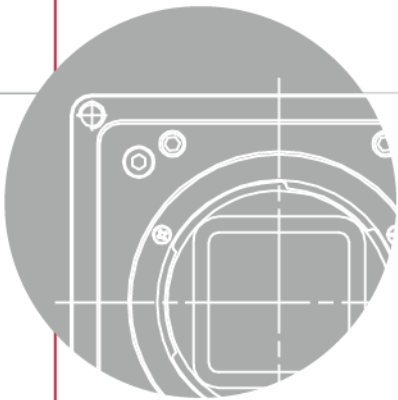


# VN series

## User Manual

English

VN-25MX-72



**VIEWWORKS**  
Imaging Expert

**Revision History**

Version	Date	Description
1.0	2015-02-12	Initial Release

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# 1 Precautions

## General



- Do not drop, disassemble, repair or alter the device. Doing so may damage the camera electronics and cause an electric shock.
- Do not let children 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



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

## Power Supply



- Applying incorrect power can damage the camera. If the voltage applied to the camera is greater or less than the camera's nominal voltage, the camera may be damaged or operate erratically. Please refer to [5.2 Specifications](#) for the camera's nominal voltage.
  - ※ Vieworks Co., Ltd. does NOT provide power supplies with the devices.
- Make sure the power is turned off before connecting the power cord to the camera. Otherwise, damage to the camera may result.

## 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 2004/108/EC.

Testing Standard EN 55022:2006+A1:2007, EN 55024:1998+A1:2001+A2:2003

Class A

### 3.3 KC

#### KCC Statement

Type	Description
<b>Class A</b> (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

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Package Components

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VN CXP Camera



VN CXP with DIN 1.0/2.3 type connectors



Mount Plate (Optional)

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**Package Components****M5 Set Screws for Tilt Adjustment (Provided only with F-mount camera)**

- You can adjust the tilt using the M5 set screws, however it is not recommended since it is adjusted as factory default settings.
- If the tilt settings need to be adjusted inevitably, please contact your local dealer or factory representative for technical support.

## 5 Product Specifications

### 5.1 Overview

VN CXP Series is a high speed industrial area scan camera equipped with the latest CMOS image sensor. It features 25 megapixel resolutions with frame rate up to 72 fps. This is the first CMOS pixel shifting camera whose resolution is extended from 25 megapixels up to 235 megapixels through vieworks' iconic pixel shifting technology. With the VN-25MX, customers in the industrial market can take advantage of 235 million pixels resolution at 8 fps. Its CoaXPress interface supports transmitting image data at up to 6.25 Gbps using a single coaxial cable and up to 25 Gbps using four cables. Featured with high speed and high resolution, this new technology is ideal for inspection systems such as FPD, PCB and semiconductor as well as 3D imaging and digitizing of different objects.

#### Main Features

- Nano Stage Pixel Shifting Mechanism
- High Speed 25 Megapixel CMOS Imaging Sensor
- Extended Resolution up to 235 MP at 8 fps (9 Shot Mode)
- Electronic Exposure Time Control (Global Shutter)
- Output Pixel Format - 8 / 10 bit
- Strobe Output
- Output Channel - CXP6 × 2ch / CXP6 × 4ch
- CoaXPress Interface up to 72 fps at 25 Gbps using 4 coax cables (4ch)
- Gain/Black Level Control
- Test Pattern
- Temperature Monitor
- Field Upgrade
- Image Correction
- Flat Field Correction
- Defective Pixel Correction
- Fan Control
- VN CXP Series Feature Bar



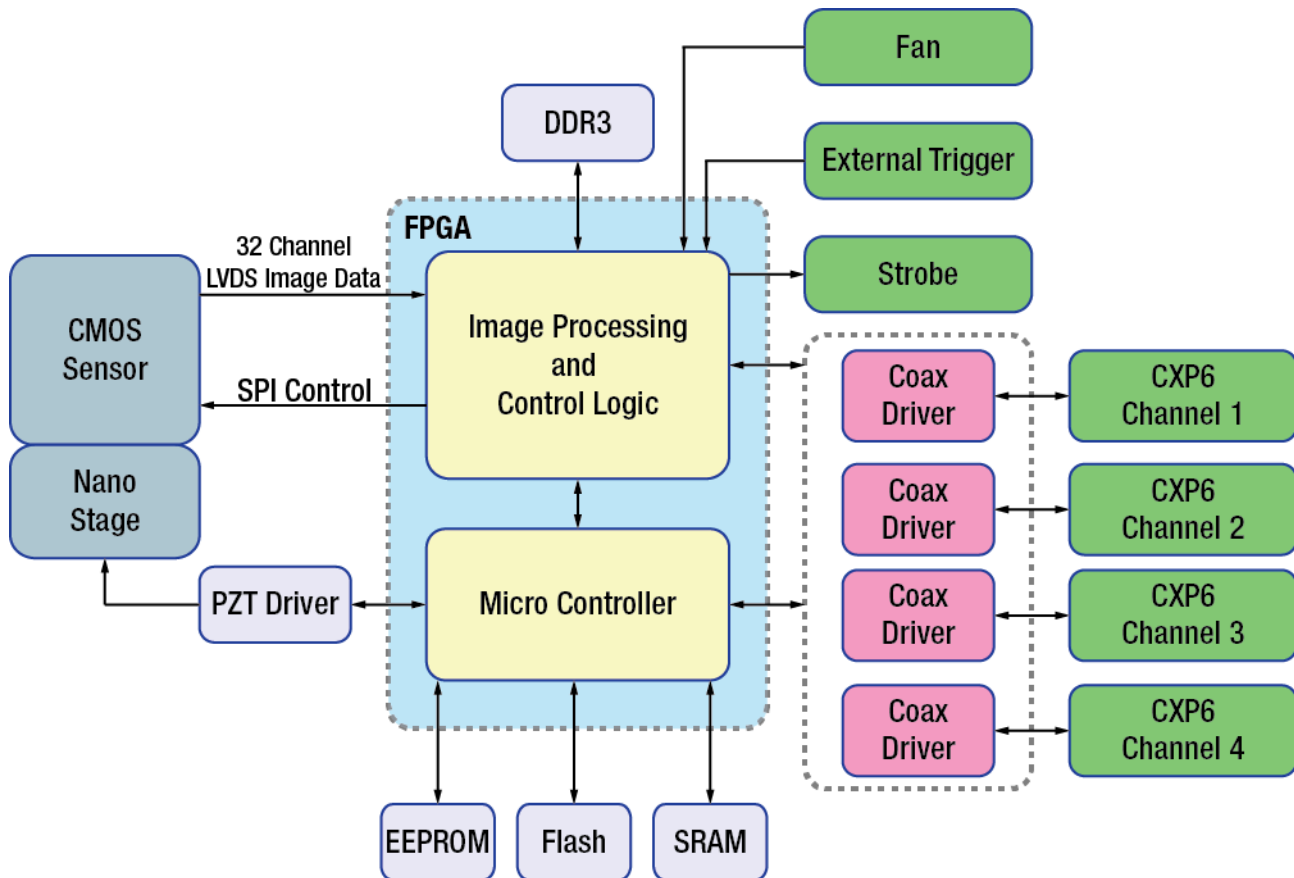
## 5.2 Specifications

Technical Specifications for VN CXP series are as follows:

VN CXP Series		VN-25MX-72	
Active Image (H × V)		5120 × 5120	
Sensor Type		On Semiconductor VITA-25K	
Pixel Size		4.5 μm × 4.5 μm	
Optical Size (Diagonal)		35 mm (32.58 mm)	
Output	Mono	Mono 8, Mono 10	
Format	Color	Bayer 8, Bayer 10	
Camera Interface		CoaXPress	
Electronic Shutter		Global Shutter	
Max. Frame Rate	25 MP	2 CH: 36 fps	4 CH: 72 fps at 6.25 Gbps
	235 MP	2 CH: 4 fps	4 CH: 8 fps at 6.25 Gbps
Dynamic Range		> 54 dB	
Shutter Speed (1 μs step)		10 μs ~ 60 s	
Partial Scan (Max. Speed)		7692 fps at 4 Lines (H: 256)	
Black Level Control		0 ~ 16 LSB at 8 bit, 0 ~ 64 LSB at 10 bit (1 LSB step)	
Gain Control		×1 ~ ×4 (0~ 12 dB)	
Exposure Mode		Free Run, Timed, Trigger Width	
External Trigger		3.3 V ~ 24.0 V, 10 mA, Logical Level Input, optically isolated CoaXPress Control Port	
Software Trigger		Asynchronous, Programmable via Camera API	
Shift Range		0 ~ 7.5 μm, 1 nm step	
Shift Resolution		0.001 μm	
Shift Control		Sequence Mode (mono4, mono9, mono2H, mono2V, bayer4, bayer16)	
Lens Mount		F-mount	
Power	Adapter	11 ~ 30 V DC, Max. 12 W	
	PoCXP	24 V DC, Minimum of two PoCXP cables required	
Environmental		Operating: 0°C ~ 40°C, Storage : -40°C ~ 70°C	
Mechanical		80×80×150 mm 1100 g (with F-mount)	
API SDK		Viewworks Imaging Solution 7.X	

**Table 5.1 Specifications of VN CXP Series**

## 5.3 Camera Block Diagram



**Figure 5.1 Camera Block Diagram**

All controls and data processing of the camera are carried out in one FPGA chip. The FPGA generally consists of a 32 bit RICS Micro-Controller and Processing & Control logic. The Micro-Controller receives commands from the user through the CoaXPress interface and then processes them. The Processing & Control Logic processes the image data received from the CMOS sensor and then transmits data through the CoaXPress interface. And also, the Processing & Control Logic controls the trigger input and strobe output signals which are sensitive to time. Furthermore, a DDR3 to process images and a Flash for operating Micro-Controller are installed outside FPGA. And, PZT Driver is applied to control XY Stage with nanometers unit.

## 5.4 Sensor Information

The following graph shows the spectral response for VN-25MX monochrome and color camera.

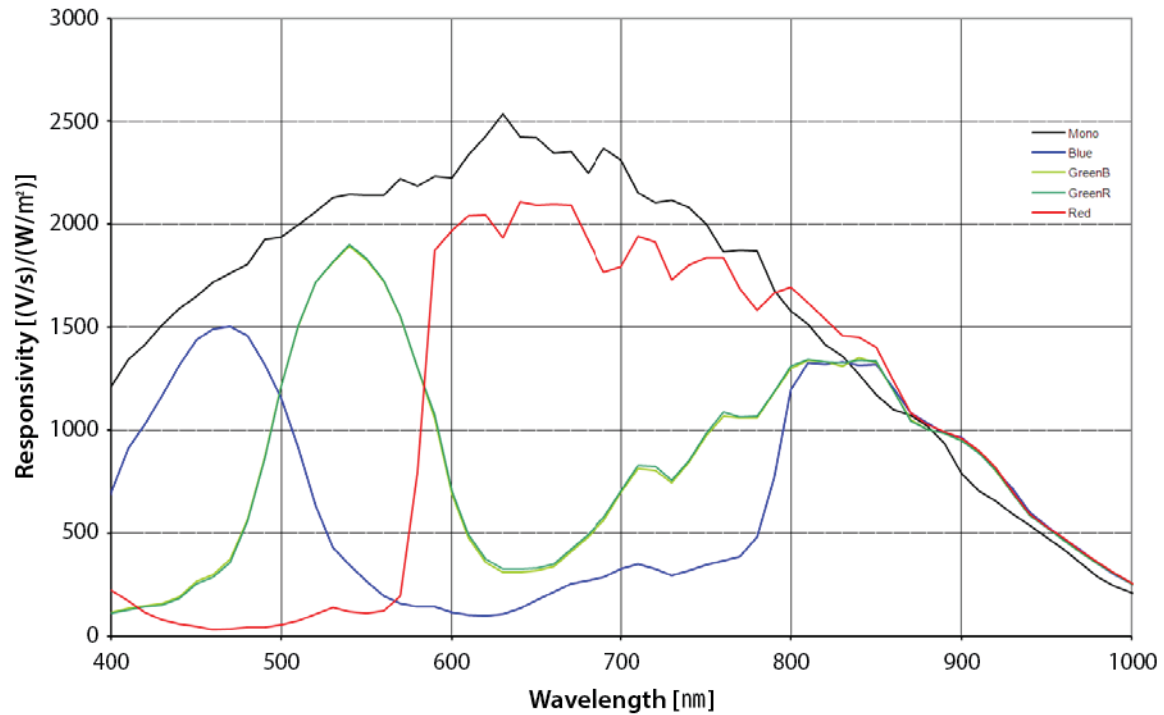


Figure 5.2 Mono and Color Spectral Response for VN-25MX

## 5.5 Mechanical Specification

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

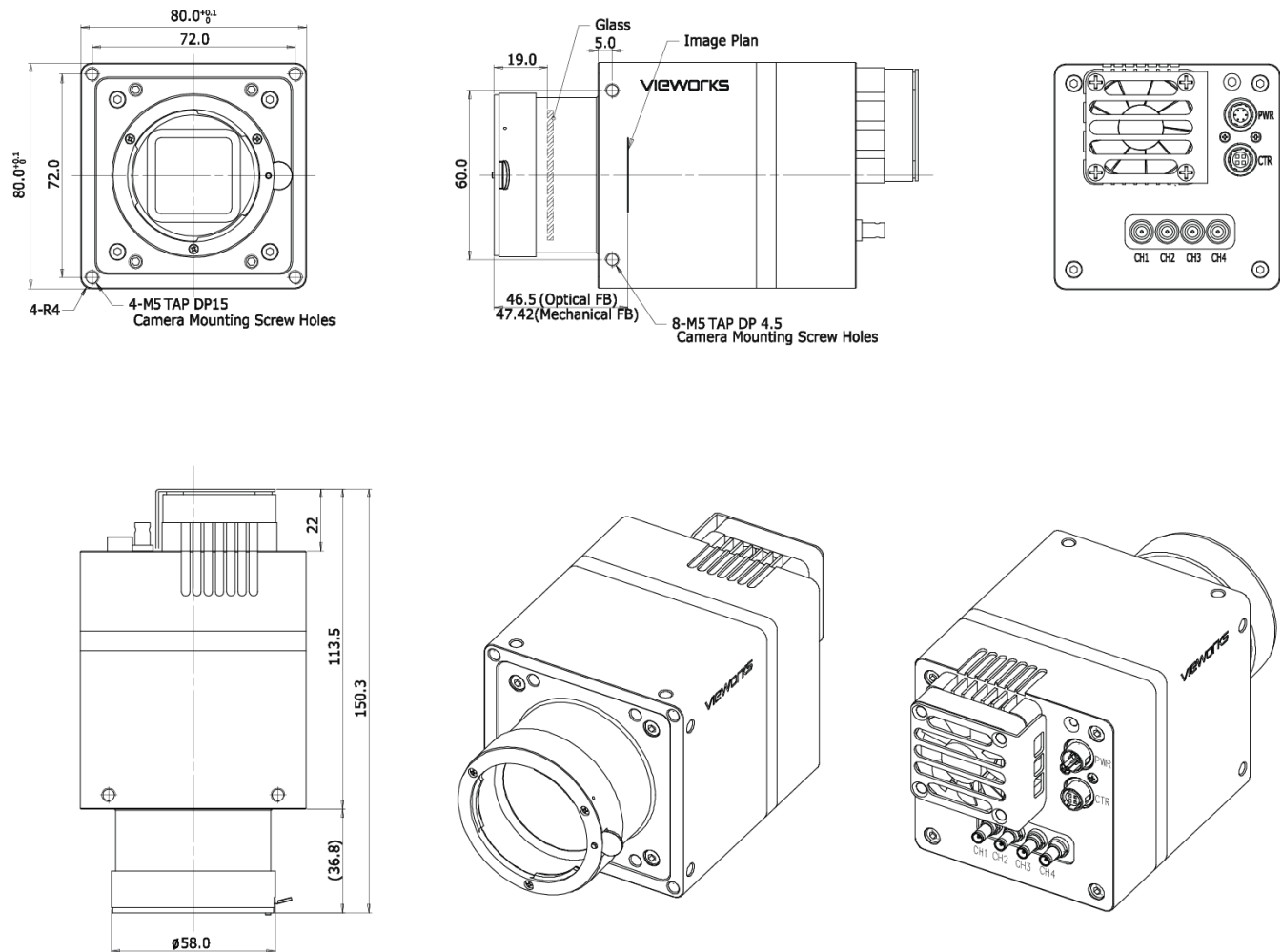


Figure 5.3 Mechanical Dimensions for VN-CXP F-mount with DIN 1.0/2.3-type Connectors

