See the possibilities

User Manual

AP-1600T-PMCL

Digital 3CMOS Progressive Scan RGB Color Camera

Document Version: 1.2

AP-1600T-PMCL_Ver.1.2_Mar.2019

Thank you for purchasing this product.

Be sure to read this manual before use.

This manual includes important safety precautions and instructions on how to operate the unit. Be sure to read this manual to ensure proper operation.

The contents of this manual are subject to change without notice for the purpose of improvement.

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Notice

The material contained in this manual consists of information that is proprietary to JAI Ltd., Japan and may only be used by the purchasers of the product. JAI Ltd., Japan makes no warranty for the use of its product and assumes no responsibility for any errors which may appear or for damages resulting from the use of the information contained herein. JAI Ltd., Japan reserves the right to make changes without notice.

Company and product names mentioned in this manual are trademarks or registered trademarks of their respective owners.

Warranty

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

Certifications

CE compliance

As defined by the Directive 2004/108/EC of the European Parliament and of the Council, EMC (Electromagnetic compatibility), JAI Ltd., Japan declares that AP-1600T-PMCL complies with the following provisions applying to its standards.
EN 61000-6-3 (Generic emission standard part 1)
EN 61000-6-2 (Generic immunity standard part 1)

FCC

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Warning

Changes or modifications to this unit not expressly approved by the party responsible for FCC compliance could void the user's authority to operate the equipment.

KC

제조년월은 제품상자의 라벨을 참조하십시요

Supplement

The following statement is related to the regulation on " Measures for the Administration of the control of Pollution by Electronic Information Products " , known as " China RoHS ". The table shows contained Hazardous Substances in this camera.

mark shows that the environment-friendly use period of contained Hazardous Substances is 15 years.

重要注意事项

有毒，有害物质或元素名称及含量表

根据中华人民共和国信息产业部『电子信息产品污染控制管理办法』，本产品《 有毒，有害物质或元素名称及含量表 》如下.

部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴联苯 (PPB)	多溴二苯醚 (PBDE)
棱镜	×	○	○	○	○	○
光学滤镜	×	○	×	○	○	○
连接插头	×	○	○	○	○	○
电路板	×	○	○	○	○	○
.....	.....	.....	.....	.....	.....	.....

○: 表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006规定的限量要求以下。
×: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006规定的限量要求。
（企业可在此处、根据实际情况对上表中打 " × " 的技术原因进行进一步说明。）

环保使用期限
电子信息产品中含有的有毒有害物质或元素在正常使用的条件下不会发生外泄或突变、电子信息产品用户使用该电子信息产品不会对环境造成严重污染或对基人身、财产造成严重损害的期限。
数字「15」为期限15年。

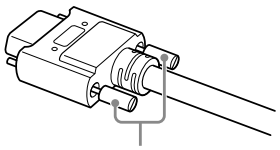
Usage Precautions

Notes on cable configurations

The presence of lighting equipment and television receivers nearby may result in video noise. In such cases, change the cable configurations or placement.

Notes on Camera Link cable connections

Secure the locking screws on the connector manually, and do not use a driver. Do not secure the screws too tightly. Doing so may wear down the screw threads on the camera. (Tightening torque: 0.291±0.049 N·m or less)



Secure manually.
Do not secure too tightly.

Notes on attaching the lens

Avoiding dust particles

When attaching the lens to the camera, stray dust and other particles may adhere to the sensor surface and rear surface of the lens. Be careful of the following when attaching the lens.

- Work in a clean environment.
- Do not remove the caps from the camera and lens until immediately before you attach the lens.
- To prevent dust from adhering to surfaces, point the camera and lens downward and do not allow the lens surface to come into contact with your hands or other objects.
- Always use a blower brush to remove any dust that adheres.
  Never use your hands or cloth, blow with your mouth, or use other methods to remove dust.

Phenomena specific to CMOS image sensors

The following phenomena are known to occur on cameras equipped with CMOS image sensors. These do not indicate malfunctions.

- **Aliasing**
  When shooting straight lines, stripes, and similar patterns, vertical aliasing (zigzag distortion) may appear on the monitor.
- **Blooming**
  When strong light enters the camera, some pixels on the CMOS image sensor may receive much more light than they are designed to hold, causing the accumulated signal charge to overflow into surrounding pixels.
  This “blooming” phenomenon can be seen in the image, but does not affect the operation of the camera.
- **Fixed pattern noise**
  When shooting dark objects in high-temperature conditions, fixed pattern noise may occur throughout the entire video monitor screen.
- **Defective pixels**
  Defective pixels (white and black pixels) of the CMOS image sensor are minimized at the factory according to shipping standards. However, as this phenomenon can be affected by the ambient temperature, camera settings (e.g., high sensitivity and long exposure), and other factors, be sure to operate within the camera’s specified operating environment.

Notes on exportation

When exporting this product, please follow the export regulations of your country or region.

Features

The AP-1600T-PMCL is an industrial progressive scan camera that uses three 1/2.9-inch global shutter CMOS image sensors with 1456×1088 effective pixels.

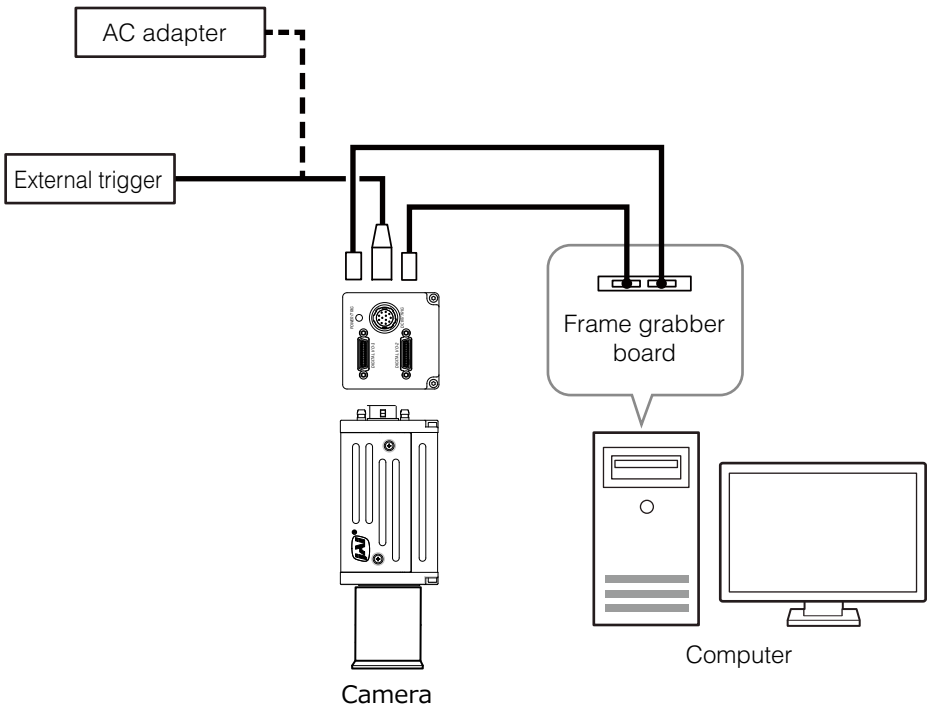
It allows maximum frame rates of 126.1 fps at full resolution.
Enhanced color reproduction is achieved via the newly-developed compact-designed 1/2.9-inch 3CMOS C-mount F1.8 prism optical system in addition to the internal color matrix circuit. Even higher definition imaging is made possible by the shading correction and gamma correction circuits.

The ROI and binning functions allow for even faster readout speeds.
The gain and exposure time can be configured individually for each CMOS sensor. A color space conversion function is also supported.

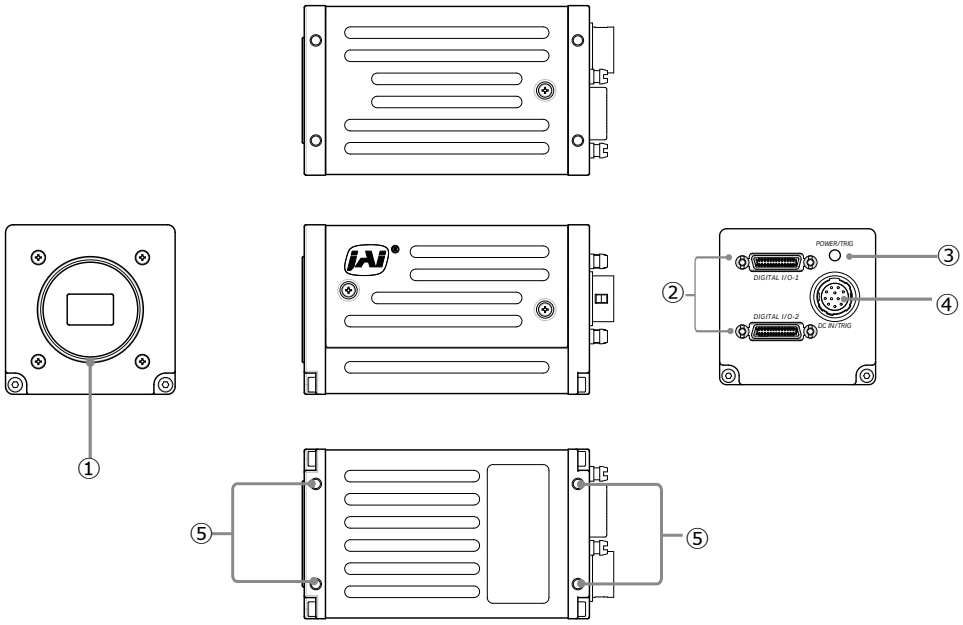
Features overview

- Compliance with CameraLink and GenICam standards
- 1/2.9-inch 3CMOS progressive RGB color camera
- Lens mount: C-mount (flange back: 17.526 mm)
- Effective pixels: 1456 (H) × 1088 (V); pixel size: 3.45 × 3.45 um
- Maximum frame rates of 126.1 fps at full resolution possible
- 24-bit or 30-bit RGB output (36-bit RGB output possible in video process bypass mode)
- Gamma correction circuit that uses lookup tables
- Color matrix that allows faithful color reproduction
- Color space conversion function (sRGB, Adobe RGB, HSI, XYZ) support
- Internal test signal for settings configuration
- JAI SDK that supports Windows Vista, 7, 8, 10

Connection example:



Parts Identification



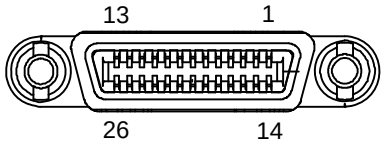
① Lens mount (C-mount)

Mount a C-mount lens, microscope adapter, etc. here.

❖ Before mounting a lens, be sure to refer to “Step 2: Connecting Devices” and confirm the precautions for attaching a lens and the supported lens types.

② Mini Camera Link connector

Connect a cable that is compatible with Mini Camera Link (SDR) connectors here.



Camera side: HONDA HDR-EC26FYTG2-SL+

Port 1

Pin No.	Input/output	Signal	Description
1, 26		Power	Power
2(–), 15(+)	Out	X_OUT0	Data out
3(–), 16(+)	Out	X_OUT1	
4(–), 17(+)	Out	X_OUT2	
5(–), 18(+)	Out	X_Clk	CL Clock
6(–), 19(+)	Out	X_OUT3	Data out
7(+), 20(–)	In	SerTC (RxD)	LVDS Serial Control
8(–), 21(+)	Out	SerTFG (TxD)	
9(–), 22(+)	In	CC1 (Trigger)	JAI standard trigger
10(+), 23(–)	In	CC2 (Reserved)	
11, 24		N.C	
12, 25		N.C	
13, 14		Shield	Power Return

Port 2

Pin No.	Input/output	Signal	Description
1, 26		Power	Power
2(–), 15(+)	Out	Y_OUT0	Data out
3(–), 16(+)	Out	Y_OUT1	
4(–), 17(+)	Out	Y_OUT2	
5(–), 18(+)	Out	Y_Clk	CL Clock
6(–), 19(+)	Out	Y_OUT3	Data out
7(+), 20(–)		N.C	
8(–), 21(+)	Out	Z_OUT0	Data out
9(–), 22(+)	Out	Z_OUT1	
10(+), 23(–)	Out	Z_OUT2	
11(–), 24(+)	Out	Z_Clk	CL Clock
12(–), 25(+)	Out	Z_OUT3	Data out
13, 14		Shield	Power Return

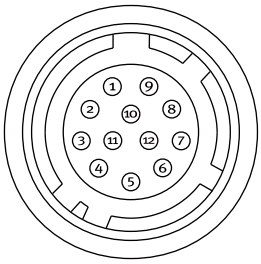
③ Power/trigger LED

Indicates the power and trigger input status.

LED status and camera status

LED	Light	Status
Power / trigger LED	Lit amber	Camera initializing.
	Lit green	Operational and no triggers being input.
	Blinking green	Operational and triggers being input. ❖ The blinking interval is not related to the actual input interval of the external trigger.

④ DC IN / trigger IN connector (12-pin round)
Connect the cable for DC IN /trigger IN here.



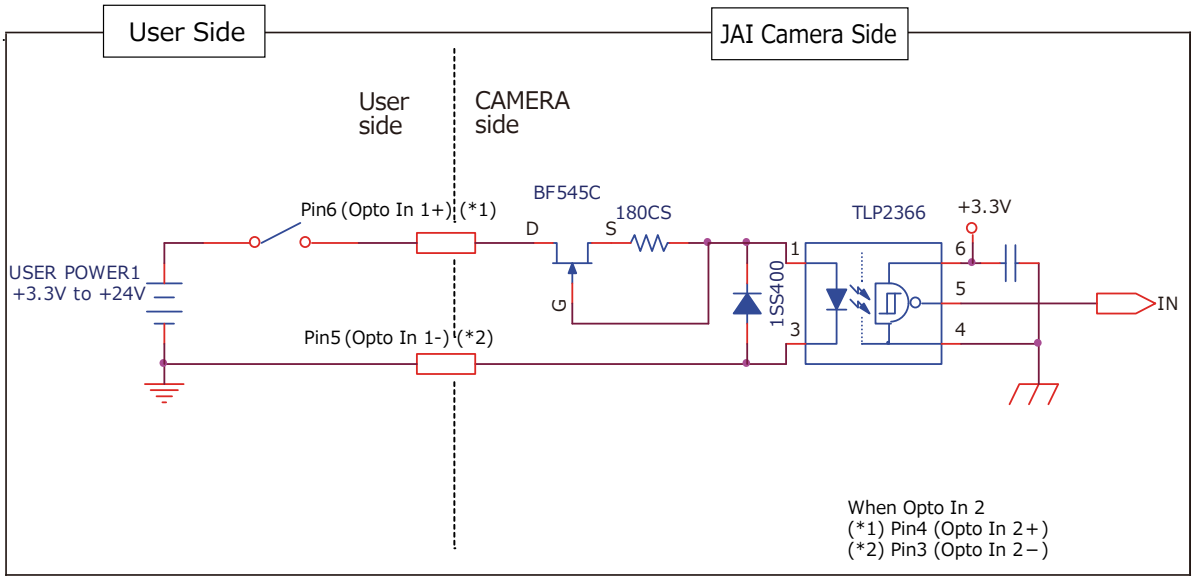
HR-10A-10R-12PB (71) (Hirose Electric or equivalent)

Pin No.	Input/ output	Signal	Description
1		GND	
2	Power IN	DC IN	DC 12 V to 24 V ±10%
3	In	Opto IN 2−	Line 6
4	In	Opto IN 2+	
5	In	Opto IN 1−	Line 5
6	In	Opto IN 1+	
7	Out	Opto OUT 1−	Line 2
8	Out	Opto OUT 1+	
9	Out	TTL OUT 1	Line 1
10			
11	Power IN	DC IN	DC 12 V to 24 V ±10%
12		GND	

Note

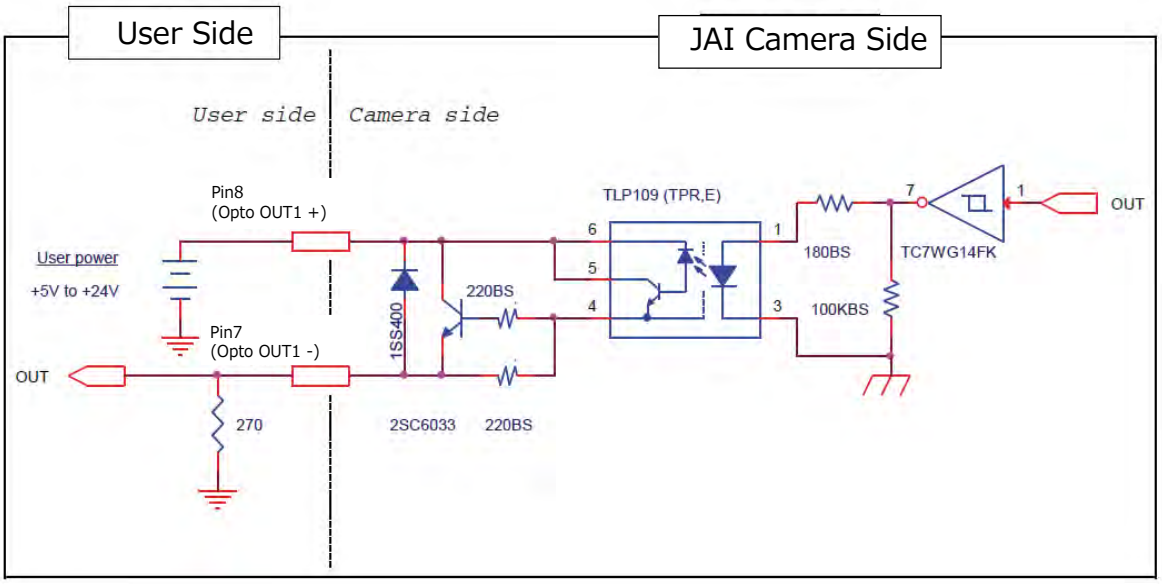
When DC power is supplied to either Pin 1/Pin 2 or Pin 11/Pin 12, the camera operates.

Recommended external input circuit diagram (reference example)



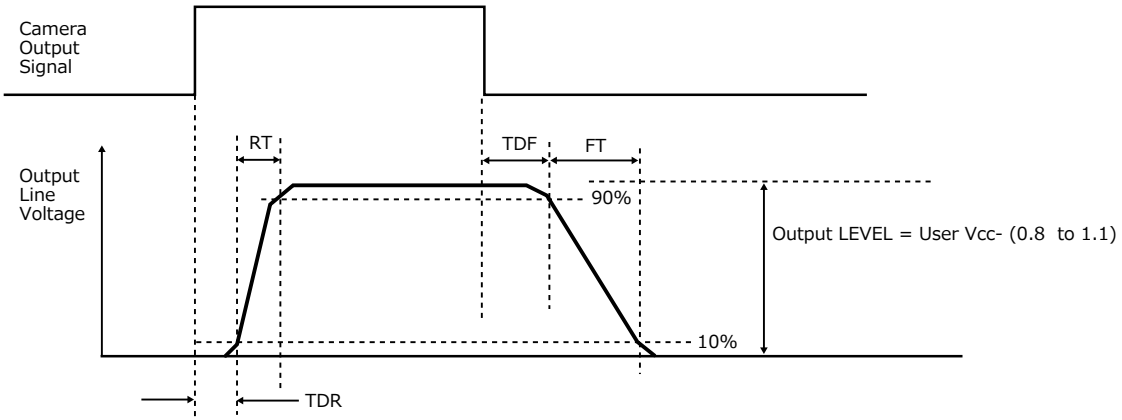
Recommended external output circuit diagram (reference example)

Standard circuit diagram example



Characteristics of the recommended circuits for Opto OUT

OUTPUT LINE RESPONSE TIME



	User power (VCC)
	3.3 V to 24 V
Time Delay Rise TDR (us)	0.5 to 0.7
Tisc Time RT (us)	1.2 to 3.0
Time Delay Fall TDF (us)	1.5 to 3.0
Fall Time FT (us)	4 to 7

⑤ **Camera locking screw holes (M3, 3 mm depth)**
Use these holes when attaching an MP-44 tripod adapter plate (optional) or mounting the camera directly to a wall or other structural system.

Preparation

Preparation Process

Step 1	**Installing the Software (first time only)** Install the software for configuring and controlling the camera (JAI SDK) on the computer.
⬇	
Step 2	**Connecting Devices** Connect the lens, LAN cable, AC adapter, computer, and other devices.
⬇	
Step 3	**Verifying Camera Operation** Verify whether the camera is turned on and ready for use.
⬇	
Step 4	**Verifying the Connection between the Camera and PC** Verify whether the camera is properly recognized via Control Tool.
⬇	
Step 5	**Changing the Camera Settings** Refer to the procedure for changing the output format setting as an example, and change various settings as necessary.
⬇	
Step 6	**Adjusting the Image Quality** Refer to the procedures for adjusting the gain, white balance, and black level as examples, and adjust the image quality.
⬇	
Step 7	**Saving the Settings** Save the current setting configurations in user memory.

Step 1: Installing the Software (first time only)

When using the camera for the first time, install the software for configuring and controlling the camera (JAI SDK) on the computer.

❖ When you install JAI SDK, JAI Camera Control Tool will also be installed.

1 Download the "JAI - Getting Started Guide" and JAI SDK from the JAI website.

URL: http://www.jai.com/en/support/download-jai-software

2 Refer to the "JAI - Getting Started Guide," and install JAI SDK on the computer.

The computer will restart when installation is complete.

Note

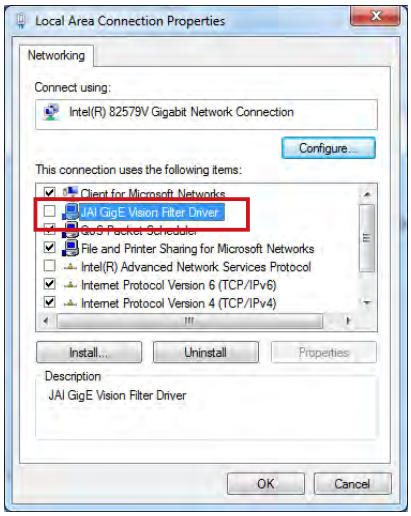
When the JAI SDK is installed, a camera driver for the GigE interface is also part of the default installation. This GigE Vision Filter Driver is added to every NIC/port on the host computer. As the driver is also added to the NIC/port for Internet connection, it may, on some systems, affect Internet access speed. If you think your Internet speed is affected, configure the following settings to disable the filter driver on that port.

