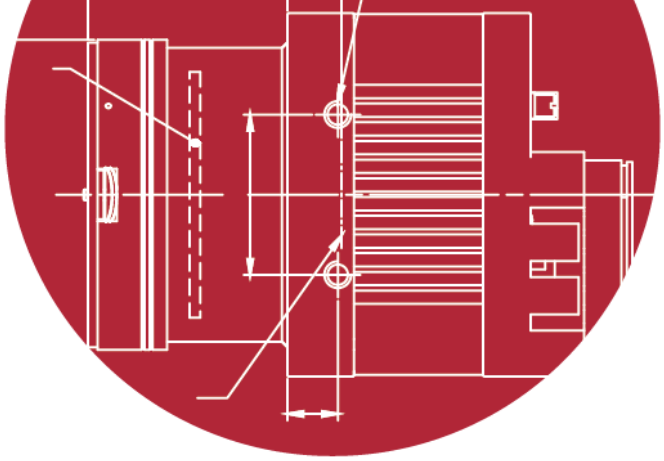


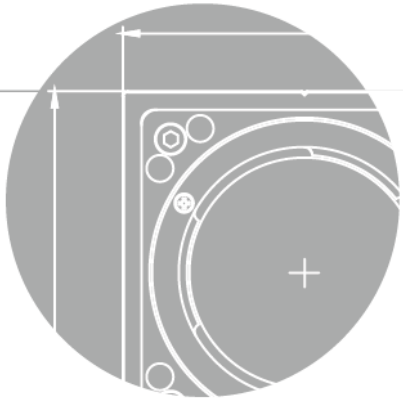
VC-50MC

User Manual

English

VC-50MC-18

CAMERA Link®



vieworks

Imaging Expert

Revision History

Revision	Date	Description
1.0	2018-09-14	Initial Release

Contents

1 Precautions

General

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

Installation and Maintenance

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

Power Supply

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

2 Warranty

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

3 Compliance & Certifications

3.1 FCC Compliance

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

3.2 CE: DoC

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

3.3 KC

KCC Statement

Type	Description
Class A (Broadcasting Communication Device for Office Use)	This device obtained EMC registration for office use (Class A), and may be used in places other than home. Sellers and/or users need to take note of this.

4 Package Components

Package Components

VC-50MC <F-Mount>

Mount Plate (Optional)

M5 Set Screws for Tilt Adjustment (Provided only with a F-mount camera)

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

5 Product Specifications

5.1 Overview

The VC-50MC, the latest member of the industrial proven VC series, is a new 50 megapixel resolution CMOS camera with the Camera Link interface. The VC-50MC uses the latest 50 megapixel CMOS image sensor (CMV50000) technology from AMS CMOSIS, and offers up to 17.5 frames per second at 7920 × 6004 resolution. Equipped with the Vieworks' innovative technologies proved by world's top FPD manufacturers, the VC-50MC camera offers not only highly uniformed images but also high speed image processing capabilities. Featured with high quality image uniformity and high resolution, this camera is ideal for demanding applications such as FPD, PCB and semiconductor inspections.

Main Features

- High Speed 50 Megapixel CMOS Image Sensor
- Electronic Exposure Time Control (Global Shutter)
- Output Pixel Format: 8 / 10 / 12 bit
- Strobe Output
- Defect Pixel Correction
- Camera Link Output Mode: 2 Tap / 3 Tap / 4 Tap / 8 Tap / 10 Tap
- Gain / Black Level Control
- Test Image
- Camera Link Base / Medium / Full
- Camera Link Clock Frequency Selector
- LVDS (RS-644) Serial Communication through Camera Link Interface
- Temperature Monitor
- Field Upgrade
- Dark Image Correction
- Flat Field Correction
- Reverse X
- GenICam Compatible – XML-based Control

5.2 Specifications

The technical specifications of the VC-50MC camera are as follows:

Specifications	VC-50MC-18
Active Image (H × V)	7920 × 6004
Sensor	AMS CMOSIS CMV 50000
Sensor Size	36.43 ㎜ × 27.62 ㎜ (Diagonal: 45.72 ㎜, Optical Format: 35 ㎜)
Sensor Type	High Speed Progressive CMOS Image Sensor
Pixel Size	4.6 ㎛ × 4.6 ㎛
Camera Interface	Camera Link Base / Medium / Full
Electronic Shutter	Global Shutter
Max. Frame Rate (85 ㎒/65 ㎒)	2 Tap: 3.5 fps / 2.7 fps
	3 Tap: 5.2 fps / 3.9 fps
	4 Tap: 7.1 fps / 5.4 fps
	8 Tap: 14.1 fps / 10.8 fps
	10 Tap: 17.5 fps / 13.4 fps
Transfer Time (85 ㎒/65 ㎒)	2 Tap: 285 ㎳ / 370 ㎳
	3 Tap: 192 ㎳ / 256 ㎳
	4 Tap: 140 ㎳ / 185 ㎳
	8 Tap: 70 ㎳ / 92 ㎳
	10 Tap: 57 ㎳ / 74 ㎳
Pixel Data Format	8 bit (2/3/4/8/10 Tap), 10 bit (2/4/8 Tap), 12 bit (2/4 Tap)
Camera Link Pixel Clock	85 ㎒ / 65 ㎒
Exposure Time	1 ㎲ ~ 60 s (1 ㎲ step)
Cable Length	< 5 m (Camera Link cable @ 85 ㎒) / < 7 m (Camera Link cable @ 65 ㎒)
Black Level	0 ~ 255 LSB at 12 bit (1 LSB step)
Video Gain	1× ~ 30×
Trigger Mode	Free-Run, Trigger Programmable Exposure Time and Trigger Polarity
External Trigger	External, 3.3 V - 24.0 V Logical level input, Optically isolated
Software Trigger	Camera Link CC1

Table 5.1 Specifications of VC-50MC (continuous)

Specifications	VC-50MC-18
Dynamic Range	64 dB
Lens Mount	F-mount
Power	10 ~ 24 V DC, Typ. 9 W
Environmental	Operating: -5℃ ~ 40℃, Storage: -40℃ ~ 70℃
Mechanical	68 mm × 68 mm × 102 mm, 432 g (with F-mount)
Configuration SW	Configurator

Table 5.2 Specifications of VC-50MC

5.3 Camera Block Diagram

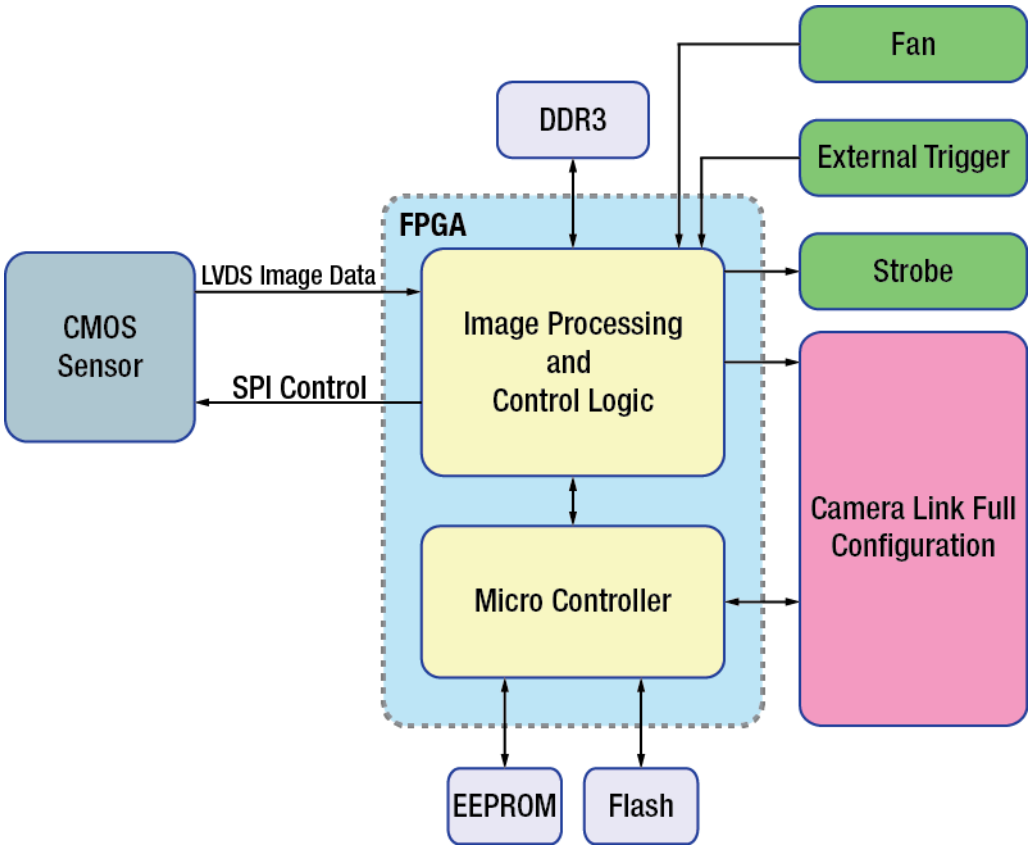


Figure 5.1 Camera Block Diagram

All controls and data processing of the VC-50MC camera are carried out in one FPGA chip. The FPGA generally consists of a 32-bit RISC Micro-Controller and Processing & Control logic. The Micro-Controller receives commands from the user through the 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 the trigger inputs and strobe outputs, which are sensitive to time. 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 Sensor Information

The following graphs show the quantum efficiency of the VC-50MC monochrome and color cameras.

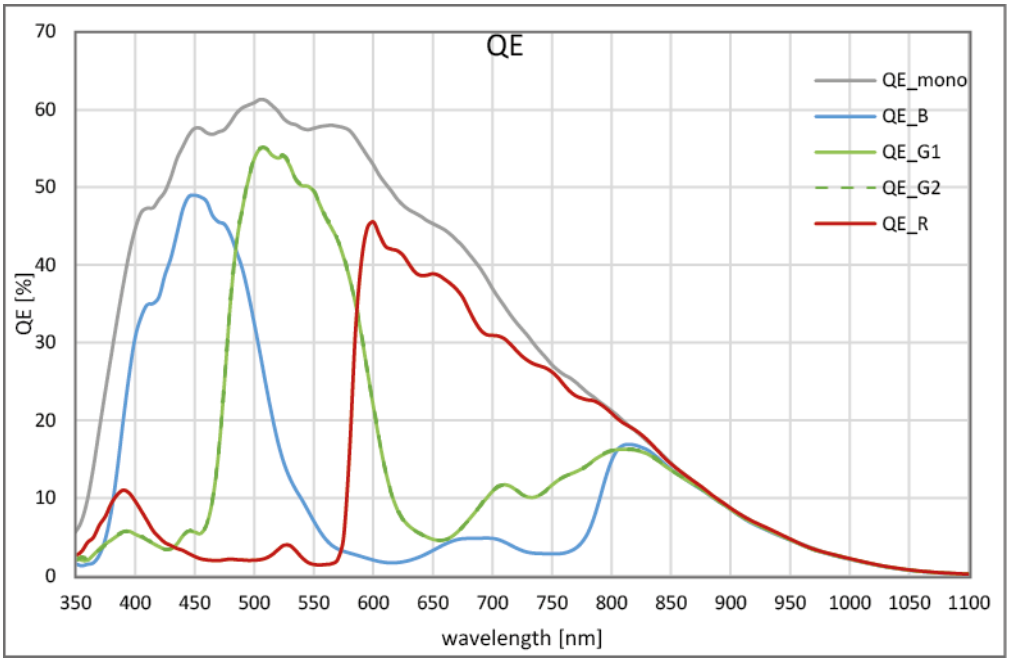


Figure 5.2 VC-50MC Quantum Efficiency

5.5 Mechanical Specification

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

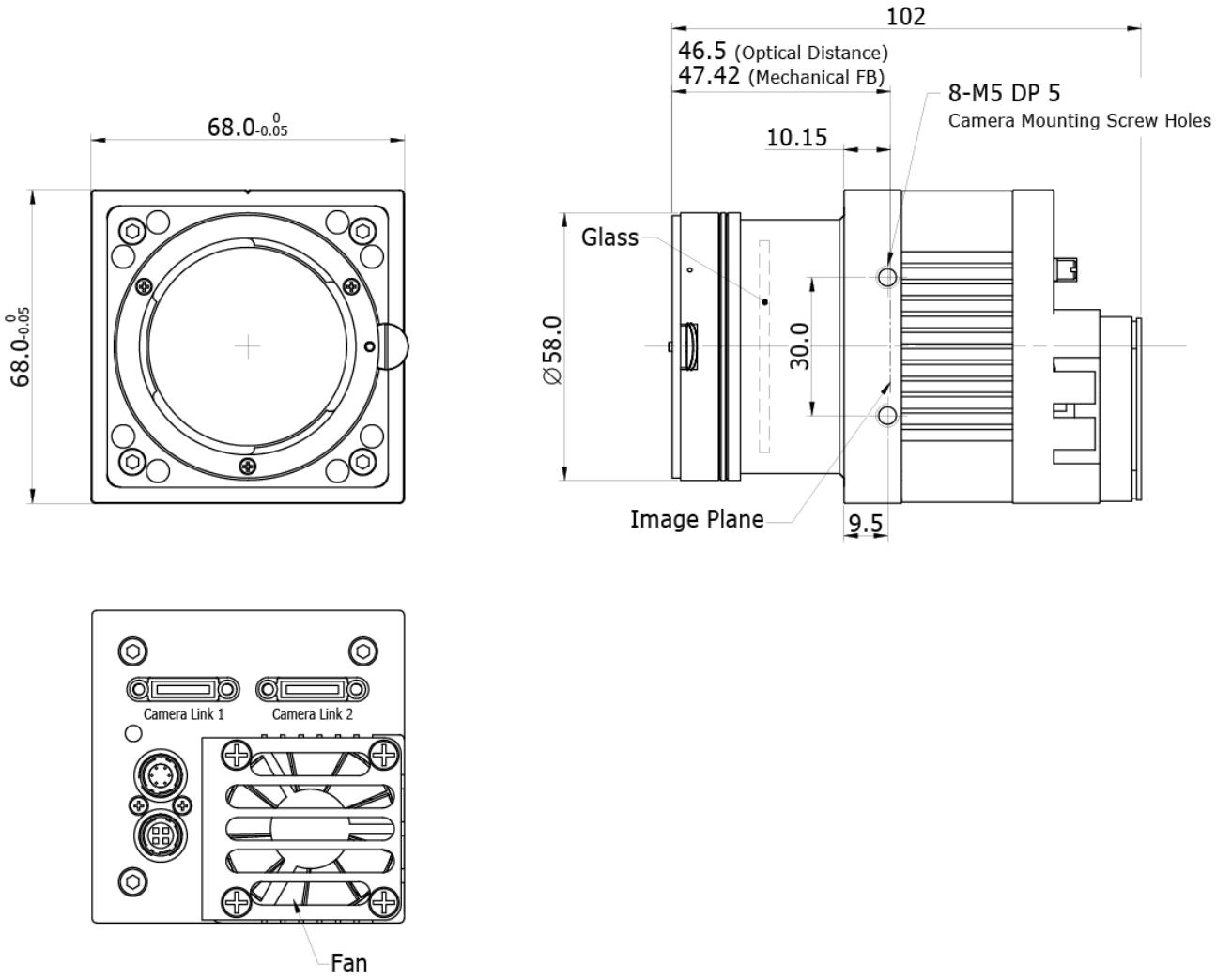


Figure 5.3 VC-50MC F-mount Mechanical Dimension

6 Connecting the Camera

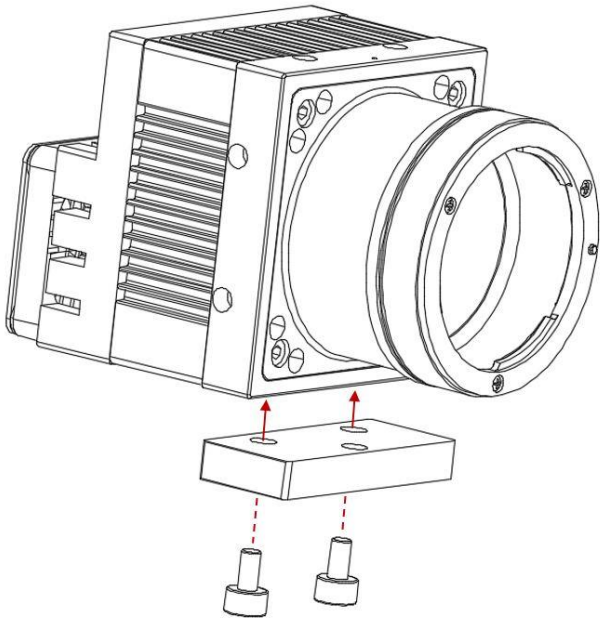
The following instructions assume that you have installed a Camera Link frame grabber in your computer including related software. For more information, refer to your Camera Link frame grabber user manual.
To connect the camera to your computer, follow the steps below:

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 of the cable connections are secure.

Precautions for using Camera Link Medium/Full Configuration

 CAUTION	The VC-50MC camera supports the Camera Link Base / Medium / Full configuration. To operate the camera in the medium or full configuration, you must connect the camera to the Camera Link frame grabber using two Camera Link cables. Please note that you must connect both Camera Link1 (Base) and Camera Link2 (Medium / Full) connectors on the camera to their respective connectors on the Camera Link frame grabber.

6.1 Mount Plate



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

6.2 Precaution to center the image sensor

- User does not need to center the image sensor as it is adjusted as factory default settings.
- When you need to adjust the center of image sensor, please contact your local dealer or factory representative for technical assistance.

6.3 Precaution about blurring compared to the center

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

6.4 Controlling the camera

- You can control the camera by using the Configurator.
- You can download the latest Configurator at http://www.vieworks.com.
- Please refer to your Camera Link frame grabber user manual.

7 Camera Interface

7.1 General Description

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

- ① 26 pin Camera Link Connector 1(Base): transmits video data and controls the camera.
- ② 26 pin Camera Link Connector 2(Medium/Full): transmits video data.
- ③ Status LED: displays power status and operation mode.
- ④ 6 pin Power Input Receptacle: supplies power to the camera.
- ⑤ 4 pin Control I/O Receptacle: inputs external trigger signal and outputs strobe signals.

