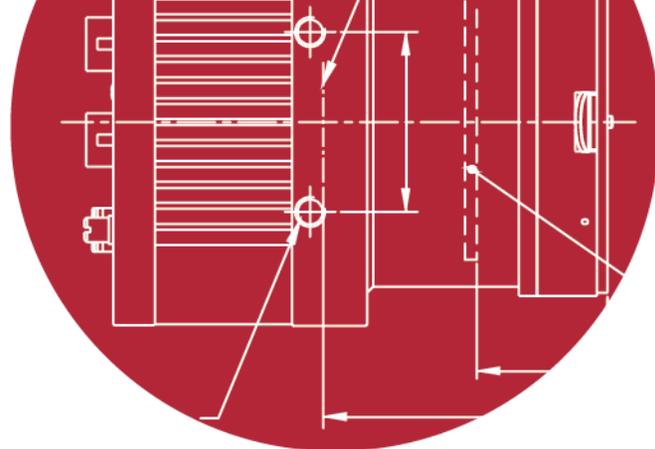


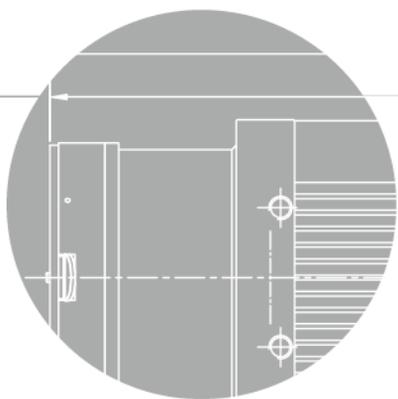
# VP series

## User Manual



English

VP-8MC  
VP-16MC  
VP-29MC



**VIEWWORKS**  
Imaging Expert

## Revision History

Revision	Date	Descriptions
1.0	2010-10-22	Initial release
1.1	2012-01-31	<ul style="list-style-type: none"><li>Added 8M and 29M</li><li>Updated MS word style</li><li>Fixed Minor errors.</li></ul>
1.2	2012-07-20	<ul style="list-style-type: none"><li>Deleted 11M</li><li>Modified Mechanical Dimension</li></ul>
1.3	2013-02-22	<ul style="list-style-type: none"><li>Modified Mechanical Dimension</li></ul>
1.4	2013-06-14	<ul style="list-style-type: none"><li>Added description of M5 set screws for tilt adjustment</li><li>Revised spectral response according to the updated TSI datasheets</li><li>Added Actual Time Applied for Commands</li><li>Removed the Horizontal Flip feature from VP-8MC and VP-29MC</li></ul>
1.5	2013-08-21	Added DSNU Correction feature to VP-8MC and VP-29MC
1.6	2014-09-19	<ul style="list-style-type: none"><li>Added “sgo”, “ggo”, and “ago” commands</li><li>Applied new CI</li></ul>

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# 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.
- Do not store the device at a higher temperature. In addition, maintain the temperature of the camera housing in a range of  $-5^{\circ}\text{C}$  to  $40^{\circ}\text{C}$  during operation. Otherwise the device may be damaged by excessively high 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 devices.
- Make sure the power is turned off before connecting the power cord to the camera. Otherwise, damage to the camera may result.

## 2 Warranty

For information about the warranty, please contact your local dealer or factory representative.

## 3 Compliance & Certifications

### 3.1 FCC Declaration

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 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

#### 3.2.1 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 Components and Connections

### Package Components



VP 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

VP Series cameras are thermoelectric Peltier (TEC) cooled high performance digital cameras. These cameras use cooling technology developed for, and used by, many demanding medical market customers. The TEC maintains the operating temperature of the CCD at up to 20 degrees below ambient temperature. These cameras provide a stable operating condition or the ability to expose for a long period of time to increase camera sensitivity. These cameras are ideal for industrial applications such as FPD inspection and microscopy.

#### Main Features

- Area Of Interest (AOI)
- Trigger Mode
- Binning Mode – 2 × 2 / 4 × 4
- Output Pixel Format – 8 / 10 / 12 bit
- Output Channel – 1 or 2 Tap
- Auto Taps Adjustment
- Electronic Shutter
- 2D Flat Field Correction
- Strobe Output
- Analog Gain adjustment function
- Analog Offset adjustment function
- Look Up Table
- Defective Pixel Correction
- Flat Field Correction
- Test Image
- Horizontal Flip (Only available on VP-16MC)
- Image Invert
- RS-644 Serial Communication
- Temperature Monitor
- Field Upgrade
- Base Camera Link
- Peltier Cooling

## 5.2 Specifications

VP Series	VP-8M	VP-16M	VP-29M
Active Image (H × V)	3296 × 2472	4872 × 3248	6576 × 4384
Sensor Type	Kodak KAI-08050	Kodak KAI-16000	Kodak KAI-29050
Pixel size	5.5 μm × 5.5 μm	7.4 μm × 7.4 μm	5.5 μm × 5.5 μm
Sensor Output	1, 2 or 4 Tap Output	1 or 2 Tap Output	1, 2 or 4 Tap Output
Video Output	8/10/12 bits, 1 or 2 Tap		
Camera Interface	Camera Link (Base)		
Electronic Shutter	Global Shutter		
Max. Frame Rate at Full Resolution	16.3 fps	4.2 fps	5 fps
Pixel Clock	40 / 80 MHz	30 / 40 MHz	40 / 80 MHz
Exposure Time	1/100000 ~ 7 sec (10 μs step)	1/4500 ~ 7 sec (10 μs step)	1/100000 ~ 7 sec (10 μs step)
Partial Scan (Max. Speed)	84 fps at 300 Lines	17 fps at 406 Lines	16 fps at 1000 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	>62 dB		
Lens Mount	F-mount		
Cooling Method	Thermoelectric Peltier Cooling		
Cooling Performance	20°C below ambient temperature Standard cooling with a fan		15°C
Power	10 ~ 14 V DC, Max. 25W		10 ~ 14 V DC, Max. 28W
Environmental	Operating: -5°C ~ 40°C, Storage : -40°C ~ 70°C		
Mechanical	90.0 mm × 90.0 mm × 142.0 mm, 1550 g (with F-mount)		

**Table 5.1 Specifications of VP Series**

### 5.3 Camera Block Diagram

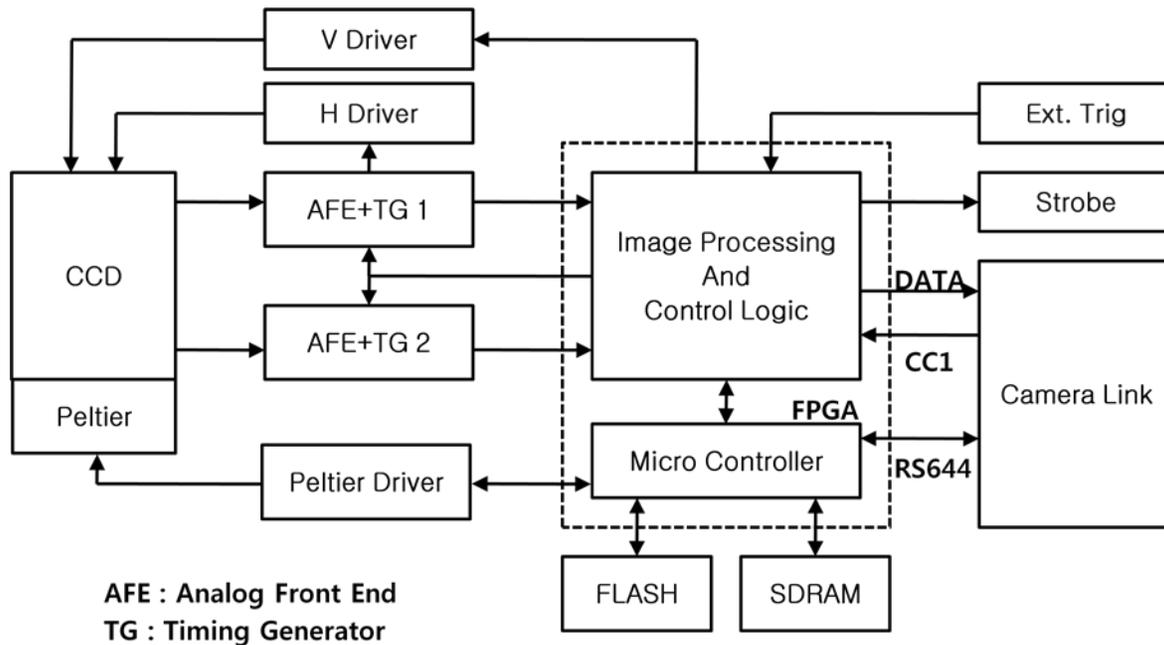


Figure 5.1 VP Camera Block Diagram

All controls and data processing of VP cameras are carried out in one FPGA chip. The FPGA generally consists of 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 inputs and strobe outputs 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. And, Peltier Driver is applied to control Thermoelectric Peltier Cooling unit.

