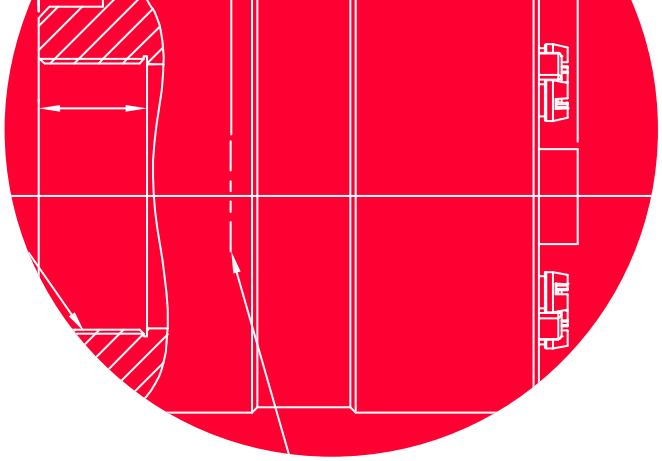


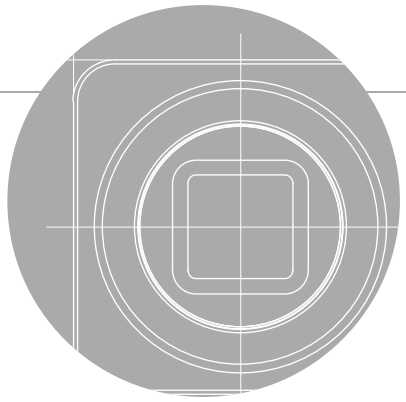
VC series

User Manual

English

VC-5MC-M110H
VC-5MC-C110H

CAMERA Link®



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 a camera in the VC-5MC-M/C110H™.

- 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-5MC-M110H
- VC-5MC-C110H

About This Manual

This manual is intended for VC-5MC-M/C110H™ 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
Configurator	The Configurator program from a seller for offering ease of use to control the camera on Windows®
Frame grabber	An computer board for high-resolution image processing

Revision History

This document has the revision history as follows:

Version	Date	Description
1.0	2022-06-20	Initial Release
1.1	2022-07-22	Added the Command List section

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 film sticker on the camera front. To prevent collecting dust or foreign matter on the camera sensor, make sure that you always put a plastic 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

A camera in the VC-5MC-M/C110H

Chapter 5. Product Specifications

5.1 Overview

The VC-5MC-M/C110H cameras, the latest model of the industrial proven VC series, are new 5-megapixel cameras with the Camera Link interface. The VC-5MC-M/C110H cameras use the latest CMOS global shutter image sensor(IMX547) technology from Sony. It offers up to 109.5 frames per second at 2,448 × 2,048 resolution. These combinations of high resolution, high speed and global shutter 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-5MC-M/C110H cameras offer not only highly uniformed images but also high speed image processing capabilities. Featured with high quality image uniformity and high resolution, the cameras are ideal for wide range of demanding applications such as FPD, PCB and semiconductor inspections.

Main Features

- High Speed 5 Megapixel CMOS Image Sensor
- Electronic Exposure Time Control (Global Shutter)
- Output Pixel Format: 8/10/12 bit
- Line Output
- Camera Link Base/Medium/Full/10-taps
- Device Tap Geometry: 2/4/8/10 Taps
- Gain / Black Level Control
- Test Pattern
- Temperature Monitor
- Field Upgrade
- Flat Field Correction
- GenICam Compatible – XML based Control

5.2 Specifications

Technical specifications for the VC-5MC-M/C110H are as follows.

Specifications		VC-5MC-M/C110H
Resolution (H × V)		2448 × 2048
Sensor		IMX547
Sensor Size (diagonal)		Type1/1.8 (8.8 ㎜)
Sensor Type		CMOS Image Sensor
Pixel size		2.74 ㎛ × 2.74 ㎛
Interface		Camera Link Base/Medium/Full/10-taps, 26-pin SDR Connector
Max. Frame Rate (8 bit)	2 Tap	31.0 fps
	4 Tap	61.2 fps
	8 Tap	109.5 fps
	10 Tap	109.5 fps
Exposure Time(1 ㎲ step)		1 ㎲ ~ 60 s
Partial Scan(Max. Speed)		1374.1 fps at 16 Lines in 8 bit
Pixel Data Format	Mono	Mono 8/10/12 bit
	Color	RG Bayer 8/10/12 bit
Electronic Shutter		Global Shutter
Digital Gain		×1 ~×32
Digital Black Level		0 ~ 255 LSB at 12 bit (1 LSB step)
Exposure Mode		Free-Run, Timed, Trigger Width
External Trigger		3.3 ~ 24.0 V, 10 ㎃, Logical Level Input Optically Isolated
Software Trigger		Asynchronous, Programmable via Camera API
Digital IO		TTL Level Exposure Active, Frame Active, User Output, Timer, Strobe Output
Dynamic Range		71 ㏈
Mechanical (W × H × L)		40.0 ㎜ × 40.0 ㎜ × 50 ㎜, 125 g (C-mount)
Environmental		Operating: 0℃ ~ 40℃, Storage: -40℃ ~ 70℃
Lens Mount		C-mount
Power		11~24 V DC, Typical 5 W, PoCL supported
Compliance		CE, FCC, KC

Table 5-1 Specifications of the VC-5MC-M/C110H

5.3 Camera Block Diagram

The block diagram of the VC-5MC-M/C110H is shown below.

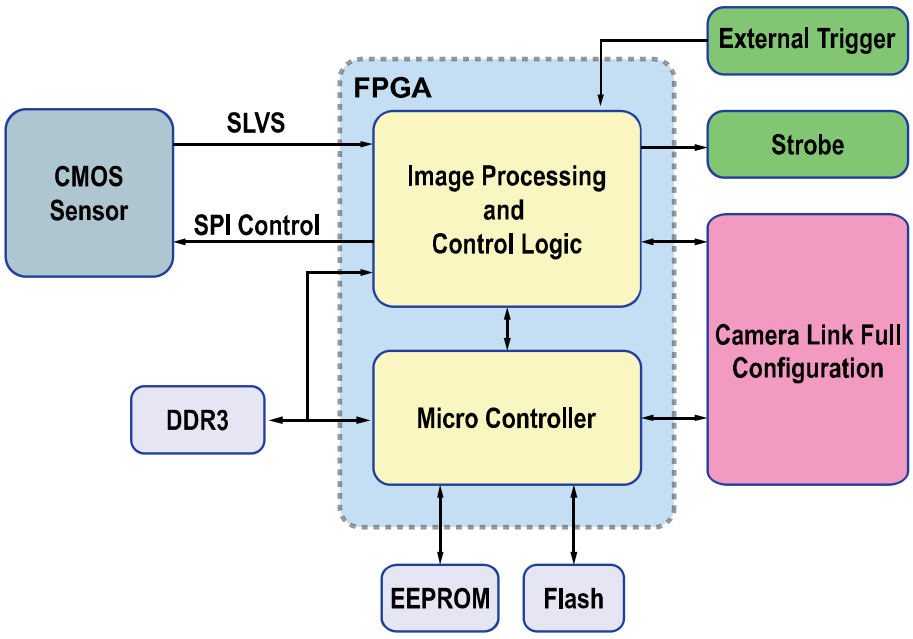


Figure 5-1 Camera Block Diagram

All controls and data processing of a camera in the VC-5MC-M/C110H 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 Camera Link 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 Camera Link 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 for the frame buffer 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 of the color and monochrome cameras in the VC-5MC-M/C110H.

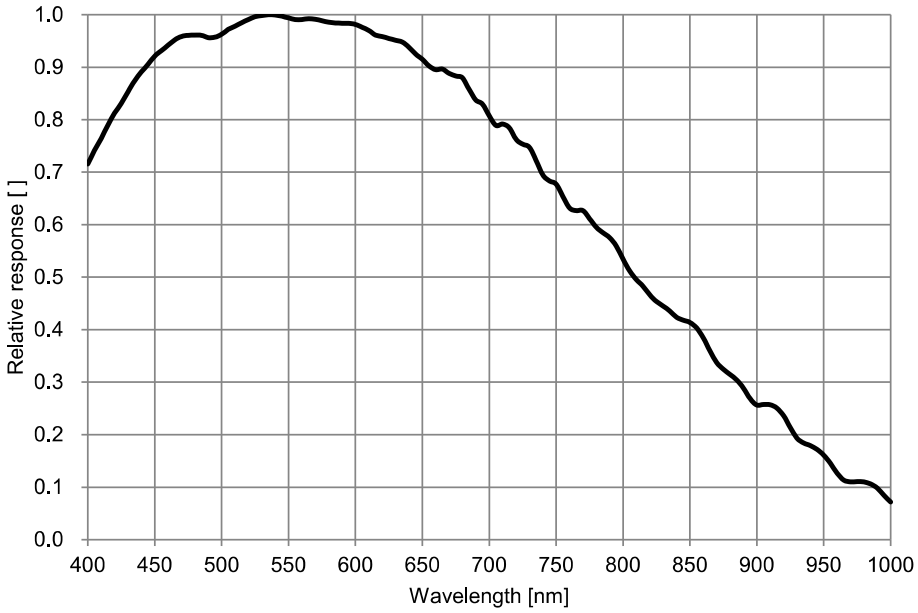


Figure 5-2 Spectral Response for VC-5M/8M Series

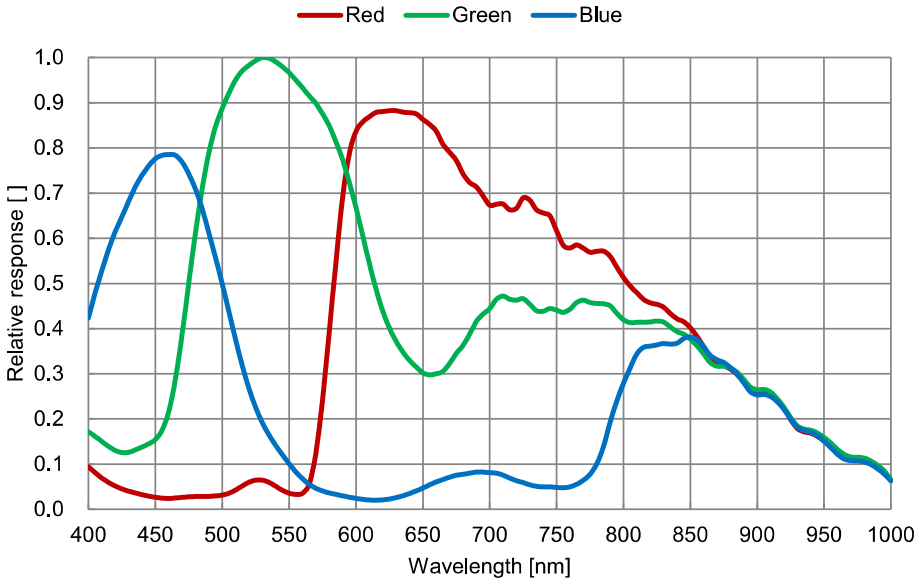


Figure 5-3 Spectral Response for VC-18M series

5.5 Mechanical Specification

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

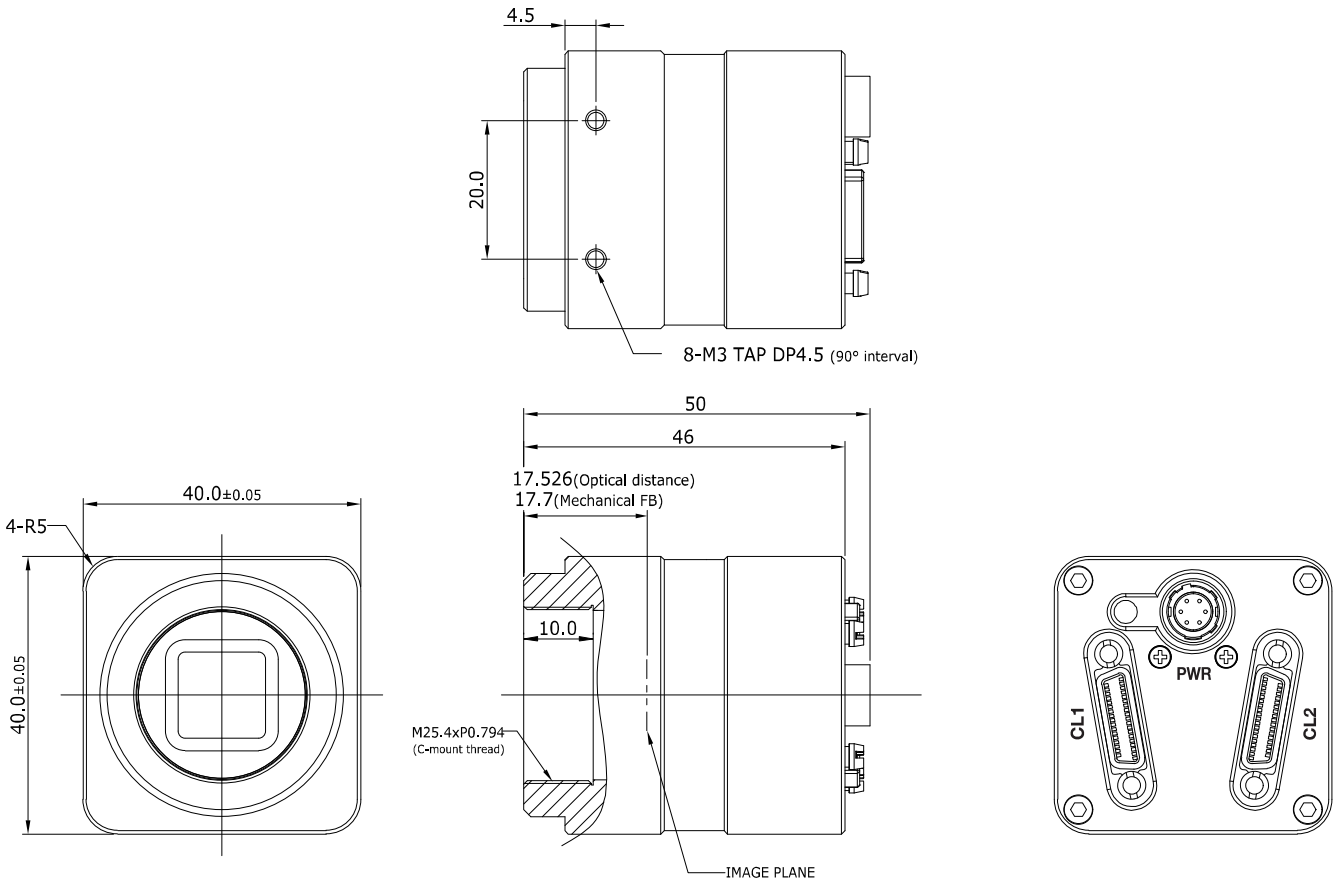


Figure 5-4 VC-5MC-M/C110H Mechanical Dimension

Chapter 6. Connecting the Camera

The following instructions assume that you have installed a Camera Link frame grabber in your computer including related software. For more information, refer to your Camera Link 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.
2. Plug one end of a Camera Link cable into the Camera Link1 connector on the camera and the other end of the Camera Link cable into the Base connector on the Camera Link frame grabber.
3. Plug one end of the other Camera Link cable into the Camera Link2 connector on the camera and the other end of the Camera Link cable into the Medium/Full connector on the Camera Link frame grabber.
4. Connect the plug of the power adapter to the power input receptacle on the camera.
5. Plug the power adapter into a working electrical outlet.
6. Verify all the cable connections are secure.

