

BU Series

CMOS Camera

Instruction Manual

Model

B/W Camera : BU302MG / BU505MG

Color Camera : BU302MCG / BU302MCF / BU505MCG / BU505MCF

Thank you for purchasing our product.

Before using this CMOS camera, please read through this instruction manual carefully in order to use this product correctly and safely.

After reading, keep this instruction manual handy so that you can refer to, whenever you need it.

Toshiba Teli Corporation

Information contained in this document is subject to change without prior notice.

Standard name might be trade mark of each company.

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Safety Precautions

Before using this product, read these safety precautions carefully. Important information is shown in this Instruction Manual to protect users from bodily injuries and property damages, and to enable them to use the product safely and correctly.

Please be sure to thoroughly understand the meanings of the following signs and symbols before reading the main text that follow, and observe the instructions given herein.

[Definition of Safety Signs]



Safety Signs	Description
 WARNING	Indicates a potentially hazardous situation that may result in death or serious injury (*1) in the event of improper handling.
 CAUTION	Indicates a potentially hazardous situation that may result in light to moderate injuries (*2) or only in property damage (*3) in the event of improper handling.

Notes *1: "Serious injury" refers to cases of loss of eyesight, wounds, burns (high or low temperature), electric shock, broken bones, poisoning, etc., which leave after-effects or which require hospitalization or a long period of outpatient treatment of cure.

*2: "Light to moderate injuries" refers to injuries, burns, electric shock etc. that do not require hospitalization or long-term treatment.

*3: "Property damage" refers to cases of extensive damage involving damage to buildings, equipment, farm animals, pet animals and other belongings.

[Explanation of Safety Symbols]

Safety Symbols	Description
 PROHIBITED	This sign indicates PROHIBITION (Do not). The content of prohibition is shown by a picture or words beside the symbol.
 MANDATORY	This sign indicates MANDATORY ACTION (You are required to do). The content of action is shown by a picture or words beside the symbol.

General Handling

WARNING



Unplug

- **Stop operation immediately when any abnormality or defect occurs.**

If abnormal conditions are present, such as smoke, a burning smell, ingress of water or foreign matter, or if the equipment is dropped or malfunctions, fire or electric shock may result.

Be always sure to disconnect the power cable from the wall socket at once and contact your dealer.



Do not get wet

- **Do not use the equipment in locations subject to water splashes.**

Otherwise, fire or electric shock may result.



Never pull apart

- **Do not disassemble, repair, or modify the equipment.**

Otherwise, fire or electric shock may result.

For internal repair, inspection, or cleaning, contact your sales representative.



Avoid

- **Do not place anything on the equipment.**

If metallic objects, liquid, or other foreign matter enters the equipment, fire or electric shock may result.



Avoid

- **Do not install the equipment in an unstable or inclined location or locations subject to vibration or impact.**

Otherwise, the equipment may topple over and cause personal injury.



Do not touch

- **During an electrical storm, do not touch the power cable and the connection cable.**

Otherwise, an electric shock may result.



Instruction

- **Use the specified voltage.**

Use of an unspecified voltage may result in fire or electric shock.



Avoid

- **Do not be handled roughly, damaged, fabricated, bent forcefully, pulled, twisted, bundled, placed under heavy objects or heated the power cable and the connection cable.**

Otherwise, fire or electric shock may result.

CAUTION



Instruction

- **Observe the following when installing the equipment:**

- Do not cover the equipment with a cloth, etc.
- Do not place the equipment in a narrow location where heat is likely to accumulate. Otherwise, heat will accumulate inside the equipment, possibly resulting in a fire.



Avoid

- **Do not place the equipment in locations subject to high moisture, oil fumes, steam, or dust.**

Otherwise, fire or electric shock may result.



Avoid

- **Do not install the equipment in locations exposed to direct sunlight or humidity.**

Otherwise, the internal temperature of the equipment will rise, which may cause a fire.



Instruction

- **Use only specified the power cable and the connection cables.**

Otherwise, fire or electric shock may result.



Avoid

- **Do not give strong impact against the equipment.**

It may cause the trouble.



Instruction

- **When performing connection, turn off power.**

When connecting the power cable and the connection cable, turn off the equipment power.

Otherwise, fire or electric shock may result.



Avoid

- **Do not expose its camera head to any intensive light (such as direct sunlight).**

Otherwise, its inner image pickup device might get damaged.



Avoid

- **Avoid short-circuiting signal output.**

Otherwise, a malfunction may occur.



Avoid

- **Avoid giving a strong shock against the camera body.**

It might cause a breakdown or damage. If your camera is used in a system where its connector is subjected to strong repetitive shocks, its connector is possible to break down. If you intend to use your camera in such a situation, if possible, bundle and fix a cable in the place near the camera, and do not transmit a shock to the connector.



Instruction

- **Contact your sales representative to request periodic inspection and cleaning (every approx. five years).**

Accumulation of dust inside the equipment may result in fire or electric shock. For inspection and cleaning costs, contact your sales representative.

CASES FOR INDEMNITY (LIMITED WARRANTY)

We shall be exempted from taking responsibility and held harmless for damage or losses incurred by the user in the following cases.

- In the case damage or losses are caused by natural disasters, such as an earthquake and thunder, fire, or other acts of God, acts by a third party, deliberate or accidental misuse by the user, or use under extreme operating conditions.
- In the case of indirect, additional, consequential damages (loss of business interests, suspension of business activities) are incurred as result of malfunction or non-function of the equipment, we shall be exempted from responsibility for such damages.
- In the case damage or losses are caused by failure to observe the information contained in the instructions in this instruction manual and specifications.
- In the case damage or losses are caused by use contrary to the instructions in this instruction manual and specifications.
- In the case damage or losses are caused by malfunction or other problems resulting from unintended use of equipment or software etc. that are not specified.
- In the case damage or losses are caused by repair or modification conducted by the customer or any unauthorized third party (such as an unauthorized service representative).
- Expenses we bear on this product shall be limited to the individual price of the product.
- The item that is not described in specifications of this product is out of the guarantee.
- The case of damages or losses which are caused by incorrect connection of the cable is out of the guarantee.

RESTRICTION FOR USE

- Should the equipment be used in the following conditions or environments, give consideration to safety measures and inform us of such usage:
 1. Use of the equipment in the conditions or environment contrary to those specified, or use outdoors.
 2. Use of the equipment in applications expected to cause potential hazard to people or property, which require special safety measures to be adopted.
- This product can be used under diverse operating conditions. Determination of applicability of equipment or devices concerned shall be determined after analysis or testing as necessary by the designer of such equipment or devices, or personnel related to the specifications. Such designer or personnel shall assure the performance and safety of the equipment or devices.
- This product is not designed or manufactured to be used for control of equipment directly concerned with human life (*1) or equipment relating to maintenance of public services/functions involving factors of safety (*2). Therefore, the product shall not be used for such applications.
 - (*1): Equipment directly concerned with human life refers to.
 - Medical equipment such as life-support systems, equipment for operating theaters.
 - Exhaust control equipment for exhaust gases such as toxic fumes or smoke.
 - Equipment mandatory to be installed by various laws and regulations such as the Fire Act or Building Standard Law
 - Equipment related to the above
 - (*2): Equipment relating to maintenance of public services/functions involving factors of safety refers to.
 - Traffic control systems for air transportation, railways, roads, or marine transportation
 - Equipment for nuclear power generation
 - Equipment related to the above

Notes on using this product

- Handle carefully

Do not drop the equipment or allow it to be subject to strong impact or vibration, as such action may cause malfunctions. Further, do not damage the connection cable, since this may cause wire breakage.

- Environmental operating conditions

Do not use the product in locations where the ambient temperature or humidity exceeds the specifications.

Otherwise, image quality may be degraded or internal components may be adversely affected. In particular, do not use the product in areas exposed to direct sunlight. Moreover, during shooting under high temperatures, vertical stripes or white spots (noise) may be produced, depending on the subject or camera conditions (such as increased gain). However, such phenomena are not malfunctions.

- Check a combination with the lens

Depending on the lens and lighting you use, an image is reflected as a ghost in the imaging area. However, this is not because of a fault of the camera.

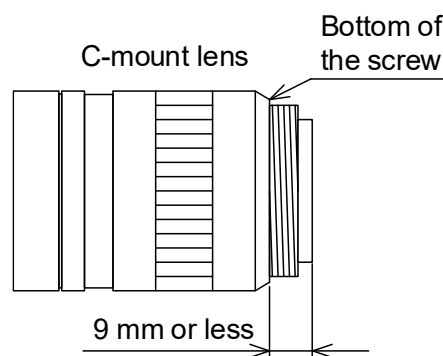
In addition, depending on the lens you use, the performance of the camera may not be brought out fully due to deterioration in resolution and brightness in the peripheral area, aberration and others.

Be sure to check a combination with the camera by using the lens and lightning you actually use.

When installing a lens in the camera, make sure carefully that it is not tilted.

In addition, use a mounting screw free from defects and dirt. Otherwise, the camera may be unable to be removed.

Install a next lens; its dimension of protrusion from bottom of the screw is equal to or less than 9 mm. If a lens does not stand to this condition, it might not be installed to this camera.



- Mounting to pedestal

When mounting this product to a pedestal, make sure carefully that lens doesn't touch with the pedestal.

- Do not expose the camera's image-pickup-plane to sunlight or other intense light directly
Its inner CMOS sensor might be damaged.
- Occurrence of moiré
If you shoot thin stripe patterns, moiré patterns (interference fringes) may appear. This is not a malfunction.
- Occurrence of noise on the screen
If an intense magnetic or electromagnetic field is generated near the camera or connection cable, noise may be generated on the screen. If this occurs, move the camera or the cable.
- Handling of the protective cap
If the camera is not in use, attach the lens cap to the camera to protect the image pickup surface.
- If the equipment is not to be used for a long duration
Turn off power to the camera for safety.
- Maintenance
Turn off power to the equipment and wipe it with a dry cloth.
If it becomes severely contaminated, gently wipe the affected areas with a soft cloth dampened with diluted neutral detergent. Never use alcohol, benzene, thinner, or other chemicals because such chemicals may damage or discolor the paint and indications.
If the image pickup surface becomes dusty, contaminated, or scratched, consult your sales representative.
- Disposal
When disposing of the camera, it may be necessary to disassemble it into separate parts, in accordance with the laws and regulations of your country and/or municipality concerning environmental contamination.

Following information is only for EU-member states:

The use of the symbol indicates that this product may not be treated as household waste. By ensuring this product is disposed of correctly, you will help prevent potential negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. For more detailed information about the take-back and recycling of this product, please contact your supplier where you purchased the product.



“This symbol is applicable for EU member states only”

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 communication.

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.

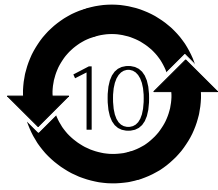
[Phenomena specific to CMOS sensor]

- **Defective pixels**

A CMOS image sensor is composed of photo sensor pixels in a square grid array. Due to the characteristics of CMOS image sensors, over- or under-driving of the pixels results in temporary white or black areas (as if these are noises) appearing on the screen. This phenomenon, which is not a defect is exacerbated under higher temperatures and long exposure time.

- **Image shading**

The brightness of the upper part of the screen may be different from that of the lower part. Note that this is a characteristic of a CMOS image sensor and is not a fault.



中华人民共和国
环保使用期限

环保使用期限标识，是根据电子信息产品污染控制管理办法以及，电子信息产品污染控制标识要求(SJ/T11364-2014)、电子信息产品环保使用期限通则，制定的适用于中国境内销售的电子信息产品的标识。

电子信息产品只要按照安全及使用说明内容，正常使用情况下，从生产月期算起，在此期限内，产品中含有的有毒有害物质不致发生外泄或突变，不致对环境造成严重污染或对其人身、财产造成严重损害。

产品正常使用后，要废弃在环保使用年限内或者刚到年限的产品时，请根据国家标准采取适当的方法进行处置。

另外，此期限不同于质量/功能的保证期限。

The Mark and Information are applicable for People's Republic of China only.

<产品中有害有毒物质或元素的名称及含量>

部件名称	有害有毒物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
相机本体	×	○	○	○	○	○

本表格依据SJ/T 11364的规定编制

○：表示该有害有毒物质在该部件所有均质材料中的含量均在电子信息产品中有毒有害物质的限量要求标准规定的限量要求(GB/T26572)以下

×：表示该有害有毒物质至少在该部件的某一均质材料中的含量超出电子信息产品中有毒有害物质的限量要求标准规定的限量要求(GB/T26572)

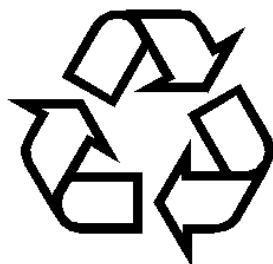
This information is applicable for People's Republic of China only.

