CIS

CoaXPress I/F
5M CMOS Color (RAW) Camera

VCC-5CXP4R

Product Specifications
& Operational Manual

(Preliminary)

CIS Corporation

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1. Handling Precautions

1.1. Camera Handling Precautions

- ☐ Do not use or store camera in dusty or humid places.
- ☐ Do not apply excessive force, vibration, or static electricity that could damage camera. Please handle camera with care.
- ☐ Do not shoot direct images that are extremely bright (e.g., strong light source, sun, etc.). When extremely strong light source is shot, smear or blooming may occur. Put the lens cap on when camera is not in use.
- ☐ Follow the instructions in Chapter 3.3., "External Connector" for connecting camera.
  Improper connection may cause damages not only to the camera but also to the connected devices.
- ☐ Confirm mutual ground potential carefully before connecting camera to monitors or computers.
  Any AC leak from the connected devices may cause damages or destroy the camera.
- ☐ Do not apply excessive voltage. (Use only the specified voltage.) Unstable or improper power supply voltage may cause damages or malfunction of the camera.
- ☐ Voltage ripple of camera power must be within ±50mV. Improper power supply voltage may cause noises on video signals.
- ☐ Rise time of camera power supply voltage must be less than +10V, Max. 60ms. Please avoid noises like chattering.
- ☐ Our warranty does not apply to damages or defects caused by irregular and/or abnormal use of the product.

Our warranty does not apply to damages or defects caused by neglecting the instructions and precautions explained in this manual.

1.2. Restrictions on Applications

- ☐ The camera must not be used for any nuclear equipment or aerospace equipment with which mechanical failure or malfunction could result in serious bodily injury or loss of human life.
- ☐ The camera must not be used under conditions or environments other than those specified in this manual.

1.3. Disclaimers (Exception Clause)

CIS should not be liable for any damages or losses if;

- damages or losses are caused by earthquake, lightning strike, fire, flood, or other acts of God.
- damages or losses are caused by deliberate or accidental misuse by user, or failure to observe information and instructions explained in this manual.
- damages or losses are caused by repair or modification conducted by user or any unauthorized party.

2. Product Outline

VCC-5CXP4R is a color camera with CoaxPress interface.
Using 2/3", global shutter type 5.01M pixels CMOS image sensor, frame rate reaches 163.4fps with CXP6x2 8bit. Complies with CoaXPress Version 1.1.1.
Must have function ready for Machine Vision applications such as trigger shutter, ROI, Gain, black level adjustment, and defective pixels correction. Suitable for various FA/Machine Vision applications.

2.1. Features

- ☐ Global shutter type, CMOS sensor (Color)
- ☐ Complies with CoaXPress Ver. 1.1.1.and supports CXP-3 and CXP6.
- ☐ Supports 2 lanes or 1 lane.
- ☐ ROI function (Vertical 8 areas)
- ☐ Exposure setting, Gain setting
- ☐ External trigger mode (Fixed trigger shutter mode/Pulse width trigger shutter mode)
- ☐ Complies with GenICam
- ☐ C lens mount
- ☐ 55mm(H) x 55mm(W) x 30mm(D) in size

3. Specifications

3.1. General Specifications

Electrical Specifications			
Image sensor	Sensor type	2/3", Global shutter type CMOS sensor	
	Effective pixels	2464 (H) × 2056 (V)	
	Unit cell size	3.45µm (H) × 3.45µm (V)	
Interface		Complies with CoaXPress Ver. 1.1.1. Supports CXP6 and CXP3_x2 and x1	
Video output format		BayerRG8 / BayerRG10 / BayerRG12 BayerGR8 / BayerGR10 / BayerGR12 (with horizontal flip setting) BayerGB8 / BayerGB10 / BayerGB12 (with vertical flip setting) BayerBG8 / BayerBG10 / BayerBG12 (with horizontal and vertical flip setting)	
Frame rate	CXP-3 x1 8/10/12bit	54.5fps / 43.6fps / 36.3fps	
	CXP-3 x2 8/10/12bit	108.8fps / 87.1fps / 72.7fps	
	CXP-6 x1 8/10/12bit	108.8fps / 87.1fps / 72.7fps	
	CXP-6 x2 8/10/12bit	163.4fps / 144.7fps / 89.5fps	
Sync. system		Internal sync.	
Resolution (maximum resolution)		2464 (H) × 2056(V)	
Video signals (Gain 0dB)	White clip level	255dig	with 8bit
	Set up level	0～2dig	with 8bit
	Dark shading	Under 4dig for both vertical and horizontal	with 8bit
Sensitivity		TBD 2000lx (8bit mode, gain x1, shutter 5001us)	
Minimum illumination		TBD (CXP-6x1, 8bit mode, gain x16, shutter 9041us, level=50%)	
Gain variable range		8bitMode: x1～x16 (0dB～+24dB) [guarantee range] 10bit/12bit/Low Frame Rate Mode: x1～x64 (0dB～+36dB) [guarantee range]	
White balance adjustment range		2800K ～ 9000K	
Shutter speed		Manual	
Trigger mode		Free run mode (Camera internal trigger) Trigger mode (Host, External terminal) ・ Fixed trigger shutter ・ Pulse width trigger shutter	
Partial scan		Vertical 8 areas	
Power requirements		PoCXP (18.5~26V) or 6pins circular connector (12~26V) TBD (Cable length of power supply cable with circular connector must be less than 10m.)	
Power consumption		TBD 4.6W (CXP-6 2lane) [with free run]	

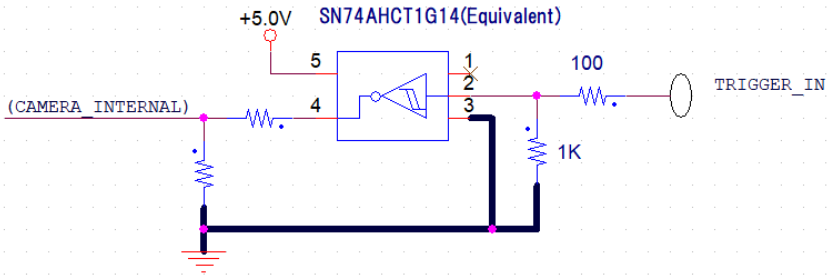
Mechanical Specifications	
Dimensions	H: 55mm W: 55mm D: 30mm excluding projection.
Weight	Approx. 140g
Lens mount	C mount

Environmental Specifications			
Safety/Quality standard (To be applied for)		UL: Complies with UL standard including materials. CE EMC: 2014/30/EU To be applied for Emission: EN61000-6-4:2007+A1:2011 To be applied for Immunity: EN61000-6-2:2019 RoHS: 2011/65/EU (EU)2015/863 Complies with EN50581 (RoHS2)	
Durability	Vibration	Acceleration	: 98m/s^2 (10G)
		Frequency	: 20 ~ 200Hz
		Direction	: X, Y, and Z 3 directions
		Testing time	: 120min for each direction
	Shock	No malfunction with 980m/s^2(100)G for ±X, ±Y, and ±Z 6 directions without packaging.	
Operational temperature		0 ~ +45°C Humidity: 20 ~ 80%RH with no condensation.	
Storage temperature		-30 ~ +60°C Humidity: 20 ~ 80%RH with no condensation.	

3.2. Input and Output Specifications

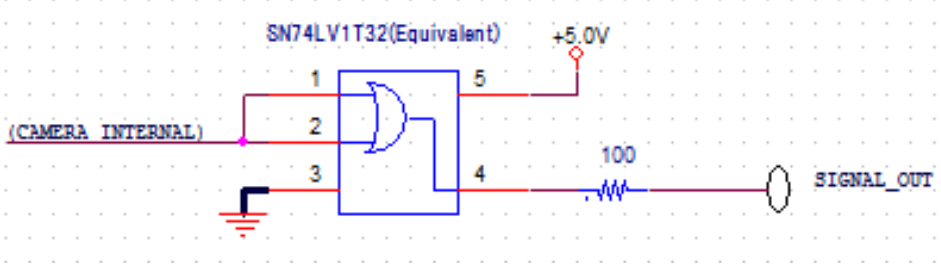
3.2.1 TRIGGER_IN Input (6pins connector No.5 pin)

- ☐ 5.0V, 3.3V CMOS level / TTL level
- ☐ Input voltage Low: 0.5Vdc (Max.), High: 2.1Vdc (Min.)
- ☐ This is to directly input a trigger from an external equipment. To use this terminal, set Trigger Source of AcquisitionControl to Line0.



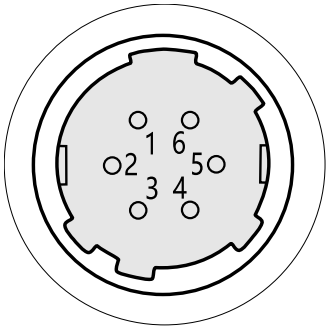
3.2.2 SIGNAL_OUT Output (6pins connector No.3pin)

- ☐ 5.0V CMOS logic level output
- ☐ Output voltage Low: 0.55Vdc (Max.), High: 3.8Vdc (Min.)
- ☐ This is to output a timing signal of the camera. Set a signal with Line Source of Digital IO Control.



3.3. External Connector Pin Assignment

3.3.1 6pins Circular Connector (I/O)



Pin No.	Signals	Note
1	POWER	Power input
2	NC	
3	Line1	SIGNAL_OUT (Exposure/FVAL/LVAL/LinkTrigger)
4	NC	
5	Line0	Trigger IN
6	GND	GND

HR10A-7R-6PB

(HIROSE or equivalent)

※NC=Non-Connection. Do not connect anything to the terminal.

※Recommended value for power voltage

1. Power voltage: E [V]
2. Cable length to use: ℓ[m]
3. Resistance value per 1m of cable to use: r [Ω/m]

Formula to calculate output voltage of external power:

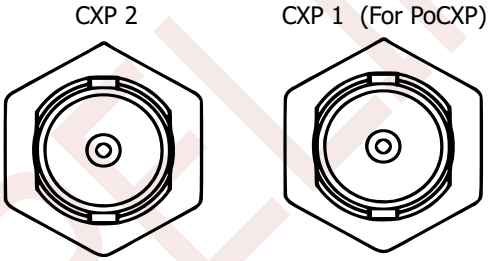
E[V]=24[V]+r[Ω/m]×ℓ[m]×0.2[A]

Supply E [V] from external power to the camera and make sure that camera connector input will be within the range of the specified power voltage.

