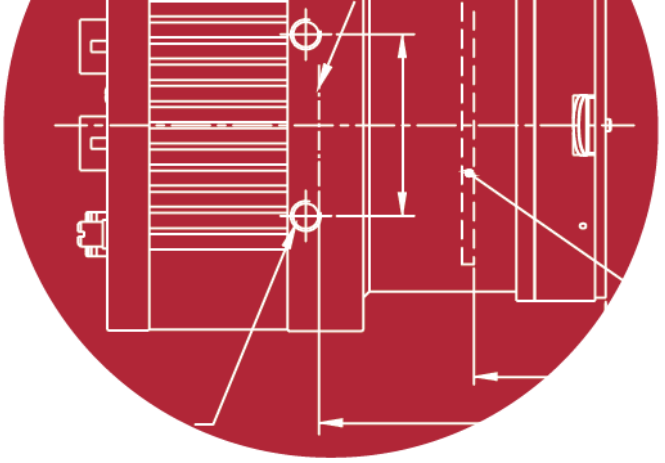


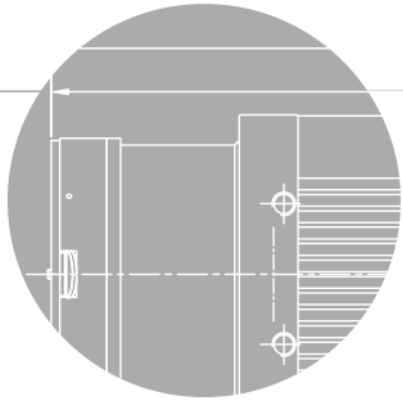
VA series

User Manual

English

VA-1MC
VA-2MC
VA-4MC
VA-8MC
VA-16MC
VA-29MC
VA-47MC

CAMERA Link®



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Revision History

Revision	Date	Description
1.0	2010-01-01	Initial release
1.1	2010-05-10	Revised “ssp”,”stp” command, added “gmn” command
1.2	2010-06-28	Added Serial command response example
1.3	2010-07-23	Revised FPS formula
1.4	2010-11-22	Revised Binning content
1.5	2010-11-28	Revised Model naming conventions
1.6	2011-04-06	Added VA-29M model, Revised Word Style
1.7	2011-07-20	Revised VA series frame rate depending on the minimum AOI, revised AOI Frame Rate formula and timing value for VA series
1.8	2011-08-01	Added 4 Tap-I (Sensor Readout: 4 Tap, Data Output: 2 Tap Interleaved) Added Figure 7.24 Revised Figure 7.6, 7.7, 7.8, 7.9, 7.10, 7.11, 7.12, 7.13, 7.16 Added 4 Tap-I to “scm” command of Table 8.1
1.9	2011-10-26	VA-29M does NOT support 4 Tap-I. Changed VA-29M Timing values – Table 7.1 Added VA-29M Frame Rate by VAOI changes graph – Figure 7.3
2.0	2013-06-14	• Added description of M5 set screws for tilt adjustment • Revised spectral response according to the updated TSI datasheets • Added Actual Time Applied for Commands
2.1	2013-08-06	Corrected Frame Rate by VAOI changes for the VA-4MC
2.2	2014-04-11	Removed the Horizontal Flip feature from VA-29MC
2.3	2014-09-19	• Applied new CI • Added VA-16MC
2.4	2014-11-28	Added DSNU Correction feature to VA-29MC
2.5	2015-02-04	Added missing commands to 9.4 Command List • soo, goo, sps, gps
2.6	2015-05-08	Replaced KAI-08050 with KAI 08051
2.7	2015-07-31	Removed VA-2MC-M/C 64
2.8	2016-04-22	• Revised contents of the Flat Field Correction • Added typical and maximum power requirements • Revised the minimum AOI settings of the VA-16MC and VA-29MC

Revision	Date	Description
2.9	2016-10-21	Added VA-47MC
3.0	2017-03-24	Updated the EMC Directive
3.1	2017-08-21	Added the DSNU Correction feature to the VA-47MC
3.2	2018-05-03	Revised the mechanical dimension of the VA-47MC
3.3	2018-06-15	Revised the maximum allowed frame rate of the VA-29MC (5 fps ➔ 4.8 fps)
3.4	2018-12-14	Updated Quantum Efficiency graphs

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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 Compliance

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

3.2 CE: DoC

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

3.3 KC

KCC Statement

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

4 Package Components

Package Components		
		
VA Camera <C-mount>	or	VA Camera <F-Mount>

VA-47MC Camera <M72-mount>

Package Components

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

Main Features

- Area Of Interest (AOI)
- Trigger Mode
- Binning Mode – 2 × 2 / 4 × 4
- Output Pixel Format – 8 / 10 / 12 bit
- Output Channel – 1 Tap / 2 Tap / 4 Tap / 16 Tap
- Auto Taps Adjustment
- Electronic Shutter – Global Shutter
- 2D Flat Field Correction
- Strobe Output
- Analog Gain adjustment function
- Analog Offset adjustment function
- Advanced PRNU and DSNU Correction (VA-47MC only)
- Tap Linearity Correction (VA-29MC and 47MC only)
- Lookup Table (LUT, All VA cameras except VA-47MC)
- Pixel Defect Correction
- Flat Field Correction
- Test Image
- Horizontal Flip (Only available on VA-1MC, 2MC, 4MC, 8MC and 47MC)
- Image Invert
- RS-644 Serial Communication
- Temperature Monitor
- Field Upgradeable Firmware
- Camera Link Base Configuration (All VA cameras except VA-47MC)
- Camera Link Medium Configuration (VA-47MC only)
- GenICam Compatible – XML-based Control (VA-47MC only)

5.2 Specifications

Technical specifications for VA Camera Link series are as follows:

VA Series		VA-1M	VA-2M	VA-4M
Active Image (H x V)		1024 × 1024	1600 × 1200	2336 × 1752
Sensor (ON Semiconductor)		KAI-01050	KAI-02050	KAI-04050
Pixel Size		5.5 μm × 5.5 μm		
Sensor Output		1, 2 or 4 Tap Output		
Video Output		8/10/12 bits, 1 or 2 Tap (Interleaved or Top & Bottom)		
Camera Interface		Camera Link (Base)		
Electronic Shutter		Global Shutter		
Max. Frame Rate at Full Resolution		125 fps	70 fps	33 fps
Camera Link Pixel Clock	1, 2 Tap	40 MHz		
	4 Tap	80 MHz		
Exposure Time		1/100000 ~ 7 sec (10 μs step)		
Partial Scan (Max. Speed)		337 fps at 120 Lines	183 fps at 150 Lines	142 fps at 200 Lines
Gamma Correction		User defined LUT (Look Up Table)		
Black Offset		Adjustable (0 ~ 127 LSB at 12 bit, 256 step)		
Video Gain		Analog Gain: 0 ~ 32 dB, 900 step		
Trigger Mode		Mode (Free-Run, Overlap, Fast, Double) Programmable exposure time and trigger polarity		
External Trigger		External, 3.3 V - 5.0 V, 10 mA, optically isolated		
Software Trigger		Camera Link CC1, Programmable Exposure		
Dynamic Range		64 dB		
Lens Mount		C-mount or F-mount		
Power		10 ~ 14 V DC Typ. 6 W / Max. 7 W	10 ~ 14 V DC Typ. 6.5 W / Max. 7 W	10 ~ 14 V DC Typ. 6.5 W / Max. 8.5 W
Environmental		Operating: -5℃ ~ 40℃, Storage: -40℃ ~ 70℃		
Mechanical		68 mm × 68 mm × 54 mm, 420 g (with C-mount) 68 mm × 68 mm × 83 mm, 460 g (with F-mount)		

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

VA Series		VA-8M	VA-16M	VA-29M
Active Image (H x V)		3296 × 2472	4896 × 3264	6576 × 4384
Sensor (ON Semiconductor)		KAI-08051	Kodak KAI-16050	Kodak KAI-29050
Pixel Size		5.5 μm × 5.5 μm		
Sensor Output		1, 2 or 4 Tap Output		
Video Output		8/10/12 bits, 1 or 2 Tap (Interleaved or Top & Bottom)		
Camera Interface		Camera Link (Base)		
Electronic Shutter		Global Shutter		
Max. Frame Rate at Full Resolution		16 fps	8 fps (High Speed)	4.8 fps (High Speed)
Camera Link Pixel Clock	1, 2 Tap	40 MHz	Normal Speed: 30 MHz / High Speed: 40 MHz	
	4 Tap	80 MHz	Normal Speed: 60 MHz / High Speed: 80 MHz	
Exposure Time		1/100000 sec ~ 7 sec (10 μs step)		
Partial Scan (Max. Speed)		84 fps at 300 Lines	23 fps at 1000 Lines	15.2 fps at 1000 Lines
Gamma Correction		User defined LUT (Look Up Table)		
Black Offset		Adjustable (0 ~ 127 LSB at 12 bit, 256 step)		
Video Gain		Analog Gain: 0 ~ 32 dB, 900 step		
Trigger Mode		Mode (Free-Run, Overlap, Fast, Double) Programmable exposure time and trigger polarity		
External Trigger		External, 3.3 V - 5.0 V, 10 mA, optically isolated		
Software Trigger		Camera Link CC1, Programmable Exposure		
Dynamic Range		66 dB	64 dB	
Lens Mount		C-mount or F-mount	F-mount, Custom mount available upon request	
Power		10 ~ 14 V DC Typ. 7 W / Max. 8.5 W	10 ~ 14 V DC Typ. 8 W / Max. 9 W	10 ~ 14 V DC Typ. 9.5 W / Max. 12 W
Environmental		Operating: -5℃ ~ 40℃, Storage: -40℃ ~ 70℃		
Mechanical		68 mm × 68 mm × 54 mm, 420 g (with C-mount) 68 mm × 68 mm × 83 mm, 460 g (with F-mount)		68 mm × 68 mm × 104 mm 500 g (with F-mount)

Table 5.2 Specifications of VA Series (VA-8M/16M/29M)

VA Series		VA-47M
Active Image (H × V)		8856 × 5280
Sensor (ON Semiconductor)		KAI-47051
Pixel Size		5.5 μm × 5.5 μm
Sensor Output		16 Tap Output
Video Output		8/10/12 bits, 4 Tap (1X2-2YE)
Camera Interface		Camera Link (Medium)
Electronic Shutter		Global Shutter
Max. Frame Rate at Full Resolution		7 fps
Camera Link Pixel Clock	16 Tap	85 MHz
Exposure Time		28 sec ~ 60 sec (10 μs step)
Partial Scan (Max. Speed)		10 fps at 1056 Lines
Black Offset		Adjustable (0 ~ 255 LSB at 12 bit)
Video Gain		×1 ~ ×4
Trigger Mode		Free-Run, Timed Exposure, Trigger Width Exposure
External Trigger		3.3 V - 24.0 V, 10 mA, Asynchronous, optically isolated
Software Trigger		Camera Link CC1, Programmable Exposure
Dynamic Range		66 dB
Lens Mount		M72-mount, Custom mount available upon request
Fan / Heat Sink		VA-47MC is available with a Fan by default. (An optional heat sink instead of the fan is available upon request.)
Power		10 ~ 15 V DC Typ. 16 W / Max. 17 W, Inrush current: 1.6 A
Environmental		Operating: -5℃ ~ 40℃, Storage: -40℃ ~ 70℃
Mechanical		85 mm × 85 mm × 71 mm, 660 g (with M72-mount)

Table 5.3 Specifications of VA Series (VA-47M)

