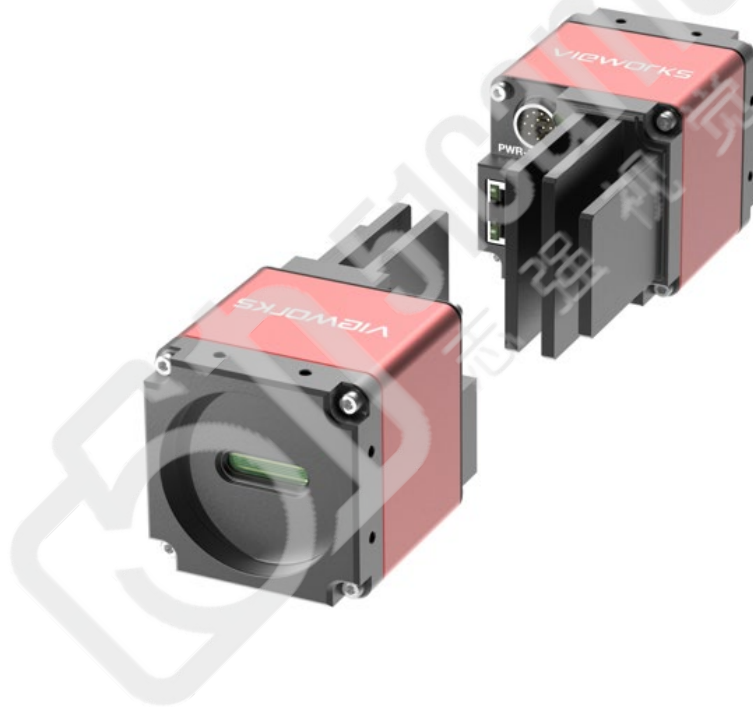


VIEWWORKS

VL Series User Manual

VL-2K7NG-M170I-2, VL-2K7NG-C44I-4
VL-4K3.5NG-M83I-2, VL-4K3.5NG-C42I-2



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Preface

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Before Using the Product

Thank you for purchasing the VL-2K7NG™ and VL-4K3.5NG™.

- Please be sure to read the manual before using the product.
- Make sure that the product is installed and optimized by a professional engineer.
- Keep the manual in a place where you can easily see it while using the product.
- This manual assumes that you are knowledgeable about your camera.

Applicable products

This manual is intended for users of the following products.

- VL-2K7NG-M170I-2™
- VL-2K7NG-C44I-4™
- VL-4K3.5NG-M83I-2™
- VL-4K3.5NG-C42I-2™

About This Manual

This manual is intended for VL-2K7NG-M170I-2, VL-2K7NG-C44I-4, VL-4K3.5NG-M83I-2, VL-4K3.5NG-C42I-2 camera users. It is recommended to refer to the Frame Grabber's User Manual of yours, with this manual.

Convention in This Manual

For better understanding, the following conventions are used throughout the manual.

Names and Fonts

The names and fonts of user interfaces are used as follows:

- The menu and icon names in this manual are used as displayed in the product.

Warning, Caution, and Note

This manual shows warnings, cautions, and notes with the following figures:



Warning!

This indicates that you need to follow this message for your safety and to prevent the product from damage.



Caution!

This indicates that you need to follow this message to prevent data from being lost or corrupted.



Note:

This indicates that this message provides additional information.

Revision History

This document has the revision history as follows:

Ver.	Date	Description
1.0	2024-11-25	Initial release

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Chapter 1. Precautions

General



- Do not drop, disassemble, repair, or alter the device. Doing so may damage the camera electronics and cause an electric shock.
 - Do not let children or companion animals touch the device without supervision.
 - 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 specified in 5.2 Specification. Otherwise, the device may be damaged by extreme temperature.
-

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 5.2 Specifications for the camera's nominal voltage.
 - ※ Vieworks Co., Ltd. does NOT provide power supplies with the device.
 - Make sure the power is turned off before connecting the power cord to the camera. Otherwise, damage to the camera may result.
-

Chapter 2. Warranty

The following are excluded from warranty coverage.

- The manufacturer is not responsible for any failure of the equipment due to service or modification by unauthorized manufacturers, agents, or technicians.
 - The manufacturer is not responsible for loss or damage to the data due to the operator's negligence.
 - In the event of damage or breakdown caused by the user's use for purposes other than those intended for use, excessive use, or negligence.
 - Incorrect use of power, or failure to use under the conditions of use specified in the instruction manual.
- Natural disasters caused by lightning, earthquake, fire, flood, etc.
- If the equipment's parts and software are replaced or modified without authorization, resulting in problems.

For product-related inquiries and service, please contact your dealer or manufacturer.

The warranty period is the period specified in the warranty statement at the time of sale and applies from the time the equipment is shipped.

Chapter 3. Compliance & Certifications

3.1 FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

3.2 CE: DoC

EMC Directive 2014/30/EU

EN 55032:2012 (Class A), EN 55024:2010

Class A

3.3 UL



This is the Canadian / US safety compliance mark applies to electric shock, fire and mechanical hazards.

In accordance with UL 62368-1.

3.4 KC

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.

Chapter 4. Package Component

Package Component



VL-2K7NG, VL-4K3.5NG

Chapter 5. Product Specifications

5.1 Overview

The VL-2K7NG and VL-4K3.5NG, new line scan camera models in the VL series, are small format cameras compatible with M42 and C-mount lenses and are equipped with a 5GigE (NBASE-T) interface compatible with 2.5GigE and 1GigE for fast line speeds.

It can acquire 2K resolution images at speeds up to 170kHz, and the GL3504 image sensor supports 7μm pixel lines at 2k resolution and 3.5μm pixel lines at 4k resolution.

With their high speed and wide range of colors, the VL-2K7NG and VL-4K3.5NG cameras are ideal for demanding 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 NBASE-T and backward compatibility (5GigE, 2.5GigE, 1GigE)
- Supports 2 stage TDI (Mono)
- GL3504 2k color supports 3-line true color with RGBW Quad-Linear method
- Individual Gain/Exposure Control
- Supports PoE (IEEE 802.3af)
- Optimized for M42, 50x50mm size

Applicable Fields

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

5.2 Specifications

The technical specifications of the VL-2K7NG and VL-4K3.5NG cameras are as follows.

Specification	VL-2K7NG-M170I-2	VL-2K7NG-C44I-2	VL-4K3.5NG-M83I-2	VL-4K3.5NG-C42I-2
Resolution(H × V)	2048 × 2	2048 × 4	4096 × 2	4096 × 2
Sensor	GL3504			
Pixel Size	7.0 μm × 7.0 μm		3.5 μm × 3.5 μm	
Interface	5 GigE (Nbase-T)			
Dynamic Range	65.5 dB		65.8 dB	
Line Rate	170kHz (@Single line) 87kHz (@Dual line)	44kHz (@Qaud line)	83kHz (@Single line) 42kHz (@Dual line)	42kHz (@Dual line)
Pixel Data Format	Mono 8/10/12 Mono 10/12 Packed	Mono 8/10/12 Mono 10/12 Packed RGB/BGR 8/10/12 RGBa/BGRa 8	Mono 8/10/12 Mono 10/12 Packed	Mono 8/10/12 Mono 10/12 Packed RGB/BGR 8/10/12
Black Level Control	Adjustable (-2048 ~ 2048 LSB at 12 bits)			
Gain Control	Individual Band Gain: x1.0 ~ x4.0 Digital Gain: x1.00 ~ x32.00			
Exposure Time	0.1 ~ 1000.0μs (All or Individual band)			
Trigger Synchronization	Free-Run, Hardware Trigger			
External Trigger	3.3 V			
Gamma Correction	User defined LUT (Look Up Table)			
Offset and Gain Correction	DSNU, PRNU			
Lens Mount	M42, C-mount (Adaptor)			
Mechanical / Weight	50 mm × 50 mm × 99 mm, 279 g			
Environmental	Storage: -40°C ~ 70°C			
Power External	11 - 24 V DC			
Power Dissipation	Max. 10W (@PoE)			
PoE	48 VDC, 802.3af (Class 0)			
Compliance	CE, FCC, KC, UL (in preparation)			
API SDK	Viewworks Imaging Solution 7.x			

Table 5-1 Specifications of VL-2K7NG and VL-4K3.5NG

5.3 Camera Block Diagram

The VL-2K7NG and VL-4K3.5NG cameras are composed of four PCBs, and the block diagram is shown below.

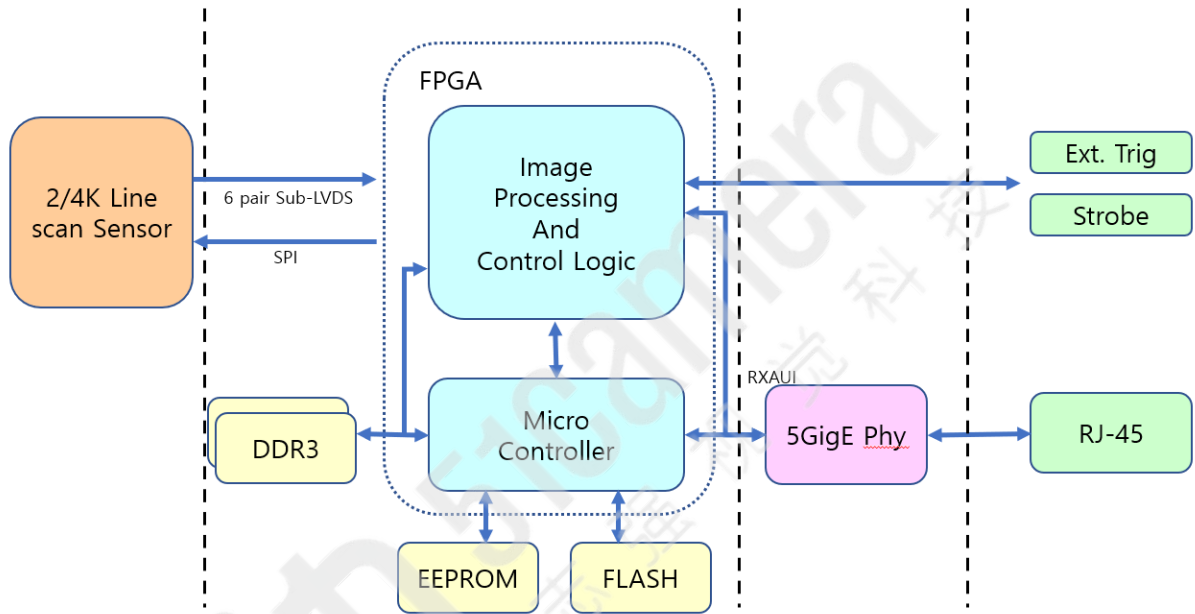


Figure 5-1 Camera Block Diagram

5.4 Spectral Response

The following graphs show the spectral response of the VL-2K7NG and VL-4K3.5NG cameras.

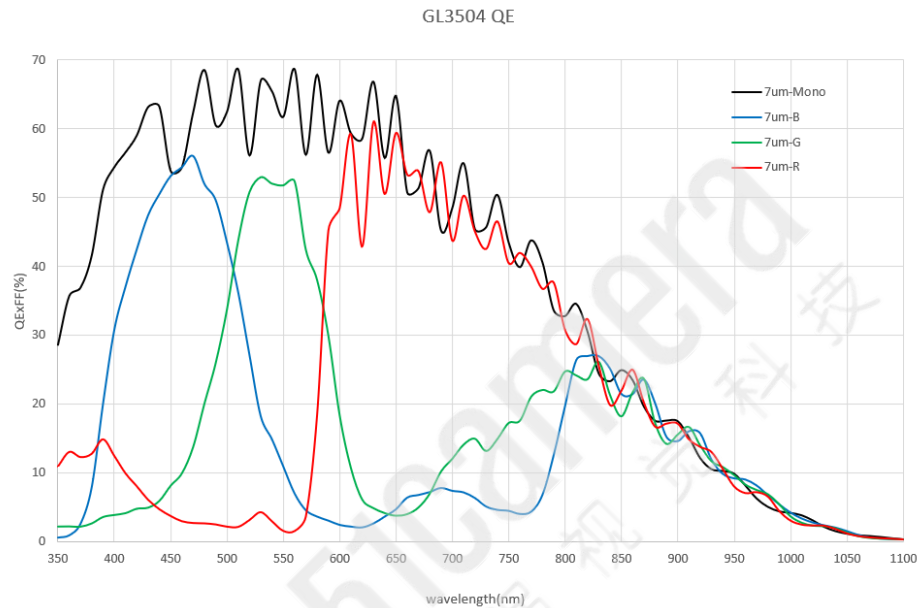


Figure 5-2 Spectral Response (VL-2K7NG)

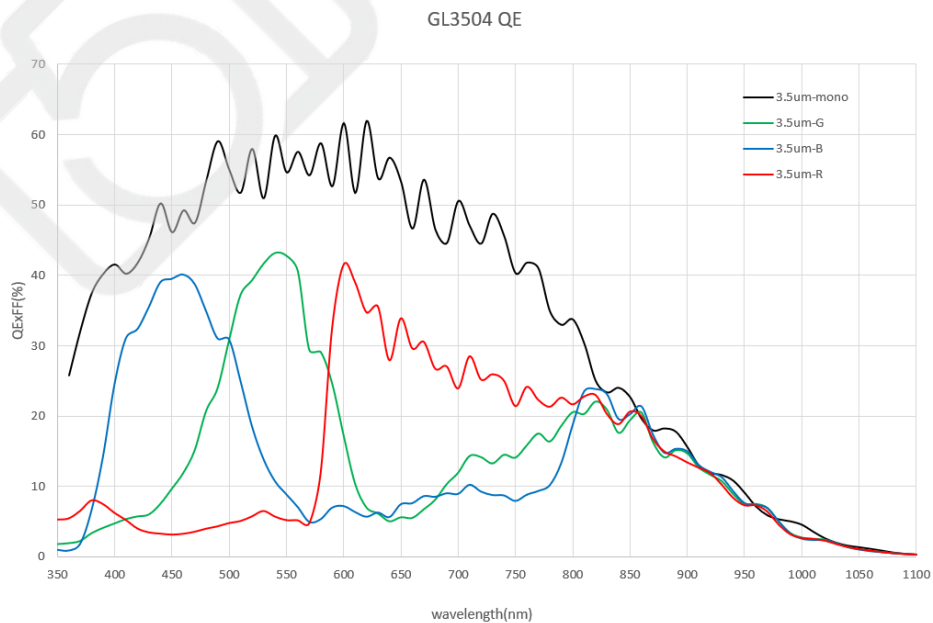


Figure 5-3 Spectral Response (VL-4K3.5NG)

5.5 Mechanical Specification

The camera dimensions in millimeters are shown in the following figure.

