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Mitsubishi Contact Image Sensor （CIS）

KD-CXL series for surface inspection

Function Specification

Mitsubishi Electric Corporation

April 25th, 2020

Specifications are subject to change without notice.

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1 Application

This document explains how to control Color version of Mitsubishi Electric Contact Image Sensor (CIS) KD-CX series of the following products.

KD6R1064CXL-NL (hereinafter refered to L4), KD6R1247CXL-NL (L5), KD6R1688CXL-NL (L6)

Light source is not included in these products.

This product is a line scan image sensor developed for an application of vision inspection for surface inspection such as web and printing and features following points.

- Comprises 600dpi tri-linear CMOS sensor with RGB color filters
- Non-contacting with the object you inspect, less-distortion on image, and high-speed line scanning. (Working distance between this product and the object is 27.3mm typ., Max 45.1KHz(L4) 47.6KHz(L5/L6)@600dpi for line frequency)
- CoaXPress® I/F (easy to replace from existing line scan cameras)
- Communication control is applied with a control standard, GenIcam®, and Camera Description File (XML format) is stored on this product.
- Standard image processing is initially installed such as White/Dark correction, γ correction, LED control (only for Built-in light source type), Line adjustment function etc.
- The original light source that can reduce the output variation due to the moving object.
- 5V power supply for sensor and signal processing operation.
- Highly rigid frame and factory-adjusted focus position can provide an easy setup-adjustment to scan based on a uniform resolution within entire scanning width.
- Easy to handle vibration and impacting due to the all in one package of sensor, lens, light source, and signal processing board.
- Temperature of built-in ICs and rotational state of built-in fan can be monitored.
- By powering up or external control, the factory settings of operation parameters on flush memory on this product are automatically set to operation control ICs on this product, and then you can start using this product immediately. The factory setting and 3 other user settings are available as operation parameters. Also, you can set a setting of parameters that is automatically selected when powering up.

2 Function overview

Operation setting of this product can be controlled over CoaXpress® I/F. Additionally, communication between this product and frame grabber is complied with GenICam®.

Operations and parameters that can be set and controlled over communication are listed below.

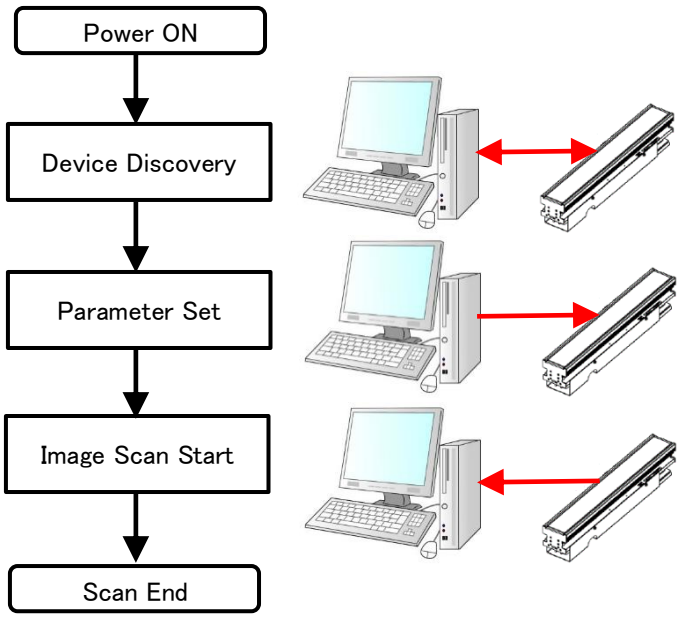
- Settings directly related operations of image acquisition of this product (to set and read registers for operations of this product)
- Set and read-out image processing or image correction data of this product (Dark Correction coefficient, White correction coefficient, γ correction table value)
- Data-transfer between registers to operate this product flash memory to store operation parameters.

2.1 Communication control

This product is controlled and communicated over CoaXPress®.

This product is complied with GenICam®. By exciting Device Dicovery process, Camera Description File (XML file: Camera description file) is automatically downloaded to a frame grabber or system side. (Refer to a manual of your frame grabber about how to process Device Discovery.)

Fig 2.1-1 Startup flow



After completing Device Discovery, a register setting software based on GenICamAPI of GenICam® standard or control software attached in your frame grabber package indicates register information.

This product can be controlled by changing register values on the software. (Refer to a manual of your frame grabber about how to indicate and change register information)

Notice)

Camera Description File is a file based on GenICam GenAPI standard. All of the information to associate each function of the cameras with each register to set parameters of the function is defined. By initiating the Device Dicovery process, GenAPI library reads out Camera Description File from cameras and acquires each function and register information. Camera Description File is defined to be written XML (Extensible Markup Language). Therefore, on GenAPI, Camera Description File is said to be XML file. Camera Description File is a file that GenAPI library uses and is not a file that users read and write. Therefore, this document doesn't explain details of Camera Description File.

【Notice】

① Following periods of time are necessary to make the product ready to use from power up to completion of boot.
L4type: about 10 seconds, L5 type: about 12 seconds, L6 type: about 16 seconds

② Before starting Device Discovery, this boot operation of this product has to be completed.

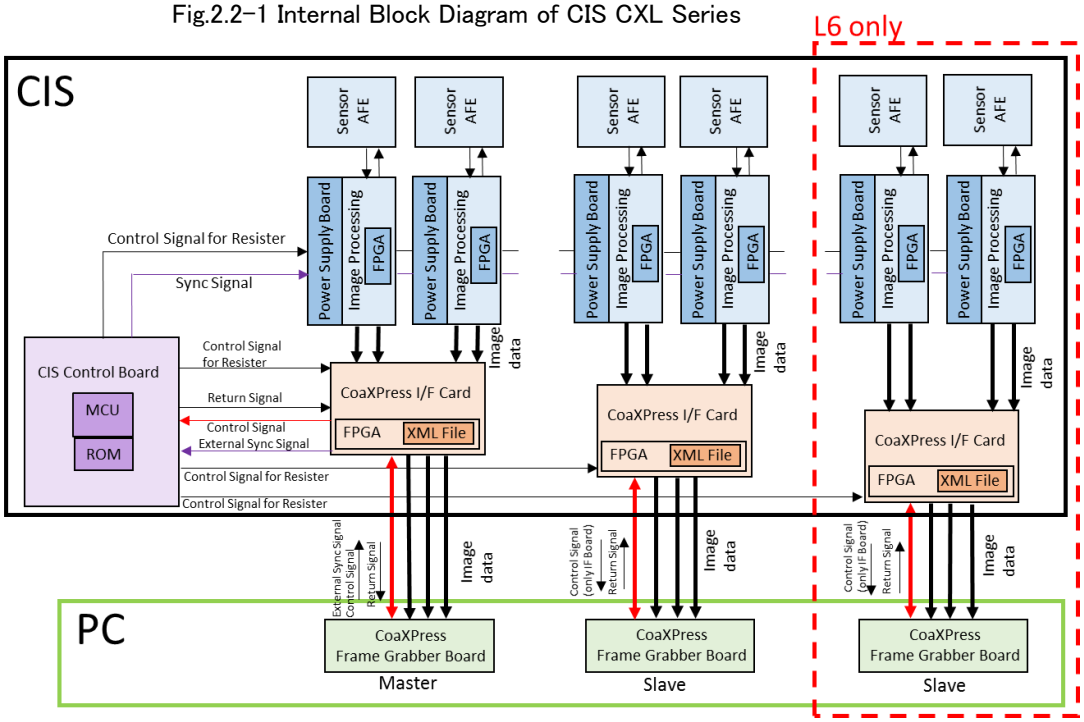
2.2 Product types and communication channels

The product lineup includes three different types of scanning width (L4: 1064mm size, L5: 1247mm, L6:1688mm size).

On L4 type and L5 type, there are 2 blocks of signal channel of CoaXPress®. First block (Connector D1 – D4) is master block. And, 2nd block (Connector D5 –D8) is slave block. On L6 type, there are 3 blocks of signal channel of of CoaXPress®. 2nd block (Connector D5– D8) is master block. And 1st (Connector D1 – D4) and 3rd (Connector D9 – D12) is slave blocks.

Main functions of this product need to be set over master block. However, there are some registers that need to be set over slave block. Refer to Table 2.2–1 regarding the details.

Fig.2.2–1 Internal Block Diagram of CIS CXL Series



(For L4/L5)

In case of using external sync mode, external sync signal needs to be provided to a master port (D1) of the first master block. These sync signals enable this product to opearate and synchronize entierly. (In case of using internal sync mode, any sync signals are not necessary.)

As the register table below indicates, Slave block (Connector D5 – D8) is mainly used to change according to any changes of settings at master block, which relate to CoaXPress® I/F control. (The register information to use on slave block is stored on this product as a XML file for slave block.

(For L6)

In case of using external sync mode, external sync signal needs to be provided to a master port (D5) of the first master block. These sync signals enable this product to opearate and synchronize entierly. (In case of using internal sync mode, any sync signals are not necessary.)

As the register table below indicates, Slave block (Connector D1 – D4 and D9 – D12) is mainly used to change according to any changes of settings at master block, which relate to CoaXPress® I/F control. (The register information to use on slave block is stored on this product as a XML file for slave block.

Operation controls over CoaXPress® on this product are categolized by register address domain.Detail is shown in Table 2.2–1 in next page.

Table 2.2-1　Register contents

Address		Function	Master block	Slave block	Note
Upper 16bit	Lower 16bit				
0000h	0000h～6FFFh	CIS control register area 1 (CoaXpress™ I／F control)	●	●	defined on XML file
	7000h～8FFFh	CIS control register area 2 (Main function control of this product)	●	–	defined on XML file
1###h	0000h～FFFFh	Read and write Dark/White Correction Coefficient,γ table	●	–	defined on XML file

When you control registers in CIS control register area 1, changing settings of both master and slave blocks is required. Refer Register list table below for more details.

Table 2.2-2　Register list

Register setting table

●：Registers that the same values at master and slave blocks need to be set

○：Registers that respective values at each master and slave blocks need to be set

△：Registers only for read-out

—：Registers without any functions

Address lowre16bit	Register name	R/W	Master block	Slave block	Remark
4014h	LinkConfig	R/W	●	●	
6004h	Height	R	△	△	Fixed to be 1
6008h	Width	R/W	○	○	Need respective values
600Ch	OffsetX	R/W	●	●	Fixed to be 0
6010h	PixelFormat	R/W	●	●	
6014h	AcquisitionStart	R/W	●	●	
6018h	AcquisitionStop	R/W	●	●	
601Ch	AcquisitionMode	R	△	△	Fixed to be Continuous
6020h	TestImageSelector	R/W	●	●	
6024h	TestLineRate	R/W	●	●	
6028h	TriggerMode	R/W	●	●	
7000h	LinePeriodCounter	R/W	●	—	
7010h	LedSelector	R/W	●	—	
7014h	LedPulseDivision	R/W	●	—	
7018h	LedPulseWidthA	R/W	●	—	
701Ch	LedPulseWidthB	R/W	●	—	
7020h	LedEffectivePeriod	R/W	●	—	
7030h	ShutterEnable	R/W	●	—	
7034h	ShutterEnd	R/W	●	—	
7038h	ShutterWidth_R	R/W	●	—	
703Ch	ShutterWidth_G	R/W	●	—	
7040h	ShutterWidth_B	R/W	●	—	
7050h	DarkCorrectionEnable	R/W	●	—	

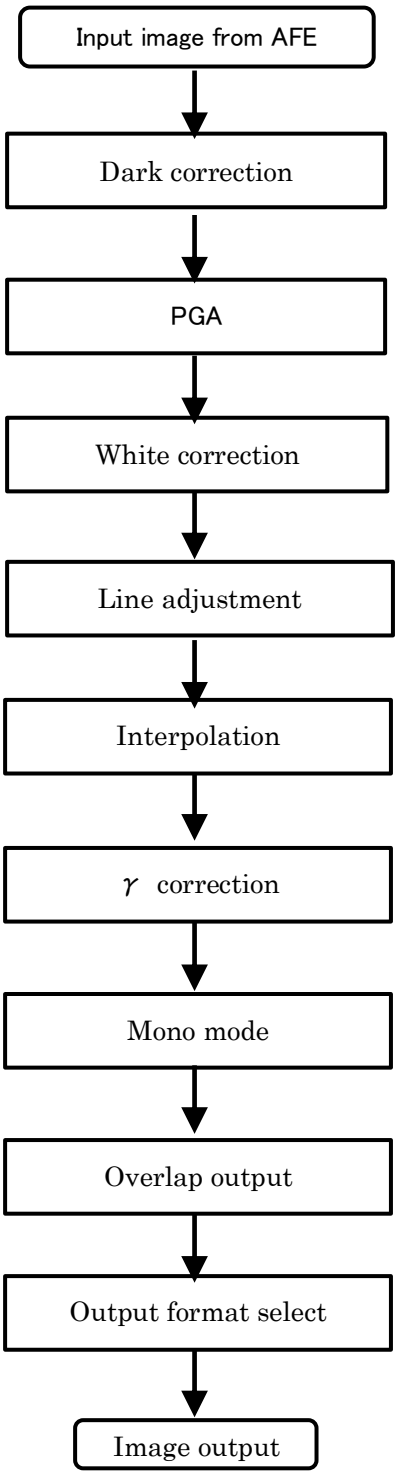
Address lowre16bit	Register name	R/W	Master block	Slave block	Remark
7054h	DarkCorrectionExecute	R/W	●	—	
7070h	WhiteCorrectionEnable	R/W	●	—	
7074h	WhiteTarget_R	R/W	●	—	
7078h	WhiteTarget_G	R/W	●	—	
707Ch	WhiteTarget_B	R/W	●	—	
7080h	WhiteCorrectionExecute	R/W	●	—	
7084h	WhiteCorrectionExtraTriger	R/W	●	—	
70A0h	DegitalGainEnable	R/W	●	—	
70A4h	DegitalGain_R	R/W	●	—	
70A8h	DegitalGain_G	R/W	●	—	
70ACh	DegitalGain_B	R/W	●	—	
70B0h	ResolutionSetting	R/W	●	—	
70C0h	LineAdjustment Enable	R/W	●	—	
70C4h	LineAdjustmentDirection	R/W	●	—	
70C8h	LineAdjustmentRatio	R/W	●	—	
70CCh	LineAdjustmentOfset	R/W	●	—	
70E0h	GammaCorrectionEnable	R/W	●	—	
70E4h	GammaThreshhold1_R	R/W	●	—	
70E8h	GammaThreshhold2_R	R/W	●	—	
70ECh	GammaThreshhold3_R	R/W	●	—	
70F0h	GammaThreshhold1_G	R/W	●	—	
70F4h	GammaThreshhold2_G	R/W	●	—	
70F8h	GammaThreshhold3_G	R/W	●	—	
70FCh	GammaThreshhold1_B	R/W	●	—	
7100h	GammaThreshhold2_B	R/W	●	—	
7104h	GammaThreshhold3_B	R/W	●	—	
7110h	MonoModeSelect	R/W	●	—	
7120h	OverlapEnable	R/W	●	—	
7200h	UserSet_1_Save	R/W	●	—	
7204h	UserSet_2_Save	R/W	●	—	
7208h	UserSet_3_Save	R/W	●	—	
720Ch	UserSet_1_Load	R/W	●	—	
7210h	UserSet_2_Load	R/W	●	—	
7214h	UserSet_3_Load	R/W	●	—	
7218h	UserSet_Load_FactoryDefalut	R/W	●	—	
7224h	DeviceTemperature Mainboard	R	△	—	
7228h	DeviceTemperature Ifboard	R	△	—	
7230h	DeviceError	R	△	—	
7240h	UserSet_BootSet_select	R/W	●	—	
7248h	UserSet_Use_600dpi	R/W	●	—	
724Ch	UserSet_Use_300dpi	R/W	●	—	
7250h	UserSet_Use_200dpi	R/W	●	—	

Address lowre16bit	Register name	R/W	Master block	Slave block	Remark
7254h	UserSet_Use_150dpi	R/W	●	—	
7300h	DevicePassward	R/W	●	—	
7400h	STSP_Enable	R/W	●	—	
7404h	STSP_MaxLine Period Counter	R/W	●	—	
7408h	STSP_Prohibited Time Counter	R/W	●	—	
2020h	DeviceModelName	R	△	—	
2090h	DeviceFirmwareVersion	R	△	—	
20B0h	DeviceID	R	△	—	

2.3 Image processing function

Flow of Image processing of FPGA on image processing board is explained below.

Fig 2.3-1 Image processing flow



Refer to 「3.7 Dark correction」.

Refer to「3.9 PGA」.

Refer to「3.8 White correction」.

Refer to 「3.10 Dark correction」

Refer to 「3.4 Switching Resolution」

Refer to 「3.11 γ correction」.

Refer to 「3.12 Mono mode」 and 「3.3 Output format select」

Refer to 「3.14 Overlap output」

Refer to 「3.3 Output format select」

[Notice]

・ When operating Dark/White correction, input external sync signal continuously, or conduct with internal sync mode.

・ Generate Dark/White correction datat at every scan.

3 Function

This chapter explains operation settings of this product by register setting.

3.1 Output mode setting

【Overview】

This is a function to set output bit rate of CoaXpress® and number of output channel.

Output bit rate of CoaXpress® can be set among CXP6(6.25Gbps), CXP(5Gbps)5, and CXP3(3.125Gbps) and the number of output channel can be set 1 ch, 2ch, and 4ch in each bit rate.

【Register list】

Address Lower16bit	Register name	R/W	Value		Function	Factory setting
4014h	LinkConfig	R/W	CXP6-X4 CXP5-X4 CXP3-X4 CXP6-X2 CXP5-X2 CXP3-X2 CXP6-X1 CXP5-X1 CXP3-X1	40048h 40040h 40038h 20048h 20040h 20038h 10048h 10040h 10038h	Set bit-rate of output data and number of output channel ・6.25Gbps 4ch/block ・5Gbps 4ch/block ・3.125Gbps 4ch/block ・6.25Gbps 2ch/block ・5Gbps 2ch/block ・3.125Gbps 2ch/block ・6.25Gbps 1ch/block ・5Gbps 1ch/block ・3.125Gbps 1ch/block	40048h

【Function】

Switch image output format, and select number of output channels.

- Register Address and name

  4014h/LinkConfig

- Factory setting

  LinkConfig ＝ CXP6-X4(0x40048:6.25Gbps 4ch/block)

- Explanation

  Chaging this register enables to switch the following settings

  CXP6-X4(0x40048:6.25Gbps 4ch/block)
  CXP5-X4(0x40040:5Gbps 4ch/block)
  CXP3-X4(0x40038:3.125Gbps 4ch/block)
  CXP6-X2(0x20048:6.25Gbps 2ch/block)
  CXP5-X2(0x20040:5Gbps 2ch/block)
  CXP3-X2(0x20038:3.125Gbps 2ch/block)
  CXP6-X1(0x10048:6.25Gbps 1ch/block)
  CXP5-X1(0x10040:5Gbps 1ch/block)
  CXP3-X1(0x10038:3.125Gbps 1ch/block)

【Notice】

① Output mode is complied with CoaXPress® standard and means as follows.

Bit rate CXP6: 6.25, CXP: 5, CXP3 3.125 [Gbps/ch]

Number of link channel X1: Single(1ch), X2: Dual(2ch), X4:Quad(4ch)

② After power up, LinkConfig setting is always to be CXP6_X4.

③ Maximum line rate changes according to output mode. Set operable line rate according to the following table.

