See the possibilities

User Manual

Tentative Version

SW-4010Q-MCL-M52

RGB Color & SWIR Prism Line Scan Camera
with Mini Camera Link Interface

Document Version: Tentative
SW-4010Q-MCL-M52_Manual_Ver.Tentative_2022-11-25

Thank you for purchasing this product.

⚠Be sure to read this documentation before use.

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

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

Table of Contents

About Technical Note

Some additional technical information is provided on the JAI website as Technical Notes. In this manual, if a technical note is available for a particular topic, the above icon is shown. Please refer to the following URL for Technical notes.

https://www.jai.com/support-software/technical-notes

Notice/Warranty

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 SW-4010Q-MCL-M52 complies with the following provisions applying to their standards.

EN61000-6-2

EN61000-6-3

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.

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 Attaching the Lens

Technical Notes How to Clean a Sensor

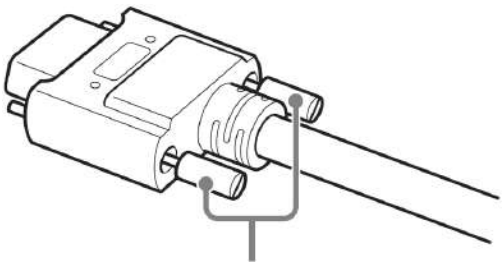
Avoiding Dust Particles

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.

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: 0.15 N·m or less)



Caution: Secure manually. Do not secure too tightly.

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.

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.

Package Contents

	Camera (1)
	Sensor protection cap (1)
	Dear customer (sheet) (1)

Optional Accessories (Sold Separately)

	Custom Lens: JMO-M5231-2828-C4

Features

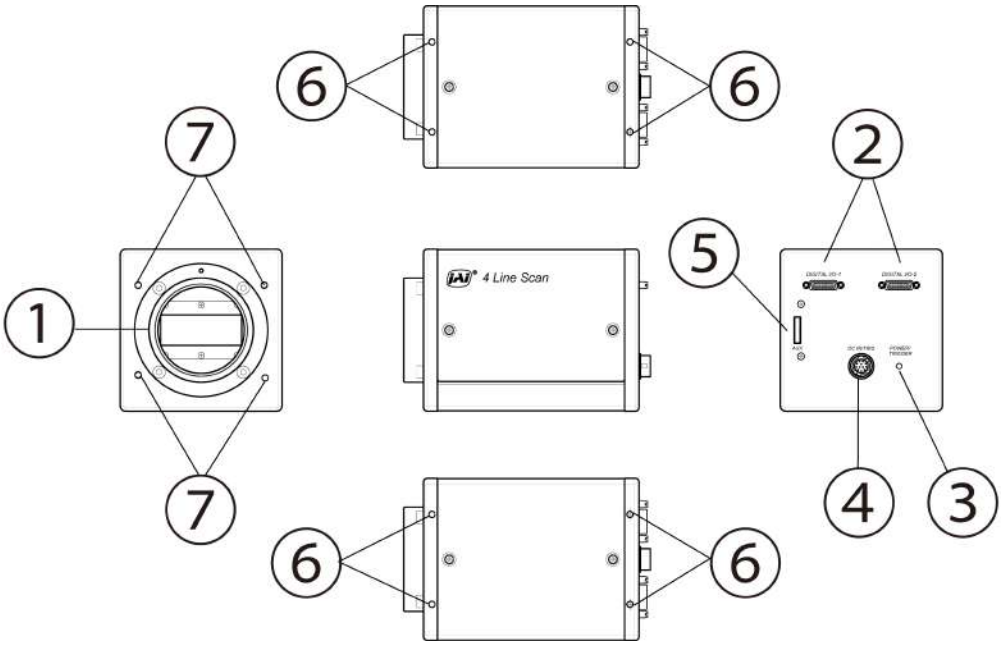
The SW-4010Q-MCL-M52 is a line scan camera with three CMOS sensors and one InGaAs linear image sensor for the R, G, B, and SWIR channels, mounted on a prism.

The camera has a Camera Link pixel clock of 42.5/65/85 MHz and is capable of scanning up to 40 kHz (RGB) / 39kHz (SWIR). 8/10/12-bit video output is possible via Camera Link. Camera and external trigger settings are configured via the Camera Link interface, 12-pin or AUX connector.

Feature Overview

Interface	Mini Camera Link (Video output and trigger input) Dual Base, independent line rates
Active Pixels	RGB: 4096 pixels SWIR: 1024 pixels
Pixel Size	RGB (400 - 700nm): 7.5 µm x 7.5 µm SWIR (800 - 1700nm): 25.0 µm x 25.0 µm
Output Format	RGB8-bit (RGB10/12-bit with custom pixel format) SWIR8/10/12-bit
Line Rate	RGB 4K: Up to 20.5kHz, 2K: Up to 40.8kHz SWIR: Up to 39.2kHz
Main Functions	Flexible ROI, rescaling function, traditional binning function, blemish compensation, shading correction, and encoder support.
Lens	Customized lens: JMO-M5231-2828-C4 (Sold Separately)
Dimensions	90mm x 90mm x 120mm (WHD, excluding mount and connectors)

Parts Identification



① Lens Mount (M52-Mount)	② Digital I/O-1 and Digital I/O-2 Video Output Connectors
③ POWER/TRIG LED	④ DC IN/TRIG Connector (12-Pin Round)
⑤ AUX Connector (10-pin)	⑥ ⑦ Mounting Holes

① Lens Mount (M52-Mount)

Mount the custom lens (JMO-M5231-2828-C4, sold separately) to the camera.

> **Note:** Before mounting a lens, be sure to refer to ① Lens and confirm the precautions for attaching a lens and the supported lens types.

② Digital I/O-1 and Digital I/O-2 Video Output Connectors

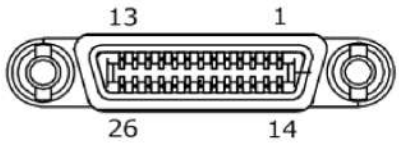
Connect a Cable Link compatible cable here.

Camera Side: HDR-EC26FYTG2-SL+(HONDA)

Cable: SDR Connector Cable

> **Note:** The cable length at which communication will be possible will be limited when using a cable that is not compatible with Camera Link, a small diameter type cable, or a high flex type cable.

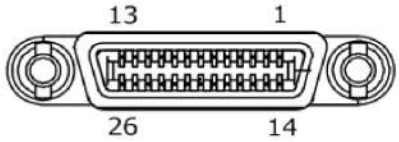
DIGITAL I/O - 1



Camera Link Connector 1

Pin	Input Output	Signal	Description
1, 26		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)	
9 (-), 22 (+)	In	CC1	Trigger
10 (-), 23 (+)		CC2	Reserved
11, 24		N.C	
12, 25		N.C	
13, 14		Shield	GND

DIGITAL I/O - 2



Caution: There are no serial communication or CC1/CC2 signals on Connector 2. Use Connector 1 to communicate these signals.

Camera Link Connector 2

Pin	Input Output	Signal	Description
1, 26		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 (-)		Reserved	
8 (-), 21 (+)		N.C	
9 (-), 22 (+)		N.C	
10 (+), 23 (-)		N.C	
11 (-), 24 (+)		N.C	
12 (+), 25 (-)		N.C	
13, 14		Shield	GND

③ POWER/TRIG LED

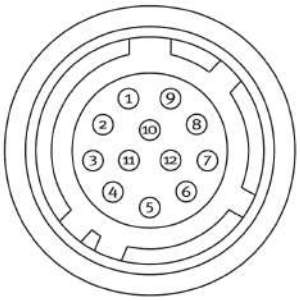
Indicates the power or trigger input status.

LED		Status
	Lit amber	Camera initializing.
	Lit green	Camera in operation
	Blinking green	During operation in trigger mode, trigger signals are being input. **Note:** The blinking interval is not related to the actual input interval of the external trigger.

④ DC IN/TRIG Connector (12-Pin Round)

Related Setting Items: DigitalIOControl

Connect the cable for a power supply or for DC IN / trigger IN here.



Camera Side: HR10A-10R-12PB (71) (Hirose Electric or equivalent)

Cable Side: HR-10A-10P-12S (Plug) (Hirose Electric or equivalent)

Pin No.	Input/Output	Signal	Description
1		GND	
2	Power In	DC In	DC 12V to 24V ± 10%
3		GND	
4		Reserved	External connection not possible
5	In	OPT IN1 -	Line 5
6	In	OPT IN1 +	
7	Out	TTL OUT 4	Line 12
8		NC	
9	Out	TTL OUT 1	Line 1
10	In	TTL IN 1	Line 4
11	Power In	DC In	+12 V ~ 24 V ± 10%
12		GND	

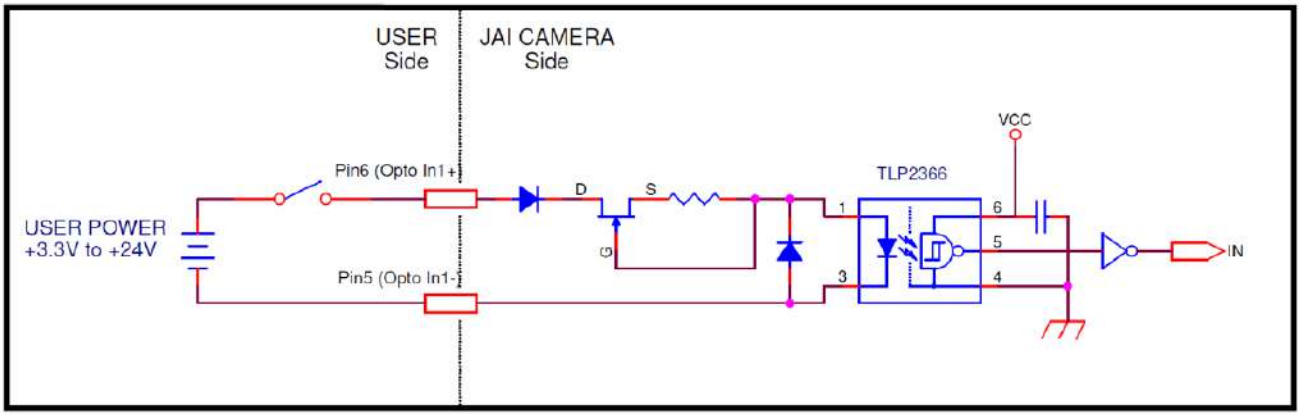
Caution: The DC IN / TRIG IN connector, AUX connector, or the CC1 of the DIGITAL I/O-1 video output connector will be used for external trigger inputs. You can switch which of these is used via a command.

TTL Signal specification

TTL out signal specification (Typ.)	Output voltage: Low 0.0V, High 5.0V Input/Output current: +/-32mA
TTL in signal specification (Typ.)	Input voltage: Low 0.0 ~ 0.8V, High 2.0 ~ 5.5V

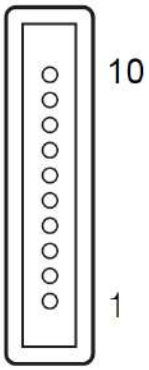
Caution: About Opto In: Check the recommended external input circuit diagram (reference example) and connect correctly. If you connect Opto In 1 and Opto In 2 in reverse, camera may be damaged.

Recommended External Input Circuit Diagram (Reference Example)



⑤ AUX Connector (10-pin)

Connect the cable for DC IN / trigger IN here.



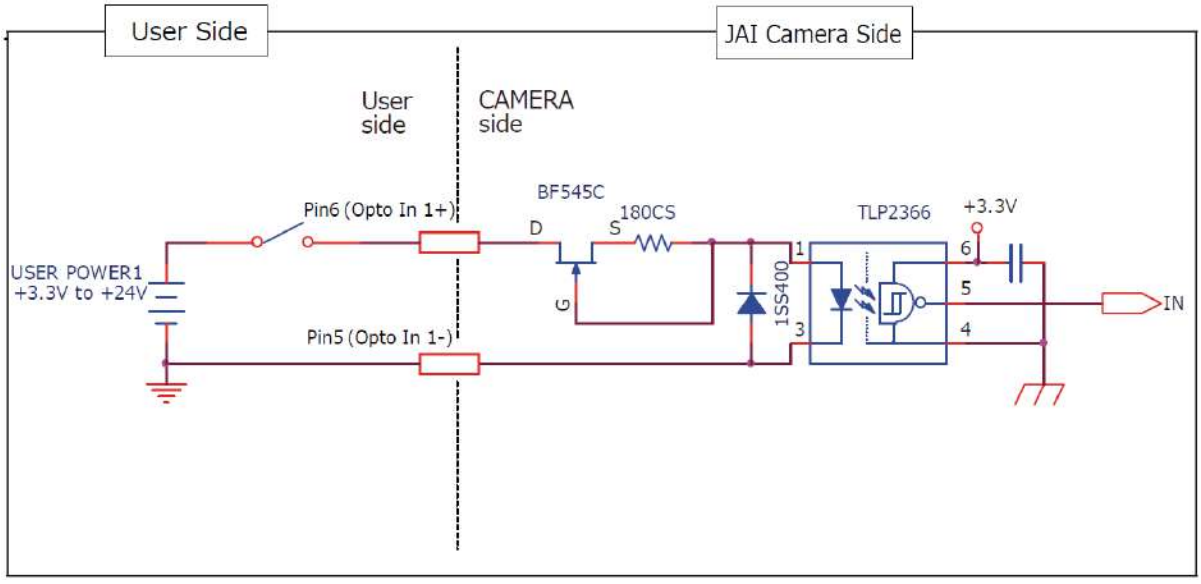
Camera side: Equivalent to Hirose Electronic 3260-10S3(55)

Cable side: Equivalent to Hirose Electronic 3240-10P-C(50)

Pin No.	Attribute	Name	Description
1	Out	TTL OUT2	Line 8
2	Out	TTL OUT3	Line 9
3	IN	TTL_IN2	Line 10
4		N.C	
5	GND	GND	
6	IN	TTL_IN3	Line 13
7		N.C	
8		N.C	
9	GND	GND	
10	GND	GND	

Recommended External Output Circuit Diagram (Reference Example)

Standard circuit diagram example



⑥ ⑦ Mounting Holes

Use these holes when mounting the camera directly to a wall or other structural system (⑥ : M4/depth 6mm, ⑦ : M4/depth 5mm).

Preparation

Read this section to learn how the camera connects to devices and accessories. The preparation process is described below.

> **Note:** This camera does not support eBUS Player for JAI.

Step 1: Connect Devices

- Connect the lens, Camera Link cable, AC adapter, computer, and other devices.

Step 2: Verify Camera Operation

- Verify whether the camera is turned on and ready for use.

Step 3: Verify the Connection Between the Camera and PC

- Verify whether the camera is properly recognized.

Step 4: Configure Basic Settings for the Camera

- Configure the camera output formats, ImageScalingMode, trigger, exposure, and line rate settings.

Step 5: Adjust the Image Quality

- Configure exposure time, shutter, gain, DSNU, PRNU, and shading correction settings.

Step 6: Configure Various Other Settings

- Configure various other settings as necessary.

Step 7: Save the Settings

- Save the current setting configurations in user memory.

Short ASCII Commands

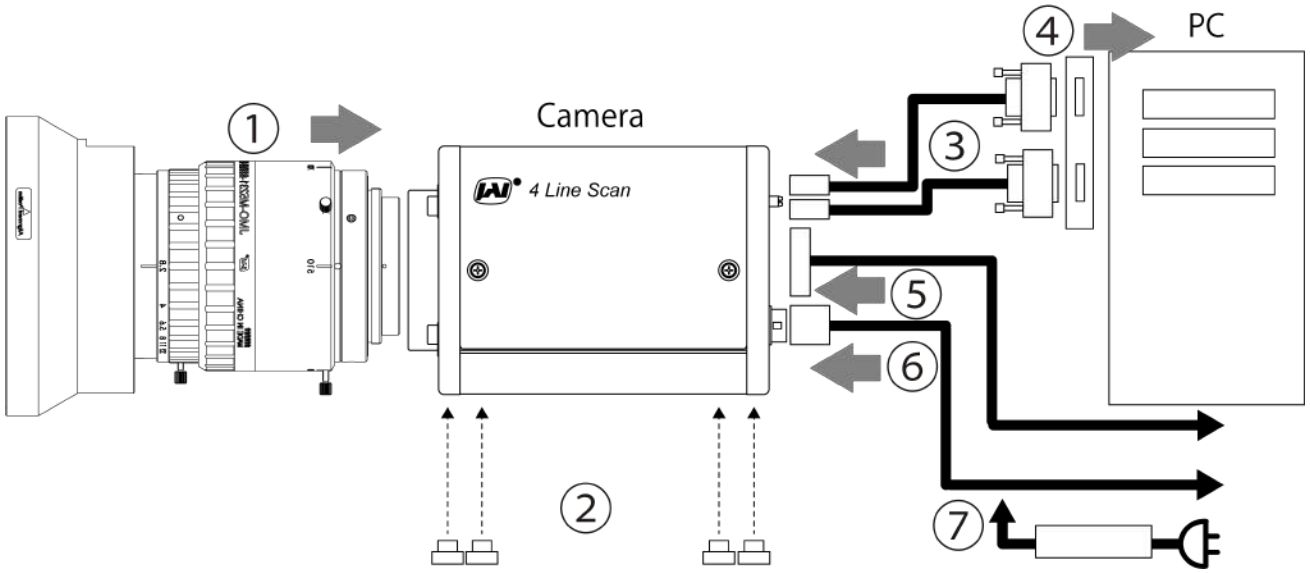
The most universal method for controlling a Camera Link camera such as SW-4010Q-MCL-M52 is by the use of short ASCII commands sent via serial communications. All Camera Link frame grabber boards support the use of these short ASCII commands. SDKs that utilize these ASCII commands for developing machine vision applications are typically available from the grabber manufacturer, as well as from third-party vendors.

This section describes how to configure various camera settings using serial communication and specific short ASCII commands. A complete list of all available ASCII commands for this camera is available on the JAI's SW-4010Q-MCL-M52 page.

Later sections of the manual refer to GenICam nomenclature for various features/functions and includes a complete list of all camera settings (Setting List).