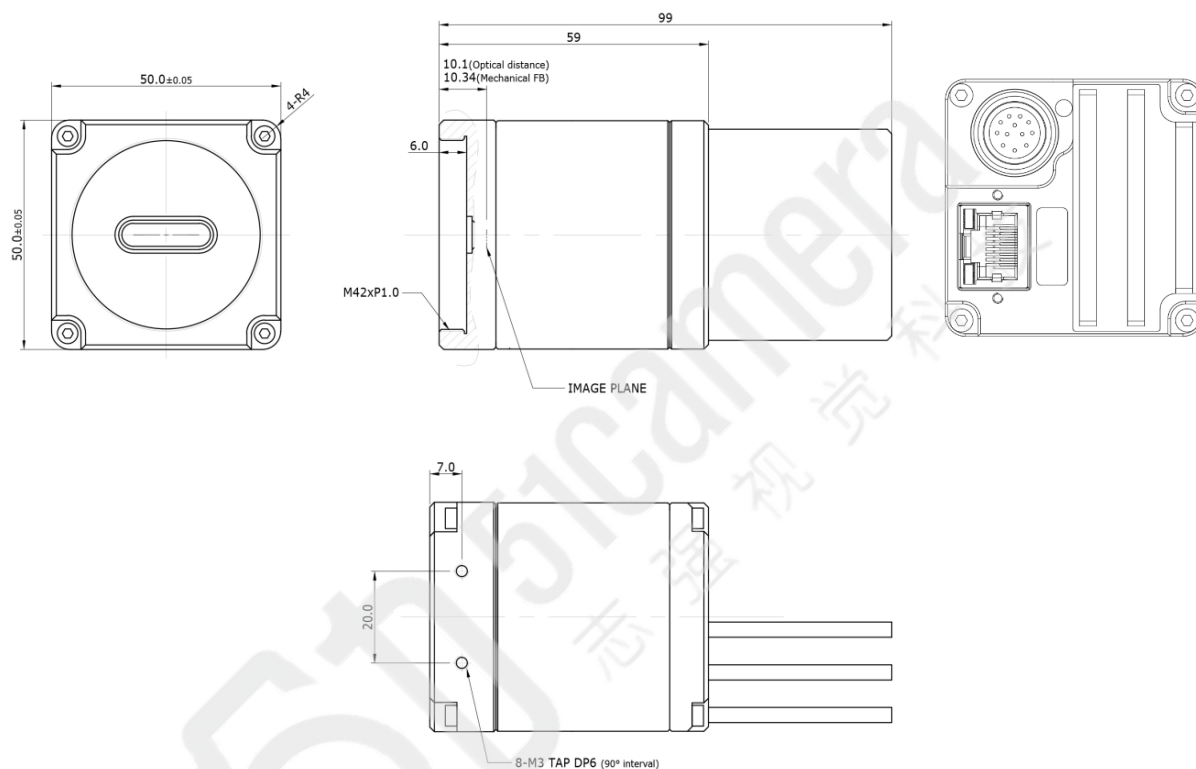


Figure 5-4 Mechanical Dimension

5.5.1 Camera Mounting and Heat Dissipation

The camera must be installed in a structure with sufficient heat dissipation to keep the temperature of the camera housing below 50 degrees. VL cameras are designed to be low power, so the camera's housing temperature stays within the specified temperature limits during operation. However, the camera can overheat if it is not able to dissipate heat or if it is installed in a harsh environment. We recommend following these general guidelines for installation.

- In all cases, it is recommended that you monitor the camera's housing temperature and keep it below 50 degrees. You can measure the current internal temperature of the camera using the Device Temperature parameter.
- Mounting the camera to a metal structure in your system will allow it to dissipate heat sufficiently.

5.5.2 Fixing the Camera

If needed, you can fix the VL-2K7NG and VL-4K3.5NG cameras firmly to use. When doing this, the sections available to be used for tightening by the setscrews are 8 parts marked with the dashed lines in the following figure:

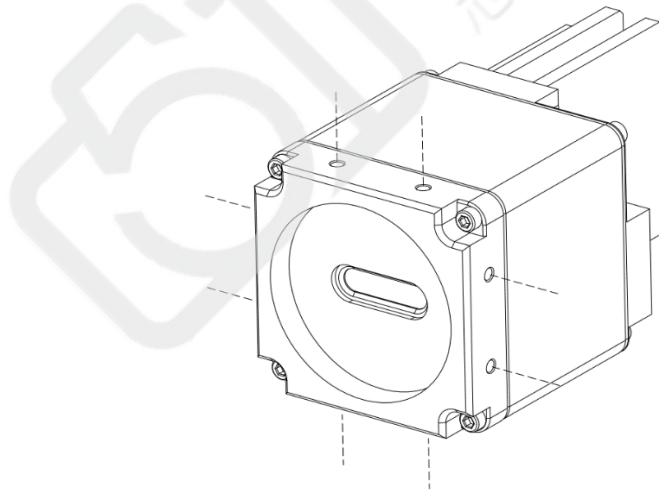


Figure 5-5 Locations available to Tighten the Setscrews when Mounting the Product

At least one of the four surfaces must be fixed, and at this time, all two setscrews must be fastened on one surface. For this product, the type of the fixing setscrew is M3, and this setscrew must be screwed into the camera by at least 4 mm.

Chapter 6. Connecting the Camera

The following instructions assume that you have installed a 5 GigE Network Adapter in your computer including related software. For more detailed information, refer to your 5 GigE Network Adapter User Manual.

To connect the camera to your computer, follow the steps below:

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

Go on to step 2 if you are using a power supply.

Go on to step 3 if you are using a Power over Ethernet (PoE) capable 5 GigE Network Adapter.

2. If you are using a power supply:
 - Plug one end of an Ethernet cable into the RJ45 input receptacle on the camera and the other end of the Ethernet cable into the 5 GigE Network Adapter in your computer.
 - Connect the plug of the power adapter to the power input receptacle on the camera.
 - Plug the power adapter into a working electrical outlet.
3. If you are using a Power over Ethernet (PoE) capable 5 GigE Network Adapter:

Plug one end of an Ethernet cable into the RJ45 input receptacle on the camera and the other end of the Ethernet cable into the PoE-capable 5 GigE Network Adapter in your computer.
4. Verify all the cable connections are secure.

Precautions for using Power over Ethernet



- Make sure that your network adapter card or PoE injector is compliant with IEEE 802.3af standard if you want to supply power to the camera using PoE.
 - You do not need to connect a power adapter to the camera if you supply power to the camera using PoE.
-

6.1 Precaution about Blurring Compared to the Center

- 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.

6.2 Installing Vieworks Imaging Solution

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

Chapter 7. Camera Interface

7.1 General Description

On the rear of the VL-2K7NG and VL-4K3.5NG cameras, there are two types of connection jacks and status LEDs, each of which has the following functions:

- ① 12-pin power input and control input/output terminals
: Camera power input and control inputs/outputs
- ② Status LED: Displays power status and operating mode.
- ③ RJ-45 input terminal: Transmits image data and controls the camera.

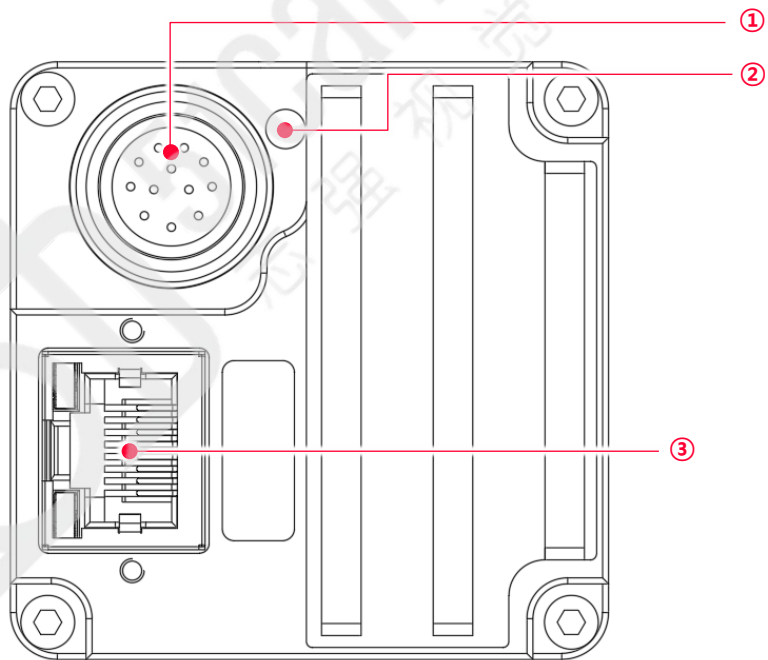


Figure 7-1 VL-2K7NG and VL-4K3.5NG Back Panel

7.2 Power Input and Control Input/Output Terminals

The pinout and configuration of the Power Input Receptacle and Control Input/Output terminals of the camera are as follows:



Figure 7-2 Pin Assignments

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	Line 3+	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	Line 2+	Input	Connected with Frame Start In+ function
11	NC		Not Connected
12	Signal Ground	Ground	Common Ground

Table 7-1 Pin Configurations



Note:

- A recommended mating connector for the Hirose 12-pin connector is the Hirose 12-pin plug (part # HR10A-10P-12S) or the equivalent.
- It is recommended that you use the power adapter, which has at least 3 A current output at 10 – 24 VDC voltage output (You need to purchase a power adapter separately, as the manufacturer (VIEWWORKS) does not provide it.
- When using a power supply device, the Listed product with an output of PS2 or less and certified as UL 62368-1 or UL 60950-1 should be used.

Precaution for Power Input



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.

7.3 RJ-45 Jack

The 8-pin RJ-45 jack provides Ethernet access to the camera and can be used to provide Power over Ethernet (IEEE 802.3af compliant) to the camera. The pin assignments for the RJ-45 jack adhere to the Ethernet standard.

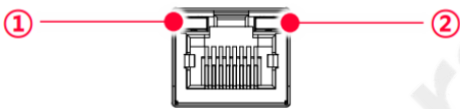


Figure 7-3 RJ-45 Jack

- ① Ethernet Active LED (Orange): LED blinks when Rx/Tx is active.
- ② Ethernet Active LED (Green / Orange): LED is lit when Ethernet link is active.

Ethernet Link LED	Description
Fast Flashing Green	Configured to operate at 5 Gbps.
Fast Flashing Orange	Configured to operate at 2.5 Gbps.
Steady Orange	Configured to operate at 1 Gbps or less.

Table 7-2 Ethernet Link LED

PAIR List	Pin	Signal Name	Type	Description
PAIR 0	1	+TXA	Differential	Gigabit Ethernet Transceiver
	2	-TXA	Differential	Gigabit Ethernet Transceiver
PAIR 1	3	+TXB	Differential	Gigabit Ethernet Transceiver
	6	-TXB	Differential	Gigabit Ethernet Transceiver
PAIR 2	4	+TxC	Differential	Gigabit Ethernet Transceiver
	5	-TxC	Differential	Gigabit Ethernet Transceiver
PAIR 3	7	+TXD	Differential	Gigabit Ethernet Transceiver
	8	-TXD	Differential	Gigabit Ethernet Transceiver

Table 7-3 Pin Assignments for RJ-45 Jack

7.4 Input Circuit

The following figure shows trigger signal input circuit of the 12-pin connector.

The trigger input signal is passed through a CMOS buffer with an excellent noise margin to the internal circuit. 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 shown below.

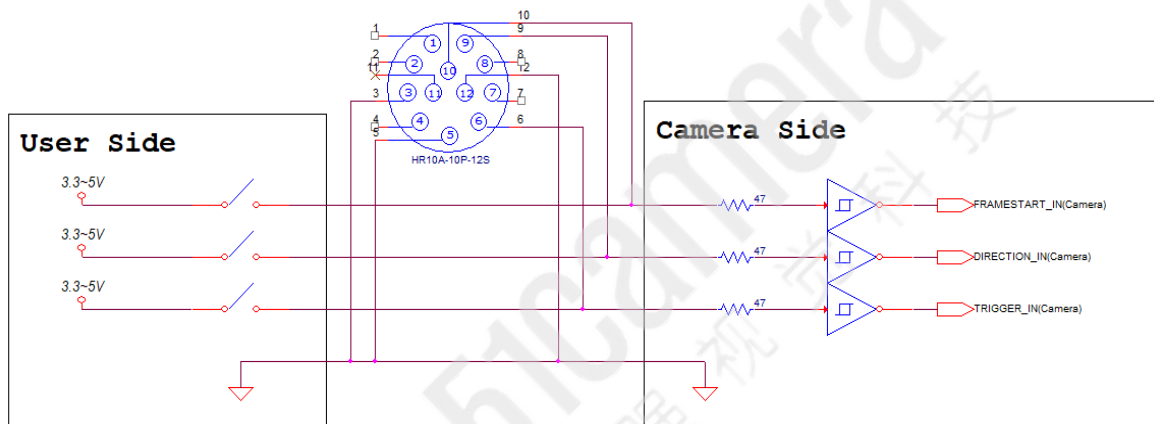


Figure 7-4 Input Schematic

7.5 Output Circuit

The output signal comes out through a 3.3V output level of TTL Driver IC. You can configure the output line by setting the Digital I/O Control (refer to 9.17 Digital I/O Control).

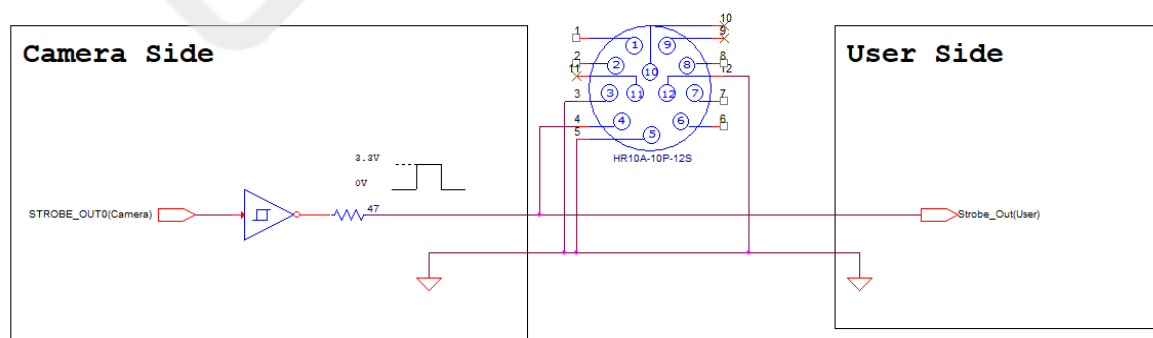


Figure 7-5 Output Schematic

Chapter 8. Acquisition Control

This chapter provides detailed information about controlling image acquisition.

