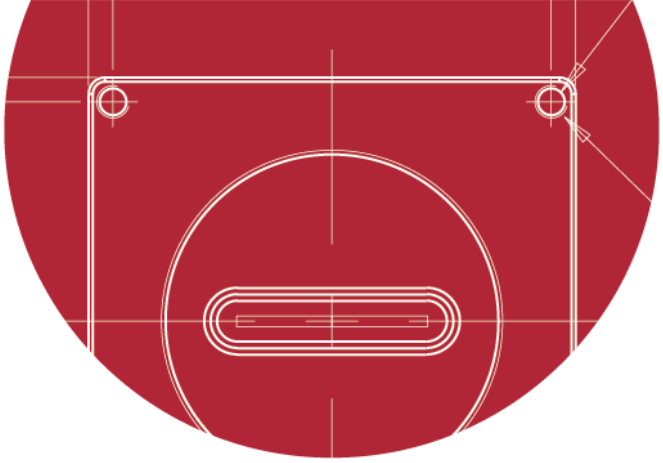


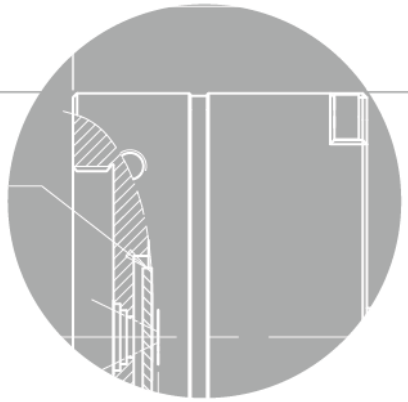
VTC 2k Color

User Manual

English

VTC-2K10.5X-C140

CoaXPress®



VIEWORKS

Imaging Expert

Revision History

Version	Date	Description
1.0	2018-09-05	Initial Release

Contents

1 Precautions

General

CAUTION	• 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 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 Specifications. Otherwise the device may be damaged by extreme temperatures.

Installation and Maintenance

CAUTION	• 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

CAUTION	• 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 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.

CAUTION	**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.

Procedures for Cleaning the Sensor

If you have dust or foreign matter on the sensor surface, follow the procedures 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.

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

2 Warranty

Do not open the housing of the camera. The warranty becomes void if the housing is opened.
For information about the warranty, please contact your local dealer or factory representative.

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 expenses.

3.2 CE: DoC

EMC Directive 2014/30/EU
EN 55032:2012 (Class A), EN 55024:2010
Class A

3.3 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.

4 Package Components

Package Components

VTC-2K10.5X-C140 Camera with M42 mount

5 Product Specifications

5.1 Overview

The VTC-2K10.5X camera, a hybrid Time Delayed Integration (TDI) color line scan camera, provides faster line rates and higher sensitivity than existing line scan cameras. With hybrid TDI line scan technology combining the strengths of both CCD and CMOS image sensors, the M42 mount based VTC-2K10.5X camera can acquire True Color images at faster line rates of up to 140 ㎑ with up to 80× higher sensitivity.
Featured with high speed and high sensitivity, the VTC-2K10.5X camera is ideal for demanding applications such as flat panel display inspection, wafer inspection, printed circuit board inspection, and high performance document scanning.

Main Features

- Hybrid TDI Color Line Scan
- True Color Imaging
- 2160 × 80 Pixel Resolution
- Bidirectional Operations with up to 80 TDI Stages
- Exposure Control
- Anti-blooming
- Trigger Rescaler and Strobe Output Control
- CoaXPress Interface up to 140 ㎑
- 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

5.2 Specifications

Technical specifications for the VTC-2K10.5X camera are as follows.

Specification		VTC-2K10.5X-C140
Active Image(H × V)		2160 × 80
Sensor Type		Hybrid TDI Color Line Scan
Pixel Size		10.5 ㎛ × 10.5 ㎛
Interface		CoaXPress (CXP-6)
Pixel Data Format		8 /10 / 12 bit
TDI Stage		20 / 40 / 60 / 80
TDI Direction		External Port or Programmable
Trigger Synchronization		Free-Run, External Trigger Signal, CoaXPress Programmable Line Rate
Max. Line Rate		140 ㎑
Min. Line Rate		1 ㎑
Throughput		0.30 Gpix/s (CXP 2 CH)
Gamma Correction		User Defined LUT (Look Up Table)
Black Level		Adjustable (-255 ~ 255 at 8 bits)
Gain Control		Analog Gain: 1×, 2×, 3×, 4× / Digital Gain: 1.0× ~ 8.0×
External Trigger		External, 3.3 V – 5.0 V
Power	External	10 ~ 30 V DC
	Dissipation	Typ. 5.5 W
	PoCXP	24 V DC, Minimum of one PoCXP cable required
Environmental		Operating: 0℃ ~ 50℃, Storage: -40℃ ~ 70℃
Mechanical / Weight		60 ㎜ × 60 ㎜ × 36 ㎜, 223 g
API SDK		Vieworks Imaging Solution 7.X
Optical Interface		
Lens Mount		M42
Sensor to Camera Front		10.10 ㎜ (Optical Distance)
Sensor Alignment		
Flatness		±25 ㎛
x		±0.15 ㎜
y		±0.15 ㎜
z		±0.1 ㎜

Table 5.1 Specifications of the VTC-2K10.5X camera

5.3 Camera Block Diagram

The VTC-2K10.5X camera consists of three printed circuit boards (PCB), and its block diagram is shown below.

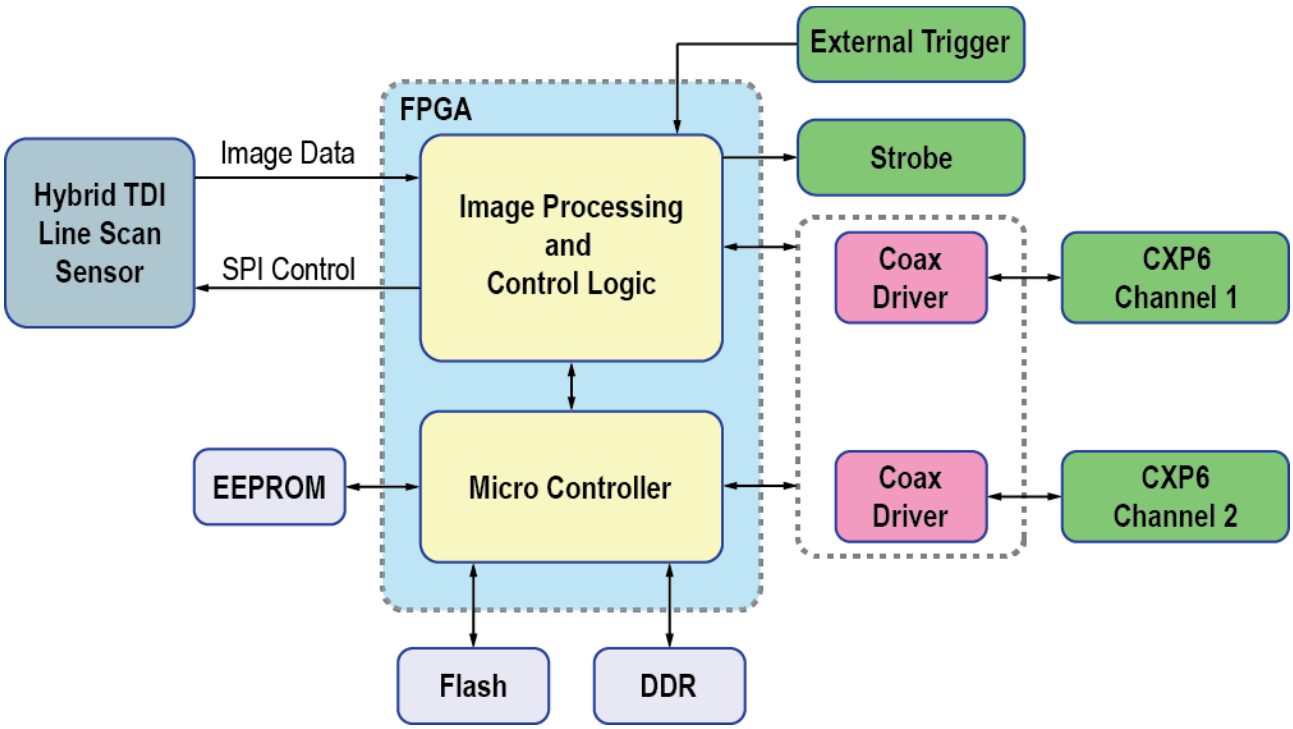


Figure 5.1 VTC-2K10.5X-C140 Camera Block Diagram

5.4 Spectral Response

The following graphs show the spectral response for the VTC-2K10.5X camera.

