JAI®

See the possibilities

User Manual

WA-1000D-CL

SWIR
InGaAs Line Scan Camera

Document Version: 1.0
WA-1000D-CL_Ver.1.0_July.2016

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.

Contents

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.

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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 WA-1000D-CL comply 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.

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.

🔄15 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 （PBB）	多溴二苯醚 （PBDE）
连接插头	×	○	○	○	○	○
电路板	×	○	○	○	○	○
光学滤镜	×	○	×	○	○	○
棱镜	×	○	○	○	○	○
螺丝固定座	×	○	○	○	○	○
机体外壳	×	○	○	○	○	○

○：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 and audio noise. In such cases, change the cable configurations or placement.

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 InGaAs image sensors

The following phenomena are known to occur on cameras equipped with InGaAs linear image sensors. These do not indicate malfunctions.
• Blooming
  When the camera is pointed at scenes containing very bright areas or strong light sources, some pixels on the InGaAs linear image sensor may accumulate more than the maximum charge allowed, causing the excess charge to overflow into the surrounding pixels. While this "blooming" affects image quality, it does not affect the operation of the camera.

Notes on exportation

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

Features

The WA-1000D-CL is a dual-band line scan camera that uses a prism and a combination of bandpass filters to divide incoming light by wavelength and direct it to two separate InGaAs linear image sensors. Wavelengths captured are in the NIR and SWIR spectral ranges spanning from approximately 900 nm to 1700 nm and are output in two video channels (ch1/ch2) via the Camera Link interface.

See "Spectral Response" (page 46) for a description of the wavelengths output by each channel.

❖ The M52 mount meets the recommended machine vision lens guidelines for large sensor mounts as established by the Japan Industrial Imaging Association in cooperation with AIA and EMVA (JIIA LER-004-2010 mechanical interface recommendations by image size).

Camera Link compatible interface
• Video outputs can be used as trigger inputs.
• The video output can be switched between a dual-base configuration and a 2-ch configuration.

Output formats
You can choose from 8-bit, 10-bit, and 12-bit output.

Variety of pre-process functions
• LUT (Lookup Table)
  Programmable control over gamma and contrast is possible.
• Gamma correction
  Gamma can be set to 0.45 or 1.0 (off).
• Shading correction (flat field)
  Non-uniformity (i.e., shading) in the amount of light generated by the lens and lighting equipment can be corrected.
• Variable line rate
  By varying the line rate, the scanning speed of the camera can be matched to the feeding speed of the object, and the accumulation time can be lengthened to increase sensitivity.

Connection example:

— 6 —
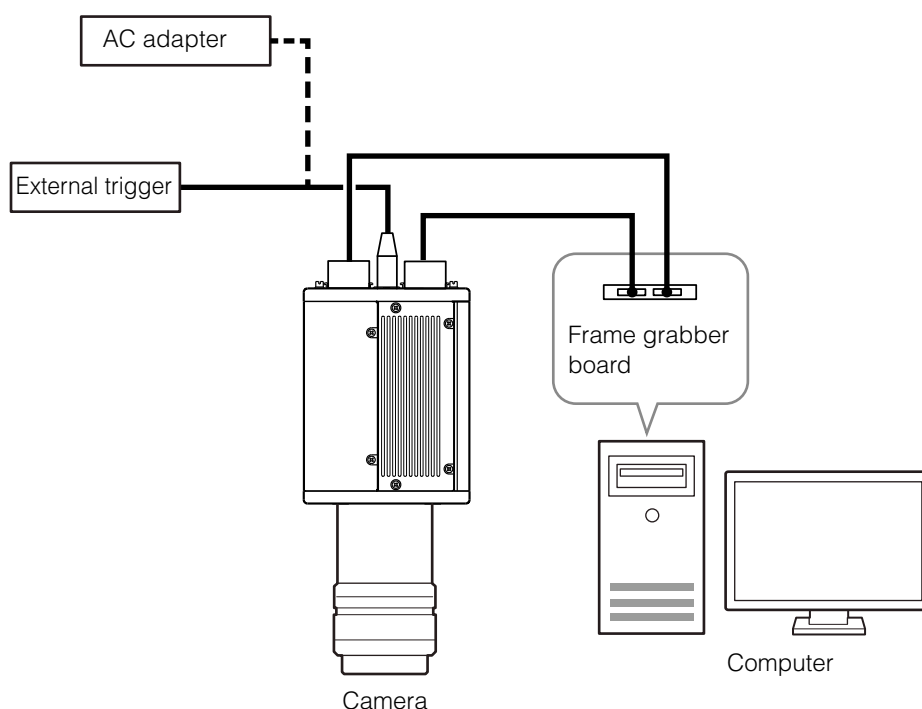
Parts Identification
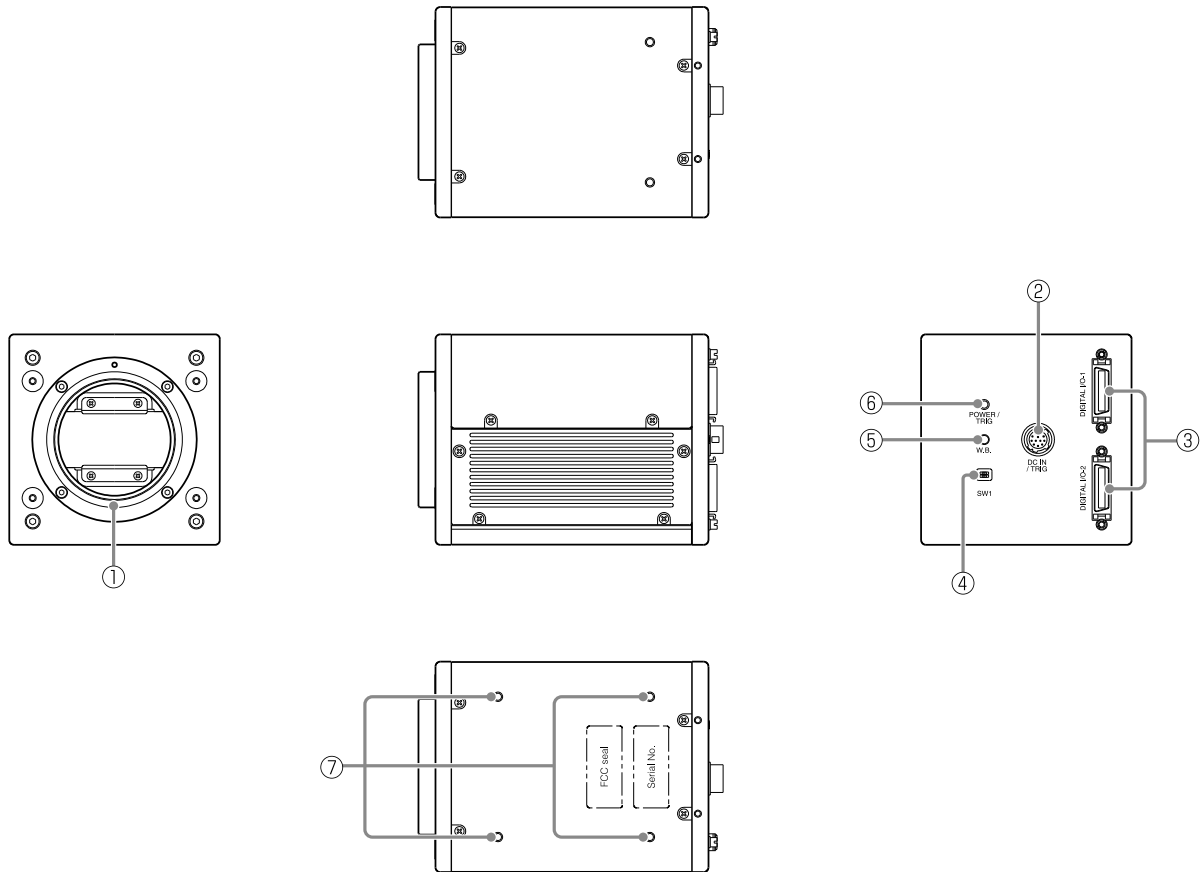
① Lens mount (M52 mount)

Mount an M52 lens here.

- ❖ Before mounting a lens, be sure to refer to "Step 2: Connecting Devices" (page 13) and confirm the precautions for attaching a lens and the supported lens types.
- ❖ Lenses without the aperture ring on the lens side are not supported.

② DC IN / trigger IN connector (12-pin round)
Connect the cable for a power supply (sold separately) or for DC IN /trigger IN here.
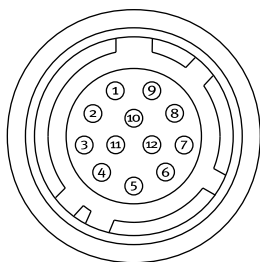
HR-10A-10R-12PB (71) (Hirose Electric or equivalent)

Pin No.	Input/ output	Signal	Description
1		GND	
2		DC IN	+12 to +24 V
3		GND	
4		Reserved	External connection not possible
5		GND	
6	In	RxD In	RS-232C
7	Out	TxD Out	RS-232C
8		GND	
9		XEEN	
10	Out	Trigger	
11	In	DC IN	+12 to +24 V
12		GND	

Caution

The DC IN / trigger IN connector or the CC1 of the DIGITAL I/O 1 video output connector will be used for external trigger inputs. You can switch which of these two are used via a command.

Compatible connectors
Camera side: HR10A-10R-12PB (71) (Hirose Electric or equivalent)
Cable side: HR-10A-10P-12S (plug) (Hirose Electric or equivalent)

③ DIGITAL I/O 1 and DIGITAL I/O 2 video output connectors
Connect a Cable Link compatible cable here.

Connector 1 (used during 2ch 8-/10-bit, Dual Base 1ch 8-/10-bit output)

Pin No.	Input/ output	Signal	Description
1, 14		Shield	GND
2 (-), 15 (+)	Out	TxOUT0	Data output
3 (-), 16 (+)	Out	TxOUT1	Data output
4 (-), 17 (+)	Out	TxOUT2	Data output
5 (-), 18 (+)	Out	TxClk	CL Clock
6 (-), 19 (+)	Out	TxOUT3	Data output
7 (+), 20 (-)	In	SerTC (RxD)	LVDS serial control
8 (-), 21 (+)	Out	SerTFG (TxD)	LVDS serial control
9 (-), 22 (+)	In	CC1	Trigger
10 (-), 23 (+)	In	CC2	Reserved
11, 24		N.C	
12, 25		N.C	
13, 26		Shield	GND

Channel 2 (used during Connector Dual Base 2ch 8-/10-bit output)

Pin No.	Input/output	Signal	Description
1, 14		Shield	GND
2 (-), 15 (+)	Out	TxOUT0	Data output
3 (-), 16 (+)	Out	TxOUT1	Data output
4 (-), 17 (+)	Out	TxOUT2	Data output
5 (-), 18 (+)	Out	TxClk	CL Clock
6 (-), 19 (+)	Out	TxOUT3	Data output
7 (+), 20 (-)		N.C	
8 (-), 21 (+)		N.C	
9 (-), 22 (+)		N.C	
10 (-), 23 (+)		N.C	
11, 24		N.C	
12, 25		N.C	
13, 26		Shield	GND

❖ For details on bit assignments for TxOUT0 to 3, see "Camera Link Bit Assignments" (page 22).

Compatible connectors / cable assembly
Camera side: 110226-1A10PL (3M or equivalent)
Cable assembly: 14B26-SZLB-XXX-OLC1)[1] (standard type) (3M or equivalent)

❖ Compatible cable length is 0.5 to 10 m.
❖ The cable length at which communication will be possible will be limited when using a cable that is not compatible with Camera Link or the 14B26-SZ3B-XXX-03C[1] (small diameter type) or 14B26-SZ3B-XXX-04C[1] (high flex type) cable.

*1 "XXX" represents the cable length.

④ SW1 DIP switch
Specify the following functions regarding external trigger signals.

Serial Communication   CL ⇔ HR
75Ω   OFF ⇔ ON
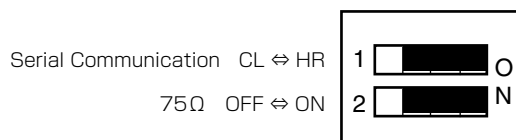
SW No.	Function		Function setting	
			ON	OFF
1	Communication switching	Switch between using the DC IN / trigger IN connector (12-pin) or the Tx.Rx of the DIGITAL I/O 1 video output connector as the communication port.	Control via 12-pin connector	Control via Camera Link (CC1)[1]
2	Switching the external trigger signal input termination	Specify whether to terminate (75Ω) the external trigger within the camera.	75Ω	TTL[1]

*1 Factory default state

⑤ W.B. Push button
Adjust the One Push channel balance.

⑥ POWER/TRIG LED
Indicates the power and trigger input status.

LED status and camera status

LED	Light	Status
POWER/TRIG 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.

⑦ Camera locking screw holes (M4, 6 mm depth)
   Use this to connect the camera to the system.

Preparation

Preparation Flow

Step 1	Installing the Software (first time only) Install the software for configuring and controlling the camera (JAI SDI) on the computer.

⬇

Step 2	Connecting Devices Connect the lens, cables, AC adapter, computer, and other devices.

⬇

Step 3	Verifying the Camera's Network Connection Status Verify whether the camera is ready for use via the LEDs at the rear of the camera.

⬇

Step 4	Configuring Initial Settings for the Camera • Configure the Camera Link output port. • Configure external trigger settings.

⬇

Step 5	Configuring Basic Functions Configure exposure time, shutter, gain, DSNU, PRNU, and shading correction settings.

⬇

Step 6	Configuring Various Other Settings Configure various other settings as necessary.

⬇

Step 7	Saving the Settings Save the current setting configurations as 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/jp/camerasolutions/download/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 interface is also part of the default installation. This 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 affect Internet access speed on some systems. 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.

