetition is decremented internally. In this case, if the result of decrement is not “0”, the index table starts from Index 0 again. If the result of decrement is 0, the status changes to Acquisition Stop and cannot accept the external trigger. The following chart shows the flow chart. **Note:** See "Flow chart of Trigger Sequence" below.
Next Sequence Index	0 ~ 9	If Command Sequence is selected, Next Sequence Index can be used. When the index is changed in the Next Sequence Index selector, a Next Sequence Index command is sent to the camera manually. The index table which is indicated by the Next Sequence Index command is executed by the next trigger input. However, when Command Sequence is used, Sequence ROI Frame Count and Sequence ROI Next Index are disabled and ignored. In the case of Command Sequence, as Next Sequence Index command is not sent after the acquisition starts, Index 0 is executed if the external trigger is input. The index table indicated by the Next Sequence Index command executed by the external trigger. But, if the following Next Sequence Index command is not sent, and then the external trigger is input, the same index table is executed again.

Sequence ROI trigger timing chart



Flow chart of Trigger Sequence



Operation and Function Matrix

Exposure Mode	Trigger Mode	Trigger Option	V-Binning [1]	H-Binning [1]	Exposure Control	ROI	Auto White Balance[2]	Auto Gain	Auto Exposure	Trigger Overlap	Video Send Mode	
											Multi ROI	Sequence ROI
OFF[3]	OFF	OFF	1	1		●	●	●			●	
			2	2		●	●	●			●	
Timed[3]	OFF	OFF	1	1	●	●	●	●	●		●	
			2	2	●	●	●	●	●		●	
Timed[4]	ON	OFF	1	1	●	●	●	●	●	●	●	●
			2	2	●	●	●	●	●	●	●	●
Trigger Width[4]	ON	OFF	1	1		●				●	●	
			2	2		●				●	●	
Timed[4]	ON	PIV	1	1	●	●					●	
			2	2	●	●					●	

Notes:

1. Monochrome model only
2. Color model only
3. Continuous trigger operation
4. External trigger operation

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	-128 ~ +127
	Black Level Blue	-128 ~ +127

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

This camera can adjust the master gain level (DigitalGainAll) from x1 (0dB) to 16 times (+24dB) using x1 (0dB) as the reference (Factory default).

On the color model, the master gain level (DigitalGainAll) 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 3.16 times (+ 10dB) using the master gain as the reference.

Resolution:

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

On this camera, the digital gain is entirely used for adjusting the gain. Therefore, if a high gain setting is used, breaks in the histogram may occur.

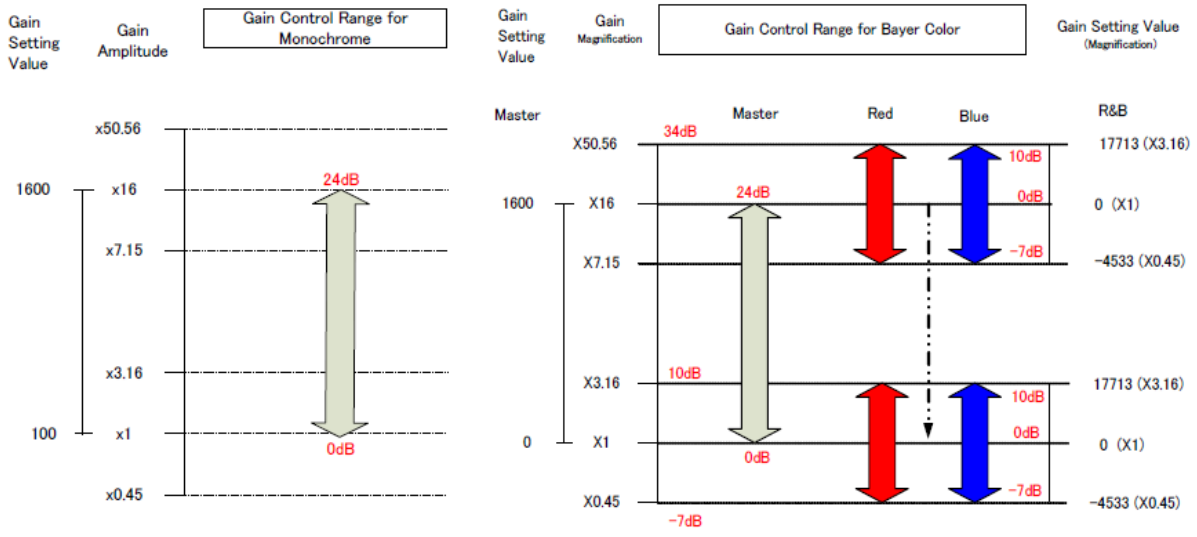
On the color model, the color temperature adjusting range is specified in order to maintain the maximum dynamic range of the sensor. Therefore, if the white balance is adjusted out of the specified color temperature adjusting range and if the gain setting is less than the following conditions, the sensor output may clip before it is saturated.