The SW-4010Q-MCL-M52 fully supports applications written using GenICam-based SDKs. The advantage of this is that programs written using GenICam names can be applied with little or no modification to control cameras with other GenICam-compliant interfaces and even GenICam-compliant cameras from different vendors.

Step 1: Connect Devices



① Lens

② Mounting

③ Camera Link Cable

④ Frame Grabber Board

⑤ AUX Cable (10 Pin) (Option)

⑥ DC IN / Trigger IN Connection Cable

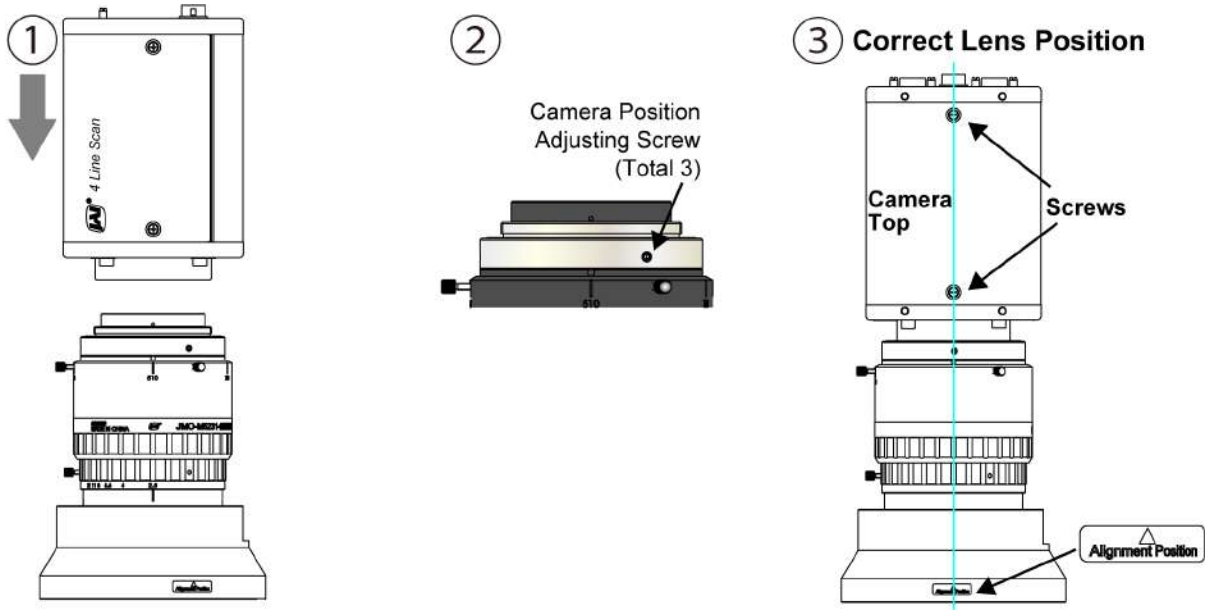
⑦ AC Adapter (Power Supply)

① Lens

Attach the customized lens JMO-M5231-2828-C4 (sold separately) to the camera. This lens is for a prism camera and is optimized to match the camera's pixel size.

- Focal length: 28mm
- Spectral Range: 400 - 1700 nm
- Aperture: F2.8 - F22
- Working Distance: 510mm (optimized). 400 - 700mm full range.

Attach the Lens



1. Attach the lens JMO-M5231-2828-C4 to the camera.
2. Loosen three camera position adjusting screws (see #2 above) on the lens mount using the hex wrench included in the lens box.

   > **Caution:** Do not loosen the screws too much. If loosened too much, the lens mount may come off.

3. Rotate the lens to align with the screws on the top plate of the camera (see #3 Correct Lens Position).

   > **Note:** The lens has the best optical performance in the correct alignment.

4. Tighten the loosened screws.

② Mounting

When mounting the camera directly to a wall or other device, use screws that match the mounting holes on the camera (M4: depth 6mm).

> **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.

> **Caution:** Refer to Notes on Camera Link Cable Connections when connecting the cables to the connectors.

> **Note:** The maximum Camera Link cable length is 10 m. The maximum length of cable you can use will also vary depending on type and maker. If the **CableEmphasis** setting of TransportLayerControl is changed from Normal to **Medium** or **Strong**, it may be possible to lengthen the Camera Link cable.

④ Frame Grabber Board

Refer to the operating instructions of the frame grabber board and configure settings on the computer as necessary. (Use a computer that meets the requirements of your frame grabber board).

⑤ AUX Cable (10 Pin) (Option)

Performs external I/O such as trigger input.

⑥ DC IN / Trigger IN Connection Cable

Performs external I/O such as power supply and trigger input.

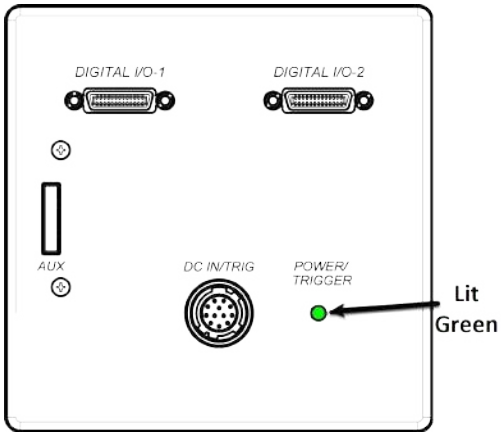
⑦ AC Adapter (Power Supply)

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

Step 2: Verify 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, the power LED is lit green.



For details on how to read the LEDs, see the ③ POWER/TRIG LED section.

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

Step 3: Verify the Connection Between the Camera and PC

Use a short ASCII command to verify whether the camera is properly recognized in your setup.

1. Install terminal emulator software capable of serial communication to the PC connected to the camera via the frame grabber board.

   Set the following serial communication.

   - Baud Rate: 9600
   - Data Length: 8bit
   - Start Bit: 1bit
   - Stop Bit: 1 bit
   - Parity: None
   - Xon/Xoff Control: None

2. Enter the command **DVN? <CR><LF>** from the terminal emulator software.

   If correctly connected, response **DVN = JAI Corporation** will be displayed.

Item	Short ASCII Command	Description
DeviceVendorName	DVN	DVN? <CR><LF> Display the device vendor name: "JAI Corporation"

Step 4: Configure Basic Settings for the Camera

> **Note:** On this camera, you must configure both the RGB and SWIR channels individually.

Configure the Camera Output Formats

Configure the pixel formats of the image output from the RGB and SWIR channels.

1. To check the current pixel format setting of the RGB channels, enter the command **BA?<CR><LF>** from the terminal emulator software. The default setting is RGB8 (BA=0).
2. To change the pixel format setting to RGB10BasePacked, enter **BA=1<CR><LF>**.
3. To check the current pixel format setting of the SWIR channel, enter the command **IRBA?<CR><LF>** from the terminal emulator software. The default setting is Mono8 (IRBA=0).
4. To change the pixel format setting to Mono10, enter **IRBA=1<CR><LF>**.

For more information, see the following Short ASCII command table.

	Item	Short ASCII Command	Values	Command Examples
RGB	PixelFormat	BA	0: RGB8 (Default) 1: RGB10BasePacked* 2: RGB12BasePacked*	BA=[Param.]<CR><LF> BA?<CR><LF>
SWIR	SWIRPixelFormat	IRBA	0: Mono8 (Default) 1: Mono10 2: Mono12	IRBA=[Param.]<CR><LF> IRBA?<CR><LF>

> **Caution:** *The RGB10BasePacked and RGB12BasePacked formats are customized pixel formats for the Camera Link interface. To view image output in this format, a viewer that supports these formats is required. For more information, see Camera Output Formats.

Configure the ImageScalingMode Settings

> **Notes:**
> - The SWIR channel does not support the ImageScalingMode function.
> - For more information on this function, see Image Scaling Mode (Xscale).

1. To check the ImageScalingMode setting, enter the command **ISM?<CR><LF>** from the terminal emulator software. The default setting is Off (ISM=0).
2. Enter **ISM=1<CR><LF>** to enable ImageScalingMode.
3. Configure other ImageScalingMode settings as required.

For more information, see the following Short ASCII command table.

Item	Short ASCII Command	Values	Command Examples
ImageScalingMode	ISM	0: Off (Default) 1: On 2: SWIRPixelMode 3: SWIRHalfPixelMode	ISM=[Param.]<CR><LF> ISM?<CR><LF>
ImageScalingSumMode	ISSM	0: Off (Average) (Default) 1: On (Sum)	ISSM=[Param.]<CR><LF> ISSM?<CR><LF>
ImageScalingHorizontalRaw	ISH	256 ~ 4096 (Default), Step 2	ISH=[Param.]<CR><LF> ISH?<CR><LF>
ImageScalingWidthMax	ISWMAX	**Min, Step**: 16 **Default**: 4096 **Max**: ImageScalingMode=Off: 4096 ImageScalingMode=On:((4096 x ImageScalingHorizontal*) / 16) x 16 ImageScalingMode=SWIRPixelMode: 1024 ImageScalingMode=SWIRHalfPixelMode: 2048 **Note:** *ImageScalingHorizontal = ImageScalingHorizontalRaw /4096	ISWMAX= [Param.]<CR><LF> ISWMAX?<CR><LF>

Configure Trigger, Exposure, and Line Rate Settings

This section describes how to control the exposure time with or without external triggers.

> **Note:** For the detailed setting information, see Short ASCII Commands for Trigger, Exposure, Line Rate Settings.

Control via External Triggers

When Controlling the Exposure Time Using Specified Exposure Times

1. First, configure the RGB channels. Set **Exposure Mode** to **Timed**. (Timed = Default).
2. Specify the Exposure Time in **Exposure Time**. For the RGB channels, you must configure each R, G, and B channel individually.
3. Set **Trigger Mode** to **On**.
4. Configure the **Trigger Source** and **Trigger Activation** settings if necessary.
5. Second, configure the SWIR channel. Repeat steps 1 through 4 to configure.

Control Without External Triggers

When Controlling the Exposure Time Using Specified Exposure Times

1. First, configure the RGB channels. Set **Exposure Mode** to **Timed**. (Timed = Default).
2. Set **Trigger Mode** to **Off**. (Off = Default)
3. Specify a line period slower than the exposure time in **Acquisition Line Rate**.
4. Specify the Exposure Time in **Exposure Time**. For the RGB channels, you must configure each R, G, and B channel individually.
5. Second, configure the SWIR channel. Repeat steps 1 through 4 to configure.

When Not Controlling the Exposure Time

1. First, configure the RGB channels. Set **Exposure Mode** to **Off**. (Off =Default)
   The exposure will be performed with an exposure time equal to 1 / line rate.

   > **Note:** The exposure time specified in ExposureTime will be disabled.

2. Second, configure the SWIR channel. Repeat step 1 to configure.

Short ASCII Commands for Trigger, Exposure, Line Rate Settings

This section shows the short ASCII commands to configure the Trigger, Exposure, and Line Rate settings.

RGB

Item	Short ASCII Command	Values	Command Examples
ExposureMode	TR	0: Off 1: Timed (Default)	TR=[Param.]<CR><LF> TR?<CR><LF>
ExposureTime	Red: PER Green: PEG Blue: PEB	300 ~ 1514907 (Default) [100 = 1us]	Varies depending on the CIConfiguration and CameraLinkClockFrequency settings. When setting the Red channel: PER=[Param.]<CR><LF> PER?<CR><LF>
TriggerMode	TM	0: Off (Default) 1: On	TM=[Param.]<CR><LF> TM?<CR><LF>M
TriggerSource	TI	0: Low 1: High 10-13: PulseGenerator0-3 14-17: UserOutput0-3 20: Line4 TTL In1 (Default) 21: Line5 Opt In1 23: Line7 CC1 24: Line10 TTL In2 26: NAND0 Out 27: NAND1 Out 28: Line13 TTL In3 29: EncoderTrigger	TI=[Param.]<CR><LF> TI?<CR><LF>M
TriggerActivation	TA	1:Rising Edge 2:Falling Edge (Default)	TA=[Param.]<CR><LF> TA?<CR><LF>M
AquisitionLineRate	LR	4855 ~ 200000 (Default) [100 = 1us]	LR=[Param.]<CR><LF> LR?<CR><LF> Use this command to set the line rate of the camera by specifying the line period. The unit value is 1/100us.

SWIR

Item	Short ASCII Command	Values	Command Examples
SWIRExposureMode	IRTR	0: Off 1: Timed (Default)	IRTR=[Param.]<CR><LF> IRTR?<CR><LF>
SWIRExposureTime	IRPE	136 (Default) ~ 13306 (Unit: 149.9ns)	IRPE=[Param.]<CR><LF> IRPE?<CR><LF>
SWIRTriggerMode	IRTG	0: Off (Default) 1: On	IRTG=[Param.]<CR><LF> IRTG?<CR><LF>M
SWIRTriggerSource	IRTI	0: Low 1: High 10-13: PulseGenerator0-3 14-17: UserOutput0-3 20: Line4 TTL In1 (Default) 21: Line5 Opt In1 23: Liune7 CC1 24: Line10 TTL In2 26: NAND0 Out 27: NAND1 Out 28: Line13 TTL In3 29: EncoderTrigger	IRTI=[Param.]<CR><LF> IRTI?<CR><LF>M
SWIRTriggerActivation	IRTP	1:Rising Edge 2:Falling Edge (Default)	IRTP=[Param.]<CR><LF> IRTP?<CR><LF>M
SWIRAcquisitionLineRate	IRLR	170 (Default) ~ 13340 (Unit: 149.9ns)	IRLR=[Param.]<CR><LF> IRLR?<CR><LF> Use this command to set the line rate of the camera by specifying the line period. The unit value is 1/100us.

Step 5: Adjust the Image Quality

> **Related Setting Items:** AnalogControl

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

> **Note:** On this camera, you must configure both the RGB and SWIR channels individually.

Configure the 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.

> **Note:** Refer to the Control via External Triggers and Control Without External Triggers topics.

DSNU Correction (Pixel Black Correct)

DSNU (dark signal non-uniformity) is a variation between pixels in the dark areas generated by the sensor. If the line rate is slowed or a long exposure time is set, the dark current in the sensor may change and the state of the DSNU may change.

RGB

1. Specify the user area (User1 ~ User3) to save the black level correction value with **PixelBlackCorrectionMode**.

   > **Note:** You cannot perform calibration when **Off** or **Default** is selected.

2. Black level correction data is automatically generated by **PerformPixelBlackCalibration** and saved in the user area specified in step 1.
3. You can check the execution result of black level correction by **PixelBlackDetectResult**.

For more information, see the following Short ASCII command table.

Item	Short ASCII Command	Values	Command Examples
PixelBlack CorrectionMode	PBC	0:Off 1:Default (Default) 2:User1 3:User2 4:User3	PBC=[Param.]<CR><LF> PBC?<CR><LF> **Note:** Default stores correction data with factory settings.
PerformPixelBlackCalibration	PBR	-	PBR<CR><LF>
PixelBlackDetectResult	PBS	1: Succeeded 2: Image too bright 3: Image too dark 4: Timeout error	PBS?<CR><LF>

SWIR

1. Select **User** to save the black level correction value with **SWIRPixelBlackCorrect**.

   Note: You cannot perform calibration when **Off** or **Factory** is selected.

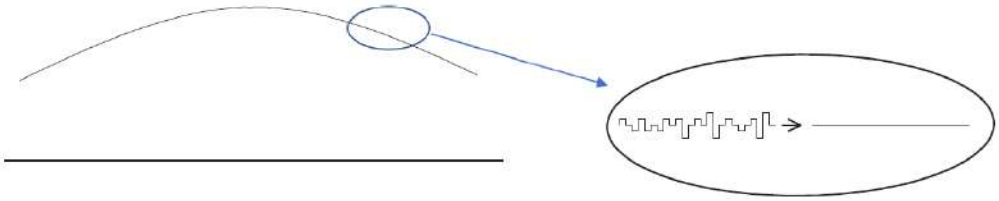
2. Black level correction data is automatically generated by **SWIRPixelBlackCalibration** and saved in the user area specified in step 1.
3. You can check the execution result of black level correction by **SWIRPixelBlackCalibrationResult**.

For more information, see the following Short ASCII command table.

Item	Short ASCII Command	Values	Command Examples
SWIRPixelBlackCorrect	IRPBC	0:Off (Default) 1:Factory 2:User	IRPBC=[Param.]<CR><LF> IRPBC?<CR><LF> **Note:** Factory stores correction data with factory settings.
SWIRPixelBlackCalibration	IRPBR	-	IRPBR<CR><LF>
SWIRPixelBlackCalibration Result	IRPBS	0: Pixel black correction has not been finished yet. 1: Succeeded. 2: Error1 –Image was too bright. 3: Error2 –Image was too dark. 4: Error3 –Timeout occurred.	IRPBS?<CR><LF>

PRNU Correction (Pixel Gain Correct)

PRNU (photo response non-uniformity) is a variation between pixels generated by the sensor under bright conditions. If the line rate is slowed or a long exposure time is set, the dark current in the sensor may change and the state of the PRNU may change.



RGB

1. Specify the user area (User1 ~ User3) to save the gain correction value with **PixelGainCorrectionMode**.

   > **Note:** You cannot perform calibration when **Off** or **Default** is selected.

2. Gain correction data is automatically generated by **PerformPixelGainCalibration** and saved in the user area specified in step 1.
3. You can check the execution result of gain correction by **PixelGainDetectResult**.

For more information, see the following Short ASCII command table.

Item	Short ASCII Command	Values	Command Examples
PixelGainCorrectionMode	PGC	0:Off 1:Default (Default) 2:User1 3:User2 4:User3	PGC=[Param.]<CR><LF> PGC?<CR><LF> **Note:** Default stores correction data with factory settings.
PerformPixelGainCalibration	PGR	-	PGR<CR><LF>
PixelGainDetectResult	PGS	1: Succeeded 2: Image too bright 3: Image too dark 4: Timeout error	PGS?<CR><LF>

SWIR

1. Select **User** to save the gain correction value with **SWIRPixelGainCorrect**.

   > **Note:** You cannot perform calibration when **Off** or **Factory** is selected.

2. Gain correction data is automatically generated by **SWIRPixelGainCalibration** and saved in the user area specified in step 1.
3. You can check the execution result of gain correction by **SWIRPixelGainCalibrationResult**.

For more information, see the following Short ASCII command table.