Table 3.1-1 max line rate of each output mode

Output bit rate	Number of output channel	Resolution	Max. Line Frequency [KHz]							
			L4				L5,L6			
			30bit Color	24bit Color	10bit Mono	8bit Mono	30bit Color	24bit Color	10bit Mono	8bit Mono
CXP6	X4	600dpi	45.1	55.0	55.0	55.0	37.6	47.0	55.0	55.0
		300dpi	90.5	96.2	96.2	96.2	75.4	94.3	96.2	96.2
		200dpi	130.6	130.6	130.6	130.6	113.2	130.6	130.6	130.6
		150dpi	159.1	159.1	159.1	159.1	150.9	159.1	159.1	159.1
	X2	600dpi	22.6	28.2	55.0	55.0	18.8	23.5	55.0	55.0
		300dpi	45.3	56.6	96.2	96.2	37.7	47.2	96.2	96.2
		200dpi	67.9	84.9	130.6	130.6	56.6	70.7	130.6	130.6
		150dpi	90.5	113.2	159.1	159.1	75.4	94.3	159.1	159.1
	X1	600dpi	11.3	14.1	33.8	42.3	9.4	11.7	28.2	35.2
		300dpi	22.6	28.3	67.9	84.9	18.9	23.6	56.6	70.7
		200dpi	34.0	42.4	101.9	127.3	28.3	35.4	84.9	106.1
		150dpi	45.3	56.6	135.8	159.1	37.7	47.2	113.2	141.5
CXP5	X4	600dpi	36.1	45.1	55.0	55.0	30.1	37.6	55.0	55.0
		300dpi	72.4	90.5	96.2	96.2	60.4	75.4	96.2	96.2
		200dpi	108.6	130.6	130.6	130.6	90.5	113.2	130.6	130.6
		150dpi	144.9	159.1	159.1	159.1	120.7	150.9	159.1	159.1
	X2	600dpi	18.0	22.6	54.1	55.0	15.0	18.8	45.1	55.0
		300dpi	36.2	45.3	96.2	96.2	30.2	37.7	90.5	96.2
		200dpi	54.3	67.9	130.6	130.6	45.3	56.6	130.6	130.6
		150dpi	72.4	90.5	159.1	159.1	60.4	75.4	159.1	159.1
	X1	600dpi	9.0	11.3	27.1	33.8	7.5	9.4	22.6	28.2
		300dpi	18.1	22.6	54.3	67.9	15.1	18.9	45.3	56.6
		200dpi	27.2	34.0	81.5	101.9	22.6	28.3	67.9	84.9
		150dpi	36.2	45.3	108.6	135.8	30.2	37.7	90.5	113.2
CXP3	X4	600dpi	22.6	28.2	55.0	55.0	18.8	23.5	55.0	55.0
		300dpi	45.3	56.6	96.2	96.2	37.7	47.2	96.2	96.2
		200dpi	67.9	84.9	130.6	130.6	56.6	70.7	130.6	130.6
		150dpi	90.5	113.2	159.1	159.1	75.4	94.3	159.1	159.1
	X2	600dpi	11.3	14.1	33.8	42.3	9.4	11.7	28.2	35.2
		300dpi	22.6	28.3	67.9	84.9	18.9	23.6	56.6	70.7
		200dpi	34.0	42.4	101.9	127.3	28.3	35.4	84.9	106.1
		150dpi	45.3	56.6	135.8	159.1	37.7	47.2	113.2	141.5
	X1	600dpi	5.6	7.0	16.9	21.1	4.7	5.9	14.1	17.6
		300dpi	11.3	14.1	34.0	42.4	9.4	11.8	28.3	35.4
		200dpi	17.0	21.2	50.9	63.7	14.1	17.7	42.4	53.0
		150dpi	22.6	28.3	67.9	84.9	18.9	23.6	56.6	70.7

④ Make sure a capability or specification of your frame grabber board.

⑤ When changing PixelFormat and LinkConfig, change all settings of CoaXPress® signal block including slave block.

3.2 Initial setting slect

【Overview】

This function is to bidirectionally read out and save at operation setting strage memory (flash memory) defining the operation of this product and at registers set on ICs of this product during actual image acquisition operation period.

The operation setting strage memory includes a factory setting area and three other user setting area (total 4 areas), you can read and save at three user setting area. Also, values of factory setting area is protected from overwriting. In factory setting area, only reading settings on ICs of this product is available.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
7200h	UserSet_1_Save	R/W	(Execute)	1	Save CISsettings to User Setting 1 on Flush Memory	–
7204h	UserSet_2_Save	R/W	(Execute)	1	Save CISsettings to User Setting 2 on Flush Memory	–
7208h	UserSet_3_Save	R/W	(Execute)	1	Save CISsettings to User Setting 3 on Flush Memory	–
720Ch	UserSet_1_Load	R/W	(Execute)	1	Readout CIS settings on User Setting 1.	–
7210h	UserSet_2_Load	R/W	(Execute)	1	Readout CIS settings on User Setting 2.	–
7214h	UserSet_3_Load	R/W	(Execute)	1	Readout CIS settings on User Setting 3.	–
7218h	UserSet_Load_FactoryDefalut	R/W	(Execute)	1	Readout CIS settings on Factory Setting (Initial Setting)	–
7240h	UserSet_BootSet_select	R/W	FactoryDefalut UserSet_1 UserSet_2 UserSet_3	0 1 2 3	Select a setting to boot afterpower-ON. 0:FactorySetting, 1:User Setting 1, 2:User Setting 2, 3:User setting 3	0
7244h	UserSet_Boot_Error	R	0 to 7		Error flag of booting CIS ‘0’ or ‘1’ at bit0 :normal operation, ‘1’ at bit1: Error of User setting value, ‘1’ at bit2: Error of FPGA starting.	0
7248h	UserSet_Use_600dpi	R/W	(Execute)	0 1	Correction data for 600dpi resolution 0: Disable 1: Enable	1
724Ch	UserSet_Use_300dpi	R/W	(Execute)	0 1	Correction data for 300dpi resolution 0: Disable 1: Enable	0
7250h	UserSet_Use_200dpi	R/W	(Execute)	0 1	Correction data for 200dpi resolution 0: Disable 1: Enable	0
7254h	UserSet_Use_150dpi	R/W	(Execute)	0 1	Correction data for 150dpi resolution 0: Disable 1: Enable	0

【Function】

1） Select Boot data when powering up.

This function sets registers which will be set for operation after power on.

- Register address and register nam

  7240h/UserSet_BootSet_Select

- Factory setting

  UserSet_BootSet_Select ＝ FactoryDefalut (0:factory setting)

- Explanation

  When powering on after this register is set, the setting designated among factory setting and user setting 1 –3 is automatically transferred to operation registers and this product can be operated based on the setting among four settings stored on operation setting strage memory.

2） Save setting data

Operating or running register settings of ICs on this product can be saved or stored at an area set by this register on the operation setting strage memory (flash memory)

- Register address and register name

  7200h/ UserSet_1_save, 7204h/ UserSet_2_save, 7208h/ UserSet_3_save

- Factory setting value

  Not available

- Explanation

  All of setting information including any changes which you directly accessed with operation register on this product (setting parameter, white reference coefficient, dark correction coefficient, γ correction coefficient) can be saved or copied at an area designated among user setting 1–3 of storage memory areas. In order to start to use the saved setting data right after powering up, set the user region saved at UserSet_BootSet_Select.

  - UserSet_1_save : Operation register value → Save at user setting 1
  - UserSet_2_save : Operation register value → Save at user setting 2
  - UserSet_3_save : Operation register value → Save at user setting 3

  This operation register information of this product is to be erased. However, the setting stored at the operation setting storage memory will not be eliminated even if this product is powered off.

【Notice】

① Any communication settings of CoaXPress® cannot be stored.

Values at the following register is a fixed value after powering up.

Register name	Initial value
LinkConfig	CXP6_4

After Divice discovery, change the register values to the setting you would like to use.
The setting values of the slave blocks need to be set the same value of master block.

3） Save setting of each resolution (For products with DeviceFirmwareVersion 2. *. *. *)

This product has the data regions of dark correction coefficient, the white correction coefficient and γ correction coefficient according to each resolution.

As for the Save / Load to strage memory (flash memory) of the CIS, only a correction coefficient of resolution setting becomes a target if "User use it" in this command.

At the time of configured data save, this setting is necessary to shorten the save / load time of the correction value (white reference coefficient, dark correction coefficient, γ correction coefficient).

- Register address and register name

  7248h / UserSet_Use_600dpi、 724Ch / UserSet_Use_300dpi、
  7250h / UserSet_Use_200dpi、 7254h / UserSet_Use_150dpi

- Factory setting value

  UserSet_Use_600dpi = 1 (Eable)、 UserSet_Use_300dpi = 0 (Disable)、
  UserSet_Use_200dpi = 0 (Disable)、 UserSet_Use_150dpi = 0 (Disable)

- Explanation

  According to 2), a data on the strage memory (flash memory) of the CIS can be saved / loaded to a current CIS setting state by excuting UserSet_#_Save / UserSet_#_Load. And, the correction data for 600dpi is stored in initial setting. Excute UserSet_#_Save / UserSet_#_Load after changing to "using" (ParameterData=1) setting of the resolution to transmit this command to save the correction coefficient when user changed resolution.

  This product has data regions of dark correction coefficient and white correction coefficient for each resolution (four kinds of 600 – 150dpi) in each user setting 1-3. **In case of setting "Using" (ParameterData=1) of an operation register value, the CIS Boot processes slowly. Therefore, set a resolution setting that you don't use to be "Not using" (ParameterData=0).**

  - UserSet_Use_600dpi : Operation register value
    = Select "Using" or "Not using" of a correction value of 600dpi
  - UserSet_Use_300dpi : Operation register value
    = Select "Using" or "Not using" of a correction value of 300dpi
  - UserSet_Use_200dpi : Operation register value
    = Select "Using" or "Not using" of a correction value of 200dpi
  - UserSet_Use_150dpi : Operation register value
    = Select "Using" or "Not using" of a correction value of 150dpi

  This operation register information of this product is to be erased. However, the setting stored at the operation setting storage memory will not be eliminated even if this product is powered off.

4) Read setting data

Register setting values stored at the user setting 1–3 on the operation setting strage memory (flash memory) can be read and copied to the operation registers of ICs on this product.

- Register address and register name

  720Ch/ UserSet_1_Load, 7210h/ UserSet_2_Load, 7214h/ UserSet_3_Load

- Factory setting value

  Not available

- Explanation

  All setting information of this product saved on the user setting 1–3 (setting parameter, white correction coefficient, dark correction coefficient, and γ correction coefficient) can be copied as a current setting values.

  - UserSet_1_Load : Read user setting 1 → Operation register values
  - UserSet_2_Load : Read user setting 2 → Operation register values
  - UserSet_3_Load : Read user setting 3 → Operation register values

5) Reset to factory seting

Factory setting values on the operation setting storage memory (flash memory) can be copied to the operation registers of ICs on this product.

- Register address and register name

  7218h/ UserSet_Load_FactoryDefault

- Factory setting value

  Not available

- Explanation

  A default operation setting adjusted in out-going inspection at factory can be copied to the operation registers. This register control enables this product be reset back to the initial factory setting.

  - UserSet_Load_FactoryDefault : Factory setting values → Operation registers

【Notice】

① Any controls to save/read setting data of this product and to reset to factory setting have to be done after stopping image output.

② The controls to save/read setting data of this product and reset to factory setting take following time. L1 type : about 4 sec, L2 type : about 6 sec, L3 type : about 9 sec

③ After reading setting data of this product and resetting back to factory seting, the renewed data of this product need to be distributed control software side. Process device discovery again, and the renewed setting value will be distributed to the control software side.

④ (For products with DeviceFirmwareVersion 1. 4. *. *)
If the product automatically detects that user settings data is corrupted, the factory settings will be booted instead of the user settings when the power is turned on.

3.3 Output mode setting

【Overview】

This function is to select color/mono of image data and to switch bit length of data and enables to switch data length 8bit or 10bi of color and mono image.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
6010h	PixelFormat	R/W	RGB8 RGB10 Mono8 Mono10	0401h 0402h 0101h 0102h	Switch image output format 0x0401:24bit RGB color 0x0402:30bit RGB color 0x0101:8bit mono, 0x0102:10bit mono	0401h

【Function】

This function can set mono or color of output image data and data bit length.

- Register address and register name

  6010h/PixelFormat

- Factory setting value

  PixelFormat ＝ RGB8(0x0401:24bit RGB color)

- Explanation

  By setting this register, you can switch scanning image output of this product as follows.

  24bitRGB color / 30bitRGB color /8bit mono /10bit mono

【Notice】

① Maximum line rage depends on output mode you select. Refer to table 3.1-1 for your line rate setting.
② Confirm a specification of frame grabber you use.
③ When changing PixelFormat and LinkConfig, set the same changes to the all CoaXpress® signal blocks including the slave block.
④ When powering up, the initial setting of LinkConfig is always CXP6_X4.

3.4 Switching resolution

【Overview】

This function can change optical resolution based on binning function of CMOS sensor IC on this product and to switch on/off interpolation.

【Register list】

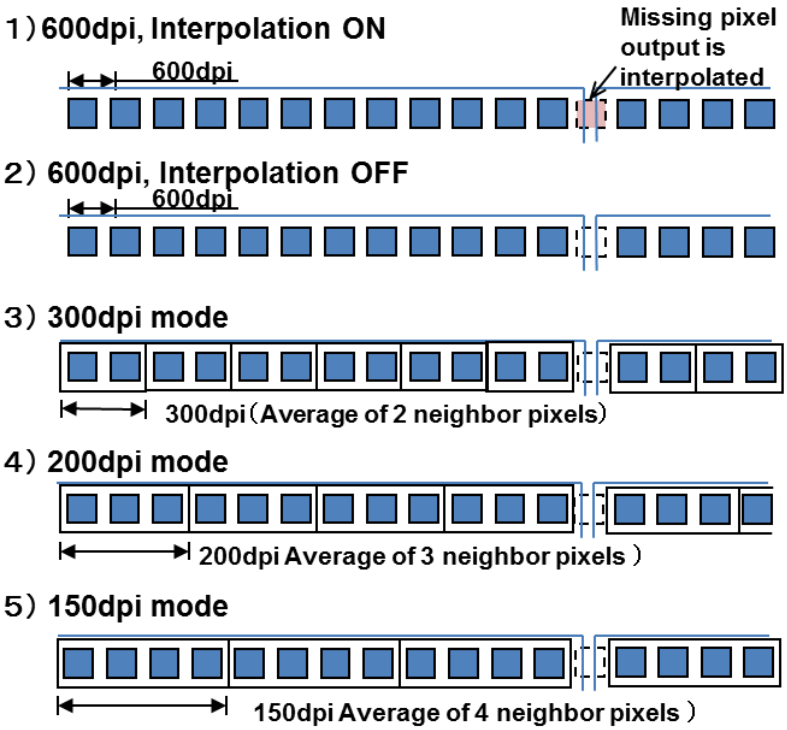
Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
70B0h	ResolutionSetting	R/W	R600dpi_with_Interpolation	0	Resolution, Interpolation On/Off setting 0:600dpi, Interpolation ON	1
			R600dpi	1	1:600dpi, Interpolation OFF	
			R300dpi	2	2:300dpi mode	
			R200dpi	3	3:200dpi mode	
			R150dpi	4	4:150dpi mode ※Interpolation based on 300, 200, and150dpi modes are not suppored.	

【Function】

The resolution is changed by averaging neighboring pixels of analog syginal from photo diodes array assembled based on 600 dpi.

Interpolation is available only based on 600 dpi resolution. When using lower resolution, the only switching resolution function is available.

Fig 3.4-1 Output resolution and pixel layout



- Register address and register name

  70B0h/ResolutionSetting

- Factory setting value

  ResolutionSetting ＝R600dpi（1： Optical resolution 600dpi Interpolation＝OFF）

- Explanation

  By setting this register, you can switch the following settings.

R600dpi_with_Interpolation	（0： Optical resolution 600dpi Interpolation＝ON ）
R600dpi	（1： Optical resolution 600dpi Interpolation＝OFF）
R300dpi	（2： Optical resolution 300dpi Interpolation＝OFF）
R200dpi	（3： Optical resolution 200dpi Interpolation＝OFF）
R150dpi	（4： Optical resolution 150dpi Interpolation＝OFF）

【Notice】

① Maximum scanning line rate depends on output resolution. Refer to table 3.1-1 for more details and make sure any applicability of the setting you choose to your image acquisition systems.

② When setting lower scanning resolution, change your relative transportation speed of your object according to the change of the resolution.

③ Interpolation is to judge image information of neighboring pixels, to estimate pixel information, and then to add the estimated pixel information. Therefore, the interpolated pixel data is not actually scanned data. When using this function, evaluate this function by using an actual object you scan, and decide if you can use this function for your application.

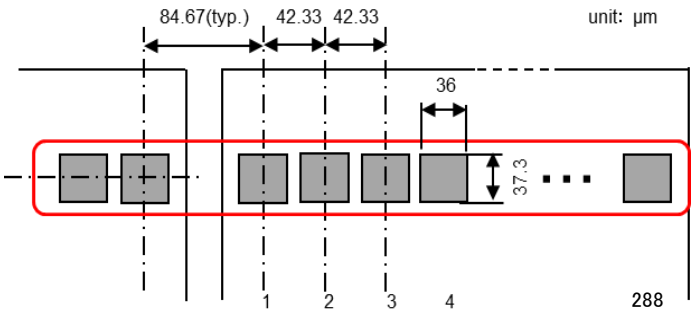
④ Interpolation between I/F boards is also processed in this series. In this case, the interpolated pixl data is to be adde at the last pixel of the block which is closed to first pixel.

⑤ Refer to the following explanation for more details of interpolation function.

【Remark】 Interpolation function

This function is to interpolate for a missing pixel between sensor ICs.

Fig 3.4-2 Pixel alignment of Sensor ICs



The multiple sensor ICs are assembled in a line that becomes a line sensor.

On this product,

L4(1064mm size): 87 pieces,

L5(1247mm size): 102 pieces,

L6(1688mm size): 168 pieces of

288 pixels × 3 colors (refer to the drawing on the left) of sensor ICs are assembled. Because the marginal area of IC chip has to be kept in order to keep performing and dicing area, assembling the ICs in 42 μm pitch is impossible

Therefore, missing one pixel between sensor ICs is designated and the sensor ICs are assembled with 300 dpi pitch. (The variation of mounting is designated less than 1/3 pixel (about 15 μm). Missing one pixel based on the variation of the assembly pitch is called missing pixel. This is an interpolation function that can generate the missing pixel by using the neighboring pixel information.

Based on this accuracy of the assembly and on the following algorithm, the image information of the missing pixel is generated.

① Because the appropriate interpolation calculation depends on images, there are multiple calculation

circuits and simultaneously interpolation pixel is estimated. It generates simultaneously multiple interpolated pixels based on multiple calculation circuits that have different performance.

② The multiple interpolated data generated by the neighboring pixel data in the control circuit are evaluated as image.

③ The interpolated pixel that can be estimated as the data which has the minimum interpolation error is automatically selected from the multiple interpolated pixel data.

④ The interpolated pixel is inserted in the scanned data and then it outputs.

