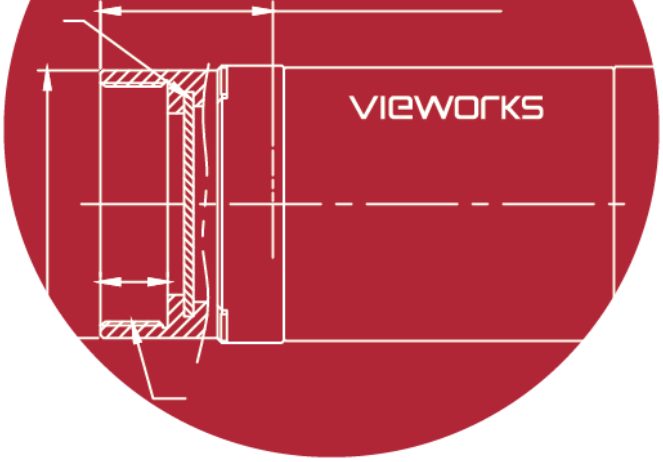


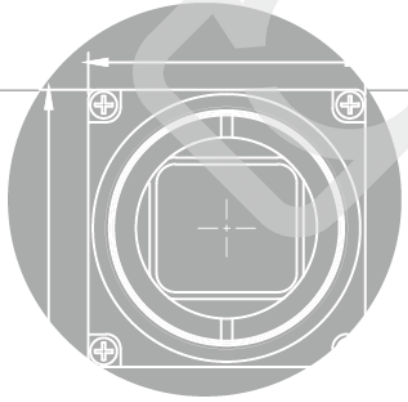
VQ series

User Manual

English

VQ-4MC-M/C 180 F

CAMERA Link



vieworks

Imaging Expert

Revision History

Revision	Date	Description
1.0	2018-11-27	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

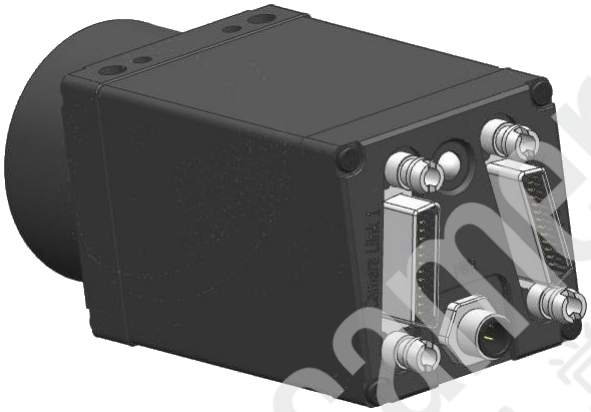
EMC Directive 2014/30/EU
EN 55032:2012 (Class A), EN 55024:2010
Class A

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 Component

Package Component

VQ-4MC-M/C 180 F <C-mount>

5 Product Specifications

5.1 Overview

The VQ-4MC-180, a very compact solution for easy system integration, is a new 4 megapixel resolution CMOS camera with the Camera Link interface. The VQ-4MC-180 uses the 4 megapixel CMOS image sensor (CMV4000) technology from AMS CMOSIS, and offers up to 180 frames per second at 2048 × 2048 resolution. Featured with high image uniformity and high speed image processing capability in a compact form factor, the VQ-4MC-180 camera is ideal for demanding applications such as PCB and semiconductor inspections.

Main Features

- High Speed 4 Megapixel CMOS Image Sensor
- Electronic Exposure Time Control (global shutter)
- Output Pixel Format: 8 / 10 bit
- Strobe Output
- Defect Pixel Correction
- Camera Link Tap Geometry: 2Tap / 4 Tap / 8 Tap / 10 Tap
- Gain / Black Level Control
- Test Image
- Camera Link Base / Medium / Full / 10 Tap
- 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 VQ-4MC-180 camera are as follows.

Specifications	VQ-4MC-M/C 180 F
Active Image (H × V)	2048 × 2048
Sensor	AMS CMOSIS CMV 4000
Sensor Size	11.26 ㎜ × 11.26 ㎜ (Optical Format: 1″)
Sensor Type	High Speed CMOS Image Sensor
Pixel size	5.5 ㎛ × 5.5 ㎛
Interface	Camera Link Base / Medium / Full / 10 Tap
Electronic Shutter	Global Shutter
Max. Frame Rate	2 Tap: 39.6 fps
	4 Tap: 79.1 fps
	8 Tap: 157.8 fps
	10 Tap: 180.0 fps
Transfer Time	2 Tap: 25.25 ㎳
	4 Tap: 12.64 ㎳
	8 Tap: 6.34 ㎳
	10 Tap: 5.56 ㎳
Pixel Data Format	8 bit (2 / 4 / 8 / 10 Tap), 10 bit (2 / 4 / 8 Tap)
Camera Link Pixel Clock	85 ㎒ / 68 ㎒
Exposure Time	16 ㎲ ~ 60 s (1 ㎲ step)
Cable Length	< 5 m (Camera Link Cable at 85 ㎒) / < 7 m (Camera Link Cable at 68 ㎒)
Black Level	0 ~ 63 LSB at 10 bit (1 LSB step)
Video Gain	1×, 2×, 3×, 4×
Trigger Mode	Free-Run, Trigger Programmable Exposure Time and Trigger Polarity
External Trigger	External, 3.0 V ~ 24.0 V Logical level input, Optically isolated Camera Link CC1

Table 5.1 Specifications of VQ-4MC-180 F (continuous)

Specifications	VQ-4MC-M/C 180 F
Dynamic Range	50 dB
Lens Mount	C-mount
Power	10 ~ 35 V DC, Typ. 5 W
Environmental	Ambient Operating: -5 ~ 40℃(Housing: 10℃ ~ 50℃), Storage: -40℃ ~ 70℃
Mechanical	29 mm × 29 mm × 61 mm, 64 g (with C-mount)
Configuration SW	Configurator

Table 5.2 Specifications of VQ-4MC-M/C 180 F

5.3 Camera Block Diagram

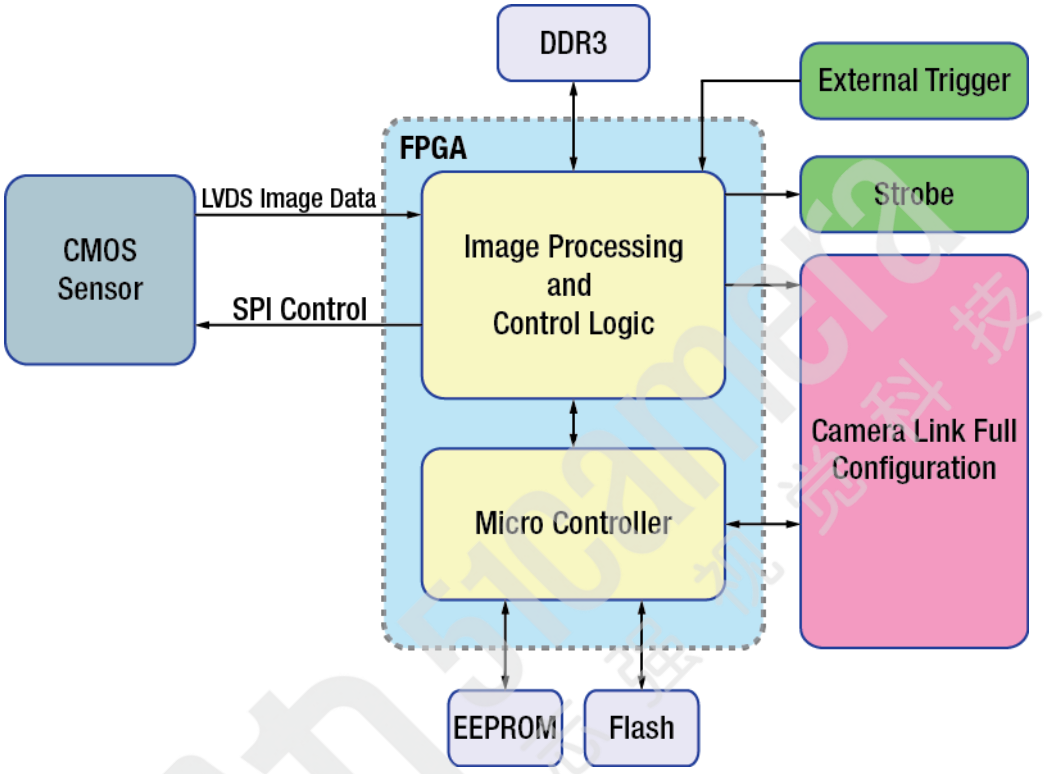


Figure 5.1 Camera Block Diagram

All controls and data processing of the VQ-4MC-180 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 spectral response of the VQ-4MC-180 monochrome and color cameras.

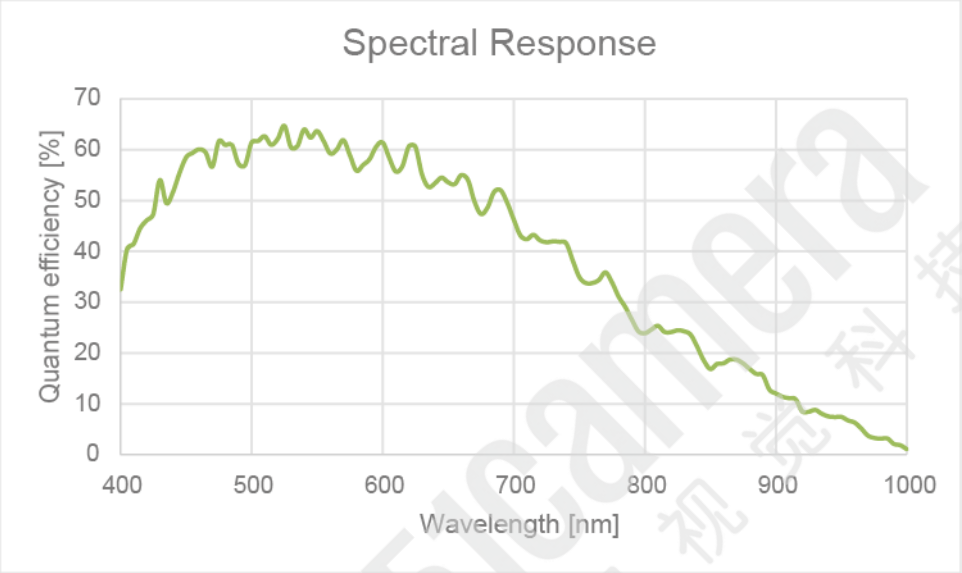


Figure 5.2 Mono Spectral Response for VQ-4MC-M/C 180 F

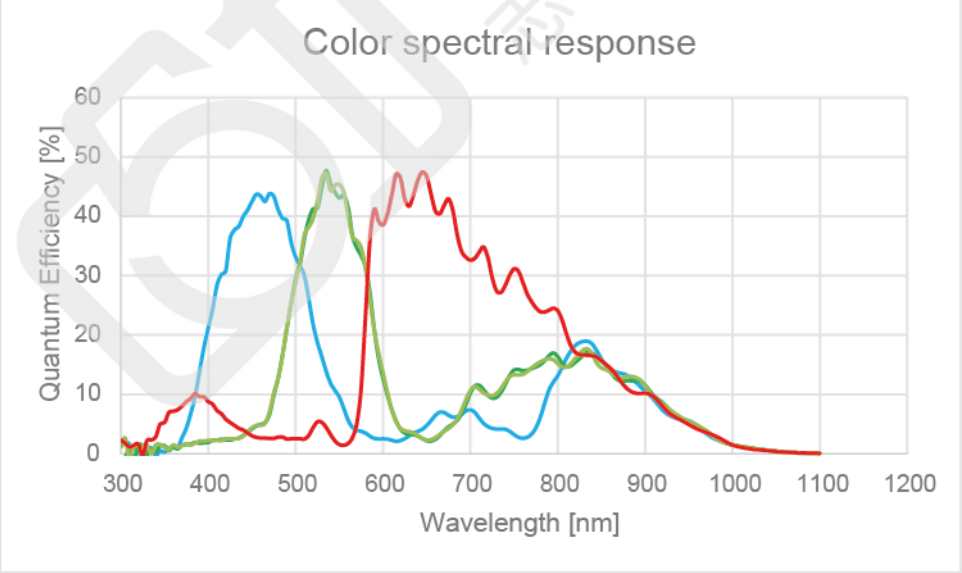


Figure 5.3 Color Spectral Response for VQ-4MC-M/C 180 F

5.5 Mechanical Specification

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

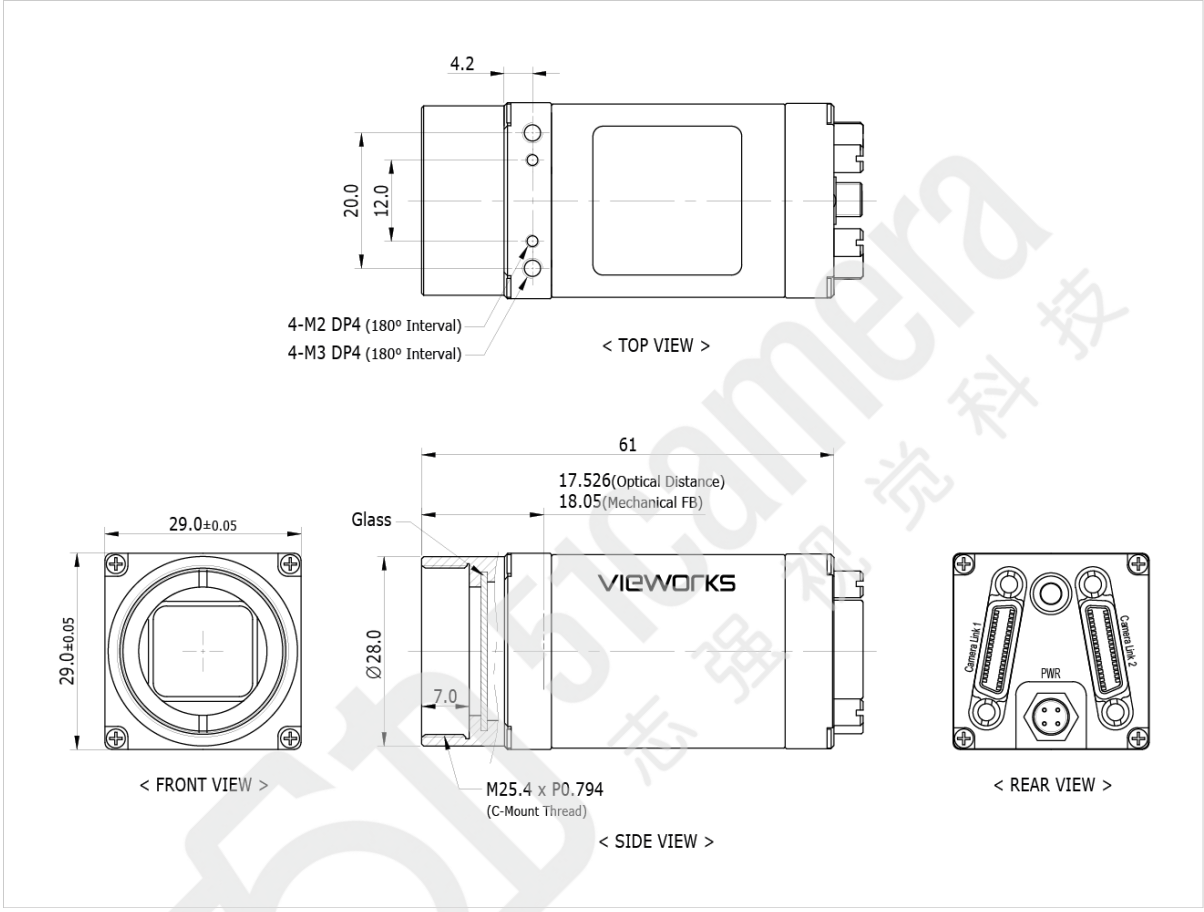


Figure 5.4 VQ-4MC-M/C 180 F C-mount Mechanical Dimension

5.5.1 Camera Mounting and Heat Dissipation

You must mount the camera on a heat dissipation structure to maintain the temperature of the camera housing at 50℃ or less. Given the low power consumption of the VQ-4MC-180 camera, its housing temperature during operation will generally stay within the specified limits. However, overheating can occur if heat dissipation is restricted or if the camera is mounted on a severe environment. We strongly recommend that you follow the general guidelines below when you mount the camera.

