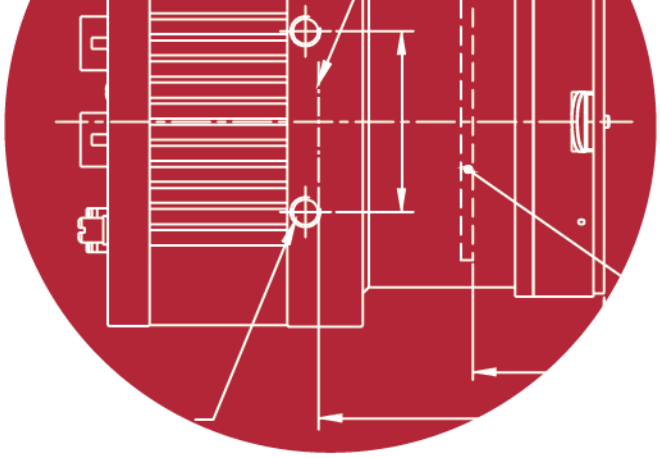


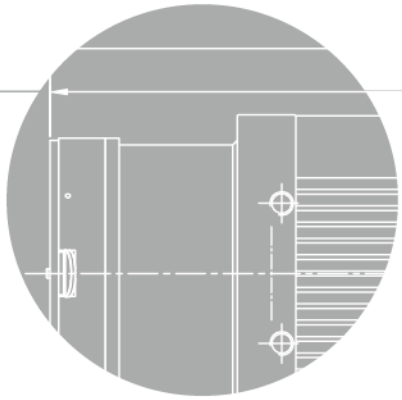
VNP series

User Manual

English

VNP-29MC-5

CAMERA Link



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Revision History

Version	Date	Description
1.0	2013-04-11	Initial Release
1.1	2013-06-14	• Added description of M5 set screws for tilt adjustment • Revised spectral response according to the updated TSI datasheets • Added Actual Time Applied for Commands • Removed the Horizontal Flip feature
1.2	2013-08-21	Added DSNU Correction feature
1.3	2014-09-19	Applied new CI
1.4	2015-05-14	• Modified the minimum vertical AOI • Added missing commands to 9.4 Command List ▫ soo, goo • Corrected errors on the mechanical dimension
1.5	2016-04-22	• Revised contents of the Flat Field Correction • Added typical and maximum power requirements
1.6	2016-06-01	Changed the mechanical dimension

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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.
- Make sure that the temperature of the camera does not exceed the temperature range specified in 5.2 Specifications. Otherwise the device may be damaged by extreme temperatures.

Installation and Maintenance

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

Power Supply

- Applying incorrect power can damage the camera. If the voltage applied to the camera is greater or less than the camera's nominal voltage, the camera may be damaged or operate erratically. Please refer to 5.2 Specifications for the camera's nominal voltage.

  ※ Vieworks Co., Ltd. does NOT provide power supplies with the 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

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 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 Package Components

Package Components

VNP Camera (F-Mount)

Mount Plate (Optional)

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

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

5 Product Specifications

5.1 Overview

The VNP Camera Link series, pixel shifting camera equipped with thermo-electric Peltier (TEC) cooled, is designed not only for applications where extremely high resolution is required but also where high quality image is essential. The TEC maintains the operating temperature of the CCD at up to 15 degrees below ambient temperature to reduce noise significantly. Pixel shifting technology based on a precise piezoelectric stage allows image captures as high as 260 million pixels using the VNP-29MC cameras.
These cameras are ideal for applications such as FPD inspection, document/film scanning, research and scientific imaging.

Main Features

- Nano Stage Pixel Shifting Mechanism
- Thermoelectric Peltier Cooled
- Extended Resolutions up to 260 megapixels
- True Color Full Image Resolution
- Improved Fill Factor
- Progressive Scan Interline Transfer CCD Imager
- Flat Field Correction
- Field Upgradable Firmware
- Pixel Defect Correction
- Area Of Interest (AOI)
- 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
- Strobe Output
- Analog Gain/Offset adjustment function
- Look Up Table
- Test Image
- Temperature Monitor
- Base Camera Link

5.2 Specifications

VNP Series		VNP-29MC
Active Image (H × V)		6576 × 4384
Sensor Type		ON Semiconductor KAI-29050
Pixel Size		5.5 ㎛ × 5.5 ㎛
Sensor 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 Resolution	×1 (1 Shot)	5 fps @ 28.8 M (6576 × 4384)
	×4 (4 Shot)	1.3 fps @ 115.3 M (13152 × 8768)
	×9 (9 Shot)	0.6 fps @ 259.5 M (19728 × 13152)
Camera Link Pixel Clock		1, 2 Tap: 40 ㎒ / 4 Tap: 80 ㎒
Exposure Time		1/100000 sec ~ 7 sec (10 ㎲ step)
Partial Scan (Max. Speed)		15.3 fps at 1200 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 ㏈, 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 ㎃, optically isolated
Software Trigger		Camera Link CC1, Programmable Exposure
Dynamic Range		>62 ㏈
Control		RS-232C via Camera Link (115.2 K bps)
Shift Range		0 ~ 15 ㎛, 1 ㎚ step
Shift Resolution		0.001 ㎛
Shift Control		Manual Mode or Sequence Mode (4/9 Shot Mono, 4/16/36 Shot Color)
Shift Latency		< 8 ㎳
Cooling Method		Thermoelectric Peltier Cooling
Cooling Performance		15℃ below ambient temperature – Standard cooling with a fan
Lens Mount		F-mount
Power		10~14 V DC, Typ. 26.5 W / Max. 29 W
Environmental		Operating: 10℃ ~ 40℃, Storage: -40℃ ~ 70℃
Dimension (W×H×L) / Weight		94 ㎜ × 120 ㎜ × 183.9 ㎜, 2.3 ㎏

Table 5.1 Specifications of VNP 29MC

5.3 Camera Block Diagram

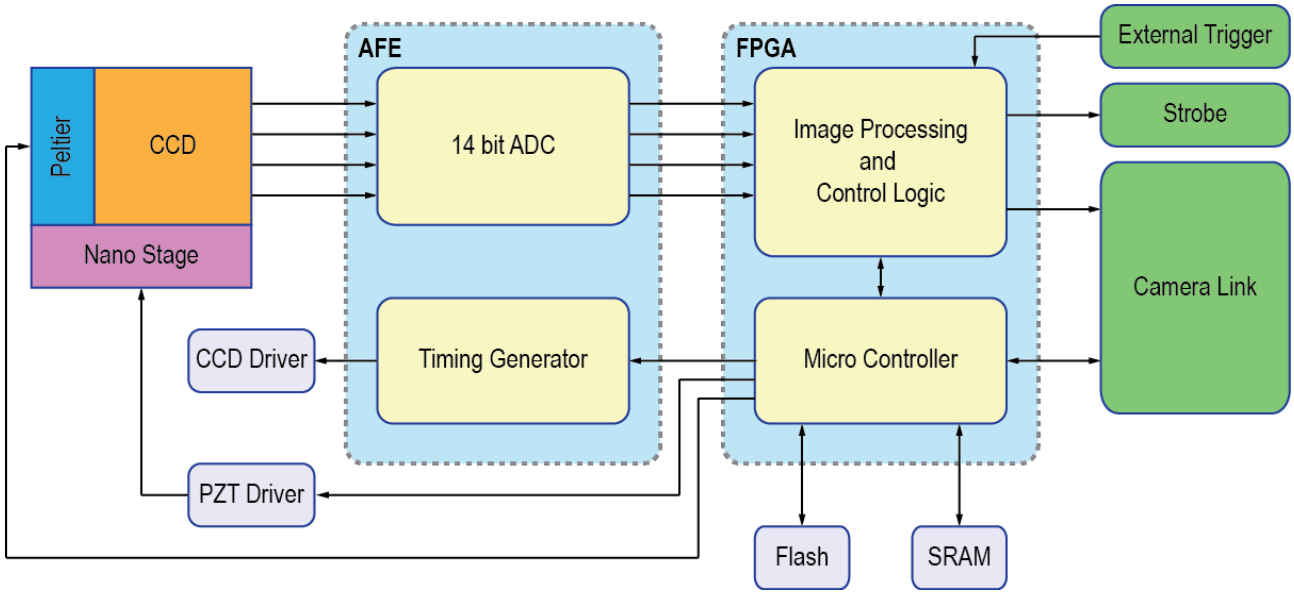


Figure 5.1 VNP Camera Block Diagram

All controls and data processing of VNP 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 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, PZT Driver is applied to control XY Stage with nanometers unit and Peltier Driver is applied to control Thermoelectric Peltier Cooling unit.

5.4 Spectral Response

The following graphs show the spectral response for VNP monochrome and color cameras.

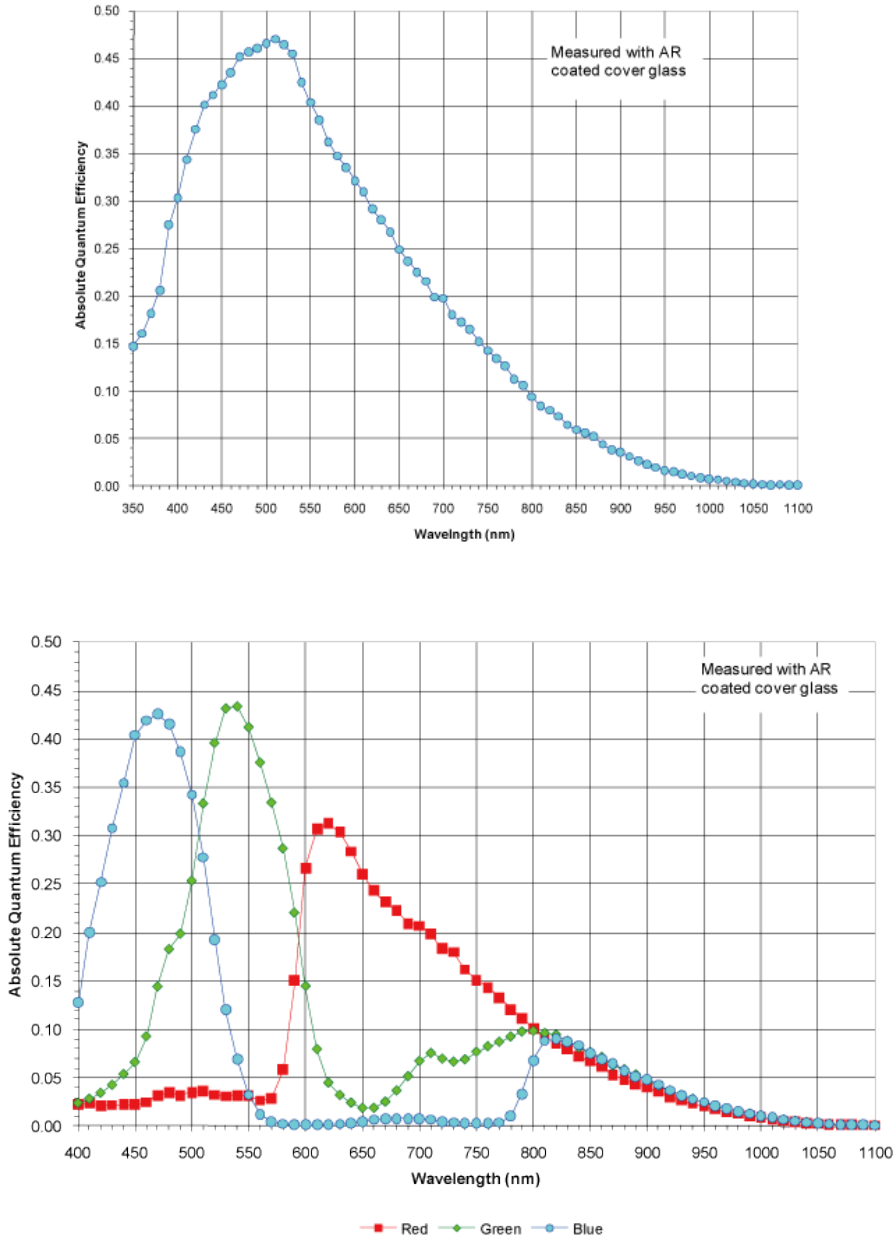


Figure 5.2 VNP-29MC Spectral Response (Top: Monochrome, Bottom: Color)

5.5 Mechanical Specification

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

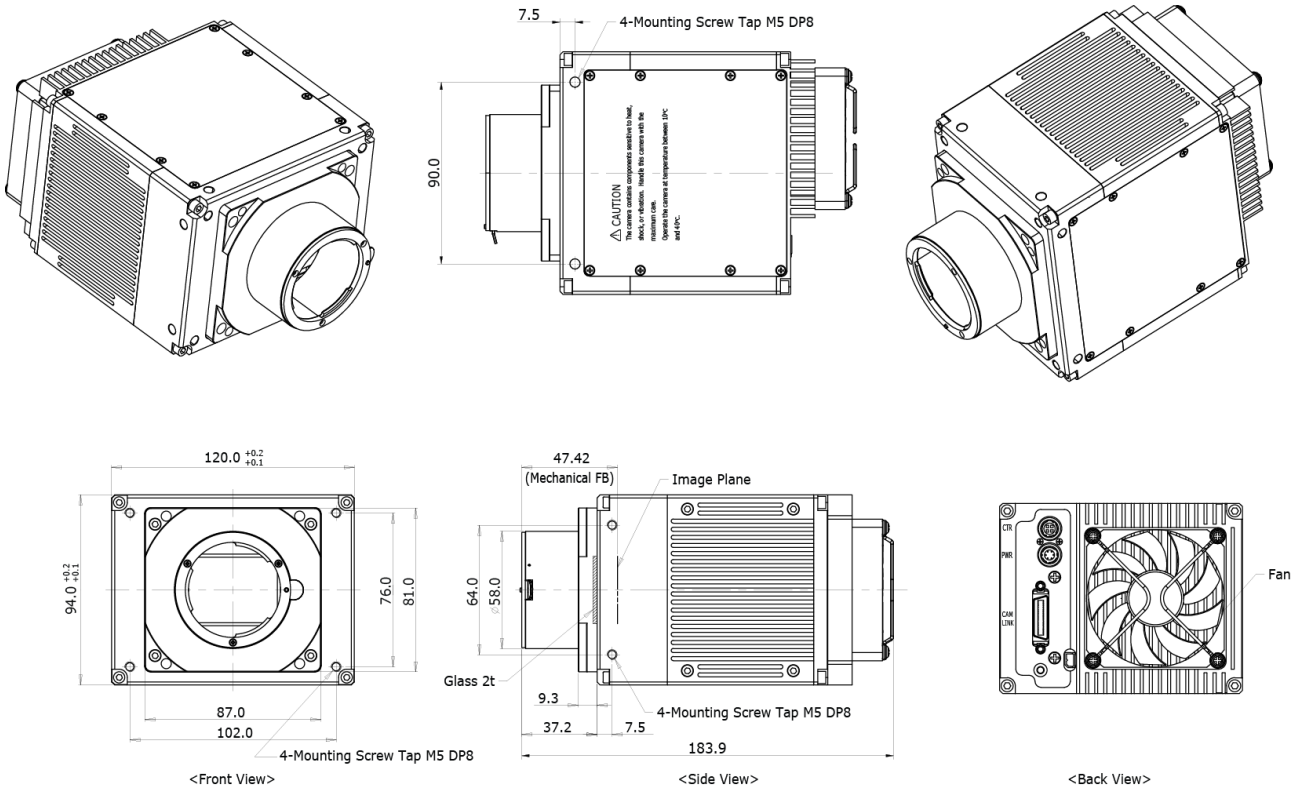


Figure 5.3 VNP Camera Link Mechanical Dimension (F-Mount)

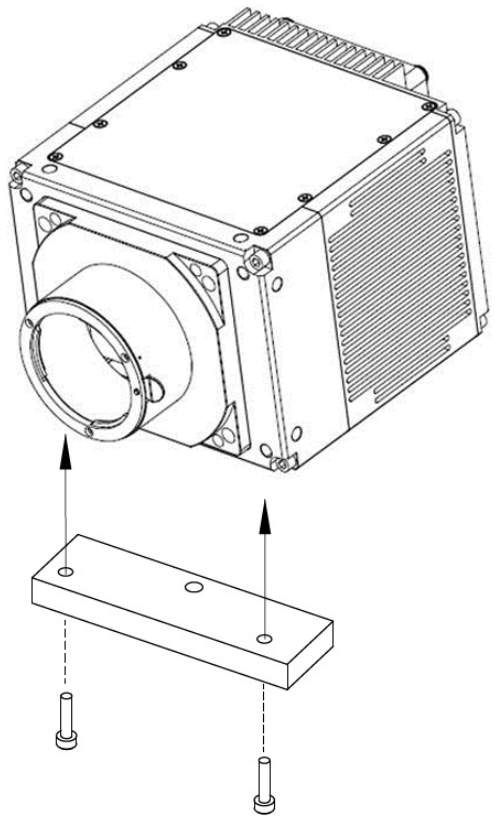
6 Connecting the Camera

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 connector on your Camera Link frame grabber.
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 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 http://www.vieworks.com.
- For more information, refer to your 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 4 pin Control Receptacle: inputs external trigger signal and outputs strobe.
- ② 6 pin Power Input Receptacle: supplies power to the camera.
- ③ 26 pin Camera-Link Connector: controls video data transmission and the camera.
- ④ Status LED: displays power status and operation mode.

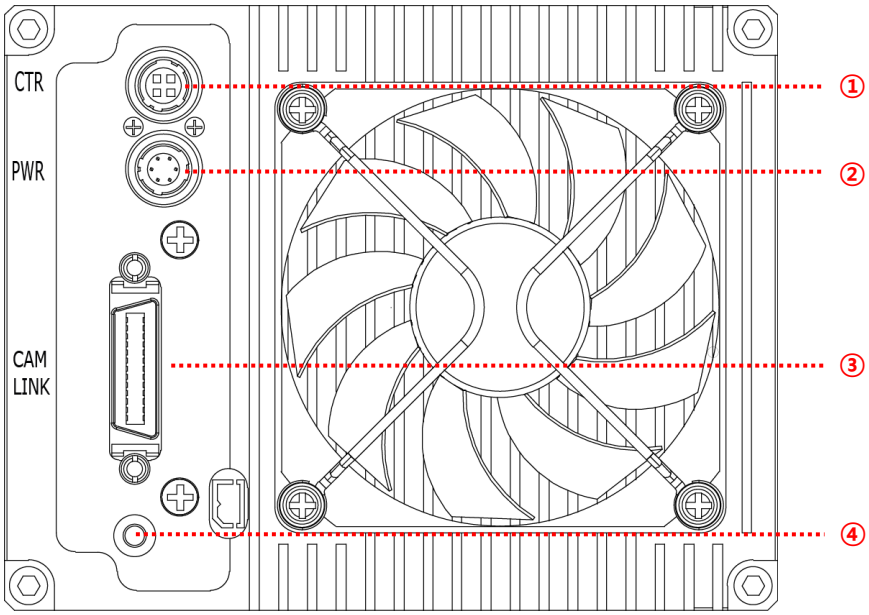


Figure 7.1 VNP Series Back Panel

7.2 Camera Link Connector

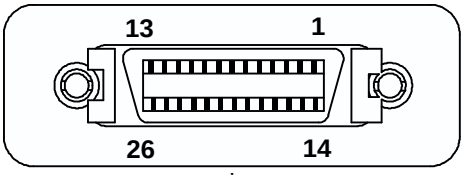


Figure 7.2 Camera Link Connector

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). Pin arrangement and configuration are as follows:

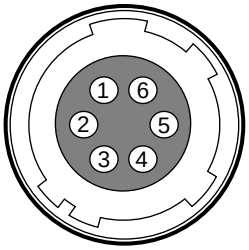


Figure 7.3 Pin Arrangement of Power Input Receptacle

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

Table 7.2 Pin Configuration of 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 ±10% voltage output (Users need to purchase the power adaptor separately).

Precaution for Power Input

CAUTION	• Make sure the power is turned off before connecting the power cord to the camera. Otherwise, damage to the camera may result. • If the camera input voltage is greater than specified input voltage range, 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 external trigger signal input and strobe output ports. The pin arrangement and configuration are as follows:

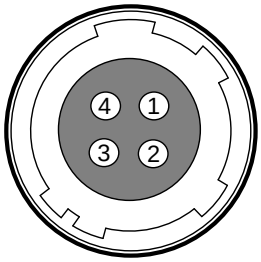


Figure 7.4 Pin Arrangement of Control Receptacle

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 Arrangement of Control Receptacle

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 μs. If transmitted trigger signal is less than 1 μs, the camera will ignore the trigger signal. External trigger circuit example is shown below.