- Acquisition Start/Stop commands and Acquisition Mode parameters
- Line Start Trigger
- Line Rate Control
- Exposure Time Settings

8.1 Acquisition Start and Stop Commands and Acquisition Mode

The Acquisition Start command prepares the camera to acquire frames. The camera cannot acquire frames unless an Acquisition Start command has first been executed.

- When you issue the Acquisition Stop command, the camera stops acquiring images.
- The Acquisition Mode parameter directly affects how the Acquisition Start command works, and the VL-2K7NG and VL-4K3.5NG cameras support Continuous only.
- An Acquisition Start command remains in effect until an Acquisition Stop command is issued. When you issue an Acquisition Stop command, the camera cannot acquire images until you issue a new Acquisition Start command.

8.2 Frame Start Trigger

The Frame Start trigger is used in conjunction with the Line Start trigger to control the acquisition of line footage to be included in each frame of video. The camera can only respond to Line Start triggers when a Frame Start trigger is valid. Line Start triggers supplied when the Frame Start trigger is invalid are ignored by the camera and no line footage can be acquired.

You can select the Frame Start trigger using the Trigger Selector parameter. Frame Start triggers can be generated internally in the camera or supplied externally by setting the Trigger Source parameter to 'Line2'. The most important parameter associated with the Frame Start trigger is the Trigger Mode parameter. The Trigger Mode parameter can be set to Off or On.

8.2.1 Trigger Mode (Frame Start) = Off

If you set the Trigger Mode parameter to Off, the camera generates all Frame Start triggers internally, so you do not need to supply the camera with Frame Start triggers.

After setting Trigger Mode to Off, the camera automatically generates a Frame Start trigger signal when you issue an Acquisition Start command.

Here's how to operate the Frame Start trigger on the camera.

1. When you issue an Acquisition Start command, the camera automatically enables the Frame Start trigger.
2. The Frame Start trigger remains valid until all the line images that make up a frame have been acquired and are invalidated when acquisition is complete.
3. The Frame Start trigger automatically becomes valid when you start acquiring line images for the next frame and becomes invalid after all the line images that make up the frame have been acquired.
4. Repeat step 3 until you issue an Acquisition Stop command. When you issue an Acquisition Stop command, the Frame Start trigger continues to be invalidated.

8.2.2 Trigger Mode (Frame Start) = On

When the Trigger Mode parameter is set to On, the user must select a source signal for the Frame Start trigger signal. The Trigger Source parameter can be used to specify the source signal that will serve as the Frame Start trigger signal.

The following Trigger Source parameters can be set:

- Line2: You can supply the camera with a Line2 trigger signal by injecting an externally generated electrical signal (called a hardware or external trigger signal) into the camera's control input/output terminals. For more information, see 8.5 Trigger Input Circuit.

After the **Trigger Source** parameter is set, you should also set the **Trigger Activation** parameter. The following **Trigger Activation** parameters can be set.

Parameter	Description
Rising Edge	Specifies that the Frame Start trigger is valid from the rising edge of the electrical signal. The Frame Start trigger remains valid until all the line images that make up a single frame have been acquired and is invalidated when acquisition is complete.
Falling Edge	Specifies that the Frame Start trigger is valid from the falling edge of the electrical signal. The Frame Start trigger remains valid until all the line images that make up one frame have been acquired and is invalidated when acquisition is complete.
Any Edge	Specifies that the Frame Start trigger is valid from the time the electrical signal rises or falls. The Frame Start trigger remains valid until all the line images that make up a single frame have been acquired and is invalidated when acquisition is complete.
Level high	Specifies that the Frame Start trigger is valid from the time the electrical signal rises. The Frame Start trigger is valid for the duration of the signal's high and is invalidated when the signal goes low.
Level Low	Specifies that the Frame Start trigger is valid from the time the electrical signal goes low. The Frame Start trigger is valid while the signal is Low and is invalidated when the signal goes High.

Table 8-1 Trigger Activation Parameters

8.3 Line Start Trigger

The Line Start trigger is used to start line image acquisition. The camera can only respond to a Line Start trigger when a Frame Start trigger is valid. Line Start triggers supplied when the Frame Start trigger is not valid are ignored.

You can select the Line Start trigger using the Trigger Selector parameter.

- Line Start triggers can be generated internally in the camera or supplied externally by setting the Trigger Source parameter to LineIn0. When a Line Start trigger is fed to the camera, the camera starts acquiring line images.

8.3.1 Trigger Mode

The main parameter associated with the line start trigger is the Trigger Mode parameter. The Trigger Mode parameter for the line start trigger has two available settings: Off and On.



When alternating between Trigger Mode and Free-Run

If you repeat On and Off on the Trigger Mode parameter while acquiring an image, the brightness of the image may differ. Therefore, it is recommended not to alternate between Trigger Mode and Free-Run Mode during an image acquisition.

Trigger Mode = Off

When the Trigger Mode parameter is set to Off, the camera will generate all required line start trigger signals internally, and you do not need to apply line start trigger signals to the camera. With the Trigger Mode set to Off, the camera will automatically generate a line start trigger signal whenever it receives an Acquisition Start command. The camera will automatically do this until executing an Acquisition Stop command.



Free-Run

When you set the Trigger Mode parameter to Off, the camera will generate all required trigger signals internally. When the camera is set this way, it will constantly acquire images without any need for triggering by the user. This use case is commonly known 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.

- If the parameter is set to a value less than the maximum allowed line rate with the current camera settings, the camera will acquire images at the rate specified by the parameter setting.
- If the parameter is set to a value greater than the maximum allowed line rate with the current camera settings, the camera will acquire images at the maximum allowed line rate.

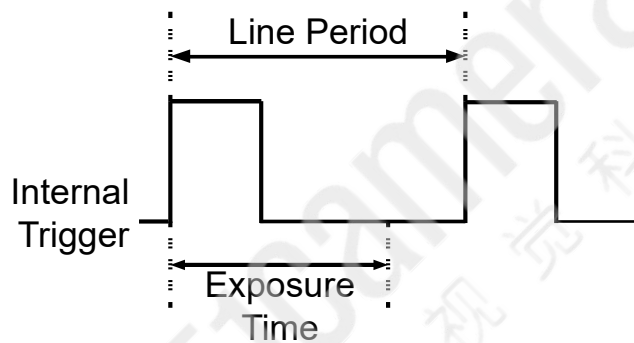


Figure 8-1 Trigger Mode = Off

Trigger Mode = 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.

The available settings for the Trigger Source parameter are:

- Line0: You can apply a line start trigger signal to the camera by injecting an externally generated electrical signal (commonly referred to as a hardware or external trigger signal) into the Control I/O Receptacle on the camera. Refer to <8.2.2 Using an External Trigger Signal> for more information.

If the Trigger Source parameter is set, you must also set the Trigger Activation parameter. The available settings for the Trigger Activation parameter are:

- 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 trigger.
- Any Edge: Specifies that both rising and falling edges of the electrical signal will act as the line start trigger.

When the Trigger Mode parameter is set to On, the camera's line rate can be controlled by manipulating the external trigger signal. At this point, it is important that you do not attempt to trigger images at a rate that is greater than the maximum allowed.

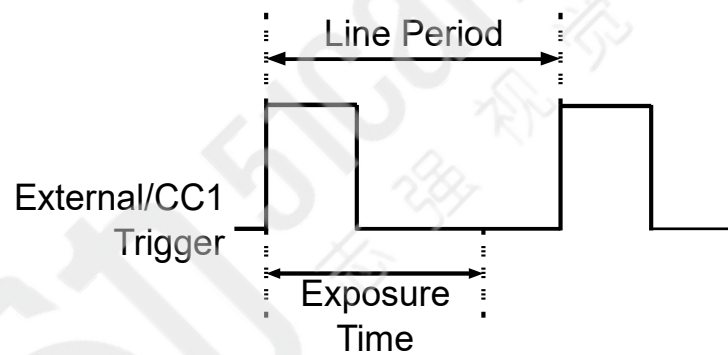


Figure 8-2 Trigger Mode = On

8.3.2 Using an External Trigger Signal

If the Trigger Mode parameter is set to 'On' and the Trigger Source parameter is set to 'Line0', the camera must be supplied with an external trigger signal (Line Start) to start image acquisition. To apply trigger signals via hardware, you must set the Trigger Source parameter to Line0. Then, when the appropriate electrical signal is sent to the camera, the camera will recognize the generated Line Start trigger signal.

A rising edge and/or a falling edge of the external signal can be used as Line Start trigger. In the Trigger Activation parameter, select whether to set the rising edge and/or falling edge as the trigger. If the camera is operated under the control of an external signal, the period of the external trigger signal determines the line rate as follows:

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

For example, if you are operating a camera with an external trigger signal period of 20 μs (0.00002 s). So in this case, the line rate is 50 kHz.

8.3.3 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

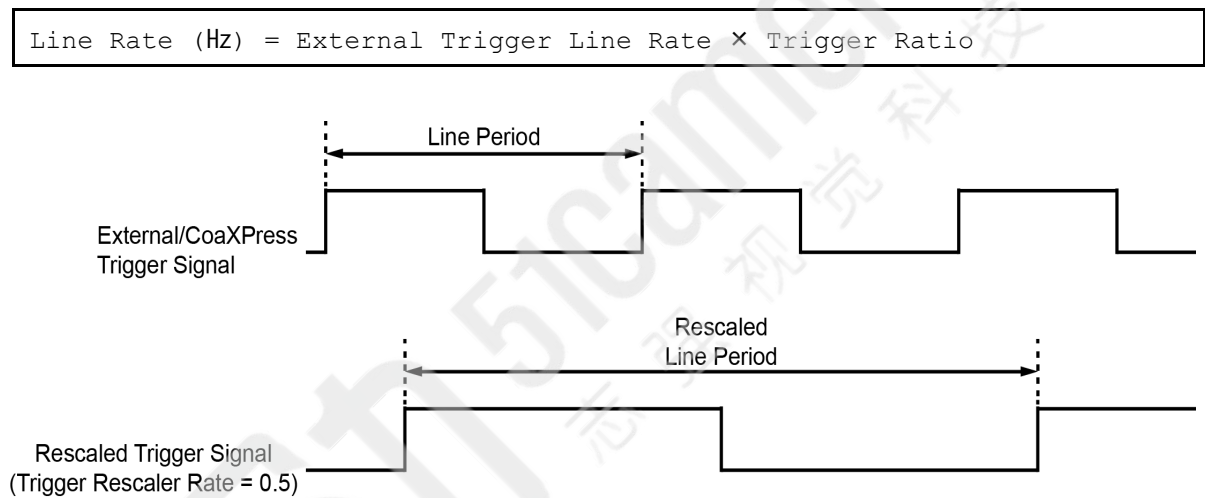


Figure 8-3 Trigger Ratio = 0.5

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

XML Parameters	Value	Description
Trigger Multiplier	1 - 1024	Sets the trigger rescaler rate for converting trigger signals.
Trigger Divider	1 - 1024	Sets the trigger rescaler rate for converting trigger signals.
Trigger Ratio	0.000977 - 1024	Sets the trigger rescaler rate for converting trigger signals.
Acquisition Control		Set the filter exponent to attenuate jitter from external trigger signals
	TriggerRescaler FilterSize	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 8-2 XML Parameters related to Trigger Multiplier/Divider Mode

Multiplier and 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.

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

8.3.4 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.

Timed Exposure Mode

When the Timed mode is selected, the exposure time for each frame acquisition is determined by the value of the camera's Exposure Time parameter. If the camera is set for rising edge triggering, the exposure time starts when the external trigger signal rises. If the camera is set for falling edge triggering, the exposure time starts when the external trigger signal falls. The following figure illustrates Timed exposure with the camera set for rising edge triggering.

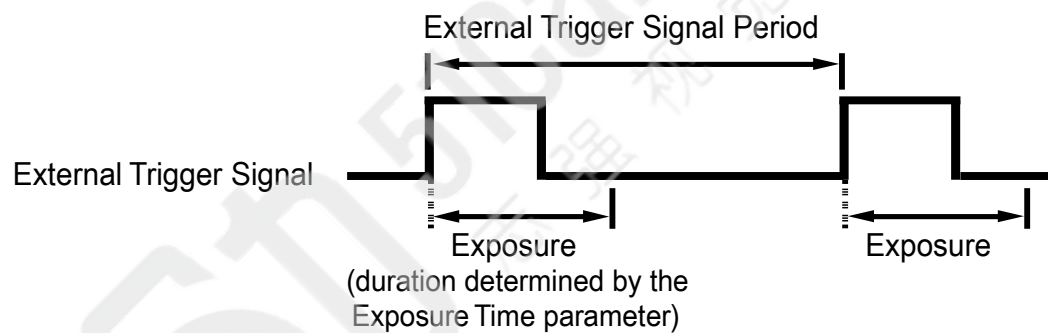


Figure 8-4 Timed Exposure Mode

Note that if you attempt to trigger a new exposure start while the previous exposure is still in progress, the trigger signal will be ignored.

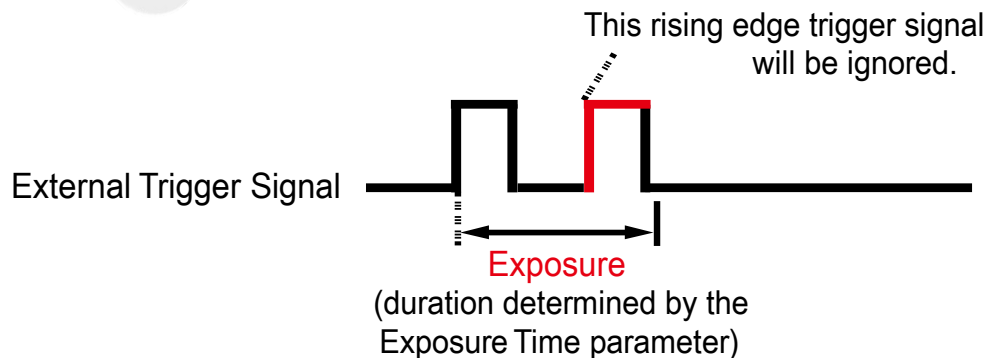


Figure 8-5 Trigger Overlapped with Timed Exposure Mode

TriggerWidth Exposure Mode

When the TriggerWidth exposure mode is selected, the length of the exposure for each frame acquisition will be directly controlled by the external trigger signal. If the camera is set for rising edge triggering, the exposure time begins when the external trigger signal rises and continues until the external trigger signal falls. If the camera is set for falling edge triggering, the exposure time begins when the external trigger signal falls and continues until the external trigger signal rises. The following figure illustrates TriggerWidth exposure with the camera set for rising edge triggering.