## 6 Installation

The following instructions assume that you have installed a CoaXPress Frame Grabber (hereinafter 'CXP Frame Grabber') 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 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:

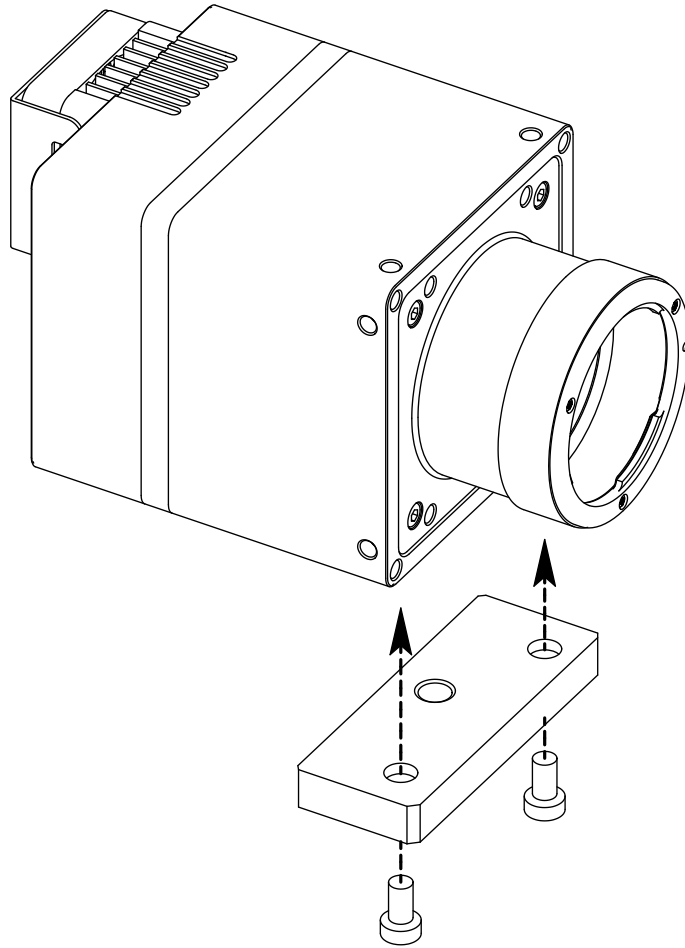
1. Make sure that the power supply is not connected to the camera and your computer is turned off.
  - Go on to step 2 if you are using a power supply.
  - Go on to step 3 if you are using a Power over CoaXPress (PoCXP) Frame Grabber.
2. **If you are using a power supply:**
  - a. Plug one end of a coax 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 one ends of the other three coax cables into CH2, CH3 and CH4 of the CXP connector on the camera and the other ends of the coax cables into the CH2, CH3 and CH4 of the CXP Frame Grabber respectively.
  - b. Connect the plug of the power adapter to 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 one ends of the other three coax cables into CH2, CH3, and CH4 of the CXP connector on the camera and the other ends of the coax cables into the CH2, CH3 and CH4 of the CXP Frame Grabber respectively.
  - b. You must connect both CH1 and CH2 channels to power the camera via PoCXP.
4. Verify all the cable connections are secure.

### Precautions for using Power over CoaXPress



- Since VN-25MX supports only two and four channels, you must use two or more coax cables to configure a link between a camera and CXP Frame Grabber. At this time, you must connect the CH1 of the CXP connector on the camera to the CH1 of the CXP Frame Grabber.
- To power a camera via PoCXP Frame Grabber, you must connect both CH1 and CH2 channels of the camera to their respective connectors on the CXP Frame Grabber.

## 6.1 Mount Plate



- The mount plate is provided as an optional item.
- The camera can be fixed without using this mount plate.



## 6.2 Precaution to Center the Imaging Sensor

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

## 6.3 Precaution about Blurring Compared to Center

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

## 6.4 Installing Vieworks Imaging Solution

You can download the Vieworks Imaging Solution at [machinevision.vieworks.com](http://machinevision.vieworks.com). You should perform the software installation first and then the hardware installation.

## 7 Camera Interface

### 7.1 General Description

As shown in the figure below, 3 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 6 pin power input receptacle: supplies power to the camera (if PoCXP is not used).
- ③ 4 pin control receptacle: provides access to the camera's I/O lines.
- ④ CoaXPress connector: controls video data and the camera.

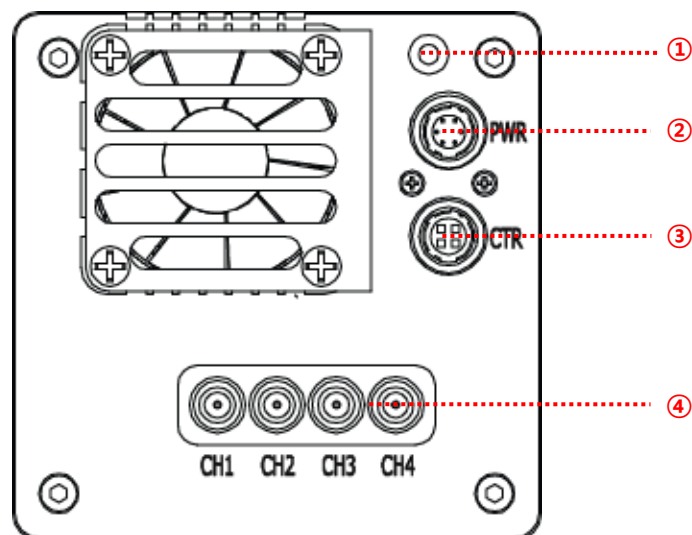


Figure 7.1 VN CXP with DIN 1.0/2.3-type Connectors

## 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. VN-25MX cameras can be powered over the coax cable if you are using a PoCXP enabled Frame Grabber.

### 7.2.1 CoaXPress DIN Connector (75 $\Omega$ 1.0/2.3 DIN Receptacle)

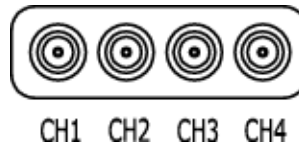


Figure 7.2 CoaXPress DIN 1.0/2.3-type Connectors

The CoaXPress connector on the VN CXP 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
CH3	6.25 Gbps	Extension Connection	No
CH4	6.25 Gbps	Extension Connection	No

Table 7.1 Channel Assignments for CoaXPress Connector



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 serial 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:

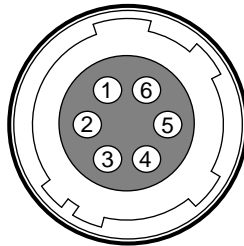


Figure 7.3 Pin Assignments for 6-pin Power Input Receptacle

Pin Number	Signal	Type	Description
1, 2, 3	+12V DC	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. The power adapter is recommended to have at least 2 A current output at 12 V DC  $\pm 10\%$  voltage output (Users need to purchase a power adapter separately).

### Precaution for Power Input



- 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:

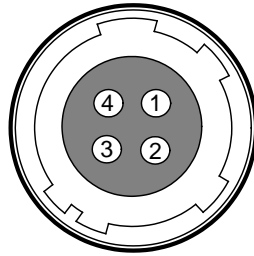


Figure 7.4 Pin Assignments for 4-pin Control I/O Receptacle

Pin Number	Signal	Type	Description
1	Trigger Input +	Input	-
2	Trigger Input -	Input	-
3	DC Ground	-	DC Ground
4	Strobe Out	Output	3.3 V TTL Output Output Resistance: 47Ω

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 Input Circuit

The following figure shows trigger signal input circuit of the 4-pin connector. Transmitted trigger signal is applied to the internal circuit through a photo coupler. The minimum trigger width that can be recognized by the camera is 1  $\mu$ s. If transmitted trigger signal is less than 1  $\mu$ s, the camera will ignore the trigger signal. An external trigger circuit example is shown below.

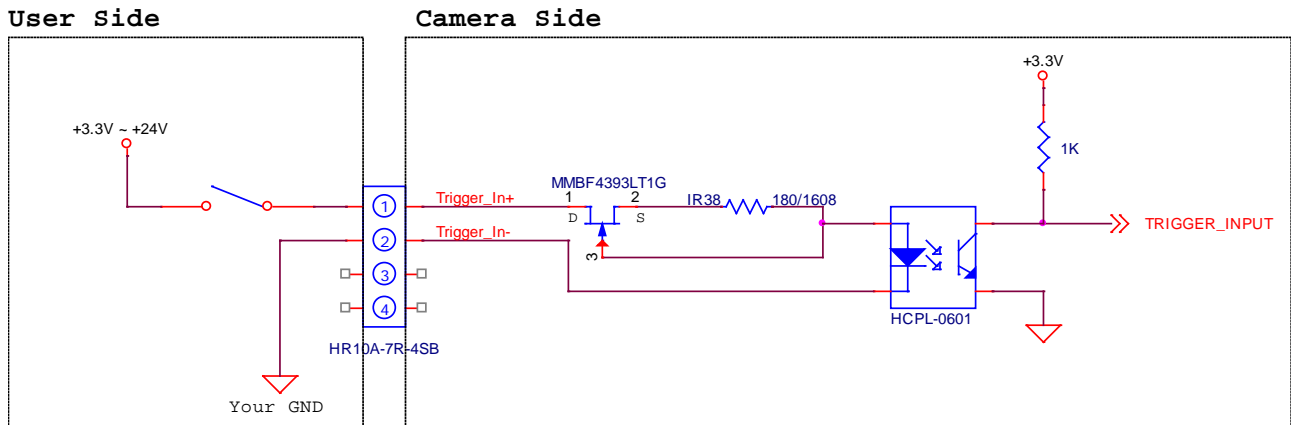


Figure 7.5 Trigger Input Schematic

## 7.6 Strobe Output Circuit

The strobe output signal comes out through a 3.3 V output level of TTL Driver IC. A pulse width of the signal is synchronized with an exposure (shutter) signal of the camera (refer to [9.13 Digital IO Control](#)).

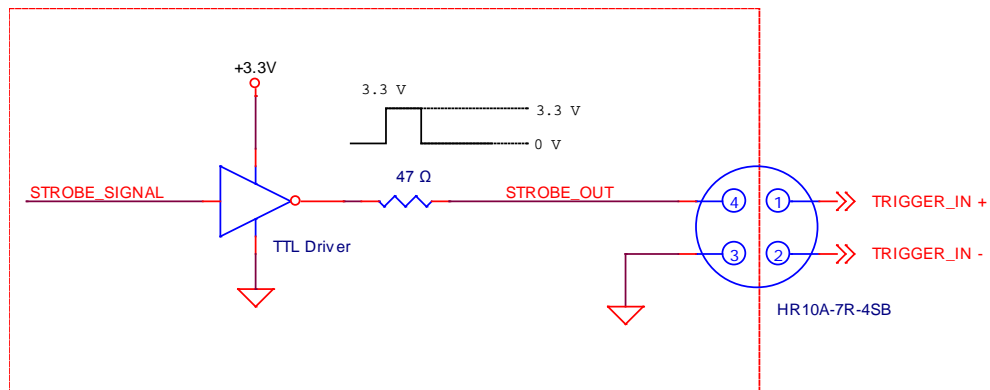


Figure 7.6 Strobe Output Schematic

## 8 Acquisition Control

This chapter provides detailed information about controlling image acquisition.

- Triggering image acquisition
- Setting the exposure time
- Controlling the camera's image acquisition rate
- Variation of the camera's maximum allowed image acquisition rate according to the camera settings

### 8.1 Overview

This section presents an overview of the elements involved with controlling the acquisition of images.

Three major elements are involved in controlling the acquisition of images:

- **Acquisition Start** and **Acquisition Stop** commands and the **Acquisition Mode** parameter
- Exposure Start trigger
- Exposure time control



When reading the explanations in the overview and in this entire chapter, keep in mind that the term **frame** is typically used to mean a single acquired image.

#### Acquisition Start and Stop Commands and the Acquisition Mode

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

A parameter called the **Acquisition Mode** has a direct bearing on how the **Acquisition Start** command operates. VN CXP cameras only support **Continuous** for the **Acquisition Mode** parameter.

If the **Acquisition Mode** parameter is set to **Continuous**, an **Acquisition Start** command does not expire after a single frame is acquired. Once an **Acquisition Start** command has been executed, you can acquire as many frames as you like. The **Acquisition Start** command will remain in effect until you execute an **Acquisition Stop** command. Once an **Acquisition Stop** command has been executed, the camera will not be able to acquire frames until a new **Acquisition Start** command is executed.

## Exposure Start Trigger

Applying an exposure start trigger signal to the camera will exit the camera from the *waiting for exposure start trigger* acquisition status and will begin the process of exposing and reading out a frame (see Figure 8.1).

As soon as the camera is ready to accept another exposure start trigger signal, it will return to the *waiting for exposure start trigger* acquisition status. A new exposure start trigger signal can then be applied to the camera to begin another frame exposure.

The exposure start trigger has two modes: off and on.

If the **Trigger Mode** parameter is set to **Off**, the camera will generate all required exposure start trigger signals internally, and you do not need to apply exposure start trigger signals to the camera. The rate at which the camera will generate the signals and acquire frames will be determined by the way that you set several frame rate related parameters.

If the **Trigger Mode** parameter is set to **On**, you must trigger exposure start by applying exposure start trigger signals to the camera. Each time a trigger signal is applied, the camera will begin a frame exposure. When exposure start is being triggered in this manner, it is important that you do not attempt to trigger frames at a rate that is greater than the maximum allowed (There is a detailed explanation about the maximum allowed frame rate at the end of this chapter.). Exposure start trigger signals applied to the camera when it is not in a *waiting for exposure start trigger* acquisition status will be ignored.

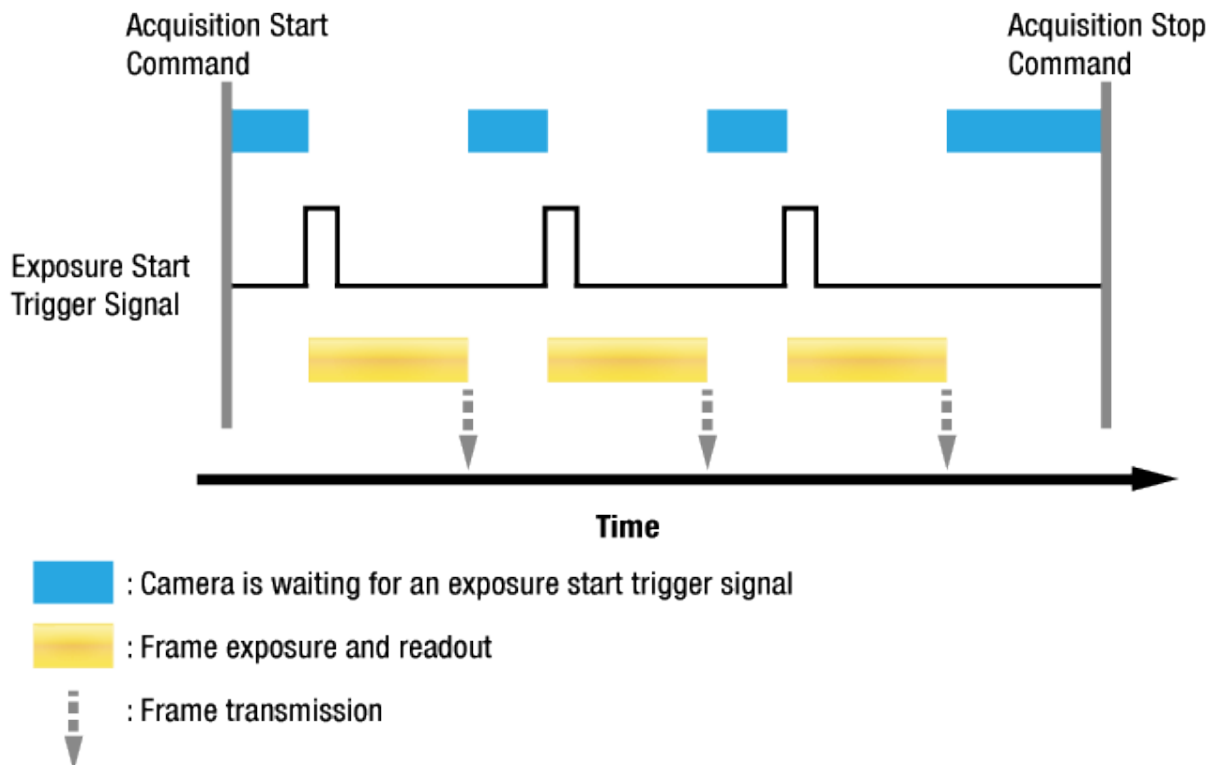


Figure 8.1 Exposure Start Triggering



## Applying Trigger Signals

The paragraphs above mention "applying a trigger signal". There are three ways to apply an exposure start trigger signal to the camera: via **Software**, via **CXPin** or via **Lineln0** (commonly referred to as hardware).