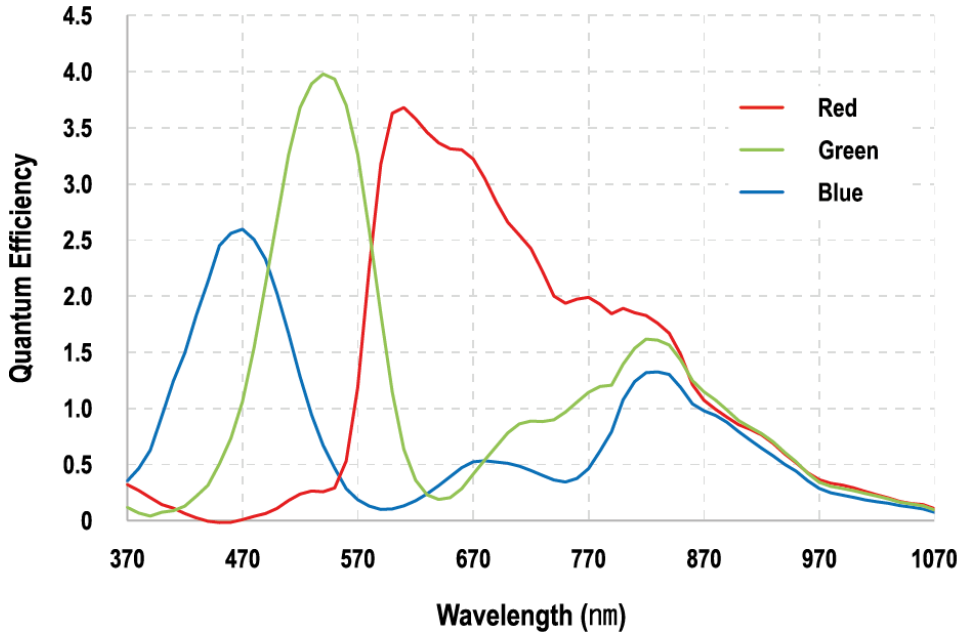


Figure 5.2 Spectral Response

5.5 Mechanical Specification

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

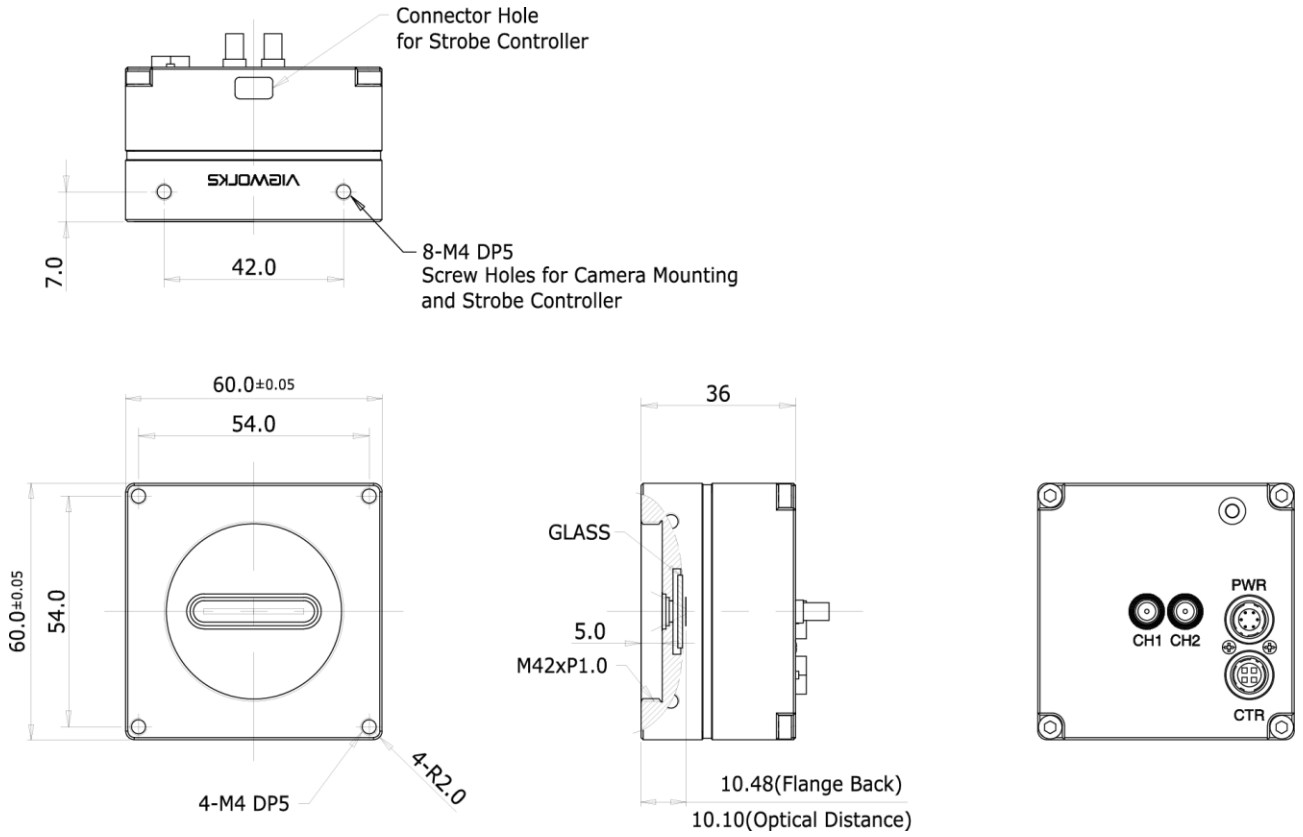


Figure 5.3 VTC-2K10.5X Mechanical Dimension

5.5.1 Camera Mounting and Heat Dissipation

You must mount the camera on a heat dissipation structure to maintain the temperature of the camera housing at 50℃ or less. Given the low power consumption of the VTC camera, its housing temperature during operation will generally stay within the specified limits. However, overheating can occur if heat dissipation is restricted or if the camera is mounted on a severe environment. We strongly recommend that you follow the general guidelines below when you mount the camera.

- In all cases, you should monitor the temperature of the camera housing and make sure that the temperature does not exceed 40℃. You can monitor the internal temperature of the camera by using the **Device Temperature** parameter.
- If your camera is mounted on a metal component in your system, this may provide sufficient heat dissipation.

6 Connecting the Camera

The following instructions assume that you have installed a CoaXPress Frame Grabber (hereinafter 'CXP Frame Gabber') in your computer including related software. Procedures below also assume that you may attempt to configure a link between a camera and CXP Frame Grabber by using two 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.

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 CoaXPress (PoCXP) Frame Grabber.

2. **If you are using a power supply:**
   a. 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, plug the other coax cable into the CH2 of the camera and CXP Frame Grabber.
   b. Connect the plug of the power adapter into the 6-pin power input receptacle on the camera.
   c. Plug the power adapter into a working electrical outlet.

3. **If you are using PoCXP Frame Grabber:**
   a. 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, plug the other coax cable into the CH2 of the camera and CXP Frame Grabber.
   b. You must connect the CH1 channel to power the camera via PoCXP.

4. Verify all the cable connections are secure.

CAUTION	To power the camera via PoCXP Frame Grabber, you must connect the CH1 channel of the camera to its respective connector on the CXP Frame Grabber.

6.1 Precaution to Center the Image Sensor

- Users do 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.

6.2 Installing Vieworks Imaging Solution

You should perform the software installation first and then the hardware installation.

You can download the Vieworks Imaging Solution at http://www.vieworks.com.

7 Camera Interface

7.1 General Description

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

- ① Status LED: displays power status and operation mode.
- ② CoaXPress connector: transmits video data and controls the camera.
- ③ 6 pin power input receptacle: supplies power to the camera (if PoCXP is not used).
- ④ 4 pin control receptacle: provides access to the camera's I/O lines.

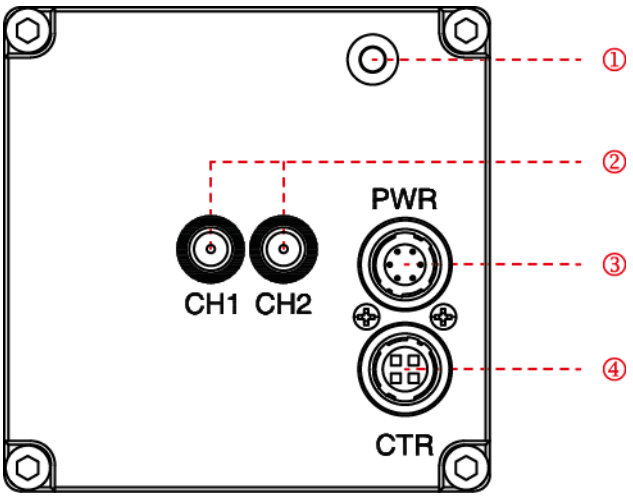


Figure 7.1 VTC-2K10.5X Back Panel

7.2 CoaXPress Connector

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

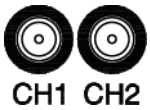


Figure 7.2 CoaXPress DIN Connector (75Ω 1.0/2.3 DIN Receptacle)

The CoaXPress connector on the VTC-2K10.5K camera complies with the CoaXPress standard and the following table shows the channel assignments.

Channel	Max. Bit Rate per Coax	Type	PoCXP Compliant
CH1	6.25 Gbps	Master Connection	Yes
CH2	6.25 Gbps	Extension Connection	Yes

Table 7.1 Channel Assignments for CoaXPress Connectors

CAUTION	When you connect a camera to a CXP Frame Grabber using coax cables, make sure to connect the cables to their correct channels. If you connect the CH1 of the CXP connector on the camera to a channel other than CH1 of the CXP Frame Grabber, the camera may not transmit images properly or the communication between the computer and camera may fail.

7.3 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:

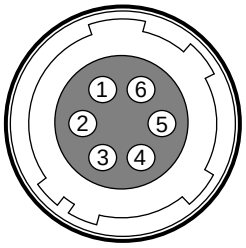


Figure 7.3 Pin Assignments for 6-pin Power Input Receptacle

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

Table 7.2 Pin Arrangements for Power Input Receptacle

The mating connector is a Hirose 6-pin plug (part # HR10A-7P-6S) or the equivalent connectors.
We recommend using a power adapter which has at least 2 A current output at 10 ~ 30 V voltage output (User needs to purchase a power adapter separately.).

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.

7.4 Control I/O Receptacle

The control I/O receptacle is a Hirose 4-pin connector (part # HR10A-7R-4S) and consists of an external trigger signal input and strobe output ports. The pin assignments and configurations are as follows:

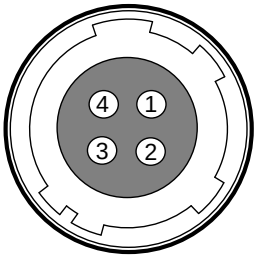


Figure 7.4 Pin Assignments for 4-pin Control I/O Receptacle

Pin Number	Signal	Type	Description
1	Trigger Input	Input	3.3 V ~ 5.0 V TTL input
2	Scan Direction Input	Input	3.3 V ~ 5.0 V TTL input
3	DC Ground	-	DC Ground
4	Strobe Out	Output	3.3 V TTL Output Output resistance: 47 Ω

Table 7.3 Pin Arrangements for Control I/O Receptacle

The mating connector is a Hirose 4-pin plug (part # HR10A-7P-4P) or the equivalent connectors.

7.5 Trigger / Direction Input Circuit

The following figure shows trigger signal input and TDI direction signal input circuit of the 4-pin connector. Transmitted trigger signal and TDI direction signal is applied to the internal circuit through a CMOS buffer with a good noise margin. The minimum trigger width that can be recognized by the camera is 1 μs. If transmitted trigger signal is less than 1 μs, the camera will ignore the trigger signal. An external trigger and TDI direction circuit example is shown below.

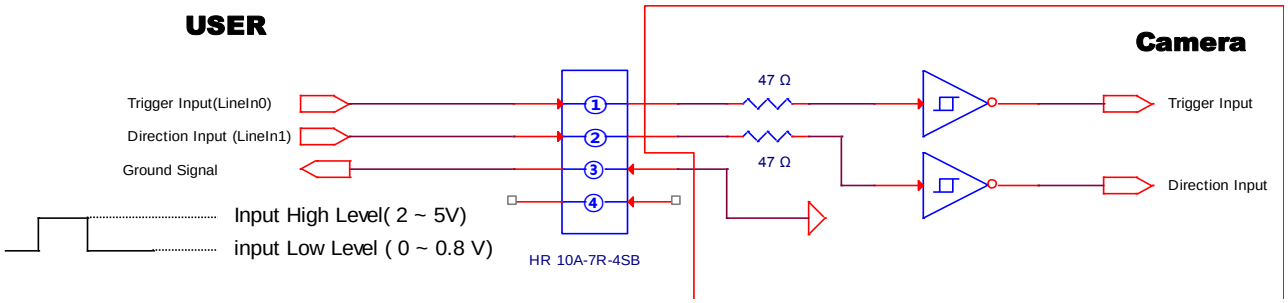


Figure 7.5 Trigger / Direction Input Schematic

7.6 Strobe Output Circuit

The strobe output signal comes out through a 3.3 V output level of Line Driver IC. A pulse width of the signal is synchronized with a Line Start trigger (shutter) of the camera (refer to 9.14 Strobe Mode).

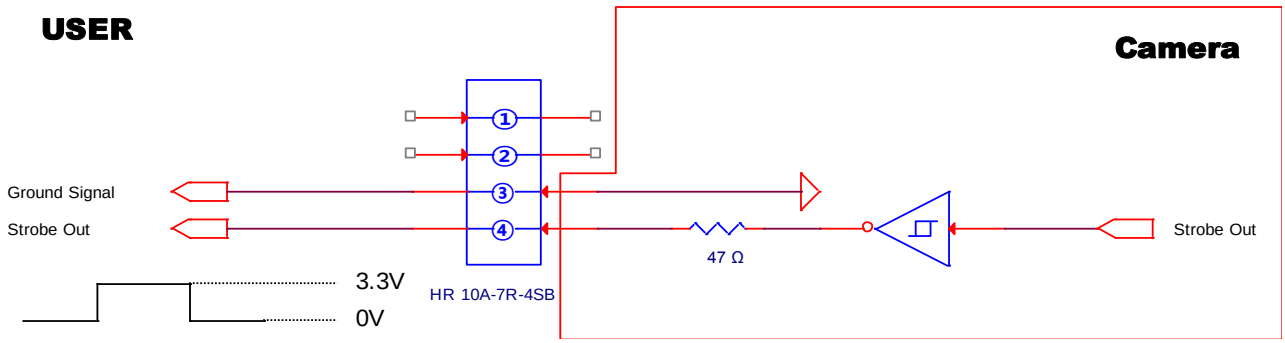


Figure 7.6 Strobe Output Schematic

8 Acquisition Control

This chapter 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

8.1 Acquisition Start/Stop Commands and Acquisition Mode

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

Executing an **Acquisition Stop** command terminates the camera's ability to acquire images.

