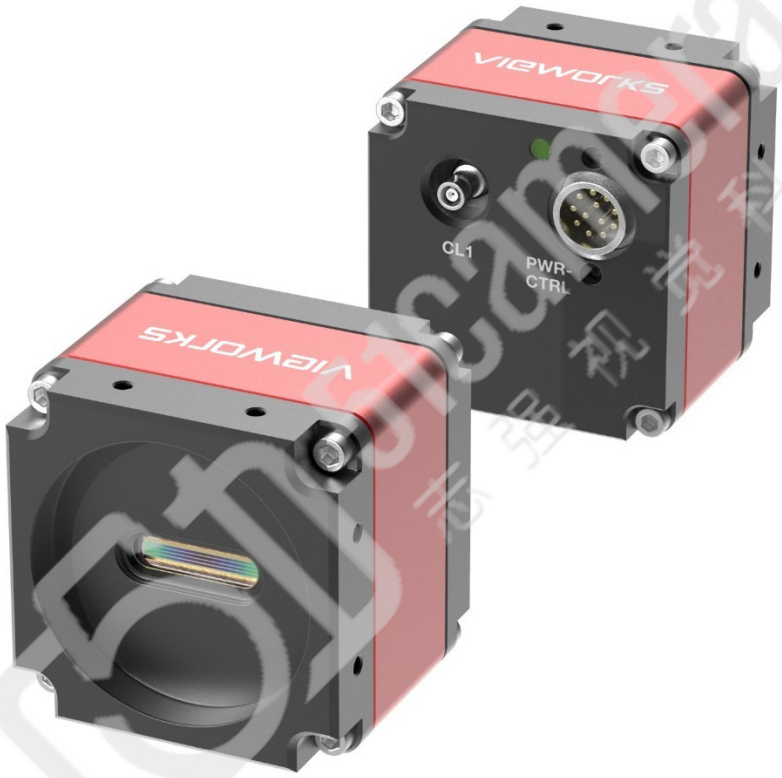
VIEWORKS

VL-2K7X / VL-4K3.5X

VL-2K7X-M170I-2 / VL-2K7X-C44I-4 / VL-4K3.5X-M83I-2 / VL-4K3.5X-C42I-2



CoaXPress®

Contents

1. Instruction

This section gives basic information about this manual and safe product use.

Document Guide

Precautions

Product Use

Revision History

1.1 Document Guide

1.1.1 Target Audience

This manual is intended for the users who set up and operate the **VL-2K7X and VL-4K3.5X CXP** series cameras. This product should be operated under the safety instructions with the warning or caution symbol in this manual. It is important for you to read and understand the contents to operate the products safely.

Caution

- This symbol is used to indicate a potentially hazardous situation that may cause death, personal injury, or substantial property damage if the instructions are ignored. Users should be well acquainted with this symbol and the related contents.

Information

- This symbol is used for indicating product related references and supplementary information. Users are recommended to read the sentences with this notice carefully.

1.1.2 Notations

Bold Types

Words in bold indicate products terms, or the sentences which are needed to transmit clear meaning to the customers.

- Among the references specified in this document, some installations and settings are performed by qualified service engineers. For proper product installation and setup, please check the manuals listed in the references or contact your service engineer.

1.2 Precautions

General

- Do not drop, disassemble, repair or alter the device. Doing so may damage the camera electronics and cause an electric shock.
- For safety, do not store the product where it can be accessed by children or pets.
- Stop using the device and contact the nearest dealer or manufacturer for technical assistance if liquid such as water, drinks or chemicals gets into the device.
- Do not touch the device with wet hands. Doing so may cause an electric shock.
- Make sure that the temperature of the camera does not exceed the temperature range indicated in <2.2 Product Specification>. Otherwise the device may be damaged by extreme temperatures.

Installation and Maintenance

- Do not install in dusty or dirty areas – or near an air conditioner or heater to reduce the risk of damage to the device.
- Avoid installing and operating in an extreme environment where vibration, heat, humidity, dust, strong magnetic fields, explosive/corrosive mists or gases are present.
- Do not apply excessive vibration and shock to the device. This may damage the device.
- Avoid direct exposure to a high intensity light source. This may damage the image sensor.
- Do not install the device under unstable lighting conditions. Severe lighting change will affect the quality of the image produced by the device.
- Do not use solvents or thinners to clean the surface of the device. This can damage the surface finish.

Power Supply

- Applying incorrect power can damage the camera. If the voltage applied to the camera is greater or less than the camera's nominal voltage, the camera may be damaged or operate erratically. Please refer to <2.2 Product Specification> for the camera's nominal voltage.

  ※ Vieworks Co., Ltd. does NOT provide power supplies with the devices.
- Make sure the power is turned off before connecting the power cord to the camera. Otherwise, damage to the camera may result.

Cleaning the Sensor Surface

Avoid cleaning the surface of the camera's sensor if possible. If you have dust or foreign matter on the sensor surface, use a soft lint free cotton bud dampened with a small quantity of high-quality lens cleaner. Because electrostatic discharge (ESD) can damage the sensor, you must use a cloth (e.g. cotton) that will not generate static during cleaning.

Avoid dust or foreign matter on the sensor surface.

- The camera is shipped with a protective plastic seal on the camera front. To prevent collecting dust or foreign matter on the camera sensor, make sure that you always put the protective seal in place when there is no lens mounted on the camera. In addition, make sure to always point the camera downward when there is no protective seal on the camera front or no lens mounted.

Procedure for Cleaning the Sensor

If you have dust or foreign matter on the sensor surface, follow the procedure below to wipe off:

1 Remove a contaminant by using an ionizing air gun.
If this step does not remove the contaminant, proceed to the next step.

2 Clean the contaminant on the sensor using one drop of lens cleaner on a non-fluffy cotton bud.

3 Wipe the cotton bud gently in only one direction (either left to right or right to left). Avoid wiping back and forth with the same cotton bud in order to ensure that the contaminants are removed and not simply transferred to a new location on the sensor surface.

4 Mount a lens, set the lens at a smaller aperture (e.g. F8), and then acquire images under bright lighting conditions. Check the images on the monitor for dark spots or stripes caused by the contaminant. Repeat the steps above until there is no contaminant present.

- If the sensor is damaged due to electrostatic discharge or the sensor surface is scratched during cleaning, the warranty is void.

1.3 Product Use

1.3.1 Warrant Coverage

The following cases are excluded from the warranty coverage:

- The manufacturer is not responsible for equipment failures caused by services or modifications performed by unauthorized manufacturers, agents, or technicians.
  - The manufacturer is not liable for the loss or damage of data due to operator error.
  - Warranty coverage is void if the product is used for purposes other than its intended use, subjected to excessive use, or damaged due to negligence.
  - Damage or malfunction caused by incorrect power usage or failure to follow the operating conditions specified in the user manual is not covered.
- Natural disasters, such as lightning, earthquakes, fires, and floods, are not covered under the warranty.
- If components or software of the equipment are replaced or modified without authorization, any resulting issues are not covered by the warranty.

For product-related inquiries or service requests, please contact the seller or the manufacturer.
The warranty period is as specified in the warranty certificate at the time of purchase and is effective from the date the equipment is shipped.

1.3.2 KCC Statement

Type	Description
Class A (Broadcasting Communication Device for Office Use)	This device obtained EMC registration for office use (Class A), and may be used in places other than home. Sellers and/or users need to take note of this.

1.4 Revision History

Version	Date	Description
1.0	2025-06-30	Initial release

2. Product

This section gives instructions about the product components and their specifications.

Product Components

Product Specification

2.1 Product Components

Product Components

VL-2K7X-M/C and VL-4K3.5X-M/C cameras

2.2 Product Specifications

The VL-2K/4K series are small-format line cameras compatible with M42 and C-mount lenses. It acquires images in 2K resolution at up to 170㎑. The GL3504 image sensor, installed in the camera, supports 7㎛ pixel lines at 2k resolution and 3.5㎛ pixel line at 4k resolution. With high speed and various range of color embodiment capabilities, it is a perfect fit for the complicated applications, such as food and agriculture inspection, pharmaceutical inspection, wood inspection, and textile inspection.

Main features

- M42-mount based 2k / 4k Line Scan Cameras
- Supports CoaxPress 1.0 (CXP-3, CXP-6)
- Supports 2 stage TDI (Mono)
- GL3504 2k color supports 3-line true color with RGBW Quad-Linear method
- Individual Gain/Exposure Control
- Supports PoCXP
- Optimized for M42, 50x50mm size

Applications

- Food & Agricultural Inspection
- Pharmaceutical Inspection
- Wood Inspection
- Fabric Inspection

The specifications of the VL-2K/4K CXP series cameras are as follows:

Specification		VL-2K7X-M170I-2	VL-2K7X-C44I-4	VL-4K3.5X-M83I-2	VL-4K3.5X-C42I-2
Resolution (H × V)		2048 x 2	2048 x 4	4096 x 2	4096 x 2
Sensor		GL3504			
Mono / Color		Mono	True Color	Mono	Bayer Color
Pixel Size		7.0 μm × 7.0 μm		3.5 μm × 3.5 μm	
Electronic Shutter		Global Shutter			
Interface		CoaXPress 1.0 (CXP-3 / CXP-6)			
Max. Line Rate		Single: 170 kHz Dual: 87 kHz	Quad: 44 kHz	Single: 83 kHz Dual: 42 kHz	Dual: 42 kHz
Exposure Time		0 μs to 1000 μs (All or Individual band)			
Pixel Data Format		Mono 8/10/12	RGB/BGR 8/10/12 RGBa/BGRa 8	Mono 8/10/12	RGB/BGR 8/10/12
Gamma Correction		User defined LUT (Look Up Table)			
Offset and Gain Correction		DSNU and PRNU			
External Trigger		3.3 V to 5.0 V			
Black Level Control		-2040 to 2040 LSB at 12 bit			
Trigger Synchronization		Free-Run, Hardware Trigger, and CoaXPress			
Dynamic Range		65.5 dB		65.8 dB	
Gain Control	Individual Gain	1.00 x to 4.00 x			
	Digital Cain	1.00 x to 32.00 x			
Dimension / Weight		50 mm x 50mm x 46.5mm, 195g			
Environmental Temperature		Operating: 0℃ to 40℃, Storage: -40℃ to 70℃			
Lens Mount		M42, C-mount			
Power	External	11 to 24 V DC,			
	Dissipation	Max. 5.0 W			
	PoCXP	Supported			
API SDK		Vieworks Imaging Solution 7.X			

Table 2-1 VL-2K/4K Specifications

2.2.1 Camera Block Diagram

The VL-2K/4K CXP series cameras are composed of 4 PCBs, and the block diagram is as shown below:

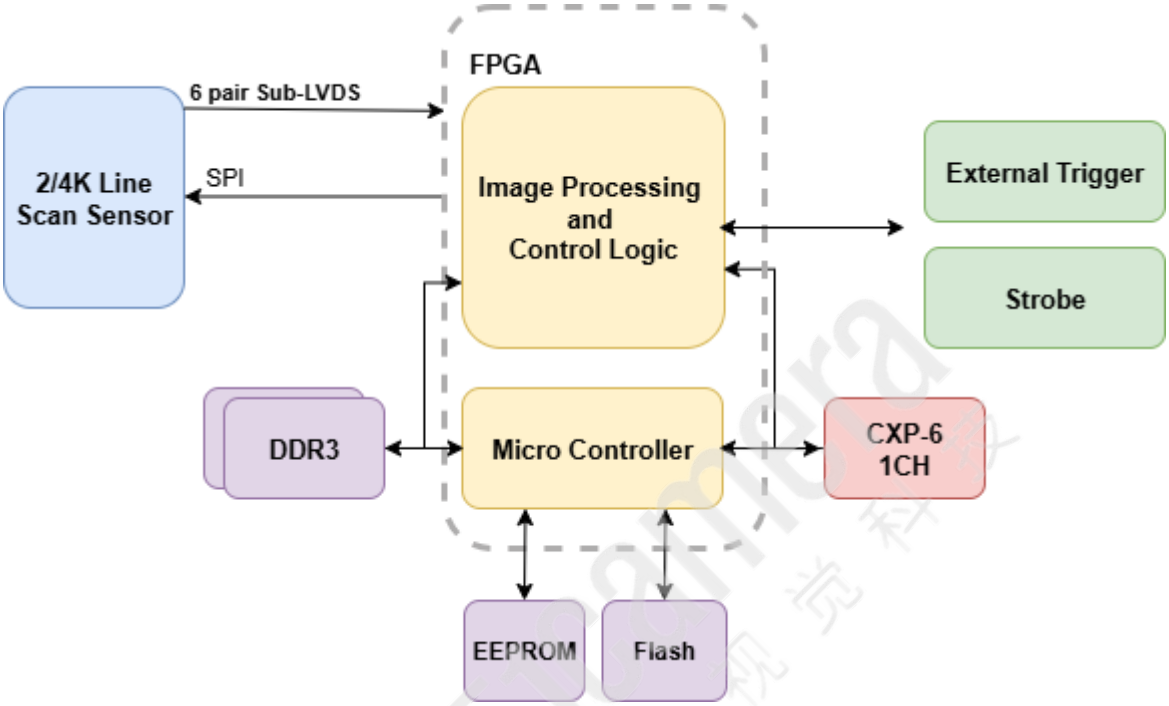
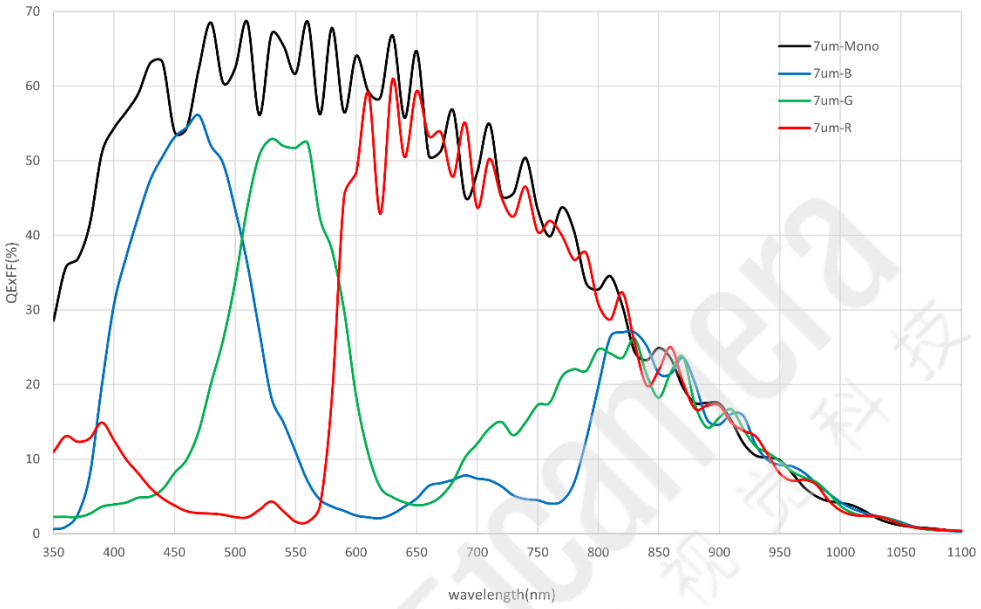


Figure 2-1 Camera Block Diagram

2.2.2 Spectral Response

The graph below represents the spectral response of the VL-2K/4K series cameras.

