See the possibilities

Elite Series

User Manual

EL-2800M-USB
EL-2800C-USB

2.8M Digital Progressive Scan Monochrome and Color Camera

Document Version: Ver.1.3
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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-USB and EL-2800C-USB 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.

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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。
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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。
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Before using USB 3.0 camera

EMVA 1288

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

Interface

The EL-2800-USB employs a USB 3.0 interface and is in the process of being certified for compliance with the USB3 Vision standard. USB3 Vision is a new standard interface for machine vision applications being developed and managed by the AIA (Automated Imaging Association). USB3 Vision uses USB 3.0 ports that will soon be standard on most PCs (with Windows 7 service pack and Windows 8 native support expected soon). Components from different manufacturers will easily communicate with each other.

USB3 Vision also supports the GenICam™ standard which is managed 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 manufacturers can seamlessly connect in one platform.

The maximum transfer speed of USB 3.0 is specified at 5.0 Gbps, however effective bandwidth is reduced by a number of factors including pixel format conversions and the physical interface components used. The USB3 Vision standard specifies a bandwidth of 2.8 Gbps or greater. Maximum cable length for passive cables is five meters, but this can be made longer using active cables.

As for the USB connector, EL-2800-USB uses a Micro B connector which complies with USB 3.0. This connector has an additional 5-pin plug "stacked" on the side of a standard USB 2.0 Micro B connector. However, USB 2.0 cannot be used with the EL-2800-USB.

Power supply

Although the USB 3.0 interface is capable of supporting both data and power, EL-2800-USB requires both +5V and +12V. A separate power supply unit must be connected to the 12-pin connector for providing +12V.

Computer used for EL-2800-USB series

It is necessary to use a PC equipped with a USB 3.0 interface. It is also recommended to use a PC equipped with slots of better than PC Express 2.0 x 8. Please note that the EL-2800-USB may not work properly depending on the chipset used in the PC.

1. General

The EL-2800M-USB and EL-2800C-USB 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-USB is a monochrome progressive scan CCD camera and the EL-2800C-USB 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 new cameras feature a USB 3.0 interface. A full pixel readout, partial scan readout, or binning mode (monochrome only) can be selected depending on the application.

EL-2800M-USB and EL-2800C-USB 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-USB and EL-2800C-USB 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-USB and EL-2800C-USB 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.

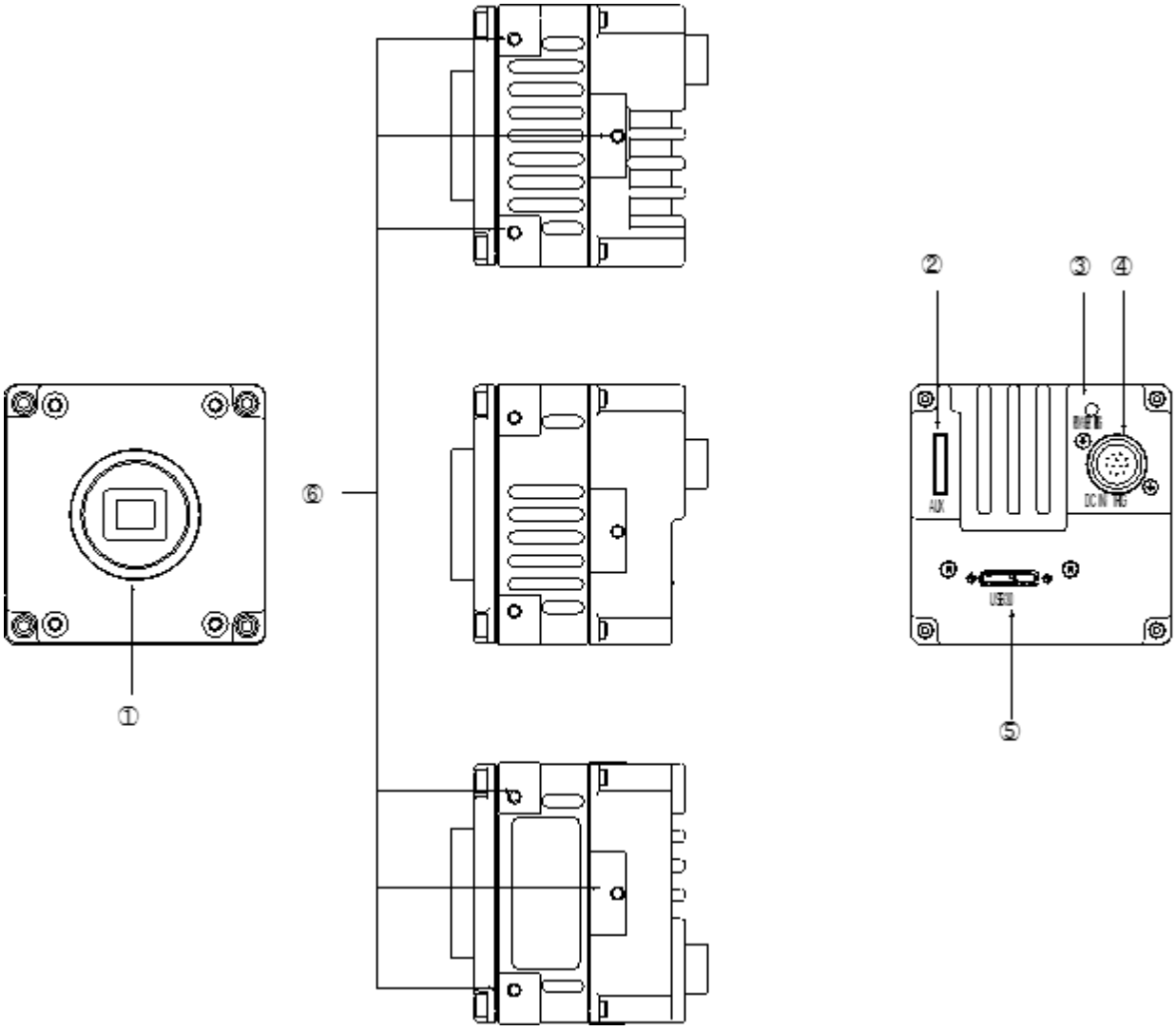
Tripod base	MP-42
Power supply unit	PD-12 series

3. Main features

- New Elite Series, 2/3 ” progressive scan camera
- Intelligent body design for easy and flexible installation
- Utilizes USB 3.0 interface
- 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
- 54.6 frames/second with full resolution in continuous operation (monochrome or Bayer)
- Various readout modes, including horizontal and vertical binning (EL-2800M-USB only) and ROI (Region Of Interest) for faster frame rates
- 0dB to +30dB gain control for EL-2800M-USB and 0dB to +27dB for EL-2800C-USB
- 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-USB only)
  Blemish compensation
- Test pattern signal generator is built in
- Auto iris lens video output with H-sync if AUX Type 2 is configured
- 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	AUX 10-pin connector	AUX Connector for lens control
③	LED	Indicator for power and trigger input
④	12-pin connector	DC and trigger input
⑤	USB 3.0 connector	Connector for interfacing via USB 3.0
⑥	Mounting holes	Holes for mounting tripod base or direct installation. Depth 5 mm (Note*2)

Note1: Rear protrusion on C-mount lens must be less than 10.0 mm.
Note2: The part number for the tripod adapter plate (with 1/4"-20 thread) is MP-42 (option). When the camera is mounted directly using mounting holes, the length of screws must be less than 5mm. If they are longer than 5mm, they may not fasten securely due to the 5mm hole depth.

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.

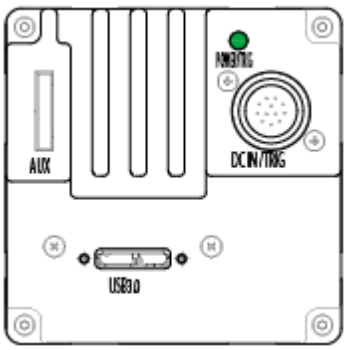


Fig. 2 Rear panel

5. Input and output

5.1 USB 3.0 Interface Specifications

The EL-2800-USB employs a USB 3.0 interface for video and data transfer. USB 3.0 is an upgraded version of USB 2.0 widely used in the industry. Its transfer rate is 5 Gbps, which is 10 times faster than the 480 Mbps rate of USB 2.0. USB 3.0 employs a full-duplex system which executes both transmitting and receiving at the same time. USB 3.0 has downward compatibility to USB 2.0 but in the EL-2800-USB, USB 2.0 cannot be used because the performance is not guaranteed.
The connector used for USB 3.0 in the EL-2800-USB is a Micro B Type connector with a USB 3.0 form factor.

5.2 Connectors and pin assignment

5.2.1 Output connector for Digital Video Output (USB 3.0 Micro B connector)

Type : ZX3600-B-10p or equivalent

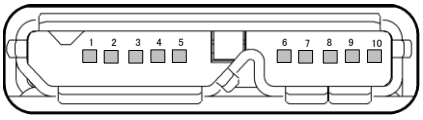
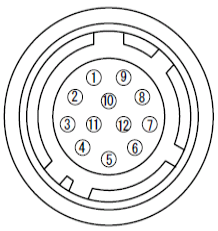


Fig.3 USB 3.0 Micro B Connector

Table1 USB 3.0 Micro B connector pin configuration

No	I/O	Name	Note
1	I	Power(VBUS)	+5V
2	I/O	USB2.0 Differential pair(D-)	Differential pair
3	I/O	USB2.0 Differential pair(D+)	
4	I	USB OTG ID for identifying lines	Line identification ID
5		GND	
6	O	USB 3.0 Signal Transmission line (-)	Signal transmission line
7	O	USB 3.0 Signal Transmission line (+)	
8		GND	
9	I	USB 3.0 Signal Receiving line (-)	Signal Receiving line
10	I	USB 3.0 Signal Receiving line (+)	

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 In	+12V ～ +24V
3	GND	
4	NC	
5	Opt In1(-)	Line5
6	Opt In1(+)	
7	Opt Out1(-)	Line2
8	Opt Out1(+)	
9	TTL Out1	Line1（Note1）
10	TTL In1	Line4（Note2）
11	DC In	+12V ～ +24V
12	GND	

Note1: The factory default is Negative, Exposure Active signal.
Note2: The factory default is Trigger input signal.

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 A+	DC Iris
7	O	DC IRIS DAMP A-	DC Iris
8	O	DC IRIS DRIVE B+	DC Iris
9	O	DC IRIS DRIVE B-	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_In(+)	Line11
7	I	LVDS_In(-)	
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%	808mV	255LSB	1023LSB	4095LSB
Color	445mV					

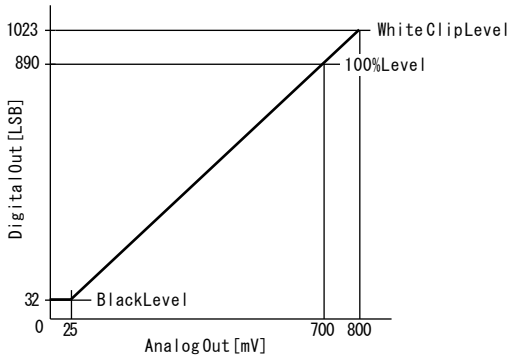


Fig.6 Bit allocation(10-bit)

5.4 Digital IN/OUT interface

In the EL-2800-USB, 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 1 TTL1 Out	TTL 1 output from 12P connector #9 pin located on the rear panel
Line 2 OPT Out	OPT 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	First input at first NAND gate in GPIO
NAND 0 In 2	Second input at first NAND gate in GPIO
NAND 1 In 1	First input at second NAND gate in GPIO
NAND 1 in 2	Second input at second NAND gate in GPIO

Note: Lines 8 and 9 are available if AUX Type 3 is used for AUX connector.

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
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
Line 4 TTL 1 In	Connect TTL 1 In signal to line item selected in Line Selector
Line 5 OPT In	Connect OPT In signal to line item selected 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

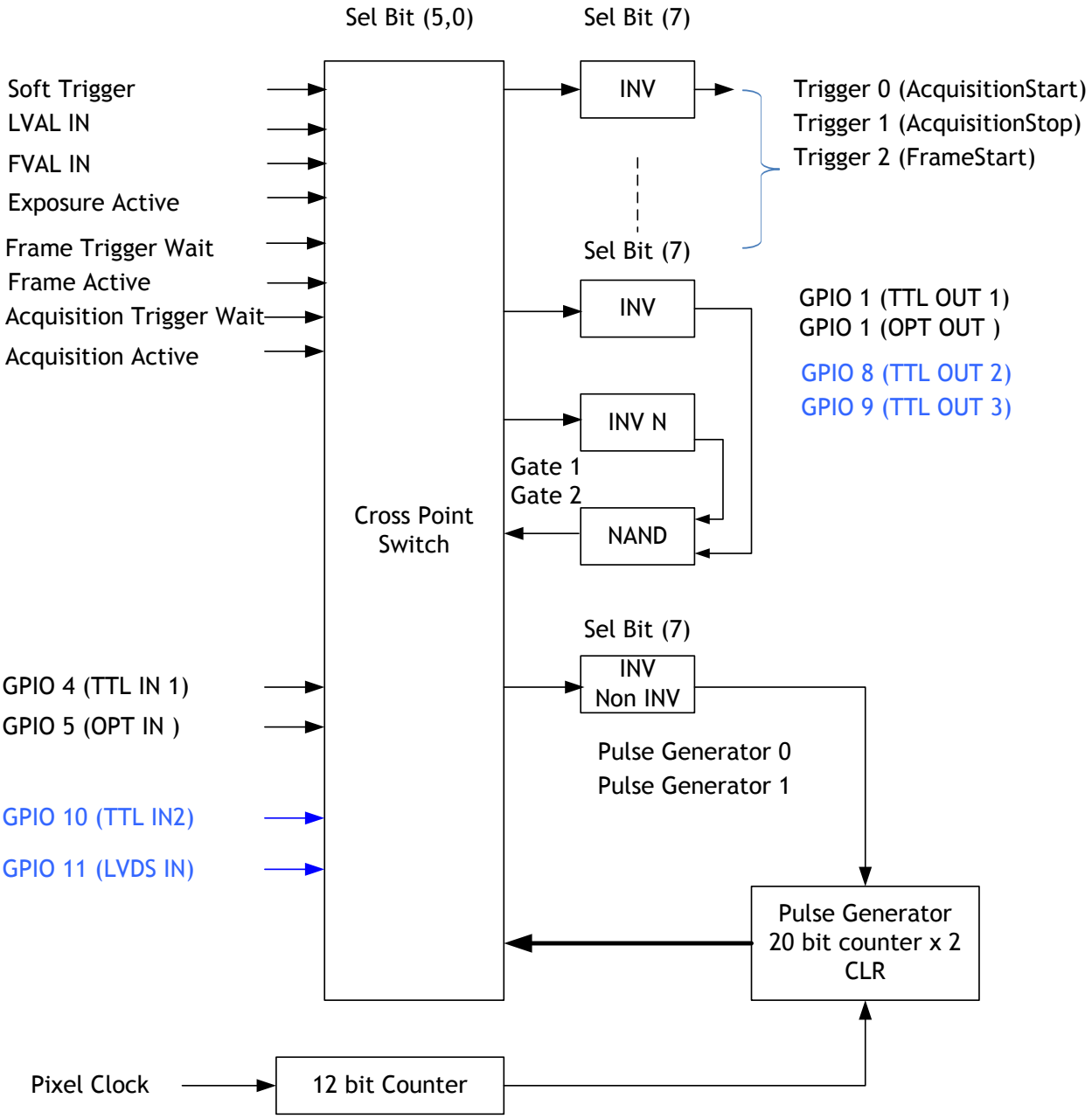
Display the input or output interface format of the line item selected in Line Selector.
Interface format: No Connect, TTL, LVDS, Opto Coupled

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 generators. 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-USB, 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 1 - 12P TTL Out 1	Line 2 - 12P OPT Out	Line 8 - TTL 2 Out	Line 9 - TTL 3 Out	NAND 1 In 1	NAND 1 In 2	NAND 2 In 1	NAND 2 In 2	Pulse Generator 0	Pulse Generator 1	
LOW	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	
Line 4 - 12P TTL IN 1	o	o	o	o	o	o	o	o	o	o	o	o	o	
Line 5 - 12P Opt IN	o	o	o	o	o	o	o	o	o	o	o	o	o	
NAND 1 Out 1	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	
Pulse Generator 0	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	×	
Software Trigger	o	o	o	×	×	×	×	o	o	o	o	×	×	
FVAL	×	×	×	o	o	o	o	o	o	o	o	o	o	
LVAL	×	×	×	o	o	o	o	o	o	o	o	o	o	
Exposure Active	×	×	×	o	o	o	o	o	o	o	o	o	o	
Acquisition Trigger Wait	×	×	×	o	o	o	o	o	o	o	o	o	o	
Acquisition Active	×	×	×	o	o	o	o	o	o	o	o	o	o	
Frame Trigger Wait	×	×	×	o	o	o	o	o	o	o	o	o	o	
Frame Active	×	×	×	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	Extension GPIO Connection
Line 11 - LVDS 1 In	o	o	o	o	o	o	o	o	o	o	o	o	o	
	Trigger Source			Line Source								Pulse Generator Clear Source		