A parameter called the **Acquisition Mode** has a direct bearing on how the **Acquisition Start** command operates. The VTC-2K10.5X camera only supports Continuous for the **Acquisition Mode** parameter.

The **Acquisition Start** command will remain in effect until you execute the **Acquisition Stop** command. Once an **Acquisition Stop** command has been executed, the camera will not be able to acquire images until a new **Acquisition Start** command is executed.

8.2 Line Start Trigger

The **Trigger Selector** parameter is used to select a type of trigger and only the Line Start trigger is available on the VTC-2K10.5X camera. The Line Start trigger is used to begin line acquisition.
Line Start trigger signals can be generated within the camera or may be applied externally by setting the **Trigger Source** parameter to **LineIn0** or **CXPin**. If a line start trigger signal is applied to the camera, the camera will begin to acquire images.

8.2.1 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**.

8.2.1.1 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.

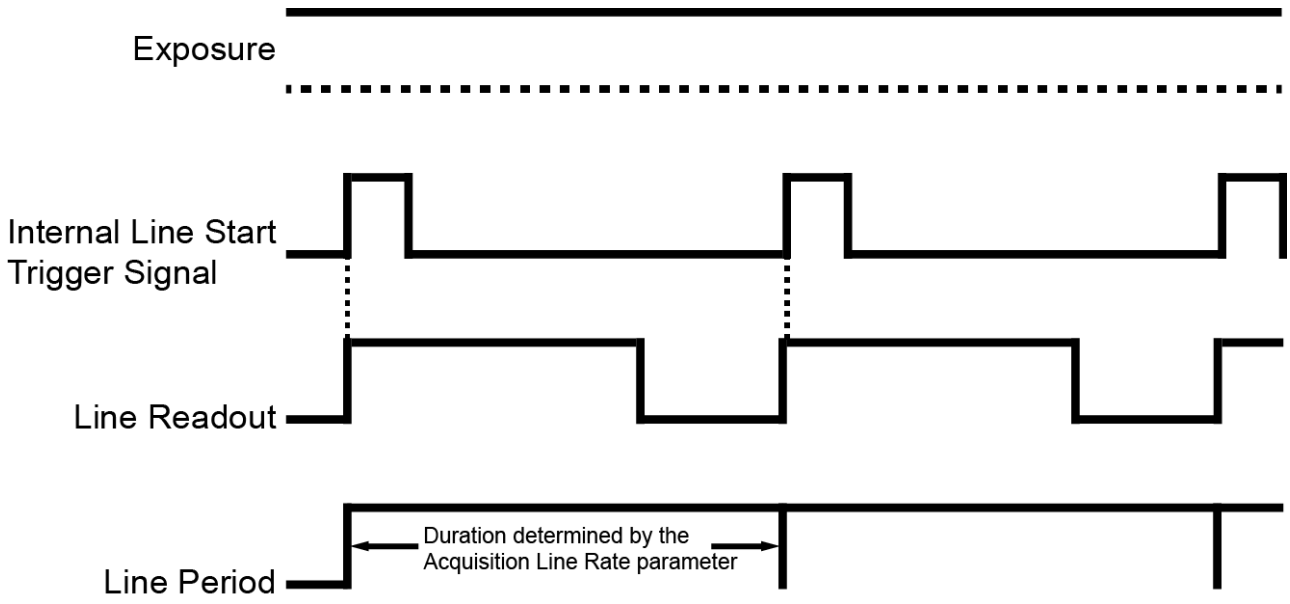


Figure 8.1 Trigger Mode = Off

8.2.1.2 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:

- **LineIn0**: 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 7.5 Trigger / Direction Input Circuit for more information.
- **CXPin**: You can apply a line start trigger signal via CH1 of the CXP Frame Grabber. For more information, refer to your CXP Frame Grabber User Manual.

If the **Trigger Source** parameter is set to **LineIn0** or **CXPin**, 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.

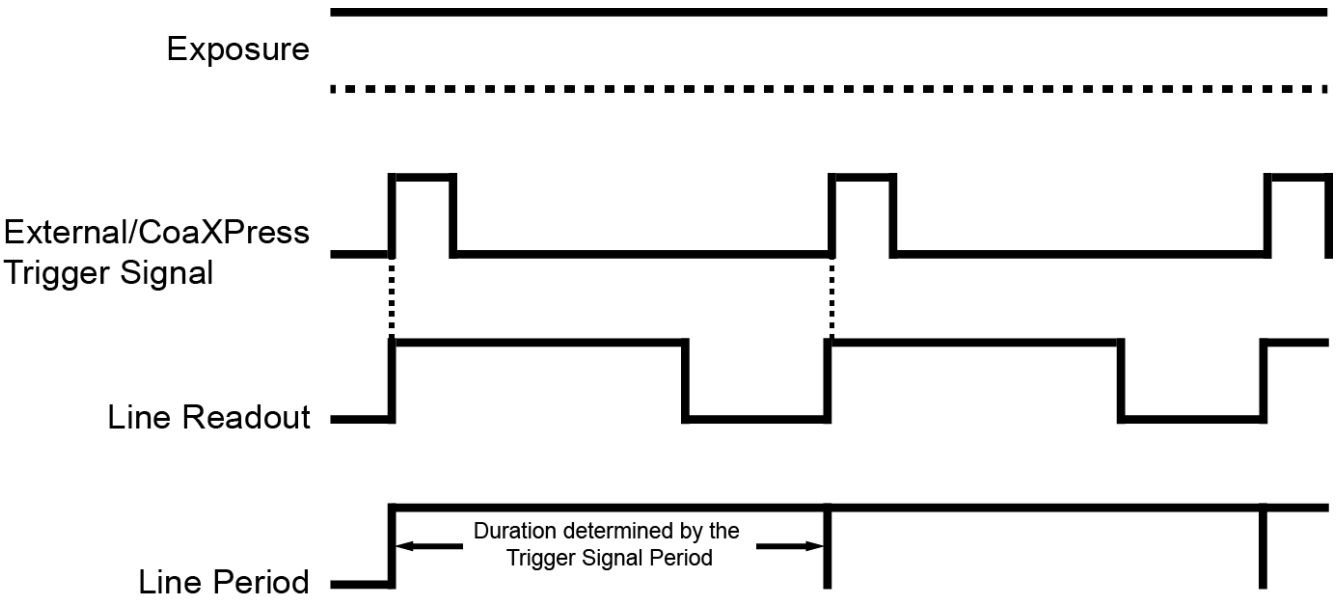


Figure 8.2 Trigger Mode = On

8.2.2 Using an External/CoaXPress Trigger Signal

If the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **LineIn0** or **CXPin**, you must apply an external or CoaXPress trigger signal to the camera to begin image acquisition.

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

To apply trigger signals via hardware (external), you must set the **Trigger Source** parameter to **LineIn0**. At that point, each time a proper electrical signal is applied to the camera, an occurrence of the line start trigger signal will be recognized by the camera.

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

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

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

8.2.3 Trigger Rescaler Mode

With the **Trigger Rescaler Mode**, you can modulate the period of the external trigger signal as desired. For example, if you supply the external trigger signal into the camera's I/O receptacle using the conveyor's encoder, the number of output pulses per revolution of the encoder is fixed. In this situation, you can modulate the period of the trigger signal received from the camera in the following manner to match the pitch of the image in vertical direction.

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

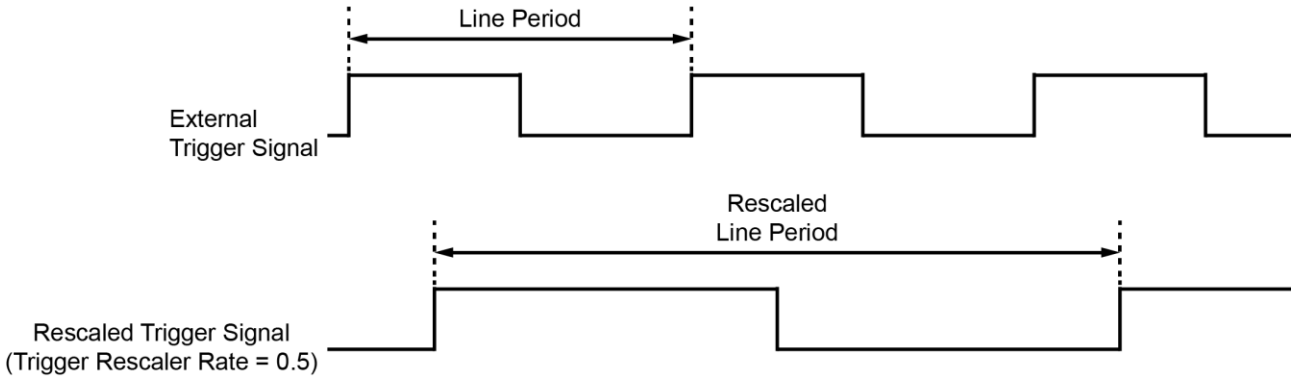


Figure 8.3 Trigger Rescaler Rate = 0.5

The XML parameters related to Trigger Rescaler Mode are as follows.

XML Parameters		Value	Description
AcquisitionControl	TriggerRescalerMode	Off	Disables Trigger Rescaler Mode.
		On	Enables Trigger Rescaler Mode.
	TriggerRescalerRate	0.010000 ~ 100.000000	Sets the trigger rescaler rate for converting trigger signals.
	TriggerRescalerFilter	Sets the rescaler filter factor to decrease the jitter of the external trigger signals.	
		SIZE16	Sets the rescaler filter factor to 16.
		SIZE32	Sets the rescaler filter factor to 32.
		SIZE64	Sets the rescaler filter factor to 64.
		SIZE128	Sets the rescaler filter factor to 128.
		SIZE256	Sets the rescaler filter factor to 256.
		SIZE512	Sets the rescaler filter factor to 512.

Table 8.1 XML Parameters related to Trigger Rescaler Mode

8.2.4 Trigger Statistics

The Trigger Statistics feature allows you to determine the trigger signals applied to the camera and then converted by the Trigger Rescaler.

The XML parameters related to Trigger Statistics are as follows.

XML Parameters		Value	Description
TriggerStatistics	InputTriggerRate	-	Displays the rate at which the input trigger signals are applied to the camera in Hz.
	InputTriggerRateHighest	-	Displays the highest rate at which the input trigger signals are applied to the camera in Hz.
	InputTriggerJitter	-	Displays the jitter of the input trigger signals in %.
	InputTriggerDuration	-	Displays the pulse duration of the input trigger signals in μs.
	RescaledTriggerRate	-	Displays the rate of the trigger signals converted by the Trigger Rescaler in Hz.
	RescaledTriggerJitter	-	Displays the jitter of the input trigger signals converted by the Trigger Rescaler in %.

Table 8.2 XML Parameters related to Trigger Statistics

8.3 Maximum Allowed Line Rate

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

- The maximum allowed bit rate per cable and the number of CXP Link Configurations

  When the maximum allowed bit rate per cable is set to a high value (e.g., CXP5 supports up to 5.000 Gbps and CXP6 supports up to 6.250 Gbps), it will take less time to transfer acquired images from the camera to the CXP Frame Grabber in your computer.

  When the camera is set for a CXP Link Configuration that uses more channels (e.g., CXP6_X1 uses one channel and CXP6_X2 uses two channels), it can typically transfer data out of the camera faster.

  So if the camera is set for a higher bit rate and number of channels, it will typically have a much higher maximum allowed line rate than when it is set for a lower bit rate and number of channels.
- The amount of time it takes to read acquired line images out of the image sensor and into the camera's line buffer. This time varies depending on the length of image ROI. Images with a smaller length take less time to read out of the sensor. The image length is determined by the camera's **Width** setting under the **Image Format Control** category.