VL-2K7X-M/C



VL-4K3.5X-M/C

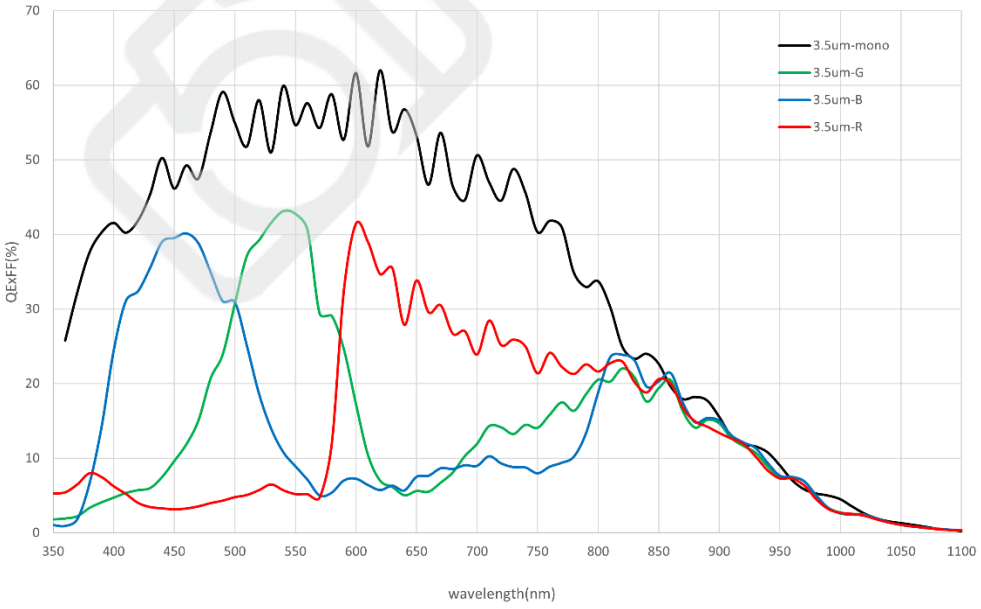


Figure 2-2 Quantum Efficiency

Mechanical Specification

Unit: mm

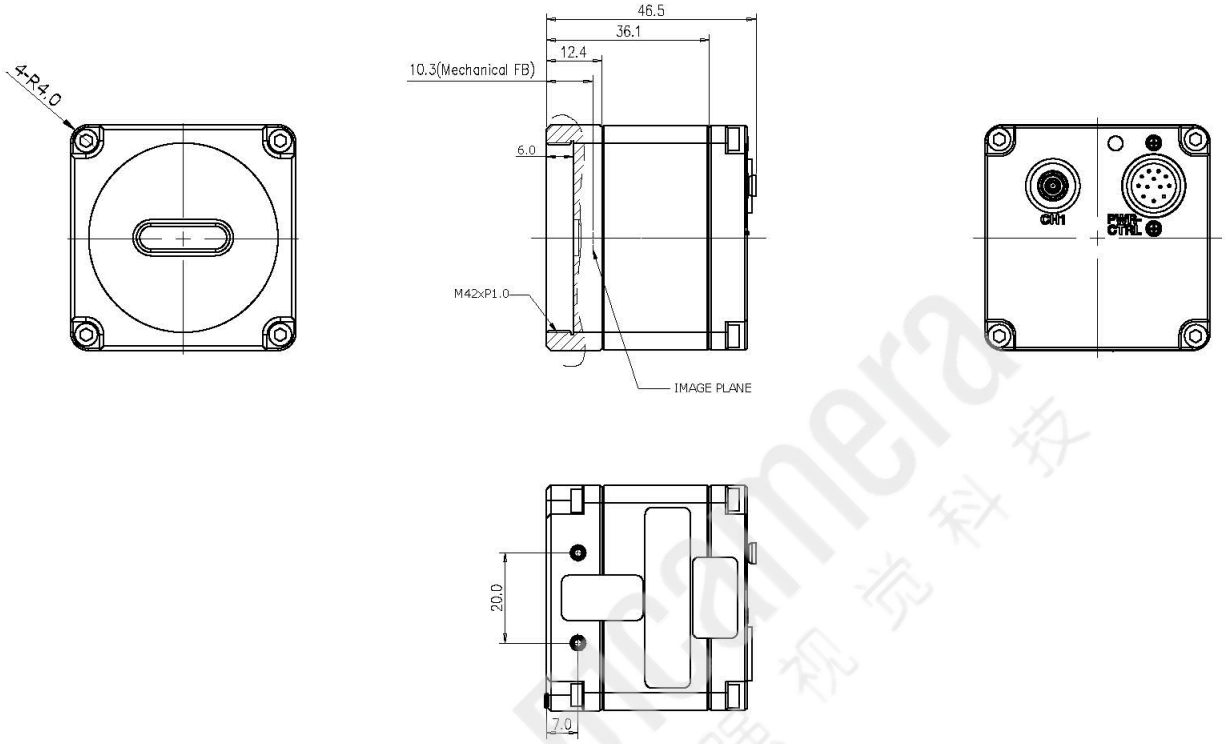


Figure 2-3 Mechanical Dimension of the VL-2K/4K cameras

3. Installation

This section explains how to install and connect the camera.

Camera Installation

Camera Connection

Camera Interface

3.1 Camera Installation

Heat Dissipation

Install the camera in a well-ventilated area to keep the device temperature below 50°C. The VL camera is designed to operate within the specified temperature limits with its low-power design. However, if the camera is installed in an environment without sufficient heat dissipation, it may overheat.

Please follow the installation guidelines below.

- Ensure the camera temperature remains below 50°C. The internal temperature can be adjusted with the Device Temperature parameters.
- Mounting the camera on the system's metal structure enhances heat dissipation

Camera Mounting

As shown in the figure below, VL-2K7X and VL-4K3.5X can be securely fastened using mounting screws. There are eight mounting points, indicated by solid lines. Use M3 screws, and ensure they are inserted at least 4 mm into the camera.

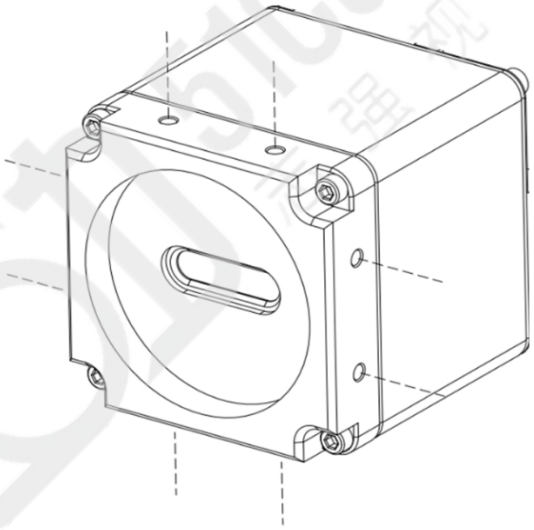


Figure 3-1 The Setscrew Location of VL-2K7X and VL-4K3.5X Cameras

3.2 Camera Connection

The following instructions assume that you have installed a CoaXPress Frame Grabber (hereinafter 'CXP Frame Grabber') in your computer including related software. The procedure below also assumes that you may attempt to configure two links between a camera and CXP Frame Grabber by using 1 coax cable. For more detailed information, refer to your CXP Frame Grabber User Manual.
To connect the camera to your computer, follow the steps below:

Step 1: Make sure that the power supply is not connected to the camera and your computer is turned off.

- Go to Step 2-a if you are using a power supply.
- Go to Step 2-b if you are using a Power over CoaXPress (PoCXP) Frame Grabber.

Step 2-a: If you are using a power supply:

1 Plug one end of a coax cable into the CH1 of the CXP connector on the camera and the other end of the coax cable into the CH1 of the CXP Frame Grabber in your computer.
2 Connect the plug of the power adapter into the 6-pin power input receptacle on the camera.
3 Plug the power adapter into a working electrical outlet.

Step 2-b: If you are using PoCXP Frame Grabber:

1 Plug one end of a coax cable into the CH1 of the CXP connector on the camera and the other end of the coax cable into the CH1 of the CXP Frame Grabber in your computer.

Step 3: Verify all the cable connections are secure.

3.2.1 Precaution to Center the Image Sensor

- User does not need to center the image sensor as it is adjusted as factory default settings.
- When you need to adjust the center of the image sensor, please contact your local dealer or the manufacturer for technical assistance.

3.2.2 Precautions Regarding Blur Between Center and Periphery

- Users do not need to adjust the tilt as it is adjusted as factory default settings.
- If the tilt settings need to be adjusted inevitably, please contact your local dealer or factory representative for technical support.

3.2.3 Installing Vieworks Imaging Solution

You can download the Vieworks Imaging Solution at http://www.vieworks.com. You should perform the software installation first and then the hardware installation.

3.3 Camera Interface

As shown in the figure below, three types of connectors and an LED indicator are located on the back of the camera and have the functions as follows:

No.	Item	Description
1	Status LED	Displays power status and operation mode.
2	CoaXPress connector	Transmits video data and controls the camera.
3	12-pin control I/O receptacle	Supplies power to the camera (if PoCXP is not used).

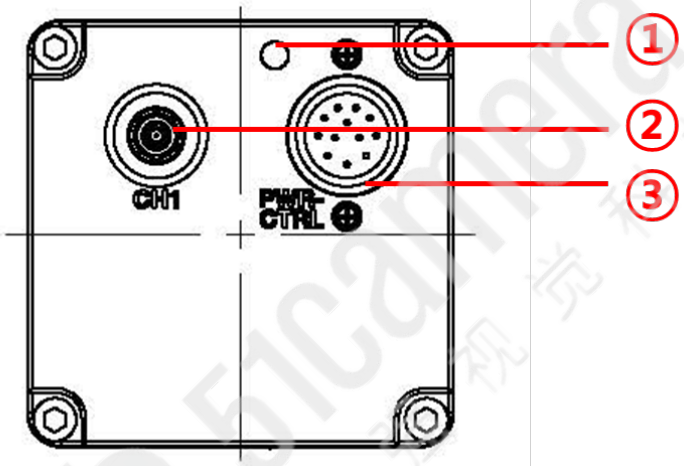


Figure 3-2 VL Camera Back Panel

3.3.1 CoaXPress Connector

CoaXPress protocol includes an automatic link detection mechanism (Plug and Play) to correctly detect the camera to the CXP Frame Grabber connection. The connection between the camera and CXP Frame Grabber uses a coax (also known as 'coaxial') cable and provides up to 6.25 Gbps bit rate per cable. The cameras can be powered over the coax cable if you are using a PoCXP enabled Frame Grabber.

Micro-BNC Connector

Figure 3-3 Micro-BNC Connector

The CoaXPress connector of the camera complies with the CoaXPress standard, and the channel configuration of the connector is as shown in the following table:

Channel	Max. Bit Rate per Coax	Type	PoCXP Compliant
1	6.25 Gbps	Master Connection	Yes

Table 3-1 CoaXPress Connector Pin Configuration

- When connecting the CXP frame grabber and the camera using a coaxial cable (also referred to as a "coax cable"), pay close attention to the connection ports.
- If the camera's CXP connector CH1 is not properly connected to CH1 on the CXP frame grabber, the camera image may not display correctly, or communication between the PC and the camera may fail.

3.3.2 Power I/O Receptacle

The pin layout and configuration of the camera's Power Input Receptacle and Control I/O connectors are as follows:

Figure 3-4 Pin Assignment of the Power Input Receptacle

Pin No.	Signal	Type	Description
1	DC Ground	Ground	Camera Power Ground
2	+ 12 VDC	Power	Camera Power +12 VDC
3	Signal Ground	Ground	Common Ground
4	Line2+	Output	3.3 V TTL Output
5	Signal Ground	Ground	Common Ground
6	Line 0+	Input	Connected with Trigger In+ function
7	NC		Not Connected
8	NC		Not Connected
9	Line 1+	Input	Connected with Scan direction In+ function
10	NC		Not Connected
11	NC		Not Connected
12	Signal Ground	Ground	Common Ground

Table 3-2 Pin Arrangements for Power Input Receptacle

- The recommended mating connector for the Hirose 12-pin receptacle is the Hirose 12-pin plug (part # HR10A-10P-12S) or an equivalent connector.
- It is recommended that you use the power adapter, which has at least 3 A current output at 11 to 24 V voltage output (A power adapter should be individually purchased.)
- When using a power supply, make sure it has an output of PS2 or lower and is certified to UL 62368-1 or UL 60950-1 standards.

CAUTION

- Make sure the power is turned off before connecting the power cord to the camera. Otherwise, damage to the camera may result.
- If the voltage applied to the camera is greater than specified in the specifications, damage to the camera may result.

3.3.3 Trigger Input Circuit

The following figure shows trigger signal input circuit of the 12 pin connector. Transmitted trigger signal is applied to the internal circuit through a photo coupler. With the Debounce feature, you can specify the width of input signal to be considered as a valid input signal. An external trigger circuit example is as shown below

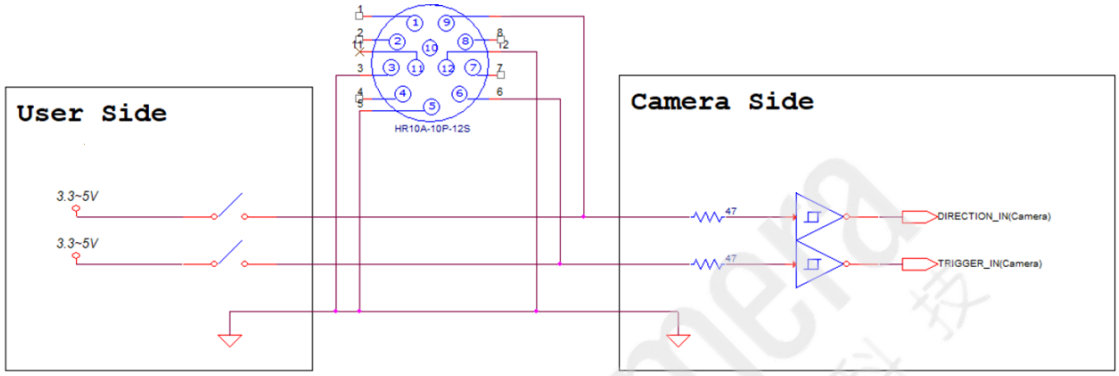


Figure 3-1 Input Schematic

3.3.4 Strobe Output Circuit

The strobe output signal comes out through a 3.3 V output level of TTL Driver IC. A pulse width of signal is synchronized with an exposure (shutter) signal of the camera.

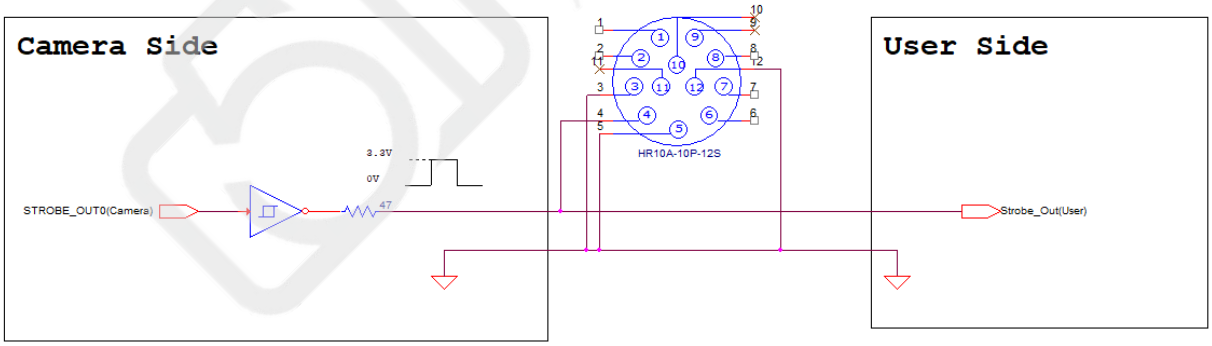


Figure 3-2 Output Schematic

4. Image Acquisition Control

This section provides information on image acquisition control.

