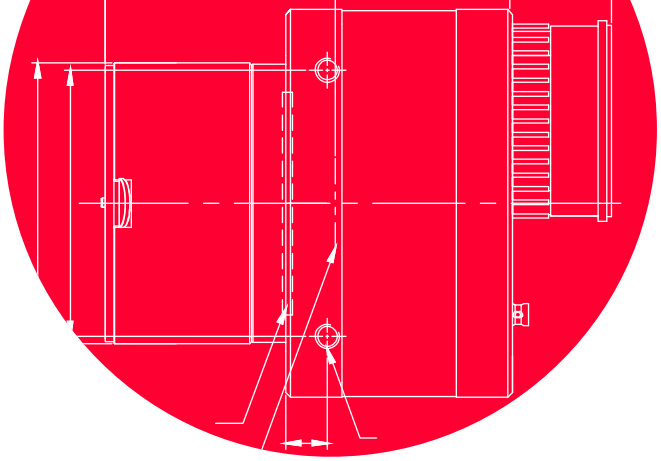


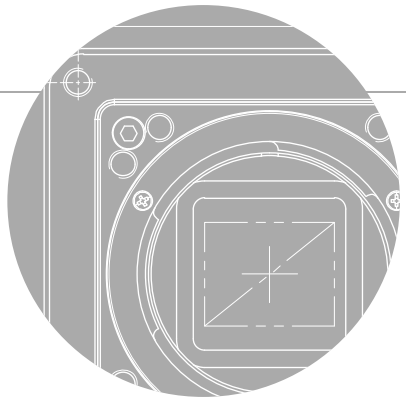
VC series

User Manual

English

VC-21MX2-M/C230I
VC-21MX2-M/C230I-HS

CoaXPress®



vieworks

Preface

Although Vieworks made every effort to ensure the accuracy of this document, it assumes no responsibility for errors or omissions that may appear herein. The figures in this manual may differ depending on the version of the product or operating system, or the way how it runs. Information in this manual is subject to change without notice.

Before Using This Product

Thank you for choosing VC-21MX2-M/C230I™.

- Make sure to read this manual before using the product.
- Make sure to check whatever a professional engineer has finished installation and configuration.
- Make sure to keep this manual at hand as a reference while using the product.
- This manual assumes that you have expertise in how to use an industrial camera.

The Series

This manual is intended for users of the following products:

- VC-21MX2-M/C230I

About This Manual

This manual is intended for VC-21MX2-M/C230I™ camera users. It is recommended to refer to the Frame Grabber's User Manual of yours, with this manual.

Convention in This Manual

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

Names and Fonts

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

- The menu and icon names in this manual are used as displayed in the product.
- The menu and icon names are marked in this font.
- Button or keyboard key names are marked in this font.

Warning, Caution, and Note

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

Warning!

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

Caution!

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

Note:

This indicates that this message provides additional information.

Definition of Terms

For clarity, this manual defines some terms as follows:

Term	Definition
Preface	The introductory part preceding the Table of Contents in this manual
Vieworks Imaging Solution	Indicates the control software provided with the product together by Vieworks
VIS	Vieworks Imaging Solution

Revision History

This document has the revision history as follows:

Version	Date	Description
1.0	2022-12-30	Initial Release
1.1	2023-07-07	• Added the Heat Sink model • Added description for the binning function • Added description for the sensor ROI function • Updated description for XML parameters of the following items: Sequencer Control DSNU correction, PRNU correction, Flat-Field-data correction, Sequencer Control

Contents

Tables

Figures

Chapter 1. Precautions

General

- Do not drop, disassemble, repair or alter the device. Doing so may damage the camera electronics and cause an electric shock.
- Do not let children or companion animals touch the device without supervision.
- Stop using the device and contact the nearest dealer or manufacturer for technical assistance if liquid such as water, drinks or chemicals gets into the device.
- Do not touch the device with wet hands. Doing so may cause an electric shock.
- Make sure that the temperature of the camera does not exceed the temperature range specified in 5.2 Specifications. Otherwise the device may be damaged by extreme temperature.

Installation and Maintenance

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

Power Supply

- Applying incorrect power can damage the camera. If the voltage applied to the camera is greater or less than the camera's nominal voltage, the camera may be damaged or operate erratically. Please refer to 5.2 Specifications for the camera's nominal voltage.
  ※ Vieworks Co., Ltd. does NOT provide power supplies with the 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 that will not blow off, use a soft lint free cotton bud dampened with a small quantity of high quality lens cleaner. Because electrostatic discharge (ESD) can damage the sensor, you must use a cloth (e.g. cotton) that will not generate static during cleaning.

Avoid dust or foreign matter on the sensor surface.

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

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.

Chapter 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.

Chapter 3. Compliance & Certifications

3.1 FCC Compliance

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

Chapter 4. Package Components

Package Components

VC-21MX2-M/C230I

VC-21MX2-M/C230I-HS

Chapter 5. Product Specifications

5.1 Overview

The VC-21MX2-M/C230I, the latest model of the industrial proven VC series, is a new 21-megapixel CoaXPress camera and based on the CMOS global shutter image sensor technology (GSPRINT4521) from Gpixel. The VC-21MX2-M/C230I offers up to 230 frames per second at 5120 × 4096 resolution. The camera comes with the next generation CoaXPress 2.0 (CXP-12) interface delivering up to 50 Gigabits per second over four coaxial cables. These combinations of the CMOS sensor technology and CoaXPress 2.0 interface set a new standard for industrial, scientific and surveillance digital imaging applications. Equipped with the Vieworks' innovative technologies proved by world's top FPD manufacturers, the VC-21MX2-M/C230I camera offers not only highly uniformed images but also high-speed image processing capabilities. Featured with high-quality image uniformity and high-resolution, this camera is ideal for demanding applications such as FPD, PCB and semiconductor inspections.

For wide range of choice, Vieworks provides this amazing product in two different types, the fan type and the heat sink type, with the same specification.

Main Features

- High Speed 21 Megapixel CMOS Image Sensor
- CoaXPress 2.0 Interface up to 230 fps at 50 Gbps using 4 channels
- Power over CoaXPress (PoCXP)
- Output Channel: CXP-12 × 1 / CXP-12 × 2 / CXP-12 × 4
- Electronic Exposure Time Control (Global Shutter)
- Output Pixel Format: 8/10/12 bit
- Flat Field Correction
- Defective Pixel Correction
- Gain/Black Level Control
- Test Pattern
- Temperature Monitor
- Field Upgrade
- GenICam Compatible – XML based Control

5.2 Specifications

Technical specifications for the VC-21MX2-M/C230I are as follows.

Specifications		VC-21MX2-M/C230I	VC-21MX2-M/C230I-HS
Resolution (H×V)		5120 × 4096	
Sensor		GSPRINT4521	
Sensor Size (Diagonal)		23.04 ㎜ × 18.43 ㎜ (29.5 ㎜)	
Sensor Type		High Speed CMOS Image Sensor	
Pixel size		4.5 ㎛ × 4.5 ㎛	
Interface		CXP-12 4 Channels	
Max. Frame Rate (8 bit)	CXP6 × 4	56 fps	
	CXP10 × 4	114 fps	
	CXP12 × 4	229 fps	
Exposure Time		4 ㎲ ~ 60 s (1 ㎲ step)	
Partial Scan (Max. Speed)		10011.7 fps at 32 Lines, CXP-12(4 channels)	
Pixel Data Format	Mono	Mono 8/10/12 bit	
	Color	Bayer GB 8/10/12 bit	
Electronic Shutter		Global Shutter	
Gain Control	Analog	1.0×, 1.3×, 2.0×, 4.2×	
	Analog (Sensor Binning 2×2)	1.0×, 1.4×, 2.0×, 3.0× (Mono Only)	
	Digital	1.0× ~ 32.0×	
Digital Black Level		0~255 LSB at 12 bit	
Exposure Mode		Free-Run, Timed, TriggerWidth	
External Trigger		3.3 ~ 24.0 V, 10 ㎃, Logical Level Input Optically Isolated CoaXPress Control Port(CXP only)	
Software Trigger		Asynchronous, Programmable via Camera API(CXP only)	
Digital I/O		TTL Level Exposure Active, Frame Active, User Output, Timer, Strobe Output	
Dynamic Range		12 bit: Typical 68 ㏈ (EMVA 1288)	
Cooling Method		Standard Cooling with a Fan	
Mechanical (W×H×L)		80 ㎜ × 80 ㎜ × 104.5 ㎜, 0.75 ㎏ (F-mount)	80 ㎜ × 80 ㎜ × 111 ㎜, 0.70 ㎏ (F-mount)
Environmental		Operating: 0℃ ~ 40℃, Storage: -40℃ ~ 70℃	
Lens Mount		F-mount, Custom mount available upon request	
Power	External	12~24 VDC	
	PoCXP	24 VDC (minimum 2 of PoCXP cables required)	
	Dissipation	Typical 27.5 W	
Compliance		CE, FCC, KC	

Table 5-1 Specifications VC-21MX2-M/C230I

Note:

It is recommended for the frame grabber to be updated the latest version of its driver.

5.3 Camera Block Diagram

The block diagram of VC-21MX2-M/C230I is shown below.

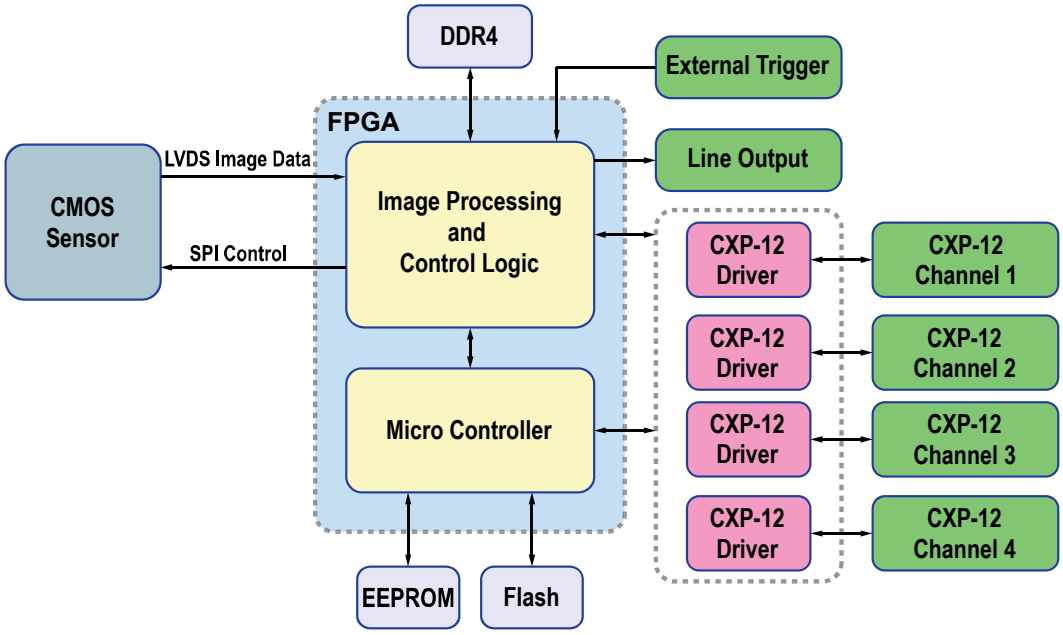


Figure 5-1 Camera Block Diagram

All controls and data processing of the camera are carried out in one FPGA chip. The FPGA generally consists of a 32-bit RISC Micro-Controller and Processing & Control logic. The Micro-Controller receives commands from the user through the CoaXPress 2.0 interface and then processes them.

The Processing & Control logic processes the image data received from the CMOS image sensor and then transmits data through the CoaXPress 2.0 interface. The Processing & Control logic also controls time-sensitive trigger inputs and output signals. Furthermore, Flash and DDR4 are installed outside FPGA. The DDR3 is used to process images and the Flash stores the firmware to operate the Micro-Controller.

5.4 Spectral Response

The following graphs show the spectral response for the VC-21MX2-M/C230I.