To apply trigger signals via **Software**, you must set the **Trigger Source** parameter to **Software**. At that point, each time a **Trigger Software** command is executed, the exposure start trigger signal will be applied to the camera.

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 exposure 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 **Lineln0**. At that point, each time a proper electrical signal is applied to the camera, an occurrence of the exposure start trigger signal will be recognized by the camera.

## Exposure Time Control

When an exposure start trigger signal is applied to the camera, the camera will begin to acquire a frame.

A critical aspect of frame acquisition is how long the pixels in the camera's sensor will be exposed to light during the frame acquisition.

If the **Trigger Source** parameter is set to **Software**, a parameter called the **Exposure Time** will determine the exposure time for each frame. At this point, you must set the **Exposure Mode** parameter to **Timed**.

If the **Trigger Source** parameter is set to **CXPin** or **Lineln0**, there are two modes of operation: **Timed** and **Trigger Width**.

With the **Timed** mode, the **Exposure Time** parameter will determine the exposure time for each frame.

With the **Trigger Width** mode, the way that you manipulate the rise and fall of the CoaXPress or external signal will determine the exposure time. The **Trigger Width** mode is especially useful if you want to change the exposure time from frame to frame.

## 8.2 Acquisition Start/Stop Commands and Acquisition Mode

Executing an **Acquisition Start** command prepares the camera to acquire frames. You must execute an **Acquisition Start** command before you can begin acquiring frames. Executing an **Acquisition Stop** command terminates the camera's ability to acquire frames. When the camera receives an **Acquisition Stop** command:

- If the camera is not in the process of acquiring a frame, its ability to acquire frames will be terminated immediately.
- If the camera is in the process of acquiring a frame, the frame acquisition process will be allowed to finish and the camera's ability to acquire new frames will be terminated.

VN CXP cameras only provide the '**Continuous**' mode of operation for the **Acquisition Mode**.

After an **Acquisition Start** command has been executed, exposure start can be triggered as desired. Each time an exposure start trigger is applied while the camera is in a *waiting for exposure start trigger* acquisition status, the camera will acquire and transmit a frame. The camera will retain the ability to acquire frames until an **Acquisition Stop** command is executed. Once the **Acquisition Stop** command is received, the camera will no longer be able to acquire frames.

## 8.3 Exposure Start Trigger

The **Trigger Selector** parameter is used to select a type of trigger and only the **Exposure Start** trigger is available on the VN CXP camera. The Exposure Start trigger is used to begin frame acquisition.

Exposure start trigger signals can be generated within the camera or may be applied externally by setting the **Trigger Source** parameter to **Software**, **CXPIn** or **LineIn0**. If an exposure start trigger signal is applied to the camera, the camera will begin to expose a frame.

### 8.3.1 Trigger Mode

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

#### 8.3.1.1 Trigger Mode = Off

When the **Trigger Mode** parameter is set to **Off**, the camera will generate all required exposure start trigger signals internally, and you do not need to apply exposure start trigger signals to the camera.

If the **Trigger Mode** parameter is set to **Off**, the camera will automatically begin generating exposure start trigger signals when it receives an **Acquisition Start** command. The camera will continue to generate exposure 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 referred to as “free run”.

The rate at which the exposure start trigger signals are generated may be determined by the camera's **Acquisition Frame Rate** parameter.

- If the parameter is set to a value less than the maximum allowed frame rate with the current camera settings, the camera will generate exposure start trigger signals at the rate specified by the parameter setting.
- If the parameter is set to a value greater than the maximum allowed frame rate with the current camera settings, the camera will generate exposure start trigger signals at the maximum allowed frame rate.

### Exposure Time Control with Trigger Mode = Off

When the **Trigger Mode** parameter is set to **Off**, the exposure time for each frame acquisition is determined by the value of the camera's **Exposure Time** parameter. For more information about the Exposure Time parameter, see [8.4 Setting the Exposure Time](#).

### 8.3.1.2 Trigger Mode = On

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

The available settings for the **Trigger Source** parameter are:

- **Software:** You can apply an exposure start trigger signal to the camera by executing a **Trigger Software** command for the exposure start trigger on your computer.
- **CXPin:** You can apply an exposure start trigger signal via CH1 of the CXP Frame Grabber. For more information, refer to your CXP Frame Grabber User Manual.
- **LineIn0:** You can apply an exposure 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 Input Circuit](#) for more information.

If the **Trigger Source** parameter is set to **CXPin** or **LineIn0**, 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 exposure start trigger.
- **Falling Edge:** Specifies that a falling edge of the electrical signal will act as the exposure start trigger.

### Exposure Time Control with Trigger Mode = On

When the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **Software**, the exposure time for each frame acquisition is determined by the value of the camera's **Exposure Time** parameter.

When the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **CXPin** or **LineIn0**, the exposure time for each frame acquisition can be controlled with the **Exposure Time** parameter or it can be controlled by manipulating the external trigger signal.

### 8.3.2 Using a Software Trigger Signal

If the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **Software**, you must apply a software trigger signal (exposure start) to the camera to begin each frame acquisition. Assuming that the camera is in a *waiting for exposure start trigger* acquisition status, frame exposure will start when the software trigger signal is received by the camera. Figure 8.2 illustrates frame acquisition with a software trigger signal.

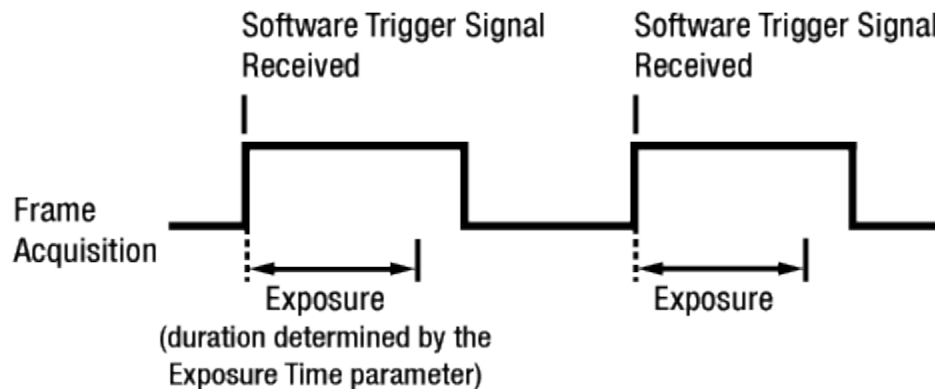
When the camera receives a software trigger signal and begins exposure, it will exit the *waiting for exposure start trigger* acquisition status because at that point, it cannot react to a new exposure start trigger signal.

As soon as the camera is capable of reacting to a new exposure start trigger signal, it will automatically return to the *waiting for exposure start trigger* acquisition status.

When you are using a software trigger signal to start each frame acquisition, the camera's **Exposure Mode** parameter must be set to **Timed**. The exposure time for each acquired frame will be determined by the value of the camera's **Exposure Time** parameter.



When you use a software trigger signal to acquire frames, be aware that there is a Trigger Latency due to the characteristics of the CoaXPress. Use an external trigger signal to precisely synchronize the trigger signal with the exposure timing.



**Figure 8.2 Frame Acquisition with Software Trigger Signal**

When you are using a software trigger signal to start each frame acquisition, the frame rate will be determined by how often you apply a software trigger signal to the camera, and you should not attempt to trigger frame acquisition at a rate that exceeds the maximum allowed for the current camera settings. (There is a detailed explanation about the maximum allowed frame rate at the end of this chapter.) Software trigger signals that are applied to the camera when it is not ready to receive them will be ignored.

### 8.3.3 Using a CoaXPress Trigger Signal

If the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **CXPin**, you must apply a CoaXPress trigger signal to the camera to begin each frame acquisition. A CoaXPress trigger signal will act as the exposure start trigger signal for the camera. For more information, refer to your CXP Frame Grabber User Manual.

A rising edge or a falling edge of the CoaXPress signal can be used to trigger frame acquisition. The **Trigger Activation** parameter is used to select rising edge or falling edge triggering.

Assuming that the camera is in a *waiting for exposure start trigger* acquisition status, frame acquisition will start whenever the appropriate edge transition is received by the camera.

When the camera receives a CoaXPress trigger signal and begins exposure, it will exit the waiting for exposure start trigger acquisition status because at that point, it cannot react to a new exposure start trigger signal.

As soon as the camera is capable of reacting to a new exposure start trigger signal, it will automatically return to the *waiting for exposure start trigger* acquisition status.

When the camera is operating under control of a CoaXPress signal, the period of the CoaXPress trigger signal will determine the rate at which the camera is acquiring frames:

$$\frac{1}{\text{CoaXPress signal period in seconds}} = \text{Frame Rate}$$

For example, if you are operating a camera with a CoaXPress trigger signal period of 50 ms (0.05 s):

So in this case, the frame rate is 20 fps.

### 8.3.4 Using an External Trigger Signal

If the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **LineIn0**, an externally generated electrical signal injected into the Control I/O Receptacle pin 1 will act as the exposure start trigger signal for the camera. This type of trigger signal is generally referred to as a hardware trigger signal.

A rising edge or a falling edge of the external signal can be used to trigger frame acquisition. The **Trigger Activation** parameter is used to select rising edge or falling edge triggering.

Assuming that the camera is in a *waiting for exposure start trigger* acquisition status, frame acquisition will start whenever the appropriate edge transition is received by the camera.

When the camera receives an external trigger signal and begins exposure, it will exit the *waiting for exposure start trigger* acquisition status because at that point, it cannot react to a new exposure start trigger signal.

As soon as the camera is capable of reacting to a new exposure start trigger signal, it will automatically return to the *waiting for exposure start trigger* acquisition status.

When the camera is operating under control of an external signal, the period of the external trigger signal will determine the rate at which the camera is acquiring frames:

$$\frac{1}{\text{External signal period in seconds}} = \text{Frame Rate}$$

For example, if you are operating a camera with an External trigger signal period of 50 ms (0.05 s):

So in this case, the frame rate is 20 fps.

### 8.3.4.1 Exposure Modes

If you are triggering the start of frame acquisition with an externally (CoaXPress or External) generated trigger signal, two exposure modes are available: **Timed** and **Trigger Width**.

#### Timed Exposure Mode

When the **Timed** mode is selected, the exposure time for each frame acquisition is determined by the value of the camera's **Exposure Time** parameter. If the camera is set for rising edge triggering, the exposure time starts when the external trigger signal rises. If the camera is set for falling edge triggering, the exposure time starts when the external trigger signal falls. Figure 8.3 illustrates **Timed** exposure with the camera set for rising edge triggering.

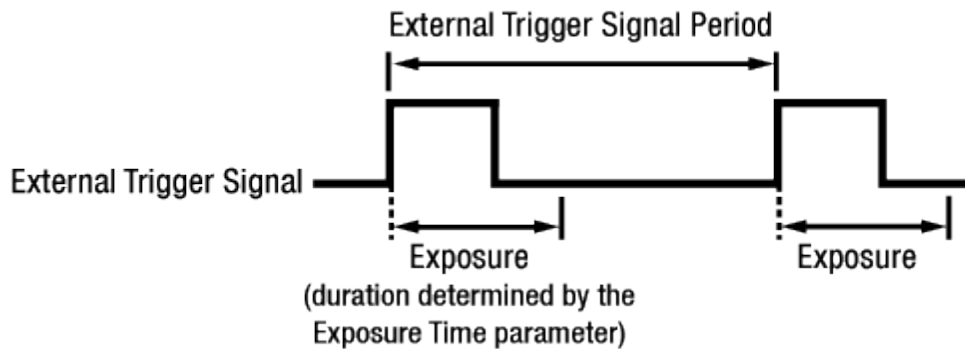


Figure 8.3 Timed Exposure Mode

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

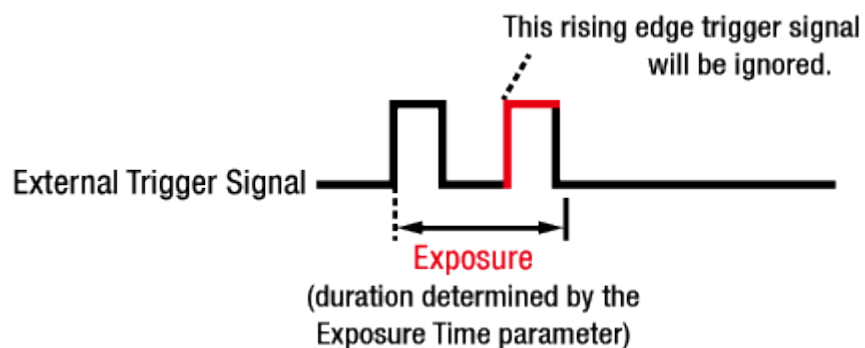


Figure 8.4 Trigger Overlapped with Timed Exposure Mode



## Trigger Width Exposure Mode

When the **Trigger Width** exposure mode is selected, the length of the exposure for each frame acquisition will be directly controlled by the external trigger signal (CoaXPress or External). If the camera is set for rising edge triggering, the exposure time begins when the external trigger signal rises and continues until the external trigger signal falls. If the camera is set for falling edge triggering, the exposure time begins when the external trigger signal falls and continues until the external trigger signal rises. Figure 8.5 illustrates **Trigger Width** exposure with the camera set for rising edge triggering.

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

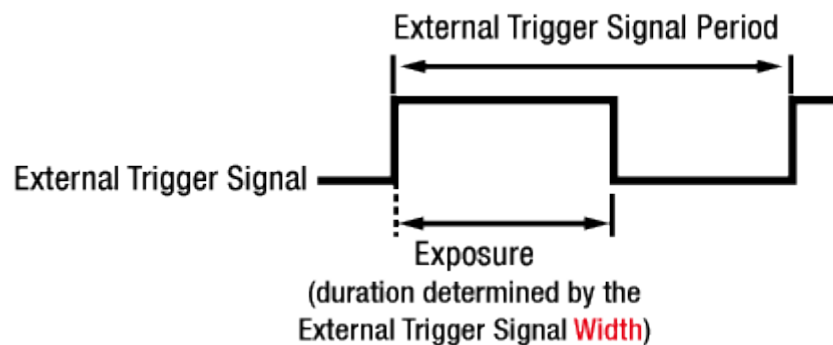


Figure 8.5 Trigger Width Exposure Mode

## 8.4 Setting the Exposure Time

This section describes how the exposure time can be adjusted manually by setting the value of the **Exposure Time** parameter. If you are operating the camera in any one of the following ways, you must specify an exposure time by setting the camera's **Exposure Time** parameter.

- the **Trigger Mode** is set to **Off**
- the **Trigger Mode** is set to **On** and the **Trigger Source** is set to **Software** (In this case, you must set the **Exposure Mode** parameter to **Timed**.)
- the **Trigger Mode** is set to **On**, the **Trigger Source** is set to **CXPIn** or **LineIn0**, and the **Exposure Mode** is set to **Timed**.

The **Exposure Time** parameter must not be set below a minimum specified value. The **Exposure Time** parameter sets the exposure time in microseconds ( $\mu\text{s}$ ). The minimum and maximum exposure time settings for each camera model are shown in the following table.

Camera Model	Number of Channels	Minimum Exposure Time	Maximum Exposure Time <sup>†</sup>
VN-25MX	2 Channels	10 $\mu\text{s}$	60,000,000 $\mu\text{s}$
	4 Channels	10 $\mu\text{s}$	60,000,000 $\mu\text{s}$

<sup>†</sup>: When the **Exposure Mode** is set to **Trigger Width**, the exposure time is controlled by the external trigger signal and has no maximum limit.

**Table 8.1 Minimum and Maximum Exposure Time Setting**

## 8.5 Overlapping Exposure with Sensor Readout

The frame acquisition process on the camera includes two distinct parts. The first part is the exposure of the pixels in the imaging sensor. Once exposure is complete, the second part of the process – readout of the pixel values from the sensor – takes place. In regard to this frame acquisition process, VN CXP cameras basically operate with 'overlapped' exposure so that the exposure for a new frame can be overlapped with the sensor readout for the previous frame.

When the **Trigger Mode** parameter is set to **On**, the exposure of a new frame begins while the camera is still reading out the sensor data for the previously acquired frame. This situation is illustrated in Figure 8.6 with the **Trigger Source** parameter set to **LineIn0** and the **Exposure Mode** parameter set to **Trigger Width**.