## 5.4 Spectral Response

### 5.4.1 Mono Camera Spectral Response

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

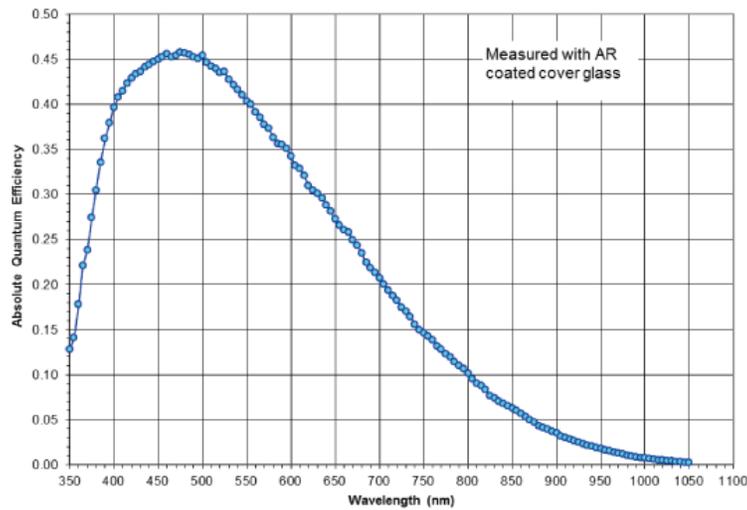


Figure 5.2 VP-8MC-M16 Spectral Response

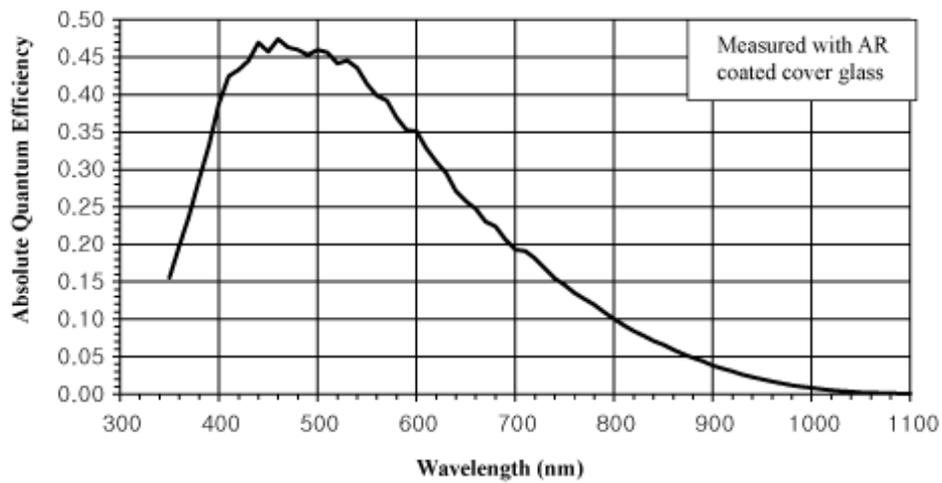


Figure 5.3 VP-16MC-M4 Spectral Response

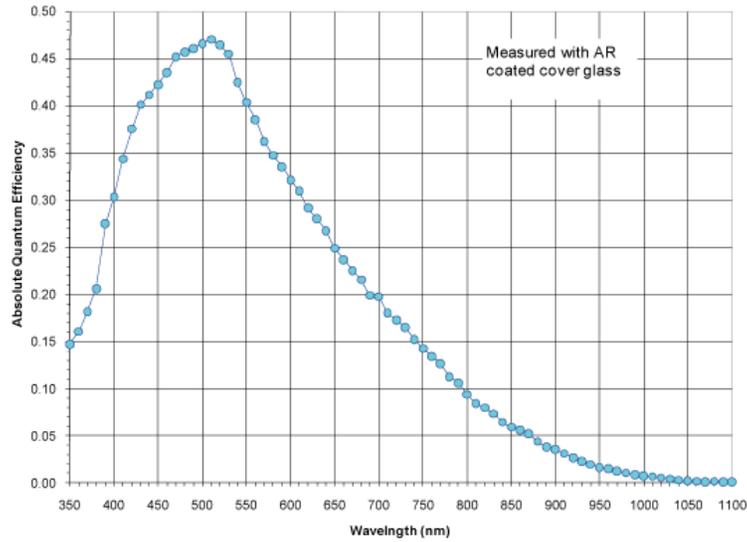


Figure 5.4 VP-29MC-M5 Spectral Response

### 5.4.2 Color Camera Spectral Response

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

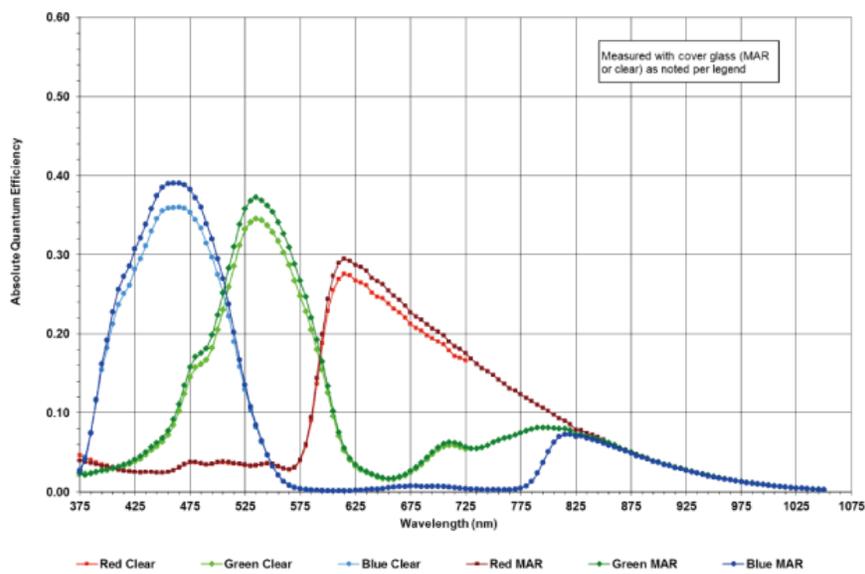


Figure 5.5 VP-8MC-C16 Spectral Response

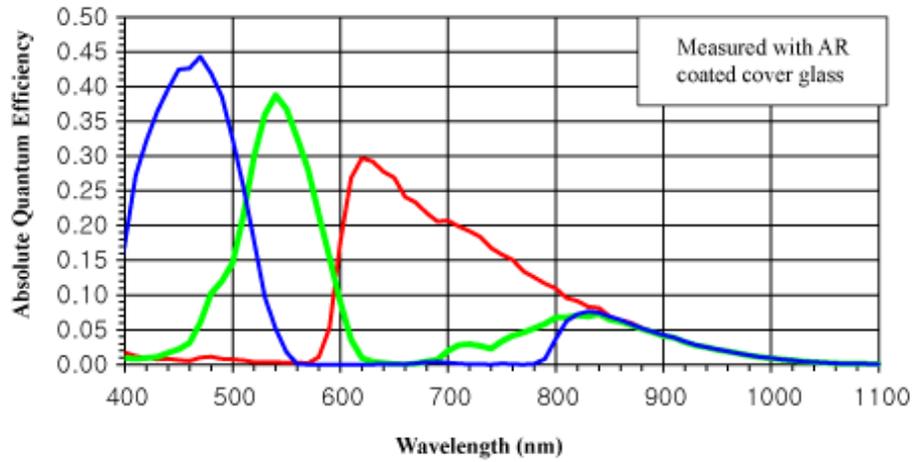


Figure 5.6 VP-16MC-C4 Spectral Response

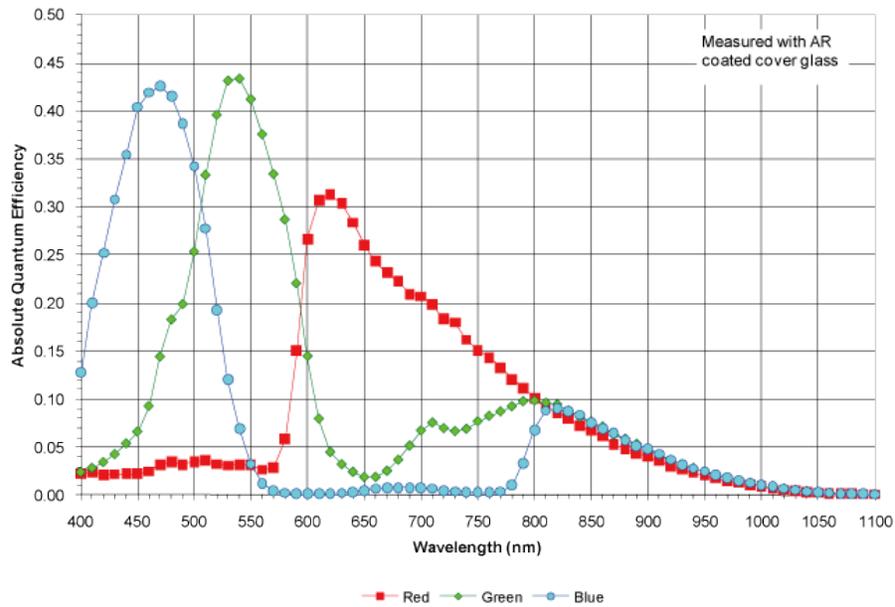
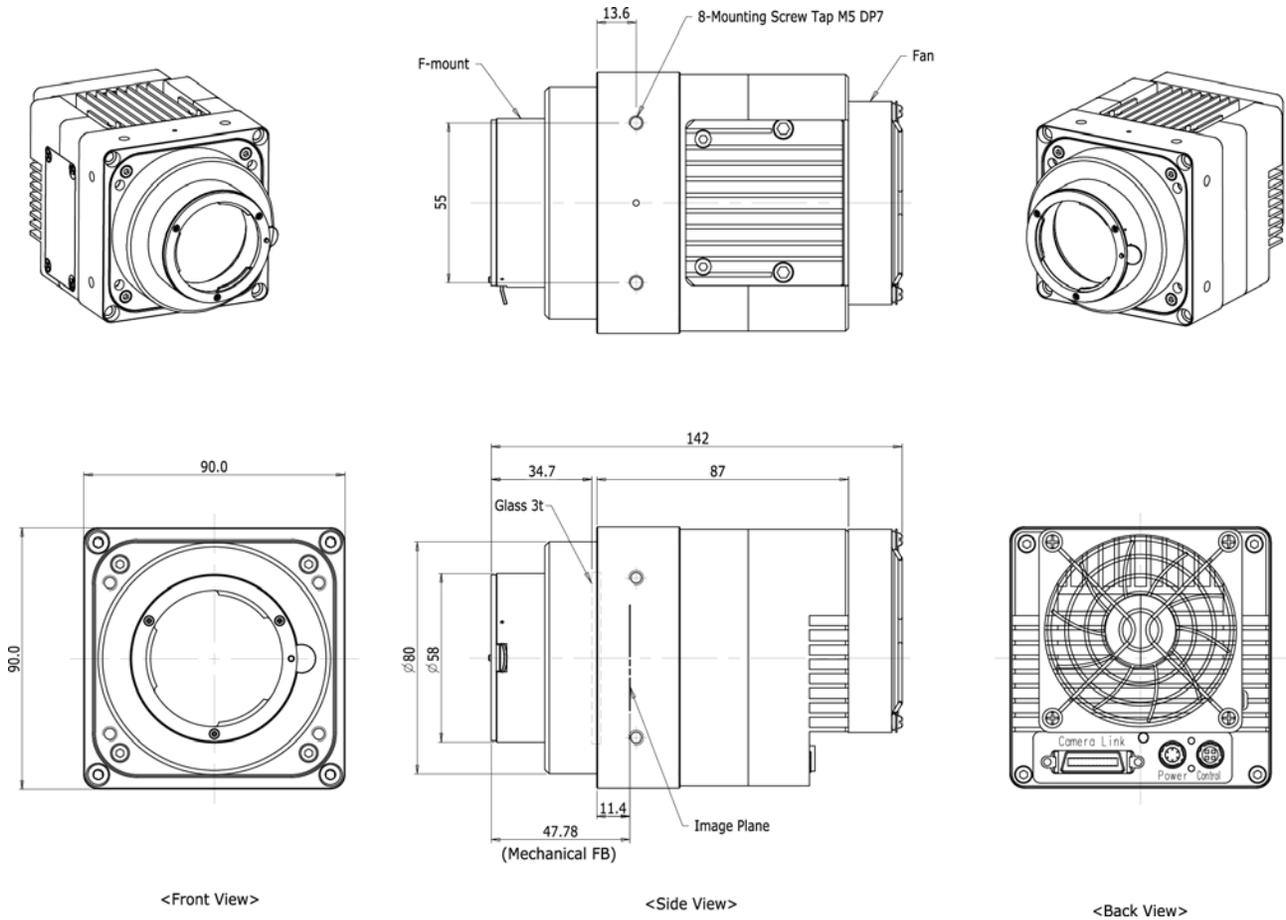


Figure 5.7 VP-29MC-C5 Spectral Response

## 5.5 Mechanical Specification

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



**Figure 5.8 VP Camera Link Mechanical Dimension (F-Mount)**

## 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 connector on the camera.
4. Plug the power adaptor into a working electrical outlet.
5. Verify all the cable connections are secure.

### 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 the manufacturer for technical assistance.

### 6.2 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.

### 6.3 Installing the Configurator

- You can control the camera by executing the Configurator.exe file.
- You can download the latest Configurator at <http://machinevision.vieworks.com>.
- Please refer to your Frame Grabber User Manual.

## 7 Camera Interface

### 7.1 General Description

As shown in the following figure, 4 types of connectors and status indicator LED are located on the back of the camera and have the functions as follows:

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

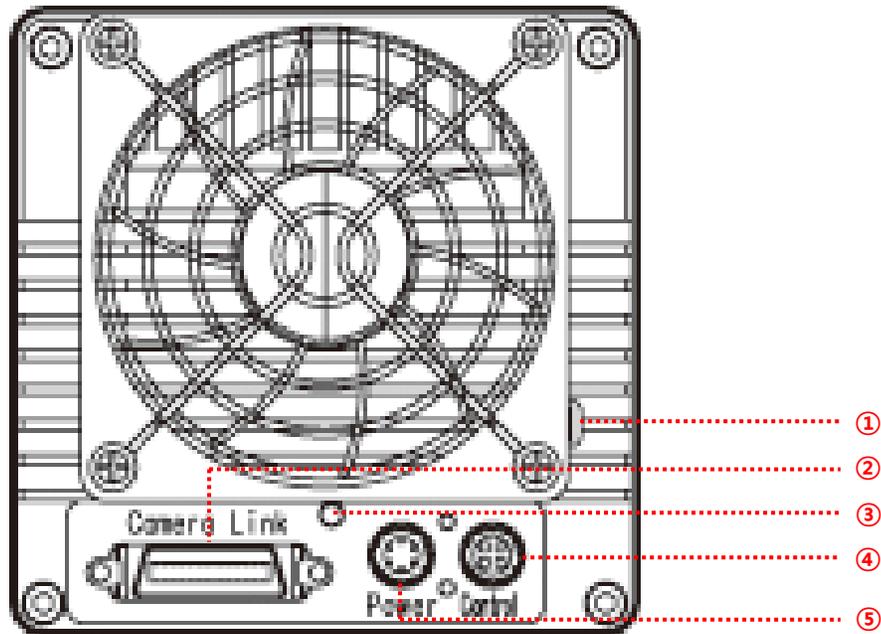


Figure 7.1 VP Series Back Panel

### 7.2 Camera Link Connector

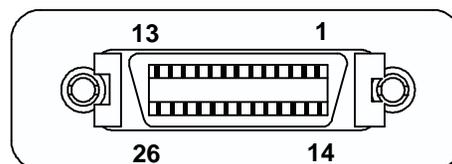


Figure 7.2 Camera Link Connector

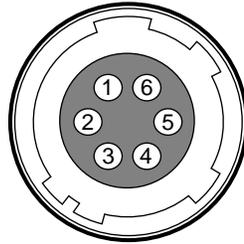
Camera Link connector complies with Camera Link Standard and the following list shows the pin configuration of the connector.

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 Connector

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



**Figure 7.3 Pin Arrangement of Power Input Connector**

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 Configuration of Power Input Connector**

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 3A current output at 12 V DC  $\pm 10\%$  voltage output (Users need to purchase the power adaptor separately).

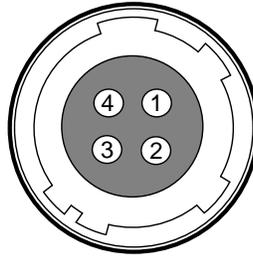
### Precaution for Power Input



- 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 specified input voltage range, damage to the camera may result.

## 7.4 Control Connector

The control connector is a Hirose 4 pin connector (part # HR10A-7R-4S) and consists of external trigger signal input and strobe output ports. Pin arrangement and configuration are as follows:



**Figure 7.4 Pin Arrangement of Control Connector**

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

**Table 7.3 Pin Arrangement of Control Connector**

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

## 7.5 Trigger Input Circuit

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  $1 \mu\text{s}$ . If transmitted trigger signal is less than  $1 \mu\text{s}$ , the camera will ignore the trigger signal. External trigger circuit example is shown below.

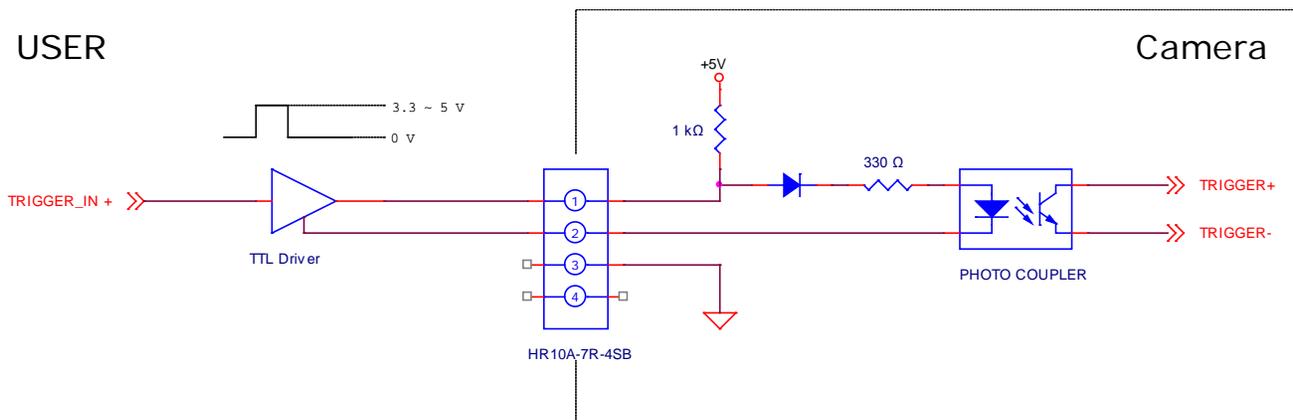


Figure 7.5 Trigger Input Schematic

## 7.6 Strobe Output Circuit

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

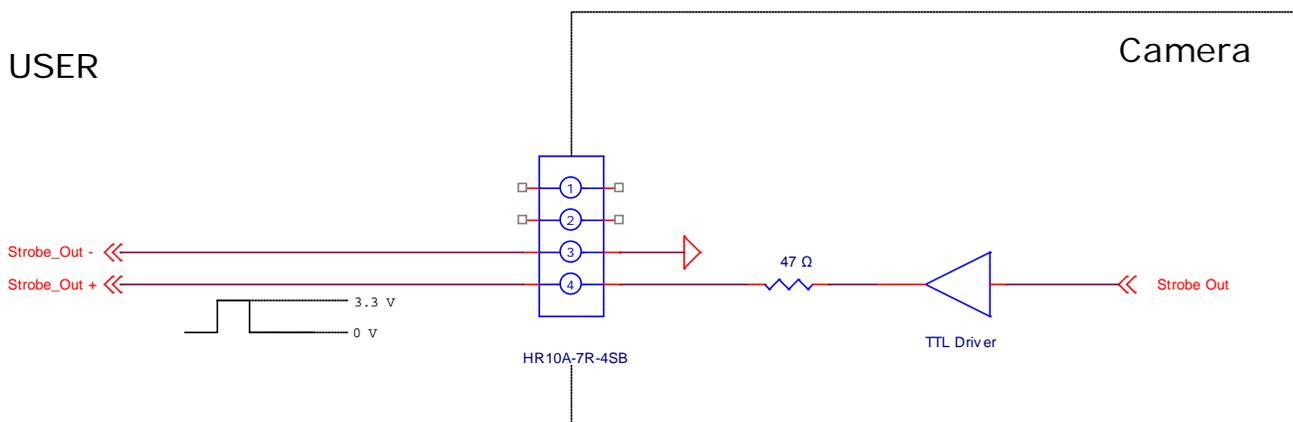


Figure 7.6 Strobe Out Schematic

## 8 Camera Features

### 8.1 Area Of Interest (AOI)

AOI is the area containing the data required by the user within the entire image. The user can obtain the image faster than obtaining overall areas by designating the area as AOI while keeping the same high quality. AOI is determined as the overlapping area of 2 areas when designating start point and end point in horizontal and vertical direction as shown in 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:

$$V \text{ End} = (V \text{ SIZE} - V \text{ Start}) - 1$$

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

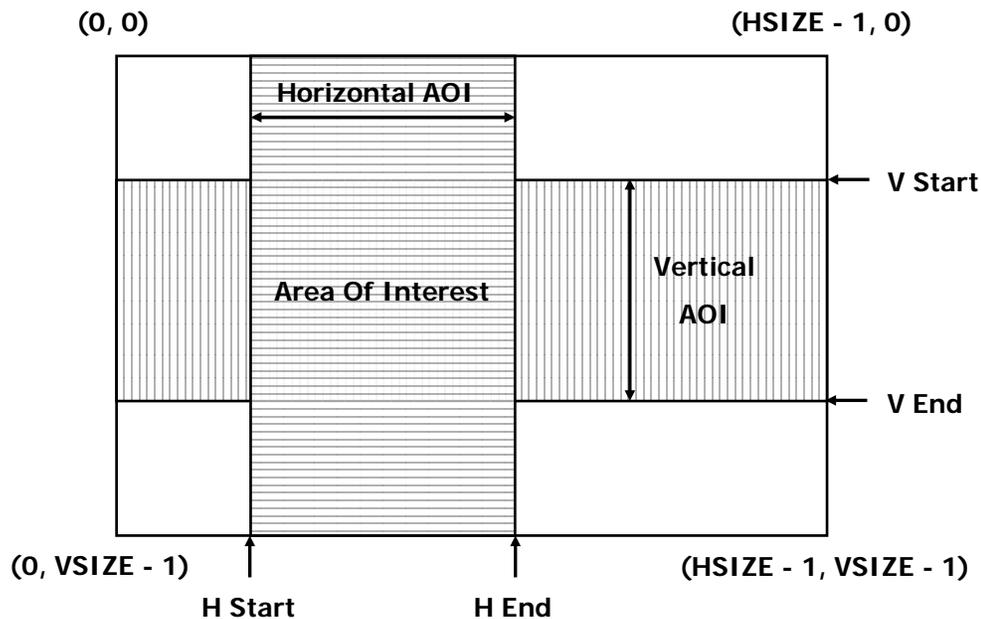


Figure 8.1 AOI



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

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

1 or 2 Channel Mode for <b>VP-8M &amp; VP-29M:</b> $\text{Frame Rate (fps)} = 1000000 / [T_{VCCD} + T_{FD} \times \{V_{SIZE} - (V_{AOI} + 12)\} + (V_{AOI} + 12) \times T_L]$
1 or 2 Channel Mode for <b>VP-16M:</b> $\text{Frame Rate (fps)} = 1000000 / \{T_{VCCD} + T_{FD} \times (V_{SIZE} - V_{AOI}) + V_{AOI} \times T_L\}$
4 Channel Mode for <b>VP-8M &amp; VP-29M:</b> $\text{Frame Rate (fps)} = 1000000 / [T_{VCCD} + T_{FD} \times \{V_{SIZE} - (V_{AOI} + 12)\}/2 + \{(V_{AOI} + 12) \times T_L\}/2]$
$T_{VCCD}$ : time required to move electric charges accumulated on pixel to Vertical Register $T_{FD}$ : time required for Fast Dump $V_{SIZE}$ : number of Vertical Line of CCD $T_L$ : time required for transmission of one line $V_{AOI}$ : size of Vertical AOI

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.

