See the possibilities

Spark Series

User Manual

SP-5000M-CXP2
SP-5000C-CXP2

5M Digital Progressive Scan
Monochrome and Color Camera

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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-5000M-CXP2 and SP-5000C-CXP2 comply with the following provisions applying to its standards.
EN 61000-6-3 (Generic emission standard part 1)
EN 61000-6-2 (Generic immunity standard part 1)

FCC

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

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

Warning

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

KC

상 호 : JAI Ltd.,Japan
기자재 명칭 : Industrial camera
모 델 명 : SP-5000M-CXP2
제조자 및 제조국가: JAI Ltd.,Japan / JAPAN
R-REM-JAi-SP-5000M-CXP4

상 호 : JAI Ltd.,Japan
기자재 명칭 : Industrial camera
모 델 명 : SP-5000C-CXP2
제조자 및 제조국가: JAI Ltd.,Japan / JAPAN
R-REM-JAi-SP-5000M-CXP4

제조년월은 제품상자의 라벨을 참조하십시요

Supplement

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

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

重要注意事项

有毒，有害物质或元素名称及含量表

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

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

○: 表示该有毒有害物质在该部件所有均质材料中的含量均在GB/T 26572-2011规定的限量要求以下。
×: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出GB/T 26572-2011规定的限量要求。
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数字「15」为期限15年。

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	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PPB)	多溴二苯醚 (PBDE)
螺丝固定座	×	○	○	○	○	○
光学滤色镜	×	○	×	○	○	○
连接插头	×	○	○	○	○	○
电路板	×	○	○	○	○	○
.....	.....	.....	.....	.....	.....	.....

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

EMVA 1288

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

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

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

Interface

The SP-5000M-CXP2 and SP-5000C-CXP2 employ 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.

Computer used for SP-5000 series

In order to get proper performance from this camera, it is necessary to use a PC equipped with a PCIe 2.0 slot with a size and capacity of 16 lanes or higher (x16 or x32).

Frame grabber boards used with SP-5000 series

As the SP-5000M-CXP2 and SP-5000C-CXP2 employ 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 at least two interface connectors be used in order to maximize camera performance.

Cables used with SP-5000 series

For the CoaXPress interface, coaxial cables are used. In the SP-5000M-CXP2 and SP-5000C-CXP2, they use 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.

1. General

The SP-5000M-CXP2 and SP-5000C-CXP2 are among the first new Spark Series cameras to be introduced. They are high performance cameras with high resolution and a fast frame rate suitable for high speed machine vision applications. The SP-5000M-CXP2 is a monochrome progressive scan CMOS camera and the SP-5000C-CXP2 is the equivalent Bayer mosaic progressive scan CMOS camera. Both are equipped with a CMOS sensor offering a 1-inch optical format, a resolution of 5.24 million pixels, and a 5:4 aspect ratio. They provide 211 frames per second for continuous scanning with 2560 x 2048 full pixel resolution for both monochrome and raw Bayer output.

8-bit, 10-bit or 12-bit output can be selected for both monochrome and raw Bayer formats. The SP-5000C-CXP2 is also capable of performing in-camera color interpolation at reduced frame rates. The new cameras feature a CoaXPress interface which uses coax cable with the capability of supplying power through the cable. The SP-5000M-CXP2 and SP-5000C-CXP2 use a dual coaxial cable interface. A full pixel readout, partial scan readout, or binning mode (monochrome only) can be selected depending on the application.

The SP-5000M-CXP2 and SP-5000C-CXP2 have various comprehensive functions needed for automated optical inspection applications, such as solid state device inspection or material surface inspection. They incorporate video processing functions such as a look-up table, shading compensation and blemish compensation in addition to fundamental functions such as trigger, exposure setting and video level control.

As a common Spark Series feature, a new connector for lens control is employed. SP-5000M-CXP2 and SP-5000C-CXP2 support P-iris and motor-driven lenses as standard lens control capabilities. Factory options are available to configure this connector to support DC iris systems, as well as provide a video iris output signal, or to provide additional TTL IN and OUT lines.

The latest version of this manual can be downloaded from: www.jai.com
The latest version of the Camera Control Tool for the SP-5000M-CXP2 and SP-5000C-CXP2 can be downloaded from: www.jai.com
For camera revision history, please contact your local JAI distributor.

2. Camera composition

The standard camera composition is as follows.

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

The following optional accessories are available.

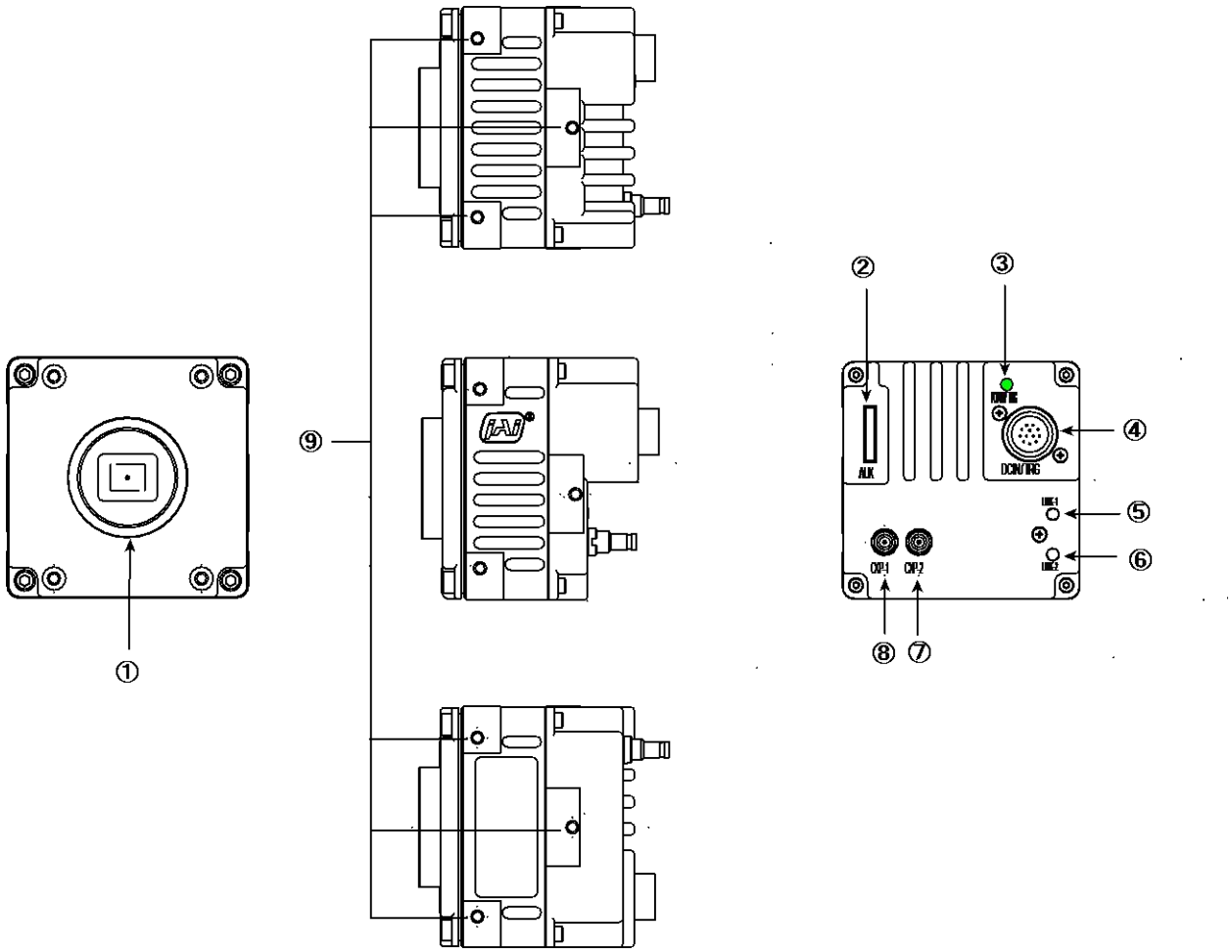
Tripod base	MP-42
Power supply unit	PD-12 series

3. Main features

- New Spark Series, 1” progressive scan camera
- Intelligent body design for easy and flexible installation
- Utilizes new CoaXPress interface using two coaxial cables
- Aspect ratio 5:4, 2560(H) x 2048(V) - 5.2 million effective pixels
- 5 µm square pixels
- S/N 55 dB for monochrome and 53 dB for color
- 8-bit, 10-bit or 12-bit output for monochrome and Bayer
- 3 x 8-bit output for RGB interpolated color
- 211 frames/second with full resolution in continuous operation (CXP-6x2)
- Various readout modes, including horizontal and vertical binning (SP-5000M-CXP2 only) and ROI (Region Of Interest) for faster frame rates
- 0 dB to +24 dB gain control for both SP-5000M-CXP2 and SP-5000C-CXP2
- 10 µs (1/100,000) to 8 seconds exposure control in 1 µs step
- Auto exposure control
- Timed and trigger width exposure control
- RCT and PIV trigger modes for specific applications
- ALC control with combined function of AGC, auto exposure and auto iris
- HDR (High Dynamic Range) function is available (SP-5000M-CXP2 only)
- 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 (SP-5000C-CXP2 only)
  Blemish compensation
- New Hirose 10P connector for lens interface including P-Iris lens control
- C-mount for lens mount
- Setup by Windows XP/Vista/7/8 via serial communication

4. Locations and functions

4.1 Locations and functions



①	Lens mount	C-mount (Note *1)
②	10-pin connector	AUX Connector for lens control (Standard)
③	LED	Indication for power and trigger input
④	12-pin connector	DC and trigger input
⑤	LINK 1	LINK Status indication for CXP#1
⑥	LINK 2	LINK Status indication for CXP#2
⑦	CXP#2	CoaXPress No.2 connector
⑧	CXP#1	CoaXPress No.1 connector (Note*2)
⑨	Mounting holes	Holes for mounting tripod base or direct installation. Depth 5 mm (Note*3)

*1) Note1: Rear protrusion on C-mount lens must be less than 10.0 mm.
*2) Note2: When one coaxial cable is used, CXP#1 must be used.
*3) Note3: The part number for the tripod adapter plate (with 1/4"-20 thread) is MP-42 (option).

Fig. 1 Locations

4.2 Rear panel

The rear panel mounted LEDs provide the following information:

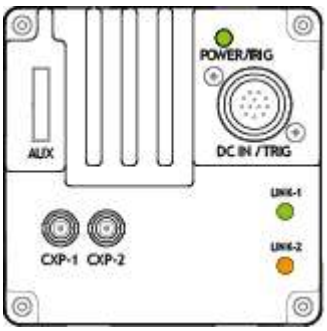


Fig. 2 Rear panel

POWER/TRIG

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

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

LINK1

- Flashing green: Searching LINK (in case of using PoCXP)
- Flashing amber: Searching LINK (in case of PoCXP not being used)

LINK2

- Flashing amber: Searching LINK (in case of PoCXP not being used)

5. Input and output

5.1 CoaXpress interface

5.1.1 CoaXPress interface standard

The SP-5000M-CXP2 and SP-5000C-CXP2 use 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.
In the SP-5000M-CXP2 and SP-5000C-CXP2, a 2 coaxial cable system is used.

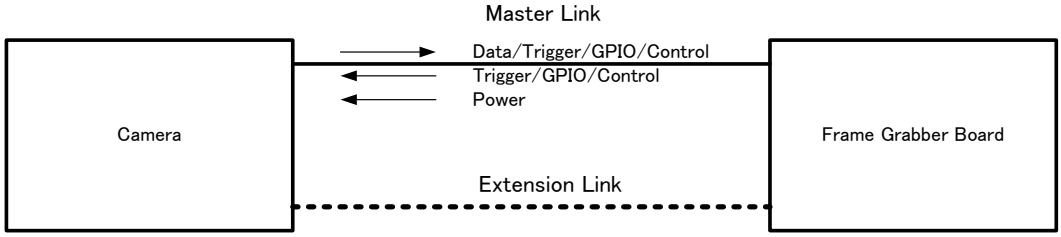


Fig.3 CoaXPress interface

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.

Table -1 Compliance labeling

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)

In the SP-5000M-CXP2 and SP-5000C-CXP2, the maximum bit rate is 6.25 Gbps per one cable and the power supply is available on the CXP#1 connector only.
For the details of the specifications, please refer to “JIIA-NTF-001-2010” published by Japan Industrial Imaging Association, http://www.jiia.org.

5.1.2 CoaXpress interface used in SP-5000-CXP2

SP-5000-CXP2 utilizes the following CoaXpress interface and the following table exhibits frames rate for different output format.

Number of lines: 1 or 2 lines
PoCXP is available in Line 1 only.

Pixel format in CoaXPress can be set to either 8-bit, 10-bit or 12-bit output. However, as shown in the chart below, the 10-bit CoaXPress pixel format is only available (○) if the sensor format is equal to or greater than the output format.

Sensor Pixel Format	CXP 8bit	CXP 10bit	CXP 12bit
Sensor 8bit	○	×	×
Sensor 10bit	○	○	×
Sensor 12bit	○	○	○

JAI recommends the following settings depending on applications.

- If the objective is to maximize the frame rate:
  The sensor pixel format should be set to a smaller value.

- If picture quality is the first priority:
  The sensor pixel format should be set larger than that of the CXP pixel format.
  Example: Sensor format is 12-bit and CXP format is 8-bit

The relationship between pixel format and maximum frame rate is determined as described in the following table.

Table – 2(1) CoaXPress Interface (For Mono and Bayer)

Link Configuration	Number of lanes	PoCXP (Note)	Sensor 8bit CXP8bit	Sensor 10bit CXP8bit	Senso 10bit CXP10bit	Sensor 12bit CXP8bit	Sensor 12bit CXP10bit	Sensor 12bit CXP12bit
CXP-3x1	1	CXP#1	53fps	42fps	42fps	35fps	35fps	35fps
CXP-3x2	2	CXP#1	106fps	84fps	84fps	70fps	70fps	70fps
CXP6x1	1	CXP#1						
CXP6x2	2	CXP#1	211fps	169fps	166fps	141fps	141fps	141fps

Note: PoCXP is only available on CXP#1 connector.

Table – 2(2) CoaXPress Interface (For RGB 8-bit)

Link Configuration	Number of lanes	PoCXP (Note)	Sensor8bit CXP8bit	Sensor10bit CXP8bit	Sensor12bit CXP8bit
CXP-3x1	1	CXP#1	11fps	8fps	7fps
CXP-3x2	2	CXP#1	22fps	17fps	14fps
CXP6x1	1	CXP#1			
CXP6x2	2	CXP#1	44fps	35fps	29fps

Note: PoCXP is only available on CXP#1 connector.

5.1.3 The relationship between sensor bit, pixel clock and output format.

In the SP-5000-CXP2, there are three sensor bit depths available as well as three pixel clocks,72MHz, 57.6 MHz and 48 MHz. The combination of these settings is directly related to which Link Configuration can be used. The following table shows the available combinations.

Table – 3 Sensor bit, Pixel clock and output format relationship

Sensor bit	Pixel clock	Available Link Configuration	Mono	Bayer	RGB
8bit	72MHz	CXP-3x1/8bit	○	○	○
		CXP-6x1/CXP-3x2/8bit	○	○	○
		CXP-6x2/8bit	○	○	○
10bit	57.6MHz	CXP-3x1/8bit	○	○	○
		CXP-3x1/10bit	○	○	–
		CXP-6x1/CXP-3x2/8bit	○	○	○
		CXP-6x1/CXP-3x2/10bit	○	○	–
		CXP-6x2/8bit	○	○	○
		CXP-6x2/10bit	○	○	–
12bit	48MHz	CXP-3x1/8bit	○	○	○
		CXP-3x1/10bit	○	○	–
		CXP-3x1/12bit	○	○	–
		CXP-6x1/CXP-3x2/8bit	○	○	○
		CXP-6x1/CXP-3x2/10bit	○	○	–
		CXP-6x1/CXP-3x2/12bit	○	○	–
		CXP-6x2/8bit	○	○	○
		CXP-6x2/10bit	○	○	–
		CXP-6x2/12it	○	○	–

Note1: By selecting sensor bit depth, available link configuration is determined.

5.1.4 Associated GenICam register

GenICam Name	Access	Values	Category
Link Config	R/W	Single3125Gbps Single625Gbps Dual3125Gbps Dual625Gbps	Device Control
Pixel Format	R/W	[Mono] Mono8 Mono10 [Color] BayerGB8 BayerGB10 8 Bit RGB	Image Format Control
Sensor Pixel Format	R/W	10bit 12bit	JAI-Custom

5.2 Connectors and pin assignment

5.2.1 Digital Video Output (75Ω 1.0・2.3 DIN Receptacle)

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

CXP#1	PoCXP compliant
CXP#2	

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

5.2.2 12-Pin connector

Type: HR-10A-10R-12PB(72) Hirose male or equivalent.

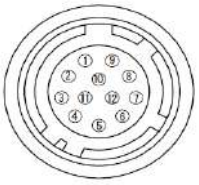


Fig.4 12-pin connector

Table – 4 Hirose 12P pin assignment

Pin no.	Signal	Remarks
1	GND	
2	DC input	+12V to +24V
3	GND	
4	NC	
5	Opto in-	Line5
6	Opto in+	
7	Opto out-	Line2
8	Opto out+	
9	TTL out	Line 1 (Note*1)
10	TTL in	Line 4 (Note*2)
11	DC input	+12V to +24V
12	GND	

*1) Factory default setting is an Exposure Active signal with negative polarity.
*2) Factory default setting is a trigger input

5.2.3 AUX Standard Hirose 10-Pin connector

5.2.3.1 Figure and pin configuration

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

Fig.5 Hirose 10-pin connector

Table – 5 Hirose 10P pin assignment (Standard)

No	I/O	Name	Note
1	O	DRIVE IRIS+	Motorized Lens
2	O	DRIVE FOCUS+	Motorized Lens
3	O	DRIVE ZOOM+	Motorized Lens
4	O	COMMON	Motorized Lens
5		GND	
6	O	P-IRIS OUT A+	P-Iris Lens
7	O	P-IRIS OUT A-	P-Iris Lens
8	O	P-IRIS OUT B+	P-Iris Lens
9	O	P-IRIS OUT B-	P-Iris Lens
10	O	GND	

5.2.4 AUX Type 2 HIROSE 10-Pin connector (factory option)

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

Table – 6 Hirose 10P pin assignment (Option 1)

No	I/O	Name	Note
1	O	Video Signal	Video Iris Lens
2	O	Power DC+12V	Video Iris Lens
3		NC	
4		NC	
5		GND	
6	O	DC IRIS DAMP-	DC Iris
7	O	DC IRIS DAMP+	DC Iris
8	O	DC IRIS DRIVE+	DC Iris
9	O	DC IRIS DRIVE-	DC Iris
10		GND	

5.2.5 AUX Type 3 HIROSE 10-Pin connector (factory option)

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

Table – 7 HIROSE 10P pin assignment

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-	
8		NC	
9		GND	
10		GND	

5.3 Digital IN/OUT interface

In the SP-5000M-CXP2 and SP-5000C-CXP2, the digital IN/OUT capability in the software control tool can assign the necessary signals needed for the system.

