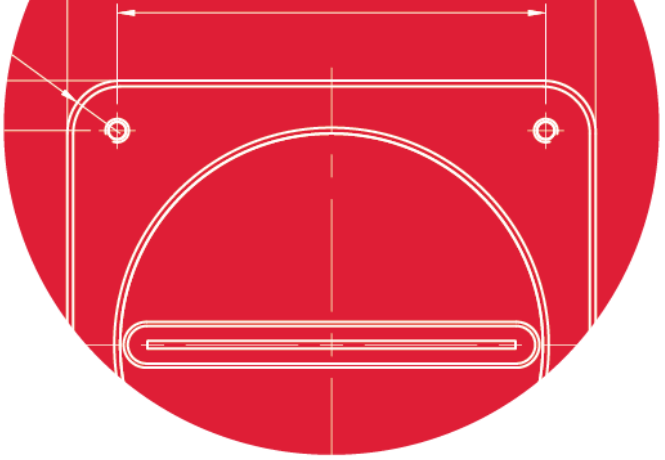


VTD series

User Manual

English

VTD-16K5X2-H150A

CoaXPress®

vieworks

Contents

Figures

Tables

1. Instruction

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

Document Guide

Precautions

Product Use

Revision History

1.1 Document Guide

1.1.1 Target Audience

This manual is intended for the users who set up and operate the **VTD-16K5X2-H150**.

1.1.2 Symbols

This product should be operated under the safety instructions with the warning or caution symbol in this manual. It is important for you to read and understand the contents to operate the products safely.

Caution

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

Information

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

1.1.3 Notations

Bold Types

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

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

1.2 Precautions

General

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

Installation and Maintenance

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

Power Supply

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

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

Cleaning the Sensor Surface

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

Avoid dust or foreign matter on the sensor surface.

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

Procedure for Cleaning the Sensor

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

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

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

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

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

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

1.3 Product Use

1.3.1 Warrant Coverage

The following cases are excluded from the warranty coverage:

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

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

1.3.2 KCC Statement

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

1.3.3 Camera Mounting and Heat Dissipation

The camera should be installed in a structure that allows sufficient heat dissipation to keep the camera housing temperature below 50°C. The VTD camera is designed for low power consumption, ensuring that the housing temperature remains within the specified limit during operation. However, if the camera is installed in an environment where heat cannot dissipate properly or in harsh conditions, it may overheat. It is recommended to follow these general guidelines for installation:

- In all cases, make sure to monitor the camera housing temperature and keep it below 50°C. The **Device Temperature** parameter can be used to check the current internal temperature of the camera.
- Mounting the camera onto a metallic structure within the system can help facilitate adequate heat dissipation.

1.4 Revision History

Version	Date	Description
1.0	2025-02-12	Initial release
1.1	2025-07-04	Changed) 2.2.3 Mechanical Specification

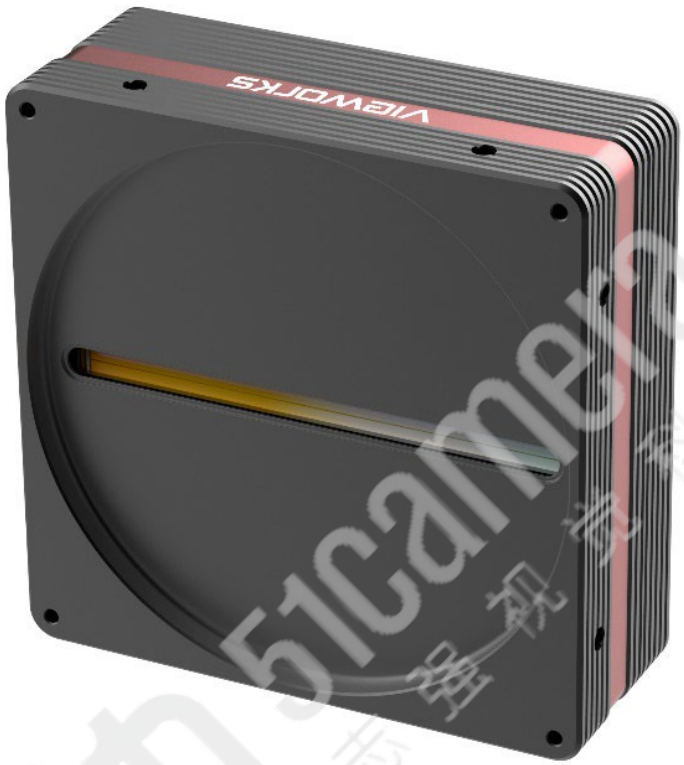
2. Product

This section gives an instruction about the product components and their specifications.

Product Components

Product Specification

2.1 Product Components

Package Components

VTD-16K5X2-H150 Camera with M95 mount

2.2 Product Specification

The VTD-16K5X2-H150 camera is a Time Delayed Integration (TDI) camera that utilizes a back-side illuminated (BSI) sensor with charge-domain CMOS technology. It is capable of capturing 2 different images in a single scan by using two different lighting conditions (such as transmission, coaxial, or diffuse reflection).

To obtain 2 distinct images, the lighting strobing must be controlled so that the ON times of the two light sources do not overlap, ensuring clearer image capture.

Additionally, the camera supports the CoaXPress 2.0 interface, allowing data transmission at speeds of up to 50 Gbps with a simple CoaX cable connection. With its cutting-edge BSI sensor, which enables high speed and high sensitivity, this camera is ideal for applications such as FPD inspection, wafer inspection, PCB inspection, and high-performance document scanning.

Main Features

- 16k, BSI(Back-Side Illuminated), Hybrid TDI Line Scan
- 16384 x 256 (X2) Pixel Resolution
- Bidirectional Operations with up to 256 (X2) TDI Stages
- Trigger Rescaler and Strobe Output Control
- CoaXPress 2.0 Interface up to 50 Gbps using 4 CoaX cables (4 channels)
- Advanced PRNU and DSNU Correction
- Area Scan Mode for Camera Alignment

Applications

- Flat Panel Display Inspection
- Printed Circuit Board Inspection
- Wafer Inspection
- High Performance Document Scanning

The specification of the VTD-16K5X2-H150 camera is as follows:

Specification		**VTD-16K5X2-H150A-256**
Resolution (H × V)		16384 × 256 (x2)*
Sensor Type		BSI Dual Hybrid TDI Line Scan
Pixel Size		5.0 μm × 5.0 μm
Interface		CoaXPress 2.0 (CXP-12, 4 CH)
Pixel Data Format		8 / 10 / 12 bit
TDI Stage		128 / 256 (x2)*
TDI Direction		External Control Port or Programmable
Trigger Synchronization		Free-Run, External Trigger Signal, CoaXPress Programmable Line Rate and Trigger Polarity
Max. Line Rate (ROI 16,000 pixels)	8 bit	150 kHz
	10 bit	120 kHz
	12 bit	100 kHz
Min. Line Rate		10 kHz
Throughput		4.8 Gpix/s
Gamma Correction		User Defined LUT (Look Up Table)
Black Level		-255 to 255 at 8 bits
Gain Control	Analog Gain	1×, 2×, 3×, 4×
	Digital Gain	1.0× to 32.0×
External Trigger		3.3 V to 5.0 V
Power	Adapter	11 to 24 VDC
	Dissipation	Typ. 26 W
	PoCXP	24 VDC, at least 2 PoCXP cables required
Temperature		Ambient Operating: 0℃ to 40℃ (Housing: 10℃ to 50℃) Storage: -40℃ to 70℃
Mechanical		100 mm × 100 mm × 72 mm, 860 g
API SDK		Vieworks Imaging Solution 7.X
Optical Interface		
Lens Mount		M95 × 1.0 mm
Sensor to Camera Front		9.50 mm (Optical Distance)
Sensor Alignment		
Flatness		±25 μm
x		±0.15 mm
y		±0.15 mm
z		±0.1 mm

Table 2-1 The specification of VTD CXP Series with M95 mount

*: This model is equipped with a dual band, generating two types of data when both bands are activated for scanning, with each dataset containing 256 stages.

2.2.1 Camera Block Diagram

The VTD-16K5X2-H150 camera is composed of 3 PCBs, and its block diagram is as shown below:

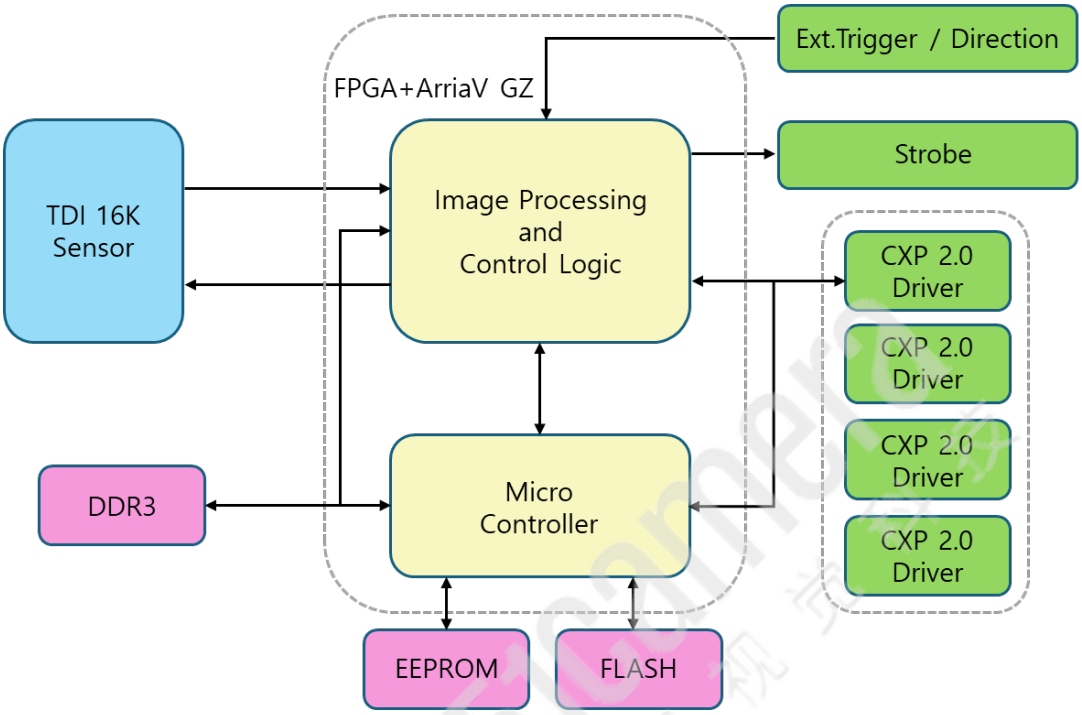


Figure 2-1 M95 mount Camera Block Diagram

2.2.2 Spectral Response

The below graph represents the spectral response of the VTD-16K5X2-H150 camera.