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

6 Connecting the Camera

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

1. Make sure that the power supply is not connected to the camera and your computer is turned off.

2. Plug one end of a Camera Link cable into the Camera Link1 connector on the camera and the other end of the Camera Link cable into the Base connector on the Camera Link frame grabber.

3. Plug one end of the other Camera Link cable into the Camera Link2 connector on the camera and the other end of the Camera Link cable into the Medium/Full connector on the Camera Link frame grabber.

4. Connect the plug of the power adapter to the power input receptacle on the camera.

5. Plug the power adapter into a working electrical outlet.

6. Verify all the cable connections are secure.

Precautions for using Camera Link Medium / Full / 10 Tap Configuration

 CAUTION	The VQ-4MC-180 camera supports the Camera Link Base / Medium / Full / 10 Tap configuration. To operate the camera in the medium, full or 10 Tap 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 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.

6.2 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.

6.3 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, three types of connectors and an LED indicator are located on the back of the camera and have the functions as follows:

- ① 26-pin 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 LED indicator: displays power status and operation mode.
- ④ 4-pin Power Input & Control I/O Receptacle: supplies power to the camera and inputs external trigger signals or outputs strobe signals.

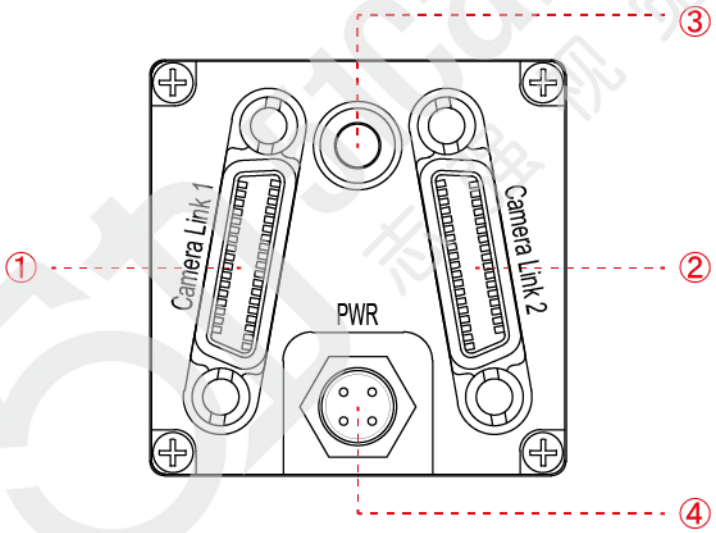


Figure 7.1 VQ-4MC-M/C 180 F Back Panel

7.2 Camera Link Connector

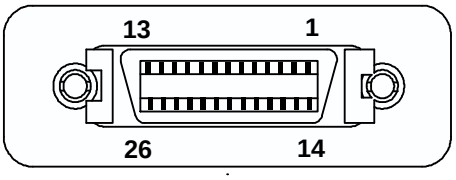


Figure 7.2 Camera Link Connector

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 Tap Geometry	CL Configuration	CL Connector 1	CL Connector 2
VQ–4MC-180	2 Tap	BASE	O	X
	4 Tap	MEDIUM	O	O
	8 Tap	FULL	O	O
	10 Tap	10 Tap	O	O

Table 7.3 Connector Arrangement for the Camera Link Tap Geometry

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

7.3 Power Input and Control I/O Receptacle

The power input and control I/O receptacle is a Binder M5 4-pin connector (part # 09-3111-81-04). The pin assignments and configurations are as follows:

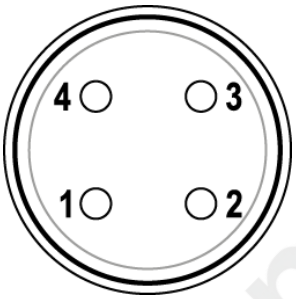


Figure 7.3 Pin Assignments for Power Input and Control I/O Receptacle

Pin Number	Signal	Type	Description
1	+12V DC	Input	DC Power Input
2	Trigger Input / Strobe Out	Input / Output	General Purpose I/O
3	DC Ground	-	Camera Power Ground
4	DC Ground	-	General Purpose I/O Ground

Table 7.4 Pin Configuration for Power Input and Control I/O Receptacle

- A recommended mating connector for the Binder M5 4-pin connector is the Binder M5 plug (part # 79-3108-52-04) or the equivalent.
- 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 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.

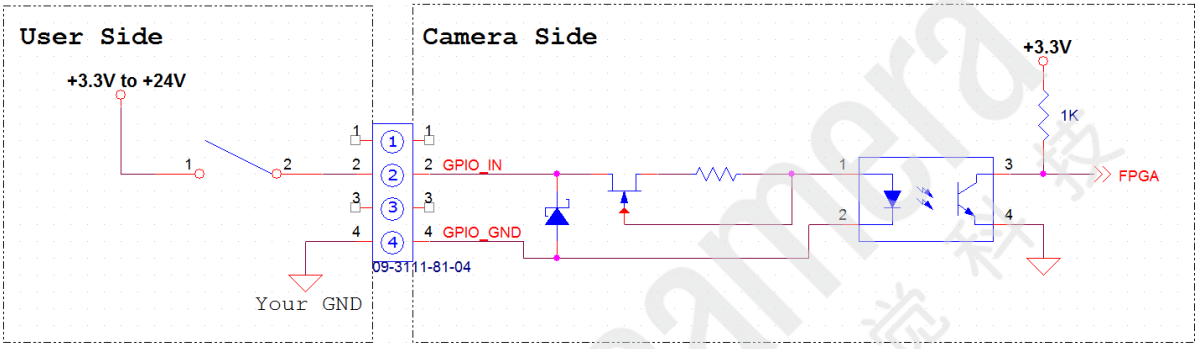


Figure 7.4 Trigger Input Schematic

7.5 Strobe Output Circuit

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

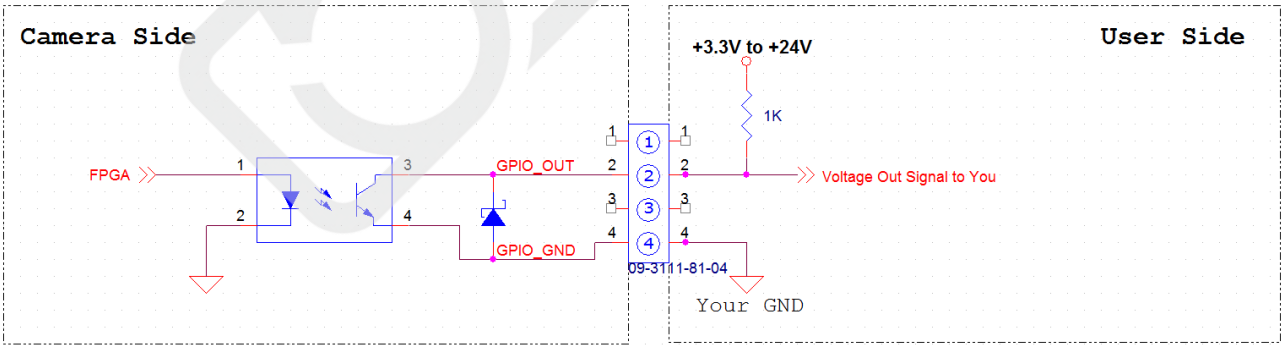


Figure 7.5 Strobe Output Schematic

8 Acquisition Control

This chapter provides detailed information about controlling image acquisition.

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

8.1 Overview

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

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

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

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

Acquisition Start and Stop Commands and Acquisition Mode

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

A parameter called the Acquisition Mode has a direct bearing on how the **Acquisition Start** command operates. The VQ-4MC-180 camera only supports Continuous for the Acquisition Mode parameter.

If the Acquisition Mode parameter is set to Continuous, an **Acquisition Start** command does not expire after a single frame is acquired. Once an **Acquisition Start** command has been executed, you can acquire as many frames as you like.

The **Acquisition Start** command will remain in effect until you execute an **Acquisition Stop** ('asp') command. Once an **Acquisition Stop** command has been executed, the camera will not be able to acquire frames until a new **Acquisition Start** command is executed.

Exposure Start Trigger

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

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

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

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

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

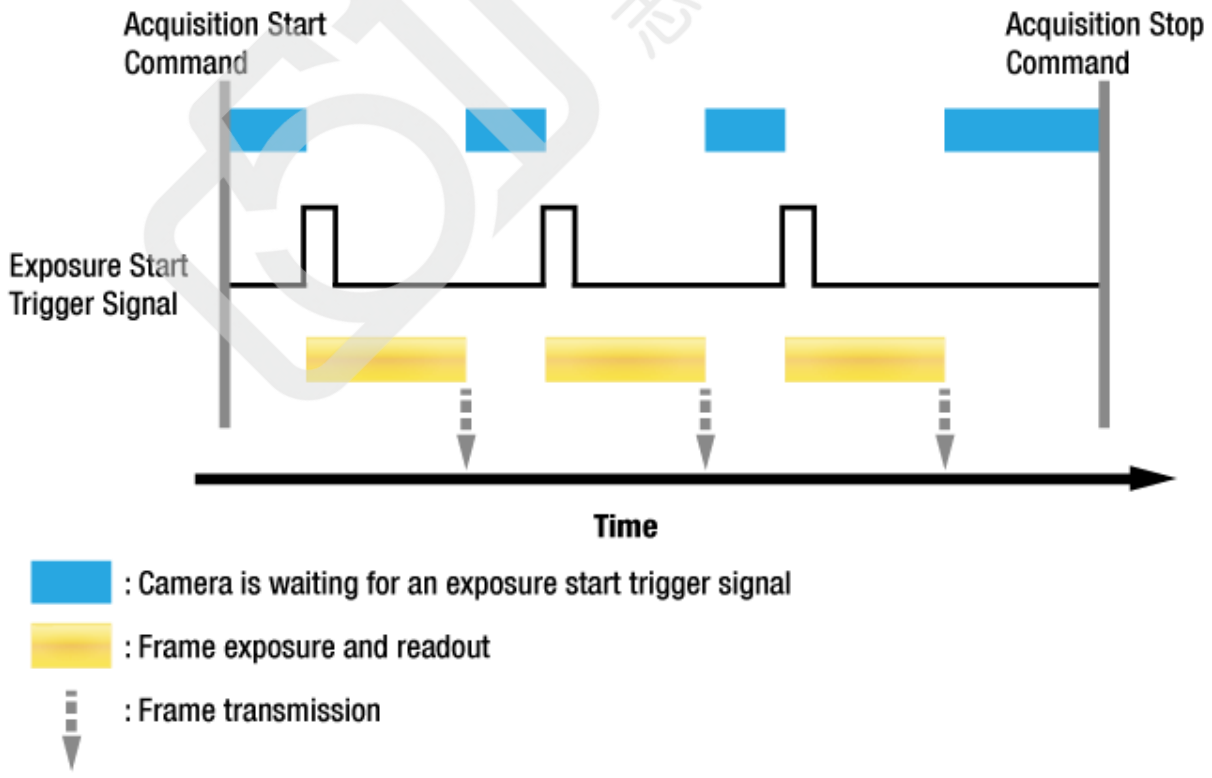


Figure 8.1 Exposure Start Triggering

Applying Trigger Signals

The paragraphs above mention “applying a trigger signal”. There are four ways to apply an exposure start trigger signal to the camera: via **Software**, via **User Output0**, via **CC1** or via **LineIn0** (commonly referred to as hardware).

To apply trigger signals via **Software**, you must set the **Trigger Source** parameter to **Software**.

At that point, each time a **Trigger Software** (‘gst’) command is executed, the exposure start trigger signal will be applied to the camera.

To apply trigger signals via **User Output0**, you must set the **Trigger Source** parameter to **User Output0**.

At that point, you can apply an exposure start trigger signal to the camera by switching the **User Output Value** parameter between **On** (rise) and **Off** (fall).

To apply trigger signals via Camera Link frame grabber, you must set the **Trigger Source** parameter to **CC1**.

At that point, each time an externally generated electrical signal is applied to the camera by using the APIs provided by a Camera Link frame grabber manufacturer, the exposure start trigger signal will be applied to the camera. For more information, refer to your Camera Link frame grabber user manual.

To apply trigger signals via hardware (external), you must set the **Trigger Source** parameter to **LineIn0**.

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

Exposure Time Control

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

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

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

If the **Trigger Source** parameter is set to **User Output0**, **CC1** or **LineIn0**, there are two modes of operation: **Timed** and **Trigger Width**.

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

With the **Trigger Width** mode, the way that you manipulate the rise and fall of the User Output, CC1 or hardware (external) signal will determine the exposure time. The **Trigger Width** mode is especially useful if you want to change the exposure time from frame to frame.

8.2 Acquisition Start/Stop Commands and Acquisition Mode

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

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

The VQ-4MC-180 camera only provides the ‘Continuous’ mode of operation for the Acquisition Mode.
After an **Acquisition Start** command has been executed, exposure start can be triggered as desired. Each time an exposure start trigger is applied while the camera is in a *waiting for exposure start trigger* acquisition status, the camera will acquire and transmit a frame. The camera will retain the ability to acquire frames until an **Acquisition Stop** command is executed. Once the **Acquisition Stop** command is received, the camera will no longer be able to acquire frames.

8.3 Exposure Start Trigger

The exposure start trigger is used to begin frame acquisition. Exposure start trigger signals can be generated within the camera or may be applied externally by setting the **Trigger Source** parameter to **Software**, **User Output0**, **CC1** or **LineIn0**. If an exposure start trigger signal is applied to the camera, the camera will begin to expose a frame.

8.3.1 Trigger Mode

The main parameter associated with the exposure start trigger is the **Trigger Mode** (‘stm 0/1’) parameter.
The **Trigger Mode** parameter for the exposure start trigger has two available settings: **Off** and **On**.

8.3.1.1 Trigger Mode = Off

When the **Trigger Mode** parameter is set to **Off**, the camera will generate all required exposure start trigger signals internally, and you do not need to apply exposure start trigger signals to the camera.
If the **Trigger Mode** parameter is set to **Off**, the camera will automatically begin generating exposure start trigger signals when it receives an **Acquisition Start** command. The camera will continue to generate exposure start trigger signals until it receives an **Acquisition Stop** command.

Free Run
When you set the **Trigger Mode** parameter to **Off**, the camera will generate all required trigger signals internally. When the camera is set this way, it will constantly acquire images without any need for triggering by the user. This use case commonly referred as “free run”.

The rate at which the exposure start trigger signals are generated may be determined by the camera’s **Frame Rate** (‘sfr n’) parameter.

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

Exposure Time Control with Trigger Mode = Off

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

8.3.1.2 Trigger Mode = On

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

- **Software**: You can apply an exposure start trigger signal to the camera by executing the **Trigger Software** command for the exposure start trigger on your computer.
- **User Output0**: You can apply an exposure start trigger signal to the camera by switching the **User Output Value** parameter between **On** and **Off** on your computer.
- **CC1**: You can apply an exposure start trigger signal to the camera via CC1 in the Camera Link interface. For more information, refer to your Camera Link frame grabber user manual.
- **LineIn0**: You can apply an exposure start trigger signal to the camera by injecting an externally generated electrical signal (commonly referred to as a hardware or external trigger signal) into the Control I/O receptacle on the camera. Refer to 7.4 Trigger Input Circuit for more information.