❶ Open [Control Panel] → [Network and Internet] → [Connect to a network], and right-click the port used for Internet connection to open the properties dialog box.

Caution

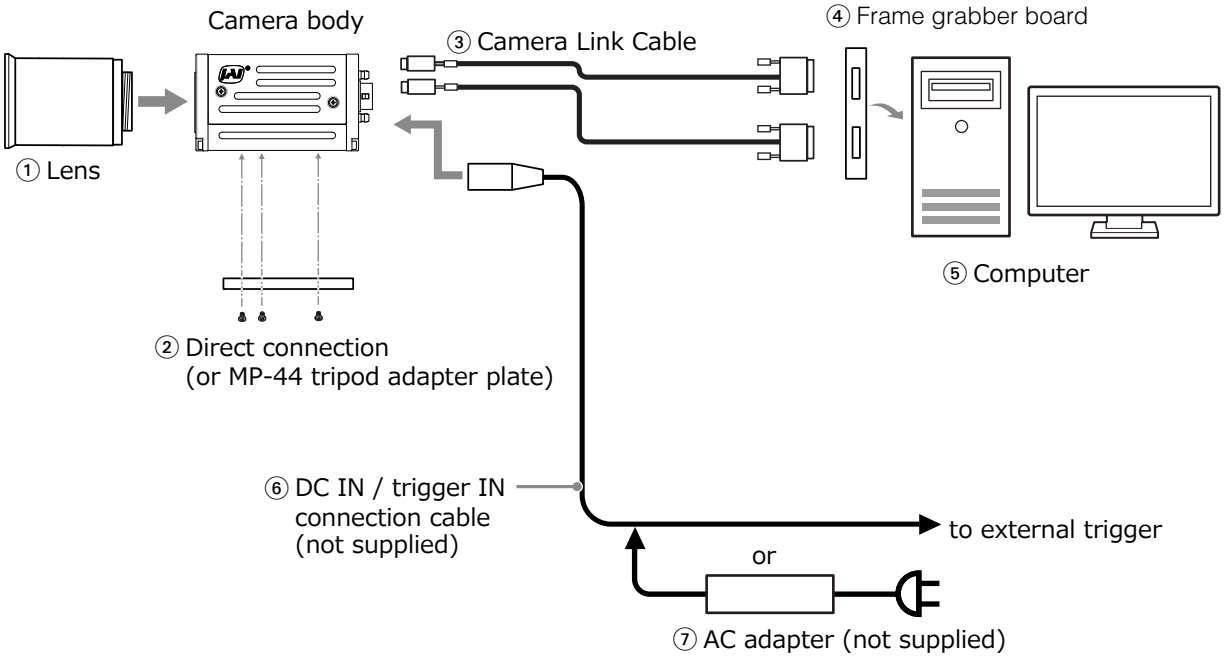
JAI SDK Version 3.0.2 or later is required to use this camera model.

❷ Clear the [JAI GigE Vision Filter Driver] checkbox, and save.



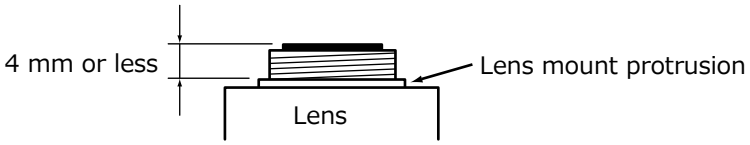
Step 2: Connecting Devices

Connect the lens, LAN cable, AC adapter, and other devices.
Attach the lens in a clean environment to prevent dust from adhering to the unit.



① Lens

- C-mount lenses with lens mount protrusions of 4 mm or less can be attached.



- Use a lens designed for three-sensor cameras. Using a lens for single-sensor cameras may hinder full performance of the camera.
- The diagonal of the camera's CMOS image sensor is 6.27 mm, the size of standard 1/2.9-inch lenses. To prevent vignetting and to obtain the optimal resolution, use a lens that will cover the 6.27 mm diagonal. Some lens manufacturers offer lenses with an 6.27 mm format. If not, a 1/2.9-inch lens is recommended.

Caution

- The maximum performance of the camera may not be realized depending on the lens.
- Attaching a lens with a mount protrusion of 4 mm or longer may damage the lens or camera.

Note

The following formula can be used to estimate the focal length.

focal length = WD / (1 + W/w)

WD: Working distance (distance between lens and object)

W: Width of object

w: Width of sensor (5.02 mm on this camera)

② **Direct connection (or MP-44 tripod adapter plate)**

When mounting the camera directly to a wall or other device, use screws that match the camera locking screw holes on the camera. (M3, depth: 3 mm)

Use the supplied screws to attach the tripod adapter plate.

Caution

For heavy lenses, be sure to support the lens itself. Do not use configurations in which its weight is supported by the camera.

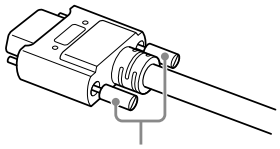
③ Camera Link cable

Connect the Camera Link cable to the Mini Camera Link connector.

- Use a cable that supports the Camera Link standard and is compatible with Mini Camera Link (SDR) connectors.
- Refer to the specifications of the cable for details on its bend radius.
- For details on the cable, see “2 Mini Camera Link connector”.

Caution

Secure the locking screws on the connector manually, and do not use a driver. Do not secure the screws too tightly. Doing so may wear down the screw threads on the camera. (Tightening torque: 0.291±0.049 N·m or less)



Secure manually.
Do not secure too tightly.

When power is supplied by PoCL, be sure to connect the camera link cable to both DIGITAL I / O - 1 and DIGITAL I / O - 2 regardless of the setting.

④ Frame grabber board

Refer to the operating instructions of the frame grabber board, and configure settings on the computer as necessary.

⑤ **Computer**

Use a computer that meets the following requirements.

Operating system (OS):

Microsoft Windows Vista/7/8 32-bit/64-bit edition

CPU: Intel Core i3 or higher

Memory:

Windows Vista/7/8/10 32-bit edition: DDR3, 4 GB or higher

Windows Vista/7/8/10 64-bit edition: DDR3, 8 GB or higher

Graphics card: PCI-Express 3.0 or higher

Network card: We recommend using a network card that uses an Intel chip.

⑥ **DC IN / trigger IN connection cable**

⑦ **AC adapter (power supply) (if necessary)**

Connect the AC adapter and the round connector of the connection cable to the DC IN / trigger IN connector on the camera.

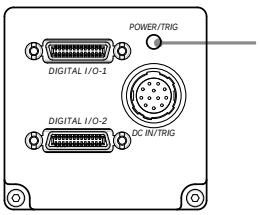
❖ The AC adapter is not required when using PoCL.

Step 3: Verifying Camera Operation

When power is supplied to the camera while the necessary equipment is connected, the POWER/TRIG LED at the rear of the camera lights amber, and initialization of the camera starts. When initialization is complete, the POWER/TRIG LED lights green.

Verify whether power is being supplied to the camera by checking the rear LED.

When properly turned on



❖ For details on how to read the LEDs, see “LED status and camera status” in the “Parts Identification” section.

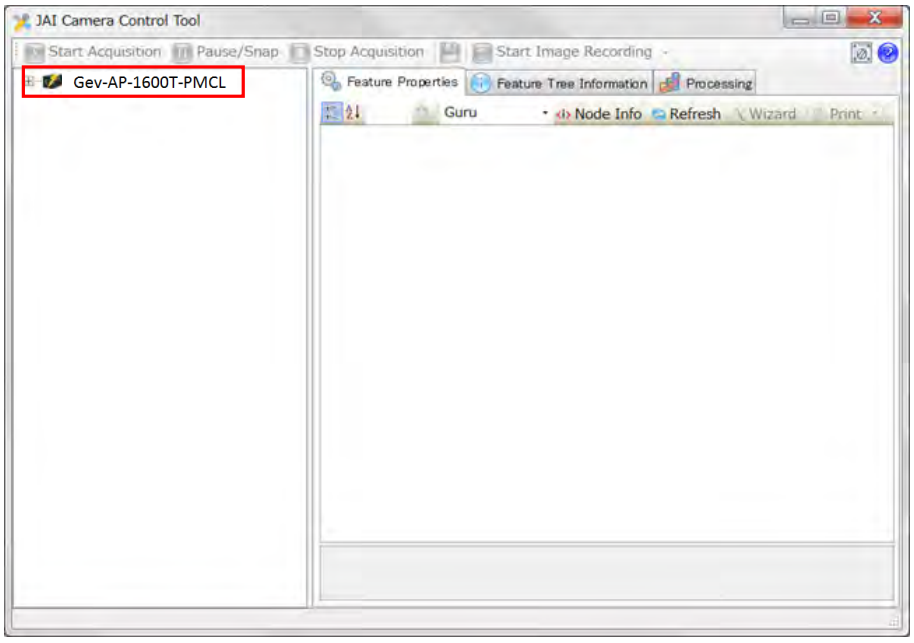
Step 4: Verifying the Connection between the Camera and PC

Verify whether the camera is properly recognized via Control Tool.

Connecting the Camera to Control Tool

1 Start JAI Control Tool.

The JAI Control Tool startup screen appears.



Check the settings when using Camera Link.

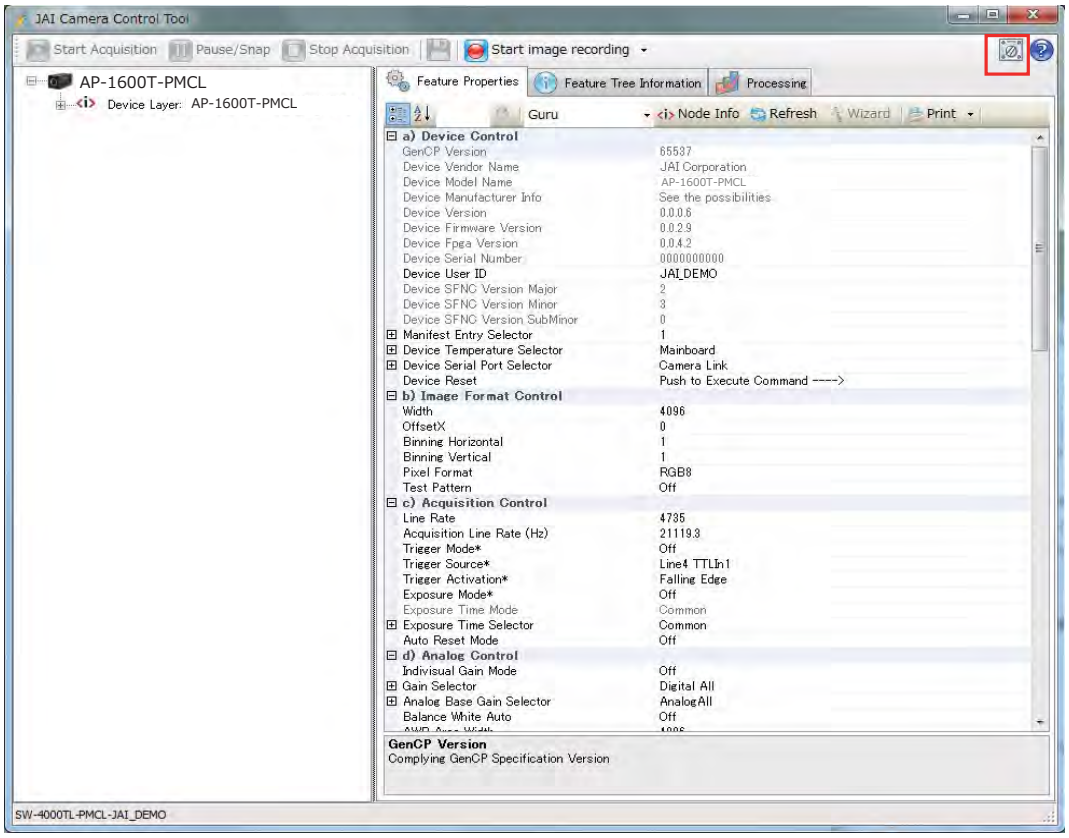
AP-1600T-PMCL supports GenICam and GenCP. If you want to control the camera with the JAI SDK, check the following settings.

Confirmation of frame grabber board

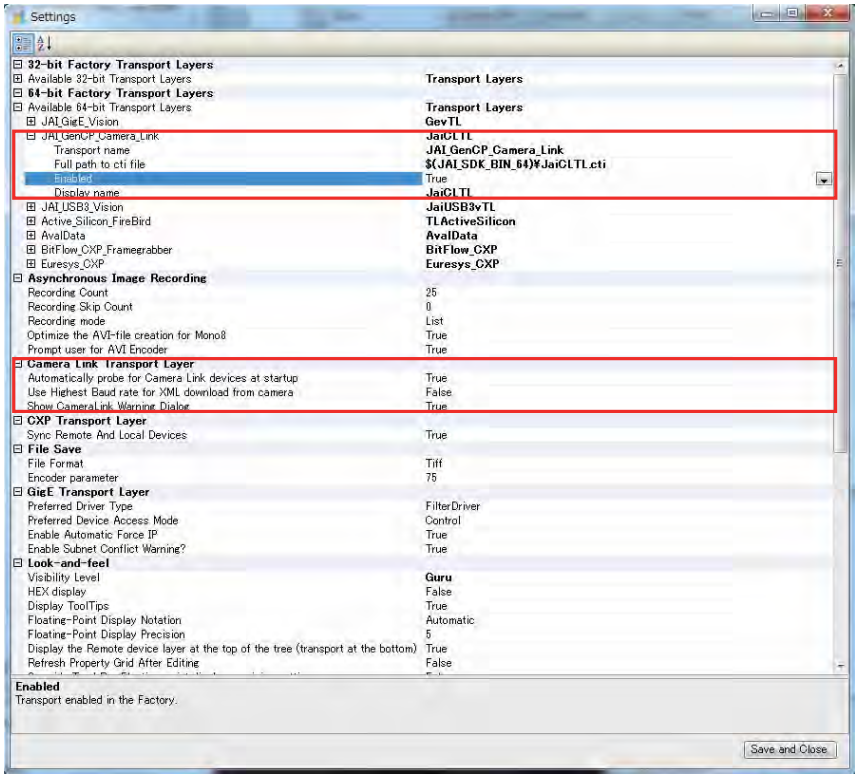
In order to support GenCP, it is necessary to set the COM port on the frame grabber board. For details, please refer to the instruction manual of each board maker.

Confirmation of JAI SDK

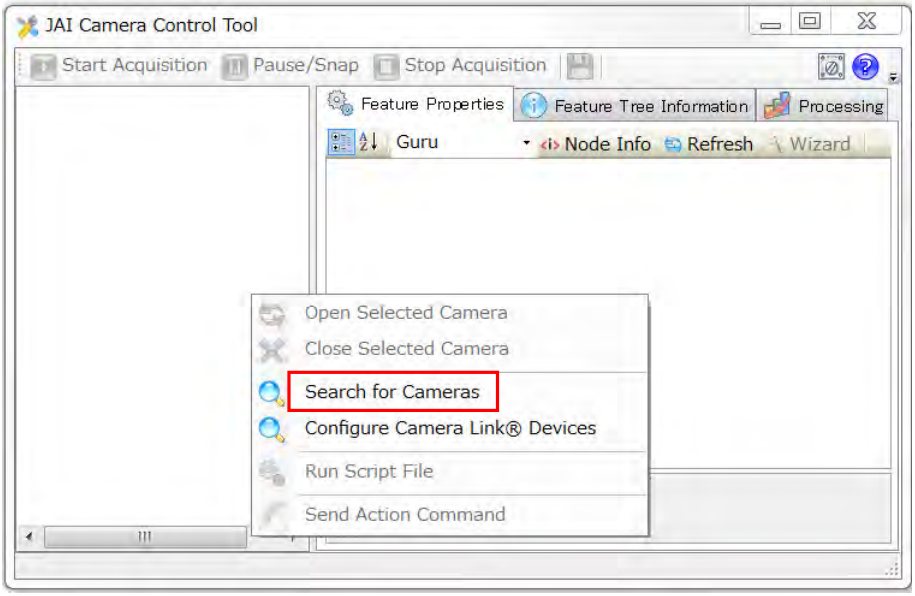
❶ Start JAI Control Tool and click  (Settings) in the upper right.



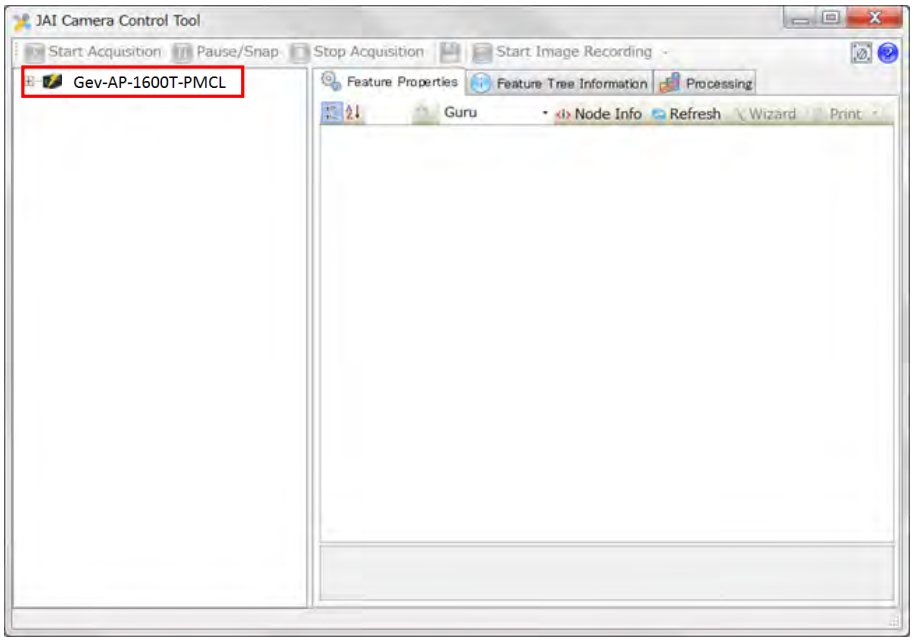
❷ The items of [JAI_GenCP_Camera_Link] and [Camera Link Transport Layer] are set to the following settings Confirm that it is.



If a camera is not detected, right-click within the window and select [Search for Cameras].

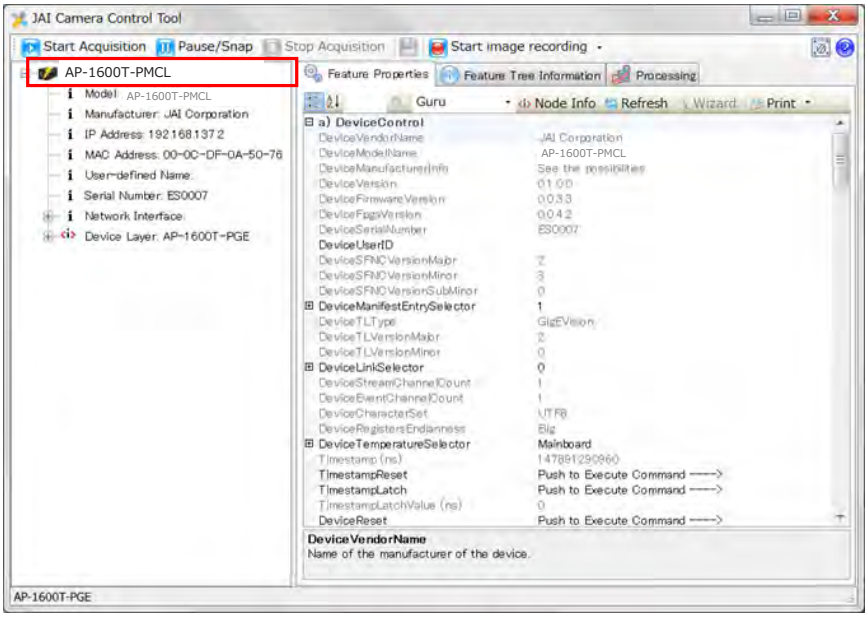


2 Select the camera you want to configure.



3 Check that the settings of the selected camera are displayed.

Check that the settings information of the selected camera appears in the right area.



This completes the procedure for verifying whether the camera is properly recognized and whether control and settings configuration are possible.

Step 5: Changing the Camera Settings

This section explains how to change settings by describing the procedure for changing the output format as an example.

Configuring the Output Format

Configure the size, position, pixel format of the images、ClConfiguration and CameraLinkClockFrequency to be acquired.
The factory settings are as follows. Change the settings as necessary.

Factory default values

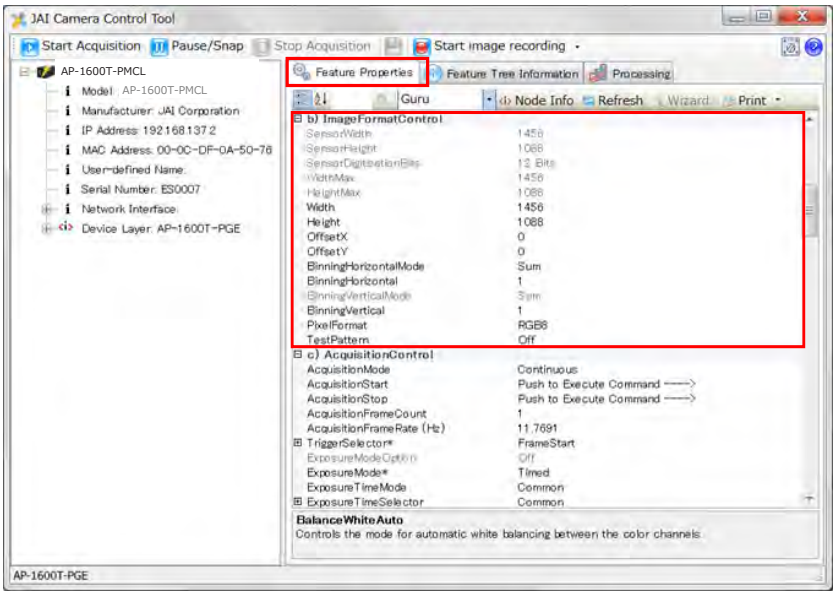
Item		Default value
ImageFormatControl	Width	1456
	Height	1088
	OffsetX (horizontal position)	0
	OffsetY (vertical position)	0
	Pixel Format	RGB8

Item		Default value
TransportLayerControl	ClConfigurtion	Medium
	CameraLinkClockFrequency	74.3MHz

❖ You can specify the image acquisition area. For details, see “ROI (Regional Scanning Function)” .