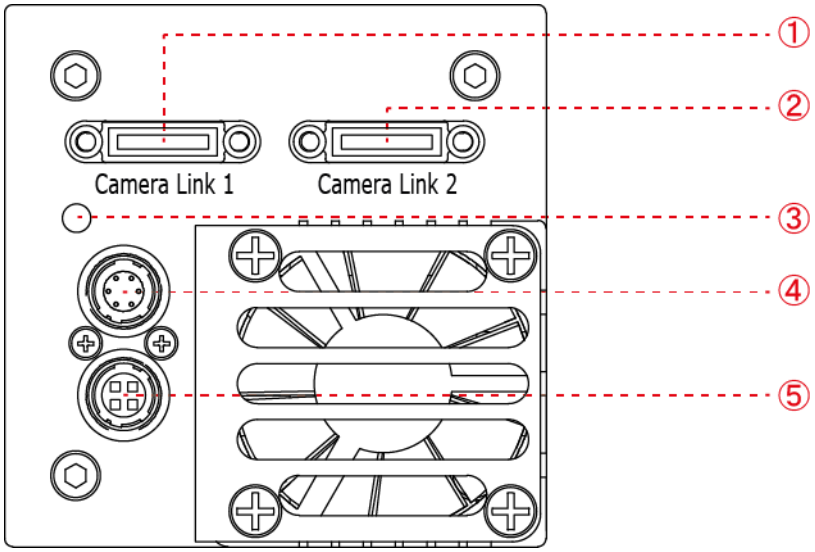


Figure 7.1 VC-50MC Camera Back Panel

7.2 Camera Link Connector

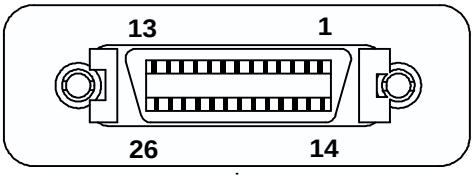


Figure 7.2 Camera Link Connector

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	Camera Link Output Mode	CL Configuration	CL Connector 1	CL Connector 2
VC-50MC-18	2 Tap	Base	O	X
	3 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 Camera Link Output Modes

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 Receptacle

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

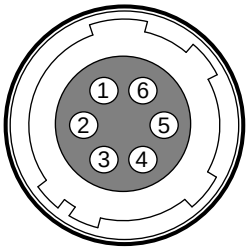


Figure 7.3 Pin Assignments for Power Input Receptacle

Pin Number	Signal	Type	Description
1, 2, 3	+ 12V DC	Input	DC Power Input
4, 5, 6	DC Ground	Input	DC Ground

Table 7.4 Pin Configuration for Power Input Receptacle

The mating connector is a Hirose 6 pin plug (part # HR10A-7P-6S) or the equivalent connectors. It is recommended that you use the power adapter, which has at least 1 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 Control I/O Receptacle

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

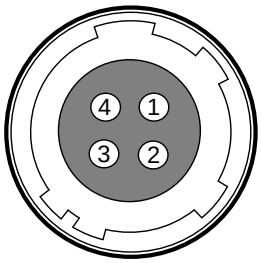


Figure 7.4 Pin Assignments for Control I/O Receptacle

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

Table 7.5 Pin Configurations for Control I/O Receptacle

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

7.5 Trigger Input Circuit

The following figure shows trigger signal input circuit of the 4 pin connector. Transmitted trigger signal is applied to the internal circuit through a photo coupler. 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.

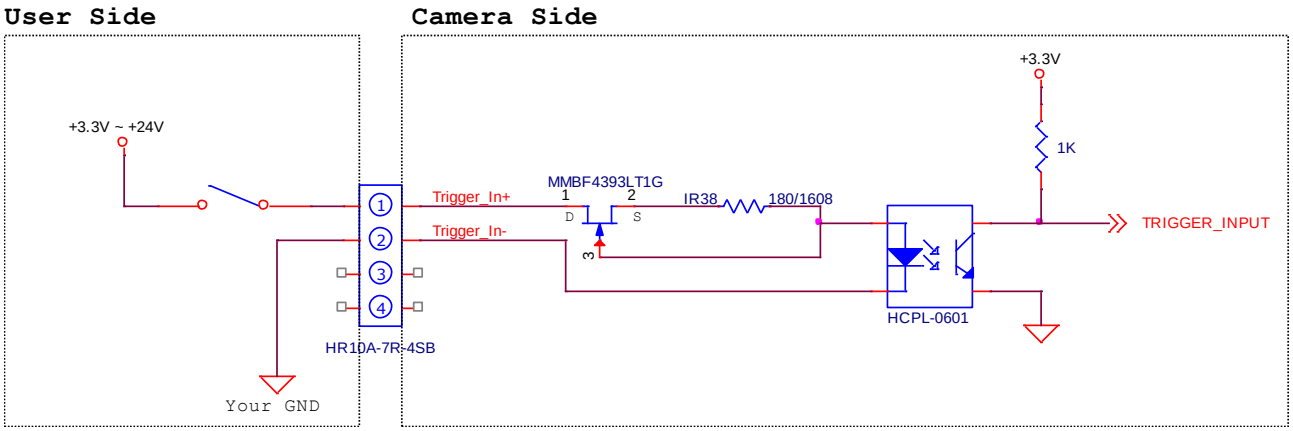


Figure 7.5 Trigger Input Schematic

7.6 Strobe Output Circuit

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

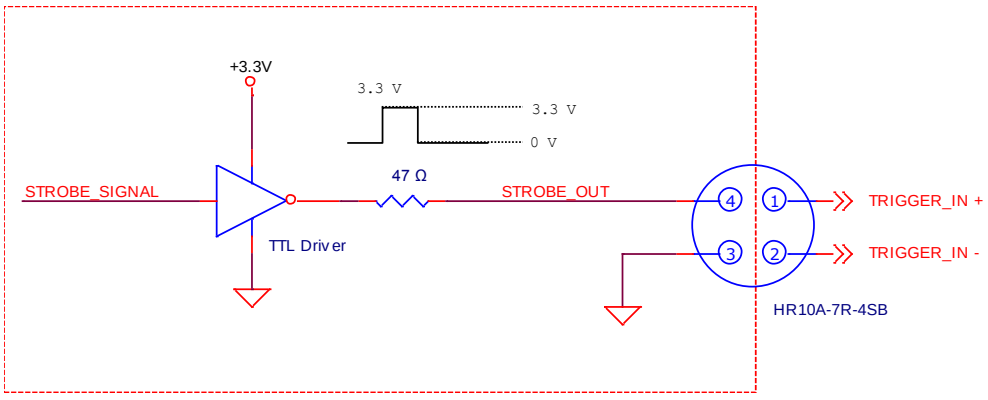


Figure 7.6 Strobe Output Schematic

8 Camera Features

8.1 Region of Interest

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

On the VC-50MC camera, decreasing the **Height** of the ROI can increase the camera's maximum allowed frame rate. But remember that you cannot increase the maximum frame rate by decreasing the **Width** of the ROI.

The ROI is referenced to the top left corner [origin (0, 0)] of the sensor array as shown below.

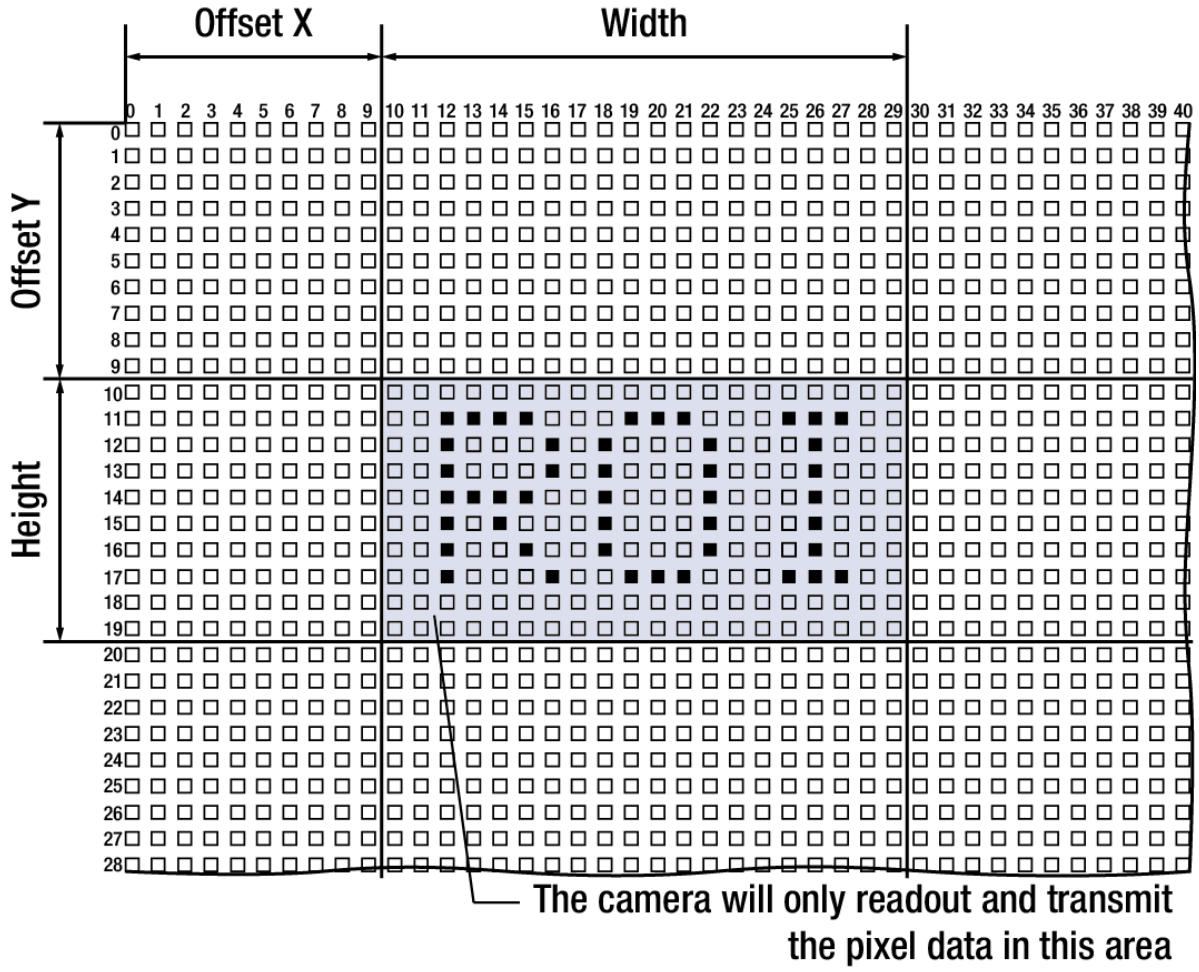


Figure 8.1 Region of Interest

On the VC-50MC, the maximum allowed frame rates depending on Vertical ROI changes are shown below.

ROI Size (H × V)	2 Tap	3 Tap	4 Tap	8 Tap	10 Tap
7920 × 1000	21.0 fps	30.4 fps	41.8 fps	82.3 fps	101.8 fps
7920 × 2000	10.6 fps	15.4 fps	21.1 fps	41.9 fps	51.9 fps
7920 × 3000	7.0 fps	10.3 fps	14.1 fps	28.1 fps	34.8 fps
7920 × 4000	5.3 fps	7.8 fps	10.6 fps	21.1 fps	26.2 fps
7920 × 5000	4.2 fps	6.2 fps	8.5 fps	16.9 fps	21.0 fps
7920 × 6004	3.5 fps	5.2 fps	7.1 fps	14.1 fps	17.5 fps

Table 8.1 Maximum Frame Rates by VC-50MC ROI Changes (@ Camera Link Freq. 85 ㎒)

- Your Camera Link 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.
- The VC-50MC camera provides the Multi-ROI feature.
  Refer to Table 9.2 Command List #1 for the commands related to the feature.

8.2 Multi-ROI

The VC-50MC camera provides the Multi-ROI feature which allows you to define up to ten 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. It is recommended that you first set the **Region Width** parameter, since all of the regions must be the same width. The next step in the setup procedure is to define each individual region as desired. Up to ten regions can be set up ranging from 0 through 9. Use the **Region Selector** parameter to select which ROI to set and then set the ROI to On or Off by using the **Region Mode** parameter. Then, set the **Region Offset X**, **Region Offset Y** and **Region Height** 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 with 1280 (width) × 4660 (the total height of the three regions) size.

- Region Width = 1280
- ROI_Region0
  - Region Offset X = 600, Region Offset Y = 0, Region Height = 1280
- ROI_Region1
  - Region Offset X = 3264, Region Offset Y = 3720, Region Height = 1280
- ROI_Region2
  - Region Offset X = 1984, Region Offset Y = 1420, Region Height = 2100

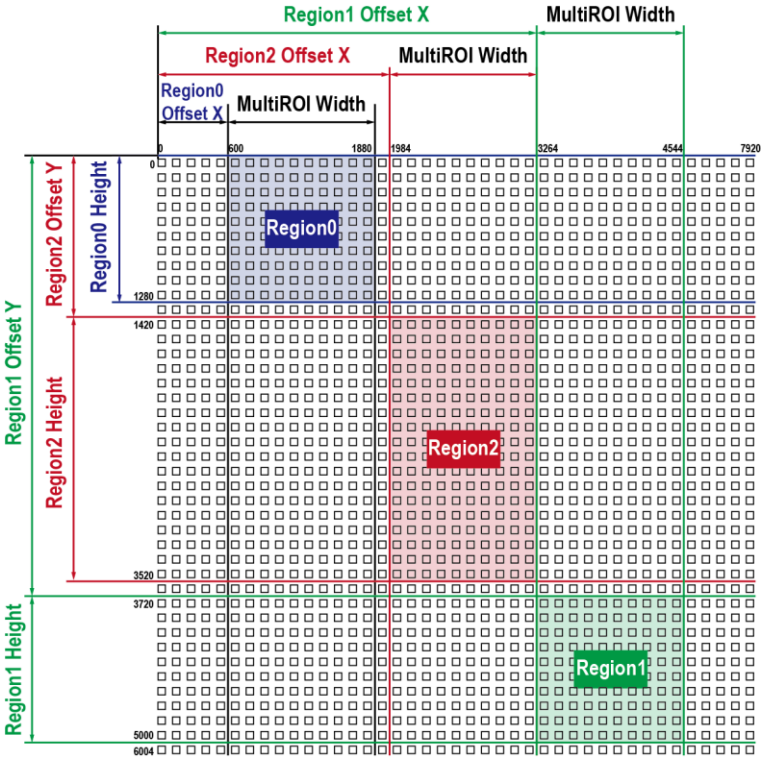


Figure 8.2 Multi-ROI

There are several things to keep in mind when setting the Multi-ROI feature on the VC-50MC camera:

- The sum of the Region Offset X value plus the Region Width value must not exceed the width (7920) of the camera's sensor.
- The sum of the Region Offset Y value plus the Region Height value must not exceed the height (6004) of the camera's sensor.
- The Region Offset X and the Region Width value must be a multiple of 16.
- The Region Offset Y and the Region Height value must be a multiple of 4.
- You can save the Multi-ROI setting values as a User Set (**Configurator** > **File** > **Save Setting** > **User 1** or **User 2**) and then load the values to the camera when desired.
- If you make changes to the Multi-ROI settings, you must execute the 'ast' command (Update Multi-ROI) to apply the changes.
- If you attempt to set the Multi-ROI settings with invalid values, the camera will not acquire images.
- Refer to Table 9.2 Command List #1 for the commands related to the Multi-ROI feature.

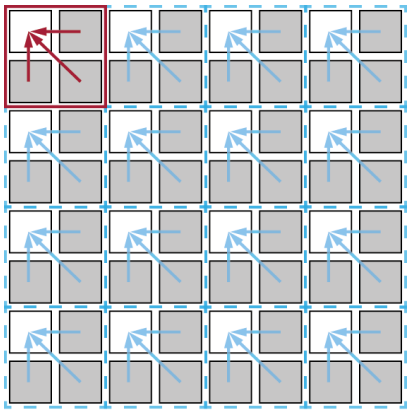
8.3 Binning

The Binning has the effects of increasing the level value and decreasing resolution by summing the values of the adjacent pixels and sending them as one pixel. The commands related to the Binning feature are as follows.

Command		Value	Description
Binning Mode	sbm	0: Average	Sum the adjacent pixels as many as specified by the Binning Vertical setting value and divide them by the number of summed pixels, and then send them as one pixel.
		1: Sum	Sum the adjacent pixels as many as specified by the Binning Vertical setting value, and then send them as one pixel.
Binning Vertical	sbv	1: 1×	Disables the Vertical Binning.
		2: 2×	Sets the number of vertical pixels to combine together to 2.
Binning Horizontal	sbh	1: 1×	Updated automatically according to the Binning Vertical.
		2: 2×	

Table 8.2 Commands related to Binning

For example, if you set 2 × 2 binning, the camera's resolution is reduced to 1/4. If you set the **Binning Mode** to **Sum**, the maximum allowed resolution of the image is reduced to 1/2 and the responsivity of the camera is quadrupled. If you set the **Binning Mode** to **Average**, the maximum allowed resolution of the image is reduced to 1/2, but there is no difference in responsivity between a binned image and an original image. You can use the binning feature and the ROI feature at the same time.



2 × 2 Binning

Figure 8.3 2 × 2 Binning

8.4 Pixel Format

The camera processes image data in the unit of 12 bit. You can determine the pixel format (8 bit, 10 bit or 12 bit) of image data transmitted from the camera by using the ‘sdb 8 / 10 / 12’ command. When the camera is set for 8 bit or 10 bit pixel format, the 4 or 2 least significant bits will be dropped from overall 12 bits.

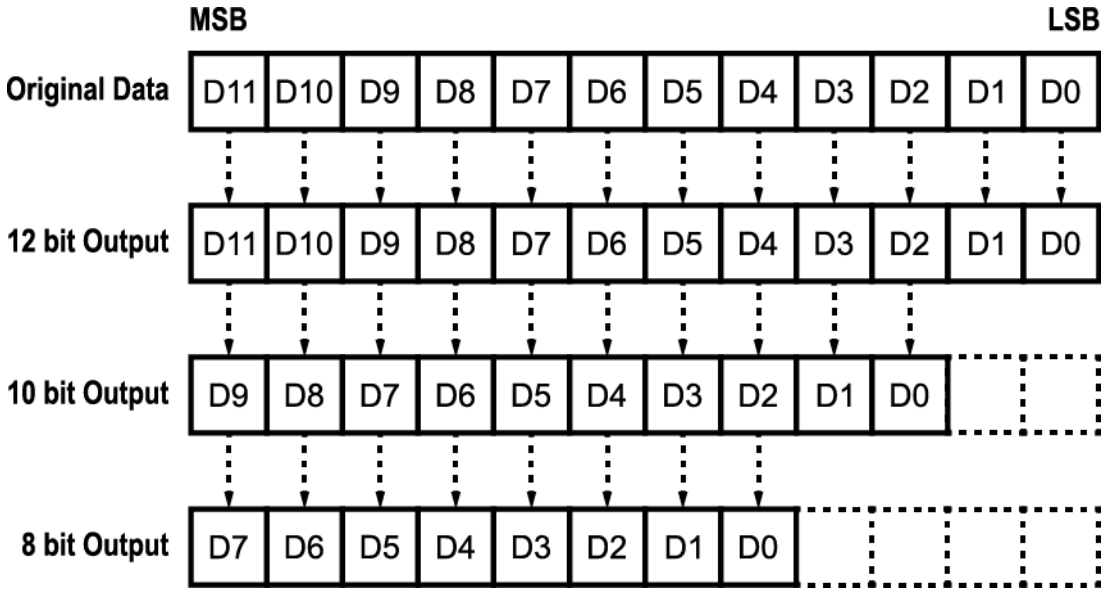


Figure 8.4 Pixel Format

8.5 AWB ROI (Color Camera)

The Auto White Balance (AWB) feature provided by the color camera uses the pixel data from an AWB Region of Interest (ROI) to adjust the white balance. The commands related to AWB ROI are as follows.