You must also set the **Trigger Activation** parameter after setting the **Trigger Source** parameter.
The available settings for the **Trigger Activation** parameter are:

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

Exposure Time Control with Trigger Mode = On

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

When the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **CC1** or **LineIn0**, the exposure time for each frame acquisition will be determined by the **Exposure Mode** parameter settings as follows:

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

When the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **User Output0**, the exposure time for each frame acquisition will be determined by the **Exposure Mode** parameter settings as follows:

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

8.3.2 Using a Software Trigger Signal

If the **Trigger Mode** parameter is set to **On** and the **Trigger Source** parameter is set to **Software**, you must apply a software trigger signal (exposure start) to the camera to begin each frame acquisition. Assuming that the camera is in a *waiting for exposure start trigger* acquisition status, frame exposure will start when the software trigger signal is received by the camera. Figure 8.2 illustrates frame acquisition with a software trigger signal.
When the camera receives a software trigger signal and begins exposure, it will exit the *waiting for exposure start trigger* acquisition status because at that point, it cannot react to a new exposure start trigger signal.
As soon as the camera is capable of reacting to a new exposure start trigger signal, it will automatically return to the *waiting for exposure start trigger* acquisition status.
When you are using a software trigger signal to start each frame acquisition, the camera's **Exposure Mode** parameter must be set to **Timed**. The exposure time for each acquired frame will be determined by the value of the camera's **Exposure Time** parameter.

	When you use a software trigger signal to acquire frames, be aware that there is a Trigger Latency due to the characteristics of the Camera Link. Use a CC1 trigger signal to precisely synchronize the trigger signal with the exposure timing.

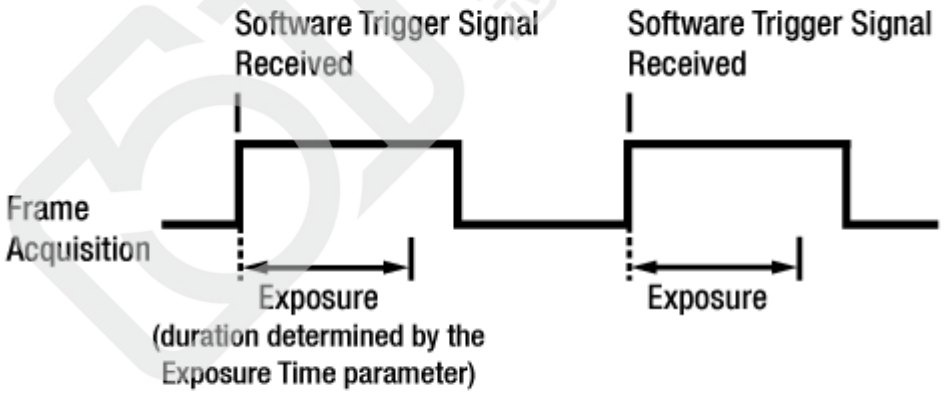


Figure 8.2 Frame Acquisition with Software Trigger Signal

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

8.3.3 Using a CC1 Trigger Signal

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

A rising edge or falling edge of the CC1 signal can be used to trigger frame acquisition. The **Trigger Activation** parameter is used to select rising edge or falling edge triggering.

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

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 the camera is operating under control of a CC1 signal, the period of the CC1 trigger signal will determine the rate at which the camera is acquiring frames:

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

For example, if you are operating a camera with a CC1 trigger signal period of 50 ms (0.05 s):

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

8.3.4 Using an External Trigger Signal

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

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

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

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

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

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

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

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

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

8.3.5 Exposure Mode

If you are triggering the start of frame acquisition with an externally generated trigger signal (CC1 or External), two exposure modes are available: **Timed** and **Trigger Width**.

Timed Exposure Mode

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

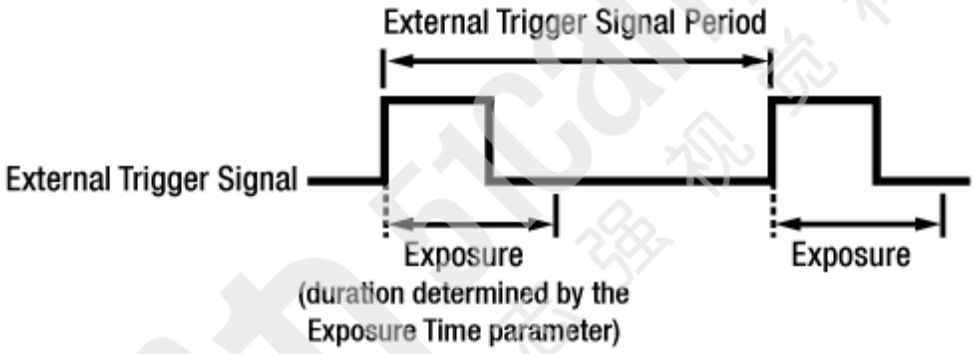


Figure 8.3 Timed Exposure Mode

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

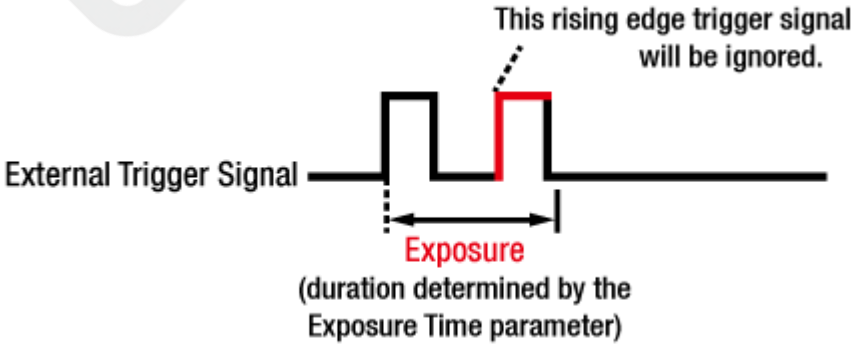


Figure 8.4 Trigger Overlapped with Timed Exposure Mode

Trigger Width Exposure Mode

When the **Trigger Width** exposure mode is selected, the length of the exposure for each frame acquisition will be directly controlled by the external trigger signal (CC1 or External). If the camera is set for rising edge triggering, the exposure time begins when the external trigger signal rises and continues until the external trigger signal falls. If the camera is set for falling edge triggering, the exposure time begins when the external trigger signal falls and continues until the external trigger signal rises. The following figure illustrates **Trigger Width** exposure with the camera set for rising edge triggering.

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

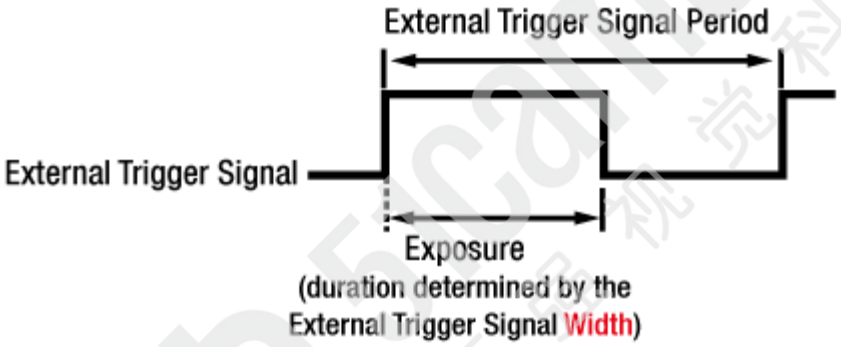


Figure 8.5 Trigger Width Exposure Mode

8.4 Setting the Exposure Time

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

- the **Trigger Mode** is set to **Off**
- the **Trigger Mode** is set to **On** and the **Trigger Source** is set to **Software** (In this case, you must set the **Exposure Mode** parameter to **Timed**.)
- the **Trigger Mode** is set to **On**, the **Trigger Source** is set to **CC1** or **LineIn0**, and the **Exposure Mode** is set to **Timed**.

The **Exposure Time** parameter must not be set below a minimum specified value. The **Exposure Time** parameter sets the exposure time in microseconds (*μs*). The minimum and maximum exposure time settings for the VQ-4MC-180 camera are shown in the following table.

Camera Model	Minimum Exposure Time	Maximum Exposure Time†
VQ-4MC-180	16 *μs*	60,000,000 *μs*

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

Table 8.1 Minimum and Maximum Exposure Time Setting

8.5 Overlapping Exposure with Sensor Readout

The frame acquisition process on the camera includes two distinct parts. The first part is the exposure of the pixels in the image sensor. Once exposure is complete, the second part of the process – readout of the pixel values from the sensor – takes place. In regard to this frame acquisition process, the VQ-4MC-180 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 the **Trigger Mode** parameter is set to **On**, the exposure of a new frame begins while the camera is still reading out the sensor data for the previously acquired frame. This situation is illustrated in the following figure with the **Trigger Source** parameter set to **LineIn0** and the **Exposure Mode** parameter set to **Trigger Width**.

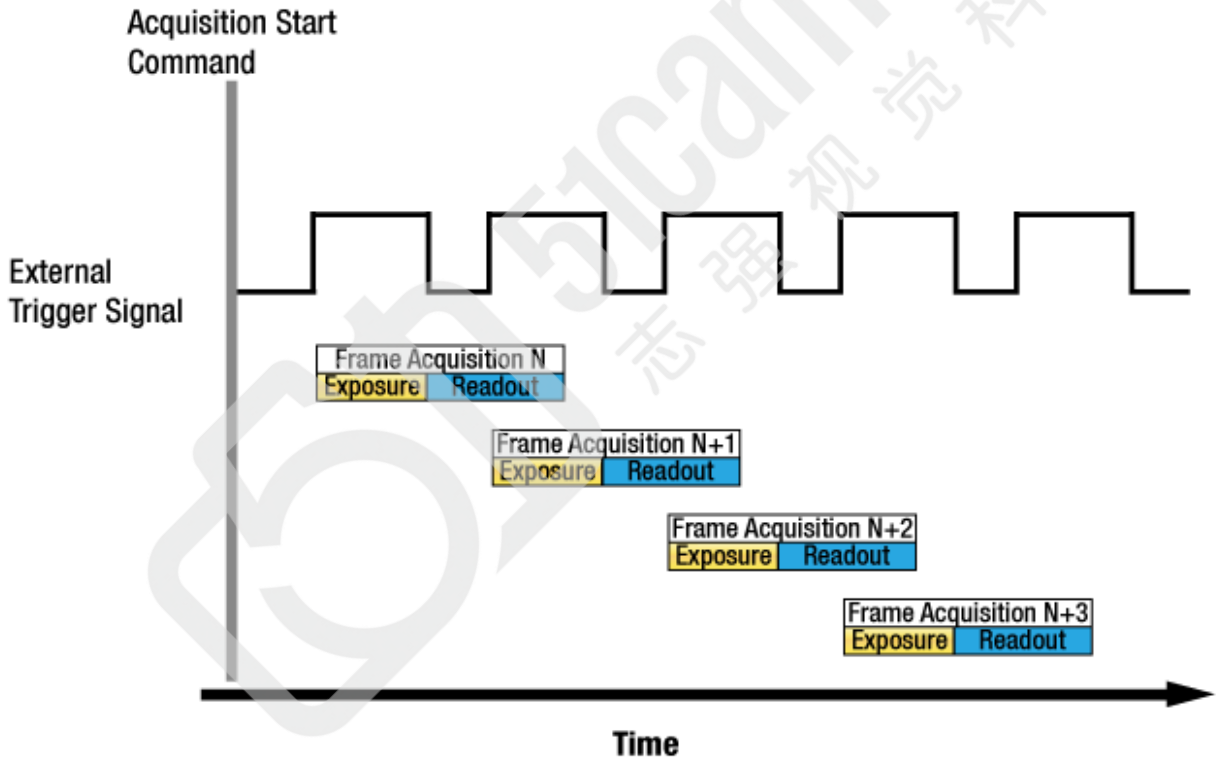


Figure 8.6 Overlapped Exposure and Readout

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

- Overlapped: Frame Period ≤ Exposure Time + Readout Time

Guidelines for Overlapped Exposure

Since the VQ-4MC-180 camera operates with overlapped exposure, there are two important guidelines to keep in mind:

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

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

8.6 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. This time varies depending on the Height setting of the frame. 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 Camera Link Tap Geometry. When the camera is set for a Camera Link Tap Geometry that uses more taps, it can typically transfer data out of the camera faster than when it is set for a Camera Link Tap Geometry that uses less taps.
- The exposure times for acquired frames. If you use very long exposure time, you can acquire fewer frames per second.

8.6.1 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.

- Decreasing the height of the Image ROI may increase the maximum allowed frame rate. If possible, decrease the height of the Image ROI.
- If you have set the Camera Link Pixel Clock speed to a low value, consider setting it to a higher value. Before setting 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 a Camera Link Tap Geometry with a low number of taps, consider using a Camera Link Tap Geometry with a higher number of taps. This will usually increase the maximum allowed frame rate.
- If you are using normal exposure times and you are using the camera at its maximum resolution, your exposure time will not normally restrict the frame rate. However, if you are using long exposure 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.

9 Camera Features

9.1 Image Region of Interest

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

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

Command		Value	Description
ROI Width	siw	-	Sets the Width of the Image ROI.
ROI Height	sih	-	Sets the Height of the Image ROI.
ROI Offset X	sox	-	Sets the horizontal offset from the origin to the Image ROI.
ROI Offset Y	soy	-	Sets the vertical offset from the origin to the Image ROI.

Table 9.1 Commands related to Image ROI

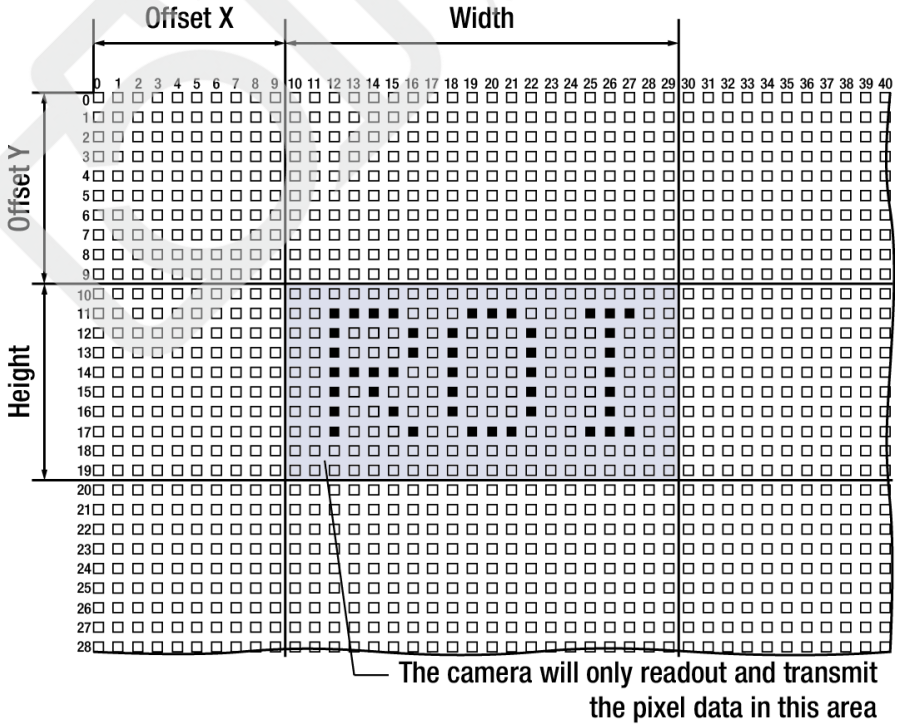


Figure 9.1 Region of Interest

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

The **Width + Offset X** value must not exceed 2048, i.e., the width of the camera's image sensor, and the **Height + Offset Y** value must not exceed 2048, i.e., the height of the camera's image sensor.

You must set the size of the ROI first, and then the Offset values since the Width and Height parameters are set to their maximum values by default.

On the VQ-4MC-180 camera, the **Width** parameter must be set to a multiple of 16, and the **Height** parameter must be set to a multiple of 4.

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

Camera Model	Minimum Width Settings	Minimum Height Settings
VQ-4MC-180	256	4

Table 9.2 Minimum ROI Width and Height Settings

On the VQ-4MC-180 camera, the maximum allowed frame rates depending on Vertical ROI changes are shown below.

