



GigE Line Scan Industrial Cameras

User Manual



CIC-L041-CG-42-5G

CIC-L041-MG-84-5G

V1.0.1

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1. Safety Instructions

Read the information in this topic carefully before installing and using a Cognex camera.

Cognex can't be held responsible for any damage or injury due to incorrect handling of the product and ignoring the safety instructions.

1.1 General Safety Notices



WARNING – Electric Shock and Fire Hazard / Risque de choc électrique et d'incendie

Unapproved power supplies may cause electric shock or fire or both. Serious injury or death may occur.

- You must use power supplies that meet the Safety Extra Low Voltage (SELV) and Limited Power Source (LPS) or the Electrical Source 1 (ES1) and Power Source 2 (PS2) requirements.
- If you use a powered hub or powered switch, they must meet the above requirements.

Les blocs d'alimentation non approuvés peuvent causer des décharges électriques ou des départs de feu, ou les deux. Celles-ci représentent un risque de mort ou de blessure grave.

- Vous devez utiliser un bloc d'alimentation conforme aux exigences Safety Extra Low Voltage (SELV) et Limited Power Source (LPS) ou Electrical Source 1 (ES1) et Power Source 2 (PS2).
- Si vous utilisez un hub alimenté ou un switch alimenté, ils doivent être conformes aux exigences ci-dessus.



CAUTION – Temperatures outside of the specified range may cause burns or damage the camera.

Operating the camera at temperatures outside of the range given in the camera specification causes the following problems:

- The camera housing gets hot and may cause burns when touching it.
- The camera itself may get damaged.
- The camera's lifetime decreases.
- Image quality may degrade.

You must provide sufficient heat dissipation. For more information, see [Providing Heat Dissipation](#).



NOTICE – Voltages outside of the specified range may damage the camera.

- You must supply camera and I/O power within the safe operating voltage ranges given in the camera specification.



NOTICE – Using unsuitable lenses may damage camera components or the lens itself.

Make sure that your lens is compatible with the lens mount dimensions given in the [Maximum Allowed Lens Intrusion](#) topic. If you try to mount a lens with an overall lens intrusion that is larger than specified, you may damage the lens or the filter holder and the camera may not work properly anymore.



NOTICE – Dust on the sensor may impair the camera's performance.

- Always put the plastic cap in place when there is no lens mounted on the camera.
- Make sure that the camera is pointing down whenever you remove or replace the plastic cap, a lens, or a lens adapter.
- Never apply compressed air to the camera.

 NOTICE – Using incorrect plugs may damage the I/O connector.

The plug on the cable that you attach to the camera's 6-pin I/O connector must have 6 female pins. Using a plug designed for a smaller or a larger number of pins may damage the connector.

 Info

Cognex may use Loctite as an additive in the production process of Cognex cameras.

Observe the following:

- Don't open the camera housing. Touching internal components may damage them.
- Prevent ingress or insertion of any foreign substances into the camera housing. If operated with any foreign substances inside, the camera may fail or cause a fire.
- Don't remove the camera's serial number label.
- Don't operate the camera in the vicinity of strong electromagnetic fields. Avoid electrostatic charging. For more information, see [Avoiding EMI and ESD Problems](#).
- Transport and store the camera in its original packaging only. Don't discard the packaging.
- Avoid cleaning the sensor. If you must clean it, follow the [cleaning instructions](#), which will also tell you about cleaning the camera housing.
- Read the camera documentation carefully before using the camera.

1.2 Conformity, Intended Use, and Authorized Users

1.2.1 General Information

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Cognex customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Cognex for any damages resulting from such improper use or sale.

FCC Compliance

FOR CUSTOMERS IN THE USA

See the FCC Supplier's Declaration of Conformity to check whether your camera is a Class A or a Class B digital device.

Class A device: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Class B device: 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.

You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment.

The shielded cables recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart B of Part 15 of FCC Rules.

FOR CUSTOMERS IN CANADA

This apparatus complies with the Class A or Class B limits for radio noise emissions set out in Radio Interference Regulations. See the [FCC Supplier's Declaration of Conformity](#) on the Cognex website.

POUR UTILISATEURS AU CANADA

Cet appareil est conforme aux normes Classe A ou Classe B pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique. Consultez la [déclaration de conformité du fournisseur FCC](#) sur le site web de Cognex.

1.2.2 Intended Use of Cognex Cameras for Machine Vision

Cognex digital cameras for machine vision are designed exclusively for indoor professional image capture. Temperature and humidity requirements apply as detailed in the camera's "Environmental Requirements" section of the Cognex Product Documentation. All relevant product documentation must be observed, including directions for correct camera use.

The cameras must not be used for the following:

- Purposes and installations requiring special camera certification other than mentioned in the Cognex Product Documentation.
- Purposes and installations requiring specific design and precautions for use under harsh conditions.

If in doubt whether a specific camera is compatible with certain operating conditions and uses, contact your [Cognex Product Support](#).

1.2.3 Authorized Users for Cognex Cameras for Machine Vision

Cognex digital cameras for machine vision are designed for use by professionals only, concerned with the following tasks:

- Selection of cameras for use
- Camera integration and setup
- Everyday camera use

The Cognex Product Documentation assumes the skills of electrical engineers, systems engineers, mechatronics engineers, technicians, and information technology engineers.

Camera use is not allowed for persons with insufficient skills or with impairments that prevent them from doing the following tasks:

- Using cameras correctly
- Adhering to the safety instructions
- Fully understanding all relevant camera documentation

2. Camera Specifications

2.1 CIC-L041-CG-42-5G

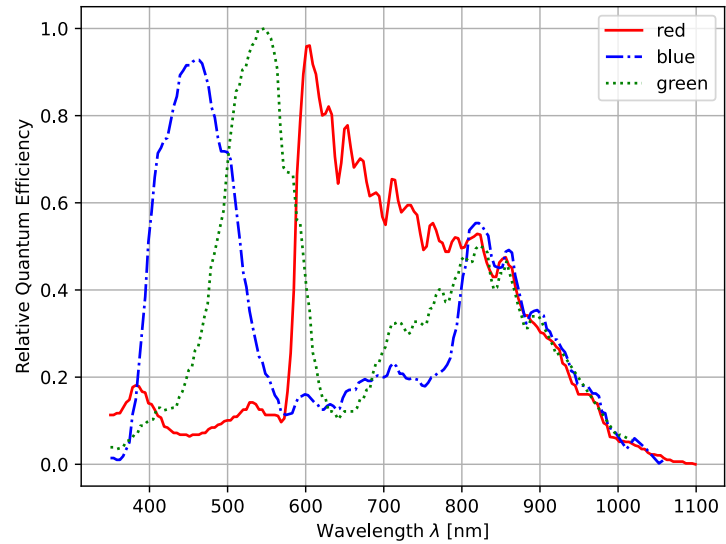
CIC-L041-CG-42-5G	
Resolution	4096 x 1 pixels
Sensor Type	Gpixel GL3504, Color Linear CMOS, 2 lines Global shutter Camera will output the color channels as follows: G in one line, R and B alternating in the other line.
Sensor Format	14.34 mm
Pixel Size (H x V)	3.5 x 3.5 μm
Max. Line Rate	42 kHz See also note on Line Rates
Mono / Color	Color (delivered without IR cut filter)
Image Data Interface	Fast Ethernet (100 Mbit/s) Gigabit Ethernet (1000 Mbit/s) 2.5 Gigabit Ethernet (2500 Mbit/s) 5 Gigabit Ethernet (5000 Mbit/s)
Pixel Formats	See Pixel Format .
Sensor Bit Depth	12 bit
Synchronization	Via hardware trigger Via software trigger Via free run
Exposure Time Control	Via hardware trigger Programmable via the camera API
Camera Power Requirements	$\approx 6.5\text{ W}$ (typical) @ 12–24 VDC (supplied only via I/O connector)
I/O Lines	1 opto-coupled input line 2 general purpose I/O (GPIO) lines
Lens Mount	C-mount
Size (L x W x H)	48.9 mm x 29 mm x 29 mm (without lens mount or connectors) 62.2 mm x 29 mm x 29 mm (with lens mount and connectors)
Weight	<105 g
Conformity	CE (includes RoHS), UKCA, EAC, UL Listed, FCC, KC, GenICam, GigE Vision, IP30 Certificates for your camera model

2.1.1 Line Rates

Camera Settings	Line Rate [kHz] with Sensor Bit Depth set to Bpp12
Image acquisition: Via free run	42.6
Image acquisition: Via hardware triggering Exposure mode: Timed	42.6
Image acquisition: Via hardware triggering Exposure mode: Trigger Width Line Start trigger: Via a GPIO line	42.6
Image acquisition: Via hardware triggering Exposure mode: Trigger Controlled Exposure Start trigger/Exposure End trigger: Via GPIO lines	42.6

Line rates measured with exposure time set to minimum and the ROI set to a size so that the speed of the camera wasn't reduced.
Trigger Width and Trigger Controlled exposure modes made with GPIO Line 2 and/or Line 3.

2.1.2 Relative Quantum Efficiency



The quantum efficiency curve excludes lens characteristics and light source characteristics.

2.2 CIC-L041-MG-84-5G

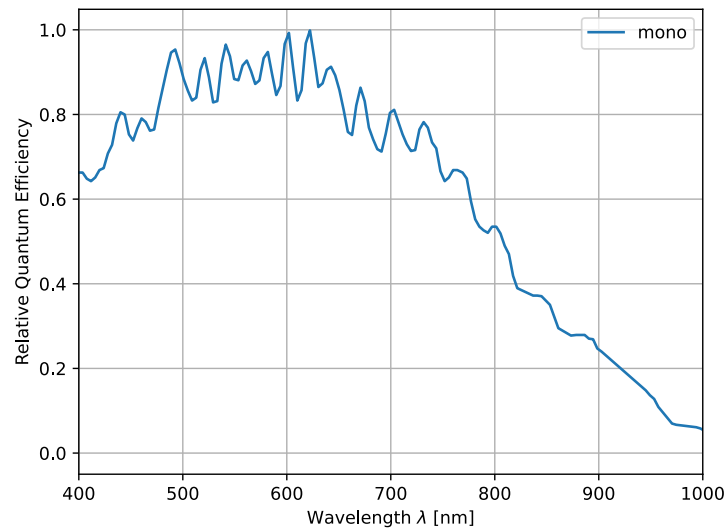
CIC-L041-CG-42-5G	
Resolution	4096 x 1 pixels
Sensor Type	Gpixel GL3504, Color Linear CMOS, 2 lines Global shutter Camera will output the color channels as follows: G in one line, R and B alternating in the other line.
Sensor Format	14.34 mm
Pixel Size (H x V)	3.5 x 3.5 μ m
Max. Line Rate	42 kHz See also note on Line Rates
Mono / Color	Color (delivered without IR cut filter)
Image Data Interface	Fast Ethernet (100 Mbit/s) Gigabit Ethernet (1000 Mbit/s) 2.5 Gigabit Ethernet (2500 Mbit/s) 5 Gigabit Ethernet (5000 Mbit/s)
Pixel Formats	See Pixel Format .
Sensor Bit Depth	12 bit
Synchronization	Via hardware trigger Via software trigger Via free run
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Camera Power Requirements	$\approx$ 6.5 W (typical) @ 12–24 VDC (supplied only via I/O connector)
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Lens Mount	C-mount
Size (L x W x H)	48.9 mm x 29 mm x 29 mm (without lens mount or connectors) 62.2 mm x 29 mm x 29 mm (with lens mount and connectors)
Weight	<105 g
Conformity	CE (includes RoHS), UKCA, EAC, UL Listed, FCC, KC, GenICam, GigE Vision, IP30 Certificates for your camera model

2.2.1 Line Rates

Camera Settings	Line Rate [kHz] with Sensor Bit Depth set to Bpp12
Image acquisition: Via free run	84.3
Image acquisition: Via hardware triggering Exposure mode: Timed	84.1
Image acquisition: Via hardware triggering Exposure mode: Trigger Width Line Start trigger: Via a GPIO line	84.1
Image acquisition: Via hardware triggering Exposure mode: Trigger Controlled Exposure Start trigger/Exposure End trigger: Via GPIO lines	84.1

Line rates measured with [exposure time](#) set to minimum and the [ROI](#) set to a size so that the speed of the camera wasn't reduced.
Trigger Width and Trigger Controlled exposure modes made with GPIO Line 2 and/or Line 3.

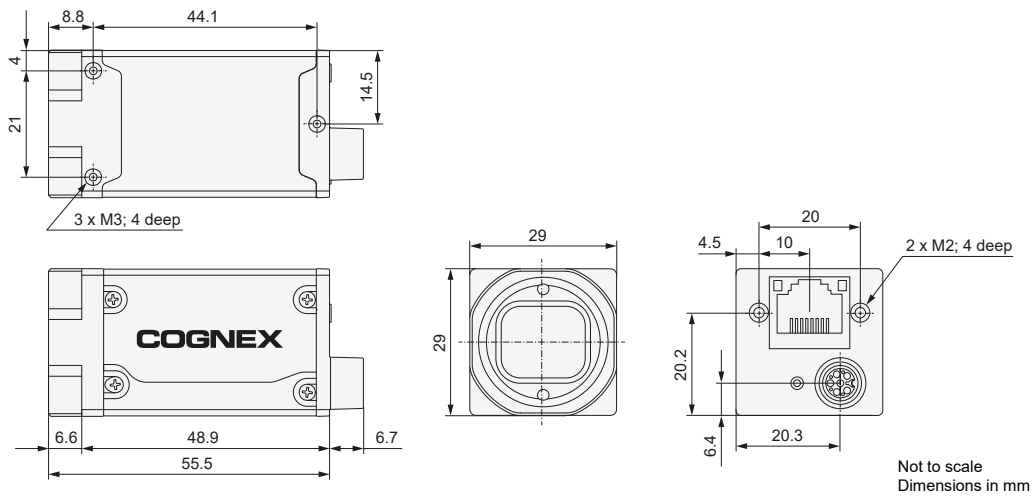
2.2.2 Relative Quantum Efficiency



The quantum efficiency curve excludes lens characteristics and light source characteristics.

2.3 Mechanical Specifications

2.3.1 Camera Dimensions and Mounting Points



2.3.2 Maximum Allowed Lens Intrusion

→ See [Maximum Allowed Lens Intrusion](#).

2.3.3 Mounting Instructions

→ See [Mounting Instructions](#).

2.3.4 Stress Test Results

→ See [Stress Test Results](#).

2.4 Requirements

2.4.1 Environmental Requirements

Temperature and Humidity

Housing temperature during operation	-10–50 °C (14–122 °F)
Humidity during operation	20–80 %, relative, non-condensing
Storage temperature	-20–80 °C (-4–176 °F)
Storage humidity	20–80 %, relative, non-condensing
Housing temperature according to UL 62368-1	max. 70 °C (158 °F)
Ambient temperature according to UL 62368-1	max. 30 °C (86 °F)

Heat Dissipation

→ See [Providing Heat Dissipation](#).

2.4.2 Electrical Requirements

WARNING – Electric Shock and Fire Hazard / Risque de choc électrique et d'incendie

Unapproved power supplies may cause electric shock or fire or both. Serious injury or death may occur.

- You must use power supplies that meet the Safety Extra Low Voltage (SELV) and Limited Power Source (LPS) or the Electrical Source 1 (ES1) and Power Source 2 (PS2) requirements.
- If you use a powered hub or powered switch, they must meet the above requirements.

Les blocs d'alimentation non approuvés peuvent causer des décharges électriques ou des départs de feu, ou les deux. Celles-ci représentent un risque de mort ou de blessure grave.

- Vous devez utiliser un bloc d'alimentation conforme aux exigences Safety Extra Low Voltage (SELV) et Limited Power Source (LPS) ou Electrical Source 1 (ES1) et Power Source 2 (PS2).
- Si vous utilisez un hub alimenté ou un switch alimenté, ils doivent être conformes aux exigences ci-dessus.

NOTICE – Incorrect voltage can damage the camera.

You must supply I/O power within the safe operating voltage ranges specified below.

Do not use negative voltage for an I/O line.

Camera Power

Power supply via I/O connector: The operating voltage is 12–24 VDC. As a minimum, 10.8 VDC must be supplied. To avoid damaging the camera, a maximum of 30 VDC must not be exceeded.

Power over Ethernet (PoE) is not supported.

Opto-Coupled I/O Input Line

Voltage	Description
30 VDC	Absolute maximum. This voltage must never be exceeded. Doing so may damage the camera and voids the warranty.
0–24 VDC	Safe operating range.
0–1.4 VDC	Indicates a logical 0 (with inverter disabled).
>1.4–2.2 VDC	Region where the logic level transition occurs; the logical state is not defined in this region.
>2.2 VDC	Indicates a logical 1 (with inverter disabled).

- **Input current (high-level):** <15 mA internally limited
- **Input current (high-level):** >5 mA required to drive the opto-coupler

General Purpose I/O Lines

NOTICE: Applying incorrect electrical signals to the camera's GPIO line can severely damage the camera.

Before you connect any external circuitry to the GPIO line, use the [Line Mode](#) feature to configure the line for input or output.

Make sure to apply appropriate input or output signal voltages as specified below.

OPERATION AS INPUT

Voltage	Description
30 VDC	Absolute maximum. This voltage must never be exceeded. Doing so may damage the camera and voids the warranty.
0–24 VDC	Safe operating range. The minimum external pull-up voltage is 3.3 VDC.
0–0.8 VDC	Indicates a logical 0 (with inverter disabled).
>0.8–2.0 VDC	Region where the logic level transition occurs; the logical state is not defined in this region.
>2.0 VDC	Indicates a logical 1 (with inverter disabled).

- **Input current (high-level):** <100 μ A
- **Input current (low-level):** <5 mA sink current from the GPIO input line without exceeding 0.8 VDC.

OPERATION AS OUTPUT

Voltage	Description
30 VDC	Absolute maximum. This voltage must never be exceeded. Doing so may damage the camera and voids the warranty.
3.3–24 VDC	Safe operating range.
<3.3 VDC	Unreliable GPIO output.

- **Internal pull-up resistor:** $\approx$ 650 Ω , with open collector. Many applications will have to provide an additional pull-up resistor.
- **Residual voltage ("on" state):** $\approx$ 0.4 V at 50 mA and 25 °C (77 °F) housing temperature. Actual residual voltage depends on operating temperature, load current, and production spread of electronic components.
- **Leakage current:** <60 μ A. Actual leakage depends on operating temperature and production spread of electronic components.
- **Maximum load current:** 50 mA
- **Minimum load current:** Not specified. Consider the following:
 - Leakage current will have a stronger effect when load currents are low.
 - Propagation delay of the output increases as load currents decrease.
 - Higher-impedance circuits tend to be more susceptible to EMI.
 - Higher currents cause higher voltage drops in long cables.

For more information about the I/O lines, see the [I/O Control](#) section.

2.4.3 Circuit Diagrams

→ See [Circuit Diagrams](#).

2.4.4 Cable Requirements

Ethernet Cable

- Use a high-quality Ethernet cable. Use of shielded Cat 6 or better cables with S/STP shielding is recommended. For applications with long distance cabling Cat 6a cables are recommended.
- Use either a straight-through (patch) or a cross-over Ethernet cable.
- Proximity to strong magnetic fields should be avoided.

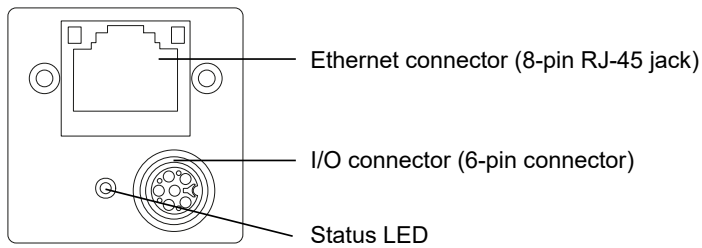
I/O Cable

- The I/O cable must be shielded.

- The I/O cable must have a cross-section of at least 0.25 mm² (close to AWG24).
- Maximum recommended cable length: 10 m
- Camera-side connector: M8 6-pin male, coding A-standard, according to IEC 61076-2-104
- Close proximity to strong magnetic fields should be avoided.
- If you are supplying power to the camera via Power over Ethernet, the I/O cable will not be used to supply power. However, you can still use the cable to connect to the I/O lines.

2.5 Physical Interface

2.5.1 Camera Connectors



Ethernet Connector

- 100/1000/2500/5000 Mbit/s Ethernet connection to the camera
- 8-pin RJ-45 jack
- Recommended mating connector: 8-pin RJ-45 plug (snap-in or with locking screws)
- When using locking screws, note the horizontal orientation of the screws.

I/O Connector

- Power supply
- M8 6-pin female connector
- Recommended mating connector: M8 6-pin male, coding A-standard, according to IEC 61076-2-104

Status LED

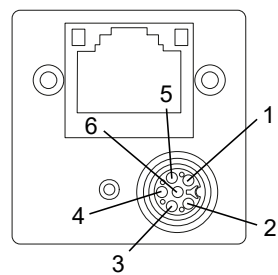
Indicates camera operation (LED lit = camera operating).

The LED can be turned off permanently by setting the `DeviceIndicatorMode` parameter to `Inactive`.

LED States

LED State	Meaning
Off	No power
Solid green	Powered, network connection established
Flashing green (3x short – 3x long – 3x short) repeatedly until error is corrected	System error (e.g., internal error)
Flashing green (3x long) repeatedly until error is corrected	User error (e.g., temperature error)
Alternating: Bright green / off	Link down (powered, but no GigE connection)
Alternating: Bright green / dark green	Allocating IP address
Solid green with a periodical, short dark phase	Network conflict

2.5.2 Connector Pinout



Pin	Line	Function
1	-	12–24 VDC camera power
2	Line 1	Opto-coupled I/O input line
3	-	Ground for opto-coupled I/O lines
4	Line 2	General purpose I/O (GPIO) line
5	Line 3	General purpose I/O (GPIO) line
6	-	Ground for camera power and General Purpose I/O (GPIO) lines

2.6 Precautions

→ See [Safety Instructions](#).

2.7 Installation

→ See [Hardware Installation \(GigE Cameras\)](#).

3. Features

3.1 Action Commands

The Action Commands camera feature allows you to execute actions on multiple GigE cameras at roughly the same time by using a single broadcast protocol message.

If you want to execute actions on multiple cameras at **exactly** the same time, use the [Scheduled Action Commands](#) feature instead.

3.1.1 Using the Feature

Why Use Action Commands

You can use action commands to perform, e.g., the following tasks:

- Synchronously acquire images with multiple cameras
- Synchronously reset the frame counter on multiple cameras

How It Works

Action commands are broadcast protocol messages that you can send to multiple devices in a GigE network.

Each action protocol message contains the following information:

- [Action device key](#)
- [Action group key](#)
- [Action group mask](#)
- [Broadcast address](#) (optional, default: 255.255.255.255)

If the camera is within the specified network segment and if the protocol information matches the action command configuration in the camera, the camera executes the corresponding action.

Info

For more information about the action command parameters and their implementation, refer to the following documents:

- [GigE Vision Specification, version 2.0](#), Section 14.3

ACTION DEVICE KEY

A 32-bit number of your choice used to authorize the execution of an action command on the camera. If the action device key on the camera and the action device key in the protocol message are identical, the camera executes the corresponding action.

ACTION GROUP KEY

A 32-bit number of your choice used to define a group of devices on which an action should be executed. If the action group key on the camera and the action group key in the protocol message are identical, the camera executes the corresponding action.

ACTION GROUP MASK

A 32-bit number of your choice used to filter out a sub-group of cameras belonging to a group of cameras. The cameras belonging to a sub-group execute an action at the same time.

The filtering is done using a logical bitwise AND operation on the group mask number of the action command and the group mask number of a camera. If both binary numbers have at least one common bit set to 1 (i.e., the result of the AND operation is non-zero), the corresponding camera belongs to the sub-group.

Example: Assume that A group of six cameras is installed on an assembly line. To execute actions on specific sub-groups, the following group mask numbers have been assigned to the cameras (sample values):

Camera	Group Mask Number (Binary)	Group Mask Number (Hexadecimal)
1	000001	0x1
2	000010	0x2
3	000100	0x4
4	001000	0x8
5	010000	0x10
6	100000	0x20

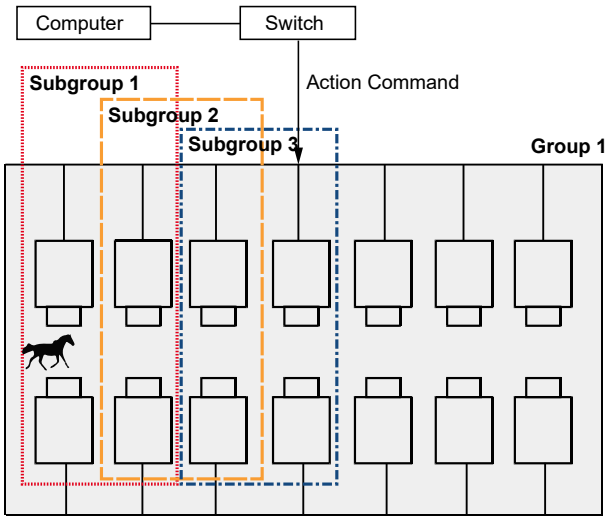
In this example, an action command with an action group mask of 000111 (0x7) executes an action on cameras 1, 2, and 3. And an action command with an action group mask of 101100 (0x2C) executes an action on cameras 3, 4, and 6.

BROADCAST ADDRESS

A string variable used to define where the action command will be broadcast to.
This parameter is optional. If omitted, "255.255.255.255" will be used.

EXAMPLE SETUP

The following example setup will give you an idea of the basic concept of action commands.
To analyze the movement of a horse, a group of cameras is installed parallel to a race track.



When the horse passes, four cameras (subgroup 1) synchronously execute an action (image acquisition in this example). As the horse advances, the next four cameras (subgroup 2) synchronously capture images. One after the other, the subgroups continue in this fashion until the horse has reached the end of the race track. The resulting images can be combined and analyzed in a subsequent step.

In this sample use case, the following must be defined:

- A unique device key to authorize the execution of the synchronous image acquisition. The device key must be configured on each camera and it must be the same as the device key for the action command protocol message. To define the device key, use the [action device key](#).
- The group of cameras in a network segment that is addressed by the action command (in this example: group 1). To define the groups, use the [action group key](#).
- The subgroups in the group of cameras that capture images synchronously (in this example: subgroups 1, 2, and 3). To define the subgroups, use the [action group mask](#).

Using Action Commands

CONFIGURING THE CAMERAS

To configure the cameras so that they are able to receive and process action commands:

Info

The same procedure applies if you want to configure [Scheduled Action Commands](#) on your cameras.

1. Make sure that the following requirements are met:
 - All cameras on which you want to configure action commands are installed and configured in the same network segment.
2. Open the connection to one of the cameras that you want to control using action commands.
3. Set the `ActionDeviceKey` parameter to a 32-bit number of your choice. The key must be unique among all cameras in the network segment.
4. Configure the following parameters:
 - `ActionGroupKey`
 - `ActionGroupMask`
5. Depending on which task you want to use action commands for, set the corresponding camera source to `Action1`.

Example 1: If you want to use action commands to acquire images, set the `TriggerSource` parameter to `Action1`.

Example 2: If you want to use action commands to reset a counter, set the `CounterResetSource` parameter to `Action1`.
6. Repeat steps 2 to 4 on all cameras.

Info

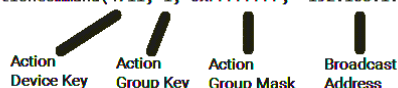
You can also set multiple sources to `Action1`. This allows you to execute multiple tasks at once whenever an action command is received.

ISSUING AN ACTION COMMAND

To issue an action command, call the `IssueActionCommand` method in your application.

Example:

```
IssueActionCommand(4711, 1, 0xFFFFFFFF, "192.168.1.255")
```



Example

Your camera is configured as follows:

```
Device key = 4711

ActionSelector = 1:
- Group key = 1
- Group mask = 0xFFFFFFFF

ActionSelector = 2:
- Group key = 2
- Group mask = 0xFFFFFFFF

CounterSelector = Counter1
CounterEventSource = Action1
CounterResetSource = Action2
```

Now, you can call `IssueActionCommand(4711, 1, 0xFFFFFFFF)` to increase counter 1, and `IssueActionCommand(4711, 2, 0xFFFFFFFF)` to reset counter 1.

External Links

- [Broadcast Address \(Wikipedia\)](#)

- [Broadcast Address Calculator \(EtherTek Circuits\)](#)

3.2 Auto Functions

Auto functions allow you to control image properties automatically.

Auto functions are particularly useful to maintain good image quality when imaging conditions change frequently, e.g., unreliable light conditions.

Most auto functions are the automatic counterparts to setting a parameter manually. For example, the [Gain Auto](#) feature controls the `Gain` parameter automatically within specified limits.

3.2.1 Available Auto Functions

On your camera model, the following auto functions are available:

- [Gain Auto](#)
- [Balance White Auto](#)

3.2.2 Operation

The individual auto functions can be used at the same time.

The pixel data for the auto functions can come from one or multiple [auto function ROIs](#). To operate properly, at least one auto function ROI must be assigned to each auto function.