※To supply power from 6pins circular connector, stop supplying power from CoaXPress cable to avoid malfunction of the camera.

3.3.2 75Ω BNC Connector

- ☐ CoaXPress video output signals
- ☐ CXP 1 is for PoCXP connection.



3.3.3 LED Indicator

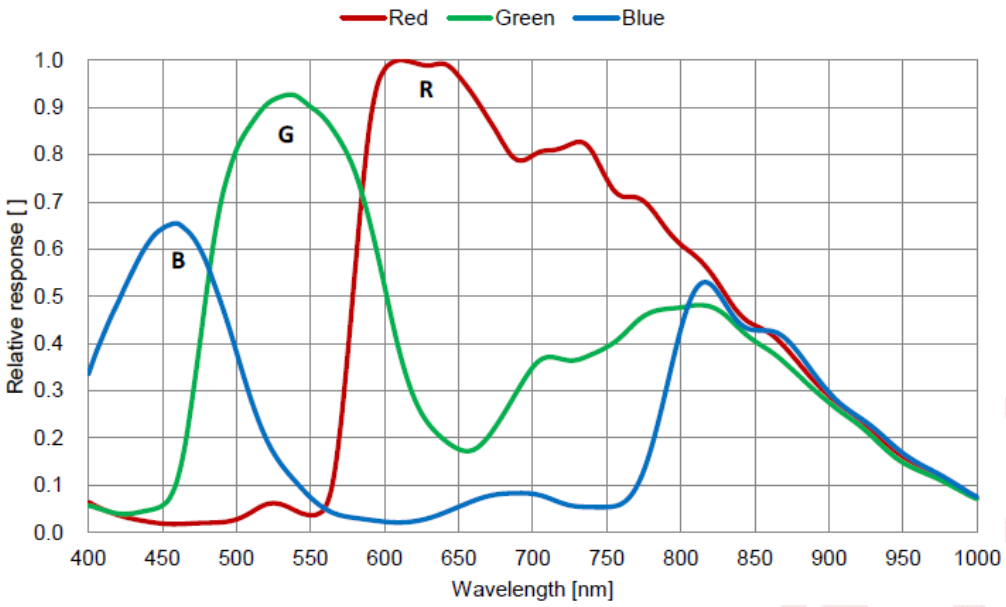
☐ With LED indicator active, lighting patterns show the camera status by its way of lighting.

LED	**Camera status**
OFF	No power supply.
Green/Orange fast blinking [12.5Hz]	No cable connection. (※)
Green lighting	Completion of connection between device and host.
Green fast blinking [12.5Hz]	Transmitting video data.
Orange slow blinking [1Hz]	Waiting for a trigger input.
Red fast blinking [12.5Hz]	System error or inappropriate trigger input.

※When the number of cable connections does not meet the number of links designated with ConnectionConfig, LED will be Green/Orange fast blinking [12.5Hz]

3.4. Spectral Response

※ Excludes characteristics of lens, optical glasses, and light source.



3.5. Frame Rate

3.5.1. Frame rate with Internal Sync. Mode

[Formula for calculating frame rate]

Frame rate = 1/(Time for 1 line x (Output video line count+38)) [fps]

Please refer to the following table for the time for 1 line and frame rate value with full size output.

※ Frame rate with full size = 1/(Time for 1 line x (2056+38))

LinkConfig	PixelFormat (※)	Time for 1 line [μs]	Frame rate with full size [fps]	Frame time with full size [ms]
CXP6_x2	BayerRG8	2.923	163.4	6.120
	BayerRG 10	3.300	144.7	6.909
	BayerRG 12	5.333	89.5	11.168
CXP6_x1	BayerRG 8	4.391	108.8	9.194
	BayerRG 10	5.481	87.1	11.478
	BayerRG 12	6.572	72.7	13.763
CXP3_x2	BayerRG 8	4.391	108.8	9.194
	BayerRG 10	5.481	87.1	11.478
	BayerRG 12	6.572	72.7	13.763
CXP3_x1	BayerRG 8	8.768	54.5	18.360
	BayerRG	10.963	43.6	22.956
	BayerRG 12	13.145	36.3	27.525

※ PixelFormat with flipping function disabled (Off). Frame rate stays the same when flipping function enabled (On).

The following command enables to readout frame rate of internal sync. mode.

AcquisitionControl	
AcquisitionFrameRate	(Read Only)

- AcquisitionFrameRate: This is to indicate the frame rate with internal sync mode (free run mode).

※Even with external trigger mode, this command shows frame rate with internal sync mode.

3.5.2. Frame rate with External Trigger Sync. Mode

The maximum frame rate with H sync. trigger (LineSync) mode is the value of the internal sync. mode explained in the above section.

User can calculate the maximum frame rate with CLk sync. trigger (ClkSync) mode with the formula below.

Max. frame rate = 1/(Exposure time + (Time for 1 line x (Output video line count +38)))

However, without ROI, and when exposure time is less than 16 lines, the following formula applies.

Max. Frame rate = 1/(Exposure time + (Time for 1 line x 2110))

※Input trigger with the cycle less than the maximum frame rate explained in the above.

※Please refer to Section 3.5.1. Frame rate with Internal Sync. Mode for the time for 1 line.

※Please refer to Section 4.6.2. External Trigger Mode for details on external sync mode.

4. Camera Functions

4.1. Camera Interface

☐ Complies with CoaXPress1.1.1 standard.

4.2. How to Save and Initialize Settings

☐ This is a function to save camera settings in operation into nonvolatile memory and to load setting values saved in the nonvolatile memory.

UserSetControl	
UserSetSelector	Default UserSet0
UserSetLoad	(Execute)
UserSetSave	(Execute)

☐ UserSetSelector: This is to save the current setting values or to select setting values saved in nonvolatile memory to read out.

- Default: Factory setting. (User can execute UserSetLoad only. UserSetSave is not subject to save.)
- UserSet0: User settings.

※ Default (Factory setting) is not subject to save.

※ Values of UserSetSelector are not subject to save with UserSetSave. The values always become Default upon next rebooting. Please set values before executing UserSetLoad or UserSetSave.

☐ UserSetLoad: This is to load setting values selected with UserSetSelector.

☐ UserSetSave: This is to save the current setting values to the area selected with UserSetSelector. Make sure to set UserSetSelector to UserSet0 to execute.

☐ Do not execute UserSetLoad while grabbing (acquiring images).

☐ Defective pixel correction values, DeviceUserID, and DeviceUserString are not subject to UserSetLoad for Default. (Camera keeps those values.)

☐ ConnectionConfig, PixelFormat, ImageQualityMode, ReverseX, and ReverseY are not subject to UserSetLoad so that camera keeps values in operation. If you wish to change those values, set values with each command.

Please refer to the table below to save and load settings.

UserSetSelector	UserSetLoad/Save	Status
Default	UserSetLoad	Load Factory settings.
	UserSetSave	- (Not subject to execute.)
UserSet0	UserSetLoad	Load user settings.
	UserSetSave	Save user settings.

4.3. Link Speed and Link Count

Transfer Control	
ConnectionConfig	CXP3_X1 CXP3_X2 CXP6_X1 CXP6_X2

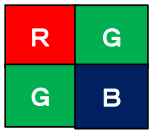
- ConnectionConfig: Selection of Link speed and Link count
  CXP3_X1: Link speed=3.125Gbps, Link count=1
  CXP3_X2: Link speed=3.125Gbps, Link count=2
  CXP6_X1: Link speed=6.250Gbps, Link count=1
  CXP6_X2: Link speed=6.250Gbps, Link count=2

※ Do not change ConnectionConfig while grabbing (acquiring images).

4.4. Pixel Format

ImageFormatControl	
PixelFormat	BayerRG8 BayerRG10 BayerRG12 BayerGR8 (ReverseX = On) BayerGR10 (ReverseX = On) BayerGR12 (ReverseX = On) BayerGB8 (ReverseY= On) BayerGB10 (ReverseY= On) BayerGB12 (ReverseY= On) BayerBG8 (ReverseX= On, ReverseY= On) BayerBG10 (ReverseX= On, ReverseY= On) BayerBG12 (ReverseX= On, ReverseY= On)

- PixelFormat: Selection of Pixel format
  - BayerRG8 : Bayer 8bit
  - BayerRG10 : Bayer 10bit
  - BayerRG12 : Bayer 12bit
  - BayerGR8 : Bayer 8bit (ReverseX = On)
  - BayerGR10 : Bayer 10bit (ReverseX = On)
  - BayerGR12 : Bayer 12bit (ReverseX = On)
  - BayerGB8 : Bayer 8bit (ReverseY= On)
  - BayerGB10 : Bayer 10bit (ReverseY= On)
  - BayerGB12 : Bayer 12bit (ReverseY= On)
  - BayerBG8 : Bayer 8bit (ReverseX= On, ReverseY= On)
  - BayerBG10 : Bayer 10bit (ReverseX= On, ReverseY= On)
  - BayerBG12 : Bayer 12bit (ReverseX= On, ReverseY= On)
  -
  - Bayer Pattern of VCC-5CXP4R is"RGGB" as shown as the figure to the left.
  - Bayer Pattern also flips when images flip in X and Y directions as explained in section 4.5. Flip.
  - PixelFormat RG, GR, GB, and BG also change accordingly.



※ Do not change PixelFormat while grabbing (acquiring images).

4.5. Flip

☐ This is a function to flip images in X direction or Y direction.

☐ With True, function flips image with normal rotation. With False, function flips mage with reversal rotation.

ImageFormatControl	
ReverseX	True/False
ReverseY	True/False

- ReverseX: Flip the image in X direction.
- ReverseY: Flip the image in Y direction.