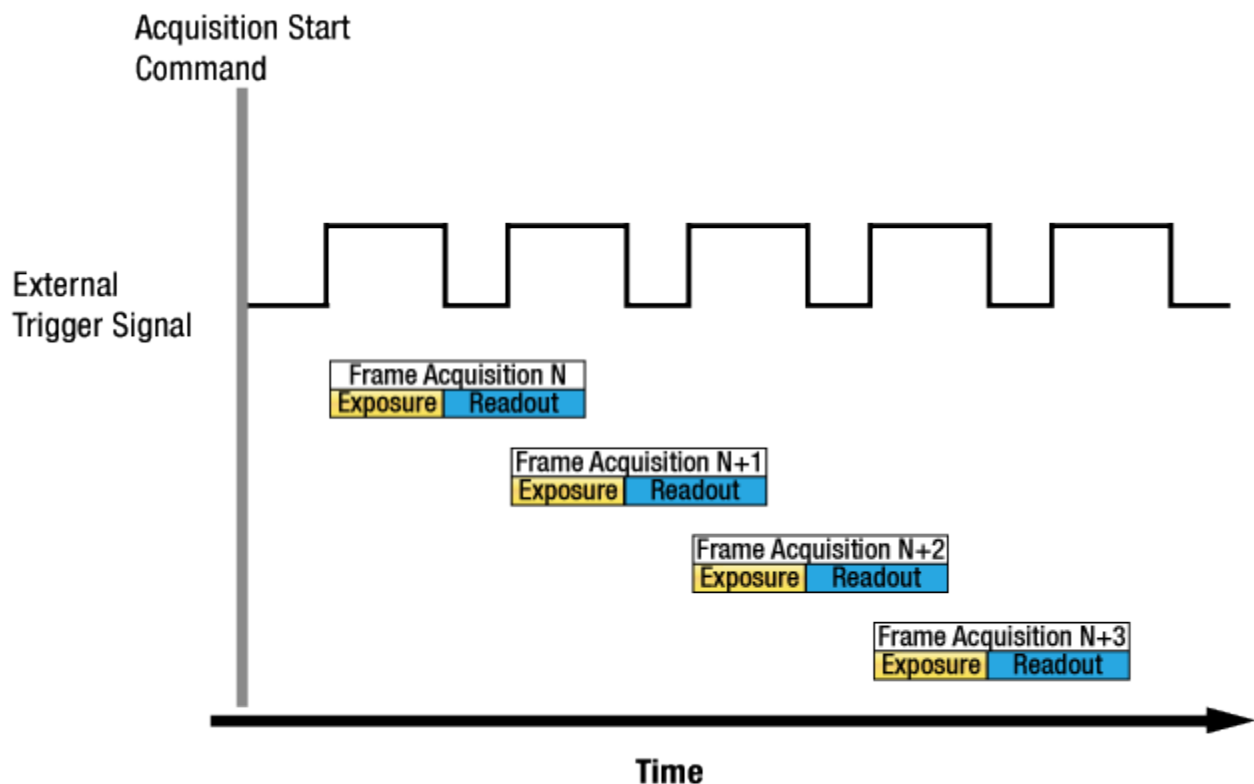


Figure 8.6 Overlapped Exposure and Readout

Determining whether your camera is operating with overlapped exposure and readout is not a matter of issuing a command or changing a setting. Rather a way that you operate the camera will determine whether the exposures and readouts are overlapped or not. If we define the "Frame Period" as the time from the start of exposure for one frame acquisition to the start of exposure for the next frame acquisition, then:

- Overlapped:  $\text{Frame Period} \leq \text{Exposure Time} + \text{Readout Time}$

## Guidelines for Overlapped Exposure

Since VN CXP cameras operate with overlapped exposure, there are two important guidelines to keep in mind:

- You must not begin the exposure time for a new image acquisition while the exposure time of the previous acquisition is in progress.
- You must not end the exposure time of the current image acquisition until readout of the previously acquired image is complete.

When you are operating a camera with overlapped exposure and using an external trigger signal to trigger image acquisition, you could use the camera's Exposure Time parameter settings and timing formula to calculate when it is safe to begin each new acquisition.

## 8.6 Electronic Shutter Operation

VN CXP cameras are equipped with imaging sensors that have an electronic shutter. There are two types of electronic sensors, i.e. global and rolling. VN CXP cameras use sensors with global shutters.

### 8.6.1 Global Shutter

When an exposure start trigger signal is applied to the cameras equipped with a global shutter, exposure begins for all lines in the sensor as shown in Figure 8.7. Exposure continues for all lines in the sensor until the programmed exposure time ends or when the exposure start trigger signal ends the exposure time if the camera is using the trigger width exposure mode. At the end of the exposure time, exposure ends for all lines in the sensor. Immediately after the end of exposure, pixel data readout begins and proceeds line by line until all pixel data is read out of the sensor. A main characteristic of a global shutter is that for each frame acquisition, all of the pixels in the sensor start exposing at the same time and all end exposing at the same time. This means that image brightness tends to be more uniform over the entire area of each acquired image, and it helps to minimize problems with acquiring images of object in motion.

The cameras can provide a **Strobe Out** output signal that will go high when the exposure time for a frame acquisition begins and will go down when the exposure time ends.

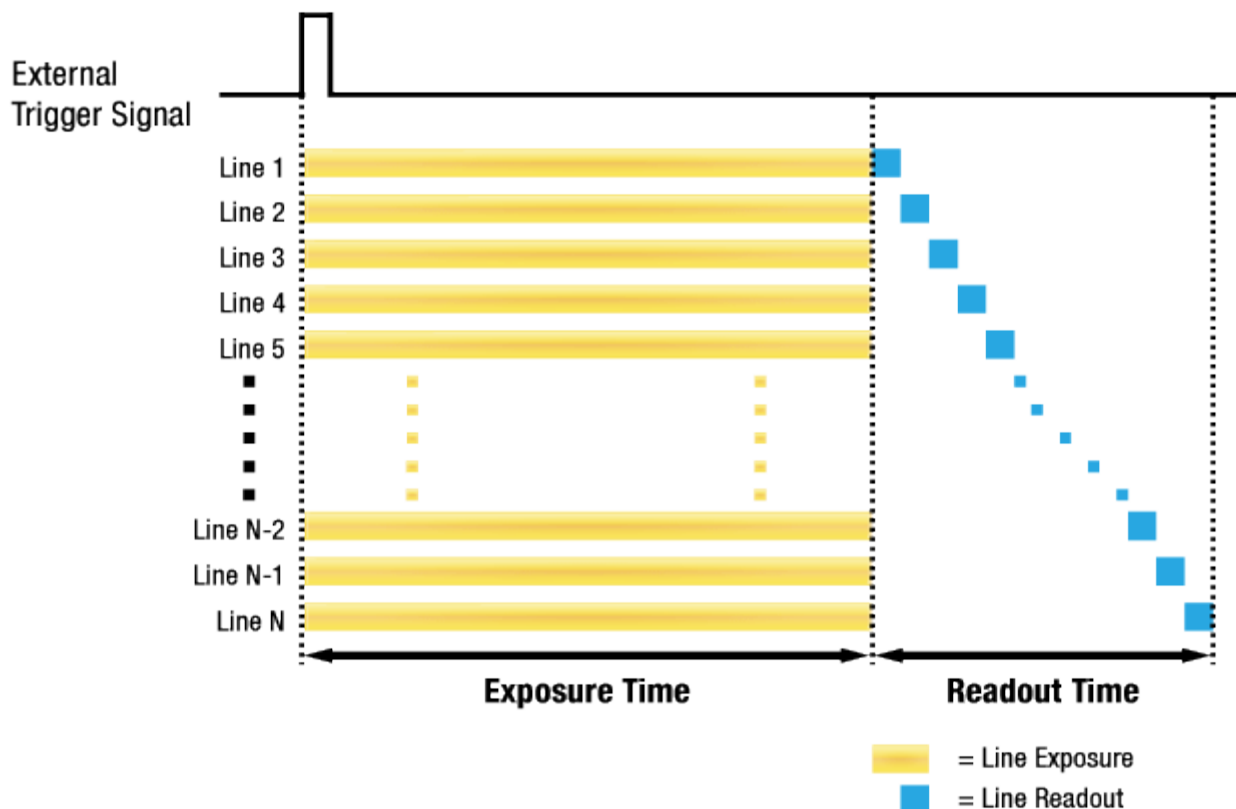


Figure 8.7 Global Shutter

## 8.7 Maximum Allowed Frame Rate

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

- The amount of time that it takes to transmit an acquired frame from the camera to your computer.  
The amount of time needed to transmit a frame depends on the bandwidth assigned to the camera.
- The amount of time it takes to read an acquired frame out of the imaging sensor and into the camera's frame buffer. This time varies depending on the setting for the **Height** parameter. Frames with a smaller height take less time to read out of the sensor. The frame height is determined by the camera's **Height** settings (**Image Format Control**).
  - On the VN-25MX camera, frames with a smaller width also take less time to read out of the sensor.  
For more information, refer to [Table 9.3](#).
- The exposure time for acquired frames. If you use very long exposure times, you can acquire fewer frames per second.

### 8.7.1 Increasing the Maximum Allowed Frame Rate

You may find that you would like to acquire frames 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 frame rate and then check to see if the maximum allowed frame rate has increased:

- The time that it takes to transmit a frame out of the camera is the main limiting factor on the frame rate. You can decrease the frame transmission time (and thus increase the maximum allowed frame rate) by using the ROI feature.
  - Use a smaller ROI. Decreasing the ROI means that the camera has less data to transmit and therefore the transmission time will decrease.
- If you are using normal exposure times and you are using the camera at its maximum resolution, your exposure time will not normally restrict the frame rate. However, if you are using long exposure times or small region of interest, it is possible that your exposure time is limiting the maximum allowed frame rate. If you are using a long exposure time or a small ROI, try using a shorter exposure time and see if the maximum allowed frame rate increases. (You may need to compensate for a lower exposure time by using a brighter light source or increasing the opening of your lens aperture.)



A very long exposure time severely limits the camera's maximum allowed frame rate.

As an example, assume that your camera is set to use a 1 second exposure time. In this case, because each frame acquisition will take at least 1 second to be completed, the camera will only be able to acquire a maximum of one frame per second.

## 9 Camera Features

### 9.1 Image Region of Interest

The Image Region of Interest (ROI) feature allows you to specify a portion of the sensor array. You can acquire only the frame data from the specified portion of the sensor array while preserving the same quality as you acquire a frame from the entire sensor array.

On the VN-25MX camera, you can achieve increased frame rates by decreasing the height and/or width of the ROI. The ROI is referenced to the top left corner [origin (0, 0)] of the sensor array as follows.

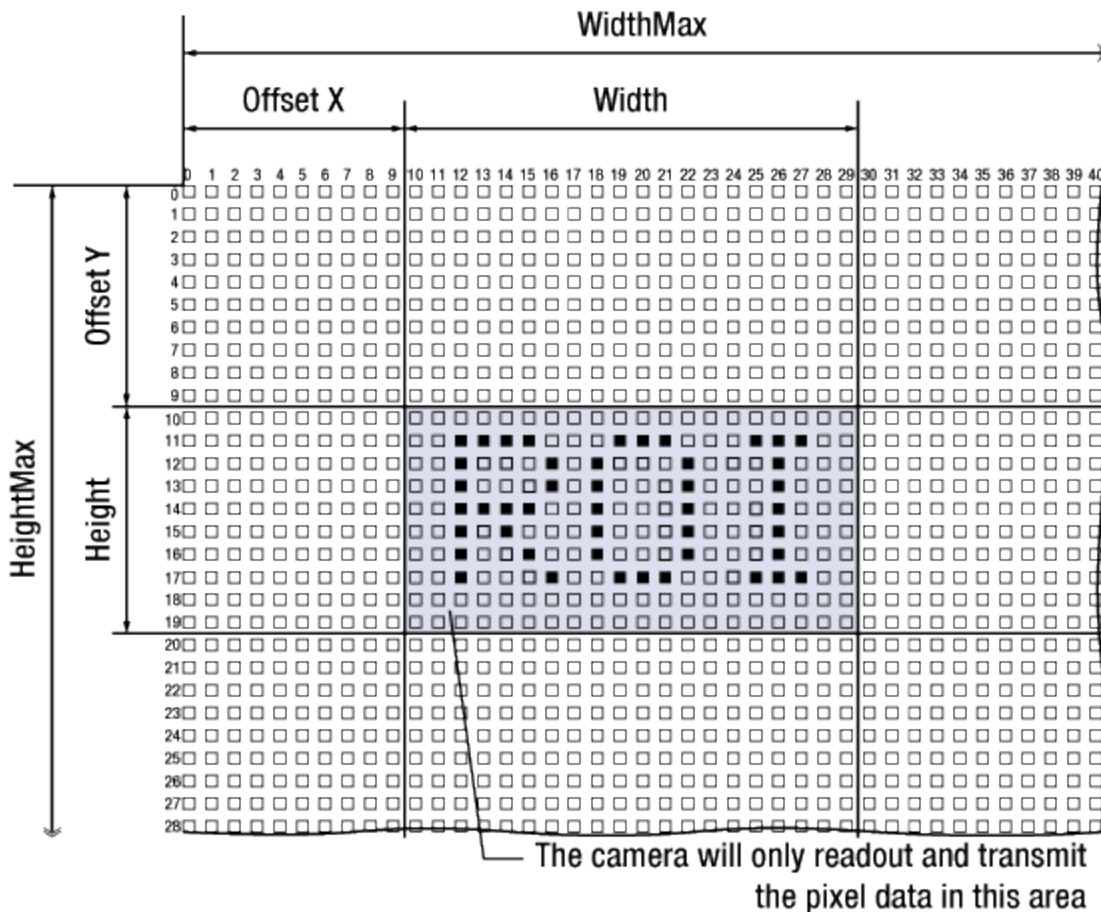


Figure 9.1 Image Region of Interest

The XML parameters related to ROI settings are as follows.

XML Parameters	Value	Description	
ImageFormatControl	SensorWidth <sup>a</sup>	-	Effective width of the sensor
	SensorHeight <sup>a</sup>	-	Effective height of the sensor
	WidthMax	-	Maximum allowed width of the image with the current camera settings
	HeightMax	-	Maximum allowed height of the image with the current camera settings
	Width <sup>b</sup>	-	Current width of the image
	Height <sup>b</sup>	-	Current height of the image
	OffsetX <sup>c</sup>	-	Horizontal offset from the origin to the Image ROI
	OffsetY <sup>c</sup>	-	Vertical offset from the origin to the Image ROI

The unit for all parameters in this table is pixel

a: Read only. User cannot change the value

b: User configurable parameters for setting ROI

c: User configurable parameters for setting the origin of the ROI

**Table 9.1 XML parameters related to ROI**

You can change the size of ROI by setting the **Width** and **Height** parameters. And also, you can change the position of the ROI origin by setting the **Offset X** and **Offset Y** parameters.

Make sure that the **Width + Offset X** value is less than the **Width Max** value, and the **Height + Offset Y** value is less than the **Height Max** value. You must set the size of the ROI first, and then set the Offset values since the **Width** and **Height** parameters are set to its maximum value by default.

- On the VN-25MX camera, the **Width** parameter must be set to a multiple of 64, and the **Height** parameter must be set to a multiple of 2 only on the color model.

The minimum allowed setting values for the ROI Width and Height are shown below.

Camera Model	Minimum Width Settings	Minimum Height Settings
VN-25MX	256	4

**Table 9.2 Minimum ROI Width and Height Settings**



On the VN-25MX camera, the maximum frame rates depending on Vertical and Horizontal ROI changes are shown below.

ROI Size (H × V)	2 Channels	4 Channels
5120 × 1000	180 fps	360 fps
5120 × 2000	92 fps	184 fps
5120 × 3000	62 fps	124 fps
5120 × 4000	46 fps	92 fps
5120 × 5120	36 fps	72 fps
256 ~ 3776 × 5120	49 fps	98 fps
4032 × 5120	46 fps	92 fps
4544 × 5120	41 fps	82 fps
5120 × 5120	36 fps	72 fps

**Table 9.3 Maximum Frame Rates by VN-25MX ROI Changes**

When you set the Sequence Mode to Mono4Frame (Bayer4Frame) or Mono9Frame, the maximum frame rates depending on Vertical and Horizontal ROI changes are shown below.

