See the possibilities

User Manual

AT-140GE

Digital 3CCD Progressive Scan RGB Color Camera

Document Version:Ver.1.0
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1013E-0912

Notice

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Warranty

For information about the warranty, please contact your factory representative.

Certifications

CE compliance

As defined by the Directive 2004/108/EC of the European Parliament and of the Council, EMC (Electromagnetic compatibility), JAI Ltd., Japan declares that AT-140GE complies with the following provisions applying to its standards.
EN 61000-6-3 (Generic emission standard part 1)
EN 61000-6-2 (immunity)

FCC

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

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

Warning

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

Supplement

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

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

重要注意事项

有毒，有害物质或元素名称及含量表

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

部件名称	有毒有害物质或元素					
	铅（Pb）	汞（Hg）	镉（Cd）	六价铬（Cr(Ⅵ)）	多溴联苯（PPB）	多溴二苯醚（PBDE）
棱镜	×	○	○	○	○	○
光学滤色镜	×	○	×	○	○	○
…….	…….	…….	…….	…….	…….	…….	…….

○：表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006规定的限量要求以下。
×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006规定的限量要求。
（企业可在此处、根据实际情况对上表中打 " × " 的技术原因进行进一步说明。）

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数字「15」为期限15年。

Table of Contents

JAI GigE Vision® Camera operation manuals

To understand and operate this JAI GigE Vision® camera properly, JAI provides the following manuals.

User's manual (this booklet)	Describes functions and operation of the hardware
JAI SDK & Control Tool User Guide	Describes functions and operation of the Control Tool
JAI SDK Getting Started Guide	Describes the network interface

User's manual is available at **www.jai.com**
JAI SDK & Control Tool User Guide and JAI SDK Getting Started Guide are provided with the JAI SDK which is available at **www.jai.com**.

Introduction

GigE Vision is the new standard interface using Gigabit Ethernet for machine vision applications and it was mainly set up by AIA (Automated Imaging Association) members. GigE Vision is capable of transmitting large amounts of uncompressed image data through an inexpensive general purpose LAN cable for a long distance.

GigE Vision also supports the GenICam™ standard which is mainly set up by the EMVA (European Machine Vision Association). The purpose of the GenICam standard is to provide a common program interface for various machine vision cameras. By using GenICam, cameras from different manufactures can seamlessly connect in one platform.

For details about the GigE Vision standard, please visit the AIA web site, www.machinevisiononline.org and for GenICam, the EMVA web site, www.genicam.org.

JAI GigE Vision cameras comply with both the GigE Vision standard and the GenICam standard.

Before using GigE Vision camera

All software products described in this manual pertain to the proper use of JAI GigE Vision cameras. Product names mentioned in this manual are used only for the explanation of operation. Registered trademarks or trademarks belong to their manufacturers.
To use the JAI SDK, it is necessary to accept the "Software license agreement" first.

This manual describes necessary equipment and the details of camera functions.

Equipment to be used

In order to set up the GigE Vision system, use the following equipment or equivalent.
It is necessary to use a PC and peripherals which comply with Gigabit Ethernet requirements.

1. Camera(s) which comply with GigE Vison and GenICam
2. Power supply for camera
3. Network cable (CAT5e or CAT6)
4. Computer
   CPU: Intel Core Duo 2 2.4GHz or more
   Memory: 2GB (recommended)
   Video card: PCI Express Bus x 16 connection
   VRAM : DDR2 with 256MB or more
   DVI : capable of display 2560 x 1600 pixels
5. Network adapter (note 1)
6. Network HUB (if needed)
7. Trigger switch (If needed)
8. JAI SDK (Software Development kit)

Note:
Pentium 4 type PC is not recommended due to dependency on chip set bus performance.

Note1: At the time of publishing this document these combinations have been verified:

NIC manufacturer	Model	PCI Bus	PCI-X Bus	PCI-Express Bus
Intel	PRO/1000MT (PWLA8490MT)	√ (33MHz)	√(100MHz)	–
Intel	PRO/1000GT (PWLA8391GT)	√ (33MHz)	√ (33MHz)	–
Intel	PRO/1000PT (EXPI9300PT)	–	–	√ (x1)
Intel	Gigabit CT Desktop adaptor (EXPI9301CT)	–	–	√ (x1)
Intel	PRO/1000PT Quad port (EXPI9404PT)	–	–	√ (x4)
Intel	PRO/1000PT Dual port (EXPI9402PT)	–	–	√ (x4)

The above NICs are verified under the following conditions.

- CPU:Intel Core 2 Duo, 2.4GHz
- 2 GB memory
- Windows XP, SP2(32 bit)
- Driver: Filter driver supplied with JAI SDK

Software installation

The JAI GigE Vision SDK & Control Tool can be downloaded from the JAI web site at www.jai.com. The JAI SDK is available for Windows XP and Vista, 32-bit and 64-bit.
For the details of software installation, please refer to the “Getting Started Guide” supplied on the JAI SDK download page.

Camera Operation

1. General

The AT-140GE is a digital 3CCD progressive scan RGB color camera. It employs three 1/2-inch 1392 (h) x 1040 (v), 1.45 Megapixel CCDs and runs at 20 frames per second in full resolution mode. The AT-140GE has a GigE Vision interface and its output can be either 24-bit or 32-bit RGB. JAI developed a new 1/2-inch compact F4.0 prism optical system and in combination with a linear color matrix, the AT-140GE provides a higher fidelity of color reproduction. The AT-140GE also incorporates a dynamic shading circuit, gamma correction circuit and knee correction circuit to provide high picture quality. Functions like partial scanning and vertical binning allow higher frame rates.

The latest version of this manual can be downloaded from: www.jai.com
The latest version of the JAI GigE Vision SDK & Control Tool for the AT-140GE can be downloaded from: www.jai.com

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

2. Camera nomenclature

The standard camera composition consists of the camera main body and C-mount protection cap.

The camera is available in the following versions:

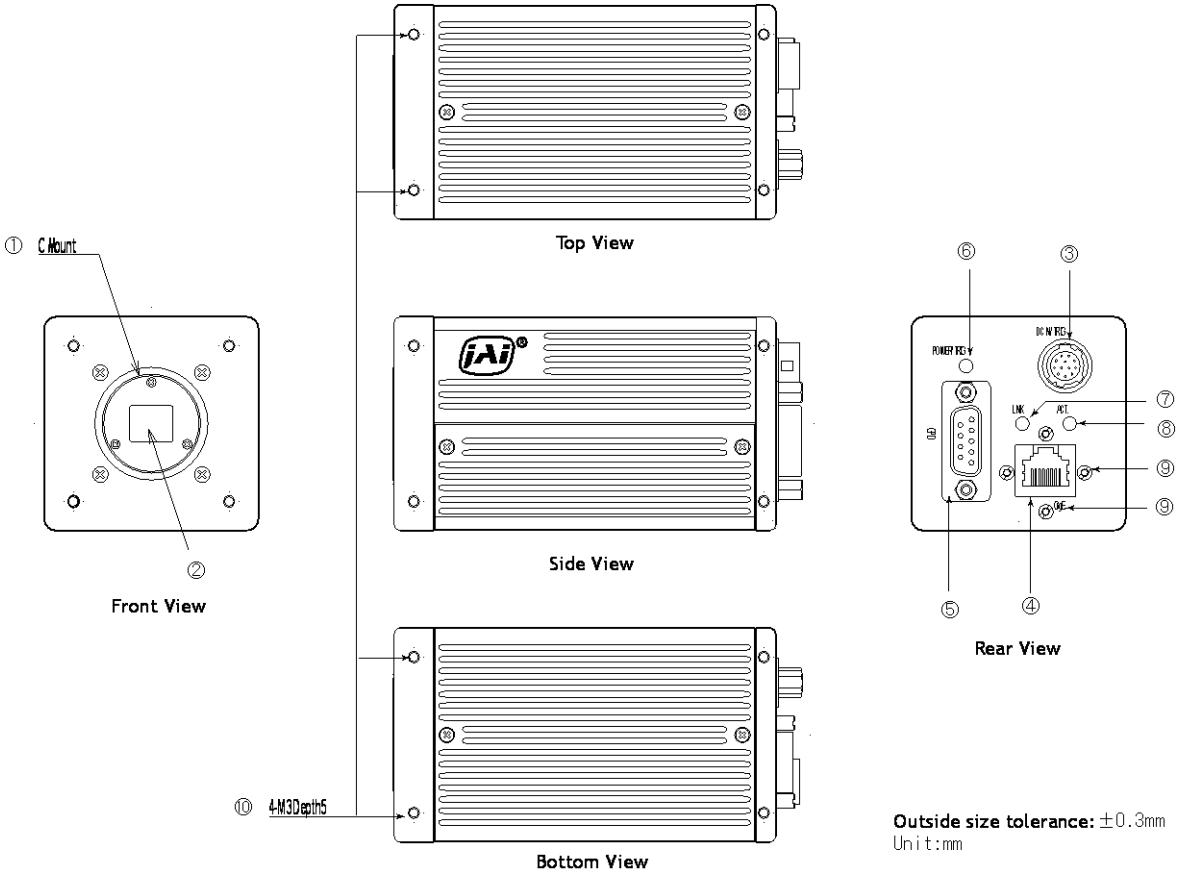
AT-140GE
Where A stands for "Advanced" family, T stands for "3 CCD", **140** represents the resolution "1.4 million pixels" , and **GE** stands for "GigE Vision " interface.

3. Main Features

- 3 x 1/2" CCD progressive scan RGB color camera for vision applications
- 3 x 1392(h) x 1040 (v) 4.65μm effective square pixels
- Compact RGB prism for C-mount lenses
- Shading reduction permits wider choice of lenses
- 20.77 frames per second with 1392 (h) x 1040 (v) pixels
- 59.45 fps with 1392 (h) x 131 (v) pixels in 1/8 partial scan mode
- Variable partial scan is available for faster frame rate
- Vertical binning for higher sensitivity and frame rate of 32.92 fps
- 24-bit RGB output or 32-bit RGB output (RGB 8, RGB 10V1 or RGB 10V2 pixel format)
- Gamma is selectable for 0.45, 0.6 or LUT (Look Up Table)
- Linear matrix circuit with sRGB or Adobe RGB pre-setting
- Knee function available for knee point and knee slope settings.
- Shading compensation circuit built in
- Blemish compensation ON/OFF
- Noise reduction circuit (ON/OFF, level settings)
- Smearless mode available in EPS and PWC
- Edge Pre-select, Pulse Width Control and Reset Continuous Trigger modes
- Sequence trigger mode for on-the –fly change of gain, exposure and ROI
- Delayed readout mode for smooth transmission of multi-camera applications
- Common or individual programmable exposure for RGB
- Auto exposure capability
- AGC (Automatic Gain Control) from -3dB to 12dB
- Manual, continuous, one push or pre-set white balance
- Analog iris video output for lens iris control
- LVAL synchronous/asynchronous operation (auto-detect)
- Comprehensive software tools and SDK for Windows XP/Vista (32 bit “x86” and 64 bit “x64” JAI SDK Ver. 1.2.1 and after)

4. Locations and Functions

4.1. Locations and functions



1. Lens mount	Lens mount of C-mount type. *1)
2. CCD sensor	1/2 inch CCD
3. RJ-45 connector	GigE Vision interface with thumb screws
4. 12-pin connector	DC+12V, Trigger IN and EEN out
5. D-sub 9-pin connector	LVDS IN and TTL IN and OUT
6. LED	Power and trigger indications
7. LINK	Indication for Network connection
8. ACT	Indication for GigE communication
9.Holes for RJ-45 thumbscrews	Vertical type and horizontal type (*2)
10.Mounting holes	M3, max length 5mm (*3)

*1) Note: Applicable C-mount lens should be designed for 3-CCD cameras. Rear protrusion on C-mount lens must be less than 4mm.
Be advised: when using a lens with the iris diaphragm fully open, vignetting on corners may occur.

*2) Note: When an RJ-45 cable with thumb screws is connected to the camera, please do not excessively tighten screws by using a driver. The RJ-45 receptacle on the camera might be damaged. For security, the strength to tighten screws is less than 0.147 Newton meter (Nm). Tightening by hand is sufficient in order to achieve this.

*3) Note: The tripod adapter plate MP-41 can be used.

Fig. 1. Locations

4.2. Rear panel indicator

The rear panel mounted LED provides the following information:

- Amber : Power connected - initiating
- Steady green : Camera is operating in Continuous mode
- Flashing green : The camera is receiving external trigger

Ethernet connector indicates,

- Steady green : 1000 Base-T has been connected
- Flashing green : 100 Base-TX has been connected (Note)
- Flashing amber : Network active in communication

Note: When 10BASE-T is connected, the green is also flashing.
However, the video is not streamed through Ethernet.

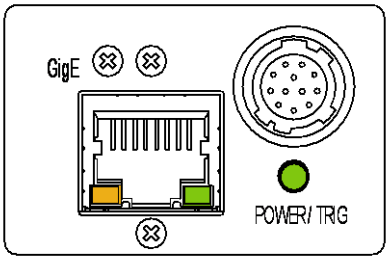


Fig.2 Rear Panel

5. Pin Assignment

5.1. 12-pin Multi-connector (DC-IN/Trigger)

Type: HR10A-10R-12PB-01
(Hirose) male.
(Seen from rear of camera.)

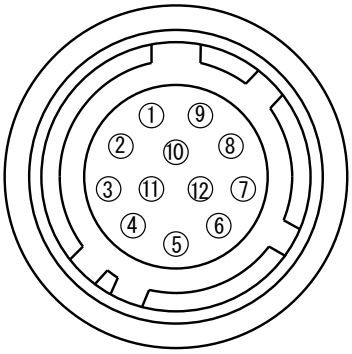
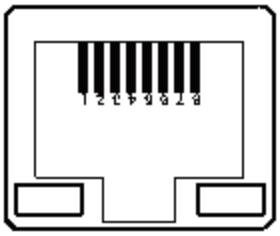


Fig. 3. 12-pin connector.

Pin no.	Signal	Remarks
1	GND	
2	+12 V DC input	
3	GND	
4	Iris video	Continuous and RCT modes only
5	GND	
6	-	
7	-	
8	GND	
9	XEEN out	Negative logic
10	Trigger in	*1)
11	-	
12	GND	

*1) 75 ohm termination can be selected by DIP SW600.

5.2. Digital Output Connector for Gigabit Ethernet



Type: RJ-45
HFJ11-1G02E-L21RL or equivalent

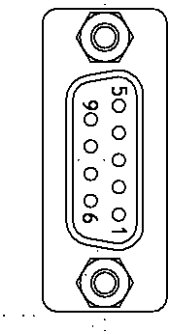
The AT-140GE cameras also accept industrial RJ-45 connectors with thumbscrews. This assures that the connector does not come undone in tough industrial environments.
Please contact the nearest JAI distributor for details on recommended industrial RJ-45 connectors.

Fig. 4. Gigabit Ethernet connector

The digital output signals follow the Gigabit Ethernet interface using RJ-45 conforming connector. The following is the pin assignment for the Gigabit Ethernet connector.

Pin No	In/Out	Name
1	In/Out	MX1+ (DA+)
2	In/Out	MX1- (DA-)
3	In/Out	MX2+ (DB+)
4	In/Out	MX3+ (DC+)
5	In/Out	MX3- (DC-)
6	In/Out	MX2- (DB-)
7	In/Out	MX4+ (DD+)
8	In/Out	MX4- (DD-)

5.3. D-Sub 9pin connector (For GPIO)



Type : DD-09SSG

Fig. 5. D Sub 9pin connector

No	I/O	Name	Note
1	I	LVDS In 1-	
2	I	LVDS In 1+	
3	I	TTL IN 1	75ohm Terminator (Note 1)
4	O	TTL Out 1	
5		GND	
6		NC	
7		NC	
8	O	TTL OUT 2	
9		GND	

Note1) Can be changed by DIP switch (SW600).

5.4. DIP switch

DIP switches are located on circuit boards. When the top cover is removed, please pay careful attention so that circuit boards may not be damaged.

5.4.1 SW-600

This switch sets the 75 ohm trigger input termination to ON or OFF.
The factory default setting is OFF which is TTL level.

No	Functions	Setting	
		ON	OFF
1	**Trigger input termination**	**75Ω**	**TTL**

Fig.6. SW600 (On rear panel)

5.4.2 SW-100

This switch can select the type of the signal which is output through 12-pin #10. The factory default is TTL (XEEN) and it can be changed to Open collector (EEN).

No	Functions	Setting	
		ON	OFF
1	**EEN output select**	**Open collector (EEN)**	**TTL (XEEN)**
2	**NC**	**-**	**-**

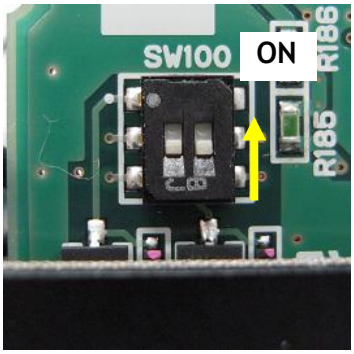


Fig.7. SW100 (Right board looking from the front)

5.4.3 SW-700

This DIP switch can select OPT IN or Iris video output through pin#3 and #4 of the HIROSE 12 pin connector.

No	Functions	Setting	
		ON	OFF
1	**OPT IN(+) / Iris video OUT select**	**Iris video**	**OPT IN (+)**
2	**OPT IN(-) / Iris video OUT select**	**GND for iris video**	**OPT IN (-)**

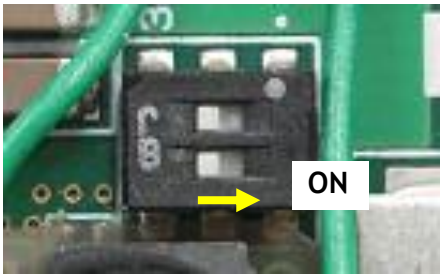


Fig.8 SW700 (On the top board)

6. Input and output circuits

This chapter introduces the basic diagram and bit allocation of digital output.

6.1. Iris video output

This signal can be used for lens iris control In Continuous and RCT modes. The signal is NUM luminance signal and passes through the gain circuit. However, due to reversed compensation applied, the gain settings do not influence this signal. The iris video output is 0.7 V p-p from 75 Ω and without sync.

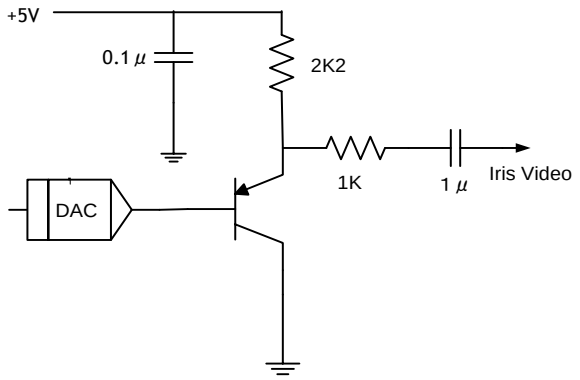


Fig. 9 Iris video output.

6.2. Trigger input

The trigger input is on pin #10 on the 12-pin connector or pin#3 on the D-sub 9-pin connector. The input is AC coupled. To allow a long pulse width, the input circuit is a flip-flop, which is toggled by the negative or positive differentiated spikes caused by the falling or rising trigger edges.
The trigger polarity can be changed.
Trigger input level is 4 V ±2 V. It can be terminated by SW600: ON for 75Ω. OFF for TTL(Factory default).

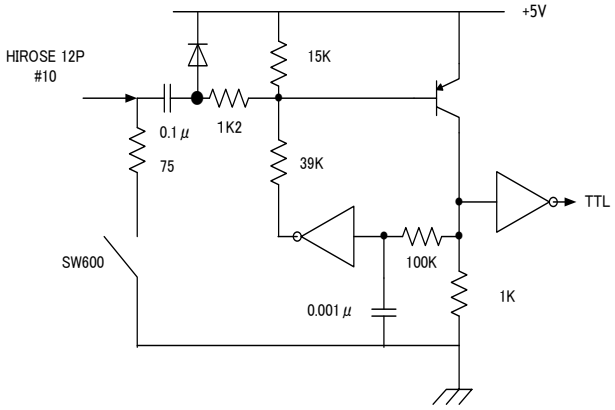


Fig.10 Trigger input.

6.3. XEEN output

XEEN is found on pin #4 or #8 on D-sub 9-pin connector.
The output circuit is 75 Ω complementary emitter followers. Output level ≥3 V from 75Ω. (No termination).
When the open collector is used, the maximum current is 120mA. However, if a current of more than 50mA is flowed, it is necessary to use bigger diameter wires for connecting pin#8 and 9. In case of narrower wires, due to its resistance, it may not work properly.

This output can be changed to Open collector signal by SW100.
EEN is found in OPT out in 12-pin connector.

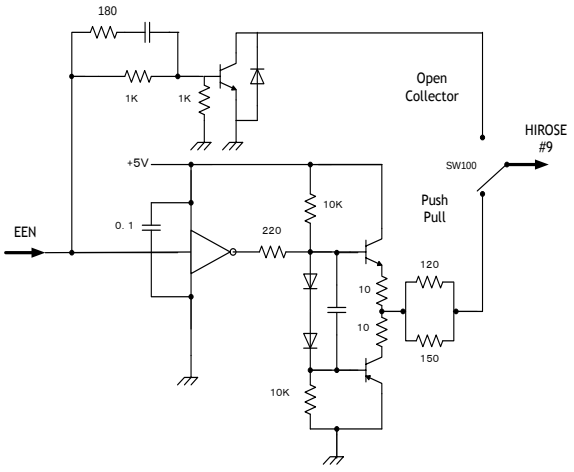


Fig.11 EEN output

6.4. Auto iris video output level

This video output signal is NUM luminance signal and does not have SYNC. It is available only in Continuous mode and RCT mode. It is also not available in partial scan mode.
This signal is not affected by the gain control.