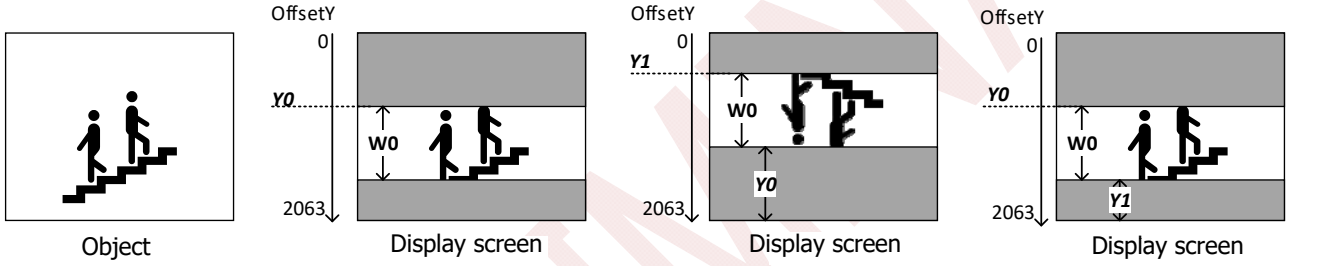
※ Do not change ReverseX/Y while grabbing (acquiring images)

※ Bayer Pattern also flips when images flip in X and Y directions.

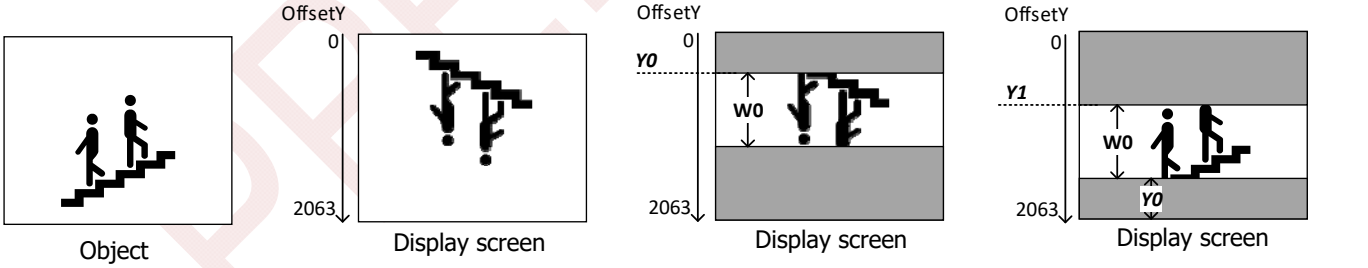
※ RG, GR, GB, and BG of frame grabber board also change accordingly.

※ With ROI, the origin coordinate (0) of OffsetY appears on the display screen regardless of On/Off of flipping.
The illustration below shows coordinates according to the setting order of ReverseY and ROI.

- Flip operation with ROI



- ROI operation with flip



4.6. Trigger Mode

There are 2 types of trigger modes; internal sync. mode and external trigger mode.
Trigger mode is selectable with the following commands.

Acquisition Control	
TriggerMode	Off/On
TriggerSelector	AcquisitionStart FrameStart

- TriggerMode : Trigger mode (Links with TriggerSelector)
  Off: Operates with internal sync mode (free run mode) (TriggerSelector = AcquisitionStart)
  On: Operates with external trigger mode (TriggerSelector = FrameStart)
  ※Do not change TriggerMode while grabbing (acquiring image).

- TriggerSelector: Trigger selector (Links with TriggerMode)
  AcquisitionStart: Operates with internal sync mode (Free run mode) (TriggerMode = Off)
  FrameStart: Operates with external trigger mode (TriggerMode = On)
  ※Do not change TriggerSelector while grabbing (acquiring image).

4.6.1 Internal Sync. Mode (Free Run Mode)

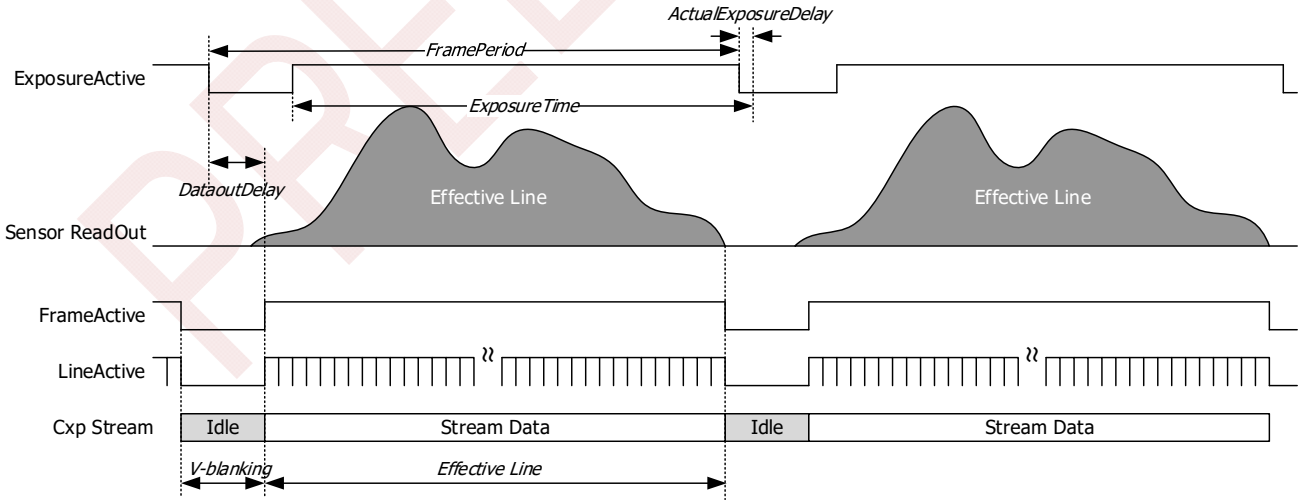
☐ This is a mode to use internal triggers continuously generated.

☐ Turn off TriggerMode and set TriggerSelector to AcquisitionStart.
※When TriggerSyncMode (explained later) is with ClockSync, user cannot turn TriggerMode Off.
Please set to LineSync.

☐ For frame rate, please refer to section 3.5.1. Frame rate with Internal Sync Mode.

☐ Set exposure time with ExposureTime command. Please refer to section 4.7. Exposure Time.

☐ The following shows timing chart and timing parameter with internal sync mode.



Vertical sync. Timing chart (with free run) TriggerMode=Off

Timing Parameter	Value	Description
Dataout Delay	35	Time from ExposureActive falling edge to FrameActive rising [H]
V-blanking	38	Vertical blanking line count [H]
Actual Exposure Delay	13.73	Delay time from ExposureActive falling edge to the completion of exposure of the sensor. [µs]

※For time for 1H, please refer to the time for 1 line in Section 3.5.1. Frame rate with Internal Sync. Mode.
※ExposureActive outputs for a period of difference between Actual Exposure Delay and ExposureTime setting, subtraction of Actual Exposure Delay from ExposureTime setting.

4.6.2 External Trigger Mode

☐ This is a mode to input external trigger signals to capture images by any preferred timings.

☐ Turn on TriggerMode and set TriggerSelector to FrameStart. When TriggerMode is off, the camera will become internal sync mode.

☐ User can select function details with the following commands. (Make sure to stop inputting triggers while selecting function.)

Acquisition Control	
TriggerSyncMode	LineSync ClockSync
TriggerSource	LinkTrigger0 Line0 Software
TriggerSoftware	(Execute)
TriggerActivation	RisingEdge FallingEdge LevelHigh LevelLow

- TriggerSyncMode:
  - LineSync : H sync trigger mode (Controls exposure time per line)
    - ※High frame-rate operation is valid by overlapping operation (exposure while reading out images).
    - ※Since it synchronizes with H, 1 line of jitter may occur for external trigger input.
  - ClockSync: CLK sync trigger mode (Controls exposure time per sensor clock)
    - ※Overlapping operation (exposure while readout images) is invalid.
    - ※Since it synchronizes with CLK, this mode can start exposure with low-latency for external trigger input.

- TriggerSource: This is to select where to send external triggers.
  - LinkTrigger0: External trigger input from CoaXPress Host Device.
    - ※Please refer to specification manuals of the Host Device such as frame grabber board to know how to generate triggers.
  - Line0: External trigger input from 6pins circular connector.
  - Software: Input trigger with TriggerSoftware command.
    - ※Software Trigger is valid only when TriggerActivation is Rising Edge.

- TriggerSoftware: Camera generates a trigger to capture one frame image by executing this command. Make sure to set TriggerSource to Software.

- TriggerActivation: This is to select how to start capturing video or its polarity.
  - RisingEdge: Fixed trigger shutter mode: Start exposure (Timed) with rising edge.
  - FallingEdge: Fixed trigger shutter mode: Start exposure (Timed) with falling edge. (※)
  - LevelHigh: Pulse width trigger shutter mode: Exposure during high active period. (TriggerWidth)
  - LevelLow: Pulse width trigger shutter mode: Exposure during low active period. (TriggerWidth) (※)

※If user set FallingEdge and LevelLow with LinkTrigger0, disturbed images may occur on the first grabbing.

Combination of trigger mode ※Please refer to the next section for detail on each combination.