3.3 Auto Function Profile

The Auto Function Profile camera feature allows you to specify how gain and exposure time are balanced when the camera is making automatic adjustments.

3.3.1 Using the Feature

Setting the Auto Function Profile

To set the auto function profile:

1. Set the `Gain Auto` auto function to `Continuous`.
2. Set the `AutoFunctionProfile` parameter to one of the following values:
 - `GainMinimum`
 - `ExposureMinimum`

Available Auto Function Profiles

MINIMIZE GAIN (= GAIN MINIMUM)

The gain is kept as low as possible during the automatic adjustment process. If the exposure time is at its upper limit and the target brightness value has not been reached yet, the gain will be increased in order to reach the target.

MINIMIZE EXPOSURE TIME (= EXPOSURE MINIMUM)

The exposure time is kept as low as possible during the automatic adjustment process. If the gain is at its upper limit and the target brightness value has not been reached yet, the exposure time will be increased in order to reach the target.

3.4 Auto Function ROI

The Auto Function ROI camera feature allows you to specify the part of the sensor array with which you want to control the camera's [auto functions](#).

ROI is short for region of interest (formerly AOI = area of interest).

You can create several auto function ROIs, each occupying different parts of the sensor array.

The settings for the Auto Function ROI feature are independent of the settings for the [Image ROI](#) feature.

3.4.1 Using the Feature

Changing Position and Size of an Auto Function ROI

By default, all auto function ROIs are set to the same size as the camera's [image ROI](#). You can change their positions and sizes to suit your needs.

To change the position and size of an auto function ROI:

1. Set the `AutoFunctionROISelector` parameter to one of the [available auto function ROIs](#), e.g., `ROI1`.

2. Enter values for the following parameters to specify the **position** of the auto function ROI selected:

- `AutoFunctionROIOffsetX`
- `AutoFunctionROIOffsetY`

3. Enter values for the following parameters to specify the **size** of the auto function ROI selected:

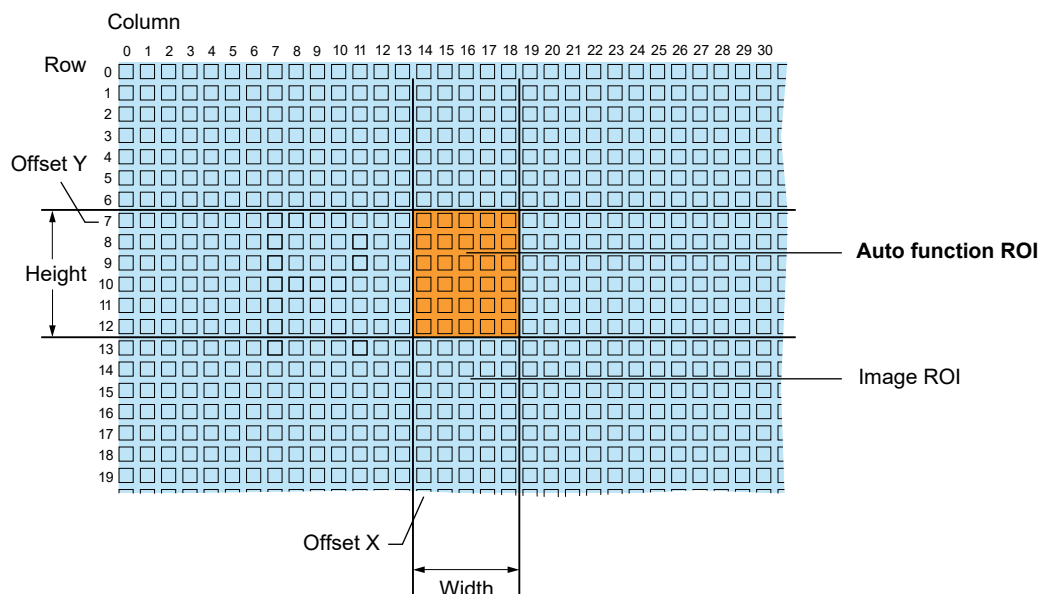
- `AutoFunctionROIWidth`
- `AutoFunctionROIHeight`

The position of an auto function ROI is specified based on the lines and rows of the sensor array.

Example: Assume that you have selected auto function ROI 1 and specified the following settings:

- `AutoFunctionROIOffsetX = 14`
- `AutoFunctionROIOffsetY = 7`
- `AutoFunctionROIWidth = 5`
- `AutoFunctionROIHeight = 6`

This creates the following auto function ROI 1:



Only the pixel data from the **area of overlap** between the auto function ROI and the **image ROI** will be used by the auto function assigned to it.

Info

- On color cameras, Cognex recommends setting the parameters for position and size to even values (multiples of 2). This matches the auto function ROI to the color filter pattern of the sensor.
- On the CIC-L041-CG-42-5G camera, you can set the `AutoFunctionROIHeight` parameter to a value bigger than 1.
- If the **Binning** feature is enabled (only available on the CIC-L041-MG-84-5G camera), the auto function ROI settings refer to the binned lines and columns and not to the physical lines in the sensor.
- If the **Reverse X** feature is enabled, the position of the auto function ROI relative to the sensor remains the same. As a consequence, different regions of the image will be controlled depending on whether or not Reverse X, Reverse Y or both are enabled.

AUTO FUNCTION ROI HIGHLIGHTING

You can highlight one or multiple Auto Function ROIs. Areas that don't belong to the Auto Function ROIs appear darker:

Sample Image: Auto Function ROI Highlighting

To highlight an Auto Function ROI:

1. Set the `AutoFunctionROISelector` parameter to the desired auto function ROI, e.g., `ROI1`.
2. Set the `AutoFunctionROIHighlight` parameter to `true`.

Assigning Auto Functions

By default, each auto function ROI is assigned to a specific auto function. For example, the pixel data from auto function ROI 2 is used to control the **Balance White Auto** auto function.

The default assignments can be changed. To do so:

Set the `AutoFunctionROISelector` parameter to one of the **available auto function ROIs**, e.g., `ROI1`.

Assign the desired auto functions to the auto function ROI selected:

- If you want to assign **Balance White Auto**, set the `AutoFunctionROIUseWhiteBalance` parameter to `true`.
- If you want to assign **Gain Auto**, set the `AutoFunctionROIUseBrightness` parameter to `true`.

Info

- If you assign **one** auto function to **multiple** auto function ROIs, the pixel data from all selected auto function ROIs will be used for the auto function.
- If you assign **multiple** auto functions to **one** auto function ROI, the pixel data from the auto function ROI will be used for all auto functions selected.

Guidelines

When you are setting an auto function ROI, you must follow these guidelines:

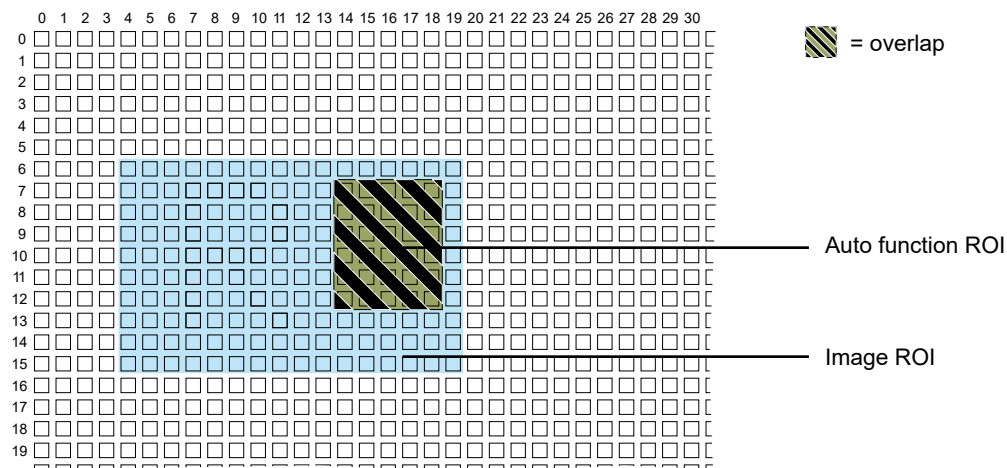
Guideline	Example
$\text{AutoFunctionROIOffsetX} + \text{AutoFunctionROIWidth} \leq \text{Width of camera sensor}$	Camera with a 1920 x 1080 pixel sensor: $\text{AutoFunctionROIOffsetX} + \text{AutoFunctionROIWidth} \leq 1920$
$\text{AutoFunctionROIOffsetY} + \text{AutoFunctionROIHeight} \leq \text{Height of camera sensor}$	Camera with a 1920 x 1080 pixel sensor: $\text{AutoFunctionROIOffsetY} + \text{AutoFunctionROIHeight} \leq 1080$

Overlap Between Auto Function ROI and Image ROI

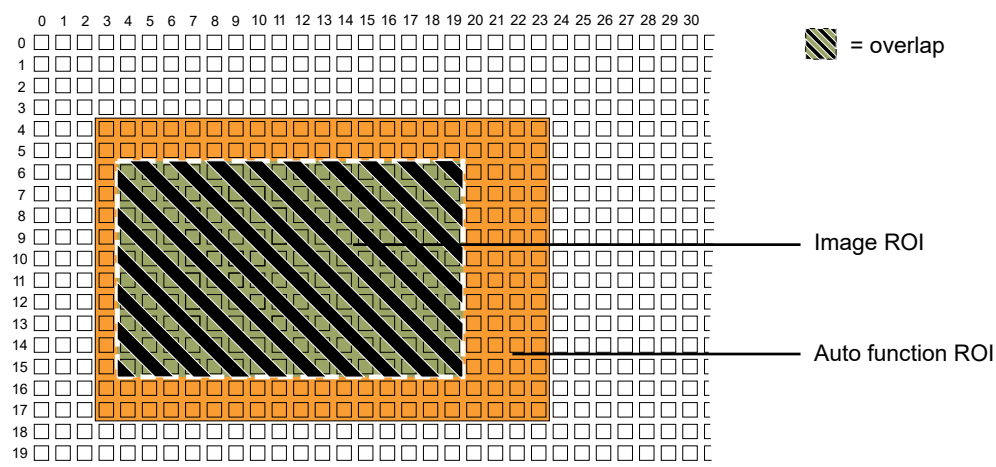
The size and position of an auto function ROI can be identical to the size and position of the [image ROI](#), but this is not a requirement. For an auto function to work, it is sufficient if both ROIs overlap each other partially.

The overlap between auto function ROI and image ROI determines whether and to what extent the auto function will control the related image property. Only the pixel data from the areas of overlap will be used by the auto function to control the image property of the entire image.

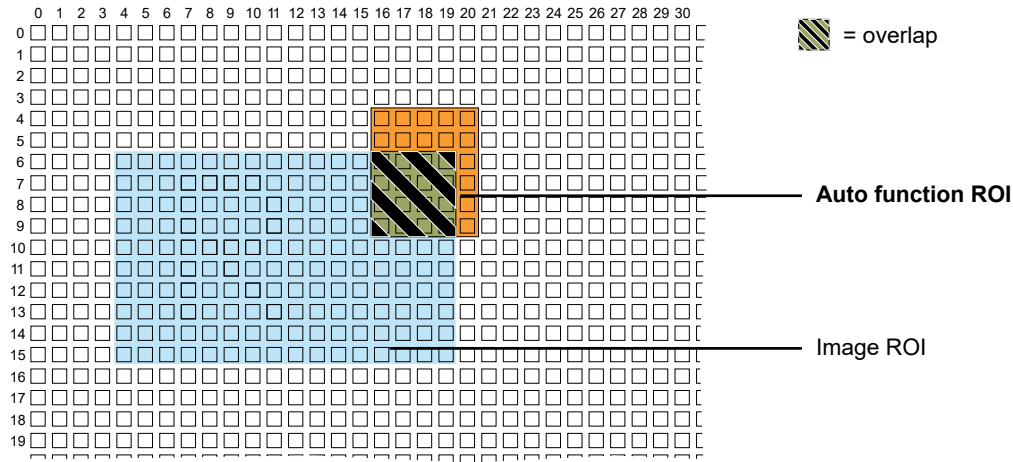
- If the **auto function ROI** is completely contained in the **image ROI**, the pixel data from the auto function ROI will be used to control the image property.



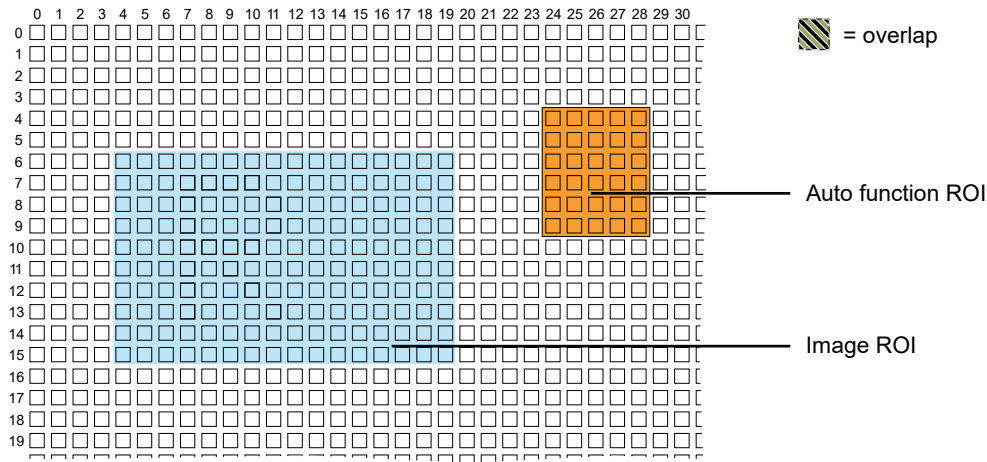
- If the **image ROI** is completely contained in the **auto function ROI**, only the pixel data from the image ROI will be used to control the image property.



- If the **auto function ROI** overlaps the **image ROI** only partially, only the pixel data from the area of partial overlap will be used to control the image property.



• If the **auto function ROI** does not overlap the **image ROI**, the related auto function will **not work**.



Info

Cognex strongly recommends completely including the auto function ROI within the image ROI or choosing identical positions and sizes for auto function ROI and image ROI.

3.4.2 Specifics

Camera Model	Auto Function ROIs	Default Assignments	Assignments Can Be Changed	Highlighting Supported
CIC-L041- CG-42-5G	ROI 1	ROI 1: Brightness (Gain	Yes	Yes
	ROI 2	Auto + Exposure Auto) ROI 2: White Balance (Balance White Auto)		
CIC-L041- MG-84-5G	ROI 1	ROI 1: Brightness (Gain	Yes	Yes
	ROI 2	Auto + Exposure Auto) ROI 2: -		

3.5 Balance White

The Balance White camera feature allows you to manually correct color shifts so that white objects appear white in images acquired. For this purpose, a digital gain correction can be applied per color channel (red, green, blue). To automatically correct color shifts, use the [Balance White Auto](#) feature.

 Note

This feature is **not** available on the CIC-L041-MG-84-5G camera.

3.5.1 Using the Feature

Why Perform White Balance Correction

Images acquired by your camera may have a color cast, i.e., a tint of a particular color. The reason for this is that different sources of light have different color temperatures. Fluorescent lighting adds a bluish cast to images whereas tungsten incandescent light adds a yellowish cast.

The white balance feature allows you to correct these color shifts by adjusting the intensity of the colors red, green, and blue. As a result, white objects appear white in the acquired images.

Performing White Balance Correction

To perform white balance correction:

1. Set the [Balance White Auto](#) auto function to `Off`.
2. For best results, set the [black level](#) to 0 (zero).
3. Set the `BalanceRatioSelector` parameter to one of the available color channels (`Red` , `Green` , or `Blue`).
4. Adjust the `BalanceRatio` parameter value for the selected color channel:
 - **Balance ratio = 1:** The intensity of the color remains **unchanged**.
 - **Balance ratio > 1:** The intensity of the color is **increased** relative to the other two colors.
 - **Balance ratio < 1:** The intensity of the color is **decreased** relative to the other two colors. (This is only possible if your camera model supports balance ratio values lower than 1.)
 - Repeat steps 3 and 4 for all available color channels.

The increase or decrease in intensity is proportional. For example, if the balance ratio for a color is set to 1.2, the intensity of that color is increased by 20 %.

 Info

- Specifying a balance ratio lower than 1 also decreases the maximum intensity that the color can achieve. Unless you want to correct a strong predominance of one color, specifying a balance ratio of less than 1 is not recommended.
- Some color enhancement features, e.g., [Color Transformation](#), also have an effect on the white balance settings. If necessary, you can manually re-adjust the white balance after having used these features.

External Links

- [Color balance \(Wikipedia\)](#)
- [Understanding White Balance \(Photoxels\)](#)

3.6 Balance White Auto

The Balance White Auto camera feature automatically corrects color shifts in images acquired.

The pixel data for the auto function can come from one or multiple [auto function ROIs](#).

To correct color shifts manually, use the [Balance White](#) feature.

Note

This feature is **not** available on the CIC-L041-MG-84-5G camera.

3.6.1 Using the Feature

Enabling or Disabling Balance White Auto

To enable or disable the Balance White Auto auto function:

1. [Assign](#) at least one auto function ROI to the Balance White Auto auto function.
Make sure the auto function ROI [overlaps](#) the image ROI, either partially or completely.
2. Set the `BalanceWhiteAuto` parameter to one of the following operating modes:
 - **Once** : The camera adjusts the white balance until the [average gray values for red, green, and blue are identical](#). When this has been achieved, or after several calculation cycles, the camera sets the auto function to `Off` and applies the balance ratios resulting from the last calculation to all following images.
 - **Continuous** : The camera adjusts the white balance continuously while images are being acquired. The adjustment process continues until the operating mode is set to `Once` or `Off`.
 - **Off** : Disables the Balance White Auto auto function. The `BalanceRatio` parameters remain at the values resulting from the last automatic or manual adjustment.

Info

On the CIC-L041-CG-42-5G camera, the Continuous operating mode is not available.

How It Works

Automatic white balancing is a two-step process:

1. The camera compares the average gray values of the red, green, and blue pixels. It determines the color with the highest average gray value (i.e., the brightest color) and sets the `BalanceRatio` parameter value for this color to 1.
2. The camera automatically adjusts the `BalanceRatio` parameter values of the other two colors until the average gray values for red, green, and blue are identical.

As a result, the `BalanceRatio` parameter is set to 1 for one color and to a value between 1 and ≈ 15.98 for the other two colors.

Example: Assume the green pixels in your image have the highest average gray value. If you enable the Balance White Auto auto function, the camera sets the `BalanceRatio` parameter value for green to 1. Then, the camera automatically adjusts the `BalanceRatio` parameter values for red and blue until the average gray values for red, green, and blue are identical. The new balance ratios could be, e.g., green = 1, red = 1.08789, and blue = 2.19678.

Info

- To view the `BalanceRatio` parameter values for red, green, or blue, switch to the respective color channel using the `BalanceRatioSelector`.
- When the camera is capturing images continuously, the auto function takes effect with a short delay. The first few images may not be affected by the auto function.

3.7 Binning

The Binning camera feature allows you to combine sensor pixel values into a single value. This may increase the signal-to-noise ratio, the camera's response to light, or the frame rate.

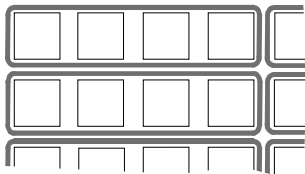
Note

This feature is **not** available on the CIC-L041-CG-42-5G camera.

3.7.1 Using the Feature

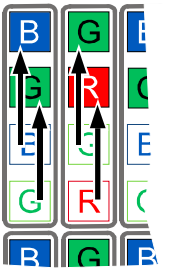
How It Works

On **monochrome** cameras, the camera combines ([sums or averages](#)) the pixel values of **directly adjacent** pixels:



Horizontal mono binning by 4

On **color** cameras, the camera combines ([sums or averages](#)) the pixel values of **adjacent pixels of the same color**:



Vertical color binning by 2

The **binning factor** specifies the number of combined adjacent pixels. The **binning mode** defines how pixels are combined when binning is enabled.

Specifying the Binning Factors

To specify the binning factors:

1. Make sure the camera is idle, i.e., not capturing images.
2. Set the `BinningHorizontal` parameter to one of the following values:
 - **1:** Disables binning in horizontal direction.
 - **2, 3, 4:** Sets the number of combined adjacent pixels in horizontal direction to 2, 3, or 4.

Example: You set the `BinningHorizontal` parameter to 3 and the `BinningVertical` parameter to 2. This enables 3x2 binning.

Info

If you use different binning factors for horizontal and vertical binning, objects will [appear distorted](#) in the image.

Choosing a Binning Mode

To choose a binning mode:

1. Make sure the camera is idle, i.e., not capturing images.
2. Set the `BinningHorizontalMode` parameter to one of the following values:
 - **Sum:** The values of the affected pixels are **summed**. This improves the signal-to-noise ratio, but also increases the camera's response to light.
 - **Average:** The values of the affected pixels are **averaged**. This greatly improves the signal-to-noise ratio without affecting the camera's response to light.

Both binning modes (Sum and Average) reduce the amount of image data to be transferred. This may increase the camera's frame rate.

Sensor and FPGA Binning

On the CIC-L041-MG-84-5G camera, the `BinningSelector` parameter is available. This parameter allows you to select whether to configure Sensor or FPGA binning.

Sensor binning has the following benefits:

- May increase the camera's frame rate
- Allows binning on color cameras

To configure sensor or FPGA binning:

1. Set the `BinningSelector` parameter to one of the following values:
 - `Region1` : FPGA binning can be configured.
2. Specify the [binning factor](#) and [binning mode](#).

Considerations When Using Binning

EFFECT ON ROI SETTINGS AND RESOLUTION

When you are using binning, the settings for your [image ROI](#) and [auto function ROIs](#) refer to the binned rows and columns. Also, the effective resolution of the sensor is reduced.

For example, assume that you are using a camera with a 1280 x 960 sensor. Horizontal binning by 2 and vertical binning by 2 are enabled. In this case, the maximum ROI width is 640 and the maximum ROI height is 480. The effective resolution of the sensor is reduced to 640 x 480.

INCREASED RESPONSE TO LIGHT

Using binning with the [binning mode](#) set to **Sum** can significantly increase the camera's response to light. When pixel values are summed, the acquired images may look overexposed. If this is the case, you can reduce the lens aperture, the intensity of your illumination, the camera's [Exposure Time](#) setting, or the camera's [Gain](#) setting.

POSSIBLE IMAGE DISTORTION

Objects will only appear undistorted in the image if the numbers of binned lines and columns are equal. With all other combinations, objects will appear distorted. For example, if you combine vertical binning by 2 with horizontal binning by 4, the target objects will appear squashed.

3.7.2 Specifics

Binning Factors

Horizontal Binning Factors	Vertical Binning Factors	Allowed Combinations
1, 2, 3 ^a , 4	Vertical binning feature not supported	Not applicable

Binning Modes

Horizontal Binning Modes	Vertical Binning Modes	Allowed Combinations (H x V Binning Mode)
Average, Sum	Vertical binning feature not supported	Not applicable

Binning Settings

BinningSelector Parameter Available	BinningSelector Parameter Values
Yes	Region1

a. Horizontal binning and vertical binning by 3 are not supported. Setting the parameter value to 3 is allowed, but will result in an effective horizontal binning or vertical binning by 2.

3.8 Black Level

The Black Level camera feature allows you to change the overall brightness of an image. Adjusting the camera's black level will result in an offset to the pixel's gray values output by the camera.
For example, you can increase the gray value of each pixel in the image by 3.

3.8.1 Using the Feature

 Info

This feature is pre-configured by VisionPro. Therefore, it isn't recommended that you configure this feature manually.

 Info

Cognex recommends setting the black level to 0 before using any of the color enhancement features, e.g., [Balance White](#), [Color Transformation](#), or [Gamma](#). After the color enhancements have been applied, you can change the black level as desired. However, increasing the black level will decrease the color accuracy.

Setting the Black Level

1. Enter a value for the `BlackLevel` parameter.
 - Specifying a black level value of 0 effectively disables the respective adjustment.

3.8.2 Specifics

Change in BlackLevel Parameter Value	Resulting Change in Gray Value
± 1	± 1

3.9 Color Adjustment

Note

This feature is **not** available on the CIC-L041-MG-84-5G camera.

The Color Adjustment camera feature allows you to adjust the hue and saturation of individual colors in your images.

You can adjust hue and saturation separately for each primary and secondary color in the RGB color space (red, green, blue, yellow, cyan, and magenta).

If you want to adjust the appearance of all colors in a single step, use the [Hue and Saturation](#) feature.

3.9.1 Using the Feature

Why Use Color Adjustment

- Adjusting the **hue** shifts the colors of the image. This can be useful, e.g., to correct minor, undesirable, color shifts or to create false-color images.
- Adjusting the **saturation** changes the colorfulness (intensity) of the colors. Increasing the saturation can be useful to make colors easier to distinguish.

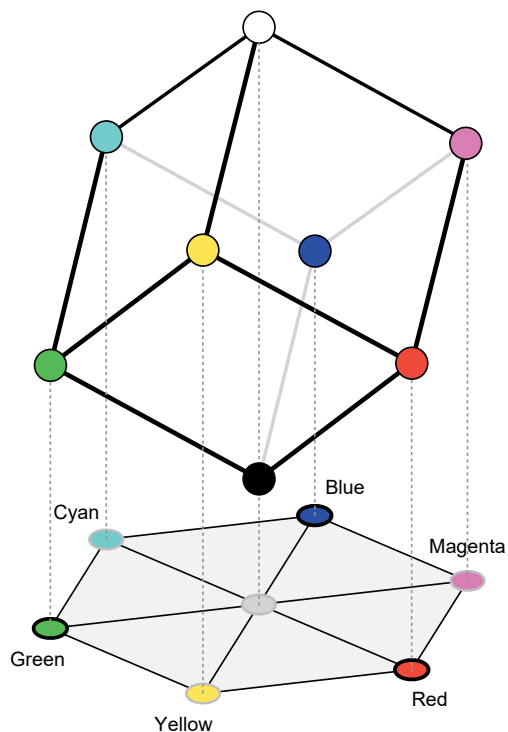
Setting the Color Adjustment Parameters

1. Set the `ColorAdjustmentEnable` parameter to `true`.
2. Set the `ColorAdjustmentSelector` parameter to the desired color, e.g., `Red`.
3. Enter the desired value for the `ColorAdjustmentHue` parameter. When the parameter is set to 0, the hue is not changed.
4. Enter the desired value for the `ColorAdjustmentSaturation` parameter. When the parameter is set to 1, the saturation is not changed.

How It Works

The parameters of the Color Adjustment feature refer to the RGB color cube.

For easier visualization, the color cube can be projected onto a plane, resulting in a color hexagon:

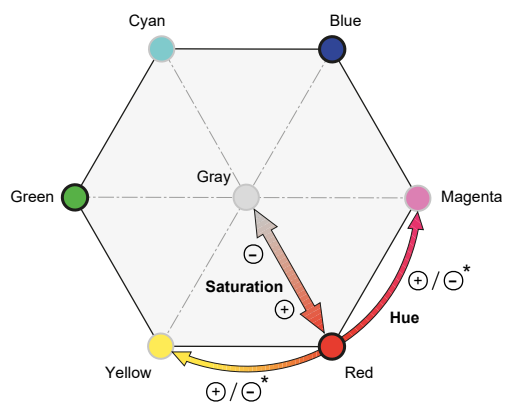


The primary colors (red, green, blue) and the secondary colors (yellow, cyan, magenta) are placed at the corners of this color hexagon.

You can adjust hue and saturation for each of these colors. This affects all areas in the image where the adjusted color predominates.

For example, adjusting red affects the colors in the image with a predominantly red component.

The following diagram shows how changing hue and saturation of the color red affects the colors of your images:



* depending on parameter range

The following effects become apparent:

If the value range of the `ColorAdjustmentHue` parameter is -4.0 to 3.96875:

- **Decreasing the hue** changes all red colors (i.e., colors with a predominantly red component) towards yellow.
- **Increasing the hue** changes all red colors towards magenta.

If the value range of the `ColorAdjustmentHue` parameter is -1.0 to 1.0:

- **Increasing the hue** changes all red colors (i.e., colors with a predominantly red component) towards yellow.
- **Decreasing the hue** changes all red colors towards magenta.

Decreasing the saturation decreases the colorfulness of all red colors. At minimum, all red colors will be replaced by gray.

Increasing the saturation increases the colorfulness of all red colors. At maximum, all red colors are replaced by 100 % red.

 Info

When you adjust a color, the nearest neighboring colors in the color hexagon will also be affected to some degree. For example, when you adjust red, yellow and magenta will also be affected.

3.10 Color Transformation

Note

This feature is **not** available on the CIC-L041-MG-84-5G camera.

The Color Transformation camera feature allows you to correct the color information delivered by the sensor.

Using a color transformation matrix, the feature can correct color shifts caused by the light source used during image acquisition as well as compensate for imperfections in the sensor's color generation process.

Info

You should only use this feature if you are thoroughly familiar with matrix color transformations. It is nearly impossible to enter correct values in the transformation matrix by trial and error.