Fig 3.4-3 Interpolation circuit block diagram

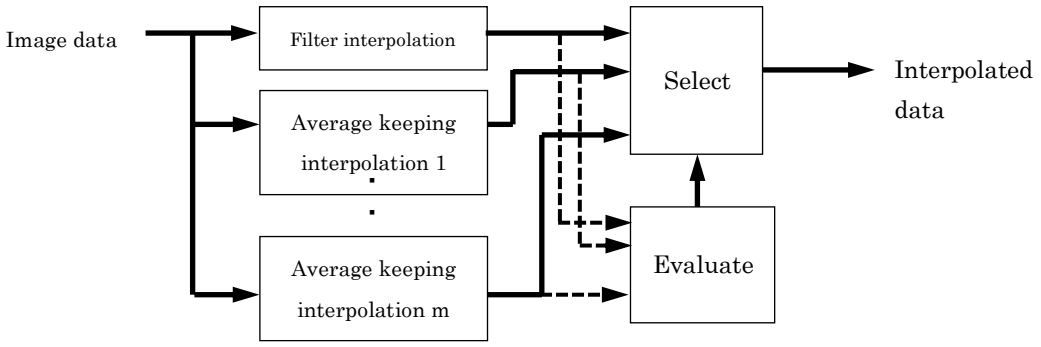
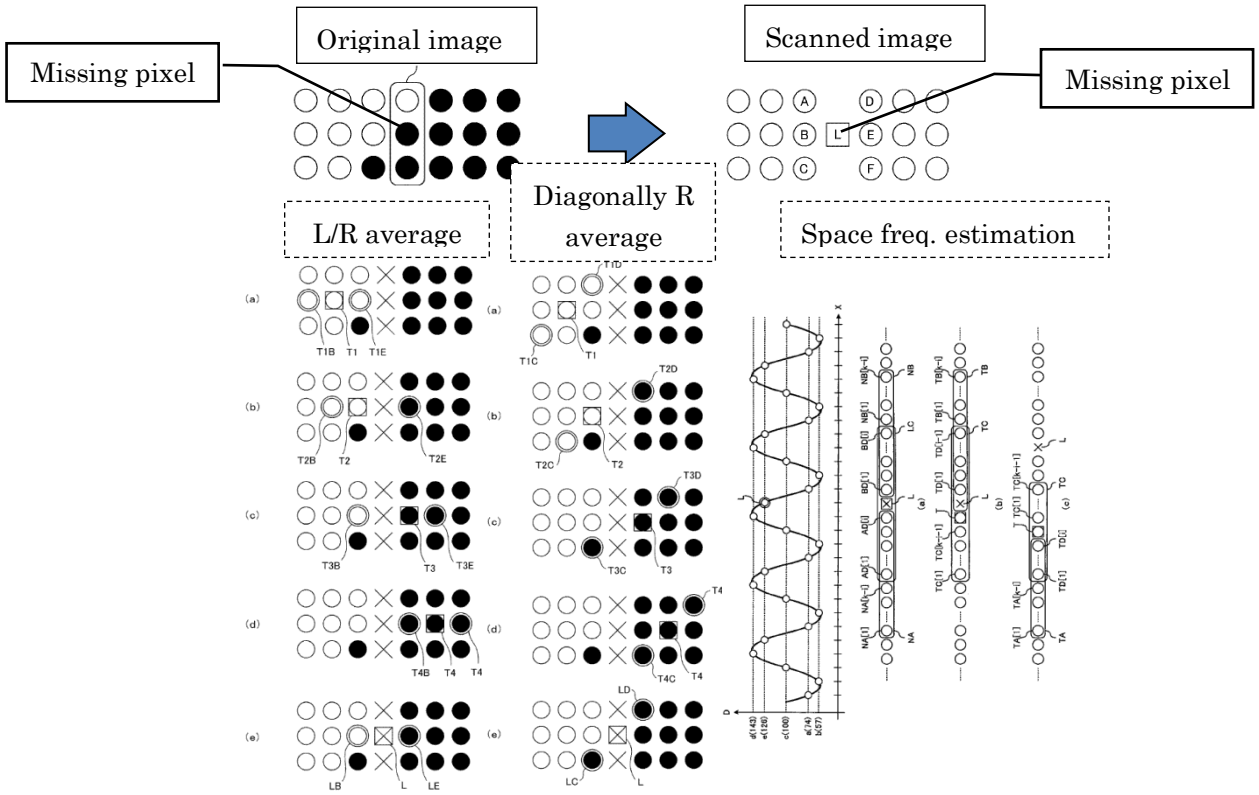


Fig 3.4-4 Interpolation algorithm



These technologies are patented based on the followings.

Japanese Related Patent No.

- Patent number 3767593
- Patent number 3810404
- Patent number 4199784
- Patent number 4772754

3.5 Sync signal setting

【Overview】

This function is to set an input source of sync signal to make this product operate. This product has external sync mode which this product is operated by sync signals provided over CoaXpress ® interface from your frame grabber and internal sync mode which this product is operated by the other sync signals generated automatically by timer function of this product.

Internal sync mode covers from 1.8 msec/line (about 530 Hz) to maximum line rate (line frequency) defined on this product.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
6028h	TriggerMode	R/W	Off On	0 1	Set Sync Signal inputsource 0: Internal Sync mode 1: External Sync mode	0
7000h	LinePeriodCounter	R/W	–	0 to 65535	Set Line Frequency (Internal Sync mode)	1749

【Function】

1） Sync mode setting

This is a function to set an input source of sync signal (trigger signal) to start scanning operation of this product.

In case of internal sync mode TriggerMode=0, this product starts scanning automatically and continuously based on the line cycle set by LinePeriodCounter.

In case of external sync mode TriggerMode=1, this product starts scanning operation by synchronizing with sync signals provided over CoaXpress® interface from syste (frame grabber).

- Register address and register name

  6028h/TriggerMode

- Factory setting values

  TriggerMode ＝ Off（0 ： internal sync mode）

- Explanation

  By setting this register, you can switch internal sync mode/external sync mode.

  ※ When using internal sync mode, set line cycle according to the next chapter.

【Notice】

① In external sync mode, input a line trigger signal having an appropriate frequency that can fit with a speed of the object you scan.

2） Line sync cycle setting (internal sync mode)

Set a line cycle to operate this product in internal sync mode.

- Register Address and name

  7000h/ LinePeriodCounter

- Factory setting value

  LinePeriodCounter ＝ 692dec (Line cycle 19.8μsec)

- Explanation

  When this product is set as internal sync mode, the sync signals are automatically generated based on the values which are set at the registers. Set the values of line cycle setting based on the following formula.

  Line cycle setting register values (LinePeriodCounter) ＝ **35×(desired line cycle (μsec))－1**

  In this formula, the value of "35" is a fixed value. (The value depends on a fixed CLK frequency usedonthis product.)

[Notice]

① The line cycle can be set as maximum 1872us/line (Register setting LinePeriodCounter＝65,535dec).

② Set an appropriate line rate which can fit with a speed of the object you scan.

3.6 LED Control

【Function description】

Light source is not included in this series. If you need the illumination to scan your target object, you need to prepare external light source(s). To contral external light source easily, control signals is output from LED SIG OUT (L1) on the CIS.

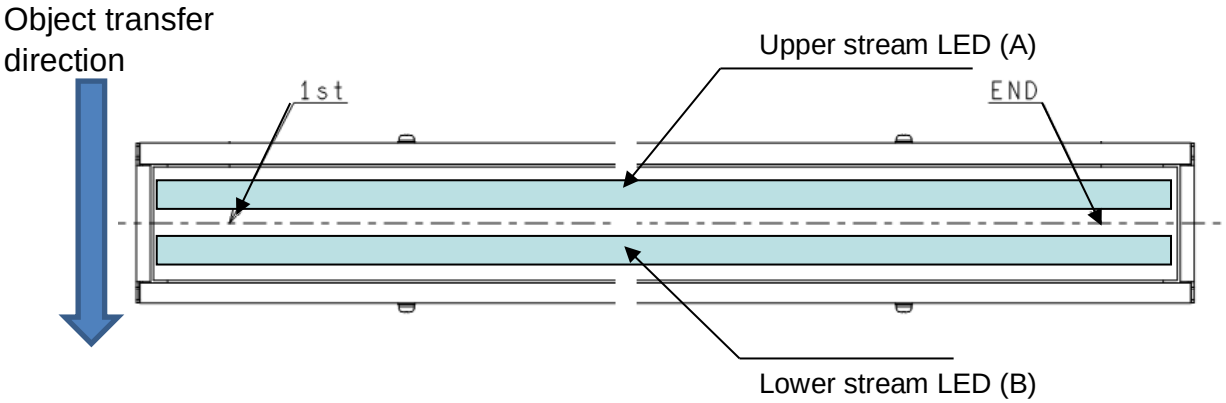


Fig 3.6-1 Assumption of Light Source (LED) position

Fig 3.6-1 shows the assumption of light sources. There are 2 external light sources are assumed and these light soureces is located on Upper stream side and Lower stream side.

Light source is oprated by pulse on each scanning lines. For control intensity of light source, pulse width (pulse period) of control signals should be changed through this function. (Light source is assumed to operate under constant current.)

By changing the registers for the LED Control on this product, each Upper stream LED (A) and Lower stream LED (B) can be turned ON and OFF and each intensity of Upper stream LED (A) and Lower stream LED (B) can be controlled.

This series outputs a LED pulse signal over a connector (L1), that ennables to control an external illumination easily.

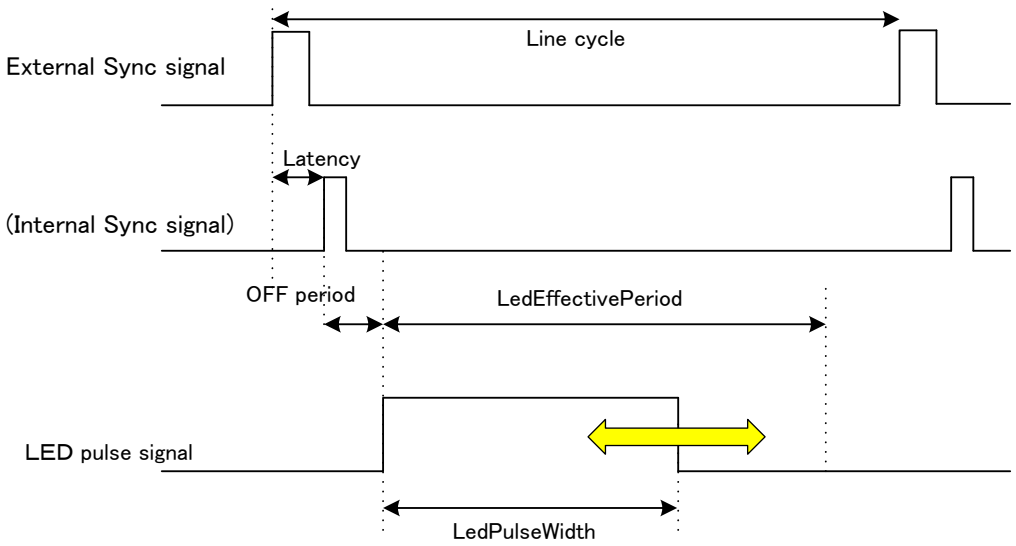


Fig 3.6-2 LED control pulse timing

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
7010h	LedSelector	R/W	LedOff LedOn_A LedOn_B LedOn_AB	0 1 2 3	LED lighting control 0: OFF 1: Upper-stream side LED-A, one side lighting ON (output OUT PULSE1 signal only) 2: Lower-stream side LED-B, one side lighting ON (output OUT PULSE2 signal only) 3: Both Upper-stream LED-A and Lower-stream LED-B ON(output OUT PULSE1and 2 signals)	0
7014h	LedPulseDivision	R/W	Div0 Div2 Div4 Div8	0 1 2 3	Set LED Pulse division 0:OFF, 1: 2 pulses, 2: 4 pulses, 3: 8 pulses	0
7018h	LedPulseWidthA	R/W	-	0 to 65535	Upper-stream LED-A (OUT PULSE1) lighting period or pulse width	450
701Ch	LedPulseWidthB	R/W	-	0 to 65535	Lower-stream LED-B (OUT PULSE2) lighting period or pulse width	450
7020h	LedEffectivePeriod	R/W	-	0 to 65535	Set LED Effective Period	692

【Function】

1） LED ON/OFF control

By controlling pulse output to turn on the illuminations, the illuminations can be turned ON and OFF. By selecting LED pulse to LED control circuit that operates Upper and Lower stream light sources, the external light sources are individually turned ON/OFF.

- Register Address and name

  7010h/LedSelector

- Factory setting

  LedSelector ＝ LedOff（0： Upper stream (A)., Lower stream (B) LED OFF)
  (OUT PULSE1,2 are turned off)

- Explanation

  By changing the registers, the illuminations can be turned ON and OFF.

  LedSelector ＝ LedOff （0： Upper stream (A)., Lower stream (B) LED OFF)
  (OUT PULSE1,2 are turned off)

  LedSelector ＝ LedOn_A （1： Upper stream (A) LED ON)
  (OUT PULSE1 is turned on)

  LedSelector ＝ LedOn_B （2： Lower stream (B) LED ON)
  (OUT PULSE2 is turned on)

  LedSelector ＝ LedOn_AB （3： Upper stream (A), Lower stream (B) LED ON)
  (OUT PULSE1,2 are turned on)

2） LED intensity control

You can set a pluse width to control LED duty. Maximum pluse width of line scan cycle is defined at a register LedEffectivePeriod. The values denied at LedEffectivePeriod sets the pulse width (Duty period). (LedPulseWidthA/ LedPulseWidthB)

- Register Address and name

  7018h/LedPulseWidthA : Upper stream LED (A) (OUTPULSE1) lighting period or pulse width
  7018h/LedPulseWidthB : Lower stream LED (B) (OUTPULSE2) ligting period or pulse width
  7020h/LedEffectivePeriod : Set maximum LED effective period

- Factory setting

  LedPulseWidthA ＝ 450dec : Approximately 12.8 μsec/line
  LedPulseWidthB ＝ 450dec : Approximately 12.8 μsec/line
  LedEffectivePeriod ＝ 692dec : Approximately 19.8 μsec/line

- Explanation

  By setting a value at this register, you can change LED pulse width and control the intensity of of Upper stream LED (A) and Lower stream LED (B) respectively.

  The following formula shows how to set the register values of pulse width at LedPulseWidthA, LedPulseWidthB, and LedEffectivePeriod.

  Register value ＝ 35× Pulse width setting (μsec)

  (LedPulseWidthA/LedPulseWidthB/LedEffectivePeriod)

  In this formula, the value of "35" is a fixed value. (The value depends on a fixed CLK frequency usedonthis product.)

【Remark】

① If you set LED Pulse Width (LedPulseWidthA/B) longer than LED Effective Period (LedEffectivePeriod), the value of the pulse width that actually outputs is not the value of LedPulseWidthA/B and is the other value that is set on LedEffectivePeriod.

3） LED pulse division

This is a function to turn on LED by dividing LED Pulse Width within a scan cycle.

You can set LED pulse as 0 (no division), 1 (2 divided pulses), 2 (4 divided pulses), and 3 (8 divided pulses). The same setting of the Pulse Division is applied to both Upper steam LED (A) (OUTPLSE1) and Lower stream LED (B) (OUTPULSE2).

- Register Address and name

  7014h/LedPulseDivision : Set LED pulse division for Upper stream (A) and Lower stream (B) LED

- Factory setting

  LedPulseDivision ＝ Div0 (0: no division)

- Explanation

  You can set the number of division of LED pulse. Each divided pulse outputs during a period of Pulse Width set at LedPulseWidthA/B devided by the number of division from the beginning of the period set at LedEffectivePeriod divided by the number of division defined at LedPulseDivision.

  The following formula indicates LED duty period. And, LED pulse width is a pulse width that is set at LedPulseWidthA/B.

$$\text{LED Duty pulse width} = \sum_{n=1}^{Number\ of\ Division(N)} (Duty\ pulse\ width\ n)$$

Fig 3.6-3 shows LED duty pulse timing in dividing into two division.

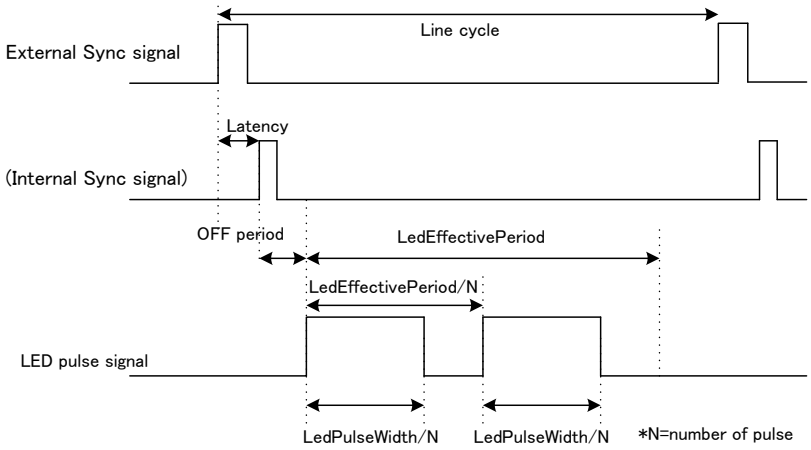


Fig 3.6-3 Division (N=2) LED control pulse timing

The LED on this product is operated by the constant current driving circuit. Therefore, the illumination intensity within a certain period cannot be changed. If you acquire an image based on a longe line cycle and short LED duty, the image sampling timing in transport direction may be deviated and you may not be able to acquire necessary image information from the scanned image. In this case, this function may improve the phenomenon described abotve by having multiple samplings.

【Remark】

① The settings of LED Effective Period (LedEffectivePeriod) and LED Pulse Division (LedPulseDivision) are applied to Upper stream LED (A) and Lower stream LED (B) both in common.

② You can set a certain value of LED Effective Period. However, if you set it longer than the line cycle, the remaining period after the end of the line cycle becomes invalid or reset, and the next line scan automatically starts.

③ Because there are rise time and fall time for LED duty that become a delay, the effective LED duty period becomes shorter than the setting. If you increase the number of duty pulse, the total delay of multiple LED pulse duties are accumulated, and the intensity or brightness of the effective LED (*N=number of pulse mes darker. Set an appropriate LED duty pulse period, considering this point.

④ If you need detail respective pulse delay information, please contact a contact that you got this product.

⑤ If you use LED pulse division, evaluate image quality based on your setting, and decide the number of the pulse division.

3.7 Dark Correction

【Overview】

CMOS sensor IC is used on this product. The CMOS sensor IC has DC offset caused by FET switch on each pixel. To crrect the DC offset on each pixel, this function performs to correct the offset output variation by using a dark output when illuminations are turned off.

The initial dark correction data is captured on outgoing test at our factory. And, the data is saved on EEPROMs. This function can be operated by turning ON/OFF.

Also, you can create a new dark correction data and save it as a user setting.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
7050h	DarkCorrectionEnable	R/W	Off On	0 1	Dark correction ON/OFF setting 0:OFF 1:ON	0
7054h	DarkCorrectionExecute	R/W	(Execute)	1	Generate Dark Correction Data	-

【Function】

1） Dark Correction application

This is a function to switch ON/OFF the Dark correction to correct the DC offset on each pixel by using the dark correction data stored on EEPROM of Dark correction circuit.

- Register Address and name

  7050h/DarkCorrectionEnable

- Factory setting

  DarkCorrectionEnable ＝ OFF (0： Dark correction OFF)

- Explanation

  When applying Dark Correction (DarkCorrectionEnable ＝ ON), this product outputs a delta of the output between each pixel output and Dark Correction data that is stored on the EEPROM for each pixel. When not applying Dark Correction (DarkCorrectionEnable ＝ OFF), the original output of each pixel outputs without any corrections.

  The data of the Dark Correction is calculated by the following formula by using image data after Dark Correction “DVp’(n)”, Dark Correction data created pixel by pixel “DVd0 (n) _R/G/B”, and real-time scanned image data “DVp(n)_R/G/B”.