1 Select the [FeatureProperties] tab, and select the item you want to configure under [ImageFormatControl].

▼ when a configurable item is selected.



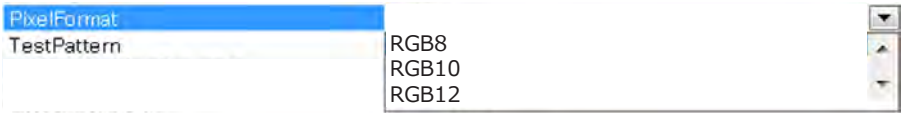
Note

Settings can only be changed when image acquisition on the camera is stopped. If an item is grayed out and ▼ does not appear even when you select it, click ■ (Stop Acquisition) to stop image acquisition.

2 Click ▼ and change the setting value.

Example: When changing [Width]

Example: When changing [PixelFormat]



Note

Direct entry of numerical and text values is possible for some setting items.

Step 6: Adjusting the Image Quality

Display the camera image and adjust the image quality.

Displaying the Image

Display the image captured by the camera.

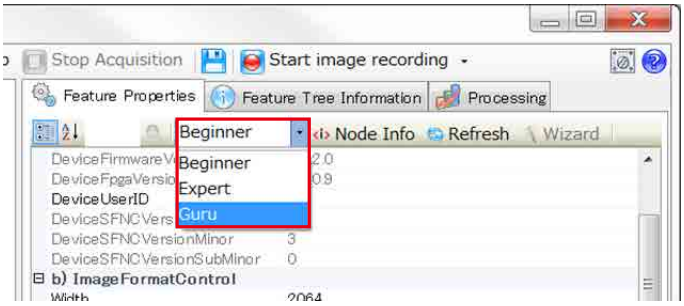
Please display the image with the viewer on the frame grabber board application.

Adjusting the Gain

Adjust the image quality using the gain and white balance functions.

To adjust the image quality

The display level must be changed from [Beginner] to [Guru].



Adjust the sensitivity via the analog gain (i.e., master gain).

❖ For details on gain control, see “Gain Control” in the “Main Functions” section.

■ Manual adjustment

1 Expand [AnalogControl], and set [GainAuto] and [IndividualGainMode] to [Off].

([Off] is the default setting.)

2 Configure the gain.

❶ Expand [AnalogControl], and select the gain you want to configure in [GainSelector]. [AnalogAll] (master gain), [AnalogRed] (R gain), [AnalogBlue] (B gain), [DigitalRed] (digital R gain), and [DigitalBlue] (digital B gain) can be configured.

❷ Configure the gain value in [Gain].

- [AnalogAll] (master gain) can be set to a value from x1 to x8 (0 dB to about +18 dB) the analog gain value. The resolution is set in x0.1 steps. Values are configured by multipliers.
- The [AnalogRed] (R gain) and [AnalogBlue] (B gain) can be set to a value from x0.47 to x4.0 (−6.5 dB to +12 dB) the [AnalogAll] (master gain) value.
- The [DigitalRed] (digital R gain) and [DigitalBlue] (digital B gain) can be set to a value from x0.9 to x1.1 (−0.915 dB to +0.828 dB) the [AnalogAll] (master gain) value.

Note

The following two methods are available for adjusting the gain manually.

- MasterMode (set IndividualGainMode to Off) (see the above)
- IndividualMode (set IndividualGainMode to On)

❖ For details, see "Gain Control".

Adjusting the White Balance

Adjust the white balance using the automatic adjustment function.

■ Automatic white balance adjustment

1 Place a white sheet of paper or similar object under the same lighting conditions as the intended subject, and zoom in to capture the white.

White objects near the subject, such as a white cloth or wall, can also be used.

Be sure to prevent the high-intensity spot lights from entering the screen.

2 Select the [BalanceWhiteAuto] tab, and select [Continuous], [Once], [ExposureContinuous], or [ExposureOnce] for the adjustment method.

The white balance is automatically adjusted.

Note

- The white balance is adjusted via gain adjustment for [Continuous] and [Once].
- The white balance is adjusted via exposure time adjustment for [ExposureContinuous] and [ExposureOnce].

Adjusting the Black Level

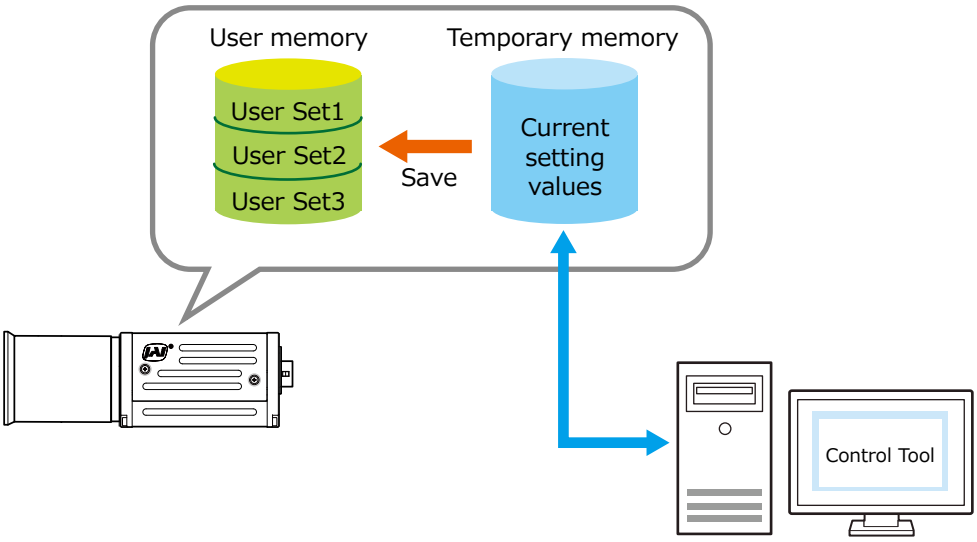
1 Expand [AnalogControl], and select the black level you want to configure in [BlackLevelSelector].

[DigitalAll] (master black), [DigitalRed] (digital R), and [DigitalBlue] (digital B) can be configured.

2 Specify the adjustment value in [BlackLevel].

Step 7: Saving the Settings

The setting values configured in Control Tool will be deleted when the camera is turned off. By saving current setting values to user memory, you can load and recall them whenever necessary. You can save up to three sets of user settings in the camera. (User Set1 to 3)



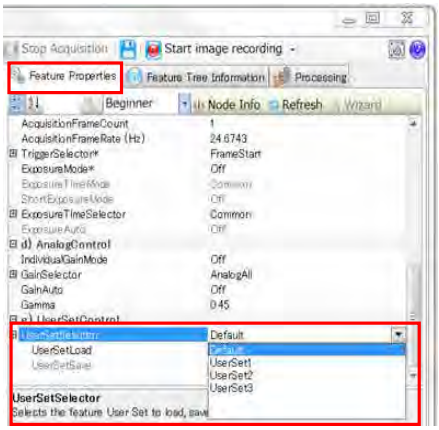
Note

Changes to settings are not saved to the computer (Control Tool).

■ To save user settings

1 Stop image acquisition.

2 Expand [UserSetControl], and select the save destination ([UserSet1] to [UserSet3]) in [UserSetSelector].



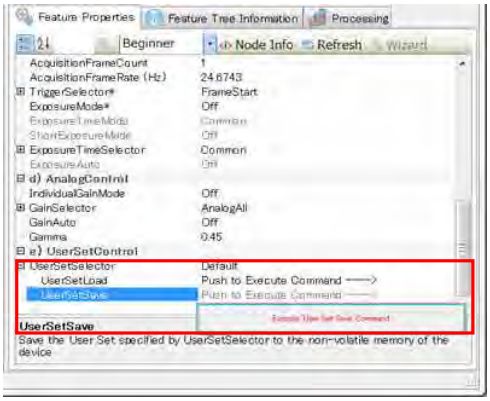
Note

The factory default setting values are stored in [Default] and cannot be overwritten.

Caution

Settings can only be saved when image acquisition on the camera is stopped.

3 **Select [UserSetSave], and click [Execute 'UserSetSave' Command].**



The current setting values are saved as user settings.

■ To load user settings

1 **Stop image acquisition.**

User settings can only be loaded when image capture on the camera is stopped.

2 **Select the settings to load (UserSet1 to UserSet3) in [UserSetSelector].**

3 **Select [UserSetLoad], and click [Execute 'UserSetLoad' Command].**

The selected user settings are loaded.

Main Functions

Basic Function Matrix

The combinations of settings for the basic functions that can be used together are as follows.

ExposureMode	FrameStartTrigger	BinningVertical	BinningHorizontal	ExposureTime	ROI	BalanceWhiteExposureAuto	BalanceWhiteGainAuto	GainAuto	ExposureAuto	Sequencer	
										TriggerSequencerMode	CommandSequencerMode
Off	Off	1 × 1 (Off)		×	○	×	○	○	×	×	×
		1 × 2		×	○	×	○	○	×	×	×
		2 × 1		×	○	×	○	○	×	×	×
		2 × 2		×	○	×	○	○	×	×	×
Timed	Off	1 × 1 (Off)		○	○	○	○	○	○	×	○
		1 × 2		○	○	○	○	○	○	×	○
		2 × 1		○	○	○	○	○	○	×	○
		2 × 2		○	○	○	○	○	○	×	○
Timed (EPS)	On	1 × 1 (Off)		○	○	○	○	○	○	○	○
		1 × 2		○	○	○	○	○	○	○	○
		2 × 1		○	○	○	○	○	○	○	○
		2 × 2		○	○	○	○	○	○	○	○
TriggerWidth	On	1 × 1 (Off)		×	○	×	○	○	×	×	×
		1 × 2		×	○	×	○	○	×	×	×
		2 × 1		×	○	×	○	○	×	×	×
		2 × 2		×	○	×	○	○	×	×	×
RCT	On	1 × 1 (Off)		○	○	○	○	○	○	×	×
		1 × 2		○	○	○	○	○	○	×	×
		2 × 1		○	○	○	○	○	○	×	×
		2 × 2		○	○	○	○	○	○	×	×

GPIO (Digital Input/Output Settings)

The camera is equipped with GPIO (general-purpose input/output) functions for generating and using combinations of triggers and other necessary signals within the camera and of signals output from the camera to the system such as those used for lighting equipment control.

Valid Input/Output Combinations

The following signals can be used as sources for each output destination (Trigger Selector, Line Selector, Pulse Generator Selector).
You can also connect two different sources to NAND paths in the GPIO and reuse the signal generated there as a source for a different selector.

The combinations of source signals and output destinations are indicated in the following.

Selector (Cross point switch output) / Source signal (Cross point switch input)		Output destination										
		TriggerSelector	LineSelector						PulseGeneratorSelector			
		FrameStart	Line1-TTLOut1	Line2-OptOut1	NANDGate0In1	NANDGate0In2	NANDGate1In1	NANDGate1In2	PulseGenerator0	PulseGenerator1	PulseGenerator2	PulseGenerator3
Signals to use as output	Low	○	○	○	○	○	○	○	○	○	○	○
	High	○	○	○	○	○	○	○	○	○	○	○
	Line5-OptIn1	○	○	○	○	○	○	○	○	○	○	○
	Line6-OptIn2	○	○	○	○	○	○	○	○	○	○	○
	Line7-CC1	○	○	○	○	○	○	○	○	○	○	○
	UserOutput0	○	○	○	○	○	○	○	○	○	○	○
	UserOutput1	○	○	○	○	○	○	○	○	○	○	○
	UserOutput2	○	○	○	○	○	○	○	○	○	○	○
	UserOutput3	○	○	○	○	○	○	○	○	○	○	○
	PulseGenerator0	○	○	○	○	○	○	○	×	○	○	○
	PulseGenerator1	○	○	○	○	○	○	○	○	×	○	○
	PulseGenerator2	○	○	○	○	○	○	○	○	○	×	○
	PulseGenerator3	○	○	○	○	○	○	○	○	○	○	×
	Nand0Out	○	○	○	×	×	○	○	○	○	○	○
	Nand1Out	○	○	○	○	○	×	×	○	○	○	○
	ExposureActive	–	○	○	○	○	○	○	○	○	○	○
	FrameTriggerWait	–	○	○	○	○	○	○	○	○	○	○
	FrameActive	–	○	○	○	○	○	○	○	○	○	○
	FVAL	–	○	○	○	○	○	○	○	○	○	○
	LVAL	–	x	x	○	○	○	○	○	○	○	○
	Software	○	–	–	–	–	–	–	–	–	–	–
		TriggerSelector	LineSelector						PulseGeneratorSelector			
		Use										

: Indicates default values for each selector.

Camera Output Formats

The AP-1600T-PMCL supports three output formats (RGB 8, RGB 10, RGB 12).

In accordance with the setting of ClConfiguration, PixelFormat on the camera side, the frame grabber board must also be set to the same setting.For details on how to set the frame grabber board, please refer to the owner's manual of each board.

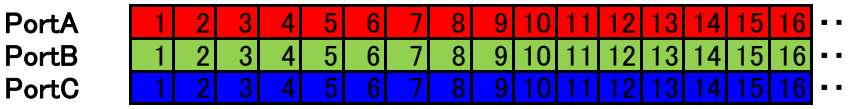
ClConfiguration	**PixelFormat**
Base	RGB8
Medium	RGB8、RGB10, RGB12
Full	RGB8
EightyBit	RGB8

■ Estimated camera link cable length that can be used with this camera

The Camera Link cable length is less than 10 m.However, if CameraLinkClockFrequency is 84.9 MHz, the Camera Link cable length is 7 m or less.
(Cable length that can be used will vary depending on cable type and manufacturer.)

■ ClConfiguration Base / PixelFormat　RGB8

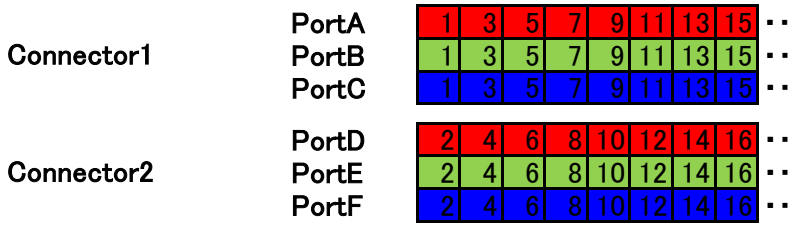
Connetor1



Connetor1

Port / bit	24-bit RGB
Port A0	R0
Port A1	R1
Port A2	R2
Port A3	R3
Port A4	R4
Port A5	R5
Port A6	R6
Port A7	R7
Port B0	G0
Port B1	G1
Port B2	G2
Port B3	G3
Port B4	G4
Port B5	G5
Port B6	G6
Port B7	G7
Port C0	B0
Port C1	B1
Port C2	B2
Port C3	B3
Port C4	B4
Port C5	B5
Port C6	B6
Port C7	B7

■ ClConfiguration Medium / PixelFormat RGB8



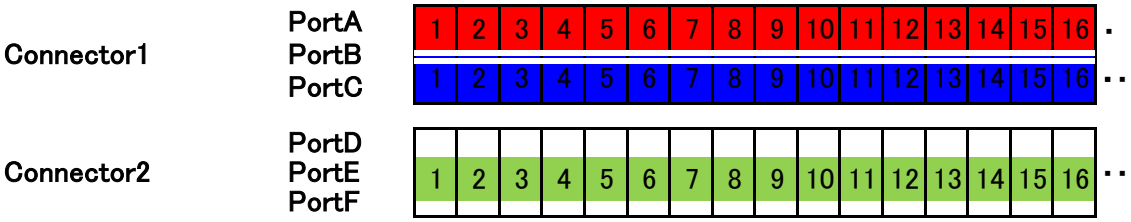
Connector1

Port / bit	Custom
Port A0	R0
Port A1	R1
Port A2	R2
Port A3	R3
Port A4	R4
Port A5	R5
Port A6	R6
Port A7	R7
Port B0	G0
Port B1	G1
Port B2	G2
Port B3	G3
Port B4	G4
Port B5	G5
Port B6	G6
Port B7	G7
Port C0	B0
Port C1	B1
Port C2	B2
Port C3	B3
Port C4	B4
Port C5	B5
Port C6	B6
Port C7	B7

Connector2

Port / bit	Custom
Port D0	R0
Port D1	R1
Port D2	R2
Port D3	R3
Port D4	R4
Port D5	R5
Port D6	R6
Port D7	R7
Port E0	G0
Port E1	G1
Port E2	G2
Port E3	G3
Port E4	G4
Port E5	G5
Port E6	G6
Port E7	G7
Port F0	B0
Port F1	B1
Port F2	B2
Port F3	B3
Port F4	B4
Port F5	B5
Port F6	B6
Port F7	B7

■ ClConfiguration Medium / PixelFormat RGB10



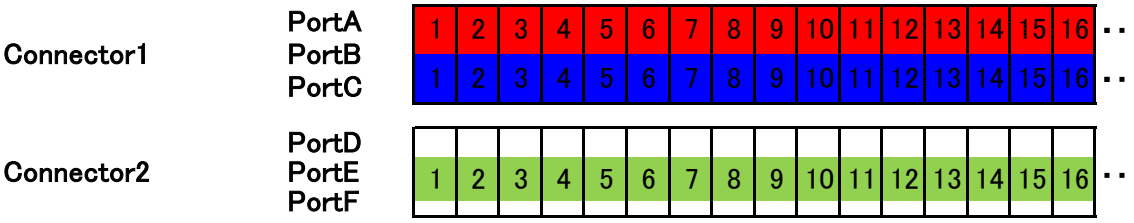
Connector1

Port / bit	30-bit RGB
Port A0	R0
Port A1	R1
Port A2	R2
Port A3	R3
Port A4	R4
Port A5	R5
Port A6	R6
Port A7	R7
Port B0	R8
Port B1	R9
Port B2	-
Port B3	-
Port B4	B8
Port B5	B9
Port B6	-
Port B7	-
Port C0	B0
Port C1	B1
Port C2	B2
Port C3	B3
Port C4	B4
Port C5	B5
Port C6	B6
Port C7	B7

Connector2

Port / bit	30-bit RGB
Port D0	-
Port D1	-
Port D2	-
Port D3	-
Port D4	-
Port D5	-
Port D6	-
Port D7	-
Port E0	G0
Port E1	G1
Port E2	G2
Port E3	G3
Port E4	G4
Port E5	G5
Port E6	G6
Port E7	G7
Port F0	G8
Port F1	G9
Port F2	-
Port F3	-
Port F4	-
Port F5	-
Port F6	-
Port F7	-

■ ClConfiguration Medium / PixelFormat RGB12



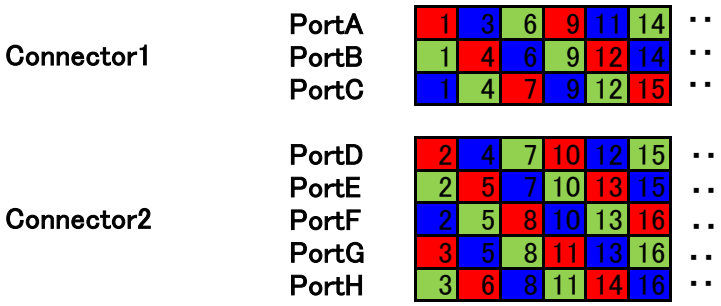
Connector1

Port / bit	36-bit RGB
Port A0	R0
Port A1	R1
Port A2	R2
Port A3	R3
Port A4	R4
Port A5	R5
Port A6	R6
Port A7	R7
Port B0	R8
Port B1	R9
Port B2	R10
Port B3	R11
Port B4	B8
Port B5	B9
Port B6	B10
Port B7	B11
Port C0	B0
Port C1	B1
Port C2	B2
Port C3	B3
Port C4	B4
Port C5	B5
Port C6	B6
Port C7	B7

Connector2

Port / bit	36-bit RGB
Port D0	-
Port D1	-
Port D2	-
Port D3	-
Port D4	-
Port D5	-
Port D6	-
Port D7	-
Port E0	G0
Port E1	G1
Port E2	G2
Port E3	G3
Port E4	G4
Port E5	G5
Port E6	G6
Port E7	G7
Port F0	G8
Port F1	G9
Port F2	G10
Port F3	G11
Port F4	-
Port F5	-
Port F6	-
Port F7	-

■ ClConfiguration Full / PixelFormat RGB8



Connector1

Port / bit	24-bit RGB
Port A0	R0
Port A1	R1
Port A2	R2
Port A3	R3
Port A4	R4
Port A5	R5
Port A6	R6
Port A7	R7
Port B0	G0
Port B1	G1
Port B2	G2
Port B3	G3
Port B4	G4
Port B5	G5
Port B6	G6
Port B7	G7
Port C0	B0
Port C1	B1
Port C2	B2
Port C3	B3
Port C4	B4
Port C5	B5
Port C6	B6
Port C7	B7

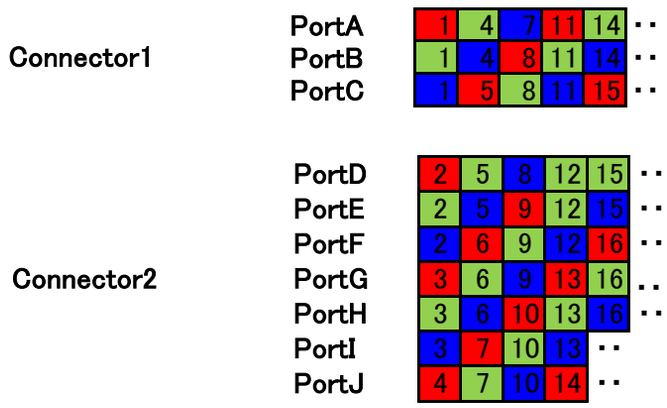
Connector2

Port / bit	24-bit RGB
Port D0	R0
Port D1	R1
Port D2	R2
Port D3	R3
Port D4	R4
Port D5	R5
Port D6	R6
Port D7	R7
Port E0	G0
Port E1	G1
Port E2	G2
Port E3	G3
Port E4	G4
Port E5	G5
Port E6	G6
Port E7	G7
Port F0	B0
Port F1	B1
Port F2	B2
Port F3	B3
Port F4	B4
Port F5	B5
Port F6	B6
Port F7	B7

Connector2

Port / bit	24-bit RGB
Port G0	R0
Port G1	R1
Port G2	R2
Port G3	R3
Port G4	R4
Port G5	R5
Port G6	R6
Port G7	R7
Port H0	G0
Port H1	G1
Port H2	G2
Port H3	G3
Port H4	G4
Port H5	G5
Port H6	G6
Port H7	G7

■ ClConfiguration EightyBit / PixelFormat RGB8



Connector1

Port / bit	24-bit RGB
Port A0	R0
Port A1	R1
Port A2	R2
Port A3	R3
Port A4	R4
Port A5	R5
Port A6	R6
Port A7	R7
Port B0	G0
Port B1	G1
Port B2	G2
Port B3	G3
Port B4	G4
Port B5	G5
Port B6	G6
Port B7	G7
Port C0	B0
Port C1	B1
Port C2	B2
Port C3	B3
Port C4	B4
Port C5	B5
Port C6	B6
Port C7	B7

Connector2

Port / bit	24-bit RGB
Port D0	R0
Port D1	R1
Port D2	R2
Port D3	R3
Port D4	R4
Port D5	R5
Port D6	R6
Port D7	R7
Port E0	G0
Port E1	G1
Port E2	G2
Port E3	G3
Port E4	G4
Port E5	G5
Port E6	G6
Port E7	G7
Port F0	B0
Port F1	B1
Port F2	B2
Port F3	B3
Port F4	B4
Port F5	B5
Port F6	B6
Port F7	B7

Connector2

Port / bit	24-bit RGB
Port G0	R0
Port G1	R1
Port G2	R2
Port G3	R3
Port G4	R4
Port G5	R5
Port G6	R6
Port G7	R7
Port H0	G0
Port H1	G1
Port H2	G2
Port H3	G3
Port H4	G4
Port H5	G5
Port H6	G6
Port H7	G7
Port I0	B0
Port I1	B1
Port I2	B2
Port I3	B3
Port I4	B4
Port I5	B5
Port I6	B6
Port I7	B7
Port J0	R0
Port J1	R1
Port J2	R2
Port J3	R3
Port J4	R4
Port J5	R5
Port J6	R6
Port J7	R7

Image Acquisition Controls (Acquisition Control)

Perform operations and configure settings related to image acquisition in [AcquisitionControl].