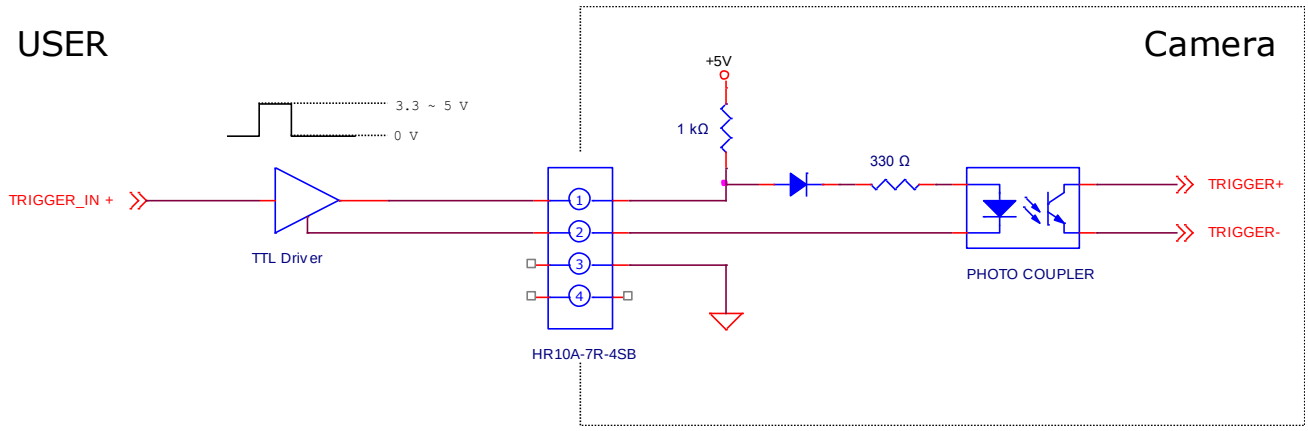


Figure 7.5 Trigger Input Schematic

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.

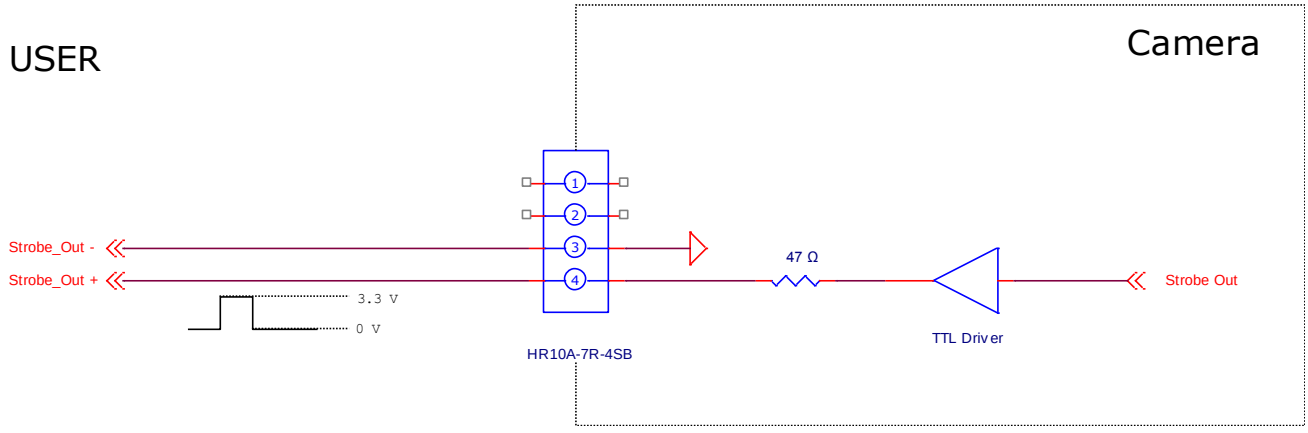


Figure 7.6 Strobe Output Schematic

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 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 = (VSIZE – 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.

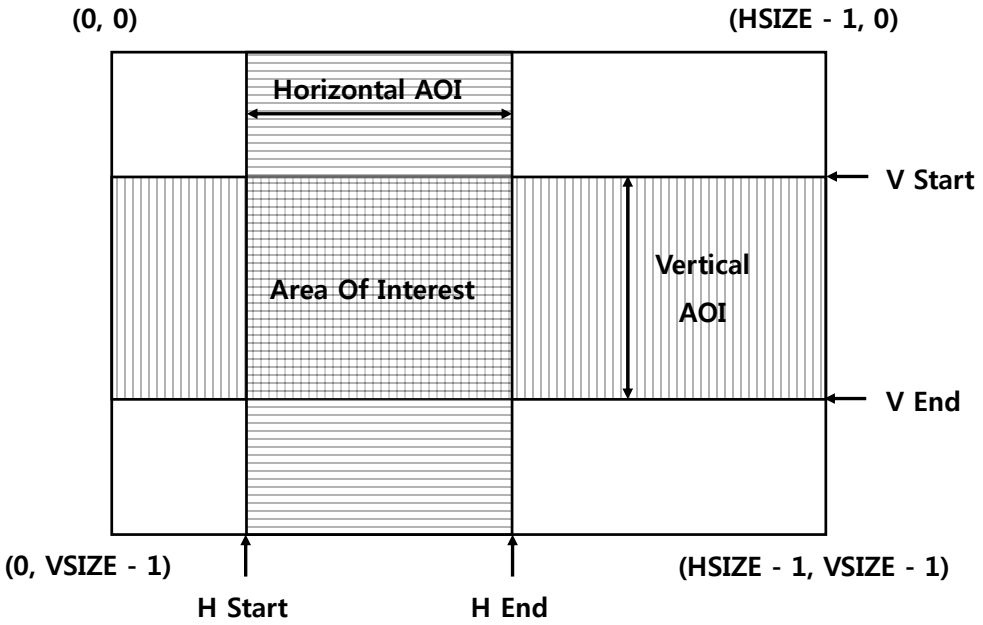


Figure 8.1 Area of Interest

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

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

1 or 2 Channel Mode:

$$\text{Frame Rate(fps)} = 1000000 / [T_{VCCD} + T_{RF} \times \{V_{SIZE} - (V_{AOI} + 12)\} + (V_{AOI} + 12) \times T_L]$$

4 Channel Mode:

$$\text{Frame Rate(fps)} = 1000000 / [T_{VCCD} + T_{RF} \times \{V_{SIZE} - (V_{AOI} + 12)\}/2 + \{(V_{AOI} + 12) \times T_L\}/2]$$

T_{VCCD}: time required to move electric charges accumulated on pixel to Vertical Register

T_{RF}: 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_{RF}, 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 are shown below.

VNP Series	VNP-29MC
T_{VCCD}	56.3 μs
T_L (1 channel)	172.3 μs
T_L (2 channel)	90.125 μs
T_L (4 channel)	90.125 μs
T_{RF}	6.8 μs
V_{SIZE}	4384 Lines
Minimum Vertical AOI Size	1200 Lines

Table 8.1 Timing Value for VNP-29MC

The following figure shows frame rate depending on VAOI changes.

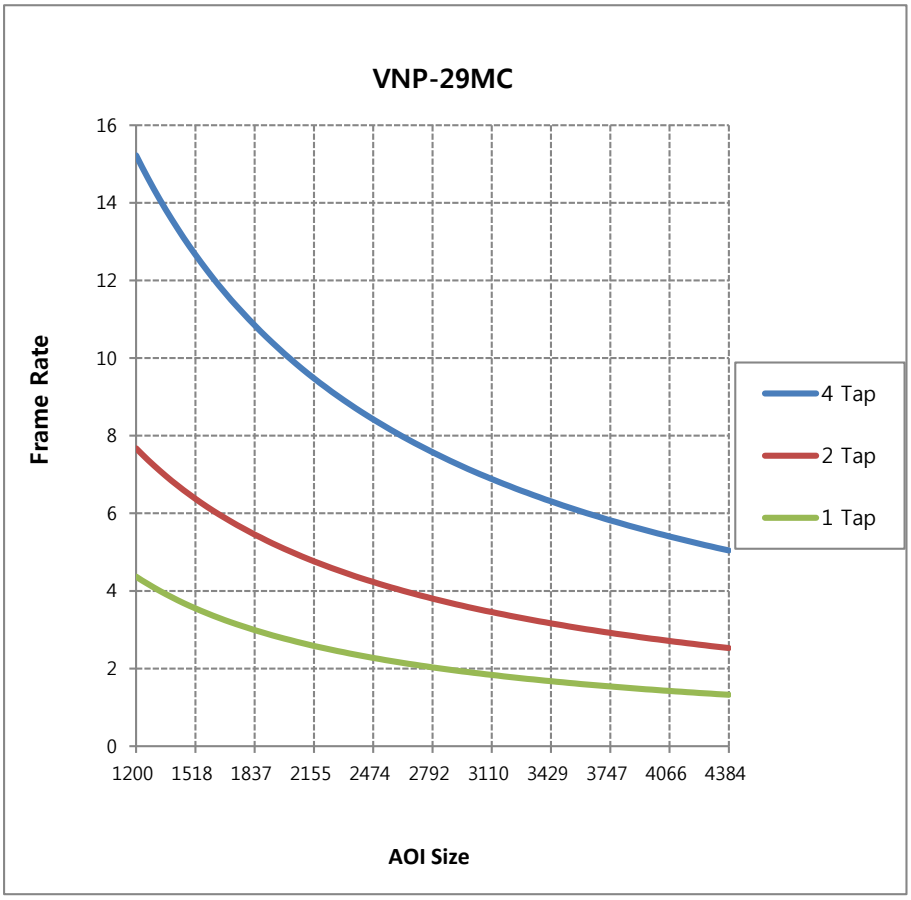


Figure 8.2 Frame Rate by VAOI changes

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 ratio imaging. 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 frame speed. Binning Factor is set using “sbf” command.

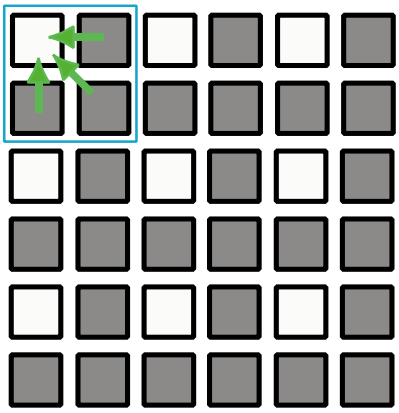


Figure 8.3 2 × 2 Binning

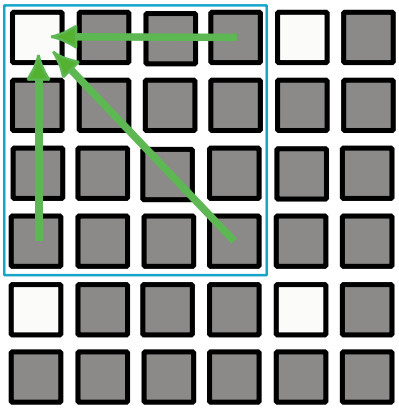


Figure 8.4 4 × 4 Binning

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

8.3 Trigger Mode

When the **Trigger Mode** is set to **Free-Run**, the camera will generate all required trigger signals internally, and you do not need to apply trigger signals to the camera.

When the **Trigger Mode** is set to **Standard**, **Fast**, **Double** or **Overlap**, you must apply a trigger signal to the camera each time you want to begin a frame acquisition. The **Source** parameter specifies the source signal that will act as the trigger signal.

The available settings for the **Source** parameter are:

- **CC1**: You can apply a trigger signal to the camera via Camera Link CC1 channel.
  For more information, refer to your Camera Link frame grabber user manual.
- **Ext.**: You can apply a trigger signal to the camera by injecting an externally generated electrical signal (commonly referred to as a hardware trigger signal) into the Control I/O receptacle on the camera.

If the **Source** parameter is set to CC1 or Ext., you must also set the **Polarity** parameter.

The available settings for the **Polarity** parameter are:

- **Active Low**: Specifies that a falling edge of the electrical signal will act as the trigger signal.
- **Active High**: Specifies that a rising edge of the electrical signal will act as the trigger signal.

8.3.1 Free-Run Mode

When the **Trigger Mode** is set to **Free-Run**, the camera will generate all required trigger signals internally. When the camera is set this way, the exposure time for each frame acquisition is determined by the value of the camera's **Exposure Time** parameter. The camera will constantly acquire images (repeat exposure and readout) without any need for triggering by the user.

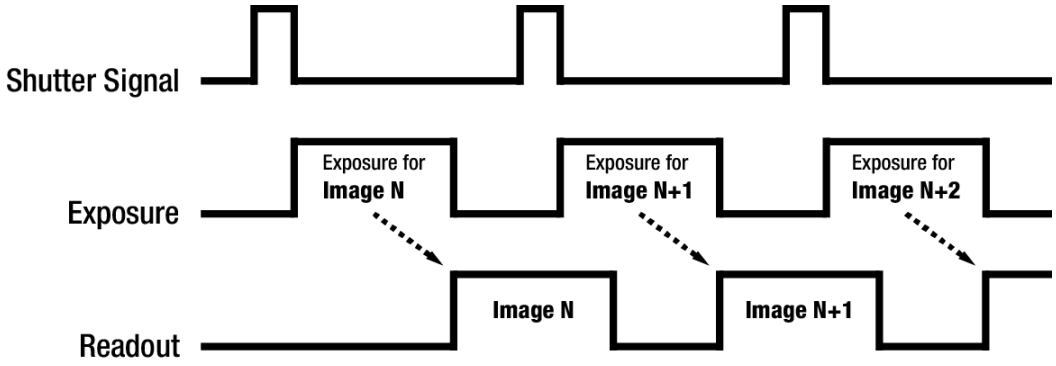


Figure 8.5 Free-Run Mode

With the Trigger Mode set to Free-Run, the exposure for a new frame will overlap the readout for the previous frame. The operation of the camera may differ depending on the length of the exposure time and readout time.

If the exposure time is shorter than the readout time, a shutter signal will be generated while reading out the sensor data for the previously acquired frame. Then, the camera will begin reading out the sensor data for a new frame as soon as it finishes reading out the sensor data for the previous frame. In this case, the frame speed will be constant regardless of changes in the exposure time.

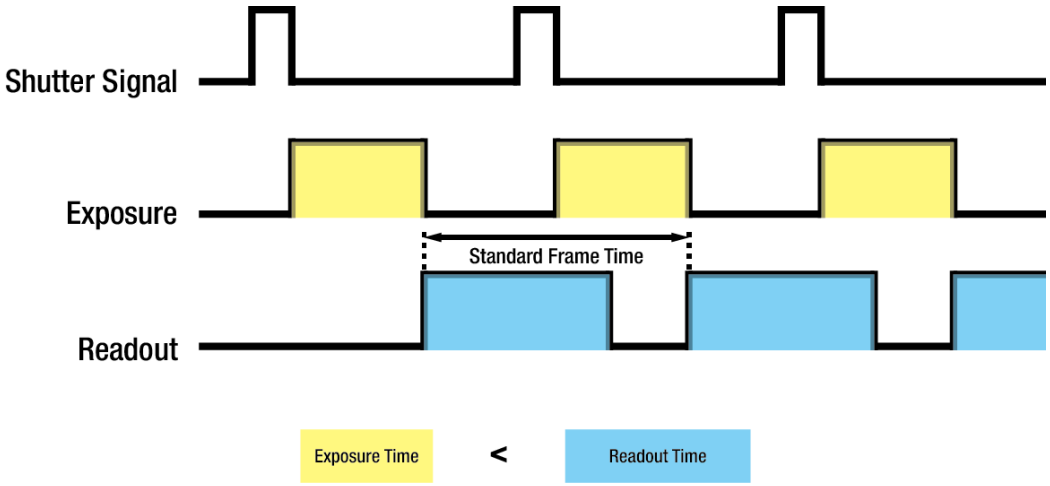


Figure 8.6 Exposure Time is Shorter than Readout Time

If the exposure time is longer than the readout time, the camera will begin the process of reading out a frame each time a shutter signal is generated. After completing the process of reading out the frame, the camera will not begin the process of reading out a new frame until the camera completes the process of exposing a new frame. In this case, the frame speed becomes slower as you increase the exposure time value.

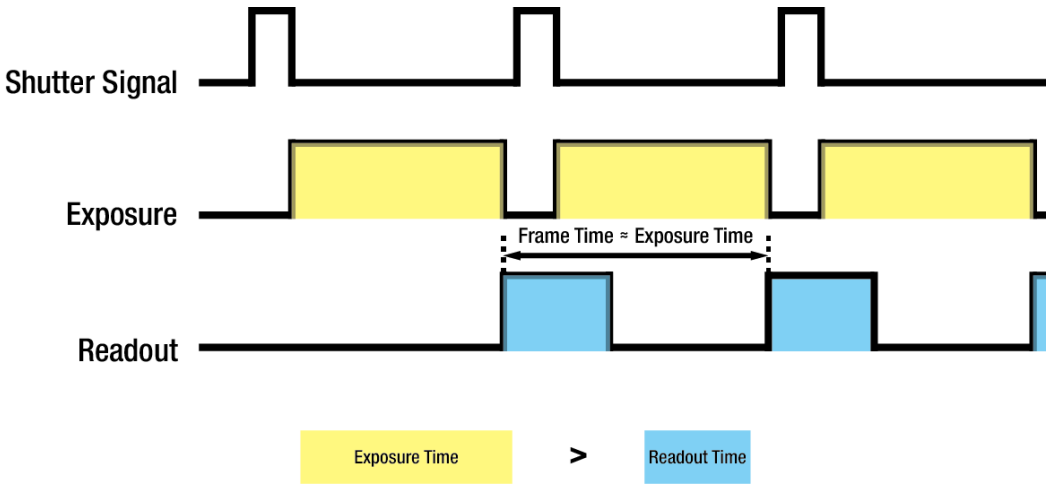


Figure 8.7 Exposure Time is longer than Readout Time

8.3.2 Standard Mode

When the **Trigger Mode** is set to **Standard**, you must trigger exposure start by applying trigger signals to the camera. Applying a trigger signal to the camera will exit the camera from the waiting for trigger signal acquisition status and will begin the process of exposing and reading out a frame. After the readout for the frame is complete and the camera is ready to accept another trigger signal, it will return to the waiting for trigger signal acquisition status. Trigger signals applied to the camera when it is not in a waiting for trigger signal acquisition status will be ignored.

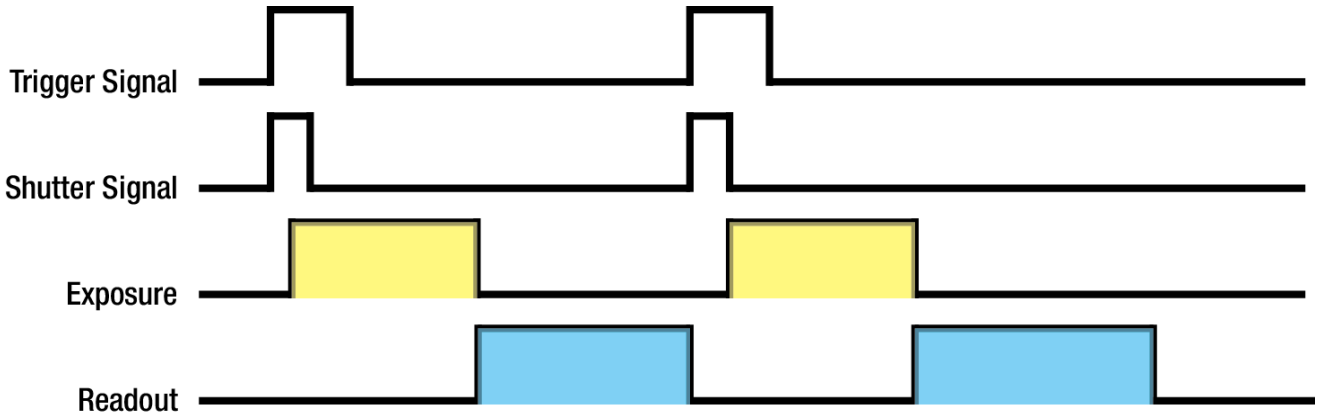


Figure 8.8 Standard Trigger Mode

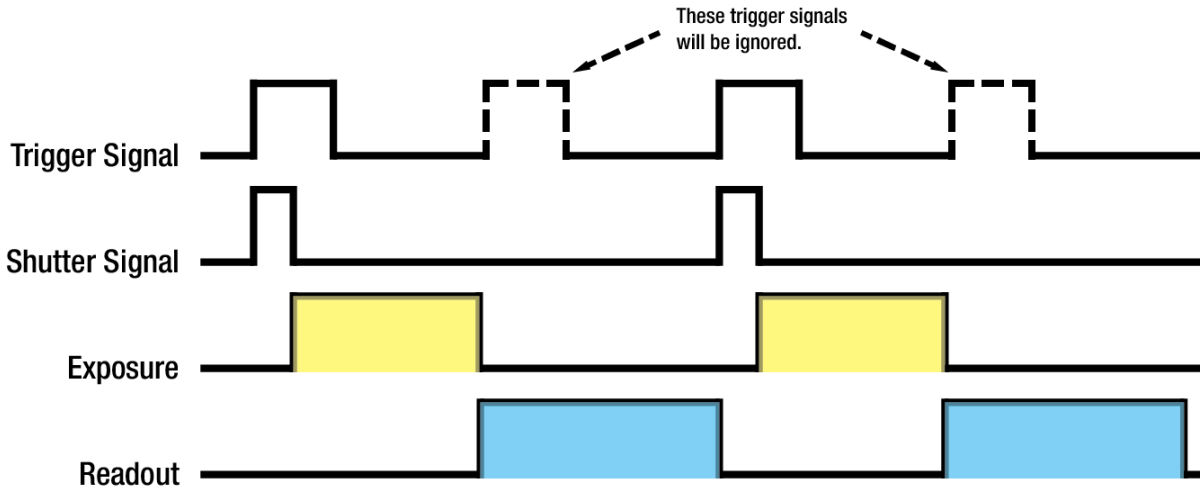


Figure 8.9 Trigger Ignored

8.3.3 Double Mode

When the **Trigger Mode** is set to **Double**, two frames can be acquired with a single trigger signal. When a trigger signal is applied to the camera, the camera begins the process of exposing the first frame according to the current exposure time settings. Once the exposure for the first frame is complete, the camera reads out the sensor data. At this point, the process of exposing the second frame begins. Then, the camera reads out the sensor data for the second frame after reading out the sensor data for the previous frame.