❷ Clear the [JAI GigE Vision Filter Driver] checkbox, and save.
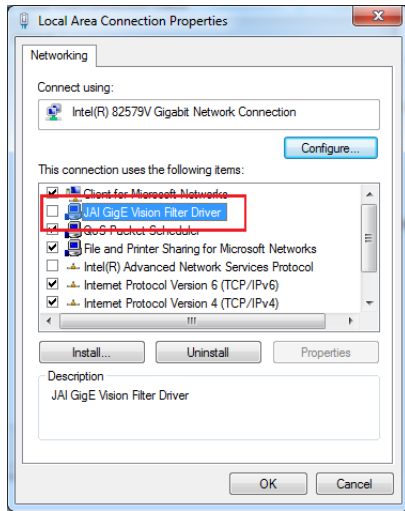
3 Verify the settings for using Camera Link.

The GO-1000D-CL supports GenIcam and Gen-CP. Check the following settings when controlling the camera via JAI SDK.

Checking the frame grabber board's settings

Settings must be configured on the frame grabber board to enable Gen-CP support.

For details, refer to the operating instructions for each board.

Checking JAI SDK's settings

❶ Start JAI Control Tool, and click the [⊘] (Settings) icon at the top right.
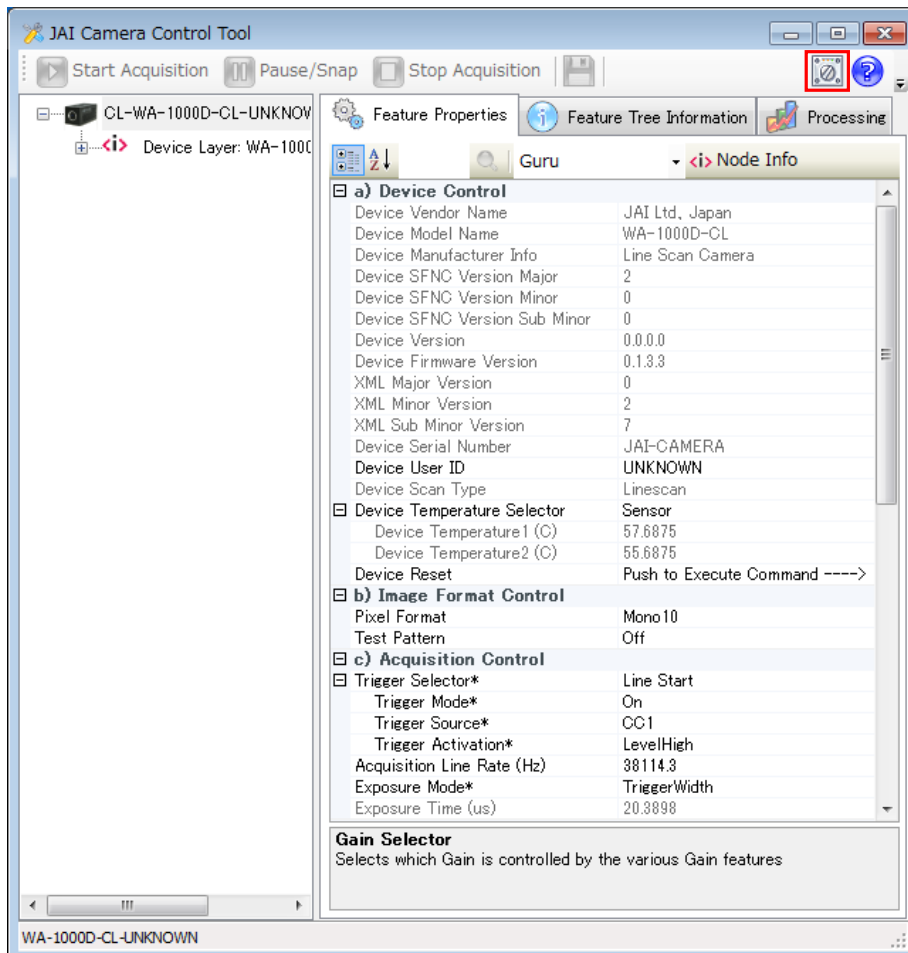
❷ Check that the [JAI_GenCP_Camera_Link] and [Camera Link Transport Layer] settings are configured as follows.
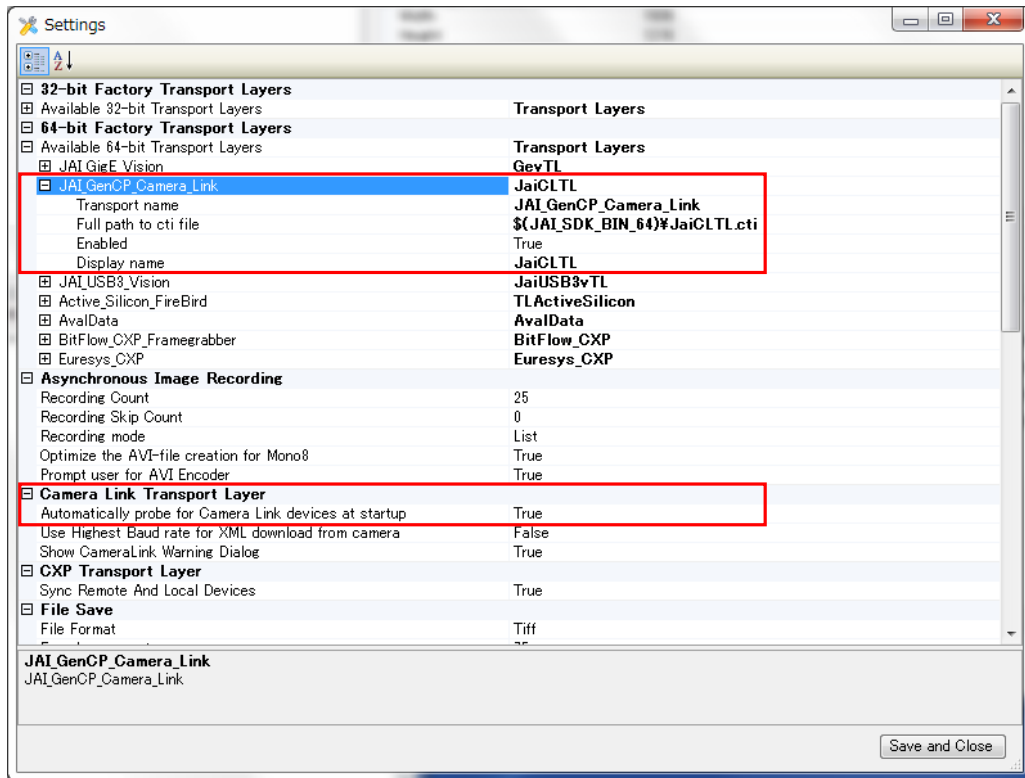
Step 2: Connecting Devices

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

① Lens
② Direct connection
Camera body
③ Camera Link cable
④ Frame grabber board
⑤ Computer
⑥ DC IN / trigger IN connection cable
to external trigger
or
⑦ AC adapter (not supplied)
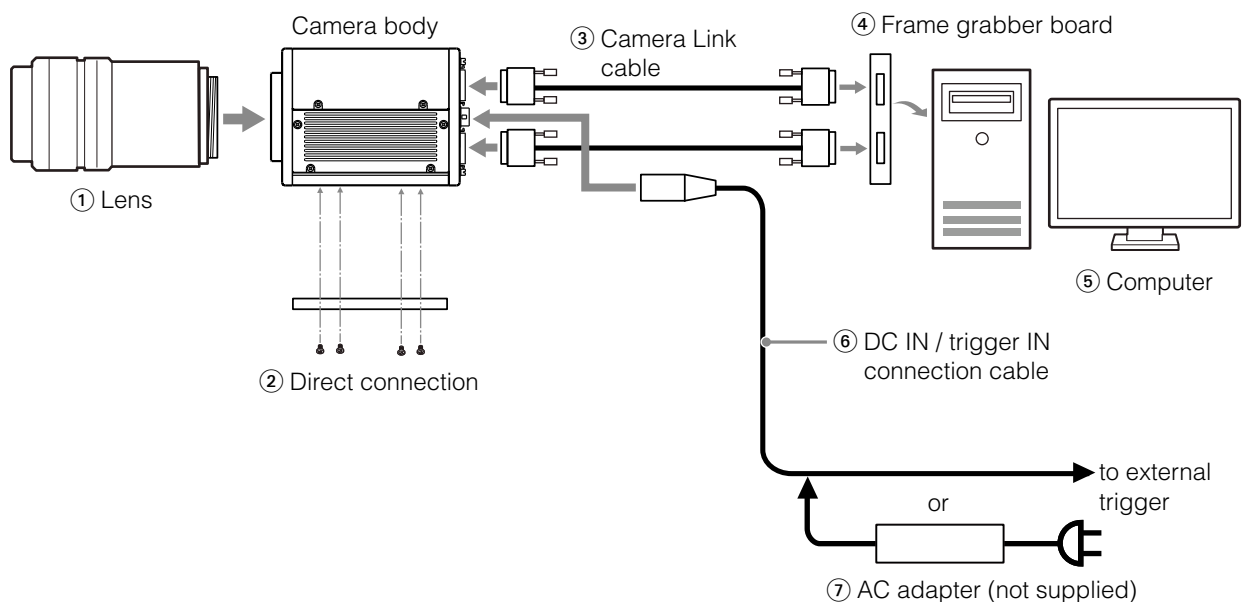
① Lens
• M52-mount lenses with lens mount protrusions of 13 mm or less can be attached.

13 mm or less ⟶ Lens mount protrusion
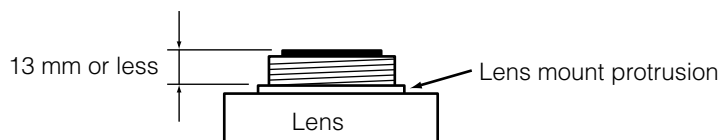
Lens

Caution

• The maximum performance of the camera may not be realized depending on the lens.
• Attaching a lens with a mount protrusion longer than 13.1 mm 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 (25.6 mm on this camera)

② Direct connection
When mounting the camera directly to another device, for example, use screws that match the camera locking screw holes on the camera. (M4, 6 mm depth)
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 cables to the DIGITAL I/O 1 and DIGITAL I/O 2 video output connectors.
• Use Cable Link compatible cables.
• Refer to the specifications of the cable for details on its bend radius.
❖ For details on the cable, see "③ DIGITAL I/O 1 and DIGITAL I/O 2 video output connectors" (page 8).

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)

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 requirements of your frame grabber board.

⑥ DC IN / trigger IN connection cable

⑦ AC adapter (if necessary)
Connect the AC adapter and the round connector of the connection cable to the DC IN / trigger IN connector on the camera.

Step 3: Verifying the Camera Connection Status

When the necessary devices are connected and power is supplied to the camera, 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 and whether the camera is operational by checking the rear LED.

During normal status

Lit green ———————

Press to adjust the One Push channel balance. ———————
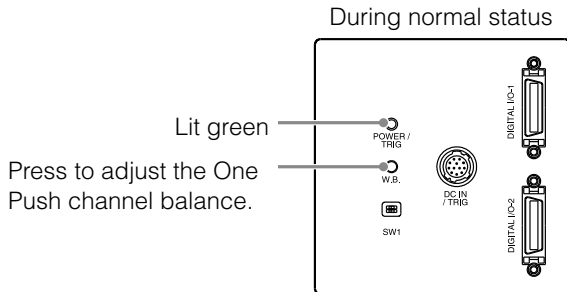
❖ For details on how to read the LED, see "LED status and camera status" (page 10) in the "Parts Identification" section.

| Note |

If the POWER/TRIG LED does not switch to green within minutes of supplying power, check the Camera Link cable and other connections.

Step 4: Configuring Basic Settings for the Camera

Start Control Tool, connect the camera to the frame grabber board, and configure initial settings for the output format.

Connecting to the Camera to Control Tool

1 Start JAI Control Tool.

Cameras connected to the frame grabber board are detected, and a window appears. If they do not appear, right-click inside 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.

Configuring the Output Format

The camera is equipped with two sensors. You can specify whether to output the images of the two sensors as a single screen or separately via two ports. You can also specify whether the two sensors operate identically or independently according to individual settings.

Item		Setting value / selectable range
JAI Custom Control	Device TG Mode	Sync (sensors synced), Async (sensors not synced) ❖ [Async] is selectable when [CL Type] is set to [Dual Base].
	CL Type	2 Channel (output as one screen), Dual Base (output separately via two ports)

Control via External Triggers

When Controlling the Exposure Time Using Specified Exposure Times

When [Device TG Mode] is set to [Async] (not synced), configure [JAI Custom Control] - [Acquisition Control Selector] as follows.

Item		Setting value / selectable range
Trigger Selector (trigger operation)		Line Start
	Trigger Mode	On
	Trigger Source (trigger signal source)	Any
	Trigger Activation (trigger polarity)	Rising Edge (rising edge of input signal), Falling Edge (falling edge of input signal)
Exposure Mode		Timed (control via exposure time)
Exposure Time		Dependent on the [Exposure Mode] and [Acquisition Line Rate] settings.

1 Set [Exposure Mode] to [Timed].

([Timed] is the default setting.)

2 Specify the exposure time in [Exposure Time].

The setting value for the exposure time can only be changed when [Exposure Auto] is set to [Off]. If [Exposure Auto] is set to [Continuous], temporarily set it to [Off] before changing the [Exposure Time].

3 Set [Trigger Selector] to [Line Start].

([Line Start] is the default setting.)

4 Set [Trigger Mode] to [On].

5 If necessary, change the [Trigger Source] and [Trigger Activation] settings.

When Controlling the Exposure Time Using the Pulse Width of the Trigger Input Signal

Configure the settings as follows.

Item		Setting value / selectable range
Trigger Selector (trigger operation)		Line Start
	Trigger Mode	On
	Trigger Source (trigger signal source)	Any
	Trigger Activation (trigger polarity)	Rising Edge (rising edge of input signal), Falling Edge (falling edge of input signal)
Acquisition Line Rate		500.0 to 39235.29411 (Hz)
Exposure Mode		Trigger Width (control via trigger width)

1 Set [Exposure Mode] to [Trigger Width] .

When you select [Trigger Width], [Trigger Mode] will automatically be set to [On].

2 Set [Trigger Selector] to [Line Start].

([Line Start] is the default setting.)