3.10.1 Using the Feature

Configuring Color Transformation

1. Make sure the [white balance](#) is configured appropriately.
2. Set the `ColorTransformationValueSelector` parameter to the desired [position in the matrix](#), e.g., `Gain00`.
3. Enter the desired value for the `ColorTransformationValue` parameter to adjust the value at the selected position. The parameter's value range is -8.0 to +7.96875.

Info

The transformation matrix is already populated with color transformation values. They correspond to unit vectors, or result from a previous use of the color transformation feature.

How It Works

The color transformation feature uses a transformation matrix to deliver modified red, green, and blue pixel data for each pixel.

The transformation is performed by premultiplying a 3 x 1 matrix containing R, G, and B pixel values by a 3 x 3 matrix containing the color transformation values:

$$\begin{bmatrix} \text{Gain00} & \text{Gain01} & \text{Gain02} \\ \text{Gain10} & \text{Gain11} & \text{Gain12} \\ \text{Gain20} & \text{Gain21} & \text{Gain22} \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix}$$

You can set each matrix value (Gain00, Gain01, etc.) according to your requirements.

External Links

- [Basics of color matrix transformation for video data \(Institute for Telecommunication Sciences\)](#)

3.11 Counter

The Counter camera feature allows you to count certain camera events, e.g., the number of images acquired.

3.11.1 Using the Feature

How It Works

On your camera model, four counters are available: Counter 1, Counter 2, Counter 3, and Counter 4.

Every counter has the following characteristics:

- It starts at 0.
- It must be **started** before it can count.
- Once started, it can count a specific type of event (the "event source"). For example, it can count the number of images exposed.
- It can be **reset** to 0 at any time.
- Its current value can be determined by getting the value of the `CounterValue` parameter.
- Its maximum value is defined by the `CounterDuration` parameter value (default: 4 294 967 295). After reaching the maximum value, the counter stops counting and must be **reset**.
- Its current status can be determined by getting the value of the `CounterStatus` parameter.
- It is reset to 0 whenever the camera is powered off and on again.

Getting the Value of a Counter

To determine the current value of a counter, get the value of the `CounterValue` parameter. This parameter is read-only.

Starting a Counter

To start a counter:

1. Set the `CounterSelector` parameter to the desired counter, e.g., `Counter2`.
2. Set the `CounterTriggerSource` parameter to the source that you want to use to start the counter, e.g., `Line2`.
3. If applicable, set the `CounterTriggerActivation` parameter to one of the following values:
 - `RisingEdge` (default): The counter starts when the signal **rises**, i.e., when the signal status changes from low to high.
 - `FallingEdge`: The counter starts when the signal **falls**, i.e., when the signal status changes from high to low.
 - `AnyEdge`: The counter starts when the signal **falls or rises**.
 - `LevelHigh`: The counter starts when the signal is **high**. When the signal changes to low, the counter **status** is set to `CounterTriggerWait` and must be **started** again.
 - `LevelLow`: The counter starts when the signal is **low**. When the signal changes to high, the counter **status** is set to `CounterTriggerWait` and must be **started** again.
4. Start the counter by sending a signal on the selected counter trigger source.

When started, the counter's **status** changes from `CounterTriggerWait` to `CounterActive`.

Info

- If you start a counter, it will **not** necessarily start counting. If and when the counter counts depends on the **event source** set.
- The `CounterTriggerActivation` parameter is only available for event sources that can be high (1) or low (0), i.e., an I/O signal or an "Active" signal like `ExposureActive`.

Increasing a Counter

Once a counter is **started**, it can be increased, i.e., it can count.

To increase a counter:

1. Set the `CounterSelector` parameter to the desired counter, e.g., `Counter2`.
2. Set the `CounterEventSource` parameter to the source that you want to use to increase the counter, e.g., `Line2`.
3. If applicable, set the `CounterEventActivation` parameter to one of the following values:
 - `RisingEdge` (default): The counter counts when the signal **rises**, i.e., when the signal status changes from low to high.
 - `FallingEdge`: The counter counts when the signal **falls**, i.e., when the signal status changes from high to low.
 - `AnyEdge`: The counter counts when the signal **falls or rises**.
4. Set the `CounterDuration` parameter to the desired maximum value.
5. Increase the counter by sending a signal on the selected counter event source.

Whenever the camera detects a signal on the selected source, the timer increases, up to the defined maximum value.

Info

The `CounterEventActivation` parameter is only available for event sources that can be high (1) or low (0), i.e., an I/O signal or an "Active" signal like `ExposureActive`.

Resetting a Counter

You can reset the counter to 0 at any time.

You must reset the counter if it has reached its maximum value (defined by the `CounterDuration` parameter value) and you want to reuse it.

RESET BY SOFTWARE

To reset a counter by software, execute the `CounterReset` command.

Alternatively, you can set a software signal as the reset source (see below).

RESET USING A RESET SOURCE

The `CounterResetSource` parameter allows you to specify which source resets the counter.

To reset the counter using a reset source:

1. Set the `CounterSelector` parameter to the desired counter, e.g., `Counter2`.
2. Set the `CounterResetSource` parameter to the source that you want to use to reset the counter, e.g., `Line2`.
3. If applicable, set the `CounterResetActivation` parameter to one of the following values:
 - `RisingEdge` (default): The counter resets when the signal **rises**, i.e., when the signal status changes from low to high.
 - `FallingEdge`: The counter resets when the signal **falls**, i.e., when the signal status changes from high to low.
 - `AnyEdge`: The counter resets when the signal **falls or rises**.
4. Reset the counter by sending a signal on the selected counter reset source.

When reset, the counter's **status** changes to `CounterTriggerWait` and must be **started** again.

Info

The `CounterResetActivation` parameter is only available for event sources that can be high (1) or low (0), i.e., an I/O signal or an "Active" signal like `ExposureActive`.

Stopping a Counter

To stop a counter, do any of the following:

- Stop sending signals on the selected [event source](#).
- Set the `CounterEventSource` parameter to `Off`.
- [Reset](#) the counter.

Getting the Status of a Counter

To get the current status of a counter, get the value of the `CounterStatus` parameter. This parameter is read-only.
Possible values are:

- `CounterTriggerWait` : The counter is waiting to be [started](#).
- `CounterActive` : The counter is waiting to be increased by the selected [event source](#) or is currently counting.
- `CounterCompleted` : The counter has reached its maximum value defined by the `CounterDuration` parameter.
- `CounterIdle` : The counter is idle. A counter is in this state whenever the `CounterTriggerSource` parameter is set to `Off`, i.e., the counter can't be started.

3.11.2 Specifics

Available Counters	Function	Event Source	Can Be Reset
Counter 1	Configurable	Configurable	Counter 1: Yes
Counter 2			Counter 2: Yes
Counter 3			Counter 3: Yes
Counter 4			Counter 4: Yes

3.12 Data Chunks

The Data Chunks camera feature allows you to generate supplementary image data and append that data to every image that you acquire.

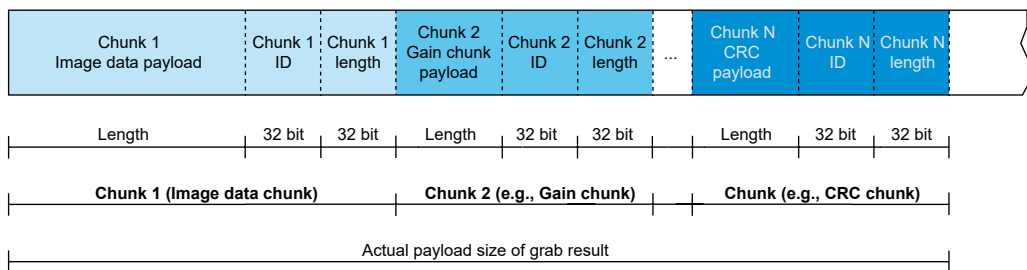
3.12.1 Using the Feature

How It Works

Data chunks allow you to add supplementary information to individual image acquisitions. The desired supplementary information is generated and appended as data chunks to the image data.

Image data is also considered a "chunk". This "image data chunk" can't be disabled and is always the first chunk transmitted by the camera. If one or more data chunks are enabled, these chunks are transmitted as chunk 2, 3, and so on.

The figure below shows a set of chunks with the leading image data chunk and appended data chunks. The example assumes that the CRC checksum chunk feature is enabled.



After data chunks have been transmitted to the computer, they must be retrieved to obtain their information. The exact procedure depends on your camera model and the programming language used for your application.

ADDITIONAL METADATA

Besides the data chunks, the camera adds additional metadata to individual images, e.g., the image height, image width, the image ROI offset, and the pixel format used. This information can be retrieved by accessing the grab result data.

Enabling and Retrieving Data Chunks

1. Set the `ChunkModeActive` parameter to `true`.
2. Set the `ChunkSelector` parameter to the kind of chunk that you want to enable:
 - `CounterValue`
 - `ExposureTime`
 - `FrameID`
 - `Gain`
 - `LineStatusAll`
 - `PayloadCRC16`
 - `Timestamp`
3. Enable the selected chunk by setting the `ChunkEnable` parameter to `true`.
4. Repeat steps 2 and 3 for every desired chunk.
5. Implement chunk retrieval in your application.

Using Data Chunks for Line Scan GigE Cameras

The Data Chunks and `Counter` features, in combination with the trigger settings, can be used to specify which lines belong to a frame and which frames belong to the correct test object. The combination of trigger, counter, and data chunks settings makes it possible to create a coherence between the frames recorded and the corresponding chunk data.

Available Data Chunks

COUNTER VALUE CHUNK

If this chunk is enabled, the camera appends the current value of the camera's [counter](#) to every image.
Your camera always retrieves the current value of Counter 1, which counts the number of acquired images.

ENCODER VALUE CHUNK

If this chunk is enabled, the camera appends the value of the encoder position counter for the first exposed line of a frame to every image.
For information about how to control and monitor an encoder, see the [Encoder Control](#) topic.

EXPOSURE TIME CHUNK

If this chunk is enabled, the camera appends the exposure time used for image acquisition to every image.
The data chunk includes the [ExposureTime](#) and the [ChunkExposureTimeSelector](#) parameter values.
The [ChunkExposureTimeSelector](#) parameter selects the exposure time to be included in the exposure time chunk.

FRAME ID CHUNK

If this chunk is enabled, the camera appends the frame ID indicating the number of the image that has been exposed.
The frame ID starts at 0 and keeps incrementing by 1 for each exposed image until the camera is powered off. The maximum value is 2^{48} .

GAIN CHUNK (= GAINALL CHUNK)

If this chunk is enabled, the camera appends the gain used for image acquisition to every image.
The data chunk includes the [Gain](#) parameter value.

LINE STATUS ALL CHUNK

If this chunk is enabled, the camera appends the [status of all I/O lines](#) at the moment when image acquisition was triggered to every image.
The data chunk includes the [LineStatusAll](#) parameter value.

PAYLOAD CRC 16 CHUNK

If this chunk is enabled, the camera appends a CRC (Cyclic Redundancy Check) checksum to every image.
The checksum is calculated using the X-modem method and includes the image data and all appended chunks, if any, except the CRC chunk itself.
The CRC checksum chunk is always the last chunk appended to image data.

TIMESTAMP CHUNK

If this chunk is enabled, the camera appends an internal [timestamp](#) (in ticks) of a certain event to every image.
The parameter including the timestamp is named [ChunkTimestamp](#). It always indicates when acquisition of the current image started.

3.13 Device Information Parameters

Device information parameters allow you to retrieve basic information about the camera.

This topic describes the parameters and the information each parameter provides.

3.13.1 Using the Feature

Standard Device Information Parameters

Your camera provides the following device information parameters:

Parameter Name	Display Name	Description
DeviceFirmwareVersion	Device Firmware Version	The camera's firmware version number.
DeviceManufacturerInfo	Device Manufacturer Info	The camera's manufacturer name. Usually contains an empty string.
DeviceModelName	Device Model Name	The camera's model name, e.g., CIC-L041-MG-84-5G.
DeviceScanType	Device Scan Type	The scan type of the camera's sensor (Areascan or Linescan)
DeviceSerialNumber	Device Serial Number	The camera's serial number.
DeviceUserID	Device User ID	Used to assign a user-defined name to a camera.
DeviceVendorName	Device Vendor Name	The camera's vendor name, e.g., Cognex.
DeviceVersion	Device Version	The camera's version number.
HeightMax	Height Max	The maximum allowed height of the image ROI in pixels. The value adapts to the current settings for Binning (available only on the CIC-L041-MG-84-5G camera).
SensorHeight	Sensor Height	The actual height of the camera's sensor in pixels.
SensorWidth	Sensor Width	The actual width of the camera's sensor in pixels.
WidthMax	Width Max	The maximum allowed width of the image ROI in pixels. The value adapts to the current settings for Binning (available only on the CIC-L041-MG-84-5G camera).

Additional Device Information Parameters

The following additional device information parameters are available:

Parameter Name	Display Name	Description
DeviceIndicatorMode	Device Indicator Mode	Allows you to set the behavior of the camera's status LED. To turn the status LED on, set the parameter to <code>Active</code> . To turn the status LED off, set the parameter to <code>Inactive</code> . To turn the status LED off unless an error occurs, set the parameter to <code>ErrorStatus</code> (if available).
DeviceLinkCurrentThroughput	Device Link Current Throughput	The actual bandwidth currently used for data transmission in bytes per second.
DeviceLinkSpeed	Device Link Speed	The net link speed. The unit varies by camera model. On newer cameras, the speed is specified in bits per second.
DeviceLinkThroughputLimit	Device Link Throughput Limit	Specifies the maximum available bandwidth for data transmission in bytes per second. To enable the limit, set the <code>DeviceLinkThroughputLimitMode</code> parameter to <code>On</code> . On GigE cameras, the camera automatically adjusts the inter-packet delay to set the bandwidth to the specified limit.
DeviceLinkThroughputLimitMode	Device Link Throughput Limit Mode	Allows you to limit the maximum available bandwidth for data transmission. This parameter is read-only. If not, set the parameter to <code>On</code> to enable the limit. The maximum bandwidth is limited to the <code>DeviceLinkThroughputLimit</code> parameter value. Note that the actual bandwidth used for data transmission may be lower than the <code>DeviceLinkThroughputLimit</code> parameter value.
DeviceSFNCVersionMajor	Device SFNC Version Major	The major version of the Standard Features Naming Convention (SFNC) that the camera complies with, e.g., "2" for SFNC 2.3.1.
DeviceSFNCVersionMinor	Device SFNC Version Minor	The minor version of the Standard Features Naming Convention (SFNC) that the camera complies with, e.g., "3" for SFNC 2.3.1.
DeviceSFNCVersionSubMinor	Device SFNC Version Sub Minor	The subminor version of the Standard Features Naming Convention (SFNC) that the camera complies with, e.g., "1" for SFNC 2.3.1.

3.14 Device Temperature

The Device Temperature camera feature allows you to determine the camera temperature at various locations within the camera, e.g., core board, sensor board, or camera housing.

Use the [Temperature State](#) feature to determine the camera's current internal temperature state.

3.14.1 Using the Feature

Determining the Device Temperature

To determine the device temperature:

1. If the `DeviceTemperatureSelector` parameter is available, set the parameter to the desired location where the temperature should be measured, e.g., `Sensor`.
2. Get the value of the `DeviceTemperature` parameter.

The temperature is given as a floating-point value in degrees Celsius.

3.15 Digital Shift

The Digital Shift camera feature allows you to multiply the pixel values of the images.

This increases the brightness of the image. If your camera doesn't support the digital shift feature, you can use the [Gain](#) feature to achieve a similar effect.

3.15.1 Using the Feature

How It Works

Configuring a digital shift factor of n results in a **logical left shift by n** on all pixel values. This has the effect of multiplying all pixel values by 2^n .

If the resulting pixel value is greater than the maximum value possible for the current [pixel format](#) (e.g., 4 095 for a 12-bit pixel format), the value is set to the maximum value.

For more information, see the [examples](#) below.

Configuring Digital Shift

To configure the digital shift factor, enter the desired value for the `DigitalShift` parameter.

By default, the parameter is set to 0, i.e., digital shift is disabled.

Examples

EXAMPLE 1: DIGITAL SHIFT BY 1, 12-BIT IMAGE DATA

Assume that you have entered a digital shift factor of 1 on a camera that uses a 12-bit [pixel format](#). This has the following effects:

	MSB						LSB						
	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
Binary	0	0	0	0	0	0	0	1	0	1	1	0	Original pixel value: 22
Decimal	0	0	0	0	0	0	0	16	0	4	2	0	
	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
Binary	0	0	0	0	0	0	1	0	1	1	0	0	New pixel value: 44
Decimal	0	0	0	0	0	0	32	0	8	4	0	0	

- The least significant bit in each 12-bit image data word is set to 0.
- The pixel values are multiplied by $2^1 = 2$.
- Because the least significant bit is set to 0, the camera transmits only even pixel values, e.g., 2, 4, 6, 8, 10, and so on.

EXAMPLE 2: DIGITAL SHIFT BY 2, 12-BIT IMAGE DATA

Assume that you have entered a digital shift factor of 2 on a camera that uses a 12-bit [pixel format](#). This has the following effects:

	MSB						LSB						
	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
Binary	0	0	0	0	1	1	0	1	0	1	1	0	Original pixel value: 214
Decimal	0	0	0	0	128	64	0	16	0	4	2	0	
	↙	↙	↙	↙	↙	↙	↙	↙	↙	↙	↙	↙	
	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
Binary	0	0	1	1	0	1	0	1	1	0	0	0	New pixel value: 856
Decimal	0	0	512	256	0	64	0	16	8	0	0	0	

- The least 2 significant bits in each 12-bit image data word are set to 0.
- The pixel values are multiplied by $2^2 = 4$.
- Because the two least significant bits are set to 0, the camera transmits only every fourth pixel value, e.g., 4, 8, 12, 16, 20, and so on.

EXAMPLE 3: DIGITAL SHIFT BY 2, 8-BIT IMAGE DATA

Assume that your camera has a **maximum pixel bit depth** of 12 bit, but is currently using an 8-bit pixel format.

In this case, the camera first performs the digital shift calculation on the 12-bit image data. Then, the camera drops the 4 least significant bits and transmits the 8 most significant bits:

	MSB								LSB				
	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
Binary	0	0	1	0	1	1	0	1	0	1	1	0	Original pixel value (8 bit): 45 Original pixel value (12 bit): 726
Decimal	0	0	512	0	128	64	0	16	0	4	2	0	
	↙	↙	↙	↙	↙	↙	↙	↙	↙	↙	↙	↙	
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0					
Binary	1	0	1	1	0	1	0	1	-	-	-	-	New pixel value (8 bit): 181
Decimal	128	0	32	16	0	4	0	1	-	-	-	-	

EXAMPLE 4: DIGITAL SHIFT BY 1, 12-BIT IMAGE DATA, HIGH VALUE

Assume that your camera is using a 12-bit **pixel format**. Also assume that one of your original pixel values is 2 839:

	MSB						LSB						
	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
Binary	1	0	1	1	0	0	0	1	0	1	1	1	Original pixel value: 2839
Decimal	2048	0	512	256	0	0	0	16	0	4	2	1	

If you apply digital shift by 1 to this pixel value, the resulting value is greater than the maximum possible value for 12-bit pixel formats ($4096 + 1024 + 512 + 32 + 8 + 4 + 2 = 5678$; maximum value for 12-bit formats: 4 095). In this case, the value is set to the maximum value, i.e., all bits are set to 1:

	MSB						LSB						
	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
Binary	1	1	1	1	1	1	1	1	1	1	1	1	
Decimal	2048	1024	512	256	128	64	32	16	8	4	2	1	New pixel value: 4095

i Info

As a consequence, make sure not to apply a digital shift factor that is too high for your imaging scenario. Otherwise, all bright areas in your images will be set to white, i.e., image information will be lost.

External Links

- [Logical Shift \(Wikipedia\)](#)

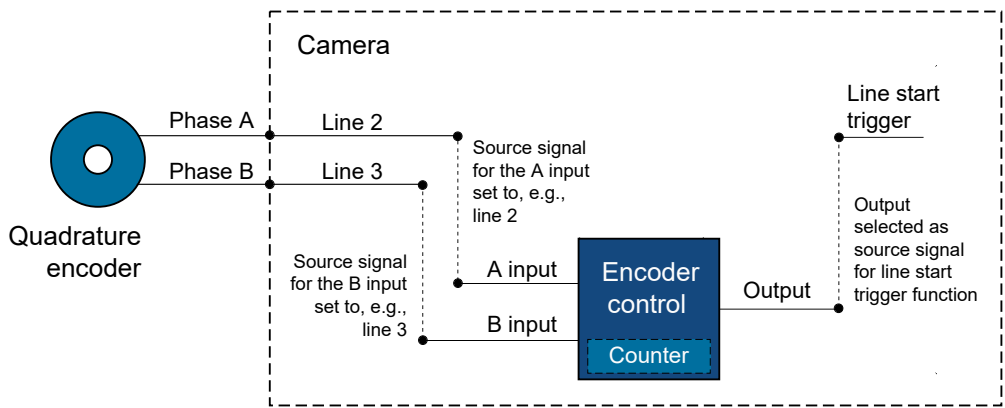
3.16 Encoder Control

The Encoder Control camera feature allows you to control and monitor a quadrature encoder. Quadrature encoders are also known as incremental, rotary, or shaft encoders. They are typically used in automation applications where motion or changes in position must be measured.

3.16.1 Using the Feature

How It Works

The Encoder Control is interfaced to a quadrature encoder, which can be either rotary or linear, that generates two output signals A and B. These are also called phase or source A and B. The two signals have a phase difference of 90° used to track the encoder's forward and backward direction of motion. Phase A and B are the input signals for the camera's encoder control. The following image shows a typical implementation of the encoder control.

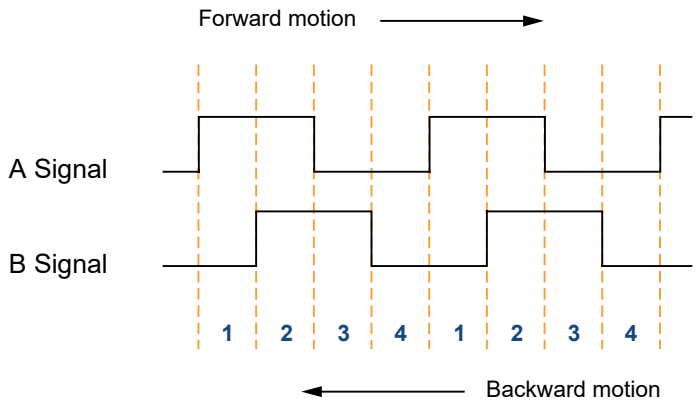


ENCODER DIRECTION OF MOTION

The encoder can either move in forward or in backward direction. To detect the direction of motion, the encoder control reads the order of the rising and falling edges of the A and B signals.

- **Forward direction of motion:** The A signal rises 90° ahead of the B signal. The phase order is 1-2-3-4.
- **Backward direction of motion:** The B signal rises ahead of the A signal. The phase order is 4-3-2-1.

The following image shows the four phases corresponding to the digital signal levels of the A and B signals.



Position Counter

The encoder control uses a position counter driven by the A and B signals. The counter value increments in forward direction of motion and decrements in backward direction of motion.

The position counter runs continuously. Its value represents the number of incoming signals received since the last reset. Therefore, the counter value always reflects the current position of the target object in relation to the forward or backward direction of motion.

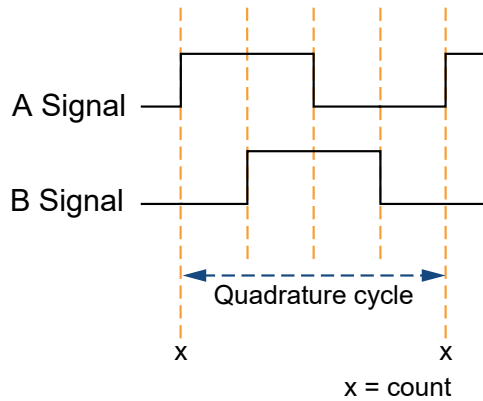
Encoder Mode

The encoder mode controls how the incoming encoder signals are calculated by the encoder control.

FOUR PHASE MODE

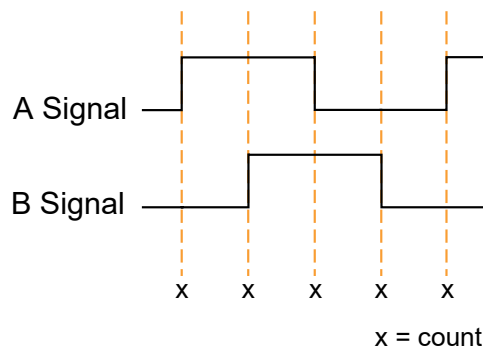
Four fully completed signal phases form a quadrature cycle. Every full quadrature cycle, i.e., when the A signal edge is rising, the quadrature encoder counter increments or decrements by 1.

The Four Phase mode is quite robust and allows to filter out a small amount of signal jitter between two phases.



HIGH RESOLUTION MODE

In High Resolution mode, the counts per cycle are quadrupled. The encoder counter increments or decrements by 1 on each signal phase, i.e., when the A **and** B signal edges are rising **and** falling.



Info

Jitter filtering isn't possible in High Resolution mode. The High Resolution mode isn't therefore recommended to be used together with an **encoder output mode** set to **Motion** since jitter between two phases can result in continuous output trigger pulses.

Encoder Output Mode

The encoder output mode allows you to set the conditions for the encoder control to generate a valid output signal. The following encoder output modes are available:

- `Motion`: Output trigger signals are generated regardless of the direction of motion.
- `DirectionUp`: Output trigger signals are generated at all position increments in **forward** direction. Backward direction of motion is ignored.
- `DirectionDown`: Output trigger signals are generated at all position increments in **backward** direction. Forward direction of motion is ignored.
- `PositionUp`: Output trigger signals are generated at all **new** positions in **forward** direction. If the encoder reverses, no output trigger signals are generated until it has again passed the position where the reversal started.
- `PositionDown`: Output trigger signals are generated at all **new** positions in **backward** direction. If the encoder reverses, no output trigger signals are generated until it has again passed the position where the reversal started.
- `Off`: No output trigger signals are generated.

Additional Parameters

- `EncoderDivider`: Determines the number of input signals from the encoder needed to generate an encoder output trigger signal.
- `EncoderValue`: Gets the current value of the position counter. This parameter is read-only.
- `EncoderReset`: Resets the current counter value of the position counter to 0. This also resets and restarts the entire encoder control. Signal pulses are counted immediately after restart.

Configuring the Encoder Control

To configure the encoder control:

1. Set the `EncoderSelector` parameter to `Encoder1`.
2. Set the `EncoderSourceA` parameter to one of the available source signals, e.g., `Line2`.
3. Set the `EncoderSourceB` parameter to one of the available source signals, e.g., `Line3`.
4. Set the `EncoderMode` parameter to one of the following values:
 - `FourPhase`
 - `HighResolution`
5. Set the `EncoderDivider` parameter to the desired number of input signals.
6. Set the `EncoderOutputMode` parameter to the kind of **output mode** that you want to enable, e.g., `Motion`.

To configure the camera to be triggered by the encoder signal:

1. Set the `TriggerSelector` parameter to `LineStart`.
2. Set the `TriggerMode` parameter to `On`.
3. Set the `TriggerSource` parameter to `Encoder1`.

3.17 Error Codes

The Error Codes camera feature allows you to read error codes from the camera.

If several different errors occur, they are stored in an error list and can be retrieved one by one.

3.17.1 Using the Feature

How It Works

The camera can detect certain errors. If such an error occurs, the camera assigns an error code to this error and stores the error code in memory.

If several different errors occur, the camera stores the code for each type of error detected. The camera stores each code only once regardless of how many times it has detected the corresponding error.

Checking Error Codes

Checking error codes is an iterative process, depending on your camera model and how many errors have occurred.

Your camera can generate a list of errors that can be evaluated by [Cognex support](#).

To check error codes:

1. Get the value of the `BslErrorPresent` parameter.
2. If the parameter value is `true` :
 - a. Get the value of the `BslErrorReportValue` parameter.
 - b. Store the value on your computer or write it down for further reference.
 - c. Execute the `BslErrorReportNext` command. This retrieves the next error code from the device.
 - d. Repeat steps a) to c) until the `BslErrorReportValue` parameter value is `0` . A parameter value of 0 means that there are no more error codes to retrieve.
 - e. [Cognex Product Support](#) with the list of error codes.

3.18 Event Notification

The Event Notification camera feature allows you to enable camera events and event messages.

3.18.1 Using the Feature

Enabling Event Notification

1. Set the `EventSelector` parameter to one of the following values:
 - `ActionLate`
 - `EventOverrun` or `Overrun`
 - `TemperatureStatusChanged`
 - `Test`
2. Set the `EventNotification` parameter to `On`.
3. Repeat steps 1 and 2 for all types of event notifications that you want to enable.
4. Implement event handling in your application:
 - For a C++ sample implementation.
 - For a C and C.NET sample implementation.

Info

- Event messages are sent to the computer if there is sufficient bandwidth available. When the camera operates at high frame rates, event messages may be lost. There is no mechanism to monitor the number of event messages lost.
- After the camera has sent an event message, it waits for an acknowledgement. If no acknowledgement is received within a specified time frame, the camera resends the event message. If an acknowledgement is still not received, the resend mechanism repeats until the maximum number of retries is reached. If this maximum number of retries is reached, the message is dropped. While the camera is waiting for an acknowledgement, no new event messages can be transmitted.

