See the possibilities

Elite Series

User Manual

EL-2800M-GE2
EL-2800C-GE2

2.8M Digital Progressive Scan Monochrome and Color Camera

Document Version: Ver.1.4
EL-2800-GE2_Ver.1.4_May2015

1052E-1403

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 EL-2800M-GE2 and EL-2800C-GE2 comply with the following provisions applying to its standards.
EN 61000-6-3 (Generic emission standard part 1)
EN 61000-6-2 (Generic immunity standard part 1)

FCC

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

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

Warning

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

Supplement

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

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

重要注意事项

有毒，有害物质或元素名称及含量表

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

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

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

环保使用期限

电子信息产品中含有的有毒有害物质或元素在正常使用的条件下不会发生外泄或突变、电子信息产品用户使用该电子信息产品不会对环境造成严重污染或对基人身、财产造成严重损害的期限。

数字「15」为期限15年。

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

○: 表示该有毒有害物质在该部件所有均质材料中的含量均在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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- Contents -

Introduction

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.

1 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**

2 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, Vista, and Windows 7, 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.

Important: Please note that if you use LAG function, refer to the chapter 5.1.1.5 first. It explains the order to install NIC driver and SDK.

3 About GigE Vision Ver2.0

EL-2800-GE2 complies with the Latest GigE Vision version 2.0. 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.

As a new extension of standards, GigE Vision Ver.2.0 employs Link Aggregation which combines two independent ports and identifies these as one port, making much higher transfer rates possible; PTP (IEE1588) which provides more precise time management; and Manifest which enables either GigE Vision Ver.1.X or Ver.2.0 on demand. EL-2800-GE2 complies with those extensions. For the details, please refer to Chapter 5.1.

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.

4 Recommended PC to be used

The PC used should have the following performance or better

1) Recommended CPU : Core i3 or better,
2) Recommended memory: DDR3, 4GB fully equipped (Windows 7 32-bit)
   DDR3, 8GB fully equipped (Windows 7 64-bit)
3) Graphics card : Should apply with PCI Express Generation 3.0 or better
4) NIC : Use Intel NIC
   PCI-Express Bus to install Intel NIC should be better than Generation 2.0. Generation 1.0 cannot be used.
5) Other: If the picture is always displayed on the monitor, it is not recommended to use the CPU in the PC.

5 About the network card to be used

SP-5000-GE2 complies with Link Aggregation which handles two ports as one port. To make the best use of this function, the network card used should comply with 1000BASE-T as well as Link Aggregation. It also complies with Jumbo Frame. If Jumbo Frame is set to a large value, the PC processing load can be reduced. The packet overhead is also reduced and as the result, the bandwidth of the communication line has more room.

Table1. NIC

NIC manufacturer	Model	PCI-Express Bus	Data
Intel	PRO/1000PT,dual port Server Adapter	√ (x4)	
Intel	Gigabit ET2, Quad port Server Adapter	√ (x4)	10Gbps uni-directional 20Gbps bi-directional
Intel	i340-T4, Quad port Server Adapter	√ (x4)	

Note: Intel Pro/1000PT Quad does not comply with Link Aggregation.

6 Cables to be used

GigEVision configures the system by using 1000BASE-T.
In the market, CAT5e (125MHz), CAT6 (250MHz) and CAT7 (600MHz) cables are available for 1000BASE-T. There are crossover cables and straight through cables available. Currently, as most equipment complies with Auto MDI/MDI-X, please use straight through cables. (Among crossover cables, a half crossover type exists, which the Ethernet will recognize as 100BASE-T).

7 EMVA 1288

With regard to signal to noise ratio in this manual, specifications measured by EMVA 1288 are used together with specifications by a traditional measurement method.
EMVA 1288 is a more complete measurement that considers multiple noise sources, including random noise, pattern noise, and shading. Additionally, EMVA 1288 incorporates temporal variances in pixel output by capturing 100 frames of data and computing the RMS variations over the captured frames. Because of the comprehensive nature of the noise analysis and the additional consideration for RMS variances over time, EMVA 1288 SNR measurements are inherently lower than the traditional SNR measurements given by manufacturers. However, the comprehensive nature combined with rigid test parameters, means that all manufacturers are measuring their products equally and EMVA 1288 tested parameters can be compared among different manufacturers' products.
In order to learn more about EMVA 1288, please visit http://www.emva.org

Camera Operation Manual

1. General

The EL-2800M-GE2 and EL-2800C-GE2 are new cameras in JAI's Elite Series. They provide high picture quality, such as high sensitivity and low noise, suitable for machine vision applications. The EL-2800M-GE2 is a monochrome progressive scan CCD camera and the EL-2800C-GE2 is the equivalent Bayer mosaic progressive scan CCD camera. Both are equipped with a 2/3 inch CCD sensor offering 2.83 million pixels resolution and a 4:3 aspect ratio. They provide 54.6 frames per second for continuous scanning with 1920 x 1440 full pixel resolution for both monochrome and raw Bayer output.

8-bit, 10-bit, or 12-bit output can be selected for both monochrome and Bayer outputs. The EL-2800C-GE2 is also capable of performing in-camera color interpolation to produce 24-bit (8-bit per color) RGB output at 27.7fps in 2-port LAG. The EL-2800C-GE2 also provides YUV411, YUV422 or YUV444. The new cameras feature a GigEVision ver. 2.0 interface which supports the use of a 2-port configuration for a faster transfer rate. A full pixel readout, partial scan readout, or binning mode (monochrome only) can be selected depending on the application.

EL-2800M-GE2 and EL-2800C-GE2 have various comprehensive functions needed for automated optical inspection applications, such as solid state device inspection or material surface inspection. They incorporate video processing functions such as a look-up table, shading compensation, and blemish compensation in addition to fundamental functions such as trigger, exposure setting and video level control.

As a common Elite Series feature, a new connector for lens control is employed. EL-2800M-GE2 and EL-2800C-GE2 support P-iris and motor-driven lenses as standard lens control capabilities. Factory options are available to configure this connector to support DC iris systems as well as provide a video iris output signal, or to provide additional TTL IN and OUT lines.

The latest version of this manual can be downloaded from: www.jai.com
The latest version of the Camera Control Tool for the EL-2800M-GE2 and EL-2800C-GE2 can be downloaded from: www.jai.com
For camera revision history, please contact your local JAI distributor.

2. Camera composition

The standard camera composition is as follows.

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

The following optional accessories are available.

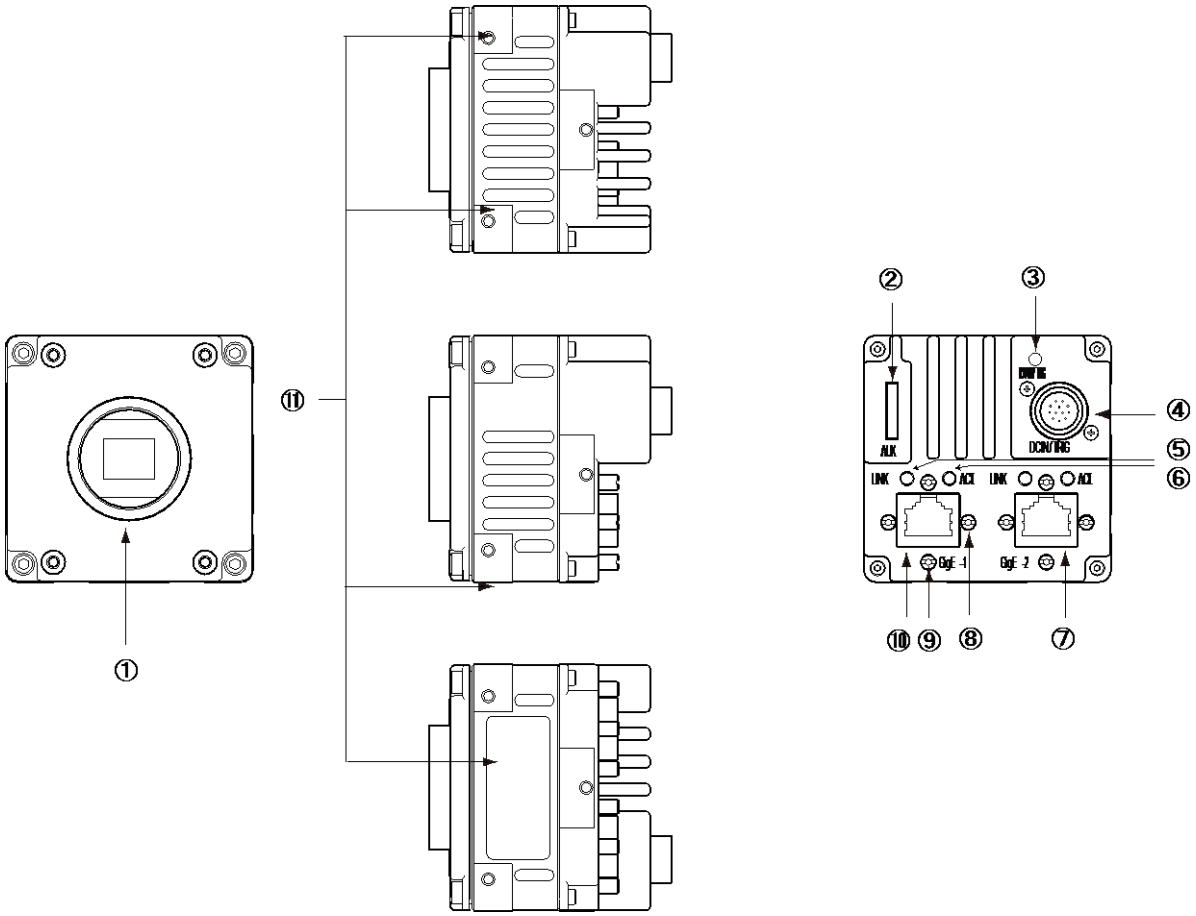
Tripod base	MP-42
Power supply unit	PD-12 series

3. Main features

- New Elite Series, 2/3" progressive scan camera
- Intelligent body design for easy and flexible installation
- Utilizes GigEVision 2.0 interface using two RJ-45 connectors
- Aspect ratio 4:3, 1920(H) x 1440(V), 2.8 million effective pixels
- 4.54 μm square pixels
- S/N 61dB for monochrome and 58.5dB for color
- 8-bit, 10-bit, or 12-bit output for monochrome and Bayer or in-camera interpolation such as 8-bit per color output for RGB color, YUV411, YUV422 or YUV444.
- 54.6 frames/second with full resolution in continuous operation (monochrome or Bayer) and 27.7 frames for RGB 24-bit output or YUV444.
- Various readout modes, including horizontal and vertical binning (EL-2800M-GE2 only) and ROI (Region Of Interest) for faster frame rates
- 0dB to +30dB gain control for EL-2800M-GE2 and 0dB to +27dB for EL-2800C-GE2
- 10 μs (1/100,000) to 8 seconds exposure control in 1 μs step
- Auto exposure control
- Timed and trigger width exposure control,
- RCT, PIV and sequential trigger modes for specific applications
- ALC control with combined function of AGC, auto exposure, and auto iris
- Various pre-processing circuits are provided
  Programmable LUT
  Gamma correction from 0.45 to 1.0
  Shading compensation
  Bayer white balance with manual or one-push auto (EL-2800C-GE2 only)
  Bayer color interpolation (EL-2800C-GE2 only)
  Blemish compensation
- Test pattern signal generator is built in
- Auto iris lens video output with H-sync
- New Hirose 10P connector for lens interface including P-Iris lens control
- C-mount for lens mount

4. Locations and functions

4.1 Locations and functions



①	Lens mount	C-mount (Note *1)
②	10-pin connector	AUX Connector for lens control (Standard)
③	LED	Indicator for power and trigger input
④	12-pin connector	DC and trigger input
⑤	LED (LINK)	GigE network indication (LINK for GigE 1)
⑥	LED (ACT)	GigE network indication (ACT for GigE 1)
⑦	RJ45 connector	GigE connector 2 (With lock mechanism)
⑧	Hole for RJ-45 fixing screw	Hole for RJ-45 fixing screw (Horizontally) (Note*2)
⑨	Hole for RJ-45 fixing screw	Hole for RJ-45 fixing screw (Vertically) (Note*2)
⑩	RJ45 connector	GigE connector 1 (With lock mechanism)
⑪	Mounting holes	Holes for mounting tripod base or direct installation. Depth 5 mm (Note*3)

Note1: Rear protrusion on C-mount lens must be less than 10.0 mm.
Note2: When an RJ-45 cable with thumbscrews is connected to the camera, please do not excessively tighten screws by using a screw 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.
Note3: The part number for the tripod adapter plate (with 1/4"-20 thread) is MP-42 (option).

Fig. 1 Locations

4.2 Rear panel

The rear panel mounted LED provides the following information:

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

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

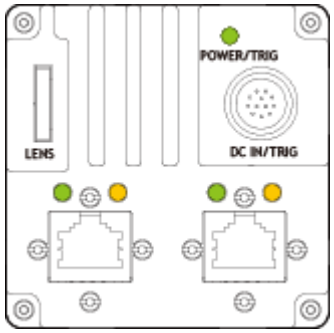


Fig. 2 Rear panel

GigE 1
LINK
- Steady green: Connecting in 1000BASE-T
- Flashing green: Connecting in 100BASE-T

ACT
- Flashing amber: GigE Network indication

LINK2
LINK
- Steady green: Connecting in 1000BASE-T
- Flashing green: Connecting in 100BASE-T

ACT
- Flashing amber: GigE Network indication

5. Input and output

5.1 GigE Interface

5.1.1 GigE Vision 2.0 Extension functions

EL-2800-GE2 complies with GigE Vision 2.0. Its extension functions are described below.

5.1.1.1 Link Aggregation

By handling two ports as one port, the maximum transfer rate can be achieved at 2 Gbps.
This function is based on IEEE802.3ad, IEEE802.1AX Link Aggregation and GigE Vision 2.0.

Table 2. Link Aggregation Specifications

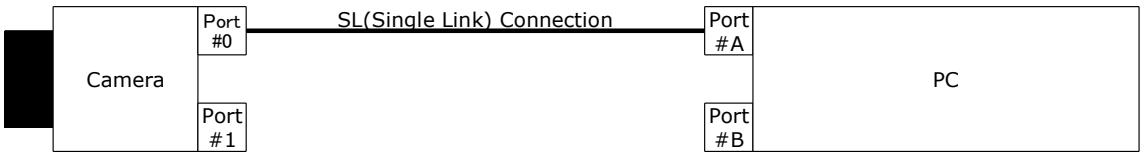
Link Aggregation system	sLAG(Static Link Aggregation Group) and dLAG(Dynamic Link Aggregation Group)	When dLAG is selected, LACP selects automatically. When sLAG is selected, if HW conditions are not satisfied, SL (Single Link) is activated.
Load distribution system	Round-robin processing	GVSP Ether Frame is output from Port 0 or Port 1 alternatively.
		When the first packet (Leader packet : Leader frame) of the video frame is output, the output port is reset to 0.
Physical Network Number	2 Ports	Port 0 and Port 1 are enabled.
		In Single Link (SL), either Port 0 or Port 1 is used.
MAC Address Number	1	As only SL, sLAG and dLAG are supported, MAC Address is one. Port 0 and Port 1 use the same MAC Address.（Note 1）
IP Address Number	1	As only SL, sLAG and dLAG are supported, IP Address is one. Port 0 and Port 1 use the same IP Address.（Note 1）
GVCP Port		GVCP returns ACK to the port which receive the command.
Stream Channel Number	1 Channel	When SL is used, one stream is output from either Port0 or Port1 which is linked up. When sLAG or dLAG is used, one stream is output in load-balanced from Port 0 and Port1.
SL/sLAG Selecting Method	Selected by the status of Port Link UP	If only 1 port is linked up, it is SL.
		If sLAG is enabled, and if Port 0 and Port 1 are linked up, the status is changed to sLAG.
		If dLAG is enabled, and if Port 0 and Port 1 are linked up, the status is set to dLAG by LACP or is reverted to SL.
Event Message	GEV_EVENT_LINK_SPEED_CHANGE	If a change of SL to or from LAG occurs, GEV_EVENT_SPEED_CHANGE Event Message can be issued.

Note 1: In Link Aggregation operation, two ports use the same MAC Address and IP Address. Accordingly, if these two ports are connected to only one non-compliant IEEE802.3ad or IEEE802.1AX switch, the function is not properly executed. If non-compliant IEEE802.3ador IEEE802.1AX switch is used, 2 sets should be used and connected to each port.

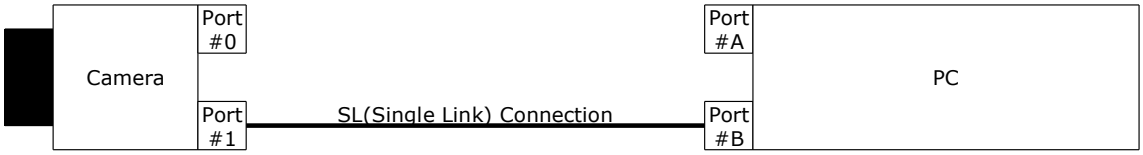
Connecting configuration

1. If only Port 0 is linked up, the connecting configuration is SL (Single Link).
2. If Port 0 and Port 1 are linked up, and if dLAG is enabled, the operation is determined by LACP or if sLAG is enabled, the operation is sLAG connecting configuration.
3. As GVCP applies only for Port 0, it does not work in the following cases, (2) and (3).
4. If the connecting status is changed, the operation is automatically changed to appropriate connecting configuration.

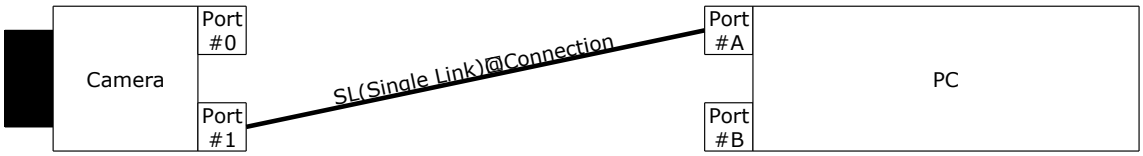
(1) 1Gbps (1000Mbps)



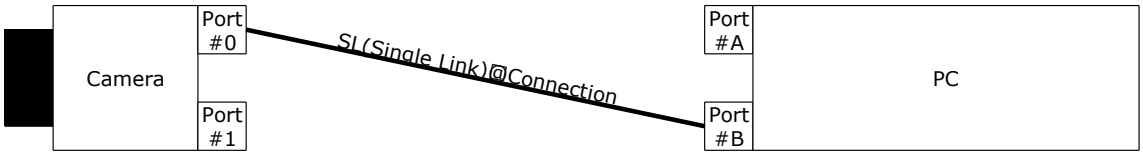
(2) 1Gbps (1000Mbps)



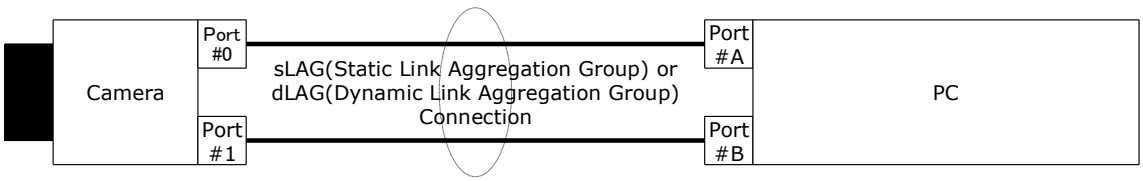
(3) 1Gbps (1000Mbps)



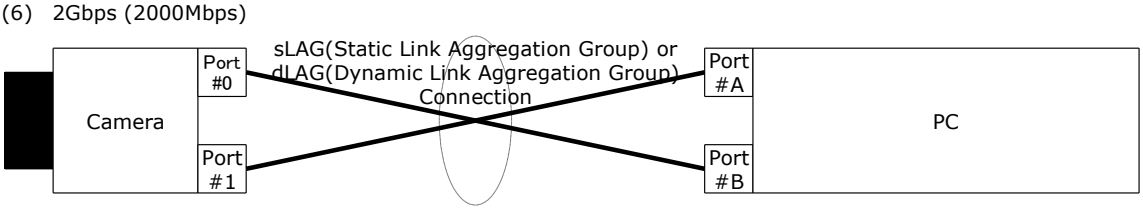
(4) 1Gbps (1000Mbps)



(5) 2Gbps (2000Mbps)



(6) 2Gbps (2000Mbps)



5.1.1.2 PTP (IEEE 1588-2008:Precision Time Protocol)

Table 3. Specifications

Equipped functions	Only slave		Master function is not equipped
Used Transport	Multicast UDP datagram But, Delay_Req and Delay_Resp are Unicast UDPdatagram		In IEEE1588, various transport including Ether Frame are defined. In GigE Vision 2.0, it is defined to use UDP datagram.
Destination Port number	Event message: 319		Sync, Delay_Req, Pdelay_Req, Pdelay_Resp
	General mesage:320		Announce, Follow_Up, Delay_Resp, Pdelay_Resp, Management, Signaling
Multicast address	224.0.1.129		
Synchronized item	Time only		Frequency synchronization is not equipped
PTP Time Data (Comply with IEEE 1588)	bit length	80bit	Time with 1 ns unit increment starting at 00:00:00 on 1/1/1970
Camera Time Stamp	bit length	64bit (Note2)	At PTP synchronization, LSB64bit of PTP time data At PTP non-synchronization, 1ns unit increment at starting on any time (Note 1)
Applicable PTP Message	Announce message		Receiving only
	Sync message		Receiving only
	Follow_Up message		Receiving only (used if the master is 2 step clock)
	Delay_Req message		Sending only
	Delay_Resp message		Receiving only
GigE Vision proper regulation	Timestamp Tick Frequency register value is fixed at 1,000,000,000 (1GHz). (Note 3)		
	While PTP synchronizing operation, Timestamp Reset function is disabled and if the reset is required, GEV_STATUS_WRITE_PROTECT status code is returned.		

Note1: If there is IEEE 1588 master clock in the network, the camera time stamp is synchronized at the master clock.
If there is no IEEE1588 master clock in the network, the camera time stamp operates by the free running of the internal clock at starting on the power being ON.

Note2: In GenICam standard, 64-bit integer is handled as signed value, thus only 63 bits are available through GenICam interface.

Note3: As 1GHz clock is not actually operated, the time stamp is incremented by 8 (1GHz/125MHz) on every 1 clock of actual frequency.

5.1.1.3 Manifest

EL-2800-GE2 equips Manifest, both GenICam Version 1.x and Version 2.0 are applied by selecting the entry. EL-2800-GE2 has three entries and two entries are for Ver.1/Ver.2 and third one is ready for future extension.

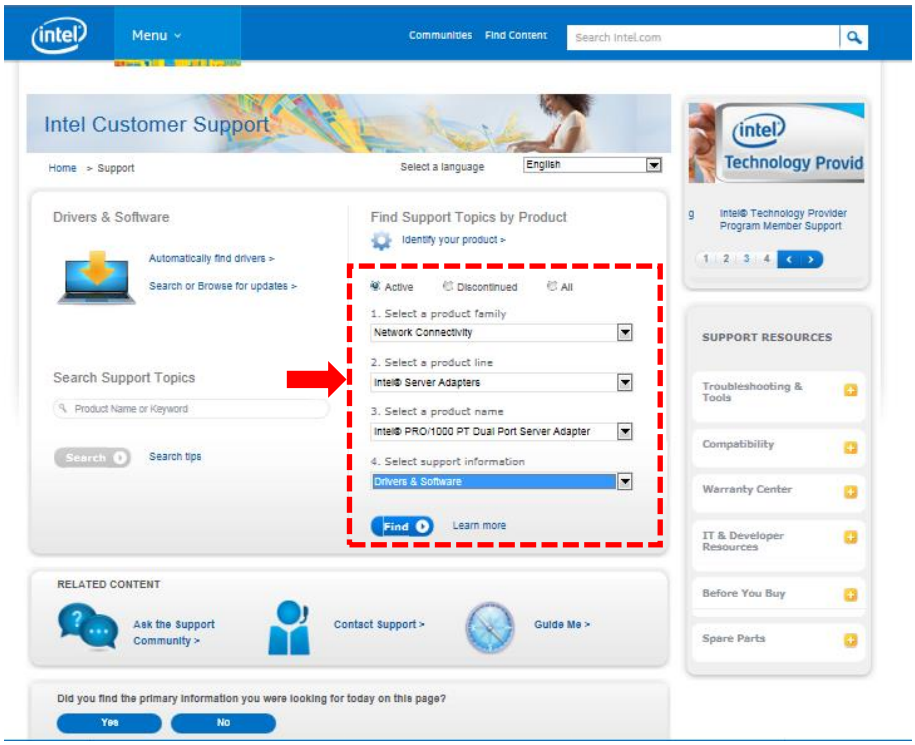
5.1.1.4 Notes for connecting 100BASE-TX

- In order to use 100 Mbps 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 of connecting on 100BASE-TX, the specifications such as frame rate, trigger interval and so on described in this manual cannot be satisfied.

5.1.1.5 Example of setting method of Link Aggregation

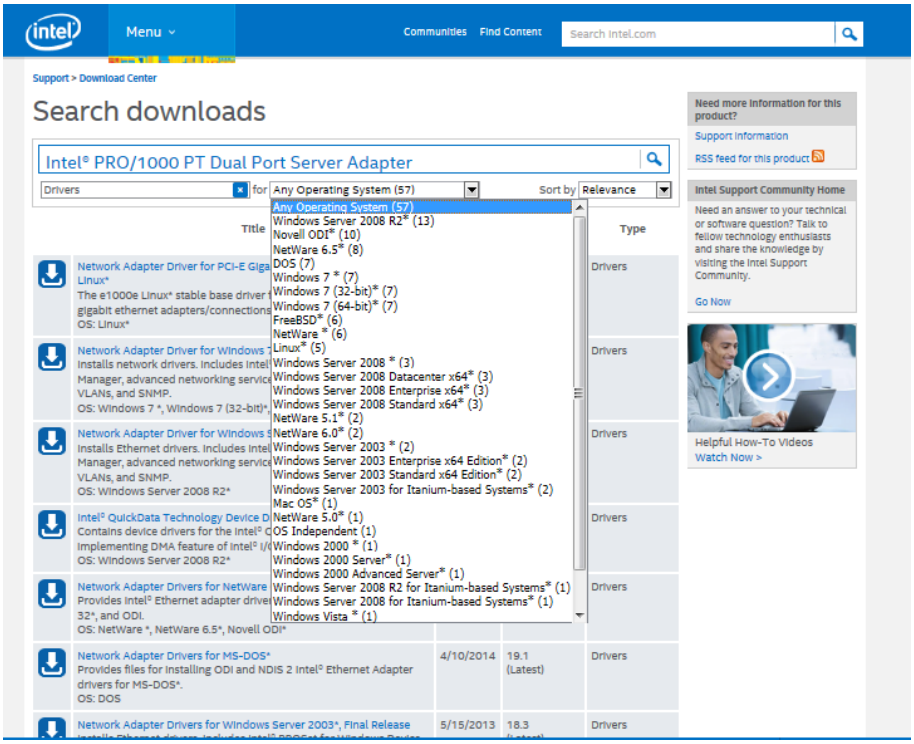
1. Intel NIC driver installation

In Windows 7 or Windows 8.1 OS, when a NIC is installed and the PC is started, the default driver supported by the Microsoft OS may be automatically installed. The Microsoft driver does not have the "Teaming" function needed for the GigE Vision Link Aggregate Method (LAG). Therefore, in order to make the "Teaming" function available, it is necessary to install the Intel NIC driver. Please note that if Intel ceases support for this driver, "Teaming" may not be available on the latest OS. The following describes the procedure to install the Intel NIC driver.

