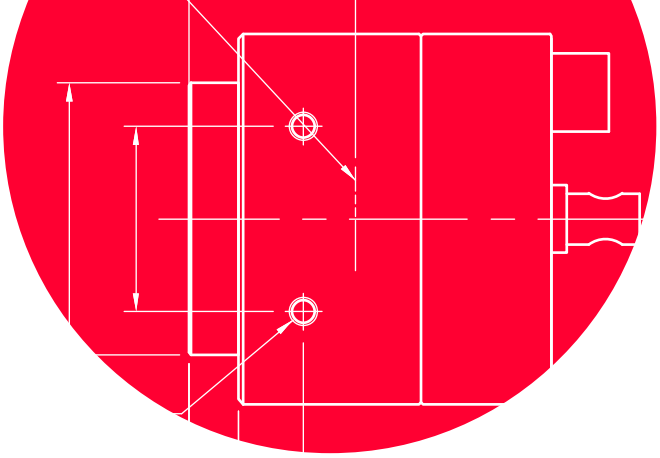


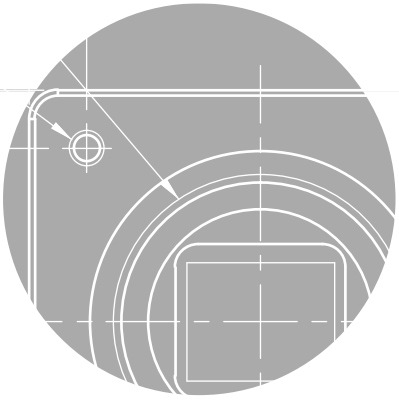
VC series

User Manual

English

VC-4MX-M144F

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-4MX-M144F™.

- 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-4MX-M144F00
- VC-4MX-M144F00-FAN

About This Manual

This manual is intended for VC-4MX-M144F™ 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

Revision History

This document has the revision history as follows:

Version	Date	Description
1.0	2021-04-30	Initial Release
1.1	2022-04-22	• Revised the document template • Added descriptions about the Multi-ROI feature • Modified some items in the latest specification
1.2	2023-02-15	• Added descriptions about the FFC feature • Added some contents related to UL certification
1.3	2023-07-07	Added descriptions about the LUT feature
1.4	2023-08-30	• Added descriptions about the Debounce feature • Added information on the VC-4MX-M144F00-FAN model

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.
  When using a Power Supply device, use a device below PS2 certified as UL 62368-1.
- Make sure the power is turned off before connecting the power cord to the camera. Otherwise, damage to the camera may result.

Chapter 2. Warranty

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.

3.4 UL

This is the Canadian / US safety compliance mark applies to electric shock, fire and mechanical hazards.
In accordance with UL 62368-1.

Chapter 4. Package Components

Package Components

VC-4MX-M144F00 or VC-4MX-M144F00-FAN

Chapter 5. Product Specifications

5.1 Overview

The VC-4MX-M144F, a very compact solution for easy system integration, is based on the CMOS global shutter imager. The VC-4MX-M144F camera features 4-megapixel resolution with frame rate up to 144 fps. This combination of global shutter, resolution and frame rate sets a new standard for industrial, scientific and surveillance digital imaging applications. Customers in the industrial market can take advantage of common coax cabling to transmit images at rates and distance above and beyond previous standards.

With this camera, image data can be transmitted at up to 6.25 Gbps using a single coaxial cable. Featuring high quality image and high speed, this camera is ideal for wide range of demanding applications including PCB and semiconductor inspections.

Main Features

- High Speed 4 Megapixel CMOS Image Sensor
- Electronic Exposure Time Control (Global Shutter)
- Output Pixel Format: 8 bit
- Line Output
- Output Channel: CXP6 × 1ch
- Power over CoaXPress (PoCXP)
- Gain/Black Level Control
- Test Pattern
- Temperature Monitor
- Field Upgrade
- Image Correction
- Defective Pixel Correction
- VC-4MX-M144F Feature Bar

5.2 Specifications

The technical specifications of the VC-4MX-M144F camera are as follows:

Specifications		VC-4MX-M144F00	VC-4MX-M144F00-FAN
Active Image (H × V)		2048 × 2048	
Sensor		AMS CMOSIS CMV4000	
Pixel Size		5.5 μm × 5.5 μm	
Sensor Size (Optical Format)		11.26 mm × 11.26 mm (1")	
Interface		CoaXPress (CXP-6)	
Electronic Shutter		Global Shutter	
Max. Frame Rate		144 fps @ 6.25 Gbps	
Pixel Data Format		Mono8	
Exposure Time		1 μs ~ 60 s (1 μs step)	
Partial Scan (Max. Speed)		19607 fps at 1 Line	
Black Level Control		0 ~ 16 LSB	
Gain Control	Analog	1× ~ 3.2×	
	Digital	1× ~ 4×	
Trigger Synchronization		Free-Run, Hardware Trigger or CXP	
External Trigger		3.3 V ~ 24.0 V, 10 mA, Logical Level Input, Optically Isolated	
Dynamic Range		53 dB	
Lens Mount		C-mount, Custom mount available upon request	
Power	External	10 ~ 24 VDC	
	Dissipation	Typ. 3.5 W	Typ. 4.2 W
	PoCXP	24 VDC	
Environmental		Operating: -5℃ ~ 40℃, Storage: -40℃ ~ 70℃	
Dimension / Weight		40 mm × 40 mm × 39 mm, 105 g	40 mm × 40 mm × 54 mm, 110 g
API SDK		Vieworks Imaging Solution 7.X	

Table 5-1 Specifications of VC-4MX-M144F

5.3 Camera Block Diagram

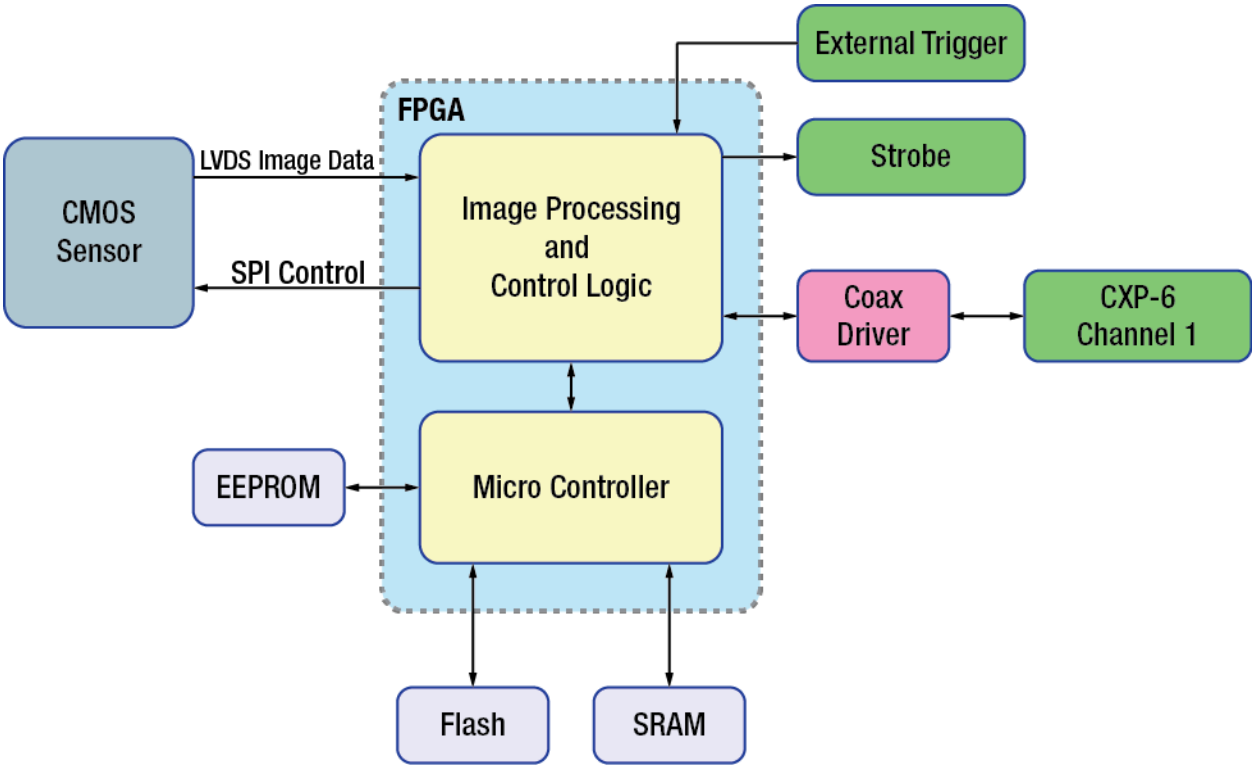


Figure 5-1 Camera Block Diagram

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

The Processing & Control logic processes the image data received from the CMOS image sensor and then transmits data through the CoaXPress interface. The Processing & Control logic also controls time-sensitive trigger inputs and output signals. Furthermore, Flash and DDR3 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 graph shows the spectral response of the VC-4MX-M144F monochrome camera.