Precautions for using Camera Link Medium/Full/10-taps Configuration

Caution!

- The VC-5MC-M/C110H supports the Camera Link Base/Medium/Full/10-taps configuration. To operate the camera in the medium, full or 10-taps configuration, you must connect the camera to the Camera Link frame grabber using two Camera Link cables. Make sure that you connect both Camera Link1 (Base) and Camera Link2 (Medium/Full) connectors on the camera to their respective connectors on the Camera Link frame grabber.
- Depending on the type of the frame grabber in use, images acquired may not appear correctly in the 10-taps mode, sometimes. Therefore, it is recommended to use the latest Camera Link frame grabber.

6.1 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.

6.2 Controlling the Camera

- You can control the camera easily by executing the Configure.exe file to open the Configurator.
- You can download the latest Configurator by contacting the manufacturer of your frame grabber.
- For more information on the Configurator, refer to your Camera Link frame grabber's manual.

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 26 pin SDR Connector 1 (Camera Link Base): transmits video data and controls the camera.

② Status LED: displays power status and operation mode.

③ 6-pin Power Input and Control I/O Receptacle: supplies power to the camera and can be set to operate as an input and output line.

④ 26 pin SDR Connector 2 (Camera Link Medium/Full): transmits video data.

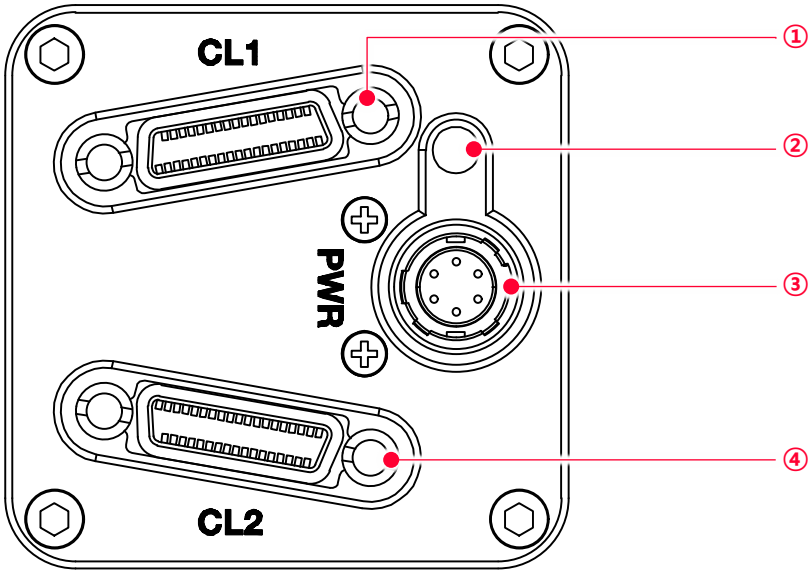


Figure 7-1 VC-5MC-M/C110H' Back Panel

7.2 Camera Link SDR Connector

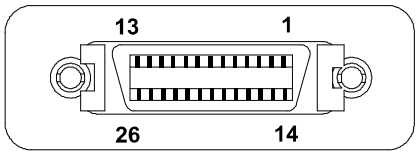


Figure 7-2 Micro-BNC Connector

The Camera Link connectors on the camera comply with the Camera Link standard and the following lists show the pin assignments of the connectors.

PAIR List	Pin	Signal Name	Type	Description
PAIR 0	1	Ground	Ground	Cable Shield
	14	Ground	Ground	Cable Shield
PAIR 1	2	-X0	LVDS - Out	Camera Link Transmitter
	15	+X0	LVDS - Out	Camera Link Transmitter
PAIR 2	3	-X1	LVDS - Out	Camera Link Transmitter
	16	+X1	LVDS - Out	Camera Link Transmitter
PAIR 3	4	-X2	LVDS - Out	Camera Link Transmitter
	17	+X2	LVDS - Out	Camera Link Transmitter
PAIR 4	5	-XCLK	LVDS - Out	Camera Link Transmitter
	18	+XCLK	LVDS - Out	Camera Link Transmitter
PAIR 5	6	-X3	LVDS - Out	Camera Link Transmitter
	19	+X3	LVDS - Out	Camera Link Transmitter
PAIR 6	7	+ SerTC	LVDS - In	Serial Data Receiver
	20	- SerTC	LVDS - In	Serial Data Receiver
PAIR 7	8	- SerTFG	LVDS - Out	Serial Data Transmitter
	21	+ SerTFG	LVDS - Out	Serial Data Transmitter
PAIR 8	9	- CC 1	LVDS - In	Software External Trigger
	22	+ CC 1	LVDS - In	Software External Trigger
PAIR 9	10	N/C	N/C	N/C
	23	N/C	N/C	N/C
PAIR 10	11	N/C	N/C	N/C
	24	N/C	N/C	N/C
PAIR 11	12	N/C	N/C	N/C
	25	N/C	N/C	N/C
PAIR 12	13	Ground	Ground	Cable Shield
	26	Ground	Ground	Cable Shield

Table 7-1 Pin Assignments for Camera Link Connector 1

PAIR List	Pin	Signal Name	Type	Description
PAIR 0	1	Ground	Ground	Cable Shield
	14	Ground	Ground	Cable Shield
PAIR 1	2	-Y0	LVDS - Out	Camera Link Transmitter
	15	+Y0	LVDS - Out	Camera Link Transmitter
PAIR 2	3	-Y1	LVDS - Out	Camera Link Transmitter
	16	+Y1	LVDS - Out	Camera Link Transmitter
PAIR 3	4	-Y2	LVDS - Out	Camera Link Transmitter
	17	+Y2	LVDS - Out	Camera Link Transmitter
PAIR 4	5	-YCLK	LVDS - Out	Camera Link Transmitter
	18	+YCLK	LVDS - Out	Camera Link Clock Tx
PAIR 5	6	-Y3	LVDS - Out	Camera Link Channel Tx
	19	+Y3	LVDS - Out	Camera Link Channel Tx
PAIR 6	7	-	Not Used	Connected with 100 ohm
	20	-	Not Used	
PAIR 7	8	-Z0	LVDS - Out	Camera Link Transmitter
	21	+Z0	LVDS - Out	Camera Link Transmitter
PAIR 8	9	-Z1	LVDS - Out	Camera Link Transmitter
	22	+Z1	LVDS - Out	Camera Link Transmitter
PAIR 9	10	-Z2	LVDS - Out	Camera Link Transmitter
	23	+Z2	LVDS - Out	Camera Link Transmitter
PAIR 10	11	-ZCLK	LVDS - Out	Camera Link Transmitter
	24	+ZCLK	LVDS - Out	Camera Link Clock Tx
PAIR 11	12	-Z3	LVDS - Out	Camera Link Channel Tx
	25	+Z3	LVDS - Out	Camera Link Channel Tx
PAIR 12	13	Ground	Ground	Cable Shield
	26	Ground	Ground	Cable Shield

Table 7-2 Pin Assignments for Camera Link Connector 2

Model	Device Tap Geometry	CL Configuration	CL Connector 1	CL Connector 2
VC-5MC-M/C110H	2 Tap	BASE	O	X
	4 Tap	MEDIUM	O	O
	8 Tap	FULL	O	O
	10 Tap	10 Tap	O	O

Table 7-3 Connector Arrangement for the Device Tap Geometry

Note:

When you connect a Camera Link frame grabber to the Camera Link connectors on the camera using Camera Link cables, make sure you connect the cables to their correct connectors. If you connect the Camera Link connector 1 on the camera to a connector other than connector 1 of the Camera Link frame grabber, the camera may not transmit images correctly or the serial communication between the camera and the computer may fail.

7.3 Power Input and Control I/O Receptacle

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

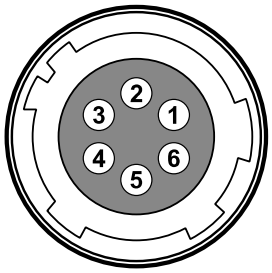


Figure 7-3 Pin Assignments for Power Input Receptacle

Pin Number	Signal	Type	Description
1	+ 12V DC	Input	DC Power Input
2	Trigger Input +	Input	-
3	Trigger Input -	Input	-
4	I/O Output+	Output	-
5	I/O Output-	Output	-
6	DC Ground	Input	DC Ground

Table 7-4 Pin Configurations for Power Input 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 V DC ±10% 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 6-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.

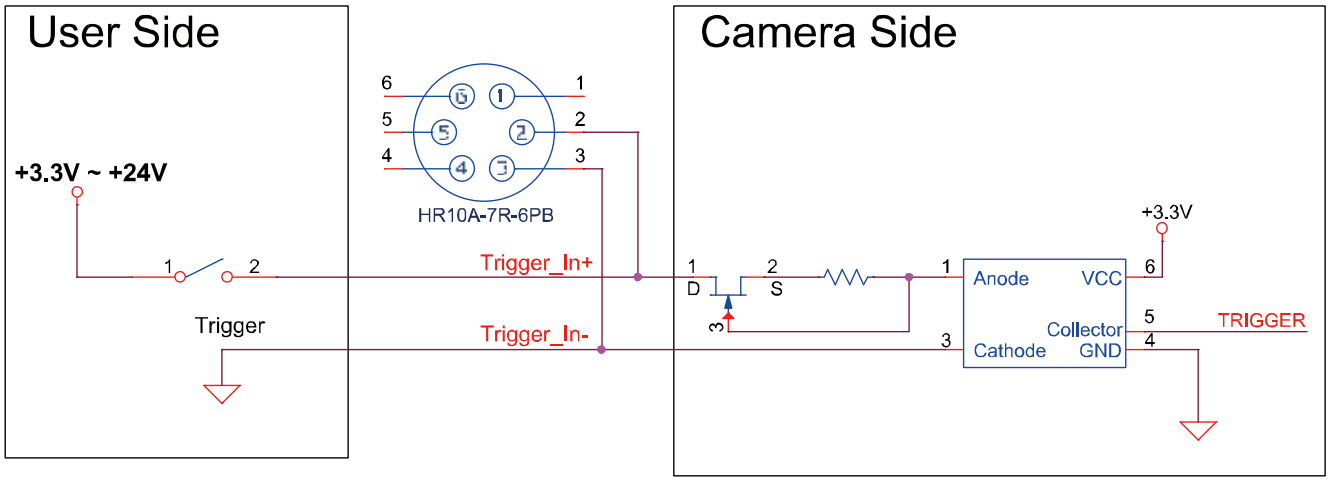


Figure 7-4 Trigger Input Schematic

7.5 Strobe Output Circuit

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

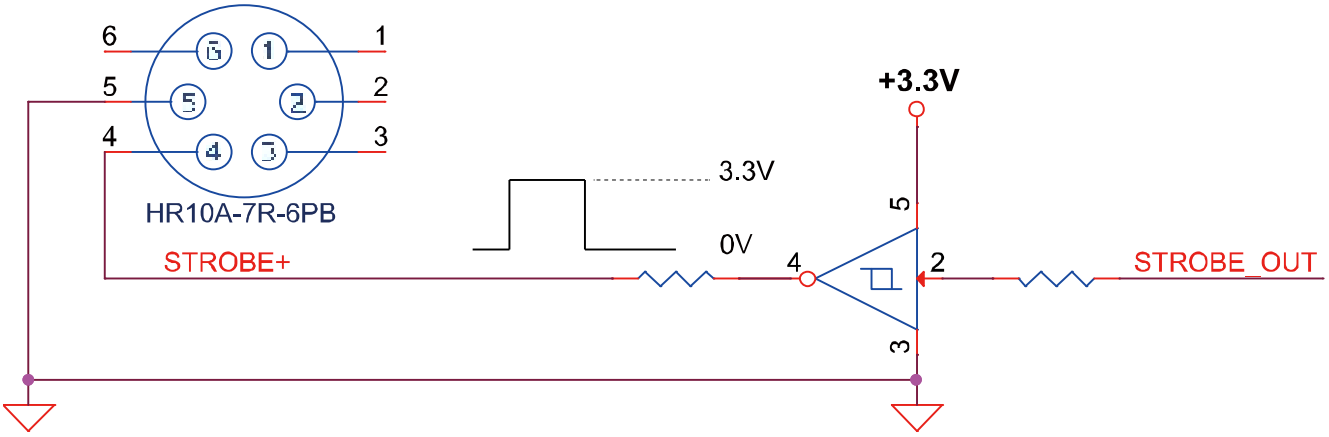


Figure 7-5 Strobe Output Schematic

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:

A recommended mating connector for the Hirose 4-pin connector is the Hirose 4-pin plug (part # HR10A-7P-4P) or the equivalent.

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.

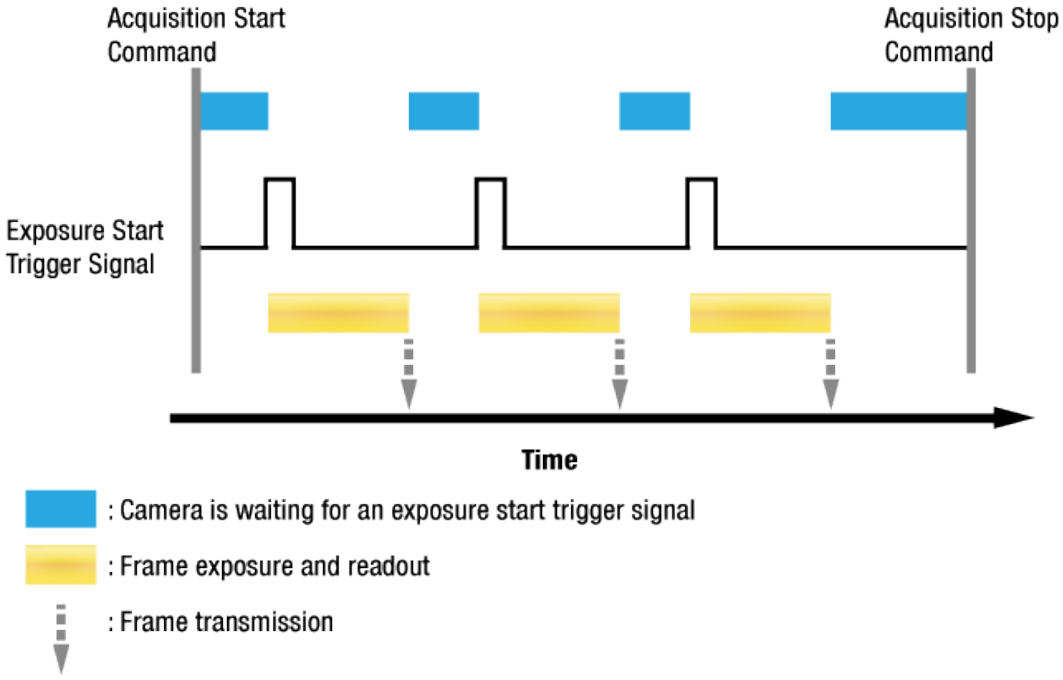


Figure 8-1 Exposure Start Triggering

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 **User Output0**, via **CC1**, via **Time0Active**, 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 User Output0, you must set the Trigger Source parameter to User Output0. 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 Camera Link frame grabber, you must set the Trigger Source parameter to CC1. At that point, each time an externally generated electrical signal is applied to the camera by using the APIs provided by a Camera Link frame grabber manufacturer, the exposure start trigger signal will be applied to the camera. For more information, refer to your Camera Link 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 User Output0, CC1 or Line0, there are two modes of operation: Timed and Trigger Width.

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

With the Trigger Width mode, the way that you manipulate the rise and fall of the User Output, CC1 or hardware (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.