5.5 Optical Interface

EL-2800-USB 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

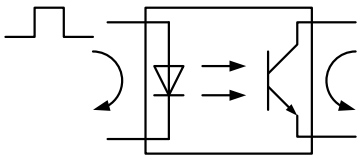


Fig.8 Photo coupler

5.5.1 Recommended External Input circuit diagram for customer

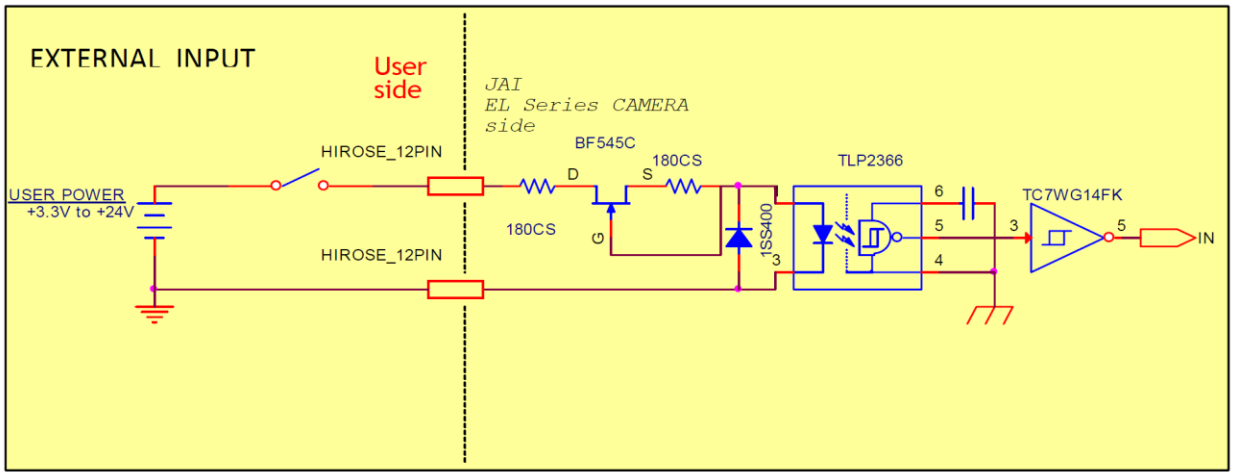


Fig.9 Example of external input circuit

5.5.2 Recommended External Output circuit diagram for customer

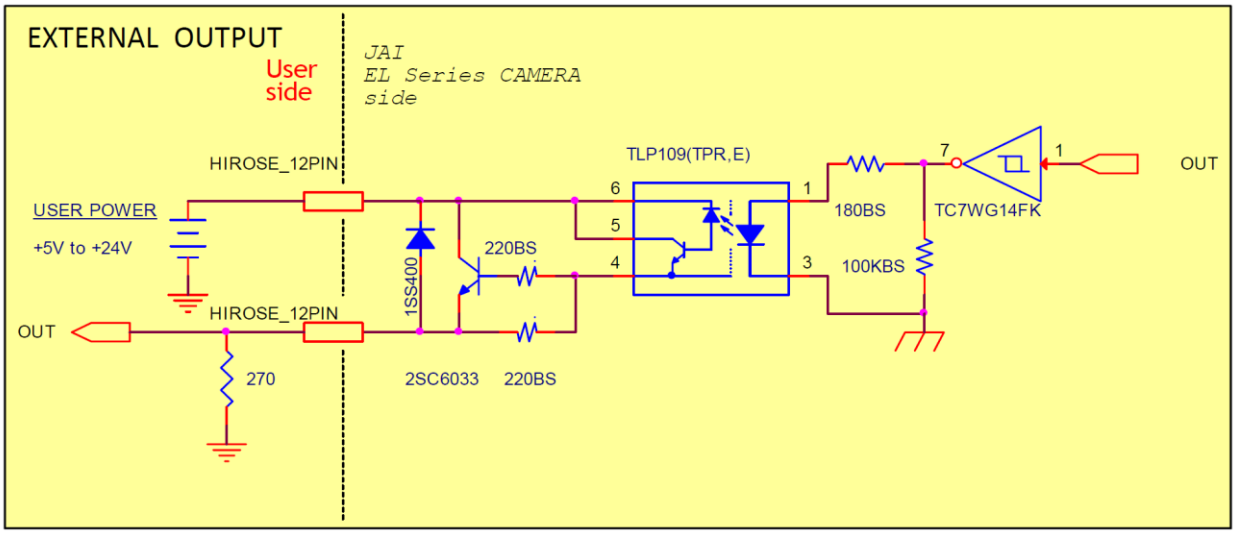
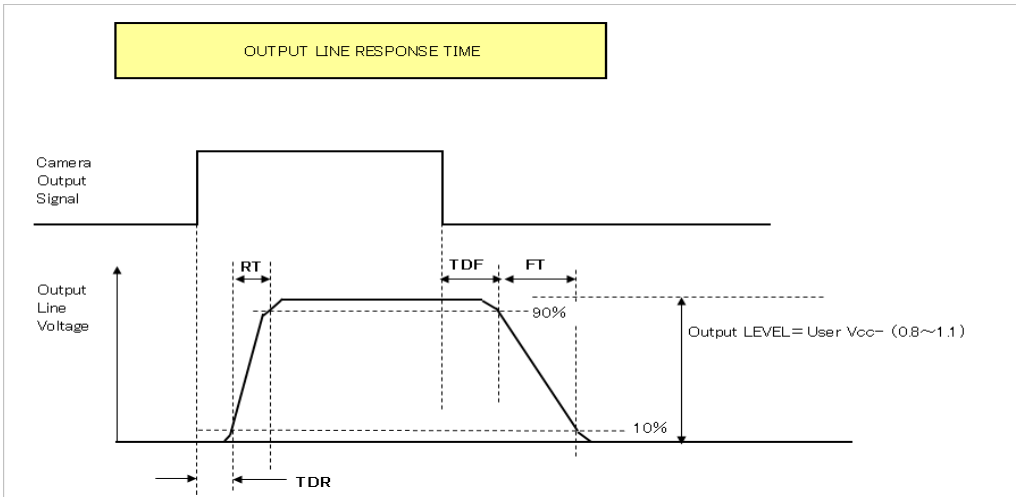


Fig.10 Example of external output circuit

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

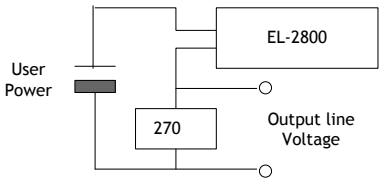


Fig.11 Optical interface characteristics

5.6 Pulse Generator

The EL-2800-USB has a frequency divider using the internal pixel clock as the basic clock and two 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 Selector	Pulse Generator							
	Length	Start Point	End Point	Repeat Count	Clear Source	Clear Inverter	Clear Activation	Clear Sync Mode
- Pulse Generator 0	1	0	1	0	Off	True	Off	Async Mode
- Pulse Generator 1	1	0	1	0	Off	True	Off	Async Mode

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. Two built-in pulse generators work by the same clock. In the EL-2800-USB, 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.

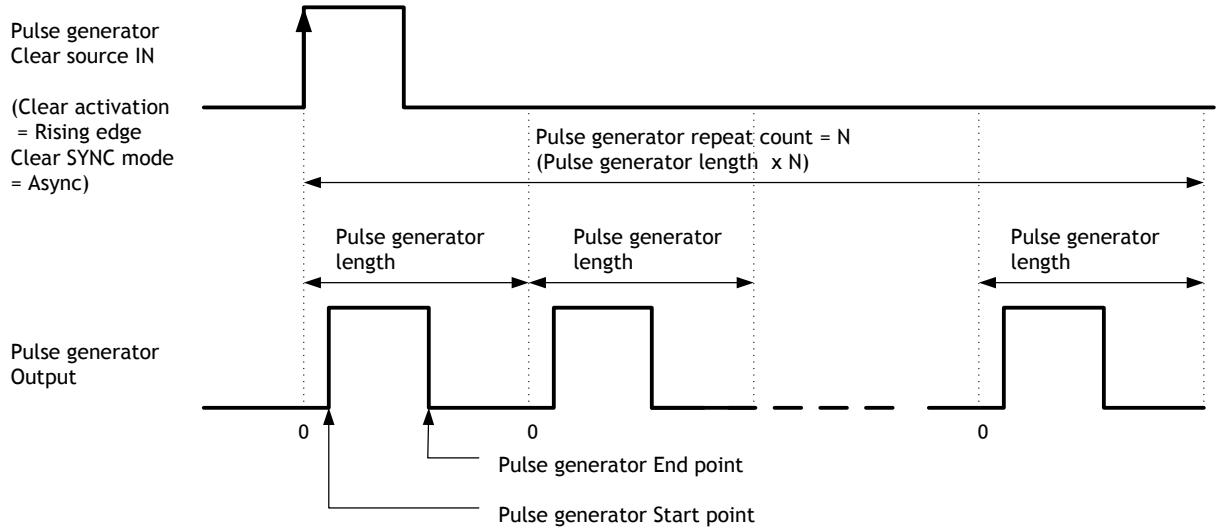


Fig.12 Pulse Generator Pulse construction

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.

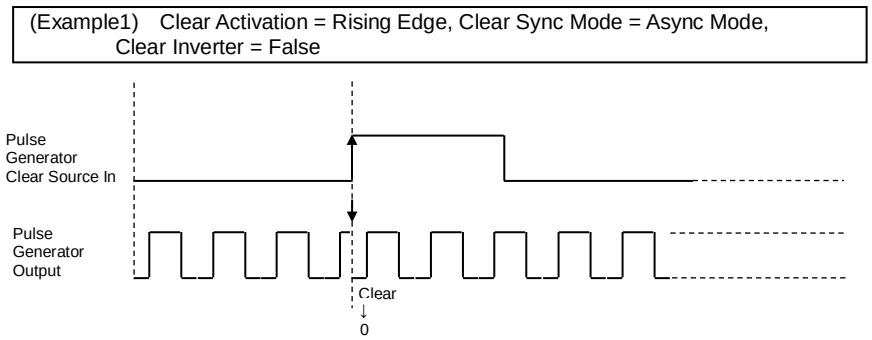


Fig.13 Counter clear in Async mode

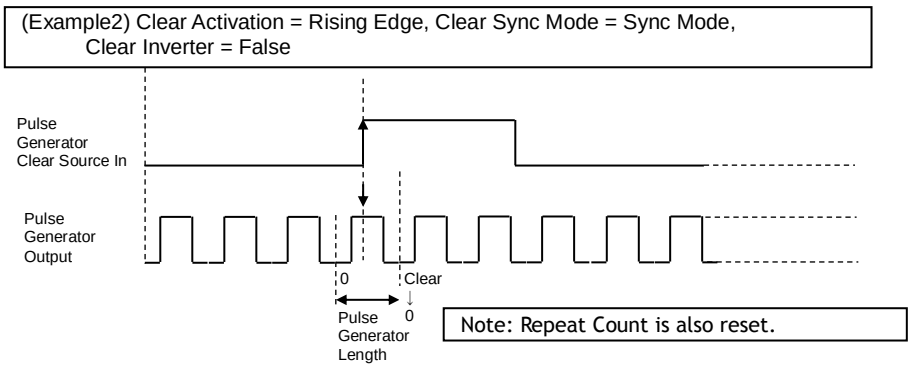


Fig.14 Counter clear in Sync mode

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.
TTL 1 In	Connect TTL 1 In signal to Clear Source for the selected pulse generator.
Opt 1 In	Connect Opt 1 In signal to Clear Source for the selected pulse generator.
NAND 0 Out	Connect NAND 0 output signal to Clear Source for the selected pulse generator.
NAND 1 Out	Connect NAND 1 output signal to Clear Source for the selected pulse generator.
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 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
	- TTL 1 In
	- Opt 1 in
	- NAND 0 Out
	- NAND 1 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 and EL-2800C have the following tap and pixel layout.

6.1.1 Monochrome sensor

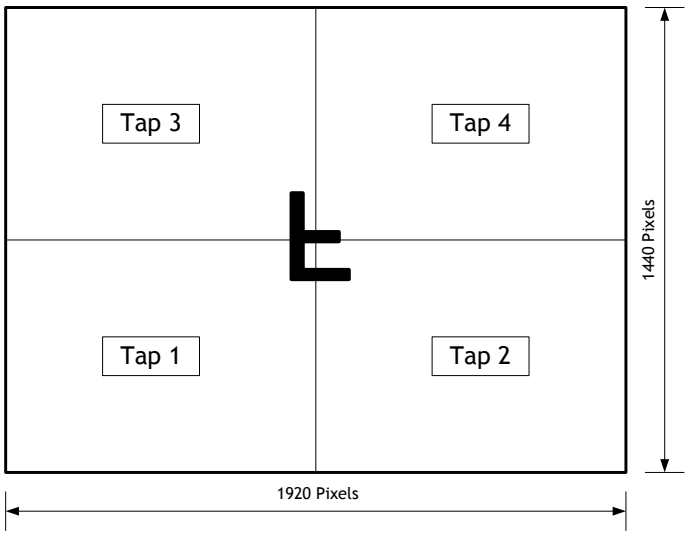


Fig.15 Monochrome sensor layout

6.1.2 Bayer color sensor

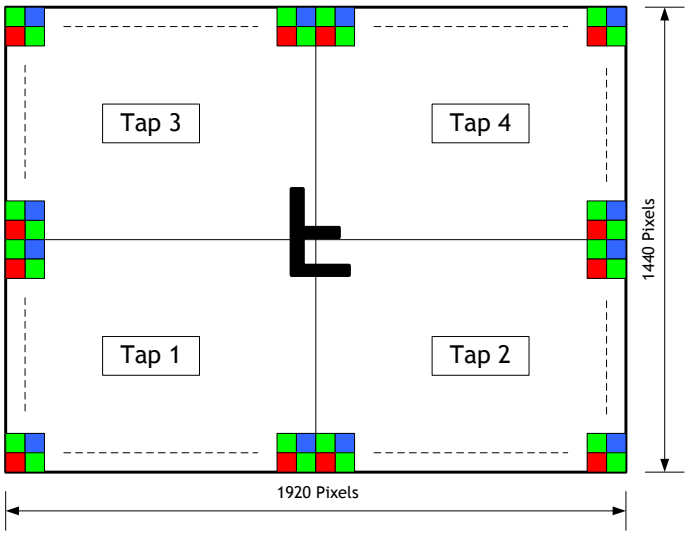


Fig.16 Bayer color sensor layout

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. The EL-2800-USB has two readout modes, one is 1X2-2YE and the other is 1X-1Y.

6.2.1 4 taps readout (1X2-2YE)

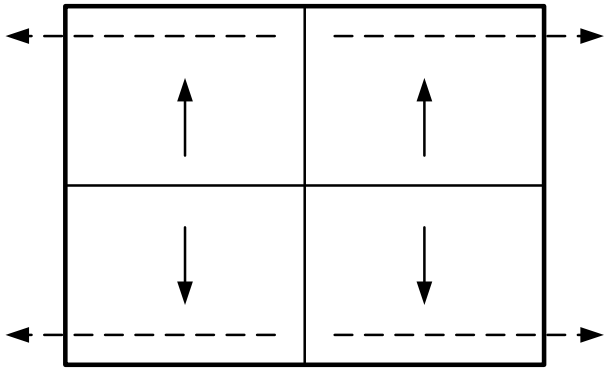


Fig.17 Sensor Readout 4-tap

6.2.2 1 Tap readout (1X-1Y)

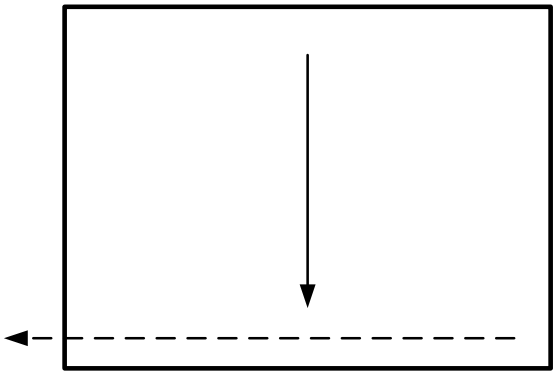


Fig.18 Sensor Readout 1 Tap

6.3. Camera output format and sensor readout system

The following table shows the camera output format based on GenIcam S.F.N.C version 1.5.1.