リサイクルに関する情報（包装物）

有关再利用的信息(包装物)

Information on recycling of wrapping composition

箱 / 箱子 / Box



ペーパーボード
纸板
Paper board

内部緩衝材料・袋

内部缓冲材料・袋

Internal buffer materials・Bag



PE-LD

Installation

Before using this product, you shall install application software to display image and control registers of camera, and IP configuration tool for network setting.

You can download the SDK for our USB camera products (TeliCamSDK) from the Service & Support section of our website.

User registration is necessary to use downloading service. Please make a user registration, or contact your sales representative.

- TOSHIBA TELI CORPORATION Top Page
<https://www.toshiba-teli.co.jp/en/>
- Service & Support
<https://www.toshiba-teli.co.jp/cgi/ss/en/service.cgi>

Please refer to the TeliCamSDK startup guide, about Operation environment, Installation, and Setup.

Specifications

Overview

BU302M/BU505M series is an integrated-(one-body)-type camera that adopts a global shutter CMOS sensor. These are BU302MG (3M type1/1.8) BU505MG (5M type2/3). Suffix [CG] or [CF] are attached to the color models. For video output and camera control, the USB3.1 Gen1 (USB3.0) interface standard is adopted for high transfer rate, and it is easy to integrate into industrial equipment.

Features

- High frame rate

Supporting high frame rate, BU302MG 120fps, BU505MG 75fps.

- Global shutter

As it employs a global electronic shutter similar to a CCD image sensor, clear images of even fast-moving object are obtainable with less blur.

- USB3.1 Gen1 (USB3.0) interface

Video output and camera control are performed via the USB 3.1 Gen1 (USB3.0, after here USB 3.1 Gen1) standard interface. Data transfer is up to 5Gbps (Maximum) that enables to output uncompressed video data at high frame rate.

- USB3 Vision

This product is based on USB3 Vision Ver.1.0.

- GenICam Ver. 2.4, Ver. 3.0

This product is based on GenICam (Generic Interface for Cameras) Ver. 2.4 and Ver. 3.0.

- IIDC2 Digital Camera Control Specification Ver.1.1.0

This product is based on IIDC2 Digital Camera Control Specification Ver.1.1.0.

- e-CON Connector adoption

The e-CON connector adoption enables to assemble the cable easily without using special tools.

- Random Trigger Shutter

The Random Trigger Shutter function provides images in any timing by input of an external trigger signal. Trigger control from PC is available as well.

- Scalable

Selectable video output area. This mode achieves higher frame rate by reducing vertical output area. And reduces occupied data rate of USB bus by reducing horizontal output area.

- Binning

In this mode, pixel data is combined by vertical and horizontal. Vertical binning achieves high frame rate.

- Decimation

Camera reads all effective areas at high speed by skipping lines.

- Color processing

Color models have built in color processing. There are RGB, BGR, YUV422, YUV411, Bayer and Mono output modes. In addition, it produced an image with restrained false color by adaptive filter interpolating 7 x 7 pixels.

- IR-cut filter

Build-in IR-cut filter models are optional for color models.

Suffix [F] is attached to the model name of built-in IR-cut filter model. (e.g. BU302MCF)

* Suffix [F] is not shown in the common part of specifications.

- Compact and lightweight

This camera is compact and lightweight; it is easy to integrate into industrial equipment.

- ShortExpousreMode

Firmware Ver.4.1.0 or later models have ShortExpousreMode. By setting the ShortExpousreMode to enable, high-speed exposure time setting from 1.08μs to 14.44μs is possible.

Configuration

The system configuration of this camera series is as follows;

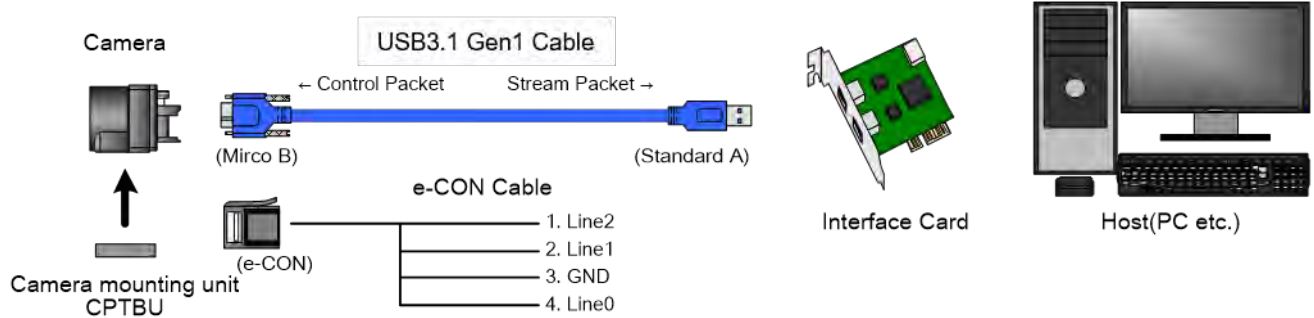
This camera has no accessories, please prepare other equipment separately.

- Camera: This product. (BU)
- Camera mounting kit CPTBU, CPTBUBG (*1): To fix a camera to a tripod; attach this to the bottom of the camera.
- USB3.1 Gen1 Cable (*2): This cable is used to connect the camera to host PC. Please use a USB3.1 Gen1 cable of Standard A - Micro B. This product is able to connect a USB cable equipped with screw lock mechanism. Please use it as needed.
- USB3.1 Gen1 Interface Card (*2): This is the interface card to connect to the camera. Usually this card is installed to expansion slot of PC etc.
- e-CON Cable. (*2): This cable is used to input external trigger signal and output GPIO signal.
We recommend using shielded cable, because there is likely to be affected by the noise depending on the operating environment of the camera.

*1: Optional part. Contact your sales representative for details of option units.

*2: Commercial items.

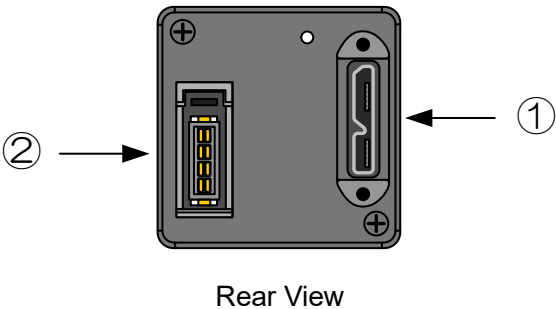
Connection



Notes on Connection:

- Please confirm the power supply of the camera off when plugging in or pulling out the I/O Connector. It causes the breakdown.
- If your camera is used in a system where its connectors are subjected to strong repetitive shocks, its connectors are possible to break down. If you use your camera in such a situation, use an USB3.1 Gen1 cable with a lock screw, and secure the camera cable as close as possible to the camera body for avoid physical shock to the camera connector.
- About e-CON cable: In the case that electric-wire is long or thin, input and output voltage may not satisfy specifications of the camera or your system by voltage drop. Please confirm wires' specifications before use them.
- Lost packets may occur by an electrical characteristic of the transmission line of USB3.1 Gen1. (USB3.1 Gen1 Interface Card, USB3.1 Gen1 Cable, and USB3.1 Gen1 HUB).

Connector Pin Assignment



1. USB3.1 Gen1 Interface Connector

Connector model: WMUR-10F6L1PH5N (WIN WIN PRECISION INDUSTRIAL)

Pin No.	I/O	Signal	Function
1	-	VBUS	Power
2	I/O	D-	USB2.0 differential pair
3	I/O	D+	
4	-	NC	Not connected
5	-	GND	Ground for power return
6	O	SSTX-	SuperSpeed transmitter differential pair
7	O	SSTX+	
8	-	GND_DRAIN	Ground for SuperSpeed signal return
9	I	SSRX-	SuperSpeed receiver differential pair
10	I	SSRX+	

2. I/O Connector

Connector (Camera side)

Matching connector (Cable side)

37204-62B3-004PL (3M Japan Limited) or equivalent

Connectors which conformed to e-CON

e.g. 37104 series (3M Japan Limited),

RITS 4P series (TE Connectivity Ltd.)

* Matching connector is not an accessory of this product.

Pin assignment

①

②

③

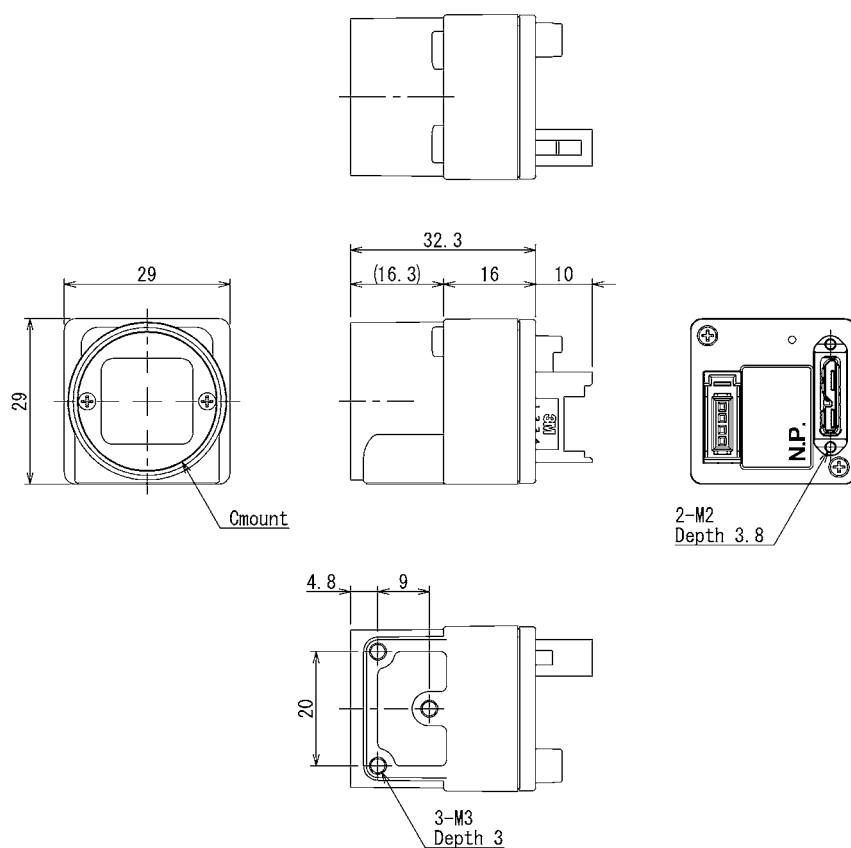
④

↑ TOP

*Above figure is connector view from insert side.