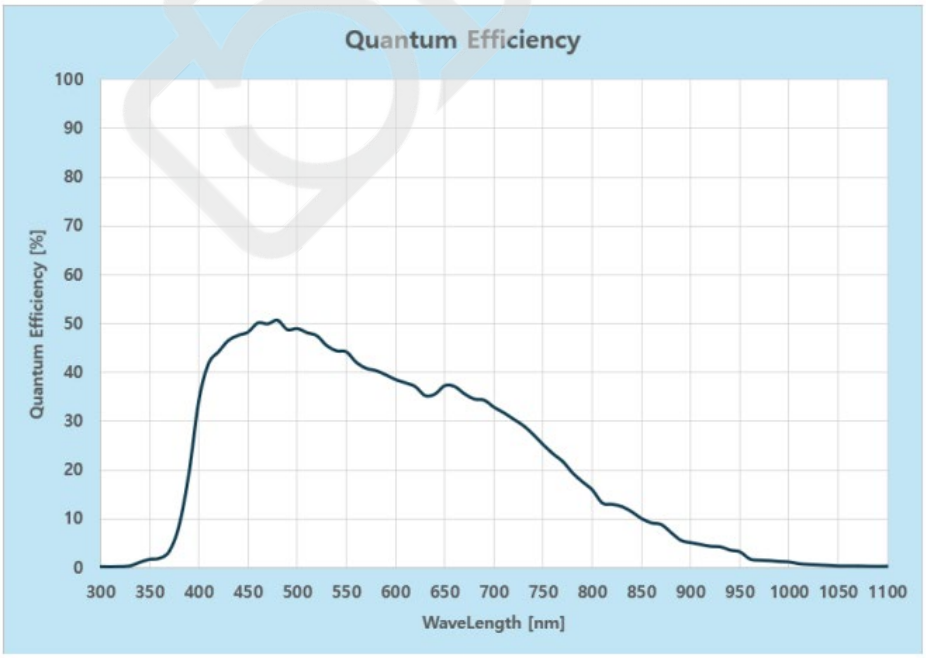


Figure 2-2 Quantum Efficiency (Monochrome)

2.2.3 Mechanical Specification

Unit: mm

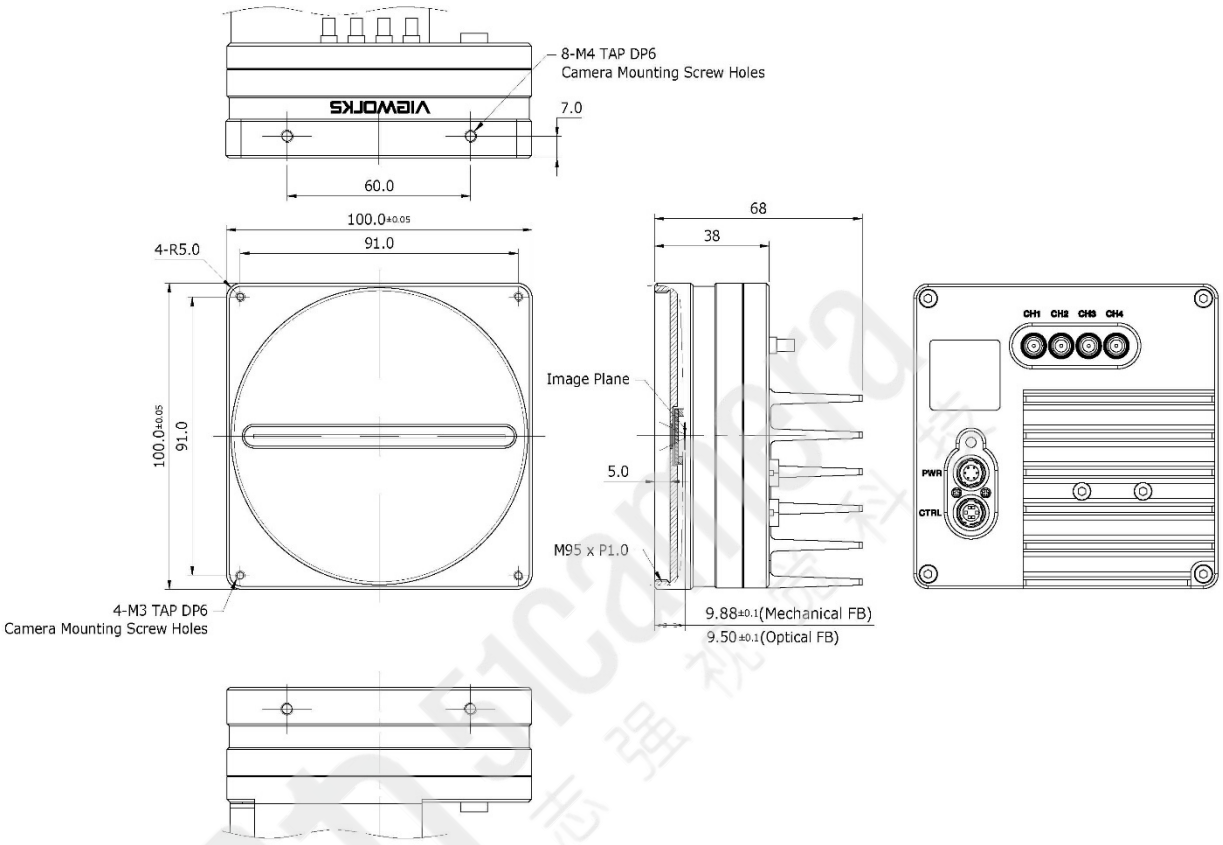


Figure 2-3 Mechanical Dimension of the VTD CXP Camera with M95 mount

3. Installation

This section explains how to install and connect the camera.

Camera Connection

Camera Interface

Acquisition Control

3.1 Camera Connection

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

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

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

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

1 Plug one end of a coax cable into the CH1 of the CXP connector on the camera and the other end of the coax cable into the CH1 of the CXP Frame Grabber in your computer. Then, connect the CH2, CH3 and CH4 of the CXP connector on the camera to the CH2, CH3 and CH4 of the CXP Frame Grabber respectively using the other three coax cables.
2 Connect the plug of the power adapter into the 6-pin power input receptacle on the camera.
3 Plug the power adapter into a working electrical outlet.

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

1 Plug one end of a coax cable into the CH1 of the CXP connector on the camera and the other end of the coax cable into the CH1 of the CXP Frame Grabber in your computer. Then, connect the CH2, CH3 and CH4 of the CXP connector on the camera to the CH2, CH3 and CH4 of the CXP Frame Grabber respectively using the other three coax cables.
2 You must connect the CH1 and CH2 channels to power the camera via PoCXP.

Step 3: Verify all the cable connections are secure.

- To power a camera via PoCXP Frame Grabber, you must connect the CH1 and CH2 channels of the camera to their respective connectors on the CXP Frame Grabber.

3.1.1 Precaution to Center the Image Sensor

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

3.1.2 Installing Vieworks Imaging Solution

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

3.2 Camera Interface

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

No.	Item	Description
1	CoaXPress connector	Transmits video data and controls the camera.
2	Status LED	Displays power status and operation mode.
3	6 pin power input receptacle	Supplies power to the camera (if PoCXP is not used).
4	6 pin control I/O receptacle	Inputs external trigger signal and outputs strobe

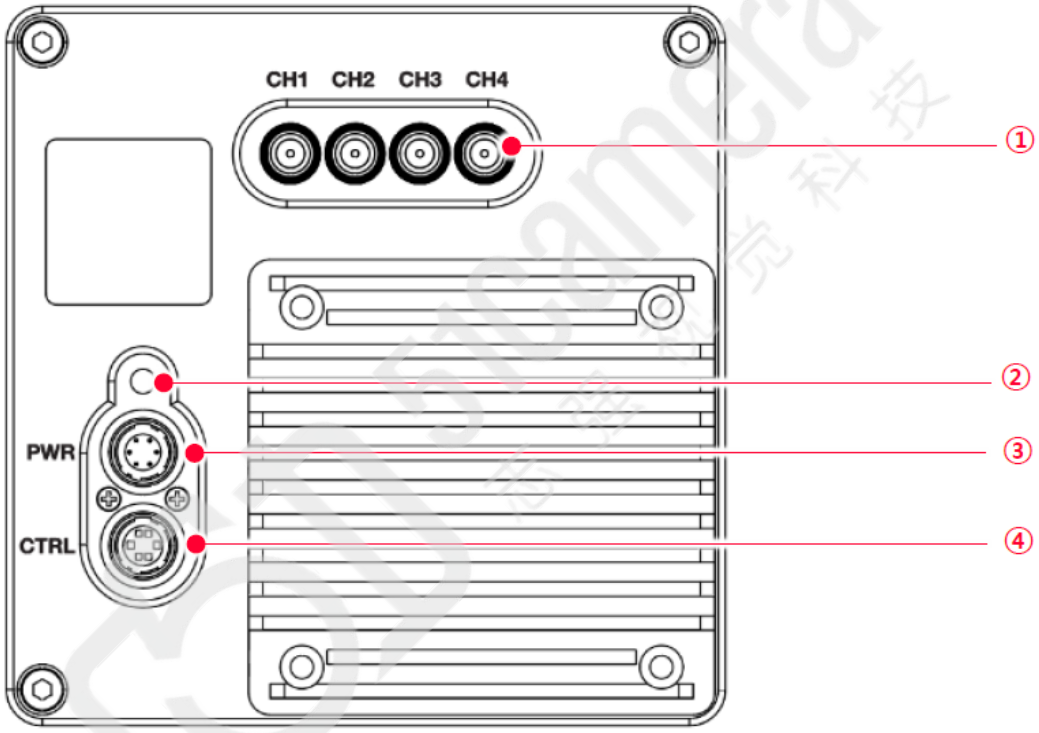


Figure 3-1 M95 mount VTD Camera Back Panel

3.2.1 CoaXPress Connector

CoaXPress protocol includes an automatic link detection mechanism (Plug and Play) to correctly detect the camera to the CXP Frame Grabber connection. The connection between the camera and CXP Frame Grabber uses a coax (also known as 'coaxial') cable and provides up to 12.5 Gbps bit rate per cable. The cameras can be powered over the coax cable if you are using a PoCXP enabled Frame Grabber.

CoaXPress Micro-BNC Connector (75 Ω Micro-BNC Receptacle)

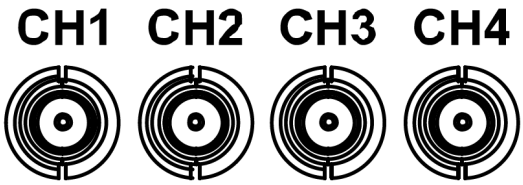


Figure 3-2 CoaXPress Micro-BNC Connector

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

Channel	Max. Bit Rate per Coax	Type	PoCXP Compliant
CH1	12.5 Gbps	Master Connection	Yes
CH2	12.5 Gbps	Extension Connection	Yes
CH3	12.5 Gbps	Extension Connection	No
CH4	12.5 Gbps	Extension Connection	No

Table 3-1 CoaXPress Connector Pin Configuration of VTD CXP Camera (CXP Link Count : 1)

Channel	Max. Bit Rate per Coax	Type	PoCXP Compliant
CH1	12.5 Gbps	Main Connection1	Yes
CH2	12.5 Gbps	Extension Connection1	Yes
CH3	12.5 Gbps	Extension Connection2	No
CH4	12.5 Gbps	Extension Connection2	No

Table 3-2 CoaXPress Connector Pin Configuration of VTD CXP Camera (CXP Link Count : 2)

- When connecting the CXP Frame Grabber and the camera using coaxial cables (also referred to as "coax cables"), pay close attention to the connection positions. If the camera's CXP connectors (CH1, CH2, CH3, and CH4) are not properly connected to the corresponding channels (CH1, CH2, CH3, and CH4) on the CXP Frame Grabber, the camera's image may not be displayed correctly, or communication between the PC and the camera may not function properly.

3.2.2 Power Input Receptacle

The power input receptacle is a Hirose 6-pin connector (part # HR10A-7R-6PB). The pin assignments and configurations are as follows:

Figure 3-3 Pin Assignments for 6-pin Power Input Receptacle

Pin Number	Signal	Type	Description
1, 2, 3	DC Power +	Input	DC Power Input
4, 5, 6	DC Ground -	Input	DC Ground

Table 3-3 Pin Arrangements for Power Input Receptacle

- A recommended mating connector for the Hirose 6-pin connector is the Hirose 6-pin plug (part # HR10A-7P-6S) or the equivalent connectors.
- It is recommended that you use the power adapter, which has at least 3 A current output at 10 ~ 30 V voltage output (You need to purchase a power adapter separately.).

CAUTION

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

3.2.3 Control I/O Receptacle

The control I/O receptacle is a Hirose 6-pin connector (part # HR10A-7R-6SB) and consists of an external trigger signal input and strobe output ports. The pin assignments and configurations are as follows:

Figure 3-4 Pin Assignments for 6-pin Control I/O Receptacle

Pin Number	Signal	Type	Description
1	Line0	Input	3.3 V to 5.0 V TTL input
2	Line1	Input	3.3 V to 5.0 V TTL input
3	DC Ground	-	DC Ground
4	DC Ground	-	DC Ground
5	Line3	Output	3.3 V TTL Output Output resistance: 47 Ω
6	Line2	Output	3.3 V TTL Output Output resistance: 47 Ω

Table 3-4 Pin Arrangements for Control I/O Receptacle

- A recommended mating connector for the Hirose 6-pin connector is the Hirose 6-pin plug (part # HR10A-7P-6P) or the equivalent connectors.