On the AP-1600T-PMCL, acquisition control always operates in [Continuous] mode.

Changing the Frame Rate

When [TriggerMode] is disabled, you can change the frame rate in [AcquisitionFrameRate].

Note

- The shortest frame period varies depending on the ROI, pixel format, ClConfiguration, CameraLinkClockFrequency and binning mode selected. The longest frame period is 0.125 Hz (8 sec.).
- When TriggerMode[FrameStart] is enabled, the [AcquisitionFrameRate] setting is disabled.

■ Maximum frame rate period formula

About H_Period

For a full image, the H_period values are as follows for each ClConfiguration, PixelFormat and CameraLink Clock Frequency.

ClConfiguration/ PixelFormat	CameraLink Clock Frequency	H period (µs)
Base/RGB8	37.125MHz	39.33
	74.25 MHz	19.66
	84.86 MHz	17.21
Medium/RGB8	37.125MHz	19.72
	74.25 MHz	9.86
	84.86 MHz	8.63
Medium/RGB10	37.125MHz	39.33
	74.25 MHz	19.66
	84.86 MHz	17.21
Medium/RGB12	37.125MHz	39.33
	74.25 MHz	19.66
	84.86 MHz	17.21
Full/RGB8	37.125MHz	14.81
	74.25 MHz	7.41
	84.86 MHz	7.00
EightyBit/RGB8	37.125MHz	11.88
	74.25 MHz	7.00
	84.86 MHz	7.00

Calculate the H_Period using the following formulas when cutting out a portion of the image using ROI.

H_Count = Max(Sensor_H_Max, CL_H_Count_Max)
H_Period = H_Count / 74.25MHz

The Sensor_H_Max values and Pack Value are as follows for each ClConfiguration, PixelFormat and CameraLink Clock Frequency.

ClConfiguration/ PixelFormat	CameraLink Clock Frequency	Sensor_H_Max	Pack Value
Base/RGB8	37.125MHz	612	1
	74.25 MHz	612	1
	84.86 MHz	612	1
Medium/RGB8	37.125MHz	612	2
	74.25 MHz	612	2
	84.86 MHz	612	2
Medium/RGB10	37.125MHz	612	1
	74.25 MHz	612	1
	84.86 MHz	612	1
Medium/RGB12	37.125MHz	612	1
	74.25 MHz	612	1
	84.86 MHz	612	1
Full/RGB8	37.125MHz	612	8/3 (2.667)
	74.25 MHz	520	8/3 (2.667)
	84.86 MHz	520	8/3 (2.667)
EightyBit/RGB8	37.125MHz	612	10/3 (3.333)
	74.25 MHz	520	10/3 (3.333)
	84.86 MHz	520	10/3 (3.333)

Calculate the CL_H_Count_Max using the following formulas.

CL_H_Count_Max =
Roundup((Width / Pack Value) + 4) × 74.25MHz / CameraLink Clock Frequency, 0)

■ During continuous operation ([Frame Start] trigger is [Off] or [ExposureMode] is [Off])

- When the exposure time is longer than the frame interval
  MaxOverlapTime_longExp = (1 / FR_Cont) - (20 × H_Period)
- Exposure time outside of frame interval
  NonOverlapExposureTime = ExposureTime - MaxOverlapTime_long
  However, MaxOverlapTime_long calculation results that are 0 or below will be considered as 0.
  For TriggerWidth, the trigger pulse is equivalent to ExposureTime.
- Maximum frame rate
  FR_longExp = 1 / {(1 / FR_Cont) + NonOverlapExposureTime}

  *)Calculate the FR_Cont using the following formulas.
  FR_Cont = 1 / ((Height + 44)×H_Period)

■ When [Frame Start] trigger is [On] and [TriggerOverLap] is [Off]

- Maximum frame rate
  FR_TrOloff = 1 / { (1 / FR_Cont) + NonOverlapExposureTime_TrOloff}

  *) Calculate the FR_Cont using the following formulas.
  FR_Cont = 1 / ((Height + 44)×H_Period)

■ When [Frame Start] trigger is [On] and [TriggerOverLap] is [Readout]

- Exposure time possible within frames
  MaxOverlapTime_TrOlrd = (1 / FR_Cont) - (20 × H_Period)
- Exposure time outside of frame interval
  NonOverlapExposureTime_TrOlrd = ExposureTime - MaxOverlapTime_TrOlrd
  However, NonOverlapExposureTime_TrOlrd calculation results that are 0 or below will be considered as 0.
  For TriggerWidth, the trigger pulse is equivalent to ExposureTime.
- Maximum frame rate
  FR_TrOlrd = 1 / {(1 / FR_Cont) + NonOverlapExposureTime_TrOlrd}

  *) Calculate the FR_Cont using the following formulas.
  FR_Cont = 1 / ((Height + 44)×H_Period)

ExposureMode

The following exposure modes are available on the camera.

ExposureMode	Description
Off	Exposure control is not performed (free-running operation).
Timed	Mode in which control is performed using exposure time. Acquire images using an exposure time configured beforehand on an external trigger.
TriggerWidth	Mode in which control of the exposure time is performed using the pulse width of the trigger input signal. The exposure time will be the same as the pulse width of the trigger input signal. This allows long exposure.

❖ The settings for exposure control and triggers are related to each other. Be sure to configure the settings described in “Trigger Control”.

❖ When [ExposureTimeMode] is set to [Individual], you can set the exposure times for Red, Green, and Blue individually. To set the exposure time individually for Red, set [ExposureTimeSelector] to [Red], and configure the exposure time for Red in [ExposureTime]. Similarly, configure the exposure times individually for Green and Blue.

Actual Exposure Times

The shortest exposure times that can be configured are as follows.

ExposureMode	Shortest exposure time
Timed	15.26 µs (8-bit)
TriggerWidth	15.26 µs (8-bit)

❖ The actual exposure time will consist of the image sensor’s offset duration (14.26 µs) added to the setting configured on the camera.

When [ExposureMode] is set to [Timed] and the exposure time is set to 1 µs, the actual exposure time will be as follows.
1 µs + 14.26 µs (offset duration of image sensor) = 15.26 µs

When [ExposureMode] is set to [TriggerWidth], the exposure is slightly longer than the width of the trigger signal. To achieve an exposure time of 15.26 µs and the exposure time offset is 14.26 µs, use 15.26 µs - 14.26 µs = 1 µs as the high or low time for the trigger signal.

Trigger Control

The camera allows the following controls to be performed via external trigger signals.

TriggerSelector	Description
FrameStart	Start exposure in response to the external trigger signal input. Select this to perform exposure control using external triggers.[1)]

❖ The settings for exposure control and triggers are related to each other. Be sure to configure the settings described in “ExposureMode”.

1) You can delay when exposure actually starts after a trigger is received by a specific amount of time by configuring [TriggerDelay].

Shortest Repetition Period for Triggers

The reciprocal of the maximum frame rate is the time required to output one frame. The shortest repetition periods for triggers cannot be lower than that value.

CameraLink ClockFrequency	Shortest period of trigger					
	Base	Medium	Medium	Medium	Ful	EightyBit
	RGB8	RGB8	RGB10	RGB12	RGB8	RGB8
37.125MHz	44.5ms	22.3ms	44.5ms	44.5ms	16.8ms	13.4ms
74.25 MHz	22.3ms	11.2ms	22.3ms	22.3ms	8.4ms	7.9ms
84.86 MHz	19.5ms	9.8ms	19.5ms	19.5ms	7.9ms	7.9ms

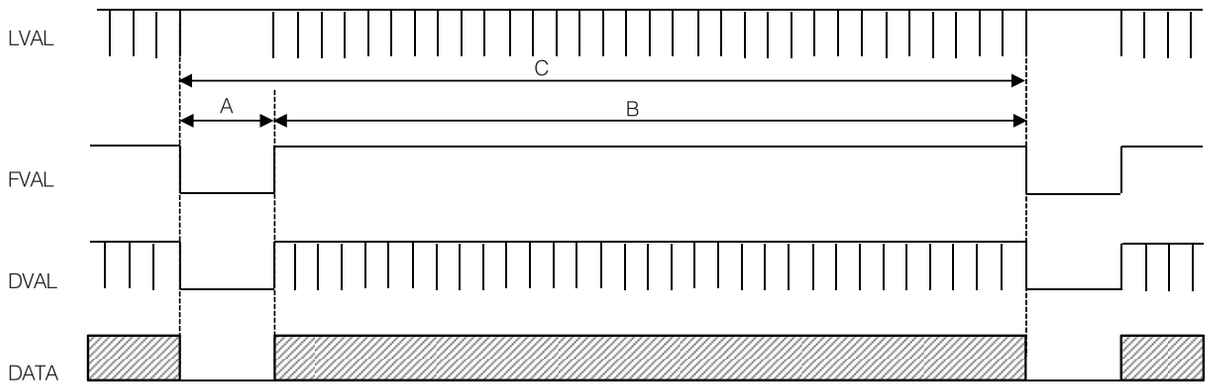
The above table indicates the shortest trigger periods for when [TriggerOverLap] is set to [Readout]. When [TriggerOverLap] is set to [Off], the exposure time is added to the period.

Minimum trigger pulse width

Camera Link	TTL In
3 µs	50 ns

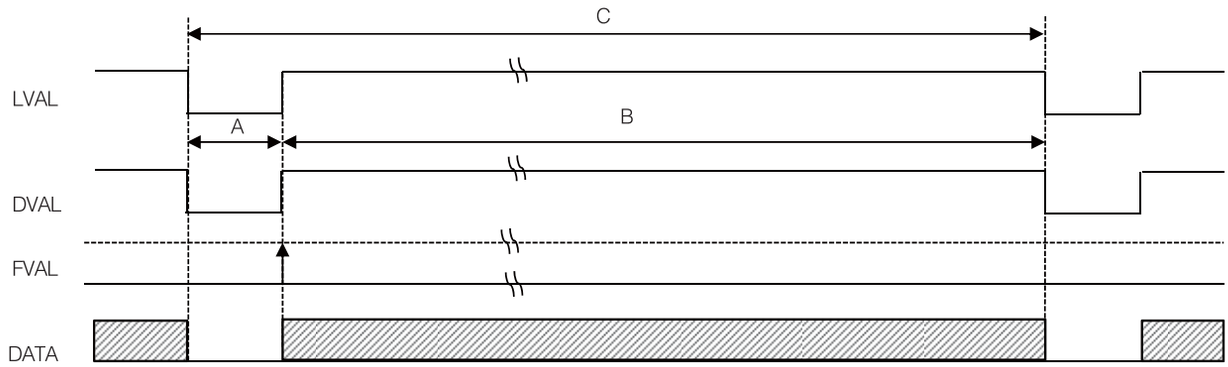
Image Output Timing

■ Vertical timing



ClConfiguration/ PixelFormat	CL PixelClock [MHz]	H Frequency (KHz)	FVAL BlankingLine [A]	FVAL Valid Line [B]	Total FrameLine [C]	Total Frame Period (msec)	Frame Rate (Hz)
	37.125	25.428	44	1088	1132	44.518	22.46
	74.25	50.856	44	1088	1132	22.259	44.93
Base/RGB8	84.86	58.121	44	1088	1132	19.476	51.34
	37.125	50.717	44	1088	1132	22.32	44.8
	74.25	101.434	44	1088	1132	11.16	89.61
Medium/RGB8	84.86	115.925	44	1088	1132	9.765	102.33
	37.125	25.428	44	1088	1132	44.518	22.46
	74.25	50.856	44	1088	1132	22.259	44.93
Medium/RGB10	84.86	58.121	44	1088	1132	19.476	51.34
	37.125	25.428	44	1088	1132	44.518	22.46
	74.25	50.856	44	1088	1132	22.259	44.93
Medium/RGB12	84.86	58.121	44	1088	1132	19.476	51.34
	37.125	67.5	44	1088	1132	16.77	59.63
	74.25	135	44	1088	1132	8.385	119.26
Full/RGB8	84.86	142.788	44	1088	1132	7.927	126.14
	37.125	84.183	44	1088	1132	13.447	74.37
	74.25	142.788	44	1088	1132	7.928	126.14
EightyBit/RGB8	84.86	142.788	44	1088	1132	7.928	126.14

■ Horizontal timing

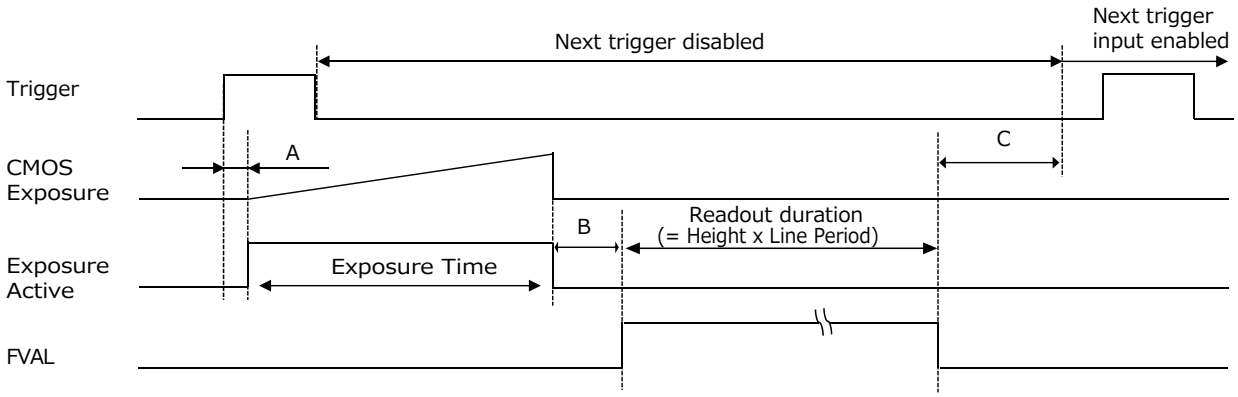


ClConfiguration/ PixelFormat	CL PixelClock [MHz]	Line BlankingClock [A]	Line Valid Clock [B]	Total Line Clock [C]	Total Line Period (usec) [C]	Line Rate (KHz) [C]
	37.125	4	1456	1460	39.33	25.428
	74.25	4	1456	1460	19.66	50.856
Base/RGB8	84.86	4	1456	1460	17.21	58.121
	37.125	4	728	732	19.72	50.717
	74.25	4	728	732	9.86	101.434
Medium/RGB8	84.86	4	728	732	8.63	115.925
	37.125	4	1456	1460	39.33	25.428
	74.25	4	1456	1460	19.66	50.856
Medium/RGB10	84.86	4	1456	1460	17.21	58.121
	37.125	4	1456	1460	39.33	25.428
	74.25	4	1456	1460	19.66	50.856
Medium/RGB12	84.86	4	1456	1460	17.21	58.121
	37.125	4	546	550	14.81	67.5
	74.25	4	546	550	7.41	135
Full/RGB8	84.86	49	546	595	7	142.788
	37.125	4	437	441	11.8	84.184
	74.25	83	437	520	7	142.788
EightyBit/RGB8	84.86	158	437	595	7	142.788

■ When [ExposureMode] is [Timed]

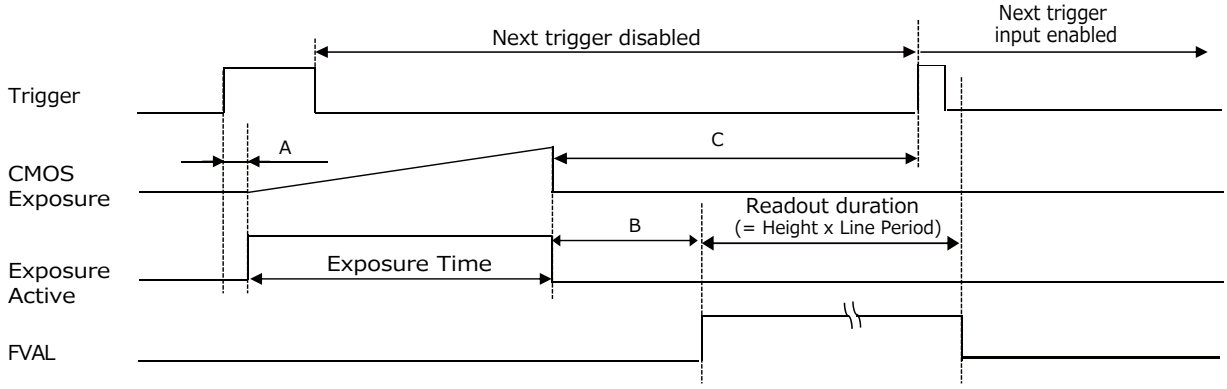
Example: When [TriggerSource] is set to [Line 5 - OptIn1] and [OptInFilterSelector] is set to [10 µs]

- **TriggerOverlap: Off**



CLConfiguration/ PixelFormat	CameraLink Clock Frequency	Line Period (usec)	Period from Trigger start edge to Exposure start[A](usec)	Period from Exposure end to FVAL start[B] (usec)	Period FVAL end to next trigger start[C](usec)
Base/RGB8	37.125MHz	39.33	119	1479	3426
	74.25 MHz	19.66	60	751	1702
	84.86 MHz	17.21	53	661	1493
Medium/RGB8	37.125MHz	19.72	60	753	1761
	74.25 MHz	9.86	31	388	868
	84.86 MHz	8.63	27	343	764
Medium/RGB10	37.125MHz	39.33	119	1479	3426
	74.25 MHz	19.66	60	751	1702
	84.86 MHz	17.21	53	661	1493
Medium/RGB12	37.125MHz	39.33	119	1479	3426
	74.25 MHz	19.66	60	751	1702
	84.86 MHz	17.21	53	661	1493
Full/RGB8	37.125MHz	14.81	46	572	1343
	74.25 MHz	7.41	23	297	660
	84.86 MHz	7.00	22	282	1142
EightyBit/RGB8	37.125MHz	11.88	37	463	1094
	74.25 MHz	7.00	22	282	1690
	84.86 MHz	7.00	22	282	2426

- **TriggerOverlap: Readout**

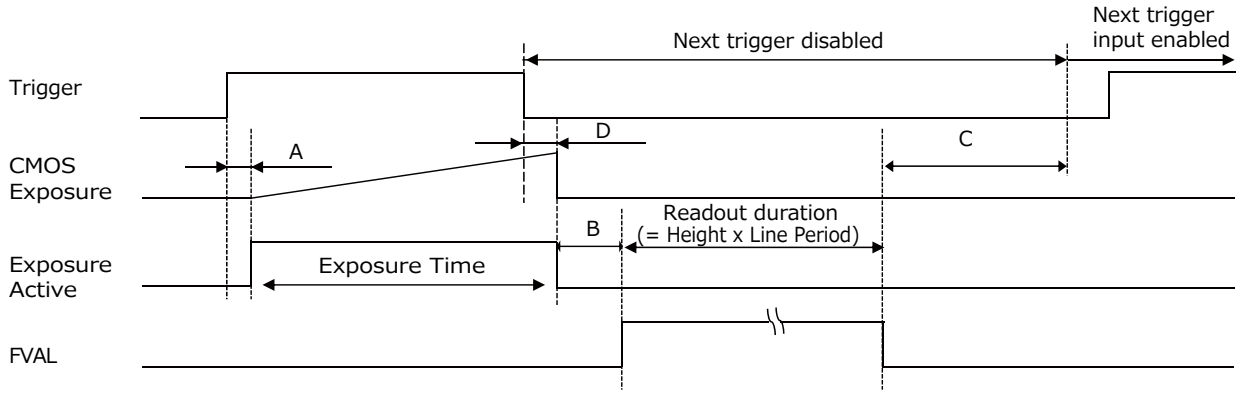


CLConfiguration/ PixelFormat	CameraLink Clock Frequency	Line Period (usec)	Period from Trigger start edge to Exposure start[A](usec)	Period from Exposure end to FVAL start[B] (usec)	Period from Exposure end to next trigger start[C](usec)
Base/RGB8	37.125MHz	39.33	119	1479	787～44517
	74.25 MHz	19.66	60	751	393～22258
	84.86 MHz	17.21	53	661	344～19483
Medium/RGB8	37.125MHz	19.72	60	753	394～22319
	74.25 MHz	9.86	31	388	197～11159
	84.86 MHz	8.63	27	343	173～ 9772
Medium/RGB10	37.125MHz	39.33	119	1479	787～44517
	74.25 MHz	19.66	60	751	393～22258
	84.86 MHz	17.21	53	661	344～19483
Medium/RGB12	37.125MHz	39.33	119	1470	787～44517
	74.25 MHz	19.66	60	751	393～22258
	84.86 MHz	17.21	53	661	344～19483
Full/RGB8	37.125MHz	14.81	46	572	296～16769
	74.25 MHz	7.41	23	297	148～ 8384
	84.86 MHz	7.00	22	282	140～ 7927
EightyBit/RGB8	37.125MHz	11.88	37	463	238～13446
	74.25 MHz	7.00	22	282	140～ 7927
	84.86 MHz	7.00	22	282	140～ 7927