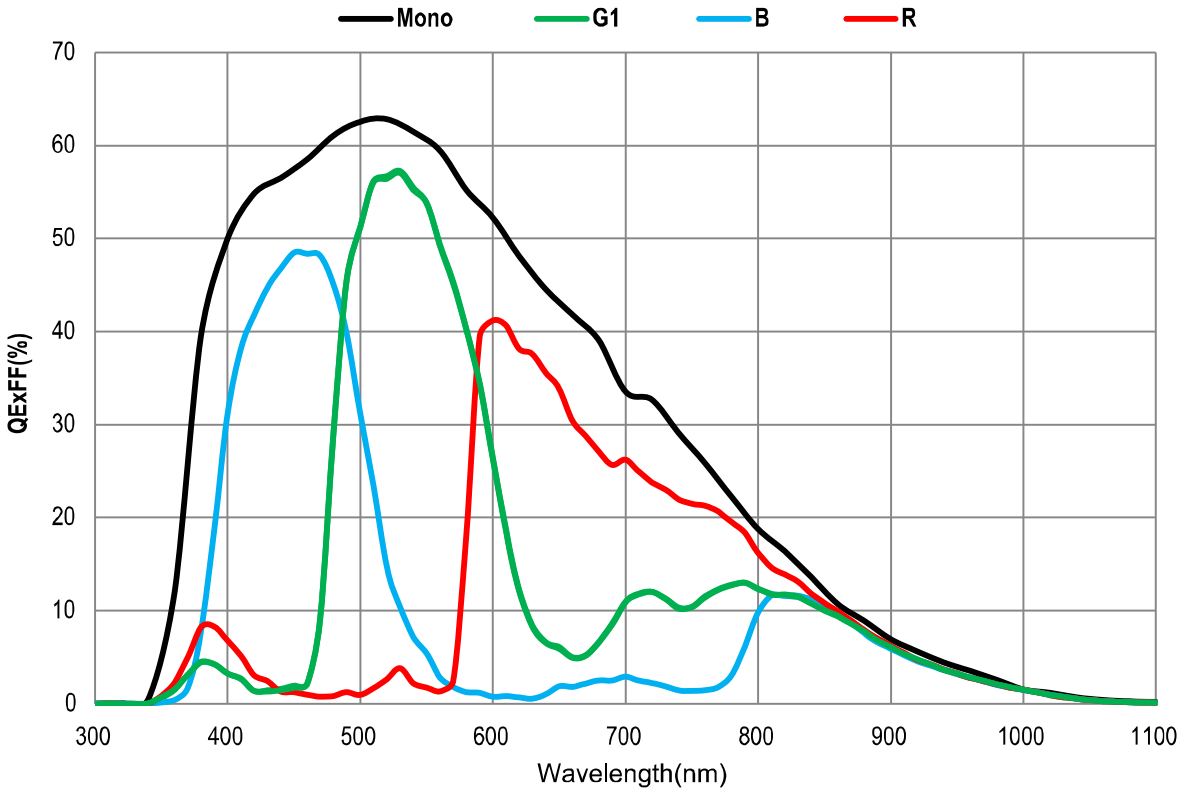


Figure 5-2 Spectral Response

5.5 Mechanical Specification

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

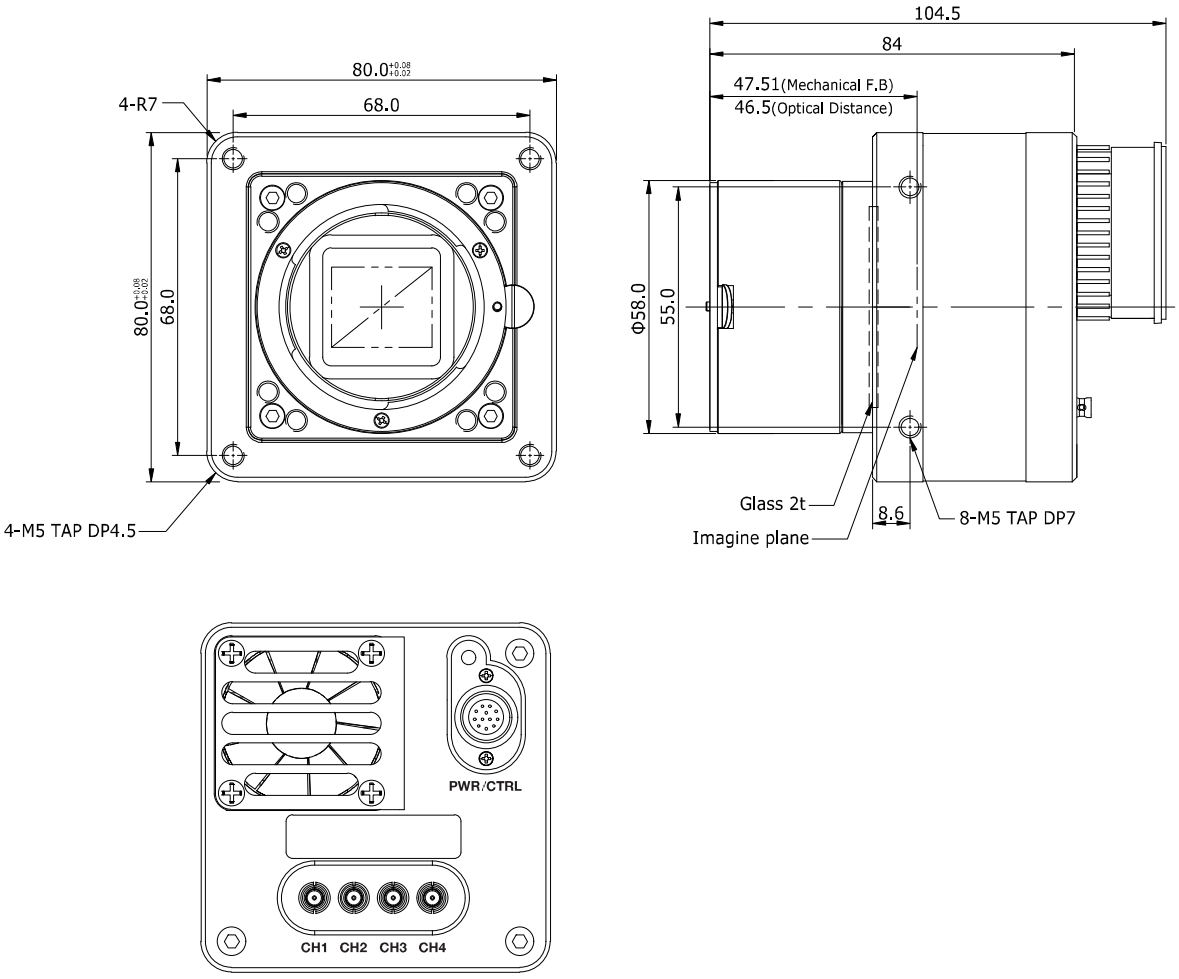


Figure 5-3 VC-21MX2-M/C230I Mechanical Dimension

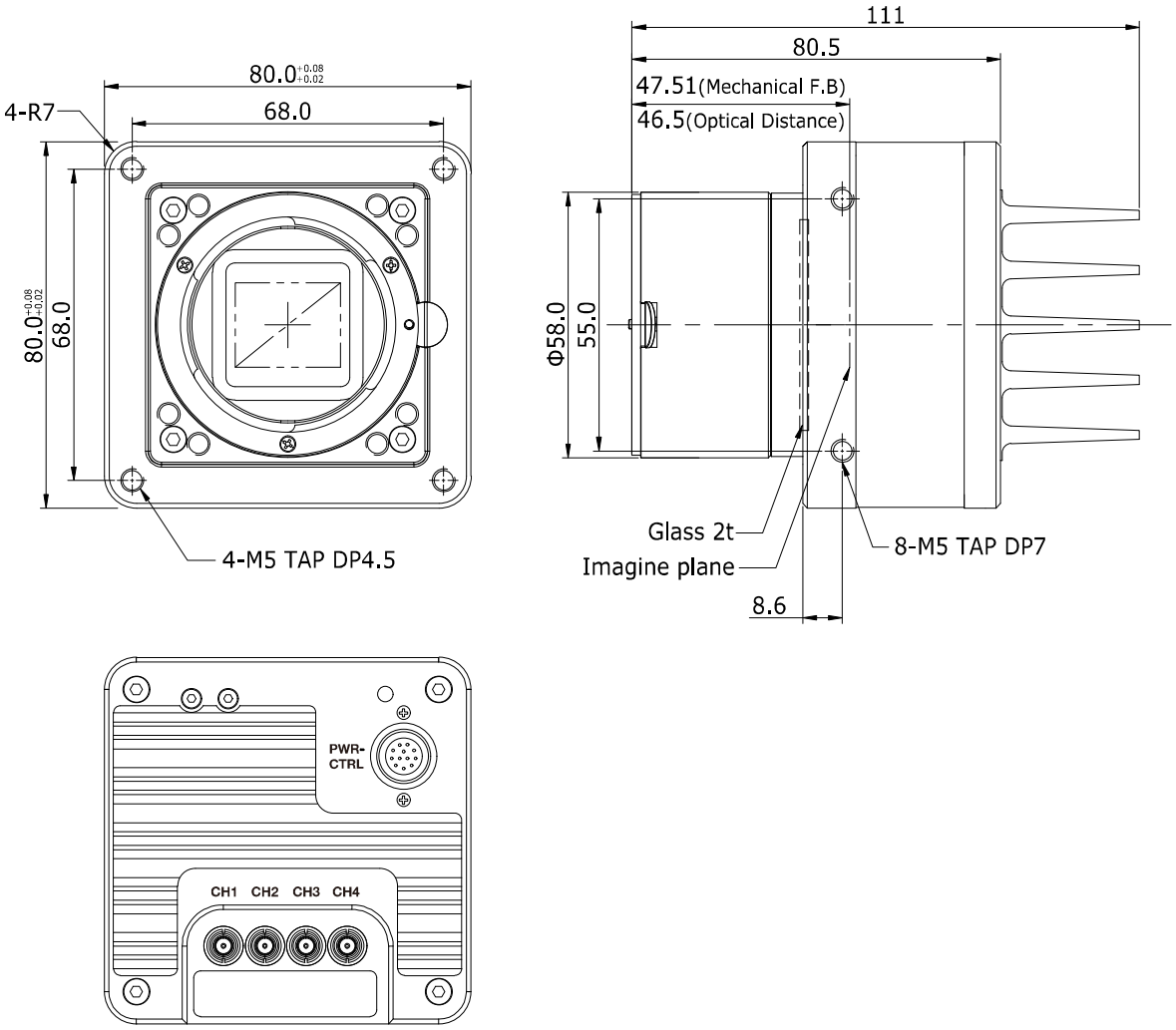


Figure 5-4 VC-21MX2-M/C230I-HS Mechanical Dimension

5.5.1 Camera Mounting and Heat Dissipation

Camera Mounting Recommendations for Antivibration

When you mount a camera in a poor condition, the fan equipped on the camera may amplify vibrations which can lead to blurry images. Follow the instructions below to prevent and/or reduce vibrations caused by the fan.

- Fix the camera's front or side surface by using at least four screws.
- Prevent ingress of foreign objects between the camera and system surfaces.
- Keep the camera's center of gravity as near as possible to the system's center of gravity.
- If your lens' weight or size is greater than the camera's, make and use proper mounting brackets to support the lens.
- Prevent foreign matters from falling into the fan. This may cause damage to the fan blades.

Camera Mounting Recommendations for Effective Heat Dissipation

- Do not obstruct the air inlets and outlets of the fan.
- If the fan is not available, leave enough space around the heat sink so that heat can be easily dissipated through the heat sink by natural convection.
- If the fan is not available, mount the camera on a metal structure made of high thermal conductive materials (e.g. Aluminum) to properly dissipate the heat generated by the camera.
- The contact surface of the camera must be at least 30% of the camera's Front-Block.

Chapter 6. Connecting the Camera

The following instructions assume that you have installed a CoaXPress 2.0 Frame Grabber (hereinafter 'CXP-12 Frame Grabber') in your computer including related software. The procedure below also assumes that you may attempt to configure a link between a camera and CXP-12 Frame Grabber by using four coax cables. For more detailed information, refer to your CXP-12 Frame Grabber User Manual.

To connect the camera to your PC, follow the steps below.

1. Make sure that the power supply is not connected to the camera and your computer is turned off.
2. 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-12 Frame Grabber in your computer. Then, connect the CH2, CH3 and CH4 of the CXP connector on the camera to the CH2, CH3 and CH4 of the CXP-12 Frame Grabber respectively using the other three coax cables.
   - Connect the plug of the power adapter to the power input receptacle on the camera.
   - Plug the power adapter into a working electrical outlet.

   The power adapter isn't necessary to be connected if using Power over CoaXPress.

Caution!

To power a camera via PoCXP Frame Grabber, you must connect both the CH1 and CH2 channels of the camera to their respective connectors on the CXP-12 Frame Grabber.

3. Verify all the cable connections are secure.

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 Precaution about Blurring Compared to the Center

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

6.3 Installing Vieworks Imaging Solution

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

Chapter 7. Camera Interface

7.1 General Description

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

① Status LED: displays power status and operation mode.

② 12-pin Power Input and Control Receptacle: supplies power to the camera (if PoCXP is not used), and can be set to operate as an input and output line.

③ CoaXPress Connector: transmits video data and controls the camera.

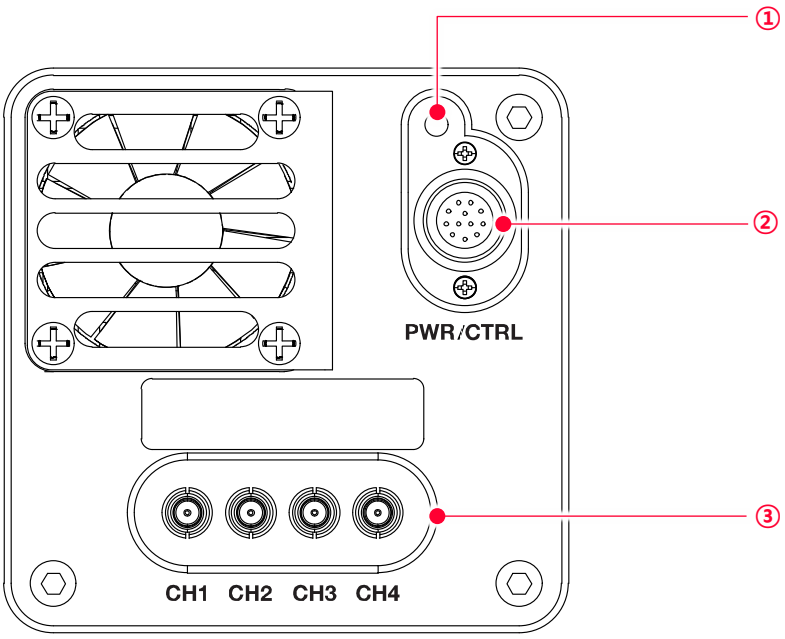


Figure 7-1 VC-21MX2-M/C230I Back Panel

Note:

Information on the back panel of VC-21MX2-M/C230I-HS is the same as above.

7.2 CoaXPress Connector

CoaXPress protocol includes an automatic link detection mechanism (Plug and Play) to correctly detect the camera to the CXP-12 Frame Grabber connection. The connection between the camera and CXP-12 Frame Grabber uses a coax (also known as 'coaxial') cable and provides up to 12.5 Gbps bit rate per cable.

7.2.1 Micro-BNC Connector

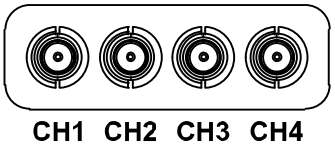


Figure 7-2 Micro-BNC Connector

The CoaXPress connectors on the VC-21MX2-M/C230I camera comply with the CoaXPress 2.0 standard and the following table shows the channel assignments.

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

Table 7-1 Channel Assignments for Micro-BNC Connector

Note:

When you connect a camera to a CXP-12 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-12 Frame Grabber, the camera may not transmit images properly or the communication between the computer and camera may fail.

7.3 Power Input and Control I/O Receptacle

The power input receptacle is a Hirose 12-pin connector (part # HR10A-10R-12PB). The pin assignments and configurations are as follows:

Figure 7-3 Pin Assignments for Power Input and Control I/O Receptacle

Pin Number	Signal	Type	Description
1	DC Ground	Input	Camera Power Ground
2	+12 VDC	Input	Camera Power +12 VDC
3	I/O Output-	Output	-
4	I/O Output 1+	Output	-
5	Trigger Input-	Input	-
6	Trigger Input+	Input	-
7	I/O Output 2+	Output	-
8	I/O Output 3+	Output	-
9	I/O Output 4+	Output	-
10	I/O Output 5+	Output	-
11	I/O Output 6+	Output	-
12	N/C	-	Not Connected

Table 7-2 Pin Configurations for Power Input and Control I/O Receptacle

Note:

- A recommended mating connector for the Hirose 12-pin connector is the Hirose 12-pin plug (part # HR10A-10P-12S) or the equivalent.
- It is recommended that you use the power adapter, which has at least 3 A current output at 12 - 24 VDC voltage output (You need 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 Trigger Input Circuit

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

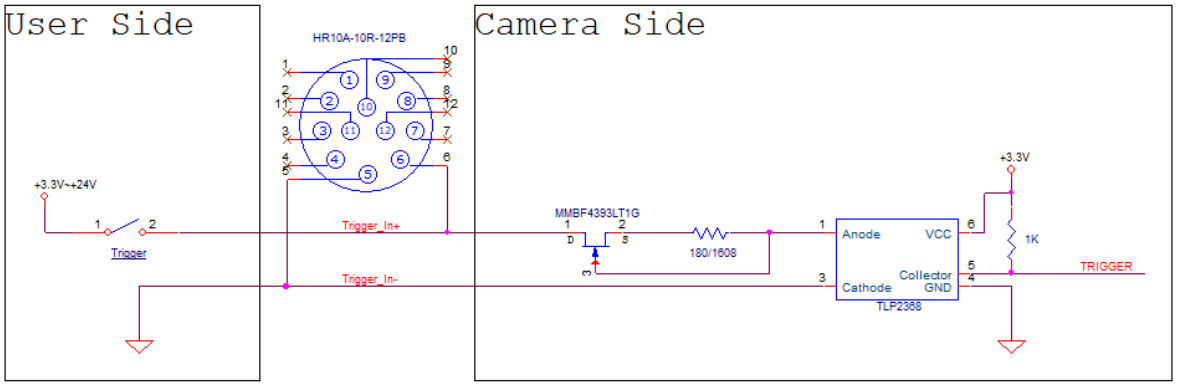


Figure 7-4 Trigger Input Schematic

7.5 Strobe Output Circuit

The following figure shows the output circuit of the 12-pin connector. You can configure the output line by setting the Digital I/O Control (refer to **9.15 Digital I/O Control**).

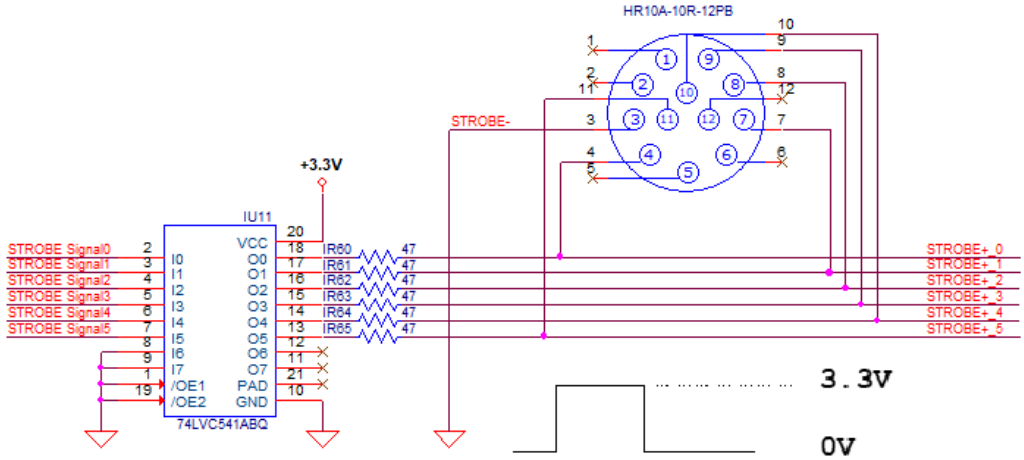


Figure 7-5 Strobe Output Schematic

Chapter 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.

The followings 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
- Frame acquisition process on the camera
- Global shutter
- Maximum Allowed Frame Rate

Note:

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.

8.2 Acquisition Start/Stop Commands and Acquisition Mode

This section describes function available to use via the followings:

- Acquisition Start/Stop commands
- Acquisition Mode

The details about each item above is described in the order from the following section.

8.2.1 Acquisition Start/Stop Commands

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.

8.2.2 Acquisition Mode

The **Acquisition Mode** parameter affects directly how the **Acquisition Start** command works. There are three of types available to select in this parameter as follows:

- Continuous:
  Acquires frames continuously once the Acquisition Start command is called until the Acquisition Stop command is called.
- SingleFrame:
  Acquires one single frame after the Acquisition Start command is called, and then, finishes acquiring images with calling the Acquisition Stop command automatically.
- MultiFrame:
  Acquires frames as many as the numbers designated on the AcqusitionFrameCount parameter after the Acquisition Start command is called, and then, finishes acquiring images with calling the Acquisition Stop command automatically.