Acquisition Command and Acquisition Mode

Line Start Trigger

Maximum Configurable Line Rate

4.1 Acquisition Command and Acquisition Mode

Acquisition Command	Description
Acquisition Start	Starts image acquisition until the Acquisition Stop commend executes. • Acquisition Mode ▫ VL-2K7X and VL-4K3.5X cameras only support **Continuous** mode.
Acquisition Stop	Ends image acquisition. Image acquisition is unavailable until the Acquisition Start command runs.

4.2 Line Start Trigger

You can select the Line Start trigger using the Trigger Selector parameter. This trigger can either be generated internally by the camera or supplied externally by setting the Trigger Source parameter to Line0 or LinkTrigger0.

4.2.1 Trigger Mode

The most important parameter related to the Line Start trigger is the Trigger Mode parameter. You can set the Trigger Mode to either Off or On.

When switching repeatedly between Trigger Mode and Free-Run

If you repeatedly turn Trigger Mode on and off during image acquisition, the image brightness may vary. To prevent this, it is recommended not to alternate between Trigger Mode and Free-Run Mode.

Trigger Mode (Line Start) = Off

When Trigger Mode is set to Off, all Line Start triggers are generated internally by the camera, so there is no need to supply the triggers externally. After setting Trigger Mode to Off and executing the Acquisition Start command, the camera automatically generates Line Start trigger signals and continues image acquisition until the Acquisition Stop command is issued..

Free-Run

When the Trigger Mode parameter is set to Off, the camera generates all the required trigger signals internally. With this configuration, the camera continuously captures images without the need for external trigger signals. This mode is commonly referred to as **Free-Run**.

The rate at which the line start trigger signals are generated may be determined by the camera's acquisition Line Rate parameter

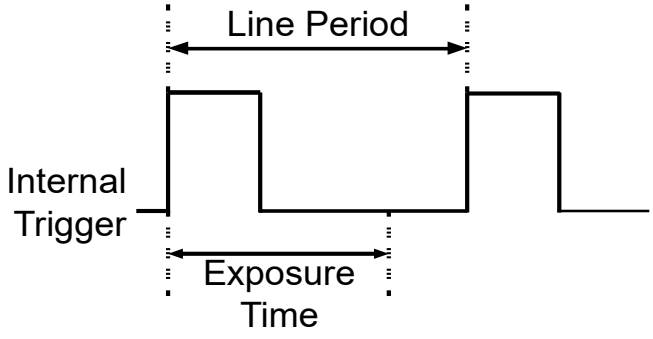


Figure 4-1 Line Start Mode = Off

Trigger Mode (Line Start) = On

When the Trigger Mode parameter is set to On, you must apply a line start trigger signal to the camera each time you want to begin an image acquisition. The Trigger Source parameter specifies the source signal that will act as the line start trigger signal.

Trigger Source Parameter	Description
Line0	An electrical signal generated externally is fed into the camera's control I/O connector to provide the Line Start trigger signal.
LinkTrigger0	You can supply the line start trigger signal to the camera through channel CH1 of the CXP Frame Grabber. For more details, refer to the CXP Frame Grabber user manual.

Trigger Activation parameters should be also determined after Trigger Source parameters are configured.

Trigger Activation Parameter	Description
Rising Edge	Specifies that a rising edge of the electrical signal will act as the line start trigger.
Falling Edge	Specifies that a falling edge of the electrical signal will act as the line start triggers.
Any Edge	Specifies that both rising and falling edges of the electrical signal will act as the line start trigger.

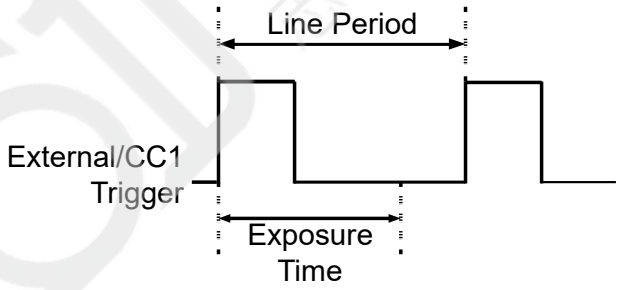


Figure 4-2 Line Start Mode = On

4.2.2 Using an External Trigger Signal

If the Trigger Mode parameter is set to On and the Trigger Source parameter is set to LinkTrigger0, you must apply an external or CoaXPress trigger signal to the camera to begin image acquisition.

To apply trigger signals via CH1 of the CXP Frame Grabber, you must set the Trigger Source parameter to LinkTrigger0. At that point, each time a proper CoaXPress trigger signal is applied to the camera by using the APIs provided by a CXP Frame Grabber manufacturer, the line start trigger signal will be applied to the camera.

For more information, refer to your CXP Frame Grabber User Manual.

To apply trigger signals via hardware (external), you must set the Trigger Source parameter to Line0. At that point, each time a proper electrical signal is applied to the camera, an occurrence of the line start trigger signal will be recognized by the camera.

A rising edge and/or a falling edge of the external or CoaXPress signal can be used to trigger image acquisition. The Trigger Activation parameter is used to select rising edge and/or falling edge triggering. When the camera is operating under control of an external or CoaXPress signal, the period of trigger signal will determine the rate at which the camera is acquiring images:

$$\text{Line Rate(Hz)} = \frac{1}{\text{External/CoaXPress signal period in seconds}}$$

For example, if you are operating a camera with an external trigger signal period of 100 μs (10㎑). So in this case, the line rate is 10 ㎑.

4.2.3 Trigger Multiplier/Divider

With the Trigger Multiplier or Trigger Divider, you can modulate the period of the external trigger signal as desired. For example, if you use an encoder on a conveyor belt to supply a trigger signal to the camera's input terminal, the number of pulses output by the encoder per revolution is fixed. In this case, if you need to adjust the period of the trigger signal to match the pitch of the image in the vertical direction, the Trigger Multiplier or Trigger Divider allows you to adjust the period of the trigger signal input to the camera as follows:

```
Line Rate (Hz) = External Trigger Line Rate × Trigger Ratio
```

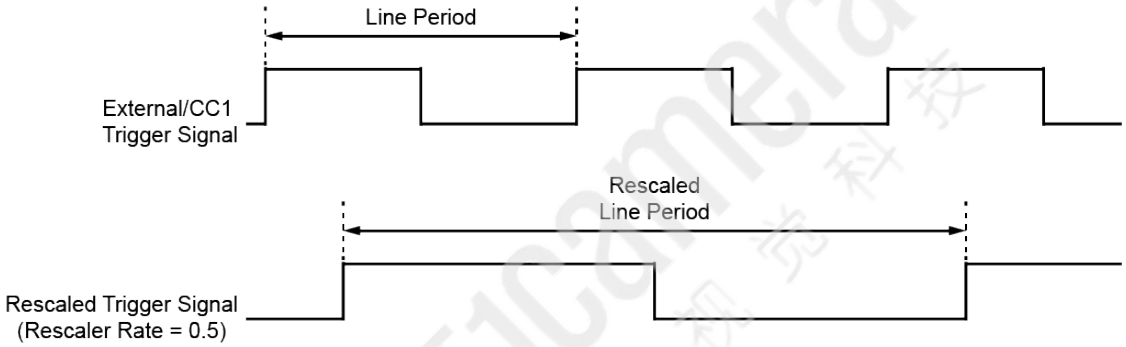


Figure 4-3 Trigger Ratio = 0.5

The XML parameters related to Trigger Multiplier or Trigger Divider are as follows:

XML Parameters		Value	Description
Acquisition Control	Trigger Multiplier	1 to 1024	Sets the trigger rescaler rate for converting trigger signals.
	Trigger Divider	1 to 1024	Sets the trigger rescaler rate for converting trigger signals.
	Trigger Ratio	0.000977 to 1024	Sets the trigger rescaler rate for converting trigger signals.
	TriggerRescaler FilterSize	Sets the filter exponent to attenuate jitter from external trigger signals	
		SIZE16	Sets the rescaler filter factor to 16.
		SIZE32	Sets the rescaler filter factor to 32.
		SIZE64	Sets the rescaler filter factor to 64.
		SIZE128	Sets the rescaler filter factor to 128.
		SIZE256	Sets the rescaler filter factor to 256.
		SIZE512	Sets the rescaler filter factor to 512.

Table 4-1 XML Parameters for Trigger Rescaler Mode

Multiplier와 Divider

- To apply setting values successfully, it is necessary for Multiplier and Divider to input trigger signals several times at the beginning. Strobe outputs are delayed until the setting is applied well.

	• When specifying the values of Multiplier and Divider, it is recommended to combine them so that the Divider value ÷ Multiplier value is 255 or less. If this number is higher than 265, speed to acquire images may not come out properly.

4.2.4 Exposure Mode

If you are triggering the start of frame acquisition with an externally generated trigger signal, two exposure modes are available: Timed and TriggerWidth.

Exposure Mode = Timed

When using external trigger signals, such as CoaXPress or External, as the Exposure trigger, two modes are available: **Timed** and **TriggerWidth**.

Timed Exposure Mode

When **Timed Mode** is selected, the exposure time required for image acquisition is determined by the **Exposure Time** parameter.

- If set to a **rising edge** trigger, the exposure time starts when the external trigger signal rises (transitions from low to high).
- If set to a **falling edge** trigger, the exposure time starts when the external trigger signal falls (transitions from high to low).

The diagram below illustrates the Timed exposure mode set with a rising edge trigger, where the exposure begins as the external trigger signal rises

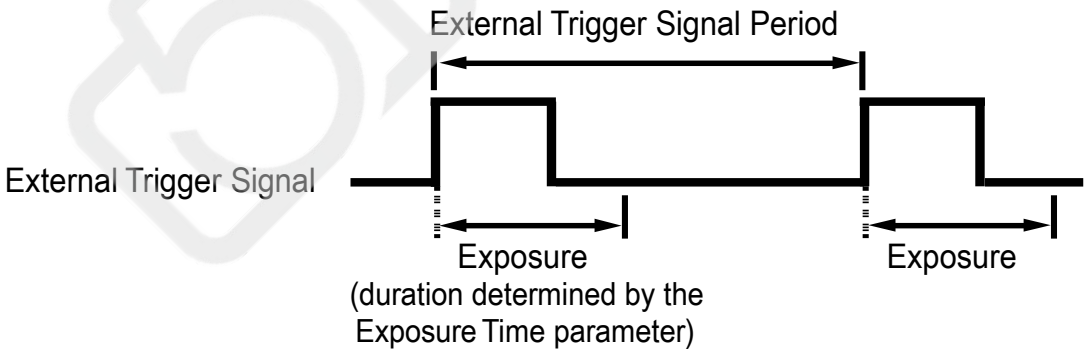


Figure 4-4 Timed Exposure Mode

If a new **Exposure Start trigger** signal is supplied while exposure is ongoing, that trigger signal will be ignored.

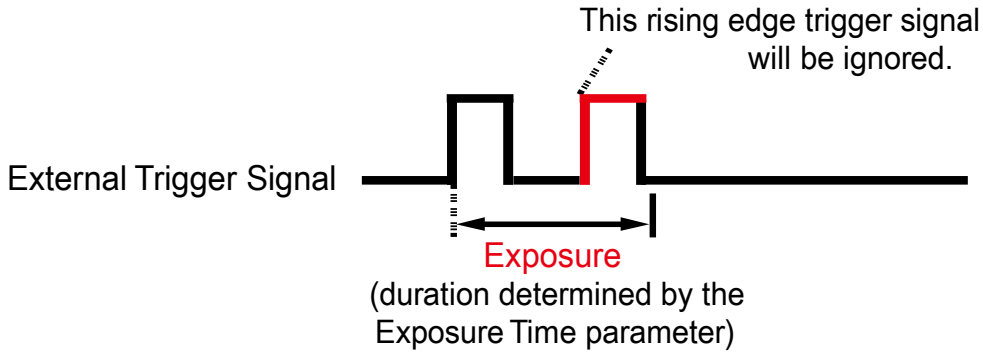


Figure 4-5 Trigger Overlapped with Time Exposure Mode

Exposure Time = TriggerWidth

If you select the TriggerWidth exposure mode, you can directly control the exposure period for each image acquisition using the external trigger signal (CoaXPress or External).

- When set to a rising edge trigger, exposure starts when the external trigger signal rises, and the exposure period continues until the signal falls.
- When set to a falling edge trigger, exposure starts when the external trigger signal falls, and the exposure period continues until the signal rises.

The following illustration shows the TriggerWidth exposure mode set with a rising edge trigger. TriggerWidth exposure is useful when applying different exposure periods for each image.

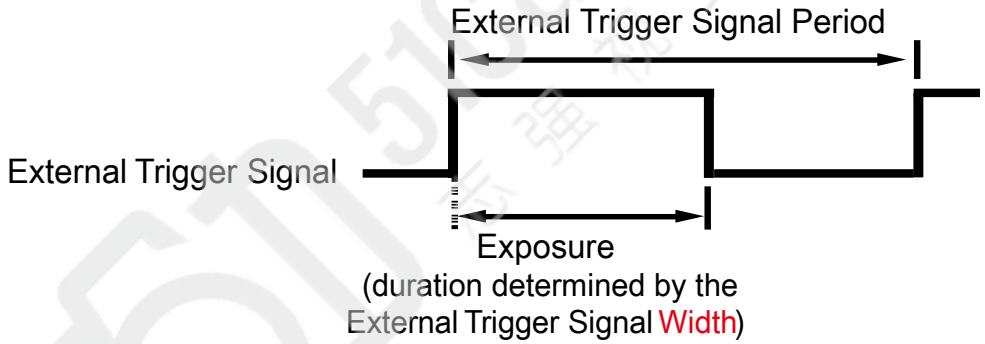


Figure 4-6 TriggerWidth Exposure Mode

4.3 Maximum Configurable Line Rate

The maximum configurable line rates for the VL-2K7X and VL-4K3.5X cameras are as follows:

Model	Mode	Maximum Line Rate
VL-2K7X-M170I-2	Single line	170 ㎑
VL-2K7X-C44I-4	Quad line	44 ㎑
VL-4K3.5X-M83I-2	Single line	83 ㎑
VL-4K3.5X-C42I-2	Dual line	42 ㎑

Table 4-2 Maximum Configurable Line Rate

Increasing the Maximum Allowed Frame Rate

To capture images at a faster rate than the maximum allowed frame rate for the camera's current settings, adjust one or more of the following factors that affect the maximum frame rate and verify if the speed has increased.

- The time it takes for the camera to transmit a line image is a key factor that limits the line rate. Reducing the line transmission time by performing one or more of the following actions can increase the maximum line rate.
  - Use 8 bit pixel data format rather than 12 bit pixel format. Images with fewer bits per pixel will take less time to transmit
  - Use a shorter length of ROI. Decreasing the length of ROI means that the camera has less data to transmit and therefore the transmission time will decrease.

5. Camera Features

This section provides information on each camera feature.

5.1 Scan Direction

In Linescan mode, the **Scan Direction** parameter is used to select the image sensor's scan direction. Set the **Scan Direction** to **Forward** if the object being imaged passes from the top to the bottom of the camera. Conversely, set it to **Backward** if the object passes from the bottom to the top of the camera.