TriggerWidth exposure is especially useful if you intend to vary the length of the exposure time for each frame.

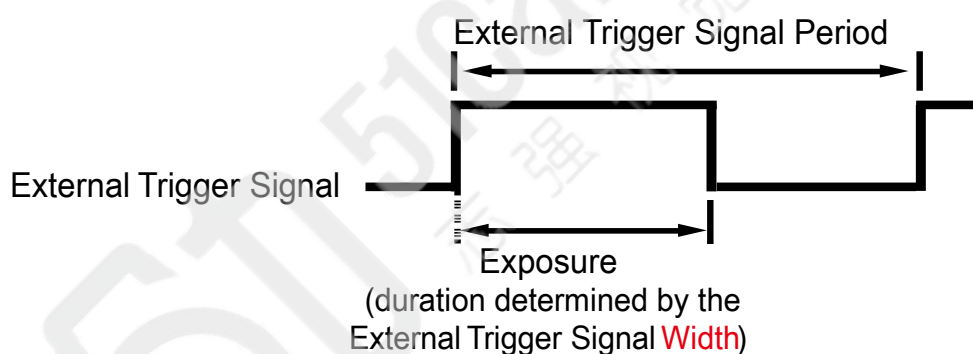


Figure 8-6 TriggerWidth Exposure Mode

8.4 Maximum Allowed Line Rate

In general, the maximum allowed acquisition line rate on the camera may be limited by various factors.

The maximum allowed line rates of the VL-2K7NG and VL-4K3.5NG cameras are as follows:

Model	Mode	Max. Line Rate
VL-2K7NG-M170I-2	Single line	170 kHz
VL-2K7NG-C44I-2	Quad line	44 kHz
VL-4K3.5NG-M83I-2	Single line	83 kHz
VL-4K3.5NG-C42I-2	Dual line	42 kHz

Table 8-3 Maximum Allowed Line Rates

Increasing the Maximum Allowed Line Rate

You may find that you would like to acquire line images at a rate higher than the maximum allowed with the camera's current settings. In this case, you must adjust one or more of the factors that can influence the maximum allowed line rate and then check to see if the maximum allowed line rate has increased.

- The time that it takes to transmit line images out of the camera is the main limiting factor on the line rate. You can decrease the line transmission time (and thus increase the maximum allowed line rate) by doing one or more of the following:
 - Use an 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 smaller length of ROI. Decreasing the length of ROI means that the camera has less data to transmit and therefore the transmission time will decrease.

Chapter 9. Camera Features

9.1 Scan Direction

In Linescan mode, the Scan Direction parameter allows you to select the scan direction of the image sensor. If the object you want to acquire a line image passes through the lower part of the camera first, and then passes through the upper part of the camera, you should use Forward mode (In the opposite case, Backward mode should be used).

In addition, if Scan Direction is set to Line 1, the scan direction can be controlled by an externally generated electrical signal (Low = Forward, High = Reverse) sent to pin 9 of the camera's control input/output terminal.

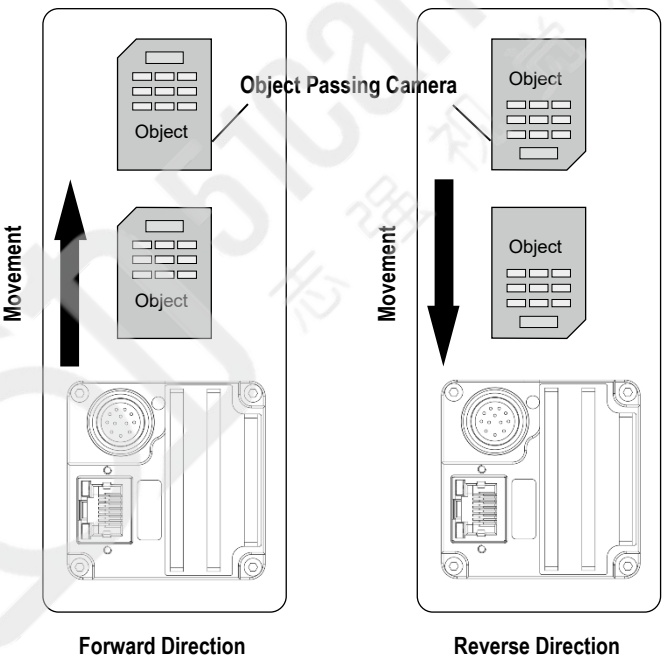


Figure 9-1 Scan Direction

XML Parameters		Value	Description
ImageFormatControl	Scan Direction	Forward	Forward 방향으로 영상 스캔
		Backward	Backward 방향으로 영상 스캔
		Line 1	외부 신호를 통해서 스캔 방향 제어

Table 9-1 XML Parameters related Scan Direction

In Area mode, you can set the Scan Direction parameter to Backward to get vertically reoriented images.

9.2 Region of Interest

The Region of Interest (ROI) feature allows you to specify a portion of the sensor lines. During operation, only the pixel information from the specified portion of the lines is read out of the sensor and transmitted from the camera to the frame grabber.

The ROI is referenced to the left end of the sensor array. The location and size of the ROI is defined by declaring the Offset X and Width settings. For example, suppose that you set the Offset X parameter to 24 and the Width parameter to 160 as shown in the figure below. With these settings, the camera will read out and transmit pixel values for pixels 24 through 184.

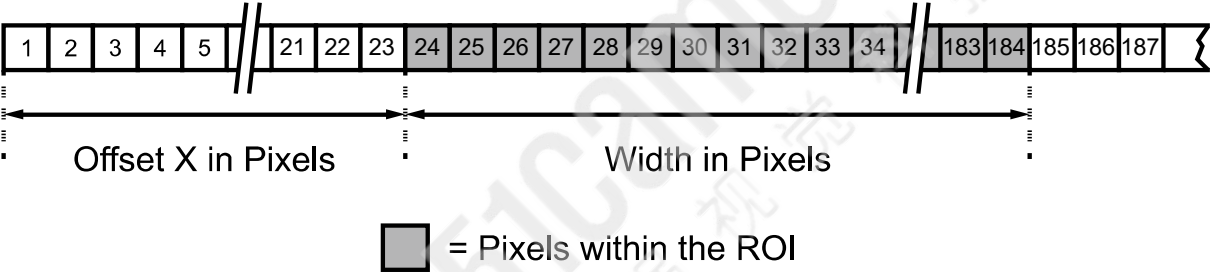


Figure 9-2 Region of Interest

The XML parameters related to ROI on the Linescan mode are as follows.

XML Parameters		Value†	Description
ImageFormatControl	Width	2K: 8 -2048 (Step 8) 4K: 8 -4096 (Step 8)	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.

†The unit for all parameters in this table is pixel.

Table 9-2 XML Parameters related to ROI

The user can change the size of the ROI by setting the Width parameter in the Image Format Control category and change the origin position of the ROI by setting the Offset X parameter. The value of Width + Offset X must be less than the value of Width Max. The camera's Width is set to the maximum value by default, so users should set the ROI size first, and then set the Offset value.

- The Width parameter should be set to a multiple of 8.
- The minimum ROI Width that can be set is 8.



Caution!

Changing the camera's Image ROI setting after executing the Acquisition Start command can result in abnormal image acquisition. Be sure to change the Image ROI setting after executing the Acquisition Stop command.

9.3 Binning (Monochrome Only)

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 Parameters	Value	Description
ImageFormat Control	BinningSelector	Logic Select Logic as the binning engine. Binning is applied digitally by FPGA.
	Binning HorizontalMode	Sum Adds the value of pixels that are neighboring by the Binning Horizontal setting and exports them as a single pixel value.
		Average Exports the average of pixels that are adjacent by the Binning Horizontal setting as a single pixel value.
	BinningHorizontal	×1, ×2, ×4 The number of horizontal pixels to combine.
	BinningVertical Mode (VL-4K3.5NG-M83I only)	Sum, Average Adds pixel values that are adjacent by the Binning Vertical setting and exports them as a single pixel value.
	BinningVertical (VL-4K3.5NG-M83I only)	×1, ×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 9-3 XML Parameters related to Binning

For example, if you select BinningHorizontalMode as Sum, you can increase the sensitivity by 2x.

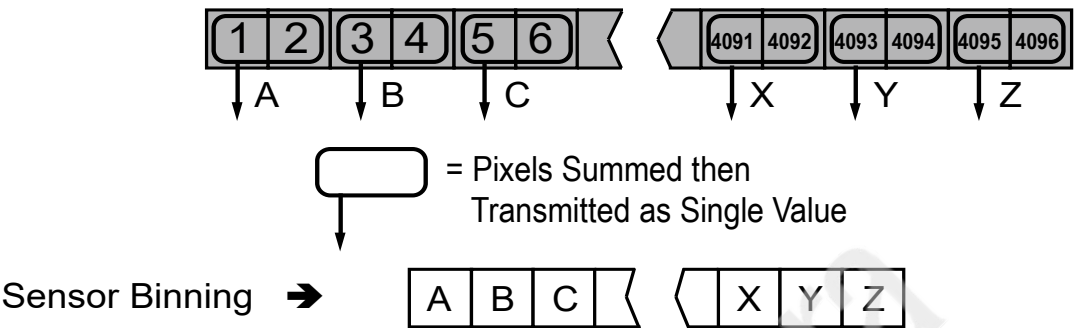


Figure 9-3 Horizontal Binning (Sum)

9.4 Pixel Format

You can determine the pixel format of image data transmitted from the camera by using the Pixel Format parameter.

The XML parameter related to Pixel Format is as follows.

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

Table 9-4 XML Parameter related to Pixel Format

The following pixel formats are supported by the VL-2K7NG and VL-4K3.5NG cameras.

모델	지원 Pixel Format
VL-2K7NG-M170I-2	Mono 8/10/12 Mono 10/12 Packed
VL-2K7NG-C44I-2	Mono 8/10/12 Mono 10/12 Packed RGB/BGR 8/10/12 RGBa/BGRa 8
VL-4K3.5NG-M83I-2	Mono 8/10/12 Mono 10/12 Packed
VL-4K3.5NG-C42I-2	Mono 8/10/12 Mono 10/12 Packed RGB/BGR 8/10/12

Table 9-5 Pixel Format Values

9.5 Inter-Packet Delay

The VL-2K7NG and VL-4K3.5NG cameras provide the Inter-Packet Delay feature to set a delay (in nanoseconds) between packets transmitted by the camera.

Setting a Packet Size

The DeviceStreamChannelPacketSize parameter sets the size of the packets that the camera will use when it sends the data via Ethernet stream channel. This parameter should always be set to the maximum size that your network components (Ethernet Adapter) can handle.

**Note:**

To obtain best performance from the VL-2K7NG and VL-4K3.5NG cameras, use of an Ethernet Adapter with a jumbo frame size of 9,000 bytes or above is strongly recommended.

Setting a Delay between Packets

The GevSCPD parameter sets a delay in nanoseconds between the packets transmitted from the camera. Increasing the delay will decrease the camera's effective data transmission rate and will thus decrease the network bandwidth used by the camera.

In case of multiple cameras or other devices working on the same physical network, it might be desirable to send the packets of a camera's streaming channel with a certain inter-packet delay to allow multiple cameras or devices to share a given network bandwidth.

XML Parameter		Value	Description
DeviceControl	DeviceStreamChannel PacketSize	576-16,000 Bytes	Sets the packet size (The maximum value may vary depending on the Ethernet Adapter.).
TransportLayerControl GigE Vision	GevSCPD	0-42949679295	Sets a delay between packets.

Table 9-6 XML Parameters related to Inter-Packet Delay

9.6 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.

The XML parameters related to Data ROI are as follows.

XML Parameters	Value	Description
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 9-7 XML Parameters related to Data ROI

Only the pixel data from the area of overlap between the Data ROI and the Image ROI by your settings will be effective if you use the Image ROI and Data ROI at the same time. The effective ROI is determined as shown in the figure below.

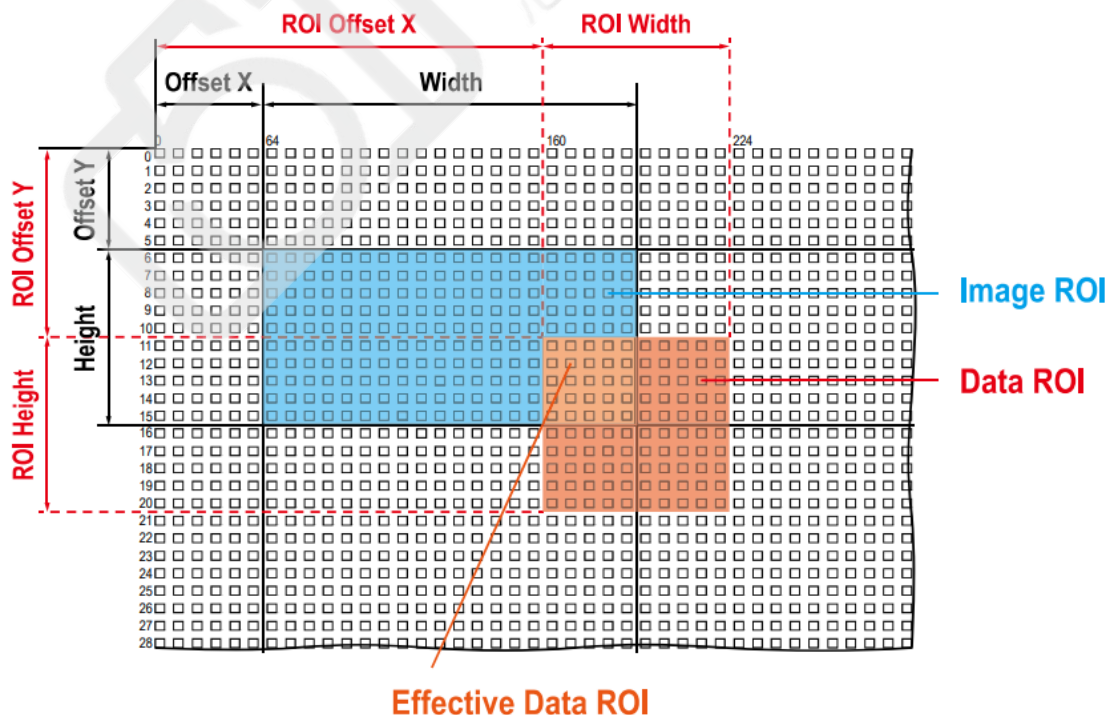


Figure 9-4 Effective Data ROI

9.7 Data ROI (Color Camera)

The Balance White Auto feature provided by color cameras uses pixel data from a data region of interest (ROI) to adjust parameter values.