8.3 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-5MC-M/C110H 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, User Output0, CC1, Time0Active, 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: You can apply an exposure start trigger signal to the camera by executing a Trigger Software command for the exposure start trigger on your computer.
- User Output0: You can apply an exposure start trigger signal to the camera by switching the User Output Value parameter between On and Off on your computer.
- CC1: You can apply an exposure start trigger signal to the camera via CC1 in the Camera Link interface. For more information, refer to your Camera Link frame grabber user manual.
- Timer0Active: You can apply an exposure start trigger signal to the camera using a user defined Timer signal. When you set the Timer Trigger Source parameter to Line0 in the Counter And Timer Control category, you can specify a delay for the Line0 signal by using the Timer Delay parameter. For more information, refer to 9.13 Timer Control.
- Line0: 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:

- 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 **CC1** 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 = Trigger Width: 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 = Trigger Width: 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 **User Output0**, 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 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.

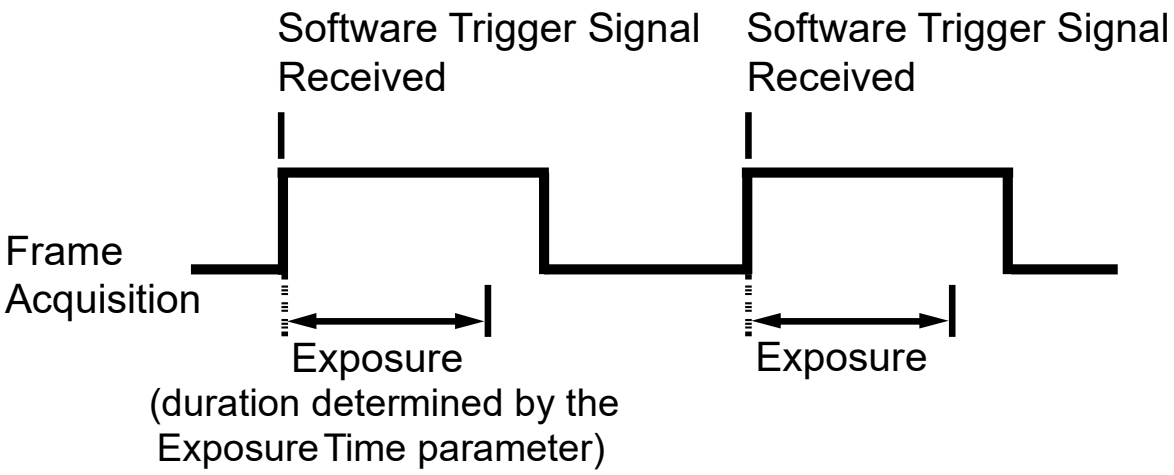


Figure 8-2 Frame Acquisition with Software Trigger Signal

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 CC1 Trigger Signal

If the Trigger Mode parameter is set to On and the Trigger Source parameter is set to CC1, you must apply a CC1 trigger signal to the camera to begin each frame acquisition. A CC1 trigger signal will act as the exposure start trigger signal for the camera. For more information, refer to your Camera Link frame grabber user manual.

A rising edge or falling edge of the CC1 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.

The camera starts the exposure after receiving a CC1 trigger signal, however, additional new CC1 trigger signal would be ignored while the previous exposure is still in progress. When the camera is operating under control of a CC1 signal, the period of the CC1 trigger signal will determine the rate at which the camera is acquiring lines:

$$\frac{1}{\text{CC1 signal period in seconds}} = \text{Line Rate}$$

For example, if you are operating a camera with a CC1 trigger signal period of 1 μs (0.001 s): So in this case, the line rate is 1 kHz.

Note:

Apply 50% duty cycle to your external trigger when using AnyEdge in the TriggerActivation parameter. By doing this, you will be able to avoid malfunction originated from the different widths of the trigger because of the incorrect setting of the duty cycle. Additionally, it is recommended to use either RisingEdge or FallingEdge rather than AnyEdge in the TriggerRescaler parameter.

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 **TimerOActive**, 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 **TimerOActive**.
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.

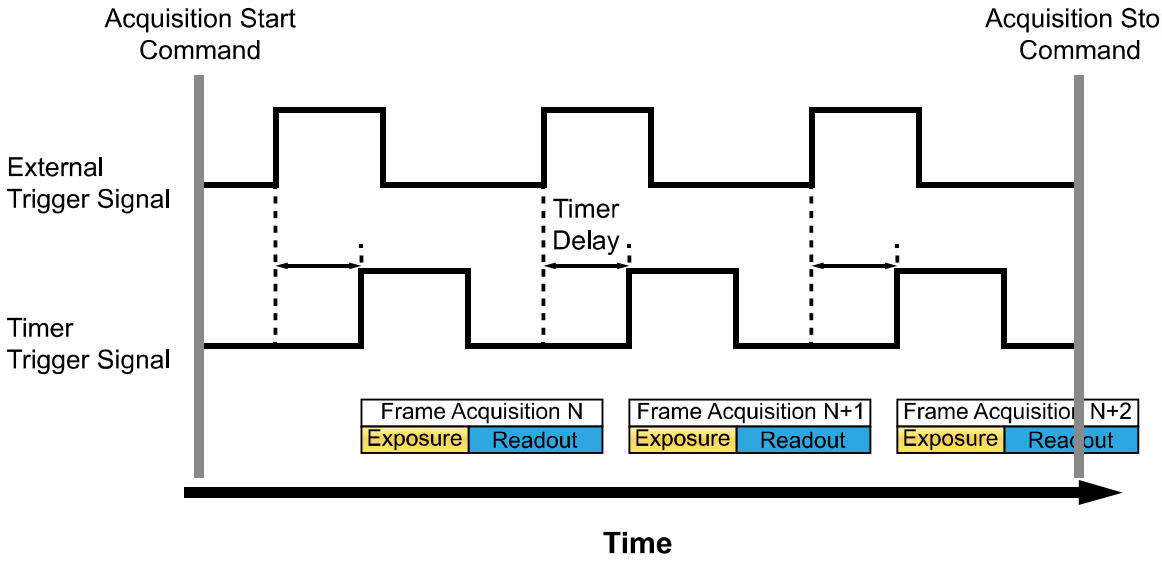


Figure 8-3 External Trigger Delay

8.3.5 Exposure Mode

If you are triggering the start of frame acquisition with an externally (CC1 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.

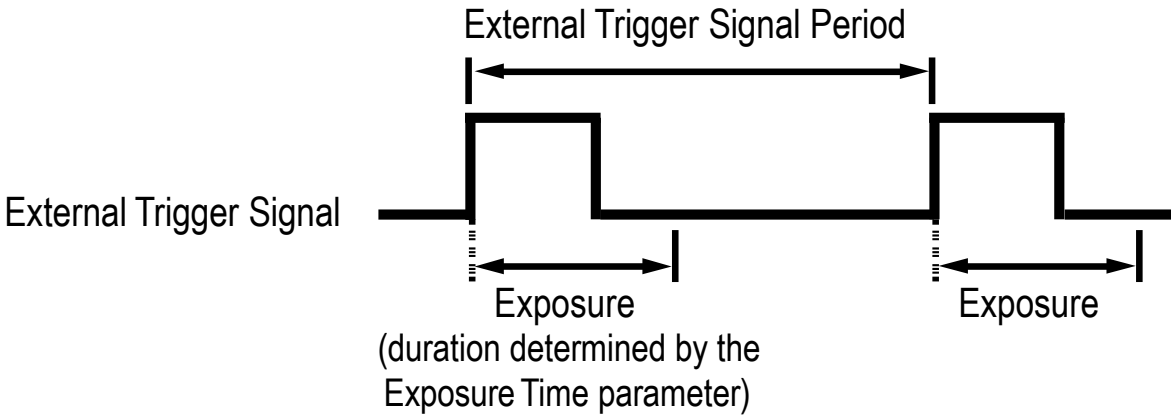


Figure 8-4 Timed Exposure Mode

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.

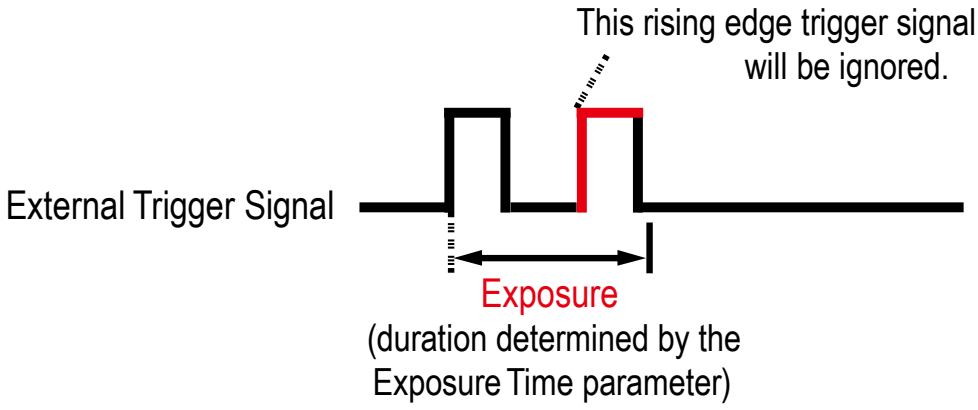


Figure 8-5 Trigger Overlapped with Timed Exposure Mode

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.

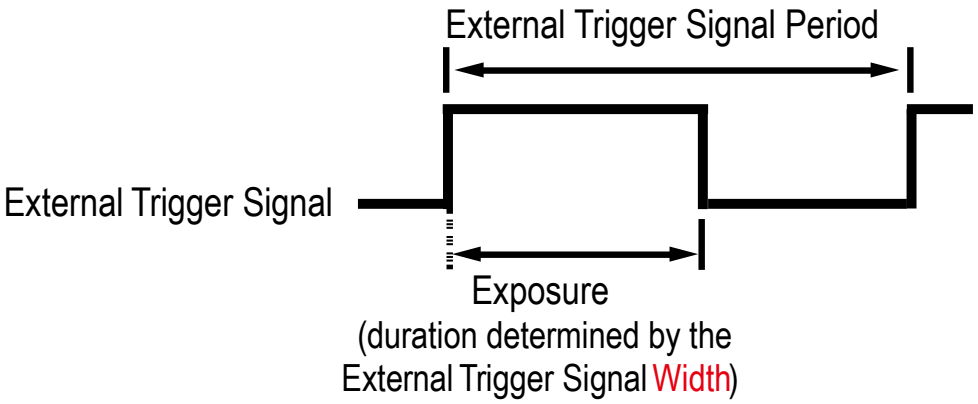


Figure 8-6 Trigger Width Exposure Mode

8.3.6 Short Exposure Mode

The VC-5MC-M/C110H camera provides the **Short Exposure Mode** which allows you to set a shorter exposure time than the normal Exposure Mode. The available setting range of the exposure time (refer to **Table 8-2**) and the **Exposure Offset** values (**Table 8-1**) vary depending on the **Short Exposure Mode** setting.

- Short Exposure Mode = Off: Enables the normal Exposure Mode.
- Short Exposure Mode = Ultra Short: Allows you to set the shortest exposure time by adding the shortest Exposure Offset to the exposure time.

Exposure Mode:

When you set the Short Exposure Mode parameter to Off, both the Timed and Trigger Width exposure mode are available. However, with the Short Exposure Mode set to Ultra Short, the Timed exposure mode is only available.

8.3.7 Exposure Offset

The VC-5MC-M/C110H 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.

Short Exposure Mode	Exposure Offset
Off (Normal Exposure Mode)	2.47 μs
Ultra Short	0 μs

Table 8-1 Exposure Offset

For example, if you want to set an exposure time to about 300 μs under setting **Short Exposure Mode** to **Off**, set the **Exposure Time** parameter to 297.53 μs (300 – 2.47 = 297.53) or use 270 μs as the high or low time for the external trigger signal.

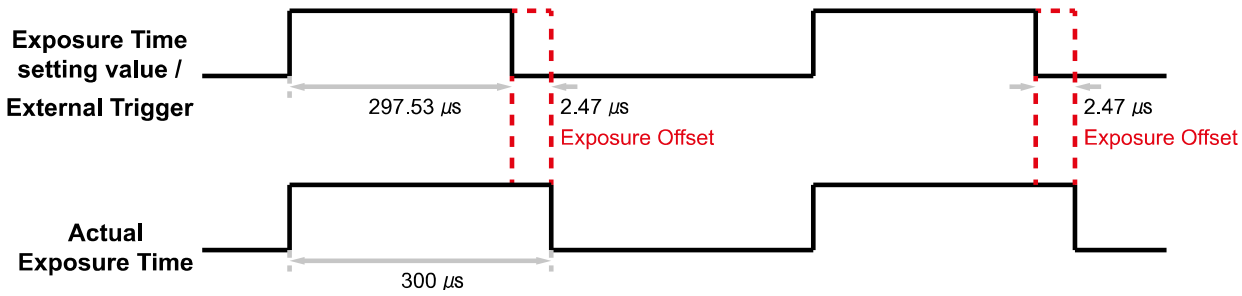


Figure 8-7 Setting Exposure Time to compensate for the Exposure Offset

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 User Output0, Link Trigger0, Timer0 Active, Line0 or CC1, and the Exposure Mode is set to Timed.

The VC-5MC-M/C110H camera adds an Exposure Offset (refer to Table 8-1) 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.

Short Exposure Mode	Minimum Exposure Time	Maximum Exposure Time
Off (Normal Exposure Mode)	4.13 μs	60,000,000 μs†
Ultra Short	1.02 μs	32.27 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-5MC-M/C110H 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 **Trigger Width**.

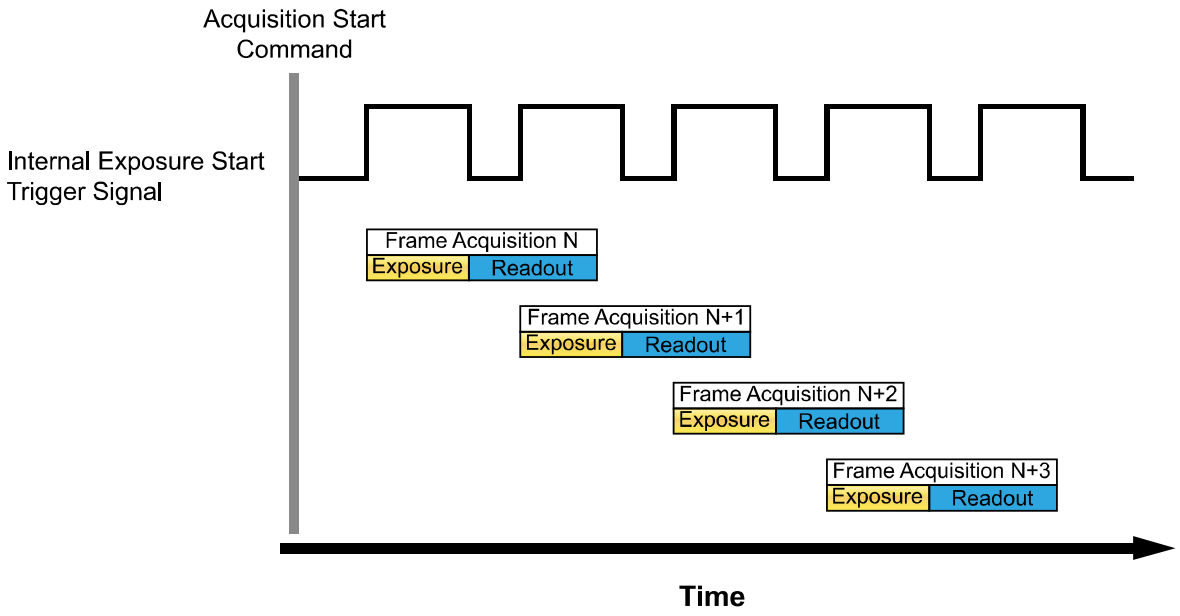


Figure 8-8 Overlapped Exposure and Readout

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-5MC-M/C110H 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-5MC-M/C110H 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 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 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.