Table – 14 Camera output format

Sensor readout output (Sensor Tap geometry)	Camera output format (Tap Geometry)	Reference figure
4 taps readout (1X2-2YE)	1X – 1Y	6.3.1
1 Tap readout (1X-1Y)		

6.3.1 1X-1Y

1X-1Y is 1-Tap Camera output format based on GenICam SFNC Ver. 1.5.1.

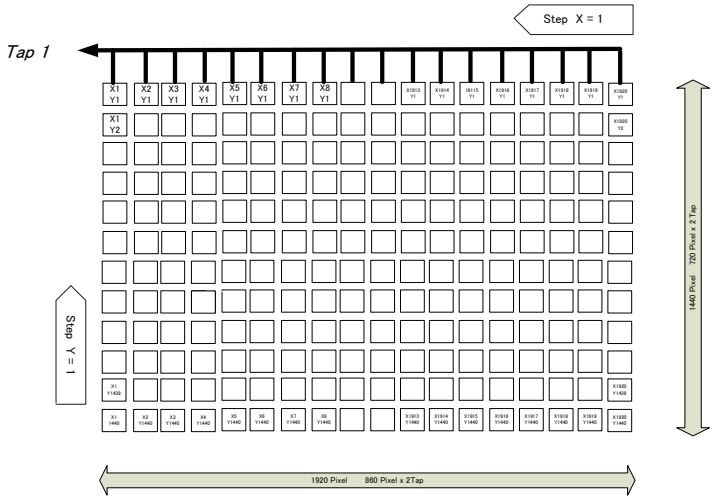


Fig.19 1X-1Y Camera Output Geometry

6.4 Sensor Output timing

6.4.1 Horizontal timing

6.4.1.1 Output format 1X2-2YE (Vertical binning OFF)

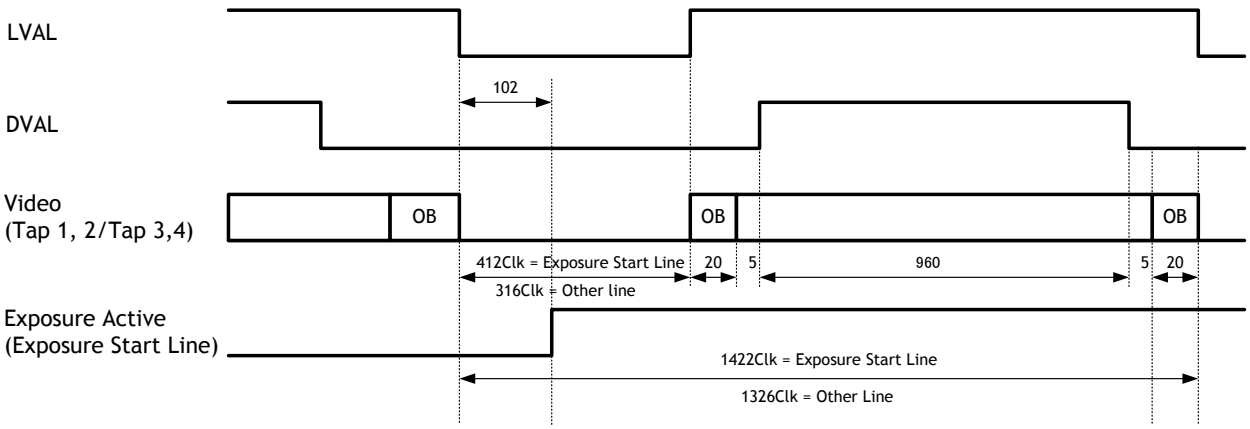


Fig.20 1X2-2YE Horizontal Timing (Vertical timing OFF)

6.4.1.2 Output format 1X2-2YE (Vertical binning ON)

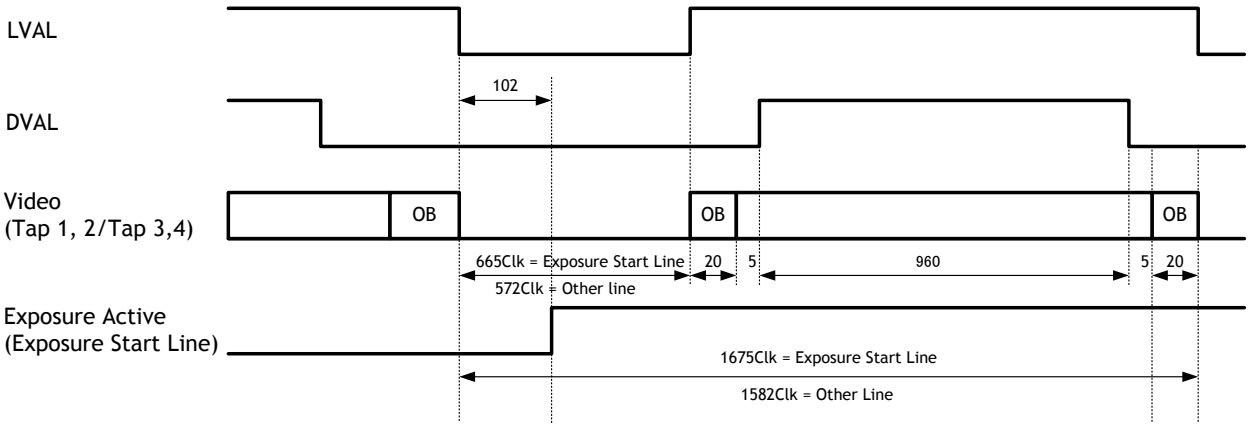


Fig.21 1X2-2YE Horizontal timing (Vertical binning ON)

6.4.1.3 Output format 1X – 1Y (Vertical Binning OFF)

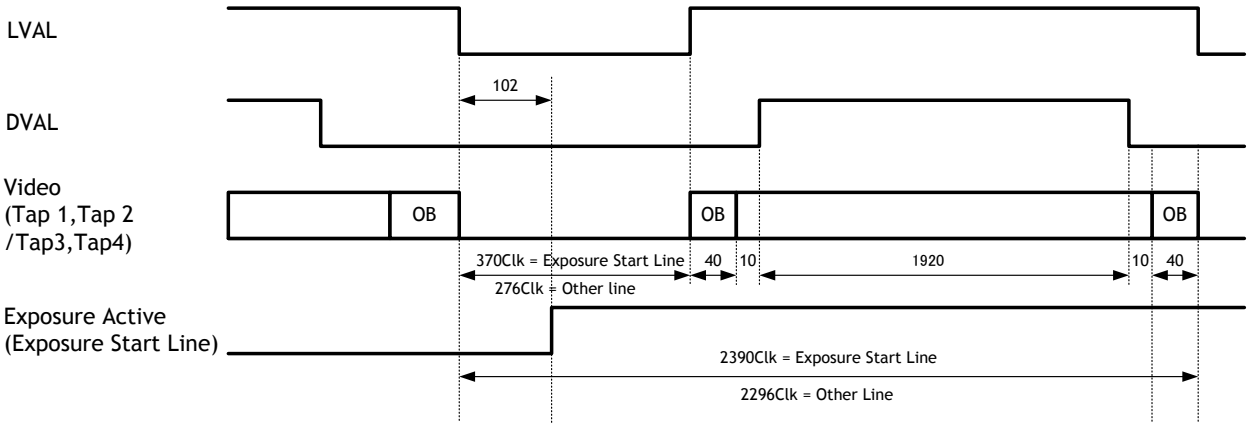


Fig. 22 X – 1Y Horizontal timing (Vertical binning ON)

6.4.1.4 Output format 1X – 1Y (Vertical binning Binning ON)

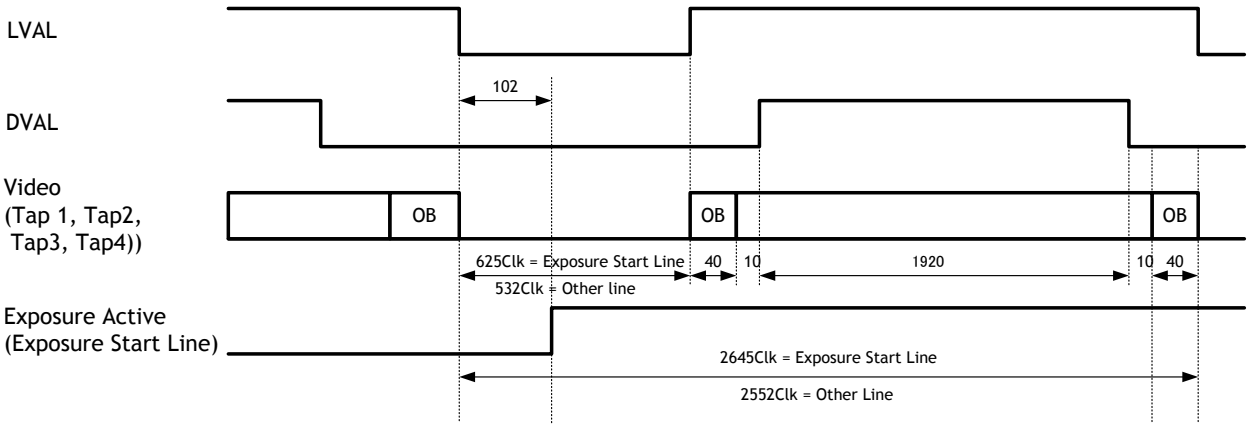


Fig.23 1X - 1Y Horizontal timing (Vertical binning OFF)

6.4.2 Sensor Vertical timing

6.4.2.1 Output format 1X2-2YE (Vertical binning OFF)

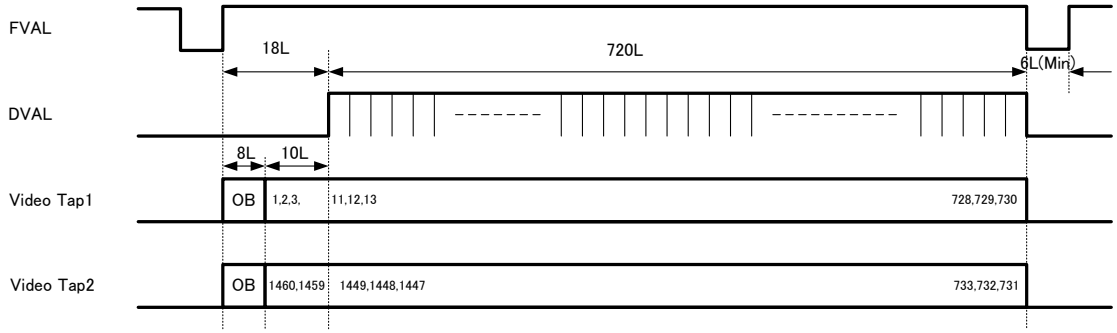


Fig.24 1X2-2YE Vertical Timing (Vertical timing OFF)

6.4.2.2 Output format 1X2-2YE (Vertical binning ON)

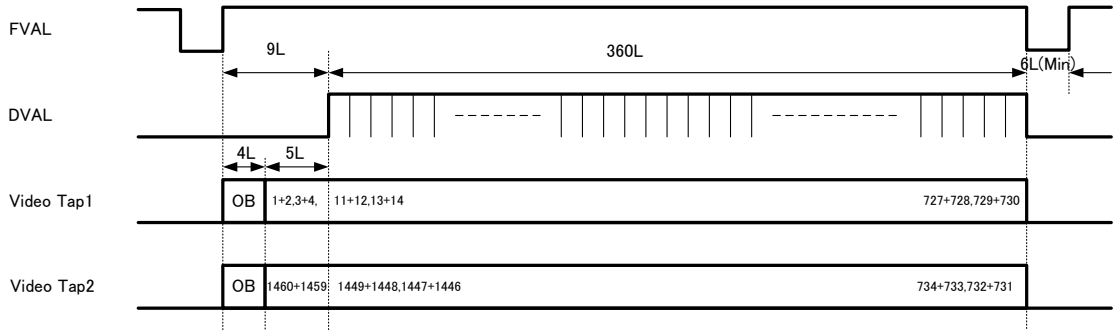


Fig. 25 1X2-2YE Vertical timing (Vertical binning ON)

6.4.2.3 Output format X - 1Y (Vertical binning OFF)

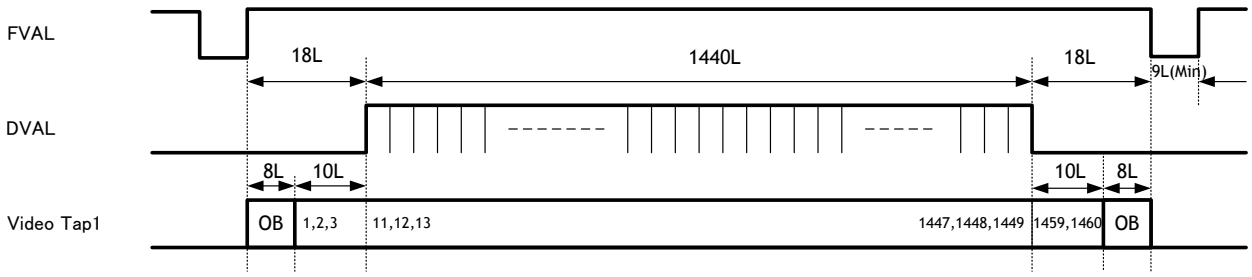


Fig. 26 1X - 1Y Vertical timing (Vertical binning OFF)

6.4.2.4 Output format 1X - 1Y Vertical timing (Vertical binning ON)

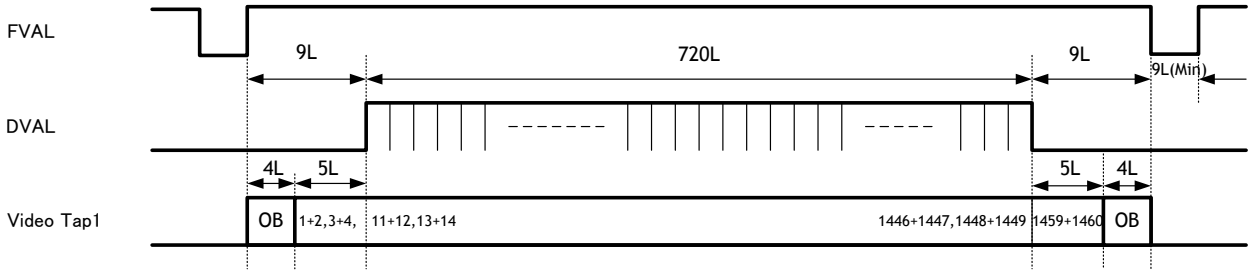


Fig.27 1X - 1Y Vertical timing (Vertical binning ON)

7. Operating modes

7.1. Acquisition control

7.1.1 Acqusition mode

In the EL-2800M-USB and EL-2800C-USB, 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.