Pin No.	I/O	Signal	Function
1	I/O	Line2	GPIO Input / Output
2	O	Line1	GPIO Output
3	-	GND	Ground
6	I	Line0	GPIO Input

Outline Drawing



Specification

Main material : Aluminum die-cast metal
Processing : Cation coating (black)

General Specifications

- B/W model

Model Name	BU302MG	BU505MG
Imager	CMOS image sensor	
Number of Video out pixels (H) × (V)	2048 × 1536	2448 × 2048
Optical Size	type1/1.8	type2/3
Scanning area (H) × (V)[mm]	7.12 × 5.33	8.50 × 7.09
Pixel size (H) × (V)[μm]	3.45 ×3.45	
Scan method	Progressive	
Electronic shutter method	Global shutter	
Aspect ratio	4 : 3	6 : 5
Sensitivity	3250lx, F5.6, 1/120s	2100lx, F5.6, 1/75s
Minimum illuminance (*1)	Ver.4.0.8 or earlier: 7lx Ver.4.1.0 or later: 2lx	Ver.4.0.8 or earlier: 5lx Ver.4.1.0 or later: 2lx
Power supply	DC +5V±5% (from USB connector)	
Power consumption (*2)	SER No. 0300001 to 0309999 : 3.2W (maximum)	
	SER No. 0310001 or later : 2.9W (maximum)	
Interface	USB 3.1 Gen1 (Only SuperSpeed is supported)	
Transmission speed	5Gbps (maximum)	
Protocol	USB3 Vision	
Image format	Mono8, Mono10, Mono12	
Maximum Frame rate (*2)		
Mono8	120 fps	75 fps
Mono10, Mono12	63 fps	39 fps
Dimensions	29 mm(W) x 29 mm (H) x 16 mm (D) (Not including protrusion)	
Mass	Approximately 33g	
Lens mount	C-mount	
Flange back	17.526mm	
Camera body grounding: insulation status	Conductive between circuit GND and camera body	

*1 F1.4, Gain: Maximum (+24dB), video level: 50%

F1.4, Gain: Maximum (+36dB), video level: 50%

*2 at the all pixel readout

● Color model

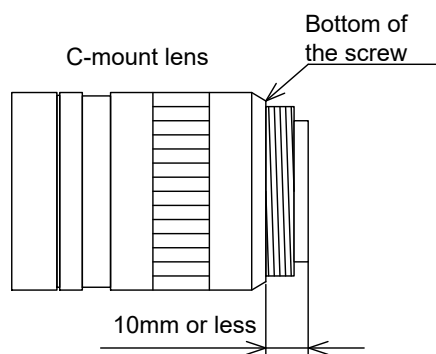
Model Name		
With optical glass	BU302MCG	BU505MCG
With IR-cut filter	BU302MCF	BU505MCF
Imager	CMOS image sensor	
Number of Video out pixels (H) × (V)	2048 × 1536	2448 × 2048
Optical Size	type1/1.8	type2/3
Scanning area (H) × (V)[mm]	7.12 × 5.33	8.50 × 7.09
Pixel size (H) × (V)[μm]	3.45 × 3.45	
Scan method	Progressive	
Electronic shutter method	Global shutter	
Aspect ratio	4 : 3	6 : 5
Sensitivity		
With optical glass	2400lx, F4, 1/120s	3000lx, F5.6, 1/75s
With IR-cut filter	2650lx, F4, 1/120s	3300lx, F5.6, 1/75s
Minimum illuminance (*1)		
With optical glass	10lx	6lx
With IR-cut filter	11lx	7lx
Power supply	DC +5V±5% (from USB connector)	
Power consumption (*2)	With optical glass	SER No. 0300001 to 0309999 : 4.0W (maximum)
		SER No. 0310001 or later : 3.6W (maximum)
	With IR-cut filter	SER No. 0500001 to 0509999 : 4.0W (maximum)
		SER No. 0510001 or later : 3.6W (maximum)
Interface	USB 3.1 Gen1 (Only SuperSpeed is supported)	
Transmission speed	5Gbps (maximum)	
Protocol	USB3 Vision	
Image format	RGB, BGR, YUV422, YUV411, Bayer8, Bayer10, Bayer12, Mono8	
Maximum Frame rate (*2)		
Bayer8, Mono8	120 fps	75 fps
YUV411	84 fps	52 fps
YUV422	63 fps	39 fps
Bayer10, Bayer12	63 fps	39 fps
RGB, BGR	42 fps	26 fps
Dimensions	29 mm(W) x 29 mm (H) x 16 mm (D) (Not including protrusion)	
Mass	Approximately 33g	
Lens mount	C-mount	
Flange back	17.526mm	
Camera body grounding: insulation status	Conductive between circuit GND and camera body	

*1 F1.4, Gain: Maximum (+24dB), video level: 50%

*2 at the all pixel readout

Notes on combination of C-mount lens:

- Depending on the lens you use, the performance of the camera may not be brought out fully due to the deterioration in resolution and brightness in the peripheral area, occurrence of a ghost, aberration and others. When you check the combination between the lens and camera, be sure to use the lens you actually use.
- In addition, use a mounting screw free from defects and dirt. Otherwise, the camera may be unable to be removed.
- As for the C-mount lens used combining this camera, the projection distance from bottom of the screw should use 10mm or less.



LED Status

Camera state	Lamp indication
No power	Off
Link detection in progress	Fast flash green (ON:20ms, OFF:60ms)
Connection Error	Flash alternate red / green
SuperSpeed connected, but no data being transferred	Flash green (ON: 200ms, OFF: 800ms)
SuperSpeed connected, waiting for trigger	Flash orange (ON: 200ms, OFF: 800ms)
Data being transferred	Fast flash green (ON:60ms, OFF:20ms)
Error during data transfer	Solid Red (Time period: 500ms)
Stand-by	Super slow flash orange (ON:200ms, OFF: 2800ms)

I/O Specification

- Signal Specification

- Line0 (I/O connector : 4 pin)

Input / Output Specification : Input only

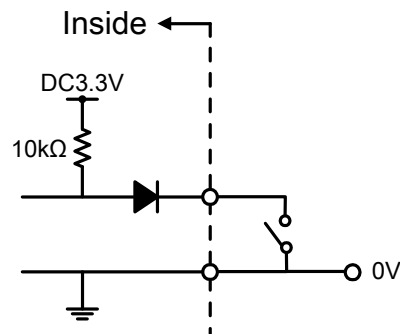
Input Circuit : LVTTL

Level : Low 0 ~ 0.5V, High 2.0 ~ 24.0V

Polarity : High active / Low active (initial factory setting: Low active)

Pulse Width : Minimum 50μs

Input circuit diagram



Notes of external trigger signal:

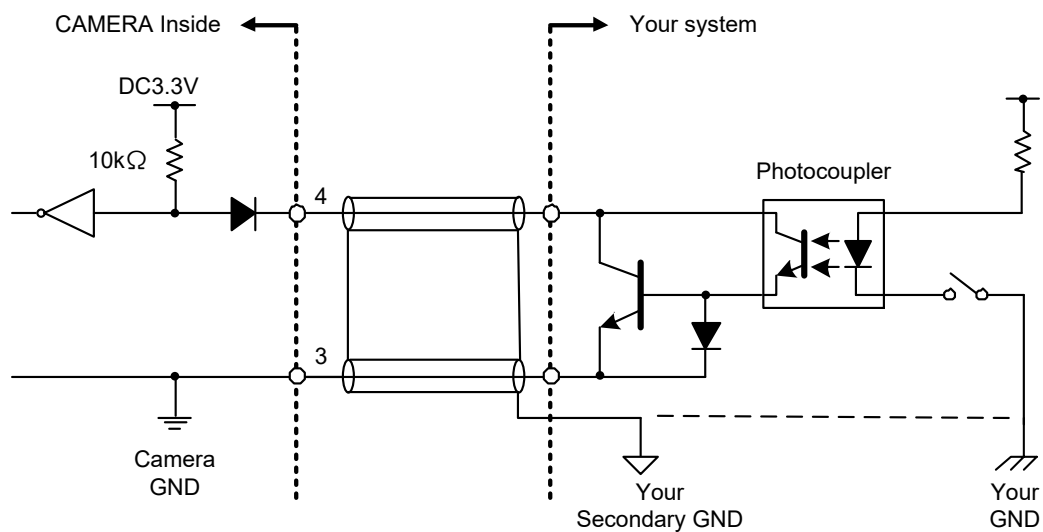
Depending on cable length, cable kinds and input current of trigger input line, Random Trigger Shutter operation may not satisfy timing specification or camera may not receive EXT_TRIG signal. Please confirm it before use.

Notes of input level:

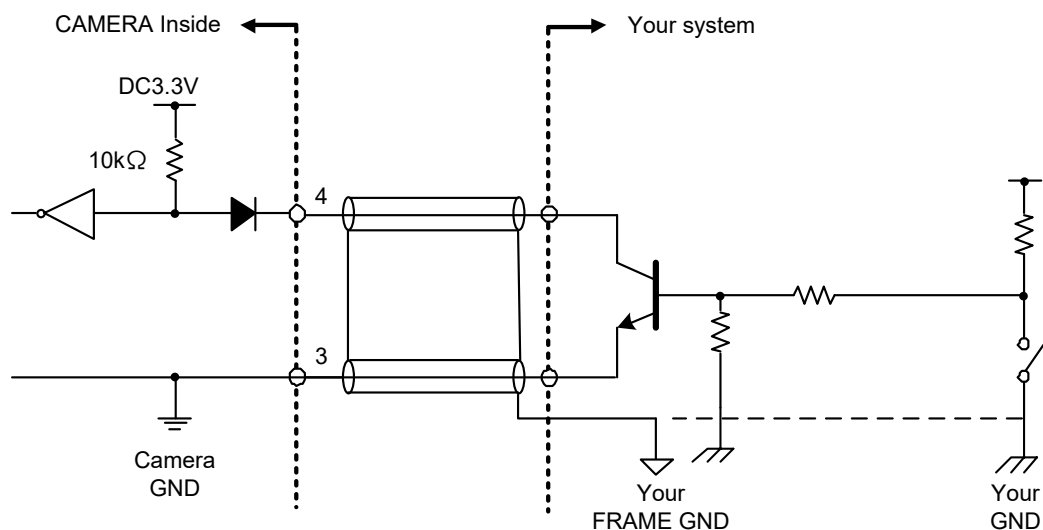
Line0 and Line2 have different input level. Please use input level within the voltage described in this specification.

- External trigger input recommended circuit

- Isolated I/F



- Non-Isolated I/F



Notes of trigger input cable:

- The recognition of the trigger signal depends on the length, characteristic or driving current of the cable. Therefore please confirm your system about those conditions.
- Pin 3 is signal ground. It is conducted with camera frame.
Using shield cable, terminal processing of the shield is referred as above.
- Please confirm the EMC adaptability in whole of your system.

- Line2 (I/O connector : 1 pin)

Input / Output specification : Input / Output (switch by LineMode is possible)

Factory setting : Output

- Input signal specification

Level : Low 0 ~ 0.5V, High 4.0 ~ 5.0V

Polarity : High active / Low active (initial factory setting: Low active)

Pulse Width : Minimum 50μs

Notes of external trigger signal:

Depending on cable length, cable kinds and input current of trigger input line, Random Trigger Shutter operation may not satisfy timing specification or camera may not receive EXT_TRIG signal. Please confirm it before use.

Notes of input level:

Line0 and Line2 have different input level. Please use input level within the voltage described in this specification.

- Output signal specification

Output Circuit : 5V CMOS

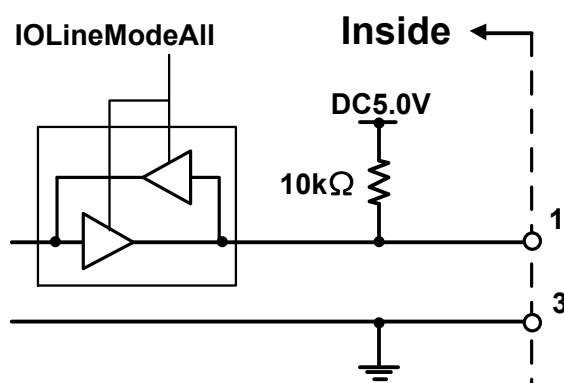
Maximum Current : +/-32mA

Polarity : High active / Low active (initial factory setting: Low active)

Signal Source (LineSource) : Off* / UserOutput / Timer0Active / AcquisitionActive
FrameTriggerWait / FrameActive / FrameTransferActive
ExposureActive

*Even if LineMode is set as Output, the input signal to Line2 is valid when LineSource is set as Off.