Item	Short ASCII Command	Values	Command Examples
SWIRPixelGainCorrect	IRPGC	0:Off (Default) 1:Factory 2:User	IRPGC=[Param.]<CR><LF> IRPGC?<CR><LF> **Note:** Factory stores correction data with factory settings.
SWIRPixelGainCalibration	IRPGR	-	IRPGR<CR><LF>
SWIRPixelGainCalibrationResult	IRPGS	0: Pixel black correction has not been finished yet. 1: Succeeded. 2: Error1 –Image was too bright. 3: Error2 –Image was too dark. 4: Error3 –Timeout occurred.	IRPGS?<CR><LF>

Adjust the Black Level

Black level correction is a function for adjusting the setup level.

1. Configure the RGB channels' black level with **BlackLevel**.
2. Configure the SWIR channel's black level with **SWIRBlackLevel**.

For more information, see the following Short ASCII command table.

	Item	Short ASCII Command	Values	Command Examples
RGB	BlackLevel	All: BL Red: BLR Blue: BLB	All: -133 ~ 255 Red: -64 ~ 64 Blue: -64 ~ 64 Default = 0 (All, Red, Blue)	When setting All: BL=[Param.]<CR><LF> BL?<CR><LF>
SWIR	SWIRBlackLevel	IRBL1S	-256 ~ 255 Default: 0	IRBL1S=[Param.]<CR><LF> IRBL1S?<CR><LF>

Adjust the White Balance

Adjust the white balance using the automatic adjustment function.

> **Note:** The white balance function is only supported on RGB channels.

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 spotlights from entering the screen.

2. Set **BalanceWhiteAuto** to **Once**. The white balance is automatically adjusted.

For more information, see the following Short ASCII command table.

Item	Short ASCII Command	Values	Command Examples
BalanceWhiteAuto	AWB	0:Off (Default) 2:Once 4:Exposure Once 5:Preset 5000K 6:Preset 6500K 7:Preset 7500K	AWB=[Param.]<CR><LF> AWB?<CR><LF>

Step 6: Configure Various Other Settings

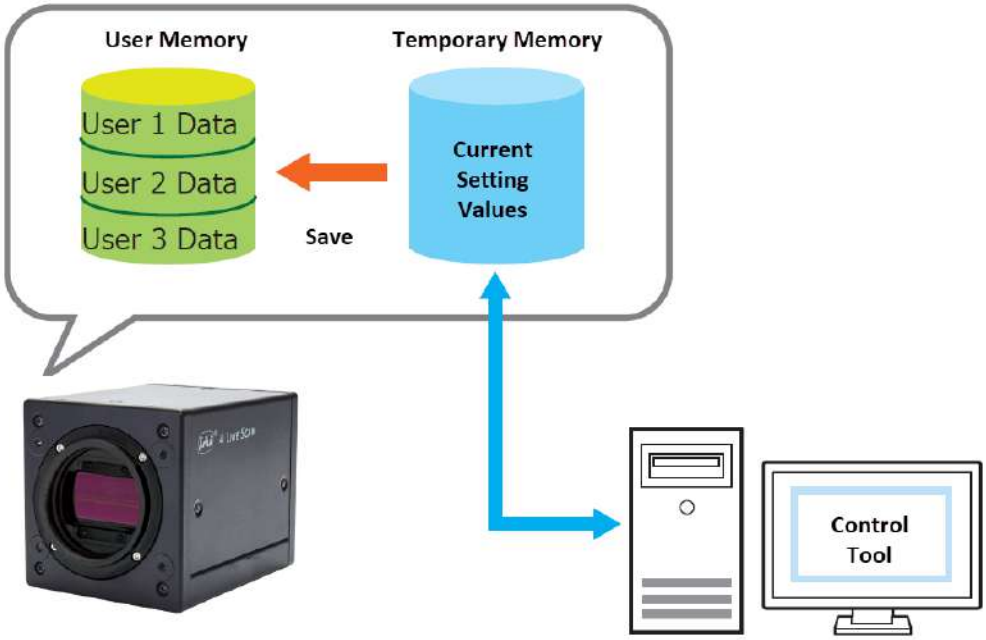
See “Setting List” or "SW-4010Q-MCL-M52 Command List" (available from the JAI website) to configure settings as necessary.

> **Note:** We recommend performing DSNU and PRNU calibration again whenever the line rate setting is changed significantly.

Step 7: Save the Settings

Related Setting Items: UserSetControl

The configured setting values 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)



Save the User Settings

1. Stop image acquisition. Settings can only be saved when image acquisition on the camera is stopped.
2. Specify the storage location (UserSet1 - UserSet3) using the **UserSetSave** command and save the current camera settings.

For more information, see the following Short ASCII command table.

Item	Short ASCII Command	Values	Command Examples
UserSetSave	SA	1:User1 2:User2 3:User3	SA=[Param.]<CR><LF> SA?<CR><LF>

Load the User Settings

1. Stop image acquisition. User settings can only be loaded when image capture on the camera is stopped.
2. Specify the storage location (UserSet1 - UserSet3) using the **UserSetLoad** command and read the settings of the camera.

> **Note:** When selecting **Default** for UserSetSelector, the factory settings are loaded.

For more information, see the following Short ASCII command table.

Item	Short ASCII Command	Values	Command Examples
UserSetLoad	LD	0:Default (Default) 1:User1 2:User2 3:User3	LD=[Param.]<CR><LF> LD?<CR><LF>

Main Functions

This chapter describes the camera's main functions.

Basic Function Matrix

Related Setting Items: DigitalIOControl, AcquisitionControl, SWIRAcquisitionControl, PulseGenerator

The following signals can be used as sources for each output destination (TriggerSelector, LineSelector, PulseGeneratorSelector).

The combinations of source signals and output destinations are indicated in the following. "Trigger" indicates both TriggerSource and SWIRTriggerSource.

✓	Can Be Used
🚫	Cannot Be Used
NA	Not Applicable

	Output Destination										
	Trigger	LineSelector						PulseGeneratorSelector			
Source Signal (Cross Point Switch Point)	Line Start	Line 1 TTLOut1	Line 8 TTLOut2	Line9 TTLOut3	Line12 TTLOut4	NAND0	NAND1	Pulse Genera-tor 0	Pulse Genera-tor 1	Pulse Genera-tor 2	Pulse Genera-tor 3
Low	Default SWIR	Default	Default	Default	Default	Default	Default	Default	Default	Default	Default
High	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Line4 TTL Input1	Default RGB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Line5 Opto In1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Line7 CL CC1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Line10 TTL Input2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Line13 TTL Input3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Encoder Trigger	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
User Output 0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
User Output 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
User Output 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

	Output Destination										
	Trigger	LineSelector						PulseGeneratorSelector			
Source Signal (Cross Point Switch Point)	Line Start	Line 1 TTLOut1	Line 8 TTLOut2	Line9 TTLOut3	Line12 TTLOut4	NAND0	NAND1	Pulse Genera-tor 0	Pulse Genera-tor 1	Pulse Genera-tor 2	Pulse Genera-tor 3
User Output 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pulse Generator0	✓	✓	✓	✓	✓	✓	✓	⛔	⛔	⛔	⛔
Pulse Generator1	✓	✓	✓	✓	✓	✓	✓	⛔	⛔	⛔	⛔
Pulse Generator2	✓	✓	✓	✓	✓	✓	✓	⛔	⛔	⛔	⛔
Pulse Generator3	✓	✓	✓	✓	✓	✓	✓	⛔	⛔	⛔	⛔
NAND0 Out	✓	✓	✓	✓	✓	⛔	✓	✓	✓	✓	✓
NAND1 Out	✓	✓	✓	✓	✓	✓	⛔	✓	✓	✓	✓
Exposure Active	NA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
LVAL	NA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Encoder Direction	NA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SWIR Exposure Active	NA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SWIRLVAL	NA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

GPIO (Digital Input/Output Settings)

Related Setting Items: DigitalIOControl

The camera can input/output the following signals to and from external input/output connectors.

External Output	TTL OUT 1 (Line 1)	DC IN / TRIG IN Connector (12-pin)
	TTL OUT 4 (Line 12)	
	TTL OUT2 (Line 8)	AUX Connector (10-pin)
	TTL OUT3 (Line 9)	
External Input	OPT IN1 - (Line 5)	DC IN / TRIG IN Connector (12-pin)
	OPT IN1 + (Line 5)	
	TTL IN 1 (Line 4)	
	TTL IN2 (Line 10)	AUX Connector (10-pin)
	TTL IN3 (Line 13)	
	CC1 (Line 7)	Camera Link Cable

These signals can be used as triggers and other necessary signals within the camera or as signals output from the camera to the system, such as those used for lighting equipment control.

Signals are selected as follows.

- When using external signals or the signals of each GPIO module as trigger signals: Select in **TriggerSource** (AcquisitionControl), **SWIRTriggerSource** (SWIRAcquisitionControl)
- When selecting the signals to use for external outputs: Select in **LineSource** (DigitalIOControl).

  You can verify the **LineMode** and **LineFormat** status, and configure the **LineInverter** setting. You can also verify each Digital IO's status using the **LineStatusAll** setting (table below):

LineSelector	LineMode	LineFormat	LineInverter	LineStatusAll
TTL OUT 1 (Line 1)	Output	TTL	True/False	bit0
TTL OUT 4 (Line 12)			True/False	bit11
TTL OUT2 (Line 8)			True/False	bit7
TTL OUT3 (Line 9)			True/False	bit8
OPT IN1 - (Line 5)	Input	OptoCoupled	False (Fixed)	bit4
OPT IN1 + (Line 5)			False (Fixed)	bit4
TTL IN 1 (Line 4)		TTL	False (Fixed)	bit3
TTL IN2 (Line 10)			False (Fixed)	bit9
TTL IN3 (Line 13)			False (Fixed)	bit12
Nand0In1		Internal Signal	True/False	
Nand0In2			True/False	
Nand1In1			True/False	
Nand1In2			True/False	

For digital output, set the output source signal using **LineSource**. Set the source signal in the same way for NAND Logic (Nand0In1, Nand0In2, Nand1In1, Nand1In2).

> **Note:** For more information on the combinations of source signals and output destinations, see Basic Function Matrix.

Camera Output Formats

> **Related Setting Items:** ImageFormatControl, SWIRImageFormatControl

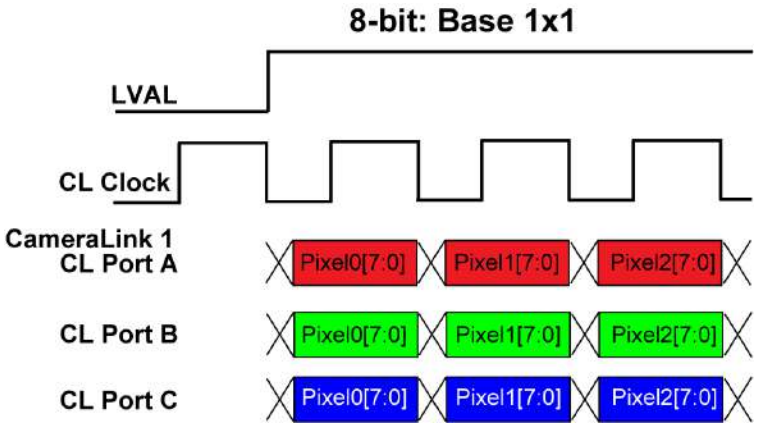
This camera supports the following output format:

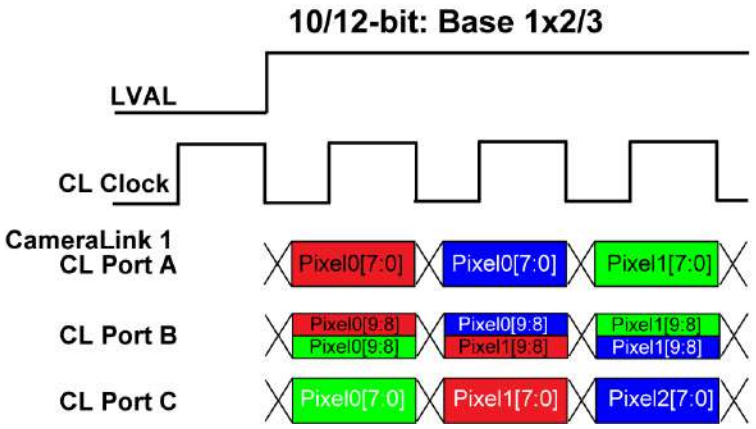
Channel	PixelFormat	Camera Link Connector
RGB	RGB8, RGB10BasePacked*, RGB12BasePacked*	1
SWIR	Mono8, Mono10, Mono12	2

The PixelFormat setting on the camera side and the frame grabber board side must match. For details on frame grabber board settings, refer to the instruction manual of the board.

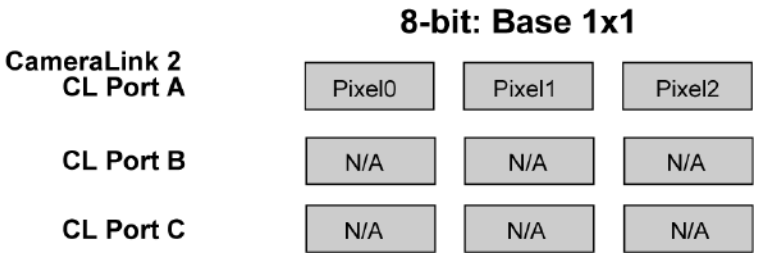
> **Caution:** *The RGB10BasePacked and RGB12BasePacked formats are customized pixel formats for the Camera Link interface. To view image output in this format, a viewer that supports these formats is required.

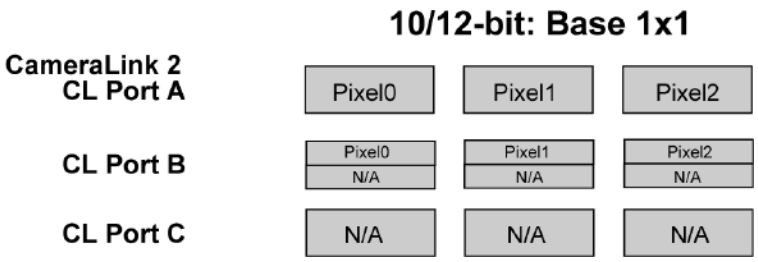
RGB


8-bit: Base 1x1
LVAL
CL Clock
CameraLink 1
CL Port A
Pixel0[7:0]
Pixel1[7:0]
Pixel2[7:0]
CL Port B
Pixel0[7:0]
Pixel1[7:0]
Pixel2[7:0]
CL Port C
Pixel0[7:0]
Pixel1[7:0]
Pixel2[7:0]


10/12-bit: Base 1x2/3
LVAL
CL Clock
CameraLink 1
CL Port A
Pixel0[7:0]
Pixel0[7:0]
Pixel1[7:0]
CL Port B
Pixel0[9:8]
Pixel0[9:8]
Pixel0[9:8]
Pixel1[9:8]
Pixel1[9:8]
Pixel1[9:8]
CL Port C
Pixel0[7:0]
Pixel1[7:0]
Pixel2[7:0]

SWIR


8-bit: Base 1x1
CameraLink 2
CL Port A
Pixel0
Pixel1
Pixel2
CL Port B
N/A
N/A
N/A
CL Port C
N/A
N/A
N/A


10/12-bit: Base 1x1
CameraLink 2
CL Port A
Pixel0
Pixel1
Pixel2
CL Port B
Pixel0
N/A
Pixel1
N/A
Pixel2
N/A
CL Port C
N/A
N/A
N/A

Camera Link Bit Assignments

This camera conforms to the Camera Link standard. The bit assignments are as follows.

Camera Link Connector 1 (RGB)

Port/Signal	8-bit (RGB8)	RGB10BasePacked RGB12BasePacked			Connector	Pin Name
Port A0	R_D0	R_D0	B_D0	G_D0	1	Tx0
Port A1	R_D1	R_D1	B_D1	G_D1	1	Tx1
Port A2	R_D2	R_D2	B_D2	G_D2	1	Tx2
Port A3	R_D3	R_D3	B_D3	G_D3	1	Tx3
Port A4	R_D4	R_D4	B_D4	G_D4	1	Tx4
Port A5	R_D5	R_D5	B_D5	G_D5	1	Tx6
Port A6	R_D6	R_D6	B_D6	G_D6	1	Tx27
Port A7	R_D7	R_D7	B_D7	G_D7	1	Tx5
PortB0	G_D0	R_D8	B_D8	G_D8	1	Tx7
PortB1	G_D1	R_D9	B_D9	G_D9	1	Tx8
PortB2	G_D2	R_D10	B_D10	G_D10	1	Tx9
PortB3	G_D3	R_D11	B_D11	G_D11	1	Tx12
PortB4	G_D4	G_D8	R_D8	B_D8	1	Tx13
PortB5	G_D5	G_D9	R_D9	B_D9	1	Tx14
PortB6	G_D6	G_D10	R_D10	B_D10	1	Tx10
PortB7	G_D7	G_D11	R_D11	B_D11	1	Tx11
PortC0	B_D0	G_D0	R_D0	B_D0	1	Tx15
PortC1	B_D1	G_D1	R_D1	B_D1	1	Tx18
PortC2	B_D2	G_D2	R_D2	B_D2	1	Tx19
PortC3	B_D3	G_D3	R_D3	B_D3	1	Tx20
PortC4	B_D4	G_D4	R_D4	B_D4	1	Tx21
PortC5	B_D5	G_D5	R_D5	B_D5	1	Tx22
PortC6	B_D6	G_D6	R_D6	B_D6	1	Tx16
PortC7	B_D7	G_D7	R_D7	B_D7	1	Tx17
LVAL 1					1	Tx24
LVAL 2					1	Tx25
DVAL					1	Tx26
ExposureActive					1	Tx23

Camera Link Connector 2 (SWIR)

Port/Signal	Mono8	Mono10/Mono12	Connector	Pin Name
Port A0	SWIR_D0	SWIR_D0	2	Tx0
Port A1	SWIR_D1	SWIR_D1	2	Tx1
Port A2	SWIR_D2	SWIR_D2	2	Tx2
Port A3	SWIR_D3	SWIR_D3	2	Tx3
Port A4	SWIR_D4	SWIR_D4	2	Tx4
Port A5	SWIR_D5	SWIR_D5	2	Tx6
Port A6	SWIR_D6	SWIR_D6	2	Tx27
Port A7	SWIR_D7	SWIR_D7	2	Tx5
PortB0	-	SWIR_D8	2	Tx7
PortB1	-	SWIR_D9	2	Tx8
PortB2	-	SWIR_D10	2	Tx9
PortB3	-	SWIR_D11	2	Tx12
PortB4	-	-	2	Tx13
PortB5	-	-	2	Tx14
PortB6	-	-	2	Tx10
PortB7	-	-	2	Tx11
PortC0	-	-	2	Tx15
PortC1	-	-	2	Tx18
PortC2	-	-	2	Tx19
PortC3	-	-	2	Tx20
PortC4	-	-	2	Tx21
PortC5	-	-	2	Tx22
PortC6	-	-	2	Tx16
PortC7	-	-	2	Tx17
LVAL 1			2	Tx24
LVAL 2			2	Tx25
DVAL			2	Tx26
ExposureActive			2	Tx23

Image Scaling Mode (Xscale)

> **Related Setting Items:** ImageFormatControl

JAI's Xscale algorithm digitally reduces the sensor's pixel resolution by specifying the RGB channels' scaling. This function allows finer adjustment of resolution than the conventional Binning function. The output image types are Average or Sum.