When you set the Scan Direction parameter to Line 1, you can also select the scan direction by injecting an externally generated electrical signal (Low = Forward, High = Backward) into the pin 2 of the Control I/O receptacle on the camera.

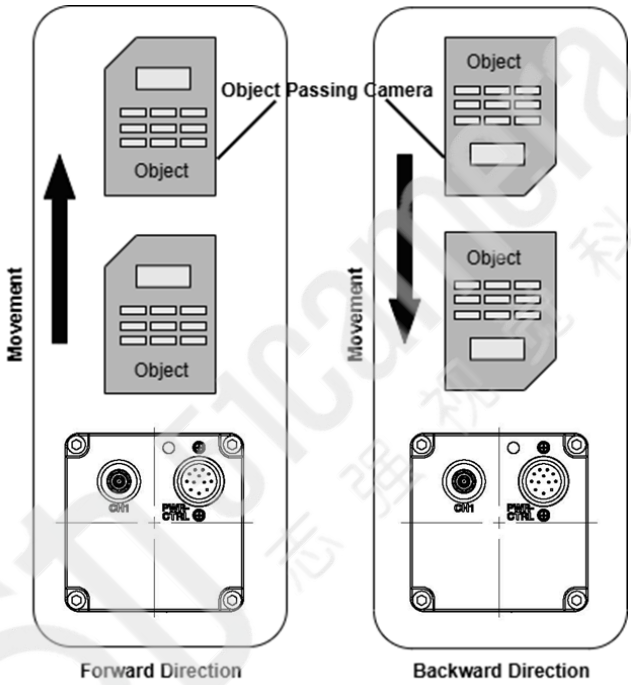


Figure 5-1 Scan Direction

- The above image assumes the use of a camera equipped with a lens, so the image is vertically flipped.

XML Parameter		Value	Description
ImageFormatControl	Scan Direction	Forward	Scans images in the forward direction.
		Backward	Scans images in the backward direction.
		Line1	Controls the direction depending on external signals

Table 5-1 XML Parameters for Scan Direction

5.2 Region of Interest

The ROI (Region of Interest) feature allows the user to specify and analyze an interested area of the image. It reads out the pixel information from the sensor and sent it to the frame grabber.

The ROI is defined relative to the left edge of the sensor row, and its position and size are determined by the **Offset X** and **Width** settings. For example, if **Offset X** is set to 32 and **Width** is set to 256, the ROI is configured as shown in the following image. In this case, the camera reads out and transmits pixels from position 32 to 287.

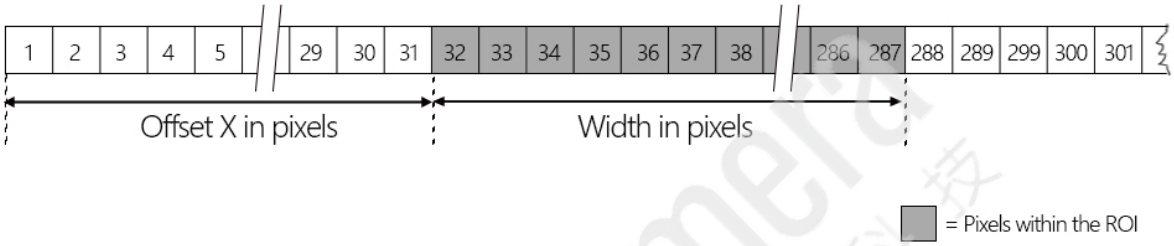


Figure 5-2 Region of Interest

The XML parameters in pixels for ROI are as follows:

XML Parameter		Value	Description
ImageFormatControl	Width	2K: 256 to 2048 (Step 16) 4K: 256 to 4096 (Step 16)	Sets the Width of the Image ROI.
	OffsetX	-	Sets the horizontal offset from the origin to the Image ROI.
	OffsetY	0	Sets the vertical offset from the origin to the Image ROI.

Table 5-2 XML Parameters for ROI

The user can change the ROI size by setting the Width parameter under the Image Format Control category. The ROI's starting position can be adjusted by setting the Offset X parameter. At this time, the sum of Width and Offset X must be smaller than the Width Max value. Since the camera's Width is set to the maximum value by default, the user should first configure the ROI size and then set the Offset X value.

- The Width parameter must be set in multiples of 16.
- The minimum configurable ROI Width is 256.

CAUTION

- If you change the camera's Image ROI settings after executing the **Acquisition Start** command, the image may not be acquired correctly. Therefore, make sure to execute the **Acquisition Stop** command before changing the Image ROI settings.

5.3 Binning

The Binning has the effects of increasing the level value and decreasing resolution by summing the values of the adjacent pixels and sending them as one pixel. The XML parameters related to Binning are as follows:

XML Parameter		Value	Description
ImageFormatControl	BinningSelector	Logic	Applies the Binning in digital by the logic.
	BinningHorizontalMode	Sum	Adds pixel values from the adjacent pixels as specified in the Binning Horizontal, and then sends them as one pixel.
		Average	Adds pixel values from the adjacent pixels as specified in the Binning Horizontal and divides them by the number of combined pixels, and then sends them as one pixel.
	BinningHorizontal	1×, 2×, and 4x	The number of horizontal pixels to combine together. 4× is supported only for monochrome.
	BinningVerticalMode (Available only for VL-4K3.5X)	Sum	Adds pixel values that are adjacent by the Binning Vertical setting and exports them as a single pixel value.
		Average	Adds pixel values from the adjacent pixels as specified in the Binning Vertical and divides them by the number of combined pixels, and then sends them as one pixel.
	BinningVertical (Available only for VL-4K3.5X)	1× and 2×	Adds pixel values that are adjacent by the Binning Vertical setting, then divides by the number of pixels added and exports as a single pixel value.

Table 5-3 XML Parameters for Binning

if you set BinningHorizontalMode to Sum, you can increase the sensitivity by 2x.

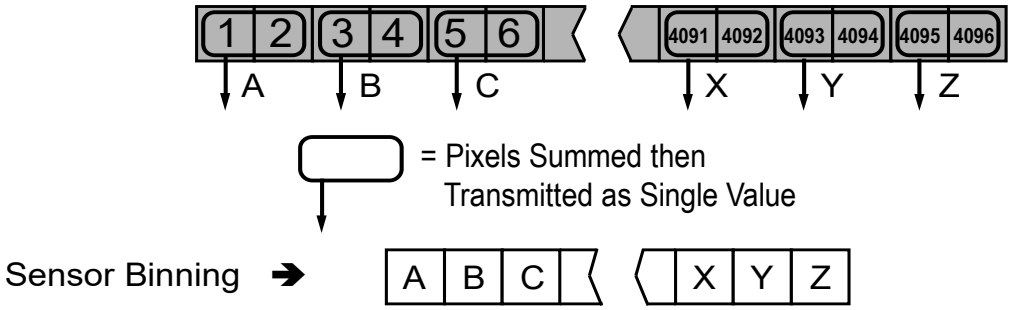


Figure 5-3 Horizontal Binning (Sum)

5.4 Pixel Format

You can use the **Pixel Format** parameter to set the pixel format of the image data.

The XML parameter for Pixel Format is as follows:

XML Parameter		Description
ImageFormatControl	PixelFormat	Sets the pixel format supported by the device.

Table 5-4 XML Parameter for Pixel Format

The pixel formats supported by color and mono sensors are as follows:

Mono Sensor	Color Sensor
VL-2K7X-M170I-2	Mono 8/10/12
VL-2K7X-C44I-4	Mono 8/10/12 RGB/BGR 8/10/12 RGBa/BGRa 8
VL-4K3.5X-M83I-2	Mono 8/10/12
VL-4K3.5X-C42I-2	Mono 8/10/12 RGB/BGR 8/10/12

Table 5-5 Pixel Format Values

5.5 Data ROI

To correct images with Fixed Pattern Noise, you can adjust the parameter value of the data's Region of Interest (ROI) to specify the area to be worked. For more information on FPN, refer to <5.15 FPN Coefficients Control>.

The XML parameters for Data ROI settings are as follows:

XML Parameter		Value	Description
DataRoiControl	DataRoiSelector	FixedPatternNoise	Select the data ROI to which to apply the values in FPNCoefficientsControl.
	DataRoiOffsetX	-	X coordinate of start point ROI
	DataRoiOffsetY	-	Y coordinate of start point ROI (Not supported by the models in this manual)
	DataRoiWidth	-	Width of ROI
	DataRoiHeight	-	Height of ROI

Table 5-6 XML Parameters for Data ROI

When using both Image ROI and Data ROI simultaneously, only the pixel data within the overlapping area of the defined Image ROI and Data ROI is valid. The **Height** parameter specifies the number of lines required to generate correction data. The camera captures the specified number of lines into its internal buffer and uses them for image correction. The valid area is determined as shown in the image below:

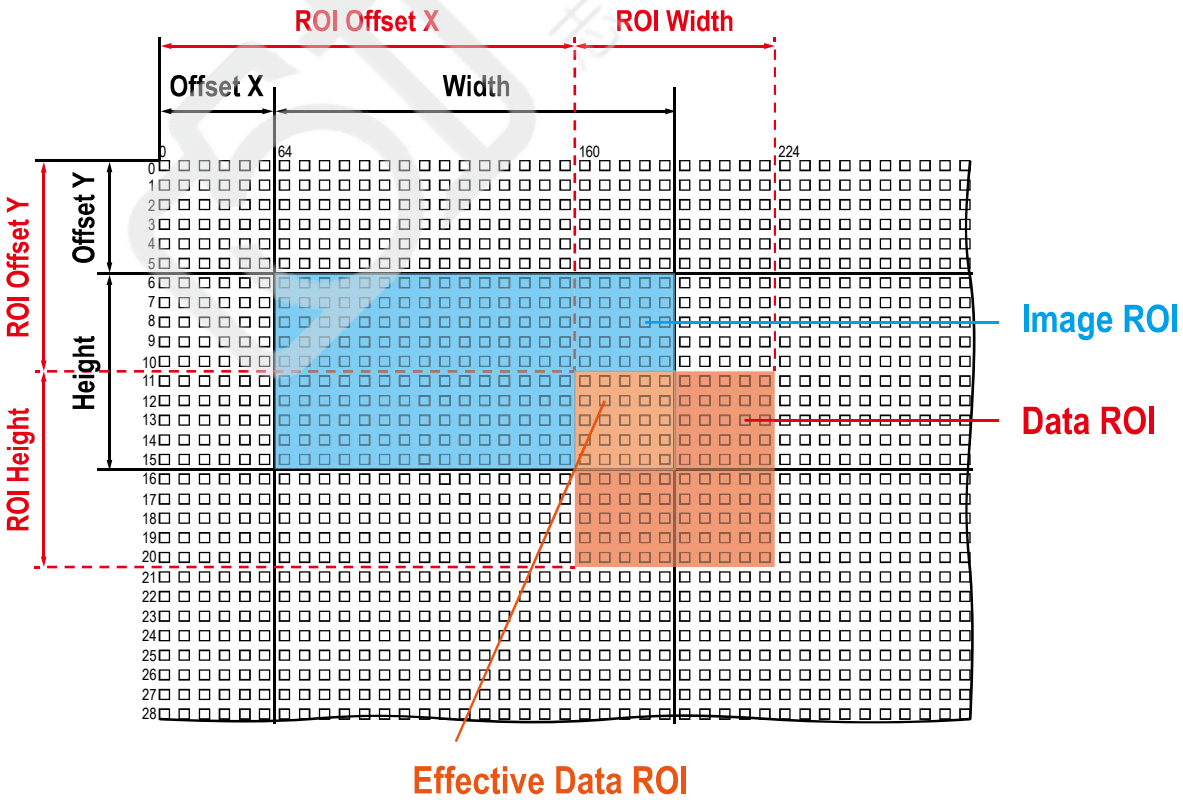


Figure 5-4 Effective Data ROI(Sample)

5.6 Data ROI (Color Only)

The Balance White Auto feature provided by the color camera uses the pixel data from a Data Region of Interest (ROI) to adjust the related parameters.

The XML parameters related to Data ROI are as follows:

XML Parameter		Value	Description
DataRoiControl	DataRoiSelector	BalanceWhiteAuto	Selects a Data ROI used for Balance White Auto. Only available on the color camera
	DataRoiOffsetX	-	X coordinate of start point Data ROI
	DataRoiOffsetY	-	Y coordinate of start point Data ROI (Not supported by the camera)
	DataRoiWidth	-	Width of Data ROI
	DataRoiHeight	-	Height of Data ROI

Table 5-7 XML Parameters for Data ROI (Color Only)

When both image ROI and data ROI are enabled, only the pixels in the overlapping region between the defined image ROI and data ROI are considered valid. The valid region is illustrated in the figure below.

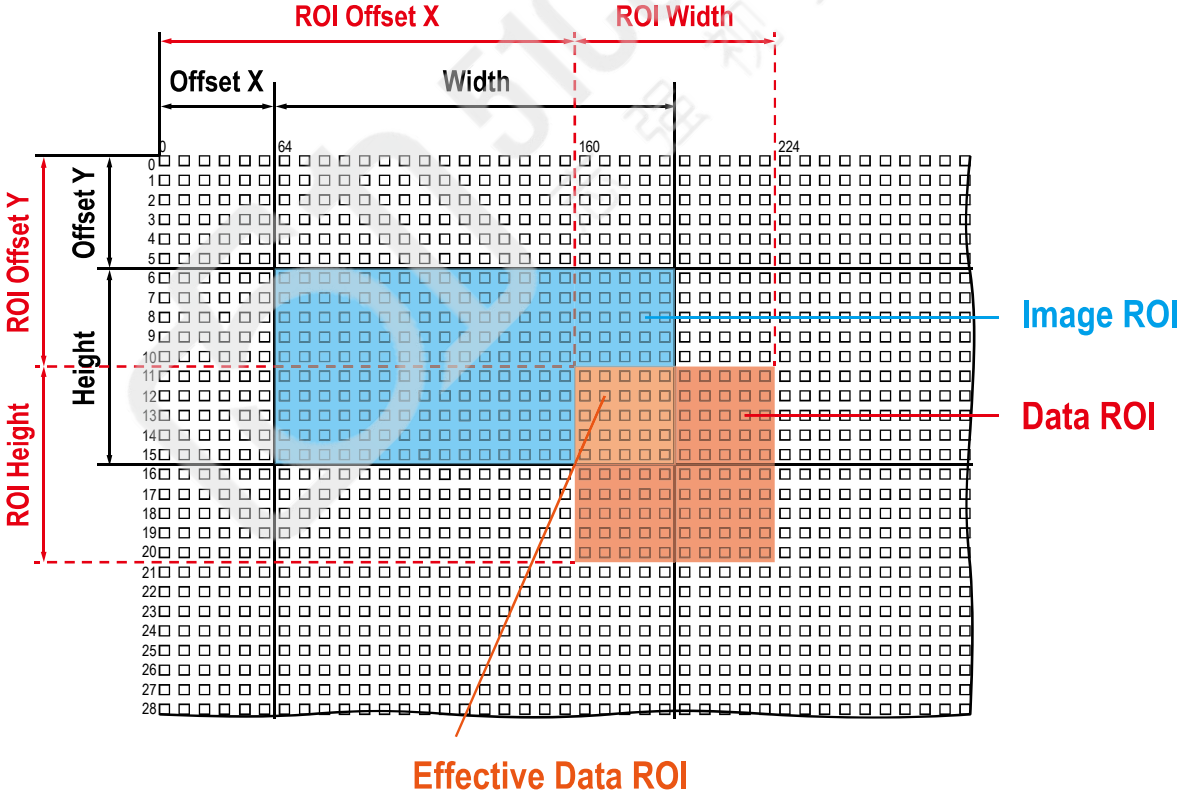


Figure 5-5 Effective Data ROI(Sample)

5.7 Band (Single/Dual/Triple/Quad)

Other than the previous models, the sensor of the VL-2K7X products is divided into 2 or 4 bands in the below form:

- Single/Dual band
- Single/Quad band
- Turn-on or turn-off per each band
- Applying exposure time to each band

5.7.1 Single/Dual Band

The sensors for each model in the table below operate in two bands: M0 and M1. By turning these two bands on or off to match the pixel format or speed you need, you can use Single and Dual modes.