In the **Double** mode, the exposure time for the second frame equals to the readout time of the first frame. There is a just few microseconds (or dozen of microseconds) between the point where the exposure process for the first frame ends and the point where the exposure process for the second frame begins. This is because the camera does not generate a shutter signal while reading out the sensor data for the first frame. At this point, the camera outputs a strobe out signal reflecting the exposure time for the first frame.

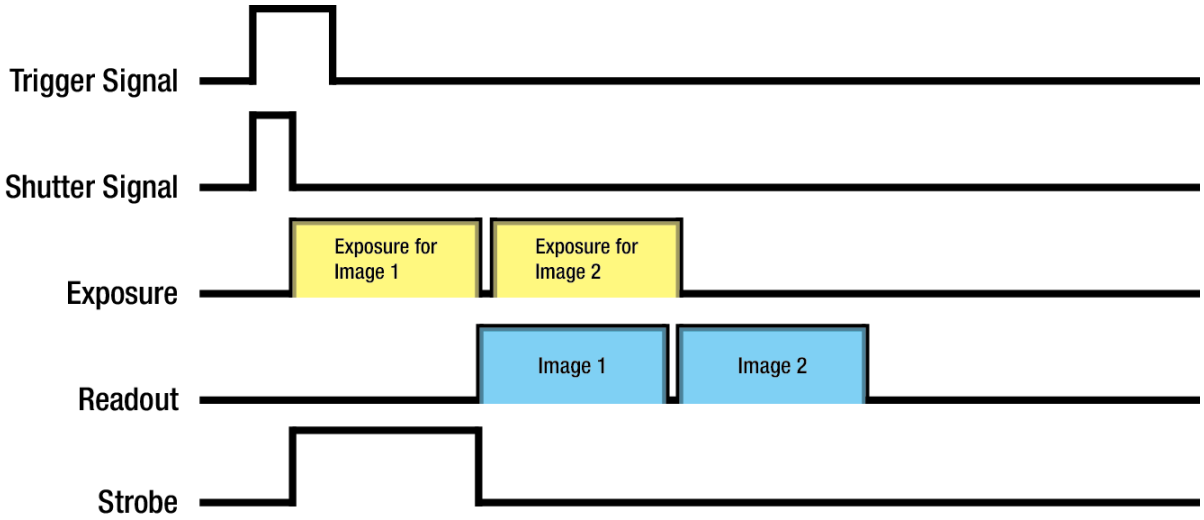


Figure 8.10 Double Mode

8.3.4 Fast Mode

The **Fast** mode is useful to apply trigger signals with shorter interval than those in the Standard mode. In the Fast mode, the camera begins the process of reading out the previous frame as soon as a new trigger signal is applied to the camera. The trigger signal interval determines the exposure time for a frame since the camera does not generate a shutter signal during the process of reading out a frame.

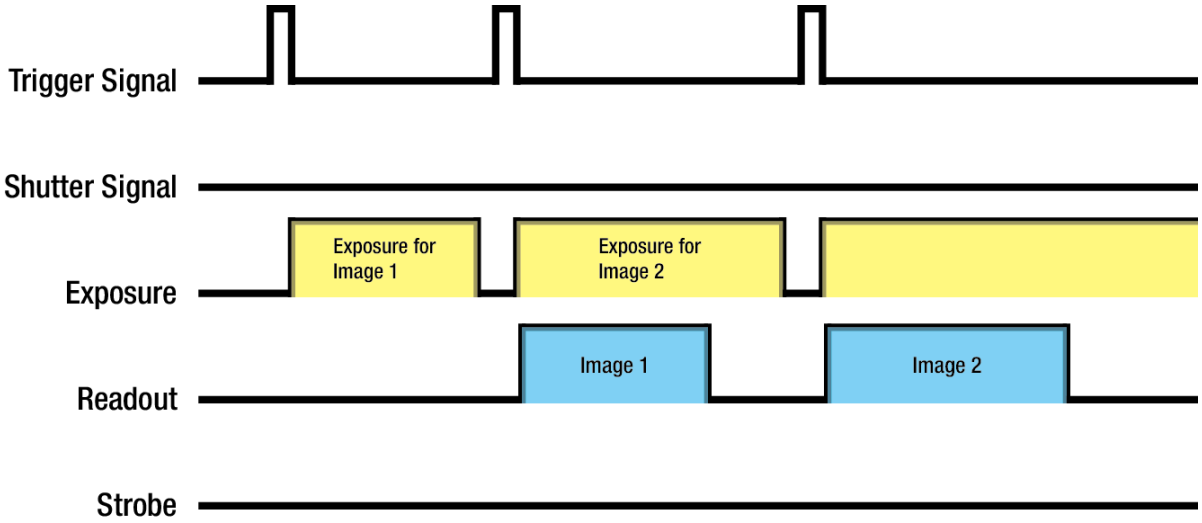


Figure 8.11 Fast Mode

8.3.5 Overlap Mode

When the **Trigger Mode** is set to **Overlap**, the camera operates in the 'overlapped' mode which allows the exposure for a new frame to overlap the sensor readout for the previous frame. When a new trigger signal is applied to the camera while reading out the previous frame, the camera begins the process of exposing a new frame. If you will be operating the camera with the Overlap mode, there are important guidelines to keep in mind:

- You must not begin the exposure for a new frame while the exposure for the previous frame is in progress.
- You must not end the exposure for the current frame until the readout for the previous frame is complete.
- To acquire images with the maximum frame rate, the exposure time must not be longer than the readout time and the trigger signal interval must not be shorter than the readout time.

The readout time varies depending on the Channel mode as shown in the following table.

Channel Mode	VNP-29MC
1 channel	763.1 ㎳
2 channel	397.7 ㎳
4 channel	199.6 ㎳

Table 8.2 VNP-29MC Readout Time

To achieve best performance in the overlapped mode, trigger signal interval and exposure time need to be kept constant.

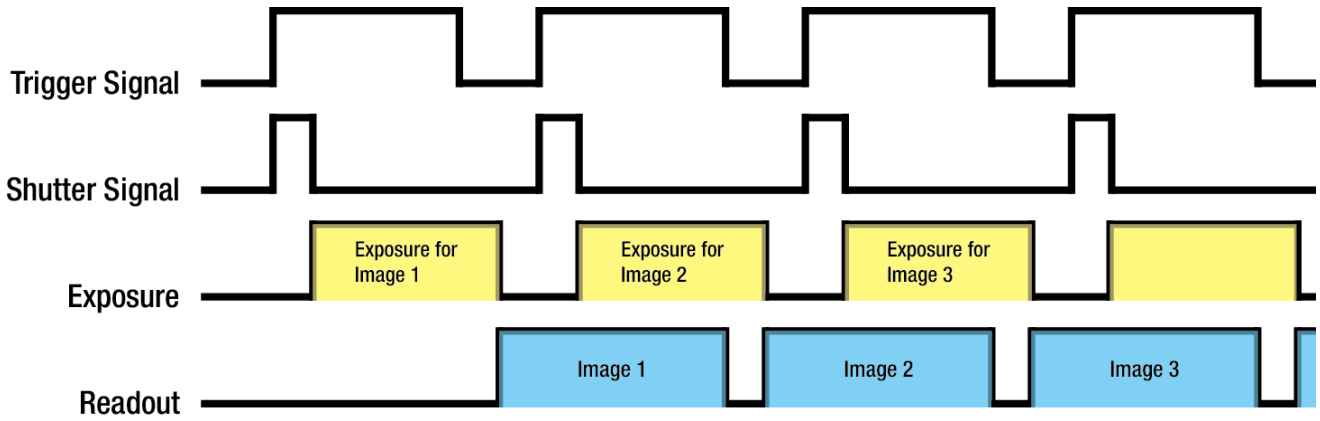


Figure 8.12 Overlap Mode

8.4 Channel Mode

The Channel mode determines how the image data in the horizontal register of the CCD will be read out. The available settings are: 1 Tap (Single Channel), 2 Tap (Dual Channel) or 4 Tap (Quadrant Channel). With the 1 Tap setting, all pixel values in the horizontal register will be read out from the left bottom Video Amplifier (Video A). With the 2 Tap setting, pixel values from the left of the CCD will be read out from the Video A and pixel values from the right of the CCD will be read out from the Video B. With 4 Tap setting, pixel values from the left bottom of the CCD will be read out from the Video A, pixel values from the right bottom of the CCD will be read out from the Video B, pixel values from the left top of the CCD will be read out from the Video C, and pixel values from the right top of the CCD will be read out from the Video D. The advantage of the 4 Tap setting is that it makes readout about four times faster than the 1 Tap setting. This is true because the four channels are used simultaneously to read out the sensor.

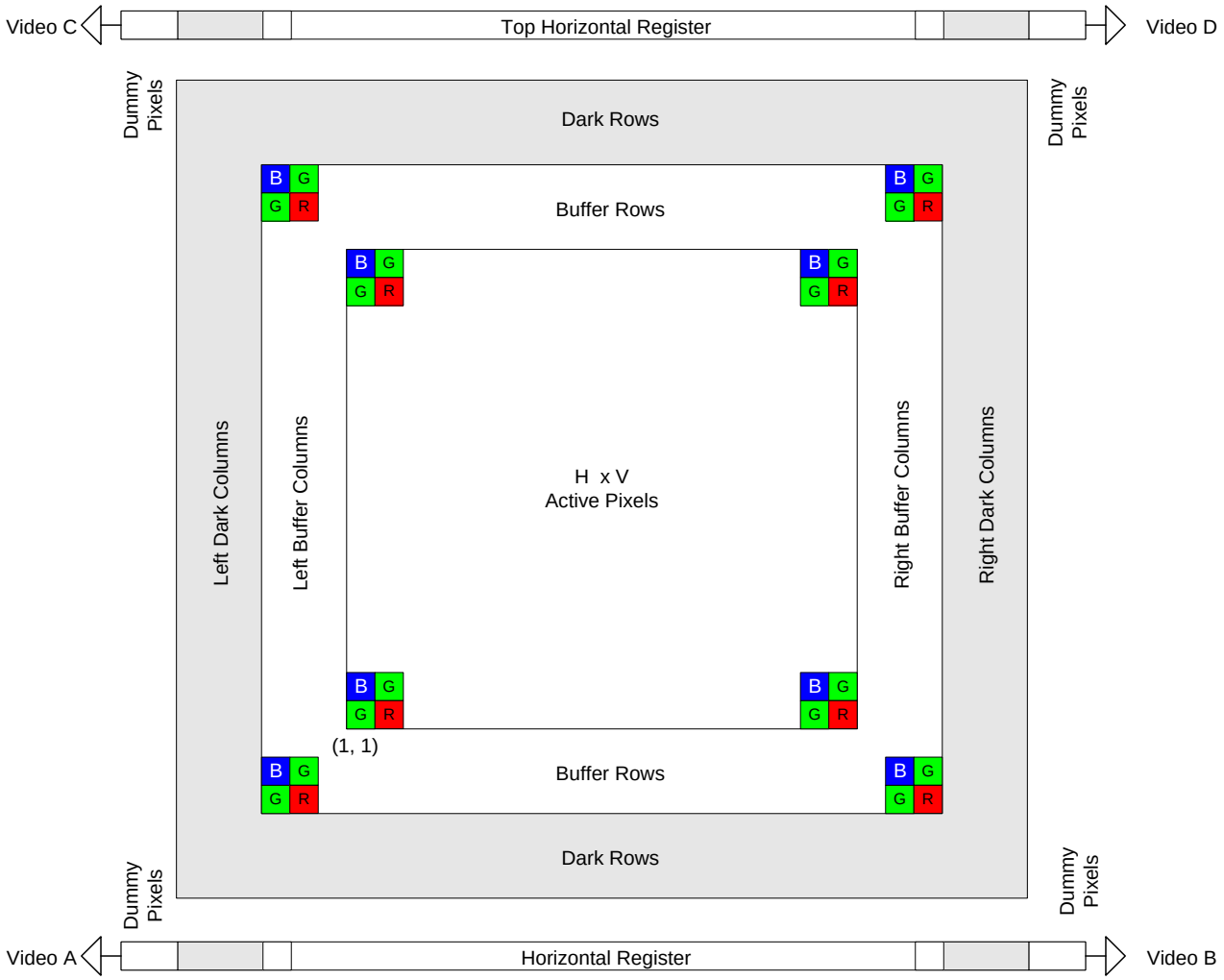


Figure 8.13 Channel Mode

The image data read out from the CCD goes through image processing and it is reordered to be compliant with the Camera Link standard. With the 1 Tap setting, image data read out from the Video A will be transmitted in a Camera Link 1 Tap fashion. With the 2 Tap setting, image data read out from the Video A and B simultaneously will be transmitted in a Camera Link A, B 2 Tap Interleaved fashion. With the 4 Tap setting, image data read out from the Video A, B, C and D simultaneously will be transmitted in a Camera Link 2 Tap Top-Bottom fashion.

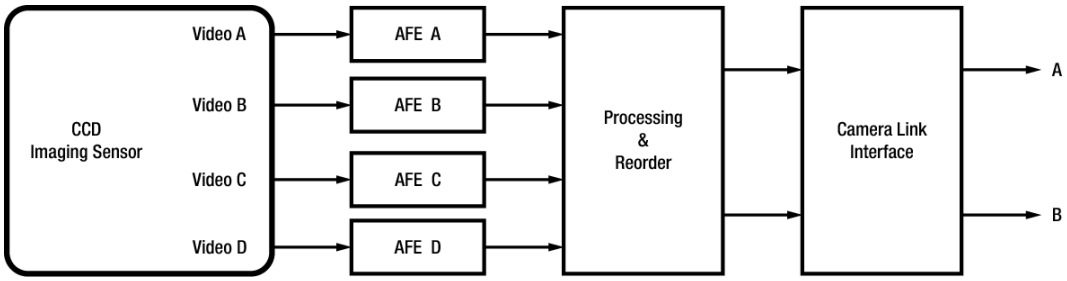


Figure 8.14 Image Data Flow

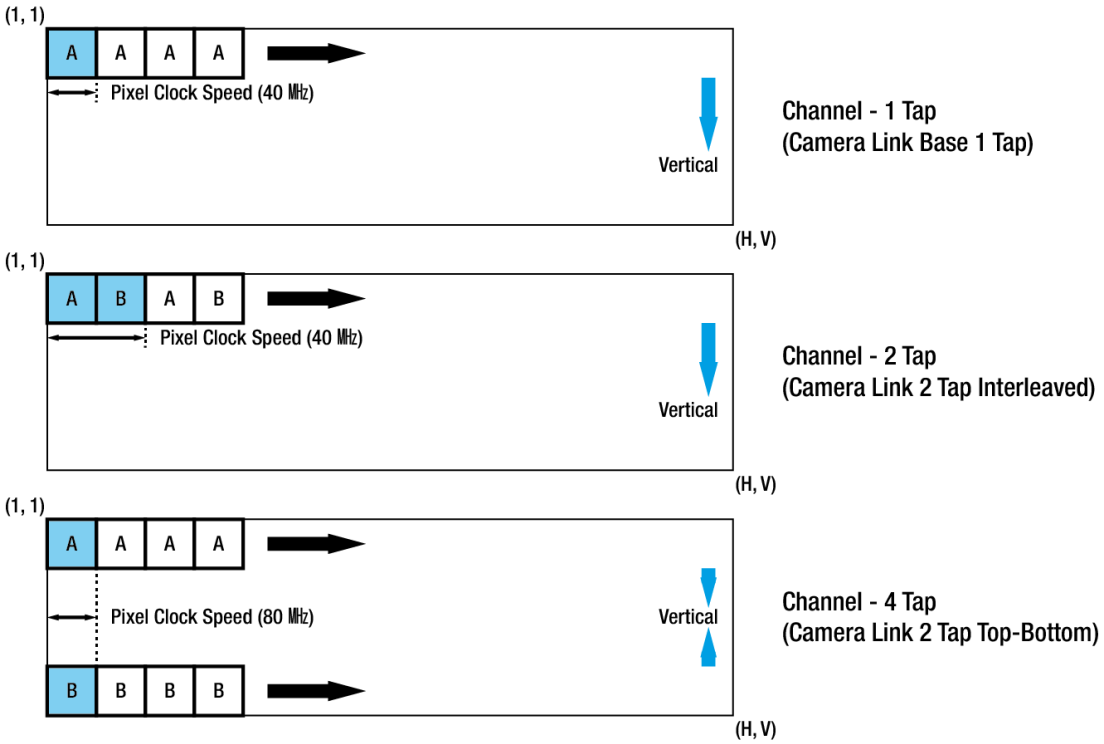


Figure 8.15 Data Output

8.5 Gain and Offset

The camera has one Analog Signal Processor (or Analog Front End, 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. The AFE has a register for the Gain and Offset values. You can adjust the Gain and Offset values by entering a proper value in the register. The Gain value can be set in a range from 0 to 899. If you know the current setting value for the Gain, you can use the formula below to calculate the actual Gain (dB).

```
Gain(dB) = (Setting value × 0.035 dB)
```

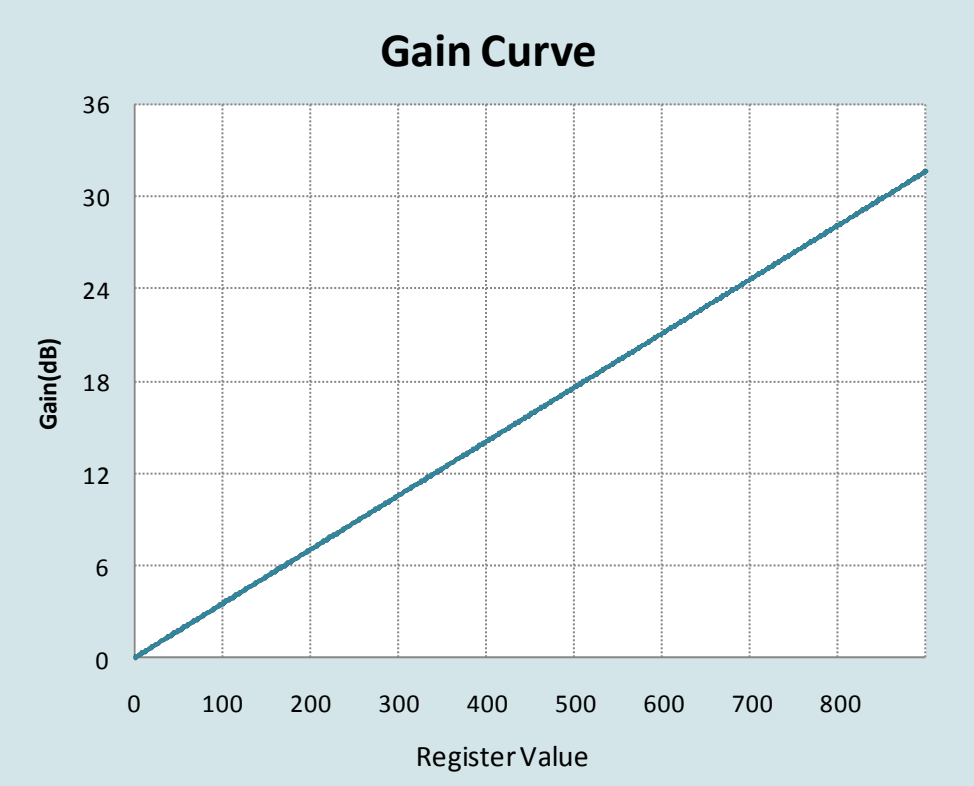


Figure 8.16 Register Setting Values for the Actual Gain Values

The Offset value can be set in a range from 0 to 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 VNP-29MC provides 2 non-volatile spaces for LUT data storage. You can determine whether to apply LUT and which LUT to use by using “sls” command. For more information about how to download LUT to camera, refer to Appendix B.