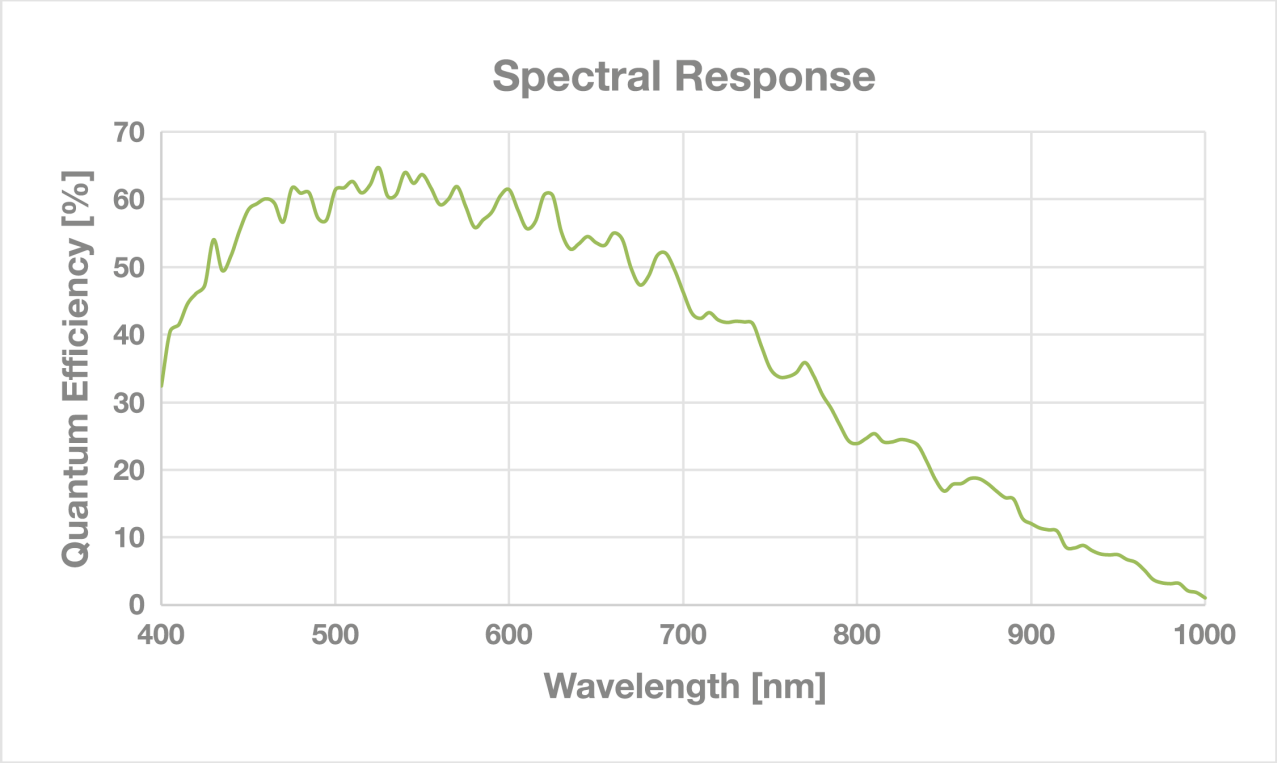


Figure 5-2 VC-4MX-M144F Spectral Response

5.5 Mechanical Specification

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

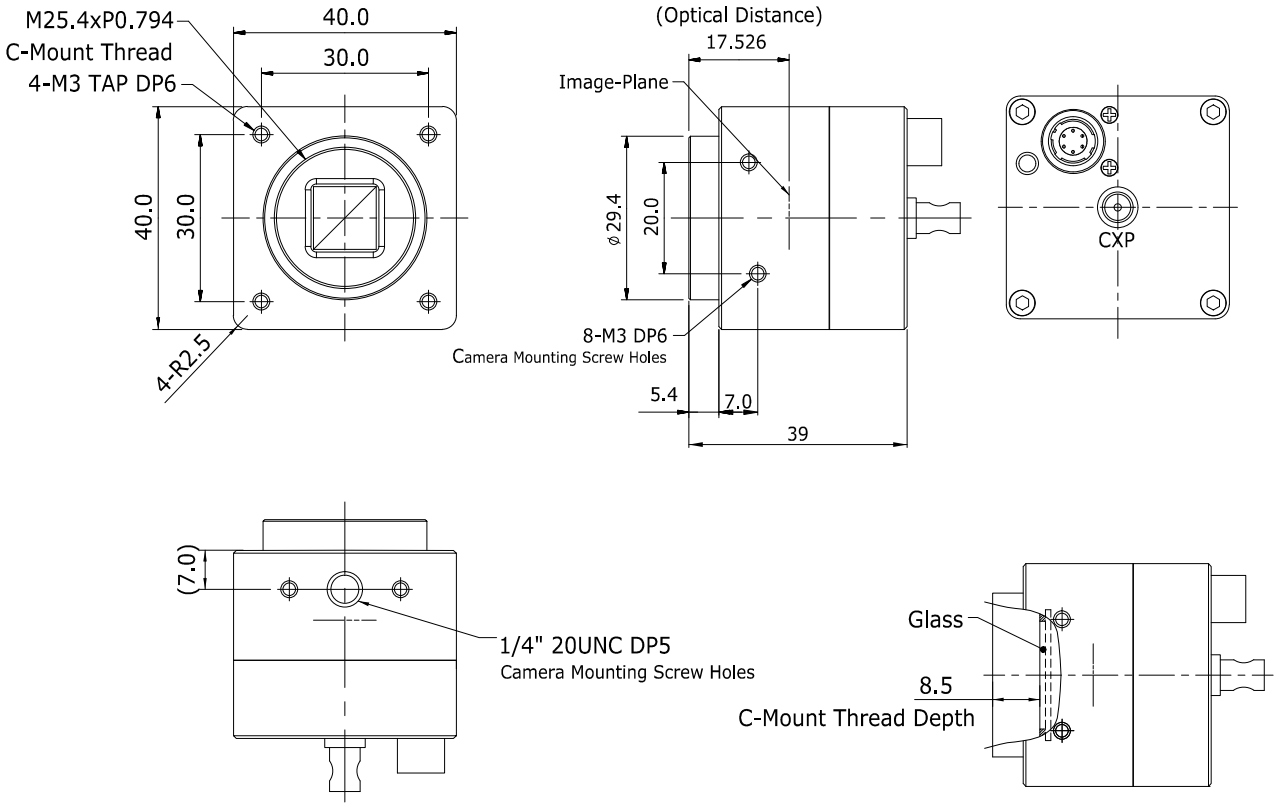


Figure 5-3 VC-4MX-M144F00 Mechanical Dimension

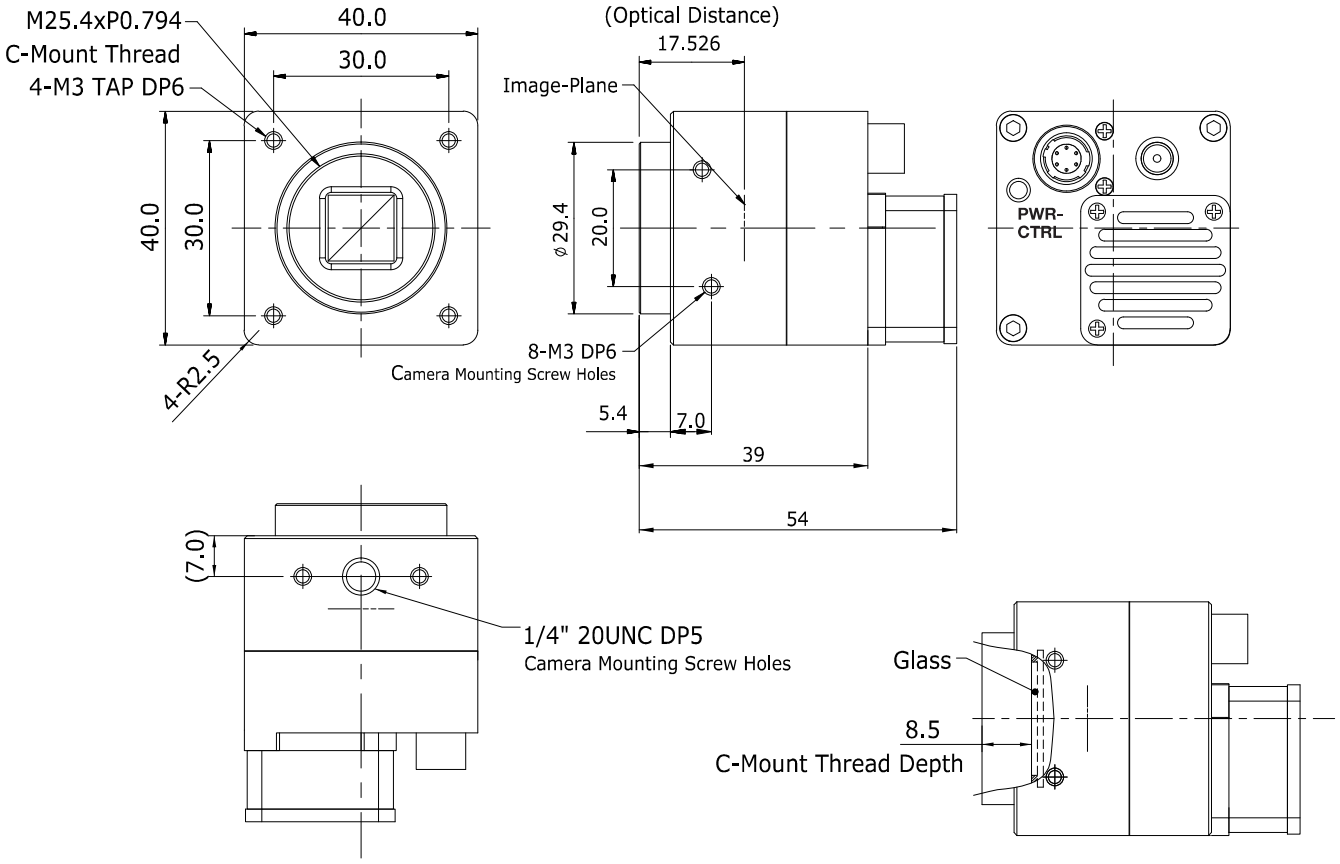


Figure 5-4 VC-4MX-M144F00-FAN Mechanical Dimension

5.5.1 Camera Mounting and Heat Dissipation

You must mount the camera on a heat dissipation structure to maintain the temperature of the camera housing at 50℃ or less. Given the low power consumption of the VC-5/9/18MX2 series camera, its housing temperature during operation will generally stay within the specified limits. However, overheating can occur if heat dissipation is restricted or if the camera is mounted on a severe environment. It is recommended to follow the general guidelines below when you mount the camera.

- In all cases, you should monitor the temperature of the camera housing and make sure that the temperature does not exceed 50℃. You can monitor the internal temperature of the camera by using the Device Temperature parameter.
- If your camera is mounted on a metal component in your system, this may provide sufficient heat dissipation.

5.5.2 Fixing the Camera

If needed, it enables to fix the VC-4MX-M144F product firmly to use. When doing this, the sections available to be used for tightening by the setscrews are 8 parts marked with the dashed lines in the following figure:

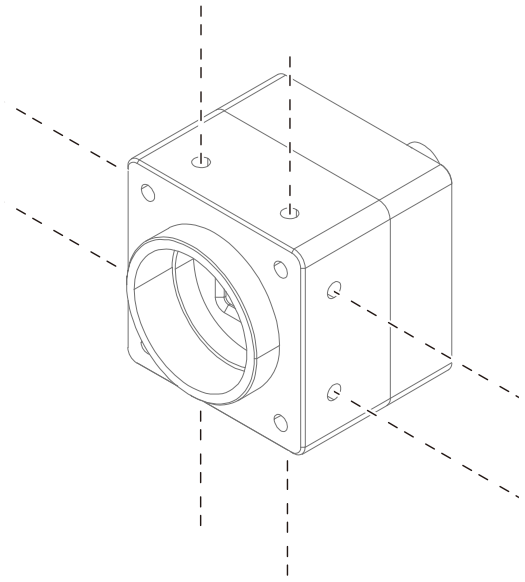


Figure 5-5 Locations available to Tighten the Setscrews when Mounting the Product

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

Chapter 6. Connecting the Camera

The following instructions assume that you have installed a CoaXPress Frame Grabber (hereinafter 'CXP 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 Frame Grabber by using one coax cable. For more detailed information, refer to your CXP Frame Grabber User Manual.

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

1. Make sure that the power supply is not connected to the camera and your computer is turned off.
   - Go on to step 2 if you are using a power supply.
   - Go on to step 3 if you are using a Power over CoaXPress (PoCXP) Frame Grabber.

2. If you are using a power supply:
   a. Plug one end of a coax cable into the CXP connector on the camera and the other end of the coax cable into the CH1 of the CXP Frame Grabber in your computer.
   b. Connect the plug of the power adapter to the power input receptacle on the camera.
   c. Plug the power adapter into a working electrical outlet.

3. If you are using PoCXP Frame Grabber:
   Plug one end of a coax cable into the CXP connector on the camera and the other end of the coax cable into the CH1 of the CXP Frame Grabber in your computer.

4. 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 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

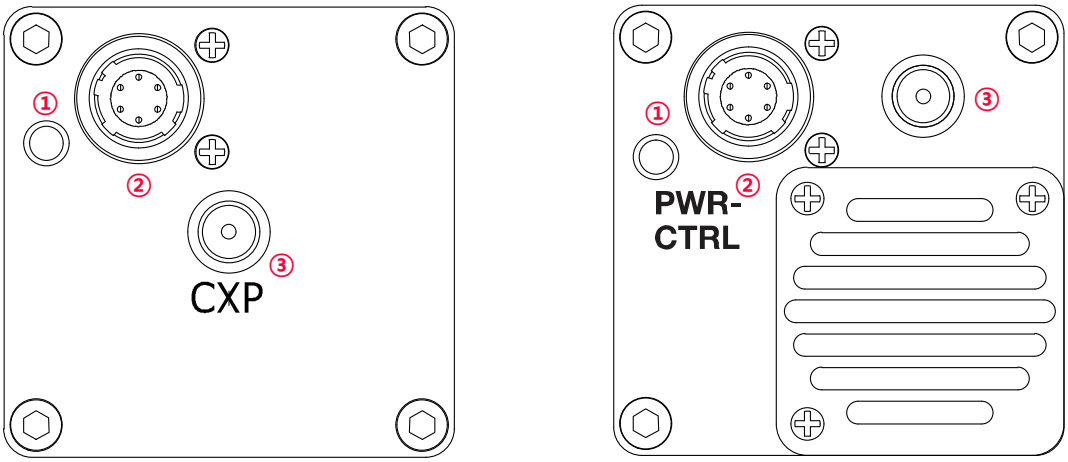
7.1 General Description

As shown in the figure below, two 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 6 pin Power Input and Control I/O Receptacle: supplies power to the camera (if PoCXP is not used), and provides access to the camera's I/O lines.

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



<VC-4MX-M144F00> <VC-4MX-M144F00-FAN>

Figure 7-1 VC-4MX-M144F with DIN 1.0/2.3-type Connector

7.2 CoaXPress Connector

CoaXPress protocol includes an automatic link detection mechanism (Plug and Play) to correctly detect the camera to the CXP Frame Grabber connection. The connection between the camera and CXP Frame Grabber uses a coax (also known as 'coaxial') cable and provides up to 6.25 Gbps bit rate per cable. The VC-4MX-M144F camera can be powered over the cable if you are using a PoCXP enabled Frame Grabber.

7.2.1 CoaXPress DIN Connector (75 Ω 1.0/2.3 DIN Receptacle)

Figure 7-2 CoaXPress DIN 1.0/2.3-type Connector

The CoaXPress connector on the VC-4MX-M144F camera complies with the CoaXPress standard and the following table shows the channel assignments.

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

Table 7-1 Channel Assignment for CoaXPress Connector

Caution!

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

7.3 Power Input and Control I/O Receptacle

The Power Input and Control I/O Receptacle is a Hirose 6-pin connector (part # HR10A-7R-6PB).