CCD out	Analog Out
200mV	700mV
230mV ↑	800mV

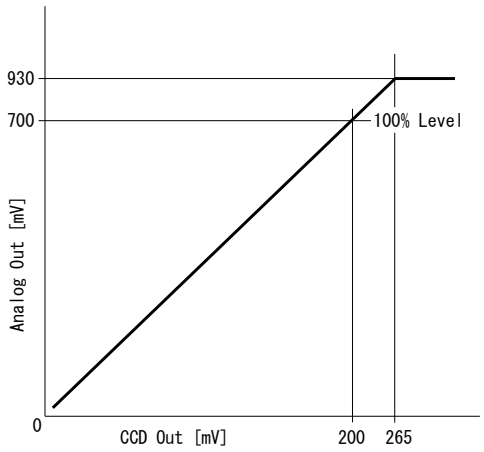


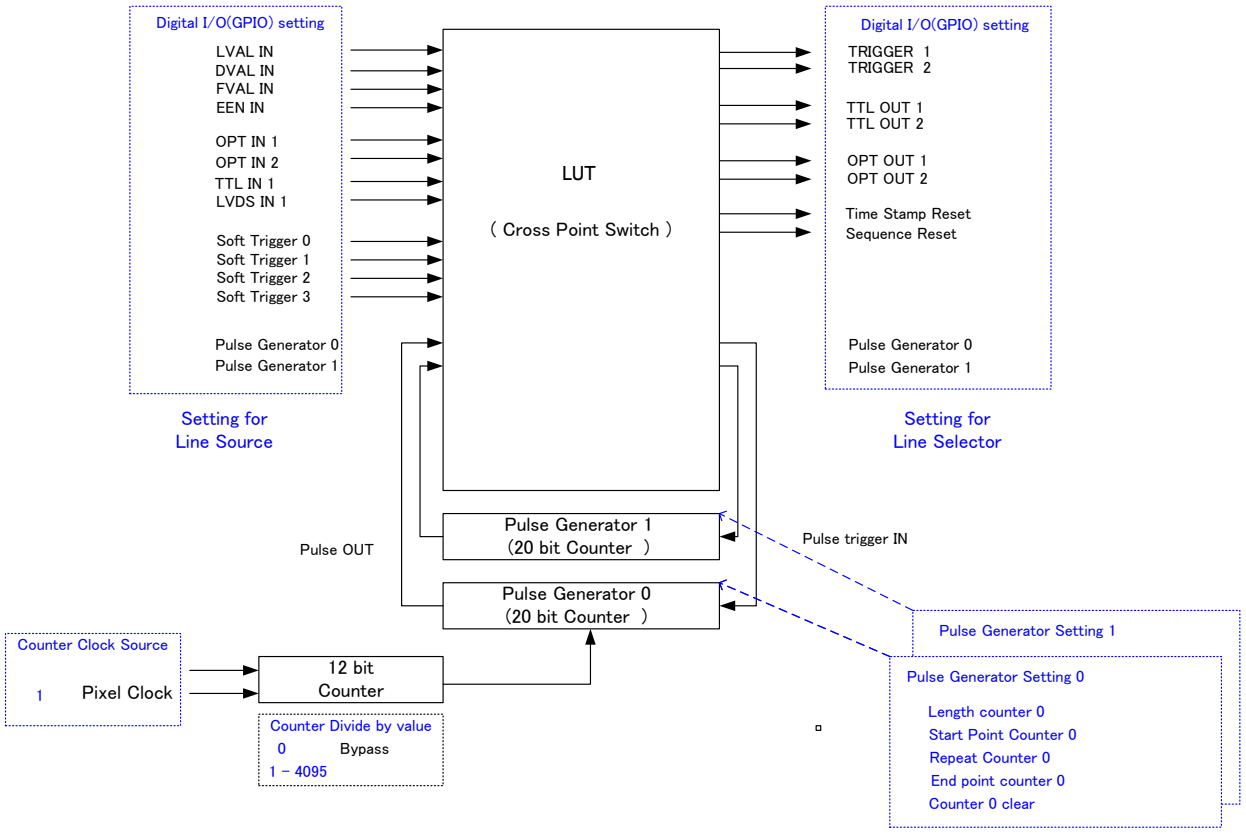
Fig.12 Iris video output

7. GPIO (General purpose inputs and outputs)

In chapter 7, there are some examples of settings. the values shown in these examples may need to be adjusted to fit the pixel clock specifications of this particular model.

7.1. Overview

All input and output signals pass through the GPIO (General Purpose Input and Output) module. The GPIO module consists of a Look-Up Table (LUT – Cross-Point Switch), 2 Pulse Generators and a 12-bit counter. In the LUT, the relationship between inputs, counters and outputs is governed by internal register set-up.



On the above block diagram, Trigger 0 is used for Exposure and Trigger 1 is used for Delayed Readout. The Time Stamp Reset can reset the time stamp in compliance with the GigE Vision standard. This is used for having the same time stamp in case of using multiple cameras.

The blocks shown in the above diagram have the following functionality:

7.1.1 LUT (Look Up Table)

The LUT works as a cross-point switch, which allows connecting inputs and outputs freely. The signals LVAL_IN, DVAL_IN, FVAL_IN and EEN_IN all originate from the camera timing circuit. Trigger 0 is connected to the camera's timing circuit and is used for initiating triggered exposure. Trigger 1 is used for Delayed Readout mode. The Time Stamp Reset signal is used to reset the camera's time stamp function, also making it possible to reset and synchronize the time stamp of multiple cameras.

7.1.2 12-bit Counter

The camera pixel clock (42.954 MHz) can be used as a source. The counter has a “Divide by N”, where N has the range 1 through 4096, allowing a wide range of clock frequencies to be programmed. Setting value 0 is bypass, setting value 1 is 1/2 dividing and setting value 4095 is 1/4096 dividing.

7.1.3 Pulse Generators (0 to 1)

Each pulse generator consists of a 20-bit counter. The behavior of these signals is defined by their pulse width, start point, end point and number of repetitions.
The pulse generator signals can be set in either triggered or periodic mode.
In triggered mode, the pulse is triggered by the rising edge/falling edge/high level or low level of the input signal.
In periodic mode, the trigger continuously generates a signal that is based on the configured pulse width, starting point and end point.

7.2. Opto-isolated Inputs/Outputs

The control interface of the C3 GigE Vision camera series has 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 figure below shows the functional principle (opto-coupler) of the opto-isolated inputs/outputs.

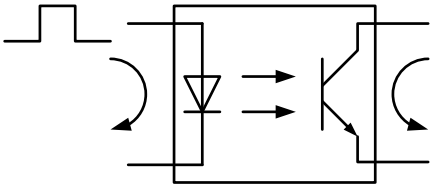


Fig.13 Opto-coupler

7.2.1 Recommended External Input circuit diagram for customer

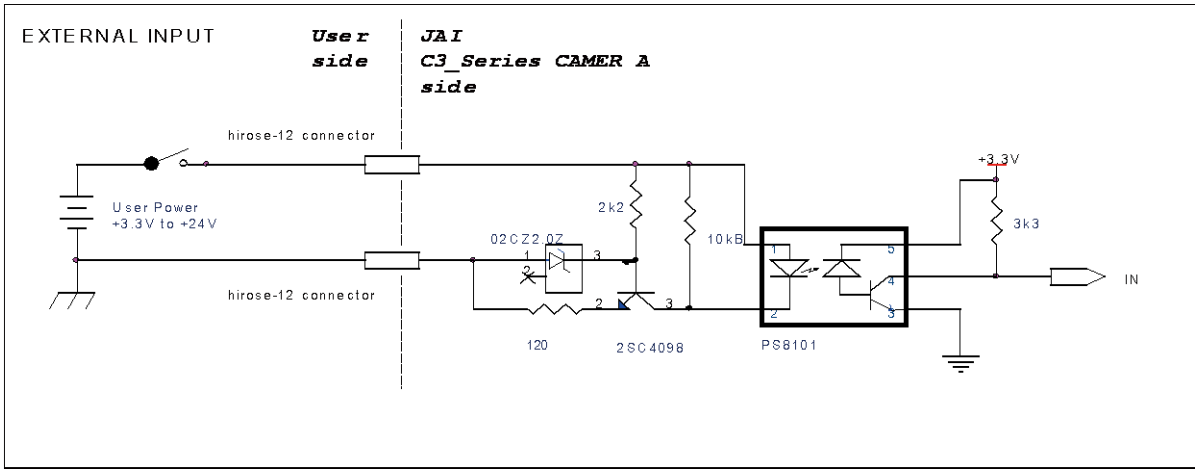


Fig.14 External Input Circuit, OPT IN 1 and 2

7.2.2 Recommended External Output circuit diagram for customer

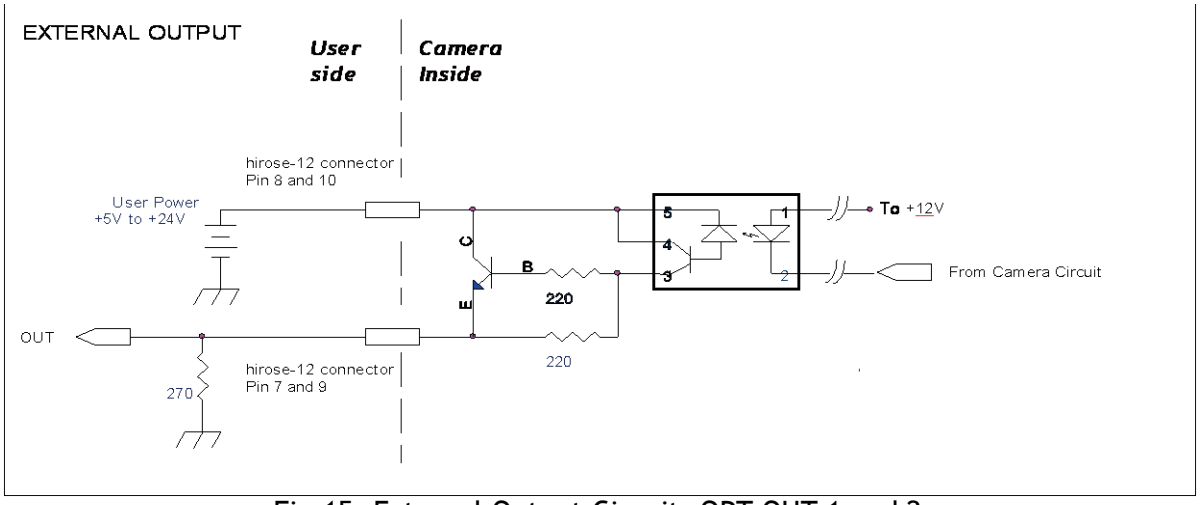
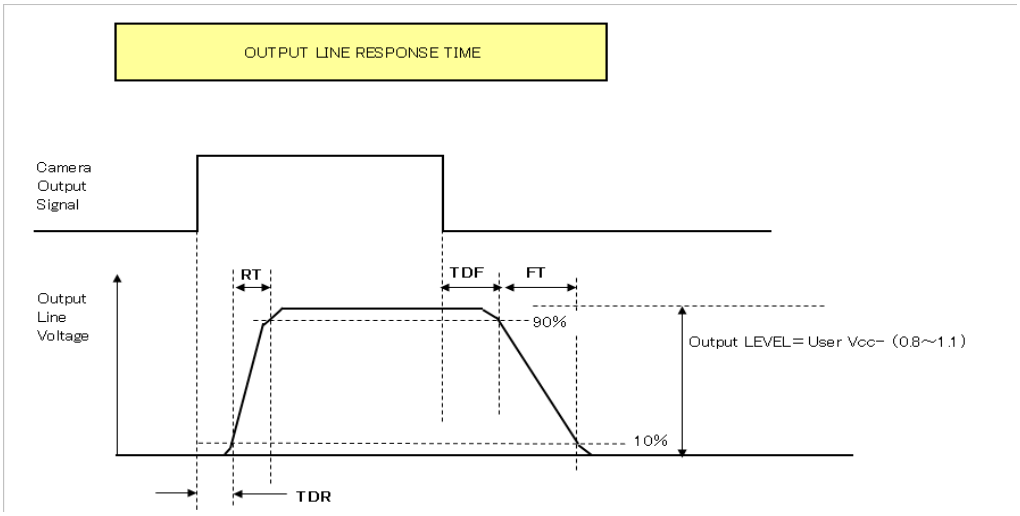


Fig.15. External Output Circuit, OPT OUT 1 and 2

7.2.3 Optical Interface Specifications

The relation of the input signal and the output signal through the optical interface is as follows.



		User Power (VCC)			
		3.3V	5V	12V	24V
Time Delay Rising	TDR(μs)	0.54	0.54	0.62	0.68
Rising Time	RT(μs)	1.2	1.2	2.0	3.0
Falling Delay Time	FDR(μs)	1.5	1.5	2.4	2.1
Falling Time	FT(μs)	3.6	3.4	4.5	6.8

Fig.16 Optical Interface Performance

7.3. Inputs and outputs table

		Output Port									
		Trigger 0	Trigger 1	OPT OUT1	OPT OUT2	TTL OUT 1	TTL OUT 2	Time Stamp Reset	Seq. Reset	Pulse Gen. 0	Pulse Gen. 1
Input Port	LVAL IN	×	×	×	×	○	○	×		○	○
	DVAL IN	×	×	×	×	○	○	×		○	○
	FVAL IN	×	×	×	×	○	○	×		○	○
	EEN IN	×	×	○	○	○	○	×		○	○
	OPT IN 1	○	○	○	○	○	○	○	○	○	○
	OPT IN 2	○	○	○	○	○	○	○	○	○	○
	TTL IN	○	○	○	○	○	○	○	○	○	○
	LVDS IN	○	○	○	○	○	○	○	○	○	○
	Soft Trigger 0	○	○	○	○	○	○	○	○	○	○
	Soft Trigger 1	○	○	○	○	○	○	○	○	○	○
	Soft Trigger 2	○	○	○	○	○	○	○	○	○	○
	Soft Trigger 3	○	○	○	○	○	○	○	○	○	○
	Pulse Gen. 0	○	○	○	○	○	○	○	○	×	○
	Pulse Gen. 1	○	○	○	○	○	○	○	○	○	×

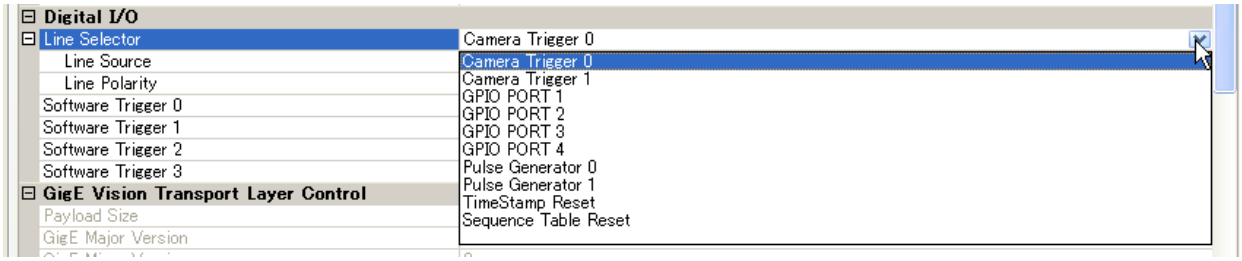
LEGEND: 0 = valid combination / x = Not valid (do not use this combination)

7.4. Configuring the GPIO module (register settings)

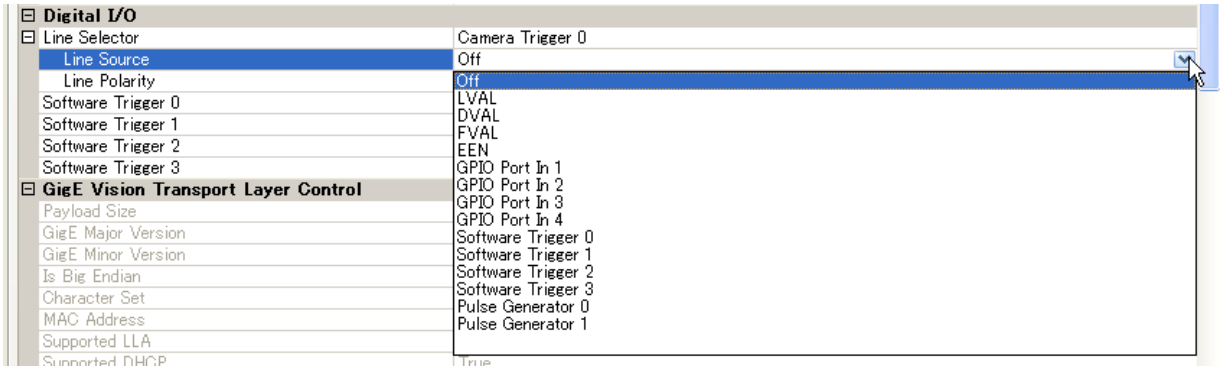
7.4.1 Input /Output Signal Selector

GPIO is used to determine which signal is assigned which terminal. For the details, please refer to Register Map, Digital I/O, Acquisition and Trigger Control and Pulse Generator.

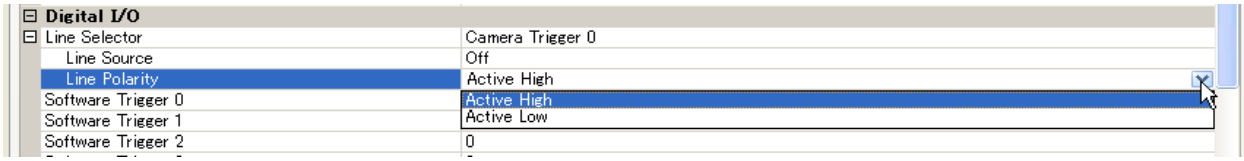
Line Selector



Line Source



Line Polarity

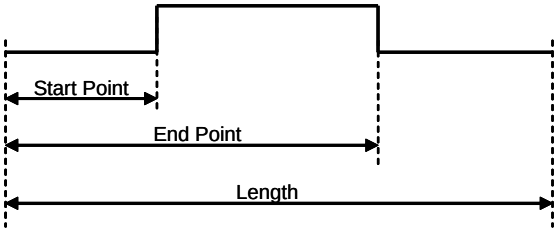


7.4.2 12-bit counter

Address	Internal Name	GenIcam Name	Access	Size	Value (Range)
0xB004	Counter Dividing Value	ClockPreScaler	R/W	4	0x000: Bypass 0x001: 1/2 Dividing 0x002: 1/3 Dividing | 0xFFF: 1/4096 Dividing

7.4.3 Pulse generators (20-bit x 2)

There are 2 pulse generators (designated 0 through 1) that can be used to create various timing scenarios by programming start point, endpoint, length and repeats.



An example of settings

The following example shows the FVAL input to a pulse generator. The pulse generator creates the pulse using FVAL and the pulse is output through GPIO PORT 1.

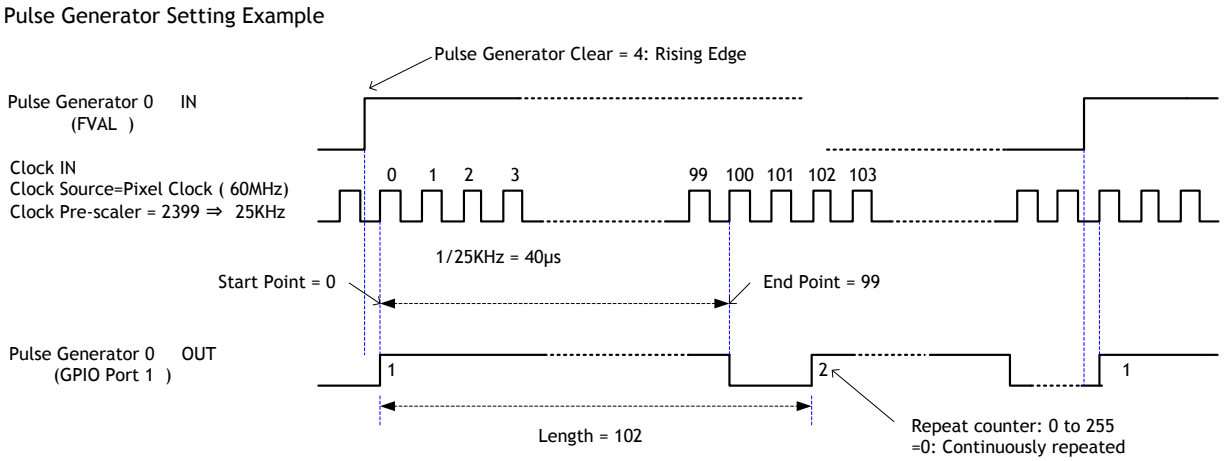


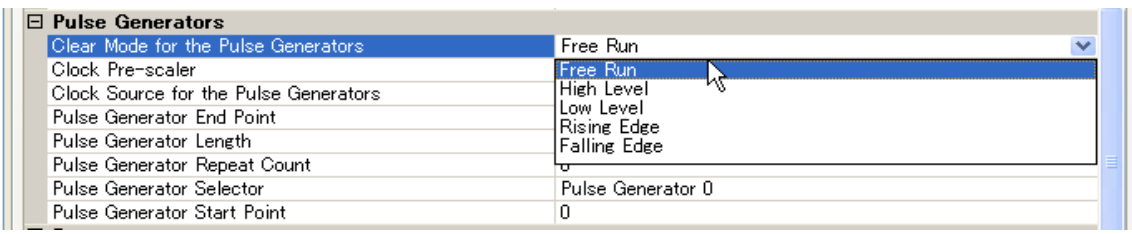
Fig.17 Pulse generator setting example

The created pulse rises up at the start point and falls down at the end point, as shown above. Accordingly, the High duration is (End point – Start point) clocks x (1/Pulse gen. frequency).

In the above example, the original oscillation uses pixel clock (60 MHz) and the pixel clock is divided by 2400. A pulse frequency of the generator is 25 KHz (60000000/2400). As the start point is 0 and the end point is 99, a pulse having a width of 100 x 1/25000 = 4ms is created.

If the High duration needs to be delayed against an incoming trigger, the start point should be set at “N”. The delay value is N x (1/ 25000). In the above example, the N is “0” which is no delay. The length, in this case, is 102 clocks.

These settings can be achieved by using the JAI Control Tool which is part of the JAI SDK.



7.5. GPIO programming examples

7.5.1 GPIO Plus PWC shutter

Example: 10µs unit pulse width exposure control (PWC).
Pixel clock is ~43MHz. 430 clocks (530-100) equals 10µs.