The guideline for settings at which the sensor output is clipped

At Master Gain 0 dB: R/B Gain = -2995 (approx. x 0.6)

The guideline for R and B gain

Color Temprature	R Gain	B Gain
3000K	-2110 (approx. x 0.74)	16828(approx. x 3)
9000K	18057 (approx. x 3.2)	-2993 (approx. x 0.6)



Gain Settings

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.

	Setting Range	Description
GainAuto	Off (Default)	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.

Item	Setting Range	Default	Description
ALCControlSpeed	1 ~ 8	8	The rate of adjustment of GainAuto can be set (Common with Exposure Auto)
AutoGainControlGainRawMax	100 ~ 1600	1600	The maximum value of GainAuto control range can be set
AutoGainControlGainRawMin	100 ~ 1599	100	The minimum value of GainAuto control range can be set
ALCReference	1 ~ 100	70	The reference level of Gain Auto control can be set (Common with Exposure Auto)
ALC Area Selector	16 areas (see below)	-	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.

	Setting Range	Description
BalanceWhiteAuto	Off (Default)	Adjust manually.
	Once	Performs auto white balancing once when this function is called.
	Continuous	Continuously adjusts white balance.
AWBAreaSelector	16 areas (see below)	Set the area to control the auto white balance.

Detection Area

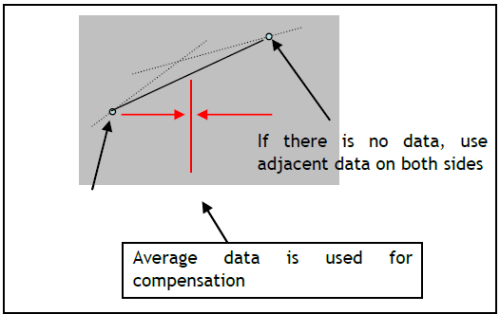
HighLeft	High MidLeft	High MidRight	HighRight
MidHigh Left	MidHigh MidLeft	MidHigh MidRight	MidHigh Right
MidLow Left	MidLow MidLeft	MidLow MidRight	MidLow Right
LowLeft	Low MidLeft	Low MidRight	LowRight

LUT (Lookup Table)

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.

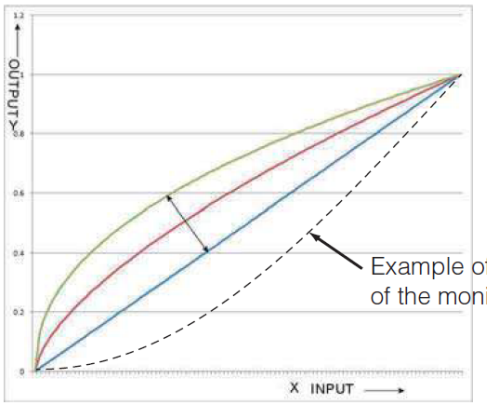
To Use the LUT function

Configure the settings as follows.

Item	Setting Value / Selectable Range	Description
JAI LUT Mode	Off, Gamma, LUT	Can be selected from OFF, Gamma or LUT Table.
LUT Selector	Mono model: Mono Color model: Red, Green, Blue	Select the LUT channel to control.
LUT Index	0 ~ 255	This represents the "starting" or "input" pixel value to be modified by the Lookup Table. This camera has a 256-point Lookup Table, meaning the index points is treated like an 8bit image with 0 representing a full black pixel and 255 representing a full white pixel. The index points are automatically scaled to fit the internal pixel format of the camera. This is common for all output configuration.
LUT Value	0 ~ 4095	This is the “adjusted” or “output” pixel value for a given LUT index. It has a range of 0 to 4095 (12-bit) and is automatically scaled to the bit depth of the current operating mode (8-bit or 10-bit). **Note:** Linear interpolation is used if needed to calculate LUT values between index points. In the color mode, the LUT function works the same regardless of the color of the pixel.  • Output Data = Video IN x LUT data

Gamma Function

This command is used to set gamma between gamma 0.45 and gamma 1.0 (OFF). 16 steps are provided. The gamma value is an approximate value.