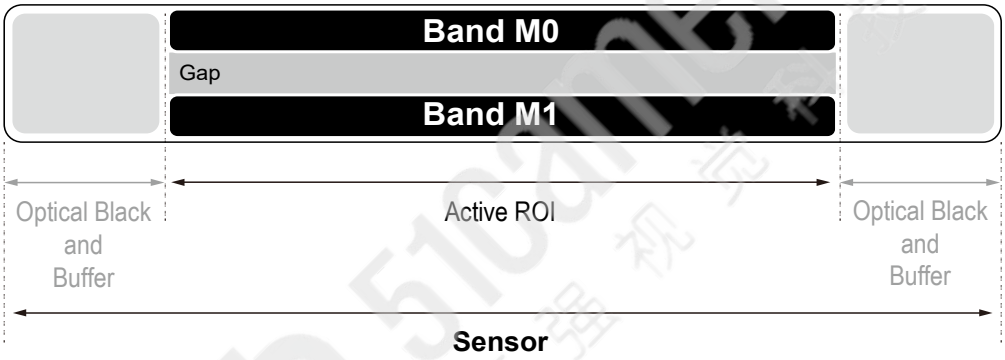


Figure 5-6 VL-2K7X Band(M0, M1)

Available Band(s) for each mode is as follow:

Model	Mode	Available Band	Pixel Format	Note
VL-2K7X-M170I-2	Single mode	M0	Mono 8/10/12	Max. line rate: 170 ㎑
VL-2K7X-M170I-2	Dual mode	M0, M1	Mono 8/10/12	Max. line rate: 87 ㎑

Table 5-8 Bands and Single/Dual Mode of VL-2K7X

The value related to Exposure Time is applicable to each band differently, or the same value is applicable to all the activated (On) bands at once. Refer to <5.7.4 Exposure Time per Band>for more information.

5.7.2 Single/Quad Band

Among the VL-2K7X models, the sensor of the VL-2K7X-C44I-4 operates in four bands, named M0 and BGR, as shown in the following figure. By turning these four bands on or off to match the required pixel format or speed, Single and Quad modes are available.

For VL-2K7X-C44I-4, each band has its own color information, with the 'B' band responsible for Blue, 'G' band for Green, and 'R' band for Red, respectively.

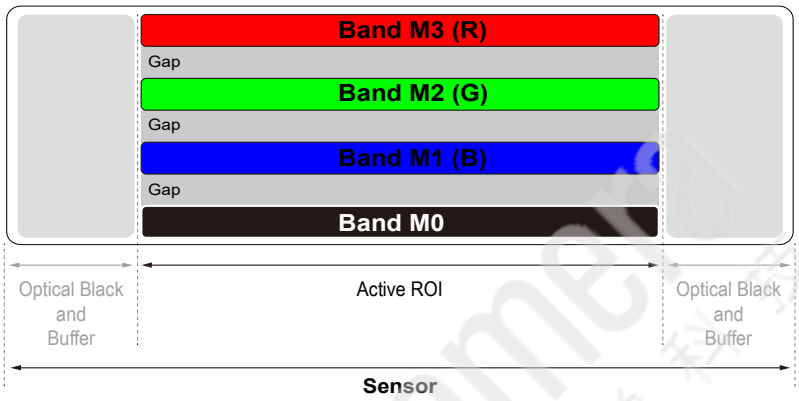


Figure 5-7 VL-2K7X-C44I-4 Bands

Bands used for each mode are as follows:

Model	Mode	Available Band	Pixel Format	Note
VL-2K7X-C-44I-4	Single Mode	M0	Mono	Max. line rate: 170 ㎑
	Quad Mode	M0, B,G,R	RGB/BGR 8/10/12 RGBa/BGRa 8	Max. line rate: 44㎑

Table 5-9 VL-2K7X-C44I-4 Bands in Single/Quad Mode.

5.7.3 Turning Off/On Bands

The XML parameters for turning off/on band are as follows:

XML Parameters		Product	Value	Description
ImageFormat Control	BandSelector	VL-2K7X-M170I-2 VL-4K3.5X-M83I-2	M0	Selects the M0 band
			M1	Selects the M1 band
		VL-2K7X-C44I-4	M0	Selects the M0 band
			Blue	Selects the Blue/M1 band
			Green	Selects the Green/M2 band
			Red	Selects the Red/M3 band
	BandEnable	All	Off	Turns the band selected on BandSelector off
			On	Turns the band selected on BandSelector on

Table 5-10 XML Parameters for Turning Bands On/Off

- When using a single line, please set Band M0 to 'On' and Band M1 to 'Off' to run the product at the maximum line rate (VL-2k7X: 170kHz and VL-4k3.5X: 83kHz).

5.7.4 Exposure Time per Band

For VL-2K7X and VL-4K3.5X, the value related to Exposure Time is applicable to each band differently, or the same value is applicable to all the activated (On) bands at once.

The XML parameters related to setting Exposure Time per each band are as follows:

XML Parameters		Value	Description
AcquisitionControl	ExposureTime Mode	Common	• Applies Exposure Time to all activated bands at once.
		Individual	• Applies Exposure Time to each band individually.
	ExposureTime Selector	Common	• Applies Exposure Time to all activated bands at once. • Available when Common is selected on ExposureTimeMode.
		M0	• Applies Exposure Time to the M0 band. • Available when Individual is selected on ExposureTimeMode.
		Blue/M1	• Applies Exposure Time to the Blue (M1) band. • Available when Individual is selected on ExposureTimeMode..
		Green	• Applies Exposure Time to the Green (M2) band. • Available when Individual is selected on ExposureTimeMode.
		Red	• Applies Exposure Time to the Red (M3) band • Available when Individual is selected on ExposureTimeMode
	ExposureTime	0.1 to 1000μs	• Inputs the value of Exposure Mode to apply to the band selected on ExposureTimeSelector

Table 5-11 XML Parameters for Exposure Time per Band

5.8 White Balance (Color Only)

The color camera includes the white balance capability to adjust the color balance of the images transmitted from the camera. With the white balancing scheme used on the VL-2K/4K he Red, Green and Blue intensities can be adjusted individually. You can set the intensity of each color by using the Balance Ratio parameter. The Balance Ratio value can range from 1.0 to 4.0. If the Balance Ratio parameter is set to 1.0 for a color, the intensity of the color will be unaffected by the white balance mechanism. If the Balance Ratio parameter is set to greater than 1.0, the intensity of the color will be proportionally increased to the ratio. For example, if the Balance Ratio is set to 1.5, the intensity of that color will be increased by 50%

The XML parameters for White Balance are as follows:

XML Parameter		Value	Description
AnalogControl	BalanceRatioSelector	Red	A Balance Ratio value will be applied to red pixels.
		Green	A Balance Ratio value will be applied to green pixels.
		Blue	A Balance Ratio value will be applied to blue pixels.
	BalanceRatio	x1.0 to x4.0	Adjusts the ratio of the selected color.

Table 5-12 XML Parameters for White Balance

5.8.1 Balance White Auto

The Balance White Auto feature is implemented on the color camera. It will control the white balance of the image acquired from the color camera according to the GreyWorld algorithm. Before using the Balance White Auto feature, you need to set the Data ROI for Balance White Auto. If you do not set the related Data ROI, the pixel data from the Image ROI will be used to control the white balance. As soon as the Balance White Auto parameter is set to Once, the Balance Ratio values for Red and Blue will be automatically adjusted to adjust the white balance by referring to Green.

The XML parameter for Balance White Auto is as follows:

XML Parameter		Value	Description
AnalogControl	BalanceWhiteAuto	Off	Turns Balance White Auto Off
		Once	White Balance is adjusted once and then turned off.

Table 5-13 XML parameter for Balance White Auto

5.9 Gain and Black Level

Increasing the Gain parameter increases all pixel values of the image. This results in a higher grey value output from the camera for a given amount of output from the image sensor.

1 Using Gain Selector parameters, select a type of Gain Control: Analog All and Digital All.

2 Input the desired value of Gain parameters.

By adjusting Black Level parameters, the pixel values output by the camera can be offset by the configured value.

1 Using Black Level Selector parameters, select a type of Black Level Control: Digital All

2 Set the Black Level parameter to the desired value. The available setting range varies depending on the Pixel Format settings.

The XML parameters related to Gain and Black Level are as follows:

VL-2K7X

XML Parameter		Value	Description
Analog Control	GainSelector	DigitalAll	Applies the set digital gain value to all bands equally
		DigitalM0 (Mono,Color)	Applies the set Digital Gain value to M0 band
		DigitalM1(Mono)	Applies the set Digital Gain value to M1 band
		DigitalBlue (Color)	Applies the set Digital Gain value to Blue band
		DigitalGreen (Color)	Applies the set Digital Gain value to Green band
		DigitalRed (Color)	Applies the set digital gain value to Red band
	Gain	1.0× to 32.0×	Sets the Digital Gain value (DigitalAll)
		1.0× to 4.0×	Sets the digital gain value (if you want to set it by band per Band)
	BlackLevelSelector	Digital All	Applies the Black Level value to all digital channels
	BlackLevel	-256 to 255	Sets Black Level value (set value based on 8 bit)

Table 5-14 XML Parameters related to Gain and Black Level (VL-2K7X)

VL-4K3.5X

XML Parameter		Value	Description
Analog Control	GainSelector	DigitalAll	Applies the set digital gain value to all bands equally
		DigitalM0 (Mono)	Applies the set Digital Gain value to

			M0 band
		DigitalM1(Mono)	Applies the set Digital Gain value to M1 band
		DigitalBlue (Color)	Applies the set Digital Gain value to the Blue band
		DigitalGreen (Color)	Applies the set Digital Gain value to the Green band
		DigitalRed (Color)	Applies the set digital gain value to the Red band
	Gain	1.0× to 32.0×	Sets the Digital Gain value (DigitalAll)
		1.0× to 4.0×	Sets the digital gain value (if you want to set it by band per Band)
	BlackLevelSelector	Digital All	Applies the Black Level value to all digital channels
	BlackLevel	-256 to 255	Sets Black Level value (set value based on 8 bit)

Table 5-15 XML Parameters related to Gain and Black Level (VL-4K3.5X)

5.10 Color Transformation

The VL-2K7X and VL-4K3.5X cameras provide the Color Transformation feature. After adjusting the white balance, you can adjust colors to your light source by using the Color Transformation feature. The Color Transformation feature converts the RGB triplet from the camera color space to the RGB triplet of the final color space when you enter nine Gain factors in the 3 × 3 matrix as shown below

$$\begin{pmatrix} R' \\ G' \\ B' \end{pmatrix} = \begin{pmatrix} Gain\ 00 & Gain\ 01 & Gain\ 02 \\ Gain\ 10 & Gain\ 11 & Gain\ 12 \\ Gain\ 20 & Gain\ 21 & Gain\ 22 \end{pmatrix} \times \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

$$\text{Equivalent:} \quad \begin{pmatrix} R_{out} \\ G_{out} \\ B_{out} \end{pmatrix} = \begin{pmatrix} RR & RG & RB \\ GR & GG & GB \\ BR & BG & BB \end{pmatrix} \times \begin{pmatrix} R_{in} \\ G_{in} \\ B_{in} \end{pmatrix}$$

Figure 5-8 Color Transformation

The XML parameters related to Color Transformation are as follows:

XML Parameter		Value	Description
Color Transformation Control	ColorTransformation Selector	RGBtoRGB	Selects a type of color transformation to be performed.
	ColorTransformationEnable	False/True	Activates the selected color transformation.
	ColorTransformation ValueSelector	Gain00	Red contribution to the red pixel
		Gain01	Green contribution to the red pixel
		Gain02	Blue contribution to the red pixel
		Gain10	Red contribution to the green pixel
		Gain11	Green contribution to the green pixel
		Gain12	Blue contribution to the green pixel
		Gain20	Red contribution to the blue pixel
		Gain21	Green contribution to the blue pixel
		Gain22	Blue contribution to the blue pixel
		Offset0 to 2	Not used for RGBtoRGB color transformation
	ColorTransformation Value	-4.0× to 4.0×	Sets a value of the selected Gain factor.

Table 5-16 XML Parameters for Color Transformation

5.11 LUT

By using the Lookup Table (LUT) function, you can convert the original image values to any arbitrary level.

Luminance

Since there is a one-to-one mapping for each level, arbitrary 12-bit inputs can be mapped to arbitrary 12-bit outputs. The LUT is structured as a table with 4096 input values (ranging from 0 to 4095), and the cameras provides one non-volatile storage space for storing LUT data. Users can choose whether to apply the LUT. For instructions on how to download LUT data to the camera, refer to <7.1 LUT Download>.

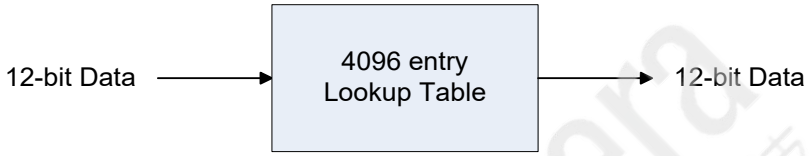


Figure 5-9 LUT Block

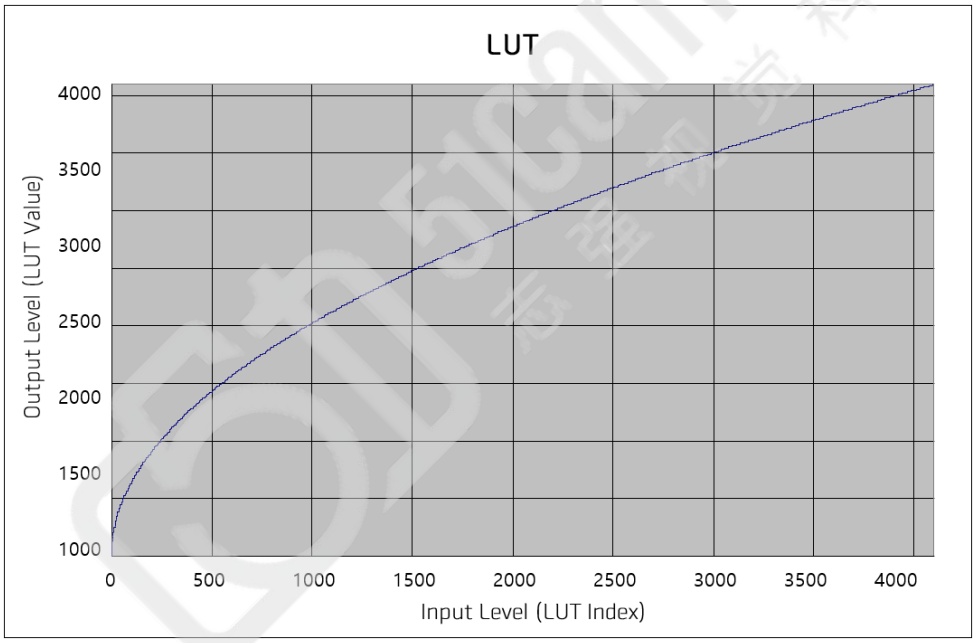


Figure 5-10 LUT when Gamma=0.5

The XML parameters for LUT settings are as follows:

XML Parameter		Value	Description
LUTControl	LUTSelector	Luminance	Luminance LUT
	LUTEnable	True/False	Activates/Deactivates the selected LUT.
	LUTIndex	0 to 4095	The coefficient of Index to check LUTValue.
	LUTValue	0 to 4095	The output value of the current LUT corresponding to the input value of LUTIndex.
	LUTSave	-	Saves the current LUT data to the non-volatile memory.
	LUTLoad	-	Loads the current LUT data.