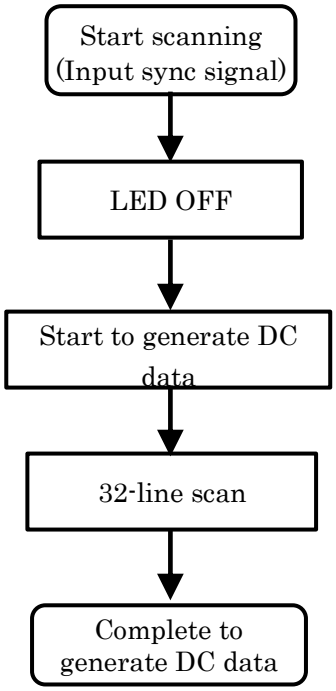
  $$DVp'(n)\_R/G/B = DVp(n)\_R/G/B - DVd0(n)\_R/G/B$$ (n means an integer from 1 to total number of pixel)

2） Dark Correction Data generation

This is a function to generate a new Dark Correction (DC) data. By excuting this register, 32 continuous lines of data are acquired, every pixel output average is calculated to be a new Dark Correction data, and you can save the new Dark Correction data on EEPROM.

- Register address and name
  7054h/DarkCorrectionExecute
- Factory
  No
- Explanation

Fig 3.7-1 Dark Correction



During scanning operation of this product (LED OFF), you can start an auto-generation sequence to create Dark Correction data by excuting Dark Correction Data self-generation register (DarkCorrectionExecute).

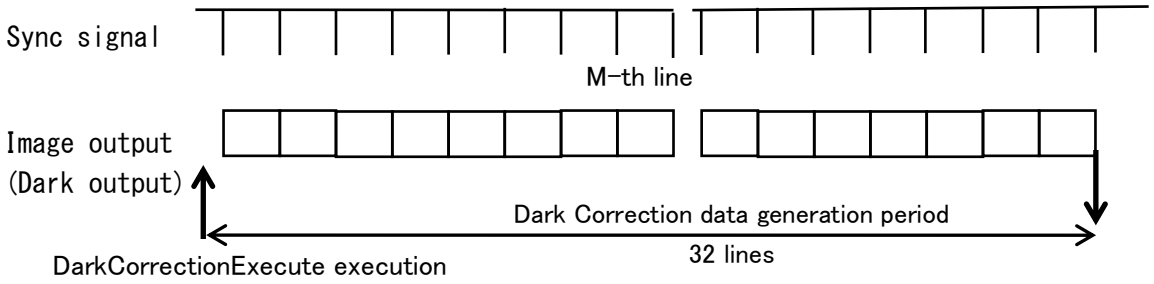
After this status remains in 32 line cycles, this sequence finishes, and the auto-generated Dark Correction data is automatically saved on Dark Correction data strage area of FPGA (Line memory).

The Dark Correction data is calculated by the following formula.

$$DVd0(n) = \frac{\sum_{m=1}^{M} DVdm(n)}{M}$$

DVd0(n)	n^{th} pixel of Dark Correction data
DVdm(n)	n^{th} pixel output at m^{th} line in creating Dark Correction data
M	Number of line to generate Dark Correction data M is a fixed value, 32.

Fig 3.7-2 Dark Correction data auto-generation sequence



3） Preservation of the Dark Correction data according to the resolution
(For products with DeviceFirmwareVersion 2. *. *. *)

This product has memory for saving correction data every resolution. Correction data is saved in memory for current resolution by this operation. If using multiple resolution, execute this operation in each resolution. The correction data which is applied for this proudct is automatically changed when resolution is changed.

【Remark】

① **This proudct has an initial dark correction data for only 600dpi** in factory setting memory. After turning on power, the initial dark correction data are booted automatically and dark correction function becomes available.

② When acquiring an image, make sure that you use Dark Correction function. Without using this function, you may see image variation like vertical stripes.

③ The dark output can be vaired by changes of temeperature and scanning line cycle. Regenerate Dark Correction data within an appropriate cycle according to your applications. If Dark Correction is not operated correctly, you may see some stripes on the scanned images.

④ Make sure if you generate Dark Correction data under a condition of your application that you actually use this product. For example, if the line cycle is significantly different, you may not be able to acquire a correct data.

3.8 White Correction

【Overview】

There is output images non-uniformity caused by the sensitivity variation on each pixel of sensor IC and intensity variation of light source on this product. In that situation, Output images have this non-uniformity and the streaks (they drop quality of images).

White correction is a function to get uniform output images by correcting each pixel output scanning a test chart having a uniform reflectiveness. (In our outgoing inspection, we generate the White Correction data by scanning a white target chart having 82% – 89% uniforminty.)

The white correction calculated by the data captured on outgoing test in our factory is stored as an initial setting. This function can be operated by switching ON/OFF.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
7070h	WhiteCorrectionEnable	R/W	Off On	0 1	Set White Correction On/Off 0:OFF 1:ON	0
7074h	WhiteTarget_R	R/W	–	0 to 4095	Set Red White Correction Target value	4000
7078h	WhiteTarget_G	R/W	–	0 to 4095	Set Green White Correction Target value	4000
707Ch	WhiteTarget_B	R/W	–	0 to 4095	Set Blue White Correction Target value	4000
7080h	WhiteCorrectionExecute	R/W	(Execute)	1	Generate White Correction data (Normal Trigger mode)	–
7084h	WhiteCorrectionExtraTriger	R/W	Stop Start	0 1	Generate White Correction data (External Trigger mode) 0: White Correction data generation END 1: White Correction data generation START	0

【Function】

1） White Correction applicaton

This is a function to switch ON/OFF the White Correction to offset each pixel output by using the White correction data stored on EEPROM of White correction circuit. This function enables you to acquire a uniform image output of each pixel as a target value or designated value of each pixel (WhiteTarget_R,G,B) under a scanning condition that you acquired White Correction data.

- Register Address and name
  - 7070h/WhiteCorrectionEnable
  - 7074h/WhiteTarget_R
  - 7078h/WhiteTarget_G
  - 707Ch/WhiteTarget_B
- Factory setting
  - WhiteCorrectionEnable ＝ OFF (0 : White Correction OFF)
  - WhiteTarget_R ＝ 4000 dec calculated by 12bit/pixel 4095max.
  - WhiteTarget_G ＝ 4000 dec calculated by 12bit/pixel 4095max.
  - WhiteTarget_B ＝ 4000 dec calculated by 12bit/pixel 4095max.

- Explanation

When using White Corretion (WhiteCorrectionEnable ＝ ON), this product outputs an image output calculated by each pixel output and White Correction data that is stored on the EEPROM for each pixel according to the following formula.

$$DVp'(n) = \frac{WhiteTarget\_R、G、B}{DVp0(n)} \times DVp(n)$$

$DVp'(n)$	:	n^{th} pixel output after White Correction
$DVp(n)$	:	n^{th} pixel output before White Correction
$DVp0(n)$	:	n^{th} pixel White Correction data
WhiteTarget_R,G,B	:	White Correction target value (Register value) for each color

You can adjust the register values set at WhiteTarget_, WhiteTarget_G, and WhiteTarget_B for each color output target value as color balance.

2） White Correction data generation

This is a function to generate a new White Correction (WC) data. There are 2 types of generation procedures, such as ①Normal Trigger mode (Simple averaging) and ②External Trigger mode (Max hold mode). You can select one of the procedures in order to correspond to your scanning object and status of the object that you use to generate White Correction data.

In ①Normal Trigger mode (Simple averaging), by excuting WhiteCorrectionExecute, 32 continuous lines of data are acquired, every pixel output average is calculated to be a new White Correction data, and you can save the new White Correction data on EEPROM.

In ②External Trigger mode (Max hold mode), by excuting WhiteCorrectionExtraTriger = Start, 32 continuous lines of data are kept acquired until WhiteCorrectionExtraTriger = Stop is excuted, and the maximum values among the the data acquired several times in this averaging process are saved on line memory as White Correction data.

- Register Address and name

7080h/WhiteCorrectionExecute : White Correction data auto-generation register
Normal Trigger mode (Simple averaging)

7080h/WhiteCorrectionExtraTriger : White Correction data auto-generation register
External Trigger mode (Max hold mode)

- Factory setting

WhiteCorrectionExecute ＝ NO

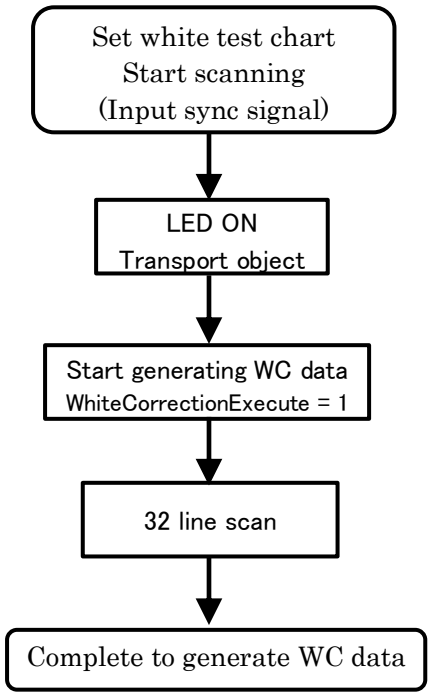
WhiteCorrectionExtraTriger ＝ Stop (0: White Correction data generation END)

- Explanation

①White Correction data generation by Normal Trigger mode (Simple averaging)

During scanning operation of this product (LED ON), you can start an auto-generation sequence to create White Correction data by excuting White Correction Data self-generation register (WhiteCorrectionExecute).

Fig 3.8-1 WC data generation flow (Normal Trigger mode)



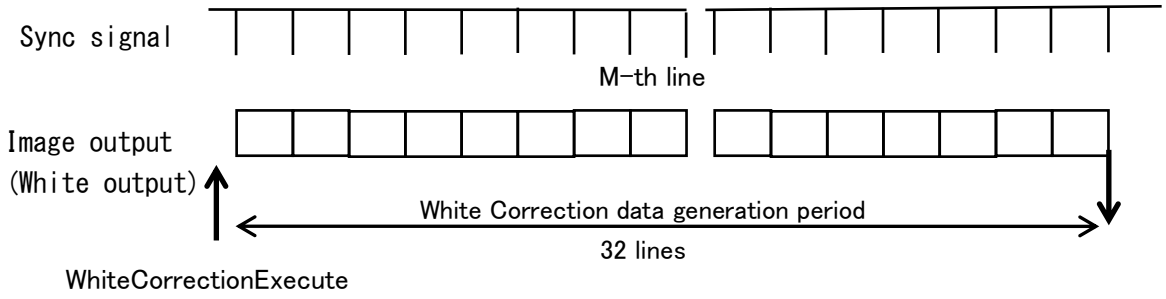
After this status remains in 32 line cycles, this sequence finishes, and the auto-generated White Correction data is automatically saved on White Correction data strage area of FPGA (Line memory).

The White Correction data is calculated by the following formula.

$$DVp0(n) = \frac{\sum_{m=1}^{M} DVpm(n)}{M}$$

DVp0(n)	n^{th} pixel of White Correction data
DVpm(n)	n^{th} pixel output at mth line in creating White Correction data
M	Number of line to generate WC data. M is a fixed value, 32.

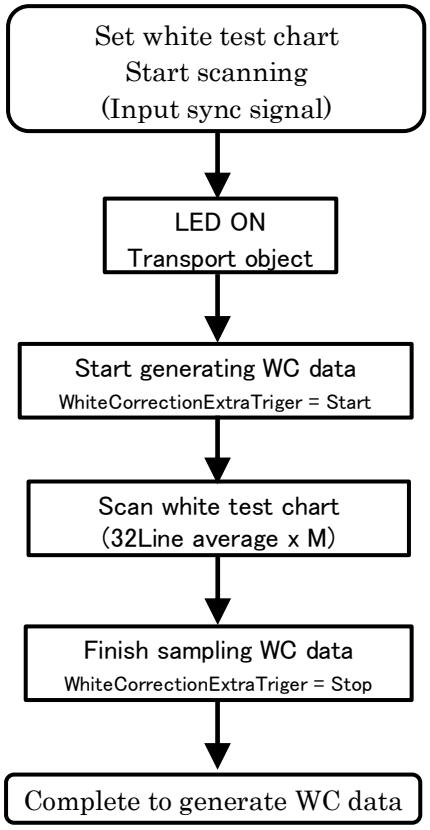
Fig 3.8-2 White Correction Data auto-generation sequence (Normal Trigger mode)



②White Correction Data by External Trigger mode (Max hold mode)

During scanning operation of this product (LED ON), you can start an auto-generation sequence to create White Correction data by excuting White Correction Data self-generation register (WhiteCorrectionExtraTriger = Start).

Fig 3.8-3 WC Data generation flow (External Trigger mode)



White Correction data of each pixel is gererated by averaging 32 continuous lines of each pixel output. And, the previous line of the averaged line data and the next line of the averaged line data are compared and greater averaged data is saved as White Correction data. This procedure remais until this register is changed to stop the sequence (WhiteCorrectionExtraTriger = Stop). Therefore, the White Correction data that is eventually acquired is the maximum values among the averages of 32 lines of each pixel.

The White Correction data is calculated by the following formula.

$$DVp0l(n) = \frac{\sum_{m=1}^{M} DVpml(n)}{M}$$

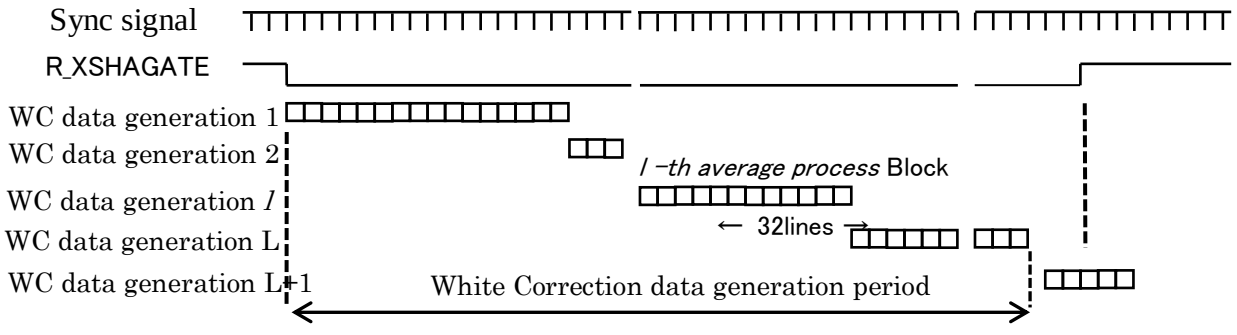
DVp0(n) : n^{th} pixel White Correction data in averaging processing block

DVpm(n) : n^{th} pixel White Correction data of M^{th} line in averaging block

M : Number of line to generate White Correction data M is a fixed value, 32.

$$DVp0(n) = \max_{L} DVp0l(n)$$

Fig 3.8-4 White Correction data Auto-generation sequence (External Trigger mode(Max hold))



3) Preservation of the White Correction data according to the resolution
(For products with DeviceFirmwareVersion 2. *. *. *)

This product has memory for saving correction data every resolution as same as dark correction. The white correction data which is applied for CIS is automatically changed when resolution is changed.

【Remark】

① This proudct has an initial white correction data for only 600dpi in factory setting memory.

② When starting White Correction data auto-generation sequence, make sure if this product operates and outputs image data stably. Right after power cycle or under a condition that an external trigger is not provided to this product stably, do not generate White Correction data.

③ If there are a scratch, dust, or any particles on your test chart when generating White Correction data, you may see an image variation such as vertical stripe.

④ White Correction data generated by External Trigger mode (Max hold mode) may not be sufficient for a dust or particle having higher reflectiveness than that of your test chart, although the White Correction data might be sufficient for a particl having less reflectiveness than that of your test chart.

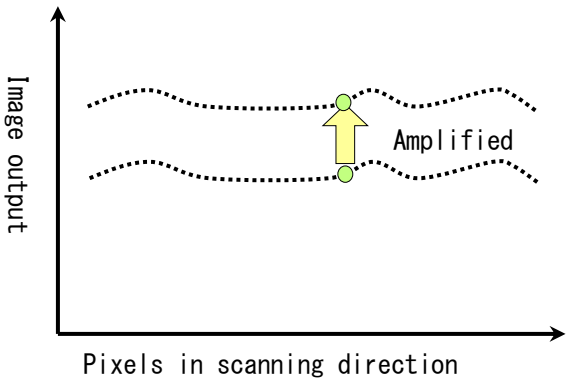
⑤ Make sure if you generate White Correction data under a condition of your application that you actually use this product. For example, if the line cycle is significantly different, you may not be able to acquire a correct data.

3.9 PGA

【Overview】

This is a function that you can add a gain on the image output signal. You can set from 0 to 4 times amplifier.

Fig 3.9-1 PGA concept



This function can be used to offset output of entire line, corresponding to LED intensity decline by surrounding temperature change.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
70A0h	DegitalGainEnable	R/W	Off On	0 1	Set PGA On/Off 0:OFF 1:ON	0
70A4h	DegitalGain_R	R/W	–	-1024 to 3071	Set a value of Red PGA (0 to 4.0 times)	0
70A8h	DegitalGain_G	R/W	–	-1024 to 3071	Set a value of Green PGA (0 to 4.0 times)	0
70ACh	DegitalGain_B	R/W	–	-1024 to 3071	Set a value of Blue PGA (0 to 4.0 times)	0

【Function】

This is a function that you add a gain on each pixel output of all colors. The gain can be set from 0 to 4 times with 1024 steps.

1） PGA application control

You can add a gain on each color output for all colors by setting 3 registers corresponding each color. Gain amplification ranges from 0 to 4 times for all pixels. And, the same amplification is added on the entire valid pixels.

- Register Address and name

  70A0h/DigitalGainEnable

- Factory setting

  DigitalGainEnable ＝ OFF （0 :PGA OFF）

- Explanation

  When using this function (DigitalGainEnable ＝ ON), the gains set at the registers of DigitalGain_R, DigitalGain_G, and DigitalGain_B on the image output.

  When not using this function (DigitalGainEnable ＝ OFF), each pixel data outputs as it is without any amplification. This is as same as a case using this function (DigitalGainEnable ＝ ON） and setting the gain for each color = 1.

2） Gain value setting

You can set a gain value that you can add on each color image data.

- Register Address and name

  70A4h/DigitalGain_R : Set gain for Red data (0 to 4 times)

  70A8h/DigitalGain_G : Set gain for Green data (0 to 4 times)

  70ACh/DigitalGain_B : Set gain for Blue data (0 to 4 times)Factory setting

  DigitalGain_R ＝ 0 : 1 time

  DigitalGain_G ＝ 0 : 1 time

  DigitalGain_B ＝ 0 : 1 time

- Explanation

  Digital gain of PGA function is calculated by the following formula.

$$\text{Data after PGA (R, G, and B)} = \text{Input image data (R, G, B)} \times \frac{1024 + DigitalGain\_R,G,B}{1024}$$

The value of DegitalGain_R, G, B is a register setting value. And this value or ratio set on this function is used to multiply each color pixel output.

The values set at the register DegitalGain_R, G, B are based on 4Byte. The register setting values covers from −1024 to 3071.

【Remark】

① This function add a gain process. Thus, if you set a large gain on the image data, it may cause the degradation of the data accuracy (for example missing bit). Make sure image quality when using this function.

② This register values is defined to be a signed integer. A negative value means a complement of 2. Access the register and set the value by hex number.