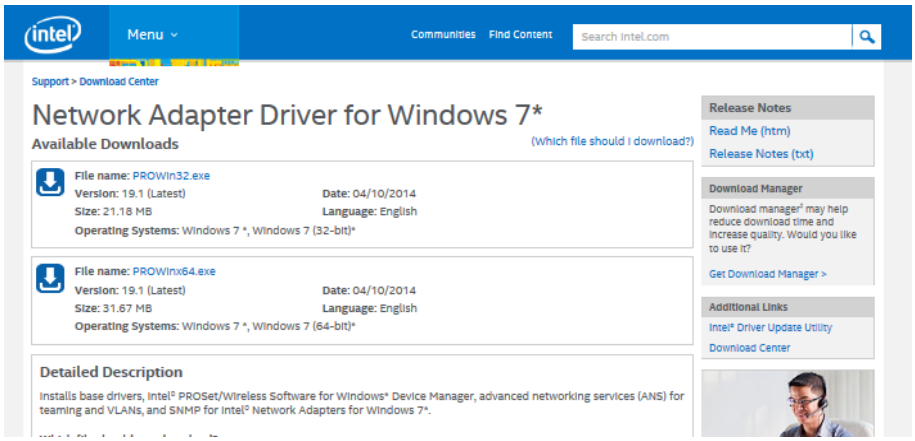


Navigate to the Intel web site and open the Drivers & Software page. Select the appropriate items from the drop-down selection lists.
In this example, select Network Connectivity, Intel Server Adapters, Intel PRO1000 PT Dual Port Server Adapter and Drivers & Software. Then click the "Find" button.

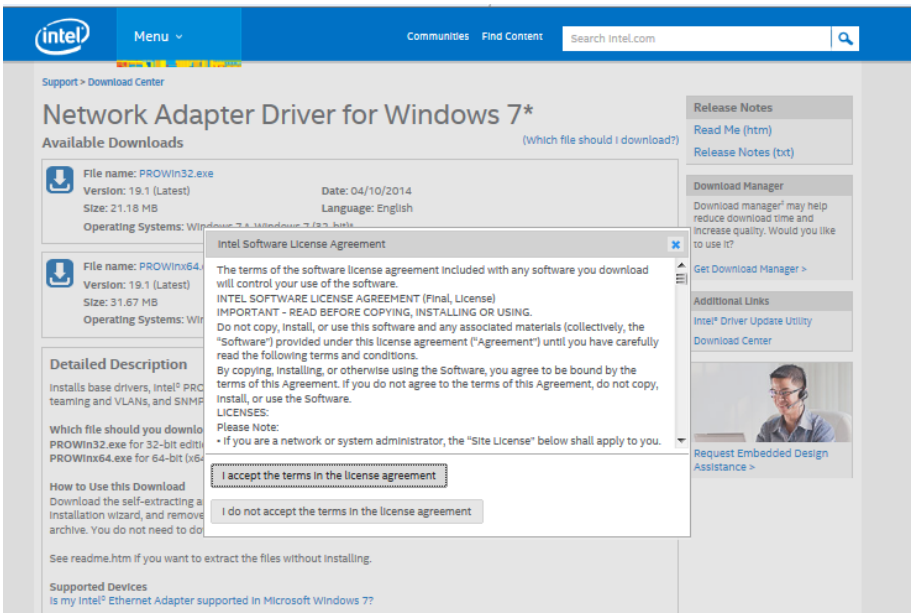
On the Search Downloads page, select your operating system -- in this case Windows 7.



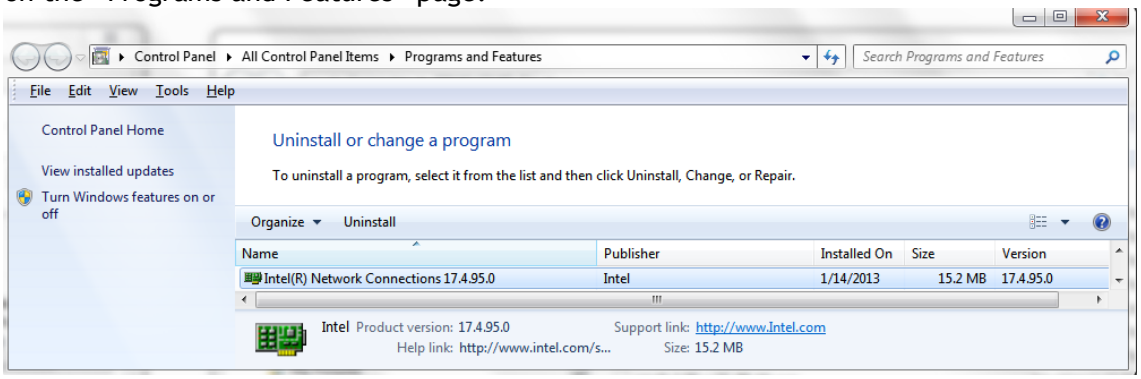
Select either 32-bit or 64-bit version.



After downloading the driver, double-click PROWin32.exe or PROWin64.exe to install the driver.



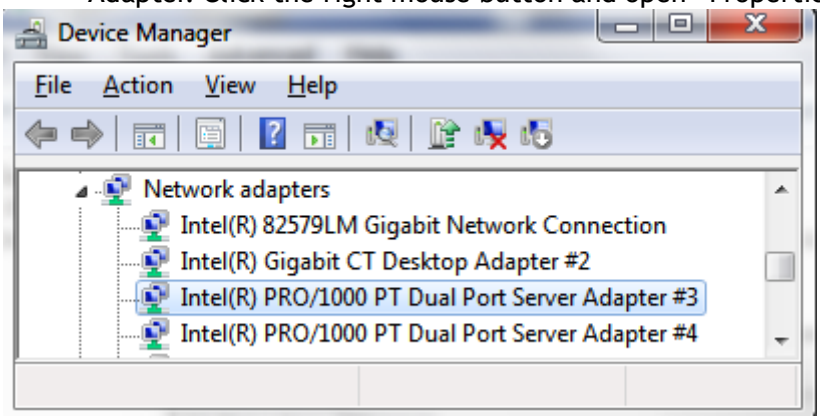
After installing the driver, it is possible to confirm version information about the driver in the listing on the “Programs and Features” page.



2. Setting of NIC properties

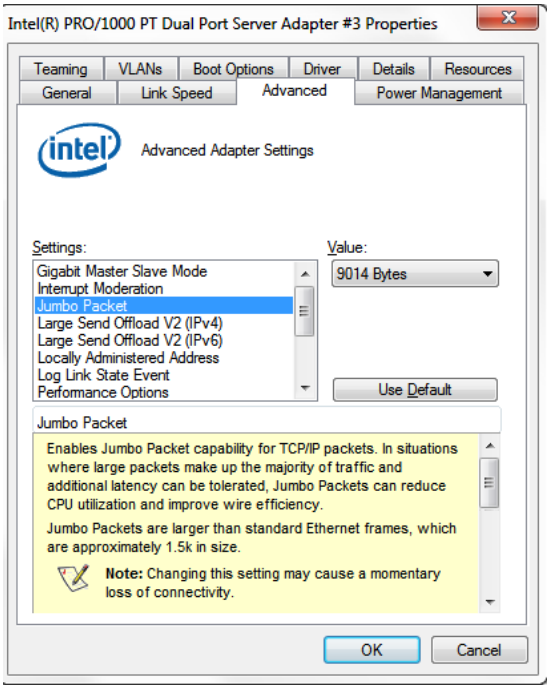
2.1 Settings of each port.

Open the “Device Manager” and find the network adapter, Intel PRO 1000 PT Dual Port Server Adapter. Click the right mouse button and open “Properties”.

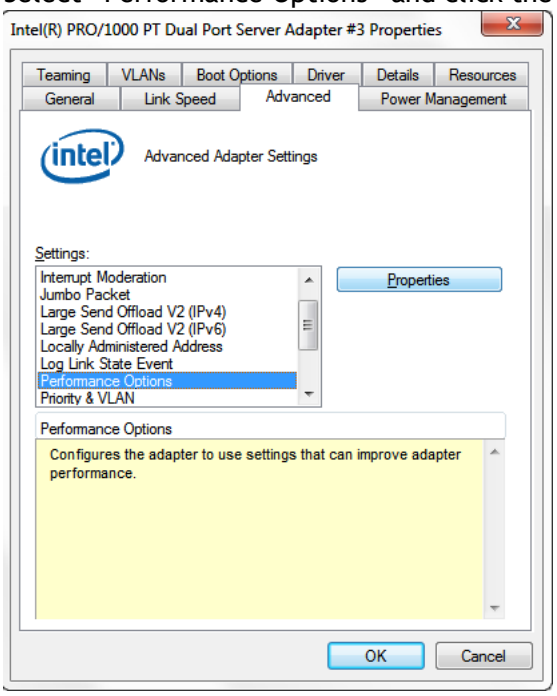


The following settings must be applied to each port. This is especially true for Jumbo Packet and Interrupt Moderation. If the settings for these items remain as default, it will affect when images are captured.

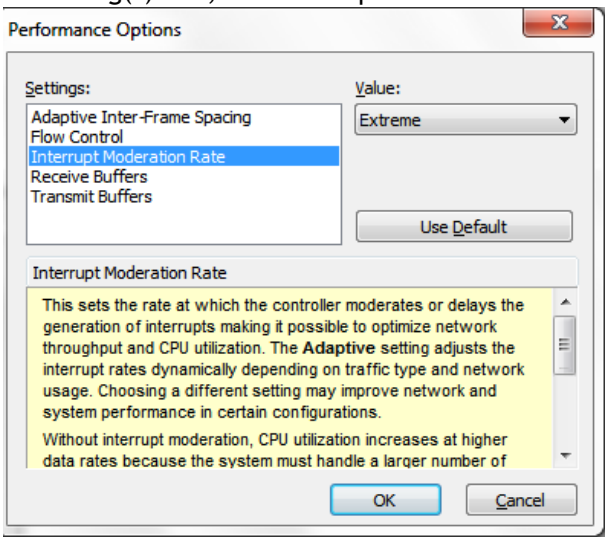
Set Jumbo Frame (Jumbo Packet) to 9014 Bytes.



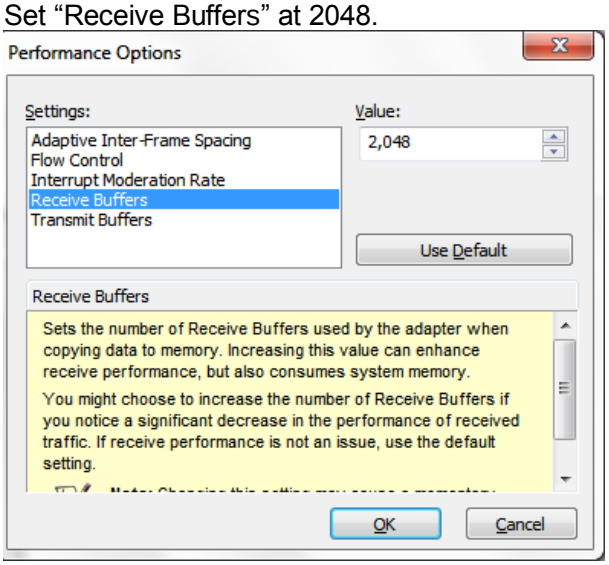
Select “Performance Options” and click the “Properties” button.



In setting(s) box, set “Interrupt Moderation Rate” to “Extreme.”

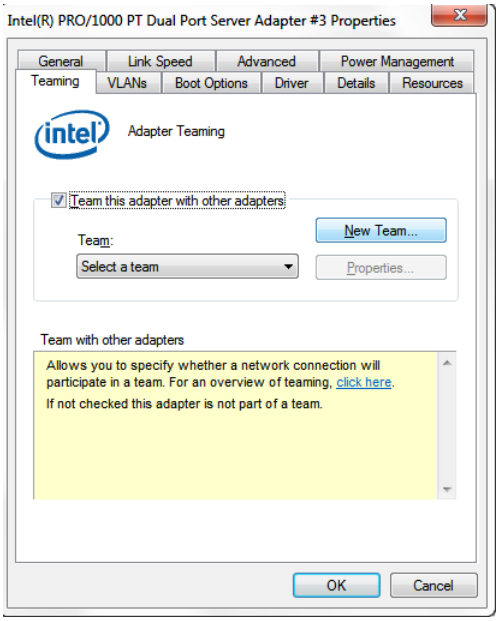


Set “Receive Buffers” at 2048.

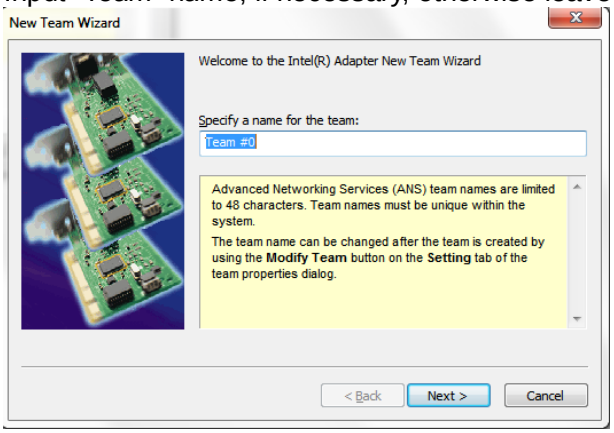


2.2 Settings of “Teaming”

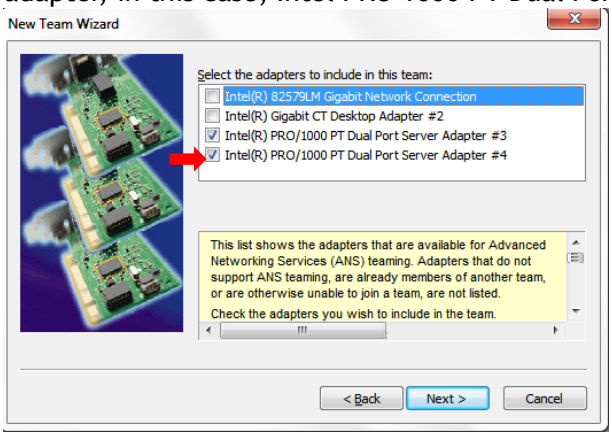
Open “Teaming” tab. Check “Team this adapter with other adapters” and click “New Team” button.



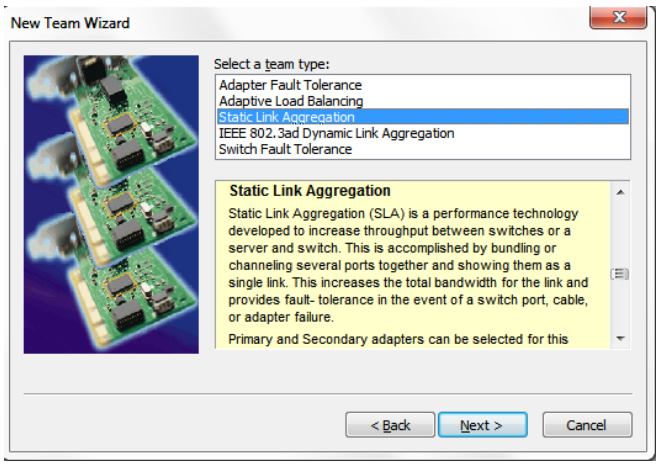
Input “Team” name, if necessary, otherwise leave it as is. Then click “Next”.



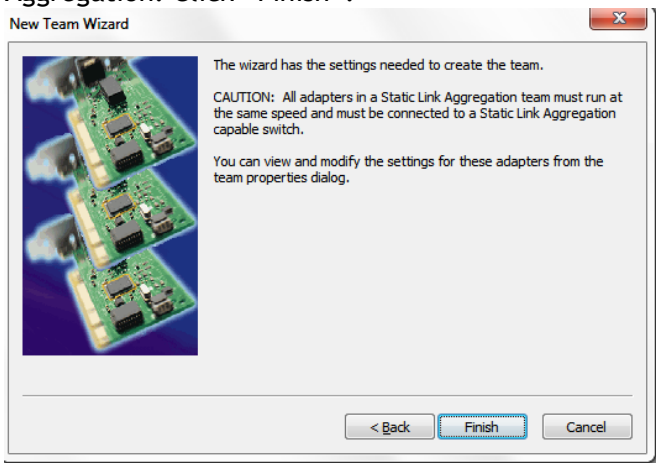
The “Select adapters to include in this team” dialog will open.
The adapter with its properties dialog currently open will already be checked. Check the other adapter, in this case, Intel PRO 1000 PT Dual Port Server Adapter #4. Then click “Next”.



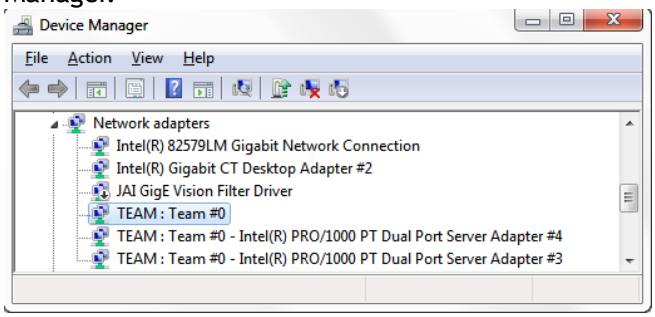
"Team Type Selection" will open. In the SP-5000-GE2, only "Static Link Aggregation" and "IEEE 802.3ad Dynamic Link Aggregation" are available. In this example, "Static Link Aggregation" is selected. Then click "Next".



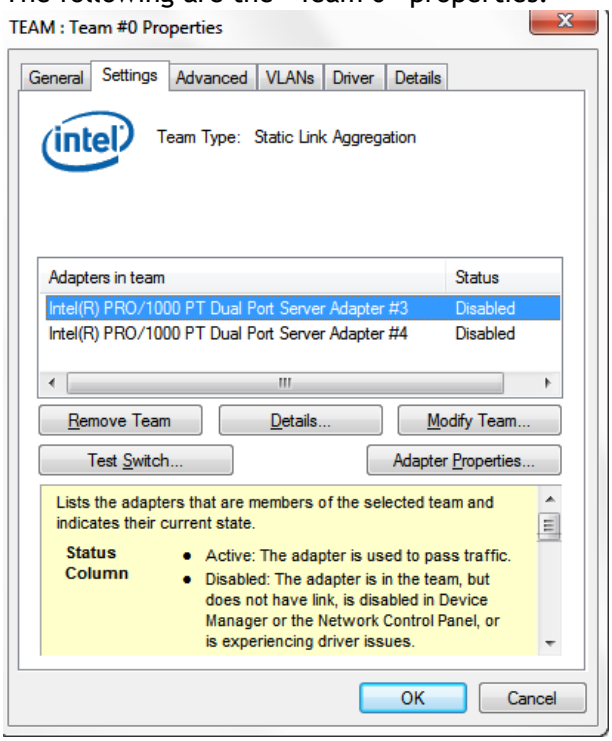
The confirmation message for creating new team will be displayed. In this example, it is Static Link Aggregation. Click "Finish".



When "Teaming" is completed, "Team: Team Number 0" is added to the network adapter in Device Manager.

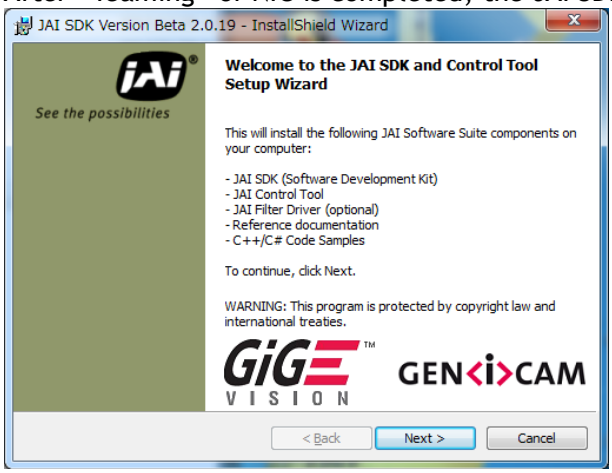


The following are the “Team 0” properties.

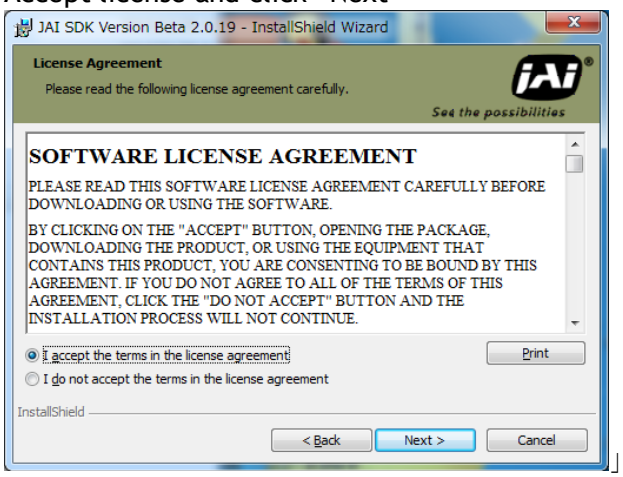


3. JAI SDK Install

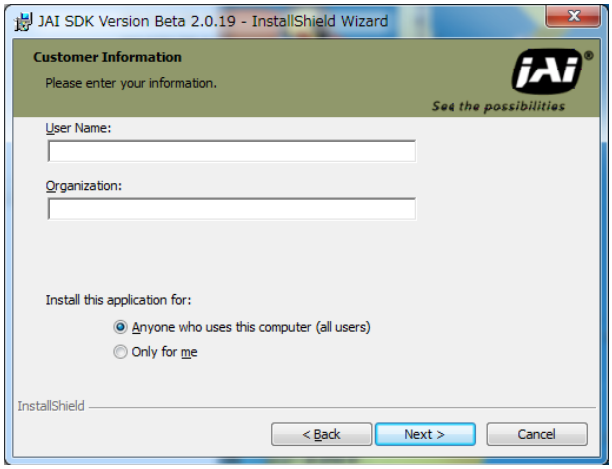
After “Teaming” of NIC is completed, the JAI SDK must be installed.



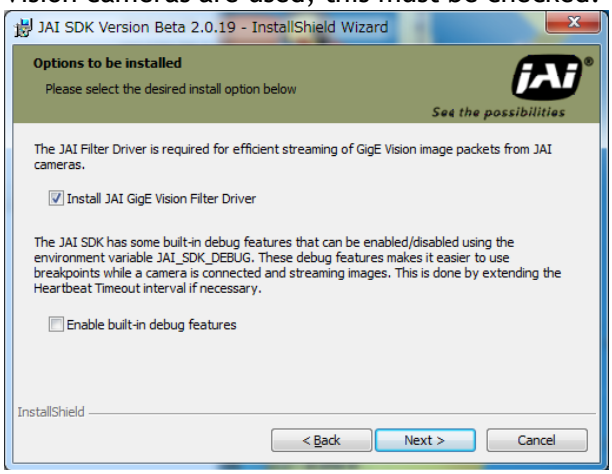
Accept license and click “Next”



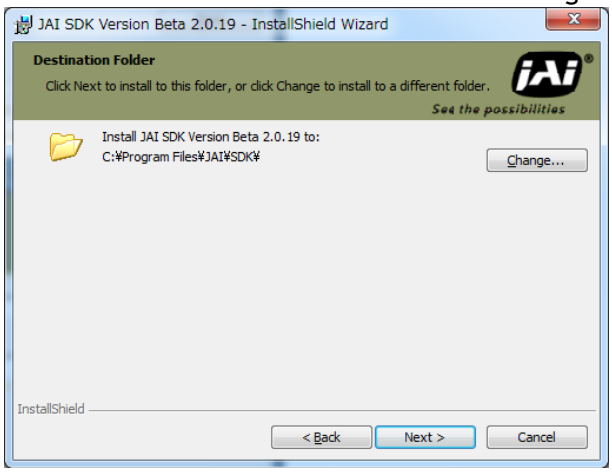
Fill in the fields if needed. Then click “Next”.



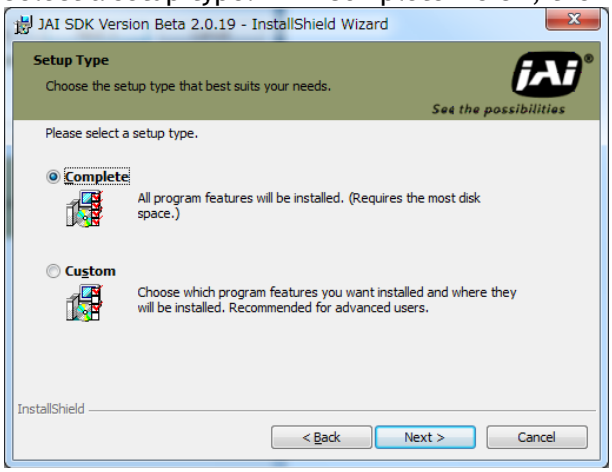
This screen confirms whether or not the JAI GigE Vision Filter Driver is to be installed. When GigE Vision cameras are used, this must be checked.



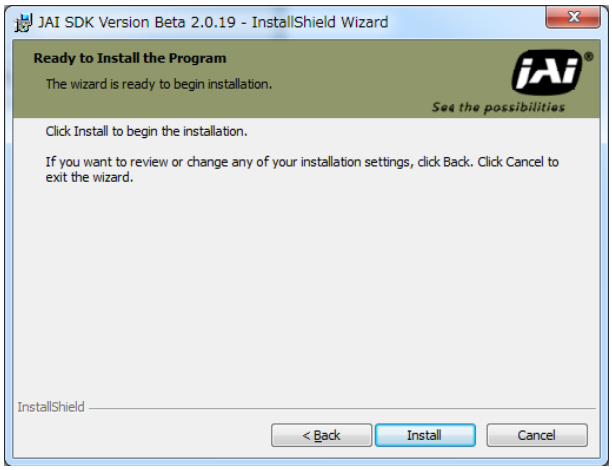
Set the folder to install. If the default setting is OK, just click “Next”.

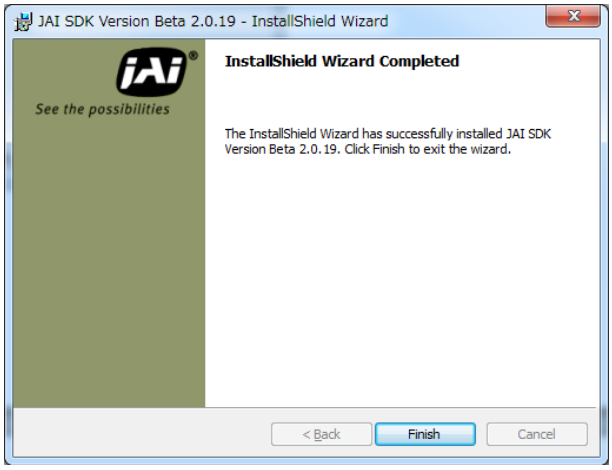


Select a setup type. If “Complete” is OK, then click “Next”.