ROI Size (H × V)	2 Tap	4 Tap	8 Tap	10 Tap
2048 × 16	3717.4 fps	6578.9 fps	10638.2 fps	12195.1 fps
2048 × 32	2050.5 fps	4000.0 fps	6993.0 fps	8000.0 fps
2048 × 64	1165.5 fps	2237.1 fps	4149.3 fps	4739.3 fps
2048 × 128	607.9 fps	1190.4 fps	2283.1 fps	2610.9 fps
2048 × 256	310.8 fps	615.0 fps	1203.3 fps	1375.5 fps
2048 × 512	157.1 fps	312.5 fps	618.4 fps	706.7 fps
2048 × 1024	79.0 fps	157.6 fps	313.4 fps	358.2 fps
2048 × 2048	39.6fps	79.1 fps	157.8 fps	180.0 fps

Table 9.3 Maximum Frame Rates by VQ-4MC-M/C 180 F ROI Changes (@ Camera Link Pixel Clock 85㎒)

CAUTION

- 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 VQ-4MC-180 camera provides the Multiple ROI feature. Refer to 9.2 Multi-ROI for more information.

9.2 Multi-ROI

The VQ-4MC-180 camera provides the Multi-ROI feature which allows you to define up to eight 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 Offset X** and **Region Width** parameters, since all of the regions must be the same width and all of the regions must be vertically aligned. The next step in the setup procedure is to define each individual region as desired. Up to eight regions can be set up ranging from 0 to 7.

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 Y** (the offset between the top of the sensor and the top of the region) and **Region Height** (the height of the region) parameters to define each region.

The commands related to Multi-ROI are as follows.

Command		Value	Description
Region Selector	srs	0 – 7	Selects a ROI to set.
Region Mode	src	0: Off	Disables the usage of the selected ROI.
		1: On	Enables the usage of the selected ROI.
Region Width	srw	-	Sets the width for the selected ROI.
Region Height	srh	-	Sets the height for the selected ROI.
Region Offset X	srx	-	Sets the horizontal offset from the origin to the selected ROI.
Region Offset Y	sry	-	Sets the vertical offset from the origin to the selected ROI.

Table 9.4 Commands related to Multi-ROI

In the figure below, for example, three regions have been set. With these settings, the camera would output an image with 1024 (width) × 924 (the total height of the three regions) size.

- Multi-ROI Offset X = 512, Multi-ROI Width = 1024
- ROI_Region0
  - Offset Y = 96, Height = 256
- ROI_Region1
  - Offset Y = 592, Height = 356
- ROI_Region2
  - Offset Y = 1624, Height =312

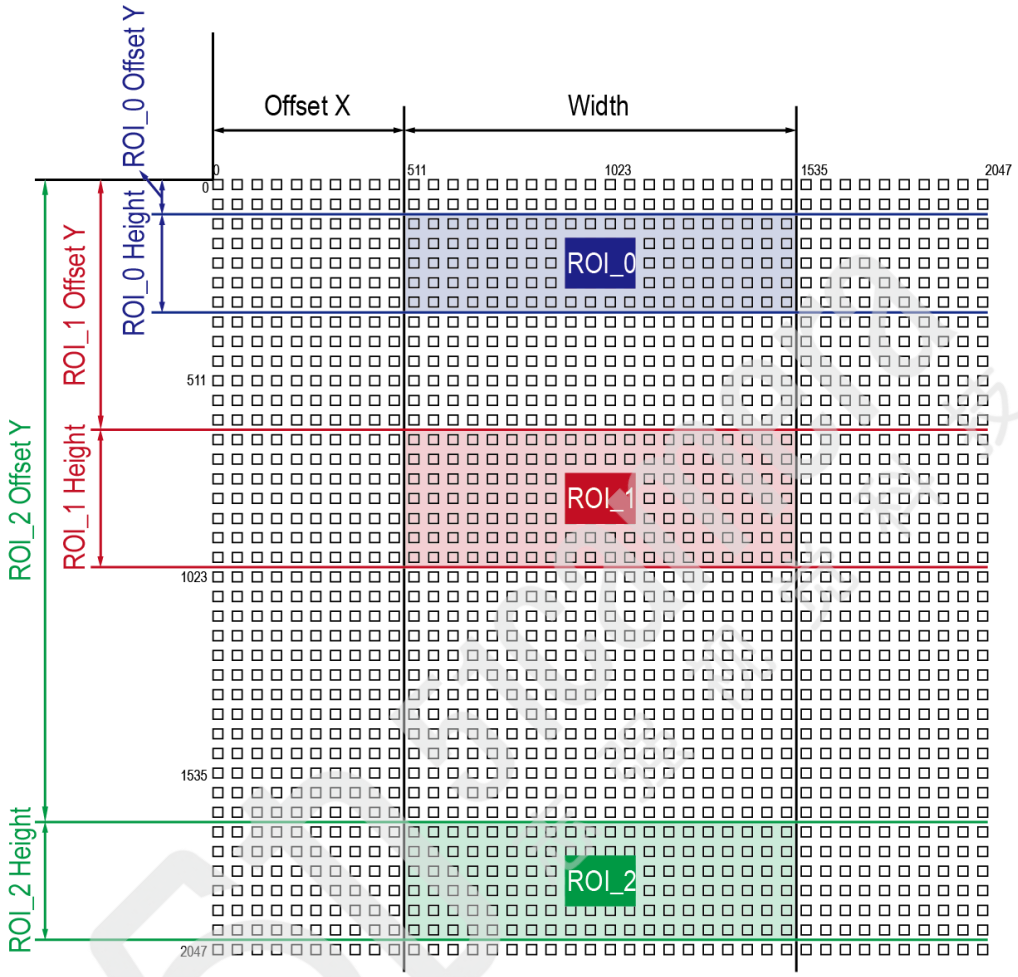


Figure 9.2 Multi-ROI

There are several things to keep in mind when setting the Multi-ROI feature on the VQ-4MC-180 camera:

- The sum of the Multi-ROI Offset X value plus the Multi-ROI Width value must not exceed the width (2048) of the camera's sensor.
- The sum of the Multi-ROI Offset Y value plus the Multi-ROI Height value must not exceed the height (2048) of the camera's sensor.
- The Multi-ROI Offset X value must be a multiple of 16.
- The Multi-ROI Width value must be a multiple of 16 ranging from 256 to 2048.
- The Multi-ROI Offset Y value must be a multiple of 2.
- The Multi-ROI Height value must be a multiple of 2 ranging from 2 to 2048.
- You can save (**Configurator** > **File** > **Save Setting** > **User 1** or **User 2**) the Multi-ROI setting values as a User Set and then load (**Configurator** > **File** > **Load Setting** > **From User 1 Space** or **From User 2 Space**) the values to the camera when desired.

9.3 AWB ROI (Color Camera)

The Auto White Balance 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 9.5 Commands related to AWB 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 AWB ROI at the same time. The effective ROI is determined as shown in the figure below.

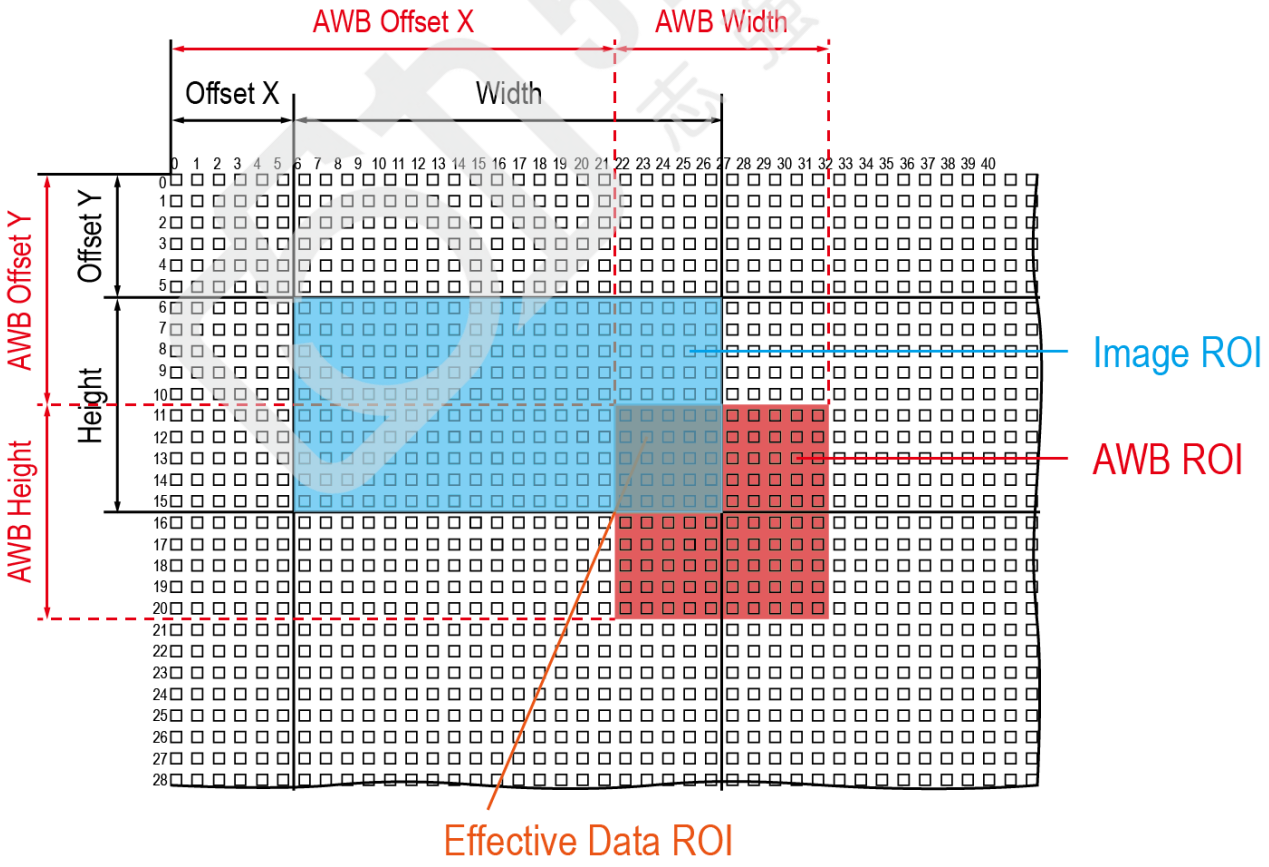


Figure 9.3 Effective Data ROI

9.4 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 VQ-4MC-180 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 9.6 Commands related to White Balance

9.4.1 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 GreyWorld algorithm. Before using the Auto White Balance feature, you need to set the AWB ROI. If you do not set the AWB 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 9.7 Command related to Auto White Balance

9.5 Pixel Format

The camera processes image data in the unit of 12 bit. You can determine the pixel format (8 bit or 10 bit) of image data transmitted from the camera by using the ‘sdb 8 / 10’ 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.

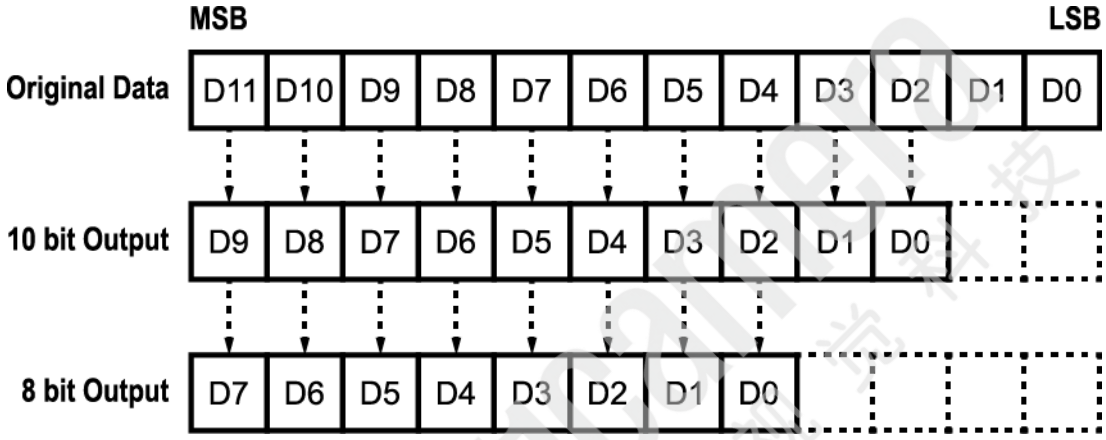


Figure 9.4 Pixel Format

The command related to Pixel Format is as follows.

Command		Value	Description
Pixel Format	sdb	8	Sets the pixel format to 8 bit.
		10	Sets the pixel format to 10 bit.

Table 9.8 Command related to Pixel Format

9.6 Camera Link Tap Geometry

The VQ-4MC-180 camera supports 2 Tap, 4 Tap, 8 Tap and 10 Tap Camera Link Tap Geometry. The number of taps represents the number of pixel data that will be output on each cycle of the Camera Link Pixel Clock. The maximum allowed frame rate will be changed according to the Camera Link Tap Geometry settings. The image data is transmitted in the interleaved order as shown in the figure below.

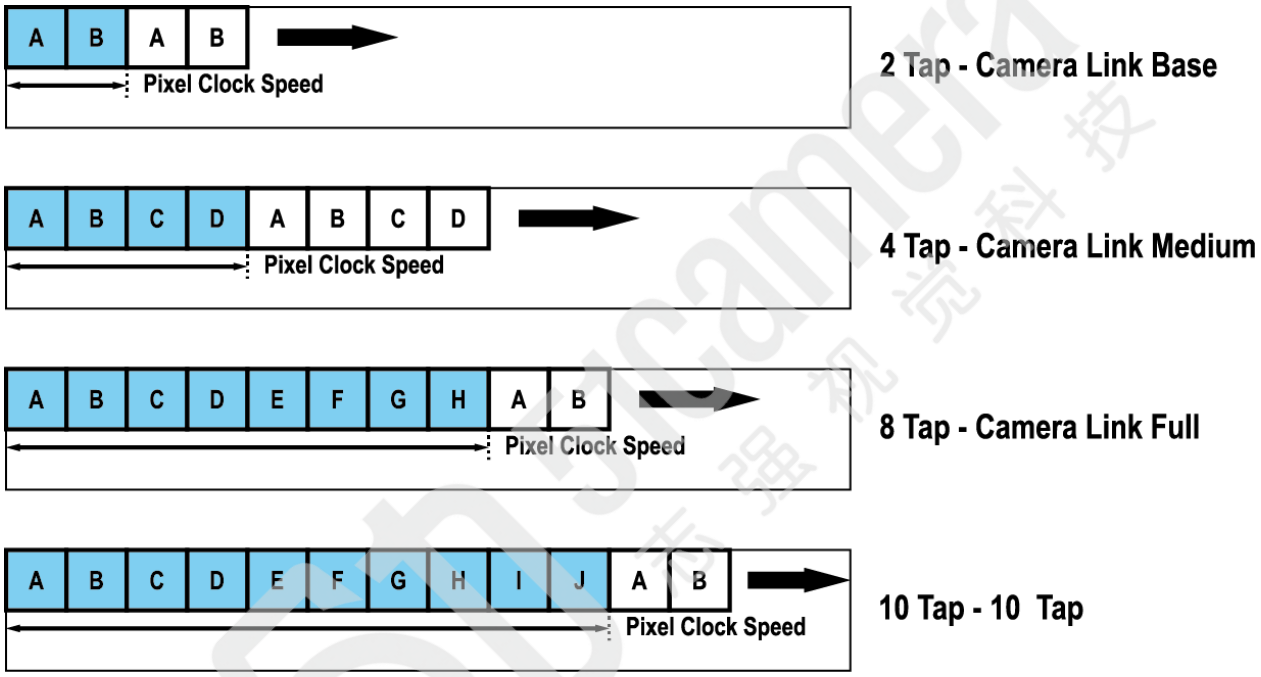


Figure 9.5 Camera Link Tap Geometry

The command related to Camera Link Tap Geometry is as follows.

Command		Value	Description
Camera Link Tap Geometry	stg	2: 1X2-1Y	Sets the Camera Link Tap Geometry to 2 Tap.
		4: 1X4-1Y	Sets the Camera Link Tap Geometry to 4 Tap.
		8: 1X8-1Y	Sets the Camera Link Tap Geometry to 8 Tap.
		10: 1X10-1Y	Sets the Camera Link Tap Geometry to 10 Tap.

Table 9.9 Command related to Camera Link Tap Geometry

9.7 Camera Link Pixel Clock Speed

The VQ-4MC-180 camera provides 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 command related to Camera Link Pixel Clock speed is as follows.