> **Notes:**
> - When using this function with the ROI function, first, set the Width and OffsetX settings, and then configure the Image Scaling Mode settings.
> - This function cannot be used together with the Binning function (ImageFormatControl).
> - The SWIR channel does not support this function.

How To Configure

1. If necessary, configure the Width and OffsetX settings.
2. Enable **ImageScalingMode**. The options are:
   - **On**: Enables ImageScalingMode.
   - **SWIRPixelMode**: Enables ImageScalingMode, and sets the RGB channels' PixelSize and Width to match the SWIR channel's Pixel Size and Width (PixelSize = 25um, Width = 1024).
   - **SWIRHalfPixelMode**: Enables ImageScalingMode, and sets the RGB channels' PixelSize to 12.5um (= half the size of the SWIR channel's PixelSize), and sets the RGB channels' Width to 2048 (= twice the size of the SWIR channel's Width).

     > **Note:** For more information on SWIRPixelMode and SWIRHalfPixelMode, see SWIRPixelMode and SWIRHalfPixelMode.
3. Use **ImageScalingSumMode** to specify the output image mode. The options are "**Average** (Off)" or "**Sum** (On)." Depending on the mode, the output image's brightness will be different.

   Average Mode: The average brightness of the sensor image is equal to the average brightness of the reduced output image.

   Sum Mode: The sum of the brightness of all pixels in the sensor image and the sum of the brightness of all pixels in the reduced output image is equal, thus increasing the brightness of the output image.

4. When **ImageScalingMode** is set to **On**, specify the scaling using **ImageScalingHorizontalRaw**. For example, if you want to reduce the output image by 50%, set ImageScalingHorizontalRaw to 2048.

> **Note:** ImageScalingHorizontalRaw cannot be configured when ImageScalingMode is set to **SWIRPixelMode** or **SWIRHalfPixelMode**.

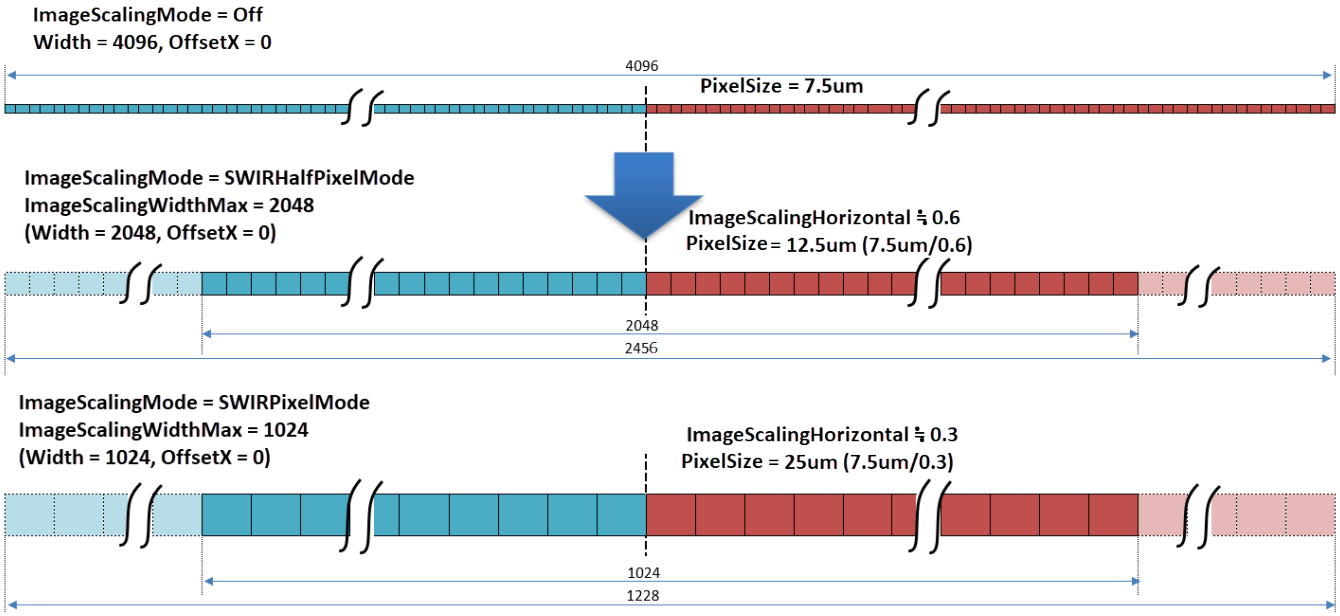
5. Configure the RGB channels' WidthMax when **ImageScalingMode** is **On** or in **SWIRPixelMode**/ **SWIRHalfPixelMode**. The WidthMax value can be reduced while maintaining the center of the image. The user-configured Width and OffsetX values must be controlled within this ImageScalingWidthMax range.

SWIRPixelMode and SWIRHalfPixelMode

The SWIRPixelMode and SWIRHalfPixelMode options configure the RGB channels' PixelSize and Width settings to match the SWIR channel's PixelSize and Width settings, by automatically setting ImageScalingHorizontal and ImageScalingWidthMax.

ImageScalingMode	ImageScalingHorizontal	PixelSize	Width / ImageScalingWidthMax
Off	1	7.5um	Width: 4096
SWIRPixelMode	0.3	25um	ImageScalingWidthMax: 1024
SWIRHalfPixelMode	0.6	12.5um	ImageScalingWidthMax: 2048

These options set the horizontal scaling ratio (ImageScalingHorizontal) to 0.3 or 0.6 to scale the PixelSize, and then cut off the ROI from the left and right edges equally to set ImageScalingWidthMax to 1024 or 2048. This way, the center of the image is aligned with the center of the original object.



Notes:
The ImageScalingHorizontal values are calculated from the following formulas and they are not 0.3 or 0.6 exact. If you use a Control Tool, the following value will be displayed.

- **SWIRPixelMode** : ImageScalingHorizontal = ImageScalingHorizontalRaw/ImageScalingBaseAbs = 1228/4096 ≒ 0.2998
- **SWIRHalfPixelMode**: ImageScalingHorizontal = ImageScalingHorizontalRaw/ImageScalingBaseAbs = 2456/4096 ≒ 0.5996

Exposure Mode

Related Setting Items: AcquisitionControl, SWIRAcquisitionControl

This camera has two Exposure modes (Off, Timed). Use the AcquisitionControl and SWIRAcquisitionControl settings to perform operations and settings for exposure.

Operation Mode	
Exposure Mode	**Trigger Mode**
OFF	OFF
	ON
TIMED	OFF
	ON

ExposureMode = Off

Exposure control is not performed (free-running operation). The exposure time is the longest possible time within the operating conditions such as the line rate.

ExposureMode = Timed

Mode in which control is performed using ExposureTime. Acquire images using an exposure time configured beforehand on an external trigger.

Notes:
- See Basic Function Matrix for the combination of operation modes and functions.
- For more information on how to configure the settings, see Configure Trigger, Exposure, and Line Rate Settings.

Trigger Control

> **Related Setting Items:** AcquisitionControl, SWIRAcquisitionControl

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.

> **Note:** The settings for exposure control and triggers are related to each other. Be sure to configure the settings described in Control via External Triggers.

Shortest Repetition Period for Triggers

Trigger Mode ON, full resolution

		Shortest Period (µs)
OFF	Camera Link	Varies depending on the DeviceTapGeometry (TransportLayerControlSWIRTransportLayerControl), CameraLinkClockFrequency (TransportLayerControl) settings.
	12pin/AUX	
TIMED	Camera Link	
	12pin/AUX	

Shortest Trigger Pulse Width

Trigger Mode ON

Camera Link	TTL In
3µs	50ns

Pixel Sensitivity Correction

> **Related Topic:** CorrectionControl, SWIRCorrectionControl

Correct variations between the sensor's pixels.

Calibration must be performed within the camera and correction data must be created beforehand. DSNU (PixelBlackCorrect) / PRNU (PixelGainCorrect) can be reduced using that correction data.

We recommend performing calibration and creating correction data whenever the line rate setting or Analog base gain setting or vertical binning setting are changed significantly.

Refer to the following topics on how to perform the calibration.

- PRNU Correction (Pixel Gain Correct)
- DSNU Correction (Pixel Black Correct)

> **Notes:**
> - Correction data is saved for DSNU (PixelBlackCorrect) / PRNU (PixelGainCorrect) according to the conditions adjusted at the factory.
> - We recommend performing DSNU and PRNU calibration again whenever the line rate setting is changed significantly.
> - A single correction data entry can be saved on the camera for each user. When calibration is performed, the correction data is saved to the non-volatile ROM at the same time.

Defective Pixel Correction

Related Setting Items: SWIRBlemishControl

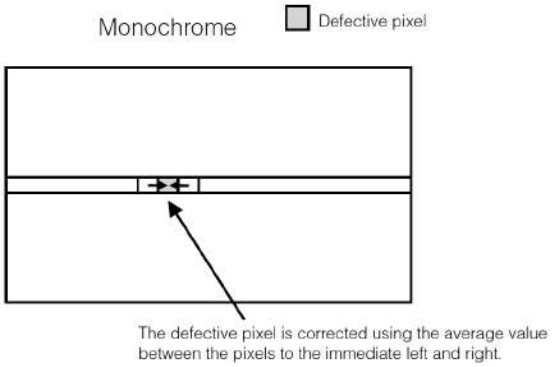
Correct defective pixels. Correction is performed using the average value between the pixels to the immediate left and right. Up to eight defective pixels can be corrected. The pixels at the left and right edges cannot be corrected.

Note: This function is only supported on the SWIR channel.

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.



Notes:

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

Gain Control (RGB Channels)

> **Related Setting Items:** AnalogControl

The following gain functions are available on the camera: Analog Base Gain and Digital Gain (MasterMode, IndividualMode)

Analog Base Gain

Analog base gain (ABG) is gain that is performed to the analog video signal output from the sensor. The gain steps can be configured to one of three levels (0 dB, 6 dB, 12 dB).

Digital Gain

Two digital gain control modes are available; a mode where you adjust the master gain and then perform fine adjustment for R and B (MasterMode), and a mode where R, G, and B gain are adjusted individually (IndividualMode).

MasterMode: Set **IndividualGainMode** to **Off**, and adjust the gain by configuring the following three items.

DigitalAll	× 1 ~ × 32 (0 dB ~ 30 dB)
DigitalRed	× 0.4 ~ × 4.0 (-7.96 dB ~ 12 dB)
DigitalBlue	

Individual Mode: Set **IndividualGainMode** to **On**, and adjust the gain by configuring the following three items.

DigitalGreen	× 1 ~ × 64 (0 dB ~ 36 dB)
DigitalRed	
DigitalBlue	

> **Notes:**
> - The following two gain values are added together for the total gain value.
>
> Total Gain = AnalogBaseGain (dB) + DigitalGain (dB)
> - In the IndividualGainMode, BalanceWhiteAuto cannot be set automatically.

Gain Control (SWIR Channel)

Related Setting Items: SWIRAnalogControl

The following three gain functions are available on the camera: Sensor Conversion Gain, Analog Base Gain, and Analog Fine Gain.

Sensor Conversion Gain

Sensor conversion gain (SCG) is InGaAs sensors' internal gain. Settings 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)
1	0	1	0.25
1	1	1	0.25

Note: *Sensitivity (all scaling values are TYP values)

Analog Base Bain

Analog base gain (ABG) is gain that is performed prior to the video signal output from the sensor passing through the CDS circuit. Settings 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	-6dB ± 1 dB
1	-3dB ± 1 dB
2	0dB ± 1 dB (Default)
3	+3dB± 1 dB

Note: *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). The setting range is 0 ~ +11dB (0 ~ 308).

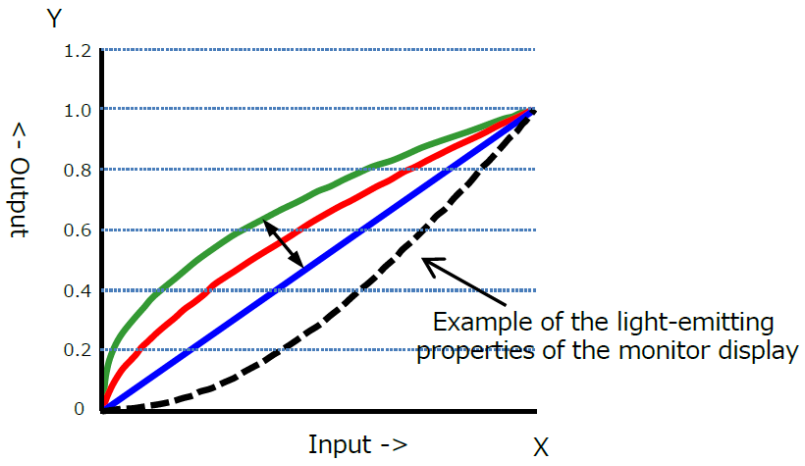
> **Notes:**
> The following three gain values are added together for the total gain value.
>
> Total Gain = SensorConversionGain (dB) + AnalogBaseGain (dB) + AnalogFineGain (dB)

Gamma Function

> **Related Setting Items:** AnalogControl, SWIRAnalogControl

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.
LUTMode	Gamma	Use Gamma.
SWIRGamma	0.45, 0.5, 0.55, 0.6, 0.65, 0.75, 0.8, 0.9, 1.0	Select the Gamma correction value.
SWIRLUTMode	Gamma	Use Gamma.

> **Note:** You can use the LUT function to configure a curve with more detailed points. For details, see LUT (Lookup Table).

LUT (Lookup Table)

Related Setting Items: LUTControl

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. On this camera, you can specify the output curve using 257 setting points (indexes) for the RGB channels and 256 setting points (indexes) for the SWIR channel.

To Use the LUT Function

Configure the settings as follows.

RGB

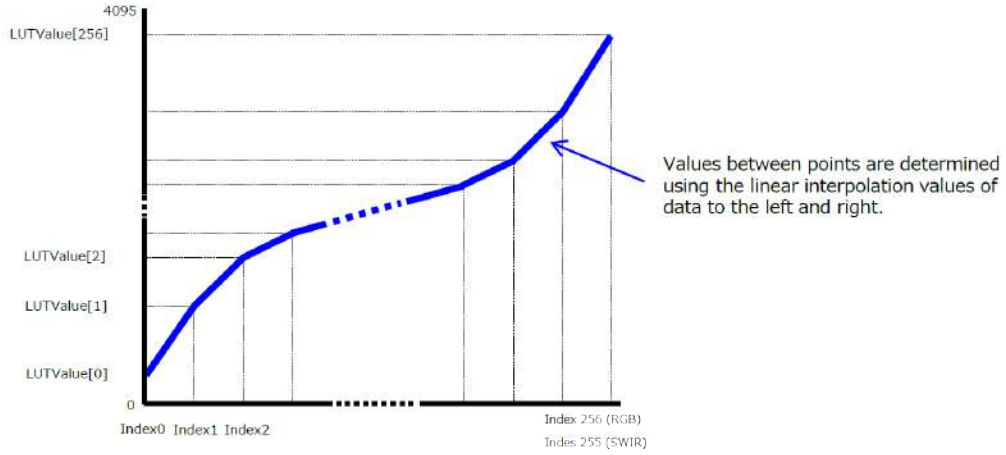
Item	Setting Value / Selectable Range	Description
LUTSelector	Red, Green, Blue	Select the LUT channel to control.
LUTIndex	0 ~ 256	Select the LUT index to configure. Indexes represent the possible pixel values captured on the sensor, from the lowest value (Index 0) to the highest (Index 256). For example,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

SWIR

Item	Setting Value / Selectable Range	Description
SWIRLUTSelector	Luminance (Fixed)	Display the LUT data type.
SWIRLUTIndex	0 ~ 255	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 255). For example, Index 0 represents a full black pixel and Index 255 represents a full white pixel.
SWIRLUTValue	0 ~ 4095	Set the LUT output value for the selected index.

LUT Value

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.



Shading Correction

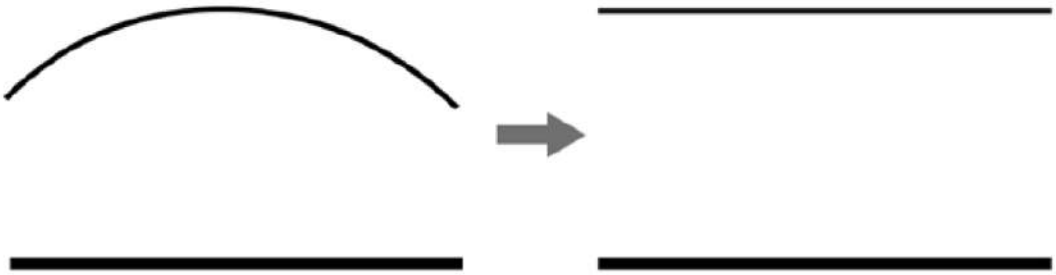
Related Setting Items: ShadingControl, SWIRShadingControl

The ShadingCorrection function 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.