No	TriggerMode	TriggerSyncMode	TriggerActivation	TriggerSource
1	Off	LineSync	-	-
2	On	LineSync	RisingEdge/FallingEdge	LinkTrigger0/Line0/Software
3	On	ClockSync	RisingEdge/FallingEdge	LinkTrigger0/Line0/Software
4	On	LineSync	LevelHigh/LevelLow	LinkTrigger0/Line0
5	On	ClockSync	LevelHigh/LevelLow	LinkTrigger0/Line0

4.6.3 Fixed trigger shutter mode + H sync trigger (LineSync)

(TriggerMode=On, TriggerSyncMode=LineSync, TriggerActivation= RisingEdge)

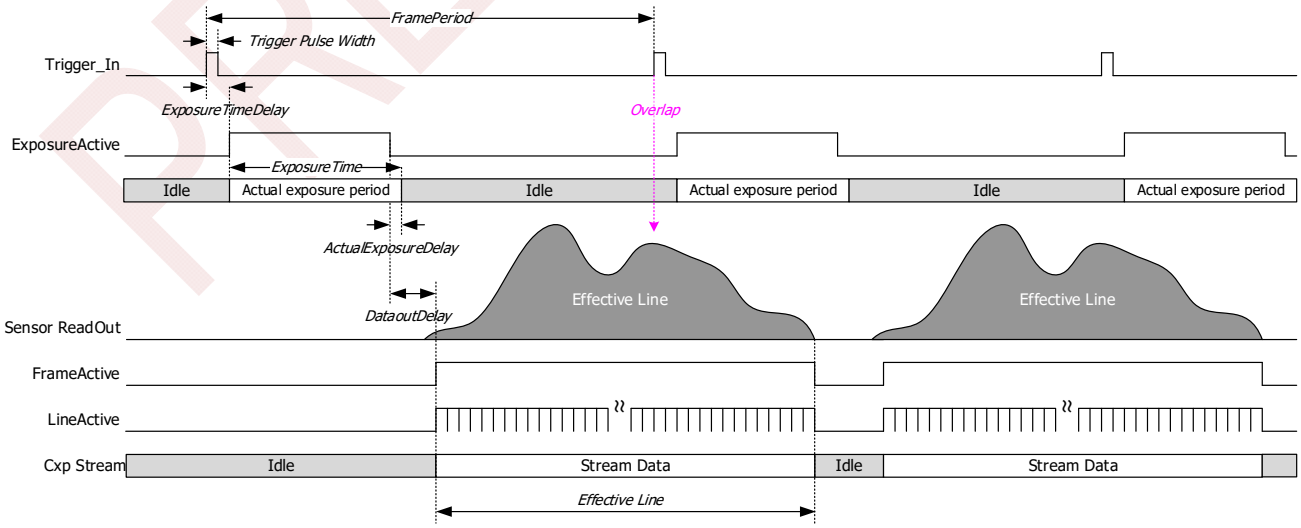
☐ This is a mode to start exposure with external trigger input and expose for a set period with ExposureTime command explained in section 4.8.

☐ Trigger operation is H sync. High speed operation is valid since user can input the next trigger while reading out images (=overlap). However, 1H jitter will occur to exposure timing due to H sync. operation.

☐ Set Frame rate (=trigger input cycle) lower than the maximum frame rate explained in Section 3.5.2. Frame rate with External Trigger Sync. Mode.

☐ There are some restrictions for trigger input. Please refer to Section 4.6.7. Restrictions on Trigger Pulse Input Timing.

☐ The following shows the timing chart and the timing parameter with internal sync. mode + H sync trigger (LineSync)



Vertical sync. timing chart (Fixed trigger shutter mode + H sync. trigger (LineSync))

Timing Parameter	Value	Description
Trigger Pulse Width	1	Trigger input pulse width (minimum value) [H]
Exposure Time Delay	2 ~ 3	Delay time from rising edge of trigger input to ExposureActive rising [H]
Actual Exposure Delay	13.73	Delay time from falling edge of ExposureActive to completion of exposure of the sensor [µs]
Dataout Delay	35	Time from falling edge of ExposureActive to FrameActive rising [H]

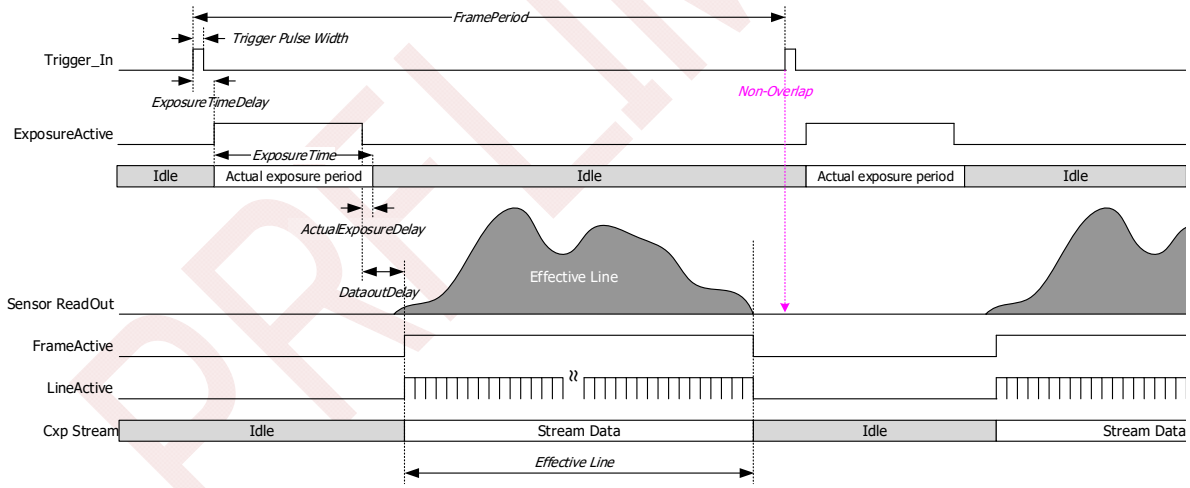
※For time for 1H, please refer to the time for 1 line in Section 3.5.1. Frame rate with Internal Sync. Mode.

※ExposureActive outputs for a period of difference between Actual Exposure Delay and ExposureTime setting, subtraction of Actual Exposure Delay from ExposureTime setting.

4.6.4 Fixed trigger shutter mode + CLK sync trigger (ClockSync)

(TriggerMode=On, TriggerSyncMode=ClockSync, TriggerActivation= RisingEdge)

- ☐ This is a mode to start exposure with external trigger input and expose for a set period with ExposureTime command explained in section 4.8.
- ☐ Since trigger synchronizes with CLK, this mode can start exposure with low-latency. User cannot input the next trigger while reading out images.
- ☐ Set Frame rate (=trigger input cycle) lower than the maximum frame rate explained in Section 3.5.2. Frame rate with External Trigger Sync. Mode.
- ☐ There are some restrictions for trigger input. Please refer to Section 4.6.7. Restrictions on Trigger Pulse Input Timing.
- ☐ The following shows the timing chart and the timing parameter with fixed trigger shutter mode + CLK sync trigger (ClockSync)



Vertical sync. timing chart (Fixed trigger shutter mode + CLK sync. trigger (ClockSync))

Timing Parameter	Value	Description
Trigger Pulse Width	1	Trigger input pulse width (minimum value) [µs]
Exposure Time Delay	0.013	Delay time from the rising edge of trigger input to ExposureActive rising [µs]
Actual Exposure Delay	13.78	Delay time from falling edge of ExposureActive to completion of exposure of the sensor [µs]
Dataout Delay	35	Time from falling edge of ExposureActive to FrameActive rising [H]

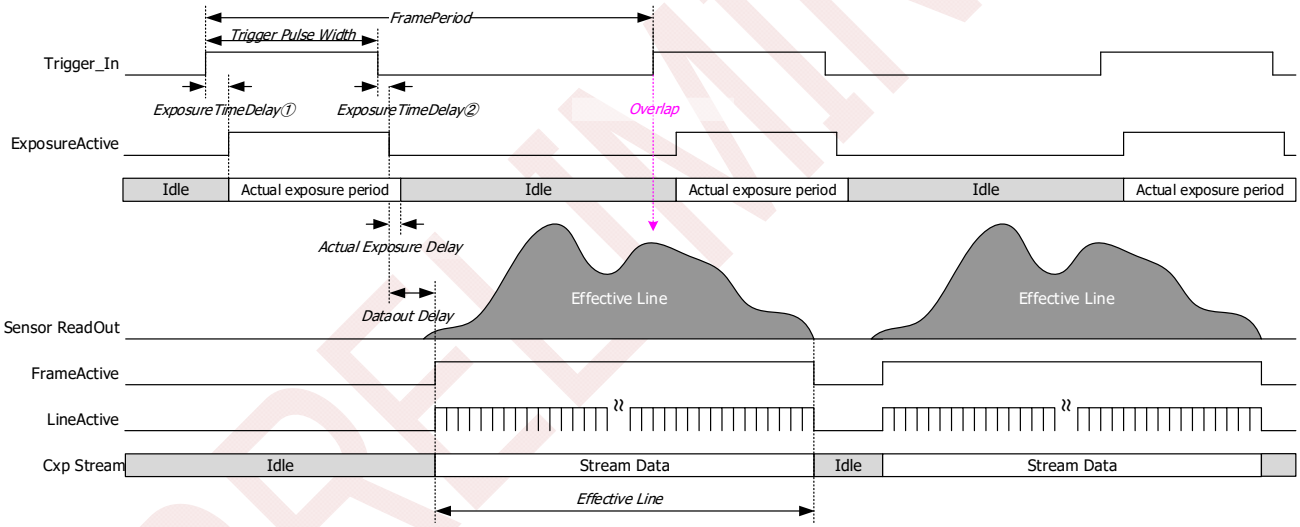
※For time for 1H, please refer to the time for 1 line in Section 3.5.1. Frame rate with Internal Sync. Mode.

※ExposureActive outputs for a period of difference between Actual Exposure Delay and ExposureTime setting, subtraction of Actual Exposure Delay from ExposureTime setting.