Command		Value	Description
AWB Offset X	swx	-	X coordinate of start point ROI
AWB Offset Y	swy	-	Y coordinate of start point ROI
AWB Width	sww	-	Width of ROI
AWB Height	swh	-	Height of ROI

Table 8.3 Commands Related to Data ROI

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

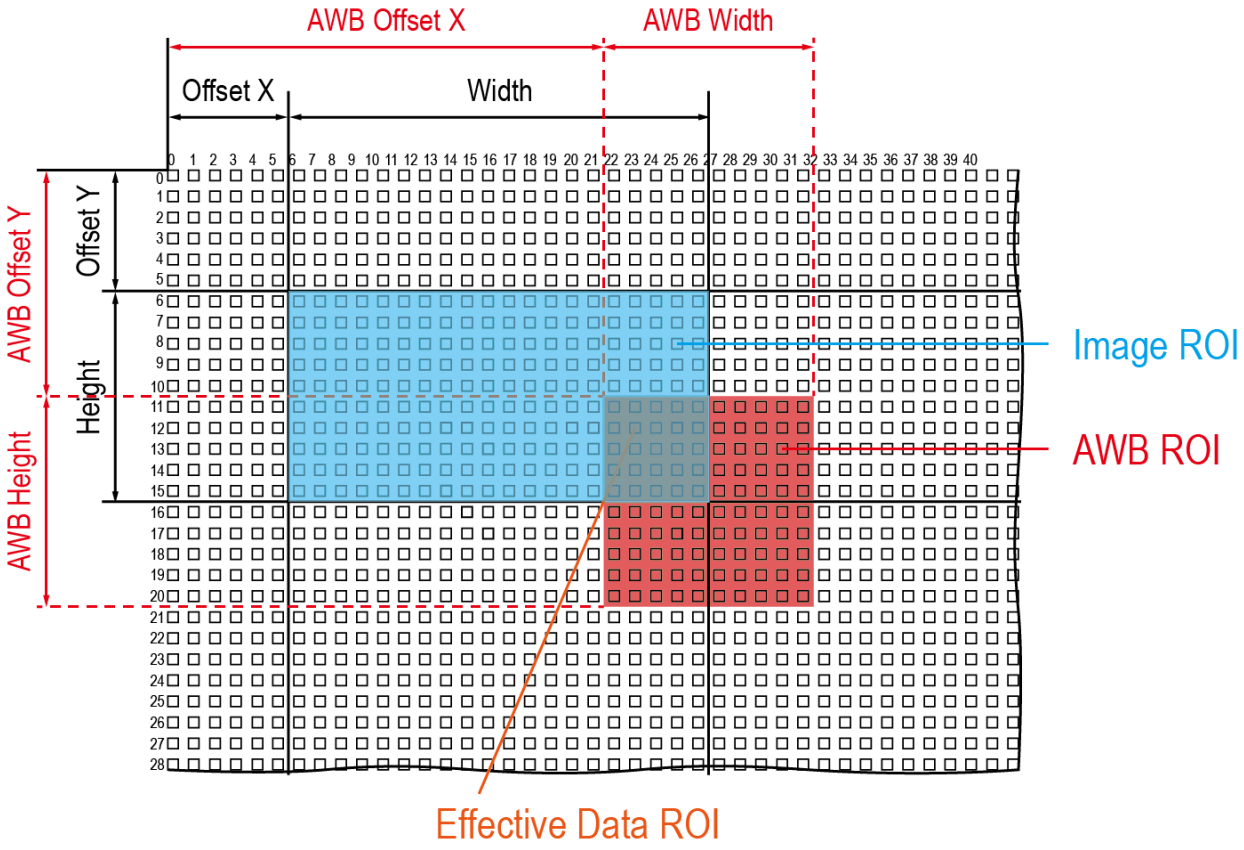


Figure 8.5 Effective Data ROI

8.6 White Balance (Color Camera)

The color camera includes the white balance capability to adjust the color balance of the images acquired from the image sensor. With the white balancing scheme used on the VC-50MC camera, the Red intensity, Green intensity and Blue intensity can be adjusted individually. You can set the intensity of each color by using the 'srg' command. The intensity value can range from 1.0 to 4.0. If you set the 'srg r / g / b' command to 1.0 for a color, the intensity of the color will be unaffected by the white balance mechanism. If you set the 'srg r / g / b' command to greater than 1.0, the intensity of the color will be proportionally increased to the ratio.
For example, if you execute the 'srg b 1.5' command, the blue intensity will be increased by 50%.
The commands related to White Balance are as follows.

Command		Value	Description
RGB Gain	srg r	×1.0 ~ ×4.0	Sets the intensity of the red pixels.
	srg g	×1.0 ~ ×4.0	Sets the intensity of the green pixels.
	srg b	×1.0 ~ ×4.0	Sets the intensity of the blue pixels.

Table 8.4 Commands related to White Balance

8.6.1 Auto White Balance

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

Command		Value	Description
Auto White Balance	arg	-	White Balance is adjusted once and then Off.

Table 8.5 Command related to Auto White Balance

8.7 Trigger Mode

The Exposure Start trigger is used to begin frame acquisition. The main parameter associated with the exposure start trigger is the **Trigger Mode** parameter. The **Trigger Mode** parameter for the exposure start trigger has two available settings: **Off** and **On**.

8.7.1 Trigger Mode = Off

When the **Trigger Mode** parameter is set to **Off**, the camera will generate all required exposure start trigger signals internally, and you do not need to apply exposure start trigger signals to the camera.
This use case commonly referred as “Free-Run”.

Exposure Time Control with Trigger Mode = Off

When the **Trigger Mode** parameter is set to **Off** (the ‘stm 0’ command is executed), the exposure time for each frame acquisition is determined by the value of the camera’s **Exposure Time** (‘set’ command) parameter.

8.7.2 Trigger Mode = On

When the **Trigger Mode** parameter is set to **On** (the ‘stm 1’ command is executed), you must apply an exposure start trigger signal to the camera each time you want to begin a frame acquisition. The **Source** parameter (‘sts’ command) specifies the source signal that will act as the exposure start trigger signal.
The available settings for the **Source** parameter are:

- **CC1**: You can apply an exposure start trigger signal to the camera via CC1 of the Camera Link frame grabber. For more information, refer to your Camera Link frame grabber user manual.
- **External**: You can apply an exposure start trigger signal to the camera by injecting an externally generated electrical signal (commonly referred to as a hardware trigger signal) into the Control Receptacle pin 1 on the camera.

After setting the **Source** parameter, you must also set the **Activation** parameter (‘stp’ command).
The available settings for the **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**, the exposure time for each frame can be controlled with the **Exposure Time** parameter (‘set’ command) or it can be controlled by manipulating the external trigger signal.

8.7.3 Using a CC1 Trigger Signal

If the **Trigger Mode** parameter is set to **On** (the 'stm 1' command is executed) and the **Source** parameter is set to **CC1** (the 'sts 1; command is executed), you must apply a CC1 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 CC1 trigger signal is received by the camera.

When the camera receives a CC1 trigger signal and begins exposure, it will exit the *waiting for exposure start trigger* acquisition status because at that point, it cannot react to a new exposure start trigger signal. As soon as the camera is capable of reacting to a new exposure start trigger signal, it will automatically return to the *waiting for exposure start trigger* acquisition status.

When you are using a CC1 trigger signal to start each frame acquisition, the frame rate will be determined by how often you apply a CC1 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. CC1 trigger signals that are applied to the camera when it is not ready to receive them will be ignored.

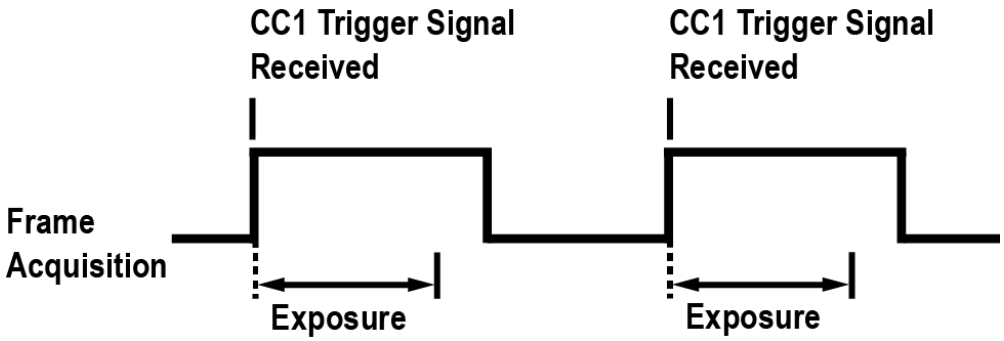


Figure 8.6 Frame Acquisition with CC1 Trigger Signal

8.7.4 Using an External Trigger Signal

If the **Trigger Mode** parameter is set to **On** (the 'stm 1' command is executed) and the **Source** parameter is set to **External** (the 'sts 5' command is executed), an externally generated electrical signal injected into the Control 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 **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 500 ms (0.5 s):

So in this case, the frame rate is 2 fps.

8.7.5 Exposure Mode

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

Timed Exposure Mode

When the **Timed** mode is selected (the 'ses 0' command is executed), the exposure time for each frame acquisition is determined by the value of the camera's **Exposure Time** parameter ('ses' command). If the camera is set for rising edge triggering, the exposure time starts when the external trigger signal rises. If the camera is set for falling edge triggering, the exposure time starts when the external trigger signal falls.

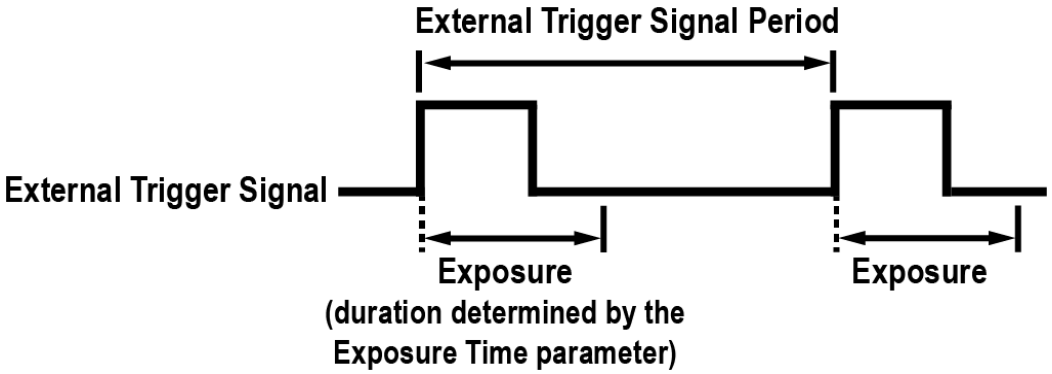


Figure 8.7 Timed Exposure Mode

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.

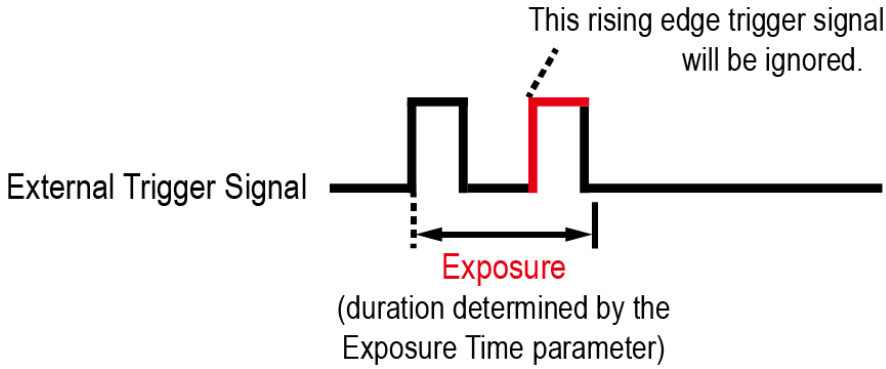


Figure 8.8 Trigger Overlapped with Timed Exposure Mode

Trigger Width Exposure Mode

When the **Trigger Width** exposure mode is selected (the ‘ses 1’ command is executed), the length of the exposure for each frame acquisition will be directly controlled by the external trigger signal. If the camera is set for rising edge triggering, the exposure time begins when the external signal rises and continuous 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 continuous until the external trigger signal rises.

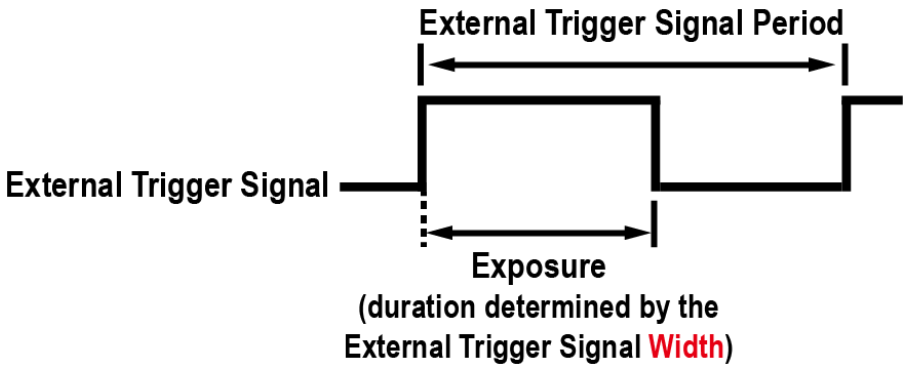


Figure 8.9 Trigger Width Exposure Mode

8.8 Setting the Exposure Time

This section describes how the exposure time can be adjusted manually by setting the value of the **Exposure Time** parameter on the VC-50MC camera.

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 ('set' command):

- the Trigger Mode is set to Off (the 'stm 0' command is executed).
- the Trigger Mode is set to On (the 'stm 1' command is executed) and the Source is set to CC1 (the 'sts 1' command is executed) – In this case, you must set the Exposure parameter to Timed (the 'ses 0' command is executed).
- the Trigger Mode is set to On (the 'stm 1' command is executed), the Source is set to External (the 'sts 5' command is executed), and the Exposure is set to Timed (the 'ses 0' command is executed).

The **Exposure Time** parameter must not be set below a minimum specified value. The **Exposure Time** parameter sets the exposure time in μs. The minimum and maximum exposure time settings for the VC-50MC camera are shown in the following table.

Camera Model	Minimum Allowed Exposure Time	Maximum Allowed Exposure Time †
VC-50MC	1 μs	60,000,000 μs

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

Table 8.6 Minimum and Maximum Exposure Time Setting

8.9 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-50MC 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 **Exposure** set to **Trigger Width** and the **Source** set to **External**.

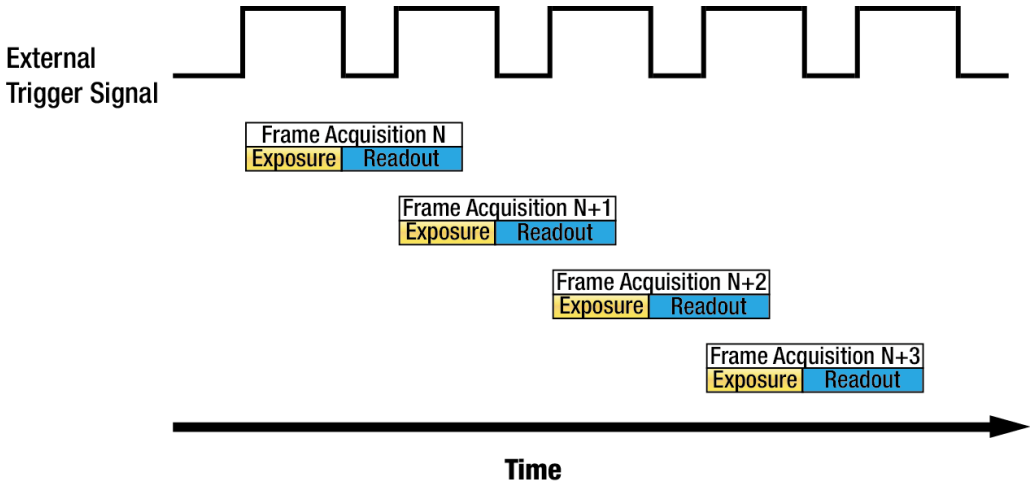


Figure 8.10 Overlapped Exposure and Readout

Determining whether your camera is operating with overlapped exposure and readout is not a matter of 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 Operation: Frame Period ≤ Exposure Time + Readout Time

Guidelines for Overlapped Exposure

If you are operating the camera in a way that exposure and readout will be overlapped, there are two important guidelines to keep in mind:

- 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.

8.10 Electronic Shutter Operation

The VC-50MC camera is equipped with an image sensor that has an electronic shutter. There are two types of electronic shutters, i.e. global and rolling. The VC-50MC camera uses a sensor with a global shutter.

8.10.1 Global Shutter

When a 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 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 a **Exposure Active** output signal (the 'slos 1' command is executed) that will go high when the exposure time for a frame acquisition begins and will go down when the exposure time ends.