3.2.4 Trigger/Direction Input Circuit

The diagram below illustrates the trigger signal input and TDI direction input circuit of the 6-pin connector. The trigger input and TDI direction signals are transmitted to the internal circuit through a CMOS buffer, which provides excellent noise margin. The minimum trigger pulse width recognized by the camera is **1 μs**. If the input trigger signal has a pulse width smaller than **1 μs**, the camera will ignore the trigger signal. The external trigger signal and TDI direction input can be supplied as shown in the circuit diagram below:

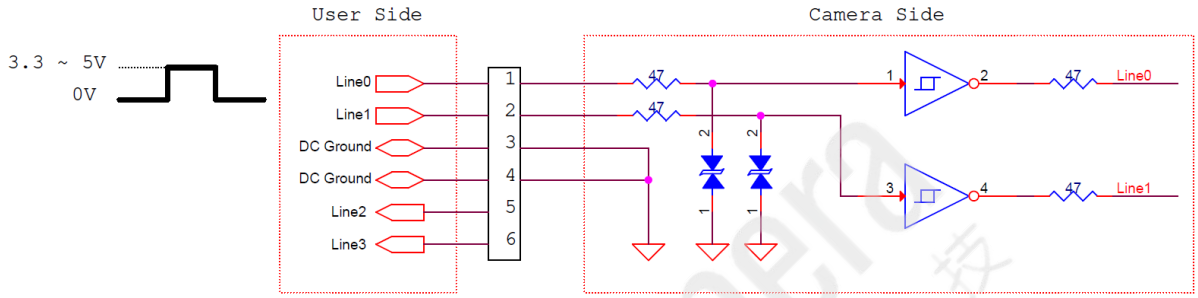


Figure 3-5 Trigger / Direction Input Schematic

3.2.5 Strobe Output Circuit

The strobe output signal is generated through a Line Driver IC with a 3.3 V output level. The pulse width of the signal can be synchronized with the camera's Line Start trigger signal (shutter) for output (see <4.18 Digital I/O Control> for reference).

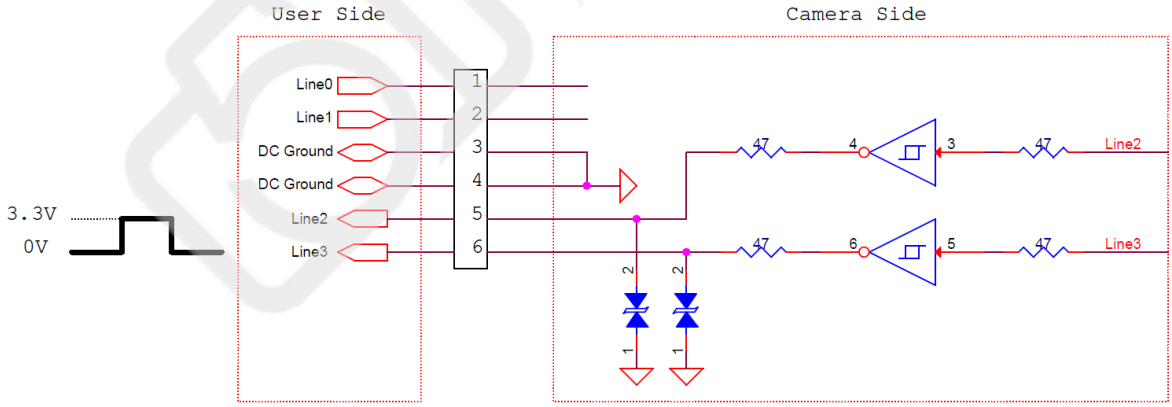


Figure 3-6 Strobe Output Schematic

3.3 Acquisition Control

This section provides detailed information about the following elements involved with the image acquisition:

- Acquisition Start/Stop commands and Acquisition Mode parameter
- Line Start trigger
- Line Rate control

3.3.1 Acquisition Start/Stop Commands and Acquisition Mode

- When the **Acquisition Start** command is executed, the camera prepares to capture images. Without executing the **Acquisition Start** command, the camera will not be able to capture images.
  When the **Acquisition Stop** command is executed, the camera stops capturing images.
- The **Acquisition Mode** parameter directly affects the operation of the **Acquisition Start** command. The VTD-16K5X2-H150 camera only supports **Continuous** mode.
- The **Acquisition Start** command remains active until the **Acquisition Stop** command is executed. Once the **Acquisition Stop** command is executed, the camera will not be able to capture images again until a new **Acquisition Start** command is issued.

3.3.2 Line Start Trigger

The **Trigger Selector** parameter allows you to select the trigger type, and the VTD-16K5X2-H150 camera can only use the **Line Start** trigger. The **Line Start** trigger is used to begin line image acquisition.
The **Line Start** trigger can either be generated internally by the camera or supplied externally by setting the **Trigger Source** parameter to **Line0**, **Line1**, or **LinkTrigger0**. When the **Line Start** trigger is supplied to the camera, the camera will start the line image acquisition.

a) Trigger Mode

The most critical 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 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.
If the Trigger Mode parameter is set to Off, the camera will automatically begin generating line start trigger signals when it receives an Acquisition Start command. The camera will continue to generate line start trigger signals until it receives 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 generate line start trigger signals 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 generate line start trigger signals at the maximum allowed line rate.

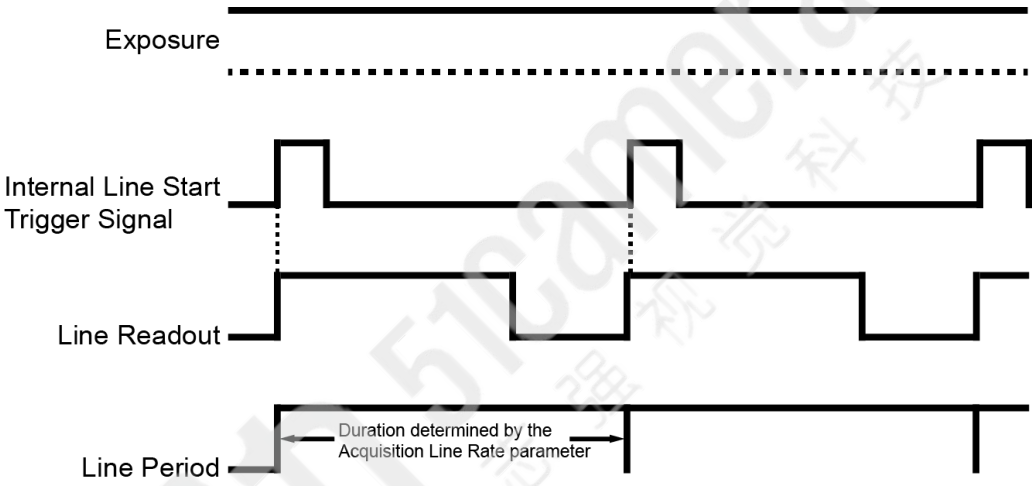


Figure 3-7 Trigger Mode = Off

When 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 as below:

- **Line0 and Line1**: You can supply the **Line Start** trigger signal to the camera by injecting an externally generated electrical signal (commonly known as hardware or external trigger signal) into the camera's control I/O terminal. For more details, refer to <3.2.5 Trigger/Direction Input Circuit>.
- **LinkTrigger0**: The Line Start trigger signal can be supplied to the camera through the CH1 channel of the CXP Frame Grabber. For more details, refer to the CXP Frame Grabber user manual.

The **Trigger Activation** parameter should be set after setting the Trigger Source parameter is complete.

The available settings for the Trigger Activation parameter are as follows:

- **Rising Edge**: Specifies that the **rising edge** of the electrical signal will trigger the **Line Start** trigger.
- **Falling Edge**: Specifies that the **falling edge** of the electrical signal will trigger the **Line Start** trigger.
- **Any Edge**: Specifies that either the **rising edge** or **falling edge** of the electrical signal will trigger 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. However, the trigger signal should not be supplied at a speed faster than the allowable maximum line rate.

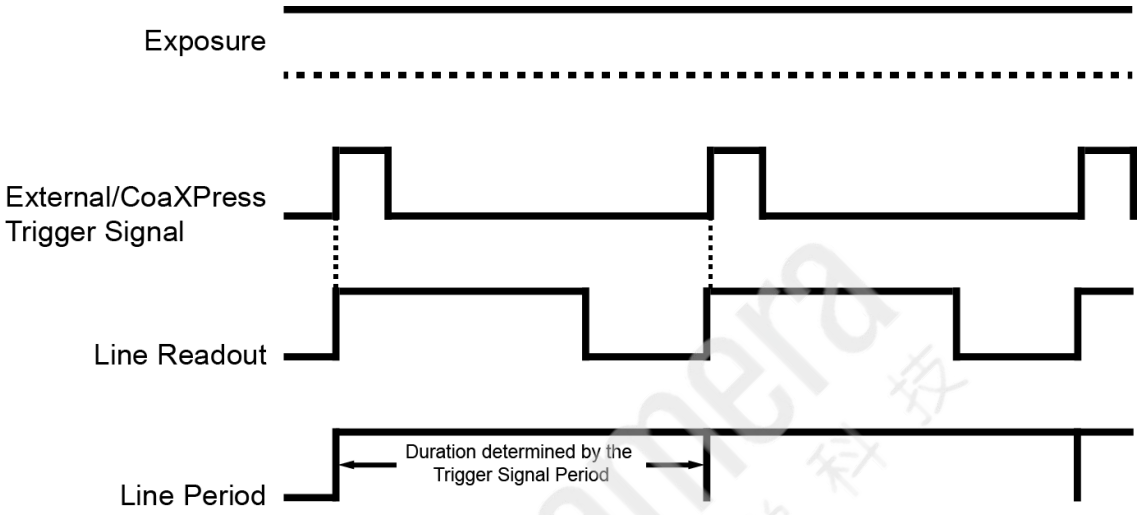


Figure 3-8 Trigger Mode = On

b) Using an External/CoaXPress Trigger Signal

- When the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **Line0**, **Line1**, or **LinkTrigger0**, an external or CoaXPress trigger signal (Line Start) must be supplied to the camera to begin image acquisition.
- To supply the trigger signal through the **CH1** channel of the **CXP Frame Grabber**, the **Trigger Source** parameter must be set to **LinkTrigger0**. Then, you can use the API provided by the **CXP Frame Grabber** manufacturer to supply the CoaXPress trigger signal as the **Line Start** trigger to the camera. For more details, refer to the **CXP Frame Grabber** user manual.
- To supply the trigger signal via hardware, the **Trigger Source** parameter should be set to **Line0** or **Line1**. Then, by supplying the appropriate electrical signal to the camera, the camera will recognize the generated **Line Start** trigger signal.
- The rising edge and/or falling edge of the external or CoaXPress signal can be used as the **Line Start** trigger. The **Trigger Activation** parameter allows you to choose whether to set the rising edge and/or falling edge as the trigger.
- When the camera operates based on an external or CoaXPress signal, the **line rate** is determined by the period of the external trigger signal as follows:

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

For example, if the camera is operated with an external trigger signal having a period of 20 μs (0.00002 seconds), the line rate will be **50 kHz.**

c) Trigger Multiplier/Divider

By using the **Trigger Multiplier** or **Trigger Divider**, the period of the external trigger signal can be adjusted by the desired ratio. For example, when using an encoder on a conveyor belt to supply a trigger signal to the camera's input terminal, the number of pulses output per rotation from the encoder is fixed. In this case, if the period of the trigger signal needs to be adjusted to match the vertical image pitch, the user can adjust the period of the trigger signal input to the camera using the **Trigger Multiplier** or **Trigger Divider** as follows:

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

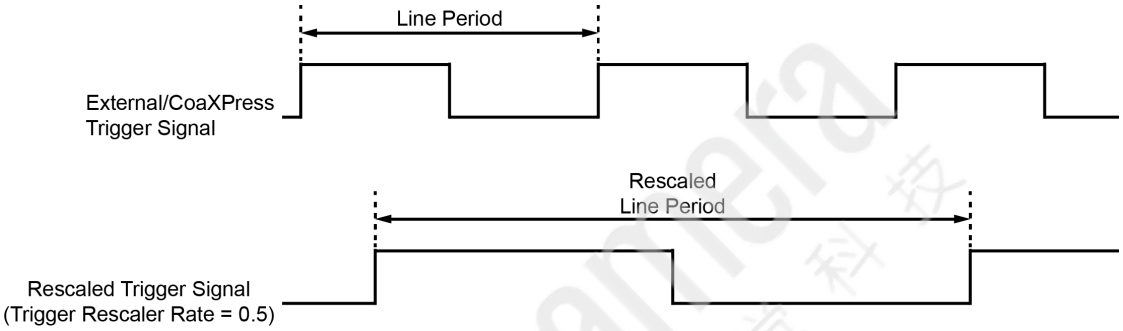


Figure 3-9 Trigger Ration = 0.5

The XML parameter regarding the Trigger Rescaler mode is as below:

XML Parameters		Value	Description
AcquisitionControl	Trigger Multiplier	1 to 1024	Disables Trigger Rescaler Mode.
	Trigger Divider	1 to 1024	Enables Trigger Rescaler Mode.
	Trigger Ratio	0.010000 to 100.000000	Sets the trigger rescaler rate for converting trigger signals.
	TriggerRescaler FilterSize	Sets the rescaler filter factor to decrease the jitter of the external trigger signals.	
		16	Sets the rescaler filter factor to 16.
		32	Sets the rescaler filter factor to 32.
		64	Sets the rescaler filter factor to 64.
		128	Sets the rescaler filter factor to 128.
		256	Sets the rescaler filter factor to 256.
		512	Sets the rescaler filter factor to 512.