The pin assignments and configurations are as follows:

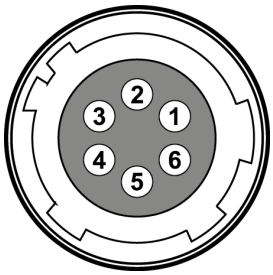


Figure 7-3 Pin Assignments for Power Input and Control I/O Receptacle

Pin Number	Signal	Type	Description
1	+12 VDC	Input	Camera Power +12 VDC
2	Trigger Input +	Input	-
3	Trigger Input -	Input	-
4	Line Out + (Default: Strobe Out)	Output	3.3 V TTL Output Output Resistance: 47 Ω
5	Line Out	Output	-
6	DC Ground	-	Camera Power GND

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

Note:

A recommended mating connector for the Hirose 6-pin connector is the Hirose 6-pin plug (part # HR10A-7P-6S) or the equivalent.
It is recommended that you use the power adapter, which has at least 3 A current output at 12 VDC ±10% voltage output.
(You need to purchase a power adapter separately. When using a Power Supply device, use a device below PS2 certified as UL 62368-1.)

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 figures show the trigger signal input circuit of the 6-pin connector. Transmitted trigger signal is applied to the internal circuit through a photo coupler. The minimum trigger width that can be recognized by the camera is 1 μs. If transmitted trigger signal is less than 1 μs, the camera will ignore the trigger signal.

An external trigger circuit example is shown below.

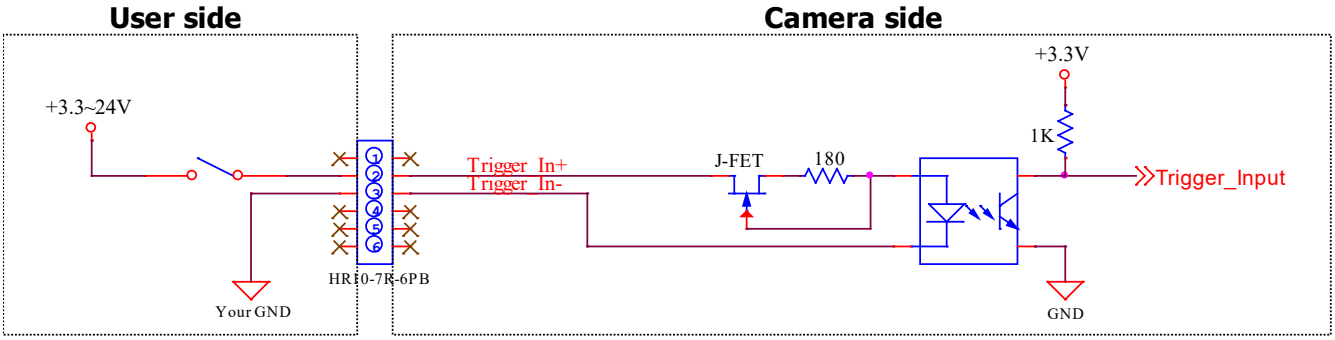


Figure 7-4 Trigger Input Schematic

7.5 Strobe Output Circuit

The strobe output signal comes out through a 3.3 V output level of TTL Driver IC. A pulse width of the signal is synchronized with an exposure (shutter) signal of the camera.

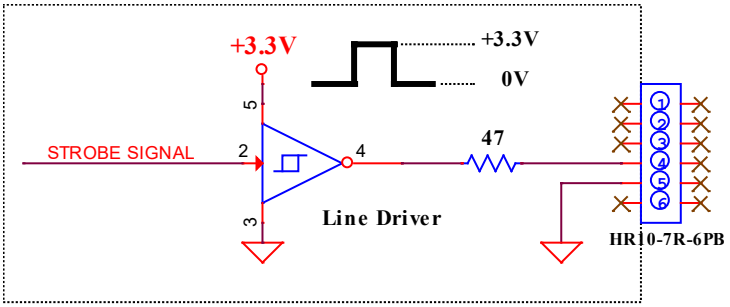


Figure 7-5 Strobe Output Schematic

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.

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

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

> **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.

Acquisition Start and Stop Commands and the Acquisition Mode

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

A parameter called the **Acquisition Mode** has a direct bearing on how the **Acquisition Start** command operates. The VC-4MX-M144F camera only supports **Continuous** for the **Acquisition Mode** parameter.

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

Exposure Start Trigger

Applying an exposure start trigger signal to the camera will exit the camera from the *waiting for exposure start trigger* acquisition status and will begin the process of exposing and reading out a frame (see Figure 8-1).

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

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

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

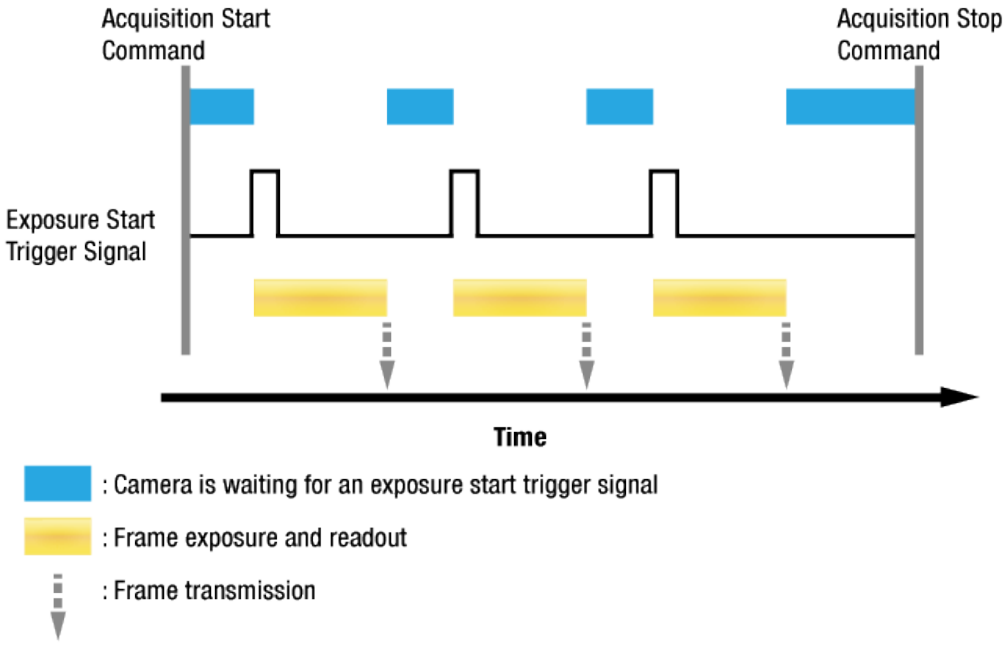


Figure 8-1 Exposure Start Triggering

Applying Trigger Signals

The paragraphs above mention "applying a trigger signal". There are two ways to apply an exposure start trigger signal to the camera: via **CXPin** or via **LineIn0** (commonly referred to as hardware).

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

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

Exposure Time Control

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

A critical aspect of frame acquisition is how long the pixels in the camera's sensor will be exposed to light during the frame acquisition. The VC-4MX-M144F camera provides two exposure modes, **Timed** and **Trigger Width**.

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

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

8.2 Acquisition Start/Stop Commands and Acquisition Mode

Executing an **Acquisition Start** command prepares the camera to acquire frames. You must execute an **Acquisition Start** command before you can begin acquiring frames.

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

When the camera receives an **Acquisition Stop** command:

If the camera is not in the process of acquiring a frame, its ability to acquire frames will be terminated immediately.

If the camera is in the process of acquiring a frame, the frame acquisition process will be allowed to finish and the camera's ability to acquire new frames will be terminated.

The VC-4MX-M144F camera only provides the '**Continuous**' mode of operation for the **Acquisition Mode**.

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

8.3 Exposure Start Trigger

The Trigger Selector parameter is used to select a type of trigger and only the Exposure Start trigger is available on the VC-4MX-M144F 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 CXPin or LineIn0. If an exposure start trigger signal is applied to the camera, the camera will begin to expose a frame.

8.3.1 Trigger Mode

The main parameter associated with the exposure start trigger is the Trigger Mode parameter.

The Trigger Mode parameter for the exposure start trigger has two available settings: Off and On.

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:

- CXPin: You can apply an exposure start trigger signal via CH1 of the CXP Frame Grabber. For more information, refer to your CXP Frame Grabber User Manual.
- LineIn0: You can apply an exposure start trigger signal to the camera by injecting an externally generated electrical signal (commonly referred to as a hardware or external trigger signal) into the Control I/O Receptacle on the camera. Refer to 7.4 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:

- Rising Edge: Specifies that a rising edge of the electrical signal will act as the exposure start trigger.
- Falling Edge: Specifies that a falling edge of the electrical signal will act as the exposure start trigger.

Exposure Time Control with Trigger Mode = On

When the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **CXPin** or **LineIn0**, 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 = Trigger Width: Exposure time can be controlled by manipulating the external trigger signal.

8.3.2 Using a CoaXPress Trigger Signal

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

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

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

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

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

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

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

For example, if you are operating a camera with a CoaXPress trigger signal period of 50 ㎳ (0.05 s): So in this case, the frame rate is 20 fps.

8.3.3 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 ㎳ (0.05 s): So in this case, the frame rate is 20 fps.

8.3.4 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 **Trigger Width**.

Timed Exposure Mode

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

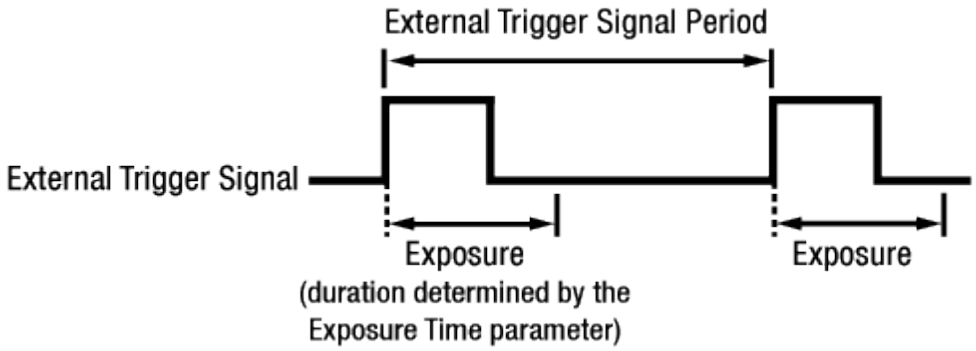


Figure 8-2 Timed Exposure Mode

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.

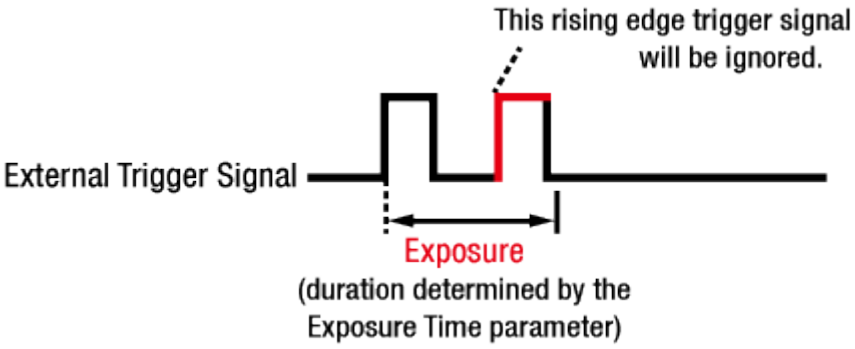


Figure 8-3 Trigger Overlapped with Timed Exposure Mode

Trigger Width Exposure Mode

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

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

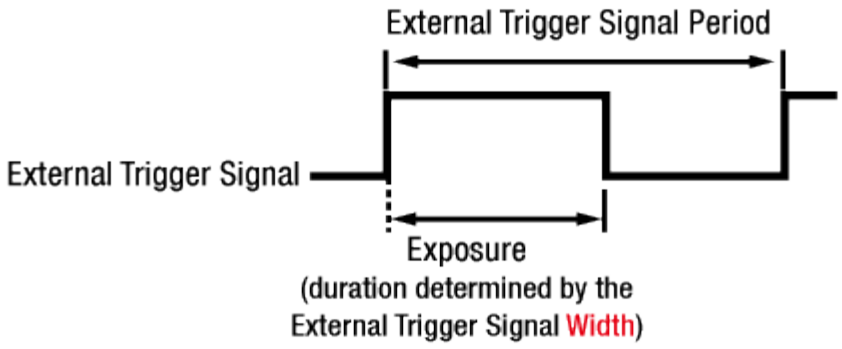


Figure 8-4 Trigger Width Exposure Mode

8.3.5 Exposure Offset

The VC-4MX-M144F camera adds an Exposure Offset automatically to the exposure time determined by the **Exposure Time** parameter or the width of the external trigger signal.