The XML parameters related to Data ROI are as follows.

XML Parameters	Value	Description
DataRoiSelector	WhiteBalanceAuto	Selecting the Data ROI to use for Balance White Auto. Supported for color cameras only.
DataRoiControl	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 9-8 XML Parameters related to Data ROI (Color Camera)

Only the pixel data from the area of overlap between the Data ROI and the Image ROI by your settings will be effective if you use the Image ROI and Data ROI at the same time. The effective ROI is determined as shown in the figure below. (Y coordinate is not supported)

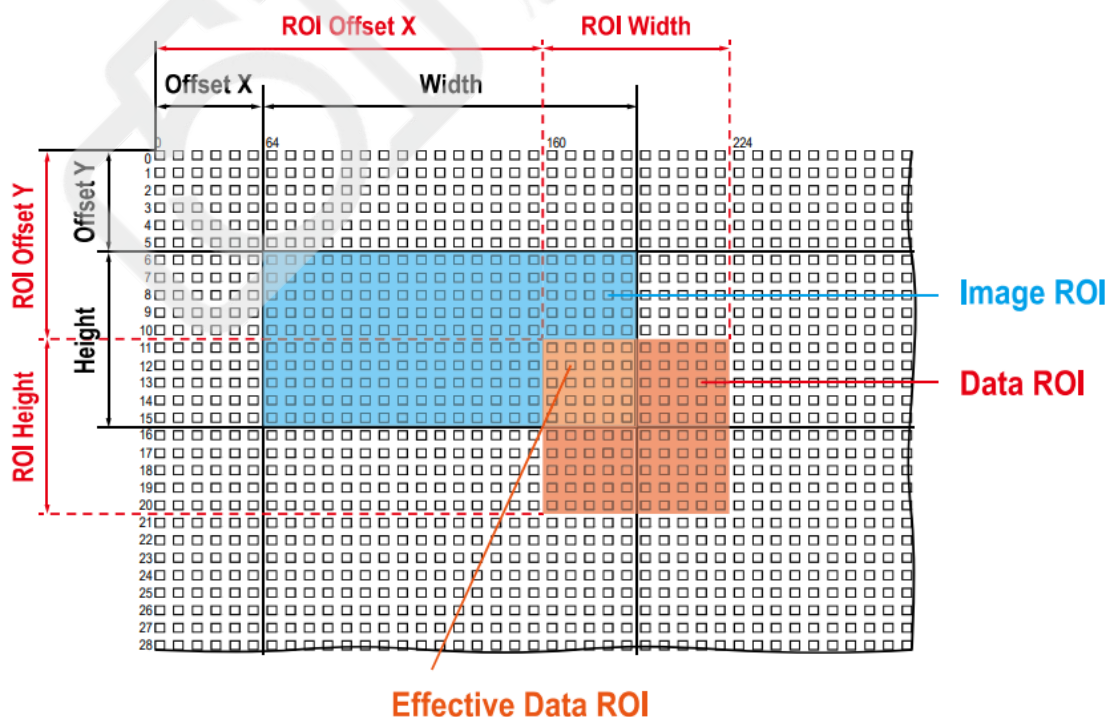


Figure 9-5 Effective Data ROI

9.8 Bands (Single/Dual/Triple/Quad)

The VL-2K7NG camera is different from the previous products in that the sensor is divided into two or four bands, which can be utilized by turning them off or on individually for a variety of uses.

This section provides description of the bands in the following order:

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

9.8.1 Single/Dual Band

The sensors for each model in the table below operate in two bands, which we'll call M0 and M1, as shown in the following figure. By turning these two bands on or off to match the pixel format or speed you need, you can use Single and Dual modes.

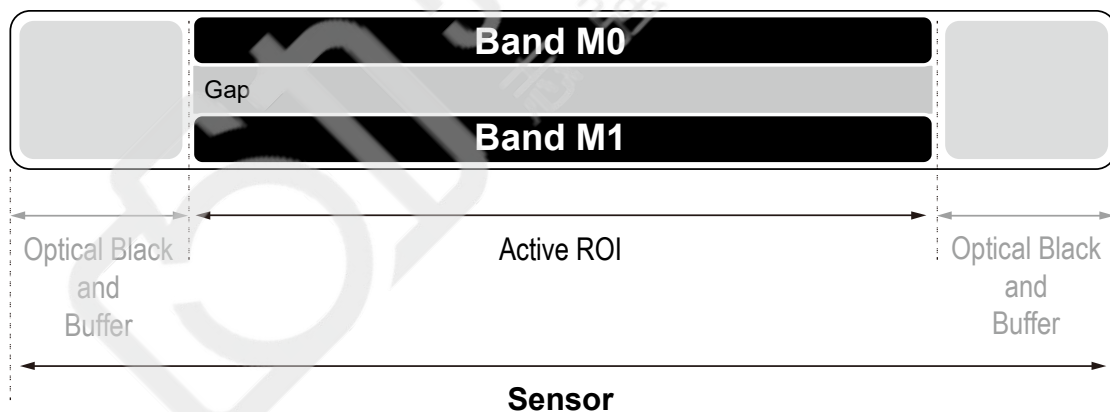


Figure 9-6 VL-2K7NG Bands (M0, M1)

How-to-use these bands according to each mode is as follows:

Model	Mode	Band to use	Pixel Format	Note
VL-2K7NG-M170I-2	Single mode	M0	Mono 8/10/12	Max. line rate: 200 kHz
VL-2K7NG-M170I-2	Dual mode	M0, M1	Mono 8/10/12	Max. line rate: 100 kHz

Table 9-9 Bands and Single/Dual Mode of VL-2K7NG

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 Table 9-12 for more information.

9.8.2 Single/Quad Band

Among the VL-2K7NG models, the sensor of the VL-2K7NG-C44I-2 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.

In the case of the VL-2K7NG-C44I-2, each band has its own color information, with the 'B' band responsible for Blue, 'G' band for Green, and 'R' band for Red, respectively.

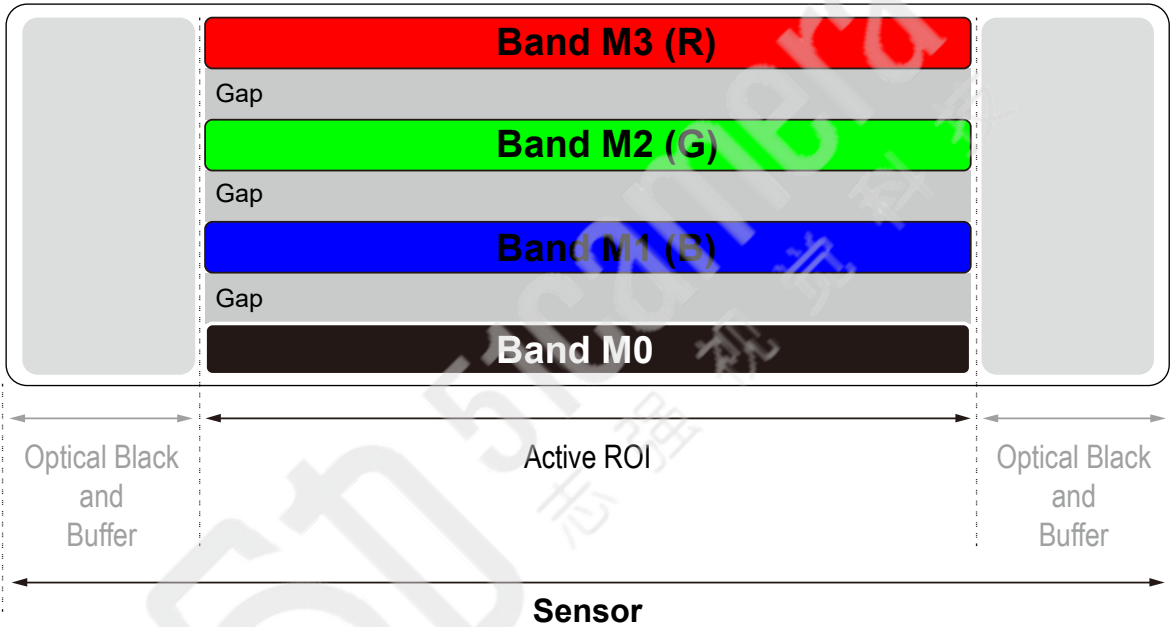


Figure 9-7 VL-8K7X2-M/C67I-4 Bands

How-to-use these bands according to each mode is as follows:

Model	Mode	Band to use	Pixel Format	Note
VL-2K7NG-C44I-4	Single Mode	M0	Mono	Max. line rate: 170kHz
	Quad Mode	M0, B, G, R	RGB/BGR 8/10/12 RGBa/BGRa 8	Max. line rate: 44kHz

Table 9-10 Bands and Single/Dual Mode of VL-2K7NG-C44I-4

9.8.3 Turn-on or Turn-off per Each Band

The XML parameters related to turning the band on/off are as follows.

XML Parameters	Product	Value	Description
ImageFormat Control	VL-2K7NG-M170I-2	M0	Selects the M0 band
	VL-4K3.5NG-M83I-2	M1	Selects the M1 band
	VL-2K7NG-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	Off	Turns the band selected on BandSelector off
		On	Turns the band selected on BandSelector on

Table 9-11 XML Parameters related to Turn Bands On/Off



Note:

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-2k7NG: 170kHz, VL-4k3.5NG: 83kHz).

9.8.4 Applying Exposure Time to Each Band

For the VL-2K7NG, VL-4K3.5NG cameras, 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
AquisitionControl	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

ExposureTime	Red	Applies Exposure Time to the Red (M3) band Available when Individual is selected on ExposureTimeMode
	0.1 ~ 1000 μ s	Inputs the value of Exposure Mode to apply to the band selected on ExposureTimeSelector

Table 9-12 XML Parameters related to Exposure Time per a band

9.9 White Balance (Color Camera)

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-2K7NG and VL-4K3.5NG cameras, the 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 related to White Balance are as follows.

XML Parameters		Value	Description
AnalogControl	BalanceRatio Selector	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	$\times 1.0 \sim \times 4.0$	Adjusts the ratio of the selected color.

Table 9-13 XML Parameters related to White Balance

9.9.1 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 parameters related to Balance White Auto are as follows.

XML Parameter		Value	Description
AnalogControl	BalanceWhite Auto	Off	Balance White Auto Off
		Once	White Balance is adjusted once and then Off.

Table 9-14 XML Parameter related to Balance White Auto

9.10 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. Selects the Gain Control (Digital All) to be adjusted by using the Gain Selector parameter.
2. Sets the Gain parameter to the desired value.

Adjusting the Black Level parameter will result in an offset to the pixel values output from the camera.

1. Selects the Black Level Control (Digital All) to be adjusted by using the Black Level Selector parameter.
2. Sets 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-2K7NG

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

Table 9-15 XML Parameters related to Gain and Black Level (VL-2K7NG)

VL-4K3.5NG

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

Table 9-16 XML Parameters related to Gain and Black Level (VL-4K3.5NG)

9.11 Optical Black Clamp

The Optical Black Clamp function allows to correct changes of pixel values due to changes of sensor temperature. With this function, the VL-2K7NG and VL-4K3.5NG cameras minimize changes of pixel's level by temperature through removing offsets from temperature differences in real time.

The XML parameters related to Optical Black Clamp are as follows.

XML Parameters		Value	Description
Analog Control	OpticalBlack	Off	Deactivates the Optical Black Clamp function.
	Clamp	On	Activates the Optical Black Clamp function.

Table 9-17 XML Parameters related to Optical Black Clamp

9.12 Color Transformation

The VL-2K7NG and VL-4K3.5NG 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.

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

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

The XML parameters related to Color Transformation are as follows.

XML Parameters		Value	Description
Color Transformation Control	ColorTransformation Selector	RGBtoRGB	Selects a type of color transformation to be performed.
	ColorTransformation Enable	-	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 ~ 2	Not used for RGBtoRGB color transformation
	ColorTransformation Value	-4.0× ~ 4.0×	Sets a value of the selected Gain factor.

Table 9-18 XML Parameters related to Color Transformation

9.13 LUT (Lookup Table)

The Lookup Table (LUT) feature allows you to convert original image values to certain level values.

Luminance

Since it is mapped one to one for each level value, 12 bit output can be connected to 12 bit input. The LUT is in the form of table that has 4096 entries between 0 ~ 4095 and the VL-2K7NG, VL-4K3.5NG cameras provide a non-volatile space for LUT data storage.

You can determine whether to apply LUT. For more information about how to download LUT to the camera, refer to Appendix B.

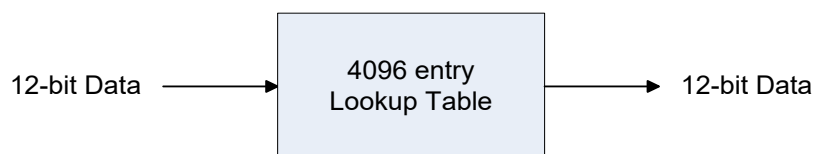


Figure 9-8 LUT Block

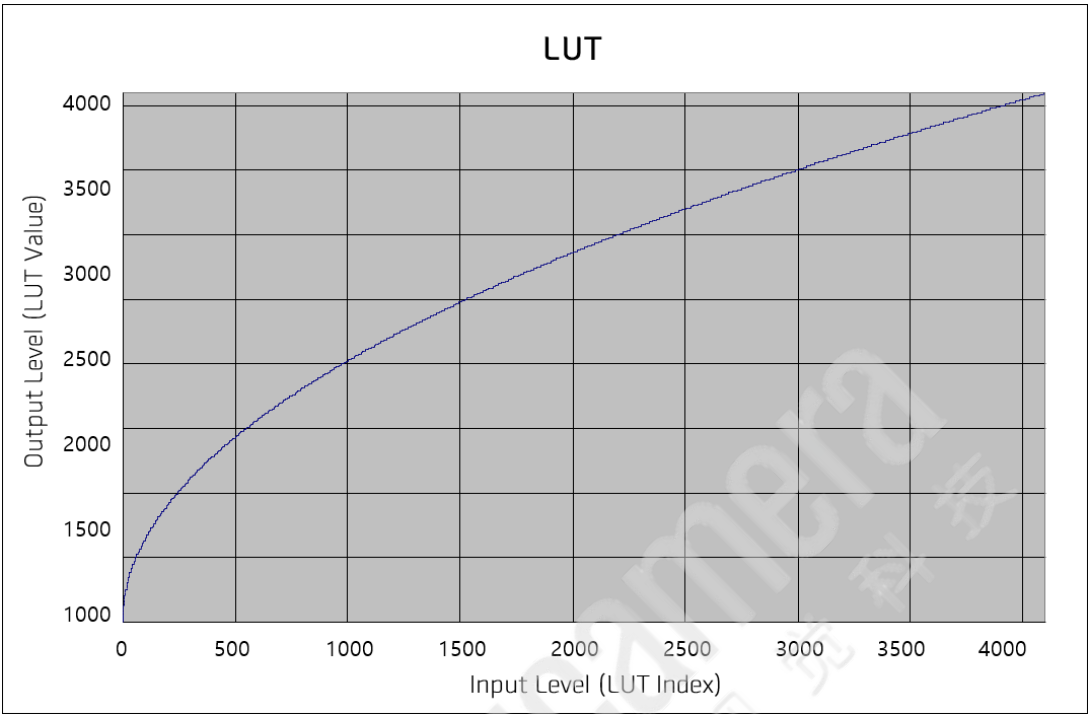


Figure 9-9 LUT at Gamma 0.5

The XML parameters related to LUT are as follows.