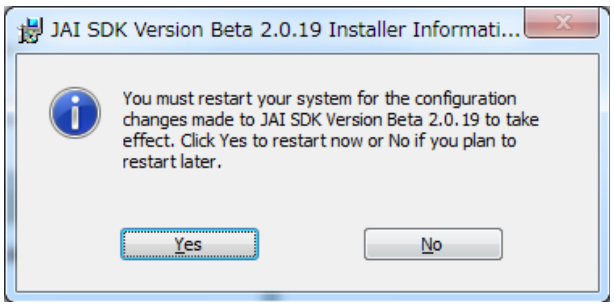


Click the “Install” button to start installation.

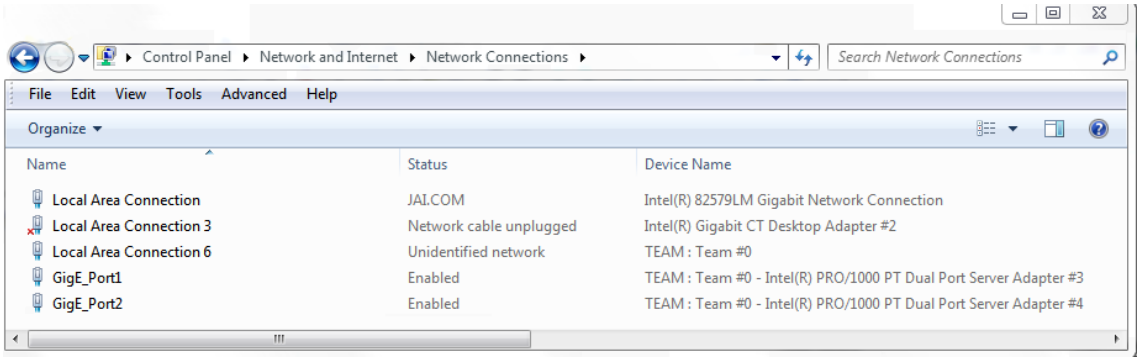




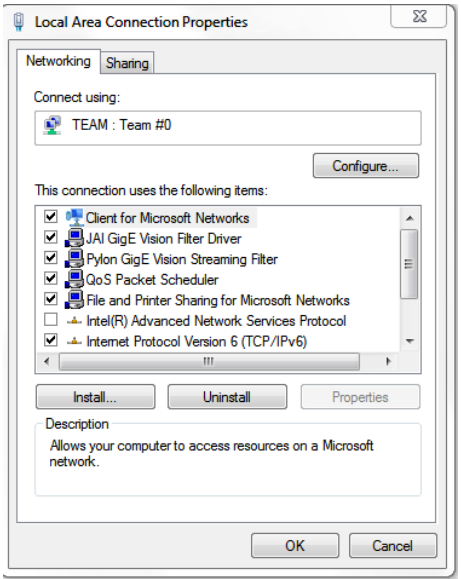
Click “Yes” to restart the PC.

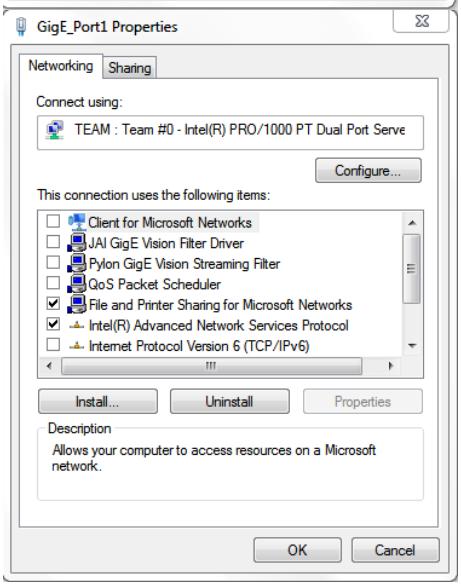


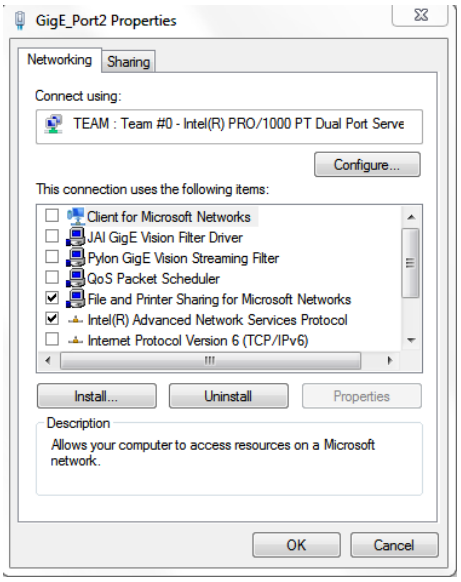
After restarting, check to see that the filter driver is in the local area network.
In the following example, two port names of the Intel PRO 1000 PT Dual Port Server Adapter are re-named. (GigE_Port and Number)
If the team name used the default setting, the ports are automatically named by local area network and number.



In the Properties window of the Local Area Network which is to be Teamed, the JAI GigE Vision Filter Driver is initially checked. After "Teaming," JAI GigE Vision Filter Drivers are not checked in the Properties of Port 1 and Port 2 of the Intel PRO 1000 PT Dual Port Server Adapter Local Area Network.

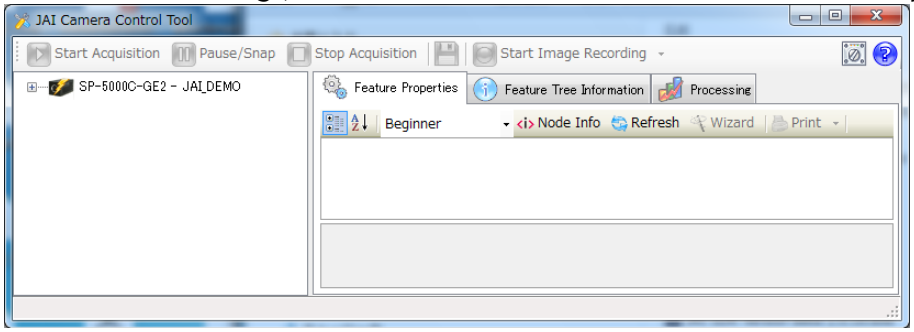




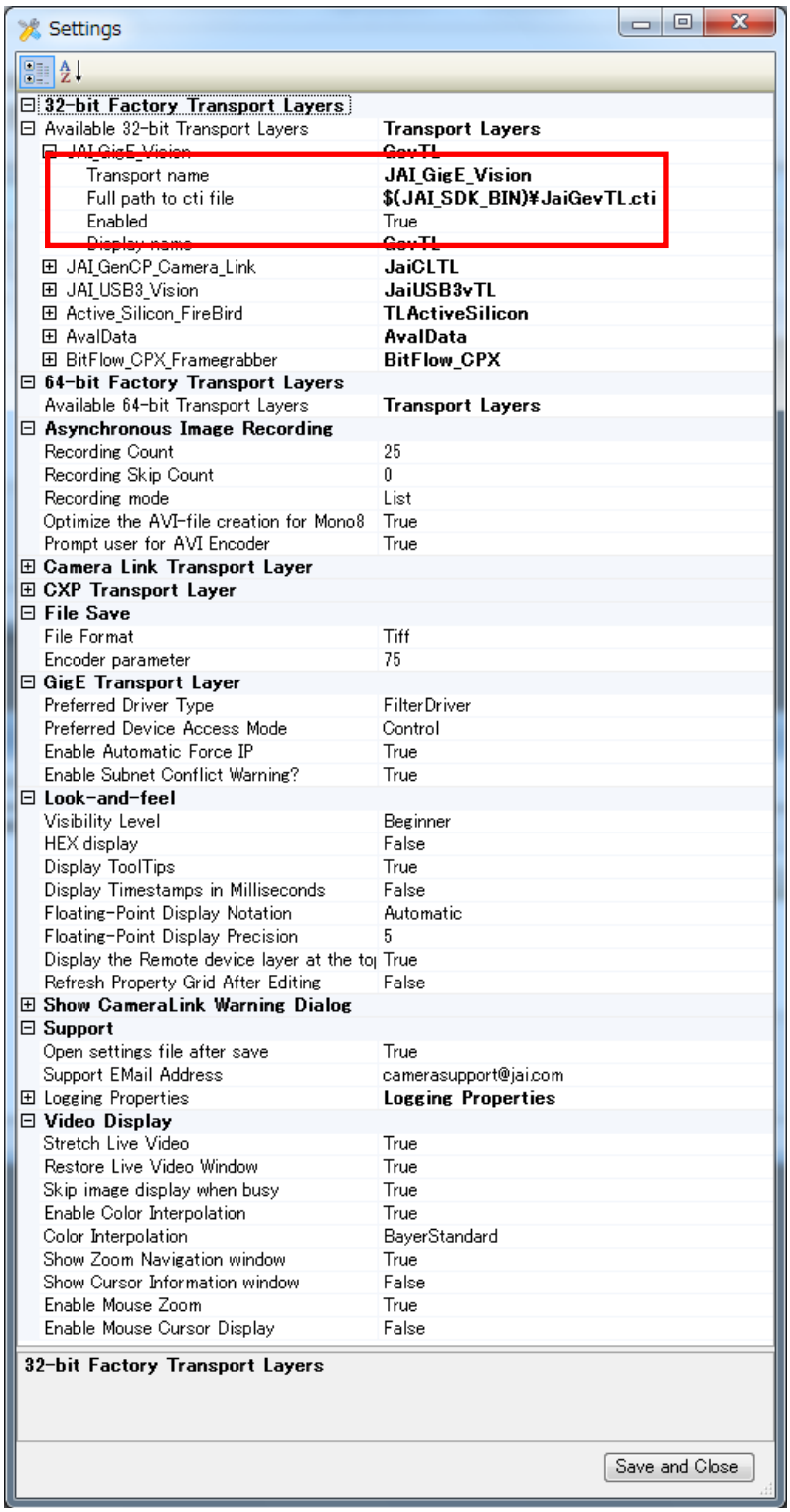


4. Settings of JAI Camera Control Tool

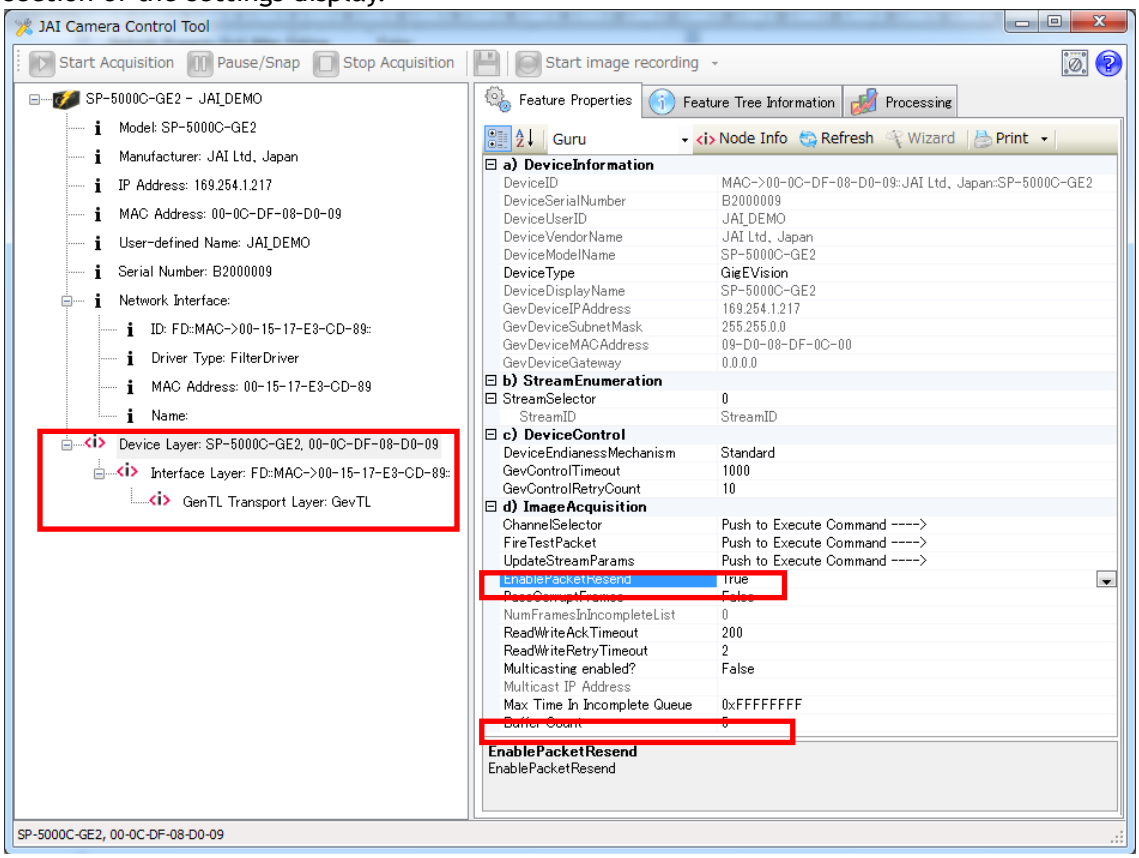
Start JAI Camera Control Tool in Windows Start Menu.
In the default settings, the camera control tool will search automatically for connected cameras.



In JAI SDK 2.0.x, the Settings window is updated with the applicable camera interface settings.

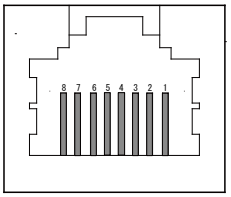


In JAI SDK 2.0.x, “Buffer Count” and “Enable Packet Resend” are found under the GenICam (GenTL) settings as a Device Layer property, while they are found in the Settings dialog in the JAI SDK 1.4.1 camera control tool. These settings can be set every time the camera is connected.
To access the settings in SDK 2.0.x, open the selector of the connected camera, and find the Device Layer in the properties tree. Expand the Device Layer node to reveal the GenTL Transport layer under Interface Layer. Buffer Count and Enable Packet Resend are available in the Image Acquisition section of the settings display.



5.2 Connectors and pin assignment

5.2.1 Output connector for Gigabit Ethernet



Type : RJ-45

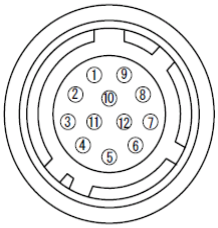
Fig.3 RJ-45 connector

The digital output signals follow the Gigabit Ethernet interface using an RJ-45 conforming connector. The following table shows pin configuration.

Table 4. RJ-45 pin configuration

Pin No.	Input /Output	Description
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-)

5.2.2 12-Pin connector



Type: HR10A-10R-12PB-01 male or equivalent
Use the part number HR10A-10P-12S for the cable side

Fig.4 12-pin connector

5.2.2.1 Pin assignment

Table – 2 12P Pin assignment

Pin no.	Signal	Remarks
1	GND	
2	DC (+12V) in	+12V ~ +24V
3	Opto in 2-	Line6
4	Opto in 2+	
5	Opto in 1-	Line5
6	Opto in 1+	
7	Opto out 1-	Line2
8	Opto out 1+	
9	Opto out 2-	Line3
10	Opto out 2+	
11	DC (+12V) in	+12V ~ +24V
12	GND	

5.2.3 AUX Standard Hirose 10-Pin connector for Lens

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

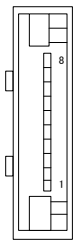


Fig.5 Hirose 10-pin connector

Table – 3 Hirose 10P Pin Assignment

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

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

HIROSE 10-Pin Connector 3260-10S3(55)
Note: This is a factory option.

Table – 4 Hirose 10P Pin assignment (Option)

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

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

HIROSE 10-Pin Connector 3260-10S3(55)
Note: This is a factory option.

Table – 5 Hirose 10P Pin Assignment (Option)

No	I/O	Name	Note
1	O	TTL OUT2	Line8
2	O	TTL OUT3	Line9
3	I	TTL_IN2	Line10
4		NC	
5		GND	
6	I	LVDS_IN1+	Line11
7	I	LVDS_IN1-	
8		NC	
9		GND	
10		GND	

5.3 Output

5.3.1 Digital output

5.3.1.1 Output level

Table – 6 Output level

CCD out			Analog Out (Equivalent)	Digital Out		
				8-bit	10-bit	12-bit
Black		0%	Setup 3.6%, 25mV	8LSB	32LSB	128LSB
Monochrome	574mV	100%	700mV	222LSB	890LSB	3560LSB
Color	386mV					
Monochrome	662mV	115%	800mV	255LSB	1023LSB	4095LSB
Color	445mV					

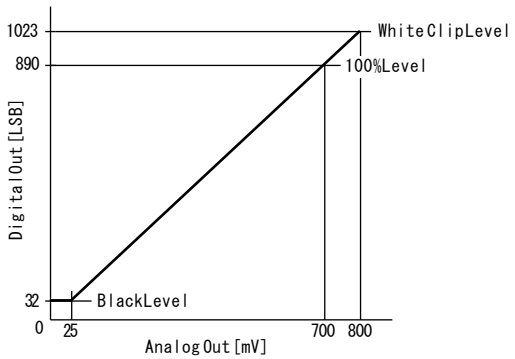


Fig.6 Bit allocation (8-bit)

5.4 Digital IN/OUT interface

In the EL-2800-GE2, the software control tool can assign the necessary signals to the digital I/O ports.

5.4.1 Line Selector

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

Table – 7 Line selector

Line Selector item	Description
Line 2 OPT Out1	Opt 1 output from 12P connector #9/10 pin located on the rear panel
Line 3 OPT Out2	Opt 2 output from 12P connector #7/8 pins located on the rear panel
Line 8 TTL 2 Out	TTL 2 output from "AUX" HIROSE 10-Pin connector #1 pin
Line 9 TTL 3 Out	TTL 3 output from "AUX" HIROSE 10-Pin connector #2 pin
NAND 0 In 1	NAND first gate, No. 1 input on GPIO
NAND 0 In 2	NAND first gate, No. 2 input on GPIO
NAND 1 In 1	NAND second gate, No. 1 input on GPIO
NAND 1 in 2	NAND second gate, No. 2 input on GPIO

Note: Line 8 and 9 are available if AUX Type 3 is used for AUX connector (option).

5.4.2 Line source

Line source signal is selected against the dedicated line selected in the line selector.

Table – 8 Line source

Line Source item	Description
Low	Connect Low Level signal to line item selected in Line Selector, **Default setting**
High	Connect High Level signal to line item selected in Line Selector
Frame Trigger Wait	Connect Frame Trigger Wait signal to line item selected in Line Selector
Frame Active	Connect Frame Active signal to line item selected in Line Selector
Acquisition Trigger Wait	Connect Acquisition Trigger Wait signal to line item selected in Line Selector
Acquisition Active	Connect Acquisition Active signal to line item selected in Line Selector
Exposure Active	Connect Exposure Active signal to line item selected in Line Selector
FVAL	Connect FVAL signal to line item selected in Line Selector
LVAL	Connect LVAL signal to line item selected in Line Selector
PulseGenerator0 Out	Connect Pulse Generator 0 signal to line item selected in Line Selector
PulseGenerator1 Out	Connect Pulse Generator 1 signal to line item selected in Line Selector
PulseGenerator2 Out	Connect Pulse Generator 2 signal to line item selected in Line Selector
PulseGenerator3 Out	Connect Pulse Generator 3 signal to line item selected in Line Selector
Line 5 Opt In 1	Connect Opt In 1 signal to line 5 in Line Selector
Line 6 Opt In 2	Connect Opt In 2 signal to line 6 in Line Selector
NAND 0 Out	Connect NAND 0 signal to line item selected in Line Selector
NAND 1 Out	Connect NAND 1 signal to line item selected in Line Selector
Line 10 TTL 2 In	Connect TTL 2 In signal to Line 10
Line 11 LVDS 1 In	Connect LVDS 1 In signal to Line 11

Note: As for LVAL, some line items cannot be connected. Refer to "5.4.7.2 GPIO matrix table"

5.4.3 Line Mode

Indicates the status of the interface, input or output.

5.4.4 Line Inverter

Sets the polarity of the selected input or output.

5.4.5 Line Status

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

5.4.6 Line Format

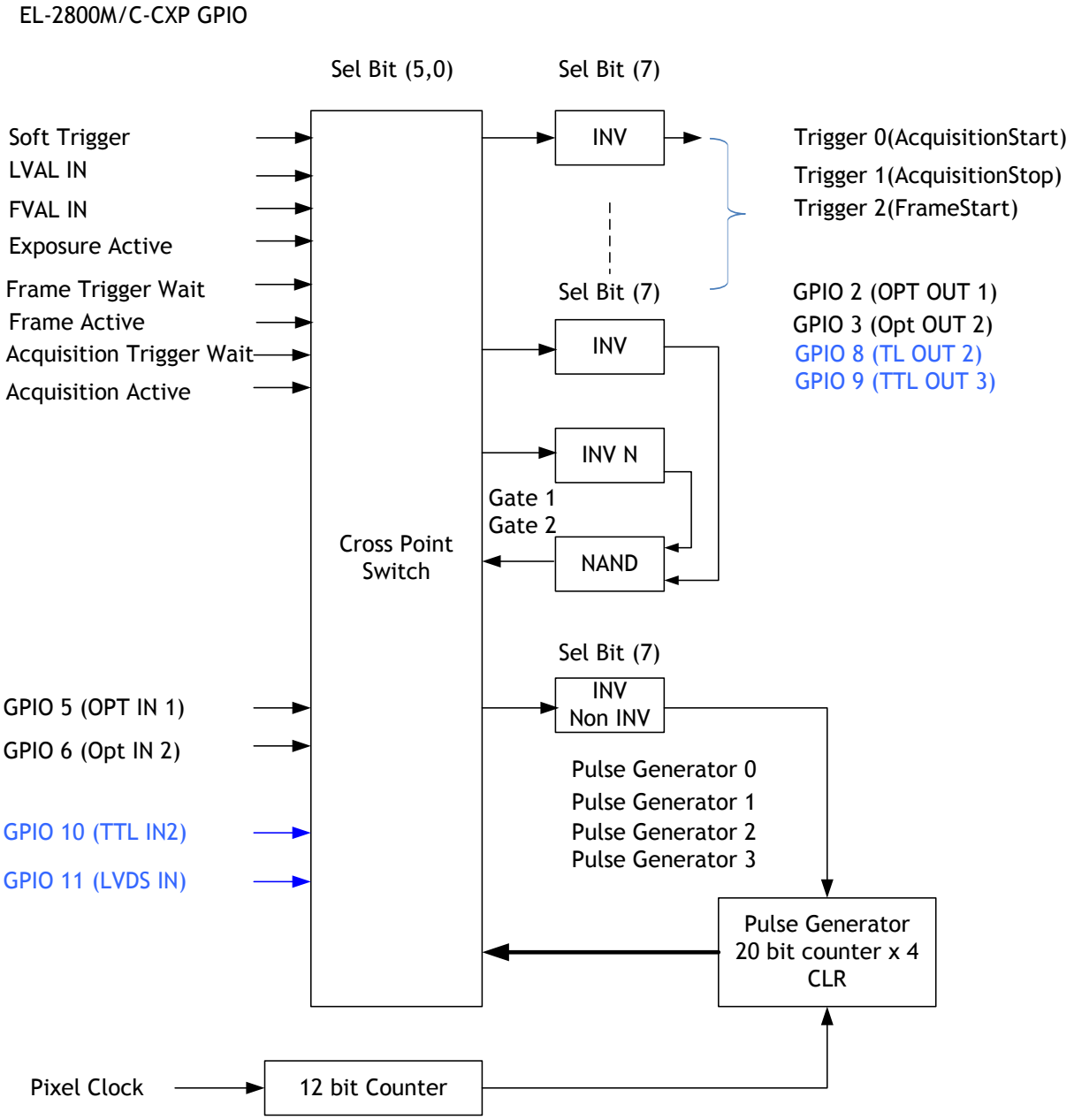
Display the input or output interface format of the line item selected in Line Selector.
Interface format: No Connect, TTL, LVDS, Opto Coupled

5.4.7 GPIO

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

5.4.7.1 GPIO block diagram

Basic block diagram is as follows.



Note 1: For EL-2800-GE2, Camera Output Pixel Clock is 54 MHz.
Note 2: Signals indicated in blue letters are available if the factory option AUX Type 3 is configured as AUX interface.

Fig. 7 GPIO diagram

5.4.7.2 IN and OUT matrix table

The following table shows the input and output matrix.