Input / Output circuit diagram



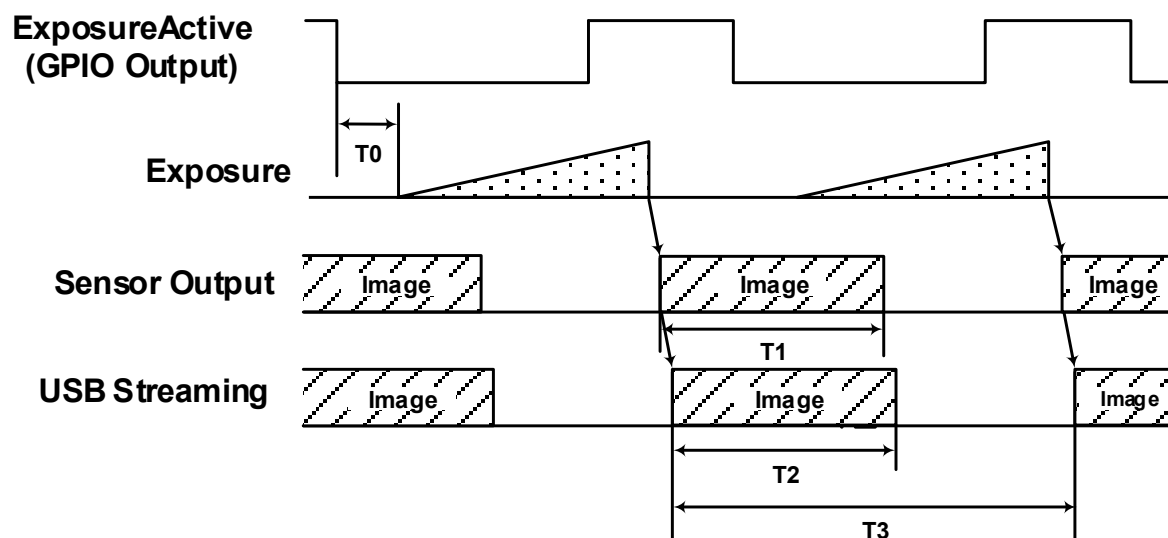
- Line1 (I/O connector : 2 pin)

Input / Output Specification	: Output only
Output Circuit	: 5V CMOS
Maximum Current	: +/-32mA
Polarity	: High active / Low active (initial factory setting: Low active)
Signal Source (LineSource)	: Off / UserOutput / Timer0Active / AcquisitionActive FrameTriggerWait / FrameActive / FrameTransferActive ExposureActive

Timing Specification

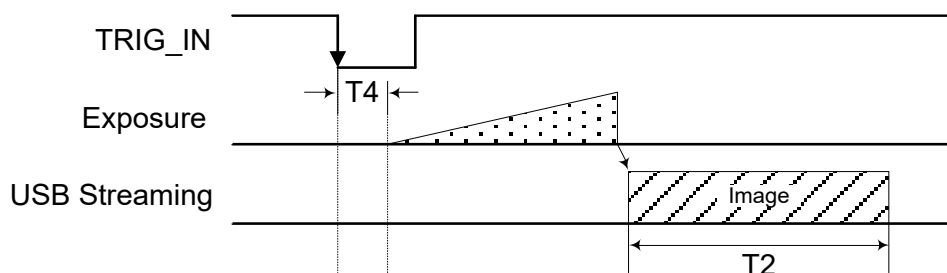
Image data outputs are transferred with USB bulk transfer. Timing numerical value below is described by absolute prerequisite that camera can use transmission band without restriction of other device. When there is other device on the same bus, the value described below is not guaranteed.

- In normal shutter mode

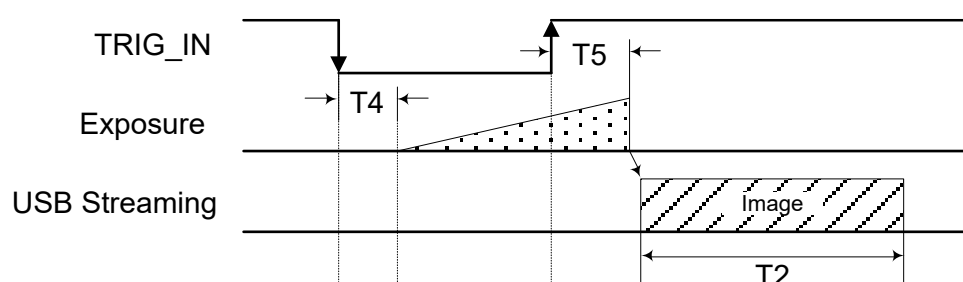


Model Name	format	T0 [μs]	T1 [ms]	T2 [ms]	T3 [s]
BU302MG	Mono8	15.8	8.1	8.1	1/(Frame Rate setting)
	Mono10, Mono12	18.7	9.6	9.6	
BU505MG	Mono8	18.9	12.9	12.9	
	Mono10, Mono12	22.3	15.3	15.3	
BU302MCG	Bayer8, Mono8	15.8	8.1	8.1	
	YUV411	18.7	9.6	11.5	
	YUV422			15.3	
	Bayer10, Bayer12			15.3	
	RGB, BGR			23.0	
BU505MCG	Bayer8, Mono8	18.9	12.9	12.9	
	YUV411	22.3	15.3	18.4	
	YUV422			24.6	
	Bayer10, Bayer12			24.6	
	RGB, BGR			36.8	

- In Random Trigger Shutter mode



Edge mode / Bulk mode (at all pixels readout)



Level mode (at all pixels readout)

Model Name	format	T4 [μs]	T5 [μs]
BU302MG	Mono8	16.1	29.8
	Mono10, Mono12	19.0	32.7
BU505MG	Mono8	19.2	32.9
	Mono10, Mono12	22.6	36.3
BU302MCG	Bayer8, Mono8	16.1	29.8
	YUV411	19.0	32.7
	YUV422		
	Bayer10, Bayer12		
	RGB, BGR		
BU505MCG	Bayer8, Mono8	19.2	32.9
	YUV411	22.6	36.3
	YUV422		
	Bayer10, Bayer12		
	RGB, BGR		

* The value of T2 is the same as the value of normal shutter mode.

* T4 and T5 are typical value.

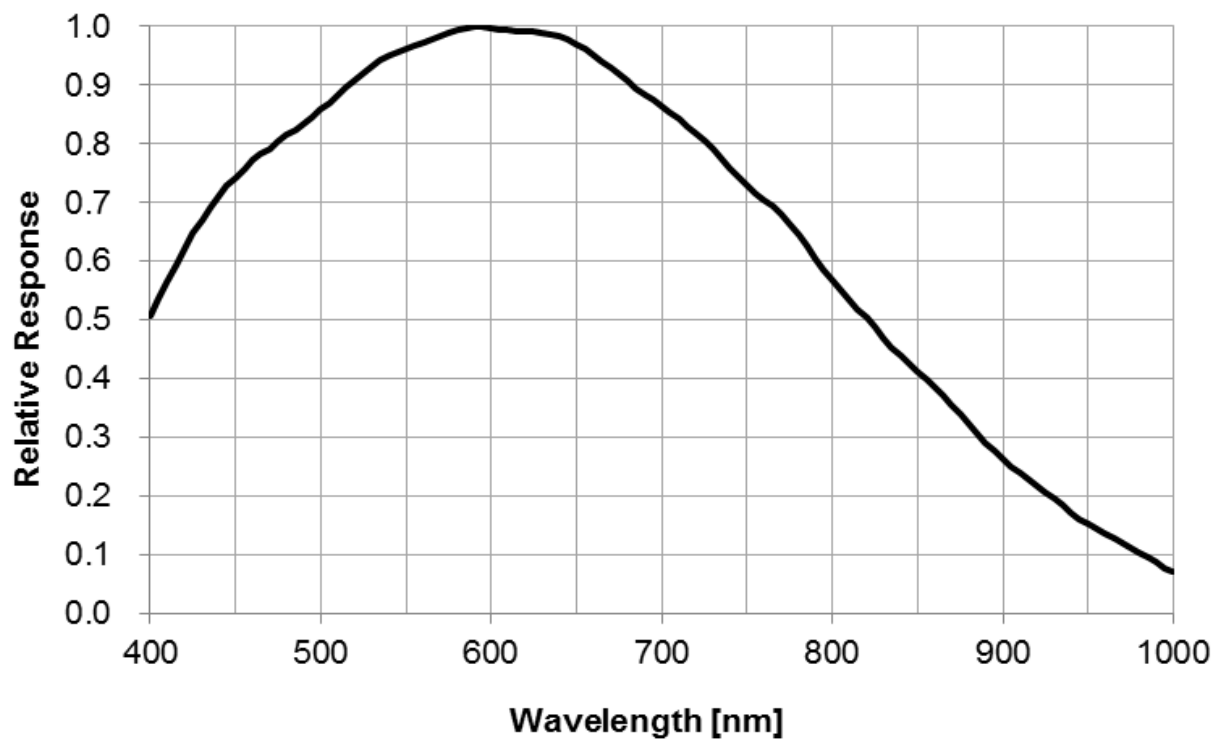
Notes of random trigger shutter mode:

- In the period when FRAME_TRIGGER_WAIT (GPIO signal) is inactive, user must not input external trigger signal to this camera.
- When the interval of the input trigger signal is extremely short, or when the trigger signal is noisy, there is a possibility of causing the malfunction. In this case, please input a proper trigger signal.

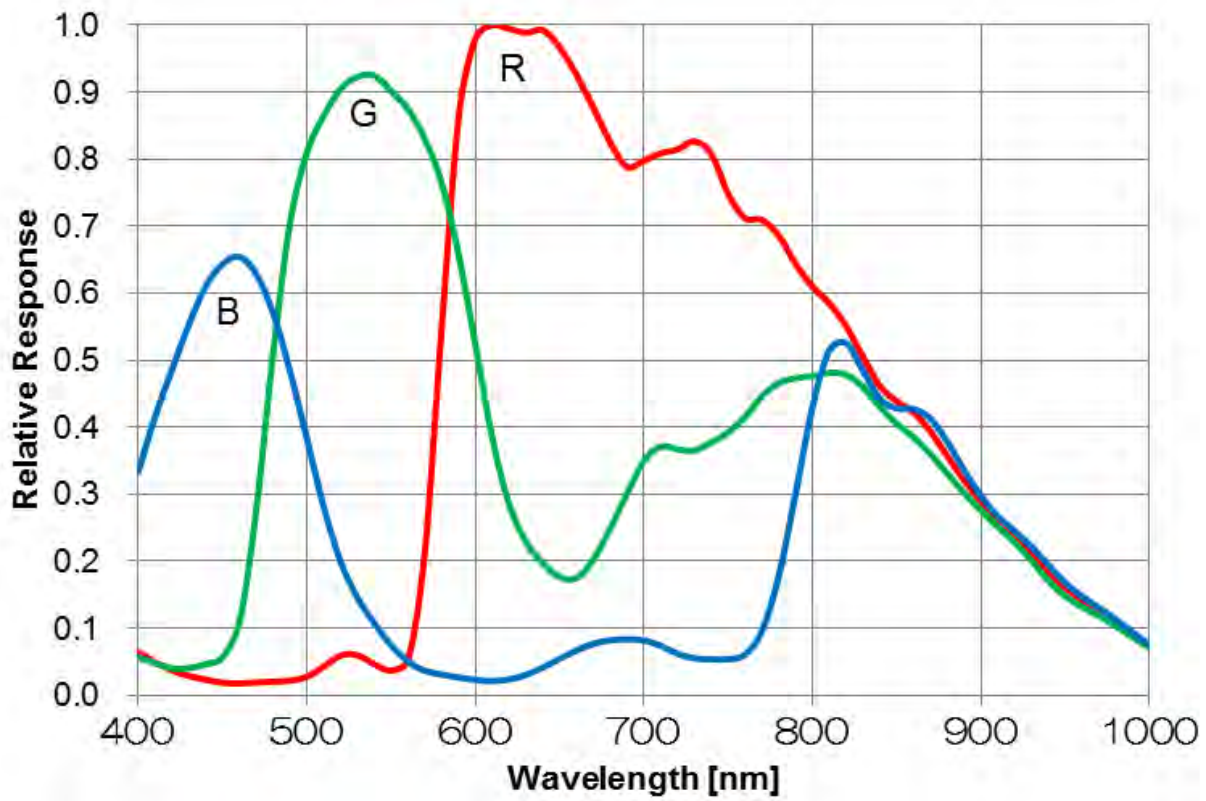
Typical Spectral Response

* The lens characteristics and light source characteristics is not reflected in table.