	Address	*Register*	*Value*
	0xA040	Trigger Mode	2 = PWC (Pulse Width Control)
①	0xB090	Pulse Generator 0 Selector	4 =OPT IN 1
②	0xB000	Clock Choice	1 = Pixel Clock (43MHz)
	0xB004	Counter Dividing Value	0 = Pass through
	0xB008	Length Counter 0	1000 Clocks
	0xB00C	Start point Counter 0	100 Clocks
	0xB010	Repeat Count 0	1
	0xB014	End point Counter 0	530 Clocks
	0xB018	Counter Clear 0	4 = Rising Edge Clear
③	0xB060	CAMERA TRIGGER Selector	16 = pulse generator 0

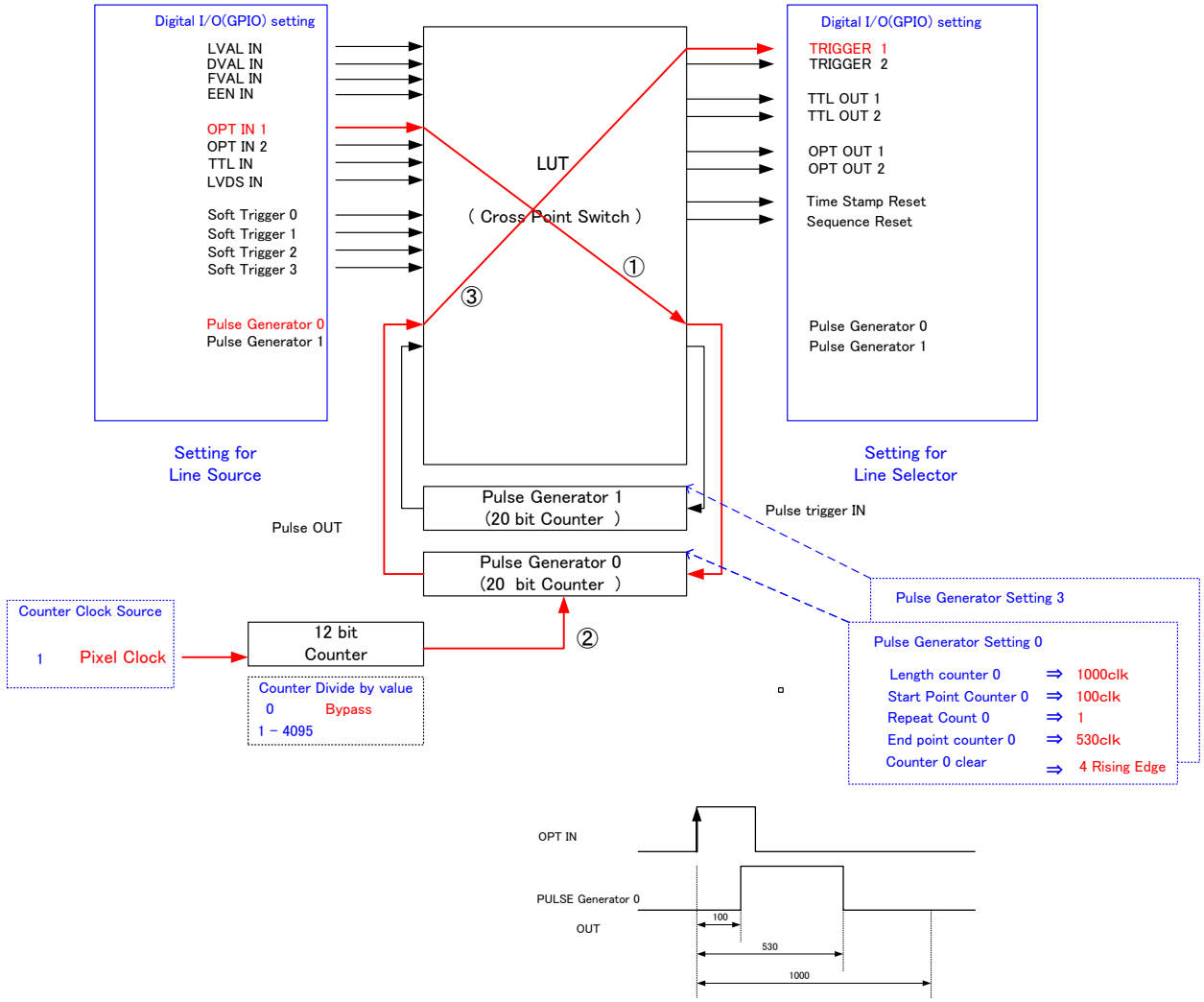


Fig.18 Pulse Generator Timing Example 1

7.5.2 Internal Trigger Generator

Create a trigger signal and trigger the camera

	Address	Register	Value
	0xA040	Trigger Mode	1 = EPS
①	0xB000	Clock Choice	1 = Pixel Clock
	0xB004	Counter Dividing Value	1829= 1/1830 dev(Line Rate)
	0xB008	Length Counter 0	1000 Clocks
	0xB00C	Start point Counter 0	100 Clocks
	0xB010	Repeat Count 0	0 = Free Run
	0xB014	End point Counter 0	500 Clocks
	0xB018	Counter Clear 0	0 = No Clear
②	0xB060	CAMERA TRIGGER Selector	11 = pulse generator 0

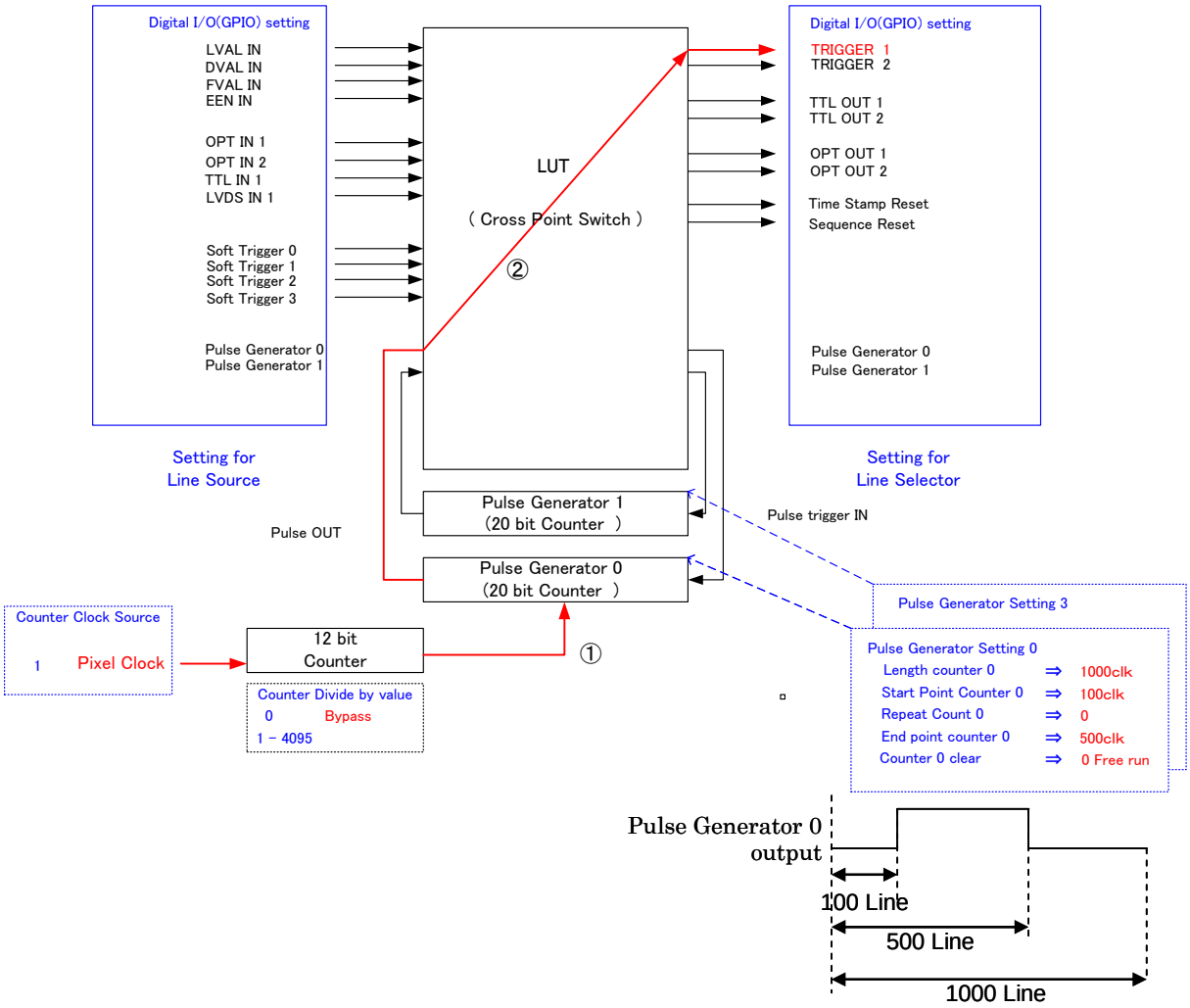


Fig.19 Pulse Generator 0 timing Example 2

8. GigE Vision Streaming Protocol (GVSP)

8.1. Digital Video Output (Bit Allocation)

Although the AT-140GE is a digital camera, the image is generated by an analog component, the CCD sensor.
The table and diagram below show the relationship between the analog CCD output level and the digital output.

CCD out	Analog Signal *	Digital Out(24-bit)	Digital Out(32-bit)
Black	Setup 3.6%, 25mV	8LSB	32LSB
200mV	700mV	222LSB	890LSB
230mV	800mV	255LSB	1023LSB

The standard setting for 10-bit video level is 890 LSB. 200 mV CCD output level equals 100% video output.

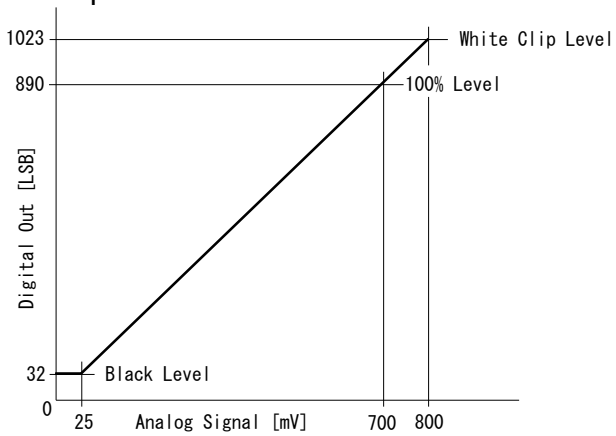


Fig.20 Digital output (10-bit output)

8.2. Bit Allocation (Pixel Format / Pixel Type)

In the GigE Vision Interface, GVSP (GigE Vision Streaming Protocol) is used for an application layer protocol relying on the UDP transport layer protocol. It allows an application to receive image data, image information and other information from a device.
As for the sensors in the AT-140GE, the following pixel types supported by GVSP are available. With regard to the details of GVSP, please refer to the GigE Vision Specification available from the AIA (www.machinevisiononline.org).

8.2.1 GVSP_PIX_RGB8_PACKED (RGB 24bit output)

1 Byte								2 Byte								3 Byte							
R0								G0								B0							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

8.2.2 GVSP_PIX_RGB10V1_PACKED (RGB 32bit output)

1 Byte								2 Byte								3 Byte								4 Byte							
R0				G0				B0								R0								G0							
0	1	0	1	0	1	X	X	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

B0							
0	1	2	3	4	5	6	7

8.2.3 GVSP_PIX_RGB10V2_PACKED (RGB 32bit output)

1 Byte								2 Byte								3 Byte								4 Byte							
R0										G0														B0							
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	X	X

Address	Internal Name	Access	Size	Value
0xA410	Pixel Format type	R/W	4	0x02180014:RGB8Packed 0x0220001C:RGB10V1Packed 0x0220001D:RGB10V2Packed

9. Functions and Operations

9.1. GigE Vision Standard Interface

The AT-140GE is designed in accordance with the GigE Vision standard. Digital images are transmitted over Cat5e or Cat6 Ethernet cables. All camera functions are also controlled via the GigE Vision interface.

The camera can operate in Continuous mode, providing an endless stream of images. For capturing individual images related to a specific event, the camera can also be triggered. For precise triggering, it is recommended to use a hardware trigger applied to the Hirose 12-pin connector. It is also possible to initiate a software trigger through the GigE Vision interface. However, when using a software trigger, certain latency inherent to the GigE interface must be expected. This latency, which manifests itself as jitter, greatly depends on the general conditions and traffic on the GigE connection. The frame rate described in this manual is for the ideal case and may deteriorate depending on conditions.

When using multiple cameras (going through a switch and/or a single path) or when operating in a system with limited transmission bandwidth the Delayed Readout Mode and Inter-Packet Delay functions can be useful.

9.2. Recommended Network Configurations

Although the AT-140GE conforms to Gigabit Ethernet (IEEE 802.3) not all combinations of network interface cards (NICs) and switches/routers are suitable for use with the GigE Vision compliant camera.
JAI will endeavor to continuously verify these combinations, in order to give users the widest choice of GigE components for their system design.

9.2.1 Guideline for network settings

To ensure the integrity of packets transmitted from the camera, it is recommended to follow these simple guidelines:

1. Whenever possible use a peer-to-peer network.
2. When connecting several cameras going through a network switch, make sure it is capable of handling jumbo packets and that it has sufficient memory capacity.
3. Configure inter-packet delay to avoid congestion in network switches.
4. Disable screen saver and power save functions on computers.
5. Use high performance computers with multi-CPU, hyper-thread and 64-bit CPU, etc.
6. Only use Gigabit Ethernet equipment and components together with the camera.
7. Use at least Cat5e and preferably Cat6 Ethernet cables.
8. Whenever possible, limit the camera output to 8-bit.

☞ For more details regarding network settings, please refer to the "Getting Started Guide" which is a separate document.

9.2.2 Video data rate (network bandwidth)

The video bit rate for the AT-140GE in Continuous mode is:

Model	Pixel Type	Frame Rate	Packet data volume (assumes the packet size is 4036)
AT-140GE	RGB8Packed	20.77 fps	732 Mbit/s
	RGB10V1Packed RGB10V2Packed	20.77 fps (Note 1)	972 Mbit/s

Note1: depending on the packet size, the frame rate of 20.77 fps may not be achieved. It may be reduced to 18 to 19 frames per seconds. This figure will depend of the system configuration used (RESEND not possible)

- If Jumbo Frames (Max.16020) are not used, the packet data will be bigger by 2%.
- If Jumbo frames are used, the packet size may be automatically optimized to a smaller size.
- For details of setting Jumbo Frames, please refer to the "Getting Started Guide".

9.2.3 Note for setting packet size

The packet size is set to 1476 as the factory default. Users may enter any value for the packet size and the value will be internally adjusted to an appropriate, legal value that complies with the GenICam standard. The packet size can be modified in the GigE Vision Transport Layer Control section of the camera control tool.

Regarding data transfer rate, a larger packet size produces a slightly lower data transfer rate. The AT-140GE can support a maximum of 16020 byte packets provided the NIC being used has a Jumbo Frames function with a setting of a 16020 bytes or larger.

Caution: do not set the packet size larger than the maximum setting available in the NIC or switch to which the camera is connected . Doing so will cause output to be blocked.

9.2.4 Calculation of Data Transfer Rate

In order to calculate the data transfer rate, the following parameters and formula are required.

Setting parameter

Item	Unit	Symbol
Image Width	[pixels]	A
Image Height	[pixels]	B
Bits per Pixel	[bits]	C
Frame Rate	[fps]	D
Packet Size	[Bytes]	E
Number of Packets (including Data Leader & Trailer Packet)	[packets]	G
Data Transfer Rate	[Mbit/s]	J

Fixed value

Item	Unit	value
Data Leader Packet Size	[Bytes]	90
Data Trailer Packet Size	[Bytes]	62

Formula to calculate Data Transfer Rate

J= {90+62+(E+18)*(G-2)} *8*D/1000000

Where, **G=ROUNDUP{A*B*C/8/(E-36)}+2**

The following table shows Bits per Pixel (Item C) which depends on the pixel format.

Pixel format	Bit
RGB8	24
RGB10V1Packed	32
RGB10V2Packed	32

Calculation example: AT-140GE Pixel type RGB8

Item	Unit	Symbol	Setting
Image Width	[pixels]	A	1392
Image Height	[pixels]	B	1040
Bits per Pixel	[bits]	C	24
Frame Rate	[fps]	D	20.77
Packet Size	[Bytes]	E	4036
Number of Packets (including Data Leader & Trailer Packet)	[packets]	G	
Transfer Data Rate	[Mbit/s]	J	

G=ROUNDUP {(1392 x 1024 x 24/ 8 / (4036-36)) + 2 = 1086 + 2 = 1088
J={90+62+(4036+18)x(1088-2)} x 8 x 20.77 / 1000000 = 732 Mbit/s

9.2.5 Note for 100BASE-TX connection

- In order to use 100Mbps network, 100BASE-TX and Full Duplex are available. Half Duplex cannot be used.
- In the case of connecting on 100BASE-TX, the maximum packet size should be 1500 bytes.
- In the case the of connecting on 100BASE-TX, the specifications such as frame rate, trigger interval and so on described in this manual cannot be satisfied.

Pixel Type	Frame rate at Full Frame scan[fps]
RGB8_Packed	Approx. 2
RGB10V1_Packed,RGB10V2_Packed	Approx.1.5

Note: The above frame rates are based on approx. 70Mbps of total frame transfer data.

9.3. Basic Functions

9.3.1 Basic construction

The AT-140GE is a 3CCD camera equipped with F4, 1/2 inch prism optics. Red, green and blue color signals are taken from each 1.45 mega CCD which are filtered to the red, green and blue spectral wavelengths. A 32-bit microprocessor controls all functions in the AT-140GE camera. The CCD sensor output is normalized in CDS and preamplifiers. The signals are then digitized to 16 bits. Digital gain control, color matrix, look-up tables and setup can do signal processing in 16 bits before the signal is converted to a 32- or 24-bit RGB pixel format via GigE Vision interface.

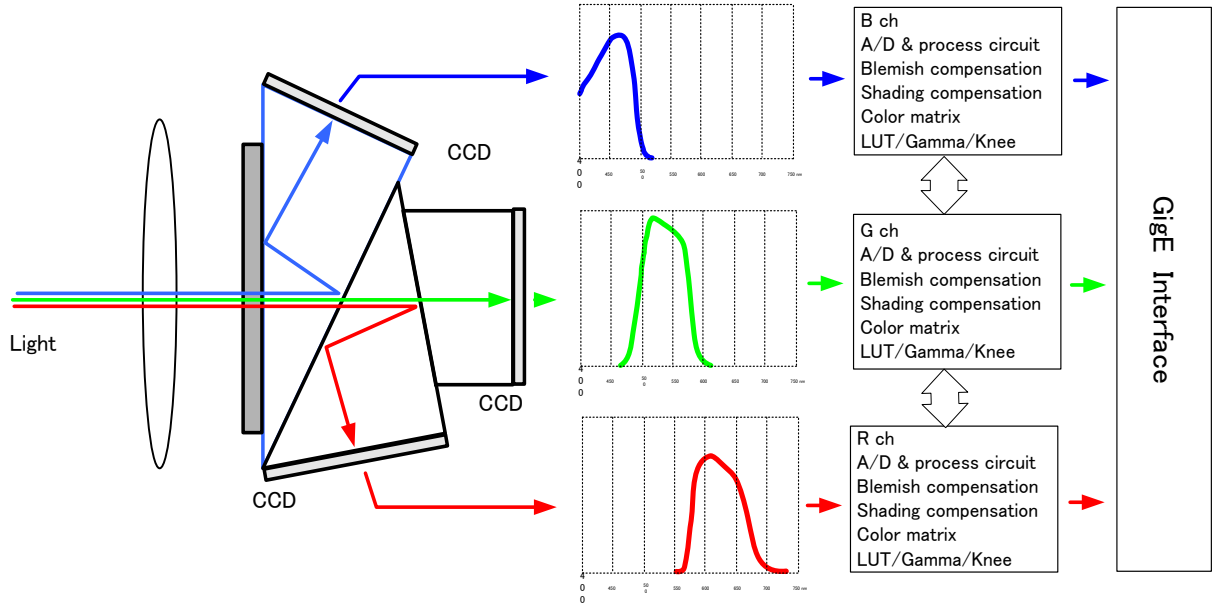


Fig.21 Principle diagram for signal processing

9.3.2 Modes of operation

The AT-140GE has multiple operating modes including a normal continuous mode, triggered modes and others. In the normal continuous mode, the camera runs at 20.77 frames per second continuously. This is used for operation when a trigger signal is not required. There are 5 triggered modes and the trigger signal is supplied via HIROSE 12-pin or D-Sub 9-pin connectors. In the triggered modes, the frame rate is 20 fps.

- Normal continuous mode
- Edge pre-select trigger mode (EPS)
- Pulse width control trigger mode (PWC)
- Reset continuous trigger mode (RCT)
- EPS Sequential trigger mode
- Frame delay readout trigger mode (EPS and PWC)
- Smearless mode
- OB transfer mode
- Multi ROI mode

9.3.3 Partial scan (Fast Dump ON)

The partial scanning function uses the middle of the image vertically to achieve faster frame rates. This is very useful when capturing and inspecting an image which does not require the full height.

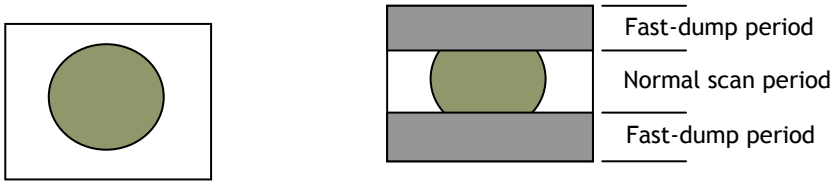


Fig.22 Partial scan conceptual drawing

The partial scan mode for the AT-140GE is variable. The first line and the last line to be read out can be set.

The variable scan readout is connected with the ROI settings.

1. If ROI is set, these settings are applied to the partial scan settings.
2. If the multi ROI feature is used, the smallest line number and the largest line number of the multi ROI areas define the partial scan area.
3. When the sequence trigger is used, the situation is the same as for multi ROI. The smallest line and the largest line define the partial scan.

In order to execute partial scanning, the fast dump setting should be ON.

The first line can be set anywhere from the 1st line to 1033rd line and the end line can be set from the 8th line to 1040th line. This means the minimum height of the partial scan is 8 lines.

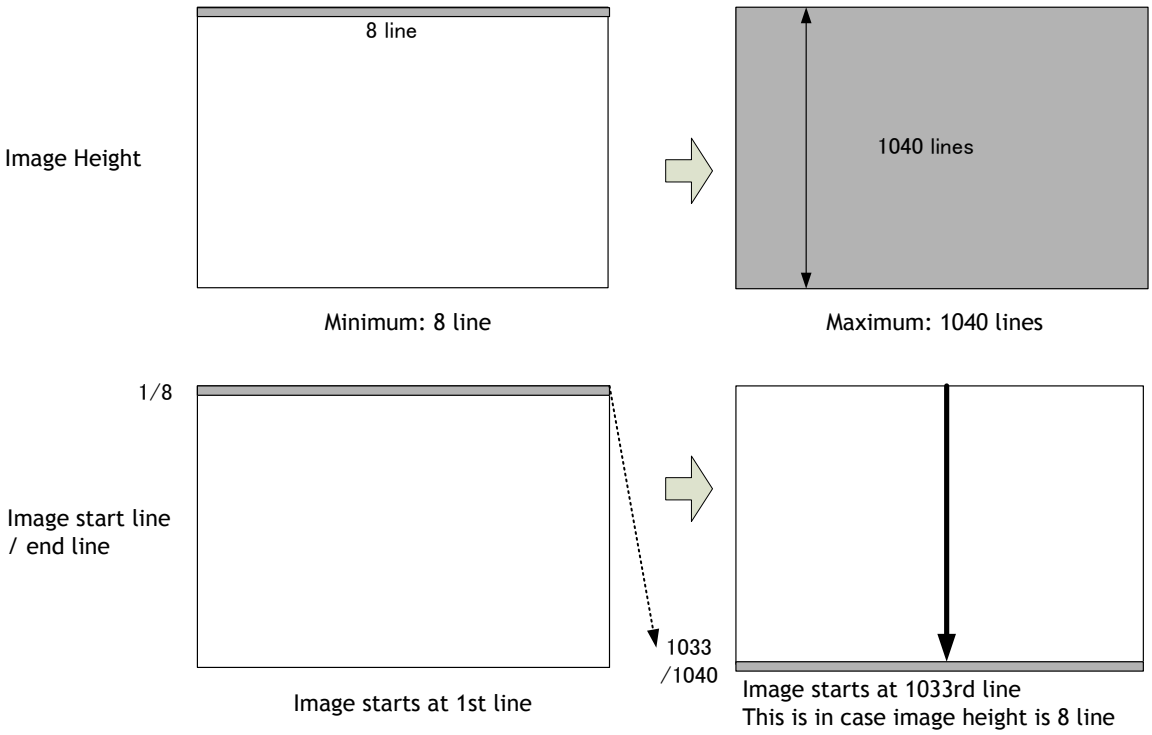


Fig.23 Variable Partial scan

◆ **How to calculate total line number and frame rate in variable partial scan mode**

Frame rate (fps) = Horizontal frequency(21.938KHz) / Total lines

Total lines = ①OB period + ②Fast Dump period in the upper part of the frame (L) + ③Effective image period (L) + ④Fast dump period in the lower part of frame (L) + ⑤Blank period (L)

Where,
OB period = 4L (Fixed)
Blank period = 6L (Fixed)

Fast dump period for the upper part = $\text{Round up}\left(\frac{4+\text{Start line}-1}{4}\right)+1$

Fast dump period for the lower part = $\text{Roud up}\left(\frac{1040-\text{End line}+2}{4}\right)$

Calculation example
Readout: 1/2 partial scan at the center (520L), Start line (261), End line (780)

OB period = 4L
Blank period =6L
Fast dump period for the upper part = (4+261-1) ÷4 +1= 66 + 1=67 → 67
Fast dump period for the lower part = (1040-780+2) ÷ 4 =65.5 → 66
Total lines = 4+67+520+66 +6 = 663
Frame rate = 21.938/ 663 =33.08 fps

9.3.4 Vertical Binning (VB)

Vertical Binning mode is a function where the signal charges from 2 adjacent (vertical) pixels are added together and read out as one pixel. Binning results in half vertical resolution but higher frame rate and sensitivity. The charge accumulated in 2 adjacent lines is added together in the horizontal CCD register. This is done by providing two pulses to the vertical CCD register for each line read out. Vertical binning cannot be used together with partial scanning.