Command		Value	Description
Camera Link Pixel Clock Speed	sccs	0: 85 ㎒	Sets the Camera Link Pixel Clock speed to 85 ㎒.
		1: 68 ㎒	Sets the Camera Link Pixel Clock speed to 68 ㎒.

Table 9.10 Command related to Camera Link Pixel Clock Speed

9.8 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.

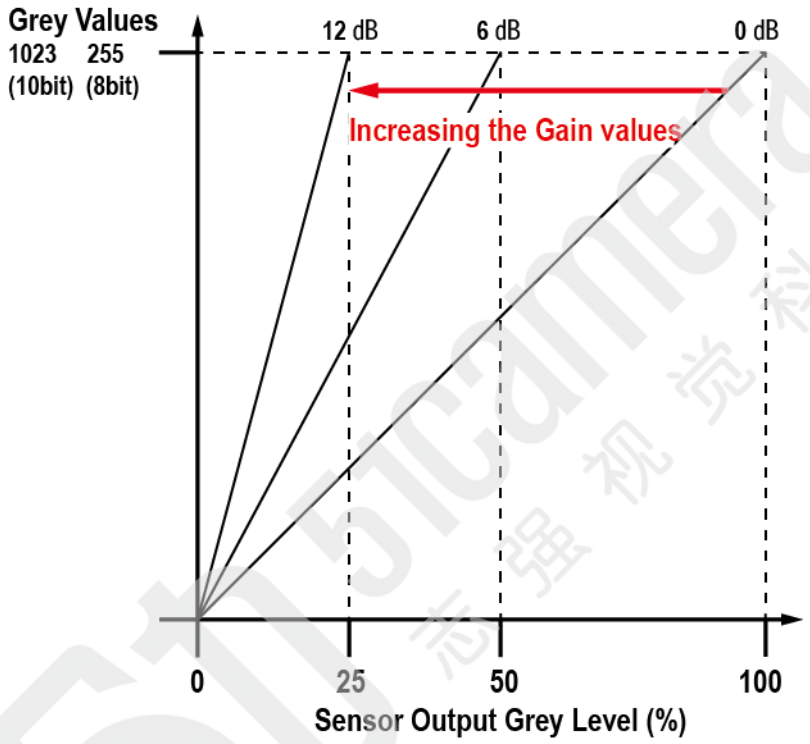


Figure 9.6 Setting the Gain

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×, 2×, 3×, 4×	Sets a digital gain value.
Black Level	sbl	0 ~ 63	Sets a black level value.

Table 9.11 Commands related to Gain and Black Level

9.9 Defect Pixel Correction

The CMOS sensor may have Defect Pixels which cannot properly respond to the light. The VQ-4MC-180 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.

9.9.1 Correction Method

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

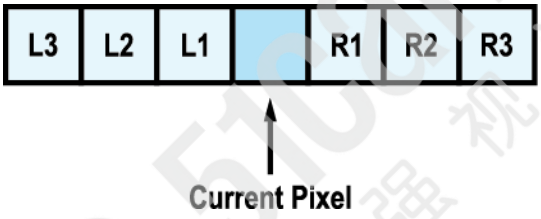


Figure 9.7 Location of Defect Pixel to be corrected

If the Current Pixel is a defect pixel as shown in the figure above, 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 9.12 Calculation of Defect Pixel Correction Value

9.10 Flat Field Correction

The Flat Field Correction feature improves the image uniformity when you acquire a non-uniformity image due to external conditions. The Flat Field Correction feature 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 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 9.13 Commands related to Flat Field Correction

9.10.1 Sequence of Flat Field Correction

Under actual use 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** 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. 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 9.10 when they are used for correction.

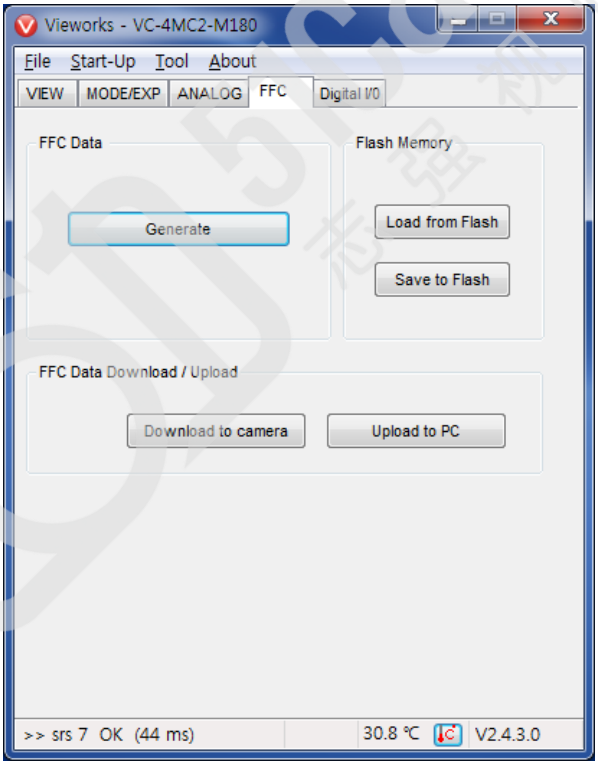


Figure 9.8 Flat Field Correction in Configurator

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. 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 9.10 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

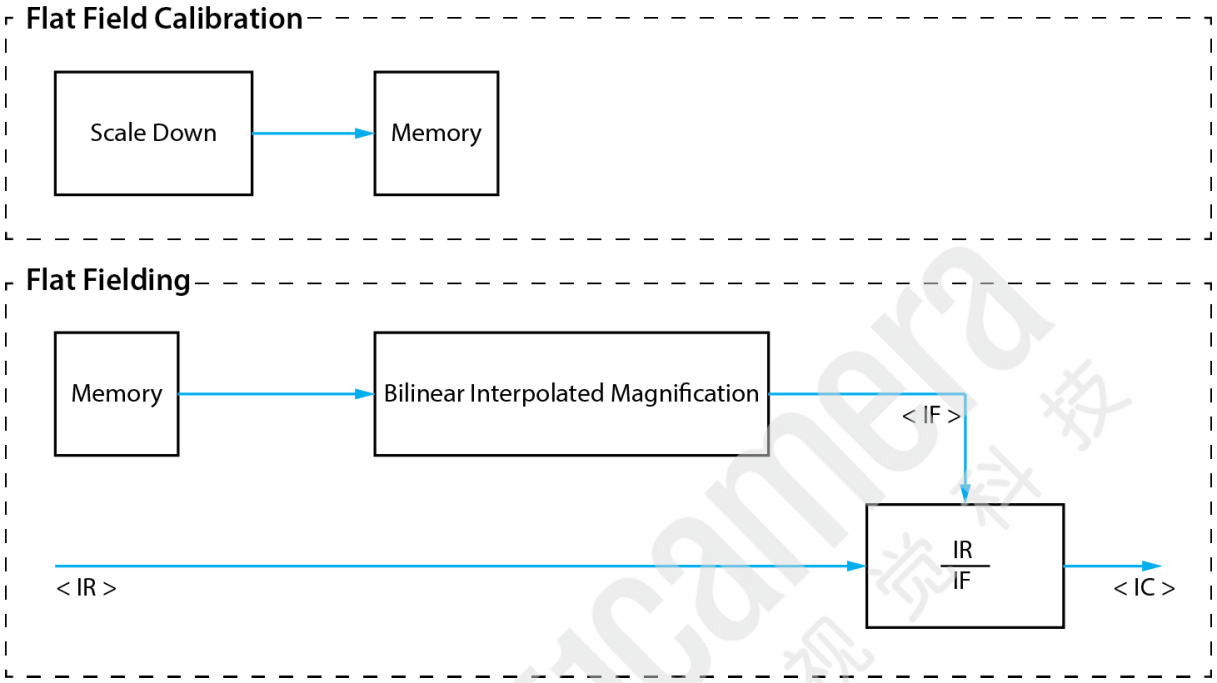


Figure 9.9 Generation and Application of Flat Field Data

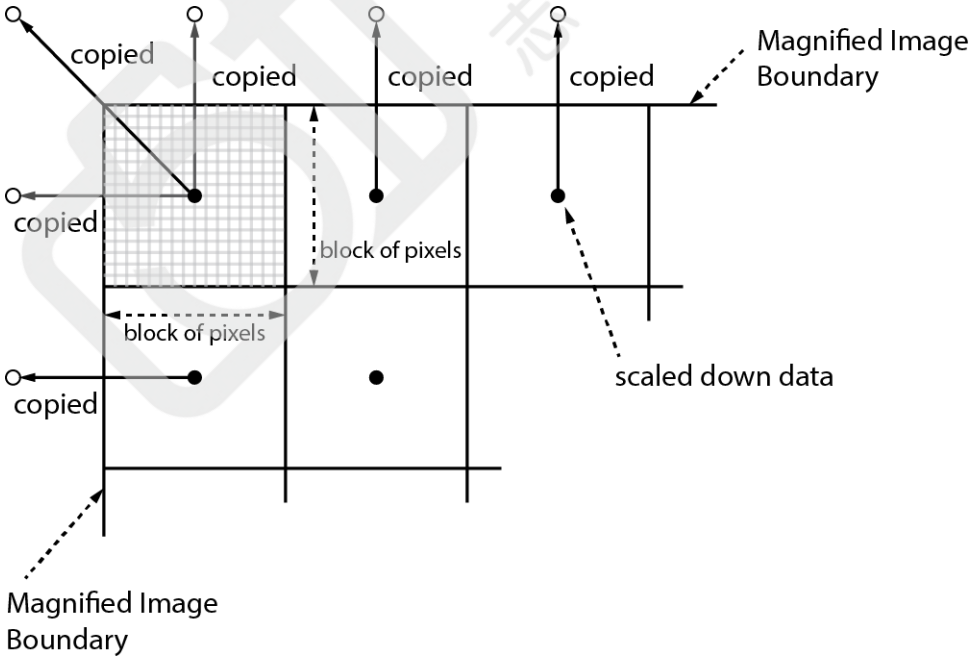


Figure 9.10 Bilinear Interpolated Magnification

9.11 Digital I/O 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 Mode	slnm	0: Input	Sets the control I/O receptacle to the Input mode.
		1: Output	Sets the control I/O receptacle to the Output mode.
Line Source	slnc	0: Off	Disables the line input/output.
		4: Frame Active	Outputs pulse signals indicating a frame readout time.
		6: Exposure Active	Outputs pulse signals indicating the current exposure time.
		10: User Output	Outputs pulse signals set by the User Output Value (‘suov’).
		18: Timer0	Outputs user-defined Timer0 signals as pulse signals.
Line Inverter	slni	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 9.14 Commands related to Digital I/O Control

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

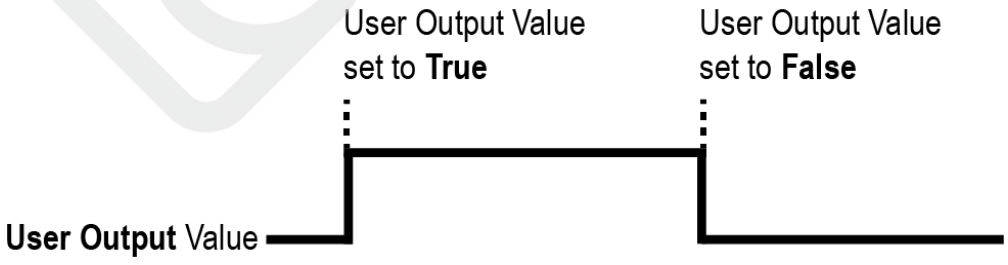


Figure 9.11 User Output

9.11.1 Debounce

The Debounce feature of the VQ-4MC-180 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.

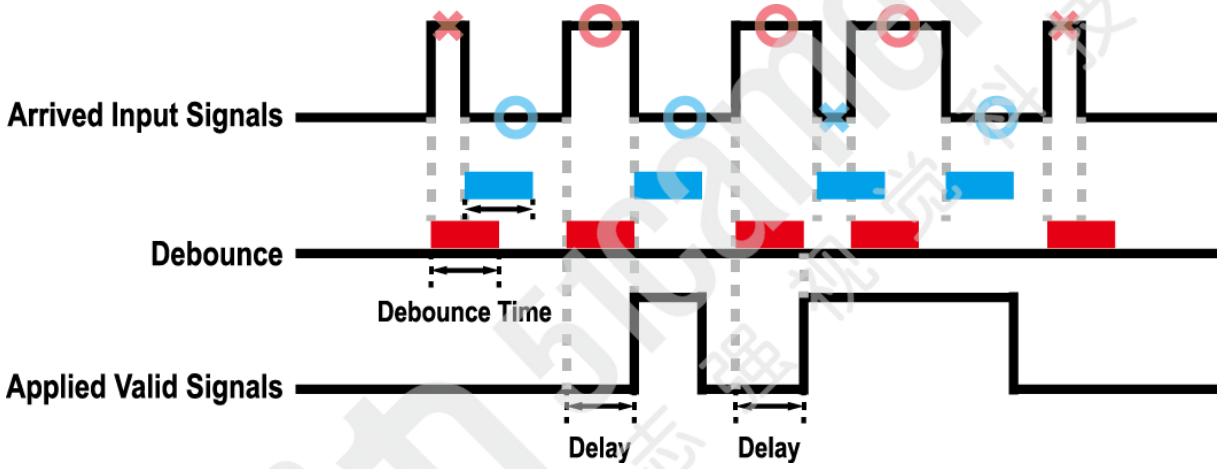


Figure 9.12 Debounce

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 9.15 Command related to Debounce Time

9.11.2 Timer Control

When the Line Source is set to Timer0 (the ‘slnc 18’ command is executed), the camera can provide output signals by using the Timer. The VQ-4MC-180 camera has one Timer designated as Timer0. The source signals available for the Timer are Frame Active or Exposure Active events.

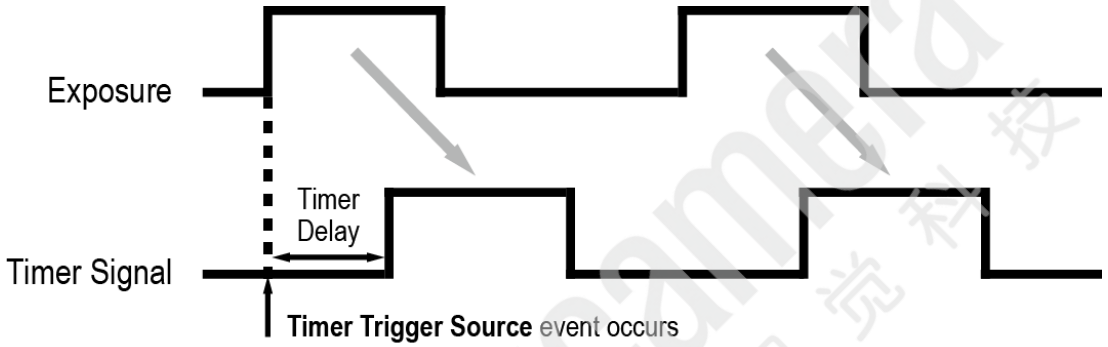
The commands related to Timer are as follows.

Command		Value	Description
Timer Trigger Source	stts	0: Off	Disables the Timer trigger.
		4: Frame Active	Sets the Timer to use a frame readout time as source signals.
		6: Exposure Active	Sets the Timer to use the current exposure time as source signals.
Timer Duration	stdu	1 ~ 60,000,000 μs	Sets the duration of the Timer output signal when the Timer Trigger Activation is set to Falling/Rising Edge (‘stta 0/1’).
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 9.16 Commands related to Timer Control

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

1. When the source signals set by the Timer Trigger Source 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.



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

Figure 9.13 Timer Signal

9.12 Temperature Monitor

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

The command related to device temperature is as follows.

Command		Value	Description
Device Temperature	gct	-	Displays device temperature in Celsius.

Table 9.17 Command related to Device Temperature

9.13 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 corresponding camera status are as follows:

- Steady Red: The camera is not initialized.
- Fast Flashing Green: The camera is transmitting image data.

9.14 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 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).