■ When [ExposureMode] is [TriggerWidth]

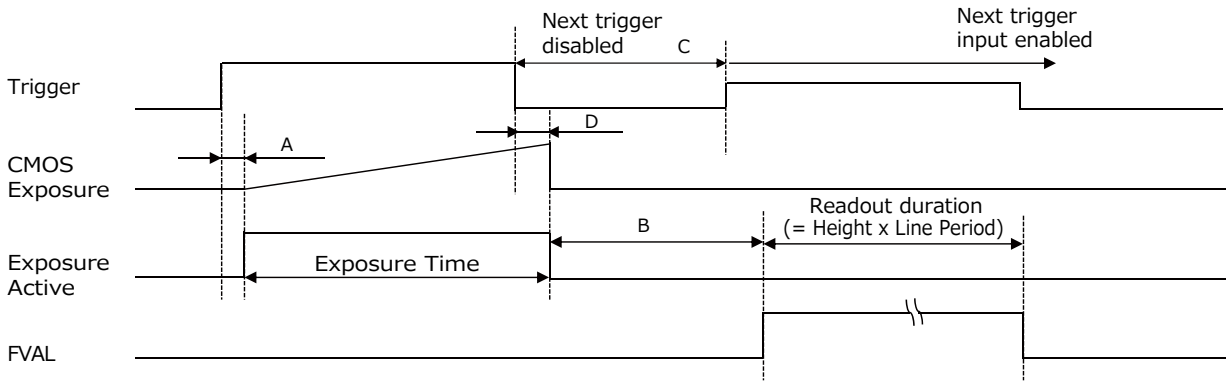
Example: When [TriggerSource] is set to [Line 5 - Optical In 1] and [OptInFilterSelector] is set to [10 µs]

• TriggerOverlap: Off



CLConfiguration/ PixelFormat	CameraLink Clock Frequency	Line Period (usec)	Period from Trigger start edge to Exposure start[A](usec)	Period from Exposure end to FVAL start[B](usec)	Period FVAL end to next trigger start[C](usec)	Period from Trigger end edge to Exposure end[D](usec)
Base/RGB8	37.125MHz	39.33	119	1479	3426	119
	74.25 MHz	19.66	60	751	1702	60
	84.86 MHz	17.21	53	661	1493	53
Medium/RGB8	37.125MHz	19.72	60	753	1761	60
	74.25 MHz	9.86	31	388	868	31
	84.86 MHz	8.63	27	343	764	27
Medium/RGB10	37.125MHz	39.33	119	1479	3426	119
	74.25 MHz	19.66	60	751	1702	60
	84.86 MHz	17.21	53	661	1493	53
Medium/RGB12	37.125MHz	39.33	119	1479	3426	119
	74.25 MHz	19.66	60	751	1702	60
	84.86 MHz	17.21	53	661	1493	53
Full/RGB8	37.125MHz	14.81	46	572	1343	46
	74.25 MHz	7.41	23	297	660	23
	84.86 MHz	7.00	22	282	1142	22
EightyBit/RGB8	37.125MHz	11.88	37	463	1094	37
	74.25 MHz	7.00	22	282	1690	22
	84.86 MHz	7.00	22	282	2426	22

• TriggerOverlap: Readout



CLConfiguration/ PixelFormat	CameraLink Clock Frequency	Line Period (usec)	Period from Trigger start edge to Exposure start[A](usec)	Period from Exposure end to FVAL start[B](usec)	Next trigger start prohibited period[C] (usec)	Period from Trigger end edge to Exposure end[D](usec)
Base/RGB8	37.125MHz	39.33	119	1479	906	119
	74.25 MHz	19.66	60	751	453	60
	84.86 MHz	17.21	53	661	397	53
Medium/RGB8	37.125MHz	19.72	60	753	454	60
	74.25 MHz	9.86	31	388	228	31
	84.86 MHz	8.63	27	343	200	27
Medium/RGB10	37.125MHz	39.33	119	1479	906	119
	74.25 MHz	19.66	60	751	453	60
	84.86 MHz	17.21	53	661	397	53
Medium/RGB12	37.125MHz	39.33	119	1479	906	119
	74.25 MHz	19.66	60	751	453	60
	84.86 MHz	17.21	53	661	397	53
Full/RGB8	37.125MHz	14.81	46	572	342	46
	74.25 MHz	7.41	23	297	171	23
	84.86 MHz	7.00	22	282	162	22
EightyBit/RGB8	37.125MHz	11.88	37	463	275	37
	74.25 MHz	7.00	22	282	162	22
	84.86 MHz	7.00	22	282	162	22

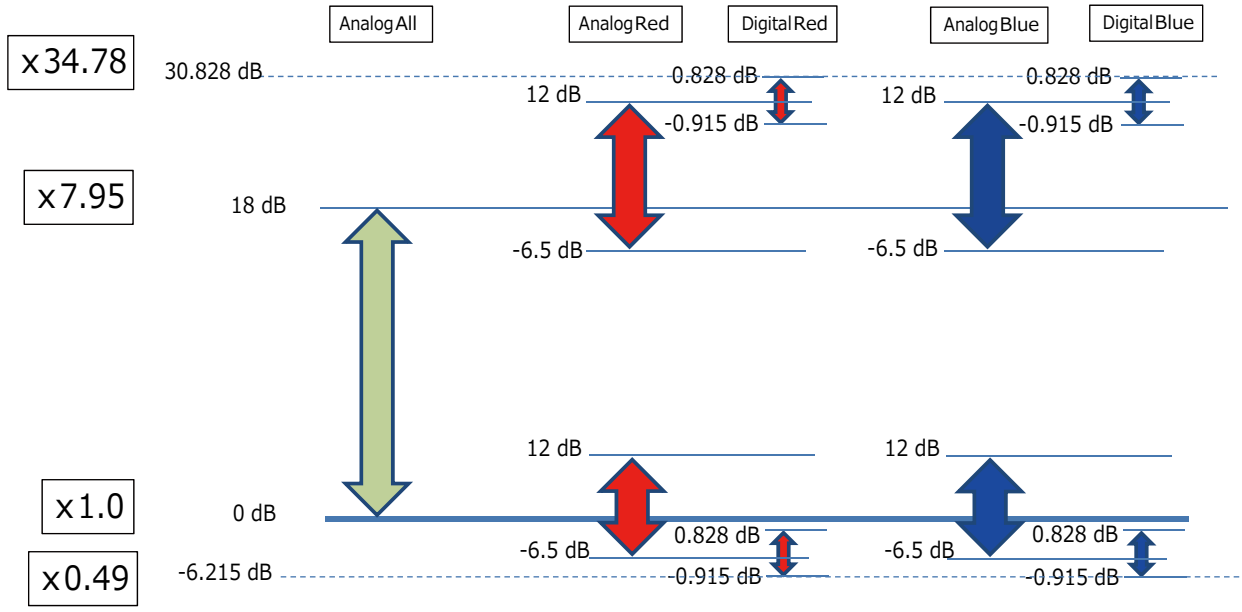
Gain Control

Gain control can be performed in the following two modes on this camera.

Adjusting the Master Gain and Performing Fine Adjustment with R and B (Master Mode)

When using this mode, set IndividualGainMode to Off.
Adjust the [AnalogAll] (master gain) setting first, and then adjust the [AnalogRed], [DigitalRed], [AnalogBlue], and [DigitalBlue] setting values to perform fine adjustment.

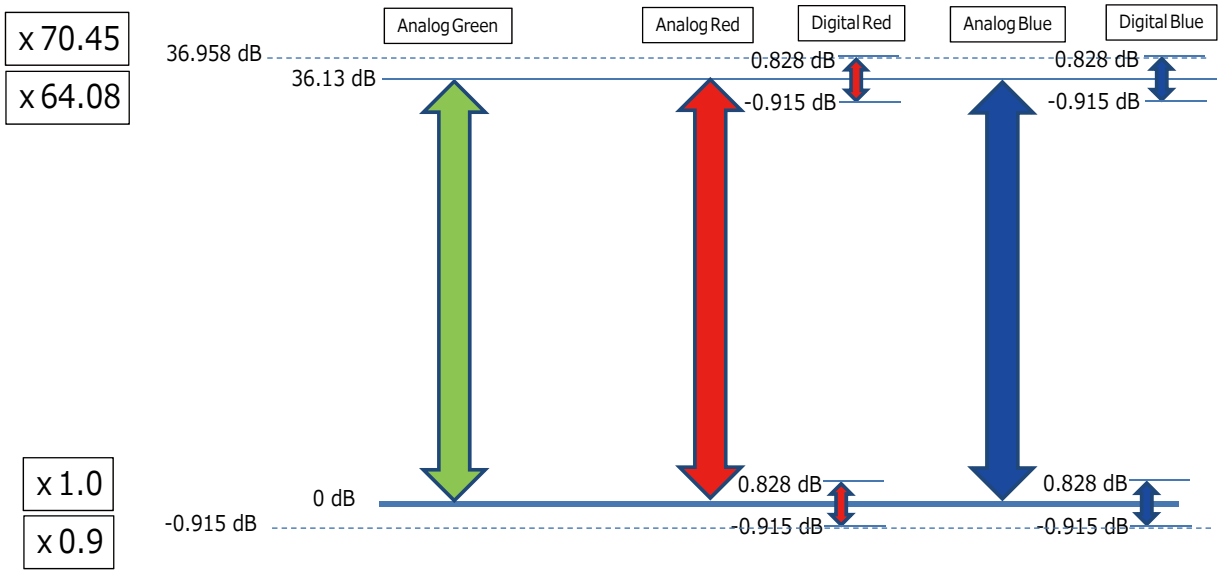
When IndividualGainMode is set to Off



Adjusting the Gain Individually for RGB (Individual Mode)

When using this mode, set IndividualGainMode to On.
Adjust the [AnalogGreen], [AnalogRed], [DigitalRed], [AnalogBlue], [DigitalBlue] setting values to adjust the gain.
This mode allows a wider range of adjustment by the user when compared to Master Mode.

When IndividualGainMode is set to On



Note

The baseline for 0 dB is different between MasterMode and IndividualMode. 0 dB in MasterMode is about 6 dB higher than 0 dB in IndividualMode.

Automatic Gain Level Control

Set [GainAuto] to [Continuous] to control the gain level automatically.

Note

When [IndividualGainMode] is set to [On], [GainAuto] will be fixed at [Off].

When [GainAuto] is set to [Continuous], you can configure the conditions for automatic adjustment in detail.

Item	Description
ALCReference	Specify the target level for automatic gain control. (This setting is also used for automatic exposure control.)
ALCAreaEnableAll	Select whether to specify all areas as auto gain metering areas or whether to specify the areas individually. [False]: Specify areas as auto gain metering areas (16 areas) individually. [True]: Specify all areas as auto gain metering areas.
ALCAreaSelector	Individually select any of 16 areas for automatic gain metering. (This setting is also used for automatic exposure control.)
ALCAreaEnable	Select [True] to enable the metering area selected in [ALCAreaSelector], or select [False] to disable it.
AGCMax.	Specify the maximum value for the automatic gain control range.
AGCMin.	Specify the minimum value for the automatic gain control range.
ALCControlSpeed	Specify the reaction speed for automatic gain control. (This setting is also used for automatic exposure control.)

When [GainAuto] is set to [Continuous], automatic adjustment will be performed continuously.

When [GainAuto] is set to [Once], automatic adjustment will be performed only once.

Auto gain metering areas (16 areas)

High Left	High Mid-left	High Mid-right	High Right
Mid-High Left	Mid-High Mid-left	Mid-High Mid-right	Mid-High Right
Mid-Low Left	Mid-Low Mid-left	Mid-Low Mid-right	Mid-Low Right
Low Left	Low Mid-left	Low Mid-right	Low Right

Lookup Table (LUT)

The LUT function is used to generate a non-linear mapping between signal values captured on the sensor and those that are output from the camera. You can specify the output curve using 257 setting points (indexes).

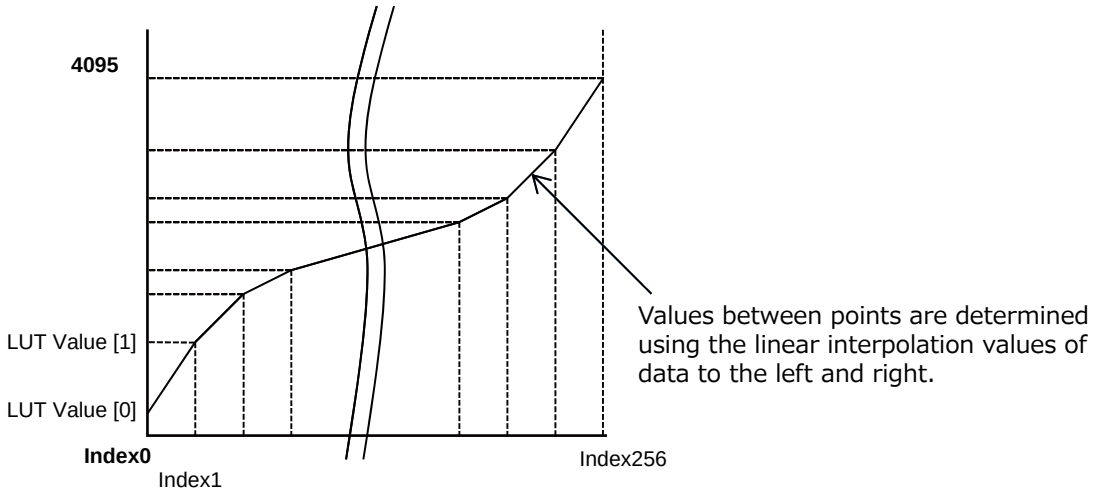
■ To use the LUT function

Configure the settings as follows.

Item	Setting value / selectable range	Description
LUTMode	LUT	Use LUT.
LUTSelector	Red, Green, Blue	Select the LUT channel to control.
LUTIndex	0 to 256	Select the LUT index to configure. Indexes represent the possible pixel values captured on the sensor, from the lowest value (Index 0) to the highest (Index 256). For example, Index 0 represents a full black pixel and Index 256 represents a full white pixel.
LUTValue	0 to 4095	Set the LUT output value for the selected index.

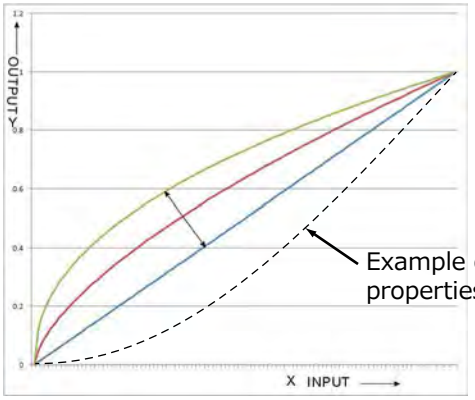
■ LUT values

LUT values range from 0 at the lowest to 4095 at the highest. Linear interpolation is used to calculate LUT values between the index points.



Gamma Function

The gamma function corrects the output signals from the camera beforehand (reverse correction), taking into consideration the light-emitting properties of the monitor display.
As the light-emitting properties of the monitor are not linear, the entire image may be darker or the gradation in the dark areas may be less noticeable when camera outputs are displayed without processing.
The gamma function can be used to correct the camera signals with an opposite-direction curve and produce a display that is close to linear.



■ To use the gamma function

Configure the settings as follows.

Item	Setting value / selectable range	Description
Gamma	0.45, 0.5, 0.55, 0.6, 0.65, 0.75, 0.8, 0.9, 1.0	Select the gamma correction value.
JAI LUTMode	Gamma	Use gamma.

Note

You can use the LUT function to configure a curve with more detailed points. For details, see “Lookup Table (LUT)”.

LineStatus

The line status function allows you to verify the status of external input/output signals.
You can verify the status of the following signals.

- Line1-TTLOut1, Line2-OptOut1
- Line5-OptIn1, Line6-OptIn2
- Line7-CC1
- NAND0In1, NAND0In2, NAND1In1, NAND1In2

BlemishCompensation

Multiple defective pixels that are not adjacent to each other can occur on conventional CMOS sensor cameras.
This camera features a function that interpolates defective pixels using the surrounding pixels.
Up to 200 pixels can be corrected for each of the three sensors.
Pixel interpolation can be performed via automatic detection or point-by-point manual settings.

■ Automatic detection

Automatic detection can only detect lit defective pixels (i.e., white blemishes).

1 **Shield the camera sensor.**

If a lens is attached, use the lens cap as a shield, for example.

2 **Configure the threshold level for defective pixel detection.**

Up to 200 pixels can be corrected for each of the three sensors.

The threshold value is specified as a percentage.

The default setting is "10" with 10% of the full scale (100%) specified as the threshold value.

3 **Execute [BlemishDetect] to start automatic detection.**

After detection, the interpolation data is saved to the camera's internal memory.

To check the number of interpolated pixels after automatic detection
You can check the number of pixels interpolated via automatic detection by loading the BlemishNum data.

■ Manual configuration

1 **Select the index in [BlemishCompensationIndex].**

You can select from 1 to 200. However, configure the indexes in order starting with the smallest index. If you skip indexes while configuring settings, interpolation may not be performed.

2 **Specify the pixel points for interpolation using the [BlemishCompensationPositionX] and [BlemishCompensationPositionY] settings.**

You can configure values that are within the total effective pixel area. Specify pixels for which interpolation is not necessary as -1. If 0 is specified, the first line or first pixel will be interpolated.

Note

BlemishCompensationDataClear[specify sensor][BlemishCompensationIndex], you can return a specific pixel correction setting to the default value (storage not required).

3 **Execute [BlemishStore].**

Blemish compensation data will be stored.

4 **Set [BlemishEnable] to [True], and execute interpolation.**

If it is set to [False] , Blemish compensation is not effective.

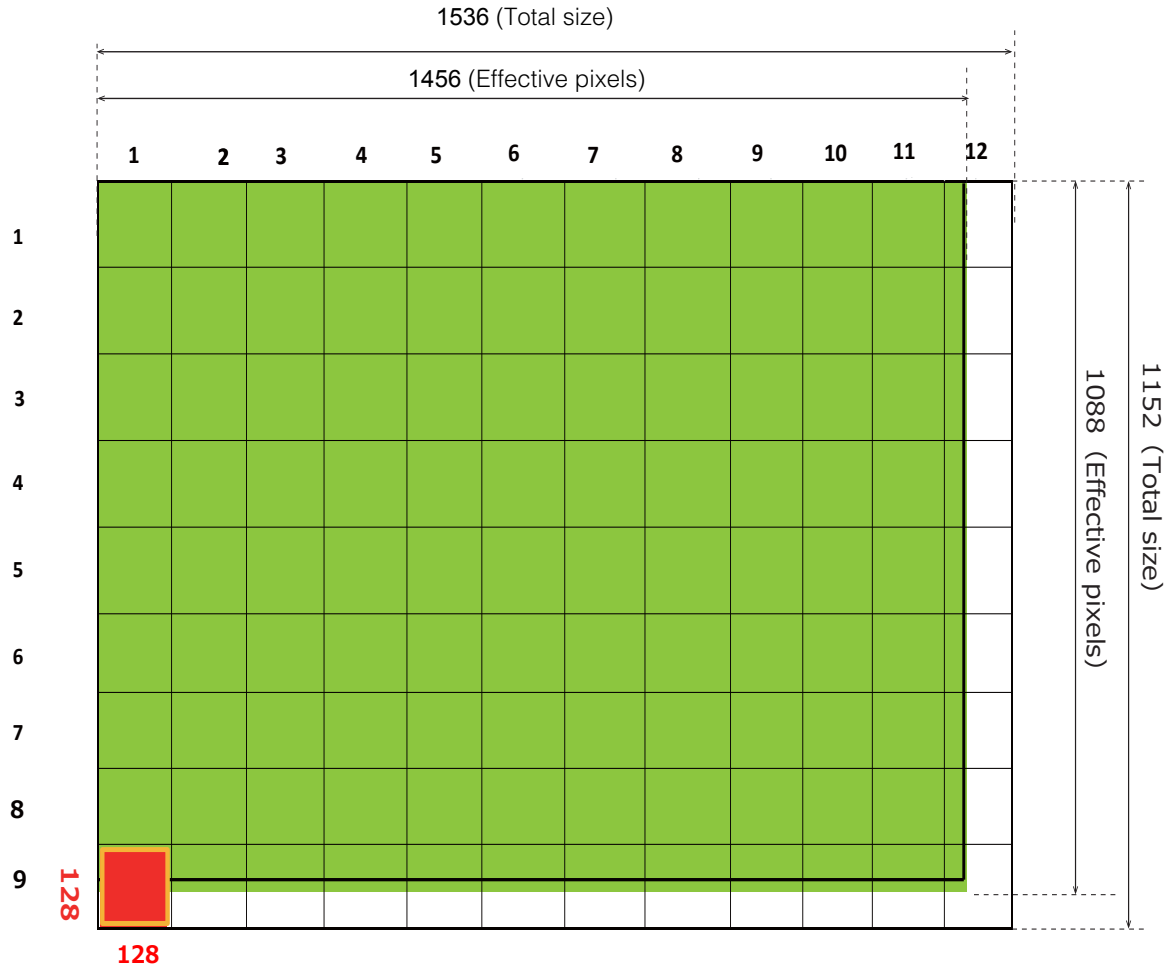
ShadingCorrection

The ShadingCorrection function corrects non-uniformity (i.e., shading) in the amount of light generated by the lens and lighting equipment. Using this function allows correction even if top, bottom, left, and right shading is not symmetrical in relation to the center of the screen (H, V).

This function can be used even when the effective image area is limited (an area with both Width and Height set to more than 128 must must be configured) by the ROI function. In such cases, the correction area is included in the image area configured by the ROI.

