

User Manual

English



Model : VA-1MC
VA-2MC
VA-4MC
VA-8MC
VA-29MC



vieworks



Revision History

Revision	Date	Description
1.0	2010/01/01	Initial release
1.1	2010/05/10	Revised "ssp","stp" command, added "gmn" command
1.2	2010/06/28	Added Serial command response example
1.3	2010/07/23	Revised FPS formula
1.4	2010/11/22	Revised Binning content
1.5	2010/11/28	Revised Model naming conventions
1.6	2011/04/6	Added VA-29M model, Revised Word Style
1.7	2011/07/020	Revised VA series frame rate depending on the minimum AOI, revised AOI Frame Rate formula and timing value for VA series
1.8	2011/08/01	Added 4 Tap-I (Sensor Readout: 4 Tap, Data Output: 2 Tap Interleaved) Added Figure 7.24 Revised Figure 7.6, 7.7, 7.8, 7.9, 7.10, 7.11, 7.12, 7.13, 7.16 Added 4 Tap-I to "scm" command of Table 8.1
1.9	2011/10/26	VA-29M does NOT support 4 Tap-I. Changed VA-29M Timing values – Table 7.1 Added VA-29M Frame Rate by VAOI changes graph – Figure 7.3
2.0	2013/06/14	<ul style="list-style-type: none">• Added description of M5 set screws for tilt adjustment• Revised spectral response according to the updated TSI datasheets• Added Actual Time Applied for Commands



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1 Precautions

General



- Do not drop, damage, disassemble, repair or alter the device.
- Do not let children touch the device without supervision.
- Do not use the device for any other purpose than specified.
- Contact your nearest distributor in case of trouble or problem.

Installation and Maintenance



- Do not install the device in a place subject to direct sun light, humidity, dust or soot.
- Do not place magnets near the product.
- Do not place the device next to heating equipments.
- Be careful not to let liquid like water, drinks or chemicals leak inside the device.
- Clean the device often to remove dust on it.
- In clearing, do not splash water on the device but wipe it out with a smooth cloth or towel.

Power Supply



- Applying incorrect power can damage the camera. If the voltage applied to the camera is greater or less than the camera's nominal voltage, the camera may be damaged or operate erratically. Please refer to [5.2 Specifications](#) for the camera's nominal voltage.
- ※ Vieworks Co., Ltd. does NOT provide power supplies with the devices.

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 2004/108/EC.

Testing Standard EN 55022:2006+A1:2007, EN 55024:1998+A1:2001+A2:2003

Class A

3.3 KC

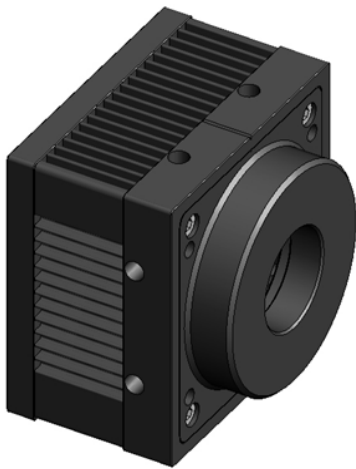
KCC Statement

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



4 Package Components

Package Components



VA Camera <C-mount>

or



VA Camera <F-Mount>



Mount Plate (Optional)



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



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



5 Product Specifications

5.1 Overview

The VA Series is a progressive scan, high-resolution industrial area scan cameras. All features of VA cameras can be programmed and updated in the field. The image processing and controls of VA Series are based on embedded FPGA with a 32-bit microprocessor.

Main Features

- Area Of Interest (AOI)
- Trigger Mode
- Binning Mode – 2 × 2 / 4 × 4
- Output Pixel Format – 8 / 10 / 12 bit
- Output Channel – 1 Tap / 2 Tap / 4 Tap
- Auto Taps Adjustment
- Electronic Shutter – Global Shutter
- 2D Flat Field Correction
- Strobe Output
- Analog Gain adjustment function
- Analog Offset adjustment function
- Lookup Table
- Pixel Defect Correction
- Flat Field Correction
- Test Image
- Horizontal Flip
- Image Invert
- RS-644 Serial Communication
- Temperature Monitor
- Field Upgradeable Firmware
- Base Camera Link



5.2 Specifications

VA Series	VA-1M	VA-2M	VA-2M (HD)	VA-4M	VA-8M
Active Image (H x V)	1024 x 1024	1600 x 1200	1920 x 1080	2336 x 1752	3296 x 2472
Sensor Type	Kodak KAI-01050	Kodak KAI-02050	Kodak KAI-02150	Kodak KAI-04050	Kodak KAI-08050
Pixel size	5.5 μm x 5.5 μm				
Sensor Output	1, 2 or 4 Tap Output				
Video Output	8/10/12 bits, 1 or 2 Tap (Interleaved or Top & Bottom)				
Camera Interface	Camera Link (Base)				
Electronic Shutter	Global Shutter				
Max. Frame Rate at Full Resolution	125 fps	70 fps	67 fps	33 fps	16 fps
Pixel Clock	40 / 80 MHz				
Exposure Time	1/100000 ~ 7 sec (10 μs step)				
Partial Scan (Max. Speed)	337 fps at 120 Lines	183 fps at 150 Lines	180 fps at 120 Lines	142 fps at 200 Lines	84 fps at 300 Lines
Gamma Correction	User defined LUT (Look Up Table)				
Black Offset	Adjustable (0 ~ 127 LSB at 12 bits , 256 step)				
Video Gain	Analog Gain : 0 ~ 32 dB, 900 step				
Trigger Mode	Mode(Free-Run, Overlap, Fast, Double), Programmable exposure time and trigger polarity				
External Trigger	External, 3.3 V - 5.0 V, 10 mA, optically isolated				
Software Trigger	Camera Link CC1, Programmable Exposure				
Dynamic Range	64 dB				
Lens Mount	C-mount or F-mount				
Power	10 ~ 14 V DC, Max. 6W				
Environmental	Operating: -5°C ~ 40°C, Storage : -30°C ~ 65°C				
Mechanical	68 mm x 68 mm x 54 mm, 420 g (with C-mount adaptor) 68 mm x 68 mm x 83 mm, 460 g (with F-mount adaptor)				

Table 5.1 Specifications of VA Series (VA-1/2/4/8M)



VA Series	VA-29M
Active Image (H x V)	6576 x 4384
Sensor Type	Kodak KAI-29050
Pixel size	5.5 μm x 5.5 μm
Sensor Output	1, 2 or 4 Tap Output
Video Output	8/10/12 bits, 1 or 2 Tap (Interleaved or Top & Bottom)
Camera Interface	Camera Link (Base)
Electronic Shutter	Global Shutter
Max. Frame Rate at Full Resolution	5 fps (High Speed)
Pixel Clock	30 / 60 MHz or 40 / 80 MHz (High Speed)
Exposure Time	1/100000 sec ~ 7 sec (10 μs step)
Partial Scan	16 fps at 1000 Lines (max. speed)
Gamma Correction	User defined LUT (Look Up Table)
Black Offset	Adjustable (0 ~ 127 LSB at 12 bit, 256 step)
Video Gain	Analog Gain : 0 ~ 32 dB, 900 step
Trigger Mode	Mode (Free-Run, Overlap, Fast, Double), Programmable exposure time and trigger polarity
External Trigger	External, 3.3 V - 5.0 V, 10 mA, optically isolated
Software Trigger	Camera Link CC1, Programmable Exposure
Dynamic Range	64 dB
Lens Mount	C-mount or F-mount
Power	10 ~ 14 V DC, Max. 6W
Environmental	Operating: -5°C ~ 40°C, Storage :-30°C ~ 65°C
Mechanical	68 mm X 68 mm X 83 mm, 460 g (with F-mount adaptor)

Table 5.2 Specifications of VA Series (VA-29M)

5.3 Camera Block Diagram

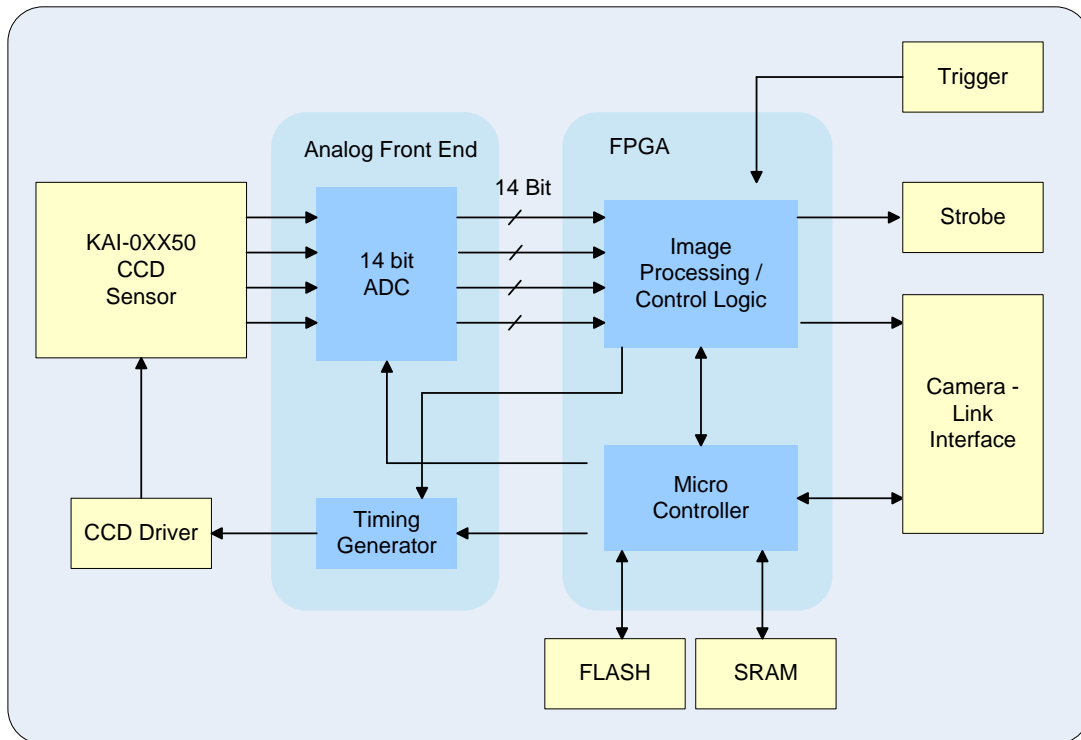


Figure 5.1 Camera Block Diagram

All controls and data processing of VA cameras are carried out in one FPGA chip. The FPGA generally consists of a 32 bit RICS Micro-Controller and Processing & Control Logic. The Micro-Controller receives commands from the user through the Camera Link interface and then processes them. The FPGA controls the Timing Generators (TGs) and the Analog Front End (AFE) chips where the TGs generate CCD control signals and AFE chips convert analog CCD output to digital values to be accepted by the Processing & Control Logic. The Processing & Control Logic processes the image data received from AFE and then transmits data through the Camera Link interface. And also, the Processing & Control Logic controls the trigger input and output signals which are sensitive to time. Furthermore, SDRAM and FLASH is installed outside FPGA. SDRAM is used for the frame buffer to process images and FLASH contains the firmware that operates the Micro-Controller.



5.4 Spectral Response

5.4.1 Mono Camera Spectral Response

The following graphs show the spectral response for VA Camera Link monochrome cameras.

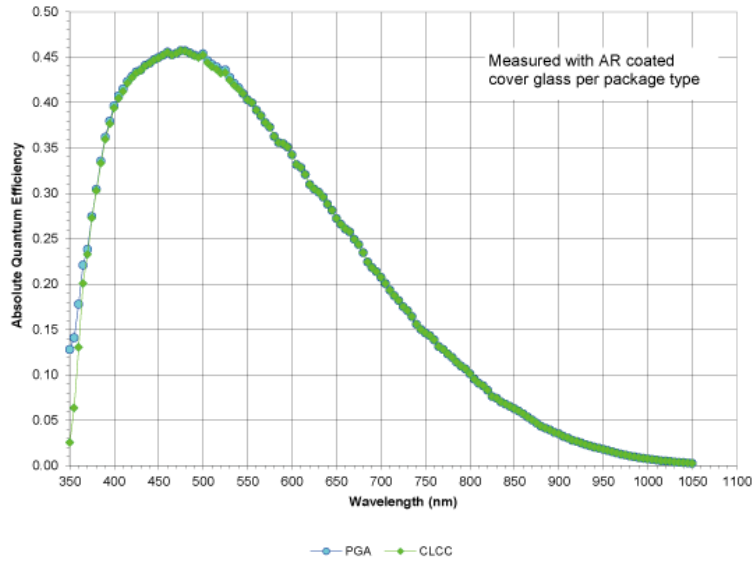


Figure 5.2 VA-1MC-M120 Spectral Response

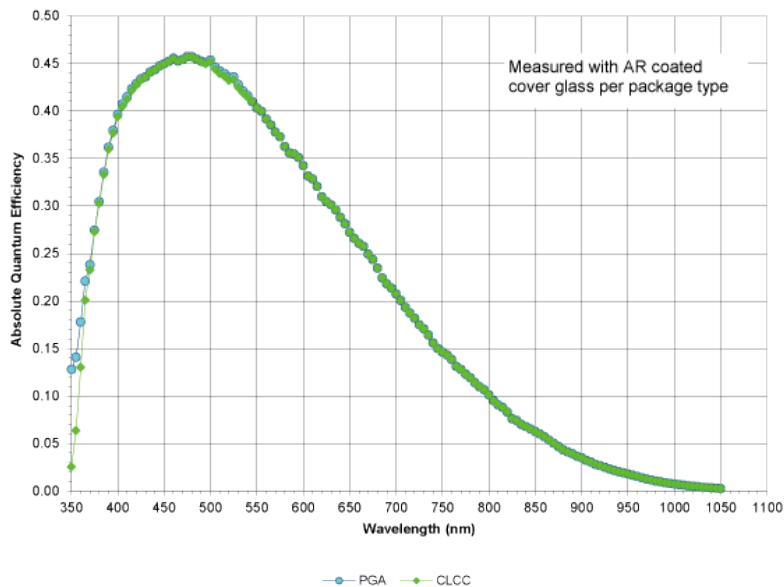


Figure 5.3 VA-2MC-M68 Spectral Response

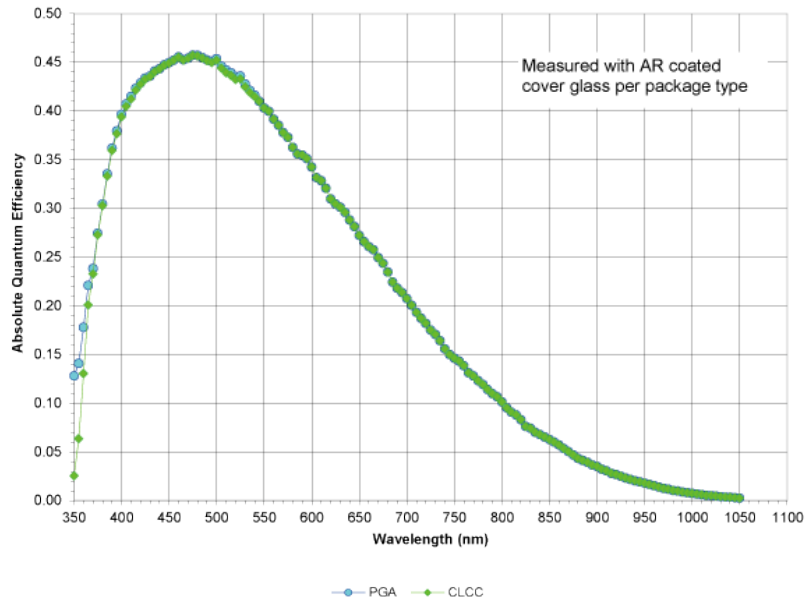


Figure 5.4 VA-2MC-M64 Spectral Response

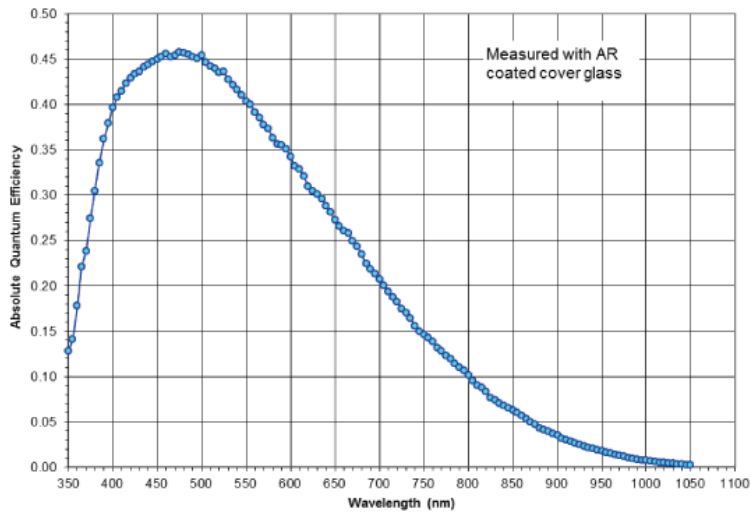


Figure 5.5 VA-4MC-M32 Spectral Response

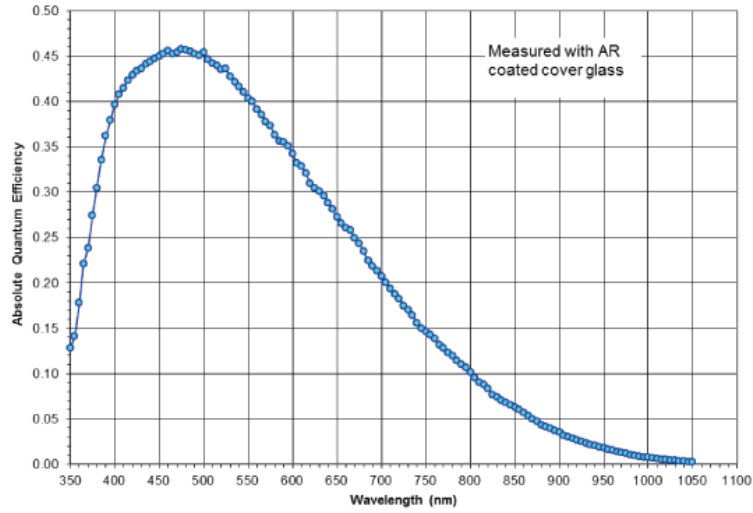


Figure 5.6 VA-8MC-M16 Spectral Response

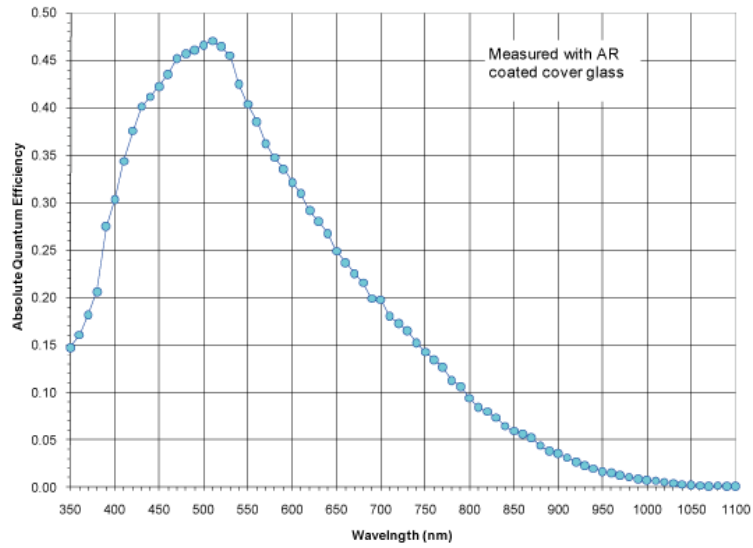


Figure 5.7 VA-29MC-M5 Spectral Response



5.4.2 Color Camera Spectral Response

The following graphs show the spectral response for VA Camera Link series color cameras.