The command related to Test Image is as follows.

Command		Value	Description
Test Image	sti	0: Off	Disables the Test Image feature.
		1: Test Image 1	Sets to Grey Horizontal Ramp.
		2: Test Image 2	Sets to Grey Diagonal Ramp.
		3: Test Image 3	Sets to Grey Diagonal Ramp Moving.

Table 9.18 Command related to Test Image

Figure 9.14 Test Image 1

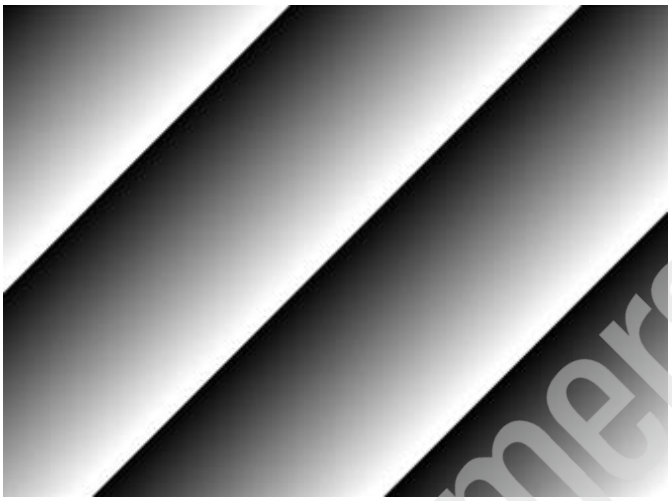


Figure 9.15 Test Image 2

Figure 9.16 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.

9.15 Reverse X

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

Command		Value	Description
Reverse X	shf	-	Flips images horizontally.

Table 9.19 Command related to Reverse X

Figure 9.17 Original Image

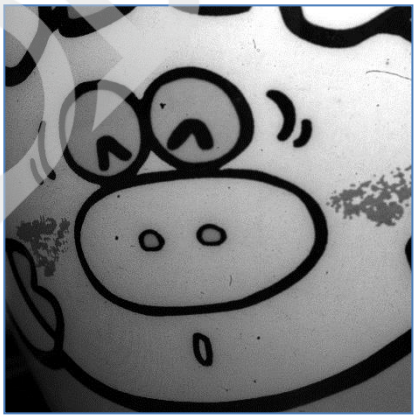


Figure 9.18 Reverse X Image

9.16 Device Reset

Resets the camera physically to power off and on.

The command related to Device Reset is as follows.

Command		Value	Description
Device Reset	rst	-	Resets the camera physically.