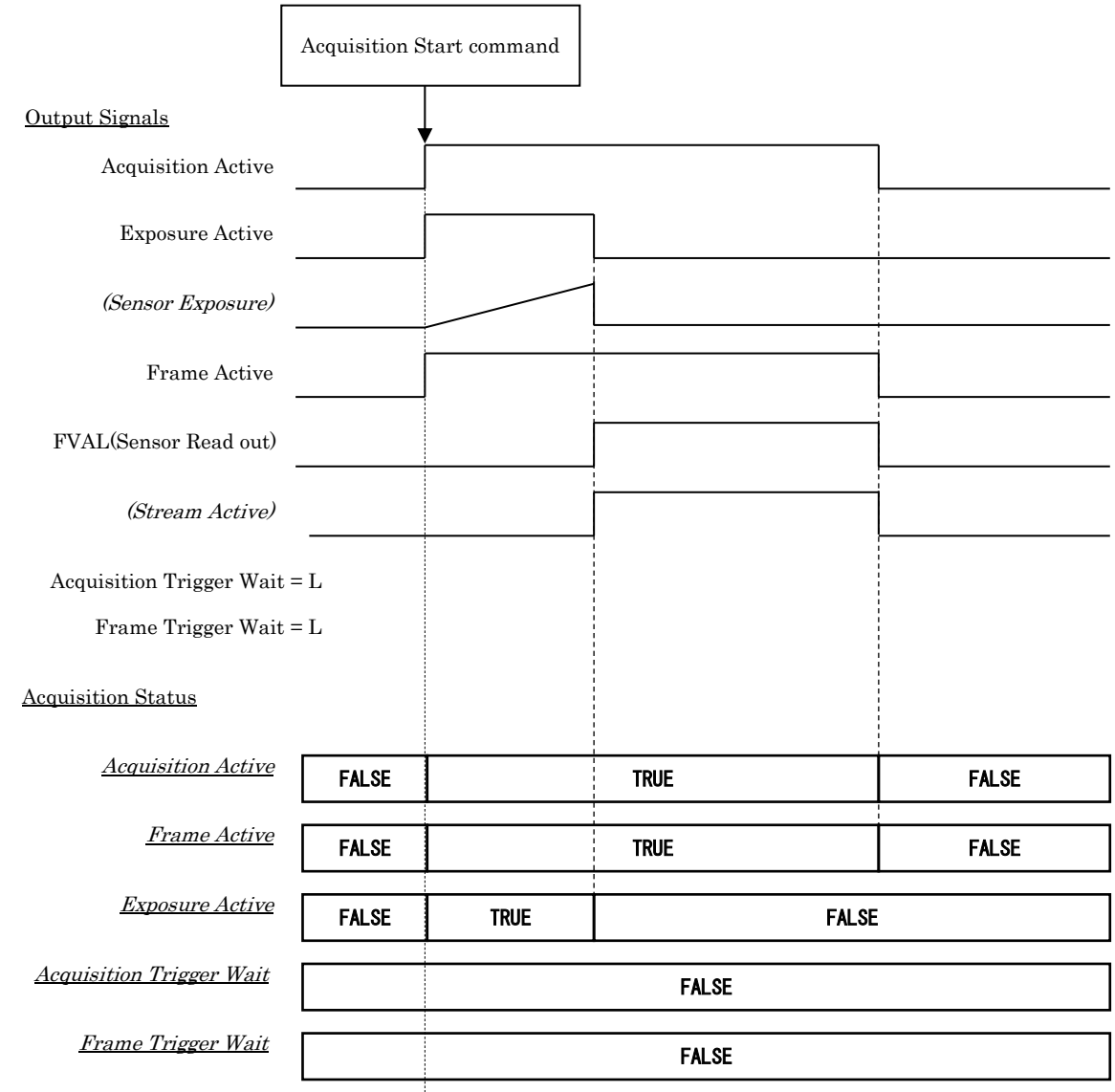
7.1.1.1 Single Frame

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.

Setting condition 1
Acquisition Mode : Single
Trigger Selector : Acquisition Start
Trigger Mode : OFF



Note: Signals shown in ( ) are internal signals within the camera.

Fig.28 Single frame operating timing (1)

Setting condition 2

Acquisition Mode : Single
Trigger Selector : Acquisition Start
Trigger Mode : ON

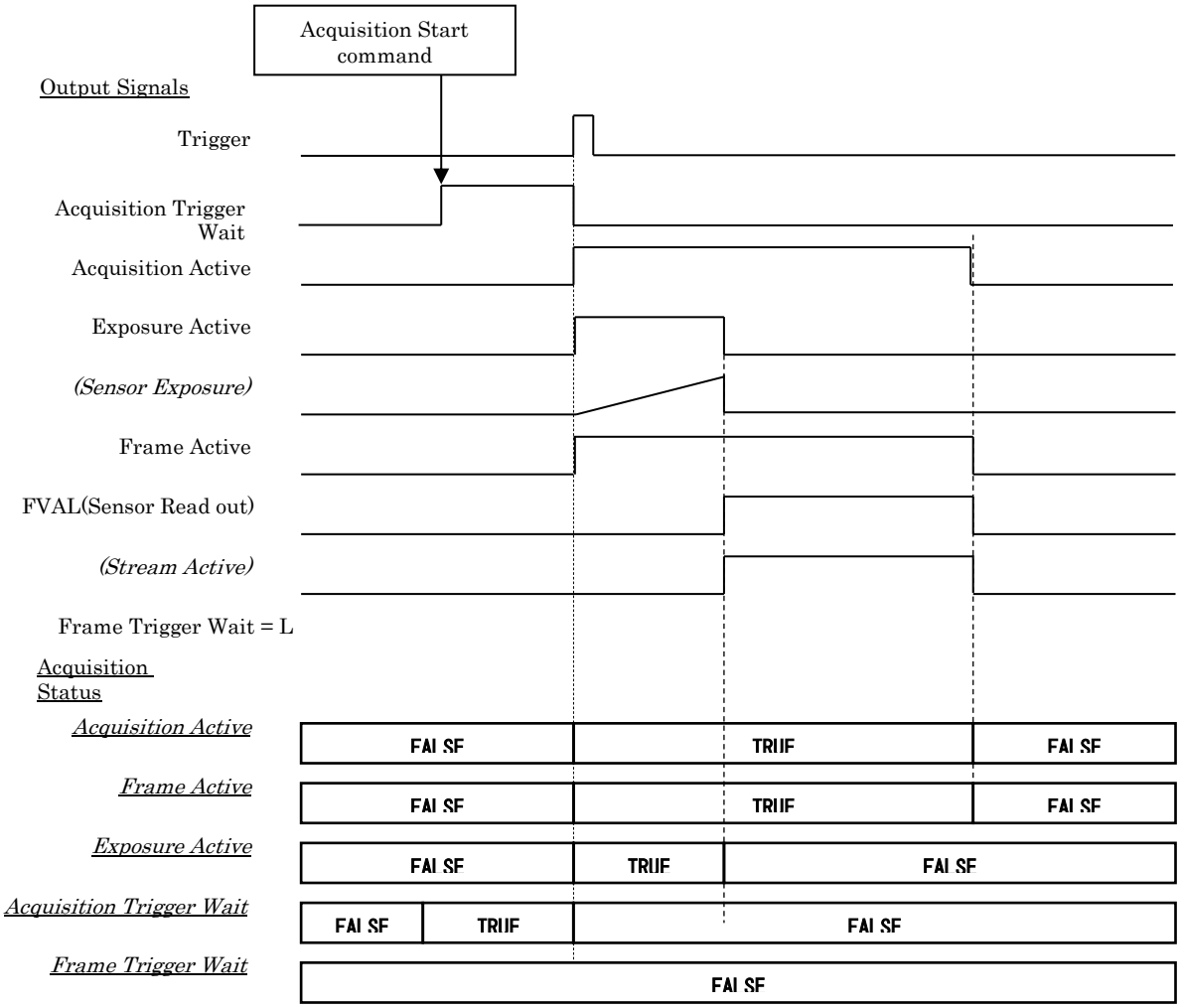


Fig. 29 Single frame operation timing (2)

Setting condition 3

Acquisition Mode : Single
Trigger Selector : Frame Start
Trigger Mode : ON

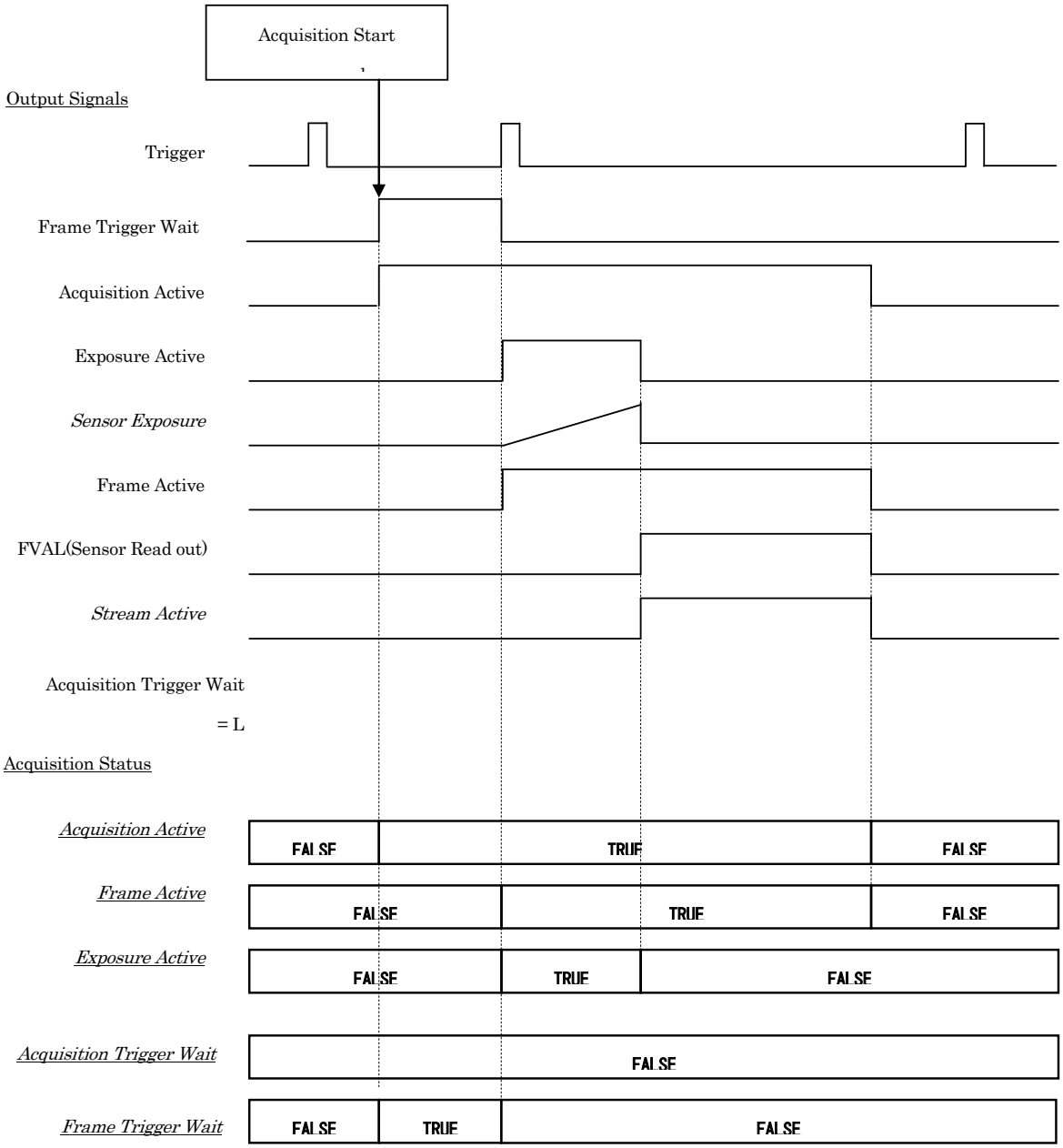


Fig. 30 ngle frame operation timing (3)

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)

  Note: This drawing shows if the trigger is OFF. If the trigger is ON, FrameActive turns to True at a different AcquisitionActive timing.

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

Setting condition 1

Acquisition Mode : Multi
Trigger Selector : Acquisition Start
Acquisition Frame Count : 2
Trigger Mode : OFF

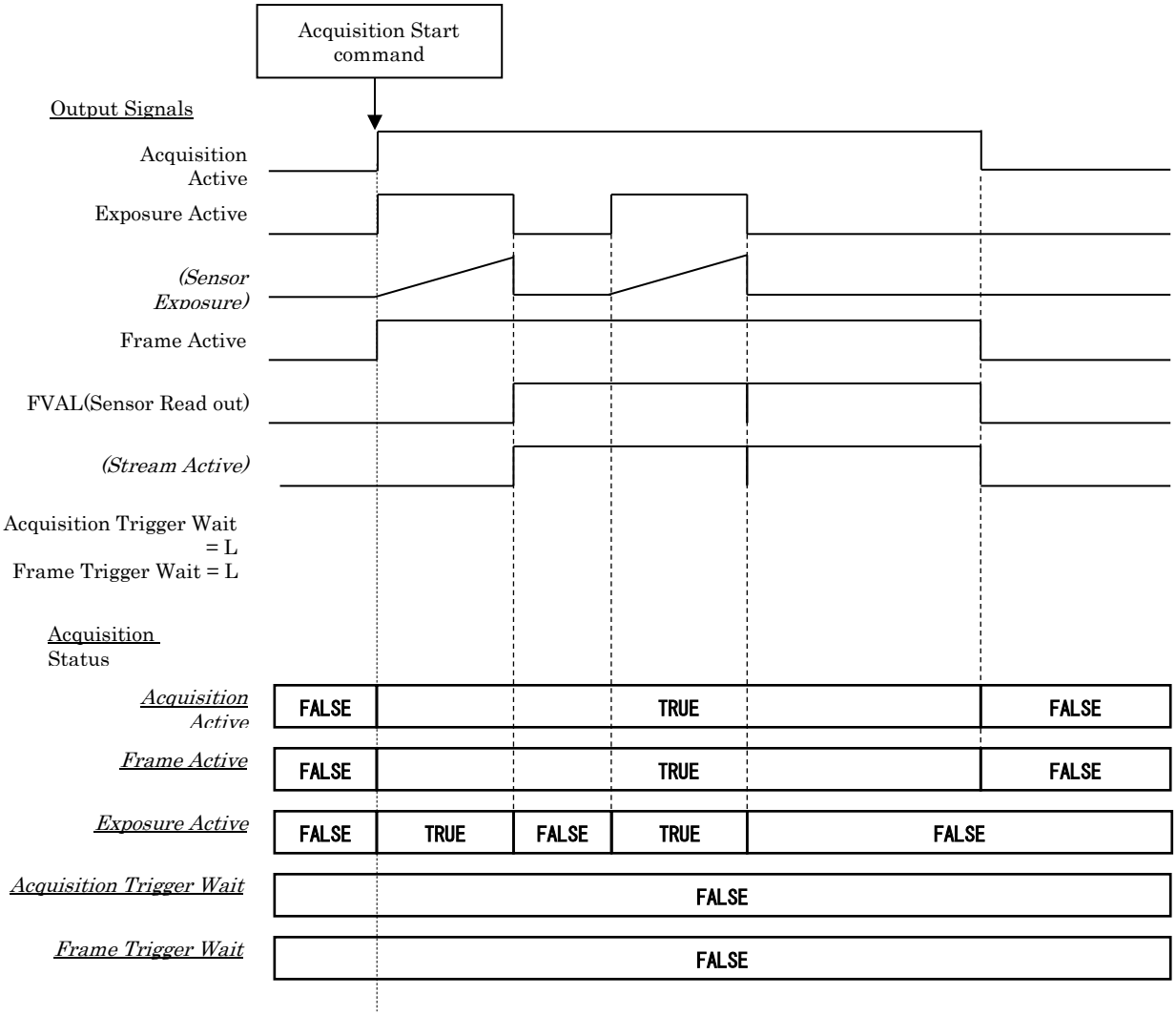


Fig. 31 Multi frames operating timing (1)

Setting condition 2

Acquisition Mode : Multi
Trigger Selector : Acquisition Start
Acquisition Frame Count : 2
Trigger Mode : ON

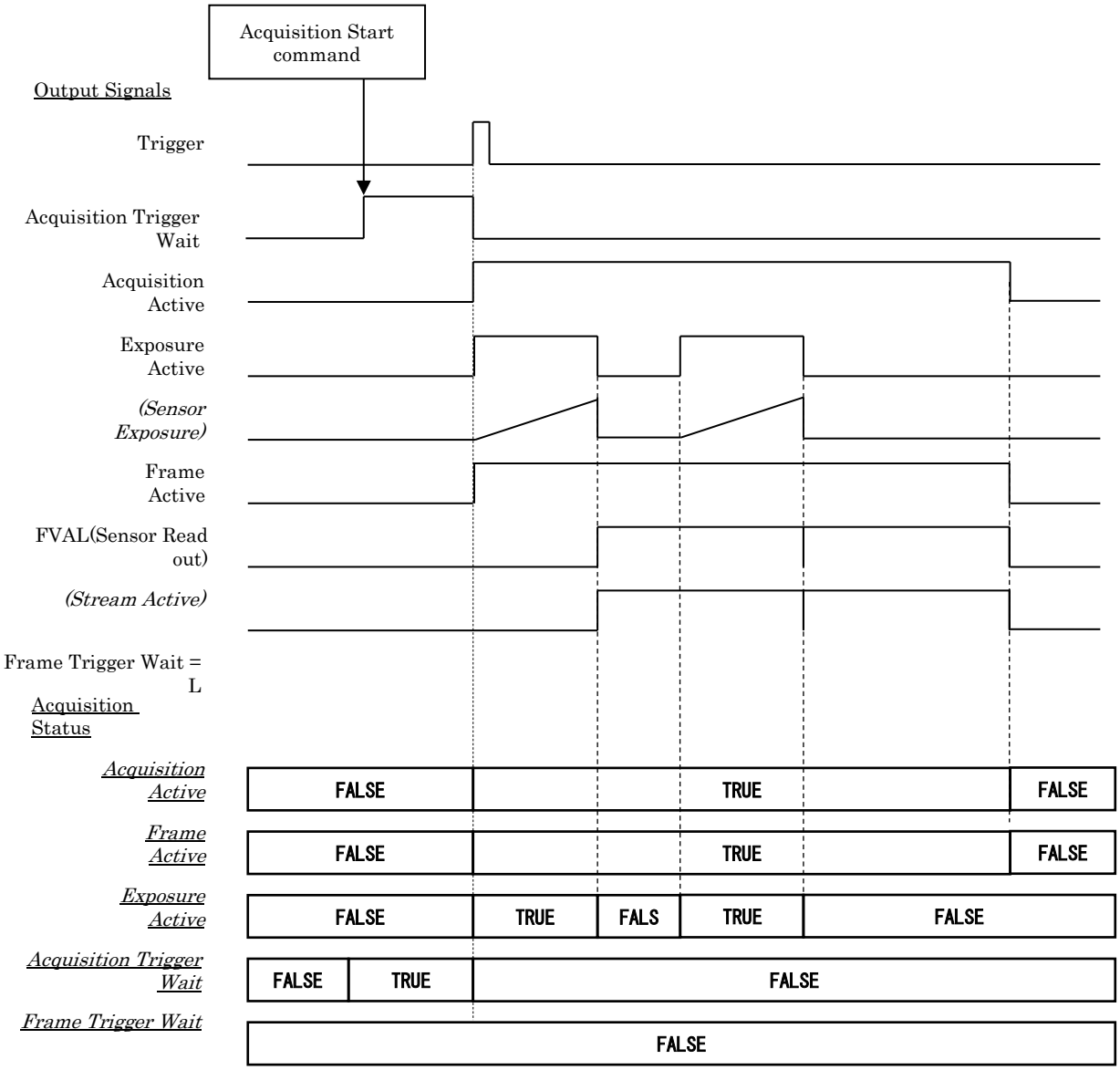


Fig.32 Multi frame operation timing (2)