Table 3-5 XML Parameters related to Trigger Rescaler Mode

- For both the **Multiplier** and **Divider**, it is necessary to input the trigger signal several times initially for the settings to be applied correctly. Additionally, the **Strobe output** will be delayed until these settings are properly applied.

3.3.3 Maximum Allowable Line Rate

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

- **Maximum Allowed Bit Rate per Coax Cable and CXP Link Configuration Number**
  Setting the maximum allowed bit rate per coaxial cable to a higher value (for example, the maximum bit rate for **CXP5** is 5.000 Gbps, and for **CXP6**, it is 6.250 Gbps) reduces the time required to transfer line images captured by the camera to the user's computer's **CXP Frame Grabber**.

- By setting the camera's **CXP Link Configuration** parameter to use more channels (for example, **CXP6_X2** uses 2 channels, and CXP6_X4 uses 4 channels), data is generally transmitted from the camera to the computer at a faster speed. Therefore, by configuring the camera to use a higher maximum bit rate and more channels, the maximum allowable **line rate** will be faster compared to settings with a lower maximum bit rate and fewer channels.

The maximum allowable line rate of the VTD-16K5X2 camera is as follows:

CXP Link Configuration	The maximum line rate in full resolution
CXP1 x 4	14.95 kHz
CXP2 x 4	29.9 kHz
CXP3 x 4	37.35 kHz
CXP5 x 4	99.8 kHz
CXP6 x 4	74.75 kHz
CXP10 x 4	119.6 kHz
CXP12 x 4	149.5 kHz

Table 3-6 The Maximum Allowable Line Rate of VTD-16K5X2 Camera

How to increase the maximum allowable line rate

To capture line images at a speed faster than the maximum allowable line rate based on the camera's current settings, adjust one or more of the following factors that influence the maximum line rate and check if the speed increases:

The time required to transfer line images from the camera is a critical factor that limits the line rate. You can reduce the line image transfer time by performing one or more of the following actions (which will increase the maximum line rate):

- Use an **8-bit pixel format** instead of a **12-bit pixel format**. Transmitting images with a lower bit depth takes less time than transmitting images with a higher bit depth.
- Use a **smaller ROI (Region of Interest)**. By reducing the ROI length, the camera will transmit less data, resulting in shorter transfer times.
- Set the camera to use a **higher bit rate** and **more channels** whenever possible.

4. Camera Feature

Device Scan

TDI Stage

ROI / binning / pixel

Band Control

Gain and Black Level

Optical Black Clamp

LUT

Non-Uniformity Correction

FPN Coefficient Control

Reverse X

CXP Configuration

Digital I/O Control

Counter Control

Timer Control

Device User ID / Reset

Temperature Monitor

Status LED

Test Patter

User Set Control

Field Upgrade

4.1 Device Scan Type

The **VTD-16K5X2-H150** camera can operate in either Area Scan or Line Scan mode.

- In **Area Scan** mode, the camera operates like an Area Scan camera, using a 2D pixel array to capture images. This mode is useful for aligning the camera with the inspection target.
- In **Line Scan** mode, the camera operates as a high-sensitivity Line Scan camera, capable of capturing images with up to 256 times the enhanced sensitivity compared to a standard Line Scan camera.

The XML parameters related to the Device Scan Type setting are as follows:

XML Parameters		Value	Description
DeviceControl	DeviceScanType	Areascan	Operates the camera in the Areascan mode.
		Linescan	Operates the camera in the Linescan mode.

Table 4-1 XML Parameters related to Device Scan Type

When using **Area Scan** mode, the XML parameters related to the image vertical size are as follows:

XML Parameters		Value	Description
ImageFormatContol	Height	256 to 16384	Configures the height of the Areascan mode

Table 4-2 Parameter regarding the Area Scan Height

4.2 TDI Stages

In the **Linescan** mode, the **TDI Stages** parameter is used to determine the number of integration stages used by the camera. For example, if the TDI Stages parameter is set to 256, the camera will acquire images with 256x higher sensitivity.

The XML parameter regarding the TDI Stage settings is as follows:

XML Parameters		Value	Description
ImageFormatControl	TDI Stages	128	Sets the number of TDI Stage to 128
		256	Sets the number of TDI Stage to 256

Table 4-3 XML Parameters regarding TDI Stages

4.3 Scan Direction

In **Line Scan** mode, the **Scan Direction** parameter is used to select the scan direction of the image sensor. If the object to be captured by the line scan passes the camera's bottom side first and then moves toward the top side, the **Forward** mode should be used. Conversely, if the object passes the camera's top side first and then moves toward the bottom side, the **Reverse** mode should be used.

Additionally, by setting the Scan Direction to **Line0, Line1, or LinkTrigger0**, the scan direction can be controlled through each signal (Low = Forward, High = Reverse).

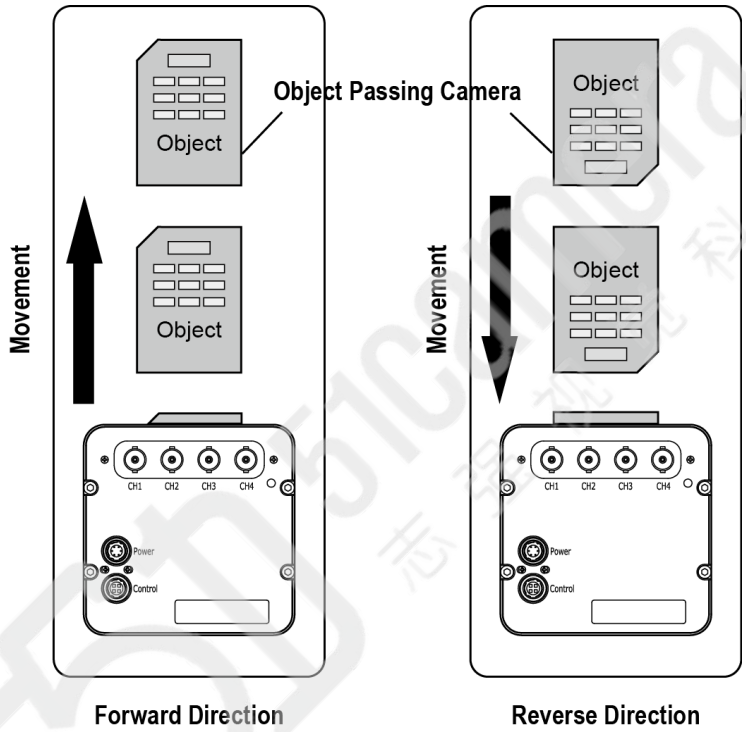


Figure 4-1 Scan Direction

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

XML Parameters		Value	Description
ImageFormatControl	Scan Direction	Forward	Forwards scan direction.
		Reverse	Reverses scan direction.
		Line0	Controls scan direction using external signal from pin 1.
		Line1	Controls scan direction using external signal from pin 2.
		Linktrigger0	Controls scan direction using Linktrigger0 signal.

Table 4-4 XML Parameters related to Scan Direction

- When setting the Scan Direction parameter to Reverse in Area mode, the image orientation is changed portrait.

4.4 Region of Interest

With the ROI (Region of Interest) feature, users can specify a localized area that includes the required data from the sensor lines. During camera operation, only the pixel data from the defined region is read out from the sensor and then transmitted from the camera to the frame grabber.

The ROI is based on the left end of the sensor's column, and the position and size of the ROI are defined by the **Offset X** and **Width** settings. For example, setting Offset X to 32 and Width to 160 would configure the ROI as shown in the following image. In this case, the camera will read out and transmit pixels from 32 to 192.

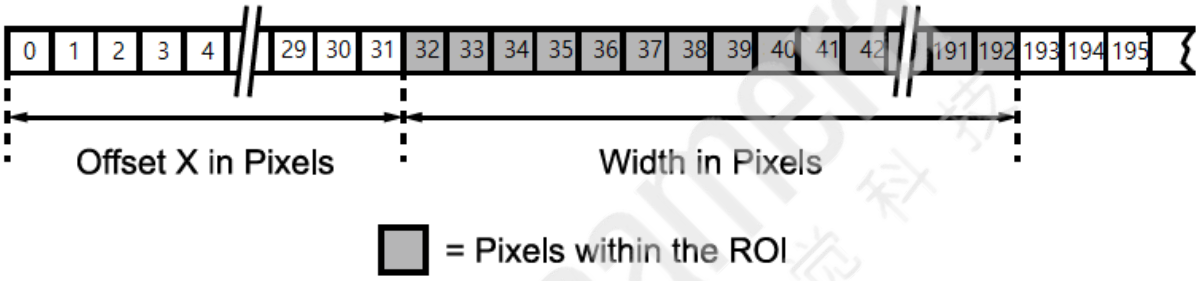


Figure 4-2 Region of Interest

4.4.1 ROI Settings

The ROI is set to use the full resolution of the camera's image sensor. You can change the size and location of the ROI by changing the Offset X and Width parameter values.
In the Linescan mode, the XML parameters related to ROI settings are as follows:

XML Parameters		Value	Description
ImageFormatControl	Width	128 to 16384	Sets the width of the Image ROI.
	OffsetX	0 to 16256	Sets the horizontal offset of the Image ROI from the origin.
	OffsetY	0	Sets the vertical offset of the Image ROI from the origin.

Table 4-5 XML Parameters related to ROI

When setting the camera's ROI, the following points must be considered:

- The sum of the **Offset X** and **Width** settings should not exceed the camera's sensor width. For example, the sum of **Offset X** and **Width** should not exceed **16384**.
- **Offset X** must be set as a multiple of 32, starting from 0, and **Width** must be set as a multiple of 32, with a minimum value of 128.

- Changing the camera's **Image ROI** settings after executing the **Acquisition Start** command may result in abnormal image capture. Please change the **Image ROI** settings after executing the **Acquisition Stop** command.

	• Depending on the frame grabber being used, there may be additional restrictions on the position and size of the ROI. Refer to the user manual of the frame grabber you are using for more details.

4.5 Binning

The binning function accumulates the values of adjacent pixels, increasing sensitivity while reducing image resolution. This feature is useful when acquiring line images of a target with lower resolution without changing the lens or lighting.

The XML parameters regarding the Binning are as follows:

XML Parameters		Value	Description
ImageFormatControl	BinningSelector	Sensor	Selects the binning engine as **Sensor** to apply binning analogically through the sensor.
	BinningHorizontal Mode	Sum	Sums up the values of adjacent pixels according to the Binning Horizontal setting and outputs as a single pixel value.
	BinningHorizontal	x1,x2,x3,x4	Number of pixels to be summed in the horizontal direction.

Table 4-6 XML Parameters related to Binning

Horizontal Binning

With Horizontal Binning parameters set to x2, x3, and x4, the sensitivity increases while the resolution decreases.

4.6 Pixel Format

The camera internally processes data in 12-bit units. The Pixel Format parameter can be used to determine the pixel format of the image data transmitted by the camera.

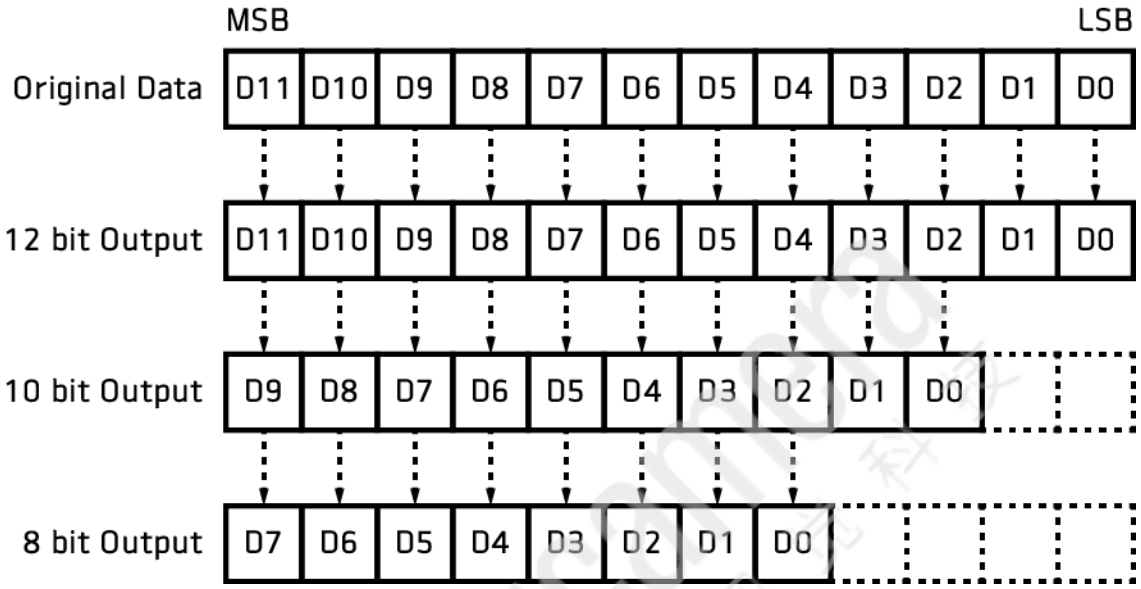


Figure 4-3 Data Format

The XML parameters regarding the Pixel Format are as follows:

XML Parameters		Value	Description
ImageFormatControl	PixelFormat	Mono8	Sets the pixel format to 8 bit.
		Mono10	Sets the pixel format to 10 bit.
		Mono12	Sets the pixel format to 12 bit.