For a full image, the number of correction blocks is 12 (H) × 9 (V) blocks and calculation errors in the correction data are minimized due to the small interpolation areas. Each block is 128 × 128 pixels. The total size of the blocks is 1536 (H) × 1152 (V), but the actual number of effective pixels for the camera is 1456 (H) × 1088 (V). The ineffective peripheral areas will be deleted internally on the camera automatically.

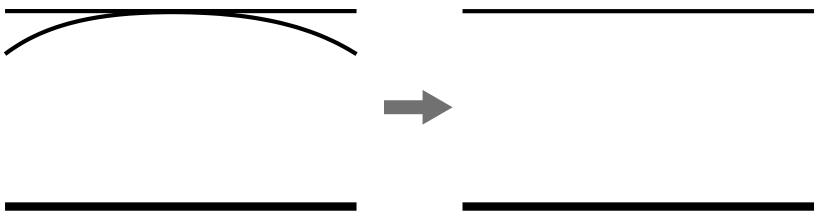
When using ROI, the number of blocks and the number of pixels that comprise each block differ from a full image.



The following shading correction modes are available on the camera.

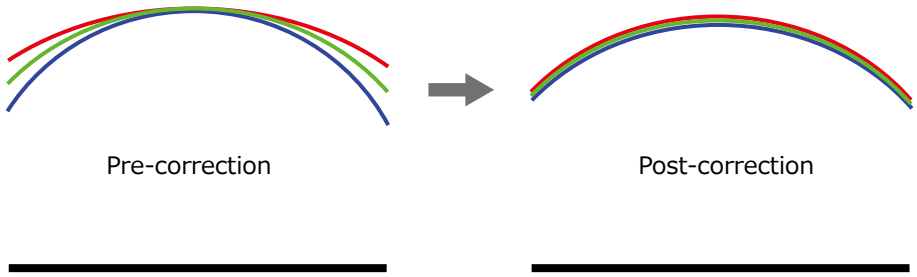
■ FlatShading

Correction is performed using the area of the screen with the highest brightness level as the reference, and adjusting the brightness levels of the other areas to match this level.



■ ColorShading

R-channel and B-channel properties are adjusted to using the G-channel shading properties as a reference.



Caution

- For FlatShading and ColorShading, the maximum amount of correction gain for all pixels is limited to twice the amount of gain before correction. (The amount of gain cannot be increased to more than twice the amount of gain from before correction.)
- If the area in the screen with the highest brightness level is 175 LSB or less (during 10-bit video output), proper correction is not possible.

■ To use the shading correction function

Configure the settings as follows.

Item	Setting value	Description
ShadingCorrectionMode	FlatShading, ColorShading	Select the shading correction mode.
ShadingMode	User1, User2, User3, Off	Select the user area to which to save the shading correction value.

Display a white chart under a uniform light, and execute [PerformShadingCalibration].

Note

After shading correction is executed, the shading correction value is automatically saved to the user area selected in [ShadingMode].

Binning Function

The binning function allows you to combine the signal values of clusters of adjacent pixels to create improved virtual pixels. Using the function results in images with lower pixel resolution and higher sensitivity.
This camera performs vertical binning and horizontal binning via digital addition or averaging processing.

ROI (Regional Scanning Function)

The ROI (region of interest) function allows you to output images by specifying the areas to scan.

ROI Settings

Specify the area to scan by specifying width, height, and horizontal/vertical offset values under [ImageFormatControl].

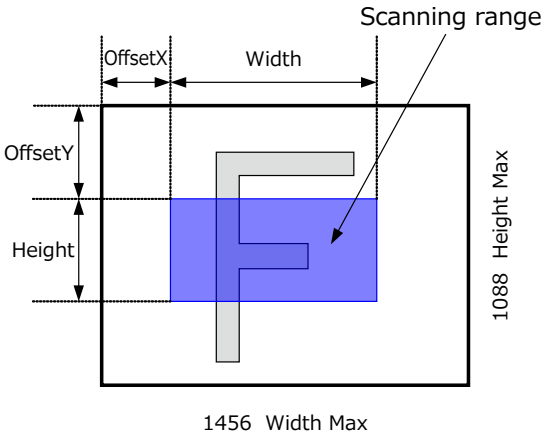
❖ For details on how to configure the settings, see “Configuring the Output Format”.

You can increase the frame rate by specifying a lower height, as the number of lines scanned decreases.
The setting ranges for the ROI function's readable area based on the Binning setting (BinningHorizontal, BinningVertical) are as follows.

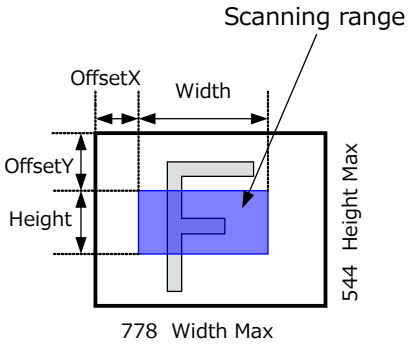
Width (pixels)	Height (pixels)
BinningHorizontal Off: 96 to 1456, 16 pxels / step	BinningVertical Off: 2 to 1088, 2 lines / step
BinningHorizontal On: 48 to 728, 8 pxels / step	BinningVertical On: 2 to 544, 2 lines / step

Offset X (pixels)	Offset Y (pixels)
BinningHorizontal Off: 0 to 1440, 16 pxels / step	BinningVertical Off: 0 to 1086, 2 lines / step
BinningHorizontal On: 0 to 720, 8 pxels / step	BinningVertical On: 0 to 542, 2 lines / step

Example 1: Without binning
[BinningHorizontal] *: 1
[BinningVertical] *: 1



Example 2: With binning
[BinningHorizontal] *: 2
[BinningVertical] *: 2



❖ For details on the frame rates for common ROI sizes, see “Frame Rate Reference”.

Sensor Multi ROIMode

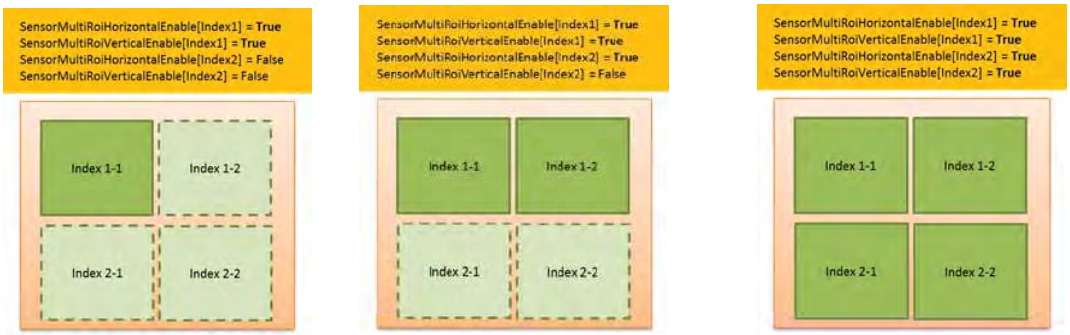
In this mode, the Multi ROI function built into the image sensor is used. Up to 4 areas can be specified. In this mode, areas can not be overlapped.

*) Binning mode (BinningVertical = 2 and BinningHorizontal = 2) and SensorMultiROI mode can not be used at the same time.
Binning mode and SensorMultiROI mode can be used at the same time, if BinningVertical = 1 or BinningHorizontal =1.

*) Sequencer mode and SensorMultiROI mode can not be used at the same time.

The setting is [JAICustomControlSensorMultiROI]. Specify width, height, horizontal / vertical offset value for each index.

Please refer to the example in the figure below and set SensorMultiRoiHorizontalEnable, SensorMultiRoiVerticalEnable.
For Index 1, both SensorMultiRoiHorizontalEnable and SensorMultiRoiVerticalEnable are fixed to True.



*). When using SensorMultiROI mode, if EdgeEnhancer is enabled, the boundaries of each area may be edge-emphasized depending on the acquired image.

Sequencer Function

The Sequencer function lets you define up to 128 index combinations of exposure time, gain, ROI, and other settings which can be stepped through each time a trigger is received.
This is particularly useful for quickly capturing multiple exposures of objects under inspection to adjust for areas or components with significantly different levels of reflectance. You can specify the next index in the stepping sequence and the order in which indexes are executed. Multiple indexes can also be executed repeatedly.

Two operation modes (TriggerSequencer mode and CommandSequencer mode) are available for the Sequencer function.

Note
Sequencer function cannot be used together with Sensor Multi ROI function.

About indexes (imaging conditions)

Up to 128 indexes can be configured.
The following settings can be configured for each index. However, SequencerFrameNumber and SequencerSetNext can only be configured in TriggerSequencer mode.

Trigger Sequenceer Mode	Command Sequenceer Mode	Item	Setting range	Default value	Description
○	-	SequencerFrameNumber	1 to 255	1	Set the number of frames to display for the selected SequencerIndex. (Enabled only for TriggerSequencer.)
○	-	SequencerSetNext	1 to128	1	Set the next index to be displayed for the selected SequencerIndex.
○	○	SequencerWidth	SequencerBinningHorizontal 1: 96 to 1456 SequencerBinningHorizontal 2: 48 to 728	1456	Set the width of the selected SequencerIndex.
○	○	SequencerHeight	SequencerBinningVertical 1: 2 to 1088 SequencerBinningVertical 2: 2 to 544	1088	Set the Height of the selected SequencerIndex.
○	○	SequencerOffsetX	SequencerBinningHorizontal 1: 0 to 1440 step 16 SequencerBinningHorizontal 2: 0 to 720 step 8	0	Set the horizontal offset value for the selected SequencerIndex.
○	○	SequencerOffsetY	SequencerBinningVertical 1: 0 to 1086 SequencerBinningVertical 2: 0 to 542	0	Set the vertical offset value for the selected SequencerIndex.
○	○	SequencerGainAnalogAll	1.0 to 8.0	1.0	Set the GainAnalogAll value.
○	○	SequencerGainAnalogRed	0.47 to 4.0 / 1.0 to 64.0	1.0	
○	○	SequencerGainAnalogGreen	1.0 fixed / 1.0 to 64.0	1.0	
○	○	SequencerGainAnalogBlue	0.47 to 4.0 / 1.0 to 64.0	1.0	
○	○	SequencerExposureTimeCommon			
○	○	SequencerExposureTimeRed			
○	○	SequencerExposureTimeGreen			
○	○	SequencerExposureTimeBlue			
○	○	SequencerBinningHorizontal	1, 2	1	For the selected SequencerIndex, set the number of pixels in the horizontal direction for which to perform binning.
○	○	SequencerBinningVertical	1, 2	1	For the selected SequencerIndex, set the number of pixels in the vertical direction for which to perform binning.
○	○	SequencerLUTEnable	True, False		

○	○	SequencerBlackLevelDigitalAll	-133 to 255	0	Set the black level value for the selected SequencerIndex.

Trigger Sequencer mode

With this mode, the Sequencer Trigger “pattern” is predetermined by the user. The user defines up to 128 different “indexes.” The items indicated in the above index can be configured for each index.
The operation of this mode is controlled using the following five commands.

[SequencerSetActive]
This allows you to confirm the currently configured index number.

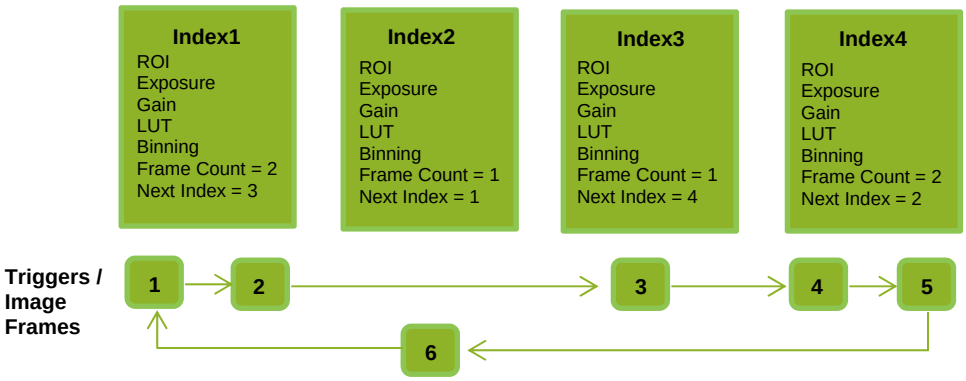
[SequencerSetStart]
This configures the index number to execute at the start of TriggerSequencer mode.

[SequencerLUTMode]
This defines whether to apply gamma or LUT to the sequence.
When gamma is selected, the gamma setting defined in [AnalogControl] is applied to all exposures in the sequence. When LUT is selected, the LUT characteristics defined in [AnalogControl] are applied to indexes for which [SequencerLUT enable] is set to ON.

[SequencerReset]
During TriggerSequencer mode operation, this switches the index number to be executed to

Sample TriggerSequencer mode operation

User-defined Indexes (up to 128)



1 Specify "1" in [SequencerSetStart], and start TriggerSequencer mode with index 1.

2 Capture a 2-frame image with the first and second triggers.

3 For the next index, configure index 3 specified in [SequencerSetNext], and capture an image with the number of frames (number of triggers) specified in [SequencerFrameNumber].

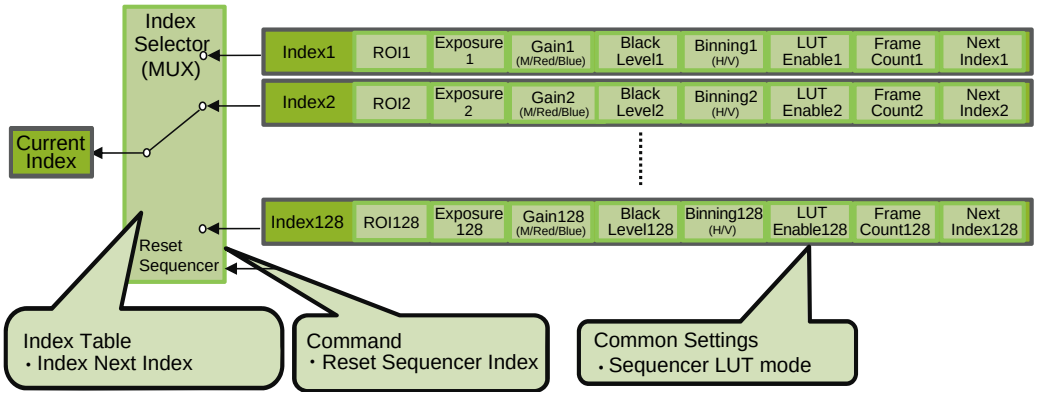
Proceed to sequence from index 4 to index 2 to index 1.

Command Sequencer mode

As with TriggerSequencer mode, you can define up to 128 indexes beforehand in this mode. Set [SequencerCommandIndex] to point to one of your pre-configured indexes. This index will be executed on each trigger, until it is changed to point to a different index, typically by your vision application. In this way, Command Sequencer mode allows you to programmatically adjust your sequence in response to image analysis or input from other sensors.

Note

- The same index table will be executed for subsequent triggers unless the [CommandSequencerIndex] value is changed.
- [SequencerFrameNumber] and [SequencerSetNext] cannot be used in CommandSequencer mode.

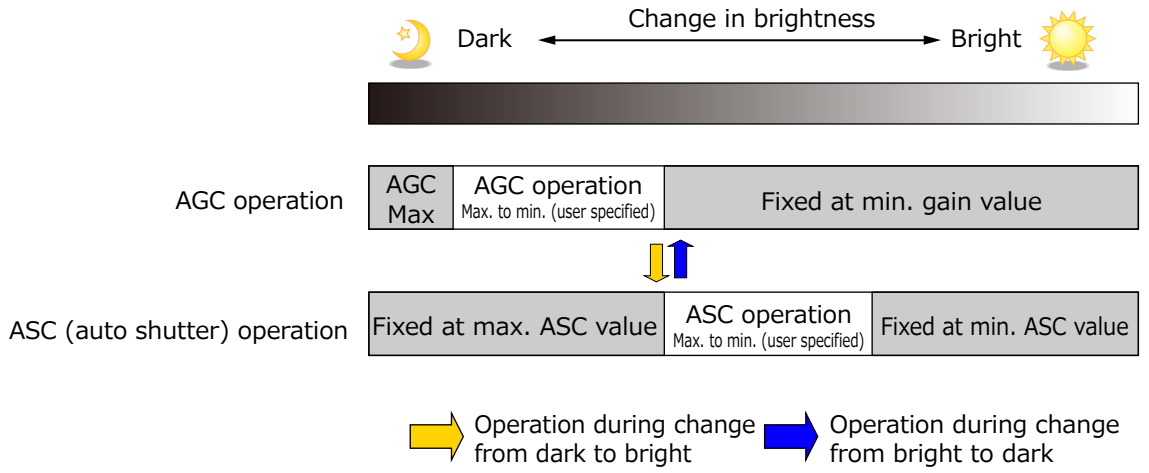


ALC (Automatic Level Control) Function

The ALC (automatic level control) function combines the automatic gain control (AGC/Auto Gain Control) and automatic exposure control (ASC/Auto Shutter Control) functions, and is capable of handling various changes in brightness.
The function operates as follows in response to changes in brightness.

Change from bright to dark: ASC → AGC

Change from dark to bright: AGC → ASC



■ To use the ALC function

Set [GainAuto] or [ExposureAuto] or both to [Continuous] mode. Configure the minimum value, maximum value, etc. for AGC and ASC under [JAICustomControlALC].
The target video levels for AGC and ASC are configured in [ALCReference]. For example, when [ALCReference] is set to 95%, video levels will be maintained at 95% for AGC and ASC.

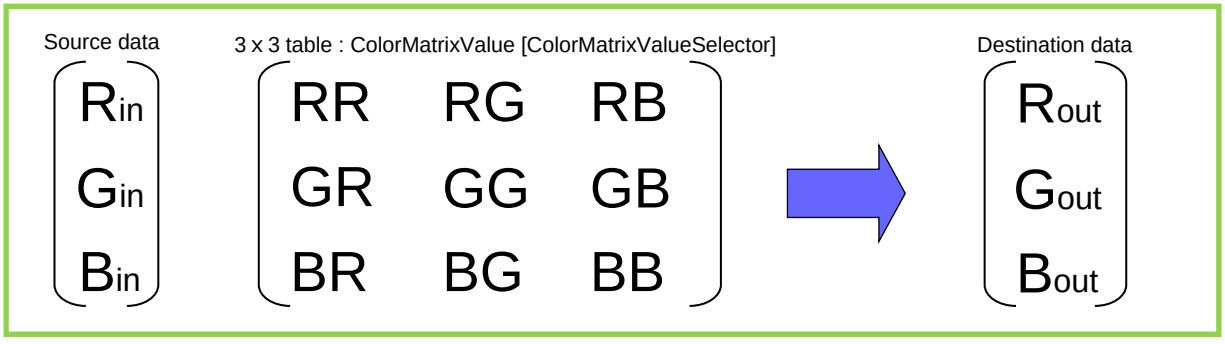
Color Space Conversion (ColorTransformationControl)

This camera allows you to convert the standard color space (RGB) that is used to produce colors into other color spaces, including XYZ and HSI.
Five color spaces are available: RGB(sRGB), RGB(AdobeRGB), RGB(UserCustom), XYZ, and HSI.
Specify the desied color space by configuring ColorTransofrmationMode and ColorTransformationRGBMode as follows.

ColorTransformation	ColorTransformationMode	ColorTransformationRGBMode
RGB(sRGB)	RGB	sRGB
RGB(AdobeRGB)	RGB	AdobeRGB
RGB(UserCustom)	RGB	UserCustom
XYZ	XYZ	Off
HSI	HSI	Off
Default	RGB	Off

■ Note on RGB(UserCustom)

This allows you to use user configured 3x3 conversion tables to perform color space conversion.



Caution

If you set the color space to XYZ or HSI, JAI Control Tool will not display the images captured by the camera properly. To display them properly, XYZ- or HSI-compatible image processing

must be performed on the computer side.

Configuration 3x3 table
Select the item you want to configure in [ColorMatrixValueSelector].
And configure the value in [ColorMatrixValue].
[ColorMatrixValue] can be set to a value from -2 to +2.

Item	Setting value	Description
ColorMatrixValueSelector	ColorMatrixR-R, ColorMatrixR-G, ColorMatrixR-B, ColorMatrixG-R, ColorMatrixG-G, ColorMatrixG-B, ColorMatrixB-R, ColorMatrixB-G, ColorMatrixB-B	Select the ColorMatrix setting component.
ColorMatrixValue	-2.0 to 2.0	Set the Color Matrix value.

Edge Enhancer, Color Enhancer

This camera is equipped with an edge enhancer function for enhancing the contrast of lines or edges within images and a color enhancer function for enhancing specified colors.

Edge enhancer function
The edge enhancer function is enabled when EnhancerEnable[Edge] is set to True.
Four enhancement levels are available: Low, Middle, High, and Strong.

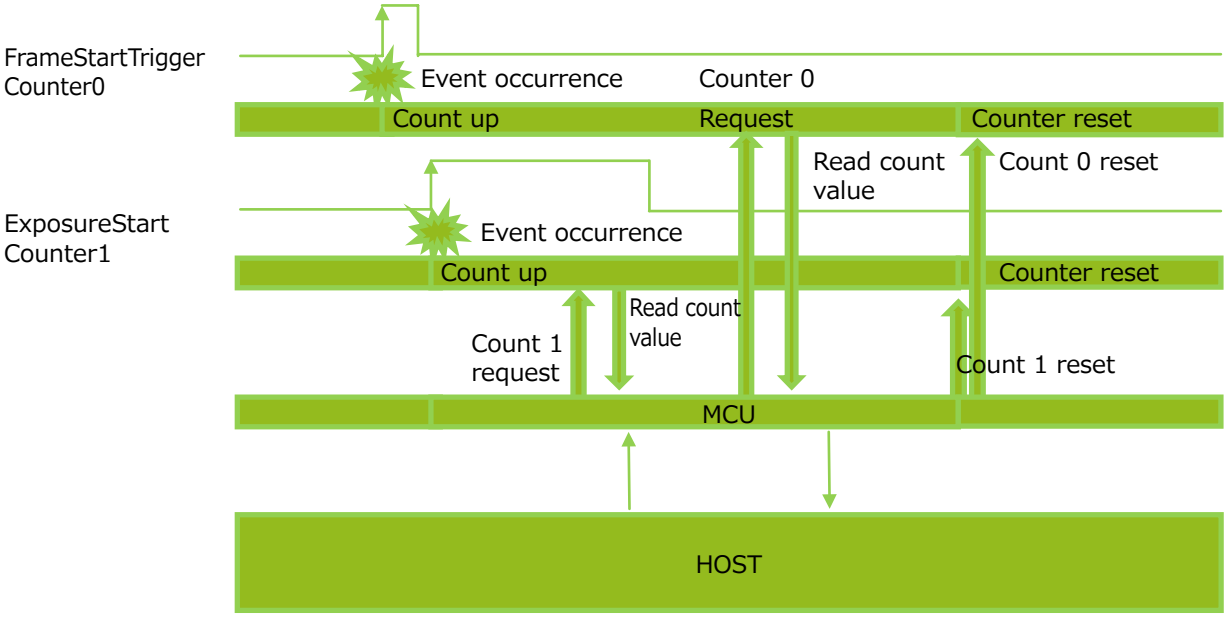
Color enhancer function
The color enhancer function is enabled when EnhancerEnable[Color] is set to True.
Set a value from 0 to 1 (0.1 steps) for ColorEnhancerValue[ColorEnhancerSelector] to set the enhancement to one of ten levels.
(0: no enhancement; 1: approx. x2 the color level of the original data)
Six colors can be specified in ColorEnhancerSelector: Red, Cyan, Green, Magenta, Blue, and Yellow.