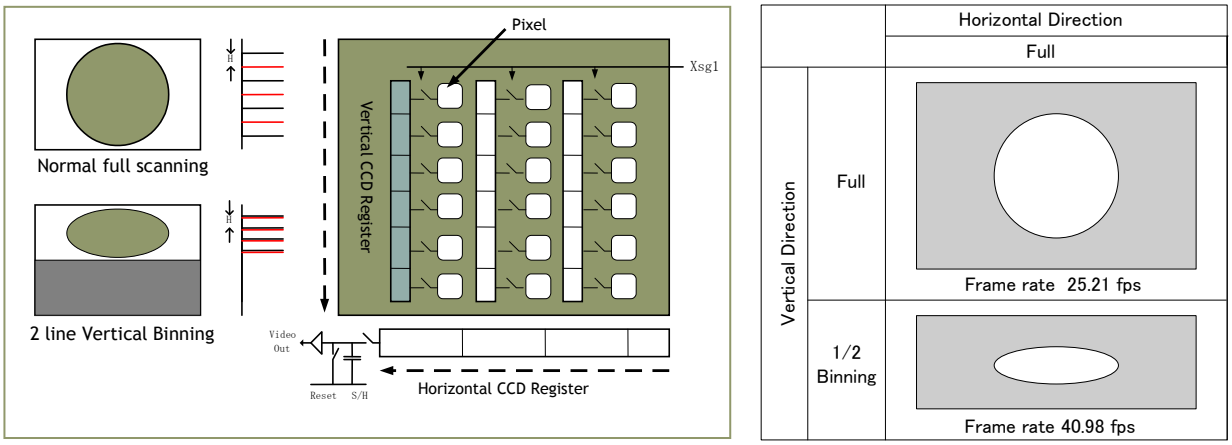


Fig.24 Vertical Binning

Setting	Effective/total	Horizontal Frequency	Frame rate
Off (No V Binning))	1040 /1056	21.938 KHz	20.77 frames/sec.
2:1 V Binning	520 / 530	17.447 KHz	32.92 frames /sec.

9.3.5 Electronic shutter (SM)

The AT-140GE has the following shutter modes.

◆ **Programmable Exposure (PE)**

The setting command is PE and the exposure time can be controlled from 0L to 1056L in 1 LVAL units (45.58µs). Calculating actual shutter speed requires adding 0.5L to the setting value. This is because there is 0.5L overhead.
The resulting range is from 0.5LVAL to 1056LVAL. Setting 1056L is Shutter OFF.
Programmable exposure can be set for R, G and B together or individually in EPS and RCT modes.

The shutter speed for each operation mode is shown below.

Mode	Read Out	Minimum shutter speed	Maximum shutter speed
Continuous Edge Pre-select	Full Partial	22.8 µs at PE=0(1/43,000s)	45.58µs x 1056L=1 Frame (48.13 ms)
	V binning	28.7 µs at PE=0(1/35,000s)	
Pulse Width	Full Partial	45.58 µs x 2L+22.9 µs(0.5L)= 114 µs （≒1/10,000s） (Note)	42 Frames (2 seconds)
	V Binning	57.32 µs x 2L + 28.7 µs(0.5L)= 143.3µs （≒1/8.000s） (Note)	

Note: In Pulse Width mode, the minimum trigger pulse width requires more than 2LVAL.

◆ **Exposure Time Abs** (GenICam Standard)

This is a function specified in the GenICam standard.
The shutter speed can be entered as an absolute exposure time in microseconds (µs) in register address 0xA018. The entered absolute time (Time Abs) is then converted to a programmable exposure (PE) value inside the camera.

The calculating formula below shows the relationship between the PE value used by the camera for the different readout modes and the value entered in register 0xA018.
Due to rounding (decimals rounded down), some discrepancies may occur.

The relation between PE value and Time Abs
Normal readout PE= INT (Exposure time – 64.13) µs / (1958/42954000)
Vertical Binning PE= INT (Exposure time – 84.13) µs / (2462/42954000)
(Note: INT means round down.)

Note :The minimum value in normal readout is 22.8µs.

◆ **GPIO in combination with Pulse Width trigger**

More precise exposure time can be obtained by using GPIO in combination with Pulse Width mode. The clock generator and counter can be programmed in very fine increments.
For an example, refer to 7.5.1 GPIO Plus PWC shutter

◆ Auto shutter

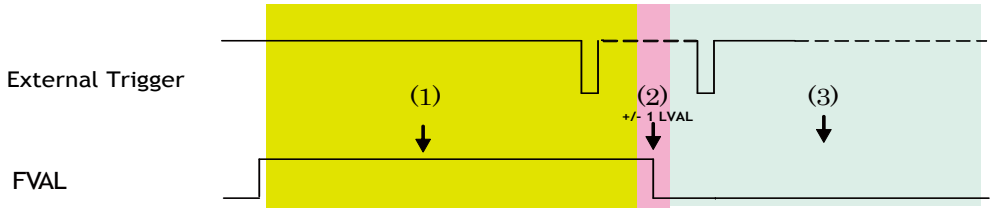
The AT-140GE has an automatic shutter function which sets the video at an appropriate level depending on illumination.

Auto shutter range : 1/25 sec to 1/250 sec

9.3.6 Auto-detect LVAL-sync / async accumulation

This function replaces the manual setting found in older JAI cameras. Whether accumulation is synchronous or asynchronous in relation to LVAL depends on the timing of the trigger input. When a trigger is received while FVAL is high (during readout), the camera works in LVAL-synchronous mode, preventing reset feed-through in the video signal. There is a maximum jitter of one LVAL period from issuing a trigger and accumulation start.
When a trigger is received during FVAL low, the camera works in LVAL-asynchronous mode (no delay) mode.

This applies to both Edge Pre-select (EPS) trigger mode and Pulse Width Control (PWC) trigger mode.



(1) In this period camera executes trigger at next LVAL (prevents feed-through noise)
(2) Avoid trigger at FVAL transition (+/- LVAL period), as the function may randomly switch between " next LVAL " and " immediate ".
(3) In this period, camera executes trigger immediately (no delay).

Fig.25 Auto-detect LVAL sync/async accumulation

9.4. Pre-processing functions

9.4.1 Shading compensation

The AT-140GE implements a digital shading compensation circuit for the white shading which could be caused in the prism or optical system. The whole image is divided horizontally and vertically and uses the center level as the reference. The circuit will compensate the difference between the center and each divided area. The range for compensation is a maximum of 30%. In the factory, the shading compensation is done under the following conditions and stored in the "Factory" area of the memory.

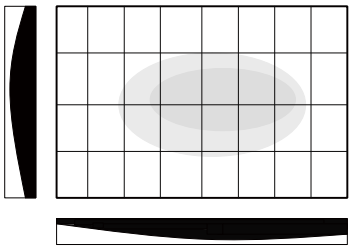


Fig.26 Shading compensation

Lens used: Kowa 12mm F1.8 to F16
F value: F5.6

Note: Conditions for lens used with AT-140GE

In order to get an appropriate picture, it is recommended to use 1/2 inch, 3CCD lenses. Shading is dependent on F value and focal length. Using a wide angle lens or using the lens fully open, will cause the shading characteristics to deteriorate.

The AT-140GE has two shading compensation circuits.

1. Color shading compensation
   In this mode, the shading is compensated using the G channel as the reference. Adjust R and B channels to match the characteristics of the G channel. Use white balance to match R, G and B levels.

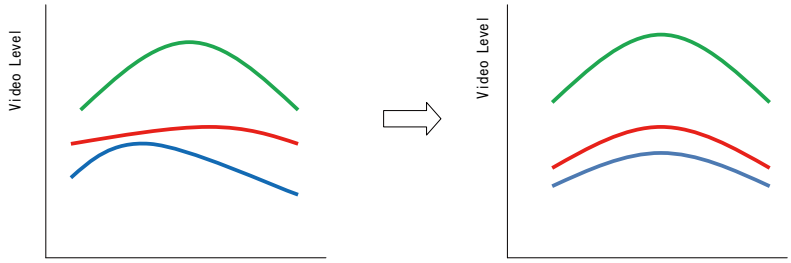


Fig.27 Conceptual drawing for color shading compensation

2. Flat shading compensation
   In this mode, each channel can be adjusted to achieve flat characteristics.

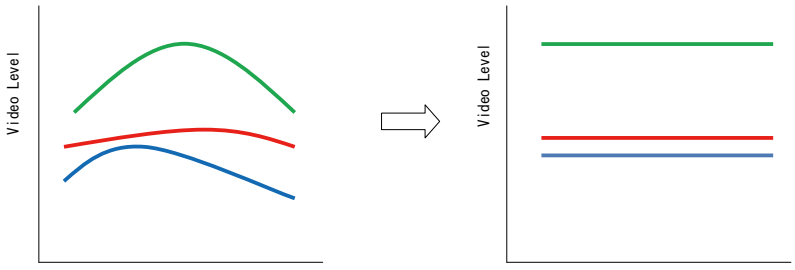


Fig.28 Conceptual drawing for flat shading compensation

9.4.2 White balance

The AT-140GE has 4 white balance modes: manual balance, one push auto white balance, continuous auto white balance and pre-set white balance.
The pre-set white balance can be set to 4000K, 4600K or 5600K.
The white balance of the AT-140GE is set under 7800K lighting in factory. When the camera is started up at the first time, it is white balanced to 7800K and R and B gain settings are 0.

For executing the white balance, the entire image is
divided into 64 areas, 8 for horizontal and 8 for vertical.
The following drawing is an example of using a 2 x 2 area in the image center.

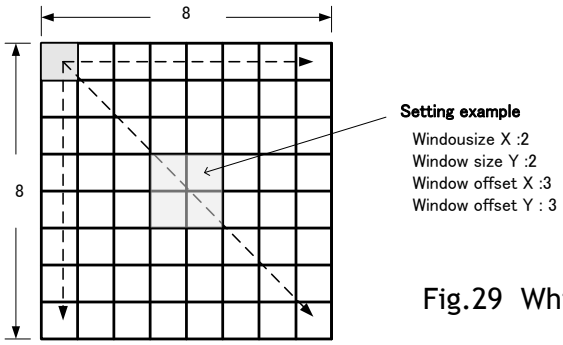


Fig.29 White balance measuring area

	Continuous	One push	Manual
Tracking range	4000K to 9,000K	4000K to 9,000K	4000K to 9,000K
Adjustable range	-6dB ～ +6dB	-6dB ～ +6dB	-6dB ～ +6dB
Store the setting value	No	Yes	Yes

Note: In continuous mode, if the white part is not enough to make an adjustment, the white balance may not achieve a proper white color.
Note: The completion of one push auto white requires a maximum of 5 seconds to complete.
Note: If the master gain is set less than 0dB, R and B gain can not be controlled up to -6dB. For instance, if the master gain is set at -3dB, the saturation level of R and B gain is deteriorated under 0dB.

9.4.3 Linear matrix

The AT-140GE incorporates a linear color matrix circuit to improve color reproduction.
As this circuit processes signals in the linear stage, before the gamma correction circuit, the gamma circuit does not affect color reproduction.

This circuit has:
1. Linear OFF
2. sRGB Standard which HP and Microsoft specify for printers and monitors. This preset is based on this standard.
3. Adobe RGB Standard which Adobe systems specify. This preset is based on this standard.
4. User User can manipulate R, G and B color relationships based on applications. Set the **gain for R-R, R-G, R-B, G-R, G-G, G-B, B-R, B-G, B-B to adjust.**

Important Note:
If sRGB or Adobe RGB is used, please note the following procedure.
1) Achieve the white balance under the condition of D65 (6500K) illumination.
2) Gamma should be set at 0.45 and set the linear matrix at either sRGB or Adobe RGB.
3) Monitor should comply with sRGB or Adobe RGB color reproduction capability.

9.4.4 Blemish compensation

The AT-140GE has a blemish compensation circuit.
Blemish control has 0:OFF, 1:Black, 2:White and 3:Both. When 1, 2 or 3 is selected, the stored factory data can be loaded.

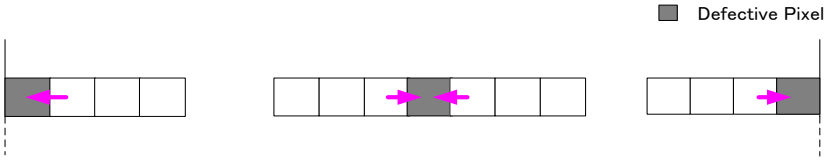


Fig.30 Conceptual drawing for blemish compensation

9.4.5 Gamma setting (Look Up Table)

The AT-140GE has various gamma settings including LUT (Look Up Table). Gamma can be set OFF (1.0), 0.6, 0.45, or to exhibit characteristics set using LUT.
The following shows the typical characteristics in the case of gamma 0.6.

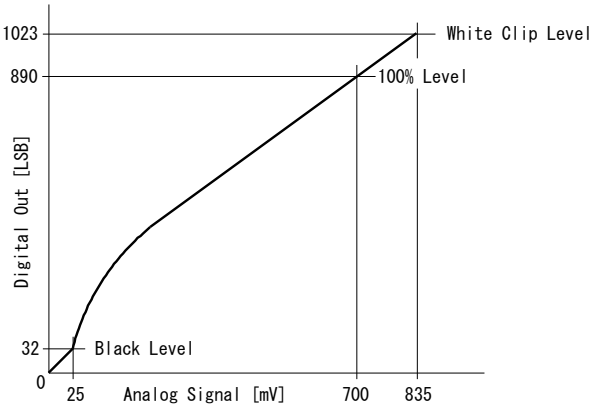


Fig.31. Gamma setting

CCD out	Analog Signal	Digital Out(32bit)	Digital Out(24bit)
Black	Setup 3.6%, 25mV	32LSB	8LSB
200mV	700mV	890LSB	222LSB
230mV ↑	800mV	1023LSB	255LSB

9.4.6 Knee compensation

If the relation of input and output is linear (1:1), the output signal is saturated at a certain level of the input signal and details cannot be reproduced in the saturated area. The knee compensation circuit maintains linear output up to a knee point and compresses the level after the knee point. This is set by a knee slope function. The AT-140GE supports up to 200% signal compression by knee slope. Factory default is OFF.

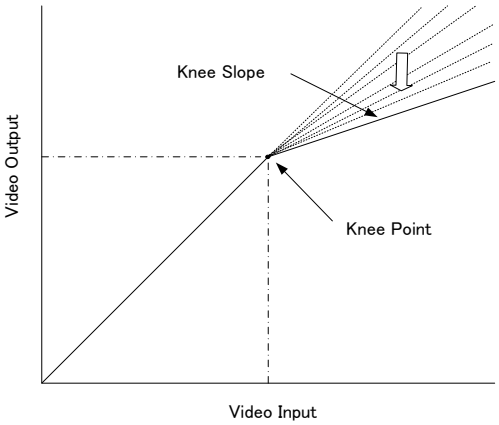


Fig.32 Example of Knee characteristics

Functions	Data length	Setting range
Knee Point	10bit	0LSB ～ 1023LSB
Knee Slope	12bit	0(x0.0005) ～ 4095(x2.0000)

9.5. Other functions

9.5.1 Test pattern generator (Address 0xA13C)

The AT-140GE has an internal test pattern generator. These signals are output as the last process of the digital signal processing circuit and can be used for adjustment of the related system. The AT-140GE has a total of 6 test pattern types.

Value	Description
0	OFF
4	Horizopntal Ramp Scale
5	Vertical Ramp Scale
6	Moving Ramp Scale
8	Normal Color Bar
9	Vertical Color Bar
10	Moving Color Bar

9.5.2 Center marker

The AT-140GE is equipped with a center marker generator. The center marker can be selected from three types as described below.

1 = Vertical 2 = Horizontal 3 = Both

Note: The center marker is displayed only in full scan mode.