Setting condition 3

Acquisition Mode : Multi
Trigger Selector : Frame Start
Acquisition Frame Count : 2
Trigger Mode : ON

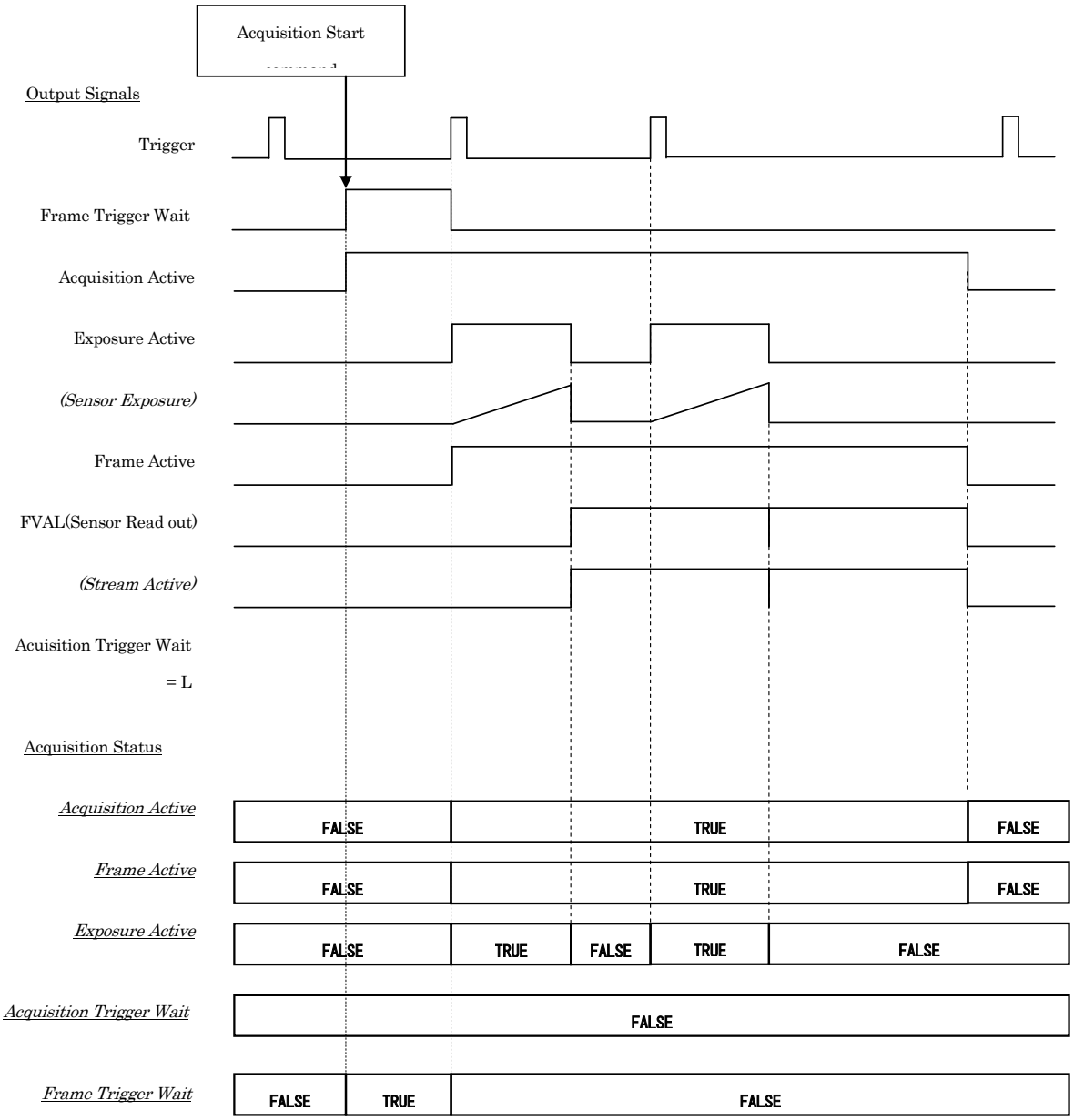


Fig.33 Multi frame operation timing (3)

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-USB and EL-2800C-USB.

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.

Setting condition 1

Acquisition Mode : Continuous
Trigger Selector : Acquisition Start
Trigger Mode : OFF

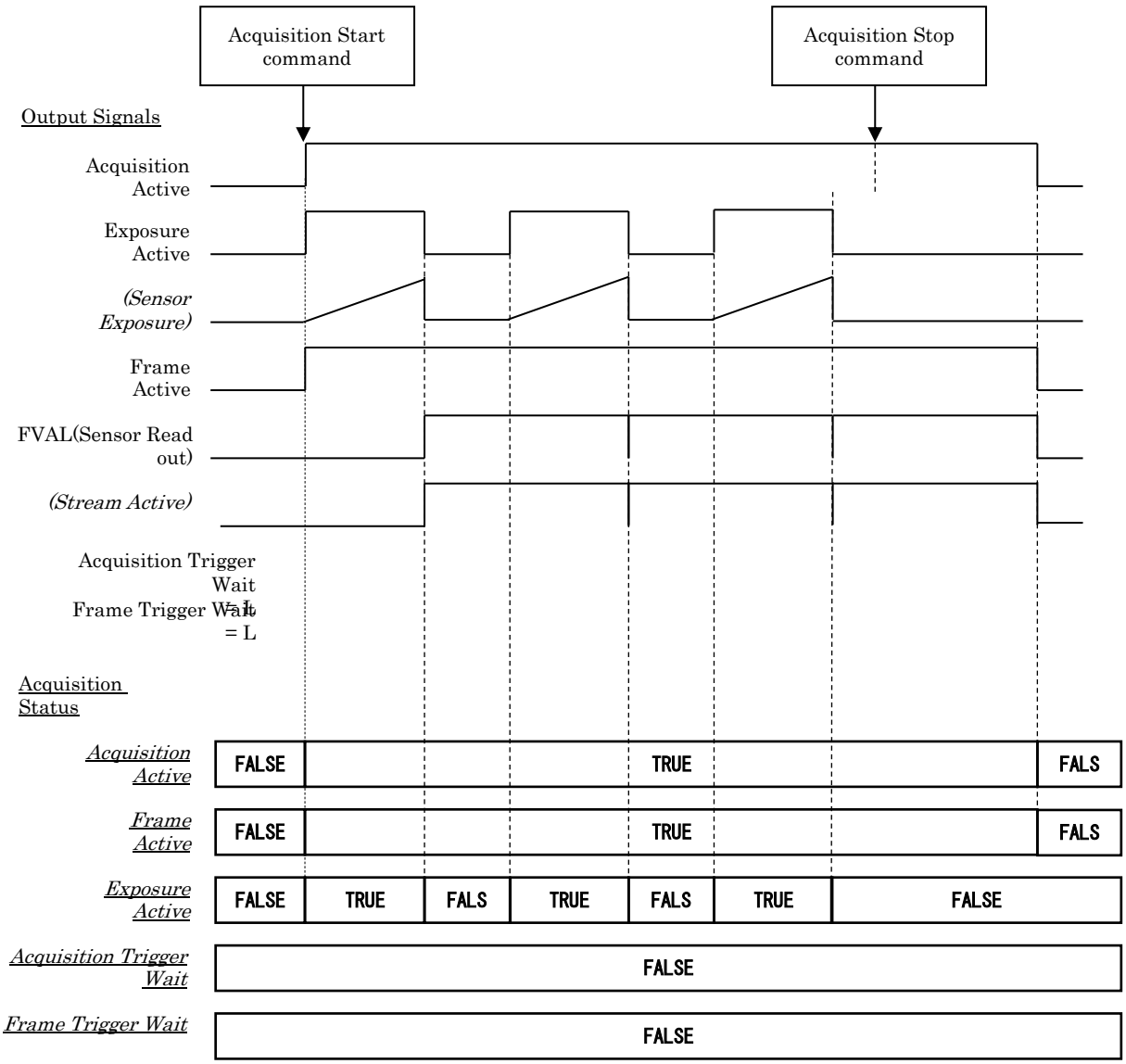


Fig.34 Continuous operation timing (1)

Setting condition 2

Acquisition Mode : Continuous
Trigger Selector : Acquisition Start
Trigger Mode : ON

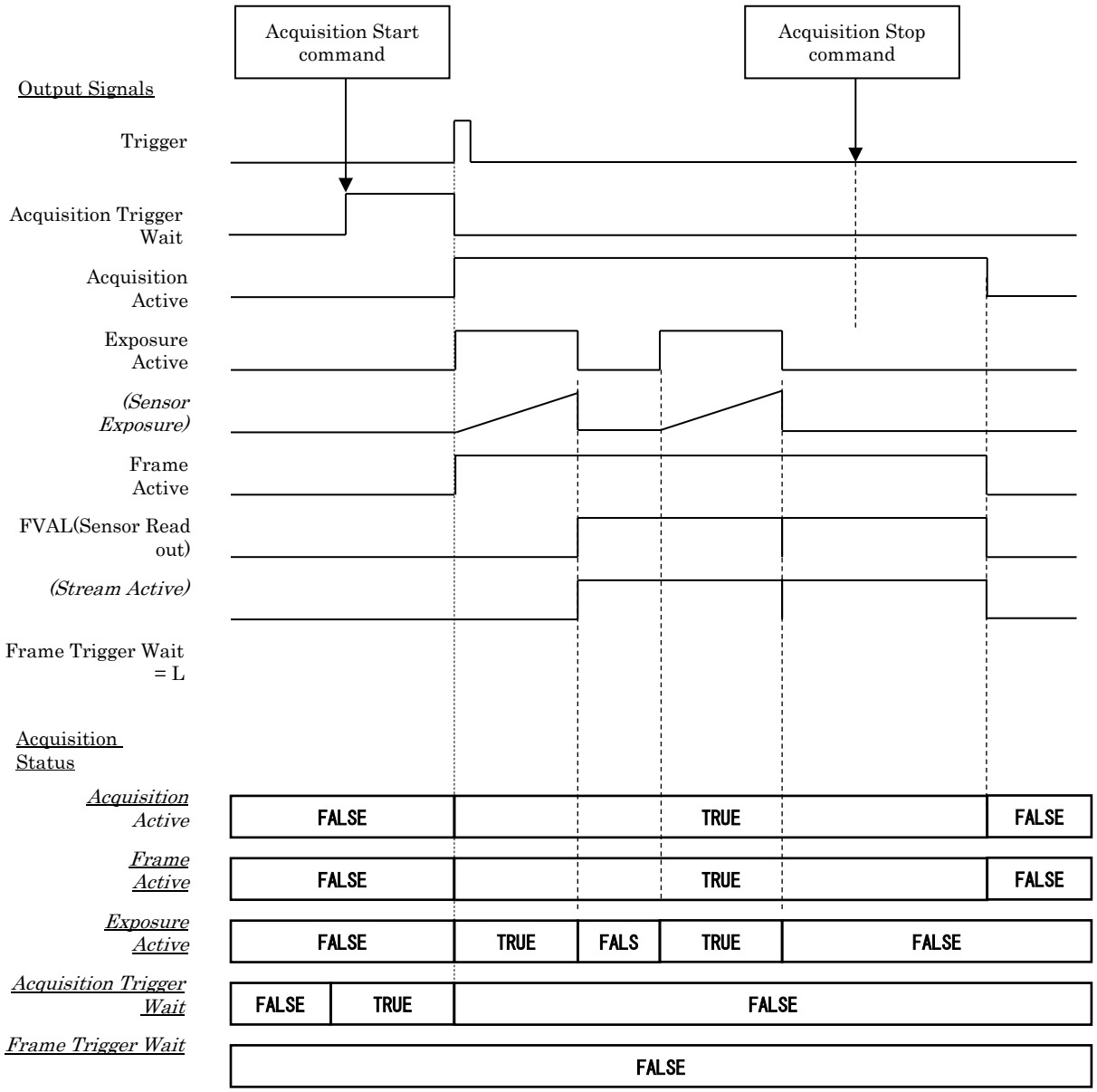


Fig.35 Continuous operation timing (2)

Setting condition 3
Acquisition Mode : Continuous
Trigger Selector : Frame Start
Trigger Mode : ON

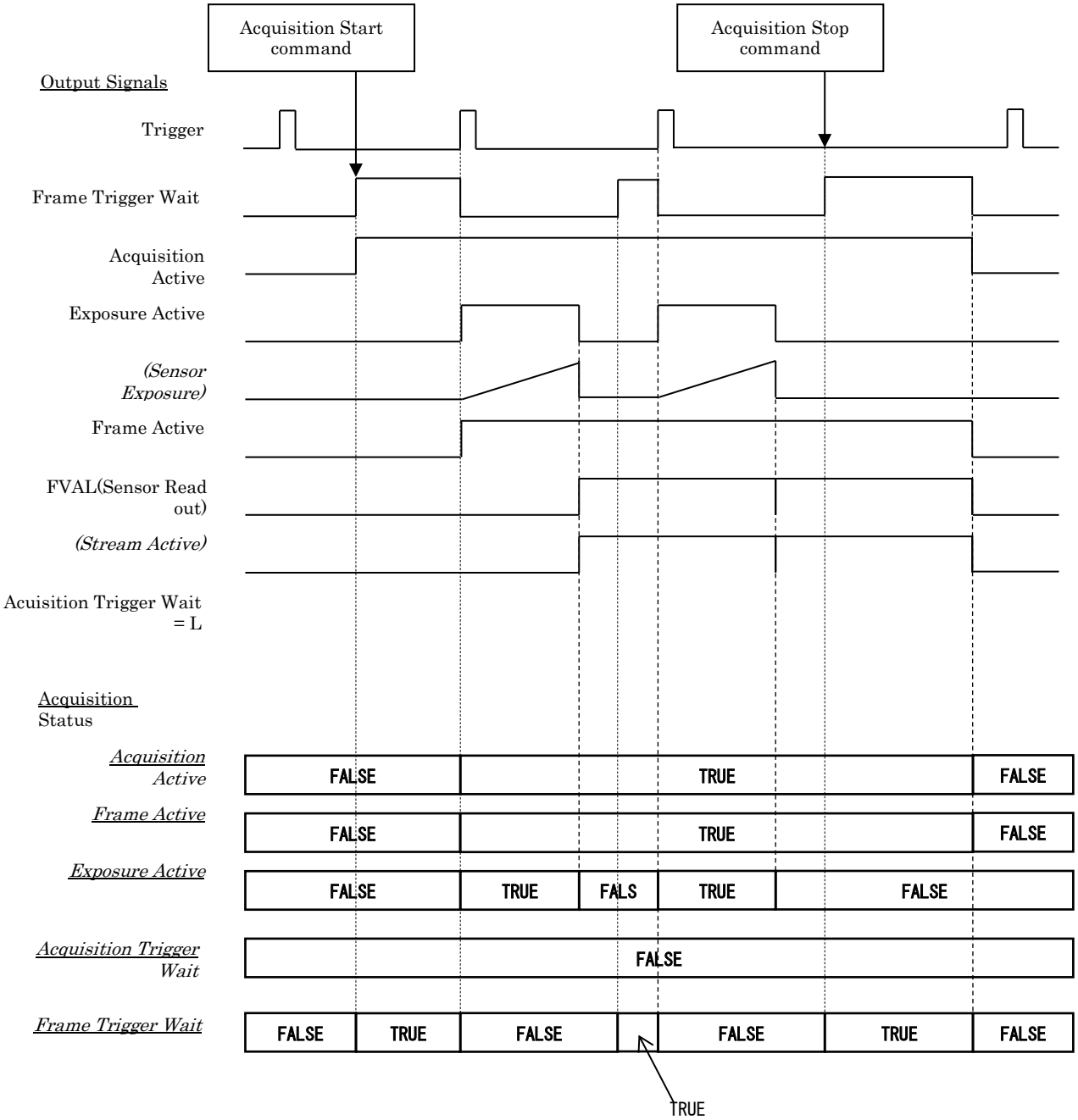


Fig.36 Continuous operation timing (3)

7.1.2 AcquisitionFrameCount

This is the command to configure the number of frames to acquire in MultiFrame mode.
The range of setting is 1 to 65535 but in PIV mode, it is 2 to 65534.