4.6.5 Pulse width trigger shutter mode + H sync trigger (LineSync)

(TriggerMode=On, TriggerSyncMode=LineSync, TriggerActivation=LevelHigh)

- ☐ This is to start exposure with external trigger input, and control exposure time with trigger pulse width.
- ☐ Trigger operation is H sync. High speed operation is valid since user can input the next trigger while reading out images (=overlap). However, 1H jitter will occur to exposure timing due to H sync. operation.
  ※Please note that 1H jitter may occur at exposure start and exposure end so that exposure time may change.
- ☐ Long time exposure is valid by extending trigger pulse width. However, noises such as dark noise and shading noise may become noticeable.
- ☐ Set Frame rate (=trigger input cycle) lower than the maximum frame rate explained in Section 3.5.2. Frame rate with External Trigger Sync. Mode.
- ☐ There are some restrictions for trigger input. Please refer to Section 4.6.7. Restrictions on Trigger Pulse Input Timing.
- ☐ The following shows the timing chart and the timing parameter with pulse width trigger shutter mode + H sync. trigger (LineSync)



Vertical sync. timing chart (Pulse width trigger shutter mode + H sync. trigger (LineSync))

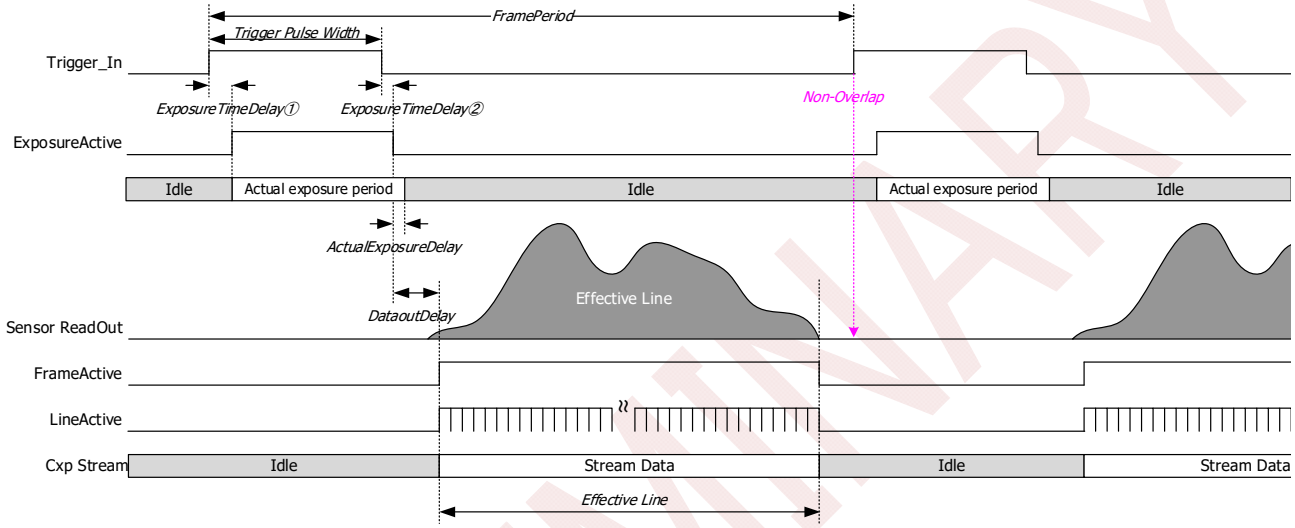
Timing Parameter	Value	Description
Trigger Pulse Width (min)	1	Trigger input pulse width (minimum value) [H]
(max)	200	Trigger input pulse width (minimum value) [ms]
Exposure Time Delay ①	2 ~ 3	Delay time from the rising edge of trigger input to ExposureActive rising [H]
Exposure Time Delay ②	2 ~ 3	Delay time from the falling edge of trigger input to ExposureActive falling [H]
Actual Exposure Delay	13.73	Delay time from falling edge of ExposureActive to completion of exposure of the sensor [µs]
Dataout Delay	35	Time from the falling edge of ExposureActive to FrameActive rising [H]

※For time for 1H, please refer to the time for 1 line in Section 3.5.1. Frame rate with Internal Sync. Mode.

4.6.6 Pulse Width Trigger Shutter Mode + CLK Sync. Trigger (ClockSync)

(TriggerMode=On, TriggerSyncMode=ClockSync, TriggerActivation=LevelHigh)

- ☐ This is to start exposure with external trigger input, and control exposure time with trigger pulse width.
- ☐ Since it synchronizes with CLK, this mode can start/end exposure with low-latency. However, user cannot input the next trigger while reading out images.
- ☐ Set Frame rate (=trigger input cycle) lower than the maximum frame rate explained in Section 3.5.2. Frame rate with External Trigger Sync. Mode.
- ☐ There are some restrictions for trigger input. Please refer to Section 4.6.7. Restrictions on Trigger Pulse Input Timing.
- ☐ The following shows the timing chart and the timing parameter with pulse width trigger shutter mode + CLK sync. trigger (ClockSync)



Vertical sync. timing chart (Pulse width trigger shutter mode + CLK sync. trigger (ClockSync))

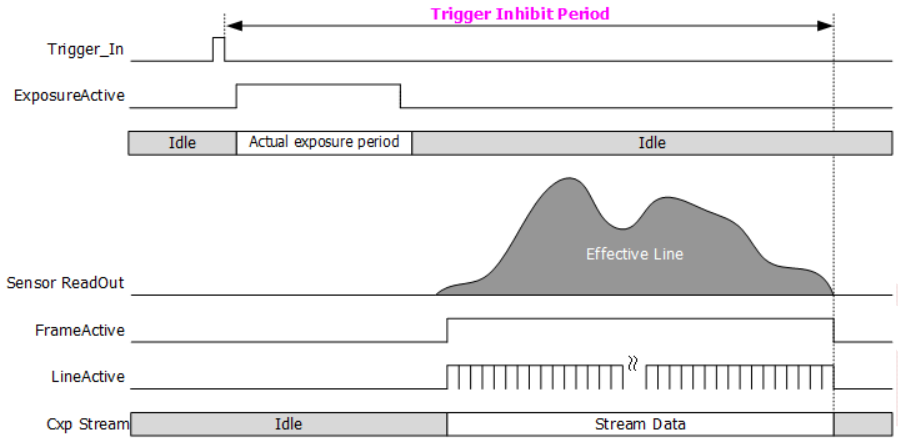
Timing Parameter	Value	Description
Trigger Pulse Width(min)	15 (TBD)	Trigger input pulse width (minimum value) [μs]
(max)	200 (TBD)	Trigger input pulse width (minimum value) [ms]
Exposure Time Delay ①	0.013	Delay time from the rising edge of trigger input to ExposureActive rising [μs]
Exposure Time Delay ②	0.013	Delay time from the falling edge of trigger input to ExposureActive falling [μs]
Actual Exposure Delay	13.78	Delay time from the falling edge of ExposureActive to completion of exposure of the sensor [μs]
Dataout Delay	35	Time from the falling edge of ExposureActive to FrameActive rising [H]

※For time for 1H, please refer to the time for 1 line in Section 3.5.1. Frame rate with Internal Sync. Mode.

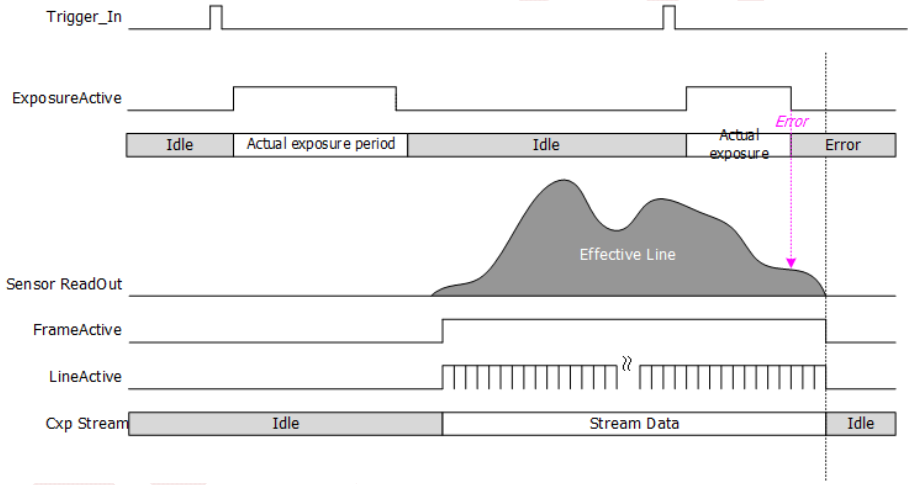
4.6.7 **Restrictions on Trigger Pulse Input Timing**

There are some restrictions on timing for external trigger input. Follow instructions, or error occurs.

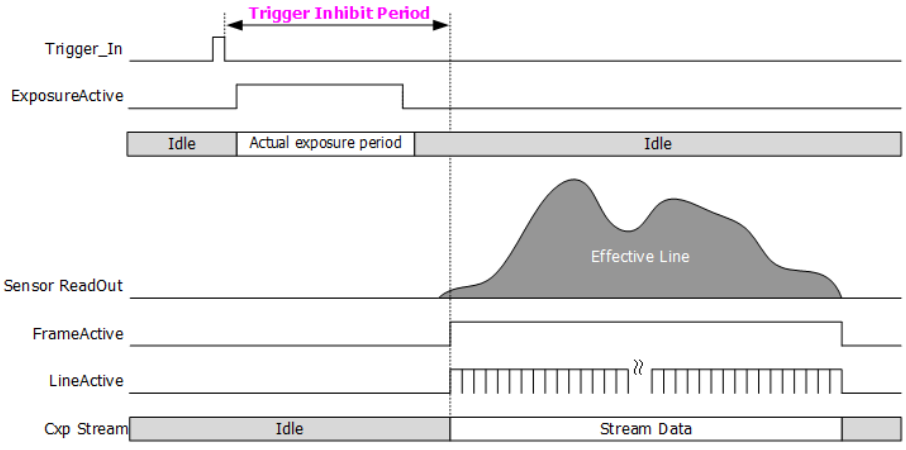
(1) With TriggerSyncMode=ClockSync, user cannot input the next trigger before completion of reading out images. Trigger Inhibit Period shown in the picture below prohibits any trigger input. Wait for completion of reading out.



(2) With TriggerSyncMode=LineSync, user can input the next trigger while reading out images. However, do not end exposure before completion of reading out images. Make sure to end exposure after completion of reading out to start the next.



(3) With TriggerSyncMode=LineSync and TriggerActivation= RisingEdge/FallingEdge, user cannot input the next trigger during exposure period.



If user inputs external trigger during the restricted period, camera LED emission status becomes error.
User can check the error status with the following command.

Acquisition Control	
IllegalTriggerFlag	0 or 1 (Read Only)

- IllegalTriggerFlag: If there is a trigger input with restricted timing explained in the above, "IllegalTriggerFlag" becomes "1".

Device Control	
ErrorFlagReset	(Execute)

- ErrorFlagReset: This is to reset IllegalTriggerFlag to "0".

4.7. Exposure Time

AcquisitionControl	
ExposureMode	Timed Trigger Width
ExposureTime (us)	LineSync: 17us ~ Maximum exposure time ClockSync: 15us~200ms
ExposureTimeMax	(Read Only)

・ExposureMode: You can check if the current mode is Timed or Trigger Width.

・ExposureTime: Exposure time (Valid when ExposureMode is Timed)
  ・With H sync trigger, exposure time becomes the rounded values (us) per 1H.
  Please refer to section 4.7.1.
  ・With CLK sync trigger, exposure time is set per approx. 1us.