VP Series	VP-8M	VP-16M	VP-29M
$T_{VCCD}$	17.0 $\mu s$	242.0 $\mu s$	56.3 $\mu s$
$T_L$ (1 channel)	90.5 $\mu s$	135.0 $\mu s$	172.3 $\mu s$
$T_L$ (2 channel)	46.6 $\mu s$	73.0 $\mu s$	90.125 $\mu s$
$T_L$ (4 channel)	46.6 $\mu s$	-	90.125 $\mu s$
$T_{FD}$	4.1 $\mu s$	16.0 $\mu s$	6.8 $\mu s$
$V_{SIZE}$	2520 Lines	3248 Lines	4384 Lines
Minimum Vertical AOI Size	300 Lines	406 Lines	500 Lines

**Table 8.1 Timing Value for VP Series**

The following figure shows frame rate depending on VAOI changes.

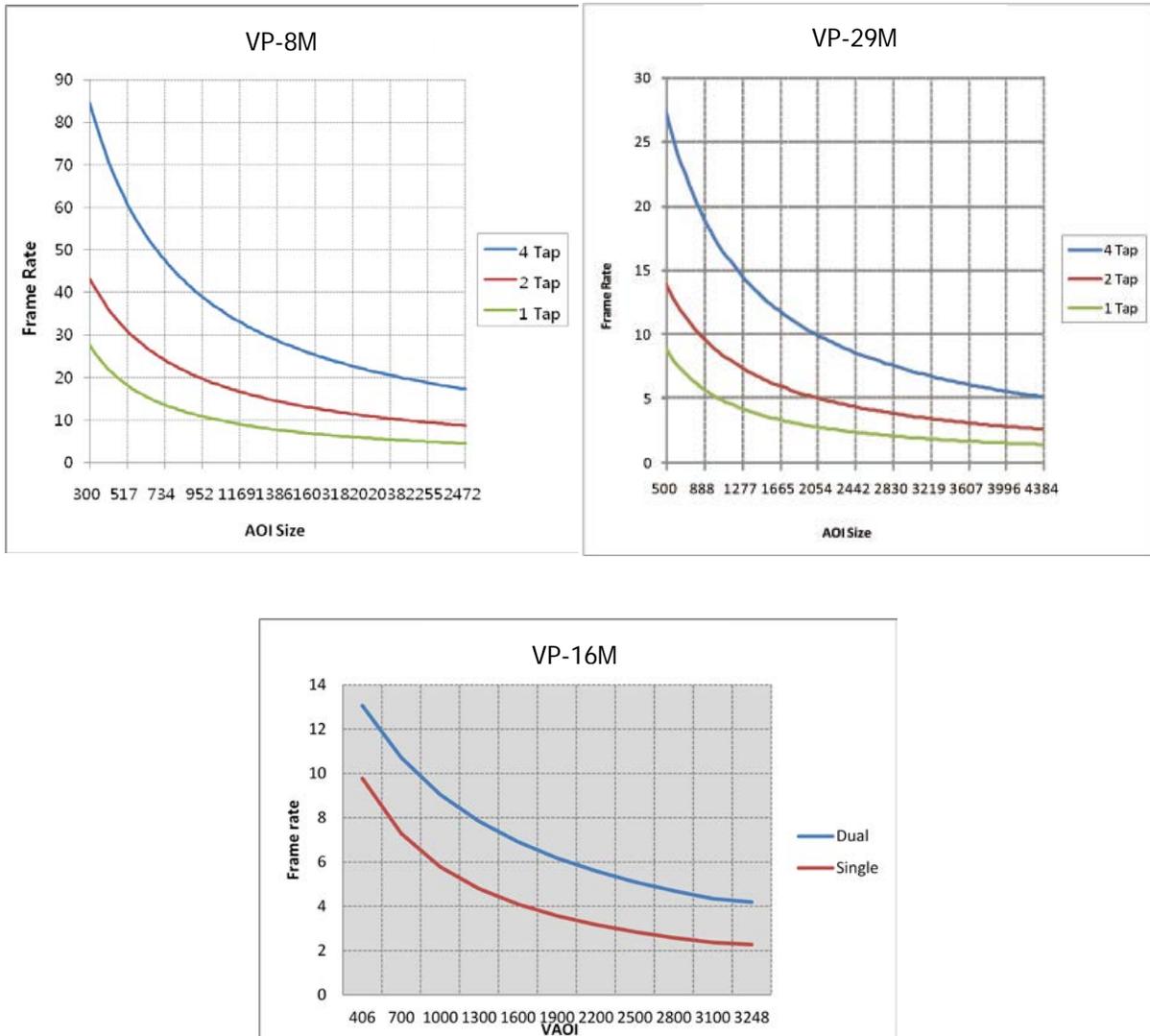


Figure 8.2 Frame Rate by VAOI changes

## 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. The camera applies same Binning Factor (2 or 4) to both directions in order to keep the percentage of image. The below figure shows application of  $2 \times 2$  Binning and  $4 \times 4$  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 frame speed. Binning Factor is set using “sbf” command.

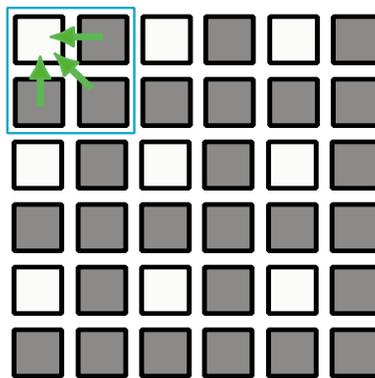


Figure 8.3  $2 \times 2$  Binning

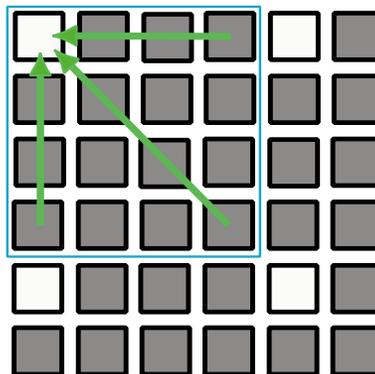


Figure 8.4  $4 \times 4$  Binning



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

## 8.3 Trigger

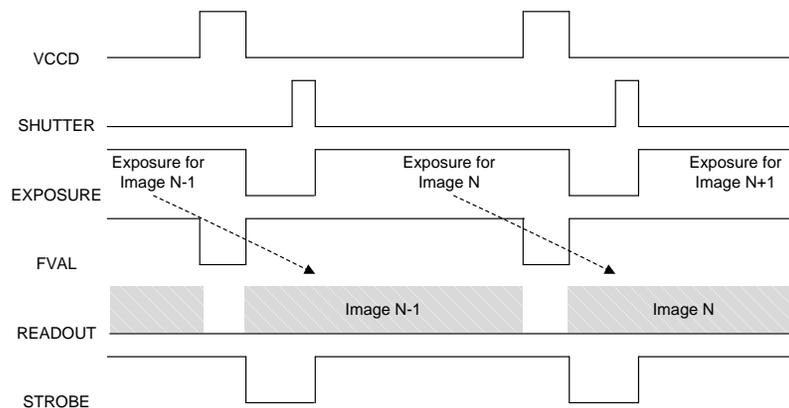
### 8.3.1 Trigger Input

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.

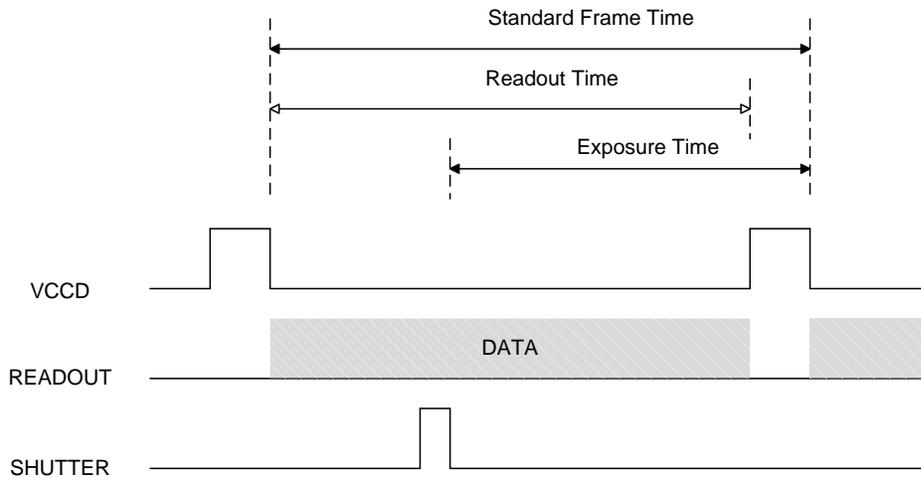
#### 8.3.1.1 Free-Run Mode

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

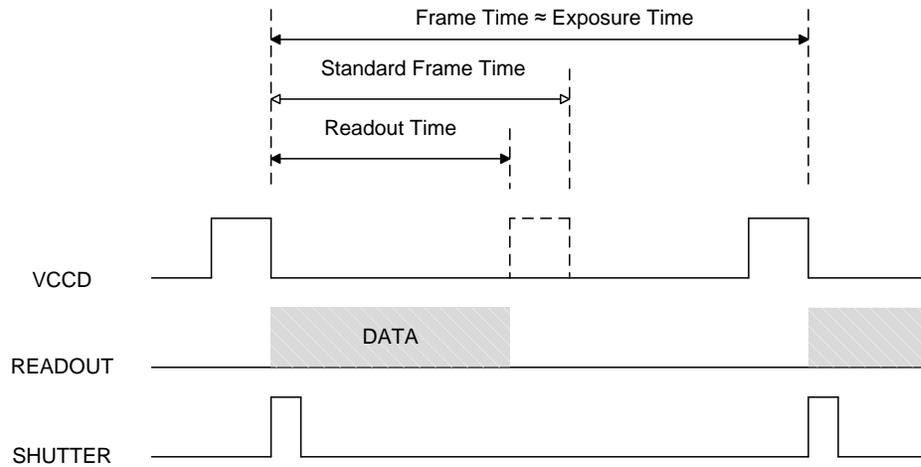


**Figure 8.5 Free-Run Mode**

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 8.6](#)). In this case, 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 8.7](#)). In this case, frame speed gets lower as the setting value of Exposure Time increases.



**Figure 8.6 Exposure Time is Shorter than Readout Time**



**Figure 8.7 Exposure Time is longer than Readout Time**

### 8.3.1.2 Standard Mode

In Standard Mode, camera keeps standby status until trigger signal is entered, and when trigger input occurs, Readout start after Exposure process set earlier. After Readout is completed, and returns to trigger standby status again. In Standard Trigger mode, if a new trigger input occurs during readout, the new trigger input is ignored.

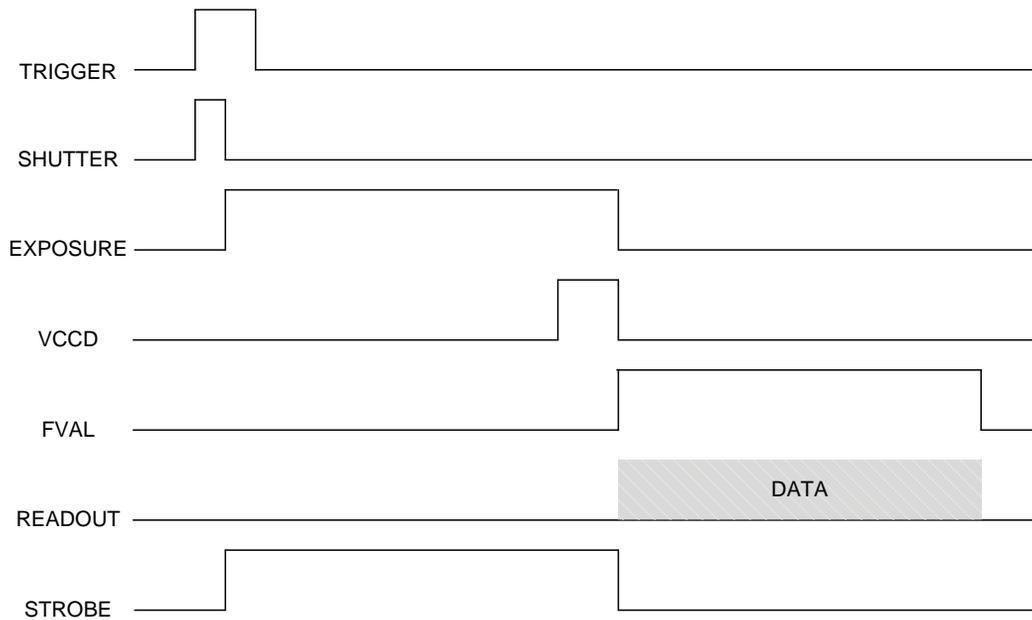


Figure 8.8 Standard Trigger Mode

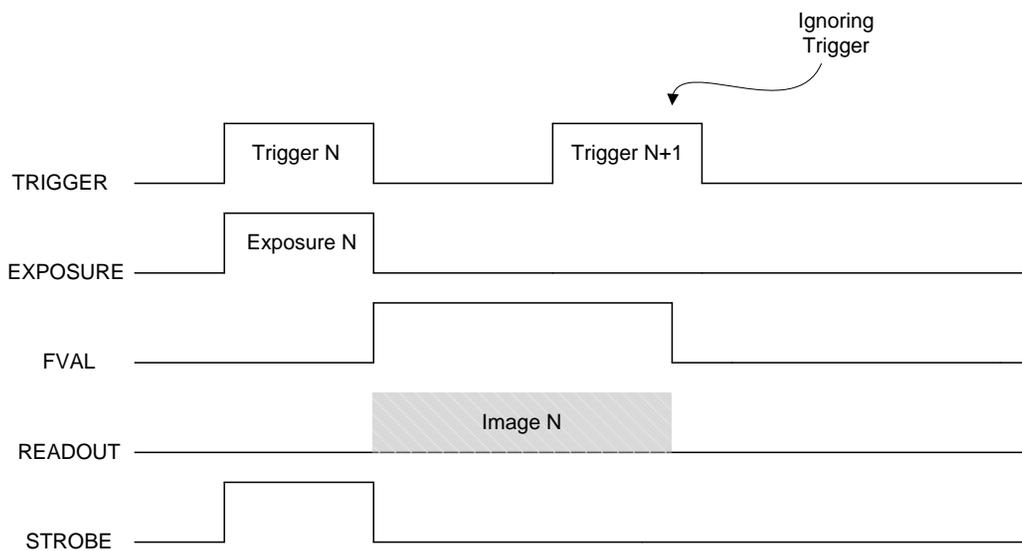
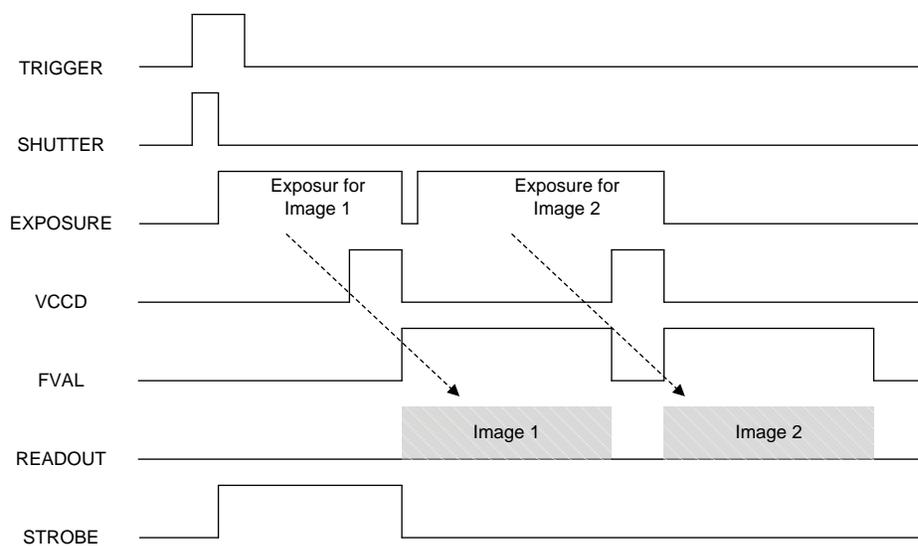


Figure 8.9 Retriggering

### 8.3.1.3 Double Exposure Mode

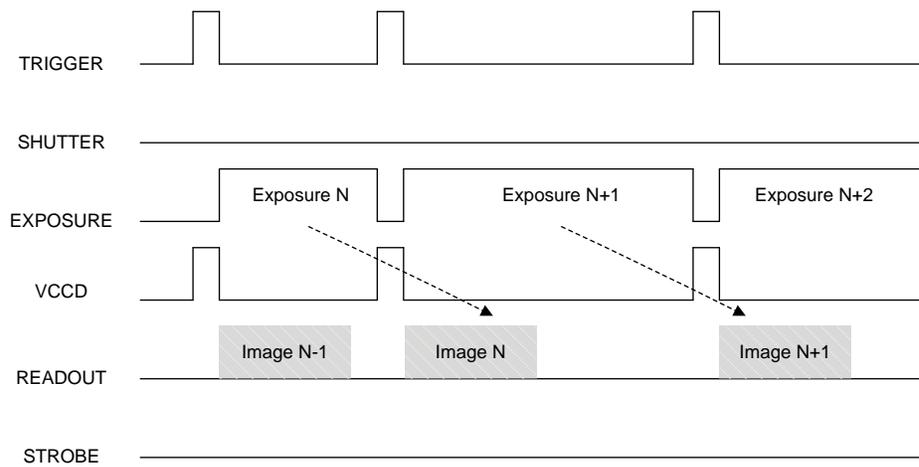
In Double Exposure mode, 2 images are obtained with 1 trigger input. When trigger input is entered in this mode, the camera starts Readout after passing through exposure process according to exposure setting as in Standard mode. At this time, exposure of second image starts with Readout. When Readout is completed, the camera performs the second Readout. Since it does not generate shutter signal during Readout of the 1st image, the interval between completion of 1st exposure and starting of 2nd exposure is as short as several  $\mu\text{s}$  ~ several decades  $\mu\text{s}$ .