Note:

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. If a user calls an Acquisition Stop command on the way of image acquisition, the work will finish after finishing the ongoing acquisition all.

8.2.3 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.

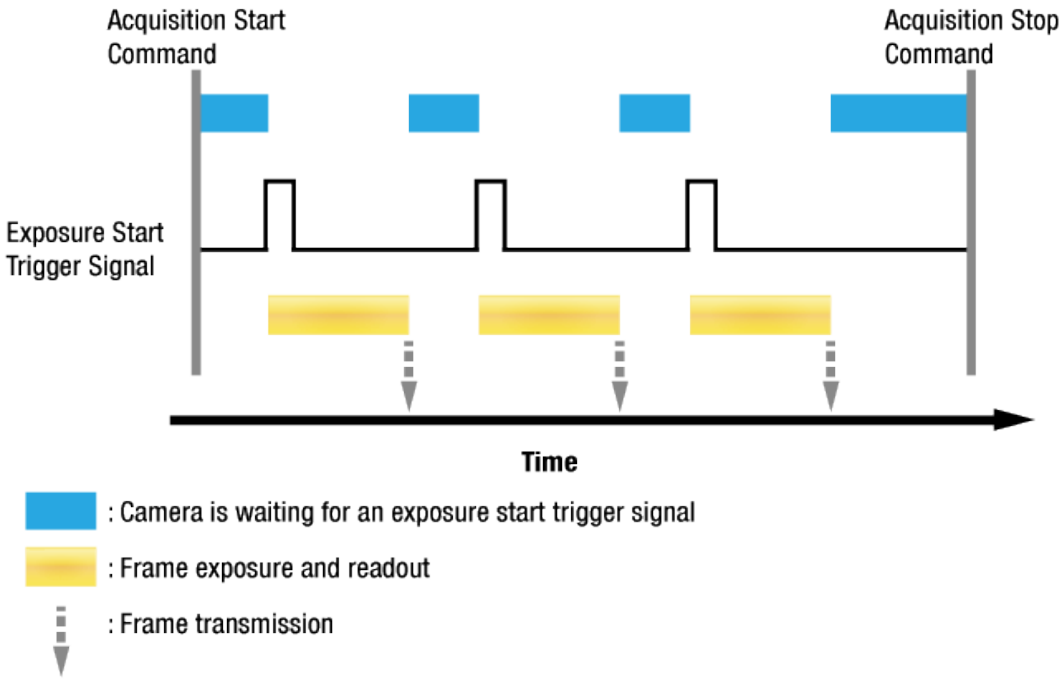


Figure 8-1 Exposure Start Triggering

8.2.4 Applying Trigger Signals

The paragraphs above mention "applying a trigger signal". There are five ways to apply an exposure start trigger signal to the camera: via **Software**, via **UserOutput0**, via **LinkTrigger0**, via **Timer0 Active** or via **Line0** (commonly referred to a 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 UserOutput0, you must set the Trigger Source parameter to UserOutput0. At that point, you can apply an exposure start trigger signal to the camera by switching the User Output Value parameter between On (rise) and Off (fall).
- To apply trigger signals via CH1 of the CXP-12 Frame Grabber, you must set the Trigger Source parameter to LinkTrigger0. At that point, each time a proper CoaXPress trigger signal is applied to the camera by using the APIs provided by a CXP-12 Frame Grabber manufacturer, the exposure start trigger signal will be applied to the camera. For more information, refer to your CXP-12 Frame Grabber User Manual.
- To apply trigger signals via the user-defined Timer feature, you must set the Trigger Source parameter to Timer0 Active. When you set the Timer Trigger Source parameter to Line0 in the Counter And Timer Control category, you can apply an exposure start trigger signal to the camera by using a Timer that uses the Line0 signal as the source signal.
- To apply trigger signals via hardware (external), you must set the Trigger Source parameter to Line0. At that point, each time a proper electrical signal is applied to the camera, an occurrence of the exposure start trigger signal will be recognized by the camera.

8.2.5 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**, the **Exposure Time** parameter will determine the exposure time for each frame.

If the **Trigger Source** parameter is set to **UserOutput0**, **LinkTrigger0**, **Timer0 Active** or **Line0**, there are two modes of operation: **Timed** and **TriggerWidth**.

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

With the **TriggerWidth** mode, the way that you manipulate the rise and fall of the User Output, CoaXPress, Timer or hardware (external) signal will determine the exposure time. The **TriggerWidth** mode is especially useful if you want to change the exposure time from frame to frame.

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 VC-21MX2-M/C230I 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**, **UserOutput0**, **LinkTrigger0**, **Timer0 Active** or **Line0**. 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**.

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 commonly referred 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.

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
- UserOutput0
- LinkTrigger0: For more information, refer to your CXP-12 Frame Grabber User Manual.
- Timer0Active: For more information, refer to 9.17 Timer Control.
- Line0: Refer to 7.4 Trigger Input Circuit for more information.

You must also set the **Trigger Activation** parameter after setting the **Trigger Source** parameter.

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

- Falling Edge: Specifies that a falling edge of the electrical signal will act as the exposure start trigger.
- Rising Edge: Specifies that a rising 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 **LinkTrigger0** or **Line0**, the exposure time for each frame acquisition will be determined by the **Exposure Mode** parameter settings as follows:

- Exposure Mode = Timed: Exposure time can be controlled with the Exposure Time parameter.
- Exposure Mode = TriggerWidth: Exposure time can be controlled by manipulating the external trigger signal.

When the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **Timer0 Active**, the exposure time for each frame acquisition will be determined by the **Exposure Mode** parameter settings as follows:

- Exposure Mode = Timed: Exposure time can be controlled with the Exposure Time parameter.
- Exposure Mode = TriggerWidth: When you set the Timer Trigger Activation parameter to Rising/Falling Edge, the exposure time is controlled with the Timer Duration parameter. When you set the Timer Trigger Activation parameter to Level High/Low, the exposure time can be controlled by manipulating the external trigger signal.

When the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **UserOutput0**, the exposure time for each frame acquisition will be determined by the **Exposure Mode** parameter settings as follows:

- Exposure Mode = Timed: Exposure time can be controlled with the Exposure Time parameter.
- Exposure Mode = TriggerWidth: Exposure time can be controlled by switching the User Output Value parameter between On and Off.

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.

The exposure time for each acquired frame will be determined by the value of the camera's **Exposure Time** parameter.

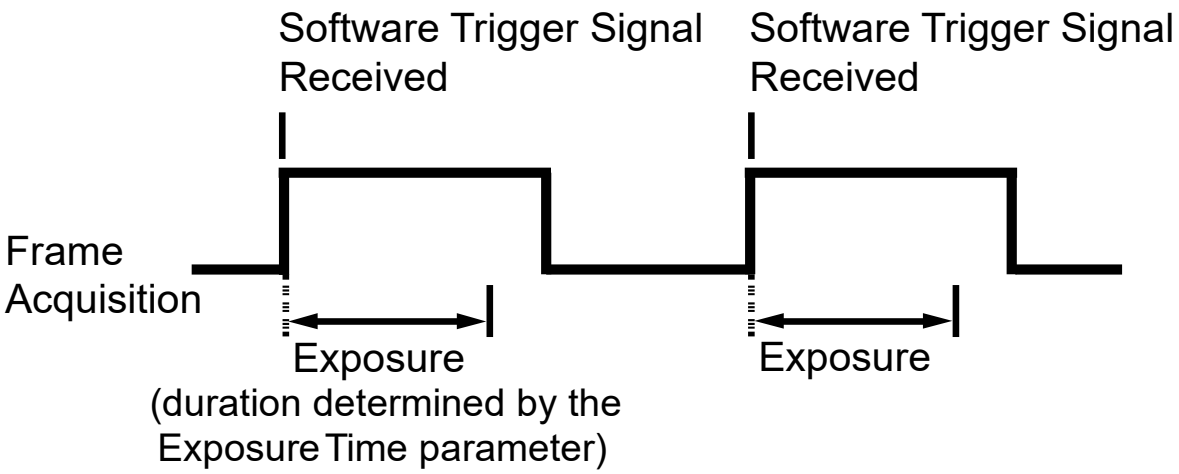


Figure 8-2 Frame Acquisition with Software Trigger Signal

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 **LinkTrigger0**, 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-12 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 Line0, an externally generated electrical signal injected into the Control I/O receptacle 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.

External Trigger Delay

When you set the **Trigger Source** parameter to **Timer0Active**, you can specify a delay between the receipt of a hardware trigger signal and when the trigger becomes effective.

1. Set the **Timer Trigger Source** parameter in the **Counter And Timer Control** category to **Line0**.
2. Set the **Timer Delay** parameter to the desired Timer delay in microseconds.
3. Set the **Trigger Source** parameter in the **Acquisition Control** category to **Timer0Active**.
4. Execute the **Acquisition Start** command and inject an externally generated electrical signal into the Control I/O receptacle. Then, the delay set by the **Timer Delay** parameter expires and the exposure for image acquisition begins.

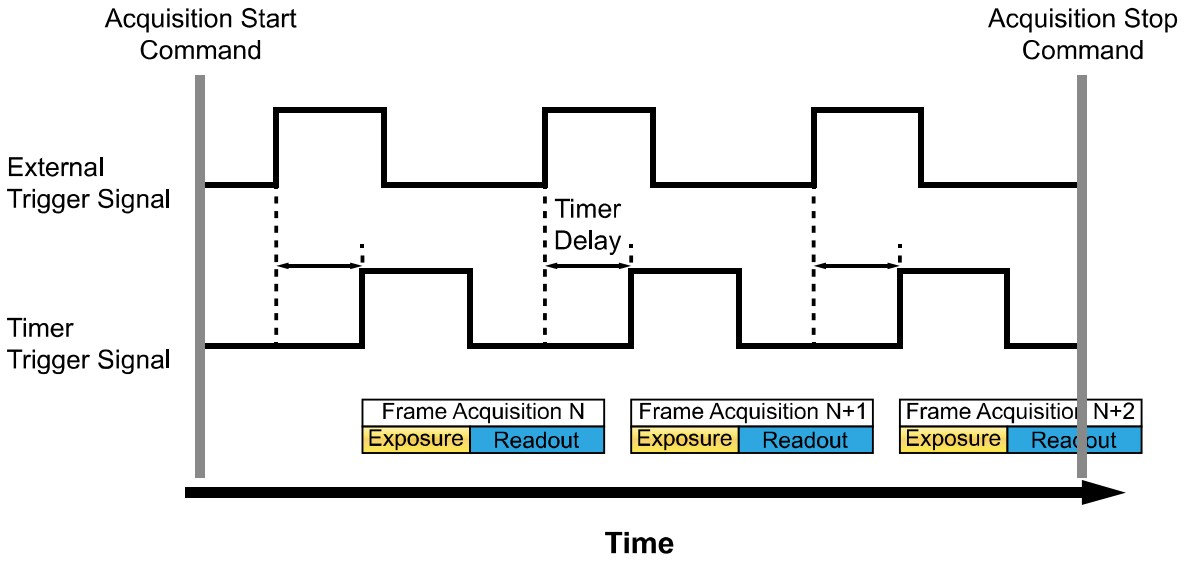


Figure 8-3 External Trigger Delay

8.3.5 Exposure Mode

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 **TriggerWidth**.

Timed Exposure Mode

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

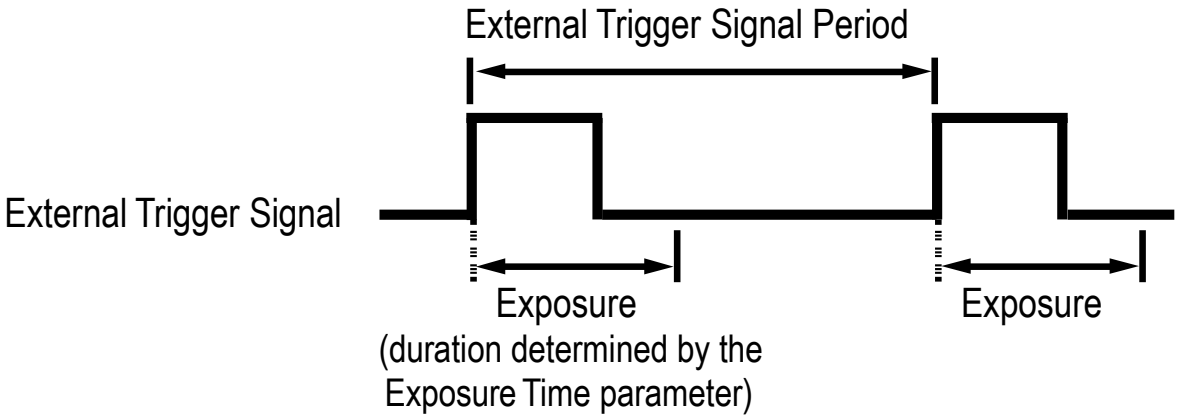


Figure 8-4 Timed Exposure Mode

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

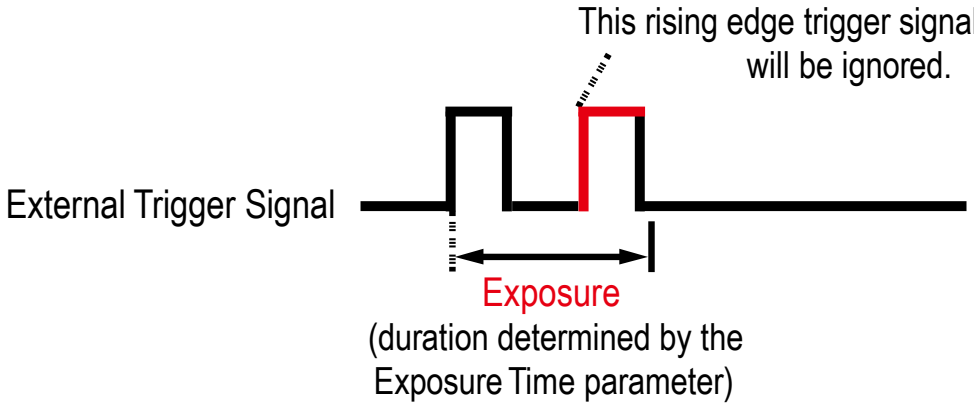


Figure 8-5 Trigger Overlapped with Timed Exposure Mode

TriggerWidth Exposure Mode

When the TriggerWidth exposure mode is selected, the length of the exposure for each frame acquisition will be directly controlled by the external trigger signal (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. The following figure illustrates TriggerWidth exposure with the camera set for rising edge triggering.

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

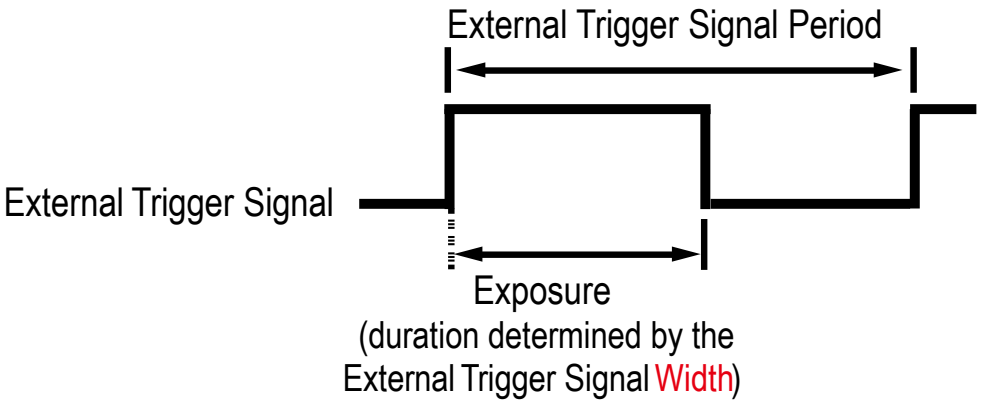


Figure 8-6 TriggerWidth Exposure Mode

8.4 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.
- the Trigger Mode is set to On, the Trigger Source is set to UserOutput0, LinkTrigger0, Timer0 Active or Line0, 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 (*μs*). The minimum and maximum exposure time settings for the VC-21MX2-M/C230I camera are shown in the following table.

Number of Channels	Minimum Exposure Time †	Maximum Exposure Time † †
1/2/4 Channel	4 *μs*	60,000,000 *μs*

†: The actual exposure time is determined by adding the **Exposure Time** value in the **Timed** or **TriggerWidth** items to the **Exposure Offset** value of user's choice.
††: When the **Exposure Mode** is set to **TriggerWidth**, 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 image 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, the VC-21MX2-M/C230I camera basically operates with 'overlapped' exposure so that the exposure for a new frame can be overlapped with the sensor readout for the previous frame.