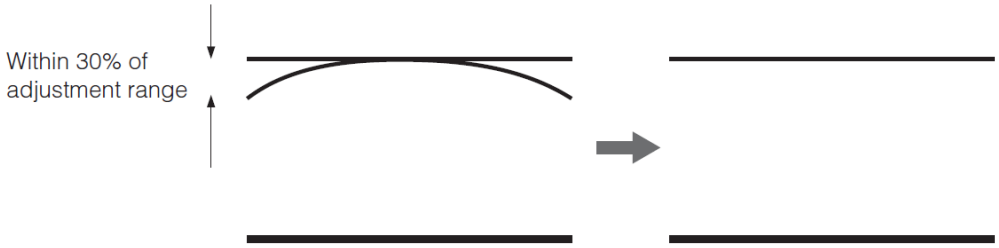
Shading Correction

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

The following shading correction modes are available on the camera

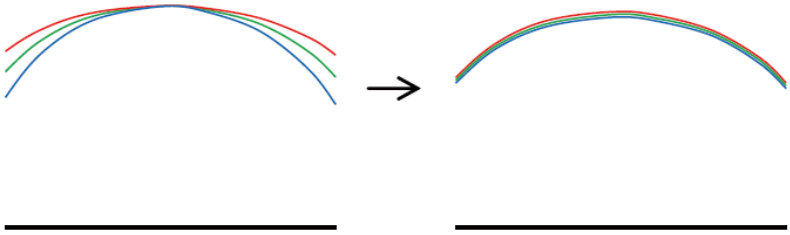
Flat Shading

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 are adjusted to match with G channel characteristics. The block grid 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.



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

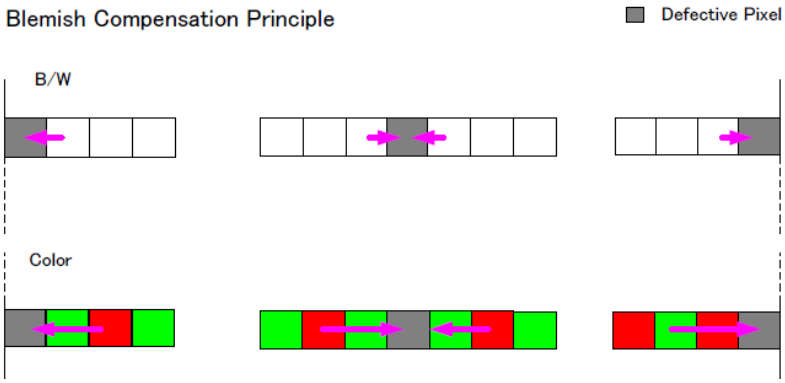
- If there is some area in the image with a video level less than 70%
- If part of the image or the entire image is saturated
- If the highest video level in the image is less than 300LSB (at 10-bit output)

Associated GenICam Register Information

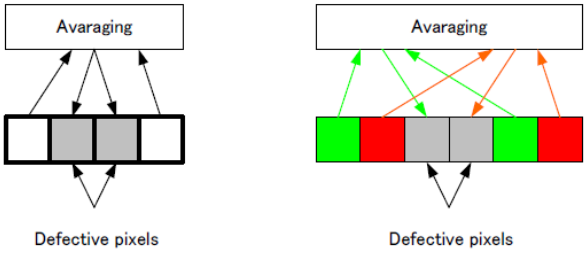
GenICam Name	Access	Values
ShadingCorrectionMode (Color model only)	R/W	Flat Shading, Color Shading
ShadingCalibration	WO	-
Shading Mode	R/W	Off, User1, User2, User3

Blemish Compensation

This camera has a blemish compensation circuit. This function compensates blemishes on the CMOS sensor (typically pixels with extremely high response or extremely low response). 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, 3 pixels in monochrome and 2 same color pixels in color can be compensated.