・ExposureTimeMax: Maximum exposure time. Shown with us unit.

Note)
・With internal sync mode, set a smaller value than ExposureTimeMax.
・With H sync trigger mode (LineSync), effective line count (including with Partial setting) clips Exposure Time.
・With CLK sync trigger mode (ClockSync), you can set Exposure Time from 91us to 200ms.

4.7.1 Calculation Formula for Manual Shutter with H Sync Mode

Exposure time becomes the rounded value calculated by the formula below.

Exposure Time =Time for 1 Line x Exposure Line Count + 13.73 μs

・The minimum exposure line count is 1 line.
・The maximum exposure line count is 2056 or clipped value by entire line count with partial.

4.8. Gain

AnalogControl	
Gain	1.00～256.00

・ Gain: Preferred gain settings per 0.01 from 1.00 to 256.00.
User can set gain values up to x256 but guaranteed range is up to x64.
With high gain settings, noise will increase and image quality deteriorates.
(Please note that guaranteed range with 8-bit mode is x16 due to 4 times off set gain.)

4.9. Sensor Black Level Adjustment

AnalogControl	
BlackOffset	-64～63

BlackOffset: This is to adjust black level of image sensor.

・ This is not to set the absolute black level value, but to change black level settings relatively.
・ Values are 12 bit converted. With 10-bit, value becomes 1/4 of the set value. With 8-bit, value becomes 1/16 of the set value.

4.10. Partial Scan (ROI)

☐ This is to vertically cut and reduce read out area. User can set up to 8 partial areas (=8 regions).
☐ By vertically cutting and reducing read out area, user can increase frame rate.
☐ For frame rate correspond to the cut out image size, please refer to Section 3.5. Frame Rate.

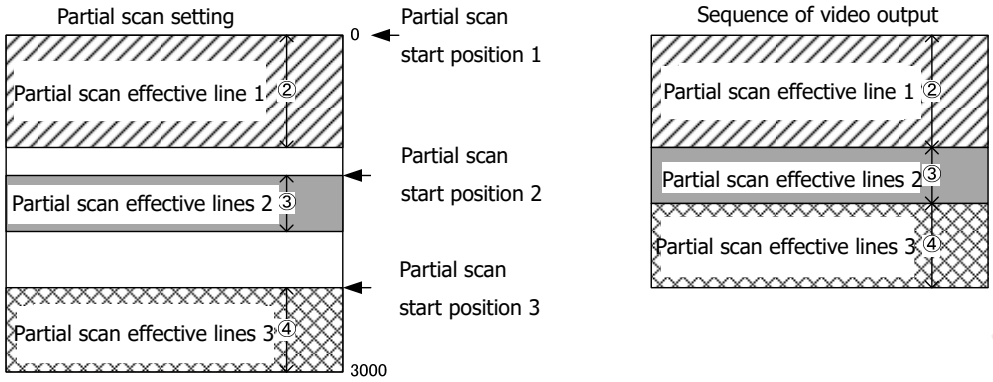
ImageFormatControl	
RegionSelector	EffectiveRegion , Region0～7
RegionMode	On/Off
RegionDestination	Stream0 (fix)
Width	2464 (fix)
Height	4～2056 (multiple of 4)
OffsetX	0 (fix)
OffsetY	0～2052 (multiple of 4)

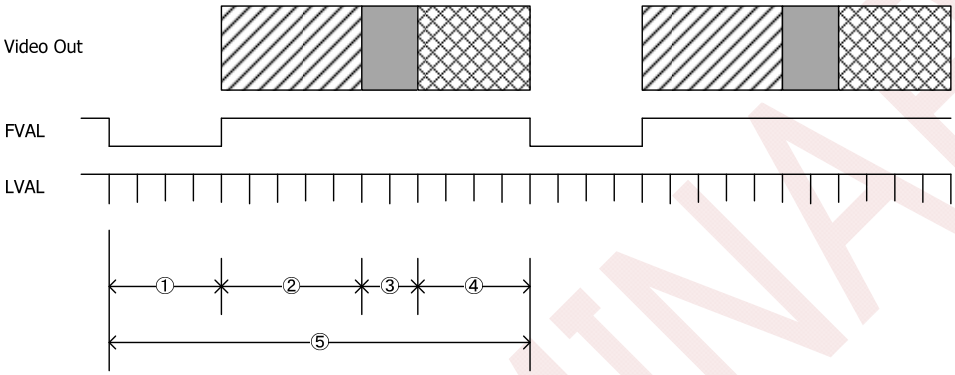
・RegionSelector: This is to select Region to set.
EffectiveRegion: User can check the total value of width and height of effective region.
Region0～7: Select region to set.
※Make sure to select EffectiveRegion to start capturing images.
※User cannot select EffectiveRegion when there is no effective region.

・RegionMode: On/Off of the selected Region.
※Enabled only when Width, Height, OffsetX, and OffsetY are effective.

・RegionDestination: Selection of Stream to output. Fixed with Stream0.
・Width: Width of Region. 2464 fix with this model.
・Height: Height of Region. Set multiple of 4.
・OffsetX: Offset for X direction of Region. 0 fix with this model.
・OffsetY: Offset for Y direction of Region. Set multiple of 4.
※Make sure to set Height and OffsetY not to overlap with other regions.
※Make sure to set that the sum total of effective Region and Height will be 2056 or less.

Setting example of ROI: 3 partial areas





① : Vertical blanking line
② : Partial area 1
③ : Partial area 2
④ : Partial area 3
⑤ : Total line count per frame

※ With 8 frames after changing partial scan settings, disturbed images may occur. For external trigger mode, input dummy triggers 8 times and use images taken with the 9th trigger and after.

4.11. Defective Pixel Correction

☐ This is a function to detect, add, and correct defective pixels in output data from the sensor.

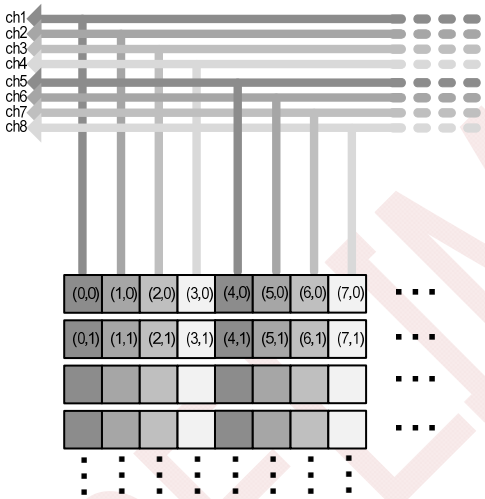
☐ There are two types of defective pixel data.

- Defective data registered at factory
  Black and white defective pixel data registered upon shipment from our factory. These data cannot be over-written.
- Defective data registered by user
  Data registered by user. In addition to the correction of defective pixel data registered upon shipment, we provide a method to update the defective pixel data. With DefectPixelDefault command, user can delete these user-registered data.

☐ Camera keeps defective pixel correction data for normal setting and for vertical flip setting separately.
(The position and count of defective pixels are different for normal setting mode and vertical flip setting mode).

☐ User can register up to 256 points. (Note: Up to 32 points per CH.)

[CH (Channel)]
Camera performs image processing with 8CH interleave.



☐ Enable or disable Defective Pixel Correction

AnalogControl	
DefectPixelCorrection	On/Off

- DefectPixelCorrection: This is to enable or disable defective pixel correction function.

※ Please note that function controls both defective pixel correction data registered at factory and registered by user at one time.

☐ Updating defective pixel data with coordinates X and Y.
This is to update defective pixel data by specifying coordinates to add or delete.

AnalogControl	
DefectPixelAdd	(Execute)
DefectPixelAddOffsetY	0～2055
DefectPixelAddOffsetX	0～2463
DefectPixelDelete	(Execute)

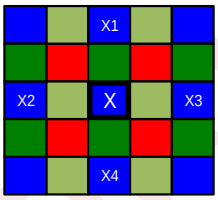
- DefectPixelAdd: This is to register the specified coordinates as defective pixels.
- DefectPixelAddOffsetY: Specify Y coordinate.
- DefectPixelAddOffsetX: Specify X coordinate
- DefectPixelDelete: This is to delete the specified coordinates from registered defective pixels.

- DefectPixelDelete command deletes only added pixels by user with coordinates. Data registered at factory is not subject to delete with DefectPixeDelete command.
  When user specify the same coordinates as those registered at factory, function ignores them.

- DefectPixelAdd command registers defective pixels but not save. To save data to non-volatile memory, execute UserSetSave command.

- When DefectDetectionStatus is error (0x000e0001 and 0x000e0002), DefectPixelAdd and DefectPixelDelete are disabled. Execute DefectPixelDefault to re-execute, or execute DefectDetection when DefectCorrectionMode is with Reacquire.

- Depending on the pattern of coordinates, there are some cases that defective pixel correction function does not correct the data. For example, when all peripheral pixels, X1, X2, X3, and X4 are already registered as defective pixels as shown in the picture below, user cannot correct the X pixel.



[Neighboring pixels in the same color with Blue defective pixel]

☐ Updating defective pixel data with detection function
This is for user to detect and register white defect pixels.

AnalogControl	
DefectDetectionThesholdValue	0~4095
DefectDetection	(Execute)
DefectDetectionStatus	(Read Only)
DefectCorrectMode	Reacquire/Add

- DefectDetectionThresholdValue: This is to set a threshold value (12-bit equivalent) for user defective pixel detection. Function registers data with luminance level that exceeds the threshold value specified here. Since threshold value is 12-bit equivalent, for 8-bit images, specify a value of 16 times of signal level as a threshold value.

- DefectDetection: This is to detect defective pixels. Function automatically registers pixel coordinates that exceed the level specified with DefectDetectionThresholdValue. Execute UserSetSave to save data into non-volatile memory.

  ※ Make sure to execute DefectDetection command while grabbing (acquiring images).

  ※ Make sure to turn off partial scan (=2464x2056 in size) to execute.

  ※ When DefectCorrectMode = Add and DefectDetectionStatus is error (0x000e0001 and 0x000e0002), DefectDetection command is disabled. Execute DefectPixelDefault to re-execute or execute when DefectCorrectionMode is with Reacquire.

