Small Cubic Type

12.3M CMOS

Color / Monochrome PoCL CameraLink Camera

STC-SPC123BPCL (1.1”CMOS Color)
STC-SPB123BPCL (1.1”CMOS Monochrome)

Product Specifications

Table of Contents

Product Precautions

- Handle the camera with care. Do not abuse the camera. Avoid striking or shaking it. Improper handling or storage could damage the camera.
- Do not pull or damage the camera cable.
- During camera use, do not wrap the unit in any material. This will cause the internal temperature of the unit to increase.
- Do not expose the camera to moisture, or do not try to operate it in wet areas.
- Do not operate the camera beyond its temperature, humidity and power source ratings.
- While the camera is not being used, keep the lens or lens cap on the camera to prevent dust or contamination from getting in the CCD or filter area and scratching or damaging this area.
- Do not keep the camera under the following conditions:
    - In wet, moist, and high humidity areas
    - Under hot direct sunlight
    - In high temperature areas
    - Near an object that releases a strong magnetic or electric field
    - Areas with strong vibrations
- Apply the power that satisfies the requirements specified in this document to the camera.
- Use a soft cloth to clean the camera. Use pressured air spray to clean the surface of the glass. DO not scratch the surface of the glass.
- The camera is a general-purpose electronic device; using the camera for the equipment that may threaten human life or cause dangers to human bodies directly in case of failure or malfunction of the camera is not guaranteed. Use the camera for special purposes at your own risk.

1 Overview

This camera is the 12.3 Mega pixels global shutter CMOS sensor with the Camera Link interface camera.
This camera has the external trigger function to obtain the fast moving target image for the machine vision usage.

2 Features

- High resolution

The camera has Sony Pregius 12.3 Mega pixels global shutter CMOS sensor to achieve the maximum 66.99 fps at 10TAP 8bits output.

- Camera Link standard (PoCL) compliance

The camera is compliance with the Camera Link Deca configuration (10TAP 8bits and 8TAP 10bits), Full configuration (8TAP 8bits), Medium configuration (4TAP 8bits, 4TAP 10bits and 4TAP 12bits) and Base configuration (3TAP 8bits, 2TAP 8bits, 2TAP 10bits and 2TAP 12bits).
The camera power can be supply from the PoCL supported Camera Link frame grabber board.

- Global shutter

The camera has Sony Pregius 12.3 Mega pixels global shutter CMOS sensor to support obtaining fast moving target image.

- Fast exposure time

The minimum 1μseconds fast exposure time is supported for the free-run / continuous mode and edge preset trigger mode.

- Trigger operation

Expose and obtain the image by the external trigger signal through CC1 on Camera Link or 2pin on the power / I/O signal connector.

- ROI (Region Of Interest)

The frame rate can be increase by the ROI (eight regions) function.

- Decimation

The horizontal and vertical thinning image is output. The half resolution (2x2 sub-sampling) without change the view angle, and twice faster frame rate image can be obtained by the decimation function.

- Binning *only available for the monochrome model

The brightness of two vertical pixels are summing into one pixel. (No horizontal brightness summing) The twice brighter, half resolution and twice faster frame rate image can be obtained by the binning function.

- Selectable Camera Link clock speed

The Camera Link clock speed can be selectable from 84.857MHz, 66MHz or 33MHz.
Please select the optimum Camera Link clock speed if the long length Camera Link cable is required.

- Heat dissipation design

The heat of the electronics components inside of the camera is dissipated to the camera housing with the mechanical design, which is the minimized the thermal resistance between the components and housing.
Please manage the camera housing temperature when the camera using in the environment exceeding the ambient temperature specified in this specifications.

3 Specifications

3.1 Electronic specifications

Product		STC-SPB123BPCL	STC-SPC123BPCL
Image Sensor		1.1" 12.3 Mega pixels Progressive Monochrome CMOS (Sony: IMX253)	1.1" 12.3 Mega pixels Progressive Color CMOS (Sony: IMX253)
Shutter Type		Global shutter	
Effective Picture Resolution		8TAP / 4TAP / 2TAP: 4,096 (H) x 3,000 (V) 3TAP: 4,095 (H) x 3,000 (V) 10TAP: 4,090 (H) x 3,000 (V)	
Cell Size		3.45 (H) µm x 3.45 (V) µm	
Sync System		Free-run (continuous) / External Trigger (hardware / software)	
Maximum Frame Rate (at full resolution) *1	10TAP Output	**66.99 fps**	
	8TAP Output	53.65 fps	
	4TAP Output	26.88 fps	
	3TAP Output	15.02 fps	
	2TAP Output	13.47 fps	
ADC Bits		12 bits	
Video Output		**8** / 10 / 12 bits	
Camera Link Data Output *2		Deca / Full / Medium / Base Configuration	
Camera Link TAP Configuration		10TAP **/ 8TAP** / 4TAP / 3TAP / 2TAP	
Camera Link Clock Speed *3	3TAP Output	66 / 33 MHz	
	2TAP, 4TAP, 8TAP, 10TAP Output	**84.857** / 66 / 33 MHz	
Noise Level (Gain 0 dB)	8bits Output	8TAP / 4TAP / 3TAP / 2TAP: Less than 3 LSBs 10TAP: Less than 6 LSBs	
	10bits Output	Less than 12 LSBs	
	12bits Output	Less than 48 LSBs	
Sensitivity *5		8TAP / 4TAP / 3TAP / 2TAP: 530 Lux 10TAP: 120 Lux (F5.6, 1/30s, 5100K, Video level 100%)	8TAP / 4TAP / 3TAP / 2TAP: 1160 Lux 10TAP: 270 Lux (F5.6, 1/30s, 5100K, Video level 100%)
Exposure Time (All TAP common)		1 µseconds to 16.777 seconds	
Gain	Analog Gain	0 dB to 18 dB	
	Digital Gain	0 dB to 24 dB	
Black Level *4	8bits Output	0 to 63 digits	
	10bits Output	0 to 255 digits	
	12bits Output	0 to 1023 digits	
White Balance Gain		Non-Support	-40 dB to 12 dB

Product			STC-SPB123BPCL	STC-SPC123BPCL
ROI	Position	Horizontal	0 to 4,095 pixels (adjustable unit: 1 pixel)	0 to 4,094 pixels (adjustable unit: 2 pixels)
		Vertical	0 to 2,996 lines (adjustable unit: 4 lines)	
	Size	Horizontal	2TAP: 2 to 4,096 pixels (adjustable unit: 2 pixels) 3TAP: 3 to 4,095 pixels (adjustable unit: 3 pixels) 4TAP: 4 to 4,096 pixels (adjustable unit: 4 pixels) 8TAP: 8 to 4,096 pixels (adjustable unit: 8 pixels) 10TAP: 10 to 4,090 pixels (adjustable unit: 10 pixels)	
		Vertical	4 to 3,000 lines (adjustable unit: 4 lines)	
	Region		Horizontal	
Gamma			**OFF (1.0)** / Programmable Table (Default: 0.45)	
Binning			Two vertical pixels summing / **OFF**	Non-Support
Decimation			2 x 2 / **OFF**	
Mirror Image			Horizontal / Vertical / Horizontal and Vertical / **OFF**	
Pixel Defect Correction			Up to 256 points	
Auto Image Control	Auto Exposure		Non-Support	
	Auto Gain		Non-Support	
	Auto White Balance		Non-Support	
Operating Mode			Free-run (continuous) / **Edge preset trigger** / Pulse width trigger	
Save User Mode			Support	
I/O Ports			4 I/Os	
Power	Input Voltage		DC12V +/- 10% (PoCL Support)	
	Consumption		Maximum: 3.6 W, Typical: 2.7 W	

Default setting: **Bold**

Precautions

*1: The selected video output bit does not make any influence for the maximum frame rate.

*2: Camera Link data output formats (TAP configuration and output bits) are in below table:

	10TAP	8TAP	4TAP	3TAP	2TAP
8bits	Deca configuration	Full configuration	Medium configuration	Base configuration	Base configuration
10bits	Non-Support	Deca configuration	Medium configuration	Non-Support	Base configuration
12bits	Non-Support	Non-Support	Medium configuration	Non-Support	Base configuration

*3: Please select the optimum Camera Link clock speed if the long length Camera Link cable is required. Please refer “The image data transferring speed” for more details.

*4: The selected TAP configuration does not make any influence for the Camera Link clock speed.

*5: The sensitivity is measured the light source illumination for 100% white under below conditions:

Camera Settings		**Environment condition**	
Parameter	**Setting**	**Parameter**	**Setting**
Gain up	0 dB	**Light source**	Light box (White)
AGC	Off	**Color temperature**	5100K
White balance	Optimum	**Lens**	
Exposure time	1/30 seconds	**F on lens**	F5.6
Black level	Optimum	**Illuminometer**	IM1624
Gamma	Factory default		

3.2 Mechanical specifications

Product	STC-SPB123BPCL	STC-SPC123BPCL
Dimensions	35 (W) x 35 (H) x 40.7 (D) mm (*1)	
Optical Filter	Non-Optical Filter	
Optical Center Accuracy	Positional accuracy in Horizontal and Vertical directions: +/- 0.3 mm Rotational accuracy of Horizontal and Vertical directions: +/- 1.5 deg.	
Material	Aluminum alloy	
Lens Mount	C Mount	
Interface Connectors	Camera Link connector: SDR connector (3M) or equivalent x 2 Power / I/O connector: HR10A-7R-6PB (Hirose) or equivalent x 1	
Camera Mounting	1/4” Tripod screw holes (One on each top and bottom plate) M4 screws holes (Four on each top and bottom, three on each side plate)	
Weight	Approximately 71 g	

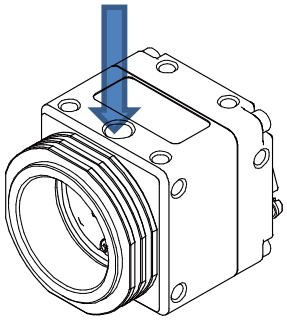
(*1) Excluding the connectors

3.3 Environmental specifications

Product	STC-SPB123BPCL	STC-SPC123BPCL
Operational temperature	Ambient temperature: 0 to 45 deg. C (camera housing temperature (top plate): less than 64 deg. C (*1)) Ambient humidity: 0 to 85 %RH (without condensation)	
Storage temperature	Ambient temperature: -20 to 75 deg. C Ambient humidity: 0 to 85 %RH (without condensation)	
Vibration	20 Hz to 200 Hz to 20 Hz (5 min. / cycle), acceleration 10G, XYZ 3 directions 30 min. each	
Shock	Acceleration 38 G half amplitude 6 ms, XYZ 3 directions 3 times each	
Standard compliancy	EMS: EN61000-6-2, EMI: EN55011	
RoHS	RoHS compliance	

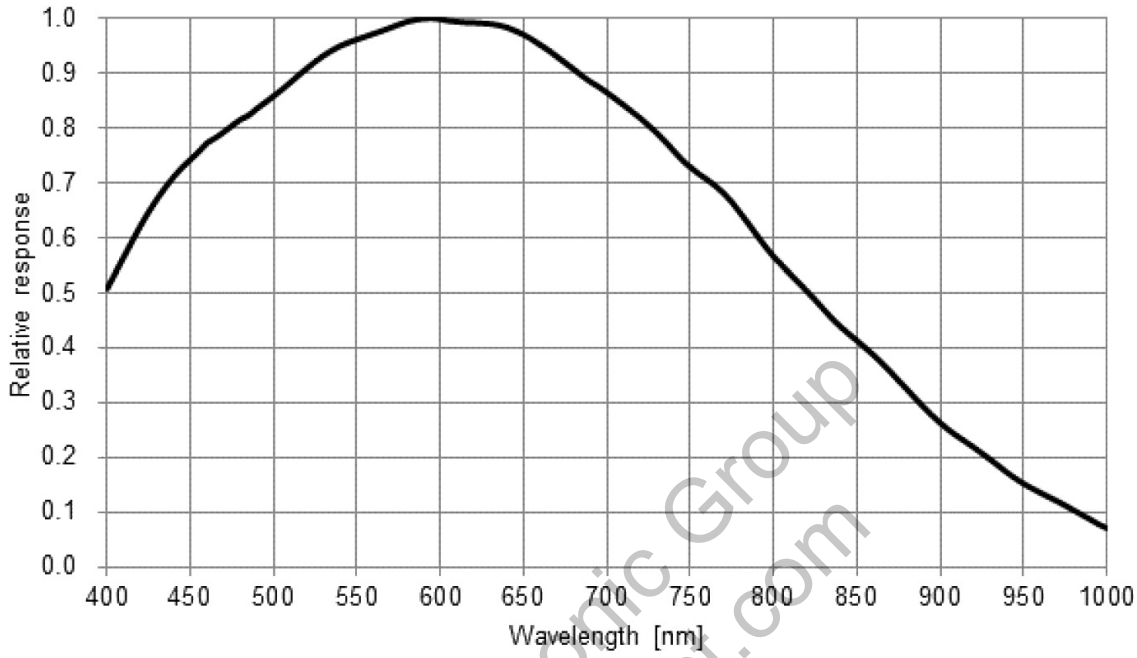
(*1) Please insure the camera is installed with the appropriate heat dissipation to keep the camera housing temperature (top plate) is less than 64 deg. C when the camera using the ambient temperature is exceeded 45 deg. C.
If the camera has a mounted lens and a tripod with an aluminum plate, this could decrease the camera housing temperature for the heat dissipation.

Temperature measuring point

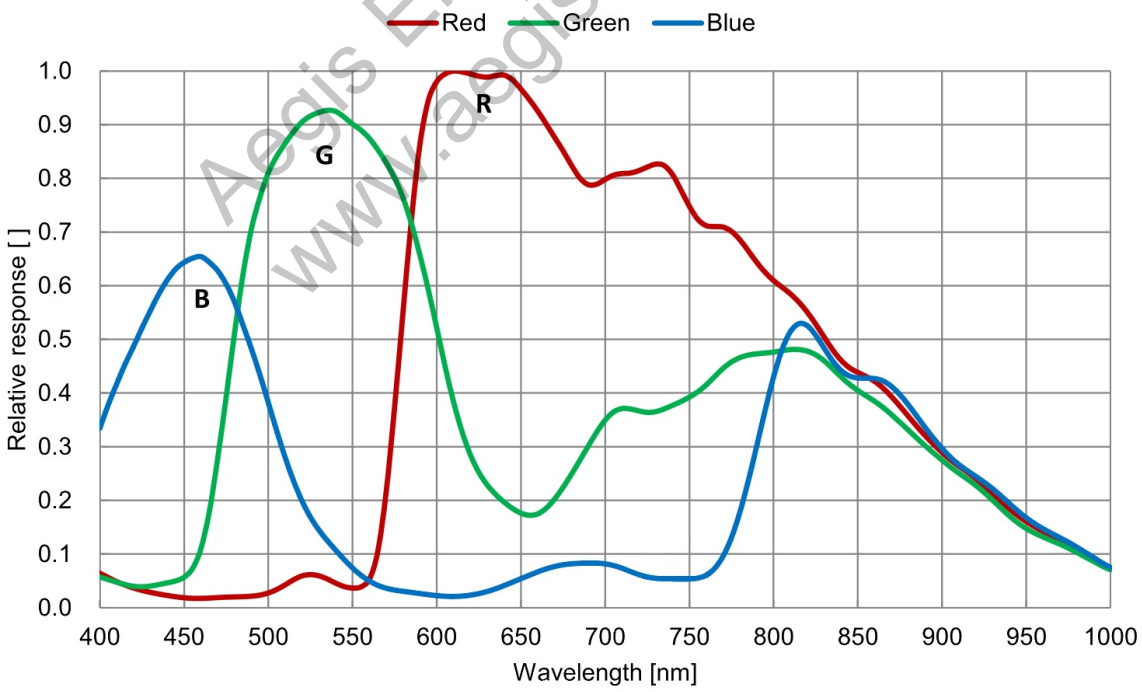


3.4 Spectral Sensitivity Characteristics

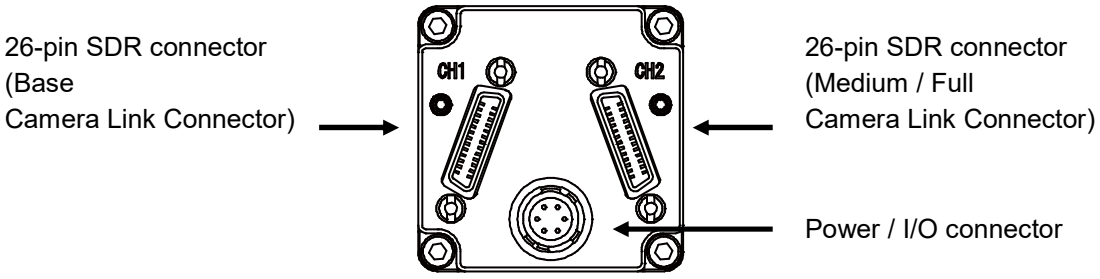
STC-SPB123BPCL



STC-SPC123BPCL



3.5 Connector specifications



3.5.1 Camera Link connectors

SDR (3M) or equivalent x 2

This camera is PoCL supported Camera Link camera.
The Camera Link frame grabber board is supplied the power to the camera through the Camera Link cable and connectors if the frame grabber board and the cable are applicable for the PoCL.