ROI Size (H × V)	Sequence Mode	2 Channels	4 Channels
5120 × 1000	Mono4Frame	45 fps	90 fps
	Mono9Frame	20 fps	40 fps
5120 × 2000	Mono4Frame	23 fps	46 fps
	Mono9Frame	10.2 fps	20.4 fps
5120 × 5120	Mono4Frame	9 fps	18 fps
	Mono9Frame	4 fps	8 fps
256 ~ 3776 × 5120	Mono4Frame	12.25 fps	24.5 fps
	Mono9Frame	5.4 fps	10.8 fps
4032 × 5120	Mono4Frame	11.5 fps	23 fps
	Mono9Frame	5.1 fps	10.2 fps
4544 × 5120	Mono4Frame	10.25 fps	20.5 fps
	Mono9Frame	4.5 fps	9.1 fps
5120 × 5120	Mono4Frame	9 fps	18 fps
	Mono9Frame	4 fps	8 fps

**Table 9.4 Maximum Frame Rates according to the Sequence Mode and ROI Changes**

## 9.2 CXP Link Configuration

VN CXP cameras 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. VN CXP cameras support one master connection and up to three extension connections to configure a link. In compliance with the CoaXPress standard, VN CXP cameras include an automatic link detection mechanism to correctly detect the camera to CXP Frame Grabber connections.

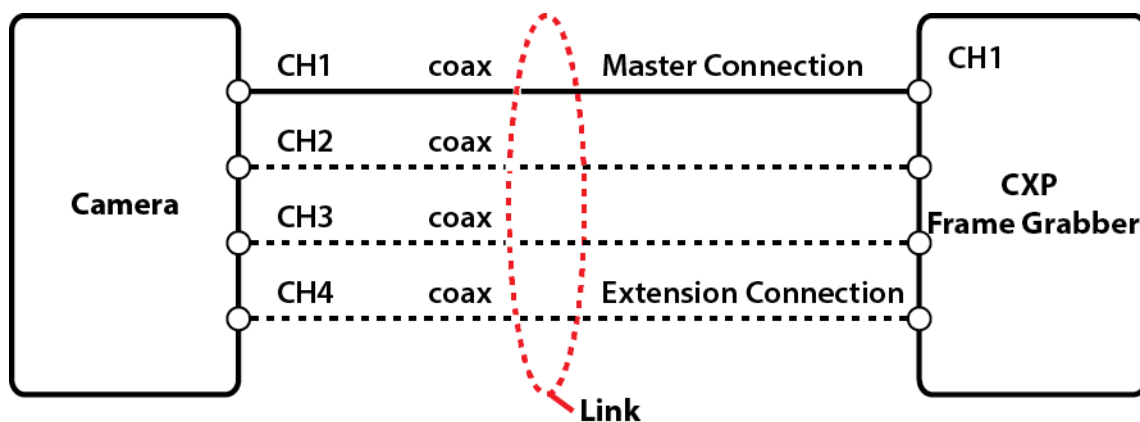


Figure 9.2 CXP Link Configuration

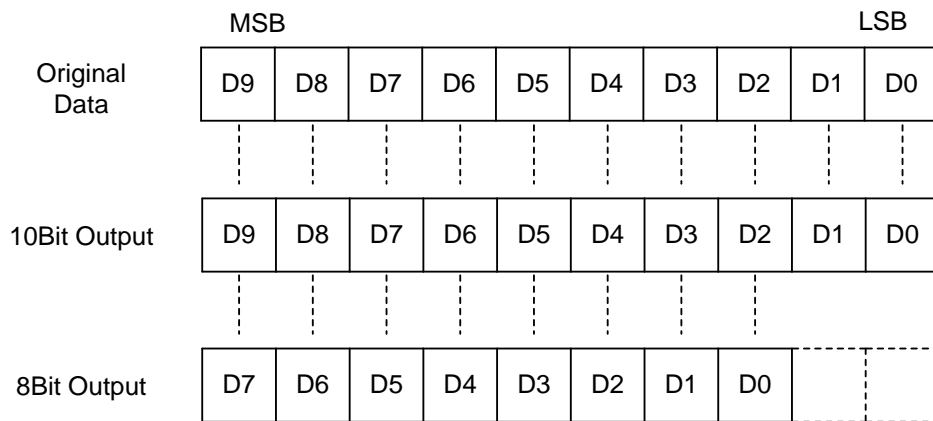
The XML parameters related to the link configuration between the camera and CXP Frame Grabber are located in the CoaXPress category under the Transport Layer Control as shown below.

XML Parameters		Value	Description
CoaXPress	CxpLinkConfigurationPreferredSwitch	CXP6_X2	Sets the <b>A</b> parameter value to CXP6_X2.
		CXP6_X4	Sets the <b>A</b> parameter value to CXP6_X4.
	CxpLinkConfigurationPreferred <sup>A</sup>	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	CXP6_X2 CXP6_X4	Forcefully sets bit rate and the number of connections for the link configuration. ex) CXP6_X4: Four connections running at a maximum of CXP6 speed (6.25 Gbps)

Table 9.5 XML Parameter related to CXP Link Configuration

## 9.3 Pixel Format

The camera processes image data in the unit of 10 bit. You can determine the format (8 bits or 10 bits) of these image data transmitted from the camera by selecting the **Pixel Format** parameter. When the camera is set for 8 bit pixel format, the 2 least significant bits will be dropped from overall 10 bits.



**Figure 9.3 Pixel Format**

The XML parameter related to the Pixel Format is as follows.

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

**Table 9.6 XML Parameter related to Pixel Format**

The available pixel formats on the monochrome and color cameras are as follows.

Mono Sensor	Color Sensor
<ul style="list-style-type: none"> <li>Mono 8</li> <li>Mono 10</li> </ul>	<ul style="list-style-type: none"> <li>Bayer RG 8</li> <li>Bayer RG 10</li> </ul>

**Table 9.7 Pixel Format Values**

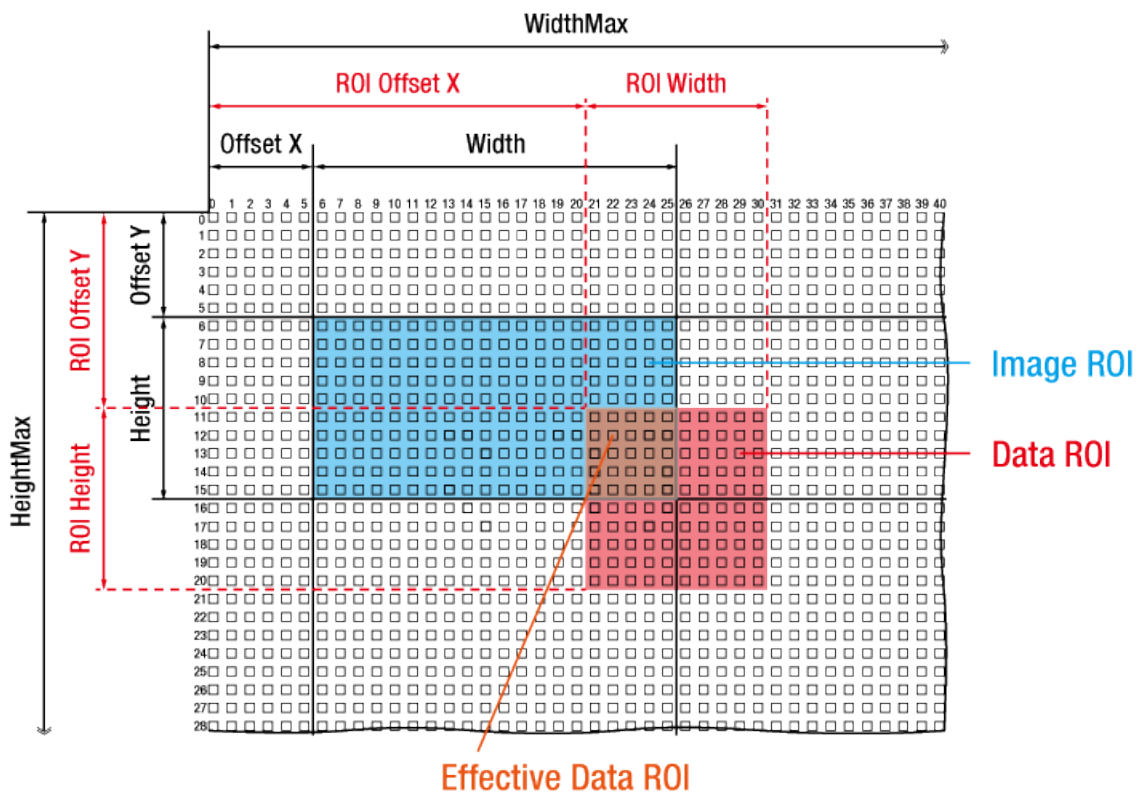
## 9.4 Data ROI (Color Camera)

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

XML Parameters		Value	Description
DataRoiControl	RoiSelector	WhiteBalanceAuto	<ul style="list-style-type: none"> <li>Selects a Data ROI used for Balance White Auto.</li> <li>Only available on color cameras</li> </ul>
	RoiOffsetX	-	X coordinate of start point ROI
	RoiOffsetY	-	Y coordinate of start point ROI
	RoiWidth	-	Width of ROI
	RoiHeight	-	Height of ROI

**Table 9.8 XML Parameters related to Data ROI**

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



**Figure 9.4 Effective Data ROI**

## 9.5 White Balance (Color Camera)

The color cameras include the white balance capability to adjust the color balance of the images transmitted from the cameras. With the white balancing scheme used on VN CXP cameras, the Red intensity and Blue intensity can be adjusted individually. You can set the intensity of each color by using the **Balance Ratio** parameter. The Balance Ratio value can range from 1.0 to 4.0. If the **Balance Ratio** parameter is set to 1.0 for a color, the intensity of the color will be unaffected by the white balance mechanism. If the **Balance Ratio** is set to greater than 1.0, the intensity of the color will be proportionally increased to the ratio. For example, if the Balance Ratio is set to 1.5, the intensity of that color will be increased by 50%.

The XML parameters related to White Balance are as follows.

XML Parameters		Value	Description
AnalogControl	BalanceRatioSelector	Red	A Balance Ratio will be applied to red pixels.
		Blue	A Balance Ratio will be applied to blue pixels.
	BalanceRatio	×1.0 ~ ×4.0	Controls ratio of the selected color by referring to Green.

Table 9.9 XML Parameters related to White Balance

### 9.5.1 Balance White Auto

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

XML Parameters		Value	Description
AnalogControl	BalanceWhiteAuto	Off	Balance White Auto Off
		Once	White Balance is adjusted once and then Off.

Table 9.10 XML Parameters related to Balance White Auto

## 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 imaging sensor.

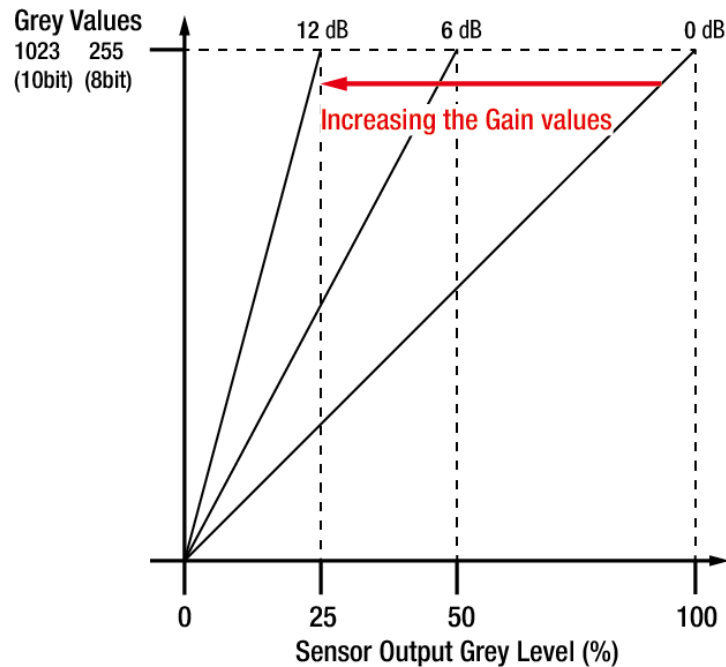


Figure 9.5 Setting the Gain

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	GainSelector	DigitalAll	Applies gain to all digital channels.
	Gain	× 1.0~× 4.0	Sets an absolute physical gain value (0 dB ~ 12 dB)
	BlackLevelSelector	DigitalAll	Applies black level to all digital channels.
	BlackLevel	0~16 0~64	Sets an absolute physical black level value. <ul style="list-style-type: none"> <li>0 ~ 16 LSB @ 8 bit</li> <li>0 ~ 64 LSB @ 10 bit</li> </ul>

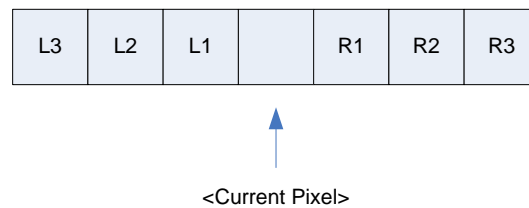
Table 9.11 XML Parameters related to Gain and Black Level

## 9.7 Defective Pixel Correction

The CMOS sensor may have Defect Pixels which cannot properly react to the light. Correction is required since it may deteriorate the quality of output image. Defect Pixel information of CMOS used for each camera is entered into the camera during the manufacturing process. If you want to add Defect Pixel information, it is required to enter coordinate of new Defect Pixel into the camera. For more information, refer to [Appendix A](#).

### 9.7.1 Correction Method

Correction value for Defect Pixel is calculated based on valid pixel value adjacent in the same line.



**Figure 9.6 Location of Defect Pixel to be corrected**

If Current Pixel is a Defect Pixel as shown in the above figure, correction value of this pixel is obtained as shown in the following table depending on whether surrounding pixel is Defect Pixel or not.

Adjacent Defect Pixel (s)	Correction Value of Current Pixel
None	$(L1 + R1) / 2$
L1	R1
R1	L1
L1, R1	$(L2 + R2) / 2$
L1, R1, R2	L2
L2, L1, R1	R2
L2, L1, R1, R2	$(L3 + R3) / 2$
L2, L1, R1, R2, R3	L3
L3, L2, L1, R1, R2	R3

**Table 9.12 Calculation of Defect Pixel Correction Value**



You must download a Defect Pixel Map to the camera before using the **Defective Pixel Correction** feature. For more information about how to download a Defect Pixel Map to the camera, refer to [Appendix A](#).

## 9.8 Flat Field Correction

The **Flat Field Correction** feature improves the image uniformity when you acquire a non-uniformity image due to external conditions. The Flat Field Correction feature can be summarized by the following equation:

$$IC = IR / IF$$

Where,

IC : Level value of corrected image;

IR : Level value of original image;

IF : Level value of Flat Field data.

In actual use conditions, generate a Flat Field data (IF) and apply the Flat Field Correction feature according to the following procedures.

1. Execute the **Ffc Generate** parameter.

After executing the **Ffc Generate** parameter, you must acquire one image to generate the scaled-down Flat Field data.

2. Execute the **Ffc Save** parameter to save the generated Flat Field data into the non-volatile memory.

When the scaled-down Flat Field data is used for corrections, it is expanded and applied with a Bilinear Interpolation as shown in the Figure 9.8.

3. Set the **Ffc Mode** parameter to **On** to apply the Flat Field data to the camera.



- It is recommended that you enable the Defective Pixel Correction feature before executing the **Ffc Generate** parameter.
- Before executing the **Ffc Generate** parameter, you must set the camera as follows:
  - OffsetX, Y: 0
  - Width, Height: Maximum values
- After executing an **Acquisition Start** command, you need to operate the camera with free-run mode or apply a trigger signal to acquire an image.