7.1.3 Acquisition frame rate

With Trigger OFF (free-running operation), the default frame rate of the camera is based on the specified ROI. However, 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.
This is done by entering a value in the AcquisitionFrameRate control corresponding to the acquisition frame frequency.

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	0.125 Hz (fps)

Note:
1. If the trigger is set to ON, this function is not available.
2. The value for setting is Frame Frequency.
3. If the setting value is less than the minimum period corresponding to the default frame rate, 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 Frame rate calculation formula

a) If V Bininng Off and Sensor Geometry 1X2-2YE
Frame_Rate (Hz) = 1000000/〔[Height/2 + {(720-(Height/2)-1)/4} + 26] ×24.574 〕

b) If V Bininng On and Sensor Geometry 1X2-2YE
Frame Rate (fps) = 100000/〔[(Height/2) + {(360-(Height/2)-1)/2} + 17] ×29.296 〕

c) If V Bininng Off and Sensor Geometry 1X-1Y
Frame_Rate (Hz) =
1000000/【〔 Height + {(OffsetY-1)/7} + [{1440-(OffestY + Height)}/15] + 47 〕 ×42.519】

d) If V Bininng On and Sensor Geometry 1X-1Y
Frame Rate (fps) =
1000000/【〔(Height/2)+ {(OffsetY-1)/4} + [{720-(OffsetY + (Height/2))}/8] +34 ×47.259】

Note: In this formula, the calculation results underlined must be rounded up.

7.2. Exposure settings

7.2.1 Exposure Mode

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

Table15. 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

Table16. 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.

Table17. The combination of Exposure Mode, Trigger Option and Trigger Mode

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

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.

The range of ExposureAuto is from 100 μs to Frame Rate
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 GainAuto)
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.

Table 18 Trigger source

Signal	Description
Software	Signal generated by Trigger Software Command
Pulse Generator 0 to 1	Signal generated by Pulse generator 0 to 1
Line 4	Signal which is input from TTL 1 In and output through Digital IO
Line 5	Signal which is input from Opt In 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

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 - 19 Trigger activation

	RisingEdge	FallingEdge	LevelHigh	LevelLow
Timed	○	○	×	×
Trigger Width	×	×	○	○
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

Table - 20 Minimum interval of the image (8-bit)

Readout mode	FULL	2/3 AOI	1/2 AOI	1/4 AOI	1/8 AOI	1/2V Binning (Note1)
Minimum frame lines	745	565	475	340	273	376

Note 1) Only for EL-2800M-USB

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

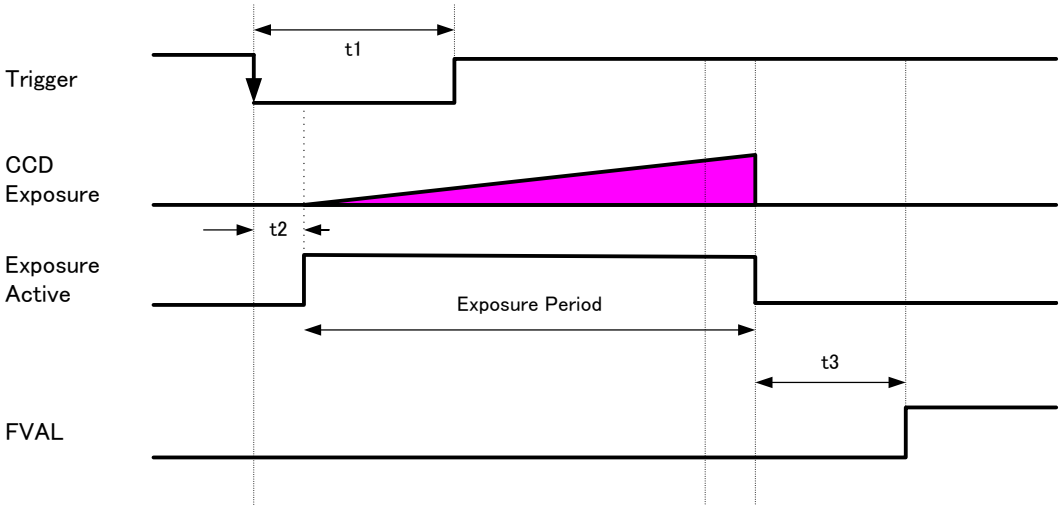
Exposure mode: Timed
Trigger mode: ON
Frame Start: ON

Table - 21 Minimum interval of the trigger pulse (Sensor Tap Geometry: 1X2 – 2YE)

Readout mode	**FULL**	**2/3 AOI**	**1/2 AOI**	**1/4 AOI**	**1/8 AOI**	**1/2V Binning (Note1)**
Minimum interval lines	746	566	476	341	274	377

Note 1) EL-2800M only
Note 2) This table shows in case of Trigger overlap being set to Readout. If Trigger overlap is set to OFF, this period is longer than the figures in this table.

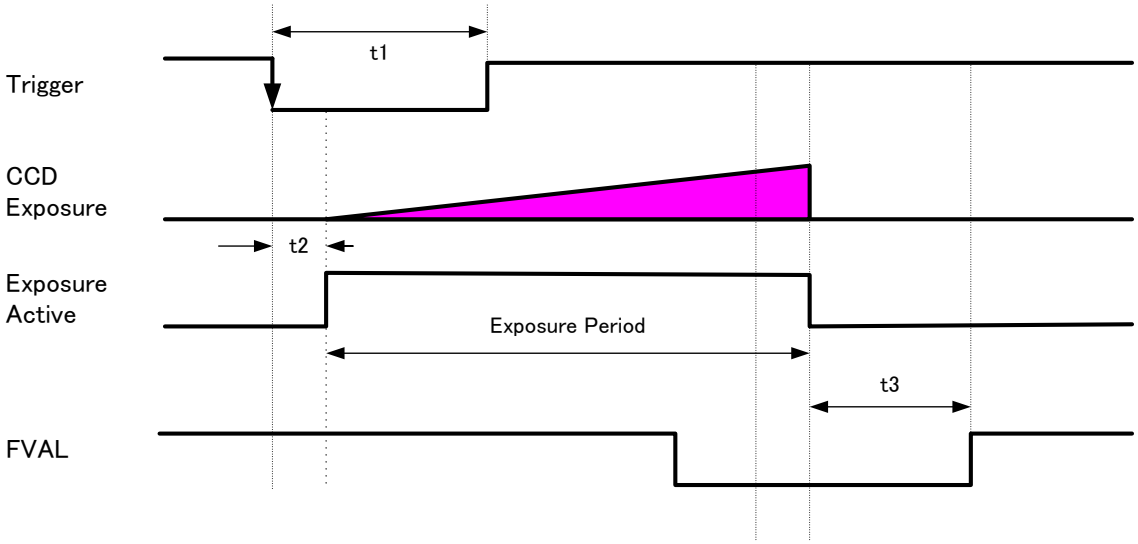
7.5.1 If the overlap setting is “OFF”



t1	t2	t3
2L (Min)	424 clk	4.5 ～ 5.5L

Fig.37 Overlap OFF

7.5.2 If the overlap setting is “Readout”



t1	t2	t3
2L (Min)	1L	4.5L ～5.5L

Fig.38 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.

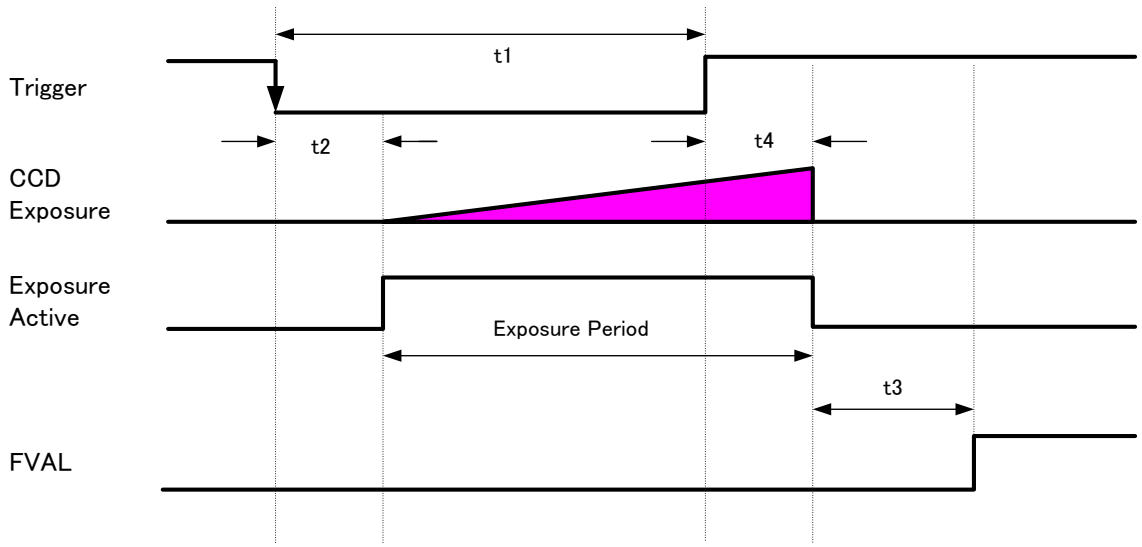
Primary settings to use this mode
Exposure mode: Trigger width
Trigger mode: ON
Frame Start: ON

Table – 22 Minimum interval of the trigger pulse (Sensor Tap Geometry: 1X2 – 2YE)

Readout mode	FULL	2/3 AOI	1/2 AOI	1/4 AOI	1/8 AOI	1/2V Binning (Note1)
Minimum interval lines	746	566	476	341	274	377

Note 1) EL-2800M only
Note 2) This table shows in case of Trigger option being set to Readout. If Trigger option is set to OFF, this period is longer than the figures in this table.

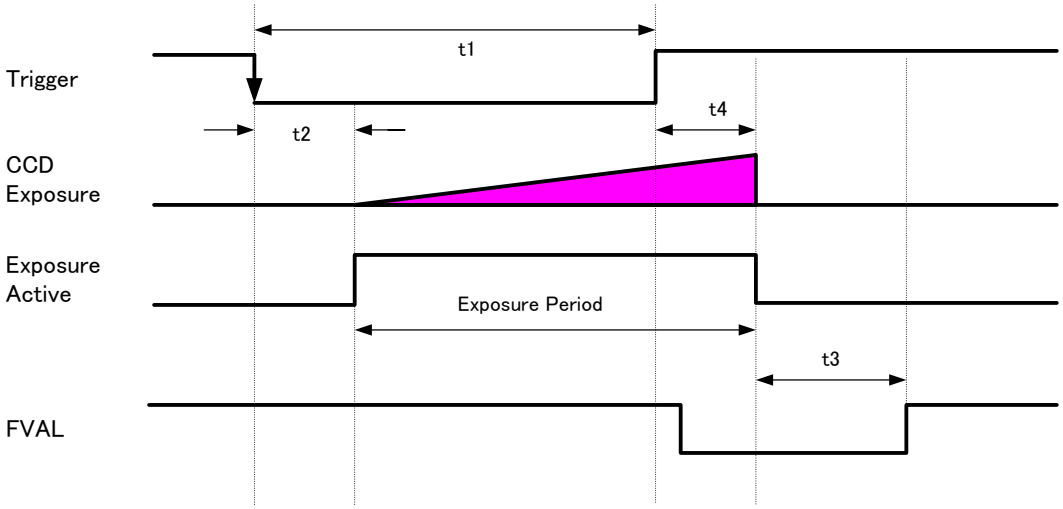
7.6.1 If the overlap setting is "OFF"



t1	t2	t3	t4
1L (Min)	424 clk	4.5L ～5.5L	8 μs

Fig.39 Overlap = OFF

7.6.2 If the overlap setting is “Readout”



t1	t2	t3	t4
1L (Min)	1L	4L	1L + 8μs

Fig.40 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

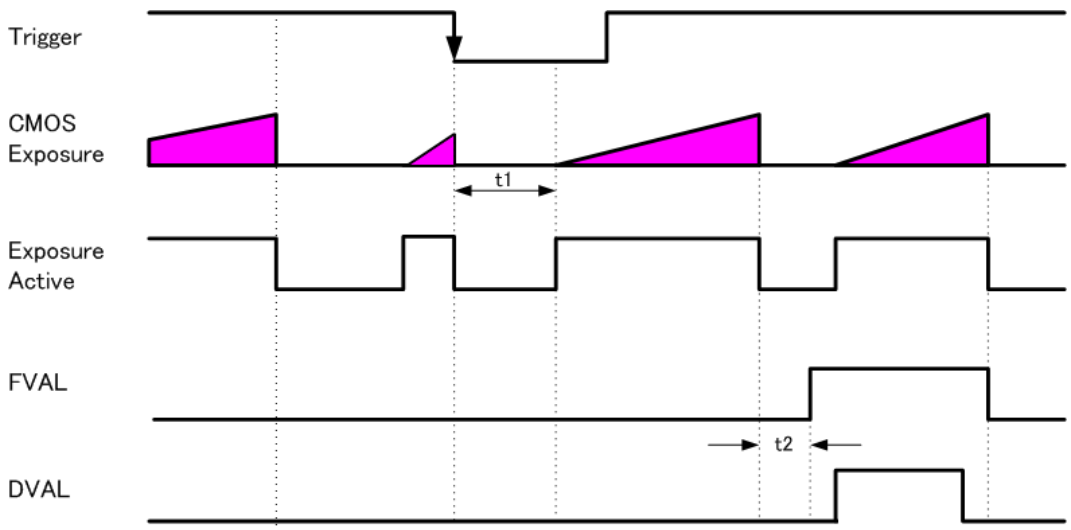
Exposure mode: Timed (RCT)
Trigger mode: ON
Frame Start: ON
Trigger option: RCT

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

Table – 23 Minimum interval of the trigger pulse (Sensor Tap Geometry: 1X2 – 2YE)

Readout mode	FULL	2/3 AOI	1/2 AOI	1/4 AOI	1/8 AOI	1/2V Binning (Note1)
Minimum interval lines	Timed Trigger Mode/Trigger Mode OFF + Exposure Time + 195					

Note 1) Only for EL-2800M-USB
Note 2) Readout mode in trigger overlap is not available.



Sensor Tap Geometry	t1	t2
1X2-2YE	194L	4.5L ～5.5L
1X-1Y	384L	4.5L ～5.5L

Fig.41 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.