Available Events

ACTION LATE EVENT

The Action Late event occurs if the camera receives a [scheduled action command](#) with a timestamp in the past. When this event occurs, the corresponding message contains a [timestamp](#) indicating the time when the event was generated.

EVENT OVERRUN EVENT

The Event Overrun event (also called Overrun event) occurs if the camera's internal event queue has overrun. This happens if events are generated at a very high frequency and there isn't enough bandwidth available to send the events. The event overrun event is a warning that events are being dropped. The notification contains no specific information about how many or which events have been dropped. When this event occurs, the corresponding message contains a [timestamp](#) indicating the time when the event was generated.

TEMPERATURE STATUS CHANGED EVENT

The Temperature Status Changed event occurs whenever the camera's [temperature state](#) has changed. When this event occurs, the corresponding message contains the `EventTemperatureStatusChangedStatus` parameter. This parameter indicates the new temperature status that applies after the event was raised:

- **Ok:** The temperature status changed to Ok.
- **Critical:** The temperature status changed to Critical.
- **Error:** The temperature status changed to Error.

Also, the corresponding message contains a [timestamp](#) indicating the time when the event was generated.

TEST EVENT

The Test event allows you to test the Event Notification feature.

When this event occurs, the corresponding message contains a [timestamp](#) indicating the time when the event was generated.

To test event notification:

1. Execute the `TestEventGenerate` command.
2. Handle the Test event in your application.

Info

The Test event is always enabled. You don't need to enable it via the `EventSelector` parameter.

3.19 Exposure Time

The Exposure Time camera feature specifies how long the image sensor is exposed to light during image acquisition.

3.19.1 Using the Feature

 **Info**

This feature is pre-configured by VisionPro. Therefore, it isn't recommended that you configure this feature manually.

Determining the Exposure Time

To determine the current exposure time in microseconds:

- Get the value of the `ExposureTime` parameter. Note that depending on the sensor type and its specific characteristics, this value may differ slightly from the effective exposure time.

Determining the exposure time can be useful, for example, if you want to retrieve the automatically adjusted exposure time.

Setting the Exposure Time

To set the exposure time:

1. Set the `ExposureMode` parameter to `Timed`.
2. Set the `ExposureTime` parameter to the desired exposure time in microseconds.

The minimum and maximum exposure time vary by camera model:

Camera Model	Minimum Exposure Time [μs]	Maximum Exposure Time [μs]
CIC-L041-CG-42-5G	3.15	1000000
CIC-L041-MG-84-5G	2.1	1000000

3.20 Frequency Converter

The Frequency Converter camera feature allows you to trigger the camera at a frequency that differs from the frequency of the input signals received. You can use it to multiply the original signal frequency by a fractional value.

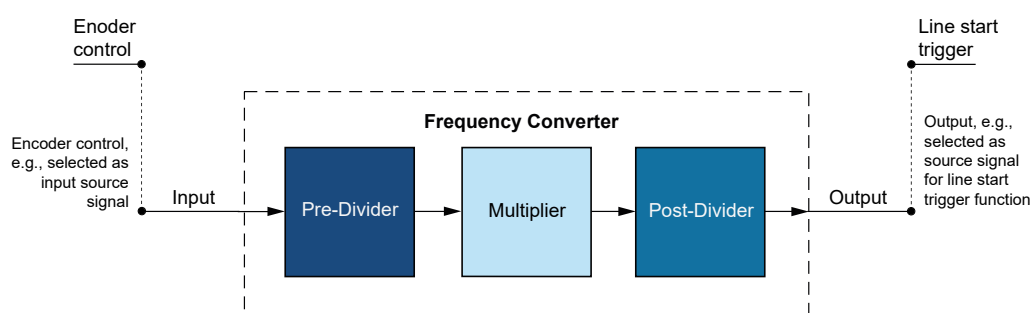
The frequency converter can accept trigger signals from different sources, e.g., from the camera's [encoder control](#), [counter](#), or [timer](#). Receiving signals from the encoder control is the most common use case.

3.20.1 Using the Feature

How It Works

The frequency converter adapts the trigger rate of signals received to a trigger rate that is suitable for use in other applications. This is done by means of division and multiplication.

The frequency converter includes three modules acting in sequence on the original signals: the pre-divider, the multiplier, and the post-divider:



Pre-Divider Module

The pre-divider module receives the input signals. The module allows you to apply an integer factor, the pre-divider, to decrease the original frequencies and passes the signals on to the next module, the multiplier module.

If, e.g., the pre-divider value is set to 2, only every other input signal is passed out unchanged to the multiplier module and, accordingly, the frequency is halved. If the pre-divider value is set to 1, every input signal is passed out unchanged to the multiplier module.

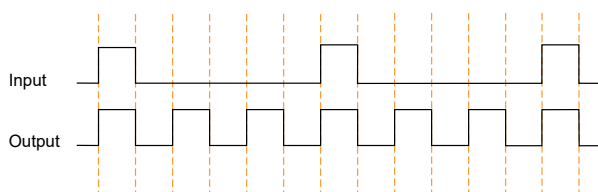
Info

- Employing the pre-divider can be advisable for decreasing periodic jitter of the input signals.
- Cognex recommends using low values for the pre-divider. The original signal frequency should be changed as little as possible to facilitate frequency adjustment by the multiplier module.

Multiplier Module

The multiplier module receives the signals from the pre-divider module. To ensure proper operation, the signal frequency received must not be less than 10 Hz. The multiplier module allows you to apply an integer factor, the multiplier, to generate signals at increased frequencies and passes the signals on to the next module, the post-divider module.

For each input signal, a synchronous output signal is generated, i.e., the signals are in phase. Applying a multiplier factor of three would look like this:



i Info

After changing the input signal or the multiplier value, it may take some time to reach such an ideal state of phase alignment as shown above. If input periods vary constantly, e.g., when signals sent by an incremental encoder have substantial jitter, a stable phase alignment might never be reached. However, the output signal will be close to optimum.

Post-Divider Module

The post-divider module receives the signals from the multiplier module. The post-divider module allows you to apply an integer factor, the post-divider, to generate signals at decreased frequencies and provides these signals to be used as camera trigger signals, e.g. as line start triggers.

Frequency Converter Source Signals

You can set the source signal of the frequency converter using the `BslFrequencyConverterSignalSource` parameter. This defines **how** the frequency converter is driven. For example, you can specify that the converter is driven by an electrical signal or by a timer signal.

i Info

The frequency converter can only process pulsed signals. When choosing a level signal, e.g., `Line1`, you must therefore also specify the [signal transition](#) that activates the frequency converter.

The following source signals are available:

- `Encoder1` : The frequency converter can be driven by an incremental encoder.
- `Line1` to `Line6` : The frequency converter can be driven by applying an electrical signal to I/O line 1, 2, 3, 4, 5, or 6.
- `Counter1Active` to `Counter4Active` : The frequency converter can be driven using the [Counter](#) feature. The signal will be high (1) as long as the given counter is counting and low (0) as long as it is not counting.
- `Counter1Start` to `Counter4Start` : The frequency converter can be driven using the [Counter](#) feature. A signal is sent whenever the given counter starts counting.
- `Counter1End` to `Counter4End` : The frequency converter can be driven using the [Counter](#) feature. A signal is sent whenever the given counter stops counting.
- `Timer1Active`, `Timer2Active` : The frequency converter can be driven using the [Timer](#) feature. The signal will be high (1) as long as the given timer is running and low (0) as long as it is not running.
- `Timer1End`, `Timer2End` : The frequency converter can be driven using the [Timer](#) feature. A signal is sent whenever the given timer has elapsed.

Frequency Converter Activation

The `BslFrequencyConverterActivation` parameter allows you to define **which signal transition** activates the frequency converter. For example, you can specify that the converter becomes active when the trigger signal falls.

i Info

The `BslFrequencyConverterActivation` parameter is only available when choosing a level signal as the source signal, i.e., a signal that can be high (1) or low (0) such as an I/O signal or an "Active" signal like `Timer1Active`.

You can set the `BslFrequencyConverterActivation` parameter to one of the following values:

- `RisingEdge` : The frequency converter becomes active when the trigger signal rises, i.e., when the signal status changes from low to high. This is the default setting.
- `FallingEdge` : The frequency converter becomes active when the trigger signal falls, i.e., when the signal status changes from high to low.
- `AnyEdge` : The frequency converter becomes active when the trigger signal falls or rises.

Configuring the Frequency Converter

To configure the frequency converter:

1. Set the `BslFrequencyConverterSignalSource` parameter to one of the available source signals, e.g., `Encoder1`.
2. If you have selected a level signal as source signal, set the `BslFrequencyConverterActivation` parameter, e.g., to `RisingEdge`.
3. Set the `BslFrequencyConverterPreDivider` parameter, e.g., to 3.
4. Set the `BslFrequencyConverterMultiplier` parameter, e.g., to 4.
5. Set the `BslFrequencyConverterPostDivider` parameter, e.g., to 2.

3.21 Gain

The Gain camera feature allows you to increase the brightness of the images output by the camera. Increasing the gain increases all pixel values of the images.

 **Info**

To adjust the gain value automatically, use the [Gain Auto](#) feature.

3.21.1 Using the Feature

 **Info**

This feature is pre-configured by VisionPro. Therefore, it isn't recommended that you configure this feature manually.

Digital Gain

The gain is an amplification factor applied to all pixel values of the acquired images. On your camera model, the mechanisms to control the gain is entirely digital:

- **Digital gain** is applied **after** the conversion, i.e., it is basically a multiplication of the digitized values.

Setting the Gain

1. Set the [GainAuto](#) parameter to `Off`.
2. Set the [Gain](#) parameter to the desired [value](#).
The minimum and maximum parameter values vary depending on your camera model, the pixel format chosen, and the Binning settings.

Gain Must be Entered as dB.

Gain Values

Minimum Gain Setting	Maximum Gain Setting (8-bit Pixel Formats)	Maximum Gain Setting (10-bit Pixel Formats)	Maximum Gain Setting (12-bit Pixel Formats)
0	36	36	36

3.22 Gain Auto

The Gain Auto camera feature automatically adjusts the [gain](#) within specified limits until a target brightness value has been reached.

The pixel data for the auto function can come from one or multiple [auto function ROIs](#).

To adjust the gain manually, use the [Gain](#) feature.

3.22.1 Using the Feature

Enabling or Disabling Gain Auto

To enable or disable the Gain Auto auto function:

1. [Assign](#) at least one auto function ROI to the Gain Auto auto function.

Make sure the auto function ROI [overlaps](#) the image ROI, either partially or completely.

2. Set the `GainAuto` parameter to one of the following operating modes:

- `Once` : The camera adjusts the gain until the specified [target brightness value](#) has been reached. When this has been achieved, or after a maximum of 30 calculation cycles, the camera sets the auto function to [Off] and applies the gain resulting from the last calculation to all following images.
- `Continuous` : The camera adjusts the gain continuously while images are being acquired.
- `Off` : Disables the Gain Auto auto function. The gain remains at the value resulting from the last automatic or manual adjustment.

Info

When the camera is capturing images continuously, the auto function takes effect with a short delay. The first few images may not be affected by the auto function.

Specifying Lower and Upper Limits

The auto function adjusts the `Gain` parameter value within limits specified by you.

To change the limits, set the `AutoGainLowerLimit` and the `AutoGainUpperLimit` parameters to the desired values.

Example: Assume you have set the `AutoGainLowerLimit` parameter to 2 and the `AutoGainUpperLimit` parameter to 6. During the automatic adjustment process, the gain will never be lower than 2 and never higher than 6.

Specifying the Target Brightness Value

The auto function adjusts the gain until a target brightness value, i.e., an average gray value, has been reached.

To specify the target value, use the `AutoTargetBrightness` parameter.

Info

The target value calculation does not include other image optimizations, e.g., [Gamma](#). Depending on the image optimizations set, images output by the camera may have a significantly lower or higher average gray value than indicated by the target value.

When a damping factor is used, the target value is reached more slowly.

3.23 Gamma

The Gamma camera feature allows you to optimize the brightness of acquired images for display on a monitor.

Note

This feature is **not** available on the CIC-L041-MG-84-5G camera.

3.23.1 Using the Feature

How It Works

The camera applies a gamma correction value (γ) to the brightness value of each pixel according to the following formula (red pixel value (R) of a color camera shown as an example):

$$R_{\text{corrected}} = \left(\frac{R_{\text{uncorrected}}}{R_{\text{max}}} \right)^{\gamma} \times R_{\text{max}}$$

The maximum pixel value (Rmax) equals, e.g., 255 for 8-bit [pixel formats](#) or 1 023 for 10-bit pixel formats.

Enabling Gamma Correction

To enable gamma correction:

1. For best results, set the [BlackLevel](#) parameter to 0.
2. Set the [Gamma](#) parameter to the desired value. The parameter's value range is 0 to ≈ 4 .
 - **Gamma = 1:** The overall brightness remains **unchanged**.
 - **Gamma < 1:** The overall brightness **increases**.
 - **Gamma > 1:** The overall brightness **decreases**.

In all cases, black pixels (brightness = 0) and white pixels (brightness = maximum) will not be adjusted.

Info

- If you enable gamma correction and the [pixel format](#) is set to a 12-bit pixel format, some image information will be lost. Pixel data output will still be 12-bit, but the pixel values will be interpolated during the gamma correction process.
- On boA13440-17cm cameras, gamma correction can only be enabled, if the [pixel format](#) is set to an 8-bit pixel format.

Additional Parameters

The following additional parameter is available:

- [BslColorSpaceMode](#) or [BslColorSpace](#) : Allows you to select one of the following gamma correction modes:
 - [RGB](#) : No additional gamma correction value is applied.
 - [sRGB](#) : The image brightness is optimized for display on an sRGB monitor. A gamma correction value of approximately 0.4 is applied. This value is applied separately and not included in the [Gamma](#) parameter value.
Example: You set the color space to sRGB and the [Gamma](#) parameter to 1.2. First, an automatic correction value of approximately 0.4 is applied to the pixel values. After that, a gamma correction value of 1.2 is applied to the resulting pixel values.

3.24 Hue and Saturation

The Hue and Saturation camera feature allows you to adjust the appearance of all colors in your images in a single step.

If you want to adjust the appearance of individual colors in your images, use the [Color Adjustment](#) feature (only available on the CIC-L041-CG-42-5G camera).

Note

This feature is **not** available on the CIC-L041-MG-84-5G camera.

3.24.1 Using the Feature

Adjusting the Hue

Adjusting the hue shifts the colors of the image. This can be useful, e.g., to correct color shifts or to create false-color images.

To adjust the hue:

1. Enter a value for the `BslHue` parameter. The parameter's value range is -180° to 180° .

The parameter value refers to a rotation of the RGB color cube. By default, the parameter is set to 0° (no color shift).

Adjusting the Saturation

Adjusting the saturation changes the colorfulness (intensity) of the colors. A higher saturation, for example, makes colors easier to distinguish.

To adjust the saturation:

1. Enter a value for the `BslSaturation` parameter. By default, the parameter is set to 1 (normal saturation).

Lower parameter values result in more muted colors that are closer to gray. Higher parameter values result in more vivid, vibrant colors.

Additional Parameters

If available, the `BslHueRaw` and `BslSaturationRaw` parameters allow you to enter integer values instead of float values for the hue and saturation parameters. Normally, you don't need to set these parameters.

3.25 Image ROI

The Image ROI camera feature allows you to specify the part of the sensor array that you want to use for image acquisition.

ROI is short for region of interest (formerly AOI = area of interest).

If an image ROI has been specified, the camera will only transmit pixel data from within that region. This might increase the camera's maximum frame rate significantly.

The image ROI settings are independent from the [auto function ROI](#) settings.

3.25.1 Using the Feature

Info

This feature is pre-configured by VisionPro. Therefore, it isn't recommended that you configure this feature manually.

Changing Position and Size of an Image ROI

With the factory settings enabled, the camera is set to a default resolution. However, you can change the position and size as required.

To change the position and size of the image ROI:

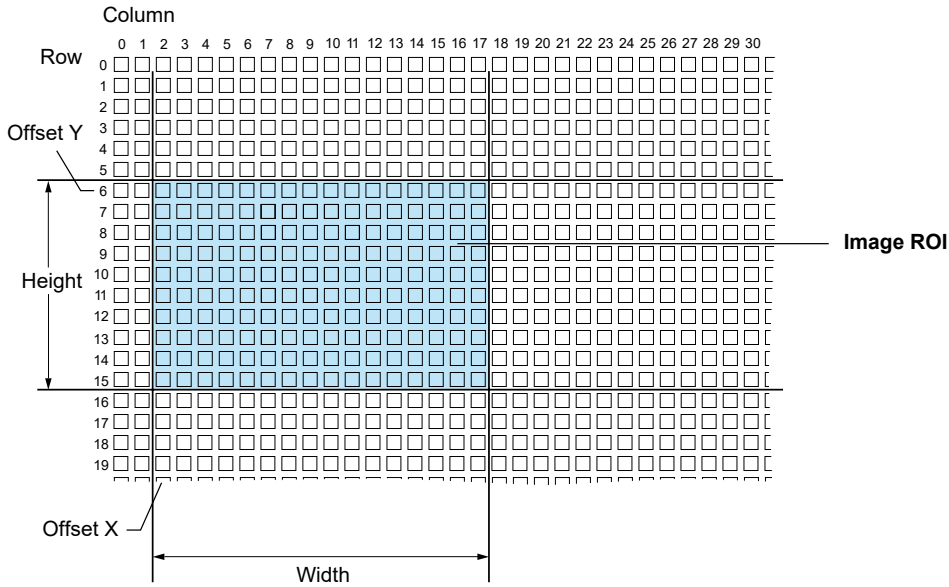
1. Make sure the camera is idle, i.e., not capturing images.
2. Use the following parameters to specify the **size** of the image ROI:
 - `Width`
 - `Height`
3. Use the following parameters to specify the **position** of the image ROI:
 - `OffsetX`
 - `OffsetY`

The origin of the image ROI is in the top left corner of the sensor array (column 0, row 0).

Example: Assume that you have specified the following settings:

- `Width = 16`
- `Height = 10`
- `OffsetX = 2`
- `OffsetY = 6`

This creates the following image ROI:



Info

- For line scan cameras having **more than one sensor line**, the following applies:
If you set the image ROI height to 1, the camera output on acquisition depends on the number of camera sensor lines:
 - Cameras with **2 sensor lines**:
The camera will output the color channels as follows:
G in one line, R and B alternating in the other. For information about the number of sensor lines available in a camera model, see the **General Specifications** table in the corresponding camera topic.
- On your camera, the `OffsetY` parameter is not available.
- On your camera, you can add several lines to build a frame. Use the `Height` parameter to define the height of the image ROI, i.e., the height of the resulting frame that is transmitted to the host computer.
Minimum number of lines per frame: 1
Depending on the host computer, a low frame height (i.e. < 10 lines) may increase the CPU load of the host computer significantly.
The **maximum number of lines per frame** depends on the camera model:
 - CIC-L041-MG-84-5G camera: **12000**
 - CIC-L041-CG-42-5G camera: **10000**

Info

For your camera, you can use the [Counter](#) and [Data Chunks](#) features, in combination with the trigger settings, to specify which lines belong to a frame and which frames belong to the correct test object.

Guidelines

When you are specifying an image ROI, follow these guidelines:

Guideline	Example
<code>OffsetX + Width ≤ WidthMax</code>	Camera with a 1920 x 1080 pixel sensor: <code>OffsetX + Width ≤ 1920</code>
<code>OffsetY + Height ≤ HeightMax</code>	Camera with a 1920 x 1080 pixel sensor: <code>OffsetY + Height ≤ 1080</code>

The `WidthMax` and `HeightMax` parameter values adapt to the current settings for [Binning](#).

3.25.2 Specifics

Image ROI Sizes

Minimum Width	Minimum Height
4	1

3.26 Input Filter

The Input Filter camera feature allows you to filter out noise, interference, or contact bounce from hardware input signals.

3.26.1 Using the Feature

How It Works

You can control input filtering by configuring one or both of the following camera settings:

- [Input filter time](#)
- [Input hold-off time](#)

INPUT FILTER TIME

Digital input signals often aren't perfectly formed when they arrive at the camera. They can pick up noise and interference from ambient electromagnetic fields, especially when long I/O cables are used, or from power equipment nearby. Also, switch outputs can cause crosstalk.

As a result, a change from "low" to "high", or vice versa, can take several microseconds, with the logic level being undefined during the transition.

Specifying an input filter time allows you to eliminate most of these problems.

The input filter evaluates all changes and durations of logical states of the input signal. The duration of this evaluation period is defined by the `BslInputFilterTime` parameter.

During evaluation, the camera calculates the mean value over time and applies a threshold function to the result to reconstruct the digital signal. This removes noise, interference, etc. as well as signal pulses shorter than the filter time.

Info

If you specify an input filter time and the input signal is not steady after the original transition, the propagation delay increases.

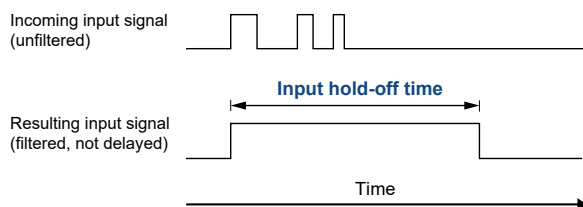
This means that the period of time between the change of the analog I/O signal and the change of the camera's internal status will be longer.

INPUT HOLD-OFF TIME

Setting an input hold-off time is useful if you want to avoid false triggering caused by multiple trigger signals arriving in quick succession (contact bounce).

If an input hold-off time is set and an input trigger signal arrives, the camera accepts the signal and stops accepting any further trigger signals or signal changes until the hold-off time has elapsed.

For example, if you set the `BslInputHoldOffTime` parameter to 10 and apply a trigger signal to the camera, the camera accepts the signal and stops accepting any further trigger signals or signal changes for 10 microseconds.



Info

Unlike the [input filter time](#), specifying an input hold-off time does not increase the propagation delay.

Configuring Input Filtering

1. Make sure the camera is configured for hardware triggering.
2. Set the `LineSelector` parameter to the desired input line, e.g., `Line1`.
3. If you want to configure the **input filter time**, enter a value for the `BslInputFilterTime` parameter.
4. If you want to configure the **input hold-off time**, enter a value for the `BslInputHoldOffTime` parameter.

Choosing the Input Filter and Input Hold-Off Time

- Choosing an input filter time or input hold-off time that is **too low** results in accepting invalid signals and signal states.
- Choosing an input filter time or input hold-off time that is **too high** results in rejecting valid signals and signal states.

Cognex recommends the following approaches:

- Choose an input filter time that is slightly longer than the longest expected duration of an invalid signal.
- Choose an input hold-off time that is slightly shorter than the shortest expected interval between two valid signals.

There is a small risk of rejecting short valid signals but in most scenarios this approach should deliver good results. Monitor your application and, if necessary, adjust the values if you find that too many valid signals are being rejected.

3.27 Line Format

The Line Format camera feature allows you to determine the electrical format of an I/O line.

3.27.1 Using the Feature

Determining the Line Format

To determine the electrical format of an I/O line:

1. Set the `LineSelector` parameter to the desired I/O line, e.g., `Line1`.
2. Get the value of the `LineFormat` parameter.
This parameter is read-only.

Possible Values

Possible values are:

- `NoConnect` : The line is not connected.
- `OptoCoupled` : The line is an **opto-coupled I/O line**.
- `OpenDrain`, `TTL`, `LVTTL`, or `RS422` : The line is a **general purpose I/O (GPIO) line**.

3.28 Line Inverter

The Line Inverter camera feature allows you to invert the electrical signal level of an I/O line. All high (1) signals are converted to low (0) signals and vice versa.

3.28.1 Using the Feature

Enabling the Line Inverter

 Info

Enable the line inverter only when the I/O lines are not in use. Otherwise, the camera may show unpredictable behavior.

1. Set the `LineSelector` parameter to the desired I/O line.
2. Set the `LineInverter` parameter to **true** to invert the electrical signal level of the I/O line selected or to **false** to disable inversion.

3.29 Line Mode

The Line Mode camera feature allows you to determine or configure whether an I/O line is used as an input, output, or input-output line.

You can configure the line mode of any [general purpose I/O line](#) (GPIO line). For [opto-coupled I/O lines](#), you can only determine the current line mode.

3.29.1 Using the Feature

Configuring the Line Mode

Configure the line mode only when the I/O lines are not in use. Otherwise, the camera may show unpredictable behavior.

Set the `LineSelector` parameter to the desired [GPIO line](#).

Set the `LineMode` parameter to one of the following values:

- `Input` : Configures the GPIO line as an input line.
- `Output` : Configures the GPIO line as an output line.

Determining the Line Mode

1. Set the `LineSelector` parameter to the desired I/O line.
2. Get the value of the `LineMode` parameter to determine the current line mode of the I/O line.

3.30 Line Overload Status

The Line Overload Status camera feature allows you to determine whether a [GPIO](#) line is overloaded, i.e., not powered correctly.

3.30.1 Using the Feature

Causes for Line Overload

If a GPIO line is [configured as an output line](#), you must apply appropriate output signal voltages as specified in your camera topic. You can find your camera topic in the "Models" section.

If you don't apply the appropriate voltages, a line overload may occur. As long as the absolute maximum voltage of the camera is not exceeded, the camera can detect the overload and report it via the `BslLineOverloadStatus` parameter.

Determining the Overload Status of an I/O Line

To determine whether a GPIO line is overloaded:

1. Set the `LineSelector` parameter to the desired I/O line, e.g., `Line1`.
2. Get the value of the `BslLineOverloadStatus` parameter. The parameter is read-only.

A value of `false` (0) means that the GPIO line is not overloaded.

A value of `true` (1) means that the GPIO line is overloaded. Check the configuration of your I/O lines.

Determining the Overload Status of All I/O Lines

To determine the overload status of all I/O lines in a single operation, read the `BslLineOverloadStatusAll` parameter. The parameter is reported as a 64-bit value.

Certain bits in the value are associated with the I/O lines. Each bit indicates the status of its associated line:

- If a bit is 0, the associated line is not overloaded.
- If a bit is 1, the associated line is overloaded. Check the configuration of your I/O lines.

The bit-to-line association is as follows:

- Bit 0 indicates Line1 status.
- Bit 1 indicates Line2 status.
- Bit 2 indicates Line3 status.

Example: All lines high = 0b111

Info

If the [Line Inverter](#) feature is enabled, the camera inverts the `BslLineOverloadStatusAll` parameter value. All 0 bits change to 1, and vice versa.

3.31 Line Selector

The Line Selector camera feature allows you to select the I/O line that you want to configure.

3.31.1 Using the Feature

Selecting a Line

To select a line, set the `LineSelector` parameter to the desired I/O line, e.g., `Line1`. Depending on the camera model, the total number of I/O lines, the format of the lines ([opto-coupled](#) or [GPIO](#)), and the pin assignment may vary. To find out what your camera model offers, check the "Physical Interface" section in your camera topic. You can find your camera topic in the "Models" section. Possible tasks depend on whether the I/O line [serves as input or output](#). Once you have selected a line, you can do the following:

Task	Feature
Configuring input filtering for an input line	Input Filter
Selecting the source signal for an output line	Line Source
Setting the line status of a user settable output line	User Output Value
Setting the line mode of a GPIO line	Line Mode
Enabling the invert function	Line Inverter
Checking the status of a single I/O line	Line Status

3.32 Line Source

The Line Source camera feature allows you to configure which signal to output on the I/O line currently [selected](#).

This allows you to monitor the status of the camera or to control external devices. For example, you can monitor if the camera is currently exposing or you can control external flash lighting.

For each camera output line, you can set exactly one signal.

Info

- For the pin numbering and pin assignment of the I/O connector, see the [Connector Pinout](#) section.
- The camera sends all output signals with a short [propagation delay](#). The delay is usually in the microseconds range.

3.32.1 Using the Feature

Setting the Line Source

To set the line source:

1. Set the [LineSelector](#) parameter to an I/O line [configured as output](#), e.g., [Line2](#).
2. Set the [LineSource](#) parameter to one of the following values:
 - [AcquisitionActive](#)
 - [Counter1Active](#), [Counter2Active](#), [Counter3Active](#), or [Counter4Active](#)
 - [ExposureActive](#)
 - [TimerActive](#), [Timer1Active](#), or [Timer2Active](#)
 - [UserOutput](#), [UserOutput1](#), [UserOutput2](#), etc.

Available Line Source Signals

The following line source signals are available:

ACQUISITION ACTIVE

You can use the Acquisition Active signal to monitor if the camera is currently acquiring an image. The signal goes high when acquisition starts. The signal goes low when acquisition ends.

Acquisition includes **exposure and readout**. Therefore, the Acquisition Active signal is high during exposure and readout, while the [Exposure Active](#) signal is high only during exposure.

COUNTER ACTIVE

You can use the camera's "Counter Active" signals, e.g., Counter 1 Active, to monitor the camera's [Counter](#) feature. The signal goes high when the counter has been [started](#). The signal goes low when the counter is [stopped](#), [reset](#), or when it has reached its maximum value.