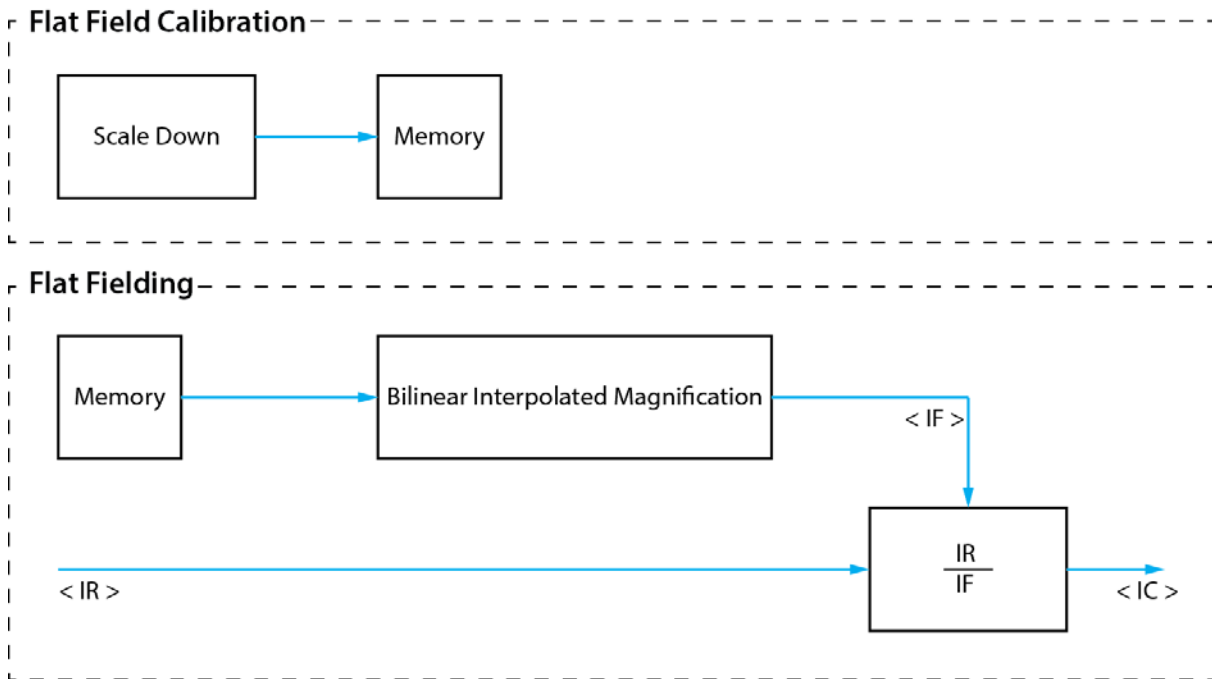


Figure 9.7 Generation and Application of Flat Field Data

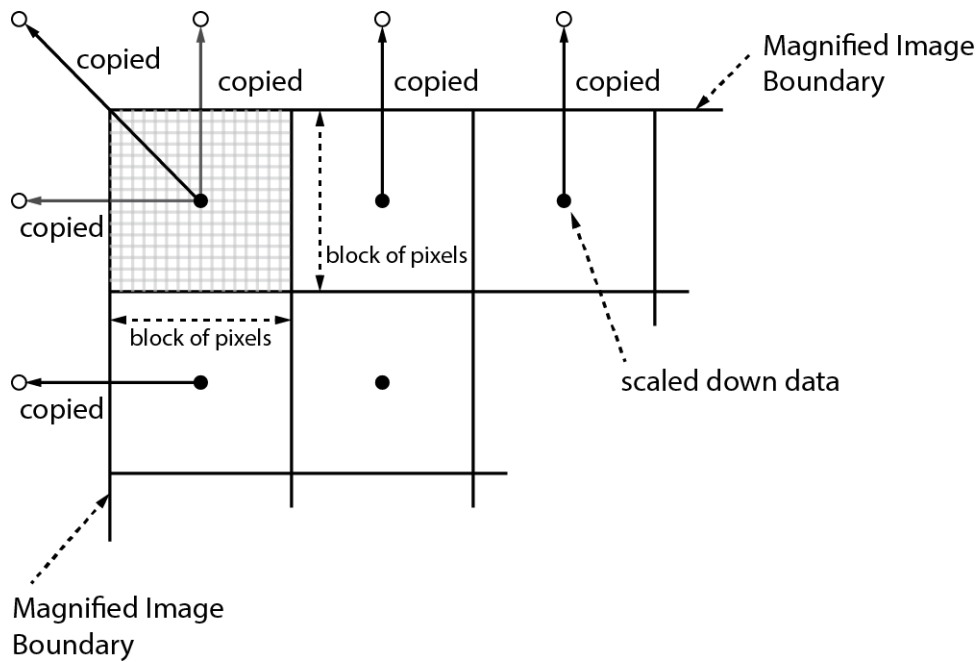


Figure 9.8 Bilinear Interpolated Magnification

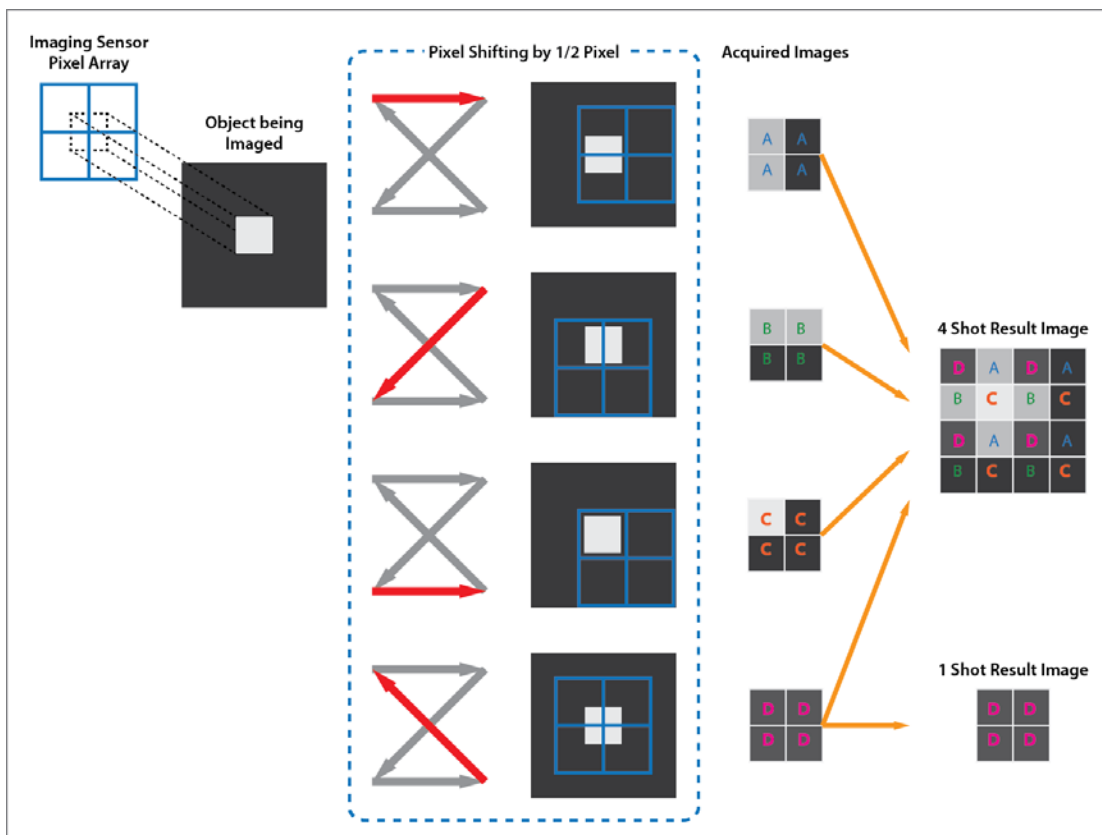
The XML parameters related to Flat Field Correction are as follows.

XML Parameters		Value	Description
FlatFieldCorrection	FfcMode	Off	Flat Field Correction Off
		On	Enables the Flat Field Correction feature.
	FfcGenerate	-	Generates the Flat Field data.
	FfcSave	-	Saves the generated Flat Field data in the non-volatile memory. The generated data by executing the <b>FfcGenerate</b> 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.
	FfcLoad	-	Loads the Flat Field data from the non-volatile memory into volatile memory.

**Table 9.13 XML Parameters related to Flat Field Correction**

## 9.9 Pixel Shifting

The VN-25MX camera has a feature to shift the imaging sensor to X and Y direction precisely using 2D-Stage. The resulting image can be combined of 4 individual images captured by shifting the imaging sensor to X and Y direction as shown in the figure below. Thus, the output image offers improved resolution (4 Shot Result Image) in comparison with standard output image (1 Shot Result Image). Combing the images should be done on the PC side with software processing. Please contact local dealer or factory representative for the details on the sample software combining the images.



**Figure 9.9 Comparison of a Pixel Shifting Image with Standard Image**



- The camera contains components sensitive to heat, shock, or vibration. Handle this camera with the maximum care. Operate the camera at temperature between 0°C and 40°C.
- Due to a temperature difference between the inside and outside of the product, moisture may condense inside or outside the camera. This moisture condensation may cause a malfunction of the camera or shorten the product life cycle. If some condensation occurs, turn off the camera and wait about an hour until the moisture evaporates.

### 9.9.1 Pixel Shifting and True Color Resolution

One benefit of pixel shifting technology in comparison to fixed sensor cameras is its ability to acquire more than 4 times higher resolution than the fixed one. The figures below show a standard output image and  $\times 9$  shifting output image. In case of VN-25MX camera model, the output image will have  $15,360 \times 15,360$  (235.9 Megapixel) resolution if the pixel shifting is applied. Otherwise, the resolution of output image is  $5,120 \times 5,120$  (25 Megapixel) without pixel shifting.

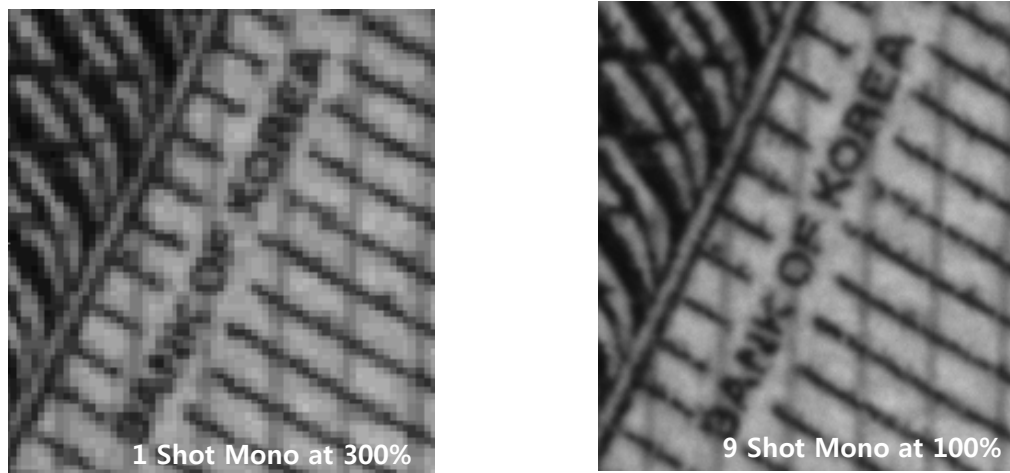


Figure 9.10 Standard (left) vs. 9 Shot Pixel Shifting (right)

Another benefit of pixel shifting technology compared to fixed CCD is acquiring True Color image. If a camera uses Bayer Interpolation to produce a color image, unwanted artifacts may occur such as color moiré or false color pixels. Using pixel shifting, no color artifacts or aliasing will occur and the color resolution is optimized.

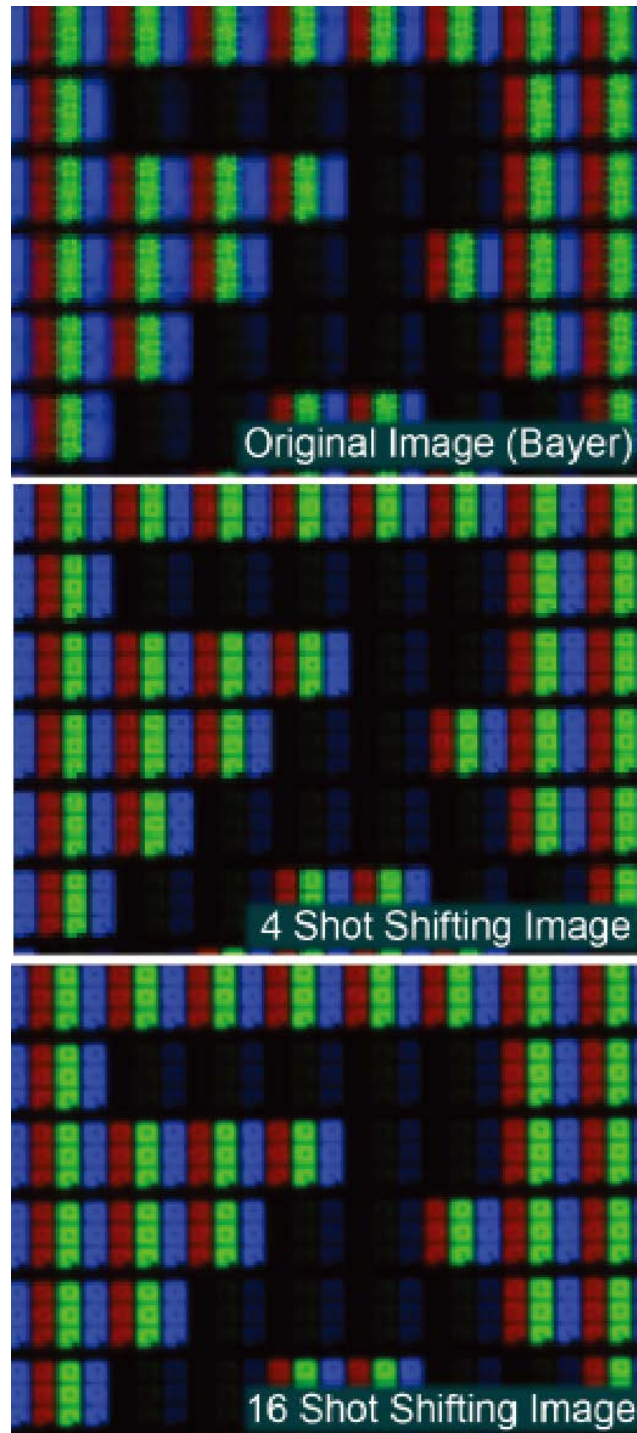


Figure 9.11 Standard Image Color vs. Pixel Shifting Image Color

## 9.9.2 Sequence Mode

### 9.9.2.1 Pixel Shifting Sequence Mode

The following Sequence Modes of pixel shifting are available on the VN-25MX camera:

- 1. Mono 4 Frame (Doubled vertical and horizontal resolution)
- 2. Mono 9 Frame (Tripled vertical and horizontal resolution)
- 3. Mono 2 Frame H (Doubled horizontal resolution)
- 4. Mono 2 Frame V (Doubled vertical resolution)
- 5. Bayer 4 Frame (Full color resolution, no increase in resolution)
- 6. Bayer 16 Frame (Full color resolution, doubled vertical and horizontal resolution)

### 9.9.2.2 Operation of Sequence Mode

In the Sequence Mode, the position of the stage has been predefined and thus you can operate the sequence just by applying a trigger signal to the camera. The default position of the stage is (0, 0) and the following position will vary depending on the sequence mode. Once one cycle of operation has completed, the stage position returns to (0, 0). When the camera is running in the Free-Run mode, the sequence mode will be deactivated because the sequence mode is synchronized only with Software Trigger, External Trigger or CoaXPress Trigger. Refer to [Appendix C](#) for the position configurations according to the sequence modes. The minimum trigger period can be obtained as shown in the following expression:

- When sum of exposure time and stage setup time is shorter than frame transfer time:  
(Frame Transfer Time > Exposure Time + Stage Setup Time)
  - Minimum Trigger Period = Frame Transfer Time
- When sum of exposure time and stage setup time is longer than frame transfer time:  
(Frame Transfer Time < Exposure Time + Stage Setup Time)
  - Minimum Trigger Period = Exposure Time + Stage Setup Time

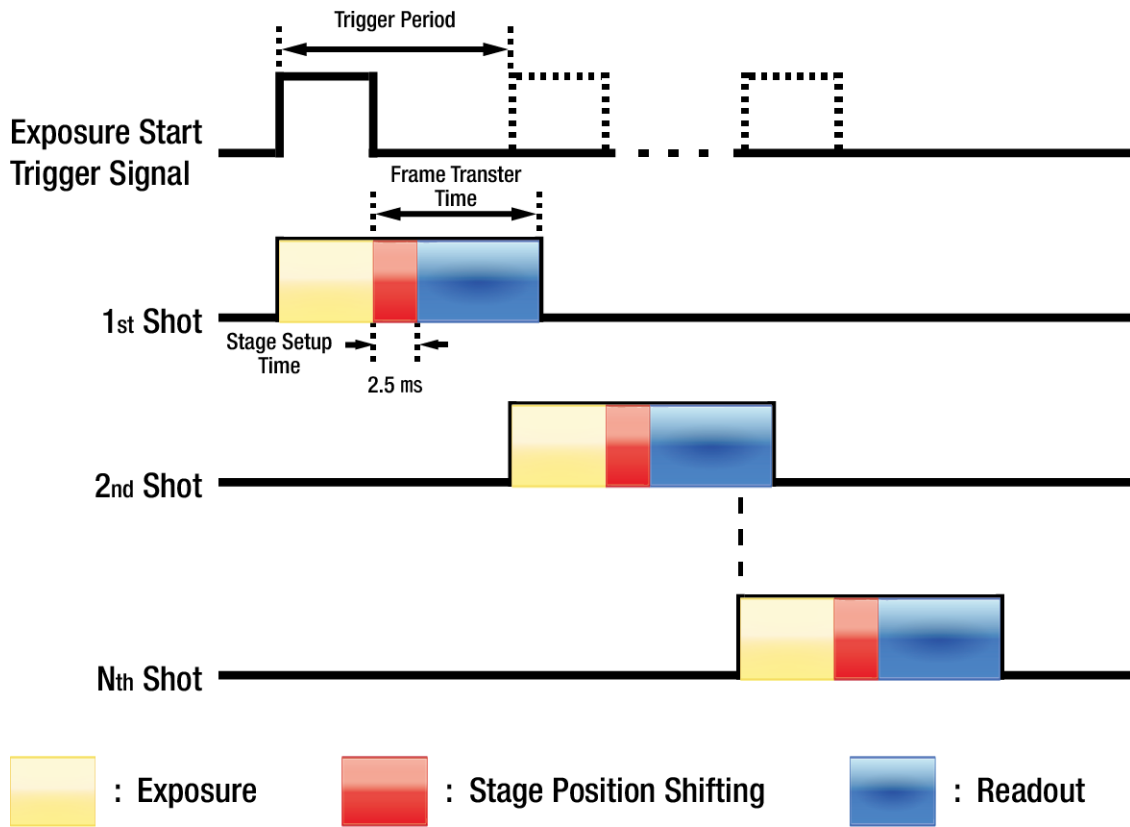


Figure 9.12 Sequence Mode Timing Diagram

The XML parameter related to Sequence Mode is as follows.