When a new trigger signal is applied to the camera while reading out the previous frame, the camera begins the process of exposing a new frame. This situation is illustrated in the following figure with the **Trigger Mode** set to **On**, the **Trigger Source** set to **Line0** and the **Exposure Mode** set to **TriggerWidth**.

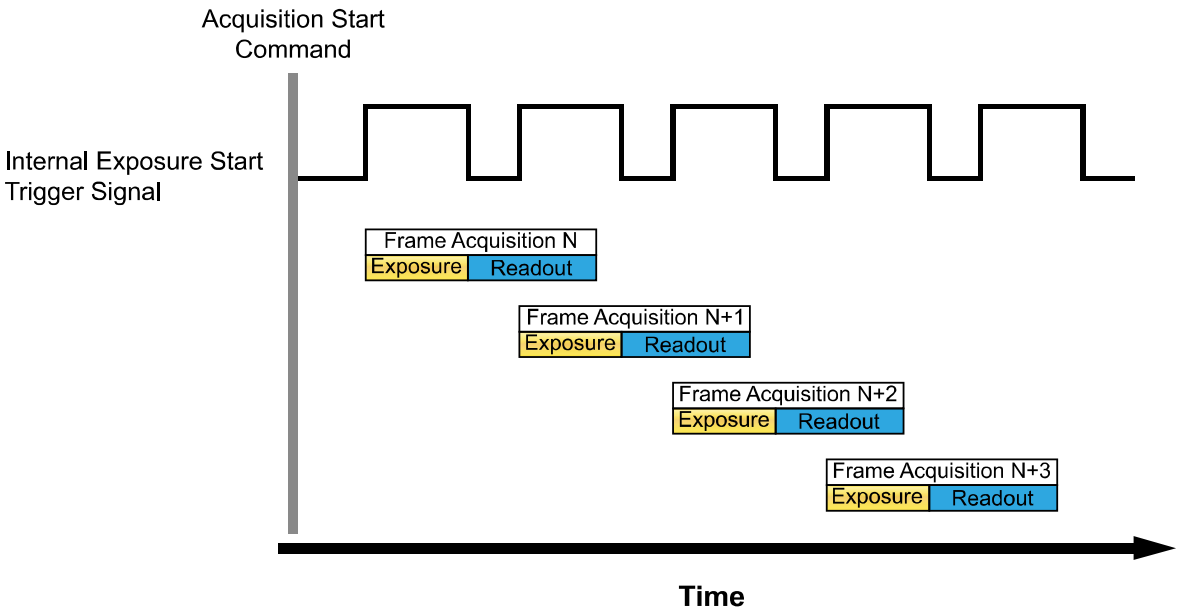


Figure 8-7 Overlapped Exposure and Readout

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: Frame Period ≤ Exposure Time + Readout Time

Guidelines for Overlapped Exposure

Since the VC-21MX2-M/C230I camera operates with overlapped exposure, you must keep in mind two important guidelines:

- You must not begin the exposure for a new frame while the exposure for the previous frame is in progress.
- You must not end the exposure for the current frame until the readout for the previous frame is complete.

When you are operating the 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 Global Shutter

The VC-21MX2-M/C230I camera is equipped with an image sensor that has an electronic global shutter. When an exposure start trigger signal is applied to the camera equipped with a global shutter, exposure begins for all lines in the sensor as shown in the figure below. 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 TriggerWidth 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 camera can provide an **Exposure Active** output signal that will go high when the exposure time for a frame acquisition begins and will go low when the exposure time ends.

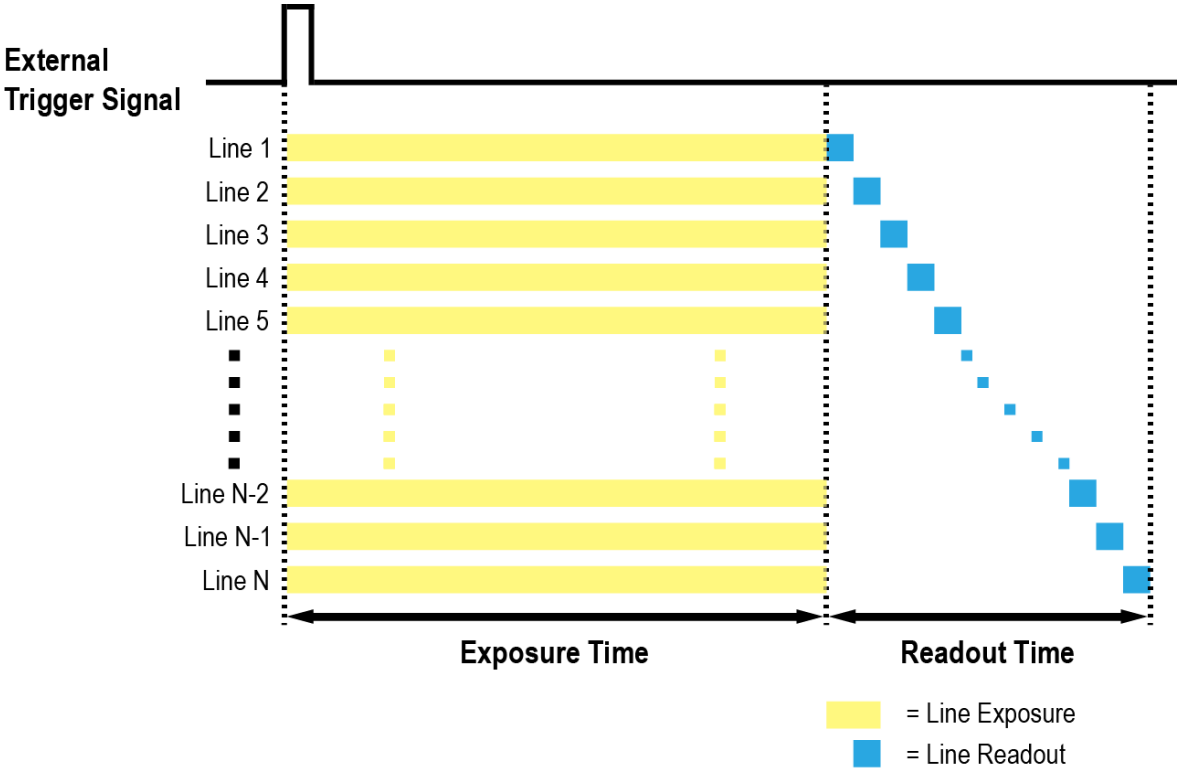


Figure 8-8 Global Shutter

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 image sensor and into the camera's frame buffer. This time varies depending on the setting for ROI. Frames with a smaller height and/or width take less time to read out of the sensor. The frame height and width are determined by the camera's Height and Width settings in the Image Format Control category.
- The CXP Link Configuration. When the camera is set for a CXP Link Configuration that uses more channels, it can typically transfer data out of the camera faster than when it is set for a CXP Link Configuration that uses less channels.
- The exposure time for acquired frames. If you use very long exposure time, 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. Decreasing the size of the Image ROI may increase the maximum allowed frame rate. If possible, decrease the height and/or width of the Image ROI.
- If you are using a CXP Link Configuration with a low number of channels, consider using a CXP Link Configuration with a high number of channels. This will usually increase the maximum allowed frame rate.
- 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 time, it is possible that your exposure time is limiting the maximum allowed frame rate. If you are using a long exposure time, 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.).

Note:

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.

Chapter 9. Camera Features

9.1 Sequence of Signal Processing

To acquire the best-quality images, the VC-21MX2-M/C230I camera handles signals in the following sequence:

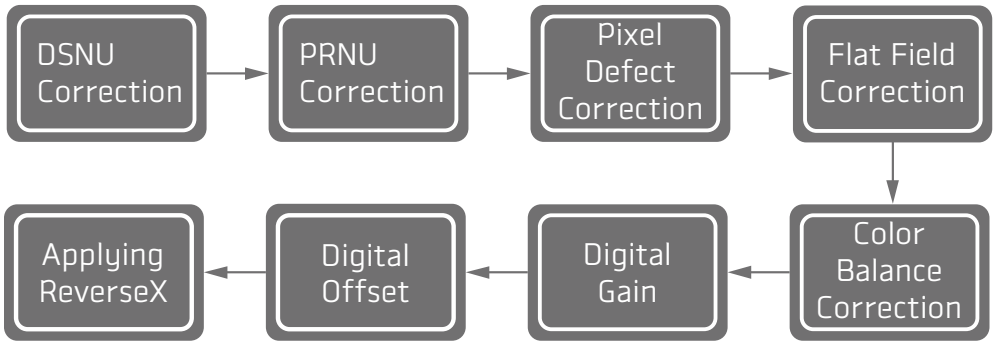


Figure 9-1 Sequence of signal processing to correct images

After finishing the current job, doing all the prior jobs to the current work again is recommended. It may affect the other jobs that have been done before the current job.

9.2 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.

With the ROI feature, you can increase the maximum allowed frame rate by decreasing the **Width** and/or **Height** parameters.

The VC-21MX2-M/C230I camera automatically centers the ROI along the sensor's Y axis. 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** parameter. When you adjust the **Height** parameter, the **Offset Y** parameter is adjusted accordingly and read only. You must set the size of the ROI first, and then the **Offset X** value since the **Width** and **Height** parameters are set to its maximum value by default.

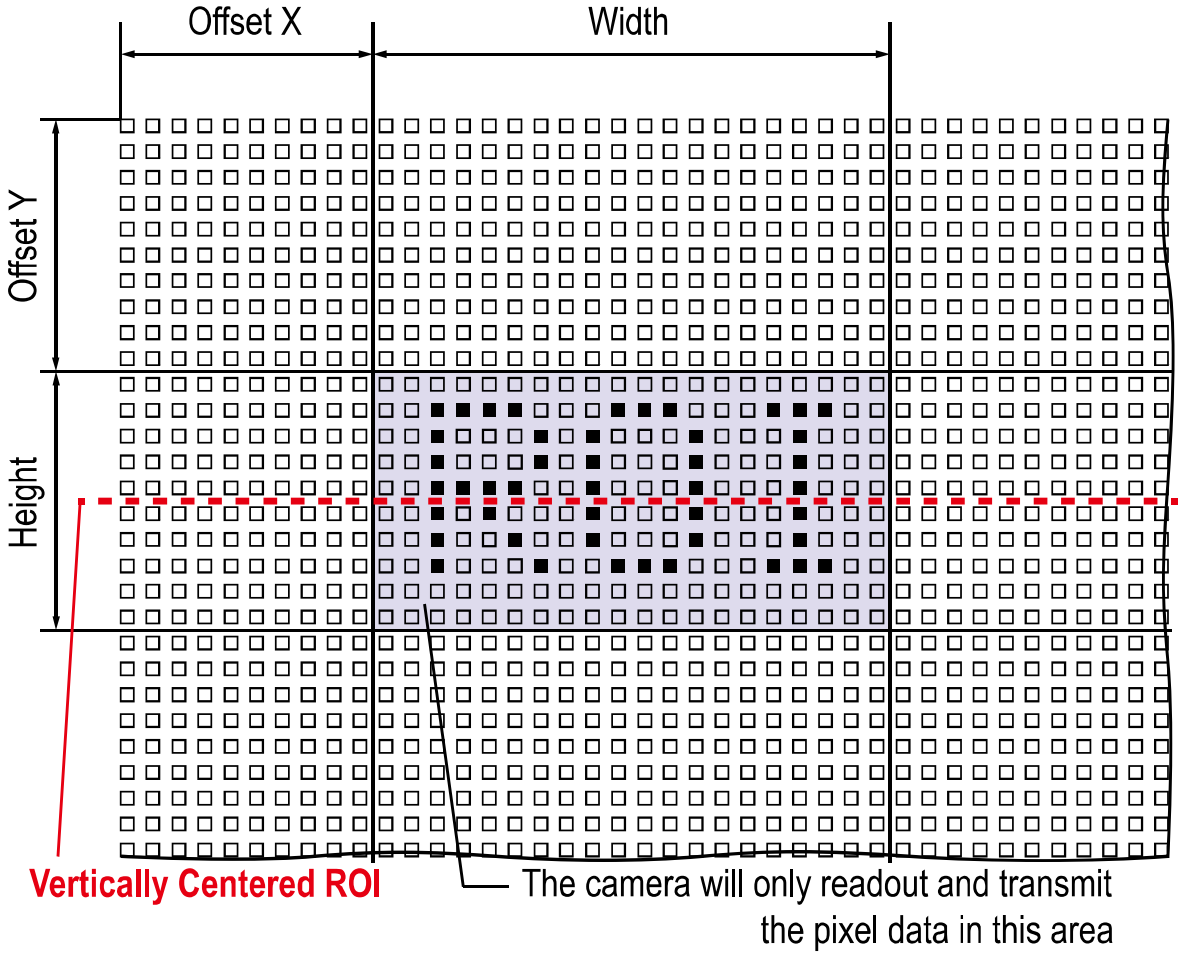


Figure 9-2 Region of Interest

The XML parameters related to ROI settings are as follows.

XML Parameters		Value	Description
ImageFormatControl	SensorWidth[a]	-	Effective width of the sensor
	SensorHeight[a]	-	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[b]	-	Sets the Width of the Image ROI.
	Height[b]	-	Sets the Height of the Image ROI.
	OffsetX[c]	-	Sets the horizontal offset from the origin to the Image ROI.
	OffsetY[a]	-	Shows the 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 in the **Image Format Control** category. You can also change the position of the ROI origin by setting the **Offset X** and **Offset Y** parameters.

In the case of this product, it aligns the center of Image ROI with the sensor's center automatically, due to the feature of the sensor. Therefore, there is no need to set the **Width** value and the **Height** value to the ROI size as needed, because the **OffsetX** and **OffsetY** values will automatically vary so that the ROI is centered on the image even if you set nothing.

- On the VC-21MX2-M/C230I camera, both the Width and the Height parameters must be set to a multiple of 32.

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

Camera Model	Minimum Width Settings	Minimum Height Settings
VC-21MX2-M/C230I	640	32

Table 9-2 Minimum ROI Width and Height Settings

On the VC-21MX2-M/C230I camera, the maximum allowed frame rates depending on Horizontal and Vertical ROI changes are shown below. The maximum allowed frame rates shown below are based on 8 bit Pixel Format, the frame rates get about 20% faster usually when the Pixel Format changes from 10 bit to 8 bit. However, the frame rate doesn't get faster if it already reaches the maximum frame rate of the sensor output.

ROI Size (H × V)	1 Channel	2 Channels	4 Channels
640 × 32	9970.0 fps	18248.1 fps	20040.0 fps
5120 × 32	1403.3 fps	2761.0 fps	5342.5 fps
5120 × 1024	111.3 fps	222.2 fps	442.7 fps
5120 × 2016	57.9 fps	115.7 fps	230.9 fps
5120 × 3008	39.1 fps	78.2 fps	156.2 fps
640 × 4096	228.1 fps	429.2 fps	429.2 fps
1024 × 4096	143.1 fps	284.9 fps	429.2 fps
2016 × 4096	73.1 fps	146.1 fps	291.7 fps
3008 × 4096	49.1 fps	98.0 fps	195.4 fps
4000 × 4096	36.9 fps	73.8 fps	147.4 fps
5120 × 4096	28.9 fps	57.7 fps	115.2 fps

Table 9-3 Maximum Frame Rates by VC-21MX2-M/C230I ROI Changes_CXP-6

ROI Size (H × V)	1 Channel	2 Channels	4 Channels
640 × 32	14992.5 fps	18248.1 fps	20040.0 fps
5120 × 32	2222.8 fps	4332.3 fps	8244.4 fps
5120 × 1024	177.9 fps	354.8 fps	706.8 fps
5120 × 2016	92.6 fps	185.0 fps	369.2 fps
5120 × 3008	62.6 fps	125.1 fps	249.8 fps
640 × 4096	362.7 fps	429.2 fps	429.2 fps
1024 × 4096	229.1 fps	429.2 fps	429.2 fps
2016 × 4096	116.9 fps	233.5 fps	429.2 fps
3008 × 4096	78.4 fps	156.8 fps	312.1 fps
4000 × 4096	59.1 fps	118.0 fps	235.7 fps
5120 × 4096	46.2 fps	92.3 fps	184.4 fps

Table 9-4 Maximum Frame Rates by VC-21MX2-M/C230I ROI Changes_CXP-10

ROI Size (H × V)	1 Channel	2 Channels	4 Channels
640 × 32	18132.3 fps	20040.0 fps	20040.0 fps
5120 × 32	2761.0 fps	5342.5 fps	10053.2 fps
5120 × 1024	222.2 fps	442.7 fps	880.8 fps
5120 × 2016	115.7 fps	230.9 fps	460.6 fps
5120 × 3008	78.2 fps	156.2 fps	311.8 fps
640 × 4096	429.2 fps	429.2 fps	429.2 fps
1024 × 4096	230.2 fps	429.2 fps	429.2 fps
2016 × 4096	146.1 fps	291.7 fps	429.2 fps
3008 × 4096	98.0 fps	195.4 fps	388.5 fps
4000 × 4096	73.8 fps	147.4 fps	293.4 fps
5120 × 4096	57.7 fps	115.2 fps	230.2 fps

Table 9-5 Maximum Frame Rates by VC-21MX2-M/C230I ROI Changes_CXP-12

Caution!