Please supply the power (DC12V) from the power / I/O connector if the frame grabber board is not applicable for the PoCL.

3.5.2 Camera Link connector pin assignment

Base Camera Link Connector

Pin No.	Signal Name	Pin No.	Signal Name
1	+12V	14	GND
2	X0-	15	X0+
3	X1-	16	X1+
4	X2-	17	X2+
5	Xclk-	18	Xclk+
6	X3-	19	X3+
7	SerTC+	20	SerTC-
8	SerTFG-	21	SerTFG+
9	CC1- (TRG)	22	CC1+ (TRG)
10	CC2+	23	CC2-
11	CC3-	24	CC3+
12	CC4+	25	CC4-
13	GND	26	+12V

Medium / Full Camera Link Connector

Pin No.	Signal Name	Pin No.	Signal Name
1	+12V	14	GND
2	Y0-	15	Y0+
3	Y1-	16	Y1+
4	Y2-	17	Y2+
5	Yclk-	18	Yclk+
6	Y3-	19	Y3+
7	100Ω	20	100Ω
8	Z0-	21	Z0+
9	Z1-	22	Z1+
10	Z2-	23	Z2+
11	Zclk-	24	Zclk+
12	Z3-	25	Z3+
13	GND	26	+12V

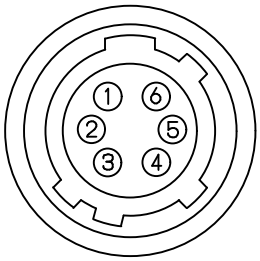
3.5.3 Power / I/O connector

HR10A-7R-6PB (Hirose) or equivalent connector x 1

This connector is for DC12V power input and the input and output signals.
Please use HR10A-7P-6S (Hirose) or equivalent connector for the connecting cable.

3.5.4 Power / I/O connector pin assignment

Pin No.	Signal Name	IN / OUT	Voltage		Consumption
			Low voltage	High voltage	
1	GND	IN	0V		
2	Trigger	IN	0 to +0.99V	+2.3 to +3.6V	5μA (typ.) (*1)
3	FVAL	OUT	0V	+3.3V	10mA (Max.) (*2)
4	LVAL	OUT	0V	+3.3V	10mA (Max.) (*2)
5	Trigger Filter	OUT	0V	+3.3V	10mA (Max.) (*2)
6	DC12V	IN	+12V		

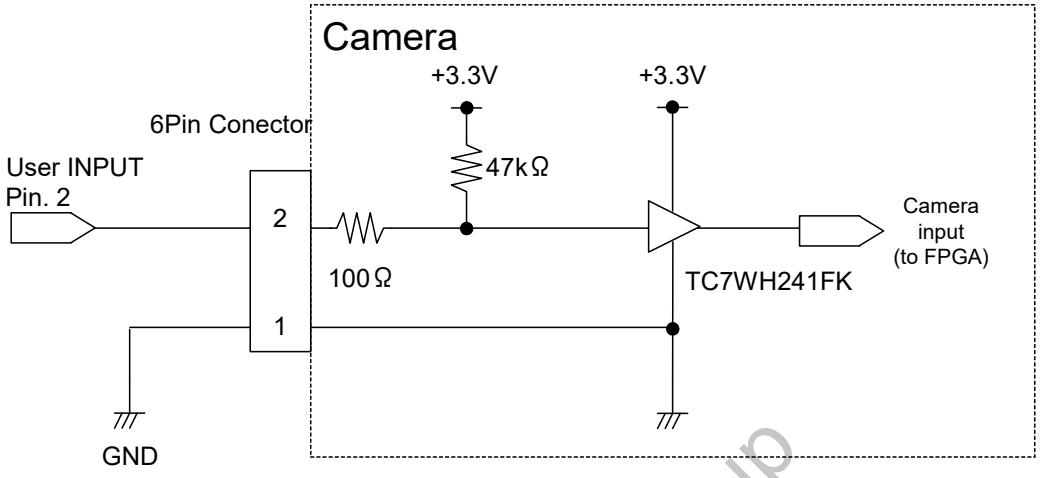


The trigger signal input connector is selectable from below two connectors by the camera control command.

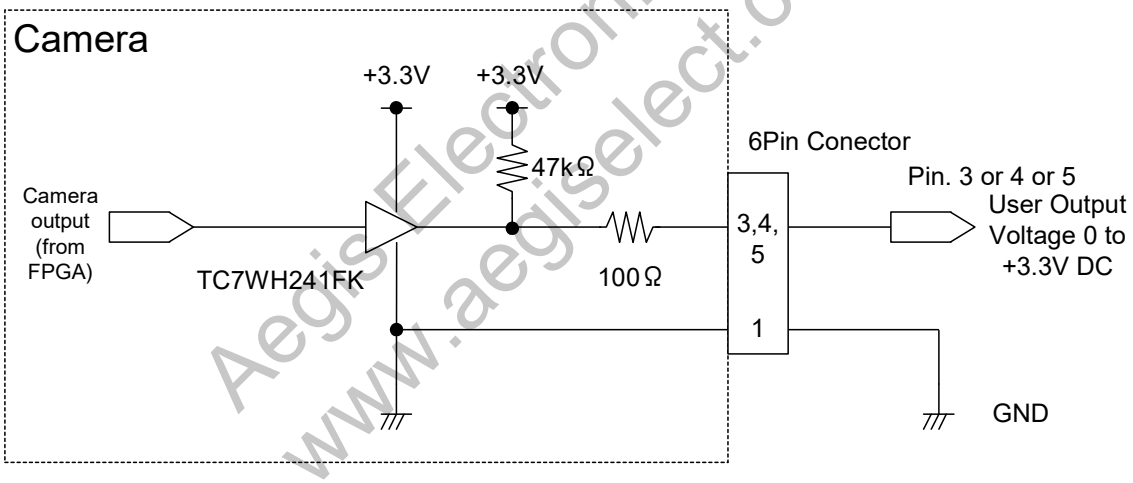
Camera Link connector: CC1
Power / I/O connector: 2pin

(*1) The power consumption when the high voltage trigger signal input to the input port.
(*2) The power consumption for the output port has to be managed less than 10mA.

3.5.5 Input signal circuit

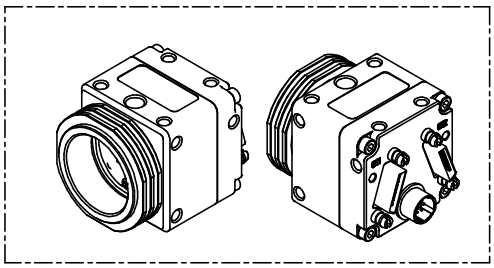


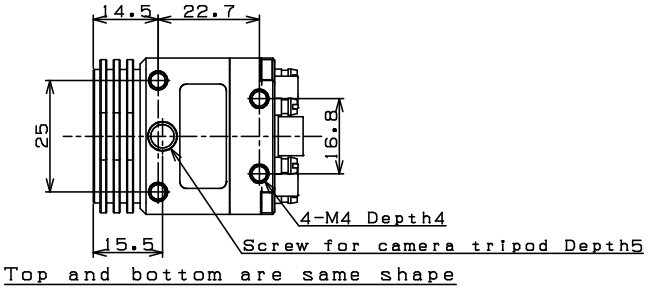
3.5.6 Output signal circuit

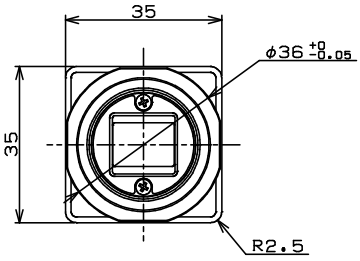


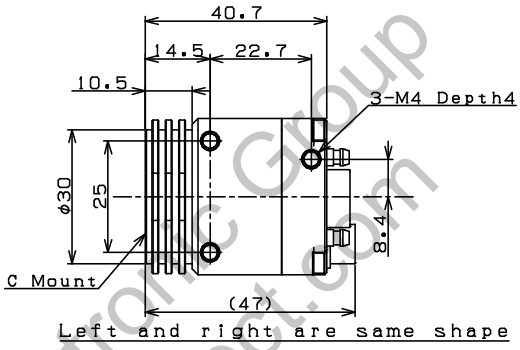
4 Dimensions

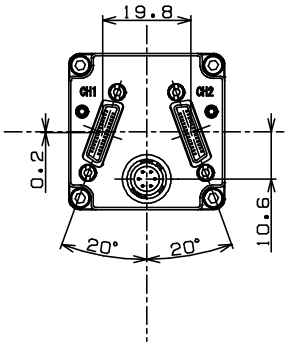
STC-SPB123BPCL / STC-SPC123BPCL

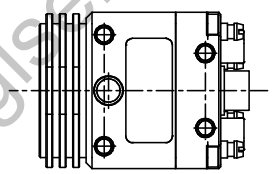








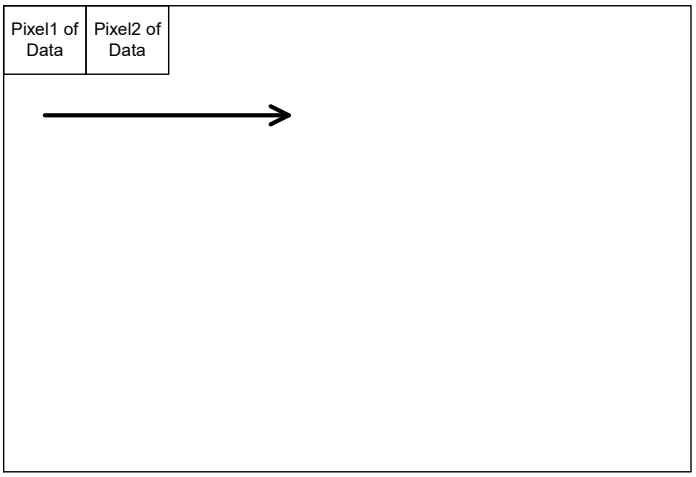




Unit: mm

5 Sensor Information

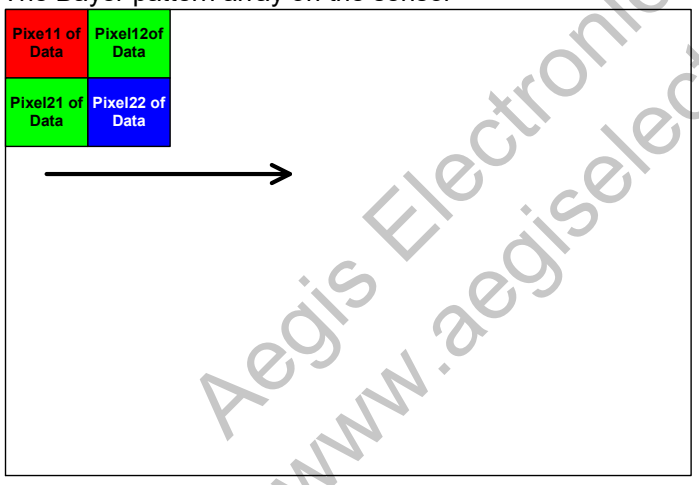
5.1 STC-SPB123BPCL (Monochrome model)



Pixel (n) of Data: nth pixel being transferred

5.2 STC-SPC123BPCL (Color model)

The Bayer pattern array on the sensor



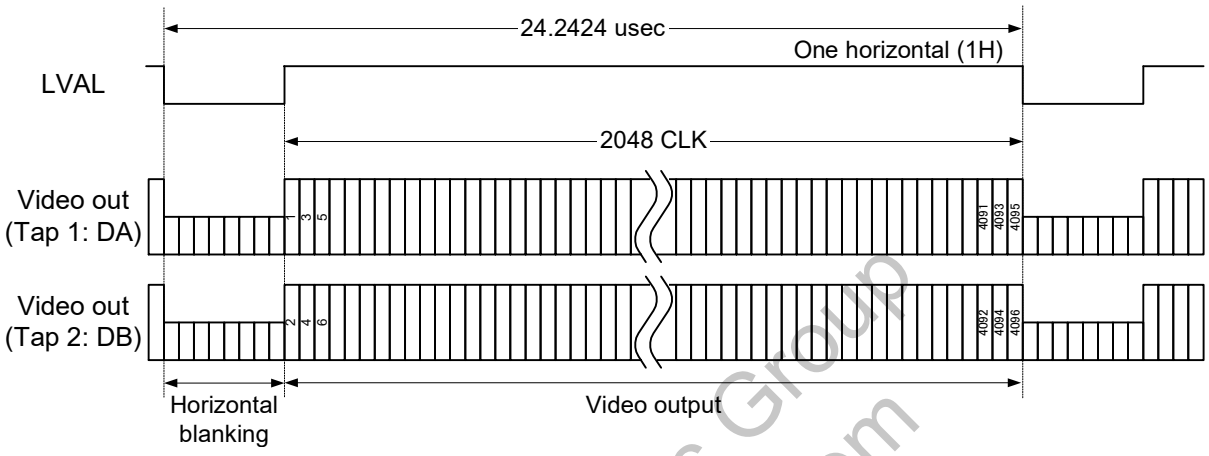
Pixel (m, n) of Data: nth pixel of the mth line being transferred

6 The camera output timing charts

6.1 The horizontal timings (STC-SPB/SPC123BPCL): Full scanning / Binning operation

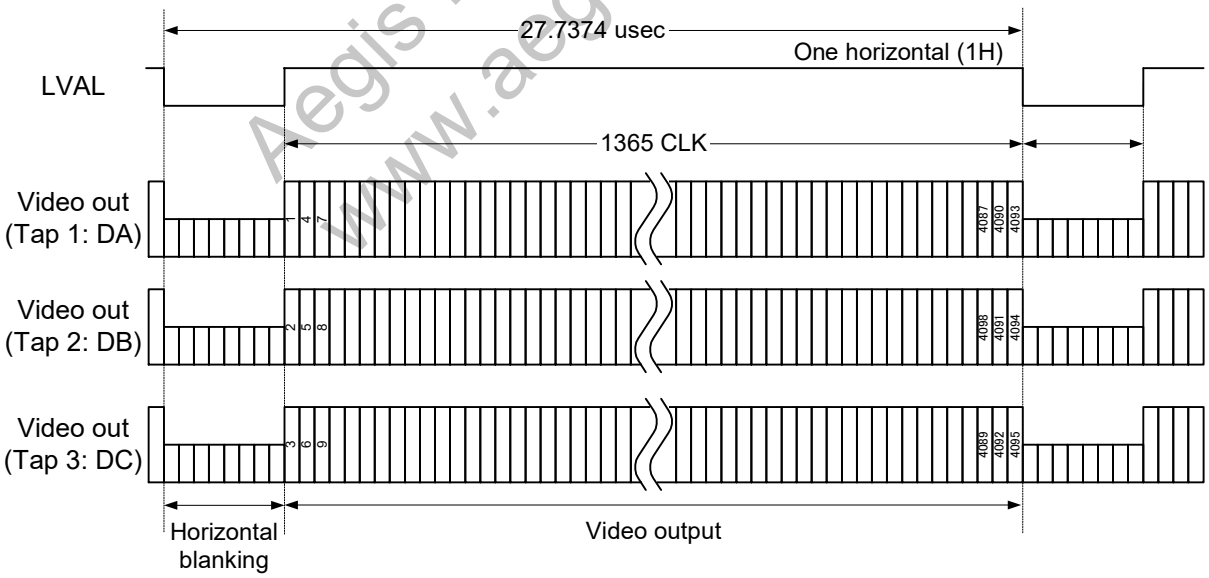
6.1.1 2 TAP (1X2-1Y) / Horizontal: 4,096 pixels

1CLK = 11.785 nsec.