Table 5-17 XML Parameters for LUT

5.12 Dark Signal Non-Uniformity Correction

In theory, when capturing an image in a completely dark environment with a digital camera, the pixel values of the image should either be almost zero or all the same. However, because each pixel in the sensor may respond differently to light, when capturing an image in a dark environment, the pixel values output by the camera can vary. This variation is known as DSNU (Dark Signal Non-Uniformity), and the camera provides a function to calibrate this DSNU.

The XML parameters regarding the DSNU are as follows:

XML Parameter		Value	Description
DSNU	DSNUBandSelector	All	Selects all currently used bands as the target for DSNU correction.
		M0(Mono/Color model)	Selects M0 band as the target for DSNU correction. • Color model is available only for **VL-2K7X**
		M1(Mono model)	Selects M1 band as the target for DSNU correction.
		Blue(Color model)	Selects band responsible for blue color as the target for DSNU correction.
		Green(Color model)	Selects band responsible for green color as the target for DSNU correction.
		Red(Color model)	Selects band responsible for red color as the target for DSNU correction.
	DSNUDataSelector	Default, Space1 to 15	Selects DSNU data.
	DSNUDataGenerate	-	Generates DSNU data for the bands selected in DSNUBandSelector.
	DSNUDataSave	-	Saves the generated DSNU data in the non-volatile memory. • The data generated by **DSNUDataGenerate** is stored in volatile memory, so it must be saved to non-volatile memory after rebooting the camera in order to be used.
	DSNUDataLoad	-	Loads the DSNU data from the non-volatile memory into the volatile memory.
	DSNUDataDefault	Default, Space1 to 15	Selects DSNU data.

Table 5-18 XML Parameters related to DSNU

5.12.1 Generating and Saving User-defined DSNU Correction Values

To generate and save the DSNU correction value according to the actual operating environment, follow the below steps:

- To generate optimized DSNU data, turn on the camera and create the DSNU data after the camera's housing temperature has stabilized.
- Before generating DSNU data, turn FFC off.

1 When generating DSNU calibration values in the camera, the entire sensor is used. Therefore, it is recommended to set the ROI to utilize the full length of the image sensor.
2 Cover the camera lens or close the lens aperture, and capture line images in a completely dark environment such as a darkroom.
3 Set the camera to Free-Run mode or supply an appropriate external trigger signal to start line image acquisition.
4 Generate the DSNU calibration values.
5 If you execute the DSNU Data Generate command,
   - The camera generates DSNU data according to the current Analog Gain setting value. The camera must acquire at least 1024 line images to create a set of DSNU correction values.
   - After completing 1024 line acquisitions, the generated DSNU correction values will be activated and saved in the camera's volatile memory.
   - To save the generated DSNU correction values in the camera's flash(non-volatile) memory, execute the DSNU Data Save command. The previous DSNU values for the current Analog Gain setting value saved in the memory will be overwritten.
   - To generate DSNU data, proceed with step 5 after executing the **DSNU Generate** command.
6 If you change the Analog Gain setting value or want to load the existing values in the flash memory, execute the DSNU Data Load command.

5.13 Photo Response Non-Uniformity Correction

In theory, when capturing an evenly illuminated object in a bright environment with a line scan camera, all pixel values in the image should be close to the maximum grey value or identical. However, due to small performance variations between each pixel in the sensor, as well as changes in the lens and lighting, the pixel values output by the camera may differ. This variation is called PRNU (Photo Response Non-uniformity), and the VL-2K/4K CXP cameras provides the capability to correct for PRNU, along with 16 PRNU storage spaces.

The XML parameters regarding the PRNU are as follows:

XML Parameter		Value	Description
PRNU	PRNUBandSelector	All	Selects all currently used bands as the target for PRNU correction.
		M0[a]	Selects M0 band as the target for PRNU correction.
		M1[a]	Selects M1 band as the target for PRNU correction.
		Blue	Selects band responsible for blue color as the target for PRNU correction.
		Green	Selects band responsible for green color as the target for PRNU correction.
		Red	Selects band responsible for red color as the target for PRNU correction.
	PRNUCorrection	False	Deactivates PRNU Correction.
		True	Activates PRNU Correction.
	PRNUTarget LevelAUTO	False	If checked, specifies PRNU Target Level manually.
		True	If checked, specifies PRNU Target Level automatically.
	PRNUTargetLevel	-	Setting PRNU Target Level (@ 8 bit Pixel Format)
	PRNUDataSelector	Default, Space 1 to Space 15	Setting the area to save or retrieve PRNU data
	PRNUDataGenerate	-	Generates PRNU data for the bands selected in PRNUBandSelector.
	PRNUDataSave	-	Saves the generated PRNU data in the non-volatile memory. The data generated by **PRNUGenerate** is stored in volatile memory, so it must be saved to non-volatile memory after rebooting the camera in order to be used.
	PRNUDataLoad	-	Loads the PRNU data from the non-volatile memory into the volatile memory.

	PRNUDataDefault	Default, Space 1 to Space 15	Selects PRNU data.

[a]: Available only on the mono camera.

Table 5-19 XML Parameters related to PRNU

5.13.1 Generating and Saving User PRNU Correction Values

To generate and save user defined PRNU correction values, use the following procedures:

- It is recommended to generate new PRNU correction values after replacing the lens or lighting, or when changing the camera's line rate.
- To generate optimized PRNU data, first perform DSNU correction, then generate the PRNU correction values.
- If **PRNU Target Level** is set to **Auto** (*PRNU Target Level Auto: True*), **Band1** and **Band2** will be adjusted to their respective highest level values.
- If **PRNU Target Level** is set to **Manual** (*PRNU Target Level Auto: False*), **Band1** and **Band2** will be adjusted to the same user-defined level value.

1 The camera will use the entire sensor when generating PRNU correction values. The PRNU correction value refers to the current setting values of the OffsetX and the Width range, therefore, we recommend checking setting of these values in advance.
2 Place a uniform white target in the field of view of the camera. Adjust the optics, lighting, and line rate as you would for normal operation. We recommend that you adjust achieve the digital output level in a range from 100 to 200 (Gain: 1.00 at 8 bit).
3 Begin acquiring line images either by setting the camera for the Free-Run mode or by supplying external trigger signals to trigger line acquisition.
4 Set the Target Level.
   ▫ To set the **Target Level** automatically, enable **Target Level AUTO**. To set it manually, disable **Target Level AUTO** and enter a desired value between 0 and 255.
5 Execute the PRNU Generate command to generate PRNU correction values.
6 The camera must acquire at least 1024-line images to create a set of PRNU correction values.
7 After completing 1024-line acquisitions, the generated PRNU correction values will be activated and saved in the camera's volatile memory.
8 To save the generated PRNU correction values in the camera's Flash (non-volatile) memory, specify a location to save by using the PRNU Selector parameter and execute the PRNU Save command. The existing values in the memory will be overwritten.

To discard the generated PRNU correction values and load the existing values from flash memory, use the **PRNU Data Selector** parameter to specify the memory area where the desired PRNU data is stored, and then execute the **PRNU Data Load** command.

.

5.14 FPN Coefficients Control

When Fixed Pattern Noise (FPN) occurs, the FPN correction function provided by this product allows you to post-correct the image. The VL-2K/4K CXP cameras provide the ability to post-correct images with FPN by specifying a Black Level value to be added to the DSNU correction value, or a Gain value to be multiplied by the PRNU correction value.

The XML parameters related to FPN Coefficients Control are as follows:

XML Parameter		Value	Description
FPNCoefficientsControl	DSNUCoefficient	-	Sets a value of Black Level to add to current value of the DSNU correction.
	DSNUCoefficientApply		Sets a value of Black Level to add to current value of the DSNU correction.
	PRNUCoefficient	-	Sets a Gain value to multiply by current value of the PRNU correction.
	PRNUCoefficientApply	-	Applies the value above to the value of the PRNU correction.

Table 5-20 XML Parameters for FPN Coefficients Control

5.15 CXP Link Configuration

The VL-2K/4K CXP cameras should be connected to a CXP Frame Grabber installed in your computer via CoaXPress interface. CoaXPress interface allows you to connect a camera to a CXP Frame Grabber by using simple coax cabling and allows up to 6.25 Gbps data rate per cable.

The cameras support one master connection. In compliance with the CoaXPress standard, it includes an automatic link detection (Plug and Play) mechanism to correctly detect the camera to CXP Frame Grabber connections.

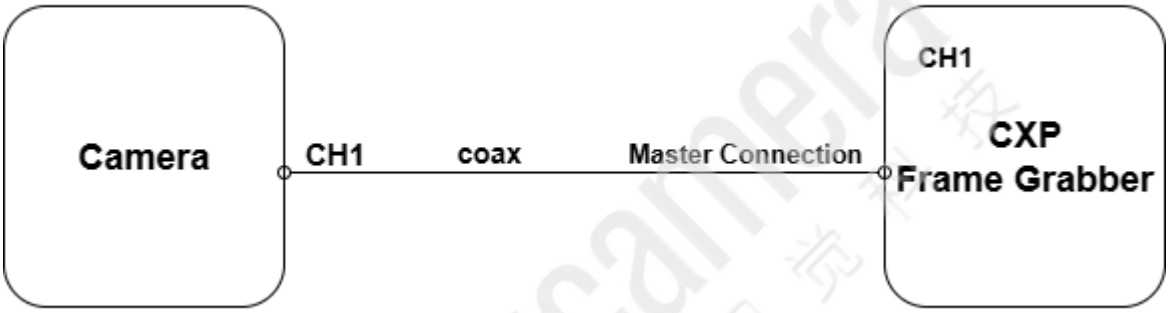


Figure 5-11 CXP Link Configuration

The XML parameters related to the Link configuration between the camera and the CXP frame grabber are located under the **Transport Layer Control** category, in the **CoaXPress** section, and are as follows:

XML Parameter		Value	Description
CoaXPress	CxpLinkConfiguration Preferred	Read Only	Displays bit rate and the number of connections to be set for the link configuration between the camera and Host (Frame Grabber) while discovering devices.
	CXPLinkConfiguration	CXP3 X1 CXP5 X1 CXP6 X1	Sets bit rate and the number of connections for the link configuration by force.

Table 5-21 XML Parameters related to CXP Link Configuration

5.16 Digital I/O Control

The Control I/O receptacle of the camera can be operated in various modes.

The XML parameters related to Digital I/O Control are as follows:

XML Parameter		Value	Description
DigitalIOControl	LineSelector	Line0	Configures for pin 6 of the camera's 12-pin control input/output terminal, which is used for setting input signals such as counters and timer, etc.
		Line1	Configures for pin 9 of the camera's 12-pin control input/output terminal, which is used for setting input signals such as counters and timer, etc.
		Line2	Configures for pin 10 of the camera's 12-pin control input/output terminal, which is used for setting input signals such as counters and timer, etc.
	LineMode	Input	Configures for pin 4 of the camera's 12-pin control input/output terminal, which is used for setting input signals such as counters and timer, etc.
		Output	Appears when Line2 is selected.
	LineInverter (Available when using Line2)	FALSE	Disables inversion on the output signal of the line.
		TRUE	Enables inversion on the output signal of the line.
	LineSource	Off	Deactivates line output.
		High	Outputs a constant 3.3V. • Activated only when LineMode is set to Output.
		FrameActive	Outputs the FrameActive signal as a pulse.
		LineActive	Outputs the LineActive signal as a pulse.
		ExposureActive	Outputs the ExposureActive signal as a pulse
		UserOutput0	Outputs a pulse based on the UserOutputValue setting.
		Timer0Active	Outputs the user-defined timer as a pulse.
		Counter0Active	Outputs the user-defined Counter output signal as a pulse.
		Strobe0	Outputs the Strobe0 signal as a pulse.
	UserOutput Selector	UserOutput0	Outputs a pulse based on the UserOutputValue setting.

	UserOutput Value	FALSE	Sets bit to Low.
		TRUE	Sets bit to High.
	StrobeSelector	Strobe0	Configures Strobe Selector.
	StrobeMode	Timed	Outputs a pulse signal based on the Strobe Duration setting.
		TriggerWidth	Outputs a signal with the same pulse width as the trigger signal input to the camera.
	StrobeDelay	0 to 1000 μs	Sets delay in 1μs increments to the current output signal.
	StrobeDuration	1 to 1000 μs	Sets the width of the pulse signal in 1μs increments when Strobe Mode is set to Timed.

Table 5-22 XML Parameter for Digital I/O Control

With Line Source being set to UserOutput0, a user-defined value can be used as an output signal.

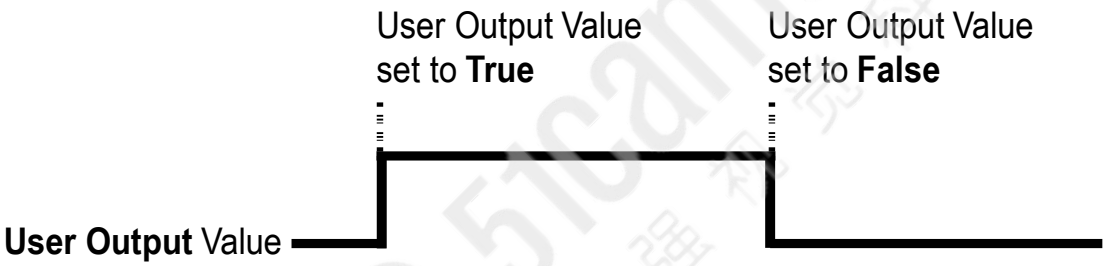


Figure 5-12 User Output

The camera provides an Exposure Active output signal. As shown in the following figure, the Exposure Active signal rises when the exposure time begins and falls when the exposure time ends. This signal can be used to trigger a flash and is especially useful in environments where either the camera or the subject is moving. Generally, the camera should remain stationary during the exposure process. By monitoring the Exposure Active signal, you can determine when exposure is occurring and when the camera must not be moved.