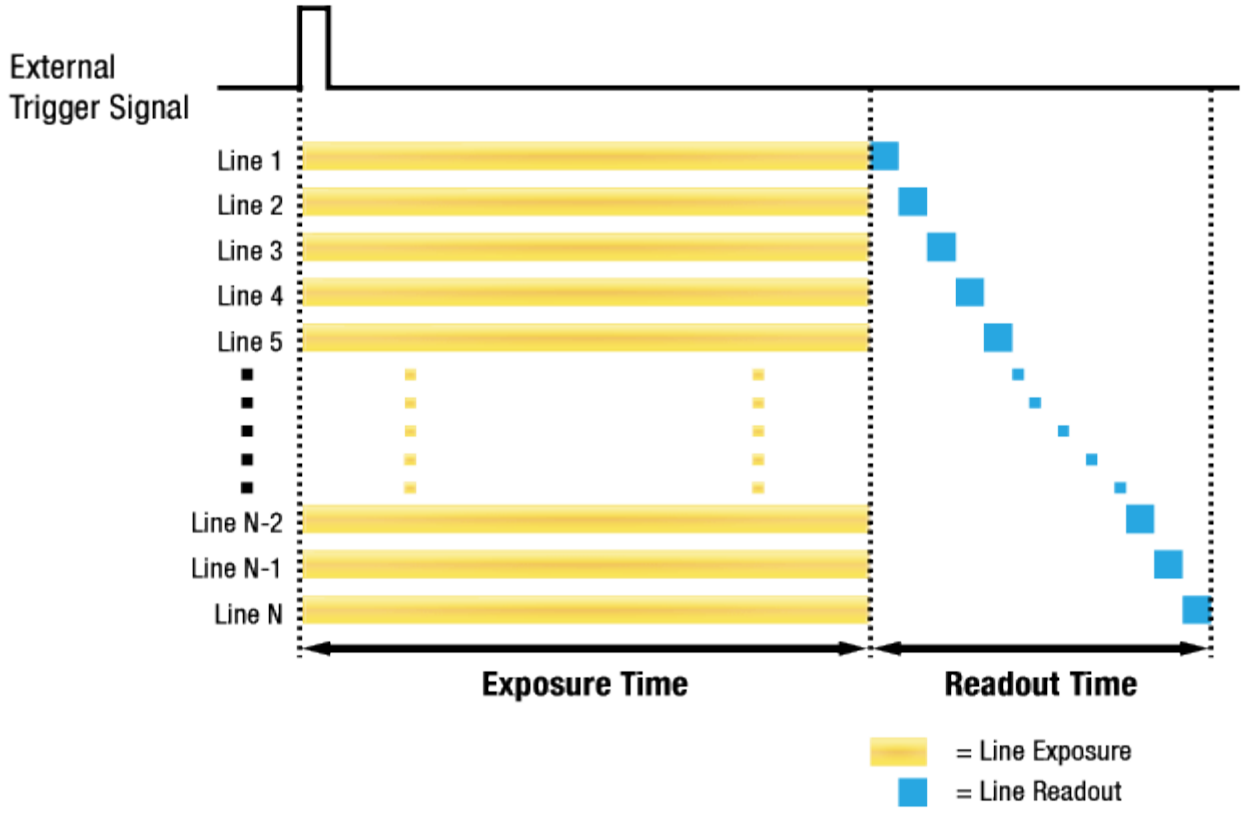


Figure 8.11 Global Shutter

8.11 Camera Link Output

The VC-50MC camera supports 2 Tap, 3 Tap, 4 Tap, 8 Tap and 10 Tap Camera Link output modes. 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 tap settings. The image data is transmitted in the interleaved order as shown in the figure below. You can set the Camera Link Output parameter by using the 'scl' command.

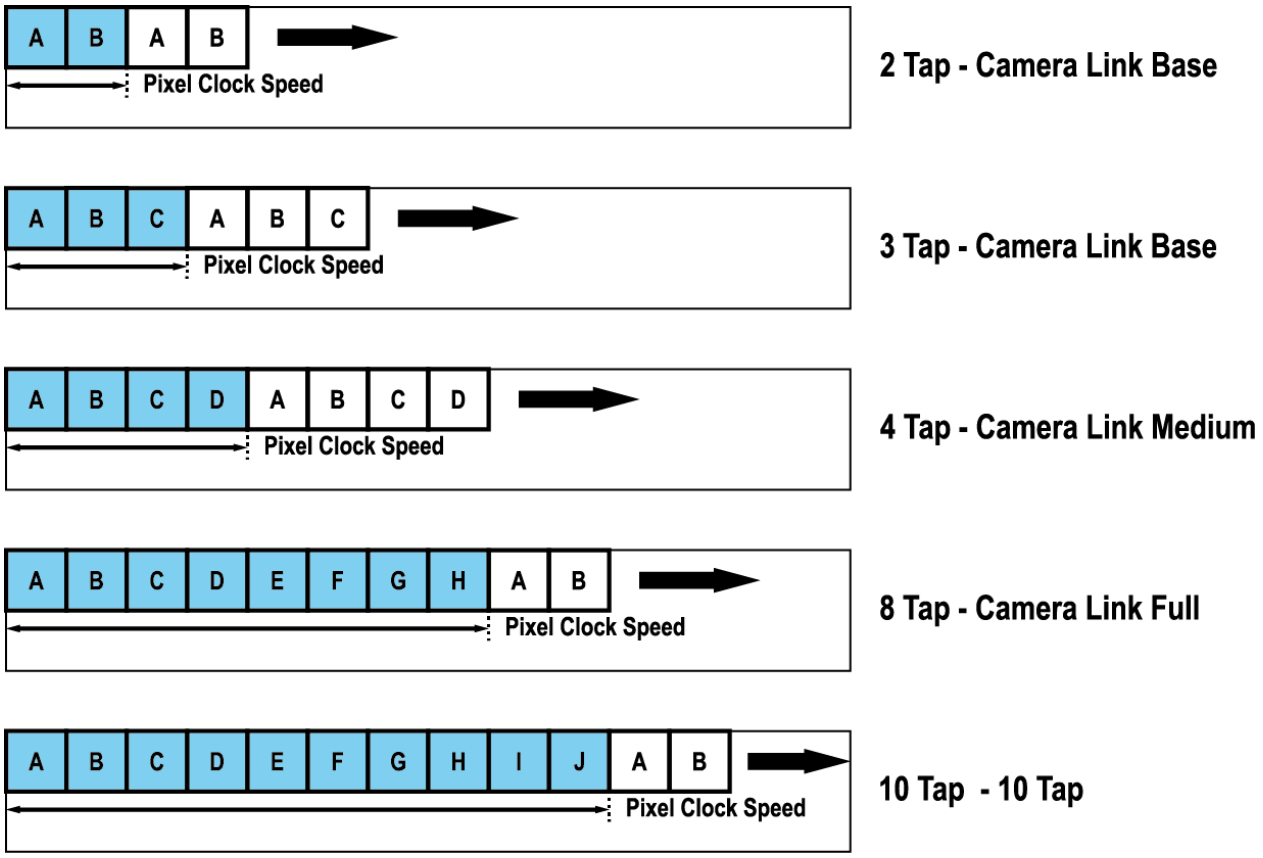


Figure 8.12 Camera Link Output Mode

8.12 Camera Link Pixel Clock Speed

The VC-50MC 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	sccs	0: 85 ㎒	Sets the Camera Link Pixel Clock Speed to 85 ㎒.
		1: 65 ㎒	Sets the Camera Link Pixel Clock Speed to 65 ㎒.

Table 8.7 Commands related to Camera Link Pixel Clock Speed

8.13 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 it takes to read an acquired frame out of the image sensor and into the camera's frame buffer. This time varies depending on the setting for the Height. Frames with a smaller height take less time to read out of the sensor. You can set the frame height by executing the 'sih' command.
- The Camera Link Pixel Clock speed. If the Pixel Clock is set to a low value, it will take longer to transfer acquired images from the camera to the Frame Grabber in your computer. With a lower Pixel Clock speed, you can acquire fewer frames per second.
- The exposure time for acquired frames. If you use very long exposure time, you can acquire fewer frames per second.

8.13.1 Increasing the Maximum Allowed Frame Rate

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

- The time that it takes to transmit a frame out of the camera is the main limiting factor on the frame rate. You can decrease the frame transmission time (and thus increase the maximum allowed frame rate) by using the ROI feature.
  - Use a smaller ROI. Decreasing the ROI means that the camera has less data to transmit and therefore the transmission time will decrease.
- If you have set the Camera Link Pixel Clock speed to a low value, consider setting it to a higher value. Before you set the camera's Pixel Clock to a higher value, make sure that your Frame Grabber is compatible with the higher Pixel Clock speed.
- If you are using normal exposure times and you are using the camera at its maximum resolution, your exposure time will not normally restrict the frame rate. However, if you are using long exposure times, 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.).

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.

8.14 Gain and Black Level

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

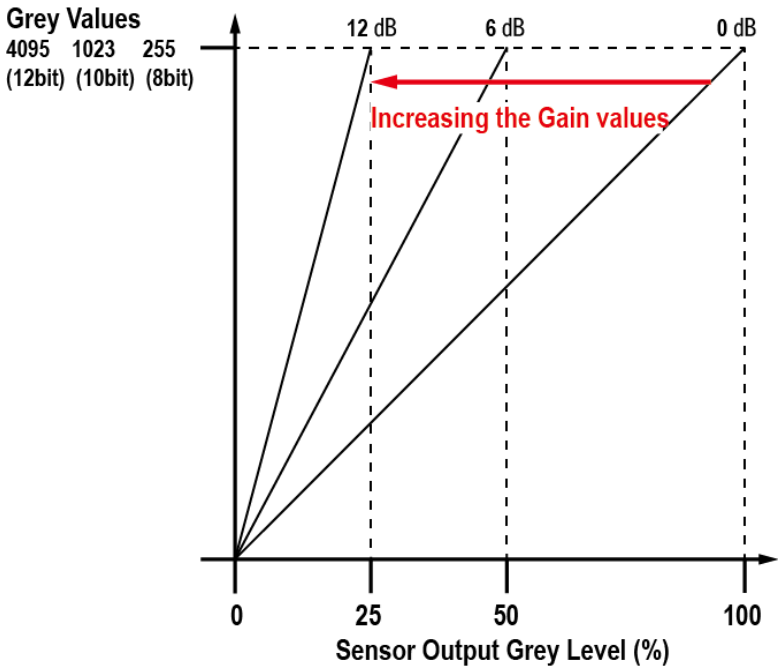


Figure 8.13 Setting the Gain

Adjusting the Black Level setting will result in an offset to the pixel values output from the camera. The ANALOG tab of the Configurator provides the following settings to adjust the gain and black level.

Command		Value	Description
Gain	sdg	1.0× ~ 30.0×	Sets a digital gain value.
Black Level	sbl	0 ~ 255	Sets a black level value.

Table 8.8 Commands related to Gain and Black Level

8.15 Defect Pixel Correction

The CMOS sensor may have Defect Pixels which cannot properly respond to the light. The VC-50MC camera provides a feature to correct the defect pixels to enhance the quality of output images. Defect Pixel information of the CMOS used for each camera is saved in the camera during the manufacturing process in the factory. If you want to add Defect Pixel information, it is required to enter the coordinate of new Defect Pixel into the camera. For more information, refer to Appendix A. You can determine whether to use the Defect Pixel Correction feature by using the 'sdc' command.

8.15.1 Correction Method

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

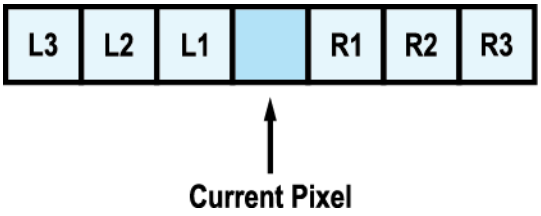


Figure 8.14 Location of Defect Pixel to be corrected

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

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

Table 8.9 Calculation of Defect Pixel Correction Value

8.16 Flat Field Correction

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

```
IC = IR /IF

IC: Level value of corrected image
IR: Level value of original image
IF: Level value of Flat Field data
```

The commands related to Flat Field Correction are as follows.

Command		Value	Description
Flat Field Data Selector	sfds	0 ~ 4	Selects a location to save Flat Field data to or load Flat Field data from. 0: Factory default location 1 ~ 4: User defined locations
Flat Field Data Generate	gfd	-	Generates the Flat Field data.
Flat Field Data Save	sfd	-	Saves the generated Flat Field data in the non-volatile memory. The generated data by executing the Flat Field Data Generate 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.
Flat Field Data Load	lfd	-	Loads the Flat Field data from the non-volatile memory into the volatile memory.

Table 8.10 Commands related to Flat Field Correction

8.16.1 Sequence of Flat Field Correction

Under actual conditions, generate Flat Field Correction data and save the Flat Field Correction data into the camera's non-volatile memory according to the following procedures.

How to generate Flat Field Correction data using Configurator

1. Select the **FFC** tab and then click the **Generate** button in the **FFC Data / Selector** category to execute the Flat Field Generator.
2. Acquire one image by operating the camera in the Free-Run mode or by applying an exposure start trigger signal to the camera.
3. Choose a location to save the generated Flat Field Correction data by using the **Selector** parameter.
4. Click the **Save to Flash** button in the **Flash Memory** category to save the generated Flat Field Correction data into the non-volatile memory. The scaled down Flat Field data will be expanded and then applied as shown in the Figure 8.17 when they are used for correction.

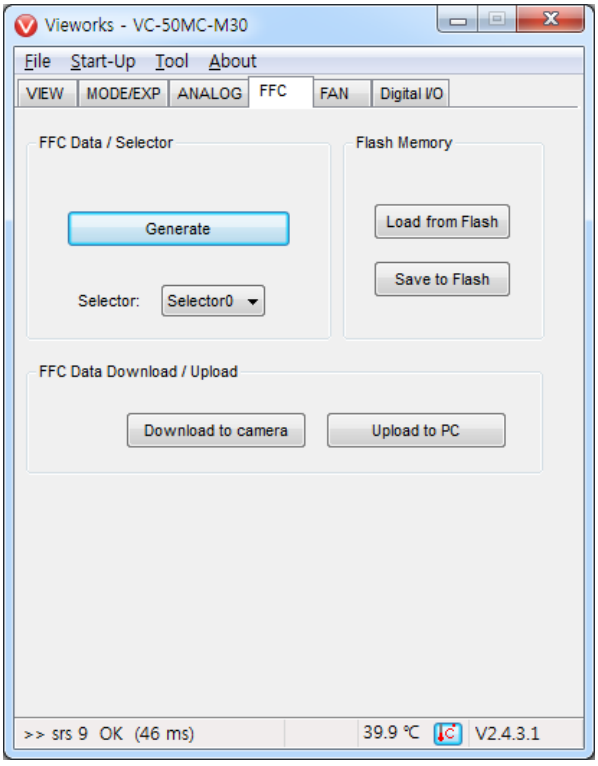


Figure 8.15 Flat Field Correction in Configurator

How to generate Flat Field Correction data using Serial Command

1. Use the ‘gfd’ command to execute the Flat Field Generator.
2. Acquire one image by operating the camera in the Free-Run mode or by applying an exposure start trigger signal to the camera.
3. Choose a location to save the generated Flat Field Correction data by using the ‘sfds 1/2/3/4’ command.
4. Execute the ‘sfd’ command to save the generated Flat Field Correction data into the non-volatile memory. The scaled down Flat Field data will be expanded and then applied as shown in the Figure 8.17 when they are used for correction.

 CAUTION	• It is recommended that you enable the Defect Pixel Correction feature before executing the Flat Field Generator. • Before executing the Flat Field Generator, you must set the camera as follows: ▫ OffsetX, Y: 0 ▫ Width, Height: Maximum values ▫ Binning: 1×

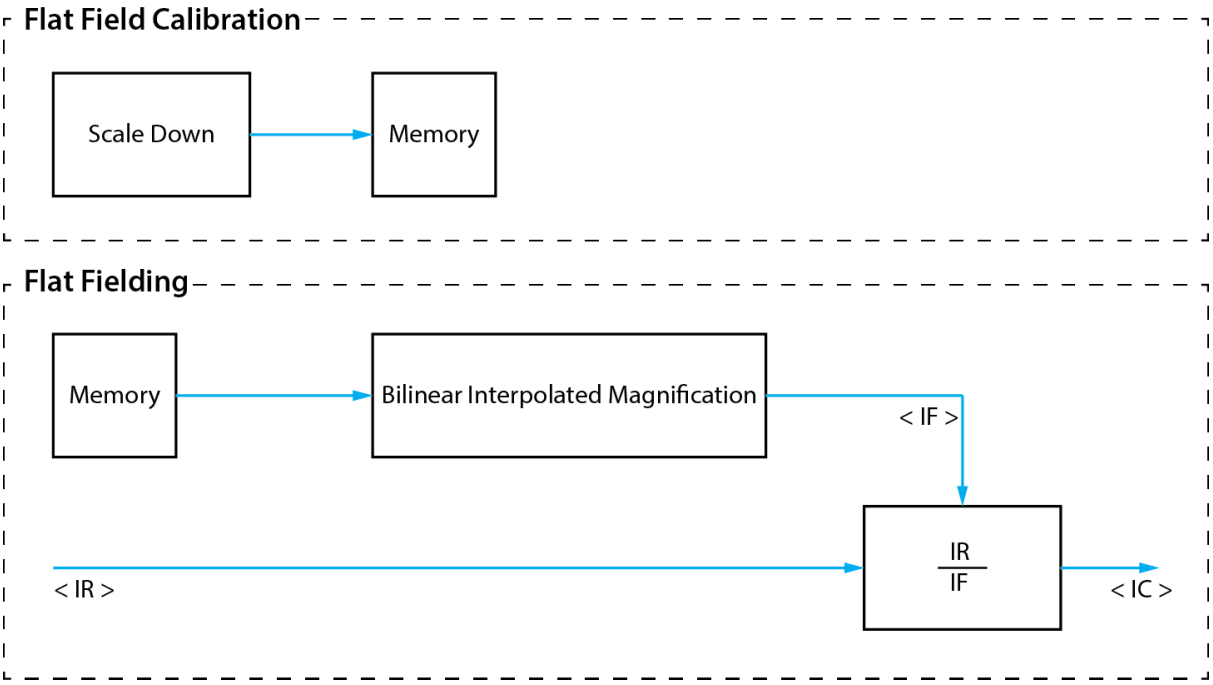


Figure 8.16 Generation and Application of Flat Field Data

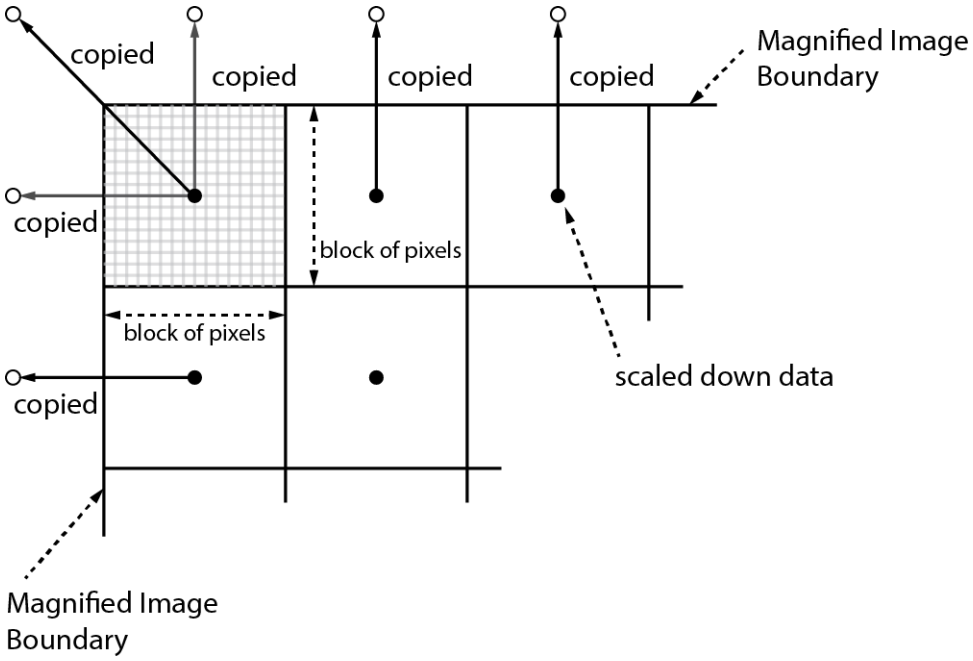


Figure 8.17 Bilinear Interpolated Magnification

8.16.2 Flat Field Data Selector

As mentioned above, the active Flat Field data is stored in the camera's volatile memory and the data is lost if the camera is reset or powered off. To use the active or generated Flat Field data after the camera is powered on or reset, you need to save them in the camera's non-volatile memory. The VC-50MC camera provides four reserved locations in the camera's non-volatile memory available for saving the active Flat Field data and five reserved locations in the camera's non-volatile memory available for loading the saved Flat Field data into the camera's active Flat Field data. You can use the 'sfds' command to select a location as desired. The factory default Flat Field data are saved into each location during the manufacturing process.