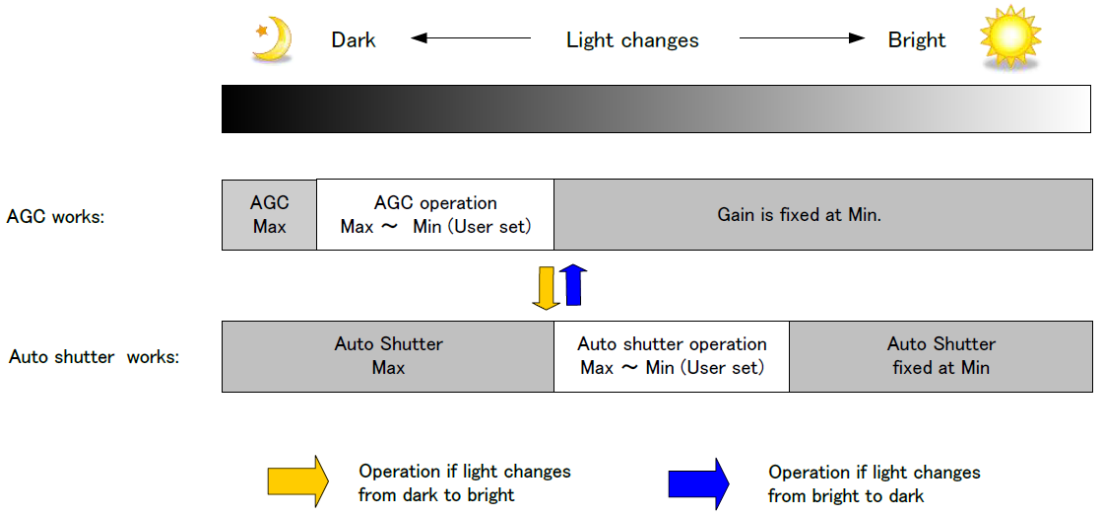
Associated GenICam Register Information

GenICam Name	Access	Values
Blemish Reduction Enable	R/W	False, True
Blemish Reduction Calibration	WO	-
Blemish Detect Threshold	R/W	0 to 100
Blemish Detect Position Index	R/W	0 to 1000
Blemish Detect Position X	R/W	0 to 5119
Blemish Detect Position Y	R/W	0 to 3839

ALC (Automatic Level Control)

On this camera, auto gain (AGC) and auto exposure (ASC) 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.

GenICamName	Access	Values
ExposureAuto	R/W	Off, Once, Continuous
GainAuto	R/W	Off, Once, Continuous
ALCControlSpeed	R/W	1 to 8
ALCReference	R/W	1 to 100
AutoShutterControlExposureMax	R/W	101 to 8000000
AutoShutterControlExposureMin	R/W	100 to 999999
AutoGainControlGainRawMax	R/W	100 to 1600
AutoGainControlGainRawMin	R/W	100 to 1599
AWBAreaEnableAll / ALCAreaEnableAll	R/W	Off, On
AWBAreaSelector / ALCAreaSelector	R/W	Off, On

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

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 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.

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>CoaXPress (JIIA NIF-011-2010 CoaXPress Standard first edition) 6.25 Gbps, 2 Link PoCXP compliance</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>Aspect Ratio: 4:3; 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>40 MHz (CXP6_X2, CXP6_X1, CXP3_X2)
20 MHz (CXP3_X1)</td></tr>
<tr><td>Link Configuration</td><td>CXP6_X2: Dual 6.25 Gbps
CXP6_X1: Single 6.25 Gbps
CXP3_X2: Dual 3.125 Gbps
CXP3_X1: Singal 3.125 Gbps</td></tr>
<tr><td>Tap Geometry</td><td>1X–1Y</td></tr>
<tr><td>Acquisition Frame rate</td><td>
<table>
<tr><th>Link Configuration</th><th>Pixel Format</th><th>Acquisition Frame Rate (Max)</th><th>Acquisition Frame Rate (Min)</th></tr>
<tr><td rowspan="3">CXP6_X2</td><td>Mono 8/10/12</td><td rowspan="2">30 fps</td><td rowspan="10">8 sec</td></tr>
<tr><td>Bayer 8/10/12</td></tr>
<tr><td>RGB 8</td><td>15 fps</td></tr>
<tr><td rowspan="3">CXP6_X1</td><td>Mono 8/10/12</td><td rowspan="2">15 fps</td></tr>
<tr><td>Bayer 8/10/12</td></tr>
<tr><td>RGB 8</td><td>7.5 fps</td></tr>
<tr><td rowspan="3">CXP3_X2</td><td>Mono 8/10/12</td><td rowspan="2">15 fps</td></tr>
<tr><td>Bayer 8/10/12</td></tr>
<tr><td>RGB 8</td><td>7.5 fps</td></tr>
<tr><td rowspan="2">CXP3_X1</td><td>Mono 8/10/12</td><td rowspan="2">7.5 fps</td></tr>
<tr><td>Bayer 8/10/12</td></tr>
</table>
</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>
</table>