5.3 Camera Block Diagram

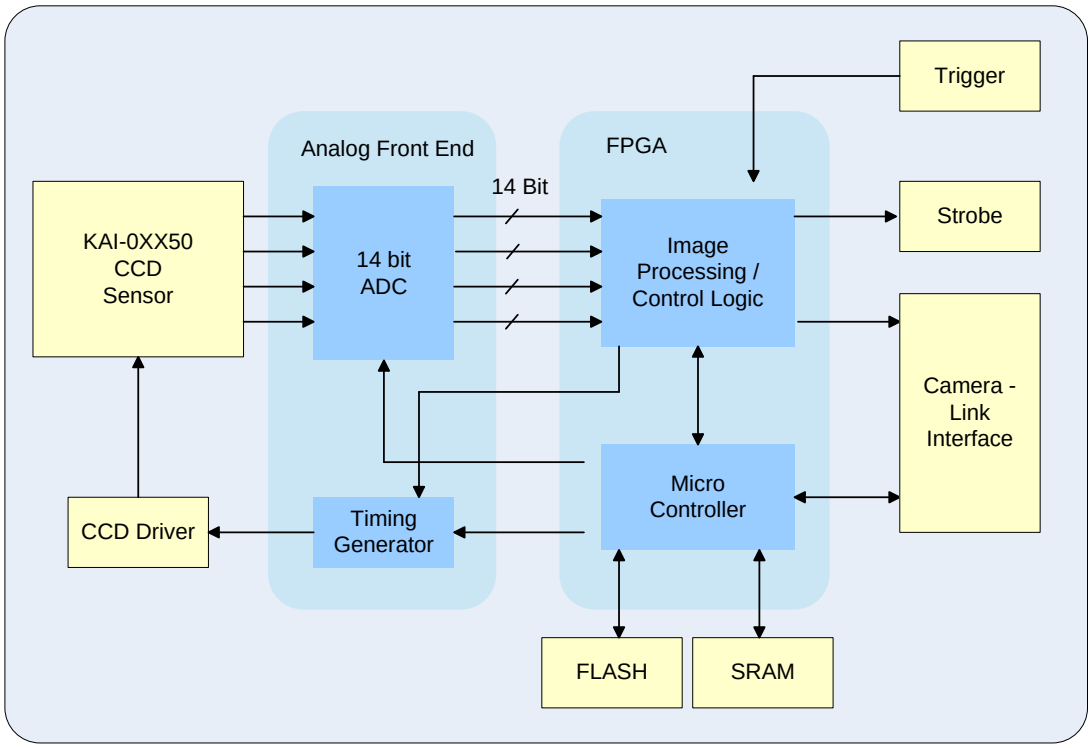


Figure 5.1 Camera Block Diagram

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

5.4 Spectral Response

5.4.1 Mono Camera Spectral Response

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

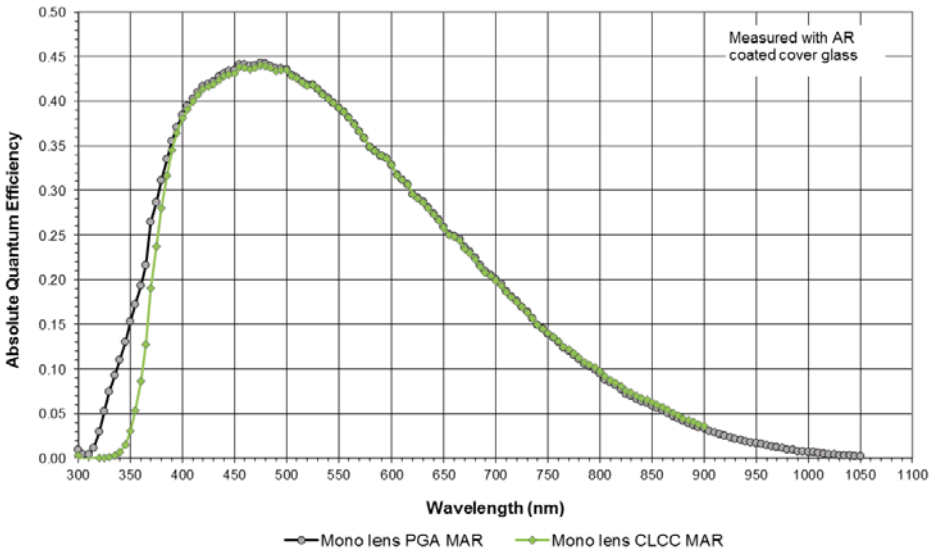


Figure 5.2 VA-1MC-M120 Spectral Response

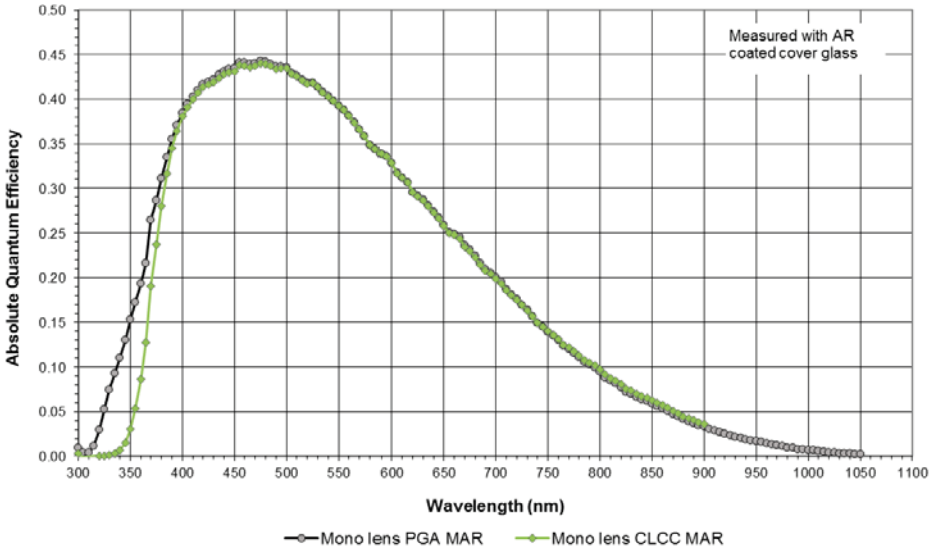


Figure 5.3 VA-2MC-M68 Spectral Response

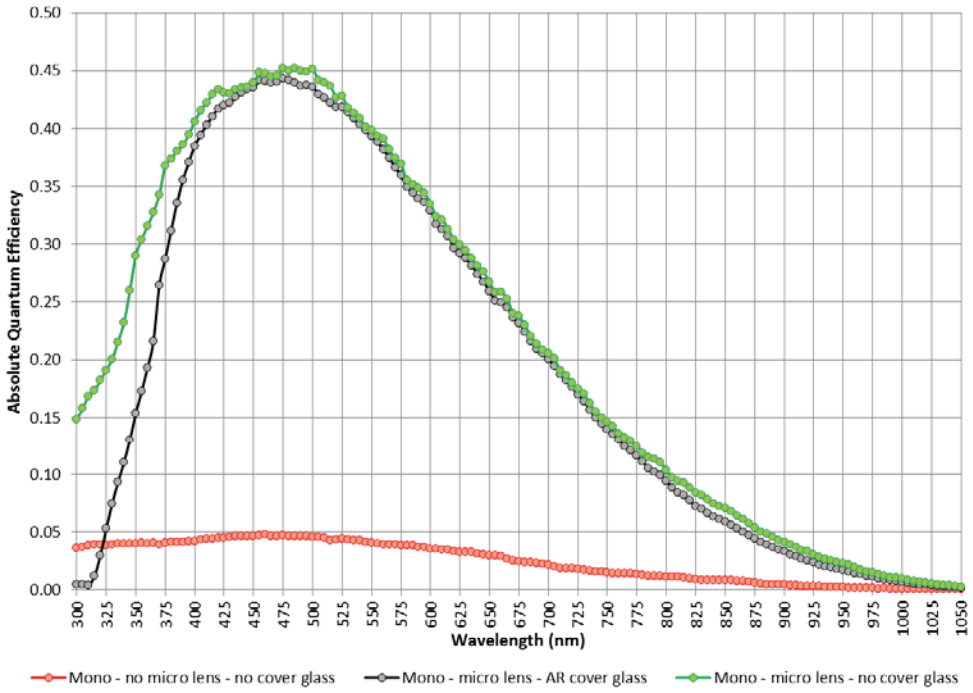


Figure 5.4 VA-4MC-M32 Spectral Response

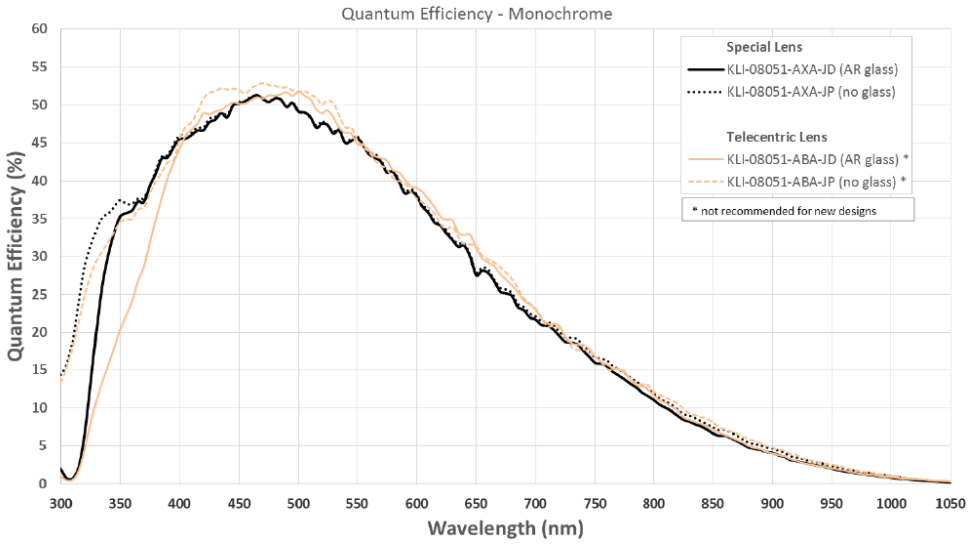


Figure 5.5 VA-8MC-M16 Spectral Response

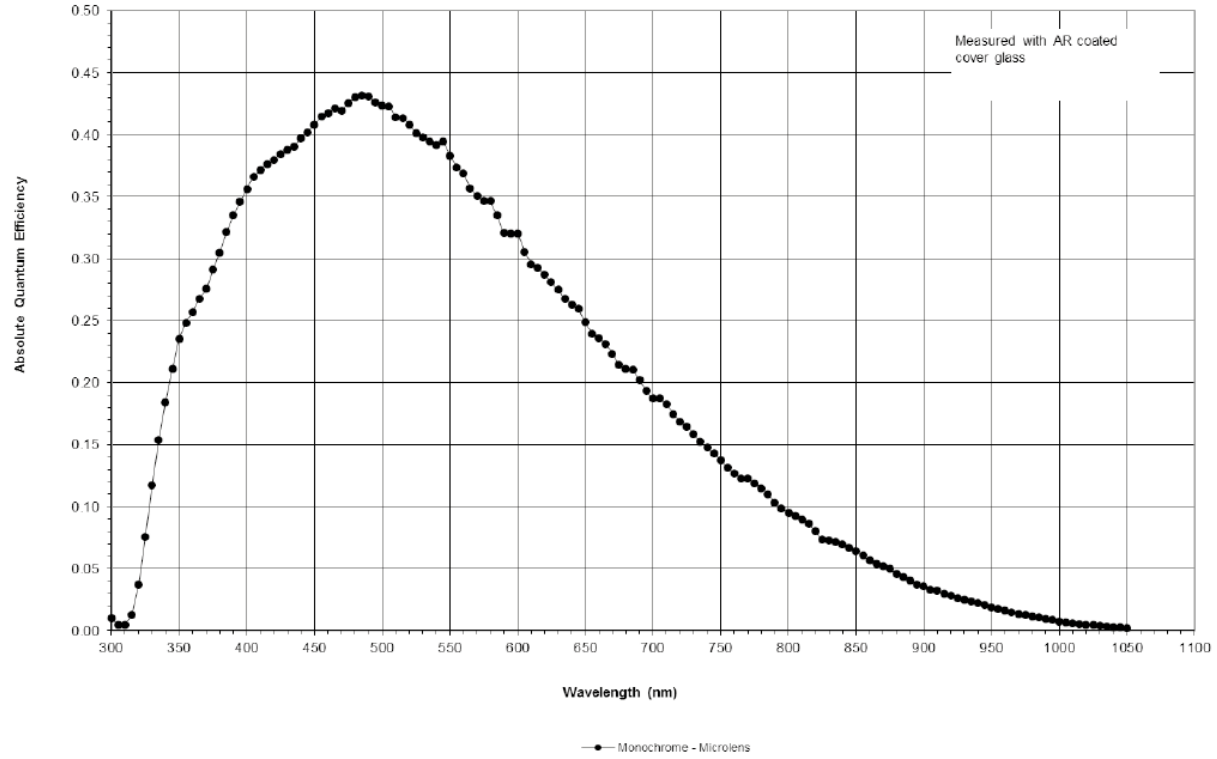


Figure 5.6 VA-16MC-M8 Spectral Response

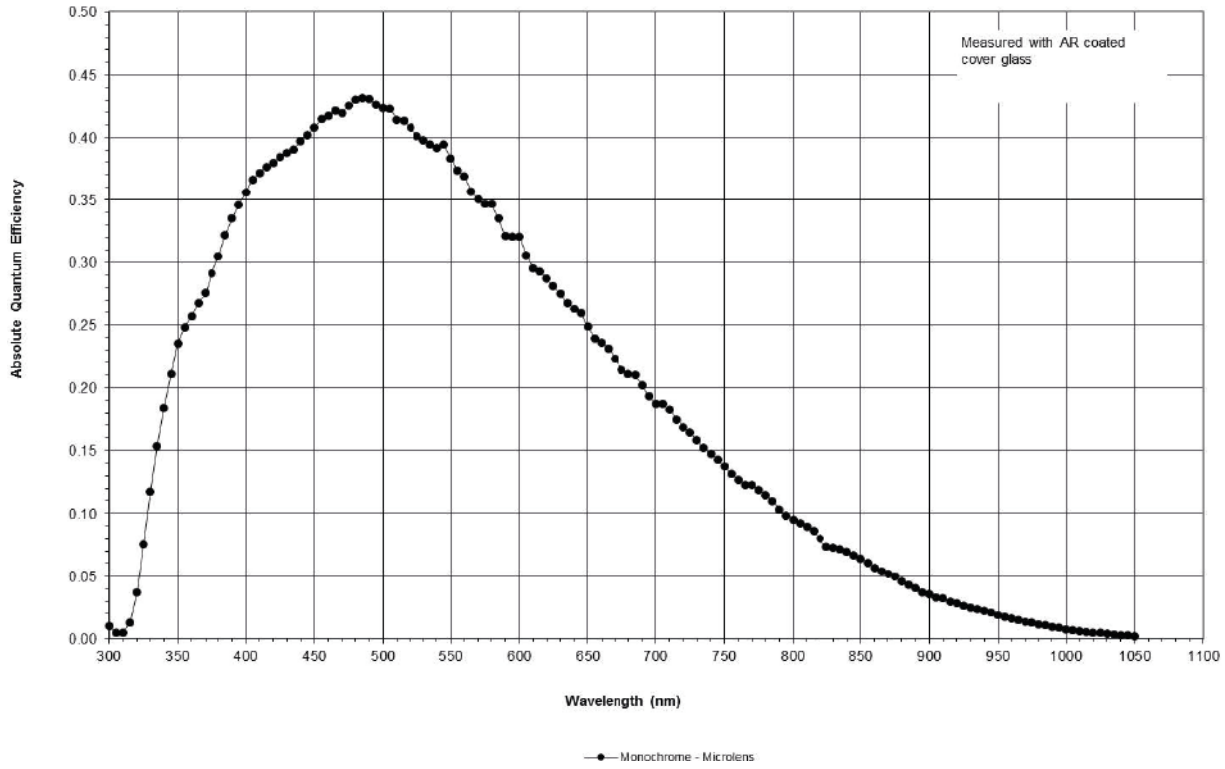


Figure 5.7 VA-29MC-M5 Spectral Response

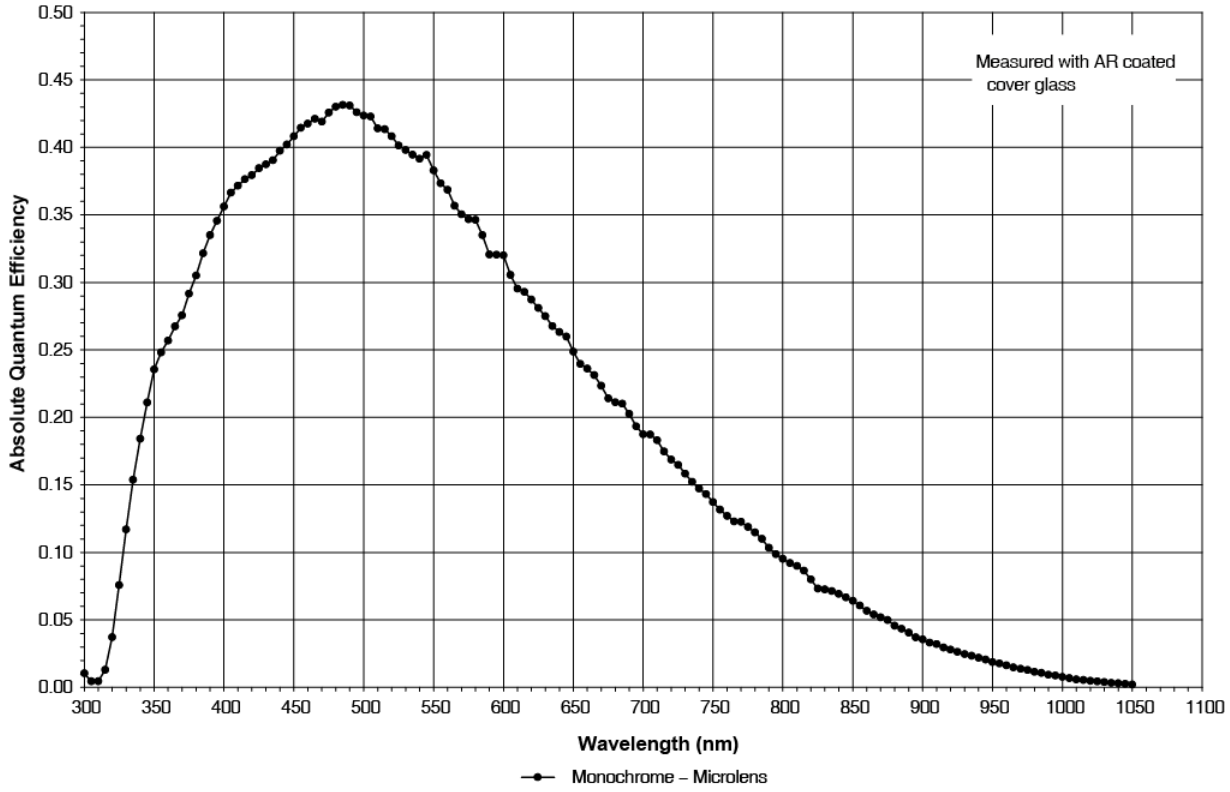


Figure 5.8 VA-47MC-M7 Spectral Response

5.4.2 Color Camera Spectral Response

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

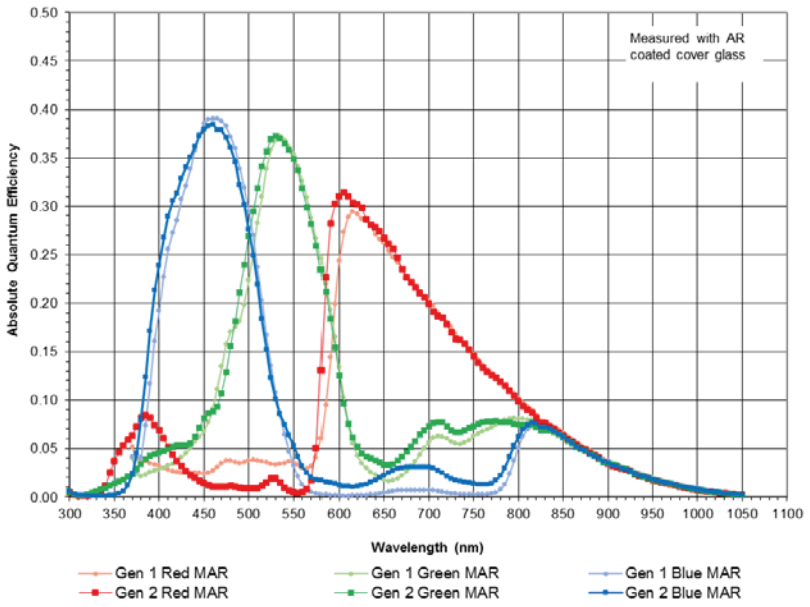


Figure 5.9 VA-1MC-C120 Spectral Response

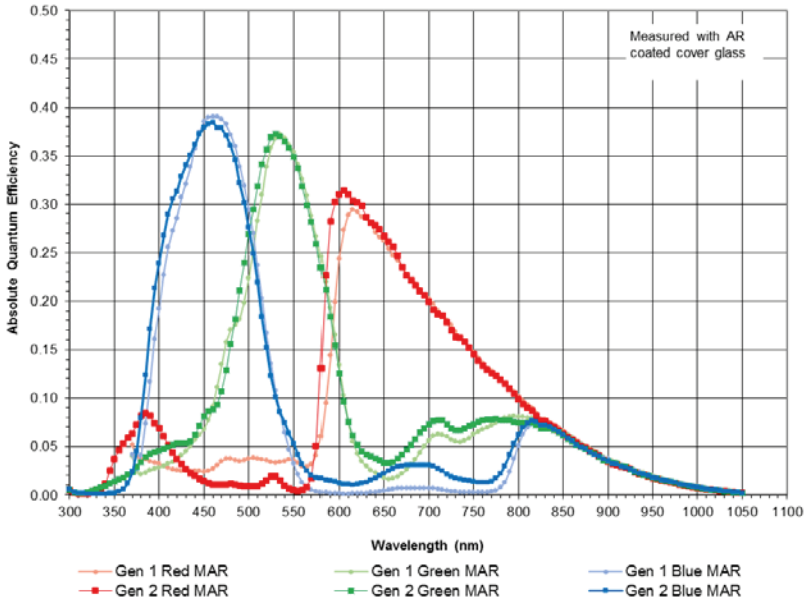


Figure 5.10 VA-2MC-C68 Spectral Response

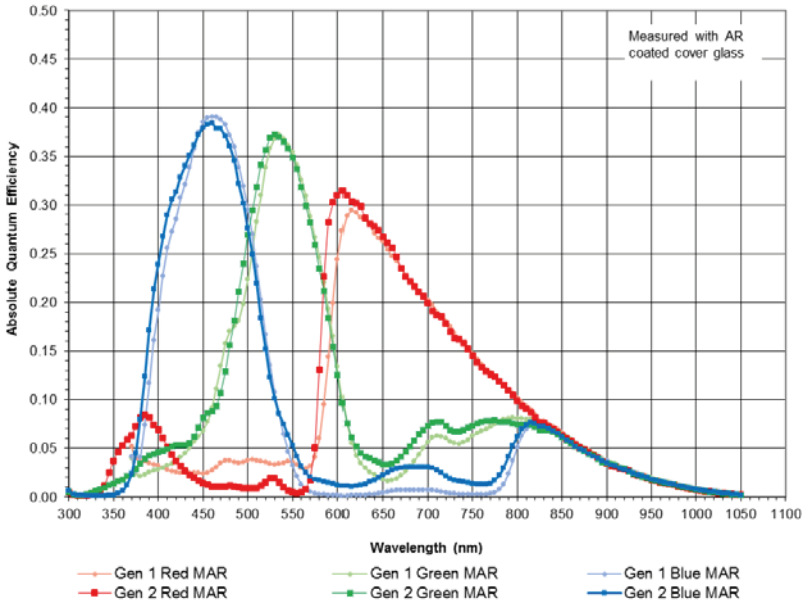


Figure 5.11 VA-4MC-C32 Spectral Response

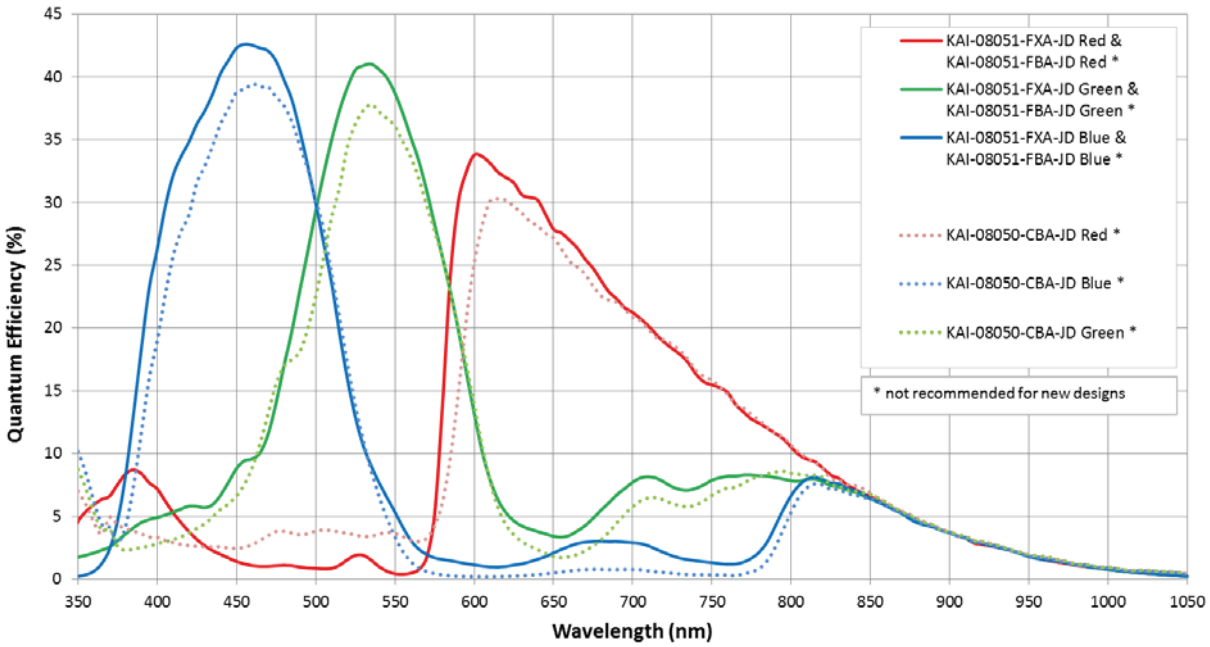


Figure 5.12 VA-8MC-C16 Spectral Response

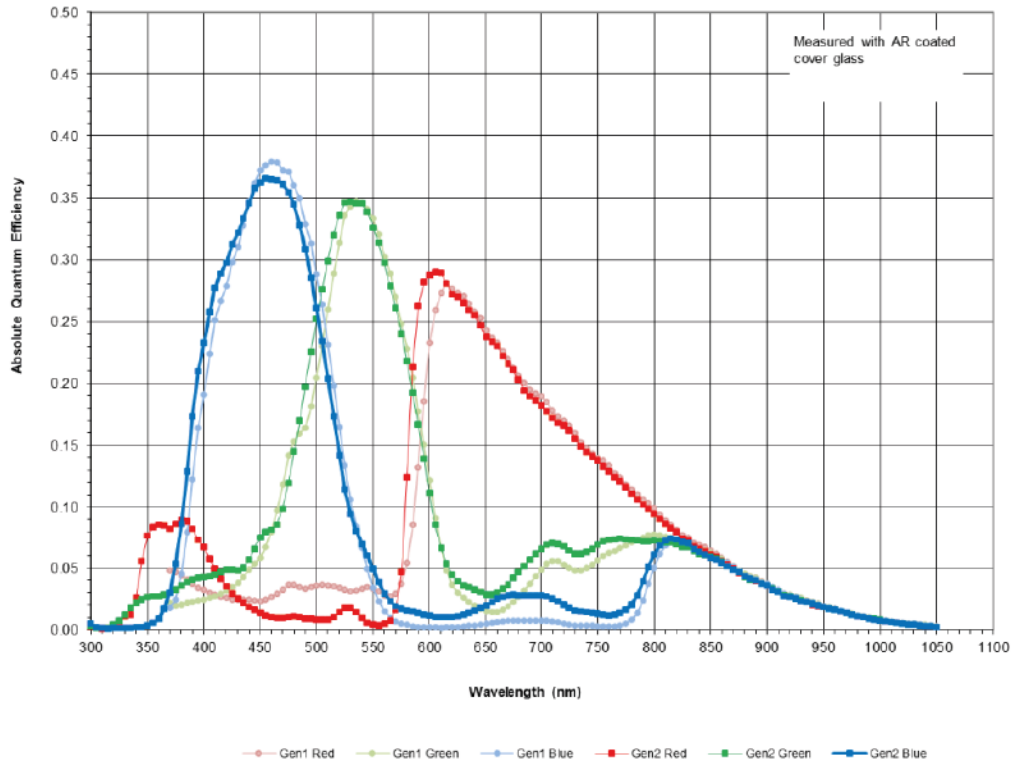


Figure 5.13 VA-16MC-C8 Spectral Response

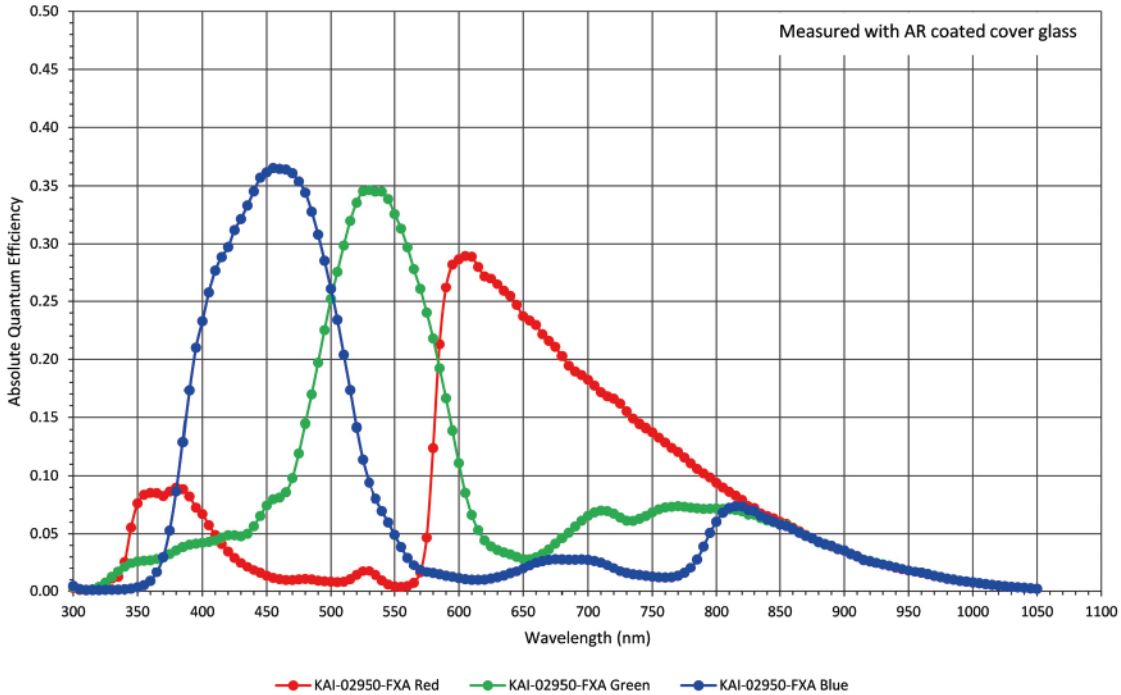


Figure 5.14 VA-29MC-C5 Spectral Response

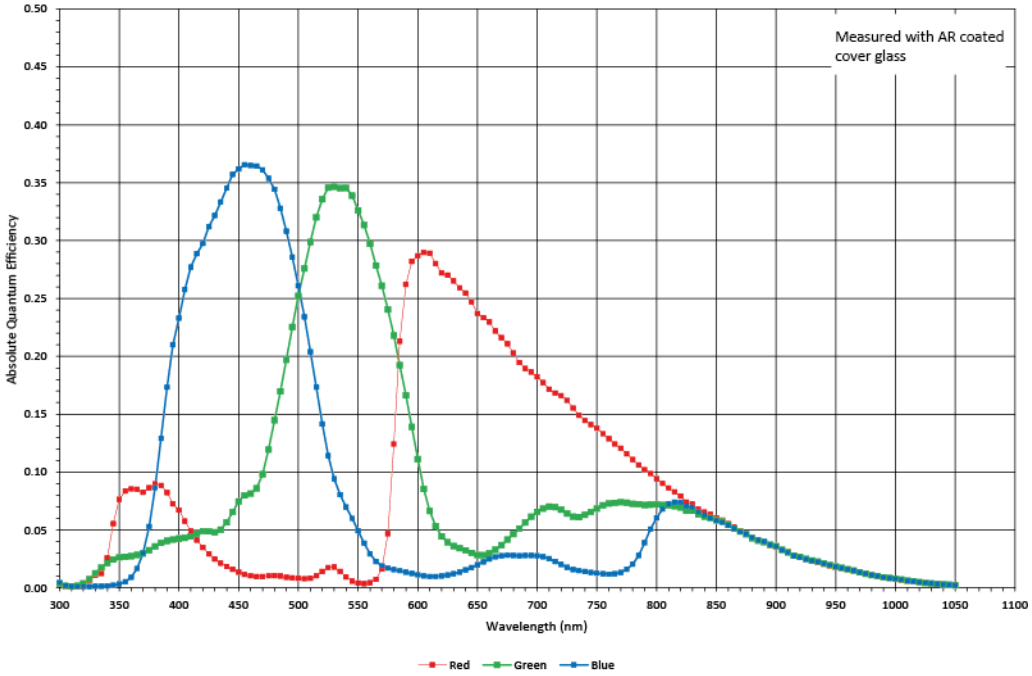


Figure 5.15 VA-47MC-C7 Spectral Response

5.5 Mechanical Specification

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

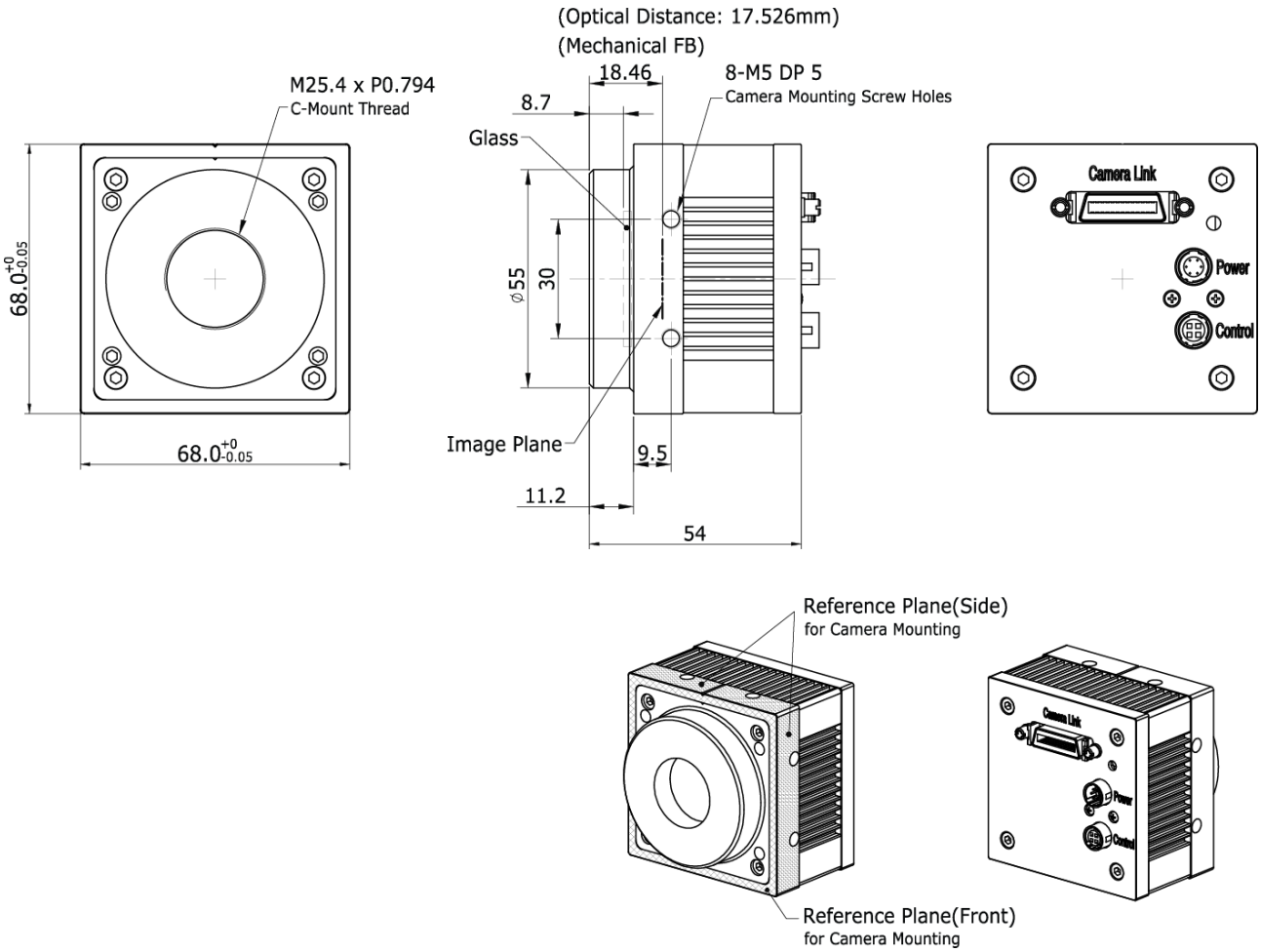


Figure 5.16 VA Camera Link Series C-mount Mechanical Dimension

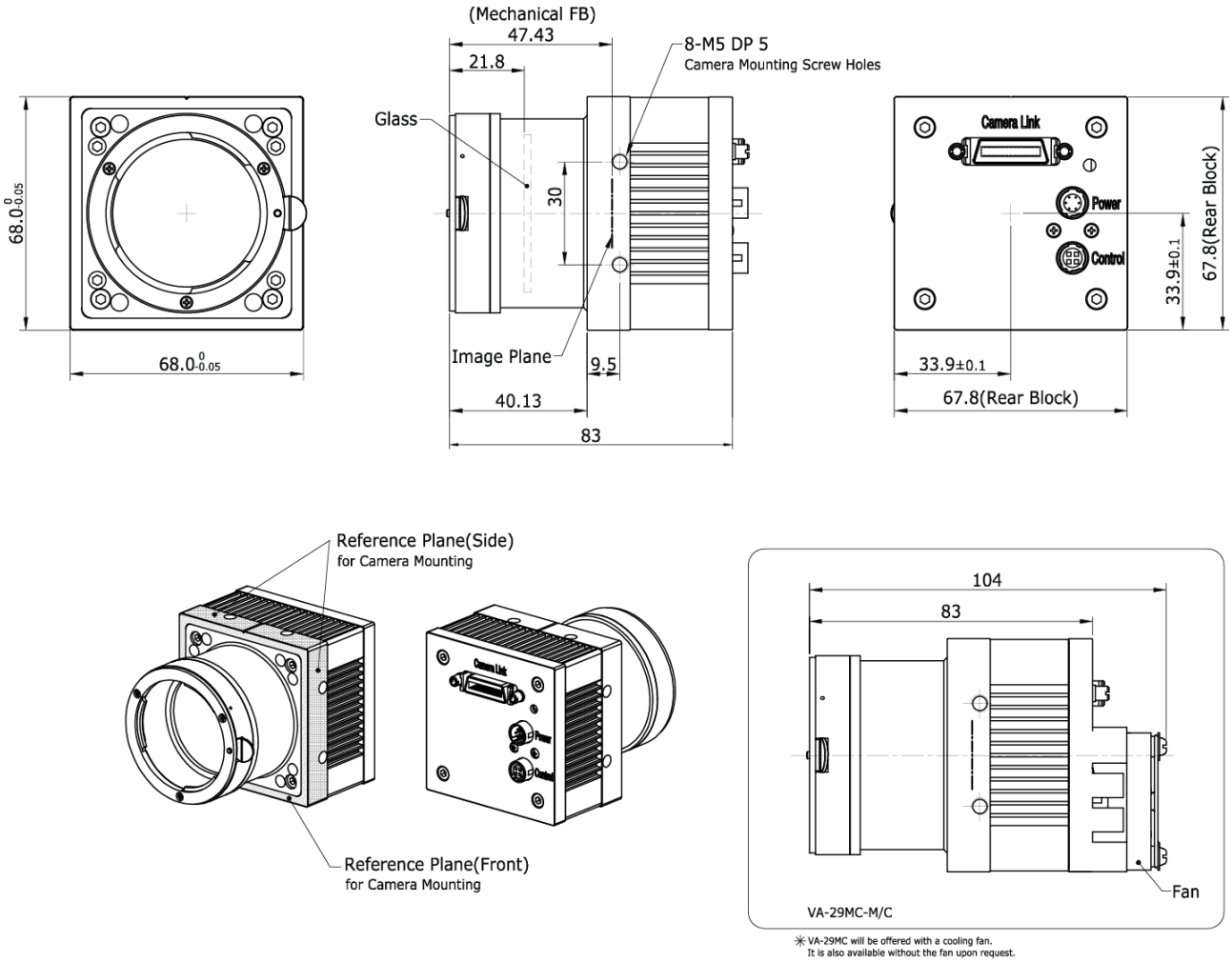


Figure 5.17 VA Camera Link Series F-mount Mechanical Dimension

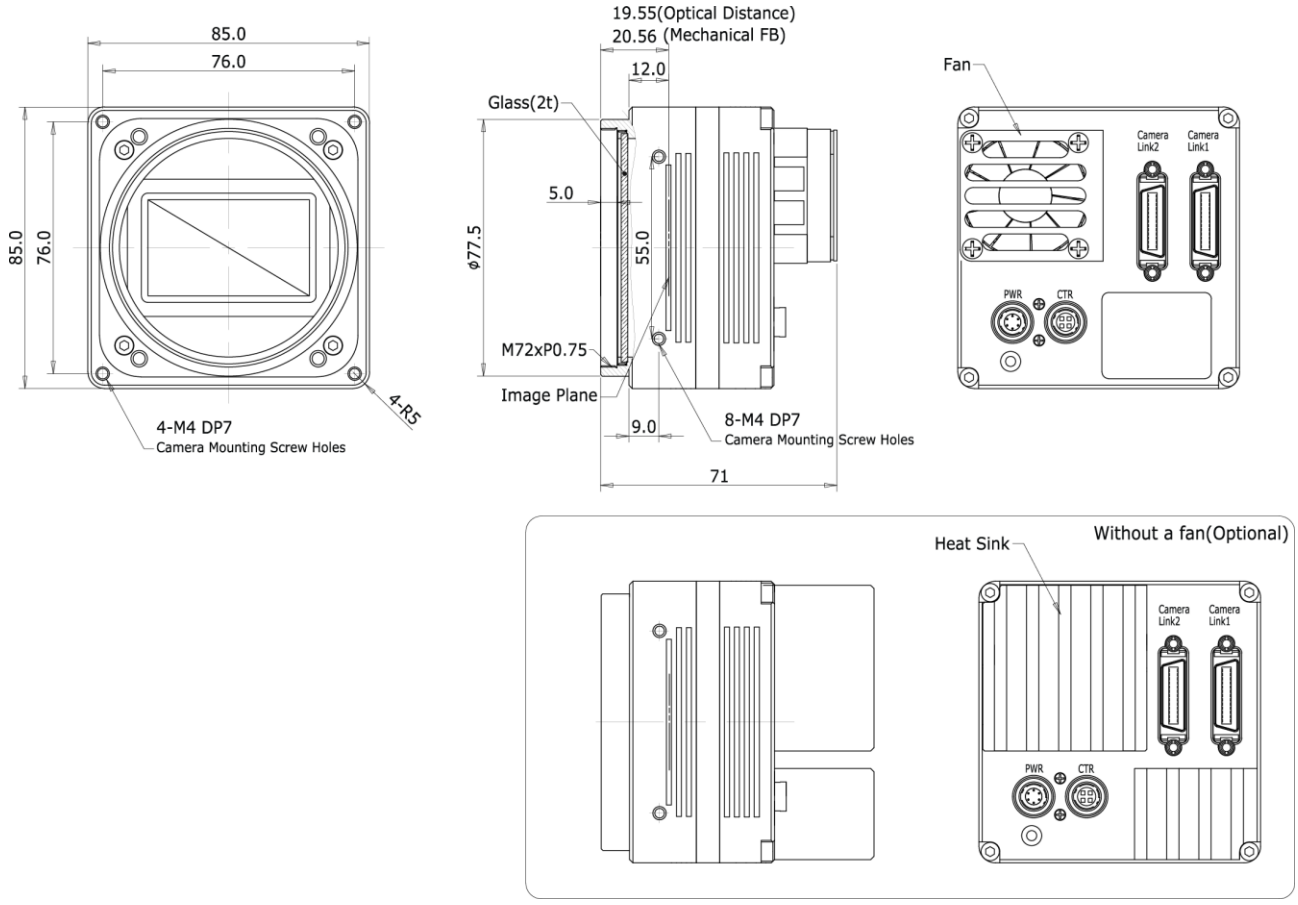


Figure 5.18 VA-47MC M72-mount Mechanical Dimension

6 Connecting the Camera

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

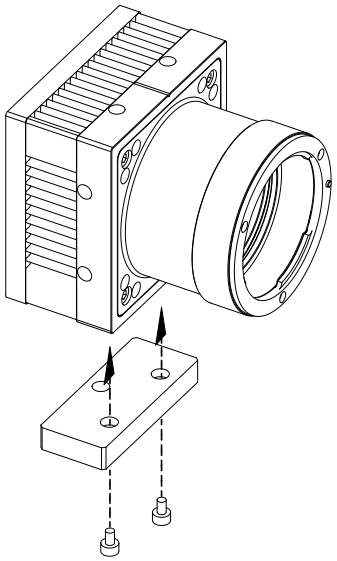
To connect the camera to your computer, follow the steps below:

1. Make sure that the power supply is not connected to the camera and your computer is turned off.
2. Plug one end of a Camera Link cable into the Camera Link connector on the camera and the other end of the Camera Link cable into the Camera Link frame grabber in your computer.
3. To connect the VA-47MC camera to the Camera Link frame grabber, you must use two Camera Link cables. Plug one end of the second Camera Link cable into the Camera Link2 connector on the camera and the other end of the Camera Link cable into the Medium/Full connector on the Camera Link frame grabber.
4. Connect the plug of the power adapter to the power input receptacle on the camera.
5. Plug the power adapter into a working electrical outlet.
6. Verify all the cable connections are secure.

Precautions for using Camera Link Medium Configuration

	The VA-47MC camera supports the Camera Link Medium configuration. To operate the camera in the Camera Link Medium configuration, you must connect the camera to the Camera Link frame grabber using two Camera Link cables. At this time, you must connect both Camera Link1 (Base) and Camera Link2 (Medium/Full) connectors on the camera to their respective connectors on the Camera Link frame grabber.

6.1 Mount Plate



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

6.2 Precaution to center the image sensor

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

6.3 Precaution about blurring compared to center

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

6.4 Controlling the Camera

- You can control the camera by executing the Configurator.exe file.
- You can download the latest Configurator at http://www.vieworks.com.
- Refer to your Camera Link frame grabber user manual.

7 Camera Interface

7.1 General Description

As shown in the figure below, 3 types of connectors and a status indicator LED are located on the back of the VA camera (except VA-47MC) and have the functions as follows:

- ① 26-pin Camera Link1 Connector(Base): controls video data and the camera.
- ② Status LED: displays power status and operation mode.
- ③ 6-pin Power Input Receptacle: supplies power to the camera.
- ④ 4-pin Control Receptacle: inputs external trigger signal and outputs strobe.

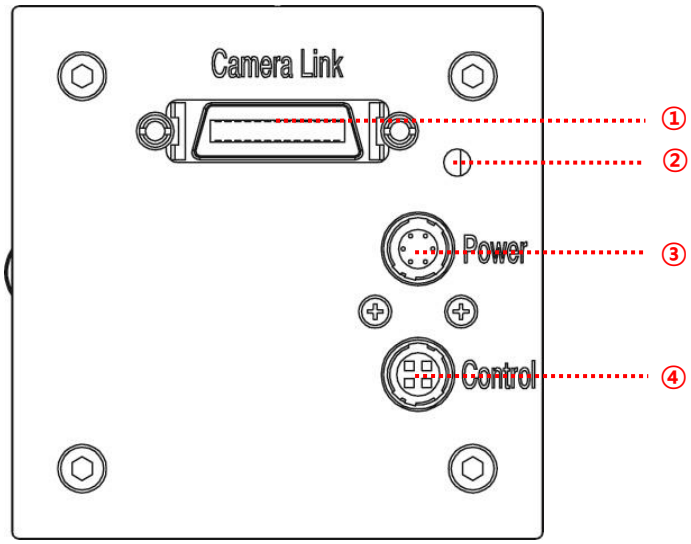


Figure 7.1 VA Camera Link Series Back Panel (Except VA-47MC)

As shown in the figure below, 4 types of connectors and a status indicator LED are located on the back of the VA-47MC camera and have the functions as follows:

- ① 26-pin Camera Link2 Connector(Medium): transmits video data.
- ② 26-pin Camera Link1 Connector(Base): transmits video data and controls the camera.
- ③ 6-pin Power Input Receptacle: supplies power to the camera.
- ④ 4-pin Control Receptacle: inputs external trigger signal and outputs strobe.
- ⑤ Status LED: displays power status and operation mode.