3 If necessary, change the [Trigger Source] and [Trigger Activation] settings.

❖ When [Exposure Mode] is set to [Off] or [Timed], [Trsigger Mode] can be set to [Off].
❖ [Exposure Mode] can be set to [PWC] only when [Trigger Mode] is set to [On].

Control Without External Triggers

When Controlling the Exposure Time Using Specified Exposure Times

Configure the settings as follows.

Item	Setting value / selectable range
Trigger Selector (trigger operation)	Line Start
Trigger Mode	Off
Exposure Mode	Timed (control via exposure time)
Exposure Time	Dependent on the [Exposure Mode] and [Acquisition Line Rate] settings.

1 Set [Exposure Mode] to [Timed].

([Timed] is the default setting.)

2 Specify the exposure time in [Exposure Time].

The setting value for the exposure time can only be changed when [Exposure Auto] is set to [Off]. If [Exposure Auto] is set to [Continuous], temporarily set it to [Off] before changing the [Exposure Time].

3 Set [Trigger Mode] to [On].

When Not Controlling the Exposure Time

Configure the settings as follows.

Item	Setting value / selectable range
Exposure Mode	Off

The exposure will be performed with an exposure time equal to 1 / frame rate.

* [Exposure Time] is disabled.

Step 5: Adjusting the Image Quality

To maximize the performance of the camera, configure its basic function in the following order.

1 Configure the line rate (exposure time and shutter).

❖ For details on this setting, "Variable Line Rate" (page 33) and "Electronic Shutter" (page 34).

2 Configure the gain.

❖ For details on this setting, see "Gain Control" (page 30).

3 Configure the DSNU and PRNU settings.

❖ For details on this setting, see "DSNU Correction" (page 29) and "PRNU Correction" (page 29).

4 Perform shading correction.

❖ For details on this setting, see "Shading Correction" (page 32).

Caution

Perform black level adjustments and magnification aberration correction after configuring the above settings.

Step 6: Configuring Various Other Settings

See "Settings List" (page 37), and configure settings as necessary.

Step 7: Saving the Settings

The setting values configured in Control Tool will be deleted when the camera is turned off. By storing current setting values to user memory, you can load and recall them whenever necessary. You can save up to two sets of user memory settings (User 1 Data and User 2 Data).
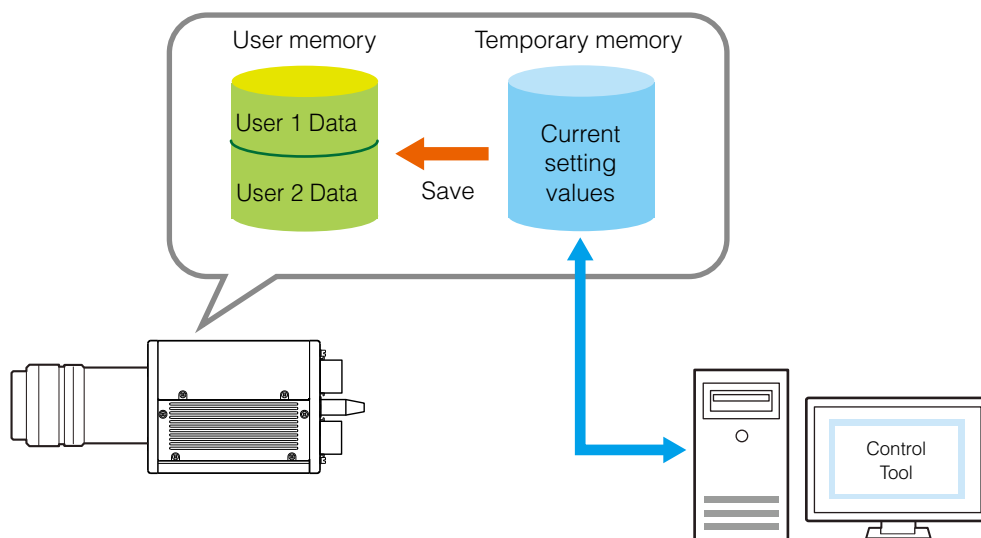
Note

The setting values are not saved to the computer (Control Tool).

■ To save user settings

1 Stop image capture.

2 Expand [User Set Control] and select the save destination ([User Set1] to [User Set3]) in [User Set Selector].
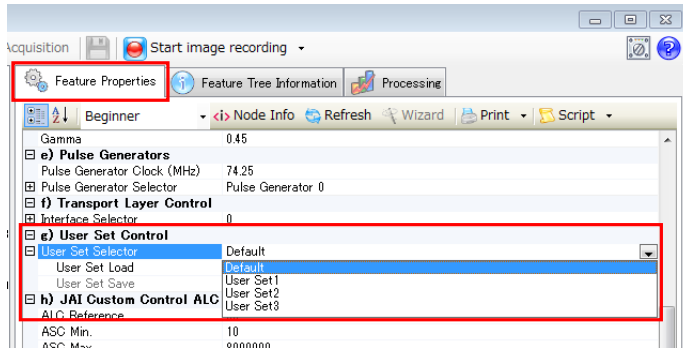
Note

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

Caution

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

3 Select [User Set Save], and click [Execute 'User Set Save' Command].
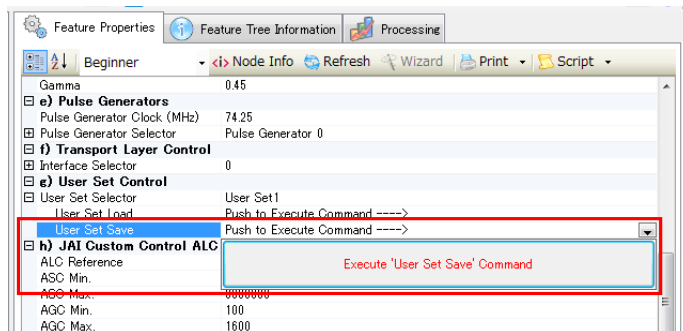
The current setting values are saved as user settings.

■ To load user settings

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

2 Select the settings to load (Default, and User Set1 to User Set3) in [User Set Selector].

3 Select [User Set Load], and click [Execute 'User Set Load' Command].
The selected user settings are loaded.

❖ The next time the unit is started up, the settings selected in [User Set Selector] will be loaded automatically.

Basic Function Matrix

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

MODE		Gain		Offset	Shading correction	ALC (automatic level control)		Test pattern	Auto Line Rate
Exposure Mode	Trigger Mode	Master tracking	Individual	Individual	FLAT	Gain	Shutter		
OFF	OFF	◎	◎	◎	◎	◎	×	◎	◎
	ON				○	○		○	×
Timed	OFF	◎	◎	◎	◎	◎	◎	◎	◎
	ON				○	○	○	○	×
PWC	ON	◎	◎	◎	○	○	×	○	×

◎: Combination supported.

○: Combination supported. However, the trigger must continue to be input during correction value learning and test pattern display.

×: Combination not supported.

■ Operation modes and One Push channel balance (WB) operations

	Trigger Mode	Control	
		Gain	Shutter
Exposure Mode OFF	OFF	○	×
	ON	○	×
Shutter select	OFF	○	○
	ON	○	○
PWC	ON	○	×

Main Functions

Camera Output Formats

Camera Link Output Ports

■ **2-ch**

For 8-bit (Base Configuration: 24-bit RGB)

Input signal

| 1ch |
| 2ch |

| – |

Camera Link output

| Port A |
| Port B |
| Port C |

Output from R and G of 24-bit RGB

B-ch not used
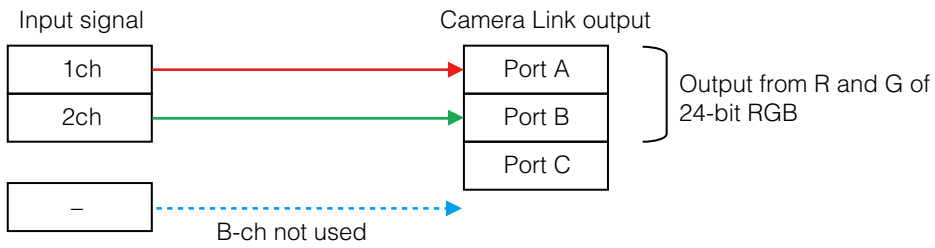
For 10-bit / 12-bit (Medium Configuration: 30- (36-) bit RGB)

Input signal

| 1ch |
| 2ch |

| – |

Camera Link output

| Port A |
| Port B |
| Port C |

Output from R and B of 30- (36-) bit RGB

| Port D |
| Port E |
| Port F |

G-ch not used

■ **Dual base**

For 8-bit

Input signal

| 1ch |

Camera Link output

| Port A |
| Port B |
| Port C |

CameraLink1 Port a

Input signal

| 2ch |

Camera Link output

| Port D |
| Port E |
| Port F |

CameraLink2 Port d
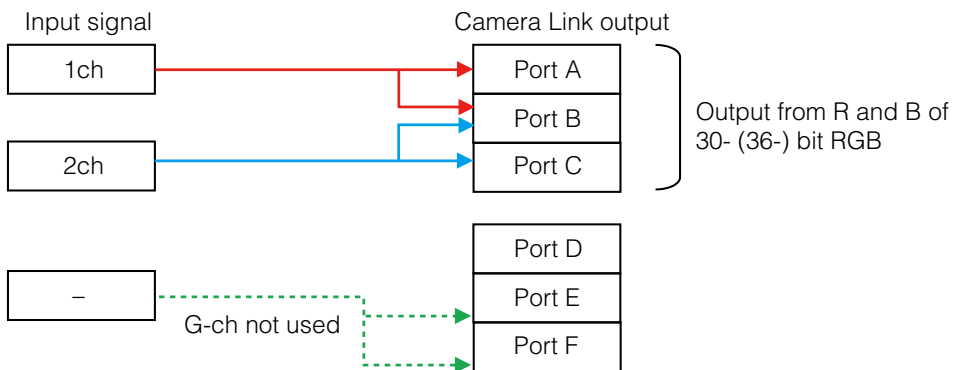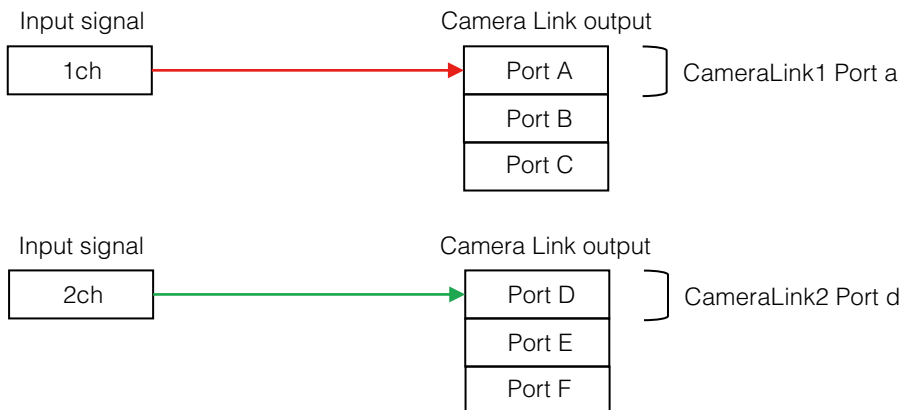
For 10-bit / 12-bit
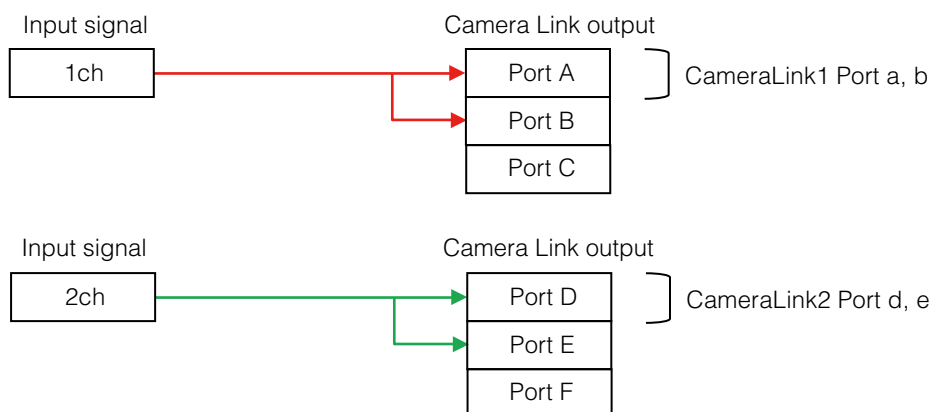
Camera Link Bit Assignments

The camera is compatible with the Camera Link standard. The bit assignments are as follows.