<table>
<tr><th>Item</th><th>Description</th></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 (OFF)</td><td>5120 (h)</td><td>3840 (v)</td></tr>
<tr><td>2 (ON)</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, RGB 8-bit*
Note: *Color model only.</td></tr>
<tr><td>Video Send Mode</td><td>Normal, Trigger Sequence, Command Sequence, Multi ROI</td></tr>
<tr><td>Acquisition Mode</td><td>Continuous / Single Frame / Multi Frame</td></tr>
<tr><td>Trigger Selector</td><td>Acquisition Start/ Acquisiition End/ Frame Start</td></tr>
<tr><td>Trigger Option</td><td>OFF(Timed), PIV(Timed PIV)</td></tr>
<tr><td>Trigger Overlap</td><td>OFF, Readout(Frame Strat only)</td></tr>
<tr><td>Trigger Input Signal</td><td>Line4 (TTL 1), Line 5 (Opt In 1), Line7(CXP IN), Pulse Generator 0/1/2/3,Soft Trigger, Line 10 (TTL 2), Line 11 (LVDS), User Output 0/1/2/3</td></tr>
<tr><td rowspan="2">Exposure Mode</td><td>Timed: 299 μs(Min) ~ 8 sec (Max), Step:1μs</td></tr>
<tr><td>Trigger Width: 299 μs (Min) ~ ∞ (Max)</td></tr>
<tr><td>Auto Exposure</td><td>OFF / Once / Continuous</td></tr>
<tr><td>Exposure Auto Speed</td><td>1 ~ 8</td></tr>
<tr><td>Digital I/O</td><td>Line Selector (12P / AUX 10P): GPIO IN / GPIO OUT</td></tr>
</table>

Item	Description
Black Level Adjustment	Reference: 33.5LSB 10bit (Average of 100*100)
	Setting Range: -256 ~ 255LSB 10bit
	Resolution: 1 STEP = 1LSB
	Mode: Auto / Limit / Fix
	Limit: 0% ~ 30 %
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
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
ALC	AGC and Auto Exposure can be combined and automatically controlled
Gamma	0.45 ~ 1.0 (16 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: 660mA ± 10% (12V input, Normal operation at CXP6_X2, 30 fps)
	Consumption: 7.9W ± 10% (12V input, Normal operation at CXP6_X2, 30 fps)
Lens Mount	F mount, Rear protrusion of the lens is less than 40 mm.
	M42 mount, Rear protrusion of the lens is less than 39 mm.
Flange Back	F mount : 46.5 mm, Tolerance 0 to -0.05 mm
	M42 mount : 45.5 mm, Tolerance 0 to -0.05 mm

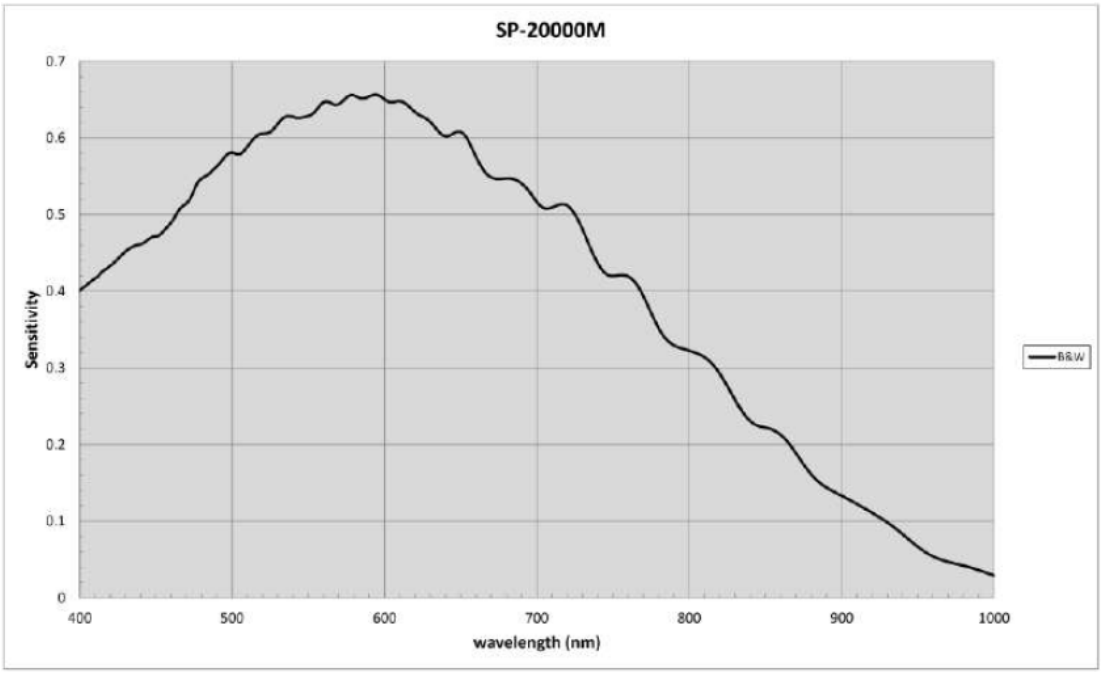
Item	Description
Optical Filter	Mono: Protection glass not provided
	Color: Optical Low Pass filter + IR cut filter (Half value is 670 nm)
Verified Performance Temperature / Humidity	- 5°C ~ + 45°C / 20% ~ 80% (non-condensing)
Operating temperature / Humidity (Performance guaranteed)	-45°C to +70°C / 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)
	M42 Mount: 62mm x 62mm x 83.5mm (Excluding Mount Protrusions)
Weight	F Mount: 350g
	M42 Mount: 345g