5.3.1 Line Selector

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

Table – 8 Line selector

Line Selector item	Description
Line 1 TTL 1 Out	TTL 1 output from #9 pin of DC In/Trigger 12-Pin on the rear
Line 2 Opt Out 1	Opt Out 1 output from # 7 & 8 pins of DC In/Trigger 12-Pin on the rear
Line 8 TTL 2 Out	TTL 2 output from #1pin “AUX” HIROSE 10-Pin on the rear (Factory option)
Line 9 TTL 3 Out	TTL 3 output from #2pin “AUX” HIROSE 10-Pin on the rear (Factory option)
NAND 0 In 1	First input at NAND first gate in GPIO
NAND 0 in 2	Second input at NAND first gate in GPIO
NAND 1 In 1	First input at NAND second gate in GPIO
NAND 1 in 2	Second input at NAND second gate in GPIO

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

5.3.2 Line Source

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

Table - 9 Line Source

Line Source item	Description
Low	Connect Low Level signal to line item selected in Line Selector, **Default setting**
High	Connect High Level signal to line item selected in Line Selector
Frame Trigger Wait	Connect Frame Trigger Wait signal to line item selected in Line Selector
Frame Active	Connect Frame Active signal to line item selected in Line Selector
Acquisition Trigger Wait	Connect Acquisition Trigger Wait signal to line item selected in Line Selector
Acquisition Active	Connect Acquisition Active signal to line item selected in Line Selector
Exposure Active	Connect Exposure Active signal to line item selected in Line Selector
FVAL	Connect FVAL signal to line item selected in Line Selector
LVAL	Connect LVAL signal to line item selected in Line Selector
PulseGenerator0 Out	Connect Pulse Generator 0 signal to line item selected in Line Selector
PulseGenerator1 Out	Connect Pulse Generator 1 signal to line item selected in Line Selector
PulseGenerator2 Out	Connect Pulse Generator 2 signal to line item selected in Line Selector
PulseGenerator3 Out	Connect Pulse Generator 3 signal to line item selected in Line Selector
User output 0	Connect User Output 0 signal to line item selected in Line Selector
User output 1	Connect User Output 1 signal to line item selected in Line Selector
User output 2	Connect User Output 2 signal to line item selected in Line Selector
User output 3	Connect User Output 3 signal to line item selected in Line Selector
Line 4 TTL 1 In	Connect TTL 1 In signal to line 4 in Line Selector
Line 5 Opt 1 In	Connect Opt 1 In signal to line 4 in Line Selector
Line 7 Trigger packet In	Connect CXP trigger packet IN signal to line 7 in Line Selector
NAND 0 Out	Connect NAND 0 signal to line item selected in Line Selector
NAND 1 Out	Connect NAND 1 signal to line item selected in Line Selector
Line 10 TTL 2 In	Connect TTL 2 In signal to Line 10
Line 11 LVDS 1 In	Connect LVDS 1 In signal to Line 11

Note] As for LVAL, some line items cannot be connected. Refer to "5.3.7.2 GPIO matrix table"

5.3.3 Line Mode

Indicates the status of the interface, input or output.

5.3.4 Line Inverter

Sets the polarity of the selected input or output.

5.3.5 Line Status

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

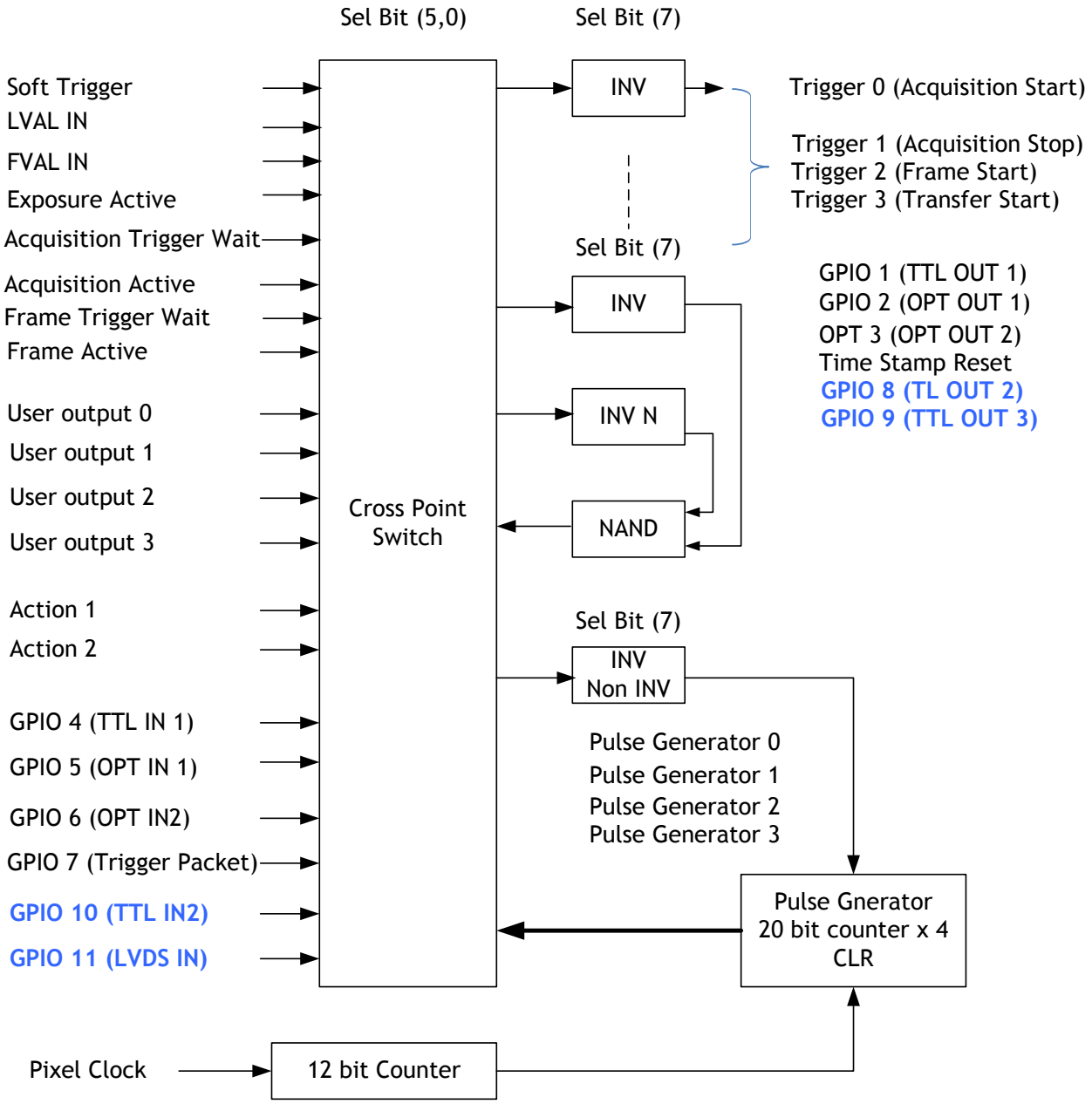
5.3.6 Line Format

Controls the format of the line item selected in Line Selector.
(No Connect, TTL, LVDS, Opt Coupled)

5.3.7 GPIO

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

5.3.7.1 Basic block diagram



Note1: There are three pixel clocks available. Pixel clock is related to Link Configuration.
If Link Configuration is set, the appropriate pixel clock is automatically used.
Note2: Items written in blue are available only if Type 3 is selected for AUX connector.

Fig. 6 GPIO

5.3.7.2 IN and OUT matrix table

The following table shows the input and output matrix table.

Table – 10 GPIO IN and OUT matrix table

Selector (Cross point switch output) / Source signal (Cross point switch input)	Trigger Selector			Line Selector								Pulse Generator Selector				
	Acquisition Start	Acquisition Stop	Frame Start	Line 1 - 12P TTL Out 1	Line 2 - 12P Opt Out 1	Line 8 - TTL 2 Out	Line 9 - TTL 3 Out	NAND 1 In 1	NAND 1 In 2	NAND 2 In 1	NAND 2 In 2	Pulse Generator 0	Pulse Generator 1	Pulse Generator 2	Pulse Generator 3	
LOW	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
HIGH	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
Line 4 - 12P TTL In	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
Line 5 - 12P OPT In	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
Line 7 - Trigger packet	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
NAND 0 Out 1	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
NAND 1 Out 1	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
Pulse Generator 0	O	O	O	O	O	O	O	O	O	O	O	×	O	O	O	
Pulse Generator 1	O	O	O	O	O	O	O	O	O	O	O	O	×	O	O	
Pulse Generator 2	O	O	O	O	O	O	O	O	O	O	O	O	O	×	O	
Pulse Generator 3	O	O	O	O	O	O	O	O	O	O	O	O	O	O	×	
User Output 0	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
User Output 1	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
User Output 2	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
User Output 3	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
Software Trigger	O	O	O	×	×	×	×	O	O	O	O	×	×	×	×	
FVAL	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
LVAL	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Exposure Active	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Acquisition Trigger Wait	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Acquisition Active	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Frame Trigger Wait	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Frame Active	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Line 10 - TTL 2 In	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	Extension GPIO Connection
Line 11 - LVDS 1 In	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
	Trigger Source			Line Source								Pulse Generator Clear Source				

Note: As for Line 8, Line 9, Line 10 and Line 11 are available if AUX Type 3 is used for AUX connector configuration.

5.3.8 Associated GenIcam register

GenICam Name	Access	Values	Category
Line Selector	R/W	Line1 - TTL Out 1 CC1 Line8 – TTL Out 2(Option) Line9 - TTL Out 3(Option) Nand Gate 0 In1 Nand Gate 0 In2 Nand Gate 1 In1 Nand Gate 1 In2	Digital I/O Control
Line Mode	RO	Output Input	Digital I/O Control
Line Inverter	R/W	False True	Digital I/O Control
Line Status	RO	False True	Digital I/O Control
Line Source	R/W	Low High Acquisition Trigger Wait Acquisition Active Frame Trigger Wait Frame Active Exposure Active FVAL PG0 to 3 User out0 to 3 TTL in Opto1 in CXP in (Trigger Packet) Nand0 to 1 Line10 - TTL In 2(Option) Line11- LVDS In(Option)	Digital I/O Control
Line Format	RO	TTL LVDS Opto CXP	Digital I/O Control

5.4 Optical Interface

SP-5000-CXP2 is equipped with opto-isolated inputs and outputs, providing galvanic separation between the camera's inputs/outputs and peripheral equipment.
In addition to galvanic separation, the opto-isolated inputs and outputs can cope with a wide range of voltages; the voltage range for inputs is +3.3V to +24V DC whereas outputs will handle +5V to +24V DC.
The following drawing is the concept of photo coupler

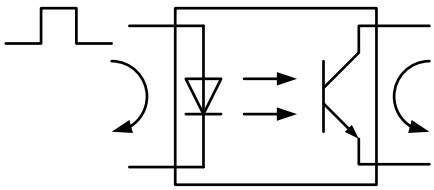


Fig.7 Photo coupler

5.4.1 Recommended External Input circuit diagram for customer

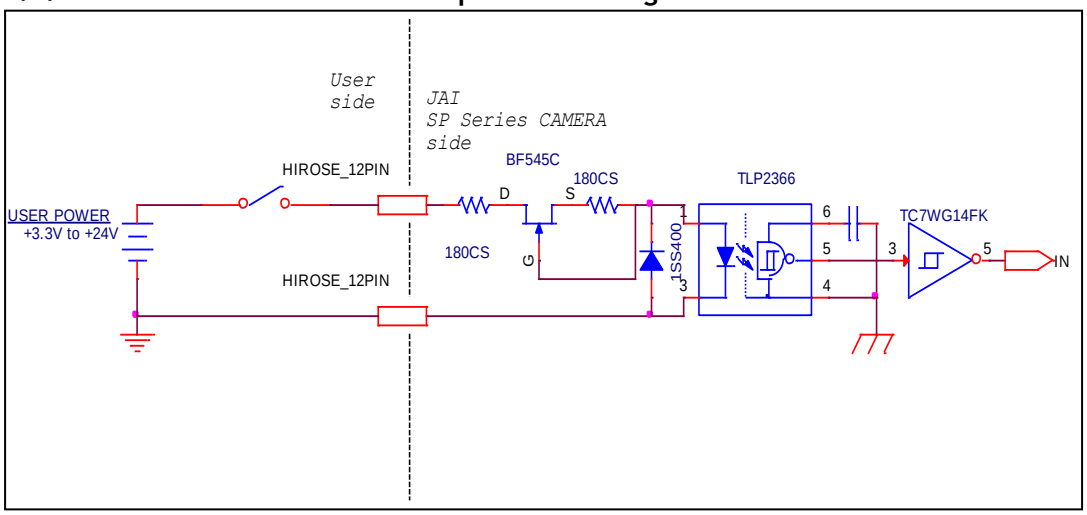


Fig.8 Example of external input circuit

5.4.2 Recommended External Output circuit diagram for customer

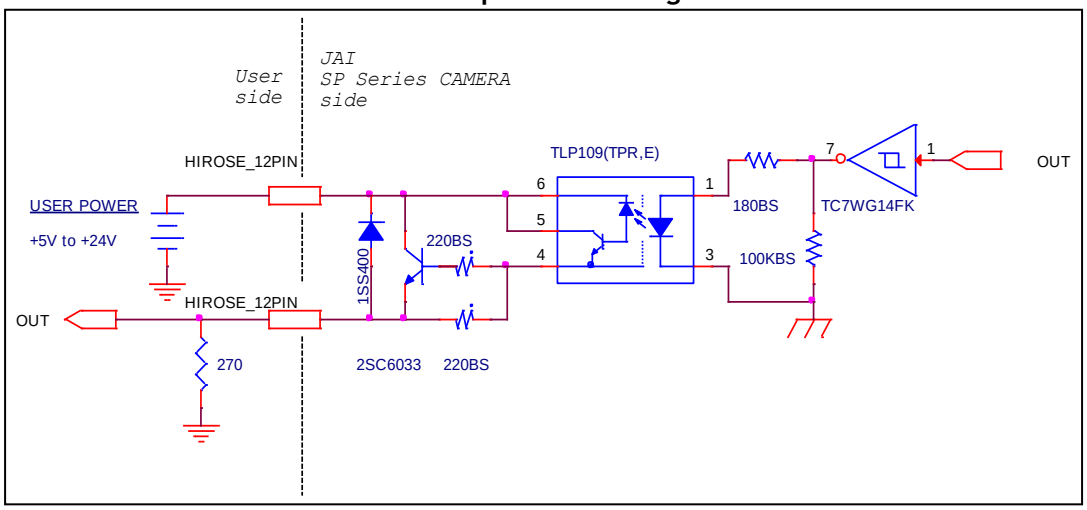
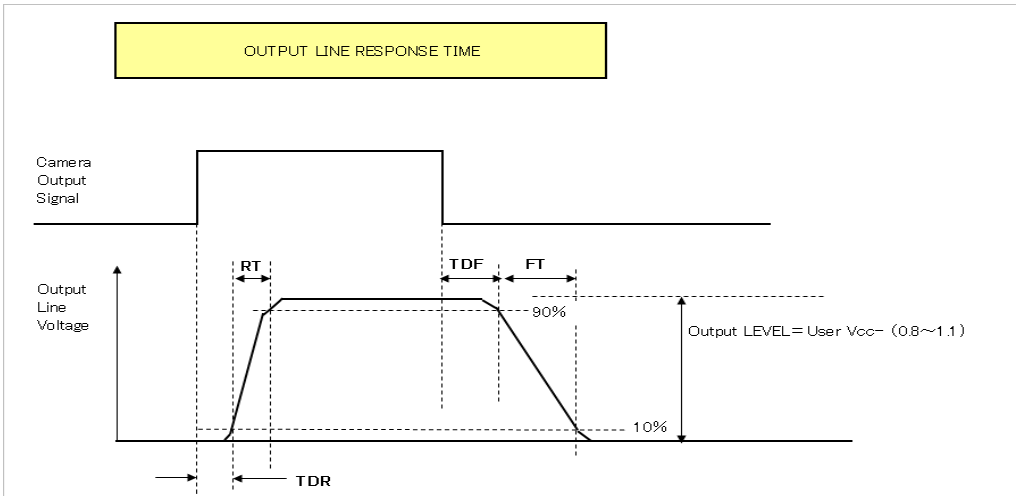


Fig.9 Example of external output circuit

5.4.3 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

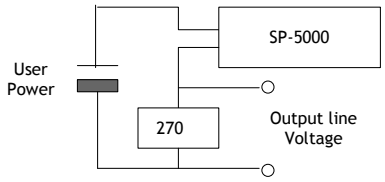


Fig.10 Optical interface characteristics

5.5 Pulse Generator

The SP-5000-CXP2 has a frequency divider using the pixel 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.

Table - 11 Pulse Generator default settings

Display Name	Value							
Clock Pre-scaler	1							
Pulse Generator Selector	Pulse Generator							
	Length	Start Point	End Point	Repeat Count	Clear Source	Clear Inverter	Clear Activation	Clear Sync Mode
- Pulse Generator 0	1	0	1	0	Off	True	Off	Async Mode
- Pulse Generator 1	1	0	1	0	Off	True	Off	Async Mode
- Pulse Generator 2	1	0	1	0	Off	True	Off	Async Mode
- Pulse Generator 3	1	0	1	0	Off	True	Off	Async Mode

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

5.5.1 Clock Pre-scaler

Clock pre-scaler (Divide Value) can set the dividing value of the frequency divider (12-bit length) and the pixel clock is used for this. Four built-in pulse generators work by the same clock. In the SP-5000-CXP2, the default pixel clock is set at 48MHz.

5.5.2 Pulse Generator Selector

This is where you select one of the 4 pulse generators in order to set or modify its parameters.