EXPOSURE ACTIVE

You can use the Exposure Active signal to monitor if the camera is currently exposing. The signal goes high when exposure starts. The signal goes low when exposure ends.

The Exposure Active signal can be used to trigger a flash.

The signal is also useful in situations where either the camera or the target object is moving. For example, assume that the camera is mounted on an arm mechanism that moves the camera to different sections of a product assembly. Typically, you don't want the camera to move during exposure. In this case, you can monitor the Exposure Active signal to know when exposure is taking place.

This allows you to avoid moving the camera during that time.

Global Shutter Cameras

On [global shutter](#) cameras, the Flash Window signal is either not available or equivalent to the Exposure Active signal.

TIMER ACTIVE

You can use the camera's "Timer Active" signals, e.g., Timer 1 Active, to monitor the camera's [Timer](#) feature. The signal goes high after the delay specified. The signal goes low after the duration specified.

USER OUTPUT

You can set the status of a line by software. This can be useful to control external events or devices, e.g., a light source. For more information, see the [User Output Value](#) feature.

Configuration: Multiple User Output Line Sources Available

On your camera, **multiple** User Output line sources are available (e.g., "User Output 1" and "User Output 2"):

1. Set the [LineSelector](#) parameter to the desired output line, e.g., `Line2`.
2. Set the [LineSource](#) parameter to the desired line source, e.g., `UserOutput1`.

Now, you can use the [User Output Value](#) feature to set the status of the line by software.

3.33 Line Status

The Line Status camera feature allows you to determine the status (high or low) of one or all I/O lines.

3.33.1 Using the Feature

Determining the Status of an I/O Line

To determine the status of an I/O line:

1. Set the `LineSelector` parameter to the desired I/O line.
2. Get the value of the `LineStatus` parameter.

This parameter is read-only.

A value of `false` (0) means that the line's status was low at the time of polling.

A value of `true` (1) means the line's status was high at the time of polling.

 Info

If the `Line Inverter` feature is enabled, the `LineStatus` parameter value may not reflect the actual status of the line:

- For **input** lines or GPIO lines **configured** for input, the camera inverts the `LineStatus` parameter value. A `true` parameter value changes to `false`, and vice versa.
- For **output** lines or GPIO lines **configured** for output, the camera may **not** invert the `LineStatus` parameter value. Check this against your camera.

Determining the Status of All I/O Lines

To determine the current status of all I/O lines, read the `LineStatusAll` parameter. The parameter is reported as a 64-bit value. Certain bits in the value are associated with the I/O lines. Each bit indicates the status of its associated line:

- If a bit is 0, the status of the associated line is currently low.
- If a bit is 1, the status of the associated line is currently high.

You can see in the [Specifics](#) section, which bit is associated with which line for your camera.

 Info

If the `Line Inverter` feature is enabled, the camera inverts the `LineStatusAll` parameter value. All 0 bits change to 1, and vice versa.

Line Status and I/O Status

GPIO LINE CONFIGURED AS INPUT

If your camera has a [GPIO line](#) and that line is **configured as input**, the relation between its input status and the `LineStatus` parameter is as follows:

Input Status	LineStatus Parameter Value
Input open (not connected)	True
Voltage level low	False
Voltage level high	True

GPIO LINE CONFIGURED AS OUTPUT

If your camera has a [GPIO line](#) and that line is [configured as output](#), the relation between its output status and the `linestatus` parameter is as described in the [Specifics](#) section.

OPTO-COUPLED INPUT LINE

If your camera has an [opto-coupled input line](#), the relation between its input status and the `LineStatus` parameter is as follows:

Input Status	LineStatus Parameter Value
Input open (not connected)	False
Voltage level low	False
Voltage level high	True

OPTO-COUPLED OUTPUT LINE

For [opto-coupled output lines](#), the relation between its output status and the `LineStatus` parameter is as follows:

Output Status	LineStatus Parameter Value	Electrical Status
0 (e.g., user output value set to <code>false</code>)	True	Voltage level high ^a
1 (e.g., User Output Value set to <code>true</code> or Flash Window signal high)	False	Voltage level low

3.33.2 Specifics



Info

For information about the line status on GPIO lines configured as **input** and on **opto-coupled** I/O lines, see the tables above.

Output Status Relation	LineStatusAll Bit-to-Line Association
Output status 0 (e.g., User Output Value set to false) = LineStatus false = voltage level low	Bit 0 indicates Line1 status
Output status 1 = LineStatus true = voltage level high	Bit 1 indicates Line2 status
	Bit 2 indicates Line3 status
	Example: All lines high = 0b111

a. An external pull-up resistor must be installed. Otherwise, the voltage level will be undefined.

3.34 LUT

The LUT camera feature allows you to replace the pixel values in your images by values defined by you. This is done by creating a user-defined lookup table (LUT).

3.34.1 Using the Feature

How It Works

LUT is short for "lookup table", which is basically an indexed list of numbers. For your camera, you can create a user-defined "luminance lookup table" to replace the pixel values, i.e., the luminance or gray values, in your images. In the lookup table you can define replacement values for individual pixel values. For example, you can replace a gray value of 4 095 (= maximum gray value for 12-bit [pixel formats](#)) by a gray value of 0 (= minimum gray value). This changes all completely white pixels in your images to completely black pixels. Setting up a user-defined LUT can be useful, e.g., if you want to optimize the luminance of your images. By defining the replacement values in advance and storing them in the camera, you avoid time-consuming calculations by your application. Instead, the camera can simply look up the desired new value in the LUT based on the pixel's initial value.

Info

The value range of the user-defined LUT (0–1 024 or 0–4 096) is **not** dependent on the currently selected [pixel format](#). It is dependent on the [maximum pixel bit depth](#) of the camera. If your camera supports 12-bit pixel formats, but currently uses an 8-bit pixel format, you will still be able to enter pixel values between 0 and 4 096. The camera uses these values for conversion. Then, it drops the 4 least significant bits of the converted values and transmits the 8 most significant bits.

Replacing Individual LUT Entries

To replace individual entries in the lookup table:

1. Set the `LUTIndex` parameter to the pixel value that you want to replace with a new value.
2. Set the `LUTValue` parameter to the new pixel value.
3. Repeat steps 1 and 2 for all pixel values that you want to replace.
4. Set the `LUTEnable` parameter to `true`.

Cognex recommends using a programming loop (e.g., a for-loop) to iterate through the values.

NUMBER OF LUT ENTRIES

On your camera, the user-defined LUT can store entries for all replacement values. 4 096 entries are available. This means that the limitations described in the section above don't apply: You can set the `LUTIndex` parameter in increments of 1, and no interpolation is performed.

Replacing All LUT Entries

You can replace all entries in the lookup table with a single operation. In many cases, this is faster than repeatedly changing individual entries in the LUT.

To replace all entries in the lookup table:

1. Set the `LUTValueAll` parameter to the desired value.
Apply `big-endian` to the 4-byte words (LUT values).
2. Set the `LUTEnable` parameter to `true`.

The parameter structure depends on the [maximum pixel bit depth](#) of your camera.

12-BIT CAMERA MODELS

Your camera has a **maximum pixel bit depth** of 12 bit, therefore the `LUTValueAll` parameter is an array that consists of 4096 x 4 bytes. Each 4-byte word represents a `LUTValue` parameter value.
The `LUTValue` parameter values are sorted by the `LUTIndex` number in ascending order (0 through 4095).

 Info

- The endianness of the 4-byte words (lut values) for your camera is big-endian.

LUTIndex	0	1	2	3	4
LUTValue (dec)	150	-	-	-	-
LUTValueAll (hex)	000000E9	00000000	00000000	00000000	00000000
LUTIndex	5	6	7	8 ...	4095
LUTValue (dec)	-	-	-	312 ...	-
LUTValueAll (hex)	00000000	00000000	00000000	00000138 ...	00000000

3.34.2 Specifics

Number of LUT Entries	Endianness of the 4-Byte Words (LUT Values)
4096	Big-endian

3.35 Network-Related Parameters

Network-related parameters allow you optimize the performance of your camera.

3.35.1 Using the Feature

Info

This feature is pre-configured by VisionPro. Therefore, it isn't recommended that you configure this feature manually.

Available Parameters

The following network-related parameters are available:

Parameter Name	Display Name	Description
BandwidthReserveMode	Bandwidth Reserve Mode	Allows you to configure the bandwidth reserve and bandwidth reserve accumulation (see below) in a single step. You can set the parameter to the following values: Standard : The camera is configured for use with moderate bandwidth demands. Performance : The camera is configured for use with high bandwidth demands. Manual : No preset is used. You can configure the bandwidth reserve and bandwidth reserve accumulation manually.
BsIDeviceLinkCurrentThroughput	Device Link Current Throughput	Indicates the actual bandwidth (in bytes per second) that the camera uses to transmit image data and chunk data given the current camera settings. This parameter is read-only.
DeviceLinkThroughputLimit	Device Link Throughput Limit	Allows you to limit the maximum available bandwidth for data transmission. For more information, see Device Information Parameters.
GevHeartbeatTimeout	Heartbeat Timeout	Sets the heartbeat timeout (in milliseconds). If a timeout occurs, the camera releases the network connection and enters a state that allows reconnection. By default, the heartbeat timeout is set to 3000 ms. Changing the value is not required for normal camera operation. However, if you are debugging an application and stop at a break point, a heartbeat timeout may occur and the connection to the camera may be lost. Therefore, you should increase the <code>GevHeartbeatTimeout</code> parameter value while debugging. When debugging is complete, you should return the timeout to its normal setting.
GevSCBWR	Bandwidth Reserve	Specifies which portion of the assigned bandwidth is reserved to handle packet resends and to control data transmission. The setting is expressed as a percentage of the assigned bandwidth. Example: If a bandwidth of 30 MByte/s is assigned to the camera and the <code>GevSCBWR</code> parameter is set to 5 %, the bandwidth reserve will be 1.5 MByte/s.
GevSCBWRA	Bandwidth Reserve Accumulation	Multiplier used to set the maximum number of resends that can be held in the "accumulator pool". You can use the <code>GevSCBWRA</code> parameter to handle situations when the network connection becomes unstable, e.g., because of a sudden EMI burst. In these situations, a larger number of packet resends may be needed to transmit an image. The bandwidth reserve accumulation is basically an extra pool of resends that the camera can use in unusual situations. Example: Assume that the current bandwidth reserve setting is large enough to allow up to 5 packet resends during a frame period. Also assume that the bandwidth reserve accumulation (<code>GevSCBWRA</code> parameter) is set to 3. With these settings, the accumulator pool can hold a maximum of $5 \times 3 = 15$ resends.

Parameter Name	Display Name	Description
GevSCFTD	Frame Transmission Delay	Sets a delay in ticks^a between when a camera would normally begin transmitting an acquired frame and when it actually begins transmission. In most cases, this parameter should be set to zero. However, if your network hardware can't handle spikes in network traffic (e.g., if you are triggering multiple cameras simultaneously), you can use the frame transmission delay parameter to stagger the start of image data transmissions from each camera.
GevSCPD	Inter-Packet Delay	Sets the inter-packet delay in ticks^a. If your network hardware can't handle the incoming packet rate, it is useful to increase the delay between packet transmissions. This may reduce the amount of dropped packets. Note that this also slows the data transmission. As a result, the camera's frame rate may decrease.
GevSCPSPacketSize	Packet Size	Specifies the maximum size of a data packet transmitted via Ethernet. The value is in bytes. The parameter should always be set to the maximum size that your network hardware can handle. By default, the packet size is set to 1 500 bytes. This will be sufficient for most configurations.^b If required, you can increase the packet size to reduce Ethernet overhead load and improve network efficiency. The size of the leader and the trailer always remains the same, regardless of the packet size. You should bear in mind that the last data packet is, in most cases, smaller than the others.
GevStreamChannelSelector	Stream Channel Selector	Specifies the stream channel that will be affected when other network related parameters are changed. The GigE Vision standard specifies a mechanism for establishing several separate stream channels between the camera and the computer. Currently, the cameras support only one stream channel, i.e., stream channel 0. Therefore, the <code>GevStreamChannelSelector</code> parameter is preset to <code>StreamChannel0</code> and can't be changed.
PayloadSize	Payload Size	Indicates the total size in bytes of the image data plus any chunk data transmitted. Packet headers are not included. This parameter is read-only.

a. On your camera, one tick always equals 1 ns. You can determine the tick frequency by reading the `GevTimestampTickFrequency` parameter value. This value indicates the number of clock ticks per second.

b. If you increase the packet size above 1 500 bytes, you must enable the so-called Jumbo Frames support on all network devices involved including any switches. Whenever you increase the packet size on the camera side, you must also adjust the packet size of your network controller card. Otherwise, streaming may fail due to blocked packets.

3.36 Periodic Signal

The Periodic Signal camera feature allows you to generate periodic trigger signals that are synchronized across devices.

This allows you to, e.g., capture images on multiple cameras at the same time and the same frame rate.

3.36.1 Using the Feature

How It Works

Your camera provides an additional camera signal source, `PeriodicSignal1`. Via this source, the camera transmits a signal with the following characteristics:

- The signal is repetitive.
- The signal can be synchronized across devices via [Precision Time Protocol](#).
- The period of the signal can be configured.
- The delay before the first period can be configured.

The `PeriodicSignal1` signal source can be used for many different purposes, e.g., to synchronize counters or image acquisition across devices.

Using Periodic Signal to Synchronize Image Acquisition

To synchronize image acquisition on multiple cameras:

1. Open one of the cameras that you want to synchronize using Periodic Signal.
2. Make sure that the `BslPeriodicSignalSource` parameter on the camera is set to `PtpClock`.
This indicates that the camera is synchronized via the [Precision Time Protocol](#) feature.
3. Set the `BslPeriodicSignalPeriod` parameter to the reciprocal of the desired frame rate, converted to microseconds. For example, if you want to synchronize the cameras at 50 frames per second, set the parameter to 20000 ($1 / 50 = 0.02$ seconds = 20000 microseconds). You must specify the same parameter value on all cameras.
4. Configure the periodic signal delay:
 - If you want all cameras to acquire images **at the same time**, set the `BslPeriodicSignalDelay` parameter to 0 on all cameras.
 - If you want all cameras to acquire images **sequentially**, i.e, in regular intervals, set the `BslPeriodicSignalDelay` parameter to 0 on the first camera and to multiples of the desired interval on the other cameras.
For example, assume you want to acquire images with an interval of 10000 μ s between cameras. To do so, set the delay to 0 on the first camera, to 10000 on the second camera, to 20000 on the third camera, and so on.
5. Configure the camera to be triggered by the periodic signal:
 - a. Set the `TriggerSelector` parameter to `FrameStart`.
 - b. Set the `TriggerMode` parameter to `On`.
 - c. Set the `TriggerSource` parameter to `PeriodicSignal1`.
6. Repeat steps 1 to 5 for all cameras.

Using Periodic Signal to Synchronously Trigger External Devices

You can use the Periodic Signal feature to synchronously trigger external devices. This allows you to make non-PTP devices PTP-capable.

The camera's internal periodic signal can't be used as an I/O signal. However, you can trigger the camera's [Timer](#) feature using the periodic signal, and then use the timer signal as an I/O signal.

To do so:

1. Open the camera that you want to use to trigger the external device.
2. Make sure that the `BslPeriodicSignalSource` parameter on the camera is set to `PtpClock`.
This indicates that the camera is synchronized via the [Precision Time Protocol](#) feature.
3. Set the `BslPeriodicSignalPeriod` parameter to the reciprocal of the desired trigger rate, converted to microseconds. For example, if you want to generate 20 trigger signals per second, set the parameter to 50000 ($1/20 = 0.05$ seconds = 50000 microseconds).
4. If you want to trigger the external device with a time delay, set the `BslPeriodicSignalDelay` parameter to the desired delay.
5. Configure the camera's **Timer** feature to be triggered by periodic signals:
 - a. Set the `TimerSelector` parameter to `Timer1`.
 - b. Set the `TimerDuration` parameter to the desired **timer duration** in microseconds.
The camera will send an I/O signal with a width equal to this value. Therefore, set a parameter value high enough for the external device to be able to receive the signal. In most cases, the default value of 10 μ s should be sufficient.
 - c. Set the `TimerTriggerSource` parameter to `PeriodicSignal1`.
6. Configure the camera to output the timer signal:
 - a. Set the `LineSelector` parameter to the desired I/O line, e.g., `Line2`. The line must be [configured as output](#).
 - b. Set the `LineSource` parameter to `Timer1Active`.
7. Connect the external device to the output line selected in step 6.
The device now receives synchronized trigger signals on this line.
8. If you want to trigger another external device, repeat steps 1 to 6, using `Timer2` and `Timer2Active` in steps 5 and 6.

Info

You can also synchronize image acquisition between cameras **and** synchronously trigger external devices using the same periodic signal. To do so, carry out both the procedures detailed above.

Additional Parameters

- `BslPeriodicSignalSelector`: Sets the periodic signal channel to be configured. Because your camera currently offers only one channel, this parameter is preset to `PeriodicSignal1` and can't be changed.

3.37 Pixel Format

The Pixel Format camera feature allows you to choose the format of the image data transmitted by the camera. There are different pixel formats depending on the model of your camera and whether it is a color or a mono camera.

Info

Detailed information about pixel formats can be found in the [GenICam Pixel Format Naming Convention 2.1](#).

3.37.1 Using the Feature

Choosing a Pixel Format

To choose a pixel format:

1. Make sure the camera is idle, i.e., not capturing images.
2. Set the `PixelFormat` parameter to one of the following values (if available):

- `MonoXX` (e.g., `Mono10`, `Mono12p`)
- `BayerXXYY` (e.g., `BayerBG10`, `BayerGR12`)
- `YCbCrXXX`, `YUVXXX`
- `RGB8`, `BGR8`
- `BiColor BGRG8`, `BiColor RGBG8`

Determining the Pixel Format

To determine the pixel format currently used by the camera, get the value of the `PixelFormat` parameter.

Available Pixel Formats

MONO FORMATS

If a **monochrome** camera uses one of the mono pixel formats, it outputs 8, 10, 12, or 14 bits of data per pixel.

If a **color** camera uses one of the mono pixel formats, the values for each pixel are first converted to the YCbCr color model. The Y component of this model represents a brightness value and is equivalent to the value that would be derived from a pixel in a monochrome sensor. So in essence, when a color camera is set to, e.g., Mono 8, it outputs an 8-bit monochrome image.

Which mono formats are available depends on [your camera model](#).

BAYER FORMATS

Color cameras are equipped with a [Bayer color filter](#) and can output color images based on Bayer pixel formats.

If a color camera uses one of the Bayer pixel formats, it outputs 8, 10, or 12 bits of data per pixel. Each pixel is filtered to record only one of the colors red, green, and blue. The pixel data is not processed or interpolated in any way. This type of pixel data is sometimes referred to as "raw" output.

Which Bayer formats are available depends on [your camera model](#).

YCBCR FORMATS

Color cameras can also output color images based on pixel data in [YCbCr](#) (or YUV) format.

If a color camera uses this format, each pixel value in the captured image goes through a conversion process as it exits the sensor and passes through the camera. This process yields Y, Cb, and Cr color information for each pixel value.

RGB AND BGR FORMATS

When a color camera uses the RGB 8 or BGR 8 pixel format, the camera outputs 8 bit of red data, 8 bit of green data, and 8 bit of blue data for each pixel in the acquired frame.

The pixel formats differ by the output sequences for the color data (red, green, blue or blue, green, red).

BICOLOR BGRG AND RGBG FORMATS

The color cameras with BiColor pixel formats are equipped with a color filter array as displayed in the example figure below. The color filter array of the sensor has the red and blue color components on the first line, and the green component on the second line.



The camera combines this color information and outputs the data as shown in the example figure below.



If a color camera uses one of the BiColor pixel formats, it outputs 8 bit of data per pixel. Each pixel is filtered to record only one of the colors red, green, and blue. The pixel data is not processed or interpolated in any way. This type of pixel data is sometimes referred to as "raw" output. The pixel formats differ by the output sequences for the color data (blue, green, red, green or red, green, blue, green).

Which BiColor formats are available depends on [your camera model](#).

Maximum Pixel Bit Depth

The maximum pixel bit depth is defined by the pixel format with the highest bit depth among the [pixel formats available on your camera](#).

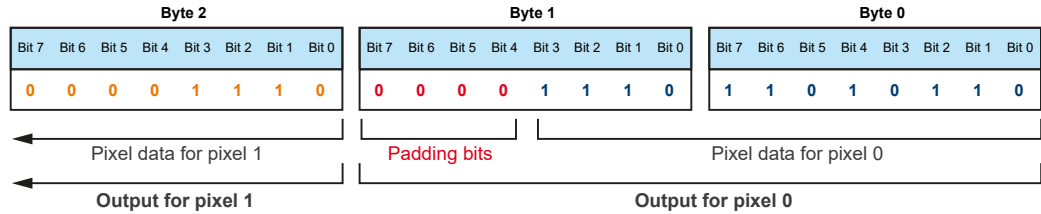
Example: If the available pixel formats for your camera are Mono 8 and Mono 12, the maximum pixel bit depth of the camera is 12 bit.

Unpacked and Packed Pixel Formats

When a camera uses an **unpacked** pixel format (e.g., Bayer 12), pixel data is always 8-bit aligned. Padding bits (zeros) are inserted as necessary to reach the next 8-bit boundary.

Example (simplified):

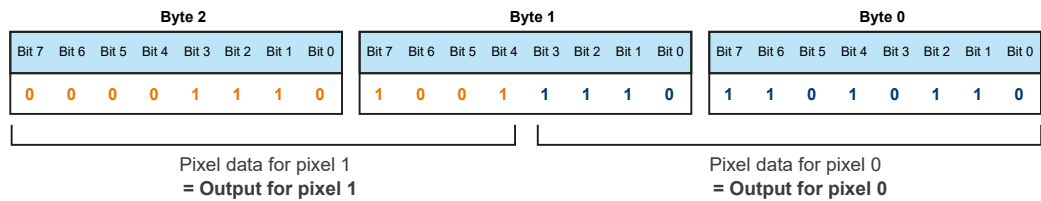
Assume that you have chosen a 12-bit unpacked pixel format. The camera outputs 16 bits per pixel: 12 bits of pixel data and 4 padding bits to reach the next 8-bit boundary.



When a camera uses a **packed** pixel format (e.g., Bayer 12p), pixel data is **not** aligned. This means that no padding bits are inserted and that one byte can contain data of multiple pixels.

Example (simplified):

Assume that you have chosen a 12-bit packed pixel format. The camera outputs 12 bits per pixel. As a consequence, data for two pixels is always spread over 3 bytes.



 Info

The exact data alignment depends on the pixel format. You can find detailed information in the [GenICam Pixel Format Naming Convention 2.1](#).

3.37.2 Specifics

Camera Model	Available Pixel Formats
CIC-L041-CG-42-5G	Mono 8
	Mono 10
	Mono 10p
	Mono 12
	Mono 12p
	RGB 8
	BGR 8
	YCbCr422_8
	BiColor BGRG 8
	BiColor RGBG 8
CIC-L041-MG-84-5G	Mono 8
	Mono 10
	Mono 10p
	Mono 12
	Mono 12p

3.38 Precision Time Protocol

The Precision Time Protocol (PTP) camera feature allows you to synchronize multiple GigE cameras in the same network. The IEEE 1588 standard defines the protocol. Your camera supports [IEEE 1588-2008](#), also known as PTP Version 2.

Info

The precision of the PTP synchronization depends to a large extent on your network hardware and setup. For maximum precision, choose high-quality network hardware, use PTP-enabled network switches, and add an external PTP clock device with a GPS receiver to your network.

3.38.1 Using the Feature

Why Use PTP

The Precision Time Protocol (PTP) feature enables a camera to use the following features:

- [Periodic Signal](#)
- [Scheduled Action Commands](#)

How It Works

Through PTP, multiple devices (e.g., cameras) are automatically synchronized with the most accurate clock found in a network, the so-called master clock or best master clock.

The protocol enables systems within a network to do the following:

- **Synchronize** with the master clock, i.e., set the local clock as precisely as possible to the time of the master clock.
- **Syntnize** with the master clock, i.e., adjust the frequency of the local clock to the frequency of the master clock. You want the duration of a second to be as identical as possible on both devices.

The master clock is determined by several criteria. The criterion with the highest precedence is the device's [Priority 1](#) setting.

TIMESTAMP SYNCHRONIZATION

The basic concept of the Precision Time Protocol (IEEE 1588) is based on the exchange of PTP messages. These messages allow the slave clocks to synchronize their [timestamp](#) value with the timestamp value of the master clock. For your camera, this means that the `TimestampLatchValue` parameter values will be as identical as possible. The precision highly depends on your network hardware and setup.

If no device in the network is synchronized to a coordinated world time (e.g., TAI or UTC), the network will operate in the arbitrary timescale mode (ARB). In this mode, the epoch is arbitrary, as it is not bound to an absolute time. The timescale is relative and only valid in this network.

Info

- IEEE 1588 defines 80-bit timestamps for storing and transporting time information. Because GigE Vision uses 64-bit timestamps, the PTP timestamps are mapped to the 64-bit timestamps of GigE Vision.
- A PTP-enabled device that operates in a network with no other PTP-enabled devices does not discipline its local clock. The precision of its local clock is identical to a non-PTP-enabled device.
- For more information about the Precision Time Protocol, see the [Synchronous and in Real Time: Multi-Camera Applications in the GigE Network](#) white paper.

Enabling PTP Clock Synchronization

When powering on the camera, PTP is always disabled. If you want to use PTP, you must enable it.

To enable PTP:

1. If you want to use an external device as the master clock (e.g., a GPS receiver), configure the external device as the master clock. Cognex recommends an ANNOUNCE interval of 2 seconds and a SYNC interval of 0.5 seconds.
2. Make sure that all cameras that you want to synchronize via PTP are [properly configured](#).
3. On all cameras that you want to synchronize via PTP, set the `GevIEEE1588` parameter to `true`.
4. **Wait** until all PTP network devices are sufficiently synchronized. Depending on your network setup, this may take a few seconds or minutes.
You can determine when the devices are synchronized by [checking the status of the PTP clock synchronization](#).

Now, you can use the [PTP-enabled camera features](#).

Info

On your camera, the tick frequency is always 1 GHz.

Configuring PTP Clock Synchronization

Depending on your camera model, the following settings are available:

PRIORITY 1

In a PTP-enabled network, the master clock is determined by several criteria. The most important criterion is the device's Priority 1 setting. The network device with the **lowest** Priority 1 setting is the master clock.

On your camera, the Priority 1 setting is preset to 128 and can't be changed.

Info

For more information about the master clock criteria, see the [IEEE 1588-2008 specification](#), clause 7.6.2.2.

PTP DELAY MECHANISM

The delay measurement mechanism defines how PTP delay measurement messages are sent and received within the network. The PTP standard defines two mechanisms: end-to-end (E2E, also "delay request-response") and peer-to-peer (P2P). For more information, see [this article](#).

On your camera, the delay measurement mechanism is preset to end-to-end and can't be changed.

Info

- In most cases, use end-to-end delay measurement. Only use peer-to-peer if your entire network is set up for peer-to-peer delay measurement. This means that all switches and routers are PTP-enabled, and all PTP devices are configured for peer-to-peer communication.
- When using peer-to-peer delay measurement, the following restrictions apply:
 - The [network mode](#) can't be set to Hybrid.
 - [One-step clock operation](#) can't be enabled. The camera always operates in two-step mode.

NETWORK MODE

The network mode setting defines how PTP messages are transferred within the network.

On your camera, the network mode is preset to multicast. However, these cameras can also receive unicast messages and respond accordingly.

 Info

When using unicast mode, all devices involved must support unicast negotiation. Some PTP implementations don't use unicast negotiation and therefore aren't compatible with your camera.

PTP MANAGEMENT

The PTP Management Protocol allows you to read the settings of any PTP device via management messages. If permitted, the settings can also be written.

On your camera, PTP management is always enabled and preset to read-only access.

Supported Management Messages

Management Message ID	Supported Action
NULL_MANAGEMENT	GET, SET
CLOCK_DESCRIPTION	GET
USER_DESCRIPTION	GET, SET
INITIALIZE	COMMAND ^a
DEFAULT_DATA_SET	GET
CURRENT_DATA_SET	GET
PARENT_DATA_SET	GET
TIME_PROPERTIES_DATA_SET	GET
PORT_DATA_SET	GET
PRIORITY1	GET, SET
PRIORITY2	GET, SET
DOMAIN	GET
SLAVE_ONLY	GET
LOG_ANNOUNCE_INTERVAL	GET, SET
ANNOUNCE_RECEIPT_TIMEOUT	GET, SET
LOG_SYNC_INTERVAL	GET, SET
VERSION_NUMBER	GET
ENABLE_PORT	COMMAND
DISABLE_PORT	COMMAND
TIME	GET, SET ^b
CLOCK_ACCURACY	GET, SET
UTC_PROPERTIES	GET, SET
TRACEABLE_PROPERTIES	GET, SET
TIMESCALE_PROPERTIES	GET, SET
UNICAST_NEGOTIATION_ENABLE	GET
ACCEPTABLE_MASTER_TABLE	GET, SET
ACCEPTABLE_MASTER_TABLE_ENABLED	GET, SET
ACCEPTABLE_MASTER_MAX_TABLE_SIZE	GET
DELAY_MECHANISM	GET, SET
LOG_MIN_PDELAY_REQ_INTERVAL	GET, SET

a. The INITIALIZE command resets the clock speed.
b. Can only be set if the corresponding device serves as the grandmaster clock.