XML Parameters	Value	Description
LUTControl	LUTSelector	Luminance Luminance LUT
	LUTEnable	True Activates the selected LUT.
		False Deactivates the selected LUT.
	LUTIndex	0 ~ 4095 Selects the index (Input Level) to apply the LUTValue to.
	LUTValue	0 ~ 4095 Output value of the current LUT corresponding to the input value of LUT Index
	LUTSave	- Saves the current LUT data to the non-volatile memory.
	LUTLoad	- Loads the LUT data from the non-volatile memory.

Table 9-19 XML Parameters related to LUT

9.14 Dark Signal Non-Uniformity Correction

In theory, when a digital camera acquires an image in complete darkness, all the pixel values in the image should be near zero and they should be equal. In practice, however, slight variations in the performance of the pixels in the sensor will cause some variations in the pixel values output from the camera when the camera is acquiring in darkness. This variation is known as Dark Signal Non-Uniformity (DSNU). The VL-2K7NG, VL-4K3.5NG cameras provide the DSNU Correction feature.

The XML parameters related to DSNU are as follows.

VL-2K7NG

XML Parameters	Value	Description
DSNUBandSelector	All	Select All bands currently in use to apply DSNU correction to.
	M0 (Mono, Color)	Select M0 band to apply DSNU correction to.
	M1 (Mono only)	Select M1 band to apply DSNU correction to.
	Blue (Color only)	Select the band responsible for the blue color to apply DSNU correction to.
	Green (Color only)	Select the band responsible for the green color to apply DSNU correction to.
DSNU	Red (Color only)	Select the band responsible for the red color to apply DSNU correction to.
	DSNUDataSelector	Default, Space1~15 Select DSNU data
	DSNUDataGenerate	- Generates DSNU data for the bands selected in DSNUBandSelector.
	DSNUDataSave	- Saves the generated DSNU data in the non-volatile memory. The generated data by executing the DSNUDataGenerate command is saved in the volatile memory so that the data is lost if the camera is reset or if power is turned off. To use the data after the camera is powered on or reset, save them in the non-volatile memory.
	DSNUDataLoad	- Loads the DSNU data from the non-volatile memory into the volatile memory.
	DSNUDataDefault	Default, Space1~15 Select DSNU data

Table 9-20 XML Parameters related to DSNU (VL-2K7NG)

VL-4K3.5NG

XML Parameters	Value	Description
DSNU	All	Select All bands currently in use to apply DSNU correction to.
	M0 (Mono only)	Select the M0 band to apply DSNU correction to.
	M1 (Mono only)	Select the M1 band to apply DSNU correction to.
	Blue (Color only)	Select the band responsible for the blue color (M1) to apply DSNU correction to.
	Green (Color only)	Select the band responsible for the Green color (M2) to apply DSNU correction to.
	Red (Color only)	Select the band responsible for the Red color (M3) to apply DSNU correction to.
	DSNUDataSelector Default, Space1~15	Select DSNU data
	DSNUDataGenerate -	Generates DSNU data for the bands selected in DSNUBandSelecto.
	DSNUDataSave -	Saves the generated DSNU data in the non-volatile memory. The generated data by executing the DSNUDataGenerate command are saved in the volatile memory so that the data are lost if the camera is reset or if power is turned off. To use the data after the camera is powered on or reset, save them in the non-volatile memory.
	DSNUDataLoad -	Loads the DSNU data from the non-volatile memory into the volatile memory.
	DSNUDataDefault Default, Space1~15	Select DSNU data

Table 9-21 XML Parameters related to DSNU (VL-4K3.5NG)

9.14.1 Generating and Saving User DSNU Correction Values

To generate and save user-defined DSNU correction values, use the following procedures.



Note:

- To generate optimized DSNU data, generate DSNU data after the camera has been powered on and the camera's housing temperature has stabilized.

1. The camera will use the entire sensor when generating DSNU correction values. The DSNU 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. Ensure that the camera will be acquiring line images in complete darkness by covering the camera lens, closing the iris in the lens, or darkening the room.
3. Begin acquiring line images either by setting the camera for the Free-Run mode or by supplying external trigger signals to trigger line acquisitions.
4. Generate DSNU correction values.
5. If you execute the DSNU Data Generate command,
 - a. 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.
 - b. After completing 1024 line acquisitions, the generated DSNU correction values will be activated and saved in the camera's volatile memory.
 - c. 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.
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.

9.15 Photo Response Non-Uniformity Correction

In theory, when a uniformly bright target is imaged with a line scan camera in a bright environment, all pixel values in the image should be at or near the maximum gray value. However, due to small performance differences of each pixel in the sensor, variations in lenses and lighting, etc. These differences are called Photo Response Non-uniformity (PRNU), and the VL-2K7NG and VL-4K3.5NG cameras provide the ability to compensate for these PRNUs, as well as storage for 16 PRNUs.

The XML parameters related to PRNU are as follows.

XML Parameters	Value	Description
PRNUBandSelector	All	Select All bands currently in use to apply PRNU correction to.
	M0	Select the M0 band to apply PRNU correction to.
	M1	Select the M1 band to apply PRNU correction to.
	Blue	Select the band responsible for the blue color to apply PRNU correction to.
	Green	Select the band responsible for the green color to apply PRNU correction to.
	Red	Select the band responsible for the red color to apply PRNU correction to.
PRNUCorrection	False	Disable PRNU Correction
	True	Setting the PRNU Correction function
PRNUTargetLevelAUTO	False	If checked, specify PRNU Target Level manually.
	True	If checked, specify PRNU Target Level automatically.
PRNUTargetLevel	-	Setting PRNU Target Level (@ 8 bit Pixel Format)
PRNU	Default, Space 1 ~ Space 15	Setting the area to save or retrieve PRNU data
PRNUDataSelector	-	Generate PRNU data for the bands selected in PRNUBandSelector.
PRNUDataGenerate	-	Save the generated PRNU data to non-volatile memory. Because the data generated by PRNUGenerate is stored in volatile memory, the camera must be powered off and on before the data can be used. data must be saved to non-volatile memory before it can be used. to use the data after power cycling the camera.
PRNUDataSave	-	To retrieve PRNU data stored in non-volatile memory, use the volatile memory.
PRNUDataLoad	-	Select PRNU data
PRNUDataDefault	Default, Space 1 ~ Space 15	

Table 9-22 XML Parameters related to PRNU

9.15.1 Generating and Saving User PRNU Correction Values

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



Note:

- We strongly recommend that you generate new PRNU correction values whenever you make a change to the optics or lighting or if you change the camera's line rate.
- For optimum PRNU correction results, we recommend that you generate DSNU correction values first before generating PRNU correction values.
- If PRNU Target Level is set to Auto (PRNU Target Level Auto: True), Band1 and Band2 are automatically adjusted to the highest level respectively.
- If PRNU Target Level is set to Manual (PRNU Target Level Auto: False), Band1 and Band2 are adjusted to the set level.

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, select the Target Level AUTO check box.

To set the Target Level manually, deselect the Target Level AUTO check box and input the target level in a range from 0 to 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 ignore the generated PRNU correction values and load the existing values in the Flash memory, specify a location to load from by using the PRNU Selector parameter and execute the PRNU Load command.

9.16 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-2K7NG and VL-4K3.5NG 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 Parameters		Value	Description
FPN Coefficients Control	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 9-23 XML Parameters related to FPN Coefficients Control

9.17 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 Parameters	Value	Description
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.
	Line3	Configure for pin 4 of the camera's 12-pin control input/output terminal for setting general output signals.
LineMode	Input	Items that appear when Line0, 1 2 is selected
	Output	Items that appear when Line3 is selected
LineInverter	FALSE	Line output signal not inverted
	TRUE	Line output signal inverted
DigitalIOControl	Off	Line output off
	High	High output
	FrameActive	Outputs the FrameActive signal as a pulse.
	LineActive	Outputs the LineActive signal as a pulse.
LineSource	ExposureActive	Outputs the ExposureActive signal as a pulse
	UserOutput0	Pulse output by UserOutputValue setting value.
	Timer0Active	Outputs the user-set Timer output signal as a pulse.
	Strobe 0	Outputs the Strobe0 signal as a pulse.
UserOutput Selector	UserOutput0	Pulse output by the UserOutputValue set value.
UserOutput Value	FALSE	Set Bit to Low
	TRUE	Set Bit to High
StrobeSelector	Strobe0	Set 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	0~1000 μ s	Set delay in 1 μ s increments to the current output signal.

StrobeDuration	1~1000 μ s	Set the width of the pulse signal in 1 μ s increments when Strobe Mode is set to Timed.
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Table 9-24 XML Parameters related to Digital I/O Control

When you set the Line Source to User Output0, you can use the user setting values as output signals.

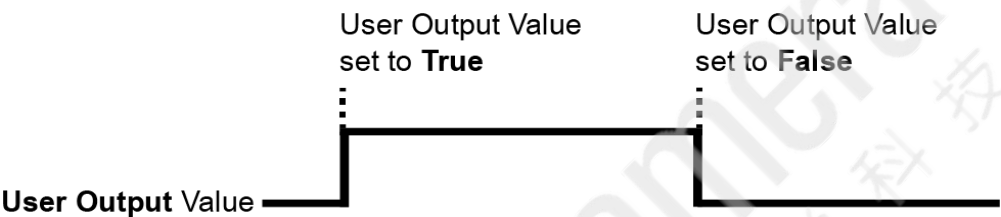


Figure 9-10 User Output

The camera can provide an Exposure Active output signal. The signal goes high when the exposure time for each frame acquisition begins and goes low when the exposure time ends as shown in the figure below. This signal can be used as a flash trigger and is also useful when you are operating a system where either the camera or the object being imaged is movable. Typically, you do not want the camera to move during exposure. You can monitor the Exposure Active signal to know when exposure is taking place and thus know when to avoid moving the camera.

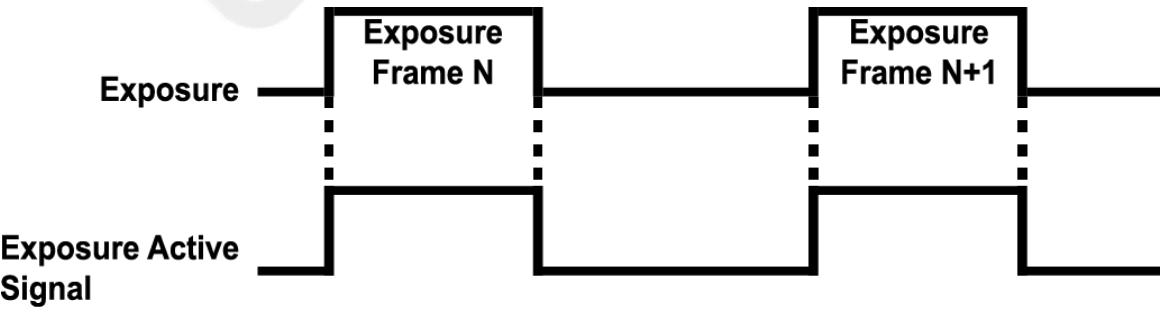


Figure 9-11 Exposure Active Signal

9.18 Debounce

The Debounce function on the VL-2K7NG and VL-4K3.5NG cameras allows you to distinguish between valid and invalid input signals and feed only valid input signals to the camera. You can set the Debounce Time to specify the minimum amount of time an input signal must remain high or low before it is determined to be a valid input signal. In this case, there is a delay equal to the Debounce Time between when a valid input signal is fed to the camera and when it is applied. When the Debounce Time is set, High and Low signals that are smaller than the set value will be judged as invalid and ignored, as shown in the following figure.

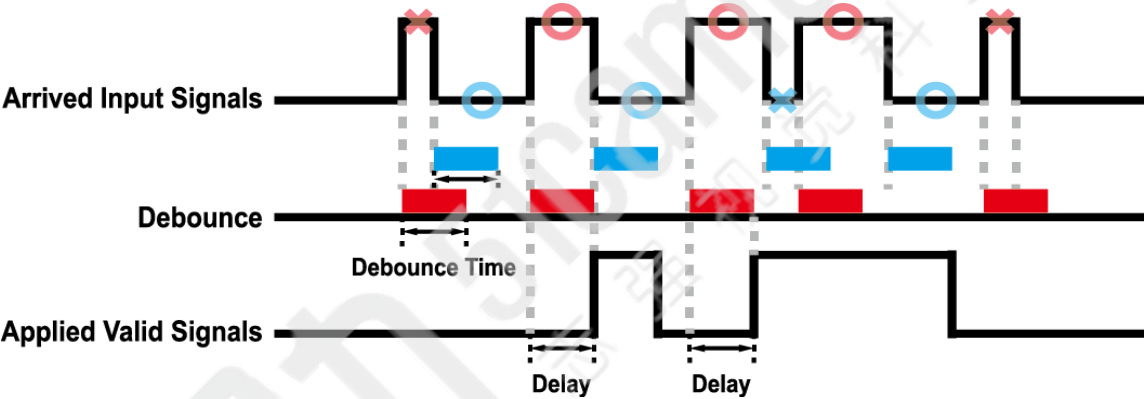


Figure 9-12 Debounce

9.19 Temperature Monitor

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

The XML parameters related to Device Temperature are as follows.

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

Table 9-25 XML Parameters related to Device Temperature

9.20 Status LED

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

LED status and corresponding camera status are as follows.

Status LED	Descriptions
Steady Red	Camera is not initialized
Slow Flashing Red	Gigabit Ethernet not connected
Fast Flashing Orange	Verifying IP address
Steady Green	IP address assigned
Fast Flashing Green	Transmitting image data

Table 9-26 Status LED

9.21 Test Pattern

To check whether the camera operates normally or not, it can be set to output test patterns generated in the camera, instead of image data from the image sensor. Four types of test patterns are available: images with different values in horizontal direction (Grey Horizontal Ramp), images with different values in diagonal direction (Grey Diagonal Ramp), moving images with different values in diagonal direction (Grey Diagonal Ramp Moving) and images with different values in horizontal direction output from the image sensor (Sensor Specific).