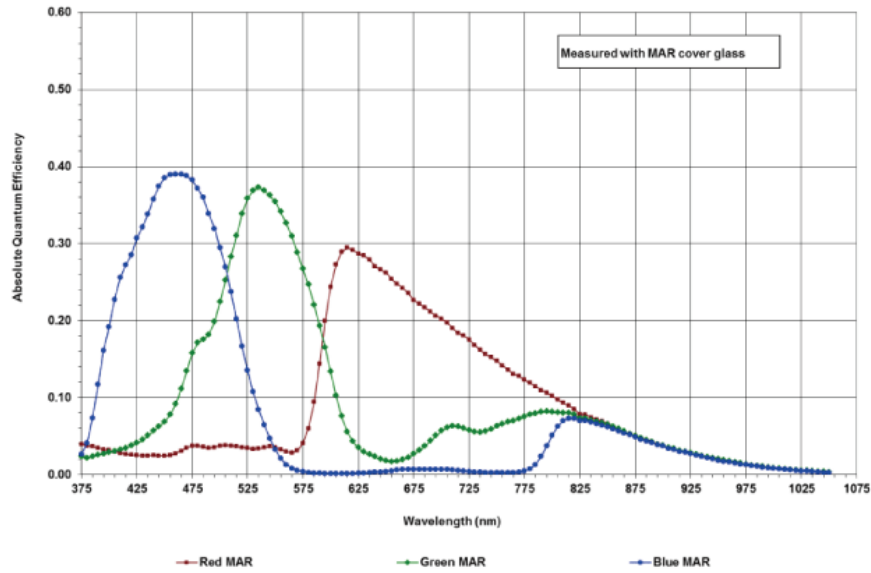


Figure 5.8 VA-1MC-C120 Spectral Response

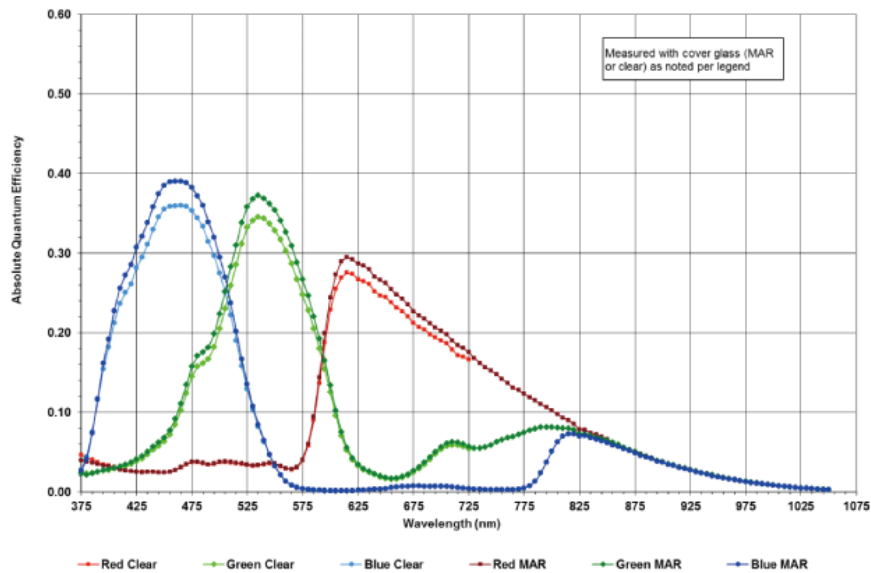


Figure 5.9 VA-2MC-C68 Spectral Response

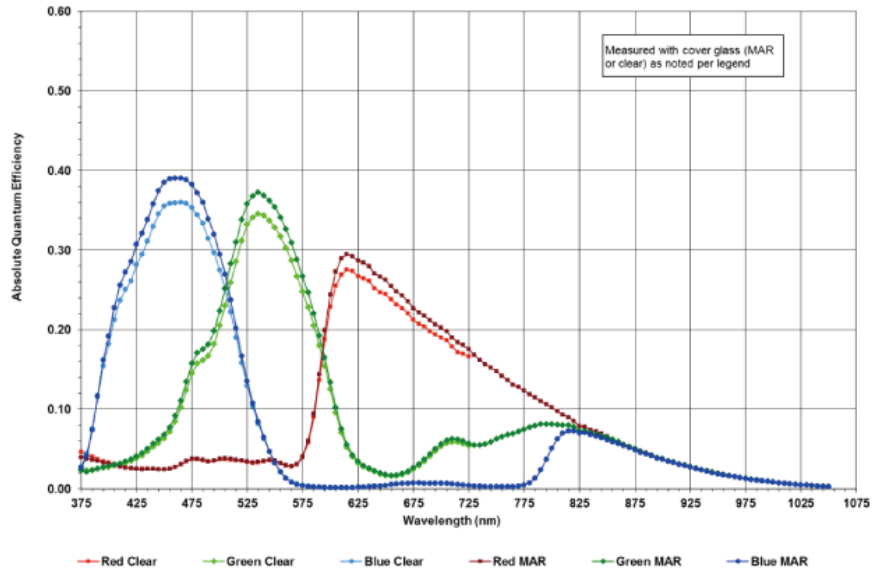


Figure 5.10 VA-2MC-C64 Spectral Response

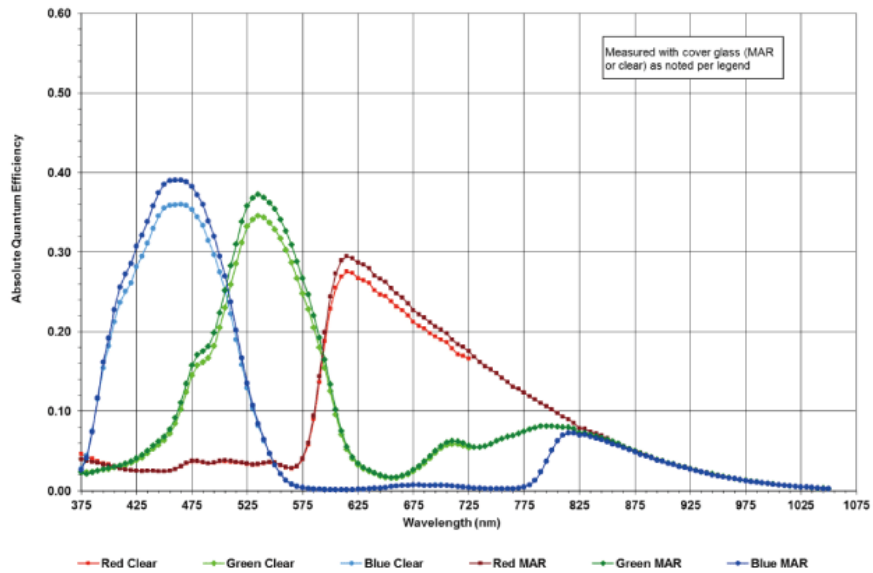


Figure 5.11 VA-4MC-C32 Spectral Response

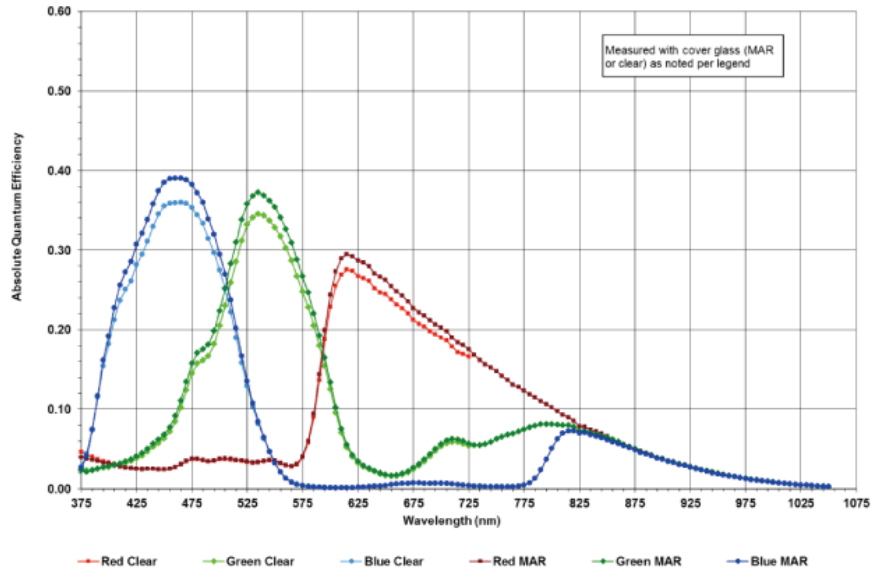


Figure 5.12 VA-8MC-C16 Spectral Response

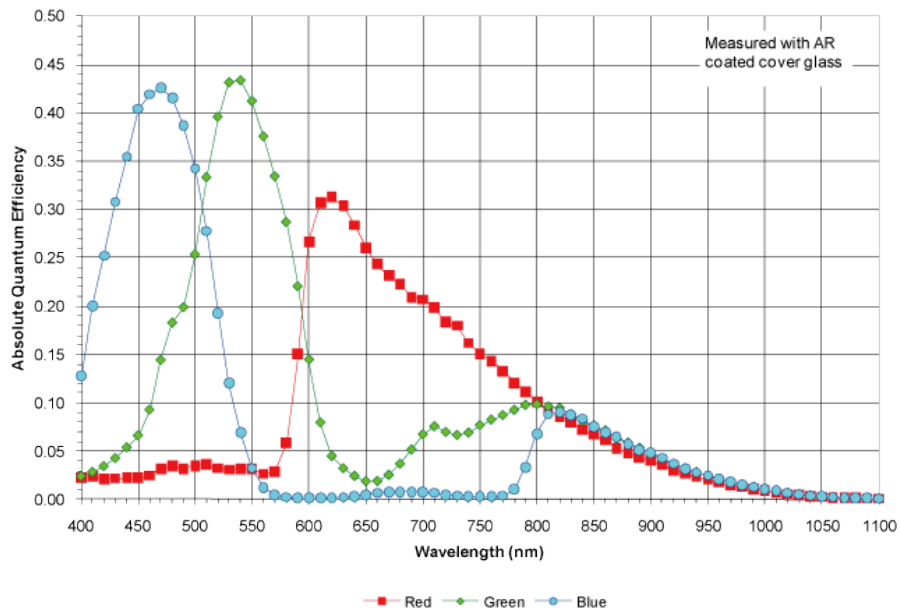


Figure 5.13 VA-29MC-C5 Spectral Response



5.5 Mechanical Specification

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

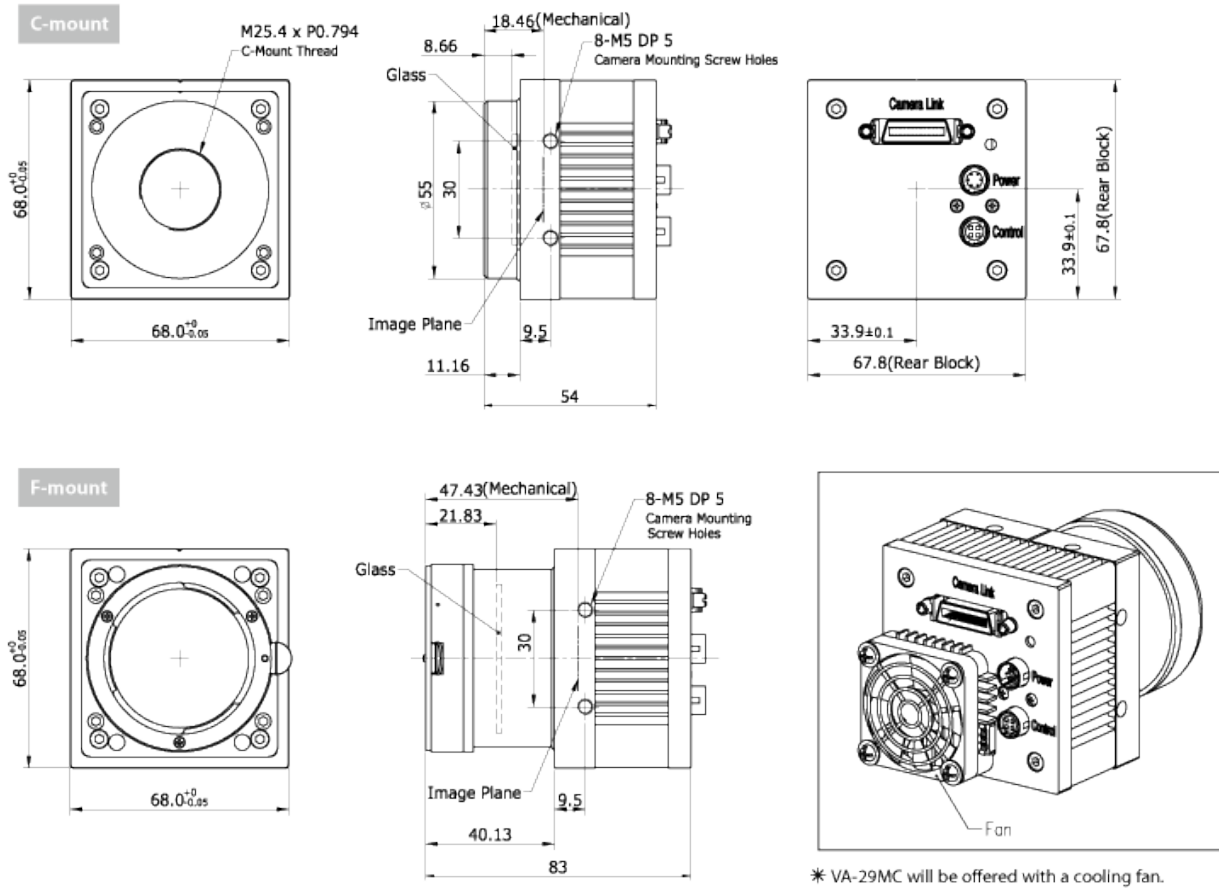


Figure 5.14 VA Camera Mechanical Dimension



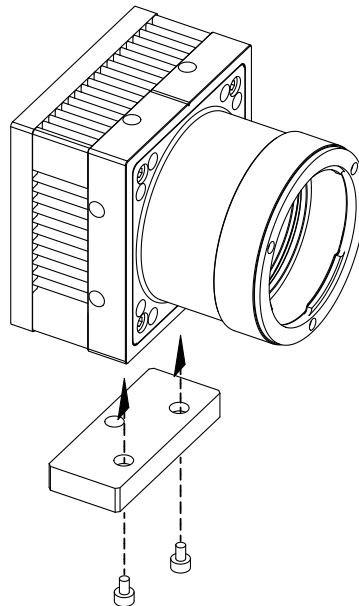
6 Connecting the Camera

The following instructions assume that you have installed a Camera Link frame grabber in your PC including related software. For more information, refer to your Camera Link frame grabber User Manual.

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

- 1 Make sure that the power supply is not connected to the camera and your PC is turned off.
- 2 Plug one end of a Camera Link cable into the Camera Link connector on the camera and the other end of the Camera Link cable into the Camera Link frame grabber in your PC.
- 3 Connect the plug of the power adaptor to the power input receptacle on the camera.
- 4 Plug the power adaptor into a working electrical outlet.
- 5 Verify all the cable connections are secure.

6.1 Mount Plate



- The Mount Plate is provided as an optional item.
- The camera can be fixed without using this Mount Plate.



6.2 Precaution to center the image sensor

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

6.3 Precaution about blurring compared to center

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

6.4 Installing the Configurator

- You can control the camera by executing the Configurator.exe file.
- You can download the latest Configurator at machinevision.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, 3 types of connectors and status indicator LED are located on the back of the camera and have the functions as follows:

- ① 26 pin Camera Link Connector: controls video data and the camera.
- ② Status LED: displays power status and operation mode.
- ③ 6 pin Power Input Receptacle: supplies power to the camera.
- ④ 4 pin Control Receptacle: inputs external trigger signal and outputs strobe.

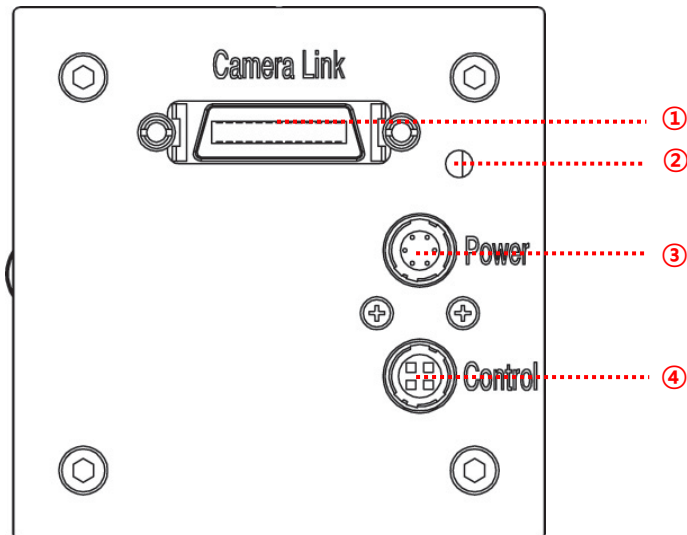


Figure 7.1 VA Series Back Panel

7.2 Camera Link Connector

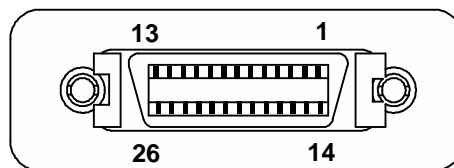


Figure 7.2 Camera Link Connector



Camera Link connector complies with Camera Link Standard and the following list shows the pin configuration of the connector.

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	-X3	LVDS - Out	Camera Link Transmitter
	18	+X3	LVDS - Out	Camera Link Transmitter
PAIR 5	6	-XCLK	LVDS - Out	Camera Link Transmitter
	19	-XCLK	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 Base Configuration

7.3 Power Input Receptacle

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

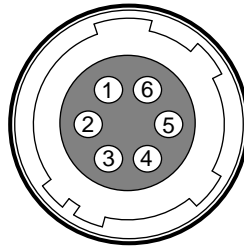


Figure 7.3 Pin Assignments for Power Input Receptacle

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

Table 7.2 Pin Configurations for Power Input Receptacle

Connecting the power cable to the camera can be made by using the Hirose 6 pin plug (part # HR10A-7P-6S) or the equivalent. The power adaptor is recommended to have at least 1A current output at 12 V DC $\pm 10\%$ voltage output (Users need to purchase the power adaptor separately).

Precaution for Power Input



- Make sure the power is turned off before connecting the power cord to the camera. Otherwise, damage to the camera may result.
- If the camera input voltage is greater than 16 V, damage to the camera may result.

7.4 Control Receptacle

The control receptacle is a Hirose 4 pin connector (part # HR10A-7R-4S) and consists of an external trigger signal input and strobe output port. The pin assignment and configurations are as follows:

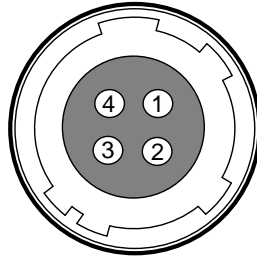


Figure 7.4 Pin Assignments for Control Receptacle

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

Table 7.3 Pin Configurations for Control Receptacle

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

7.5 Trigger Input Circuit

The following figure shows trigger signal input circuit of the 4-pin connector. Transmitted trigger signal is applied to the internal circuit through a photo coupler. Minimum trigger width that can be recognized by the camera is 1 μ S. If transmitted trigger signal is less than 1 μ S, the camera will ignore the trigger signal. External trigger circuit example is shown below.

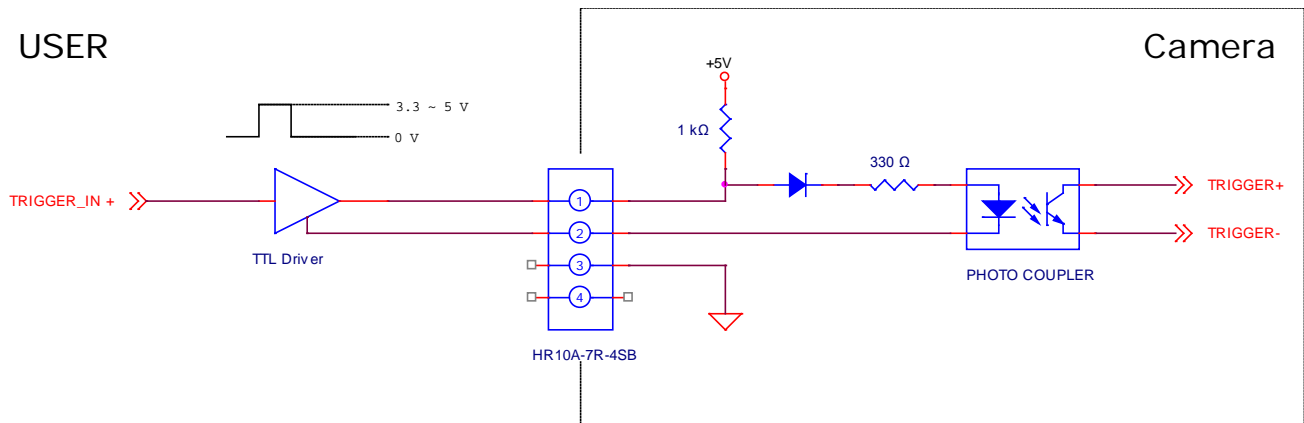


Figure 7.5 Trigger Input Schematic

7.6 Strobe Output Circuit

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

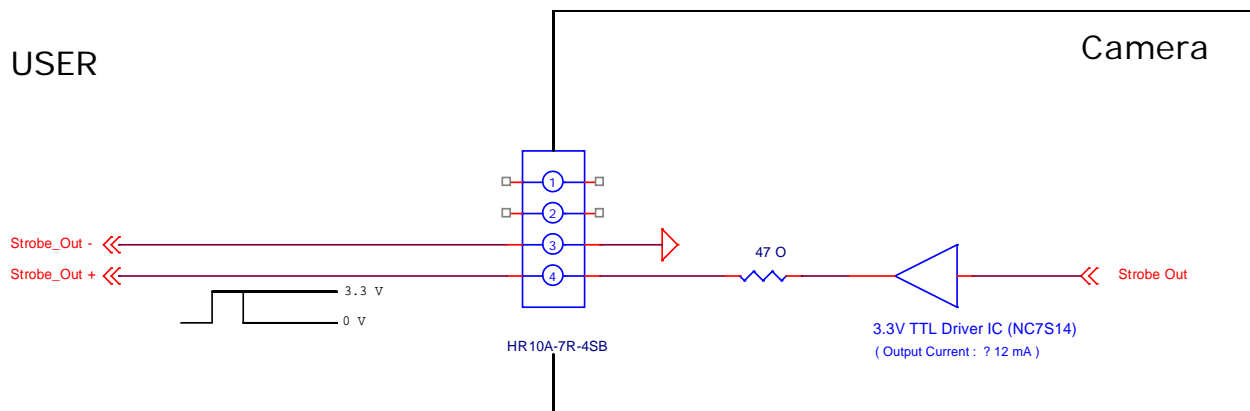


Figure 7.6 Strobe Output Schematic



8 Camera Features

8.1 Area of Interest (AOI)

The Area of Interest (AOI) 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. AOI is determined as the overlapping area of two areas when designating start point and end point in horizontal and vertical direction as shown in the figure below. Start point and End point mean the starting and end of the AOI.