FlatShading (RGB and SWIR)

The range of brightness that can be corrected is within ±30% for the RGB channels and ±20% for the SWIR channel, compared to the highest signal level on one line.

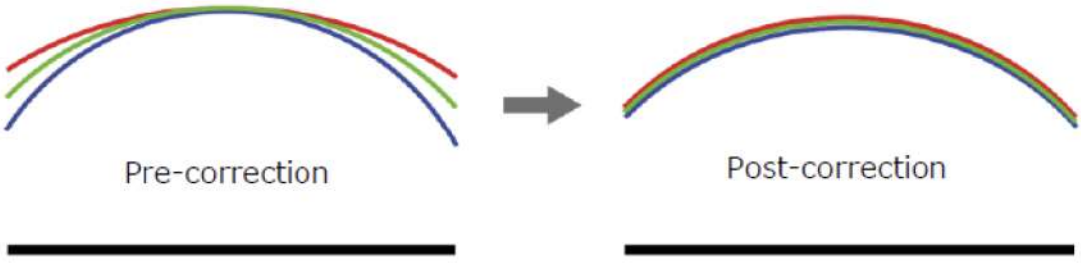


Notes:

- 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.

ColorShading (RGB)

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



To Use the Shading Correction 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.

> **Note:** You can save the setting, and have it applied whenever the power is subsequently turned on. For details on saving the setting, see Step 7: Save the Settings.

RGB

1. Select the shading correction mode (**FlatShading** or **ColorShading**) in **ShadingCorrectionMode**.
2. In **ShadingMode**, select the user area (User1 - 3) where you save the shading correction data.

   > **Note:** You cannot perform calibration when **Off** is selected.

3. Display a white chart under a uniform light and execute **PerformShadingCalibration**.

SWIR

The correction mode is fixed to FlatShading

1. In **SWIRShadingCorrect**, select **User** where you save the shading correction data.

   > **Note:** You cannot perform calibration when **Off** or **Factory** is selected.

2. Display a white chart under a uniform light and execute **SWIRShadingCalibration**.

Black Level Correction

> **Related Setting Items:** AnalogControl, SWIRAnalogControl

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.

RGB	SWIR
All: –133 ~ +255 LSB@12-bit	All: - 256 ~ + 255 LSB@12bit
Red: –64 ~ +64 LSB@12-bit	
Blue: –64 ~ +64 LSB@12-bit	

> **Note:** For more information see Adjust the Black Level.

Variable Line Rate

Related Setting Items: AcquisitionControl, SWIRAcquisitionControl

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.

<table>
<tr><th></th><th>RGB</th><th>SWIR</th></tr>
<tr><td>Variable Range</td><td><table><tr><td>Width = 4096</td></tr><tr><td>RGB8: 500 ~ 20.5kHz</td></tr><tr><td>RGB10/12: 500 ~ 13.7kHz</td></tr><tr><td>Width = 2048</td></tr><tr><td>RGB8: 500 ~ 40.8kHz</td></tr><tr><td>RGB10/12: 500 ~ 27.3kHz</td></tr></table></td><td>500 Hz ~ 39.2kHz</td></tr>
<tr><td>Variable Unit</td><td>0.1Hz</td><td>149.9 ns</td></tr>
<tr><td>Supported Mode</td><td colspan="2">Exposure Mode = OFF / TriggerMode = Off
ExposureMode = Timed / TriggerMode = Off</td></tr>
</table>

Notes:

- 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.

Electronic Shutter

Related Setting Items: AcquisitionControl, SWIRAcquisitionControl

Technical Notes How to Compensate Lateral Chromatic Aberration

When you use this function, you can set the exposure to a preconfigured accumulation time, regardless of the line rate.

	RGB	SWIR
Variable Range	3 µs ~ 15149.07 µs	20.38 µs (1L) ~ 1994.90 µs
Variable Unit	0.01µs (1clk)	0.1499 µs (1clk)
Supported Operation Mode	Trigger Mode = On / Off 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.

Notes:

- The exposure offset duration for the RGB channels is -0.85 µs. The SWIR channel does not have exposure offset duration.
- You can also save the setting, and have it applied whenever the power is subsequently turned on, but this requires additional operations.
- Switching and settings changing and storage for this function is performed via serial communication.

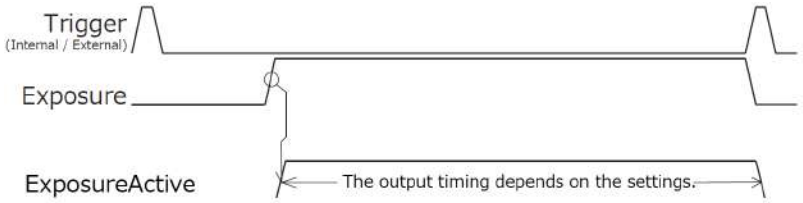
ExposureActive Function

Related Setting Items: AcquisitionControl, SWIRAcquisitionControl

Perform external output for the timing at which video is accumulated to the sensor.

The signal is output to the DC IN / TRIG 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)



Note: 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

Related Setting Items: ImageFormatControl, SWIRImageFormatControl

You can display the following 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.

Channel	Options
RGB	White, GreyPattern1(Ramp), GreyPattern2(Stripe), ColorBar
SWIR	GreyHorizontalRamp, GreyScale2, White

Color Space Conversion (Color Transformation Control)

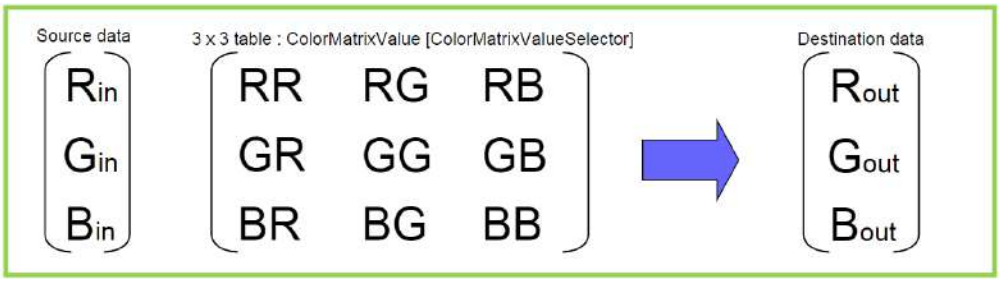
Related Setting Items: ColorTransformationControl

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 desired color space by configuring ColorTransformationMode 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, 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

1. Specify one of the nine items that are the components to the 3×3 conversion table in **ColorMatrixValueSelector**.
2. Specify a value from –2 to +2 in **ColorMatrixValue**.

See ColorTransformationControl for detailed information on the setting items.

Notes:
About Color Space HSI

Hue Value: 0° to 360° can be specified as follows.

- 8bit output: Can be specified in 2° increments - 0°(00000000) ~ 360°(10110100)
- 10bit output: Can be specified in 0.5°increments- 0°(0000000000) ~ 360°(1011010000)
- 12bit output: Can be specified in 0.5°increments- 0°(000000000000) ~ 360° (101101000000)

Saturation value, Intensity value: 0 ~ 100% can be specified as follows.

- 8bit output: 0% (00000000) ~ 100% (11111111)
- 10bit output: 0% (00000000) ~ 100% (1111111111)
- 12bit output: 0% (00000000) ~ 100% (111111111111)

Counter and Timer Control Function

Related Setting Items: CounterAndTimerControl

Note: This camera supports only the counter function.

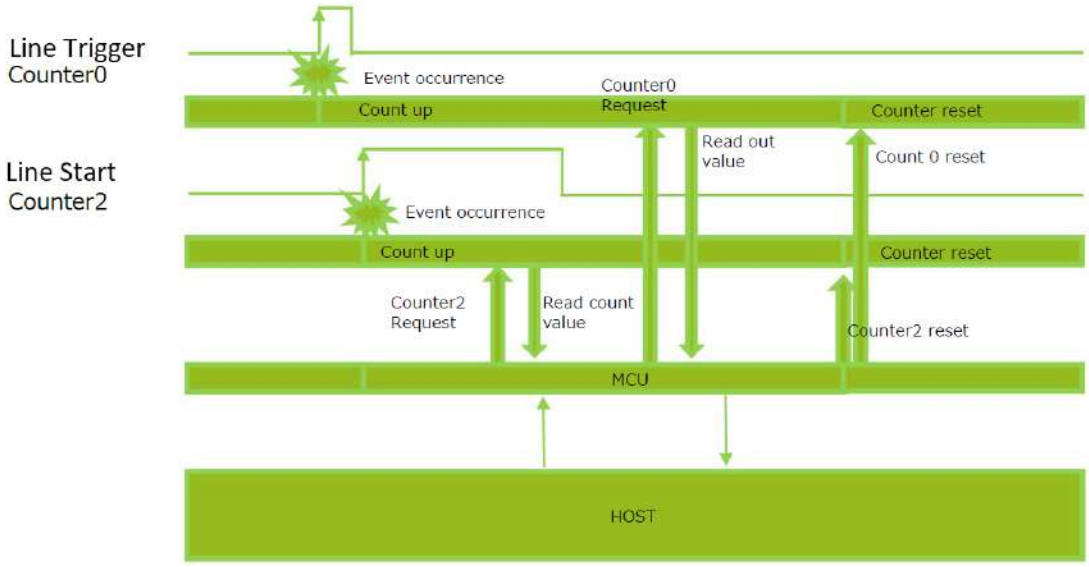
The counter function counts up change points in the camera's internal signals using the camera's internal counter and reads that information from the host side. This function is useful for verifying error conditions via the count value using internal camera operations.

The following counters are available on this camera. The functions that can be counted are fixed for each counter.

Counter	Description
Counter0	Count the number of Line Trigger instances.
Counter1	Count the number of Line Start instances.
Counter2	Count the number of Exposure Start instances.
Counter3	Count the number of Line Transfer End instances.
Counter4	Count the number of SWIR Line Trigger instances.
Counter5	Count the number of SWIR Line Start instances.
Counter6	Count the number of SWIR Exposure Start instances.
Counter7	Count the number of SWIR Line Transfer End instances.

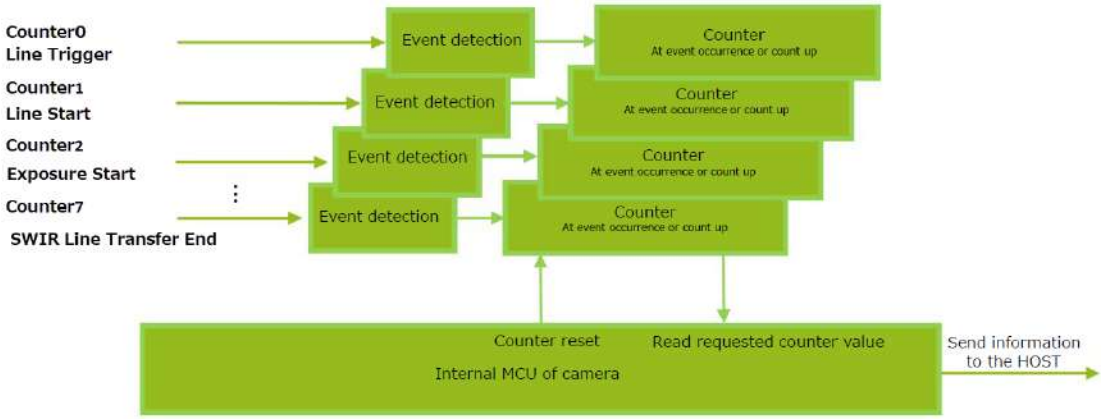
When a problem occurs in a system that includes this camera, comparing the values from multiple counters allows you to verify the extent of normal operability and can be useful when investigating the cause of the problem.

Counter Occurrence Diagram



Note: You can reset a specific counter's count value by executing CounterReset[Counter0, Counter1, Counter2, Counter3].

Internal Camera Blocks



To Use the Counter Function

Configure the settings as follows.

Eight counters are available. Specify a counter (Counter0 to Counter7), and configure the settings.

Item	Setting Value Selectable Range	Description
Counter 0 ~ 7	Counter 0 ~ 7	Select the counter.
CounterEventSource	Counter0: Off, Line Trigger Counter1: Off, Line Start Counter2: Off, Exposure Start Counter3: Off, Line Transfer End Counter4: Off, SWIR Line Trigger Counter5: Off, SWIR Line Start Counter6: Off, SWIR Exposure Start Counter7: Off, SWIR Line Transfer End	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).

Note: On this camera, the counter event activation is fixed to RisingEdge.

Chromatic Aberration Correction

> **Related Setting Items:** CorrectionControl

This Function corrects for the chromatic aberration of magnification caused by the lens (i.e., when the size of the image differs at the focal point for each color (RGB)). You can save correction data for three types of lenses.

This function assumes that the amount of deviation between the left and right is identical. If the amount of deviation between the left and right is not identical, correction will not be performed properly. Specify the number of pixels to delay or advance the R channel and B channel using the G channel as a reference. The correction range is –4.0 to +4.0 in steps of 0.1.

> **Note:** This function is supported only on the RGB channels.

Adjustment Procedure

1. Correct the R channel. Set **ChromaticAberrationCorrectionSelecter** to **RChannel**. Specify the amount of correction in **ChromaticAberrationCorrectionLens1,2,3** (–4.0 to +4.0 in steps of 0.1).
2. Similarly, correct the B channel. Set **ChromaticAberrationCorrectionSelecter** to **BChannel**. Specify the amount of correction in **ChromaticAberrationCorrectionLens1,2,3** (–4.0 to +4.0 in steps of 0.1).
3. Enable the chromatic aberration of magnification correction function. Set **ChromaticAberrationCorrectionMode** to **On**.

   Alternatively, select preset Lens1, Lens2, or Lens3.

Connecting Rotary Encoders

> **Related Setting Items:** EncoderControl

This camera can generate trigger signals or detect the scanning direction of the subject in response to signals output from the rotary encoder.

Adjustment Procedure

1. Input the two signals (phase A and phase B) from the rotary encoder. Select which I/O on the camera (Line5:OptIn1, Line4:TTLIn1,Line10:TTLIn2, Line13:TTLIn3) you want to input each of the two outputs from the rotary encoder phase A (**EncoderSourceA**), phase B (**EncoderSourceB**).
2. Specify the number of triggers (number of vertical lines) to generate during each rotation of the rotary encoder. When **EncoderDivider** is set to **N**, the rotary encoder generates 65536/N triggers.
    - When N is an integer multiple of 65536: The camera's internal trigger is generated by the decimation of the output trigger of a rotary encoder.
    - When N is not an integer multiple of 65536: Using the time interval of the output trigger of the rotary encoder, the camera's internal trigger is generated so that the set division ratio is obtained.

    > **Caution:** If the time interval of the output of the rotary encoder fluctuates greatly, the output of the camera's internal trigger generated may also fluctuate greatly. In this case, by setting **EncoderAveragingInterval**, it is possible to perform internal processing with the value obtained by averaging the time intervals of the specified number of signals.
3. If necessary, enable the low-pass filter for the signal to prevent unintended operations due to signal noise from the rotary encoder. Specify the number of cycles from a range of 0 to 15 (0 to 150 ns).
4. If necessary, specify the strobe length of the generated signal. When **EncoderStrobe** is set to **M**, the strobe length will be M×10 ns.

Noise Reduction Filter Functions

> **Related Setting Items:** CorrectionControl, SWIRCorrectionControl

The camera has noise reduction functions. The noise reduction methods vary depending on the channel.

RGB

Three filters are available for the RGB channels:

- **MEDIAN Filter**: Apply 1x3 MEDIAN filter

  Select the target to apply the filter from Red, Green, Blue, and set the **Median Filter Mode**. When set to **On**, this function is enabled. (Default = Off)

- **FIR Filter**: Apply the FIR (Finite Impulse Response) filter

  Select the target to apply the filter from Red, Green, Blue, and set the **FIR Filter Mode**. When set to **On**, this function is enabled (Default = Off). In FIR Filter, the coefficients of the three signals (left, center, right) can be set in the range of -2 to 2. The correction value through the FIR Filter is:

  - Left pixel read value x Left pixel coefficient +
  - Center pixel read value x Center pixel coefficient +
  - Right pixel read value x Right pixel coefficient.

- **Noise Reduction**: Apply the noise filter using JAI's own algorithm.

  Set the noise reduction intensity in 4 levels. Level1 = weak, Level4 = strong.

Any of the above filters can improve SNR, but it affects the sense of resolution and sensitivity. An imaging test should be performed before deciding to use this feature.

SWIR

Enables/Disables **NoiseReduction** in SWIRCorrectionControl.

Setting List

This camera complies with GenICam. Each setting item name conforms to GenICam SFNC (Standard Features Naming Convention). (There are some JAI-specific setting items).

Each setting item is an integer type (IInteger), a real type (IFloat), an element enumeration type (IEnumeration), a character string (IString), a logical type (IBoolean), and a category type (ICategory) or a command type (ICommand) for executing the function.

Beginner: For beginner users.

Expert: For users with deep knowledge of camera functions.

Guru: For advanced users who make settings, including advanced features that can cause the camera to malfunction if not set correctly.

> **Note:** For details on the ASCII Command List, see "SW-4010Q-MCL-M52 Command List" available on the JAI website.

Selector

A Selector is used to index which instance of the feature is accessed in situations where multiple instances of a feature exist.

Instance Example:

Each Line-related item (LineSource, LineInverter, etc.) has LineSelector-LineX instances, which can be set or referenced as an index.

Selectors are a feature of element enumeration type (IEnumeration) or an integer type (IInteger). However, unlike normal configuration items, it is only used to select the instance in the following configuration item.

It does not change the behavior of the camera by changing the value of the selector. Also, the selector may have only one selectable value. In this case, use the selector function only for information purposes. In this document, it is described as SelectedFeature[Selector] according to the description method of GenICam.

In the case of Line Selector with a specific I/O line selected, the description could be as follows.

LineSource[LineSelector-LineX] = High

LineInverter[LineSelector-LineX] = False

LineMode[LineSelector-LineX] = Input

LineFormat[LineSelector-LineX] = TTL

Generally, selectors only apply to a single category of features. (Example: TriggerSelector only applies to trigger related functions.)

Feature Properties

> **Note:** Depending on the setting item, you may need to change visibility. Please switch visibility (Beginner / Expert / Guru) as necessary.