Fig.33 Center marker

9.6. Sensor Layout and timing

9.6.1 CCD Sensor Layout

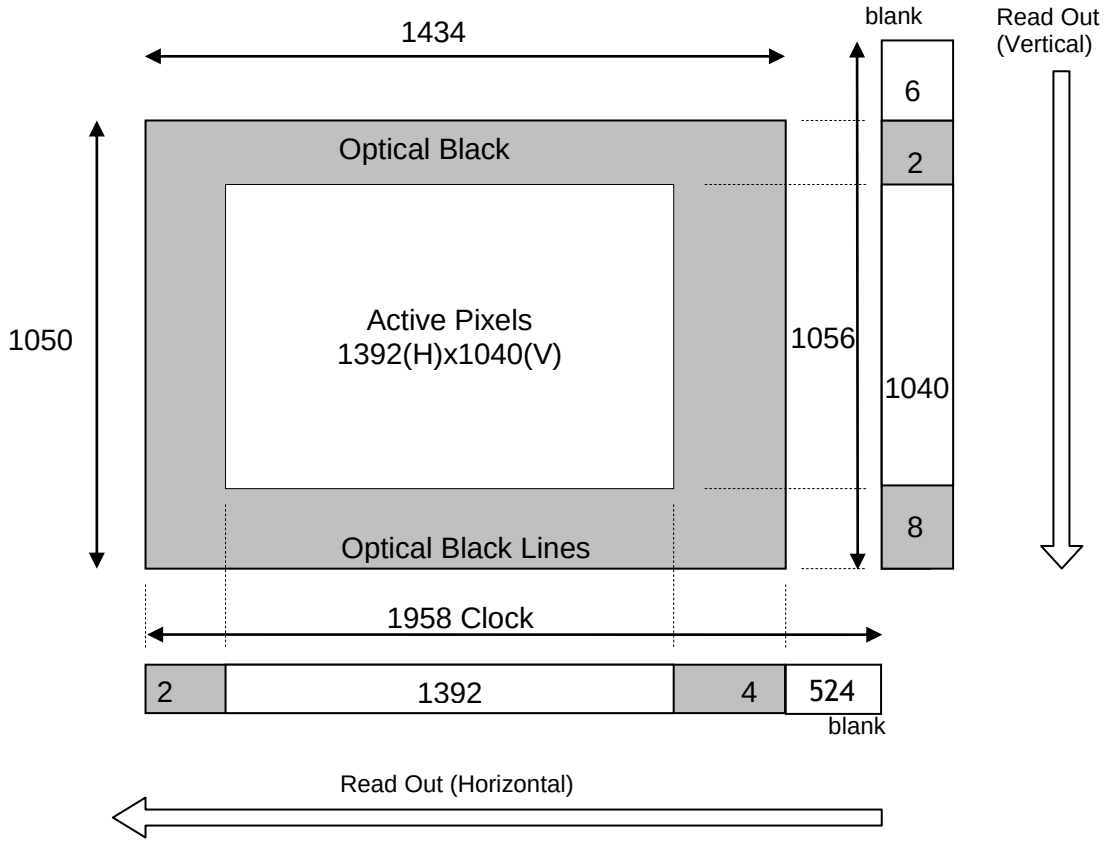


Fig.34 CCD sensor layout

9.6.2. Horizontal timing (Normal continuous mode)

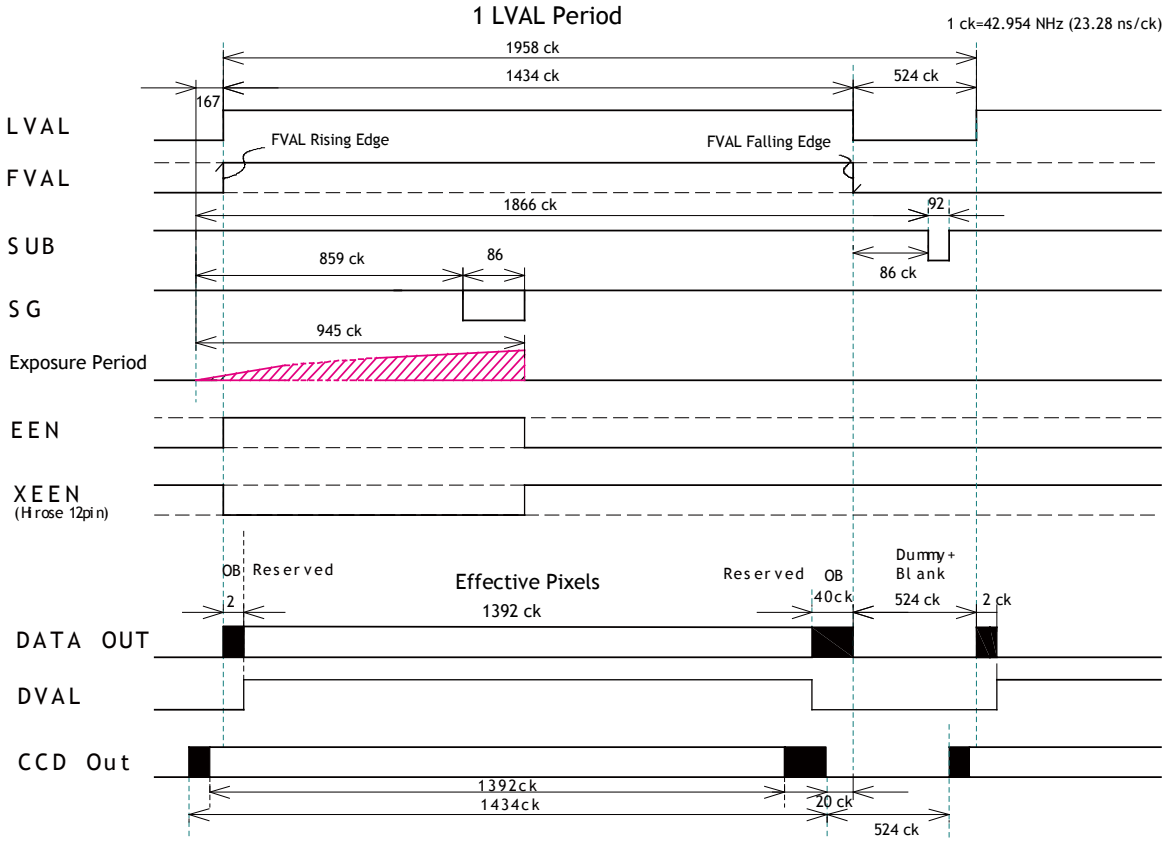


Fig. 35 Horizontal timing

9.6.3 Vertical timing (Normal continuous mode)

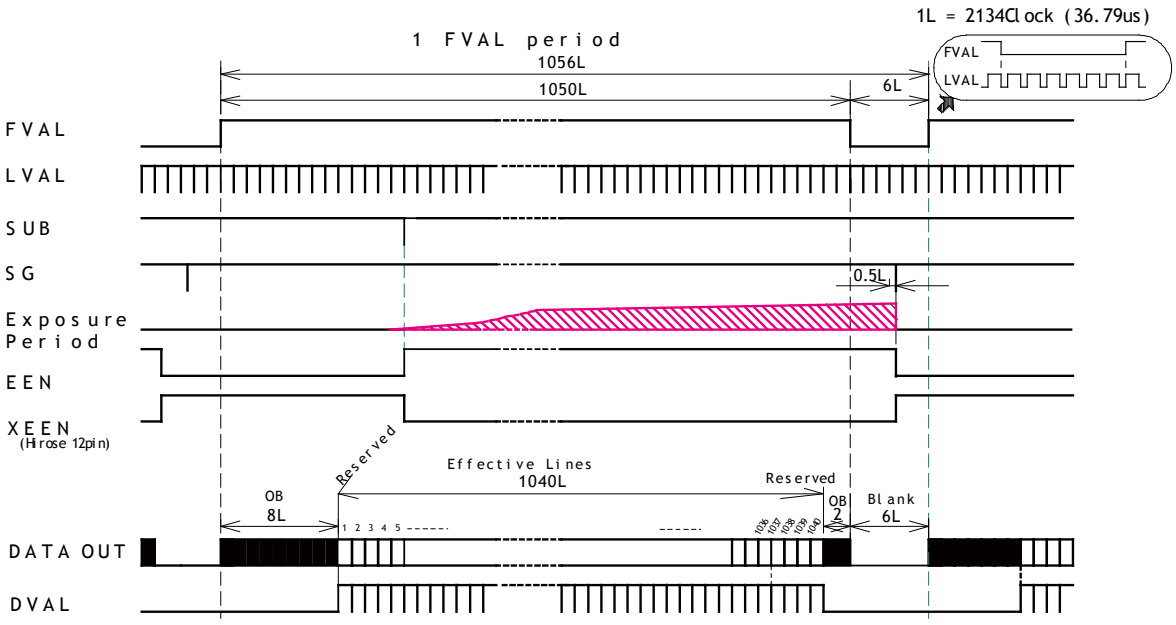


Fig.36 Vertical timing for full scan

9.6.4 Horizontal timing (Partial scan mode)

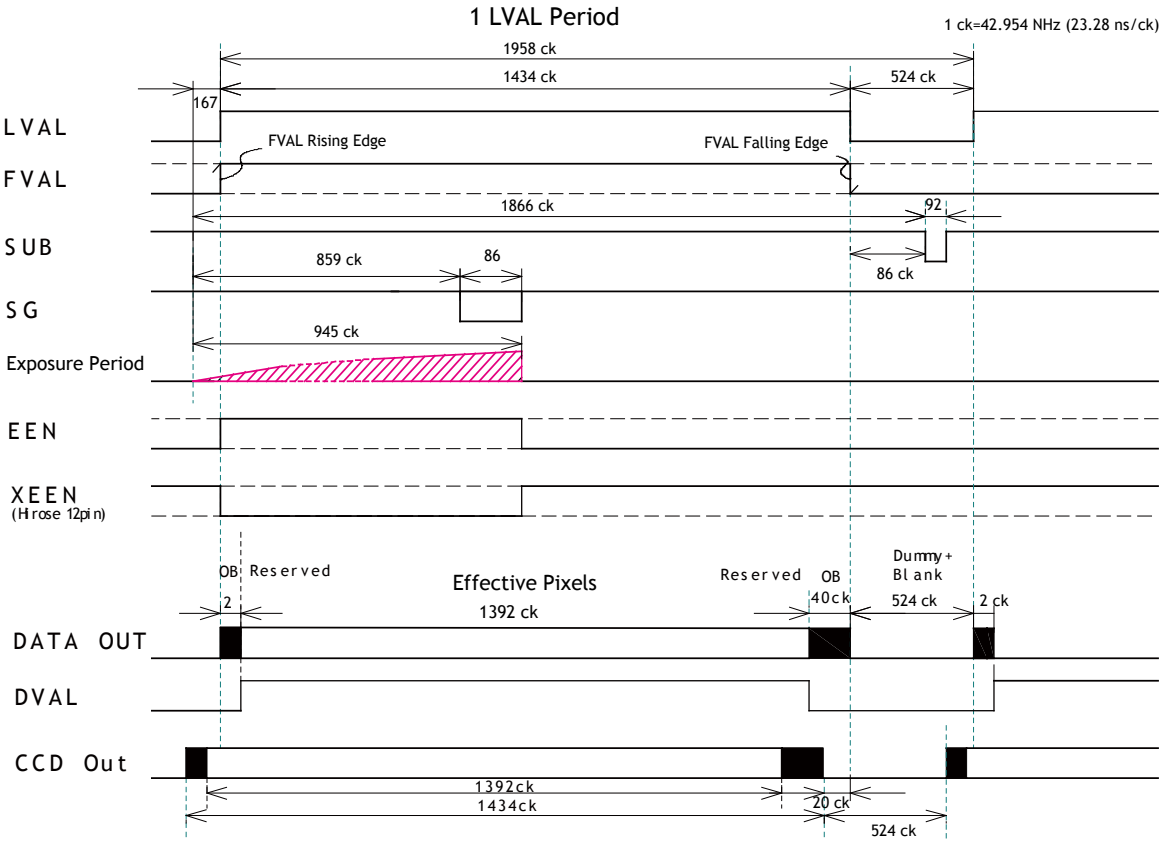


Fig.37 Horizontal timing (Partial scan, the same as normal continuous)

9.6.5 Vertical timing (Partial scan mode)

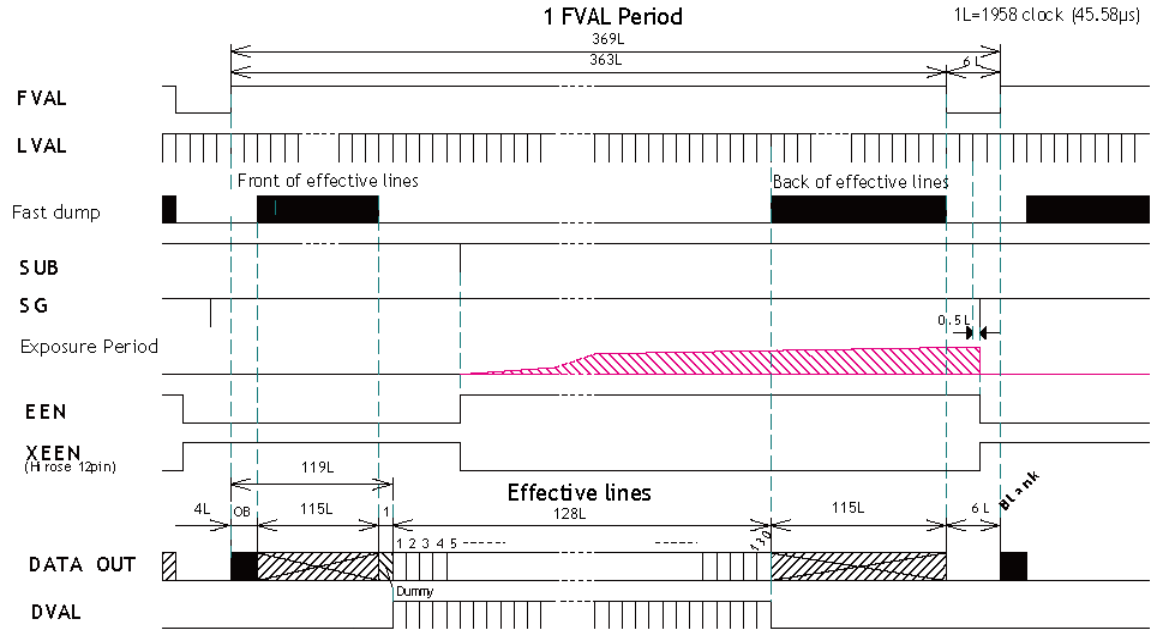


Fig.38 Vertical timing (Example:1/8 partial scan setting)

Partial scan examples	Effective lines	Total lines	Horizontal Frequency	Frame rate
2/3	692	792	21.938 KHz	27.69 fps
1/2	520	663	21.938 KHz	33.08 fps
1/4	260	468	21.938 KHz	46.87 fps
1/8	128	369	21.938 KHz	59.45 fps

9.6.6 Horizontal timing (Vertical binning mode)

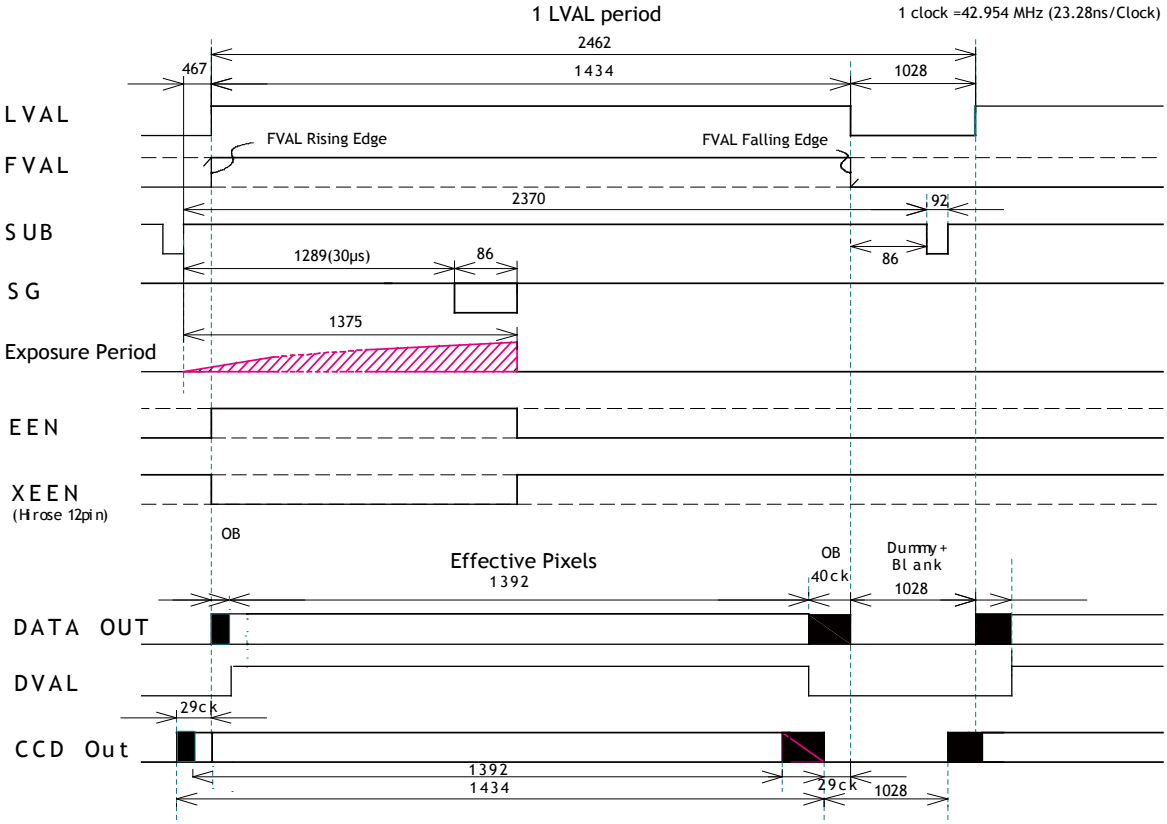


Fig. 39 Horizontal timing for V binning.

9.6.7 Vertical timing (vertical binning mode)

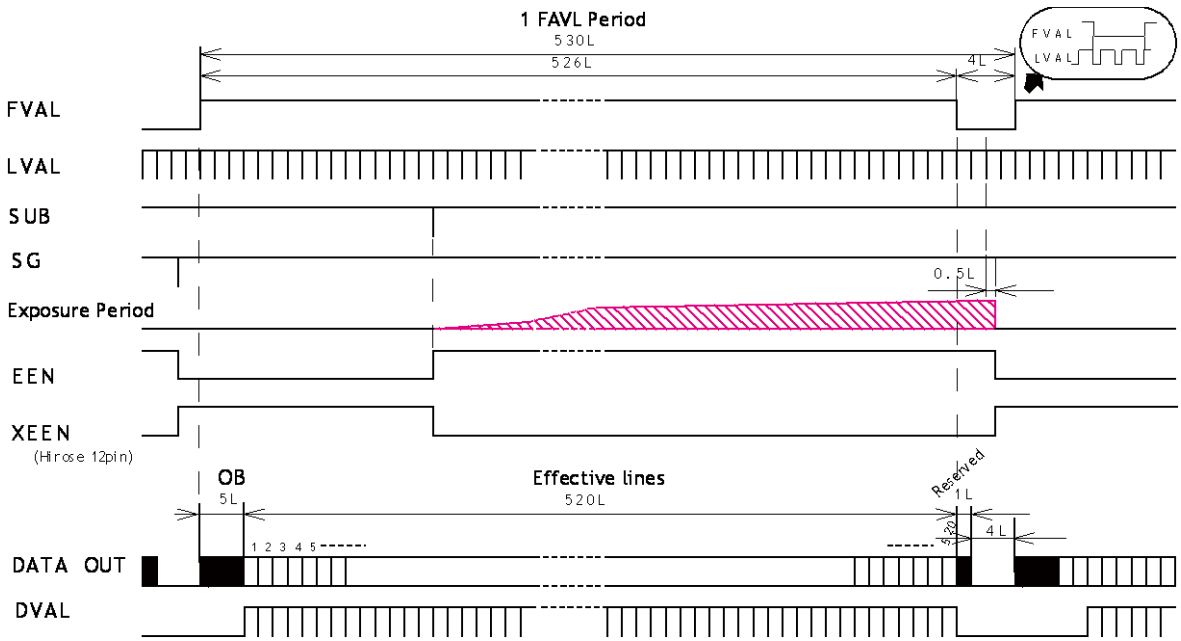


Fig.40 Vertical timing for V binning.

9.7. Operation Modes - Timing

9.7.1 Continuous operation

For applications not requiring asynchronous external triggering, this mode should be used. In this mode it possible to use a lens with a video controlled iris.
For timing details, refer to fig.35. through fig.40.

To use this mode:

Set function:	Exposure mode	Continuous
	Pixel format	RGB8, 10V1, 10V2
	Partial scan	Fast dump ON, ROI
	Vertical binning	Binning vertical ON
	Shutter mode	Programmable, Exposure Time Abs, Auto shutter

9.7.2 Edge Pre-select Trigger Mode (EPS)

An external trigger pulse initiates the capture, and the exposure time (accumulation time) is the fixed shutter speed set by programmable exposure or Exposure Time Abs. The accumulation can be automatically set either LVAL synchronous or LVAL asynchronous in relation to FVAL and trigger timing.
The resulting video signal will start to be read out after the selected shutter time.
For timing details, refer to fig35 . through fig43 .

To use this mode:

Set function:		
	Exposure mode	Edge pre-select
	Pixel format	RGB8, 10V1, 10V2
	Partial scan	Fast dump ON, ROI
	Vertical binning	Binning vertical ON
	Shutter mode	Programmable, Exposure Time Abs
	GPIO setting	

Important notes on using this mode

- Active Trigger pulse >2 LVAL to <1 FVAL
- Minimum Trigger interval is shown in the following table.

Mode	Minimum trigger interval
LVAL Sync	1056L + 3L
LVAL Async	Exposure time + 1056L + 3L
Smearless is ON	Smearless time(352L) + Maximum exposure time +1056L + 3L
Note: 1) On the above table, 1056L is FVAL interval on normal continuous mode 2) In the vertical binning mode, 1L is different from the normal scanning. So, the minimum trigger interval will be different.	

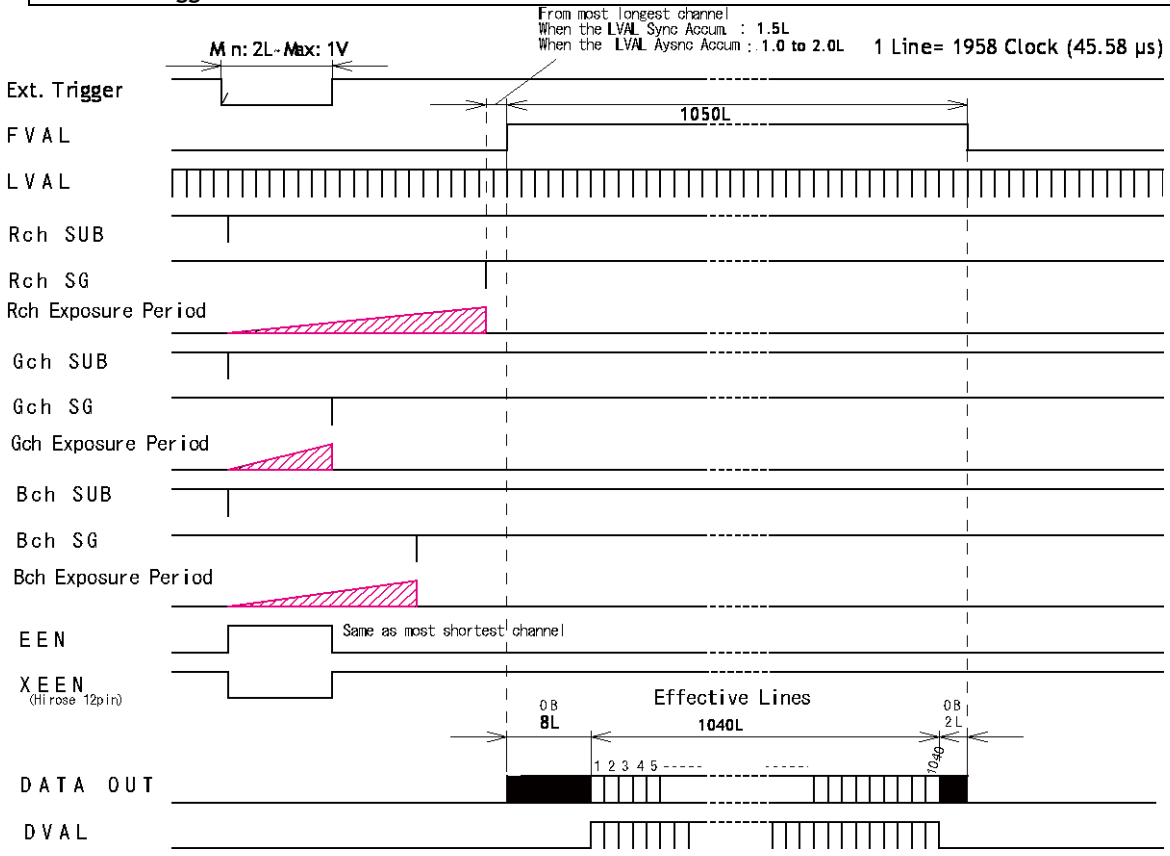


Fig.41 Edge Pre-select.

EPS timing LVAL sync details

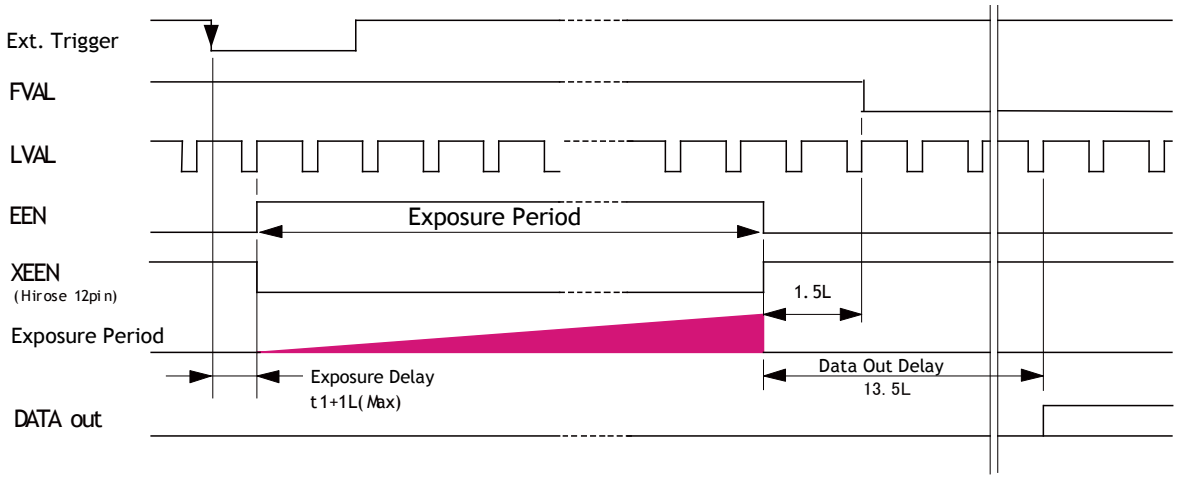


Fig.42 Edge Pre-select LVAL SYNC details

EPS timing LVAL async details

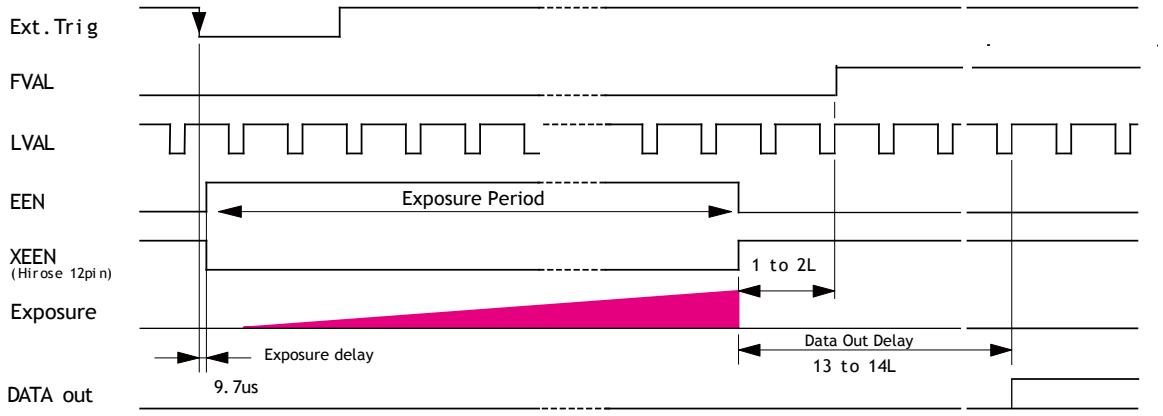


Fig.43 Edge Pre-select LVAL ASYNC details

9.7.3 Pulse Width Control Trigger Mode

In this mode the accumulation time is equal to the trigger pulse width. Here it is possible to have a long time exposure. The accumulation can be automatically set either LVAL synchronous or LVAL asynchronous in relation to FVAL and trigger timing. The maximum recommended exposure time is <2 seconds.
The resulting video signal will start to be read out after the trigger's rising edge.
For timing details, refer to fig.35 through fig.40 and fig.44 through fig.46 .