Table 4-7 XML Parameter related to Pixel Format

4.7 Data ROI

To correct an image affected by Fixed Pattern Noise, you can adjust the Data ROI (Region of Interest) parameters to define the working area. For more information refer to <4.14 FPN Coefficient Control>.

The XML parameters regarding the Data ROI are as follows:

XML Parameters		Value	Description
DataRoiControl	DataRoiSelector	FixedPatternNoise	Selects the Data ROI to apply the values of **FPN Correction Generate** (DSNU, PRNU correction) and **FPN Coefficients Control**.
	DataRoiOffsetX	-	X-coordinate of the ROI start point.
	DataRoiOffsetY	-	Y-coordinate of the ROI start point.
	DataRoiWidth	-	ROI width.
	DataRoiHeight	-	ROI height.

Table 4-8 XML Parameters related to Data ROI

When using both Image ROI and Data ROI simultaneously, only the pixel data in the overlapping region of the set Data ROI and Image ROI is valid. The **Height** specifies the number of lines required to generate correction data. The camera will acquire images into the internal buffer for the specified number of lines, and these images will be used for image correction.

The valid area is determined as shown in the diagram below:

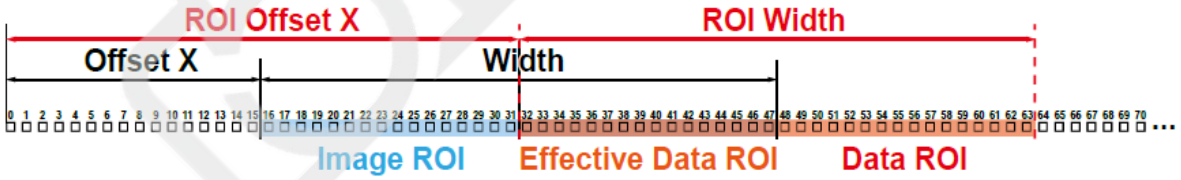


Figure 4-4 Effective Data ROI

4.8 Band Control

The VTD-16K5X2-H150 camera has a sensor area divided into two bands, and through the Band Control function, the gain, offset, and output of each band can be controlled separately to obtain two different images with a single scan.

To use the camera at its maximum speed, the following settings should be used:

- **LinkCount: Count1**, **LinkSharingHorizontalStripeCount: Count0**, **CXPLinkConfiguration: CXP12_4** to transmit Band 0 and Band 1 through a single link.

  OR

- **LinkCount: Count2**, **LinkSharingHorizontalStripeCount: Count2**, **CXPLinkConfiguration: CXP12_2** to transmit Band 0 and Band 1 through Link 0 and Link 1, respectively.

The XML parameters regarding the Band Control are as follows:

XML Parameters		Value	Description
BandControl	BandSelector	Band0/Band1	Selects the desired band.
	BandEnable	-	Selects whether to enable or disable band.
	BandIndexDisplay		On/Off Index display of the corresponding band for the pixel at X=0.

Table 4-9 XML Parameters related to Band Control

4.9 Gain and Black Level

When the **Gain** parameter is increased, the slope of the camera's response curve increases. As a result, the camera can output higher grey values than what is output by the sensor.

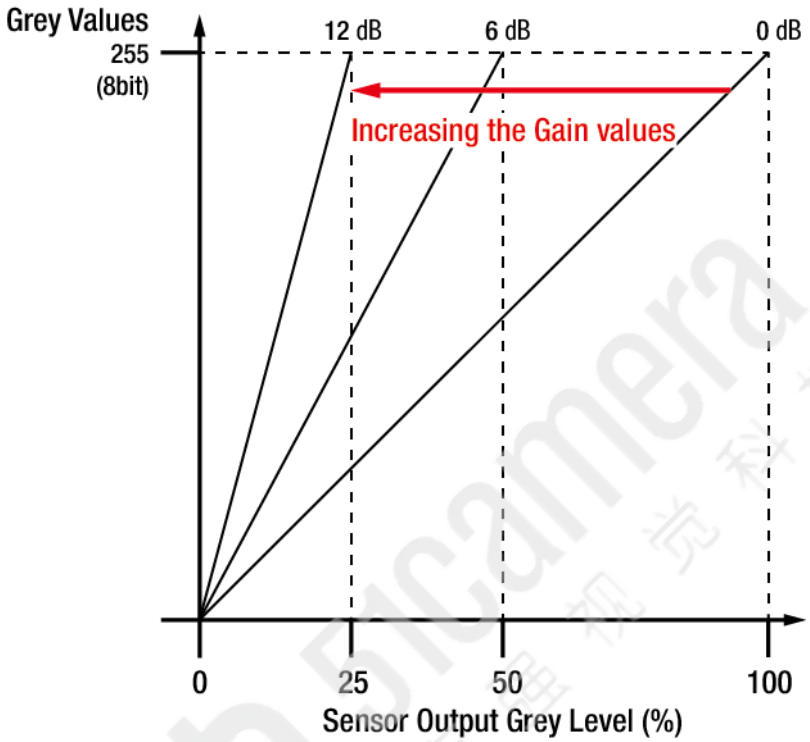


Figure 4-5 Gain Settings

Using the Black Level parameters, you can add an offset to the pixel values output by the camera by the specified amount. The parameters regarding the Gain and Black Level are as shown below:

XML Parameters		Value	Description
AnalogControl	GainSelector	AnalogAll	Applies the Gain values to all Analog channels.
		DigitalAll	Applies the Gain values to all Digital channels.
		Band0	Applies the Gain values to Band0.
		Band1	Applies the Gain values to Band1.
	Gain	1×, 2×, 3×, 4×	Configures the Analog Gain values.
		1.0× to 32.0×	Configures the Digital Gain values.
		1.0× to 4.0×	Configures the Digital Gain values of Band0 and Band1.
	BlackLevelSelector	DigitalAll	Applies the Black Level values to all Digital channels.
	BlackLevel	-255 to 255	Configures the Black Level values (@ 8bits).

Table 4-10 XML Parameters related to Gain and Black Level

4.10 Optical Black Clamp

By using the Optical Black Clamp function, you can calibrate pixel value changes caused by sensor temperature variations. When this function is enabled, the VTD-16K5X2 camera removes the offset caused by temperature changes in real-time, minimizing pixel-level variations due to temperature fluctuations.

The XML parameters regarding the Optical Black Clamp settings are as follows:

XML Parameters		Value	Description
AnalogControl	OpticalBlackClamp	Off	Deactivates the Optical Black Clamp function.
		On	Activates the Optical Black Clamp function.

Table 4-11 XML Parameters related to Optical Black Clamp

4.11 LUT

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

Luminance

Since there is a one-to-one mapping for each level, arbitrary 12-bit inputs can be mapped to arbitrary 12-bit outputs. The LUT is structured as a table with 4096 input values (ranging from 0 to 4095), and the camera provides one non-volatile storage space for storing LUT data. Users can choose whether to apply the LUT. For instructions on how to download LUT data to the camera, refer to <6.2 LUT Download>.

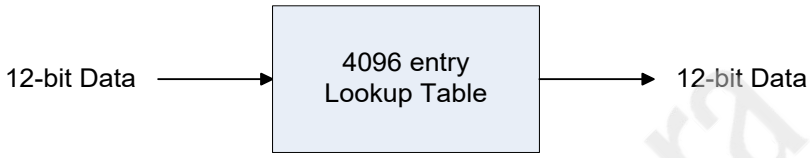


Figure 4-6 LUT Block

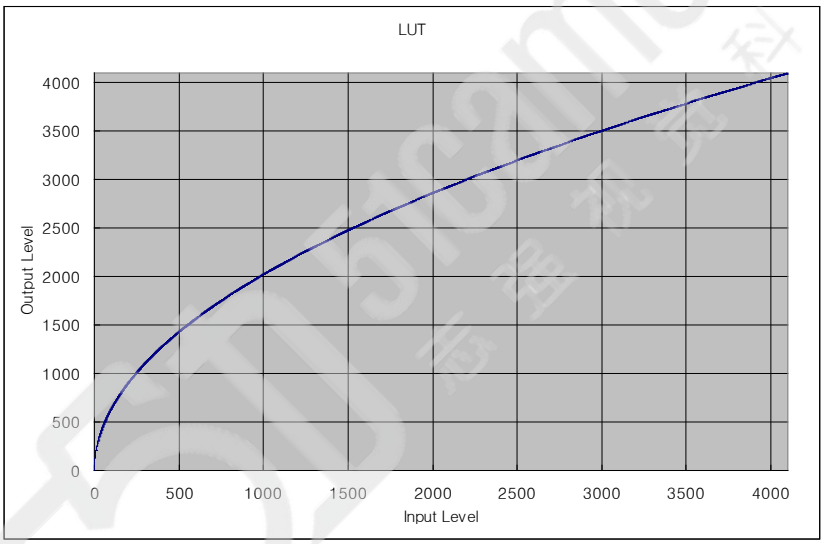


Figure 4-7 LUT when Gamma=0.5

The XML parameters regarding the LUT settings are as follows:

XML Parameters		Value	Description
LUTControl	LUTSelector	Luminance	Luminance LUT
	LUTEnable	On	Activates the selected LUT.
		Off	Deactivates the selected LUT.
	LUTIndex	0 to 4095	The coefficient of Index to check LUTValue.
	LUTValue	0 to 4095	The output value of the current LUT corresponding to the input value of LUTIndex.
	LUTSave	-	Saves the current LUT data to the non-volatile memory.
	LUTLoad	-	Imports the LUT data from the non-volatile memory.

Table 4-12 XML Parameters related to LUT

4.12 Dark Signal Non-Uniformity Correction

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

The XML parameters regarding the DSNU are as follows:

XML Parameters		Value	Description
DSNU	DSNUDataSelector	Default, Space 1 to Space 31	Selects the DSNU data.
	DSNUDataGenerate	-	Creates the DSNU data.
	DSNUDataSave	-	Saves the generated DSNU data to the non-volatile memory. The data created through **DSNUDataGenerate** is stored to the volatile memory. To use the data after rebooting the camera, the data should be saved to the non-volatile memory.
	DSNUDataLoad	-	Imports the DSNU data stored in the non-volatile memory to the volatile memory.
	DSNUDataDefault	Default, Space 1 to Space 31	Selects the DSNUData a user wants to set to default when loading the current Userset settings.

Table 4-13 XML Parameters related to DSNU

4.12.1 Generating and Saving User-defined DSNU Correction Values

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

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

1 When generating DSNU calibration values in the camera, the entire sensor is used. Therefore, it is recommended to set the ROI to utilize the full length of the image sensor.
2 Cover the camera lens or close the lens aperture, and capture line images in a completely dark environment such as a darkroom.
3 Set the camera to Free-Run mode or supply an appropriate external trigger signal to start line image acquisition.
4 Generate the DSNU calibration values.
   ▫ To generate DSNU data, proceed with step 5 after executing the **DSNU Generate** command.