CounterAndTimerControl Function

This camera supports only the counter function.
The counter function counts up change points in the camera's internal signals using the camera's internal counter, and reads that information from the host side. This function is useful for verifying error conditions via the count value using internal camera operations.
Three counters are available on the camera; Counter0, Counter1 and Counter2. The functions that can be counted are fixed for each counter.
Counter0: Counts the number of FrameStartTrigger instances.
Counter1: Counts the number of ExposureStart instances.
Counter2: Counts the number of SensorReadOut instances.

When a problem occurs in a system that includes this camera, comparing the values from multiple counters allows you to verify the extent of normal operability and can be useful when investigating the cause of the problem.

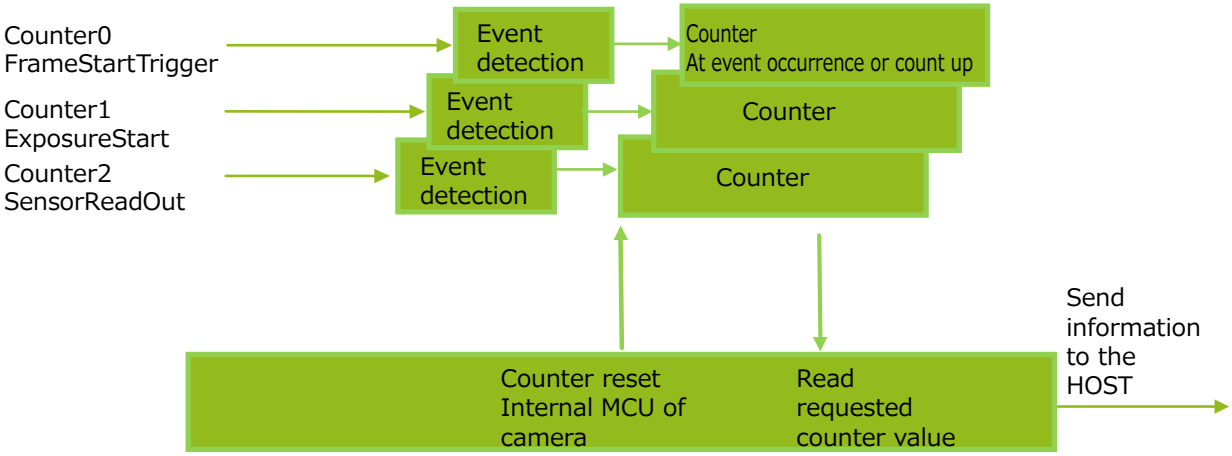
■ Counter occurrence diagram



Note

You can reset a specific counter's count value by executing CounterReset[Counter0, Counter1, Counter2].

■ Internal camera blocks



■ To use the counter function

Configure the settings as follows.
Four counters are available. Specify a counter (Counter0 to Counter3), and configure the settings.

Item		Setting value / selectable range	Description
Counter 0 to 2		Counter 0 to 2	Select the counter.
	CounterEventSource	Counter0 Off, Frame Trigger Counter1 Off, ExposureStart Counter2 Off, SensorReadOut	Select the counter event signal for which to read the count value. When set to Off, the counter operation will stop (but will not be reset).
	CounterEventActivation	When the counter function is enabled, Counter0, Counter1, and Counter2 are fixed at RisingEdge.	Specify the timing at which to count.

VideoProcessBypassMode

The video process bypass mode is a function that bypasses internal video processing on the camera. When bypass is enabled, the sensor output and camera output data can be set to the same bit width.
12-bit outputs (RGB12V1Packed) can only be performed in bypass mode.

VideoprocessbypassMode	On	Off
Camera operation	The following functions will be disabled, regardless of their configurations. Gain[DigitalRed], Gain[DigitalBlue], BlackLevel, LUT, Shading, Binning(H,V), Enhancement, ColorMatrix	All video processes are enabled.
Camera output	Base(RGB8)/Medium(RGB8, RGB10) /Full(RGB8)/EightyBit(RGB8)	Medium(RGB12)

■ Functions available in VideoProcessBypassMode

The following functions can be used in video process bypass mode.
Gain[AnalogAll], Gain[AnalogRed], Gain[AnalogGreen], Gain[AnalogBlue],
AutoGainControl, AutoShutterControl, AutoWhiteBalance,
SequencerMode,
BlemishCompensation

■ To enable VideoProcessBypassMode

Item	Setting value / selectable range	Description
VideoProcessBypassMode	On	Enable VideoProcessBypassMode.

In VideoProcessBypassMode, saturated level of brightness decreases.

Settings List

Feature Properties

: Settings that can only be configured when image acquisition on the camera is stopped.

Item	Setting range	Default value	Description
a) DeviceControl			Display/configure information related to the device.
DeviceVendorName	–	"JAI Corporation"	Display the manufacturer name.
DeviceModelName	–	AP-1600T-PMCL	Display the model name.
DeviceManufacturerInfo	–	See the possibilities	Display the manufacturer information.
DeviceVersion	–	–	Display the hardware version.
DeviceFirmwareVersion	–	–	Display the firmware version.
DeviceSerialNumber	–	–	Display the device ID.
DeviceUserID	Any	–	Set the user ID for the camera.
DeviceTemperature Selector	Mainboard	Mainboard	Select the area of the camera's interior for which to display the temperature sensor's reading.
DeviceTemperature(C)	–	–	Display the internal temperature (°C) of the camera.
DeviceSerialPortSelector	CameraLink	CameraLink	CameraLink fixed.
DeviceSerialPort BaudRate	Baud9600, Baud19200, Baud38400, Baud57600, Baud115200, Baud230400, Baud460800, Baud921600	Baud9600	Displays the baud rate of the serial port.示します。
DeviceReset	–	–	Reset the device.
b) ImageFormatControl			Configure image format settings.
SensorWidth	1456	1456	Display the maximum image width.
SensorHeight	1088	1088	Display the maximum image height.
SensorDigitizationBits	12 Bits	12 Bits	Display the number of bits at which the sensor is operating.
WidthMax	1456	1456	Display the maximum image width. (This value will vary depending on the HorizontalBinning setting.)
HeightMax	1088	1088	Display the maximum image height. (This value will vary depending on the VerticalBinning setting.)
Width	BinningHorizontal 1: 96 to 1456 BinningHorizontal 2: 48 to 728	1456	Set the image width.
Height	BinningVertical 1: 2 to 1088 BinningVertical 2: 2 to 544	1088	Set the image height.
OffsetX	BinningHorizontal 1: 0 to 1440 step 16 BinningHorizontal 2: 0 to 720 step 8	0	Set the horizontal offset.
OffsetY	BinningVertical 1: 0 to 1086 step 2 BinningVertical 2: 0 to 770 step 2	0	Set the vertical offset.
BinningHorizontalMode	Sum, Average	Sum	Set the addition process to be used during horizontal binning.

Item	Setting range	Default value	Description
BinningHorizontal	1, 2	1	Set the number of pixels in the horizontal direction for which to perform binning.
BinningVerticalMode	Sum	Sum	Display the addition process to be used during vertical binning.
BinningVertical	1, 2	1	Set the number of pixels in the vertical direction for which to perform binning.
PixelFormat	RGB8 RGB10 RGB12	RGB8	Set the pixel format. [RGB12] is enabled when [Video Process Bypass] is set to [On].
TestPattern	Off, GreyHorizontalRamp, GreyVerticalRamp, GreyHorizontalRamp Moving, HorizontalColorBar, VerticalColorBar, HorizontalColorBarMoving	Off	Select the test image.
c) AcquisitionControl			Configure image capture settings.
AcquisitionFrameRate (Hz)	0.125 to 126.1 (Full)	–	Set the frame rate as a frequency. (unit: Hz) The maximum value varies depending on the PixelFormat and ROI settings.
TriggerSelector	FrameStart	FrameStart	Select the trigger operation.
TriggerMode	Off, On	Off	Select the trigger mode.
TriggerSoftware	–	–	Execute a software trigger.
TriggerSource	Low, High, Software, PulseGenerator0-3, User Output 0-3, Line 5 - OptIn1, Line 6 - OptIn2, Line7-CC, NAND0Out, NAND1Out	Line5-OptIn1	Select the trigger signal source.
TriggerActivation	RisingEdge, FallingEdge,	RisingEdge	Select the polarity of the trigger signal (i.e., location of signal at which trigger is applied).
TriggerOverLap	Off, Readout	Readout	Select the trigger overlap operation.
TriggerDelay	0 to 500000	0	Set the time of exposure start from trigger input.
ExposureModeOption	Off、RCT	Off	Set whether to enable RCT mode.
ExposureMode	Off, Timed, TriggerWidth	Timed	Select the exposure mode.

Item	Setting range	Default value	Description
ExposureTimeMode	Common, Individual	Common	When set to Individual, ExposureTime can be adjusted for RGB individually.
ExposureTimeSelector	Common, Red, Green, Blue	Common	
ExposureTime	–	–	Set the exposure time. The specifiable range varies depending on the [StartTriggerMode] and [PixelFormat] setting.
ExposureAuto	Off, Continuous, Once	Off	Set whether to enable auto exposure.
d) AnalogControl			Configure analog control settings.
IndividualGainMode	Off, On	Off	In IndividualGainMode, RGB can be configured individually for the entire gain adjustment range of the sensor.
GainSelector	DigitalRed, DigitalBlue When IndividualGainModeOn: AnalogRed, AnalogGreen, AnalogBlue When IndividualGainModeOff: AnalogAll, AnalogRed, AnalogBlue	AnalogAll	Select the gain to configure.
Gain	–	×1	Set the gain value for the gain setting selected in [GainSelector].
GainAuto	Off, Continuous, Once	Off	Enable/disable gain auto adjustment. [Once] automatically changes to [Off] when the signal level converges once.
BalanceWhiteAuto	Off, Continuous, Once, ExposureContinuous, ExposureOnce, Preset3200K, Preset5000K, Preset6500K, Preset7500K	Off	Enable/disable auto white balance. WB adjustment via gain adjustment: Continuous, Once WB adjustment via exposure time: ExposureContinuous, ExposureOnce
BlackLevelSelector	DigitalAll, DigitalRed, DigitalBlue	DigitalAll	Select the black level to configure.
BlackLevel	DigitalAll: -133 to 255 DigitalRed: -64 to 64 DigitalBlue: -64 to 64	0	Set the black level value.
Gamma	0.45, 0.5, 0.55, 0.6, 0.65, 0.75, 0.8, 0.9, 1.0	0.45	Set the gamma value.
LUTMode	Off, Gamma, LUT	Off	Select the LUT mode.
e) LUTControl			Configure LUT settings.
LUTSelector	Red, Green, Blue	Red	Select the LUT channel to control.
LUTIndex	0 to 256	0	Set the LUT index table number.
LUTValue	0 to 4095	0	Set the LUT value.
f) ColorTransfromationControl			XXXXX
ColorTransformation Mode	RGB, XYZ, HSI	RGB	Set the output image format.

Item	Setting range	Default value	Description
ColorTransformationRGB Mode	Off, sRGB, AdobeRGB, User Custom	Off	Set the detailed mode when RGB is selected for the color space.
ColorMatrixValueSelector	ColorMatrixR-R, ColorMatrixR-G, ColorMatrixR-B, ColorMatrixG-R, ColorMatrixG-G, ColorMatrixG-B, ColorMatrixB-R, ColorMatrixB-G, ColorMatrixB-B	–	Select the ColorMatrix setting component.
ColorMatrixValue	-2.0 to 2.0	–	Set the Color Matrix value.
g) DigitalI/OControl			Configure settings for digital input/ output.
LineSelector	Line1-TTLOut1, Line2-OptOut1, Line5-OptIn1, Line6-OptIn2, Line7-CC1, NAND0In1, NAND0In2, NAND1In1, NAND1In2	Line2-OptOut1	Select the input/output to configure.
LineMode	Input, Output	Output	Display the input/output status (whether it is input or output).
LineInverter	True, False	False	Enable/disable polarity inversion for the selected input signal or output signal.
LineStatus	True, False	False	Display the status of the input signal or output signal (True: High, False: Low).
LineSource	Low, High, FrameTriggerWait, FrameActive, ExposureActive, FVAL, LVAL, PulseGenerator0-3, UserOutput0-3, Line5OptIn1, Line6OptIn2, Line7-CC1, NAND0Out, NAND1Out	Low	Select the line source signal for the item selected in [LineSelector].
LineFormat	NoConnect, TTL, OptoCoupled, InternalSignal	–	Display the signal format.
LineStatus All	–	–	Display the input/output signal status.
OptInFilterSelector	Off, 10µs, 100µs, 500µs, 1ms, 5ms, 10ms	Off	Remove noise from the OptIn input signal of Digital I/O.
UserOutputSelector	UserOutput0, UserOutput1, UserOutput2, UserOutput3	0: UserOutput0	Set the UserOutput signal.
UserOutputValue	True, False	False	Set the value for the UserOutput selected in [UserOutputSelector].
h) CounterAndTimerControl			Configure counter settings. (This camera only supports counter functions.)
CounterSelector	Counter 0 to 2	Counter 0	Select the counter.

Item		Setting range	Default value	Description
	CounterEventSource	Counter0: Off, Frame Trigger Counter1: Off, ExposureStart Counter2: Off, SensorReadOut	Off	Assign the counter event signal for which you want to read the count value to a dedicated counter, and read the value.
	CounterEvent Activation	RisingEdge, FallingEdge	–	Set the count timing.
	CounterReset	–	–	Reset the counter.
	CounterRefresh	–	–	Update the count value.
	CounterValue	–	–	Display the count value.
	CounterStatus	CounterIdle, CounterActive, CounterOverflow	CounterActive	Display the counter status. CounterIdle: Idle CounterActive: Counting CounterOverflow: Count value exceeded the maximum value
i) UserSetControl				Configure user settings.
UserSetSelector		Default, UserSet1 to 3	Default	Select the user settings.
	UserSetLoad	–	–	Load user settings.
	UserSetSave	–	–	Save the current setting values as user settings.
j) SequencerControl				Configure sequencer settings.
SequencerMode		On, Off	Off	Enable/disable [SequencerMode].
SequencerModeSelect		TriggerSequencermode, CommandSequencer mode	Trigger Sequencermode	Select the sequencer mode.
SequencerConfiguration Mode		On, Off	On	Select [On] to change the settings within the index.
SequencerSetSelector		1 to 128	1	Select the [TriggerSequencer] mode and [CommandSequencer] mode index.

Item	Setting range	Default value	Description
SequencerFrame Number	1 to 255	1	Set the number of frames to display for the selected SequencerIndex. (Enabled only for TriggerSequencer.)
SequencerSetNext	1 to 128	–	Set the next index to be displayed for the selected SequencerIndex. (Enabled only for TriggerSequencer.)
SequencerWidth	SequencerBinning Horizontal 1: 96 to 1456 SequencerBinning Horizontal 2: 48 to 728	1456	Set the width of the selected SequencerIndex.
SequencerHeight	SequencerBinning Vertical 1: 2 to 1088 SequencerBinning Vertical 2: 2 to 544	1088	Set the height of the selected SequencerIndex.
SequencerOffsetX	SequencerBinning Horizontal 1: 0 to 1440 step 16 SequencerBinning Horizontal 2: 0 to 744 step 8	0	Set the horizontal offset value for the selected SequencerIndex.
SequencerOffsetY	SequencerBinning Vertical 1: 0 to 1086 step 2 SequencerBinning Vertical 2: 0 to 542 step 2	0	Set the vertical offset value for the selected SequencerIndex.
SequencerGain AnalogAll	1.0 to 8.0	1.0	Set the GainAnalogAll value.
SequencerGain AnalogRed	0.47 to 4.0 / 1.0 to 64.0	1.0	
SequencerGain AnalogGreen	1.0 fixed / 1.0 to 64.0	1.0	
SequencerGain AnalogBlue	0.47 to 4.0 / 1.0 to 64.0	1.0	
SequencerExposure TimeCommon(µs)			Set the exposure time for the selected SequencerIndex.
SequencerExposure TimeRed(µs)			
SequencerExposure TimeGreen(µs)			
SequencerExposure TimeBlue(µs)			
SequencerLUTEnable	True, False		
SequencerBlackLevel DigitalAll	-133 to 255	0	Set the black level value for the selected SequencerIndex.
SequencerBinning Horizontal	1, 2	1	For the selected SequencerIndex, set the number of pixels in the horizontal direction for which to perform binning.
SequencerBinning Vertical	1, 2	1	For the selected SequencerIndex, set the number of pixels in the vertical direction for which to perform binning.
SequencerLUTMode	Gamma, LUT	Gamma	Set the sequence LUT mode.
SequencerSetActive	–	–	Displays the active LUT number.
SequencerCommand Index	–	1	Set this to change the SequencerIndex. (Enabled only for CommandSequencer.)
SequencerSetStart	–	1	Specify the first index number to switch to when starting [TriggerSequencerMode].

Item	Setting range	Default value	Description
SequencerReset	–	–	In [TriggerSequencerMode], reset the current index number to the number configured in [SequencerSetStart].
k) TransportLayerControl			Display information on transport layer control.
ClConfiguration	Base, Medium, Full, EightyBit	Medium	
CameraLinkClockFrequendy	37.1MHz, 74.3MHz, 84.9MHzk	74.3MHz	
l) JAICustomControl PulseGenerators			Configure pulse generator settings.
ClockPreScaler	1 to 4096	165	Set the division value for the prescaler (12 bit) using PixelClock as the base clock.
PulseGeneratorClock (MHz)	0.018127 to 74.25	0.45	Set the clock used for the pulse generator. This value is calculated using the [ClockPreScaler] value as a base.
PulseGeneratorSelector	PulseGenerator 0 to 3	PulseGenerator 0	Select the pulse generator.

Item		Setting range	Default value	Description
	PulseGeneratorLength	1 to 1048575	30000	Set the maximum count-up value as a clock count.
	PulseGeneratorLength (ms)	1 / PulseGeratorClock (MHz) to 1048575 / PulseGeneratorClock (MHz)	66.6667	Set the maximum count-up value in milliseconds. This value is calculated using the [PulseGeneratorLength] value as a base. The setting range varies depending on the [ClockPreScaler] value.
	PulseGenerator Frequency(Hz)	((PulseGeneratorClock (MHz)) ÷ 1048575) x 1000000 to (PulseGeneratorClock (MHz) x 1000000)	15	Set the maximum count-up value as a frequency. This value is calculated using the [PulseGeneratorLength] value as a base.
	PulseGeneratorStart Point	0 to 1048574	0	Set the start point of the High interval as a clock count. When the counter reaches this value, the output will be 1.
	PulseGeneratorStart Point(ms)	0 to (1048575 / PulseGeneratorClock (MHz))	0	Set the start point of the High interval in milliseconds. When the counter reaches this value, the output will be 1. The setting range varies depending on the [ClockPreScaler] value.
	PulseGeneratorEnd Point	1 to 1048575	15000	Set the start point of the Low interval as a clock count. When the counter reaches this value, the output will be 0.
	PulseGeneratorEnd Point(ms)	(1 / PulseGeneratorClock (MHz)) to (1048575 / PulseGeneratorClock (MHz))	33.3333	Set the start point of the Low interval in milliseconds. When the counter reaches this value, the output will be 0. The setting range varies depending on the [ClockPreScaler] value.
	PulseGeneratorPulse width(ms)	–	33.3333	Display the High interval width of the pulse in milliseconds. The duration between the Start Point and End Point is calculated. The setting range varies depending on the [ClockPreScaler] value.
	PulseGenerator RepeatCount	0 to 255	0	Set the repeat count for the counter. When this is set to [0], a free counter is enabled with no repeat limit.
	PulseGeneratorClear Activation	Off, LevelHigh, LevelLow, RisingEdge, FallingEdge	Off	Set the clear signal condition for the count clear input of the pulse generator.
	PulseGeneratorClear Source	Low, High, AcquisitionTriggerWait, AcquisitionActive, FrameTriggerWait, FrameActive, ExposureActive, FVAL, LVAL, PulseGenerator0-3, User Output0-3, Line5-OptIn1, Line6-OptIn2, Nand0Out, Nand1Out	Low	Select the count clear input signal source. [Line4 TTL In] can be used on the Standard Model.
	PulseGeneratorClear Inverter	True, False	False	Select whether to invert the polarity of the count clear input signal.
	PulseGeneratorClear SyncMode	AsyncMode, SyncMode	AsyncMode	Select the sync mode for the count clear input signal.