Out1_D9 to Out1_D0: Out1_Camera Data (Out1_D9 = MSB, Out1_D0 = LSB)
Out2_D9 to Out2_D0: Out2_Camera Data (Out2_D9 = MSB, Out2_D0 = LSB)
Out3_D9 to Out3_D0: Out3_Camera Data (Out3_D9 = MSB, Out3_D0 = LSB)
Out4_D9 to Out3_D0: Out4_Camera Data (Out4_D9 = MSB, Out4_D = LSB)
Out5_D7 to Out3_D0: Out5_Camera Data (Out5_D7 = MSB, Out5_D0 = LSB)
Out6_D7 to Out3_D0: Out6_Camera Data (Out6_D7 = MSB, Out6_D0 = LSB)
×: Not supported

| Port / signal	2-ch			Dual base			Connector	Pin name
	8-bit × 2 output	10-bit × 2 output	12-bit × 2 output	8-bit output	10-bit output	12-bit output		
Port A0	Out1_D0	Out1_D0	Out1_D0	Out1_D0	Out1_D0	Out1_D0	1	Tx0
Port A1	Out1_D1	Out1_D1	Out1_D1	Out1_D1	Out1_D1	Out1_D1	1	Tx1
Port A2	Out1_D2	Out1_D2	Out1_D2	Out1_D2	Out1_D2	Out1_D2	1	Tx2
Port A3	Out1_D3	Out1_D3	Out1_D3	Out1_D3	Out1_D3	Out1_D3	1	Tx3
Port A4	Out1_D4	Out1_D4	Out1_D4	Out1_D4	Out1_D4	Out1_D4	1	Tx4
Port A5	Out1_D5	Out1_D5	Out1_D5	Out1_D5	Out1_D5	Out1_D5	1	Tx6
Port A6	Out1_D6	Out1_D6	Out1_D6	Out1_D6	Out1_D6	Out1_D6	1	Tx27
Port A7	Out1_D7	Out1_D7	Out1_D7	Out1_D7	Out1_D7	Out1_D7	1	Tx5
Port B0	Out2_D0	Out1_D8	Out1_D8	×	Out1_D8	Out1_D8	1	Tx7
Port B1	Out2_D1	Out1_D9	Out1_D9	×	Out1_D9	Out1_D9	1	Tx8
Port B2	Out2_D2	×	Out1_D10	×	×	Out1_D10	1	Tx9
Port B3	Out2_D3	×	Out1_D11	×	×	Out1_D11	1	Tx12
Port B4	Out2_D4	Out2_D8	Out2_D8	×	×	×	1	Tx13
Port B5	Out2_D5	Out2_D9	Out2_D9	×	×	×	1	Tx14
Port B6	Out2_D6	×	Out2_D10	×	×	×	1	Tx10
Port B7	Out2_D7	×	Out2_D11	×	×	×	1	Tx11
Port C0	×	Out2_D0	Out2_D0	×	×	×	1	Tx15
Port C1	×	Out2_D1	Out2_D1	×	×	×	1	Tx18
Port C2	×	Out2_D2	Out2_D2	×	×	×	1	Tx19
Port C3	×	Out2_D3	Out2_D3	×	×	×	1	Tx20
Port C4	×	Out2_D4	Out2_D4	×	×	×	1	Tx21
Port C5	×	Out2_D5	Out2_D5	×	×	×	1	Tx22
Port C6	×	Out2_D6	Out2_D6	×	×	×	1	Tx16
Port C7	×	Out2_D7	Out2_D7	×	×	×	1	Tx17
LVAL	×	×	×	×	×	×	1	Tx24

Port / signal	2-ch			Dual base			Connector	Pin name
	8-bit × 2 output	10-bit × 2 output	12-bit × 2 output	8-bit output	10-bit output	12-bit output		
FVAL	×	×	×	×	×	×	1	Tx25
DVAL	×	×	×	×	×	×	1	Tx26
EEN	×	×	×	×	×	×	1	Tx23

Port / signal	Dual base			Connector	Pin name
	8-bit output	10-bit output	12-bit output		
Port D0	Out2_D0	Out2_D0	Out2_D0	2	Tx0
Port D1	Out2_D1	Out2_D1	Out2_D1	2	Tx1
Port D2	Out2_D2	Out2_D2	Out2_D2	2	Tx2
Port D3	Out2_D3	Out2_D3	Out2_D3	2	Tx3
Port D4	Out2_D4	Out2_D4	Out2_D4	2	Tx4
Port D5	Out2_D5	Out2_D5	Out2_D5	2	Tx6
Port D6	Out2_D6	Out2_D6	Out2_D6	2	Tx27
Port D7	Out2_D7	Out2_D7	Out2_D7	2	Tx5
Port E0	×	Out2_D8	Out2_D8	2	Tx7
Port E1	×	Out2_D9	Out2_D9	2	Tx8
Port E2	×	×	Out2_D10	2	Tx9
Port E3	×	×	Out2_D11	2	Tx12
Port E4	×	×	×	2	Tx13
Port E5	×	×	×	2	Tx14
Port E6	×	×	×	2	Tx10
Port E7	×	×	×	2	Tx11
Port F0	×	×	×	2	Tx15
Port F1	×	×	×	2	Tx18
Port F2	×	×	×	2	Tx19
Port F3	×	×	×	2	Tx20
Port F4	×	×	×	2	Tx21
Port F5	×	×	×	2	Tx22
Port F6	×	×	×	2	Tx16
Port F7	×	×	×	2	Tx17
LVAL	×	×	×	2	Tx24
FVAL	×	×	×	2	Tx25

❖ LVAL 1 and LAVL 2 represent the same signal, and FAVL 1 and FVAL 2 represent the same signal.

■ Video Output Timing Diagram
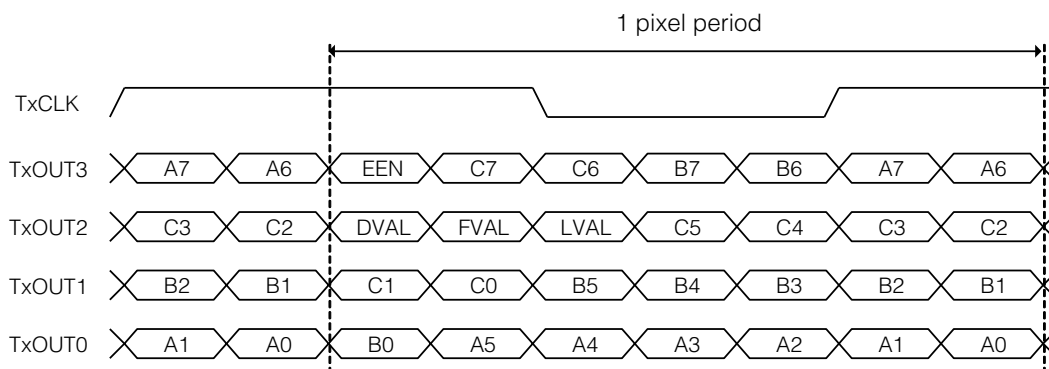
Exposure Mode
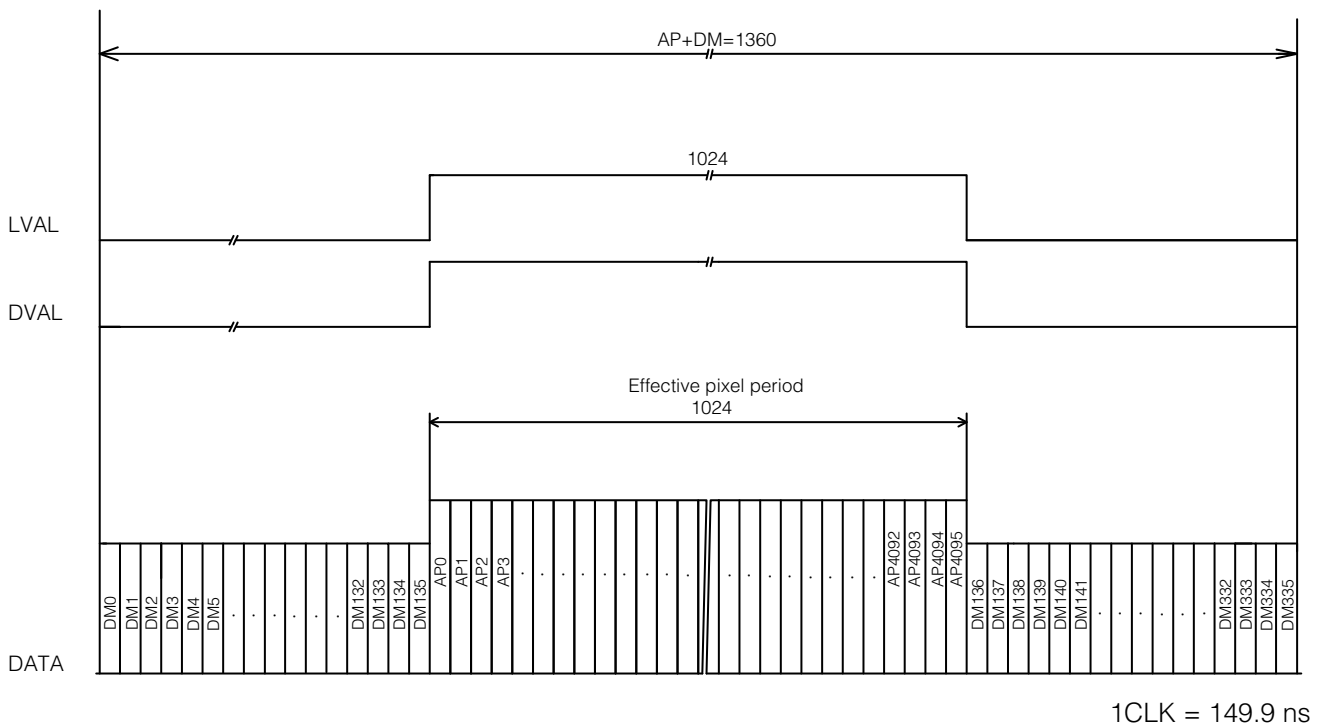
The following operation modes are available on the camera.

Operation mode		Command	
Exposure Mode	Trigger Mode	TR	TG
OFF	OFF	0	0
	ON		1
Timed	OFF	1	0
	ON		1
PWC	ON	2	1

❖ For details on operation mode and function combinations, see "Basic Function Matrix" (page 20).

Image Output Timing

Horizontal Timing

■ When [Exposure Mode] is [Off] (internal trigger)

AP+DM=1360

1024

LVAL

DVAL

Effective pixel period
1024

DATA

DM0 DM1 DM2 DM3 DM4 DM5 . . . DM132 DM133 DM134 DM135 AP0 AP1 AP2 AP3 . . . . AP4092 AP4093 AP4094 AP4095 DM136 DM137 DM138 DM139 DM140 DM141 . . . . DM332 DM333 DM334 DM335

1CLK = 149.9 ns

DM: Dummy pixel or Transfer_data pixel
LVAL: Line Valid
DVAL: Data Valid

Trigger Control

The camera allows Line Start trigger controls to be performed via external trigger signals.
The Line Start trigger allows exposure control via the trigger signal inputs.
❖ The settings for exposure control and triggers are related to each other. Be sure to configure the settings
   described in "Connecting to the Camera to Control Tool" (page 15).

Shortest Repetition Period for Triggers

Trigger Mode ON, full resolution

		Shortest period (µs)
Exposure Mode OFF	Camera Link	
	12-pin	
Exposure Mode Timed	Camera Link	Exposure time + (25.48 - 20.38)
	12-pin	
PWC	Camera Link	
	12-pin	

Shortest Trigger Pulse Width

Trigger Mode ON

	Camera Link	12-pin
Exposure Mode OFF	20.48 µs	50 µs
Exposure Mode Timed	20.48 µs	50 µs
PWC	20.48 µs	50 µs

■ When [Exposure Mode] is [Off]

Perform accumulation and scanning using triggers from an external source.
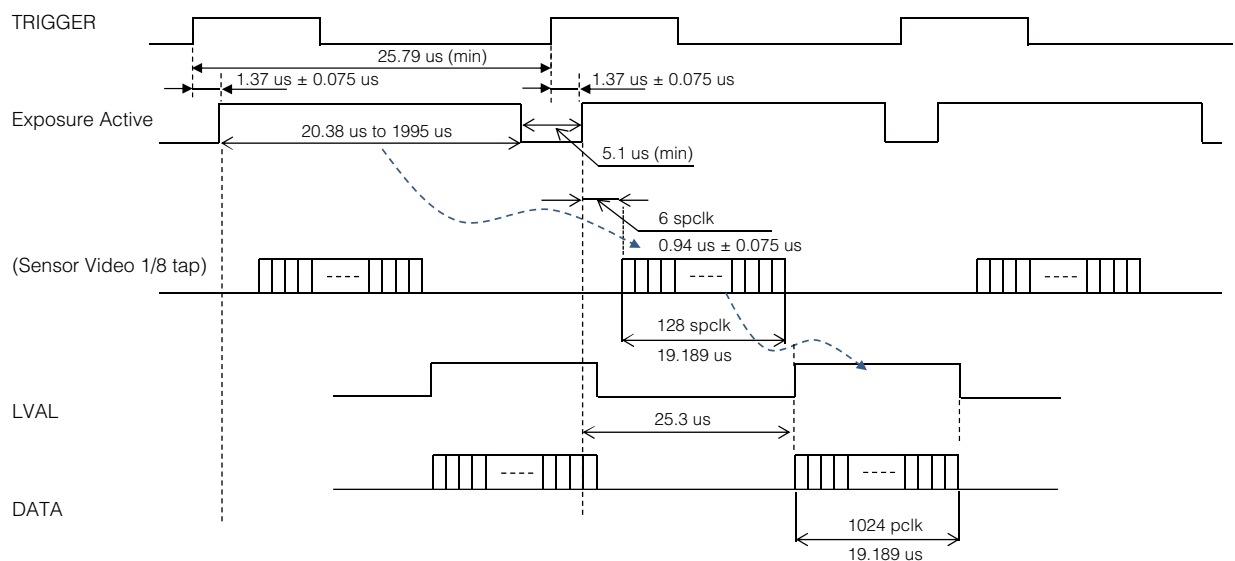As the accumulation control is performed using the camera's internal counter, accumulation will not be affected by trigger jitter.

- Actual exposure time: trigger period [*1] - 5.1 µs
- Shortest trigger period: 25.48 µs (20.38 µs exposure time)

*1 Recommended input range for trigger period: 25.48 µs to 2.0 ms

❖ The electronic shutter cannot be used in this mode.
❖ In this mode, only gain control will operate for One Push channel balance.

Caution

Be aware that the jitter that occurs in input triggers will result in accumulation errors.

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Spclk (Sensor Pixel clock): 149.92 ns (6.67 MHz)
pclk (Cameralink Pixel clock): 18.74 ns (53.36 MHz: SPCLK × 8)

Restrictions on trigger input periods and line rate conditions
As the first video signal triggered after the power is turned on or immediately after the trigger interval is 2 ms or higher is significantly affected by dark currents, we do not recommend using the first line at the beginning for [Trigger Mode].