To acquire an image with the desired exposure time, you must compensate for the Exposure Offset as follows.

1. Subtract the Exposure Offset from the desired exposure time.
2. Set the Exposure Time parameter with the resulting time or use the resulting time as the high or low time for the external trigger signal.

Camera Model	Exposure Offset
VC-4MX-M144F	14.87 μs

Table 8-1 Exposure Offset

For example, if you want to set an exposure time to about 100 μs, set the Exposure Time parameter to 85 μs (100 – 14.87 = 85.13 ≒ 85) or use 85 μs as the high or low time for the external trigger signal.

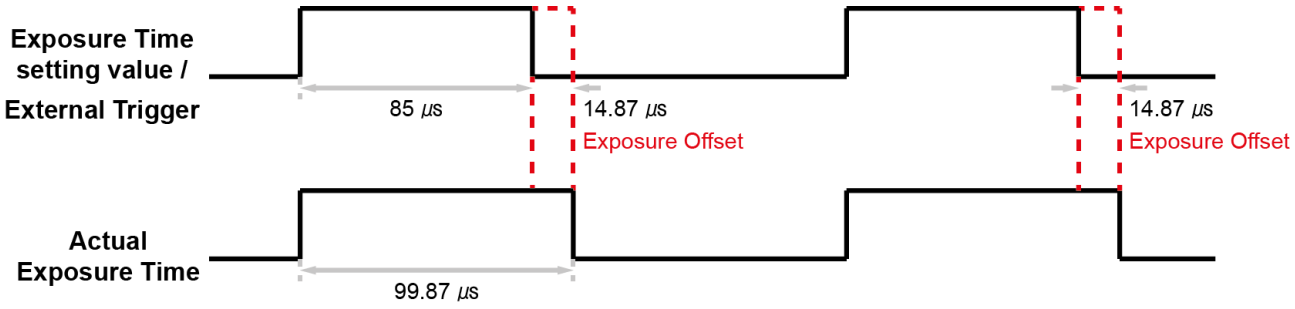


Figure 8-5 Setting Exposure Time to compensate for the Exposure Time

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 Exposure Mode is set to Timed.

The VC-4MX-M144F camera adds an Exposure Offset (refer to **Table 8-1 Exposure Offset**) automatically to the exposure time determined by the **Exposure Time** parameter. The **Exposure Time** parameter sets the exposure time in microseconds(*μs*). The minimum and maximum exposure time settings for the camera are shown in the following table.

Camera Model	Number of Channels	Minimum Exposure Time	Maximum Exposure Time †
VC-4MX-M144F	1 Channel	1 *μs*	60,000,000 *μs*
†: When the Exposure Mode is set to Trigger Width, the exposure time is controlled by the external trigger signal and has no maximum limit.			

Table 8-2 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-4MX-M144F 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 **LineIn0** and the **Exposure Mode** set to **Trigger Width**.

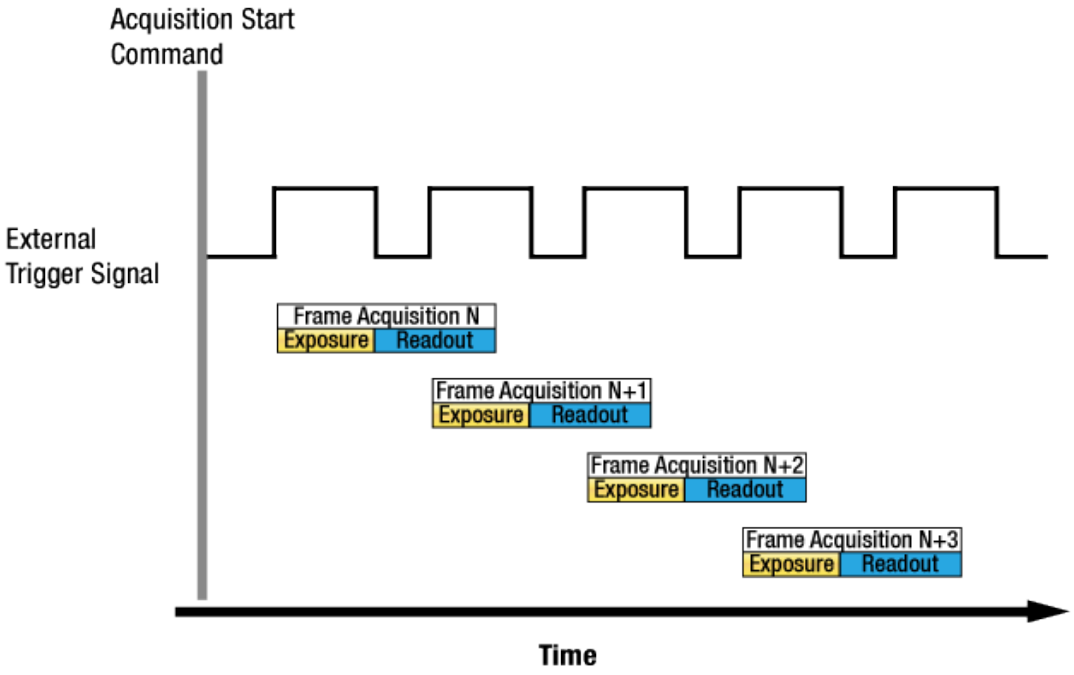


Figure 8-6 Overlapped Exposure and Readout

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

- Overlapped: Frame Period ≤ Exposure Time + Readout Time

Guidelines for Overlapped Exposure

Since the VC-4MX-M144F 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 readout of the previous frame is complete.

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

8.6 Global Shutter

The VC-4MX-M144F camera is equipped with an image sensor that have an electronic global shutter. When an exposure start trigger signal is applied to the cameras equipped with a global shutter, exposure begins for all lines in the sensor as shown in 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 trigger width exposure mode. At the end of the exposure time, exposure ends for all lines in the sensor. Immediately after the end of exposure, pixel data readout begins and proceeds line by line until all pixel data is read out of the sensor. A main characteristic of a global shutter is that for each frame acquisition, all of the pixels in the sensor start exposing at the same time and all end exposing at the same time. This means that image brightness tends to be more uniform over the entire area of each acquired image, and it helps to minimize problems with acquiring images of object in motion.

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

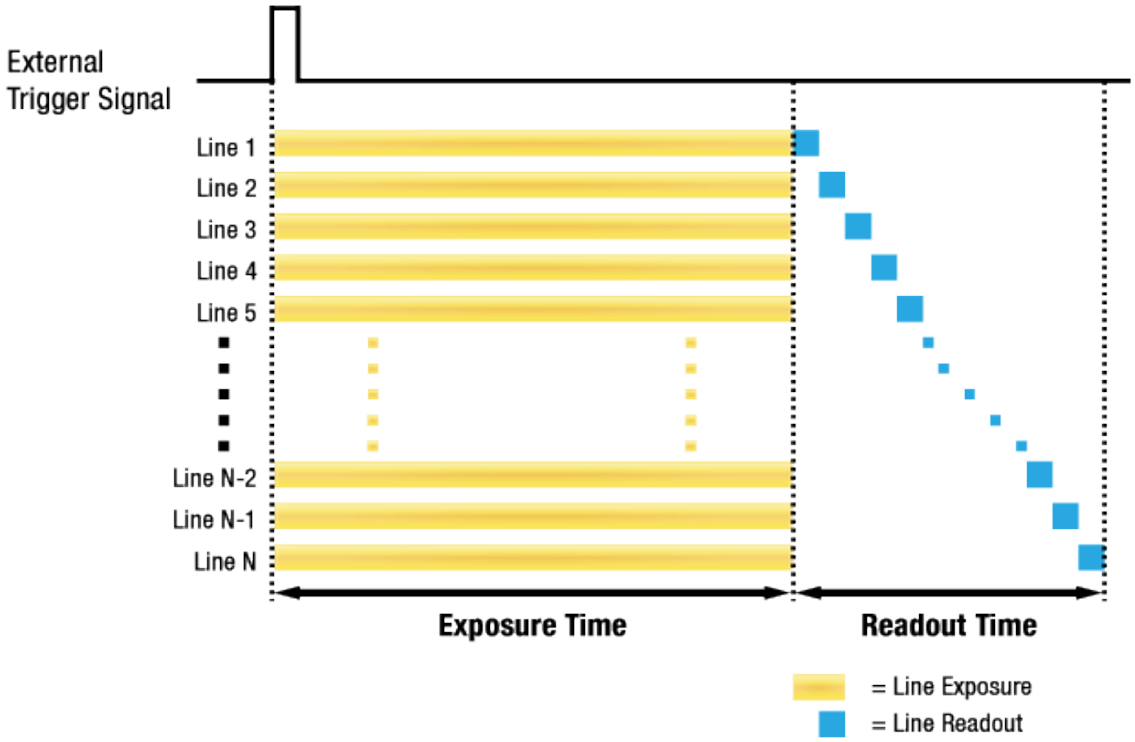


Figure 8-7 Global Shutter

8.7 Maximum Allowed Frame Rate

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

The amount of time that it takes to transmit an acquired frame from the camera to your computer.

The amount of time needed to transmit a frame depends on the bandwidth assigned to the camera.

The amount of time it takes to read an acquired frame out of the image sensor and into the camera's frame buffer. This time varies depending on the setting for the **Height** parameter. Frames with a smaller height take less time to read out of the sensor. The frame height is determined by the camera's **Height** settings in the **Image Format Control** category.

The exposure time for acquired frames. If you use very long exposure times, you can acquire fewer frames per second.

8.7.1 Increasing the Maximum Allowed Frame Rate

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

The time that it takes to transmit a frame out of the camera is the main limiting factor on the frame rate. You can decrease the frame transmission time (and thus increase the maximum allowed frame rate) by using the ROI feature.

Use a smaller ROI. Decreasing the ROI means that the camera has less data to transmit and therefore the transmission time will decrease.

If you are using normal exposure times and you are using the camera at its maximum resolution, your exposure time will not normally restrict the frame rate. However, if you are using long exposure 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 Image Region of Interest

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

With the ROI feature, you can increase the maximum allowed frame rate by decreasing the **Height** parameter; however, decreasing the **Width** parameter does not affect the frame rate. The ROI is referenced to the top left corner [origin (0, 0)] of the sensor array as shown below.

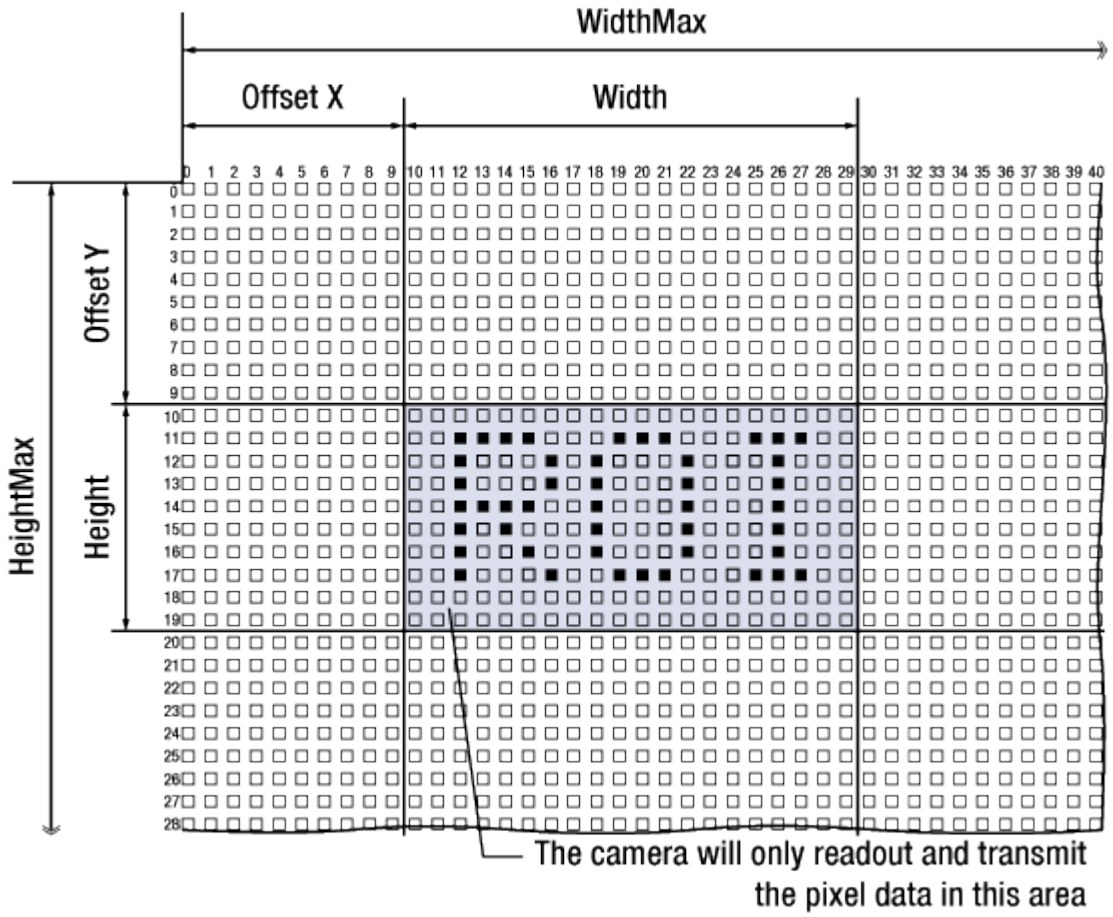


Figure 9-1 Image Region of Interest

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[c]	-	Sets 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.