Your CXP-12 Frame Grabber may place additional restrictions on how the ROI location and size must be set. Refer to your CXP-12 Frame Grabber user manual for more information.

Note:

The maximum size of ROI changes when binning. For logic binning, the maximum size becomes half, and for sensor binning, the maximum size becomes fixed as 2056×2016. For more information on changes of the ROI sizes and of the speed when binning, refer to 9.3 Binning.

9.3 Binning

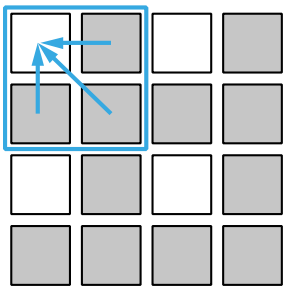
The Binning has the effects of increasing the level value and decreasing resolution by summing the values of the adjacent pixels and sending them as one pixel.

The XML parameters related to Binning are as follows.

XML Parameters		Value	Description
ImageFormat Control	BinningSelector	Sensor	Applies the Binning in analog by the sensor. (Mono only)
		Logic	Applies the Binning in digital by the logic.
	Binning HorizontalMode	Sum	Adds pixel values from the adjacent pixels as specified in the Binning Horizontal, and then sends them as one pixel.
		Average	Adds pixel values from the adjacent pixels as specified in the Binning Horizontal and divides them by the number of combined pixels, and then sends them as one pixel. (Logic binning only)
	BinningHorizontal	1×, 2×	The number of horizontal pixels to combine together.
	Binning VerticalMode	Sum	Adds pixel values from the adjacent pixels as specified in the Binning Vertical, and then sends them as one pixel.
		Average	Adds pixel values from the adjacent pixels as specified in the Binning Vertical and divides them by the number of combined pixels, and then sends them as one pixel. (Logic binning only)
	BinningVertical	1×, 2×	The number of vertical pixels to combine together.

Table 9-6 XML Parameters related to Binning

For example, if you set 2 × 2 binning, the camera's resolution is reduced to 1/4. If you set the **Binning Mode** to **Sum**, the maximum allowed resolution of the image is reduced 1/2 and the responsivity of the camera is quadrupled. If you set the **Binning Mode** to **Average**, the maximum allowed resolution of the image is reduced to 1/2, but there is no difference in responsivity between a binned image and an original image. The **Width Max** and **Height Max** parameter, indicating the maximum allowed resolution of the image with the current camera settings, will be updated depending on the binning settings. And also, the **Width**, **Height**, **Offset X** and **Offset Y** parameters will be updated depending on the binning settings. You can verify the current resolution through the **Width** and **Height** parameters.



2 × 2 Binning

Figure 9-3 2 × 2 Binning

Note:

In the color mode, binning is performed by summing values of the same-color pixels among the adjacent pixels, and after that, sending them as one pixel.

The maximum size of ROI changes when binning. For logic binning, the maximum size becomes half, and for sensor binning, the maximum size becomes fixed as 2056×2016. On the VC-21MX2-M/C230I camera when binning in sensor is performed, the maximum allowed frame rates depending on Horizontal and Vertical ROI changes are shown below. The maximum allowed frame rates shown below are based on 8 bit Pixel Format, the frame rates get about 20% faster usually when the Pixel Format changes from 10 bit to 8 bit. However, the frame rate doesn't get faster if it already reaches the maximum frame rate of the sensor output.

Sensor Binning (2×2)			
ROI Size (H × V)	1 Channel	2 Channels	4 Channels
640 × 32	5767.0 fps	10980.9 fps	19788.9 fps
2560 × 64	1280.1 fps	2519.5 fps	4883.1 fps
2560 × 512	377.1 fps	751.0 fps	1488.8 fps
2560 × 992	214.7 fps	428.4 fps	852.6 fps
2560 × 1504	147.1 fps	293.8 fps	585.6 fps
640 × 2016	441.9 fps	875.2 fps	1643.1 fps
992 × 2016	286.6 fps	571.4 fps	1135.3 fps
1504 × 2016	189.8 fps	378.8 fps	751.2 fps
1984 × 2016	144.2 fps	287.5 fps	571.4 fps
2560 × 2016	111.9 fps	223.6 fps	446.0 fps

Table 9-7 Maximum Frame Rates When Binning in Sensor by ROI Changes_CXP-6

Sensor Binning (2×2)			
ROI Size (H × V)	1 Channel	2 Channels	4 Channels
640 × 32	8880.9 fps	16483.5 fps	21691.9 fps
2560 × 64	2030.4 fps	3959.0 fps	7539.9 fps
2560 × 512	601.3 fps	1191.9 fps	2342.4 fps
2560 × 992	342.8 fps	681.5 fps	1347.3 fps
2560 × 1504	235.0 fps	467.8 fps	927.2 fps
640 × 2016	701.6 fps	1381.6 fps	1643.1 fps
992 × 2016	456.6 fps	908.5 fps	1643.1 fps
1504 × 2016	303.0 fps	603.9 fps	1191.9 fps
1984 × 2016	230.6 fps	458.8 fps	908.5 fps
2560 × 2016	178.8 fps	356.1 fps	706.8 fps

Table 9-8 Maximum Frame Rates When Binning in Sensor by ROI Changes_CXP-10

Sensor Binning (2×2)			
ROI Size (H × V)	1 Channel	2 Channels	4 Channels
640 × 32	10905.1 fps	19788.9 fps	21691.9 fps
2560 × 64	2519.5 fps	4883.1 fps	9235.7 fps
2560 × 512	751.0 fps	1488.8 fps	2913.2 fps
2560 × 992	428.4 fps	852.6 fps	1680.6 fps
2560 × 1504	293.8 fps	585.6 fps	1157.9 fps
640 × 2016	875.2 fps	1643.1 fps	1643.1 fps
992 × 2016	571.4 fps	1135.3 fps	1643.1 fps
1504 × 2016	378.8 fps	751.2 fps	1489.3 fps
1984 × 2016	287.5 fps	571.4 fps	1135.3 fps
2560 × 2016	223.6 fps	446.0 fps	883.3 fps

Table 9-9 Maximum Frame Rates When Binning in Sensor by ROI Changes_CXP-12

9.4 CXP Link Configuration

The VC-21MX2-M/C230I camera must be connected to a CXP-12 Frame Grabber of CXP 2.0 interface. CoaXPress 2.0 interface allows you to connect a camera to a Frame Grabber supporting CXP 2.0 by using simple coax cabling and allows up to 12.5 Gbps data rate per cable. The VC-21MX2-M/C230I camera supports one master connection and up to three extension connections to configure a link. In compliance with the CoaXPress standard, the camera includes an automatic link detection mechanism (Plug and Play) to correctly detect the camera to CXP-12 Frame Grabber connections.

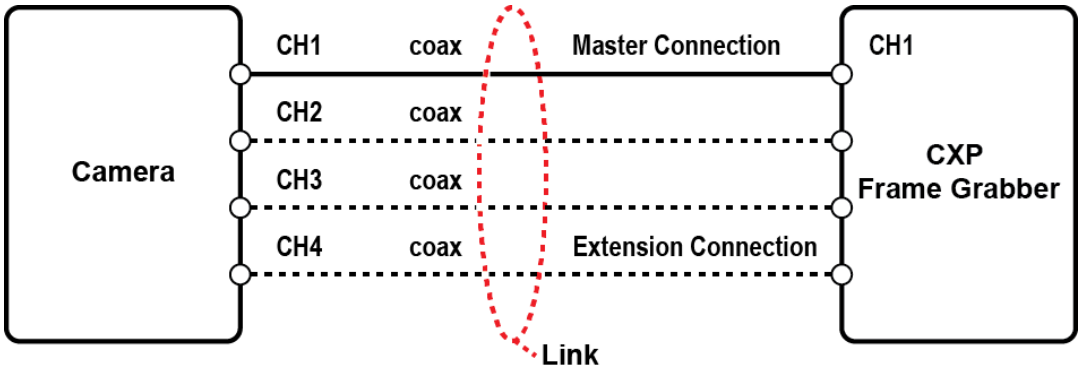


Figure 9-4 CXP Link Configuration

The XML parameters related to the link configuration between the camera and CXP-12 Frame Grabber are as follows.

XML Parameters		Value	Description
CoaXPress	CxpLinkConfiguration Preferred	Read Only	Displays bit rate and the number of connections to be set for the link configuration between the camera and Host (Frame Grabber) while discovering devices. Saves the current CxpLinkConfiguration values as the CxpLinkConfigurationPreferred value when you execute the User Set Save parameter.
	CxpLinkConfiguration	CXP6_X1 CXP6_X2 CXP6_X4 CXP10_X1 CXP10_X2 CXP10_X4 CXP12_X1 CXP12_X2 CXP12_X4	Sets bit rate and the number of connections for the link configuration. e.g. CXP12_X4: Four connections running at a maximum of CXP12 speed (12.5 Gbps)

Table 9-10 XML Parameters related to CXP Link Configuration

9.5 Pixel Format

The VC-21MX2-M/C230I camera processes image data in the unit of 12 bit. The pixel format of the image data is available to be chosen among 8 bit, 10 bit, or 12 bit with the Pixel Format parameter. For instance, the 2 least significant bits will be dropped from overall 10 bits when the camera is set for 10-bit pixel format.

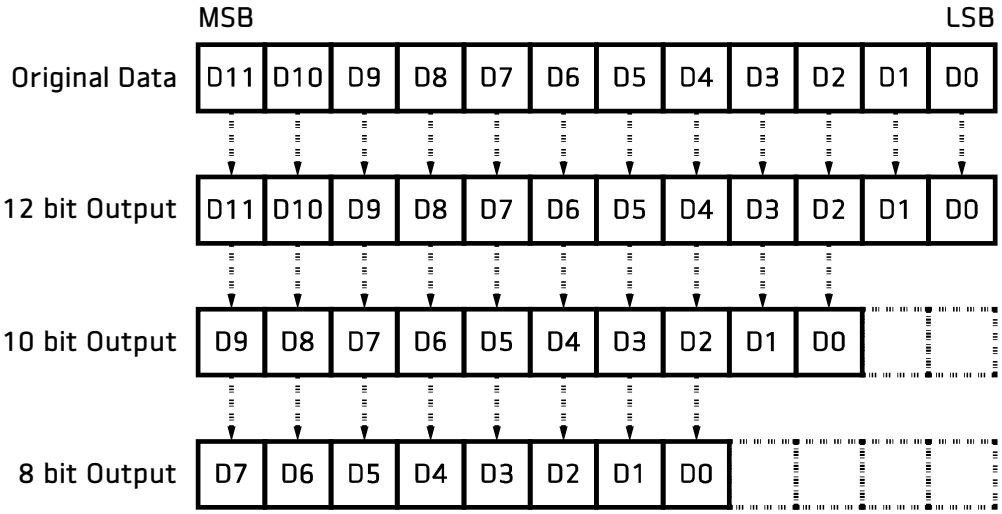


Figure 9-5 VC-21MX2-M/C230I Pixel Format

The XML parameter related to Pixel Format is as follows.

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

Table 9-11 XML Parameter related to Pixel Format

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

Mono Sensor	Color Sensor
Mono 8 Mono 10 Mono 12	Mono 8 Mono 10 Mono 12 Bayer GB 8 Bayer GB 10 Bayer GB 12

Table 9-12 Pixel Format Values

9.6 Data ROI (Color Only)

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

The XML parameters related to Data ROI are as follows.

XML Parameters		Value	Description
DataRoiControl	DataRoiSelector	Balance WhiteAuto	Selects a Data ROI used for Balance White Auto. (Only available on the color camera)
	DataRoiOffsetX	-	X coordinate of start point Data ROI
	DataRoiOffsetY	-	Y coordinate of start point Data ROI
	DataRoiWidth	32 - 5120	Width of Data ROI
	DataRoiHeight	2 - 4096	Height of Data ROI

Table 9-13 XML Parameters related to Data ROI

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

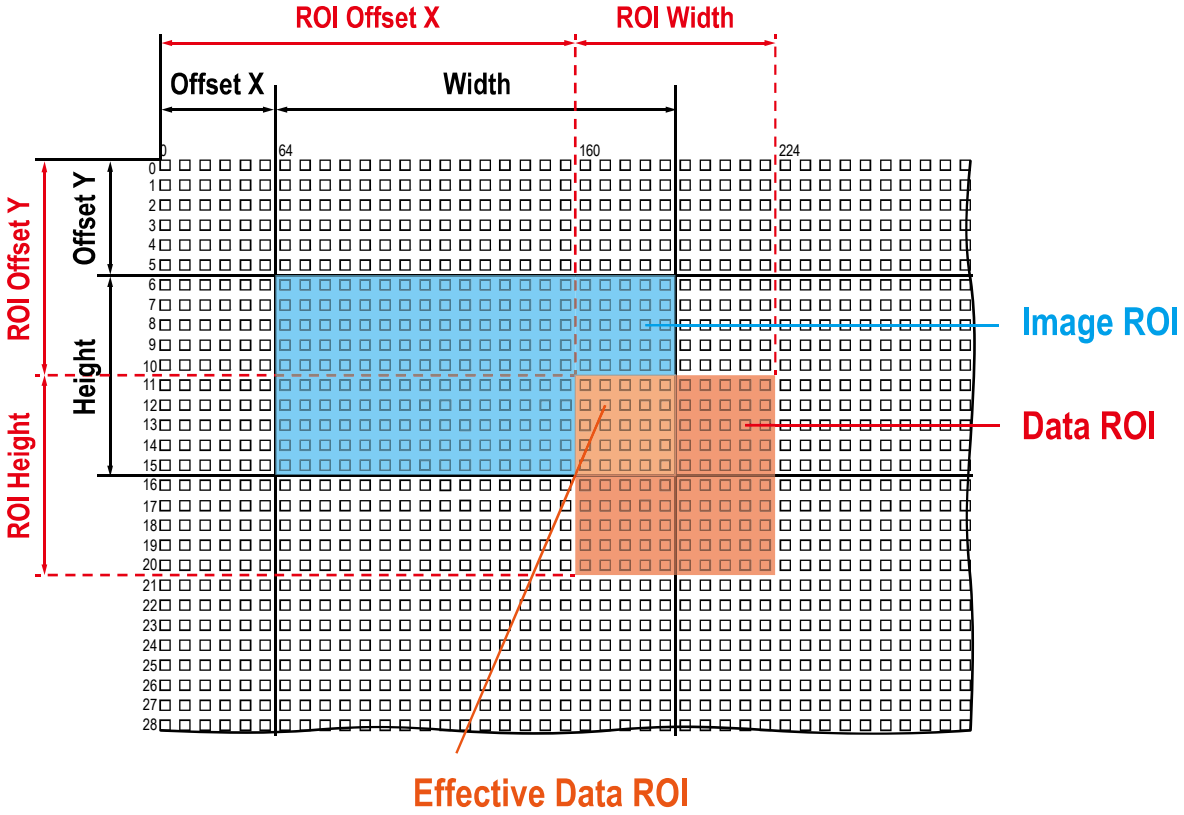


Figure 9-6 Effective Data ROI

9.7 White Balance (Color Only)

The color camera includes the white balance capability to adjust the color balance of the images transmitted from the camera. With the white balancing scheme used on the VC-25MC-31 I camera, the Red, Green and Blue intensities can be adjusted individually. You can set the intensity of each color by using the **Balance Ratio** parameter. The Balance Ratio value can range from 1.0 to 4.0. If the **Balance Ratio** parameter is set to 1.0 for a color, the intensity of the color will be unaffected by the white balance mechanism. If the **Balance Ratio** parameter is set to greater than 1.0, the intensity of the color will be proportionally increased to the ratio. For example, if the **Balance Ratio** is set to 1.5, the intensity of that color will be increased by 50%.

The XML parameters related to White Balance are as follows.

XML Parameters		Value	Description
AnalogControl	BalanceRatio Selector	Red	A Balance Ratio value will be applied to red pixels.
		Green	A Balance Ratio value will be applied to green pixels.
		Blue	A Balance Ratio value will be applied to blue pixels.
	BalanceRatio	×1.0 ~ ×4.0	Adjusts the ratio of the selected color.