XML Parameters	Value	Description
StageControl	Off	Sequence Off
	Mono4Frame	4 shot Mono
	Mono9Frame	9 shot Mono
	Mono2FrameH	2 shot Mono in horizontal direction
	Mono2FrameV	2 shot Mono in vertical direction
	Bayer4Frame	4 shot Color (Color Camera Only)
	Bayer16Frame	16 shot Color (Color Camera Only)

Table 9.14 XML Parameters related to Sequence Mode

### 9.9.2.3 Multi Shot

When **Multi Shot** is enabled, the sequence operation that is followed by the first trigger input will be performed automatically by internal trigger. Internal trigger is generated by calculating the optimized timing reflecting trigger delay and stage setup time. Trigger input from the external ports will be ignored until completing the readout of the last image.

Multi Shot Enable: 1 trigger N snap  
 Sequence is performed in sequence with one trigger input.

Multi Shot Disable: 1 trigger 1 snap  
 Exposure synchronizes with trigger input and N times trigger input is required to acquire N images.

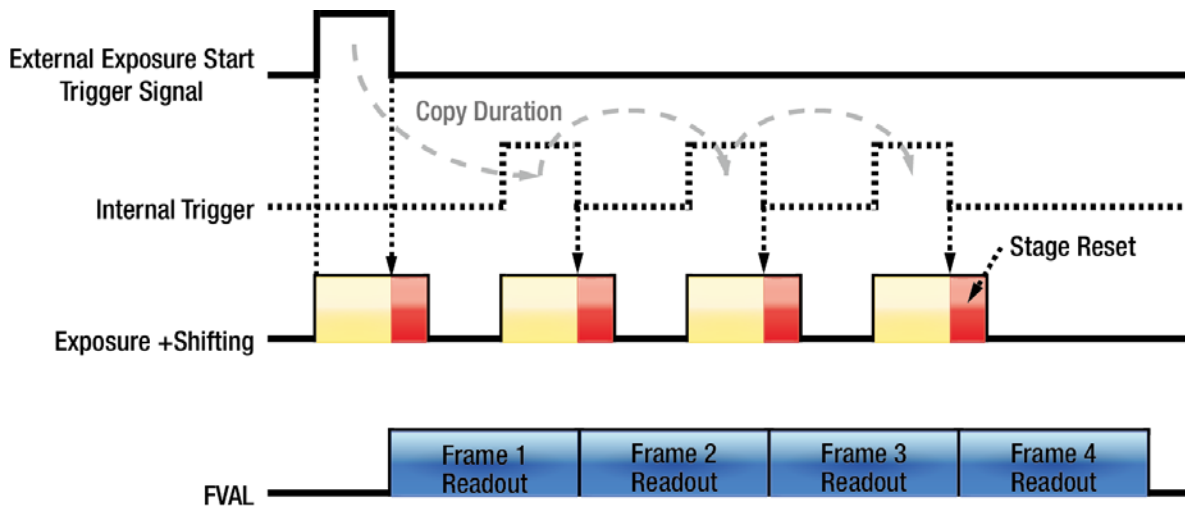


Figure 9.13 Timing Diagram when Multi Shot is enabled on Sequence 4 Shot Mode

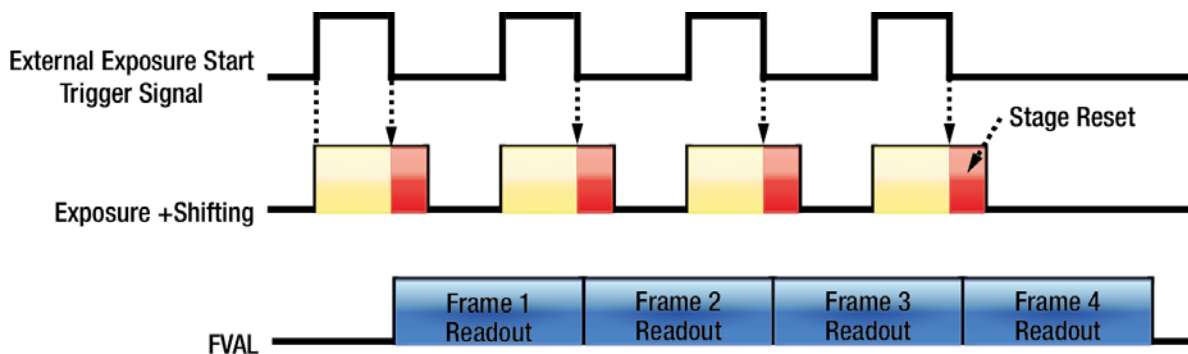


Figure 9.14 Timing Diagram when Multi Shot is disabled on Sequence 4 Shot Mode



The XML parameter related to Multi Shot is as follows.

XML Parameters		Value	Description
StageControl	MultishotEnable	Off	Multi Shot feature Off
		On	Enables the Multi Shot feature.

**Table 9.15 XML Parameters related to Multi Shot**

### 9.9.2.4 Stage Reset

Executing the **Stage Reset** command will reset the stage. Stage reset performs the following two features depending on the current status of the stage.

- Sequence Mode reset
  - When the **Stage Reset** command is executed while running the stage, the camera stops and resets the sequence, and then returns to the waiting for the trigger input status.
- Stage Position Sensor Calibration
  - Zero points can be changed according to temperature changes since the displacement sensor of the stage is sensitive to temperature. This feature adjusts zero point of the displacement sensor so that the sensor can be maintained within the operating range.



Zero point drift (the displacement sensor strays from the stage's operating range) may occur according to changes to mechanical parts of the camera or to the temperature on the installation environment. In this case, executing a **Stage Reset** command will compensate zero point drift to operate the stage normally.

### 9.9.2.5 Calibration Auto

This feature is only available when the Sequence Mode is enabled. If the **Calibration Auto** feature is set to **On**, the displacement sensor of the stage will be reset (zero point adjustment) whenever one cycle of sequence is completed.

### 9.9.2.6 Stage Status

In the Sequence Mode, you can determine whether the stage normally operates or not by counting the number of images acquired. When you set the **Sequence Mode** to **Mono4Frame**, for example, the camera will acquire and transfer four images. However, if the camera unexpectedly stops the sequence, the camera cannot acquire and transfer four images in this abnormal operation status. In this case, read the **StageStatus** parameter value in the **StageControl** category and then send it to local dealer or factory representative. Vieworks can diagnose the camera with the error code.



An impact of 5G or more would distort the operation range of the stage or alignment of the sensor and cause permanent damage to the stage since it is mechanically sensitive to shocks. Please handle the camera with care.

The XML parameters related to Stage Reset and Stage Status are as follows.

XML Parameters		Value	Description
StageControl	StageReset	–	Resets the stage.
	CalibrationAuto	Off	Not to execute the Stage Reset after completing one cycle of sequence.
		On	Executes the Stage Reset automatically after completing one cycle of sequence.
	StageStatus	–	Returns an error code if the stage operates abnormally.

**Table 9.16 XML Parameters related to Stage Reset and Stage Status**

### 9.9.2.7 Stage Index Display

When the **Stage Index Display** feature is enabled in the Sequence Mode, you can output images with the specified grey level for the (0, 0) coordinates. Thus, you can verify the order of images acquired.

For example, if the **Sequence Mode** parameter is set to **Mono4Frame**, the grey level for the (0, 0) coordinate of the first image is '0', the grey level for the (0, 0) coordinate of the second image is '1', the grey level for the (0, 0) coordinate of the third image is '2', and the grey level for the (0, 0) coordinate of the fourth image is '3'.

The XML parameter related to Stage Index Display is as follows.

XML Parameters		Value	Description
StageControl	StageIndexDisplay	Off	Disables the Index Display when acquiring images in the Sequence Mode.
		On	Enables the Index Display when acquiring images in the Sequence Mode.

**Table 9.17 XML Parameters related to Stage Index Display**

## 9.10 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 9.18 XML Parameter related to Device Temperature**

## 9.11 Status LED

A 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:

- 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 transmitting image data.

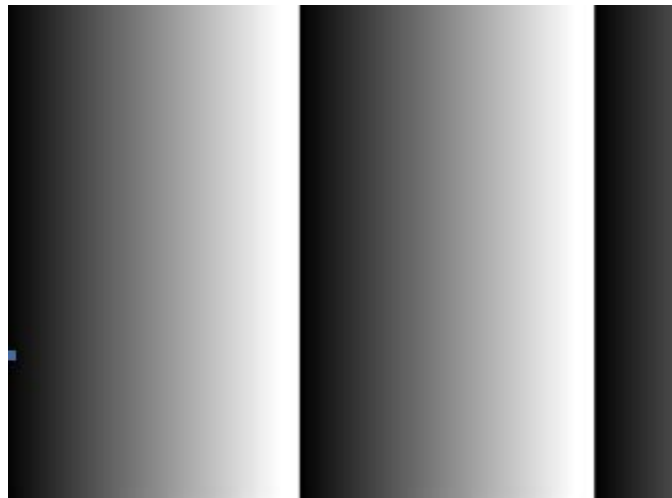
## 9.12 Test Pattern

To check normal operation of the camera, it can be set to output test patterns created inside, instead of image data from the imaging 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).

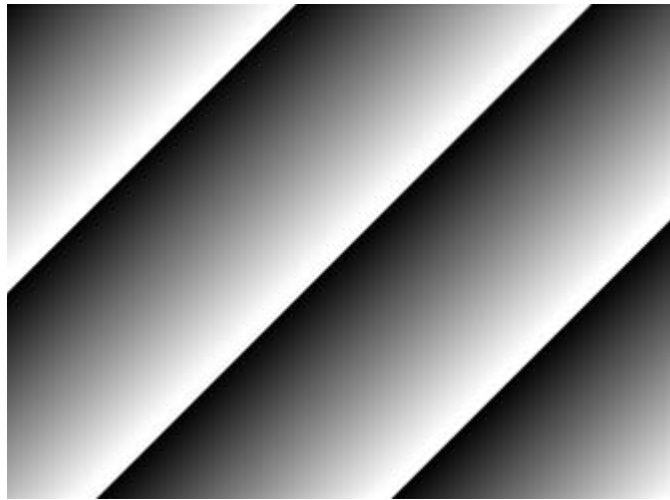
The XML parameter related to Test Pattern is as follows.

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.

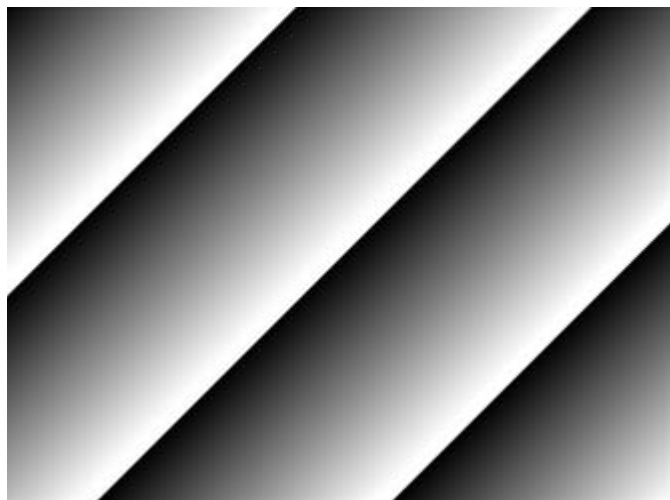
**Table 9.19 XML Parameter related to Test Pattern**



**Figure 9.15 Grey Horizontal Ramp**



**Figure 9.16 Grey Diagonal Ramp**



**Figure 9.17 Grey Diagonal Ramp Moving**



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

## 9.13 Digital IO Control

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

The XML parameters related to Digital IO Control are as follows.

XML Parameters		Value	Description
DigitalIOControl	LineSelector	LineIn0	Selects the number 1 pin of the camera's control I/O receptacle as an input line.
		LineOut0	Selects the number 4 pin of the camera's control I/O receptacle as an output line.
	LineInverter	On	Enables inversion on the output signal of the line.
		Off	Disables inversion on the output signal of the line.
	Line Source	Off	Disables the line output.
		Frame Active	Outputs pulse signals indicating a frame readout time.
		Strobe Out	Outputs pulse signal indicating the current exposure time with Strobe Out Delay.
		User Output	Outputs User Output signal set by User Output Value.
	UserOutputValue	On	Sets the bit state of the line to High.
		Off	Sets the bit stage of the line to Low.
	StrobeOutDelay	0 ~ 65535	Sets a delay in microseconds when the Line Source is set to Strobe Out.

**Table 9.20 Digital IO Control**

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

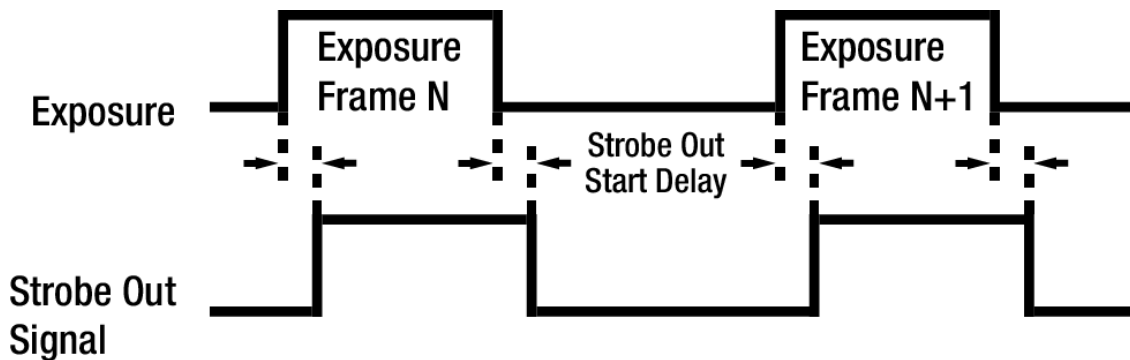


Figure 9.18 Strobe Out Signal



When you use the Strobe Out signal, be aware that there is a Strobe Out delay as shown in the Table 9.21.

Camera Model	Strobe Out Start Delay
VN-25MX	$\leq 0.8 \mu\text{s}$

Table 9.21 Strobe Out Start Delay



## 9.14 Fan Control

A fan is installed on the rear panel of the camera to radiate heat. You can set the fan to turn on or off. You can also set the fan to turn on when a specified internal temperature is reached.

The XML parameters related to Fan Control are as follows.

XML Parameters		Value	Description
FanControl	FanOperationMode	Off	Turns off the fan.
		On	Turns on the fan.
		Temperature	Turns on the fan when the internal temperature exceeds the value set in the <b>Fan Operation Temperature</b> parameter.
	FanOperationTemperature	-10°C~80°C	Sets the temperature to operate the fan when the <b>Fan Operation Mode</b> parameter is set to <b>Temperature</b> .
FanSpeed	-	Verifies the current Fan RPM.	

Table 9.22 XML Parameters related to Fan Control

## 9.15 Device User ID

You can input user defined information up to 16 bytes.

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

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

Table 9.23 XML Parameter related to Device User ID

## 9.16 Device Reset

Reset 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 9.24 XML Parameter related to Device Reset

## 9.17 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 User Set1 settings.
		UserSet2	Selects the User Set2 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. <ul style="list-style-type: none"> <li>The Default is a Factory Default Settings and allowed to load only.</li> </ul>
	UserSetDefault	Default	Applies the Factory Default settings when reset.
		UserSet1	Applies the User Set1 when reset.
		UserSet2	Applies the User Set2 when reset.