**Figure 8.10 Double Exposure Trigger Mode**

### 8.3.1.4 Fast Mode

Fast Mode is used when interval of trigger input is faster and more continuous than in Standard Mode. Its difference from Standard Mode is that while Readout starts in exposure time as set earlier when trigger input occurs in Standard Mode, while Readout immediately starts after trigger input in Fast Mode. And Interval between triggers becomes the exposure time of image since it does not generate shutter signal during Readout.



**Figure 8.11 Fast Trigger Mode**

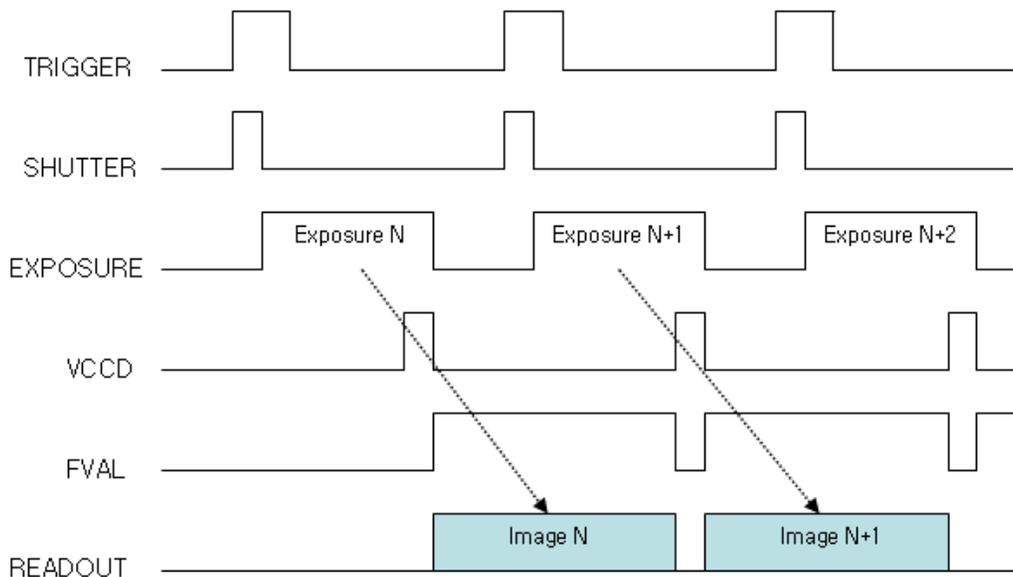
### 8.3.1.5 Overlap Mode

Camera keeps standby status until trigger signal is entered like in Standard Mode, and Readout starts after exposure process set earlier if trigger input occurs. When new trigger input occurs during Readout of First image, it keeps Readout and performs exposure process of new trigger input. Provided, however, that when trigger input occurs during Exposure since Exposure Time is longer than trigger interval, that trigger signal is ignored. To obtain the image as maximum frame for trigger input, Exposure Time should not be longer than Readout time, trigger time should not be shorter than Readout time. Readout time for each model is as follows:

Channel Mode	VP-8M	VP-16M	VP-29M
1 channel	226.5 ms	454.5 ms	763.1 ms
2 channel	121.9 ms	238.1 ms	397.7 ms
4 channel	61.3 ms	-	199.6 ms

**Table 8.2 Readout Time for each model**

In addition, overlap mode operates ideally when trigger signal interval or exposure time is constantly kept.



**Figure 8.12 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 - VP-8MC and VP-29MC only). In case of one tap output, all pixel values of 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 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 (VP-8MC and VP-29MC), pixel values of the lower left area are shifted towards the Video A, pixel 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 4 times faster than one tap output.

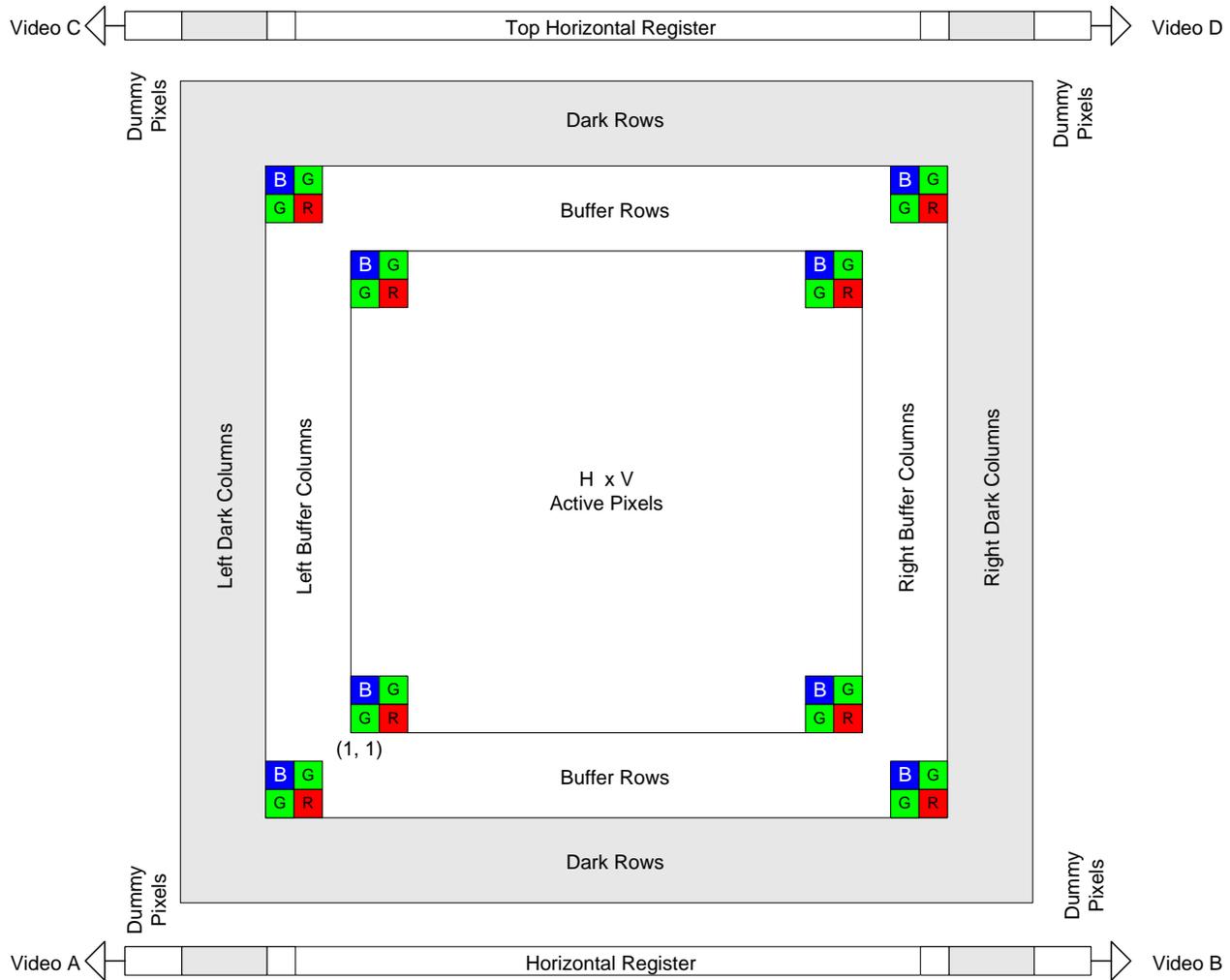
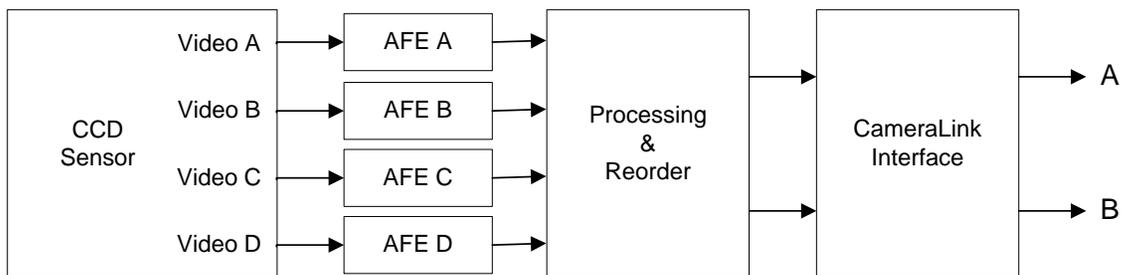


Figure 8.13 Channel Mode

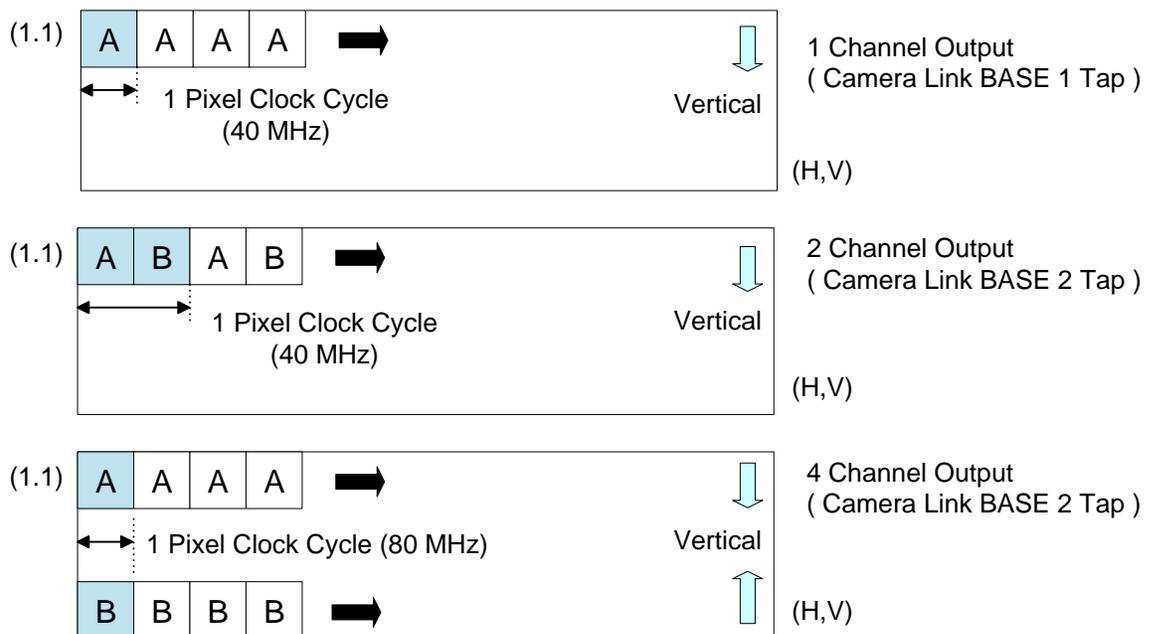
The camera processes and rearranges the image data in order to be compliant with the base Camera Link Standard. In single channel, image data is read out line-by-line from the upper left corner until the last pixel in the lower right corner is read out. In dual channel, image data is read out of Channel 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 8.15](#)).



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



**Figure 8.14 Image Data Flow**



**Figure 8.15 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 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:

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

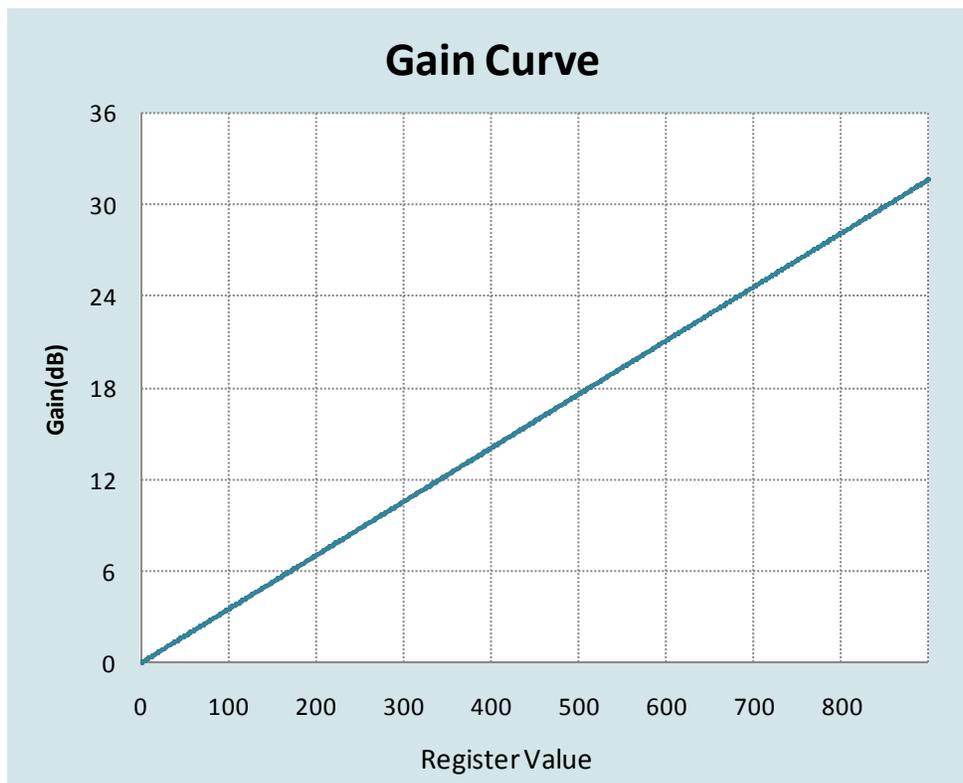
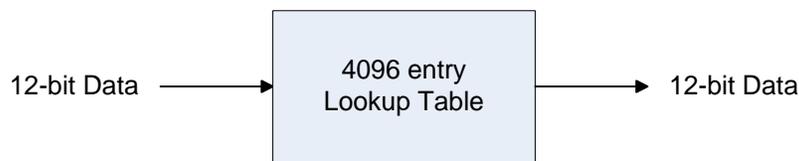


Figure 8.16 Register Setting for Gain Value

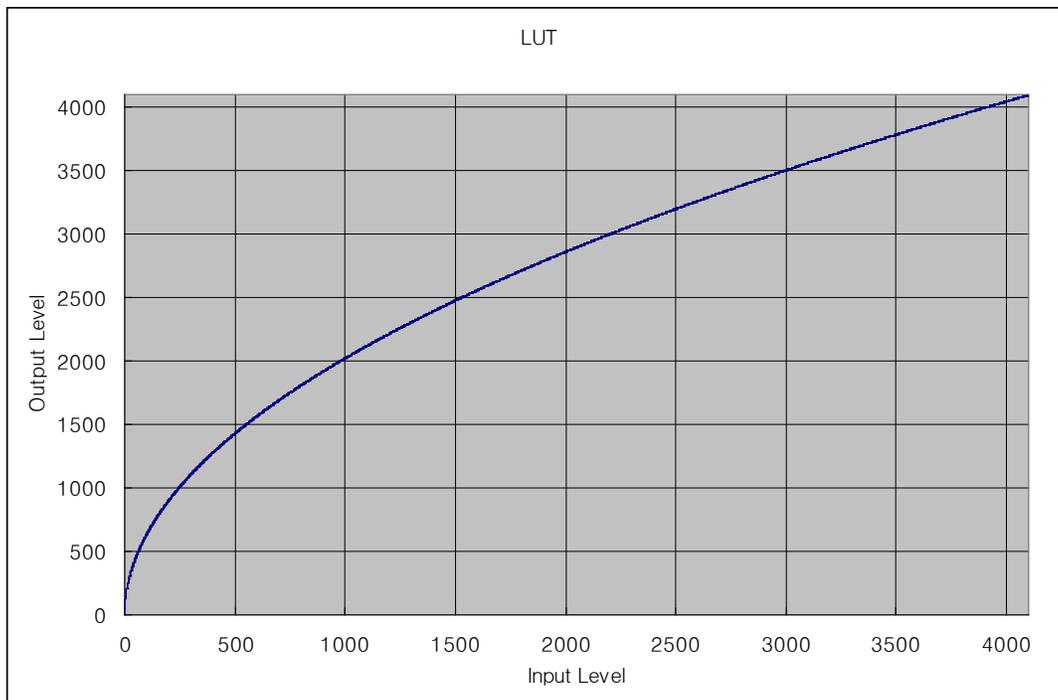
Offset can be set between 0 ~ 255 (LSB).