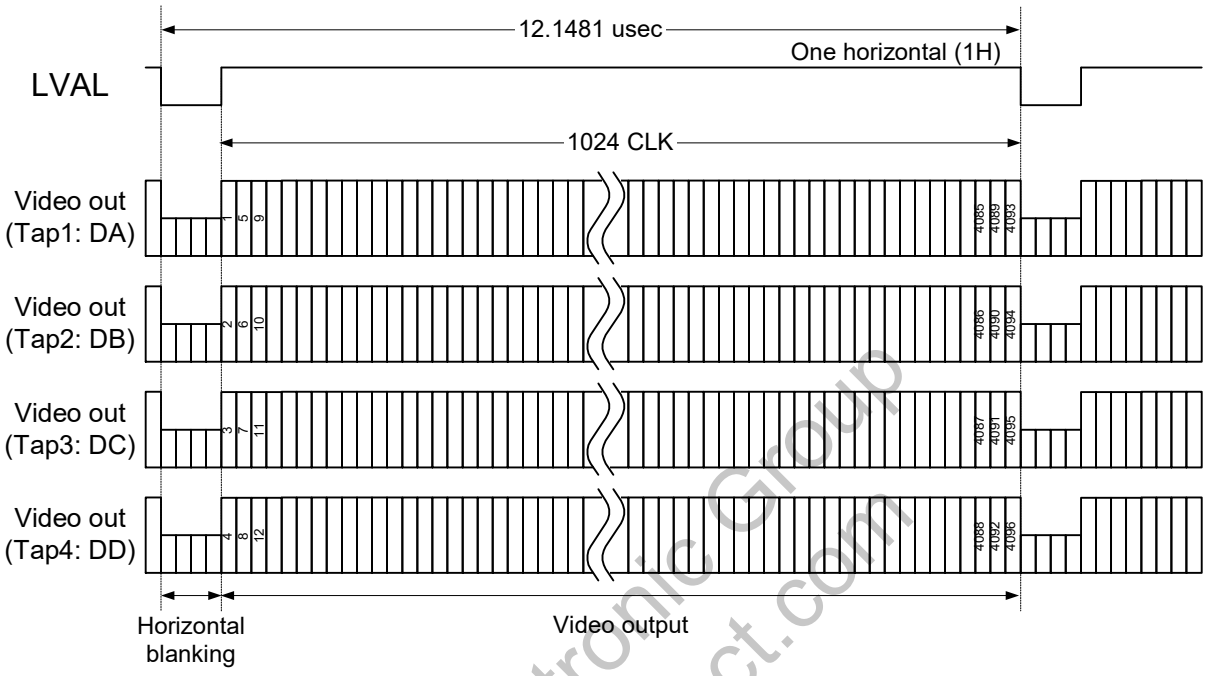
6.1.2 3TAP (1X3-1Y) / Horizontal: 4,095 pixels

1CLK = 15.15 nsec.



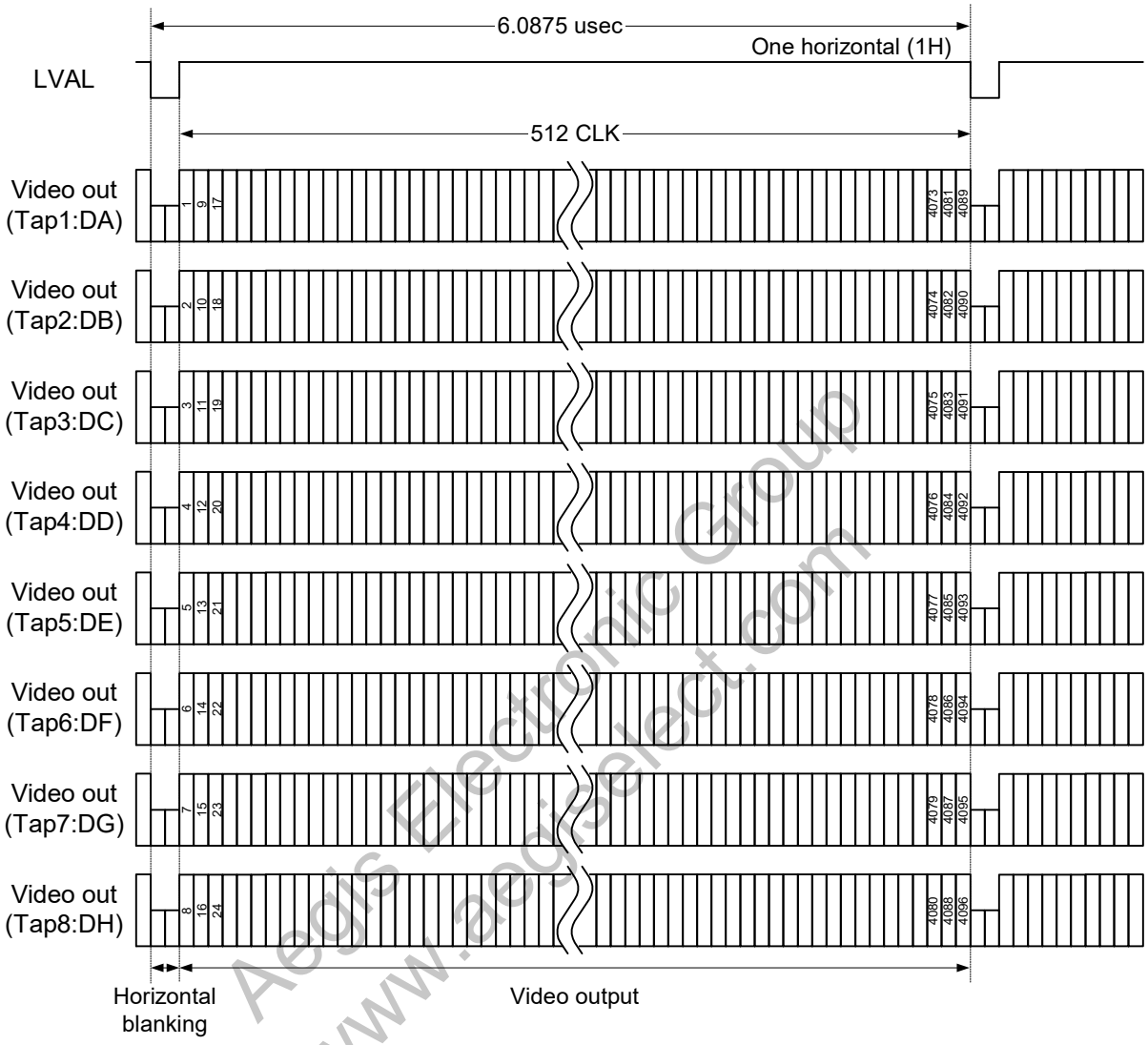
6.1.3 4TAP (1X4-1Y) / Horizontal: 4,096 pixels

1CLK = 11.785 nsec.



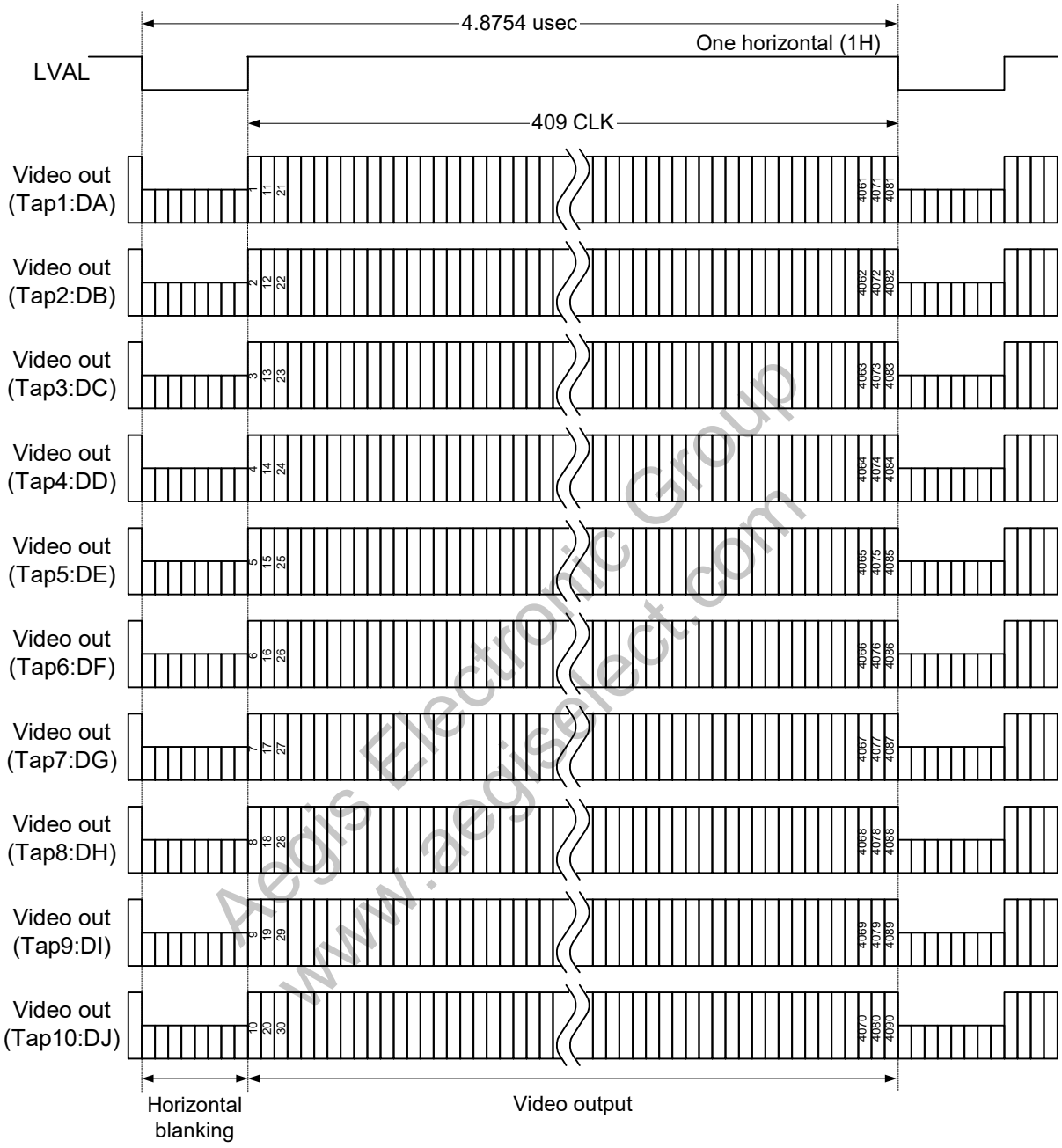
6.1.4 8TAP (1X8-1Y) / Horizontal: 4,096 pixels

1 CLK = 11.785 nsec.



6.1.5 10TAP (1X10-1Y) / Horizontal: 4,090 pixels

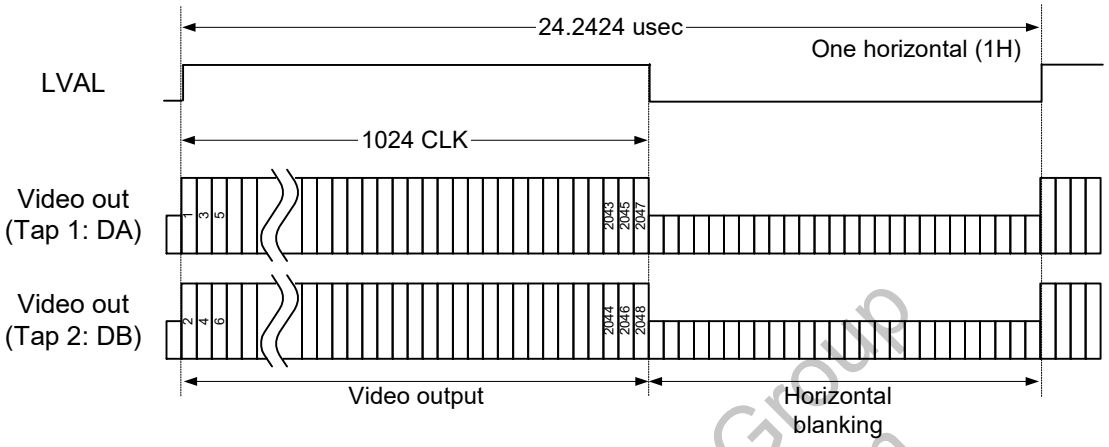
1 CLK = 11.785 nsec.



6.2 The horizontal timings (STC-SPB/SPC123BPCL): Decimation operation

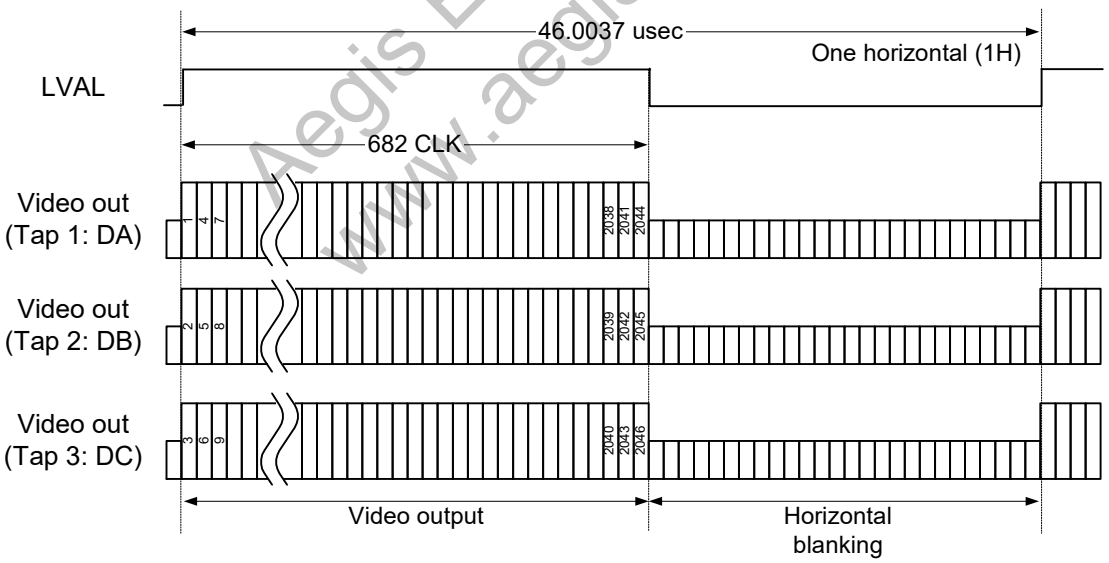
6.2.1 2TAP (1X2-1Y) / Horizontal: 2,048 pixels

1CLK = 11.785 nsec.