Table - 9 GPIO IN and OUT matrix

Selector (Cross point switch output) / Source signal (Cross point switch input)	Trigger Selector			Line Selector								Pulse Generator Selector				
	Acquisition Start	Acquisition Stop	Frame Start	Line 2 - 12P OPT Out 1	Line 3 - 12P Opt Out 2	Line 8 - TTL 2 Out	Line 9 - TTL 3 Out	NAND 1 In 1	NAND 1 In 2	NAND 2 In 1	NAND 2 In 2	Pulse Generator 0	Pulse Generator 1	Pulse Generator 2	Pulse Generator 3	
LOW	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
HIGH	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
Line 5 - 12P Opt IN 1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
Line 6 - 12P Opt IN 2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
NAND 1 Out 1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
NAND 2 Out 1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
Pulse Generator 0	o	o	o	o	o	o	o	o	o	o	o	×	o	o	o	
Pulse Generator 1	o	o	o	o	o	o	o	o	o	o	o	o	×	o	o	
Pulse Generator 2	o	o	o	o	o	o	o	o	o	o	o	o	o	×	o	
Pulse Generator 3	o	o	o	o	o	o	o	o	o	o	o	o	o	o	×	
Software Trigger	o	o	o	×	×	×	×	o	o	o	o	×	×	×	×	
FVAL	×	×	×	o	o	o	o	o	o	o	o	o	o	o	o	
LVAL	×	×	×	o	o	o	o	o	o	o	o	o	o	o	o	
Exposure Active	×	×	×	o	o	o	o	o	o	o	o	o	o	o	o	
Acquisition Trigger Wait	×	×	×	o	o	o	o	o	o	o	o	o	o	o	o	
Acquisition Active	×	×	×	o	o	o	o	o	o	o	o	o	o	o	o	
Frame Trigger Wait	×	×	×	o	o	o	o	o	o	o	o	o	o	o	o	
Frame Active	×	×	×	o	o	o	o	o	o	o	o	o	o	o	o	
Line 10 - TTL 2 In	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	Extension GPIO
Line 11 - LVDS 1 In	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	Connection
	Trigger Source			Line Source								Pulse Generator Clear Source				

5.5 Optical Interface

EL-2800-GE2 is equipped with opto-isolated inputs and outputs, providing galvanic separation between the camera's inputs/outputs and peripheral equipment.
In addition to galvanic separation, the opto-isolated inputs and outputs can cope with a wide range of voltages; the voltage range for inputs is +3.3V to +24V DC whereas outputs will handle +5V to +24V DC.
The following drawing is the concept of photo coupler

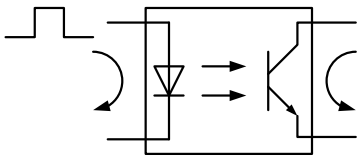


Fig.7 Photo coupler

5.5.1 Recommended External Input circuit diagram for customer

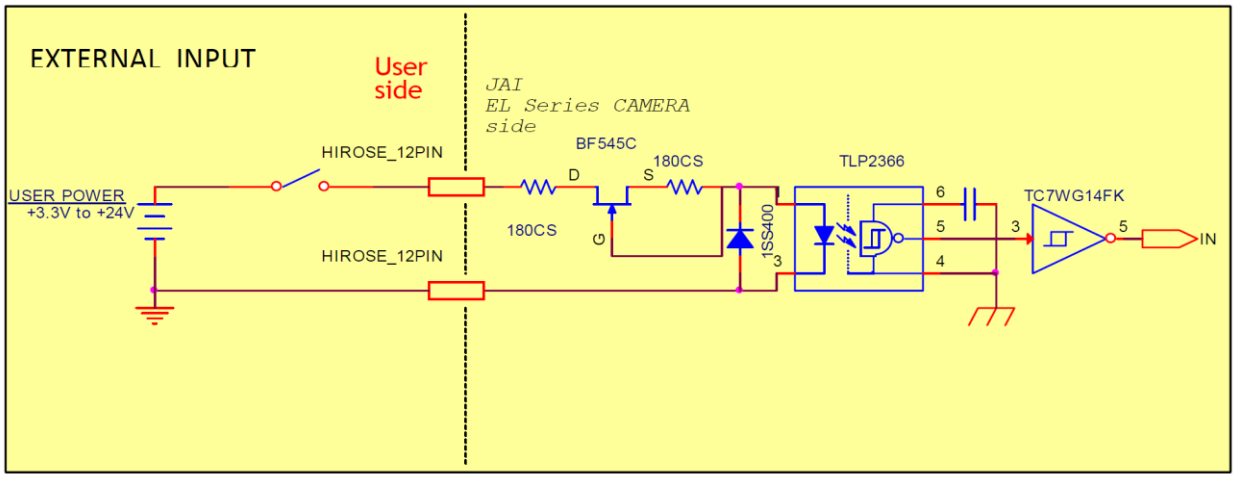


Fig.8 Example of external input circuit

5.5.2 Recommended External Output circuit diagram for customer

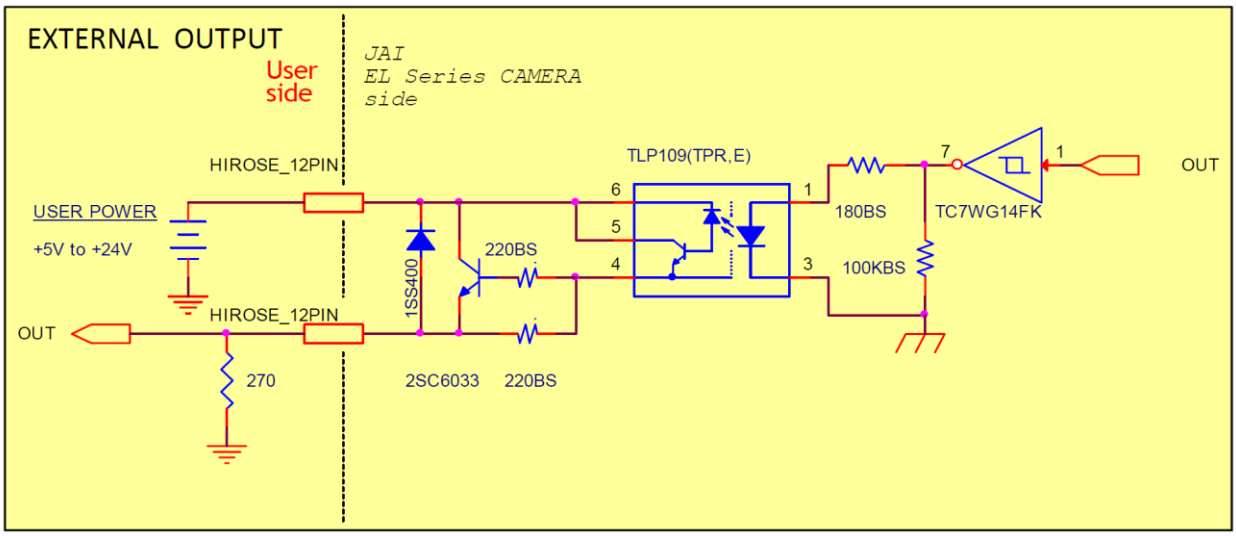
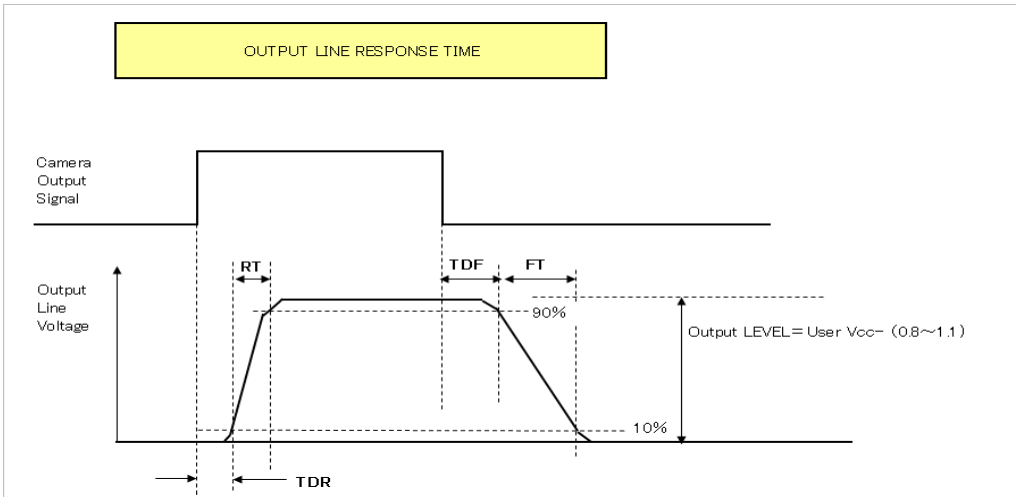


Fig.9 Example of external output circuit

5.5.3 Characteristics of optical interface

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



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

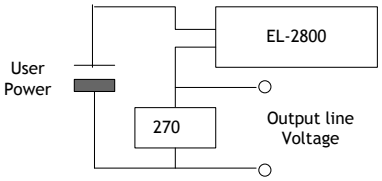


Fig.10 Optical interface characteristics

5.6 Pulse Generator

The EL-2800-GE2 has a frequency divider using the internal pixel clock as the basic clock and four pulse generators. In each Pulse Generator, various Clear settings are connected to GPIO. The following shows Pulse Generator default settings.

Table - 10 Pulse Generator default settings

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

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

5.6.1 Clock Pre-scaler

Clock pre-scaler (Divide Value) can set the dividing value of the frequency divider (12-bit length) and the pixel clock is used for this. Four built-in pulse generators work by the same clock. In the EL-2800M/C-GE2, the internal pixel clock is 54 MHz.

5.6.2 Pulse Generator Selector

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

Table - 11 Pulse Generator setting

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

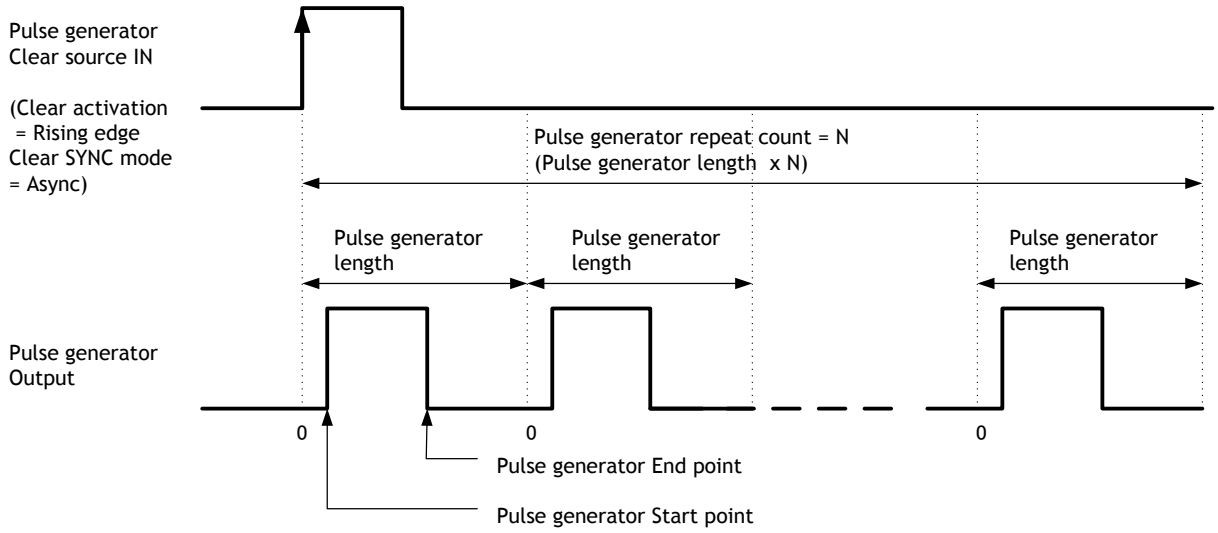


Fig.11 Pulse Generator Pulse construction

5.6.3 Pulse Generator Length

Set the counter up value (number of clocks, refer to Table 12) for the selected pulse generator. If Repeat Count value is “0”, and if Pulse Generator Clear signal is not input, the pulse generator generates the pulse repeatedly until reaching this counter up value.

5.6.4 Pulse Generator Start Point

Set the active output start count value for the selected pulse generator.
However, please note that a maximum 1 clock jitter for the clock which is divided in the clock pre-scaler can occur.

5.6.5 Pulse Generator End Point

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

5.6.6 Pulse Generator Repeat Count

Set the repeating number of the pulse for the selected pulse generator. After Trigger Clear signal is input, the pulse generator starts the count set in Repeat Count. Accordingly, an active pulse which has a start point and end point can be output repeatedly.
However, if Repeat Count is set to "0", it works as a free-running counter.

5.6.7 Pulse Generator Clear Activation

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

5.6.8 Pulse Generator Clear Sync Mode

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

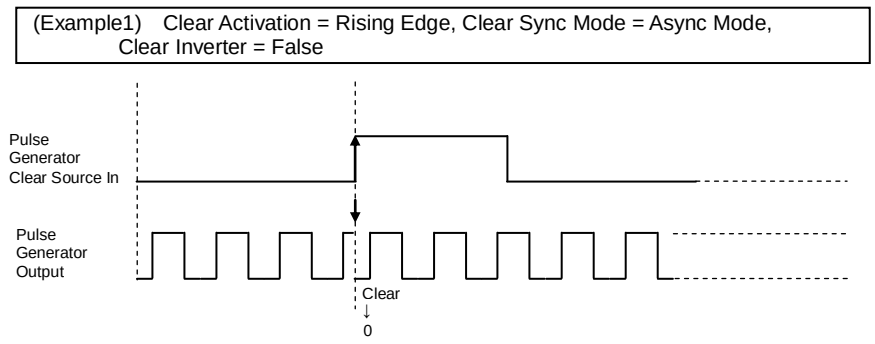


Fig.12 Counter clear in Async mode

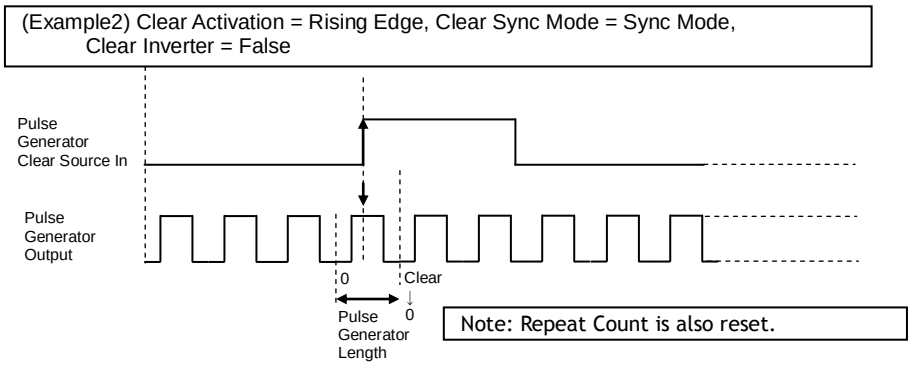


Fig.13 Counter clear in Sync mode

5.6.9 Pulse Generator Clear Source

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

Table - 12 Pulse generator clear source

Pulse Generator Clear Source item	Description
Low	Connect Low level signal to Clear Source for the selected pulse generator. **Default setting**
High	Connect High level signal to Clear Source for the selected pulse generator.
Frame Trigger Wait	Connect Frame Trigger Wait signal to Clear Source for the selected pulse generator.
Frame Active	Connect Frame Active signal to Clear Source for the selected pulse generator.
Exposure Active	Connect Exposure Active signal to Clear Source for the selected pulse generator.
Acquisition Trigger Wait	Connect Acquisition Trigger Wait signal to Clear Source for the selected pulse generator.
Acquisition Active	Connect Acquisition Active signal to Clear Source for the selected pulse generator.
FVAL	Connect FVAL signal to Clear Source for the selected pulse generator.
LVAL	Connect LVAL signal to Clear Source for the selected pulse generator.
PulseGenerator0 Out	Connect Pulse Generator 0 output to Clear Source for the selected pulse generator.
PulseGenerator1 Out	Connect Pulse Generator 1 output to Clear Source for the selected pulse generator.
PulseGenerator2 Out	Connect Pulse Generator 2 output to Clear Source for the selected pulse generator.
PulseGenerator3 Out	Connect Pulse Generator 3 output to Clear Source for the selected pulse generator.
Line 5 Opt In 1	Connect Opt In1 signal to Clear Source for the selected pulse generator.
Line 6 Opt In 2	Connect Opt In2 signal to Clear Source for the selected pulse generator.
Nand0 Out	Connect NAND 0 output signal to Clear Source for the selected pulse generator.
Nand1 Out	Connect NAND 1 output signal to Clear Source for the selected pulse generator.
Line 10 TTL 2 In	Connect TTL 2 IN signal to LINE 10.
Line 11 LVDS 1 In	Connect LVDS 11 1 IN signal to Line 11

Note:
The pulse generator output cannot be used as the clear input to the same pulse generator. Refer to “5.4.7.2 GPIO matrix table”.

5.6.10 Pulse Generator Inverter

Clear Source Signal can have polarity inverted.

5.6.11 Pulse Generator Setting table

Table - 13 Pulse Generator setting parameters

Display Name	Value
Clock Pre-scaler	1 to 4096
Pulse Generator Clock (MHz)	[Internal Pixel Clock:54 MHz]÷[Clock Pre-scaler]
Pulse Generator Selector	- Pulse Generator 0
	- Pulse Generator 1
	- Pulse Generator 2
	- Pulse Generator 3
- Pulse Generator Length	1 to 1048575
- Pulse Generator Length (ms)	([Clock Source]÷[Clock Pre-scaler])$^{-1}$ x [Pulse Generator Length]
- Pulse Generator Frequency (Hz)	[Pulse Generator Length (ms)]$^{-1}$
- Pulse Generator Start Point	0 to 1048574
- Pulse Generator Start Point (ms)	([Clock Source]÷[Clock Pre-scaler])$^{-1}$ x [Pulse Generator Start Point]
- Pulse Generator End Point	1 to 1048575
- Pulse Generator End Point (ms)	([Clock Source]÷[Clock Pre-scaler])$^{-1}$ x [Pulse Generator End Point]
- Pulse Generator pulse-width (ms)	[Pulse Generator End Point (ms)]－[Pulse Generator Start Point (ms)]
- Pulse Generator Repeat Count	0 to 255
- Pulse Generator Clear Activation Clear Mode for the Pulse Generators	- Off
	- High Level
	- Low level
	- Rising Edge
	- Falling Edge
- Pulse Generator Clear Sync Mode	- Async mode
	- Sync mode
- Pulse Generator Clear Source	- Low
	- High
	- Frame Trigger Wait
	- Frame Active
	- Exposure Active
	- Acquisition Trigger Wait
	- Acquisition Active
	- FVAL
	- LVAL
	- PulseGenerator0
	- PulseGenerator1
	- PulseGenerator2
	- PulseGenerator3
	- Line 5 Opt In 1
	- Line 6 Opt In 2
	- Nand0 Out
	- Nand1 Out
	- Line 10 - TTL 2 In
	- Line 11 - LVDS 1 In
- Pulse Generator Inverter (Polarity) Pulse Generator Clear Inverter	- False
	- True

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

6. Sensor layout, output format and timing

6.1 Sensor layout

CCD sensors used in the EL-2800M-GE2 and EL-2800C-GE2 have the following tap and pixel layout.

6.1.1 Monochrome sensor

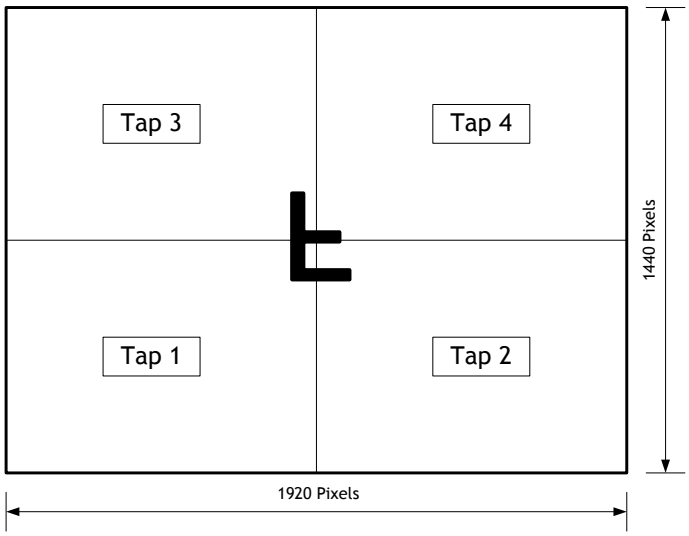


Fig.14 Monochrome sensor layout

6.1.2 Bayer color sensor

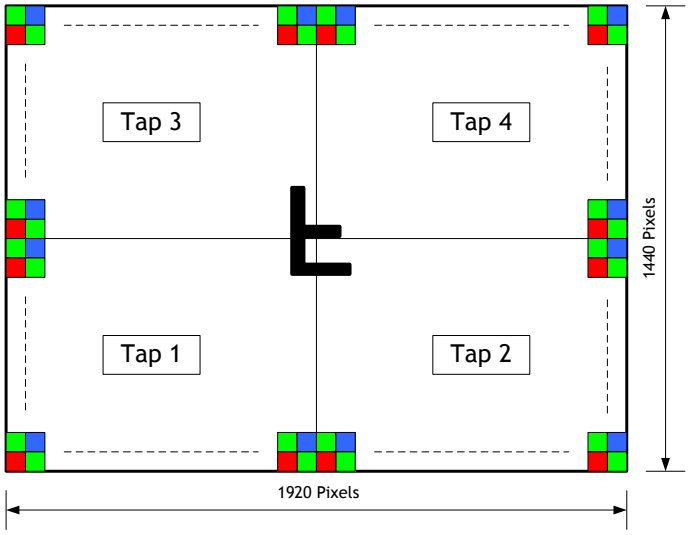


Fig.15 Bayer color sensor layout

6.2. Sensor readout (Sensor Tap Geometry)

The following drawings show how the image is read out from the sensor.
This is different from how the image is read out from the camera.

6.2.1 4 taps readout (1X2-2YE)

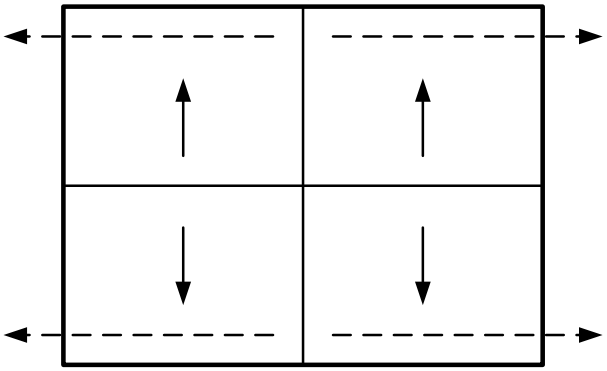


Fig.16 Sensor readout 4-tap

6.3 EL-2800-GE2 Pixel Formats

Model	Supported Pixel Formats
Monochrome	Mono8, Mono10, Mono10_Packed, Mono 12, Mono12_Packed
Bayer color	BayRG8, BayRG10, BayRG12, BayRG10_Packed, BayRG12_Packed, RGB8_Packed, YUV411_PACKED, YUV422_PACKED, YUV444_Packed

6.3.1 EL-2800M-GE2 Pixel Formats

6.3.1.1 GVSP_PIX_MONO8

Y0								Y1								Y2							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

6.3.1.2 GVSP_PIX_MONO10

Y0								Y0								Y1								Y1							
0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X	0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X

6.3.1.3 GVSP_PIX_MONO10_PACKED

Y0												Y1												Y2												Y3											
2	3	4	5	6	7	8	9	0	1	X	X	0	1	X	X	2	3	4	5	6	7	8	9	2	3	4	5	6	7	8	9	0	1	X	X	0	1	X	X	2	3	4	5	6	7	8	9

6.3.1.4 GVSP_PIX_MONO12

Y0								Y0								Y1								Y1							
0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X	0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X

6.3.1.5 GVSP_PIX_MONO12_PACKED

Y0												Y1												Y2												Y3											
4	5	6	7	8	9	10	11	0	1	2	3	0	1	2	3	4	5	6	7	8	9	10	11	4	5	6	7	8	9	10	11	0	1	2	3	0	1	2	3	4	5	6	7	8	9	10	11

6.3.2 EL-2800-GE2 Pixel Formats

6.3.2.1 GVSP_PIX_BAYRG8

odd Line

R0								G1								R2							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

Even Line

G0								B1								G2							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

6.3.2.2 GVSP_PIX_BAYRG10

Odd Line

R0								R0								G1								G1							
0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X	0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X

Even Line

G0								G0								B1								B1							
0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X	0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X

6.3.2.3 GVSP_PIX_BAYRG10_PACKED

Odd Line

R0												G1											
2	3	4	5	6	7	8	9	0	1	X	X	0	1	X	X	2	3	4	5	6	7	8	9

Even Line

G0												B1											
2	3	4	5	6	7	8	9	0	1	X	X	0	1	X	X	2	3	4	5	6	7	8	9

6.3.2.4 GVSP_PIX_BAYRG12

Odd Line

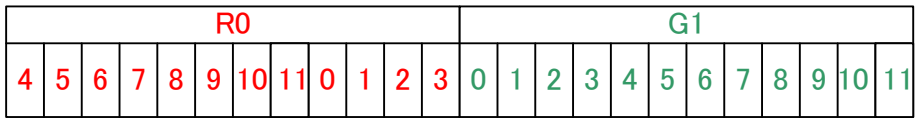
R0								R0								G1								G1							
0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X	0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X

Even Line

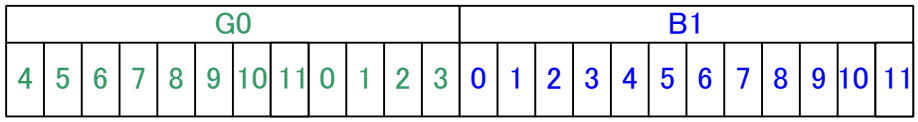
G0								G0								B1								R1							
0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X	0	1	2	3	4	5	6	7	8	9	10	11	X	X	X	X

6.3.2.5 GVSP_PIX_BAYRG12_PACKED

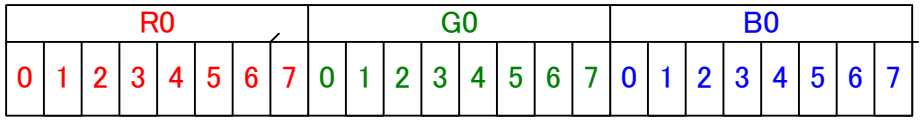
Odd Line



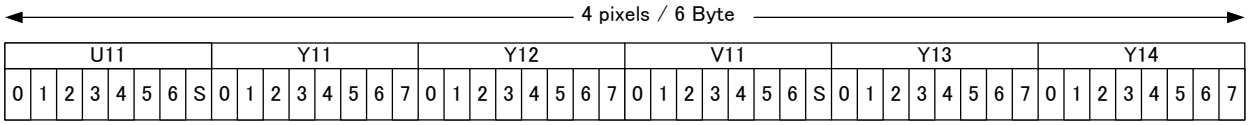
Even Line



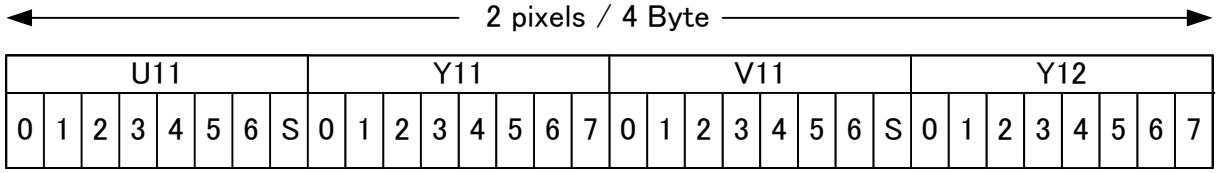
6.3.2.6 GVSP_PIX_RGB8_PACKED (24-bit)



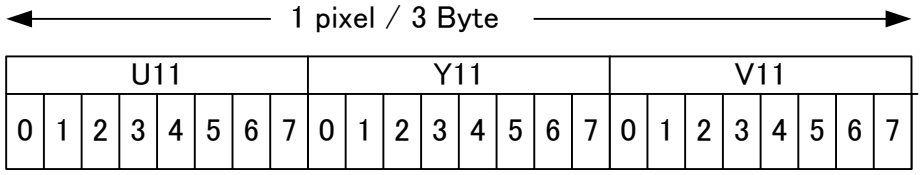
6.3.2.7 GVSP_PIX_YUV411_Packed



6.3.2.8 GVSP_PIX_YUV422_Packed



6.3.2.9 GVSP_PIX_YUV444_Packed



6.3.3 PixelSize

Table 16. Pixel Size

Bits Per Pixel	Pixel Format	
	EL-2800M-GE2	EL-2800C-GE2
Bpp8	Mono8	BayerRG8
Bpp12	Mono10Packed Mono12Packed	BayerRG10Packed、BayerRG12Packed、YUV411Packed
Bpp16	Mono10 Mono12	BayerRG10、BayerRG12、YUV422Packed
BPP24		RGB8、YUV444

6.4 Output timing

6.4.1 Horizontal timing

6.4.1.1 Output format (Vertical binning OFF)

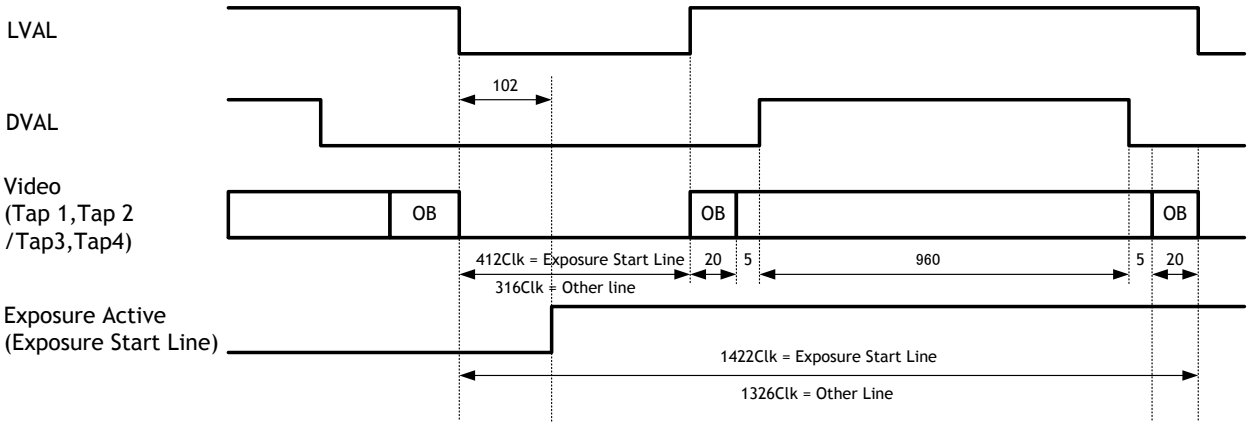


Fig.17 Horizontal Timing (Vertical timing OFF)