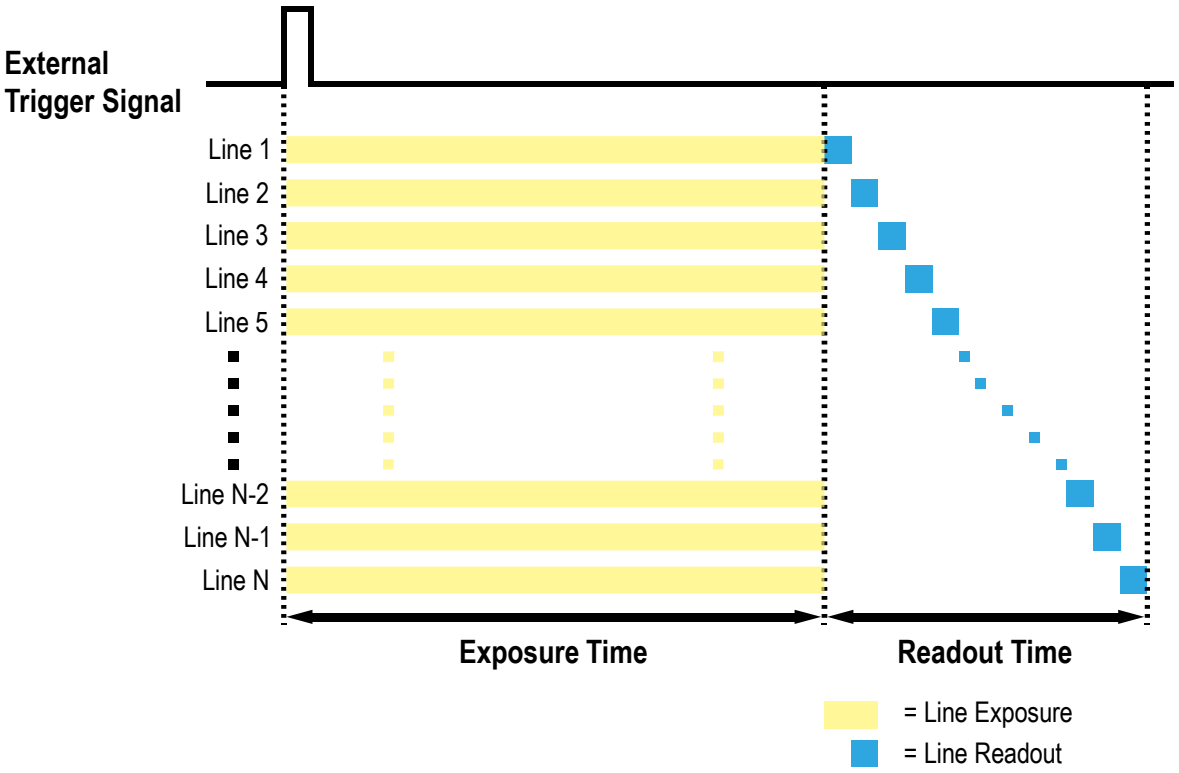


Figure 8-9 Global Shutter

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.
- Camera Link Tap Configuration (Tap Mode) Settings
  When the camera is set for a Tap Mode that uses more taps, it will take less time to transfer acquired images from the camera to the Camera Link frame grabber in your computer. For example, if the camera is set to 8 Tap (Camera Link Full Configuration), it can typically transfer data out of the camera two times faster than when the camera is set to 4 Tap (Camera Link Medium).
- 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 Device Tap Geometry with a low number of taps, consider using a Device Tap Geometry with a high number of taps. 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 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 ROI is referenced to the top left corner [origin (0, 0)] of the sensor array as shown below.

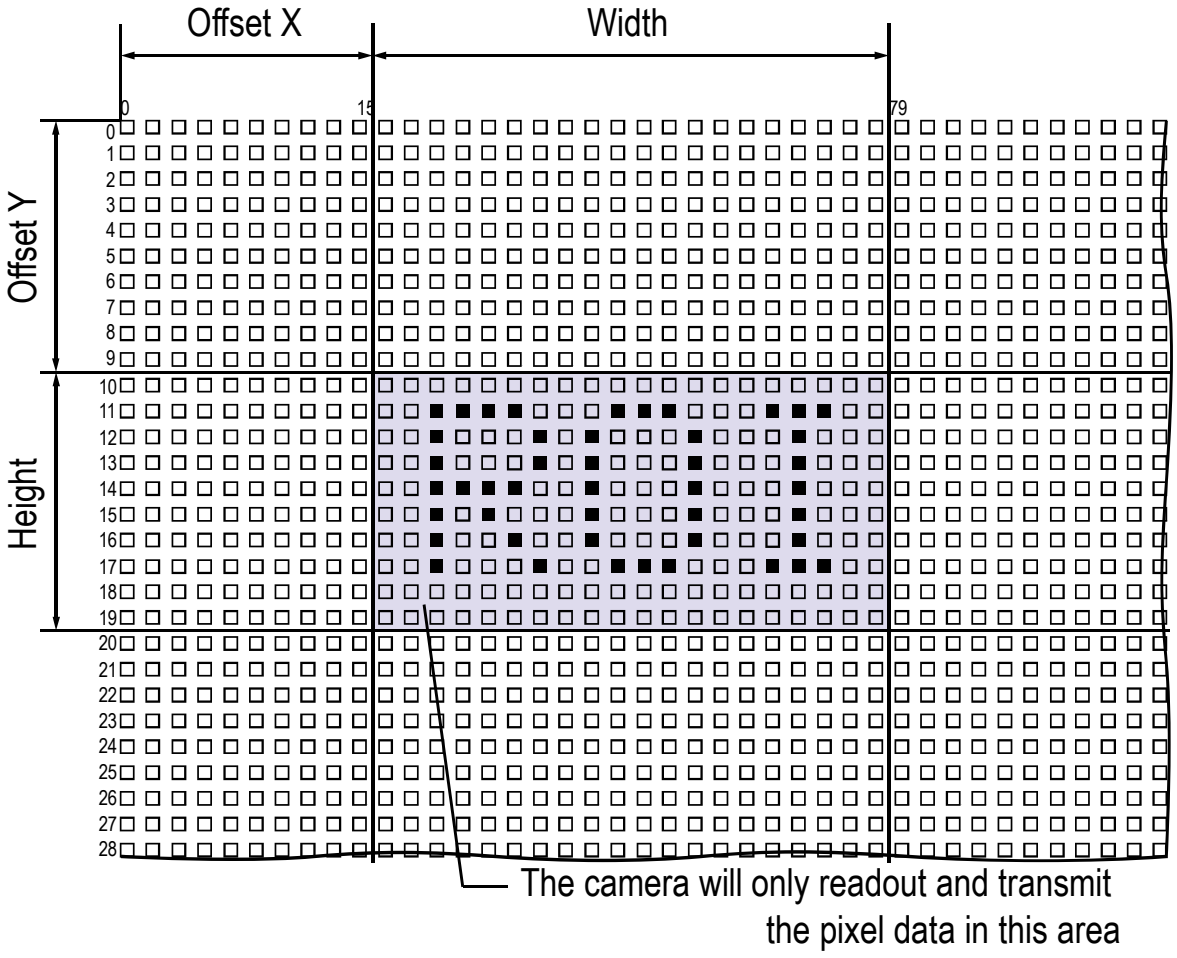


Figure 9-1 Region of Interest

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[a]	-	Maximum allowed width of the image with the current camera settings
	HeightMax[a]	-	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-5MC-M/C110H camera, both the Width and Height parameters must be set to a multiple of 8.

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

Camera Model	Minimum Width Settings	Minimum Height Settings
VC-5MC-M/C110H	8	16

Table 9-2 Minimum ROI Width and Height Settings

On the VC-5MC-M/C110H camera, the maximum allowed frame rates depending on Horizontal and Vertical ROI changes are shown below, the values shown below are based on Pixel Format of 8 bit.

ROI Size (H × V)	2 Tap	4 Tap	8 Tap	10 Tap
2448 × 2048	31.0 fps	61.2 fps	109.5 fps	109.5 fps
8 × 2048	109.5 fps	109.5 fps	109.5 fps	109.5 fps
800 × 2048	92.3 fps	109.5 fps	109.5 fps	109.5 fps
1600 × 2048	47.1 fps	92.3 fps	109.5 fps	109.5 fps
2448 × 16	389.1 fps	768.4 fps	1374.1 fps	1374.1 fps
2448 × 160	214.0 fps	422.6 fps	755.8 fps	755.8 fps
2448 × 480	107.0 fps	211.3 fps	377.9 fps	377.9 fps
2448 × 960	61.1 fps	120.7 fps	215.9 fps	215.9 fps
2448 × 1440	42.8 fps	84.5 fps	151.1 fps	151.1 fps
2448 × 1920	32.9 fps	65.0 fps	116.2 fps	116.2 fps

Table 9-3 Maximum Frame Rates by ROI Changes

Caution!

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

9.2 Multi-ROI

The VC-5MC-M/C110H camera provides the Multi-ROI feature which allows you to define up to 8 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	8 - 2448	Width setting for the selected ROI
	MultiRoiHeight	16 - 2048	Height setting for the selected ROI
	MultiRoiOffsetX	0 - 2448	Horizontal offset from the origin to the selected ROI
	MultiRoiOffsetY	0 - 2048	Vertical offset from the origin to the selected ROI
	MultiRoiValid[a]	-	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:

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

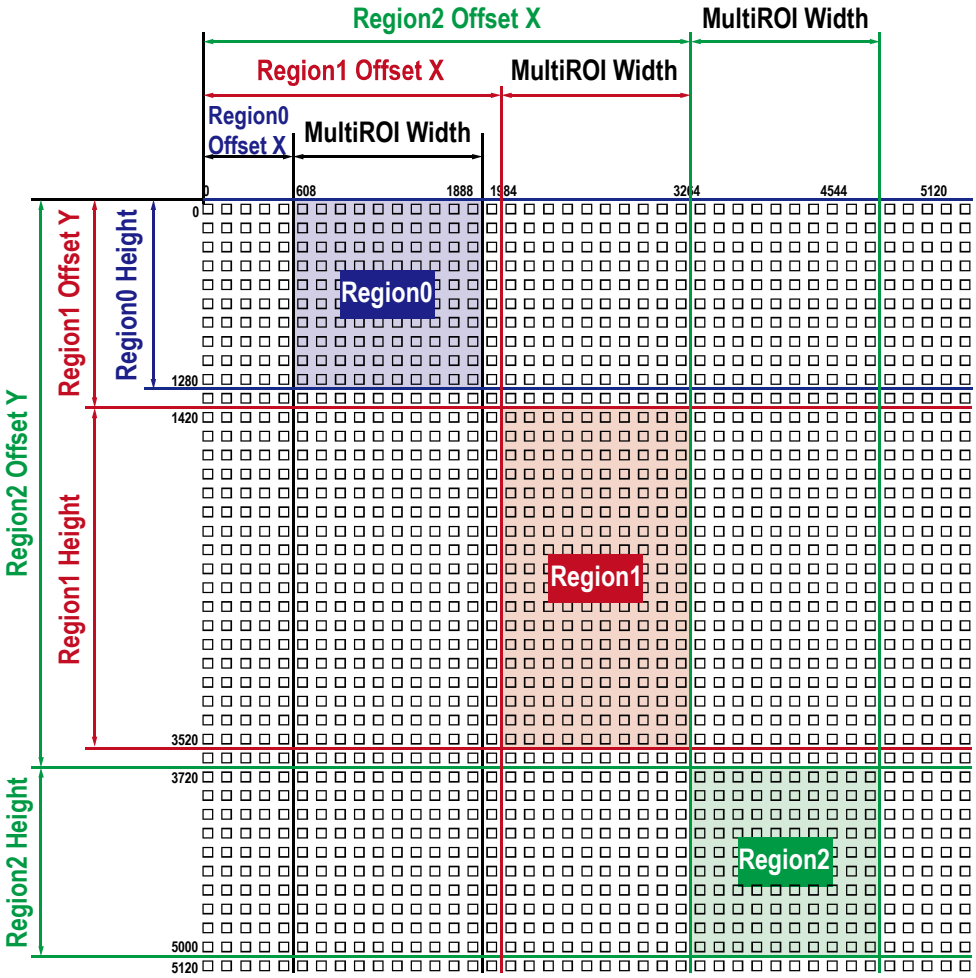


Figure 9-2 Multi-ROI

There are several things to keep in mind when setting the Multi-ROI feature on the VC-5MC-M/C110H camera:

- The sum of the MultiRoiOffsetX value plus the MultiRoiWidth value must not exceed the width of the camera's sensor.
- The sum of the MultiRoiOffsetY value plus the MultiRoiHeight value must not exceed the height of the camera's sensor.
- The MultiRoiOffsetX and MultiRoiWidth value must be a multiple of 8.
- The MultiRoiOffsetY and MultiRoiHeight value must be a multiple of 8.
- The MultiRoiWidth 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 9.24 User Set Control.

9.3 Device Tap Geometry

The VC-5MC-M/C110H camera supports 2 Tap, 4 Tap, 8 Tap and 10 Tap Device Tap Geometry. The number of taps represents the number of pixel data that will be output on each cycle of the Camera Link Pixel Clock. The maximum allowed frame rate will be changed according to the Device Tap Geometry settings. The image data is transmitted in the interleaved order as shown in the figure below.

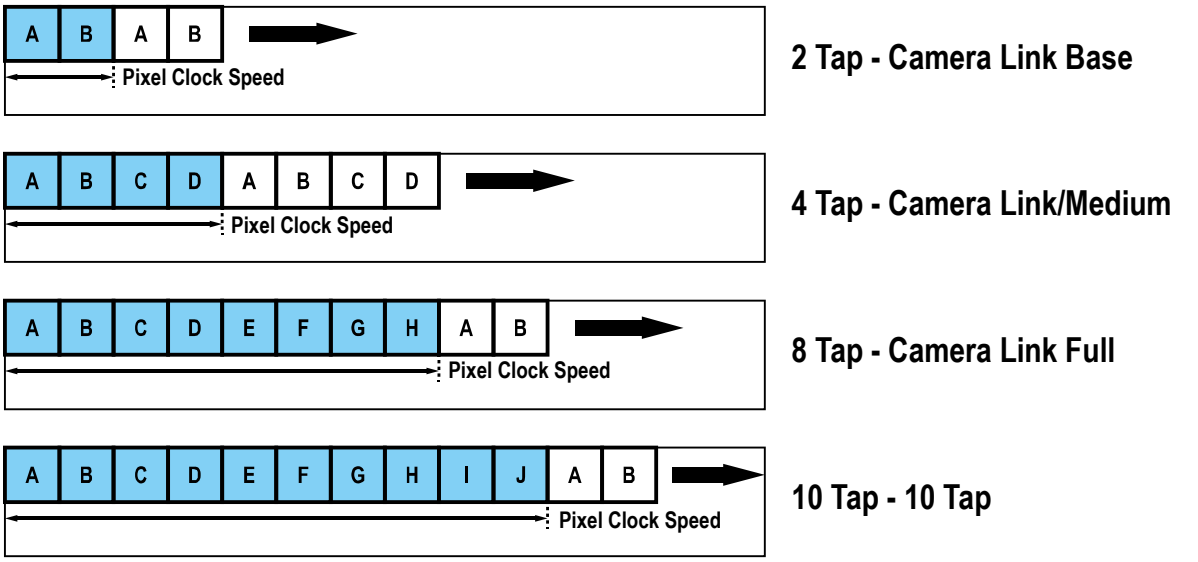


Figure 9-3 Device Tap Geometry

The XML parameter related to Device Tap Geometry is as follows.