To use this mode:

Set function:	Exposure mode	Pulse width control
	Pixel format	RGB8, 10V1, 10V2
	Partial scan	Fast Dump ON, ROI
	Vertical binning	Binning vertical ON
	GPIO settings	

Important notes on using this mode

- Trigger pulse width >2 LVAL to <2 seconds.
- Minimum trigger interval is shown in the following table.

Mode	Minimum trigger interval
LVAL Sync	1.Exposure time < 1056L 1056L + 3L 2.Exposure time ≥ 1056L Exposure time +2L
LVAL aSync	Exposure time + 1056L + 3L
Smearless is ON	Smearless time (352L) + Exposure time + 1056L + 3L
Note: 1) On the above table, 1252L is FVAL interval in normal continuous mode 2) In the vertical binning mode, 1L is different from the normal scanning. So, the minimum trigger interval will be different.	

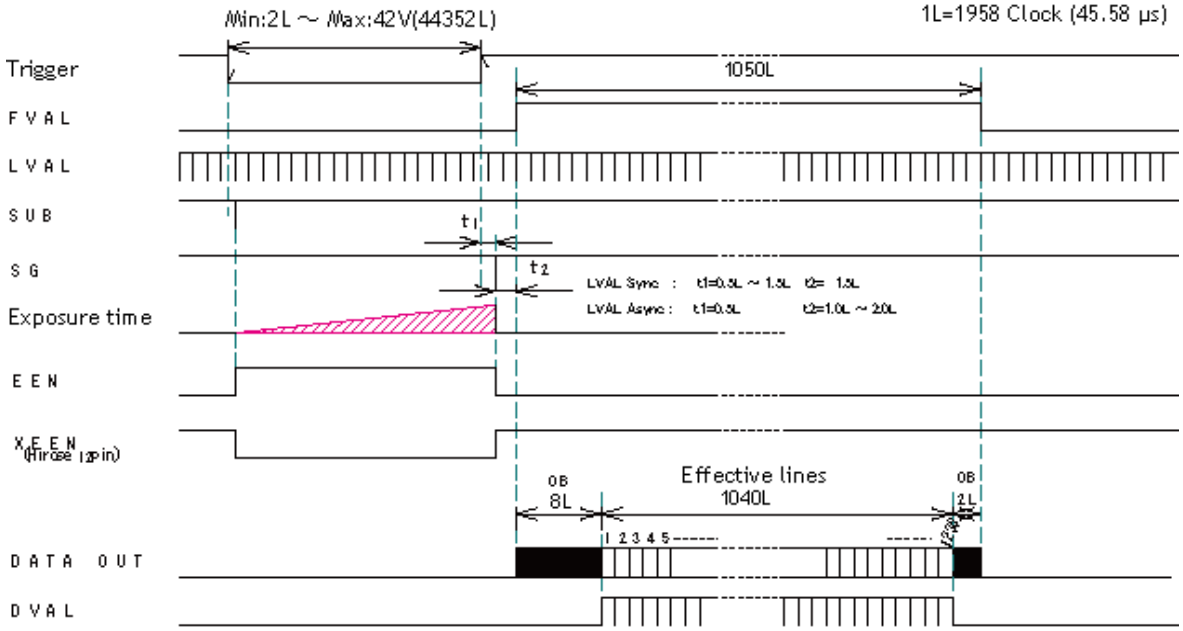


Fig.44 Pulse Width Control.

PWC timing - LVAL sync details

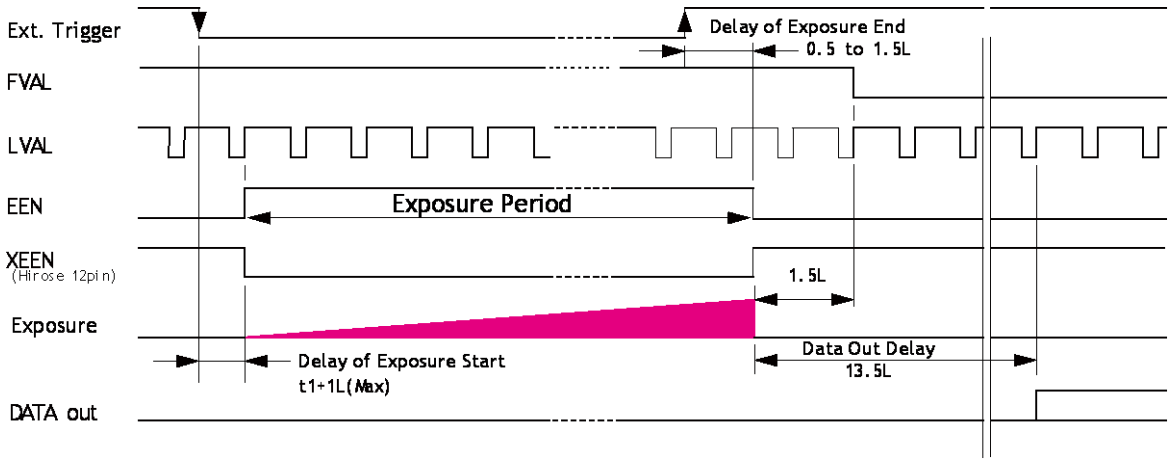


Fig.45 Pulse Width Control LVAL SYNC details

PWC timing - LVAL async details

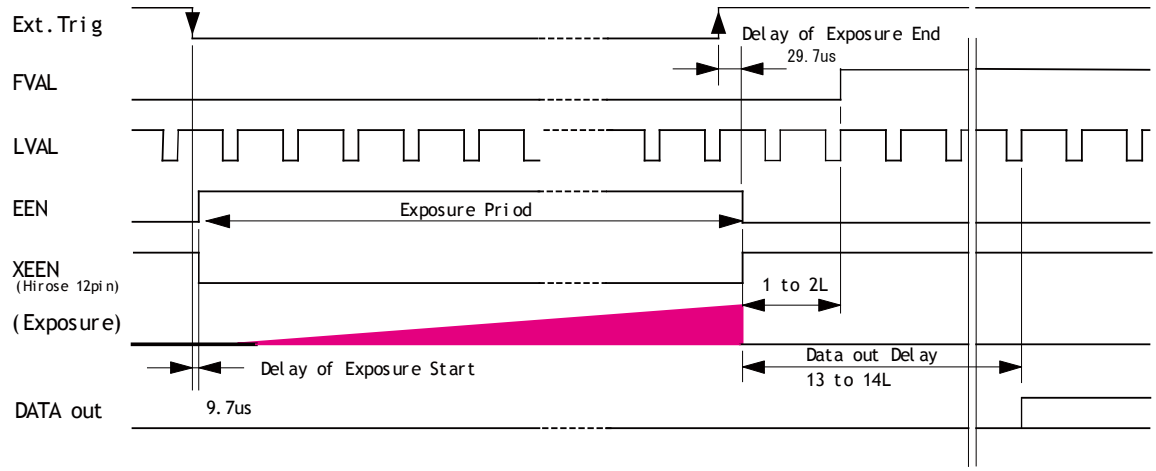


Fig.46 Pulse Width Control LVAL ASYNC Details

Note: In PWC mode, if a smearless function is ON, the real exposure time is the period which the smearless period (352L) is deducted from the trigger active period. If the input trigger pulse width is shorter than 352L, accumulation does not occur.

9.7.4 Reset Continuous Trigger (RCT)

The RCT mode operates like EPS (Edge Pre-select) mode with smearless function. An external trigger pulse will immediately stop the video read out, reset and restart the exposure, then operate as normal mode until the next trigger. After the trigger pulse is input, a fast dump read out is performed. In the AT-140GE, this period is 16.04ms which is 352L. The exposure time is determined by the pre-set shutter speed. If no further trigger pulses are applied, the camera will continue in normal mode and the video signal is not output. The fast dump readout has the same effect as "smearless readout". Smear above bright areas is reduced for the trigger frame. The reset continuous trigger mode makes it possible to use triggering in conjunction with a lens with video controlled iris.
RCT mode is available only in LVAL asynchronous.

To use this mode:

Set function:	Exposure mode	RCT
	Pixel format	RGB 8, 10V1, 10V2
	Partial scan	Fast Dump ON, ROI
	Vertical binning	Binning vertical ON
	Shutter mode	Programmable, Exposure Time Abs
	GPIO settings	

Important notes on using this mode

- Active Trigger pulse >2 LVAL to <1 FVAL
- Minimum Trigger interval is shown in the following table.

Mode	Minimum trigger interval
LVAL Async	Smearless time(265L) + Maximum exposure time +1252L + 3L

Note: 1) On the above table, 1252L is FVAL interval on normal continuous mode
2) In the vertical binning mode, 1L is different from the normal scanning. So, the minimum trigger interval will be different.

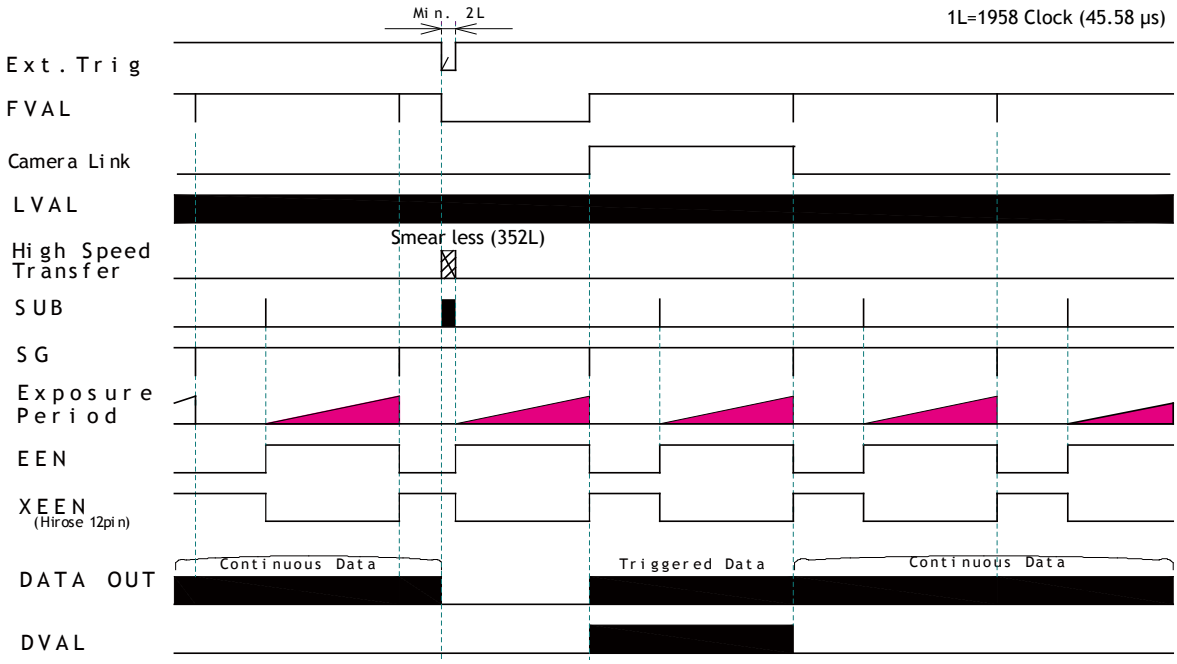


Fig.47 RCT mode

Note: In this mode, if the next trigger is input while the data is read out, the data can be immediately transferred. The minimum trigger interval should be kept.

9.7.5 Sequential Trigger Mode (EPS)

This mode allows the user to define a preset sequence of up to 10 images, each with its own ROI, Shutter and Gain values. As each trigger input is received, the image data with the preset sequence is output as described below.

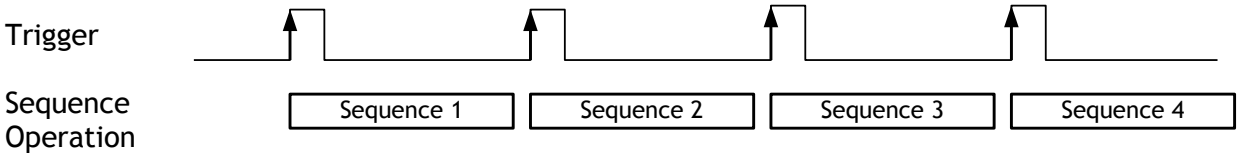


Fig.48 Sequential Trigger Mode

Signals added to a trigger can be selected by 0xB060 Camera Trigger Selector in the register map via GPIO. The camera will function on the rising edge of the trigger and Negative or Positive should be determined accordingly.

The following default settings can be modified by the user to define a sequence.

ID	ROI				Shutter	Gain	Repeat For each ID (1 to 50)
	Width	Height	Offset X				
1	1392	1040	0	1	1056	0	1
2	1392	1040	0	1	1056	0	1
3	1392	1040	0	1	1056	0	1
4	1392	1040	0	1	1056	0	1
5	1392	1040	0	1	1056	0	1
6	1392	1040	0	1	1056	0	1
7	1392	1040	0	1	1056	0	1
8	1392	1040	0	1	1056	0	1
9	1392	1040	0	1	1056	0	1
10	1392	1040	0	1	1056	0	1

The following registers are used to configure the sequence.

0xC0F4 Sequence Repetitions (Number of Repetitions – note: 0 = repeat indefinitely)
0xC0F8 Sequence Ending Position (Ending Position)
0xC0F0 Sequence Reset Command (1 only)
0xB060 Selection for camera trigger 0
0xA040 Trigger mode selection and 0x09 for Sequential PS mode

Example of settings

Setting: Repeat 5 times from ID 1 through ID 8

0xC0F4 Set to 0x05
0xC0F8 Set to 0x08
0xB060 For instance, 12p #6 for Optical IN 1
0xA040 Sequential PS (9)
0xA604 Set video sending flag to1 for start
0xA604 Set video sending flag to 0 for stop
Please refer to the detailed register description on the Camera Register Map which is included in the SDK.

Important Notes:

- Minimum trigger interval is; Exposure time + 1056L(FVAL on normal scan) + 1L
- In order to operate this mode, it is recommended to set the shutter speed first at a smaller value and then a bigger value.
- Do not input the trigger signal right after the sequence is reset. At least, 500ms duration is needed. This may cause malfunction.
- ROI can be set for horizontal direction by 8 pixels increment. For vertical direction, it is 1 pixel increment.

9.7.6 Delayed Readout EPS and PWC Modes (EPS and PWC)

This mode can be used to delay the transmission of a captured image. When several cameras are triggered simultaneously and connected to the same GigE interface, it allows the cameras to be read out in sequence, preventing congestion.

The image data is not transmitted directly by the trigger 0 and is stored in the memory located at the Ethernet Interface. By the falling edge of the soft trigger 1, the image data is output.
The AT-140GE has up to 4 frames to store, and the stored image data can be output at the consecutive timing of trigger 1.
This mode can work in EPS mode and PWC mode.

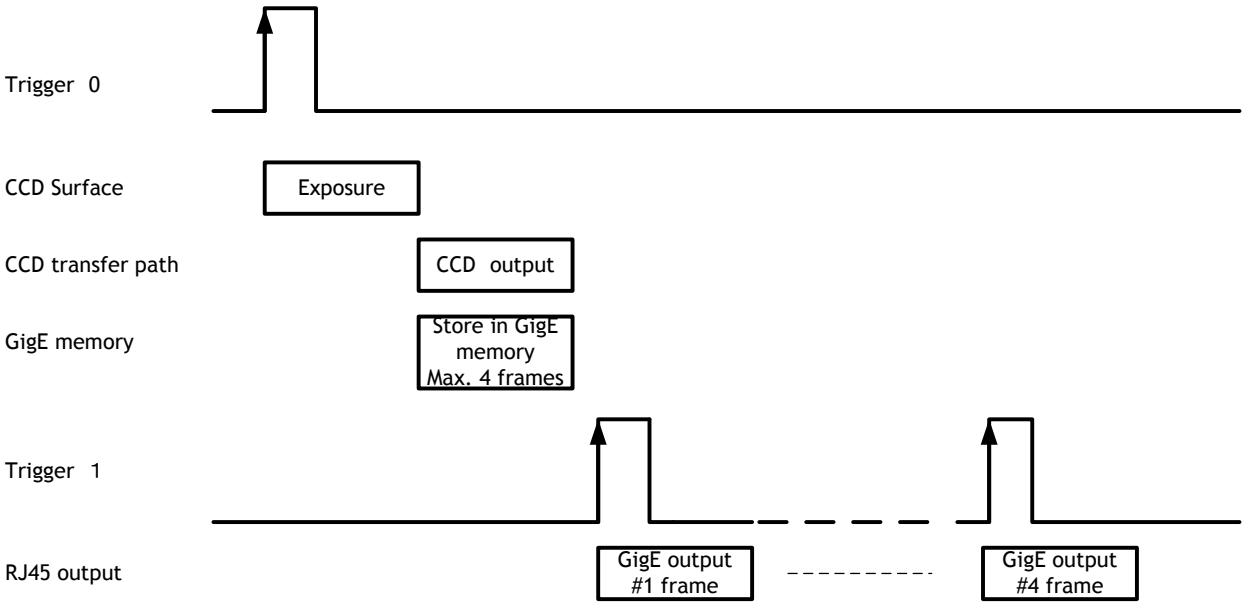


Fig.49 Delayed Read Out Mode

Example of setting

0xA040 PS Delayed Readout (0x17)
0xB060 Trigger 0 select, e.g. 0x04 OPT IN 1
0xB-064 Trigger 1 select, e.g. 0x05 OPT IN 2

For the details of Registers, please refer to the Camera Register Map which is included in the SDK.

9.7.7 Smearless mode

This function can be used to reduce the smear coming from bright areas of the image. This is effective for both EPS and PWC trigger modes. Before accumulation starts, the charge that is stored in the pixel is dumped by a high-speed transfer. This can reduce the smear that appears above the bright area but the smear below the area is unaffected.
At the falling edge of the trigger pulse the high speed transfer starts. This period is 16.04ms which is 352L. Thereafter the residual charge in the horizontal CCD register is read out in 1L and the new exposure starts. This function is available for both full scan and partial scan.

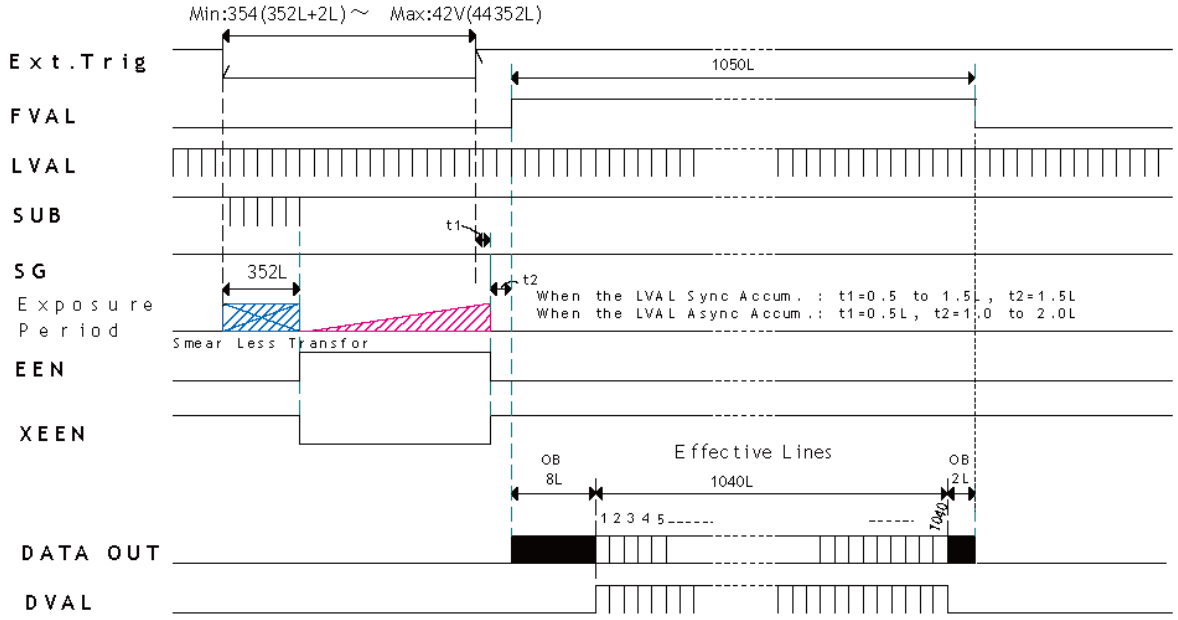
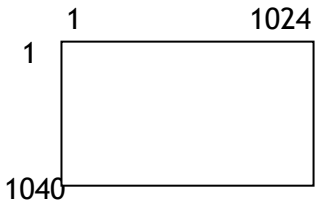
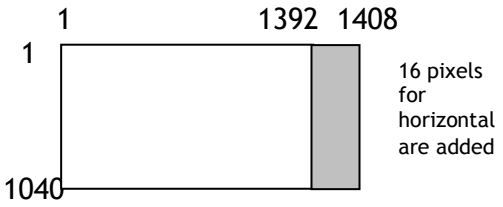
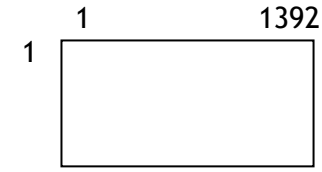
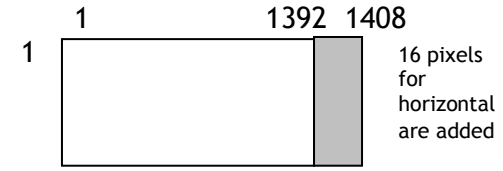
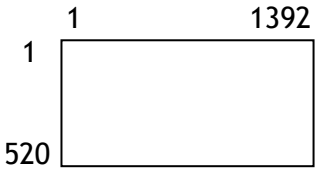
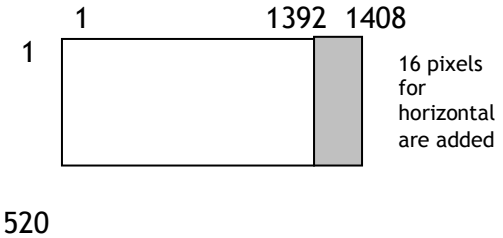


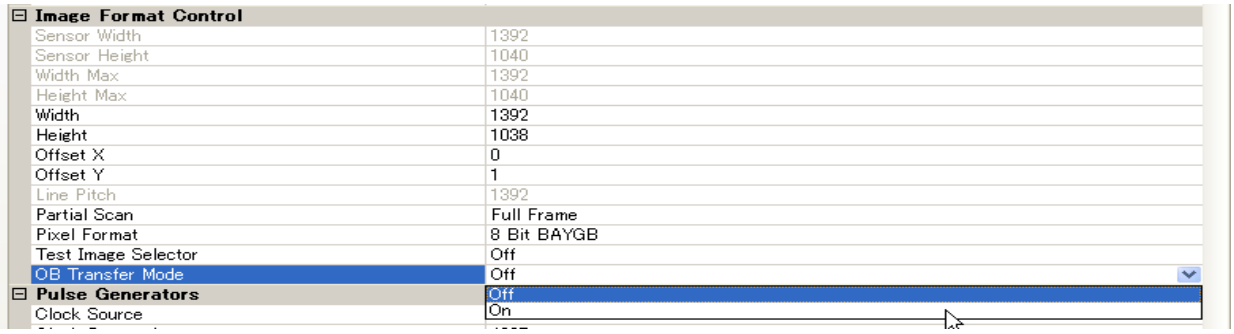
Fig.50 Smearless mode

9.7.8 Optical Black transfer mode

It is possible for the user to decide whether the optical black (OB) portion of the image will be transferred or not. The optical black part can be used for black reference in the application software. Setting register 0xA41C turns the optical black transfer ON or OFF. The default condition is OFF.