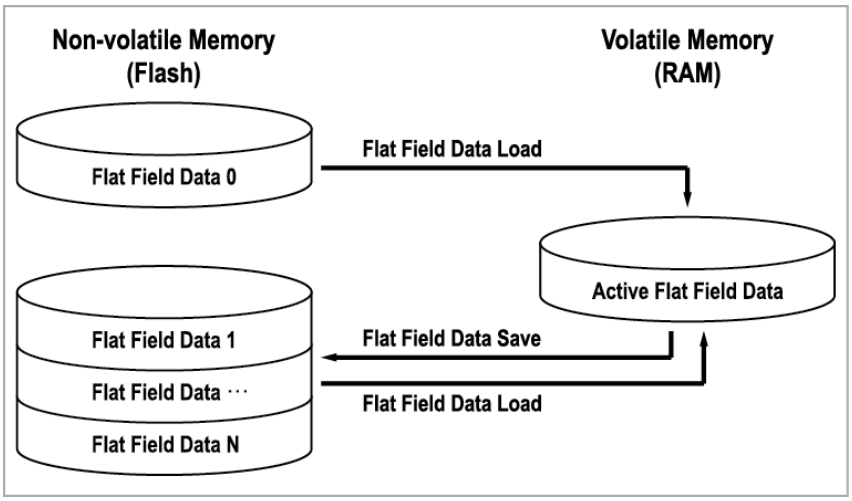


Figure 8.18 Flat Field Data Selector

Saving Flat Field Data

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

1. User the 'sfds 1/2/3/4' command to specify a location to save the active Flat Field data.
2. Execute the 'sfd' command to save the active Flat Field data to the selected location.

Loading Flat Field Data

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

1. Use the 'sfds 0/1/2/3/4' command to specify a reserved location whose Flat Field data will be loaded into the camera's active Flat Field data location.
2. Execute the 'lfd' command to load the selected Flat Field data into the active Flat Field data location.

8.17 Temperature Monitor

The camera has an embedded sensor chip to monitor the internal temperature. To check the temperature of the camera, use the ‘gct’ command.

8.18 Status LED

A green LED is installed on the back panel of the camera to inform the operation status of the camera. LED status and its corresponding camera status are as follows:

- LED Off: The camera is not initialized.
- Fast Flashing Green: The camera is operating.

8.19 Test Image

To check whether the camera operates normally or not, it can be set to output test images generated in the camera, instead of the image data from the image sensor. Three types of test images are available; image with different value in horizontal direction (Test Image 1), image with different value in diagonal direction (Test Image 2), and moving image with different value in diagonal direction (Test Image 3). You can set the Test Image feature by using the ‘sti’ command.

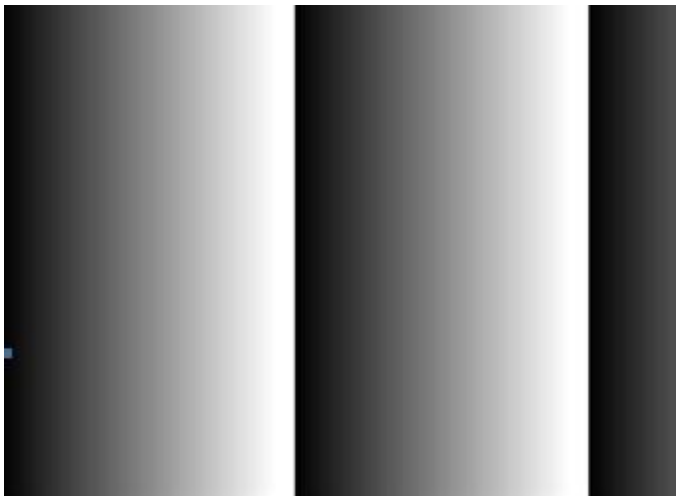


Figure 8.19 Test Image 1

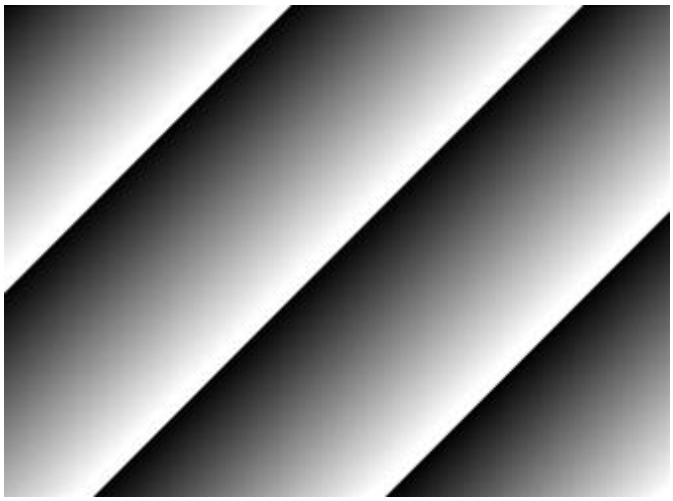


Figure 8.20 Test Image 2

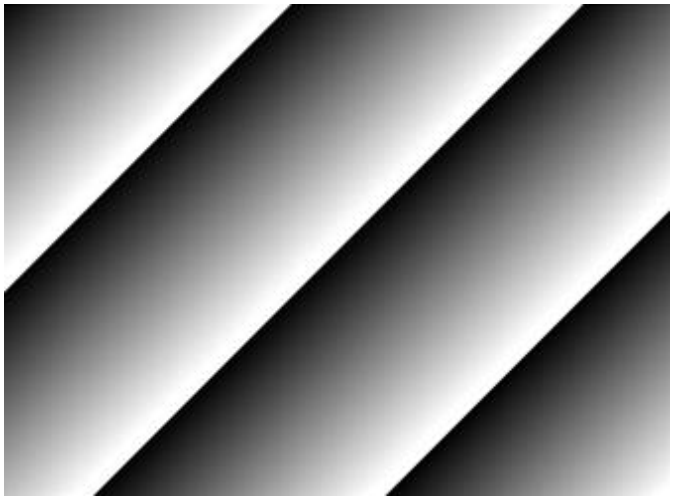


Figure 8.21 Test Image 3

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

8.20 Reverse X

The Reverse X feature lets you flip images horizontally. This feature is available in all operation modes of the camera. You can set the Reverse X feature by using the ‘shf’ command.

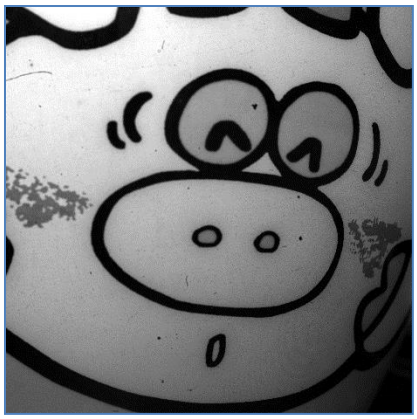


Figure 8.22 Original Image

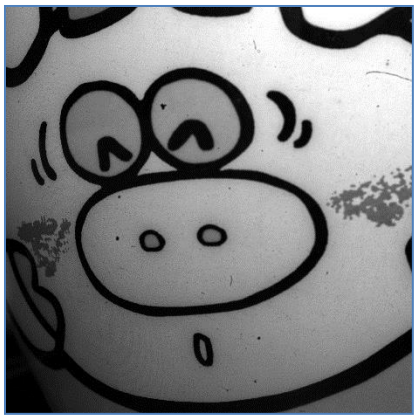


Figure 8.23 Reverse X Image

8.21 Digital IO Control

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

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

Command		Value	Description
Line Source	slos	0: Off	Disables the line output.
		1: Exposure	Outputs pulse signals indicating the current exposure time.
		2: Frame	Outputs pulse signals indicating a frame readout time.
		5: User Output	Outputs pulse signals set by the User Output Value (the 'suov' command).
		7: Timer	Outputs user-defined Timer signals as pulse signals.
Line Inverter	sloi	0: FALSE	Disables inversion of the output signal of the line.
		1: TRUE	Enables inversion of the output signal of the line.
User Output Value	suov	0: FALSE	Sets the bit state of the line to Low.
		1: TRUE	Sets the bit state of the line to High.

Table 8.11 Commands related to Digital IO Control

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

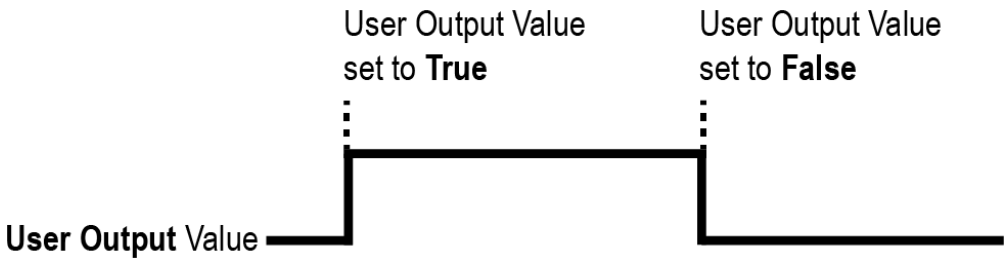


Figure 8.24 User Output

8.21.1 Debounce

The Debounce feature of the VC-50MC camera allows to supply only valid signals to the camera by discriminating between valid and invalid input signals. The Debounce Time setting 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 setting value. When you set the Debounce Time, High and Low signals shorter than the setting value are considered invalid and ignored as shown in the figure below.

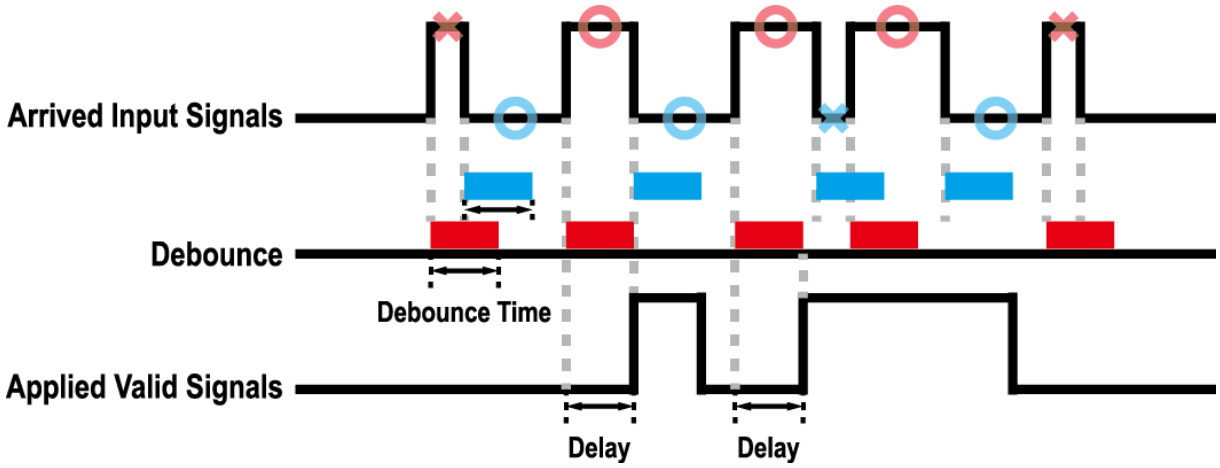


Figure 8.25 Debounce

The command related to Debounce Time is as follows.

Command		Value	Description
Debounce Time	sdbt	0 ~ 1,000,000 μs	Sets a Debounce Time in microseconds.

Table 8.12 Command related to Debounce Time

8.21.2 Timer Control

When the Line Source is set to Timer (the ‘slos 7’ command is executed), the camera can provide output signals by using the Timer. The VC-50MC camera has one Timer and exposure start is the only trigger source event available to start the Timer.

The commands related to Timer are as follows.

Command		Value	Description
Timer Trigger Source	stts	0: Off	Disables the Timer trigger.
		1: Exposure	Sets the Timer to use the exposure start as source signals.
Timer Duration	stdu	0 – 60,000,000 μs	Sets the duration of the Timer output signal.
Timer Delay	stdl	0 – 60,000,000 μs	Sets the delay time to be applied before starting the Timer.
Timer Trigger Activation	stta	0: Falling Edge	Specifies that a falling edge of the selected trigger signal will act as the Timer trigger.
		1: Rising Edge	Specifies that a rising edge of the selected trigger signal will act as the Timer trigger.
		2: Level Low	Specifies that the Timer output signal will be valid as long as the selected trigger signal is Low.
		3: Level High	Specifies that the Timer output signal will be valid as long as the selected trigger signal is High.

Table 8.13 Commands related to Timer Control

For example, when 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 command are applied, the Timer will start operations.
2. The delay set by the Timer Delay command begins to expire.
3. When the delay expires, the Timer signal goes high as long as the source signal is high.

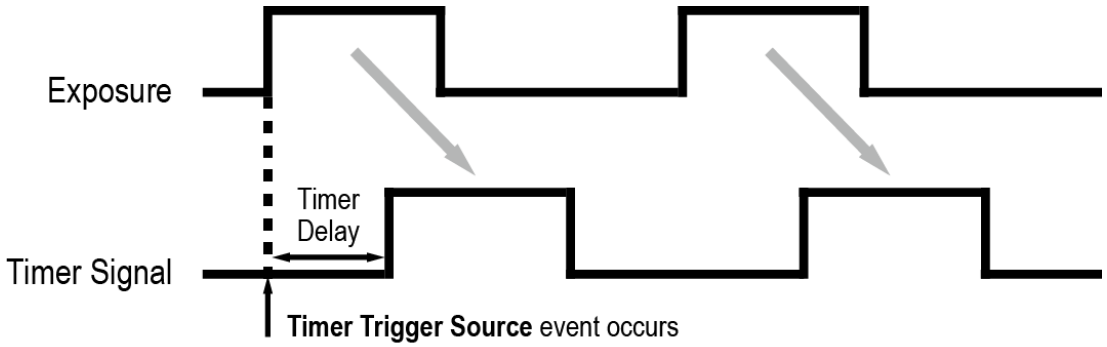


Figure 8.26 Timer Signal

8.22 Fan Control

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

Command		Value	Description
Fan Mode	sfm	0: Off	Turns off the fan.
		1: On	Turns on the fan.
		2: Temperature	Turns on the fan when the internal temperature exceeds the value set in the Target Temperature.
Target Temperature	stt	-10℃ - 80℃	Sets the temperature to operate the fan when the Fan Mode is set to Temperature.

Table 8.14 Commands related to Fan Control

8.23 Device Reset

Resets the camera physically to power off and on. You can reset the camera by using the ‘rst’ command.

8.24 Field Upgrade

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

8.25 Dark Signal Non-uniformity Correction

In theory, when a digital camera acquires images in complete darkness, all of the pixel values in the image should be near zero and they should be equal. In practice, however, slight variations in the performance of the pixels in the image sensor will cause some variations in the pixel values output from the camera when the camera is acquiring in darkness. This variation is known as Dark Signal Non-Uniformity (DSNU). The VC-50MC camera provides the DSNU Correction feature.

8.25.1 Generating and Saving DSNU Correction Values

To generate and save DSNU correction values for your operating temperature, follow the procedures below.

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

1. To generate optimized DSNU correction values, set the ROI setting to use the entire resolution of the image sensor.
2. Ensure that the camera will be acquiring images in complete darkness by covering the camera lens, closing the iris in the lens, or darkening the room.
3. Begin acquiring images by setting the camera for the Free-Run mode.
4. Execute the ‘gdd’ command to generate DSNU data.
5. The generated DSNU correction values will be activated and saved in the camera’s volatile memory.
6. To save the generated DSNU correction values in the camera’s Flash (non-volatile) memory, execute the ‘sdd’ command. The existing DSNU values saved in the memory will be overwritten.

9 Camera Configuration

9.1 Setup Command

You can configure all camera settings via RS-644 serial interface of the Camera Link. When you want to control the camera using a terminal or access directly to the camera at 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

All camera setting commands are transmitted in the ASCII command type except a command for transmitting a large file such as firmware download. All camera setting commands are transmitted from the user application, and then the camera returns a response (‘OK’, ‘Error’ or information) for a command. When you execute a write command, the camera returns a response to inform whether the command has been successfully executed. When you execute a read command, the camera returns an error or information.

```
Command format:
<command> <parameter1> <parameter2> <cr>
0 – 2 parameters follow the command.
Response:
If a write command is successfully executed
OK <cr> <lf>
```

ex) Write command

```
In response to a “set 100” command the camera will return (in hex value)
Command    : 73 65 74 20 31 30 30 0D
             set 100<cr>
Response   : 73 65 74 20 31 30 30 0D 0A 4F 4B 0D 0A 3E
             set 100<cr><lf>           OK<cr><lf>  >
             Echo                      result      prompt
```

```
If a read command is successfully executed
<parameter1> <cr> <lf>
```

ex) Read command

```
In response to a "get" command the camera will return (in hex value)
Command    : 67 65 74 0D
             get <cr>
Response   : 67 65 74 0D 0A 31 30 30 0D 0A 3E
             get<cr><lf>    100<cr><lf>    >
             Echo           response       prompt
```

```
If a command is not executed successfully
Error: <Error code> <cr> <lf>
```

```
Prompt:
A prompt always follows after the response. '>' is used as a prompt.

Types of Error Code
0x80000481: value of parameter is not valid
0x80000482: the number of parameter is not matched
0x80000484: command does not exist
0x80000486: no permission to execute
```

9.2 Actual Runtime of Commands

When you execute a command, the actual runtime of the command varies depending on the type of the command and the operating status of the camera.