■ When [Exposure Mode] is [Timed]

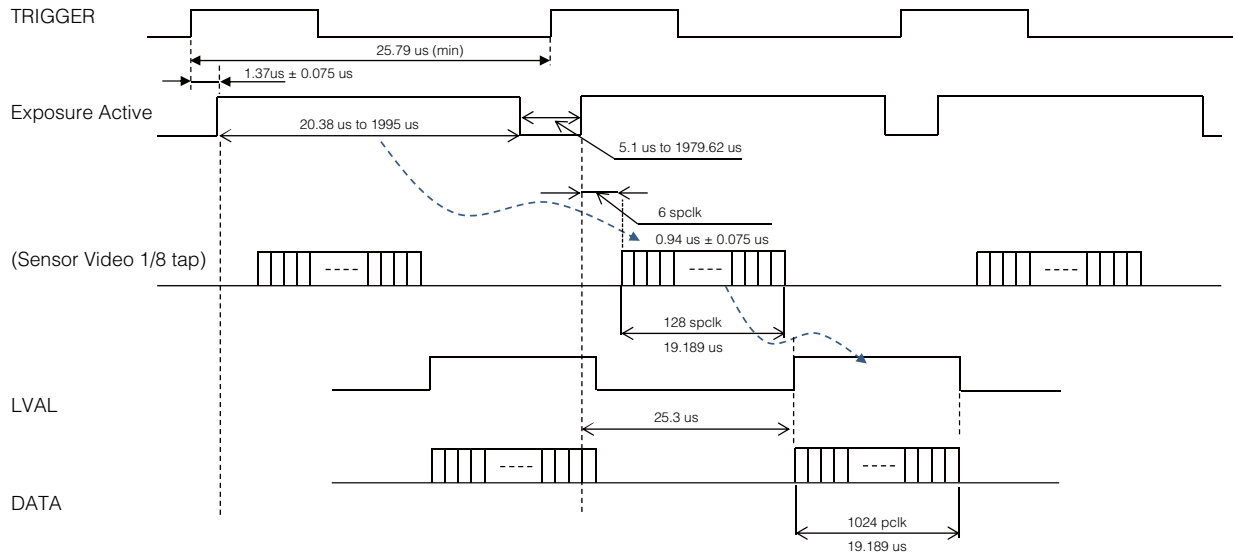Perform accumulation and scanning using triggers from an external source.
As the accumulation control is performed using the camera's internal counter, accumulation will not be affected by trigger jitter.
In addition, accumulation control can be performed individually for ch1 and ch2.

- Trigger period: exposure time + 5.1 μs
- Shortest trigger period: 25.48 μs (20.38 μs exposure time)

Electronic shutter
- Variable range: 20.38 μs (1L) to 1.995 ms (individual ch1/ch2 control possible)
- Variable unit: 149.9 ns (1clk) (individual ch1/ch2 control possible)

Spclk (Sensor Pixel clock): 149.92 ns (6.67 MHz)
pclk (Cameralink Pixel clock): 18.74 ns (53.36 MHz: SPCLK × 8)

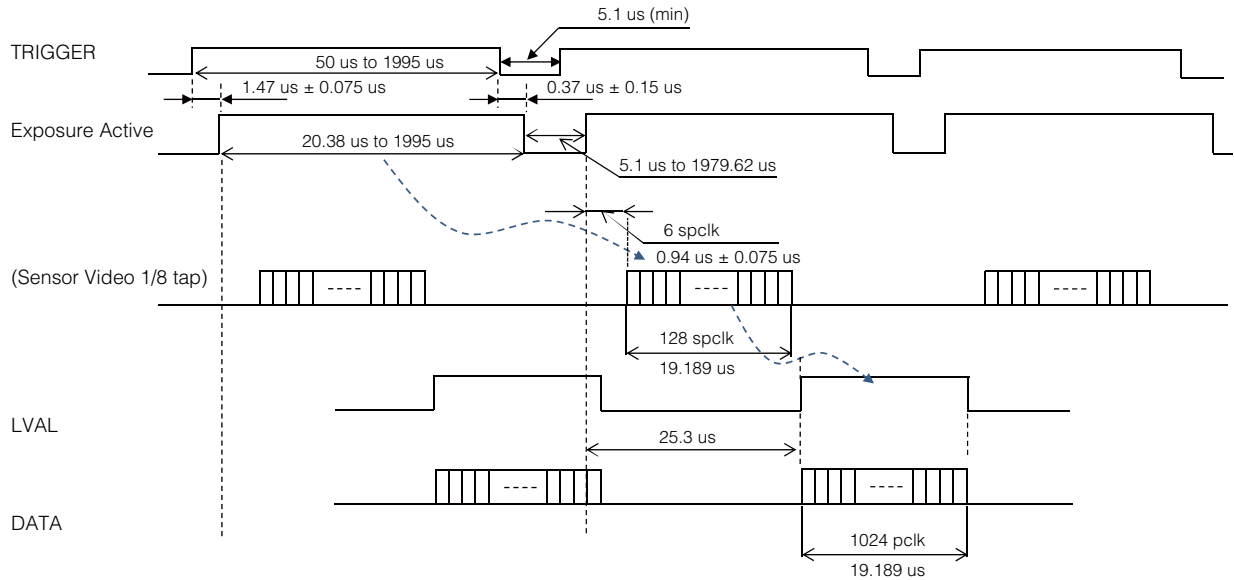**Restrictions on trigger input periods and line rate conditions**
As the first video signal triggered after the power is turned on or immediately after the trigger interval is 2 ms or higher is significantly affected by dark currents, we do not recommend using the first line at the beginning for [Trigger Mode].

■ When [Exposure Mode] is [Trigger Width]

Perform accumulation and scanning using triggers from an external source.
The accumulation time depends on the pulse width of the supplied trigger.

- Shortest trigger period: 25.48 µs
- Acceptable input pulse width: 50 µs to 1.995 ms (during TTL Interface input);
  20.38 µs to 1.995 ms (during Camera Link CC1 input)

❖ When executing One Push channel balance (i.e., the camera's W.B. LED is lit amber), triggers must be input continuously with the same trigger period as during actual use.

Spclk (Sensor Pixel clock): 149.92 ns (6.67 MHz)
pclk (Cameralink Pixel clock): 18.74 ns (53.36 MHz: SPCLK × 8)

Restrictions on trigger input periods and line rate conditions

As the first video signal triggered after the power is turned on or immediately after the trigger interval is 2 ms or higher is significantly affected by dark currents, we do not recommend using the first line at the beginning for [Trigger Mode].
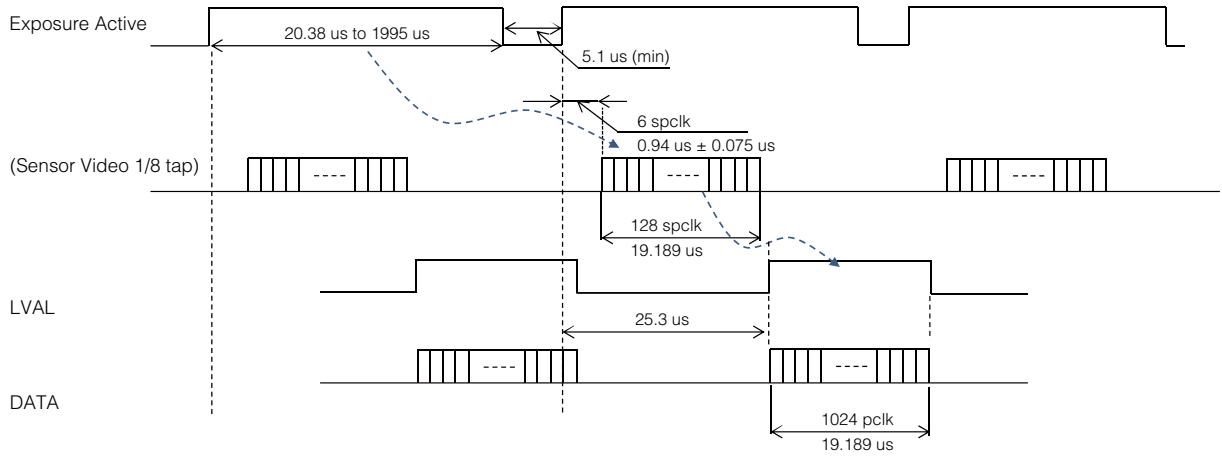
■ During normal continuous operation

When [Exposure Mode] is [Off]

Perform accumulation and scanning using triggers generated internally on the camera.
As the accumulation control is performed using the camera's internal counter, accumulation will not be affected by trigger jitter.
The accumulation time depends on the trigger interval. By increasing the length of the trigger interval, you can achieve high sensitivity.

Line period

- Variable range: 25.48 µs (1L) to 2.0 ms
- Variable unit: 149.9 ns (1clk)
- Actual exposure time: line rate - 5.1 µs

Spclk (Sensor Pixel clock): 149.92 ns (6.67 MHz)
pclk (Cameralink Pixel clock): 18.74 ns (53.36 MHz: SPCLK × 8)

When [Exposure Mode] is [Timed]

Perform accumulation and scanning using triggers generated internally on the camera.
As the accumulation control is performed using the camera's internal counter, accumulation will not be affected by trigger jitter.
In addition, accumulation control can be performed individually for ch1 and ch2.
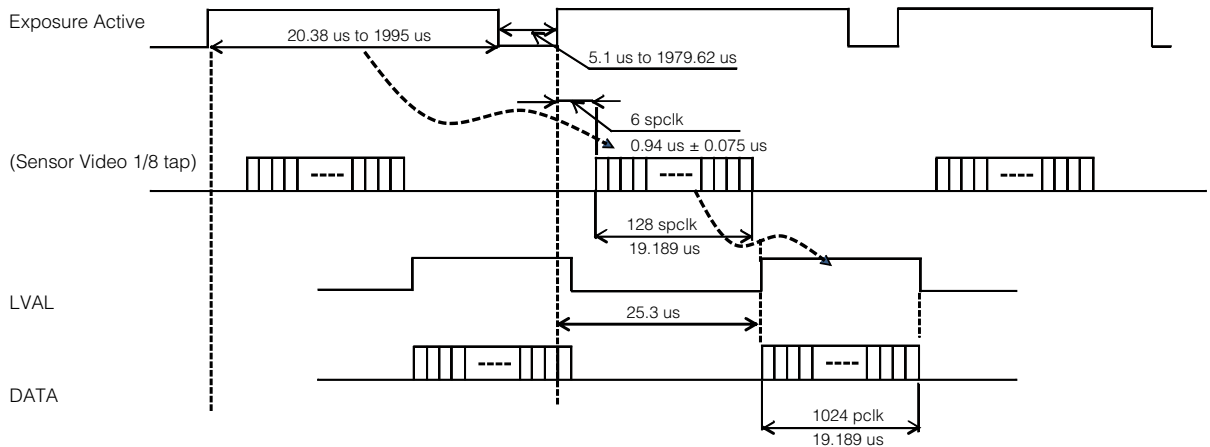
Line period
• Variable range: 25.48 μs (1L) to 2.0 ms
• Variable unit: 149.9 ns (1clk)

Electronic shutter
• Variable range: 20.38 μs (1L) to 1.995 ms [*1] (individual ch1/ch2 control possible)
• Variable unit: 149.9 ns (1clk) (individual ch1/ch2 control possible)
*1 The maximum duration will be the configured line period minus 5.1 μs.

Spclk (Sensor Pixel clock): 149.92 ns (6.67 MHz)
pclk (Cameralink Pixel clock): 18.74 ns (53.36 MHz: SPCLK × 8)
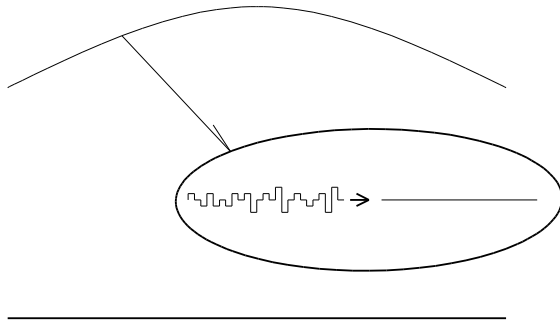
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Pixel Sensitivity Correction

Correct variations between the sensor's pixels.
❖ Switching for this function is performed via serial communication.
❖ This function is dependent on the operation mode.

PRNU Correction

Correct sensitivity variations between the sensor's pixels.
Level differences between taps will also be corrected simultaneously.

DSNU Correction

Correct offset variations between the sensor's pixels.

Black level

Defective Pixel Correction

Correct defective pixels.
Correction is performed using the average value between the pixels to the immediate left and right.
Up to eight defective pixels per channel can be corrected.
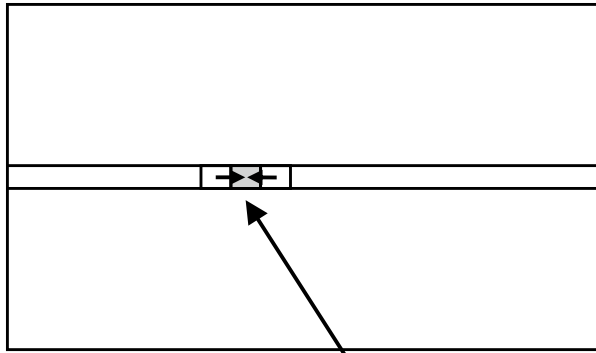The pixels at the left and right edges cannot be corrected.

■ **Auto detection function**

When a threshold value is configured and auto detection is performed, the defects are detected and their data points are stored internally on the camera.
When the defective pixel correction function is enabled after executing auto detection, the detected values are corrected.

Monochrome ☐ Defective pixel

The defective pixel is corrected using the average value
between the pixels to the immediate left and right.

❖ White defects can be recorrected.
❖ Black defects cannot be redetected.

Gain Control

The following three gain functions are available on the camera.
• Sensor conversion gain
• Analog base gain
• Analog fine gain

■ Sensor conversion gain

Sensor conversion gain (SCG) is InGaAs sensors' internal gain.
Settings for ch1 and ch2 can be configured individually from an external source, and the amount of gain can be adjusted via different combinations of 3-bit setting values.

Configuration bit			Scaling*
Cfa	Cfb	Cfc	
1	0	0	3.5
1	1	0	1 (default setting)
1	0	1	0.25
1	1	1	0.05

* Sensitivity (all scaling values are TYP values)

■ Analog base gain

Analog base gain (ABG) is gain that is performed prior to the video signal output from the sensor passing through the CDS circuit.
Settings for ch1 and ch2 can be configured individually from an external source. The gain steps can be configured to one of four levels.
When the gain level is low, the video output may not be saturated in some cases. Therefore, check whether the video is saturated whenever you change the settings.