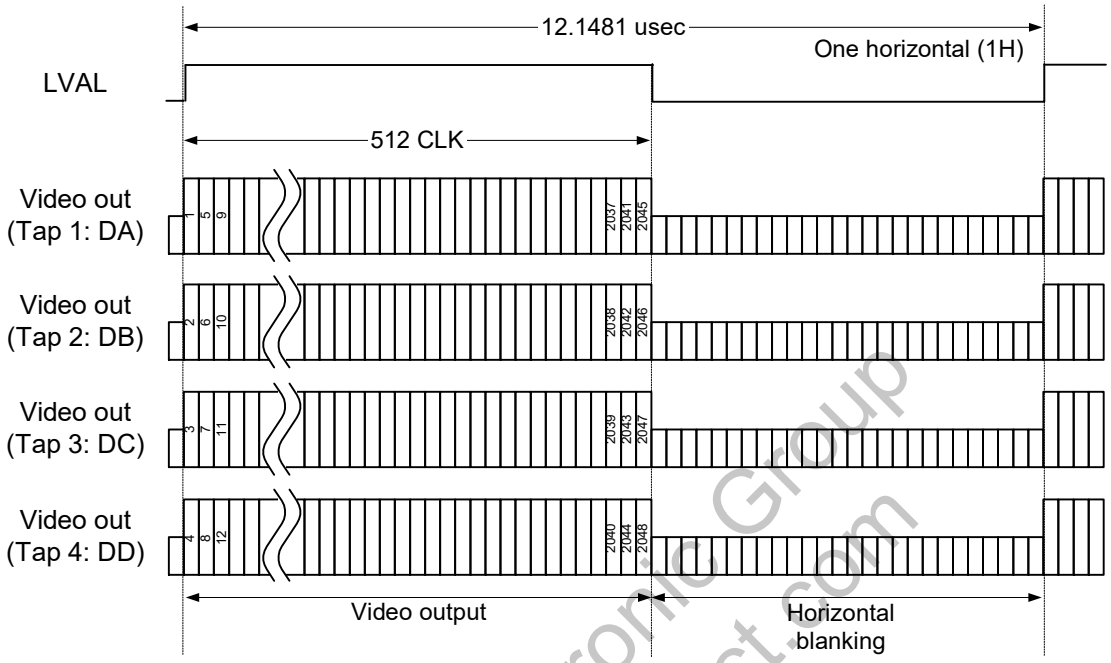
6.2.2 3TAP (1X3-1Y) / Horizontal: 2,046 pixels

1CLK = 15.15 nsec.



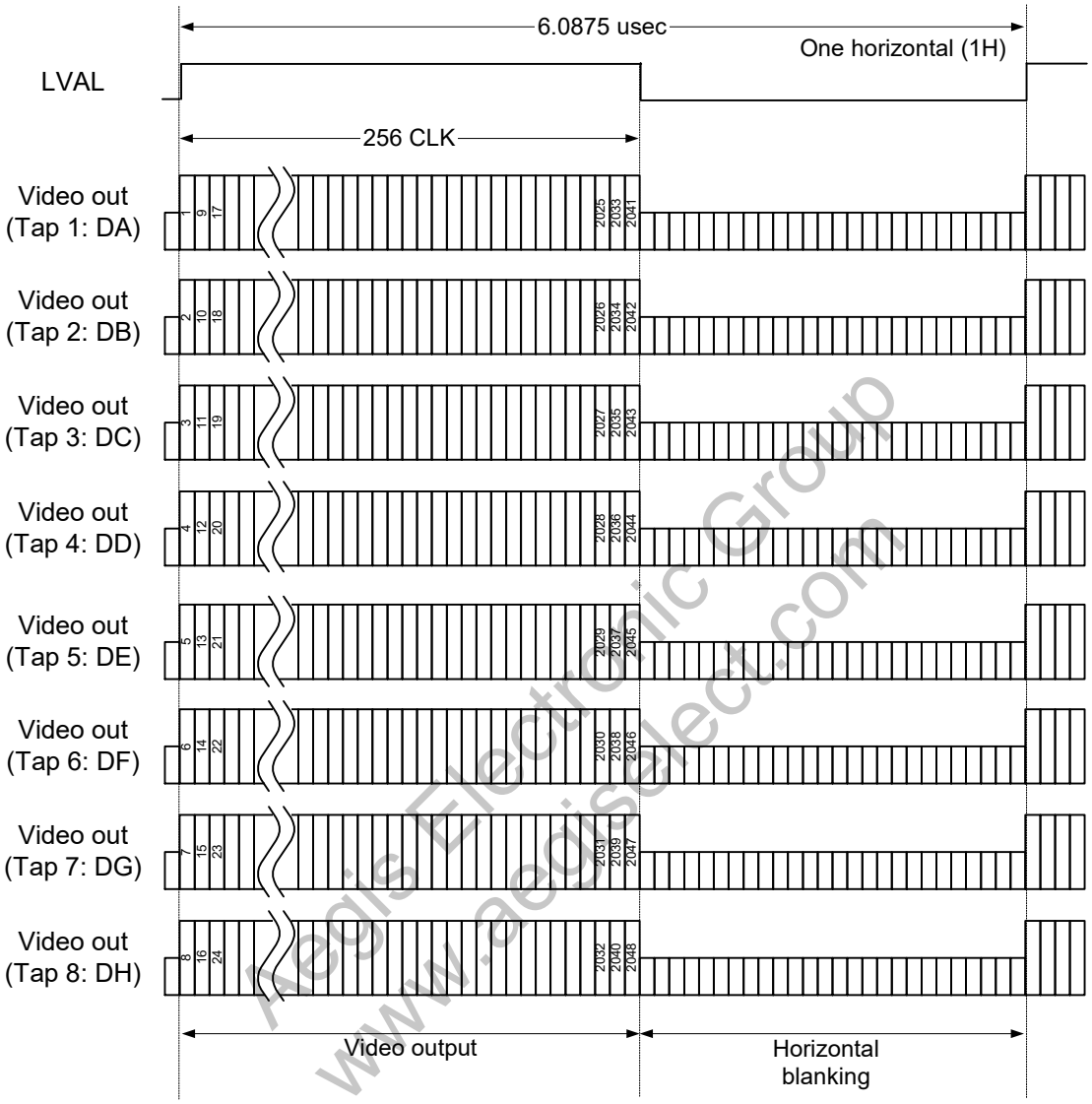
6.2.3 4TAP (1X4-1Y) / Horizontal: 2,048 pixels

1CLK = 11.785 nsec.



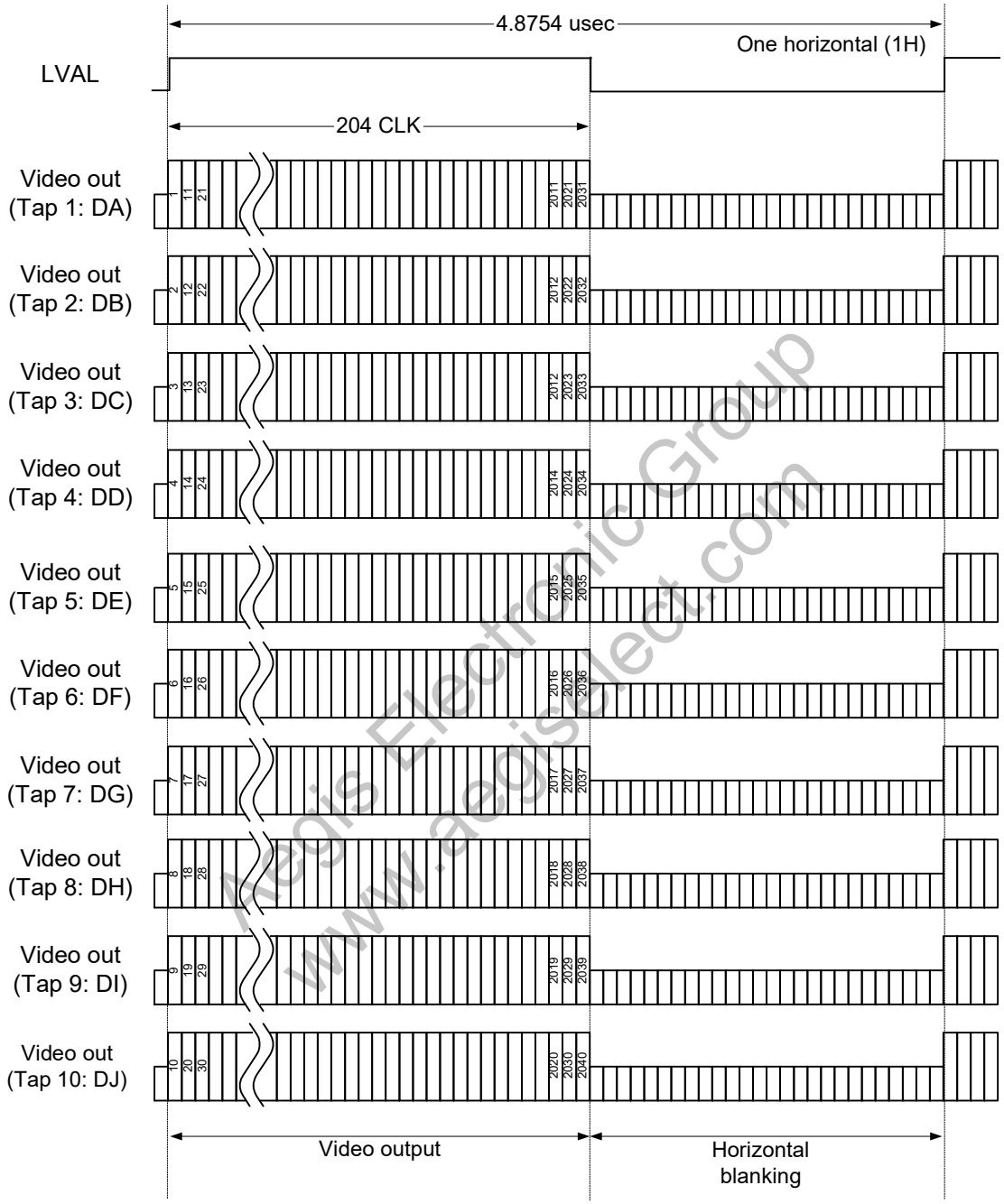
6.2.4 8TAP (1X8-1Y) / Horizontal: 2,048 pixels

1 CLK = 11.785 nsec.



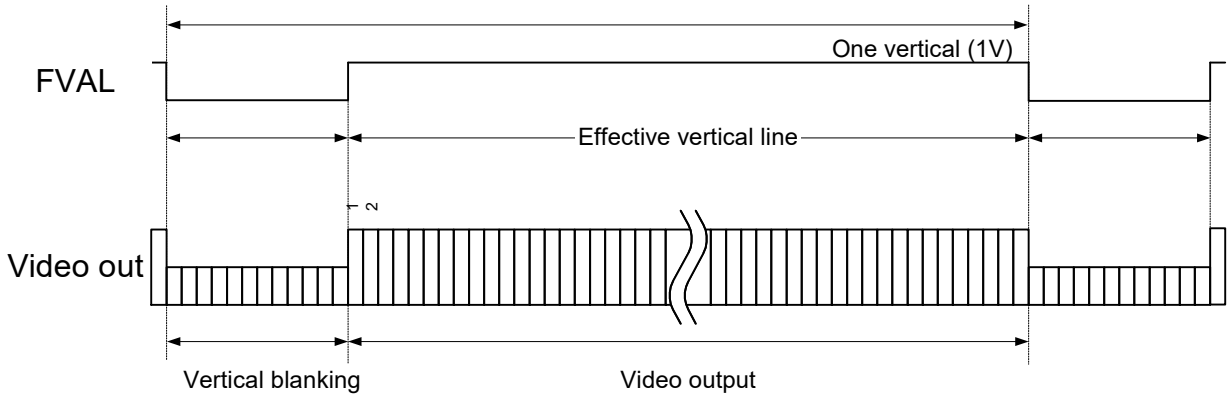
6.2.5 10TAP (1X10-1Y) / Horizontal: 2,040 pixels

1 CLK = 11.785 nsec



6.3 The Vertical timings

6.3.1 Full Scanning / Decimation / Binning



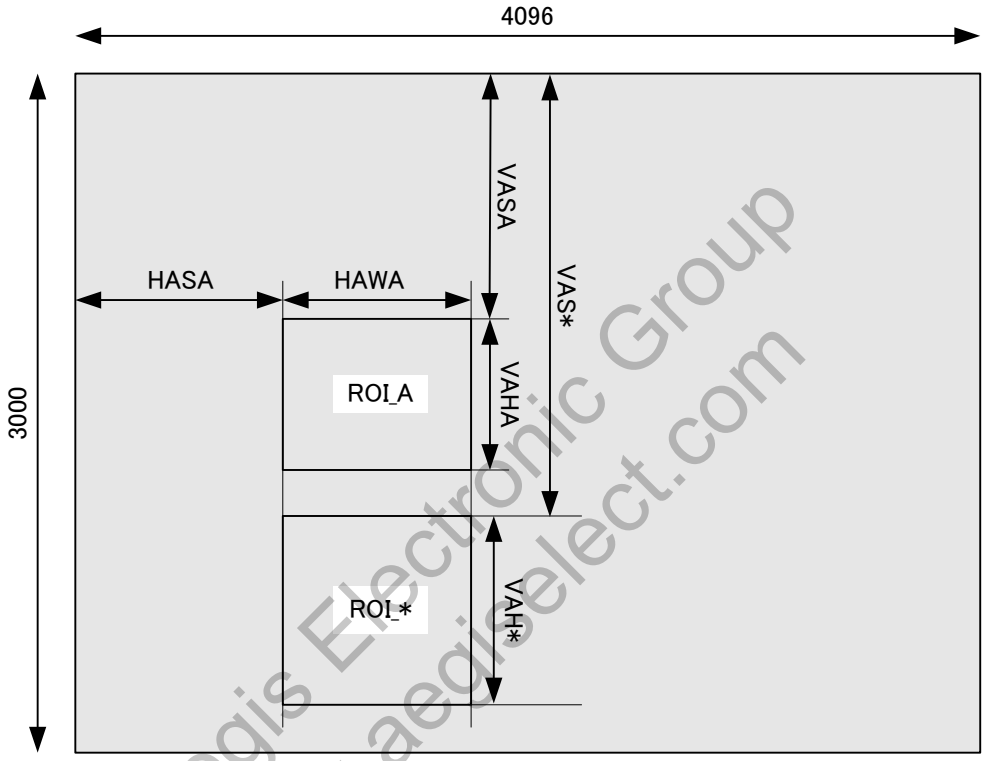
The table of the vertical effective lines and vertical blanking (Free-run / continuous operation)

Camera Link output TAP number	Full scanning			Decimation / Binning		
	Vertical blanking (H)	Vertical effective lines (H)	Frame rate (fps)	Vertical blanking (H)	Vertical effective lines (H)	Frame rate (fps)
10	62	3,000	66.99	62	1,500	131.31
8			53.65			105.17
4			26.88			52.70
3			15.02			29.45
2			13.47			26.59

7 The scanning modes

7.1 ROI Output Timing

The vertical size and vertical position for eight ROI regions are adjustable.
The horizontal size and horizontal position for the ROI region is common for all eight regions, are adjustable.
Please refer the ROI setting parameters in below drawing.