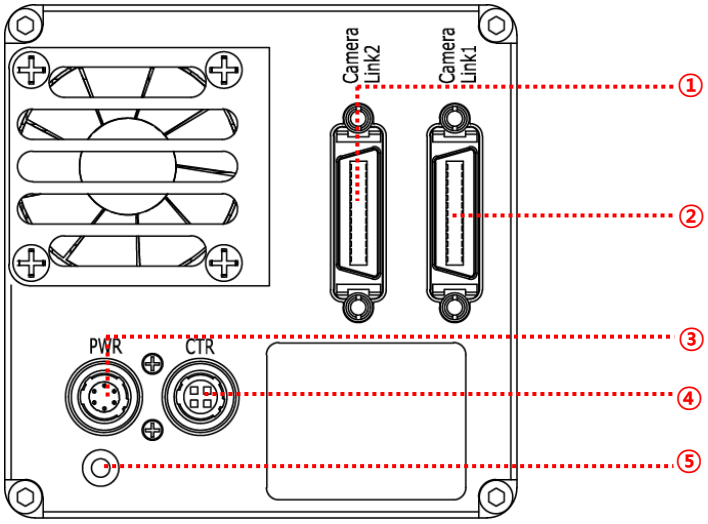


Figure 7.2 VA-47MC Back Panel

7.2 Camera Link Connector

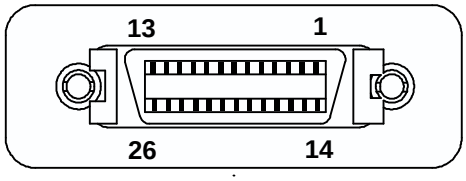


Figure 7.3 Camera Link Connector

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	-XCLK	LVDS - Out	Camera Link Transmitter
	18	+XCLK	LVDS - Out	Camera Link Transmitter
PAIR 5	6	-X3	LVDS - Out	Camera Link Transmitter
	19	+X3	LVDS - Out	Camera Link Transmitter
PAIR 6	7	+ SerTC	LVDS - In	Serial Data Receiver
	20	- SerTC	LVDS - In	Serial Data Receiver
PAIR 7	8	- SerTFG	LVDS - Out	Serial Data Transmitter
	21	+ SerTFG	LVDS - Out	Serial Data Transmitter
PAIR 8	9	- CC 1	LVDS - In	Software External Trigger
	22	+ CC 1	LVDS - In	Software External Trigger
PAIR 9	10	N/C	N/C	N/C
	23	N/C	N/C	N/C
PAIR 10	11	N/C	N/C	N/C
	24	N/C	N/C	N/C
PAIR 11	12	N/C	N/C	N/C
	25	N/C	N/C	N/C
PAIR 12	13	Ground	Ground	Cable Shield
	26	Ground	Ground	Cable Shield

Table 7.1 Pin Assignments for Camera Link1 Connector

PAIR List	Pin	Signal Name	Type	Description
PAIR 0	1	Ground	Ground	Cable Shield
	14	Ground	Ground	Cable Shield
PAIR 1	2	-Y0	LVDS - Out	Camera Link Transmitter
	15	+Y0	LVDS - Out	Camera Link Transmitter
PAIR 2	3	-Y1	LVDS - Out	Camera Link Transmitter
	16	+Y1	LVDS - Out	Camera Link Transmitter
PAIR 3	4	-Y2	LVDS - Out	Camera Link Transmitter
	17	+Y2	LVDS - Out	Camera Link Transmitter
PAIR 4	5	-YCLK	LVDS - Out	Camera Link Transmitter
	18	+YCLK	LVDS - Out	Camera Link Clock Tx
PAIR 5	6	-Y3	LVDS - Out	Camera Link Channel Tx
	19	+Y3	LVDS - Out	Camera Link Channel Tx
PAIR 6	7	-	Not Used	Connected with 100 ohm
	20	-	Not Used	
PAIR 7	8	-Z0	LVDS - Out	Camera Link Transmitter
	21	+Z0	LVDS - Out	Camera Link Transmitter
PAIR 8	9	-Z1	LVDS - Out	Camera Link Transmitter
	22	+Z1	LVDS - Out	Camera Link Transmitter
PAIR 9	10	-Z2	LVDS - Out	Camera Link Transmitter
	23	+Z2	LVDS - Out	Camera Link Transmitter
PAIR 10	11	-ZCLK	LVDS - Out	Camera Link Transmitter
	24	+ZCLK	LVDS - Out	Camera Link Clock Tx
PAIR 11	12	-Z3	LVDS - Out	Camera Link Channel Tx
	25	+Z3	LVDS - Out	Camera Link Channel Tx
PAIR 12	13	Ground	Ground	Cable Shield
	26	Ground	Ground	Cable Shield

Table 7.2 Pin Assignments for Camera Link2 Connector

7.3 Power Input Receptacle

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

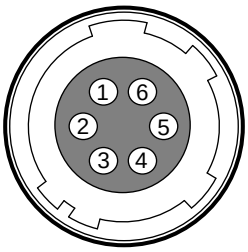


Figure 7.4 Pin Assignments for 6-pin Power Input Receptacle

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

Table 7.3 Pin Configurations for Power Input Receptacle

The mating connector is a Hirose 6-pin plug (part # HR10A-7P-6S) or the equivalent connectors. The power adapter is recommended to have at least 1 A current output at 12 V DC ±10% voltage output (Users need to purchase the power adapter separately).

Precautions 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 voltage applied to the camera is greater than specified in the specifications, damage to the camera may result.

7.4 Control I/O Receptacle

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

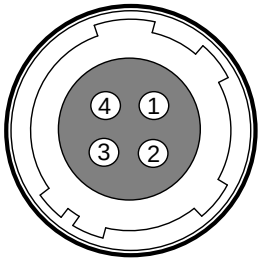


Figure 7.5 Pin Assignments for Control I/O Receptacle

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

Table 7.4 Pin Configurations for Control I/O Receptacle

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

7.5 Trigger Input Circuit

The following figure shows trigger signal input circuit of the 4-pin connector. Transmitted trigger signal is applied to the internal circuit through a photo coupler. The 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. An external trigger circuit example is shown below.

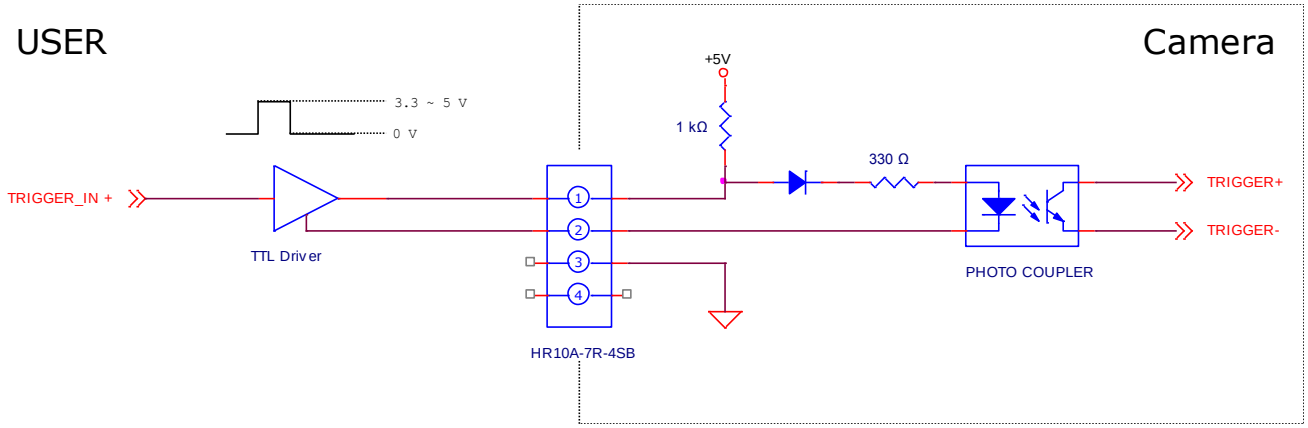


Figure 7.6 Trigger Input Schematic (All cameras except VA-47MC)

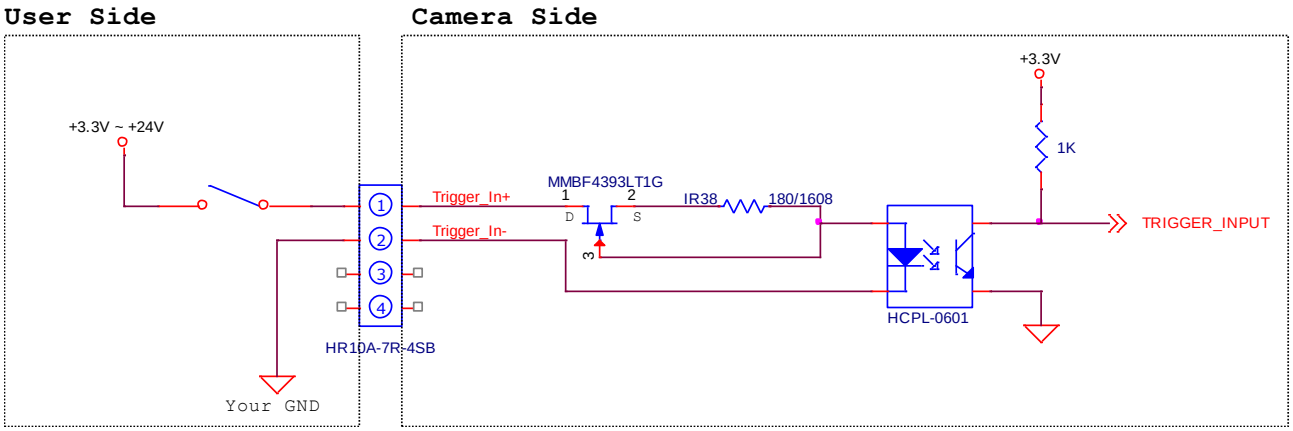


Figure 7.7 Trigger Input Schematic (VA-47MC only)

7.6 Strobe Output Circuit

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

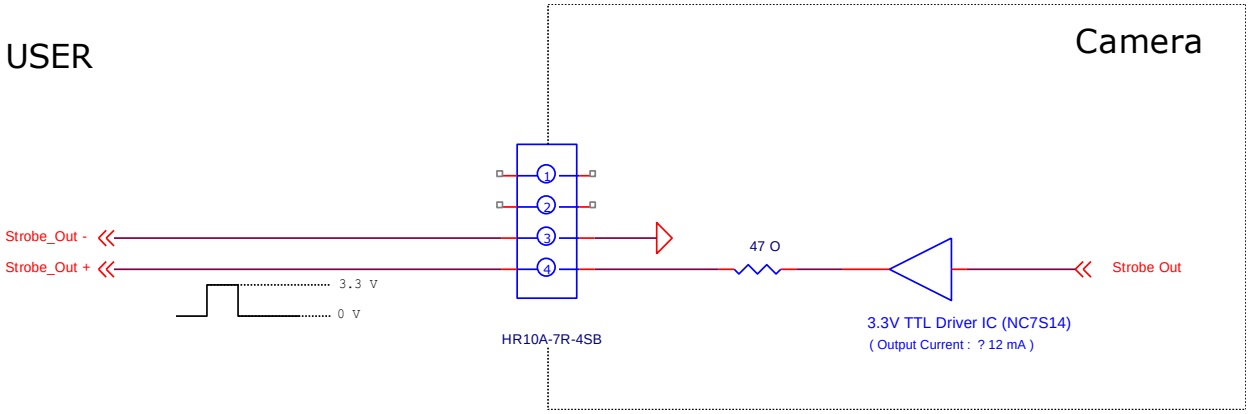


Figure 7.8 Strobe Output Schematic

8 Camera Features

8.1 Area of Interest (All VA cameras except VA-47MC)

The Area of Interest (AOI) feature allows you to specify a portion of the sensor array. You can acquire only the frame data from the specified portion of the sensor array while preserving the same quality as you acquire a frame from the entire sensor array. AOI is determined as the overlapping area of two areas when designating start point and end point in horizontal and vertical direction as shown in the figure below. Start point and End point mean the starting and end of the AOI.

According to the characteristics of the imaging sensor structure, readout of the image will be proceeded at the top and bottom simultaneously. When you try to set Vertical AOI with the Channel mode set to 4 Tap, 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” commands in the Command List.

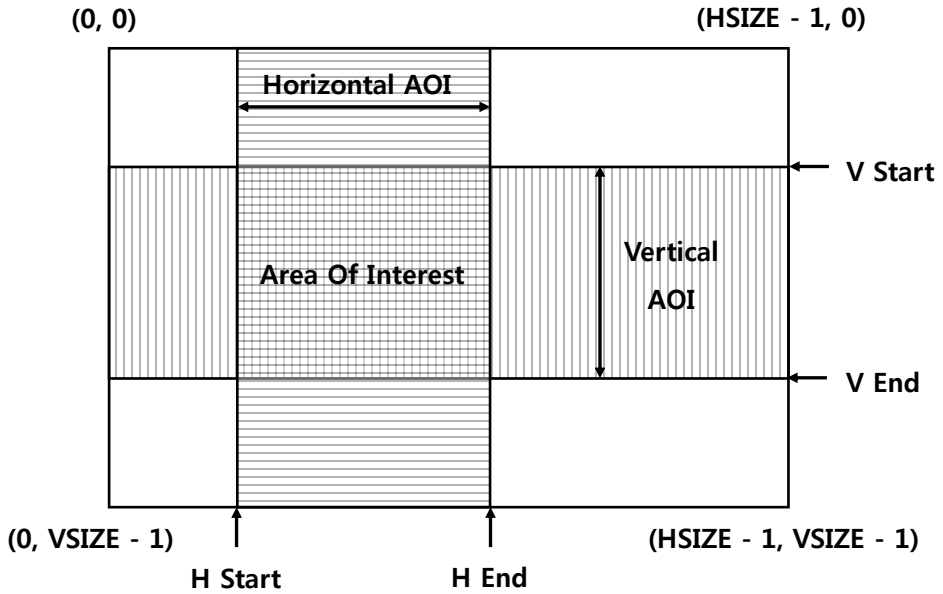


Figure 8.1 AOI

CAUTION

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

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

1 or 2 Channel Mode: Frame Rate (fps) = $1000000/[T_{VCCD} + T_{FD} \times \{V_{SIZE} - (V_{AOI} + 12)\} + (V_{AOI} + 12) \times T_L]$
4 Channel Mode: Frame Rate (fps) = $1000000 / [T_{VCCD} + T_{FD} \times \{(V_{SIZE} - (V_{AOI} + 12)\}/2 + \{(V_{AOI} + 12) \times T_L\}/2]$
1 or 2 Channel Mode for VA-29MC: Frame Rate (fps) = $1000000/[T_{VCCD} + T_{FD} \times \{(V_{SIZE} - V_{AOI}) + 12)\} + (V_{AOI} + 98) \times T_L]$
4 Channel Mode for VA-29MC: Frame Rate (fps) = $1000000 / [T_{VCCD} + T_{FD} \times \{(V_{SIZE} - V_{AOI})/2 + 12)\} + \{(V_{AOI}/2 + 98) \times T_L\}]$
T_{VCCD} : the amount of time required to transmit electric charges accumulated on the pixels to Vertical Register T_{FD} : the amount of time required for fast dump V_{SIZE} : the number of vertical lines of CCD T_L : the amount of time required for transmission of one line V_{AOI} : size of the Vertical AOI

The available minimum values of T_{VCCD}, T_{FD}, V_{SIZE}, T_L and V_{AOI} vary depending on the camera model. The value of T_L varies depending on the Channel mode. The values of each parameter depending on the camera model are shown in the table below.

VA Series	VA-1M	VA-2M	VA-4M	VA-8M	VA-16M	VA-29M
T_{VCCD}	11.4 μs	12.0 μs	15.0 μs	17.0 μs	28.0 μs	28.5 μs
T_L(1 channel)	28.6 μs	44.5 μs	63.9 μs	90.5 μs	130.525 μs	172.8 μs
T_L(2 channel)	15.2 μs	23.4 μs	34.4 μs	46.6 μs	69.325 μs	90.6 μs
T_L(4 channel)	15.2 μs	23.4 μs	34.4 μs	46.6 μs	69.325 μs	90.6 μs
T_{FD}	(T_L * 1.1)/4	(T_L * 1.1)/4	4.2 μs	4.1 μs	7.0 μs	6.8 μs
V_{SIZE}	1064 Lines	1264 Lines	1800 Lines	2520 Lines	3264 Lines	4384 Lines
Minimum Vertical AOI Size	120 Lines	150 Lines	200 Lines	300 Lines	1000 Lines	1000 Lines

Table 8.1 Timing values for VA Series

The following graphs show frame rates depending on VAOI changes.

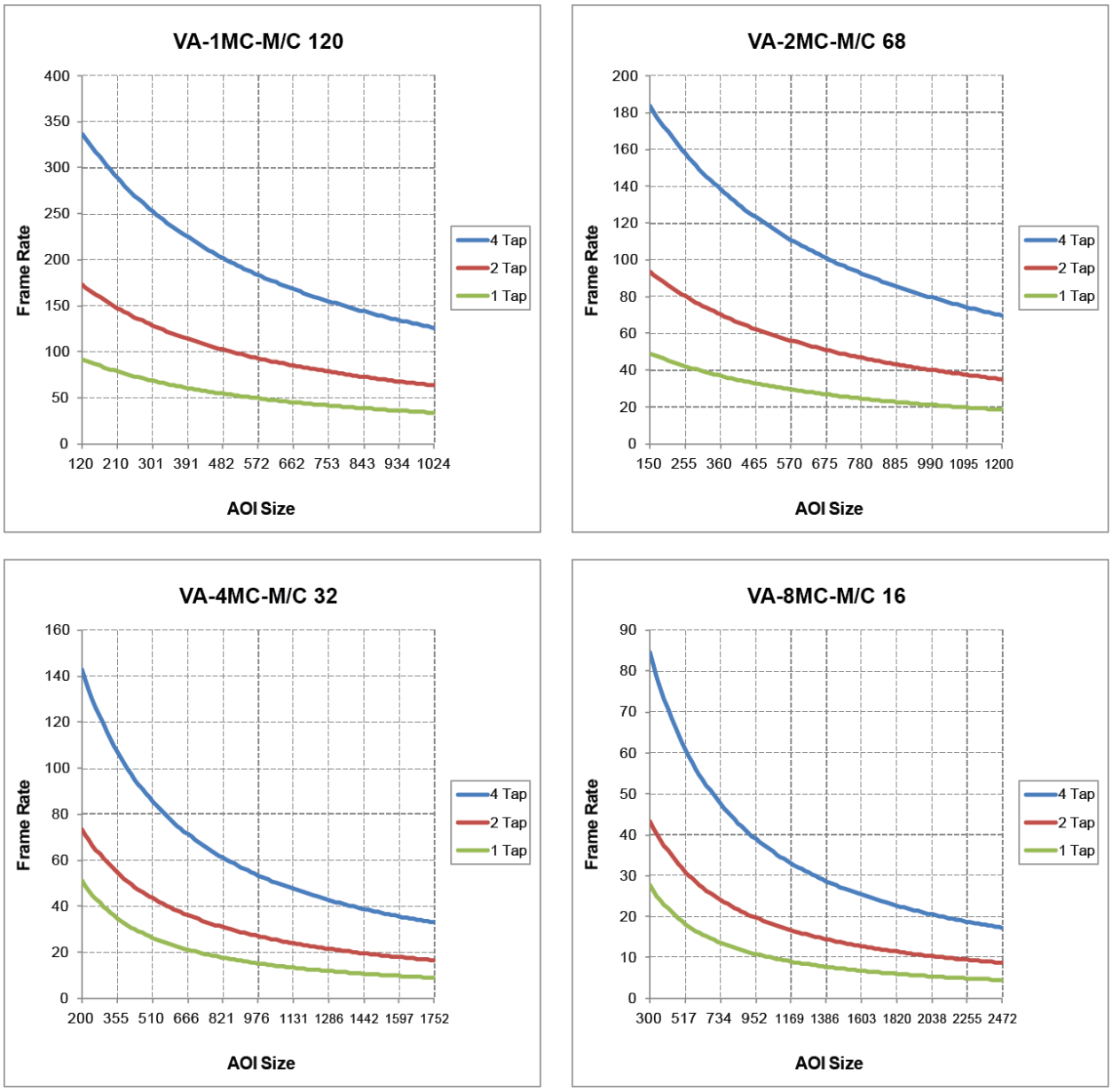


Figure 8.2 Frame Rate by VAOI changes (continuous)

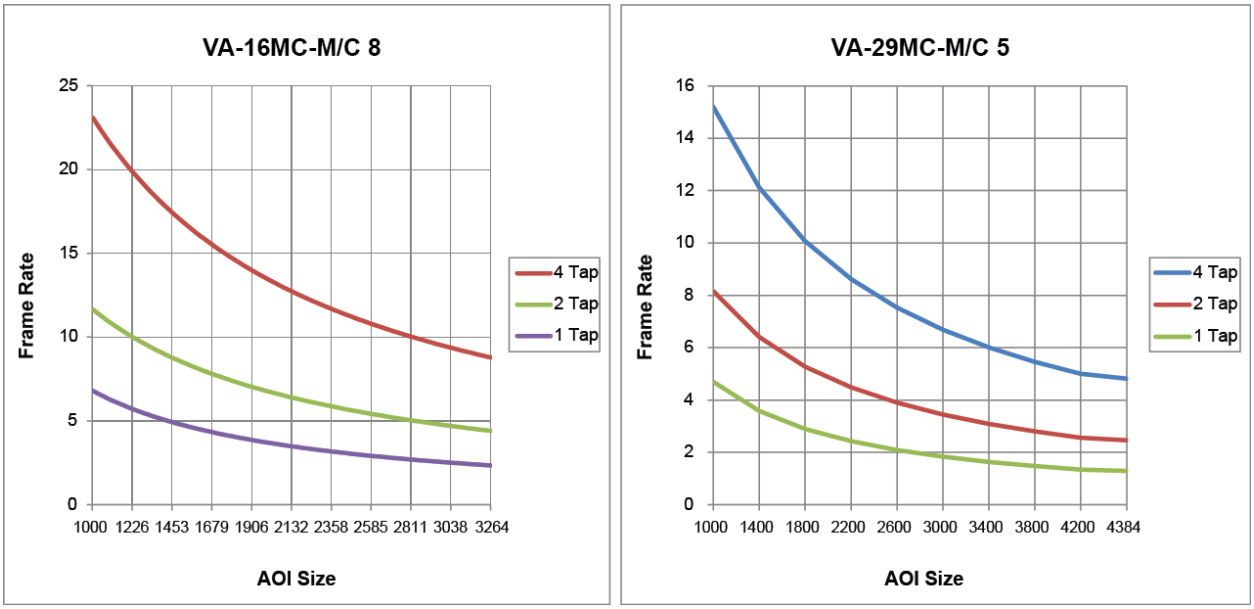


Figure 8.3 Frame Rate by VAOI changes

8.2 Region of Interest (VA-47MC Only)

The VA-47MC's Region on Interest (ROI) feature allows you to specify a portion of the sensor array. You can acquire only the frame data from the specified portion of the sensor array while preserving the same quality as you acquire a frame from the entire sensor array. With the ROI feature, you can achieve increased frame rates by decreasing the **Height** of the ROI; however, decreasing the **Width** of the ROI does not affect the frame rate. The ROI is referenced to the top left corner [origin (0, 0)] of the sensor array as follows.

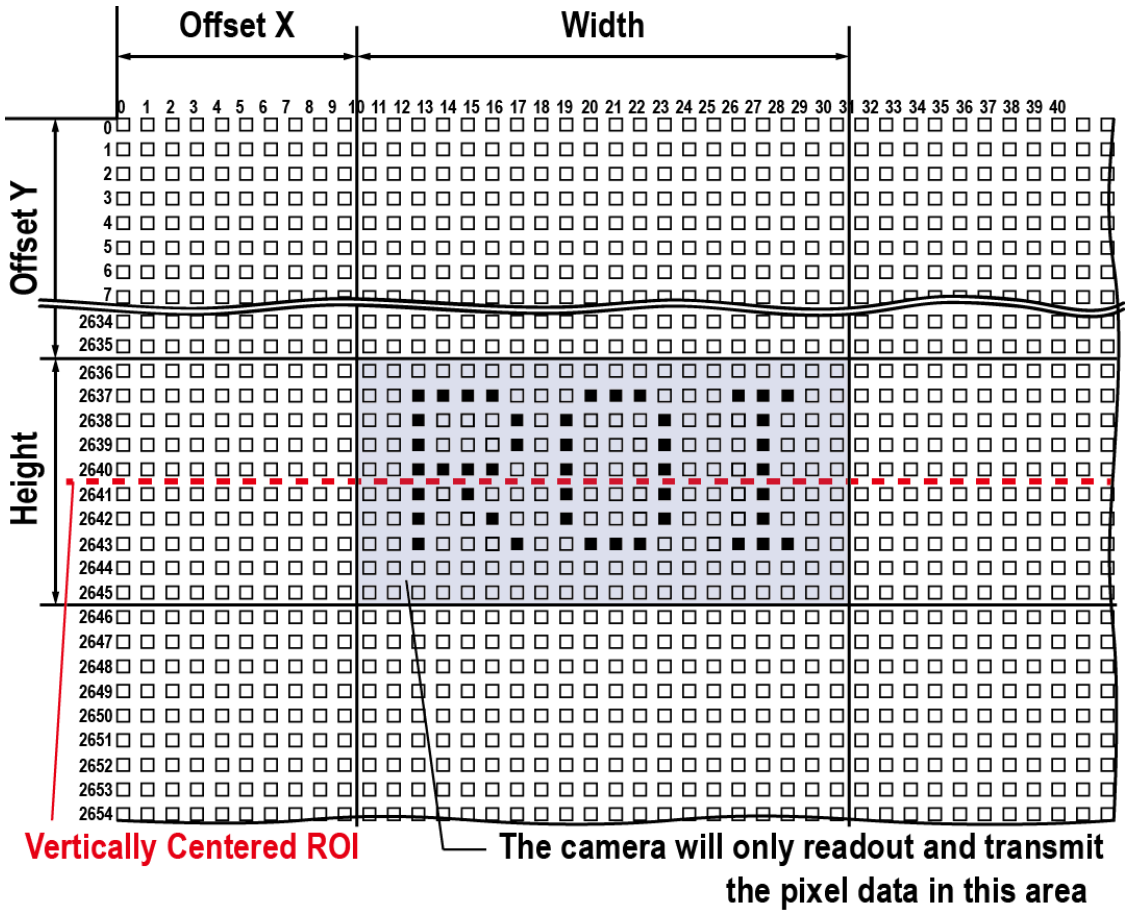


Figure 8.4 Region of Interest

The VA-47MC camera automatically center the ROI along the sensor's Y axis. You can change the size of ROI by setting the **Width** and **Height** parameters. And also, you can change the position of the ROI origin by setting the **Offset X** parameter. When you adjust the **Height** parameter, the **Offset Y** parameter is adjusted accordingly and read only. You must set the size of the ROI first, and then the **Offset X** value since the **Width** and **Height** parameters are set to its maximum value by default.

The **Width** parameter must be set to a multiple of 4, and the **Height** parameter must be set to a value greater than the minimum Vertical ROI size shown in the table 8.2. The **Width**, **Height**, **Offset X** and **Offset Y** parameters will be updated respectively according to the **Horizontal** and **Vertical** parameter settings in the **Binning** category.

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

16 Channel Mode :

$$\text{Frame Rate (fps)} = 1000000 / [T_{VCCD} + T_{FD} \times \{V_{SIZE} - (V_{ROI} + 8)\}/2 + \{(V_{ROI} + 8) \times T_L\}/2)$$

T_{VCCD} : the amount of time required to transmit electric charges accumulated on the pixels to Vertical Register

T_{FD} : the amount of time required for fast dump

V_{SIZE} : the number of vertical lines of CCD

T_L : the amount of time required for transmission of one line

V_{ROI} : size of the Vertical ROI

The available minimum values of T_{VCCD}, T_{FD}, V_{SIZE}, T_L and V_{ROI} may vary depending on the camera model. The value of each item for the VA-47MC are shown below.

VA Series	VA-47M
T_{VCCD}	57.2 μs
T_L(16 channel)	54 μs
T_{FD}	30.4 μs
V_{SIZE}	5392 Lines
Minimum Vertical AOI Size	1056 Lines

Table 8.2 Timing Value for VA-47MC

The following figure shows frame rate for the VA-47MC depending on Vertical ROI changes.

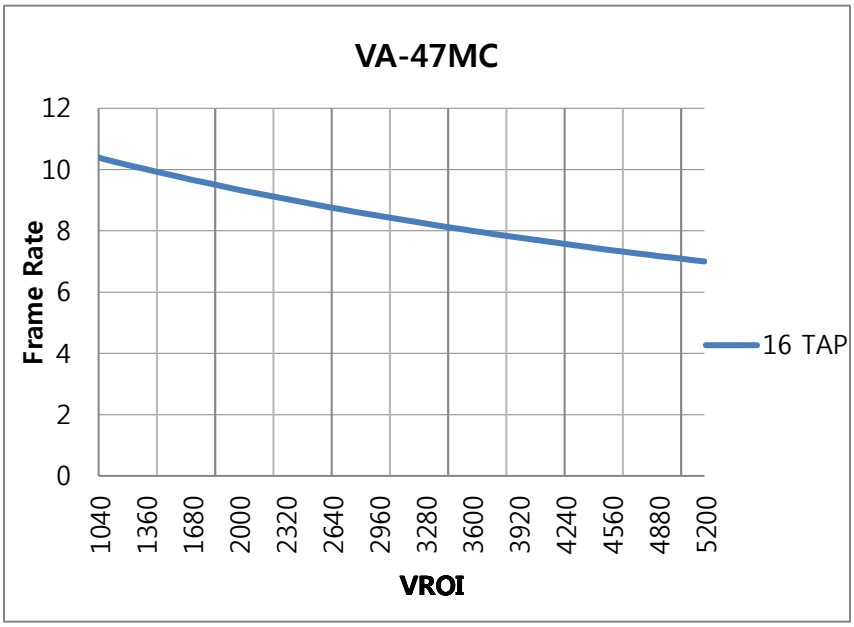


Figure 8.5 Frame Rate by Vertical ROI changes

8.3 Binning

Binning has the effects of increasing the level value and decreasing resolution by summing the values of the adjacent pixels and sending them as one pixel. VA Series provides two binning factors (×2, ×4) that users can apply in either vertical, horizontal or both directions. The below figure shows application of 2 × 2 Binning and 4 × 4 Binning respectively. Since vertical binning is processed in the internal register of CCD, the frame rate will be increased as many as Binning Factor if the Binning is set, but horizontal binning does not affect the frame rate. You can set the Binning Factor using the “sbf” command.

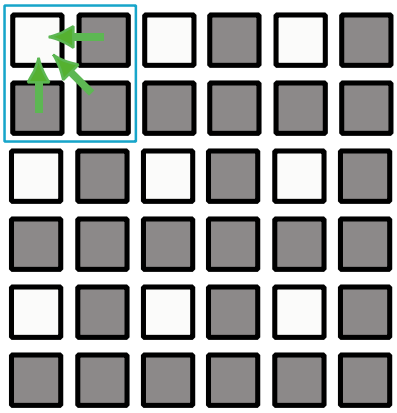


Figure 8.6 2 × 2 Binning

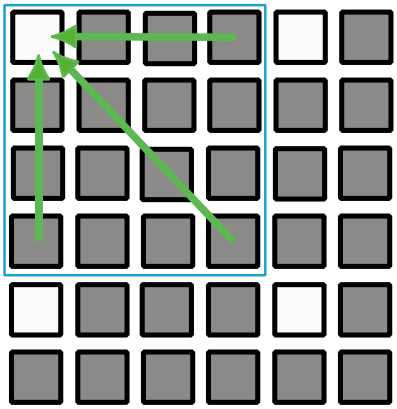


Figure 8.7 4 × 4 Binning

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

8.4 Trigger Mode (All VA cameras except VA-47MC)

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.

8.4.1 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.

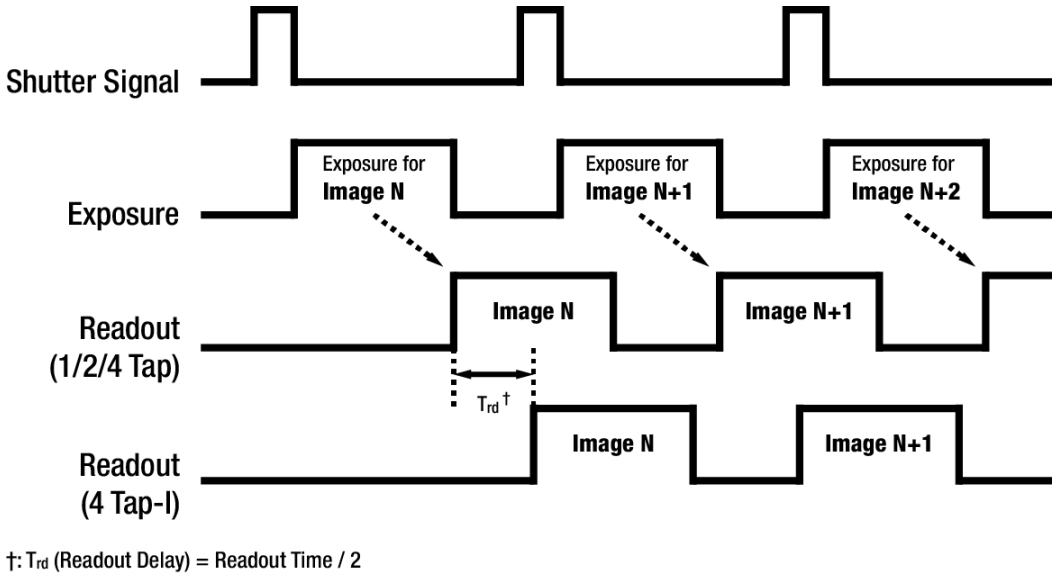


Figure 8.8 Free-Run Mode

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.