## 8.6 LUT

LUT (Lookup Table) converts original image value to certain level value. 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 provides 2 non-volatile spaces for LUT data storage. User can select whether to apply LUT or not and where to apply the LUT using “sls” command. See [Appendix B](#) for how to download LUT data in the camera.



**Figure 8.17 LUT Block**



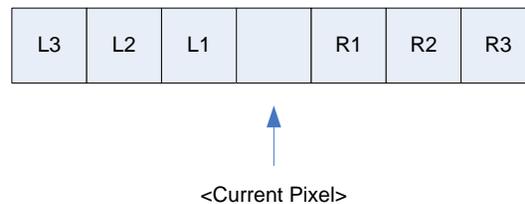
**Figure 8.18 LUT at Gamma 0.5**

## 8.7 Defective Pixel Correction

The CCD may have Defective Pixels which cannot properly react to the light. Correction is required since it may deteriorate the quality of output image. Defective Pixel information of CCD used for each camera is entered into the camera at the factory. If the user wants to add Defective Pixel information, it is required to enter coordinate of new Defective Pixel into the camera. See [Appendix A](#) for details. “sdc” command is used to set whether to use Defective Pixel Correction function.

### 8.7.1 Correction Method

Correction value of Defective Pixel is calculated based on valid pixel value adjacent in the same line.



**Figure 8.19 Location of Defective Pixel to be corrected**

If Current Pixel is a Defective Pixel as shown in the above figure, correction value of this pixel is obtained as shown in the following table depending on whether surrounding pixel is Defective Pixel or not.

Adjacent Defective 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 Defective Pixel Correction Value**

## 8.8 Flat Field Correction

Flat Field Correction is a function which corrects a non-uniform pixel response across a CCD and makes the response as uniform as possible (flat), assuming the offsets are non-varying (fixed) patterns. The Flat Field Correction function 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;

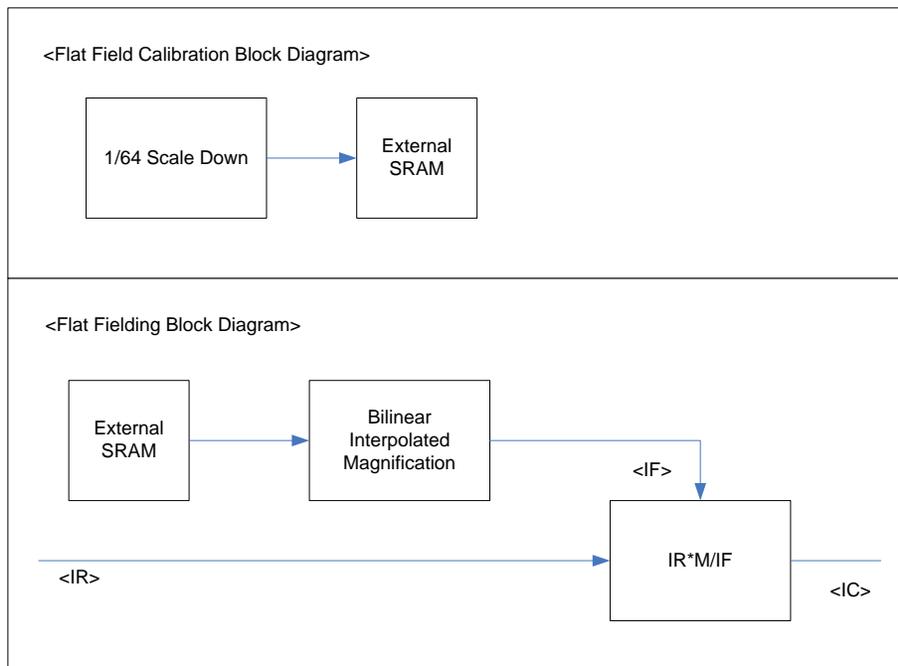
M : Offset value of image after correction;

IF : Level value of Flat Field data.

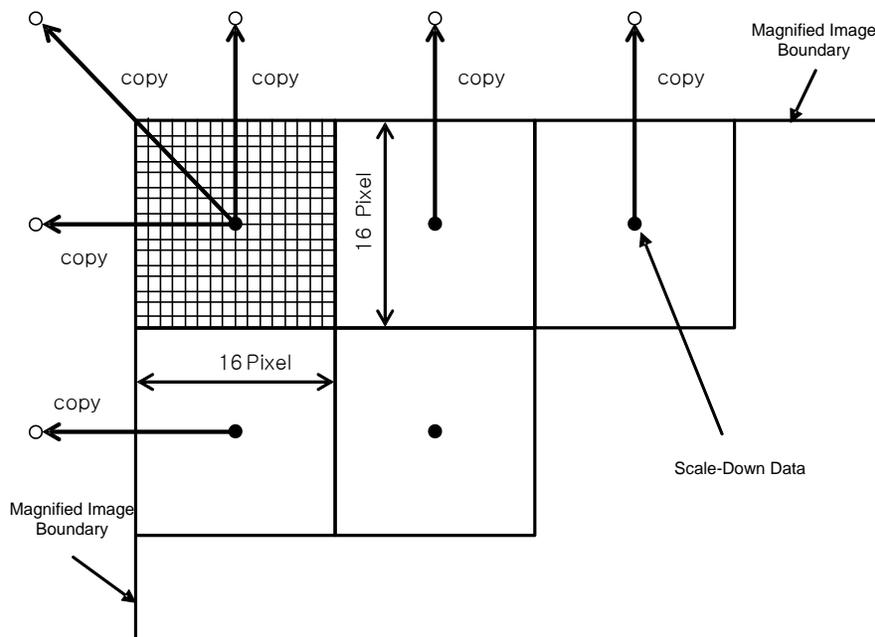
In order to use the Flat Field Correction function, one must first generate IF, the Flat Field data. This can be done by adjusting the camera to the environment and activating the Flat Field Generator. The Flat Field Generator will standardize a series of images, curtailing the image to 1/16 pixel, generate 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 8.21](#). 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. Here, 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. The activation of the Flat Field Generator will ignore the current camera configuration and will temporarily change the camera configuration to operate under the following default conditions. When the generation of the Flat Field data is complete, the original setting 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 8.20 Generation and Application of Flat Field Data**



**Figure 8.21 Bilinear Interpolated Magnification**

## 8.9 Dark Signal Non-uniformity Correction (VP-8M/29M Only)

In theory, when an area scan camera captures a frame in complete darkness, all of the pixel values in the frame should be near zero and they should be equal. In practice, however, slight variations in the performance of the pixels in the sensor will cause some variations in the pixel values output from the camera when the camera is capturing in darkness. This variation is known as Dark Signal Non-uniformity (DSNU). The VP-8M and VP-29M models provide the DSNU Correction feature. “sdsnu” command is used to set whether to use the DSNU correction feature.



When you enable the **DSNU** Correction feature, you cannot acquire frames at the camera's nominal maximum frame rate.

- This is true because the camera takes time (milliseconds) to apply the DSNU Correction feature after reading out the pixel values.
- When you acquire frames using the CC1 or external triggering, you must consider the triggering cycle properly.

## 8.10 Temperature Monitor

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

## 8.11 Status LED

There is green LED to inform the operation status of camera on the back of camera. LED status and corresponding camera status are as follows:

- Continuous ON: operates in Free-Run Mode.
- Repeat ON for 0.5 seconds, OFF for 0.5 seconds: operates in 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 Trigger Mode and outputs Test Image.

## 8.12 Data Format

Data can be processed in the unit of 12 bit internally, but can be selectively output in the unit of 8, 10 or 12bit at output. When it is output in 8bit and 10bit unit, lower 4 bit and 2 bit are cut out from overall 12bits.

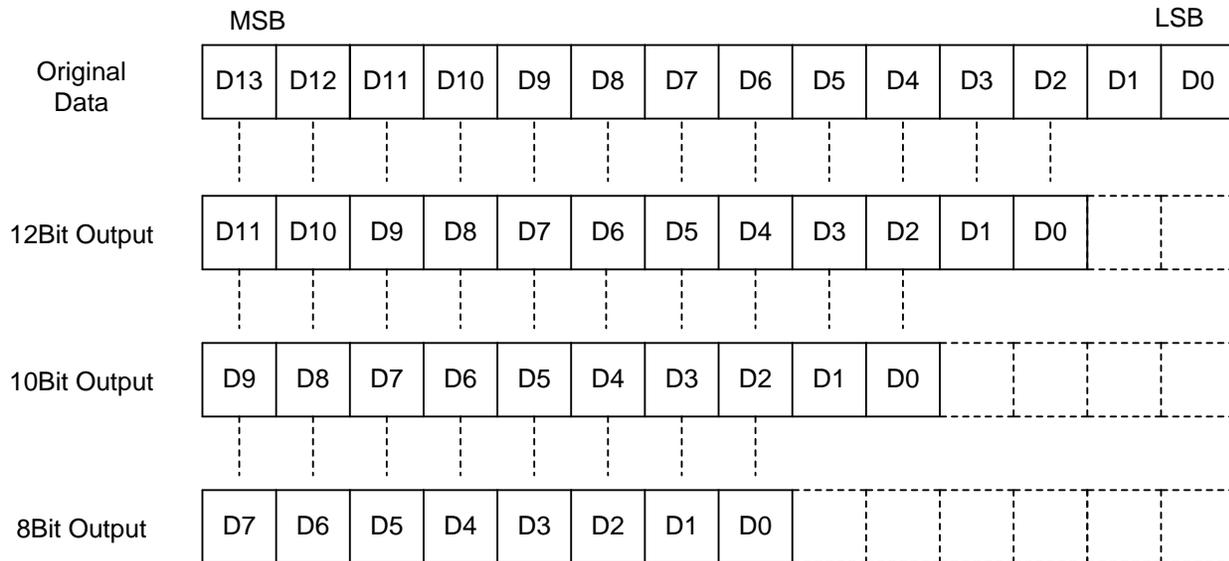


Figure 8.22 Data Format

## 8.13 Test Image

To check normal operation of camera, it can be set to output test image created inside, instead of image data from CCD. There are 3 types of test image; 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.

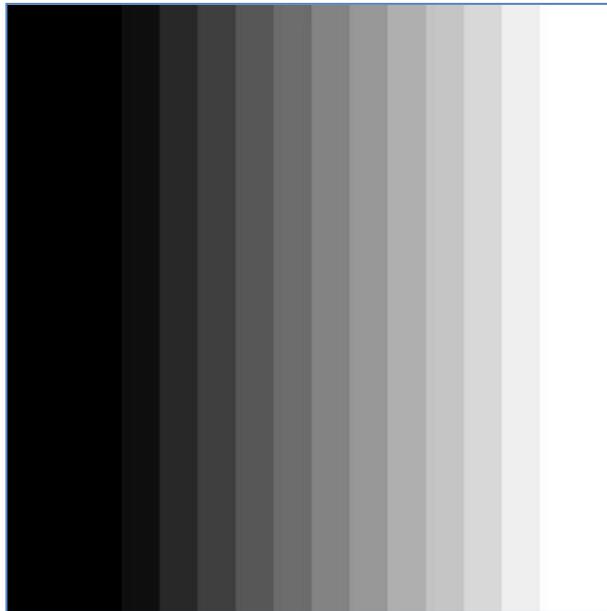


Figure 8.23 Test Image 1

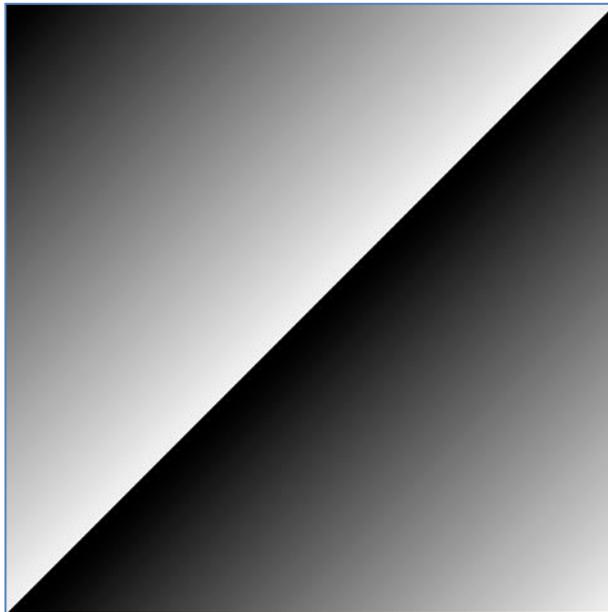


Figure 8.24 Test Image 2

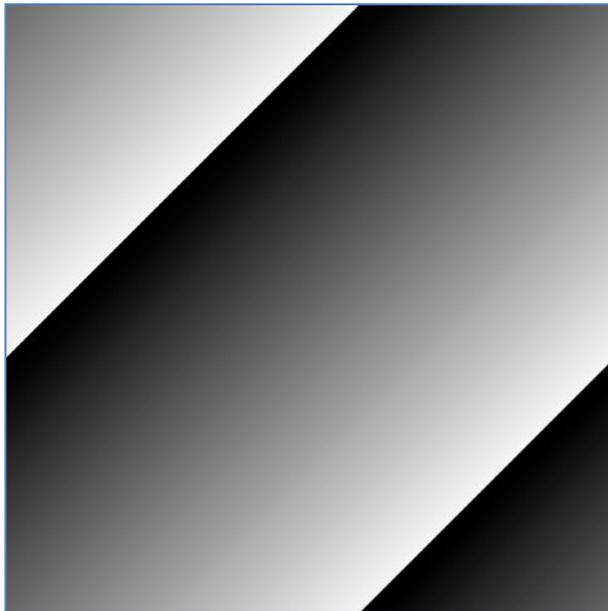


Figure 8.25 Test Image 3



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

## 8.14 Horizontal Flip (Only available on VP-16MC)

Function to flip the image right and left based on the central axis of image. This function can be applied to all operation modes and “shf” command is used to set whether to use this function or not.



Figure 8.26 Original Image

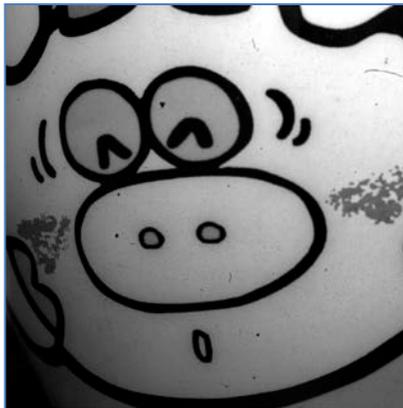


Figure 8.27 Horizontally Flipped Image

## 8.15 Image Invert (Positive/Negative)

Function to invert the level value of output image. Level value inverted differs depending on output data format even if input value is same. This function can be applied in all operation modes of camera and “sii” command is used to set whether to use this function 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 8.28 Original image (Positive)



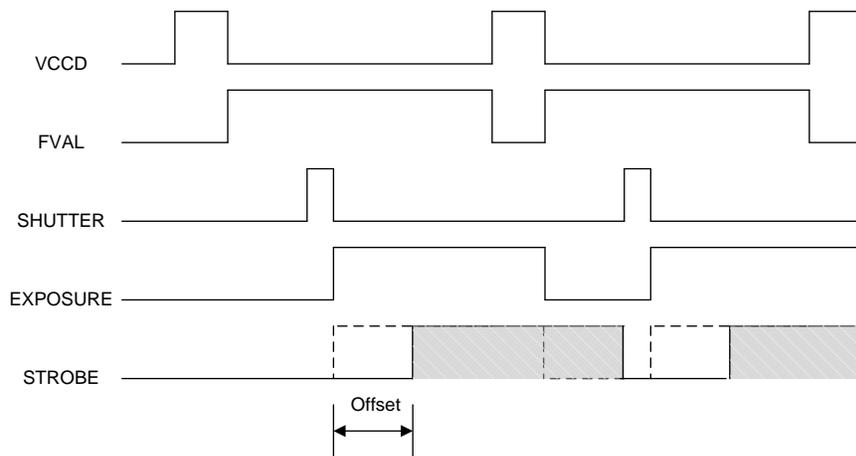
Figure 8.29 Inverted image (Negative)

## 8.16 Strobe

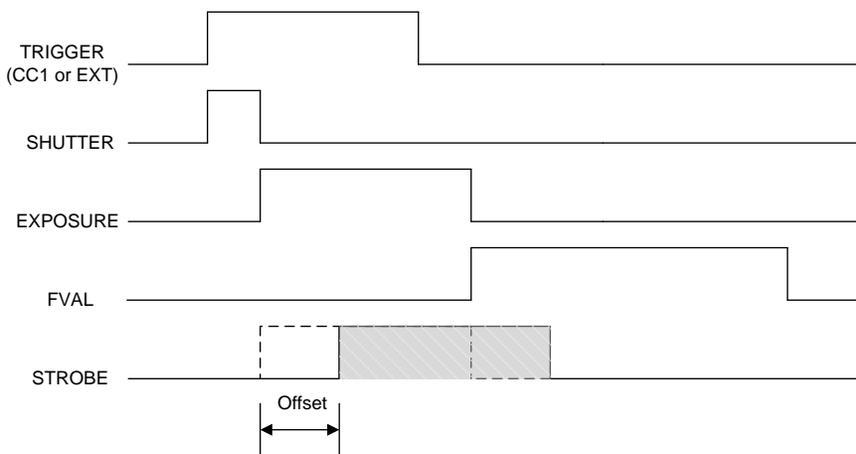
Strobe signal is used to synchronize the external light source with camera or to measure the exposure time applied to current camera. Pulse width of Strobe signal is from the generating point of Shutter signal to the starting point of Readout, which coincides with exposure time of camera.