Table 9.20 Command related to Device Reset

9.17 Field Upgrade

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

10 Camera Configuration

10.1 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: 1152200 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 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
```

10.2 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.

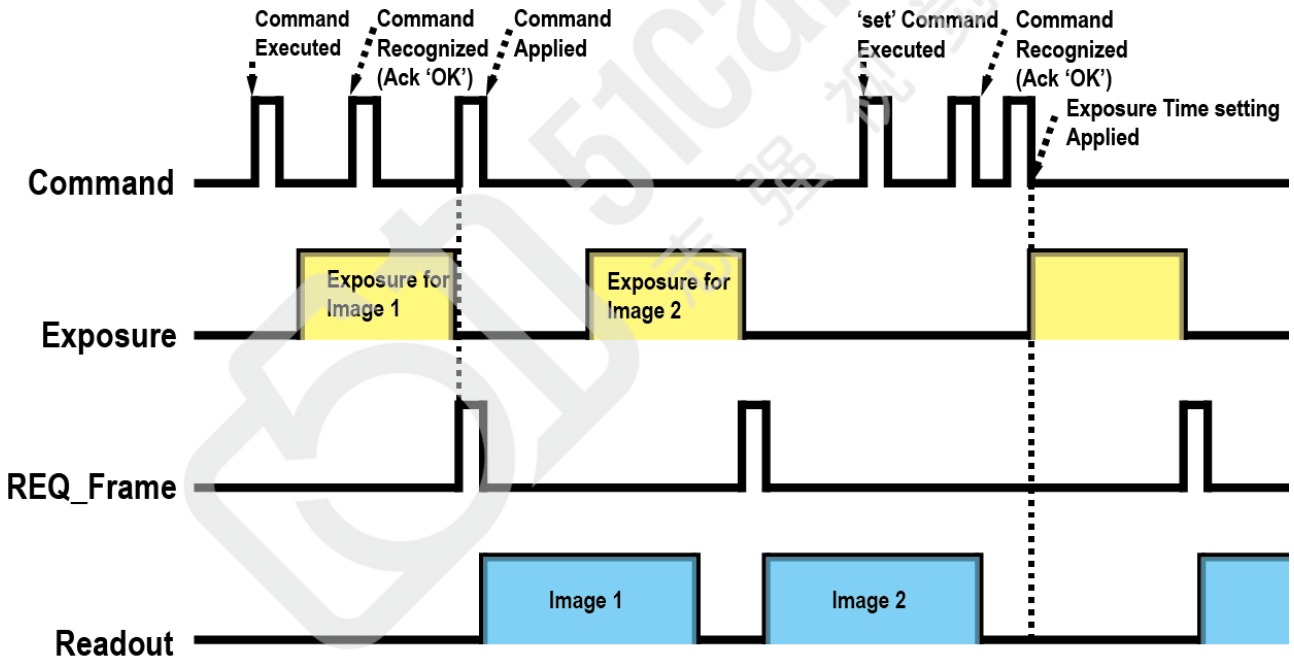


Figure 10.1 Actual Runtime of Commands

10.3 User Set Control

You can save the current camera settings to the camera's internal Flash memory. You can also load the camera settings from the camera's internal Flash memory. The camera provides two setups to save and three setups to load settings. The 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 the User 2 Setting when reset.

Table 10.1 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.

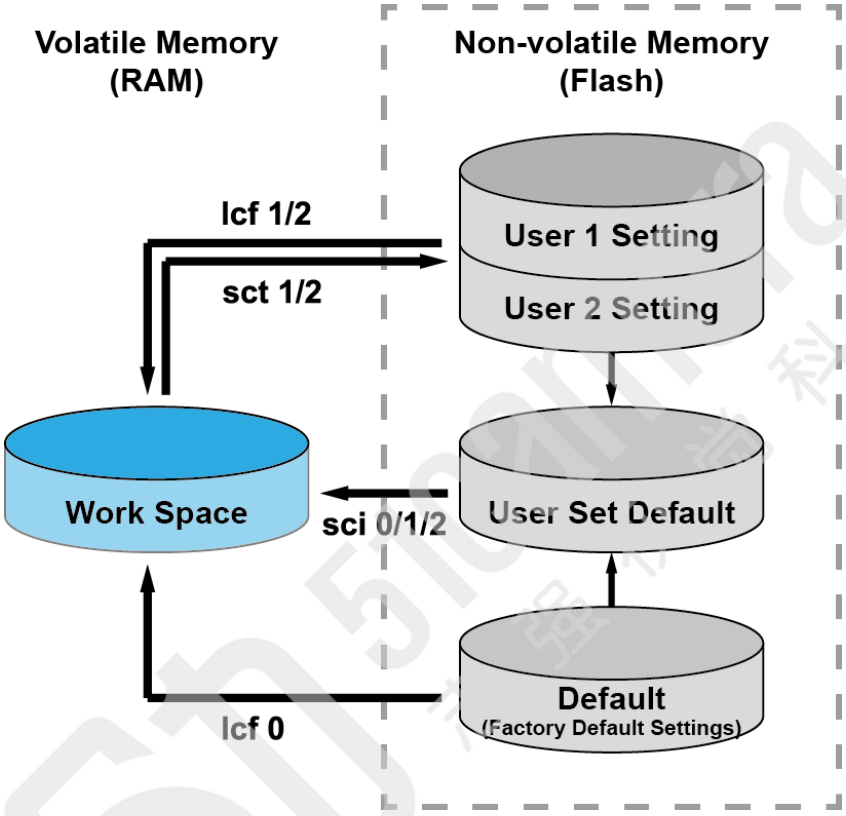


Figure 10.2 User Set Control

10.4 Command List

You can set all features provided by the VQ-4MC-180 camera by using the following commands.

Command	Syntax	Return Value	Description
Help	help	String	Displays a list of all commands.
Set ROI Offset X Get ROI Offset X	sox n gox	OK n	X coordinate of start point ROI n: X axis offset
Set ROI Offset Y Get ROI Offset Y	soy n goy	OK n	Y coordinate of start point ROI n: Y axis offset
Set Image Width Get Image Width	siw n giw	OK n	Sets a width of the Image ROI. n: Width value (Setting range: 256 - 2048)
Set Image Height Get Image Height	sih n gih	OK n	Sets a height of the Image ROI. n: Height value (Setting range: 4 – 2048)
Set Region Selector Get Region Selector	srs n grs	OK n	Selects a ROI when setting the Multi-ROI. n: ROI number (0 – 7)
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.
Acquisition Start	ast	OK	Starts image acquisitions.
Acquisition Stop	asp	OK	Stops image acquisitions.

Table 10.2 Command List #1

Command	Syntax	Return Value	Description
Set Trigger Mode Get Trigger Mode	stm 0|1 gtm	OK 0|1	Sets the Trigger Mode. 0: Trigger Mode Off (Free run mode) 1: Trigger Mode On
Set Trigger Source Get Trigger Source	sts 3|10|14|22 gts	OK 3|10|14|22	Specifies a source signal when the Trigger Mode is set to On. 3: Software 10: User Output 14: CC1 22: LineIn0
Generate SW Trigger	gst	OK	Generates a Software trigger signal.
Set Trigger Activation Get Trigger Activation	sta 0|1 gta	OK 0|1	Sets the activation mode for the selected source signal when the Trigger Mode is set to On. 0: Falling Edge 1: Rising Edge
Set Exposure Mode Get Exposure Mode	sem 0|1 gem	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: 16 – 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: 0.0 – 63.0)
Set Digital Gain Get Digital Gain	sdg n gdg	OK n	Sets the Gain. n: Gain value (Setting range: 1.0× – 4.0×)
Set Test Image Get Test Image	sti 0|1|2|3 gti	OK 0|1|2|3	Sets the Test Image. 0: Disables the Test Image feature. 1: Sets to Grey Horizontal Ramp. 2: Sets to Grey Diagonal Ramp. 3: Sets to Grey Diagonal Ramp Moving.

Table 10.3 Command List #2

Command	Syntax	Return Value	Description
Set Data Bit Get Data Bit	sdb 8|10 gdb	OK 8|10	Sets the Pixel Format. 8: 8 bit 10: 10 bit
Set Frame Rate Get Frame Rate	sfr n gfr	OK n	Sets the rate at which the exposure start trigger will be generated when the Trigger Mode is set to Off.
Set Camera Link Tap Geometry Get Camera Link Tap Geometry	stg 2|4|8|10 gtg	OK 2|4|8|10	Sets the Camera Link Tap Geometry. 2:1X2-1Y (2 Tap) 4: 1X4-1Y (4 Tap) 8: 1X8-1Y (8 Tap) 10: 1X10-1Y (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 Speed. 0: 85 MHz 1: 68 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 Generator.
Set Flat Field Data Selector Get Flat Field Data Selector	sfds 0|1|2|3 gfds	OK 0|1|2|3	Selects a Flat Field Correction data location. 0: Factory default location 1 ~ 3: User defined locations
Save Flat Field Data	sfd	OK	Saves the generated Flat Field Correction data in the selected Flat Field Correction data location.
Load Flat Field Data	lfd	OK	Loads the Flat Field Correction data from the non-volatile memory into the volatile memory.

Table 10.4 Command List #3

Command	Syntax	Return Value	Description
Set Line Mode Get Line Mode	slnm 0|1 glnm	OK 0|1	Sets the control I/O receptacle to the Input or Output mode. 0: Input 1: Output
Set Line Source Get Line Source	slnc 0|4|6|10|18 glnc	OK 0|4|6|10|18	Specifies a source signal for the control I/O receptacle. 0: Disables the Line input/output. 4: Frame Active 6: Exposure Active 10: User Output 18: Timer0
Set Line Inverter Get Line Inverter	slni 0|1 glni	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|4|6 gtts	OK 0|4|6	Specifies the source signal for the Timer output signal. 0: Disables the Timer trigger. 4: Frame Active 6: Exposure Active
Set Timer Duration Get Timer Duration	stdu n gtdu	OK n	Sets the duration of the Timer output signal. n: 1 – 60,000,000 μs
Set Timer Delay Get Timer Delay	stdl n gtdl	OK n	Sets the delay time for the Timer. n: 0 – 60,000,000 μs
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

Table 10.5 Command List #4

Command	Syntax	Return Value	Description
Set Debounce Time Get Debounce Time	sdbt n gdbt	OK n	Sets the Debounce time. n: Debounce time in microseconds.
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 n grg r|g|b	OK n	Sets the intensity of color pixels. r|g|b: Red / Green / Blue pixels n: Gain value (1.0× ~ 4.0×)
Auto White Balance	arg	OK	Automatically adjusts the white balance once.
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