The maximum allowed line rates of the VTC-2K10.5X camera are as follows:

CXP Link Configuration	VTC-2K10.5X-C140
CXP5 × 1	70 ㎑
CXP6 × 1	90 ㎑
CXP5 × 2	140 ㎑
CXP6 × 2	140 ㎑

Table 8.3 Maximum Allowed Line Rates of the VTC-2K10.5X camera

The VTC-2K10.5X camera also supports CXP 3 (3.125 Gbps).

8.3.1 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.
  - Use a CXP Link Configuration with a higher bit rate and number of channels.

9 Camera Features

9.1 Operation Mode

The VTC-2K10.5X camera has two different operation modes: **Area** and **TDI** (Time Delayed Integration).

If the **Operation Mode** parameter is set to **Area**, the camera will operate as an area scan camera using two dimensional array of pixels. This mode is useful for aligning the camera to your target object.

If the **Operation Mode** parameter is set to **TDI**, the camera will operate as a high sensitivity line scan camera and provide up to 80× higher sensitivity than existing line scan cameras.

The XML parameters related to Operation Mode is as follows.

XML Parameters		Value	Description
AcquisitionControl	OperationMode	TDI	Operates the camera in the TDI mode.
		Area	Operates the camera in the Area mode.

Table 9.1 XML Parameter related to Operation Mode

9.2 TDI Stages

In the **TDI** 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 **80**, the camera will acquire images with 80× higher sensitivity.

In the **Area** mode, the **TDI Stages** parameter is used to determine the height of the image sensor. For example, if the **Operation Mode** is set to **Area** and the **TDI Stages** parameter is set to **80** on the VTC-2K10.5X camera, the camera will acquire 2160 × 80 area images.

The XML parameter related to TDI Stages is as follows.

XML Parameters		Value	Description
ImageFormatControl	TDI Stages	20	Sets the number of TDI Stages to 20.
		40	Sets the number of TDI Stages to 40.
		60	Sets the number of TDI Stages to 60.
		80	Sets the number of TDI Stages to 80.

Table 9.2 XML Parameter related to TDI Stages

9.3 Scan Direction

In the **TDI** mode, the **Scan Direction** parameter is used to select the image sensor's scan direction. You need to set the **Scan Direction** parameter to **Forward** if the object being imaged will pass the bottom of the camera, and then pass the top of the camera. On the contrary, you need to set the **Scan Direction** parameter to **Reverse** if the object being imaged will pass the top of the camera, and then pass the bottom of the camera.
When you set the **Scan Direction** parameter to **LineIn**, you can also select the scan direction by injecting an externally generated electrical signal (Low = Forward, High = Reverse) into the pin 2 of the Control I/O receptacle on the camera.

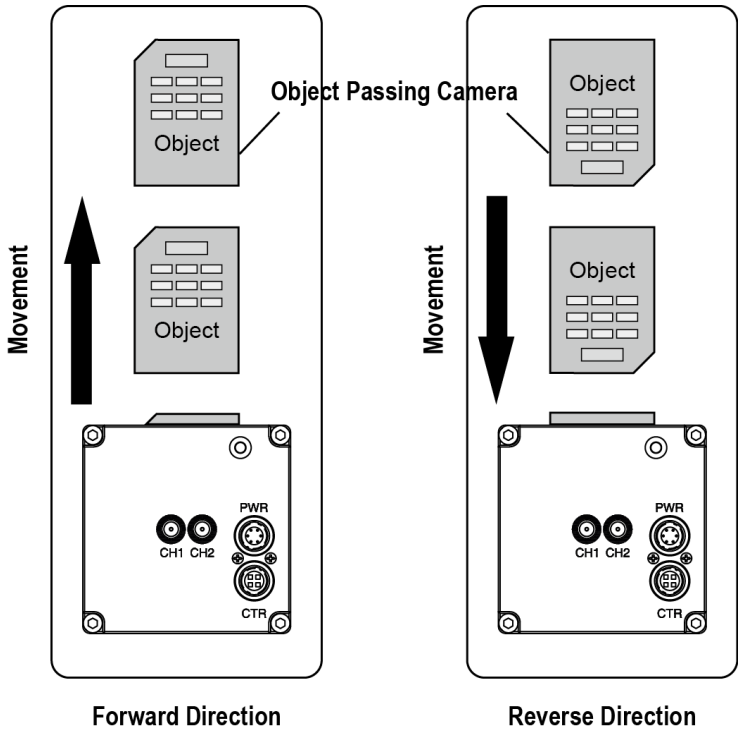


Figure 9.1 Scan Direction

XML Parameters		Value	Description
ImageFormatControl	Scan Direction	Forward	Scans images in the forward direction.
		Reverse	Scans images in the reverse direction.
		LineIn	Selects the scan direction using an external signal.

Table 9.3 XML Parameter related to Scan Direction

When you set the **Scan Direction** parameter to **Reverse** in the **Area** mode, you can acquire vertically flipped images.

9.4 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 are 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 48 and the Width parameter to 288 as shown in the figure below. With these settings, the camera will read out and transmit pixel values for pixels 49 through 336.

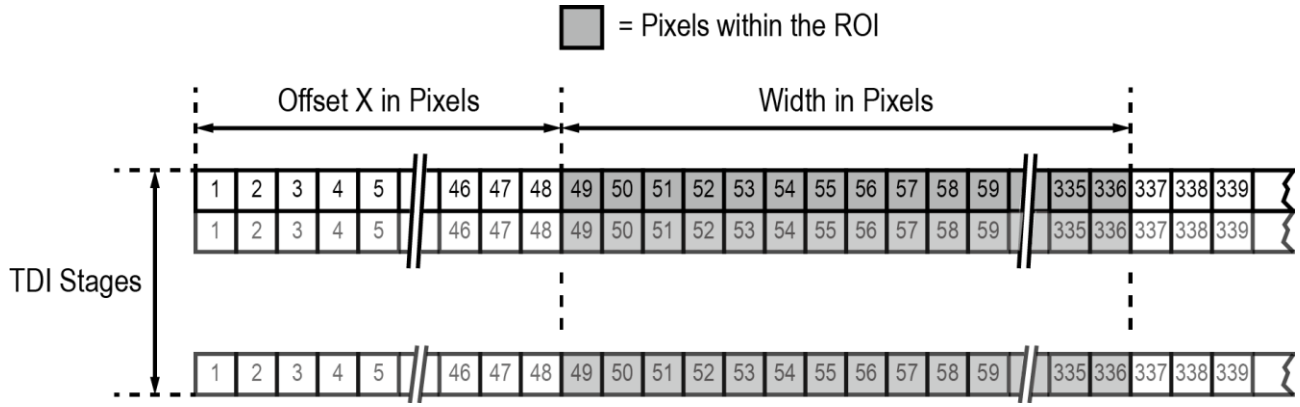


Figure 9.2 Region of Interest

9.4.1 Setting the ROI

By default, 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.

When you are setting the camera's region of interest, you must consider the following guidelines:

- The sum of the Offset X and Width setting values must not exceed the width of the camera's image sensor. For example, on the VTC-2K10.5X camera, the sum of the Offset X and Width setting values must not exceed 2160.
- The Offset X setting value can be set to 0 and can be increased in increments of 48. The Width setting value must be a minimum of 48 and can be set to a multiple of 48.

On the VTC-2K10.5X camera, the maximum line rates depending on ROI changes are shown below.

Width	VTC-2K10.5X
384	140.0 ㎑
528	140.0 ㎑
720	140.0 ㎑
1056	140.0 ㎑
1536	140.0 ㎑
2160	140.0 ㎑

Table 9.4 Maximum Line Rates by ROI Changes (RGB8 Pixel Format)

Your CXP Frame Grabber may place additional restrictions on how the ROI location and size must be set. Refer to your CXP Frame Grabber User Manual for more information.

9.5 Pixel Format

The camera processes image data in the unit of 12 bit internally. You can determine the format of these image data transmitted from the camera by using the **Pixel Format** parameter.

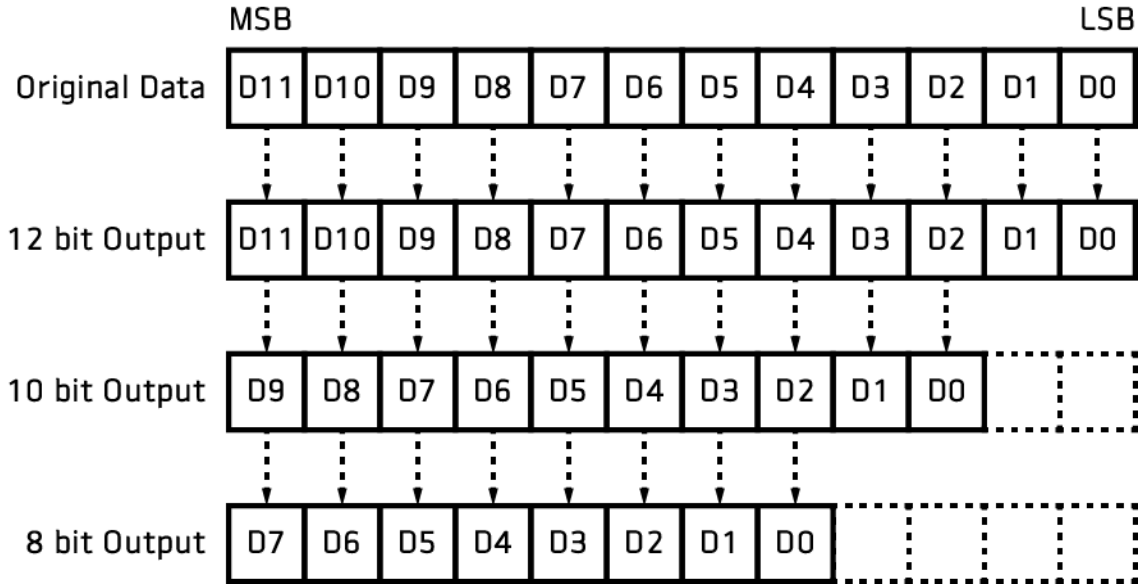


Figure 9.3 Data Format

The XML parameter related to Pixel Format is as follows.

XML Parameters		Value	Description
ImageFormatControl	PixelFormat	RGB8	Sets the pixel format to RGB 8 bit.
		RGB10	Sets the pixel format to RGB 10 bit.
		RGB12	Sets the pixel format to RGB 12 bit.
		BGR8	Sets the pixel format to BGR 8 bit.
		BGR10	Sets the pixel format to BGR 10 bit.
		BGR12	Sets the pixel format to BGR 12 bit.

Table 9.5 XML Parameter related to Pixel Format

9.6 Gain and Black Level

Increasing the **Gain** parameter increases the slope of the camera's response curve as shown in the figure below. This results in a higher grey value output from the camera for a given amount of output from the image sensor.

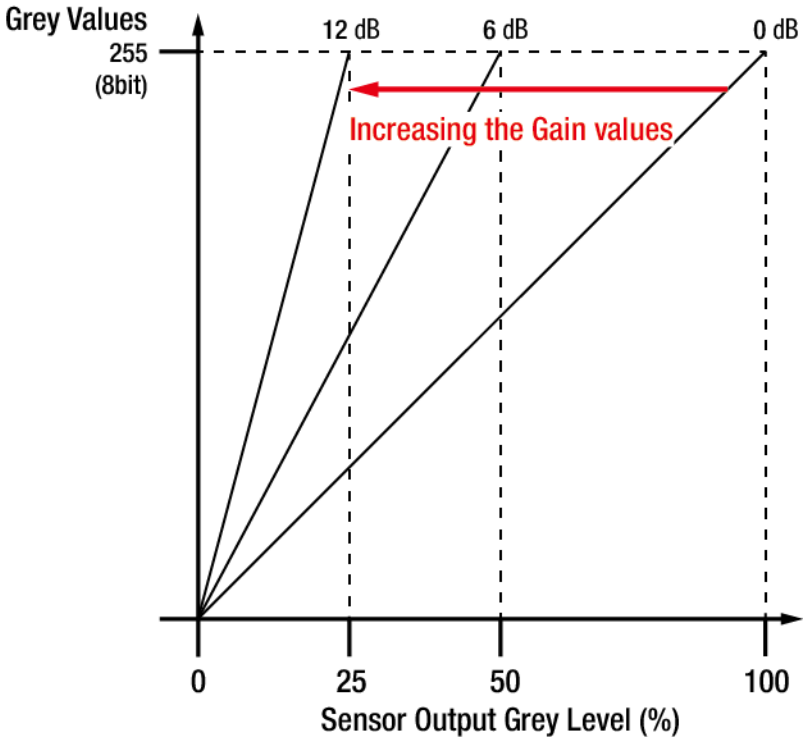


Figure 9.4 Setting the Gain

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

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

XML Parameters		Value	Description
AnalogControl	AnalogGain	1×, 2×, 3×, 4×	Sets an absolute analog gain value.
	DigitalGain	1.0× ~ 8.0×	Sets an absolute digital gain value (0 dB ~ 18 dB).
	BlackLevel	-255 ~ 255	Sets a physical black level value (@ 8 bits).