For information about the default values and ranges of these attributes, see the [IEEE 1588-2008 specification](#), annex J.

ONE-STEP OR TWO-STEP CLOCK

This setting defines how many messages are generated for any PTP event message that requires an egress timestamp:

- In **one-step** operation, one message is sent. The message includes the message data and the egress timestamp.
- In **two-step** operation, two messages are sent. The first message includes the message data. The second message includes the egress timestamp.

For more information, see [this article](#).

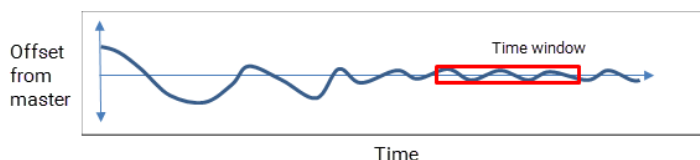
On your camera, two-step operation is always enabled.

Checking the Status of the PTP Clock Synchronization

To check the status of the PTP clock synchronization, you must develop your own check method.

A typical implementation of a PTP status check involves the following steps:

1. Execute the `GevIEEE1588DataSetLatch` command.
The command allows you to take a "snapshot" of the camera's current PTP state. The "snapshot" implementation ensures that all [parameter values in the latched data set](#) refer to exactly the same point in time.
2. Wait until the `GevIEEE1588Status` parameter value is no longer `Initializing`.
3. Depending on the camera model, read the following parameter values from the device:
 - On your camera, read the `GevIEEE1588OffsetFromMaster` parameter value from all slave cameras until the highest offset from master is below a certain threshold (according to your requirements, e.g., 1 millisecond).
Due to the fact that the clock is continuously adjusted by a control mechanism, the offset is not decreasing monotonically. Cognex recommends that you check the maximum `GevIEEE1588OffsetFromMaster` parameter value within a given time window:



4. Repeat steps 1 and 2 until the devices are sufficiently synchronized.

WHAT'S IN A LATCHED DATA SET?

After executing the `GevIEEE1588DataSetLatch` command, you can read the following parameter values from the device:

- `GevIEEE1588ClockId` : Indicates the unique ID of the current PTP device (the "clock ID").
- `GevIEEE1588OffsetFromMaster` : Indicates the estimated temporal offset between the master clock and the clock of the current PTP device in ticks (1 tick = 1 nanosecond).
- `GevIEEE1588ParentClockId` : Indicates the clock ID of the PTP device that currently serves as the master clock (the "parent clock ID").
- `GevIEEE1588Status` : Indicates the state of the current PTP device, e.g., whether it is a master or a slave clock. The returned values match the PTP port state enumeration (Initializing, Faulty, Disabled, Listening, Pre_Master, Master, Passive, Uncalibrated, and Slave). For more information, refer to the [IEEE 1588-2008 specification](#).
- `GevIEEE1588StatusLatched` : If this parameter is available, Cognex recommends using it instead of the `GevIEEE1588Status` parameter. This is because the `GevIEEE1588Status` parameter is not tied to the `GevIEEE1588DataSetLatch` command. Therefore, if you read multiple PTP-related values from a device, the device state will not relate to the same point in time as the other values.

External Links

- [End-to-End Versus Peer-to-Peer \(Time Synchronization Blog\)](#)
- [Hybrid Mode PTP: Mixed Multicast and Unicast \(Time Synchronization Blog\)](#)
- [IEEE 1588-2008 Specification \(IEEE Standards Association\)](#)

- [One-step or Two-step? \(Time Synchronization Blog\)](#)
- [Precision Time Protocol \(Wikipedia\)](#)

3.39 Resulting Acquisition Line Rate

The Resulting Acquisition Line Rate camera feature allows you to determine the estimated line rate with the current camera settings.

This is useful, for example, if you want to know how long you have to wait between triggers.

The line rate is expressed in hertz (Hz).

3.39.1 Using the Feature

Checking the Resulting Acquisition Line Rate

To check the resulting acquisition line rate, i.e., the estimated line rate with the current camera settings, get the value of the `BslResultingAcquisitionLineRate` parameter. The value is expressed in hertz (Hz).

The parameter value takes all [factors limiting the line rate](#) into account.

Info

- On some camera models, the `ResultingFramePeriod` parameter is also available. It allows you to determine the resulting frame period, which is the reciprocal of the resulting frame rate (1 / frame rate).
- Checking the resulting acquisition line rate works when the camera is idle as well as when the camera is acquiring images.

Factors Limiting the Line Rate

Several factors may limit the line rate on your camera:

- **Bandwidth Assigned:** Bandwidth limitations can reduce the line rate, especially when more than one camera is connected to a computer. The extent of the reduction depends on the camera model, the number of cameras connected to the computer, and the computer's hardware.
- **Device Link Throughput:** If the `DeviceLinkThroughputLimitMode` parameter is available and set to `On`, it limits the available bandwidth for data transmission to the `DeviceLinkThroughputLimit` parameter value. This also limits the line rate.
- **Exposure Time:** If you use very long exposure times, you can acquire fewer lines per second.
- **Field Output Mode:** If available, using the Field 0 Output Mode or Field 1 Output Mode increases the camera's line rate.
- **Image ROI:** If you use a large image ROI, you can acquire fewer lines per second. On most cameras, decreasing the image ROI [height](#) increases the line rate. On some cameras, decreasing the image ROI [width](#) also increases the line rate.

3.40 Reverse X

The Reverse X camera features allow you to mirror acquired images horizontally.

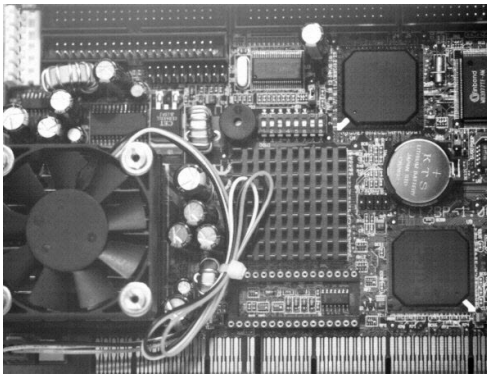
3.40.1 Using the Feature

Enabling Reverse X

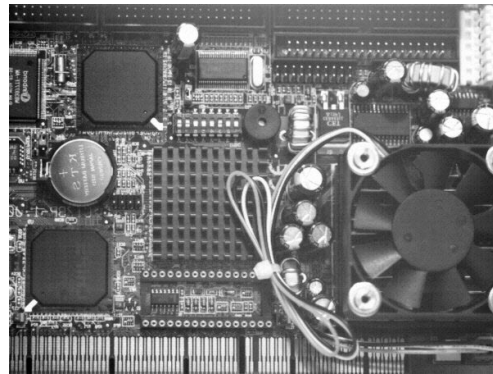
To enable Reverse X, set the `ReverseX` parameter to `true`.

The camera mirrors the image horizontally:

Reverse X disabled



Reverse X enabled



Using Image ROIs or Auto Function ROIs with Reverse X

If you have specified an [image ROI](#) or [auto function ROI](#) while using Reverse X, the position of the ROI relative to the sensor adapts to the mirrored image. The camera captures the same portions of the image.

Reverse X disabled

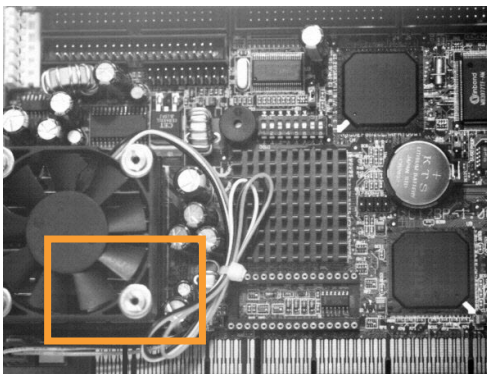


Image ROI

Reverse X enabled

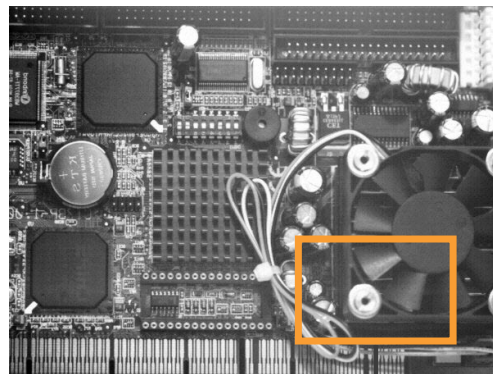


Image ROI

3.41 Scheduled Action Commands

The Scheduled Action Commands camera feature allows you to send [action commands](#) that are executed in multiple GigE cameras at exactly the same time.

If exact timing is not a critical factor in your application, you can use the [Action Commands](#) feature instead.

3.41.1 Using the Feature

How It Works

The basic parameters of the Scheduled Action Command feature are the same as for the [Action Commands](#) feature:

- [Action Device Key](#)
- [Action Group Key](#)
- [Action Group Mask](#)
- [Broadcast Address](#)

In addition to these parameters, the Scheduled Action Command feature uses the Action Time parameter:

ACTION TIME

A 64-bit GigE Vision timestamp used to define when the action is to be executed.

The action is executed as soon as the internal [timestamp](#) value of a camera reaches the specified value.

With the [Precision Time Protocol](#) enabled, the timestamp value is synchronized across all cameras in the network. As a result, the action will be executed on all cameras in the network at exactly the same time.

The value must be entered in ticks. On cameras with the [Precision Time Protocol](#) feature enabled, one tick equals one nanosecond.

Example: Assume you issue a scheduled action command with the action time set to 100 000 000 000. The action will be executed as soon as the timestamp value of all cameras in the specified network segment reaches 100 000 000 000.

Info

If 0 (zero) is entered or if the action time is set to a time in the past, the action command will be executed immediately, equivalent to a standard [action command](#).

Using Scheduled Action Commands

CONFIGURING THE CAMERAS

Follow the procedure outlined in the [Action Commands](#) topic.

ISSUING A SCHEDULED ACTION COMMAND

General Use

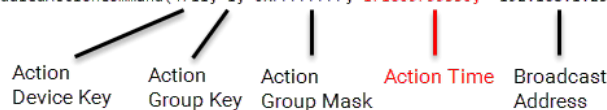
To issue a scheduled action command:

1. Make sure that all cameras in your network are synchronized via the [Precision Time Protocol](#) feature.
2. Call the `IssueScheduledActionCommand` method in your application.

The parameters are similar to the `IssueActionCommand` method. The only difference is the additional [Action Time](#) parameter.

Example:

```
IssueScheduledActionCommand(4711, 1, 0xFFFFFFFF, 171609799550, "192.168.1.255")
```



Issuing a Scheduled Action Command to Be Executed after a Certain Delay

To issue a scheduled action command that is executed after a certain delay:

1. Make sure that all cameras in your network are synchronized via the [Precision Time Protocol](#) feature.
2. Execute the `TimestampLatch` command on one of your cameras. If one of your cameras serves as the PTP master clock, use this camera.
A "snapshot" of the camera's current `timestamp` value is taken.
3. Get the value of the `TimestampLatchValue` parameter on the same camera.
The value is given in ticks. On cameras with the [Precision Time Protocol](#) feature enabled, one tick equals one nanosecond.
4. Call the `IssueScheduledActionCommand` method with the action time set to the value determined in step 3 plus the desired delay in ticks (= nanoseconds).
For example, if you want the command executed after roughly 30 seconds, set the action time to `TimestampLatchValue + 30 000 000 000`.

All cameras in the network segment will execute the command simultaneously after the given delay.

Issuing a Scheduled Action Command to Be Executed at a Precise Point in Time

To issue a scheduled action command that is executed at a precise point in time:

1. Make sure that all cameras in your network are synchronized via the [Precision Time Protocol](#) feature to a time standard, e.g., Coordinated Universal Time (UTC).
This can be achieved, e.g., by integrating a IEEE 1588-enabled UTC clock device in your network.
2. Call the `IssueScheduledActionCommand` method with the action time set to a coordinated time value.
For example, if your cameras are synchronized to UTC, you can set the action time to 1 765 537 200 000 000 000 to execute the action command exactly on Fri Dec 12 2025 11:00:00 UTC.

Queueing Scheduled Action Commands

You can queue scheduled action commands.

This means that the camera can store and process multiple scheduled action commands. The camera will execute them in ascending order of action time. If the queue is full, additional commands will be ignored.

Example: Assume the value of the `ActionQueueSize` parameter is 2. Now, assume you send the following commands to the camera:

1. `IssueScheduledActionCommand(4711, 1, 0xFFFFFFFF, 20000000000, "192.168.1.255")`
2. `IssueScheduledActionCommand(4711, 1, 0xFFFFFFFF, 10000000000, "192.168.1.255")`
3. `IssueScheduledActionCommand(4711, 1, 0xFFFFFFFF, 5000000000, "192.168.1.255")`

Command 2 will be executed first, after 10 000 000 000 nanoseconds. Command 1 will be executed second, after 20 000 000 000 nanoseconds. Command 3 will be ignored because the queue is full.

3.41.2 Specifics

Action Queue Size

2

3.42 Sensor Readout Time

The Sensor Readout Time camera feature allows you to determine the amount of time it takes to read out the data of an image from the sensor.

3.42.1 Using the Feature

Why Determine the Sensor Readout Time

Each image acquisition process includes two parts:

1. **Exposure** of the pixels of the image sensor, i.e., the [exposure time](#).
2. **Readout** of the pixel values from the sensor, i.e., the sensor readout time.

The Sensor Readout Time feature is useful if you want to estimate which part of the image acquisition process is limiting the camera's frame rate.

To do so, compare the exposure time with the sensor readout time:

- If the sensor readout time is considerably **longer** than the exposure time, consider adjusting camera features that affect the sensor readout time, e.g., [Binning](#) (only available on the CIC-L041-MG-84-5G camera), or [Image ROI](#).
- If the sensor readout time is considerably **shorter** than the exposure time, consider reducing the [exposure time](#).

Determining the Sensor Readout Time

To determine the sensor readout time at the current settings, get the value of the `SensorReadoutTime` parameter. The sensor readout time is measured in microseconds.

The result is only an **approximate value** and depends on various camera settings and features, e.g., [Binning](#) (only available on the CIC-L041-MG-84-5G camera), or [Image ROI](#).

3.43 Sensor State

The Sensor State camera feature allows you to set the power state of the sensor.

This can be useful to reduce power consumption, heat generation, and delays when acquiring images.

3.43.1 Using the Feature

Why Use Sensor State

The camera sensor has the following power states:

- On
- Standby
- Off

The default sensor state after camera startup or reset is the standby mode. When configuring certain parameters, the sensor automatically switches into standby mode. As soon as image acquisition starts, the sensor is switched on again, but with a certain delay.

The Sensor State feature allows you to manually set the sensor state. This may reduce delays when acquiring images.

Putting the sensor in standby mode can also be useful to reduce power consumption and heat generation. This in turn can have a positive effect on image quality.

Determining the Sensor State

To determine the current sensor state, get the `BslSensorState` parameter value.

Setting the Sensor State

To set the sensor state, execute one of the following commands:

- `BslSensorOn` : The sensor is switched on.
- `BslSensorStandby` : The sensor is put in standby mode. Power consumption is reduced.
- `BslSensorOff` : The sensor is switched off.

3.44 Shading Correction

The Shading Correction camera feature allows you to reduce non-uniformities in the image caused by differing light sensitivities of the sensor pixels. Also artifacts caused by the illumination and illumination optics can be minimized.

Shading correction is based on files that are stored on the camera and contain appropriate correction data. During image acquisition, these are applied to the original pixel values, which results in an improved image.

3.44.1 Using the Feature

How It Works

DSNU AND PRNU CORRECTION

Shading correction minimizes image artifacts caused by **dark signal non-uniformities (DSNU)** and **photo response non-uniformities (PRNU)**. The following two types of shading correction are available on the camera:

- **DSNU correction:** When the camera captures a line in complete darkness, all of the pixel values in the line should be near zero and they should be equal. In practice, slight variations in the performance of the pixels in the sensor will cause some variation in the pixel values output from the camera when the camera is capturing lines in darkness. DSNU correction corrects for this type of variation. It works by adding an individual gray value (offset) to each pixel value in the lines acquired.
- **PRNU correction:** When the camera captures a line while being pointed at a bright, homogeneously illuminated surface, all of the pixel values in the line should be near their maximum gray value and they should be equal. In practice, slight variations in the performance of the pixels in the sensor as well as variations in the optics and in lighting will cause variations in the pixel values output from the camera. PRNU correction corrects for this type of variation. It works by applying an individual multiplier (gain) to each pixel value in the lines acquired.

Shading correction is a pixel-to-pixel calibration method, i.e., a correction value is calculated for each single pixel.

Info

You can set the camera to only perform DSNU correction, to only perform PRNU correction, or to perform both types of shading correction. If you perform both types of shading correction, the camera first performs DSNU correction, then PRNU correction.

Shading Correction Sets

The correction values used for DSNU and PRNU correction are stored in files referred to as **shading correction sets**. There are the following two types:

- **Factory** correction set: Contains correction values that were stored on the camera during the camera production process. The factory correction set can only reduce image artifacts caused by dark signal non-uniformities (DSNU).
- **User** correction set: Contains correction values that must be [created by the user](#) and stored on the camera. You can create up to 16 user correction sets.

You can [download](#) or [upload](#) a user shading correction file.

DOWNLOADING A SHADING CORRECTION FILE

Info

- Downloading your shading correction files is useful to back up your correction data.
- Cognex strongly recommends to back up your correction files before performing a firmware update.
- Don't edit a downloaded shading correction file.

UPLOADING A SHADING CORRECTION FILE

 Info

- If you upload a user shading correction file to a camera, make sure that the selected correction set was created on the camera you load the correction data on.
- Cognex strongly recommends **not** to upload a user shading correction file that has been edited.

To apply the shading correction file after uploading, make sure that the `BslShadingCorrectionMode` parameter is set to `User` and the `BslShadingCorrectionSetIndex` parameter is set to the corresponding index number.

Shading Correction Mode

The shading correction mode determines whether shading correction is based on the values stored in the factory or the user correction set.

To set the shading correction mode, set the `BslShadingCorrectionMode` parameter to one of the following values:

- `Factory` (default): Shading correction is based on the values stored in the **factory** correction set.
- `User`: Shading correction is based on the values stored in the **user** correction set.
- `Off`: The camera does **not** perform shading corrections.

Creating a Shading Correction Set

You need the following items before you start creating a user-defined shading correction set:

- An appropriate object to completely cover the lens, e.g., the lens cap
- A target with a uniform background, e.g., a white sheet of paper

 Info

- For best results, adjust the optics, line rate, exposure time, gain, and camera temperature as you would for normal operation. Cognex recommends acquiring the dark and bright field images in your actual application environment.

DSNU CORRECTION SET

To create a shading correction set for **DSNU correction**:

1. Prevent any light from hitting the camera's sensor, e.g., by placing a plastic cap on the lens.
2. Set the `BslShadingCorrectionSelector` parameter to `DSNU`.
3. Set the `BslShadingCorrectionMode` parameter to `User`.
4. Set the `BslShadingCorrectionSetIndex` parameter to the desired index number of the set to be created, e.g., 1.
5. Set the `BslShadingCorrectionROISelector` parameter to the desired shading correction ROI, e.g., ROI 1.
6. If desired, set the position and size of the shading correction ROI by using the following parameters:
 - `BslShadingCorrectionROIOffsetX`: Horizontal offset of the shading correction ROI from the left side of the sensor (in pixels).
 - `BslShadingCorrectionROIWidth`: Width of the shading correction ROI (in pixels).
7. Configure your camera to make continuous shots.
8. Execute the `BslShadingCorrectionSetCreate` command to create a new shading correction set.

A total of 256 dark images are acquired and evaluated. The resulting DSNU correction data are generated, collected in the shading correction set defined, and saved to the camera's flash memory. If the shading correction set with, e.g., index number 1, already contains correction data, these are overwritten and replaced by the new correction values.

i Info

If a PRNU correction set is enabled while creating DSNU correction data, the PRNU correction values will be ignored for the calculation.

The created shading correction set is enabled automatically.

9. To verify the result of the shading correction set creation, get the value of the `BslShadingCorrectionSetCreateResult` parameter.

PRNU CORRECTION SET

To create a shading correction set for **PRNU correction**:

1. Illuminate the sensor homogeneously to 70 % saturation, e.g., by placing a white sheet of paper in the camera's entire field of view.
2. Set the `BslShadingCorrectionSelector` parameter to `PRNU`.
3. Set the `BslShadingCorrectionMode` parameter to `User`.
4. Set the `BslShadingCorrectionSetIndex` parameter to the desired index number of the set to be created, e.g., 2.
5. Set the `BslShadingCorrectionROISelector` parameter to the desired shading correction ROI, e.g., ROI 1.
6. If desired, set the position and size of the shading correction ROI by using the following parameters:
 - `BslShadingCorrectionROIOffsetX`: Horizontal offset of the shading correction ROI from the left side of the sensor (in pixels).
 - `BslShadingCorrectionROIWidth`: Width of the shading correction ROI (in pixels).
7. Configure your camera for continuous shot and start image acquisition.
8. Execute the `BslShadingCorrectionSetCreate` command to create a new shading correction set.
 A total of 256 bright images are acquired and evaluated. The resulting PRNU correction data are generated, collected in the shading correction set selected, and saved to the camera's flash memory. If the shading correction set with, e.g., index number 2, already contains correction data, these are overwritten and replaced by the new correction values.

Info

If a DSNU correction set is enabled while creating PRNU correction data, the DSNU correction values are taken into account for the calculation.

The created shading correction set is enabled automatically.

9. To verify the result of the shading correction set creation, get the value of the `BslShadingCorrectionSetCreateResult` parameter.
10. If required, adjust the [target gray value for PRNU correction](#) and repeat step 7. If you're using a color camera, adjust the target gray value for PRNU correction for each color channel separately and repeat step 7.

Adjusting the Target Gray Value for PRNU Correction

During the [creation of a PRNU correction set](#), the camera detects the maximum brightness value in the bright field image. However, you may want to adjust the relative target gray value of the sensor brightness you want to achieve. Possible reasons for this are, e.g.:

- Your shading correction set can't be created because the correction values are outside the allowed range.
- Bright spots on the image (e.g., caused by light reflections) result in a high maximum brightness value detected by the camera during the creation of the correction set. You may want to reduce this value, which is relevant for calculating the correction data, to improve your correction data.

To adjust the target gray value for PRNU correction:

1. Set the `BslShadingCorrectionTargetSelector` parameter to one of the following values:
 - `All` (mono cameras only): The target gray value is applied to all sensor lines.
 - `Red`, `Green`, `Blue` (color cameras only): The target gray value is applied to the respective color channel.
2. Set the `BslShadingCorrectionTargetValue` parameter to the desired relative target gray value.
3. If you're using a color camera, repeat steps 1 and 2 to apply the desired target gray value to the other color channels.

 Info

- The `BslShadingCorrectionTargetValue` parameter can only be used when [creating PRNU correction sets](#).
- Only pixels with an absolute target gray value lower than the value of the maximum measured value are corrected.

Further parameters:

- `BslShadingCorrectionAbsoluteTargetValue` : Absolute target value of the sensor brightness. This is the actual brightness value that has been calculated based on the sensor bit depth of your camera.
- `BslShadingCorrectionMaximumMeasuredValue` : Maximum brightness value detected by the camera during the [creation of a PRNU correction set](#).

Enabling a Shading Correction Set

To enable a shading correction set:

1. Set the `BslShadingCorrectionMode` parameter to `User`, if you want to enable a user-defined correction set, or to `Factory`, if you want to enable the factory correction set.
2. Set the `BslShadingCorrectionSetIndex` parameter to the index number of the set to be used, e.g., index number 2.

The shading correction set is enabled automatically.
3. To verify whether this process was successful, get the value of the `BslShadingCorrectionSetStatus` parameter. If the value is `Ok`, the shading set has been enabled successfully. The camera now performs shading correction based on the correction values in the shading correction set selected.

 Info

Changing a shading correction set is possible during image acquisition. However, slight image artifacts may occur during that process.

Disabling Shading Correction

To disable shading correction, set the `BslShadingCorrectionMode` parameter to `Off`.

3.44.2 Specifics

The following table shows the number of shading sets available for your camera.

Camera Model	Max. Number of Lines Exposed per Acquisition	Available Number of Shading Corrections Sets
CIC-L041-CG-42-5G	2	16
CIC-L041-MG-84-5G	1	16

3.45 Software Signal Pulse

The Software Signal Pulse camera feature allows you to execute a software command that can be used for multiple purposes. The feature serves as an alternative to software commands that are limited to a specific purpose, e.g., the `TriggerSoftware` command.

3.45.1 Using the Feature

Why Use Software Signal Pulse Commands

Standard software commands can only be used for a single purpose. For example, you can use the `TriggerSoftware` command only to trigger the camera and the `UserSetLoad` command only to load a user set. The `SoftwareSignalPulse` command, however, can be used for multiple purposes. You can also use the command to control multiple camera features in a single operation.

How It Works

SUPPORTED CAMERA FEATURES

The Software Signal Pulse feature can be used to control the following camera features:

- **Counter**
You can count certain camera events.
- **Timer**
You can configure a timer output signal.

SIGNAL CHANNELS

Three signal channels are available: `SoftwareSignal1`, `SoftwareSignal2`, and `SoftwareSignal3`. Using different signal channels is useful if you want to keep the camera features you control separate. For example, you can trigger the camera via signal channel 1 and advance the sequencer via signal channel 2.

Using Software Signal Pulse Commands

To configure the `SoftwareSignalPulse` command:

1. Set the source of the desired camera feature to one of the available **signal channels**. For example, set the `TriggerSource` parameter to `SoftwareSignal1`.
2. Repeat the step above for all camera functions that you want to control with the Software Signal Pulse feature. If you want to control multiple features at the same time, assign the same signal channel to each of them. If you want to keep the controlled features separate, assign a different signal channel to each of them.

To execute a `SoftwareSignalPulse` command:

1. Set the `SoftwareSignalSelector` parameter to one of the available **signal channels**, e.g., `SoftwareSignal1`.
2. Execute the `SoftwareSignalPulse` command.
A software signal is sent. The signal uses the selected signal channel and executes the assigned action(s), e.g., advances the sequencer.

3.45.2 Specifics

Supported Camera Features	Available Software Signal Channels
Triggered Image Acquisition	Software Signal 1
Counter	Software Signal 2
Timer	Software Signal 3

3.46 Spatial Correction

The Spatial Correction camera feature allows you to combine the color information of a line scan sensor where more than one pixel line is exposed simultaneously.

Info

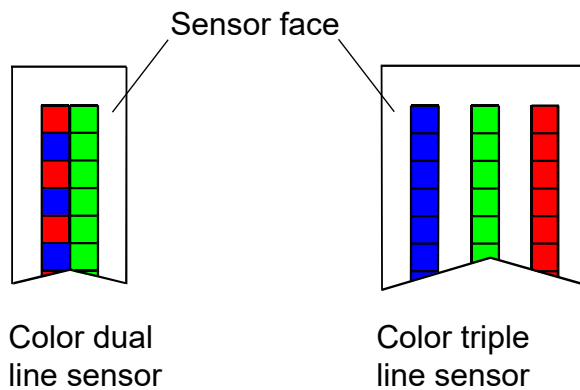
This feature is basically a **color** camera feature. Thus, this feature is **not** available on the CIC-L041-MG-84-5G camera.

3.46.1 Using the Feature

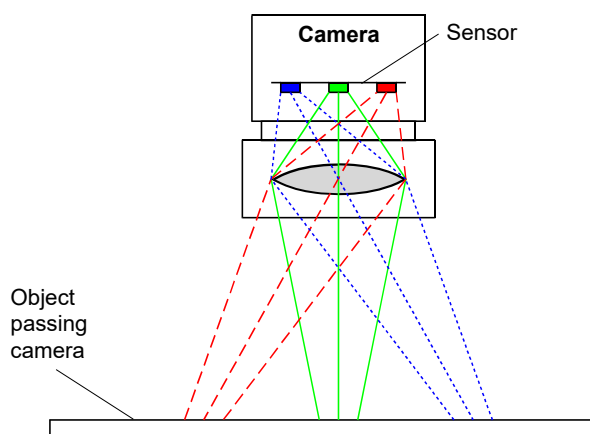
How It Works

Color cameras might be equipped with two different sensor types: a color dual line or a color triple line sensor. The CIC-L041-CG-42-5G camera has a color dual line sensor.