Table - 12 Pulse Generator setting

Trigger Selector item	Description
Pulse Generator 0	If Pulse Generator 0 is selected, Length Start Point、End Point、Repeat Count、Clear Source、Clear Inverter Clear Activation and Clear Sync Mode of pulse generator 0 are displayed under the selector.
Pulse Generator 1	If Pulse Generator 1 is selected, Length Start Point、End Point、Repeat Count、Clear Source、Clear Inverter Clear Activation and Clear Sync Mode of pulse generator 1 are displayed under the selector.
Pulse Generator 2	If Pulse Generator 2 is selected, Length Start Point、End Point、Repeat Count、Clear Source、Clear Inverter Clear Activation and Clear Sync Mode of pulse generator 2 are displayed under the selector.
Pulse Generator 3	If Pulse Generator 3 is selected, Length Start Point、End Point、Repeat Count、Clear Source、Clear Inverter Clear Activation and Clear Sync Mode of pulse generator 3 are displayed under the selector.

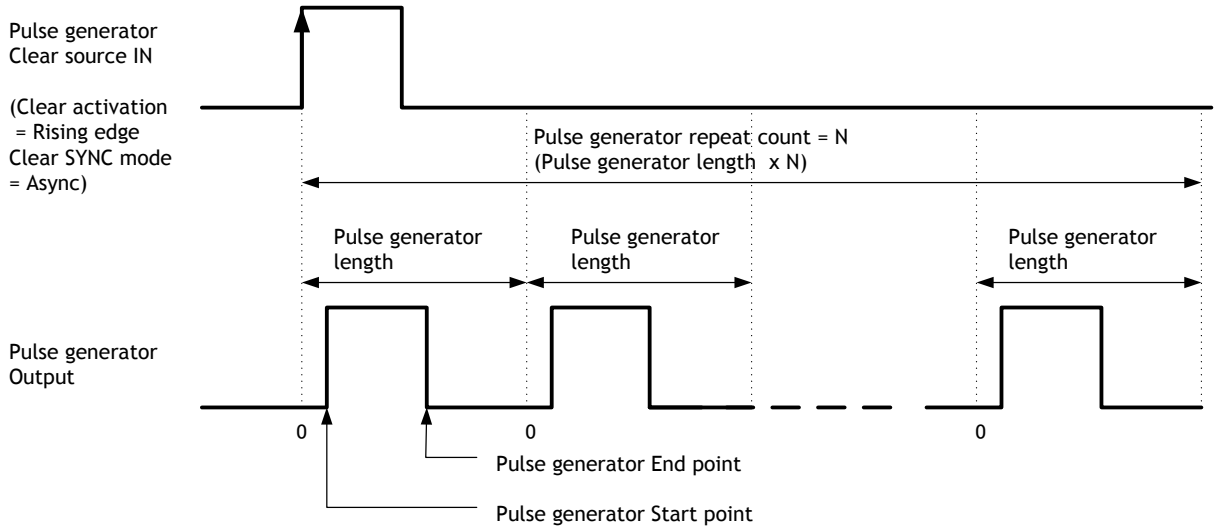


Fig.11 Pulse Generator Pulse construction

5.5.3 Pulse Generator Length

Set the counter up value (number of clocks, refer to Table 14) for the selected pulse generator.

If Repeat Count value is “0”, and if Pulse Generator Clear signal is not input, the pulse generator generates the pulse repeatedly until reaching this counter up value.

5.5.4 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.

5.5.5 Pulse Generator End Point

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

5.5.6 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 a Free-Running counter.

5.5.7 Pulse Generator Clear Activation

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

5.5.8 Pulse Generator Clear Sync Mode

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

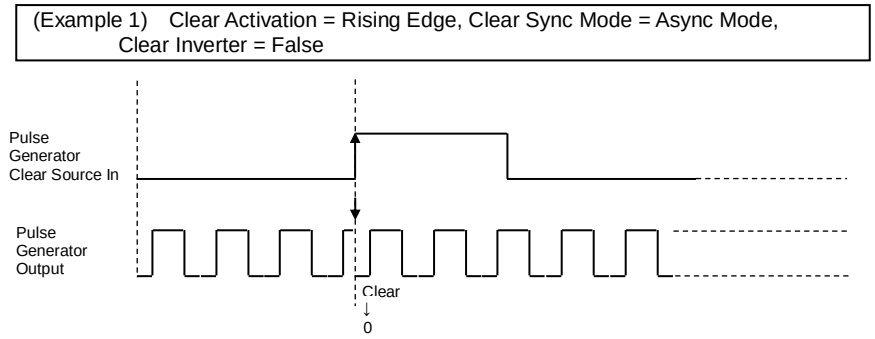


Fig.12 Counter clear in Async mode

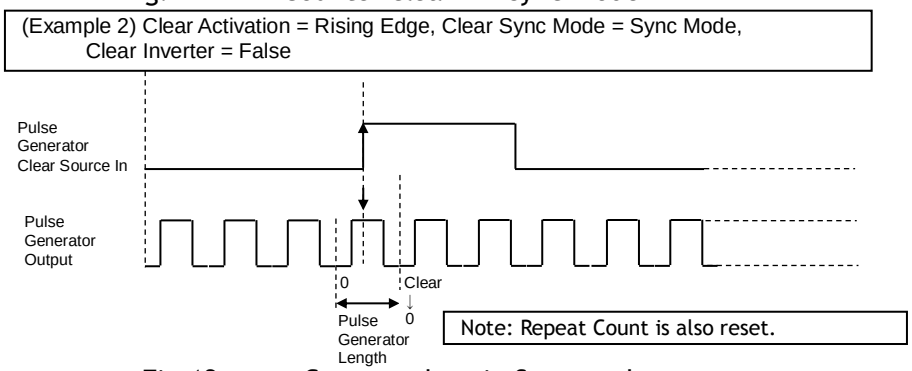


Fig.13 Counter clear in Sync mode

5.5.9 Pulse Generator Clear Source

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

Table - 13 Pulse generator clear source

Pulse Generator Clear Source item	Description
Low	Connect Low level signal to Clear Source for the selected pulse generator. **Default setting**
High	Connect High level signal to Clear Source for the selected pulse generator.
Frame Trigger Wait	Connect Frame Trigger Wait signal to Clear Source for the selected pulse generator.
Frame Active	Connect Frame Active signal to Clear Source for the selected pulse generator.
Exposure Active	Connect Exposure Active signal to Clear Source for the selected pulse generator.
Acquisition Trigger wait	Connect Acquisition Trigger Wait signal to Clear Source for the selected pulse generator.
Acquisition Active	Connect Acquisition Active signal to Clear Source for the selected pulse generator.
FVAL	Connect FVAL signal to Clear Source for the selected pulse generator.
LVAL	Connect LVAL signal to Clear Source for the selected pulse generator.
PulseGenerator0 Out	Connect Pulse Generator 0 output to Clear Source for the selected pulse generator.
PulseGenerator1 Out	Connect Pulse Generator 1 output to Clear Source for the selected pulse generator.
PulseGenerator2 Out	Connect Pulse Generator 2 output to Clear Source for the selected pulse generator.
PulseGenerator3 Out	Connect Pulse Generator 3 output to Clear Source for the selected pulse generator.
User output0 Out	Connect User output 0 to Clear Source for the selected pulse generator.
User output1 Out	Connect User output 1 to Clear Source for the selected pulse generator.
User output2 Out	Connect User output 2 to Clear Source for the selected pulse generator.
User output3 Out	Connect User output 3 to Clear Source for the selected pulse generator.
TTL 1 In	Connect TTL 1 In signal to Clear Source for the selected pulse generator.
OPT 1 in	Connect Opt 1 In signal to Clear Source for the selected pulse generator.
Trigger packet In	Connect Trigger packet In signal to Clear Source for the selected pulse generator.
Nand 0 Out	Connect NAND 0 output signal to Clear Source for the selected pulse generator.
Nand 1 Out	Connect NAND 1 output signal to Clear Source for the selected pulse generator.
TTL 2 In	Connect TTL 2 In signal to LINE 10.
LVDS 1 In	Connect LVDS 1 In signal to Line 11

Note:
The pulse generator output cannot be used as the clear input to the same pulse generator. Refer to “5.3.6.2. Table 8”.

5.5.10 Pulse Generator Inverter

Clear Source Signal can be have polarity inverted.

5.5.11 Pulse Generator Setting Parameters

Table - 14 Pulse Generator setting parameters

Display Name	Value
Clock Pre-scaler	1 to 4096
Pulse Generator Clock (MHz)	[Pixel Clock:57.6 MHz or 48 MHz]÷[Clock Pre-scaler]
Pulse Generator Selector	- Pulse Generator 0
	- Pulse Generator 1
	- Pulse Generator 2
	- Pulse Generator 3
- Pulse Generator Length	1 to 1048575
- Pulse Generator Length (ms)	([Clock Source]÷[Clock Pre-scaler])$^{-1}$ x [Pulse Generator Length]
- Pulse Generator Frequency (Hz)	[Pulse Generator Length (ms)]$^{-1}$
- Pulse Generator Start Point	0 to 1048574
- Pulse Generator Start Point (ms)	([Clock Source]÷[Clock Pre-scaler])$^{-1}$ x [Pulse Generator Start Point]
- Pulse Generator End Point	1 to 1048575
- Pulse Generator End Point (ms)	([Clock Source]÷[Clock Pre-scaler])$^{-1}$ x [Pulse Generator End Point]
- Pulse Generator pulse-width (ms)	[Pulse Generator End Point (ms)]－[Pulse Generator Start Point (ms)]
- Pulse Generator Repeat Count	0 to 255
- Pulse Generator Clear Activation Clear Mode for the Pulse Generators	- Off
	- High Level
	- Low level
	- Rising Edge
	- Falling Edge
- Pulse Generator Clear Sync Mode	- Async mode
	- Sync mode
- Pulse Generator Clear Source	- Low
	- High
	- Frame Trigger Wait
	- Frame Active
	- Exposure Active
	- Fval
	- Lval
	- PulseGenerator0
	- PulseGenerator1
	- PulseGenerator2
	- PulseGenerator3
	- TTL_In1
	- Trigger Packet_In
	- Nand0 Out
	- Nand1 Out
	- Line 10 - TTL 2 In
	- Line 11 - LVDS 1 In
- Pulse Generator Inverter(Polarity) Pulse Generator Clear Inverter	- False
	- True

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

5.5.12 Associated GenICam register

GenICam Name	Access	Values	Category
Pre-scaler	R/W	1 to 4096	Pulse Generators
Pulse Generator Selector	R/W	PG0 to PG3	Pulse Generators
Pulse Generator Length	R/W	0 to 1048575	Pulse Generators
Pulse Generator Start Point	R/W	0 to 1048575	Pulse Generators
Pulse Generator End Point	R/W	0 to 1048575	Pulse Generators
Pulse Generator Repeat Count	R/W	0 to 255	Pulse Generators
Pulse Generator Clear Activation	R/W	Free Run High Level Low Level Rising Edge Falling Edge	Pulse Generators
Pulse Generator Clear Source	R/W	Low High Soft Acquisition Trigger Wait Acquisition Active Frame Trigger Wait Frame Active Exposure Active FVAL PG0 to 3 User out0 to 3 TTL in Opto1 in CXP in (Trigger Packet) Nand0 to 1	Pulse Generators
Pulse Generator Invertor	R/W	True False	Pulse Generators
Pulse Generator Sync Mode	R/W	Async Mode Sync Mode	Pulse Generators

6. Sensor layout, output format and timing

6.1 Sensor layout

CMOS sensors used in the SP-5000M-CXP2 and SP-5000C-CXP2 have the following tap and pixel layout.

6.1.1 Monochrome sensor

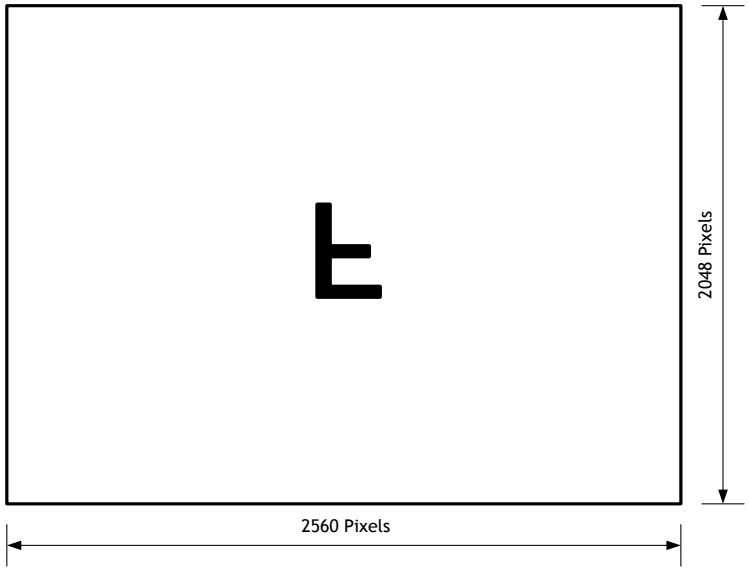


Fig.14 Monochrome sensor layout

6.1.2 Bayer color sensor

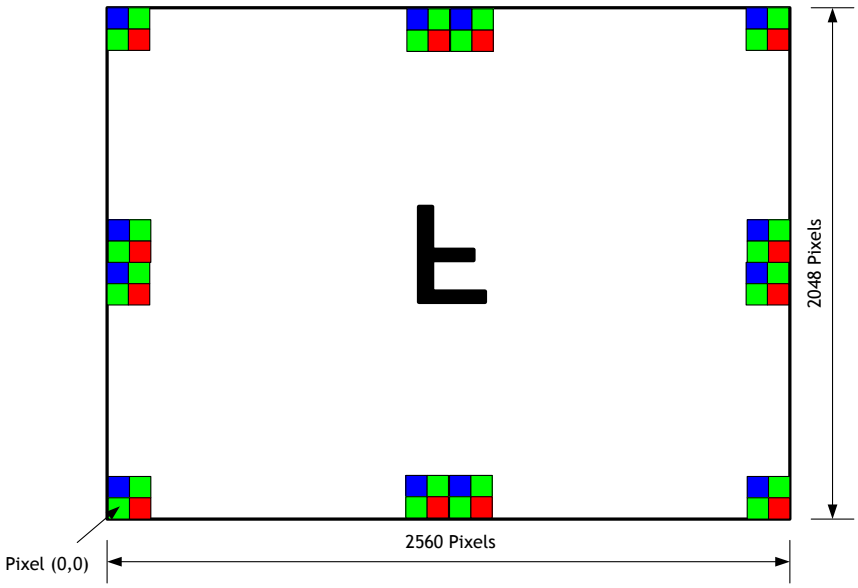


Fig.15 Bayer color sensor layout

6.2. Camera output format

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

Camera output format	Sensor readout system	Reference figure
1X-1Y	1-tap readout	6.2.1

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

6.2.1 1X-1Y

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

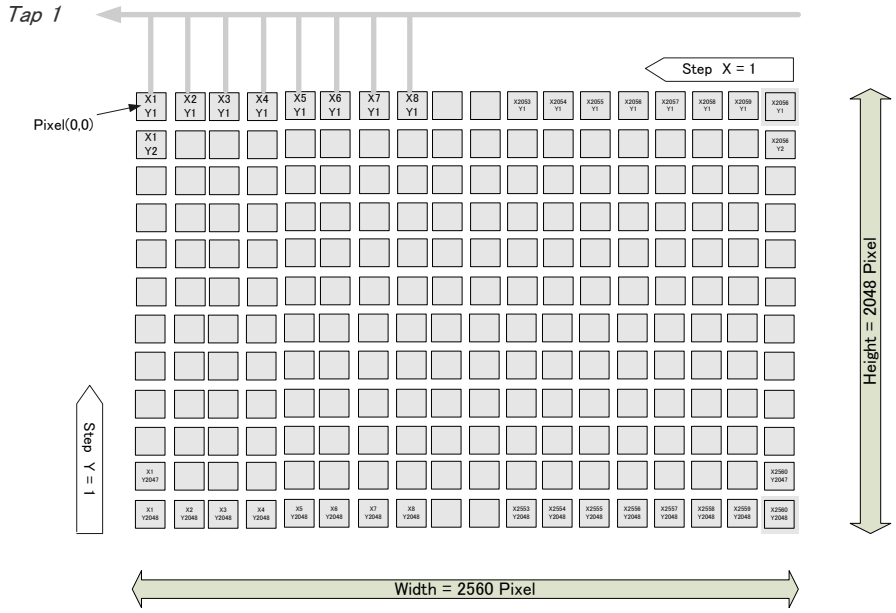


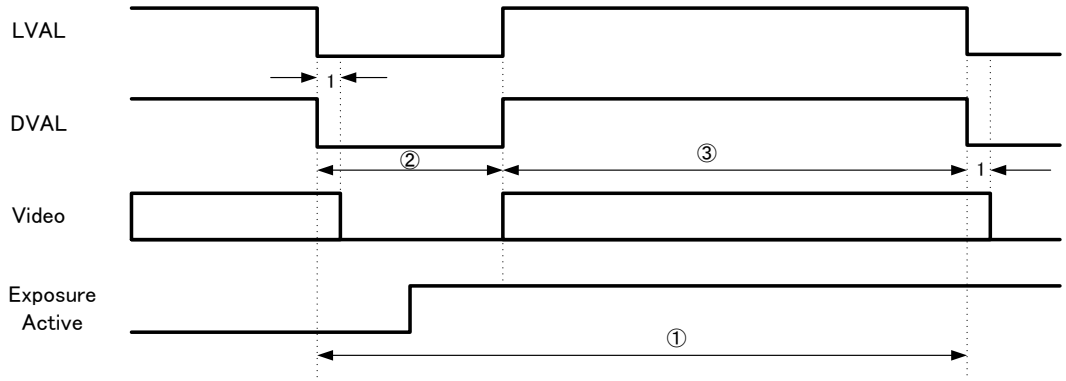
Fig.16 1X - 1Y readout

6.3 Output timing

6.3.1 Horizontal timing

Output format: 1X – 1Y
1 Clock: 13.889ns

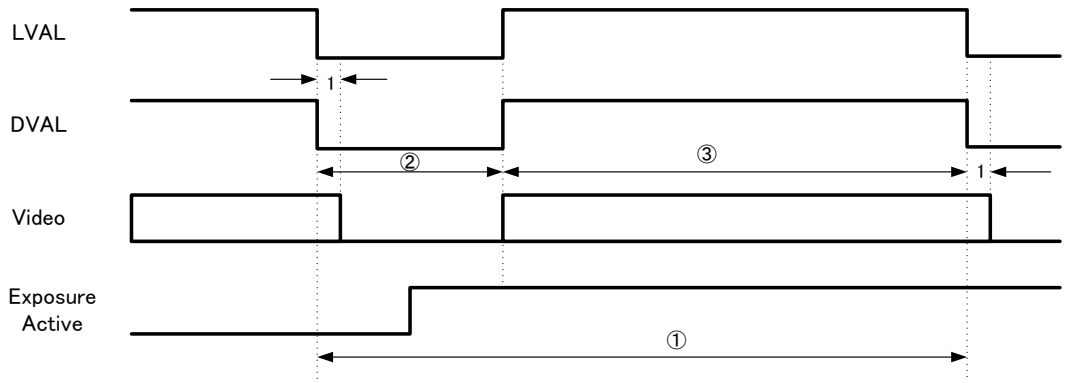
6.3.1.1 Vertical Binning OFF



Link Configuration	① (clk)	② (clk)	③ (clk)	1L (µs)
Dual CXP6 12.5 Gbps	165	42	123	2.29
Single CXP6 6.25 Gbps	330	207	123	4.59
Dual CXP3 6.25 Gbps	330	207	123	4.59
Single CXP3 3.125 Gbps	660	537	123	9.17