XML Parameters		Value	Description
TransportLayer Control	DeviceTapGeometry	Geometry_1X2_1Y	Sets the Device Tap Geometry to 2 Taps
		Geometry_1X4_1Y	Sets the Device Tap Geometry to 4 Taps
		Geometry_1X8_1Y	Sets the Device Tap Geometry to 8 Tap
		Geometry_1X10_1Y	Sets the Device Tap Geometry to 10 Tap

Table 9-5 XML Parameter related to Device Tap Geometry

9.4 Camera Link Pixel Clock Speed

The VC-5MC-M/C110H camera features selectable Camera Link Pixel Clock speeds. The Pixel Clock speed determines that the rate at which pixel data will be transmitted from the camera to the Frame Grabber in your computer via the Camera Link interface. Setting the camera for a higher Pixel Clock speed will increase the rate at which image data is transferred from the camera to the Frame Grabber. Before setting the camera's Pixel Clock speed, make sure you determine the maximum Pixel Clock speed supported by your Frame Grabber. Then, you should not attempt to set the camera's Pixel Clock speed that exceeds the maximum Pixel Clock speed for your Frame Grabber.

The commands related to Camera Link Pixel Clock speed and the available Pixel Clock speeds are as follows.

Command		Value	Description
Camera Link Pixel Clock Speed	Clock0	85	Sets the Camera Link Pixel Clock Speed to 85 ㎒.
	Clock1	65	Sets the Camera Link Pixel Clock Speed to 65 ㎒.
	Clock2	48	Sets the Camera Link Pixel Clock Speed to 48 ㎒.
	Clock3	32.5	Sets the Camera Link Pixel Clock Speed to 32.5 ㎒.

Table 9-6 Commands related to Camera Link Pixel Clock Speed

9.5 Pixel Format

The VC-5MC-M/C110H 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.

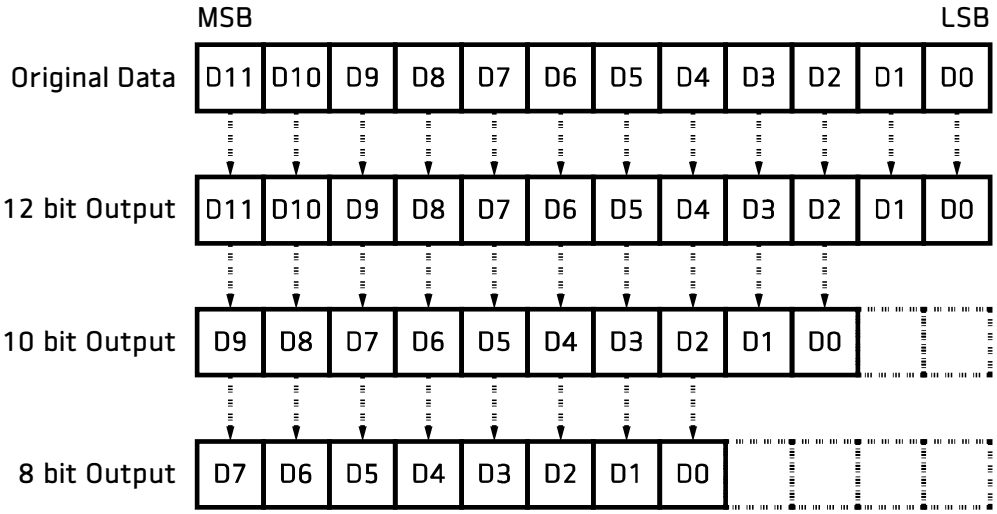


Figure 9-4 VC-5MC-M/C110H' Pixel Format

The XML parameter related to Pixel Format is as follows.

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

Table 9-7 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 RG 8 Bayer RG 10 Bayer RG 12

Table 9-8 Pixel Format Values

9.6 Data ROI (Color Camera)

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

XML Parameters		Value	Description
DataRoiControl	RoiSelector	WhiteBalanceAuto	Selects a Data ROI used for Balance White Auto. Only available on the color camera
	RoiOffsetX	-	X coordinate of start point ROI
	RoiOffsetY	-	Y coordinate of start point ROI
	RoiWidth	-	Width of ROI
	RoiHeight	-	Height of ROI

Table 9-9 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.

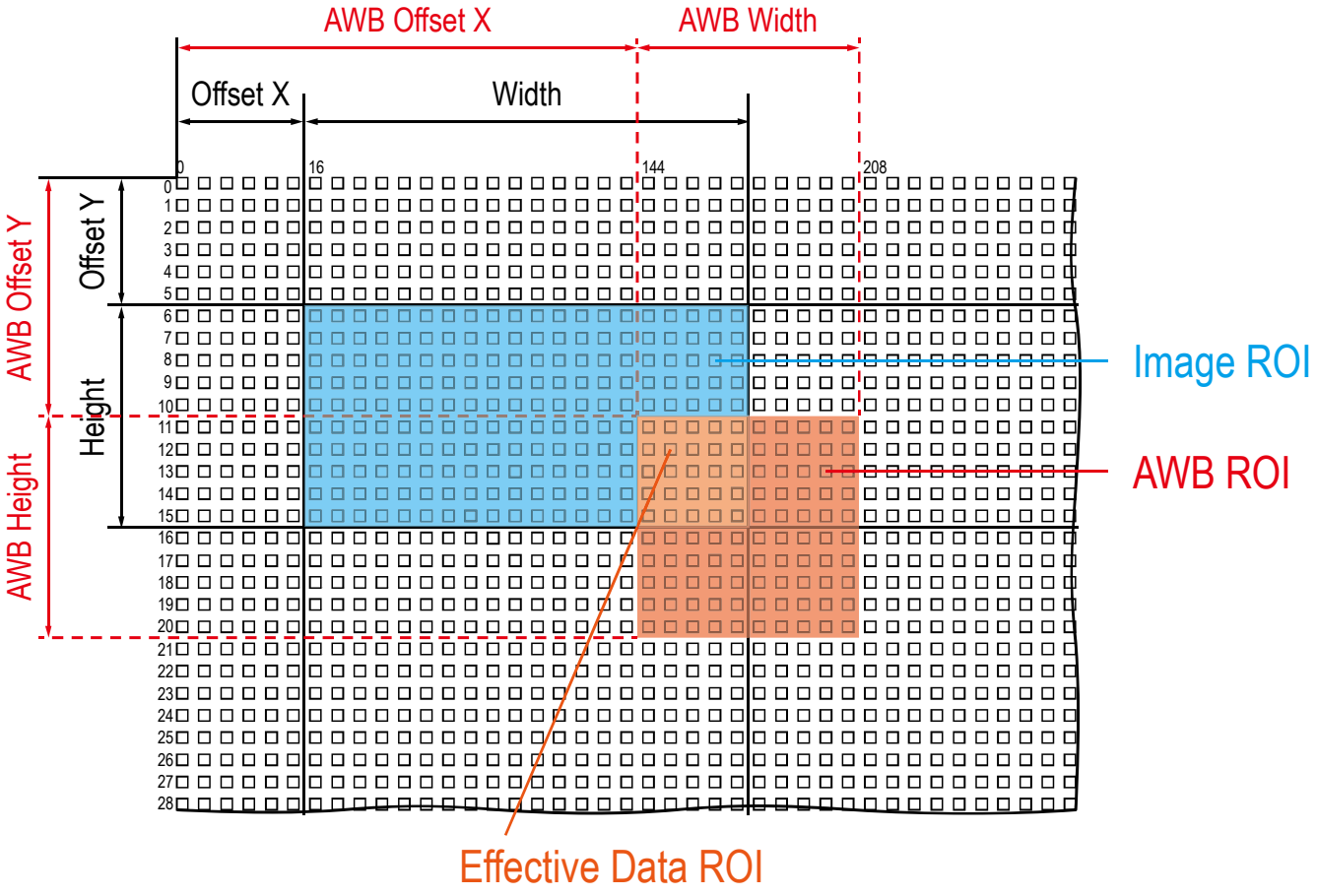


Figure 9-5 Effective Data ROI

9.7 White Balance (Color Camera)

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 9-10 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 9-11 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 (**Digital All** is only available) 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 available setting range varies depending on the **Pixel Format** settings.

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

XML Parameters		Value	Description
Analog Control	GainSelector	Digital All	Applies the Gain value to all digital channels.
	Gain	1.0× — 32.0×	Sets a digital gain value.
	BlackLevel Selector	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 9-12 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.

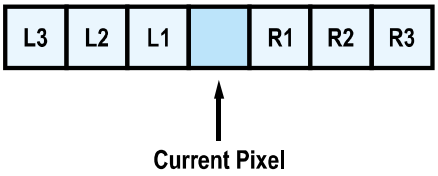


Figure 9-6 Location of Defect Pixel to be corrected

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 9-13 Calculation of Defect Pixel Correction Value

9.10 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-5MC-M/C110H 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.

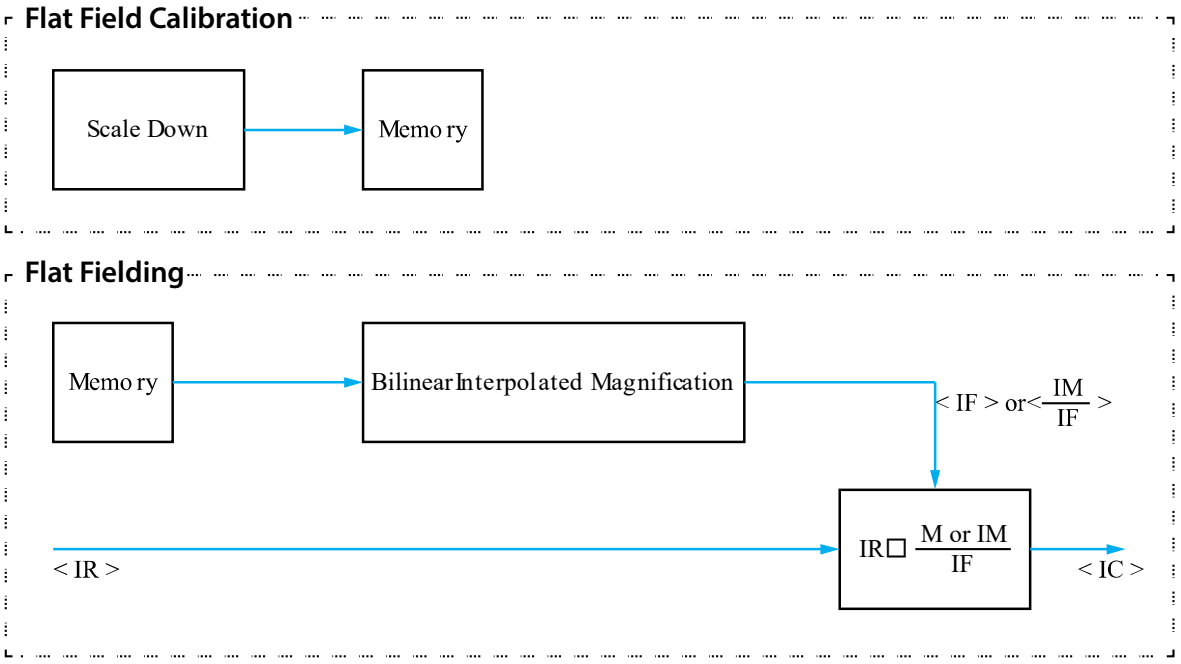


Figure 9-7 Generation and Application of Flat Field Data

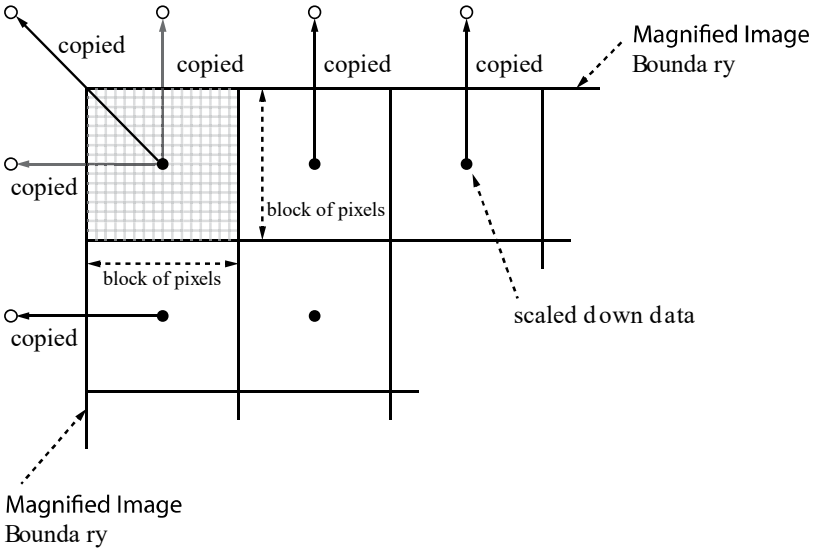


Figure 9-8 Bilinear Interpolated Magnification

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

XML Parameters		Value	Description
FlatFieldControl	FlatFieldCorrection	Off	Disables the Flat Field Correction feature.
		On	Enables the Flat Field Correction feature.
	FlatFieldData Selector	Space0 - Space11	Selects a location to save Flat Field data to or load Flat Field data from. Space0~Space11: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 9-14 XML Parameters related to Flat Field Correction

9.10.1 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-5MC-M/C110H camera provides twelve 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.

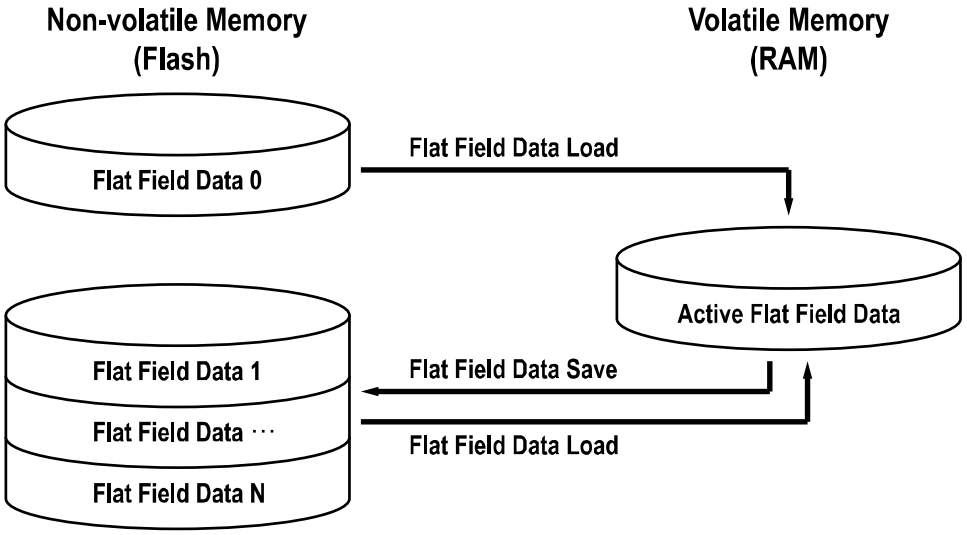


Figure 9-9 Flat Field Data Selector

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.