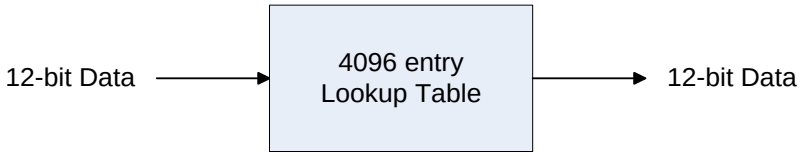


Figure 8.17 LUT Block

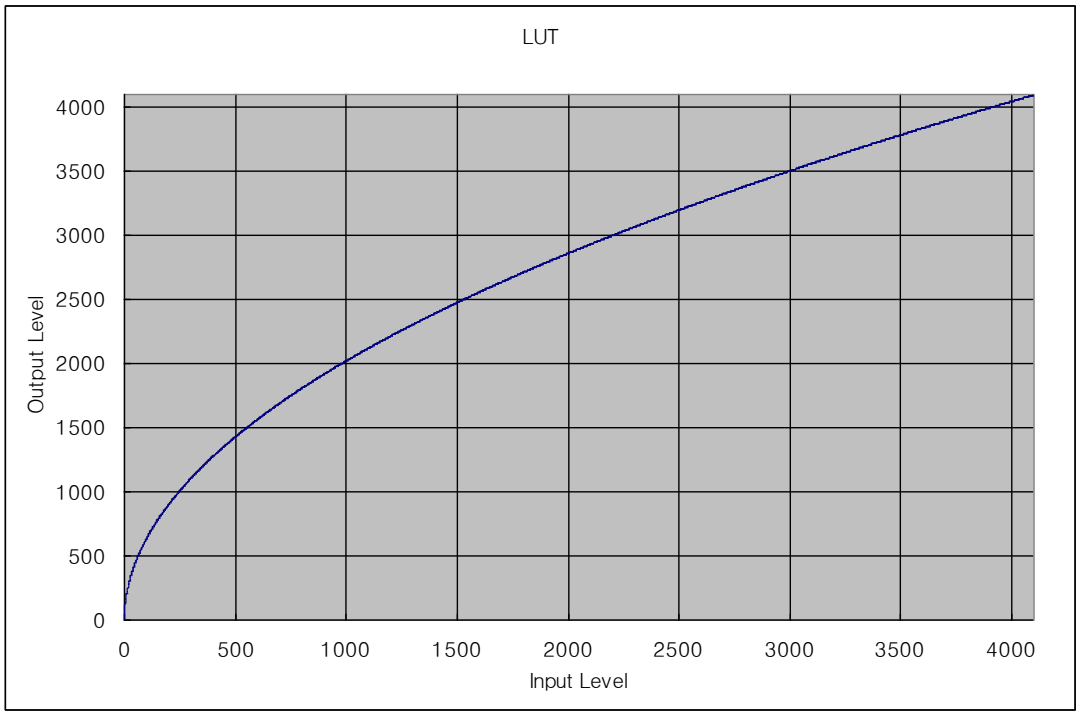


Figure 8.18 LUT at Gamma 0.5

8.7 Defective Pixel Correction

The CCD may have defect pixels which cannot properly respond to the light. VP Camera Link camera provides a feature to correct the defect pixels to enhance the quality of output images. Defect pixel information of the CCD used for each camera is saved in the camera during the manufacturing process in the factory. If you want to add defect pixel information, it is required to enter coordinate of new defect pixel into the camera. You can determine whether to use the Defective Pixel Correction feature by using the “sdc” command. For more information, refer to Appendix A.

8.7.1 Correction Method

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

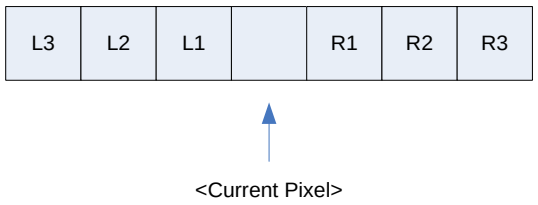


Figure 8.19 Location of Defect Pixel to be corrected

If the 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) × M} / (IF – IB)

IC: Level value of corrected image
IR: Level value of original image
IB: Black offset value
M:  Target value of image after correction
IF: Level value of Flat Field data
```

In the actual use conditions, generate a Flat Field data (IF) and enable the Flat Field Correction feature according to the following procedures.

1. Set the number of frames to be used for generating the Flat Field data by using the “sfi n” command (number of frames = 2^n).
2. Set the target value M to be applied after correction by using the “sfo” command.
3. Execute the Flat Field Generator by using the “gfd” command. The Flat Field Generator will average series of frames and scale down to 1/16 pixel to generate the Flat Field data. The Flat Field data will be saved in the external frame buffer (volatile memory).
4. Enable the Flat Field Correction feature by using the “sfc” command. The Flat Field data will be enlarged via Bilinear Interpolation as shown in the Figure 8.21.
5. Save the generated Flat Field data in the non-volatile memory by using the “sfd” command for future use.

- Executing 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 complete, the original camera settings will be restored.
  - Readout Mode: Normal
  - Trigger Mode: Free-Run
  - Defective Pixel Correction: ON
- The target value M is based on the Normal Readout mode. If you use different AOI settings, Binning mode or Channel mode, the level value of an actual image may be different with the target value.

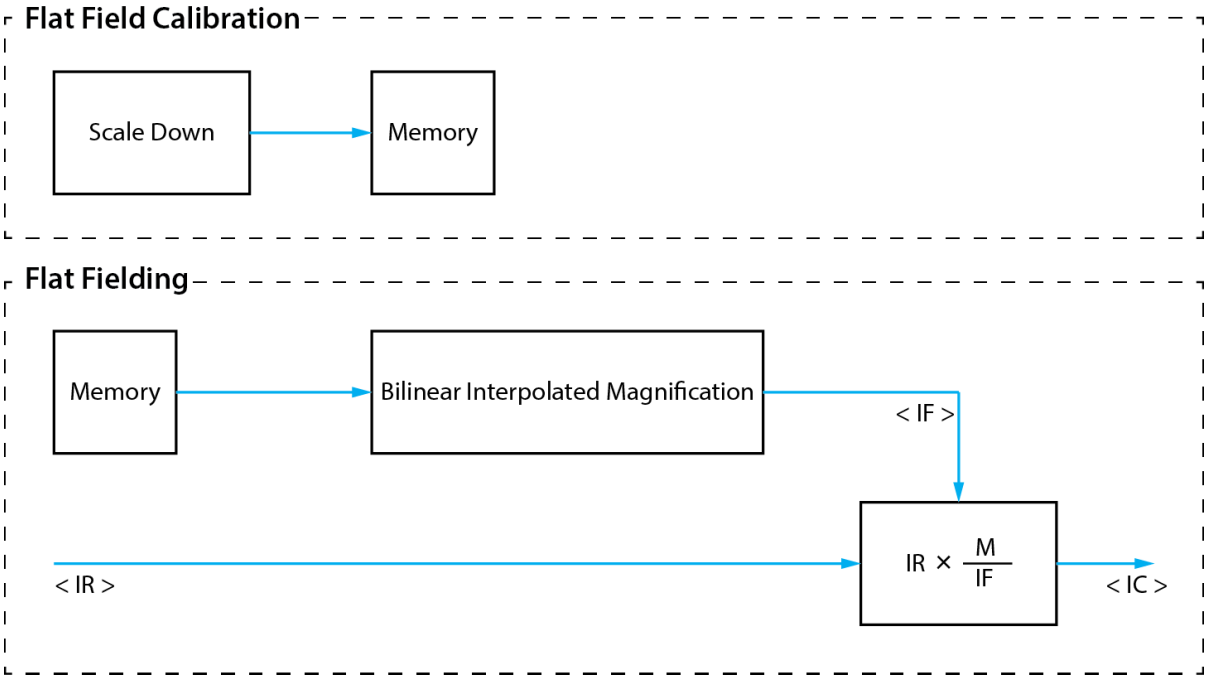


Figure 8.20 Generation and Application of Flat Field Data

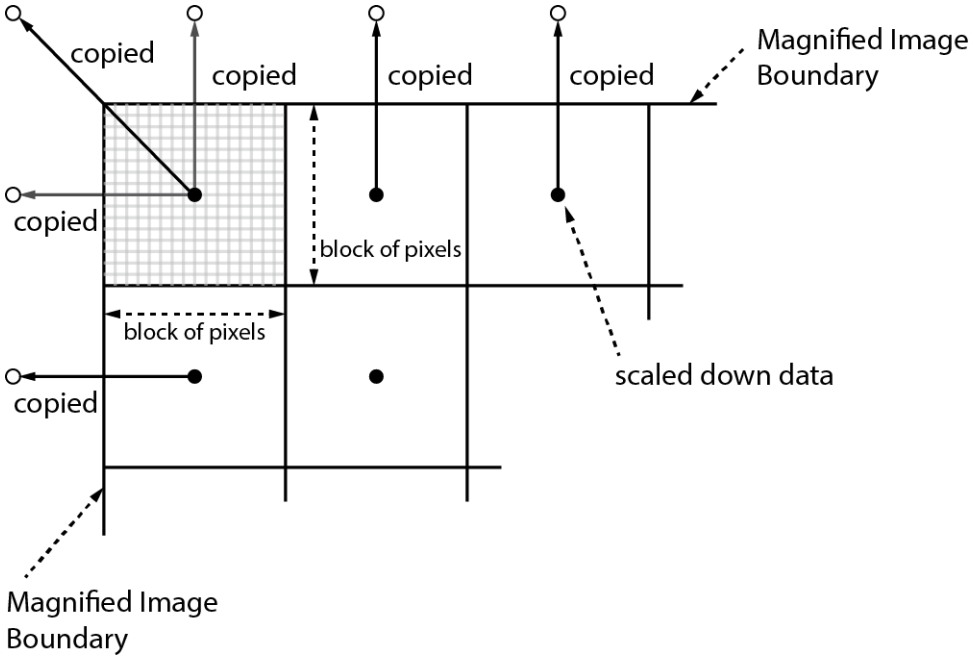


Figure 8.21 Bilinear Interpolated Magnification

8.9 Dark Signal Non-uniformity Correction

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 VNP-29MC provides the DSNU Correction feature.

8.10 Temperature Monitor

The camera is equipped with a temperature sensor to monitor the internal temperature. You can check the temperature of the camera by using the “gct” command.

8.11 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.

8.12 Pixel Shifting

The Pixel Shifting camera shifts the image sensor to X and Y direction precisely with 1/2 or 1/3 pixel distance using 2D-Stage. The resulting image can be combined of 4 individual images captured by shifting the image sensor to X and Y direction with 1/2 pixel distance as shown in the figure below. Thus, the output image offers improved resolution (4 shot result image) in comparison with standard output image (1 shot result image). Combining the images should be done on the PC side with software processing. Please contact local dealer or factory representative for the details on the sample software combining the images.

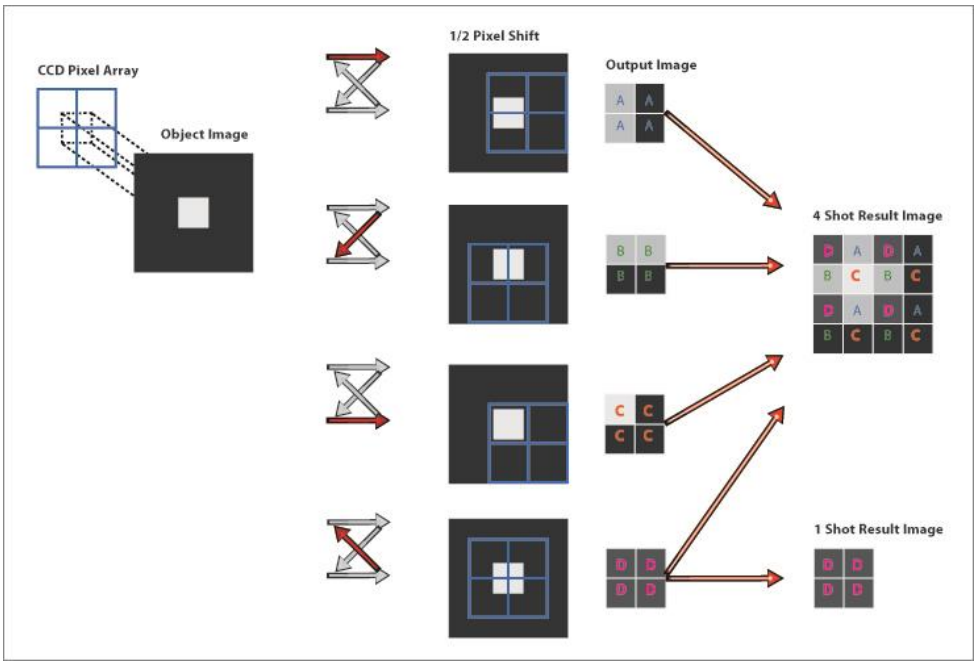


Figure 8.22 1/2 Comparison of resolution between Pixel Shifting camera and standard camera

CAUTION	• The camera contains components sensitive to heat, shock, or vibration. Handle this camera with the maximum care. Operate the camera at temperature between 10℃ and 40℃. • Due to a temperature difference between the product and environment, moisture may condense inside or outside the camera. This moisture condensation may cause a malfunction of the camera or shorten the product life cycle. If some condensation occurs, turn off the camera and wait about an hour for the moisture to evaporate.

8.12.1 Pixel Shifting and True Color resolution

One benefit of pixel shifting technology in comparison to fixed sensor cameras is its ability to acquire more than 4 times higher resolution than the fixed one. The below figure shows standard output image and ×9 shifting output image. In case of VNP-29MC camera model, the output image will have 19,728 × 13,152 (259.5 Megapixel) resolution if the pixel shifting is applied. Otherwise, the resolution of output image is 6,576 × 4,384 (28.8 Megapixel) without the pixel shifting.

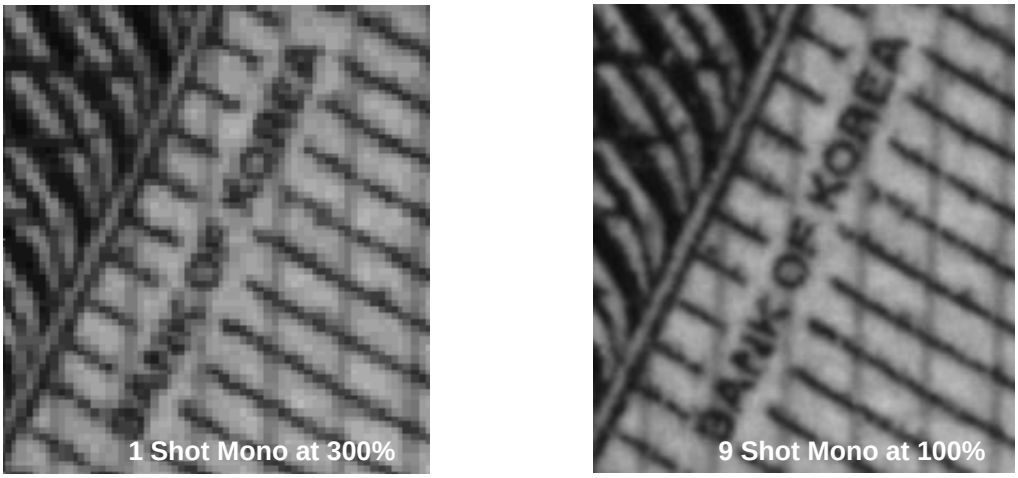


Figure 8.23 Standard (left) vs 9 Shot Pixel Shifting (right)

Another benefit of pixel shifting technology compared to fixed CCDs is acquiring True Color image. Currently CCD cameras use Bayer Interpolation to produce color images so that unwanted artifacts can occur such as color moiré or false color pixels. Using pixel shifting, no color artifacts or aliasing will occur and the color resolution is optimized.

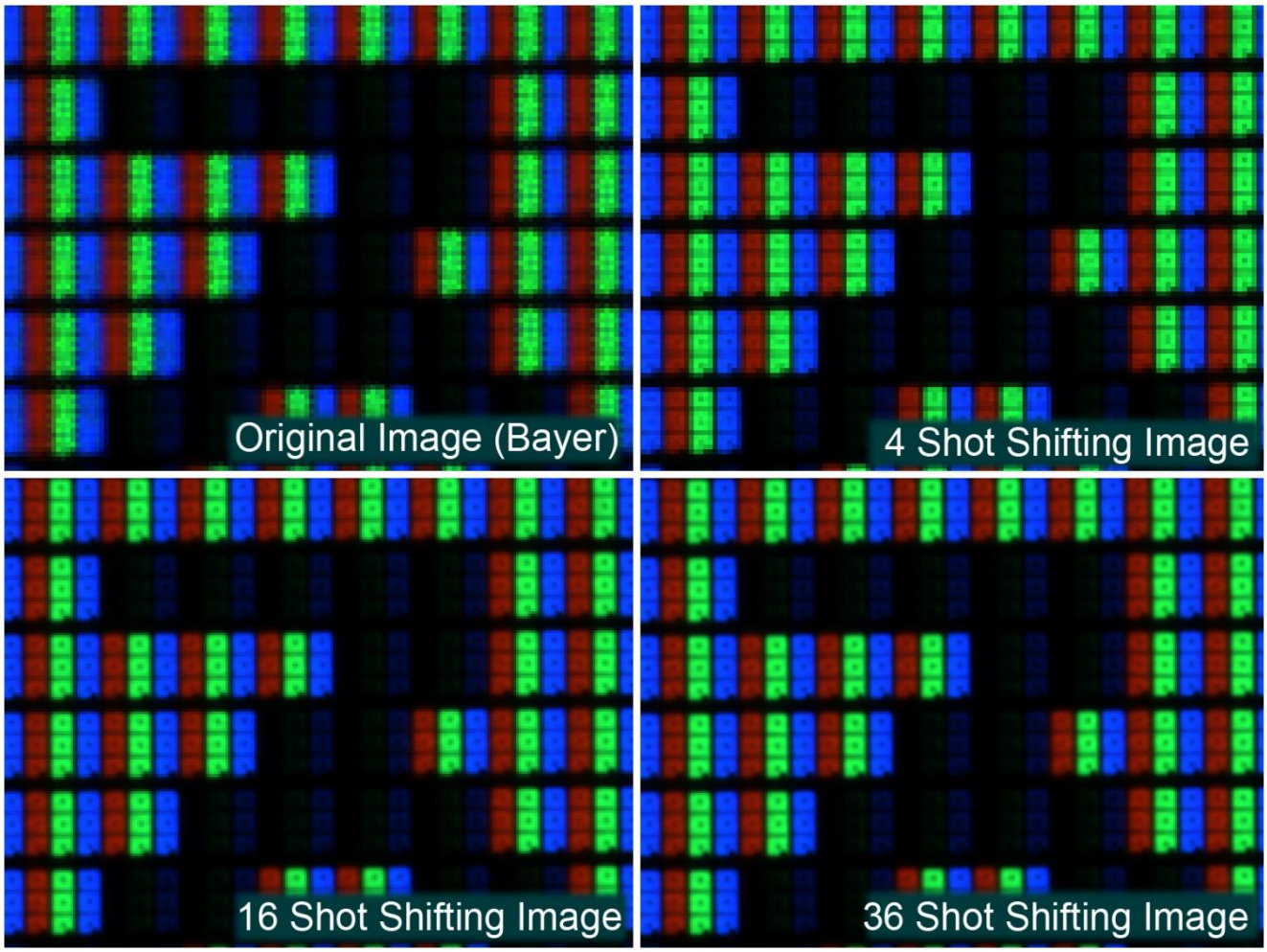


Figure 8.24 Standard Image Color vs Shifting Image Color

CAUTION	Use VNP Series camera where subjects are fixed and lighting environment is constant.

8.12.2 Sequence Mode

8.12.2.1 Components of Sequence Mode

Sequence Mode can be set with the following options.

- 0. None (Manual)
- 1. 4 Shot Mono (Doubled vertical and horizontal resolution)
- 2. 9 Shot Mono (Tripled vertical and horizontal resolution)
- 3. 4 Shot Bayer Color (Full color resolution)
- 4. 16 Shot Bayer Color (Full color resolution, doubled vertical and horizontal resolution)
- 5. 36 Shot Bayer Color (Full color resolution, tripled vertical and horizontal resolution)

8.12.2.2 Operation of Sequence Mode

In 1 – 6 sequence modes where the position of the stage has been predefined, the sequence operates by applying only trigger signal. The default position of the stage is (0, 0) and the following position will vary depending on the sequence mode. Once one cycle of operation has completed, the stage position returns to (0, 0). When the camera is running in the Free-Run mode, the sequence mode will be deactivated because the sequence mode is synchronized only with external Trigger or CC1 Trigger. Refer to Appendix D for the position settings according to sequence modes.

None (Manual) mode is useful when the sequence and stage position need to be configured manually. You can configure the stage position using “snp” serial command.

When you control the stage using serial command manually, it takes about 16 ㎳ from sending the command to shifting the stage. This period includes latency of serial communication and shifting time of the stage. Actually, it takes 8 ㎳ for the stage to be shifted.

To operate correctly in None (Manual) mode, you need to calculate the trigger timing considering frame transfer and stage setup time, and then apply the trigger signal to the camera. The minimum trigger period can be obtained as shown in the following expression:

- When sum of exposure time and stage setup time is shorter than frame transfer time:
  (Frame Transfer Time > Exposure Time + Stage Setup Time)
  - Minimum Trigger Period = Frame Transfer Time
- When sum of exposure time and stage setup time is longer than frame transfer time:
  (Frame Transfer Time < Exposure Time + Stage Setup Time)
  - Minimum Trigger Period = Exposure Time + Stage Setup Time

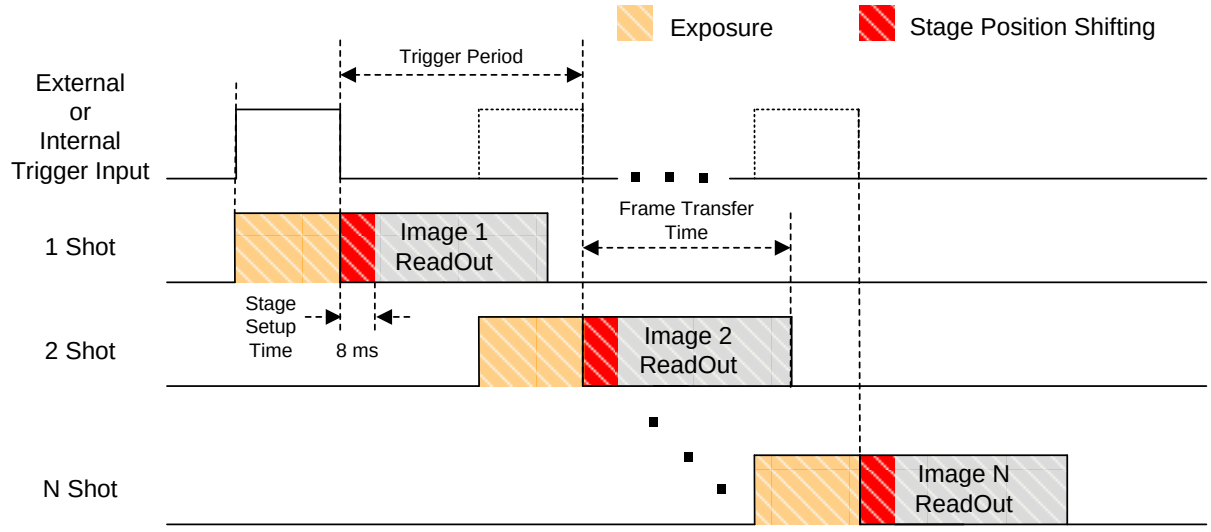


Figure 8.25 Sequence Mode Timing Diagram

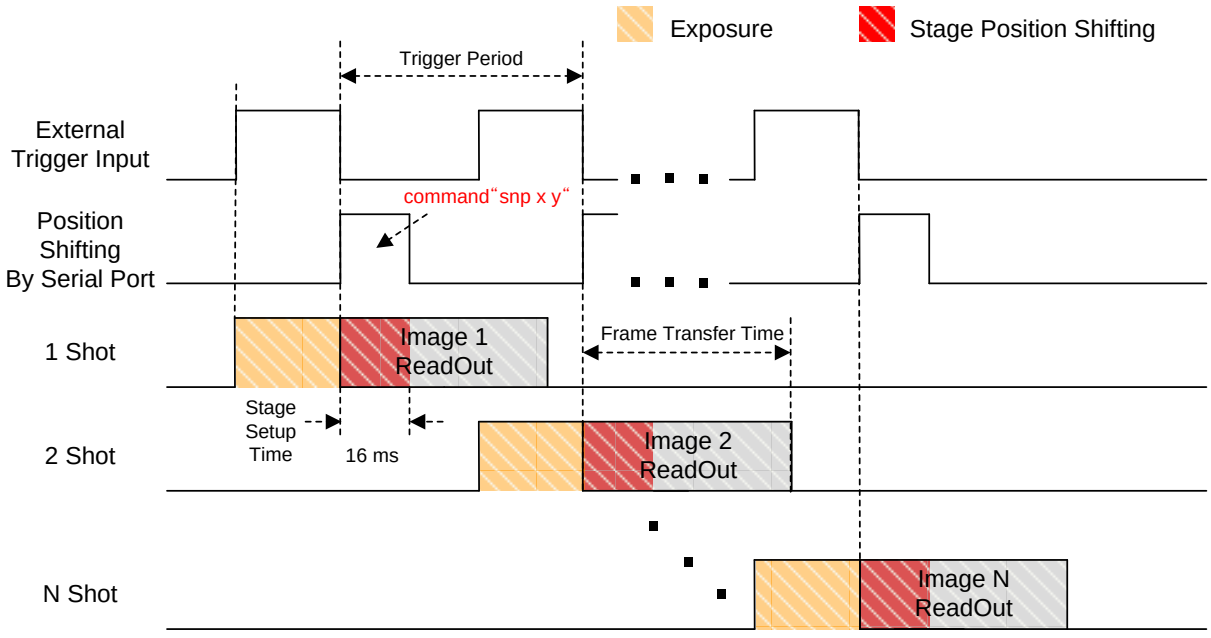


Figure 8.26 Manual Mode Timing Diagram

8.12.2.3 Multi Shot Mode

When Multi Shot Mode is activated, the sequence operation that is followed by the first trigger input will be performed automatically by internal trigger. Internal trigger is generated by calculating the optimized timing reflecting trigger delay and stage setup time. Trigger input from external ports will be ignored until completing the readout of the last image.