Fig.17 Horizontal Timing (Vertical timing OFF)

6.3.1.2 Vertical Binning ON



Link Configuration	① (clk)	② (clk)	③ (clk)	1L (µs)
Dual CXP6 12.5 Gbps	165	42	123	2.29
Single CXP6 6.25 Gbps	330	207	123	4.59
Dual CXP3 6.25 Gbps	330	207	123	4.59
Single CXP3 3.125 Gbps	660	537	123	9.17

Fig. 18 Horizontal timing (Vertical binning ON)

6.3.2 Vertical timing

Output format: 1X – 1Y, CXP-6_2
Trigger Mode: N, Exposure Mode: Timed
1L: 165 clocks, 1 clock: 13.889 ns

6.3.2.1 Vertical Binning OFF

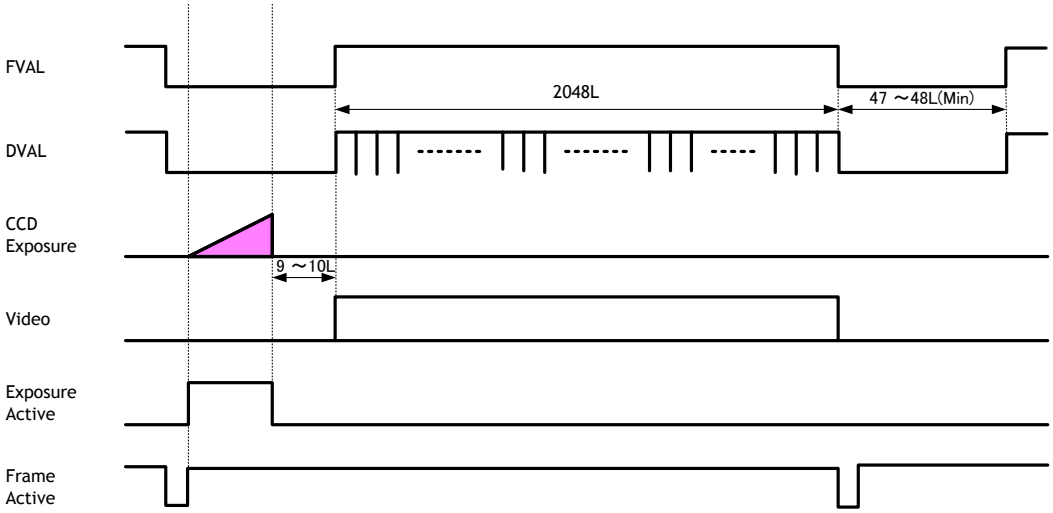


Fig.19 Vertical Timing (Vertical binning OFF)

6.3.2.2 Vertical Binning ON

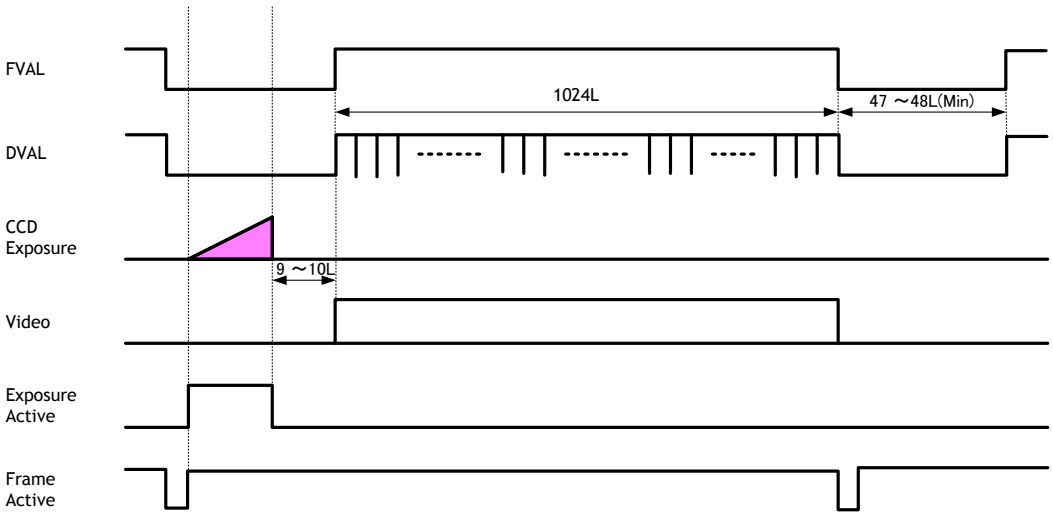


Fig. 20 Vertical timing (Vertical binning ON)

6.3.3 ROI (Region Of Interest) setting

In the SP-5000-CXP2, a subset of the image can be output by setting Width, Height, Offset-X, and Offset-Y. If the height is decreased, the number of lines read out is decreased and as the result, the frame rate is increased. However, in the horizontal direction, the horizontal frequency is not changed if the width is decreased. In the SP-5000M-CXP2, the minimum width is “64” and minimum height is “1”. In the SP-5000C-CXP2, the minimum width is “64” and minimum height is “2”.

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

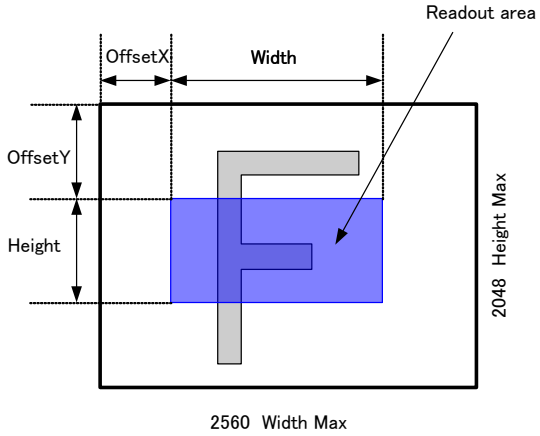


Fig. 21 Setting example (No binning)

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

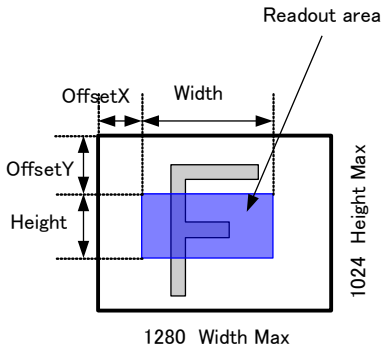


Fig.22 Setting example (Binning)

6.4 Digital output Bit allocation

CCD out		Digital Out		
		8bit	10bit	12bit
Black	0%	8LSB	32LSB	128LSB
Monochrome	100%	222LSB	890LSB	3560LSB
Color				
Monochrome	115%	255LSB	1023LSB	4095LSB
Color				

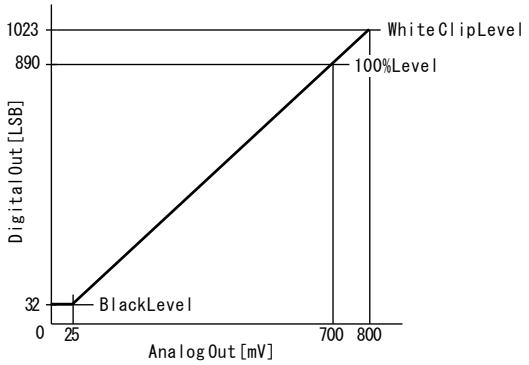


Fig.23 Bit allocation (10-bit)

7. Operating modes

7.1. Acquisition control (change the frame rate)

7.1.1 Acquisition frame rate

With Trigger OFF (free running mode – see section 7.2.1), the default frame rate of the camera is based on the specified ROI. The smaller the ROI, the faster the default frame rate. However, it is possible to specify a free-running frame rate (i.e., no trigger needed) that is slower than the default rate. This can be useful when a longer exposure time is needed for a specific ROI.

Modification of the frame rate is done by entering a value in the AcquisitionFrameRate control corresponding to frequency to be allocated to each frame period. Allowed values range from 41642 Hz to 0.125 Hz for SP-5000M-CXP2, however if the value entered is less than the time required for the default frame rate, the setting is ignored and the default frame rate is used. For example, the minimum frame period for the smallest possible ROI (1 line) requires 41642 Hz, so any entry more than 41642 will always be ignored.

The setting range in Acquisition Frame Rate is:

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

For the above setting, Acquisition Frame Rate (unit: fps or Hz) is used.
Acquisition Frame Rate: 41642 Hz to 0.125 Hz

How to set:
ROI should be set first.
The number shown in Acquisition Frame Rate will correspond to the minimum frame period for the specified ROI.
The value can be decreased up to 0.125 Hz.
If ROI is changed from a smaller size to a larger size, the default frame rate of the ROI is automatically recalculated inside the camera and changed to the slower frame rate of the larger ROI.

7.1.2 Calculation of frame rate

The frame rate for a specific ROI is calculated using the following formula.

HEIGHT and Width are the size of ROI.
C_{EXP_B}、C_{EXP_F}、C_H and F_{SYS} are listed in the table.

T_{EXP_B} (μs) = C_{EXP_B} / F_{SYS}
T_{EXP_F} (μs) = C_{EXP_F} / F_{SYS}
T_{ROW} (μs) = C_H / F_{SYS}
T_{wait} (μs) = T_{ROW} x 2
K = ceil(T_{EXP_B} / T_{ROW}) + 1.0
EX_R = 2
EX_C = 1

Normal

$T_{READOUT\ (\mu s)}$ = T_{ROW} * (HEIGHT + K + EX_R) + EX_C / F_{SYS} + T_{WAIT} + T_{EXP_F}

Frame rate(fps) = 1/Roundup (1000000.0 * $T_{READOUT}$)

PIV

$T_{READOUT\ (\mu s)}$ = T_{ROW} * (HEIGHT + K + EX_R) + EX_C / F_{SYS} + T_{WAIT} + T_{EXP_F} + 0.00005

Frame rate(fps) = 1/Roundup (1000000.0 * $T_{READOUT}$)

RCT

$T_{READOUT\ (\mu s)}$ = T_{ROW} * (HEIGHT + K + EX_R) + EX_C / F_{SYS} + T_{WAIT} + T_{EXP_F} + 0.00005

Frame rate(fps)= 1/Roundup (1000000.0 * $T_{READOUT}$) + 158

C_H

CXP LINK	Pixel Format	SP-5000M_CXP2			SP-5000C-CXP2		
		Width>2112	Width>1984	Width<=1984	Width>2112	Width>1984	Width<=1984
6GX2	Mono8/BayerGR8	165	137	130	165	165	165
	Mono10/BayerGR10	167	139	132	167	167	167
	Mono12/BayerGR12	165	137	130	165	165	165
	RGB8				792	792	792
6GX1	Mono8/BayerGR8	330	264	248	330	330	330
	Mono10/BayerGR10	330	264	248	330	330	330
	Mono12/BayerGR12	330	264	248	330	330	330
	RGB8				1584	1584	1584
3GX2	Mono8/BayerGR8	330	264	248	330	330	330
	Mono10/BayerGR10	330	264	248	330	330	330
	Mono12/BayerGR12	330	264	248	330	330	330
	RGB8				1584	1584	1584
3GX1	Mono8/BayerGR8	660	528	496	660	660	660
	Mono10/BayerGR10	660	528	496	660	660	660
	Mono12/BayerGR12	660	528	496	660	660	660
	RGB8				3168	3168	3168

F_{SYS}

Sensor Pixel Format	F_{SYS}
8bit	72,000,000
10bit	57,600,000
12bit	48,000,000

C_{EXP_F}

Sensor Pixel Format	SP-5000M_CXP2	SP-5000C-CXP2
8bit	168	168
10bit	136	136
12bit	112	112

C_{EXP_B}

Sensor Pixel Format	SP-5000M_CXP2			SP-5000C-CXP2		
	Width>2112	Width>1984	Width<=1984	Width>2112	Width>1984	Width<=1984
8bit	723	735	735	723	723	723
10bit	581	589	590	581	581	581
12bit	490	490	490	490	490	490

Associated GenICam register

GenICam Name	Access	Values	Category
Acquisition Frame Rate	R/W	0.125 to 211	Acquisition Control
Acquisition Frame Rate Raw	R/W	4785 to 8000000	Acquisition Control

7.2. Exposure setting

This section describes how to set the exposure settings.

7.2.1 Exposure Mode

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

Table35. Exposure mode

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

For trigger operation, Exposure Mode must be set to something other than OFF and Trigger Mode of Frame Start must be ON.

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

Table36. Trigger option

Trigger Option setting	Exposure operation
OFF	Timed (EPS) mode
RCT	RCT mode, the video signal is output only if the trigger signal is inout
PIV	PIV (Particle Image Velocimetry) mode
RCT Continuous	RCT mode but, the video signal is also output like a free-running operation

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

Table37. The combination of Exposure Mode, Trigger Option and Trigger Mode

Exposure Mode	Trigger Option	Trigger Mode (Frame Start)	Operation
OFF	N/A	N/A	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
	RCT/ RCT continuous	Forced to ON	RCT Operation Exposure can be controlled by Exposure Time
	PIV	Forced to ON	PIV Operation Exposure can be controlled by Exposure Time
Trigger Width	N/A	Forced to ON	Exposure is controlled by the pulse width of the external trigger

Table 38. 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 RCT PIV RCT Continuous	JAI-Custom

7.2.2 Exposure Time

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

Minimum: 10 μsec
Maximum: 8 seconds

Associated GenICam register

GenICam Name	Access	Values	Category
Exposure Mode	R/W	Off Timed TriggerWidth	Acquisition Control
Exposure Time	R/W	10 to 1000000 [us]	Acquisition Control
Exposure Time Raw	R/W	10 to 1000000 [us]	Acquisition Control

7.2.3 Exposure Auto

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

There are three modes, OFF, Once and Continuous.
OFF: No exposure control
Once: Exposure adjusts when the function is set, then remains at that setting
Continuous: Exposure continues to be adjusted automatically

In this mode, the following settings are available.
ALC Speed: Rate of adjustment can be set
ASC Max: The maximum value for the exposure time to be controlled can be set
ASCMin: 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
ALC Channel area: The measurement area of the exposure control can be set

Associated GenICam register

GenICam Name	Access	Values	Category
Exposure Auto	R/W	Off Continuous Once	Acquisition Control
Exposure Auto Max	R/W	100 to 1000000	JAI-Custom
Exposure Auto Min	R/W	100 to 1000000	JAI-Custom

7.3. Trigger Control

7.3.1 Trigger Source

The following signals can be used as the trigger source signal.
OFF
Line 5 (Input to Opt In 1 and output from Digital IO
Line 4 (Input to TTL In1 and output from Digital IO
User Out 0 to 3
Trigger Packet IN
Soft Trigger
Pulse Generator 0 to 3
NAND1/NAND2

7.3.2 Trigger activation

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

Table – 16 Trigger activation for each trigger mode

	RisingEdge	FallingEdge	LevelHigh	LevelLow
Timed	○	○	×	×
TriggerWidth	×	×	○	○
Timed - PIV	○	○	×	×
Timed - RCT	○	○	×	×

7.3.3 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 the sensor readout.

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

7.3.4 Associated GenICam register

GenICam Name	Access	Values	Category
Trigger Selector	R/W	Acquisition Start Acquisition End Frame Start	Acquisition Control
Trigger Mode	R/W	On Off	Acquisition Control
Trigger Software	W	Command	Acquisition Control
Trigger Source	R/W	Low High Soft Frame Trigger Wait Frame Active Exposure Active FVAL PG0 to PG3 User out0 to 3 TTL in Optp1 in CXP in (Trigger Packet) Nand0 to 1	Acquisition Control
Trigger Activation	R/W	Rising Edge Falling Edge Level High Level Low	Acquisition Control
Trigger Over Lap	R/W	Off Read out	Acquisition Control

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

This is used for applications which do not require triggering. In this mode, the video signal for the auto-iris lens is available if AUX connector is configured with option Type 2.
For the video timing, refer to chapter 6.3.
The frame rate of full pixels readout is 211 fps.