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

On the VC-4MX-M144F camera, the **Width** parameter must be set to a multiple of 16, and the **Height** parameter can be set in increments of 1.

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

Camera Model	Minimum Width Settings	Minimum Height Settings
VC-4MX-M144F	256	1

Table 9-2 Minimum ROI Width and Height Settings

On the VC-4MX-M144F camera, the maximum frame rates depending on Vertical ROI changes are shown below.

ROI Size (H × V)	1 Channel
2048 × 1	19607 fps
2048 × 4	16393 fps
2048 × 500	580 fps
2048 × 1000	294 fps
2048 × 1500	197 fps
2048 × 2048	144 fps

Table 9-3 Maximum Frame Rates by VC-4MX-M144F ROI Changes

9.2 Multi-ROI

The VC-4MX-M144F camera provides the Multi-ROI feature which allows you to define up to 32 regions of the sensor array. When an image is acquired, only the pixel information from the defined regions will be readout of the sensor. The pixel data read out of the regions will then be combined together and will be transmitted from the camera as a single image.

The XML parameters related to Multi-ROI are as follows.

XML Parameters		Value	Description
MultiROIControl	MultiROISelector	Region0 – Region7	Selects the ROI to set.
	MultiROIMode	On/Off	Enables / Disables the selected ROI.
	MultiROIWidth	256 - 2048	Width setting for the selected ROI
	MultiROIHeight	1 - 2048	Height setting for the selected ROI
	MultiROIOffsetX	0 - 2048	Horizontal offset from the origin to the selected ROI
	MultiROIOffsetY	0 - 2048	Vertical offset from the origin to the selected ROI
	MultiROIValid[a]	Ture/False	Verifies the validation of the Multi-ROI setting values.
	MultiROIStatus	Active/Inactive	Displays the status of the Multi ROI feature. Active: The Multi-ROI feature is in use. Inactive: The Multi-ROI feature is not in use.

The unit for all parameters in this table is pixel.
a: If the setting values for the Multi-ROI feature are valid, 'True' will be returned or the check box will be selected.

Table 9-4 XML parameters related to Multi-ROI

It is recommended that you first set the **MultiROIWidth** parameter, since all of the regions must be the same width. The next step in the setup process is to define each individual region as desired. Up to 8 regions can be set up ranging from 0 through 7. Use the **MultiROISelector** parameter to select which ROI to set and then set the ROI to On/Off by using the **MultiROIMode** parameter. Then, set the **MultiROIOffsetX**, **MultiROIOffsetY** and **MultiROIHeight** parameters to define each region.

In the figure below, for example, three regions have been set. With these settings, the camera would output an image as follows:

- MultiROI Width × the total height of the three regions (Region0 Height + Region1 Height + Region2 Height)

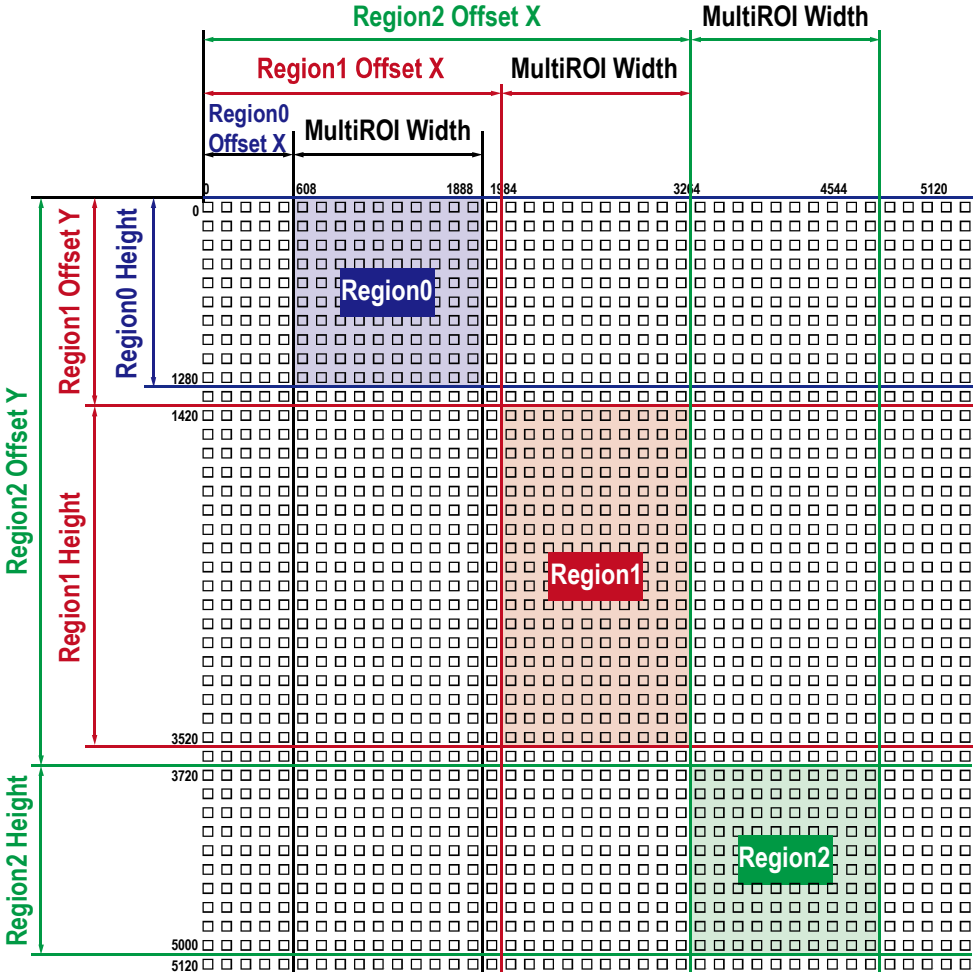


Figure 9-2 Multi-ROI

There are several things to keep in mind when setting the Multi-ROI feature on the VC-4MX-M144F camera:

- The sum of the Multi-ROI Offset X value plus the Multi-ROI Width value must not exceed the Width value of the camera's sensor.
- The sum of the Multi-ROI Offset Y value plus the Multi-ROI Height value must not exceed the Height value of the camera's sensor.
- The Multi-ROI Offset X and Multi-ROI Width value must be a multiple of 16.
- The Multi-ROI Offset Y and Multi-ROI Height value must be an increment or a decrement of 1.
- The MultiROI Width values are equal, so the widths of the Region 0, Region 1, and Region 2 are the same in the figure above.
- You can save the Multi-ROI setting values as a User Set and then load the values to the camera when desired. For more information, refer to 9.16 User Set Control.

9.3 CXP Link Configuration

The VC-4MX-M144F camera must be connected to a CXP Frame Grabber installed in your computer via CoaXPress interface. CoaXPress interface allows you to connect a camera to a CXP Frame Grabber by using simple coax cabling and allows up to 6.25 Gbps data rate per cable. The VC-4MX-M144F camera supports one master connection to configure a link. In compliance with the CoaXPress standard, the VC-4MX-M144F camera includes an automatic link detection mechanism to correctly detect the camera to CXP Frame Grabber connection.

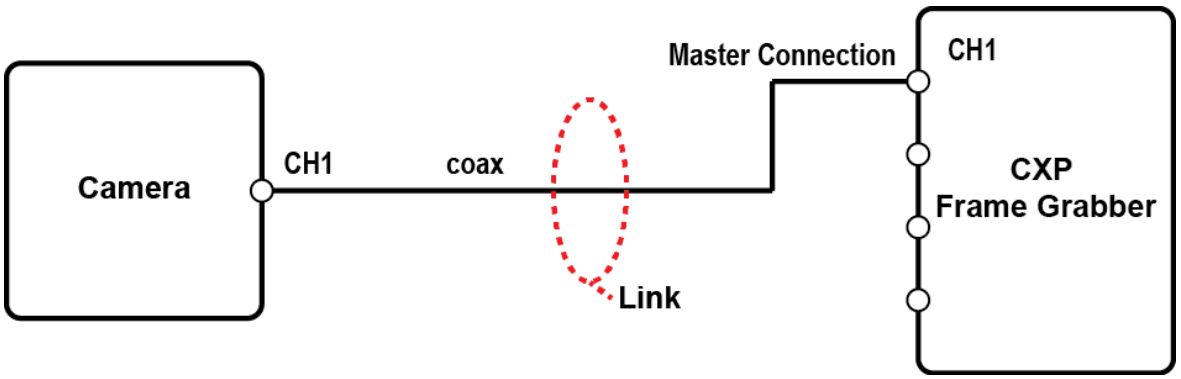


Figure 9-3 CXP Link Configuration

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

XML Parameters		Value	Description
CoaXPress	CxpLinkConfiguration PreferredSwitch	CXP6_X1	Sets the CxpLinkConfigurationPreferred parameter value to CXP6_X1.
	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.
	CXPLinkConfiguration	CXP6_X1	Forcefully sets bit rate and the number of connections for the link configuration. e.g.) CXP6_X1: One connection running at a maximum of CXP6 speed (6.25 Gbps)

Table 9-5 XML Parameter related to CXP Link Configuration

9.4 Pixel Format

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

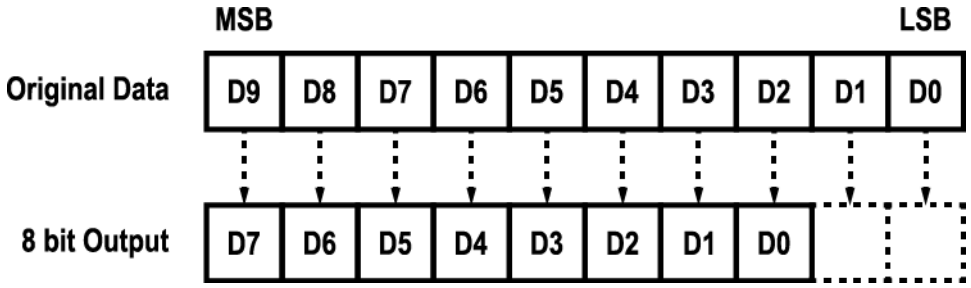


Figure 9-4 Pixel Format

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

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

Table 9-6 XML Parameter related to Pixel Format

The available pixel format on the monochrome camera is as follows.

Mono Sensor
Mono 8

Table 9-7 Pixel Format Value

Note:

The VC-4MX-M144F camera supports only the 8 bit pixel format.

9.5 LUT

LUT (Lookup Table) converts original image values to certain level values.

Luminance

Since it is mapped one to one for each level value, 12-bit output can be connected to 12-bit input. LUT is in the form of table that has 4096 entries between 0~4095 and VA GigE camera provides a non-volatile space for LUT data storage. You can determine whether to apply LUT and which LUT to use. For more information about how to download LUT to the camera, refer to Appendix B.