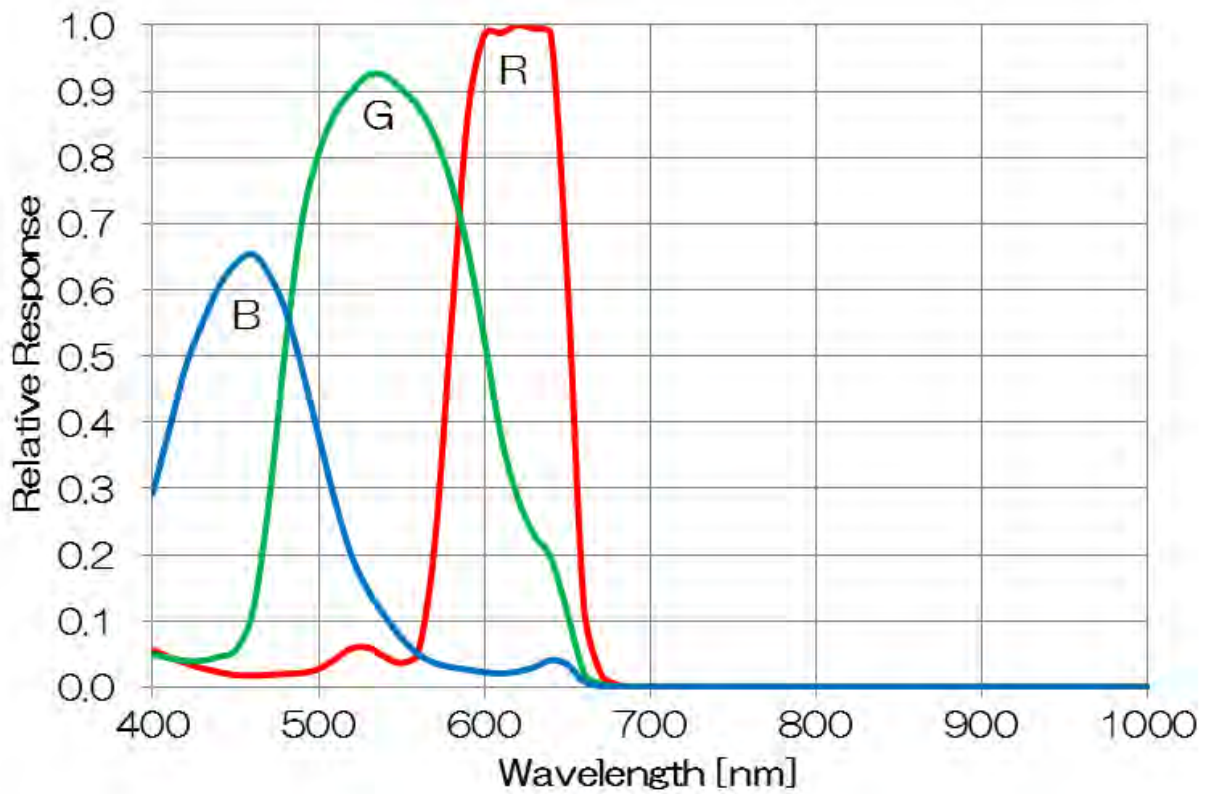
- BU302MG / BU505MG



• BU302MCG / BU505MCG



• BU302MCF / BU505MCF



Operating Ambient Conditions

- Ambient conditions

- Operating Assurance

Temperature: 0°C to +40°C, Camera housing temperature: less than 50°C

Humidity: 10% to 90% (no condensation)

- Storage Assurance

Temperature: -20°C to +60°C

Humidity: 90% or less (no condensation)

Notes on Heat Radiation:

The temperature of camera housing must be kept less than 50 °C.

Please provide sufficient heat radiation depending on your installation.

- EMC Conditions

- EMI (Electro-Magnetic Interference): EN61000-6-4
FCC Part 15 Subpart B Class A
 - EMS (Electro-Magnetic Susceptibility): EN61000-6-2

Notes on Conformity of the EMC:

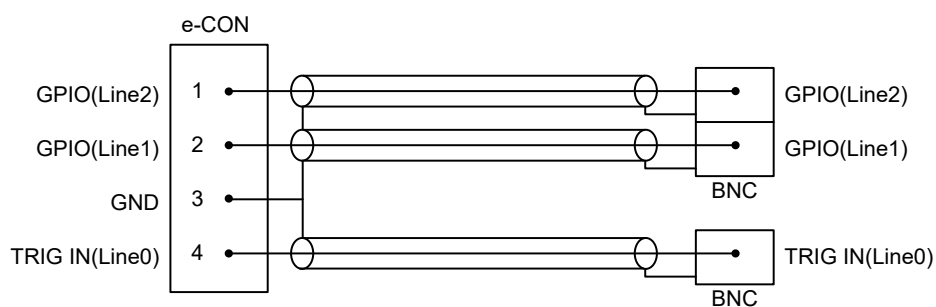
The adaptability of the safety standard of this camera is assured in the condition of combination with the following parts:

- USB Cable USB3-KR1-A-MBS-030 (OKI Electric Cable Co., Ltd.)
- e-CON Cable 3.0m, Shield cable (Fabricated parts)

Parts:

- e-CON connector 37104-3163-000 FL (3M Japan Limited)
- Shielded wire UL1533 (AWG28) (Hitachi cable, Ltd.)

Connection:



Please confirm the EMC adaptability when it combines with parts other than them.

Functions

This section introduces standard functions. BU302M/BU505M series provides following functions.

Category	Function	
USB3 Vision	Bootstrap Registers	USB3 Vision standard registers
DeviceControl	DeviceControl	Device information
ImageFormatControl	ImageFormatSelector	Image format selection
	Scalable	Scalable control
	Binning	Binning control
	Decimation	Decimation control
	Reverse	Image flip
	PixelFormat	Pixel format selection
	TestPattern	Test pattern control
AcquisitionControl	AcquisitionControl	Image stream start / stop
	ImageBuffer	Image buffer control
	TriggerControl	Trigger control
	ExposureControl	Exposure time control
DigitalIOControl	DigitalIOControl	GPIO signal control
	AntiGlitch	AntiGlitch control
	AntiChattering	AntiChattering control
CounterAndTimerControl	TimerControl	Timer0Active signal control
AnalogControl	Gain	Gain control
	BlackLevel	Black level control
	Gamma	Gamma correction
	Hue	Hue control
	Saturation	Saturation control
	BalanceRatio	Color gain (R, B)
	BalanceWhiteAuto	Execute auto white balance once
	ColorCorrectionMatrix	Color matrix correction
ALCCControl	ALCCControl	ALC Control
LUTControl	LUTControl	LUT control
UserSetControl	UserSetControl	Load / Save user setting
EventControl	EventControl	Event packet control
VenderUniqueControl	FrameSynchronization	Frame synchronization control
	LEDIndicatorLuminance	LED luminance control
DPCCControl	DPCCControl	Defect pixel correction control
SequentialShutterControl	SequentialShutterControl	Sequential shutter control

Features supported by each model are as follows.

Function	BU302MG	BU505MG	BU302MCG	BU505MCG
Bootstrap Registers	○	○	○	○
DeviceControl	○	○	○	○
ImageFormatSelector	○	○	○	○
Scalable	○	○	○	○
Binning	○	○	○	○
Decimation	○	○	○	○
Reverse	○	○	○	○
PixelFormat	○	○	○	○
TestPattern	○	○	○	○
AcquisitionControl	○	○	○	○
ImageBuffer	○	○	○	○
TriggerControl	○	○	○	○
ExposureControl	○	○	○	○
DigitalIOControl	○	○	○	○
TimerControl	○	○	○	○
Gain	○	○	○	○
BlackLevel	○	○	○	○
Gamma	○	○	○	○
Hue	-	-	○	○
Saturation	-	-	○	○
BalanceRatio	-	-	○	○
BalanceWhiteAuto	-	-	○	○
ColorCorrectionMatrix	-	-	○	○
ALCCControl	-	-	○	○
LUTControl	○	○	○	○
UserSetControl	○	○	○	○
EventControl	○	○	○	○
FrameSynchronization	○	○	○	○
LEDIndicatorLuminance	○	○	○	○
AntiGlitch	○	○	○	○
AntiChattering	○	○	○	○
DPCCControl	○	○	○	○
SequentialShutterControl	○	○	○	○

Details of each feature are described in following pages.

Bootstrap Registers

This camera is based on USB3 Vision.

Please refer to USB3 Vision specification for details about Bootstrap Registers defined in USB3 Vision.

AIA (Automated Imaging Association) USB3 Vision Homepage.

<http://www.visiononline.org/vision-standards-details.cfm?type=11>

Followings are commonly used registers.

● Registers

USB3 Vision ABRM			
Register	Visibility	Access	Description
UserDefinedName	Expert	R/W	Store user's arbitrary string in non-volatile memory.

USB3 Vision SIRM			
Register	Visibility	Access	Description
StreamEnable	-	R/W	Open and close the stream channel.

USB3 Vision EIRM			
Register	Visibility	Access	Description
EventEnable	Expert	R/W	Activate event notification function. Please refer to EventControl section as well.
TriggerEventTest	Expert	W	Issue test event packet.

● Note

When opening and closing the stream channel, it is required to control StreamEnable plus SDK setups on your application. Please refer to the TeliCamSDK for details.

DeviceControl

Registers of this category provide various information of the camera. And you can set the free user ID to the camera.

• Registers

Register	Visibility	Access	Description
DeviceReset	Expert	W	Resets the device.
DeviceVendorName	Beginner	R	Returns the vendor name.
DeviceModelName	Beginner	R	Returns the model name.
DeviceManufacturerInfo	Beginner	R	Returns the manufacturer information.
DeviceVersion	Beginner	R	Returns the device version.
DeviceID	Beginner	R	Returns the device ID (serial number).

ImageFormatControl

Registers of this category are related to image format control.

• Registers

Register	Visibility	Access	Description
ImageFormatSelector	Beginner	R/W	Selects an image format.

• Setting

- Select an image format.

Set a following value to “ImageFormatSelector” register. Setting value is Enumeration type.

ImageFormatSelector	Function
Format0 (*)	Scalable / Binning / Decimation
Format1	Scalable / Binning / Decimation
Format2	Scalable / Binning / Decimation

* initial factory setting

• Note

Changing “ImageFormatSelector” register value is invalid during image stream data output.

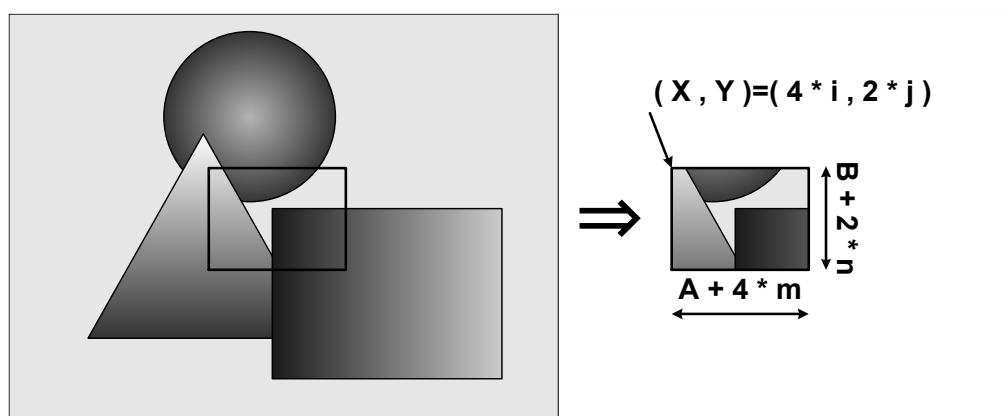
Scalable

BU series provides the scalable that can read out defined area of the screen.

In the scalable mode, camera reads out only necessary area at the normal speed and reads out other area at high speed. The frame rate can be faster when the vertical height size is small. However, the frame rate cannot be faster only when the horizontal width size is small.

Only single rectangle is selectable. Concave or convex shape is not selectable.

- Window size: $\{A + 4 \times m (H)\} \times \{B + 2 \times n (V)\}$
 $A, B = \text{minimum unit size}$
 $m, n = \text{integer}$
 The window size is equal or less than maximum image size.
- Start address: $\{4 \times i (H)\} \times \{2 \times j (V)\}$
 $i, j = \text{integer}$
 The window size is equal or less than maximum image size.



Scalable

• Registers

Register	Visibility	Access	Description
Width	Beginner	R/W	Sets width (in pixels) of the image data.
Height	Beginner	R/W	Sets Height (in pixels) of the image data.
OffsetX	Beginner	R/W	Sets horizontal offset (in pixels) from the origin to the region of interest.
OffsetY	Beginner	R/W	Sets vertical offset (in pixels) from the origin to the region of interest.

● Setting

- Select an image format.

Select "Format0" of "ImageFormatSelector" register.

- Set image size and image start position

Set the following value to "Width", "Height", "OffsetX", "OffsetY" registers. Setting value is Integer type. "Width", "Height" registers are image size setting. "OffsetX", "OffsetY" registers are image start position setting.