Primary settings to use this mode

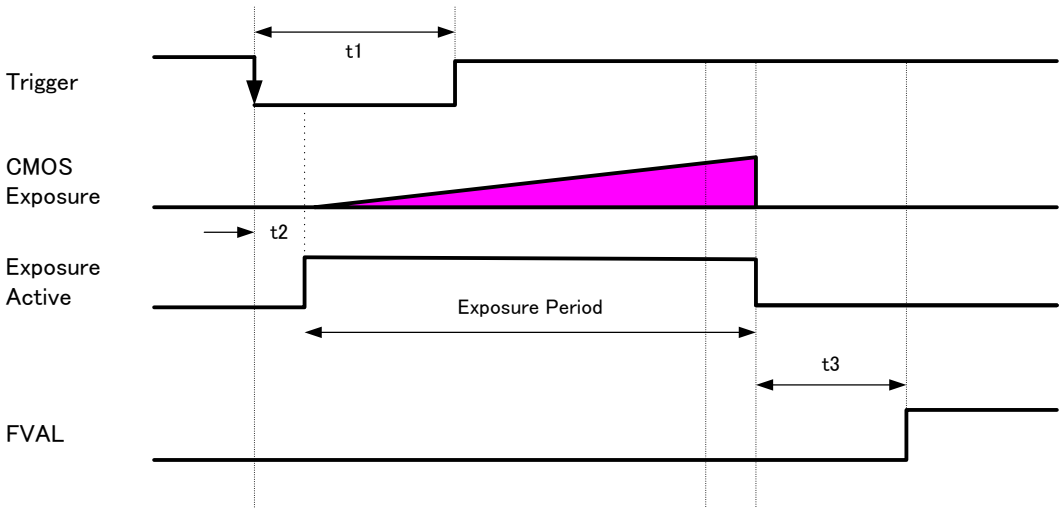
Trigger Mode: Off

7.5. Timed mode

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

Primary settings to use this mode
Exposure Mode: Timed
Trigger Mode: ON

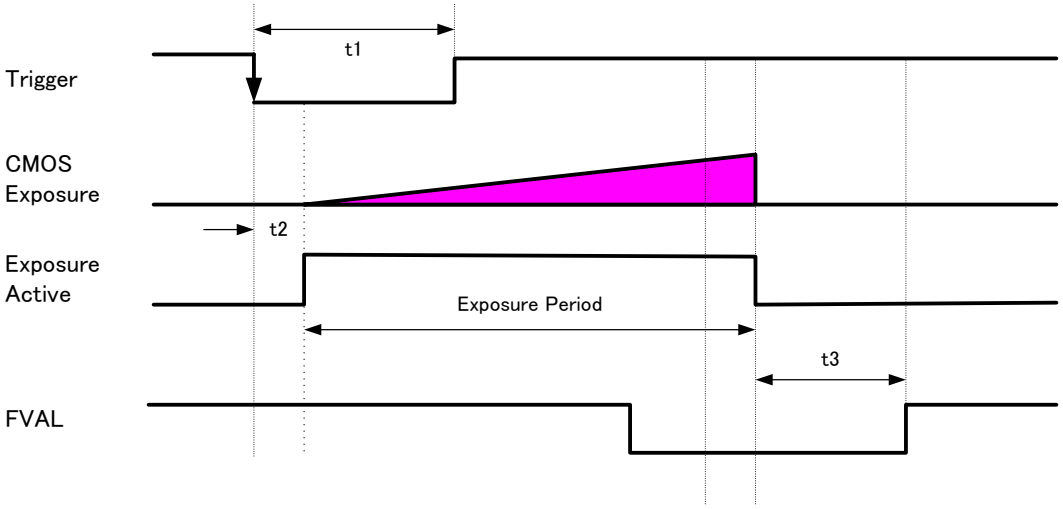
7.5.1 If the overlap setting is "OFF"



t1	t2	T3
2L (Min)	12.2 us	8L to 9L

Fig.24 Overlap OFF

7.5.2 If the overlap setting is “Readout”



t1	t2	t5
2L	12.2 us	8L to 9L

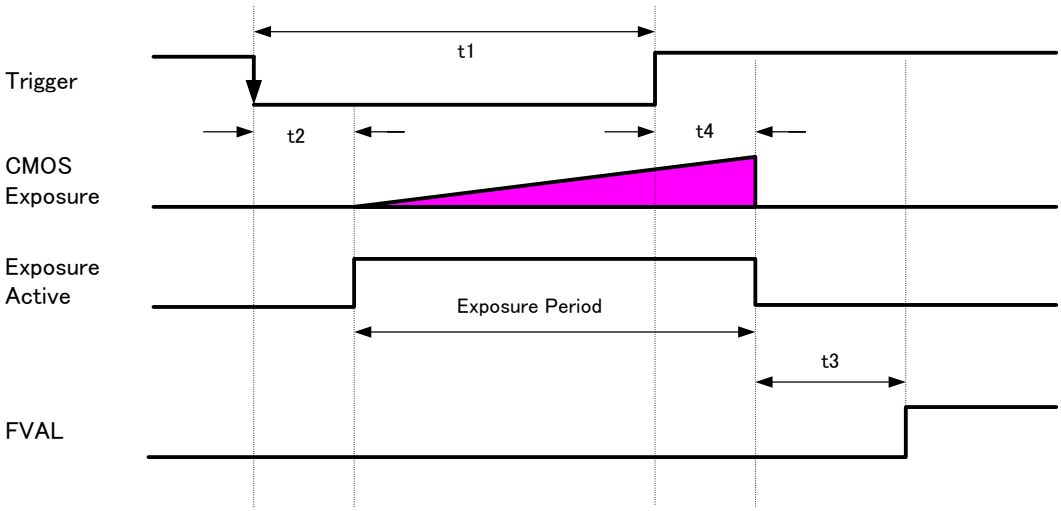
Fig.25 Readout

7.6. Trigger width mode

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

Primary settings to use this mode
Exposure Mode: Trigger Width
Trigger Mode: ON

7.6.1 If the overlap setting is "OFF"

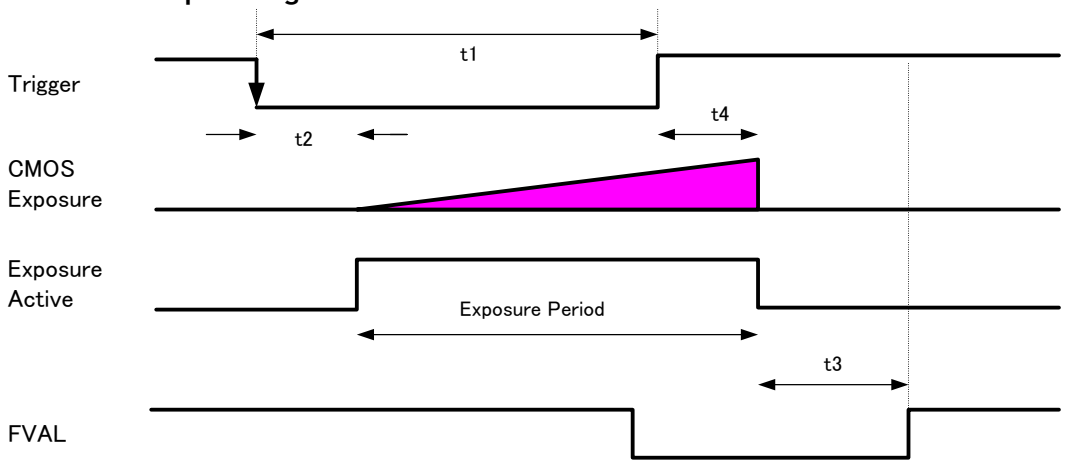


t1	t2	t3	t4
10 μs + 2.7 μs(Min)	12.2 μs	7.5L ～8.5L	8.8 μs

Note: In this mode, Exposure Active signal is -2.7 μs against the external trigger signal. Therefore, the external trigger signal should be +2.7 μs against the required Exposure Active signal.

Fig.26 Overlap = OFF

7.6.2 If the overlap setting is “Readout”



t1	t2	t3	t4
10 μs + 2.7 μs(Min)	12.2 μs	7.5L ～8.5L	8.8 μs

Fig.27 Readout

Note: In this mode, Exposure Active signal is -2.7μs against the external trigger signal. Therefore, the external trigger signal should be +2.7μs against the required Exposure Active signal.

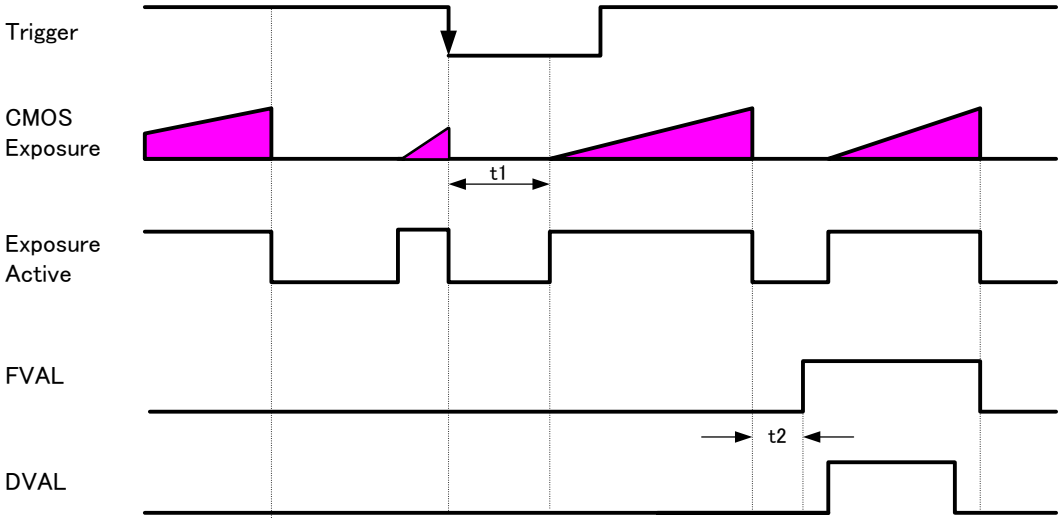
7.7. RCT mode

Until the trigger is input, the camera operates continuously and the video signal for the auto-iris lens is output provided the AUX connector has been ordered with a Type 2 configuration option. At this moment, the video signal, FVAL and LVAL are output but DVAL is not output. When the trigger is input, the fast dump is activated to read out the electronic charge very quickly, after which the accumulation and the readout are performed. When the accumulated signal against the trigger is read out, FVAL, LVAL and DVAL are output too.

Primary settings to use this mode

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

In this mode, the setting of Trigger Overlap is invalid.



t1	t2
56.8 μs	8L ～9L

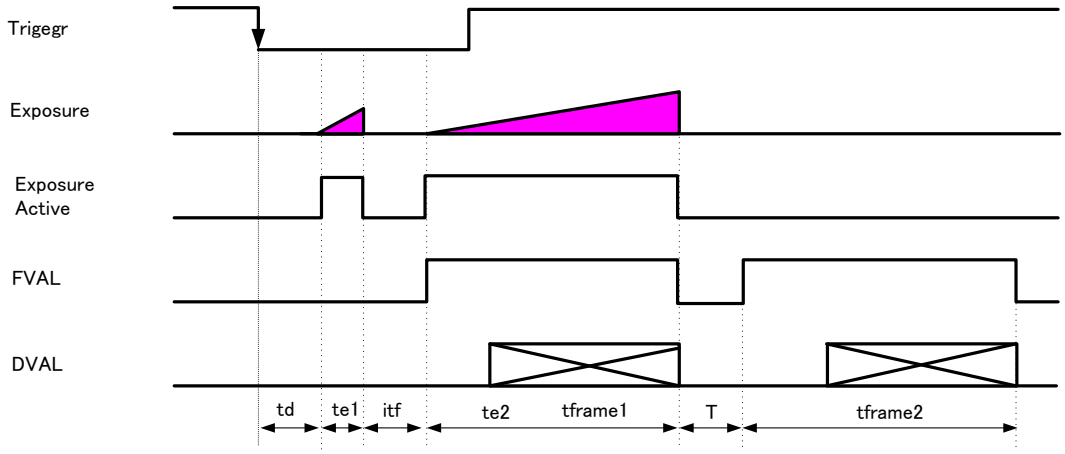
Fig.28 RCT mode timing

7.8. 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 μsec to 2 sec. Then, the second exposure will be taken. The accumulation is LVAL asynchronous. 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.

Primary Settings
Exposure Mode: Timed
Trigger Mode: ON
Trigger Option: PIV

In this mode, the setting of Trigger Overlap is invalid.



time name	description	time
td	Exposure beginning delay	12.2μs
te1	First exposure time period	10μs ～ 1s
te2	Second exposure time	2082L
itf	Inter framing time	12.8μs
T	FVAL non active	36 ～37 L
tframe1	First Frame read out	1 frame
tframe2	Second Frame read out	1 frame

Fig.29 PIV mode

7.9. Sequence Mode

This mode allows the user to define a preset sequence of up to 10 images, each with its own ROI, exposure time and gain values. In this mode, auto functions such as AGC, ASC, AIC and AWB are not available.

7.9.1 Video send mode

The sequential trigger mode is selected via the Video Send Mode command and has the following options.

Video send mode	How to select the index
Trigger Sequence	Select the index by the Frame Start trigger signal. (The setting index can be determined by the next index setting.)
Command Sequence	Select the index number to assign directly by the Command Sequence Index command.

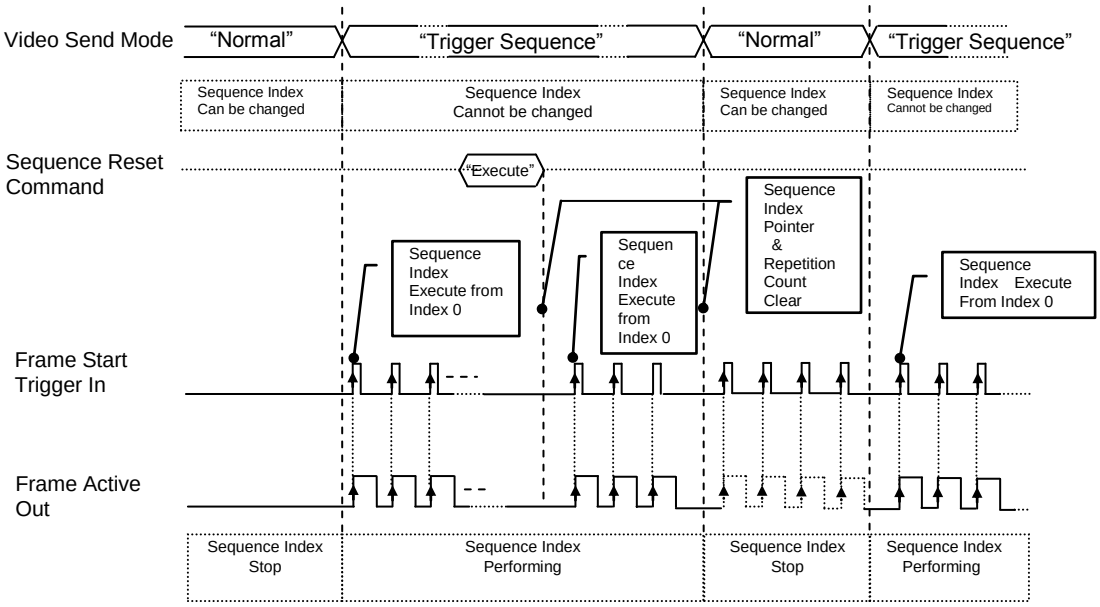


Fig. 30 Behavior if Video Send Mode is set to Trigger Sequence

7.9.2 Sequence mode basic timing

In this mode, as each trigger input is received, the image data associated with the next index within the preset sequence is output.

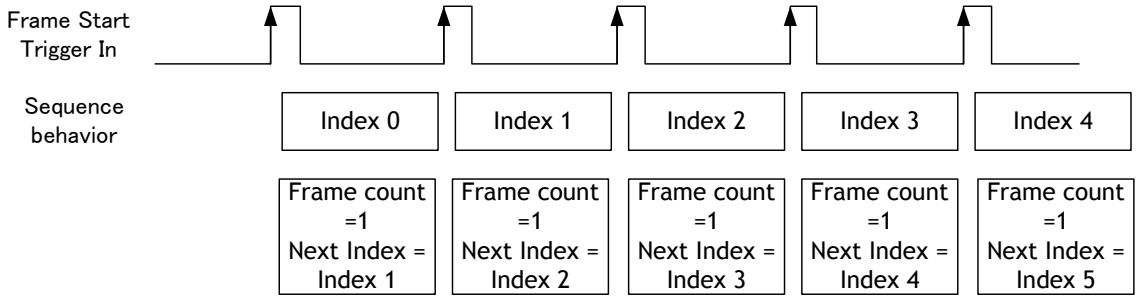


Fig. 31 Behavior of Sequence trigger

7.9.3 Sequence ROI setting parameters

7.9.3.1 Sequence index table (Default)

The following table shows the default settings.

Table – 17 Sequence Index table (Default)

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

7.9.3.2 Descriptions of index table parameters

(1) Sequence ROI Index Selector
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.

(2) Sequence ROI Width
Set the width of sequence ROI. The setting range is 16 to 2560 pixels.
Rules for setting area and step number are the same as the normal ROI mode set by [Video Send Mode] =“Normal”.

(3) Sequence ROI Height
Set the height of sequence ROI. The setting range is 1 to 2048 lines.
Rules for setting area and step number are the same as the normal ROI mode set by [Video Send Mode] =“Normal”.

(4) Sequence ROI Offset X
Set Offset X of sequence ROI.
Sequence ROI Binning Horizontal = 1 (Off):
Setting range is 0 to (2560 - [Sequence ROI Width])
Sequence ROI Binning Horizontal = 2 (On):
Setting range is 0 to (1280 - [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”.

(5) Sequence ROI Offset Y
Set Offset Y of sequence ROI.
Sequence ROI Binning Vertical = 1 (Off):
Setting range is 0 to (2048 - [Sequence ROI Height])
Sequence ROI Binning Vertical = 2 (On):
Setting range is 0 to (1024 - [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”.

(6) Sequence ROI Gain Selector
In Sequence ROI Gain Selector, the gain settings for each index are available.
SP-5000C-CXP2: Gain (ALL), Red and Blue can be set.
SP-5000M-CXP2: Only Gain is displayed and can be set.

(7) Sequence ROI Black Level
Black Level setting is available for each index.

(8) Sequence ROI Exposure Time
Exposure Time setting is available for each index.

(9) Sequence ROI Binning Horizontal
ON or OFF of Horizontal Binning for each index can be set.

(10) Sequence ROI Binning Vertical
ON or OFF of Vertical Binning for each index can be set.

(11) Sequence ROI LUT Enable
Enable or disable of LUT function for each index 0 to 9 can be set.

(12) Sequence ROI Frame Count
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.

(13) Sequence ROI Next Index
The number of the index that will follow the current index can be set.
If [Video Send Mode] is set to “Trigger Sequence” and the trigger pulse is input in EPS trigger, the sequence is executed from index 0.

(14) Sequence ROI Reset Command
This command resets the current index pointer and reverts to index 0 in the table. Frame Count is also re-initialized.

7.9.4 Associated GenICam register

GenICam Name	Access	Values	Category
Video Send Mode Selector	R/W	Normal Trigger Sequence Command Sequence Multi ROI	JAI-Custom
Sequence ROI Index	R/W	0 to 9	JAI-Custom
Sequence Repetition	R/W	0 to 255	JAI-Custom
Sequence ROI Frame Count	R/W	0 to 255	JAI-Custom
Sequence ROI Next Index	R/W	0 to 10	JAI-Custom
Sequence ROI Width	R/W	0 to 2560	JAI-Custom
Sequence ROI Height	R/W	0 to 2048	JAI-Custom
Sequence ROI OffsetX	R/W	0 to (2560 – Sequence ROI Width)	JAI-Custom
Sequence ROI OffsetY	R/W	0 to (2048 – Sequence ROI Height)	JAI-Custom
Sequence ROI Gain	R/W	100 to 1600	JAI-Custom
Sequence Exposure Time	R/W	10 to Acquisition Frame rate Raw	JAI-Custom
Sequence ROI H Binning	R/W	1 or 2	JAI-Custom
Sequence ROI V Binning	R/W	1 or 2	JAI-Custom
Sequence ROI LUT Enable	R/W	Off On	JAI-Custom
Sequence ROI Black Level	R/W	-256 to 255	JAI-Custom
Sequence ROI Gain Red (for Color Model)	R/W	-4533 to 17713	JAI-Custom
Sequence ROI Gain Blue (for Color Model)	R/W	-4533 to 17713	JAI-Custom

7.10 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”.