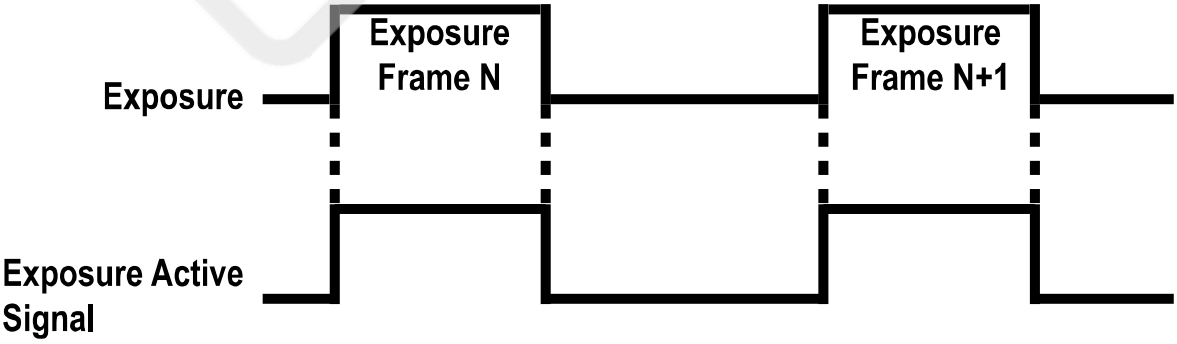


Figure 5-13 Exposure Active Signal

5.17 Debounce

A Debounce feature allows to supply only valid signals to the camera by discriminating between valid and invalid input signals. The Debounce Time parameter specifies the minimum time that an input signal must remain High or Low in order to be considered as a valid input signal. When you use the Debounce feature, be aware that there is a delay between the point where the valid input signal arrives and the point where the signal becomes effective. The duration of the delay is determined by the Debounce Time parameter setting value.

When you set the Debounce Time parameter, High and Low signals shorter than the setting value are considered invalid and ignored as shown in the figure below:

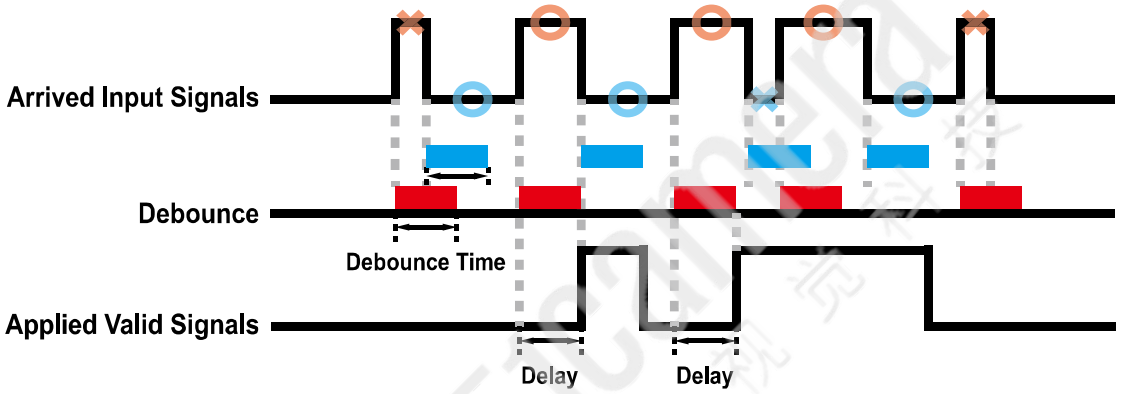


Figure 5-14 Debounce

5.18 Temperature Monitor

The camera has an embedded sensor chip to monitor the internal temperature.

The XML parameter for the device temperature is as follows:

XML Parameter		Value	Description
DeviceControl	DeviceTemperatureSelector	Mainboard	Sets a temperature measuring spot to the mainboard.
	DeviceTemperature	-	Displays device temperature in Celsius.

Table 5-23 XML Parameter for Device Temperature

5.19 Status LED

A LED is installed on the rear panel of the camera to inform the operation status of the camera.

Status LEDs indicating the camera status are as follows:

Status LED	Description
Steady Red	The camera is not initialized.
Slow Flashing Red	A CXP Link is not configured.
Fast Flashing Orange	The camera is checking a CXP Link configuration.
Steady Green	A CXP Link is configured.
Fast Flashing Green	The camera is transmitting image data.

Table 5-24 Status LED

5.20 Test Pattern

To verify the normal operation of the camera, you can configure it to output an internally generated test pattern instead of the image data from the image sensor. There are four types of test patterns available.

The XML parameter for test patterns is as follows:

XML Parameter		Value	Description
ImageFormatControl	TestPattern	Off	Disables the Test Pattern feature.
		GreyHorizontalRamp	Outputs a test pattern image with varying horizontal values.
		GreyDiagonalRamp	Outputs a test pattern image with varying diagonal values.
		GreyDiagonalRampMoving	Outputs a test pattern image with varying diagonal values in motion.
		SensorSpecific0	Outputs an image with varying horizontal values from the sensor.

Table 5-25 XML Parameter for Test Pattern

Figure 5-15 Grey Horizontal Ramp

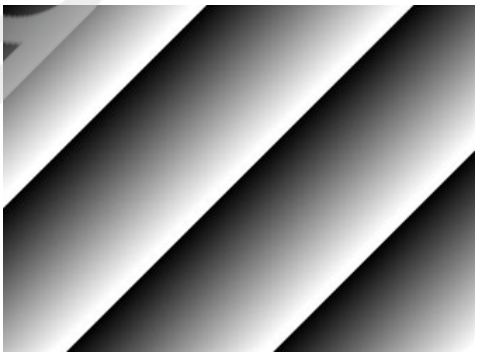


Figure 5-16 Grey Diagonal Ramp

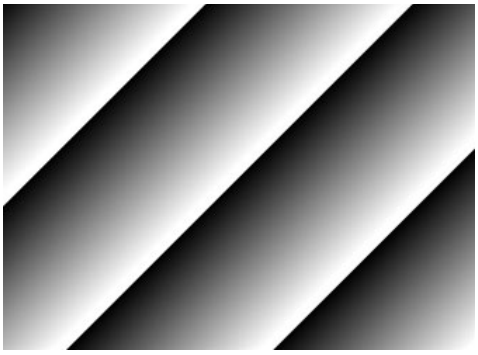


Figure 5-17 Grey Diagonal Ramp Moving

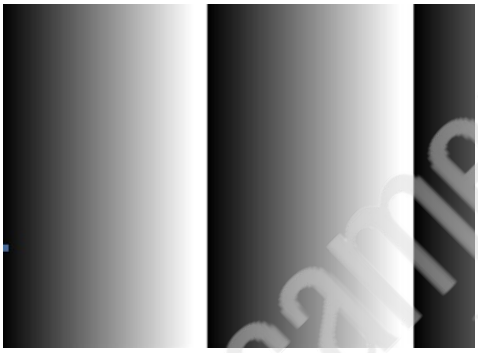


Figure 5-18 Sensor Specific

CAUTION

- Depending on the resolution, the area of the output test pattern varies, and the image may look different.

5.21 Reverse X

A user can horizontally reverse an image. It is available in almost all of the operation modes of the camera, except for the Test Image mode.

The XML parameter for Reverse X is as follows:

XML Parameter		Value	Description
ImageFormatControl	ReverseX	FALSE	Disables the Reverse X feature.
		TRUE	Flips images horizontally.

Table 5-26 XML Parameter for Reverse X

Figure 5-19 Image before applying Reverse X

Figure 5-20 Image after applying Reverse X

5.22 Counter Control

The Counter function allows you to count the number of specific events in the camera. For example, you can check the number of trigger signals supplied externally to the camera.

The XML parameters regarding the Counter Control are as follows:

XML Parameter		Value	Description
CounterAndTimerControl	CounterSelector	Counter0	Selects a Counter.
	CounterEventActivation	RisingEdge	Counts the rising edges of the selected Event Source signal.
		FallingEdge	Counts the falling edges of the selected Event Source signal.
	CounterEventSource	Off	Stops the Counter.
		ExposureActive	Counts the number of ExposureActive signals.
		LineActive	Counts the number of LineActive signals.
		Line0	Counts the number of Line0 signals.
		Line1	Counts the number of Line1 signals.
	CounterResetSource	Off	Deactivates Counter Reset trigger.
		ExposureActive	Uses ExposureActive signal as Reset Source.
		AcquisitionActive	Uses Acquisition Active signal as Reset Source.
		Line0	Uses Line0 signal as Reset Source.
		Line1	Uses Line1 signal as Reset Source.
	CounterResetActivation	RisingEdge	Resets the counter on the rising edge of the selected Reset Source signal.
		FallingEdge	Resets the counter on the falling edge of the selected Reset Source signal.
		AnyEdge	Resets the counter on the falling or rising edge of the selected Reset Source signal.
		LevelHigh	Resets the counter if the signal level of the selected Reset Source is high.
		LevelLow	Resets the counter if the signal level of the selected Reset Source is low.
	CounterReset	-	Resets the selected Counter.
	CounterValue	-	Displays the current value of the selected Counter.
	CounterValueAtReset	-	Displays the Counter value when Counter Reset command is executed.
	CounterDuration	1 to 4294967295	Sets the number of cell events until the counter ends.
	CounterStatus	-	Displays the current status of Counter
		Off	Deactivates Counter Trigger Source.

	CounterTrigger Source	ExposureActive	Uses the ExposureActive signal as the Counter Trigger Source.
		AcquisitionActive	Uses the Acquisition Active signal as the Counter Trigger Source.
		Line0	Uses the Line0 signal as the Counter Trigger Source.
		Line1	Uses the Line1 signal as the Counter Trigger Source.
	CounterTrigger Activation	RisingEdge	Starts Counter from the rising edge of the selected Counter Trigger Source signal.
		FallingEdge	Starts Counter from the falling edge of the selected Counter Trigger Source signal.
		AnyEdge	Starts Counter from the rising/falling edge of the selected Counter Trigger Source signal.
		LevelHigh	Starts Counter if the level of the selected Counter Trigger Source signal is high.
		LevelLow	Starts Counter if the level of the selected Counter Trigger Source signal is low.

Table 5-27 XML Parameters for Conter Control

5.23 Timer Control

If you set the Line Selector to Line1 and the Line Source to Timer (Timer0Active), the camera can output a signal using the Timer. The VL-2K7X and VL-4K3.5X cameras can use Exposure Active, Frame Active, or an external trigger input signal as the source signal for the Timer.

The XML parameters regarding Timer Control are as follows:

XML Parameter		Value	Description
CounterAnd TimerControl	TimerSelector	Timer0	Selects the Timer.
	TimerDuration	1 to 60,000,000 μs	Determines the duration of timer output signal if the Timer Trigger Activation is set to Rising/Falling Edge.
	TimerDelay	0 to 60,000,000 μs	Determines delay time to be applied before executing the timer output signal.
	TimerReset	-	Resets the Timer.
	TimerStatus	TimerIdle	Indicates that the Timer is in idle state.
		TimerTriggerWait	Indicates that the Timer is waiting for a trigger signal.
		TimerActive	Indicates that the Timer is in active state.
	TimerTrigger Source	Off	Deactivates the Timer output signal.
		ExposureActive	Sets the Timer to use the current exposure time as the source signal.
		Line0	Sets the Timer to use the external trigger signal as the source signal.
		Counter0Active	Sets the Timer to use the user-defined counter signal as the source signal.
	TimerTrigger Activation	RisingEdge	Resets the Counter on the rising edge of the selected Reset Source signal.
		FallingEdge	Resets the Counter on the falling edge of the selected Reset Source signal.
		AnyEdge	Resets the Counter on the rising/falling edge of the selected Reset Source signal.
		LevelHigh	Resets the Counter when the level of the Reset Source signal is high.
		LevelLow	Resets the Counter when the level of the Reset Source signal is low.

Table 5-28 XML Parameters for Time Control

5.24 Device User ID

You can enter up to 16 bytes of user-defined information into the camera.

The XML parameter for Device User ID is as follows:

XML Parameter		Description
DeviceControl	DeviceUserID	Inputs up to 16 bytes of user-defined information.

Table 5-29 XML Parameter related to Device User ID

5.25 Device Reset

You can reset the camera by turning the power off and on.

The XML parameter is as follows:

XML Parameters		Description
DeviceControl	DeviceReset	Resets the device.

Table 5-30 XML Parameter for Device Reset

5.26 Field Upgrade

The camera provides the ability to upgrade the firmware and FPGA logic through the CoaXPress interface without the need to disassemble the camera in the field. For more details, please refer to Appendix.

5.27 User Set Control

A user can save or load the camera setting to the internal flash area. 2 save areas and 3 load areas are available.

The XML parameter for User Set Control is as follows:

XML Parameters		Value	Description
UserSetControl	UserSetSelector	Default	Selects the camera settings to Factory Default Settings.
		UserSet1	Selects the camera settings to UserSet1.
		UserSet2	Selects the camera settings to UserSet2.
	UserSetLoad	-	Loads the user settings selected in the User Set Selector into the camera.
	UserSetSave	-	Saves the current settings to the User Set specified by User Set Selector. The Default is a Factory Default Settings and allowed to load only.
	UserSetDefault	Default	Applies the Factory Default settings when reset.
		UserSet1	Applies the UserSet1 when reset.
		UserSet2	Applies the UserSet2 when reset.

Table 5-31 XML Parameter related to User Set Control

Camera settings saved in the Default area can be loaded into the camera's workspace but cannot be modified. To remove the configured values from the workspace, reboot or reset the camera. If you want to retain the current workspace settings after a reset, save them to one of the user areas.

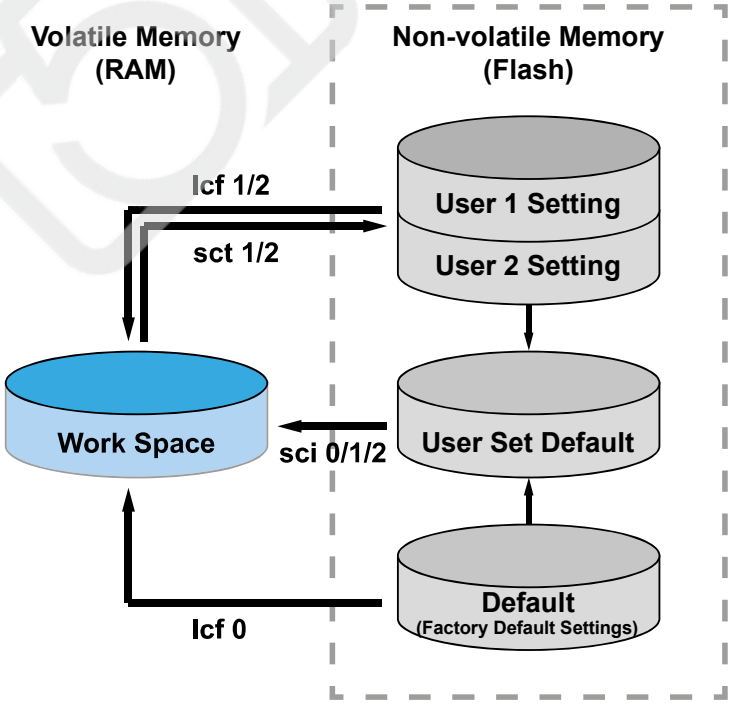


Figure 5-21 User Set Control

6. Troubleshooting

Troubleshooting

6.1 Troubleshooting

Check the below cases if the device malfunctions:

When nothing is shown on the screen

- Check if the cable connections are properly made.
- Check if the power supply is functioning correctly.
- If using external trigger input mode, make sure the trigger is being correctly input.

When the image is blurry

- Check if there is dust on the lens or glass.
- Verify that the lens focus is properly adjusted.

When the image appears dark

- Check if the lens is obstructed.
- Ensure the Line Rate setting is appropriate.
- Check if the aperture is closed.
- Make sure the Digital Gain value is not set too low.

When the camera is behaving abnormally and overheating

- Verify that the power connection is properly established.
- If smoke or abnormal heating occurs, stop using the camera immediately.

When the trigger mode is not working properly

- For CXPin trigger mode, ensure the trigger setting is correctly configured in the CXP Frame Grabber.
- For external trigger mode, check if the cable connections are properly made.