- DefectDetectionStatus: This is to indicate results of defective pixel detection proceeded by user.

0	No defective pixel correction data registered by user.
Value (Under 256)	Number of defective pixels detected and registered by user.
[Error code]	
0x000e0001 (917505)	Total number of defective pixel correction data exceeds the maximum number to register in one CH. (32)
0x000e0002 (917506)	Total number of defective pixel correction data exceeds the maximum number to register. (256 points)

When an error code returns, check if user threshold value (DefectDetectionThresholdValue) is appropriate, as well as shooting conditions (shielding light, gain, trigger, exposure time and others).
※With some frame grabber boards, error may be shown as decimal.

- DefectCorrectMode: This is to select detection mode of defective pixels out of the followings.
  - Reacquire mode: This mode deletes defective pixel data except those registered by specifying coordinates and reacquire defective pixels.
  - Add mode: This mode acquires defective pixels in addition to the current pixels registered.

[Note]

- Maximum number of defective pixels to register and to correct may not always be the same due to following reasons.
  (1) With white defects detection, if one of interleave channel reaches the maximum number of defective pixels to register, correction stops. Function registers data up to that point, outputs error, and ends operation.
  (2) When there is no effective pixel around the pixel to add (on the left, right, top, and bottom), user can register but cannot correct that pixel.

☐ Entire deletion of defective pixel data registered by user.

AnalogControl	
DefectPixelDefault	(Execute)

DefectPixelDefault: This is to delete entire defective pixel correction data registered by user.

※ Function keeps defective pixel data for vertical flip OFF/ON in different tables separately. DefectPixelDefault deletes entire defective pixel correction data of the table currently in use. In other words, when user executes DefectPixelDefault when vertical flip is ON, function deletes entire defective pixel correction data of the table with vertical flip ON. The defective pixel correction data in the table of vertical flip OFF remains as it is.

☐ Indication of defective pixel coordinates

This is to indicate the coordinates of registered defective pixels by user and factory.

AnalogControl	
RegisteredDefectSelector	UserState/InitialState
DefectPixelNumber	1~256/1~768
DefectPixelOffsetY	(Read Only)
DefectPixelOffsetX	(Read Only)
DefectPixelType	(Read Only)
ChannelNumber	1～8
DefectPixelChannelCount	(Read Only)

- RegisteredDefectSelector: Selection of defective pixel data to indicate.
  - UserState: Defective pixel correction data registered by user.
  - InitialState: Defective pixel correction data registered upon shipment from factory.
- DefectPixelNumber: This is to specify a table number of defective pixel data selected.
- DefectPixelOffsetY: This is to indicate Y coordinate of the defective pixel specified with DefectPixelNumber. When user specifies a table number with no defective pixel data, it shows 65535.
- DefectPixelOffsetX: This is to indicate X coordinate of the defective pixel specified with DefectPixelNumber. When user specifies a table number with no defective pixel data, it shows 65535.
- DefectPixelType: This is to indicate defect type of the pixel specified with DefectPixelNumber.
  - 1: White defects registered upon shipment from factory
  - 2: Black defects registered upon shipment from factory
  - 6: Defects registered by user
  - 7: Defects additionally registered by user with coordinates
  - 65535: Table without defects

The following commands show the number of defective pixel correction per channel.

- ChannelNumber: This is to specify channel number of defective pixel correction.
- DefectPixelChannelCount: Defective pixel count for the channel specified with ChannelNumber. (Total value of defective pixel with factory count and user register count.)

4.12. Test Pattern Indication

☐ This is to display test pattern from camera. This is useful to check if your system is operating properly.

ImageFormatControl	
TestPattern	Off ColorBar ColorBarMoving

※ Displaying test pattern and cursor are mutually exclusive.

4.13. Cursor Indication

☐ This is to show cursor on your display screen.

ImageFormatControl	
CursorPattern	On/Off
CursorOffsetX	0 ~ 2463
CursorOffsetY	0 ~ 2055
CursorColor	White/Black

※ Displaying test pattern and cursor are mutually exclusive.

- CursorPattern: Cursor indication On/Off.
- CursorOffsetX: X coordinate of vertical cursor.
- CursorOffsetY: Y coordinate of horizontal cursor.
- CursorColor: This is to select the color of cursor (black or white).

[Note]

- With partial scan (ROI), the left top of effective area becomes the origin (0,0) of cursor coordinates.
- With zooming out, cursor may be out of view .
- Due to color interpolation of the grabber board used, cursor may be colored.

4.14. LED Operational Mode

☐ This is to change operational mode of LED at the rear of camera. For information on lighting patterns, refer to Section 3.3.3. LED Indicator.

DeviceControl	
DeviceIndicatorMode	Active ErrorStatus Inactive

- DeviceIndicatorMode: This is to select LED operational mode out of the following 3 types.
  - Active: Indication of communication status of CoaXPress.
  - ErrorStatus: OFF with normal operation. Lights only with system error.
  - Inactive: ALL LED OFF

4.15. Camera Timing I/O

☐ According to LineSource settings, camera outputs the following signals through pin No. 3 and No.5 of 6pins circular connector.

Digital IO Control (6pin)	
LineSelector	Line0 Line1
LineMode	Input/Output (Read only)
LineSource	[With Line0] FrameTrigger (fix) [With Line1] OFF ExposureActive FrameActive LineActive TriggerPacketActive

・LineSelector: Selection of Line to set/indicate.
Line0: No.5 pin of 6pins circular connector.
Line1: No.3 pin of 6pins circular connector.
・LineMode: This is to indicate input/output direction of the selected line.
・LineSource: Selection of line signals.
FrameTrigger: Trigger input to the camera (dedicated to Line0).
ExposureActive: This is to indicate exposure period of image sensor with Hi Active
FrameActive: This is to indicate effective period of frame with Hi Active.
LineActive: This is to indicate effective period of video output line with Hi active.
TotalPacketActive: This is to decode and output packet signals of uplink trigger from frame grabber

4.16. User ID

User can register a preferred ID or letter strings to the camera.

DeviceControl	
DeviceUserID	Manual
DeviceUserString	Manual

・DeviceUserID: User can set up to 16 characters including terminal NUL letter (¥0).
・DeviceUserString: User can set up to 256 characters including terminal NUL letter (¥0).

Execute UserSetSave to save these letter strings to camera non-volatile memory. These data are not subject to "UserSetLoad" with "Default."

4.17. Temperature Indication

☐ This is to indicate temperature of image sensor (°C).

DeviceControl	
DeviceTemperatureSelector	Sensor (fixed)
DeviceTemperature	(Read Only)

- DeviceTemperatureSelector: This is to select the point of the device to measure temperature. Fixed with sensor for VCC-5CXP4R.
- DeviceTemperature: This is to indicate temperature of the image sensor.

[Note]

- This is a reference temperature and not the actual temperature.

4.18. Connection Reset

When troubles occur with CXP connection, user can reset the device with the following command.

Transfer Control	
ConnectionReset	1(Execute)

- ConnectionReset: This is to reset the device and reconnect automatically.
  ※ Please wait for few seconds to reconnect the device.
  ※ Error may occur with some items such as DeviceTemperature, IllegalTriggerFlag, and others, if connection is not completed. Please wait for completion of connection and reacquire.

4.19. Gamma Correction

AnalogControl	
Gamma	0.10~1.80 coefficient

- Gamma : This is to set gamma correction value per 0.01 step from 0.10 to 1.80.
  [Note] Camera updates gamma table at the timing of image output.
  With continuous operation mode, camera applies the updated gamma table at the timing of image output after completion of rewriting gamma table (approx. 20ms: refer to Command ACK as a rough guide).
  If user changes gamma coefficient while waiting for a trigger input, camera outputs images with updated gamma table with a trigger after completion of rewriting gamma table.

4.20. Image Quality Selection Mode

This is a function to select image quality of output images.

AnalogControl	
ImageQualityMode	StandardMode LowFrameRateMode

- Image Quality Mode: Image quality selection mode
  - StandardMode: Standard mode
  - LowFrameRateMode: This mode improves S/N compared to standard mode.

    However, frame rate and sensitivity decrease. Frame rate will be the same value as 10bit. Enabled only when PixelFormat is Bayer 8bit. With Bayer 10/12bit, mode will become StandardMode.

4.21. White Balance

AnalogControl	
BalanceRatioSelector	Red Blue
BalanceWhiteAuto	Off Once
BalanceRatio	0.00~8.00

- BalanceWhiteAuto: This is to adjust white balance gain automatically.
  - Off: Waiting
  - Once: Adjust white balance automatically with one push.

Select "Once" of BalanceWhiteAuto to adjust white balance and return to off. BalanceRatio shows new gain of color component selected with BalanceRatioSelector. Shoot an object with achromatic color to full screen to execute BalanceWhiteAuto. Recommendation is approx. 50% of signal level to execute.

Enables the following commands only when BalanceWhiteAuto is OFF.

- BalanceRatioSelector: This is to select the color component you wish to change with BalanceRatio
- BalanceRatio: This is to set gain of the selected color component from x0.00 to x8.00 per 0.01 step.

If user set 1.0 to BalanceRatio of Red/Blue when BalanceRatioSelector = Red/Blue, white balance becomes disabled.

Note)
- Make sure to execute white balance gain adjustment when camera is in operation.