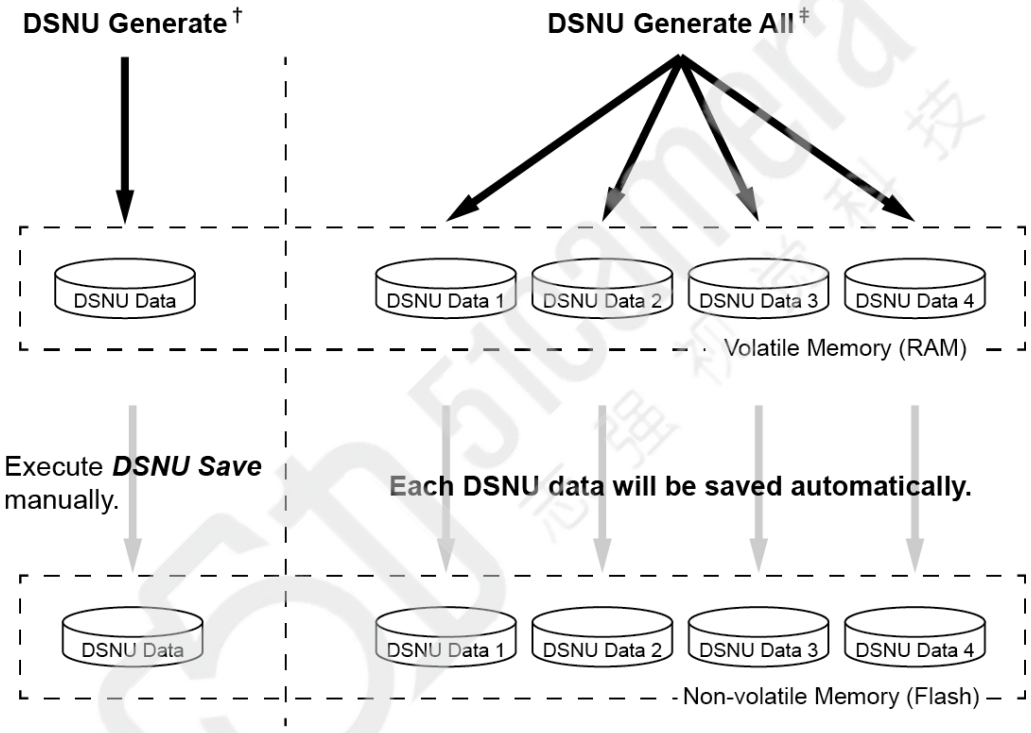
5 When executing the **DSNU Generate** command:

a. DSNU data is generated based on the current Analog Gain settings. In this case, the camera must capture at least 1024 lines of images.

b. Once line image acquisition is complete, the generated DSNU calibration values are activated and stored in the camera's volatile memory.

c. To save the generated DSNU calibration values to the camera's Flash (non-volatile) memory, execute the **DSNU Save** command. This will overwrite the existing DSNU values based on the current Analog Gain settings stored in memory.

6 To change the Analog Gain settings or load the existing values from Flash memory, execute the **DSNU Data Load** command.



†. The camera generates **DSNU data** according to **the current Analog Gain setting**.

‡. The camera generates **four different DSNU data** according to **the Analog Gain setting values**.

Figure 4-8 Creating and Saving the DSNU correction value

- It is recommended to regenerate the DSNU data when changing the camera's Analog Gain, Line rate, or Stage parameters to ensure optimal image quality.

4.13 Photo Response Non-Uniformity Correction

Theoretically, when capturing an evenly illuminated object in a bright environment with a line scan camera, all pixel values in the image should be close to the maximum grey value or identical. However, due to small performance variations between each pixel in the sensor, as well as changes in the lens and lighting, the pixel values output by the camera may differ. This variation is called PRNU (Photo Response Non-uniformity), and the VT CXP camera provides the capability to correct for PRNU, along with 5 PRNU storage spaces.

The XML parameters regarding the PRNU are as follows:

XML Parameters		Value	Description
PRNU	PRNUCorrection	False	Deactivates PRNU Correction.
		True	Activates PRNU Correction.
	PRNU Selector	Default, Space 1 to Space 31	Sets the area to store or load the PRNU data.
	PRNUTargetLevelAUTO	False	Manually sets the PRNU Target Level.
		True	Automatically sets the PRNU Target Level.
	PRNUTargetLevel	0 to 255	Sets PRNU Target Level (@ 8bit Pixel Format)
	PRNU Generate	-	Generates PRNU data
	PRNUSave	-	Saves the generated PRNU data to the non-volatile memory. The data created through **PRNUGenerate** is stored to the volatile memory. To use the data after rebooting the camera, the data should be saved to the non-volatile memory.
	PRNULoad	-	Imports the PRNU data stored in the non-volatile memory to the volatile memory.
	PRNUDataDefault	Default, Space 1 to Space 31	Selects the PRNUData a user wants to set to default when loading the current Userset settings.

Table 4-14 XML Parameters related to PRNU

4.13.1 Generating and Saving User-defined PRNU Correction Value

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

- Newly-generating PRNU correction values are recommended when replacing lens or lightings or changing camera line rate.
- To generate optimized PRNU data, generate the DSNU correction values first, then generate the PRNU correction values.

To generate PRNU correction values:

1 Use the entire sensor for generating PRNU correction values. It's recommended to set the ROI to cover the entire length of the sensor.

2 Place a uniformly white target within the camera's field of view. Adjust the lens, lighting, and line rate to match the actual usage environment. Ensure that the digital output level of the image is between 100-200 (Gain: 1.00 at 8 bit).

3 Set the camera to Free-Run mode or provide an appropriate external trigger signal to start line image acquisition.

4 Specify the Target Level:

- To automatically set the Target Level, select the Target Level AUTO checkbox.
- To manually set the Target Level, uncheck the Target Level AUTO checkbox and enter a value between 0 and 255.

5 Execute the PRNU Generate command to generate the PRNU correction values.

6 To generate PRNU correction values, at least 1024 lines of images must be acquired.

7 Once line image acquisition is complete, the generated PRNU correction values are activated and stored in the camera's volatile memory.

To save PRNU correction values:

- To save the generated PRNU correction values in the camera's Flash (non-volatile) memory, use the PRNU Selector parameter to choose the storage location, then execute the PRNU Save command. This will overwrite any existing values in memory.
- To ignore the generated PRNU correction values and load the existing ones from Flash memory, select the location using the PRNU Selector parameter and execute the PRNU Load command.

4.14 FPN Coefficient Control

With FPN Coefficient Control, the camera provides an FPN correction feature that allows you to post-process the affected image when fixed patter noise (FPN) occurs. In addition to the DSNU correction values, the VTD-16K5X2 camera offers the ability to specify a Black Level value to be added to the image or a Gain value to be multiplied with the PRNU correction values, allowing you to correct images with FPN.

The XML parameters regarding the FPN correction features are as follows:

XML Parameters		Value	Description
FPN Coefficients Control	DSNUCoefficient	-	Sets the Black Level value to be added to the current DSNU correction values.
	DSNUCoefficientApply	-	Applies the values determined from the above item to the DSNU correction values.
	PRNUCoefficient	-	Sets Gain value to be multiplied to the current PRNU correction values.
	PRNUCoefficientApply	-	Applies the values determined from the above item to the PRNU correction values.

Table 4-15 XML Parameters related to FPN Coefficients Control

4.15 Reverse X

The feature flips the image horizontally based on the central axis of the image. It is applicable in all camera operating modes.

Figure 4-9 Original Image

Figure 4-10 Image with Reverse X applied

The XML parameters regarding the Reverse X are as follows:

XML Parameters		Value	Description
ImageFormatControl	Reverse X	False	Deactivates Reverse X.
	DSNUCoefficientApply	True	Flips the image horizontally.

Table 4-16 XML Parameters related to Reverse X

4.16 CXP Link Configuration

The VTD-16K5X2 camera uses the CoaXPress interface to connect to the CXP Frame Grabber installed on the user's computer. The CoaXPress interface simply connects the camera and the CXP Frame Grabber using coaxial cables, transmitting data at up to 12.5 Gbps per cable. A 4-channel VTD-16K5X2 camera can configure links with up to three expansion connections to a single master connection. In accordance with the CoaXPress standard, it supports an automatic link detection (Plug and Play) mechanism, ensuring accurate detection of the connection between the camera and the CXP Frame Grabber.

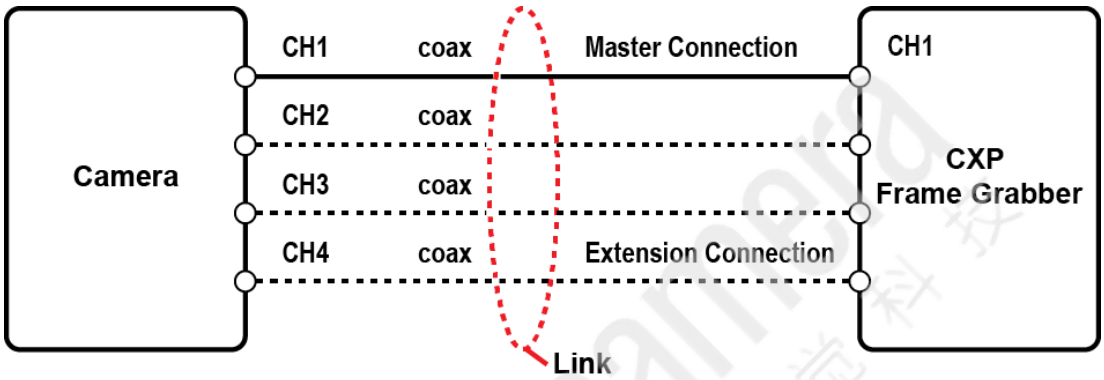


Figure 4-11 CXP Link Configuration

The XML parameters related to the link configuration between the camera and the CXP Frame Grabber are located under the *Transport Layer Control* category within the *CoaXPress* section, as follows:

XML Parameters		Value	Description
CoaXPress	CxpLinkConfiguration Preferred	Read Only	Displays the bit rate and the number of connections used for link configuration between the camera and the Host (Frame Grabber) during camera detection.
	CXPLinkConfiguration	CXP1_X1, X2, X4 CXP3_X1, X2, X4 CXP5_X1, X2, X4 CXP6_X1, X2, X4 CXP10_X1, X2, X4 CXP12_X1, X2, X4	Forces the bit rate and the number of connections between the camera and the Host. e.g. **CXP12_X4**: Configures 4 connections using CXP12 speed (12.5 Gbps per connection).

Table 4-17 XML Parameter related to CXP Link Configuration

4.17 CXP Multi-Link Configuration

Through the CXP Multi-Link configuration of the VTD-16K5X2-H150 camera, a single camera can establish two links to transmit sensor images separately. In this case, CH1 and CH2 operate as **Master-Sub Device**, while CH3 and CH4 function as **Slave-Sub Device**.

- **Master-Sub Device** is responsible for transmitting image data, configuring the camera, and receiving trigger signals
- **Slave-Sub Device** is used solely for image data transmission.

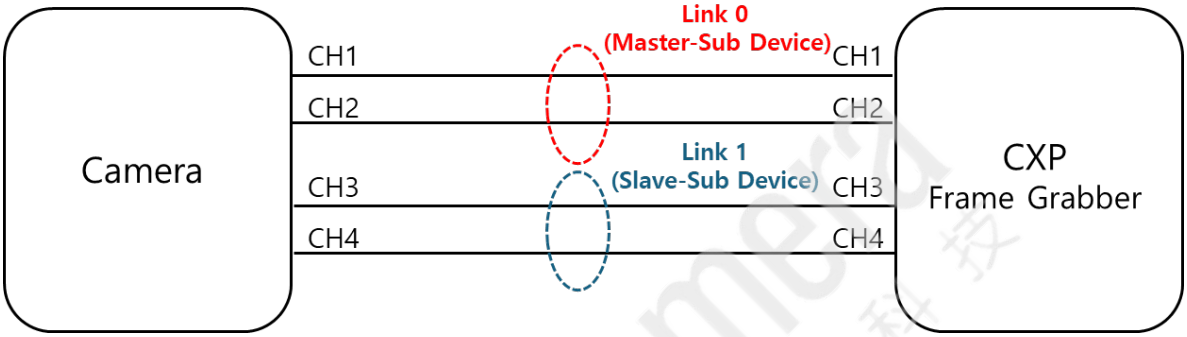


Figure 4-12 CXP Multi-Link Configuration

The XML parameters related to the multi-link configuration between the camera and the CXP Frame Grabber are located under the *Transport Layer Control* category within the *CoaXPress* section, as follows:

XML Parameters		Value	Description
LinkSharingControl	LinkCount	Count1	Forms a link between the camera and CXP Frame Grabber.
		Count2	Forms 2 links between the camera and CXP Frame Grabber.
	LinkSharingEnable	Read Only	Indicates single/dual link(s) to False or True
	LinkSharingHorizontalStripeCount	Count0	Deactivates horizontal striping.
		Count2	Activates horizontal striping.