6.4.1.2 Output format (Vertical binning ON)

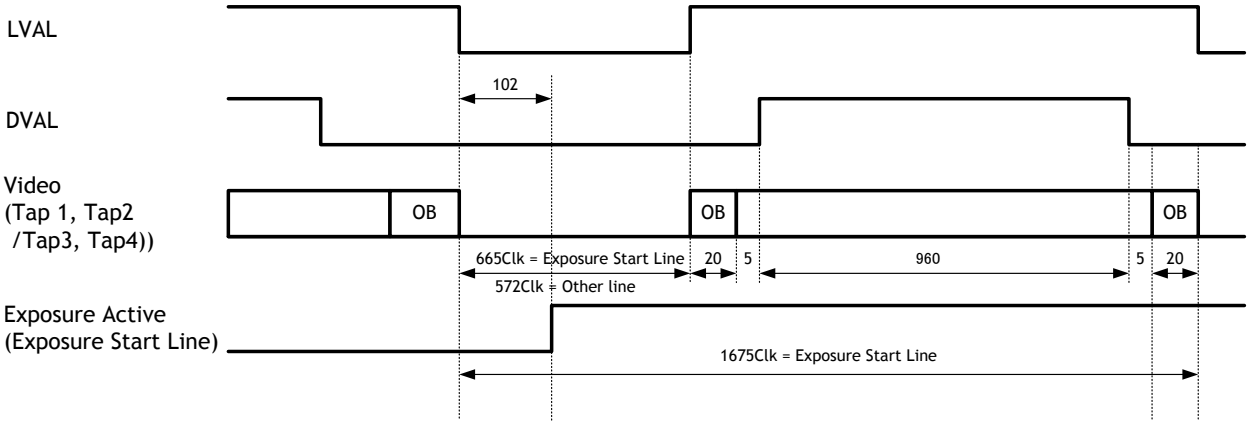


Fig. 18 Horizontal timing (Vertical binning ON)

6.4.2 Vertical timing

6.4.2.1 Output format (Vertical binning OFF)

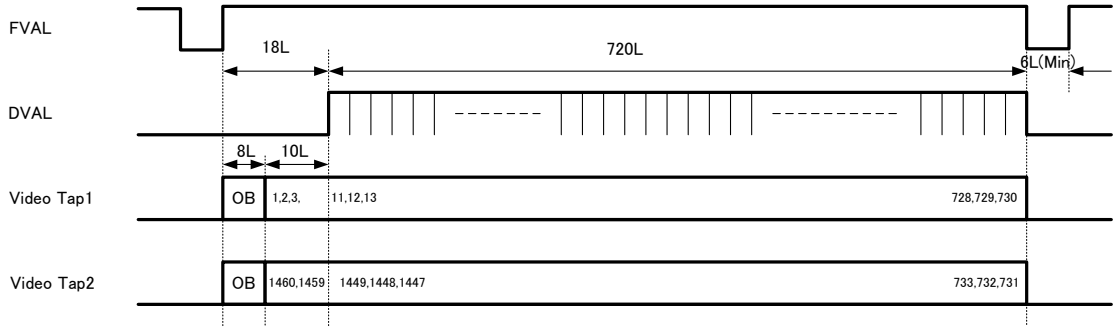


Fig.19 Vertical Timing (Vertical timing OFF)

6.4.2.2 Output format (Vertical binning ON)

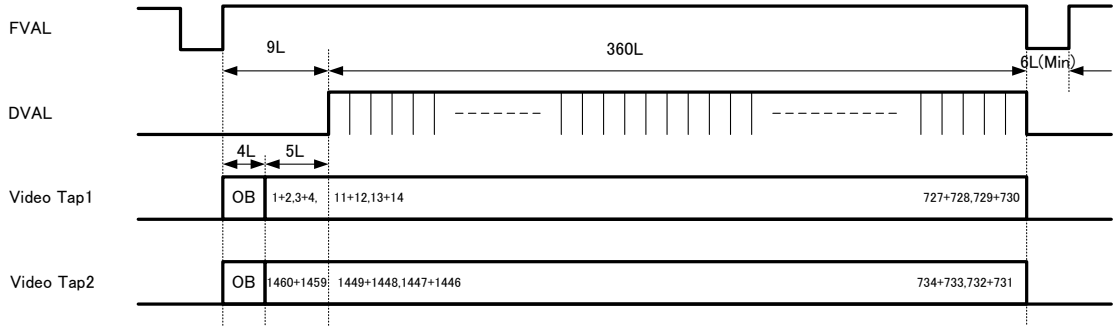


Fig. 20 Vertical timing (Vertical binning ON)

7. Operating modes

7.1. Acquisition control

7.1.1 Acqusition mode

In the EL-2800M-GE2 and EL-2800C-GE2, the following three acquisition modes are available.

Single frame :	One frame can be output by AcqusitionStart command
Multi frames :	The number of frames which is specified in Acquistion Frame Count, are output by AcquisitionStart command
Continuous :	Images are continuously output by AcquisitionStart command until AcqusitionStop command is input.

7.1.1.1 Single Frame

In single frame mode, executing the AcquisitionStart command causes one frame to be captured. After one frame is captured, this operation is automatically stopped.
In order to restart the capture, it is necessary to input the AcquisitionStart command again. BlockID is not reset until AcquisitionStop is input and is incremented when the AcquisitionStart command is called. In the case of PIV operation, 2 frames are captured instead of one frame.

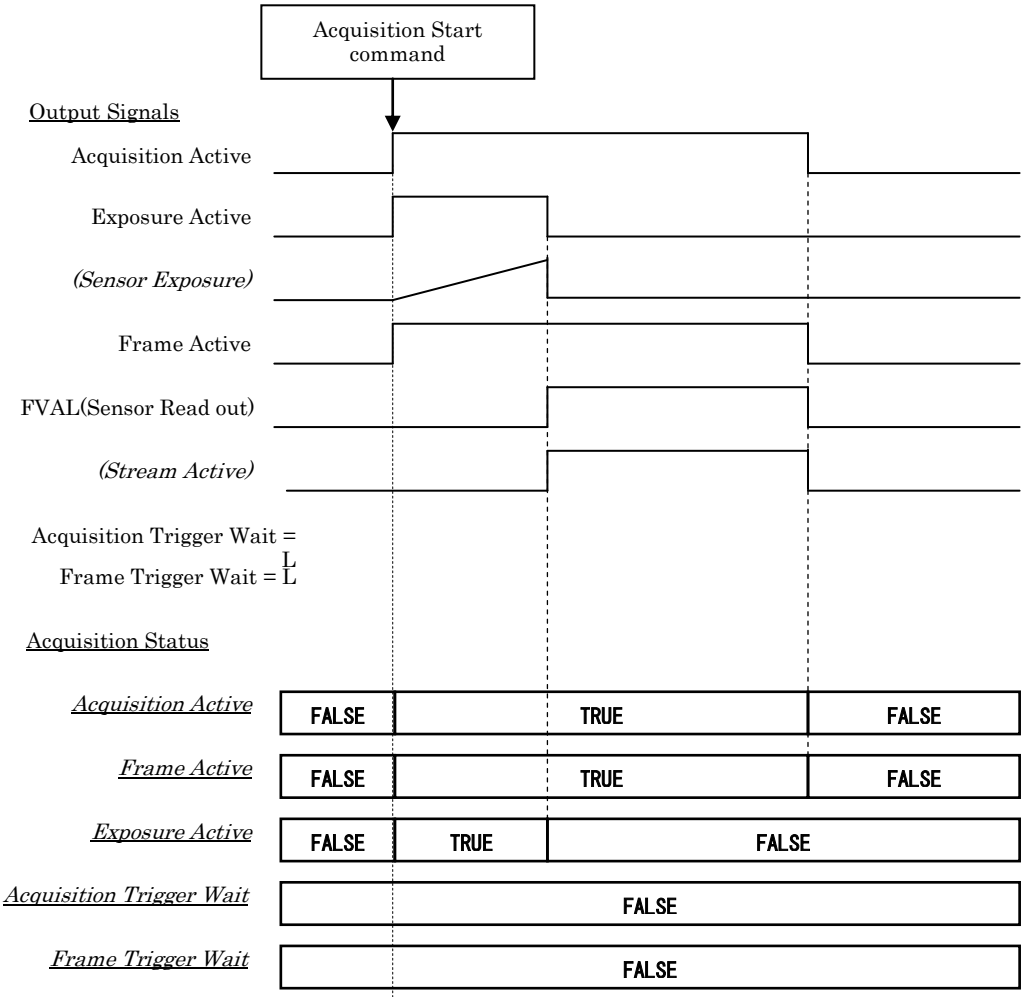
- Normal single frame operation
  1) AcquisitionStart command is input
  2) AcquisitionActive becomes “TRUE” (accepts capture)
  3) 1 frame is output
  4) AcquisitionActive becomes “FALSE” (stop capturing)

- Forcing acquisition to stop
  While AcquisitionActive is “TRUE”, if AcquisitionStop or AcquisitionAbort is initiated, AcquisitionActive becomes “FALSE” (stop capturing).
  However, if AcqusitionStop command is initiated during image output period, AcqusitionActive becomes “FALSE” (stop capturing) after image output is completed.

Associated command: Acquisition Start, Acquisition Stop

The following diagrams show the Single Frame Timing relationships.

Conditions:
Acquisition mode: Single
Trigger selector: Acquisition Start
Trigger mode: OFF



Note: Signals shown in ( ) describe the internal operation of the camera.

Fig.21 Single frame timing

Conditions:
Acquisition mode: Single
Trigger selector: Acquisition Start
Trigger mode: ON

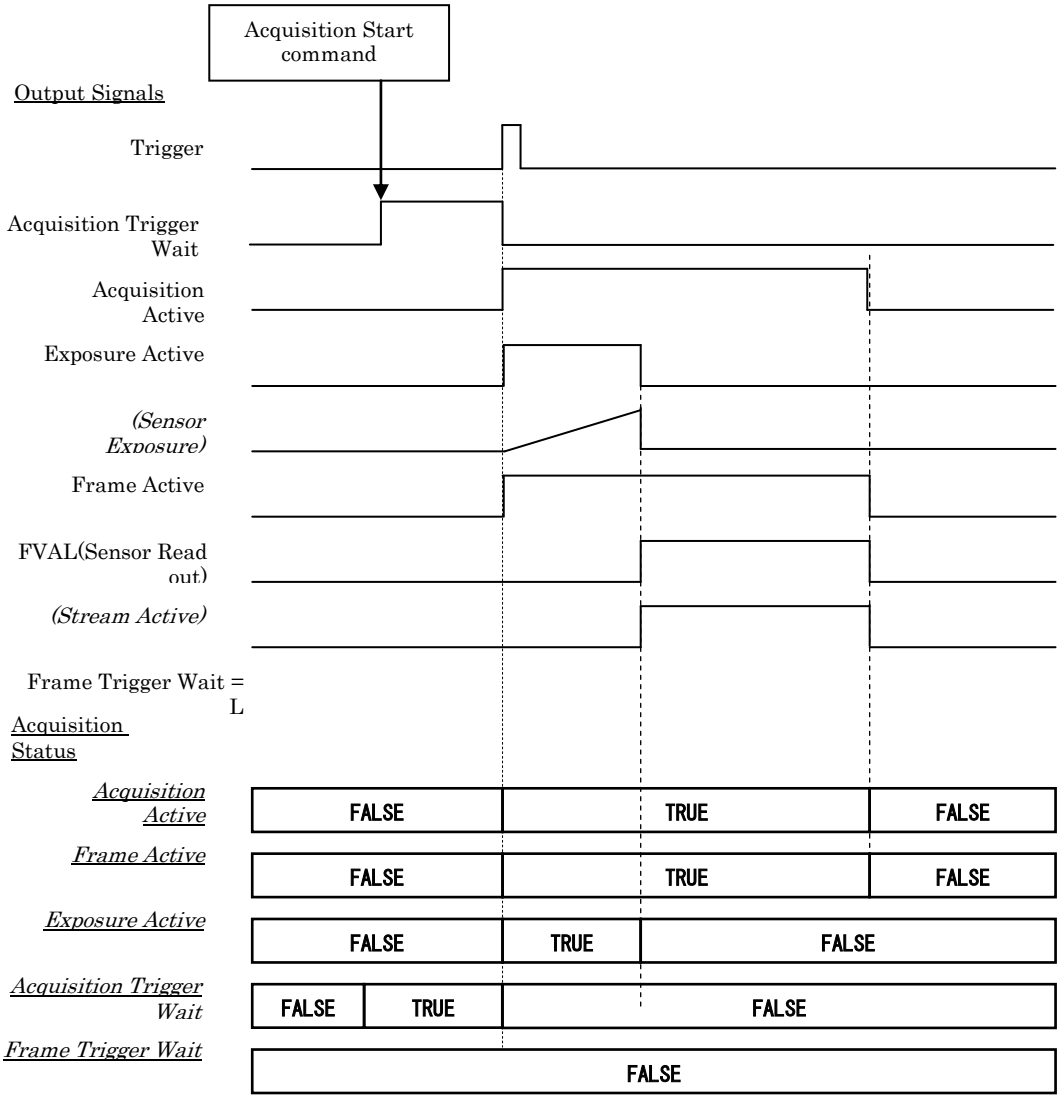


Fig. 22 Single Frame Timing

Conditions:
Acquisition mode: Single
Trigger selector: Frame Start
Trigger mode: ON

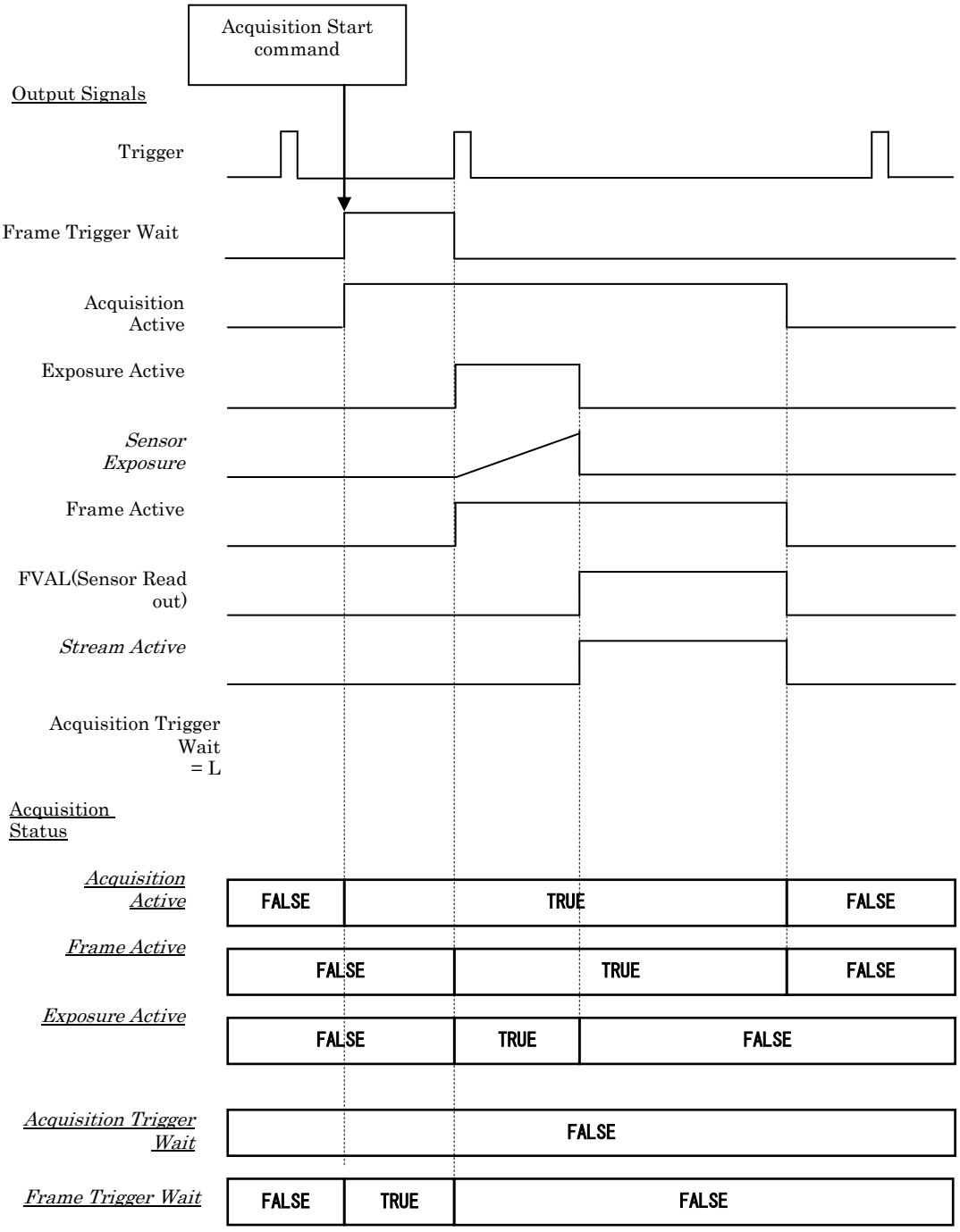


Fig. 23 Single Frame Timing

7.1.1.2 MultiFrame

In this mode, the AcquisitionStart command captures the number of frames which are specified by AcquisitionFrameCount.

- Normal multi-frame operation
  1) AcquisitionStart command is input
  2) AcquisitionTriggerWait becomes effective
  3) AcquisitionActive becomes "TRUE" (accepts capture)
  4) Output N frames as specified by AcquisitionFrameCount
  5) AcquisitionActive becomes "FALSE". Then the output stops. (See the following diagram)

- Forcing acquisition to stop
  While AcquisitionActive is "TRUE", if AcquisitionStop or AcquisitionAbort is initiated, AcquisitionActive becomes "FALSE" (stop capturing).
  Once the operation is set to "FALSE", the internal FrameCount is reset.
  However, if AcqusitionStop command is initiated during image output period, AcqusitionActive becomes "FALSE" (stop capturing) after image output is completed.
  Once, AcqusitionActive becomes "FALSE", the internal count is reset.

- Acqusition Frame Count (16-bit): Can be set in the range of 1 to 65535
  In PIV mode, Acquisition Frame Count (16-bit) can be set in the range of 2 to 65535.
  The setting for PIV mode is 2 frames per step.

Associated command: Acquisition Start, Acquisition Frame Count, Acquisition Stop

The following diagrams show the Multi Frame Timing relationships.

Conditions:
Acquisition mode: Multi
Trigger selector: Acquisition Start
Acquisition Frame Count: 2
Trigger mode: OFF

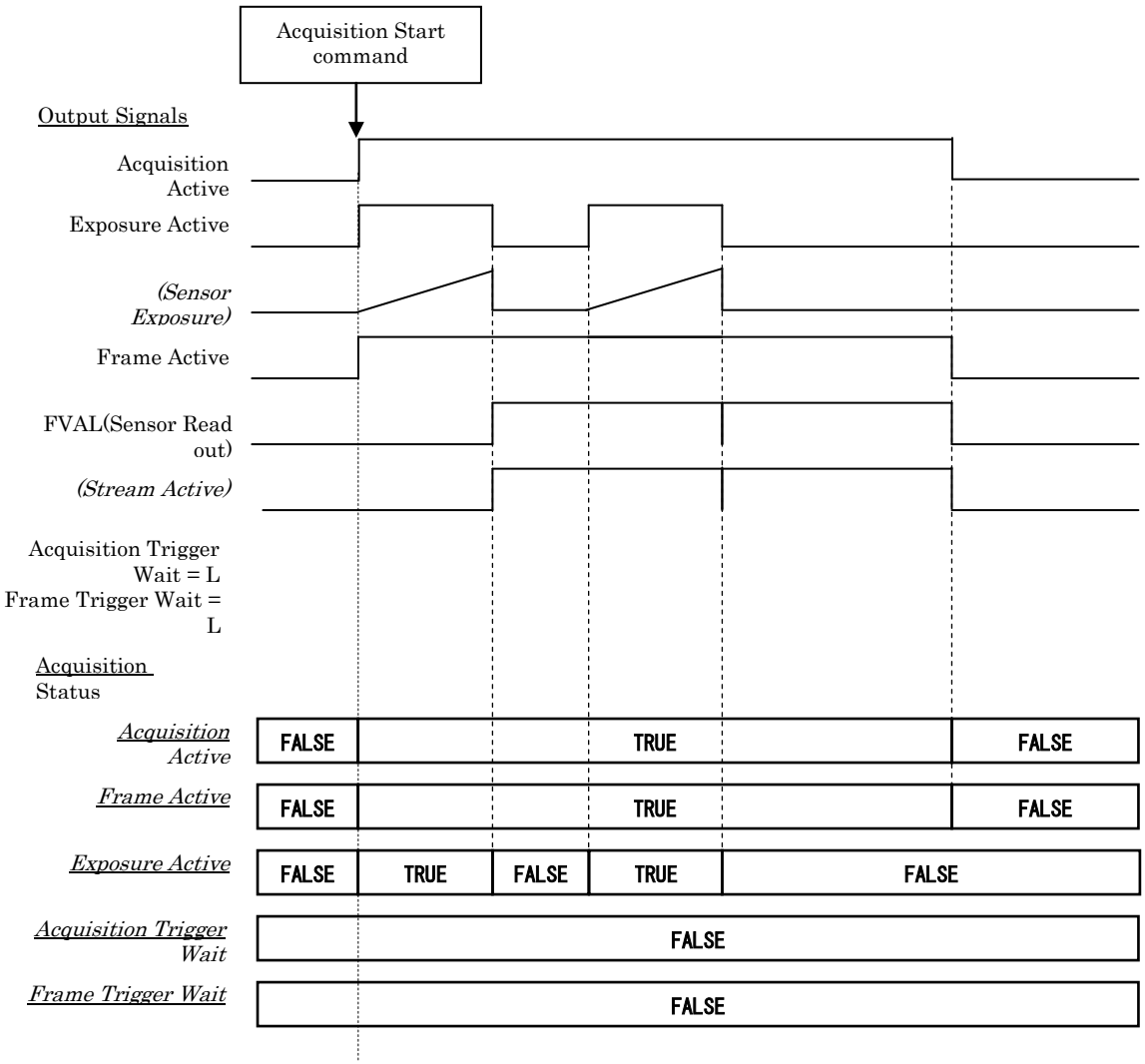


Fig.24 Multi Frame Timing

Conditions:
Acquisition mode: Multi
Trigger selector: Acquisition Start
Acquisition Frame Count: 2
Trigger mode: ON

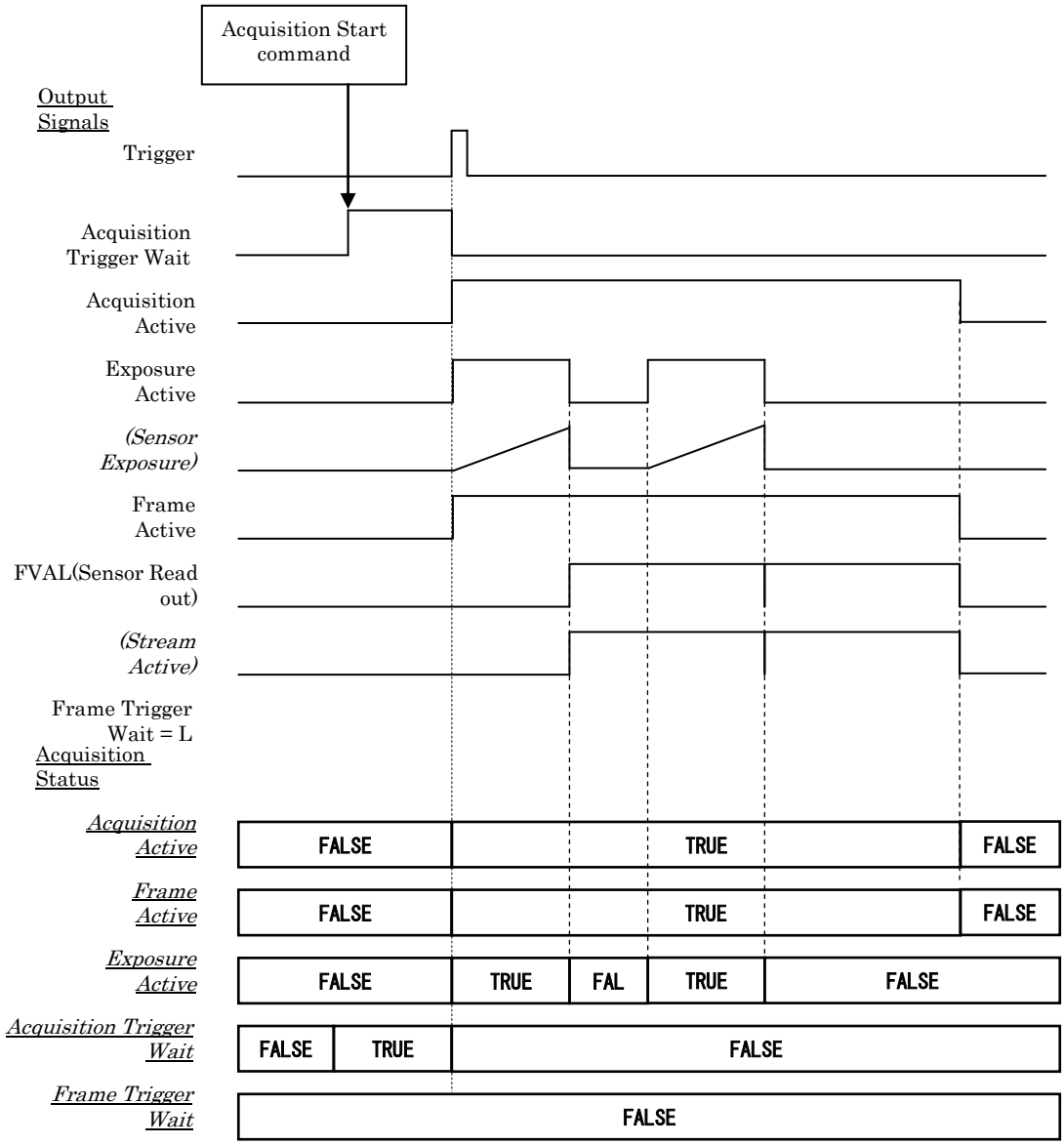


Fig.25 Multi Frame Timing

Conditions:
Acquisition mode: Multi
Trigger selector: Frame Start
Acquisition Frame Count: 2
Trigger mode: ON

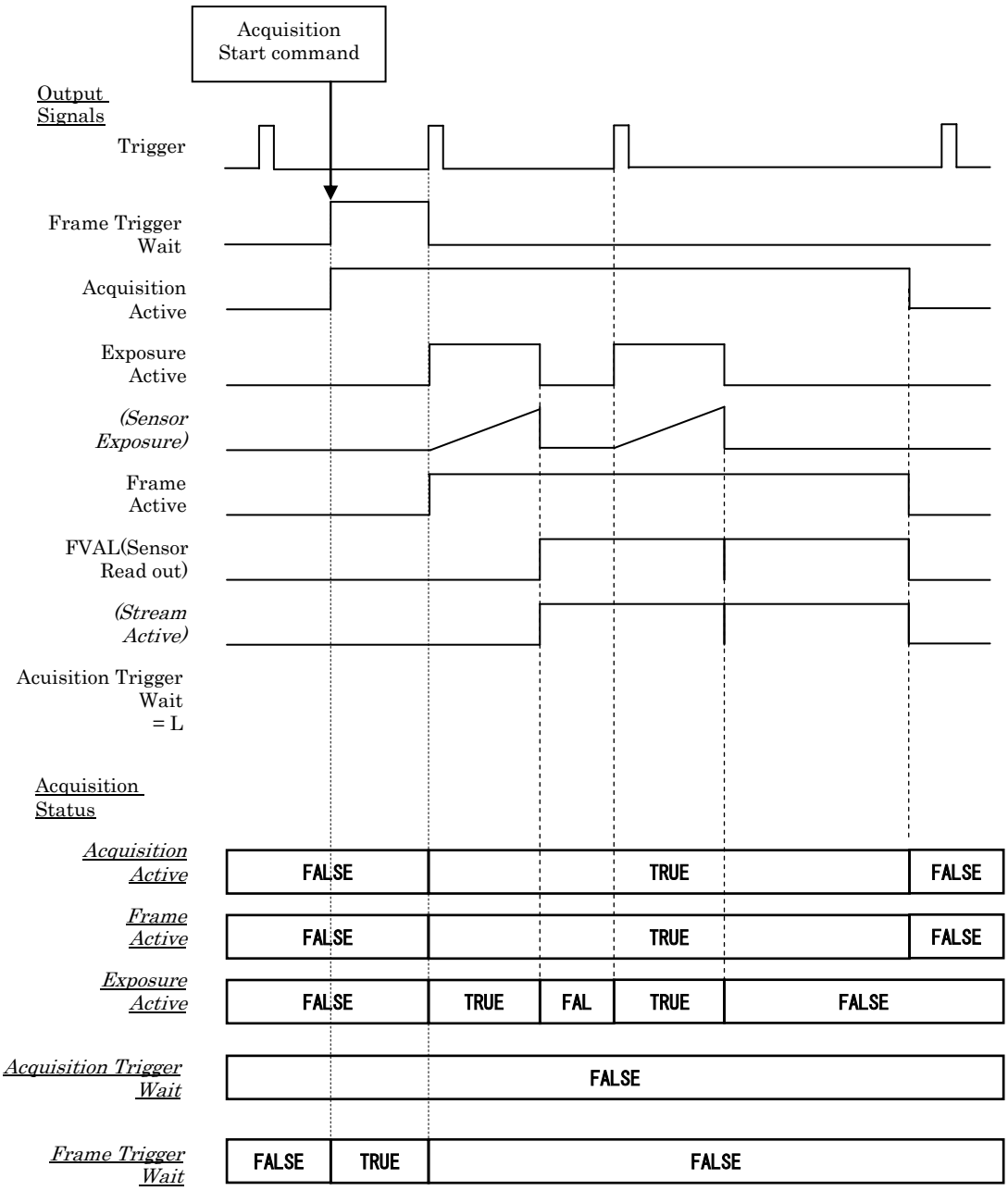


Fig.26 Multi Frame Timing (Frame Start ON)

7.1.1.3 Continuous mode

In this mode, when the AcquisitionStart command is set, the image is continuously output at the current frame rate. This is the default setting for the EL-2800M-GE2 and EL-2800C-GE2.