Cautions:

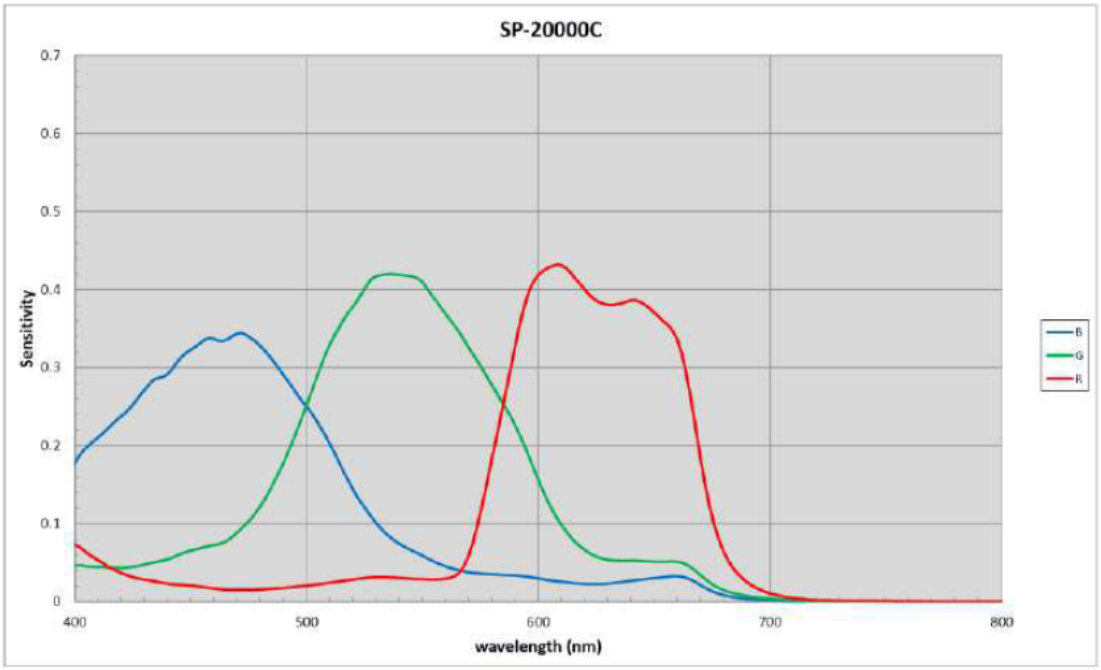
- Approximately 5 minutes pre-heating is required to achieve these specifications.
- The above specifications are subject to change without notice.