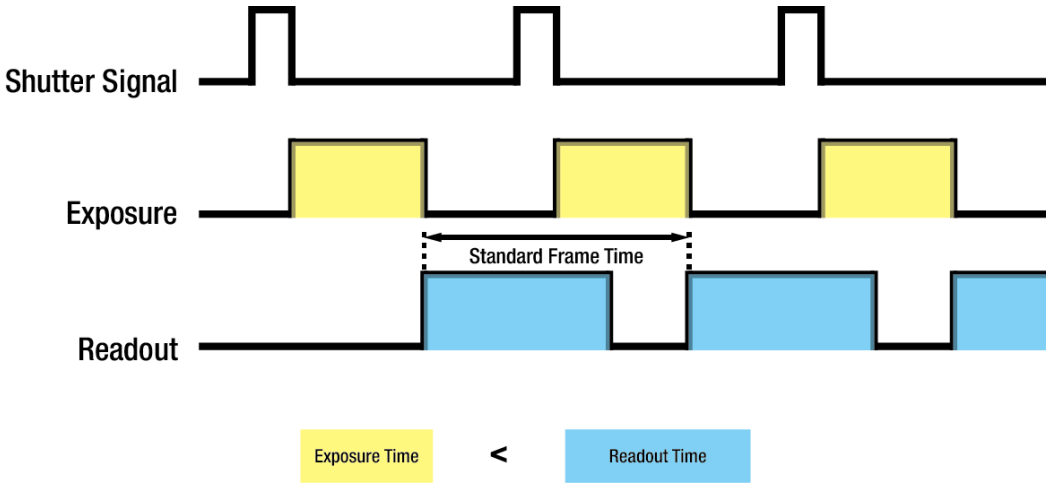


Figure 8.9 Exposure Time is shorter than Readout Time

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.

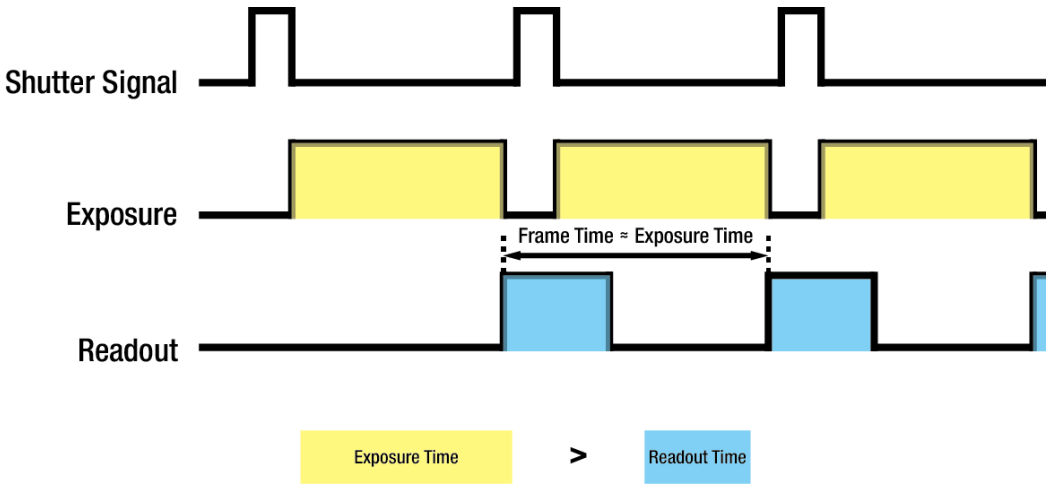


Figure 8.10 Exposure Time is longer than Readout Time

8.4.2 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.

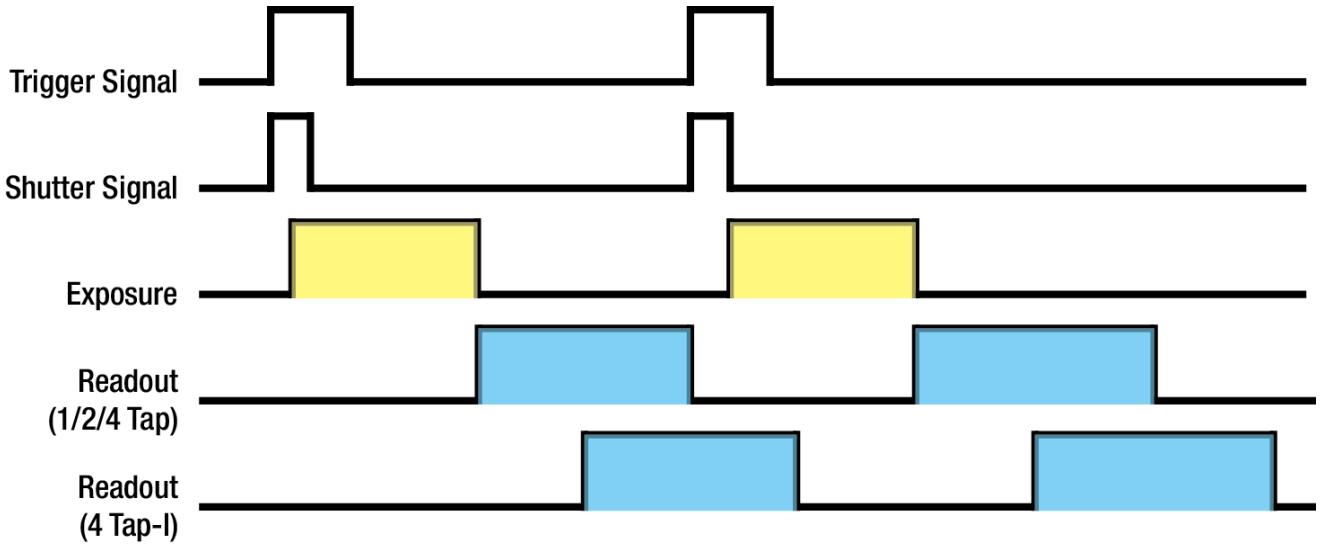


Figure 8.11 Standard Trigger Mode

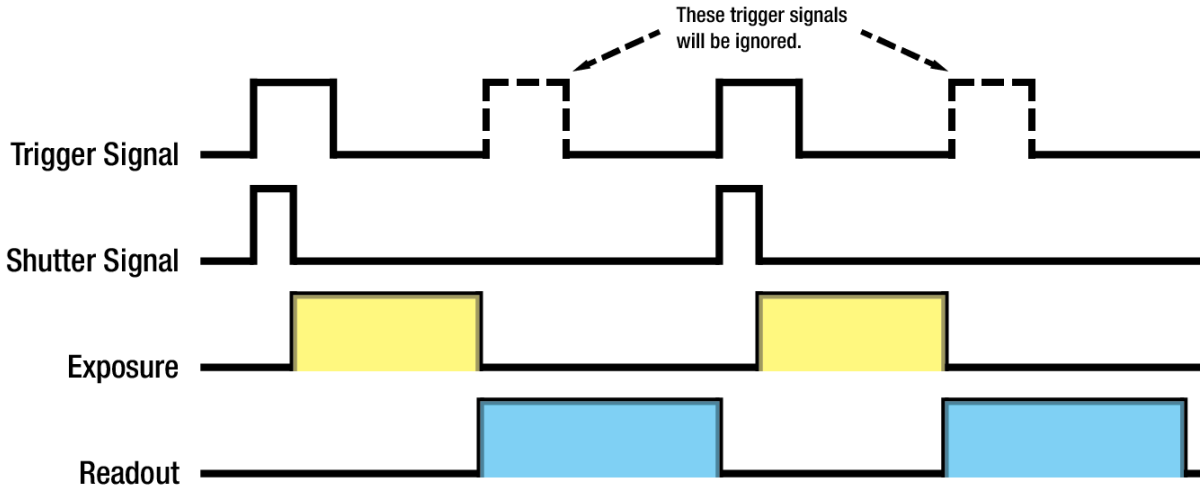


Figure 8.12 Trigger Ignored

8.4.3 Double

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.

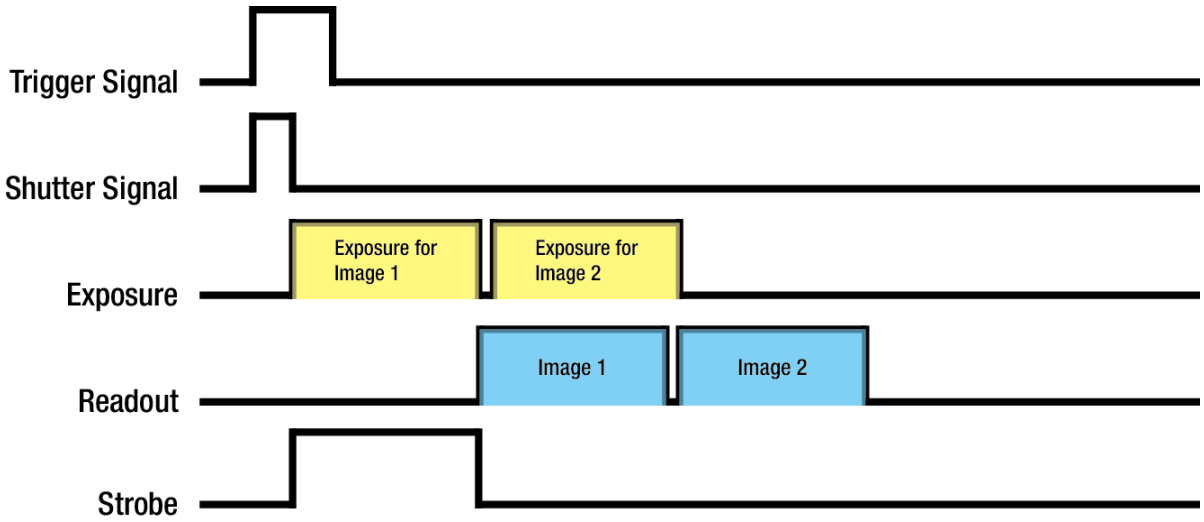


Figure 8.13 Double Mode

8.4.4 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.

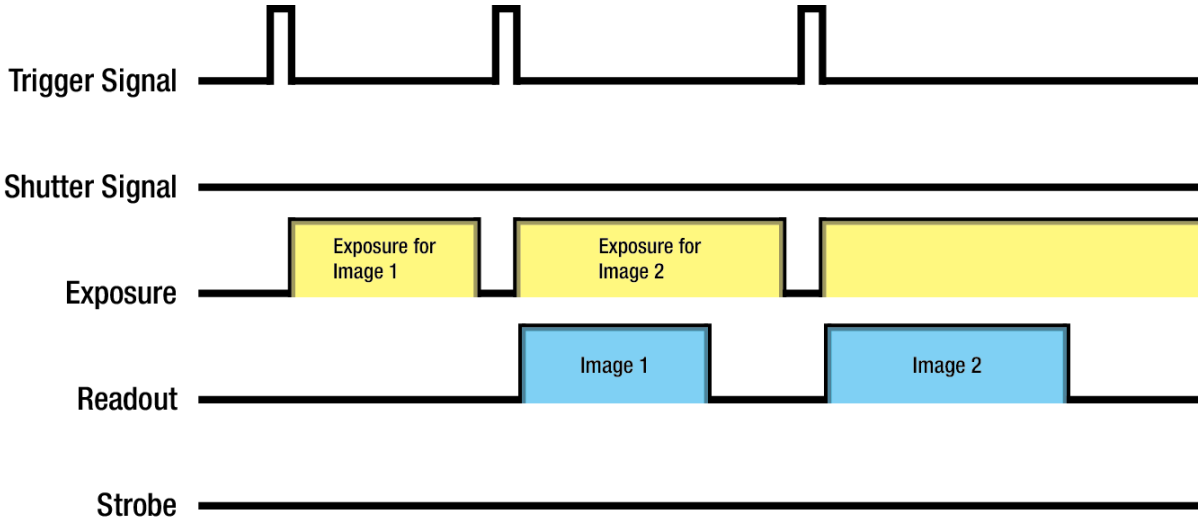


Figure 8.14 Fast Mode

8.4.5 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	VA-1M	VA-2M	VA-4M	VA-8M	VA-16M	VA-29M
1 channel	29.3 ㎳	53.5 ㎳	112.8 ㎳	226.5 ㎳	113.4 ㎳	763.1 ㎳
2 channel	15.5 ㎳	28.0 ㎳	59.7 ㎳	121.9 ㎳	226.1 ㎳	397.7 ㎳
4 channel	7.9 ㎳	14.2 ㎳	30.1 ㎳	61.3 ㎳	425.9 ㎳	199.6 ㎳

Table 8.3 Readout Time for each model

When the **Channel** mode is set to **4 Tap-I** (Sensor Readout: 4 Tap / Video Output: 2 Tap Interleaved), the camera reads a frame into the image buffer, and transmits pixel data for the frame in a 2 Tap Interleaved fashion. This leads to latency (T_{rd}: a half of the readout time) between the point where the camera completes the process of exposing a frame and the point where it begins reading out the frame.

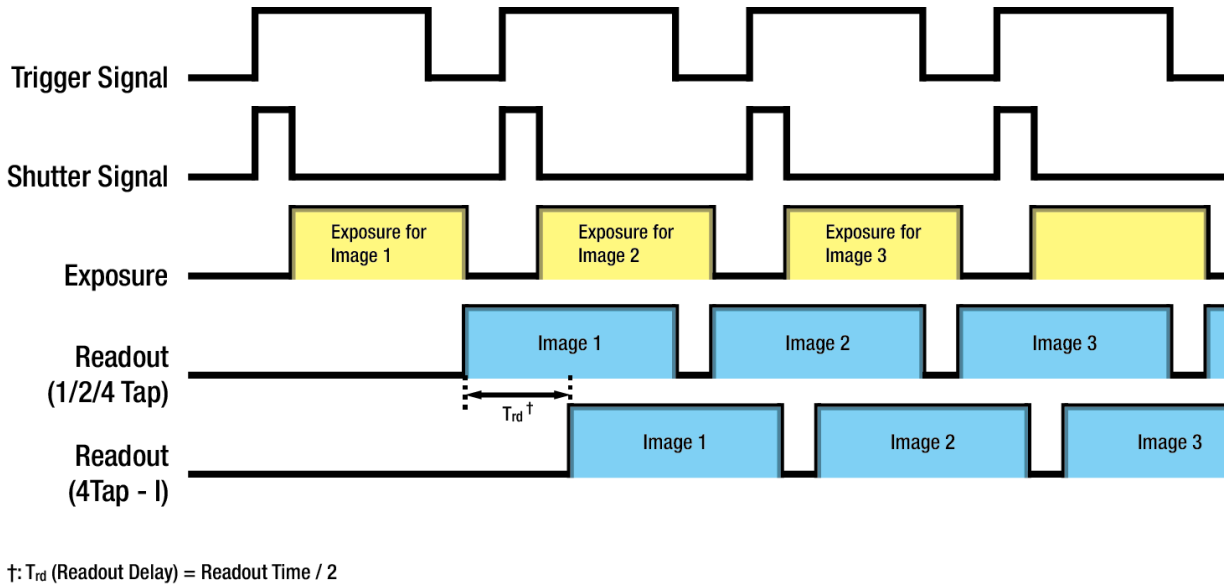


Figure 8.15 Overlap Mode

8.5 Trigger Mode (VA-47MC Only)

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

8.5.1 Trigger Mode = Off

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

Exposure Time Control with Trigger Mode = Off

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

8.5.2 Trigger Mode = On

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

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

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

After setting the **Source** parameter, you must also set the **Activation** parameter.

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

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

Exposure Time Control with Trigger Mode = On

When the **Trigger Mode** parameter is set to **On**, the exposure time for each frame can be controlled with the **Exposure Time** parameter or it can be controlled by manipulating the external trigger signal.

8.5.3 Using a CC1 Trigger Signal

If the **Trigger Mode** parameter is set to **On** and the **Source** parameter is set to **CC1**, you must apply a CC1 trigger signal (exposure start) to the camera to begin each frame acquisition. Assuming that the camera is in a *waiting for exposure start trigger* acquisition status, frame exposure will start when the CC1 trigger signal is received by the camera.

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

When you are using a CC1 trigger signal to start each frame acquisition, the frame rate will be determined by how often you apply a CC1 trigger signal to the camera, and you should not attempt to trigger frame acquisition at a rate that exceeds the maximum allowed for the current camera settings. CC1 trigger signals that are applied to the camera when it is not ready to receive them will be ignored.

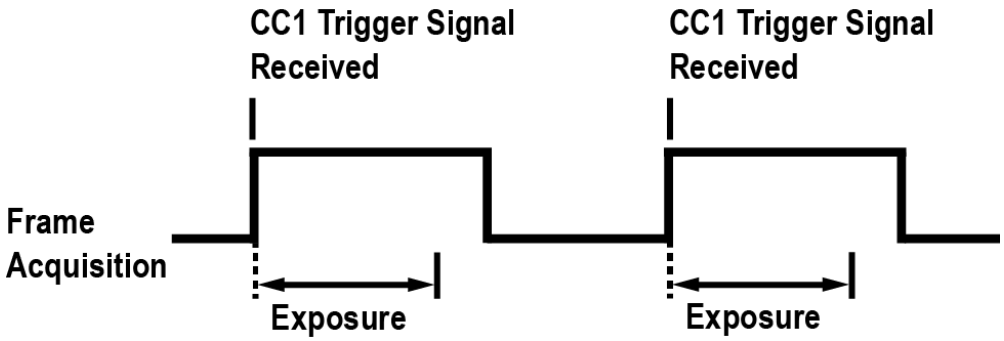


Figure 8.16 Frame Acquisition with CC1 Trigger Signal

8.5.4 Using an External Trigger Signal

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

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

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

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

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

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

For example, if you are operating a camera with an External trigger signal period of 500 ㎳ (0.5 s):

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

8.5.5 Exposure Mode

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

Timed Exposure Mode

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

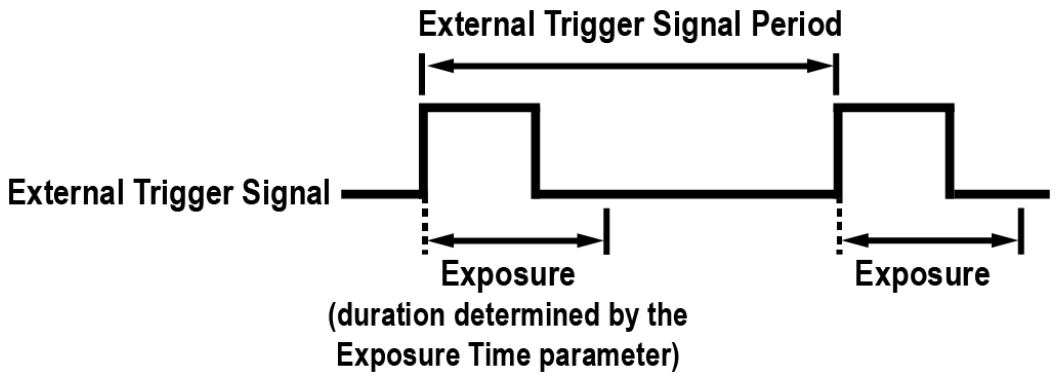


Figure 8.17 Timed Exposure Mode

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

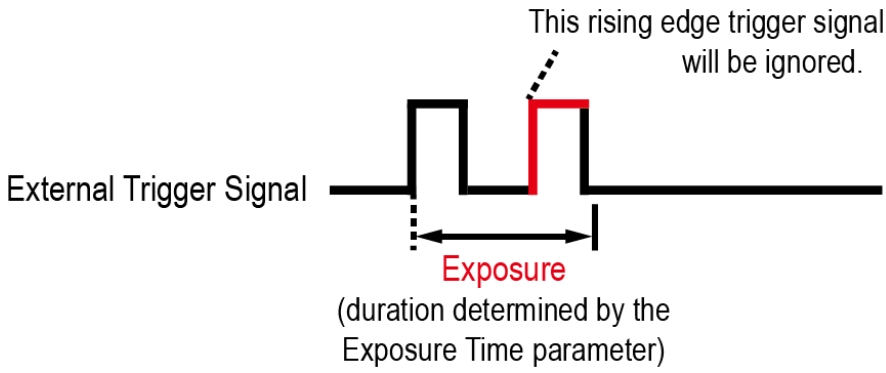


Figure 8.18 Trigger Overlapped with Timed Exposure Mode

Trigger Width Exposure Mode

When the **Trigger Width** exposure mode is selected, the length of the exposure for each frame acquisition will be directly controlled by the external trigger signal. If the camera is set for rising edge triggering, the exposure time begins when the external signal rises and continuous until the external trigger signal falls. If the camera is set for falling edge triggering, the exposure time begins when the external trigger signal falls and continuous until the external trigger signal rises.

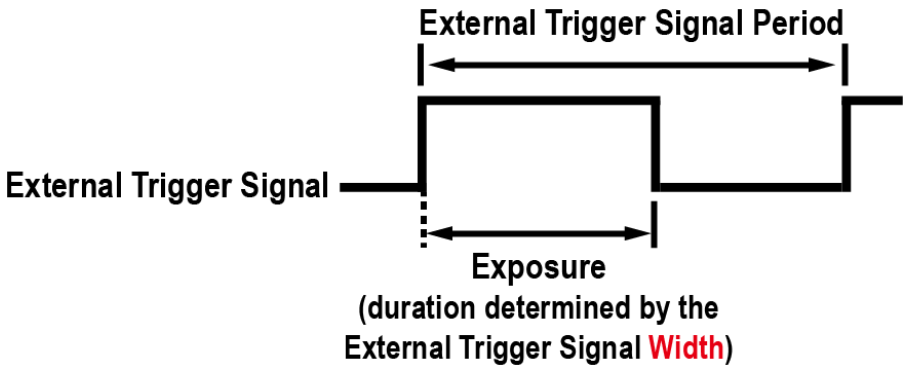


Figure 8.19 Trigger Width Exposure Mode

8.6 Setting the Exposure Time (VA-47MC Only)

This section describes how the exposure time can be adjusted manually by setting the value of the **Exposure Time** parameter on the VA-47MC camera.

If you are operating the camera in any one of the following ways, you must specify an exposure time by setting the camera's **Exposure Time** parameter:

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

The **Exposure Time** parameter must not be set below a minimum specified value. The **Exposure Time** parameter sets the exposure time in μs. The minimum and maximum exposure time settings for the VA-47MC camera are shown in the following table.

Camera Model	Minimum Allowed Exposure Time	Maximum Possible Exposure Time †
VA-47MC	28 μs	60,000,000 μs

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

Table 8.4 Minimum and Maximum Exposure Time Setting

8.7 Real Exposure (VA-47MC Only)

8.7.1 Timed Exposure Mode

When the Timed mode is selected, the exposure time is determined by the time interval between the point where an external trigger signal is applied and the point where the t_{pd} (Photodiode Transfer) signal falls.
The camera generates a shutter signal to clear pixels when an external trigger signal is applied. The exposure time begins when the shutter signal falls and continues until the t_{pd} (Photodiode Transfer) signal falls. As Figure 8.20 shows, there is an Exposure Start Delay (refer to Table 8.5) between the rise of the external trigger signal and the point where exposure actually begins. The setting value on the Exposure Time parameter is equal to the exposure time, because the t_{sub} value of the shutter signal and Transfer Pulse Offset value (t_{pd}, t_{3p}) are compensated on the exposure time by the camera's logic internally. Therefore, there is no difference between the setting value on the Exposure Time parameter and the exposure time. The t_{sub} value and Transfer Pulse Offset value are determined by the CCD sensor used in the camera.

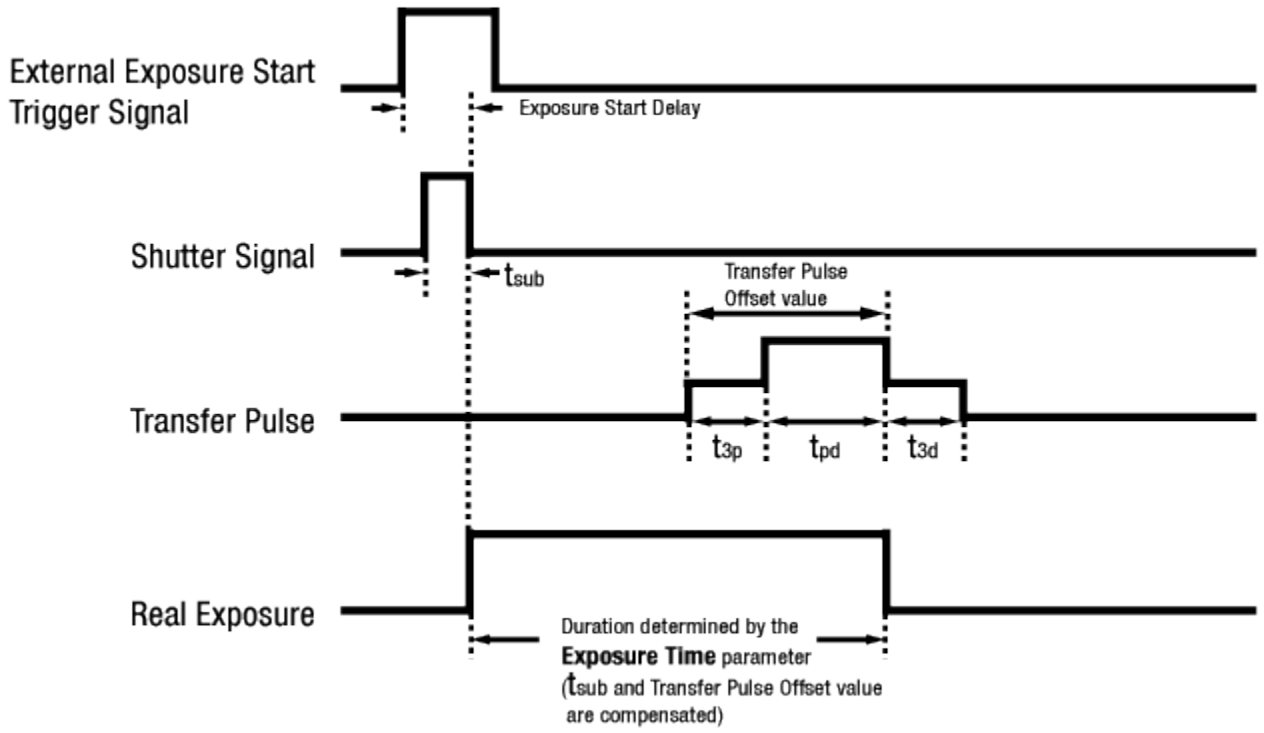


Figure 8.20 Real Exposure with Timed Exposure Mode

8.7.2 Trigger Width Exposure Mode

When the Trigger Width mode is selected, the exposure time is controlled by the external trigger signal.
The camera generates a shutter signal to clear pixels when an external trigger signal is applied. The exposure time begins when the shutter signal falls and continues until the t_{pd} (Photodiode Transfer) signal falls. As Figure 8.21 shows, there is an Exposure Start Delay (refer to Table 8.5) between the rise of the external trigger signal and the rise of the shutter signal. There is difference between the width of the external trigger signal and the exposure time as much as the t_{sub} value of the shutter signal and Transfer Pulse Offset value (t_{pd}, t_{3p}).
You can calculate an actual exposure time by using the following formula:

- Exposure Time = Trigger Width + t_{3p} + t_{pd} + t_{sub}

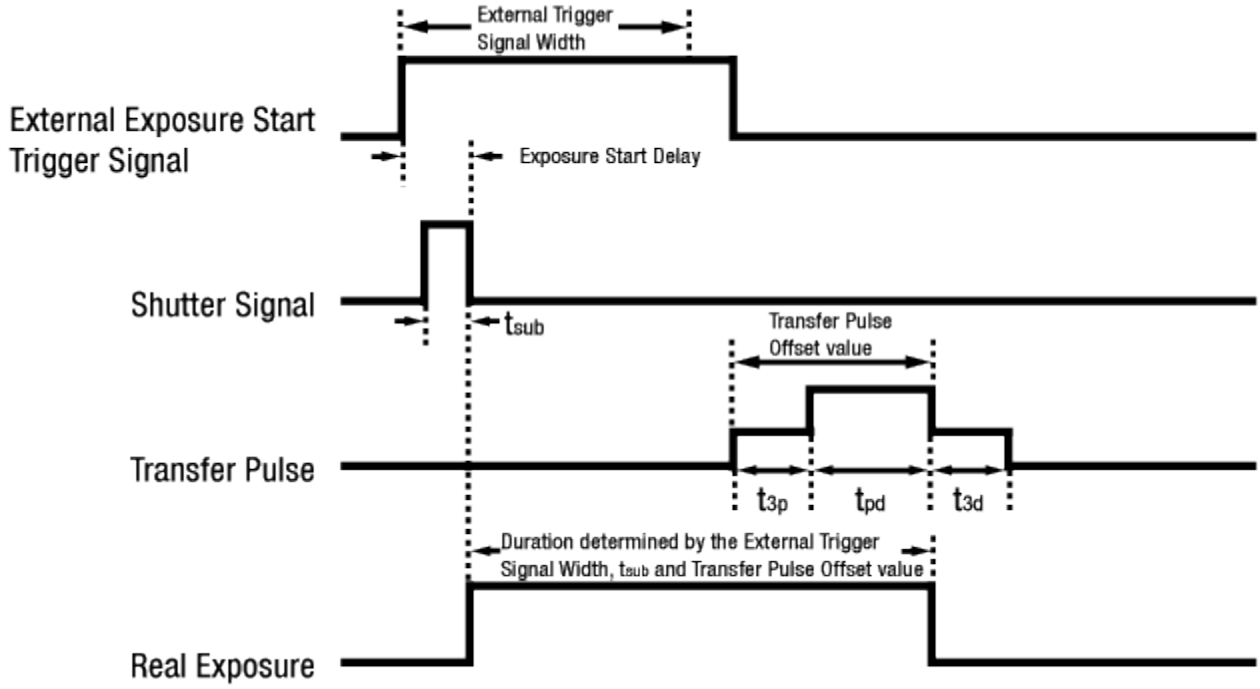


Figure 8.21 Real Exposure with Trigger Width Exposure Mode

The t_{sub} and Transfer Pulse Offset value are determined by the CCD sensor used in the camera. The following table shows the t_{sub} and Transfer Pulse Offset values for the VA-47MC camera.

Model	Real Exposure Parameters					Remarks
	t_{sub}	t_{3p}	t_{pd}	t_{3d}	Exposure Start Delay	
VA-47MC	2 μs	16 μs	6 μs	–	–	• t_{sub}: Shutter Transfer • t_{3p}: VCCD leading pedestal signal • t_{pd}: Photodiode transfer signal • t_{3d}: VCCD trailing pedestal signal • Exposure Start Delay: Trigger Latency + Trigger Jitter

Table 8.5 Real Exposure Parameters

8.8 Channel Mode (All VA cameras except VA-47MC)

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.