The XML parameter related to Test Pattern is as follows.

XML Parameter		Value	Description
ImageFormatControl	TestPattern	Off	Disables the Test Pattern feature.
		GreyHorizontalRamp	Sets to Grey Horizontal Ramp.
		GreyDiagonalRamp	Sets to Grey Diagonal Ramp.
		GreyDiagonalRampMoving	Sets to Grey Diagonal Ramp Moving.
		SensorSpecific	Sets to the Test Pattern generated by the image sensor.

Table 9-27 XML Parameter related to Test Pattern

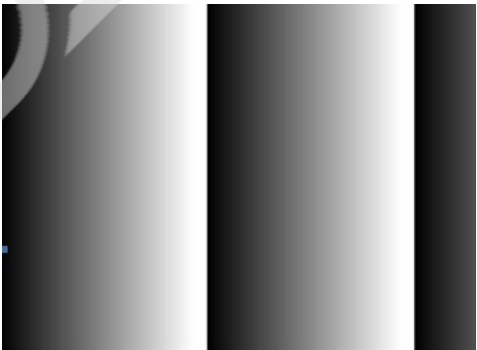


Figure 9-13 Grey Horizontal Ramp

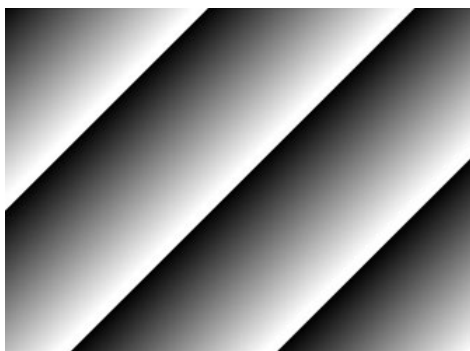


Figure 9-14 Grey Diagonal Ramp

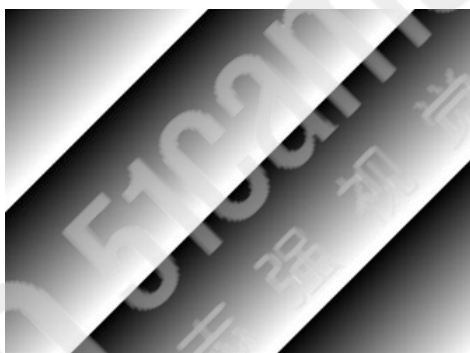


Figure 9-15 Grey Diagonal Ramp Moving

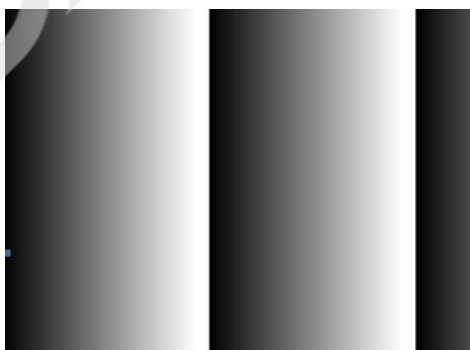


Figure 9-16 Sensor Specific

9.22 Reverse X

The Reverse X feature lets you flip images horizontally. This feature is available in almost all of operation modes of the camera, except for the Test Image mode.

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

Table 9-28 XML Parameter related to Reverse X



Figure 9-17 Original Image



Figure 9-18 Reverse X Image

9.23 Counter Control

The VL-2K7NG, VL-4K3.5NG cameras provide the Counter feature to count certain camera events. For example, you can verify the number of external trigger signals applied to the camera.

The XML parameters related to Counter Control are as follows.

XML Parameters		Value	Description
CounterAnd TimerControl	CounterSelector	Counter0	Selects a Counter to configure.
	CounterEvent Activation	RisingEdge	Counts on the rising edge of the selected Event Source signal.
		FallingEdge	Counts on the falling edge of the selected Event Source signal.
	CounterEvent Source	Off	Stops the Counter.
		FrameActive	Counts the number of FrameActive signals.
		ExposureActive	Counts the number of ExposureActive signals.
		LineActive	Counts the number of Line Active signals.
		LinkTrigger0	Counts the number of LinkTrigger0 signals.
		Line0	Counter the number of external trigger signals.
	CounterReset Source	Off	Disables the Counter Reset trigger.
		FrameActive	Uses the FrameActive signal as Reset Source.
		ExposureActive	Uses the ExposureActive signal as Reset Source.
		AcquisitionActive	Uses the AcquisitionActive signal as Reset Source.
	CounterReset Activation	Line0	Uses the Line0 signal as Reset Source.
		RisingEdge	Resets Counter on the rising edge of the selected Reset Source signal.
		FallingEdge	Resets Counter on the falling edge of the selected Reset Source signal.
		AnyEdge	Resets Counter on the rising/falling edge of the selected Reset Source signal.
		LevelHigh	Resets the Counter if the level of the selected Reset Source signal is High.
		LevelLow	Resets the Counter if the level of the selected Reset Source signal is Low.
	CounterReset	-	Resets the selected Counter and restarts.
	CounterValue	-	Displays the current value of the selected Counter.
	CounterValue AtReset	-	Displays the value of the Counter when it was reset by the Counter Reset command.

Table 9-29 XML Parameters related to Counter Control (1)

XML Parameters		Value	Description
CounterAnd TimerControl	CounterDuration	1 – 4294967295	Sets the duration or number of events to count before the Counter ends.
	CounterStatus	-	Displays the current status of the Counter.
	CounterTrigger Source	Off	Disables the Counter Trigger Source function.
		FrameActive	Uses the FrameActive signal as Trigger Source of Counter.
		ExposureActive	Uses the ExposureActive signal as Trigger Source of Counter.
		AcquisitionActive	Uses the AcquisitionActive signal as Trigger Source of Counter.
		Line0	Uses the Line0 signal as Trigger Source of Counter.
	CounterTrigger Activation	RisingEdge	Starts Counter on the rising edge of the selected Counter Trigger Source signal.
		FallingEdge	Starts Counter on the falling edge of the selected Counter Trigger Source signal.
		AnyEdge	Starts Counter on the rising/falling edge of the selected Counter Trigger Source signal.
		LevelHigh	Resets the Counter if the level of the selected Counter Trigger Source signal is High.
		LevelLow	Resets the Counter if the level of the selected Counter Trigger Source signal is Counter.

Table 9-30 XML Parameters related to Counter Control (2)

9.24 Timer Control

When the Line Source parameter is set to Timer0Active, the camera can provide output signals by using the Timer. On the VL-2K7NG, VL-4K3.5NG cameras, the Frame Active, Exposure Active event or external trigger signal is available as Timer source signal.

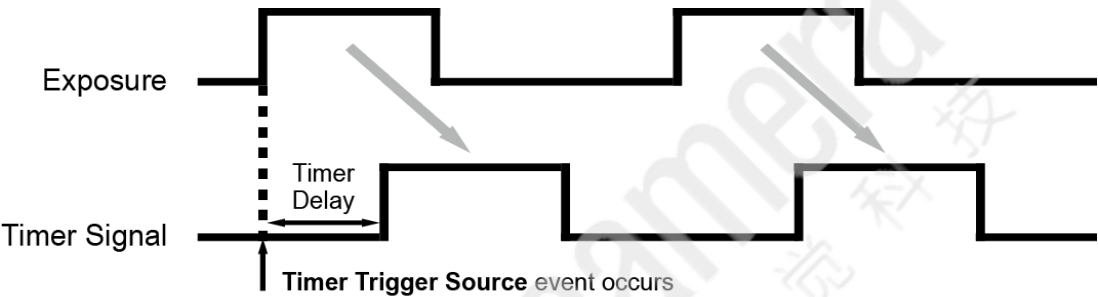
The XML parameters related to Timer are as follows.

XML Parameters		Value	Description
CounterAnd TimerControl	TimerDuration	1 ~ 60,000,000 μ s	Sets the duration of the Timer output signal to be used when Timer Trigger Activation is set to Rising/Falling Edge.
	TimerDelay	0 ~ 60,000,000 μ s	Sets the delay time to be applied before starting the Timer.
	TimerReset	-	Resets the Timer and starts it again.
	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	Disables the Timer trigger.
		ExposureActive	Sets the Timer to use the current exposure time as the source signal.
		FrameActive	Sets the Timer to use a frame readout time as the source signal.
		Line0	Sets the Timer to use the external trigger signal as the source signal.
	TimerTrigger Activation	RisingEdge	Specifies that a rising edge of the selected trigger signal will act as the Timer trigger.
		FallingEdge	Specifies that a falling edge of the selected trigger signal will act as the Timer trigger.
		LevelHigh	Specifies that the Timer output signal will be valid as long as the selected trigger signal is High.
		LevelLow	Specifies that the Timer output signal will be valid as long as the selected trigger signal is Low.

Table 9-31 XML Parameters related to Timer Control

For example, when the Timer Trigger Source is set to Exposure Active and the Timer Trigger Activation is set to Level High, the Timer will act as follows:

- 1. When the source signals set by the Timer Trigger Source parameter are applied, the Timer will start operations.
- 2. The delay set by the Timer Delay parameter begins to expire.
- 3. When the delay expires, the Timer signal goes high as long as the source signal is high.



* **Timer Trigger Activation** is set to **Level High**.

Figure 9-19 Timer Signal

9.25 Device User ID

You can input user-defined information up to 16 bytes.

The XML parameter related to Device User ID is as follows.

XML Parameters		Description
DeviceControl	DeviceUserID	Input user defined information (16 bytes).

Table 9-32 XML Parameter related to Device User ID

9.26 Device Reset

Resets the camera physically to power off and on. You must connect to the network again because the camera will be released from the network after reset.

The XML parameter related to Device Reset is as follows.

XML Parameters		Description
DeviceControl	DeviceReset	Resets the camera physically.

Table 9-33 XML Parameter related to Device Reset

9.27 Field Upgrade

The camera provides a feature to upgrade the Firmware and FPGA logic through the Gigabit Ethernet interface rather than disassemble the camera in the field. Refer to Appendix A for more details about how to upgrade.

9.28 User Set Control

You can save the current camera settings to the camera’s internal Flash memory. You can also load the camera settings from the camera’s internal Flash memory. The camera provides two setups to save and three setups to load settings.

The XML parameters related to User Set Control are as follows.

XML Parameters		Value	Description
UserSetControl	UserSetSelector	Default	Selects the Factory Default settings.
		UserSet1	Selects the UserSet1 settings.
		UserSet2	Selects the UserSet2 settings.
	UserSetLoad	-	Loads the User Set specified by User Set Selector to 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 9-34 XML Parameters related to User Set Control

The camera settings stored in the Default can be loaded into the camera's workspace but cannot be changed. The settings set in the workspace will be lost if the camera is reset or powered off. To use the current setting values in the workspace after a reset, you must save the settings to one of the user spaces.

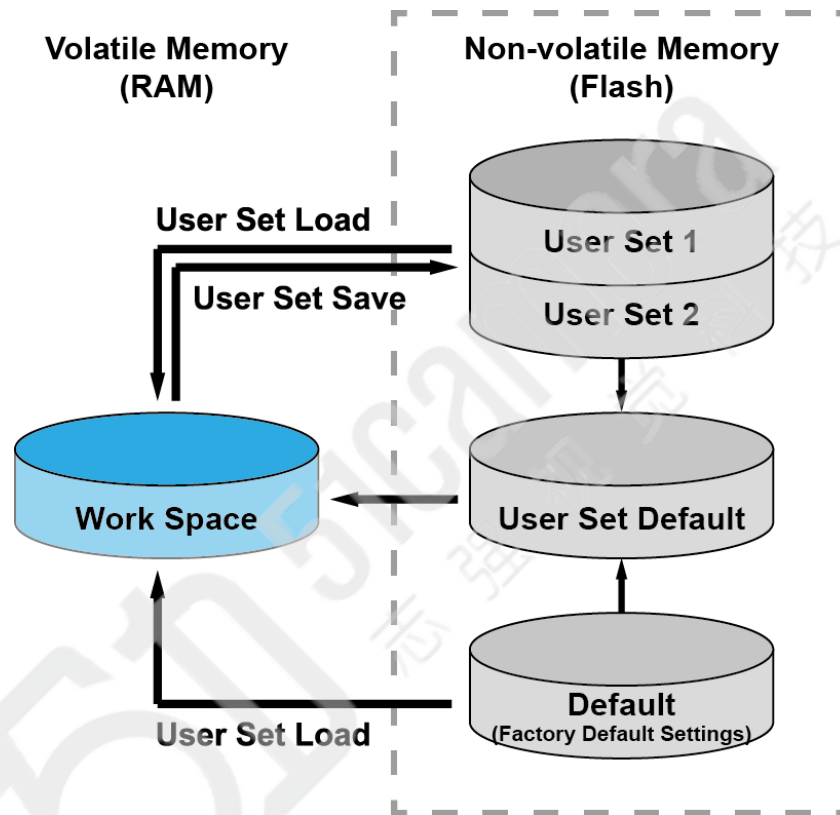


Figure 9-20 User Set Control

Chapter 10. Troubleshooting

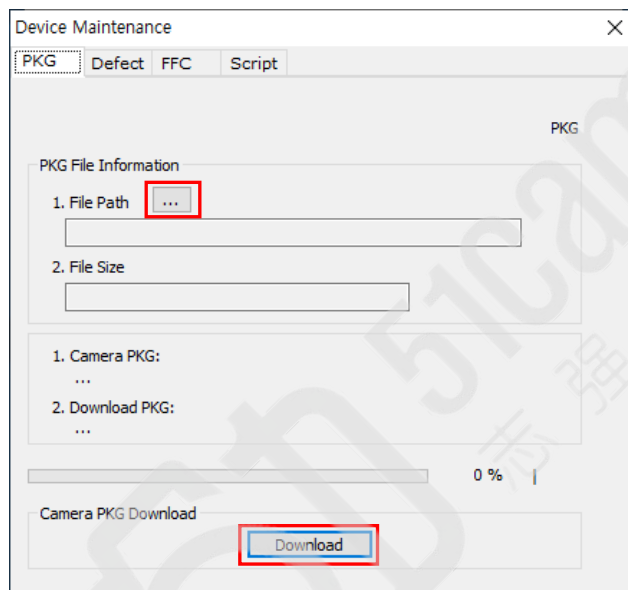
When you have a problem with a Vieworks camera, please check the following:

- If no image is displayed on your computer,
 - Ensure that all the cable connections are secure.
 - Ensure that the power supply is properly connected.
 - Ensure that trigger signals are applied correctly when you operate the camera with trigger signals.
- If images are not clear,
 - Ensure the camera lens or glass is clean.
 - Check the lens aperture is adjusted properly.
- If images are dark,
 - Ensure the camera lens is not blocked.
 - Check the exposure time is set properly.
- If you identify abnormal operation or overheating sign,
 - Ensure the power supply is properly connected.
 - Stop using the camera when you notice smoke or abnormal overheating.
- If you have a problem using the Trigger Mode,
 - For external trigger mode, make sure that the cable connections are secure.
- If there is communication failure between the camera and computer,
 - Ensure the Gigabit Ethernet cable is connected properly.
 - Ensure that you have configured the 5 GigE Network Adapter in your computer correctly and the camera is connected properly to the 5 GigE Network Adapter.