9.11 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 items related to the pins of No.2 and No.3 among 6 of the pins.
		Line1	Configures the items related to the pin No.4 among 6 of the pins.
	LineMode	Input	Appears under Line0 is chosen.
		Output	Appears under Line1 is chosen.
	LineInverter	FALSE	Disables inversion on the output signal of the line.
		TRUE	Enables inversion on the output signal of the line.
	LineSource	Off	Disables the line output.
		Frame Active	Outputs pulse signals indicating a frame readout time.
		LineActive	Outputs pulse signals indicating a line readout 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.
		Count0 Active	Outputs user-defined Counter signals as pulse signals
	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 9-15 XML Parameters related to Digital I/O Control

When you set the **Line Source** to **User Output0**, you can use the user setting values as output signals.

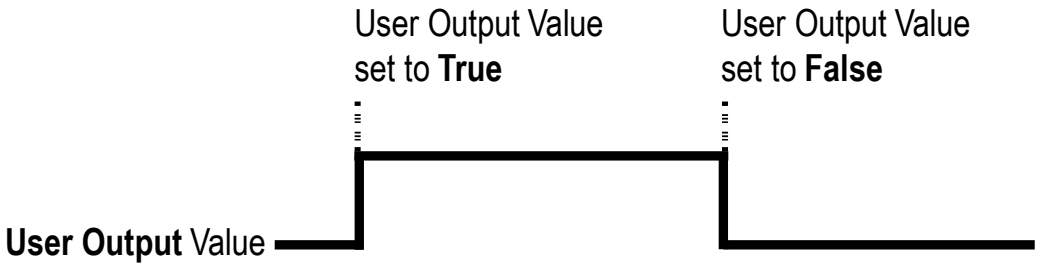


Figure 9-10 User Output

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.

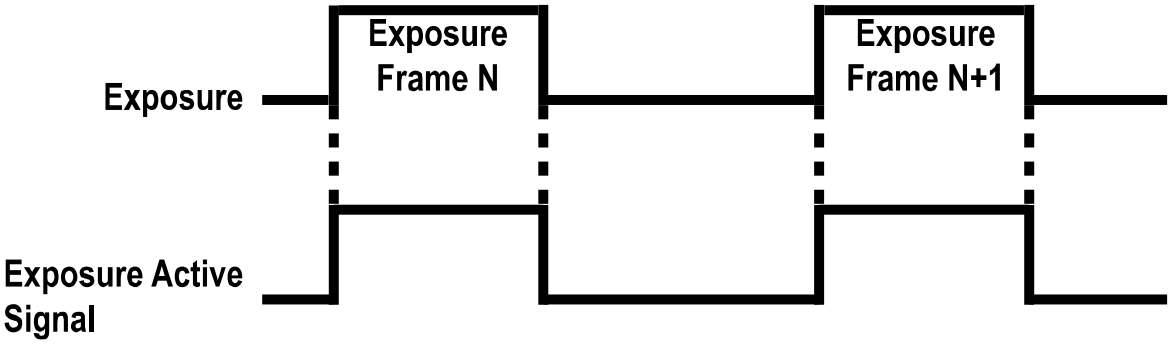


Figure 9-11 Exposure Active Signal

9.12 Debounce

The Debounce feature of the VC-5MC-M/C110H 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.

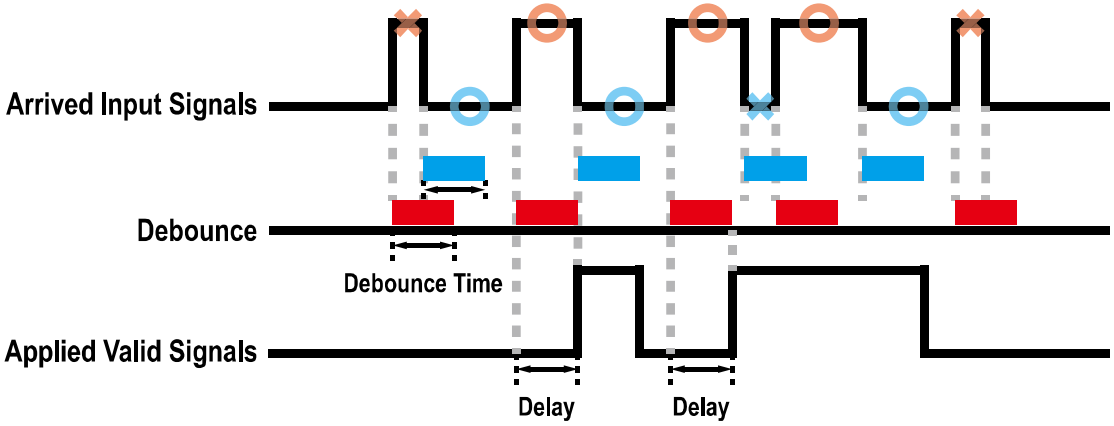


Figure 9-12 Debounce

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

9.13 Timer Control

When the **Line Source** parameter is set to **Timer0Active**, the camera can provide output signals by using the Timer. On the VC-5MC-M/C110H camera, the Frame Active, Exposure Active event or external trigger signal is available as Timer source signal.

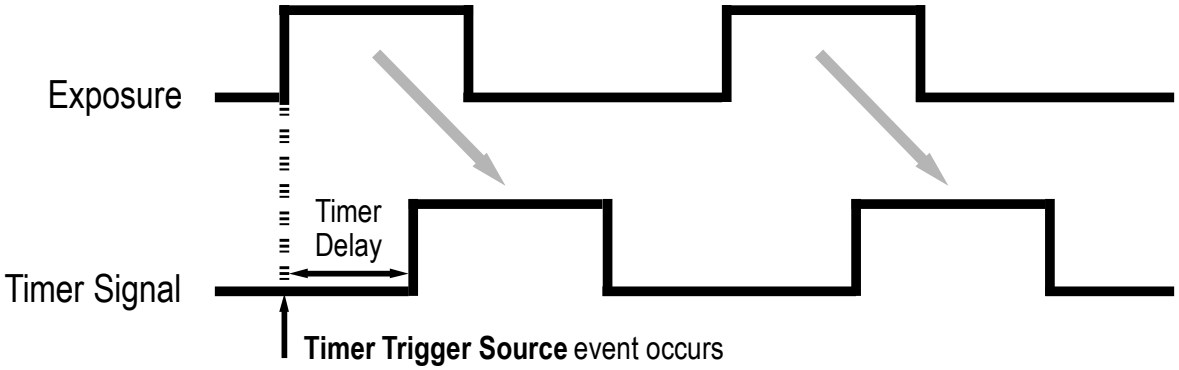
The XML parameters related to Timer are as follows.

XML Parameters		Value	Description
CounterAnd TimerControl	TimerDuration	1 ~ 60,000,000 *μs*	Sets the duration of the Timer output signal to be used when Timer Trigger Activation is set to Rising/Falling Edge.
	TimerDelay	0 ~ 60,000,000 *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.
		CC1	Sets the CC1 signal to use as the source signal of the Timer output signal.
		Line0	Sets the Timer to use the external trigger signal as the source signal.
		Counter0Start	Sets the Timer to use the Counter0 signal as the source signal.
	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.
		AnyEdge	Specifies that a rising edge or 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 9-17 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 9-13 Timer Signal

9.14 Counter Control

The VC-5MC-M/C110H camera provides the Counter feature to count certain camera events. For example, you can verify the number of external trigger signals applied to the camera.

The XML parameters related to Counter Control are as follows.

XML Parameters		Value	Description
CounterAnd TimerControl	CounterSelector	Counter0	Selects a Counter to configure.
	CounterEventSource	Off	Stops the Counter.
		FrameActive	Counts the number of Frame Active signals.
		LineActive	Counts the number of Line Active signals.
		Exposure Active	Counts the number of Exposure Active signals.
		CC1	Counts the number of CC1 signals.
		Line0	Counter the number of external trigger signals.
	CounterEvent Activation	RisingEdge	Counts on the rising edge of the selected Event Source signal.
		FallingEdge	Counts on the falling edge of the selected Event Source signal.
	CounterResetSource	Off	Disables the Counter Reset trigger.
		Frame Active	Uses the Frame Active signal as Reset Source.
		Exposure Active	Uses the Exposure Active signal as Reset Source.
		Acquisition Active	Uses the Acquisition Active signal as Reset Source.
		Line0	Uses the Line0 signal as Reset Source.
	CounterReset Activation	RisingEdge	Resets Counter on the rising edge of the selected Reset Source signal.
		FallingEdge	Resets Counter on the falling edge of the selected Reset Source signal.
		AnyEdge	Resets Counter on the rising/falling edge of the selected Reset Source signal.
		LevelHigh	Resets the Counter if the level of the selected Reset Source signal is High.
		LevelLow	Resets the Counter if the level of the selected Reset Source signal is Low.
	CounterReset	-	Resets the selected Counter and restarts.
	CounterValue	-	Displays the current value of the selected Counter.
	CounterValue AtReset	-	Displays the value of the Counter when it was reset by the Counter Reset command.

Table 9-18 XML Parameters related to Counter Control #1

XML Parameters		Value	Description
CounterAnd TimerControl	CounterDuration	1 – 4294967295	Sets the duration or number of events to count before the Counter ends.
	CounterStatus	-	Displays the current status of the Counter.
	CounterTrigger Source	Off	Disables the Counter Trigger Source function.
		Frame Active	Uses the Frame Active signal as Trigger Source of Counter.
		Exposure Active	Uses the Exposure Active signal as Trigger Source of Counter.
		Acquisition Active	Uses the Acquisition Active signal as Trigger Source of Counter.
		Line0	Uses the Line0 signal as Trigger Source of Counter.
	CounterTrigger Activation	RisingEdge	Starts Counter on the rising edge of the selected Counter Trigger Source signal.
		FallingEdge	Starts Counter on the falling edge of the selected Counter Trigger Source signal.
		AnyEdge	Starts Counter on the rising/falling edge of the selected Counter Trigger Source signal.
		LevelHigh	Resets the Counter if the level of the selected Counter Trigger Source signal is High.
		LevelLow	Resets the Counter if the level of the selected Counter Trigger Source signal is Counter.

Table 9-19 XML Parameters related to Counter Control #2

9.15 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 9-20 XML Parameters related to Device Temperature

9.16 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.
Fast Flashing Orange	The camera is transmitting image data.
Steady Green	A Camera Link stands by.

Table 9-21 Status LED

9.17 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
ImageFormatControl	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 9-22 XML Parameter related to Test Pattern

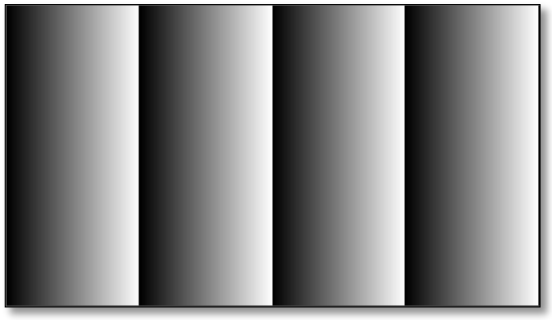


Figure 9-14 Grey Horizontal Ramp

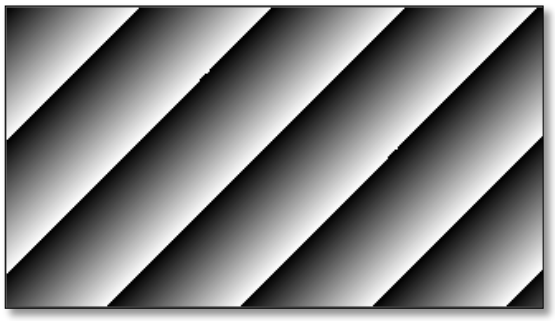


Figure 9-15 Grey Diagonal Ramp

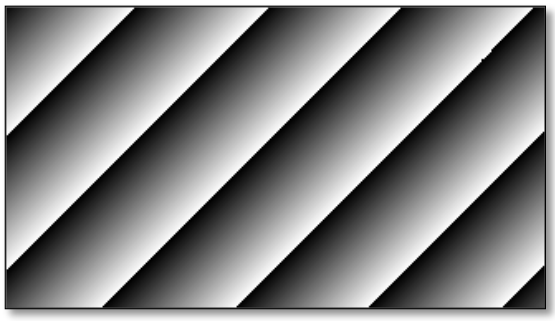


Figure 9-16 Grey Diagonal Ramp Moving

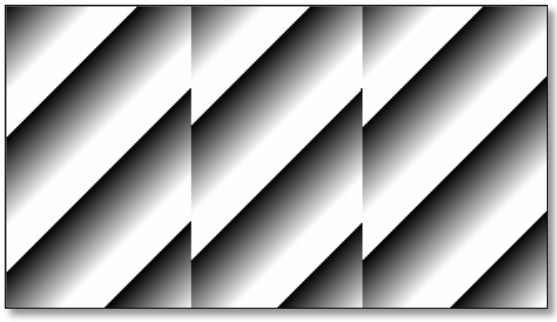


Figure 9-17 Sensor Specific

Caution!

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

9.18 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 9-23 XML Parameter related to Reverse X

Figure 9-18 Original Image

Figure 9-19 Reverse X Image

9.19 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 Parameters		Value	Description
ImageFormatControl	ReverseY	FALSE	Disables the Reverse Y feature.
		TRUE	Flips images vertically.

Table 9-24 XML Parameter related to Reverse Y

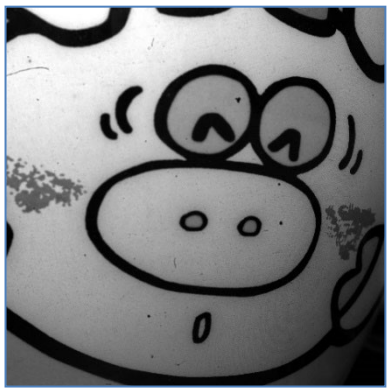


Figure 9-20 Original Image

Figure 9-21 Reverse Y Image

Caution!

After using the Reverse Y feature, you must generate the camera's correction data (FFC) again, from the beginning.

9.20 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 9-25 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-5MC-M/C110H, its maximum value is 1700.

9.21 Device User ID

You can input user-defined information up to 64 bytes.

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

XML Parameter		Description
DeviceControl	DeviceUserID	Input user-defined information (64 bytes).

Table 9-26 XML Parameter related to Device User ID

9.22 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 9-27 XML Parameter related to Device Reset

9.23 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.

9.24 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 9-28 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.

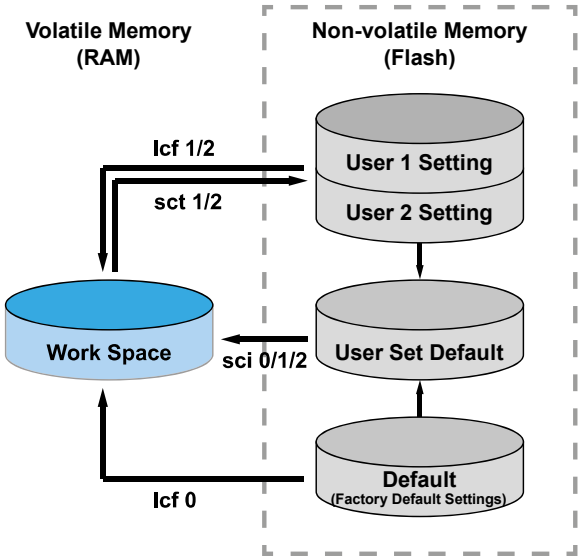


Figure 9-22 User Set Control

Chapter 10. Camera Configuration

10.1 Serial Communication

You can configure all camera settings via RS-644 serial communication of the Camera Link interface. When you want to control the camera by using a terminal or access directly to the camera by using your application, you need to set your network as follows:

- Baud Rate: 115200 bps
- Data Bit: 8 bit
- Parity Bit: No parity
- Stop Bit: 1 stop bit
- Flow Control: None

10.2 Actual Runtime of Parameters

When you set a parameter, the actual runtime of the parameter varies depending on the type of the parameter and the operating status of the camera. All parameters except the Exposure Time parameter are applied to change the camera settings as illustrated below, on the rising edge of a REQ_Frame signal before starting the readout process. When you change the Exposure Time parameter, the exposure time setting will be changed and applied at the starting of the exposure.