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 10.6 Command List #5

11 Configurator GUI

The Configurator, a sample application, is provided to control the VQ-4MC-180 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.

11.1 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.

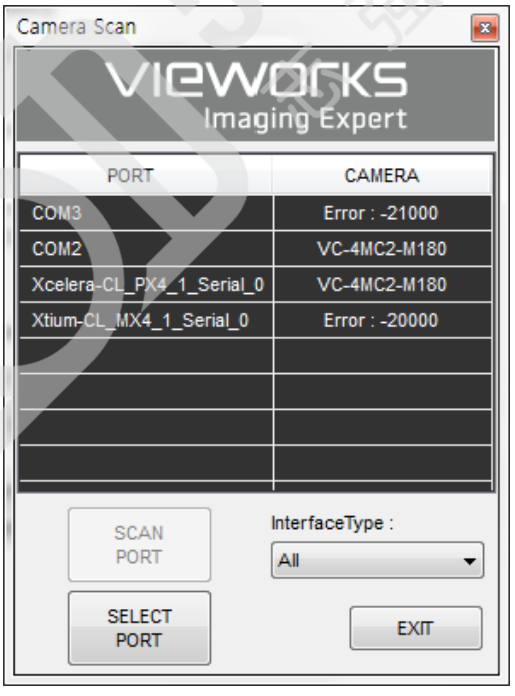


Figure 11.1 Configurator Loading Window

11.2 Menu

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

11.2.1 File

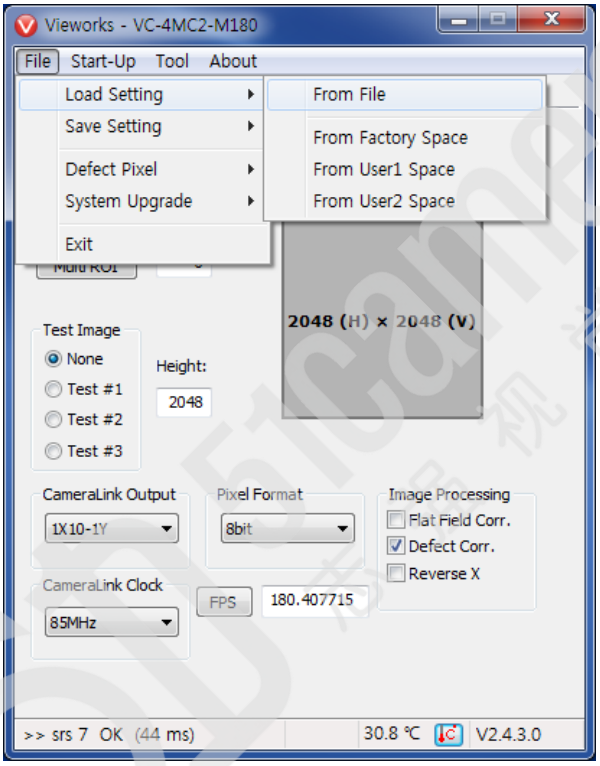


Figure 11.2 File Menu

- **Load Setting:** Loads the camera setting values from the camera memory (Factory, User1 or User2) or user's computer.
- **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.

11.2.2 Start-Up

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

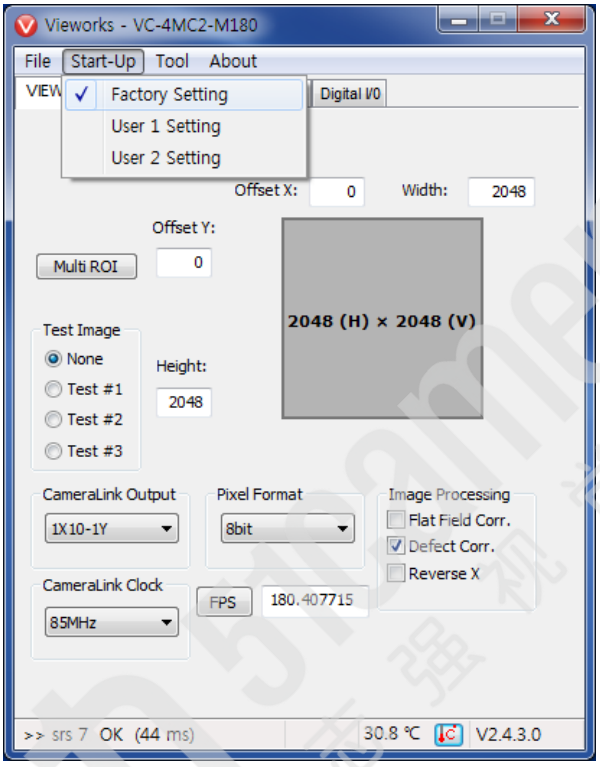


Figure 11.3 Start-Up Menu

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

11.2.3 Tool

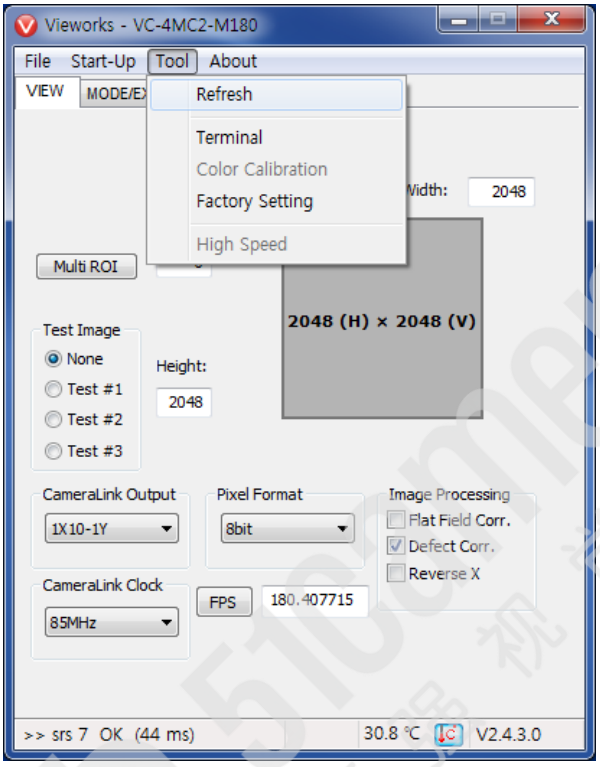


Figure 11.4 Tool Menu

- **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 on the VQ-4MC-180 camera.

11.2.4 About

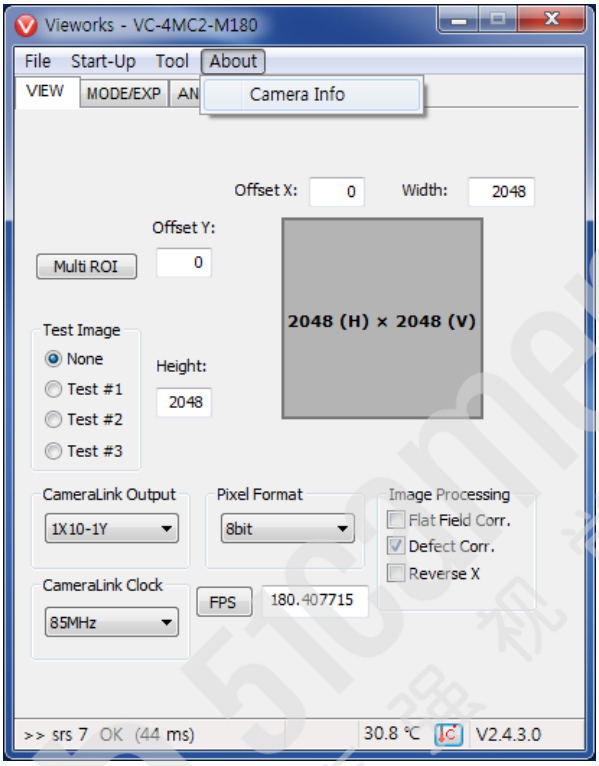


Figure 11.5 About Menu

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

11.3 Tab

11.3.1 VIEW Tab

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

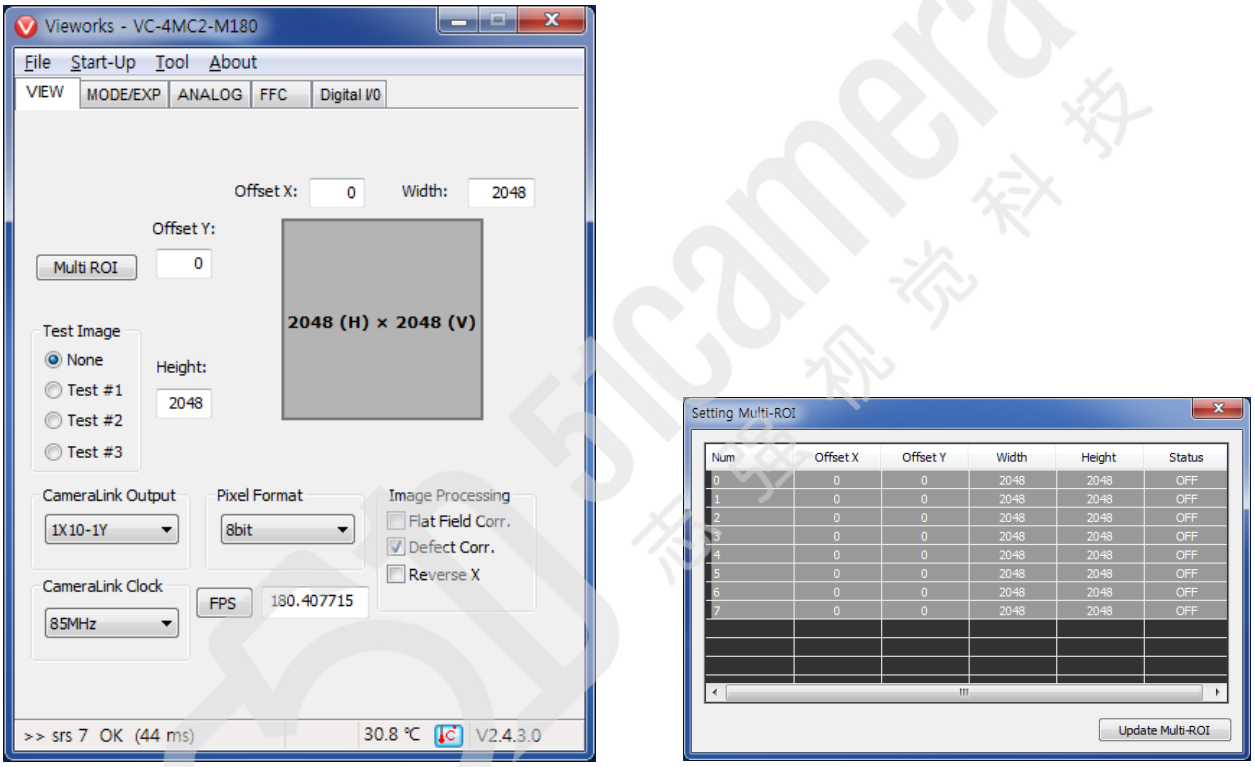


Figure 11.6 VIEW Tab

- **Offset X, Offset Y, Width, Height:** Sets the camera's Image 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 Output:** Sets the Camera Link Tap Geometry.
- **Camera Link Clock:** Selects a Camera Link Pixel Clock speed.
- **Pixel Format:** Selects a bit depth of data output.
- **Image Processing:** Enables or disables the Flat Field Correction, Defect Pixel Correction and/or Reverse X features.

11.3.2 MODE/EXP Tab

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

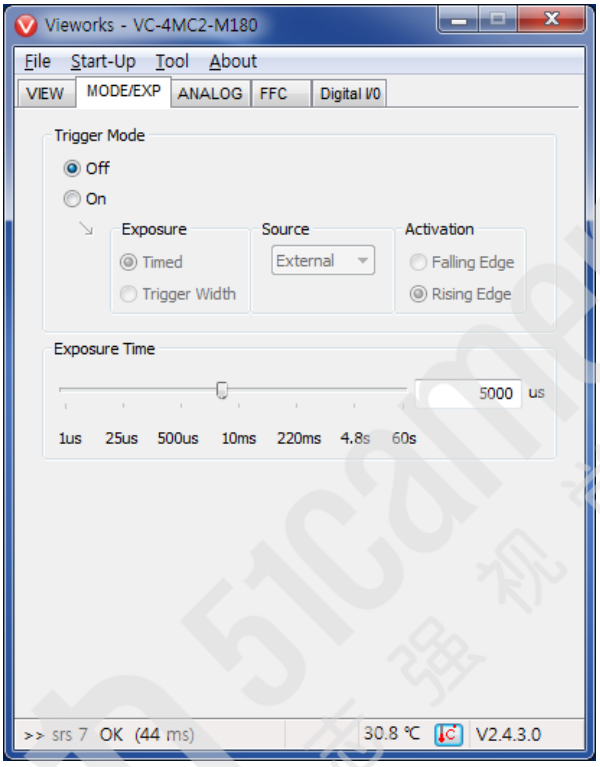


Figure 11.7 MODE/EXP Tab

- **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.

11.3.3 ANALOG Tab

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

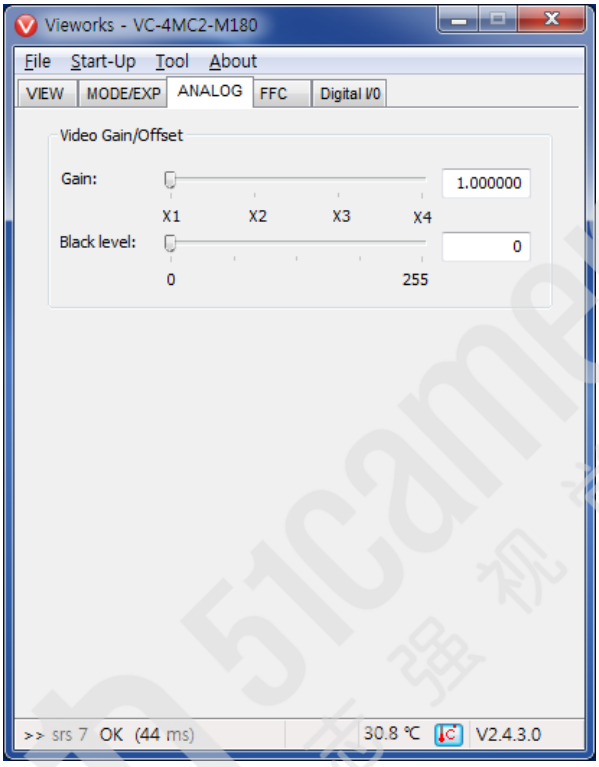


Figure 11.8 ANALOG Tab

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

11.3.4 FFC Tab

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

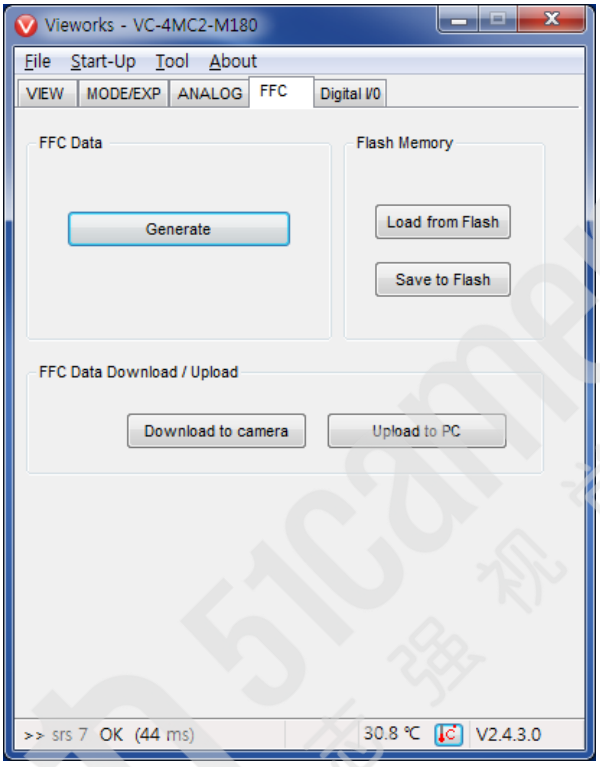


Figure 11.9 FFC Tab

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

11.3.5 Digital I/O Tab

The control I/O receptacle of the VQ-4MC-180 camera can be operated in various modes. The Digital I/O tab allows you to configure the mode of the control I/O receptacle.

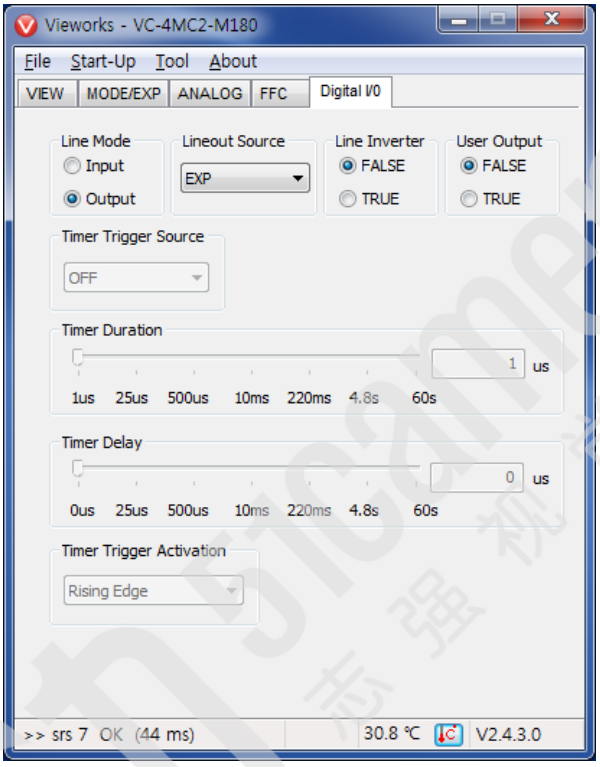


Figure 11.10 Digital I/O Tab

- **Line Mode:** Sets the control I/O receptacle to the Input or Output mode.
- **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:** Sets 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.

12 Troubleshooting

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

- If no image is displayed on your computer,
  - Ensure that all 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.

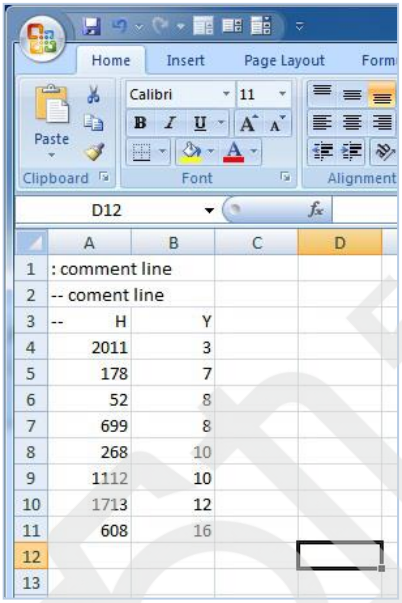
- If you identify abnormal operation or overheating sign,
  - Ensure the power supply is properly connected.
  - Stop using the camera when you notice smoke or abnormal overheating.

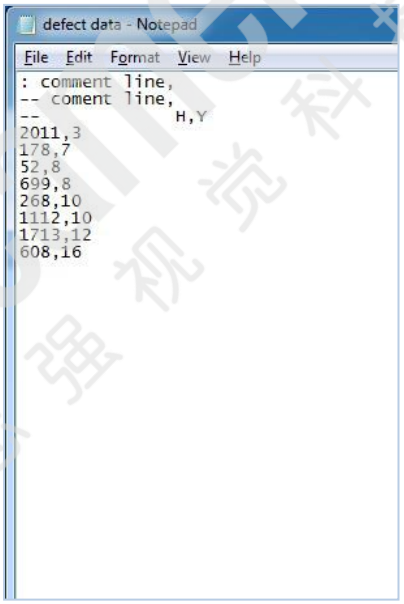
- If you have a problem using the Trigger Mode,
  - Ensure that parameter settings on your frame grabber are configured correctly when you operate the camera with CC1 trigger signals.
  - Ensure that cable connections are secure when you operate the camera with external trigger signals.

- 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.

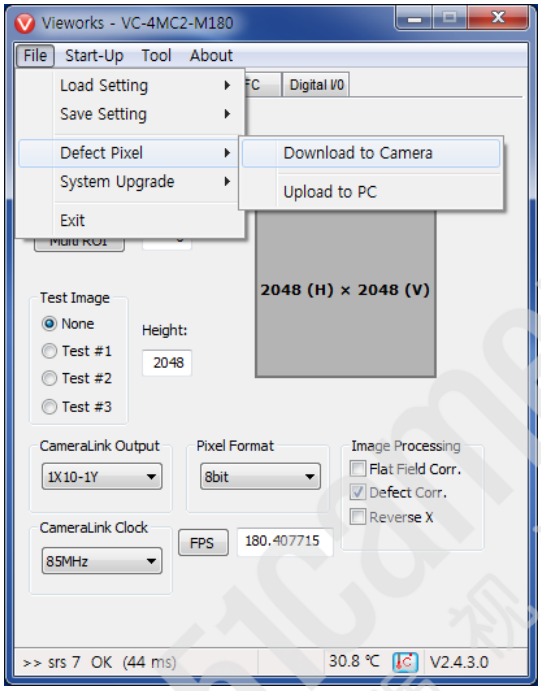
Appendix A Defective Pixel Map Download

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.

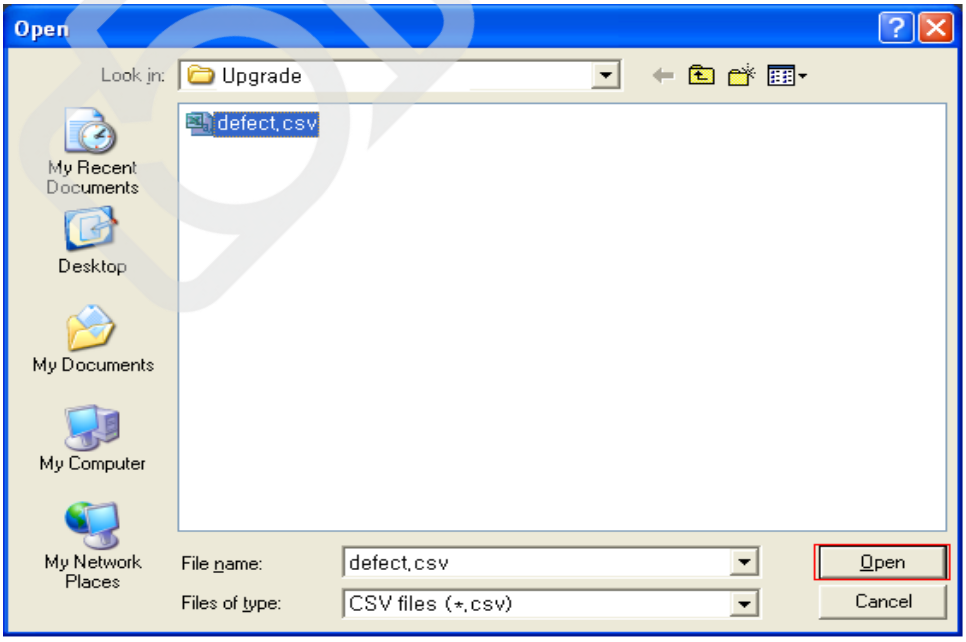




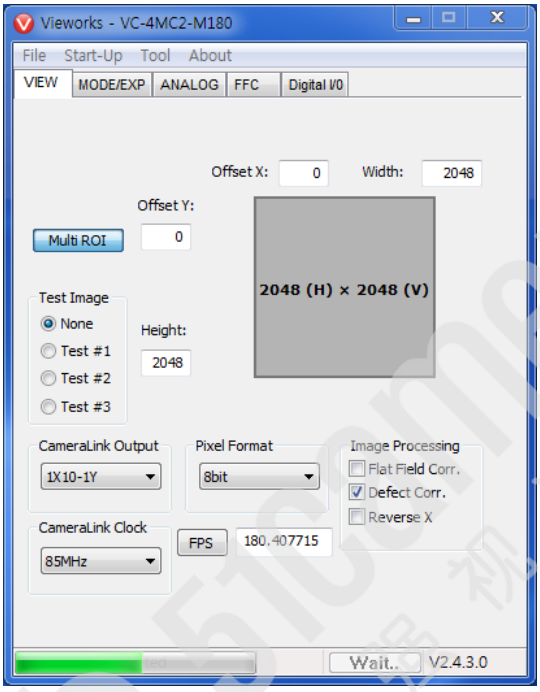
2. Select **File** > **Defect Pixel** > **Download to Camera** in the Configurator.



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.



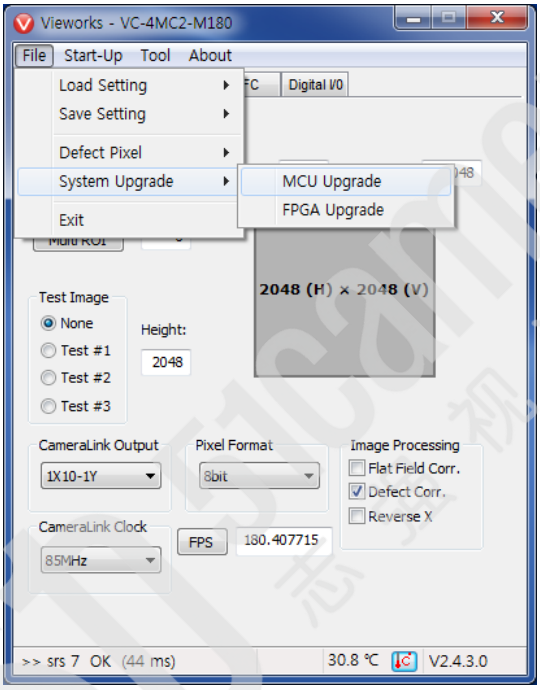
5. Once the download is complete, the saving process will begin. During the saving process, make sure not to disconnect the power cord.

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

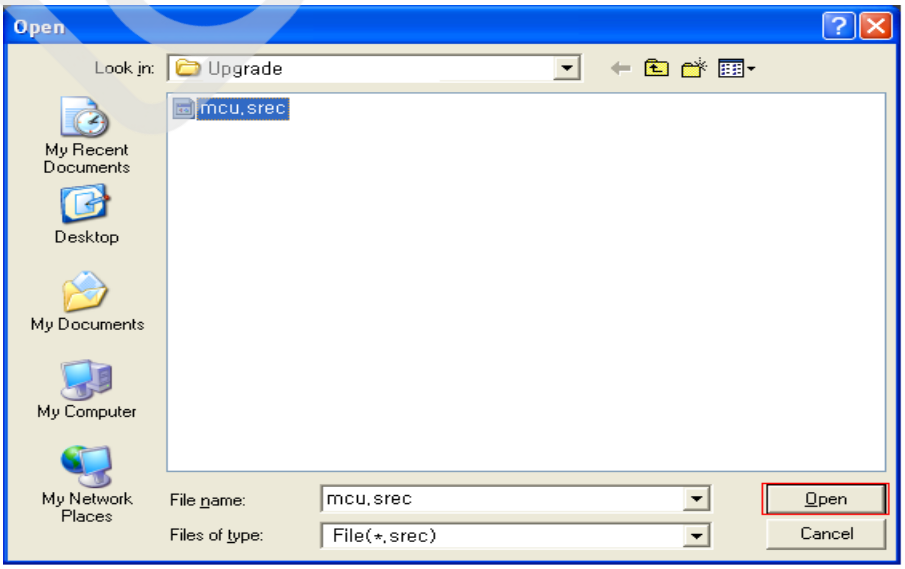
Appendix B Field Upgrade

B.1 MCU

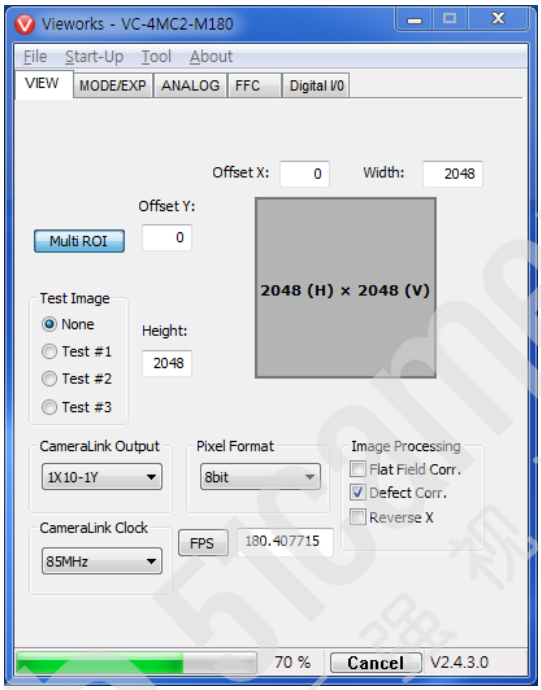
1. Select **File** > **System Upgrade** -> **MCU Upgrade** in the Configurator.



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

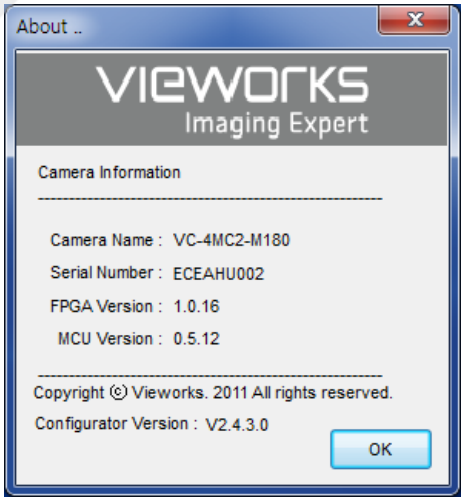


3. The Configurator starts downloading MCU upgrade file to the camera and downloading status is displayed at the bottom of the window. This process may require several minutes to complete. If you want to cancel the upgrade process, click **Cancel**.



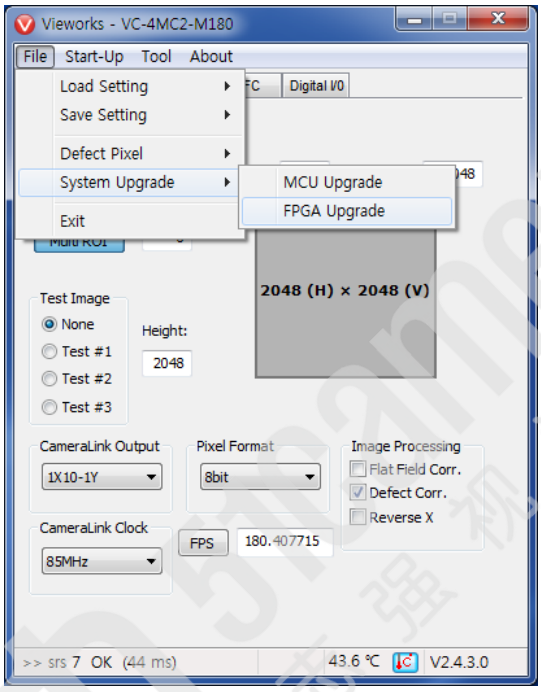
4. Once the download is complete, the saving process will begin. If a power failure occurs during the saving process, the camera cannot be restored. Make sure that the power connection is secure.

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 version.

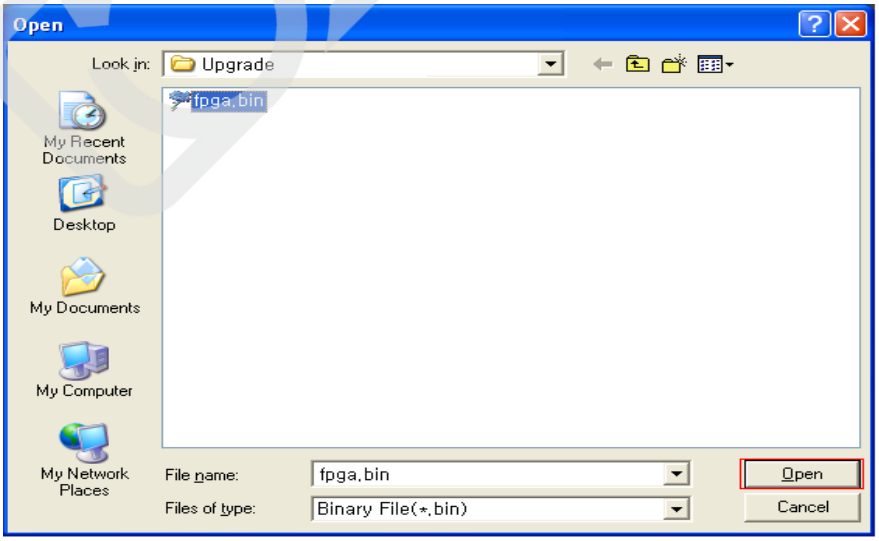


B.2 FPGA

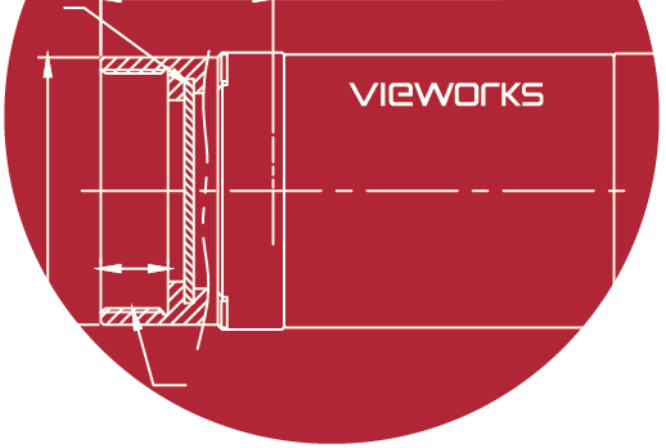
1. Select **File** > **System Upgrade** > **FPGA Upgrade** in the Configurator.

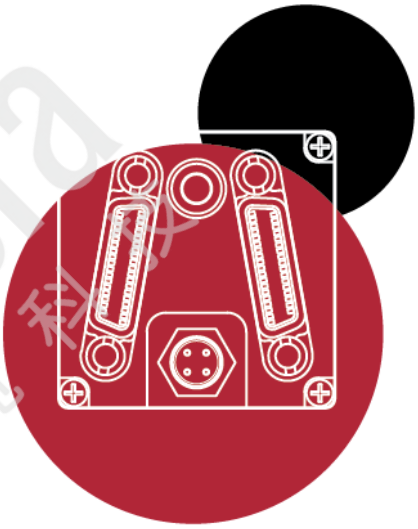


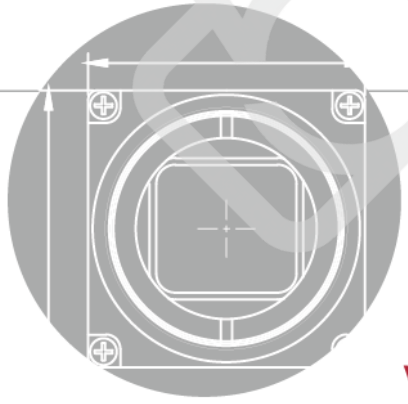
2. Search and select the provided FPGA upgrade file, and then click **Open**.



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







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