Table - 18 Multi ROI Index table default values

Multi ROI Index Max	1		
Multi ROI Width	2560		
Multi ROI Index Selector	Multi ROI		
	Height	Offset	
		X	Y
- Index 1	1	0	0
- Index 2	1	0	0
- Index 3	1	0	0
- Index 4	1	0	0
- Index 5	1	0	0
- Index 6	1	0	0
- Index 7	1	0	0
- Index 8	1	0	0

7.10.1 Multi ROI setting parameters

(1) Multi ROI Index Max : Setting value = 1 ～ 8

Maximum 8 ROI settings are possible in a frame. Set Index 1 through 8 in Multi ROI Index table as an application requires.

(2) Multi ROI Width

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.

(3) Multi ROI Index Selector :

Index 1 to 8 can be selected. [Height], [Offset X], and [Offset Y] of the selected Multi ROI Index are displayed and can be set.

(4) Multi ROI Offset X :

Offset X can be set for each ROI area of Multi ROI Index 1 to 8.

The restriction for setting Step and other factors are the same as the normal ROI setting.

As described before, in Multi ROI operation, Multi ROI Width is a common width setting for Multi ROI Index 1 to 8.

(5) Multi ROI Height :

Height can be set for each ROI area of Multi ROI Index 1 to 8.

The restriction for setting Step and other factors are the same as the normal ROI setting.

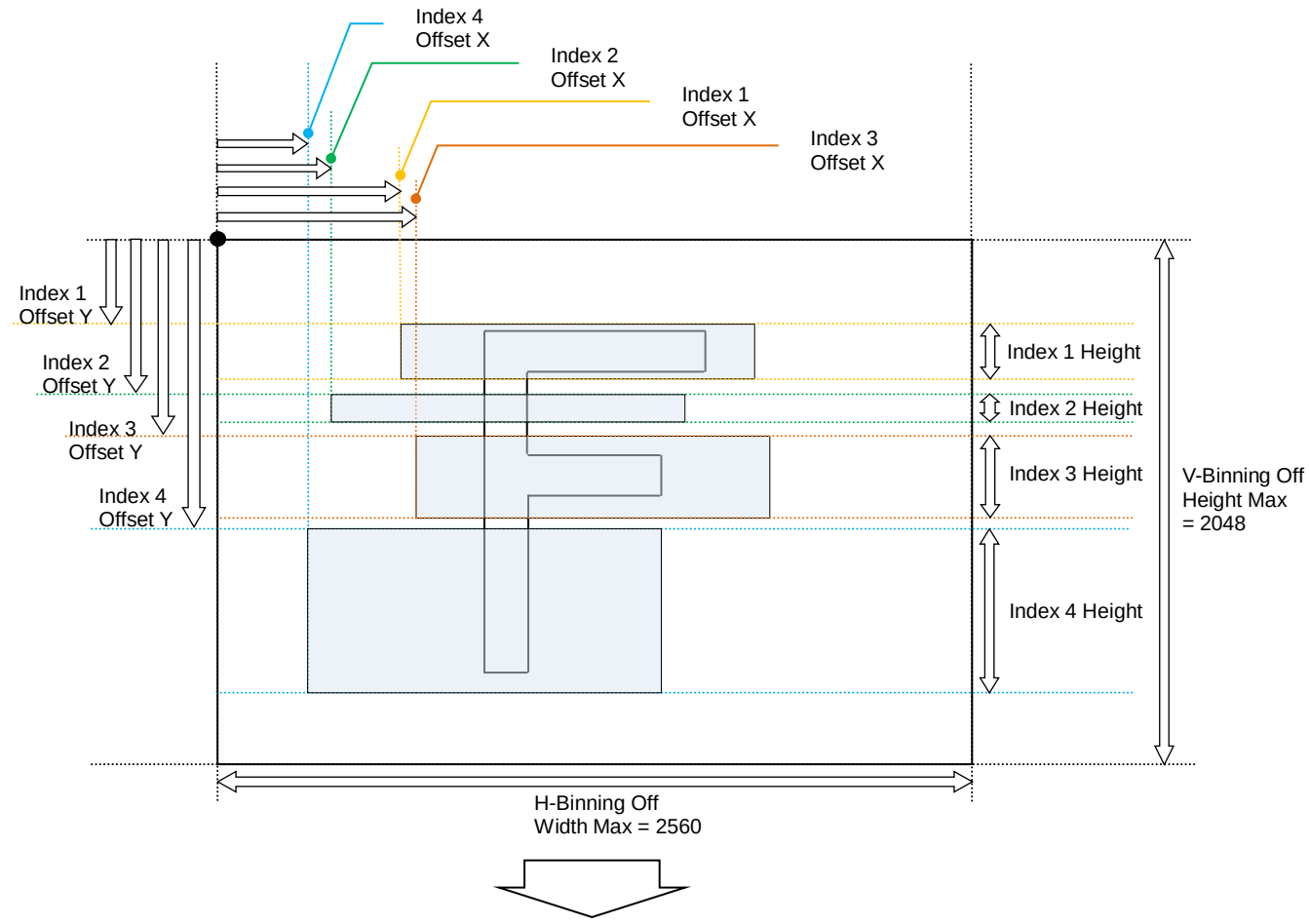
(6) Multi ROI Offset Y :

Offset Y can be set for each ROI area of Multi ROI Index 1 to 8.

The restriction for setting Step and other factors is the same as the normal ROI setting.

The sum of Multi ROI Height values of index 1 to 8 should be less than Height Max.

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



Video output of Multi ROI

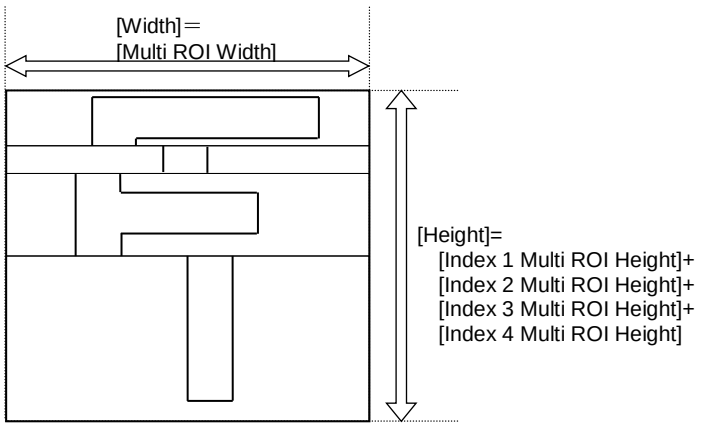


Fig. 32 Multi ROI settings and output image

7.10.2 Associated GenICam register

GenICam Name	Access	Values	Category
Video Send Mode Selector	R/W	Normal Trigger Sequence Command Sequence Multi ROI	JAI-Custom
Multi ROI Index	R/W	1 to 8	JAI-Custom
Multi ROI Width	R/W	0 to 2560	JAI-Custom
Multi ROI Next Index	R/W	1 to 8	JAI-Custom
Multi ROI Offset X	R/W	0 to 2560 – Multi ROI Width	JAI-Custom
Multi ROI Height	R/W	0 to 2048	JAI-Custom
Multi ROI Offset Y	R/W	0 to 2048 – Multi ROI Height	JAI-Custom

7.11. Operation and function matrix

Table – 19 Operation and function matrix

Trigger Mode	Trigger mode	Trigger option	V. Binning (Note1)	H. Binning (Note1)	Exposure Time	ROI	Auto White Balance (Note2)	Auto Iris Output	Auto gain	Auto Exposure	Over Lap
OFF	OFF	OFF	1	1	×	○	○	○	○	×	×
			2	2	×	○	○	○	○	×	×
Timed	OFF	OFF	1	1	○	○	○	○	○	○	×
			2	2	○	○	○	○	○	○	×
Timed (EPS)	ON	OFF	1	1	○	○	○	○ (Note3)	○	○	○
			2	2	○	○	○	○ (Note3	○	○	○
Trigger Width	ON	OFF	1	1	×	○	○	○ (Note3	○	×	○
			2	2	×	○	○	○ (Note3	○	×	○
Timed (RCT)	ON	RCT	1	1	○	○	○	○	○	○	×
			2	2	×	×	○	×	×	×	×
Timed (PIV)	ON	PIV	1	1	×	○	×	×	×	×	×
			2	2	×	×	×	×	×	×	×

Note 1. Only SP-5000M-CXP2
Note 2: Only SP-5000C-CXP2
Note 3: If the trigger interval is long, iris may exhibit a hunting phenomenon.

8. Other functions

8.1 Black level control

This function adjusts the setup level.
The adjusting level is -63 to +64LSB at 10-bit output.

8.1.1 Black Level Selector

The following factors can be set.

SP-5000M-CXP2: DigitalAll
SP-5000C-CXP2: DigitalAll/DigitalRed/ DigitalBlue

8.1.2 Black Level

The black level can be set in the following range.

SP-5000M-CXP2: DigitalAll : -256 ～255
SP-5000C-CXP2: DigitalAll : -256～255
DigitalRed/DigitalBlue : -512～ +511

8.1.3 Associated GenICam register

GenICam Name	Access	Values	Category
Black Level Selector	R/W	Digital All	Analog Control
Black Level Raw	R/W	-256 to 255	Analog Control

8.2 Gain control

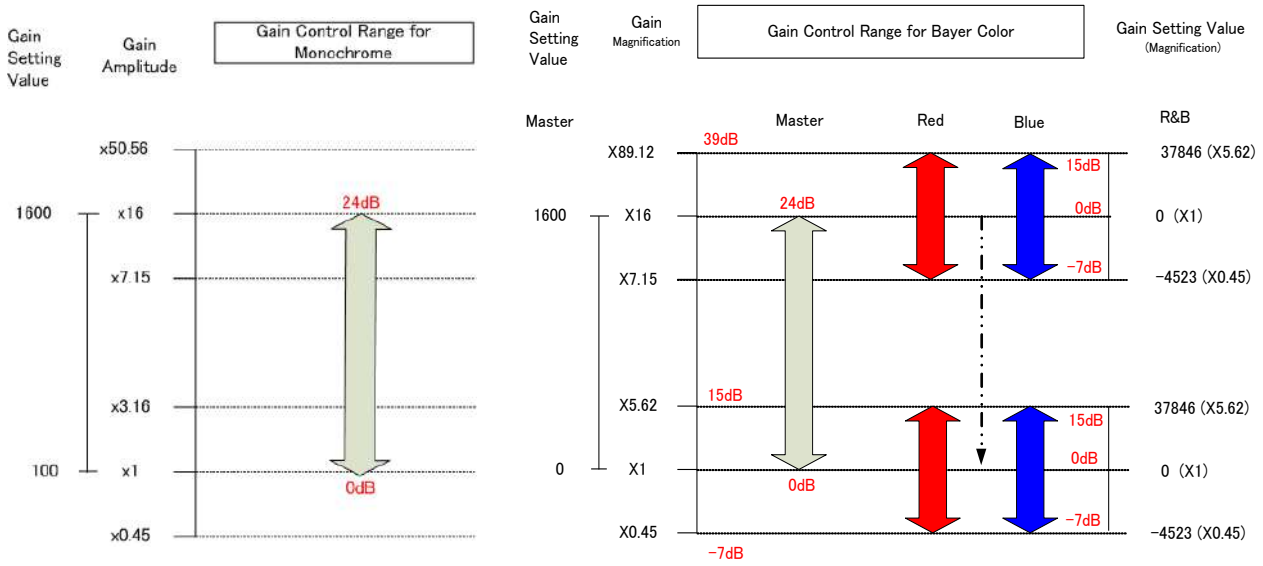
In the SP-5000-CXP2, the gain control uses Analog Base Gain and Digital Gain.
Analog Base Gain can be set at 0dB, +6dB or +12dB. The digital gain is used for the master gain setting.

For setting the gain,

1. Set analog gain (Select from 0dB, +6dB and +12dB)
2. Set digital gain
   The master gain (DigitalAll) for both monochrome and color can be set x1(0dB) to x16(+24dB) against the analog base gain. The resolution for gain setting is 0.01%/step which is 0.05dB to 0.08dB, depending on the setting value.
   In the SP-5000C-CXP2, blue and red gain can be set from x0.45 to x5.62 against the master gain setting and its resolution is x0.01/step.
3. In the SP-5000C-CXP2, Analog Gain can be applied to R, G and B channel respectively in order to cover wider range of color temperature.

Note1: If the gain up function is used, it is recommended to use the analog base gain as the master gain setting. For instance, if +12dB gain up is required, the analog base gain is set at +12dB and no digital gain is added. This is because the signal-to-noise is better on analog gain performance. However, the AGC function works only in digital gain.
Additionally, the analog base gain is effective in order to minimize gaps in the histogram at higher gain settings. Please note that the analog base gain has less accuracy due to its variability.

Note2: If Analog Base Gain is set at 0dB and Digital Gain is used at high gain setting, the video level may be unstable and fluctuating approx. 5%. In this case, it is suggested to set the analog base gain at +6dB or +12dB.



The above drawing shows the relation among gain setting value (command), gain amplitude, and dB indication. For example, the gain amplitude “x 3.16” equals 10dB.

Fig.33 Gain control

8.2.1 Gain Selector

The following parameters can be set.

SP-5000M-CXP2: DigitalAll
SP-5000C-CXP2: DigitalAll/Digital Red All/Digital Blue All

8.2.2 Gain

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

SP-5000M-CXP2: DigitalAll : 1～16 (0dB to +24dB)
SP-5000C-CXP2: DigitalAll : 1～16 (0dB to +24dB)
Digital Red All : 0.4466～5.6235
Digital Blue All : 0.4466～5.6235

8.2.3 Gain Raw

The gain raw can be adjusted in the following range.

SP-5000M-CXP2: DigitalAll : 100～1600
SP-5000C-CXP2: DigitalAll : 100～1600
Digital Red All/Digital Blue All : -45～379

8.2.4 Gain Auto

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

There are three modes.

OFF: Adjust manually.
Once: Operate only one time when this command is set
Continuous: Operate the auto gain continuously
The following detailed settings are also available.
ALC Speed: The rate of adjustment of GainAuto can be set (Common with ExposureAuto).
Gain Auto Max: The maximum value of GainAuto control range can be set
Gain Auto Min: The minimum value of GainAuto control range can be set
ALC Reference: The reference level of Gain Auto control can be set (Common with ExposureAuto)
ALC channel area: The measurement area of GainAuto control can be set, either entire area or individual section (Common with ExposureAuto)

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

Fig. 34 Channel area

8.2.5 Balance White Auto

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

OFF: Manual operation
Once: Only when this operation is set, the auto white balance is executed.
Continuous: The auto white balance is continuously executed.
4600K/5600K/6500K: Preset color temperature setting

8.2.6 Associated GenICam register

GenICam Name	Access	Values	Category
Balance White Auto (for Color)	R/W	Off Once Continuous Preset4600K Preset5600K Preset6500K	Analog Control
Balance White Channel Area ALL	R/W	Off On	JAI-Custom
Balance White Channel Area Low Right	R/W	Off On	JAI-Custom
Balance White Channel Area Low Middle Right	R/W	Off On	JAI-Custom

Balance White Channel Area Low Middle Left	R/W	Off On	JAI-Custom
Balance White Channel Area Low Left	R/W	Off On	JAI-Custom
Balance White Channel Area Middle Low Right	R/W	Off On	JAI-Custom
Balance White Channel Area Middle Low Middle Right	R/W	Off On	JAI-Custom
Balance White Channel Area Middle Low Middle Left	R/W	Off On	JAI-Custom
Balance White Channel Area Middle Low Left	R/W	Off On	JAI-Custom
Balance White Channel Area Middle High Right	R/W	Off On	JAI-Custom
Balance White Channel Area Middle High Middle Right	R/W	Off On	JAI-Custom
Balance White Channel Area Middle High Middle Left	R/W	Off On	JAI-Custom
Balance White Channel Area Middle High Left	R/W	Off On	JAI-Custom
Balance White Channel Area High Right	R/W	Off On	JAI-Custom
Balance White Channel Area High Middle Right	R/W	Off On	JAI-Custom
Balance White Channel Area High Middle Left	R/W	Off On	JAI-Custom
Balance White Channel Area High Left	R/W	Off On	JAI-Custom

8.3. LUT

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.

8.3.1 LUT Mode

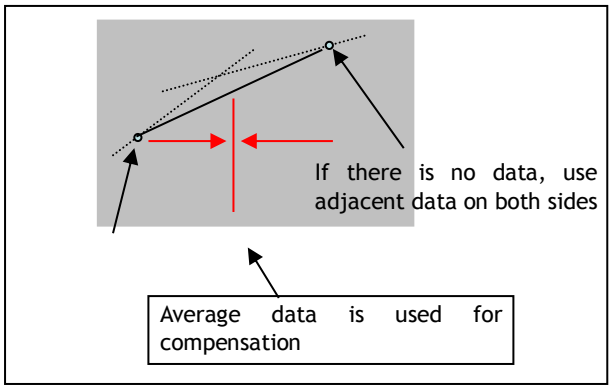
Can be selected from OFF, Gamma or LUT Table.

8.3.2 LUT Index

This represents the “starting” or “input” pixel value to be modified by the Lookup Table. The SP-5000-CXP2 has a 256-point Lookup Table, meaning the index points are treated like an 8-bit 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 configurations.

8.3.3 LUT value

This is the “adjusted” or “output” pixel value for a given LUT index. It has a range of 0 to 4095 (12-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

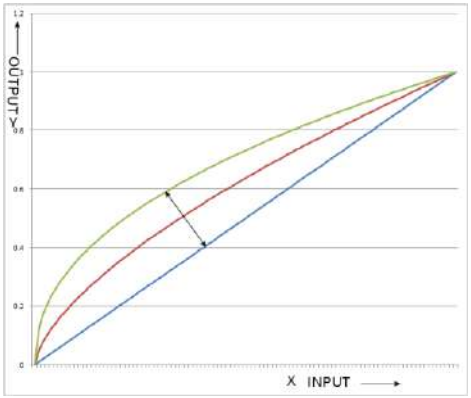
Fig. 35 LUT value

8.3.4 Associated genICam register

GenICam Name	Access	Values	Category
Gamma	R/W	0 to 15	Analog Control
JAI LUT Mode	R/W	Off Gamma LUT	Analog Control
LUT Selector	R/W	Mono (for mono) Red/Green/Blue (for Color)	LUT Control
LUT Index	R/W	0 to 255	LUT Control
LUT Value	R/W	0 to 4095	LUT Control

8.4. Gamma

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



]

Fig. 36 Gamma compensation

8.4.1 Linear and Dark Compression

SP-5000-CXP2 has a dark compression circuit to improve the signal-to-noise ratio in the dark portion of the image.