Appendix A. Field Upgrade

You can upgrade the MCU, FPGA and XML file of the camera by the following procedure below.

1. Run Viewworks Imaging Solution 7.X and click the Configure button to display the Device Maintenance window as shown below.
2. Select the PKG tab, click the [...] button of the File Path item's left, select the MCU, FPGA or XML upgrade file.



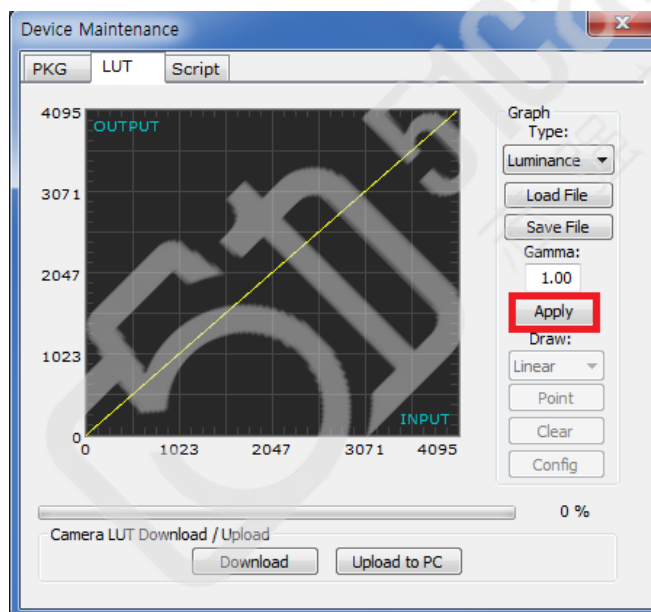
3. Click the [Download] button. The camera begins downloading the upgrade file and the downloading status is displayed at the bottom of the window.
4. After completing the download, click the [OK] button to close the confirmation.

Appendix B. LUT Download

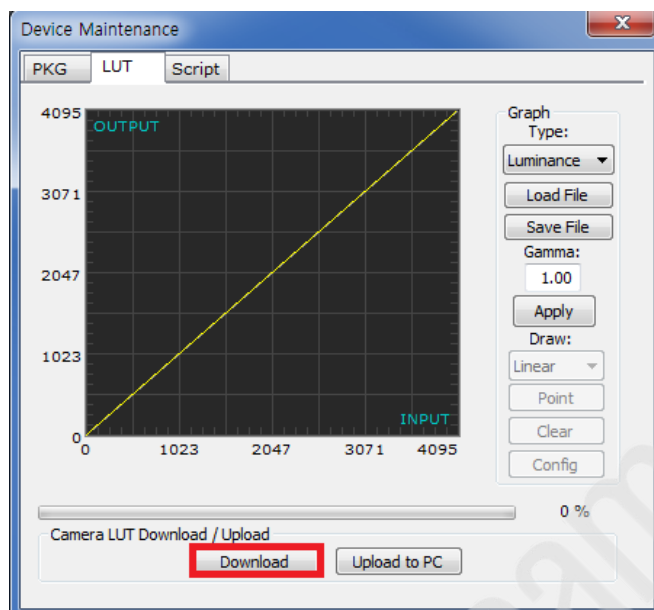
You can create LUT data in two different ways; by adjusting the gamma values on the gamma graph provided in the program and then downloading the data or by opening a CSV file (*.csv) and then downloading the data.

B.1 Gamma Graph Download

1. Run Vieworks Imaging Solution 7.X and click the Configure button to display the window as shown below. Select the LUT tab, and then select Luminance from the Type dropdown list.
2. Set a desired value in the Gamma input field and click the **Apply** button.



3. Click the **Download** button to download the gamma values to the camera.

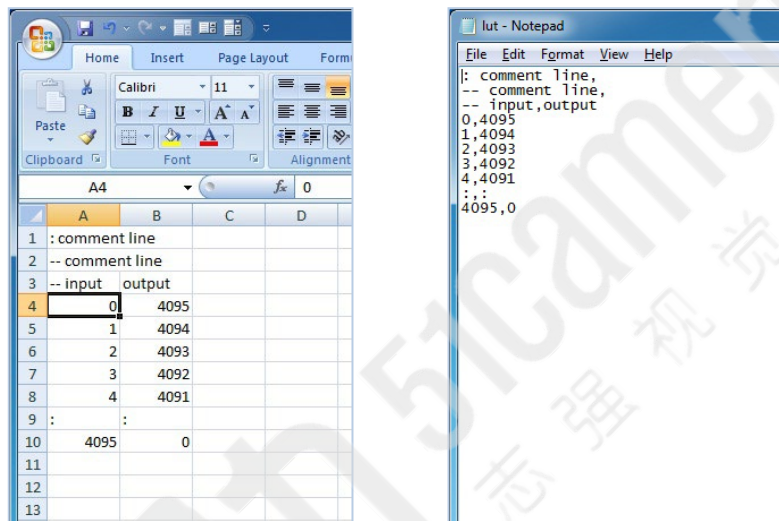


4. After completing the download, click the **OK** button to close the confirmation.

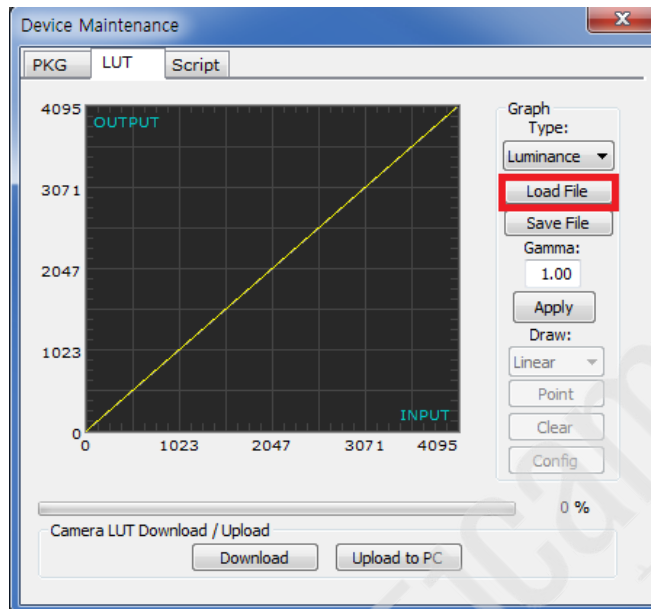
B.2 CSV File Download

1. Create the LUT table in Microsoft Excel format as shown in the left picture below and save as a CSV file (*.csv). The picture in the right shows the created file opened in Notepad. Once the file has been created completely, change the .csv file extension to .lut. Keep in mind the following rules when creating the file.

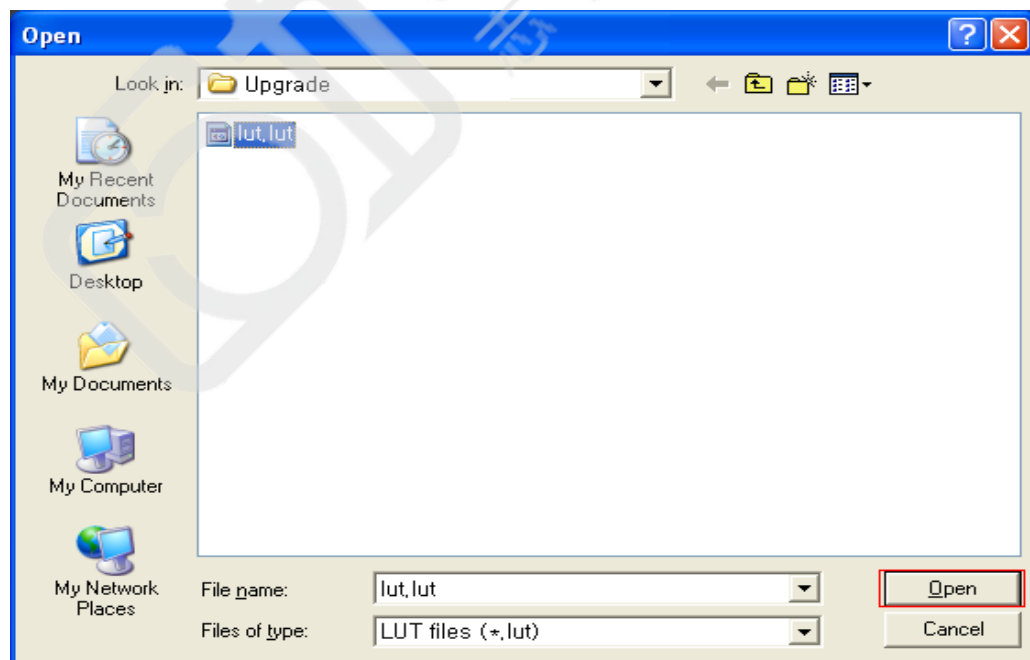
- Lines beginning with ':' or '--' are treated as notes.
- Based on the input values, make sure to record from 0 to 4095.



2. Run Vieworks Imaging Solution 7.X and click the Configure button to display the window as shown below. Select the LUT tab, select Luminance from the Type dropdown list, and then click the **Load File** button.



3. Search and select the created LUT file and click the **Open** button.



4. Click the **Download** button. After completing the download, click the **OK** button to close the confirmation.

Appendix C. Glossary

Term	Description
Binning	The process of combining the signal values of two or more neighboring pixels to create a single "virtual" pixel with a higher signal level.
Camera Link	A serial communications protocol designed for computer vision applications. Based on the National Semiconductor interface Channel Link, designed to standardize digital communications (interfaces) between industrial video products such as cameras, cables, and frame grabbers.
CMOS (Complementary Metal-Oxide Semiconductor)	Used in scanners and digital cameras based on semiconductor processes, or for the purpose of designing image sensors.
CXP (CoaXPress)	Asymmetric high-speed serial communication standard using coaxial cable.
Color Image	RGB (Red, Green, Blue = 3-Band) imaging, the three primary colors of light.
DSNU (Dark Signal Non-Uniformity)	Differences in individual pixel behavior that can be seen or measured even in the absence of light.
Dynamic Range	The maximum-to-minimum ratio of measurable light, with higher values indicating a wider range of expression (unit: dB (decibels))
FPN (Fixed Pattern Noise)	FPN has a fixed noise value and can be used to reduce level deviations between pixels, resulting in a cleaner image. Correcting FPN in the absence of light is called DSNU, and correcting FPN in the presence of light is called PRNU.
Frame Grabber	A device that converts an analog video signal from an image medium, such as a camera, into a signal that can be processed by a personal computer (PC) by digitizing it with a defined number of bits per sample (digital image signal).
Gain	The degree of brightness of light in a camera. Adjusting the strength of the signal to control the brightness of the shadows in an image.
GenICam	A universal configuration interface that supports a wide range of standard interfaces such as GigE Vision, Camera Link, and IEEE 1394-IIDC, regardless of camera type and image format. It allows users to easily identify the type of camera, the features and functions supported by a particular camera, and the range of parameters associated with each function. The main point of the GenICam standard is a Descriptor File (in XML format) on board the camera that

	maps the camera's internal registers to a standardized list of features.
Interface	A standardized protocol (means of data transfer) for connecting the camera to the Frame Grabber. Ex) Camera Link, Giga-E, USB 2.0 / 3.0, etc. (The transmission specification is determined by the interface)
Lens Mount	The part of the camera that holds the lens. (Classified as C-mount, F-mount, etc. depending on the mounting method)
Line Rate	The number of lines transmitted per second.
Line Scan Camera	A camera that uses a sensor consisting of a single row of photodetectors, collecting images line by line. Unlike Area Scan cameras, the sensor is organized in straight lines.
LUT (Lookup Table)	A user-programmable method of modifying the relationship between the value recorded by each pixel and the value output to the image for viewing or processing. In the case of LUT, the user can define and use custom mappings between input values and output values. In this case, the mapping is done by selecting "index" and assigning "value".
Mono Image	Black and white or monochrome image. Based on 8-bit data, the closer to 0, the darker, and the closer to 255, the lighter.
Resolution	Number of horizontal x vertical pixels Ex) Black and white image (capacity calculation) : $640 * 480 * 8(\text{bit}) = 2,457,600 \text{ bit} = 307,200 \text{ byte}$
Offset	Adjusting the intensity of the signal to adjust the darker parts of the image (luminance).
Parameter	An intrinsic variable used to describe or organize a particular function or model.
PCB Inspection	Automated imaging of PCB (printed circuit board) or electronics subsystem to determine proper component placement, identify defects, and assess overall quality.
Pixel	The smallest unit that makes up imaging data Ex) Pixel value = $8 \text{ Bit} = 2^8 = 256 \text{ level}$
Pixel Size	The actual size of each pixel in a camera sensor. (Unit: μm (micrometer))
PRNU (Photo Response Non-Uniformity)	The pixel-by-pixel variation in the response of an image sensor to the same amount of light falling on all pixels.
Q.E (Quantum Efficiency)	Quantum efficiency (Q.E.) is a quantity defined in photosensitive devices, such as photographic film or charge-coupled devices (CCDs), that refers to the percentage of photons that strike a photoreactive surface and create electron-hole pairs. It is a key factor in measuring the electrical sensitivity of a device to light.
Sensitivity	A term that refers to how easily a camera responds to small amounts

	of light, whether visible or invisible wavelengths. There are many factors that affect sensitivity, including the size of the pixel, its ability to collect light, its ability to convert light into electrical signals, and the amount of "noise" it produces in the process.
Shutter	For digital sensors, an electronic shutter transfers the digital charge collected by the pixels at the end of a specified exposure time to a shaded buffer area (transfer register), called a "global shutter" if all pixels are transferred simultaneously. ('rolling shutter' if pixels are transferred sequentially)
TDI (Time Delay and Integration)	A method of taking multiple shots of an area and superimposing the image data into a single image.
Viewworks Imaging Solution (VIS)	Indicates the control application provided with the product together by Viewworks
White Balance	Refers to the process of making pixels with multiple color filters respond to a light source with the correct color ratio.

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