DeviceControl

Display/configure information related to the device.

DeviceControl Item	Setting Range	Default Value	Description
DeviceScanType	-	1:Linescan	Display the device scan type.
DeviceVendorName	-	"JAI Corporation"	Display the manufacturer name.
DeviceModelName	-	-	Display the model name.
DeviceManufacturerInfo	-	See the possibilities	Display the manufacturer information.
DeviceVersion	-	-	Display the device version.
DeviceFirmwareVersion	-	-	Display the firmware version.
DeviceFpgaVersion			Display the FPGA version.
DeviceSerialNumber	-	-	Display the device ID.
DeviceUserID	Any	-	Set the user ID (16bytes) for the camera.
DeviceSFNCVersionMajor	-	2	Display the SFNC Major version.
DeviceSFNCVersionMinor	-	5	Display the SFNC Minor version.
DeviceSFNCVersionSubMinor	-	0	Display the SFNC Sub-Minor version.
DeviceManifestEntrySelector	1	1	Display the valid XML file information.
DeviceManifestXML MajorVersion	0 ~ 9	0	Display XML file's major version number.
DeviceManifestXML MinorVersion	0 ~ 9	0	Display XML file's minor version number.
DeviceManifestXML SubMinorVersion	0 ~ 9	1	Display XML file's sub-minor version number.
DeviceManifestSchema MajorVersion	0 ~ 32bit max	1	Display XML file's sub-major version number.
DeviceManifestSchema MinorVersion	0 ~ 32bit max	1	Display schema file's minor version number.
DeviceManifest PrimaryURL	-	-	Display the PrimaryURL.
DeviceTLType	1:CameraLink (Fixed)	-	Transport Layer type of the device.
DeviceGenCPVersionMajor	-	1	Display the number of supported stream channels.
DeviceGenCPVersionMinor	-	1	Display the number of supported message channels.
DeviceReset	-	-	Reset the device.(After the camera receives this command, it returns an ACK response and executes the reset.)

DeviceControl Item	Setting Range	Default Value	Description
DeviceTemperatureSelector	0: Main board 1: SWIR Sensor	0	Select the area of the camera's interior where the temperature is to be measured.
DeviceTemperature	-55 ~ 125	0	Display the internal temperature (°C) of the device specified by DeviceTemperatureSelector.
DeviceSerialPortSelector	0:CameraLink (Fixed)	0	
DeviceSerialPortBaudRate	-	1	Display the serial port's baud rate. 1(0x01): Baud9600 2(0x02): Baud19200 4(0x04): Baud38400 8(0x08): Baud57600 16(0x10): Baud115200 32(0x20): Baud230400 64(0x40): Baud460800 128(0x80): Baud921600

ImageFormatControl

Configure image format settings for the RGB channels.

Image Format Control Item	Setting Range	Default Value	Description
WidthMax	-	4096	Display the maximum image width. Default: 4096 ImageScalingMode = Off : - BinningHorizontal=1: 4096, BinningHorizontal=2: 2048 ImageScalingMode = other than Off: - WidthMax = ImageScalingWidthMax
Width	-	4096	Set the image width. Max: WidthMax - OffsetX Min,Step: - Normal: 16 - BinningHorizontal=2: 8 - ImageScalingMode =On: 8
Height	-	1	Display the image height.
OffsetX	0 ~ WidthMax - Width	0	Set the horizontal offset. Max: WidthMax - Width Step: 16 (8) **Note:** When BinningHorizontal = 2 or ImageScalingMode enabled, the value in parentheses is applicable.
BinningHorizontalMode	0:Sum 1:Average	0:Sum	Set the processing method for horizontal binning. **Note:** Refer to the blog post on how to use the binning function: https://news.jai.com/blog/pixel-binning.
BinningHorizontal	1 ~ 2	1	Set the number of pixels in the horizontal direction for which to perform binning.
BinningVerticalMode	0:Sum (Fixed)	0:Sum	Display the processing method for vertical binning.
BinningVertical	1 ~ 2	1	Set the number of pixels in the vertical direction for which to perform binning.
ImageScalingMode **Related Topic:** Image Scaling Mode (Xscale)	-	0:Off	Enable ImageScalingMode. 0:Off 1: On 2: SWIRPixelMode 3: SWIRHalfPixelMode
ImageScalingSumMode	0:Off (Ave) 1:On (Sum)	0:Off (Ave)	Select whether to use Sum or Average mode when ImageScalingMode is enabled.

Image Format Control Item	Setting Range	Default Value	Description
ImageScalingHorizontal	0.0625 ~ 1	1	Specify the horizontal scaling ratio in decimal units. For example, if you want to scale the image by 50% in the horizontal direction, specify "0.5". Value = ImageScalingHorizontalRaw / ImageScalingBaseAbs
ImageScalingHorizontalRaw	256 ~ 4096	4096	ASCII command setting item. Specify the scaling. For example, if you want to scale the image by 50% in the horizontal direction, specify "2048". Step: 2 **Note:** This item cannot be configured when **[ImageScalingMode]** is set to **[SWIRPixelMode]**or **[SWIRHalfPixelMode**.
ImageScalingBaseAbs	-	4096 (Fixed)	
ImageScalingWidthMax		4096	Specify the maximum width. **Min / Step**: 16 **Max**: ImageScalingMode=Off: 4096 ImageScalingMode=On:((4096 x ImageScalingHorizontal) / 16) x 16 ImageScalingMode=SWIRPixelMode: 1024 ImageScalingMode=SWIRHalfPixelMode: 2048
PixelFormat **Related Topic:** Camera Output Formats	-	0: RGB8	Set the pixel format. 0: RGB8 1: RGB10BasePacked 2: RGB12BasePacked
TestPattern **Related Topic:** Test Pattern Function	-	0: Off	Select the test image. 0: Off (Default) 1:White 2:GreyPattern1(Ramp) 3:GreyPattern2(Stripe) 4:ColorBar
SensorType	0:TypeA 1:TypeB	0:TypeA	Set the pixel size. TypeA: 7.5um x 7.5um TypeB: 7.5um x 10.5um

AcquisitionControl

Configure image capture settings for the RGB channels.

Acquisition Control Item	Setting Range	Default Value	Description
AcquisitionLineRate (Hz) **Related Topic:** Variable Line Rate	-	500	Set the AcquisitionLineRate(Hz). Min: 500 Max: - Width = 4096: (RGB8) 20.5kHz, (RGB10/12) 13.7kHz - Width = 2048: (RGB8) 40.8kHz, (RGB10/12) 27.3kHz Step: 0.1
TriggerMode **Related Topic:** Trigger Control	0:Off 1:On	0:Off	Select the trigger mode. When **ExposureMode** is set to **TriggerWidth**, **TriggerMode** is automatically set to **On**.
TriggerSource	-	20: Line4 TTL In1	Select the trigger signal source. 0: Low 1: High 10-13: PulseGenerator0-3 14-17: UserOutput0-3 20: Line4 TTL In1 21: Line5 Opt In1 23: Line7 CC1 24: Line10 TTL In2 26: NAND0 Out 27: NAND1 Out 28: Line13 TTL In3 29: EncoderTrigger
TriggerActivation	0:Rising Edge 1:Falling Edge	1:Falling Edge (falling edge of input signal)	Select the polarity of the trigger signal (i.e., location of signal at which trigger is applied).
ExposureMode **Related Topic:** Exposure Mode	0: Off 1: Timed	1: Timed	Select the exposure mode.
ExposureTimeMode	0: Common 1: Individual	0: Common	Select the Exposure setting method. Select **Common** to set a common value for all three sensors. Select **Individual** to set the value for each channel. **Note:** This item is available only when **ExposureMode** is set to **Timed**.

Acquisition Control Item	Setting Range	Default Value	Description
ExposureTimeSelector	0: Common 1:Red 2:Green 3:Blue	0: Common	Specify the sensor for which to set the ExposureTime. Select **Common** if **ExposureTimeMode** is set to **Common**. Select **Red/Green/Blue if ExposureTimeMode** is set to **Individual**. **Note:** This item is available only when **ExposureMode** is set to **Timed**.
ExposureTime (us) **Related Topic:** Electronic Shutter	3 ~ 15149.07	15149.07	Set the exposure time (0.01 μs) for the channel selected in **ExposureTimeSelector**. **Note:** The actual exposure time will consist of the image sensor's offset duration (**0.85us**) deducted from the ExposureTime setting.
RBExposureInterlocked	0: Off 1:On	0: Off	If set to On, you can change Green while maintaining white balance.

AnalogControl

Configure the analog control settings for the RGB channels.

Analog Control Item	Setting Range	Default Value	Description
IndividualGainMode **Related Topic:** Gain Control (RGB Channels)	0:Off 1:On	0:Off	In IndividualGainMode, RGB can be configured individually for the entire gain adjustment range of the sensor.
GainSelector	-	0:Digital All	Select the gain to configure. 0:Digital All (IndividualGainMode=OFF only) 1:Digital Green (IndividualGainMode=ON only) 2:Digital Red 3:Digital Blue
Gain	-	1	Set the gain value for the gain setting selected in GainSelector (Step = 0.01). **IndividualGainMode=OFF** **Digital All**: Min=1.0, Max=32.0 **DigitalRed/DigitalBlue**: Min=0.4, Max=4.0 **IndividualGainMode=ON**: Min=1.0, Max=64.0
GainAuto	0: Off 1: Once	0: Off	Enable/disable gain auto adjustment. When set to **Once**, the automatic adjustment will be performed only once, and then automatically switched to **Off**.
AGCReference	30 ~ 95	50	Set the target level for AGC. (Unit: %)
AGCOnceStatus	-	-	Display the status when GainAuto is set to Once. 1: Succeeded. 2: Error1- Timeout-error occurred. 3: Abort1-Contro lLimit 4: IDLE (Default)
AnalogBaseGainSelector	1:Analog Green 2:Analog Red 3:Analog Blue	1:Analog Green	Select the analog base gain to configure.
AnalogBaseGain	0:0dB 1:6dB 2:12dB	0:0dB	Set the gain value for the analog base gain item selected in **AnalogBaseGainSelector**.

Analog Control Item	Setting Range	Default Value	Description
BlackLevelSelector **Related Topic:** Adjust the Black Level	0: All 1: Red 2: Blue	0: All	Select the black level to configure.
BlackLevel	-	0	Set the black level value. **All**: Min = -133, Max = 255 **Red**: Min = -64, Max=64 **Blue**: Min = -64, Max=64
BalanceWhiteAuto **Related Topic:** Adjust the White Balance	-	0: Off	Enable/disable auto white balance. When set to **Once**, the automatic adjustment will be performed only once, and then automatically switched to **Off**. **Note:** In **IndividualGainMode**, BalanceWhiteAuto cannot be set automatically. 0: Off 2: Once 4: Exposure Once 6: Preset 5000K 7: Preset 6500K 8: Preset 7500K
AWBAreaWidth			When **BalanceWhiteAuto** is set to **Once**, specify the width of the reference area. Min: 16(8)* Max:4096 Step: 16(8)* *When BinningHorizontal = 2, the value in parenthesis is applicable.
AWBAreaOffsetX	-	-	When **BalanceWhiteAuto** is set to **Once**, specify the offset of the reference area. Min: 0 Max: WidthMax - AWBWidth Step: 16(8)* *When BinningHorizontal = 2, the value in parenthesis is applicable.
AWBOnceStatus	-	5:Idle	When **BalanceWhiteAuto** is set to **Once**, display the status. 1:Succeeded 2:Error1- G image was too bright 3:Error2 - G image was too dark 4:Error3 - Timeout 5:Idle

Analog Control Item	Setting Range	Default Value	Description
AWBExposureOnce Status	-	5:Idle	When **BalanceWhiteAuto** is set to **ExposureOnce**, display the status. 1:Succeeded 2:Error1- G image was too bright 3:Error2 - G image was too dark 4:Error3 - Timeout 5:Idle
Gamma **Related Topic:** Gamma Function	0.45 ~ 1	0.45	Set the Gamma value. Setting Range: 0.45, 0.50, 0.55, 0.60, 0.65, 0.75, 0.80, 0.90, 1.00
LUTMode	0: Off 1: Gamma 2: LUT	0:Off	Set the LUT mode.

LUTControl

Configure LUT settings.

Related Topic: LUT (Lookup Table)

LUT Control Item	Setting Range	Default Value	Description
LUTSelector	0: Red 1: Green 2: Blue	0: Red	Select the LUT channel to control. **Note:** Color models only.
LUTIndex	0 ~ 256	0	Set the LUT index table number.
LUTValue	0 ~ 4095	Gamma≒ 1.0	Set the LUT value.

ColorTransformationControl

Configure color transformation settings.

Related Topic: Color Space Conversion (Color Transformation Control)

Color Transformation Control Item	Setting Range	Default Value	Description
ColorTransformationMode	0:RGB 1: HSI 2: XYZ	0:RGB	Set the output image format.
ColorTransformationRGBMode	0: OFF 1: sRGB 2: AdobeRGB 3: UserCustom	0: OFF	Set the detailed mode when RGB is selected for the color space.
ColorMatrixValueSelector	0: R-R 1: R-G 2: R-B 3: G-R 4: G-G 5: G-B 6: B-R 7: B-G 8: B-B	0: R-R	Select the ColorMatrix setting component.
ColorMatrixValue	-2 ~ 2	-	Set the Color Matrix value. (Step = 0.1) **Default**: ColorMatrixValueSelector=0,4,8: 1.0 ColorMatrixValueSelector=1,2,3,5,6,7: 0

DigitalIOControl

Configure settings for digital input/output.

> **Related Topic:** GPIO (Digital Input/Output Settings)

<table>
<tr><th>Digital IO Control Item</th><th>Setting Range</th><th>Default Value</th><th>Description</th></tr>
<tr><td>LineSelector</td><td>-</td><td>5: Idle</td><td>Select the input/output to configure.
<table>
<tr><td>0: Line1 TTL Out1</td><td rowspan="3">12pin Connector</td></tr>
<tr><td>3: Line4 TTL In1</td></tr>
<tr><td>4: Line5 Opt In1</td></tr>
<tr><td>5: Idle</td><td></td></tr>
<tr><td>7: Line8 TTL Out2</td><td rowspan="3">AUX Connector</td></tr>
<tr><td>8: Line9 TTL Out3</td></tr>
<tr><td>9: Line10 TTL In2</td></tr>
<tr><td>11: Line12 TTL Out4</td><td>12pin Connector</td></tr>
<tr><td>12: Line13 TTL In3</td><td>AUX Connector</td></tr>
<tr><td>13: Nand0 In1</td><td></td></tr>
<tr><td>14: Nand0 In2</td><td></td></tr>
<tr><td>15: Nand1 In1</td><td></td></tr>
<tr><td>16: Nand1 In2</td><td></td></tr>
</table></td></tr>
<tr><td>LineMode</td><td>-</td><td>-</td><td>Display the input/output status (whether it is input or output).
0:Input (LineSelector=3,4,9,12,13,14,15,16)
2:Output (LineSelector=0,7,8,11)</td></tr>
<tr><td>LineInverter</td><td>0: False
1: True</td><td>0: False</td><td>Enable/disable polarity inversion for the selected input signal or output signal.
Note: LineSelector=3, 4, 9, 12 are fixed to "0".</td></tr>
<tr><td>LineStatus</td><td>0: False (Low)
1: True (High)</td><td>0: False</td><td>Display the status of the input signal or output signal (True: High, False: Low).</td></tr>
</table>

Digital IO Control Item	Setting Range	Default Value	Description
LineSource	-	0: Low	Select the line source signal for the item selected in LineSelector. 0: Low 1: High 7: ExposureActive 9: LVAL 10: PulseGenerator0 11: PulseGenerator1 12: PulseGenerator2 13: PulseGenerator3 14: UserOutput0 15: UserOutput1 16: UserOutput2 17: UserOutput3 20: Line4: TTL In1 21: Line5: Opt In1 23: Line7 - CC1 24: Line10: TTL In2 26: NAND0 Out 27: NAND1 Out 28: Line13: TTL In3 29: EncoderTriger 30: EncoderDirection 31: SWIRExposureActive 32: SWIRLVAL
LineFormat	-	-	Display the signal format. 0: NoConnect 2: TTL 5: Opto Coupled 7: Internal Signal **Default** LineSelector=0, 3, 7, 8, 9, 11, 12: TTL LineSelector=4:OptoCoupled LineSelector=13,14,15,16: Internal Signal

Digital IO Control Item	Setting Range	Default Value	Description
LineStatusAll	-	bit0:Line1 (TTL Out1)	Display the input/output signal status. bit0:Line1 (TTL Out1) bit1 - 2:Unused (fixed 0) bit3:Line4 (TTL In1) bit4:Line5 (Opt In1) bit5 - 6:Unused (fixed 0) bit7:Line8 (TTL Out2) bit8:Line9 (TTL Out3) bit9:Line10 (TTL In2) bit10:Unused (fixed 0) bit11:Line12 (TTL Out4) bit12:Line13 (TTL In3) bit13 - 15:Unused (fixed 0)
OptInFilterSelector	-	0: Off	Remove noise from the OptIn input signal of Digital I/O. 0: Off 1: 0.1 us 2: 1 us 3: 5 us 4: 10 us 5: 50 us 6: 100 us
UserOutputSelector	-	0	Set the UserOutput signal. 0: User Output 0 1: User Output 1 2: User Output 2 3: User Output 3
UserOutputValue	0: False 1: True	0: False	Set the value for the UserOutput selected in UserOutputSelector.

CounterAndTimerControl

Configure counter settings.

> **Note:** This camera only supports the counter functions.