Example : Register value −2 (decimal) = FFFFFFFEh

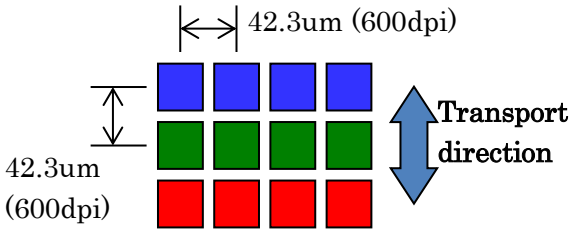
3.10 Line adjustment

【Overview】

This is a function to adjust RGB color information based on a different position in transportation direction to the information based on the same position by using internal line memory.

This product comprises RGR trilinear sensor IC array that the three lines of RG colors are mounted based on 600 dpi (42.3 μm) pitch described in below.

Fig 3.10-1 Color pixel position



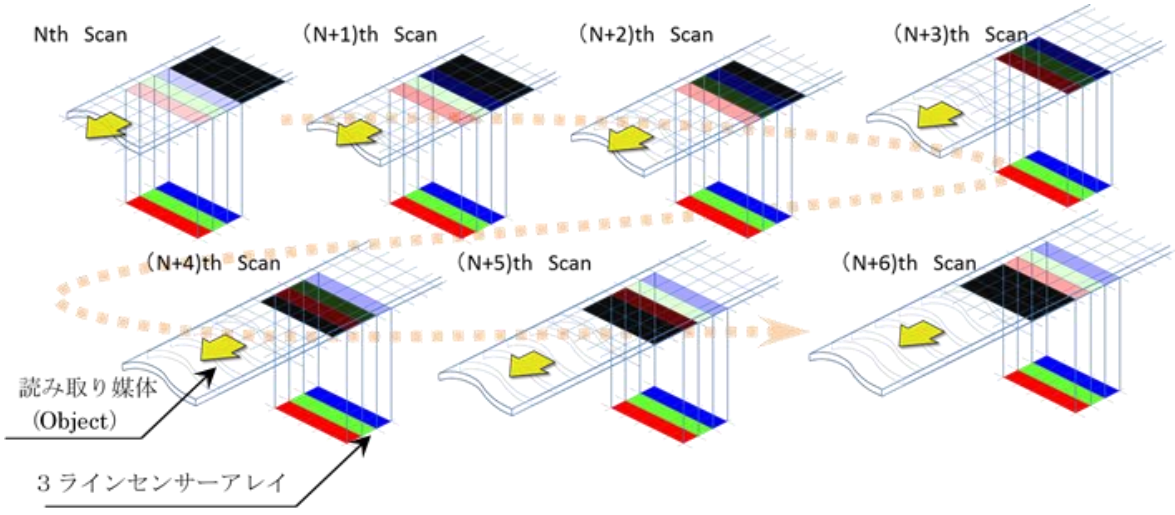
Because this trilinear sensor IC array can output image at the same time, in the same scanning period, the all color data which are output from this product are the image information based on a different position.

Thus, the false color may occur when the image data scanning the same line are combined. (Refer to the following drawing.)

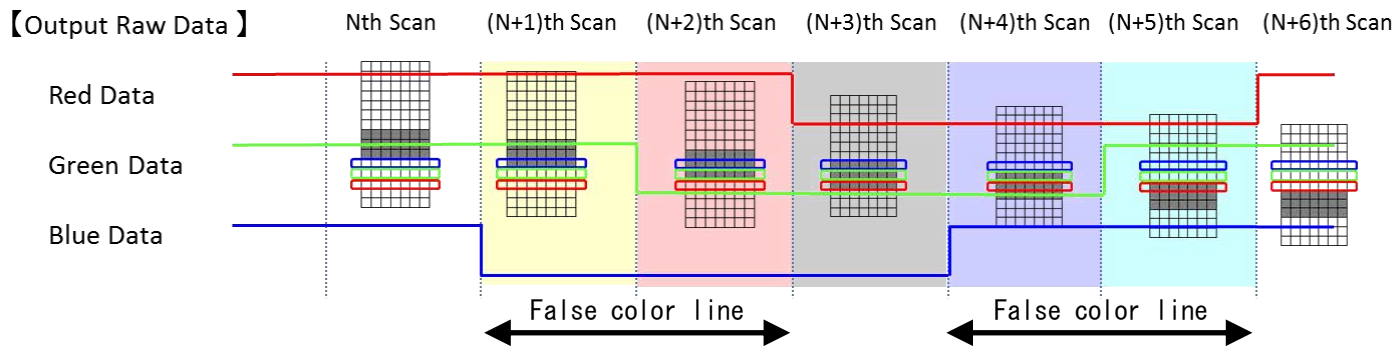
Line adjustment function is provided to minimize the occurrence of false color by replacing the color image information scanned at the different position into the image data on the same position, based on an internal line memory and an arithmetic circuit for line adjustment.

Fig 3.10-2 RGB – Trilinear sensor scanning

a) Change of scanning position when an object is transported



b) R/G/B pixel output transition



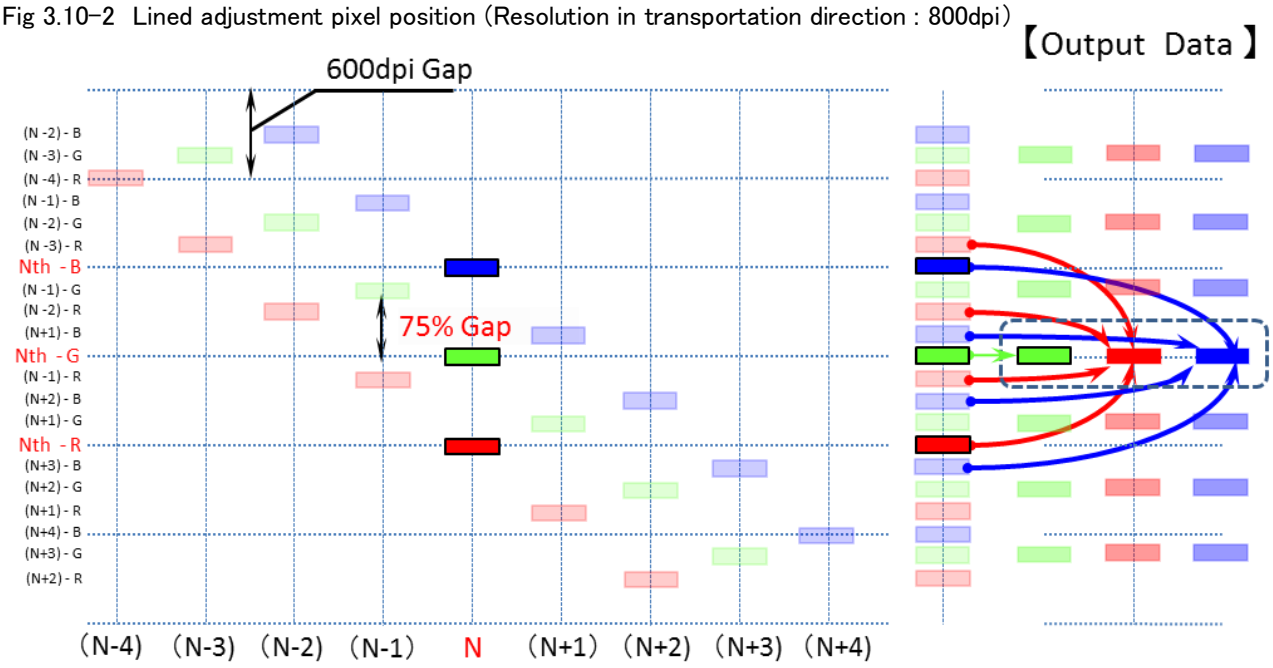
【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
70C0h	LineAdjustmentEnable	R/W	Off On	0 1	Set Line adjustment On/Off 0:OFF 1:ON	1
70C4h	LineAdjustmentDirection	R/W	BGR RGB	0 1	Set transport direction 0: Normal (B → G → R :B-line first) 1: Opposit (R → G → B :R-line first)	0
70C8h	LineAdjustmentRatio	R/W	–	1 to 16384	Resolution in transport direction/600dpi Ratio (0.03 to 4.0) LineAdjustmentRatio =Resolution(transport direction)/600dpix4096	4096
70CCh	LineAdjustmentOfset	R/W	–	0 to 4096	Offset setting of Green pixel (0 to 1.0) $Offset = \frac{(Register\ value)}{4096}$	0

【Function】

Line adjustment can be performed by estimating as Blue and Red image that have to be located at the certain position, referring to the Green pixel (line) as following diagram. The following diagram describes a case of one pixel of RGB sensor based on 800 dpi sampling in transportation direction.

Fig 3.10-2 Lined adjustment pixel position (Resolution in transportation direction : 800dpi)



The above diagram describes a case considering generating an image accommodating Nth Green pixel

G image: Use Nth of Green pixel

R image: Generate R image data of the same position with Nth Green pixel by using (N-3)th, (N-2)th, (N-1)th and Nth of Red pixel.

B image: Generate B image data of the same position with Nth Green pixel by using (N+3)th, (N+2)th, (N+1)th and Nth of Blue pixel.

1） Line adjustment application

This is a register to turn ON/OFF this function. When unsing this function, by using multiple blocks of line memory and image filter, this Line adjustment function generates the approximated image data by generating and converting the image information of R and B pixel into the image information at the referential position referring to the position of G pixel.R When not using this function, the function above doesn't operate, and RGB each color line image information are output as image information based on every 600 dpi (42.3 um) different position.

- Register Address and name

  70C0h/LineAdjustmentEnable

- Factory setting

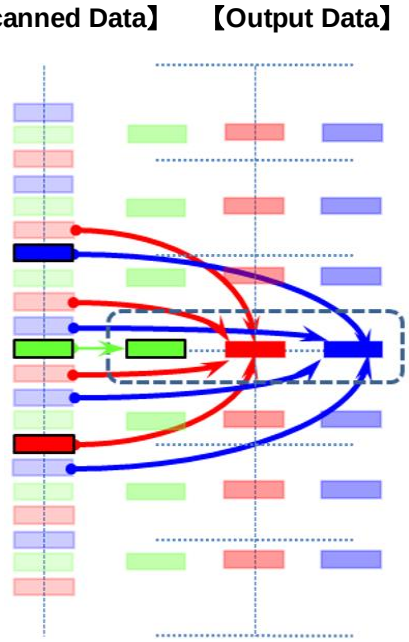
  LineAdjustmentEnable ＝ ON （1 ： Line adjustment ON）

- Explanation

  When using this function (LineAdjustmentEnable ＝ ON), each RGB line image information is saved on line memory. When Red line and Blue line corresponding to the timing that G line image is acquired are acquired, each color line image information are generated and output over CoaXpress Interface, synchronizing with referential Green line image information timing..

  When not using this function (LineAdjustmentEnable ＝ OFF), the image information is not saved on line memory and output over CoaXpress® interface. In this case, RGB each color line image information are output as image information based on every 600 dpi (42.3 um) different position.

Fig 3.10-3 Line adjustment pixel position



2） Line adjustment direction

You can set a direction of transportation of your object corresponding to position of RGB scanning line on sensor IC.

- Register Address and name

  70C4h/LineAdjustmentDirection

- Factory setting

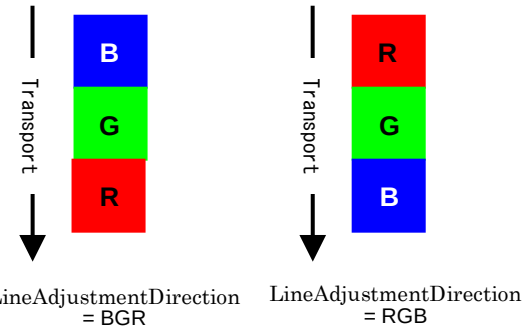
  LineAdjustmentDirection ＝ BGR （0 ：B line first (Upper stream), B → G → R）

- Explanation

  This is a function to change a direction of order to store image information on line memory and a direction of line delay.

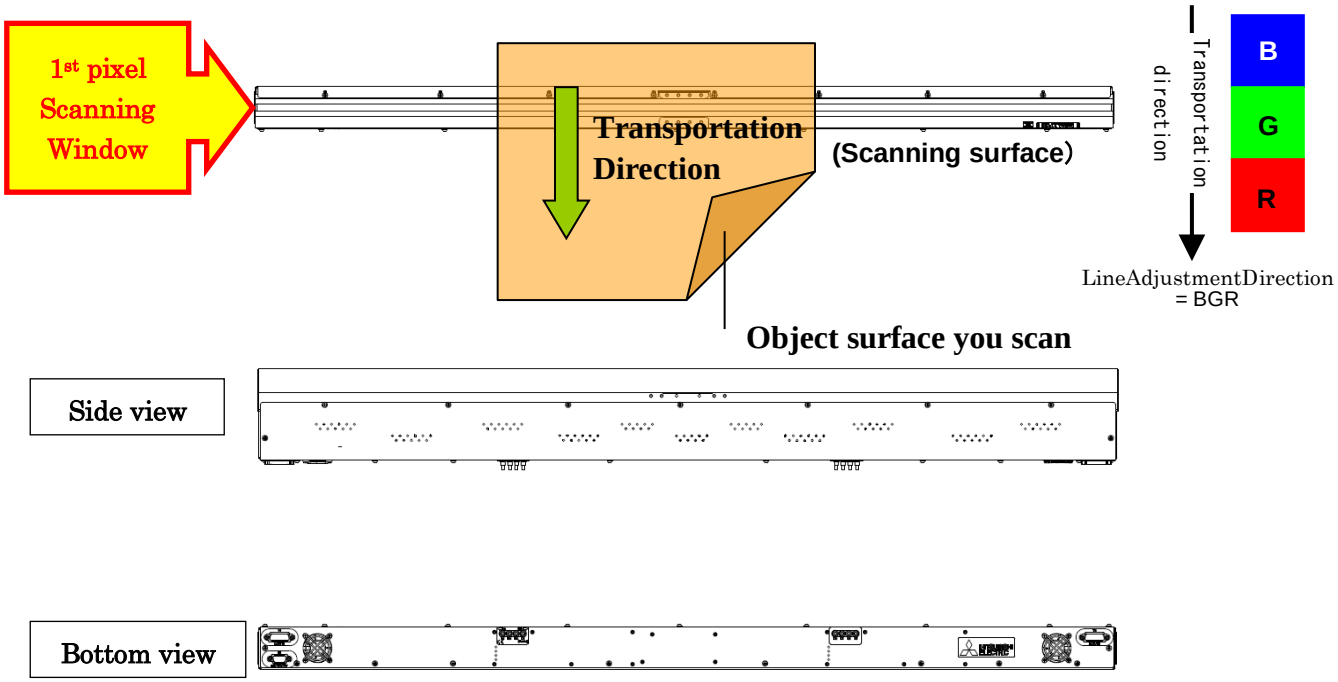
  As Fig 3.10-5 shows, setting correct relative transportation direction between this product and your object enables you to get correct color information based on initial setting of this product and a correctly erected image referring upper left point of the surface

Fig 3.10-4 Transportation direction



of your object.

Fig 3.10-5 Product position and transportation direction



3) Line adjustment transportation direction resolution

This is a register to set a resolution in transportation direction for the Line adjustment. The register value is calculated by the value defined by transportation distance of your object corresponding to scanning line cycle of this product.

- Register Address and name

  70C8h/LineAdjustmentRatio

- Factory setting

  LineAdjustmentRatio ＝ 4096dec （Transportation direction resolution 600dpi）

- Explanation

  By setting a resolution in transportation direction corresponding to RGB line distance (600dpi) at this register (LineAdjustmentRatio), you can set a parameter that is used to calculate a distance to change pixel (line) position.

  The setting value is calculated below and is a relative amount against RGB line pitch (600dpi) of this product.

$$\underline{\textit{Register value}}_{\text{LineAdjustmentRatio}} = \frac{Resolution\ in\ transportation\ direction}{600} \times 4{,}096$$

  The denominator of this formula is a fixed value, 600 (dpi).

  For example, if you transport your object by 300dpi resolution (transporting 300dpi distance within 1 line cycle),

  Resolution in transportation/600dpi ＝ “0.5”, meaning 2,048（0800hex）.

4) Green line position offset setting

This is a function to offset referential Gree line position in transportation direction.

Line adjustment function corresponds to the offset green line image data position.

- Register Address and name

  70CCh/LineAdjustmentOfset

- Factory setting

  LineAdjustmentOfset ＝ 0 （Offset 0）

- Explanation

  An offset amount of Green line from an original position to a new position that is offset by 600 dpi distance in 4,096 steps (0～4,096dec).

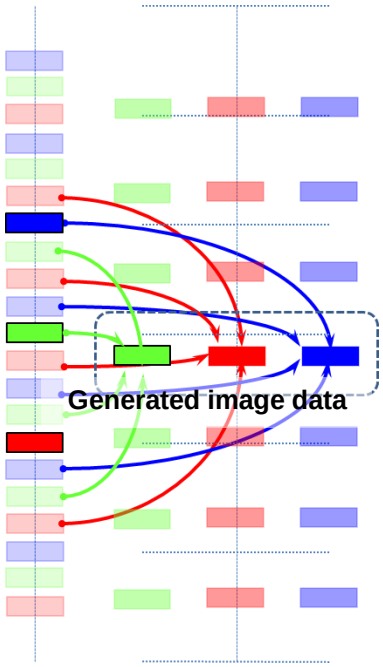
  The register value is calculated below.

$$\underline{\text{Offset amount}}_{\text{LineAdjustmentOfset}} = \text{Line shift ratio} \times 4{,}096$$

  This line shift ratio is defined by an offset amount comparing to line gap (600dpi). Andthis ratio is from 0 (no offset) to 1.0 (1 line offset).

  This function is to reduce variation of characteristics among G, R, and B lines by using same spatial filter that generated R and B line data to offset G line.

Fig 3.10-6Line adjustment pixel position
(After offsetting Green position)



  When you set LineAdjustmentOfset = 0, Green line image is the actual data, but R line and B line images are generated by a certain spatial filter (Resolution in transportation direction 600/300/150 dpi etc). Therefore, the image charachteristics of R line and B line might be different from the image charachteristics of the actual G line image. This function is provided to fullfil with this possible difference of the image charachteristics.

【Remark】

① The parameters may be changed due to the operational setting conditions of your systems. Confirm the setting corresponding to your application conditions. The above operational setting conditions mean as follows; The condition is relating to the valid area the pixel can scan such as line cycle, variation of line cycle, LED duty period, focus etc.

② Make sure about the mounting direction of this product and the transportation direction of the object you scan. This function doesn't perform appropriately for the bi-directional transportation. When considering the opposite transportation direction, make sure to process the color pixel order setting by using the register.

③ If transportation speed of your object is unstable, you may find a color false color. When using color adjustment on your system, turn off this function.

④ This function is not to completely control a color bleeding or blurring. Use the effect of this function after confirmation enough.

⑤ This function is not warranted for the all of the specification. Before using it, evaluate this function whether to perform suitably to your systems.

3.11 γ correction

【Overview】

This function can change the image output linearity (Gamma, γ) for each R, G, B. The 10 bit address length of γ table for 10 bit length image data is prepared on this product. This function allows you to use the image linearity corresponding to your systems. Additionally, the linearity for each color can be designated individually though, use the same setting for each color as long as you have a particular reason.