Model	BU302MG/MCG	BU505MG/MCG
Width/OffsetX unit size	4	4
Height/OffsetY unit size	2	2
Minimum unit size	64 x 64	64 x 64
Maximum unit size (*)	2048 x 1536	2448 x 2048

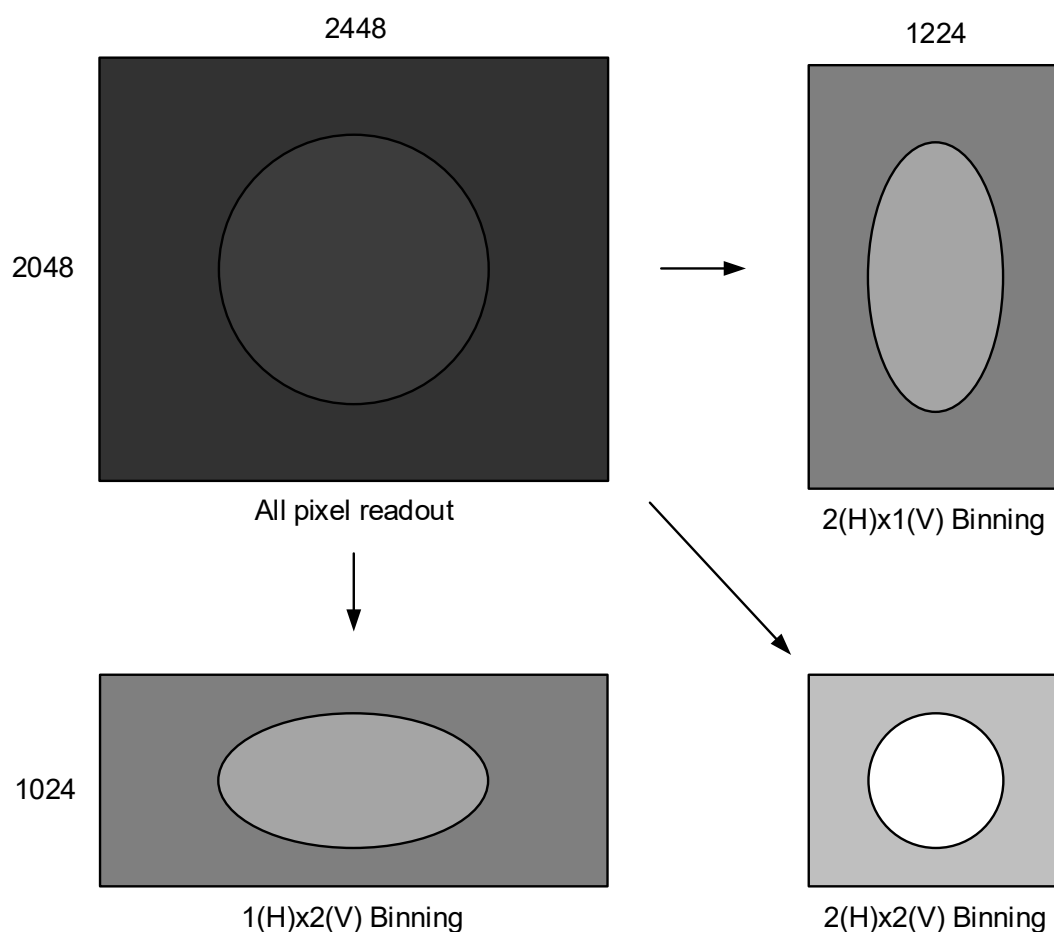
* initial factory setting

● Note

Changing "Width", "Height", "OffsetX", "OffsetY" register value is invalid during image stream data output.

Binning

In the binning mode, a pixel is added with the neighboring pixel(s). This increases the sensitivity of the image. It's alike scalable, the frame rate can be faster and USB bandwidth occupation decrease.



Binning operation (e.g. BU505MG)

• Registers

Register	Visibility	Access	Description
BinningHorizontal	Beginner	R/W	Set horizontal binning.
BinningVertical	Beginner	R/W	Set vertical binning.

● Setting

- Select an image format.

Select "Format" of "ImageFormatSelector" register.

- Set binning operation

Set the following value to "BinningHorizontal", "BinningVertical" registers. Setting value is Integer type.

"BinningHorizontal" is the number of horizontal pixel(s) to add. And "BinningVertical" is the number of vertical pixel(s) to add.

Model	BU302MG/MCG	BU505MG/MCG
Minimum (*)	1	
Value	1, 2, 4	
Maximum	4	

* initial factory setting

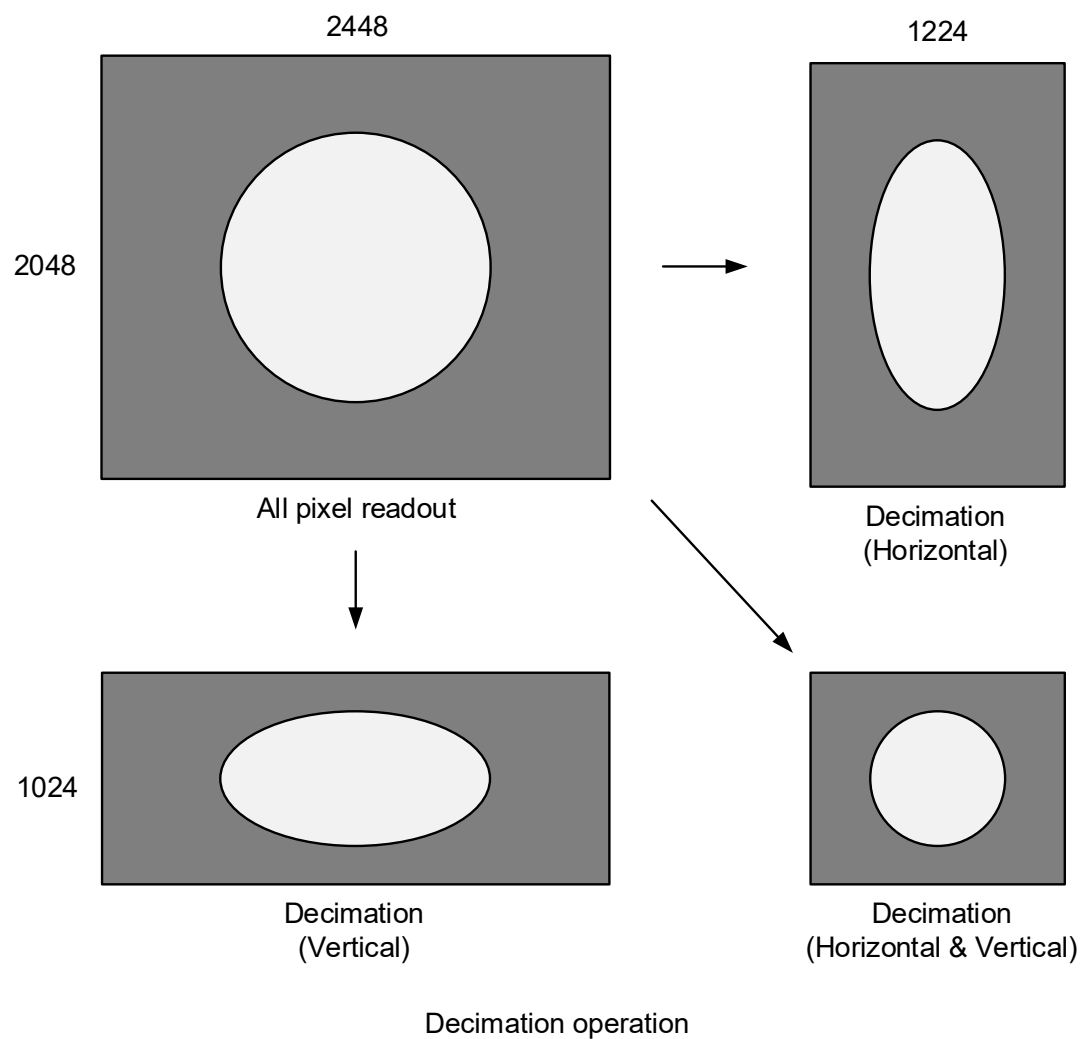
● Note

Binning is disabled when the camera is running in Decimation mode.

Changing "BinningHorizontal", "BinningVertical" register value is invalid during image stream data output.

Decimation

Decimation feature reads out all effective areas at high speed by skipping pixels and lines.
Decimation feature can make frame rate faster, and decrease interface bandwidth occupation.



• Registers

Register	Visibility	Access	Description
DecimationHorizontal	Beginner	R/W	Set the number of horizontal Decimation line(s).
DecimationVertical	Beginner	R/W	Set the number of vertical Decimation line(s).

- **Setting**

- Select an image format.

Select “Fomat” of “ImageFormatSelector” register.

- Set Decimation lines

Set the following value to “DecimationHorizontal”, “DecimationVertical” registers. Setting value is Integer type.

Model	BU302MG/MCG	BU505MG/MCG
Minimum (*)	1	
Value	1、 2、 4	
Maximum	4	

* initial factory setting

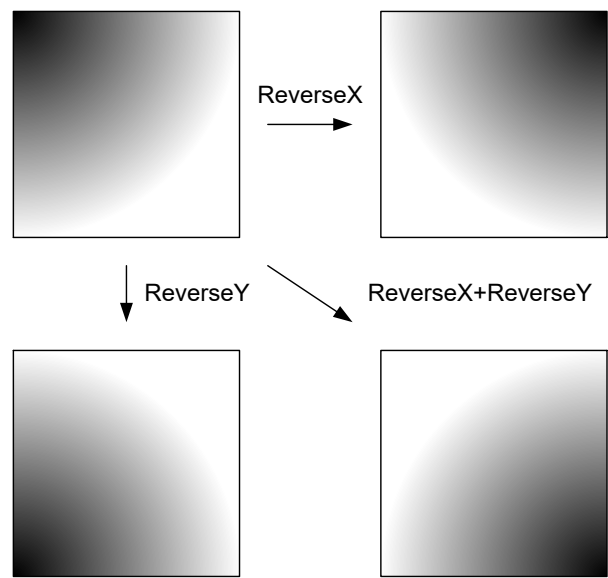
- **Note**

Decimation is disabled when the camera is running in Binning mode.

Changing “DecimationHorizontal”, “DecimationVertical” register value is invalid during image stream data output.

Reverse

Image can be flipped in horizontal and/or vertical direction.



• Registers

Register	Visibility	Access	Description
ReverseX	Expert	R/W	Flip image in horizontal direction.
ReverseY	Expert	R/W	Flip image in vertical direction.

• Setting

- Set image reverse

Set the following value to “ReverseX”, “ReverseY” registers. Setting value is Boolean type.

Value	Image reverse
FALSE (*)	Non reverse
TRUE	Reverse

* initial factory setting

PixelFormat

Select a pixel format of image stream data.

• Registers

Register	Visibility	Access	Description
PixelFormat	Beginner	R	Returns a selected pixel format. PixelFormat is conformed to AIA Pixel Format Naming Convention.
PixelCoding	Expert	R/W	Selects a pixel coding.
PixelSize	Expert	R/W	Selects a bit size of image pixel.
PixelEndian	Beginner	R/W	Selects a pixel endian.

• Setting

- Set PixelFormat

PixelFormat is determined by combination of “PixelCoding” and “PixelSize” register. Select a following combination to “PixelCoding” and “PixelSize” register. Setting values are Enumeration type.

B/W model

PixelSize PixelCoding	Bpp8	Bpp10	Bpp12
Mono PixelFormat ID	Mono8 (*) 0x01080001	Mono10 0x01100003	Mono12 0x01100005

* initial factory setting

Color model

PixelSize PixelCoding	Bpp8	Bpp10	Bpp12	Bpp16	Bpp24 (※)
Mono PixelFormat ID	Mono8 0x01080001	-	-	-	-
BayerBG(*2) PixelFormat ID	BayerBG8 0x0108000B	BayerBG10 0x0110000F	BayerBG12 0x01100013	-	-
YUV411 PixelFormat ID	-	-	YUV411Packed 0x020C001E	-	-
YUV422 PixelFormat ID	-	-	-	YUV422Packed 0x0210001F	-
RGB PixelFormat ID	-	-	-	-	RGB8 (*1) 0x02180014
BGR PixelFormat ID	-	-	-	-	BGR8 0x02180015

*1 initial factory setting

*2 ReverseX and ReverseY setting are FALSE.

- Set ProcessingMode

In the color model, you can set the ProcessingMode when Bayer output. Valid function varies depending on the setting. Set the following value to “BayerProcessingMode” register. Setting value is Enumeration type.

Register	Visibility	Access	Description
BayerProcessingMode	Expert	R/W	Selects a ProcessingMode.