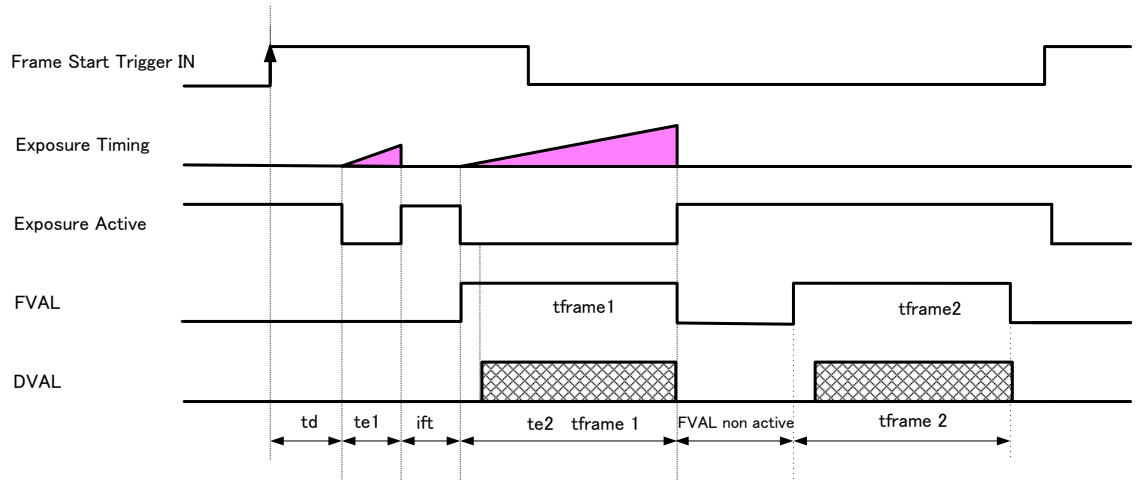
Primary Settings
Exposure mode: Timed (PIV)
Trigger mode: ON
Frame Start: ON
Trigger option: PIV

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

Table – 24 Minimum interval of the trigger pulse (Sensor Tap Geometry: 1X2 – 2YE)

1X-2YE output	FULL	2/3 AOI	1/2 AOI	1/4 AOI	1/8 AOI	1/2V Binning (Note1)
Minimum interval lines	Timed Trigger Mode/Trigger Mode OFF x 2 + Exposure Time + 1					

Note 1) Only for EL-2800M-USB



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.42 PIV mode

7.9. Sequential Timed Exposure Mode

7.9.1 Video send mode

The sequential trigger mode has the following modes which are 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.

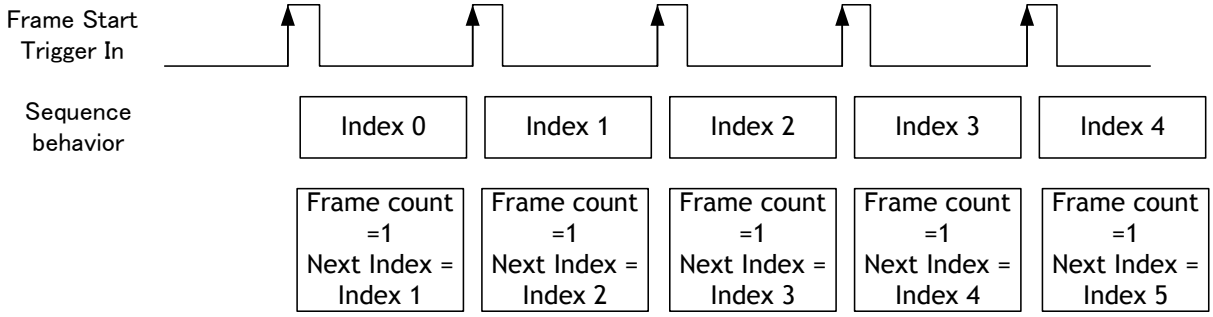


Fig. 43 Behavior of Sequence trigger

Table - 25 Minimum trigger interval (Sensor Tap Geometry: 1X2 – 2YE)

Readout mode	FULL	2/3 ROI	1/2 ROI	1/4 ROI	1/8 ROI	1/2V Binning (Note1)
Minimum frame interval lines	Timed Trigger Mode/Trigger Mode OFF + Exposure Time + 1					

Note 1. Only EL-2800-USB

Note 2. Overlap mode=Readout is not available

Note 3. The minimum interval calculation assumes that the exposure times for all sequences are equal. If there are differences, it is necessary to add the differences to the calculation. If the exposure times are different, it is recommended to organize the exposure times from the shortest exposure to the longest one.

Note 4. The sequence must start with Index 0. After Index 0 is executed, the Sequence proceeds to the next setting index.

Table – 26 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		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 1		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 2		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 3		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 4		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 5		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 6		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 7		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 8		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 9		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
Set the width of sequence ROI. The setting range is 8 to 1920 pixles.
Rules for setting area and step number are the same as the normal ROI mode set by [Video Send Mode] = “Normal”.

(3) Sequence ROI Height
Set the height of sequence ROI. The setting range is 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 X
Set Offset X of sequence ROI.
Sequence ROI Binning Vertical = 1 (Off):
Setting range is 0 to (1920 - [Sequence ROI Height])
Sequence ROI Binning Vertical = 2 (On):
Setting range is 0 to (960 - [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 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”.

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

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

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

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

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

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

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

(13) Sequence ROI Next Index (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.

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

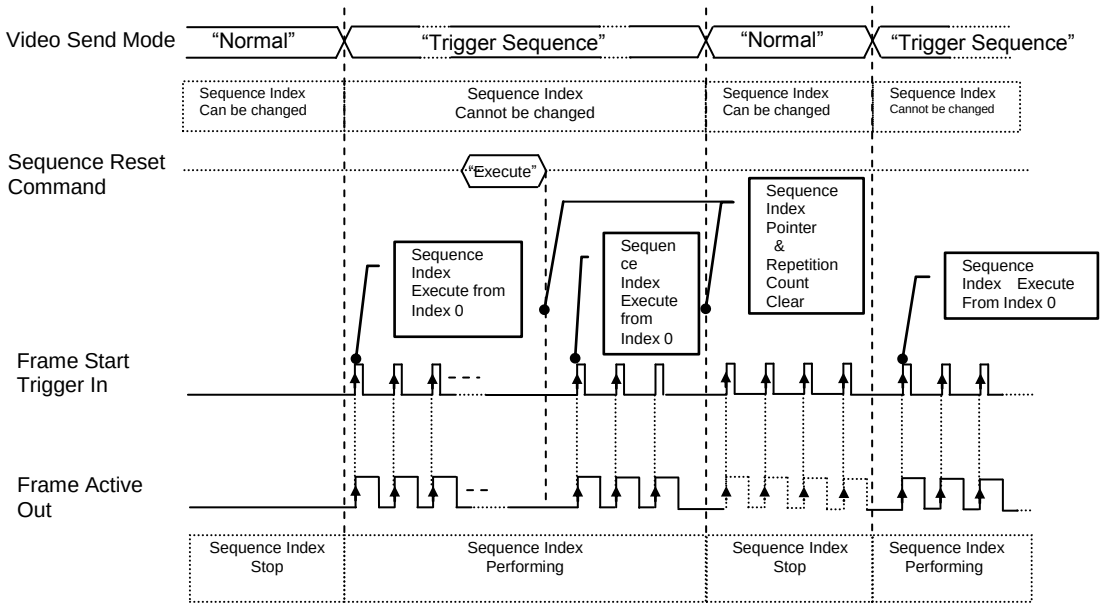


Fig. 44 Sequence trigger timing

7.10. Operation and function matrix

Table - 27 Operation and function matrix

Exposure operation	Trigger mode	Timed option	V. Binning (Note1)	H. Binning (Note1)	Exposure Time	ROI (Partial scan)	Auto White Balance (Note2)	Auto Tap Balance	Auto Iris Output (Note3)	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	○	○	×	×	○ (Note4)	○	×	○
			2	2	○	○	×	×	○ (Note4)	○	×	○
Trigger Width	ON	OFF	1	1	×	○	×	×	○ (Note4)	○	×	○
			2	2	×	○	×	×	○ (Note4)	○	×	○
Timed (RCT)	ON	RCT	1	1	○	○	○	○	○	○	○	×
			2	2	×	×	×	○	○	○	○	×
Timed (PIV)	ON	PIV	1	1	×	○	×	×	×	×	×	×
			2	2	×	×	×	×	×	×	×	×

Note 1. Only EL-2800M-USB
Note 2: Only EL-2800C-USB
Note 3: If AUX Type2 option is configured on 10P connector
Note 4: If the trigger interval is long, lens iris may exhibit “hunting” behavior.

If the video sending mode is selected other than Normal,

Video Sending Mode	Trigger Mode	Binning Vertical (Note1)	Binning Horizontal (Note1)	Exposure Time	Sequence ROI Index	Multi ROI Index
Sequence Trigger	ON	1	1	×	○	×
		2	2	×	○	×
Command Sequence	x	1	1	×	○	×
		2	2	×	○	×
Multi Mode	x	1	1	○	×	○
		2	2	○	×	○

Note 1: Only EL-2800M-USB
Note 2: TriggerOption, AutoWhiteBalance, GainAuto, ExposureAuto and Overlap are disabled.

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-USB can adjust the gain level from 0dB to +30dB using 0dB as the reference (Factory default). In the EL-2800C-USB, the master gain can be adjusted from 0dB to +27dB and R and B gains can be adjusted in the range of -7dB to + 13dB 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.

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

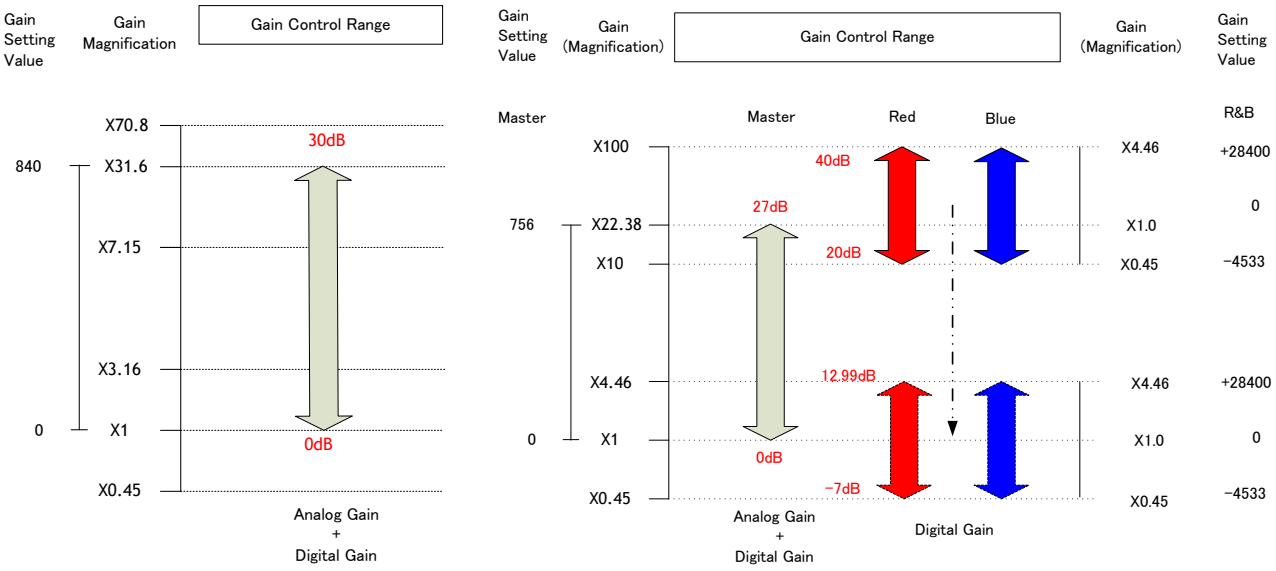


Fig. 45 Gain control

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 : 1.0～31.622
Digital Tap2All : 0.8912～1.1220
Digital Tap3All : 0.8912～1.1220
Digital Tap4All : 0.8912～1.1220

EL-2800C: AnalogAll : 1.0～22.387
Digital Red All : 0.4466～4.4668
Digital Blue All : 0.4466～4.4668
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 : -4533～28400
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 within the FOV (see figure)

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.46 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-USB, the same LUT characteristic is applied independent of the color value

8.3.1 LUT Mode

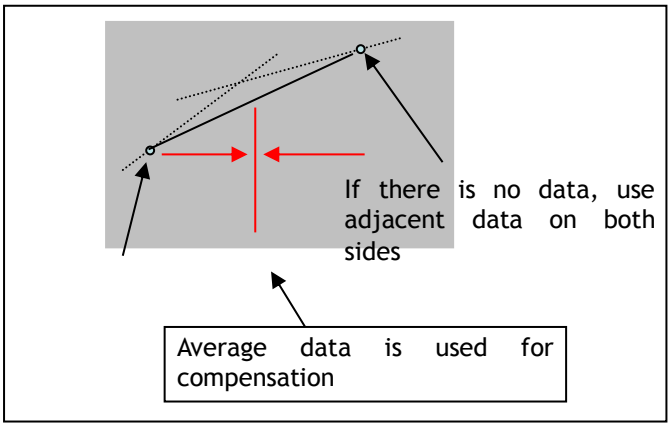
Can be selected from OFF, gamma (see section 8.4), or Lookup Table.

8.3.2 LUT Index

This represents the “starting” or “input” pixel value to be modified by the Lookup Table. The EL-2800-USB 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 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.

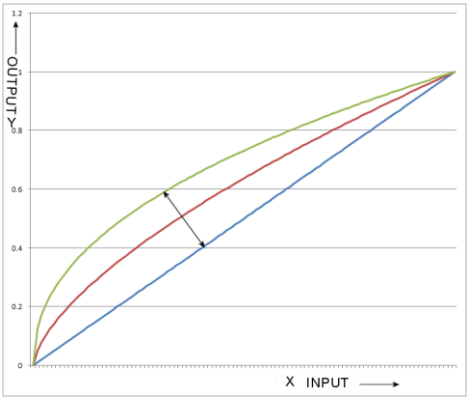


Fig. 47 Gamma compensation

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.

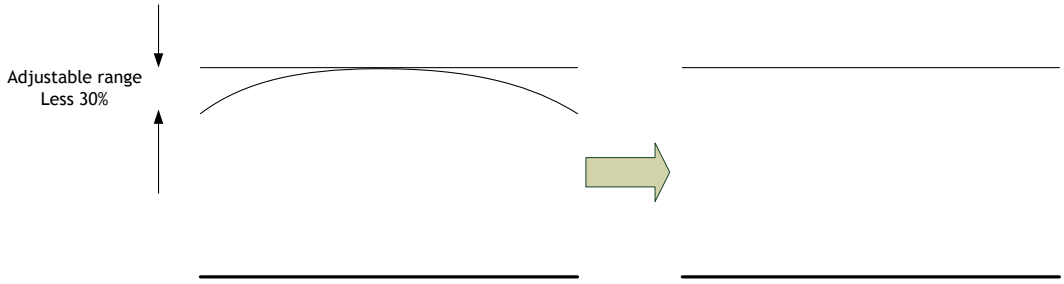


Fig. 48 Flat shading correction concept drawing

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.

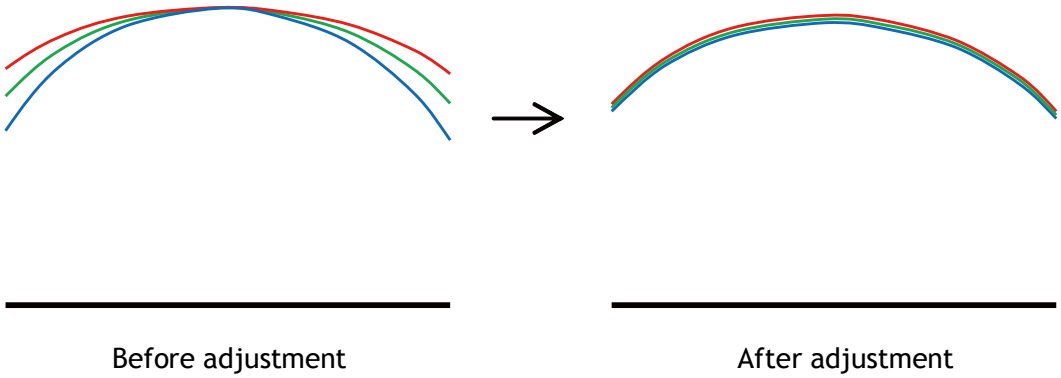


Fig.49 Color shading correction concept drawing

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-USB and EL-2800C-USB 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-USB, 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.

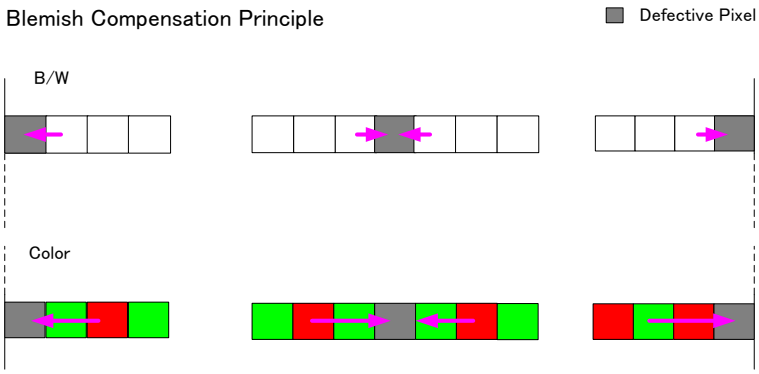


Fig. 50 Blemish compensation

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

8.7 Lens

The EL-2800-USB 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 -28 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)

8.7.1 About P-Iris

New Elite Series EL-2800M-PMCL and EL-2800C-PMCL 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).