*: 8 Regions A, B, C, D, E, F, G and H

The frame rate on ROI

The maximum frame rate can be increase by the vertical effective lines for ROI adjustment.
The frame rate calculation formula is as following:

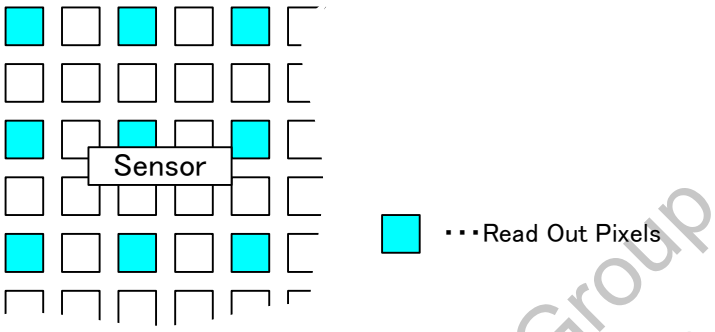
Frame rate = Horizontal frequency / (Vertical active lines + Vertical blanking)

The horizontal effective pixels for ROI do not make any influence for the maximum frame rate.
Please refer “The image data transferring speed” for the details of the horizontal frequency.

7.2 Decimation

The horizontal and vertical thinning image is output.
By using decimation function, half resolution (2x2 sub-sampling) without change the view angle, and twice faster frame rate image can be obtained.

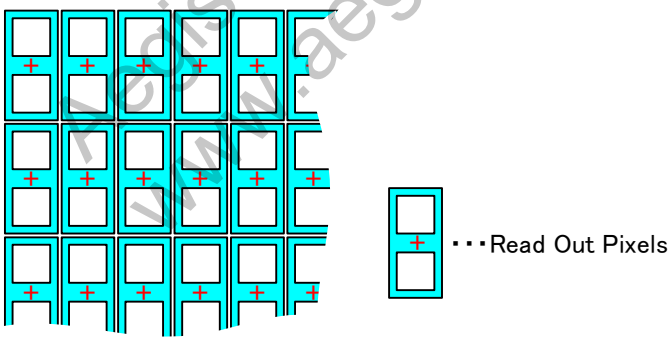
* Decimation function cannot use with the binning function.
* Decimation function cannot use with the ROI function.



7.3 Binning

The brightness of two vertical pixels are summing into one pixel. (No horizontal brightness summing)
By using binning function, twice brighter, half resolution and twice faster frame rate image can be obtained.

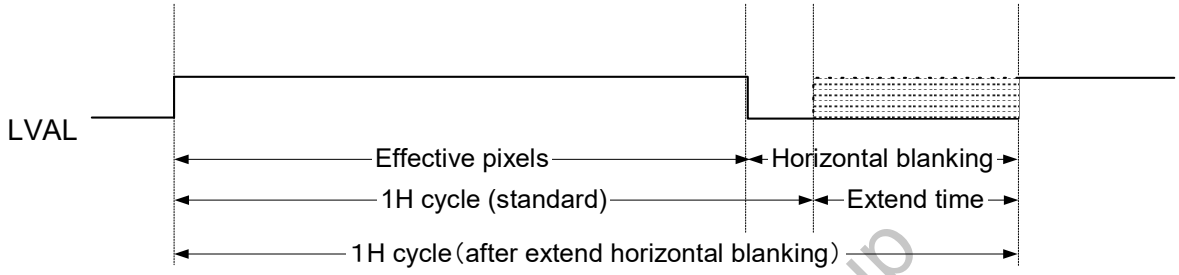
* Binning function cannot use with the decimation function.
* Binning function can use with the ROI function.



8 The image data transferring speed

The horizontal cycle of the image can extend with the camera control command.
The frame rate is changed when the horizontal cycle of the image is extended.
The Camera Link clock speed is selectable from 84.574 MHz, 66 MHz and 33MHz.

Please select the optimum Camera Link clock speed if the long length Camera Link cable is required.



The calcuate formula for extend time:
Extend time = EXT_HB [11:0] * 13.468 nsec.
* EXT_B: Data of 77H and 76H

The table of the Camera Link clock speed and the camera operation

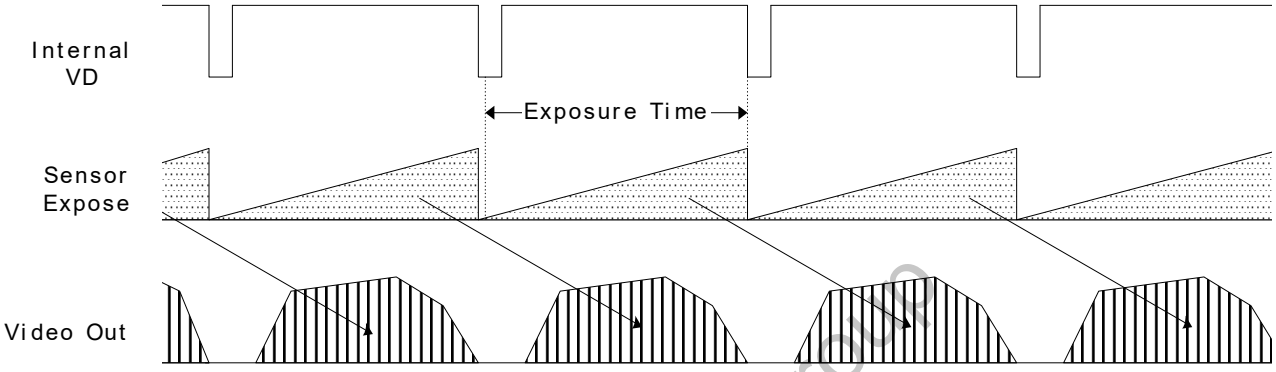
Camera settings		Camera operation		
Register [EEH]	EXT_HB[11:0] Register [77H,76H]			
Camera Link TAP Configuration	Extend horizontal cycle (steps) *1 step: 13.468 nsec.	Camera Link Clock speed (MHz)	Horizontal frequency (KHz)	Frame rate (fps)
10	0	84.857	205.11	66.99
	104	66	159.33	52.04
	570	33	79.67	26.02
8	0	84.857	164.27	53.65
	129	66	127.80	41.74
	710	33	63.90	20.84
4	0	84.857	82.32	26.88
	257	66	64.06	20.92
	1414	33	32.06	10.47
3	0	66	46.00	15.02
	1414	33	24.09	7.87
2	0	84.857	82.13	13.47
	504	66	32.16	10.50
	2818	33	16.08	5.25

9 Camera function modes

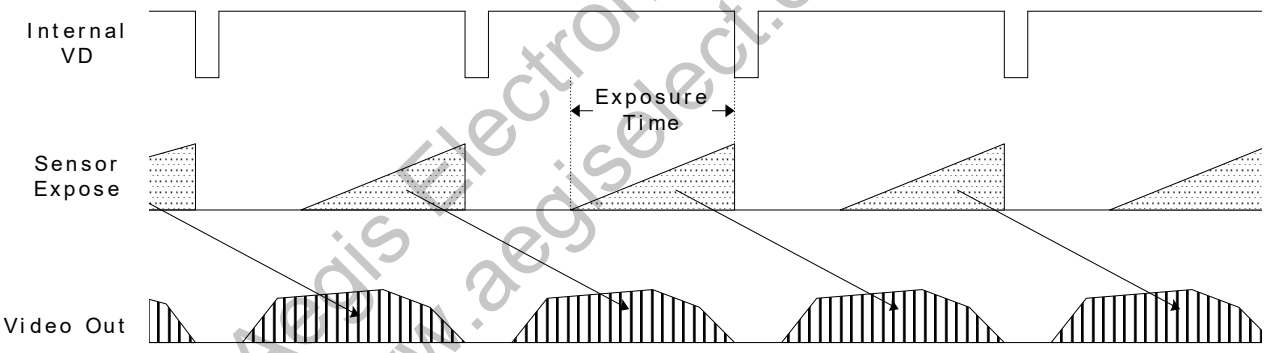
9.1 Free-run / Continuous mode

This mode can be outputted camera video signal continuously.

9.1.1 Full frame exposure



9.1.2 Electronic shutter

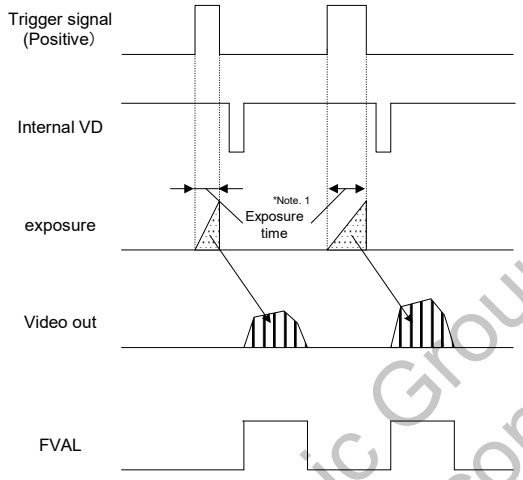


9.2 Pulse width trigger mode

The camera exposure starts by the trigger signal.

In this trigger mode with positive trigger polarity, the camera exposure starts at the rising edge of the trigger signal and stops at the falling edge of the trigger signal.

Therefore, In the case of the exposure positive polarity is selected, the exposure periods (exposure time) are the high states of the trigger signal.



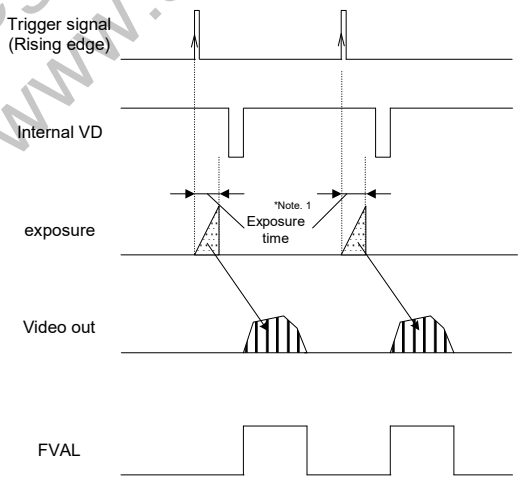
Note.1: The exposure time sets by the active pulse width of the trigger signal.
No FVAL output without any trigger signal.

9.3 Edge Preset Trigger mode

The camera exposure starts by the trigger signal.

In this trigger mode with positive trigger polarity, the camera exposure starts at the rising edge of the trigger signal.

The exposure time is preset by the “Electrical Shutter” settings.

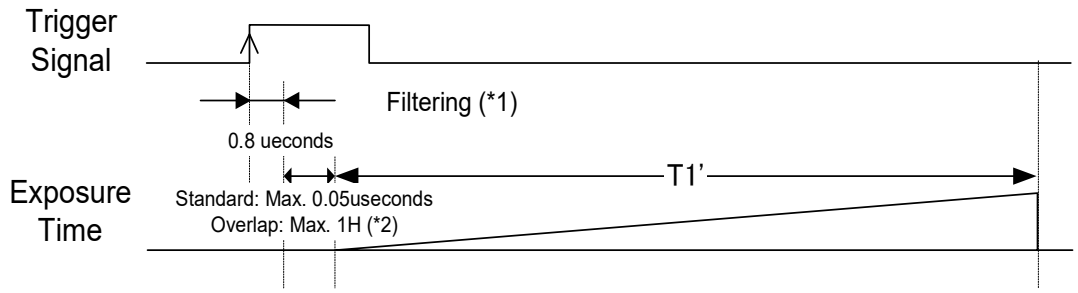


Note.1: The exposure time sets by the preset electronic shutter speed.

9.4 The details of the exposure timing

9.4.1 Fast trigger mode

The camera exposure starts immediately after the valid edge of the trigger signal is detected.



Exposure time: Pulse width trigger: T1' = Active pulse width of the trigger signal +Toffset
(Toffset = 13.73us.)

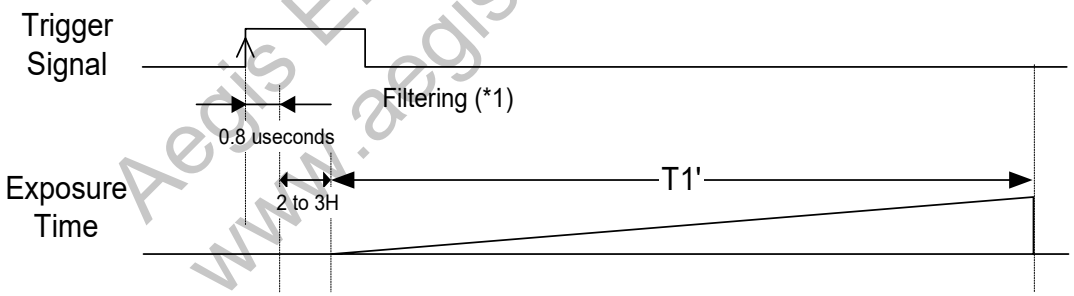
Edge preset trigger: T1' = Preset exposure time

(*1) The active pulse width for the trigger signal has to be longer than 0.8 μseconds.
If this is shorter than 0.8 μseconds, the trigger signal is invalid.

(*2) The overlap is the trigger signal input to the camera while the image is transferring.

9.4.2 Trigger overlap mode

The fast trigger mode is recommended to use.
Please use this overlap mode, if the one horizontal line has different level of the signal (similar of the horizontal line noise), is appeared in the image when the trigger signal inputs while the image data is transferring.

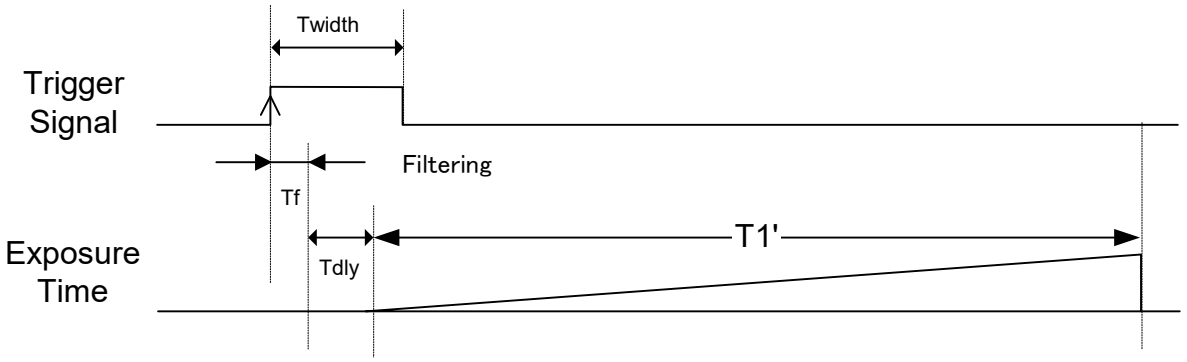


Exposure time: Pulse width trigger: T1' = Active pulse width of the trigger signal +Toffset
(Toffset = 13.73us.)

Edge preset trigger: T1' = Preset exposure time
* The actual exposure time unit is 1H cycle.

(*1) The active pulse width for the trigger signal has to be longer than 0.8 μseconds.
If this is shorter than 0.8 μseconds, the trigger signal is invalid.

9.4.3 The exposure timing for each mode



Toffset = 13.73 µs.