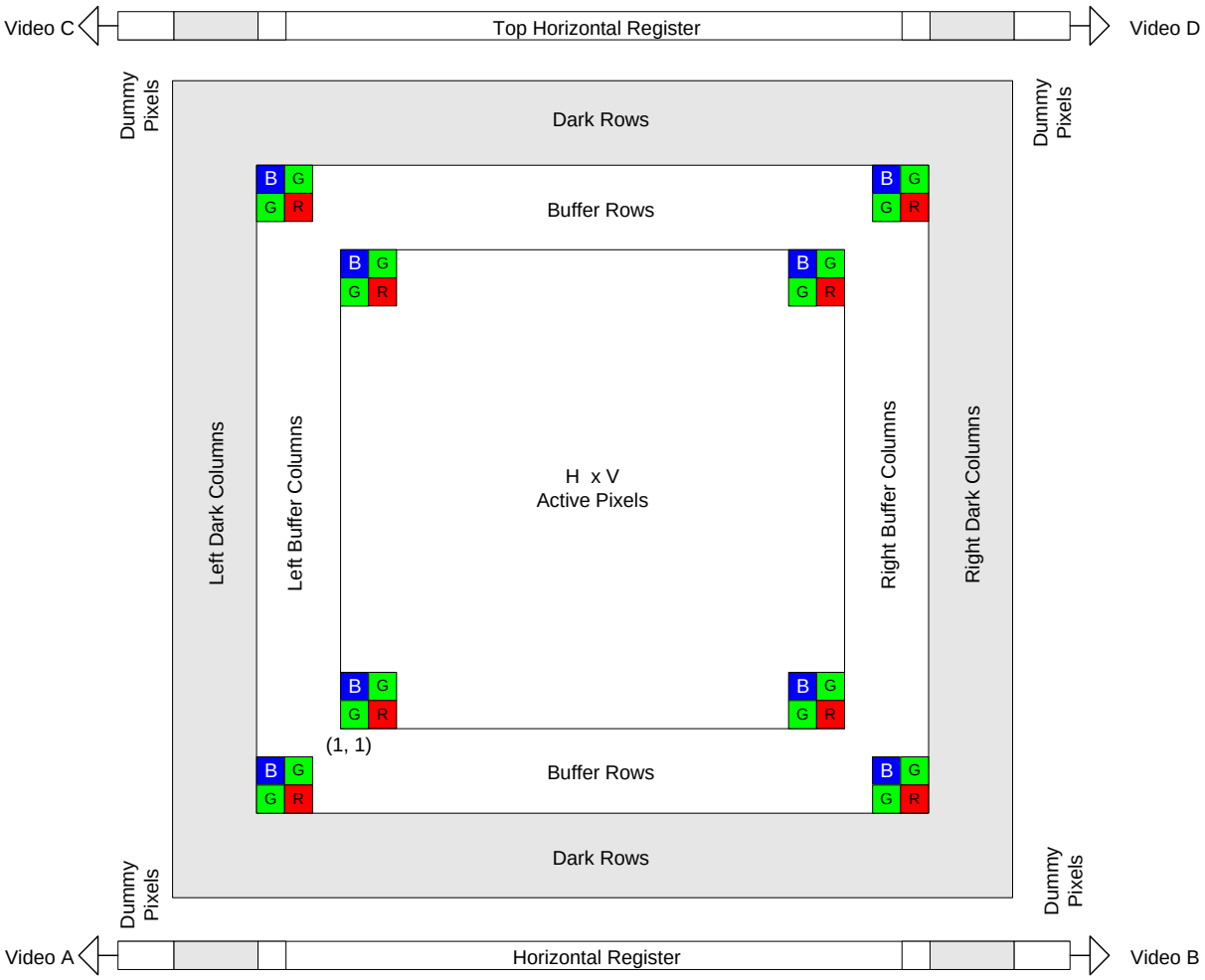


Figure 8.22 Channel Mode

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 or 2 Tap Interleaved fashion (Figure 8.24).

VA-29MC supports only the 2 Tap Top-Bottom video output mode for the 4 Tap sensor readout.

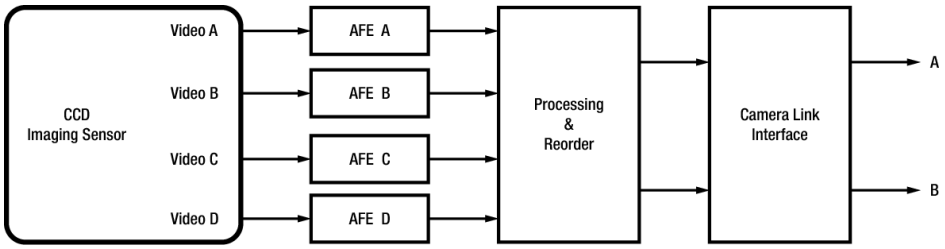


Figure 8.23 Image Data Flow

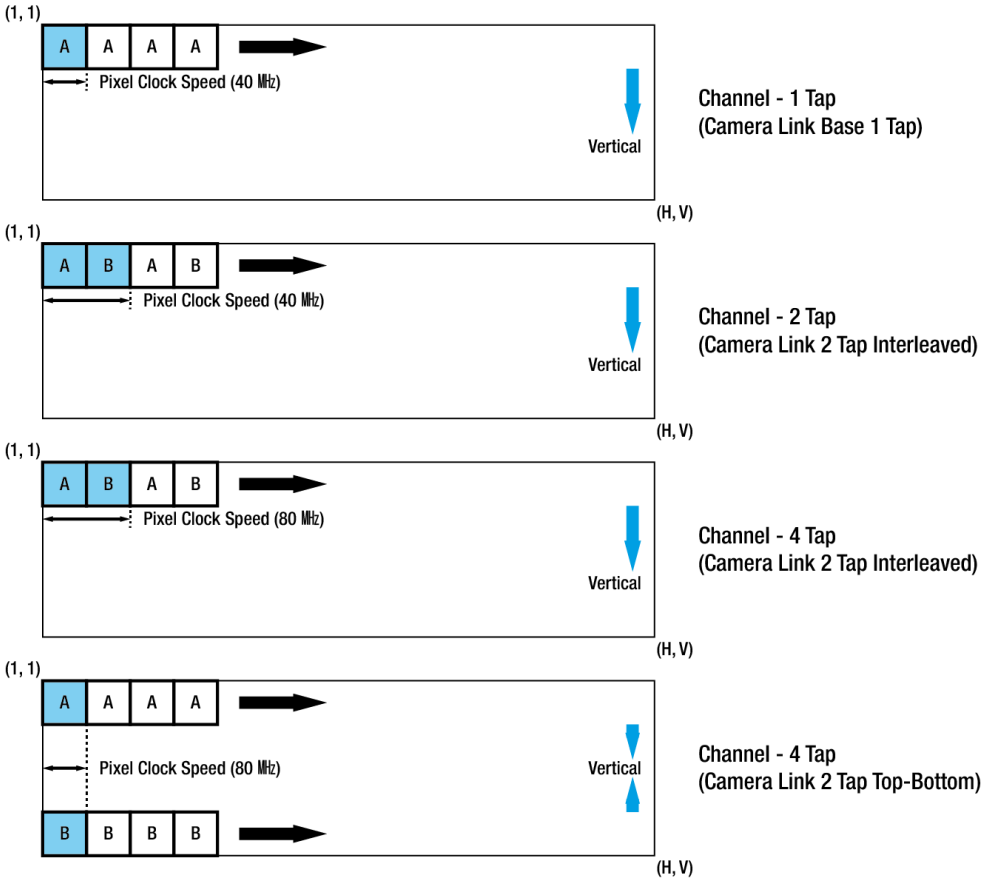


Figure 8.24 Data Output

8.9 Channel Mode (VA-47MC Only)

The VA-47MC camera is equipped with a 16 Taps imaging sensor. From VOUTa to VOUTp, all 16 channels will be used to read out image data from the CCD.

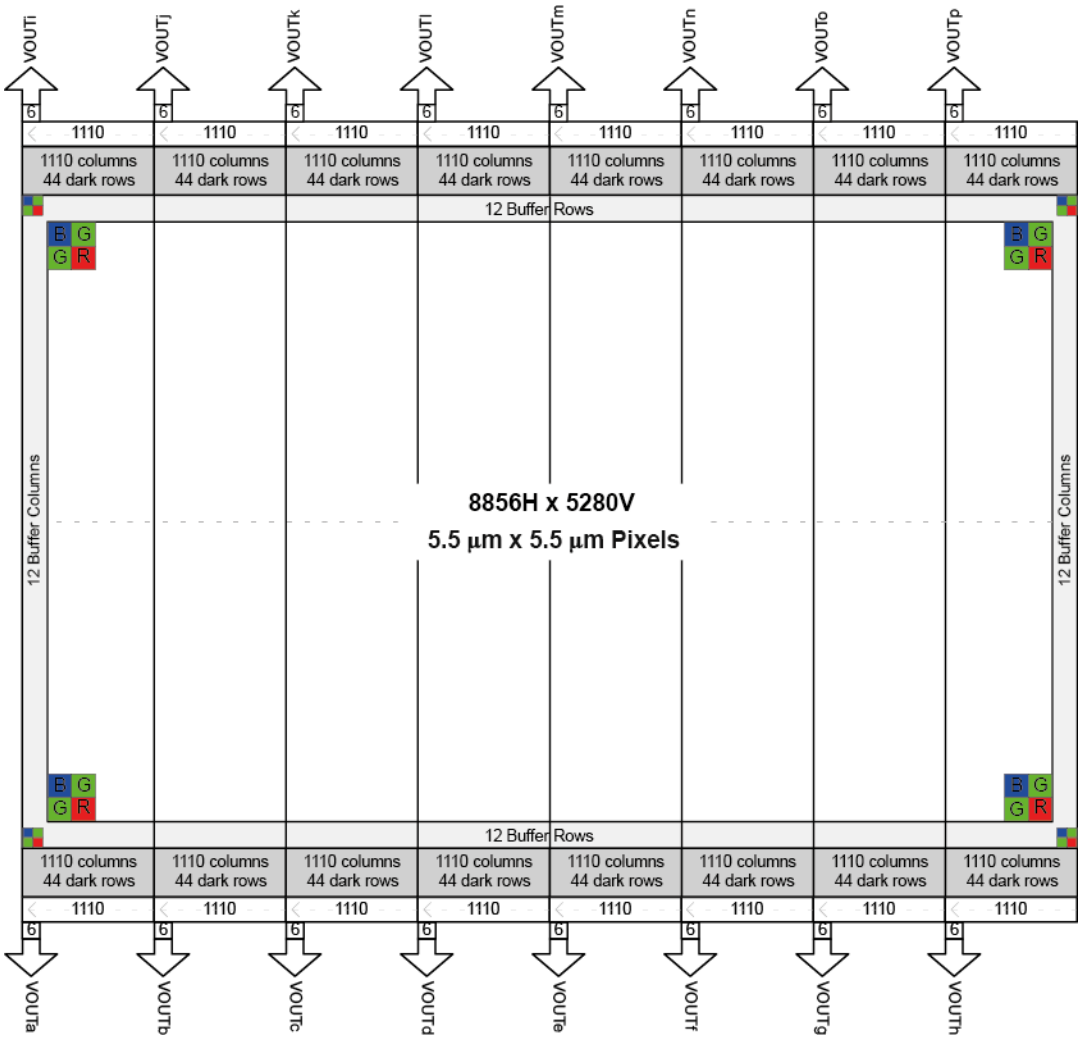


Figure 8.25 Channel Mode (VA-47MC Only)

The image data read out from the CCD goes through image processing and it is reordered to be compliant with the Camera Link standard. The image data read out from 16 channels will be transmitted in a Camera Link 4 Tap – 1X2-2YE fashion.

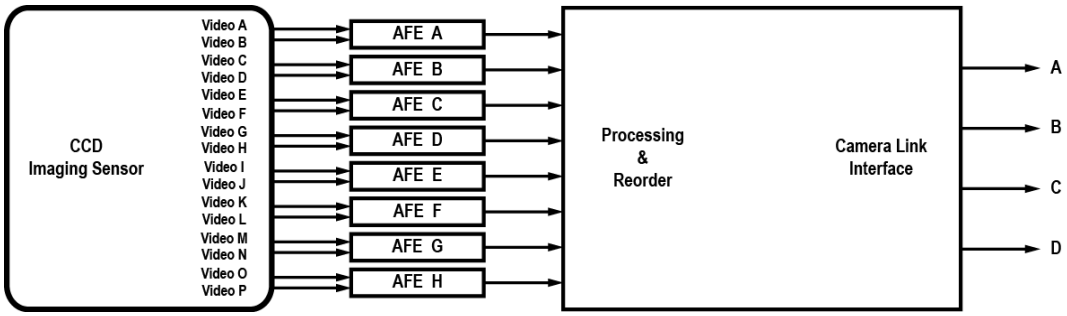


Figure 8.26 Image Data Flow (VA-47MC Only)

Figure 8.27 Data Output (VA-47MC Only)

8.10 Gain and Offset (All VA cameras except VA-47MC)

The camera has one Analog Signal Processor (or Analog Front End, AFE) for each channel. The 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 designated 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)
```

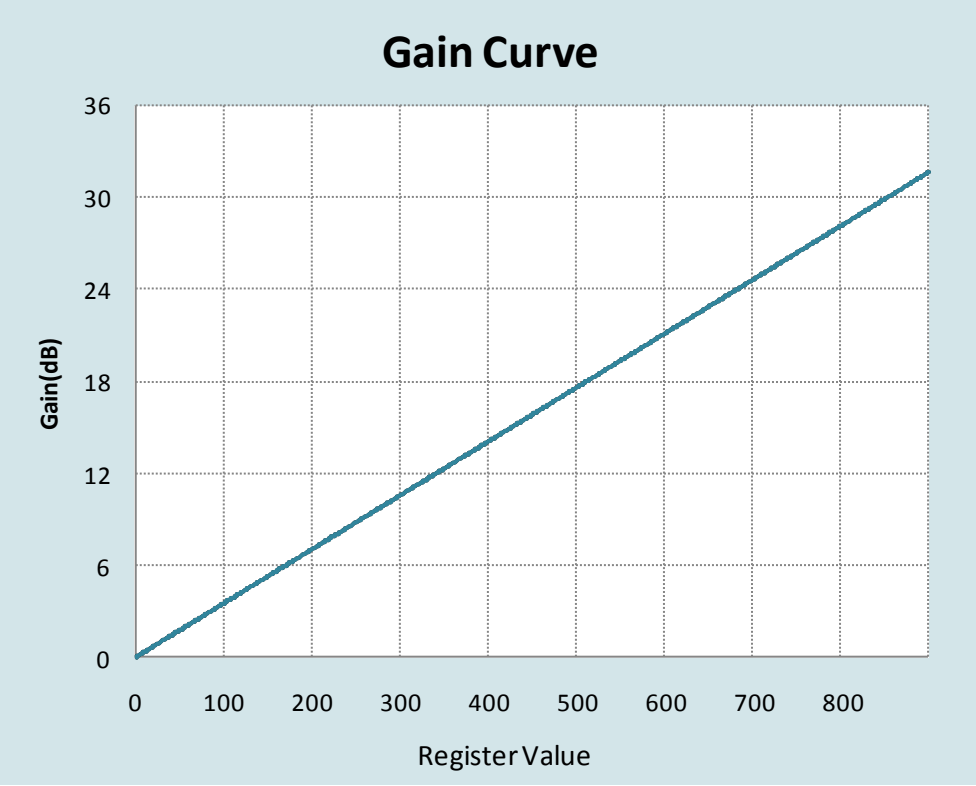


Figure 8.28 Register Setting Values for the Actual Gain Values

The Offset value can be set in a range from 0 to 255 (LSB).

8.11 Gain and Black Level (VA-47MC Only)

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

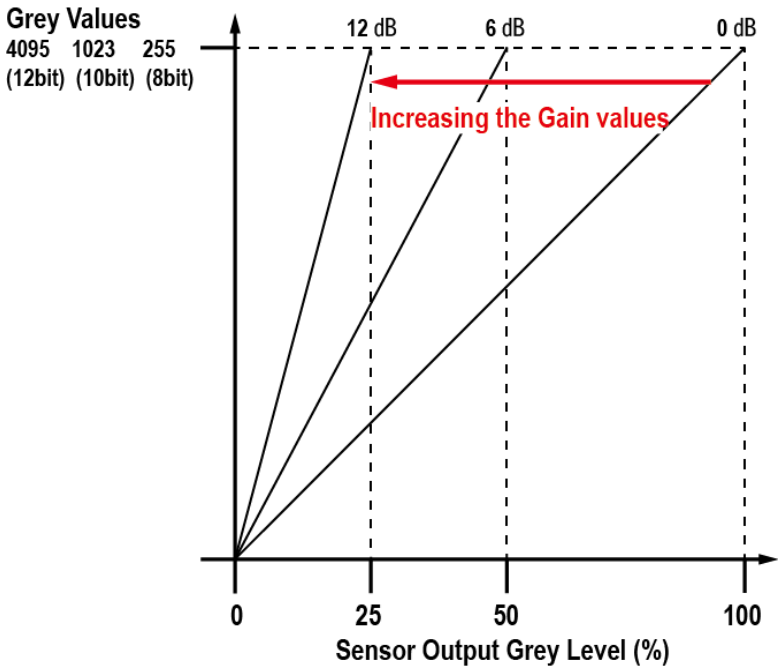


Figure 8.29 Setting the Gain

Adjusting the **Black Level** parameter will result in an offset to the pixel values output from the camera.

The **ANALOG** tab of the Configurator provides the following settings to adjust the gain and black level.

Tab	Category	Value	Description
ANALOG	Gain	×1.0 ~ ×4.0	Sets a gain value (0 dB ~ 12 dB).
	Black Level	0 ~ 255	Sets a black level value.

Table 8.6 Gain and Black Level

8.12 LUT (All VA cameras except VA-47MC)

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 from 0 to 4095 and VA Camera Link camera provides 2 non-volatile spaces for LUT data storage. You can determine whether to apply LUT and which LUT to use by using the “sls” command. For more information about how to download LUT to the camera, refer to Appendix B.

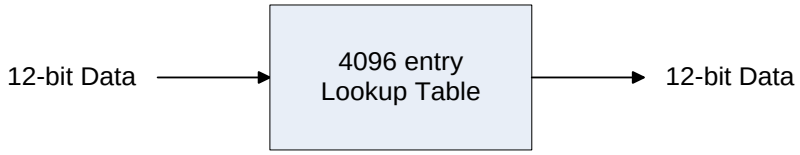


Figure 8.30 LUT Block

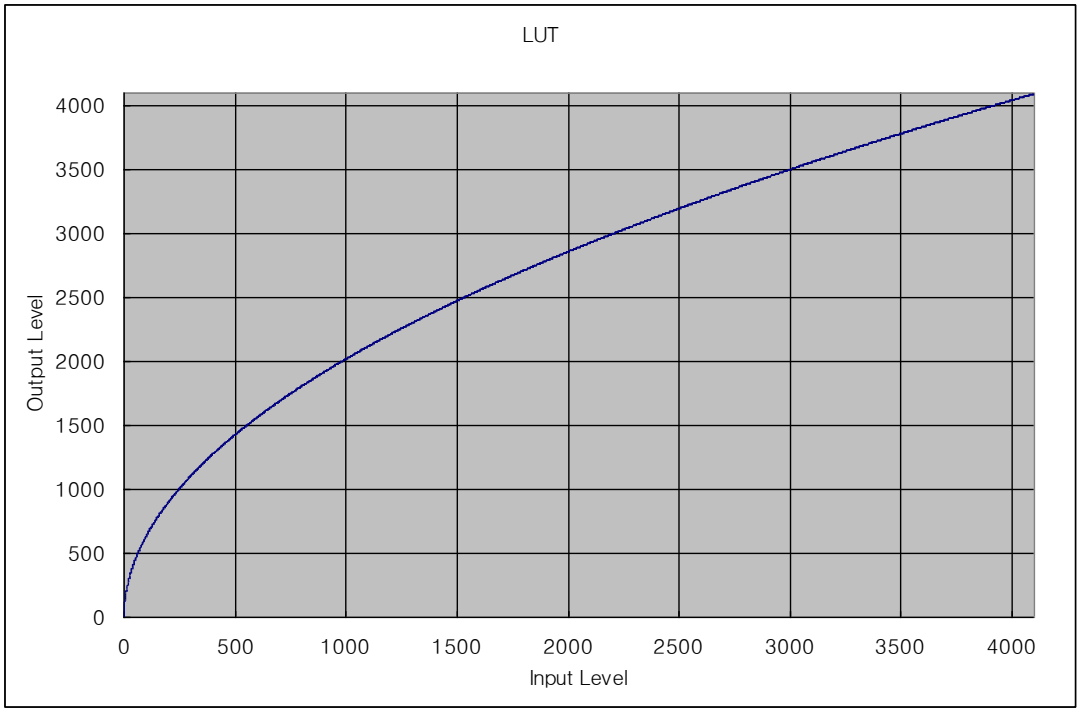


Figure 8.31 LUT at Gamma 0.5

8.13 Defective Pixel Correction

The CCD may have defect pixels which cannot properly react to the light. Correction is required since it may deteriorate the quality of output image. Defect pixel information of the CCD used for each camera is entered into 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. For more information, refer to Appendix A.
You can determine whether to use the Defective Pixel Correction feature by using the “sdc” command.

8.13.1 Correction Method

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

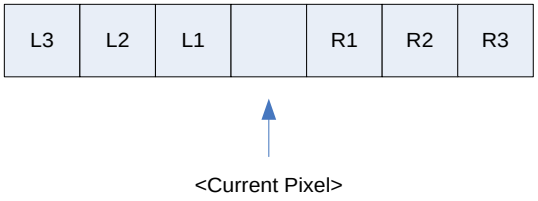


Figure 8.32 Location of Defect Pixel to be corrected

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 adjacent pixels are 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 8.7 Calculation of Defect Pixel Correction Value

8.14 Flat Field Correction (All VA cameras except VA-47MC)

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
```

8.14.1 Sequence of Flat Field Correction (All VA cameras except VA-47MC)

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

How to generate Flat Field Correction data using Serial Commands

1. Use the “sfi n” command to set the number of frames (2^n) to be used for generating the Flat Field data.
2. Use the “sfo” command to set the target value M to be applied after correction.
3. Use the “gfd” command to execute the Flat Field Generator.
4. Acquire images as many as set in the step 1 by operating the camera in the Free-Run mode or by applying trigger signals to the camera.
5. Use the “sfc” command to enable the Flat Field Correction feature. The Flat Field data will be expanded and then applied as shown in the Figure 8.36.
6. Execute the “sfd” command to save the generated Flat Field data in the non-volatile memory.

How to generate Flat Field Correction data using Configurator

1. Select the **FFC** tab and then set the number of frames to be used for generating the Flat Field data in the **Number of acquisition frame**.
2. Under the **FFC Offset Level** category, set the target value M to be applied after correction.
3. Click the **Generate** button to execute the Flat Field Generator.
4. Acquire images as many as set in the step 1 by operating the camera in the Free-Run mode or by applying trigger signals to the camera.
5. In the **VIEW** tab, click the **Flat Field Corr.** check box in the **Image Processing** category to enable the FFC.
6. In the **FFC** tab, click the **Save to Flash** button in the **Flash Memory** category to save the generated Flat Field Correction data into the non-volatile memory. The Flat Field data will be expanded and then applied as shown in the Figure 8.36 when they are used for correction.

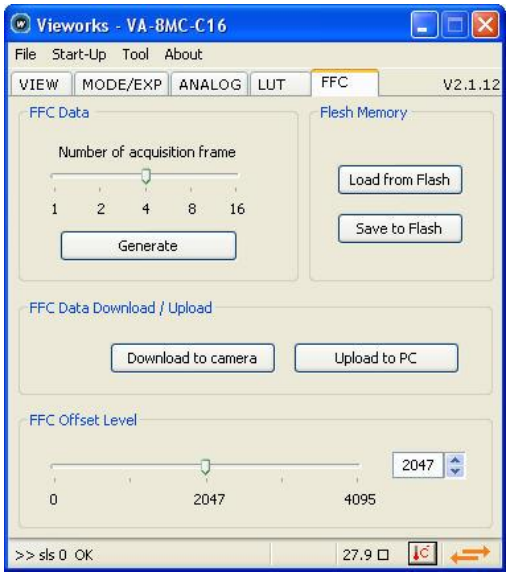


Figure 8.33 Flat Field Correction in Configurator (All VA cameras except VA-47MC)

- When you execute the Flat Field Generator, the camera will ignore the current settings and will use the default settings as shown below. After generating the Flat Field data, 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. The level values on the image may vary depending on the AOI, Binning or Channel mode settings.

8.15 Flat Field Correction (VA-47MC Only)

The Flat Field Correction feature improves the image uniformity when you acquire a non-uniformity image due to external conditions. The VA-47MC camera's Flat Field Correction feature can be summarized by the following equation:

```
IC = {(IR × (IM/IF))

IC: Level value of corrected image
IR: Level value of original image
IM: Reference value for Flat Field correction
IF: Level value of Flat Field data
```

8.15.1 Sequence of Flat Field Correction (VA-47MC Only)

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

How to generate Flat Field Correction data using Serial Commands (VA-47MC Only)

1. Use the "gfd" command to execute the Flat Field Generator.
2. Acquire one image by operating the camera in the Free-Run mode or by applying a trigger signal to the camera.
3. Use the "sfc" command to enable the Flat Field Correction feature.
4. Execute the "sfd" command to save the generated Flat Field Correction data in the non-volatile memory. The Flat Field data will be expanded and then applied as shown in the Figure 8.36 when they are used for correction.

How to generate Flat Field Correction data using Configurator

1. Select the **FFC** tab and then click the **Generate** button in the **FFC Data** category to execute the Flat Field Generator.
2. Acquire one image by operating the camera in the Free-Run mode or by applying a trigger signal to the camera.
3. In the **VIEW** tab, click the **Flat Field Corr.** check box in the **Image Processing** category to enable the FFC.
4. In the **FFC** tab, click the **Save to Flash** button in the **Flash Memory** category to save the generated Flat Field Correction data in the non-volatile memory. The Flat Field data will be expanded and then applied as shown in the Figure 8.36 when they are used for correction.

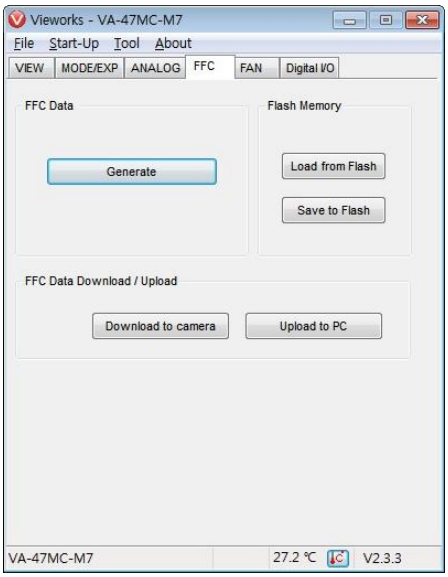


Figure 8.34 Flat Field Correction in Configurator (VA-47MC Only)

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

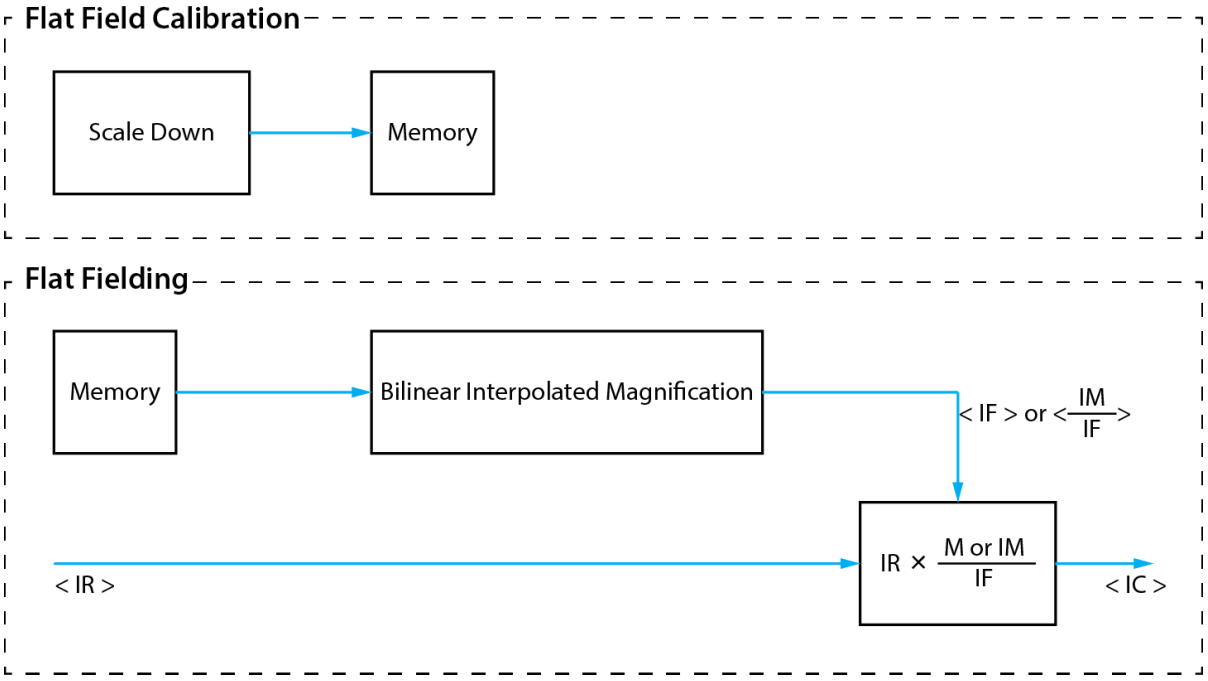


Figure 8.35 Generation and Application of Flat Field Data

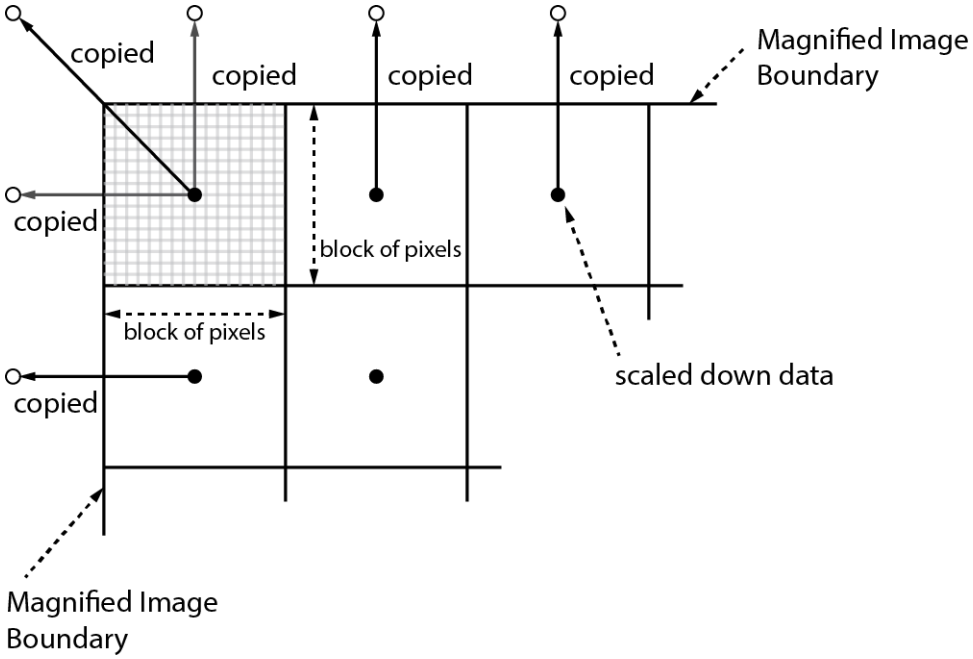


Figure 8.36 Bilinear Interpolated Magnification

8.16 Dark Signal Non-uniformity Correction (VA-29MC 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 VA-29MC camera provides the DSNU Correction feature.