AnalogBaseGain setting value	Scaling*
0	-6 dB ± 1 dB
1	-3 dB ± 1 dB
2	0 dB ± 1 dB (WA-1000D-CL default setting)
3	3 dB ± 1 dB (WAHA-1000D-CL default setting)

* Sensitivity (all scaling values are TYP values)

■ Analog fine gain

Analog fine gain (AFG) is gain that is performed after the video signal passes through the CDS circuit and prior to ADC (analog digital conversion).

This gain can be configured simultaneously for both ch1 and ch2 or individually for ch1 and ch2. Settings are configured as follows for each mode.

• Master Mode

Master: Allows simultaneous configuration of ch1 and ch2 settings.

2ch: Allows separate configuration from Master. The sum gain of Master and 2ch is applied to the ch2 video. This allows you to adjust the level differences between channels and perform fine adjustments on ch2.

• Individual Mode

Allows individual configuration of ch1 and ch2 settings.

		Setting range	Total gain
Master Mode	Master	0 to +11 dB (0 to 308)	AFG Total = Master
	2ch	-3 to +3 dB (-84 to +84)	AFG Total = Master + 2ch
Individual Mode	1ch	0 to +11 dB (0 to 308)	AFG Total = 1ch
	2ch	0 to +11 dB (0 to 308)	AFG Total = 2ch

The following diagram indicates the gain ranges of each mode.
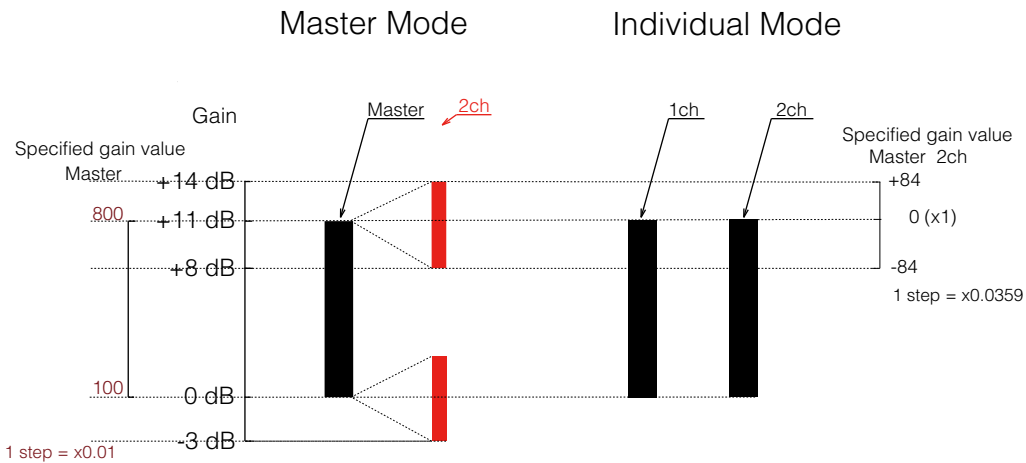
The following three gain values for ch1 and ch2 are added together for the total gain value.

Total Gain = SensorConversionGain (dB) + AnalogBaseGain (dB) + AnalogFineGain (dB)

LUT (Lookup Table) / Gamma Function

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.

The gamma function corrects the output signals from the camera beforehand (reverse correction), taking into consideration the light-emitting properties of the monitor display.

The γ0.45, LUT, and OFF settings can be selected on this camera. When OFF is selected, γ1 (linear) sensitivity is applied.

The factory default setting is OFF.

■ γ0.45

The following sensitivity curve is available internally on the camera.
In this mode, the same sensitivity curve is configured for ch1 and ch2.

CCD output level	Analog Signal	Digital Out (8-bit each)	Digital Out (10-bit each)
Black	Setup 3.6%, 25 mV	8LSB	32LSB
1912 mV	700 mV	222LSB	890LSB
2200 mV or more	800 mV	255LSB	1023LSB
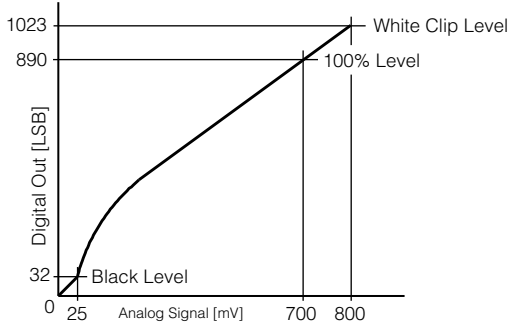
■ LUT

In this mode, the sensitivity curve can be configured for individually for ch1 and ch2.
Setting range: 0 to 8191LSB (200%)
Number of setting points: 256
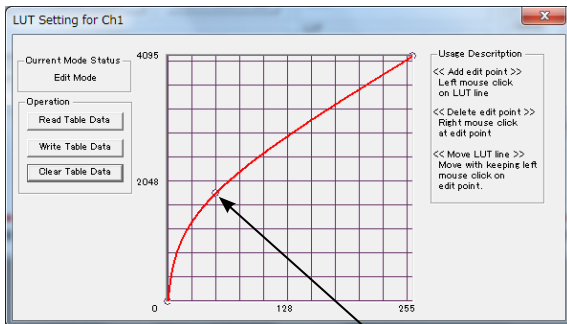
Setting point

Shading Correction

The shading correction is a function that corrects non-uniformity (i.e., shading) in the amount of light generated by the lens and lighting equipment.

The following shading correction modes are available on the camera.

■ Flat shading correction

Perform flat correction for the ch1 and ch2 signals.
The range of brightness that can be corrected is within ±20% of the region with the highest signal level on one line.

Command   SDR = 0: Flat shading correction
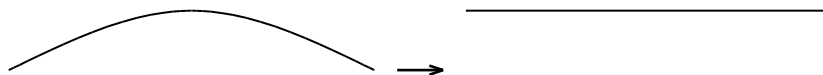
❖ Complete correction may not be possible depending on the optical system and light source you are using.
❖ Data based on corrections performed under factory conditions is stored for this function.

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■ **To perform the shading function**

The function is turned ON/OFF via serial communication.
This function is not dependent on the operation mode, but is effective when used during actual use.

❖ You can also save the setting and have it applied whenever the power is subsequently turned on. For details on saving the setting, see "Step 7: Saving the Settings" (page 18).

Channel Balancing

You can adjust the signal level of ch2 so that it matches that of ch1.
The level can be adjusted for this function by adjusting the gain or by varying the shutter.

Channel balance	Control Tool	Executed command		Rear panel SW
		CB	AH	
Gain	○	○	×	○
Shutter	○	×	○	×

Caution

When performing gain channel balancing or shutter channel balancing with external triggers (i.e., when the POWER/TRIG LED on the rear panel is lit amber), the external triggers must continue to be input.

■ **Gain channel balancing**

Calculate the difference between ch1 and ch2, and adjust the ch2 gain until the difference disappears to balance the channels.

Command   CB = 0 Manual / One push ACB

■ **Shutter channel balancing (Exposure Mode Timed only)**

Calculate the difference between ch1 and ch2, and adjust the ch2 shutter until the difference disappears to balance the channels.

Command   AH = 0 Active One push shutter ACB

Black Level Correction

Black level correction is a function for adjusting the setup level.
When this function is used, the following is performed for the gain mode setting.

Ch1/ch2: -255 to +255 LSB@12-bit

Variable Line Rate

You can set the line rate to 1L or more.
This function can be used to match the scanning speed of the camera to the feeding speed of the object or to lengthen the accumulation time to increase sensitivity.

• Variable range: 500 Hz to 39.235 kHz (25.4875 μs to 2 ms)
• Variable unit: 149.9 ns (1clk)
• Supported operation modes: Exposure Mode OFF / internal trigger
                              Shutter select / internal trigger

❖ You can also save the setting and have it applied whenever the power is subsequently turned on, but this requires addition operations.

❖ Switching and settings storage for this function is performed via serial communication.

❖ The black level will change depending on the line rate, so be sure to readjust the black level after changing the line rate or trigger period.

■ Auto line rate configuration function

You can automatically configure the optimal line rate when you want to prioritize sensitivity.

• Supported operation modes: When Trigger Mode OFF, Exposure Mode OFF / Exposure Mode Timed

❖ You can also save the setting and have it applied whenever the power is subsequently turned on. For details on saving the setting, see "Step 7: Saving the Settings" (page 18) .

Electronic Shutter

When you use this function, you can set the exposure to a preconfigured accumulation time, regardless of the line rate.
The accumulation time can be configured individually for ch1 and ch2.

• Variable range: 20.38 µs (1L) to 1.995 ms (individual ch1/ch2 control possible)
• Variable unit: 149.9 ns (1clk) (individual ch1/ch2 control possible)
• Supported operation modes: When Trigger Mode ON, Exposure Mode Timed

Caution

In "Trigger Mode OFF, Exposure Mode Timed" mode, the line rate configured will be the maximum value at which the shutter operates. However, in "Trigger Mode ON, Exposure Mode Timed" mode, the input trigger period will be the maximum value.

❖ You can also save the setting and have it applied whenever the power is subsequently turned on, but this requires addition operations.

❖ Switching and settings changing and storage for this function is performed via serial communication.

EEN (Exposure Enable) Function

Perform external output for the timing at which video is accumulated to the sensor.
The signal is output to the DC IN / trigger IN connector (12-pin round) and the DIGITAL I/O 1 video output connector (Camera Link).

Example: Output to the DIGITAL I/O 1 video output connector (Camera Link)
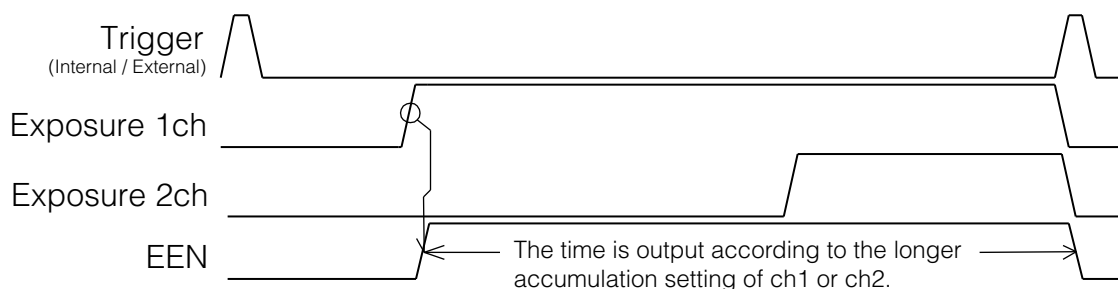
❖ The negative polarity is output to the DC IN / trigger IN connector (12-pin round), and the positive polarity is output to the DIGITAL I/O 1 video output connector (Camera Link). The polarities cannot be changed.

Test Pattern Function

You can display the following types of test patterns. Video output is not possible while a test pattern is being executed.
This function is not dependent on gain and offset values that have already been configured, and output is performed in the following states.

❖ Switching for this function is performed via serial communication.
❖ This function cannot be saved as the initial state of the camera.

■ 1: Gray 1
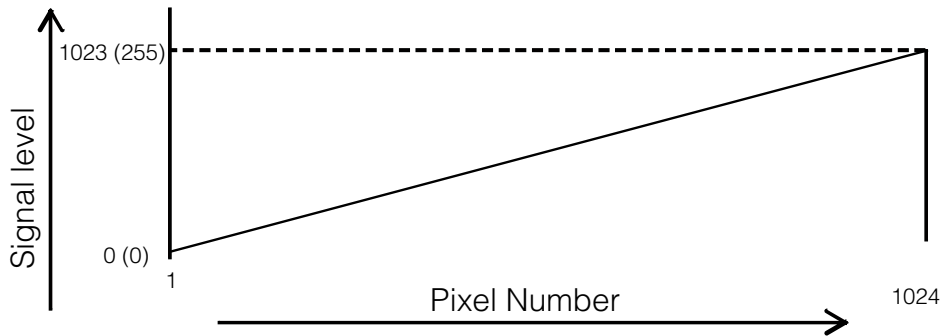
Values in parentheses indicate those during 8-bit output.

■ 2: Gray 2

Values in parentheses indicate those during 8-bit output.

■ 3: White (890LSB)
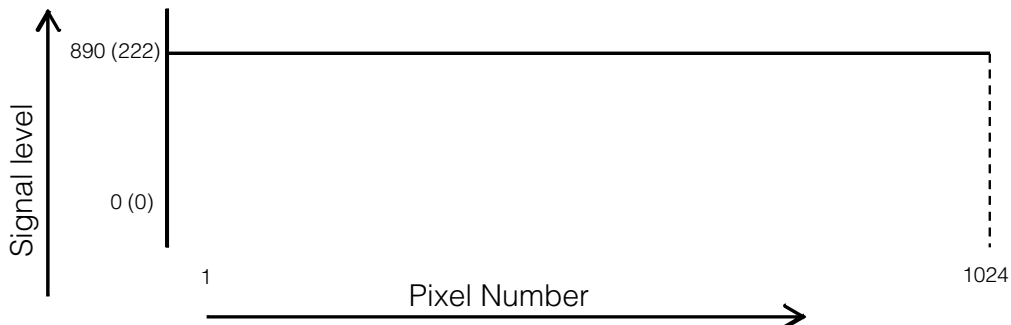
Values in parentheses indicate those during 8-bit output.

RS-232C Command Control

The basic control parameters are as follows.