1) AcquisitionStart command is input
2) AcquisitionTriggerWait becomes effective
3) AcquisitionActive becomes "TRUE"
4) Images begin outputting continuously
5) AcquisitionStop command is sent
6) AcquisitionActive becomes "FALSE". At this moment, the output stops.

However, if AcqusitionStop command is initiated during image output period, AcqusitionActive becomes "FALSE" (stop capturing) after image output is completed.

The following diagrams show the Continuous Timing relationships.

Conditions:
Acquisition mode: Continuous
Trigger selector: Acquisition Start
Trigger mode: OFF

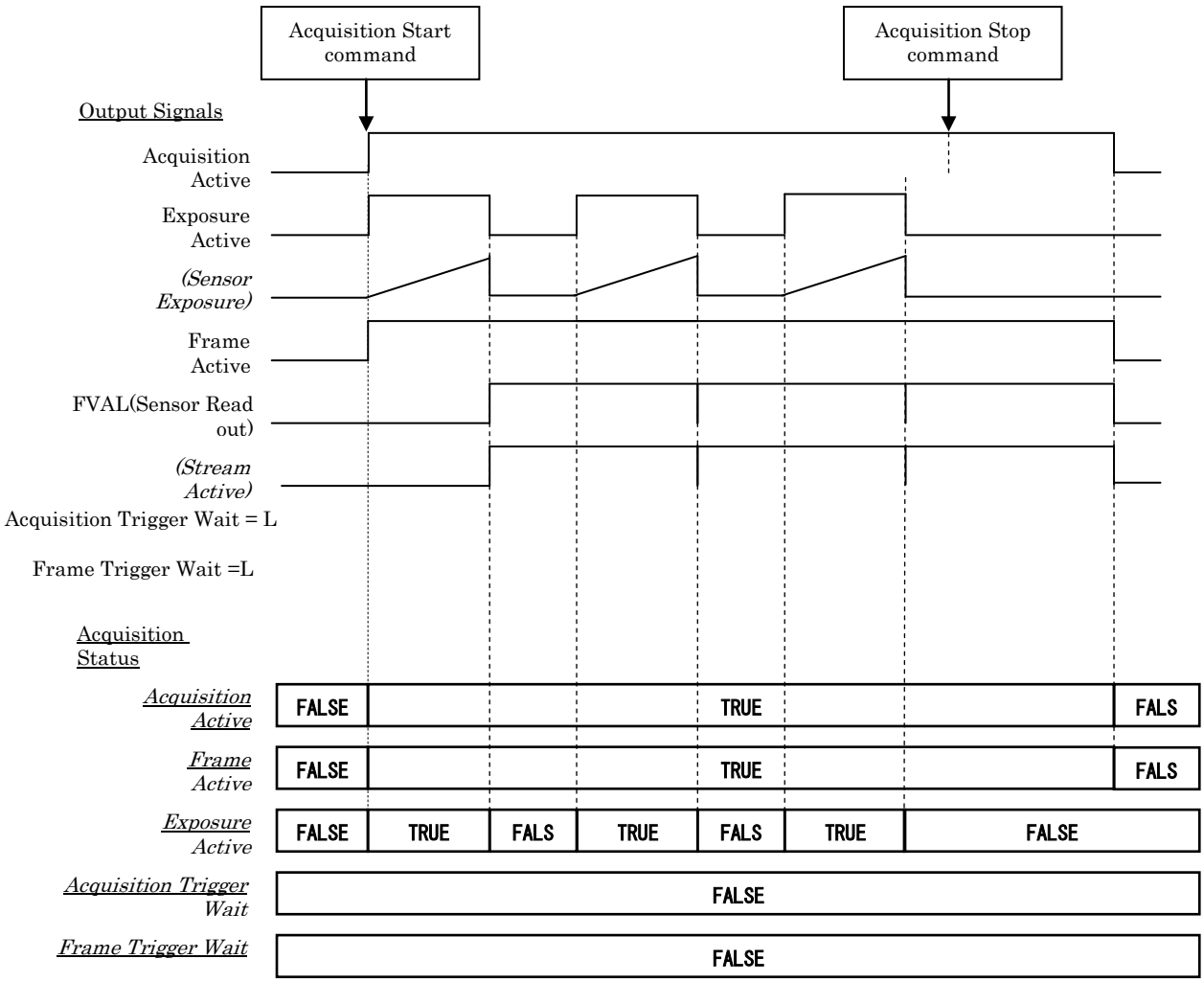


Fig.27 Continuous Timing

Conditions:
Acquisition mode: Continuous
Trigger selector: Acquisition Start
Trigger mode: ON

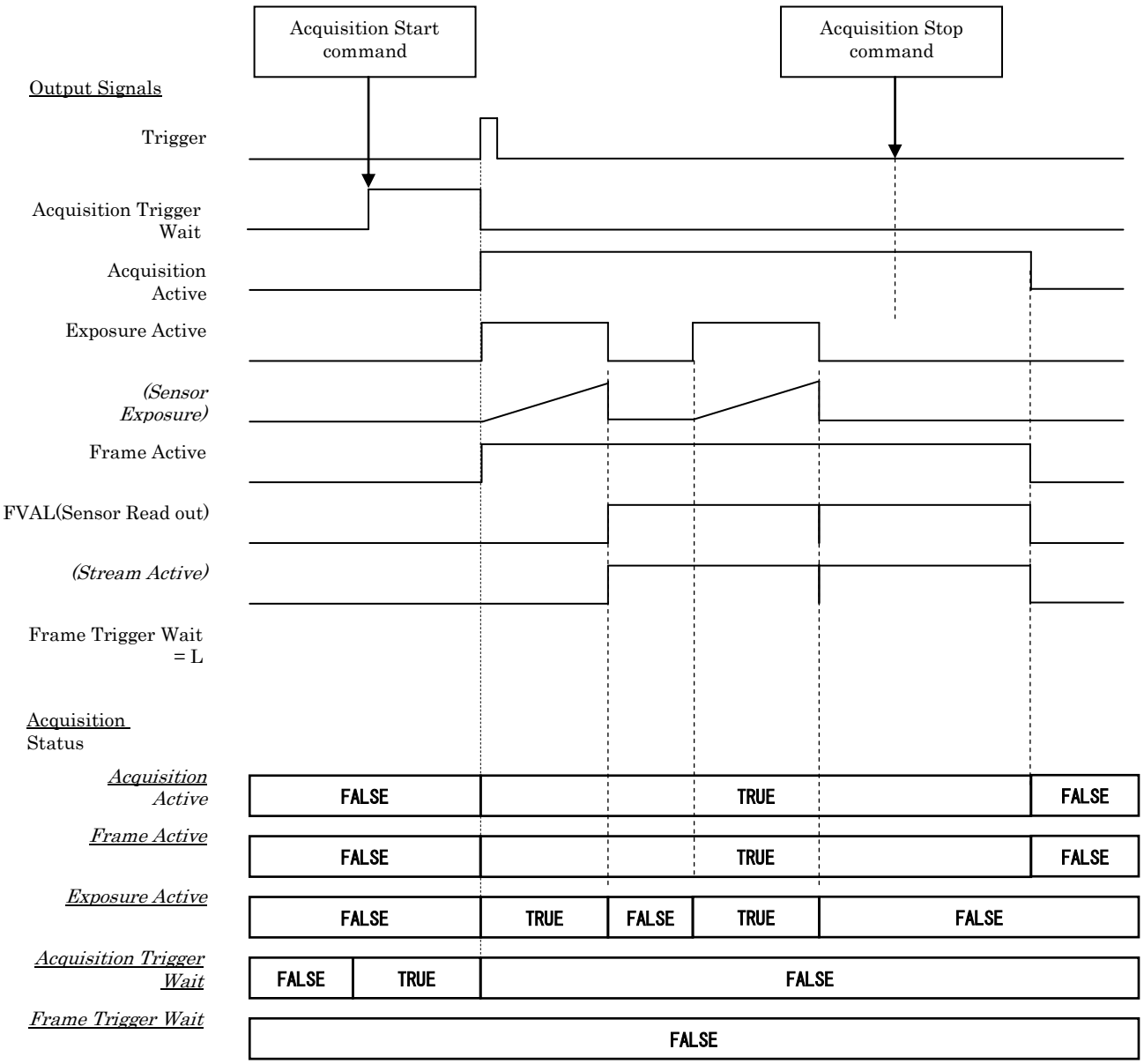


Fig. 28 Continuous Timing

Conditions:
Acquisition mode: Continuous
Trigger selector: Frame Start
Trigger mode: ON

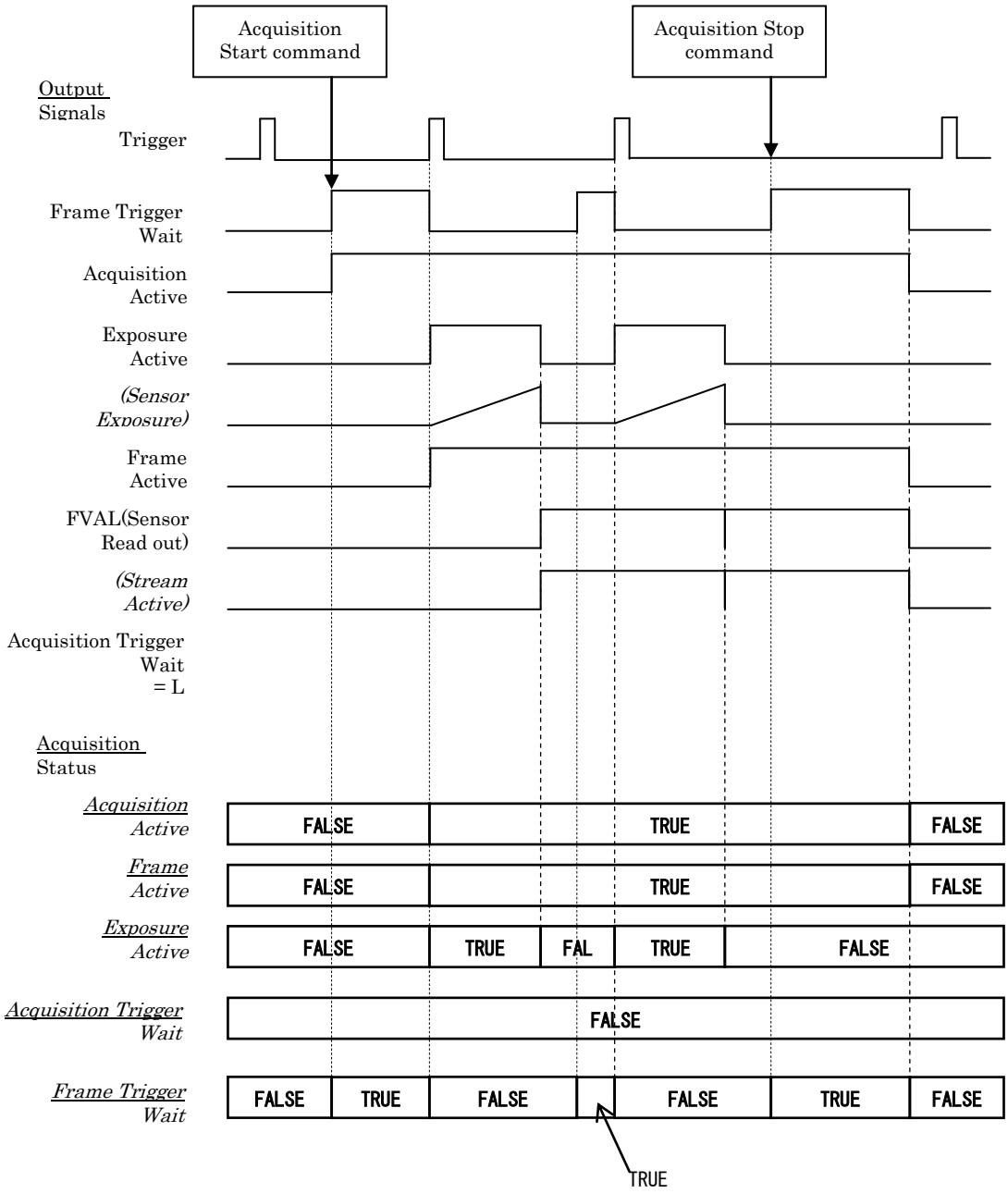


Fig.29 Continuous Timing

7.1.2 Acquisition frame rate

With Trigger OFF, which is free-running operation, it is possible to set a longer acquisition period than the time required to read out all pixels in the area set by the ROI command.
The setting is done in the acquisition frame rate.

The setting range is:

Shortest	to	Longest
The reciprocal of the time required to read out all pixels in the area set by ROI or The reciprocal of the time to transmit one frame data	to	0.5 Hz (fps)

Note:
1. If the trigger is set to ON, this function is not available.
2. The value for setting is frame frequency (Hz).
3. If the setting value is less than the minimum period, this setting is ignored and camera operates at the minimum period.

Self-running (Trigger OFF) works under the following conditions.
Exposure Mode : OFF
Exposure Mode : Timed and Frame Start OFF
Exposure Mode : Trigger Width and Frame Start OFF.

7.1.3 Calculation of frame rate

In the following formula, the underlined results should be rounded up.

7.1.4.1 V Binning Off

The frame rate is the smaller of the Sensor frame rate or the Network frame rate.

$$\text{Sensor frame rate(Hz)} = 1000000 / \left[\left[\underline{\text{Height}/2} + \underline{\{((720-(\text{Height}/2)-1)/4\}} + 25 \right] \times 24.574 \right]$$

$$\text{OR Network\_Frame\_Rate(Hz)} = \text{Network\_Bit\_Rate} / [\{(\text{Width} \times \text{Height} \times \text{BitsPerPixel} / 8) / (\text{Packet\_Size} - 36) + 1\} \times (\text{Packet\_Size} + 14) + 44] / 8$$

Note1: The network bit rate is;
1000000000 for Single
2000000000 for LAG
Maximum guaranteed bandwidth is 93% (0.93) of this value
Note2: The bit per pixel value is the number of bits associated with the selected pixel format

Bits Per Pixel	Pixel Format	
	EL-2800M-GE2	EL-2800C-GE2
Bpp8	Mono8	BayerRG8
Bpp12	Mono10Packed Mono12Packed	BayerRG10Packed、BayerRG12Packed、YUV411Packed
Bpp16	Mono10 Mono12	BayerRG10、BayerRG12、YUV422Packed
BPP24		RGB8、YUV444

7.1.4.2 V Binning On

The frame rate is the smaller of the Sensor frame rate or the Network frame rate.

Sensor Frame Rate (fps) = 1000000/〔[(Height/2) + {(360-(Height/2)-1)/2} + 16] ×29.296 〕

OR Network_Frame_Rate(Hz) = Network_Bit_Rate / [{(Width × Height × BitsPerPixel / 8) / (Packet_Size - 36) + 1} × (Packet_Size + 14) + 44] / 8

Note1: The network bit rate is;
1000000000 for Single
2000000000 for LAG
Maximum guaranteed bandwidth is 93% (0.93) of this value
Note2: The bit per pixel value is the number of bits associated with the selected pixel Format, refer to 7.1.4.1.

7.2. Exposure settings

7.2.1 Exposure Mode

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

Table18. Exposure mode

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

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

Table19. Trigger option

Trigger Option setting	Exposure operation
OFF	Timed (EPS) mode
RCT	RCT mode
PIV	PIV (Particle Image Velocimetry) mode

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

Table20. The combination of Exposure Mode, Trigger Option and Trigger Mode

Exposure Mode	Trigger Option	Trigger Mode (Frame Start)	Operation
OFF	N/A	N/A	Self-running operation Exposure control by Exposure Time is not possible
Timed	OFF	OFF	Self-running operation Exposure control by Exposure Time is not possible
		ON	Timed (EPS) Operation Exposure can be controlled by Exposure Time
	RCT	OFF	Self-running operation Exposure control is not possible
		ON	RCT operation Exposure can be controlled by Exposure Time
	PIV	OFF	Self-running operation Exposure control is not possible
		ON	PIV Operation Exposure can be controlled by Exposure Time
Trigger Width	N/A	OFF	Self-running operation Exposure control is not possible
		ON	Exposure is controlled by the pulse width of the external trigger

7.2.2 Exposure Time

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

Minimum: 10 μsec
Maximum: 8 seconds

7.2.3 Exposure Auto

This is a function to control the exposure automatically. It is effective only for Timed.
ALC Reference controls the brightness.
There are three modes: OFF, Once, and Continuous.

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

In this mode, the following settings are available.

ALC Speed: Rate of adjustment can be set(Common with Gain Auto)
Exposure Auto Max: The maximum value for the exposure range can be set
Exposure Auto Min: The minimum value for the exposure range can be set
ALC Reference: The reference level of the exposure control can be set (Common with GainAuto)
ALC Channel area: The measurement area of the exposure control can be set

7.3. Trigger Mode

7.3.1 Trigger Source

The following signals can be used as the trigger source signal.

Signal	Description
Software	Signal generated by Trigger Software Command
Pulse Generator 0 to 3	Signal generated by Pulse generator 0 to 3
Line 5	Signal which is input from Opt In 1 and output through Digital IO
Line 6	Signal which is input from Opt In 2 and output through Digital IO
NAND Gate 0,1 Output	Signal output from Digital IO
Line 10	Signal which is input from Option TTL In 2 and output through Digital IO
Line 11	Signal which is input from Option LVDS In and output through Digital IO

Note: Line 10 and 11 are available if AUX Type 3 is configured as 10P connector (option).

7.3.2 Trigger activation

This command can select how to activate the trigger.

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

Table - 16 Trigger activation

	RisingEdge	FallingEdge	LevelHigh	LevelLow
Timed	○	○	×	×
TriggerWidth	×	×	○	○
Trigger Option PIV	○	○	×	×
Trigger Option RCT	○	○	×	×

7.3.3 Trigger Overlap

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

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

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

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

Primary settings to use this mode

Trigger control
Trigger Mode: OFF

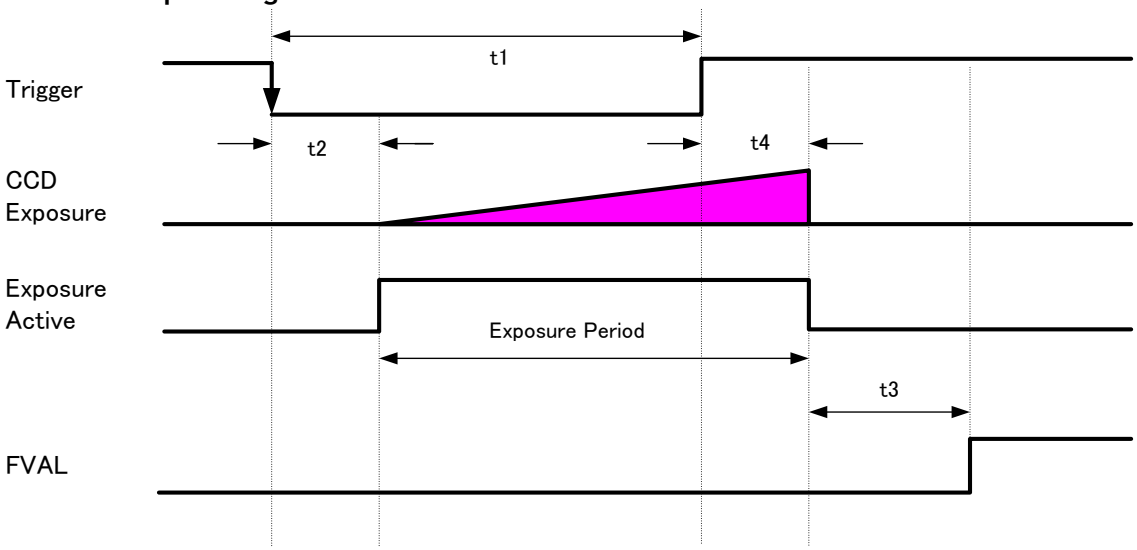
7.5. Timed mode (EPS)

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

Primary settings to use this mode

Exposure mode: Timed
Trigger mode: ON
Frame Start : ON

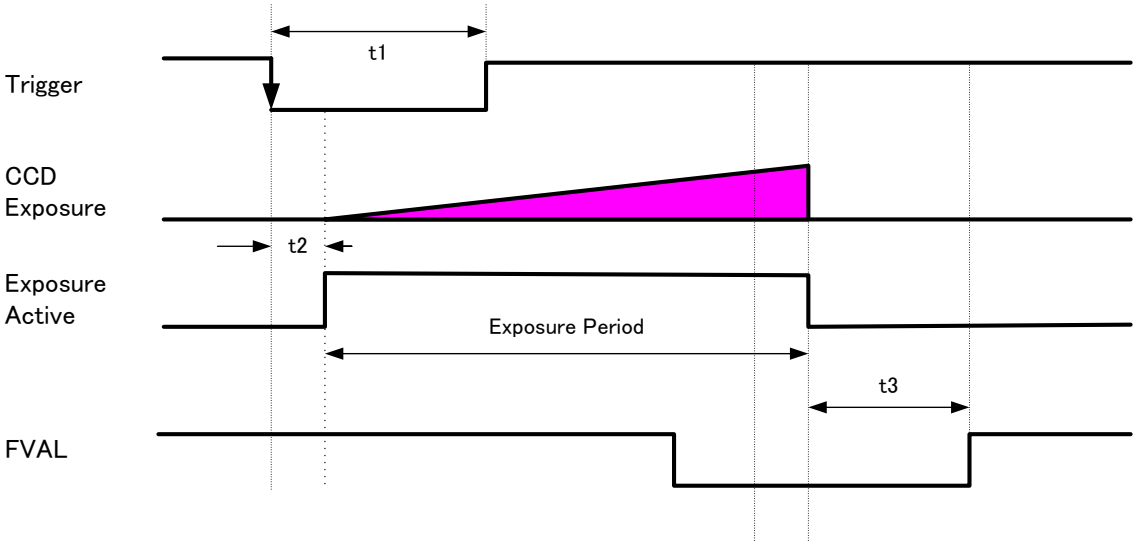
7.5.1 If the overlap setting is "OFF"



t1	t2	t3
2L (Min)	424 clk	4.5 ～ 5.5L

Fig.30 Overlap OFF

7.5.2 If the overlap setting is “Readout”



t1	t2	t3
2L (Min)	1L	4.5L ～5.5L

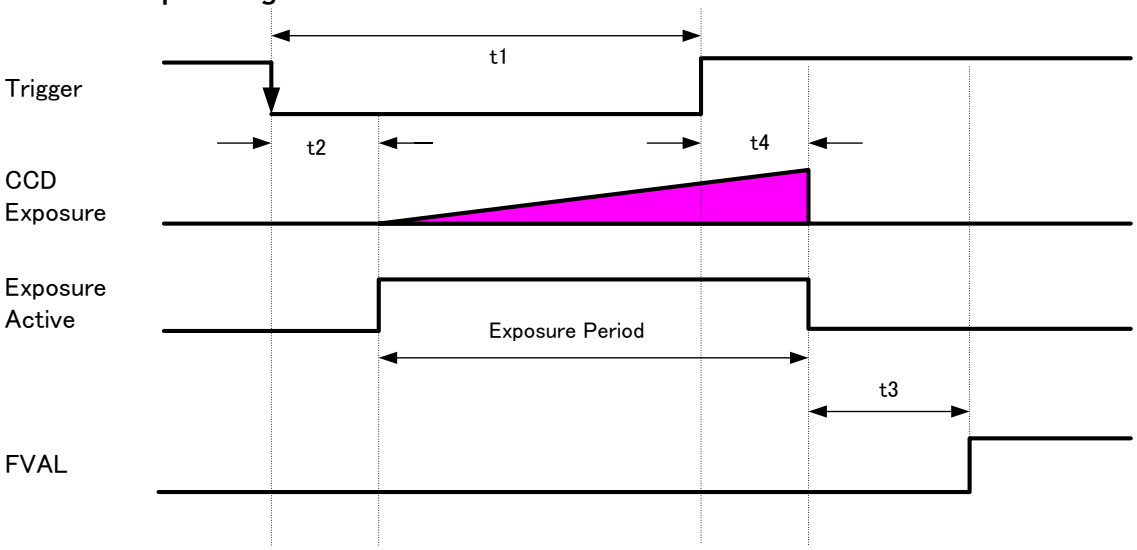
Fig.31 Readout

7.6. Trigger width mode

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

Primary settings to use this mode
Exposure mode: Trigger width
Trigger mode: ON
Frame Start : ON