＊ γ characteristics: Sensor output characteristics corresponding to the image brightness. γ characteristics is also called output linearity.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
70E0h	GammaCorrectionEnable	R/W	Off On	0 1	Set γ correction On/Off 0:OFF 1:ON	0
70E4h	GammaThreshhold1_R	R/W	–	0 to 1023	Set γ correction threshold 1 for R	49
70E8h	GammaThreshhold2_R	R/W	–	0 to 1023	Set γ correction threshold 2 for R	223
70ECh	GammaThreshhold3_R	R/W	–	0 to 1023	Set γ correction threshold 3 for R	544
70F0h	GammaThreshhold1_G	R/W	–	0 to 1023	Set γ correction threshold 1 for G	49
70F4h	GammaThreshhold2_G	R/W	–	0 to 1023	Set γ correction threshold 2 for G	223
70F8h	GammaThreshhold3_G	R/W	–	0 to 1023	Set γ correction threshold 3 for G	544
70FCh	GammaThreshhold1_B	R/W	–	0 to 1023	Set γ correction threshold 1 for B	49
7100h	GammaThreshhold2_B	R/W	–	0 to 1023	Set γ correction threshold 2 for B	223
7104h	GammaThreshhold3_B	R/W	–	0 to 1023	Set γ correction threshold 3 for B	544

【Function】

This function enables you to have this product output 10bit data rate processed by γ correction to 10bit input image data. There are each color (RGB) independent setting values for γ correction. γ correction is processed by γ table (LUT) that is stored on this product. By changing γ table, you can control the correction value under a certain condition.

1） γ correction application

This function is to process γ correction against sensor image output data (10 bit). The corrected ata is also based on 10 bit data.

- Register Address and name

  70E0h/GammaCorrectionEnable

- Factory setting

  GammaCorrectionEnable ＝ OFF（0： γ correction OFF）

- Explanation

  When using this function (GammaCorrectionEnable ＝ ON), an acquired image data (10 bit) is converted a new image data corrected by γ table (LUT) and the corrected data outputs. Factory setting of γ table is γ=2.2.

  When not using this function (GammaCorrectionEnable ＝ OFF), γ ≒ 1.0 which is an original

sensor γ characteristics.

2） γ table (LUT) setting

10 bit image data scanned by sensor is corrected by γ table.

There is each RGB color γ table for γ correction, whch enables to have each different color γ correction.

- Regsiter Address and name

70E4h/ GammmThreshold1_R	:	Set γ correction threshold 1 for R
70E8h/ GammmThreshold2_R	:	Set γ correction threshold 2 for R
70ECh/ GammmThreshold3_R	:	Set γ correction threshold 3 for R
70F0h/ GammmThreshold1_G	:	Set γ correction threshold 1 for G
70F4h/ GammmThreshold2_G	:	Set γ correction threshold 2 for G
70F8h/ GammmThreshold3_G	:	Set γ correction threshold 3 for G
70FCh/ GammmThreshold1_B	:	Set γ correction threshold 1 for B
7100h/ GammmThreshold2_B	:	Set γ correction threshold 1 for B
7104h/ GammmThreshold3_B	:	Set γ correction threshold 1 for B

- Factory setting

GammmThreshold1_R	＝	49dec
GammmThreshold2_R	＝	223dec
GammmThreshold3_R	＝	544dec
GammmThreshold1_G	＝	49dec
GammmThreshold2_G	＝	223dec
GammmThreshold3_G	＝	544dec
GammmThreshold1_B	＝	49dec
GammmThreshold2_B	＝	223dec
GammmThreshold3_B	＝	554dec

- Explanation

10bit image data scanned by sensor is converted by γ table (LUT).

γ table is not LUT which contains 10 x 10 bit space. In order to reduce memory size for this function, the γ table format is our original one. ① 3 table thresholds which indicate input value to change Upper 2 bit output data ② output value corresponding to input data between the thresholds 8 bit width x 10 bit address length of LUT defining lower 8 bit output data.

Upper 2 bit output data corresponding to input data is defined by the following values of Table threshold (GammmThreshold1～3).

	Input data			Upper 2bit output datat
Zone1	0	≦Input data	<GammmThreshold1	00
Zone2	GammmThreshold1	≦Input data	<GammmThreshold2	01
Zone3	GammmThreshold2	≦Input data	<GammmThreshold3	10
Zone4	GammmThreshold3	≦Input data1	≦1023	11

The γ table includes 10bit length address (1,024 addresses). The addresses correspond to input data, and each value stored at each address corresponds to output data (lower 8bit only) corresponding to input data.

You can excute γ correction for each RGB color because these table threshold values and γ table are inpltemented.

※ How to generate γ table

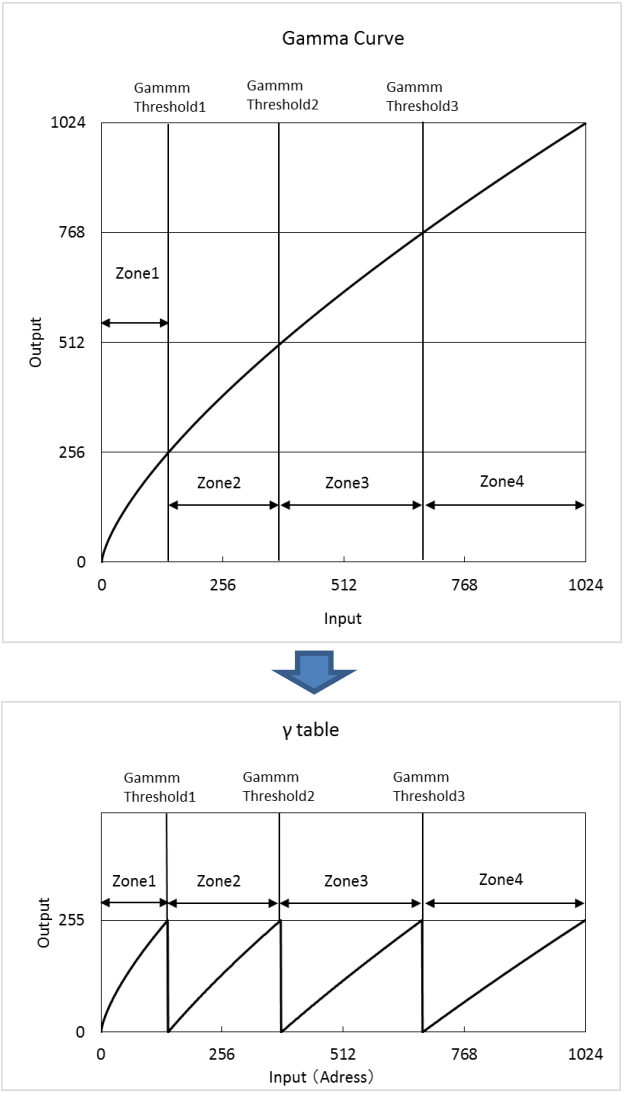
Prepare 10x10bit space γ table defining output data corresponding to input data 10bit (0～1,023) as a γ curve that you would like to set.

Define input data of points that upper 2 bit output data changes (00→01, 01→10, 10→11) as table threshold.

Save lower 8bit value of output data at 10x10 bit space γ table that you would like to apply at each address.

γ table for R data	Memory zone	0x10000000～0x100003FF
γ table for G data	Memory zone	0x10000400～0x100007FF
γ table for B data	Memory zone	0x10000800～0x10000BFF

Fig 3.11-1 γ curve and γ table



【Remark】

① Refer to 3.18 about how to read and write γ table data for γ correction.

② When not using γ correction, γ table data doesn't affect anything. In factory setting, γ correction is not turned OFF.

③ This γ function can be applied with only simple increasing function.

3.12 Mono mode

【Overview】

This is a function to switch output image data type when you set to output mono format output. You can select G pixel output or luminance value output.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
7110h	MonoModeSelect	R/W	Green Luminance Red Blue	0 1 2 3	Select Mono mode Mono mode 0: Green pixel output 1: Luminance value output 2: Red pixel output 3: Blue pixel output (This function can change output of RGB color mode.) RGB color mode 0: Color output 1: Luminance value output (the luminance value for all RGB outputs (mono image)) 2: Can not be selected 3: Can not be selected	0

【Function】

This is a function to select a method to generate mono output data, when you set Mono output (PixelFormat ＝ 0x0101 or 0x102).

There are 2 methods to generate mono output pixel data as follows and you can select one of them. Factory setting is Green pixel output mode.

- Register Address and name
  7110h/MonoModeSelect
- Factory setting
  Green (0 : Output Green pixel data as mono image)
  Luminance (1 : Output Luminance value as mono image)
  Red (2 : Output Red pixel data as mono image)
  Blue (3 : Output Blue pixel data as mono image)
- Factory setting
  MonoModeSelect ＝ Green (0 : Output Green pixel data as mono image)
- Explanation
  You can select 2 modes of mono image data a) Output Green pixel data, b) Output luminance value calculated by RGB data as mono data.
  The luminance value of RGB data is caluculated by the following formula.

$$Vp(n) = \frac{77}{256} \times R + \frac{150}{256} \times G + \frac{29}{256} \times B$$

＊ This formula is based on general RGB→YUV format conversion formula in digital image.

【Remark】

① Even though you keep RGB color output format at image data output format setting, if you set MonoModeSelect = Luminance (luminance value output), each RGB output are converted to luminance value, and you see mono image.

3.13 Electronic shutter

【Overview】

This is a function to set an exposure period of photo diode on sensor IC. The exposure period for each RGB pixel is adjustable. This function enables you to control exposure stably, when you use an external lighting which may not synchronize easily with scanning line cycle of this product. When you use an external light source of static lighting or DC lighting with this product, output value becomes stable, even though the scanning line cycle variation might affect.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
7030h	ShutterEnable	R/W	Off On	0 1	Set Electric shutter On/Off 0:OFF 1:ON	0
7034h	ShutterEnd	R/W	-	0 to 32765	Set exposure end timing	130
7038h	ShutterWidth_R	R/W	-	1 to 32764	Set Red exposure period	1
703Ch	ShutterWidth_G	R/W	-	1 to 32764	Set Green exposure period	1
7040h	ShutterWidth_B	R/W	-	1 to 32764	Set Blue exposure period	1

【Function】

1） Electronic shutter application

This is a function to turn ON/OFF Electronic shutter function built in sensor IC.

- Register Address and name

  7030h/ShutterEnable

- Factory setting

  ShutterEnable ＝ 0 (Electronic shutter OFF : exposure control by lighting)

- Explanation

  When not using this function (ShutterEnable ＝ 0), the exposure period of photo diode is set to be an entire period of line cycle. As this product, the exposure period becomes LED duty period.

  When using this function (ShutterEnable ＝ 1), the exposure period of photo diode is set to be as follows.

2） Electronic shutter exposure period setting

This is a function to set each RGB color exposure period referring to the exposure end timing of each RGB color within a scanning line cycle set at a register ShutterEnd. Therefore, the exposure period set by each register has to be greater than the period that is defined by a trigger signal and an exposure end timing.

- Register Address and name
  - 7034h/ShutterEnd
  - 7038h/ShutterWidth_R
  - 703Ch/ShutterWidth_G
  - 7040h/ShutterWidth_B
- Factory setting
  - ShutterEnd = 130dec
  - ShutterWidth_R = 1dec
  - ShutterWidth_G = 1dec
  - ShutterWidth_B = 1dec
- Explanation

As Fig 3.13-1indicates, a designed value within a scanning line cycle is set to be an end timing which is refered to set the exposure period.

Each time and period is calculated by the following formula.

Exposure end timing setting

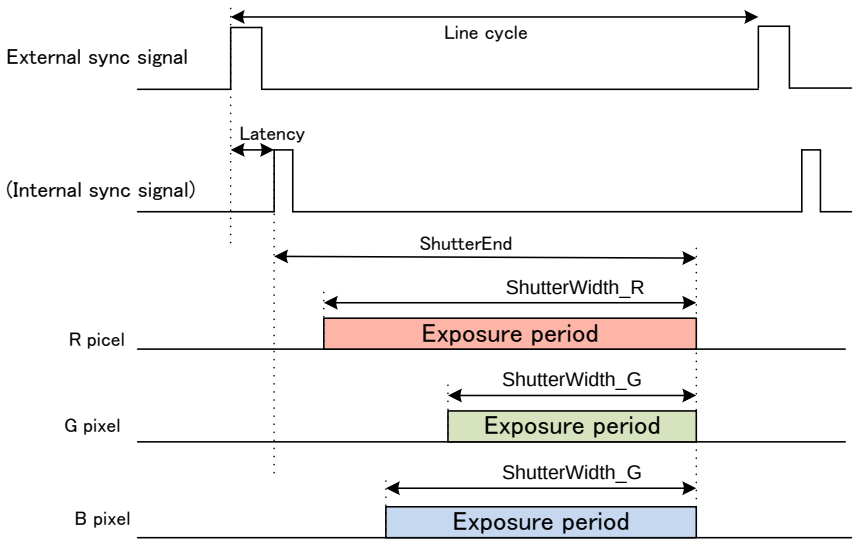
ShutterEnd = Exposure end timing (μsec) / 35

Exposure period setting

ShutterWidth_R/G/B = Exposure period R/G/B(μsec) / 35

In these formulas, 35 is a fixed value of this product.

Fig 3.13-1 Electronic shutter timing



The registers of the Electronic shutter function have to be set according to the following conditions. Also, when using the Electronic shutter function, you need to change factory setting of the function.

Condition: Set values according to the following conditions for Exposure end timing (ShutterEnd).

① Electronic shutter function ON (ShutterEnable = 1)

$$A \leqq \text{ShutterEnd} \leqq \text{Line cycle}\ (\mu\text{sec}) \times 35 - 6$$

A means : 620 resolution setting 600dpi case
358 resolution setting 300dip case
262 resolution setting 200dpi case
214 resolution setting 200dpi case

※ The minimum value that you can set changes in each resolution setting.

② Electronic shutter OFF (ShutterEnable = 0)

$$130 \leqq \text{ShutterEnd} \leqq \text{Line cycle}\ (\mu\text{sec}) \times 35 - 6$$

If you set lower value than the minimum value you can set at Exposure end timing of ShutterEnd, abnormal image data outputs. Also, If you set greater value than the maximum value you can set at Exposure end timing of ShutterEnd, skipping or ignoring sync signal may happen and eventually the number of output line may not fit with line cycle.

Condition: for Exposure period setting register of ShutterWidth_R,G,B

Set the value at Exposure period control register ShutterWidth_R,G,B for RGB each color, complying with the following condition.

$$1 \leqq \text{ShutterWidth\_R・G,B} \leqq \text{ShutterEnd} - 1$$

【Remark】

① This function is supposed to be used based on a combination of usage with a DC lighting external illumination. When using built-in LED on this product, do not use this function. LED duty control to adjust exposure period is recommended.
② Make sure if you set values which comply with the conditions mentioned above.
③ When using Electronics shutter function with External sync mode, keep a margin of Exposure end timing setting (ShutterEnd) corresponding to sync signal cycle you provide to this product.

3.14 Overlap output

【Overview】

There are 2 or 3 channels of CoaXPress® interfaces that output image information in parallel. Each image output from the 2 or 3 different channels can be overlapped partially. Like conventional line camera function, this function of this product enables you to have respective inspection process at each channel by using a part of image that is provided from the neighboring channel.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
7120h	OverlapEnable	R/W	Off On	0 1	Set Overlapoutput On/Off 0:OFF 1:ON	0

【Function】

When using this function (OverlapEnable ＝ On), 6.1mm width image data (144 pixels @600dpi) from 1st pixel of next or latter channel (or block) is added on the image data of master (or first or later) channel or block. Number of pixels that are added as overlapped pixels depends on resoulution you set.

- Register Address and name

  7120h/OverlapEnable

- Factory setting

  OverlapEnable ＝ Off (Overlapp output OFF)

- Explanation

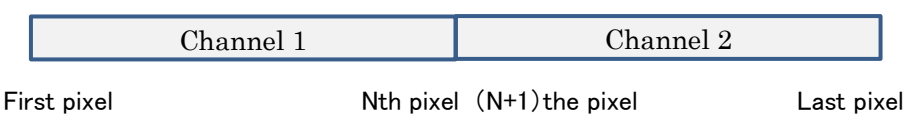
  When using initial seting of this function (OverlapEnable ＝ Off) on the products that have multiple channels of output, first channel (Master channel) outputs from first pixel to Nth pixel. And, 2nd channel (Slave channel) outputs from (N+1)th pixel to last pixel. Therefore, this product doesn't output any pixels that is overlapped and missed in entire scanning width but this product outputs an entire line data from first pixel to last pixel.

  This is a function to have overlapped image area of the each channel output by taking an image data from neighboring channel to each image output.

  Number of pixels that is overlapped at each resolution setting is listed below.

  Resolution setting 600dpi 144 pixels
  Resolution setting 300dpi 72 pixels
  Resolution setting 200dpi 48 pixels
  Resolution setting 150dpi 36 pixels

Overlap function OFF (OverlapEnable ＝ Off) case



Overlap function ON (OverlapEnable ＝ On) case

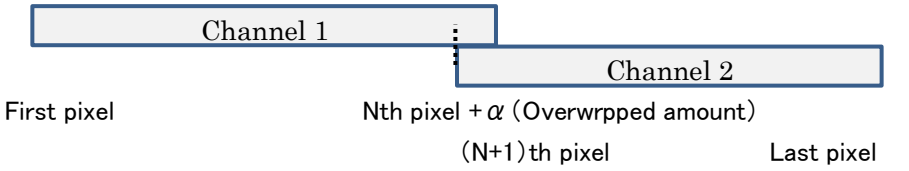
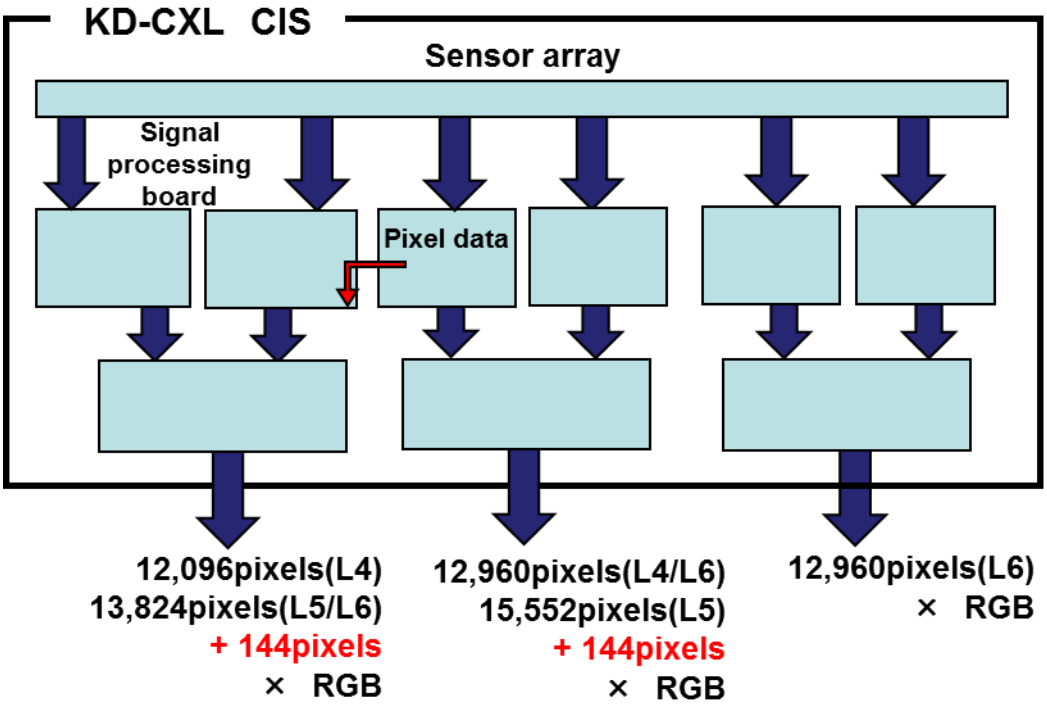


Fig 3.14-1 Function block diagram of Overlap



【Remark】

① When using this Overlap function, the number of pixel that is output increases. Make sure if you don't set less number of image output pixel than that of the necessary setting for this function. (Refer to 3.15). Also, the factory setting of the number of output pixel is designed not to be less than that of the necessary setting when using Overlap function ON.