```
Multi Shot Enable : 1 trigger N snap
Sequence is performed in sequence with one trigger input.
```

```
Multi Shot Disable : 1 trigger 1 snap
Exposure synchronizes with trigger input and N times trigger input will be
needed to acquire N images.
```

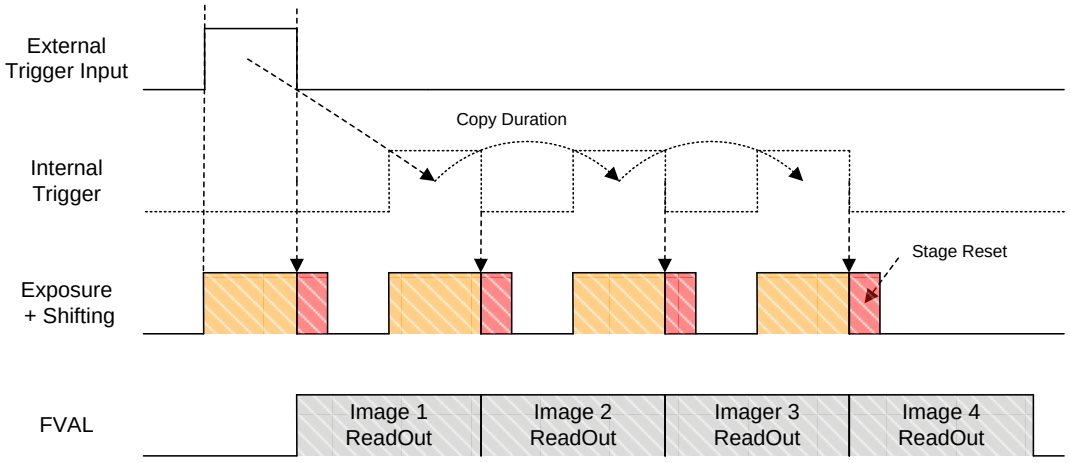


Figure 8.27 Timing Diagram when Multi Shot is enabled on Sequence 4 Shot mode

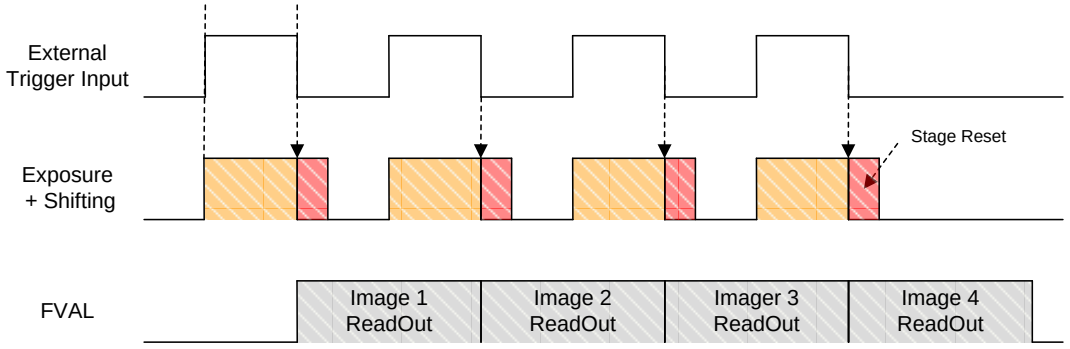


Figure 8.28 Timing Diagram when Multi Shot is disabled on Sequence 4 Shot Mode

8.12.2.4 Stage Reset

The stage can be reset by using Reset command (“rnp”) or Camera Link Camera Control Port (CC2) input.

Stage reset performs following two functions depending on the status of the stage.

- Sequence Mode reset
  - When stage reset command is entered while running the sequence, the camera stops and resets the sequence and then returns to waiting status for trigger input.
- Stage Position Sensor Calibration
  - Zero points can be changed according to temperature changes since the displacement sensor of the stage is sensitive to temperature. This function adjusts zero point of displacement sensor so that the sensor can be maintained within the operating range.

CAUTION	Zero point drift (the displacement sensor strays from the stage’s operating range) may occur according to a physical change on mechanical parts of the camera or temperature change on installed environment. In this case, executing a Stage Reset command will compensate zero point drift to operate the stage normally.

8.12.2.5 Sequence Auto-Reset

This function will be available only when Sequence mode is activated. Sequence Auto-Reset performs Stage Reset (zero point adjustment) whenever one cycle of sequence is completed.

8.12.2.6 Stage Check

The return values of reset command (“rnp”) or move stage command (“snp”) indicate whether a stage normally operates or not. If a stage normally operates, it returns “OK”, “Error” otherwise. If Multishot is enabled, it is possible to check the stage status without using “rnp” command.

When the stage does not normally operate, the camera stops the current sequence and then checks its status via the number of frame. For example, if you set Sequence Mode to 4 shot, the camera acquires and transfers 4 images normally. However, the camera could unexpectedly stop the sequence so that 4 images cannot be transferred in abnormal operation status. At this time, you can verify the number of frame to check the stage status. You can perform more detailed test on the stage by clicking the **Stage Check** button on the **Stage** tab of Configurator. Then you can send test results to local dealer or manufacturer to diagnose the camera stage.

CAUTION	An impact of 10G or more would distort the operation range of stage or alignment of the sensor and cause permanent damage to the stage since it is mechanically sensitive to shocks. Please handle the camera with care.

8.12.2.7 Image Arrangement

To acquire the resulting image, you need to combine shifted images into one result image on the PC side with software processing. Sample source or demo program that is helpful to combine images can be provided from the local dealer or manufacturer.

8.13 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.

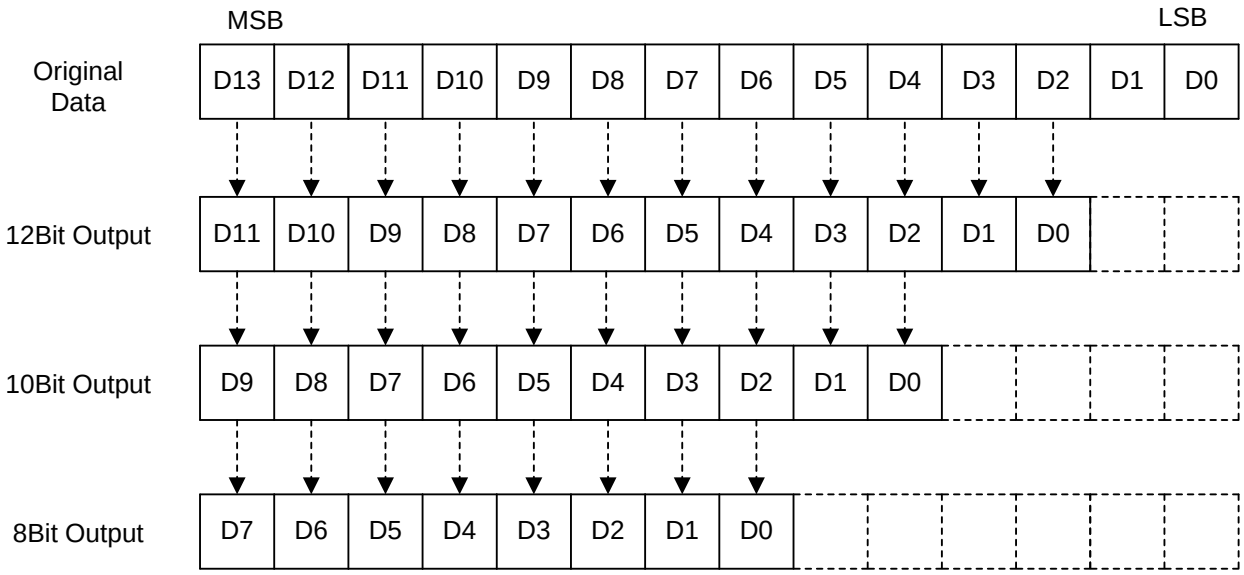


Figure 8.29 Data Format

8.14 Test Image

To check whether the camera operates normally or not, it can be set to output test image generated in the camera, instead of 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). The Test image feature is available in all operation modes of the camera. You can set the Test Image feature by using “sti” command.

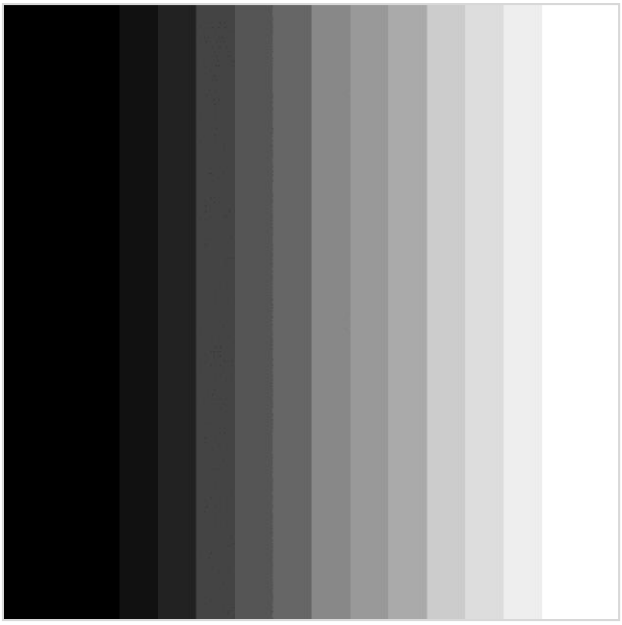


Figure 8.30 Test Image 1

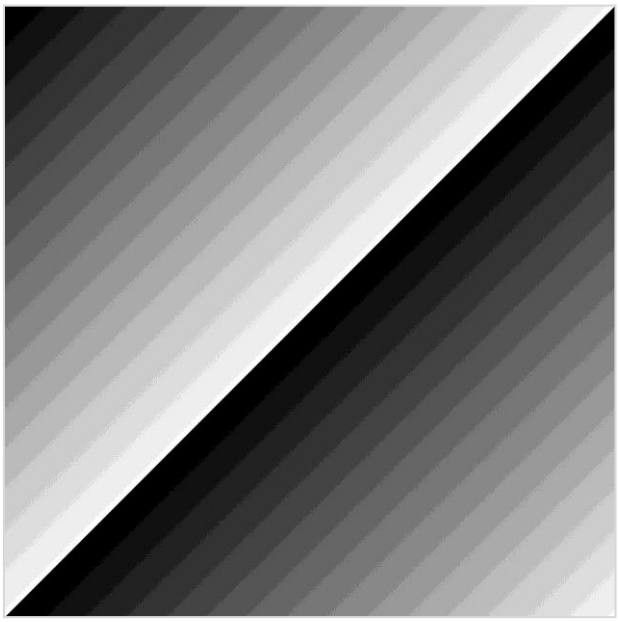


Figure 8.31 Test Image 2

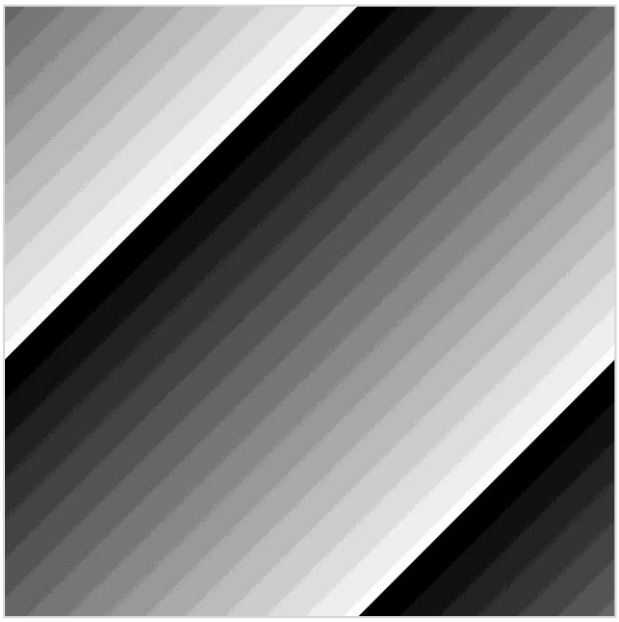


Figure 8.32 Test Image 3

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

8.15 Image Invert

The Image Invert feature lets you invert the level values of the output image. The inverted level values differ depending on the 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 8.33 Original image (Positive)

Figure 8.34 Inverted image (Negative)

8.16 Strobe

The camera provides a Strobe output signal. The signal goes high when the exposure time for each frame acquisition begins and goes low when the exposure time ends. This signal can be used as a flash trigger and is also useful when you are operating a system where either the camera or the object being imaged is movable. Typically, you do not want the camera to move during exposure. You can monitor the Strobe output signal to know when exposure is taking place and thus know when to avoid moving the camera.

8.16.1 Strobe Offset

The Strobe Offset value specifies a delay that will be applied between the point where the shutter signal rises and the point where the Strobe output signal rises. The width of Strobe output signal will be the same as the width of exposure but only the point where the Strobe output signal rises is adjusted. You can set the Strobe Offset in microseconds by using the “sso” command.

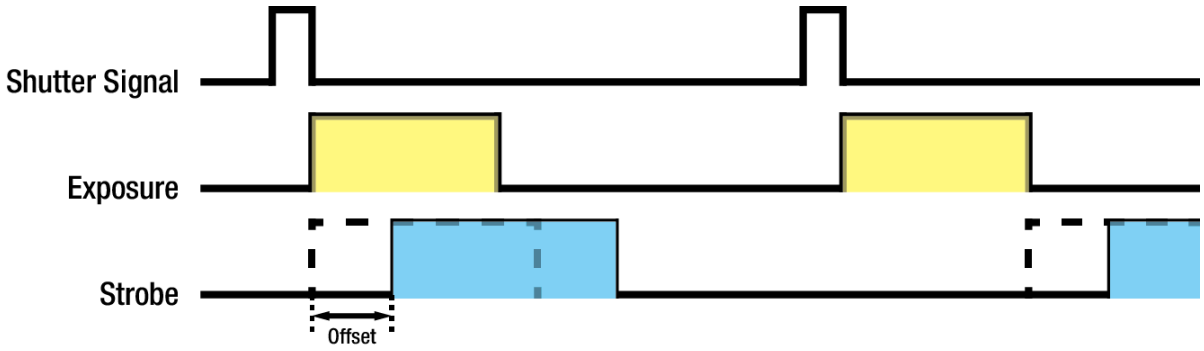


Figure 8.35 Strobe Signal in the Free-Run mode

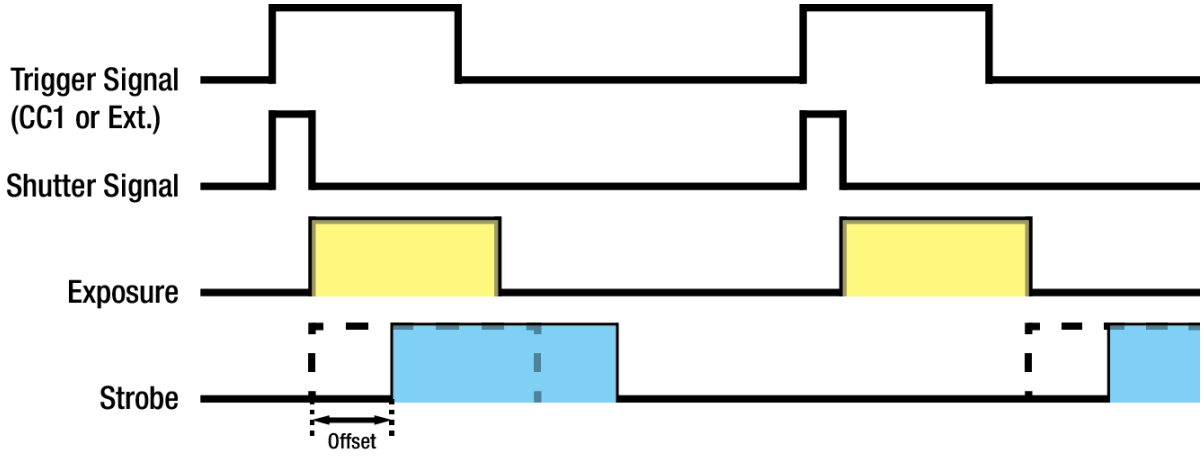


Figure 8.36 Strobe Signal in the Trigger mode

8.16.2 Strobe Polarity

The **Strobe Polarity** is used to select Active High or Active Low triggering. You can set the polarity of the strobe output signal by using the “ssp" command.

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

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

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

```
Command format:
<command> <parameter1> <parameter2> <\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.