	OB Transfer Mode OFF	OB Transfer Mode ON
Normal Scan		
Fast Dump (Partial Scan)		
Vertical Binning		

Note: The menu for ON or OFF of OB transfer mode is found in the Image Format Control section of the JAI SDK Camera Control Tool.



9.7.9 Multi ROI mode (Multi Region of Interest)

In this trigger mode, up to 5 ROIs located on one image can be output by one trigger input. By using this mode, the data stream can be smaller. Each ROI can be overlapped.

Please note that if the accumulated data size is bigger than the data size of 1 frame, the frame rate will be reduced.
As explained in section 9.3.3, a partial scan mode is associated with ROI and in the case of figure 51, the start line of ROI 2 and the end line of ROI 4 would define a partial scan area.

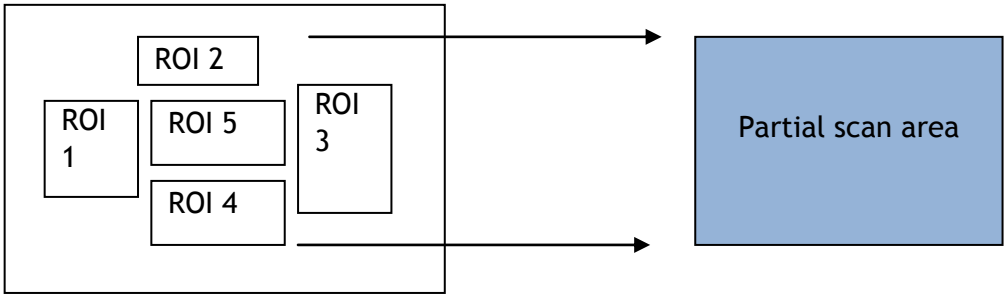


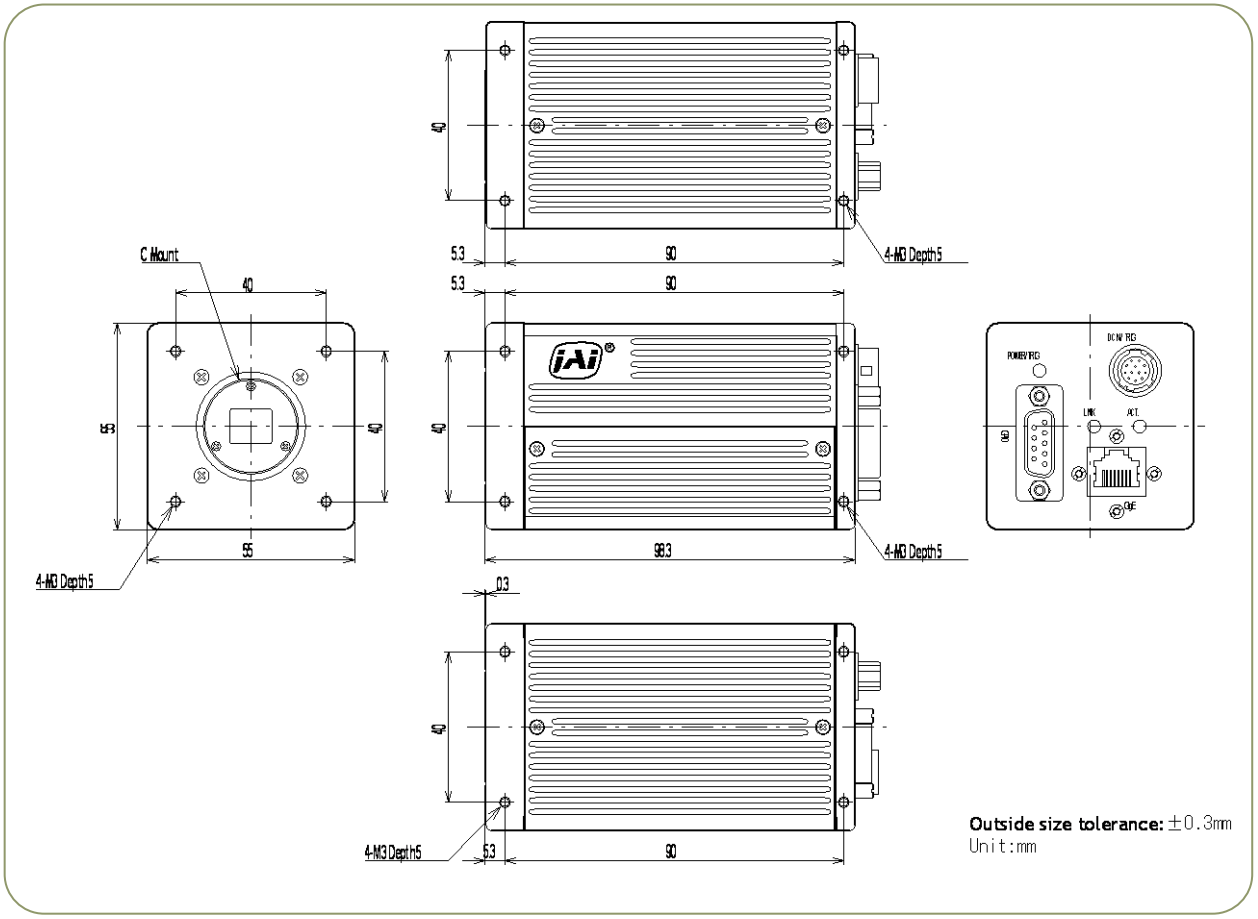
Fig. 51 Multi ROI conceptual drawing

9.8. Mode and functions matrix

ID	Mode	Shutter Programmable/ Exposure Abs	Auto shutter	V Binning	Partial scan	Smear less	Multi ROI	LVAL Sync/ Async	Auto Iris output
0x00	Continuous	○	○	○	○	×	×	---	○
0x01	EPS	○	×	○	○	○	○	Auto	×
0x02	PWC	---	×	○	○	○	○	Auto	×
0x04	RCT	○	○	○	○	○	○	Async only	○
0x09	Sequential EPS	○	×	○	○	○	×	Auto	×
0x11	EPS Delayed readout	○	×	○	○	○	×	Auto	×
0x12	PWC Delayed Readout	---	×	○	○	○	×	Auto	×

Note: 1. Trigger mode can be set by writing ID value in register 0xA040.
2. In trigger modes from ID 0x09 to ID 0x12, if trigger mode is changed, set “Acquisition Stop” and then set continuous mode(ID 0x00) first and change to required trigger mode. For instance, it is not possible to change directly from ID 0x09 sequential EPS mode to 0x11 EPS delayed readout mode.

10. External Appearance and Dimensions



***Note**: Rear protrusion on C-mount lens must be less than 4.0mm*

Fig. 52 Outline

11. Specifications

11.1. Camera sensitivity response

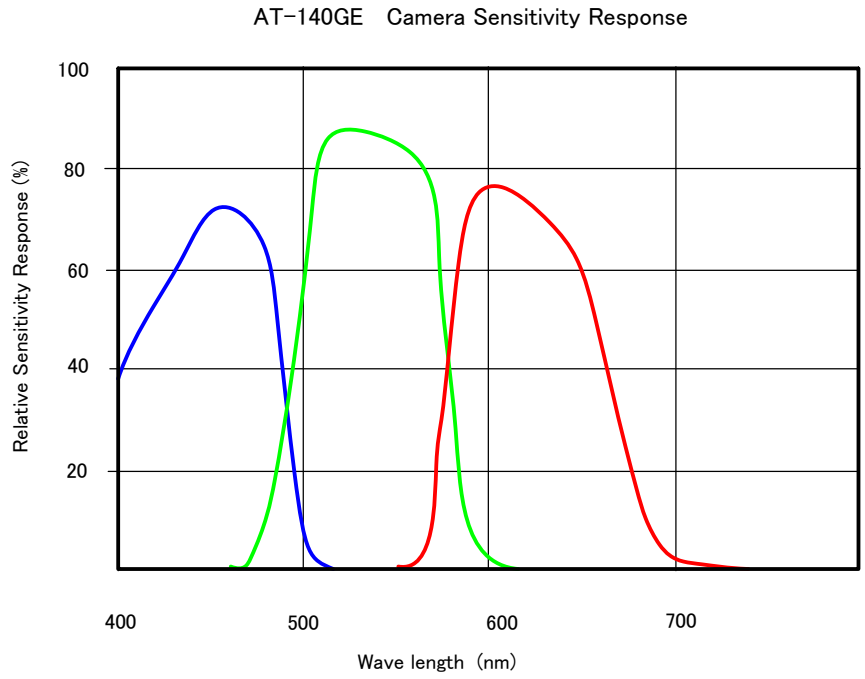


Fig.53 AT-140GE Camera Sensitivity response

11.2. Specification table

Specifications	AT-140GE
Optical system	1/2 inch F4.0 prism
Scanning system	Progressive
Synchronization	Int. X-tal
Frame rate full frame	20.77 frames/second (1056 lines per frame)
Pixel clock	42.954 MHz
Line frequency V binning	21.938 kHz (1958 clk per line) 17.447 kHz (2462 clk per line)
CCD sensors	3 x 1/2" IT CCD on prism. Sony ICX267AL
Sensing area	6.47 (h) x 4.84 (v) mm 1/2 inch diagonal
Cell size	4.65 (h) x 4.65 (v) μm
Active pixels	1392 (h) x 1040 (v)
Pixels in video output full 2/3 partial(reference value) 1/2 partial(reference value) 1/4 partial(reference value) 1/8 partial(reference value) Variable partial V binning	1392 (h) x 1040 (v) 20.77 fps. (1056 lines per frame) 1392 (h) x692 (v) 27.69 fps (792 lines per frame) 1392 (h) x 520 (v) 33.08 fps. (663 lines per frame) 1392 (h) x 260 (v) 46.87 fps. (468 lines per frame) 1392 (h) x 128 (v) 59.45 fps. (369 lines per frame) Programmable start line and height, start line 1 to 1033, height 8 to 1040 1392 (h) x 520 (v) 32.92 fps. (530 lines per frame)
Sensitivity (on sensor) (minimum)	1.0 Lux, max gain, 50% video
S/N ratio	>50 dB. (On Green)
Digital Video outputs.	GigE®Vision 8bit, 10 bit Pixel format: RGB 8, RGB 10V1, RGB 10 V2
Iris video output	0.7 V p-p, 75 Ω NUM luminance signal w/o Sync
Inputs	HIROSE 12 pin: OPT x 2 HIROSE 6 pin : TTL/75Ω x 1, LVDS x 1
Outputs	HIROSE 12 pin: OPT x 2 HIROSE 6 pin: XEEN output 4 V p-p from 75 Ω source (TTL/75Ω)
GPIO Module Input/Output switch Clock Generator (one) Pulse generator (two)	Configurable 14-in / 10-out switch 12 bit counter based on pixel clock 20-bit counter programmable for length, start point, stop point , repeat
Gain Gain range	Manual for all 3 colors Master -3 to +12 dB. R and B –6 to +6 dB (0.035dB step)
White balance Tracking range	Manual/one push, continuous, preset(4000K, 4600K,5600K) -6 to +6 dB. (4000K to 9000K) White balance setting in factory: 7800K (R and B gain settings=0)
Gamma	1.0 (OFF) , 0.6, 0.45 or LUT (Look Up Table)
Knee correction	Knee point and knee slope for R, G and B channel
Linear Matrix	Manual for R, G and B / Preset (sRGB, Adobe RGB)
Noise reduction	ON / OFF
Shading Compensation	ON /OFF
Blemish Compensation	ON / OFF
Trigger modes	Edge Pre-select, Pulse Width Control, Reset continuous, Sequential EPS, EPS/PWC delayed readout
Shutter speed Programmable exposure Exposure Abs Auto shutter	0.5L(22.8μs) to 1056L(48.13ms) , increment by 1L 25μs to 48136μs 1/20s to 1/250s
Pulse Width Control	2L to 44352L
LVAL accumulation	SYNC/ASYNC auto detect
Smear less mode	Available for EPS and PWC
OB transfer mode	ON / OFF
Event message	Exposure start, Exposure end, Trigger IN, Video start, Video end, GPIO status
Video output connector	RJ-45 x 1
Control interface	Gigabit Ethernet (IEEE802.3, ATA GigE Vision Standard)

Specifications	AT-140GE
Functions controlled via GigE Vision Interface	Shutter, gain, black Level, trigger mode, readout mode, GPIO setup, ROI (GenICam mandatory functions)
GigE Vision Streaming Control	Packet size, delayed (frame) readout, inter-packet delay Jumbo frame can be set at max. 16K (16020), default packet size is 1476 bytes.
Operating temperature	-5°C to +45°C.
Humidity	20 - 80% non-condensing
Storage temp./humidity	-25°C to 60°C./20% - 80% non-condensing
Vibration	3 G (15 Hz – 200 Hz in XYZ)
Shock	50 G
Regulations	CE (EN 61000-6-2, EN 61000-6-3), FCC part 15 class B, RoHS
Power	10.8V to 26.4V DC. 0.61 A (Typical , Full frame ,12V input) 0.68 A (Typical ,1/8 partial, +12V input)
Lens mount	C-mount (Rear protrusion on C mount must be less than 4mm) The lens used should be designed for 3CCD cameras.
Flange back	17.526mm, Tolerance +0 to –0.05mm
Optical axis	Center ±0.1mm
Dimensions	55 x 55 x 98.3 mm (HxWxD)
Weight	320g

Note: 1) Partial scan and vertical binning can not be used at the same time. Partial scan has priority.
2) Above specifications are subject to change without notice
3) Specifications are valid after a 30 min. warm up period.

Register Map

The table below provides detailed information for the hardware registers used for controlling the camera and obtaining information on the status of the camera. The content of this register map is also found in the XML file, as stipulated by the GenICam standard.

Device Information

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
0x0048	Device Vendor Name	DeviceVendoeName	R	32		Manufacture of this device	
0x0068	Device Model Name	DeviceModelName	R	32		Model Name of this device	
0x0088	Device Version	DeviceVersion	R	32		Version of this device	
0x00A8	Device Manufacturer Info	DeviceManufacturerInfo	R	48		Provides extended manufacturer information about the device.	
0x00D8	Device ID	DeviceID	R	16		Camera serial number	
0x00E8	Device User ID	DeviceUserID	RW	16		User assignable string (16 Byte)	
0xA714	FPGA version	DeviceFPGAVersion	R	4			
0xA640	Device Reset	DeviceReset	W	4	Command=1		
0xA1FC	Temperature	Temperature	R	4	0.0625° step	-55℃ ～ 150 ℃	

Image Format Control

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
0xA400	Width Max	WidthMax	R	4	1024	Width max	1024
0xA404	Height Max	HeightMax	R	4	768	Height max	768
0xA410	Pixel Format	PixelFormat	RW	4	0x02180014 0x0220001C 0x0220001D	RGB8Packed RGB10V1Packed RGBV10V2Packed	RGB 8
0xA500	ROI Mode	ROIMode	RW	4	1 to 5	1:ROI disable 2 to 5: Enable	1
0xA504	ROI 1 Width	Width	RW	4	8 - 1392	Width	W.Max
0xA508	ROI 1 Height	Height	RW	4	8 – 1040	Height	H.Max
0xA50C	ROI 1 Offset X	OffsetX	RW	4	0 – 1384	Horizontal offset	0
0xA510	ROI 1 Offset Y	OffsetY	RW	4	0 – 1032	Vertical offset	0
0xA514	ROI 2 Width	Width2	RW	4	8 - 1392	Width 2	W.Max
0xA518	ROI 2 Height	Height2	RW	4	8 – 1040	Height 2	H.Max
0xA51C	ROI 2 Offset X	OffsetX2	RW	4	0 – 1384	Offset X2	0
0xA520	ROI 2 Offset Y	OffsetY2	RW	4	0 – 1032	Offset Y2	0
0xA524	ROI 3 Width	Width3	RW	4	8 - 1392	Width 3	W.Max
0xA528	ROI 3 Height	Height3	RW	4	8 – 1040	Height 3	H.Max
0xA52C	ROI 3 Offset X	OffsetX3	RW	4	0 – 1384	Offset X3	0

0xA530	ROI 3 Offset Y	OffsetY3	RW	4	0 – 1032	Offset Y3	0
0xA534	ROI 4 Width	Width4	RW	4	8 - 1392	Width 4	W.Max
0xA538	ROI 4 Height	Height4	RW	4	8 – 1040	Height 4	H.Max
0xA53C	ROI 4 Offset X	OffsetX4	RW	4	0 – 1384	Offset X4	0
0xA540	ROI 4 Offset Y	OffsetY4	RW	4	0 – 1032	Offset Y4	0
0xA544	ROI 5 Width	Width5	RW	4	8 - 1392	Width 5	W.Max
0xA548	ROI 5 Height	Height5	RW	4	8 – 1040	Height 2	H.Max
0xA54C	ROI 5 Offset X	OffsetX5	RW	4	0 – 1384	Offset X 5	0
0xA550	ROI 5 Offset Y	OffsetY5	RW	4	0 – 1032	Offset Y 5	0
0xA080	Fast Dump	FastDumpEnable	RW	4		For enabling variable partial scan	
0xA084	Binning Vertical	BinningVertical	RW	4	1=Binning OFF 2=1/2 V Binning		1
0xA13C	Test Image Selector	TestImageSeleector	RW	4	0=OFF 4=H Rmap Scale 5=V Ramp Scale 6= Moving Ramp Scale 8=Normal Color bar 9=Vertical Color Bar 10=Moving Color Bar		0
0xA41C	OB Transfer Enable	OBTransferEnable	RW	4			

Acquisition and Trigger Control

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
0xA604	Acquisition Mode	AcquisitionMode	RW	4	0=Stop 1=Start	Acquisition start and stop	0
0xA414	Acquisition frame rate	AcquisitionFrameRate	RW	4	0=Full speed 1=1/2 speed 2=1/4 speed 3=1/8 speed		0
0xA000	Shutter mode	ShutterMode	RW	4	1= Programmable exposure in line 2=Programmable exposure(us) 3=Auto Exposure Constantly	Sets exposure time for image capture.	1
0xA008	Exposure Time Raw	ExposureTimeRaw	RW	4	0 to 1056(OFF)	Flexible setting of exposure time ranging from 25 µs to 48.136 ms using the LVAL period (L) as increment. 1L is 45.58us.	1056
0xA018	Exposure Time (us)	ExposureTimeAbs	RW	4	25 to 48136(OFF)	Actual exposure time in microseconds, µs. The camera will round value off to match LVAL increments.	48136

0xA020	Exposure Time (us) to Red	ExposureTimeAbsRed	RW	4	25 to 48136(OFF)	Set exposure time by micro second (for R channel)	48136
0xA024	Exposure Time (us) to Green	ExposureTimeAbsGreen	RW	4	25 to 48136(OFF)	Set exposure time by micro second (for G channel)	48136
0xA028	Exposure Time (us) to Blue	ExposureTimeAbsBlue	RW	4	25 to 48136(OFF)	Set exposure time by micro second (for B channel)	48136
0xA030	Auto exposure value	AutoExposureValue	R	4		Exposure time on Auto exposure mode	
0xA040	Exposure Mode	ExposureMode	RW	4	00=Continuous trigger 01=Edge pre-select 02=Pulse-width control 04=RCT mode 09=Sequential EPS trigger 17=Delayed readout EPS trigger 18=Delayed readout PWC trigger 32=PIV mode 1 64=PIV mode 2 128=PIV mode 3		0
0xB060	Camera Trigger 0	CameraTrigger0			Trigger Source Bit31 ~ Bit25 Bit24:Trigger Activation 0=Rising Edge(Active High) 1=Falling Edge(Active Low)	Trigger Source 127=OFF 9=Line4-OpticalIn 1 10=Line5-optical In 2 12=Line6-TTL In 1 13=Line7-TTL In 2 11=Line8-LVDS In 16=Pulse Generator0 17=Pulse Generator1 20=User Output 0 (Software trigger 0) 21=User Output1 (Software trigger10) 22=User Output 2 (software trigger 2) 23=User Output 3 (Software trigger 3) Add 0x80 makes「Active Low」	127
0xB064	Camera Trigger 1	CameraTrigger1					
0xB0A0	Time Stamp Reset Trigger	TimeStampReset					
0xB0A4	Sequence Table Reset Trigger	SequenceTableReset					
0xA04C	Smearless Enable	SmearlessEnable	RW	4	0:OFF 1:ON		
0xA048	LVAL Sync/Async Accumulation	LVALSyncAccumulation	RW	4	0=Auto 1:Sync 2=Async		

Video Control

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
0xA050	Analog All	AnalogAll	RW	4	-89 ～ 341	Analog all -89(－3dB) 341(＋12dB) 1 step=0.0358dB Value 0＝0dB	0
0xA054	Analog Red	AnalogRed	RW	4	-200 ～ 200	Analog all -200(－6dB) 200(＋6dB) 1 step=0.0358dB Value 0＝0dB	0
0xA058	Analog Blue	AnalogBlue	RW	4	-200 ～ 300	Analog all -200(－6dB) 200(＋6dB) 1 step=0.0358dB	0