Function	Full (*)	Partial	Raw
Gain	○	○	○
BlackLevel	○	○	-
Gamma	○	○	-
Hue	○	-	-
Saturation	○	-	-
BalanceRatio	○	○	-
ColorCorrectionMatrix	○	-	-
LUTControl	○	○	-
DPCCControl	○	○	-

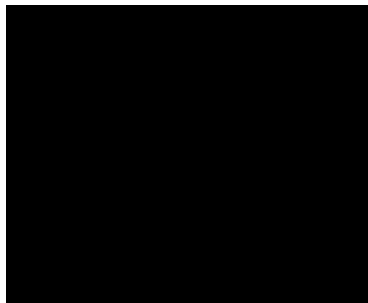
* initial factory setting

● Note

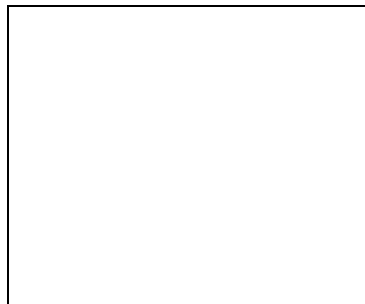
Changing “PixelSize” register value is invalid during image stream data output.

TestPattern

BU series supports test pattern data output. Camera provides following Test patterns;



Black



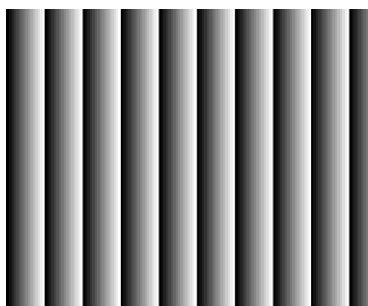
White



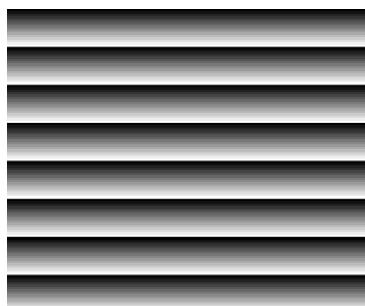
GreyA



GreyB



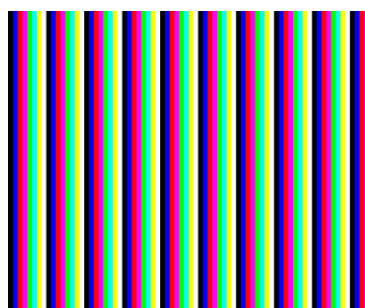
GreyHorizontalRamp



GreyVerticalRamp



GreyScale
(B/W model only)



ColorBar
(Color model only)

Test pattern (e.g. BU505MG/BU505MCG @RGB)

● Registers

Register	Visibility	Access	Description
TestPattern	Beginner	R/W	Selects a test pattern.

● Setting

- Select a test pattern output

Set the following value to “TestPattern” register. Setting value is Enumeration type.

The camera generates a test pattern.

TestPattern	Function
Off (*)	Test pattern disable(Normal data output)
Black	All pixel = 0 LSB
White	All pixel = 255 @Mono8
GreyA	All pixel = 170 @Mono8
GreyB	All pixel = 85 @Mono8
GreyHorizontalRamp	Horizontal Ramp
GreyVerticalRamp	Vertical Ramp
GreyScale	Grey scale (B/W model only)
ColorBar	Color bars (Color model only)

* initial factory setting

AcquisitionControl

Make a setting of image stream and control image stream output.

Camera starts image stream output by receiving AcquisitionStart command. And there are some registers that require camera to stop image stream output to change values.

Acquisition frame rate is variable. Maximum acquisition frame rate depends on camera operation mode (scalable.)

• Registers

Register	Visibility	Access	Description
AcquisitionMode	Beginner	R/W	Selects an acquisition mode.
AcquisitionStart	Beginner	W	Executes the image stream output start.
AcquisitionStop	Beginner	W	Executes the image stream output stop.
AcquisitionAbort	Expert	W	Executes the image stream output abort.
AcquisitionFrameCount	Beginner	R/W	Sets the number of frames to transfer in MultiFrame mode.
AcquisitionFrameRateEnable	Beginner	R/W	Activates frame rate setting.
AcquisitionFrameRate	Beginner	R/W	Sets frame rate of image stream.
AcquisitionFrameIntervalControl	Beginner	R/W	Activates frame interval setting.
AcquisitionFrameInterval	Beginner	R/W	Sets frame interval of image stream.

• Setting

- Select an acquisition mode

Set the following value to “AcquisitionMode” register. Setting value is Enumeration type.

AcquisitionMode	Function
Continuous (*)	Continuous image transfer
MultiFrame	Multi frame image transfer
SingleFrame	Single frame image transfer

* initial factory setting

- Set the number of frames to transfer (In MultiFrame mode)

Set the number of frames to transfer to “AcquisitionFrameCount”. Setting value is Integer type.

- Open/Close stream channel (to be ready to receive stream data)
Set "1" to "StreamEnable" in Bootstrap Registers before "AcquisitionStart".
Set "0" to "StreamEnable" in Bootstrap Registers before "AcquisitionStop" or "AcquisitionAbort".
- Start image stream output
The camera starts image stream output by executing "AcquisitionStart" register command.
- Stop image stream output
The camera stops image stream output by executing "AcquisitionStop" register command.
The camera aborts image stream output by executing "AcquisitionAbort" register command.
- Set frame rate
Set the "AcquisitionFrameRateEnable" register to "Manual".
And set the following value to "AcquisitionFrameRate" register. Setting value is Float type.
The range of register setting depends on camera model, and camera operation mode.
"AcquisitionFrameInterval" register is a reciprocal of "AcquisitionFrameRate".

AcquisitionFrameRateEnable	Function
NoSpecify (*)	The frame rate is determined by giving priority to ExposureTime setting value.
Manual	The frame rate is determined by giving priority to AcquisitionFrameRate setting value.

* initial factory setting

AcquisitionFrameRate	Value
Minimum	0.061[Hz]
Maximum (*)	Depend on register setting of "Height".

* initial factory setting

● Note

Changing "AcquisitionFrameRateEnable", "AcquisitionFrameRate", "AcquisitionFrameIntervalControl", "AcquisitionFrameInterval" register value is invalid during image stream data output.

When exposure time setting is longer than frame rate setting, camera operation gives priority to exposure time setting.

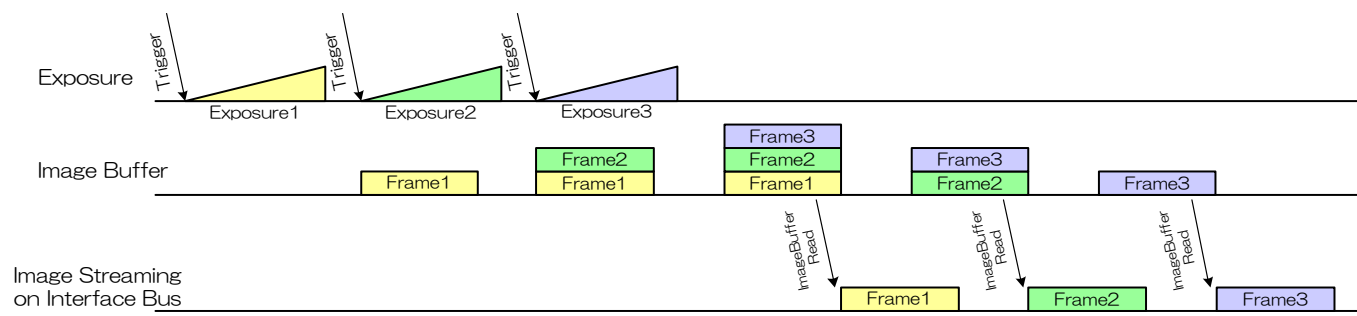
When opening and closing the stream channel, it is required to control StreamEnable plus SDK setups on your application. Please refer to the TeliCamSDK for details.

Notes on Frame Drops of Image:

Depends on your PC or USB3.1 Gen1 interface card configurations, images may not be captured normally (e.g. frame drops may occur). In this case, change to frame rate setting lower.

ImageBuffer

This section describes ImageBuffer control of AcquisitionControl category.
Camera stores images temporarily in image buffer, and read them out in arbitrary timing.
This function is typically used in Random Trigger Shutter mode.
Please refer to TriggerControl section as well.



• Registers

Register	Visibility	Access	Description
ImageBufferMode	Beginner	R/W	Selects Image Buffer mode.
ImageBufferFrameCount	Beginner	R	Returns the number of frames stored in the buffer.
ImageBufferRead	Beginner	W	Executes the image buffer read.

• Setting

- Activate trigger mode
Set "On" to "TriggerMode" register, and set "TriggerSoftware" or "Line0", "Line2" to "TriggerSource" register.
- Activate image buffer mode
Set "On" to "ImageBufferMode" register.

ImageBufferMode	Function
OFF (*)	Inactive
ON	ative

* initial factory setting


- Open/Close stream channel (to be ready to receive stream data)
 - Set "1" to "StreamEnable" in Bootstrap Registers before "ImageBufferRead".
 - Set "0" to "StreamEnable" in Bootstrap Registers after completion of image acquisition from image buffer.
- Capture and store images
 - Input trigger signals to capture and store images.
 - "ImageBufferFrameCount" register shows the number of frames stored in the buffer.
 - The maximum number of frames storable depends on the image size. (maximum 256MByte.)
- Set the number of frames to transfer (In ImageBuffer mode)
 - Set the number of frames to transfer to "AcquisitionFrameCount". Setting value is Integer type.
- Read images from the buffer
 - Read the number of AcquisitionFrameCount image(s) from the buffer by executing "ImageBufferRead" register command (it is equivalent to write value 10 to "AcquisitionCommand" register).

● Note

When opening and closing the stream channel, it is required to control StreamEnable plus SDK setups on your application. Please refer to the TeliCamSDK for details.

[Start] button in TeliCamViewer can't deal with "StreamEnable" register alone.

Please substitute procedure "StreamEnable" = 1 to following instructions.

- Push [Start] button  on TeliCamViewer main window.
- Execute [AcquisitionStop] in XML window.

TriggerControl

This section describes trigger control of TriggerControl category for the BU series.

This camera series provides two kinds of exposure synchronization.

1. Normal Shutter mode : Free run operation (internal synchronization)
2. Random Trigger Shutter mode : Synchronized with external trigger input

In Random Trigger Shutter mode, two kinds of trigger input are available.

1. Trigger signal via the I/O connector (HardwareTrigger)
2. Trigger command via the USB interface (SoftwareTrigger)

The following table shows the combination of operation mode of this camera series.

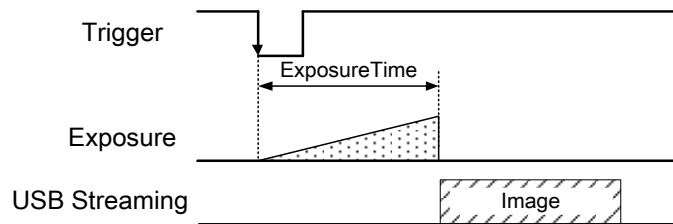
Table. Operation Mode

Trigger Mode	Synchronization	Exposure Control
Normal Shutter mode	Free run	"ExposureTime" register control
Random Trigger Shutter mode	HardwareTrigger	-Edge mode:TriggerSequence0
		-Bulk mode:TriggerSequence6 "ExposureTime" register control
	SoftwareTrigger	-Level mode:TriggerSequence1 Trigger pulse width control
		-Edge mode:TriggerSequence0 -Bulk mode:TriggerSequence6 "ExposureTime" register control

* The camera operation not mentioned above is not guaranteed.

- Edge mode (TriggerSequence0)

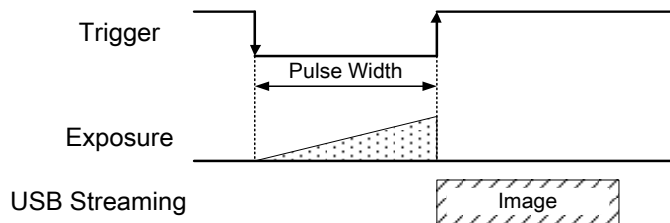
The exposure time is determined by Exposure Time setting.



- Level mode (TriggerSequence1)

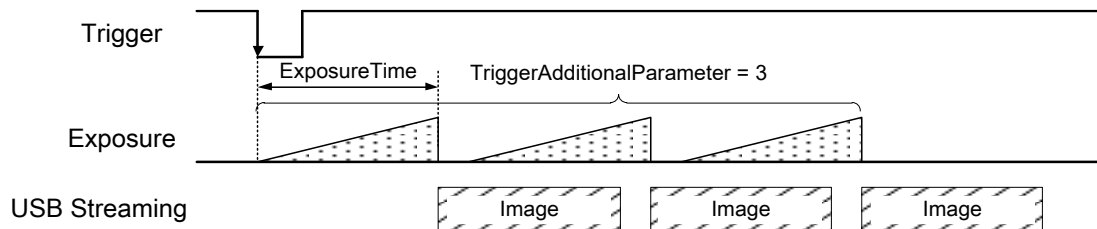
The exposure time is determined by the pulse width of the trigger signal.