Exposure start mode	Trigger mode	(Tf)	Delay for the trigger signal input to start exposure (Tdly)		Adjustment unit for the exposure time	Exposure time (T1)	Minimum Exposure time (T1min)
			Without trigger overlap	With trigger over lap			
Fast trigger	Pulse width	0.8 µs.	No delay	No delay to 1H	40.4ns (24.75MHz)	Twidth + Toffset	Toffset
	Edge preset				1us	Preset exposure time	1us
Trigger Overlap	Pulse width	0.8 µs.	2 to 3H	2 to 3H	1H	Twidth + Toffset	1H + Toffset
	Edge preset					Preset exposure time	

10 Camera function

10.1 Lookup table (Gamma)

The camera has the brightness signal conversion function based on the input brightness level with the lookup table.
This table has 32 steps (input signal (0 to 4095) divided by 32). The output signal is converted for these 32 steps.
The midpoint x that is between the 32 steps, is calculated automatically.
Please refer B0H to CEH [The lookup table (Gamma)] in the camera control command for more details.
Gamma Level can be set as15 steps.

The output signal formula is as following:

Output signal = Table value*(Gamma Level (0 to 15) [Address: 4FH]) / 15

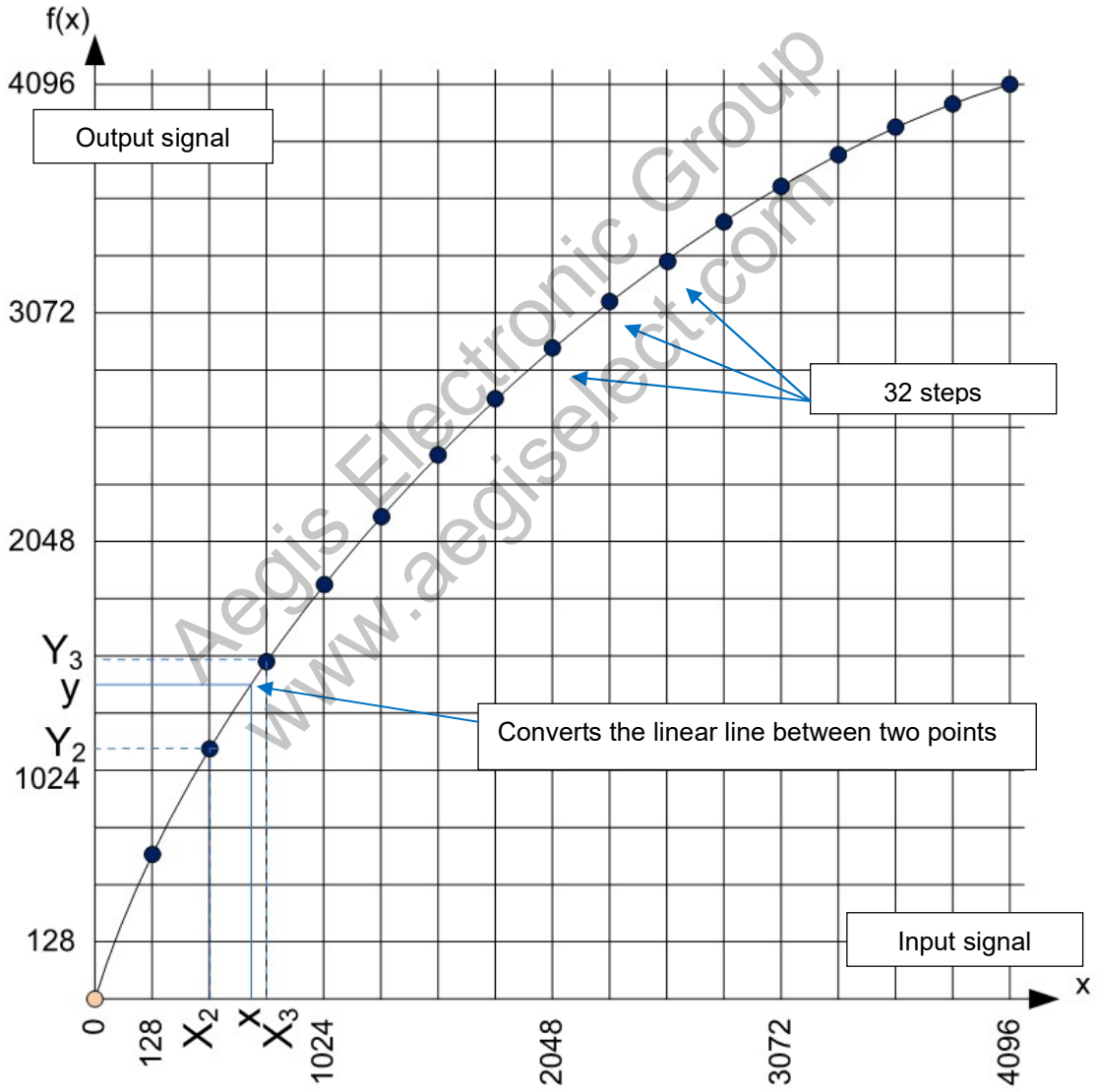


図 1.Principal of Lookup table

e.g.: X2, X3 are selected as the inputs from 32 steps, Y2, Y3 are output through the lookup table.
The output y will come from the converted point between (X2, Y2) and (X3, Y3) if the midpoint x is between X2 and X3.

11 The communication protocol specifications

This camera has a communication function that enables external devises such as a PC, to change the camera settings. Please use “CLCtrl2 (ver. 1.17 or later)” communication software or use the following communication protocol to communicate to the camera.

11.1 The communication method

UART (RS232C standard compliant), Binary communication

11.2 The communication settings

Baud rate	**9,600bps** / 38,400bps / 57,600bps / 115,200bps
Data bit	8bits
Parity	None
Stop bit	1bit
Flow control	None

11.3 The communication format

A. The sending data format from the PC to the camera is as follows:

SOF (8bits)	Device code (6bits)	Read / write (1bit)	Page selection (1bit)	Command code (8bits)	Data length (8bits)	Data (Write: Data length) (Read: 1byte)	EOF (8bits)

B. The receiving data format from the camera is as follows:

a. After sent the read command

SOF (8bits)	Data length (8bits)	Data (Data length byte)	EOF (8bits)

b. After sent the write command

SOF (8bits)	Data length (00H) (8bits)	Receiving code (8bits)	EOF (8bits)

C. Descriptions of the format

SOF	Start of the frame. Sets (or obtains) the value is as “02H” always.
Device code	Sets the device code of the camera. Sets the value is as “000000” always.
Read / Write	Sets “0” when sending read command. Sets “1” when sending write command.
Page selection	Sets “0” when accessing to the register of the camera. Obtains the current data from the register when sending read command. Replaces the data in the register by sending data when sending write command. **The data in the EEPROM does not replace.** Sets “1” when accessing to the EEPROM of the camera. Obtains the data from the EEPROM when sending read command. Replaces the data in the EEPROM by sending data when sending write command. The camera uses the data in the EEPROM when the power on the camera. The camera sends the receiving code as “01H” to the PC after the data in the EEPROM is replaced. The camera rejects any commands while the data in the EEPROM is replacing. (Approximately 5 mseconds / byte)
Command code	Sets the command code. Please refer “The camera control commands” for more details.
Data length	Sets (or obtains) the data length. (unit: byte) For receiving data: The data length is based on the command after sent read command. The data length is “00H” after sent write command. For sending data: The data length is 1 byte when sending read command. The data length is based on the command when sending write command.
Data	Sets (or obtains) the data based on the command.
EOF	End of the frame Sets (or obtains) the value is as “03H” always.
Receiving code	Obtains the result of the sending command. 01H: The command proceeded correctly (ACK) 10H: The command could not process correctly (NAC) 11H: The communication issue

D. Command example

Send the read command to read the 00H address data of the register

02, 00, 00, 01, 00, 03

SOF, (Device code / Read / Register), Command code, Data length, Data, EOF

The return command

02, 01, 00, 03

11.4 The camera control commands

11.4.1 The camera commands list

Note. 1: The data unit of the each command is 1 byte (8bits).
Note. 2: The data can be saved to the EEPROM if “X” in the “EEPROM” column in the list.
Note. 3: The camera is operating with the data of the EEPROM when the power on the camera.

Command No.	R/W	EEPROM	Function	Default Data	Data Range
00 - 0FH			Reserved	-	-
10H	R/W	X	Camera function mode 1 (8bits: D[7..0])	0	
11H	R/W	X	Camera function mode 2 (8bits: D[7..0])	0	
12H	R/W	X	Camera function mode 3 (8bits: D[7..0])	40H	
13H			Reserved	-	-
14H	R/W		Communication mode (8bits: D[7..0])	1	
15 - 1FH			Reserved	-	-
20H	R/W	X	Exposure time of the electronic shutter (24bits: D[7..0])	0	0 to 16,777,215
21H	R/W	X	Exposure time of the electronic shutter (24bits: D[15..8])		
22H	R/W	X	Exposure time of the electronic shutter (24bits: D[23..16])		
23 - 27H			Reserved	-	-
28H	R/W	X	Delay time for the trigger signal (8bits: D[7..0])	0	0 to 255
29H			Reserved	-	-
30H	R/W	X	Analog gain (8bits: D[7..0])	0	0 to 180
31H	R/W	X	Digital gain (8bits: D[7..0])	0	0 to 240
32 - 37H			Reserved	-	-
38H	R/W	X	Clamp level (8bits: D[7..0])	40	0 to 255
39H			Reserved	-	-
3AH	R/W	X	White Balance R gain (16bits: D[7..0]) *1	0	0 to 255
3BH	R/W	X	White Balance B gain (16bits: D[7..0]) *1	0	0 to 255
3CH	R/W	X	White Balance GR gain (16bits: D[7..0]) *1	0	0 to 255
3DH	R/W	X	White Balance GB gain (16bits: D[7..0]) *1	0	0 to 255
3E - 4EH			Reserved	-	-
4FH	R/W	X	Gamma level setting (4bits: D[3..0])	15	0 to 15

*1 Only available for the color model

Command No.	R/W	EEPROM	Function	Default Data	Data Range
50H	R/W	X	Lookup table (Gamma) GSTEP0 (8bits: D[7..0])	36H	0 to FFH
51H	R/W	X	Lookup table (Gamma) GSTEP1 (8bits: D[7..0])	4AH	0 to FFH
52H	R/W	X	Lookup table (Gamma) GSTEP2 (8bits: D[7..0])	58H	0 to FFH
53H	R/W	X	Lookup table (Gamma) GSTEP3 (8bits: D[7..0])	64H	0 to FFH
54H	R/W	X	Lookup table (Gamma) GSTEP4 (8bits: D[7..0])	6FH	0 to FFH
55H	R/W	X	Lookup table (Gamma) GSTEP5 (8bits: D[7..0])	79H	0 to FFH
56H	R/W	X	Lookup table (Gamma) GSTEP6 (8bits: D[7..0])	81H	0 to FFH
57H	R/W	X	Lookup table (Gamma) GSTEP7 (8bits: D[7..0])	89H	0 to FFH
58H	R/W	X	Lookup table (Gamma) GSTEP8 (8bits: D[7..0])	91H	0 to FFH
59H	R/W	X	Lookup table (Gamma) GSTEP9 (8bits: D[7..0])	98H	0 to FFH
5AH	R/W	X	Lookup table (Gamma) GSTEP10 (8bits: D[7..0])	9EH	0 to FFH
5BH	R/W	X	Lookup table (Gamma) GSTEP11 (8bits: D[7..0])	A5H	0 to FFH
5CH	R/W	X	Lookup table (Gamma) GSTEP12 (8bits: D[7..0])	ABH	0 to FFH
5DH	R/W	X	Lookup table (Gamma) GSTEP13 (8bits: D[7..0])	B0H	0 to FFH
5EH	R/W	X	Lookup table (Gamma) GSTEP14 (8bits: D[7..0])	B6H	0 to FFH
5FH	R/W	X	Lookup table (Gamma) GSTEP15 (8bits: D[7..0])	BBH	0 to FFH
60H	R/W	X	Lookup table (Gamma) GSTEP16 (8bits: D[7..0])	C1H	0 to FFH
61H	R/W	X	Lookup table (Gamma) GSTEP17 (8bits: D[7..0])	C6H	0 to FFH
62H	R/W	X	Lookup table (Gamma) GSTEP18 (8bits: D[7..0])	CAH	0 to FFH
63H	R/W	X	Lookup table (Gamma) GSTEP19 (8bits: D[7..0])	CFH	0 to FFH
64H	R/W	X	Lookup table (Gamma) GSTEP20 (8bits: D[7..0])	D4H	0 to FFH
65H	R/W	X	Lookup table (Gamma) GSTEP21 (8bits: D[7..0])	D8H	0 to FFH
66H	R/W	X	Lookup table (Gamma) GSTEP22 (8bits: D[7..0])	DDH	0 to FFH
67H	R/W	X	Lookup table (Gamma) GSTEP23 (8bits: D[7..0])	E1H	0 to FFH
68H	R/W	X	Lookup table (Gamma) GSTEP24 (8bits: D[7..0])	E5H	0 to FFH
69H	R/W	X	Lookup table (Gamma) GSTEP25 (8bits: D[7..0])	E9H	0 to FFH
6AH	R/W	X	Lookup table (Gamma) GSTEP26 (8bits: D[7..0])	EDH	0 to FFH
6BH	R/W	X	Lookup table (Gamma) GSTEP27 (8bits: D[7..0])	F1H	0 to FFH
6CH	R/W	X	Lookup table (Gamma) GSTEP28 (8bits: D[7..0])	F5H	0 to FFH
6DH	R/W	X	Lookup table (Gamma) GSTEP29 (8bits: D[7..0])	F9H	0 to FFH
6EH	R/W	X	Lookup table (Gamma) GSTEP30 (8bits: D[7..0])	FCH	0 to FFH
6FH	R/W	X	Lookup table (Gamma) GSTEP31 (8bits: D[7..0])	FFH	0 to FFH

Command No.	R/W	EEPROM	Function	Default Data	Data Range
70 - 75H			Reserved	-	-
76H	R/W	X	Horizontal cycle extend time (12bits: D[7..0])	0	0 to 4,095
77H	R/W	X	Horizontal cycle extend time (12bits: D[11..8])		
78H	R/W	X	Test Pattern (3bits: D[2..0])	0	0 to 7
79 - 7FH			Reserved	-	-
80H	R/W	X	EEPROM control (8bits: D[7..0])	0	
81 - 8FH			Reserved	-	-
90H	R/W	X	Vertical ROI_A Start line (16bits: D[7..0])	0	0 to 2,996
91H	R/W	X	Vertical ROI_A Start line (16bits: D[15..8])		
92H	R/W	X	Vertical ROI_B Start line (16bits: D[7..0])	0	0 to 2,996
93H	R/W	X	Vertical ROI_B Start line (16bits: D[15..8])		
94H	R/W	X	Vertical ROI_C Start line (16bits: D[7..0])	0	0 to 2,996
95H	R/W	X	Vertical ROI_C Start line (16bits: D[15..8])		
96H	R/W	X	Vertical ROI_D Start line (16bits: D[7..0])	0	0 to 2,996
97H	R/W	X	Vertical ROI_D Start line (16bits: D[15..8])		
98H	R/W	X	Vertical ROI_E Start line (16bits: D[7..0])	0	0 to 2,996
99H	R/W	X	Vertical ROI_E Start line (16bits: D[15..8])		
9AH	R/W	X	Vertical ROI_F Start line (16bits: D[7..0])	0	0 to 2,996
9BH	R/W	X	Vertical ROI_F Start line (16bits: D[15..8])		
9CH	R/W	X	Vertical ROI_G Start line (16bits: D[7..0])	0	0 to 2,996
9DH	R/W	X	Vertical ROI_G Start line (16bits: D[15..8])		
9EH	R/W	X	Vertical ROI_H Start line (16bits: D[7..0])	0	0 to 2,996
9FH	R/W	X	Vertical ROI_H Start line (16bits: D[15..8])		
A0H	R/W	X	Vertical ROI_A Effective lines (16bits: D[7..0])	3,000	4 to 3,000
A1H	R/W	X	Vertical ROI_A Effective lines (16bits: D[15..8])		
A2H	R/W	X	Vertical ROI_B Effective lines (16bits: D[7..0])	0	4 to 3,000
A3H	R/W	X	Vertical ROI_B Effective lines (16bits: D[15..8])		
A4H	R/W	X	Vertical ROI_C Effective lines (16bits: D[7..0])	0	4 to 3,000
A5H	R/W	X	Vertical ROI_C Effective lines (16bits: D[15..8])		
A6H	R/W	X	Vertical ROI_D Effective lines (16bits: D[7..0])	0	4 to 3,000
A7H	R/W	X	Vertical ROI_D Effective lines (16bits: D[15..8])		
A8H	R/W	X	Vertical ROI_E Effective lines (16bits: D[7..0])	0	4 to 3,000
A9H	R/W	X	Vertical ROI_E Effective lines (16bits: D[15..8])		
AAH	R/W	X	Vertical ROI_F Effective lines (16bits: D[7..0])	0	4 to 3,000
ABH	R/W	X	Vertical ROI_F Effective lines (16bits: D[15..8])		
ACH	R/W	X	Vertical ROI_E Effective lines (16bits: D[7..0])	0	4 to 3,000
ADH	R/W	X	Vertical ROI_E Effective lines (16bits: D[15..8])		
AEH	R/W	X	Vertical ROI_F Effective lines (16bits: D[7..0])	0	4 to 3,000
AFH	R/W	X	Vertical ROI_F Effective lines (16bits: D[15..8])		