8.17 Dark Signal Non-uniformity Correction (VA-47MC Only)

In theory, when a digital camera acquires images in complete darkness, all of the pixel values in the image should be near zero and they should be equal. In practice, however, slight variations in the performance of the pixels in the sensor will cause some variations in the pixel values output from the camera when the camera is acquiring in darkness. This variation is known as Dark Signal Non-Uniformity (DSNU). The VA-47MC Camera Link camera provides the DSNU Correction feature.

8.17.1 Generating and Saving User DSNU Correction Values

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

- For optimum DSNU correction results, we recommend that you generate DSNU data after the temperature of the camera housing has been stabilized.
- Before generating DSNU correction values, disable the Flat Field Correction feature.

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

8.18 Photo Response Non-uniformity Correction (VA-47MC Only)

In theory, when a digital camera acquires images with the camera viewing a uniform light-colored target in bright light, all of the pixel values in the image should be near the maximum grey value and they should be equal.
In practice, however, slight variations in the performance of the pixels in the sensor, variations in the optics, and variations in the lighting will cause some variations in the pixel values output from the camera. This variation is known as Photo Response Non-Uniformity (PRNU). The VA-47MC camera provides the PRNU correction feature. The PRNU Correction feature applied in the VA-47MC camera acquires one or more images under the unsaturated lighting condition and then obtains the average grey level value of the entire image. Then, PRNU coefficients for each pixel will be generated according to the average grey level value. These correction values will be generated and applied to the VA-47MC camera during the manufacturing process.

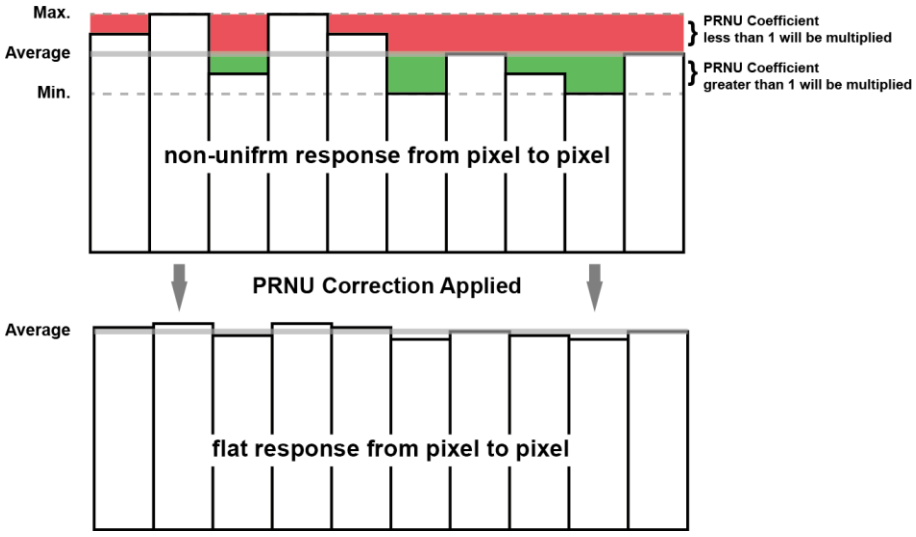


Figure 8.37 PRNU Correction

8.19 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.

8.20 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 second, Off for 0.5 second: 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.

The VA-47MC camera’s LED status and corresponding camera status are as follows:

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

8.21 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.

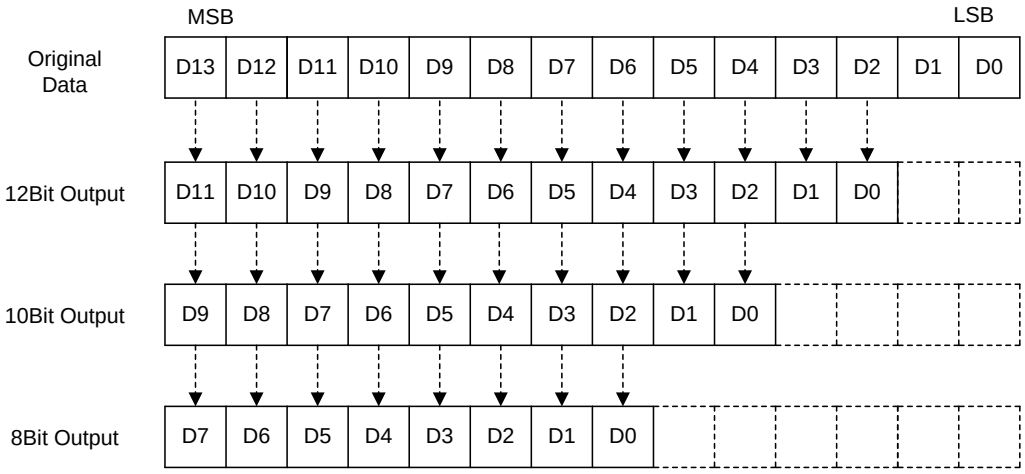


Figure 8.38 Data Format

When the **Channel** mode is set to **4 Tap-I** (Sensor Readout: 4 Tap / Video Output: 2 Tap Interleaved), image data will be transmitted in 8 bit fashion. Therefore, if the Data Format is set to 10 or 12 bit, the 2 or 4 least significant bits will be set to zero.

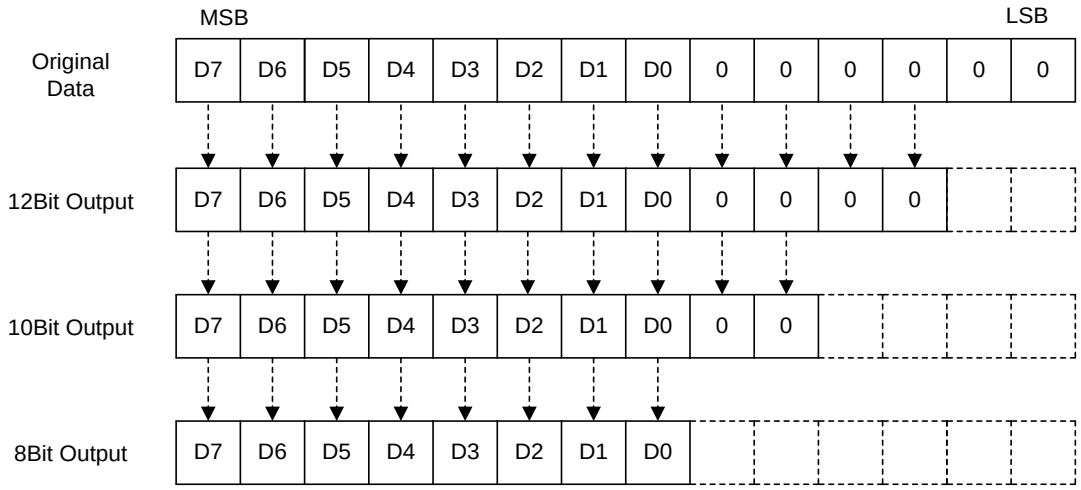


Figure 8.39 Data Format (4 Tap-I)

8.22 Auto White Balance (VA-47MC Color Only)

The AWB (Auto White Balance) feature is implemented on the VA-47MC color camera. It will adjust the white balance of the image acquired from the color camera according to the GreyWorld algorithm. Before using the AWB feature, you need to set the ROI for the AWB. If you do not set the ROI for the AWB, the pixel data from the Image ROI will be used to adjust the white balance. You can enable the AWB feature by using the 'arg' command.

8.22.1 Data ROI

The AWB feature provided by the VA-47MC camera uses the pixel data from Data ROI to adjust the white balance. The **AWB** tab of the Configurator provides the following settings to set the ROI for the AWB.

Tab	Category	Parameter	Description
AWB	ROI Selection	Offset X	Horizontal offset from the origin to the ROI for the AWB
		Offset Y	Vertical offset from the origin to the ROI for the AWB
		Width	Width of the ROI for the AWB
		Height	Height of the ROI for the AWB

Table 8.8 Setting the ROI for the AWB

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

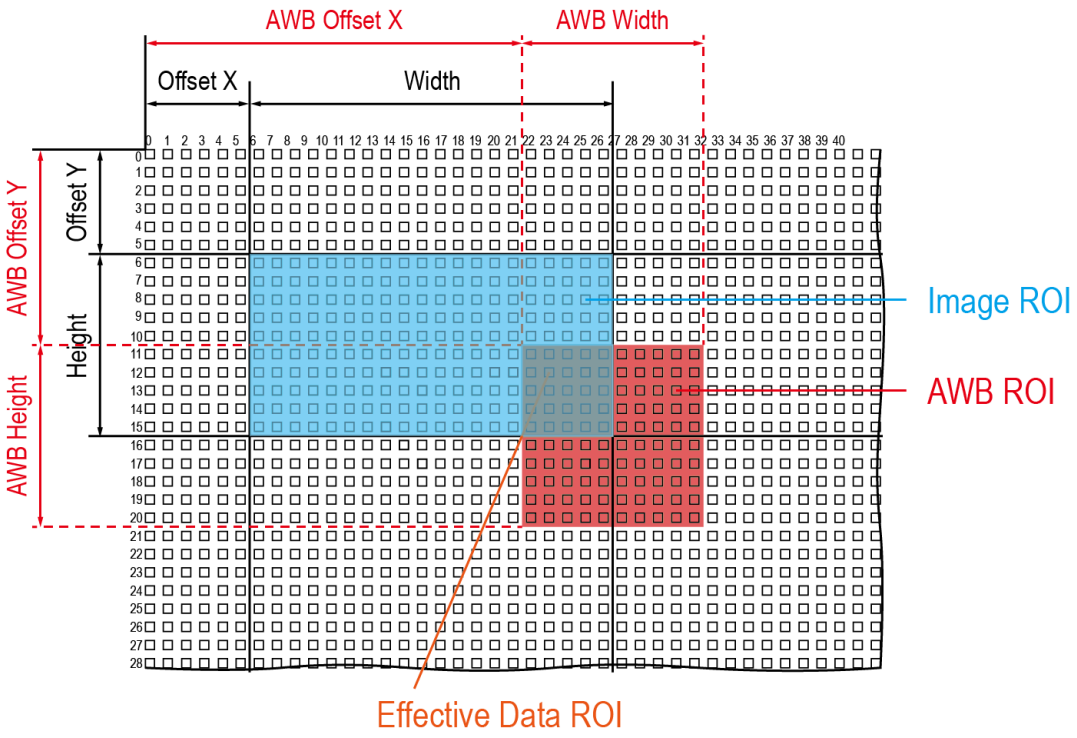


Figure 8.40 Effective Data ROI

8.23 Test Image

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

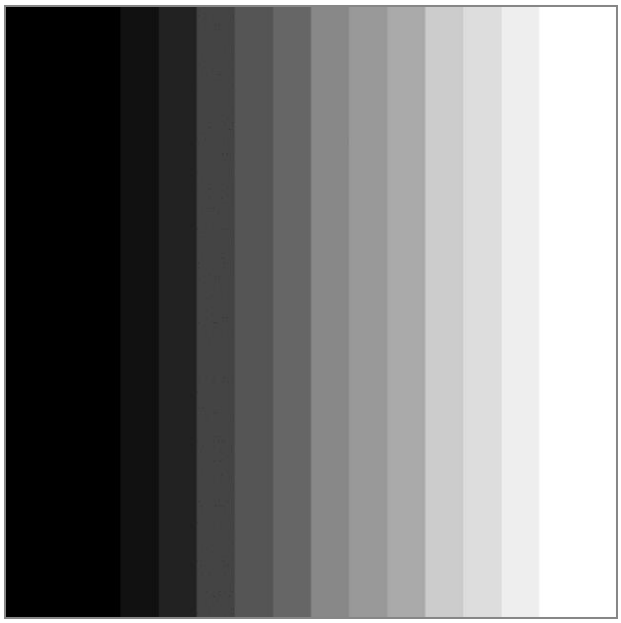


Figure 8.41 Test Image 1

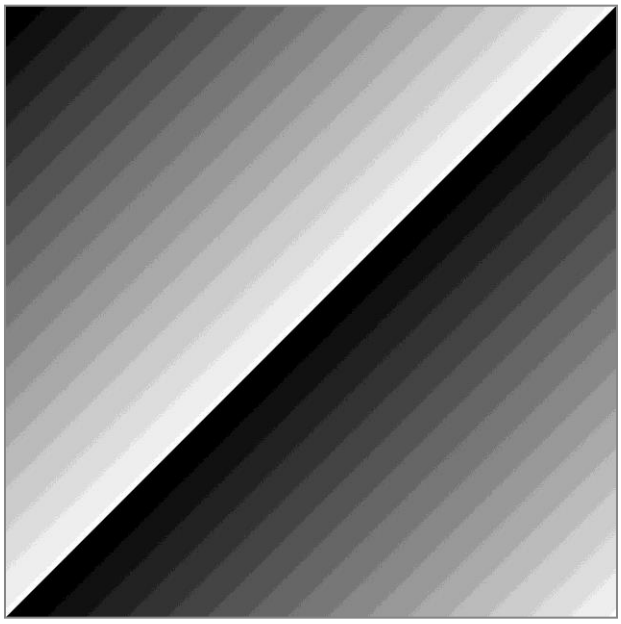


Figure 8.42 Test Image 2

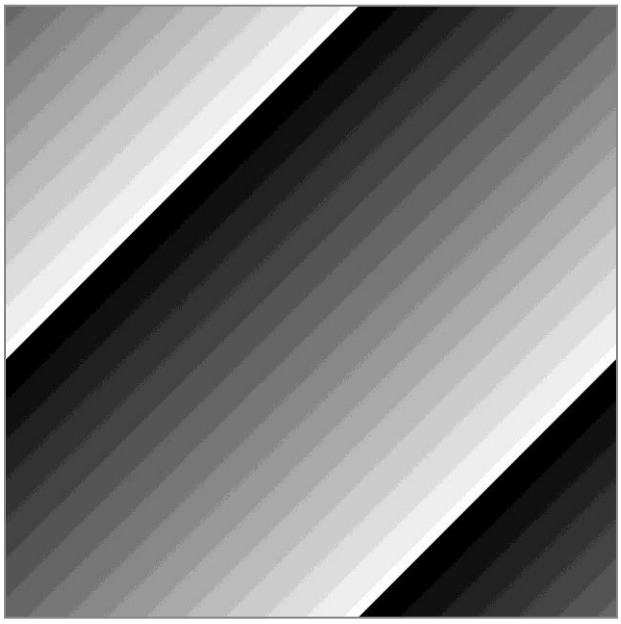


Figure 8.43 Test Image 3

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

8.24 Horizontal Flip (Only available on VA-1MC, 2MC, 4MC, 8MC and 47MC)

The Horizontal Flip feature lets you flip the image horizontally. This feature is available in all operation modes of the camera. You can set the Horizontal Flip feature by using the “shf” command.

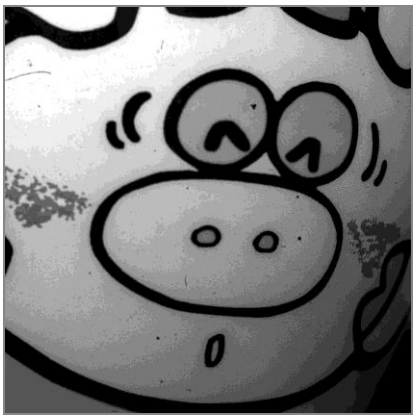


Figure 8.44 Original Image

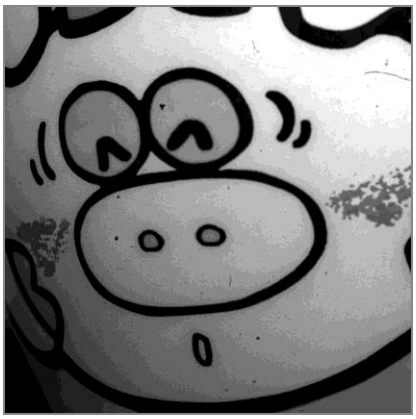


Figure 8.45 Horizontal Flipped Image

8.25 Image Invert (All VA cameras except VA-47MC)

The Image Invert feature lets you invert the level values of the output image. The inverted level values differ depending on the Data Format setting even if original values are same. This feature is available in all operation modes of the camera. You can set the Image Invert feature by using the “sii” command.

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

Table 8.9 Inverted Level Value depending on the Data Format

Figure 8.46 Original image

Figure 8.47 Inverted image

8.26 Strobe (All VA cameras except VA-47MC)

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.

8.26.1 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.

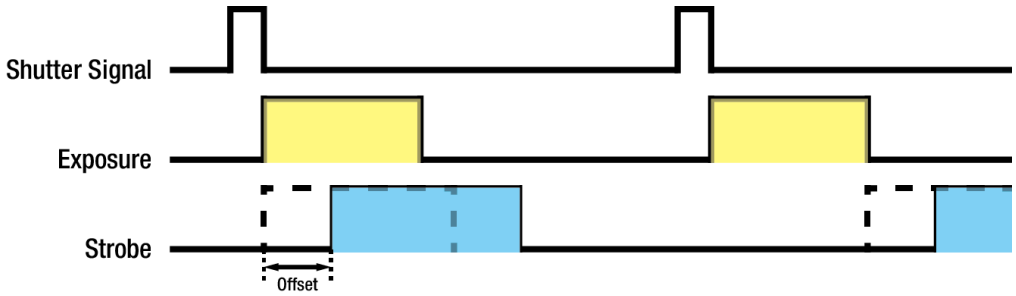


Figure 8.48 Strobe Signal in the Free-Run mode

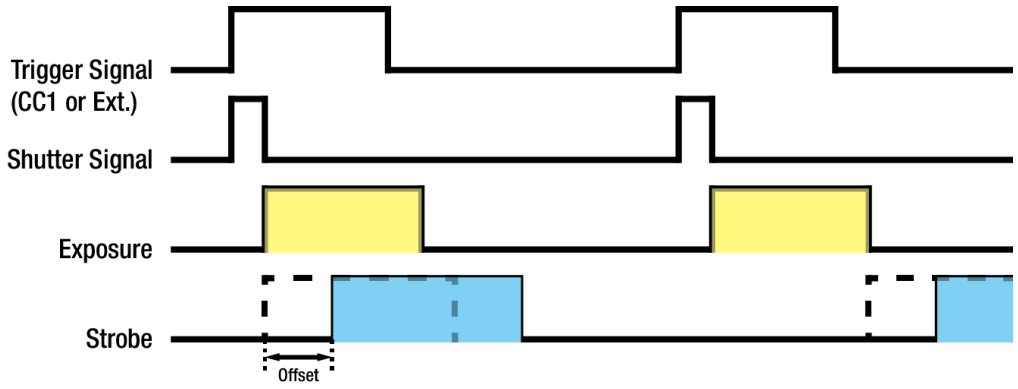


Figure 8.49 Strobe Signal in the Trigger mode

8.26.2 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.

8.27 Programmable Output Control (VA-47MC Only)

The control I/O receptacle of the VA-47MC camera can be operated in various modes.

The **Digital I/O** tab provides the following settings for the output control.

Configurator	Category	Value	Description
Digital I/O	Line Source	Off	Disables the line output.
		Exposure	Outputs pulse signals indicating the current exposure time.
		Frame	Outputs pulse signals indicating a frame readout time.
		User Output	Outputs pulse signals set by the User Output parameter.
		Timer	Outputs user-defined Timer signals as pulse signals.
	Line Inverter	FALSE	Does not invert the line output signals.
		TRUE	Inverts the line output signals.
	User Output	FALSE	Sets the bit state of the line to Low.
		TRUE	Sets the bit state of the line to High.
	Timer Trigger Source	Off	Disables the Timer trigger.
		Exposure	Specifies the Timer to use the exposure start as source signals.
	Timer Duration	0 – 60,000,000 μs	Sets the duration of the Timer pulse.
	Timer Delay	0 – 60,000,000 μs	Sets the delay time to be applied before outputting the Timer pulse.
	Timer Trigger Activation	Falling Edge	Specifies that a falling edge of the selected trigger signal will act as the Timer trigger.
		Rising Edge	Specifies that a rising edge of the selected trigger signal will act as the Timer trigger.
		Level Low	Specifies that the Timer pulse will be valid as long as the selected trigger signal is Low.
		Level High	Specifies that the Timer pulse will be valid as long as the selected trigger signal is High.

Table 8.10 Digital I/O

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

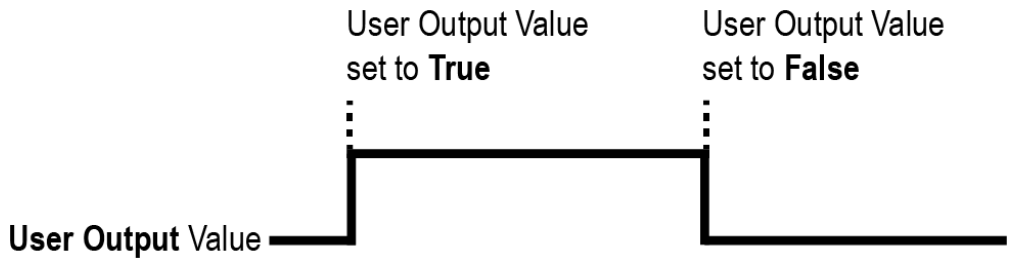


Figure 8.50 User Output

When you set the **Line Source** to **Timer**, the camera will output signals by using the Timer.

For example, if the **Timer Trigger Activation** is set to **Level High**, the Timer will act as follows:

1. When source signals set by the **Timer Trigger Source** (Exposure is only available) are applied, the Timer will start operations.
2. The delay set by the **Timer Delay** begins to expire.
3. When the delay expires, the Timer signal goes high as long as the source signal is high.

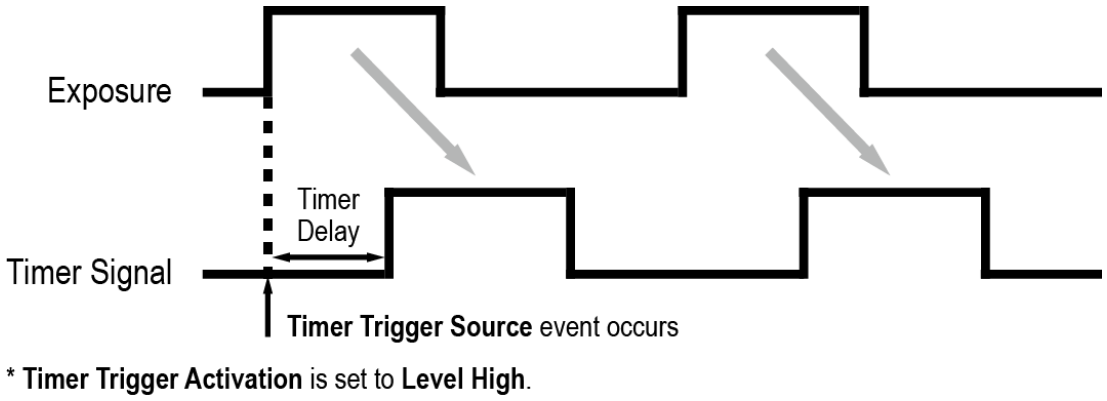


Figure 8.51 Timer Signal

8.28 Fan Control (VA-47MC Only)

A fan is installed on the rear panel of the camera to radiate heat. You can set the fan to turn on or off. You can also set the fan to turn on when a specified internal temperature is reached.

8.29 Device Reset (VA-47MC Only)

Reset the camera physically to power off and on. You can reset the camera by using the “rst” command.

8.30 Field Upgrade

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

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:
  - All VA cameras except VA-47MC: 19200 bps
  - VA-47MC Only: 115200 bps
- Data Bit: 8 bit
- Parity Bit: No Parity
- Stop bit: 1 stop bit
- Flow control: None

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

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

ex) Write Command

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

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

ex) Read Command

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

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

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

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

9.2 Actual Runtime of Commands

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

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

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

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

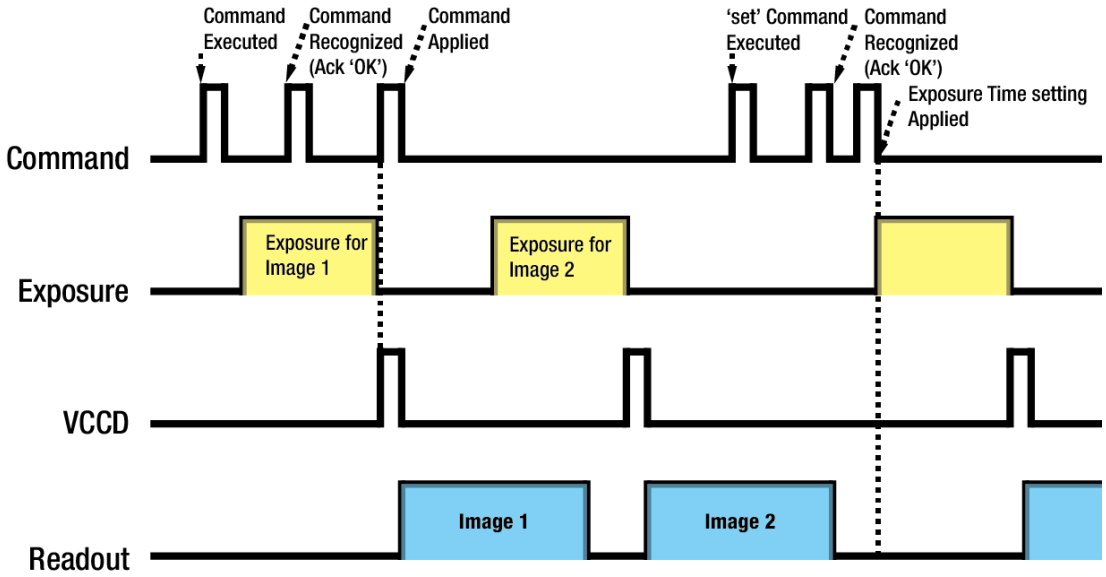


Figure 9.1 Actual Runtime of Commands

9.3 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.

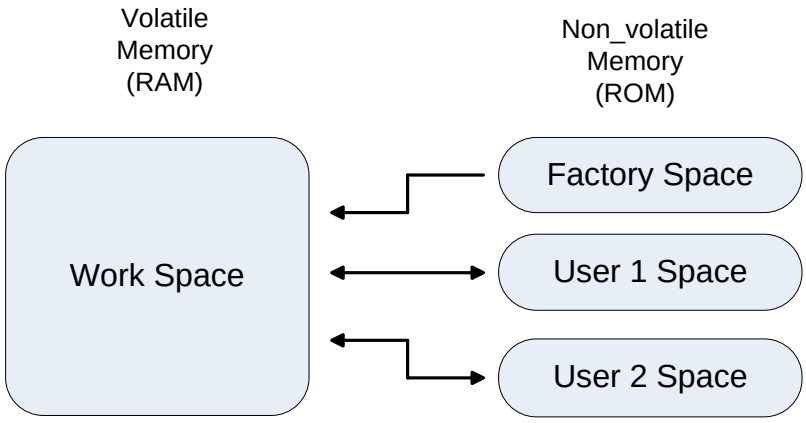


Figure 9.2 Parameter Storage Space

9.4 Command List (All VA cameras except VA-47MC)

Command	Syntax	Return Value	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 Channel Mode Get Channel Mode	scm 1|2|3|4 gcm	OK 1|2|3|4	1: 1 Tap output 2: 2 Tap output 3: 4 Tap-I output 4: 4 Tap output
Set LUT Select Get LUT Select	sls 0|1|2 gls	OK 0|1|2	0: Off 1: LUT1 2: LUT2
Set 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	Return Value	Description
Set Image Invert Get Image Invert	sii 0|1 gii	OK 0|1	0: Off 1: Active of Image Invert
Set Horizontal Flip Get Horizontal Flip	shf 0|1 ghf	OK 0|1	0: Off 1: Active of Horizontal Flip
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)

Table 9.2 Command List #2

Command	Syntax	Return Value	Description
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)
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
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
Set Pclk Selection Get Pclk Selection	sps 0|1 gps	OK 0|1	0: Normal Speed 1: High Speed (Only available on VA-16MC and VA-29MC)
Get MCU Version	gmv	String	Display MCU version
Get Model Number	gmn	String	Display 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 9.3 Command List #3

9.5 Command List (VA-47MC Only)

Command	Syntax	Return Value	Description
Help	h	String	Displays a list of all commands
Set Image Width Get Image Width	siw n giw	OK n	n: Image width (Setting range: 512 – 8848)
Set Image Height Get Image Height	sih n gih	OK n	n: Image height (Setting range: 1056 – 5280)
Set Offset X Get Offset X	sox n gox	OK n	n: Offset X
Set Offset Y Get Offset Y	soy n goy	OK n	n: Offset Y
Set Binning Horizontal Get Binning Horizontal	sbh 1|2|4 gbh	OK 1|2|4	1: Horizontal Binning Off 2: Horizontal Binning by 2 3: Horizontal Binning by 4
Set Binning Vertical Get Binning Vertical	sbv 1|2|4 gbv	OK 1|2|4	1: Vertical Binning Off 2: Vertical Binning by 2 4: Vertical Binning by 4
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 Defect Correction Get Defect Correction	sdc 0|1 gdc	OK 0|1	0: Defect correction Off 1: Defect correction On
Set Horizontal Flip Get Horizontal Flip	shf 0|1 ghf	OK 0|1	0: Horizontal flip Off 1: Horizontal flip On
Set Trigger Mode Get Trigger Mode	stm 0|1 gtm	OK 0|1	0: Trigger Mode Off 1: Trigger Mode On

Table 9.4 Command List #1 (VA-47MC Only)

Command	Syntax	Return Value	Description
Set Exposure Source Get Exposure Source	ses 0|1 ges	OK 0|1	0: Timed (by camera) 1: Trigger Width (by external trigger signal)
Set Trigger Source Get Trigger Source	sts 1|5 gts	OK 1|5	1: CC1 5: External
Set Trigger Activation Get Trigger Activation	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 – 60,000,000 μs)
Set Black Level Get Black Level	sbl n gbl	OK n	n: Black level value (Setting range: 0 - 255)
Set Gain Get Gain	sg n gg	OK n	n: Gain value (Setting range: 1.0 – 4.0)
Set Fan Mode Get Fan Mode	sfm 0|1|2 gfm	OK 0|1|2	0: Turn off the fan 1: Turn on the fan 2: Turn on the fan when the temperature exceeds the value set in Operation Temperature
Set Target Temperature Get Target Temperature	stt n gtt	OK n	n: Target temperature (Setting range: -10 – 80℃)
Set Line Output Source Get Line Output Source	slos 0|1|2|5|7 glos	OK 0|1|2|5|7	0: Disable Line output 1: Exposure 2: Frame 5: User output 7: Timer
Set Line Output Inverter Get Line Output Inverter	sloi 0|1 gloi	OK 0|1	0: Disable the inversion of the Line output 1: Enable the inversion of the Line output
Set User Output Value Get User Output Value	suov 0|1 guov	OK 0|1	0: Set the User Output to low 1: Set the User Output to high
Set Timer Trigger Source Get Timer Trigger Source	stts 0|1 gtts	OK 0|1	0: Disable the Timer output 1: Use the Exposure as source signals for the Timer

Table 9.5 Command List #2 (VA-47MC Only)

Command	Syntax	Return Value	Description
Set Timer Duration Get Timer Duration	stdu n gtdu	OK n	n: Set the duration of the Timer pulse (Setting range: 0 – 60,000,000 μs)
Set Timer Delay Get Timer Delay	stdl n gtdl	OK n	n: Set the delay time of the Timer pulse (Setting range: 0 – 60,000,000 μs)
Set Timer Trigger Activation Get Timer Trigger Activation	stta 0|1|2|3 gtta	OK 0|1|2|3	0: Falling edge 1: Rising edge 2: Level low 3: Level high
Auto White Balance	arg	OK	White balance is adjusted once and then Off.
Set AWB Offset X Get AWB Offset X	swx n gwx	OK n	n: AWB Offset X
Set AWB Offset Y Get AWB Offset Y	swy n gwy	OK n	n: AWB Offset Y
Set AWB Image Width Get AWB Image Width	sww n gww	OK n	n: AWB Image Width
Set AWB Image Height Get AWB Image Height	swh n gwh	OK n	n: AWB Image Height
Set Color Gain Get Color Gain	srg r|g|b g grg r|g|b	OK g	r / g / b: Red, Green and Blue color channels g: Gain value
Generate DSNU Data	gdd	OK	Generates DSNU data
Save DSNU Data	sdd	OK	Saves the generated DSNU data in the non-volatile memory
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 Correction Get Flat Field Correction	sfc 0|1 gfc	OK 0|1	0: Flat field correction Off 1: Flat field correction On
Reset HW	rst	OK	Reset hardware

Table 9.6 Command List #3 (VA-47MC Only)

Command	Syntax	Return Value	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 0|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 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 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 internal temperature in Celsius

Table 9.7 Command List #4 (VA-47MC Only)

10 Configurator GUI

Configurator, a sample application, is provided to control VA Camera Link series camera. Configurator provides easy-to-use Graphic User Interface (GUI) 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.