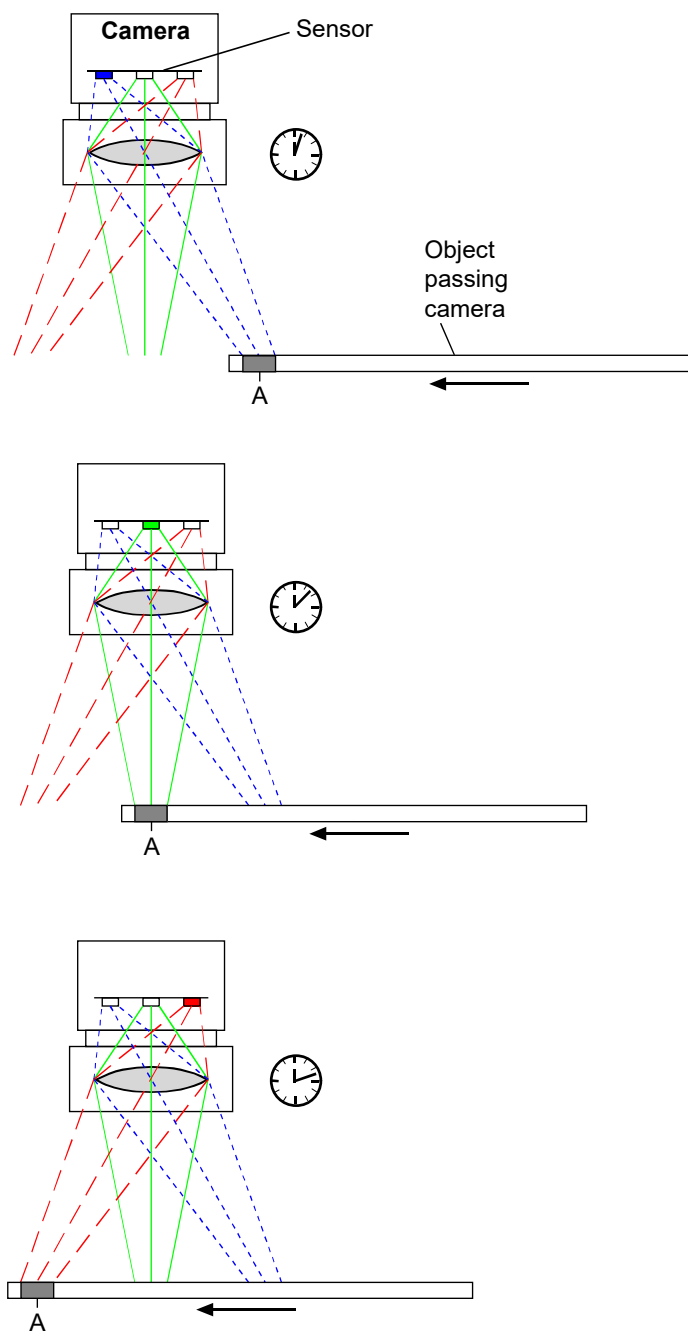
The color dual line sensor has two pixel lines and the color triple line sensor has three pixel lines arranged next to each other. The lines of the dual line sensor are directly adjacent to each other, whereas the lines of the triple line sensor are separated from each other by a gap.



Each line has a different field of view on any object passing the camera. Whenever an acquisition is triggered, all lines of the sensor are exposed simultaneously. This means that for a single exposure, each line in the sensor acquires a different area on the object. The following illustration shows the field of view of a color triple line sensor.



In the following example, a single small area "A" on an object passes the camera. As the object passes the camera, area A falls into the line of view of the blue line, of the green line, and of the red line at three different times. This means that the blue information for area A, the green information for area A, and the red information for area A are collected during three different image acquisitions.



To get the full RGB information for area A, the data from three different acquisitions must be combined. This need to combine data from different acquisitions to get the full color information is known as **spatial correction**. In other words, spatial correction aligns color information of the image. The data of the red line of the current exposure is combined with the data of the green and blue lines, taken from exposures in the past.

Spatial Correction Stride

The `BslSpatialCorrectionStride` parameter is used to enable and disable spatial correction and to set two aspects of spatial correction: the starting line and the stride.

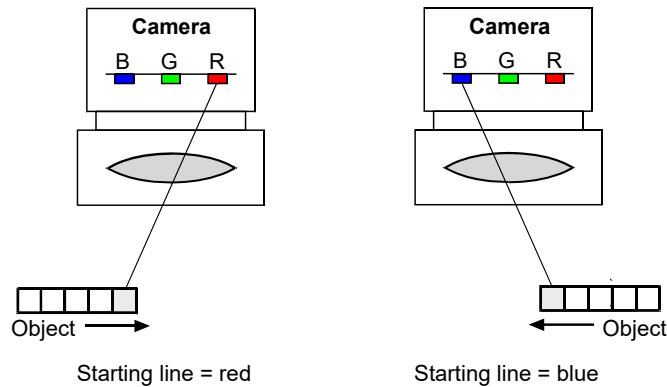
STARTING LINE

The spatial correction starting line relates to the direction in which the object is passing the camera.

Setting the `BslSpatialCorrectionStride` parameter to a positive or a negative value determines the starting line and thus the direction of spatial correction.

Line Scan Color Camera

The following illustration shows the starting line on a **color** triple line sensor depending on the direction of motion.



Color triple line sensor:

- Positive parameter value: The starting line is the blue line.
- Negative parameter value: The starting line is the red line.

Color dual line sensor:

- Positive parameter value: The starting line is the blue/red line.
- Negative parameter value: The starting line is the green line.

STRIDE

The spatial correction stride determines the number of acquisitions that have to be buffered in order to combine the correct line data and to obtain the full RGB or full HDR data for an area on the image.

The `BslSpatialCorrectionStride` parameter can be set in a range from -4 to 4, depending on your camera model. Specifying a stride value of 0 effectively disables spatial correction.

The following tables show the relation between the stride value and the number of acquisitions needed to get the full RGB/HDR information.

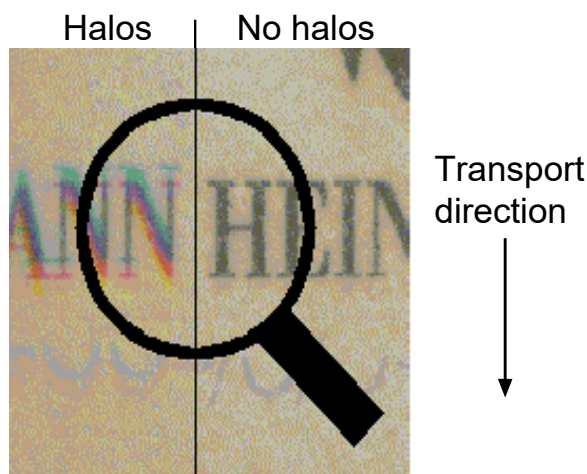
Line Scan Color Camera

Color Dual Line Sensor	
Stride = 1	Full RGB = blue/red[n-1] + green[n]
Stride = -1	Full RGB = blue/red[n] + green[n-1]

Avoiding Halo Effects

If the alignment of the color information is being done correctly, the acquired images will be sharp and clear as shown in the right side of the image below. If there are variations in the positioning of the image when it is acquired by the different lines, color "halos" will occur as shown in the left side of the image below.

For a given area on the object to be acquired correctly, its image must fall precisely on the color pixel lines in the sensor.



Info

To avoid color halos, make sure that your system design requirements are met correctly.

Reversal of Spatial Correction Direction

The direction in which the object is passing the camera may alternate in your application environment. Or, the camera may move back and forth above the object. In both cases, the direction of motion changes. The information about a change of the direction of motion is essential for achieving proper spatial correction.

This information can be obtained through an I/O line or the Encoder Reverse 1 signal output by the camera's [encoder control](#) can be used.

The `BslSpatialCorrectionDirectionReversal` parameter allows you to determine which signal source should be used to trigger a reversal of the spatial correction direction.

You can set the `BslSpatialCorrectionDirectionReversal` parameter to one of the following values:

- `Off`: Direction reversal is disabled. The spatial correction direction is determined by the positive or negative value set for the `BslSpatialCorrectionStride` parameter.
- `Line1`, `Line2`, `Line3`: The spatial correction direction is reversed if the signal level of I/O line 1, 2, or 3 is high.
- `EncoderReverse1`: The spatial correction direction is reversed if the Encoder Reverse 1 signal is high.

Configuring Spatial Correction

To configure spatial correction:

1. Set the `BslSpatialCorrectionStride` parameter, e.g., to 2.
2. If required, set the `BslSpatialCorrectionDirectionReversal` parameter, e.g., to `EncoderReverse1`.

3.47 Temperature State

The Temperature State camera feature indicates whether the camera's internal temperature is normal or too high.

When the temperature is too high, immediate cooling is required.

Use the [Device Temperature](#) feature to determine the camera's current temperature.

3.47.1 Using the Feature

How It Works

Information about the internal temperature is provided by the following parameters:

- The `DeviceTemperature` parameter value shows the current temperature at various locations within the camera. For more information, see the [Device Temperature](#) topic.
- The `TemperatureState` parameter value tells you the camera's current internal temperature state:
 - `Ok` : The device temperature is within the normal operating temperature range.
 - `Critical` : The device temperature is close to or at the allowed maximum. Provide cooling.
 - `Error` : The device temperature is above the allowed maximum. Provide cooling immediately.

The following additional parameters are available:

- The `BslTemperatureStatusErrorCount` parameter indicates how often the temperature state changed to Error.
- The `BslTemperatureMax` parameter indicates the maximum temperature the camera reached during operation.

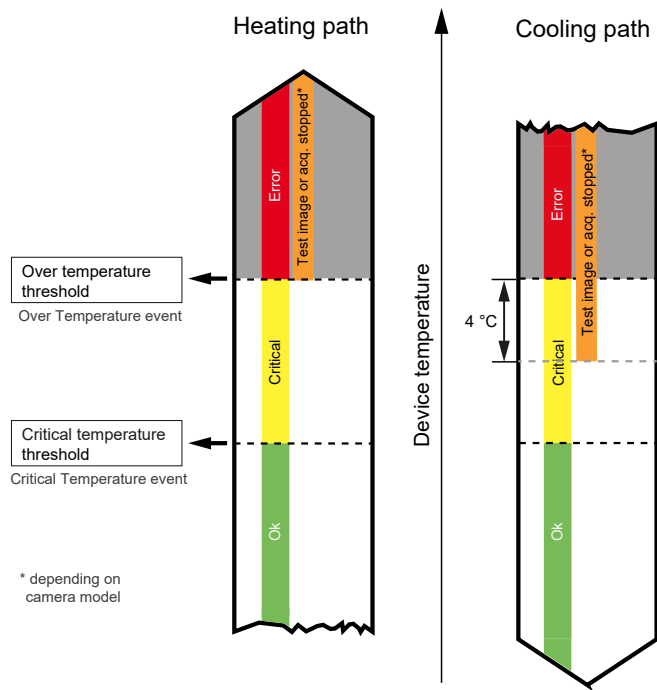
When the `TemperatureState` parameter value is `Critical` or `Error`, the camera provides a set of mechanisms that alert the user and help to protect the camera.

The mechanisms take effect at different device temperatures, depending on the alert level and on whether the camera is [heating up](#) or [cooling down](#).

Info

Normal camera operation requires that the temperature state stays at `Ok` and the housing temperature stays within the allowed range. To ensure this, follow the guidelines set out in the [Environmental Requirements](#) section.

At elevated temperatures, the camera may get damaged, the camera's lifetime is shortened, and image quality can degrade. The lifetime is also shortened by frequent high-temperature incidents.



HEATING PATH

Critical Temperature Threshold

When the device temperature reaches the [critical temperature threshold](#), the camera is close to becoming too hot. In this situation, the following happens:

- The `TemperatureState` parameter value changes to `Critical`.
- The camera sends a Critical Temperature event.

Info

Another Critical Temperature event can only be sent after the device temperature has fallen to at least 4 °C below the critical temperature threshold.

Over Temperature Threshold

When the device temperature reaches the [over temperature threshold](#), the camera is too hot. **The camera must be cooled immediately. Otherwise, the camera may get irreversibly damaged.**

In this situation, the following happens:

- The `TemperatureState` parameter value changes to `Error`.
- The camera's current draw reduces.
- Image acquisition changes:
 - On your camera, image acquisition stops and can't be started until the device has cooled down.
- The camera sends an `Over Temperature` event.
- If the [Error Code](#) feature is available on your camera model, the camera reports an over temperature error code.
- The `BslTemperatureStatusErrorCount` parameter increases by 1.

Info

Another Over Temperature event can only be sent after the device temperature has fallen to at least 4 °C below the over temperature threshold.

COOLING PATH

Over Temperature Threshold

When the device temperature falls below the [over temperature threshold](#), the following happens:

- The `TemperatureState` parameter value changes from `Error` to `Critical`.

When the device temperature falls to 4 °C below the over temperature threshold, the following happens:

- On your camera, image acquisition can be started again.

Critical Temperature Threshold

When the device temperature falls below the [critical temperature threshold](#), the following happens:

- The `TemperatureState` parameter value changes to `Ok`.

The camera's temperature state and internal temperature are normal and therefore allow normal camera operation.

Determining the Temperature State

1. Get the `TemperatureState` parameter value.
2. If the parameter value is `Critical` or `Error`, you must cool the camera until the parameter value is `Ok`.

To make full use of the Temperature State feature:

- Use the [Device Temperature](#) feature to determine the exact core board or sensor board temperature.
- Enable the [Event Notification](#) feature to receive events whenever the camera gets too hot.
- If the [Error Code](#) feature is available on your camera model, read the `LastError` parameter value to determine whether the camera was too hot.

3.47.2 Specifics

Critical Temperature Threshold	Over Temperature Threshold	Additional Parameters
76 °C (168.8 °F)	81 °C (177.8 °F)	BsITemperatureMax BsITemperatureStatusErrorCount

3.48 Test Patterns

The Test Patterns camera feature allows you to check the camera's basic functionality and its ability to transmit images.

Test patterns can be used for maintenance purposes and failure diagnostics. They are generated by the camera itself, i.e., the optics and the image sensor of the camera are not involved in their creation.

3.48.1 Using the Feature

Displaying Test Patterns

To display a test pattern:

1. Select a test pattern by setting the `TestPattern` parameter to one of the following values (if available):

- `Black`
- `White`
- `Testimage1`
- `Testimage2`
- `Testimage3`
- `Testimage6`

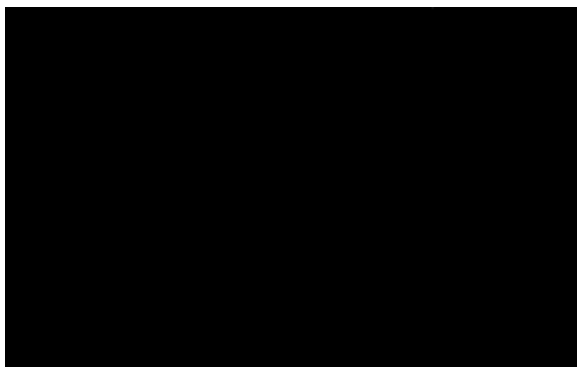
2. Acquire at least one image to display the selected test pattern.

Available Test Patterns

Depending on your camera model, the following test images are available:

BLACK

Completely black test pattern.



WHITE

Completely white test pattern.



TEST IMAGE 1

- Consists of **fixed** diagonal gray gradients ranging from 0 to 255.
- Is best suited for when the camera is configured for monochrome **8-bit** output.



TEST IMAGE 2

- See [Test Image 1](#).
- **Difference:** Consists of **moving** diagonal gray gradients ranging from 0 to 255. When a new image acquisition is triggered, the image moves left one pixel.

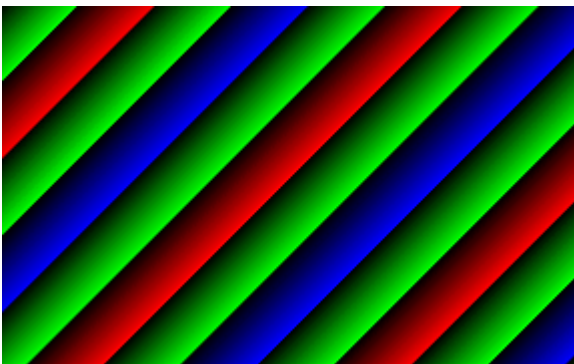
TEST IMAGE 3

- Consists of **moving** diagonal gray gradients ranging from 0 to 4095. When a new image acquisition is triggered, the image moves left one pixel.
- Is best suited for when the camera is configured for monochrome **12-bit** output.



TEST IMAGE 6

- Available on color cameras only.
- Consists of **moving** diagonal color gradients.



3.48.2 Specifics

Camera Model	Available Test Patterns
CIC-L041-CG-42-5G	Black
	White
	Test Image 1
	Test Image 2
	Test Image 3
CIC-L041-MG-84-5G	Test Image 6
	Black
	White
	Test Image 1
	Test Image 2
	Test Image 3

3.49 Timer

The Timer camera feature allows you to configure a timer output signal that goes high on specific camera events and goes low after a specific duration.

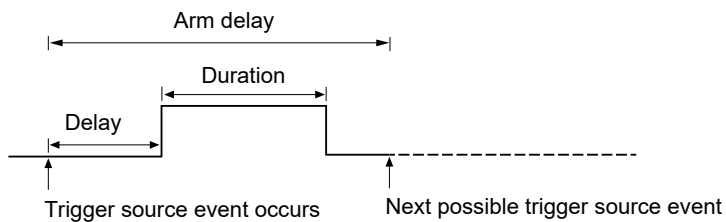
3.49.1 Using the Feature

How It Works

Two timers are available, Timer 1 and Timer 2.

This is how a timer works:

- A [trigger source event](#) that starts the internal timer occurs.
- A delay begins to expire.
- An arm delay begins to expire.
- When the delay has expired, the timer output signal goes high and stays high for the duration that you have configured.
- When the duration has expired, the timer output signal goes low.
- When the arm delay has expired, the camera can receive the next trigger source event.



Configuring a Timer

To configure a timer:

1. Set the `TimerSelector` parameter to the desired timer, e.g., `Timer1`.
2. Set the `TimerDuration` parameter to the desired [timer duration](#) in microseconds.
3. Set the `TimerDelay` parameter to the desired [timer delay](#) in microseconds.
4. Set the `TimerTriggerArmDelay` parameter to the desired [arm delay](#) in microseconds.
5. Set the [LineSelector](#) parameter to the output line that you want to use for the timer signal.
If the line is a GPIO line, the line must be [configured as output](#).
6. If you selected Timer 1 in step 1, set the [LineSource](#) parameter to `Timer1Active`.
7. If you selected Timer 2 in step 1, set the [LineSource](#) parameter to `Timer2Active`.

Starting a Timer

To start a timer:

1. Set the `TimerSelector` parameter to the desired timer, e.g., `Timer1`.
2. Set the `TimerTriggerSource` parameter to the source that you want to use to start the timer, e.g., `Line2`.
3. If applicable, set the `TimerTriggerActivation` parameter to one of the following values:
 - `RisingEdge` (default): The timer starts when the signal **rises**, i.e., when the signal status changes from low to high.
 - `FallingEdge`: The timer starts when the signal **falls**, i.e., when the signal status changes from high to low.
 - `AnyEdge`: The timer starts when the signal **falls or rises**.
 - `LevelHigh`: The timer starts when the signal is **high**. When the signal changes to low, the timer stops and must be **started** again.
 - `LevelLow`: The timer starts when the signal is **low**. When the signal changes to high, the timer stops and must be **started** again.
4. Start the timer by sending a signal on the selected timer trigger source.

When started, the timer's **status** immediately changes from `TimerTriggerWait` to `TimerActive`, regardless of the **delay** set. However, the timer output signal will only go high after the delay has expired.

Info

The `TimerTriggerActivation` parameter is only available for timer trigger sources that can be high (1) or low (0), i.e., an I/O signal or an "Active" signal like `ExposureActive`.

Resetting a Timer

To reset a timer, execute the `TimerReset` command.

The timer's **status** changes from `TimerActive` to `TimerTriggerWait`.

The timer can now be restarted immediately regardless of the **arm delay** set.

Getting the Status of a Timer

To get the current status of a timer, get the value of the `TimerStatus` parameter. This parameter is read-only.

Possible values are:

- `TimerTriggerWait`: The timer is waiting to be **started**.
- `TimerActive`: The timer has been started. A timer immediately switches to this state when the **trigger source** event occurs, regardless of the **delay** set. If an **arm delay** is set, the timer remains in the `TimerActive` state until the arm delay has expired.
- `TimerIdle`: The timer is idle. A timer is in this state whenever the `TimerTriggerSource` parameter is set to `Off`, i.e., the timer can't be started.

3.49.2 Specifics

Default Maximum Value for Timer Duration and Delay

16 777 215

3.50 Timestamp

The Timestamp camera feature counts the number of ticks generated by the camera's internal device clock.

The timestamp value is used by several camera features, e.g., [Chunk Features](#) and [Event Notification](#).

3.50.1 Using the Feature

How It Works

As soon as the camera is powered on, it starts generating and counting clock ticks. The value is reset to 0 whenever the camera is powered off and on again, or when a [reset command](#) has been executed.

The number of ticks per second, i.e., the tick frequency is 1 GHz (= 1 000 000 000 ticks per second, 1 tick = 1 ns). On GigE cameras, read the value of the `GevTimestampTickFrequency` parameter to determine the current tick frequency.

The timestamp value is also used to synchronize multiple cameras via [PTP](#). On cameras synchronized via PTP, the timestamp value will be (nearly) identical.

Determining the Current Timestamp Value

To determine the current timestamp value:

1. Execute the `GevTimestampControlLatch` command.
A "snapshot" of the camera's current timestamp value is taken.
2. Get the value of the `GevTimestampValue` parameter.
The value of the parameter refers to the point in time when the `GevTimestampControlLatch` command was executed.

Info

There is an unspecified and variable delay between sending the `GevTimestampControlLatch` command and it becoming effective.

Resetting the Timestamp Value

To reset the timestamp value to 0:

1. If the [PTP](#) feature is available, make sure it is disabled.
2. Execute the `GevTimestampControlReset` command.

3.50.2 Specifics

Timestamp Tick Frequency

1 GHz (= 1 000 000 000 ticks per second, 1 tick = 1 ns)

3.51 User-Defined Values

The User-Defined Values camera feature allows you to store user-defined values in the camera.

3.51.1 Using the Feature

How It Works

The camera can store up to five user-defined values. These can be values that you may require for your application (e.g., optical parameter values for panoramic images). These values are 32-bit signed integer values that you can set and get as desired. They serve as storage locations and have no impact on the operation of the camera.

The values are named Value1 to Value5.

Configuring User-Defined Values

To configure a user-defined value:

1. Set the `UserDefinedValueSelector` parameter to the desired user-defined value (`Value1` to `Value5`).
2. Enter the desired value for the `UserDefinedValue` parameter.

3.52 User Output Value

The User Output Value camera feature allows you to set the status of one or all output lines to high (1) or low (0) by software. This can be useful to control external events or devices, e.g., a light source.

3.52.1 Using the Feature

Setting the Output Status of an I/O Line

To set the output status of an I/O line:

1. Set the `LineSelector` parameter to the desired output line, e.g., `Line2`.
2. Set the `LineSource` parameter to `UserOutput`.
3. If multiple User Output line sources are available (e.g., "User Output 1", "User Output 2"), set the `UserOutputSelector` parameter to the corresponding line source.
Example: Assume that you have set the line source of Line 2 to `UserOutput1`. To configure the line status of Line 2, set the `UserOutputSelector` parameter to `UserOutput1`.
4. If you want to set the line status to high (1), set the `UserOutputValue` parameter to `true`.
5. If you want to set the line status to low (0), set the `UserOutputValue` parameter to `false`.

Setting the Output Status of Multiple I/O Lines

You can configure the status of multiple output lines with the `UserOutputValueAll` parameter. The parameter is reported as a 64-bit value.

Certain bits in the value are associated with the output lines. Each bit configures the status of its associated line:

- If a bit is set to 0, the status of the associated line is set to low.
- If a bit is set to 1, the status of the associated line is set to high.

See the following table to see which bit is associated with which line:

UserOutputValueAll Bit-to-Line Association

Bit 0 configures the status of the line associated to the User Output 1 signal

Bit 1 configures the status of the line associated to the User Output 2 signal

Bit 2 configures the status of the line associated to the User Output 3 signal

Example: You set the line source of Line 2 to User Output 1. Now, bit 0 configures the status of Line 1.

3.53 User Sets

The User Sets camera feature allows you to [save](#) or [load](#) camera settings. You can also specify which settings will be [loaded at camera startup](#).

A user set (also called "configuration set") is a group of parameter values. It contains all parameter settings needed to control the camera, with a few [exceptions](#).

Some user sets are preset and read-only. These user sets are also called "factory sets".

3.53.1 Using the Feature

What's in a User Set?

Each user set includes the values of all camera parameters, with the following exceptions:

- Parameter values related to the following camera features are **not** included:
 - [Action Commands](#)
 - [User-Defined Values](#)
 - [Precision Time Protocol](#)
- Values of parameters that include the term "Selector" in their names are **not** included (e.g., `GainSelector`). Exceptions: `TestImageSelector`, `GammaSelector`, `LightSourceSelector`.
- The value of the `DeviceUserID` parameter is **not** included.
- The value of the `GevGVSPExtendedIDMode` parameter is **not** included.
- Only the following [Network-Related Parameters](#) are included:
 - Packet Size (`GevSCPSPacketSize`)
 - Inter-Packet Delay (`GevSCPD`)
 - Frame Transmission Delay (`GevSCFTD`)
 - Bandwidth Reserve (`GevSCBWR`)
 - Bandwidth Reserve Accumulation (`GevSCBWRA`)
 - Bandwidth Reserve Mode (`BandwidthReserveMode`)

This means that when you [load](#) or [save](#) a user set, the values of all camera parameters will be loaded or saved, except the parameters listed above.

Loading a User Set

Info

- When a user set is loaded, it overwrites the current camera settings.
- Loading a user set is only possible when the camera is idle, i.e., not acquiring images.

1. Set the `UserSetSelector` parameter to one of the [available user sets](#), e.g., `UserSet1`.
2. Execute the `UserSetLoad` command.

Saving a User Set

Info

- Only the `UserSet1`, `UserSet2`, and `UserSet3` user sets can be saved. The other user sets are read-only.
- Saving a user set is only possible when the camera is idle, i.e., not acquiring images.

1. Set the `UserSetSelector` parameter to one of the [available user sets](#), e.g., `UserSet1`.
2. Execute the `UserSetSave` command.

Choosing a Startup Set

Info

- The user set that you have chosen as the startup set will be loaded when the camera is powered on.
- Choosing a startup set is only possible when the camera is idle, i.e., not acquiring images.

1. Set the `UserSetDefault` parameter to one of the [available user sets](#), e.g., `UserSet1`.
2. Power-cycle the camera for the new startup set to become effective.

Available User Sets

The following user sets are available:

DEFAULT

The `Default` user set is a read-only factory set. This is the default startup set on all cameras.

[Loading](#) this set configures the camera to provide good camera performance for a variety of applications under average operating conditions.

The `Default` user set contains the factory default settings of all the camera's parameter values.

USER SET 1, USER SET 2, AND USER SET 3

You can use the `UserSet1`, `UserSet2`, and `UserSet3` user sets to [load](#) and [save](#) your own camera settings.

Initially, these user sets contain the same parameter values as the `Default` user set. You can overwrite those values with your own settings to create a user set that is customized for your application.

To restore those settings every time the camera is reset, [choose a user set as the startup set](#).

4. Installation

4.1 Hardware Installation (GigE Cameras)

This topic tells you how to install your camera with a GigE interface.

4.1.1 General Considerations

Make sure that the following items are available before starting the hardware installation:

- A Cognex camera with a GigE interface.
- A computer with a [suitable GigE network adapter](#).
- As applicable, a C-mount or CS-mount lens for the camera.
If you already know what lens you will be using in your actual application, use this lens during the camera installation and setup. If not, Cognex suggests using a zoom lens for the installation and initial setup.
- A standard Ethernet cable. Cognex recommends using Cat 6 or Cat 7 S/STP cables.

4.1.2 Recommended GigE Network Adapters

5GigE Cameras

The following GigE network adapter is recommended for use with your 5GigE camera:

- [Aquantia AQtion AQC111C, non-PoE](#)
- [Marvel AQC111C 5G, PoE^a](#)

Info

You can operate your 5GigE camera with a 1GigE network adapter. However, the camera's bandwidth will be limited to 1/5 of its maximum bandwidth.

a. The Marvel AQC111C 5G network adapter works with the Cognex 5GigE non-PoE cameras, if the cameras are externally powered as documented in [Installing the Camera](#).

Network Adapters and Network Drivers

Although Cognex recommends the adapters listed above, the cameras should work with any compatible network adapter card.

Info

If the adapter is not a recommended network adapter, you may experience stability issues, e.g., image data loss. Also, the performance of your system may be degraded.

4.1.3 Installing the Camera

This procedure assumes that you want to establish a peer-to-peer connection between your GigE camera and a computer.

To install the camera:

1. Remove the protective cap from the lens mount.
2. Mount a C-mount or CS-mount lens onto your camera. Be careful not to insert the lens any deeper than specified in the [Maximum Allowed Lens Intrusion](#) topic.
3. Connect the camera to the computer and power.
4. Plug one end of an Ethernet cable into the network adapter port in your computer and plug the other end of the cable into the Ethernet connector of the camera.
5. Plug the 6-pin connector of the cable from your power supply into the 6-pin connector of the camera.
6. Switch on the power supply.

The camera starts up and will go through several initialization steps including IP address assignment. This takes some time.