Command No.	R/W	EEPROM	Function	Default Data	Data Range
B0H	R/W	X	Horizontal ROI_A Start pixel (16bits: D[7..0])	0	Color: 0 to 4,094 Monochrome: 0 to 4,095
B1H	R/W	X	Horizontal ROI_A Start pixel (16bits: D[15..8])		
B2 - BFH			Reserved	-	-
C0H	R/W	X	Horizontal ROI_A Effective pixels (16bits: D[7..0])	2,448	2TAP: 2 to 4,096 3TAP: 3 to 4,095 4TAP: 4 to 4,096 8TAP: 8 to 4,096 10TAP: 10 to 4,090
C1H	R/W	X	Horizontal ROI_A Effective pixels (16bits: D[15..8])		
C2 - CFH			Reserved	-	-
D0H	R/W	X	Pixel defect correction control (8bits: D[7..0])	0	
D1H	R/W	X	Pixel defect correction coordinate number (8bits: D[7..0])	0	0 to 255
D2H	R/W	X	Pixel defect X position (Set) (16bits: D[7..0])	0	0 to 4,096
D3H	R/W	X	Pixel defect X position (Set) (16bits: D[15..8])		
D4H	R/W	X	Pixel defect Y position (Set) (16bits: D[7..0])	0	0 to 3,000
D5H	R/W	X	Pixel defect Y position (Set) (16bits: D[15..8])		
D6H	R/W	X	Pixel defect X position (Read) (16bits: D[7..0])	0	-
D7H	R/W	X	Pixel defect X position (Read) (16bits: D[15..8])		
D8H	R/W	X	Pixel defect Y position (Read) (16bits: D[7..0])	0	-
D9H	R/W	X	Pixel defect Y position (Read) (16bits: D[15..8])		
DA - DDH			Reserved	-	-
DEH	R/W	X	Pixel defect correction mode (8bits: D[7..0])	1	
DF - E9H			Reserved	-	-
EAH	R/W	X	White Balance R gain (16bits: D[15..8]) *1	16	0 to 127
EBH	R/W	X	White Balance B gain (16bits: D[15..8]) *1	16	0 to 127
ECH	R/W	X	White Balance GR gain (16bits: D[15..8]) *1	16	0 to 127
EDH	R/W	X	White Balance GB gain (16bits: D[15..8]) *1	16	0 to 127
EEH	R/W	X	Camera function mode 6 (16bits: D[7..0])	7	
EFH	R/W	X	Reserved	-	-

*1 Only available for the color model

14.2.2 Description of the camera control commands

The underline settings are the factory default settings.

<table>
<tr><th>Command No.</th><th>Command Description</th></tr>
<tr><td>10H:
MOD1 [7..0]</td><td>[Camera function mode 1] Default data: MOD1 [7..0] = 00H
Sets the camera function mode.
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>
<table>
<tr><td>D7</td><td>No Function</td><td colspan="2">Always set as “0”</td></tr>
<tr><td>D6</td><td>Trigger Polarity</td><td>0: Positive</td><td>1: Negative</td></tr>
<tr><td>D5</td><td>Trigger Mode</td><td>0: Edge Preset</td><td>1: Pulse Width</td></tr>
<tr><td>D4</td><td>Binning Mode *1</td><td>0: Off</td><td>1: On</td></tr>
<tr><td>D3</td><td>Scanning Mode *1</td><td>0: Full Scanning</td><td>1: Decimation</td></tr>
<tr><td>D2 to D0</td><td>No Function</td><td colspan="2">Always set as “000”</td></tr>
</table>
*1 Only available for the monochrome model (Please set as “0” for the color model)</td></tr>
<tr><td>11H:
MOD2 [7..0]</td><td>[Camera function mode 2] Default data: MOD2 [7..0] = 00H
Sets the camera function mode.
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>
<table>
<tr><td>D7 to D4</td><td>No Function</td><td colspan="2">Always set as “00000”</td></tr>
<tr><td>D3</td><td>Operation Mode</td><td>0: Trigger</td><td>1: Free-run / Continuous</td></tr>
<tr><td>D2 to D0</td><td>No Function</td><td colspan="2">Always set as “000”</td></tr>
</table>
* Note: While the camera is in trigger mode, the image will not output without the trigger signal input.</td></tr>
<tr><td>12H:
MOD3 [7..0]</td><td>[Camera function mode 3] Default data: MOD3 [7..0] = 40H
Sets the camera function mode.
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>
<table>
<tr><td>D7 to D6</td><td>Output Format</td><td>00: 10bits</td><td>01: 8bits</td></tr>
<tr><td></td><td></td><td>10: 12bits</td><td>11: No Function</td></tr>
<tr><td>D5</td><td>Trigger Input Selection</td><td>0: CC1 on Camera Link</td><td>1: 2pin on power / I/O</td></tr>
<tr><td>D4</td><td>Exposure Start Mode</td><td>0: Fast Trigger</td><td>1: Trigger Overlap</td></tr>
<tr><td>D3</td><td>No Function</td><td colspan="2">Sets always as "0"</td></tr>
<tr><td>D2</td><td>Vertical Image Flip</td><td>0: Off</td><td>1: Vertical Flip</td></tr>
<tr><td>D1</td><td>Horizontal Image Flip</td><td>0: Off</td><td>1: Horizontal Flip</td></tr>
<tr><td>D0</td><td>Gamma Mode</td><td>0: Off</td><td>1: On</td></tr>
</table>
* Note: Please refer “The details of the exposure timing” for more details of the exposure start mode.</td></tr>
<tr><td>14H:
UART [7..0]</td><td>[Communication mode] Default data: UART [7..0] = 01H
Sets the communication mode.
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>
<table>
<tr><td>D7 to D2</td><td>No Function</td><td colspan="2">Sets always as "000000"</td></tr>
<tr><td>D1 to D0</td><td>Communication Mode</td><td>00: 38,400 bps</td><td>01: 9,600 bps</td></tr>
<tr><td></td><td></td><td>10: 57,600 bps</td><td>11: 115,200 bps</td></tr>
</table></td></tr>
</table>

Command No.	Command Description
20H: SVR [7:0] 21H: SVR [15:8] 22H: SVR [23:16]	[Exposure time of the electronic shutter] Default data: SVR [23..0] = 0, Data range: 0 to 16,777,215 Sets the preset shutter speed (exposure time) for electronic shutter. Exposure time (shutter speed) = 1 * SVR (µseconds)
28H: DLY [7:0]	[Delay time for the trigger signal] Default data: DLY [7..0] = 0, data range: 0 to 255 Sets the delay time from the trigger signal input to start exposure. Delay time = 2 * DLY [7..0] (µseconds)
30H: A_GAIN [7:0] 31H: D_GAIN [7:0]	[Analog gain / Digital gain] Default data: A_GAIN [7:0] = 0, D_GAIN [7:0] = The factory adjusted value, Data range: GAIN_A: 0 to 180, D_GAIN: 0 to 240 Sets the analog gain and digital gain. TOTAL_GAIN = (A_GAIN + D_GAIN + OFFSET_GAIN) / 10 [dB]
38H: CLAMP [7:0]	[Clamp level] Default data: CLAMP [7..0] = 40, Data range: 0 to 255 Sets the 10bits clamp level of the black signal.
3AH: WBR [7:0]	[White Balance R gain] Default data: WBR [15..0] = 4,096, Data range (WBR [7..0]): 0 to 255 Sets the Red gain on Bayer Video level = (Input video level - CLAMP [7..0]) * WBR [14..0] / 4,096 + CLAMP [7..0] WBR [15..0] = 4,096: x1 gain, WBR [15..0] = 8,192: x2 gain, WBR [15..0] = 12,288: x3 gain, WBR [15..0] = 16,384: x4 gain, WBR [15..0] = 20,480: x5 gain, WBR [15..0] = 24,576: x6 gain, WBR [15..0] = 28,672: x7 gain, WBR [15..0] = 32,768: x8 gain WBR [15..8]: EAH
3BH: WBB [7:0]	[White Balance B gain] Default data: WBB [15..0] = 4,096, Data range (WBB [7..0]): 0 to 255 Sets the Blue gain on Bayer Video level = (Input video level - CLAMP [7..0]) * WBB [14..0] / 4,096 + CLAMP [7..0] WBB [15..0] = 4,096: x1 gain, WBB [15..0] = 8,192: x2 gain, WBB [15..0] = 12,288: x3 gain, WBB [15..0] = 16,384: x4 gain, WBB [15..0] = 20,480: x5 gain, WBB [15..0] = 24,576: x6 gain, WBB [15..0] = 28,672: x7 gain, WBB [15..0] = 32,768: x8 gain WBB [15..8]: EBH
3CH: WBGR [7:0]	[White Balance GR gain] Default data: WBGR [15..0] = 4,096, Data range (WBGR [7..0]): 0 to 255 Sets the Green gain on Bayer GR line Video level = (Input video level - CLAMP [7..0]) * WBGR [14..0] / 4,096 + CLAMP [7..0] WBGR [15..0] = 4,096: x1 gain, WBGR [15..0] = 8,192: x2 gain, WBGR [15..0] = 12,288: x3 gain, WBGR [15..0] = 16,384: x4 gain, WBGR [15..0] = 20,480: x5 gain, WBGR [15..0] = 24,576: x6 gain, WBGR [15..0] = 28,672: x7 gain, WBGR [15..0] = 32,768: x8 gain WBGR [15..8]: ECH
3DH: WBGB [7:0]	[White Balance GB gain] Default data: WBGB [15..0] = 4,096, Data range (WBGB [7..0]): 0 to 255 Set the Green gain on Bayer GB line Video level = (Input video level - CLAMP [7..0]) * WBGB [15..0] / 4,096 + CLAMP [7..0] WBGB [15..0] = 4,096: x1 gain, WBGB [15..0] = 8,192: x2 gain, WBGB [15..0] = 12,288: x3 gain, WBGB [15..0] = 16,384: x4 gain, WBGB [15..0] = 20,480: x5 gain, WBGB [15..0] = 24,576: x6 gain, WBGB [15..0] = 28,672: x7 gain, WBGB [15..0] = 32,768: x8 gain WBGB [15..8]: EDH

<table>
<tr><th>Command No.</th><th>Command Description</th></tr>
<tr><td>4FH:
GAMMA_LEVEL
[3:0]</td><td>[Gamma Level Setting] Default data: GAMMA_LEVEL [3..0] = 15, Data range: 0 to 15
Sets the Gamma level setting for the gamma table function.
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>
<table>
<tr><td>D7</td><td>Lookup table
gamma correction</td><td>0: With Gamma correction between two points</td><td>1: Without Gamma correction between two points</td></tr>
<tr><td>D6 to D4</td><td>No Function</td><td colspan="2">Sets always as "000"</td></tr>
<tr><td>D3 to D0</td><td>Gamma level</td><td colspan="2">0 to 15</td></tr>
</table>
Please refer “Lookup table (Gamma)” for more details.</td></tr>
<tr><td>50H:
GSTEP0 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP0 [7..0] = 36H (Gamma = 0.45)</td></tr>
<tr><td>51H:
GSTEP1 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP1 [7..0] = 4AH (Gamma = 0.45)</td></tr>
<tr><td>52H:
GSTEP2 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP2 [7..0] = 58H (Gamma = 0.45)</td></tr>
<tr><td>53H:
GSTEP3 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP3 [7..0] = 64H (Gamma = 0.45)</td></tr>
<tr><td>54H:
GSTEP4 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP4 [7..0] = 6FH (Gamma = 0.45)</td></tr>
<tr><td>55H:
GSTEP5 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP5 [7..0] = 79H (Gamma = 0.45)</td></tr>
<tr><td>56H:
GSTEP6 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP6 [7..0] = 81H (Gamma = 0.45)</td></tr>
<tr><td>57H:
GSTEP7 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP7 [7..0] = 89H (Gamma = 0.45)</td></tr>
<tr><td>58H:
GSTEP8 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP8 [7..0] = 91H (Gamma = 0.45)</td></tr>
<tr><td>59H:
GSTEP9 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP9 [7..0] = 98H (Gamma = 0.45)</td></tr>
<tr><td>5AH:
GSTEP10 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP10 [7..0] = 9EH (Gamma = 0.45)</td></tr>
<tr><td>5BH:
GSTEP11 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP11 [7..0] = A5H (Gamma = 0.45)</td></tr>
<tr><td>5CH:
GSTEP12 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP12 [7..0] = ABH (Gamma = 0.45)</td></tr>
<tr><td>5DH:
GSTEP13 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP13 [7..0] = B0H (Gamma = 0.45)</td></tr>
<tr><td>5EH:
GSTEP14 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP14 [7..0] = B6H (Gamma = 0.45)</td></tr>
<tr><td>5FH:
GSTEP15 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP15 [7..0] = BBH (Gamma = 0.45)</td></tr>
<tr><td>60H:
GSTEP16 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP16 [7..0] = C1H (Gamma = 0.45)</td></tr>
<tr><td>61H:
GSTEP17 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP17 [7..0] = C6H (Gamma = 0.45)</td></tr>
</table>