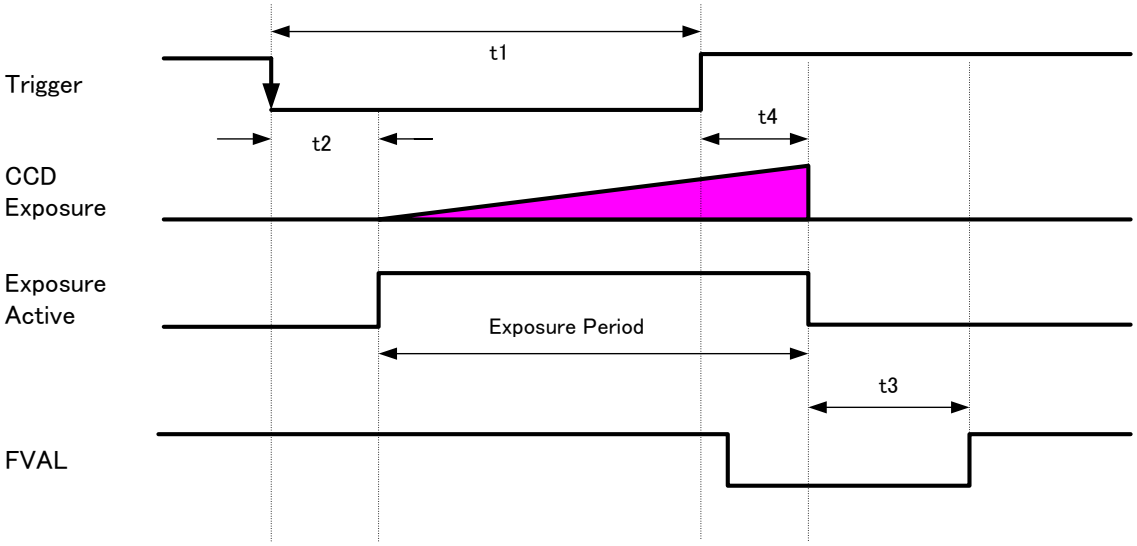
7.6.1 If the overlap setting is "OFF"



t1	t2	t3	t4
2L (Min)	424 clk	4.5L ～5.5L	8μs

Fig.32 Overlap = OFF

7.6.2 If the overlap setting is “Readout”



t1	t2	t3	t4
2L (Min)	1L	4L	1L

Fig.33 Readout

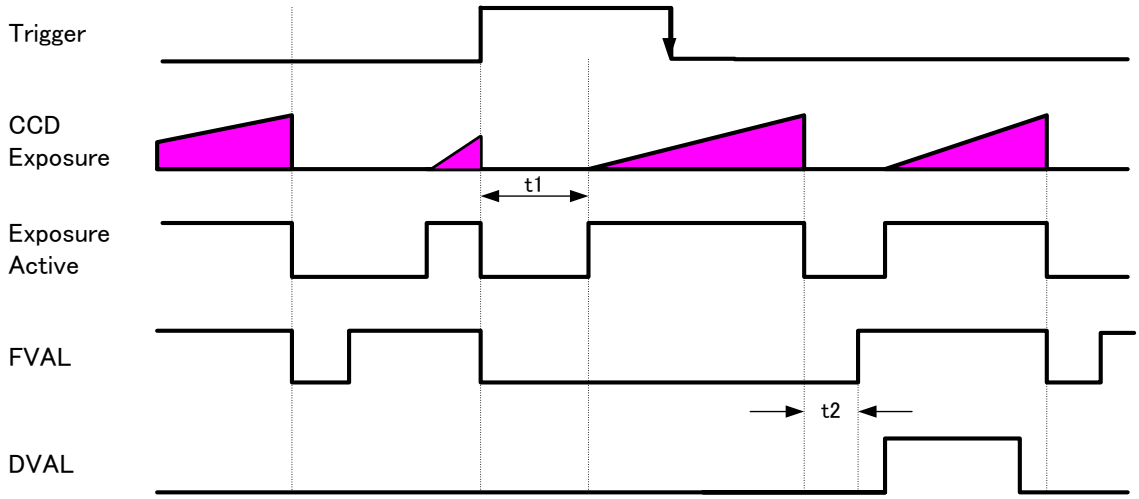
7.7. RCT mode

Until the trigger is input, the camera operates continuously and the video signal for the auto-iris lens is output. At this moment, the video signal, FVAL and LVAL are output but DVAL is not output. When the trigger is input, the fast dump is activated to read out the electronic charge very quickly, after which the accumulation and the readout are performed. When the accumulated signal against the trigger is read out, FVAL, LVAL and DVAL are output too.

Primary settings to use this mode

Exposure mode: Timed(RCT)
Trigger mode: ON
Frame Start : ON
Trigger option : RCT

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



t1	t2
1 frame high speed transfer	4.5L ～5.5L

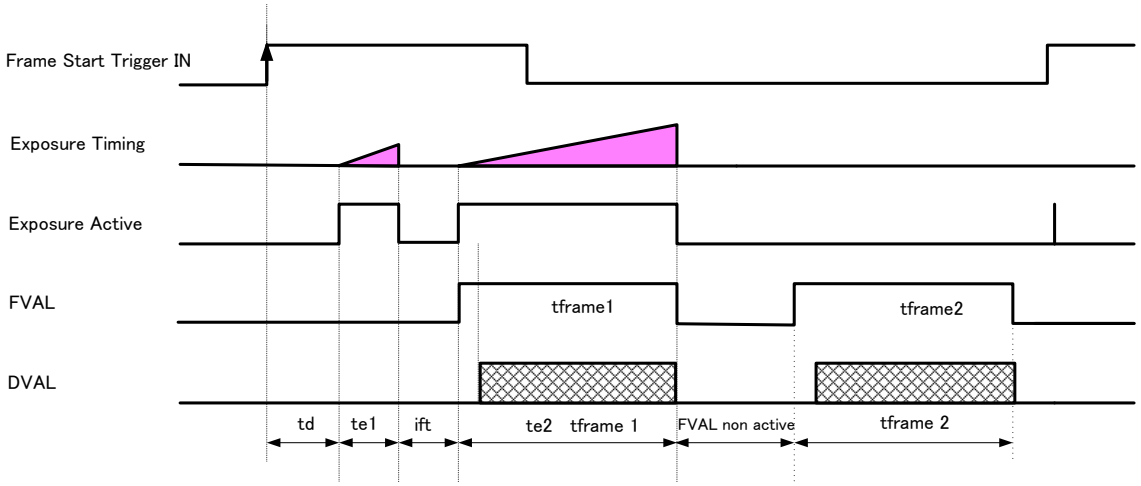
Fig.34 RCT mode timing

7.8. PIV (Particle Image Velocimetry)

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

Primary Settings
Exposure mode: Timed(PIV)
Trigger mode: ON
Frame Start : ON
Trigger option : PIV

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



Time name	Description	Time
td	Exposure beginning delay	424 clk
te1	First exposure time period	10 μs ～ 2 s
te2	Second exposure time	1 frame
ift	Inter framing time	Width of XSG
FVAL non active	FVAL non active	4LVAL
tframe1	First Frame read out	1 frame
tframe2	Second Frame read out	1 frame

Fig.35 PIV mode

7.9. Sequential Timed Exposure Mode

7.9.1 Video send mode

The sequential trigger mode has the following modes and it is selected in the video send mode. Depending on the mode selected, a different method is used to select the Sequence Index.

Trigger Sequence: Select the index by using the Frame Start trigger signal. (The setting index can be determined by the Next Index setting.)

Command Sequence: Select the index number to assign directly by using the Command Sequence Index command.

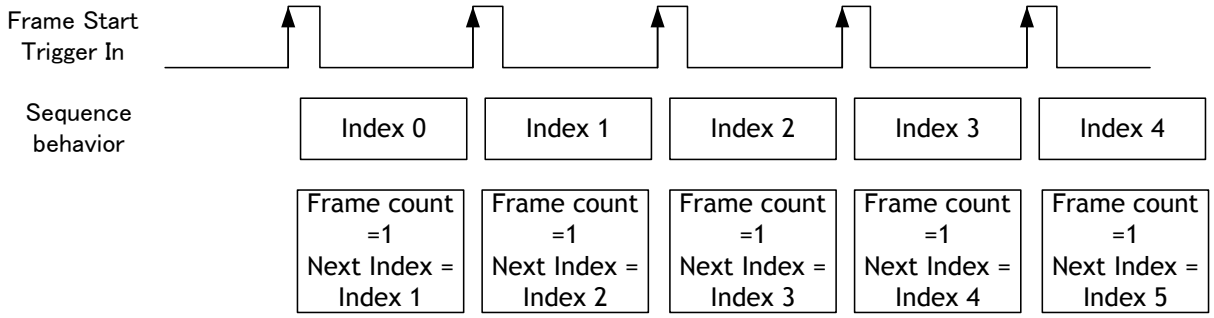


Fig. 36 Behavior of Sequence trigger

Table – 23 Sequence Index table (Default)

Sequence ROI Index	Sequence ROI													
	Width	Height	Offset		Gain Selector			Exposure Time	Black Level	Binning		LUT Enable	Frame Count	Next Index
			X	Y	Gain (ALL)	Red	Blue			Horizontal	Vertical			
- Index 0	1920	1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 1	1920	1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 2	1920	1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 3	1920	1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 4	1920	1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 5	1920	1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 6	1920	1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 7	1920	1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 8	1920	1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 9	1920	1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0

7.9.2 Sequence ROI setting parameters

Setting parameters for Sequence ROI is as follows.

(1) Sequence ROI Index Selector
In Sequence ROI Index Selector, Index 0 to 9 can be selected.
Sequence ROI – Width, Height, Offset X, Offset Y, Gain Selector - Gain/Red/Blue, Exposure Time, Black Level, Binning Horizontal, Binning Vertical, LUT Enable, Frame Count, Next Index for the selected index are displayed.

(2) Sequence ROI Width
Fixed at Width max 1920.

(3) Sequence ROI Height
Set the height of sequence ROI. The setting range is 8 to 1440 lines.
Rules for setting area and step number are the same as the normal ROI mode set by [Video Send Mode] = “Normal”.

(4) Sequence ROI Offset Y
Set Offset Y of sequence ROI.
Sequence ROI Binning Vertical = 1 (Off):
Setting range is 0 to (1440 - [Sequence ROI Height])
Sequence ROI Binning Vertical = 2 (On):
Setting range is 0 to (720 - [Sequence ROI Height])
The limitations of step number and other factors are the same as the normal ROI mode set by [Video Send Mode] = “Normal”.

(5) Sequence ROI Gain Selector
In Sequence ROI Gain Selector, the gain settings for each index are available.
EL-2800C-GE2: Gain (ALL), Red and Blue can be set.
EL-2800M-GE2: Only Gain is displayed and can be set.

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

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

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

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

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

(11) Sequence ROI Frame Count
This can set how many times the selected index is repeated. This is applied to each index. Triggers are input according to numbers set in Frame Count and index is repeated and moves to the next index. Therefore, the same number of triggers as Frame Count must be input.

(12) Sequence ROI Next Index (Effective on Trigger Sequence only)
The number of the index that will follow the current index can be set.
If [Video Send Mode] is set to “Trigger Sequence” and the trigger pulse is input in EPS trigger, the sequence is executed from index 0.
Accordingly, after the number of frame count of index 0 is set, the next index setting after index 0 will be executed.

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

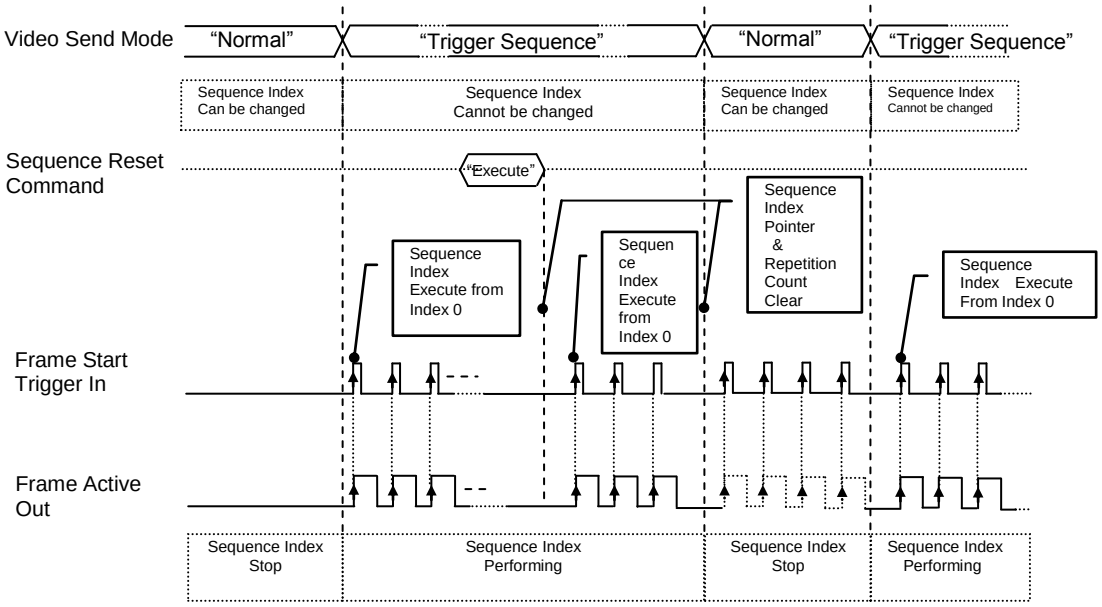


Fig. 37 Sequence trigger timing

7.10. Operation and function matrix

Table - 24 Operation and function matrix

Exposure operation	Trigger mode	Timed option	V. Binning (Note1)	H. Binning (Note1)	Exposure Time	ROI (Partial scan)	Sequence ROI (Video Send Mode)	Auto White Balance (Note2)	Auto Tap Balance	Auto Iris Output	Auto gain	Auto Exposure	Over Lap
OFF	OFF	OFF	1	1	×	○	×	○	○	○	○	×	×
			2	2	×	○	×	○	○	○	○	×	×
Timed	OFF	OFF	1	1	○	○	×	×	×	○	○	○	×
			2	2	○	○	×	×	×	○	○	○	×
Timed	ON	OFF	1	1	○	○	○	×	×	×	×	×	○
			2	2	○	○	○	×	×	×	×	×	○
Trigger Width	ON	OFF	1	1	×	○	×	×	×	×	×	×	○
			2	2	×	○	×	×	×	×	×	×	○
Timed (RCT)	ON	RCT	1	1	○	○	×	○	○	○	○	○	×
			2	2	×	×	×	○	○	×	×	×	×
Timed (PIV)	ON	PIV	1	1	×	○	×	×	×	×	×	×	×
			2	2	×	×	×	×	×	×	×	×	×

Note 1. Only EL-2800M-GE2
Note 2: Only EL-2800C-GE2

8. Other functions

8.1 Black level control

This function adjusts the setup level.

Variable range: -256 to 255 LSB (at 10-bit output)

8.1.1 Black Level Selector

The following factors can be set.

EL-2800M: DigitalAll/Tap1All/Tap2All/Tap3All/Tap4All
EL-2800C: DigitalAll/
Tap1All/Tap1Red/Tap1Blue
Tap2All/Tap2Red/Tap2Blue
Tap3All/Tap3Red/Tap3Blue
Tap4All/Tap4Red/Tap4Blue

8.1.2 Black Level

The black level can be set in the following range.

EL-2800M: DigitalAll : -512～ +511
Tap2All : -512～ +511
Tap3All : -512～ +511
Tap4All : -512～ +511

EL-2800C: DigitalAll : -512～511
DigitalRed All/DigitalBlue : -512～ +511
Tap2All/Tap2Red/Tap2Blue : -512～ +511
Tap3All/Tap3Red/Tap3Blue : -512～ +511
Tap4All/Tap4Red/Tap4Blue : -512～ +511

8.1.3 Black Level Auto

The tap balance of black level can be adjusted.
It is required to close the lens iris or cap the lens in order to cut the incident light.

OFF: Adjust manually
Once: Adjust only one time when this command is set.

8.2 Gain control

The EL-2800M-GE2 can adjust the gain level from 0dB to +30dB using 0dB as the reference (Factory default). In the EL-2800C-GE2, the master gain can be adjusted from 0dB to +27dB and R and B gains can be adjusted in the range of -7dB to + 10dB using the master gain as the reference.

Resolution:
Master Gain: 0.035dB/Step
Blue/Red Gain: x0.00012 /Step

The master gain uses both analog gain and digital gain internally. All digital gain has the resolution of x0.00012/Step and provides more precise gain setting.

The magnification of digital gain is calculated in the following formula.

$$\text{Digital Gain Magnification} = \frac{\text{Gain Value} + 8192}{8192}$$

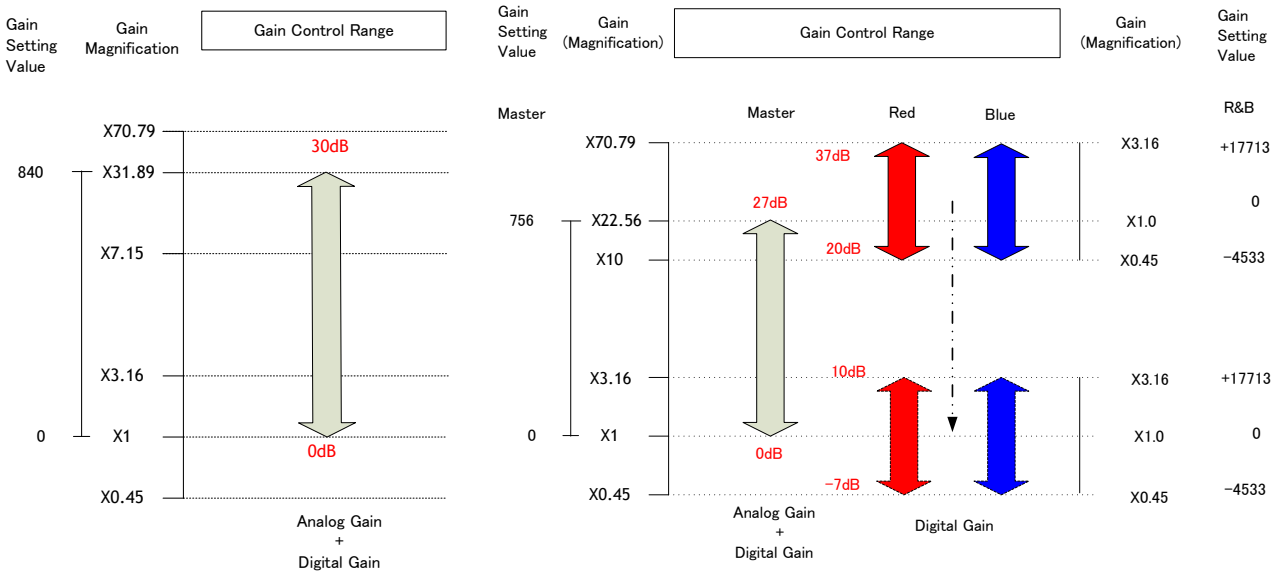


Fig. 38 Gain control

8.2.1 Gain Selector

The following parameters can be set.

EL-2800M: AnalogAll/DigitalAll/Digital Tap2/Digital Tap3/Digital Tap4

EL-2800C: AnalogAll/DigitalAll/Digital Red All/Digital Blue All
/DigitalTap2All/DigitalTap3All/DigitalTap4All
/DigitalTap2Red/DigitalTap2Blue
/DigitalTap3Red/DigitalTap3Blue
/DigitalTap4Red/DigitalTap4Blue

8.2.2 Gain

The gain can be adjusted in the following range.

EL-2800M: AnalogAll : 1.0～31.886
Digital Tap2All : 0.8912～1.1220
Digital Tap3All : 0.8912～1.1220
Digital Tap4All : 0.8912～1.1220

EL-2800C: AnalogAll : 1.0～22.555
DigitalAll : 0.7079～1.4125
Digital Red All : 0.4466～3.1623
Digital Blue All : 0.4466～3.1623
Digital Tap2All : 0.8912～1.1220/
Digital Tap2Red : 0.8912～1.1220/
Digital Tap2Blue : 0.8912～1.1220
Digital Tap3All : 0.8912～1.1220/
Digital Tap3Red : 0.8912～1.1220/
Digital Tap3Blue : 0.8912～1.1220
Digital Tap4All : 0.8912～1.1220/
Digital Tap4Red : 0.8912～1.1220/
Digital Tap4Blue : 0.8912～1.1220

8.2.3 Gain Raw

The gain raw can be adjusted in the following range.

EL-2800M:
AnalogAll : 0 ～ 840
Digital Tap2All/ Digital Tap3All/ Digital Tap4All : -891～+1000

EL-2800C:
AnalogAll : 0 ～ 756
Digital Tap2All/Digital Tap3All/Digital Tap4All : -891～+1000/
Digital Red All/Digital Blue All : -4533～17713
Digital Tap2Red/Digital Tap2Blue : -891～+1000
Digital Tap3Red/Digital Tap3Blue : -891～+1000
Digital Tap4Red/Digital Tap4Blue : -891～+1000

8.2.4 Gain Auto

This function automatically controls the gain level. This function is effective only for Frame trigger OFF and RCT modes.
This is controlled by the command ALC Reference.

There are three modes.

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

The following detailed settings are also available.

ALC Speed:	The rate of adjustment of GainAuto can be set.(Common with Exposure Auto)
Gain Auto Max:	The maximum value of GainAuto control range can be set
Gain Auto Min:	The minimum value of GainAuto control range can be set
ALC Reference:	The reference level of Gain Auto control can be set (Common with Exposure Auto)
ALC channel area:	The area of GainAuto control can be set, either entire area or individual section

High Left	High Mid−left	High Mid−right	High Right
Mid−High Left	Mid−High Mid−left	Mid−High Mid−right	Mid−High Right
Mid−Low Left	Mid−Low Mid−left	Mid−Low Mid−right	Mid− Low Right
Low Left	Low Mid−left	Low Mid−right	Low Right

Fig.39 ALC channel area

8.2.5 Balance White Auto

This is the auto white balance control function.
The operation can be selected from the following:

OFF: Adjust manually.
Once: Operate only one time when this command is set
Continuous: Operate the white balance control continuously
.

8.3. LUT

This function can be used to convert the input to the desired output characteristics.
The Look-Up Table (LUT) has 256 points for setup. The output level can be created by multiplying the gain data by the input level. In the EL-2800C-GE2, the same LUT characteristic is applied independent of the color value

8.3.1 LUT Mode

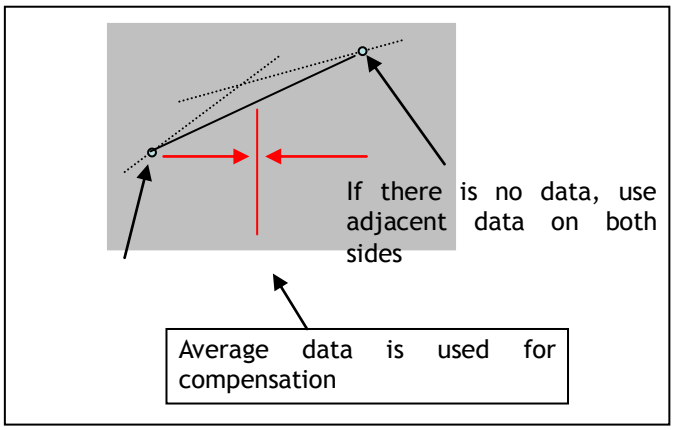
Can be selected from OFF, Gamma or LUT table.

8.3.2 LUT Index

This represents the “starting” or “input” pixel value to be modified by the Lookup Table. The EL-2800-GE2 has a 256-point Lookup Table, meaning the index points are treated like an 8-bit image with 0 representing a full black pixel and 255 representing a full white pixel. The index points are automatically scaled to fit the internal pixel format of the camera. This is common for all output configurations.

8.3.3 LUT value

This is the “adjusted” or “output” pixel value for a given LUT index. It has a range of 0 to 4095 (12-bit) and is automatically scaled to the bit depth of the current operating mode (8-bit, 10-bit or 12-bit). Note: linear interpolation is used if needed to calculate LUT values between index points. In the color mode, the LUT function works the same regardless of the color of the pixel.



Output Data = Video IN x LUT data

8.4. Gamma

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

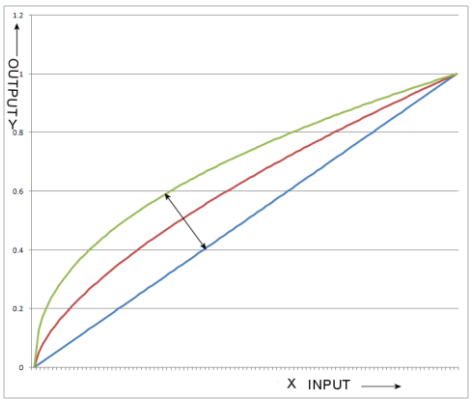


Fig. 40 Gamma compensation

8.5. Shading Correction

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

There are two methods of correction.

Flat shading correction:
The method to compensate the shading is to measure the highest luminance level in the image and use that data as the reference. Luminance levels of other areas are then adjusted so that the level of the entire area is equal. The block grid for compensation is 15 (H) x 12(V) blocks with 128 pixels x 128 pixels for each block .The complementary process is applied to produce the compensation data with less error.

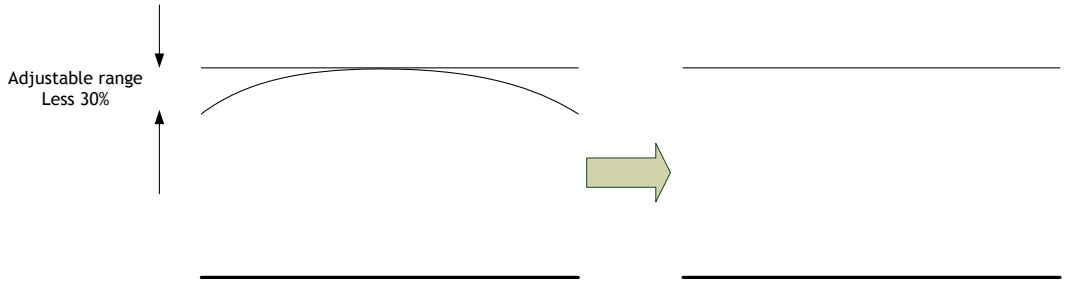


Fig. 41 Flat shading correction concept drawing

Color shading correction (For EL-2800C only):
In this case, R channel and B channel are adjusted to match with G channel characteristics. The block grid for compensation is 15(H) x 12(V) blocks and the complementary process is applied to produce the compensation data with less error.