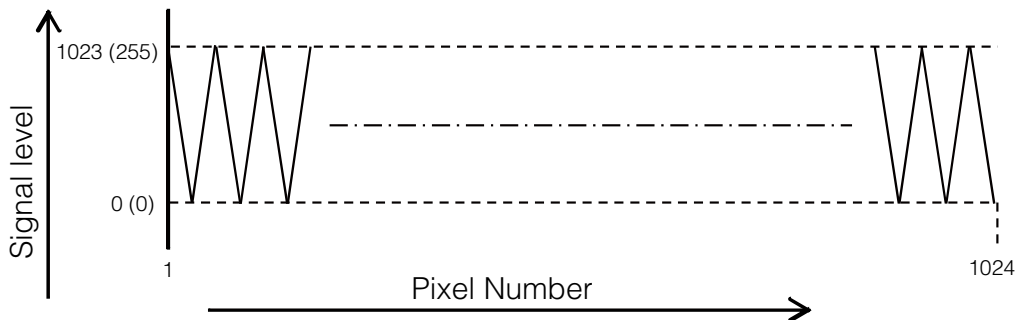| Item	Control parameter
Scanning	Independent scanning for all pixels, binning
Electronic Shutter	Accumulation time
Gain	Ch1, ch2
Black	Ch1, ch2
Trigger	Mode, trigger polarity selection
Miscellaneous	Camera Link: 8- ⇔ 10-bit switching Test pattern: ON ⇔ OFF

❖ For details, refer to the JAI WA-1000D-CL Communication Protocols.

Field Upgrade Function

You can update the timing controller and firmware using the dedicated update tool via Camera Link serial communication.

❖ Serial communication via the DC IN / trigger IN connector (12-pin round) is not supported for this function.

Settings List

For details on the ASCII Command List, visit the product page (WA-1000D-CL) on our website.

Control Tool

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

Item	Setting range	Default value	Description
a) Device Control			Display/configure information related to the device.
Device Vendor Name	—	"JAI Ltd., Japan"	Display the manufacturer name.
Device Model Name	—	WA-1000D-CL	Display the model name.
Device Manufacturer Info	—	—	Display the manufacturer information.
Device SFNC Version Major	—	2	Display the SFNC version.
Device SFNC Version Minor	—	0	
Device SFNC Version Sub Minor	—	0	
Device Version	—	—	Display the device version.
Device Firmware Version	—	—	Display the firmware version.
Device Manifest XML Major Version	—	—	Display the XML version.
Device Manifest XML Minor Version	—	—	
Device Manifest XML Sub Minor Version	—	—	
Device ID	—	—	Display the device ID.
Device User ID	Any	—	Set the user ID for the camera.
Device Scan Type	Linescan	Linescan	Display the scan type of the camera.
Device Temperature Selector	Sensor	Sensor	Display the location of the temperature sensor inside the camera.
Device Temperature 1	—	—	Display the internal temperature (°C) of the camera.
Device Temperature 2	—	—	
Device Reset	—	—	Reset the device.
b) Image Format Control			Configure image format settings.
Pixel Format	Mono8 Mono10 Mono12	Mono10	Set the pixel format.
Test Pattern	Off, GreyHorizontalRamp, Grayscale2, White	Off	Select the test image.
c) Acquisition Control			Configure image acquisition settings.
Trigger Selector	Line Start	Line Start	Select the trigger operation.
Trigger Mode	Off, On	Off	Select the trigger mode.
Trigger Source	CC1, Line4	CC1	Select the trigger signal source.
Trigger Activation	Rising Edge, Falling Edge	Rising Edge (rising edge of input signal)	Select the polarity of the trigger signal (i.e., location of signal at which trigger is applied).
Acquisition Line Rate	500.0 to 39235.29411	39235.3	Set the line rate as a frequency. (unit: Hz)
Exposure Mode	Off, Timed, Trigger Width	Timed (control via exposure time)	Select the exposure mode.
Exposure Time	20.3898 to 1994.90205	20.3898	Set the exposure time. The maximum value when [Trigger Mode] is set to [Off] varies depending on the [Acquisition Frame Rate Raw] value.
d) Analog Control			Configure analog control settings.
Black Level Selector	All	All	Select the black level to configure.
Black Level	−133 to 255	0	Set the black level value.
Gain Selector	Analog All	Analog All	Select the gain to configure.

Item	Setting range	Default value	Description
Gain	1 to 3.572	1	Set the gain value by multipliers for the gain setting selected in [Gain Selector].
Gain Raw	0 to 308	0	Set the gain value for the gain setting selected in [Gain Selector].
Analog Base Gain	0 to 3	2	Set the analog coarse gain.
e) LUT Control			Configure LUT settings.
LUT Mode	Off, Gamma, LUT	Off	Select the JAI LUT mode.
Gamma	0.45 to 1.0	1.0	Set the gamma value.
LUT Selector	Luminance	Luminance	Display the LUT data type.
LUT Index	0 to 255	0	Set the LUT index table number.
LUT Value	0 to 4095	0	Set the LUT value.
f) User Set Control			Configure user settings.
User Set Selector	0: Default, User Set1 to User Set3	Default (factory default values)	Select the user settings.
User Set Load	—	—	Load user settings.
User Set Save	—	—	Save the current setting values as user settings.
g) JAI Custom Control			Configure JAI proprietary function settings.
Image Format Control Selector	Sensor1, Sensor2	Sensor1	Select the sensor channel to be configured with [Image Format Control].
Acquisition Control Selector	Sensor1, Sensor2	Sensor1	Select the sensor channel to be configured with [Acquisition Control].
Analog Control Selector	Sensor1, Sensor2	Sensor1	Select the sensor channel to be configured with [Analog Control].
LUT Control Selector	Sensor1, Sensor2	Sensor1	Select the sensor channel to be configured with [LUT Control].
JAI Custom Control Selector	Sensor1, Sensor2	Sensor1	Select the sensor channel to be configured with [JAI Custom Control].
Auto Line Rate Reference	0 to 1023	500	Set the reference value used when performing automatic level control using line periods.
Auto Line Rate	—	—	Adjust the line rate to achieve the brightness of the reference value. This functions only when [Exposure Mode] is set to [Off].
Blemish Correct	Off, On	Off	Select whether to enable blemish correction.
Blemish Threshold	0 to 100	1	Set the blemish detection threshold.
Blemish Detect	—	—	Execute blemish detection.
Blemish Index	0 to 8	—	Set the blemish data table. Up to 8 blemish pixels can be corrected. Blemishes at the left and right edges cannot be corrected.
Blemish Position	0 to 1024	—	Set the blemish position.
Pixel Black Correct	Off, Factory, User	Factory	Select whether to enable pixel offset correction.
Pixel Black Detect	—	—	Calculate the correction data for pixel offset correction.
Pixel Gain Correct	Off, Factory, User	Off	Select whether to enable pixel gain correction.
Pixel Gain Detect	—	—	Calculate the correction data for pixel gain correction.
Shading Correct	Off, Factory, User	Off	Select whether to enable shading correction.
Shading Detect	—	—	Calculate the correction data for shading correction.
Sens Out Cfa	0, 1	1	Set the sensor's internal conversion gain.
Sens Out Cfb	0, 1	1	Set the sensor's internal conversion gain.
Sens Out Cfc	0, 1	0	Set the sensor's internal conversion gain.
Noise reduction	Off, On	Off	Select whether to enable noise reduction.

Item	Setting range	Default value	Description
Device TG Mode	Sync, Async	Sync	Select whether to operate with Channel 1 and Channel 2 synced or unsynced. [Sync]: Synchronize Channel 1 and Channel 2. [Async]: Operate with Channel 1 and Channel 2 unsynchronized.
CL Type	2 Channel, Dual Base	2 Channel	Select the camera link output type. [2 Channel]: Output two channels to one connector according to the RGB output settings. [Dual Base]: Output Channel 1 and Channel 2 to separate connectors.
CL Cable Select	Short, Middle, Long	Short	Set preemphasis to match the camera link cable length.
Gain Mode	Master, Individual	Individual	Set the gain configuration method. [Master]: Configure the gain settings for Channel 2 to match those of Channel 1. [Individual]: Configure gain settings for Channel 1 and Channel 2 separately.
Auto Channel Balance Gain	—	—	Correct the gain difference between Channel 1 and Channel 2 according to the output of Channel 1.
Auto Channel Balance Shutter	—	—	Correct the exposure time difference between Channel 1 and Channel 2 according to the output of Channel 1.
Aberration Enable	Off, On	Off	Select whether to enable aberration correction for Channel 2 according to Channel 1.
Aberration Select	Lens1, Lens2, Lens3	Lens1	Select the lens data to use for aberration correction.
	Aberration Name	Any	—	Set a name for the aberration correction.
	Aberration Left Side Pixel	-3 to 3	3	Set the parameters for aberration correction.
	Aberration Area Number	1 to 8	6	Set the parameters for aberration correction.
	Aberration Area 2nd Pixel	1 to 7	2	Set the parameters for aberration correction.
	Aberration Area 3rd Pixel	1 to 6	2	Set the parameters for aberration correction.
CL Cable Setting Short	0 to 255	80	Set the preemphasis level for when [CL Cable Select] is set to [Short].
CL Cable Setting Middle	0 to 255	120	Set the preemphasis level for when [CL Cable Select] is set to [Middle].
CL Cable Setting Long	0 to 255	160	Set the preemphasis level for when [CL Cable Select] is set to [Long].

Communication

❖ For details on the setting items, refer to the JAI Control Tool User's Guide

Item		Setting range	Default value	Description
Line Status		—	—	Displays the connection status between the camera and Control Tool.
Communication Port				Set the connection port.
	Category	Com Port, Camera Link spec. 2000, Camera Link spec. 2001, Camera Link spec. ver.1.1	Com Port	Select the connection port.
	Baud Rate	9600bps, 19200bps, 38400bps, 57600bps, 115200bps,	9600bps	Select the communication speed.
	Port Name	COM1 to COM16	COM1	Select the port name.
Files				
	Write to File	—	—	Save the setting values as a file.
	Read to File	—	—	Load a saved setting value file.
Current Area				
	Get Area	—	—	**
Factory And User Setting In Camera		Factory Data, User 1 Data, User 2 Data	—	Restore factory default setting values, or save values to user memory settings.
	Store	—	—	Save the current setting values as user memory.
	Load	—	—	Load factory default setting values or values saved to user memory.
Control Tool Message				
	Write to File	—	—	Save the currently displayed message as a file.
	Clear	—	—	Clear the currently displayed message.

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.	• A drop in voltage may have occurred due to the length of the power cable. Check whether input voltage specification for the camera is being met. • Check that the sufficient power is being provided at the power supply in regards to the camera's power usage. • Check the 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 "LUT (Lookup Table) / Gamma Function" (page 31).

■ Settings and operations

Problem	Cause and solution
Settings cannot be saved to user memory.	You cannot save to user memory while images are being captured by the camera. Stop image capture before performing the save operation.
I want to restore the factory default settings.	To restore the factory default settings, select [Load settings] in the [Settings] menu of the [WA-1000D-CL Control Tool] window, select [Factory] in the dialog box that appears, and click [OK].

Specifications

Image sensor	Model		G10768-1024DB (Hamamatsu Photonics)
	Effective pixels		1024 pixels
	Pixel size		25.0 µm × 25.0 µm
	Effective imaging lines		25.600 mm
Pixel clock	6.67 Hz		
Camera Link clock	53.36 MHz		
Line rate	Full pixel	Total clock	1360 clk
		Line rate	25.48 µs (during Continuous / Internal Trigger)
		Line frequency	39.23 KHz
Conversion efficiency	280nV/e		
Video S/N ratio	50 dB or more (when Gain = 0 dB)		
PRNU	Post-correction: Within ±5% (during 100% output)		
DSNU	Post-correction: Within ±5% (during 0% output)		
Tap Balance	Manual / Auto		
	Manual	Post-correction: ±1 dB	
	Auto	Post-correction: Within ±5% (during 100% output)	
Gain	Mode selection	Individual Mode / Master Mode selectable ❖ Master Mode is the default.	
		Master Mode	Simultaneous ch1/ch2 configuration in Master Master: x1 to x3.75 (0 dB to +11 dB) Ch2: x0.719 to x1.412 (-3 dB to +3 dB)
		Individual Mode	Individual ch1/ch2 configuration Ch1/ch2: x1 to x3.75 (0 dB to +11 dB)
	Auto Channel Balance	Adjust gain so that ch2 level matches that of ch1. Range: x0.501 to x1.995 (-6 dB to +6 dB)	

Black level
(user settings)
	Manual
	    Ch1/ch2: -256 to 255 LSB (during 12-bit)
	    Default setting: Output black level at 0		

Image output	Digital video output (Camera Link)
	    Switchable between dual-base and 2-ch.
	    Dual-base: 8-bit × 2, 10-bit × 2, 12-bit × 2
	    2-ch: 8-bit × 2-ch, 10-bit × 2-ch, 12-bit × 2-ch
	Camera Configuration
	    Dual Base: Base Configuration
	    2-ch 8-bit: Base Configuration (R and G of 24-bit RGB are used)
	    2-ch 10-/12-bit: Medium Configuration (R and B of 30- (36-) bit RGB are used)
	❖ Default: Dual-base 8-bit × 2
	❖ A pre-emphasis function exists, extending the transmission distance.		

Variable line rate	Supported (for Exposure Mode OFF mode / internal trigger mode or Shutter select mode / internal trigger mode) Variable range: 500 Hz to 39.235 kHz (25.4875 us to 2 ms) Variable unit: 149.9 ns ❖ The black level may vary with longer line rates, due to the increase in dark currents.		
Electronic shutter	Supported (during shutter select mode) Variable range: 20.38 µs[*1] (1L) to 1.995 ms Variable unit: 149.9 ns		
Test pattern	Available 1: Gray 1 2: Gray 2 3: White (890LSB)		
Synchronization	Internal		

Image processing	① Pixel sensitivity correction: Pixel correction (DSNU, PRNU)
	② Defective pixel correction: Up to 16 pix
	③ Shading correction: ON/OFF switchable
	   SWIR ch1: Flat Field correction possible.
	   SWIR ch2: Flat Field correction, correction matching SWIR ch1 selectable.
	④ LUT/Gamma function: 1.00 (OFF) / 0.45 / User (LUT) selectable
	   When set to User, table data can be applied from externally.
	   Table data can be configured individually.
	⑤ Lens aberration correction ±3 pix
	⑥ Noise reduction: Individual ON/OFF switching possible for Sensor 1 and
	   Sensor2.