Spectral Response

SP-20000M-CXP2

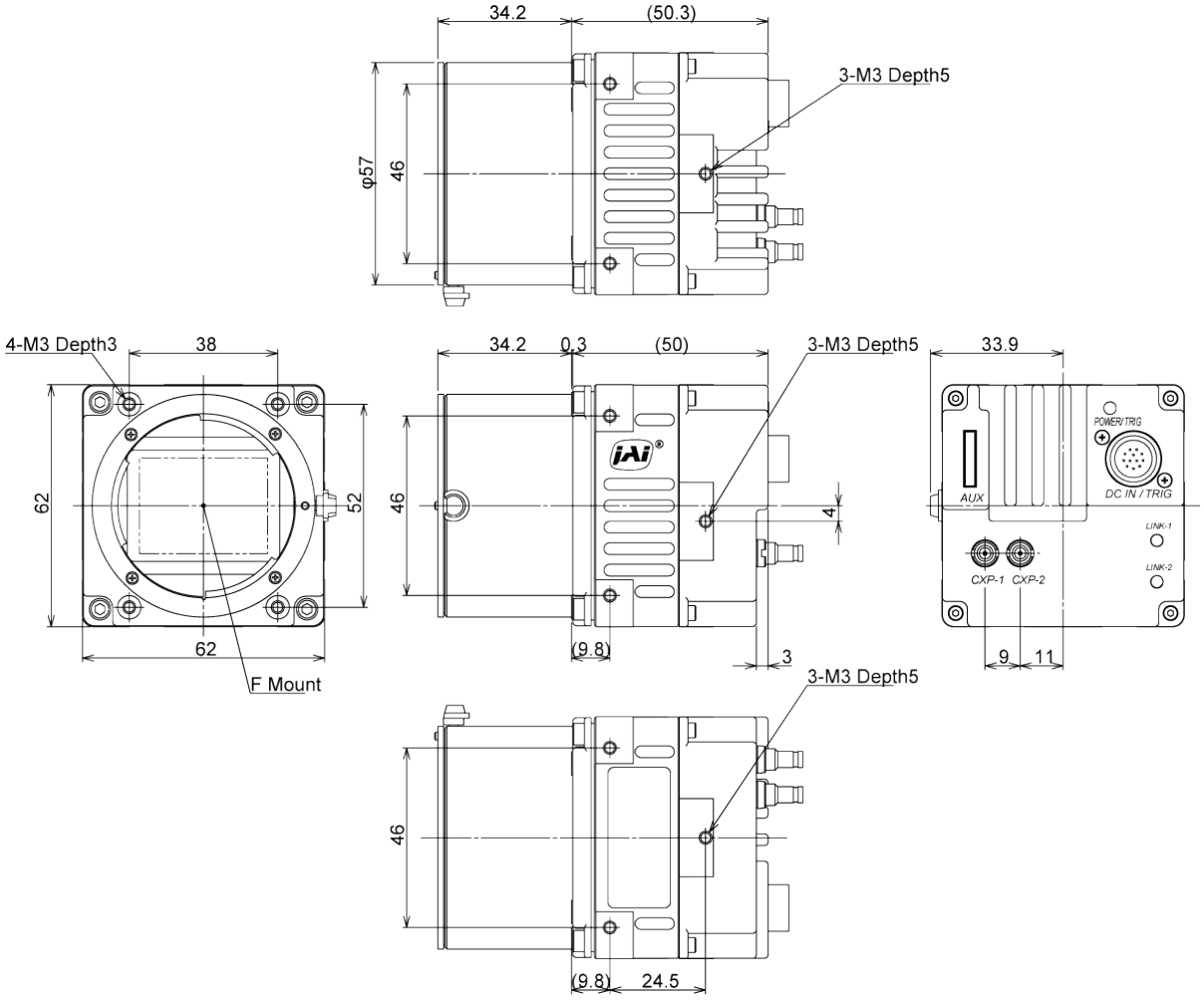


SP-20000C-CXP2 (With IR Cut Filter)