### 8.16.1 Strobe Offset

Strobe Offset value indicates when Strobe signal is to be sent after Shutter signal. Value can be set in the unit of  $1 \mu\text{s}$  using “sso” command. Only pulse location moves without change in pulse width of Strobe signal.



**Figure 8.30 Strobe signal in Free-Run**



**Figure 8.31 Strobe signal in Trigger mode**

### 8.16.2 Strobe Polarity

Polarity can be set for Strobe signal output. “ssp” command is used to set the polarity of Strobe signal.

## 8.17 Field Upgrade

The Camera provides the function to upgrade Firmware and FGPA logic through Camera Link interface rather than disassemble the camera in the field. See [Appendix C](#) for details on how to upgrade.

## 9 Camera Configuration

### 9.1 Setup command

All setup in camera is carried out RS-644 serial interface of camera link. With the following communication setting, it can be controlled using terminal or direct control at user application.

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

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

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

#### 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<\r>
Response     : 73 65 74 20 31 30 30 0D 0A 4F 4B 0D 0A 3E
               Set 100<\r><\n>          OK<\r><\n>  >
Echo         : result      prompt
```

```
If execution of read command is successfully completed
<parameter1> <\r> <\n>
```

#### ex) Read command

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

```
If execution of command is not completed
Error : <Error Code> <\r> <\n>
```

```
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

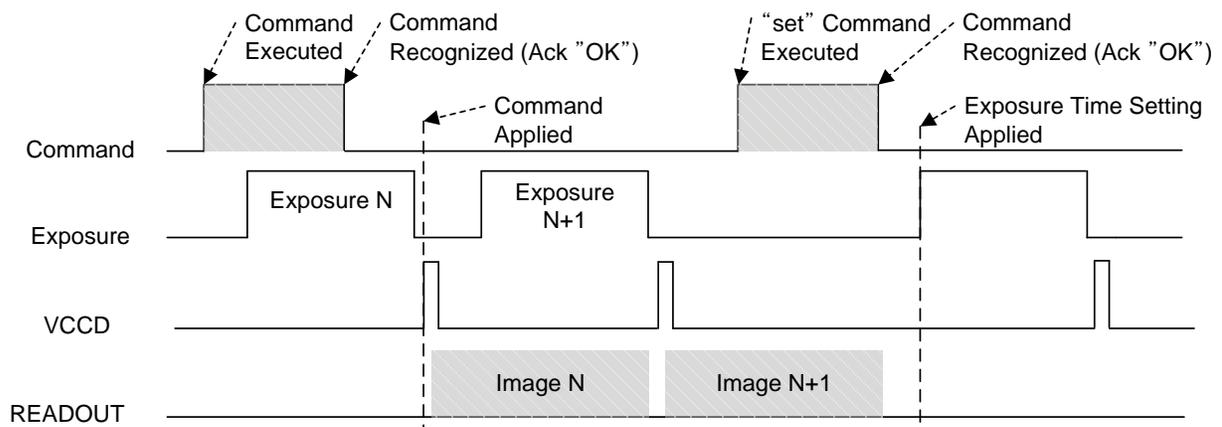
When you execute a command, the actual or real time applied for the command varies depending on the type of the command and operating status of the camera.

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 3 non-volatile storage space used for parameter storage and 1 volatile work space that is applied to actual camera operation. 3 storage space is divided into Factory Space that contain basic value at the factory, and 2 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.

At camera booting, setting value in one of 3 storage spaces is copied to work space according to Config Initialization value and value of the space is used for camera setting. Since values in work space is valid only while the power is on, it should be copied to user space 1 or user space 2 using “sct” command.

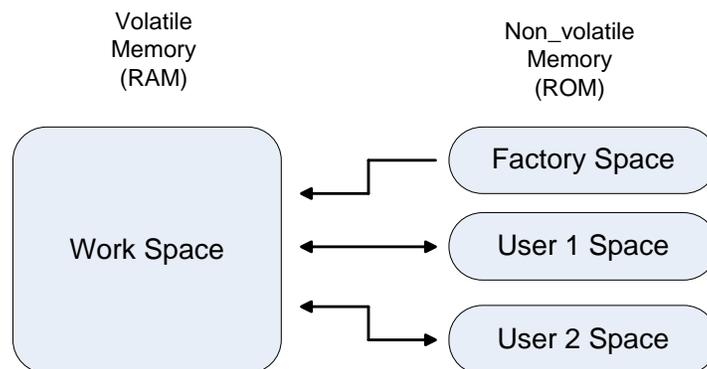


Figure 9.2 Parameter Area

### Factory Setting

List	Value	Command
Data Bits	12	sdb 12
Trigger Mode	freerun	stm 0
Readout Mode	normal	srm 0
Exposure Time	10ms	set 10000
Exposure Source	program	ses 0
Trigger Source	CC1	sts 1
Trigger Polarity	Active High	stp 1
Analog Gain	0	sag 0 0
Analog Offset	0	sao 0 0
Defect Correction	ON	sdc 1
Pixel Clock Speed (VP-16M)	1 (40MHz)	sps 1
Target Temperature	5 (Celsius)	stt 5

## 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	srn 0 1 2 grn	OK 0 1 2	0 : Nomal 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 gbf	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 LUT Select Get LUT Select	sls 0 1 2 gls	OK 0 1 2	0 : Off 1 : LUT1 2 : LUT2
Set Asynchronous Reset Get Asynchronous Reset	sar 0 1 gar	OK 0 1	0 : Inactivate Asynchronous Reset 1 : Activate Asynchronous Reset
Set Channel Mode Get Channel Mode	scm 1 2 gcm	OK 1 2	1 : 1 Channel Mode 2 : 2 Channel Mode
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 Horizontal Flip
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 us
Get Exposure Time	get	n	(Setting range: 10 ~ 7,000,000 us)
Set Strobe Offset	sso n	OK	n : Strobe Offset Time in us
Get Strobe Offset	gso	n	(Setting range: 0 ~ 10,000 us)
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
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

Table 9.2 Command List #2

Command	Syntax	Value Returned	Description
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)
Set Dark Signal Non-uniformity	sdsnu 0 1	OK	0: Disable DSNU
Get Dark Signal Non-uniformity	gdsnu	0 1	1: Enable DSNU
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 Camera Model Number
Get FPGA Version	gfv	String	Displays FPGA Version
Get Serial Number	gsn	String	Display Serial Number
Get Current Temperature	gct	String	Display Temperature Value
Get Sensor Temperature	gst	String	Display CCD Sensor Temperature Value
Set Target Temperature	stt n	OK	n : CCD Sensor target Temperature Value
Get Target Temperature	gtt	n	
Set Pclk Selection	sps 0 1	OK	0 : Pixel Clock 30MHz
Get Pclk Selection	gps	0 1	1 : Pixel Clock 40MHz (VP-8/29MC supports 40 MHz only.)
Set Fan Control	Sft 0 1	OK	Control Fan On/Off
Get Fan Status	gft	0 1	0 : Fan Off 1 : Fan On
Set Peltier Control	stc 0 1	OK	Control Peltier On/Off
Get Peltier Status	gft	0 1	0 : Peltier Off 1 : Peltier On

Table 9.3 Command List #3

## 10 Configurator GUI

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

### 10.1 VP Camera Scan

When you execute the program while the camera is turned on, Camera Scan window appears as shown in the figure below. At this time, the program checks serial port of computer and DLL provided by 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 cable with power of camera and press refresh button. When you double-click model name displayed on the screen, Configurator is executed and displays current setting value of camera connected.

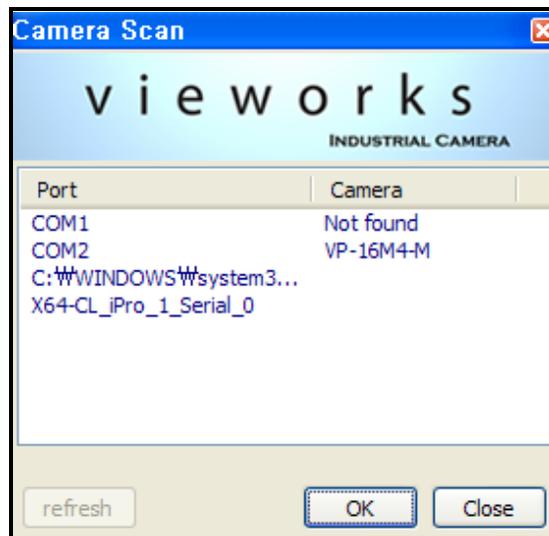
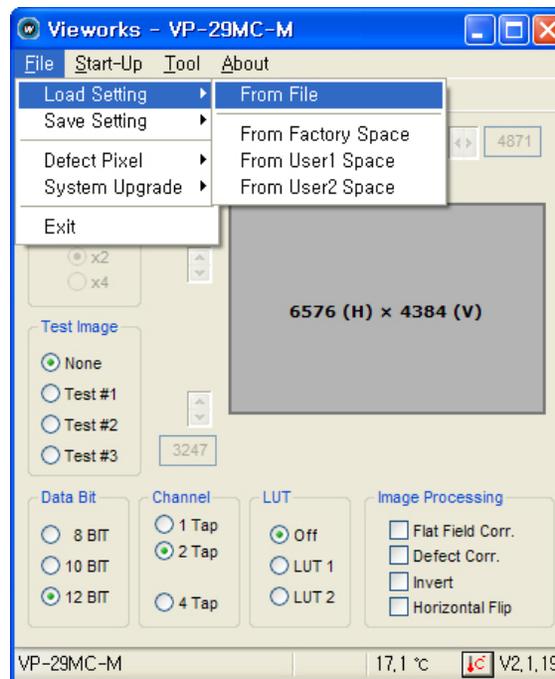


Figure 10.1 Configurator Loading Window

## 10.2 Menu

### 10.2.1 File

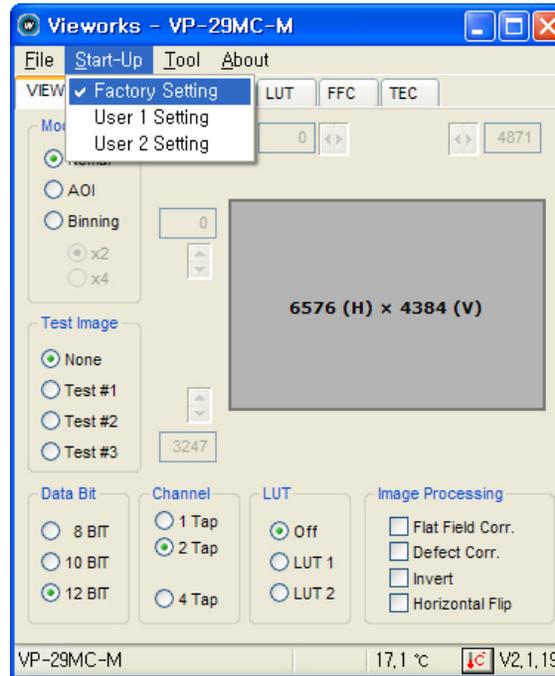


**Figure 10.2 File menu**

- **Load Setting:** Loads the camera setting values from the camera memory (i.e., specified as Factory, User1 or User2) or user computer (From File).
- **Save Setting:** Saves the camera setting values to the camera memory (i.e., specified as 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 program or FPGA logic.
- **Exit:** Exits Configurator.

## 10.2.2 Start-Up

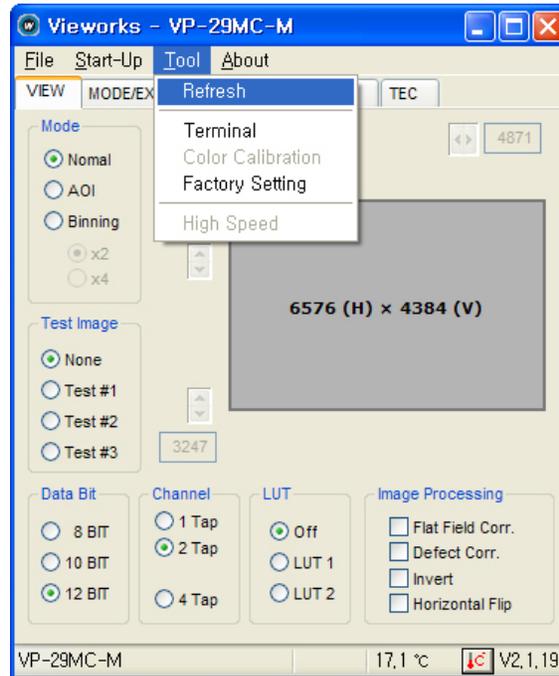
The user can select the camera setting values to load when the camera is turned on.



**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: Operates the camera with 40 MHz pixel clock (Only available on VP-16MC).

## 10.2.4 About

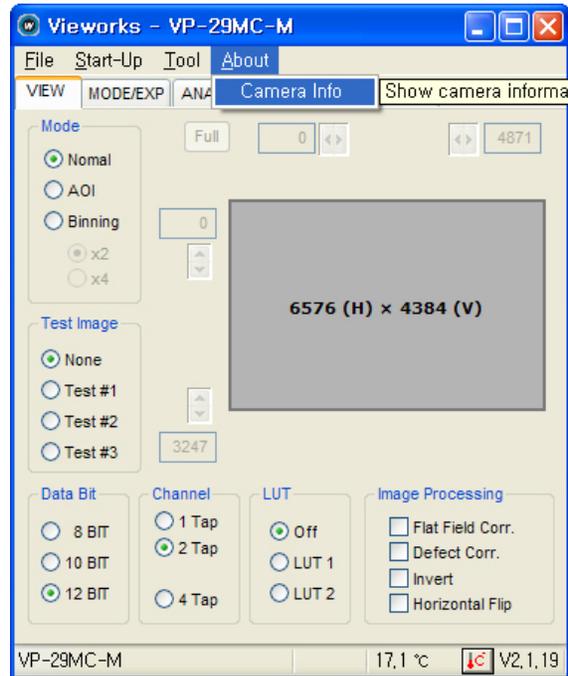


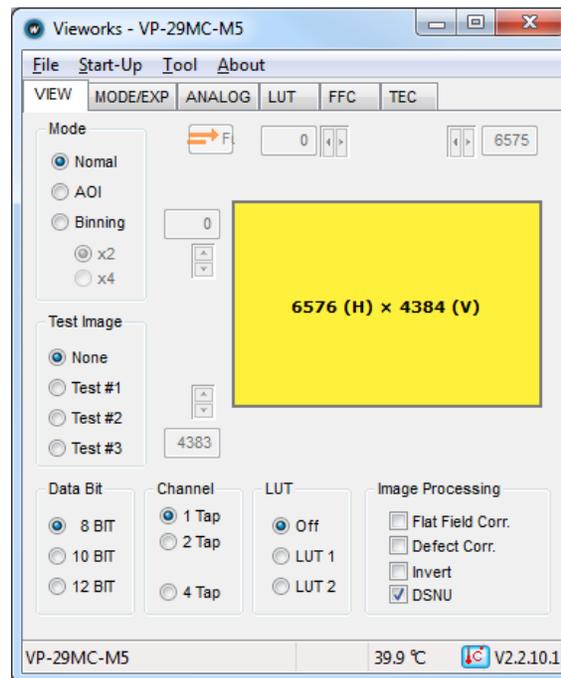
Figure 10.5 About Menu

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

## 10.3 Tab

### 10.3.1 VIEW Tab

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

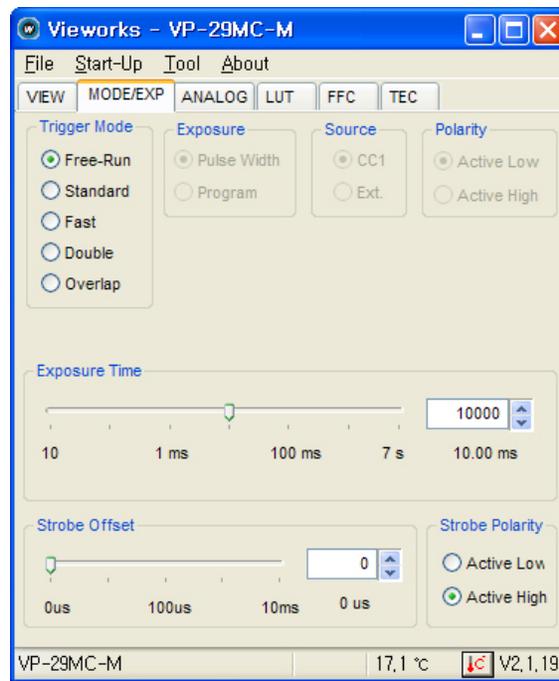


**Figure 10.6 VIEW Tab**

- **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, ×2, ×4 option buttons are activated.
- **Test Image:** Selects whether to apply test image and type of test image.
- **Data Bit:** Selects width 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, Horizontal Flip (VP-16MC Only) or DSNU (VP-8MC/29MC Only) functions On or Off.