When communication quality is poor

- Ensure the Coax cable connection is properly established.
- Verify that the camera is correctly connected to the CXP Frame Grabber installed on the user's computer and that the settings are properly configured.

7. Appendix

Defective Pixel Map Download

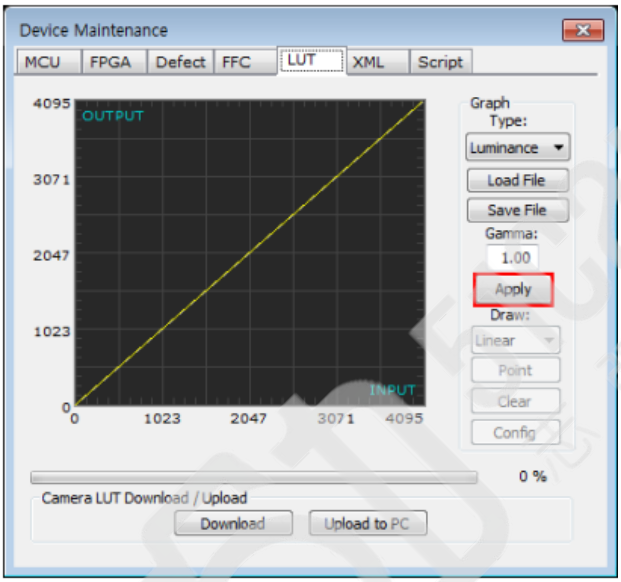
Field Upgrade

7.1 LUT Download

LUT data can be generated in two ways. You can either adjust the gamma value of luminance in the provided program and then download it, or you can import and download a CSV file (*.csv) created in Excel or similar software.

7.1.1 Gamma Curve Download

1 Open Vieworks Imaging Solution 7.X and click the **Configuration** button.
2 In the LUT tab of the Device maintenance window, select **Luminance** from the **Type** dropdown list.
3 Enter the desired value into the box below **Gamma** and click the **Apply** and **Download** buttons.

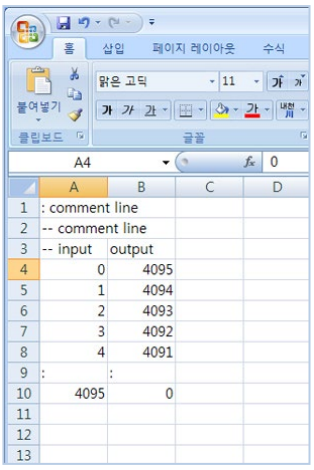


4 Once download is complete, click the OK button before closing the window.

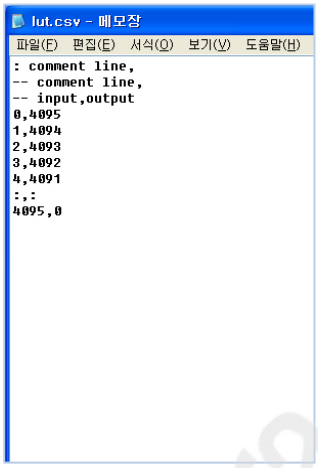
7.1.2 CSV File Download

1 In Excel, create the LUT table as shown in the image on the left below and save it as a CSV file (*.csv). The right image shows what the file looks like when opened in Notepad. After completing the file, change the file extension to .lut so that the program can read it. The following rules apply when creating the file:

- Lines starting with ':' or '—' are treated as comments.
- The input values are recorded sequentially from 0 to 4095 without any gaps.

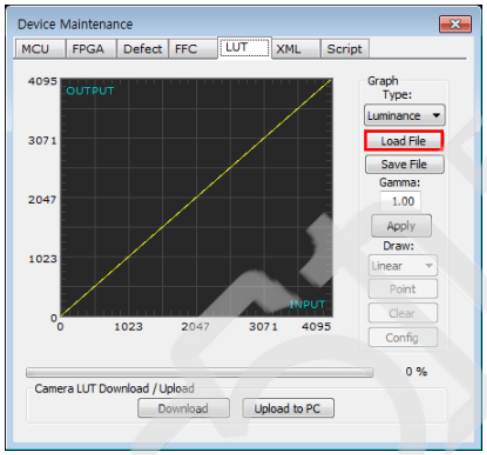


	A	B	C	D
1	: comment line			
2	-- comment line			
3	-- input	output		
4	0	4095		
5	1	4094		
6	2	4093		
7	3	4092		
8	4	4091		
9	:	:		
10	4095	0		
11				
12				
13				

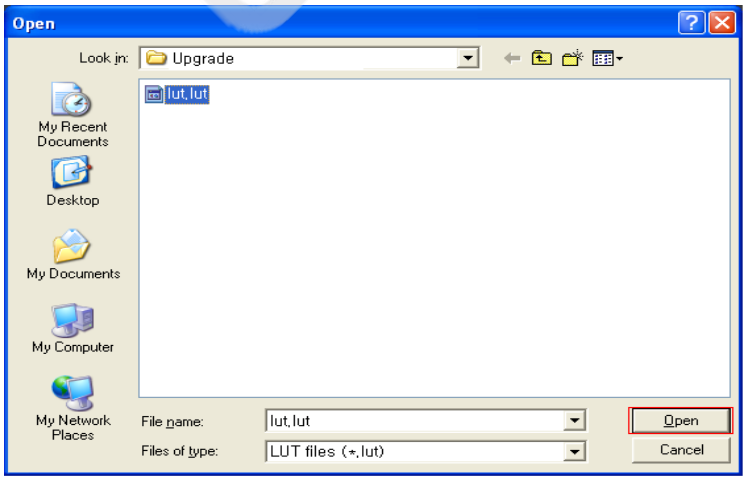


2 Open Vieworks Imaging Solution 7.X and click the **Configuration** button.

3 In the **LUT** tab of the Device maintenance window, select **Luminance** from the **Type** dropdown list and click the **Load File** button.



4 Select the LUT file you have made and click the Open button.



5 Click the Download button. Once download is complete, click the OK button.

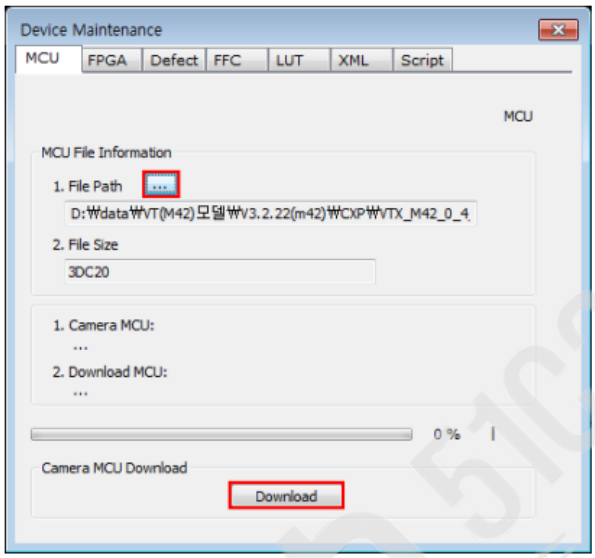
7.2 Field Upgrade

To keep the MCU, FPGA, and XML updated to the latest version, follow the steps below:

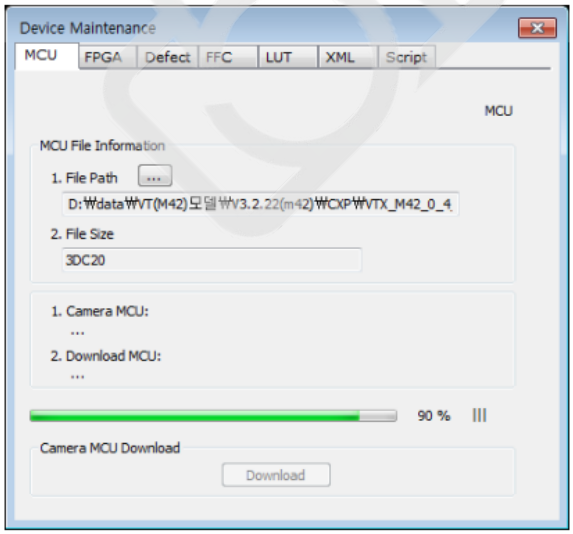
7.2.1 MCU

1 Open Vieworks Imaging Solution 7.X and click the **Configuration** button.

2 In the MCU tab of the Device maintenance window, click the … button next to the **File Path** to select the MCU Upgrade file. Then, click the **Download** button.



3 The download progress of the MCU upgrade file can be monitored as shown below:

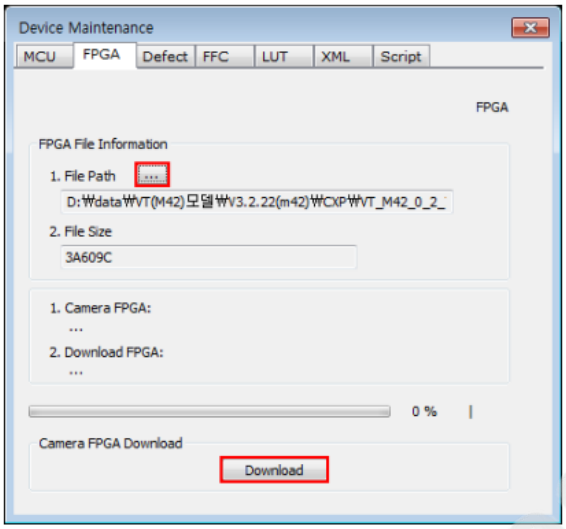


4 Once all processes are complete, turn off and on the camera. Check the version by reading the DeviceVersion parameter in the Device Control category.

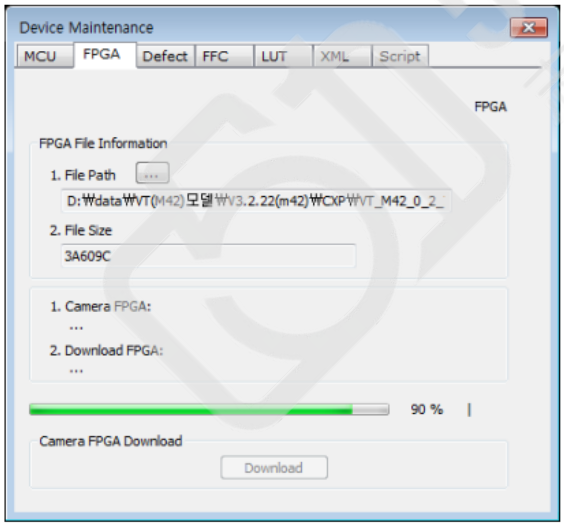
7.2.2 FPGA

1 Open Vieworks Imaging Solution 7.X and click the **Configuration** button.

2 In the FPGA tab of the Device maintenance window, click the … button next to the File Path to select the FPGA Upgrade file. Then, click the **Download** button.



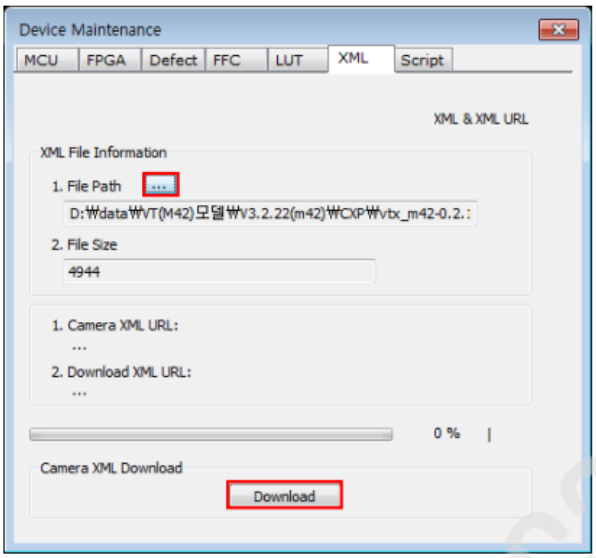
3 The process from now on is the same as the MCU upgrade process.



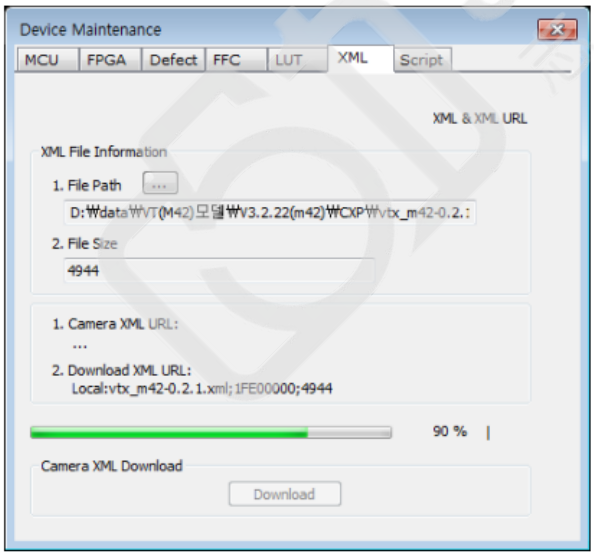
7.2.3 XML

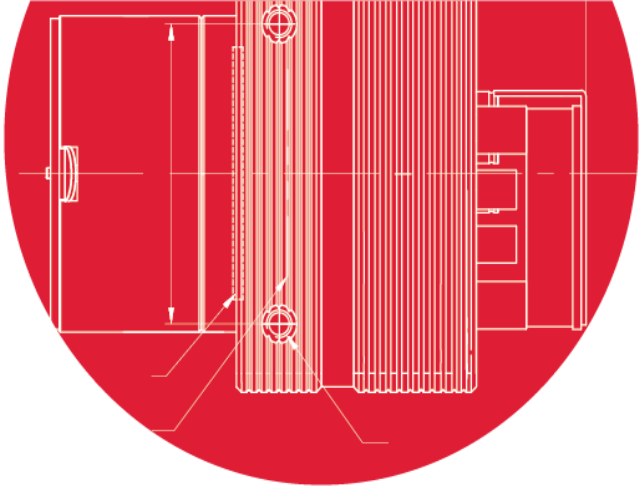
1 Open Vieworks Imaging Solution 7.X and click the **Configuration** button.

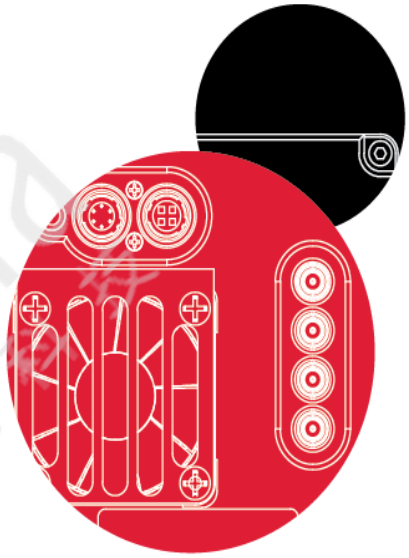
2 In the XML tab of the Device maintenance window, click the … button next to the File Path to select the XML Upgrade file. Then, click the **Download** button.

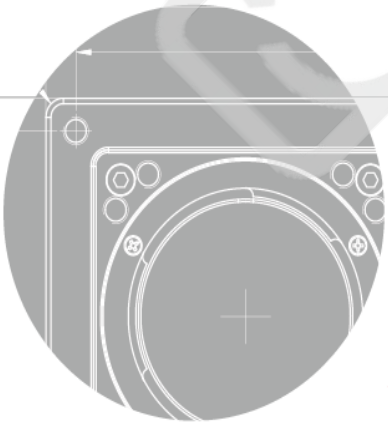


3 The process from now on is the same as the MCU upgrade process.









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