3.15 Output width setting

【Overview】

This is a function to set a width of scanning width or number of pixels in scanning direction.

Factory setting for each product is set to be maximum number of output pixel (600dpi, Interpolation ON, Overlap ON).

When you set lower resolution and line rate 55KHz, you need to change the number of pixel from a value of the factory setting.

Additionally, if the actual number of output pixel is less than the value you set, you see some dummy data (output 0) after receiving the actual image data. When you would like to remove the unnecessary dummy pixel data after the actual image output, change the values on this register.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
6008h	Width	R/W	-	0 to 16380	Set numberof output pixels in scan direction (※)Set each necessary value at master channerl and slave channel.	L4:12292/13000 L5:14016/15608 L6:14016/13156 /13000

【Function】

This is a function to set number of pixel in scanning direction from each channel of this product.

The value of Width needs to be larger than the actual number of pixel that is output from this product and to be a value that has a factor of 4.

Minimum value of Width that you can set is listed below.

【Note】 Setting of Width is required to be set Master channel and Slave channel respectively.

- Register Address and name

  6008h/Width

- Factory setting

Width	=	12,292dec	in case of L4 : KD6R1064CXL-NL Channel1
		13,000dec	in case of L4 KD6R1064CXL-NL Channel2
Width	=	14,016dec	in case of L5 : KD6R1247CXL-NL Channel1
		15,608dec	in case of L5 : KD6R1247CXL-NL Channel2
Width	=	14,016dec	in case of L6 : KD6R1688CXL-NL Channel1
		13,156dec	in case of L6 : KD6R1688CXL-NL Channel2
		13,000dec	in case of L6 KD6R1688CXL-NL Channel3

Explanation

This is a function to set number of pixel that is output from image output channel over each CoaXPress ®. Number of pixel from each channel is listed on the following table. The setting value has to be a value that has a factor of 4. And if the actual number of output pixel is larger than that of the value you set, output value “000h” output istead of image output value.

Make sure if you set this value of each channel on the product that has multiple channels of output every time when you change resolution setting.

Fig 3.15-1 Functions and number of pixels

Model			L4		L5		L6		
			Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2	Channel 3
Minimum number of "Width"	Overwrap OFF	600dpi Interpolation ON	12148 (12145+dummy3)	13000 (12997+dummy3)	13872 (13872+dummy0)	15608 (15605+dummy3)	13872 (13872+dummy0)	13012 (13012+dummy0)	13000 (12997+dummy3
		600dpi	12096	12960	13824	15552	13824	12960	12960
		300dpi	6048	6480	6912	7776	6912	6480	6480
		200dpi	4032	4320	4608	5184	4608	4320	4320
		150dpi	3024	3240	3456	3888	3456	3240	3240
	Overwrap ON	600dpi Interpolation ON	12292 (12289+dummy3)	Same as Overwrap OFF	14016 (14016+dummy0)	Same as Overwrap OFF	14016 (14016+dummy0)	13156 (13156+dummy0)	Same as Overwrap OFF
		600dpi	12240		13968		13968	13104	
		300dpi	6120		6984		6984	6552	
		200dpi	4080		4656		4656	4368	
		150dpi	3060		3492		3492	3276	

【Remark】

① When setting a value of Width less than minimum value that you can set, abnormal image outputs. After resetting a correct value of Width, reprocess Device Discovery.

3.16 Test pattern

【Overview】

This is a function to output Test pattern to make sure if image data of this product correctly output to frame grabber you have over CoaXPress®. Use this function when you set up this product.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
6020h	TestImageSelector	R/W	Off GreyHorizontalRamp GreyVerticalRamp RGBW	0 1 2 3	Set test pattern 0:OFF 1:Grey ramp horizontal 2:Grey ramp vertical 3:RGBW	0
6024h	TestLineRate	R/W	–	0 to 55000	Set line rate for test pattern $Line\ Rate[Hz]$ = (register value)	55000
6028h	TriggerMode	R/W	Off On	0 1	Set source of sync signal 0: Internalsync mode 1: External sync mode	0

【Function】

This is a function to switch a type of test pattern by changing a value of register TestImageSelector.

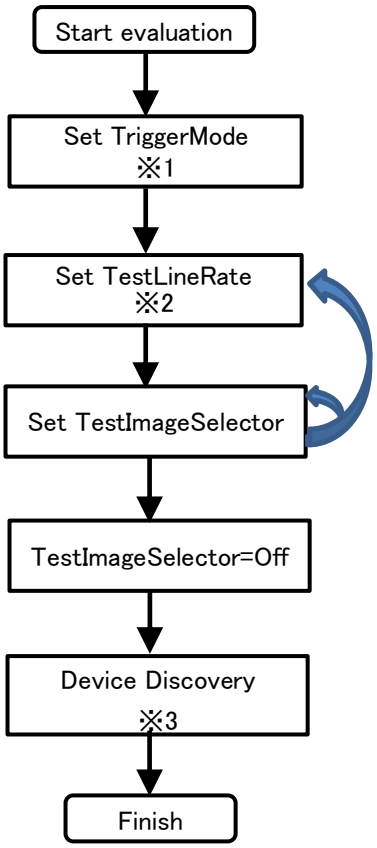
There are 3 types of test patterns that you can set.

- Register Address and name
  - 6020h/TestImageSelector
  - 6024h/TestLineRate
  - 6028h/TriggerMode
- Factory setting
  - TestImageSelector ＝ Off （0：scan image output）
  - TestLineRate ＝ 55,000dec （55KHz）
  - TriggerMode ＝ Off （Internal sync mode）

- Explanation

This is a function to output test image that is generated in this product. There are 3 different types of test pattern that can be generated on this product; A) Gray Ramp Horizontal mode which changes a gradation with a certain cycle in scanning direction, B) Gray Ramp Vertical mode which changes a gradation with a certain cycle in transport direction, and C) RGBW mode which repeat RGB mono color and white color in a cyclic manner..

Fig 3.16-1 Test pattern sequence



※1

When using test pattern based on internal sync mode, set TriggerMode Off→On→Off (you need to change to external sync mode once).
If you don't do this process and then you change Test pattern setting TestImageSelector, the test pattern does not output. When using this product based on External sync mode and TriggerMode is set to be On (external mode), test pattern outputs.

※2

When using internal sync and test pattern function, set a line cycle for the test pattern function by setting TestLineRate.

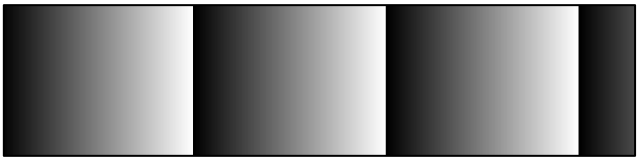
※3

When you would like to output scanning image from this product after outputting test pattern, process Device Discovery. (Before the device discovery, abnormal image outputs.)

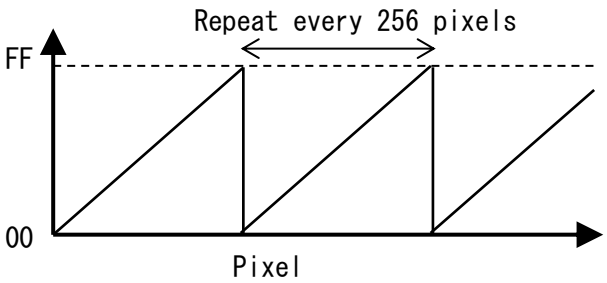
1) Grey ramp horizontal (Gray Ramp Horizontal mode)

This is a function to output that increase 1 digit pixel by pixel from first pixel in scanning direction. When setting output format 8 bit, the 1 digit increase repeats every 256 pixels. When setting output format 10 bit, the 1 digit increase repeatsevery 1024 pixels.

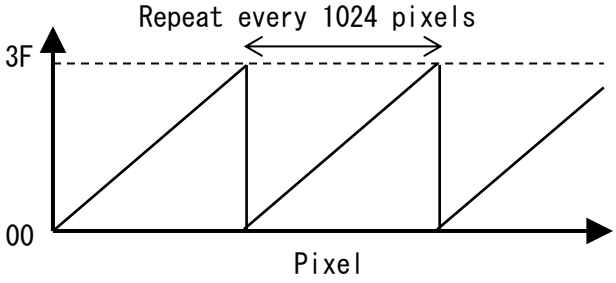
Fig 3.16-2 Test pattern Gray Ramp Horizontal mode



a) Ramp waveform (8bit/pixel output)



b) Ramp waveform (10bit/pixel output)



2) Grey ramp vertical　(Grey ramp vertical mode)

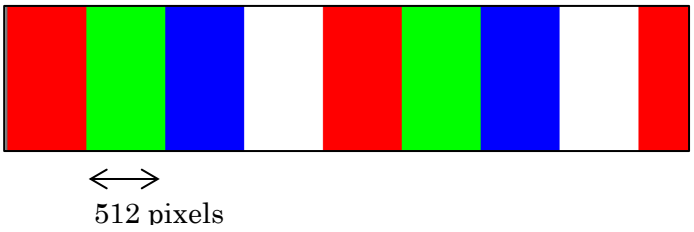
This is a function to output that increase 1 digit line by line from first line. When setting output format 8 bit, the 1 digit increase repeats every 256 lines. When setting output format 10 bit, the 1 digit increase repeatsevery 1024 lines.

Fig 3.16-3　Test pattern Gray Ramp Vertical mode

3) RGBW　(RGBW stripes in scanning direction)

This is a function to output that switches R, G, B, and White at every 512 pixels from first pixel.

Fig 3.16-4　Test pattern RGBW color stripes in scanning direction



【Remark】

① This is a function to make sure if the image data outputs from this product to your frame grabber. When outputting the test pattern, an actual scanning image data doesn't output.

3.17 Error and temperature indications

【Overview】

This function enables to provide some indications of errors, when cooling fan is stopped or operates at slow speed or a temperature of internal FPGA becomes abnormally high. Additionally, this function can provide an information of the temperature of the internal FPGA.

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
7224h	DeviceTemperature Mainboard	R	–	–	Indicate an internal temperature (℃) of FPGA on Image processing board (When using multiple image processing boards, this function indicates the maximum value.)	–
7228h	DeviceTemperature Ifboard	R	–	–	Indicate an internal temperature (℃) of FPGA on I/F board. (When using multiple image processing boards, this function indicates the maximum value.)	–
7230h	DeviceError	R	–	0 to 7	Return "Error" indications about cooling fan and FPGA temperature. 0 : Operating normally '1' at 0bit: Error of cooling fan. '1' at 1bit: Abnormal temperature of FPGA on Image processing board '1' at 2bit: Abnormal temperature of FPGA on I/F board	–

【Function】

- Register Address and name
  - 7224h/DeviceTemperatureMainboard
  - 7228h/DeviceTemperatureIfboard
  - 7230h/DeviceError
- Factory setting

DeviceTemperatureMainboard	No
DeviceTemperatureIfboard	No
DeviceError	No

- Explanation

1) Error indication

By reading a register DeviceError, you can confirm if there is an error of operation of a part of this product. At a timing that you read this register, this product confirmes an internal statu of the operation and respond if there is an error or not.

Error values and error contents that you can confirm by reading this register DeviceError are listed below.

- ・Bit 0 : Circulation error of built-in cooling fan.
- ・Bit 1 : Temperature error of FPGA on Image processing board.
- ・Bit 2 : Temperature error of FPGA on I/F board.

[Note] On your control software attached with your frame grabber, the values that you excuted to read at last are indicated. Until you excute next reading, the value at the registers will not be renewed.

2） Temeperature indication

When you read a register of DeviceTemperatureMainboard and DeviceTemperatureIfboard, this product responds an internal temperature of FPGAs. If there are multiple FPGAs on this product, maximum values on the multiple boards are responded.

【Remark】

① If an error is indicated, this product keep outputting image data. Make sure any causes of the errors by yourself.

3.18 Prevention for Exposure Saturation

(For products with DeviceFirmwareVersion 2. *. *. *)

[Overview]

In case of stopping to input external sync signal when using external sync mode, white saturated line image data and an image data that is not acuquired in an enough exposure period may output.

To prevent to occur white satulated line when restart to take image, you can use the following functions..

[Register list]

Address	Register name	R/W	Parameter Data	Function	Initial
7400h	STSP_Enable	R/W	0 1	Switching prevention for exposure saturation On/Off. 0: OFF 1: ON	0
7404h	STSP_MaxLine Period Counter	R/W	0 to 65535	Setting the period to judge whether occurring the condition without external sync signal or not. $Setting\ Period(usec) = \frac{(register\ value)+1}{35}$	3840
7408h	STSP_Prohibited Time Counter	R/W	0 to 65535	Setting prohibited period to resume to input sync signal. $Setting\ Period(usec) = \frac{(register\ value)+1}{35}$	1280

[Function]

1） You can set the prevention function for exposure saturation to be “Enable” or “disable”.

Switching prevention for exposure saturation On/Off.

- Register Address and name

  7400h /STSP_Enable

- Factory setting value

  STSP_Enable ＝ 0 （The prevention for exposure saturation OFF）

- Explanation

  When not using this function to be “Disable” (STSP_Enable = 0), an original saturated image data of a timing when line cycle was stopped outputs after restarting to acquire image data.

  When setting this function to be “Enable” (STSP_Enable = 1), this product reflects the following setting and alleviates the saturated image data and an image data that was not acuquired in an enough exposure period.Refer to fig 3.20-1 for the details of the chart in a timing.

2） Setting a period to judge whether occurring the condition without external sync. signal or not.

Set a period for this product to judge the condition that an external sync signal is not input as operatingconditions (manuscript stop). Refer to fig 3.20-1 for the details of the chart in a timing.

- Register Address and name

  7404h /STSP_MaxLine Period Counter

- Factory setting value

  STSP_MaxLine Period Counter ＝ 3840dec （Setting Period: 109.7usec）

- Explanation

  When using the prevention for exposure saturation (STSP_Enable = 1), set a period of this function at STSP_MaxLine Period Counter to judge the condition that an external sync signal is not input as operating conditions. Setting Period（usec） is calculated by the following formula.

$$Setting\ Period(usec) = \frac{(\text{Value of STSP\_MaxLinePeriod}) + 1}{35}$$

3） Image-output-prohibited-period setting to resumeto input sync signal. (STSP_ProhibitedTime)

When restarting to input sync signal (or move your object), the saturated image data or an image data that was not acuquired in an enough exposure period may output. Therefore, the image-output-prohibited-period to alleviate the saturated image or the image data that was not acuquired in an enough exposure period needs to be set. Refer to fig 3.20-1 for the details of the timing chart.

- Register Address and name

  7408h / STSP_Prohibited Time Counter

- Factory setting

  STSP_Prohibited Time Counter ＝ 1280dec （Setting Period: 36.6usec）

- Explanation

  When using the prevention for exposure saturation (STSP_Enable = 1), set the prohibited period to resume to input sync signal at STSP_Prohibited Time Counter that setting. Setting Period（usec） is calculated by the following formula.

$$Setting\ Period(usec) = \frac{(\text{Value of STSP\_ProhibitedTime}) + 1}{35}$$

[Notice]

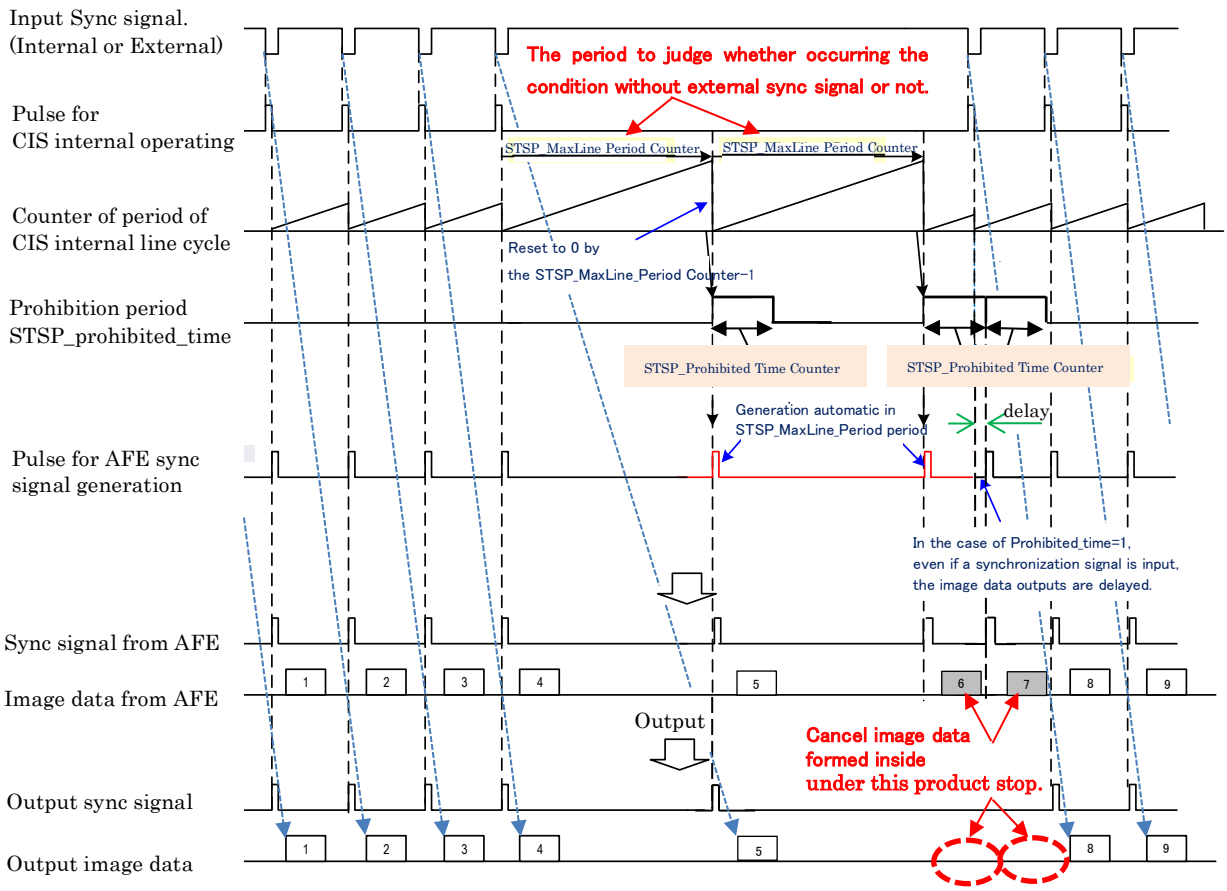
① Set STSP_MaxLinePeriod is longer than cycle time of input sync signal.

② Set STSP_ProhibitedTime according to below.

1/max line rate≦ Prohibited Time≦ cycle time of input sync signal

※Max line rate is change by data output format, output frequency, output resolution.
Refer to Table 3.3-2 for detail.

Fig 3.18-1 Timing chart of Prevention for Exposure Saturation



*AFE is abbreviation of the analog front end.

3.19 Read and write Dark and White correction coefficient, and γ table

【Overview】

This is a function to read and write Dark and White correction coefficient and γ table from frame grabber.

This register is not defined by Camera Description File (XML (Extensible Markup Language file)). By using register control function, access the registers directly. Additionally, when you access this register, make sure you use 4Byte unit.