All commands except Set Exposure Time (‘set’) command are applied to change the settings as illustrated below, on the rising edge of a REQ_Frame signal before starting the readout process. When you execute the ‘set’ command, the exposure time setting will be changed and applied at the starting of the exposure.

If you operate the camera with CC1 or external trigger signals, you must execute commands before applying the trigger signals in order to synchronize image outputs with the commands.

If you execute a command in the Free-Run mode, you may acquire up to two images that are not affected by the command execution. This is true because it is hard to verify the current operating status of the camera in the Free-Run mode.

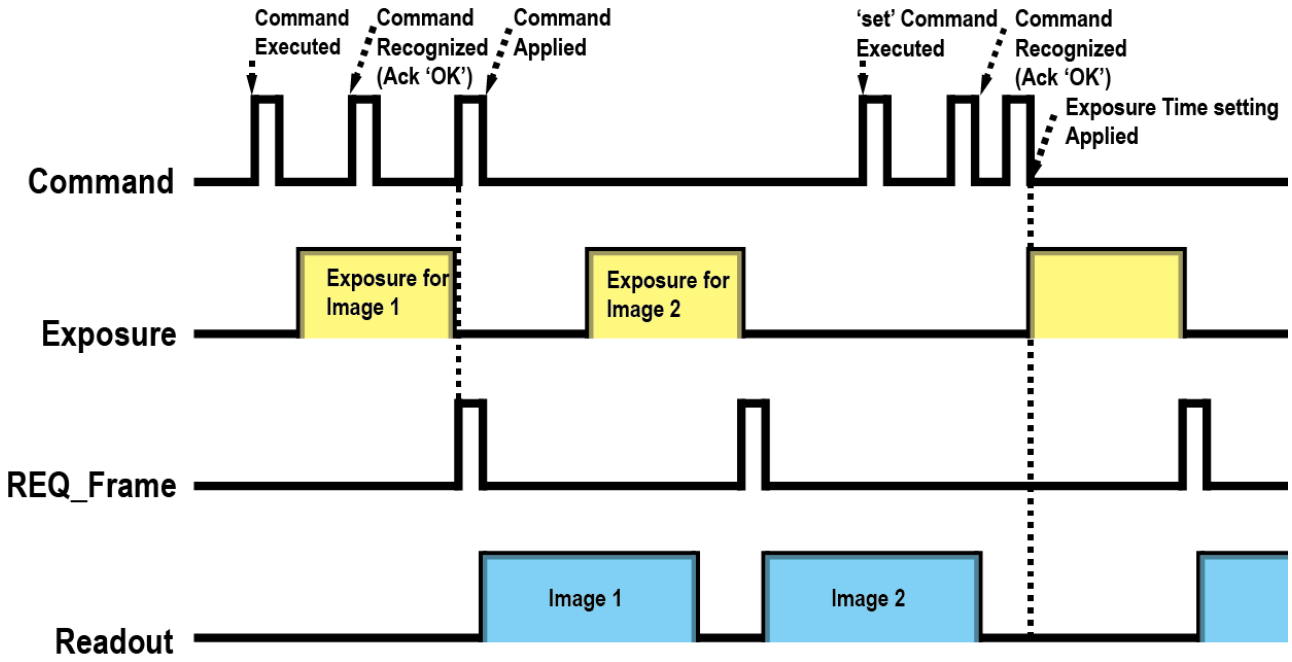


Figure 9.1 Actual Runtime of Commands

9.3 User Set Control

The VC-50MC camera provides three non-volatile spaces (Flash) for storing camera settings and one workspace (RAM) for operating the camera. Non-volatile spaces are divided into a Default space that contains default setting values entered during the manufacturing, and two User spaces that are available for saving user-defined setting values. You can save the current camera settings to a user space or you can load the settings stored in one of the non-volatile spaces into the camera's workspace.

The commands related to User Set Control are as follows.

Command		Value	Description
User Set Load	lcf	0: Default	Loads the Factory Default Setting to the camera.
		1: User 1 Setting	Loads the User 1 Setting to the camera.
		2: User 2 Setting	Loads the User 2 Setting to the camera.
User Set Save	sct	1: User 1 Setting	Saves the current camera settings to the User 1 Setting.
		2: User 2 Setting	Saves the current camera settings to the User 2 Setting.
User Set Default	sci	0: Default	Applies the Factory Default Setting when reset.
		1: User 1 Setting	Applies the User 1 Setting when reset.
		2: User 2 Setting	Applies User 2 Setting when reset.

Table 9.1 Commands related to User Set Control

The camera settings stored in the Default space can be loaded into the camera's workspace, but cannot be changed. The camera 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.

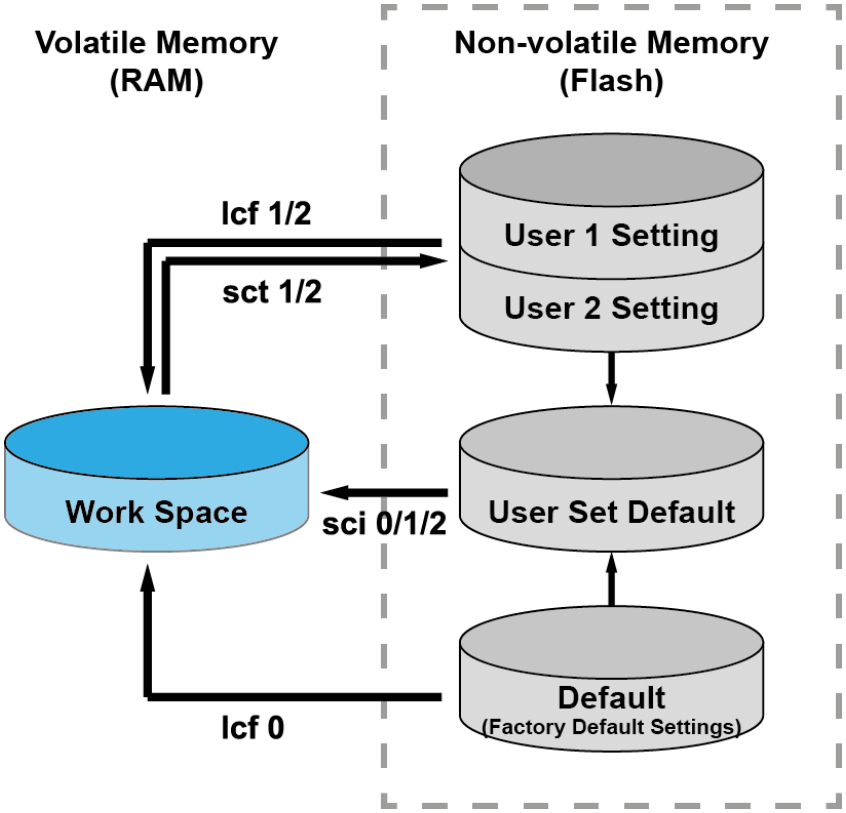


Figure 9.2 User Set Control

9.4 Command List

You can set all features provided by the VC-50MC camera by using the following commands.

Command	Syntax	Return Value	Description
Help	help	String	Displays a list of all commands.
Set Offset X Get Offset X	sox n gox	OK n	X coordinate of start point ROI n: X axis offset
Set Offset Y Get 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 a ROI. n: Width value (Setting range: 384 - 7920)
Set Image Height Get Image Height	sih n gih	OK n	Sets a height of a ROI. n: Height value (Setting range: 4 – 6004)
Set Region Select Get Region Select	srs n grs	OK n	Selects a ROI when setting the Multi-ROI. n: ROI number (0 – 9)
Set Region Mode Get Region Mode	src 0|1 grc	OK 0|1	Enables / Disables the selected ROI. 0: Disables the ROI. 1: Enables the 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.
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.
Set Region Width Get Region Width	srw n grw	OK n	Sets a width for the selected ROI when setting the Multi-ROI.
Set Region Height Get Region Height	srh n grh	OK n	Sets a height for the selected ROI when setting the Multi-ROI.
Update Multi-ROI	ast	OK	Updates setting values of the Multi-ROI.

Table 9.2 Command List #1

Command	Syntax	Return Value	Description
Set Binning Mode Get Binning Mode	sbm 0|1 gbm	OK 0|1	Sets the Binning mode. 0: Average mode 1: Sum mode
Set Binning Vertical factor Get Binning Vertical factor	sbv 1|2 gbv	OK 1|2	Sets the Binning factor. 1: Disables the Binning. 2: Sets the 2 × 2 Binning.
Set Binning Horizontal Get Binning Horizontal	sbh 1|2 gbh	OK 1|2	Updated automatically according to the Binning Vertical.
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 1|5 gts	OK 1|5	Specifies the source signal when the Trigger Mode is set to On. 1: CC1 5: External
Set Trigger Activation Get Trigger Activation	stp 0|1 gtp	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 Source Get Exposure Source	ses 0|1 ges	OK 0|1	Sets the Exposure mode. 0: Timed 1: Trigger Width
Set Exposure Time Get Exposure Time	set n get	OK n	Sets an exposure time. n: Exposure time in microseconds (Setting range: 1 – 60,000,000 μs)
Set Black Level Get Black Level	sbl n gbl	OK n	Sets the Black Level. n: Black Level value (Setting range: 0 – 255)
Set Digital Gain Get Digital Gain	sdg n gdg	OK n	Sets the Gain. n: Gain value (Setting range: 1.0 – 30.0)

Table 9.3 Command List #2

Command	Syntax	Return Value	Description
Set Test Image Get Test Image	sti 0|1|2|3 gti	OK 0|1|2|3	Sets the Test Image. 0: Test Image Off 1|2: Fixed pattern images 3: Moving pattern images
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 Camera Link Mode Get Camera Link Mode	scl 2|3|4|8|10 gcl	OK 2|3|4|8|10	Sets the Camera Link Output mode. 2: 2 Tap 3: 3 Tap 4: 4 Tap 8: 8 Tap 10: 10 Tap
Set Camera Link Clock Selector Get Camera Link Clock Selector	sccs 0|1 gccs	OK 0|1	Sets the Camera Link Pixel Clock. 0: 85 MHz 1: 65 MHz
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.
Generate Flat Field Data	gfd	OK	Executes the Flat Field (FF) Generator.
Set Flat Field Data Selector Get Flat Field Data Selector	sfds 0|1|2|3|4 gfds	OK 0|1|2|3|4	Selects a FF data location. 0: Factory default location 1 ~ 4: User defined locations
Save Flat Field Data	sfd	OK	Saves the generated FF data in the selected FF data location.
Load Flat Field Data	lfd	OK	Loads the FF data from the non-volatile memory into the volatile memory.

Table 9.4 Command List #3

Command	Syntax	Return Value	Description
Generate DSNU Data	gdd	OK	Generates DSNU data.
Save DSNU Data	sdd	OK	Saves DSNU data in the non-volatile memory.
Set Line Output Source Get Line Output Source	slos 0|1|2|5|7 glos	OK 0|1|2|5|7	Specifies the source signal for the control I/O receptacle. 0: Disables the Line output. 1: Exposure 2: Frame 5: User Output 7: Timer
Set Line Output Inverter Get Line Output Inverter	sloi 0|1 gloi	OK 0|1	Sets whether to invert the line output. 0: Disables inversion of the line output. 1: Enables inversion of 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 Timer Trigger Source Get Timer Trigger Source	stts 0|1 gtts	OK 0|1	Specifies the source signal for the Timer output signal. 0: Disables the Timer trigger. 1: Exposure
Set Timer Duration Get Timer Duration	stdu n gtdu	OK n	Sets the duration of the Timer output signal. n: 0 – 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
Set Timer Trigger Activation Get Timer Trigger Activation	stta 0|1|2|3 gtta	OK 0|1|2|3	Sets the activation mode for the Timer. 0: Falling Edge 1:Rising Edge 2: Level Low 3: Level High
Set Debounce Time Get Debounce Time	sdbt n gdbt	OK n	Sets the Debounce time. n: Debounce time in microseconds

Table 9.5 Command List #4

Command	Syntax	Return Value	Description
Set Fan Mode Get Fan Mode	sfm 0|1|2 gfm	OK 0|1|2	Sets the Fan operation mode. 0: Fan Off 1: Fan On 2: Temperature
Set Target Temperature Get Target Temperature	stt n gtt	OK n	Sets the temperature to operate the fan when the Fan Mode is set to Temperature. n: -10℃ - 80℃
Set AWB Offset X Get AWB Offset X	swx n gwx	OK n	Sets a horizontal offset from the origin to the AWB ROI.
Set AWB Offset Y Get AWB Offset Y	swy n gwy	OK n	Sets a vertical offset from the origin to the AWB ROI.
Set AWB Width Get AWB Width	sww n gww	OK n	Sets a width for the AWB ROI.
Set AWB Height Get AWB Height	swh n gwh	OK n	Sets a height for the AWB ROI.
Set RGB Gain Get RGB Gain	srg r|g|b g grg r|g|b	OK g	Sets the intensity of color pixels. r|g|b: Red / Green / Blue pixels g: Gain value (×1.0 ~ ×4.0)
Auto White Balance	arg	OK	Automatically adjusts the white balance once.
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 9.6 Command List #5

Command	Syntax	Return Value	Description
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 device temperature in Celsius.
Reset Hardware	rst	String	Resets the camera physically to power off and on.

Table 9.7 Command List #6

10 Configurator GUI

The Configurator, a sample application, is provided to control the VC-50MC camera. The Configurator provides an easy-to-use Graphic User Interface (GUI) that allows users to view and change the camera's settings mentioned in the previous chapters.

10.1 Camera Scan

When you execute the Configurator.exe file while the camera is powered on, the **Camera Scan** window appears as shown in the figure below. At that point, the Configurator checks serial ports of your computer and DLL provided by the Camera Link to scan whether a camera is connected. If the Configurator finds a connected camera, it displays the model name of the camera on the Camera Scan window. If the camera is not displayed on the window, check the cable connections and power of the camera, and then press the **refresh** button. Double-clicking the model name of the camera displayed on the window will launch the Configurator and display the current parameter settings of the camera connected.

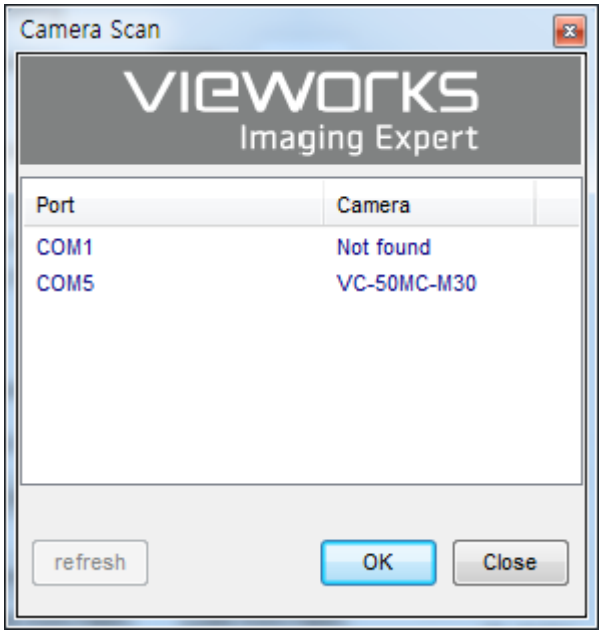


Figure 10.1 Configurator Loading Window

10.2 Menu

The menu bar of the Configurator provides the File, Start-Up, Tool and About menus.

10.2.1 File

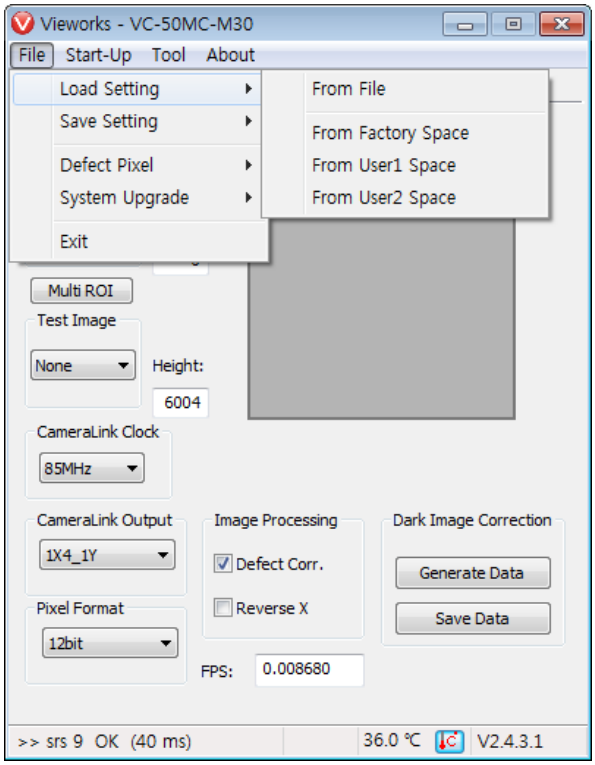


Figure 10.2 File Menu

- **Load Setting:** Loads the camera setting values from the camera memory (Factory, User1 or User2) or user's computer (File).
- **Save Setting:** Saves the camera setting values to the camera memory (User1 or User2) or user's computer (File).
- **Defect Pixel:** Downloads defect information to the camera (Download to Camera) or uploads defect information stored in the camera to user's computer (Upload to PC).
- **System Upgrade:** Upgrades the MCU or FPGA logic.
- **Exit**: Exits the Configurator.

10.2.2 Start-Up

The Start-Up menu allows you to select the camera setting values to be loaded when the camera is powered on.

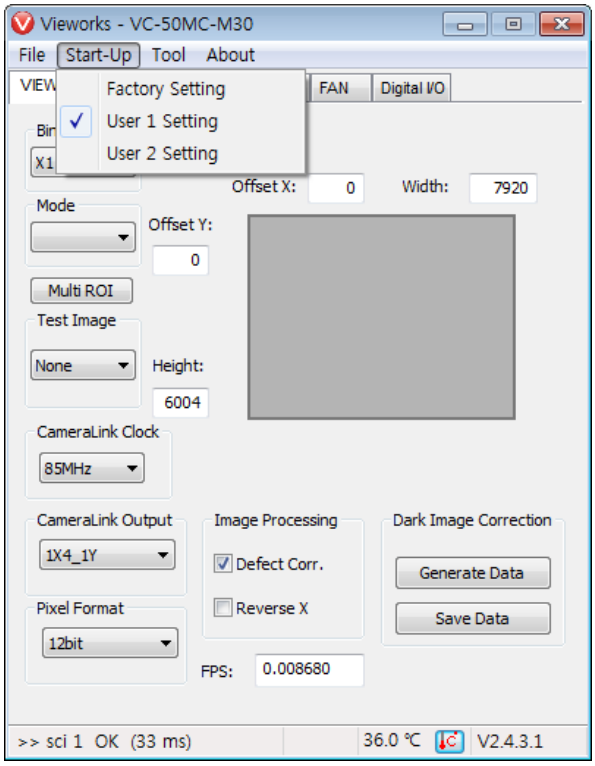


Figure 10.3 Start-Up Menu

- **Factory Setting:** Loads the camera setting values from the Factory space when the camera is powered on.
- **User 1 Setting:** Loads the camera setting values from the User1 space when the camera is powered on.
- **User 2 Setting:** Loads the camera setting values from the User2 space when the camera is powered on.