Table 4-18 XML Parameter related to CXP Multi-Link Configuration

4.18 Digital I/O Control

The camera's control input/output terminals can be used in various modes. The XML parameters related to **Digital I/O Control** are as follows:

XML Parameters		Value	Description
DigitalIOControl	LineSelector	Line0	Sets the pin of No.1 among 6 pins of the Power Input and Control I/O receptacle to configure input signals for features related to counters, timers, or the others.
		Line1	Sets the pin of No.2 among 6 pins of the Power Input and Control I/O receptacle to configure input signals for Line1 in the Scan Direction parameters.
		Line2	Sets the pin of No.5 among 6 pins of the Power Input and Control I/O receptacle to configure about output signals.
		Line3	Sets the pin of No.6 among 6 pins of the Power Input and Control I/O receptacle to configure about output signals.
	LineMode	Input	Appears under either Line0 or Line1 is chosen.
		Output	Appears under Line1 is chosen.
	LineInverter	FALSE	Disables inversion on the output signal of the line.
		TRUE	Enables inversion on the output signal of the line.
	LineSource	Off	Disables the line output.
		LinkTrigger	Outputs pulse signals set by LinkTrigger.
		UserOutput0	Outputs a pulse by UserOutputValue value.
		Timer0Active	Outputs User-Configured Timer Signal as a Pulse
		Count0Active	Outputs User-Configured Counter Signal as a Pulse
		Strobe 0	Outputs Strobe 0 signal as a pulse. Strobe 0 Signal: Synchronized with Band 0.

		Strobe 1	Outputs Strobe 1 signal as a pulse. Strobe 1 Signal: Synchronized with Band 1.
	UserOutput Selector	UserOutput0	Outputs pulse signals set by User Output Value.
	UserOutput Value	FALSE	Sets the bit state of the line to Low.
	StrobeSelector	Strobe0	Sets to Strobe 0.
		Strobe 1	Sets to Strobe 1.
	StrobeMode	Timed	Outputs a pulse signal by Strobe Duration values.
		TriggerWidth	Outputs pulse signals of which the pulse width is equal to the trigger signals applied to the camera.
	StrobeDelay	0 to 1000 μs	Sets a delay to the current output signal in microseconds.
	StrobeDuration	1 to 1000 μs	Sets a duration of pulse signal in microseconds when the Strobe Mode is set to Timed.

Table 4-19 XML Parameters related to Digital I/O Control

4.19 Counter Control

The VTD-16K5X2 camera's Counter function allows you to count the number of specific events in the camera. For example, you can check the number of trigger signals supplied externally to the camera.

The XML parameters regarding the Counter Control are as follows:

XML Parameters		Value	Description
CounterControl	CounterSelctror	Counter0	Selects the Counter.
	CounterEventSource	Off	Stops the Counter.
		FrameActive	Counts the number of FrameActive signals.
		LineActive	Counts the number of LineActive signals.
		LinkTrigger	Counts the number of LineTrigger signals.
		LinkTrigger0	Counts the number of LineTrigger0 signals.
		Line0	Counts the number of external trigger signals.
	CounterEventActivation	RisingEdge	Counts the rising edges of the selected Event Source signal.
		FallingEdge	Counts the falling edges of the selected Event Source signal.
	CounterResetSource	Off	Deactivates Counter Reset trigger.
		FrameActive	Uses Frame Active signal as Reset Source.
		LinkTrigger	Uses Link Trigger signal as Reset Source.
		Acquisition Active	Uses Acquisition Active signal as Reset Source.
		Line0	Uses Line0 signal as Reset Source.
	CounterReset Activation	RisingEdge	Resets the counter on the rising edge of the selected Reset Source signal.
		FallingEdge	Resets the counter on the falling edge of the selected Reset Source signal.
		AnyEdge	Resets the counter on the falling or rising edge of the selected Reset Source signal.
		LevelHigh	Resets the counter if the signal level of the selected Reset Source is high.
		LevelLow	Resets the counter if the signal level of the selected Reset Source is low.

Table 4-20 XML Parameter related to Counter Control (1)

XML Parameters		Value	Description
CounterControl	CounterReset	-	Resets the selected Counter.
	CounterValue	-	Displays the current value of the selected Counter.
	CounterValue AtReset	-	Displays the Counter value when Counter Reset command is executed.
	CounterDuration	1 to 4294967295	Sets the number of cell events until the counter ends.
	CounterStatus	-	Displays the current status of Counter
	CounterTrigger Source	Off	Deactivates Counter Trigger Source.
		FrameActive	Uses the Frame Active signal as the Counter Trigger Source.
		Link Trigger	Uses the Link Trigger signal as the Counter Trigger Source.
		AcquisitionActive	Uses the Acquisition Active signal as the Counter Trigger Source.
		Line0	Uses the Line0 signal as the Counter Trigger Source.
	CounterTrigger Activation	FrameActive	Uses the Frame Active signal as the Counter Reset Source.
		LinkTrigger	Uses the Link Trigger signal as the Counter Reset Source.
		Acquisition Active	Uses the Acquisition Active signal as the Counter Reset Source.
		Line0	Uses the Line0 signal as the Counter Reset Source.

Table 4-21 XML Parameter related to Counter Control (2)

4.20 Timer Control

If you set the Line Selector to Line1 and the Line Source to Timer (Timer0Active), the camera can output a signal using the Timer. The VTD-16K5X2 camera can use LineTrigger, FrameActive, or an external trigger input signal as the source signal for the Timer.

The XML parameters regarding Timer Control are as follows:

XML Parameters		Value	Description
CounterAndTimerControl	TimerSelector	Timer0	Selects the Timer.
	TimerDuration	1 to 60,000,000 μs	Determines the duration of timer output signal if the Timer Trigger Activation is set to Rising/Falling Edge.
	TimerDelay	0 to 60,000,000 μs	Determines delay time to be applied before executing the timer output signal.
	TimerReset	-	Resets the Timer.
	TimerTriggerSource	Off	Deactivates the Timer output signal.
		LineTrigger	Uses the readout section of a line as the source signal for the Timer output signal.
		FrameActive	Uses the readout section of a frame as the source signal for the Timer output signal.
		Line0	Uses the readout section of an external trigger signal as the source signal for the Timer output signal.
	TimerTriggerActivation	RisingEdge	Configures the rising edge of the selected trigger signal to act as the trigger for the Timer output signal.
		FallingEdge	Configures the falling edge of the selected trigger signal to act as the trigger for the Timer output signal.
		AnyEdge	Configures the falling or rising edge of the selected trigger signal to act as the trigger for the Timer output signal.
		LevelHigh	Sets the Timer output signal to be valid when the selected trigger signal is in the High state.
		LevelLow	Set the Timer output signal to be valid when the selected trigger signal is in the Low state.

Table 4-22 XML Parameters related to Timer Control

4.21 Device User ID

You can enter up to 16 bytes of user-defined information into the camera. The following is the XML parameter related to the Device User ID.

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

Table 4-23 XML Parameter related to Device User ID

4.22 Device Reset

You can reset the camera by turning the power off and on. Performing a reset will disconnect the camera from the CXP Frame Grabber, requiring reconnection. The following is the XML parameter related to Device Reset:

XML Parameter		Description
DeviceControl	DeviceReset	Resets the device.

Table 4-24 XML Parameter related to Device Reset

4.23 Temperature Monitor

The sensor chip is installed in the camera to monitor internal temperature of the camera in real time. The following is the XML parameter related to the camera's internal temperature:

XML Parameter		Description
DeviceControl	DeviceTemperature	Displays temperature in Celsius.

Table 4-25 XML Parameter related to Device Temperature

4.24 Status LED

On the rear of the camera, there is a red/green LED that indicates the camera's operating status. The LED states and their corresponding camera statuses are as follows:

Status LED	Description
Steady Red	The camera is not initialized.
Slow Flashing Red	The camera is not connected to CXP Link.
Fast Flashing Orange	Searching for connection to CXP Link.
Steady Green	The camera is connected to CXP Link.
Fast Flashing Green	The image is being acquired.

Table 4-26 Status LED

4.25 Test Pattern

You can configure the camera to output an internally generated test pattern instead of image data from the image sensor to verify the camera's proper operation. There are four types of test patterns:

1 **Grey Horizontal Ramp** – An image with varying values in the horizontal direction.
2 **Grey Diagonal Ramp** – An image with varying values in the diagonal direction.
3 **Grey Diagonal Ramp Moving** – A moving version of the Grey Diagonal Ramp pattern.
4 **Sensor Specific** – An image used to verify sensor output.

The related XML parameters for the Test Pattern are as follows:

XML Parameters		Value	Description
ImageFormatControl	TestPattern	Off	Deactivates Test Pattern.
		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 provided by the sensor.

Table 4-27 XML Parameter related to Test Pattern

Figure 4-13 Grey Horizontal Ramp

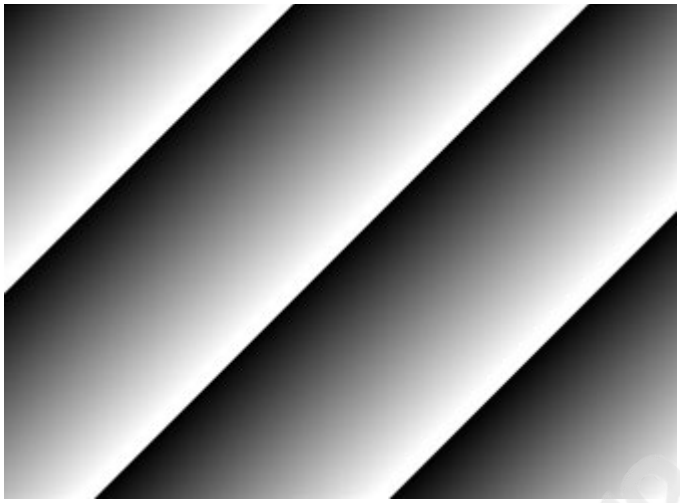


Figure 4-14 Grey Diagonal Ramp

Figure 4-15 Grey Diagonal Ramp Moving

Figure 4-16 Sensor Specific

CAUTION

- Depending on the camera resolution, the appearance of the Test Pattern may vary as the output area of the pattern changes accordingly.

4.26 User Set Control

User can save or load camera settings from the camera's internal ROM. The camera supports two storage areas for saving and three areas for loading. The related XML parameters for User Set Control are as follows:

XML Parameters		Value	Description
UserSetControl	UserSetSelector	Default	Selects the camera settings to Factory Default Settings.
		UserSet1	Selects the camera settings to UserSet1.
		UserSet2	Selects the camera settings to UserSet2.
	UserSetLoad	-	Loads the user settings selected in the User Set Selector into the camera.
	UserSetSave	-	Saves the current camera settings to the area selected in the User Set Selector.
	UserSetDefault	Default	Activates Factory Default Settings when the camera is reset.
		UserSet1	Activates UserSet1 when the camera is reset.
		UserSet2	Activates UserSet2 when the camera is reset.

Table 4-28 XML Parameters related to User Set Control

4.26.1 Factory Default Settings

When the VT CXP camera is powered on for the first time, it is set to the Factory Default settings. The Factory Default settings are as follows:

XML Parameters	Description
Operation Mode	Linescan
Scan Direction	Forward
TDI Stages	Maximum Integration Stages
Trigger Mode	Off
Test Pattern	Off
Binning	×1
Pixel Format	Mono 8
PRNU Mode	On
DSNU Mode	On
CXP Link Count	1
CXP Link Configuration Preferred	CXP12 × 4
Analog Gain	×1
Digital Gain	×1
Line Rate	180㎑

Table 4-29 Factory Default Settings

4.27 Field Upgrade

The camera provides the ability to upgrade the firmware and FPGA logic through the CoaXPress interface without the need to disassemble the camera in the field. For more details, please refer to <6.1 Field Upgrade>.