**Table 9.25 XML Parameters related to User Set Control**

## 9.18 Field Upgrade

The camera provides a feature to upgrade Firmware and FPGA logic through CoaXPress interface rather than disassemble the camera in the field. Refer to [Appendix B](#) for more details on how to upgrade.

## 10 Troubleshooting

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

- If no image is displayed on your computer,
  - Ensure that all the cable connections are secure.
  - Ensure that the power supply is properly connected.
  - Ensure that trigger signal is applied correctly when you set the Trigger Mode parameter to On.
  
- 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 your camera lens is not blocked.
  - Check the exposure time is set properly.
  - Check the aperture is opened properly.
  - Check the Gain value is not set too 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 Software trigger related parameters are configured correctly.
  - 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 set the Trigger Source parameter to LineIn0.
  
- If there is a communication failure between the camera and 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 Defective Pixel Map Download

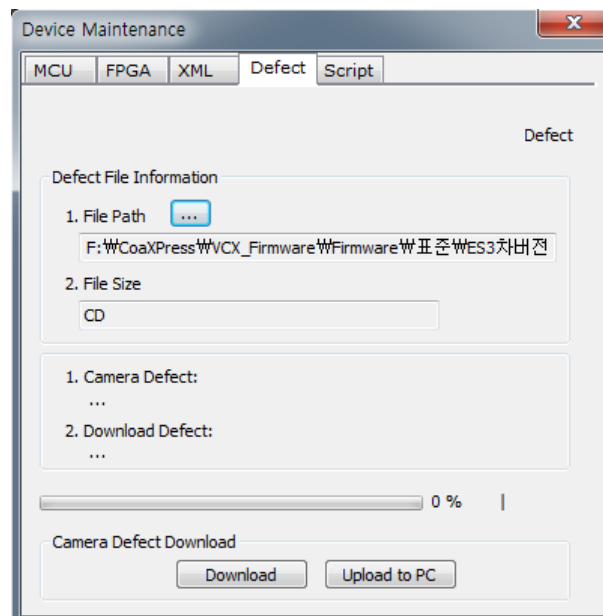
1. Create the Defect Pixel Map data in Microsoft Excel format as shown in the left picture below and save as a CSV file (\*.csv). The picture in the right shows the created Excel file opened in Notepad. The following rules need to be applied when creating the file.
  - Lines beginning with ':' or '--' are treated as notes.
  - Each row is produced in the order of the horizontal and vertical coordinate values.
  - The input sequence of pixel is irrelevant.

	A	B	C	D
1	:	comment line		
2	--	coment line		
3	--	H	Y	
4		2011	3	
5		178	7	
6		52	8	
7		699	8	
8		268	10	
9		1112	10	
10		1713	12	
11		608	16	
12				
13				

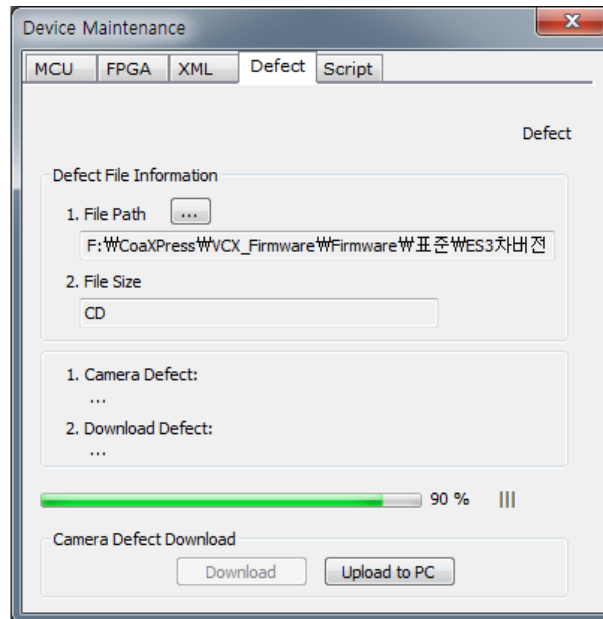
```

File Edit Format View Help
: comment line,
-- coment line,
-- H,Y
2011,3
178,7
52,8
699,8
268,10
1112,10
1713,12
608,16
  
```

2. Run Vieworks Imaging Solution 7.X and click the **Configure** button to display the window as shown below. Select the **Defect** tab, click the File Path button, search and select the defect pixel map file (\*.csv), and then click the **Download** button.



- Once the download is complete, the saving process will begin. During the saving process, make sure not to disconnect the power cord.

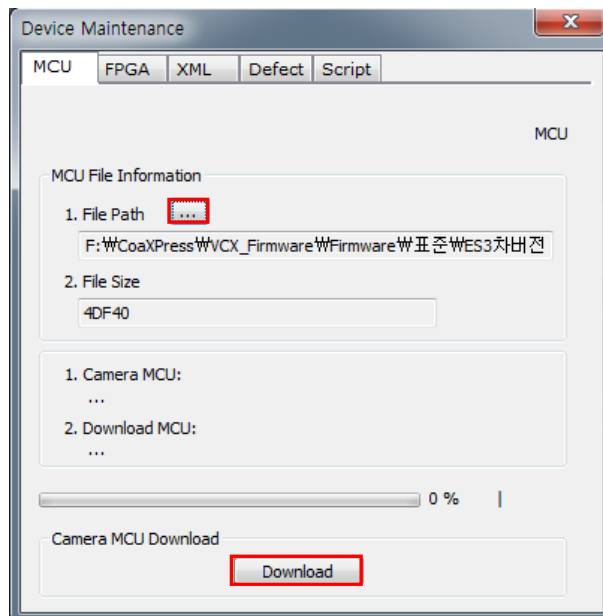


- After completing the download, click the **OK** button to close the confirmation.

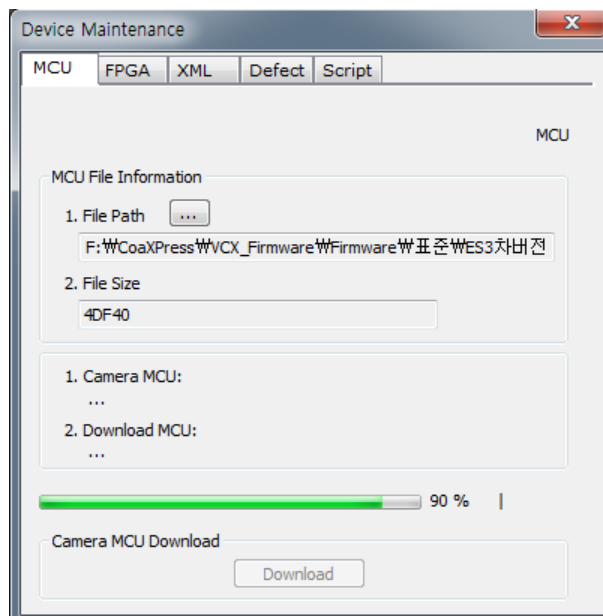
## Appendix B Field Upgrade

### B.1 MCU

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



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

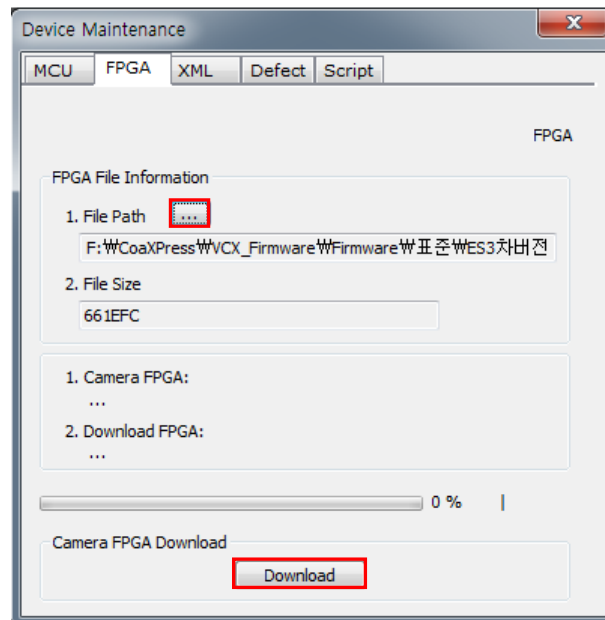


- Once all the processes have been completed, turn the camera power off and turn it back on again.  
Check the Device Version parameter value to confirm the version.

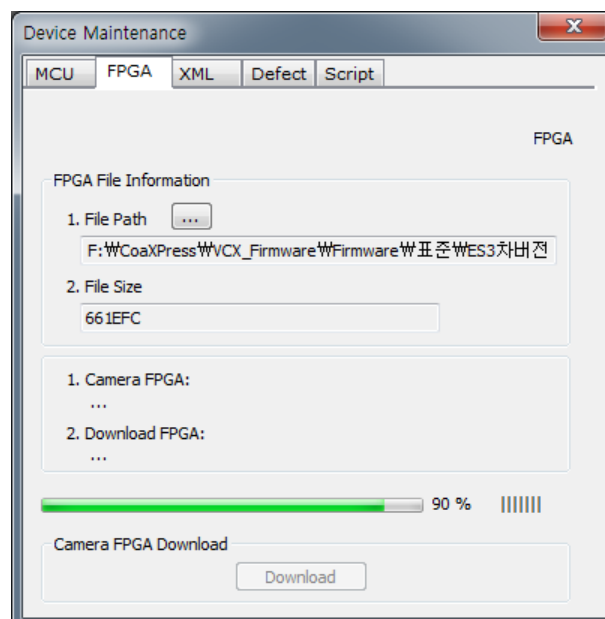
DeviceControl	
DeviceScanType	Areascan
DeviceVendorName	VIEWWORKS
DeviceModelName	VC-12MX-C180
DeviceManufacturerInfo	
DeviceVersion	M:0.4.4 F:1.1.1
DeviceSerialNumber	Z9-ECMADW001

## B.2 FPGA

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



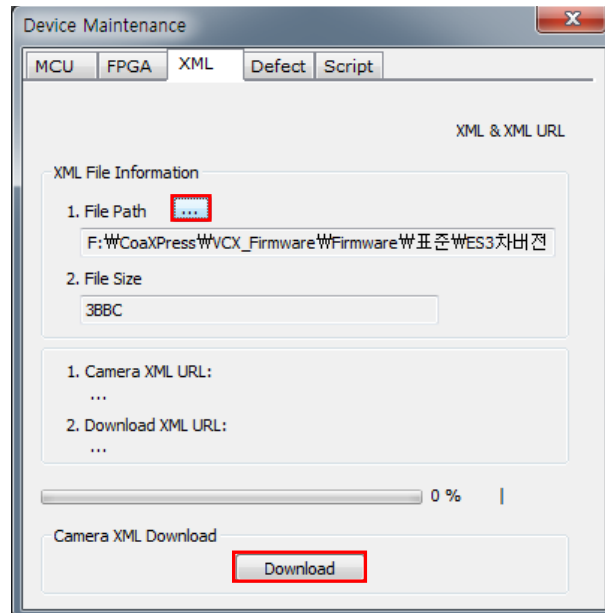
3. The subsequent processes are identical to those of MCU upgrade.



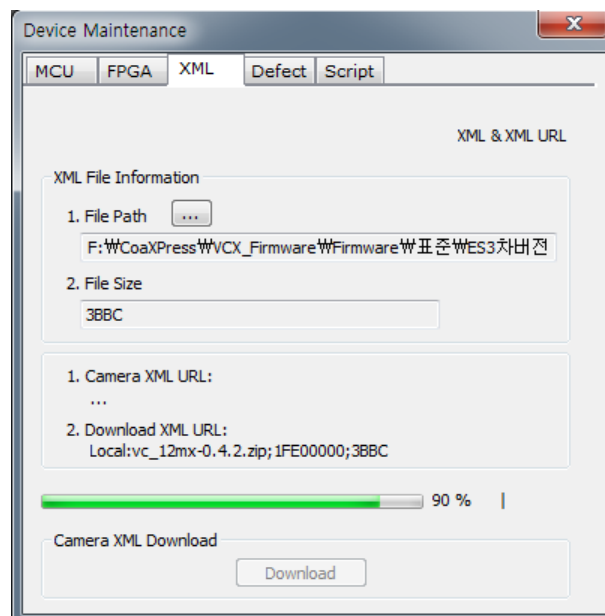


## B.3 XML

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



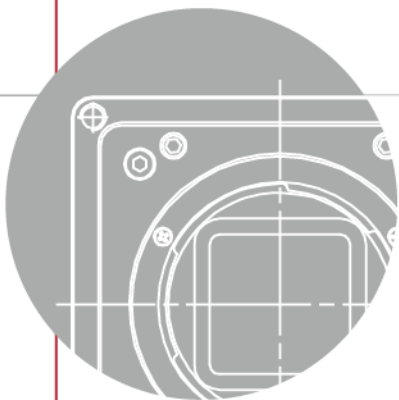
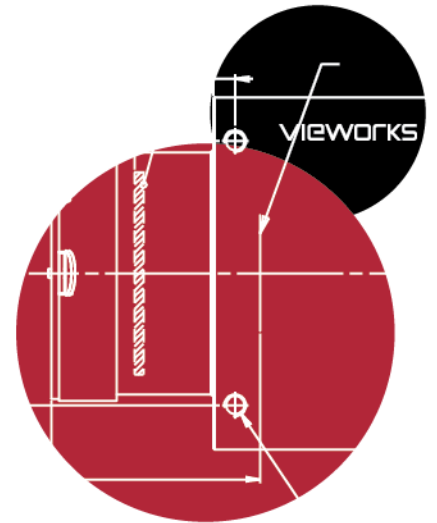
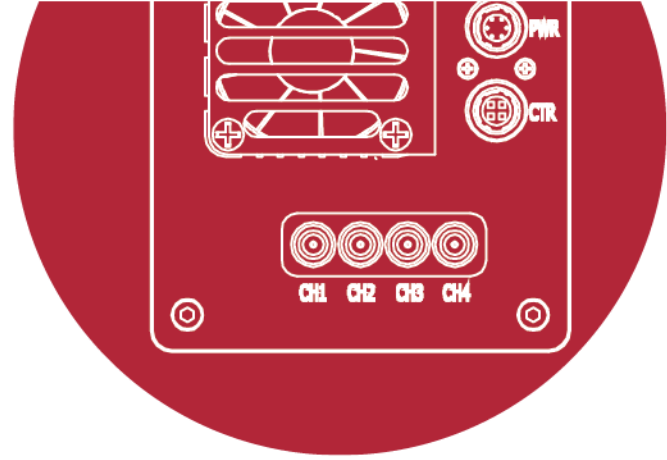
3. The subsequent processes are identical to those of MCU upgrade.



## Appendix C Position settings according to sequence modes

Ratio for 1 Pixel

Order	Mono4Frame		Mono9Frame		Mono2FrameH		Mono2FrameV		Bayer4Frame		Bayer16Frame	
	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
1	0	0	0	0	0	0	0	0	0	0	0	0
2	1/2	0	1/3	0	1/2	0	0	1/2	1	0	1	0
3	0	1/2	2/3	0	-	-	-	-	0	1	0	1
4	1/2	1/2	0	1/3	-	-	-	-	1	1	1	1
5	-	-	1/3	1/3	-	-	-	-	-	-	1/2	0
6	-	-	2/3	1/3	-	-	-	-	-	-	3/2	0
7	-	-	0	2/3	-	-	-	-	-	-	1/2	1
8	-	-	1/3	2/3	-	-	-	-	-	-	3/2	1
9	-	-	2/3	2/3	-	-	-	-	-	-	0	1/2
10	-	-	-	-	-	-	-	-	-	-	1	1/2
11	-	-	-	-	-	-	-	-	-	-	0	3/2
12	-	-	-	-	-	-	-	-	-	-	1	3/2
13	-	-	-	-	-	-	-	-	-	-	1/2	1/2
14	-	-	-	-	-	-	-	-	-	-	3/2	1/2
15	-	-	-	-	-	-	-	-	-	-	1/2	3/2
16	-	-	-	-	-	-	-	-	-	-	3/2	3/2



## Vieworks Co., Ltd.

41-3, Burim-ro, 170beon-gil,  
Dongan-gu, Anyang-si, Gyeonggi-do  
431-060 Republic of Korea

Tel: +82-70-7011-6161 Fax: +82-31-386-8631

<http://machinevision.vieworks.com> [vieworks@vieworks.com](mailto:vieworks@vieworks.com)