Operation mode	• Exposure Mode OFF mode (Internal/External trigger) • Shutter select mode (Internal/External trigger) • PWC (External trigger)
Trigger inputs	12-pin: 3.5 ± 1.5 V (p-p) TTL input Camera Link: LVDS (CC1) Positive / negative logic switchable. Minimum trigger width: EPS 500 ns or more / PWC 61.8 μs or more ❖ Use either 12-pin or Camera Link for trigger inputs.

Synchronous output (when the terminal is open)	Camera Link	• LVAL (Camera Link Tx24) • DVAL (Camera Link Tx25) • EEN (Camera Link Tx26)
	12-pin	• XEEN (negative logic) 4.0 Vp-p (when there is no termination)

Communication interface	EIA-644: Camera Link CC1 RS-232C: 12-pin Communication rate: 9600 bps ❖ Switchable via the rear panel DIP switch. ❖ EIA-644 and RS-232C cannot be used simultaneously.
Field update	Supported
Power supply voltage	DC input range: +12 V to 24 V ±10% 820 mA ±10% (current consumption at DC +12 V supply) Conditions: For 12 V input (Internal Trigger / Line Rate = 600 μs / Gain 0 dB / light shield / ambient temperature 25℃) ❖ Use a power supply that can provide 3 A or more.
Lens mount	WA-1000D-CL-M52: M52-mount standard ❖ Lens mount protrusion length of 13 mm or less is supported.
Flange back	M52-mount: 46.5 mm (in air), tolerance: ±0.1 mm
Optical axis accuracy	Center ±0.1 mm (Max)
Bonding accuracy	Within ±0.5 pixels (center) ❖ Above accuracy based on factory testing.
Operating temperature / humidity	-5℃ to +45℃ / 20% to 80% (non-condensing)
Storage temperature / humidity	-25℃ to +60℃ / 20% to 80% (non-condensing)
Vibration resistance	3G (20 Hz to 200 Hz XYZ directions)
Impact resistance	50G
Standard compliance[2]	CE (EN61000-6-2, EN61000-6-3) RoHS/WEEE IEC/EN61000-4-3 FCC Part15 Class B IEC61000-4-2 Level 4 (contact discharge = 8 kV, air discharge = 15 kV)
Dimensions	90 × 90 × 117 mm (WHD) (excluding mount and protrusions)
Weight	910 g

Connectors / LEDs	Camera Link	Model: 10226-1A10PL × 2 Function: video output / communication / external trigger / EEN ❖ Positive polarity for EEN (polarity switching not possible)
	12-pin	Model: HR10A-10R-12PB (71) Function: power supply input / communication / external trigger / EEN ❖ Negative polarity for EEN (polarity switching not possible)
	Rear panel LED	Model: SPR-39MVWF Function: operation display / trigger input display

❖ In this document, the "X" in the XEEN represents the negative polarity.

*1 Maximum accumulation time during minimum line period (25.48 µs) operation.
*2 Compliance with these standards is guaranteed when using the connectors and cable assemblies specified by JAI. For details, see "Compatible connectors / cable assembly" (page 9) and "Compatible connectors" (page 8).
We do not recommend using extension cables.

Package contents
Camera body (1)
Sensor protection cap (1)
Dear Customer (sheet) (1)

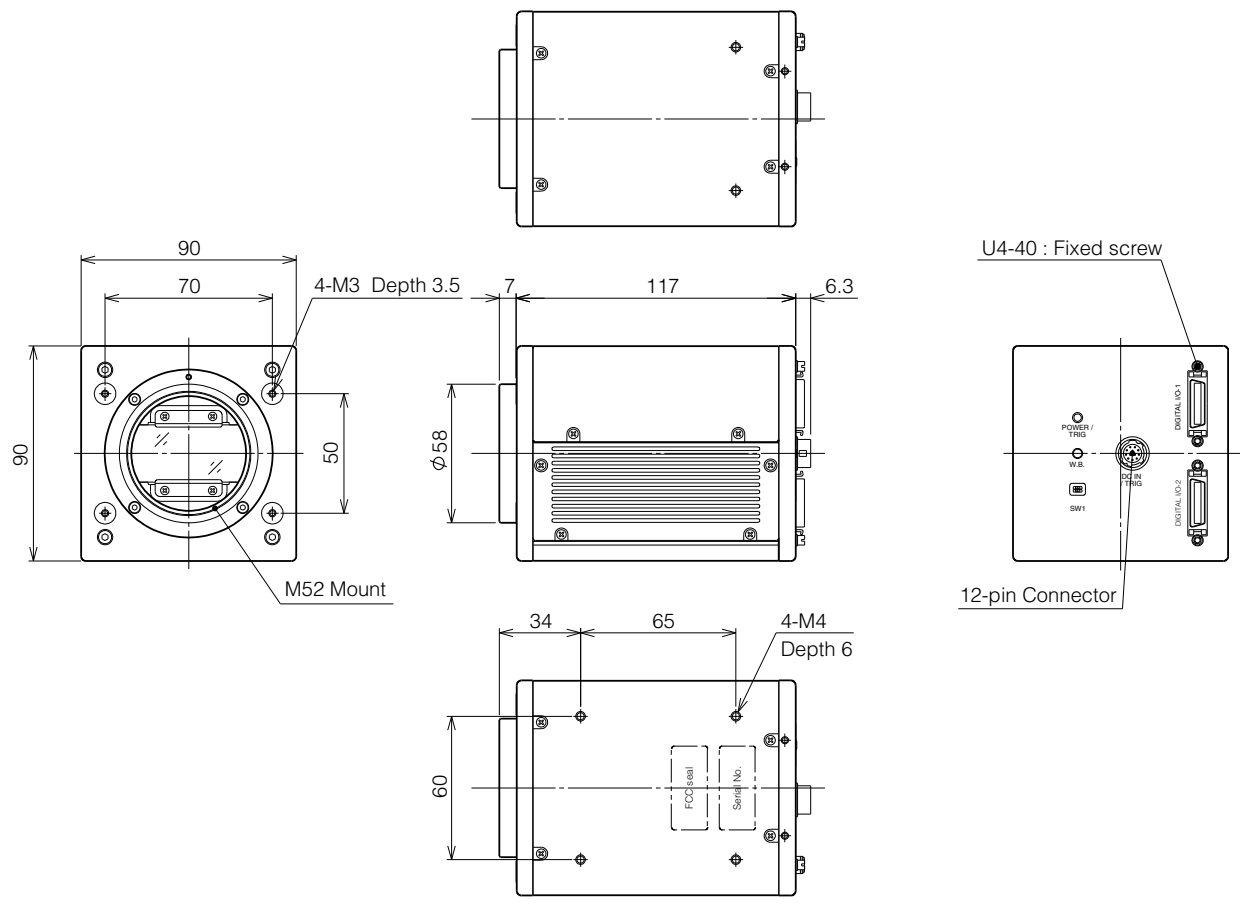Design and specifications are subject to change without notice.

Block Diagram
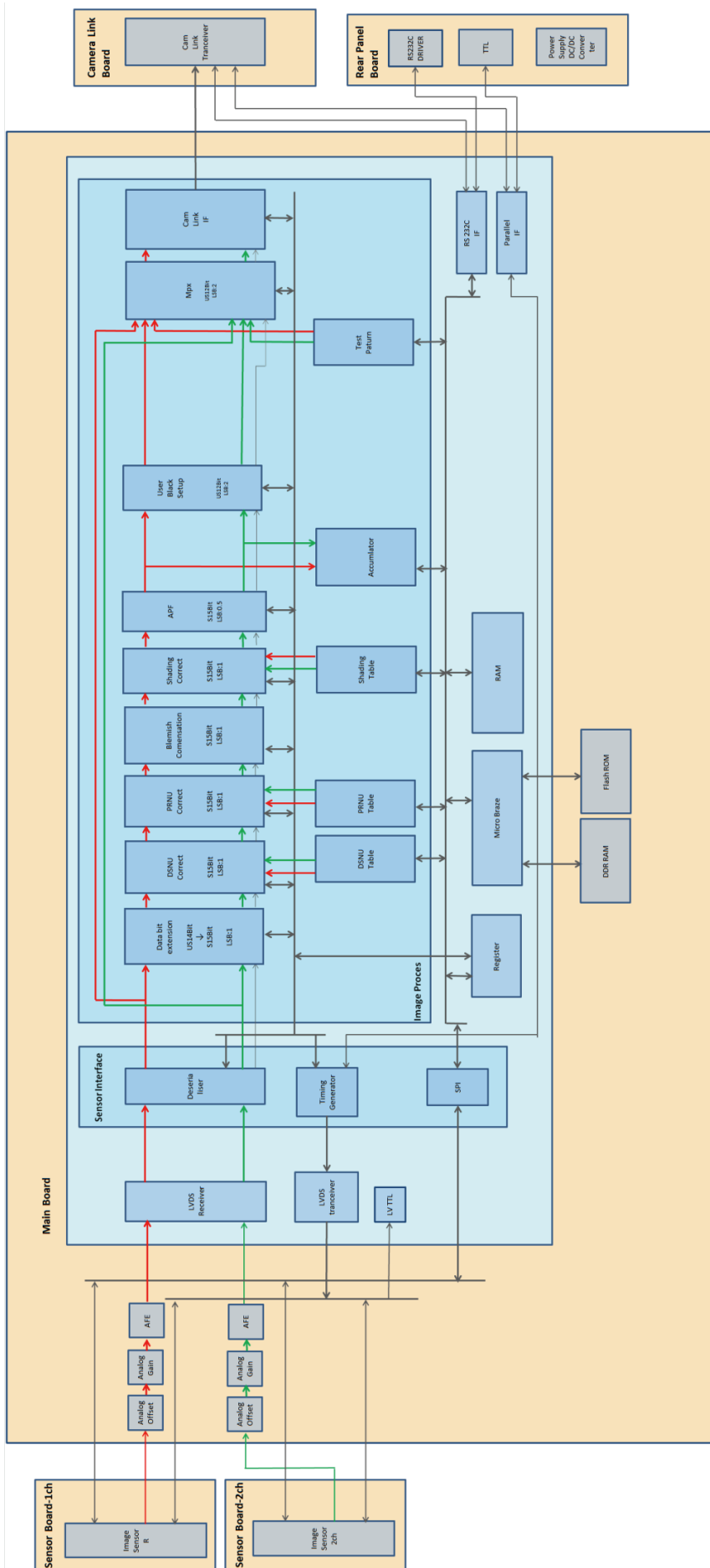
Spectral Response

InGaAs CAMERA Sensitivity

Dimensions

90

70

4-M3 Depth 3.5

7   117   6.3

90

50

ϕ58

M52 Mount

34   65   4-M4 Depth 6

60

FCC seal

Serial No.

U4-40 : Fixed screw

POWER / TRIG

W.B.

SW1

DIGITAL I/O-1

DC IN TRIG

DIGITAL I/O-2

12-pin Connector
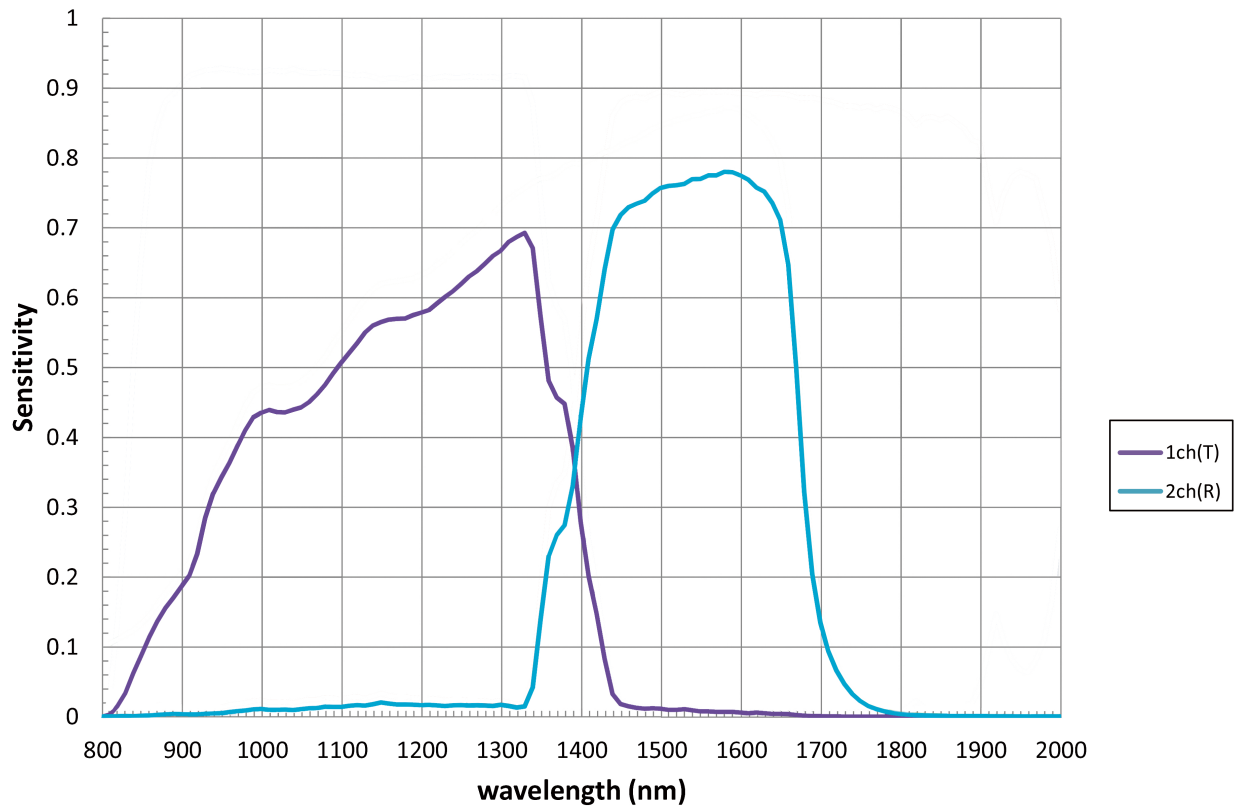
Dimensional tolerance: ±0.3 mm
Unit: mm

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