If you operate the camera with the **Trigger Mode** parameter set to **On**, you must change parameters before applying the trigger signals in order to synchronize image outputs with the parameters. If you change a parameter in the Free-Run mode, you may acquire up to two lines that are not affected by the parameter change. This is true because it is hard to verify the current operating status of the camera in the Free-Run mode.

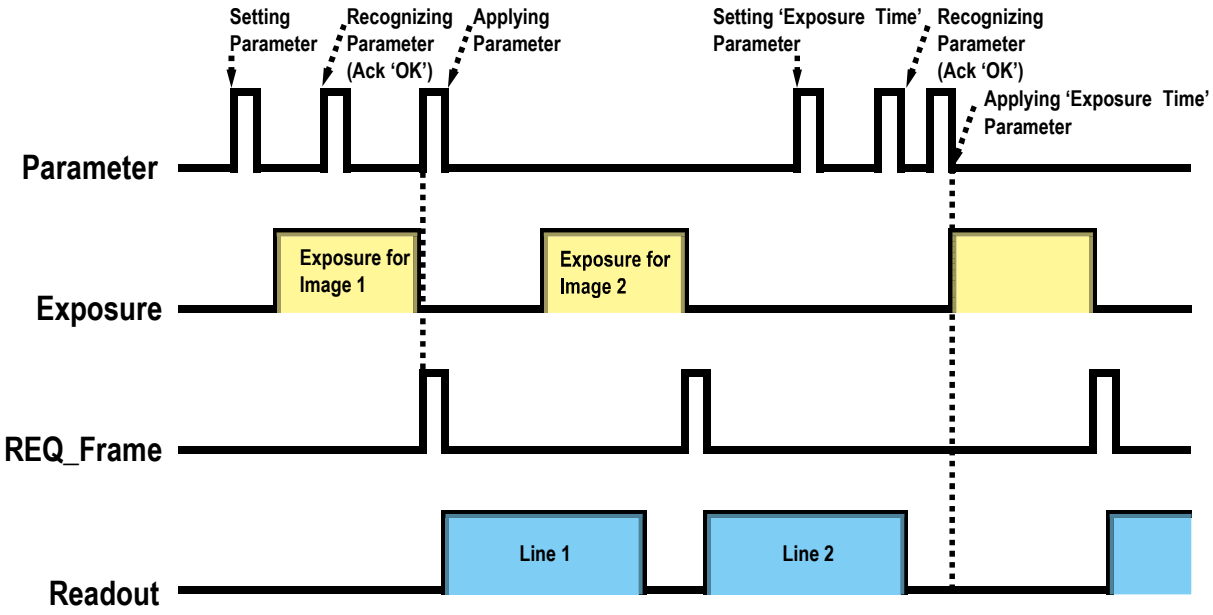


Figure 10-1 Actual Runtime of Parameters

10.3 Configurator

The Configurator, a sample application, is provided to control Vieworks Camera Link cameras. The Configurator allows you to change the camera's parameters and control the camera.

10.3.1 Starting the Configurator

After connecting the camera to your computer (refer to **Chapter 6 Connecting the Camera**), you can run the Configurator by following the procedure below.

1. Execute the **Configurator.exe** file after the camera is powered on. The **Camera Scan** window appears.
2. The **Configurator** probes if a camera is connected to your computer and then displays the model name of the connected camera in the **Camera Scan** window.
3. Right-click the model name of the camera, and then click the **Add to List** menu. By adding a Vieworks Camera Link camera which supports XML-based control to the list, you can configure the camera with a newer version of the **Configurator**.

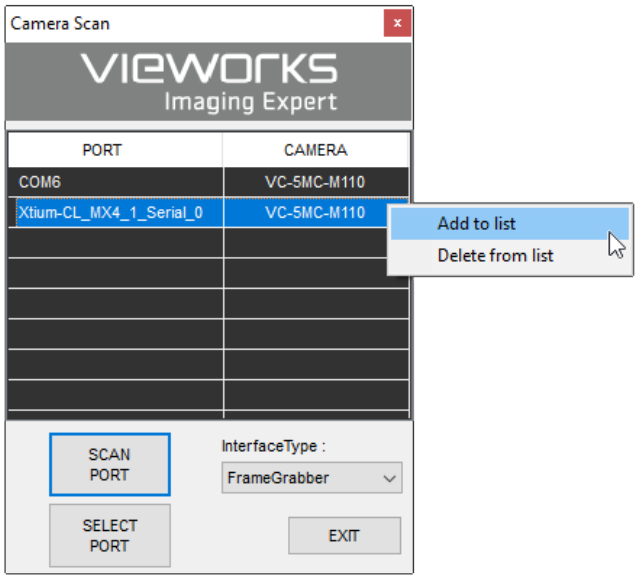


Figure 10-2 Add to list in the Camera Scan window

4. Double-click the model name of the camera. The **DeviceProperty** and **Configurator Plus** windows appear.

   The **DeviceProperty** window displays controls for setting camera parameters.

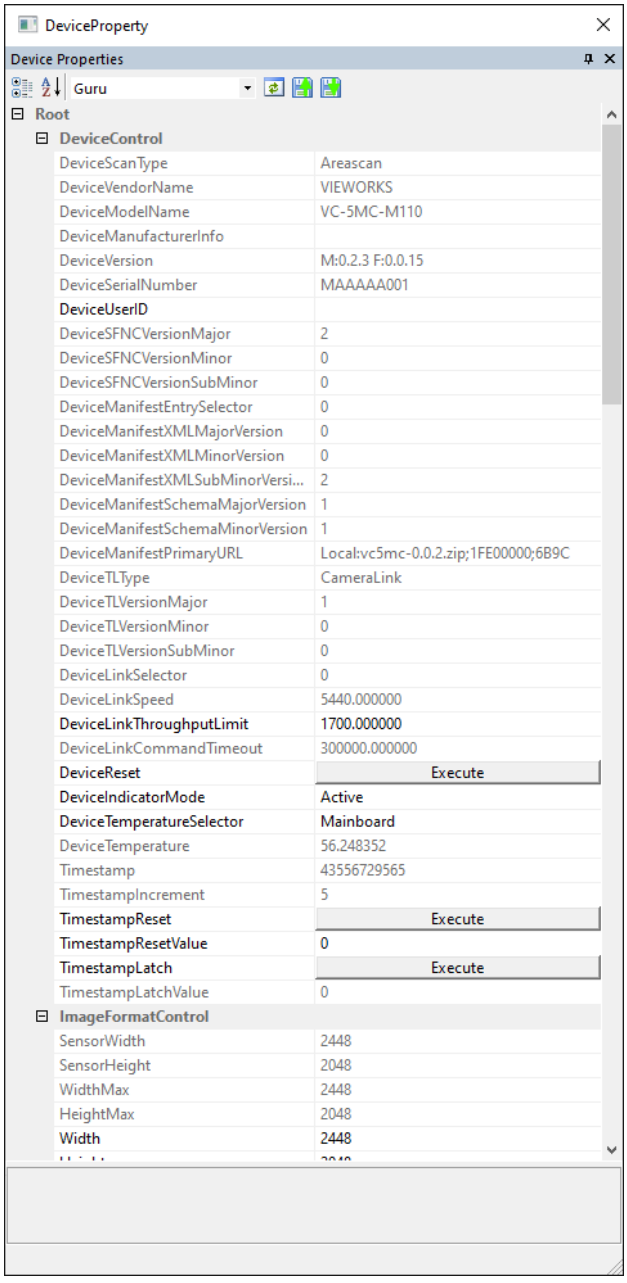


Figure 10-3 Device Property

In the **Configurator Plus** window, you can display the **Device Property** and/or **Device Maintenance** windows. In the **Device Maintenance** window, you can download a Defective Pixel Map or upgrade camera's MCU, FPGA and XML files.

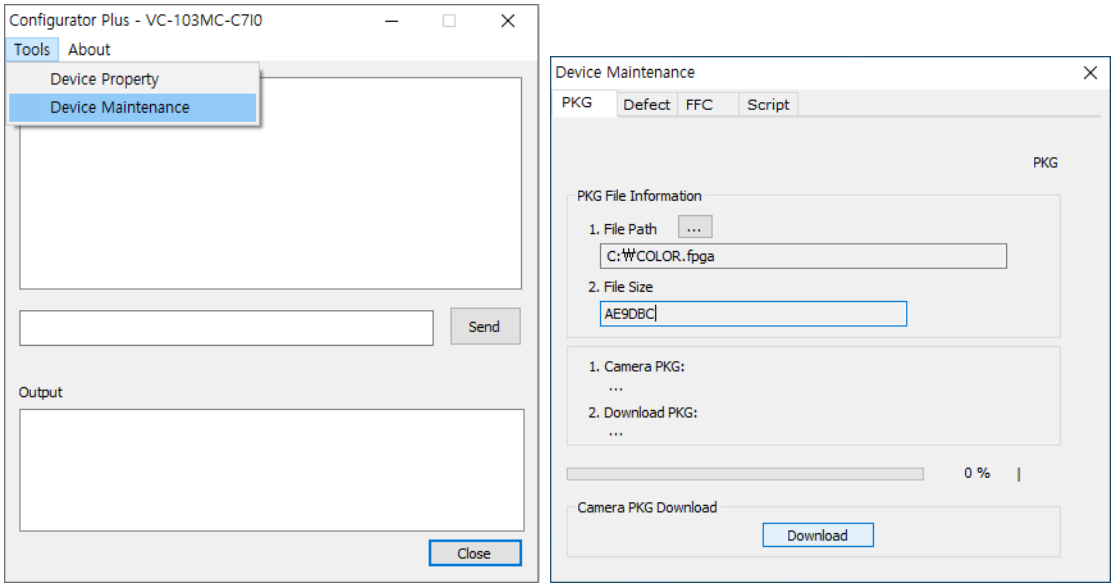


Figure 10-4 Configurator Plus and Device Maintenance

10.4 Command List

You can also set all features provided by the VC-5MC-M/C110H cameras by using the following commands.

Command	Syntax	Return Value	Description
Help	help	String	Displays a list of all commands.
Set ROI Offset X Get ROI Offset X	sox n gox	OK n	X coordinate of start point ROI n: X axis offset
Set ROI Offset Y Get ROI Offset Y	soy n goy	OK n	Y coordinate of start point ROI n: Y axis offset
Set Image Width Get Image Width	siw n giw	OK n	Sets a width of the Image ROI. n: Width value
Set Image Height Get Image Height	sih n gih	OK n	Sets a height of the Image ROI. n: Height value
Set Region Selector Get Region Selector	srs n grs	OK n	Selects a ROI to set when setting the Multi-ROI. n: Index number of a ROI
Set Region Mode Get Region Mode	src 0|1 grc	OK 0|1	Enables / Disables the selected ROI when setting the Multi-ROI. 0: Disables the selected ROI. 1: Enables the selected ROI.
Set Region Offset X Get Region Offset X	srx n grx	OK n	Sets a horizontal offset from the origin to the selected ROI when setting the Multi-ROI. n: X axis offset
Set Region Offset Y Get Region Offset Y	sry n gry	OK n	Sets a vertical offset from the origin to the selected ROI when setting the Multi-ROI. n: Y axis offset
Set Region Width Get Region Width	srw n grw	OK n	Sets a width for the selected ROI when setting the Multi-ROI. n: Width value
Set Region Height Get Region Height	srh n grh	OK n	Sets a height for the selected ROI when setting the Multi-ROI. n: Height value
Set Binning Selector Get Binning Selector	sbns 0 gbns	OK 0	Selects the Binning engine. 0: Sensor
Set Binning Horizontal Mode Get Binning Horizontal Mode	sbhm 0 gbhm	OK 0	Updates automatically according to the Binning Vertical Mode 0: Sum
Set Binning Horizontal Get Binning Horizontal	sbh 1|2 gbh	OK 1|2	Updates automatically according to the Binning Vertical. 1|2: ××1, ××2
Set Binning Vertical Mode Get Binning Vertical Mode	sbvm 0 gbvm	OK 0	Sets the Binning Mode to apply to the Binning Vertical. 0: Sum
Set Binning Vertical Get Binning Vertical	sbv 1|2 gbv	OK 1|2	The number of vertical pixels to combine together. 1|2: ××1, ××2(Mono only)

Table 10-1 Command List #1

Command	Syntax	Return Value	Description
Set Test Image Get Test Image	sti 0|1|2|3|16 gti	OK 0|1|2|3|16	Sets the Test Image. 0: Disables the Test Image feature. 1: Sets to Grey Horizontal Ramp. 2: Sets to Grey Diagonal Ramp. 3: Sets to Grey Diagonal Ramp Moving. 16: Sets to the Test Image provided by the image sensor.
Set Camera Link Tap Geometry Get Camera Link Tap Geometry	stg 2|4|8|10 gtg	OK 2|4|8|10	Sets the Camera Link Tap Geometry. 2: 1X2-1Y (2 taps) 4: 1X4-1Y (4 taps) 8: 1X8-1Y (8 taps) 10: 1X10-1Y (10 taps)
Set Camera Link Clock Selector Get Camera Link Clock Selector	sccs 0|1|2|3 gccs	OK 0|1|2|3	Sets the Camera Link Pixel Clock Speed. 0: 32.5 ㎒ 1: 48 ㎒ 2: 65 ㎒ 3: 85 ㎒
Set Data Bit Get Data Bit	sdb 8|10|12 gdb	OK 8|10|12	Sets the Pixel Format. 8: 8 bit 10: 10 bit 12: 12 bit
Set Defect Correction Get Defect Correction	sdc 0|1 gdc	OK 0|1	Sets the Defect Pixel Correction. 0: Disables the Defect Pixel Correction. 1: Enables the Defect Pixel Correction.
Set Horizontal Flip Get Horizontal Flip	shf 0|1 ghf	OK 0|1	Sets the Reverse X (Horizontal Flip). 0: Disables the Reverse X. 1: Enables the Reverse X.
Set Vertical Flip Get Vertical Flip	svf 0|1 gvf	OK 0|1	Sets the Reverse Y (Vertical Flip). 0: Disables the Reverse Y. 1: Enables the Reverse Y.
Acquisition Start	ast	OK	Starts image acquisitions.
Acquisition Stop	asp	OK	Stops image acquisitions.
Set Acquisition Mode Get Acquisition Mode	sam 0|1|2 gam	OK 0|1|2	Sets the Acquisition Mode. 0: Continuous 1: Single Frame 2: Multi-Frame
Set Acquisition Frame Count Get Acquisition Frame Count	safc n gafc	OK n	Sets the number of frames to be acquired when the Acquisition Mode is set to Multi-Frame. n: 1 – 255