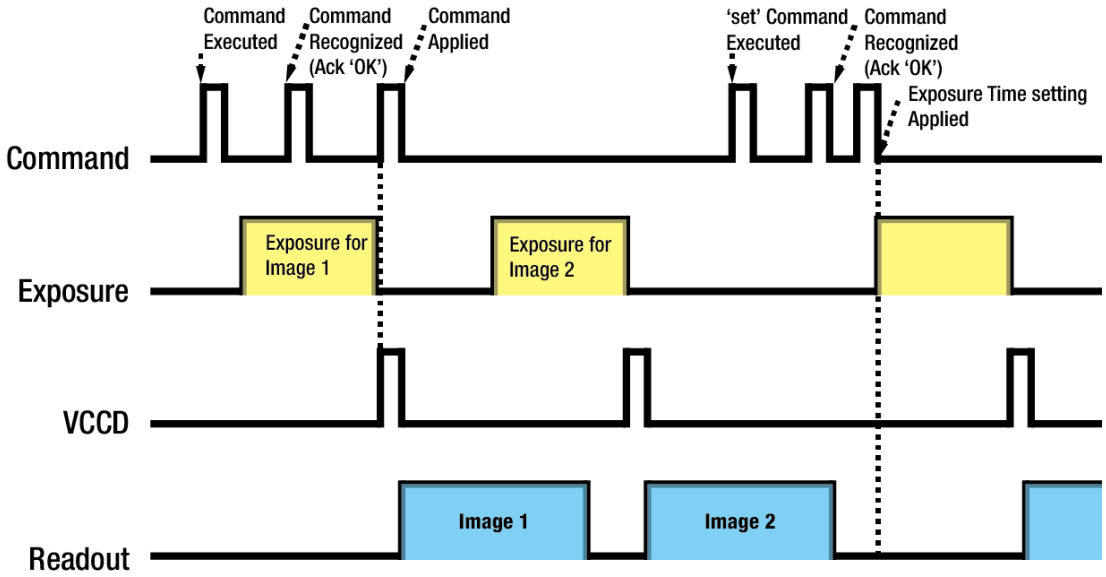


Figure 9.1 Actual Time Applied for Commands

9.3 Parameter Storage Space

The camera provides three non-volatile spaces for storing parameter settings and one volatile work space. The work space contains the camera's current parameter settings. Non-volatile spaces are divided into Factory Space that contains default values entered during the manufacturing, and two user spaces (User 1 Space and User 2 Space) that are available for saving parameter settings by users. Read and write operations are allowed in the user spaces, but only the read operations are allowed in the factory space.

When the camera is powered on or reset, parameter settings stored in one of the storage spaces are loaded into the work space according to the Config Initialization value. These parameter settings will then determine the camera's performance.

The parameter settings in the work space are lost when the camera is powered off or reset. The camera can save parameter settings from the work space to a user space in the camera's non-volatile spaces.

The parameter settings stored in the non-volatile spaces are not lost when the camera is powered off or reset. You can save the current parameter settings to User 1 Space or User 2 Space by using the "sct" command for future use.

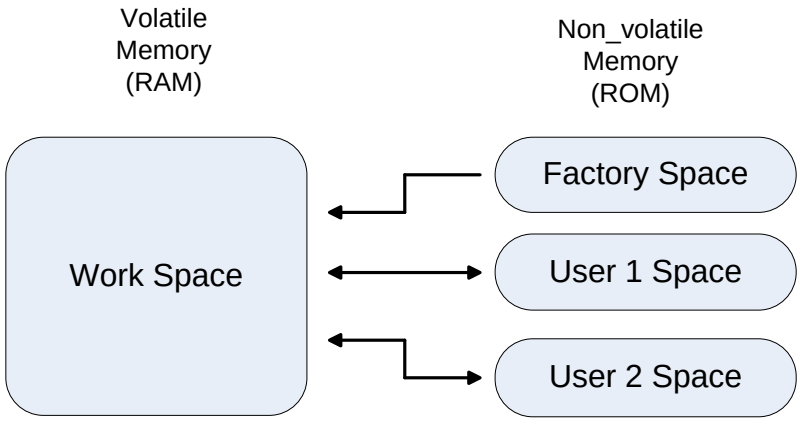


Figure 9.2 Parameter Storage Area

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 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|4 gcm	OK 1|2|4	1: 1 channel mode 2: 2 channel mode 4: 4 channel mode
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 Get Image Invert	sii 0|1 gii	OK 0|1	0: Off 1: Active of Image Invert
Set Trigger Mode Get Trigger Mode	stm 0|1|2|3|4 gtm	OK 0|1|2|3|4	0: Free-Run mode 1: Standard mode 2: Fast mode 3: Double mode 4: Overlap mode
Set Exposure Source Get Exposure Source	ses 0|1 ges	OK 1|2	0: Program Exposure (by camera) 1: Pulse Width (by trigger input signal)
Set Trigger Source Get Trigger Source	sts 1|2 gts	OK 1|2	1: CC1 port input (Camera Link) 2: External input (External control port)
Set Trigger Polarity Get Trigger Polarity	stp 0|1 gtp	OK 0|1	0: Active low 1: Active high
Set Exposure Time Get Exposure Time	set n get	OK n	n: Exposure Time in μs (Setting range: 10 ~ 7,000,000 μs)
Set Strobe Offset Get Strobe Offset	sso n gso	OK n	n: Strobe Offset Time in μs (Setting range: 0 ~ 10,000 μs)
Set Strobe Polarity Get Strobe Polarity	ssp 0|1 gsp	OK 0|1	0: Active low 1: Active high
Set Analog Gain Get Analog Gain	sag n gag	OK n	n: Analog Gain parameter (Setting range: 0 ~ 899)
Set Gain Offset Get Gain Offset	sgo 2|3|4 n ggo 2|3|4	OK n	2: AFE channel for the right top of image 3: AFE channel for the left bottom of image 4: AFE channel for the right bottom of image n: Analog Gain Offset parameter (Setting range: -20 ~ +20)
Auto Gain Offset	ago	OK	Auto-Generation Gain Offset
Set Analog Offset Get Analog Offset	sao n gao	OK n	n: Analog Offset parameter (Setting range: 0 ~ 255)
Set Offset Offset Get Offset Offset	soo 1|2|3|4 n goo 1|2|3|4	OK n	1: AFE channel for the left top of image 2: AFE channel for the right top of image 3: AFE channel for the left bottom of image 4: AFE channel for the right bottom of image n: Analog Offset Offset parameter (Setting range: 0~12)

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 Get Flat Field Iteration	sfi n gfi	OK n	n: (2 ^ n) image acquisitions (Setting range: 0 ~ 4)
Set Flat Field Offset Get Flat Field Offset	sfo n gfo	OK n	n: Flat Field target level (Setting range: 0 ~ 4095)
Set Flat-Field Correction Get Flat-Field Correction	sfc 0|1 gfc	OK 0|1	0: Off 1: Active of Flat-Field Correction

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 (not available) 1: Save to User 1 Setting 2: Save to User 2 Setting
Set Config Initialization Get Config Initialization	sci 0|1|2 gci	OK 0|1|2	0: Load from Factory Setting when initializing 1: Load from User 1 Setting when initializing 2: Load from User 2 Setting when initializing
Get MCU Version	gmv	String	Display MCU version
Get Model Number	gmn	String	Display Camera Model Number
Get FPGA Version	gfv	String	Display 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

Command	Syntax	Value Returned	Description
Set Nano-Stage Position Get Nano-Stage Position	snp <axis> <pos> gnp <axis>	OK <pos>	Move stage to specified position Axis: x or y Pos: position ex) snp x 50: move stage to 50 nm position toward x coordinate.
Reset Nano-Stage Position	rnp	–	Reset stage position to (0, 0) & Calibrate stage position sensor.
Set Sequence Mode Get Sequence Mode	ssm 0|1|2|3|4|5 gsm	OK 0|1|2|3|4|5	0: None (Manual) 1: 4 Shot Mono 2: 9 Shot Mono 3: 4 Shot Color 4: 16 Shot Color 5: 36 Shot Color
Set Multi Shot Enable Get Multi Shot Enable	sme 0|1 gme	OK 0|1	0: Disable 1: Enable
Set Reset Polarity Get Reset Polarity	srp 0|1 grp	OK 0|1	Set Camera Link – CC2 port (Stage Reset) polarity 0: Active low 1: Active high
Set Sequence Auto-Reset Get Sequence Auto-Reset	ssr 0|1 gsr	OK 0|1	Stage reset after stage sequence 0: Off 1: On
Set Fan Control Get Fan Status	sft 0|1 gft	OK 0|1	Control Fan On/Off 0: Fan Off 1: Fan On
Set Peltier Control Get Peltier Status	stc 0|1 gtc	OK 0|1	Control Peltier On/Off 0: Peltier Off 1: Peltier On

Table 9.5 Command List #5

10 Configurator GUI

Configurator, a sample application, is provided to control VP Camera Link series camera. Configurator provides easy-to-use Graphic User Interface (GUI) that allows users to view and change the camera's parameter settings mentioned in the previous chapters.

10.1 Camera Scan

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

Figure 10.1 Configurator Loading Window

10.2 Menu

10.2.1 File

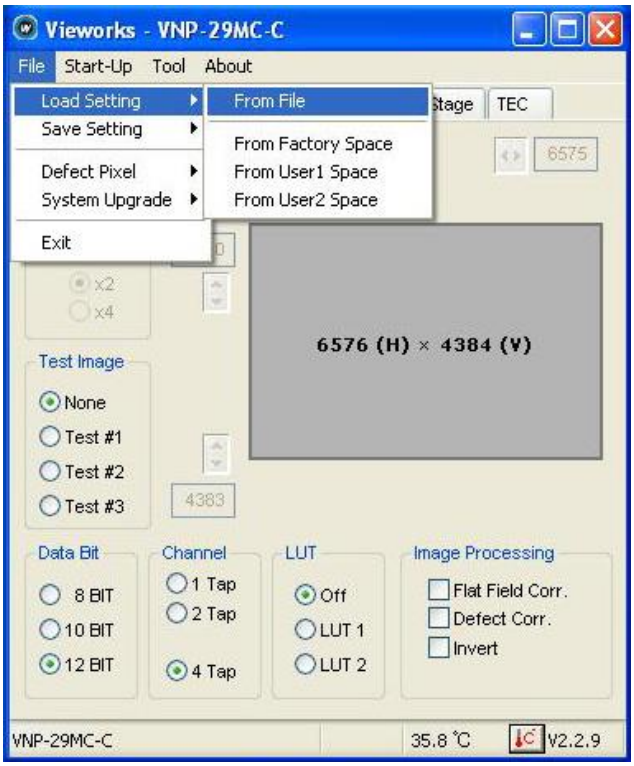


Figure 10.2 File Menu

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

10.2.2 Start-Up

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

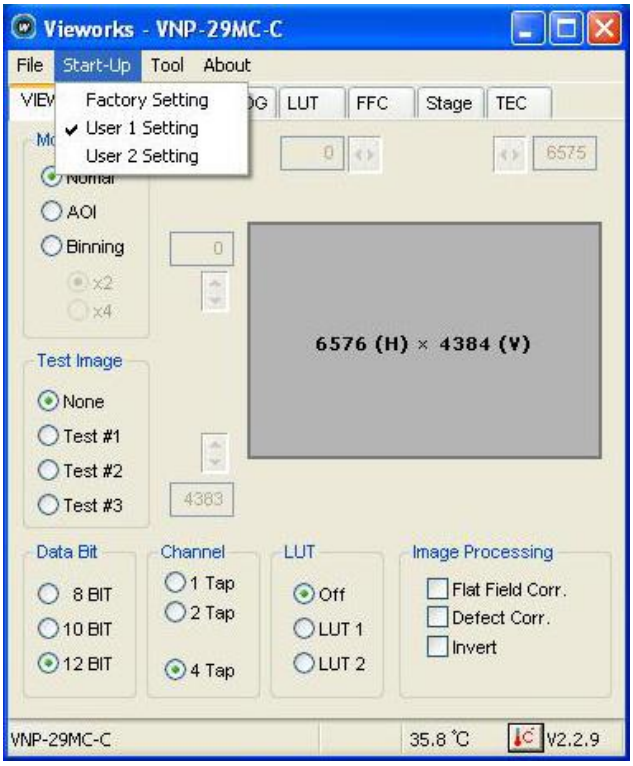


Figure 10.3 Start-Up Menu

- **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

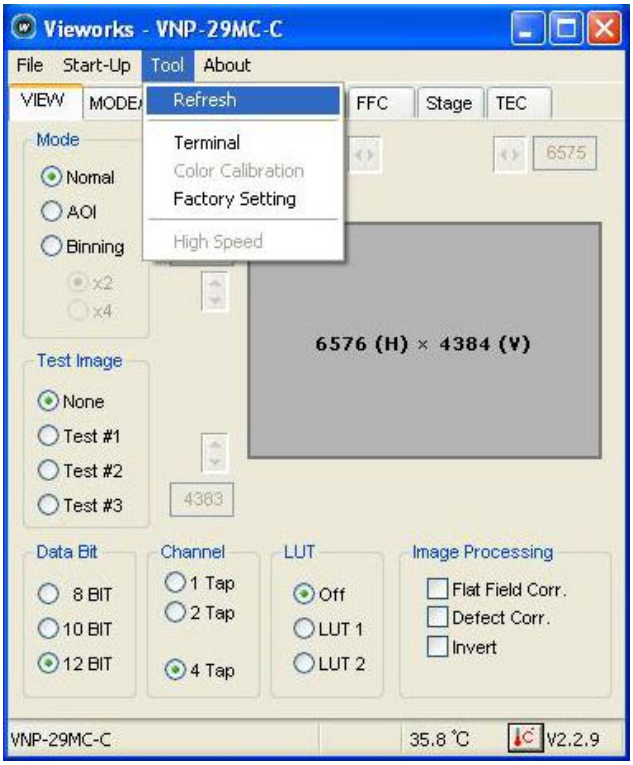


Figure 10.4 Tool Menu

- **Refresh:** Loads and displays the current camera setting values on the Configurator.
- **Terminal:** Displays user commands with a 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.

10.2.4 About

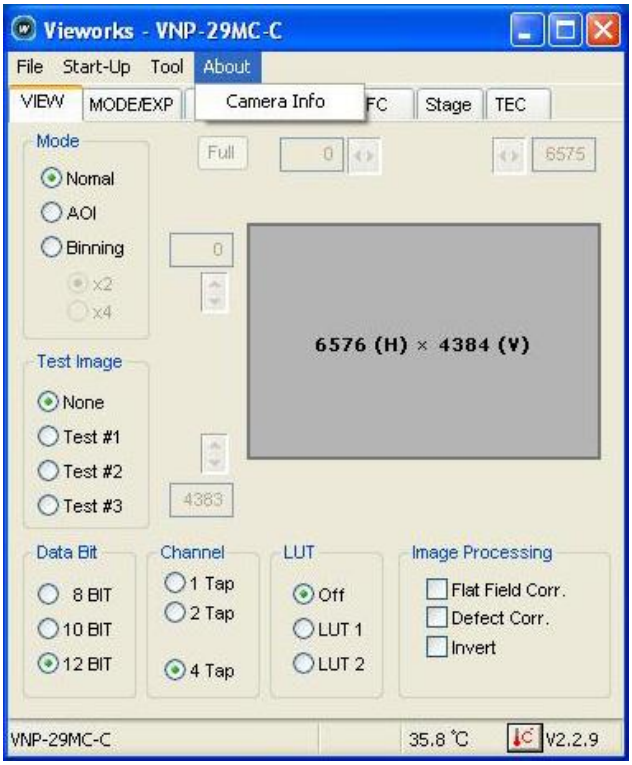


Figure 10.5 About Menu

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

10.3 Tab

10.3.1 VIEW Tab

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

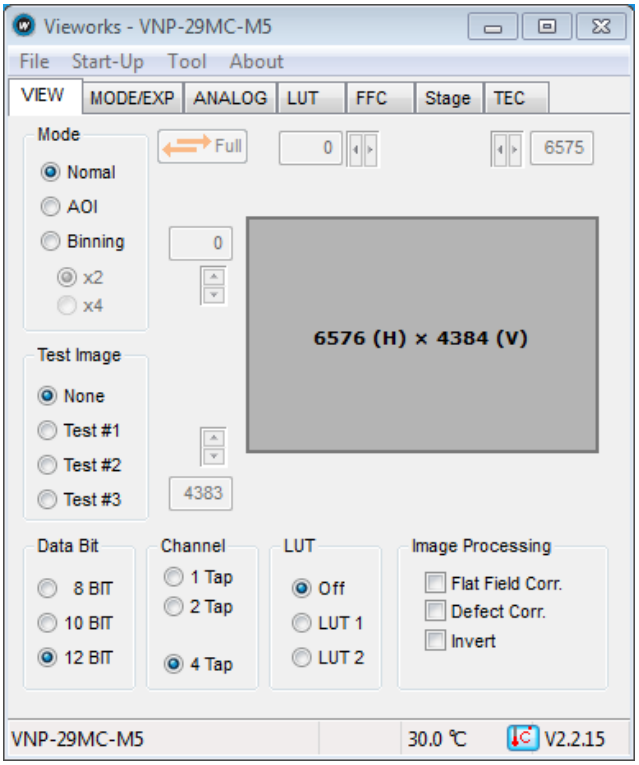


Figure 10.6 VIEW Tab

- **Mode:** Selects the readout mode. If AOI is selected, AOI setting area is activated. You can set the AOI by entering desired values. If Binning is selected, ×2, ×4 option buttons will be activated.
- **Test Image:** Selects whether to apply test image and a type of test images.
- **Data Bit:** Selects bit depth of data output.
- **Channel:** Selects a channel mode.
- **LUT:** Selects whether to apply LUT and a type of LUT.
- **Imaging Processing:** Sets Flat Field Correction, Defect Correction or Image Invert features On or Off.

10.3.2 MODE/EXP Tab

The MODE/EXP tab allows you to configure the camera's trigger mode, exposure time and strobe. All scroll bars in the GUI are controllable with the mouse wheel scroll.

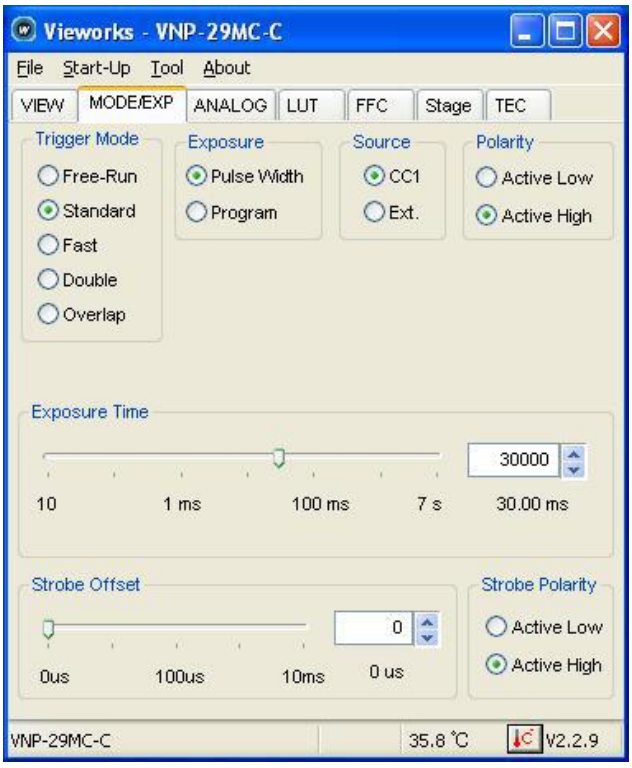


Figure 10.7 MODE/EXP Tab

- **Trigger Mode:** Selects a trigger mode. Once you select a trigger mode, selections related with the trigger mode will be activated.
- **Exposure:** Selects an exposure source.
- **Source:** Selects s source signal for exposure triggering.
- **Polarity:** Selects a polarity of trigger signals.
- **Exposure Time:** Sets exposure time when the Trigger Mode is set to Free-Run or when Exposure is set to Program.
- **Strobe Offset:** Sets a delay for the Strobe output signal.
- **Strobe Polarity:** Selects a polarity of the strobe output signal.

10.3.3 ANALOG Tab

The ANALOG tab allows you to adjust the camera's gain and offset settings. All scroll bars in the GUI are controllable with the mouse wheel scroll.

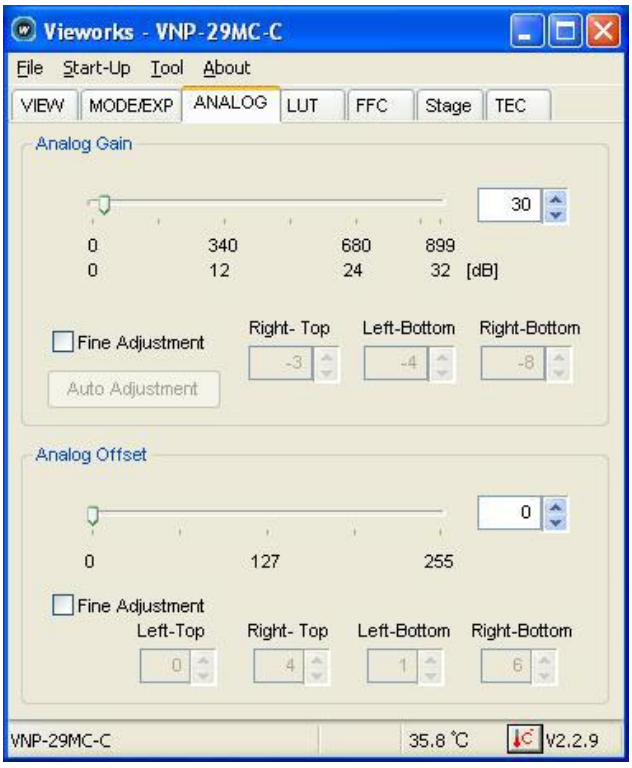


Figure 10.8 ANALOG Tab

- **Analog Gain:** Sets a gain value for each channel. The **Auto Adjustment** button will be activated after checking the **Fine Adjustment** checkbox. Clicking the Auto Adjustment button will compensate the Tap differences automatically. With the Fine Adjustment checkbox selected, you can adjust gain values for each Right-Top, Left-Bottom and Right-Bottom based on the gain values for the Left-Top.

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

- **Analog Offset:** Sets a black offset value for each channel.