10.2.3 Tool

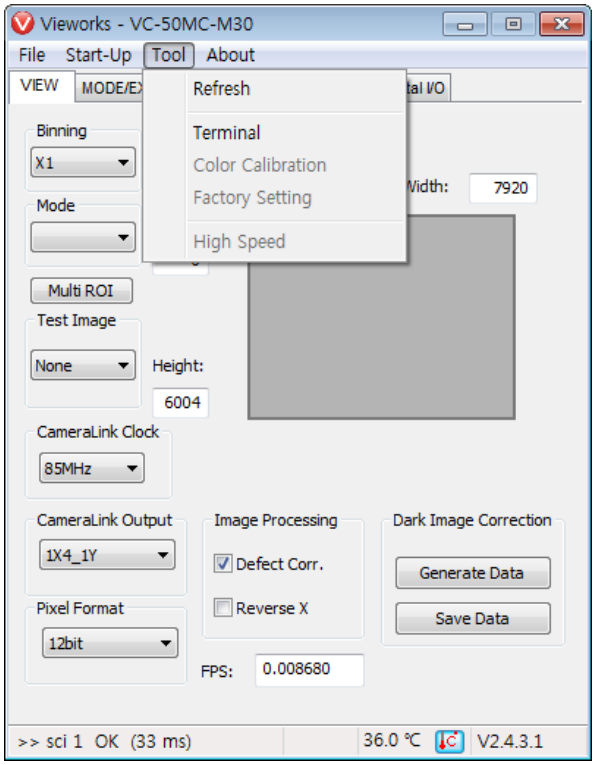


Figure 10.4 Tool Menu

- **Refresh:** Loads and displays the current camera setting values on the Configurator.
- **Terminal:** Displays the Terminal window. The Terminal window displays a user command for the feature that you have set on the Configurator. To hide the Terminal window, uncheck Terminal by clicking it again.
- **Color Calibration:** Not supported in the Configurator.
- **Factory Setting:** Not supported for users.
- **High Speed:** Not supported in the Configurator.

10.2.4 About

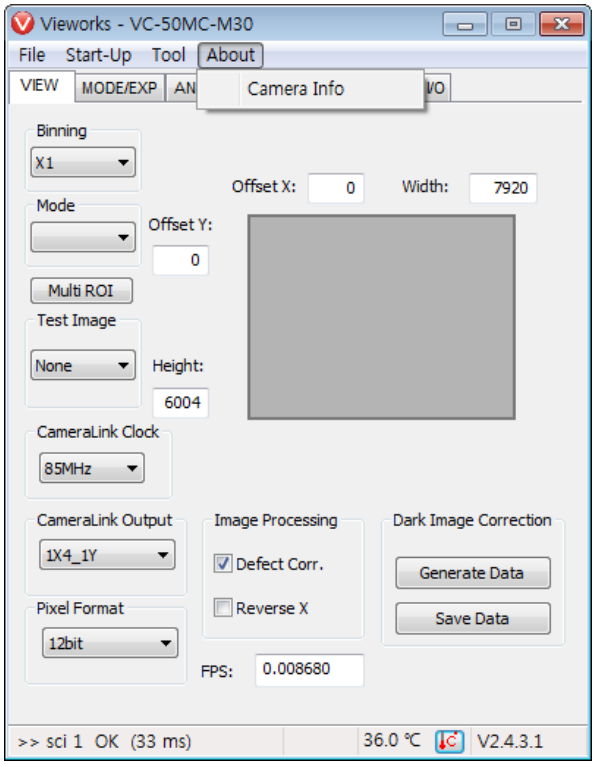


Figure 10.5 About Menu

- **Camera Info:** Displays camera information (model name, serial number, version, etc.).

10.3 Tab

10.3.1 VIEW Tab

The VIEW tab allows you to set the camera's Region of Interest (ROI), Binning mode, Test Image mode, Camera Link Pixel Clock speed, Camera Link Output mode, Pixel Format, image processing and Dark Image Correction.

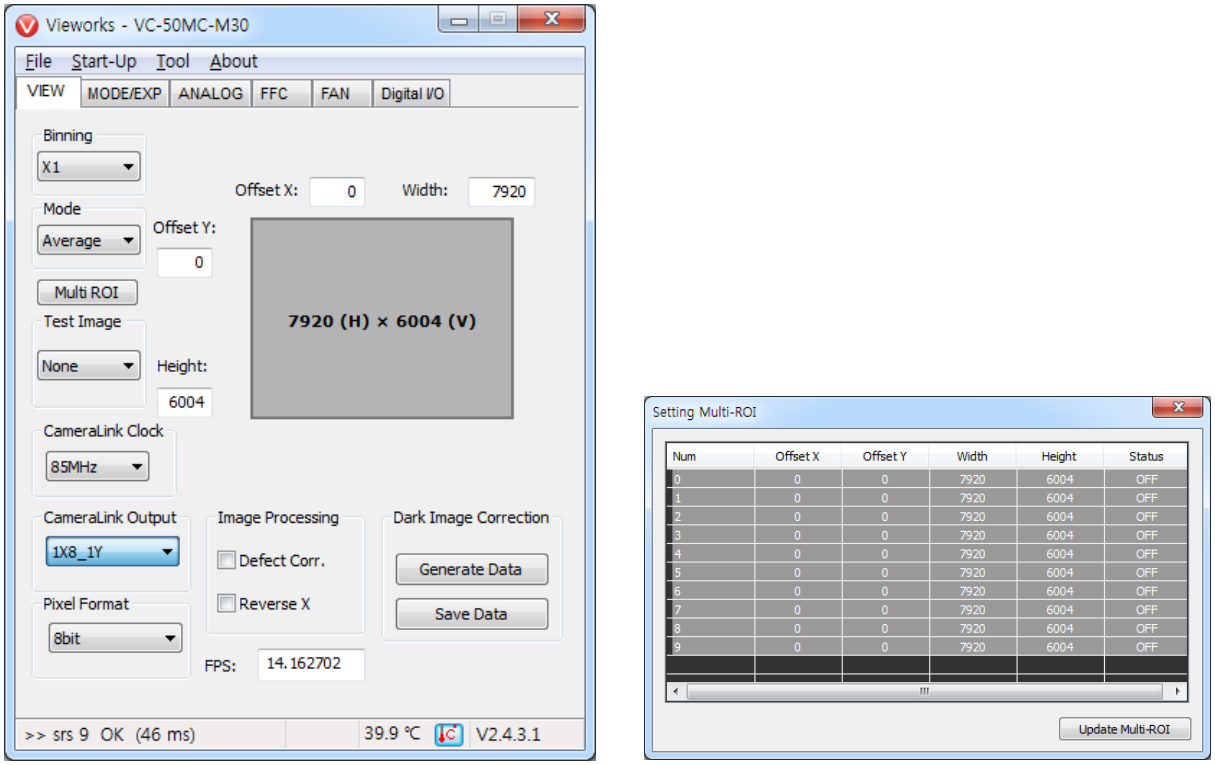


Figure 10.6 VIEW Tab

- **Binning / Mode:** Sets the Binning mode.
- **Offset X, Offset Y, Width, Height:** Sets the camera's ROI.
- **Multi-ROI:** Displays the **Setting Multi-ROI** window for setting the Multi-ROI.
- **Test Image:** Selects whether to apply the test image and a type of test images.
- **Camera Link Clock:** Selects a Camera Link Pixel Clock speed.
- **Camera Link Output:** Sets the Camera Link output mode.
- **Pixel Format:** Selects a bit depth of data output.
- **Imaging Processing:** Enables or disables the Defect Pixel Correction and/or Reverse X features.
- **Dark Image Correction:** Generates and saves the DSNU correction values.

10.3.2 MODE/EXP Tab

The MODE/EXP tab allows you to configure the camera's trigger mode and exposure time.

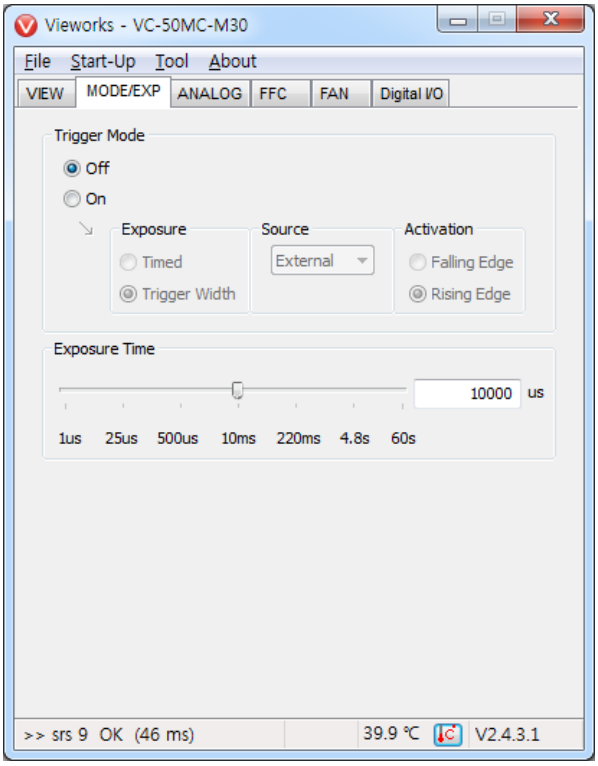


Figure 10.7 MODE/EXP Tab

- **Trigger Mode**: Sets the Trigger Mode. When you set the Trigger Mode to On, all associated options will be activated.
- **Exposure**: Selects an exposure mode.
- **Source**: Specifies a source signal for exposure triggering.
- **Activation**: Sets the activation mode for the trigger.
- **Exposure Time**: Sets an exposure time when the Trigger Mode is set to Off or when the Exposure is set to Timed.

10.3.3 ANALOG Tab

The ANALOG tab allows you to adjust the camera's gain and black level values.

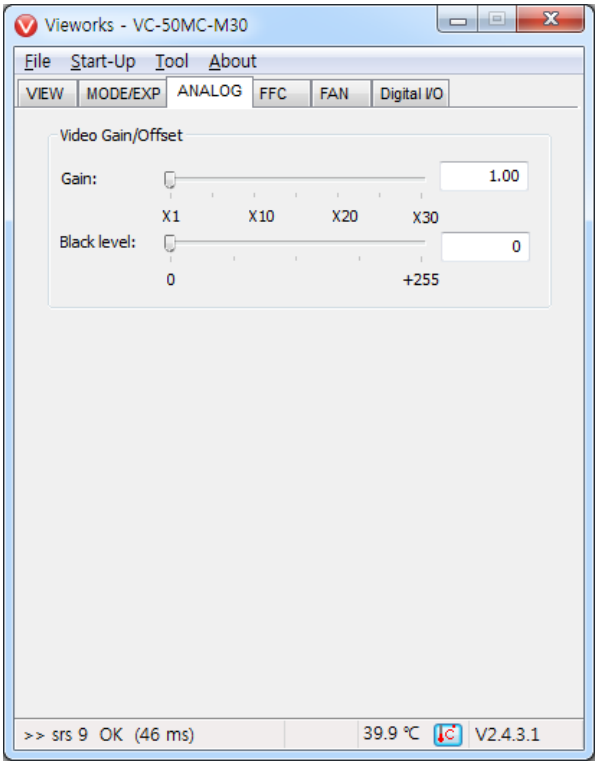


Figure 10.8 ANALOG Tab

- **Gain:** Sets a gain value.
- **Black Level:** Sets a black level value.

10.3.4 FFC Tab

The FFC Tab allows you to set the Flat Field Correction feature.

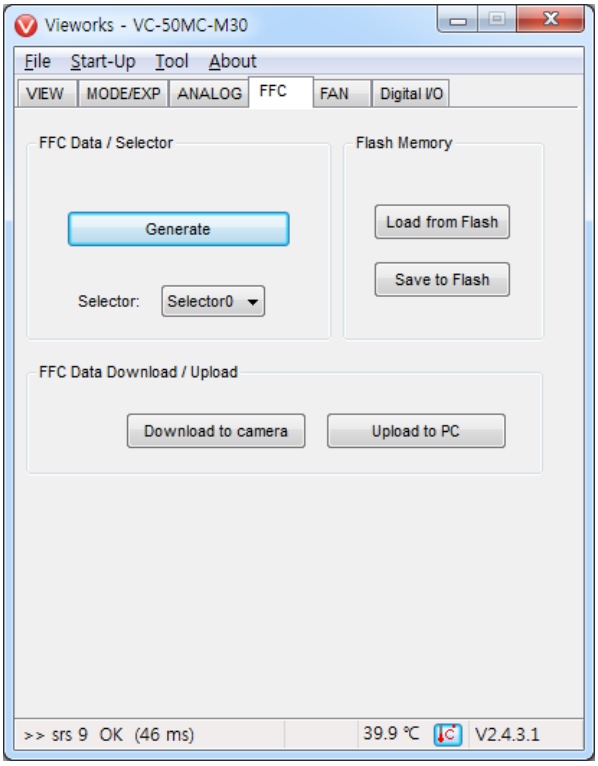


Figure 10.9 FFC Tab

- **FFC Data Generate:** Generates the Flat Field data.
- **FFC Data Selector:** Selects a location to save Flat Field data to or load Flat Field data from.
- **Flash Memory:** Saves the generated Flat Field data in the Flash memory for future use (Save to Flash) or loads the Flat Field data stored in the Flash memory (Load from Flash).
- **FFC Data Download / Upload:** Downloads the Flat Field data stored in user's computer to the camera (Download to camera) or uploads the Flat Field data stored in the camera to user's computer (Upload to PC).

10.3.5 FAN Tab

The FAN tab allows you to set the fan operation mode and operation temperature.

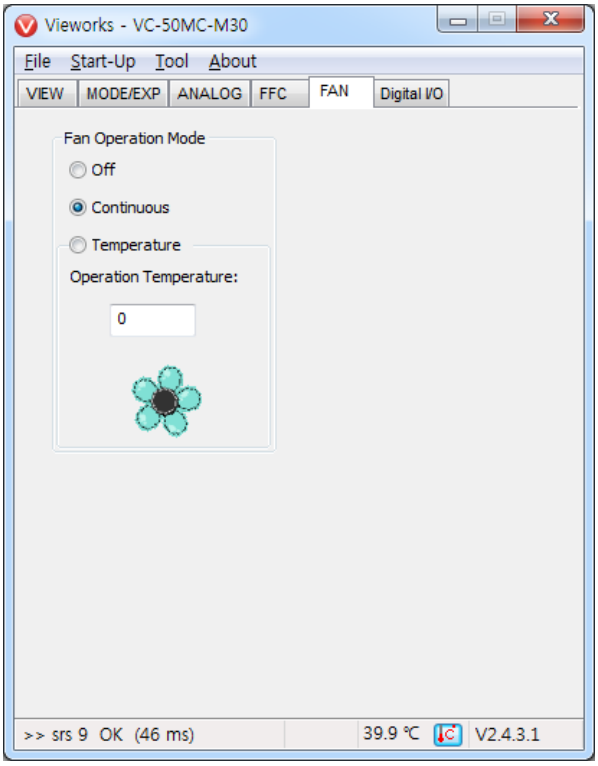


Figure 10.10 FAN Tab

- **Fan Operation Mode:** Sets the fan operation mode.
- **Operation Temperature:** Sets the temperature to operate the fan when the Fan Operation Mode is set to Temperature.

10.3.6 Digital I/O Tab

The Control I/O receptacle of the VC-50MC can be operated in various modes. The Digital I/O tab allows you to configure the mode of the Control I/O receptacle.

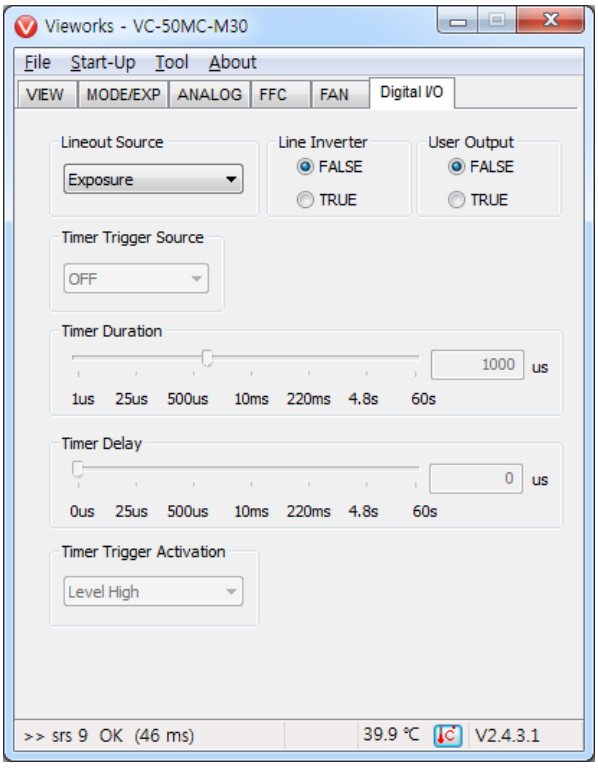


Figure 10.11 Digital I/O Tab

- **Lineout Source:** Specifies a source signal for the line output.
- **Line Inverter:** Sets whether to invert the line output signal.
- **User Output:** Sets the User Output value.
- **Timer Trigger Source:** Specifies a source signal for the Timer output.
- **Timer Duration:** Sets the duration of the Timer output signal.
- **Timer Delay:** Sets the delay time to be applied before starting the Timer output.
- **Timer Trigger Activation:** Sets the activation mode for the Timer output.

10.3.7 AWB Tab (Color Camera Only)

The VC-50MC color camera provides the Auto White Balance feature. The AWB tab allows you to set the AWB ROI or adjust the white balance.