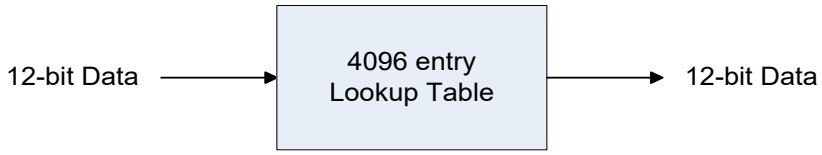


Figure 9-5 LUT Block

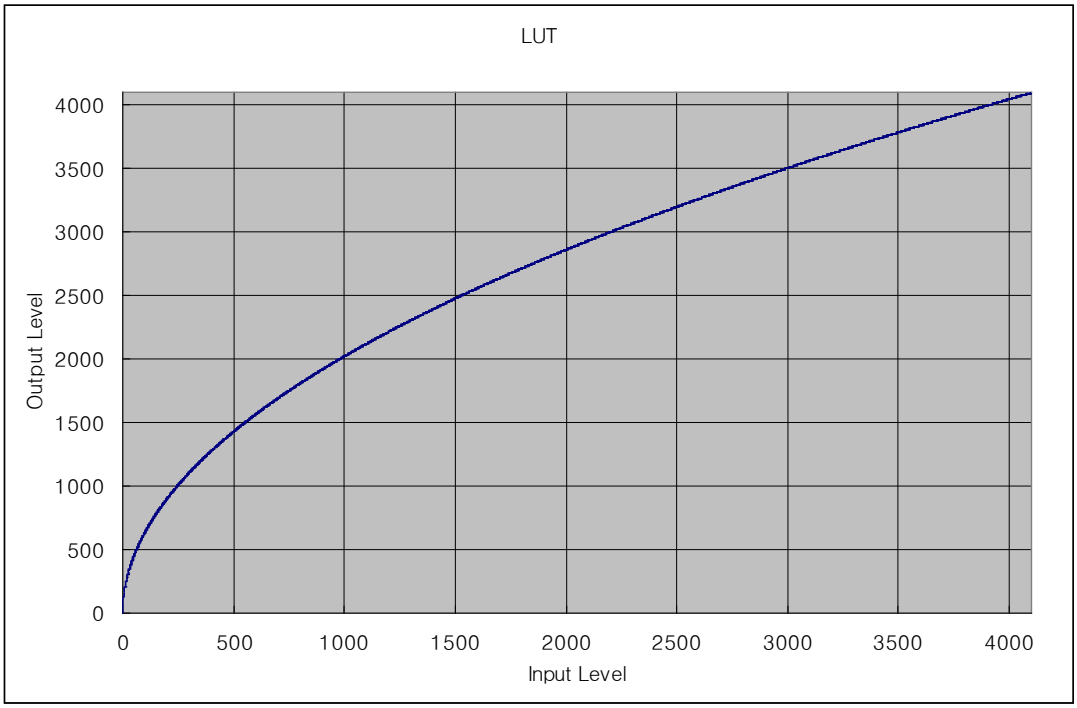


Figure 9-6 LUT at Gamma 0.5

XML parameters related to LUT are as follows.

XML Parameters		Value	Description
LUTControl	LUTSelector	Luminance	Luminance LUT
	LUTEnable	On	Activate the selected LUT
		Off	Deactivate the selected LUT
	LUTIndex	-	Index of coefficient for verifying the LUT Value Luminance: 0 ~ 4095
	LUTValue	-	Output value of the current LUT corresponding to the input value of LUT Index

Table 9-8 XML Parameters related to LUT

9.6 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** or **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	AnalogAll	Applies the Gain value to all analog channels.
		DigitalAll	Applies the Gain value to all digital channels.
	Gain	×1.0~×3.2	Sets an analog gain value.
		×1.0~×4.0	Sets a digital gain value.
	BlackLevelSelector	DigitalAll	Applies the Black Level value to all digital channels.
	BlackLevel	0~16	Sets a black level value.

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

9.7 Defective Pixel Correction

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

9.7.1 Correction Method

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

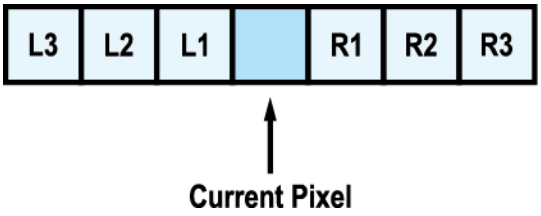


Figure 9-7 Location of Defect Pixel to be corrected

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

Table 9-10 Calculation of Defect Pixel Correction Value

9.8 Flat Field Correction

The Flat Field Correction feature improves the image uniformity when you acquire a non-uniformity image due to external conditions. The Flat Field Correction feature of the VC-4MX-M144F 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 9-8**.

   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.

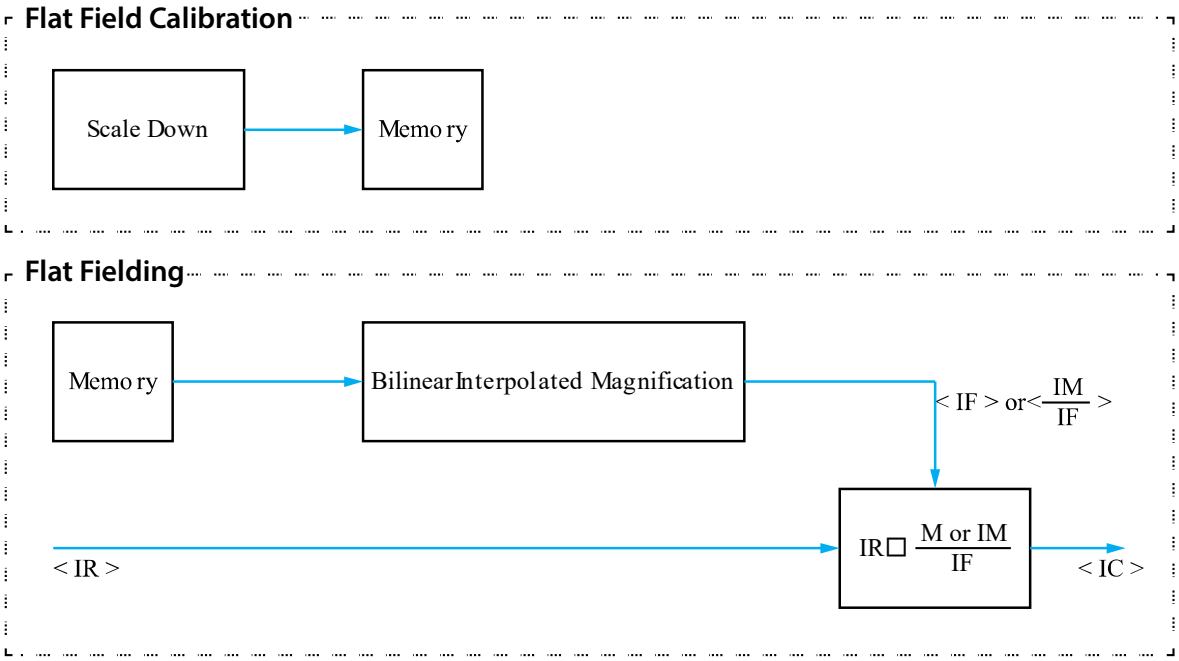


Figure 9-8 Generation and Application of Flat Field Data

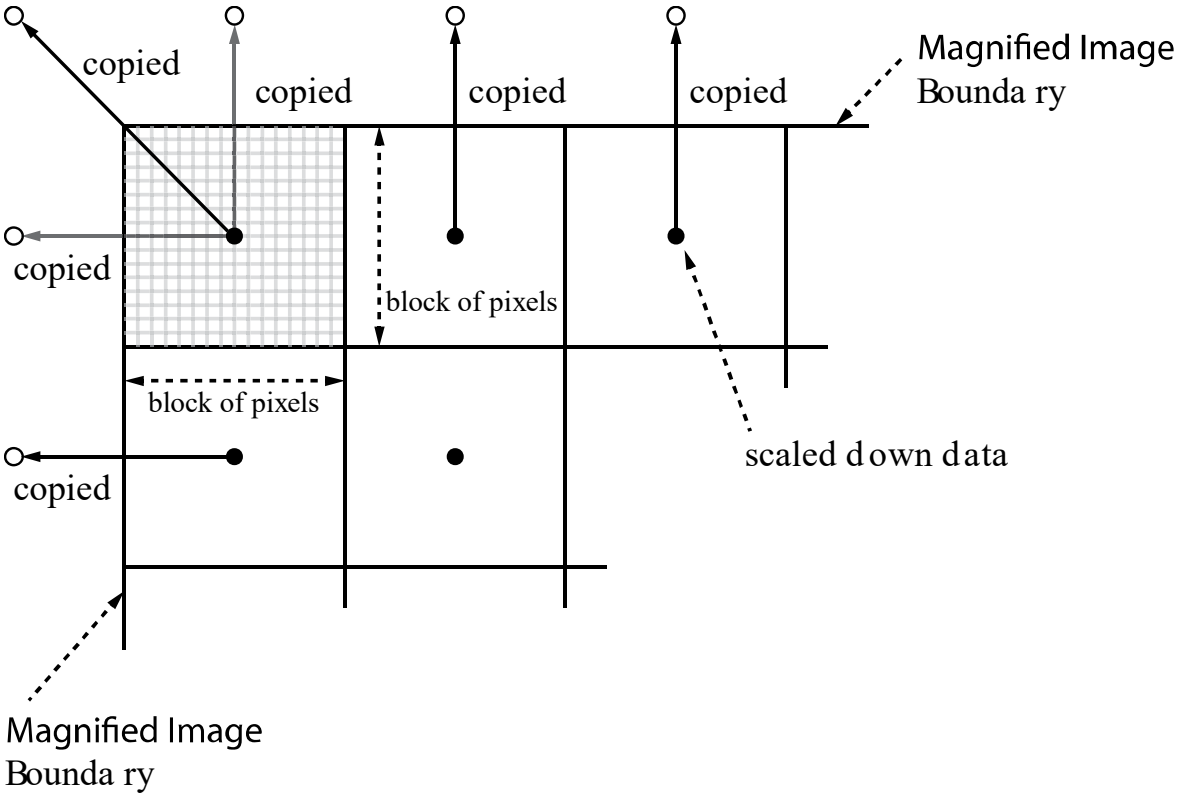


Figure 9-9 Bilinear Interpolated Magnification

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.

Table 9-11 XML Parameters related to Flat Field Correction

9.8.1 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-4MX-M144F 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.

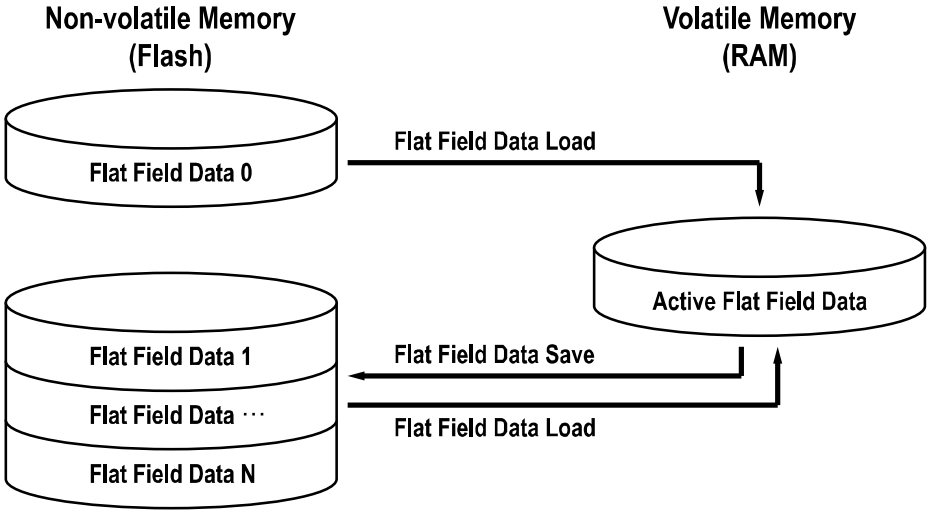


Figure 9-10 Flat Field Data Selector

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.

9.9 Fan Control

A fan is installed on the rear panel of the camera to radiate heat. You can set the fan to turn on or off. You can also set the fan to turn on when a specified internal temperature is reached. The XML parameters related to Fan Control are as follows.

XML Parameters		Value	Description
FanControl	FanOperationMode	Off	Turns off the fan.
		On	Turns on the fan.

Table 9-12 XML Parameters related to Fan Control

9.10 Temperature Monitor

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

The XML parameter related to Device Temperature is as follows.

XML Parameter		Description
DeviceControl	DeviceTemperature	Displays device temperature in Celsius.

Table 9-13 XML Parameter related to Device Temperature

9.11 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 9-14 Status LED

9.12 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. Three 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) and moving images with different values in diagonal direction (Grey Diagonal Ramp Moving).

The XML parameter related to Test Pattern is as follows.

XML Parameter		Value	Description
ImageFormatControl	TestPattern	Off	Disables the Test Pattern feature.
		GreyHorizontalRamp	Sets to Grey Horizontal Ramp.
		GreyDiagonalRamp	Sets to Grey Diagonal Ramp.
		GreyDiagonalRamp Moving	Sets to Grey Diagonal Ramp Moving.