> **Related Topic:** Counter and Timer Control Function

CounterAndTimer Control Item	Setting Range	Default Value	Description
CounterSelector		0: Counter0	Select the counter. 0 - 7: Counter0 - 7
CounterEventSource	-	0: Off	Assign the Counter Event signal for which you want to read the count value to a dedicated counter and read the value. 0: Off 1: Line Trigger (Counter0 only) 2: Exposure Start (Counter2 only) 3: Line Start (Counter1 only) 4: Line Transfer End (Counter3 only) 5: SWIR Line Trigger (Counter4 only) 6: SWIR Exposure Start (Counter6 only) 7: SWIR Line Start (Counter5 only) 8: SWIR Line Transfer End (Counter7 only)
CounterEventActivation	0:Rising Edge	-	Display the count timing. The setting value is fixed to Rising Edge.
CounterReset Source	-	-	Specify the source to reset the counter. This source triggers the counter to reset. 0: Software 3: Line4 TTL In1 4: Line5 Opt In1 9: Line10 TTL In2 12: Line13 TTL In3
CounterResetActivation	-	-	Select the timing to reset the counter. 1: Rising Edge 2: Falling Edge 3: Level High 4: Level Low
CounterReset	-	-	Reset the counter. **Note:** Available only when **CounterResetSource** is set to **Software**.
CounterRefresh	-	-	Update the counter.
CounterValue	0 - 32bit max	0	Display the count value.

CounterAndTimer Control Item	Setting Range	Default Value	Description
CounterStatus	-	0: CounterIdle	Display the counter status. 0: CounterIdle 2: CounterActive 4: CounterOverflow - Count value exceedded the maximum value.

EncoderControl

Configure the rotary encoder related settings.

> **Related Topic:** Connecting Rotary Encoders

Encoder Control Item	Setting Range	Default Value	Description
EncoderSourceA	-	0: Line5 Opt In1	Select where to input the signal from the rotary encoder. 0: Line5 Opt In1 1: Line4 TTL In1 2: Line10 TTL In2 3: Line13 TTL In3
EncoderSourceB	-	0: Line5 Opt In1	Select where to input the signal from the rotary encoder 0: Line5 Opt In1 1: Line4 TTL In1 2: Line10 TTL In2 3: Line13 TTL In3
EncoderDivider	1 ~ 32bit max	65536	Set the number of triggers to be generated during one pitch of the rotary encoder. The number of triggers is 65536 / (set value).
EncoderAveragingInterval	-	0: none	Perform the internal processing by averaging the time interval of the specified number of signals. 0: none 1: 2 pulses 2: 4 pulses 3: 8 pulses 4: 16 pulses 5: 32 pulses
EncoderFilter (cycle)	0 ~ 15	0	Apply a low-pass filter to prevent noise on the signal from the rotary encoder and stabilize the signal for the specified number of cycles. **Note:** 10ns/cycle
EncoderStrobe (ns)	1 ~ 256	1	Set the strobe length of the Trigger signal generated from the rotary encoder by the number of cycles.

Encoder Control Item	Setting Range	Default Value	Description
NonDecimationEncodeIntervalMax	-	0	Enables external setting of the upper limit of the internal frequency calculation result so that the period of the output frequency is no longer than the user-specified period. 0: none (no max) 1: 1 sec max 2: 2 sec max 3: 3 sec max 4: 4 sec max 5: 5 sec max 6: 6 sec max 7: 7 sec max 8: 8 sec max 9: 9 sec max 10: 10 sec max

UserSetControl

Configure user settings.

> **Related Topic:** Step 7: Save the Settings

User Set Control Item	Setting Range	Default Value	Description
UserSetSelector	-	0: Default	Select the user settings. 0: Default - Invalid when executing UserSetSave 1: User1 2: User2 3: User3
UserSetLoad	-	-	Read the user settings. When selecting **Default** for UserSetSelector, the factory settings are loaded.
UserSetSave	-	-	Save the current setting values as user settings. Invalid when UserSetSelector is set to Default.

TransportLayerControl

Display information on transport layer control for the RGB channels.

Transport Layer Control Item	Setting Range	Default Value	Description
DeviceTapGeometry	-	0: Geometry_1X	Set the transfer method (tap configuration) of images transferred from the camera at one time. 0: Geometry_1X (PixelFormat=RGB8) 1: JAICustom (PixelFormat=RGB10BasePacked / RGB12BasePacked:)
ClConfiguration	-	0:Base (fixed)	Set the Camera Link configuration.
CameraLinkClockFrequency	-	0: 85MHz	Set Camera Link clock frequency. 0: 85MHz 1: 65MHz 2: 42.5MH
CableEmphasis **Related Topic:** ③ Camera Link Cable	-	1: Medium	Set cableEmphasis. When set to Medium or Strong, you may be able to extend the camera link cable length. 0: Normal 1: Medium 2: Strong

PulseGenerator

Configure pulse generator settings.

Pulse Generator Item	Setting Range	Default Value	Description
ClockPreScaler	1 ~ 4096	1	Set the division value for the prescaler (12 bit) using PixelClock as the base clock.
PulseGeneratorClock (MHz)	-	100	Set the clock used for the pulse generator. This value is calculated using the ClockPreScaler value as a base. PulseGeneratorClock = 100 / ClockPreScaler
PulseGeneratorSelector	0:PulseGenerator0 1:PulseGenerator1 2:PulseGenerator2 3:PulseGenerator3	0:PulseGenerator0	Select the pulse generator.
PulseGeneratorLength	1 ~ 1048575	30000	Set the maximum count-up value as a clock count.
PulseGeneratorLengthMs (ms)	-	0.3	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. PulseGeneratorLengthMs = 1/PulseGeneratorClock * PulseGeneratorLength
PulseGeneratorFrequency (Hz)	-	3333.333333	Set the maximum count-up value as a frequency (Hz). This value is calculated using the PulseGeneratorLength value as a base. PulseGeneratorFrequency = 1sec / PulseGeneratorLengthMs
PulseGeneratorStartPoint	0 ~ 1048575	0	Set the start point of the High interval as a clock count. When the counter reaches this value, the output will be 1.
PulseGeneratorStartPointMs (ms)	-	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. PulseGeneratorStartPointMs = 1/PulseGeneratorClock * PulseGeneratorStartPoint
PulseGeneratorEndPoint	1 ~ 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.

Pulse Generator Item	Setting Range	Default Value	Description
PulseGeneratorEndPointMs (ms)	-	0.15	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. PulseGeneratorEndPoint = 1/PulseGeneratorClock * PulseGeneratorEndPoint
PulseGeneratorPulseWidth (ms)	-	0.15	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. PulseGeneratorPulseWidth = 1/PulseGeneratorClock * (PulseGeneratorEndPoint - PulseGeneratorStartPoint)
PulseGeneratorRepeat Count	0 ~ 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	0: Off 1: Level High 2: Level Low 4: Rising Edge 8: Falling Edge	0: Off	Set the clear signal condition for the count clear input of the pulse generator.
PulseGeneratorClear Source	-	0: Low	Select the count clear input signal source. 0: Low 1: High 7: ExposureActive 9: LVAL 10-13: PulseGenerator0-3 14-17: UserOutput0-3 20: Line4: TTL In1 21: Line5: Opt In1 23: Line7 - CC1 24: Line10: TTL In2 26: NAND0 Out 27: NAND1 Out 28: Line13: TTL In3 29: EncoderTriger 30: EncoderDirection 31: SWIRExposureActive 32: SWIRLVAL **Note:** (※)Disabled if the PulseGenerator is selected in PUlseGeneratorSelector.
PulseGeneratorClearInverter	0:False 1:True	0:False	Controls if the pulse generator clear signal is inverted. False means "Active High" and True for "Active Low".
PulseGeneratorClear SyncMode	0:Async Mode 1:Sync Mode	0:Async Mode	Select the sync mode for the count clear input signal.

ShadingControl

Configure shading correction settings for the RGB channels.

> **Related Topic:** Shading Correction

Shading Control Item	Setting Range	Default Value	Description
ShadingCorrectionMode	-	0: Flat Shading	Select the shading correction method. 0: Flat Shading 1: Color Shading
ShadingMode	0: Off 1: User1 2: User2 3: User3	0: Off	Set the area to which to save shading correction data. When this is set to Off, PerformShadingCalibration will not be executed.
PerformShadingCalibration	-	-	Execute shading correction. **Note:** This function cannot be executed while TestPattern (ImageFormatControl) is being output. A Condition Error is also displayed when a timeout occurs if the correction cannot be completed.
ShadingDetectResult	0: Condition Error 1: Too Dark 2: Too Bright 3: Correction Limit 4: Complete	0: Condition Error	Display the shading correction results.
ShadingDataSelector	0: Green 1: Red 2: Blue	0: Green	Read the shading correction data, and set the target sensor for modification.
ShadingDataIndex	1 ~ 1024	1	Set the number of shading correction index tables.
ShadingData	0 ~ 0x7FFF	0x4000	Display or set the shading correction data. **Note:** 0x4000= x1
ShadingDataUpdate	-	-	Make shading data reflect on video.
ShadingDataSave	-	-	Save data to be stored in Flash in the area specified by ShadingCorrectionMode.

CorrectionControl

Configure settings related to the correction function for nonuniformity in black levels and gain between pixels (RGB channels -PRNU/DSNU).

Correction Control Item	Setting Range	Default Value	Description
PixelBlackCorrectionMode **Related Topic:** DSNU Correction (Pixel Black Correct)	0: Off 1: Default 2: User1 3: User2 4: User3	1: Default	(DSNU) Select the user area to which to save the black level correction value. **Note:** Default stores correction data with factory settings.
PerformPixelBlackCalibration	-	-	(DSNU) Generate black level correction data automatically from the captured image. **Caution:** When **PixelBlackCorrectionMode** is set to **Off** or **Default** and a test pattern is being output instead of an image, this command cannot be executed.
PixelBlackDetectResult	-	5: Idle	(DSNU) Display the results of PerformPixelGainBlackCalibration execution. 1: Succeeded 2: Image too bright 3: Image too dark 4: Timeout error 5: Idle
PixelGainCorrectionMode **Related Topic:** PRNU Correction (Pixel Gain Correct)	0: Off 1: Default 2: User1 3: User2 4: User3	1: Default	(PRNU) Select the user area to which to save the gain correction value. **Note:** Default stores correction data with factory settings.
PerformPixelGainCalibration	-	-	(PRNU) Generate gain correction data automatically from the captured image. **Caution:** When **PixelGainCorrectionMode** is set to **Off** or **Default** and a test pattern is being output instead of an image, this command cannot be executed.
PixelGainDetectResult	-	5: Idle	(PRNU) Display the results of PerformPixelGainCalibration execution. 1: Succeeded 2: Image too bright 3: Image too dark 4: Timeout error 5: Idle

Correction Control Item	Setting Range	Default Value	Description
ChromaticAberration CorrectionMode **Related Topic:** Chromatic Aberration Correction	0: Off 1:Lens1 2:Lens2 3:Lens3	0: Off	Correct the color aberration that occurs at the left and right edges due to lens characteristics.
ChromaticAberration CorrectionSelector	0: R Channel 1: B Channel	0	Specify the channel for which to perform ChromaticAberration CorrectionLens1, 2, 3.
ChromaticAberrationCorrectionLens1 (pixel)	-4.0 ~ 4.0	0.0	Set the amount of correction for ChromaticAberrationCorrectionLens1. Step: 0.1
ChromaticAberrationCorrectionLens2 (pixel)	-4.0 ~ 4.0	0.0	Set the amount of correction for ChromaticAberrationCorrectionLens2. Step: 0.1
ChromaticAberrationCorrectionLens3 (pixel)	-4.0 ~ 4.0	0.0	Set the amount of correction for ChromaticAberrationCorrectionLens3. Step: 0.1
FIRFilterSelector **Related Topic:** Noise Reduction Filter Functions	0:Red 1:Green 2:Blue	0:Red	Select the target to apply FIR Filter from Red, Green, Blue.
FIRFilterMode	0: Off 1: On	0: Off	Enable / Disable FIR Filter.
FIRFilterLeftRatio	-2 ~ 2	0	Set the coefficient of the left pixel when FIR Filter is applied.
FIRFilterCenterRatio	-2 ~ 2	1	Set the coefficient of the center pixel when FIR Filter is applied.
FIRFilterRightRatio	-2 ~ 2	0	Set the coefficient of the right pixel when FIR Filter is applied.
MEDIANFilterSelector	0:Red 1:Green 2:Blue	0:Red	Select the target to apply MEDIAN Filter from Red, Green, Blue.
MEDIANFilterMode	0: Off 1: On	0: Off	Enable / Disable MEDIAN Filter.
NoiseReduction	0: Off 1:Level1 2:Level2 3:Level3	0: Off	Set the noise reduction intensity in 4 levels. Level1 = weak, Level4 = strong.

SWIRImageFormatControl

Configure image format settings for the SWIR channel.

SWIR Image Format Control Item	Setting Range	Default Value	Description
SWIRWidth	-	1024 (fixed)	Display the image width.
SWIRPixelFormat **Related Topic:** Camera Output Formats	0: Mono8 1: Mono10 2: Mono12	0: Mono8	Set the pixel format.
SWIRTestPattern **Related Topic:** Test Pattern Function	0: Off 1: GreyHorizontalRamp 2: GreyScale2 3:White	0: Off	Select the test image.

SWIRAcquisitionControl

Configure image capture settings for the SWIR channel.

SWIR Acquisition Item	Setting Range	Default Value	Description
SWIRTriggerMode **Related Topic:** Trigger Control	0:Off 1:On	0:Off	Enable/disable the Trigger mode.
SWIRTriggerSource	-	0: Low	Select the trigger signal source. 0: Low 1: High 10-13: PulseGenerator0-3 14-17: UserOutput0-3 20: Line4 TTL In1 21: Line5 Opt In1 23: Line7 CC1 24: Line10 TTL In2 26: NAND0 Out 27: NAND1 Out 28: Line13 TTL In3 29: EncoderTrigger
SWIRTriggerActivation	0:Rising Edge 1:Falling Edge	1:Falling Edge	Select the polarity of the trigger signal (i.e., location of signal at which trigger is applied).

SWIR Acquisition Item	Setting Range	Default Value	Description
SWIRAcquisitionLineRate (Hz) **Related Topic:** Variable Line Rate	500.012 ~ 39215	39215	Specify the line rate (Hz).
SWIRExposureMode **Related Topic:** Exposure Mode	0: Off 1: Timed	1: Timed	Select the exposure mode.
SWIRExposureTime (us) **Related Topic:** Electronic Shutter	20.4 ~ 1994.85	20.4	Specify the exposure time. (unit: us). Step: 0.1499 **Note:** No exposure offset duration for the SWIR channel.
SWIRFreeRunSyncMode	0: Off (Asynch) 1: Timed (Synch)	0: Off (Asynch)	Synchronizes the operation of the RGB channels and the SWIR channel when the trigger mode is off. **Off**: Use the SWIR channel's free running operation. **On**: Use the RGB channels' free funning operation; the line rate will no longer be 149.9ns step (= SWIR channel's normal operation cycle).

SWIRAnalogControl

Configure the analog control settings for the SWIR channel.

SWIR Analog Control Item	Setting Range	Default Value	Description
SWIRSensOutCfa **Related Topic:** Gain Control (SWIR Channel)	0: Zero 1: One	1: One	Set the sensor's internal conversion gain.
SWIRSensOutCfb	0: Zero 1: One	1: One	Set the sensor's internal conversion gain.
SWIRSensOutCfc	0: Zero 1: One	0: Zero	Set the sensor's internal conversion gain.
SWIRAnalogBaseGain	0: -6dB 1: -3dB 2: 0dB 3: +3dB	2: 0dB	Set the analog base gain value.
SWIRGainSelector	-	0:Analog All (fixed)	Display the Gain value to configure.
SWIRGain	1 ~ 3.572	1	Set the Gain value.
SWIRBlackLevelSelector **Related Topic:** Adjust the Black Level	-	0:Alll (fixed)	Select the black level to configure.
SWIRBlackLevel	-256 ~ 255	0	Set the black level value.
SWIRGamma **Related Topic:** Gamma Function	-	0.45	Set the Gamma value. Setting Range: 0.45, 0.50, 0.55, 0.60, 0.65, 0.75, 0.80, 0.90, 1.00
SWIRLUTMode	0: Off 1: Gamma 2: LUT	0:Off	Select the LUT mode.

SWIRLUTControl

Configure LUT settings for the SWIR channel.

> **Related Topic:** LUT (Lookup Table)

SWIR Lut Control Item	Setting Range	Default Value	Description
SWIRLUTSelector	-	0: Luminance (fixed)	Display the LUT channel to control.
SWIRLUTIndex	0 ~ 255	0	Set the LUT index table number.
SWIRLUTValue	0 ~ 4095	Gamma=1.0	Set the LUT value.

SWIRTransportLayerControl

Display information on transport layer control for the SWIR channel.

SWIR Transport Layer Control Item	Setting Range	Default Value	Description
DeviceTapGeometry	-	0: Geometry_1X (fixed)	Display the transfer method (tap configuration) of images transferred from the camera at one time.

SWIRShadingControl

Configure shading correction settings for the SWIR channel.

> **Related Topic:** Shading Correction

SWIR Shading Control Item	Setting Range	Default Value	Description
SWIRShadingCorrect	0: Off 1: Factory 2: User	0: Off	Set the area to which to save shading correction data. When this is set to Off, SWIRShadingCalibration will not be executed. **Note:** Factory stores correction data with factory settings.
SWIRShadingCalibration	-	-	Execute shading calibration.
SWIRShadingCalibrationResult	-	0: Shading correction has not been finished yet.	Display the shading correction results. 0: Shading correction has not been finished yet. 1: Succeeded. 2: Error1 –Image was too bright. 3: Error2 –Image was too dark. 4: Error3 –Timeout occurred.
SWIRShadingDataIndex	1 ~ 1024	1	Set the number of shading correction index tables.
SWIRShadingData	0 ~ 65535	0	Set the shading correction data.
SWIRShadingDataUpdate	-	-	Make shading data reflect on video.
SWIRShadingDataSave	-	-	Save data to be stored in Flash in the area specified by SWIRShadingCorrect.

SWIRCorrectionControl

Configure settings related to the correction function for nonuniformity in black levels and gain between pixels for the SWIR channel.