Table 9-14 XML Parameters related to White Balance

9.7.1 Balance White Auto

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

The XML parameters related to Balance White Auto are as follows.

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

Table 9-15 XML Parameter related to Balance White Auto

9.8 Gain and Black Level

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

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

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

1. Selects the Black Level Control (**Digital All** is only available) to be adjusted by using the **Black Level Selector** parameter.
2. Sets the **Black Level** parameter to the desired value.

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

XML Parameters		Value	Description
AnalogControl	GainSelector	Analog All	Applies the Gain value to all analog channels.
		Digital All	Applies the Gain value to all digital channels.
	Gain	1.0×, 1.3×, 2.0×, 4.2×	Sets an analog gain value.
		1.0×, 1.4×, 2.0×, 3.0×	Sets an analog gain value when 2×2 binning in senser.
		1.0× — 32.0×	Sets a digital gain value.
	BlackLevelSelector	Digital All	Applies the Black Level value to all digital channels.
	BlackLevel	8 bit: 0 ~ 15.93 10 bit: 0 ~ 63.75 12 bit: 0 ~ 255.00	Sets a black level value.

Table 9-16 XML Parameters related to Gain and Black Level

9.9 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.

9.9.1 Correction Method

A correction value for a defect pixel is calculated based on the valid pixel value adjacent in the same line.

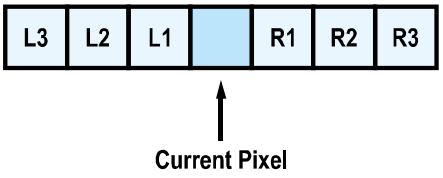


Figure 9-7 Location of Defect Pixel to be corrected

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

Adjacent Defect Pixel	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 9-17 Calculation of Defect Pixel Correction Value

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 VC-21MX2-M/C230I cameras provide the DSNU Correction feature.

The XML parameters related to DSNU are as follows.

XML Parameters		Value	Description
DSNU	DSNUDataSelector	Default	Selects Default as a non-volatile memory location to generate/save/load DSNU data from.
		Space1 - 7	Selects a user defined location as a non-volatile memory location to save DSNU data to or load DSNU data from.
	DSNUDataGenerate	-	Generates the DSNU data for the current camera settings.
	DSNUDataSave	-	Saves the generated DSNU data in the non-volatile memory: The generated data by executing the **DSNUDataGenerate** command are saved in the volatile memory so that the data are lost if the camera is reset or if power is turned off. To use the data after the camera is powered on or reset, save them in the non-volatile memory.
	DSNUDataLoad	-	Loads the DSNU data from the non-volatile memory into the volatile memory.
	DSNUDataDefault	Default	Selects the DSNU data saved in the Default parameter as the default setting of the DSNU data.
		Space1 - 7	Selects the default of the DSNU-data location among the saved data.

Table 9-18 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.

Note:

- For optimum DSNU correction results, we recommend that you generate DSNU data after the temperature of the camera housing has been stabilized.
- Before generating DSNU data, set the FFC feature to Off.

1. To obtain the optimum DSNU correction values, set the ROI to the actual settings you will be using during normal operation.
2. Ensure that the camera will be acquiring images in complete darkness by covering the camera lens, closing the iris in the lens, or darkening the room.
3. Begin acquiring images by setting the camera for the Free-Run mode.
4. Execute the **DSNU Data Generate** command to generate DSNU data for the current camera settings.
5. The generated DSNU correction values will be activated and saved in the camera's volatile memory.
6. To save the generated DSNU correction values in the camera's Flash (non-volatile) memory, use the **DSNU Data Selector** parameter to specify a location to save the DSNU correction values, and then execute the **DSNU Data Save** command. The previous DSNU values saved in the memory will be overwritten.

   To disregard the generated DSNU correction values and load the existing values in the Flash memory, use the **DSNU Data Selector** parameter to select a desired DSNU correction values, and then execute the **DSNU Data Load** command.

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 VC-21MX2-M/C230I cameras provide the PRNU Correction feature.

The XML parameters related to PRNU are as follows.

XML Parameters		Value	Description
PRNU	PRNUNUDataSelector	Default	Selects Default as a non-volatile memory location to load PRNU data from.
		Space1 - 7	Selects a user defined location as a non-volatile memory location to save PRNU data to or load PRNU data from.
	PRNUDataGenerate	-	Generates the PRNU data for the current camera settings.
	PRNUDataSave	-	Saves the generated PRNU data in the non-volatile memory. The generated data by executing the **PRNUDataGenerate** command are saved in the volatile memory so that the data are lost if the camera is reset or if power is turned off. To use the data after the camera is powered on or reset, save them in the non-volatile memory.
	PRNUDataDefault	Default	Selects the PRNU data saved in the Default parameter as the default setting of the PRNU data.
		Space1 - 7	Selects the default of the PRNU-data location among the saved data.

Table 9-19 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.

Note:

To generate the optimum PRNU data,

- we recommend that you generate DSNU correction values first before generating PRNU correction values.
- set the FFC feature to Off before generating PRNU correction values.
- the grey reference image must be acquired at uniform illumination. We strongly recommend that you use a high-quality light source to deliver uniform illumination. Standard illumination may not be appropriate.

The PRNU correction values stored in Default are optimized for use in typical situations and will provide good camera performance in most cases. Use of the values stored in Default is recommended.

1. To generate PRNU correction values suitable for your operating conditions, set the ROI to the actual settings you will be using during normal operation. We strongly recommend that you use the Default PRNU correction values stored in Default, if you cannot set up the uniform illumination.
2. Without mounting a lens on the camera, place a uniform illumination (e.g. backlight) in the field of view of the camera. Set up the camera as you would for normal operation. We recommend that you make adjustments to achieve the digital output level in a range from 150 to 200 (Gain: 1.00 at 8 bit).
3. Begin acquiring images by setting the camera for the Free-Run mode.
4. Execute the **PRNU Data Generate** command to generate PRNU correction values for the current camera settings.
5. The generated PRNU correction values will be activated and saved in the camera's volatile memory.
6. To save the generated PRNU correction values in the camera's Flash (non-volatile) memory, use the **PRNU Data Selector** parameter to specify a location to save the PRNU correction values, and then execute the **PRNU Data Save** command. The previous PRNU values saved in the memory will be overwritten.

   To disregard the generated PRNU correction values and load the existing values in the Flash memory, use the **PRNU Data Selector** parameter to select a desired PRNU correction values, and then execute the **PRNU Data Load** command.