						Value 0＝0dB	
0xA0A0	Digital Gr	DigitalGr	RW	4	0 ～ 65535	8192(-6dB) 32768 (+6dB) Value 32768 = 0dB	32768
0xA0A4	Digital Gb	DigitalGb	RW	4	0 ～ 65535	8192(-6dB) 32768 (+6dB) Value 32768 = 0dB	32768
0xA0A8	Digital Red	DigitalRed	RW	4	0～ 65535	8192(-6dB) 32768 (+6dB) Value 32768 = 0dB	32768
0xA0AC	AGC Area	AGCArea	RW	4	Bit 16-19 AGC Area Size X Bit 24-27 AGC Area Size Y Bit 20-23 AGC Area Offset X Bit 28-31 AGC Area Offset Y	Min.1- Max.8 Min.1- Max.8 Min.0- Max.7 Min.0- Max. 7	
0xA0B0	Gain Auto	GainAuto	RW	4	0=OFF 1=continuous		0
0xA0B4	AGC Reference	AGCReference	RW	4	0 to 8191	Reference value for AGC and Auto shutter	0
0xA0B8	AGC Speed	AGCSpeed	RW	4	0=Slow 1=Standard 2=Fast		1
0xA0C8	Auto Gain Value	AutoGainValue	RO	4		Indicate gain value	
0xA150	Black Level Selector(ALL)	BlackLevelRaw[DigitalALL]	R W	4	0 to 1023		
0xA154	Black Level Selector(Digital Red)	BlackLevelRaw[DigitalR]	R W	4	0 to 1023		
0xA158	Black Level Selector(Digital Green)	BlackLevelRaw[DigitalG]	R W	4	0 to 1023		
0xA15C	Black Level Selector(Digital Blue)	BlackLevelRaw[DigitalB]	R W	4	0 to 1023		
0xA0C0	Balance White Auto	BalanceWhiteAuto	RW	4	0=Manual or one push 1=Continuous 2=3200K 3=4600K 4=5600K		
0xA0D0	Balance White Auto Once	BalanceWhiteAutoOnce	W	4	Command=0		0 only
0xA0D8	Status of video processing	StatusOfProcessing	R	4	0=Complete successfully 1=Busy 2=Too high level 3=Too low level 4=Time-out error 5=Reaching a limit of Feature's value 6=Inappropriate trigger mode	For auto white balance, Exposure Mode should be 0=Continuous.	
0xA0D4	AWB Area Enable	AWBAreaEnable	RW	4	Bit 16-19 AWB Area Size X Bit 24-27 AWB Area Size Y Bit 20-23 AWB Area Offset X Bit 28-31 AWB Area Offset Y	Min.1- Max.8 Min.1- Max.8 Min.0- Max.7 Min.0- Max. 7	
0xA17C	Color Matrix Mode	ColrMatrixMode	RW	4	0=Linear 3=User Set		
0xA180	Matrix RR	MatrixRR	RW	4	-2048 ～ 2047		1024

0xA184	Matrix RG	MatrixRG	RW	4	-2048 ～ 2047		0
0xA188	Matrix RB	MatrixRB	RW	4	-2048 ～ 2047		0
0xA18C	Matrix GR	MatrixGR	RW	4	-2048 ～ 2047		0
0xA190	Matrix GG	MatrixGG	RW	4	-2048 ～ 2047		1024
0xA194	Matrix GB	MatrixGB	RW	4	-2048 ～ 2047		0
0xA198	Matrix BR	MatrixBR	RW	4	-2048 ～ 2047		0
0xA19C	Matrix BR	MatrixBG	RW	4	-2048 ～ 2047		0
0xA1A0	Matrix BB	MatrixBB	RW	4	-2048 ～ 2047		1024

Digital Processing

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
0xA0F0	Gamma Set(RGB)	GammaSet[RGB]	RW	4	0=OFF 1=0.45 2=0.6 3=LUT		0
0xA11C	Shading Correction Enable	ShadingCorrectionEnable	RW	4	0=OFF 1=On		0
0xA120	Shading Correction Mode	ShadingCorrectionMode	R	4	0=Flat shading 1=Color shading		
0xA128	Blemish Reduction Enable	BlemishReductionEnable	RW	4	0=Disable 1=Black blemish 2=White blemish 3=Both blemish		0
0xA130	Perform Flat Shading Calibration	PerformFlatShadingCalibration	WO	4	Command=0		
	Perform Color Shading Calibration	PerformColrShadingCalibration			Command=1		
0x10000 | 0x10236	Shading Data Selector (Red)	ShadingDataSelector[Red_Mono]	R	4	0 ～ 65535	Index=0～566	0
0x11000 | 0x11236	Shading Data Selector (Green)	ShadingDataSelector[Green]	R	4	0 ～ 65535	Index=0～566	0
0x12000 | 0x12236	Shading Data Selector (Blue)	ShadingDataSelector[Blue]	R	4	0 ～ 65535	Index=0～566	0
0xA138	Perform Black Blemish Reduction Calibration	PerformBlackBlemishCalibration	W	4	Command=0		
	Perform White Blemish Reduction Calibration	PerformWhiteBlemishCalibration			Command=1		
0x13000 | 0x1307C	Black Blemish of Red	BlackBlemishRed	RW	4	0 ～ 4294967295	Index=0～31	0
0x13080 | 0x130FC	White Blemish of Red	WhiteBlemishRed	RW	4	0 ～ 4294967295	Index=0～31	0
0x13100 | 0x1317C	Black Blemish of Green	BlackBlemishGreen	RW	4	0 ～ 4294967295	Index=0～31	0
0x13180 | 0x131FC	White Blemish of Green	WhiteBlemishGreen	RW	4	0 ～ 4294967295	Index=0～31	0

0x13200 | 0x1327C	Black Blemish of Blue	BlackBlemishBlue	RW	4	0 ～ 4294967295	Index=0～31	0
0x13280 | 0x132FC	White Blemish of Blue	WhiteBlemishBlue	RW	4	0 ～ 4294967295	Index=0～31	0
0xA1A4	Knee Enable	KneeEnable	RW	4	0=OFF 1=ON		0
0xA1AC	Knee Slope (Red)	KneeSlope[Red]	RW	4	0 - 16383		2347
0xA1B0	Knee Slope (Green)	KneeSlope[Green]	RW	4	0 - 16383		2347
0xA1B4	Knee Slope (Blue)	KneeSlope[Blue]	RW	4	0 - 16383		2347
0xA1BC	Knee point(Red)	KneePoint[Red]	RW	4	0 - 32767		6864
0xA1C0	Knee point(Green)	KneePoint[Green]	RW	4	0 - 32767		6864
0xA1C4	Knee point(Blue)	KneePoint[Blue]	RW	4	0 - 32767		6864
0xA1D0	Noise Reducer	NoiseReducer	RW	4	0=OFF 1=ON		
0xA1D4	Noise Reducer Threshold	NoiseReducerThershold	RW	4	0 ～ 255		
0xA1E0	Center Marker	CenterMarker	RW	4	Bit25:Center Marker Red enable Bit26:Centern Marker Green enable Bit27:Center Marker Blue ebnable	Bit 8-31 0=Normal 1=Vertical Bar 2=Horizontal Bar 3=Both	

Digital IO

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
0xA600	User Output Selector	UserOutputSelector	RW	4	Bit31=User Output 0 Bit30:User Output 1 Bit29:User output 2 Bit28:User Output 3 0=Low 1=HIGH	This was called Software Trigger.	0
0xB070	Line Selector Line1-TTL Out 1	Line1	RW	4	Line Source Bit31 ~ Bit25 Bit24:Line Inverter 0=False (Active High) 1=True(Active Low)	Line Source 127:OFF 1:LVAL 3:DVAL 5:FVAL 7:EEN 9:Line4-Ooptical In 1 10:Line5-Optical In 2 11:Line8-LVDS IN 12:Line6-TTL In 1 16:Pulse Generator 0 17:Pulse Generator 1 20:User Output 0 21:User Output 1 22:User Output 2 23:User Output 3	
0xB078	Line Selector Line2-Optical Out 1	Line2	RW	4			
0xB07C	Line Selector Line3-Optical Out 2	Line3	RW	4			
0xB080	Line Selector Line4-Optical In 1	Line4	RW	4			
0xB084	Line Selector Line5-Optical In2	Line5	RW	4			
0xB088	Line Selector Line6-TTL In 1	Line6	RW	4			
0xB08C	Line Selector Line7-TTL In 2	Line7	RW	4			
0xB090	Line Selector Line8-LVDS In	Line8	RW	4			
	Line Mode	LineMode			0=Input 1=Output		
	Line Format	LineFormat			0=Internal Logic Signal 1=TTL 2=LVDS 3=Opto-coupled		
0xB0B0	Line status		R	4		See the current input and output line	

Pulse Generator

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
0xB004	Clock Pre-scaler	ClockPreScaler	RW	4	0x000 0x001 0x002 | 0xFFF	Bypass Divide by 2 Divide by 3 | Divide by 4096	0
0xB008	Pulse Generator Length 0	PulseGeneratorLength0	RW	4	1～1048575	Defines the length of the counter 0	1
0xB00C	Pulse Generator Start Point 0	PulseGeneratorStartPoint 0	RW	4	0～1048574	Defines the starting point of the counter 0	0
0xB010	Pulse Generator Repeat Count 0	PulseGeneratorRepeatCo unt0	RW	4	0 - 255	Defines the repeat count of the counter 0	0
0xB014	Pulse Generator End Point 0	PulseGeneratorEndPoint0	RW	4	1～1048575	Defines the end point of the counter 0	1
0xB018	Clear Mode for the Pulse Generator 0	PulseGeneratorClear0	RW	4	0 :Free Run 1:High Level 2: Low Level 4: Rising Edge 8: Falling Edge		0
0xB01C	Pulse Generator Length 1	PulseGeneratorLength1	RW	4	1～1048575	Defines the length of the counter 1	1
0xB020	Pulse Generator Start Point 1	PulseGeneratorStartPoint 1	RW	4	0～1048574	Defines the starting point of the counter 1	0
0xB024	Pulse Generator Repeat Count 1	PulseGeneratorRepeatCo unt1	RW	4	0 - 255	Defines the repeat count of the counter 1	0
0xB028	Pulse Generator End Point 1	PulseGeneratorEndPoint1	RW	4	1～1048575	Defines the end point of the counter 1	1
0xB02C	Clear Mode for the Pulse Generator 1	PulseGeneratorClear1	RW	4	0 :Free Run 1:High Level 2: Low Level 4: Rising Edge 8: Falling Edge		0
0xB090	Pulse Generator Selector Pulse Generator 0	PulseGenerator0	RW	4	<u>Pulse Generator Source</u> Bit 31 ～ 25 Bit24:Inverter 0:False (Active high) 1:True(Active Low)	<u>Pulse Generator Source</u> 127:OFF 1: LVAL IN 3:DVAL IN 5:FVAL IN 7:EEN 9:LINE4(OPT IN 1) 10:LINE5(OPT IN 2) 11:LINE8(LVDS In) 12:LINE6(TTL IN 1) 13:LINE7(TTL IN 2) 16:Pulse Gen. 0 17:Pulse Gen.1 20:User Output 0 21: User Output 1 22: User Output 2 23: User Output 3	
0xB094	Pulse Generator Selector Pulse Generator 1	PulseGenerator1	RW	4			

Sequence Acquisition Mode

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
	Sequence Selector	SequenceSelector			Sequence Selector Value 0=Sequence 1 1=Sequence 2 2=Sequence 3 3=Sequence 4 4=Sequence 5 5=Sequence 6 7=Sequence 8 8=Sequence 9 9=Sequence 10	Sequence Selector value is the INDEX for each sequence。	
0xC000	Sequence Exposure Time Raw to Red	SequenceExposureTimeRawRed	RW	4	0 ～1056	Base Address INDEX=0 to 9(Sequence) (Base Address + Index *12)	1056
	Sequence Exposure Time Raw to Green	SequenceExposureTimeRawGreen	RW	4	0 ～1056	INDEX=0 to 9(Sequence) (Base Address + (Index+1) *12)	1056
	Sequence Exposure Time Raw to Blue	SequenceExposureTimeRawBlue	RW	4	0 ～1056	INDEX=0 to 9(Sequence) (Base Address + (Index+2) *12)	1056
0xC078	Sequence Master Gain Raw	SequenceMasterGain	RW	4	-89 - 341	Base Address INDEX=0 to 9 (Base Address + Index *12)	0
	Sequence Gain Red	SequenceAnalogRed	RW	4	-200～200	INDEX=0 to 9(Sequence) (Base Address + Index *12 +4)	0
	Sequence Gain Blue	SequenceAnalogBlue	RW	4	-200～300	INDEX=0 to 9(Sequence) (Base Address + Index *12+8)	0
0xC0FC	Sequence ROI Size X	SequenceROISizeX	RW	4	8 - 1392	ROI width value Base Address INDEX=0 to 9 (Base Address + Index *4)	Width max
0xC124	Sequence ROI Size Y	SequenceROISizeY	RW	4	8 - 1040	ROI Height value Base Address INDEX=0 to 9 (Base Address + Index *4)	Height Max
0xC14C	Sequence ROI Offset X	SequenceROIOffsetX	RW	4	0 - 1384	ROI H Offset value Base Address INDEX=0 to 9 (Base Address + Index *4)	0
0xC174	Sequence ROI Offset Y	SequenceROIOffsetY	RW	4	0 - 1032	ROI V Offset value Base Address INDEX=0 to 9 (Base Address + Index *4)	0
0xC19C	Repeat Count in Each Step	SequenceRepeatCountInEachStep	RW	4	1 to 255	Sequence repeat count value Base Address INDEX=0 to 9 (Base Address + Index *4)	0
0xC0F0	Reset Sequence Settings	SequenceResetCommand	RW	4	Command 1	Sequence3 reset	1
0xC0F4	Sequence Repetition Count	SequenceRepetitions	RW	4	0 to 255	Sequence repeat count	0
0xC0F8	Last Sequence	SequenceEndingPosition	RW	4	1 to 10	Last sequence number setting	1

GigE Transport Layer

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
0xA418	Payload size	PayloadSize	R	4		Return image size of 1 frame	
0x0000	GigE Major Version	GevVersionMajor	R	4		Version of the GigE Standard to which the device is compliant.	0001
	GigE Minor Version	GevVersionMinor					0000
0x0004	Is Big Endian	GevDeviceModeIsBigEndian	R	4	0:Littel-endian 1:Big-endian	0:Little endian 1:Big endian 1:UTF-8	1
	Character set	GevDeviceModeCharacterSet			0:Unknown ,1:UTF-8		1
0x0008	MAC address	GevMacAddress	R	4		MAC address	
0x0010	Support LLA	GevSupportedIPConfigurationLLA	R	4	Bit 31: persistent Bit 30: DHCP Bit 29: LLA	Bits can be OR-ed. All other bits are reserved and set to 0. DHCP and LLA bits must be on.	All True
	Support DHCP	GevSupportedConfigurationDHCP					
	Support Persistent IP	GevSupportedConfigurationPersistentIP					
0x0014	Current IP configuration LLA	GevCurrentIPConfigurationLLA	RW	4	Bit 31: persistent Bit 30: DHCP Bit 29: LLA	Bits can be OR-ed. LLA is always activated and is read only.	LLA is always true
	Current IP configuration DHCP	GevCurrentIPConfigurationDHCP					
	Current IP configuration Persistent IP	GevCurrentIPConfigurationPersistentIP					
0x0024	Current IP address	GevCurrentIPAddress	R	4			
0x0034	Current Subnet Mask	GevCurrentSubnetAddress	R	4			
0x0044	Current Default Gteway	GevCurrentDefaultGateway	R	4			
0x0200	First URL	GevFirstURL	R	512		File extension .XML indicates uncompressed text file. File extension .ZIP indicates compressed using ZIP.	
0x0400	Second URL	GevSecondURL	R	512			
0x0600	Number Of Interfaces	GevNumberOfInterfaces	R	4		Indicates the number of physical network interfaces on this device.	
0x064C	Persistent IP Address	GevPersistentIPAddress	RW	4		Valid if Persistent IP is enabled	
0x065C	Persistent Subnet Mask	GevPersistentSubnetMask	RW	4		Valid if Persistent IP is enabled	
0x066C	Persistent Default Gateway	GevPersistentDefaultGateway	RW	4		Valid if Persistent IP is enabled	
0x0900	Message Channel Count	GevMessageChannelCount	R	4		number of available message channel	
0x0904	Stream Channel Count	GevStreamChannelCount	R	4		number of available stream channel	
0x0934	Supported Optional Commands User-defined Name	GevSupportedOptionalCommandsUser-definedName	R	4	Bit 31:multiple read Bit 30:WRITEMEM Bit29: PACKETRESEND Bit 28:EVENT Bit 27:EVENTDATA Bit 1:Serial No. Bit 0:User defined name 0=false 1=True	This is a capability register indicating which one of the non-mandatory GVCP commands are supported by this device.	
	Supported Optional Commands Serial number	GevSupportedOptionalCommandsSerialnumber					
	Supported Optional Commands EVENTDATA	GevSupportedOptionalCommandsEVENTDATA					
	Supported Optional Commands EVENT	GevSupportedOptionalCommandsEVENT					
	Supported Optional Commands PACKET RESEND	GevSupportedOptionalCommandsPACKETRESEND					

	Supported Optional Commands WRITEMEM	GevSupportedOptionalCommandsWRITEMEM					
	Supported Optional Commands Concatenation	GevSupportedOptionalCommandsConcatenation					
0x0938	Heartbeat Timeout	GevHeartbeatTimeout	RW	4	0 ～4294967295		0
0x093C	Timestamp Tick Frequency	GevTimestampTickFrequency	R	4	Timestamp tick frequency is 0 if timestamp is not supported.	In milliseconds. Internally, the heartbeat is rounded according to the clock used for heartbeat.	
0x0940		GevTimestampTickFrequency	R	4		64-bit value indicating the number of timestamp clock ticks in 1 second. This register holds the most significant bytes.	
0x0944	Timestamp control Latch	GevTimestampcontrolLatch	W	4	Command 2	This register holds the least significant bytes. Used to latch the current timestamp value. No need to clear to 0.	
	Timestamp control Reset	GevTimestampcontrolReset			Command 1		
0x0948	Timestamp Tick Value	GevTimeStampValue	R	4	High	Latched value of the timestamp (most significant bytes)	
0x094C		GevTimeStampValue	R	4	Low	Latched value of the timestamp (least significant bytes)	
0x0A00	Control Channel Privilege Feature	GevCCP	R	4	0:Open Access 1:Exclusive 2:Control 3:Exclusive Control	control channel privilege register	0
0x0B00	Message Channel Port	GevMCPHostPort	R	4		message channel port register	0
0x0B10	Message Channel Destination Address	GevMCDA	R	4		message channel destination address register	
0x0B14	Message Channel Transmission Timeout	GevMCTT	R	4		message channel transfer timeout: ms	300
0x0B18	Message Channel Retry Count	GevMCRC	R	4		message channel retry count	2
0x0D00	Stream Channel Port	GevSCPHostPort	R	4		primary stream port register	
0xD04	Fire Test Packet	GevSCPSFireTestPacket	RW	4	1	The device will fire one test packet of size specified by the packet size. The “don’t fragment” bit of IP header must be set for this test packet.	
0x0D04	Packet Size	GevSCPSPacketSize	RW	4	1476 ～16020	primary stream channel packet size register/ packet size includes IP, UDP&GVSP Header	1476
	Do Not Fragment	GevSCPSDoNotFragment			0=False 1=True	This bit is copied into the “don’t fragment” bit of IP header of each stream packet. It can be used by the application to prevent IP fragmentation of packets on the stream channel.	1
0x0D08	Packet Delay	GevSCPD	RW	4	0 ～ 125000	Set the delay in between packets	0
0x0D18	Strem Channel Destination Address	GevSCDA	R	4		primary stream channel destination address register	

LUT Controls

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
0xA200	LUT Enable	LUTEnable	R W	4			
0xD000 | 0xD7FC	LUT Value (Red)	LUTValue[Red]	R W	4	0 ～ 65535		0
0xD800 | 0xDFFC	LUT Value(Green,Bayer or Monochrome)	LUTValue[Green]	R W	4	0 ～ 65535		0
0xE000 | 0xD7FC	LUT Value (Blue)	LUTValue[Blue]	R W	4	0 ～ 65535		0

Event Generation

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
0xA610	Event Selector Acquisition Trigger	GevEventtreigger	RW	4	Selector Value 0	Event message ON/OFF	0
	Exposure Start	GevEventStartOfExposure			1		0
	Exposure End	GevEventEndOfExposure			2		0
	Frame Transfer Start	GevEventStartOfTransfer			3		0
	Frame Transfer End	GevEventEndOfTransfer			4		0
	Any Lines Any Edges	AnyLineAynyEdge			17		0
	Updated All Features	UpdatedAllFeatures			18		1
	Processing Done	ProcessingDone			19		1
	Video Parameters Changed	VideoParamsChanged			20		1
	Opposite Channel Parameters changed	DioTrigParamsChanged			21		1
	Device Reset	DeviceReset			31		1
	Event Notification	EventNotification			0=Disable 1=Enable		

User Sets

Address	Display Name (JAI Control Tool)	GenICam name	Read / Write	Size	Value / Range of value	Description	Default value
0xA300	User Set Save	UserSetSave	W	4	1=User area1	Allows use to save all camera settings. Last used area number becomes new default.	1
0xA304	User Set Load	UserSetLoad	W	4	0=Factory area 1=User area1	Allow the user to recall all camera settings.	0
0xA308	User Set Selector	UserSetSelector	RW	4	When receiving following commands, store the parameters 0xA300 0xA304	Check the used data, 0=Factory or1=User	0

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 settings.

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 CCD camera captures stripes, straight lines or similar sharp patterns, jagged image on the monitor may appear.

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.

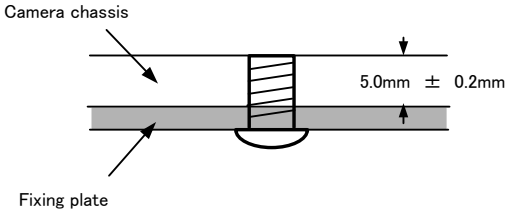
Patterned Noise
When the sensor captures a dark object at high temperature or is used for long time integration, fixed pattern noise may appear on the video monitor screen.

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.

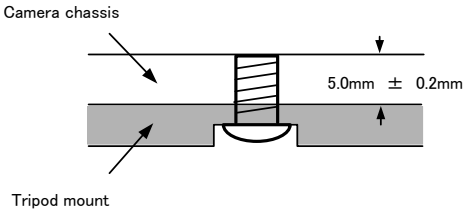
4. Caution when mounting the camera

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 and datasheet for the AT-140GE can be downloaded from www.jai.com
2. Camera control software can be downloaded from www.jai.com

Change history

Date	Revision	Changes
Dec 2009	1.0	New release

User's Record

Camera type: **AT-140GE**

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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