SWIR Correction Control Item	Setting Range	Default Value	Description
SWIRPixelBlackCorrect **Related Topic:** DSNU Correction (Pixel Black Correct)	0: Off 1: Factory 2: User	0: Off	(DSNU) Select the area to which to save the pixel black correction value. **Note:** Factory stores correction data with factory settings.
SWIRPixelBlackCalibration	-	-	(DSNU) Generate black level correction data automatically from the captured image.
SWIRPixelBlackCalibrationResult	-	0: Pixel black correction has not been finished yet.	(DSNU) Display the results of SWIRPixelBlackCalibration execution. 0: Pixel black correction has not been finished yet. 1: Succeeded. 2: Error1 –Image was too bright. 3: Error2 –Image was too dark. 4: Error3 –Timeout occurred.
SWIRPixelGainCorrect **Related Topic:** PRNU Correction (Pixel Gain Correct)	0: Off 1: Factory 2: User	0: Off	(PRNU) Select the area to which to save the pixel gain correction value. **Note:** Factory stores correction data with factory settings.
SWIRPixelGainCalibration	-	-	(PRNU) Generate gain correction data automatically from the captured image.
SWIRPixelGainCalibrationResult	-	0:Pixel gain correction has not been finished yet.	(PRNU) Display the results of SWIRPixelGinCalibration execution. 0: Pixel gain correction has not been finished yet. 1: Succeeded. 2: Error1 –Image was too bright. 3: Error2 –Image was too dark. 4: Error3 –Timeout occurred.
SWIRNoiseReduction **Related Topic:** Noise Reduction Filter Functions	0: Off 1: On	0: Off	Enable / Disable SWIRNoiseReduction.

SWIRBlemishControl

Configure settings for JAI white blemish correction for the SWIR channel.

> **Related Topic:** Defective Pixel Correction

SWIR Blemish Control Item	Setting Range	Default Value	Description
SWIRBlemishCorrect	0: Off 1: On	0: Off	Enable/disable blemish correction.
SWIRBlemishThreshold	1 ~ 100	1	Set the blemish correction threshold.
SWIRBlemishDetect	-	-	Execute blemish detection.
SWIRBlemishDetectResult	-	5: Idle	Display the blemish correction results. 1: Succeeded. 2: Error1 –Image was too bright. 3: Error2 –Image was too dark. 4: Error3 –Timeout occurred. 5: Idle
SWIRBlemishIndex	1 ~ 8	-	Select the index for the target blemish position.
SWIRBlemishPosition	0 ~ 1024	1	Display the position of the target blemish selected in SWIRBlemishIndex. You can also manually enter the position of the blemish you want to correct.

Miscellaneous

Troubleshooting

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

Power Supply and Connections

Issue: The POWER/TRIG LED remains lit amber and does not turn green, even after power is supplied to the camera.

Cause and Solution: Camera initialization may not be complete due to lack of power. Check the Camera Link cable or 6-pin power cable connection.

Image Display

Issue: Gradation in dark areas is not noticeable.

Cause and Solution: 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

Issue: Settings cannot be saved to user memory.

Cause and Solution: You cannot save to user memory while images are being acquired by the camera. Stop image acquisition before performing the save operation.

Issue: I want to restore the factory default settings.

Cause and Solution: Load Default under User Set Selector in the Feature Properties tab to restore the factory default settings.

Specifications

Item	RGB	SWIR
Image Sensor	4K line scan CMOS image sensor × 3 Effective Pixels: 4096 pixels × 3 (R, G, B) Pixel Size:7.5 µm x 7.5 µm	1K line scan InGaAs linear image sensor x 1 Effective Pixels: 1024 pixels Pixel Size:25.0 µm x 25.0 µm
Camera Link Clock	42.5 / 65 / 85 MHz	
Line Rate	4K: 500 ~ 20.5kHz 2K: 500 ~ 40.8kHz	500 ~ 39.2kHz
Conversion Efficiency		280nV/e
Video S/N ratio	>55 dB (Gain = 0dB) @10bit	>50 dB (Gain = 0dB) @10bit
PRNU	Post-correction: within ±1% (during 100% output)	Post-correction: within ± 5% (during 100% output)
DSNU	Post-correction: within ±5% (during 0% output)	Post-correction: within ± 5% (during 0% output)
Gain	**Analog** AnalogBaseGain: 0dB, 6dB, 12dB **Digital** IndividualGainMode = Off - Digital All: x1.0 ~ x32.0 - DigitalRed/DigitalBlue:x0.4 ~ x4 IndividualGainMode = ON - DigitalGreen/DigitalRed/DigitalBlue: x1.0 ~ x64.0	**Analog** AnalogBaseGain: -6dB, -3db, 0dB, +3dB AnalogAll: x1 ~ x3.572
Black Level (User Settings)	**Manual** All: -133 ~ +255 (LSB@12bit) Red: -64 ~ +64 Blue: -64 ~ +64 Default Setting: Output black level at 0 (33LSB during 10-bit)	**Manual** All: -256 ~ +255 (LSB@12bit) Default Setting: Output black level at 0
Image Output	Digital Video Output (Camera Link Connector 1): RGB8 (Default), RGB10BasePacked*, RGB12BasePacked* **Note:** *Customized pixel format. To view image output in this format, a viewer that supports these formats is required.	Digital Video Output (Camera Link Connector 2): Mono8 (Default), Mono10, Mono12

Item	RGB	SWIR
Variable Line Rate	**Variable Range: Width = 4096** RGB8: 500 ~ 20.5kHz RGB10/12: 500 ~ 13.7kHz **Variable Range: Width = 4096** RGB8: 500 ~ 40.8kHz RGB10/12: 500 ~ 27.3kHz **Variable Unit**: 0.1Hz **Supported Mode**: Exposure Mode = OFF / TriggerMode = Off ExposureMode = Timed / TriggerMode = Off	**Variable Range:** 500 Hz ~ 39.2kHz **Variable Unit**: 149.9 ns **Supported Mode**: Exposure Mode = OFF / TriggerMode = Off ExposureMode = Timed / TriggerMode = Off
Electronic shutter	Supported (Exposure Mode: Timed) Variable Range: 3 ~ 15149.07 us Variable Unit: 0.01 us **Note:** Exposure Offset Duration: -0.85 µs	Supported Variable Range: 20.38us (1L) ~ 1994.85 us Variable Unit: 149.9 ns **Note:** No exposure offset duration.
Test Pattern	White, GreyPattern1(Ramp), GreyPattern2 (Stripe), ColorBar	GreyHorizontalRamp, GreyScale2, White
Synchronization	Internal	
Image Processing	1. Pixel sensitivity correction: Pixel correction (DSNU, PRNU) 2.Shading correction: ColorShading, FlatShading 3. LUT: OFF: γ = 1.0, ON: 257 points can be set 4. Gamma: 0.45, 0.5, 0.55, 0.6, 0.65, 0.75, 0.8, 0.9, 1.0 (9 steps available) 5. Noise reduction: MEDIAN, FLIR, NoiseReduction	1. Pixel sensitivity correction: Pixel correction (DSNU, PRNU) 2. Defective pixel correction: Up to 16 pix 3. Shading correction: FlatShading 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
Operation Mode	Exposure Mode : Off (Internal/External trigger) Exposure Mode : Timed (Internal/External trigger)	Exposure Mode : Off (Internal/External trigger) Exposure Mode : Timed (Internal/External trigger) PWC (External trigger)
Trigger Inputs	TTL Input (12-pin and 10-pin) Camera Link: LVDS (CC1) Positive / negative logic switchable. Minimum trigger width: CameraLink 3µs / TTL In 50ns	
Synchronous output (when the terminal is open)	Camera Link: LVAL (Camera Link Tx24, DVAL (Camera LinkTx25), ExposureActive (Camera Link Tx26) 12-pin: Exposure Active or LVAL 10-pin: Exposure Activeor LVAL	
Communication interface	EIA-644: Camera Link (SerTFG, SerTC) Communication Rate: 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps, 921600 bps	
Field Update	Supported	

<table>
<tr><th>Item</th><th colspan="2">RGB</th><th>SWIR</th></tr>
<tr><td>Power Supply Voltage (12-pin)</td><td colspan="3">Input Range: DC +12 ~ +24V ± 10%
Power Consumption:9.3W (typ) W typical @ +12 V, 500mA/4.8W;TBD W (Max) (Default setting/25°C Environment / DC12 Vinput)</td></tr>
<tr><td>Lens mount</td><td colspan="3">M52 Mount, Custom lens JMO-M5231-2828-C4 available (Sold Separately)</td></tr>
<tr><td>Flange back</td><td colspan="3">46.5 mm (in air), Tolerance 0 mm ~ - 0.05 mm</td></tr>
<tr><td>Verified Performance Temperature/Humidity</td><td colspan="3">-5°C ~ +45°C (20 to 80%, non-condensing)
Note: It may change depending on the installation environment. Please refer to the Cautions in this chapter.</td></tr>
<tr><td>Storage Temperature/Humidity</td><td colspan="3">-25°C ~ +60°C (20 to 80%, non-condensing)</td></tr>
<tr><td>Vibration Resistance</td><td colspan="3">10G (20 Hz ~ 200 Hz X-Y-Z direction)</td></tr>
<tr><td>Impact Resistance</td><td colspan="3">50GTBD</td></tr>
<tr><td>Regulations</td><td colspan="3">CE (EN61000-6-2, EN61000-6-3), RoHS/WEEE, FCC Part15 Class B</td></tr>
<tr><td>Housing</td><td colspan="3">90mm x 90mm x 120mm (WHD, excluding connectors)</td></tr>
<tr><td>Weight</td><td colspan="3">900g (TBD)</td></tr>
<tr><td>Connectors / LEDs</td><td>Mini Camera Link</td><td>Model: HDR-EC26FYTG2-SLt × 2
Function: video output / communication / external trigger / ExposureActive
*Positive polarity for ExposureActive (polarity switching not possible)</td><td></td></tr>
<tr><td></td><td>12-pin</td><td>Model: HR10A-10R-12PB(71) (or equivalent)
Function: power supply input / communication / external trigger / ExposureActive
*Negative polarity for ExposureActive (polarity switching not possible)</td><td></td></tr>
<tr><td></td><td>10-pin</td><td>Model: Camera side: 3260-10S3 (55) (Equivalent to Hirose Electronic), Cable side:3240-10P-C(50) (Equivalent to Hirose Electronic)
Function: communication</td><td></td></tr>
<tr><td></td><td>LED</td><td>Function: Power on, trigger input indicator</td><td></td></tr>
</table>

Notes:

- Design and specifications are subject to change without notice.
- Approximately 30 minutes of warm-up are required to achieve these specifications.

Cautions:

About the verified performance temperature

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

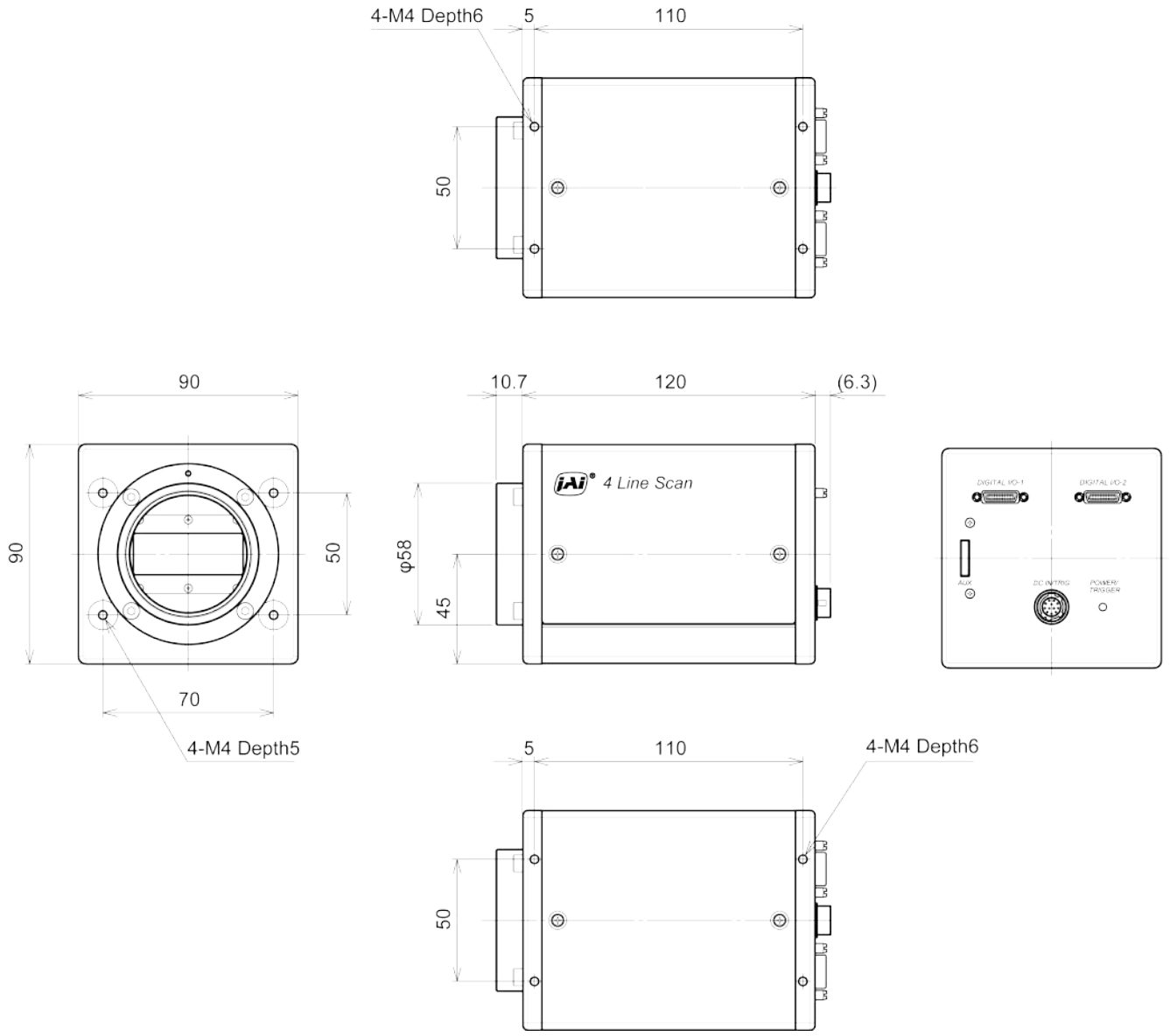
1) The camera's internal temperature sensor detects temperatures of 67 °C or less during operation.

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.

Spectral Response

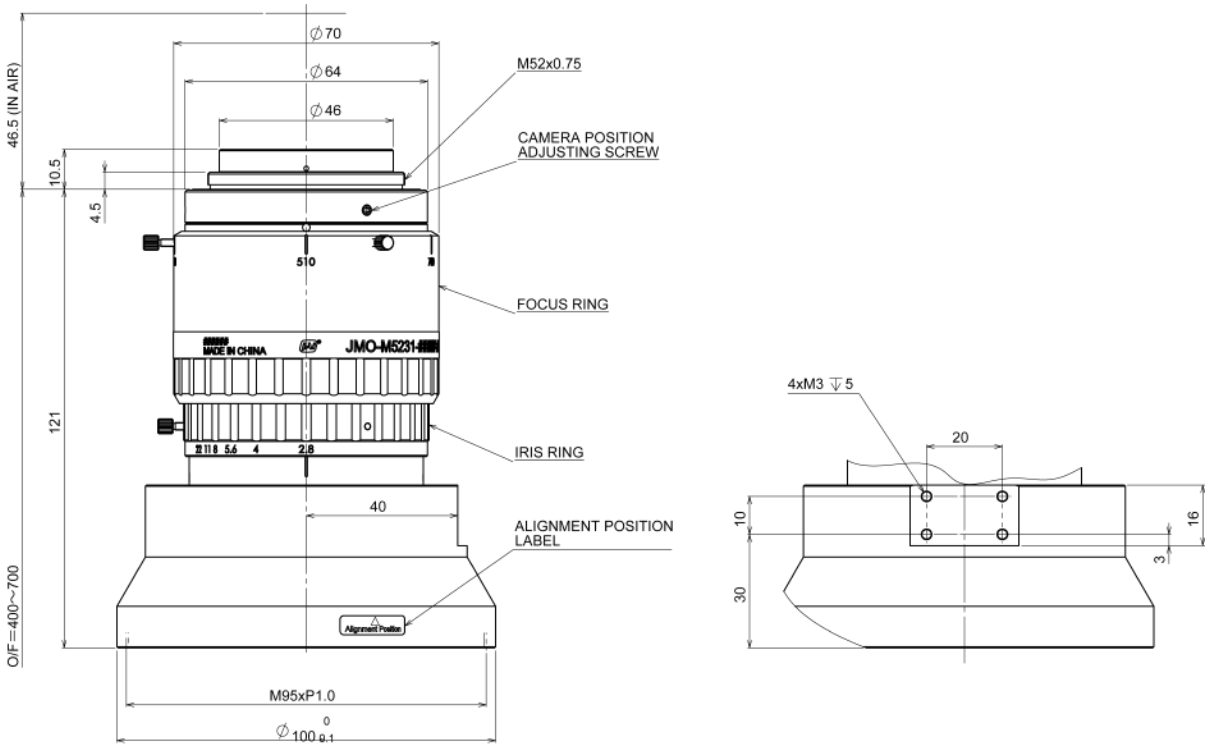
Dimensions (SW-4010Q-MCL-M52)



Notes:

- Dimensional Tolerance: ± 0.3mm
- Unit: mm

Lens Dimensions (JMO-M5231-2828-C4)



Notes:

- Unit: mm

Comparison of the Decibel Display and Multiplier Display

Decibels [dB]	Multipliers [X]	Remarks
-6	0.501	
-5	0.562	
-4	0.631	
-3	0.708	
-2	0.794	
-1	0.891	
0	1	
1	1.122	
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	
13	4.467	
14	5.012	
15	5.623	
16	6.31	
17	7.079	
18	7.943	
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	

Decibels [dB]	Multipliers [X]	Remarks
34	50.119	
35	56.234	
36	63.096	

User's Record

Model name: SW-4010Q-MCL-M52

Revision: ……

Serial No: ……

Firmware version: ……

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

Revision History

Revision	Date	Changes
Tentative	2022/11/25	Tentative Version.

Trademarks

Systems and product names described in this document are trademarks or registered trademarks of their respective owners. The ™ and ® symbols are not used in this document.

Europe, Middle East & Africa
Phone +45 4457 8888
Fax +45 4491 8880

Asia Pacific
Phone +81 45 440 0154
Fax +81 45 440 0166

Americas
Phone (Toll-Free) 1 800 445 5444
Phone +1 408 383 0300

Visit our website on www.jai.com