### 10.3.2 MODE/EXP Tab

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

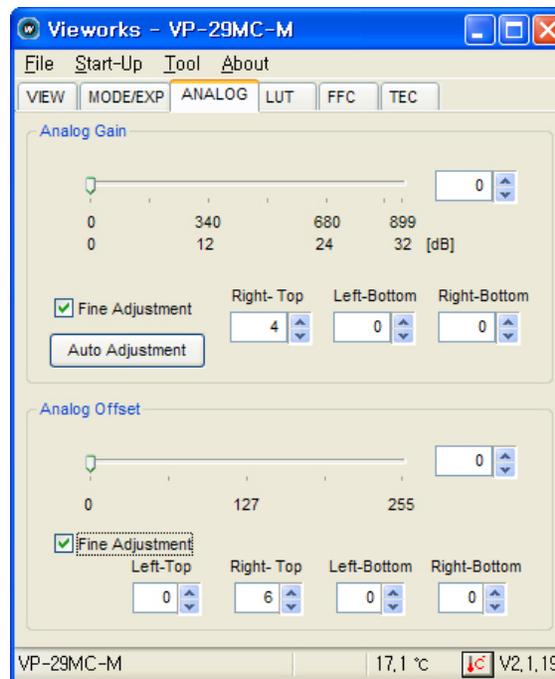


**Figure 10.7 MODE/EXP Tab**

- **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 strobe output signal.

### 10.3.3 ANALOG Tab

ANALOG tab allows the user 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. **Auto Adjustment** will be activated after checking **Fine Adjustment** and compensates Tap differences automatically. Fine Adjustment of Right-Top, Left-Bottom and Right-Bottom will be affected based on Left-Top.

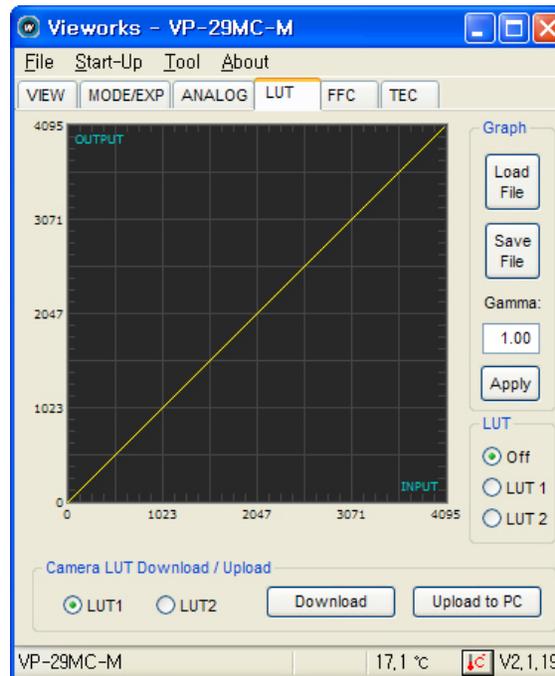


After clicking the **Auto Adjustment** button, at least one or more images must be captured by the camera.

- **Analog Offset:** Sets offset values of each channel.

### 10.3.4 LUT Tab

LUT tab allows the user to download LUT data. See [Appendix B](#) for more details on LUT Download.

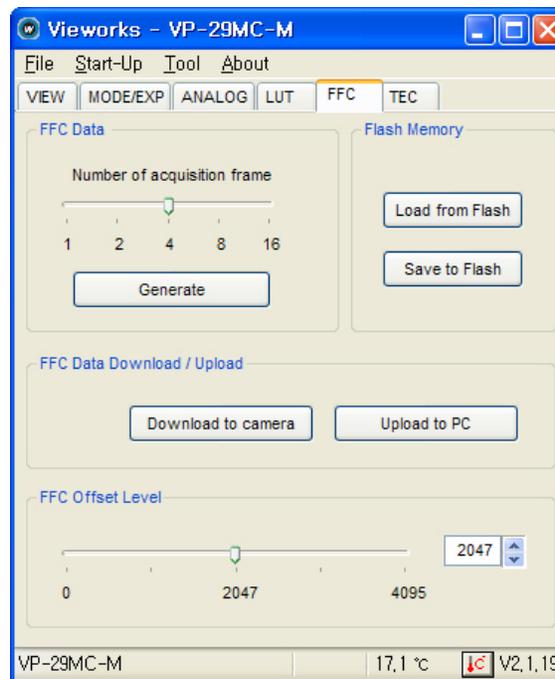


**Figure 10.9 LUT Tab**

- **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 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 the user to set Flat Field Correction settings. All scroll bars are controllable with the mouse wheel scroll.

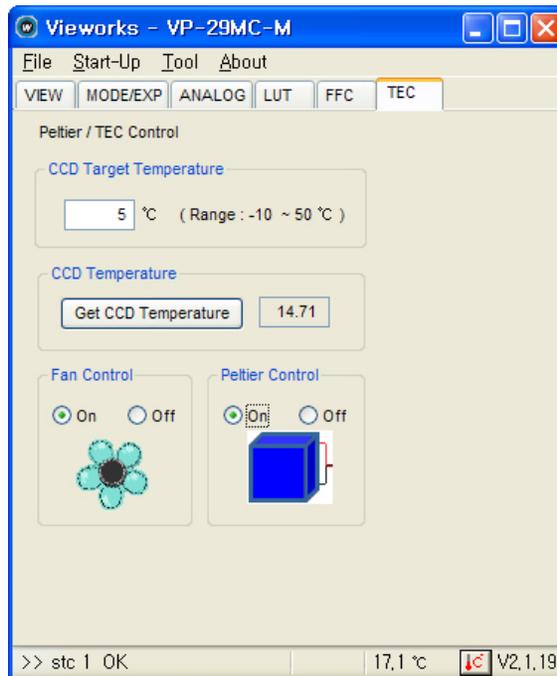


**Figure 10.10 FFC Tab**

- 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 retrieves 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.

### 10.3.6 TEC Tab

TEC Tab allows the user to control target temperature of CCD Sensor.

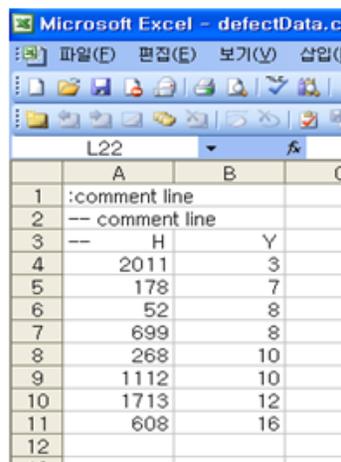


**Figure 10.11 TEC Tab**

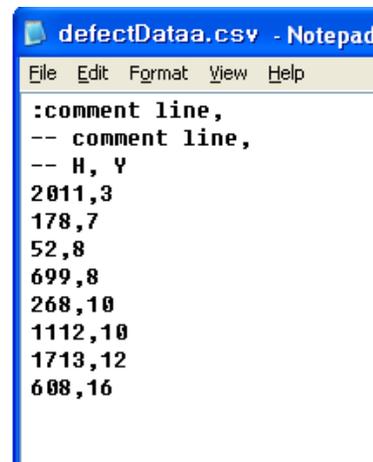
- **CCD Target Temperature:** Sets target temperature of CCD Sensor.
- **CCD Temperature:** Displays CCD Sensor temperature value.
- **Fan Control:** Turns Fan On or Off.
- **Peltier Control:** Turns Peltier On or Off.

## 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.



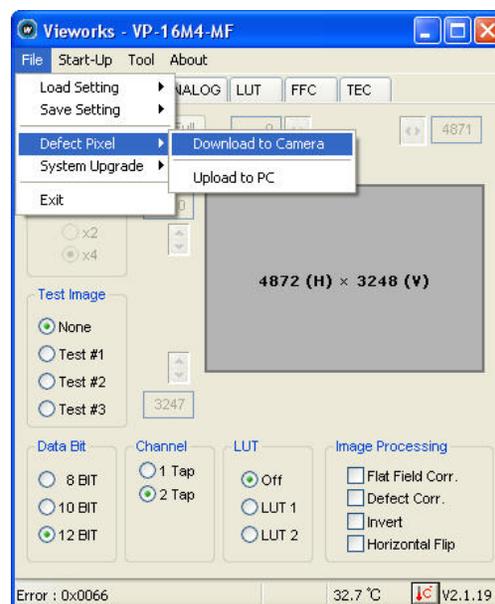
	A	B	C
1	:comment line		
2	-- comment line		
3	--	H	Y
4	2011	3	
5	178	7	
6	52	8	
7	699	8	
8	268	10	
9	1112	10	
10	1713	12	
11	608	16	
12			



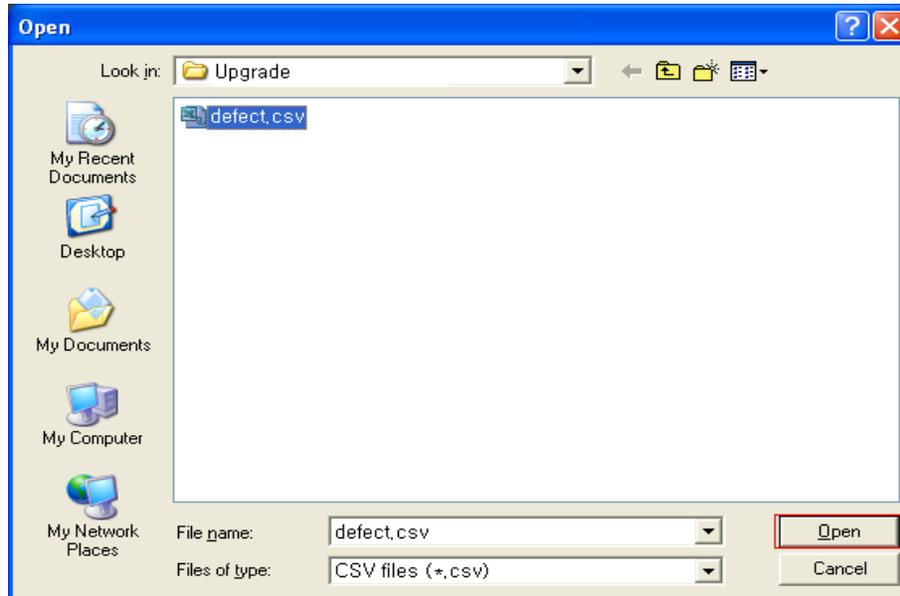
```
defectDataa.csv - Notepad
File Edit Format View Help

:comment line,
-- comment line,
-- H, Y
2011,3
178,7
52,8
699,8
268,10
1112,10
1713,12
608,16
```

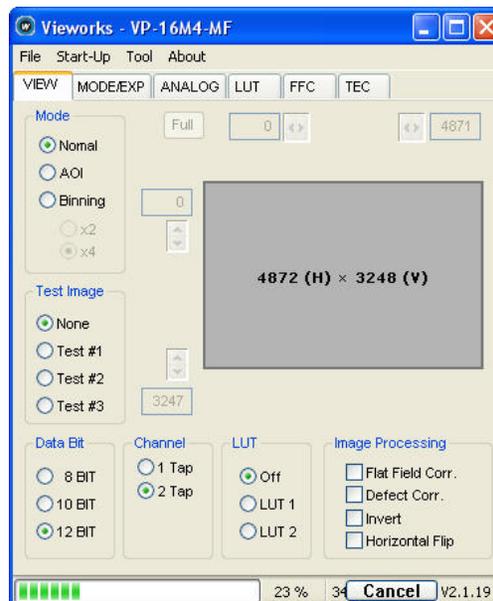
2. Select **File > Defect Pixel > Download to Camera** on Configurator.



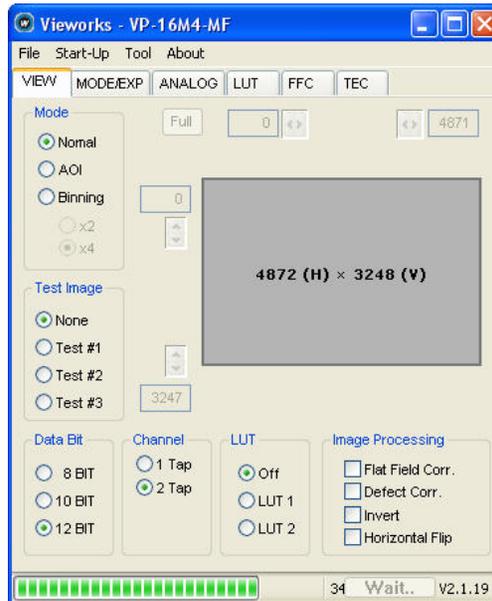
3. Search and select the created file and click **Open**.



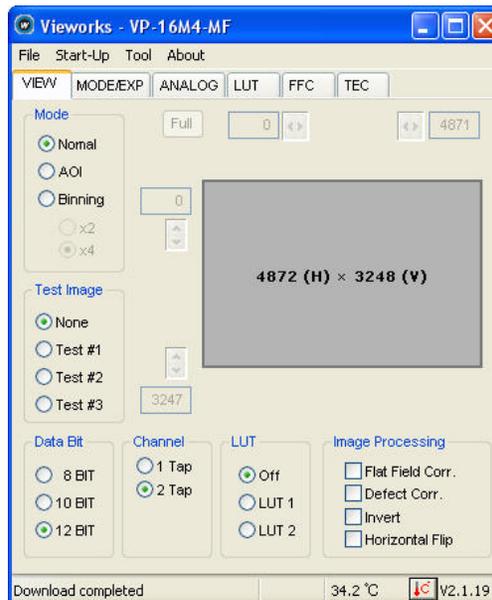
4. Configurator starts downloading defective pixel map data to the camera and downloading status is displayed at the bottom of the window.



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



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

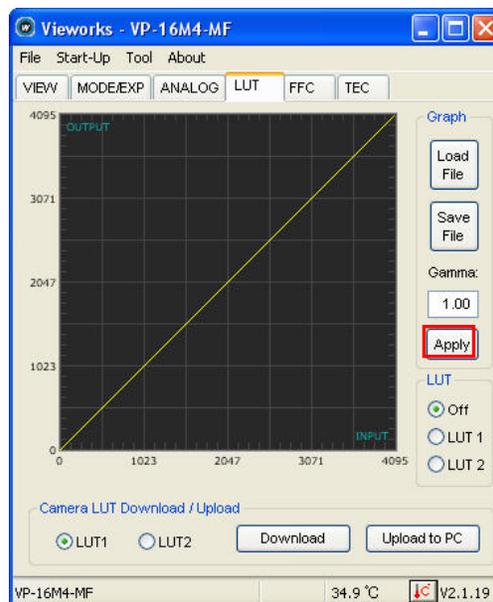


## Appendix B LUT Download

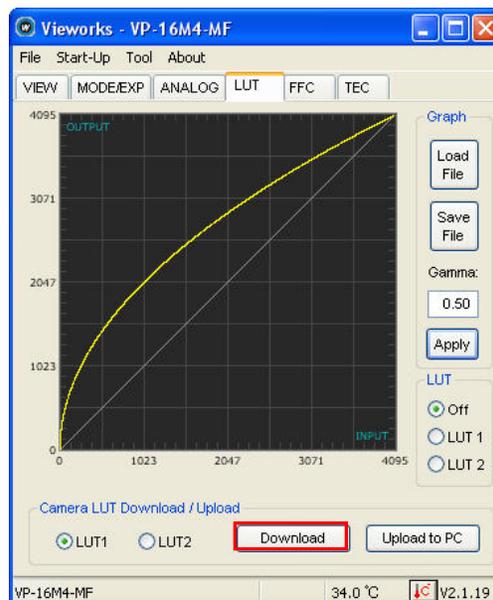
LUT data can be created in two ways; by adjusting the gamma values on the gamma graph provided in the program and then downloading the data or by opening a CSV file (\*.csv) and then downloading the data.