Dark Compression 0: Dark Compression
1: Linear (Default)

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

8.5. 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.

There are two methods of correction.

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

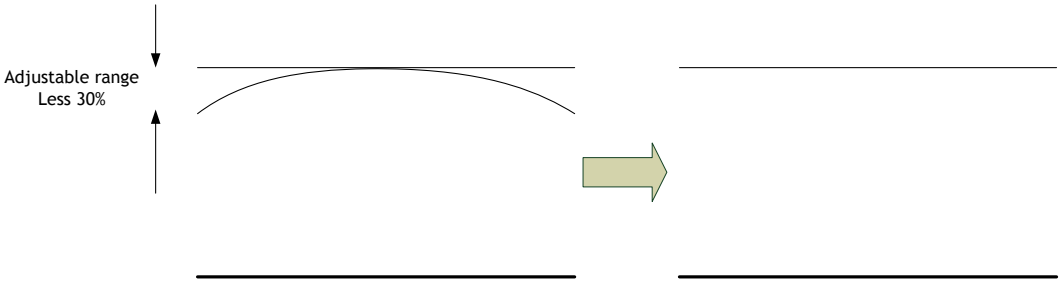


Fig. 37 Flat shading correction concept drawing

Color shading correction (For SP-5000C-CXP2 only):
In this case, R channel and B channel are adjusted to match with G channel characteristics. The block grid for compensation is 20 blocks (H) x 16 blocks (V). Each block contains 128 x 128 pixels and the complementary process is applied to produce the compensation data with less error.

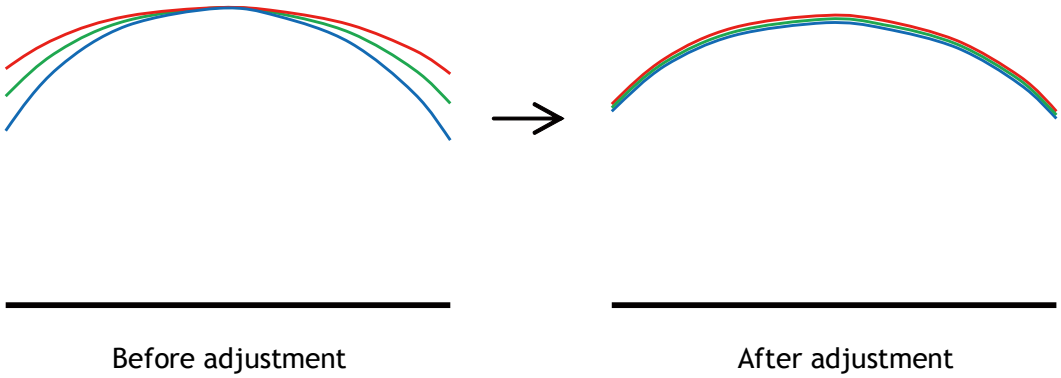


Fig.38 Color shading correction concept drawing

Note: Under the following conditions, the shading correction circuit may not work properly.

- 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

GenICam Name	Access	Values	Category
Shading Correction Mode (Only Color Model)	R/W	Flat Shading Color Shading	JAI-Custom
Shading Correct	WO	True	JAI-Custom
Shading Mode	R/W	Off User1 User2 User3	JAI-Custom

8.6. Blemish compensation

The SP-5000M-CXP2 and SP-5000C-CXP2 have 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 adjacent pixels in both columns and, in the case of the SP-5000C-CXP2, the defective pixels can be compensated by the same Bayer color pixels in both adjacent columns. The number of pixels that can be compensated is up to 512 pixels.

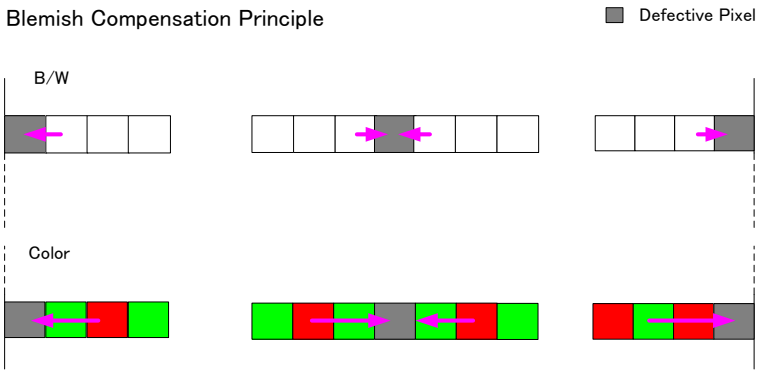


Fig. 39 Blemish compensation

If several consecutive pixels are defective in the horizontal direction, 3 pixels for monochrome and 2 same color pixels for color can be compensated.

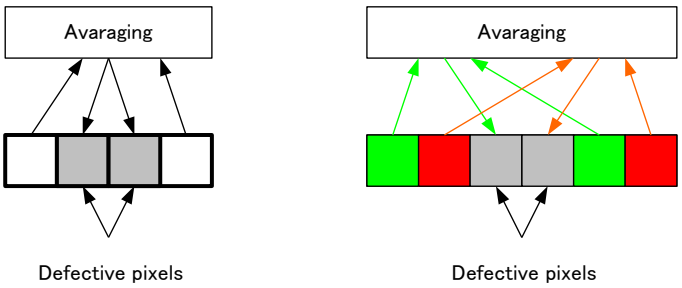


Fig 40. Compensation of consecutive defective pixels

Associated GenICam regsiter

GenICam Name	Access	Values	Category
Blemish Selector	R/W	White	JAI-Custom
Blemish White Enable	R/W	False True	JAI-Custom
Blemish White Detect	R/W	2	JAI-Custom
Blemish White Detect Threshold	R/W	0 to 100	JAI-Custom
Blemish White Detect Position Index	R/W	0 to 511	JAI-Custom
Blemish White Detect Position X	R/W	0 to 2559	JAI-Custom
Blemish White Detect Position Y	R/W	0 to 2047	JAI-Custom

8.7. Bayer color interpolation (Only for SP-5000C-CXP2)

This function is available only for SP-5000C-CXP2. The SP-5000C-CXP2 uses a CMOS sensor with an RGB Bayer pattern. If the in-camera Bayer color interpolation is not used, the following RAW data can be output.

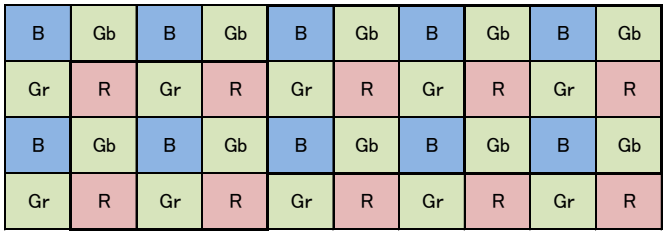


Fig.41 Bayer pattern

The RAW data contains only luminance information for each color and outputs as a monochrome signal. The Bayer color interpolation function can complement lacking color information on each pixel and output RGB color data as the result. Color interpolation compensates for the lack of color information by using information from adjacent pixels. The following is the concept drawing for the color interpolation process.

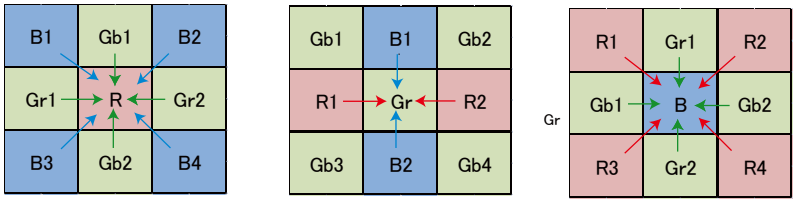


Fig.42 Color interpolation concept drawing

8.8 Lens control

The SP-5000M-CXP2 and SP-5000C-CXP2 can be used with 4 different types of auto iris lenses, in addition to standard lenses with manual iris control. If an auto iris function is to be utilized, the lens type used must be selected in Lens Select.

Table -20 Lens selector

Lens Select	Description (Control with camera)	Note
P-Iris Lens	1) Iris position can be remotely controlled manually 2) Auto iris control is also available	If P-iris lens is used, the specific model name should be selected in Lens Select.
Motor controlled lens	1) Iris position can be remotely controlled manually 2) Auto iris control is also available	
Video iris lens	Only auto iris control is available	Factory Option
DC iris lens	Only auto iris control is available	Factory Option

8.8.1 About P-Iris

New Spark Series SP-5000M-CXP2 and SP-5000C-CXP2 come equipped with P-Iris control as part of the standard lens control function. The P-Iris system is a newly developed lens control method designed to control the iris more precisely. Especially for video cameras in surveillance applications utilizing megapixel CCD or CMOS imagers, it becomes a very important factor to control an iris in order to achieve the maximum camera performance. In surveillance applications, depending on shooting conditions, resolution and depth of field are important factors. The iris is deeply related with these factors. If the iris diaphragm is smaller, but not too small, resolution gets better and the depth of field is also deeper. The P-Iris system controls the iris diaphragm precisely and maintains the best image with the highest resolution and depth of field. P-Iris can also combine with gain and electronic shutter to keep the appropriate iris position under changing lighting conditions (ALC function).

8.8.2 Setting for P-iris lens being used

P-iris lenses use an absolute setting value control system and therefore, if the following parameters are input, precise iris position control is possible.

8.8.2.1 P-Iris lens select

Select the lens used from the P-iris select list. At this moment, there are no 1-inch P-Iris lenses available in the list. When P-Iris Les Select is opened, the following lenses are indicated but they are 2/3 inch format. If they are used, the corners of the image may be vignetted.

Table – 21 P-iris lens select

P-Iris lens select	Description	Control step number	Open F value
LM16JC5MM	Kowa 16mm 2/3”	74	F1.4
LM35JC5MM	Kowa 35mm 2/3”	73	F2.0

8.8.2.2 Step max.

Iris control step depends on lens. The setting value uses the value stored in the camera.

8.8.2.3 Position

The iris position can be set between 0 to Step Max. 0 means to open the iris and Step Max means to close the iris.

In the following conditions, the camera initializes P-iris control and acquires iris position.

1) When the camera is powered
2) When the lens is selected in P-Iris Lens Select
3) If the lens is changed in P-iris Lens Select

8.8.2.4 Current F value

The current F value is indicated by using iris position information. This can be indicated during auto iris operation. The relation between iris position and F value depends on the lens used.

8.8.2.5 P-Iris Auto min. / P-Iris Auto max.

This function can set the control range when the iris is operated automatically. Auto max. sets the limit when the iris goes open and Auto min. sets the limit when the iris goes closed. Auto max. can be set to fully open but Auto min. is stopped at F5.6 as lens performance typically degrades if the iris is closed beyond this point.

8.8.3 Motorized lenses

The SP-5000C-CXP2 and SP-5000C-CXP2 can use the 3-axis motorized lens control for zoom, focus and iris. The following functions are available via the motorized lens commands.

8.7.3.1 Iris

Open: While this command is supplied, the iris will continue to open.
Close: While this command is supplied, the iris will continue to close.
Stop: When this command is supplied, the iris operation stops.

8.8.3.2 Zoom

Wide: While this command is supplied, the zoom will continue to move towards wide angle.
Tele: While this command is supplied, the zoom will continue to move towards telephoto.
Stop: When this command is supplied, the zoom operation stops.

8.8.3.3 Focus+

Near: While this command is supplied, the focus will continue to shift closer to the camera.
Far: While this command is supplied, the focus will continue to move towards infinity.
Stop: When this command is supplied, the focus operation stops.

8.8.4 Associated GenICam register

GenICam Name	Access	Values	Category
Lens Select	R/W	None PIris Lens Motor Lens	JAI-Custom
PIris Step Max	R/W	0 to 255	JAI-Custom
PIris Position	R/W	0 to 73	JAI-Custom
PIris Lens Select	R/W	LM16JC5MM	JAI-Custom
PIris Auto Min	R/W	F_OPEN F_14 F_20 F_28 F_40 F_56 F_80 F_110 F_160 F_220 F_320 F_CLOSE	JAI-Custom
PIris Auto Max	R/W	F_OPEN F_14 F_20 F_28 F_40 F_56 F_80 F_110 F_160 F_220 F_320 F_CLOSE	JAI-Custom
Auto Iris Lens Control Signal Output	R/W	Off On	JAI-Custom
Motor Lens Iris	R/W	Stop Open Close	JAI-Custom
Motor Lens Zoom	R/W	Stop Wide Tele	JAI-Custom
Motor Lens Focus	R/W	Stop Near Far	JAI-Custom

8.9 ALC

In the SP-5000M-CXP2 and SP-5000C-CXP2, auto gain, auto shutter and auto iris functions 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 linkage between the other two is maintained.

In order to make the ALC function effective, set the Auto Iris Lens Control Signal Output to “ON”. The auto iris function (AIC) works together with AGC and Exposure Auto (ASC).

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

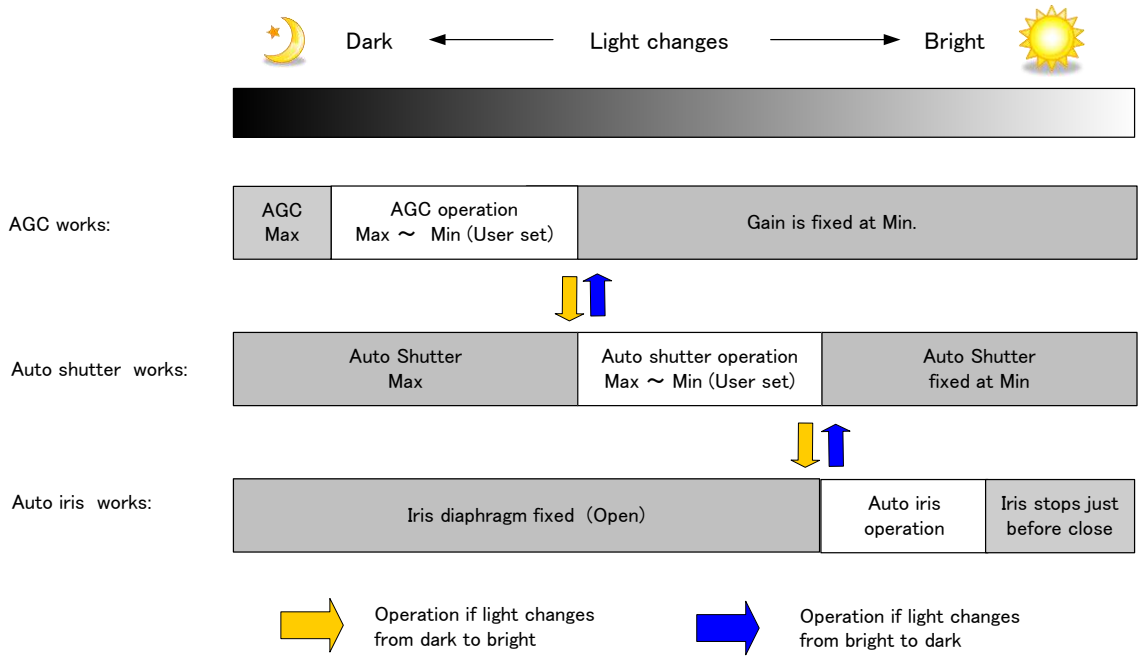


Fig.43 ALC function concept

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

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

Associated GenICam regsiter

GenICam Name	Access	Values	Category
Exposure Auto	R/W	Off Continuous Once	Acquisition Control
Gain Auto	R/W	Off Continuous Once	Analog Control
ALC Speed	R/W	1 to 8	JAI-Custom
ALC Reference	R/W	1 to 100	JAI-Custom
Exposure Auto Max	R/W	101 to 1000000	JAI-Custom
Exposure Auto Min	R/W	100 to 999999	JAI-Custom
Gain Auto Max	R/W	100 to 1600	JAI-Custom
Gain Auto Min	R/W	100 to 1599	JAI-Custom
Auto Iris Lens Control Signal Output	R/W	Off On	JAI-Custom
ALC Channel Area ALL	R/W	Off On	JAI-Custom
ALC Channel Area Low Right	R/W	Off On	JAI-Custom
ALC Channel Area Low Middle Right	R/W	Off On	JAI-Custom
ALC Channel Area Low Middle Left	R/W	Off On	JAI-Custom
ALC Channel Area Low Left	R/W	Off On	JAI-Custom
ALC Channel Area Middle Low Right	R/W	Off On	JAI-Custom
ALC Channel Area Middle Low Middle Right	R/W	Off On	JAI-Custom
ALC Channel Area Middle Low Middle Left	R/W	Off On	JAI-Custom
ALC Channel Area Middle Low Left	R/W	Off On	JAI-Custom
ALC Channel Area Middle High Right	R/W	Off On	JAI-Custom
ALC Channel Area Middle High Middle Right	R/W	Off On	JAI-Custom
ALC Channel Area Middle High Middle Left	R/W	Off On	JAI-Custom
ALC Channel Area Middle High Left	R/W	Off On	JAI-Custom
ALC Channel Area High Right	R/W	Off On	JAI-Custom
ALC Channel Area High Middle Right	R/W	Off On	JAI-Custom
ALC Channel Area High Middle Left	R/W	Off On	JAI-Custom
ALC Channel Area High Left	R/W	Off On	JAI-Custom

8.10 HDR (High Dynamic Range) (SP-5000M-CXP2 only)

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

Notes:

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

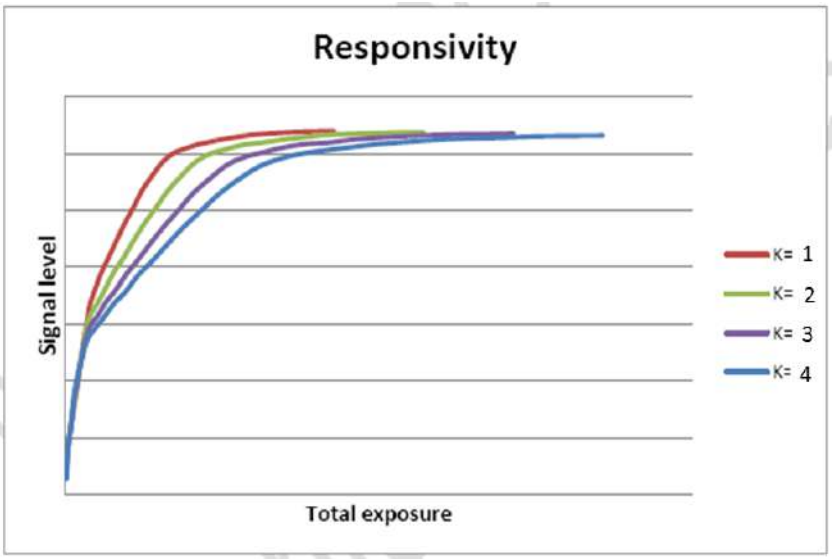


Fig. 44 HDR characteristics

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

Associated GenICam register

GenICam Name	Access	Values	Category
HDR Enable	R/W	Disable Enable	JAI-Custom
HDR Slope	R/W	HDR Slope 200% HDR Slope 400% HDR Slope 800% HDR Slope 1600%	JAI-Custom

9. Camera setting

9.1 Camera Control Tool

In the SP-5000M-CXP2 and SP-5000C-CXP2, control of all camera functions is done by the JAI SDK and Control Tool software. All controllable camera functions are stored in an XML file inside of the camera. The JAI SDK and Control Tool software can be downloaded from www.jai.com.