According to characteristics of the sensor structure, readout of the image will be proceeded at the top and bottom simultaneously. If the Channel mode is set to 4 Tap and Vertical AOI is applied, V End will be ignored because V End is defined by V Start. The actual V End will be applied according to the following formula:

$$V\ End = (V\ SIZE - V\ Start) - 1$$

The narrower Vertical AOI is designated, the faster the frame speed will be. However Horizontal AOI does not affect the frame speed. For more information about AOI parameter settings, see “sha” and “sva” command on [Command List](#).

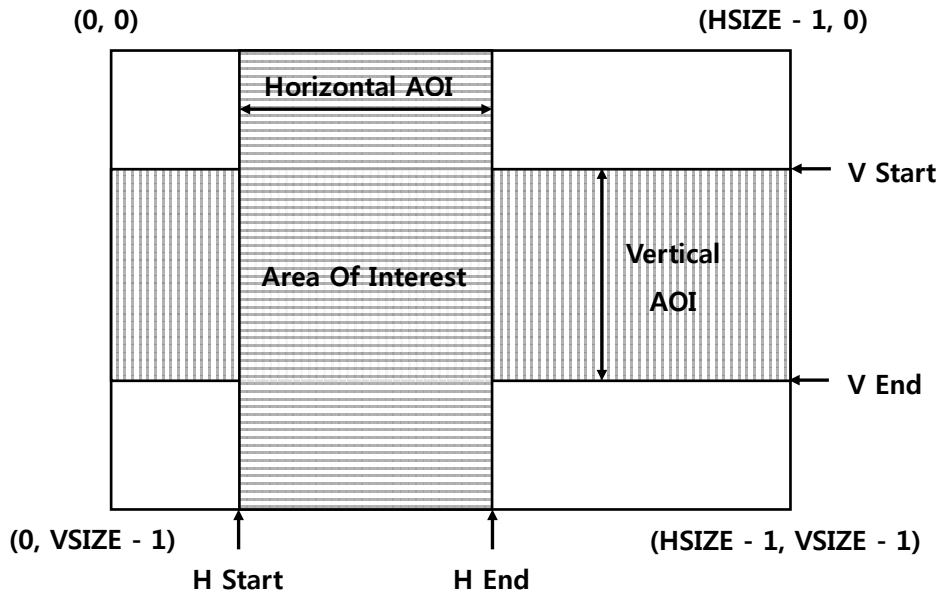


Figure 8.1 AOI



The AOI values (H × V) may vary depending on the type of Camera Link frame grabber. For technical assistance, contact to your local dealer or the manufacturer.



The approximate maximum frame speed depending on the change of Vertical AOI can be obtained as shown in the following expression.

<p>1 or 2 Channel Mode :</p> $\text{Frame Rate (fps)} = 1000000 / [T_{VCCD} + T_{FD} \times \{V_{SIZE} - (V_{AOI} + 12)\} + (V_{AOI} + 12) \times T_L]$ <p>4 Channel Mode :</p> $\text{Frame Rate (fps)} = 1000000 / [T_{VCCD} + T_{FD} \times \{V_{SIZE} - (V_{AOI} + 12)\} / 2 + \{(V_{AOI} + 12) \times T_L\} / 2]$ <p>T_{VCCD} : time required to move electric charges accumulated on pixel to Vertical Register</p> <p>T_{FD} : time required for Fast Dump</p> <p>V_{SIZE} : number of Vertical Line of CCD</p> <p>T_L : time required for transmission of one line</p> <p>V_{AOI} : size of Vertical AOI</p>

The available minimum value of T_{VCCD} , T_{FD} , V_{SIZE} , T_L and V_{AOI} may vary depending on the camera model. The value of T_L may vary depending on the channel mode. The values of each item depending on the camera model are shown below.

VA Series	VA-1M	VA-2M	VA-2M (HD)	VA-4M	VA-8M	VA-29M
T_{VCCD}	11.4 μs	12.0 μs	11.6 μs	15.0 μs	17.0 μs	56.3 μs
T_L (1 channel)	28.6 μs	44.5 μs	52.1 μs	63.9 μs	90.5 μs	172.3 μs
T_L (2 channel)	15.2 μs	23.4 μs	26.9 μs	34.4 μs	46.6 μs	90.125 μs
T_L (4 channel)	15.2 μs	23.4 μs	26.9 μs	34.4 μs	46.6 μs	90.125 μs
T_{FD}	$(T_L * 1.1) / 4$	$(T_L * 1.1) / 4$	$(T_L * 1.1) / 4$	4.2 μs	4.1 μs	6.8 μs
V_{SIZE}	1064 Lines	1264 Lines	1144 Lines	1800 Lines	2520 Lines	4384 Lines
Minimum Vertical AOI Size	120 Lines	150 Lines	120 Lines	200 Lines	300 Lines	500 Lines

Table 8.1 Timing Value for VA Series



The following figure shows frame rate depending on VAOI changes.

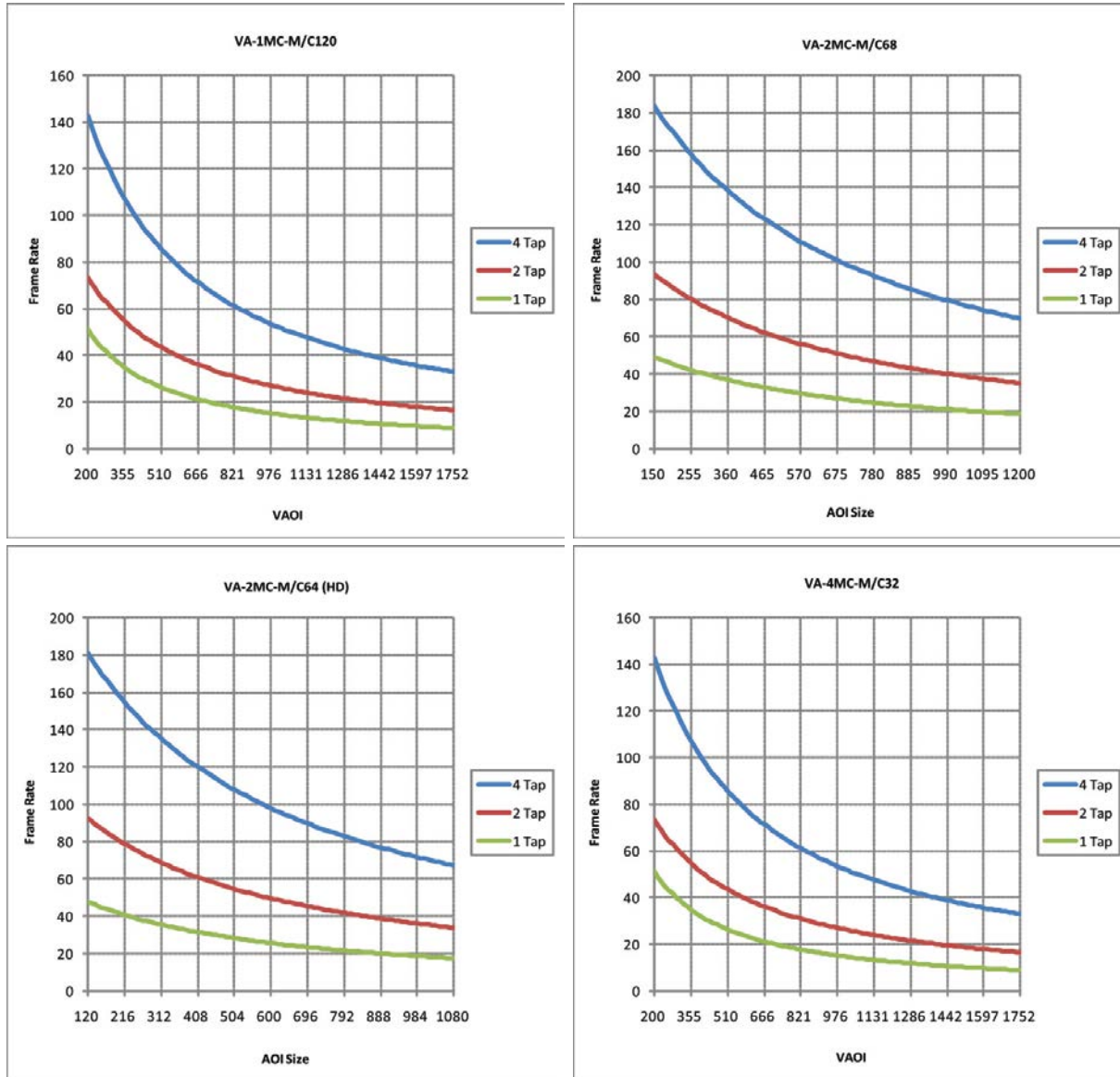


Figure 8.2 Frame Rate by VAOI changes (continuous)

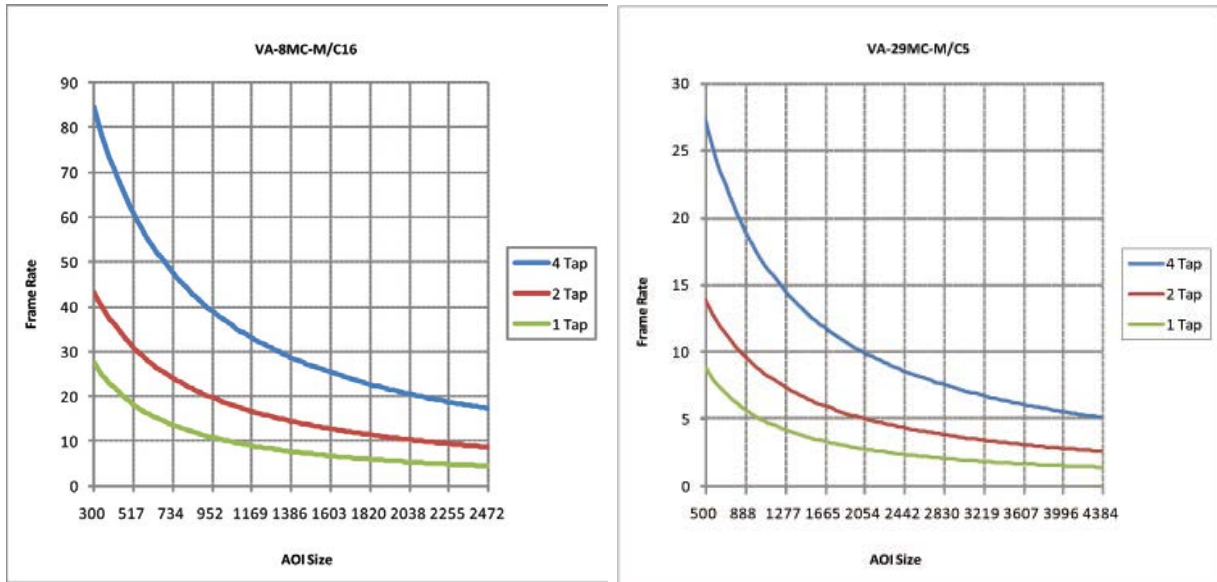


Figure 8.3 Frame Rate by VAOI changes



8.2 Binning

Binning has the effects of increasing the level value and decreasing resolution by adding the values of the adjacent pixels and sending them as one pixel. VA Series provides four binning factors (x1, x2, x4, x8) that the user can apply either vertically, horizontally or in both directions. The below figure shows application of 2 × 2 Binning and 4 × 4 Binning respectively. Since Binning in vertical direction is processed at internal register of CCD, the frame speed increases as many as Binning Factor if Binning is applied, but Binning in horizontal direction does not affect the frame speed. Binning Factor is set using “sbf” command.

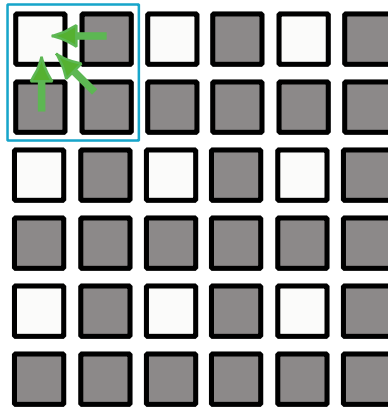


Figure 8.4 2x2 Binning

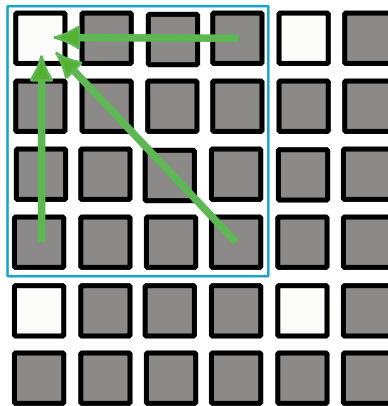


Figure 8.5 4x4 Binning



Even if the binning is performed on the color camera, the resulting image will be monochrome.

8.3 Trigger

8.3.1 Trigger Input

Trigger mode of the camera is divided into Trigger synchronous mode and Trigger asynchronous mode (hereinafter “Free-Run mode”) depending on its synchronization with trigger input. Trigger synchronous mode is divided into Standard mode, Double Exposure mode, Fast mode, Overlap mode, depending on concrete operation type.

It is required to set the trigger first to operate the camera in Trigger synchronous mode. In concrete, it is required to select which one of CC1 port and TRIGGER_IN port should be used as trigger input and to set whether polarity of trigger should be Positive or Negative.

8.3.1.1 Free-Run Mode

Free-Run Mode repeats Readout depending on parameter value set in the camera currently, regardless of trigger input.

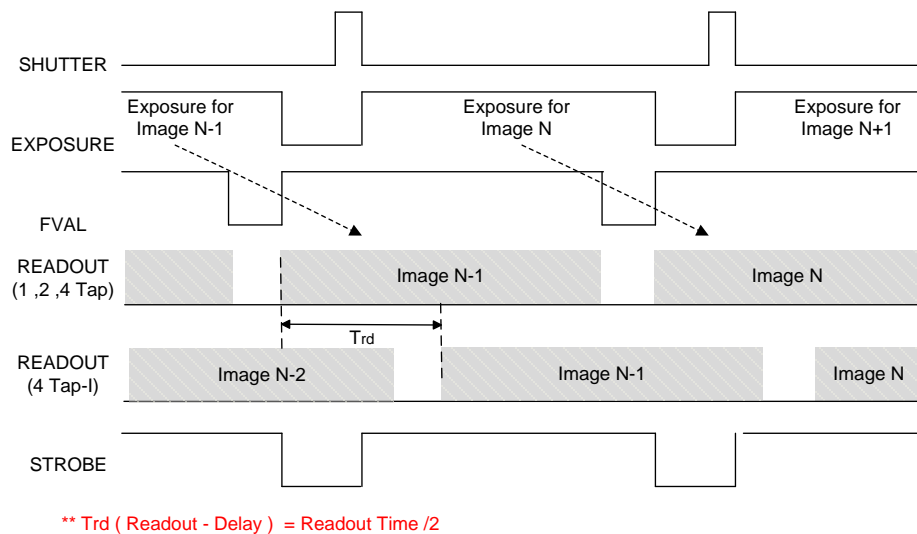


Figure 8.6 Free-Run Mode

As shown in the above figure, Readout section overlaps with exposure section of next image in Free-Run Mode. At this time, the camera operation slightly differs depending on length of Exposure Time and Readout time. If Exposure Time is shorter than Readout, Shutter signal occurs during readout, and when Readout finishes, Readout of next image starts ([Figure 8.7](#)). In this case, the frame speed is constant regardless of change in Exposure Time. But if Exposure Time is set longer than Readout time, Shutter signal occurs together with start of Readout and Readout of next image does not start until Exposure Time set elapses even if Readout finishes ([Figure 8.8](#)). In this case, the frame speed gets lower as the setting value of Exposure Time increases.

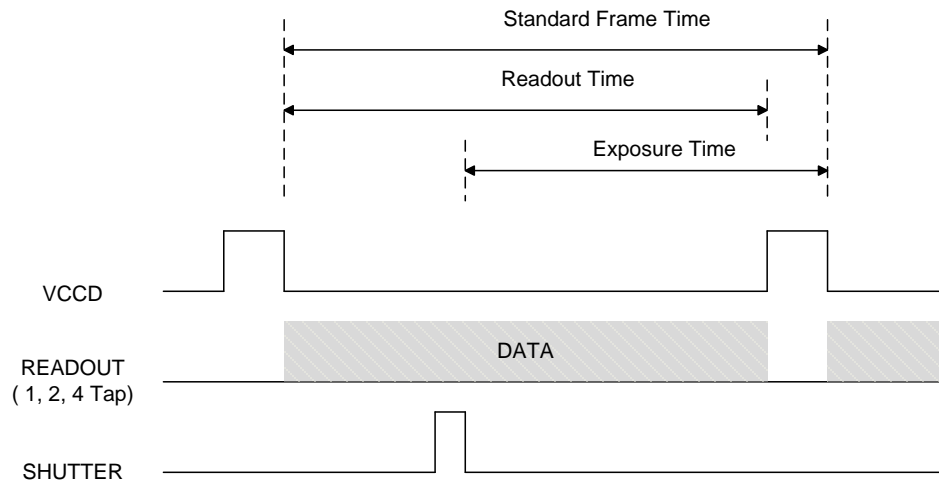


Figure 8.7 Exposure Time is shorter than Readout Time

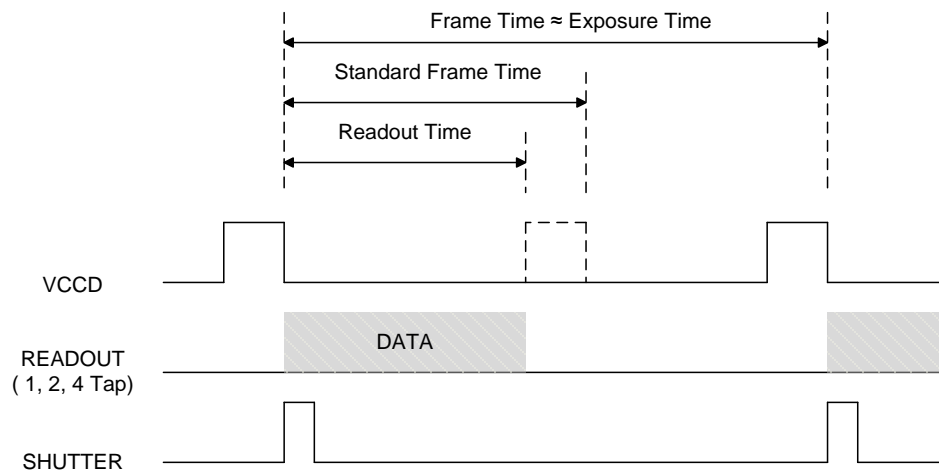


Figure 8.8 Exposure Time is longer than Readout Time



8.3.1.2 Standard Mode

In the Standard mode, the camera is in a waiting for trigger acquisition status until trigger signal is applied. When a trigger signal is received by the camera, Readout will start after performing Exposure process according to the setting. After Readout is completed, the camera returns to the waiting for trigger acquisition status and will remain in that status until a new trigger signal is applied. In the Standard Trigger mode, if a new trigger signal is applied during the readout process, the new trigger signal will be ignored.