9.12 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 of the VC-21MX2-M/C230I camera can be summarized by the following equation.

```
IC = IR / IF


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 correction data and then save the data into the non-volatile memory of the camera by following the procedure below.

1. Execute the **Flat Field Data Generate** parameter.

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

2. Use the **Flat Field Data Selector** parameter to specify a location to save the generated Flat Field correction data.
3. Execute the **Flat Field Data Save** parameter to save the generated Flat Field data into the non-volatile memory. When the scaled down Flat Field data are used for correction, they are expanded and applied with a Bilinear Interpolation as shown in the **Figure 9-9**.

   To disregard the generated Flat Field correction data and load the existing Flat Field correction data, execute the **Flat Field Data Load** parameter before executing the **Flat Field Data Save** parameter.

4. Set the **Flat Field Correction** parameter to **On** to apply the Flat Field data to the camera.

Caution!

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

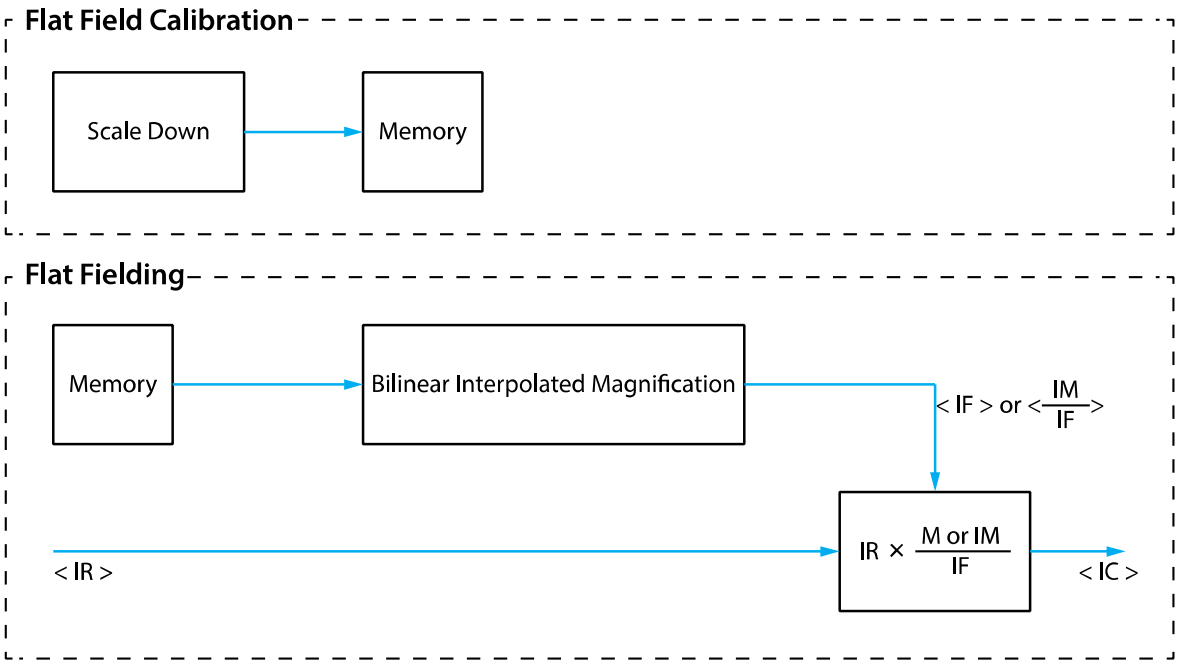


Figure 9-8 Generation and Application of Flat Field Data

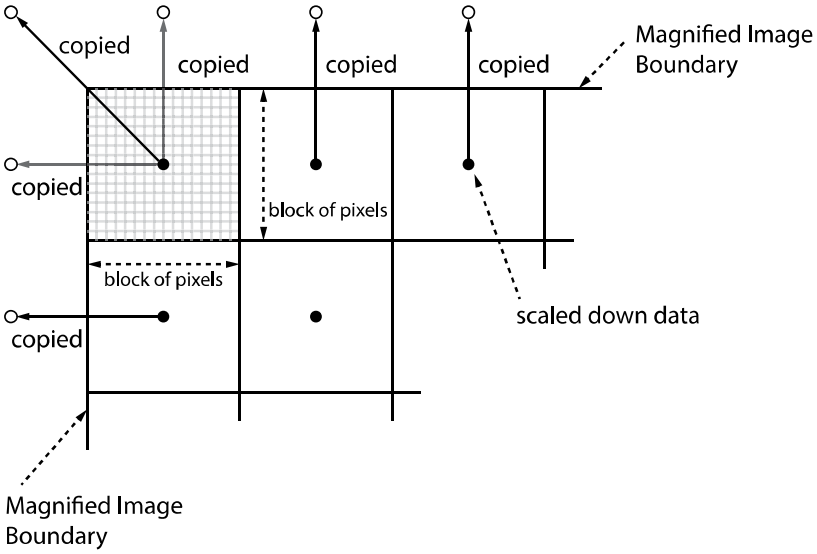


Figure 9-9 Bilinear Interpolated Magnification

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

XML Parameters		Value	Description
FlatFieldControl	FlatFieldCorrection	Off	Disables the Flat Field Correction feature.
		On	Enables the Flat Field Correction feature.
	FlatFieldData Selector	Space0 ~ Space15	Selects a location to save Flat Field data to or load Flat Field data from. Space0~Space15: User defined location
	FlatFieldData Generate	-	Generates the Flat Field data.
	FlatFieldDataSave	-	Saves the generated Flat Field correction data in the non-volatile memory: The data generated by executing the Flat Field Data Generate 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.
	FlatFieldDataLoad	-	Loads the Flat Field data from the non-volatile memory into volatile memory.
	FlatFieldDataDefault	Space0 ~ Space15	Selects the default location of the Flat Field data among the saved data. Space0~Space15: User defined location

Table 9-20 XML Parameters related to Flat Field Correction

9.12.1 Flat Field Data Selector

As mentioned above, the generated Flat Field correction data are stored in the camera's volatile memory and the data are lost if the camera is reset or powered off. To use the generated Flat Field correction data after the camera is powered on or reset, you need to save them in the camera's non-volatile memory. The VC-21MX2-M/C230I camera provides sixteen reserved locations in the camera's non-volatile memory available for saving and loading the Flat Field correction data. You can use the **Flat Field Data Selector** parameter to select a location as desired.

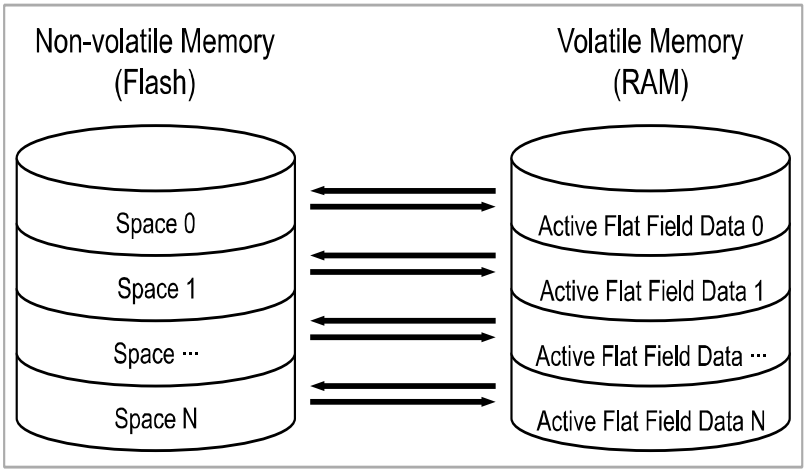


Figure 9-10 Flat Field Data Selector

Saving Flat Field Data

In order to save the active Flat Field data into a reserved location in the camera's Flash memory, follow the procedure below.

1. Use the **Flat Field Data Selector** parameter to specify a location to save the active Flat Field data.
2. Execute the **Flat Field Data Save** parameter to save the active Flat Field data to the selected location.

Loading Flat Field Data

If you saved Flat Field correction data into the camera's non-volatile memory, you could load the saved Flat Field correction data from the camera's non-volatile memory into the camera's active Flat Field data location.

1. Use the **Flat Field Data Selector** parameter to specify a reserved location whose Flat Field correction data will be loaded into the camera's active Flat Field data location.
2. Execute the **Flat Field Data Load** parameter to load the selected Flat Field correction data into the active Flat Field data location.

9.13 Timestamp

VC-21MX2-M/C230I camera provides a Timestamp feature.

XML parameters related to Timestamp are as follows.

XML Parameters		Description
DeviceControl	Timestamp	Indicates the current Timestamp value of the connected device.
	TimestampIncrement	Indicates the increment of Timestamp.
	TimestampReset	Changes the current Timestamp value into 0 and restarts counting.
	TimestampResetValue	Designates time to reset Timestamp as 0, by the form in the numeric value.
	TimestampLatch	Latches the current value of Timestamp.
	TimestampLatchValue	Indicates prior value before resetting the Timestamp value.

Table 9-21 XML Parameters related to Timestamp

9.14 Event Control

VC-21MX2-M/C230I camera provides an Event Notification feature. With the Event Notification feature, the camera can generate an event and transmit a related event message to the PC whenever a specific situation has occurred.

The VC-21MX2-M/C230I camera can generate and transmit events for the following type of situation:

- When the TestEventGenerate parameter is executed (Test)

XML parameters related to Event Control are as follows.

XML Parameters		Value	Description
EventControl	EventSelector	Test	Transfers the Test event generated from the execution of the TestEventGenerate parameter.
	Event Notification	On	Enables the selected event notification.
		Off	Disables the selected event notification.
TestControl	TestPendingAck	-	Sets time to wait before writing the device's pending acknowledge feature.
	TestEventGenerate	-	Generates a Test event.

Table 9-22 XML Parameters related to Event Control

9.15 Digital I/O Control

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

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

XML Parameters		Value	Description
DigitalIOControl	LineSelector	Line0	Configures the pin of No.1 among 12 pins of the camera's Power Input and Control I/O receptacle.
		Line1 ~ Line6	Configures the pin of No. 4, 7, 8, 9, 10 or 11 among 12 pins of the camera's Power Input and Control I/O receptacle.
	LineMode	Input	Appears under Line0 is chosen.
		Output	Appears under one of the Line1~Line6 is chosen.
	LineInverter	FALSE	Disables inversion on the output signal of the line.
		TRUE	Enables inversion on the output signal of the line.
	LineSource	Off	Disables the line output.
		Frame Active	Outputs pulse signals indicating a frame readout time.
		LineActive	Outputs pulse signals indicating the current line time.
		Exposure Active	Outputs pulse signals indicating the current exposure time.
		UserOutput0	Outputs pulse signals set by User Output Value.
		Timer0 Active	Outputs user-defined Timer signals as pulse signals.
		Count0Active	Outputs user-defined Counter signals as pulse signals
	UserOutput Selector	UserOutput0	Outputs pulse signals set by User Output Value.
	UserOutput Value	FALSE	Sets the bit state of the line to Low.
		TRUE	Sets the bit state of the line to High.
	Debounce Time	0 ~ 1,000,000	Sets a Debounce Time in microseconds (Default: 0.5 μs).

Table 9-23 XML Parameters related to Digital I/O Control

When you set the **Line Source** to **UserOutput0**, you can use the user setting values as output signals.

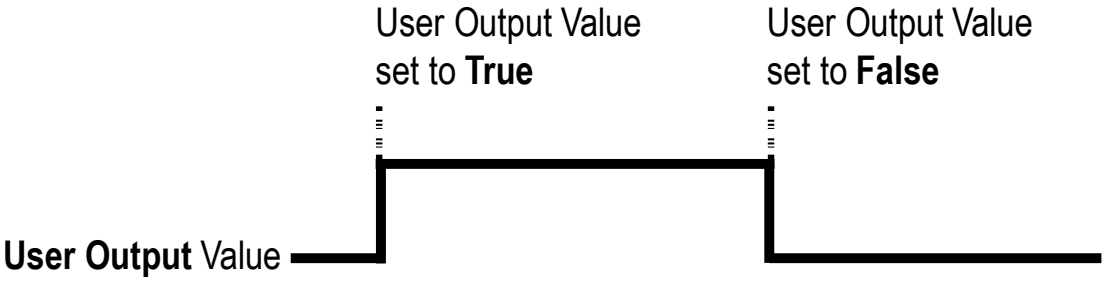


Figure 9-11 User Output

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

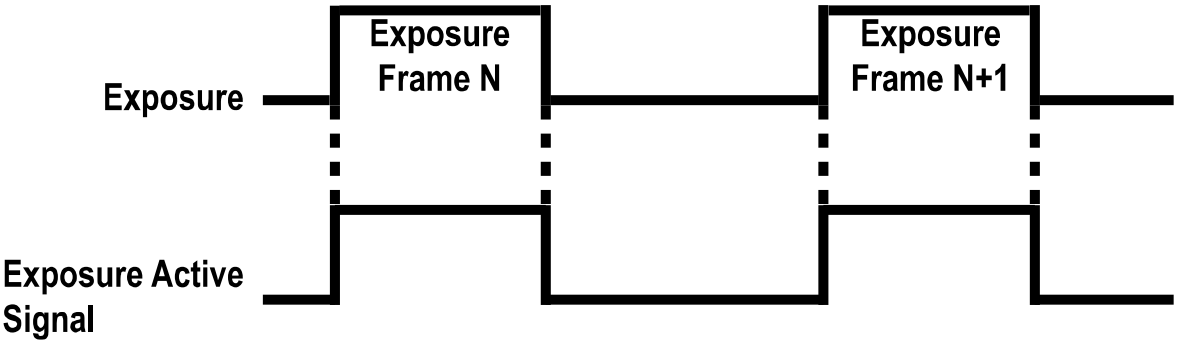


Figure 9-12 Exposure Active Signal

9.16 Debounce

The Debounce feature of the VC-21MX2-M/C230I cameras allows to supply only valid signals to the camera by discriminating between valid and invalid input signals. The Debounce Time parameter specifies the minimum time that an input signal must remain High or Low in order to be considered as a valid input signal. When you use the Debounce feature, be aware that there is a delay between the point where the valid input signal arrives and the point where the signal becomes effective. The duration of the delay is determined by the Debounce Time parameter setting value.

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

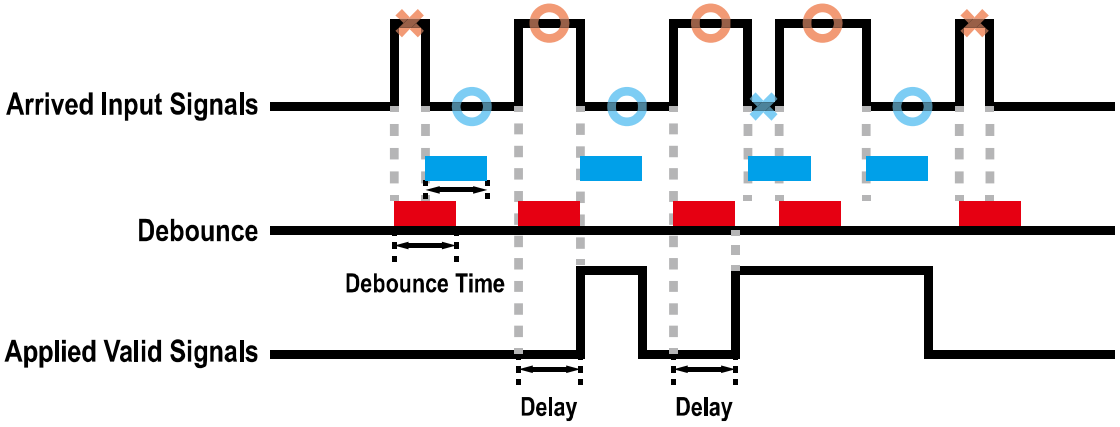


Figure 9-13 Debounce

The XML parameter related to Debounce Time is as follows.

XML Parameters		Value	Description
DigitalIOControl	Debounce Time	0 – 1,000,000 μs	Sets a Debounce Time in microseconds (Default: 0 μs).

Table 9-24 XML Parameter related to Debounce Time

9.17 Timer Control

When the **Line Source** parameter is set to **Timer0Active**, the camera can provide output signals by using the Timer. On the VC-21MX2-M/C230I camera, the Frame Active, Exposure Active event or external trigger signal is available as Timer source signal.

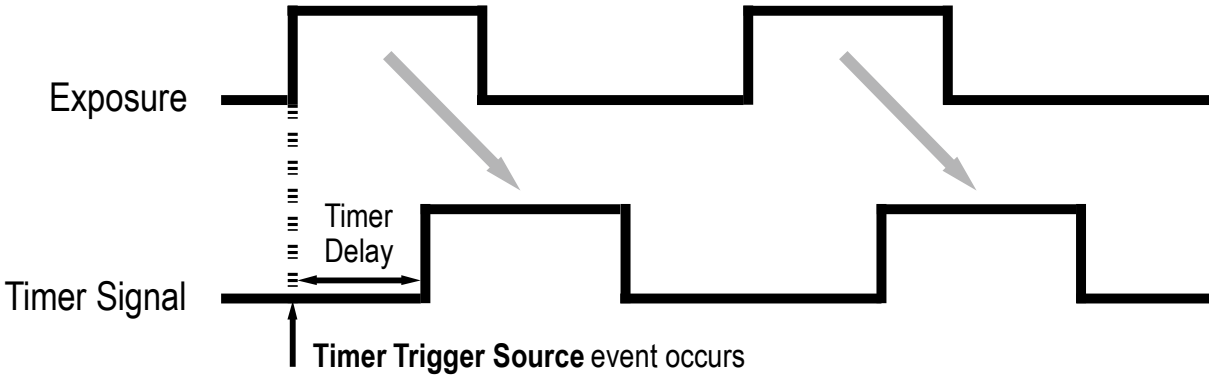
The XML parameters related to Timer are as follows.

XML Parameters		Value	Description
CounterAnd TimerControl	TimerDuration	1 ~ 85,899,344 *μs*	Sets the duration of the Timer output signal to be used when Timer Trigger Activation is set to Rising/Falling Edge.
	TimerDelay	0 ~ 85,899,344 *μs*	Sets the delay time to be applied before starting the Timer.
	TimerReset	-	Resets the Timer and starts it again.
	TimerTrigger Source	Off	Disables the Timer trigger.
		ExposureActive	Sets the Timer to use the current exposure time as the source signal.
		FrameActive	Sets the Timer to use a frame readout time as the source signal.
		Line0	Sets the Timer to use the external trigger signal as the source signal.
		Counter0Start	Outputs user-defined Counter signals as pulse signals.
	TimerTrigger Activation	RisingEdge	Specifies that a rising edge of the selected trigger signal will act as the Timer trigger.
		FallingEdge	Specifies that a falling edge of the selected trigger signal will act as the Timer trigger.
		LevelHigh	Specifies that the Timer output signal will be valid as long as the selected trigger signal is High.
		LevelLow	Specifies that the Timer output signal will be valid as long as the selected trigger signal is Low.

Table 9-25 XML Parameters related to Timer Control

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

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



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

Figure 9-14 Timer Signal

9.18 Cooling 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 Cooling Control are as follows.

XML Parameters		Value	Description
CoolingControl	TargetTemperature	-10℃ ~ 80℃	Turns on the fan automatically when the temperature set in this parameter.
	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 TargetTemperature parameter.
	FanSpeed	-	Displays the current Fan RPM.

Table 9-26 XML Parameters related to Cooling Control

9.19 Temperature Monitor

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

The XML parameters related to Device Temperature are as follows.

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

Table 9-27 XML Parameters related to Device Temperature

9.20 Status LED

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

LED status and corresponding camera status are as follows:

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

Table 9-28 Status LED

9.21 Test Pattern

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

The XML parameter related to Test Pattern is as follows.