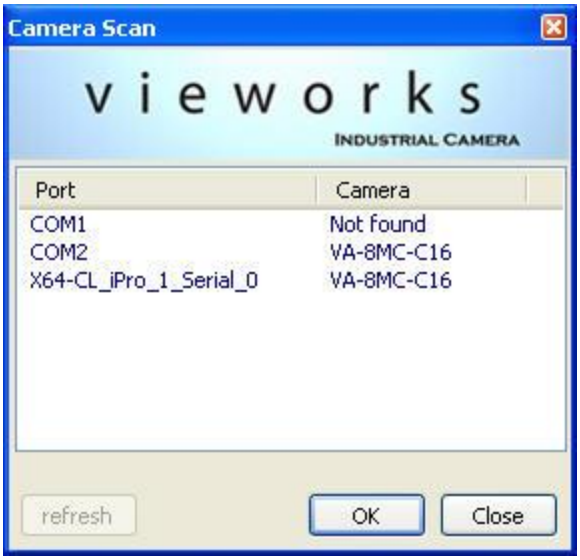


Figure 10.1 Configurator Loading Window

10.2 Menu

10.2.1 File

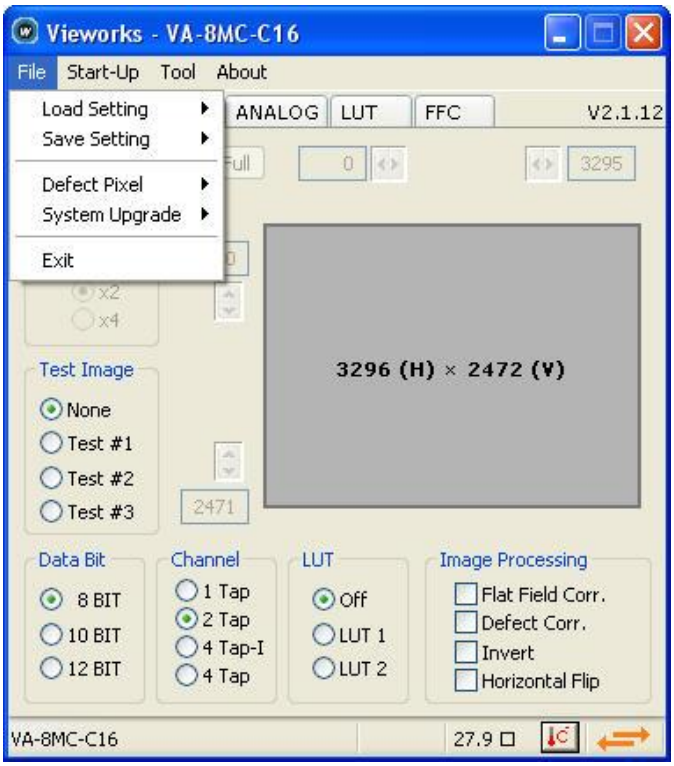


Figure 10.2 File menu

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

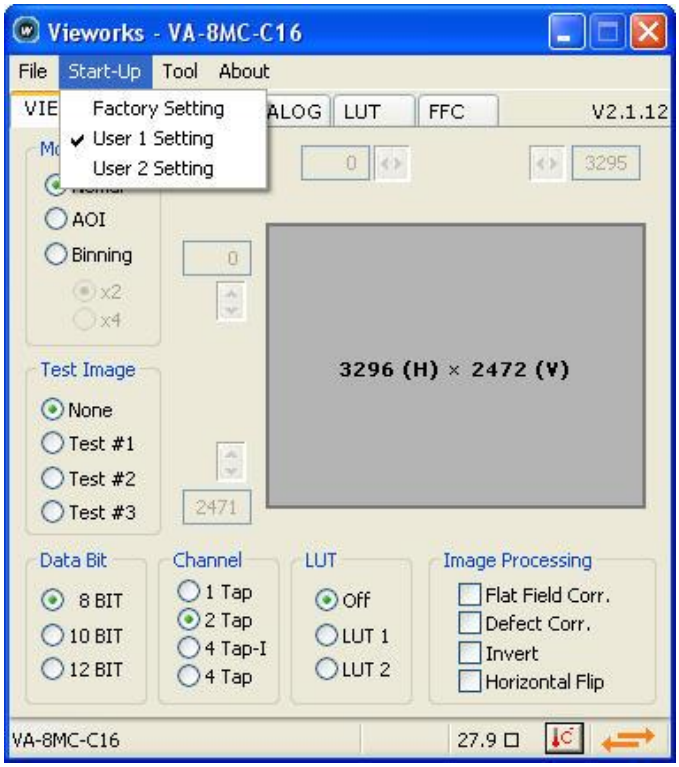


Figure 10.3 Start-Up Menu

- **Factory Setting:** Loads the camera setting values from Factory Space.
- **User 1 Setting:** Loads the camera setting values from User1 Space.
- **User 2 Setting:** Loads the camera setting values from User2 Space.

10.2.3 Tool

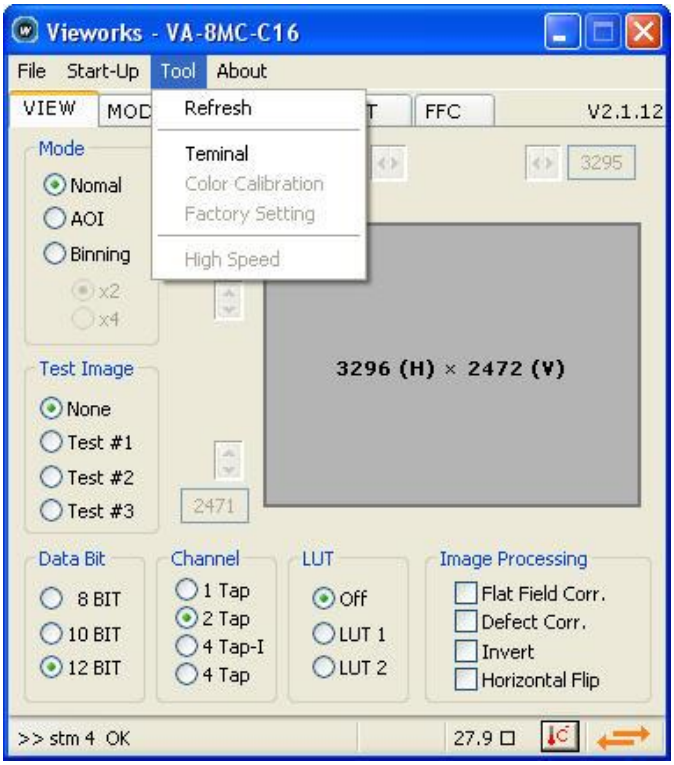


Figure 10.4 Tool Menu

- **Refresh:** Loads and displays the current camera setting values on the Configurator.
- **Terminal:** Displays a user command in the Terminal window under the GUI.
  To hide the Terminal window, uncheck Terminal by clicking again.
- **Color Calibration:** Not supported in Configurator.
- **Factory Setting:** Not supported for users.
- **High Speed:** Select the High Speed to operate the camera in the High Speed mode. To operate the camera in the Normal Speed mode, deselect the High Speed (Supported only on VA-16MC and VA-29MC).

10.2.4 About

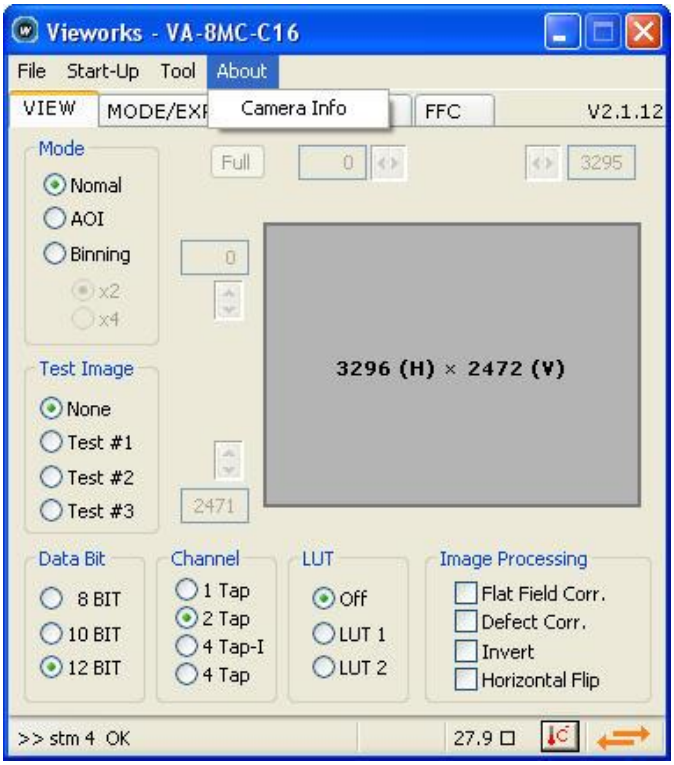


Figure 10.5 About Menu

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

10.3 Tab

10.3.1 VIEW Tab (All VA cameras except VA-47MC)

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

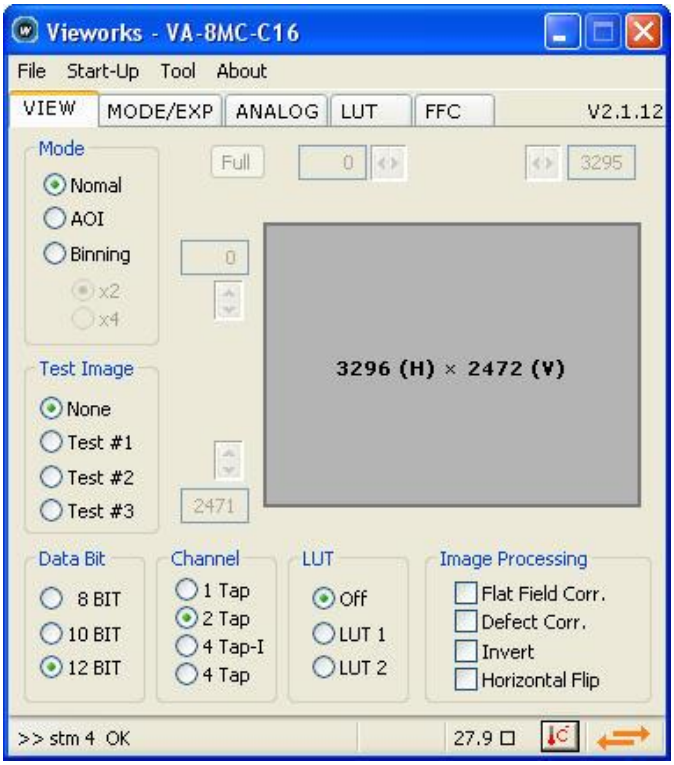


Figure 10.6 VIEW Tab

- **Mode:** Selects the readout mode. If AOI is selected, the AOI setting area will be activated. You can set the AOI by entering desired values. If Binning is selected, ×2 and ×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 the Flat Field Correction, Defect Correction, Image Invert or Horizontal Flip (Only available on VA-1MC, 2MC, 4MC and 8MC) feature to On or Off.

10.3.2 VIEW Tab (VA-47MC Only)

The VIEW tab allows you to set the camera's ROI, Binning, test image mode, pixel format, Camera Link output, image processing, Dark Image Correction, etc.

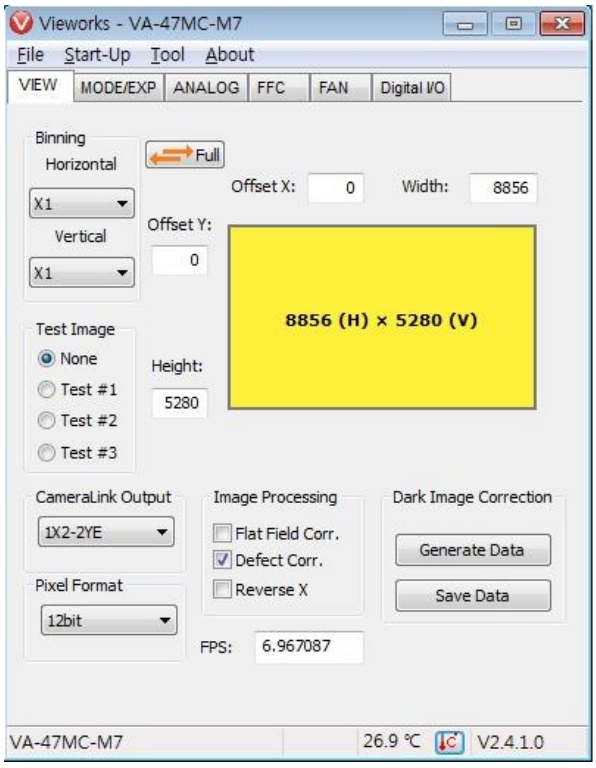


Figure 10.7 VIEW Tab (VA-47MC Only)

- **Binning**: Sets the camera's Horizontal and Vertical Binning factors.
- **Offset X, Offset Y, Width, Height**: Sets the camera's ROI.
- **Test Image**: Selects whether to apply test image and a type of test images.
- **Camera Link Output**: Sets a Camera Link output mode.
- **Pixel Format**: Selects a bit depth of data output.
- **Imaging Processing**: Sets the Flat Field Correction, Defect Correction or Reverse X feature to On or Off.
- **Dark Image Correction:** Generates and saves the DSNU correction values.

10.3.3 MODE/EXP Tab (All VA cameras except VA-47MC)

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.

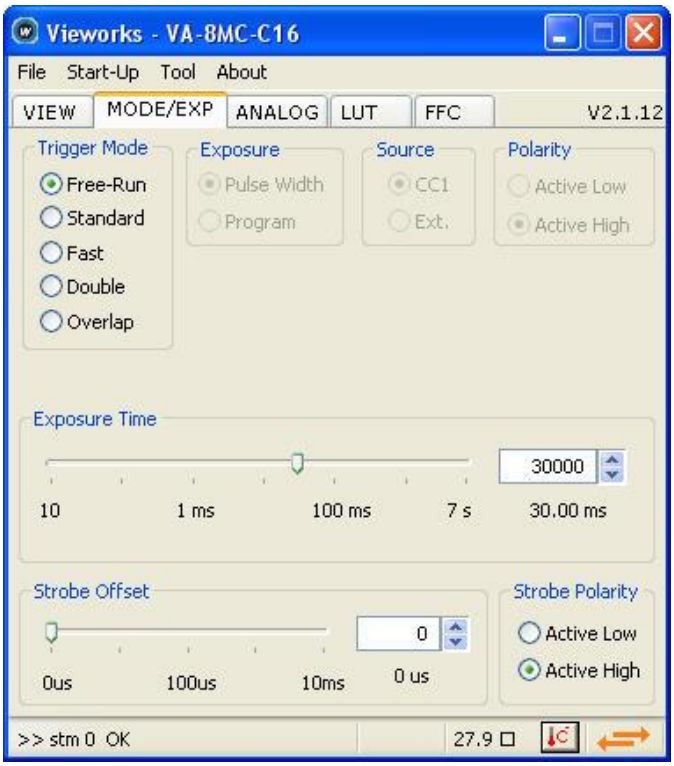


Figure 10.8 MODE/EXP Tab

- **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 mode.
- **Source:** Selects a 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.

10.3.4 MODE/EXP Tab (VA-47MC Only)

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

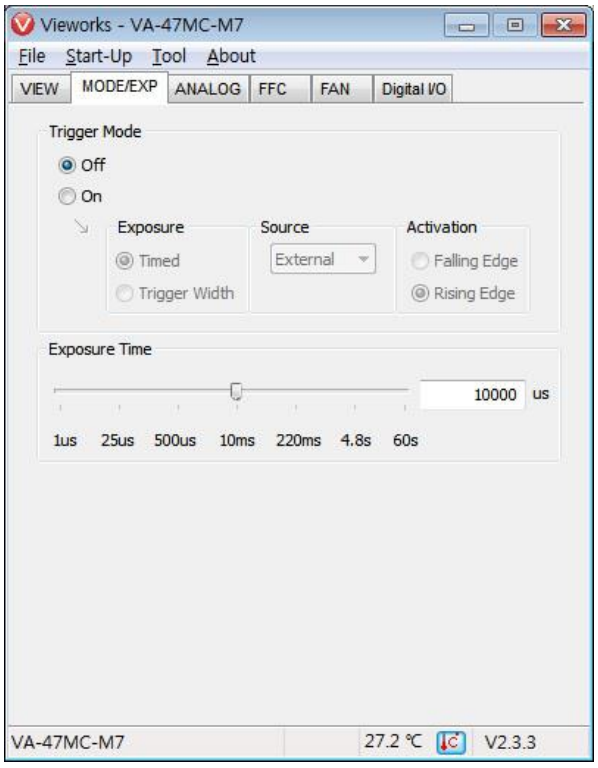


Figure 10.9 MODE/EXP Tab (VA-47MC Only)

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

10.3.5 ANALOG Tab (All VA cameras except VA-47MC)

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.

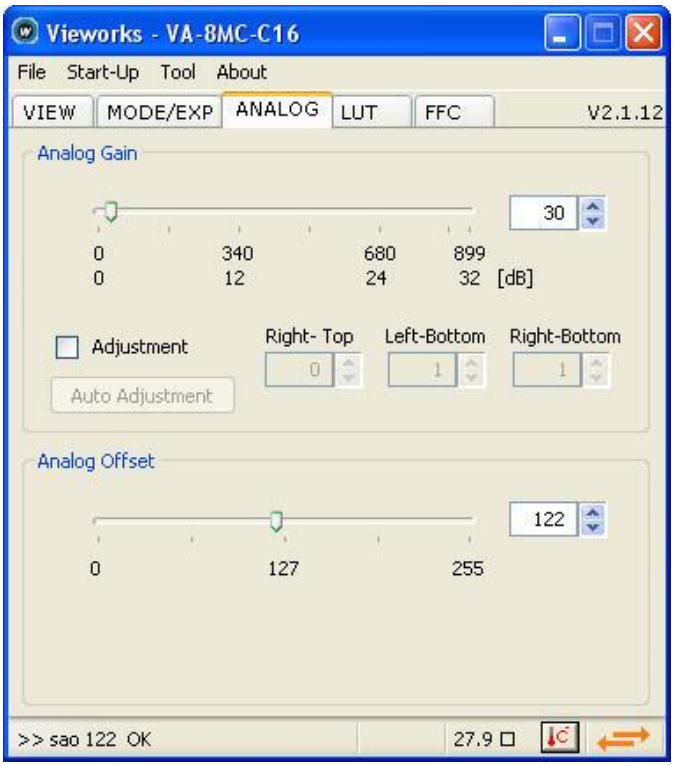


Figure 10.10 ANALOG Tab

- **Analog Gain:** Sets a gain value for each channel. The **Auto Adjustment** button will be activated after checking the **Adjustment** checkbox. Clicking the Auto Adjustment button will compensate the Tap differences automatically. With the **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 both channels.

10.3.6 ANALOG Tab (VA-47MC Only)

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

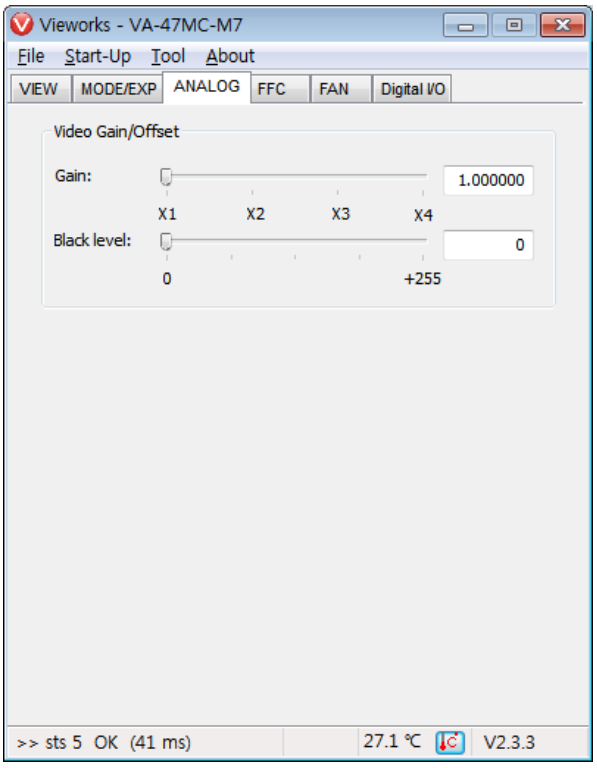


Figure 10.11 ANALOG Tab (VA-47MC Only)

- **Gain**: Sets the camera's gain value.
- **Black level**: Sets the camera's black level value.

10.3.7 LUT Tab (All VA cameras except VA-47MC)

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

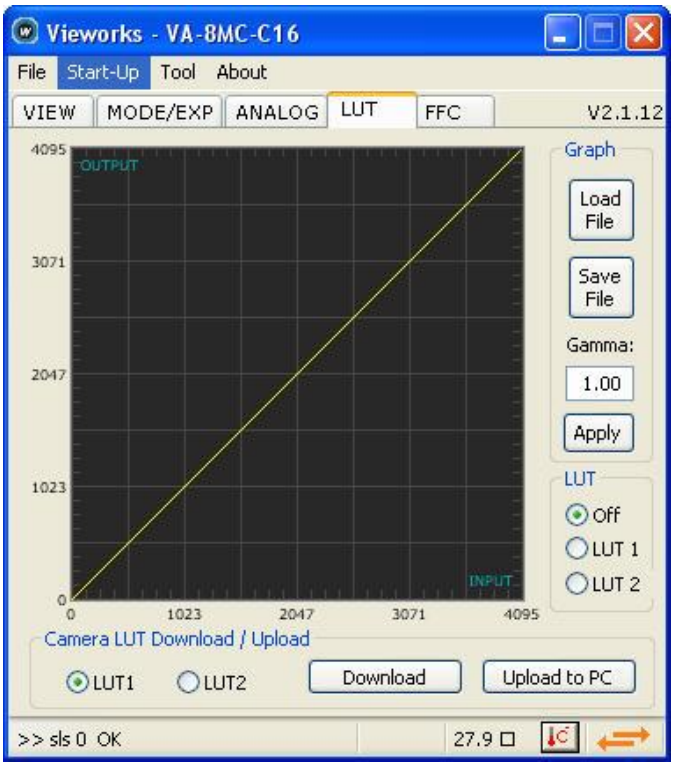


Figure 10.12 LUT Tab

- **Graph:** Loads LUT data from user's computer or sets a 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).

10.3.8 FFC Tab (All VA cameras except VA-47MC)

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

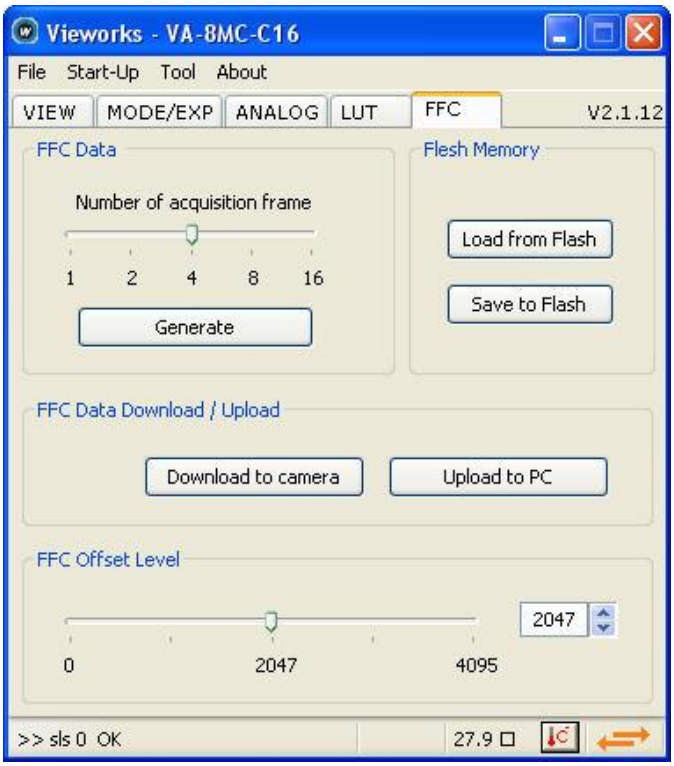


Figure 10.13 FFC Tab

- **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.

10.3.9 FFC Tab (VA-47MC Only)

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

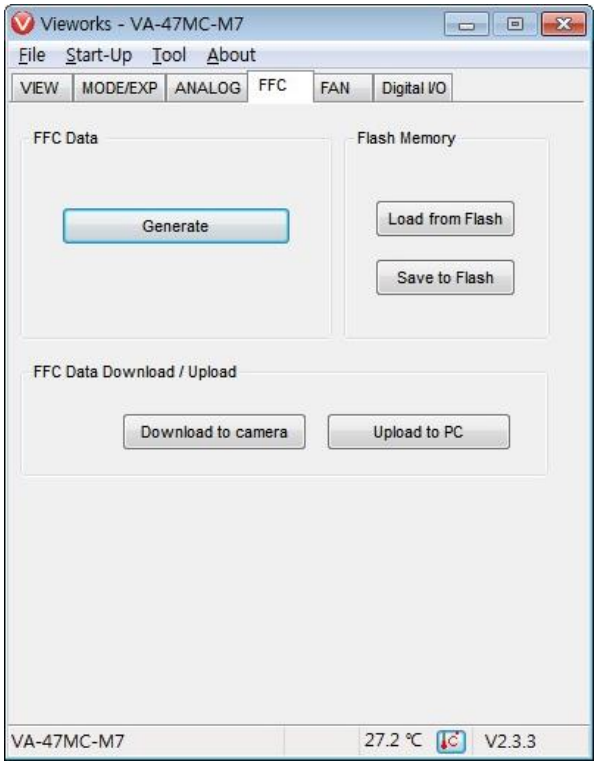


Figure 10.14 FFC Tab (VA-47MC Only)

- **FFC Data**: Generates Flat Field Correction 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).

10.3.10 FAN Tab (VA-47MC Only)

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

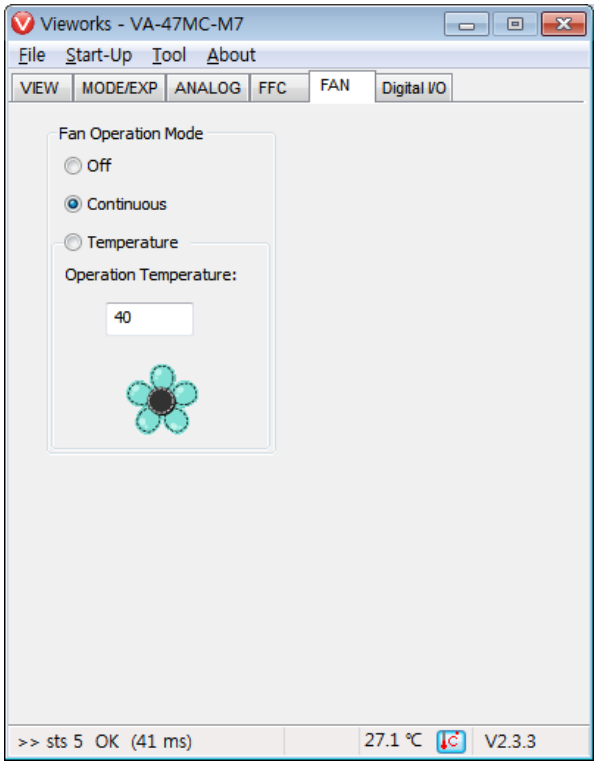


Figure 10.15 FAN Tab (VA-47MC Only)

- **Fan Operation Mode**: Sets a fan operation mode.
- **Operation Temperature**: Sets the fan operation temperature when the Temperature is selected.

10.3.11 Digital I/O Tab (VA-47MC Only)

The control I/O receptacle of the VA-47MC camera can be operated in various modes. The Digital I/O tab allows you to configure the mode of the control I/O.

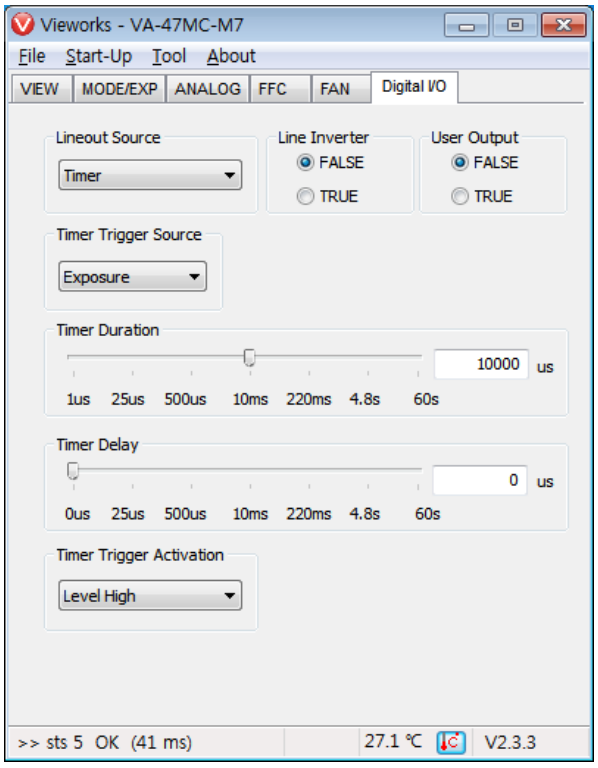


Figure 10.16 Digital I/O Tab (VA-47MC Only)

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

10.3.12 AWB Tab (VA-47MC Color Only)

The VA-47MC color camera provides the AWB (Auto White Balance) feature.