 Info

If your system is configured to show network connection icons in the Windows system tray, you may see a yellow exclamation point on the icon. You may also see a message about limited connectivity. You can ignore the icon and the message as they don't affect the camera.

4.1.4 Next Steps

- Check whether your camera has been detected.
- In most cases, you must configure your network before you can use the camera.

5. Hardware Information

5.1 Avoiding EMI and ESD Problems

This topic tells you how to avoid faulty camera behavior due to electromagnetic interference (EMI) and electrostatic discharge (ESD).

5.1.1 General Information

Your camera might be installed in industrial environments. These environments often include devices that generate electromagnetic interference (EMI) and may cause electrostatic discharge (ESD). This can lead to operational faults like false triggering or the unplanned stopping of image acquisition. EMI and ESD can also negatively affect the quality of the images transmitted out of the camera.

5.1.2 Guidelines

To avoid faulty camera behavior due to EMI and ESD, follow these general guidelines:

- Install the camera as far as possible from devices generating sparks or strong electromagnetic fields.
- Keep the cable away from unshielded electric motors, transformers, unshielded coils, and electrical devices that employ switching technology.
- Always use high-quality shielded cables. The use of high-quality cables is one of the best defenses against EMI and ESD.
- Try to use camera cables that are only as long as necessary and try to run the camera cables and power cables parallel to each other. Avoid coiling camera cables. If the cables are too long, use a meandering path rather than coiling the cables.
- Attempt to connect all grounds to a single point, e.g., use a single power outlet for the entire system and connect all grounds to the single outlet. This helps to avoid large ground loops. (Large ground loops can be a primary cause of EMI problems.)
- Use a line filter on the main power supply.
- Decrease the risk of electrostatic discharge by taking the following measures:
 - Use conductive materials at the point of installation (e.g., floor, workplace).
 - Use suitable clothing (cotton) and shoes.
 - Control the humidity in your environment. Low humidity can cause ESD problems.

5.2 Cleaning Instructions

This topic provides instructions on how to clean your camera.

Before attempting to clean the camera, consider carefully whether cleaning will actually improve your camera's performance.

Cleaning always carries the risk of introducing more dirt or even damaging the camera.

5.2.1 Cleaning the Housing or the Camera Front

To clean a camera with a housing or a camera front:

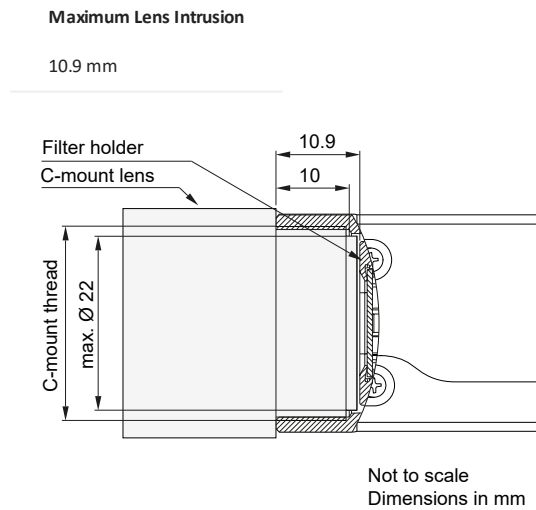
1. Disconnect the camera from camera power (and I/O power, if applicable).
2. Make sure that the lens mount is covered by a lens or a protective cap.
3. Get a soft, lint-free cloth that does not cause electrostatic charging during cleaning.
4. Dampen the cloth using a mild detergent.
5. Using the dampened cloth, wipe, as applicable, the camera's sides and front.
6. Let any residual moisture evaporate.
Never apply compressed air to speed up evaporation.
7. After the moisture has evaporated completely, you may reconnect the camera to power.

5.3 Maximum Allowed Lens Intrusion

When mounting a lens on your Cognex camera, make sure not to insert the lens any deeper than specified in this topic. The maximum lens intrusion varies by camera model and mount variant. The value is listed below.

 **NOTICE – Using unsuitable lenses may damage camera components or the lens itself.**

Make sure that your lens is compatible with the lens mount dimensions specified below. If you try to mount a lens with an overall lens intrusion that is larger than specified, you may damage the lens or the filter holder and the camera may not work properly anymore.



5.4 Mounting Instructions

This topic provides instructions on how to mount your camera in your system.

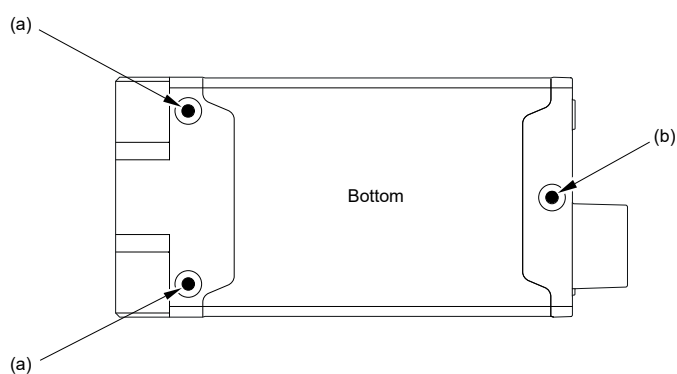
When mounting your camera in your system, you must tighten the screws in a certain order. This ensures optimum alignment of the camera.

5.4.1 Tightening the M3 Screws

To tighten the M3 screws:

1. Tighten the screws for the mounting screw holes (a) in the figure below.
2. Tighten the screw for the mounting screw hole (b) in the figure below.

GigE Cameras



5.5 Providing Heat Dissipation

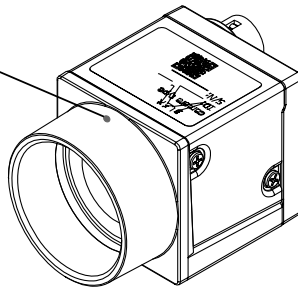
You must provide sufficient heat dissipation to keep the temperature of your camera within the specified range.

5.5.1 General Guidelines

- Mount a lens on the camera.
- Mount the camera on a substantial, thermally conductive component. The contact surface should be even. On uneven surfaces, attaching a heat-conducting foil between camera and contact surface may be helpful.
- Attach appropriate cooling elements to the camera.
- Provide an air flow over the camera.
- To ensure good image quality, Cognex advises against operating the camera at elevated temperatures.
- If you want to check the camera temperature, you can measure it directly on the camera housing using the temperature measurement point (see below).
- Some cameras provide the [Device Temperature](#) feature. This feature lets you monitor the temperature of the device.
- Bear in mind that higher frame rates increase the power consumption, leading to a higher camera temperature.

Temperature Measurement Point

Housing temperature
measurement point



5.6 Stress Test Results

To ensure stability when used in normal environments, your camera is tested under exaggerated levels of stress. Cameras were submitted to an independent mechanical testing laboratory and subjected to the stress tests listed below. The mechanical stress tests were performed on selected camera models. After mechanical testing, the cameras exhibited no detectable physical damage and produced normal images during standard operational testing.

Test	Standard	Conditions
Sine (each axis)	DIN EN 60068-2-6	10–58 Hz / 1.5 mm; 58–500 Hz / 20 g; 1 Octave/Minute 10 repetitions
Shock (each axis)	DIN EN 60068-2-27	20 g / 11 ms / 100 shocks positive 20 g / 11 ms / 100 shocks negative
Random (each axis)	DIN EN 60068-2-64	15-500 Hz / 0.05 PSD (ESS standard profile) / 00:30 h

The mechanical stress tests were performed with a dummy lens connected to a C-mount. The dummy lens was 35 mm long and had a mass of 67 g. Using a heavier or longer lens requires an additional support for the lens.

6. Image Acquisition

6.1 Acquisition Timing Information

This topic provides information about the image acquisition process on Cognex area scan cameras. Knowing the camera's timings and delays can help you to optimize your imaging system for maximum performance.

6.1.1 Timings and Delays

Sensor Readout Time

The sensor readout time is the amount of time it takes to read out image data from the sensor. You can determine the amount of time using the [Sensor Readout Time](#) camera feature. When the camera has determined that a sufficient amount of data has accumulated in the buffer, the camera begins transmitting the data from the camera to the host computer.

Frame Transmission Time

The frame transmission time is the amount of time it takes to transmit an acquired frame from the buffer in the camera to the host computer. The frame transmission time can vary between frames and partly depends on when the host computer calls for data transmission.

Transmission Start Delay

The transmission start delay is the amount of time between the point where the camera begins reading out the acquired frame data from the sensor to the point where it begins transmitting the data for the acquired frame to the host computer. The transmission start delay can vary between frames and largely depends on when the host computer starts calling for data transmission.

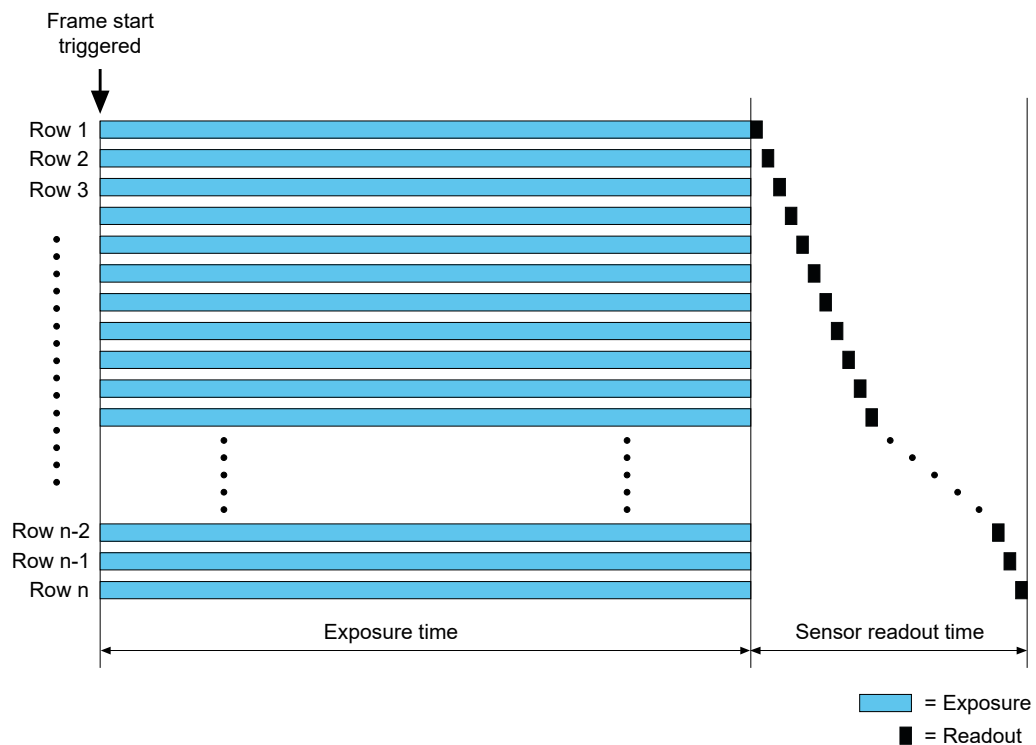
Exposure Start Delay [μs] (Non-Overlapping Image Acquisition)	Exposure Start Delay [μs] (Overlapping Image Acquisition)
12-bit sensor bit depth: 0.02	12-bit sensor bit depth: 0.02

6.2 Electronic Shutter Types

The shutter type determines the way in which image data is captured and processed. Your camera model has a [Global shutter](#).

6.2.1 Global Shutter

During image acquisition, all of the sensor's pixels start exposing at the same time and also stop exposing at the same time. Immediately after the end of exposure, pixel data readout begins and proceeds row by row until all pixel data has been read. This is particularly useful if you want to capture fast moving objects or if the camera is moving rapidly while capturing images. The sensor readout time is the sum of all row readout times. Therefore, the sensor readout time is influenced by the [image ROI](#) height. You can determine the readout time by checking the value of the camera's [SensorReadoutTime](#) parameter.



7. I/O Control

7.1 I/O Control

Your camera and camera modules offer input and output (I/O) lines. The topics in this section provide information about the I/O lines.

The input lines allow you to control the camera, e.g., trigger image captures at particular points in time. The output lines allow you to retrieve information about the camera, e.g., when you should apply flash lighting.

7.1.1 Electrical Requirements

For electrical requirements of the I/O lines of your camera model, see the [Electrical Requirements](#) topic.

7.1.2 Related Topics

- [Circuit Diagrams](#)
- [General Purpose I/O \(GPIO\) Lines](#)
- [I/O Timing Characteristics](#)
- [Opto-Coupled I/O Lines](#)

7.2 Circuit Diagrams

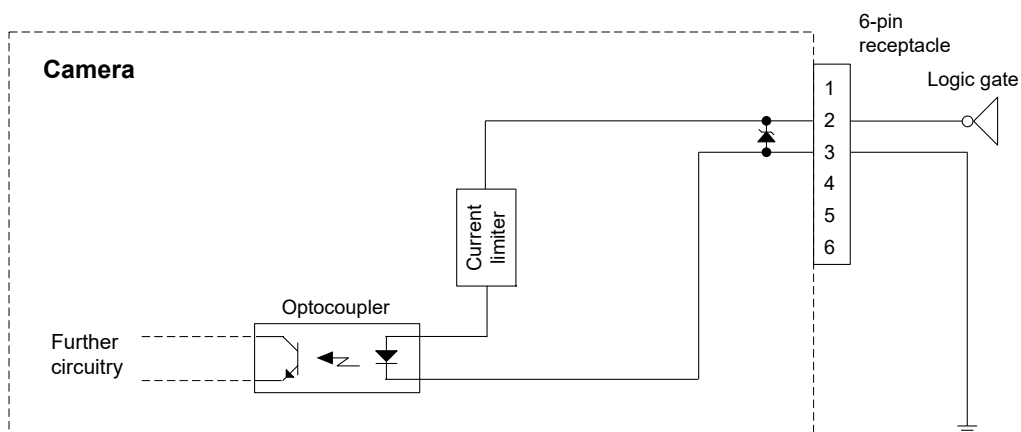
This topic provides sample circuit diagrams for connecting your camera to external circuitry.

Info

For electrical requirements of your camera model, see the [Electrical Requirements](#) section.

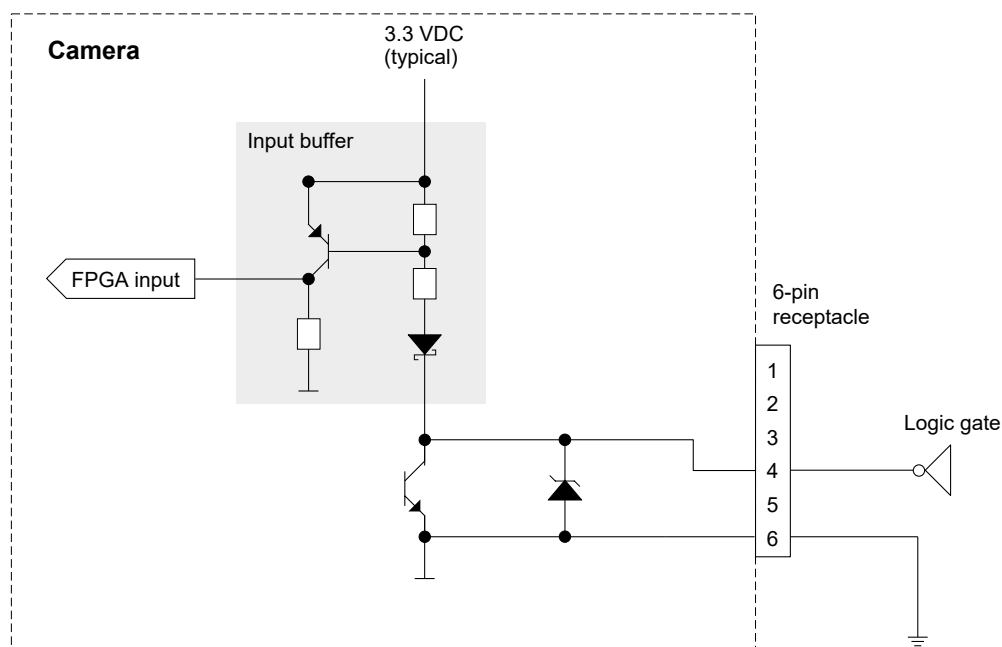
7.2.1 Opto-Coupled Input Line

The following diagram shows a typical circuit using the [opto-coupled input line](#) (Line 1). As an example, a TTL or CMOS logic gate is used in the external circuit.

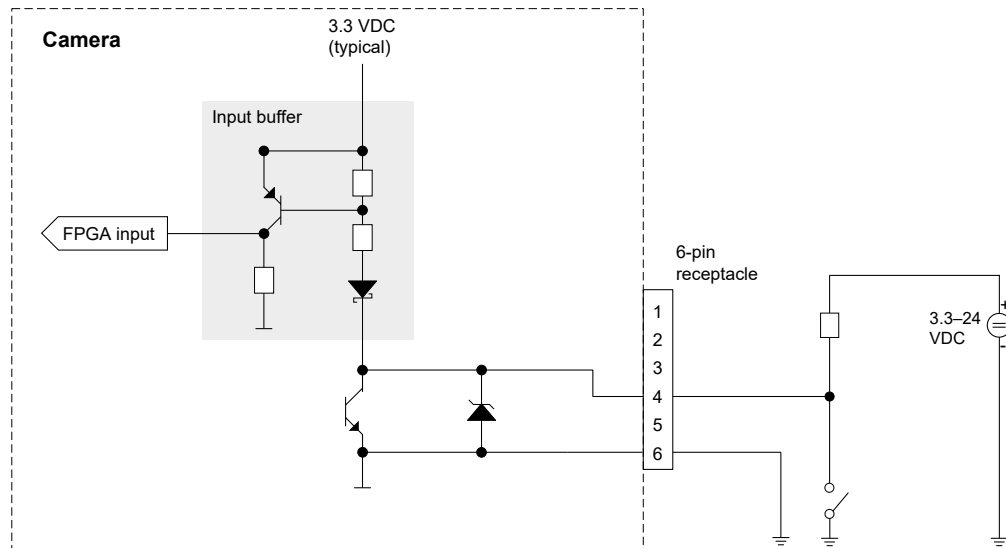


7.2.2 GPIO Input Line

The following diagram shows a typical circuit when a [GPIO line](#) is set to operate as an input. As an example, Line 2 is connected, and a TTL or CMOS logic gate is used in the external circuit.

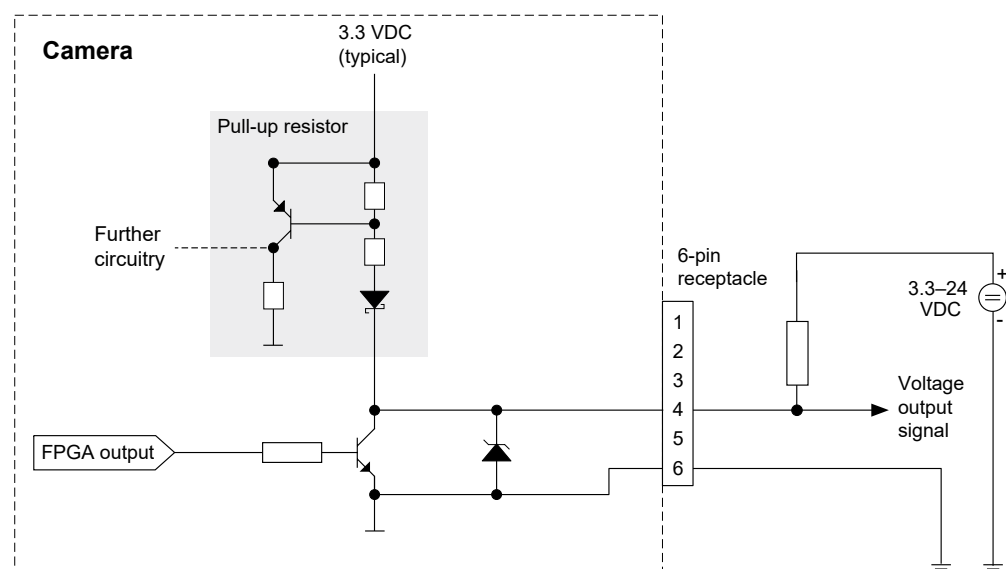


The following diagram shows a different example of an external circuit using a [GPIO line](#).



7.2.3 GPIO Output Line

The following diagram shows a typical circuit when a **GPIO line** is set to operate as an output. As an example, Line 2 is connected. This circuit only works with devices that accept NPN communication.



7.3 General Purpose I/O (GPIO) Lines

The General Purpose I/O (GPIO) lines of your camera can be configured to operate as input or output lines.

7.3.1 Characteristics

- Unlike [opto-coupled I/O lines](#), GPIO lines aren't preconfigured as input or output lines. You can specify the [line mode](#) manually.
- GPIO lines have the advantage of very short [propagation delays](#) compared to [opto-coupled I/O lines](#). The delays are approximately 10 times lower.
- GPIO lines are considerably more susceptible to [EMI](#) compared to [opto-coupled I/O lines](#). Under harsh EMI conditions, the GPIO line can turn out to be unusable.
- GPIO lines are compatible with TTL signals.

7.3.2 Common Tasks

Task	Feature
Specifying whether you want the GPIO line to operate as an input, output, or input-output line	Line Mode
Determining the current status of one or all GPIO lines (high / low)	Line Status
Selecting an output signal for a GPIO line	Line Source
Inverting all input or output signals (high -> low, low -> high)	Line Inverter

7.3.3 Sample Circuit Diagrams

→ See [Circuit Diagrams](#).

7.3.4 Timing Characteristics

→ See [I/O Timing Characteristics](#).

7.4 I/O Timing Characteristics

This topic provides information about the camera's propagation delays ("response times") when operated via I/O lines.

The propagation delay is the length of time between the change of the analog I/O signal and the change of the camera's internal status – or vice versa.

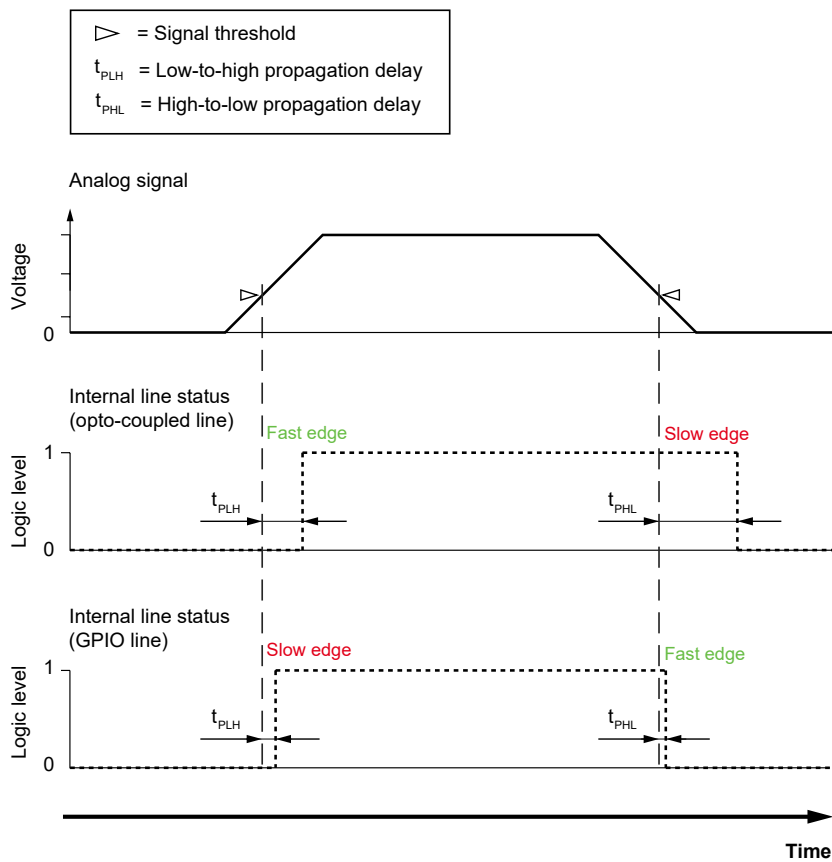
Knowing the propagation delays is useful if you want to configure I/O control with a precision in the microsecond range.

All examples in this section assume that the [Line Inverter](#) feature is disabled.

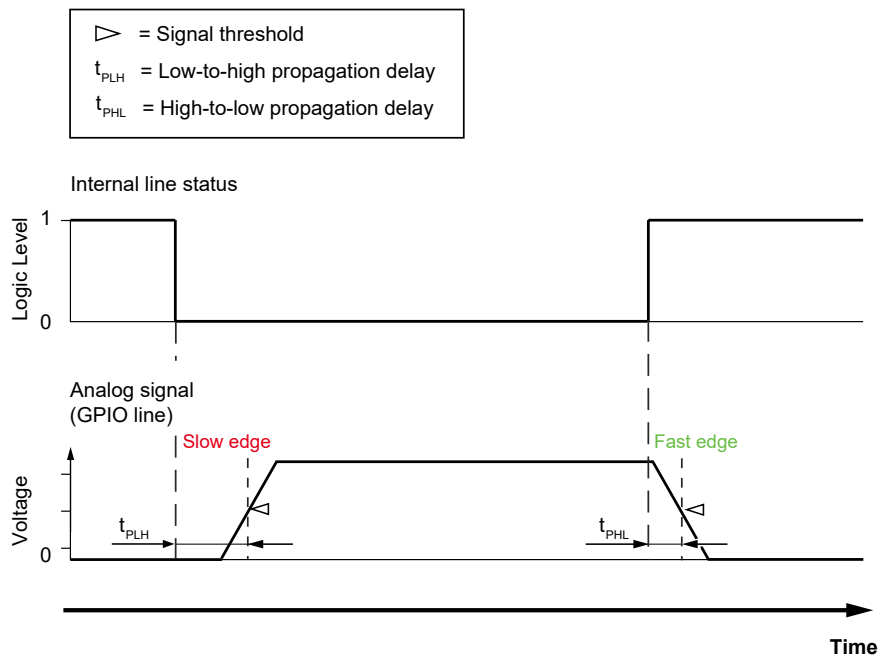
7.4.1 Characteristics

- Propagation delays of [opto-coupled I/O lines](#) are generally longer than those of [GPIO lines](#).
- For opto-coupled input lines, the propagation delay for low-to-high signal transitions (rising edges) is shorter than for high-to-low signal transitions (falling edges). For GPIO lines, the opposite applies.
- For output lines, the propagation delay for high-to-low signal transitions is always shorter.

Propagation Delays on Input Lines



Propagation Delays on Output Lines



7.4.2 Factors Influencing the Propagation Delays of I/O Lines

Factor	Opto-coupled Input Line	GPIO Input Line	Opto-coupled Output Line	GPIO Output Line
Operating temperature	●	○	●	○
Production spread of electronic components ^a	●	○	●	○
Aging	●		●	
External I/O supply voltage	●		●	○
Load resistance			●	○
Load current			●	○

● = major influence, ○ = minor influence

^a. Production spread can result in different propagation delays even in cameras from the same batch that are operated under identical conditions.

7.4.3 Recommendations

- As a general rule, use the fast edge of a signal to achieve the fastest response times. The propagation delays for a fast edge will rarely exceed 15 μ s for an opto-coupled I/O line, and rarely 1 μ s for a GPIO line.
- To minimize fast edge propagation delays, increase the load resistance.
- To minimize slow edge propagation delays:
 - Use an I/O supply voltage between 3.3 VDC and 5 VDC.
 - Decrease the load resistance to achieve a load current between 30 mA and 40 mA.
- Use GPIO lines as their propagation delays are generally shorter.

- Applying current to the input and output lines makes opto-couplers age faster. Keep the times when current flows to a minimum to preserve stable propagation delays.
- The signal edge-to-edge displacement (jitter) resulting from the use of I/O lines is negligible. However, the jitter may be increased by your trigger signal. To avoid jitter, keep the flanks of your trigger signals steep, and thereby short (preferably below 500 ns). The camera's inherent jitter is less than 100 ns, peak to peak.

7.5 Opto-Coupled I/O Lines

The opto-coupled I/O lines of your Cognex camera are preconfigured to operate either as input or output lines.

7.5.1 Characteristics

- Opto-coupled I/O lines are preconfigured to operate as input or output. You can't change the [line mode](#) of opto-coupled lines.
- If your camera has opto-coupled lines, one of them is always a dedicated input line and another a dedicated output line.
- Opto-coupled I/O lines have the advantage of being considerably more robust against [EMI](#) than [GPIO lines](#).
- Opto-coupled I/O lines have longer [propagation delays](#) (response times) compared to [GPIO lines](#).
- The minimum required pulse width for input triggers is longer compared to [GPIO lines](#). Make sure to provide sufficient time for the camera's input circuit to react. For most cases, a pulse width of 100 µs should be long enough.

7.5.2 Common Tasks

Task	Feature
Determining the current status of one or all opto-coupled I/O lines (high / low)	Line Status
Selecting an output signal for an opto-coupled I/O line	Line Source
Inverting all input or output signals (high -> low, low -> high)	Line Inverter

7.5.3 Sample Circuit Diagrams

→ See [Circuit Diagrams](#).

7.5.4 Timing Characteristics

→ See [I/O Timing Characteristics](#).

Version History

Version	Date	Changes
1.0.1	Jul. 28, 2025	First version of this document.