Table 9.6 XML Parameters related to Gain and Black Level

9.7 White Balance

The VTC-2K10.5X camera allows you to adjust the white balance manually or automatically by setting the gain values for the Red, Green and Blue channels. To adjust the white balance manually, select a color channel by using the **Balance Ratio Selector** parameter, and then set the gain value to be applied by using the **Balance Ratio** parameter. To adjust the white balance automatically, set the **Balance White Auto** parameter to **Once**. The Balance Ratio values for the Red and Blue channels will be automatically adjusted by referring to the Green channel.

The XML parameters related to White Balance are as follows.

XML Parameters		Value	Description
AnalogControl	BalanceRatioSelector	Red	A Balance Ratio value will be applied to Red pixels.
		Green	A Balance Ratio value will be applied to Green pixels.
		Blue	A Balance Ratio value will be applied to Blue pixels.
	BalanceRatio	1.0× ~ 3.9×	Sets a Gain value to be applied to the selected color channel.
	BalanceWhiteAuto	Off	Balance White Auto Off
		Once	White Balance is adjusted once and then Off.

Table 9.7 XML parameters related to White Balance

9.8 Color Transformation

The VTC-2K10.5X camera provides 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
ColorTransformation Control	ColorTransformationSelector	RGB to RGB	Selects a type of color transformation to be performed. RGB to RGB is the only setting available.
	ColorTransformationEnable	-	Activates the selected color transformation.
	ColorTransformationValue Selector	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 RGB to RGB color transformation
	ColorTransformationValue	-4.0× ~ 4.0×	Sets a value of the selected Gain factor.

Table 9.8 XML Parameters related to Color Transformation

9.9 LUT

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 VTC-2K10.5X camera provides 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.

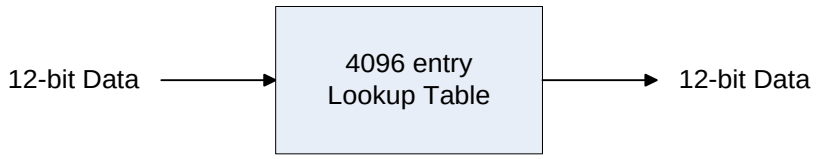


Figure 9.5 LUT Block

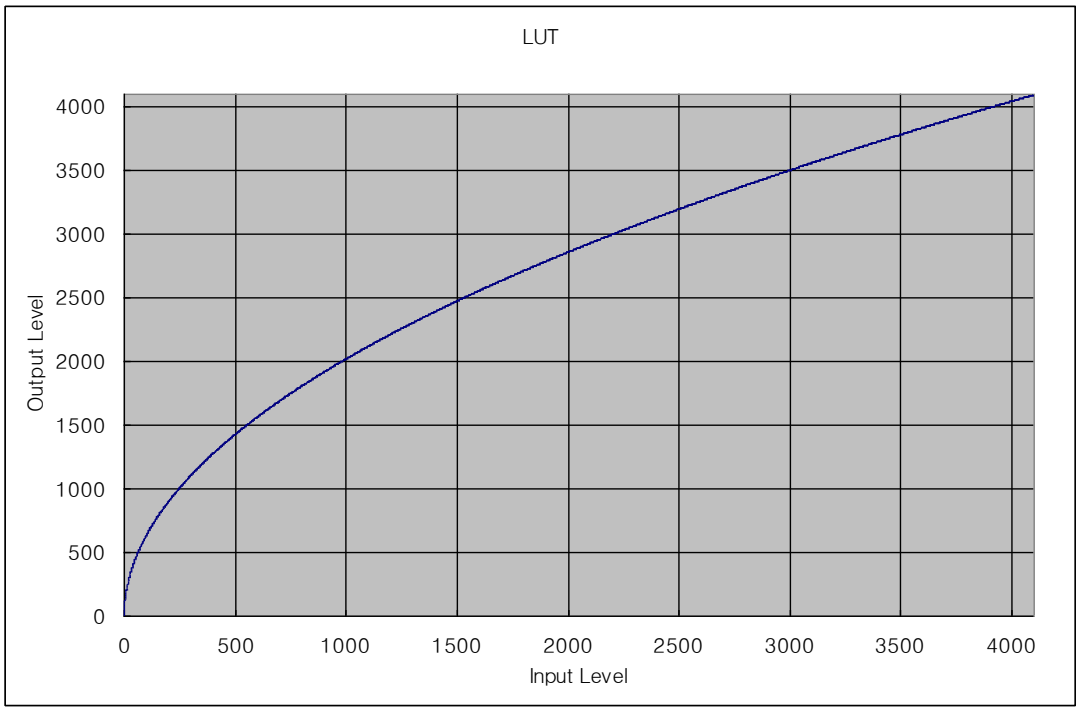


Figure 9.6 LUT at Gamma 0.5

The XML parameters related to LUT 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 ~ 4095	Index of coefficient for verifying the LUT value
	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 9.9 XML Parameters related to LUT

9.10 Dark Signal Non-uniformity Correction

In theory, when a digital camera acquires images in complete darkness, all of 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 VTC-2K10.5X camera provides the DSNU Correction feature.

The XML parameters related to DSNU are as follows.

XML Parameters		Value	Description
DSNU	DSNUGenerateAll	–	Generates and saves the DSNU data for each Analog Gain setting value (1×, 2×, 3×, 4×).
	DSNUGenerate	–	Generates the DSNU data.
	DSNUSave	–	Saves the generated DSNU data in the non-volatile memory. • The generated data by executing the **DSNUGenerate** parameter 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.
	DSNULoad	–	Loads the DSNU data from the non-volatile memory into the volatile memory.

Table 9.10 XML Parameters related to DSNU

9.10.1 Generating and Saving User DSNU Correction Values

To generate and save user DSNU correction values, use the following procedure.

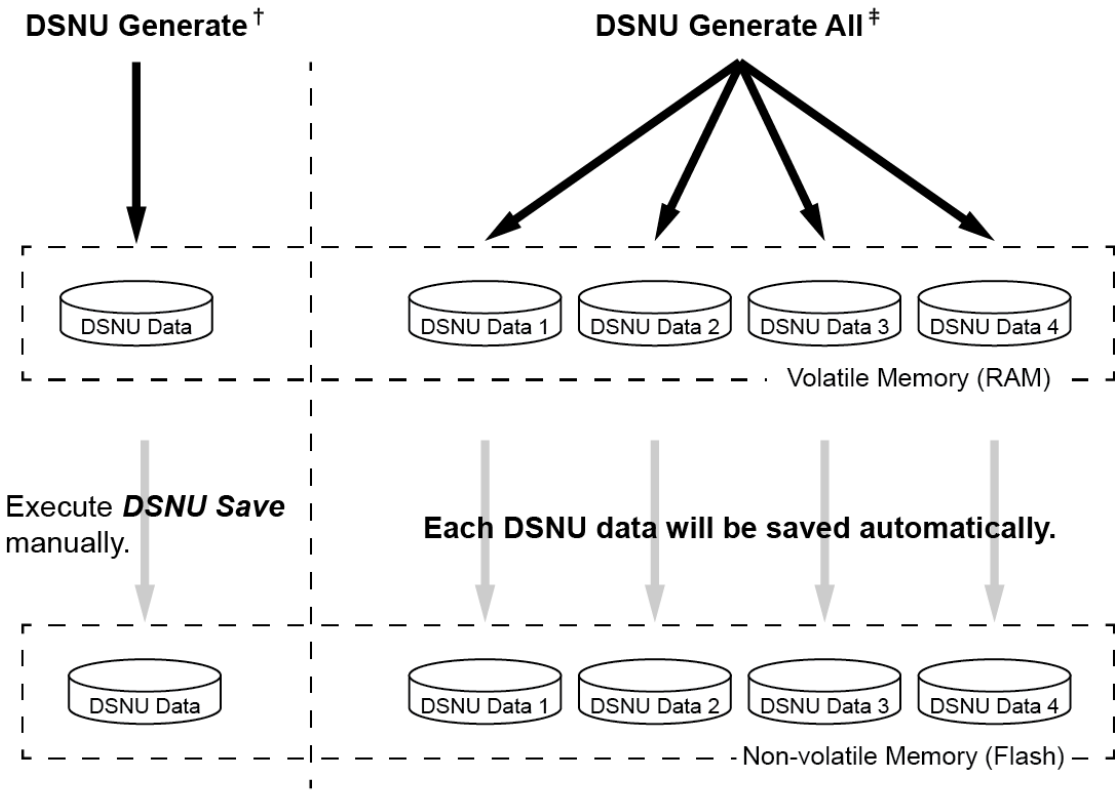
> For optimum DSNU correction results, we recommend that you generate DSNU data after the temperature of the camera housing has been stabilized.

1. The camera will use the entire sensor when generating DSNU correction values. Therefore, we recommend that you set the ROI settings to use the entire width of the sensor.
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.
   - Go to step 5 if you execute the **DSNU Generate** command to generate DSNU data.
   - Go to step 6 if you execute the **DSNU Generate All** command to generate DSNU data.

5. If you execute the **DSNU Generate** command,
   a. The camera generates DSNU data according to the current Analog Gain setting value. The camera must acquire at least 4096 line images to create a set of DSNU correction values.
   b. After completing 4096 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 Save** command. The previous DSNU values for the current Analog Gain setting value saved in the memory will be overwritten.

6. If you execute the **DSNU Generate All** command,
   a. The camera generates the DSNU data for each Analog Gain setting values (1×, 2×, 3×, 4×) and then executes the **DSNU Save** command automatically. The camera must acquire at least 4096 line images to create sets of DSNU correction values.
   b. After completing 4096 line acquisitions, the generated DSNU correction values according to the current Analog Gain setting value will be activated.

7. If you change the Analog Gain setting value or want to load the existing values in the Flash memory, execute the **DSNU 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 9.7 Generating and Saving DSNU Correction Values

9.11 Photo Response Non-uniformity Correction

In theory, when a line scan camera acquires images with the camera viewing a uniform light-colored target in bright light, all of the pixel values in the image should be near the maximum grey value and they should be equal. In practice, however, slight variations in the performance of the pixels in the sensor, variations in the optics, and variations in the lighting will cause some variations in the pixel values output from the camera. This variation is known as Photo Response Non-uniformity (PRNU). The VTC-2K10.5X camera provides the PRNU Correction feature and five storage locations for PRNU correction values.

The XML parameters related to PRNU are as follows.

XML Parameters		Value	Description
PRNU	PRNUMode	Off	Disables the PRNU Correction feature.
		On	Enables the PRNU Correction feature.
	PRNU Selector	0/1/2/3/4	Selects a location to save PRNU data to or load PRNU data from.
	TargetLevelAUTO	-	Select to set the PRNU Target Level automatically.
	PRNUTargetLevel	0 ~ 255	Sets the PRNU Target Level (@ 8 bit pixel format).
	PRNU Generate	-	Generates the PRNU data.
	PRNUSave	–	Saves the generated PRNU data in the non-volatile memory. • The generated data by executing the PRNUGenerate parameter 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.
	PRNULoad	–	Loads the PRNU data from the non-volatile memory into the volatile memory.