### B.1 Gamma Graph Download

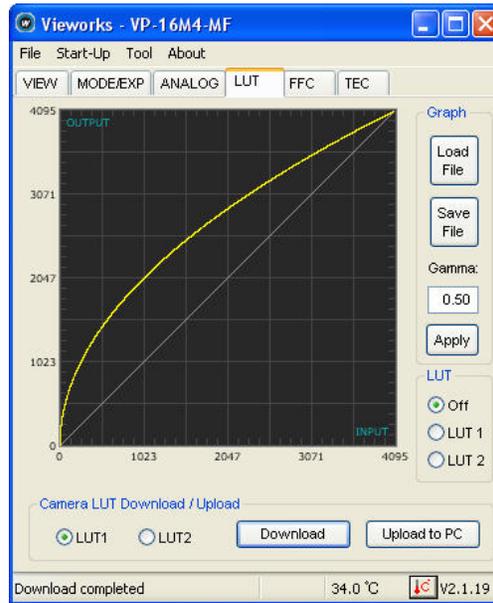
1. Set a desired gamma value on LUT tab and click **Apply**.



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



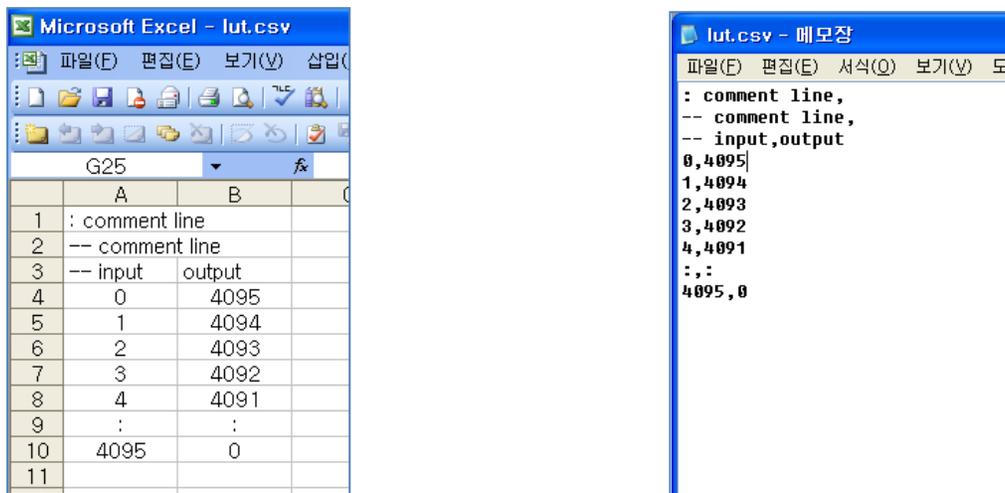
- Once the download has been completed, **Download completed** message will appear at the bottom of the window.



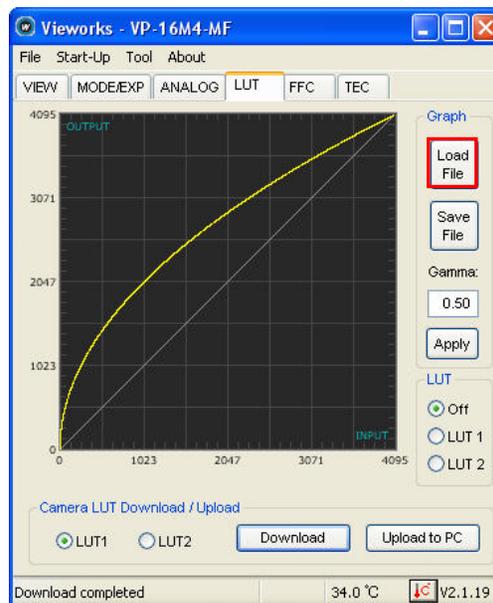
## B.2 CSV File Download

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.

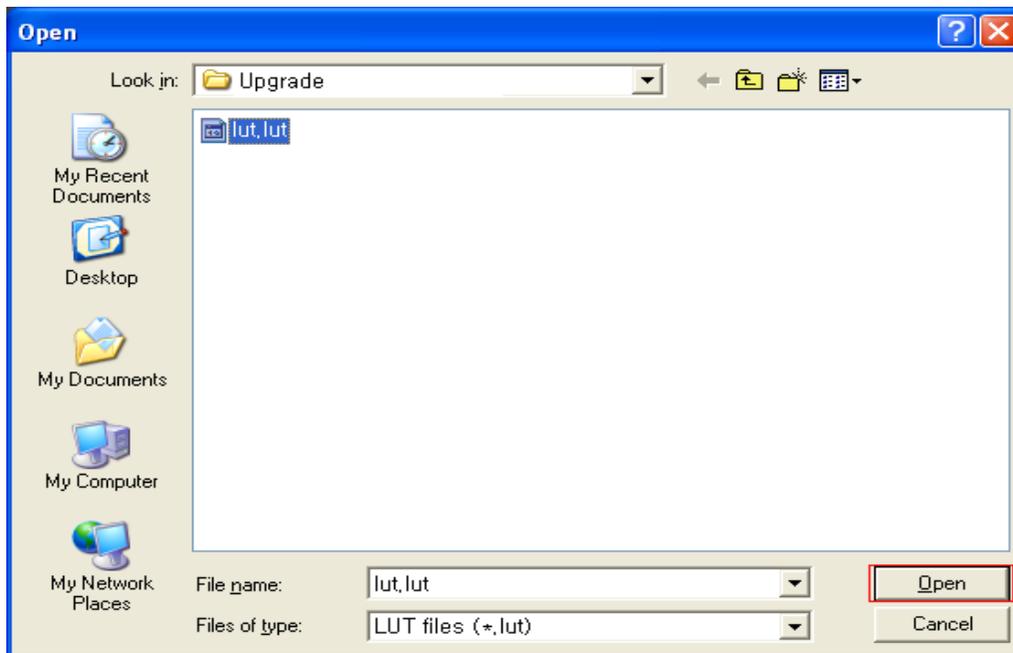
- Lines beginning with ‘:’ or ‘—’ are treated as notes.
- Based on the input values, make sure to record from 0 to 4095.



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



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

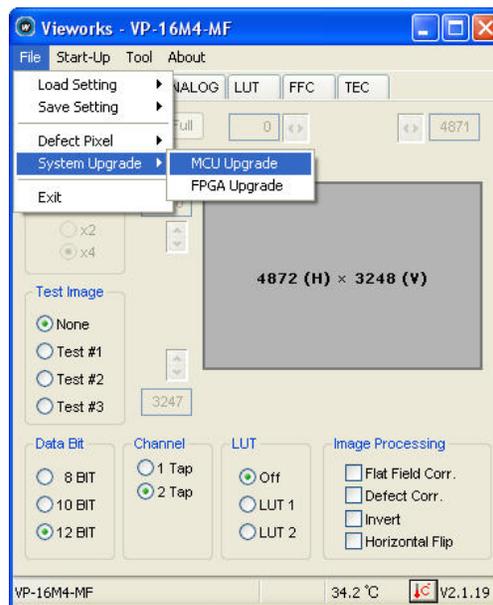


4. Select LUT1 or LUT2 as location to store the data and click **Download**. The subsequent processes are identical to those of Gamma Graph Download.

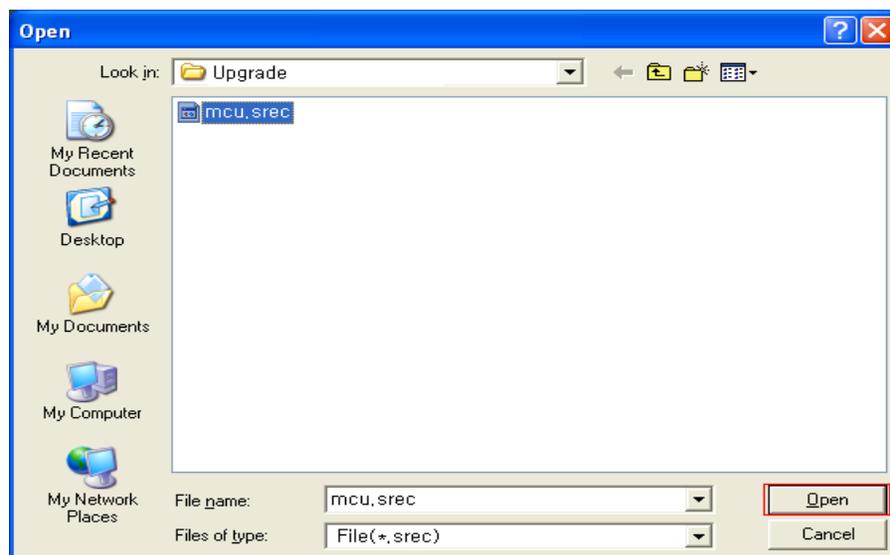
## Appendix C Field Upgrade

### C.1 MCU

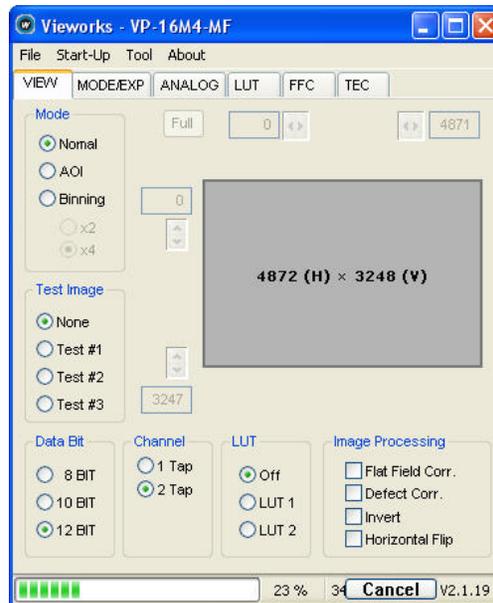
1. Select **File > System Upgrade > MCU Upgrade** on Configurator.



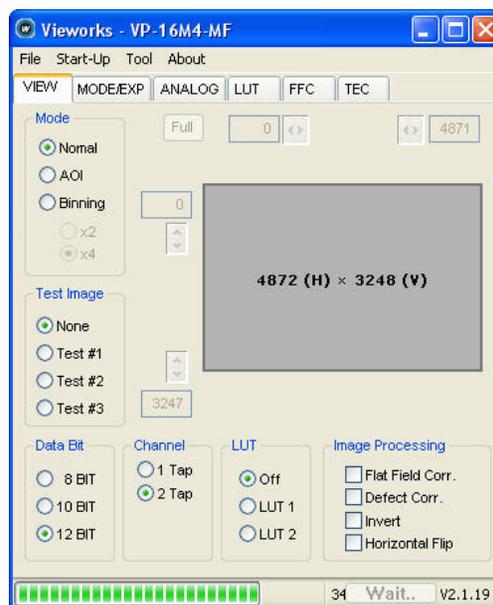
2. Search and select the provided MCU upgrade file (\*.srec) then click **Open**.



- 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.



- 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.

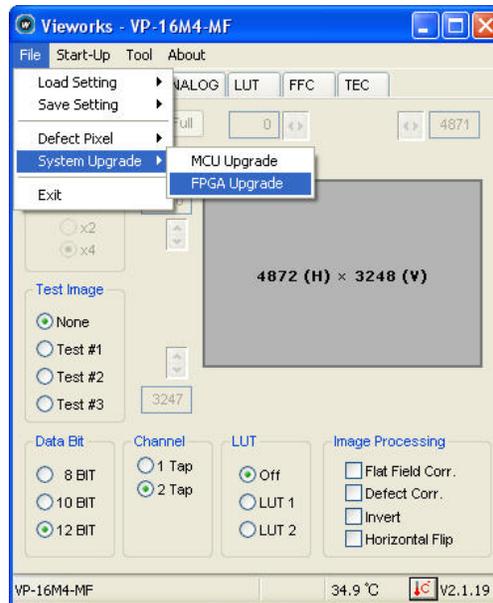


5. Once all the processes have been completed, turn the power off and turn it back on again. Select **Tool > Terminal** and enter the “gmv” command to confirm the version. Or, select **About > Camera Info** to confirm the MCU version.

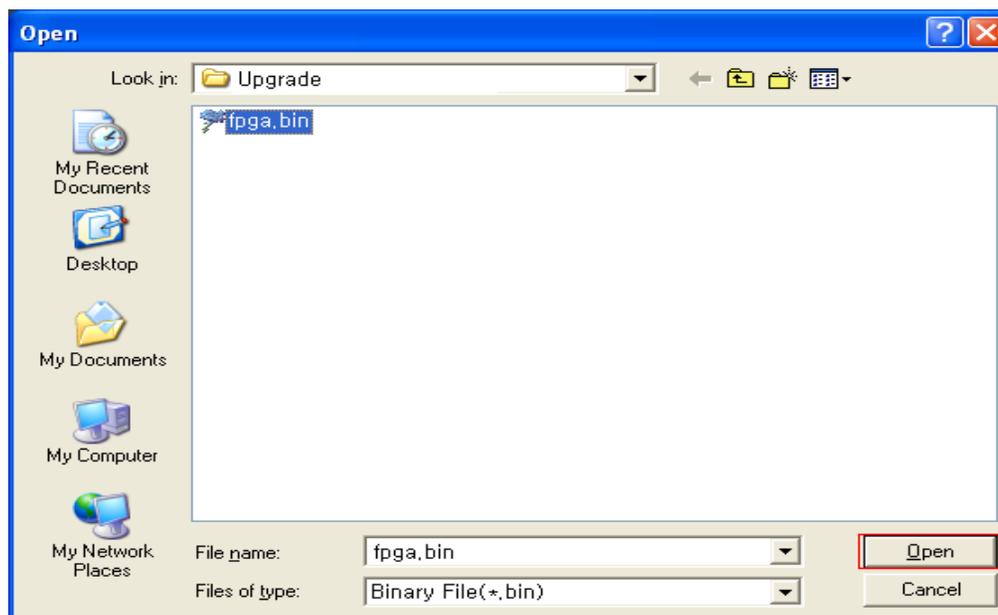


## C.2 FPGA

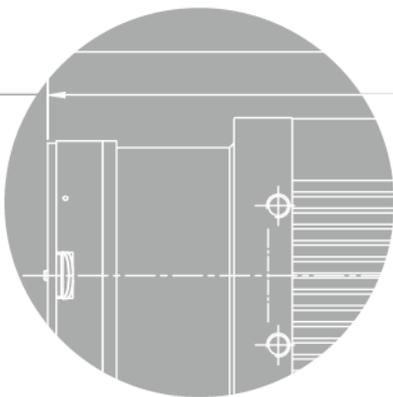
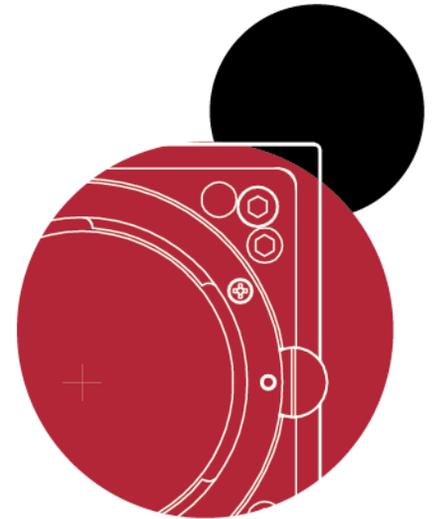
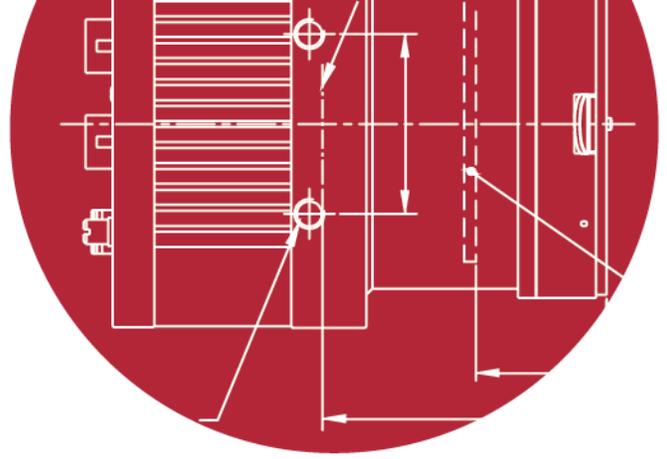
1. Select **File > System Upgrade > FPGA Upgrade** on Configurator.



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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