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

Table 9-29 XML Parameter related to Test Pattern

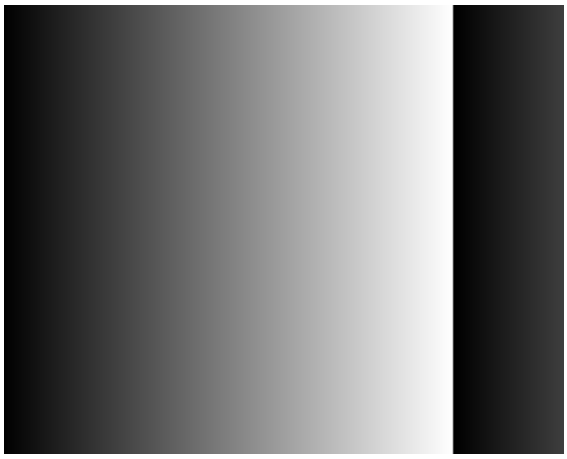


Figure 9-15 Grey Horizontal Ramp

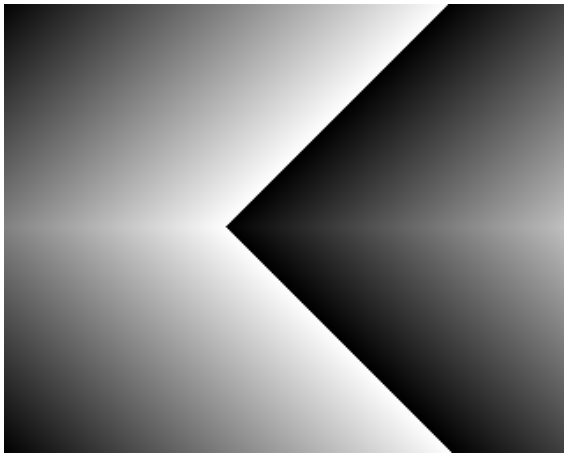


Figure 9-16 Grey Diagonal Ramp

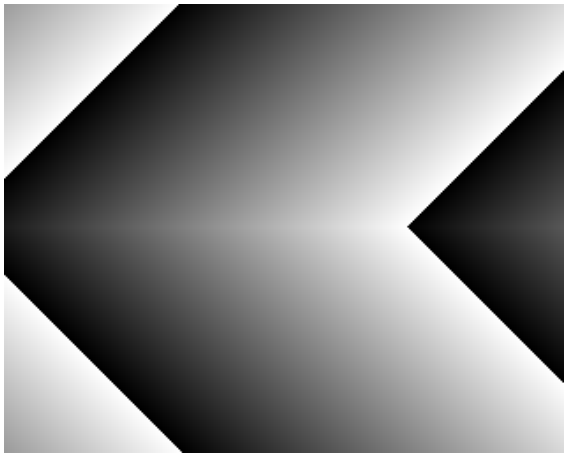


Figure 9-17 Grey Diagonal Ramp Moving

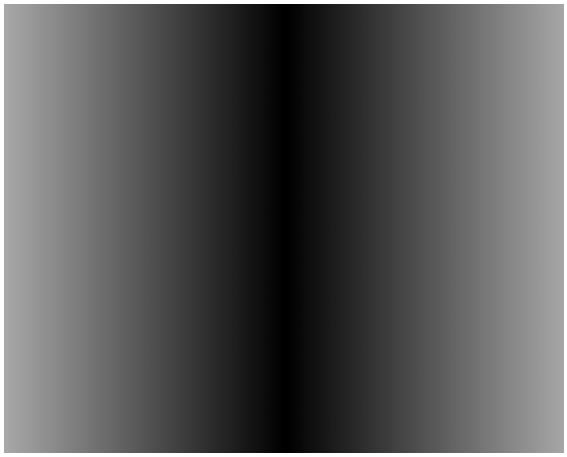


Figure 9-18 Sensor Specific

Caution!

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

9.22 Reverse X

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

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

Table 9-30 XML Parameter related to Reverse X

Figure 9-19 Original Image

Figure 9-20 Reverse X Image

9.23 Device Link Throughput Limit

The **Device Link Throughput Limit** feature allows you to limit the maximum available bandwidth for data transmission to your computer.

The XML parameter related to Device Link Throughput Limit is as follows.

XML Parameters		Description
DeviceControl	DeviceLinkThroughputLimit	Limits the maximum available bandwidth (Bps).

Table 9-31 XML Parameter related to Device Link Throughput Limit

Caution!

To ensure good image quality, we recommend that you set the Device Link Throughput Limit parameter to the maximum value. Otherwise, the image quality can decrease. In case of the VC-21MX2-M/C230I, its maximum value is 120000.

9.24 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 Parameter		Description
DeviceControl	DeviceUserID	Input user-defined information (32 bytes).

Table 9-32 XML Parameter related to Device User ID

9.25 Device Reset

Resets the camera physically to power off and on.

The XML parameter related to Device Reset is as follows.

XML Parameter		Description
DeviceControl	Device Reset	Resets the camera physically.

Table 9-33 XML Parameter related to Device Reset

9.26 Field Upgrade

The camera provides a feature to upgrade the Firmware and FPGA logic through the Camera Link interface without disassembling the camera in the field. Refer to Appendix A for more details about how to upgrade.

9.27 User Set Control

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

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

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

Table 9-34 XML Parameters related to User Set Control

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

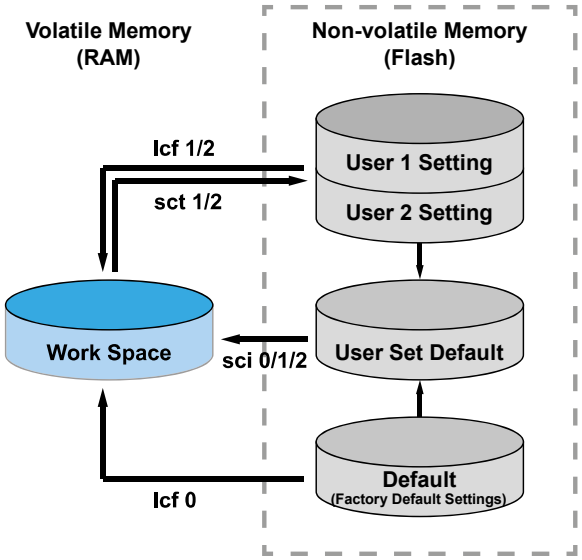


Figure 9-21 User Set Control

9.28 Sequencer Control

The Sequencer Control provided by the VC-21MX2-M/C230I cameras allows you to apply different sets of parameter settings, called 'Sequencer Set', to a sequence of image acquisitions. As the camera acquires images, it applies one Sequencer Set after the other. This allows the camera to respond quickly to changing imaging requirements. For example, if exposure time needs to vary for each shot, it is recommended to configure a sequencer set in advance so that the camera will change the exposure time every time one single shot is taken depending on the setting.

With the User Set Control feature, you can save user defined Sequencer Sets in the camera's non-volatile memory. Then after the camera is powered on or reset, the Sequencer Sets are available according to the User Set Default parameter. Each Sequencer Set is identified by an index number ranging from 0 to 7. Accordingly, you can define up to 8 different Sequencer Sets. On the VC-21MX2-M/C230I cameras, only the Flat Field correction data can be configured for Sequencer Sets.

The XML parameters related to Sequencer Sets are as follows.

XML Parameters		Value	Description
Sequencer Control	SequencerMode	Off	Disables the Sequencer.
		On	Enables the Sequencer.
	Sequencer ConfigurationMode	Off	Disables to configure the Sequencer.
		On	Enables to configure the Sequencer.
	Sequencer FeatureSelector	FlatFieldData Default	Applies the Flat-Field-data location selected on the FlatFieldDataDefault parameter to the current Sequencer Set.
		GainDigitalAll	Applies the value stored on the Gain parameter of DigitalAll to the current Sequencer Set.
		ExposureTime	Applies the value stored on the ExposureTime parameter to the selected Sequencer Set.
	Sequencer FeatureEnable	False	Enables the selected feature on SequenceFeatureSelector and to make it active in all the sequencer sets.
		True	Disables the selected feature on SequenceFeatureSelector and to make it inactive in all the sequencer sets.
	Sequencer SetSelector	0 – 7	Selects an index number of a Sequencer Set to be configured.
	SequencerSetSave	-	Saves the current camera's settings to the sequencer set selected on SequencerSetSelector.
	SequencerSetLoad	-	Loads the sequencer set selected on SequencerSetSelector and applies it to the current camera.
	SequencerSetActive	-	Displays the index number (0 – 7) of the Sequencer Set that is currently active.
	SequencerSetStart	0 - 7	Indicates the first sequencer set to operate, or designates which sequencer set would be started first as default.
	Sequencer PathSelector	0 - 1	Selects a path of the current sequencer set being configured/operated. Depending on the path selected here, the sequencer set to be executed next differs, and the number(0-1) of this item indicates the index number of each path.
	SequencerSetNext	0 - 7	Designates which next sequencer set would be operated after the current one, in the case of a path(Path 0 or Path 1) specified on SequencerPathSelector.
	Sequencer TriggerSource	Off	Disables the sequencer trigger.
		Exposure Active	Uses the ExposureActive signal as the sequencer trigger source.
		Frame Active	Uses the FrameActive signal as the sequencer trigger source.
	Sequencer TriggerActivation	FallingEdge	Indicates that a sequencer trigger operates on the Falling Edge when using the sequencer trigger.

Table 9-35 XML Parameters related to Sequencer Control

Use Case – Applying Four Different Sets of Flat Field Correction Data, Gain and Exposure Time Settings to Sequencer Sets

For example, assume that four different sets of Flat Field correction data, Gain and Exposure settings optimized for White, Green, Red and Blue pixels are applied to four different Sequencer Sets to inspect LCD panels.

1. Set the **Sequencer Mode** parameter to **Off**.
2. Select a feature to be applied to Sequencer Sets by using the **SequencerFeatureSelector** parameter. You must select features to be applied to Sequencer Sets prior to entering the **SequencerConfigurationMode**.

   Set the **SequencerFeatureSelector** parameter to **FlatFieldDataSelector**, and then set the **SequencerFeatureEnable** parameter to **True**.
   Set the **SequencerFeatureSelector** parameter to **GainDigitalAll**, and then set the **SequencerFeatureEnable** parameter to **True**.
   Set the **SequencerFeatureSelector** parameter to **ExposureTime**, and then set the **SequencerFeatureEnable** parameter to **True**.
3. Set the **SequencerConfigurationMode** parameter to **On**.
4. Set the **Sequencer Set 0** first, as follows:
   - The **SequencerSetSelector** parameter: **0**
   - The **FlatFieldDataSelector** parameter in the **FlatFieldControl** category: **Space0**
   - The **Gain** parameter of **DigitalALL** in the **Analog Control** category: **1**
   - The **ExposureTime** parameter in the **Acquisition Control** category: **10000**
   - The **SequencerSetNext** parameter: **1**
   - The **SequencerPathSelector** parameter: **0**
   - The **SequencerTriggerSource** parameter: **FrameActive**
   - The **SequencerTriggerActivation** parameter: **FallingEdge**
   - The **SequencerPathSelector** parameter: **1**
   - The **SequencerTriggerSource** parameter: **Off**

5. By referring to the procedure in the step 4 above, set the Sequencer Set 1, Sequencer Set 2 and Sequencer Set 3 also as shown below.

순서	해당 파라미터	Sequencer Set 1	Sequencer Set 2	Sequencer Set 3
1	SequencerSetSelector	1	2	3
2	FlatFieldDataSelector	Space1	Space2	Space3
3	DigitalALL, Gain	2	3	4
4	ExposureTime	20000	30000	40000
5	SequencerSetNext	2	3	0
6	SequencerPathSelector	0	0	0
7	SequencerTriggerSource	FrameActive	FrameActive	FrameActive
8	SequencerTriggerActivation	FallingEdge	FallingEdge	FallingEdge
9	PathSelector	1	1	1
10	SequencerTriggerSource	Off	Off	Off

6. Set the SequencerConfigurationMode parameter to Off, and then set the SequencerMode parameter to On.

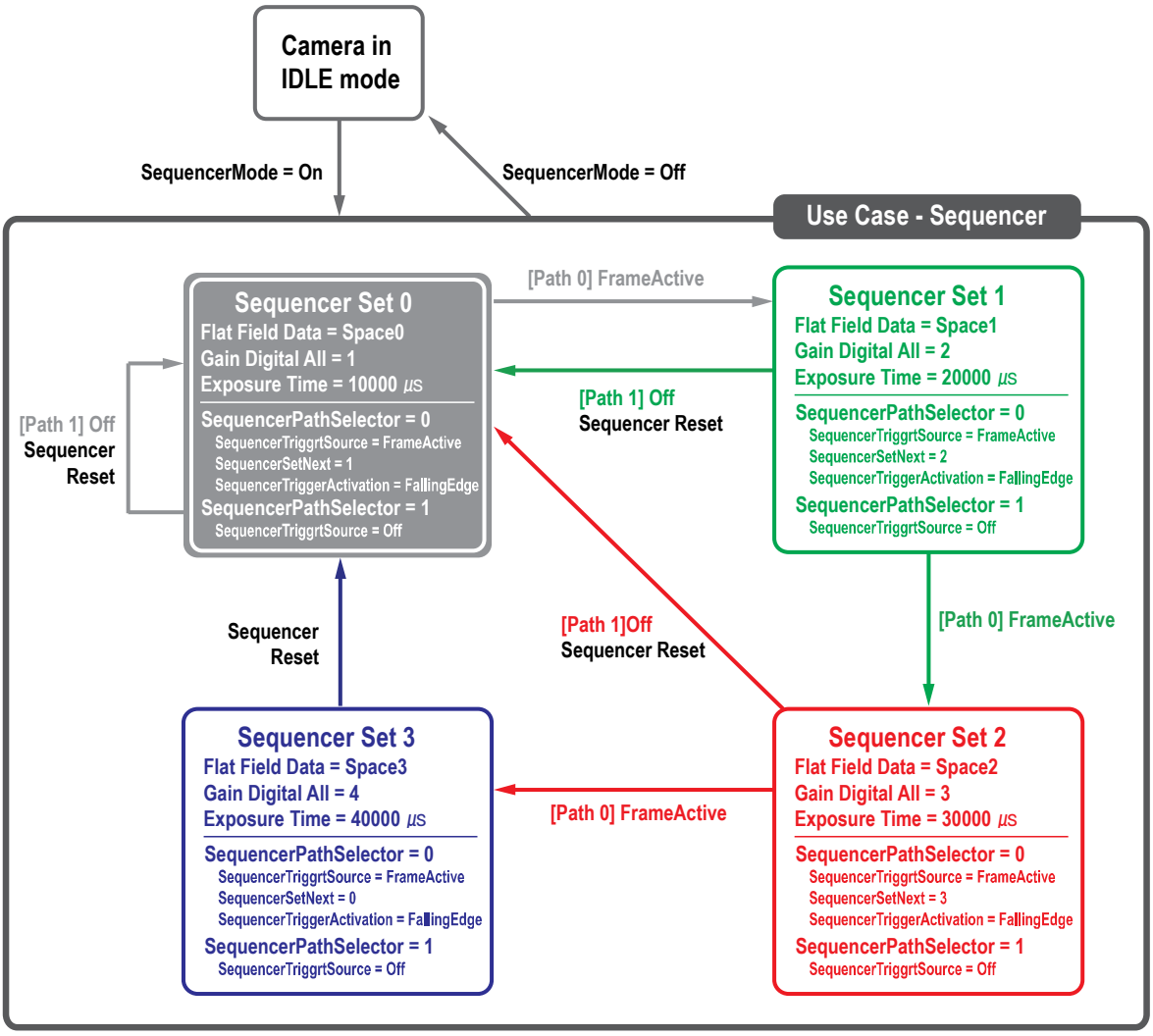


Figure 9-22 Sequencer Diagram (Use Case)

Note:

You can save the user defined Sequencer Sets in the camera's non-volatile memory by using the User Set Control feature. For more information, refer to 9.27 User Set Control.

Chapter 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 exposure time is set properly.
- If you identify abnormal operation or overheating sign,
  - Ensure the power supply is properly connected.
  - Stop using the camera when you notice smoke or abnormal overheating.
- If you have a problem using the Trigger Mode,
  - Ensure that the Software trigger related parameters are configured correctly.
  - Ensure that the trigger related parameters on your CXP-12 Frame Grabber are configured correctly when you set the Trigger Source parameter to LinkTrigger0.
  - Ensure that cable connections are secure when you set the Trigger Source parameter to Line 0.
- If there is communication failure between the camera and computer,
  - Ensure coax cables are connected properly.
  - Ensure that you have configured a CXP-12 Frame Grabber in your computer correctly and the camera is connected properly to the CXP-12 Frame Grabber.

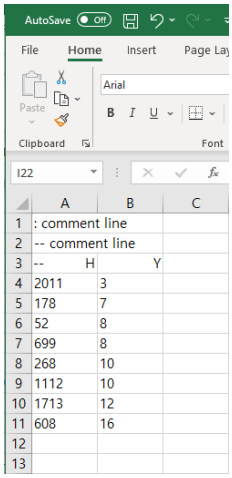
Appendix A. Defective Pixel Map Download

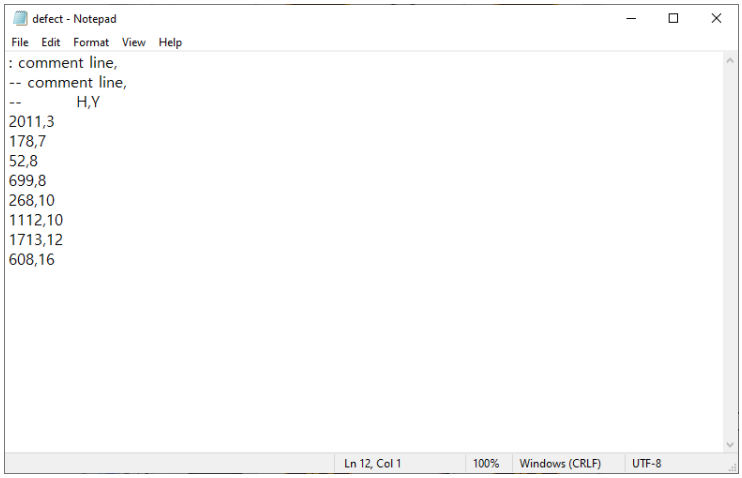
1. Create the Defective Pixel Map data in Microsoft Excel format as shown in the left picture below and save as a CSV file (*.csv). The picture in the right shows the created Excel file opened in Notepad. The following rules need to be applied when creating the file.

   • Lines beginning with ':' or '—' are treated as notes.

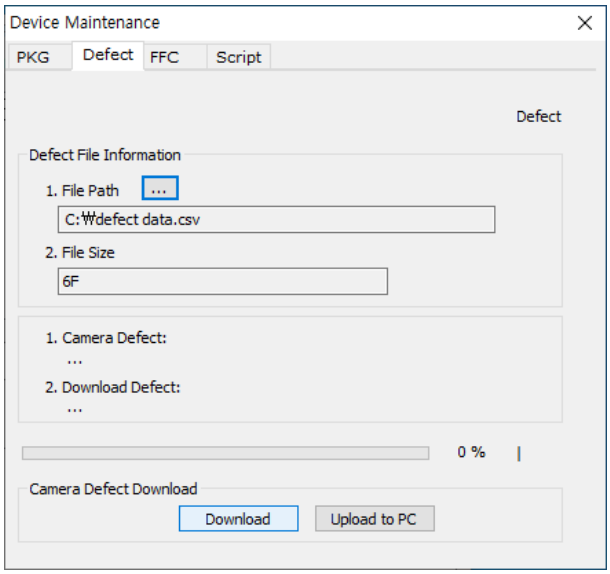
   • You must enter the horizontal value first and then the vertical value for coordinates of each defect pixel.

   • Coordinate values for each pixel can be placed in any order.





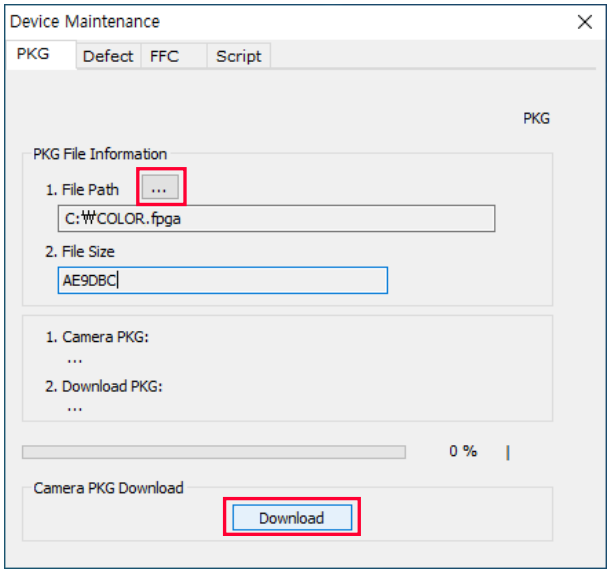
2. Run Vieworks Imaging Solution and click the Configure button to display the window as shown below. Select the **Defect** tab, click the **File Path** item, search and select the defective pixel map (*.csv), and then click the Download button.



Appendix B. Field Upgrade

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

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 button next to **File Path**, search and select the MCU, FPGA or XML upgrade file, and then click the Download button.



3. The camera begins downloading the upgrade file and the downloading status is displayed at the bottom of the window.

Appendix C. Index

1

A

B

C

D

E

F

G

H

I

K

L

M

O

P

Q

R

S

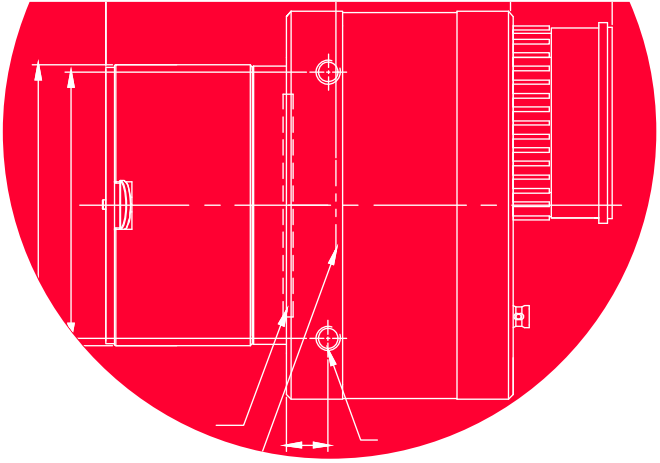
T

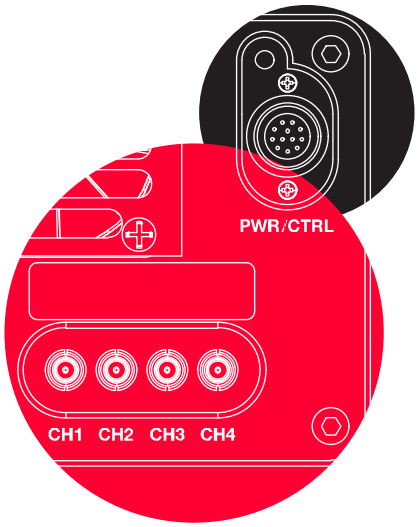
U

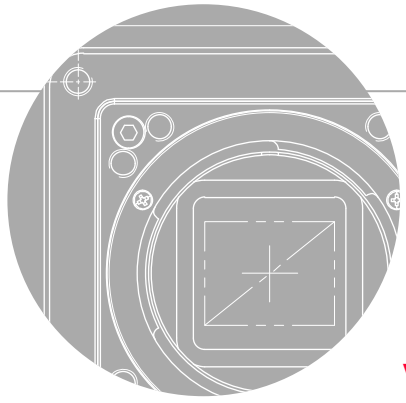
V

X

XML parameter







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