8.7.2 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.

8.7.2.1 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

8.7.2.2 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.

8.7.2.3 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

8.7.2.4 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.

8.7.2.5 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.

8.7.2.6 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.

8.7.3 Motorized lenses

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

8.7.3.1 Iris

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

8.7.3.2 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.

8.7.3.3 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.

8.7.4 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.

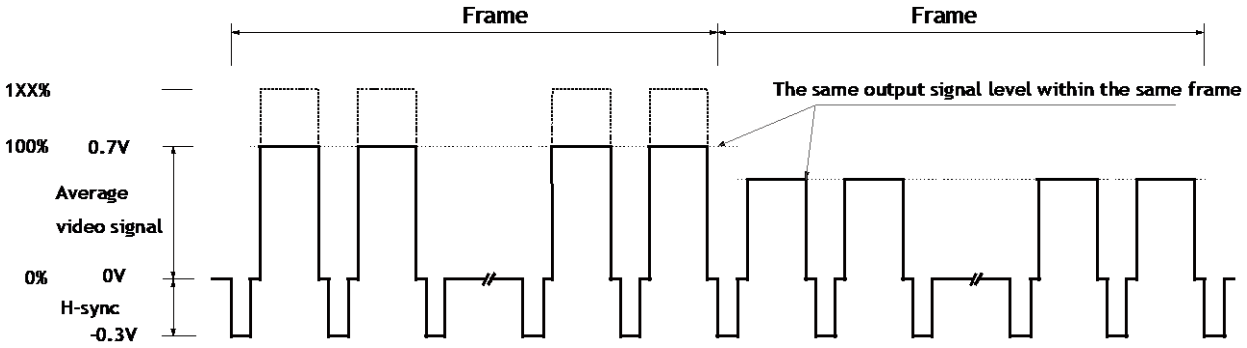


Fig. 51 Iris video output signal

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.

8.8 ALC

In the EL-2800M-USB and EL-2800C-USB, 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

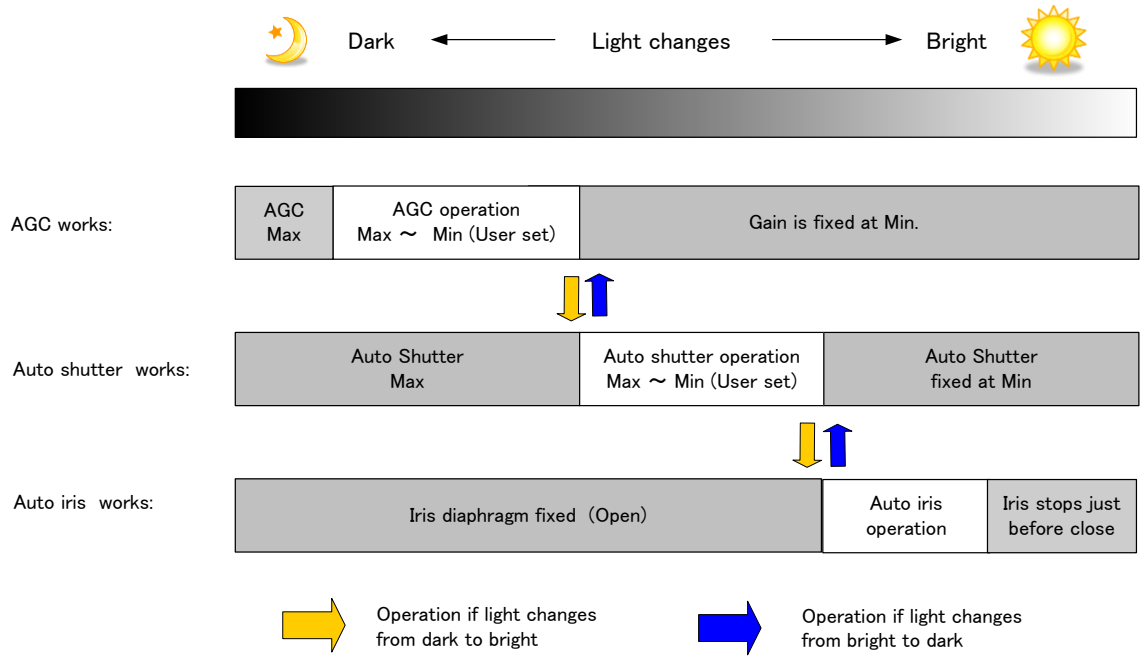


Fig.52 ALC function concept

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 Settings

9.1 Camera control Tool

In the EL-2800M-USB and EL-2800C-USB, 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 Setting

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

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

Image Format	Bit allocation	8bit Monochrome
		8bit Bayer RG
	Height	1440
	Device Tap Geometry	1x2_2YE
	Binning Horizontal	OFF
	Binning Vertical	OFF
Acquisition Control	Acquisition Mode	Continuous
	Acquisition Frame Rate	54.6
Trigger Selector		Acquisition Start
	Trigger Mode	OFF
	Trigger Source	LOW
	Trigger Activation	Rising Edge
Trigger Overlap		OFF
Exposure Control	Exposure Mode	Timed
Gain	Gain Auto	OFF
	Gain	1
Gamma		1
Video Send Mode		Normal

10. External appearance and dimensions

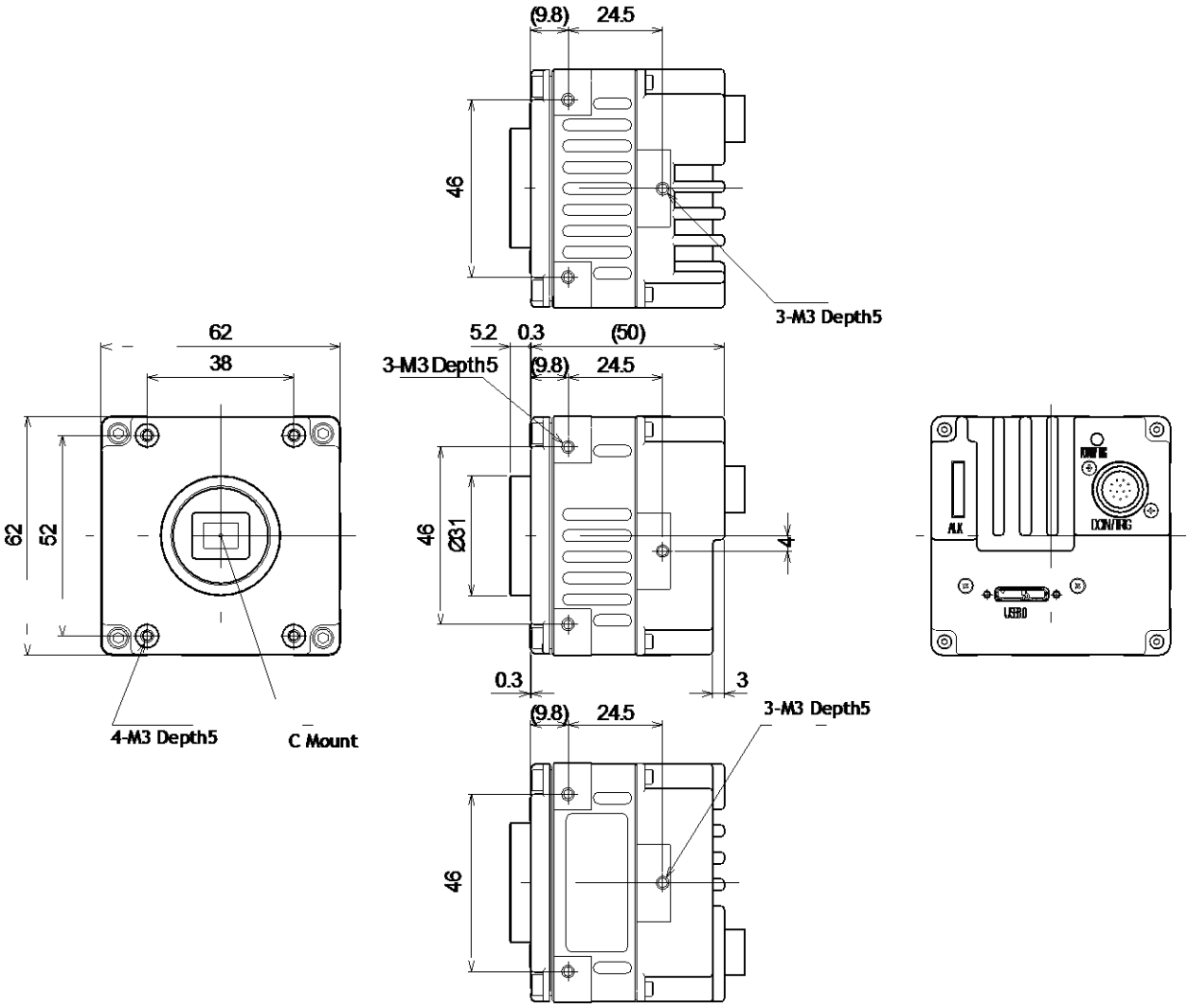


Fig. 53 Outside dimensions (C mount)

11. Specifications

11.1 Spectral response

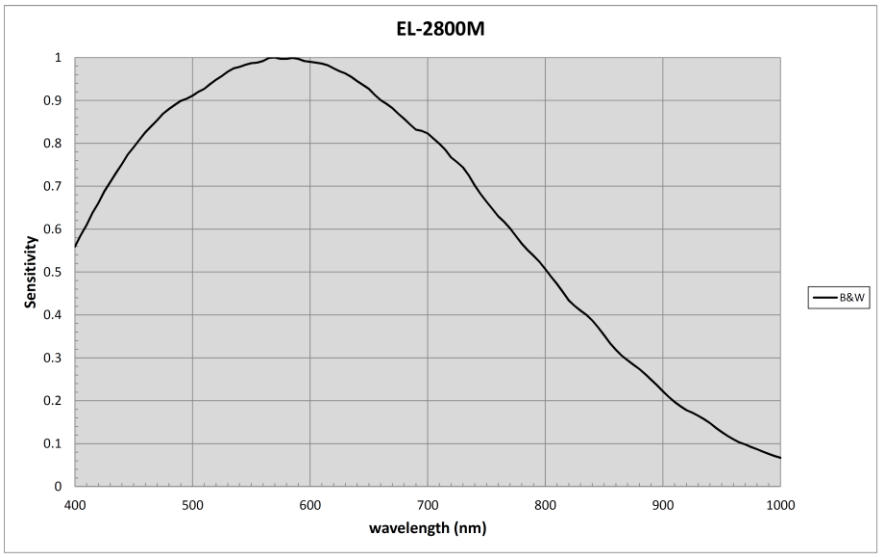


Fig. 54 Spectral response (EL-2800M-USB)

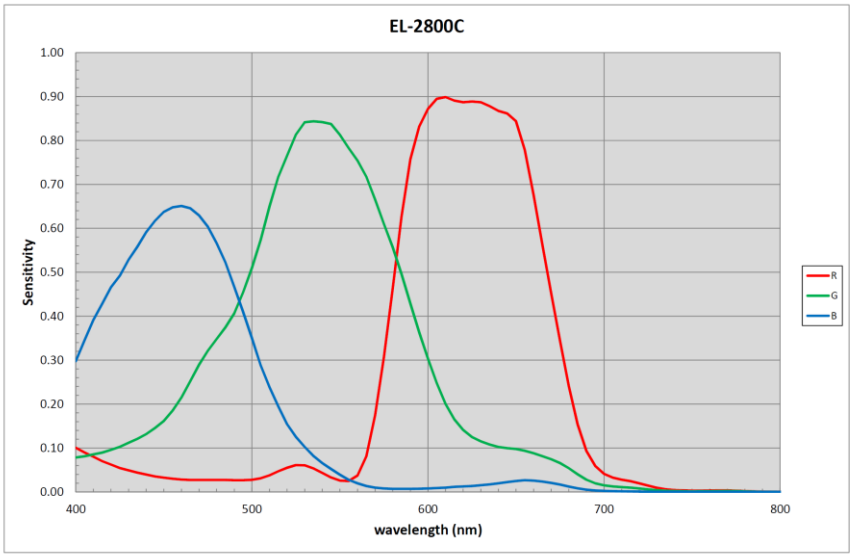


Fig.55 Spectral response (EL-2800C-USB) (With IR Cut Filter)

11.2 Specifications table

Specifications				EL-2800M-USB		EL-2800C-USB	
Scanning system				Progressive scan, 4-tap			
Synchronization				Internal			
Interface				USB 3.0 (USB3 Vision 1.0)			
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 (Minimum frame rate is 0.125 fps)	Sensor Tap Geometry			V Binning	Frame rate	V Binning	Frame rate
	1X2-2YE			V1	54.6 fps (Max)	V1	54.6 fps (Max)
				V2	91.0 fps (Max)	V2	–
	1X-1Y			V1	15.8 fps (Max)	V1	15.8 fps (Max)
				V2	28.1 fps (Max)	V2	–
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, 1 line/step		8 ～1440 lines, 2 lines/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, Mono12		BayRG8, BayRG10, BayRG12,	
Horizontal Frequency	Binning Vertical			Sensor Tap Geometry	Frequency (KHz)	Interval (μs)	Clock
	1			1X2 -2YE	40.693	24.574	2654
	1			1X - 1Y	25.519	42.519	2296
	2			1X2 -2YE	34.134	29.296	3164
	2			1X - 1Y	21.160	47.259	2552
Vertical Frequency	Binning Vertical			Sensor Tap Geometry	Frequency (Hz)	Total line number	Effective line number
	Trigger			1X2 -2YE	54.6	745	720
	1			1X - 1Y	15.8	1485	1400
	2			1X2 -2YE	91.0	375	360
	2			1X - 1Y	28.1	752	720
Trigger Selector				Acquisition		Acquisition Start / Acquisition End	
				Exposure		Frame Start	

Trigger Overlap		Acquisition Start / Acquisition End	Overlap: OFF
		Frame Start/	Overlap: OFF / READOUT (Note1)
Trigger option		OFF, JAI_RCT(w/ALC), JAI_PIV	
Video Send mode		OFF (Normal), Multi ROI, Trigger Sequence, Command Sequence	
Trigger Input Signal		Line1, 4, 5, PG0 to 1, Soft, Line 10 &11 (AUX Type 3 Option)	
Exposure Mode	OFF (Frame Start disable)	Minimum frame rate ～ 8 sec. (Max.) Variable unit: 1 μs	
	Timed	10 μs (Min.) ～ 8 sec (Max.) Variable unit: 1 μs (In RCT and PIV, the maximum value is the maximum frame rate in each mode)	
	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 +13dB, Less 0.01dB/ step
	WB Area		4 x 4
	WB Range		3000K ～ 9000K
	White Balance		OFF, Once, Continuous Preset (4600K, 5600K, 6500K)
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.
Power	Input range	DC+12V to +24V ± 10% (At the input terminal)	
	Current Consumption	460mA ± 10% (At 12V input on 12P, Full/Bayer image, Lens drive OFF) 485mA ± 10% (At 12V input on 12P, ROI, Lens drive OFF) 160mA ± 10% (At 5V input, USB VBUS)	
	Power consumption	6.32W (At 12V input on 12P Full/Bayer image, Lens drive OFF) 6.62W (At 12V input on 12P, ROI, Lens drive OFF)	
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 670 nm)
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	215 g

Note1): Except “Timed Option OFF”, Readout of Trigger Overlap is not available.
Note2): Approximately 5 minutes pre-heating is required to achieve these specifications.
Note3): 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.

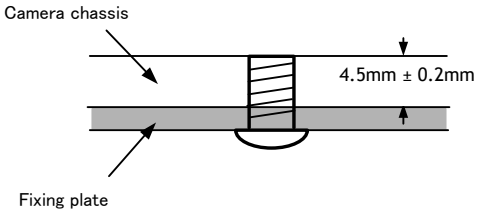
Patterned Noise
When the sensor captures a dark object at high temperature or is used for long time integration, fixed pattern noise may appear on the video monitor screen.

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.

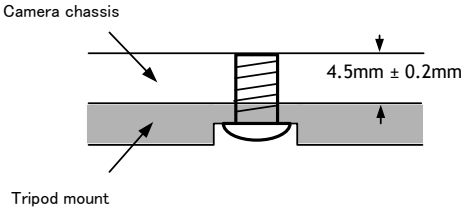
4. Caution when mounting the camera

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.



Attaching the tripod mount

5. Exportation

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

6. References

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

Manual change history

Date	Revision	Changes
May 2014	Preliminary	New release
July 2014	1.0	Release
Sept. 2014	1.1	Revised Spectral Response
Oct. 2014	1.2	Revised B/W spectral response with wider wave length range
May 2015	1.3	Add the description of the optical interface

User's Record

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

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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