<table>
<tr><th>Command No.</th><th>Command Description</th></tr>
<tr><td>62H:
GSTEP18 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP18 [7..0] = CAH (Gamma = 0.45)</td></tr>
<tr><td>63H:
GSTEP19 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP19 [7..0] = CFH (Gamma = 0.45)</td></tr>
<tr><td>64H:
GSTEP20 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP20 [7..0] = D4H (Gamma = 0.45)</td></tr>
<tr><td>65H:
GSTEP21 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP21 [7..0] = D8H (Gamma = 0.45)</td></tr>
<tr><td>66H:
GSTEP22 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP22 [7..0] = DDH (Gamma = 0.45)</td></tr>
<tr><td>67H:
GSTEP23 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP23 [7..0] = E1H (Gamma = 0.45)</td></tr>
<tr><td>68H:
GSTEP24 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP24 [7..0] = E5H (Gamma = 0.45)</td></tr>
<tr><td>69H:
GSTEP25 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP25 [7..0] = E9H (Gamma = 0.45)</td></tr>
<tr><td>6AH:
GSTEP26 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP26 [7..0] = EDH (Gamma = 0.45)</td></tr>
<tr><td>6BH:
GSTEP27 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP27 [7..0] = F1H (Gamma = 0.45)</td></tr>
<tr><td>6CH:
GSTEP28 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP28 [7..0] = F5H (Gamma = 0.45)</td></tr>
<tr><td>6DH:
GSTEP29 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP29 [7..0] = F9H (Gamma = 0.45)</td></tr>
<tr><td>6EH:
GSTEP30 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP30 [7..0] = FCH (Gamma = 0.45)</td></tr>
<tr><td>6FH:
GSTEP31 [7..0]</td><td>[Lookup table (Gamma)] Default data: GSTEP31 [7..0] = FFH (Gamma = 0.45)</td></tr>
<tr><td>76H: EXT_HB [7..0]
77H: EXT_HB [11..8]</td><td>[Horizontal cycle extend time] Default: EXT_HB [11:0] = 0. Data range: 0 to 4,095
Horizontal cycle extended time = EXT_HB * 13.468 (nseconds)
(13.468 nseconds = 1 / Pixel clock frequency)
Please refer “The image data transferring speed” for more details.</td></tr>
<tr><td>78H:
TESTP [7:0]</td><td>[Test Pattern] Default data: TESTP [7..0] = 00H
Sets the output test pattern.
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>
<table>
<tr><td>D7 to D3</td><td>No Function</td><td colspan="2">Always set as “00000”</td></tr>
<tr><td rowspan="3">D2 to D0</td><td rowspan="3">Test Pattern</td><td>0: Off (Video output)</td><td>1: Gray scale image</td></tr>
<tr><td>2: Lamp image</td><td>3: White image</td></tr>
<tr><td>4: Color bar image</td><td>Others: Black image</td></tr>
</table></td></tr>
<tr><td>80H:
E2P [7..0]</td><td>[EEPROM control] Default data: E2P[7:0] = 00H
Controls the data writing to the EEPROM.
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>
<table>
<tr><td>D7 to D1</td><td>No Function</td><td colspan="2">Always set as “0000000”</td></tr>
<tr><td>D0</td><td>Data writes to the EEPROM</td><td>0: Prohibited</td><td>1: Accept</td></tr>
</table>
Note: This bit is cleared to “0” automatically after the data writes into the EEPROM.</td></tr>
</table>

Command No.	Command Description
90H: VASA [7..0] 91H: VASA [15..8]	[Vertical ROI_A Start line] Default data: VASA [15..0] = 0, Data range: 0 to 2,996 Sets the start line (vertical) of the first ROI. The actual start line of the ROI = this value (VASA) + 1
92H: VASB [7..0] 93H: VASB [15..8]	[Vertical ROI_B Start line] Default data: VASB [15..0] = 0, Data range: 0 to 2,996 Sets the start line (vertical) of the second ROI. The actual start line of the ROI = this value (VASB) + 1
94H: VASC [7..0] 95H: VASC [15..8]	[Vertical ROI_C Start line] Default data: VASC [15..0] = 0, Data range: 0 to 2,996 Sets the start line (vertical) of the third ROI. The actual start line of the ROI = this value (VASC) + 1
96H: VASD [7..0] 97H: VASD [15..8]	[Vertical ROI_D Start line] Default data: VASD [15..0] = 0, Data range: 0 to 2,996 Sets the start line (vertical) of the fourth ROI. The actual start line of the ROI = this value (VASD) + 1
98H: VASE [7..0] 99H: VASE [15..8]	[Vertical ROI_E Start line] Default data: VASE [15..0] = 0, Data range: 0 to 2,996 Sets the start line (vertical) of the sixth ROI. The actual start line of the ROI = this value (VASE) + 1
9AH: VASF [7..0] 9BH: VASF [15..8]	[Vertical ROI_F Start line] Default data: VASF [15..0] = 0, Data range: 0 to 2,996 Sets the start line (vertical) of the sixth ROI. The actual start line of the ROI = this value (VASF) + 1
9CH: VASG [7..0] 9DH: VASG [15..8]	[Vertical ROI_G Start line] Default data: VASG [15..0] = 0, Data range: 0 to 2,996 Sets the start line (vertical) of the seventh ROI. The actual start line of the ROI = this value (VASG) + 1
9EH: VASH [7..0] 9FH: VASH [15..8]	[Vertical ROI_H Start line] Default data: VASH [15..0] = 0, Data range: 0 to 2,996 Sets the start line (vertical) of the eighth ROI. The actual start line of the ROI = this value (VASH) + 1
A0H: VAHA [7..0] A1H: VAHA [15..8]	[Vertical ROI_A Effective lines] Default data: VAHA [15..0] = 3,000, Data range: 4 to 3,000, Data adjustable unit: 4 lines Sets the effective lines (image height) of the first ROI.
A2H: VAHB [7..0] A3H: VAHB [15..8]	[Vertical ROI_B Effective lines] Default data: VAHB [15..0] = 0, Data range: 4 to 3,000, Data adjustable unit: 4 lines Sets the effective lines (image height) of the second ROI.
A4H: VAHC [7..0] A5H: VAHC [15..8]	[Vertical ROI_C Effective lines] Default data: VAHC [15..0] = 0, Data range: 4 to 3,000, Data adjustable unit: 4 lines Sets the effective lines (image height) of the third ROI.
A6H: VAHD [7..0] A7H: VAHD [15..8]	[Vertical ROI_D Effective lines] Default data: VAHD [15..0] = 0, Data range: 4 to 3,000, Data adjustable unit: 4 lines Sets the effective lines (image height) of the fourth ROI.

Command No.	Command Description
A8H: VAHE [7..0] A9H: VAHE [15..8]	[Vertical ROI_E Effective lines] Default data: VAHE [15..0] = 0, Data range: 4 to 3,000, Data adjustable unit: 4 lines Sets the effective lines (image height) of the fifth ROI.
AAH: VAHF [7..0] ABH: VAHF [15..8]	[Vertical ROI_F Effective lines] Default data: VAHF [15..0] = 0, Data range: 4 to 3,000, Data adjustable unit: 4 lines Sets the effective lines (image height) of the sixth ROI.
ACH: VAHG [7..0] ADH: VAHG [15..8]	[Vertical ROI_G Effective lines] Default data: VAHG [15..0] = 0, Data range: 4 to 3,000, Data adjustable unit: 4 lines Sets the effective lines (image height) of the seventh ROI.
AEH: VAHH [7..0] AFH: VAHH [15..8]	[Vertical ROI_H Effective lines] Default data: VAHH [15..0] = 0, Data range: 4 to 3,000, Data adjustable unit: 4 lines Sets the effective lines (image height) of the eighth ROI.
B0H: HASA [7..0] B1H: HASA [15..8]	[Horizontal ROI_A Start pixel] Default data: HASA [15..0] = 0, Data range: Color: 0 to 4,094, Monochrome: 0 to 4,095, Data adjustable unit: Color: 2 pixels, Monochrome: 1 pixel Sets the start pixel (horizontal) of the ROI. The actual start pixel of the ROI = this value (HASA) + 1
C0H: HAWA [7..0] C1H: HAWA [15..8]	[Horizontal ROI_A Effective pixels] Default data: HAWA [15..0] = 4,096, Data range: 2TAP: 2 to 4,096, 3TAP: 3 to 4,095, 4TAP: 4 to 4,096, 8TAP: 8 to 4,096, 10TAP: 10 to 4,090 Data adjustable unit: 2TAP: 2 pixels, 3TAP: 3 pixels, 4TAP: 4 pixels, 8TAP: 8 pixels, 10TAP: 10 pixels Sets the effective pixels (image width, DVAL, LVAL) of ROI.

<table>
<tr><th>Command No.</th><th>Command Description</th></tr>
<tr><td>D0H:
DEF_M[7..0]</td><td>[Pixel defect correction control] Default data: PDC0 [7..0] = 0
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>
<table>
<tr><td>D7</td><td>Set coordinate of
pixel defect position</td><td>0 to 1: Set the coordinate of the pixel defect position
Sets the correspond positions in D2H to D5H registers to the pixel defect coordinate number is assigned in D1H register.
(This bit is cleared to “0” automatically after sets the coordinate of the pixel defect position)</td></tr>
<tr><td>D6</td><td>Load coordinate of
pixel defect position</td><td>0 to 1: Read the coordinate of the pixel defect position
Reads the pixel defect coordinate number is assigned in D1H register corresponds position to D6H to D9H register.
(This bit is cleared to “0” automatically after reads the coordinate of the pixel defect position)</td></tr>
<tr><td>D5</td><td>Save coordinate of
defect pixel position
into the EEPROM</td><td>0 to 1: Save the coordinate of the pixel defect positions into the EEPROM
All 512 coordinate numbers of the pixel defect position information are saved into the EEPROM.
(This bit is cleared to “0” automatically after saves the coordinate of the pixel defect positions)</td></tr>
<tr><td>D4 to
D0</td><td>No Function</td><td>Sets always as "00000"</td></tr>
</table></td></tr>
<tr><td>D1H:
PDC1[7..0]</td><td>[Pixel defect correction coordinate number] Default data: PDC1 [7..0] = 0
Sets the coordinate number of the pixel defect correction.
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>
<table>
<tr><td>D7 to
D0</td><td>Pixel defect correction
coordinate number</td><td>0 to 255</td></tr>
</table></td></tr>
<tr><td>D2H:
PDC_WX [7..0]
D3H:
PDC_WX [15..8]</td><td>[Pixel defect X position (Set)] Default data: PDC_WX [15..0] = 0, Data range: 0 to 4,096
Sets the X (horizontal) coordinate position of the defect pixel for set the position.</td></tr>
<tr><td>D4H:
PDC_WY [7..0]
D5H:
PDC_WY [15..8]</td><td>[Pixel defect Y position (Set)] Default data: PDC_WY [15..0] = 0, Data range: 0 to 3,000
Sets the Y (vertical) coordinate position of the defect pixel for set the position.</td></tr>
<tr><td>D6H:
PDC_RX [7..0]
D7H:
PDC_RX [15..8]</td><td>[Pixel defect X position (Read)] Default data: PDC_RX [15..0] = 0
Sets the X (horizontal) coordinate position of the defect pixel for read the position.</td></tr>
<tr><td>D8H:
PDC_RY [7..0]
D9H:
PDC_RY [15..8]</td><td>[Pixel defect Y position (Read)] Default data: PDC_RY [15..0] = 0
Sets the Y (vertical) coordinate position of the defect pixel for read the position.</td></tr>
</table>

<table>
<tr><th>Command No.</th><th>Command Description</th></tr>
<tr><td>DEH:
DEF_M [7..0]</td><td>[Pixel defect correction mode] Default data: DEF_M [7..0] = 1
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>
<table>
<tr><td>D7 to D2</td><td>No Function</td><td colspan="2">Always set as “0000000”</td></tr>
<tr><td>D1</td><td>Highlight the corrected pixel</td><td>0: Disable</td><td>1: Enable</td></tr>
<tr><td>D0</td><td>Pixel defect correction</td><td>0: Disable</td><td>1: Enable</td></tr>
</table>
The corrected pixel is appeared with the highlight when “Highlight the corrected pixel” is enabled.</td></tr>
<tr><td>EAH:
WBR [15..8]</td><td>[White Balance R Gain] Default data: WBR [15..0] = 16, Data range (WBR [15..8]): 0 to 127
Sets the Red gain on Bayer
Video level = (Input video level - CLAMP [7..0]) * WBR [14..0] / 4,096 + CLAMP [7..0]
WBR [15..0] = 4,096: x1 gain, WBR [15..0] = 8,192: x2 gain, WBR [15..0] = 12,288: x3 gain,
WBR [15..0] = 16,384: x4 gain, WBR [15..0] = 20,480: x5 gain, WBR [15..0] = 24,576: x6 gain,
WBR [15..0] = 28,672: x7 gain, WBR [15..0] = 32,768: x8 gain
WBR [7:0]: 3AH</td></tr>
<tr><td>EBH:
WBB [15..8]</td><td>[White Balance B Gain] Default data: WBB [15..0] = 16, Data range (WBB [15..8]): 0 to 127
Sets the Blue gain on Bayer
Video level = (Input video level - CLAMP [7..0]) * WBB [14..0] / 4,096 + CLAMP [7..0]
WBB [15..0] = 4,096: x1 gain, WBB [15..0] = 8,192: x2 gain, WBB [15..0] = 12,288: x3 gain,
WBB [15..0] = 16,384: x4 gain, WBB [15..0] = 20,480: x5 gain, WBB [15..0] = 24,576: x6 gain,
WBB [15..0] = 28,672: x7 gain, WBB [15..0] = 32,768: x8 gain
WBB [7:0]: 3BH</td></tr>
<tr><td>ECH:
WBGR [15..8]</td><td>[White Balance GR Gain] Default data: WBGR [15..0] = 16, Data range (WBGR [15..8]): 0 to 127
Sets the Green gain on Bayer GR line
Video level = (Input video level - CLAMP [7..0]) * WBGR [7..0] / 4,096 + CLAMP [7..0]
WBGR [15..0] = 4,096: x1 gain, WBGR [15..0] = 8,192: x2 gain, WBGR [15..0] = 12,288: x3 gain,
WBGR [15..0] = 16,384: x4 gain, WBGR [15..0] = 20,480: x5 gain, WBGR [15..0] = 24,576: x6 gain,
WBGR [15..0] = 28,672: x7 gain, WBGR [15..0] = 32,768: x8 gain
WBGR [7:0]: 3CH</td></tr>
<tr><td>EDH:
WBGB [15..8]</td><td>[White Balance GB Gain] Default data: WBGB [15..0] = 16, Data range (WBGB [15..8]): 0 to 127
Sets the Green gain on Bayer GB line
Video level = (Input video level - CLAMP [7..0]) * WBGB [14..0] / 4,096 + CLAMP [7..0]
WBGB [15..0] = 4,096: x1 gain, WBGB [15..0] = 8,192: x2 gain, WBGB [15..0] = 12,288: x3 gain,
WBGB [15..0] = 16,384: x4 gain, WBGB [15..0] = 20,480: x5 gain, WBGB [15..0] = 24,576: x6 gain,
WBGB [15..0] = 28,672: x7 gain, WBGB [15..0] = 32,768: x8 gain
WBGB [7:0]: 3DH</td></tr>
<tr><td>EEH:
MOD6 [7..0]</td><td>[The camera function mode] Default data: MOD6 [7..0] = 2
Sets the camera TAP number for each setting.
<table>
<tr><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td></tr>
</table>
<table>
<tr><td rowspan="3">D7 to D2</td><td rowspan="3">TAP Configuration</td><td>1: 2TAP</td><td>2: 3TAP</td></tr>
<tr><td>3: 4TAP</td><td>4: 8TAP</td></tr>
<tr><td>9: 10TAP</td><td>Others: No Function</td></tr>
</table></td></tr>
</table>

1.1.1 The command sequence for the data saves to the EEPROM

Please follow the command sequence in below for the data saves to the EEPROM.

1) Sets “1” to command 80H.0 to accept “write control to the EEPROM”.

2) Sends the EEPROM write command with data, which sets “1” for the page selection.

3) The camera sends back one of the below receiving code after the EEPROM write command is proceed.
   01H: Data saves to the EEPROM correctly
   10H: EEPROM write error

4) Command 80H.0 is changed to “0” automatically after the EEPROM write command is proceed.

Note.1) The data does not save into the EEPROM when the command 80H.0 is “0”.

Note.2) The data of the multiple continuous commands can save to the EEPROM by one sets of above sequence (1) to 4)).
   e.g. Multiple continuous command: “10H, 11H, 12H and 13H” or “22H, 23H and 24H”.

Note.3) When save the data of the multiple commands, which is not continuous commands, to the EEPROM, it is necessary to operate the multiple sets of above sequence (1) to 4)).
   e.g. Multiple commands: “10H, 13H, 19H and 1BH” or “20H, 23H and 25H”.