Table 9-15 XML Parameter related to Test Pattern

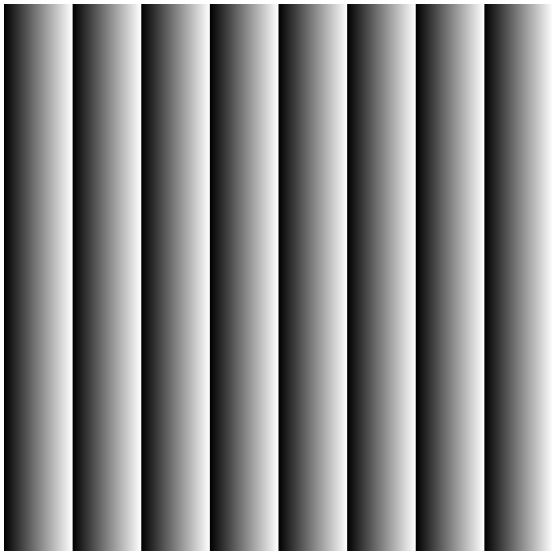


Figure 9-11 Grey Horizontal Ramp

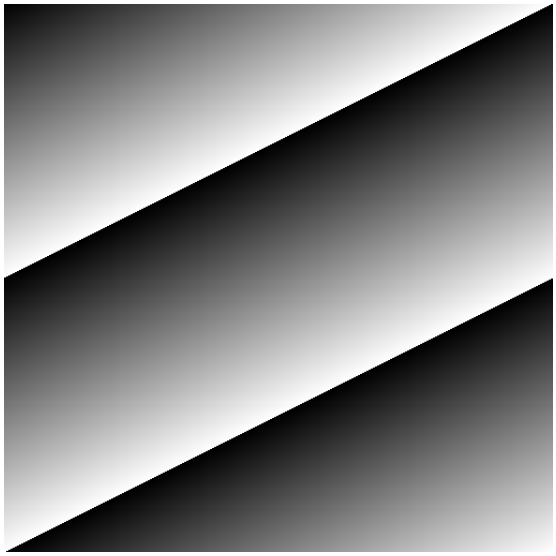


Figure 9-12 Grey Diagonal Ramp

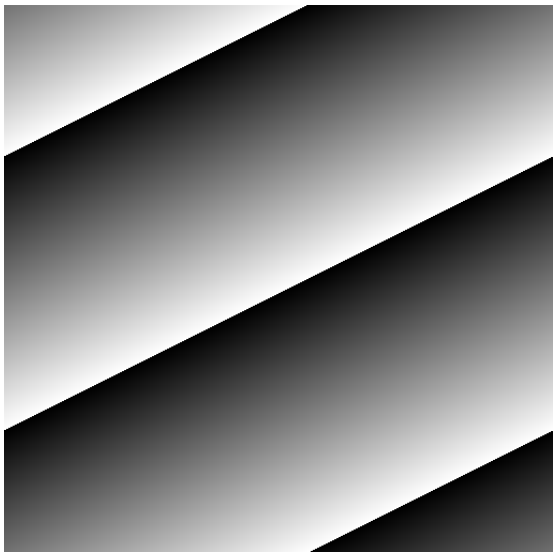


Figure 9-13 Grey Diagonal Ramp Moving

Note:

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

9.13 Debounce

The Debounce feature of the VC-4MX-M144F cameras allow 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.

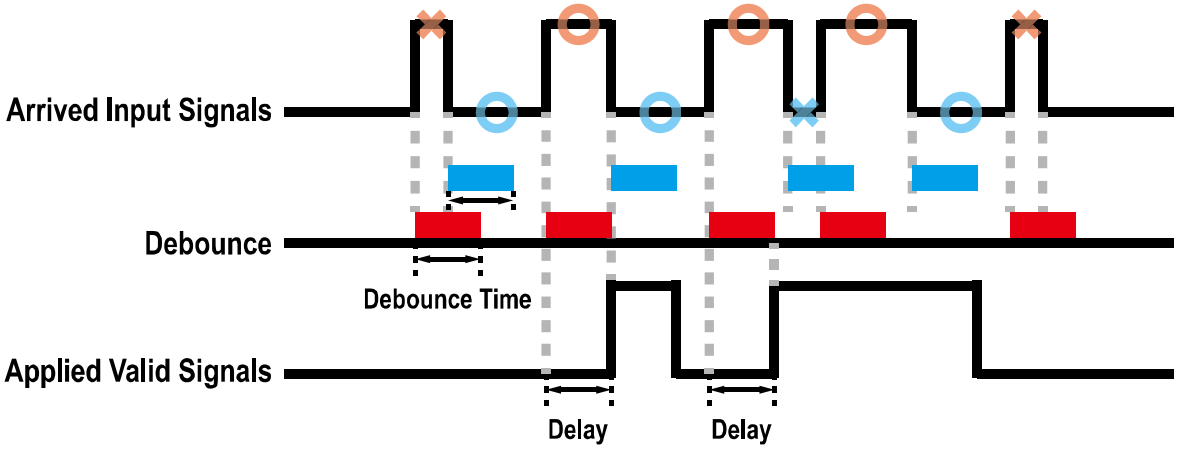


Figure 9-14 Debounce

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: 0.5 μs).

Table 9-16 XML Parameter related to Debounce Time

9.14 Reverse X

The Reverse X feature lets you flip images horizontally. This feature is available in all operation modes of the camera. The XML parameter related to Reverse X is as follows.

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

Table 9-17 XML Parameter related to Reverse X

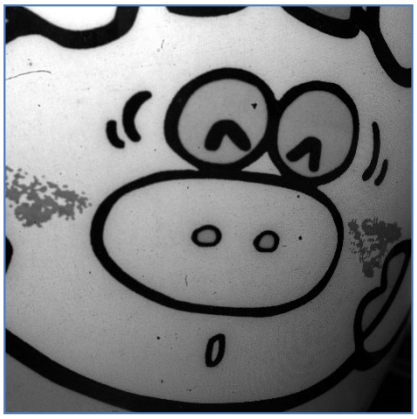


Figure 9-15 Original Image

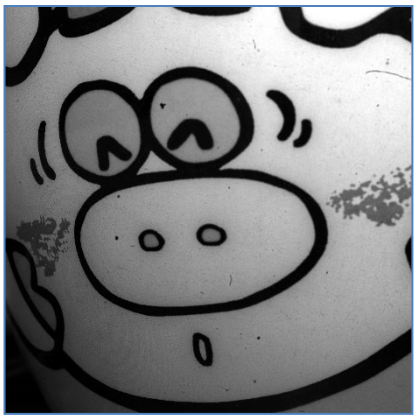


Figure 9-16 Reverse X Image

9.15 Reverse Y

The Reverse Y feature lets you flip images vertically. This feature is available in all operation modes of the camera. The XML parameter related to Reverse Y is as follows.

XML Parameter		Value	Description
ImageFormatControl	ReverseY	FALSE	Disables the Reverse Y feature.
		TRUE	Flips images vertically.

Table 9-18 XML Parameter related to Reverse Y

Figure 9-17 Original Image

Figure 9-18 Reverse Y Image

9.16 Digital IO Control

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

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

XML Parameters		Value	Description
DigitalIOControl	LineSelector	LineIn0	Selects the number 1 pin of the camera's Control I/O Receptacle as an input line.
		LineOut0	Selects the number 4 pin of the camera's Control I/O Receptacle as an output line.
	LineMode	Input	Appears under LineIn0 is chosen.
		Output	Appears under LineOutput0 is chosen.
	LineInverter	True	Enables inversion on the output signal of the line.
		False	Disables inversion on the output signal of the line.
	Line Source	Off	Disables the line output.
		FrameActive	Outputs pulse signals indicating a frame readout time.
		StrobeOut	Outputs pulse signal indicating the current exposure time with Strobe Out Delay.
		UserOutput	Outputs pulse signals set by User Output Value.
	UserOutputSelector	UserOutput0	Appears under UserOutput is chosen.
	UserOutputValue	True	Set the bit state of the line to High.
		False	Set the bit state of the line to Low.
	StrobeOutDelay	0 ~ 65535	Set a delay in microseconds when the Line Source is set to Strobe Out.

Table 9-19 Digital IO Control

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

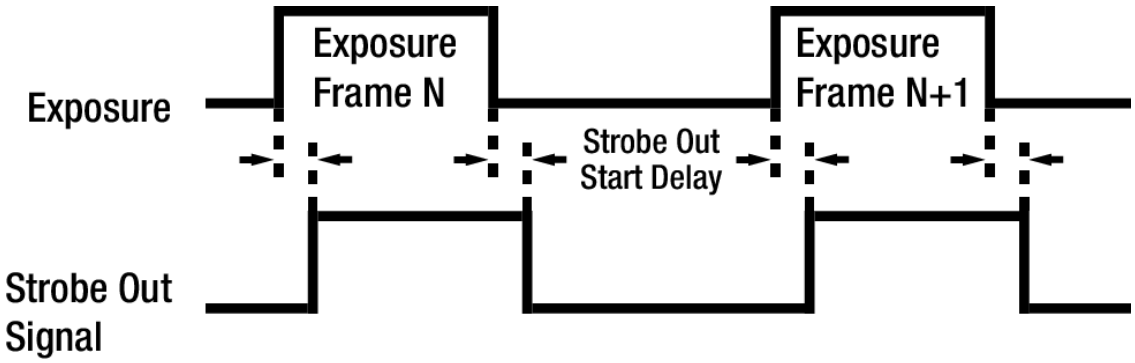


Figure 9-19 Strobe Out Signal

Note:

When you use the Strobe Out signal, be aware that there is a Strobe Out Start Delay as shown in the figure above.

Camera Model	Strobe Out Start Delay
VC-4MX-M144F	≤ 0.8 μs

Table 9-20 Strobe Out Start Delay

9.17 Device User ID

You can input user defined information up to 32 bytes.

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

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

Table 9-21 XML Parameter related to Device User ID

9.18 Device Reset

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

The XML parameter related to Device Reset is as follows.

XML Parameters		Description
DeviceControl	DeviceReset	Resets the camera physically.

Table 9-22 XML Parameter related to Device Reset

9.19 Field Upgrade

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

9.20 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 settings when reset.
		UserSet2	Applies the UserSet1 settings when reset.

Table 9-23 XML Parameters related to User Set Control

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

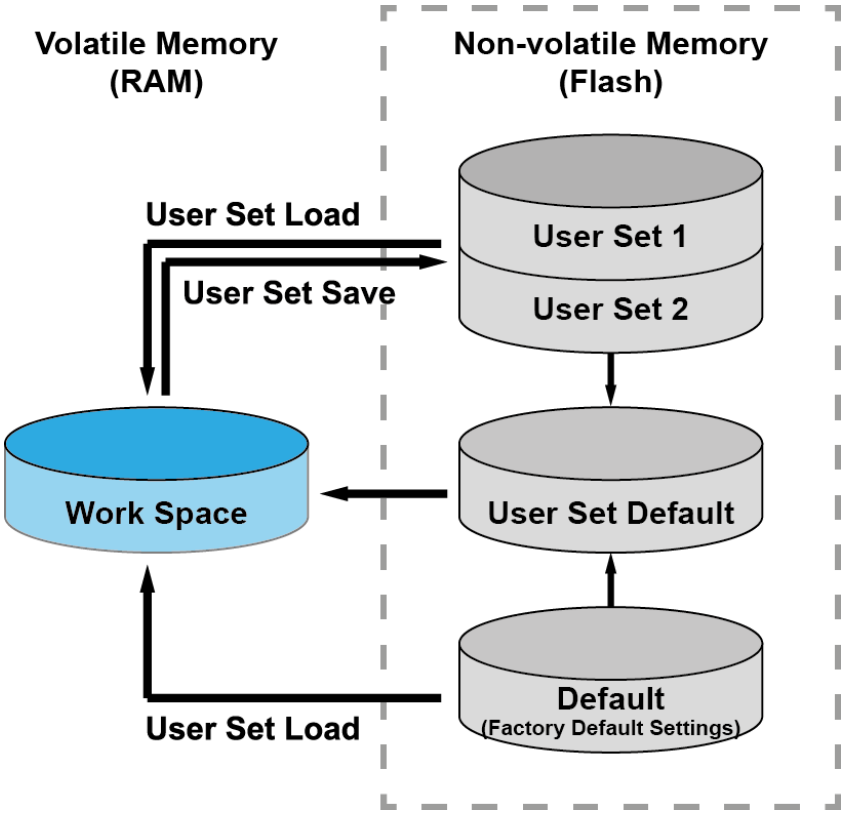


Figure 9-20 User Set Control

Chapter 10. Troubleshooting

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

- If no image is displayed on your computer,
  - Ensure that all the cable connections are secure.
  - Ensure that the power supply is properly connected.
  - Ensure that trigger signal is 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 your camera lens is not blocked.
  - Check the exposure time is set properly.
  - Check the aperture is opened properly.
  - Check the Gain value is not set too small.
- If you identify abnormal operation or overheating sign,
  - Ensure the power supply is properly connected.
  - Stop using the camera when you notice smoke or abnormal overheating.
- If you have a problem using the Trigger Mode,
  - Ensure that the trigger related parameters on your CXP Frame Grabber are configured correctly when you set the Trigger Source parameter to CXPin.
  - Ensure that cable connections are secure when you set the Trigger Source parameter to LineIn0.
- If there is a communication failure between the camera and computer,
  - Ensure the coax cable is connected properly.
  - Ensure that you have configured a CXP Frame Grabber in your computer correctly and the camera is connected properly to the CXP Frame Grabber.