Table 9.11 XML Parameters related to PRNU

9.11.1 Generating and Saving User PRNU Correction Values

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

- 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.

1. The camera will use the entire sensor when generating PRNU correction values. Therefore, we recommend that you set the ROI settings to use the entire width of the sensor.
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 make adjustments to 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 4096 line images to create a set of PRNU correction values.
7. After completing 4096 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.

9.12 Reverse X

The Reverse X feature lets you flip the image horizontally. This feature is available in all operation modes.

Figure 9.8 Original Image

Figure 9.9 Reverse X Image

The XML parameter related to Reverse X is as follows.

XML Parameters		Value	Description
ImageFormatControl	Reverse X	-	Select to enable the Reverse X feature.

Table 9.12 XML Parameters related to Reverse X

9.13 CXP Link Configuration

The VTC-2K10.5X camera must be connected to a CXP Frame Grabber installed in your computer via CoaXPress interface. CoaXPress interface allows you to connect a camera to a CXP Frame Grabber by using simple coax cabling and allows up to 6.25 Gbps data rate per cable. Two channel VTC-2K10.5X camera supports one master connection and one extension connection to configure a link. In compliance with the CoaXPress standard, the VTC-2K10.5X camera includes an automatic link detection (Plug and Play) mechanism to correctly detect the camera to CXP Frame Grabber connections.

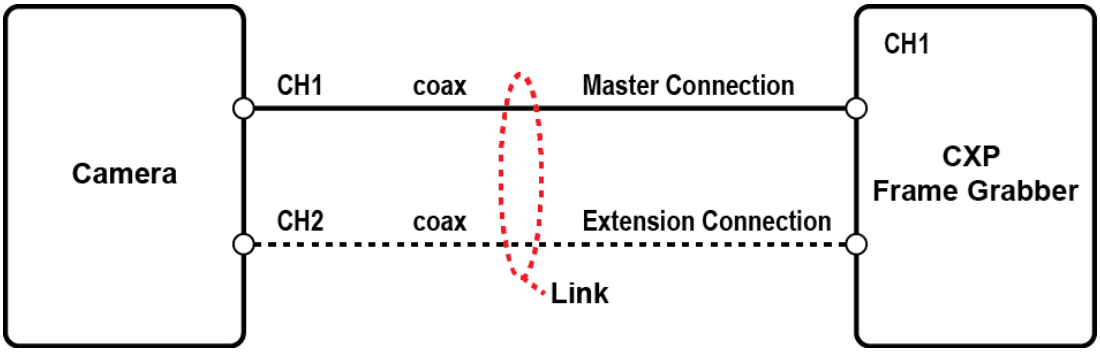


Figure 9.10 CXP Link Configuration

The XML parameters related to the link configuration between the camera and CXP Frame Grabber are located in the CoaXPress category under the Transport Layer Control as shown below.

XML Parameters		Value	Description
CoaXPress	CxpLinkConfiguration PreferredSwitch	CXP3_X1, X2	Sets the A parameter value to CXP3_X1, X2.
		CXP5_X1, X2	Sets the A parameter value to CXP5_X1, X2.
		CXP6_X1, X2	Sets the A parameter value to CXP6_X1, X2.
	CxpLinkConfiguration Preferred[A]	Read Only	Displays bit rate and the number of connections to be set for the link configuration between the camera and Host (Frame Grabber) while discovering devices.
	CXPLinkConfiguration	CXP3_X1, X2 CXP5_X1, X2 CXP6_X1, X2	Forcefully sets bit rate and the number of connections for the link configuration. ex) CXP6_X2: Two connections running at the maximum of CXP6 speed (6.25 Gbps)

Table 9.13 XML Parameters related to CXP Link Configuration

9.14 Strobe Mode

The VTC-2K10.5X camera can output pulse signals through the control I/O receptacle. You can set a width of the pulse signal by using the **Strobe Mode** feature. This feature is useful when you need to supply source signal to the other device such as a Strobe Controller.

The XML parameters related to Strobe Mode are as follows.

XML Parameters		Value	Description
DigitalIOControl	StrobeMode	Off	Disables the Strobe Mode feature.
		Timed	Outputs pulse signals according to the Strobe Duration setting value.
		PulseWidth	Outputs pulse signals of which the pulse width is equal to the trigger signals applied to the camera.
		On	Outputs continuous High signals.
	StrobeInverter	-	Select to invert the output signal.
	StrobeOutDelay	0 ~ 1000.00	Sets a delay to the current output signal in microseconds.
	StrobeDuration	0 ~ 1000.00	Sets a duration of pulse signal in microseconds when the Strobe Mode is set to Timed.

Table 9.14 XML Parameters related to Strobe Mode

9.15 Device User ID

You can input user defined information up to 32 bytes.

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

XML Parameters		Description
DeviceControl	DeviceUserID	Inputs user defined information (32 bytes).

Table 9.15 XML Parameter related to Device User ID

9.16 Device Reset

Resets the camera physically to power off and on. You must configure a link again because the camera will be released from the link between the camera and CXP Frame Grabber after reset.

The XML parameter related to Device Reset is as follows.

XML Parameters		Description
DeviceControl	DeviceReset	Resets the camera physically.

Table 9.16 XML Parameter related to Device Reset

9.17 Temperature Monitor

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

The XML parameter related to Device Temperature is as follows.

XML Parameters		Description
DeviceControl	DeviceTemperature	Displays device temperature in Celsius.

Table 9.17 XML Parameter related to Device Temperature

9.18 Status LED

A red/green LED is installed on the back 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	A CXP link is not configured.
Fast Flashing Orange	Camera is checking a CXP link configuration.
Steady Green	A CXP link is configured.
Fast Flashing Green	Camera is acquiring images.

Table 9.18 Status LED

9.19 Test Pattern

To check normal operation of the camera, it can be set to output test patterns created inside, instead of image data from the image sensor. There are three types of test pattern; image with different value in horizontal direction (Grey Horizontal Ramp), image with different value in diagonal direction (Grey Diagonal Ramp), and moving image with different value in diagonal direction (Grey Diagonal Ramp Moving).
The XML parameter related to Test Pattern is as follows.

XML Parameters		Value	Description
ImageFormatControl	TestPattern	Off	Test Pattern Off
		GreyHorizontalRamp	Sets to Grey Horizontal Ramp.
		GreyDiagonalRamp	Sets to Grey Diagonal Ramp.
		GreyDiagonalRampMoving	Sets to Grey Diagonal Ramp Moving.

Table 9.19 XML Parameter related to Test Pattern

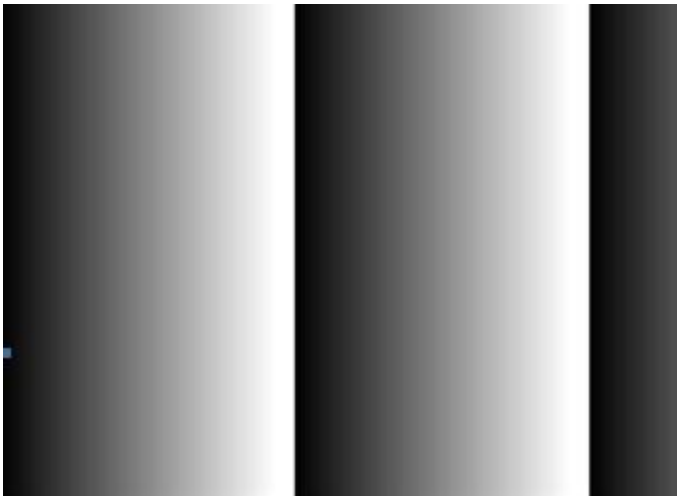


Figure 9.11 Grey Horizontal Ramp

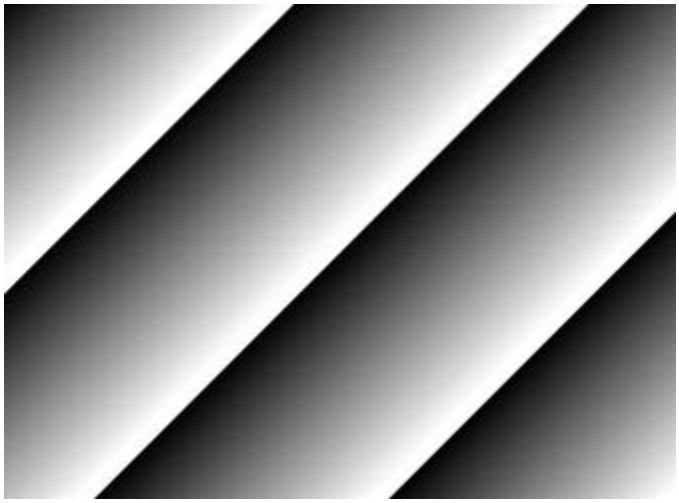


Figure 9.12 Grey Diagonal Ramp

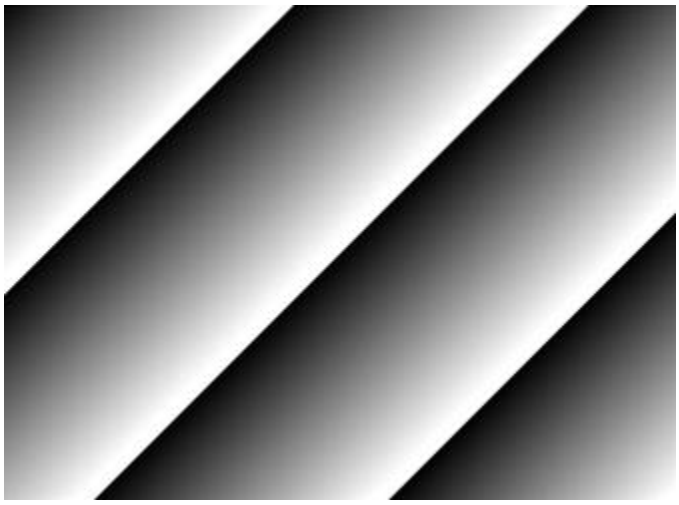


Figure 9.13 Grey Diagonal Ramp Moving

CAUTION	The test pattern may look different because the region of the test pattern may vary depending on the camera's resolution.

9.20 User Set Control

You can save the current camera settings to the camera's internal ROM. You can also load the camera settings from the camera's internal ROM. 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 Factory Default settings and allowed to load only.
	UserSetDefault	Default	Applies the Factory Default settings when reset.
		UserSet1	Applies the UserSet1 settings when reset.
		UserSet2	Applies the UserSet2 settings when reset.

Table 9.20 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.