10.3.4 LUT Tab

The LUT tab allows you to download LUT data. For more information about LUT download, refer to Appendix B.

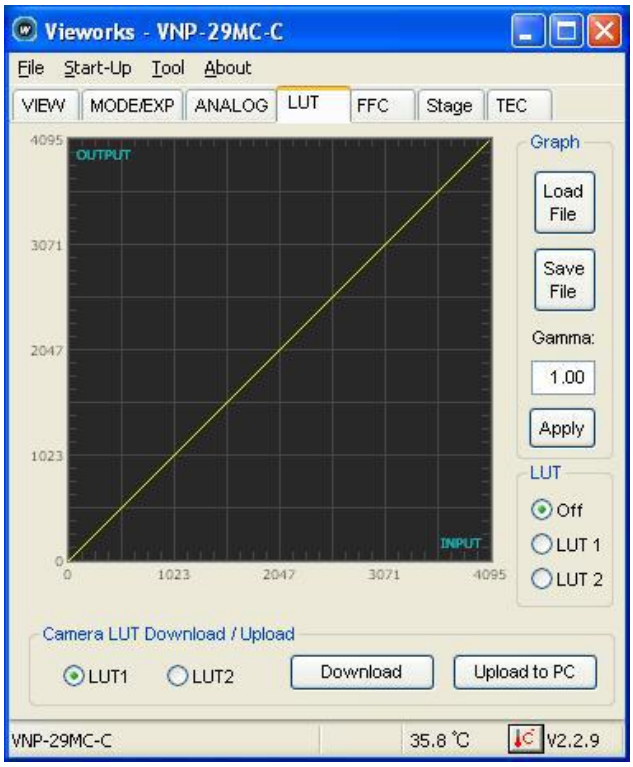


Figure 10.9 LUT Tab

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

10.3.5 FFC Tab

The FFC tab allows you to set Flat Field Correction feature. All scroll bars in the GUI are controllable with the mouse wheel scroll.

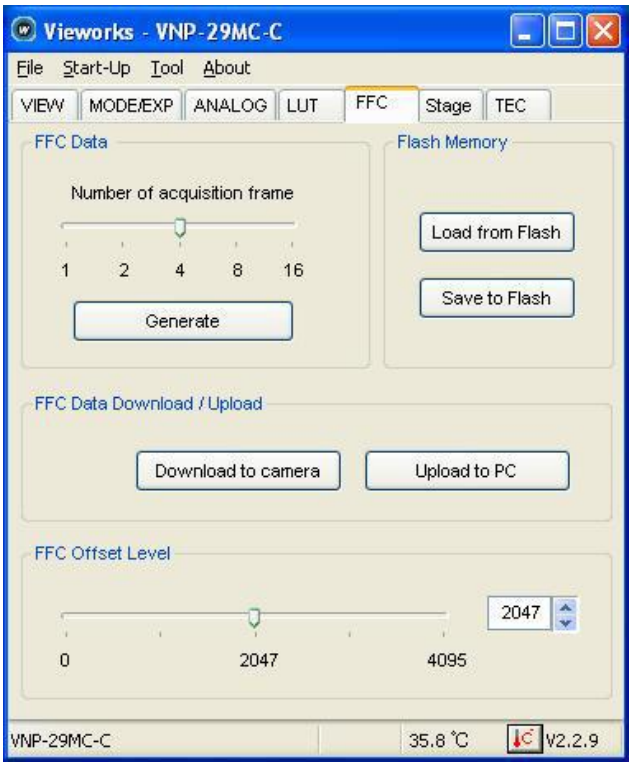


Figure 10.10 FFC Tab

- **FFC data:** Sets the number of frames to be used for generating Flat Field Correction data. Clicking the Generate button will generate Flat Field data.
- **Flash Memory:** Saves the generated FFC data in the Flash for future use (Save to Flash) or loads the FFC data stored in the Flash (Load from Flash).
- **FFC Data Download / Upload:** Downloads the FFC Data stored in user's computer to the camera (Download to camera) or uploads FFC data stored in the camera to user's computer (Upload to PC).
- **FFC Offset Level:** Sets the target value to be applied after correction.

10.3.6 Stage Tab

Before setting the stage, you must set MODE/EXP tab with the following values.

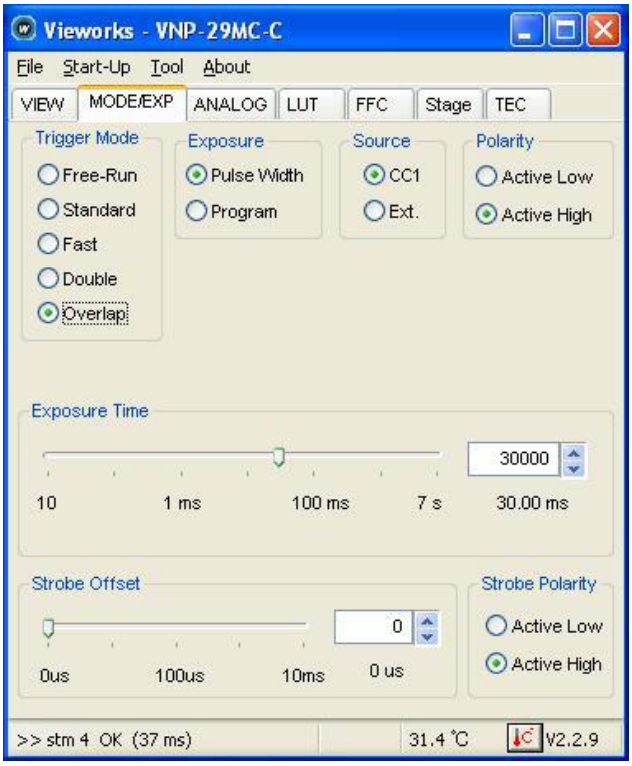


Figure 10.11 MODE/EXP settings for Nano-Stage Control

- **Trigger Mode:** Overlap
- **Exposure:** Pulse Width
- **Source:** CC1
- **Polarity:** Active High

The Stage tab allows you to set Sequence Mode and Nano-Stage.

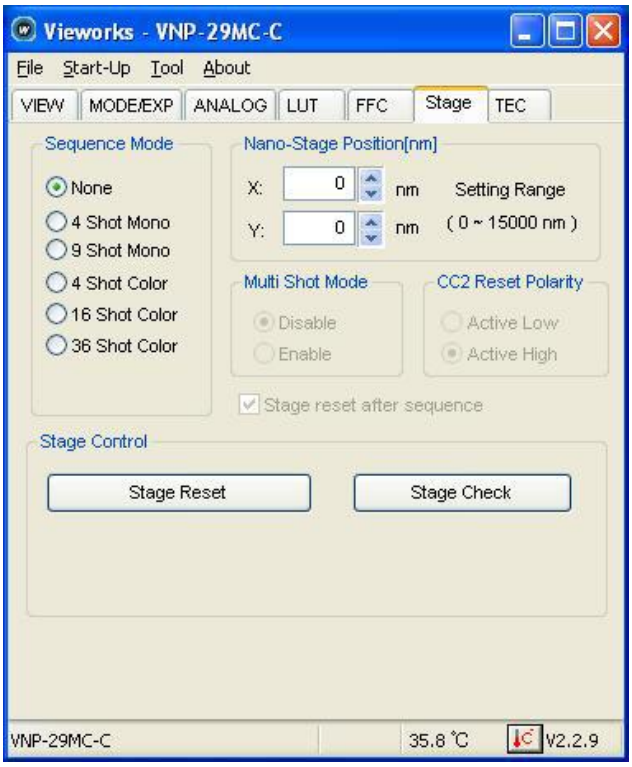


Figure 10.12 Stage Tab

- **Sequence Mode:** Selects Sequence Mode. Deactivated in the Free-Run mode.
  ex) ssm 0 ← None (Manual), ssm 1 ← 4 Shot Mono
- **Nano-Stage Position[nm]**
  - **X:** Sets the stage position of X (Horizontal) direction (applicable range: 0 ~ 15,000 nm).
  - **Y:** Sets the stage position of Y (Vertical) direction (applicable range: 0 ~ 15,000 nm).
- **Multi Shot Mode:** Sets Multi Shot Mode.
  - **Enable:** 1 trigger N snap solution
  - **Disable:** 1 trigger 1 snap solution
    ex) sme0 ← Disable, sme1 ← Enable
- **CC2 Reset Polarity:** Sets the reset polarity using CC2.
- **Stage Reset:** Initializes the stage position and adjusts zero point of displacement sensor.
- **Stage Check:** Performs a self test of the stage.

10.3.7 TEC Tab

The TEC tab allows you to control target temperature of the CCD imaging sensor.

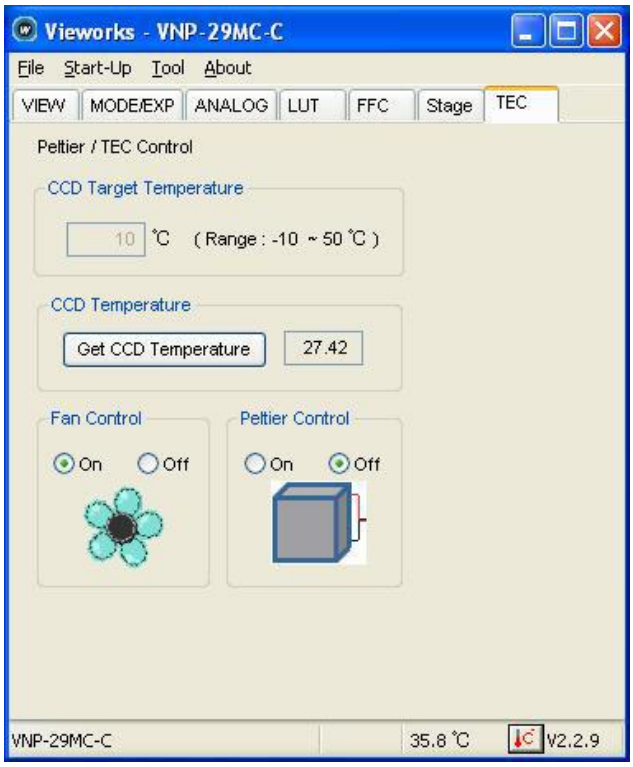


Figure 10.13 TEC Tab

- **CCD Target Temperature:** Sets target temperature of the CCD imaging sensor.
- **CCD Temperature:** Displays the current CCD imaging sensor's temperature value.
- **Fan Control:** Turns the fan On or Off.
- **Peltier Control:** Turns the Peltier On or Off.

11 Troubleshooting

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

- If no image is displayed on your computer,
  - Ensure that all the cable connections are secure.
  - Ensure that the power supply is properly connected.
  - Ensure that trigger signal is applied correctly when you use external trigger mode.

- If images are not clear,
  - Ensure the camera lens or glass is clean.
  - Check the lens aperture is adjusted properly.

- If images are dark,
  - Ensure your camera lens is not blocked.
  - Check the exposure time is set properly.
  - Check the exposure time is set properly.
  - Check the Gain value is not set to small.

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

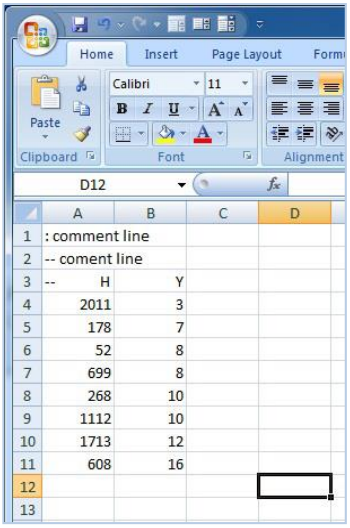
- If you have a problem using the Trigger Mode,
  - Ensure that the trigger related parameters on your Frame Grabber are configured correctly when you use CC1 trigger mode.
  - Ensure that cable connections are secure when you use external trigger mode.

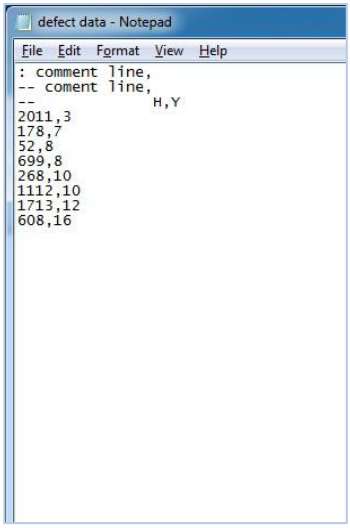
- If you notice the difference between left and right image,
  - Check whether left and right gain settings are different.
  - Check whether left and right offset settings are different.

- If there is a communication failure between the camera and computer,
  - Ensure Camera Link cables are connected properly.
  - Ensure that you have configured a Frame Grabber in your computer correctly and the camera is connected properly to the Frame Grabber.

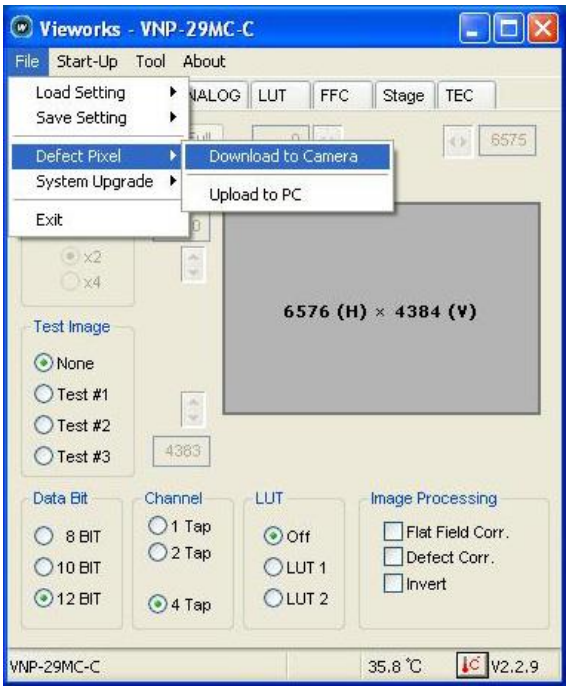
Appendix A Defective Pixel Map Download

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.

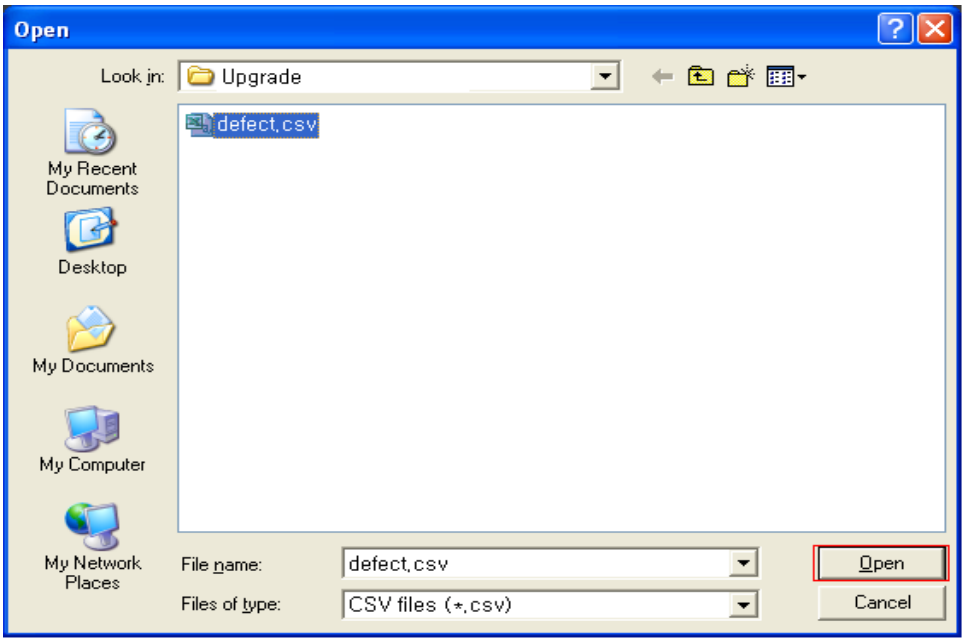




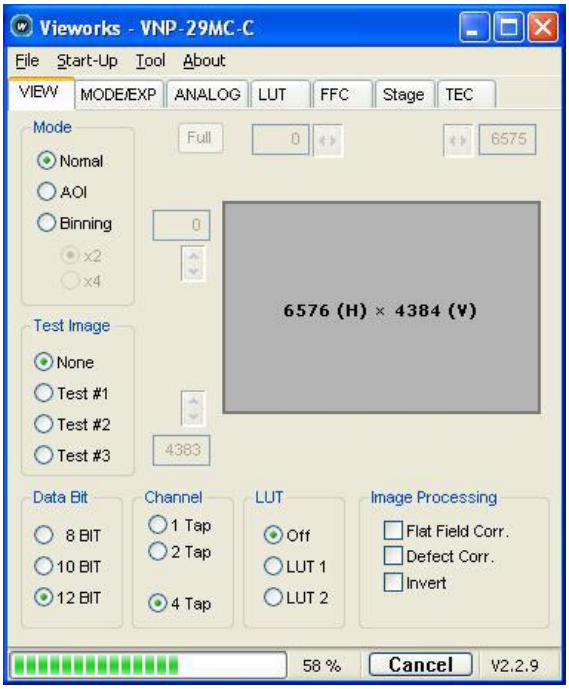
2. Select **File** > **Defect Pixel** > **Download to Camera** on Configurator.



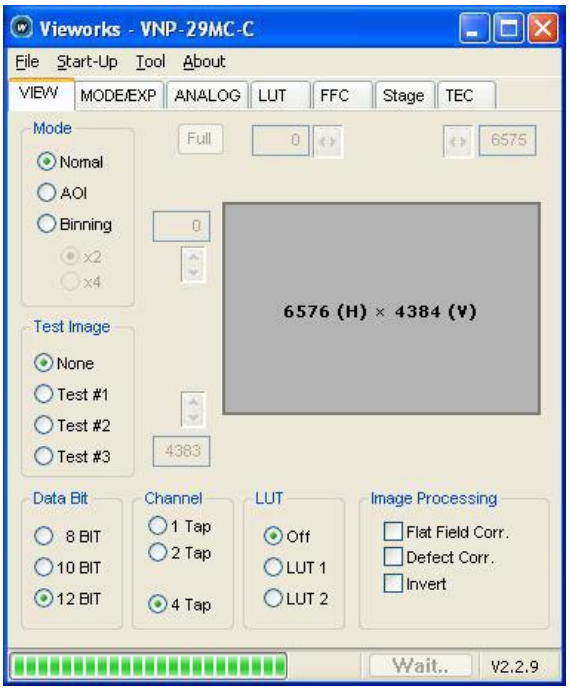
3. Search and select the created file and click **Open**.



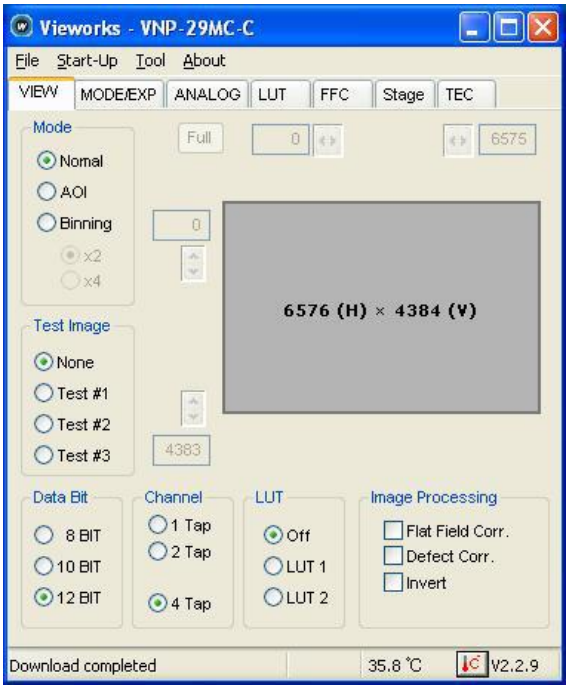
4. Configurator starts downloading defective pixel map data to the camera and downloading status is displayed at the bottom of the window.



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.

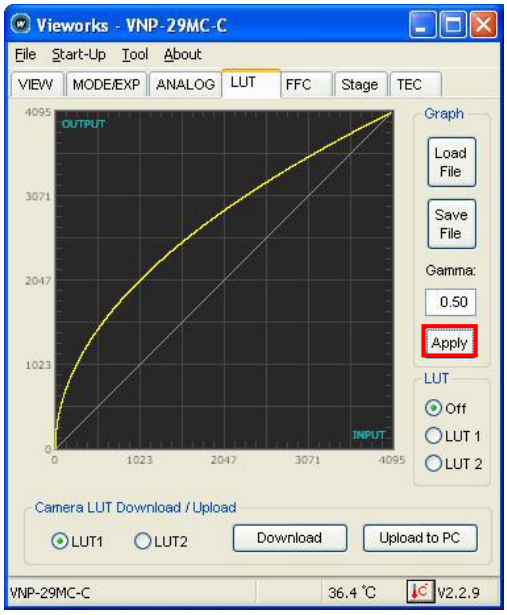


Appendix B LUT Download

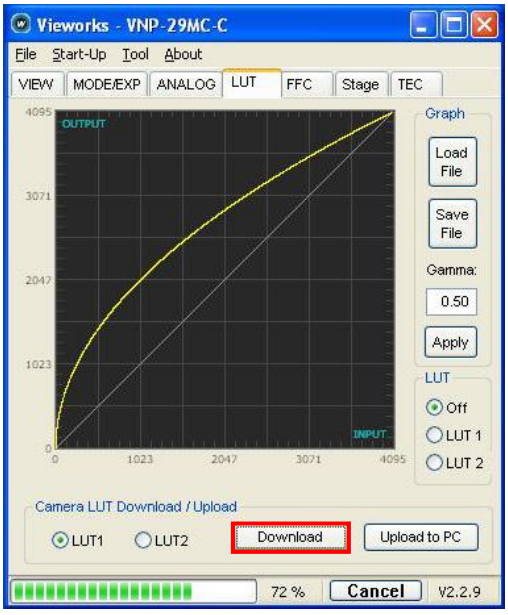
LUT data can be created in two ways; by adjusting the gamma values on the gamma graph provided in the program and then downloading the data or by opening a CSV file (*.csv) and then downloading the data.