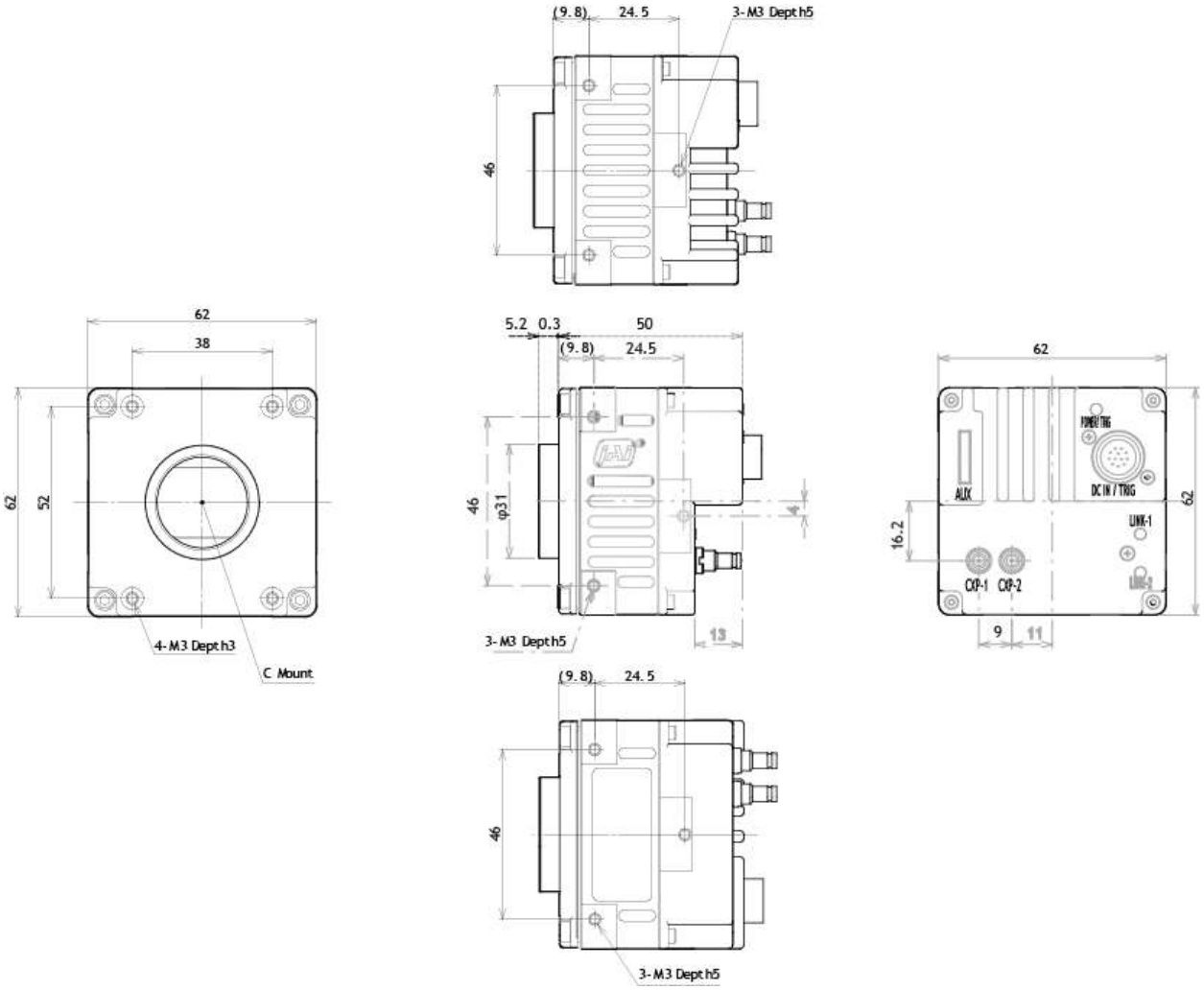
9.2 Camera Default settings

When the camera is connected to a PC and the JAI_SDK is started up, camera setting data (XML file) is downloaded from the camera.

The following table shows default settings of basic functions.

Image Format	Bit allocation	8-bit
	Width	2560
	Height	2048
	Binning Horizontal	1(OFF)
	Binning Vertical	1(OFF)
Link Configuration		CXP-3_2 (Dual, 6.25Gbps))
Acquisition Control	Acquisition mode	Continuous
Trigger Selector		Acqusition Start
	Trigger Mode	OFF
	Trigger Activation	Rising Edge
	Trigger Source	Low
Trigger Overlap		OFF
Exposure Control	Exposure Mode	OFF
Gain	Gain	1
	Gain Auto	OFF
Gamma		1
Video Send Mode		Normal

10. External appearance and dimensions



Dimensions tolerance: ± 0.3mm
Unit: mm

Fig. 45 Outside dimensions

11. Specifications

11.1 Spectral response

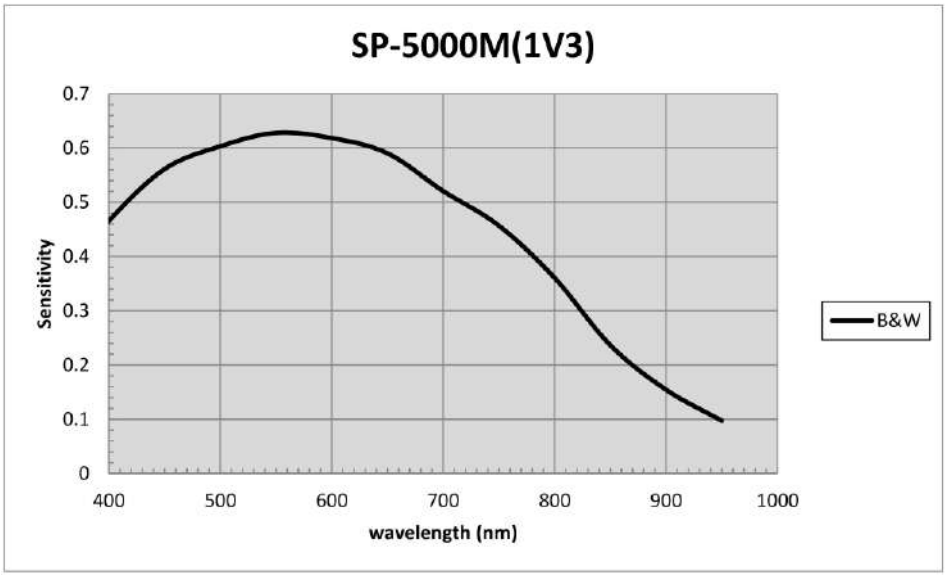


Fig. 46 Spectral response (SP-5000M-CXP2)

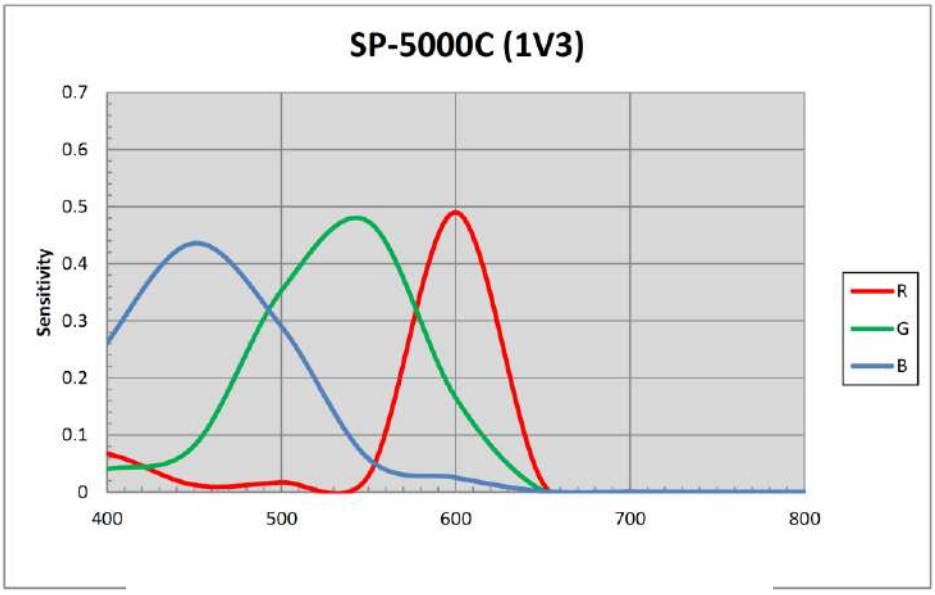


Fig.47 Spectral response (SP-5000C-CXP2) (With IR Cut Filter)

11.2 Specifications table

Specifications				SP-5000M-CXP2	SP-5000C-CXP2
Scanning system				Progressive scan, 1-tap	
Synchronization				Internal	
Interface				CoaXPress (JIIA NIF-001-2010 CoaXPress Standard First Edition) 6.25 Gbps, 2 links, Compliant with PoCXP	
Image sensor				1 inch Monochrome CMOS	1 inch Bayer color CMOS
Aspect Ratio				5:4	
Image size(Effective Image)				12.8 (h) x 10.24 (v) mm, 16.39 mm diagonal	
Pixel size				5 (h) x 5 (v) μm	
Effective Image output Pixels				2560 (h) x 2048 (v)	2560 (h) x 2048 (v)
Pixel Clock				57.6 MHz and 48 MHz Note: The details of pixel clock and link configuration relationship is described in section 5.1.3	
Acquisition Frame Rate Tap Geometry	CXP-6_2 Mono/ Bayer Full pixels	Sensor 8bit		211 fps (max) to 0.125 fps(min)	
		Sensor 10bit		169 fps (max) to 0.125 fps(min)	
		Sensor 12bit		141 fps (max) to 0.125 fps(min)	
	CXP-6_2 RGB Full pixels	Sensor 8bit		—	44 fps (max) to 0.125 fps(min
		Sensor 10bit		—	35 fps (max) to 0.125 fps(min
		Sensor 12bit		—	29 fps(max) to 0.125 fps(min)
	Binning CXP-6_2 Sensor 8bit	H1,V2		421 fps (Max) ～0.125 fps (Min)	–
		H2,V1		211 fps (Max) ～0.125 fps (Min)	–
		H2,V2		421 fps (Max) ～0.125 fps (Min)	–
EMVA 1288 Parameters Absolute sensitivity Maximum SNR				At 10-bit output 23.50 p (λ = 525 nm) 41.48 dB	At 10-bit output 36.08 p (λ = 525 nm) 38.00 dB
SN ratio				55 dB (Typical) (0dB gain, Black)	53 dB (Typical) (0dB gain, Green Black)
Image Output format Digital	Full pixels			2560 (h) x 2048 (v)	Bayer 2560 (h) x 2048 (v)
	ROI	Width		64 ～2560, 64 pixels/step	64 ～2560, 64 pixels/step
		OFFSET X		0 ～2496, 64 pixels/step	0 ～2496, 64 pixels/step
		Height		1 ～2048 lines,1 line/step	2 ～2048 lines,1 line/step
		OFFSET Y		0 ～2047 lines, 1 line/step	0 ～2046 lines, 1 line/step
	Binning	H	1	2560 (H)	2560 (H)
			2	1280 (H)	–
		V	1	2048 (V)	2048 (V)
			2	1024 (V)	–
	CXP output bit assignment			8-bit, 10-bit, 12-bit	BayerRG 8-bit, BayerRG 10-bit, BayerRG 12-bit, RGB 8-bit
Acquisition mode				Continuous / Single Frame / Multi Frame (1 ～255)	
Acquisition Frame Rate				211 fps (Max) ～ 0.125 fps (Min), at 8-bit output	
Trigger Selector				Acquisition Start/ Acquisition End /Frame Start	
Trigger mode				OFF, Continuous, Timed (EPS), Timed (PIV), Trigger Width, Timed (RCT) (w/ALC)	

Trigger option		Trigger Overlap ON/OFF, Long time exposure	
Trigger Input Signal		Line4 (TTL in), Line7 (Trigger packet), NAND0, NAND1, SW, Pulse Generator (4), User Output (4)	
Exposure Mode	Timed (EPS,RCT,PIV Sequential)	10 µs (Min.) ~ 8 second (Max.), Variable unit: 1 µs	
	Trigger Width	10 µs (Min.) ~ ∞ (Max.)	
Auto Exposure		OFF / Once / Continuous	
Auto Exposure Response Speed		1 ~ 8	
Digital I/O		Line Selector (12P): GPIO IN / GPIO OUT	
Black Level Adjust.	Ref. level	33.5LSB 10-bit (Average value of 100*100)	
	Adj. range	-256 ~ 255LSB 10-bit	
	Resolution	1 STEP = 0.25LSB	
Sensor Base Gain		0dB, 6dB, 12dB	0dB
Gain Control	Manual Adj. range	-0dB ~+24dB 1 step=0.01%(0.005dB to 0.08dB) Varies by setting value	-0dB ~+24dB 1 step=0.01%(0.005dB to 0.08dB) Varies by setting value
	WB Gain	–	R / B : -7dB to +15dB, 1 step = 0.01dB
	WB Area	–	4 x 4
	Color Temp. Range (Preset)	–	4600K, 5600K, 6500K
	WB Range	–	3000K ~ 9000K
	White Balance	–	OFF, Once, Continuous
Blemish Comp.	Detection	Detect white blemish above the threshold value (Black blemish is detected only by factory)	
	Compensation	Complement by adjacent pixels (Continuous blemishes are not compensated)	
	Numbers	512 pixels	
ALC		AGC, auto exposure, iris control can be combined and automatically controlled	
Gamma		0.45 ~ 1.0 (16 steps settings are available)	
LUT		OFF: γ=1.0, ON=256 points can be set	
HDR Correction		4 settings Level 1, 2, 3 and 4	–
Shading Compensation		Flat Field Block Comp. (20 x 16 blocks) Block size: 128 x 128 pixels	Flat Field, Color shading Block comp. (20 x 16 blocks) Block size: 128 x 128 pixels
Bayer Color Interpolation		–	3 x 3 matrix, Linear compensation
Power	PoCXP	Complies with	
	Input range	DC+12V to +24V ± 10% (At the input terminal)	
	Power consumption	490mA (At 12V input, Full pixels) 5.9W (At 12V input, Full pixels)	565mA (At 12V input, Full pixels) 6.8W (At 12V input, Full pixels)
Lens mount		C mount Rear protrusion of the lens is less than 10 mm	
Flange back		C mount : 17.526 mm, Tolerance: 0 to -0.05 mm	
Optical filter		Protection glass: Not provided	IR cut filter (Half value is 670 nm)
Operating temperature/Humidity Performance guaranteed		-5°C to +45°C / 20 – 80% (No-condensing)	
Operating Temperature / Humidity		-45°C to +70°C/20% to 80% (No-condensing)	
Storage Temp. / Humidity		-45°C to +70°C/20% to 80 % (no-condensing)	

Regulation	CE (EN61000-6-2 and EN61000-6-3), FCC part 15 class B, RoHS, WEEE
Housing Dimensions	62 x 62 x 55.5 mm (W x H x D) (excluding protrusion)
Weight	215g

Note1): Approximately 5 minutes pre-heating is required to achieve these specifications.
Note2): The above specifications are subject to change without notice.

Appendix

1. Precautions

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

2. Typical Sensor Characteristics

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

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

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

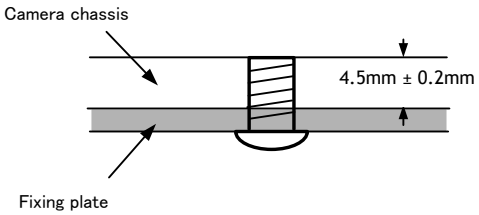
Patterned Noise
When the sensor captures a dark object at high temperature or is used for long time integration, fixed pattern noise may appear on the video monitor screen.

3. Caution when mounting a lens on the camera

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

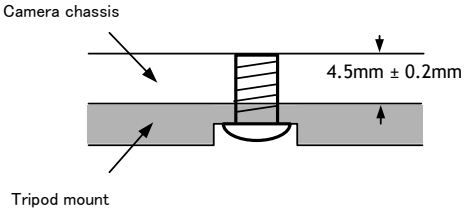
4. Caution when mounting the camera

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



Mounting the camera to fixing plate

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



Attaching the tripod mount

5. Exportation

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

6. References

1. This manual can and datasheet for SP-5000M-CXP2 / SP-5000C-CXP2 can be downloaded from www.jai.com
2. Camera control software can be downloaded from www.jai.com

Manual change history

Date	Revision	Changes
Nov. 2013	1.0	New release
Nov. 2013	1.1	Correct figures for HBlanking_cycle, t_{exp_B} and t_{exp_F} in the section 7.1.2. Add RGB8 frame rate in the specification table.
Nov. 2013	1.2	Add the caution for non- uniformity of sensor performance
		Correct TYPO.
Mar. 2014	1.3	On chapter 5.1.3, add the note for setting 12bit output Correct the pin assignment of P-Iris
June 2014	1.4	Review overall
July 2014	1.5	Correct the relations between Sensor pixel bit and output pixel bit. Due to this, the fastest frame rate is revised.
Sept. 2014	1.6	Revise Spectral Response
Oct. 2014	1.7	Revise B/W Spectral response with wider wave length, Add 8-bit Sensor pixel format, Add CXP 12-bit output, Add description of Dark Compression
May 2015	1.8	Add the description of the optical interface
Nov 2018	1.9	Add KC.

User's Record

Camera type: **SP-5000M-CXP2 / SP-5000C-CXP2**

Revision: ……..

Serial No. ……..

Firmware version. ……..

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

User's Mode Settings.

User's Modifications.

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