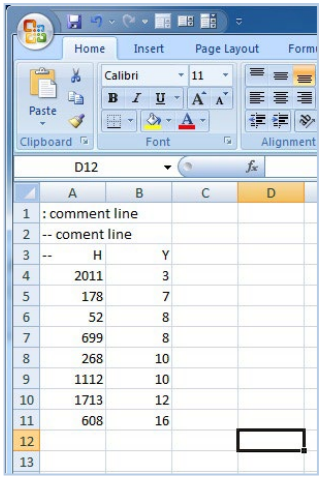
Appendix A. Defective Pixel Map Download

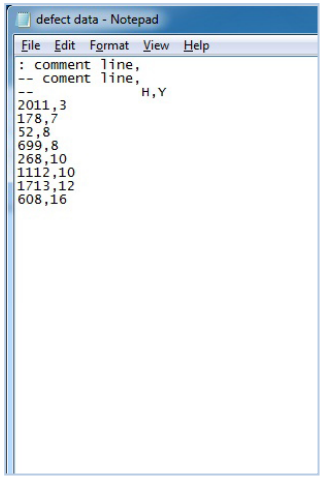
1. Create the Defective Pixel Map data in Microsoft Excel format as shown in the left picture below and save as a CSV file (*.csv). The picture in the right shows the created Excel file opened in Notepad. The following rules need to be applied when creating the file.

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

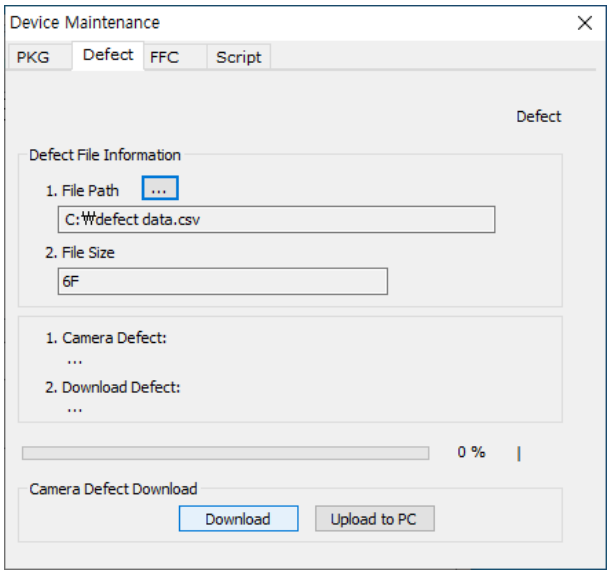
   • You must enter the horizontal value first and then the vertical value for coordinates of each defect pixel.

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





2. Run Vieworks Imaging Solution 7.X 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.



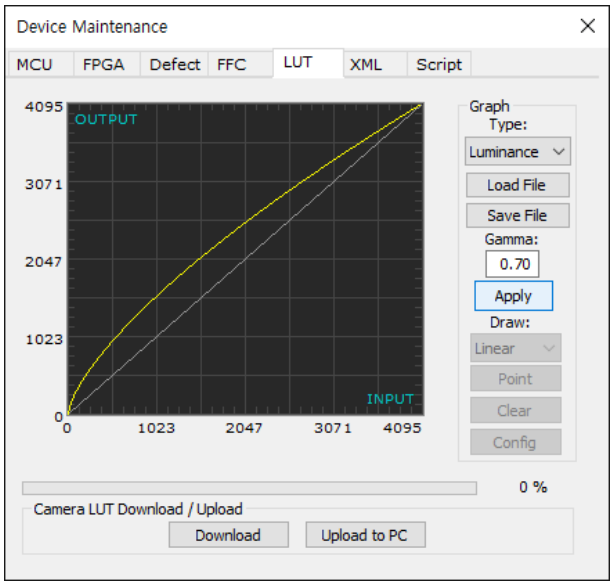
Appendix B. LUT Download

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

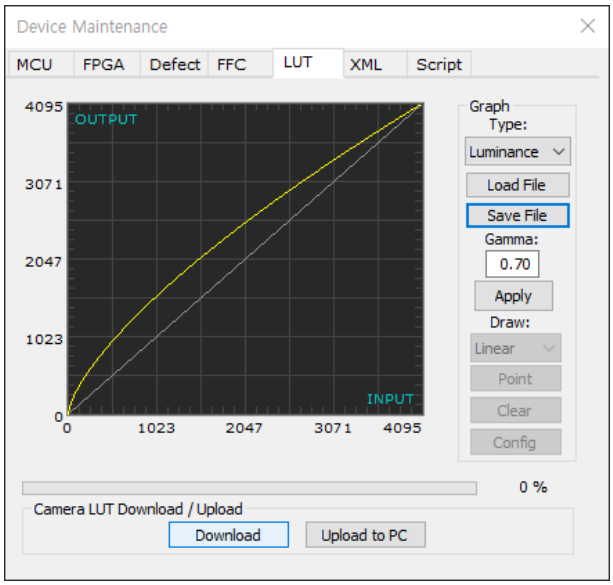
B.1 Luminance LUT

Gamma Graph Download

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



3. Click the Download button to download the gamma set to the camera.

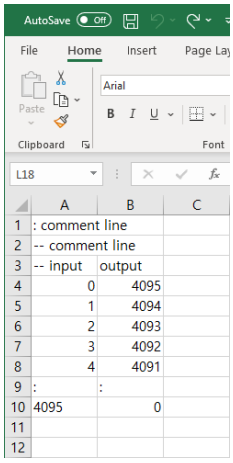


4. After completing the download, click the OK button to close the confirmation.

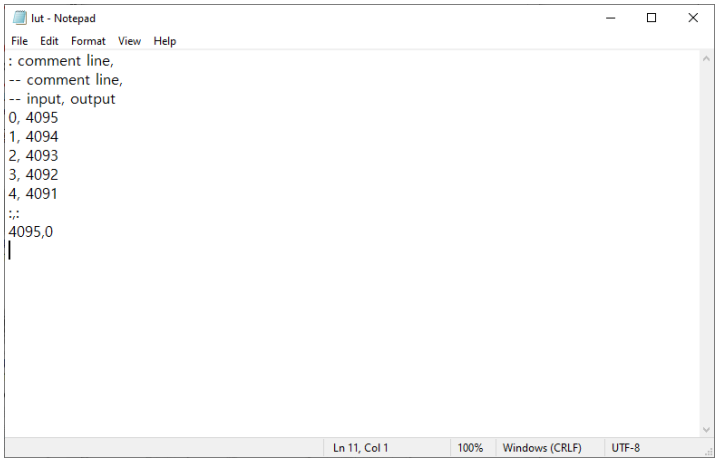
B.2 CSV File Download

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

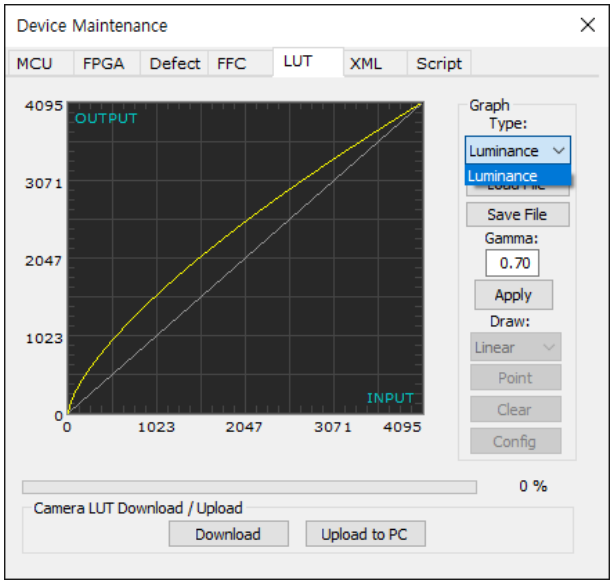
   - Lines beginning with ':' or '—' are treated as notes.
   - Based on the input values, make sure to record from 0 to 4095.



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



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

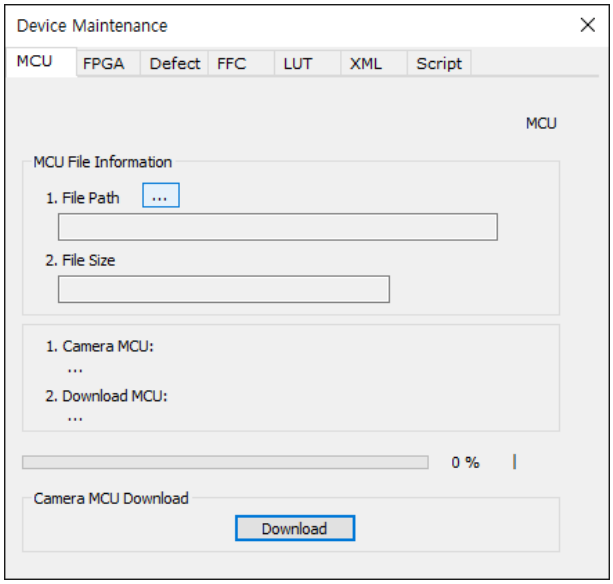


3. Search and select the created LUT file and click the **Open** button.
4. Click the **Download** button. After completing the download, click the **OK** button to close the confirmation.

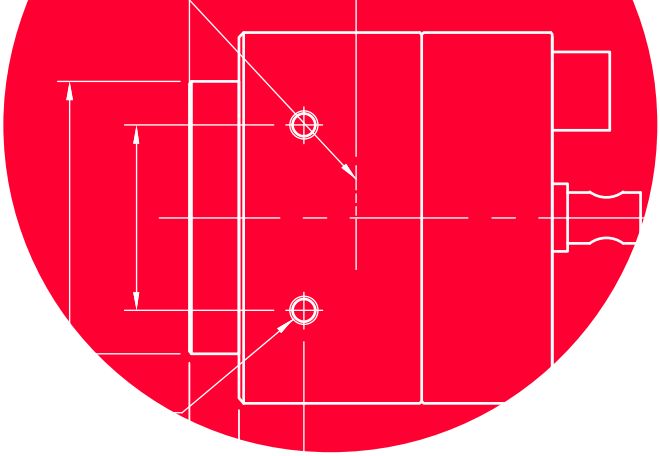
Appendix C. Field Upgrade

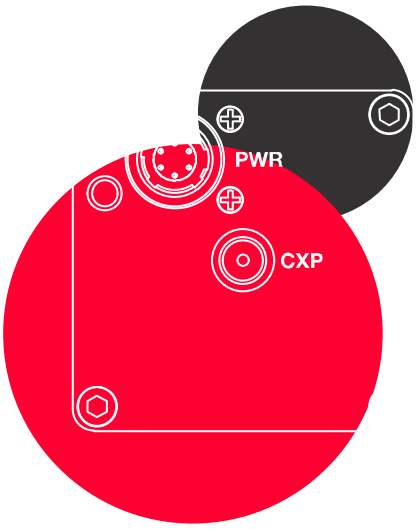
You can upgrade the MCU, FPGA and XML file of the camera by following the procedure below.

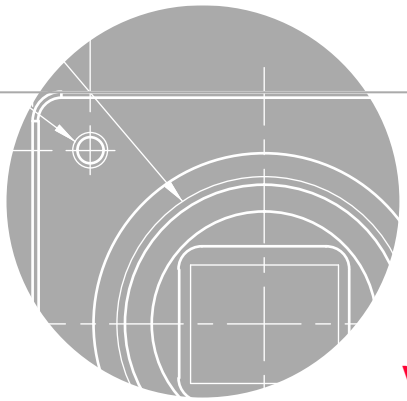
1. Run Vieworks Imaging Solution 7.X and click the Configure button to display the window as shown below.
2. Select the **MCU**, **FPGA**, or **XML** tab in consideration of the items to upgrade, click the button next to **File Path**, search and select the MCU, FPGA or XML upgrade file, and then click the Download button.



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







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