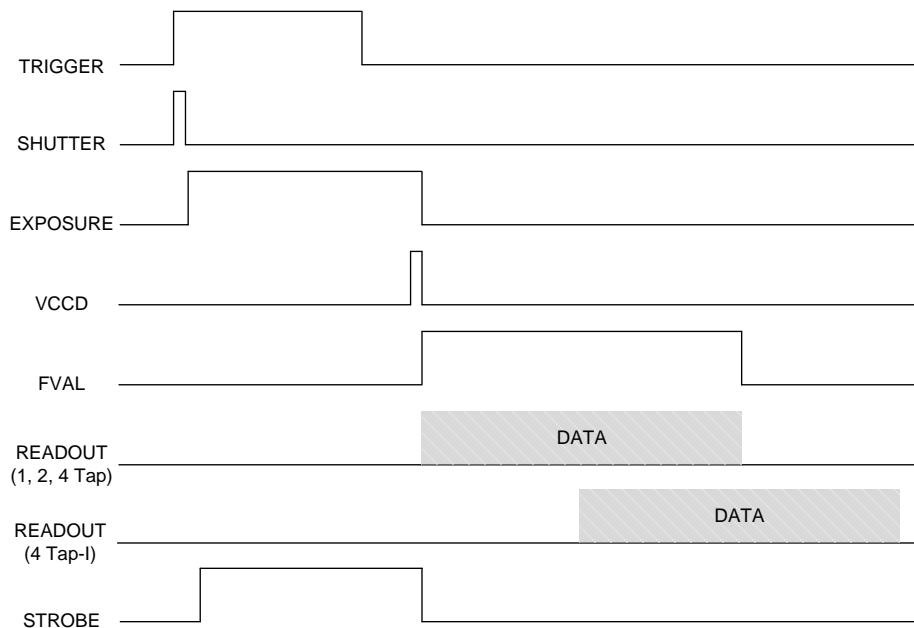


Figure 8.9 Standard Trigger Mode

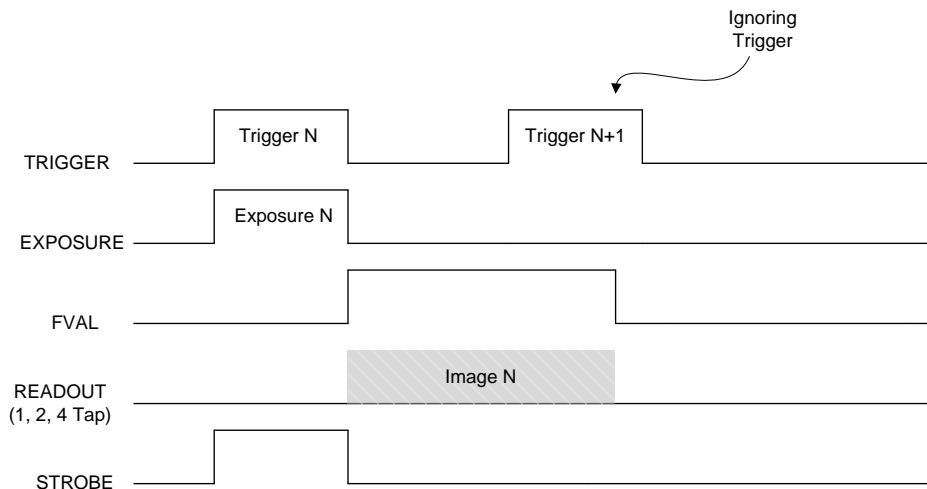


Figure 8.10 Retriggering



8.3.1.3 Double Exposure

In the Double Exposure mode, two images are acquired with one trigger signal. When a trigger signal is applied, the camera starts Readout after performing Exposure process according to the setting as in the Standard mode. At this time, exposure for the second image starts with Readout for the first image. When Readout for the first image is completed, the camera performs the second Readout. Since it does not generate shutter signal during Readout for the first image, the interval between completion of first exposure and start of second exposure is as short as a few microseconds or dozens of microseconds.

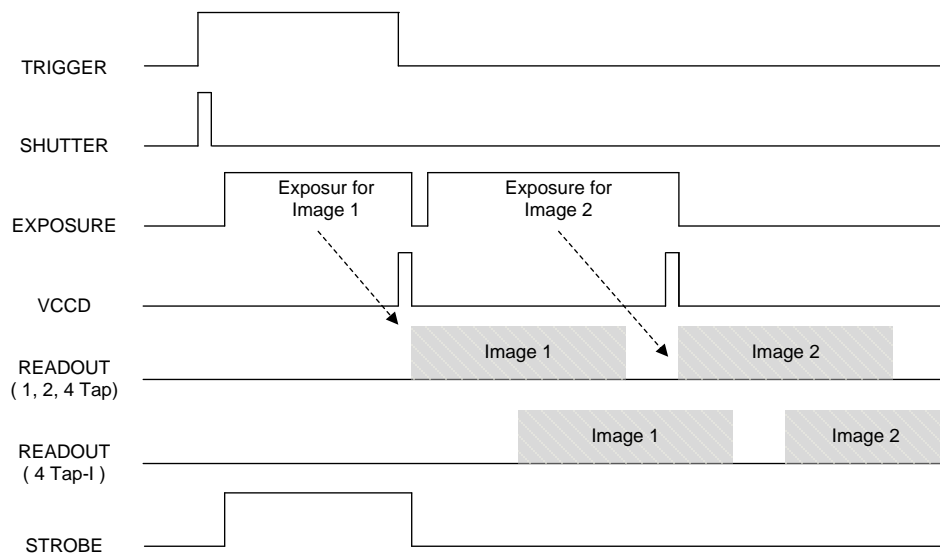


Figure 8.11 Double Exposure Trigger Mode



8.3.1.4 Fast Mode

The Fast mode is more useful than the Standard mode when interval of trigger input is relatively fast and continuous. The difference with the Standard mode is that the Readout immediately starts after a trigger signal is applied while the Readout starts after performing exposure according to the exposure time setting in the Standard mode. And the interval between trigger signals is equal to the exposure time for the images since it does not generate shutter signal during Readout.

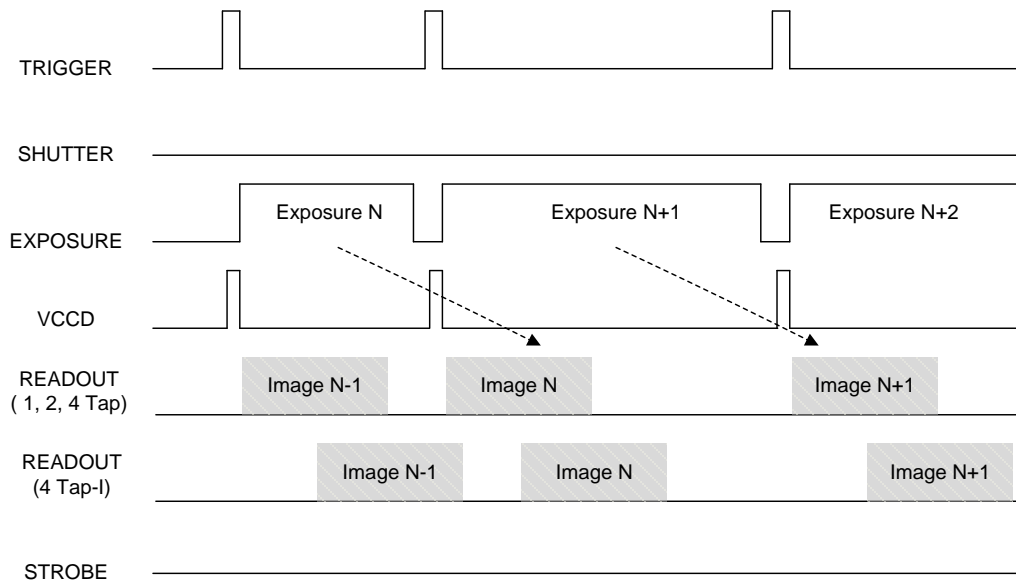


Figure 8.12 Fast Trigger Mode



8.3.1.5 Overlap Mode

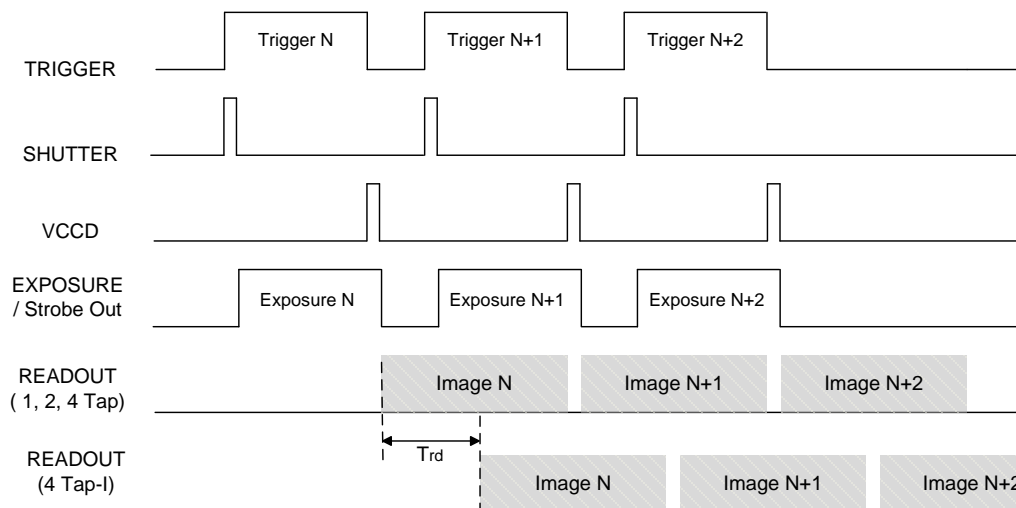
In the Overlap mode, the camera remains waiting for trigger acquisition status until a trigger signal is applied as in the Standard Mode. When a trigger signal is applied, the Readout starts after performing exposure process according to the exposure time setting. When new trigger signal is applied to the camera during the Readout process for the first image, the camera will continue to perform the Readout process while performing the exposure process for the new trigger signal. However, if the exposure time is longer than the interval of trigger input and the trigger signal is applied during the Exposure process, the trigger signal will be ignored. To acquire the image with the maximum frame, the exposure time should not be longer than the readout time and the interval of trigger input should not be shorter than the readout time.

The readout time for each model is as follows:

Channel Mode	VA-1M	VA-2M	VA-2M (HD)	VA-4M	VA-8M	VA-29M
1 channel	29.3 ms	53.5 ms	56.5 ms	112.8 ms	226.5 ms	763.1 ms
2 channel	15.5 ms	28.0 ms	29.0 ms	59.7 ms	121.9 ms	397.7 ms
4 channel	7.9 ms	14.2 ms	14.7 ms	30.1 ms	61.3 ms	199.6 ms

Table 8.2 Readout Time for each model

When an acquired image is being readout of the sensor with 4 Tap-I (Sensor Readout: 4 Tap, Data Output: 2 Tap Interleaved), the entire image will be stored in the buffer before transmitting the image to the frame grabber. This leads latency (Trd: a half of Readout time).



**** Trd (Readout - Delay) = Readout Time / 2**

Figure 8.13 Overlap Trigger Mode



8.4 Channel Mode

Accumulated charges are read out of the sensor when exposure ends. The sensor can be read out in one tap (single channel), two tap (dual channel) or four tap (quadrant channel). In case of one tap output, all pixel values in the Horizontal Register are shifted towards the left bottom Video Amplifier (Video A). In case of two tap output, pixel values from left to the center of the Horizontal Register are shifted towards the Video A, and pixel values from the right are shifted towards the Video B. In case of four tap output, pixel values of the lower left area are shifted towards the Video A, pixels values of the lower right area are shifted towards the Video B, pixel values of the upper left area are shifted towards the Video C, and pixel values of the upper right area are shifted towards the Video D. The advantage of four tap output is that it makes readout about four times faster than one tap output.

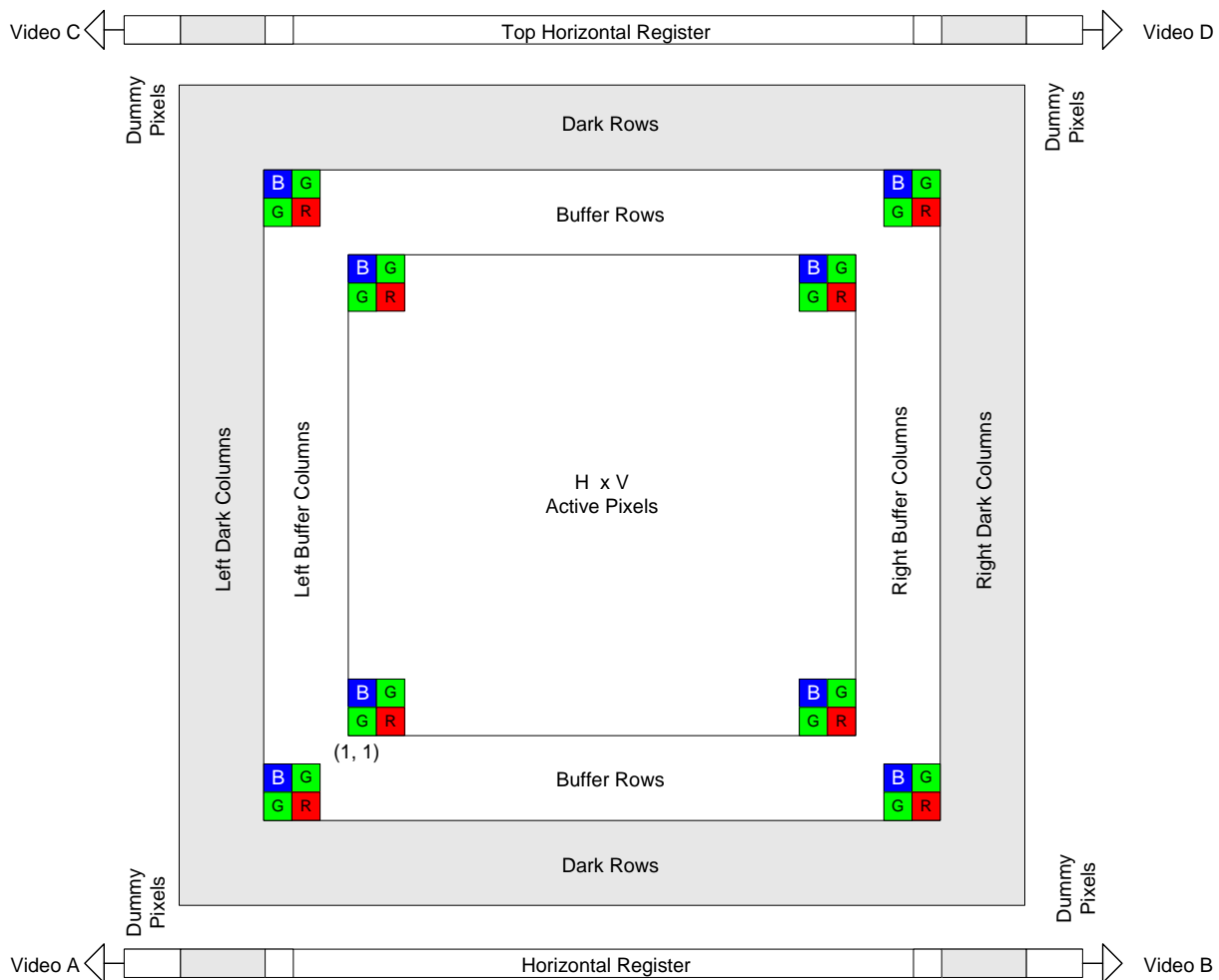


Figure 8.14 Channel Mode



The camera processes and rearranges the image data in order to be compliant with the base Camera Link Standard. In single channel, image data is read out line-by-line from the upper left corner until the last pixel in the lower right corner is read out. In dual channel, image data is read out of Channel A and B simultaneously in interleaved order. In quadrant channel, image data which is transmitted from Video A, B, C and D simultaneously, is read out with 2 Tap top and bottom or 2 Tap interleaved ([Figure 8.16](#)).



VA-29M supports only 2 Tap top and bottom readout when using the quadrant channel.

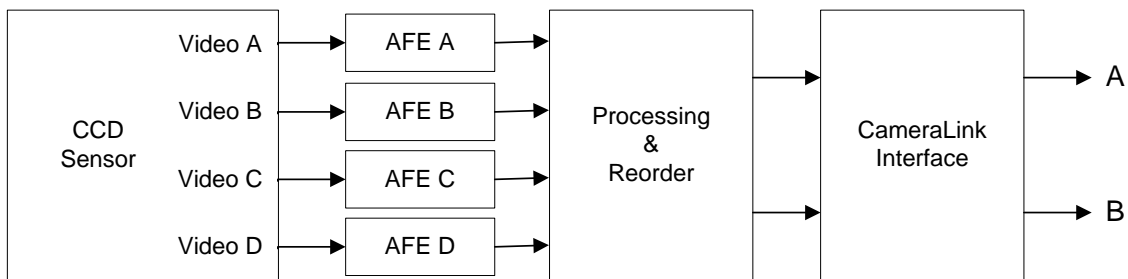


Figure 8.15 Image Data Flow

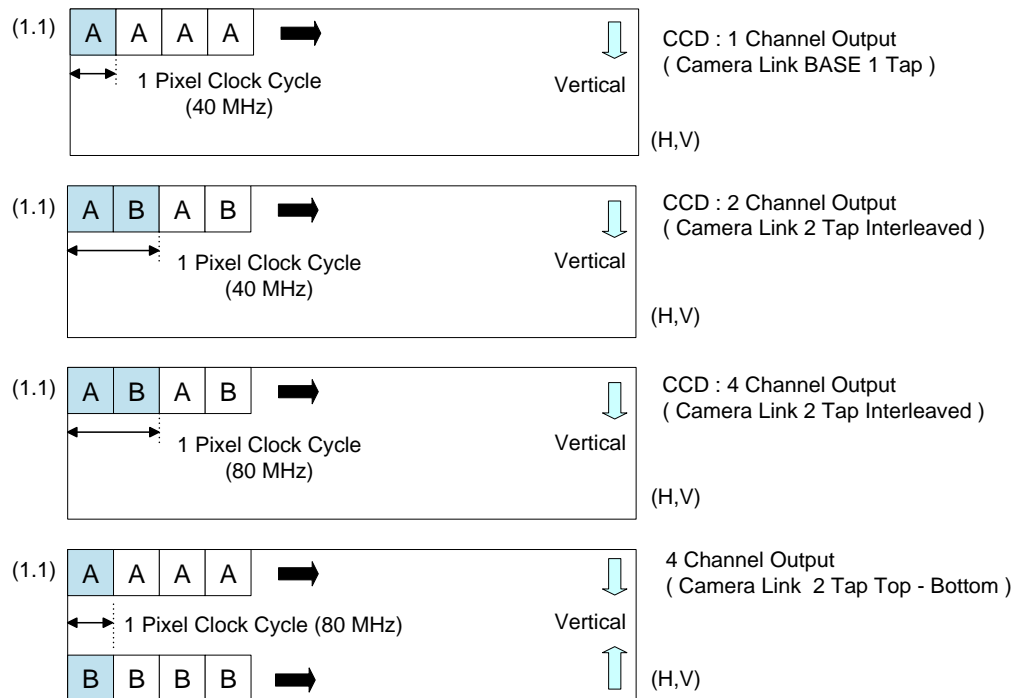


Figure 8.16 Data Output

8.5 Gain and Offset

The camera has one Analog Signal Processor (or Analog Front End, abbreviated to AFE) for each channel. This AFE consists of Correlated double Sampler (CDS), Variable Gain Amplifier (VGA), Black Level Clamp and 12 bit A/D converter. AFE has a register for Gain and Offset application inside, and can change Gain and Offset value by entering proper value in the register. Gain can be set between 0 ~ 899. The relationship between setting value and actual Gain (dB) is as follows:

$$\text{Gain(dB)} = (\text{Setting value} \times 0.035 \text{ dB})$$

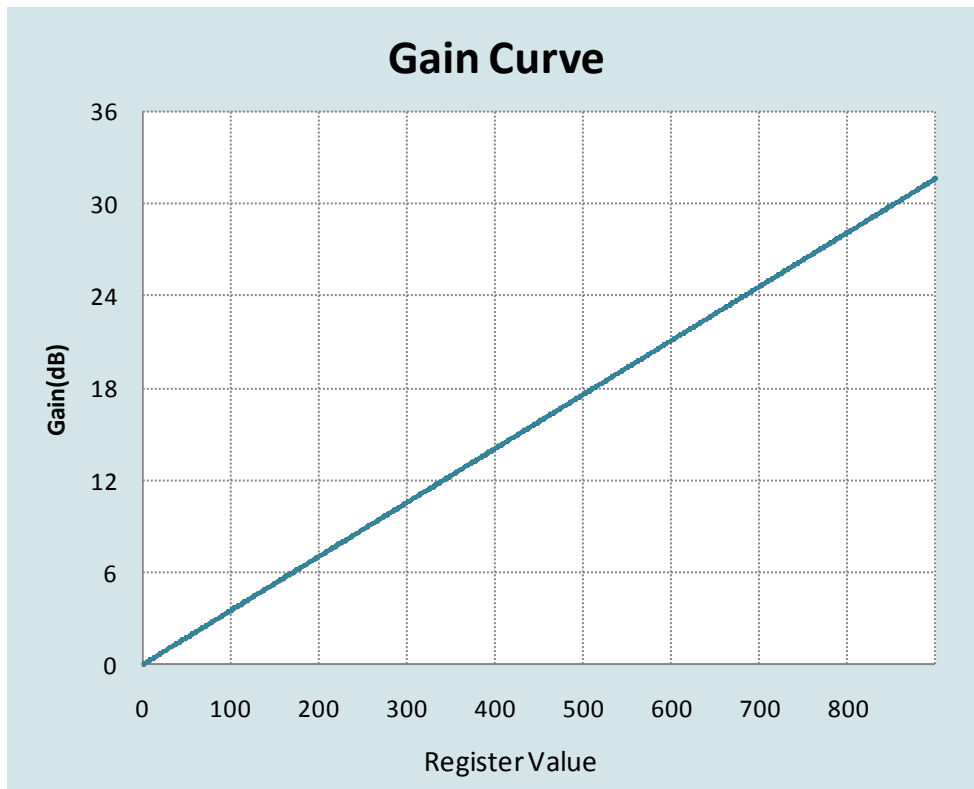


Figure 8.17 Register Setting for Gain Value

The available range of offset values is 0 ~ 255 (LSB).