This function is protected by a password (DevicePassword).

【Register list】

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
7300h	DevicePassward	R/W	–	0 to 65535	Password to canceled	–

The register addresses fothe coefficients are categolized by the upper 16 bit of the address values as follows.

【Function 】

1）Cancel password

Input 32817 (8031h)to the register of DevicePassward, then you can read and write Dark and White correction coeffients and γ table.

2）Read and write γ table

The addresses for γ table is listed as follows. After canceling the password, you can read and write the coefficients by accessing these register addresses.

Table 3.19-1 γ table address list

Address		Register function
Upper 16bit	Lower 16bit	
1000h	0000h～03FFh	γ table for Red
	0400h～07FFh	γ table for Green
	0800h～0BFFh	γ table for Blue

3）Read and write Dark and White correction coefficients

The register addresses fothe coefficients are categolized by the upper 16 bit of the address values as follows. After canceling the password, you can read and write the coefficients by accessing these register addresses.

Table 3.19-2 Dark correction data address list

Address		Product operation	
Upper 16bit	Lower 16bit	Function	Operation
1100h	0000h～FFFFh	Dark Correction Coefficient for R control	Read/Write Dark correction coefficient for R
1110h	0000h～FFFFh	Dark Correction Coefficient for G control	Read/Write Dark correction coefficient for G
1120h	0000h～FFFFh	Dark Correction Coefficient for B control	Read/Write Dark correction coefficient for B
1200h	0000h～FFFFh	White Correction Coefficient for R control	Read/Write White correction coefficient for R
1210h	0000h～FFFFh	White Correction Coefficient for G control	Read/Write White correction coefficient for G
1220h	0000h～FFFFh	White Correction Coefficient for B control	Read/Write White correction coefficient for B

Dark correction coefficient is defined by 10 bit (lower 1/4 of 12 bit step). White correction coefficient is defined by 12 bit. As described below, continuous 2 addresses consists of one pixel data.

Fig 3.19-1 White and Dark correction data bit allocation table

Dark correction coefficient

Address	MSB							LSB
#### h	b7	b6	b5	b4	b3	b2	b1	b0
####+1 h							b9	b8

White Correction coefficient

Address	MSB							LSB
#### h	b7	b6	b5	b4	b3	b2	b1	b0
####+1 h					b11	b10	b9	b8

The following table shows lower 16 bit of the addresses corresponding to each pixel position (600dpi output case).

Table 3.19-3 White correction data address list

Address		FPGA	FPGA area	Sensor IC No.	Pixel position @600dpi			Remark
Uppwer 16bit	Lower 16bit							
1###h	0000h～0D7Fh	FPGA1	1	1～6	1	～	1728	
	0D80h～1AFFh		2	7～12	1729	～	3456	
	1B00h～287Fh		3	13～15	3457	～	4320	2nd half of area is empty
	2880h～35FFh	FPGA2	1	16～21	4321	～	6048	
	3600h～437Fh		2	22～27	6049	～	7776	
	4380h～50FFh		3	28～30	7777	～	8640	2nd half of area is empty
	5100h～5E7Fh	FPGA3	1	31～36	8641	～	10368	
	5E80h～6BFFh		2	37～42	10369	～	12096	
	6C00h～797Fh		3	43～48	12097	～	13824	
	7980h～86FFh	FPGA4	1	49～54	13825	～	15552	
	8700h～947Fh		2	55～60	15553	～	17280	
	9480h～A1FFh		3	61～66	17281	～	19008	

The coefficients except for 600dpi resolution setting, are saved from beginning of the area of the FPGA.

4）Read and write Dark and White correction coefficients (For products with DeviceFirmwareVersion 2. *. *. *)

The register addresses fothe coefficients are categolized by the upper 16 bit of the address values as follows. After canceling the password, you can read and write the coefficients by accessing these register addresses.

Table 3.19-4 Dark and White correction data address

Adress		Product operation	
Upper 16bit	Lower 16bit	Function	Operation
1100h	0000h～FFFFh	Dark correction coefficient for R at 600dpi (1～32768 pixel)	Read/Write Dark correction coefficient for R
1101h	0000h～FFFFh	Dark correction coefficient for R at 600dpi (32769 pixel ～)	
1102h	0000h～FFFFh	Dark correction coefficient for R at 300dpi	
1103h	0000h～FFFFh	Dark correction coefficient for R at 200dpi	
1104h	0000h～FFFFh	Dark correction coefficient for R at 150dpi	
1110h	0000h～FFFFh	Dark correction coefficient for G at 600dpi (1～32768 pixel)	Read/Write Dark correction coefficient for G
1111h	0000h～FFFFh	Dark correction coefficient for G at 600dpi (32769 pixel ～)	
1112h	0000h～FFFFh	Dark correction coefficient for G at 300dpi	
1113h	0000h～FFFFh	Dark correction coefficient for G at 200dpi	
1114h	0000h～FFFFh	Dark correction coefficient for G at 150dpi	
1120h	0000h～FFFFh	Dark correction coefficient for B at 600dpi (1～32768 pixel)	Read/Write Dark correction coefficient for B
1121h	0000h～FFFFh	Dark correction coefficient for B at 600dpi (32769 pixel ～)	
1122h	0000h～FFFFh	Dark correction coefficient for B at 300dpi	
1123h	0000h～FFFFh	Dark correction coefficient for B at 200dpi	
1124h	0000h～FFFFh	Dark correction coefficient for B at 150dpi	
1200h	0000h～FFFFh	White correction coefficient for R at 600dpi (1～32768 pixel)	Read/Write White correction coefficient for R
1201h	0000h～FFFFh	White correction coefficient for R at 600dpi (32769 pixel ～)	
1202h	0000h～FFFFh	White correction coefficient for R at 300dpi	
1203h	0000h～FFFFh	White correction coefficient for R at 200dpi	
1204h	0000h～FFFFh	White correction coefficient for R at 150dpi	
1210h	0000h～FFFFh	White correction coefficient for G at 600dpi (1～32768 pixel)	Read/Write White correction coefficient for G
1211h	0000h～FFFFh	White correction coefficient for G at 600dpi (32769 pixel ～)	
1212h	0000h～FFFFh	White correction coefficient for G at 300dpi	
1213h	0000h～FFFFh	White correction coefficient for G at 200dpi	
1214h	0000h～FFFFh	White correction coefficient for G at 150dpi	
1220h	0000h～FFFFh	White correction coefficient for B at 600dpi (1～32768 pixel)	Read/Write White correction coefficient for B
1221h	0000h～FFFFh	White correction coefficient for B at 600dpi (32769 pixel ～)	
1222h	0000h～FFFFh	White correction coefficient for B at 300dpi	
1223h	0000h～FFFFh	White correction coefficient for B at 200dpi	
1224h	0000h～FFFFh	White correction coefficient for B at 150dpi	

Dark correction coefficient is defined by 10 bit (lower 1/4 of 12 bit step). White correction coefficient is defined by 12 bit. As described below, continuous 2 addresses consists of one pixel data.

Fig 3.19-2 Dark and White correction data bit allocation table

Dark correction coefficient

Address	MSB							LSB
#### h	b7	b6	b5	b4	b3	b2	b1	b0
####+1 h							b9	b8

White Correction coefficient

Address	MSB							LSB
#### h	b7	b6	b5	b4	b3	b2	b1	b0
####+1 h					b11	b10	b9	b8

The following shows lower 16 bit of the addresses corresponding to each pixel position.

Lower 16bit adress value for the i–th pixel = 2 x (i–1) and 2 x (i–1) +1 (decimal)

4 Control register list

4.1 Control register

Control registers of this product are categorized by the following register address area.

Fig 4.1-1 Register list

Address		Function	Master channel (L1,L2,L3type)	Slave channel (L2,L3type)	remark
Upper 16bit	Lower 16bit				
0000h	0000h～6FFFh	CIS Control register area 1 (CoaXpress™ I/F control)	●	●	Defined by XML file
	7000h～8FFFh	CIS Control register area 2 (Main control function of this product)	●	–	Defined by XML file
1###h	0000h～FFFFh	Read/Write Dark and White Correction coefficient and γ table	●	–	Defined by XML file

When controlling registers at register area 1, you need to change the register values at Master channel and Slave channel both. Except for register 6008h/Width, set the same values at Master and Slave channels.

4.2 Control register list

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
4014h	LinkConfig	R/W	CXP6-X4 CXP5-X4 CXP3-X4 CXP6-X2 CXP5-X2 CXP3-X2 CXP6-X1 CXP5-X1 CXP3-X1	40048h 40040h 40038h 20048h 20040h 20038h 10048h 10040h 10038h	Set Output data bitrate and number of output ・6.25Gbps 4ch/channel ・5Gbps 4ch/ channel ・3.125Gbps 4ch/ channel ・6.25Gbps 2ch/ channel ・5Gbps 2ch/ channel ・3.125Gbps 2ch/ channel ・6.25Gbps 1ch/ channel ・5Gbps 1ch/ channel ・3.125Gbps 1ch/ channel	40048h
6004h	Height	R	–	1	1Line fixed	1
6008h	Width	R/W	–	0 to 16380	Set number of output pixels in scan direction (※)Set each necessary value at master channerl and slave channel.	L4:12292/13000 L5:14016/15608 L6:14016/13156 /13000
600Ch	OffsetX	R/W	–	0	Line pixel position offset 0 fixed	0
6010h	PixelFormat	R/W	RGB8 RGB10 Mono8 Mono10	0401h 0402h 0101h 0102h	Switch image output format・24bit RGB カラー ・30bit RGB color ・8bit mono ・10bit mono	0401h
6014h	AcquisitionStart	R/W	(Execute)	1	AcqisitionStart 1:start	–
6018h	AcquisitionStop	R/W	(Execute)	1	AcqisitionStop 1:stop	–
601Ch	AcquisitionMode	R	Continuous	0	Continuous fixed	0
6020h	TestImageSelector	R/W	Off GreyHorizontalRamp GreyVerticalRamp RGBW	0 1 2 3	Set test pattern 0:OFF (output scan image) 1:Grey ramp horizontal 2:Grey ramp vertical 3:RGBW	0

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
6024h	TestLineRate	R/W	–	0 to 55000	Set line rate for test pattern $Line\ Rate[Hz]$ = (register value)	55000
6028h	TriggerMode	R/W	Off On	0 1	Set a source of sync signal 0: Internal sync mode 1: External sync mode	0
7000h	LinePeriodCounter	R/W	–	0 to 65535	Set Line cycle (Internal sync mode)	1749
7010h	LedSelector	R/W	LedOff LedOn_A LedOn_B LedOn_AB	0 1 2 3	LED control 0:OFF 1: Upper-stream LED-A ON 2: Down-stream LED-B ON 3: Both upper-stream (A) and down-stream (B) ON	0
7014h	LedPulseDivision	R/W	Div0 Div2 Div4 Div8	0 1 2 3	Set LED Pulse division 0:OFF 1: 2 pulses 2: 4 pulses 3: 8 pulses	0
7018h	LedPulseWidthA	R/W	–	0 to 65535	Upper-stream LED-A lighting period or pulse width	450
701Ch	LedPulseWidthB	R/W	–	0 to 65535	Down-stream LED-B lighting period or pulse width	450
7020h	LedEffectivePeriod	R/W	–	0 to 65535	Set LED Effective Period	692
7030h	ShutterEnable	R/W	Off On	0 1	Set Electronic shutter 0:OFF 1:ON	0
7034h	ShutterEnd	R/W	–	0 to 32765	Set exposure end timing	130
7038h	ShutterWidth_R	R/W	–	1 to 32764	Set Red exposure period	1
703Ch	ShutterWidth_G	R/W	–	1 to 32764	Set Green exposure period	1
7040h	ShutterWidth_B	R/W	–	1 to 32764	Set Blue exposure period	1
7050h	DarkCorrectionEnable	R/W	Off On	0 1	Set Dark correction On/Off0:OFF 1:ON	0
7054h	DarkCorrectionExecute	R/W	(Execute)	1	Generate Dark correction data	–
7070h	WhiteCorrectionEnable	R/W	Off On	0 1	Set White correction On/Off 0:OFF 1:ON	0
7074h	WhiteTarget_R	R/W	–	0 to 4095	Set Red White Correction Target value	4000
7078h	WhiteTarget_G	R/W	–	0 to 4095	Set Green White Correction Target value	4000
707Ch	WhiteTarget_B	R/W	–	0 to 4095	Set Blue White Correction Target value	4000
7080h	WhiteCorrectionExecute	R/W	(Execute)	1	Generate White Correction data (Normal Trigger mode)	–
7084h	WhiteCorrectionExtraTriger	R/W	Stop Start	0 1	Generate White Correction data (External Trigger mode) 0:END / 1:START	0
70A0h	DegitalGainEnable	R/W	Off On	0 1	Set PGA On/Off 0:OFF 1:ON	0
70A4h	DegitalGain_R	R/W	–	−1024 to 3071	Set a value of Red PGA (0 to 4.0)	0
70A8h	DegitalGain_G	R/W	–	−1024 to 3071	Set a value of Green PGA (0 to 4.0)	0

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
70ACh	DegitalGain_B	R/W	–	−1024 to 3071	Set a value of Blue PGA (0 to 4.0)	0
70B0h	ResolutionSetting	R/W	R600dpi_with_Interpolation R600dpi R300dpi R200dpi R150dpi	0 1 2 3 4	Set Resolution and Interpolation On/Off 0:600dpi, Interpolation ON 1:600dpi. Interpolation OFF 2:300dpi mode 3:200dpi mode 4:150dpi mode ※※Interpolation is not supported on 300,200, and 150dpi modes	1
70C0h	LineAdjustment Enable	R/W	Off On	0 1	Set Line adjustment On/Off 0:OFF 1:ON	1
70C4h	LineAdjustmentDirection	R/W	BGR RGB	0 1	Set transport direction 0: Normal (B → G → R :B-line first) 1: Opposit (R → G → B :R-line first)	0
70C8h	LineAdjustmentRatio	R/W	–	1 to 16384	Resolution in transport direction／600dpi Ratio (0.03 to 4.0) LineAdjustmentRatio =Resolution(transport direction)/600dpi×4096	4096
70CCh	LineAdjustmentOfset	R/W	–	0 to 4096	Offset setting of Green pixel (0 to 1.0) $Offset = \frac{(Register\ value)}{4096}$	0
70E0h	GammaCorrectionEnable	R/W	Off On	0 1	Set γ correction On/Off 0:OFF 1:ON	0
70E4h	GammaThreshhold1_R	R/W	–	0 to 1023	Set Threshold value 1 of γ correction for Red	49
70E8h	GammaThreshhold2_R	R/W	–	0 to 1023	Set Threshold value 2 of γ correction for Red	223
70ECh	GammaThreshhold3_R	R/W	–	0 to 1023	Set Threshold value 3 of γ correction for Red	544
70F0h	GammaThreshhold1_G	R/W	–	0 to 1023	Set Threshold value 1 of γ correction for Green	49
70F4h	GammaThreshhold2_G	R/W	–	0 to 1023	Set Threshold value 2 of γ correction for Green	223
70F8h	GammaThreshhold3_G	R/W	–	0 to 1023	Set Threshold value 3 of γ correction for Green	544
70FCh	GammaThreshhold1_B	R/W	–	0 to 1023	Set Threshold value 1 of γ correction for Blue	49
7100h	GammaThreshhold2_B	R/W	–	0 to 1023	Set Threshold value 2 of γ correction for Blue	223
7104h	GammaThreshhold3_B	R/W	–	0 to 1023	Set Threshold value 3 of γ correction for Blue	544
7110h	MonoModeSelect	R/W	Green Luminance Red Blue	0 1 2 3	Select Mono mode (This function can change the output of RGB color mode.) Mono mode 0: Green pixel output, 1: Luminance value output, 2:Red pixel output, 3: Blue pixel output RGB color mode 0: Color output, 1: Luminance value output, 2: Can not be selected, 3: Can not be selected	0

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
7120h	OverlapEnable	R/W	Off On	0 1	Set Overlap output On/Off 0:OFF 1:ON	0
7200h	UserSet_1_Save	R/W	(Execute)	1	Save CIS settings to User Setting 1 on Flush Memory.	–
7204h	UserSet_2_Save	R/W	(Execute)	1	Save CIS settings to User Setting 2 on Flush Memory.	–
7208h	UserSet_3_Save	R/W	(Execute)	1	Save CIS settings to User Setting 3 on Flush Memory.	–
720Ch	UserSet_1_Load	R/W	(Execute)	1	Read out CIS settings on User Setting 1.	–
7210h	UserSet_2_Load	R/W	(Execute)	1	Read out CIS settings on User Setting 2.	–
7214h	UserSet_3_Load	R/W	(Execute)	1	Read out CIS settings on User Setting 3.	–
7218h	UserSet_Load_FactoryDefalut	R/W	(Execute)	1	Read out CIS settings on Factory Setting (Initial Setting).	–
7224h	DeviceTemperature Mainboard	R	–	–	Indicate an internal temperature (℃) of FPGA on Image processing board (When using multiple image processing boards, this function indicates the maximum value.)	–
7228h	DeviceTemperature Ifboard	R	–	–	Indicate an internal temperature (℃) of FPGA on I/F board. (Whenusing multiple image processing boards, this function indicates the maximum value.)	–
7230h	DeviceError	R	–	0 to 7	Return “Error” indications about cooling fan and FPGA temperature. 0 : Operating normally ’1’ at 0bit: Error of cooling fan. ’1’ at 1bit: Abnormal temperature of FPGA on Image processing board ’1’ at 2bit: Abnormal temperature of FPGA on I/F board	–
7240h	UserSet_BootSet_select	R/W	FactoryDefalut UserSet_1 UserSet_2 UserSet_3	0 1 2 3	Select a setting to boot after power-ON. 0: Factory setting 1: User setting 1 2: User setting 2 3: User setting 3	0
7244h	UserSet_Boot_Error	R	0 to 7	–	Error flag of booting CIS ‘0’ or ‘1’ at bit0 :normal operation, ‘1’ at bit1: Error of User setting value, ‘1’ at bit2: Error of FPGA starting.	0
7248h	UserSet_Use_600dpi	R/W	(Execute)	0 1	Correction data for 600dpi resolution 0: Disable 1: Enable	1
724Ch	UserSet_Use_300dpi	R/W	(Execute)	0 1	Correction data for 300dpi resolution 0: Disable 1: Enable	0
7250h	UserSet_Use_200dpi	R/W	(Execute)	0 1	Correction data for 200dpi resolution 0: Disable 1: Enable	0
7254h	UserSet_Use_150dpi	R/W	(Execute)	0 1	Correction data for 150dpi resolution 0: Disable 1: Enable	0
7300h	DevicePassword	R/W	–	0 to 65535	Password to cancelled	–

Address Lower 16bit	Register name	R/W	Value		Function	Factory setting
7400h	STSP_Enable	R/W	OFF ON	0 1	Switching prevention for exposure saturation On/Off. 0: OFF 1: ON	0
7404h	STSP_MaxLine Period Counter	R/W	–	0 to 65535	Setting the period to judge whether occurring the condition without external sync signal or not.	3840
7408h	STSP_Prohibited Time Counter	R/W	–	0 to 65535	Setting prohibited period for resuming to input sync signal.	1280
2020h	DeviceModelName	R	–	32Byte String	The model name is stored. example:KD6R367CX	–
2090h	DeviceFirmwareVersion	R	–	32Byte String	The firmware version is stored. example:2.1.1.0	–
20B0h	DeviceID	R	–	16Byte String	The serial number is stored. example:1807190002	–