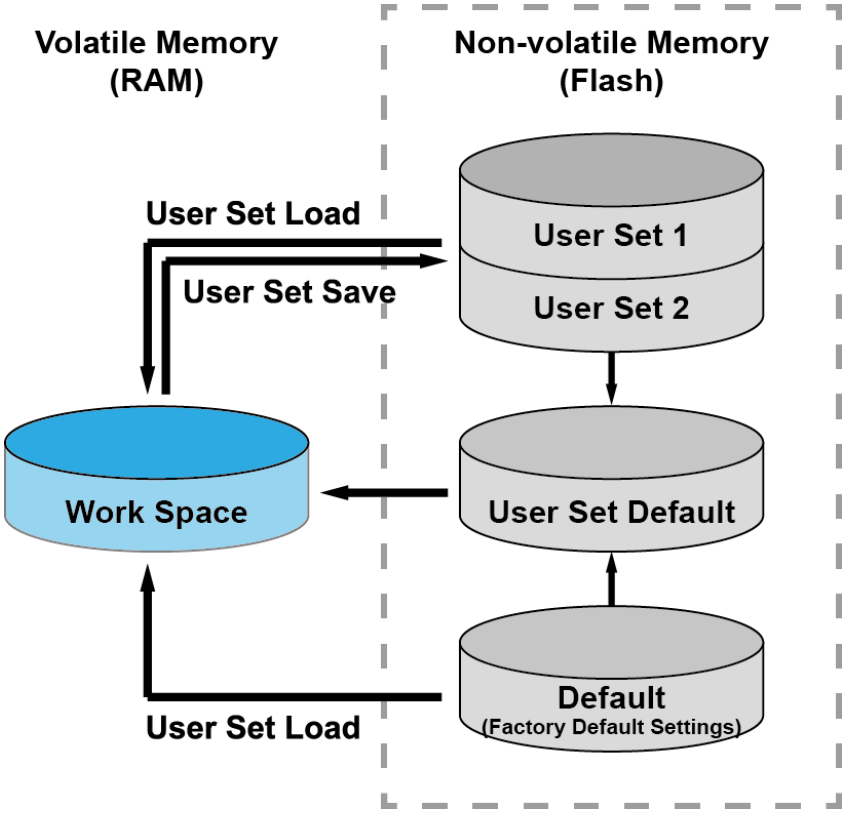


Figure 9.14 User Set Control

9.20.1 Factory Default Setting Values

When you power the camera for the first time on, the factory default setting values will be loaded into the camera and the factory default setting values are as follows:

XML Parameters	Value
Operation Mode	TDI
Scan Direction	Forward
TDI Stages	Maximum Integration Stages
Trigger Mode	Off
Test Pattern	Off
Pixel Format	RGB 8
PRNU Mode	On
DSNU Mode	On
CXP Link Configuration	CXP6 × 2
Analog Gain	1×
Digital Gain	1×
Line Rate	80 ㎑

Table 9.21 Factory Default Setting Values

9.21 Field Upgrade

The camera provides a feature to upgrade the camera's firmware and FPGA logic through CoaXPress interface rather than disassemble the camera in the field. Refer to Appendix A for more details about how to upgrade.

10 Troubleshooting

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

- If no image is displayed on your computer,
  - Ensure that all 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 line rate is set properly.
  - Check the aperture is opened properly.
  - Check the digital gain value is not set to small.

- 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.

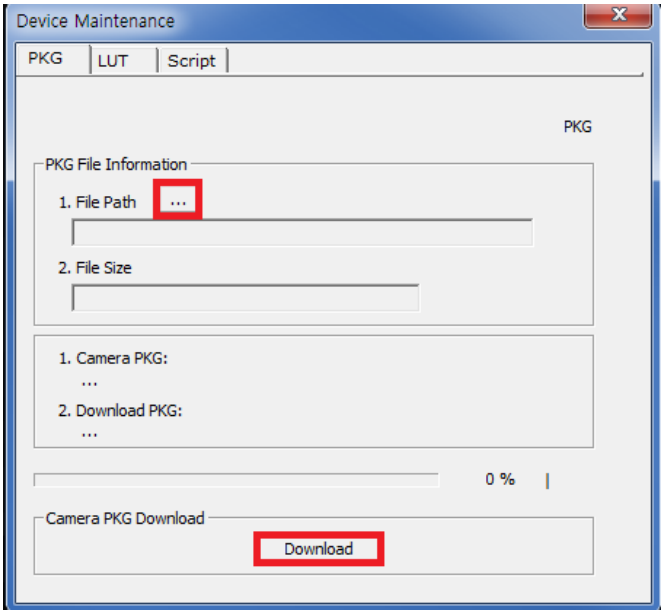
- If you have a problem using the Trigger Mode,
  - Ensure that the trigger related parameters on your CXP Frame Grabber are configured correctly when you set the Trigger Source parameter to CXPin.
  - Ensure that cable connections are secure when you operate the camera with external trigger signals.

- If there is a communication failure between the camera and user's computer,
  - Ensure coax cables are connected properly.
  - Ensure that you have configured a CXP Frame Grabber in your computer correctly and the camera is connected properly to the CXP Frame Grabber.

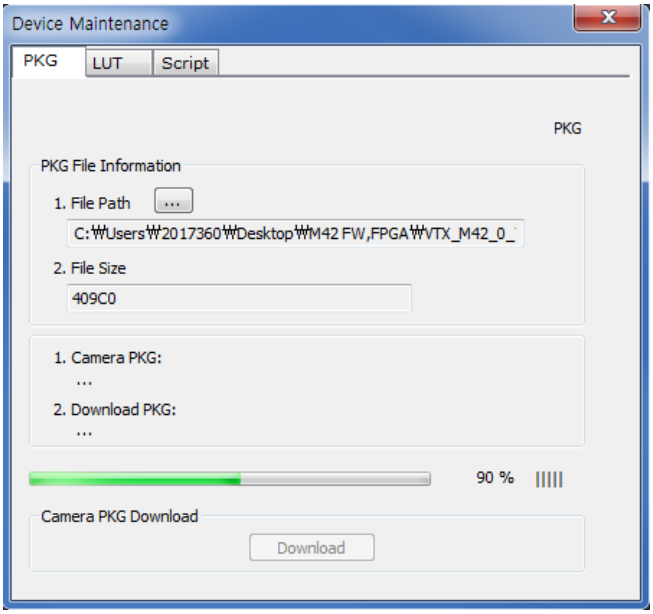
Appendix A Field Upgrade

A.1 MCU / FPGA / XML

1. Run Vieworks Imaging Solution 7.X and click the **Configure** button to display the window as shown below.
2. Select the **PKG** tab, click the File Path button, search and select the upgrade file, and then click the **Download** button.



3. The upgrade file download starts, and the downloading status is displayed at the bottom of the window.



4. Once all the processes have been completed, turn the camera power off and turn it back on again. Check the DeviceVersion parameter under the Device Control category to confirm the version.

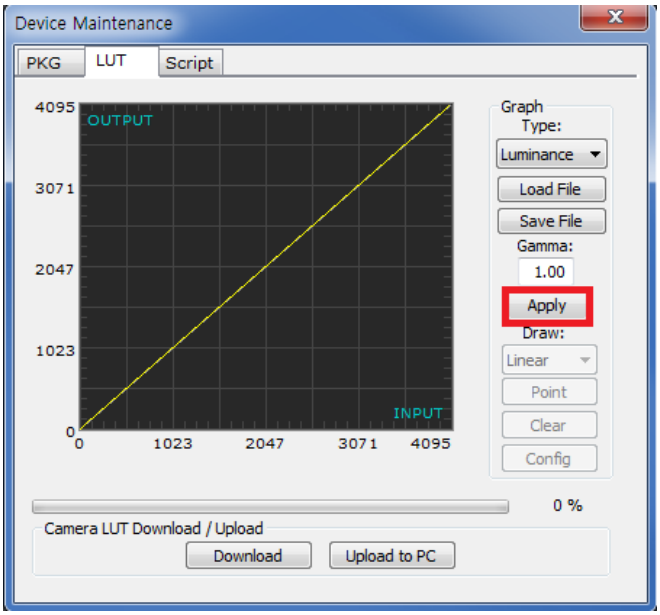
Appendix B LUT Download

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.

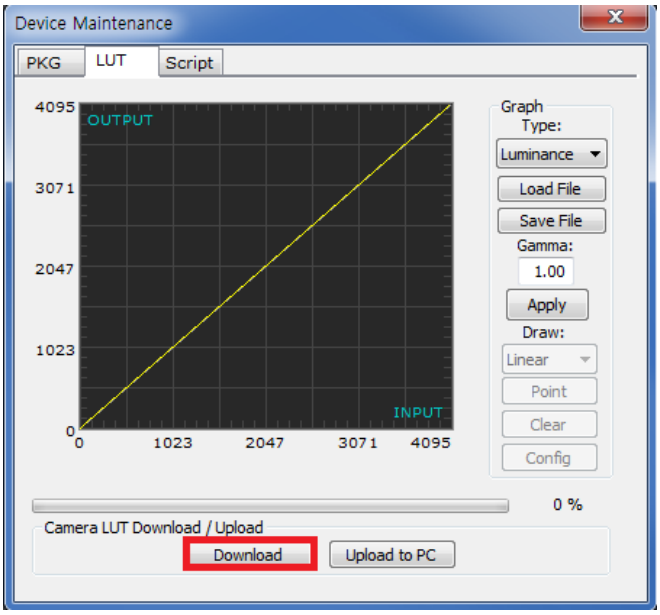
B.1 Gamma Graph Download

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.



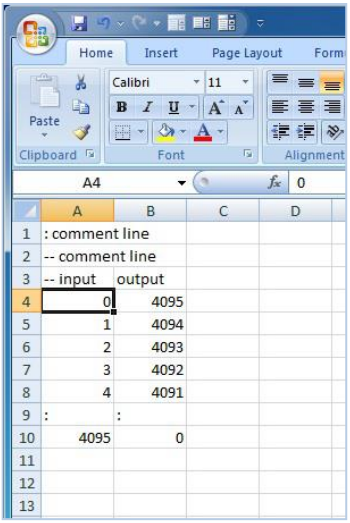
3. Click the **Download** button to download the gamma values to the camera.

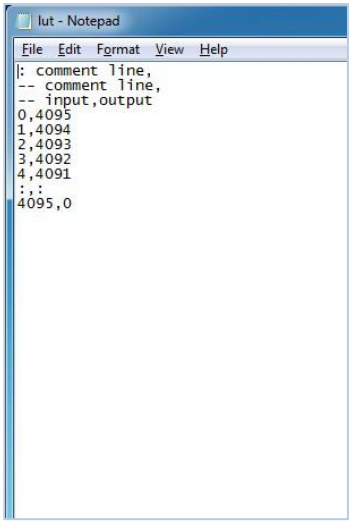


4. After completing the download, click the **OK** button to close the confirmation.

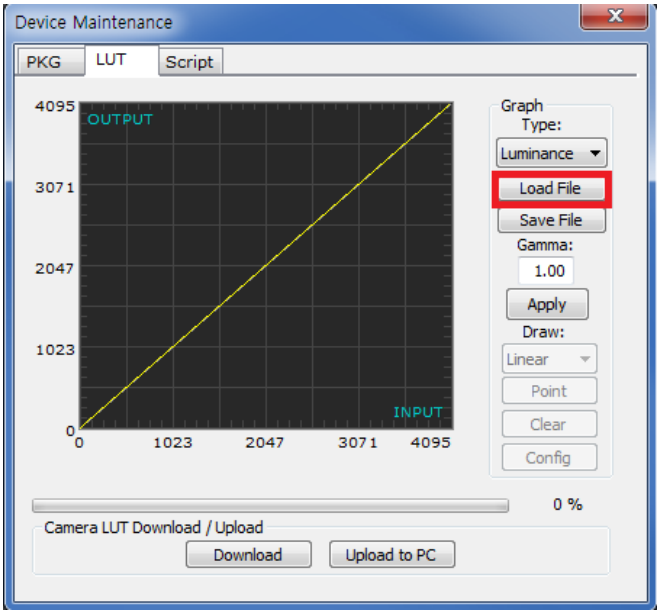
B.2 CSV File Download

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.