8.6 LUT

LUT (Lookup Table) converts original image values to certain level values. Since it is mapped one to one for each level value, 12-bit output can be connected to 12-bit input. LUT is in the form of table that has 4096 entries between 0~4095 and VA Camera Link camera provides 2 non-volatile spaces for LUT data storage. You can determine whether to apply LUT and which LUT to use using “sls” command. For more information about how to download LUT to the camera, refer to [Appendix B](#).

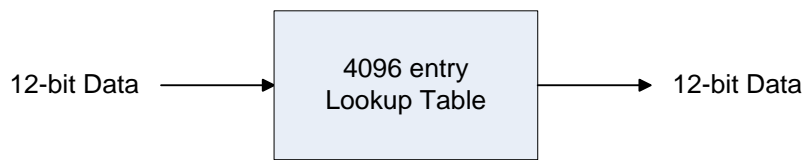


Figure 8.18 LUT Block

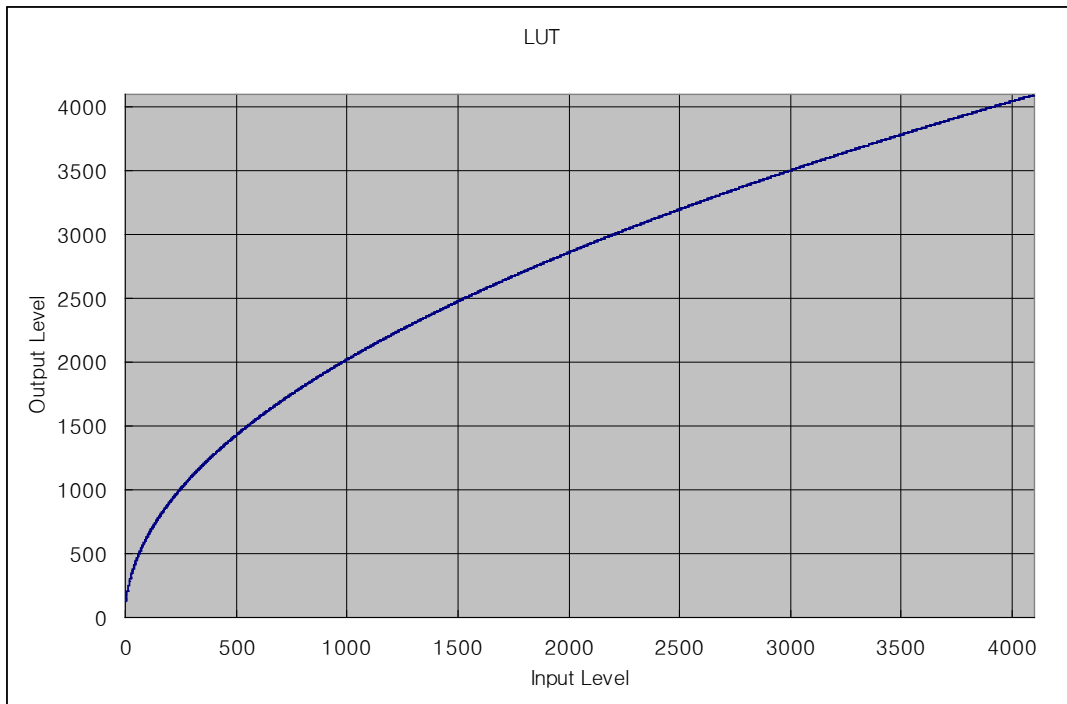


Figure 8.19 LUT at Gamma 0.5

8.7 Defective Pixel Correction

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

For more information, refer to [Appendix A](#). "sdc" command is used to set whether to use Defective Pixel Correction feature.

8.7.1 Correction Method

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

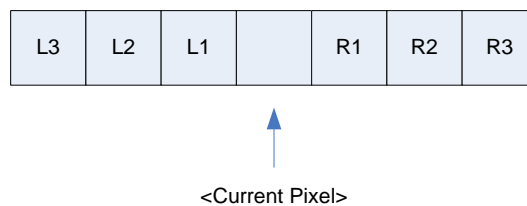


Figure 8.20 Location of Defect Pixel to be corrected

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

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

Table 8.3 Calculation of Defect Pixel Correction Value



8.8 Flat Field Correction

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

$$IC = \{ (IR - IB) \times M \} / (IF - IB)$$

Where,

IC : Level value of corrected image;

IR : Level value of original image;

IB : Black offset value;

M : Average value of image after correction;

IF : Level value of Flat Field data.

In order to use the Flat Field Correction function, one must first generate IF, the Flat Field data. This can be done by adjusting the camera to the actual environment and activating the Flat Field Generator. The Flat Field Generator will standardize a series of images, curtailing the image to 1/16 pixel, generate the curtailed Flat Field data, and store it in the external frame buffer. When curtailed images are used for corrections, it is expanded and applied with a Bilinear Interpolation as shown in [Figure 8.22](#). When the Flat Field data is generated, use the “sfo” command to set the M value, and use the “sfc” command to apply the Flat Field Correction. At this time, the Flat Field data is stored on the RAM, a volatile memory. In order to reuse the stored data, the “sdf” command must be used to store them on the FLASH, a non-volatile memory.



1. Activating the Flat Field Generator will ignore the current camera settings and will temporarily change the camera settings to operate under the following default conditions. When the generation of the Flat Field data is completed, the original settings of the camera will be restored.
 - Readout Mode: Normal
 - Trigger Mode: Free-Run
 - Channel Mode: Single
 - Defective Pixel Correction: ON
2. The offset value M is based on the Normal Readout mode. According to the AOI mode, Binning mode, or Dual Channel mode, the offset value of an actual image is expressed differently.

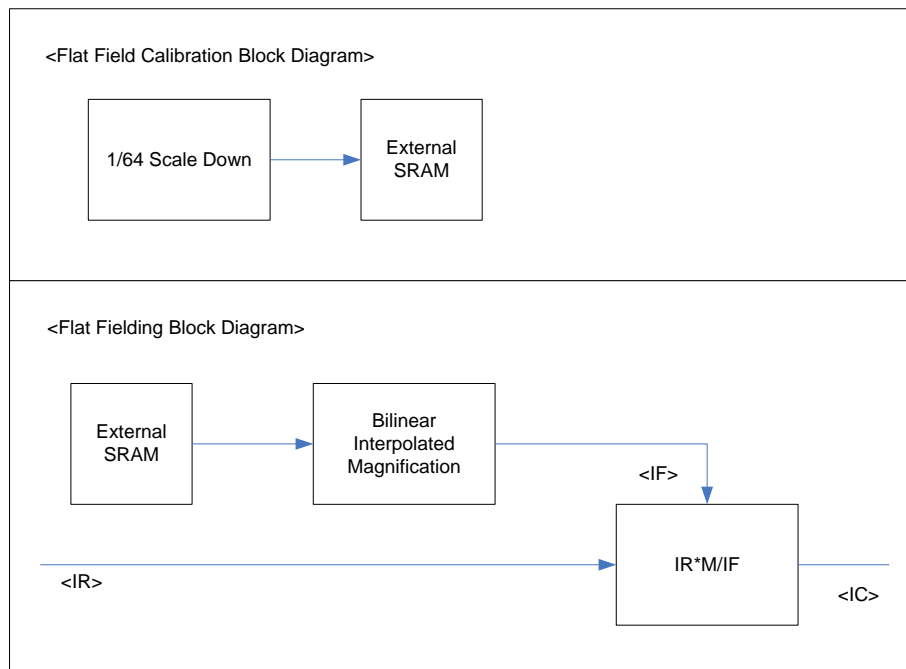


Figure 8.21 Generation and Application of Flat Field Data

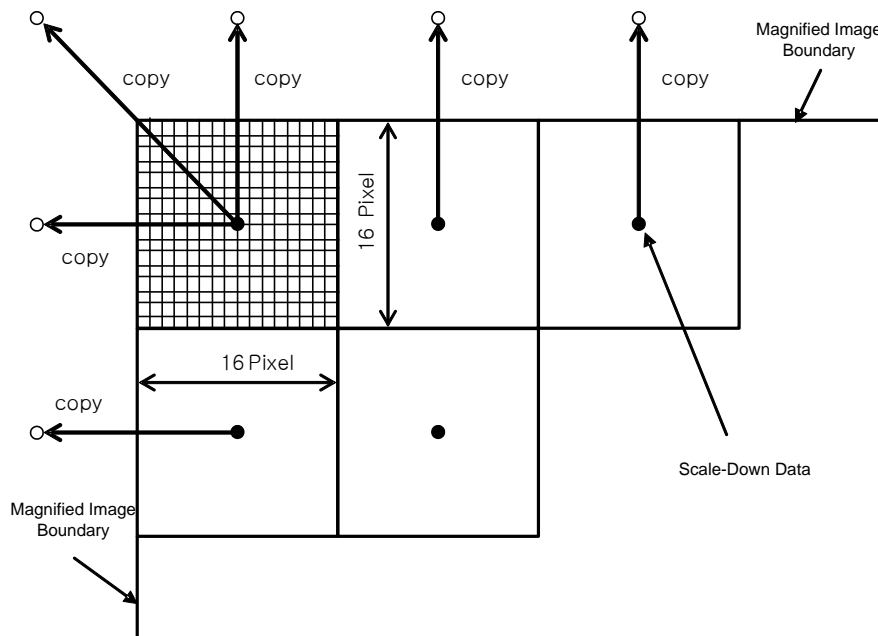


Figure 8.22 Bilinear Interpolated Magnification



8.9 Temperature Monitor

A sensor chip is embedded in the camera to monitor the internal temperature. “gct” command is used to check the temperature of camera.

8.10 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:

- Continuous ON operates in the Free-Run mode.
- Repeat On for 0.5 seconds, Off for 0.5 seconds: operates in the Trigger mode.
- Repeat On for 1 second, Off for 1 second: outputs Test Image.
- Repeat On for 0.25 second, Off for 0.25 second: operates in the Trigger mode and outputs Test Image.



8.11 Data Format

The internal processing of image data is performed in 12 bits. Then, the camera can output the data in 8, 10 or 12 bits. When the camera outputs the image data in 8 bits or 10 bits, the 4 or 2 least significant bits will be truncated accordingly.

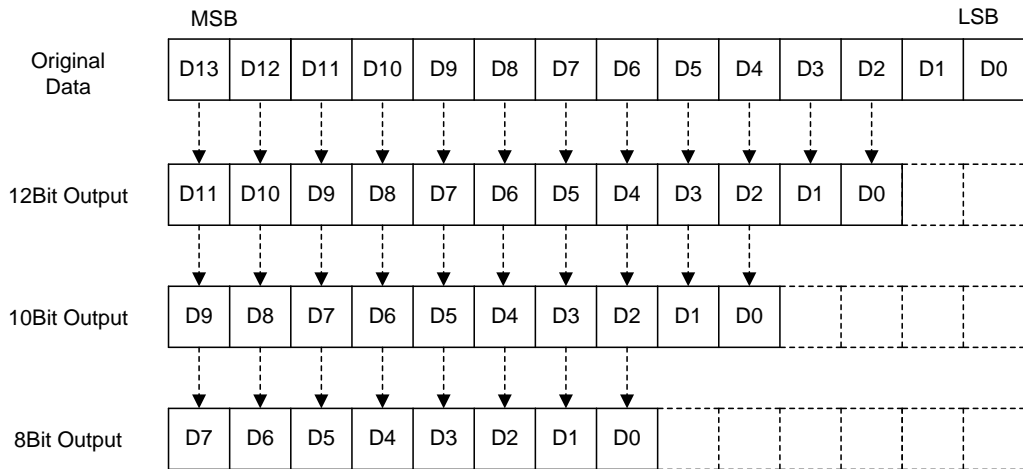


Figure 8.23 Data Format (1/2/4 Tap)

In the 4 Tap-I (Sensor Readout: 4 Tap, Data Output: 2 Tap Interleaved) mode, image data will be transmitted in the unit of 8 bit. So, if data format is set to 10 or 12 bit, the 2 or 4 least significant bits will be set to zero.

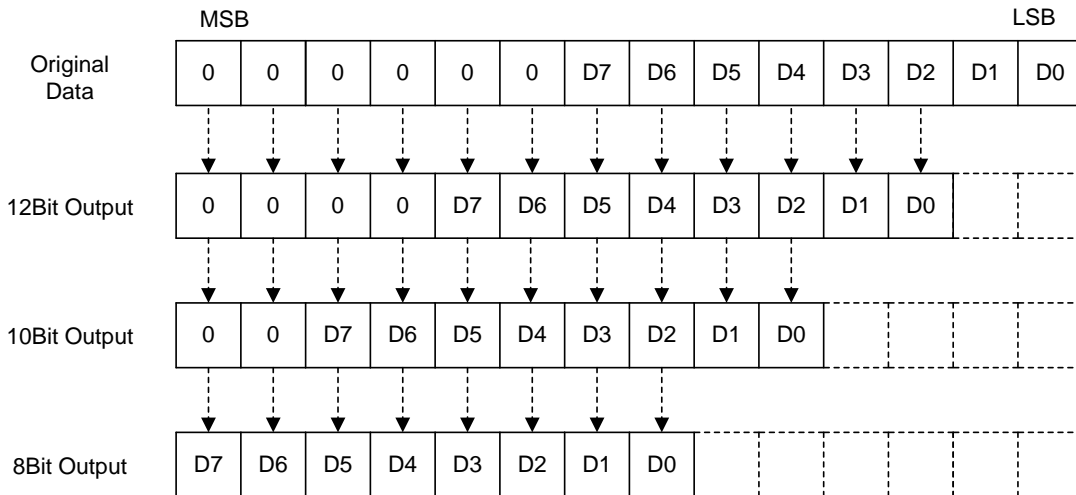


Figure 8.24 Data Format (4 Tap-I)



8.12 Test Image

To check whether the camera operates normally or not, it can be set to output test images generated in the camera, instead of the image data from the CCD. 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).

Test image can be applied in all operation modes of camera and is set using “sti” command.

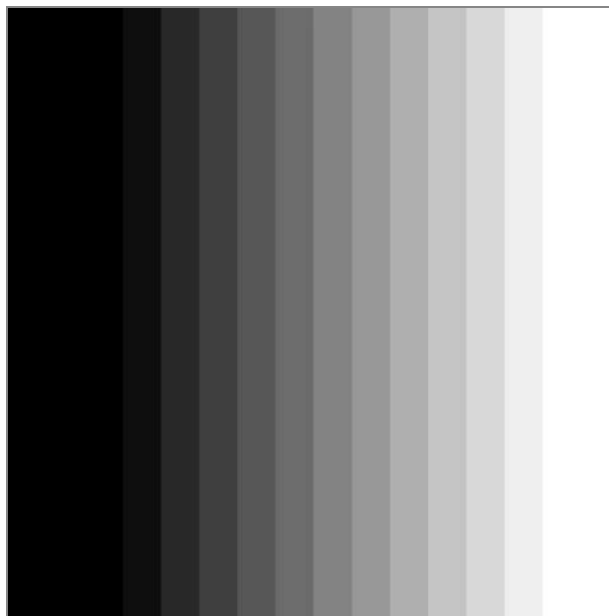


Figure 8.25 Test Image 1

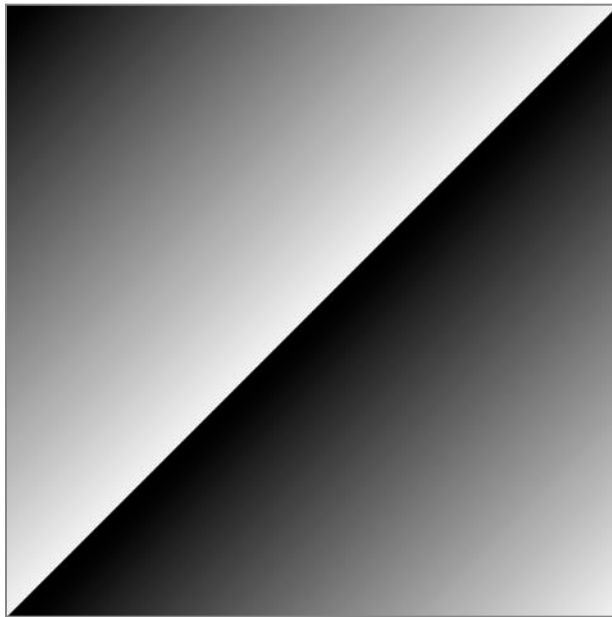


Figure 8.26 Test Image 2

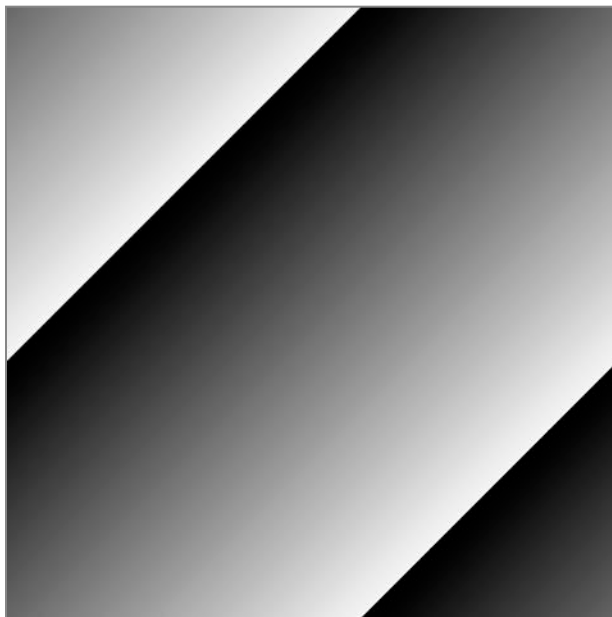


Figure 8.27 Test Image 3



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



8.13 Horizontal Flip

The Horizontal Flip feature let you flip the image horizontally. This feature is available in all operation modes and “shf” command is used to set whether to use this feature or not.



Figure 8.28 Original Image



Figure 8.29 Horizontally Flipped Image



8.14 Image Invert

The Image Invert feature let you invert the level values of the output image. The inverted level values differ depending on output data format even if input value is same. This feature is available in all operation modes and “sii” command is used to set whether to use this feature or not.

Data Format	Original Value	Inverted Level Value
8	0	255
10	0	1023
12	0	4095

Table 8.4 Inverted level value by Data Format



Figure 8.30 Original image (Positive)



Figure 8.31 Inverted image (Negative)

8.15 Strobe

The strobe signal is used to synchronize the external light source with the camera or to measure the current exposure time of the camera. The pulse width of the strobe signal is determined by the duration from the point where the shutter signal is generated until the point where the readout process begins. It is equivalent to the exposure time of the camera.

8.15.1 Strobe Offset

The strobe offset value indicates when the strobe signal is to be sent after the shutter signal is generated. The value can be set in the unit of 1 μs using “sso” command. Then, the location of the pulse will be changed accordingly without changes in the pulse width of the strobe signal.