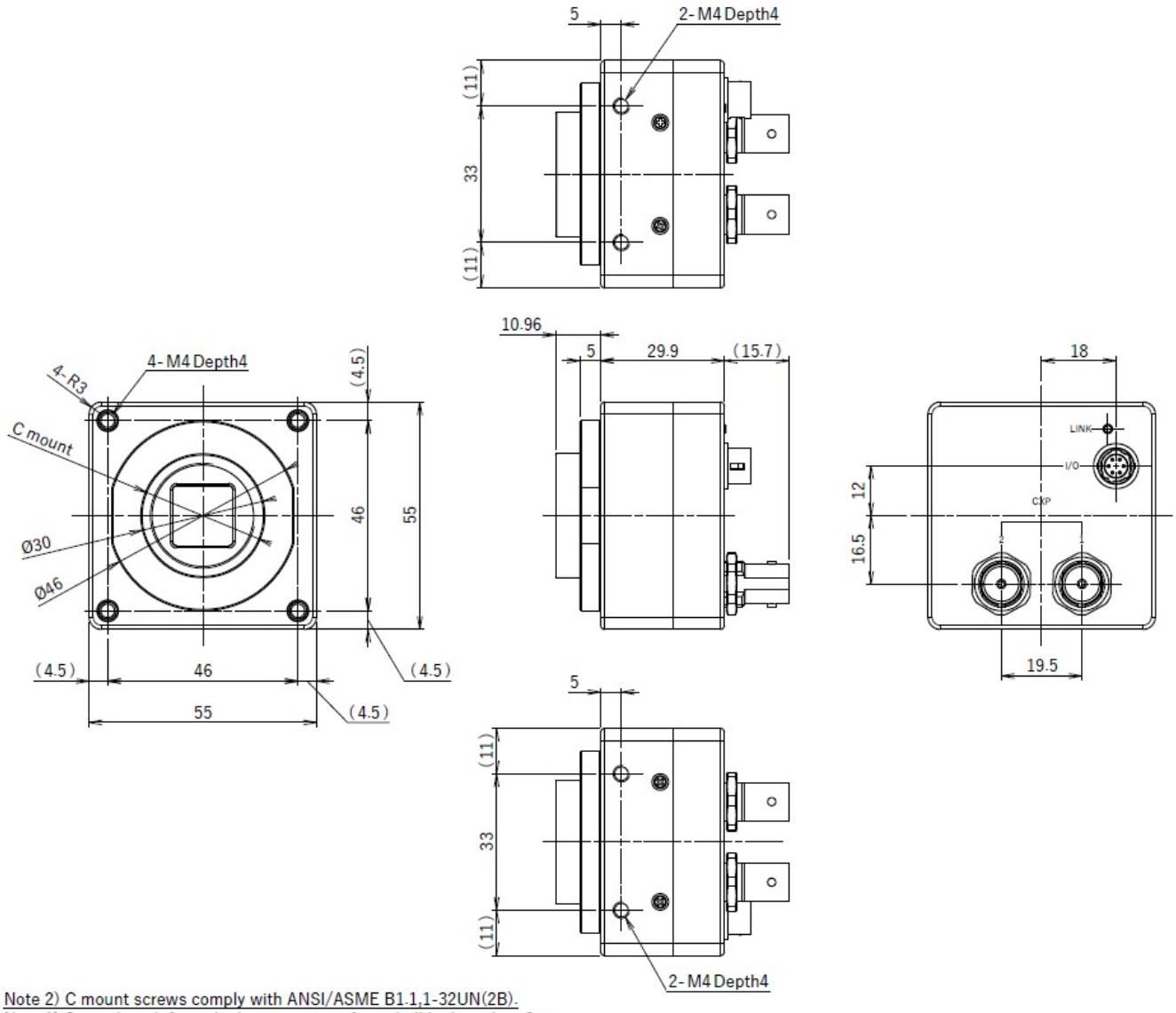
5. Factory Settings

Function	Data	Explanation
TriggerSelector	AcquisitionStart	Internal sync mode (free run)
TriggerMode	Off	Internal sync mode (free run)
TriggerSyncMode	LineSync	H sync mode
TriggerSource	LinkTrigger0	CXP UpLink trigger
TriggerActivation	RisingEdge	Rising edge
ExposureTime	5001	Exposure time 5001μs
Gain	1.00	Gain x1.00
Gamma	1.00	Gamma correction value 1.00
BlackOffset	0.0	Black level initial value
BalanceRatioSelector	Red	Color component of white balance gain = Red
BalanceWhiteAuto	Off	White balance gain auto adjustment Off
BalanceRatio	1.00	White balance gain = x1.00
DefectPixelCorrection	On	Defective pixel correction On
DefectPixelAddOffsetX	0	X coordinate of correction pixel =0
DefectPixelAddOffsetY	0	Y coordinate of correction pixel =0
DefectDetectionThresholdValue	200	Threshold value of defective pixel detection
PixelFormat	BayerRG8	Bayer 8bit (RGGB)
ConnectionConfig	CXP6_X1	CXP-6 (6.25Gbps), 1 link
ImageQualityMode	Standard	Image quality selection mode (standard mode)
TestMode	NomalOperation	Normal mode (=Link test mode Off)
RegionSelector	EffectiveRegion	Partial area (ROI) Region0 enabled
RegionMode	On	Partial area (ROI) operation On
Width	2464	Partial area (ROI) Horizontal 2464pixel (full size)
Height	2056	Partial area (ROI) Vertical 2056line (full size)
OffsetX	0	Partial area (ROI) horizontal start position 0
OffsetY	0	Partial area (ROI) vertical start position 0
ReverseX	FALSE	Horizontal flip OFF
ReverseY	FALSE	Vertical flip OFF
TestPattern	Off	Test pattern indication Off
CursorPattern	Off	Cursor indication Off
CursorOffsetX	1232	X coordinate of vertical cursor = 1232
CursorOffsetY	1028	Y coordinate of horizontal cursor = 1028
CursorColor	White	Cursor color = White
DeviceIndicatorMode	Active	CoaXPress connection status indication mode
LineSelector	Line0	Line0
LineSource	FrameTrigger	Trigger input
DeviceUserID		Character string by user (16 letters) none
DeviceUserString		Character string by user (256 letters) none

※ ConnectionConfig, PixelFormat, and ImageQualityMode are not subject to UserSetLoad.

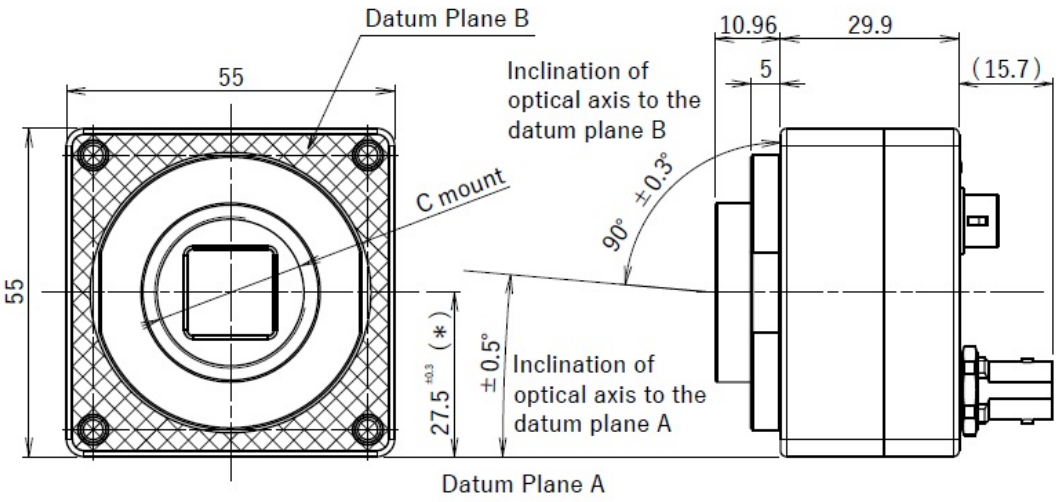
6. Dimensions

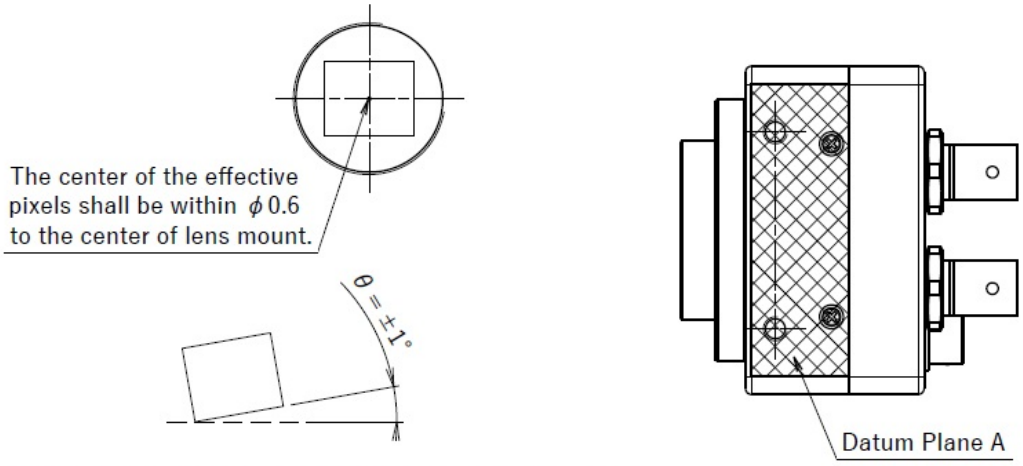
6.1. Camera Dimensions



Note 2) C mount screws comply with ANSI/ASME B1.1,1-32UN(2B).
Note 1) Screw length from the lens mount surface shall be less than 6mm.
And protruding portion of the C mount lens shall be less than 10mm.

6.2. Optical Axis Accuracy





Inclination of effective pixels θ to datum plane A is $\theta \leqq \pm 1^{\circ}$.

Note:Dimensions from datum plane A to the center of the lens mount.

7. Case for Indemnity (Limited Warranty)

7.1. Product Warranty

The term of warranty of this product is within 3 years from the date of shipping out from our factory.
If you use the product properly and discover a defect during the warranty period, and if that was caused by designing or manufacturing, CIS Corporation, at its option, repairs or replaces it at no charge to you. Products out of warranty period will be subject to charge.

CIS should not hold responsible for damages or losses if;

- damages or losses are caused by earthquake, lightning strike, fire, flood or other acts of God.
- damages or losses are caused by deliberate or accidental misuse by user, or failure to observe the information contained in the instructions in this Product Specification and Operational Manual.
- damages or losses are caused by repair or modification conducted by customer or any unauthorized party.

7.2. CMOS Defective Pixels

CIS applies defective pixel correction prior to shipment of the product. However, the number of defective pixels are subject to increase due primarily to the effect of cosmic rays. Due to this nature, CIS should not hold responsible for the natural increase of defective pixels.

7.3. Product Support

Should you have any problems in function of the product you purchased, and if you need our further analysis and/or repair, please contact your local distributor.