5. Troubleshooting

5.1 Troubleshooting

Check the below cases if the device malfunctions:

When nothing is shown on the screen

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

When the image is blurry

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

When the image appears dark

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

When the camera is behaving abnormally and overheating

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

When the trigger mode is not working properly

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

When communication quality is poor

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

6. Appendix

Field Upgrade

LUT Download

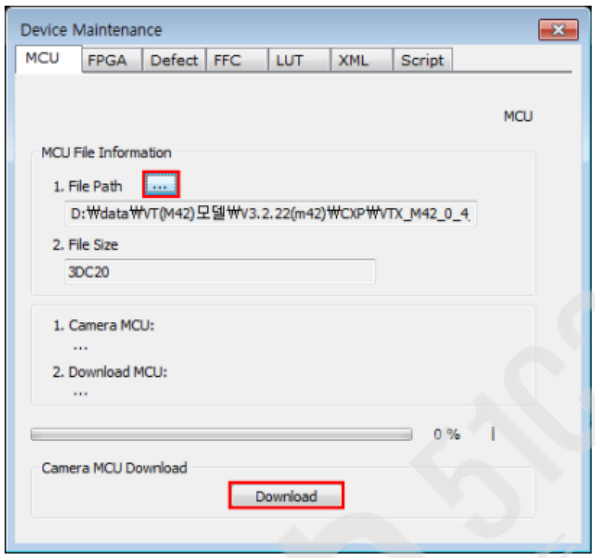
6.1 Field Upgrade

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

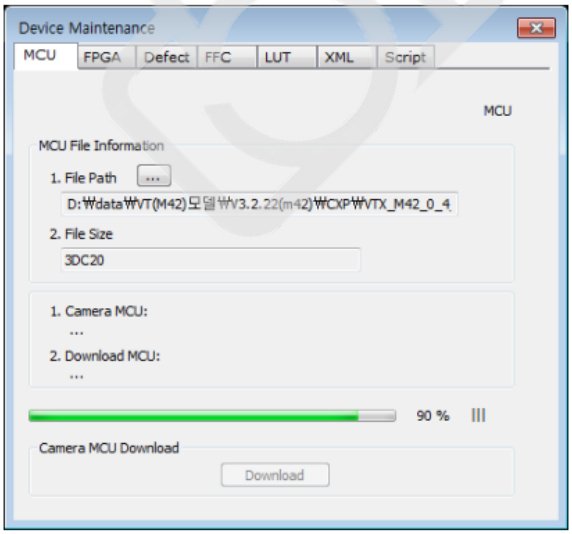
6.1.1 MCU

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

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



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

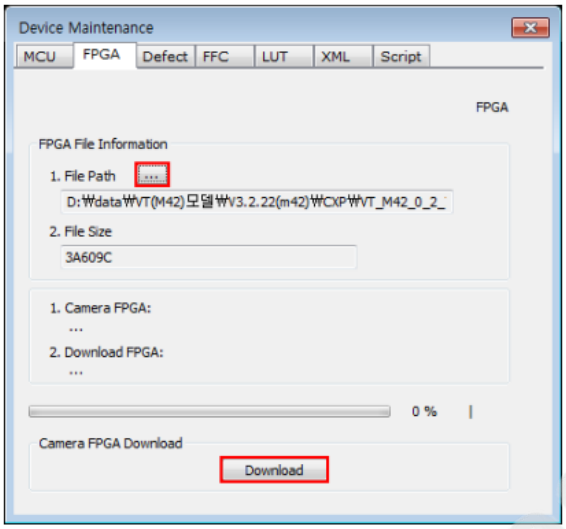


4 Once all processes are complete, turn off and on the camera. Check the version by reading the DeviceVersion parameter in the Device Control category.

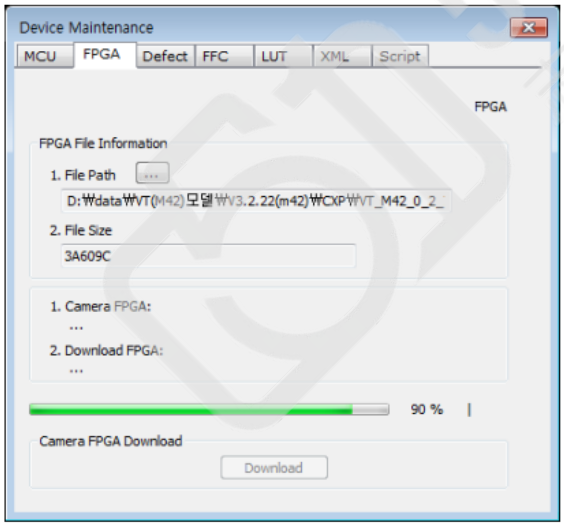
6.1.2 FPGA

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

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



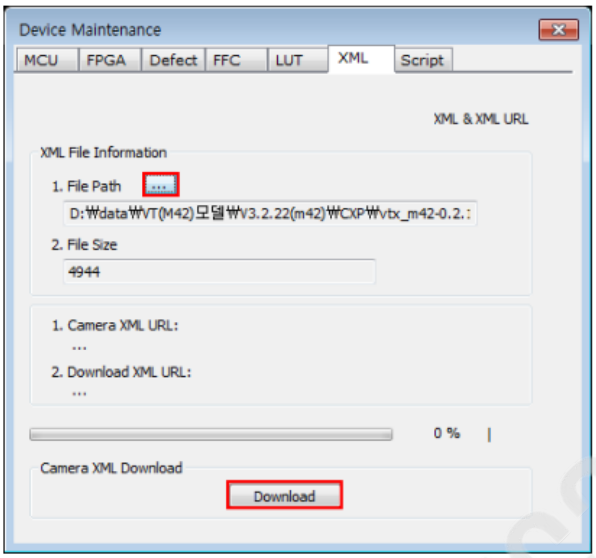
3 The process from now on is the same as the MCU upgrade process.



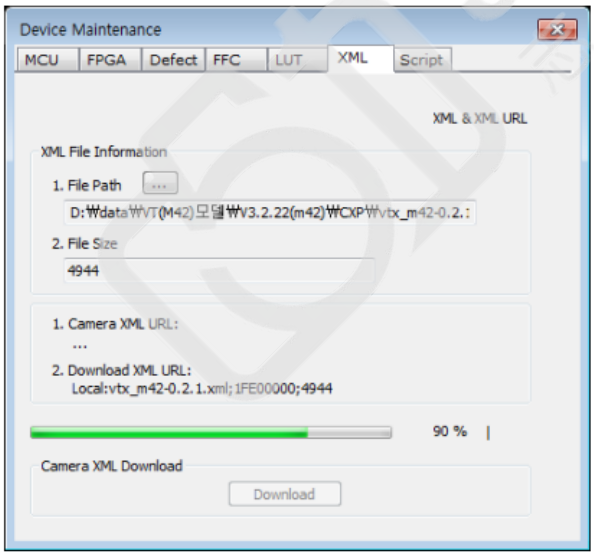
6.1.3 XML

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

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



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

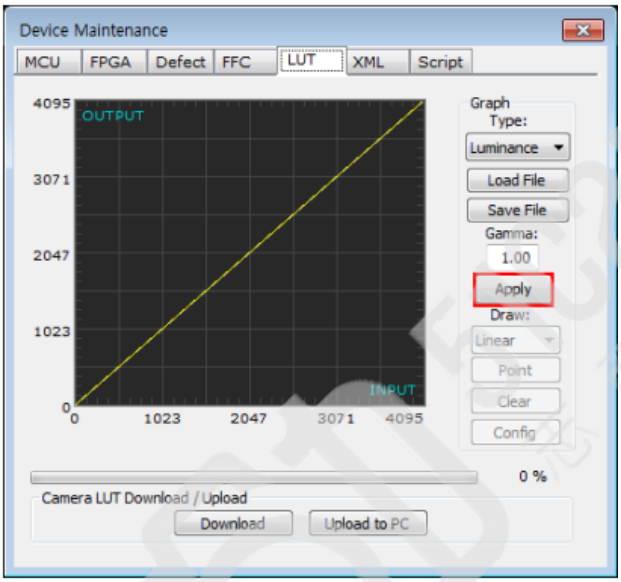


6.2 LUT Download

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

6.2.1 Gamma Curve Download

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

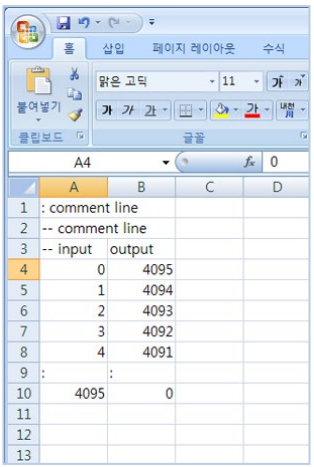


4 Once download is complete, click the OK button before closing the window.

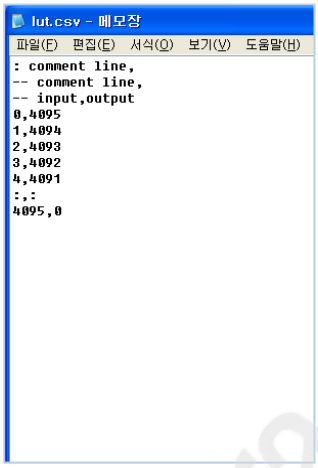
6.2.2 CSV File Download

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

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

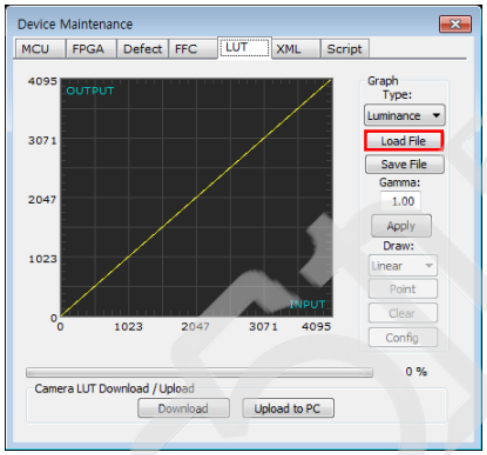


	A	B	C	D
1	: comment line			
2	-- comment line			
3	-- input	output		
4	0	4095		
5	1	4094		
6	2	4093		
7	3	4092		
8	4	4091		
9	:	:		
10	4095	0		
11				
12				
13				

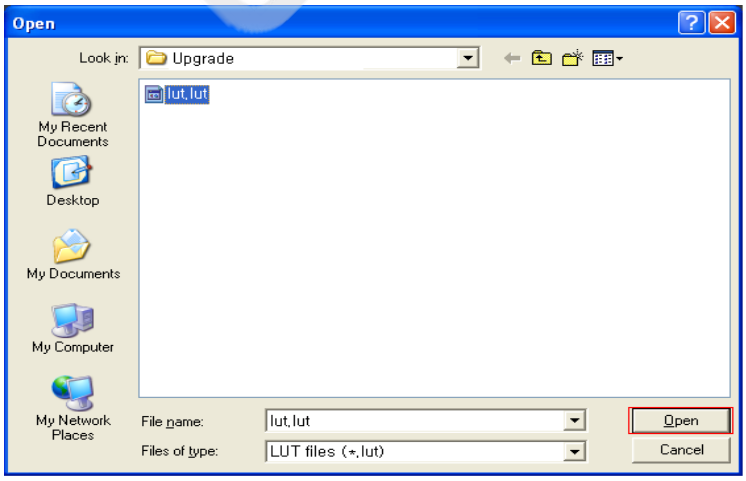


2 Open Vieworks Imaging Solution 7.X and click the **Configuration** button.

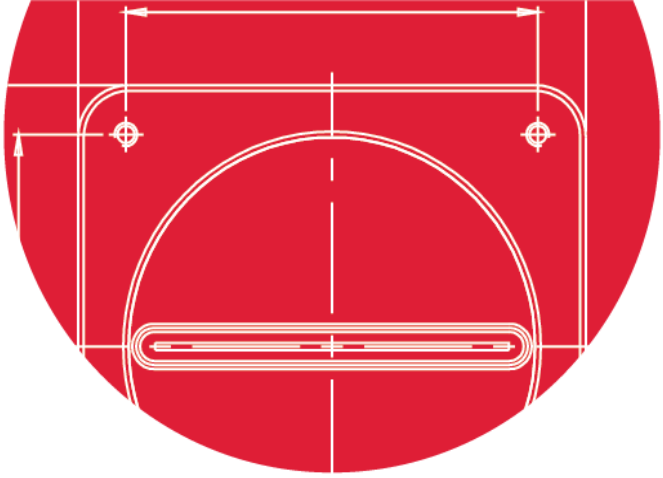
3 In the **LUT** tab of the Device maintenance window, select **Luminance** from the **Type** dropdown list and click the **Load File** button.

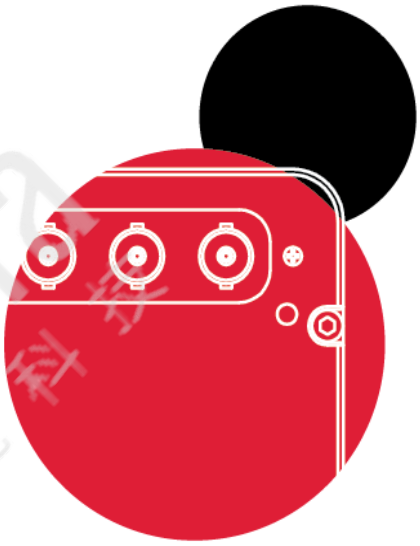


4 Select the LUT file you have made and click the Open button.



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





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