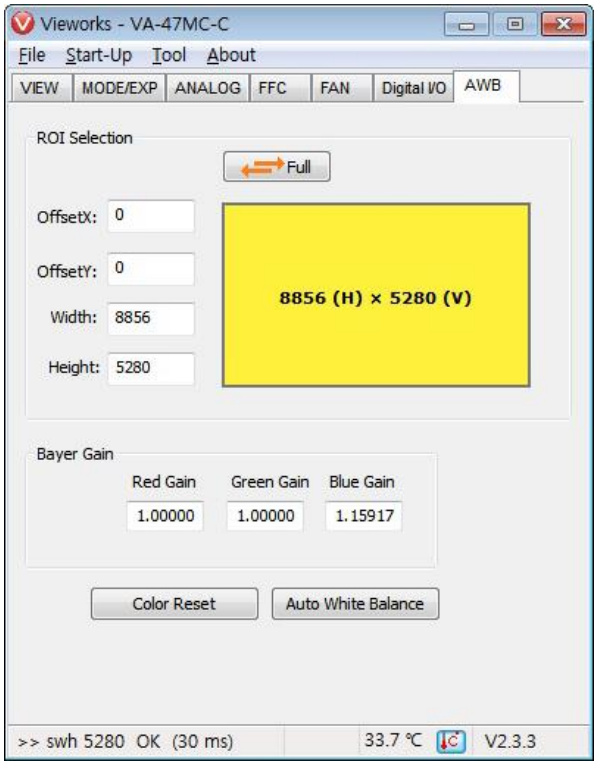


Figure 10.17 AWB Tab (VA-47MC Color Only)

- **Offset X**, **Offset Y**, **Width**, **Height**: Sets the ROI for the AWB.
- **Bayer Gain**: Sets a gain value for the Red, Green or Blue channel.
- **Color Reset**: Resets gain values applied to the Red, Green and Blue channels.
- **Auto White Balance**: Adjusts the white balance once and then 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 cable connections are secure.
  - Ensure that the power supply is properly connected.
  - Ensure that trigger signals are applied correctly when you operate the camera with trigger signals.

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

- If images are dark,
  - Ensure the camera lens is not blocked.
  - Check the exposure time is set properly.
  - Check the aperture is opened properly.

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

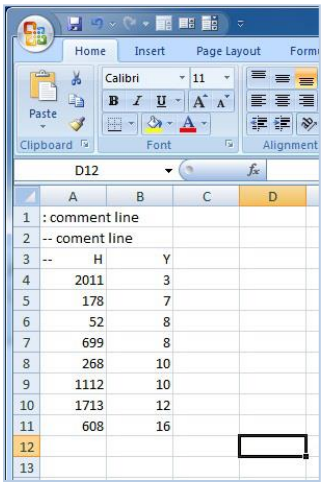
- If you have a problem using the Trigger Mode,
  - Ensure that parameter settings on your Frame Grabber are configured correctly when you operate the camera with CC1 trigger signals.
  - Ensure that cable connections are secure when you operate the camera with external trigger signals.

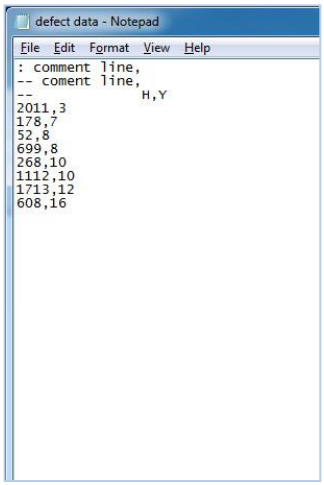
- If you notice the difference between left and right image,
  - Check whether gain settings for left and right are different.
  - Check whether black offset settings for left and right are different.

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

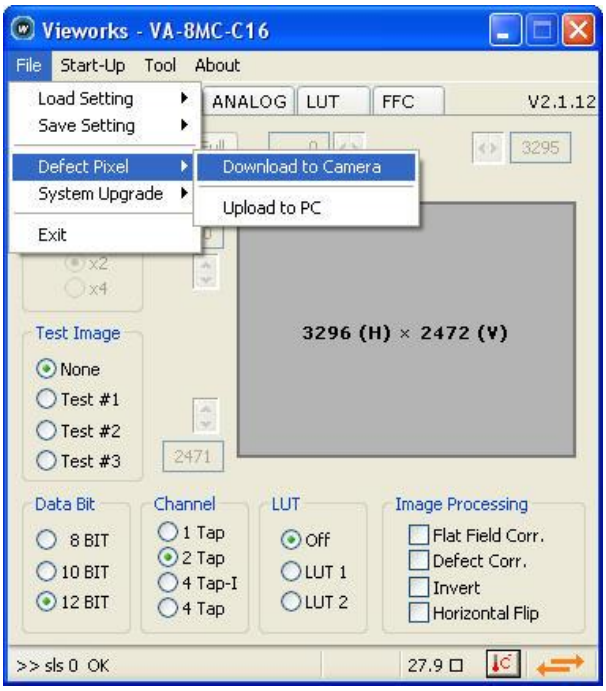
Appendix A Defective Pixel Map Download

1. Create a Defect Pixel Map in Microsoft Excel format as shown in the left picture below and save as a CSV file (*.csv). The picture in the right shows the created Excel file opened with Notepad. The following rules need to be applied when creating the file.
   - Lines beginning with ':' or '—' are treated as notes.
   - You must enter the horizontal value first and then the vertical value for coordinate of each defect pixel.
   - Coordinate values for each pixel can be placed in any order.

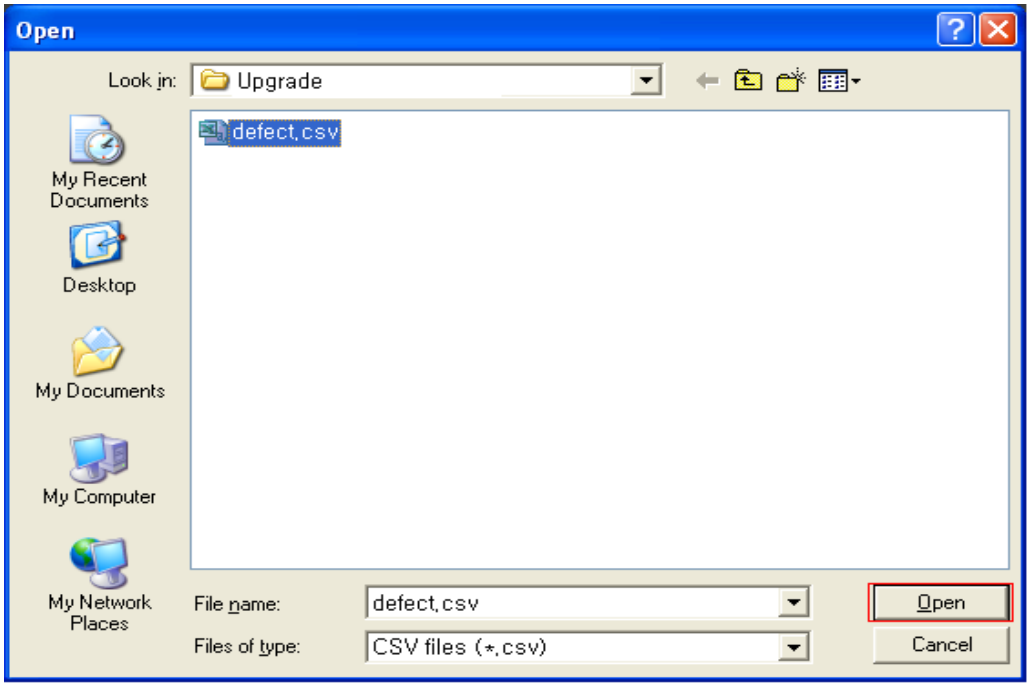




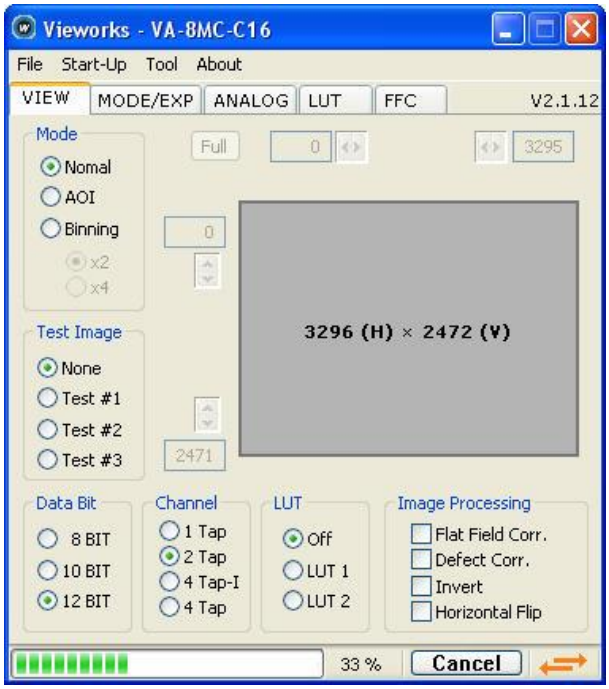
2. Select **File** > **Defect Pixel** > **Download to Camera** in the Configurator.



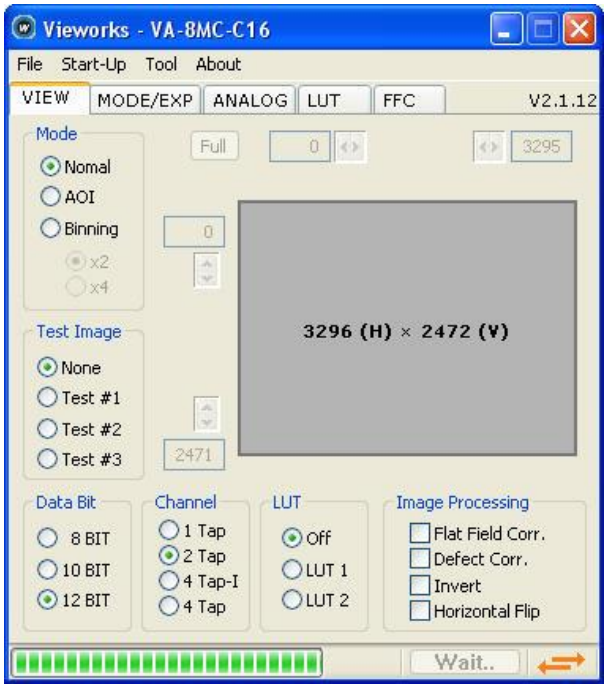
3. Search and select the created file and click **Open**.



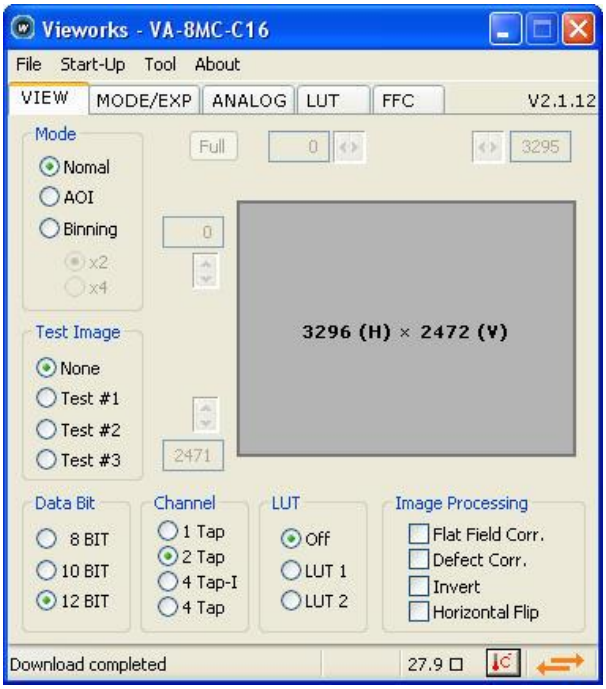
4. The Configurator starts downloading Defect Pixel Map to the camera and downloading status is displayed at the bottom of the window.



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



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

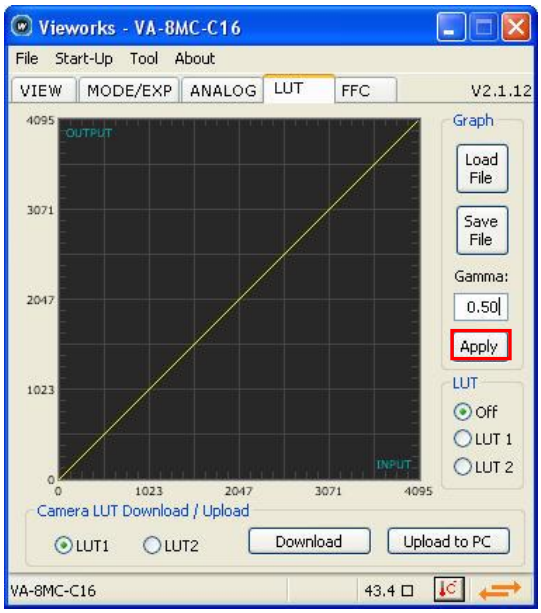


Appendix B LUT Download

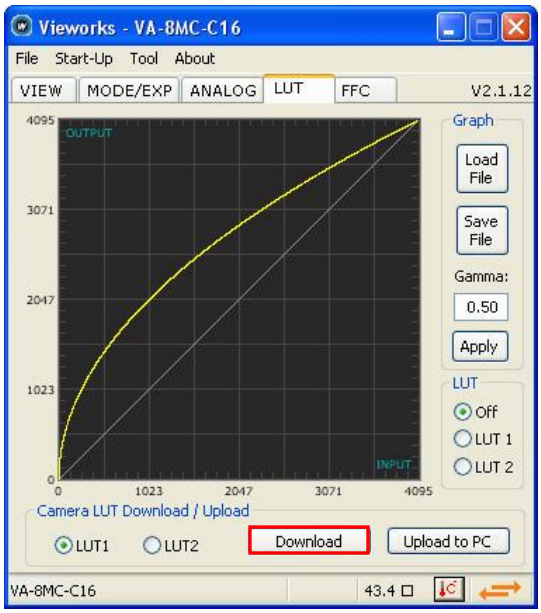
There are two ways to apply LUT data; by adjusting the gamma values on the gamma graph provided in the Configurator and then downloading the data or by opening a CSV file (*.csv) and then downloading the data.

B.1 Gamma Graph Download

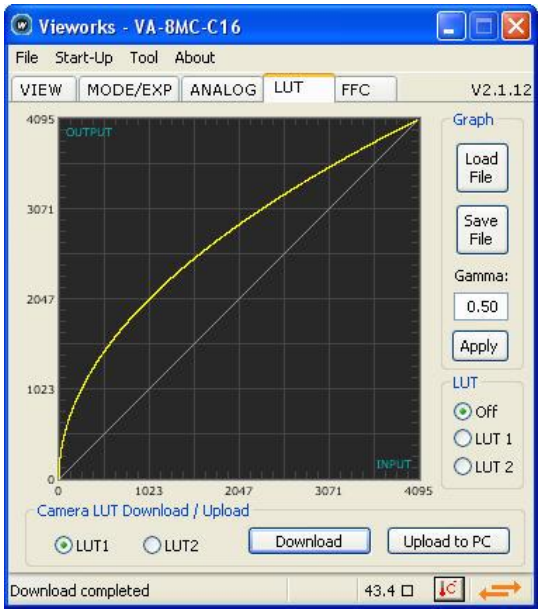
1. Set a desired gamma value in the LUT tab and click **Apply**.



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

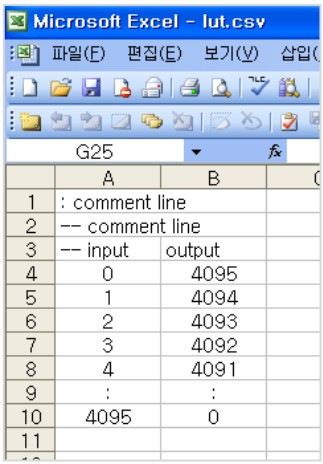


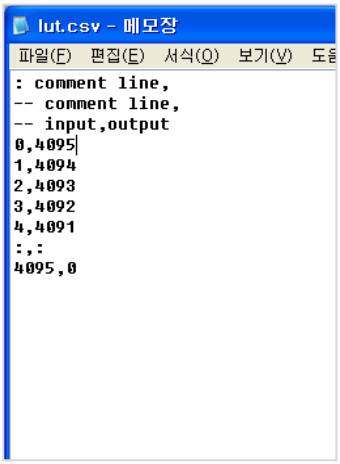
3. Once the download is complete, the **Download completed** message will appear at the bottom of the window.



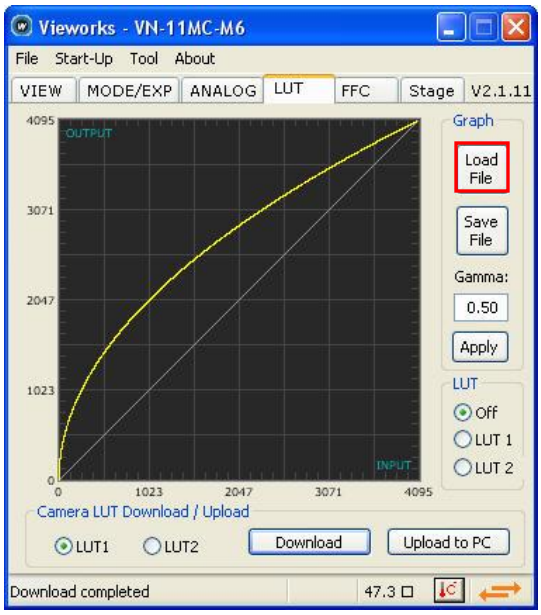
B.2 CSV File Download

1. Create a 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 with Notepad. Once the file is 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.
   - You must enter all output values corresponding to input values from 0 to 4095.

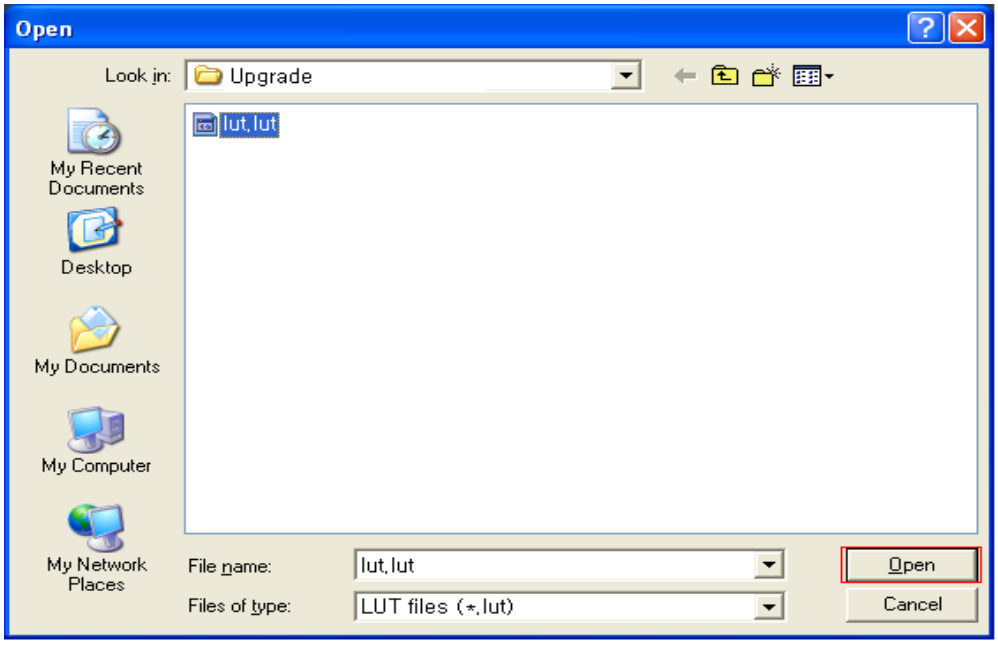




2. Click **Load File** in the **LUT** tab.



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

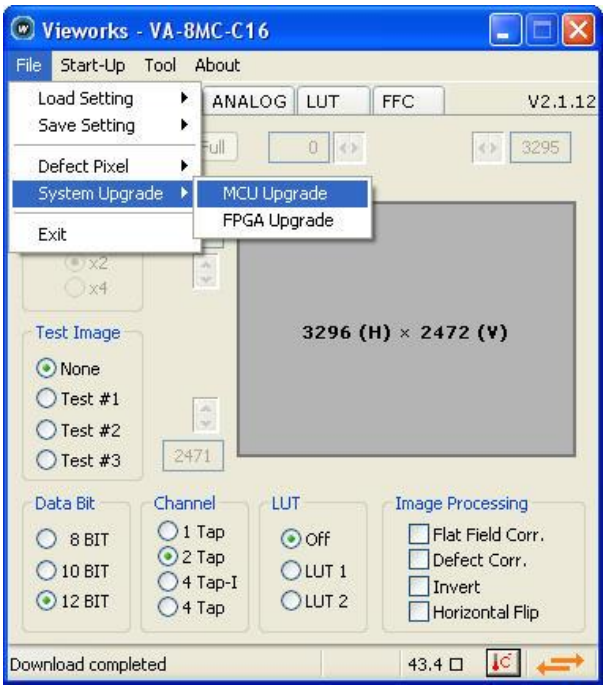


4. Select LUT1 or LUT2 as a location to store the data and click **Download**. The subsequent processes are identical to those of Gamma Graph Download.

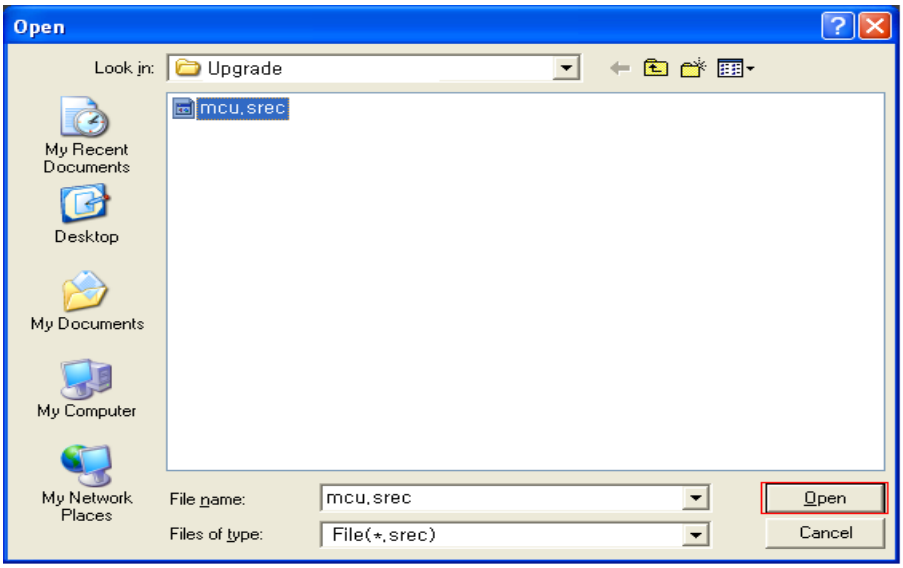
Appendix C Field Upgrade

C.1 MCU

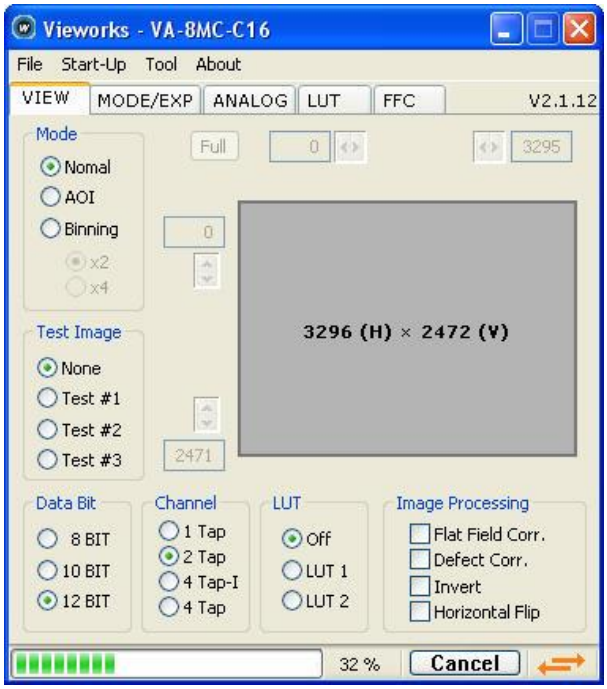
1. Select **File** > **System Upgrade** > **MCU Upgrade** in the Configurator.



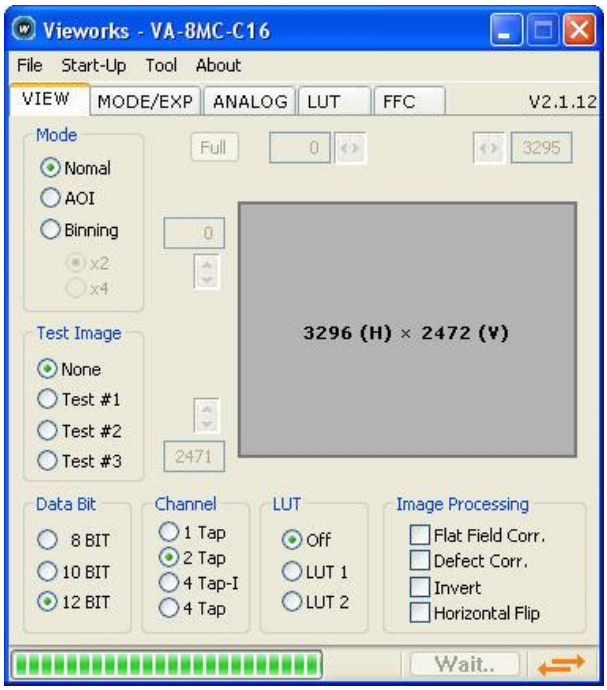
2. Search and select the provided MCU upgrade file and click **Open**.



3. The 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 may require several minutes to complete.



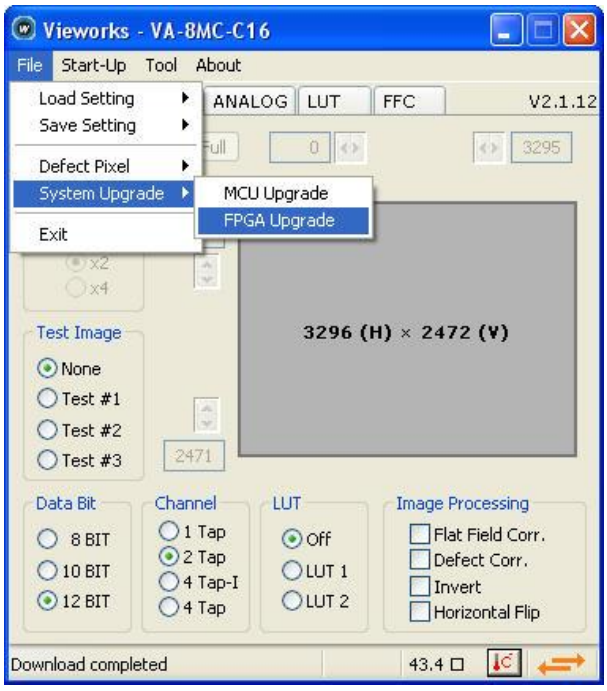
4. Once the download is complete, the saving process will begin. If a power failure occurs during the saving process, the camera cannot be restored. Make sure that the power connection is secured.



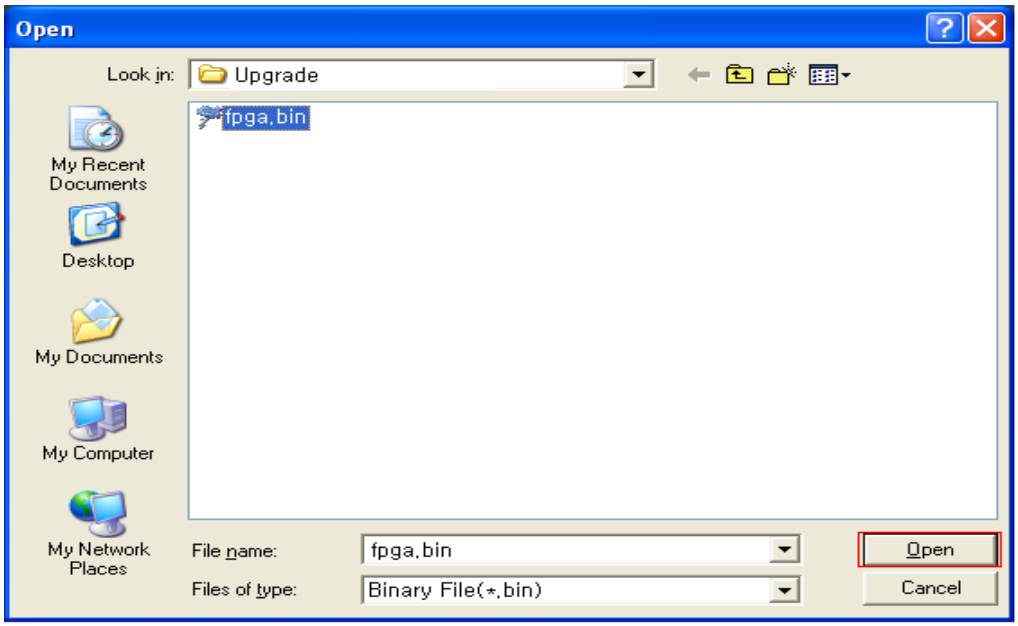
5. Once all the processes are complete, turn the camera power off and turn it back on again. Select **Tool** > **Terminal** and enter the “gmv” command to confirm the version. Or, select **About** > **Camera Info** to confirm the MCU version.

C.2 FPGA

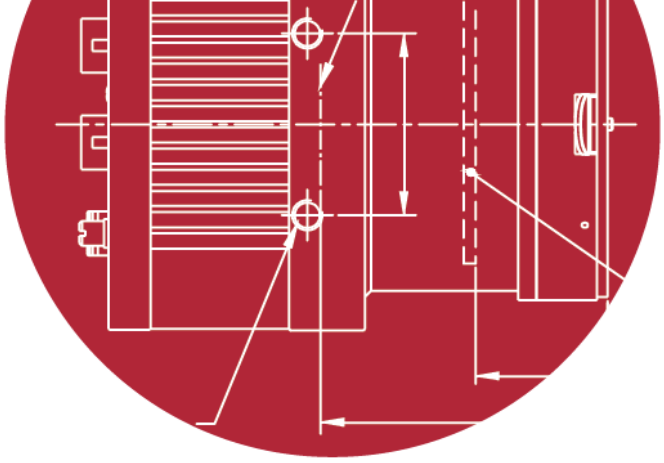
1. Select **File** > **System Upgrade** > **FPGA Upgrade** in the Configurator.

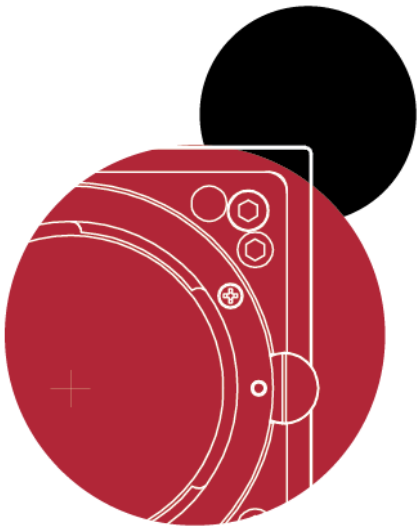


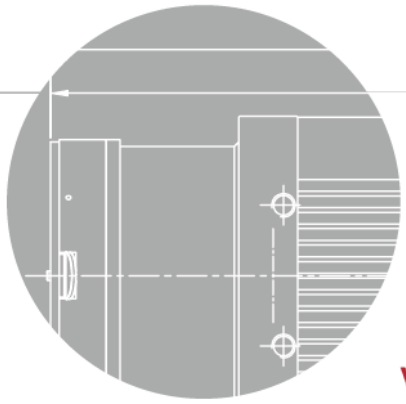
2. Search and select the provided FPGA upgrade file and click **Open**.



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







Vieworks Co., Ltd.

41-3, Burim-ro, 170beon-gil,
Dongan-gu, Anyang-si, Gyeonggi-do
14055 Republic of Korea

Tel: +82-70-7011-6161 Fax: +82-31-386-8631

http://www.vieworks.com vision@vieworks.com