Item	Setting range	Default value	Description
m) JAICustomControlALC			Configure JAI ALC settings. These settings are also used for AGC (auto gain control).
ALCReference	30 to 95	50	Set the target level for ALC. (unit: %)
ALCAreaSelector	LowRight, LowMid-Right, LowMid-Left, LowLeft, Mid-LowRight, Mid-LowMid-Right, Mid-LowMid-Left, Mid-LowLeft, Mid-HighRight, Mid-HighMid-Right, Mid-HighMid-Left, Mid-HighLeft, HighRight, HighMid-Right, HighMid-Left, HighLeft	Low Right	Select the area for which to configure [ALCAreaEnable].
ALCAreaEnable	True, False	False	Enable/disable the photometry area selected in [ALCAreaSelector].
ALCAreaEnableAll	True, False	True	On: Operate ALC with all areas designated as photometry areas, regardless of the individual enabled/disabled photometry area states configured in [ALCAreaSelector]. Off: Operate ALC according to the individual enabled/disabled photometry area states configured in [ALCAreaSelector].
AutoShutterControl ExposureMin	100 to 13426	100	Set the minimum value for the ExposureAuto(ASC) control range.
AutoShutterControl ExposueMax	101 to 13427	–	Set the maximum value for the ExposureAuto(ASC) control range.
AutoGainControlGainRaw Min	100 to 1599	100	Set the minimum value for the GainAuto(ASC) control range.
AutoGainControlGainRaw Max	101 to 800	800	Set the maximum value for the GainAuto(ASC) control range.
ALCControlSpeed	1 (slow) to 8 (fast)	4	Set the response speed for AGC/ ASC. (8 is the fastest.)
ALCStatus	Off, ASC, AGC	–	Allows confirmation of the current operation area during ALC operation.
AutoControlStatus	ExecutingASC, ExecutingAGC, ExecutingASCandAGC, ExecutingAWB, ExecutingASCandAWB, ExecutingAGCandAWB, ExecutingASCandAGCand AWB, Convergen, Idle	–	Allows confirmation of the AGC, ASC, and AWB convergence status.

Item	Setting range	Default value	Description
n) JAICustomControlAWB			Configure AWB settings.
AWBAreaSelector	LowRight, LowMid-Right, LowMid-Left, LowLeft, Mid-LowRight, Mid-LowMid-Right, Mid-LowMid-Left, Mid-LowLeft, Mid-HighRight, Mid-HighMid-Right, Mid-HighMid-Left, Mid-HighLeft, HighRight, HighMid-Right, HighMid-Left, HighLeft	LowRight	Select the area for which to configure [AWBAreaEnable].
AWBAreaEnable	True, False	False	Enable/disable the photometry area selected in [AWBAreaSelector].
AWBAreaEnableAll	True, False	False	True: Operate AWB with all areas designated as photometry areas, regardless of the individual enabled/disabled photometry area states configured in [AWBAreaSelector]. False: Operate AWB according to the individual enabled/ disabled photometry area states configured in [AWBAreaSelector].
AWBControlSpeed	1 (slow) to 8 (fast)	4	Set the AWB control speed. (8 is the fastest.)
o) JAICustomControlBlemish			Configure settings for JAI white blemish correction.
BlemishEnable	True, False	True	Enable/disable blemish correction.
BlemishDetect	–	–	Execute blemish detection.
BlemishStore	–	–	Save the location information of detected blemishes.
BlemishSelector	Red, Green, Blue	–	Specify the sensor for which to configure Blemish.
BlemishDetect Threshold	0 to 100	10	Set the blemish detection threshold.
BlemishCompensation Index	1 to 200	–	Select the index for the target blemish coordinates (BlemishDataPosition X/Y).
BlemishCompensation PositionX	−1 to 2063	–	Display the X coordinate (horizontal pixel position) of the target blemish selected in [BlemishCompensationIndex]. You can also manually enter the X coordinate of the blemish you want to correct.
BlemishCompensation PositionY	−1 to 1543	–	Display the Y coordinate (vertical pixel position) of the target blemish selected in [BlemishCompensationIndex]. You can also manually enter the Y coordinate of the blemish you want to correct.
BlemishCompensation DataClear	–	–	Delete detected or specified blemish information.
BlemishCompensation Number	–	–	Display the number of target blemishes.
p) JAICustomControlShading			Configure shading correction settings.
ShadingCorrectionMode	FlatShading, ColorShading	FlatShading	Select the shading correction method.

Item	Setting range	Default value	Description
ShadingMode	Off, User1, User2, User3	Off	Set the area to which to save shading correction data. When this is set to [Off], shading correction data is not saved.
PerformShading Calibration	–	–	Execute shading correction.
ShadingDetectResult	–	–	Display the shading correction results.
q) JAICustomControl SensorMultiROI			Configure settings for sensor Multi ROI.
SensorMultiRoiMode	On、Off	Off	Enable/disable sensor Multi Roi. *)This function can be enabled only when SequecerMode is Off and MultiRoiMode is Off.
SensorMultiRoiIndex	Index1, Index2	Index 1	Select the index for the sensor Multi Roi mode.
SensorMultiRoiWidth	96 to 1456	–	Set the width for the selected sensor Multi Roi index.
SensorMultiRoiHeight	2 to 1088	–	Set the height for the selected sensor Multi Roi index.
SensorMultiRoiOffsetX	0 to 1440 The index 2 depends on the setting value of index 1.	–	Set the horizontal offset for the selected sensor Multi Roi index.
SensorMultiRoiOffsetY	0 to 1086 The index 2 depends on the setting value of index 1.	0	Set the vertical offset for the selected sensor Multi Roi index.
SensorMultiRoi HorizontalEnable	True, False	–	For each SensorMultiRoiIndex, enable / disable is set.
SensorMultiRoi VerticalEnable	True, False	–	For each SensorMultiRoiIndex, enable / disable is set.
t) JAICustomControlFeatureMisc.			Configure settings for other JAI functions.
VideoProcessBypassMode	On, Off	Off	Enable/disable VideoProcessBypass mode.
EnhancerSelector	Edge, Color	–	Specify the operation mode for Enhancer.
EnhancerEnable	True, False	–	Enable/disable EdgeEnhancer and ColorEnhancer.
ColorEnhancerSelector	Red, Cyan, Green, Magenta, Blue, Yellow	–	Index for advanced ColorEnhancer settings.
ColorEnhancerValue	0 to 1	0	Specify the ColorEnhancer emphasis levels for each color component.
EdgeEnhancerLevel	Low, Middle, High, Strong	Middle	Set the Level for EdgeEnhancer.
VideoSendMode	NormalMode, TriggerSequencerMode, CommandSequencer Mode, MultiRoiMode	NormalMode	Set the [VideoSendMode].

Miscellaneous

Troubleshooting

Check the following before requesting help. If the problem persists, contact your local JAI distributor.

■ Power supply and connections

Problem	Cause and solution
The POWER/TRIG LED remains lit amber and does not turn green, even after power is supplied to the camera.	Camera initialization may not be complete due to lack of a network connection. Check the 12-pin power cable connection.

■ Image display

Problem	Cause and solution
Gradation in dark areas is not noticeable.	Use the gamma function to correct the display. As the light-emitting properties of the monitor are not linear, the entire image may be darker or the gradation in the dark areas may be less noticeable when camera outputs are displayed without processing. Using the gamma function performs correction to produce a display that is close to linear. For details, see “Gamma Function”.

■ Settings and operations

Problem	Cause and solution
Settings cannot be saved to user memory.	You cannot save to user memory while images are being acquired by the camera. Stop image acquisition before performing the save operation.
I want to restore the factory default settings.	Load [Default] under [User Set Selector] in the [Feature Properties] tab to restore the factory default settings.

Specifications

Item				AP-1600T-PMCL
Scanning system				Progressive scan, 1 tap
Synchronization				Internal
Interface				USB 3.0 Vision (Specification V1.0 RC4.02) compatible
Image sensor				CMOS×3
Image size (effective image)				5.02 (H) × 3.75 (V), 6.27 mm diagonal
Pixel size				3.45 (H) × 3.45 (V) µm
Effective image pixel output				1456 (H) × 1088 (V)
Acquisition Frame Rate (max)	Base	RGB8		51.3 fps
	Medium	RGB8		102.4 fps
	Medium	RGB10		51.3 fps
	Medium	RGB12		51.3 fps
	Full	RGB8		126.1 fps
	EightyBit	RGB8		126.1 fps
EMVA 1288 parameters Absolute sensitivity Maximum SN ratio				At 12-bit output 3.88p (λ=525nm) 40.66dB
Digital image output format	Full pixel			1456 (H) × 1088 (V)
	ROI	Width		96 to 1456, 16 pixels/step
		Offset X		0 to 728, 16 pixels/step
		Height		2 to 1088, 2 line/step
		Offset Y		0 to 1086, 2 lines/step
	Binning	H	1	1456 (H)
			2	728 (H)
		V	1	1088 (V)
			2	544 (V)
	Pixel Format			RGB8, RGB10, RGB12
AcquisitionMode				Continuous, SingleFrame, MultiFrame (1 to 65535)
TriggerSelector	Exposure			FrameStart
ExposureMode				Off, Timed, TriggerWidth (PWC)
Trigger overlap				Off / Readout
Trigger input signals				Low, High, Software, PulseGenerator0-3, UserOutput0-3, Line5-OptIn1, Line6-OptIn2, Line7-CC1, NAND0Out, NAND1Out
Opto filter				Off (default), 100 µs, 500 µs, 1ms, 5ms, 10ms
Exposure Mode	Timed			15.26µs (8 bit), 15.26µs (10 bit) (min)* to 8 s (max), Performance verified for up to 1 second.
	Trigger Width			15.26µs (8 bit), 15.26µs (10 bit) (min)* to 8 s (max) ❖ Performance verified for up to 1 second.
Auto exposure (Exposure Auto)				Off, Continuous, Once
Auto exposure response speed (AGC/ASC Control Speed)				1 to 8
Video send modes				NormalMode, TriggerSequencerMode, CommandSequencerMode, SensorMultiMode
Digital I/O				Line Selector (12P): GPIO IN / GPIO OUT

*) The actual exposure time will be consist of the image sensor's offset duration (14.26 µs) added to the setting configured on the camera.

Item			AP-1600T-USB
Black level adjustment	Default level		8LSB@8bit
	Video level adjustment range		DigitalAll : -133 ~ +255 LSB @12bit DigitalRed :- 64 ~ +64 LSB @12bit DigitalBlue : -64 ~ +64 LSB @12bit
	Resolution adjustment		1LSB@12bit
Gain adjustment	Manual adjustment range		MasterMode AnalogAll : 0dB ~ 18dB AnalogRed: -6.5dB ~ 12dB AnalogBlue:-6.5dB ~ 12dB DigitalRed:-0.915dB ~ 0.828dB DigitalBlue:-0.915dB ~ 0.828dB IndividualMode AnalogAll:0dB ~ 36.13dB AnalogRed:0dB ~ 36.13dB AnalogBlue:0dB ~ 36.13dB DigitalRed:-0.915dB ~ 0.828dB DigitalBlue:-0.915dB ~ 0.828dB
	Auto gain		Off, Continuous, Once
White balance	WBA		AnalogRed, AnalogBlue: -6.5dB ~ 12dB DigitalRed, DigitalBlue: -0.915dB ~ 0.828dB
	BalanceWhiteAuto		Off, Continuous, Once, ExposureContinuous, ExposureOnce, Preset3200K, Preset5000K, Preset6500K, Preset7500K
	Area		16 (4 x 4) Area
	Adjustment range		3000K ~ 9000K
Blemish correction	Detection		Detect white blemishes using threshhold values (100 steps available) (black blemish correction performed only at factory)
	Correction		Interpolation using adjacent pixels (continuous blemishes not corrected)
	Correctable pixels		200 pixels per sensor
ALC			Can be adjusted automatically together with AGC and auto exposure control
Gamma			0.45, 0.5, 0.55, 0.6, 0.65, 0.75, 0.8, 0.9, 1.0 (9 steps available)
LUT			OFF: γ = 1.0, ON = 257 points can be set
Vibration resistance			3 G (20 Hz to 200 Hz X-Y-Z direction)
Impact resistance			50 G
Power supply	12-pin connector	Input range	DC +12 V to +24 V ±10% (via input terminal)
		Consumption	6.0 W (typ.) (default settings, 25 °C ambient temp., 12 V DC input) 7.6 W (max.)
	PoCL	Input range	DC +12 V ±10% (via input terminal)
		Consumption	6.0 W (typ.) (default settings, 25 °C ambient temp., 12 V DC input) 7.4 W (max.)
Lens mount			C-mount Lens mount protrusion length of 4 mm or less is supported
Flange back			17.526, tolerance: 0 mm to -0.05 m
Optical filter			IR cut filter
Verified performance temperature / humidity			–5°C to +45°C* / 20% to 80% (non-condensing)
Storage temperature / humidity			–25°C to +60°C / 20% to 80% (non-condensing)
Regulations			CE (EN61000-6-2 and EN61000-6-3), FCC part 15 class B, RoHS, WEEE
Dimensions (housing)			44 × 44 × 74 mm (WHD) (excluding mount protrusions)
Weight			170 g

Approximately 30 minutes of warm-up are required to achieve these specifications.

***Caution**

About the verified performance temperature

Make sure the following temperature conditions are met when operating the unit.

1) The camera's internal temperature sensor detects temperatures of 72°C or less during operation.
2) The top surface of the camera's casing is 57°C or less.

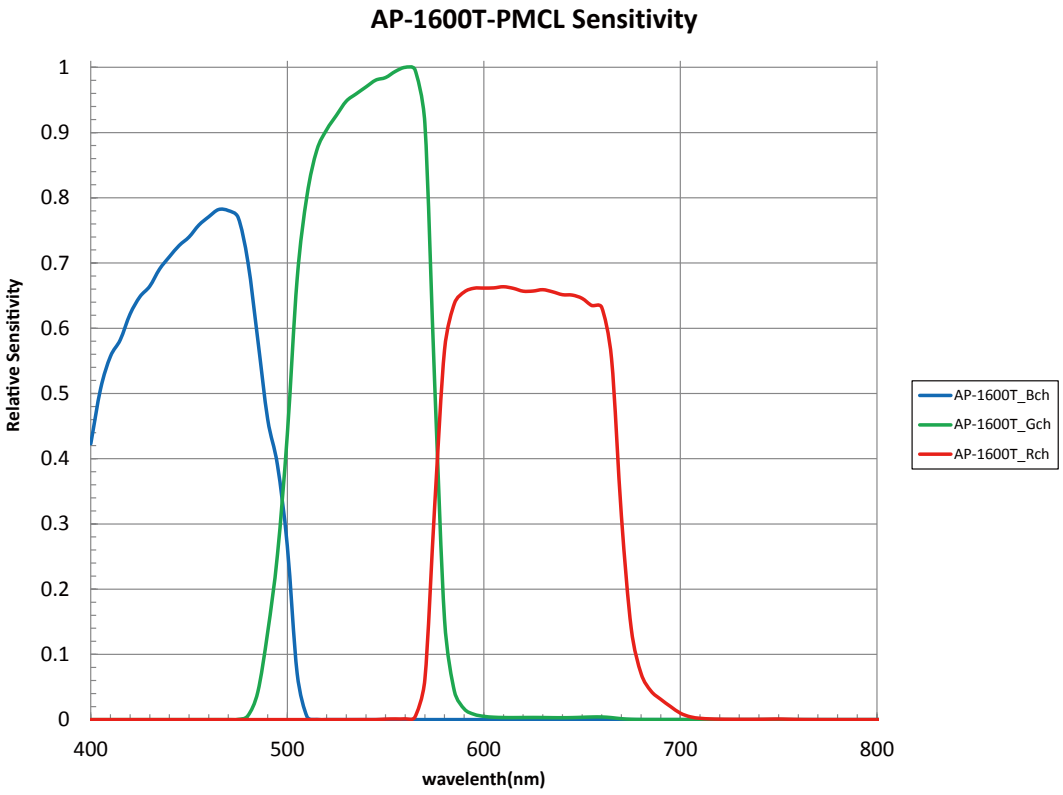
If the above temperature conditions are exceeded, take measures to dissipate heat according to your installation environment and conditions.

Frame Rate Reference

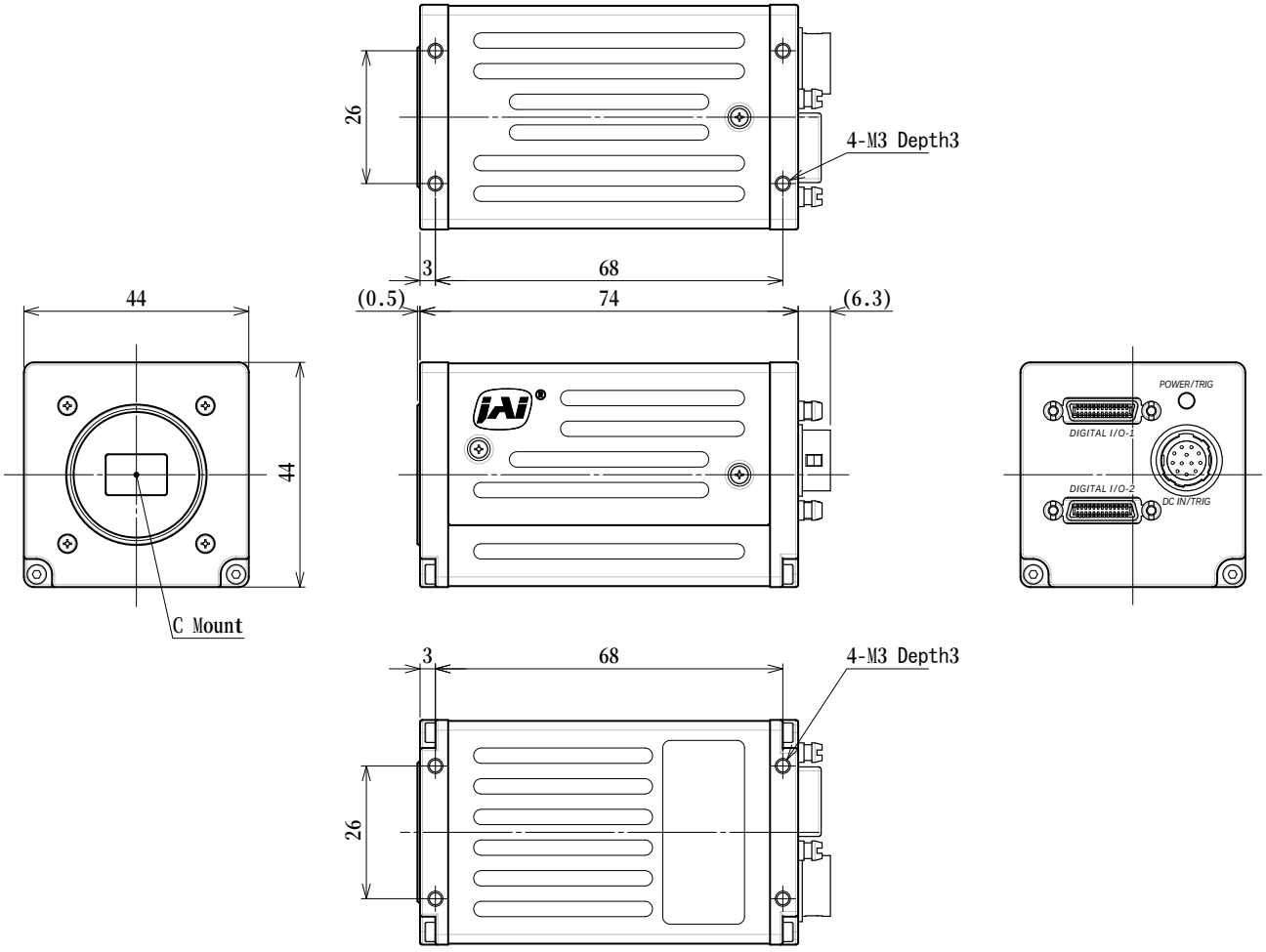
(Theoretical value)

Pixel count	Resolution (screen size)	ROI/Binning	Pixel size(μm)	Image size(mm)	Frame rate
1.6 MP	1456 × 1088	Full pixel	3.45 × 3.45	5.02 x 3.75 (6.27)	126.1 fps (@24 bit)
1.3 MP	1280 × 1024	ROI	3.45 × 3.45	4.42 x 3.53 (5.66)	133.7 fps (@24bit)
0.5 MP	800 × 600	ROI	3.45 × 3.45	2.76 x 2.07 (3.45)	221.7 fps (@24bit)
0.3 MP	640 × 480	ROI	3.45 × 3.45	2.21 x 1.66 (2.76)	272.5 fps (@24bit)
0.3 MP	640 × 480	ROI + 2x2 Binning	6.9 × 6.9	4.42 x 3.31 (5.52)	488.6 fps (@24bit)

Spectral Response



Dimensions



Dimensional tolerance: ±0.3 mm
Unit: mm

Comparison of the Decibel Display and Multiplier Display

Decibels (dB)	Multipliers (×)	Remarks
-6	0.501	Near minimum value of Gain[AnalogRed/AnalogBlue] 1)
-5	0.562	
-4	0.631	
-3	0.708	
-2	0.794	
-1	0.891	Near minimum value of Gain[DigitalRed/DigitalBlue] 2)
0	1	Minimum value of Gain[AnalogAll] Minimum value of Gain[AnalogIndividualRed/Green/Blue]
1	1.122	Near maximum value of Gain[DigitalRed/DigitalBlue] 3)
2	1.259	
3	1.413	
4	1.585	
5	1.778	
6	1.995	
7	2.239	
8	2.512	
9	2.818	
10	3.162	
11	3.548	
12	3.981	Near maximum value of Gain[AnalogRed/AnalogBlue] 4)
13	4.467	
14	5.012	
15	5.623	
16	6.31	
17	7.079	
18	7.943	Near maximum value of Gain[AnalogAll] 5)
19	8.913	
20	10	
21	11.22	
22	12.589	
23	14.125	
24	15.849	
25	17.783	
26	19.953	
27	22.387	
28	25.119	
29	28.184	
30	31.623	
31	35.481	
32	39.811	
33	44.668	
34	50.119	
35	56.234	
36	63.096	Near maximum value of Gain[AnalogIndividualRed/Green/Blue] 6)

1) Actual minimum value is 47 (×0.47, -6.558 dB).
2) Actual minimum value is 90 (×0.9, -0.915 dB).
3) Actual maximum value is 110 (×1.1, +0.828 dB).
4) Actual maximum value is 400 (×4.0, +12.041 dB).
5) Actual maximum value is 800 (×8.0, +18.06 dB).
6) Actual maximum value is 6400 (×64.0, +36.123 dB).

User's Record

Camera type: AP-1600T-PMCL

Revision: ……..

Serial No. ……..

Firmware version. ……..

For camera revision history, please contact your local JAI distributor.

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Revision history

Revision	Date	Changes
1.0	Apr. 2018	First version
1.1	Nov. 2018	Add KC.
1.2	Mar. 2019	Fix Contents and Index