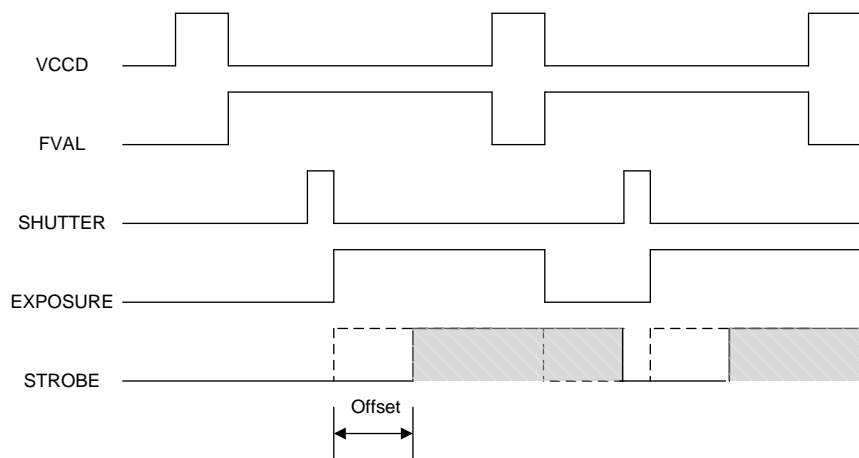


Figure 8.32 Strobe signal in the Free-Run mode

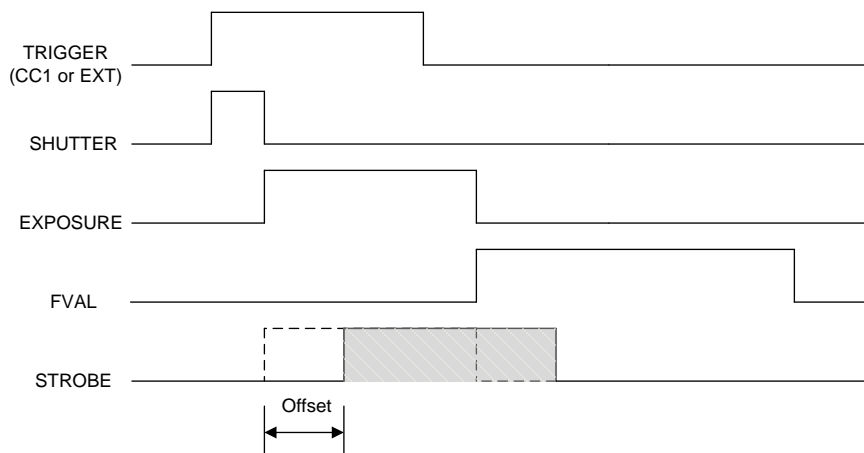


Figure 8.33 Strobe signal in the Trigger mode



8.15.2 Strobe Polarity

You can select the polarity of the strobe signal. “ssp” command is used to set the polarity of the strobe signal.

8.15.3 Field Upgrade

The camera provides a feature to upgrade the firmware and FGPA logic through the Camera Link interface rather than disassemble the camera in the field. For more information about how to upgrade, refer to [Appendix C](#).



9 Camera Configuration

9.1 Setup command

You can configure all required settings of the camera through RS-644 serial interface of the camera link. When you want to control the camera using a terminal or access to the camera at your application, you need to set your network as follows.

- Baud Rate: 19200 bps
- Data Bit: 8 bit
- Parity Bit: No Parity
- Stop bit: 1 stop bit
- Flow control: None

All types of the camera setting commands are delivered in ASCII command type except Firmware Download requiring massive data transmission. All camera setting commands start from user application and the camera returns the response ("OK", "Error" or information) for a command. The camera informs the completion of the command execution through response for a write command while the camera returns the error response or information for a read command.

```
Command format:
<command> <parameter1> <parameter2> <cr>
0~2 parameters follow the command.
Response:
- If execution of write command is successfully completed
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 execution of read command is successfully completed

```
<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 execution of command is not completed

```
Error : <Error Code> <cr> <lf>
```

Prompt:

After sending response, Camera sends prompt always. `>` is used as prompt.

Types of Error Code

0x80000481 : values of parameter not valid

0x80000482 : number of parameter is not matched

0x80000484 : command that does not exist

0x80000486 : no execution right



9.2 Actual Time Applied for Commands

When you execute a command, the actual or real time applied for the command varies depending on the type of the command and 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 VCCD signal before starting readout process.

When you execute a 'set' command, the exposure time setting will be changed at the starting of the exposure.

In the Trigger mode, you must execute commands before applying trigger signals in order to synchronize image outputs with the commands.

In the Free-Run mode, even if you execute a command, you may acquire up to two images without applying the command. This is true because it is hard to verify the current operating status of the camera in the Free-Run mode.

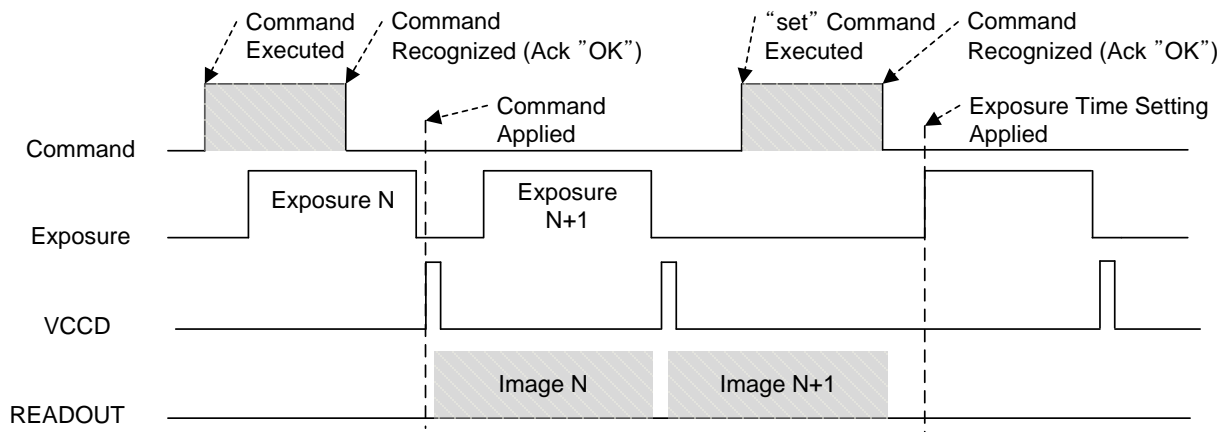


Figure 9.1 Actual Time Applied for Commands



9.3 Parameter Storage Space

The camera has three non-volatile storage spaces used for parameter storage and one volatile work space that is applied to actual camera operation. Three storage spaces are divided into Factory Space that contain basic value at the factory, and two user space (User Space 1, User Space 2) that can save parameter value temporarily set by the user. User space can be read and written, but Factory space can be read only.

When the camera is powered on or reset, setting values stored in one of the storage spaces are loaded into the work space according to the Config Initialization setting and these values will be used for the camera settings. Since values in the work space are valid only while the power is on, they should be copied to user space 1 or user space 2 using “sct” command.

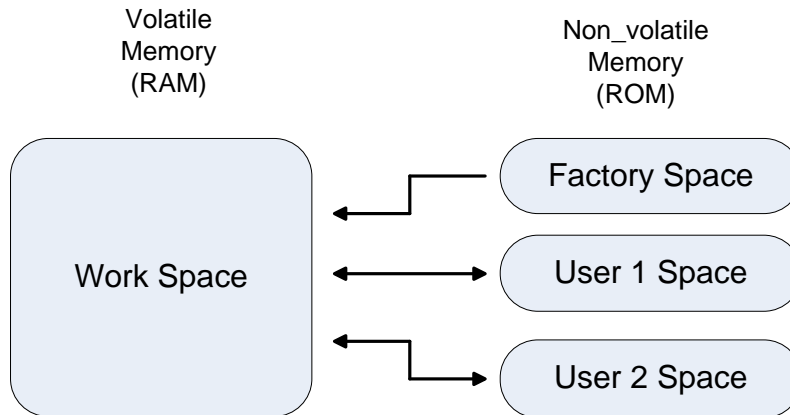


Figure 9.2 Parameter Storage Area



9.4 Command List

Command	Syntax	Value Returned	Description
Help	h	String	Displays a list of all commands
Set Read-Out Mode Get Read-Out Mode	srm 0 1 2 grm	OK 0 1 2	0 : Normal Mode 1 : AOI(Area Of Interest) Mode (AOI area is set using “sha” and “sva” commands) 2 : Binning(2 or 4) Mode (Binning Factor is set using “sbf” command)
Set Horizontal Area Get Horizontal Area	sha n1 n2 gha	OK n1 n2	n1: Starting point of horizontal direction n2 : End point of horizontal direction
Set Vertical Area Get Vertical Area	sva n1 n2 gva	OK n1 n2	n1 : Starting point of vertical direction n2 : End point of vertical direction
Set Binning Factor Get Binning Factor	sbf 2 4 gti	OK 2 4	2 : 2 by 2 binning 4 : 4 by 4 binning
Set Test Image Get Test Image	sti 0 1 2 3 gti	OK 0 1 2 3	0 : Off 1/2 : Fixed Pattern Image 3 : Moving Pattern Image
Set Data Bit Get Data Bit	sdb 8 10 12 gdb	OK 8 10 12	8 : 8 Bit Output 10 : 10 Bit Output 12 : 12 Bit Output
Set Channel Mode Get Channel Mode	scm 1 2 3 4 gcm	OK 1 2 3 4	1 : 1 Tap Output 2 : 2 Tap Output 3 : 4 Tap-I Output 4 : 4 Tap Output
Set LUT Select Get LUT Select	sls 0 1 2 gls	OK 0 1 2	0 : Off 1 : LUT1, 2 : LUT2
Set Flat-Field Correction Get Flat-Field Correction	sfc 0 1 gfc	OK 0 1	0 : Off 1 : Active of Flat-Field Correction
Set Defect Correction Get Defect Correction	sdc 0 1 gdc	OK 0 1	0 : Off 1 : Active of Defect Correction

Table 9.1 Command List #1



Command	Syntax	Value Returned	Description
Set Image Invert	sii 0 1	OK	0 : Off
Get Image Invert	gii	0 1	1 : Active of Image Invert
Set Horizontal Flip	shf 0 1	OK	0 : Off
Get Horizontal Flip	ghf	0 1	1 : Active of Defect Correction
Set Trigger Mode	stm 0 1 2 3 4	OK	0 : Free-Run Mode
Get Trigger Mode	gtm	0 1 2 3 4	1 : Standard Mode
			2 : Fast Mode
			3 : Double Mode
			4 : Overlap Mode
Set Exposure Source	ses 0 1	OK	0 : Program Exposure(by camera)
Get Exposure Source	ges	1 2	1 : Pulse Width (by trigger input signal)
Set Trigger Source	sts 1 2	OK	1 : CC1 Port Input (Camera Link)
Get Trigger Source	gts	1 2	2 : External Input (External control port)
Set Trigger Polarity	stp 0 1	OK	0 : Active Low
Get Trigger Polarity	gtp	0 1	1 : Active High
Set Exposure Time	set n	OK	n : Exposure Time in μ S
Get Exposure Time	get	n	(Setting range : 10 ~ 7,000,000 μ S)
Set Strobe Offset	sso n	OK	n : Strobe Offset Time in μ S
Get Strobe Offset	gso	n	(Setting range : 0 ~ 10,000 μ S)
Set Strobe Polarity	ssp 0 1	OK	0 : Active Low
Get Strobe Polarity	gsp	0 1	1 : Active High
Set Analog Gain	sag n	OK	n : Analog Gain Parameter
Get Analog Gain	gag	n	(Setting Range : 0 ~ 899)
Set Analog Offset	sao n	OK	n : Analog Gain Parameter
Get Analog Offset	gao	N	(Setting Range : 0 ~ 255)
Set Gain Offset	sgo 2 3 4 n	OK	2 : AFE Channel of Right Top Image
Get Gain Offset	ggo 2 3 4	n	3 : AFE Channel of Left Bottom Image
			4 : AFE Channel of Right bottom Image
			n : Analog Gain offset Parameter
			(Setting Range : -20 ~ +20)
Auto Gain Offset	ago	OK	Auto-Generation Gain Offset

Table 9.2 Command List #2



Command	Syntax	Value Returned	Description
Generate Flat Field Data	gfd	OK	Operate Flat Field Generator
Save Flat Field Data	sfd	OK	Save Flat Field Data
Load Flat Field Data	lfd	OK	Load Flat Field Data
Set Flat Field Iteration	sfi n	OK	n : (2 ^ n) image acquisitions
Get Flat Field Iteration	gfi	n	(Setting Range : 0 ~ 4)
Set Flat Field Offset	sfo n	OK	n : Flat Field Target Level
Get Flat Field Offset	gfo	n	(Setting Range : 0 ~ 4095)

Table 9.3 Command List #3

Command	Syntax	Value Returned	Description
Load Config From	lcf 0 1 2	OK	0 : Load from Factory Setting 1 : Load from User 1 Setting 2 : Load from User 2 Setting
Save Config To	sct 1 2	OK	0 : Save to User 0 Setting(inactive) 1 : Save to User 1 Setting 2 : Save to User 2 Setting
Set Config Initialization	sci 0 1 2	OK	0 : Load from Factory Setting when initializing
Get Config Initialization	gci	0 1 2	1 : Load from User 1 Setting when initializing 2 : Load from User 2 Setting when initializing
Get MCU Version	gmv	String	Displays MCU Version
Get Model Number	gmn	String	Displays Model Number
Get FPGA Version	gfv	String	Displays FPGA Version
Get Serial Number	gsn piece	String	Display Serial Number
Get Current Temperature	gct	String	Display Temperature Value

Table 9.4 Command List #4

10 Configurator GUI

Configurator, a sample application, is provided to control VA Camera Link series camera. Configurator provides easy-to-use Graphic User Interface (GUI) for the user while using the commands mentioned in the previous chapters.

10.1 Camera Scan

When you execute the program while the camera is turned on, the Camera Scan window appears as shown in the figure below. At this time, the program checks serial port of your computer and DLL provided by the camera link to scan whether the camera is connected. If there is a camera connected, it displays model name on the screen. If the camera is not properly displayed on the screen, check the connection of cables and power of the camera, and press the **refresh** button. When you double-click a model name displayed on the screen, Configurator is executed and displays current setting value of the camera connected.

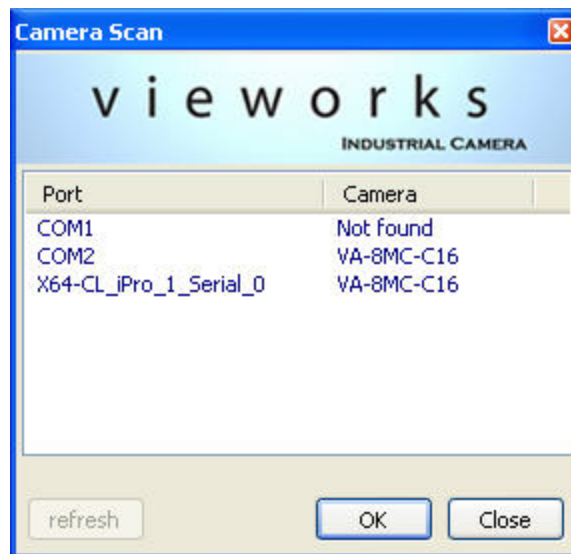


Figure 10.1 Configurator Loading Window



10.2 Menu

10.2.1 File

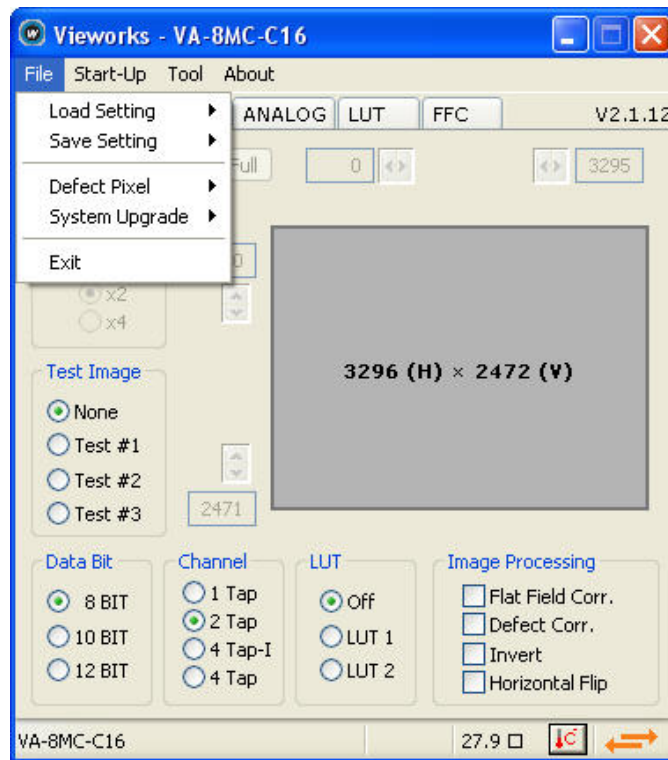


Figure 10.2 File menu

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



10.2.2 Start-Up

You can select the camera setting values to load when the camera is turned on.

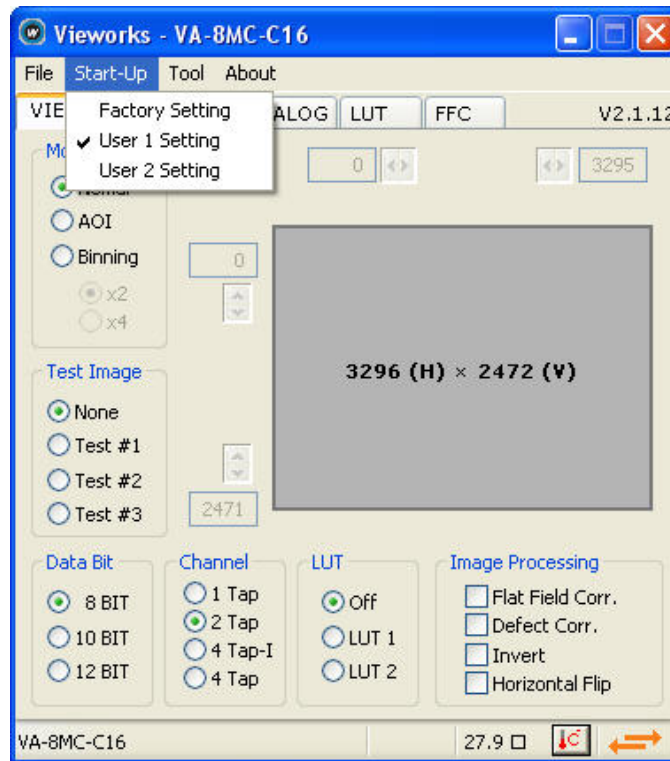


Figure 10.3 Start-Up Menu

- **Factory Setting:** Loads the camera setting values from Factory Space.
- **User1 Setting:** Loads the camera setting values from User1 Space.
- **User2 Setting:** Loads the camera setting values from User2 Space.

10.2.3 Tool

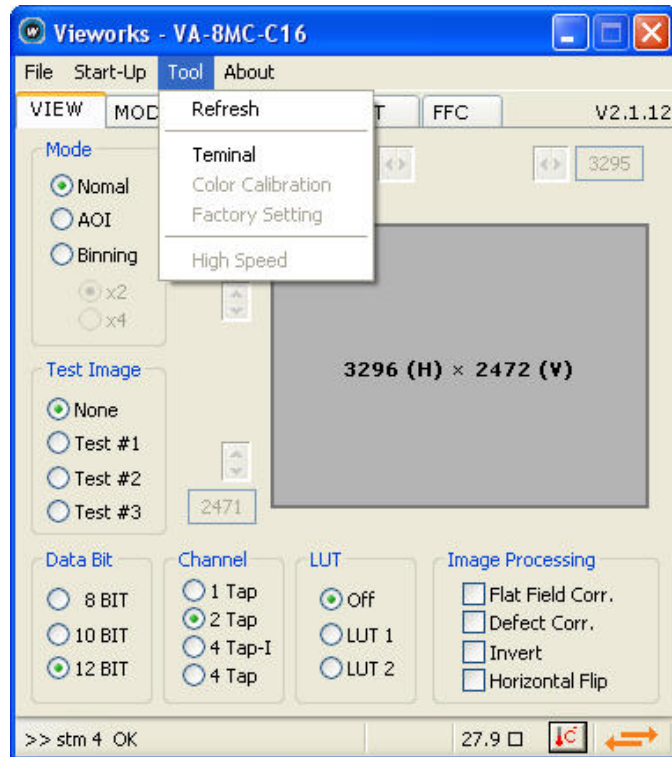


Figure 10.4 Tool Menu

- **Refresh:** Loads and displays the current camera setting values on Configurator.
- **Terminal:** Displays user commands in Terminal window under GUI.
To hide Terminal window, uncheck Terminal by clicking again.
- **Color Calibration:** Performs Bayer sensor color calibration.
- **Factory Setting:** Not supported in the user side.
- **High Speed:** Not supported on VA Camera Link series.