B.1 Gamma Graph Download

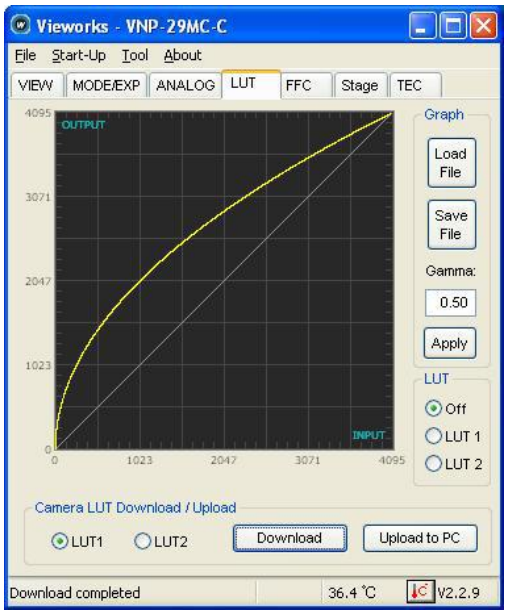
1. Set a desired gamma value on LUT tab and click **Apply**.



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

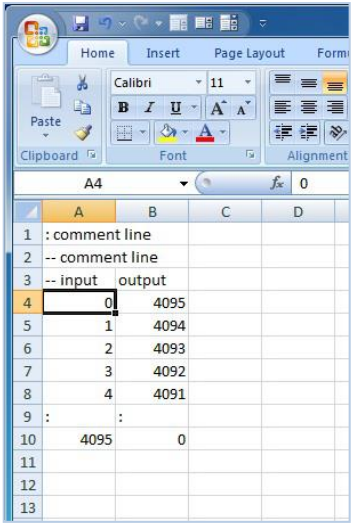


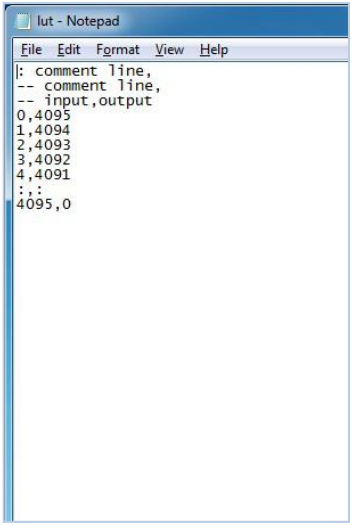
3. Once the download has been completed, **Download completed** message will appear at the bottom of the window.



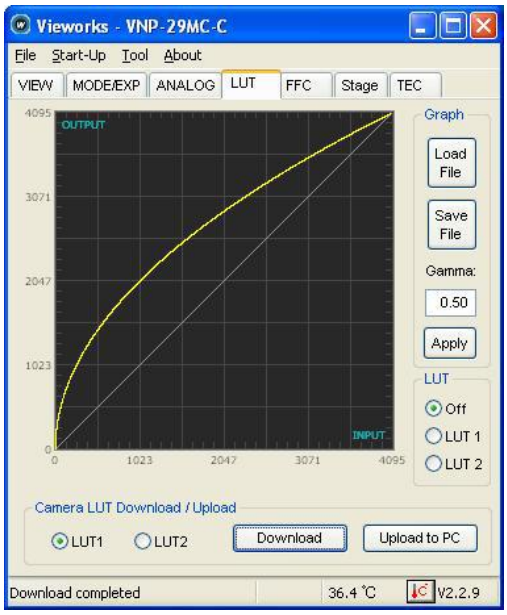
B.2 CSV File Download

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.

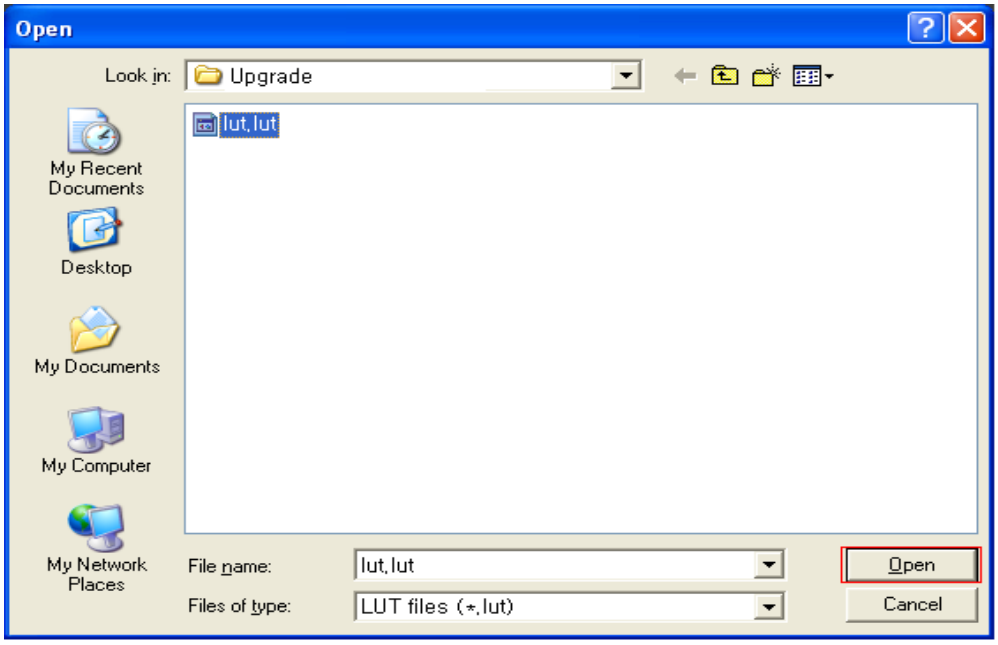




2. Click **Load File** on LUT tab.



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

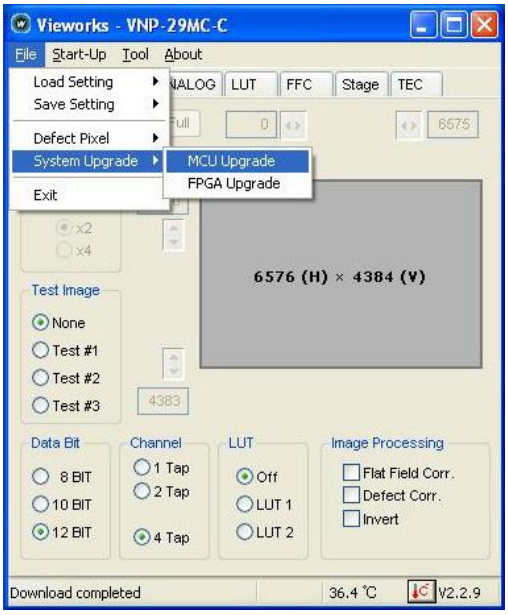


4. Select LUT1 or LUT2 as location to store the data and click **Download**. The subsequent processes are identical to those of Gamma Graph Download.

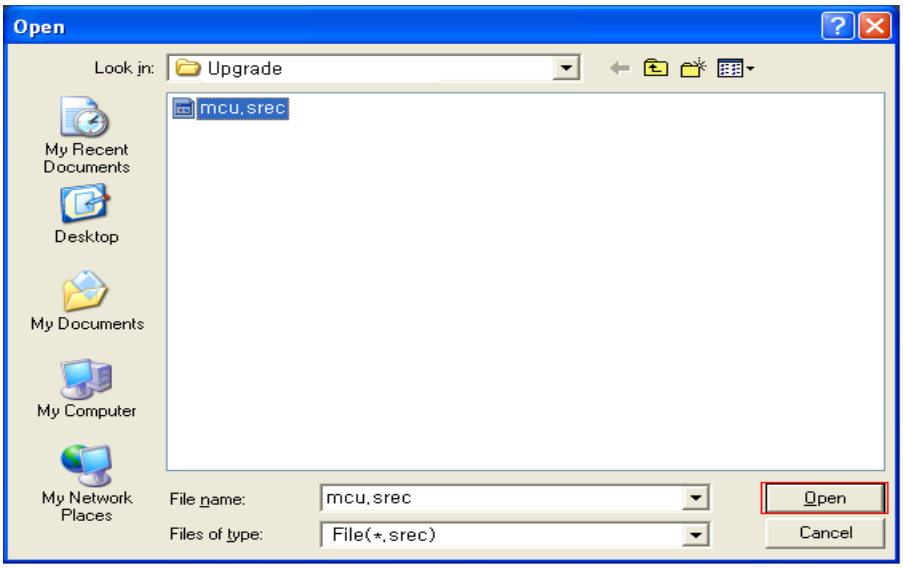
Appendix C Field Upgrade

C.1 MCU

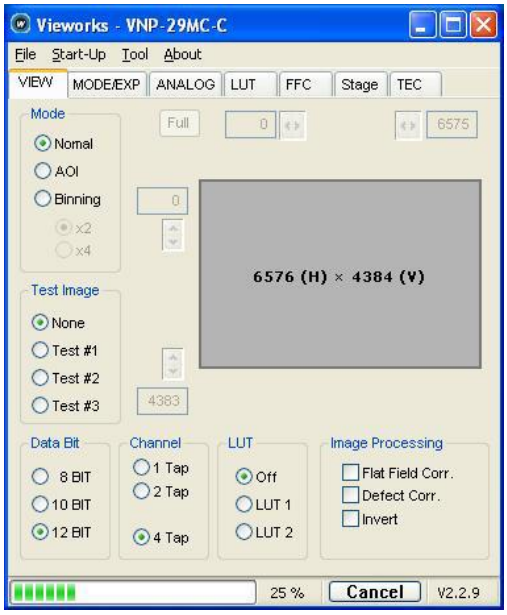
1. Select **File** > **System Upgrade** > **MCU Upgrade** on Configurator.



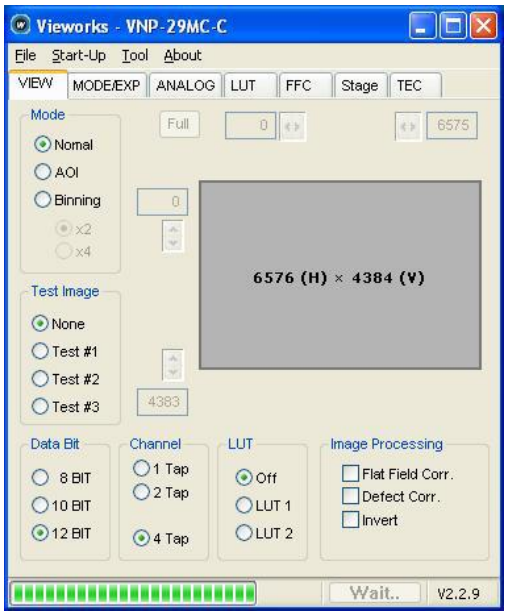
2. Search and select the provided MCU upgrade file (*.srec) then click **Open**.



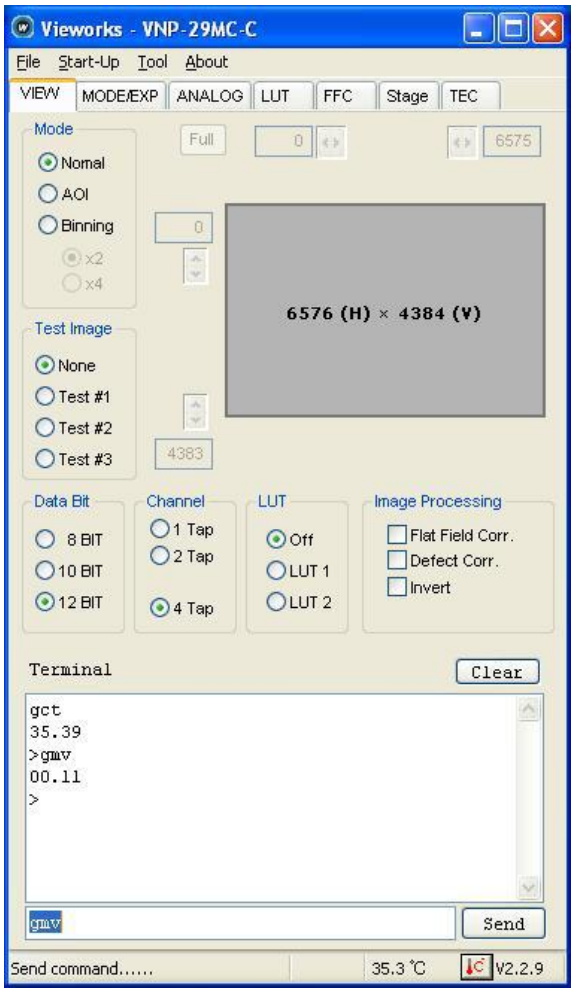
3. Configurator starts downloading MCU upgrade file to the camera and downloading status is displayed at the bottom of the window. If you want to cancel the upgrade process, click **Cancel**. This process requires several minutes to complete.



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.

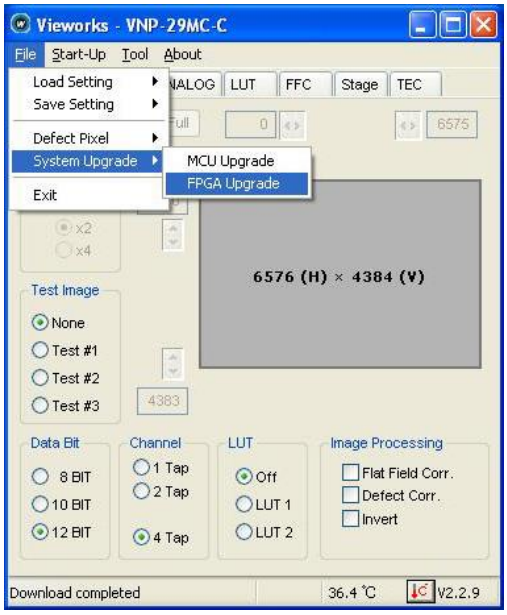


5. Once all the processes have been completed, turn the power off and turn it back on again. Select **Tool** > **Terminal** and enter the “gmv” command to confirm the version. Or, select **About** > **Camera Info** to confirm the MCU version.

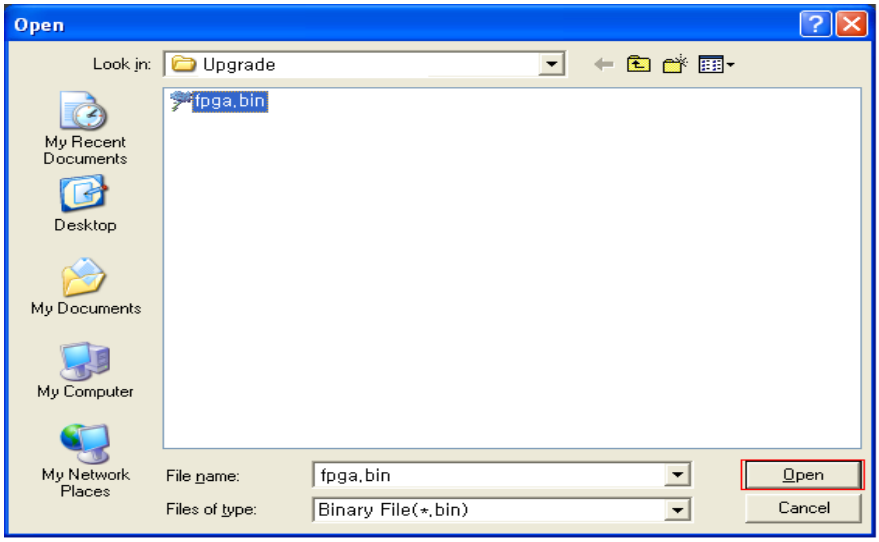


C.2 FPGA

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



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

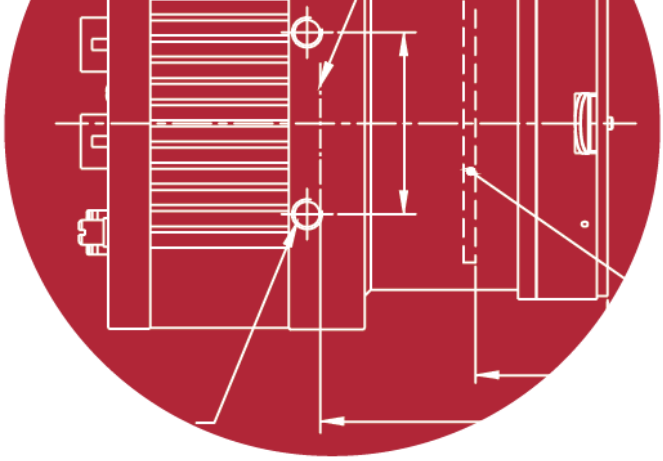


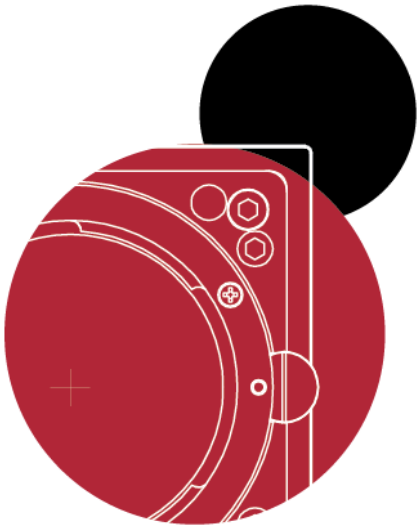
3. The subsequent processes are identical to those of MCU upgrade.

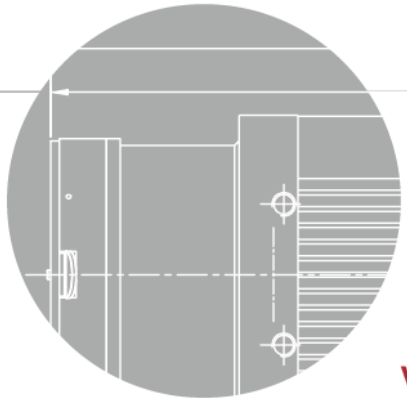
Appendix D Position settings according to sequence modes

Ratio for 1 Pixel

Order	4 Shot Mono		9 Shot Mono		4 Shot Bayer Color		16 Shot Bayer Color		36 Shot Bayer Color	
	X	Y	X	Y	X	Y	X	Y	X	Y
1	0	0	0	0	0	0	0	0	0	0
2	1/2	0	1/3	0	1	0	1	0	1	0
3	0	1/2	2/3	0	0	1	0	1	0	1
4	1/2	1/2	0	1/3	1	1	1	1	1	1
5	-	-	1/3	1/3	-	-	1/2	0	1/3	0
6	-	-	2/3	1/3	-	-	3/2	0	4/3	0
7	-	-	0	2/3	-	-	1/2	1	1/3	1
8	-	-	1/3	2/3	-	-	3/2	1	4/3	1
9	-	-	2/3	2/3	-	-	0	1/2	2/3	0
10	-	-	-	-	-	-	1	1/2	5/3	0
11	-	-	-	-	-	-	0	3/2	2/3	1
12	-	-	-	-	-	-	1	3/2	5/3	1
13	-	-	-	-	-	-	1/2	1/2	0	1/3
14	-	-	-	-	-	-	3/2	1/2	1	1/3
15	-	-	-	-	-	-	1/2	3/2	0	4/3
16	-	-	-	-	-	-	3/2	3/2	1	4/3
17	-	-	-	-	-	-	-	-	1/3	1/3
18	-	-	-	-	-	-	-	-	4/3	1/3
19	-	-	-	-	-	-	-	-	1/3	4/3
20	-	-	-	-	-	-	-	-	4/3	4/3
21	-	-	-	-	-	-	-	-	2/3	1/3
22	-	-	-	-	-	-	-	-	5/3	1/3
23	-	-	-	-	-	-	-	-	2/3	4/3
24	-	-	-	-	-	-	-	-	5/3	4/3
25	-	-	-	-	-	-	-	-	0	2/3
26	-	-	-	-	-	-	-	-	1	2/3
27	-	-	-	-	-	-	-	-	0	5/3
28	-	-	-	-	-	-	-	-	1	5/3
29	-	-	-	-	-	-	-	-	1/3	2/3
30	-	-	-	-	-	-	-	-	4/3	2/3
31	-	-	-	-	-	-	-	-	1/3	5/3
32	-	-	-	-	-	-	-	-	4/3	5/3
33	-	-	-	-	-	-	-	-	2/3	2/3
34	-	-	-	-	-	-	-	-	5/3	2/3
35	-	-	-	-	-	-	-	-	2/3	5/3
36	-	-	-	-	-	-	-	-	5/3	5/3







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