Dimensions

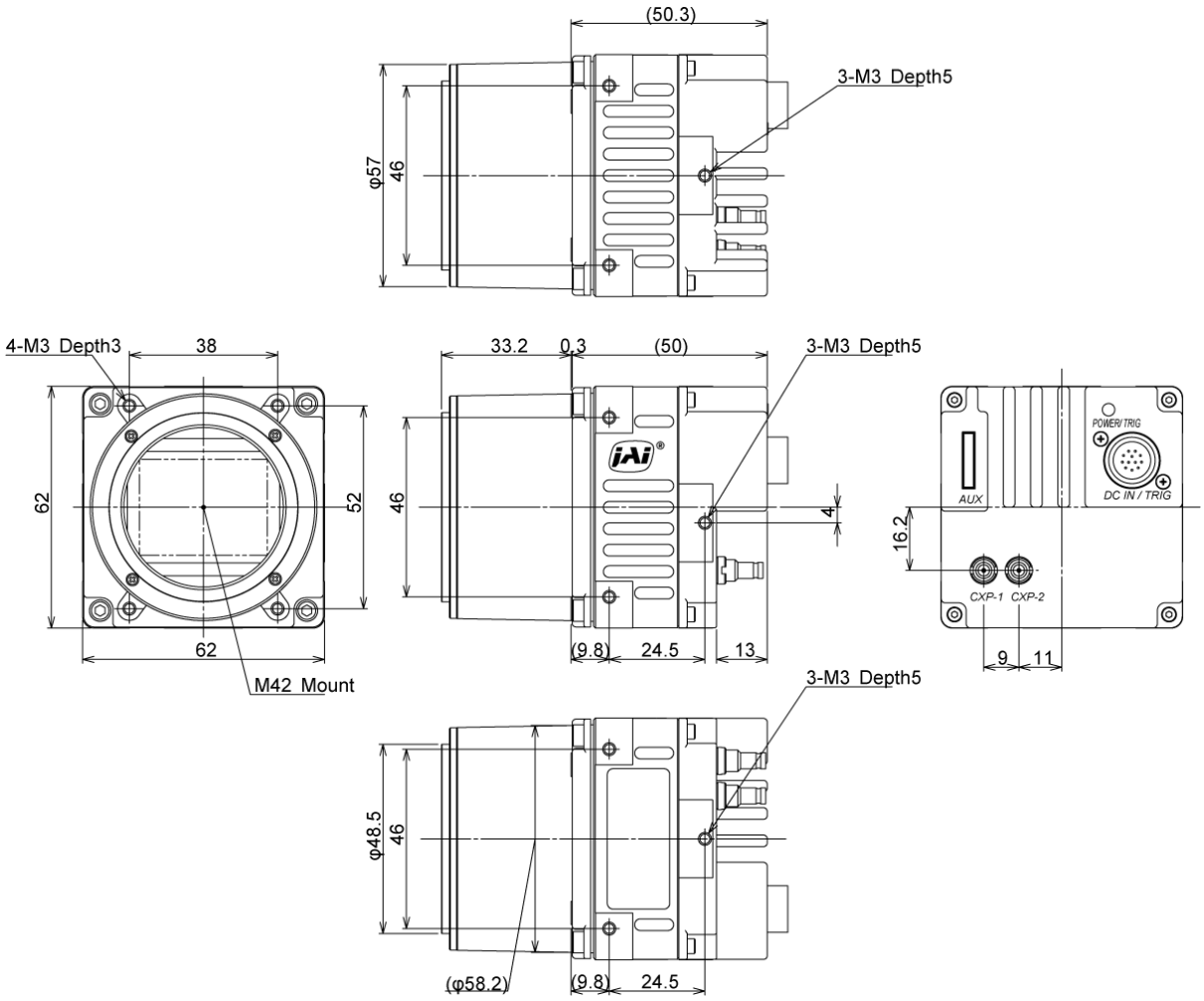
F-Mount Model



Notes:

- Dimensional tolerance: ± 0.3mm
- Unit: mm

M42-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
2.0	2024/02/16	DV0402	Added the M42-mount model information. Added the KC marks. Redesigned the user manual and corrected/updated topics.

Previous Revisions

Revision	Date	Changes
1.8	Jan. 2021	China RoHS
1.7	June 2016	Remove HDR indication. HDR function is not available.
1.6	May 2015	Add the description of the optical interface
1.5	Mar. 2015	Add 12-bit function, HDR is an optional function
1.4	Oct. 2014	Revise spectral response with wider wave length range
1.3	Sep. 2014	Revise Spectral Response, Correct Typo
1.2	June 2014	Review totally
1.1	Jan. 2014	Correct weight and power consumption in the specifications table, Change the description in Sequence ROI trigger mode, add GenICam register information to relative chapter, Add cautions to sections, 5.2.2.2, 7.1.2 and 8.2, Correct typo
1.0	Nov. 2013	New release

Europe, Middle East & Africa
Phone +45 4457 8888
Fax +45 4491 8880

Asia Pacific
Phone +81 45 440 0154
Fax +81 45 440 0166

Americas
Phone (Toll-Free) 1 800 445 5444
Phone +1 408 383 0300

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