10.2.4 About

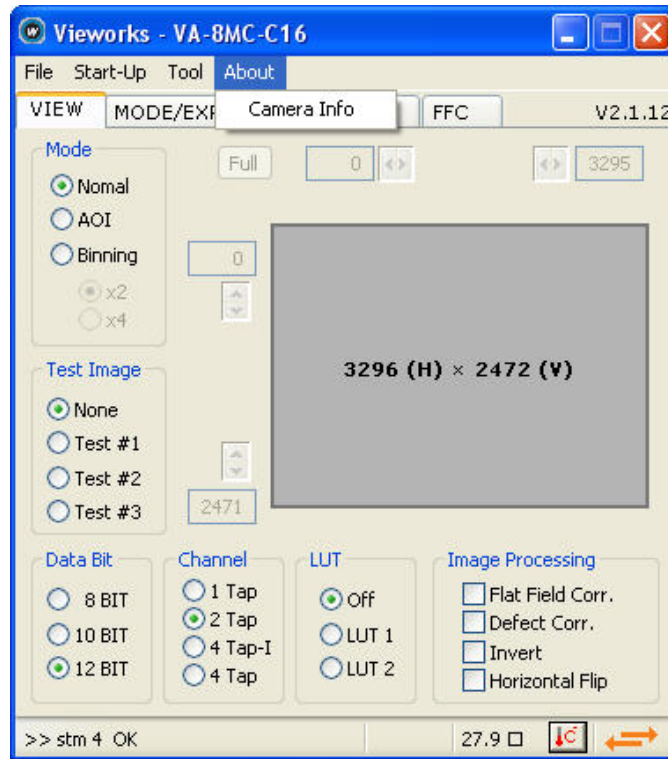


Figure 10.5 About Menu

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



10.3 Tab

10.3.1 VIEW Tab

VIEW tab allows you to set the camera readout mode, test image mode, data bit, channel, LUT, image processing, etc.

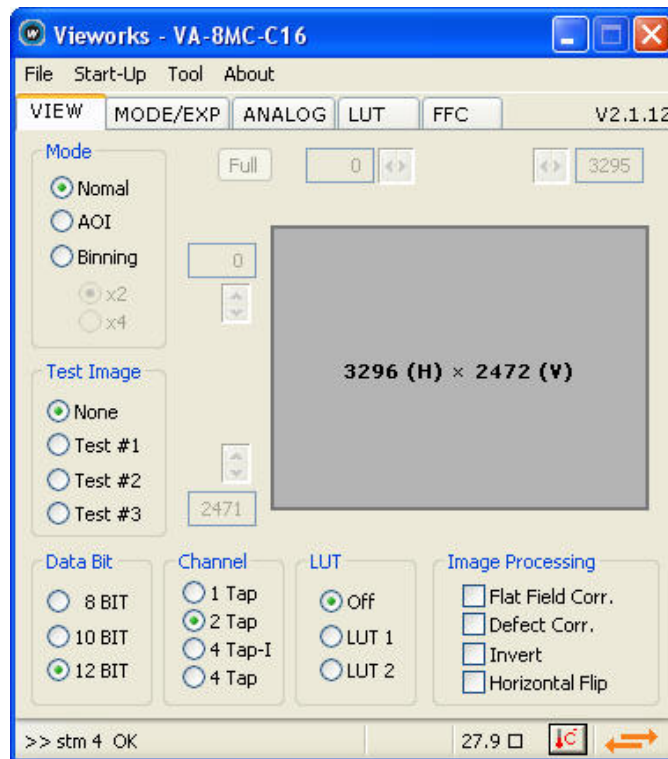


Figure 10.6 VIEW Tab

- **Mode:** Selects readout mode. If AOI is selected, AOI setting area is activated and AOI can be set by entering desired values. If Binning is selected, x2, x4 option buttons are activated.
- **Test Image:** Selects whether to apply test image and type of test image.
- **Data Bit:** Selects bit depth of data output.
- **Channel:** Selects channel mode.
- **LUT:** Selects whether to apply LUT and type of LUT.
- **Imaging Processing:** Sets Flat Field Correction, Defect Correction, Image Invert or Horizontal Flip features On or Off.

10.3.2 MODE/EXP Tab

MODE/EXP tab allows you to select trigger mode, exposure time and strobe. All scroll bars are controllable with the mouse wheel scroll.

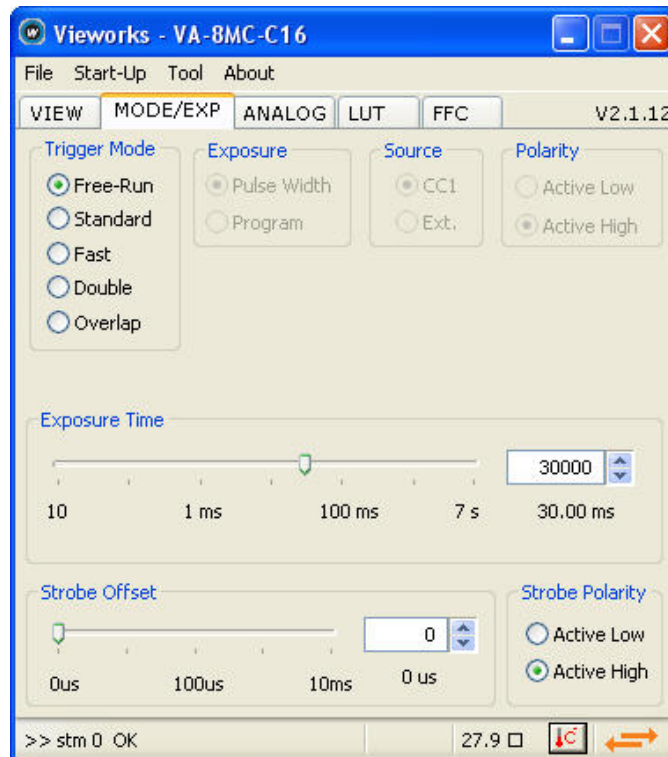


Figure 10.7 MODE/EXP Tab

- **Trigger Mode:** Selects trigger mode. Once a mode has been selected, related selections will be activated.
- **Exposure:** Selects exposure source.
- **Source:** Selects trigger source.
- **Polarity:** Selects polarity of trigger input.
- **Exposure Time:** Sets exposure time when trigger mode is set with Free-Run mode or when Exposure is set with Program.
- **Strobe Offset:** Sets strobe offset.
- **Strobe Polarity:** Sets the polarity of the strobe output signal.



10.3.3 ANALOG Tab

ANALOG tab allows you to set gain and offset settings of the image. All scroll bars are controllable with the mouse wheel scroll.

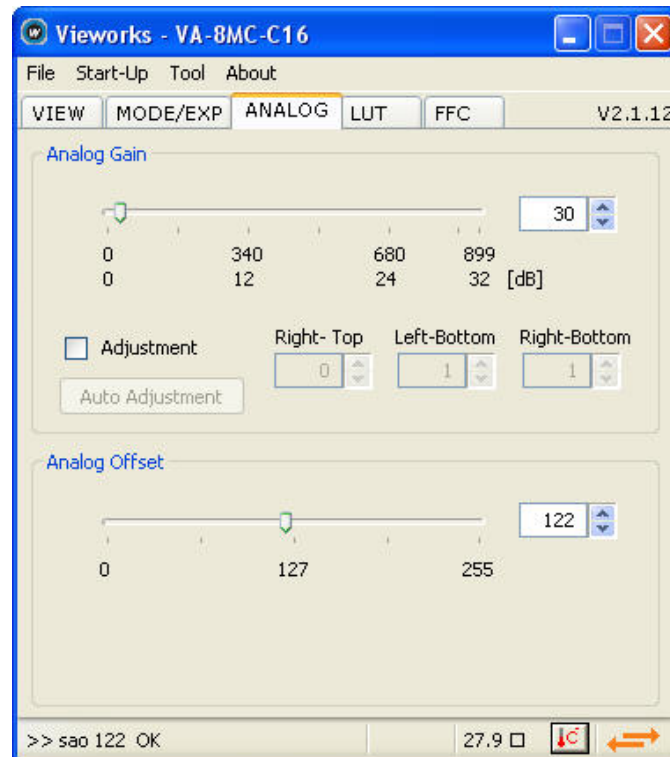


Figure 10.8 ANALOG Tab

- **Analog Gain:** Sets gain value of each channel. The **Auto Adjustment** button will be activated after checking the **Adjustment** checkbox. Press to compensate Tap differences automatically. Fine Adjustment of Right-Top, Left-Bottom and Right-Bottom will be affected based on Left-Top.



After clicking the **Auto Adjustment** button, at least one or more images must be captured by the camera.

- **Analog Offset:** Sets offset values of both channels.

10.3.4 LUT Tab

LUT tab allows you to download LUT data. For more information about LUT download, refer to [Appendix B](#).

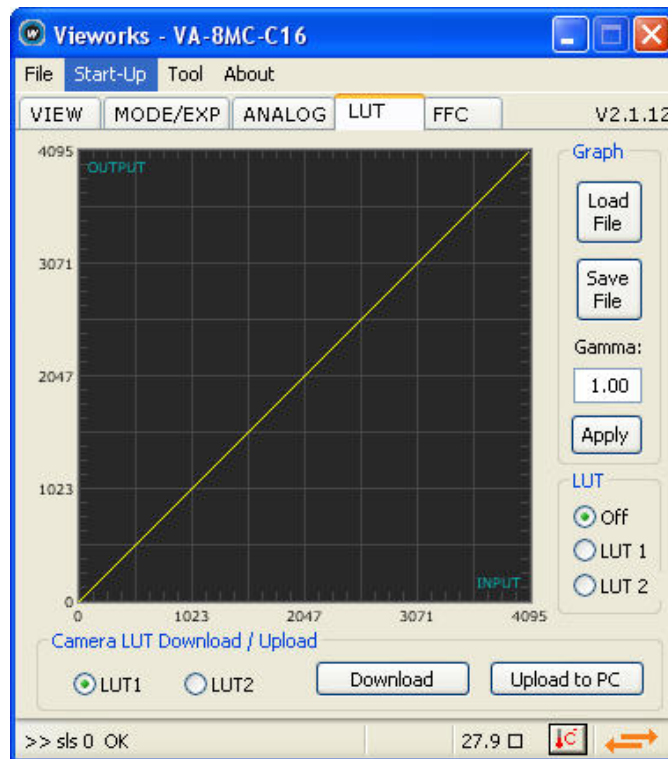


Figure 10.9 LUT Tab

- Graph:** Loads LUT data from the user computer or sets Gamma value to be applied while using Gamma curve.
- Camera LUT Download / Upload:** Downloads LUT data to the camera from the user computer (Download) or uploads LUT data saved in the camera to the user computer (Upload to PC).

10.3.5 FFC Tab

FFC tab allows you to set Flat Field Correction settings. All scroll bars are controllable with the mouse wheel scroll.

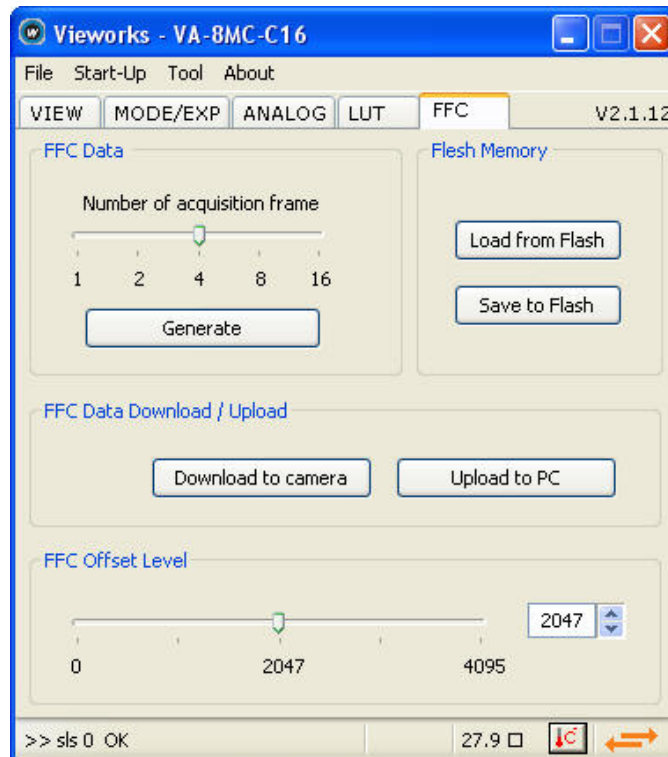


Figure 10.10 FFC Tab

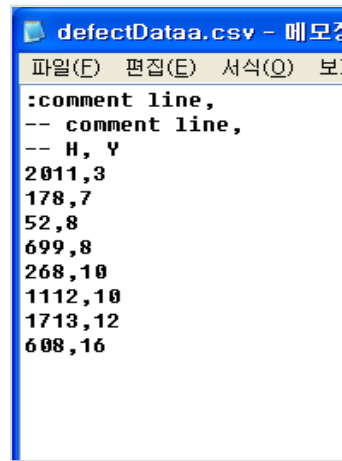
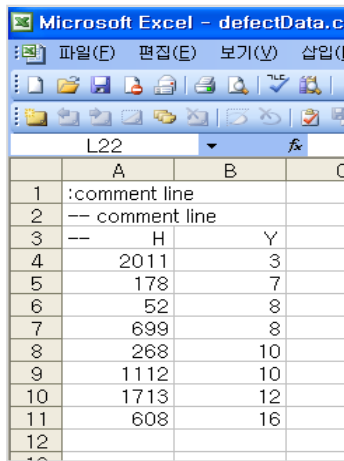
- FFC Data:** Generates the FF data to be used for correction and sets how many images will be used for the generation.
- Flash Memory:** Saves the generated FF data to Flash in order to reuse in the future or loads the saved FF data.
- FFC Data Download / Upload:** Downloads FFC Data from the user computer (Download to camera) or uploads FFC Data to the user computer (Upload to PC).
- FFC Offset Level:** Sets the offset value of the image after Flat Field Correction is applied.



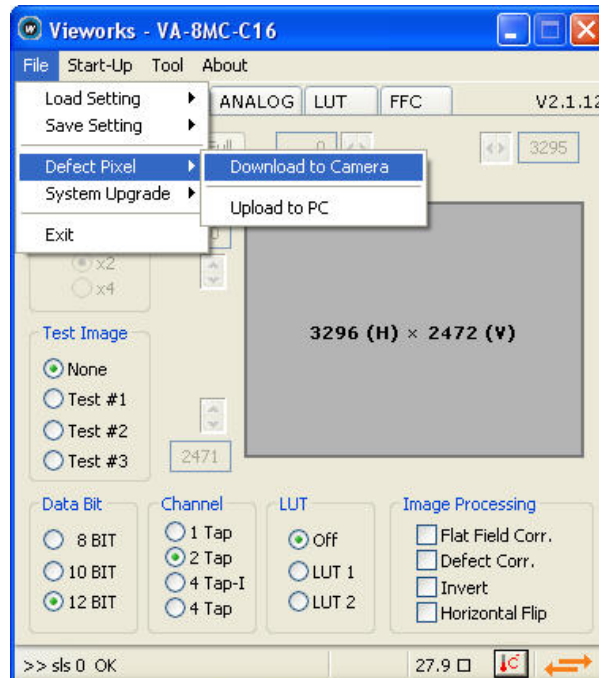
Appendix A Defective Pixel Map Download

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

- Lines beginning with ':' or '--' are treated as notes.
- Each row is produced in the order of the horizontal and vertical coordinate values.
- The input sequence of pixel is irrelevant.

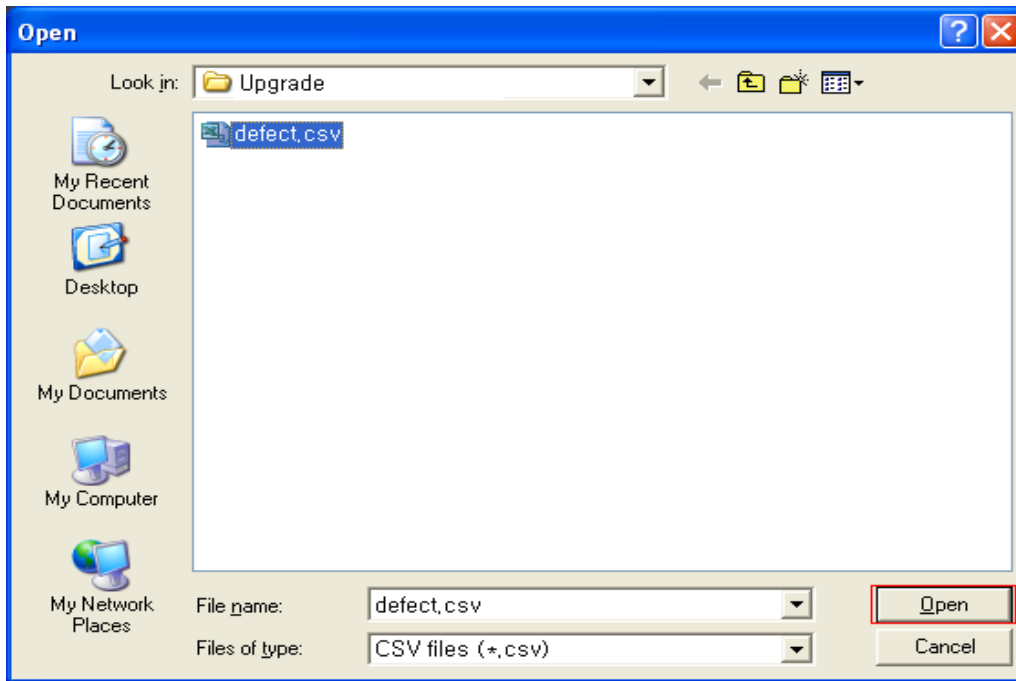


2. Select **File > Defect Pixel > Download to Camera** on Configurator.

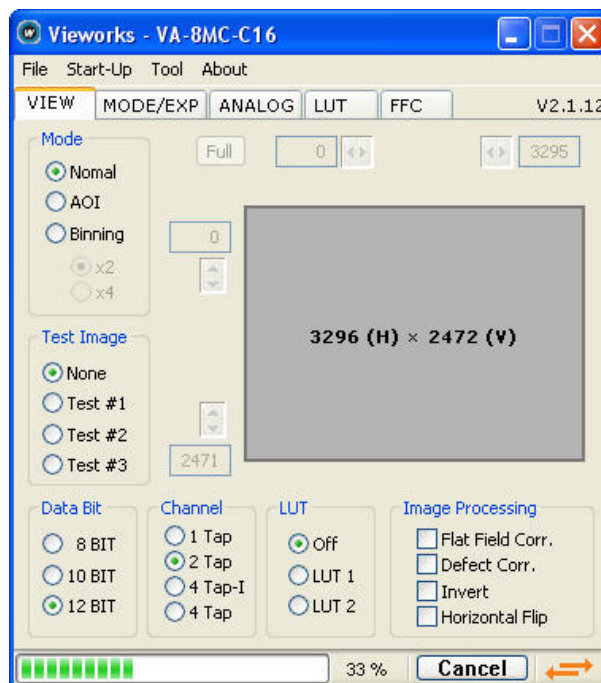




3. Search and select the created file and click **Open**.

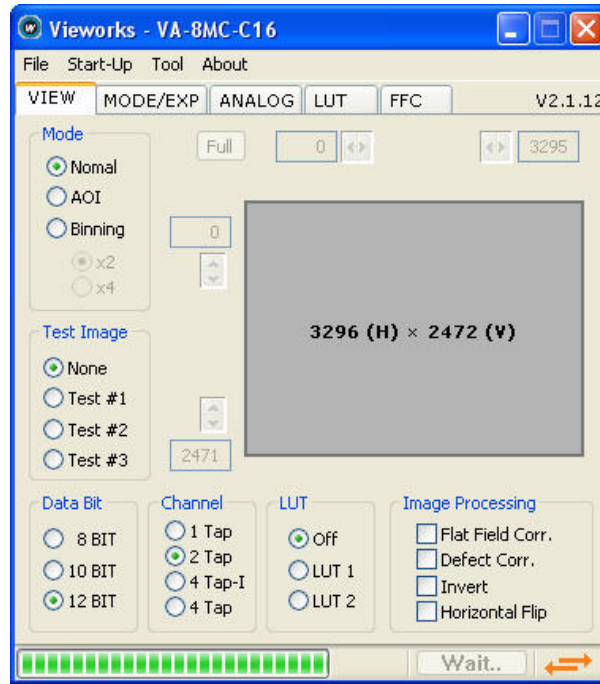


4. Configurator starts downloading defective pixel map data to the camera and downloading status is displayed at the bottom of the window.