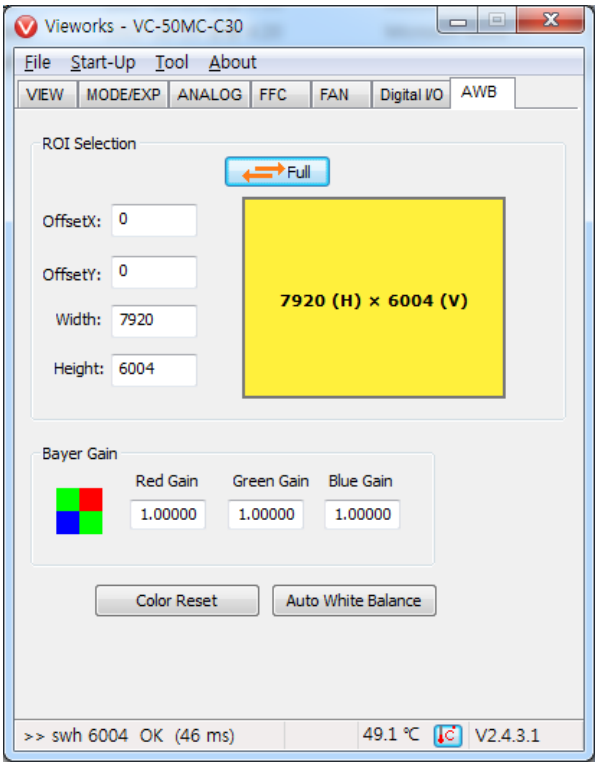


Figure 10.12 AWB Tab (Color Camera Only)

- **Offset X**, **Offset Y**, **Width**, **Height:** Sets a ROI for the Auto White Balance.
- **Bayer Gain:** Adjusts gain values for the Red, Green and Blue pixels.
- **Color Reset:** Resets gain values for the Red, Green and Blue pixels.
- **Auto White Balance:** Automatically adjusts the white balance once.

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.
  - Check the aperture is opened properly.
  - Check the Gain value is not set to small.

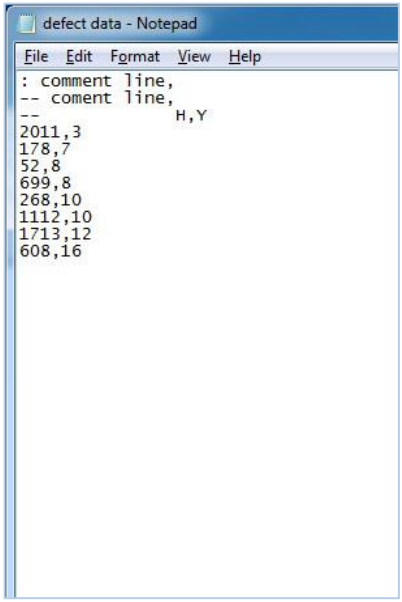
- If you identify abnormal operation or overheating sign,
  - Ensure the power supply is properly connected.
  - Stop using the camera when you notice smoke or abnormal overheating.

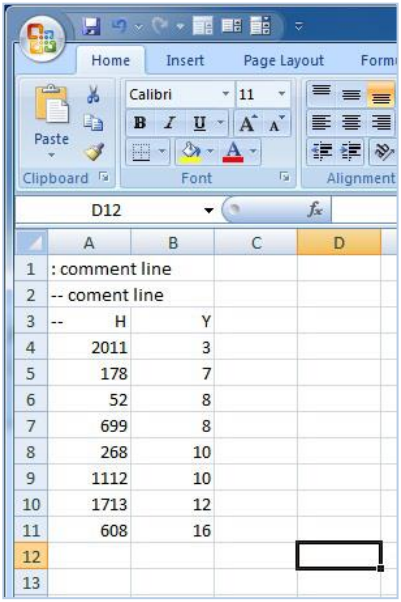
- If you have a problem using the Trigger Mode,
  - Ensure that parameter settings on your Frame Grabber are configured correctly when you operate the camera with CC1 trigger signals.
  - Ensure that cable connections are secure when you operate the camera with external trigger signals.

- If there is a communication failure between the camera and user's computer,
  - Ensure 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.

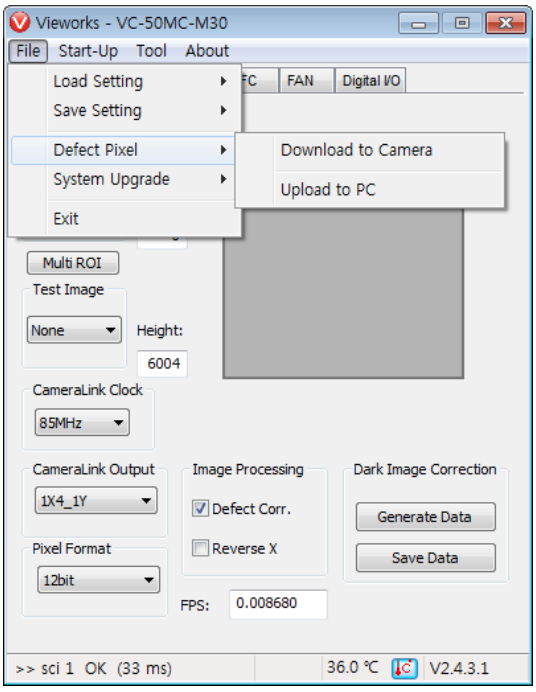
Appendix A Defect Pixel Map Download

1. Create a Defect Pixel Map 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 with 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 coordinate of each defect pixel.
   - Coordinate values for each pixel can be placed in any order.

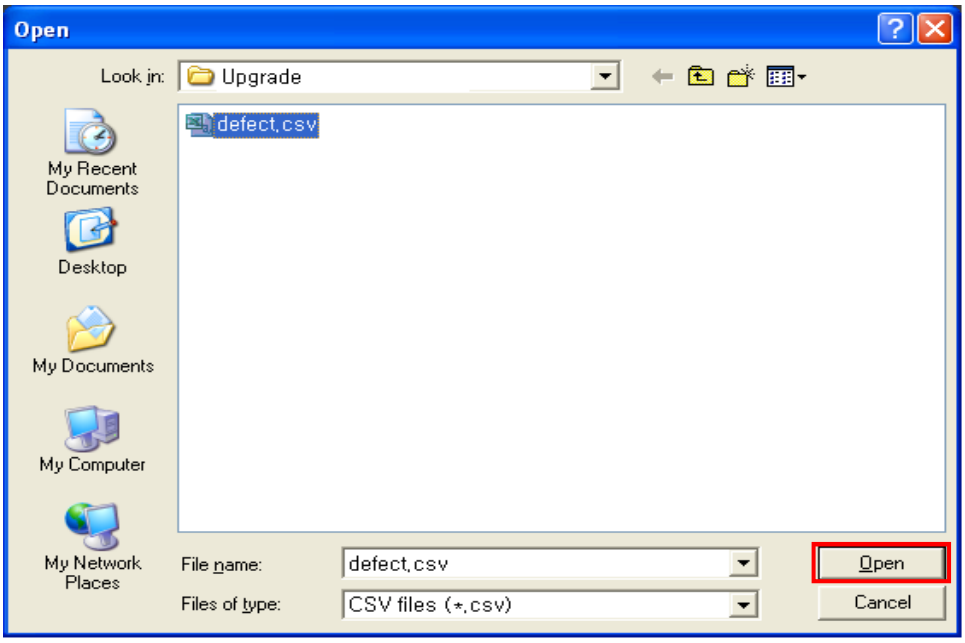




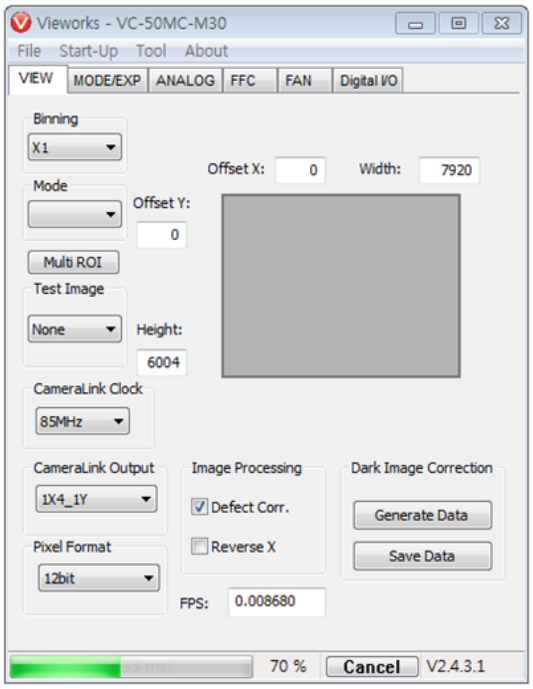
2. Select **File** > **Defect Pixel** > **Download to Camera** in the Configurator.



3. Search and select the created file, and then click **Open**.



4. The Configurator starts downloading Defect Pixel Map to the camera and downloading status is displayed at the bottom of the window.



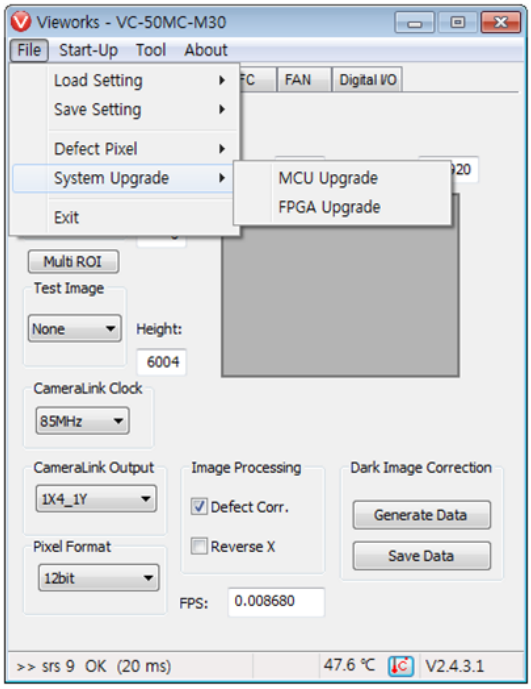
5. Once the download is complete, the saving process will begin. During the saving process, make sure not to disconnect the power cord.

6. Once all the processes are complete, the **Download completed** message will appear at the bottom of the window.

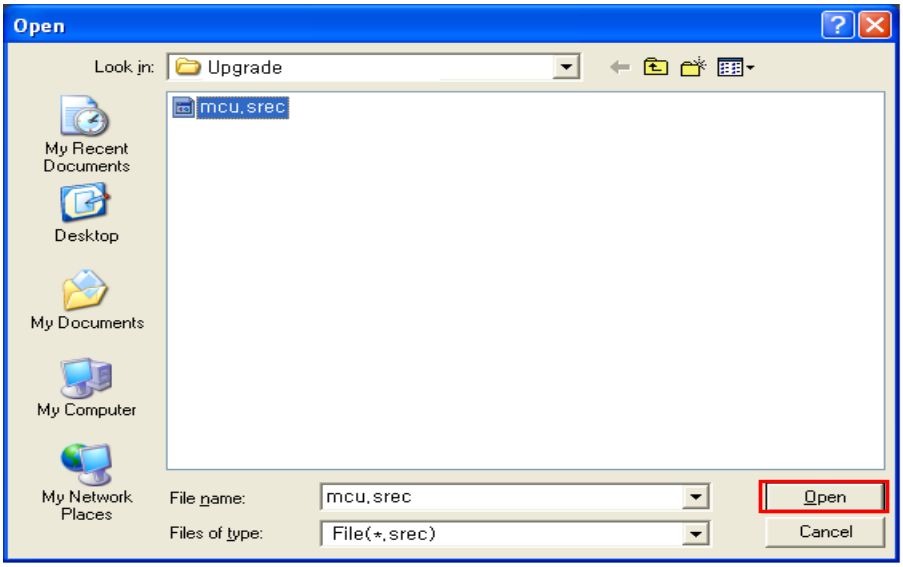
Appendix B Field Upgrade

B.1 MCU

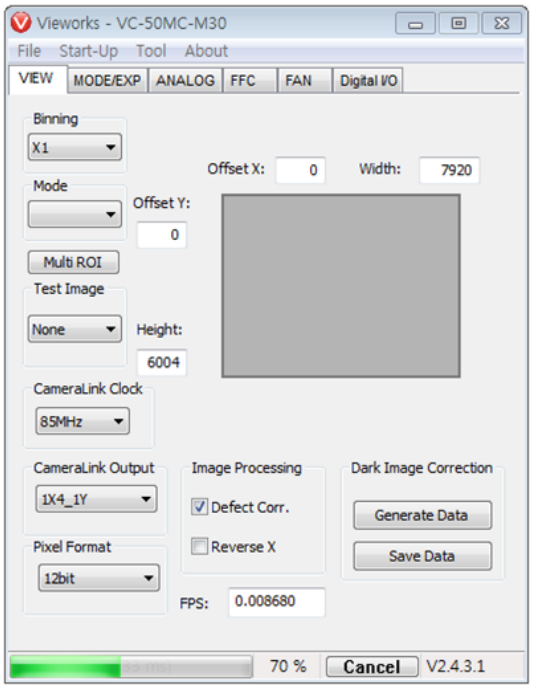
1. Select **File** > **System Upgrade** > **MCU Upgrade** in the Configurator.



2. Search and select the provided MCU upgrade file (*.srec), and then click **Open**.



3. The Configurator starts downloading MCU upgrade file to the camera and downloading status is displayed at the bottom of the window. This process may require several minutes to complete. If you want to cancel the upgrade process, click **Cancel**.

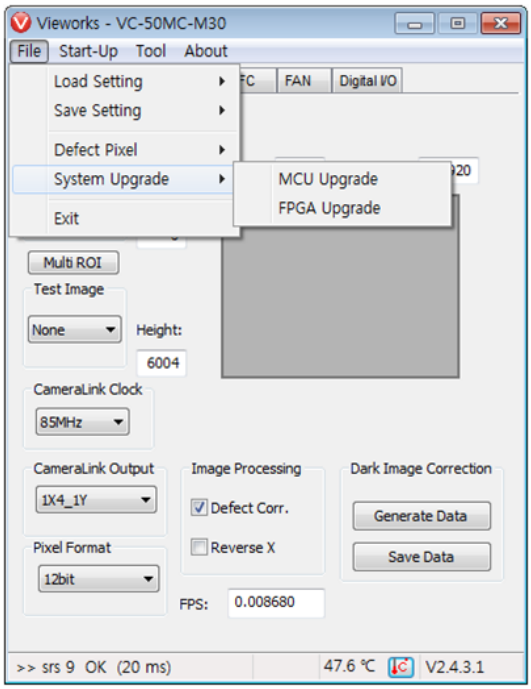


4. Once the download is complete, the saving process will begin. If a power failure occurs during the saving process, the camera cannot be restored. Make sure that the power connection is secure.

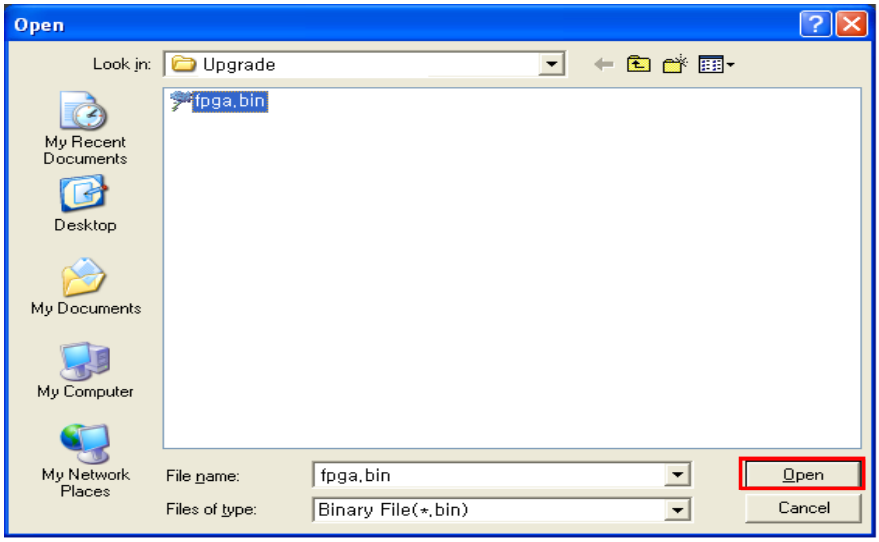
5. Once all the processes are complete, turn the camera power off and turn it back on again. Select **Tool** > **Terminal** and enter the ‘gmv' command to confirm the version. You can also select **About** > **Camera Info** to confirm the MCU version.

B.2 FPGA

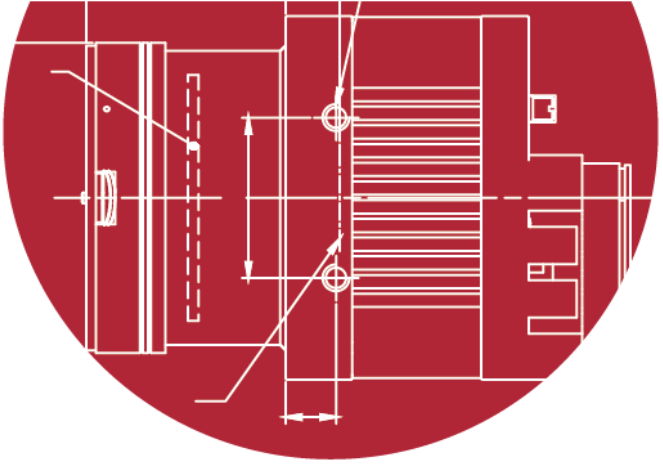
1. Select **File** > **System Upgrade** > **FPGA Upgrade** in the Configurator.

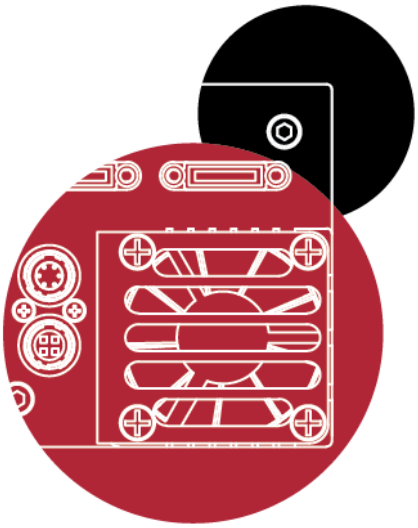


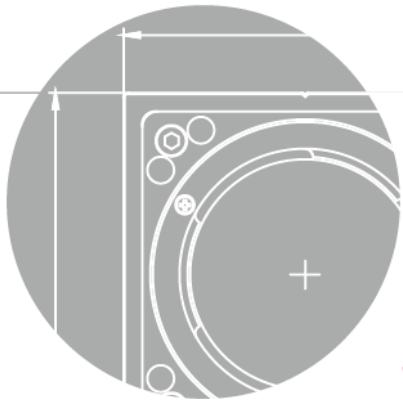
2. Search and select the provided FPGA upgrade file (*.bin), and then click **Open**.



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







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