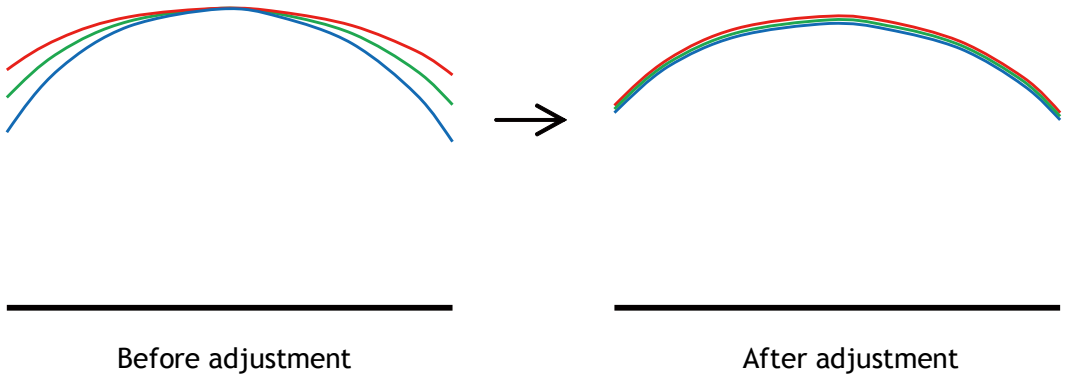


Fig.42 Color shading correction concept drawing

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

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

8.6. Blemish compensation

The EL-2800M-GE2 and EL-2800C-GE2 have a blemish compensation circuit. This function compensates blemishes on the CCD sensor (typically pixels with extremely high response or extremely low response). This applies to both monochrome and color versions. Pixels that fulfill the blemish criteria can be compensated by adjacent pixels in both columns and, in the case of the EL-2800C-GE2, the defective pixels can be compensated by the same Bayer color pixels in both adjacent columns. The number of pixels that can be compensated is up to 300 pixels.

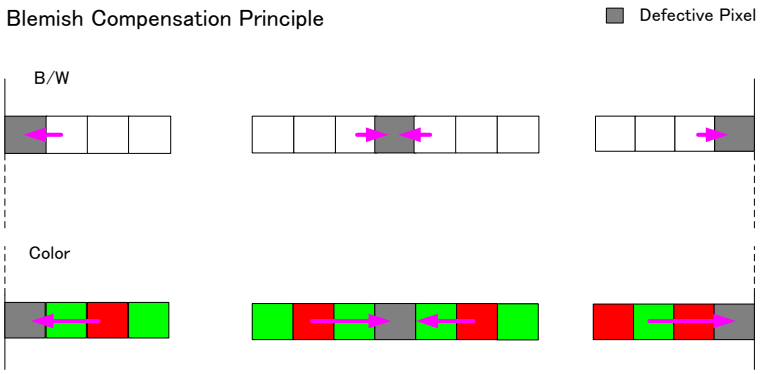


Fig. 43 Blemish compensation

Note: If defective pixels are found consecutively in the horizontal direction, the blemish compensation circuit does not work.

8.7. Bayer color interpolation (Only for EL-2800C)

This function is available only for EL-2800C-GE2. The EL-2800C-GE2 uses a CCD with an RGB Bayer pattern. If in-camera Bayer color interpolation is not used, the following RAW data can be output.

B	Gb	B	Gb	B	Gb	B	Gb	B	Gb
Gr	R	Gr	R	Gr	R	Gr	R	Gr	R
B	Gb	B	Gb	B	Gb	B	Gb	B	Gb
Gr	R	Gr	R	Gr	R	Gr	R	Gr	R

Fig.44 Bayer pattern

The RAW data contains only luminance information for each color and outputs as a monochrome signal. The Bayer color interpolation function can complement lacking color information on each pixel and output RGB or YUV color data as the result. Color interpolation compensates for the lack of color information by using information from adjacent pixels. The following is the concept drawing for the color interpolation process. It is invoked when one of the interpolated pixel formats (RGB or YUV) is selected.

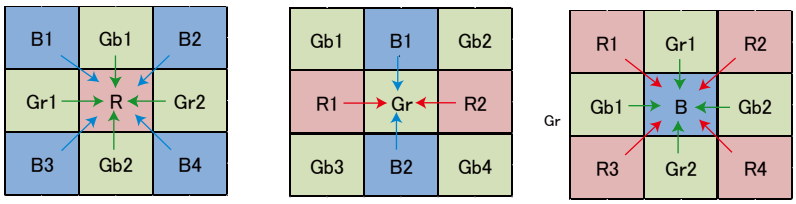


Fig.45 Color interpolation concept drawing

8.8 Lens

The EL-2800-GE2 can be used with 4 different types of auto iris lenses, in addition to standard lenses with manual iris control. If an auto iris function is to be utilized, the lens type used must be selected in Lens Select.

Table -25 Lens selector

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

8.8.1 About P-Iris

New Elite Series EL-2800M-GE2 and EL-2800C-GE2 come equipped with P-Iris control as part of the standard lens control function. The P-Iris system is a newly developed lens control method designed to control the iris more precisely. Especially for video cameras in surveillance applications utilizing megapixel CCD or CMOS imagers, it becomes a very important factor to control an iris in order to achieve the maximum camera performance. In surveillance applications, depending on shooting conditions, resolution and depth of field are important factors. The iris is deeply related with these factors. If the iris diaphragm is smaller, but not too small, resolution gets better and the depth of field is also deeper. The P-Iris system controls the iris diaphragm precisely and maintains the best image with the highest resolution and depth of field. P-Iris can also combine with gain and electronic shutter to keep the appropriate iris position under changing lighting conditions (ALC function).

8.8.2 Setting for P-iris lens being used

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

8.8.2.1 P-Iris lens select

Select the lens used. At present time, the following two lenses are available for these cameras.

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

8.8.2.2 Step max.

The iris control step depends on the lens. The setting value uses the value stored in the camera. Refer to the table above for the control step number.

8.8.2.3 Position

The iris position can be set between 0 to Step Max. 0 means to open the iris and Step Max means to close the iris. The camera initializes P-iris control and acquires iris position under the following conditions:

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

8.8.2.4 Current F value

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

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

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

8.8.2.6 Auto Iris Lens Control Signal Output

If the auto iris lens is used, this parameter should be ON. This is common for all types of auto iris lenses.

8.8.3 Motorized lenses

The EL-2800-GE2 can use the 3-axis motorized lens control for zoom, focus and iris. The following functions are available via the motorized lens commands.

8.8.3.1 Iris

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

8.8.3.2 Zoom

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

8.8.3.3 Focus+

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

8.8.4 Exclusive video output signal for iris control

This signal can be used for automatic lens iris control in Continuous and RCT modes.
This signal is available if AUX Type 2 connector is used for AUX (Factory option).
The iris video signal is composed to average the video level in the center area of each frame and can be output as a composite signal with H-sync.
The following drawing shows the waveform of the iris control video signal. This signal is output with the same video level within the same frame and the average is recalculated with each new frame.

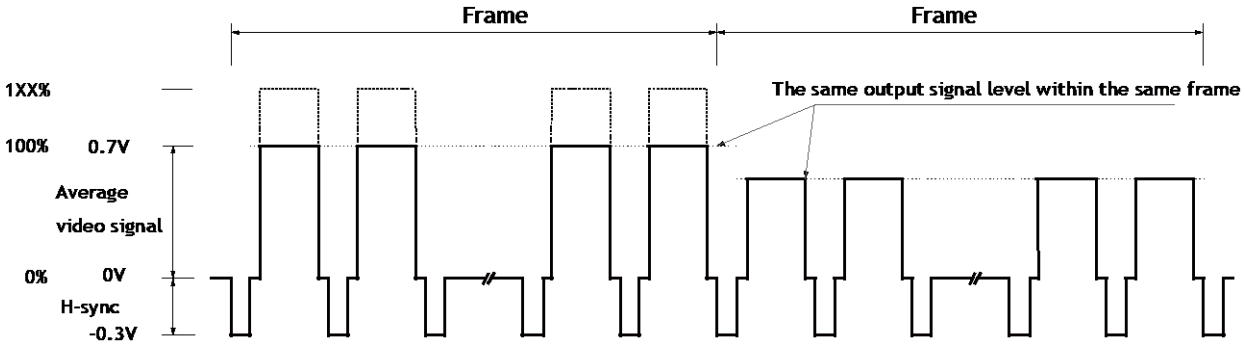


Fig. 46 Iris video output signal

The following parameters of this auto iris control signal output can be changed.

Auto Iris Control Signal Output:
ON: The auto iris control can be connected with AGC and ASC as ALC function
OFF: The auto iris control is not connected with AGC and ASC.
Iris State Control:
Video: Use the iris control in auto mode.
Close: Force the iris to close.
Open: Force the iris to open.

8.9 ALC

In the EL-2800M-GE2 and EL-2800C-GE2, auto gain, auto shutter and auto iris functions can be combined to provide a wide ranging automatic exposure control from dark to bright or vice versa. The functions are applied in the sequence shown below and if one function is disabled, the linkage between the other two is maintained.

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

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

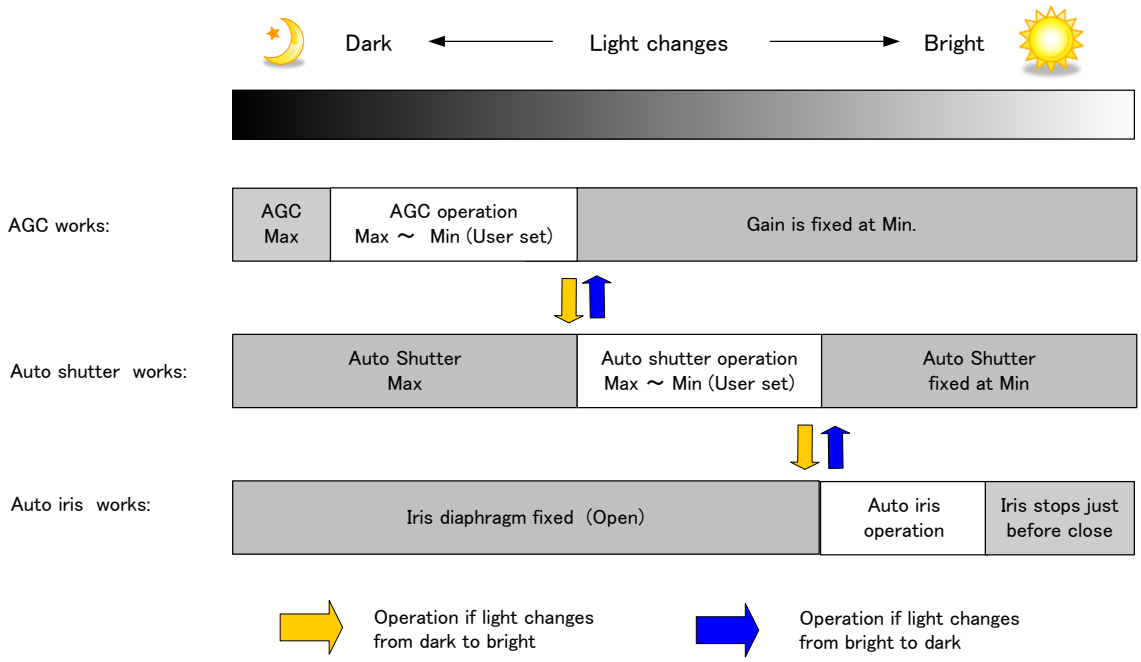


Fig.47 ALC function concept

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

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

9. Camera setting

9.1 Camera Control Tool

In the EL-2800M-GE2 and EL-2800C-GE2, control of all camera functions is done by the JAI SDK and Control Tool software. All controllable camera functions are stored in an XML file inside of the camera. The JAI SDK and Control Tool software can be downloaded from www.jai.com.

9.2 Camera Default Settings

When the camera is connected to PC and JAI SDK 2.0 is started up, XML file which stores default settings of the camera is downloaded to JAI_SDK camera control tool.

The default settings of EL-2800-GE2 are as follows.

Image Format	Bit allocation	8-bit
	Width	1920
	Height	1440
	Binning Horizontal	1(OFF)
	Binning Vertical	1(OFF)
Acquisition Control	Acquisition mode	Continuous
	Acquisition Frame Rate	54.6
Trigger Selector		Acquisition Start
	Trigger Mode	OFF
	Trigger Activation	Rising Edge
	Trigger Source	Low
Trigger Overlap		Readout
Exposure Control	Exposure Mode	OFF
Gain	Gain	0dB
	Gain Auto	OFF
Gamma		0.45
Video Send Mode		Normal

10. External appearance and dimensions

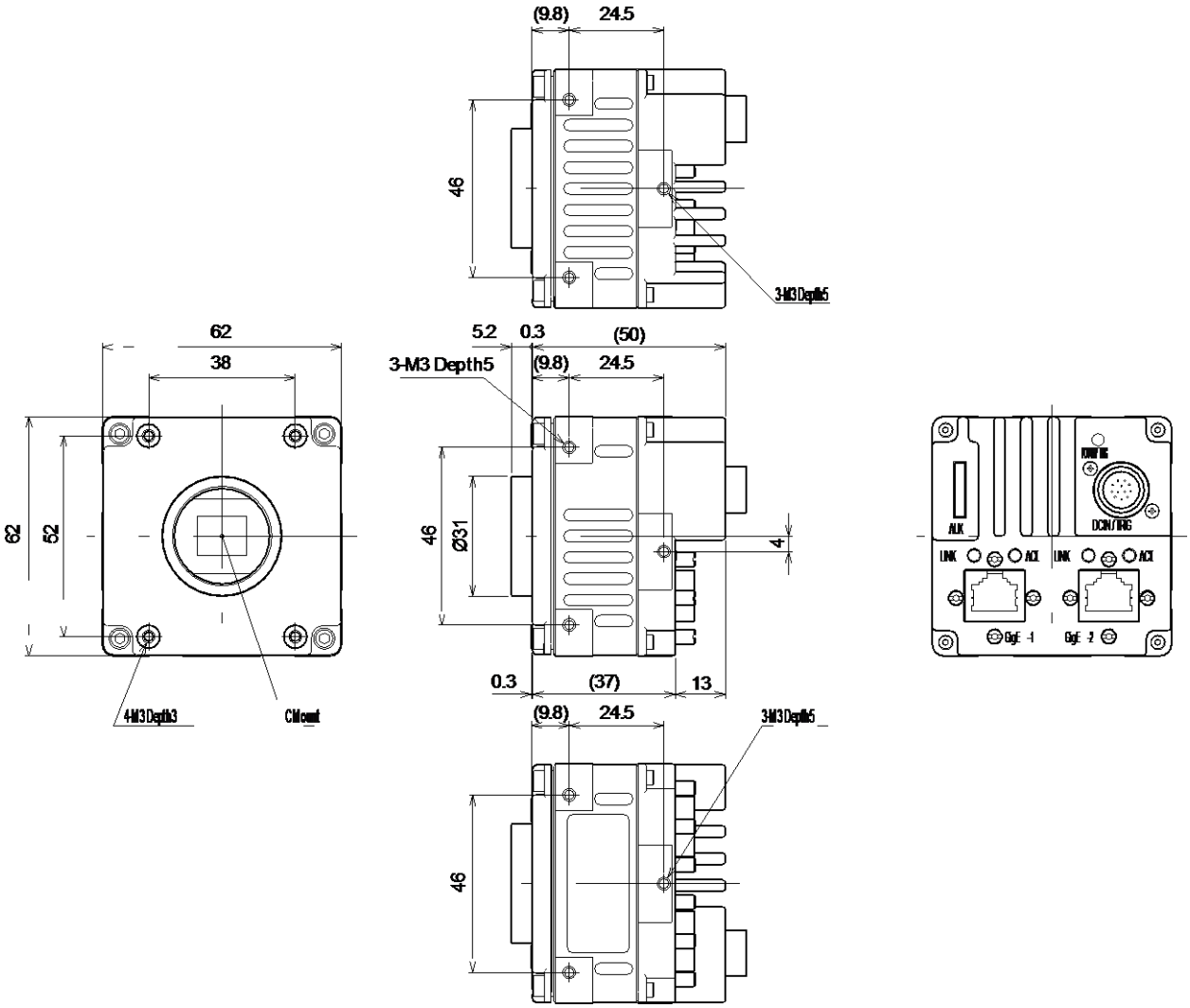


Fig. 48 Outside dimensions (C mount)

11. Specifications

11.1 Spectral response

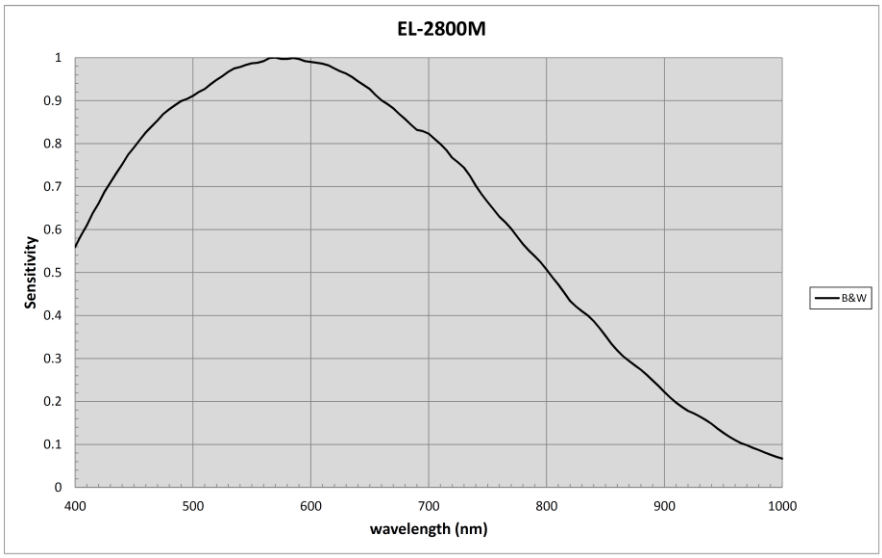


Fig. 49 Spectral response (EL-2800M-GE2)

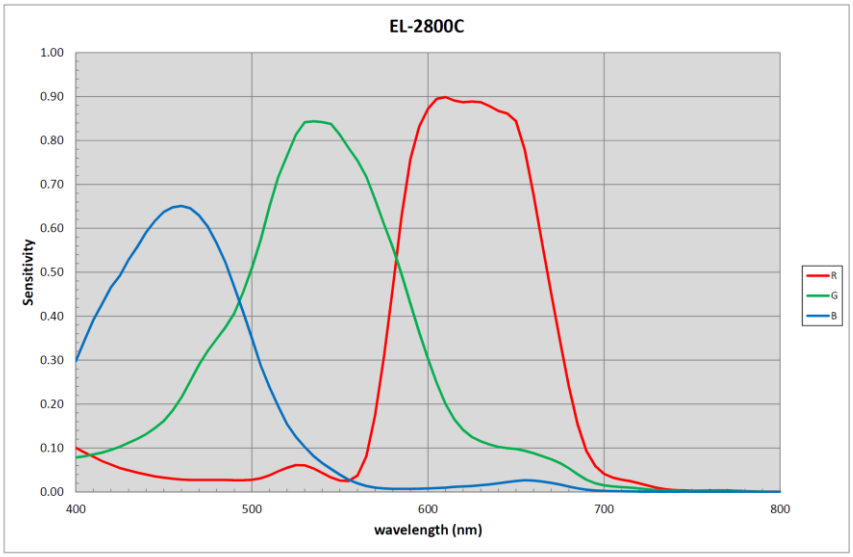


Fig.50 Spectral response (EL-2800C-GE2) (With IR Cut Filter)

11.2 Specifications table

Table - 26 Specifications table

Specifications				EL-2800M-GE2		EL-2800C-GE2	
Scanning system				Progressive scan, 4-tap			
Synchronization				Internal			
Interface				1000Base-T Ethernet (GigE Vision 2.0) x 2Ports (100Base-T can be used) Complies with Single, sLAG (Static Link Aggregation) and dLAG (Dynamic Link Aggregation)			
Image sensor				2/3 inch Monochrome CCD		2/3 inch Bayer color CCD	
Aspect Ratio				4:3			
Image size(Effective Image)				8.72 (h) x 6.54 (v) mm 10.9 mm diagonal			
Pixel size				4.54 (h) x 4.54 (v) μm			
Effective Image output Pixels				1920 (h) x 1440 (v)		1920 (h) x 1440 (v)	
Pixel Clock				54 MHz			
Acquisition frame rate (Max.) Minimum rate is the same for all configuration (0.5fps)	Single Port			41.6fps: 8-bit 27.7fps: 10-bit 20.8fps: 12-bit		41.6fps: 8-bit 27.7fps: 10-bit 20.8fps: 12-bit	
				–		27.7fps: YUV411_Packed 20.8fps: YUV422_Packed 13.9fps: YUV444_Packed 13.9fps: RGB8	
	2 Port LAG			54.6fps: 8-bit 54.6fps: 10-bit 41.6fps: 12-bit		54.6fps: 8-bit 54.6fps: 10-bit 41.6fps: 12-bit	
				–		54.6fps: YUV411_Packed 41.6fps: YUV422_Packed 27.7fps: YUV444_Packed 27.7fps: RGB8	
Acquisition mode				Single frame / Multi frame (1 to 65535) / Continuous			
EMVA 1288 Parameters Absolute sensitivity Maximum SNR				at 12-bit output 15.94 p (λ = 525 nm) 41.39dB		at 12-bit output 23.71 p (λ = 525 nm) 41.52dB	
SN ratio (traditional)				61dB (Typical) (0dB gain, Black))		58.5dB (Typical) (0dB gain, Green Pixel Black Level)	
Image Output format Digital	Full image			1920 (h) x 1440 (v)		Bayer 1920 (h) x 1440 (v)	
	ROI	Height		8 ～1440 lines, 1line/step		8 ～1440 lines, 2lines/step	
		OFFSET Y		0 ～1432 lines, 1 line/step		0 ～1432 lines, 2 lines / step	
	Binning	H	1	1920 (H)		1920 (H)	
			2	960 (H)		–	
		V	1	1440 (V)		1440 (V)	
			2	720 (V)		–	
	Bit assignment			Mono8, Mono10, Mono10_Packed, Mono12, Mono12_Packed		BayRG8, BayRG10, BayRG12, BayRG10_Packed, BayRG12_Packed, RGB8_Packed, YUV411_PACKED, YUV422_PACKED, YUV444_Packed	
Horizontal Frequency	Binning Vertical			Sensor Tap	Frequency (KHz)	Interval (μs)	Clock
	1			4-Tap	40.693	24.574	1327
Vertical Frequency	Binning Vertical			Sensor Tap	Frequency (Hz)	Total line number	Effective line number
	1			4-Tap	54.7	744	720

Trigger Selector		Acquisition Start / Acquisition End / Frame Start	
Trigger Overlap		OFF / Readout	
Trigger option		OFF, JAI_RCT(w/ALC), JAI_PIV, Sequence Trigger	
Trigger Input Signal		Line 5,6, PG0 to 3, Soft, Option (Line 10,11)	
Exposure Mode	Timed	10 μs (Min.) ～ 8 sec (Max.) Variable unit:1 μs	
	Trigger Width	1 line + 8 μs (Min.) ～ ∞ (Max.)	
Exposure Auto		OFF / Once / Continuous	
Exposure Auto Speed		1 ～ 8	
Digital I/O: Line selector		12P: GPIO IN / GPIO OUT 10P (option)	
Event Signal		AcquisitionTrigger, FrameStart, FrameEnd, FVAL Start, FVAL End, ExposureStart, ExposureEnd, Line1RisingEdge, Line1FallingEdge, Line2RisingEdge, Line2FallingEdge	
Black Level Adjust.	Ref. level	33.5LSB 10-bit (Average value of 100*100)	
	Adj. range	-256 ～ 255LSB 10-bit	
	Resolution	1 STEP = 0.25LSB	
Gain Level Adjust.	Manual Adj. range	0dB ～+30dB, Less 0.01dB/Step	0dB ～+27dB, Less 0.01dB / step
	WB Gain		R / B : -7dB to +10dB, Less 0.01dB/ step
	WB Area		4 x 4
	Preset color Temp.		4600K, 5600K, 6500K
	WB Range		3000K ～ 9000K
	White Balance		OFF, Once, Continuous
Blemish Comp.	Detection	Detect white blemish above the threshold value (Black blemish is detected only by factory)	
	Compensation	Complement by adjacent pixels in horizontal (Continuous blemishes are not compensated)	
	Numbers	300 pixels	
ALC		AGC, auto exposure, iris control can be combined and automatically controlled	
Gamma		0.45 ～ 1.0 (16 steps are available)	
LUT		OFF: γ=1.0, ON= 256 points can be set	
Shading Compensation		Flat Field Block (128 x 128 pixels) comp.	Flat Field, Color shading Block (128 x 128 pixels) comp.
Bayer Color interpolation		—	3 x 3 Linear compensation
Power	Input range	DC+12V to +24V ± 10% (At the input terminal)	
	Current Consumption	Single Port: 630mA ± 10% (At 12V input) LAG: 670mA ± 10% (At 12V input)	
	Power consumption	Single Port: 7.56W ± 10% (At 12V input) LAG: 8.04W ± 10% (At 12V input)	
Lens mount		C mount, Rear protrusion of the lens is less than10 mm	
Flange back		C mount: 17.526 mm, Tolerance: 0 to -0.05 mm	
Optical filter		Protection glass: Not provided	Optical Low Pass filter ＋ IR cut filter (Half value is 670nm)
Operating temperature (Performance guaranteed)		-10°C to +50°C	
Humidity (Performance guaranteed)		20 – 80% (non-condensing)	
Operating temperature		-45°C to +70°C	
Humidity		20 – 80% (non-condensing)	
Storage Temp. / Humidity		-45°C to +70°C/20% to 80 % (non-condensing)	
Regulation		CE (EN61000-6-2 and EN61000-6-3), FCC part 15 class B, RoHS, WEEE	

Housing Dimensions	62 x 62 x 55.5 mm (W x H x D) (excluding protrusion)
Weight	265 g

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

Appendix

1. Precautions

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

2. Typical Sensor Characteristics

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

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

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

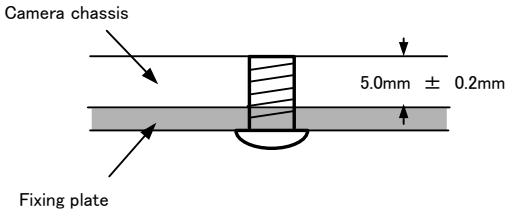
Patterned Noise
When the sensor captures a dark object at high temperature or is used for long time integration, fixed pattern noise may appear on the video monitor screen.

3. Caution when mounting a lens on the camera

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

4. Caution when mounting the camera

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



Mounting the camera to fixing plate

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

5. Exportation

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

6. References

1. This manual can and datasheet for EL-2800M-GE2 / EL-2800C-GE2 can be downloaded from www.jai.com
2. Camera control software can be downloaded from www.jai.com

Manual change history

Date	Revision	Changes
April 2014	Preliminary	New release
July 2014	1.0	Release
Aug. 2014	1.1	Revise LAG settings information
Sept. 2014	1.2	Revise Spectral Response
Oct. 2014	1.3	Revise B/W spectral response of B/W with wider wave length range
May 2015	1.4	Review the recommended circuit for the optical interface

User's Record

Camera type: **EL-2800M-GE2 / EL-2800C-GE2**

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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