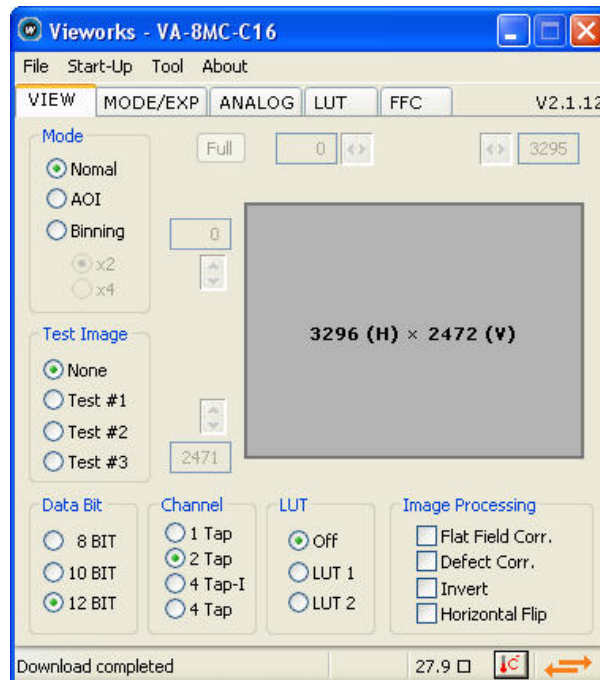




- 5. Once the download has been completed, the saving process will begin. During the saving process, make sure not to disconnect the power cord.



- 6. Once all the processes have been completed, **Download completed** message will appear at the bottom of the window.



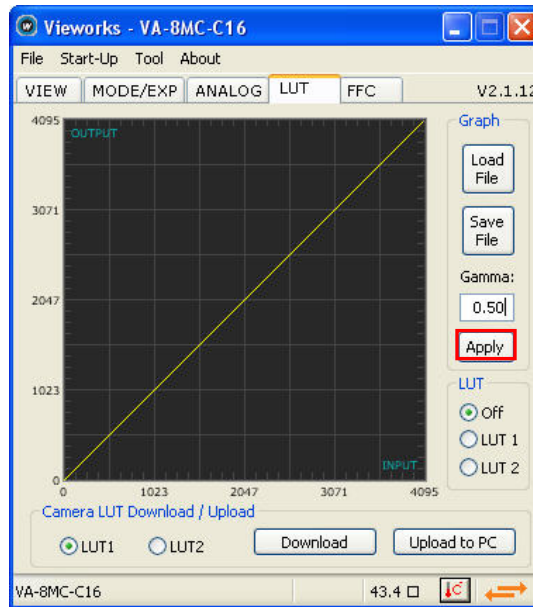


Appendix B LUT Download

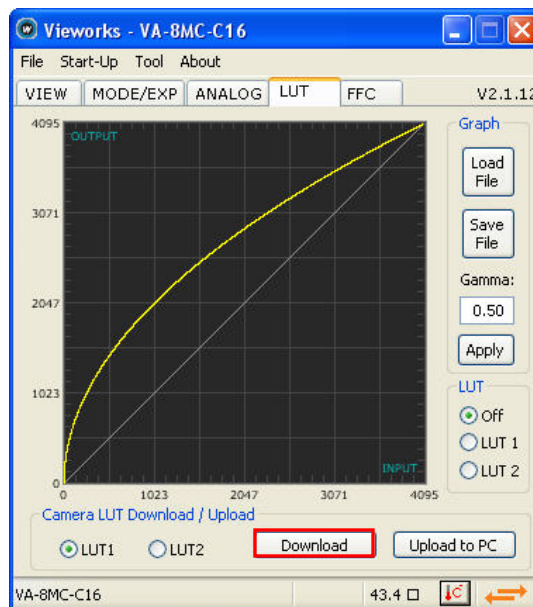
LUT data can be created in two ways; by adjusting the gamma values on the gamma graph provided in the program and then downloading the data or by opening a CSV file (*.csv) and then downloading the data.

B.1 Gamma Graph Download

1. Set a desired gamma value on LUT tab and click **Apply**.

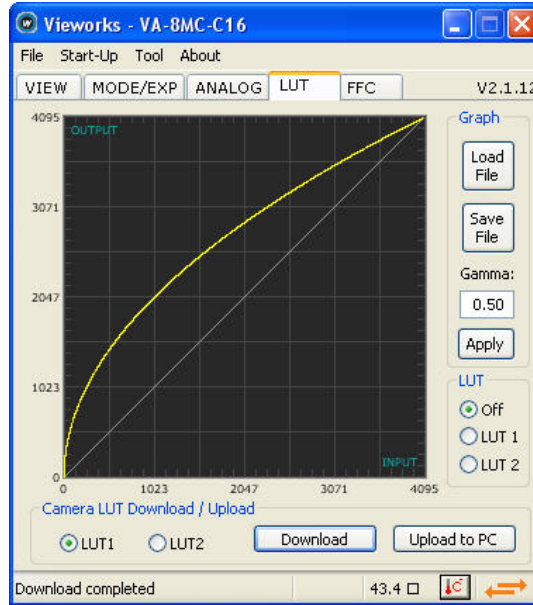


2. Select LUT1 or LUT2 as a location to store the data and click **Download**.





3. Once the download has been completed, **Download completed** message will appear at the bottom of the window.



B.2 CSV File Download

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

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

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

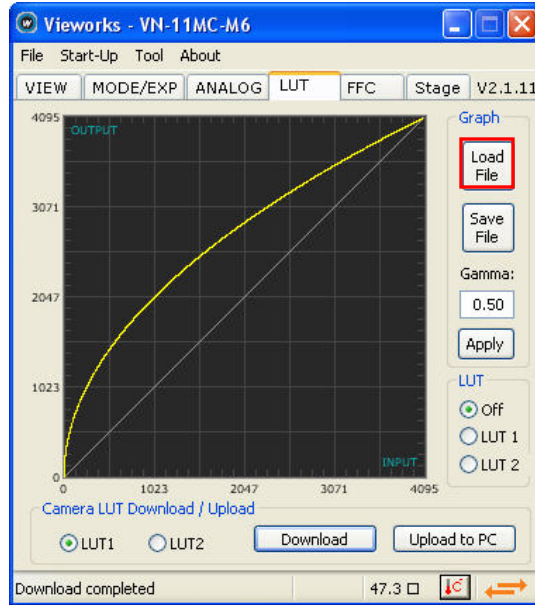
```

: comment line,
-- comment line,
-- input,output
0,4095
1,4094
2,4093
3,4092
4,4091
:,:
4095,0

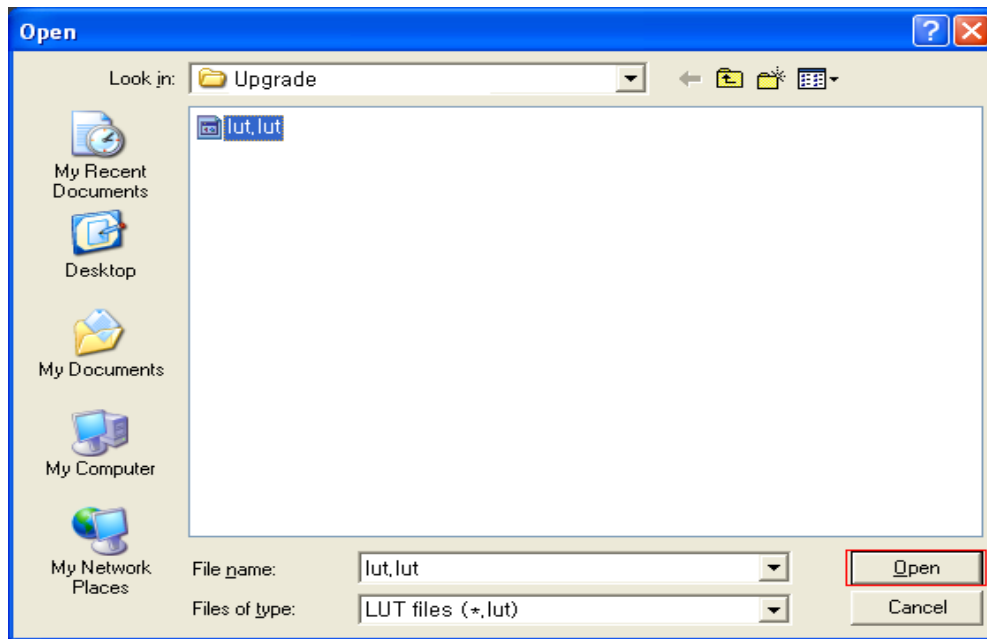
```



2. Click **Load File** on LUT tab.



3. Search and select the created LUT file and click **Open**.



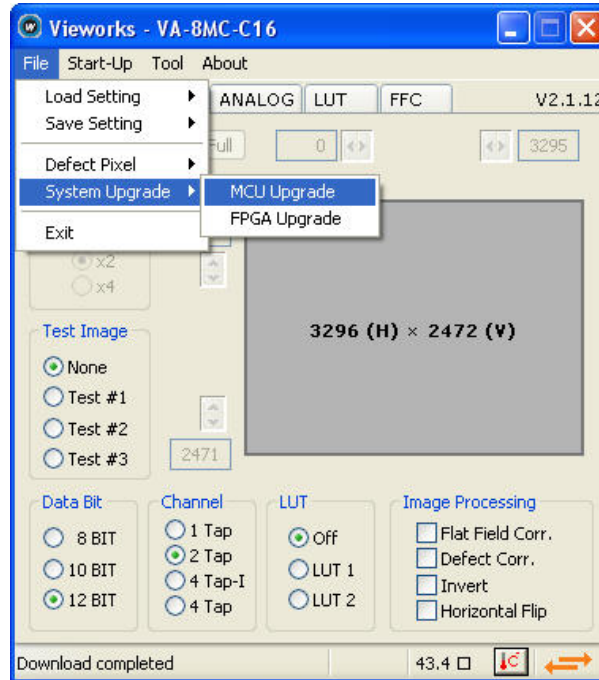
4. Select LUT1 or LUT2 as location to store the data and click **Download**. The subsequent processes are identical to those of Gamma Graph Download.



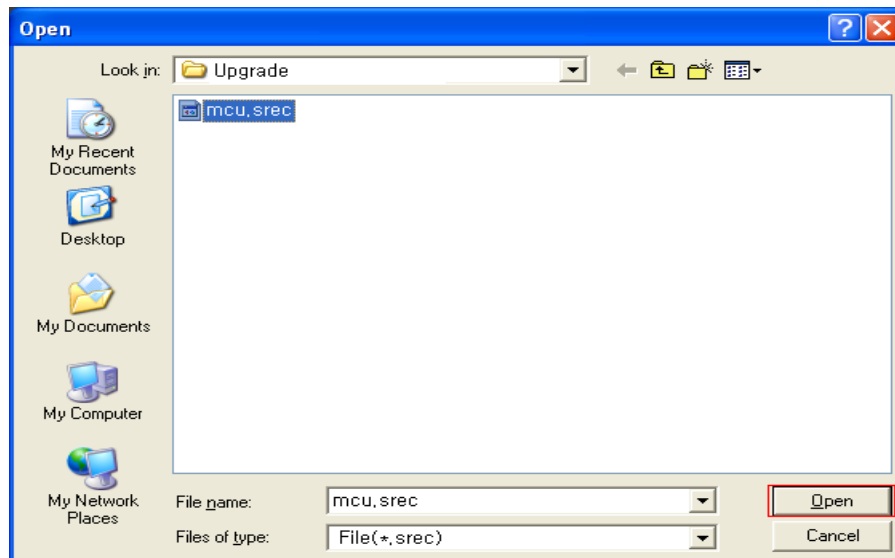
Appendix C Field Upgrade

C.1 MCU

1. Select **File > System Upgrade > MCU Upgrade** on Configurator.

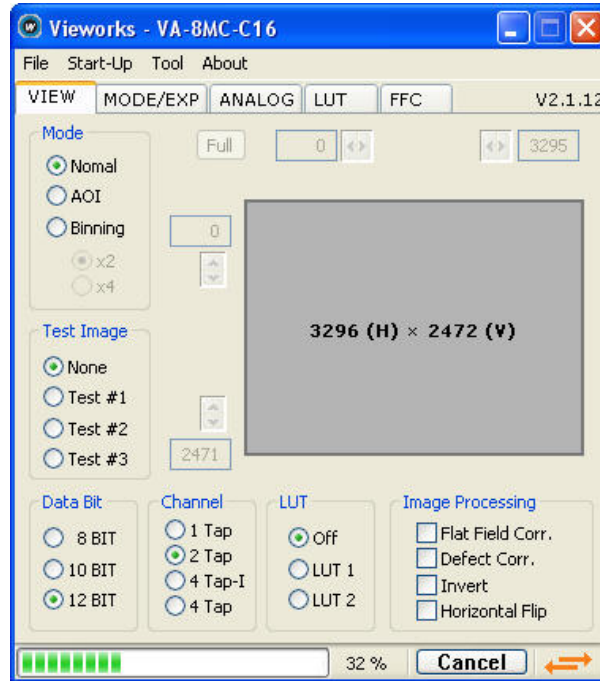


2. Search and select the provided MCU upgrade file (*.sec) then click **Open**.

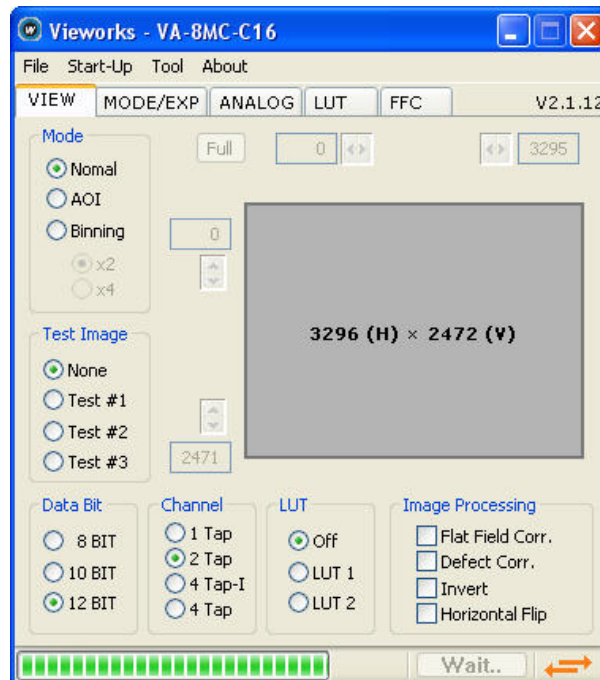




- 3. Configurator starts downloading MCU upgrade file to the camera and downloading status is displayed at the bottom of the window. If you want to cancel the upgrade process, click **Cancel**. This process requires several minutes to complete.



- 4. Once the download has been completed, the saving process will begin. During the saving process, the camera cannot be restored if a power failure occurs. Make sure that the power connection is secured.





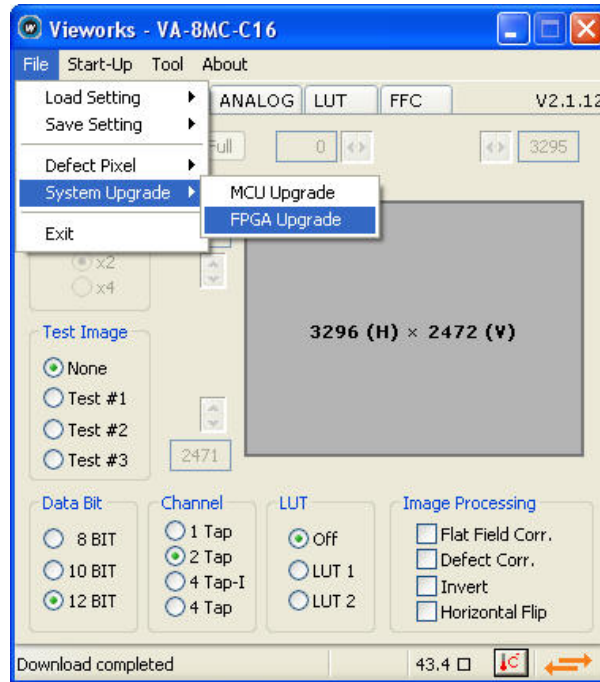
5. Once all the processes have been completed, turn the power off and turn it back on again. Select **Tool > Terminal** and enter the “gmv” command to confirm the version. Or, select **About > Camera Info** to confirm the MCU version.



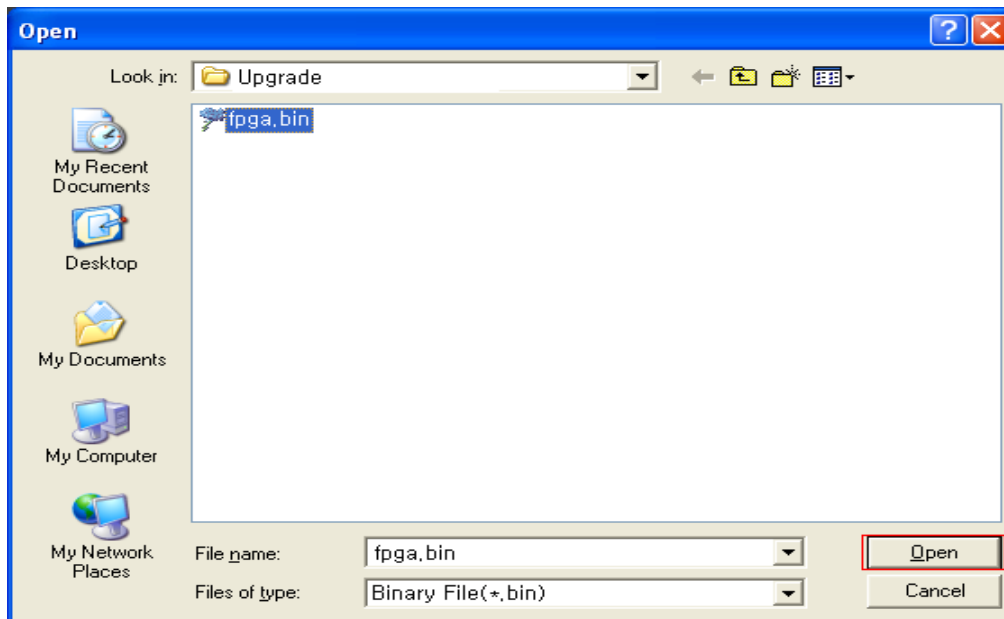


C.2 FPGA

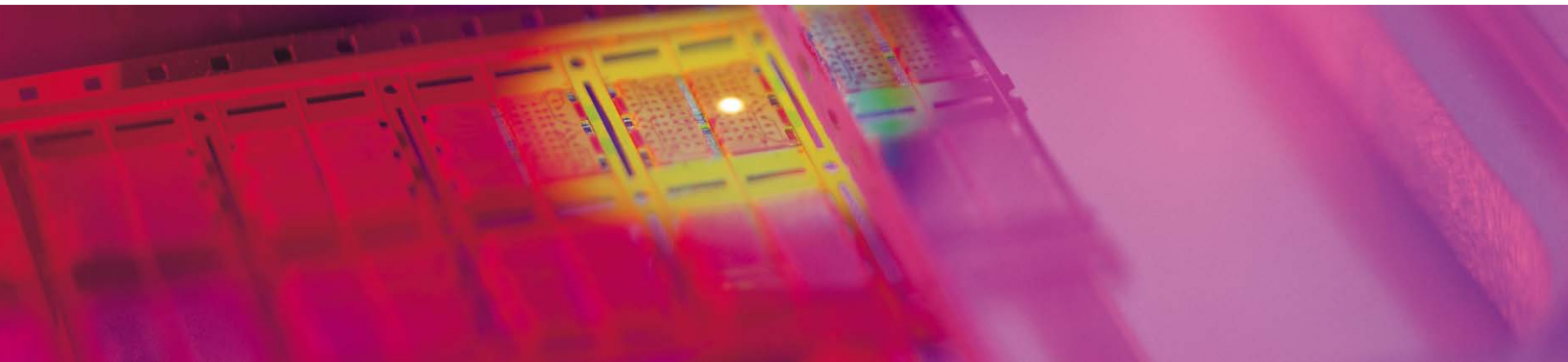
1. Select **File > System Upgrade > FPGA Upgrade** on Configurator.



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



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



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