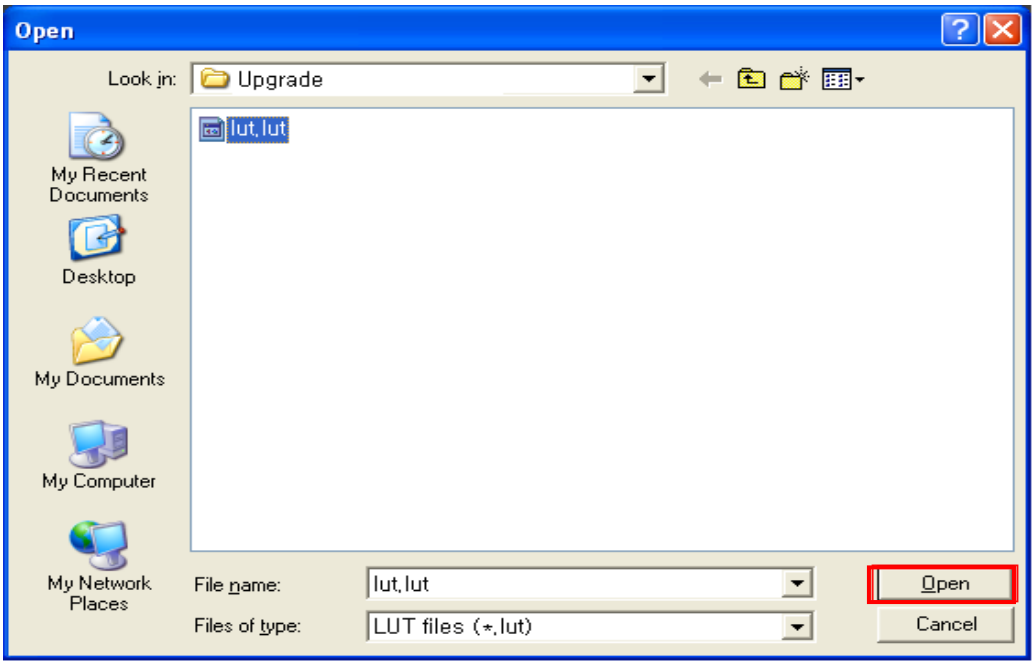




2. Run Vieworks Imaging Solution 7.X and click the **Configure** button to display the window as shown below. Select the **LUT** tab, select **Luminance** from the **Type** dropdown list, and then click the **Load File** button.



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 Correction Control

The VTC-2K10.5X camera provides an additional feature to adjust DSNU or PRNU correction values after the DSNU or PRNU Correction feature is enabled. You can specify a pixel or region of the sensor and the pixel information from the specified portion will be adjusted according to the DSNU or PRNU coefficient value.
The XML parameters related to Correction Control are as follows.

XML Parameters		Value	Description
Correction Control	StartX	-	X coordinate of a start pixel
	EndX	-	Y coordinate of an end pixel
	DSNUCoef	-	Sets an additional DSNU correction value [Black Level value to be added to the specified region (DN, digital number)].
	DSNUCoefSet	-	Applies the additional DSNU correction value to the specified region.
	PRNUCoef	-	Sets an additional PRNU correction value (Gain value to be multiplied to the specified region).
	PRNUCoefSet	–	Applies the additional PRNU correction value to the specified region.
DSNU	DSNUSave	–	Saves the generated DSNU data in the non-volatile memory. • The generated data by executing the **DSNUCoefSet** parameter 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.
	DSNULoad	–	Loads the DSNU data from the non-volatile memory into the volatile memory.
PRNU	PRNUSelector	0/1/2/3/4	Selects a location to save PRNU data to or load PRNU data from.
	PRNUSave	–	Saves the generated PRNU data in the non-volatile memory. • The generated data by executing the **PRNUCoefSet** parameter 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.
	PRNULoad	–	Loads the PRNU data from the non-volatile memory into the volatile memory.

Table C.1 XML Parameters related to Correction Control

C.1 Adjusting and Saving Additional DSNU Correction Value

For example, if you want to apply -2 black level from the 100th pixel to the 109th pixel, follow the procedures below.

1. Set the **Start X** parameter to 100.
2. Set the **End X** parameter to 109.
3. Set the **DSNU Coef** parameter to -2.
4. Execute the **DSNU Coef Set** command.
5. Execute the **DSNU Save** command to save the additional DSNU correction value in the camera's Flash (non-volatile) memory. In this case, the previous DSNU values for the current Analog Gain setting value saved in the memory will be overwritten.
   To ignore the adjusted DSNU correction values and load the existing values in the Flash memory, execute the **DSNU Load** command.

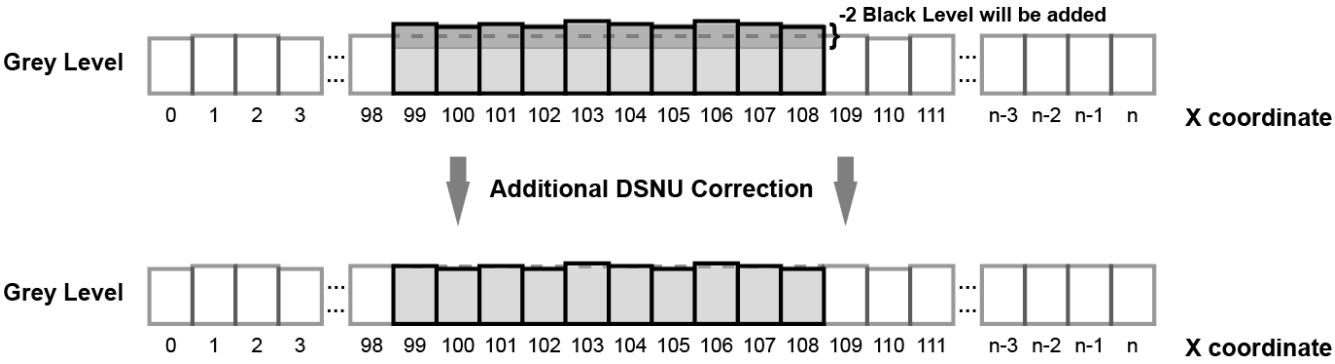


Figure C.1 Additional DSNU Correction

C.2 Adjusting and Saving Additional PRNU Correction Value

For example, if you want to apply 1.1× gain from the 100th pixel to the 109th pixel, follow the procedures below.

1. Set the **Start X** parameter to 100.
2. Set the **End X** parameter to 109.
3. Set the **PRNU Coef** parameter to 1.1.
4. Execute the **PRNU Coef Set** command.
5. Specify a location to save by using the **PRNU Selector** parameter and execute the **PRNU Save** command to save the additional PRNU correction value in the camera's Flash (non-volatile) memory. The existing values in the Flash memory will be overwritten.
   To ignore the adjusted 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.

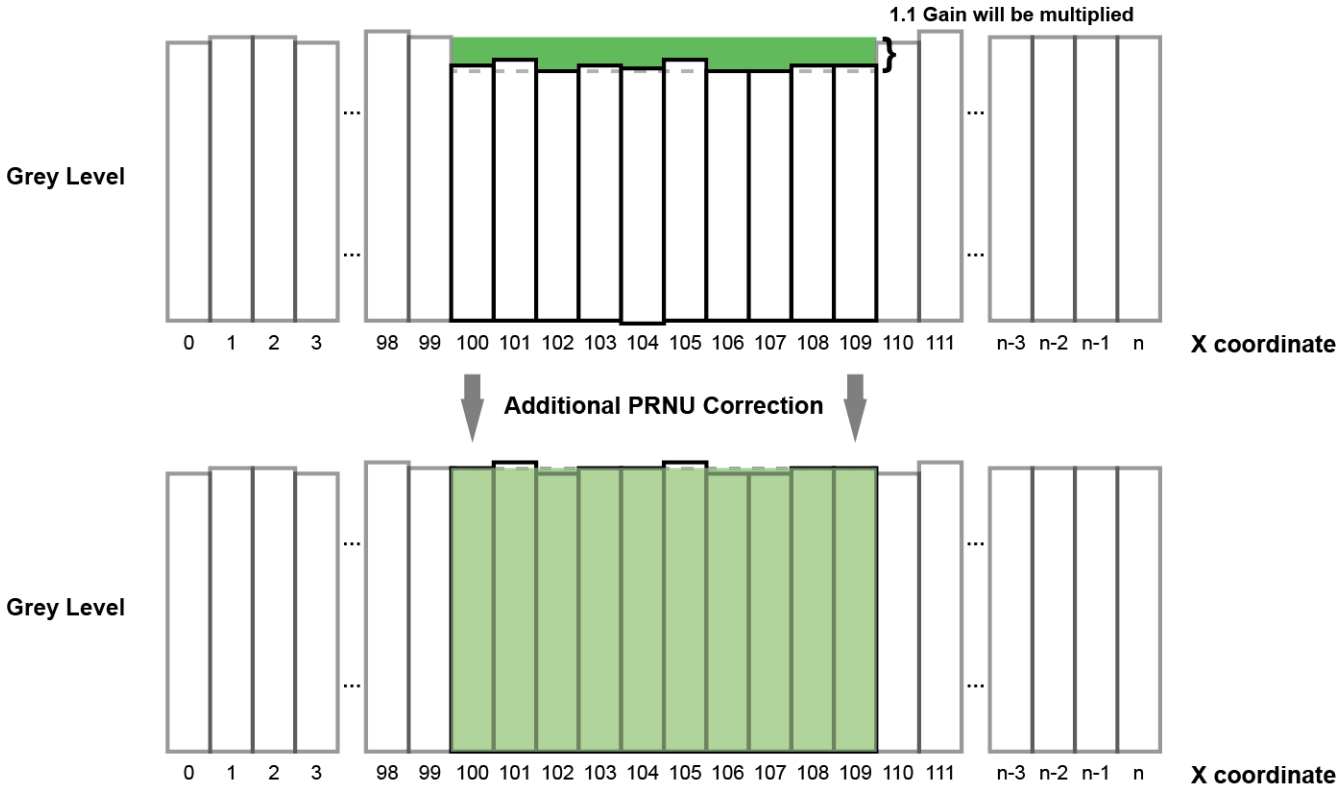
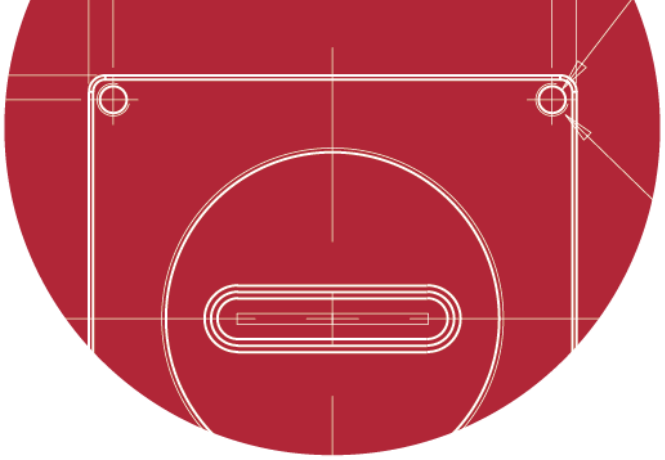
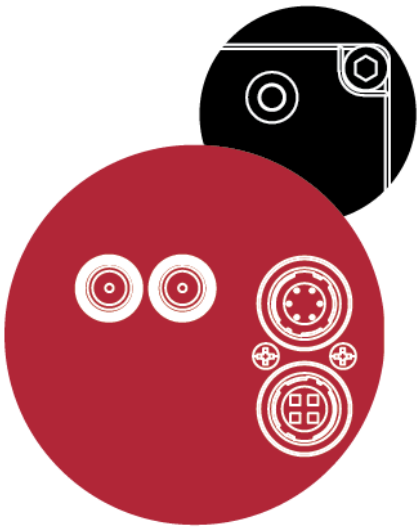
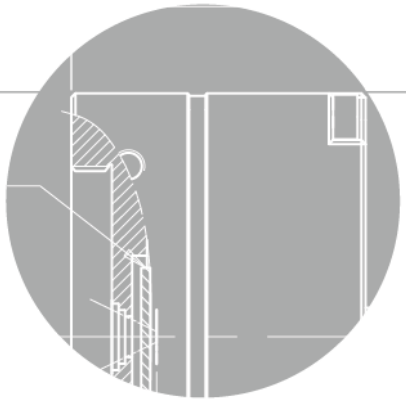


Figure C.2 Additional PRNU Correction

Before executing the **PRNU Coef Set** command, if you set the **PRNU Mode** parameter to **On**, you can determine the adjusted PRNU correction values in the acquired line images.







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