Table 10-2 Command List #2

Command	Syntax	Return Value	Description
Set Frame Rate Get Frame Rate	sfr n gfr	OK n	Sets the rate at which the exposure start trigger will be generated when the Trigger Mode is set to Off.
Get Acquisition Status	gast	0 | 1	Retrieves the internal acquisition status. 0: The camera is not in the process of acquiring a frame. 1: The camera is in the process of acquiring a frame.
Set Trigger Mode Get Trigger Mode	stm 0 | 1 gtm	OK 0 | 1	Sets the Trigger Mode. 0: Trigger Mode Off (Free run mode) 1: Trigger Mode On
Set Trigger Source Get Trigger Source	sts 3 | 10 | 14 | 18 | 22 gts	OK 3 | 10 | 14 | 18 | 22	Specifies a source signal when the Trigger Mode is set to On. 3: Software 10: User Output0 14: CC1 18: Timer0 Active 22: Line0
Generate SW Trigger	gst	OK	Generates a Software trigger signal.
Set Trigger Activation Get Trigger Activation	sta 0 | 1 gta	OK 0 | 1	Sets the activation mode for the selected source signal when the Trigger Mode is set to On. 0: Falling Edge 1: Rising Edge
Set Exposure Mode Get Exposure Mode	sem/ses 0 | 1 gem/ges	OK 0 | 1	Sets the Exposure Mode. 0: Timed 1: Trigger Width
Set Short Exposure Mode Get Short Exposure Mode	ssem 0 | 2 gsem	OK 0 | 2	Sets the Short Exposure Mode. 0: Off (Normal Exposure Mode) 2: Ultra Short
Set Exposure Time Get Exposure Time	set n get	OK n	Sets an exposure time. n: Exposure time in microseconds • Normal: 7.39 μs – 60 s • Ultra Short: 1.02 μs – 2.47 μs
Get Exposure Offset	geo	n	Retrieves the current Exposure Offset. • Normal: 2.47 μs • Ultra Short: 0.00 μs

Table 10-3 Command List #3

Command	Syntax	Return Value	Description
Set Black Level Get Black Level	sbl n gbl	OK n	Sets the black level value. n: Black Level (Setting range: 0 – 255)
Set Digital Gain Get Digital Gain	sdg n gdg	OK n	Sets the digital gain value. n: Gain (Setting range: 1× – 32×)
Generate Flat Field Data	gfd	OK	Executes the Flat Field Generator.
Set Flat Field Data Selector Get Flat Field Data Selector	sfds n gfds	OK n	Selects a Flat Field correction data location. n: 0-11 (User-defined locations)
Save Flat Field Data	sfd	OK	Saves the generated Flat Field correction data in the selected FFC data location.
Load Flat Field Data	lfd	OK	Loads the FFC data from the non-volatile memory into the volatile memory.
Set Flat Field Correction Get Flat Field Correction	sfc 0 | 1 gfc	OK 0 | 1	Sets the Flat Field Correction feature. 0: Disables the Flat Field Correction. 1: Enables the Flat Field Correction.

Table 10-4 Command List #4

Command	Syntax	Return Value	Description
Set Line Selector Get Line Selector	slns 0|1 glns	OK 0|1	Selects a physical line of the Control I/O receptacle to configure. 0: Line0 1: Line1
Get Line Mode	glnm	0|1	Retrieves the mode of the selected physical line. 0: Input 1: Output
Set Line Source Get Line Source	slnc 0|4|5|6|10|18|26 glnc	OK 0|4|5|6|10|18|26	Specifies a source signal for the Control I/O receptacle. 0: Off 4: Frame Active 5: Line Active 6: Exposure Active 10: User Output0 18: Timer0 Active 26: Counter0Active
Set Line Inverter Get Line Inverter	slni 0|1 glni	OK 0|1	Sets whether to invert the line output. 0: Disables inversion on the line output. 1: Enables inversion on the line output.
Set User Output Value Get User Output Value	suov 0|1 guov	OK 0|1	Sets the User Output value. 0: Sets the bit state of the line to Low. 1: Sets the bit state of the line to High.
Set Debounce Time Get Debounce Time	sdbt n gdbt	OK n	Sets the Debounce time n: Debounce time in microseconds (0 – 1,000,000 μs)

Table 10-5 Command List #5

Command	Syntax	Return Value	Description
Set Counter Event Source Get Counter Event Source	sces 0 | 4 | 5 | 6 | 14 | 22 gces	OK 0 | 4 | 5 | 6 | 14 | 22	Sets Counter Event Source 0: Off 4: Frame Active 5: Line Active 6: Exposure Active 14: CC1 22: Line0
Set Counter Event Activation Get Counter Event Activation	scea 0 | 1 gcea	OK 0 | 1	Sets Counter Event Activation 0: Falling Edge 1: Rising Edge
Set Counter Reset Source Get Counter Reset Source	scrs 0 | 4 | 6 | 7 | 22 gcrs	OK 0 | 4 | 6 | 7 | 22	Sets Counter Reset Source 0: Off 4: Frame Active 6: Exposure Active 7: Acquisition Active 22: Line0
Set Counter Reset Activation Get Counter Reset Activation	scra 0 | 1 | 2 | 3 | 4 gcra	OK 0 | 1 | 2 | 3 | 4	Sets Counter Reset Activation 0: Falling Edge 1: Rising Edge 2: Level Low 3: Level High 4: Any Edge
Reset Counter	rctr	OK	Resets the Counter and starts it again.
Set Counter Duration Get Counter Duration	scud gcdu	OK n	Sets the number of Counter Event
Get Counter Status	gcst	0 | 1 | 2 | 3 | 4	Displays current status of the Counter 0: Counter Idle 1: Counter Trigger Wait 2: Counter Active 3: Counter Completed 4: Counter Overflow
Set Counter Trigger Source Get Counter Trigger Source	sctts 0 | 4 | 6 | 7 | 22 gctts	OK 0 | 4 | 6 | 7 | 22	Sets a source signal to start the Counter 0: Off 4: Frame Active 6: Exposure Active 7: Acquisition Active 22: Line0
Set Counter Trigger Activation Get Counter Trigger Activation	scta 0 | 1 | 2 | 3 | 4 gcta	OK 0 | 1 | 2 | 3 | 4	Sets the Trigger Activation mode to start the Counter 0: Falling Edge 1: Rising Edge 2: Level Low 3: Level High 4: Any Edge

Table 10-6 Command List #6

Command	Syntax	Return Value	Description
Set Timer Duration Get Timer Duration	stdu n gtdu	OK n	Sets the duration of the Timer output signal. n: 1 – 60,000,000 μs
Set Timer Delay Get Timer Delay	stdl n gtdl	OK n	Sets the delay time for the Timer. n: 0 – 60,000,000 μs
Reset Timer	rtmr	OK	Resets the Timer and starts it again.
Get Timer Status	gtst	0 | 1 | 2	Displays the status of the Timer. 0: Timer Idle 1: Timer Trigger Wait 2: Timer Active
Set Timer Trigger Source Get Timer Trigger Source	stts 0 | 4 | 6 | 14 | 22 | 26 gtts	OK 0 | 4 | 6 | 14 | 22 | 26	Specifies a source signal for the Timer output signal. 0: Off 4: Frame Active 6: Exposure Active 22: Line0 26: Counter0Active
Set Timer Trigger Activation Get Timer Trigger Activation	stta 0 | 1 | 2 | 3 | 4 gtta	OK 0 | 1 | 2 | 3 | 4	Sets the activation mode for the Timer. 0: Falling Edge 1: Rising Edge 2: Level Low 3: Level High 4: Any Edge
Set AWB Offset X Get AWB Offset X	swx n gwx	OK n	Sets a horizontal offset from the origin to the Data ROI.
Set AWB Offset Y Get AWB Offset Y	swy n gwy	OK n	Sets a vertical offset from the origin to the Data ROI.
Set AWB Width Get AWB Width	sww n gww	OK n	Sets a width for the Data ROI.
Set AWB Height Get AWB Height	swh n gwh	OK n	Sets a height for the Data ROI.

Table 10-7 Command List #7

Command	Syntax	Return Value	Description
Set RGB Gain Get RGB Gain	srg r|g|b n grg r|g|b	OK n	Sets the intensity of color pixels. r|g|b: Red / Green / Blue pixels n: Gain value (1.0× ~ 4.0×)
Auto White Balance	arg	OK	Automatically adjusts the white balance once.
Get Model Name	gmn	String	Displays the camera model name.
Get MCU Version	gmv	String	Displays the version of the camera MCU.
Get FPGA Version	gfv	String	Displays the version of the camera FPGA.
Get Serial Number	gsn piece	String	Displays the serial number of the camera.
Get Current Temperature	gct	String	Displays the device temperature in Celsius.
Reset Hardware	rst	-	Resets the camera physically to power off and on.
Load Config. From	lcf 0|1|2	OK	Loads the camera setting values. 0: Loads the Factory Default Setting. 1: Loads the User 1 Setting. 2: Loads the User 2 Setting.
Save Config. To	sct 1|2	OK	Saves the current camera setting values. 1: Saves to the User 1 Setting. 2: Saves to the User 2 Setting.
Set Config. Initialization Get Config. Initialization	sci 0|1|2 gci	OK 0|1|2	Specifies setting values to be loaded when reset. 0: Factory Default Setting 1: User 1 Setting 2: User 2 Setting

Table 10-8 Command List #8

Chapter 11. 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 the Trigger Mode is not working correctly,
  - Ensure that the CC1 settings on the frame grabber are configured correctly when you use CC1 triggering.
  - Ensure that cable connections are secure when you use external triggering.

- If there is a communication failure between the camera and user's computer,
  - Ensure that the Camera Link cable connections are secure.
  - Ensure that you have configured a frame grabber in your computer and the camera is connected to the frame grabber correctly.

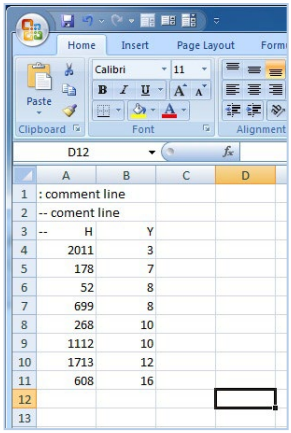
Appendix A. Defective Pixel Map Download

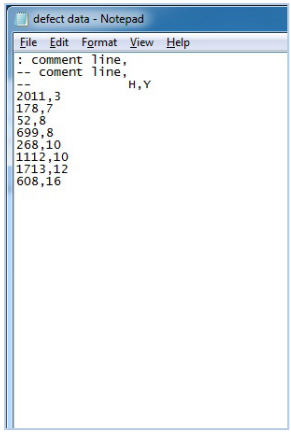
1. Create the Defective Pixel Map data in Microsoft Excel format as shown in the left picture below and save as a CSV file (*.csv). The picture in the right shows the created Excel file opened in Notepad. The following rules need to be applied when creating the file.

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

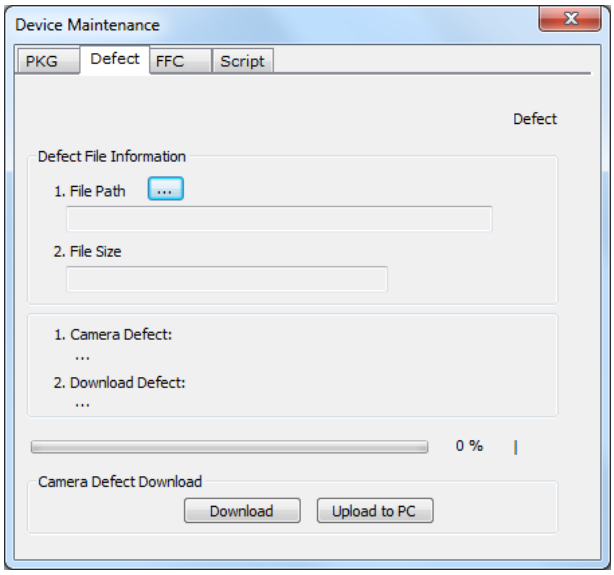
   • You must enter the horizontal value first and then the vertical value for coordinates of each defect pixel.

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





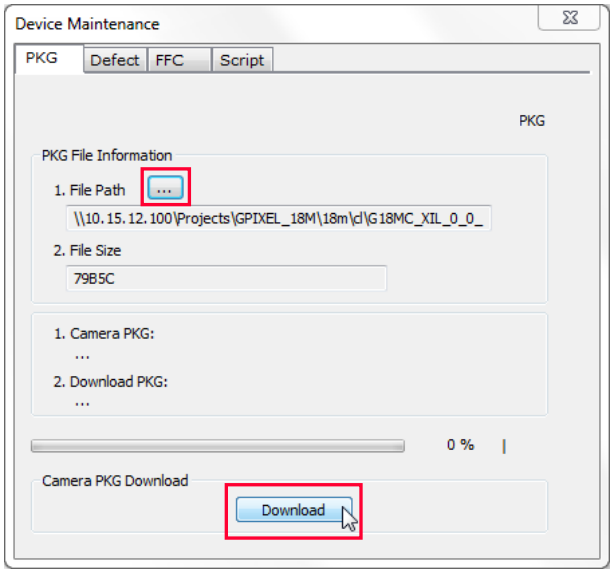
2. Run the application provided by your frame grabber to update or download the Defective Pixel Map data, and then find the window to function as shown below. Select the **Defect** tab, click the **File Path** item, search and select the defective pixel map (*.csv), and then click the **Download** button.



Appendix B. Field Upgrade

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

1. Run the application provided by your frame grabber, and then find the menu to support the necessary function.
2. Select the **PKG** tab, on the window below, 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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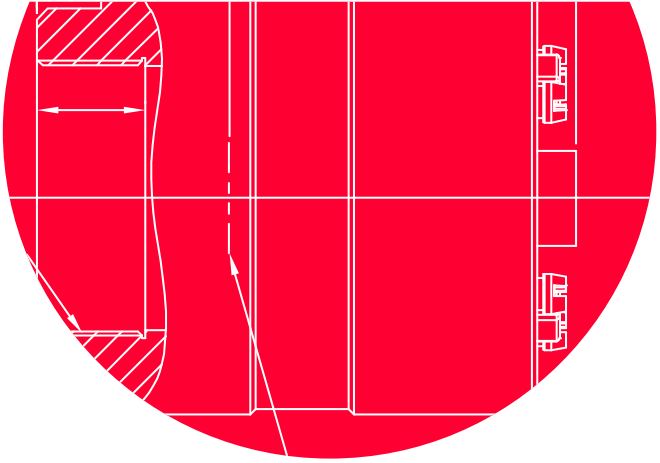

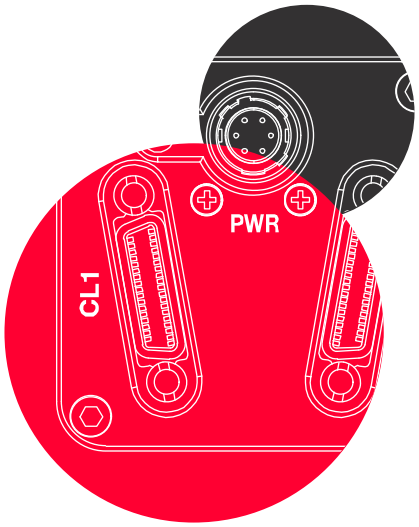

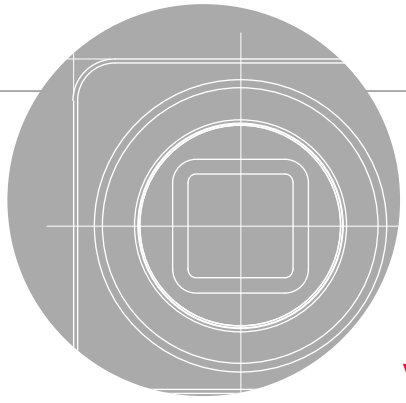

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