This feature is not supported when the ShortExposureMode is enable (ON).



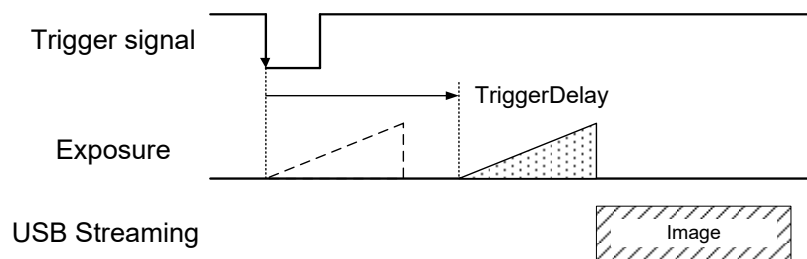
- Bulk mode (TriggerSequence6)

Camera exposes and transfers multiple frames by a single trigger.



Trigger sequence

Operation point of HardwareTrigger is at the edge of trigger signal, and active edge polarity is able to change by register setting. And you can add delay time from trigger edge to exposure start by register setting.



Trigger Delay

Details of Random Trigger Shutter operation, refer to "Timing" of "Specification".

• Registers

Register	Visibility	Access	Description
TriggerMode	Beginner	R/W	Selects Random Trigger Shutter mode.
TriggerSequence	Beginner	R/W	Selects trigger sequence.
TriggerSource	Beginner	R/W	Selects trigger source of Random Trigger Shutter.
TriggerActivation	Beginner	R/W	Selects a trigger activation of hardware trigger.
TriggerAdditionalParameter	Beginner	R/W	Sets the number of frames to exposure in Bulk mode.
TriggerDelay	Beginner	R/W	Sets trigger delay.
TriggerSoftware	Beginner	W	Executes software trigger.

• Setting

- Select trigger mode

Set the following value to “TriggerMode” register. Setting value is Enumeration type.

TriggerMode	Function
Off (*)	Normal Shutter Mode
On	Random Trigger Shutter mode

* initial factory setting

- Select trigger sequence

Set the following value to “TriggerSequence” register. Setting value is Enumeration type.

TriggerSequence	Function
TriggerSequence0 (*)	Edge mode
TriggerSequence1	Level mode
TriggerSequence6	Bulk mode

* initial factory setting

In Normal Shutter mode, the exposure time is determined by “ExposureTime” register value regardless of “TriggerSequence” register setting.

- Select trigger source

Set the following value to “TriggerSource” register. Setting value is Enumeration type.

TriggerSource	Function
Line0 (*)	Hardware trigger (I/O connector : 4 pin)
Line2	Hardware trigger (I/O connector : 1 pin)
TriggerSoftware	Software trigger

* initial factory setting

- Set the number of frames to exposure (In Bulk mode)

Set the number of frames to exposure to "TriggerAdditionalParameter". Setting value is Integer type.

TriggerAdditionalParameter	Value
Minimum (*)	0 [frame]
Maximum	255 [frames]

* initial factory setting

- Set trigger delay (HardwareTrigger operation only)

Set the following value to "TriggerDelay" register. Setting value is Float type.

Adds delay time from trigger edge to exposure start.

TriggerDelay	Value
Minimum (*)	0.00[μs]
Maximum	2000000.00[μs]

* initial factory setting

- Grabs image stream by software trigger

When executes "TriggerSoftware" register command, software trigger command is generated. Camera starts exposure by receiving software trigger command.

● Note

- In SoftwareTrigger operation, the delay time from "TriggerSoftware" to exposure is not guaranteed.
- TriggerDelay is applied to both of HardwareTrigger and SoftwareTrigger.
- TriggerAdditionalParameter is only effective in Bulk mode.

ExposureTime

BU series is able to adjust exposure time by using electric shutter control.

BU USB series provides three kinds of exposure time control mode.

Firmware Ver.4.1.0 or later models have ShortExposureMode which can set high-speed exposure time at the time of MANUAL setting (only B/W models). AutoExposure is not supported when the ShortExposureMode is enable (ON).

- NoSpecify : The exposure time is determined by “AcquisitionFrameRate” register setting value
- Manual : The exposure time is determined by “ExposureTime” register setting value.
- Auto : The exposure time is adjusted automatically.

● Registers

Register	Visibility	Access	Description
ExposureTimeControl	Guru	R/W	Selects exposure time control mode.
ExposureTime	Beginner	R/W	Sets absolute exposure time.
ShortExposureMode	Expert	R/W	Sets the activation of ShortExposureMode.

● Setting

- Select exposure time control mode

Set the following value to “ExposureTimeControl” register. Setting value is Enumeration type.

AcquisitionFrameRateControl	Function
NoSpecify	The frame rate is determined by giving priority to AcquisitionFrameRate setting value.
Manual (*)	The frame rate is determined by giving priority to ExposureTime setting value.
Auto	The frame rate is determined by giving priority to adjusted automatically.

* initial factory setting

- Sets exposure time (Manual mode only)

Set the "ExposureTimeControl" register to "Manual".

Set the following value to "ExposureTime" register. Setting value is Float type.

ShortExposureTime=OFF

Model	BU302MG	BU302MCG	BU505MG	BU505MCG
ExposureTime (*)	8000 [μs]	8000 [μs]	13000 [μs]	13000 [μs]
ExposureTimeMin	Ver.4.0.8 or earlier : 30 [μs] Ver.4.1.0 or later: 22 [μs]	30 [μs]	Ver.4.0.8 or earlier : 30 [μs] Ver.4.1.0 or later: 22 [μs]	30 [μs]
ExposureTimeMax	16000000 [μs]	16000000 [μs]	16000000 [μs]	16000000 [μs]
ExposureTimeMax (Auto)	1000000 [μs]	1000000 [μs]	1000000 [μs]	1000000 [μs]

* initial factory setting

ShortExposureTime=ON

Model	BU302MG	BU302MCG	BU505MG	BU505MCG
ExposureTime (*)	14.44 [μs]	Not supported	14.44 [μs]	Not supported
ExposureTimeMin	1.08 [μs]		1.08 [μs]	
ExposureTimeMax	14.44 [μs]		14.44 [μs]	
ExposureTimeMax (Auto)	Not supported		Not supported	

* initial factory setting

- Sets ShortExposureMode

Set the "ShortExposureMode" register. Setting value is Enumeration type.

Changing 'ShortExposureMode' register value is invalid during image stream data output.

Value	Function
Off (*)	NormalExposureMode
On	ShortExposureMode

* initial factory setting

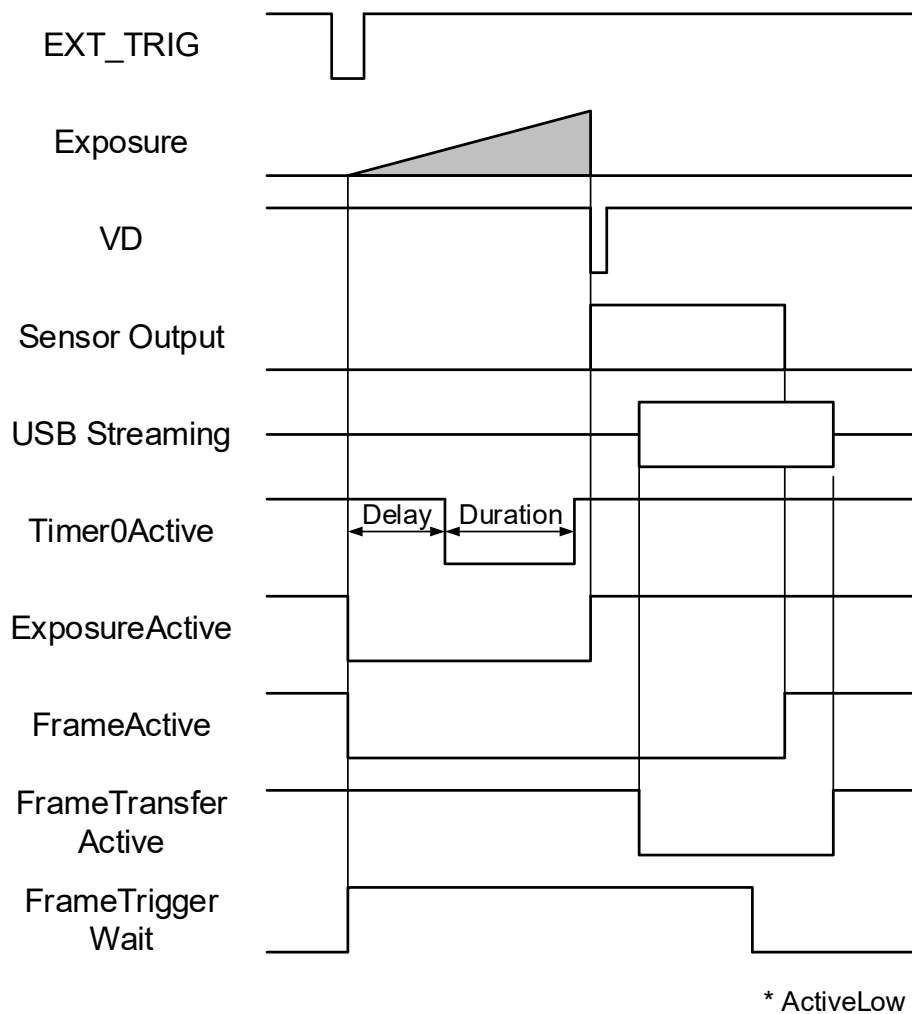
Notes on ShortExposureMode setting:

- If you use ShortExposureMode, the image quality may deteriorate. Also, the actual exposure time may vary depending on the individual differences and the operating environment (such as the operating temperature). When using the ShortExposureMode, we ask you to have final image quality checked with your environment.
- The brightness of the upper part of the screen may be different from that of the lower part. Note that this is a characteristic of a CMOS image sensor and is not a fault.

DigitalIOControl

This section describes DigitalIOControl category for the BU series.

This camera provides GPIO output selected by the register setting. And the polarity of the signal is able to switch by the register setting. The following chart shows the specifications of the selectable signals.



Selectable signals

• Registers

Register	Visibility	Access	Description
LineSelector	Beginner	R/W	Selects the Line of I/O connector.
LineSource	Beginner	R/W	Selects the source of the output signal.
LineMode	Beginner	R/W	Selects the Input / Output of each Line.
LineInverter	Beginner	R/W	Selects the polarity of each Line signal.
LineStatus	Beginner	R	Returns the status of each Line signal.
UserOutputValue	Beginner	R/W	Sets the user output value.

● Setting

- Select the Line of the I/O connector

Set the following value to “LineSelector” register. Select the line to output “LineSource” signal.

Setting value is Enumeration type.

LineSelector	I/O connector pin assignment
Line1 (*)	2 pin: GPIO Output
Line2	1 pin: GPIO Input / Output

* initial factory setting

- Select the Input / Output

Set the following value to “LineMode” register. Setting value is Enumeration type.

Line2 is available. Line0 is dedicated input. Line1 is dedicated output.

LineMode
Input (*)
Output

* initial factory setting

- Select the source of GPIO output signal

Set the following value to “LineSource” register to change GPIO output signal selected by “LineSelector”.

Setting value is Enumeration type.

LineSource	Signal description
Off (*)	No output.
ExposureActive	Period from exposure start to exposure end.
FrameTransferActive	Period of transferring image data on USB bus.
FrameActive	Period from exposure start to CMOS transfer completion.
FrameTriggerWait	Indicating waiting a Random Trigger Shutter. An External trigger is input during this period, exposure starts immediately.
AcquisitionActive	Indicates AcquisitionStart state of camera.
UserOutput	Outputs the value set in “UserOutputValueAll”.
Timer0Active	This signal can be used as strobe control signal. The delay time and pulse width of this signal are configurable.

* initial factory setting

- Set the UserOutput signal

Set the following value to “UserOutputValue” register. Setting value is Enumeration type.

Line1 and Line2 are available. Line0 is dedicated input.

UserOutputValueAll	Function
FALSE (*)	Low level output
TRUE	High level output

* initial factory setting

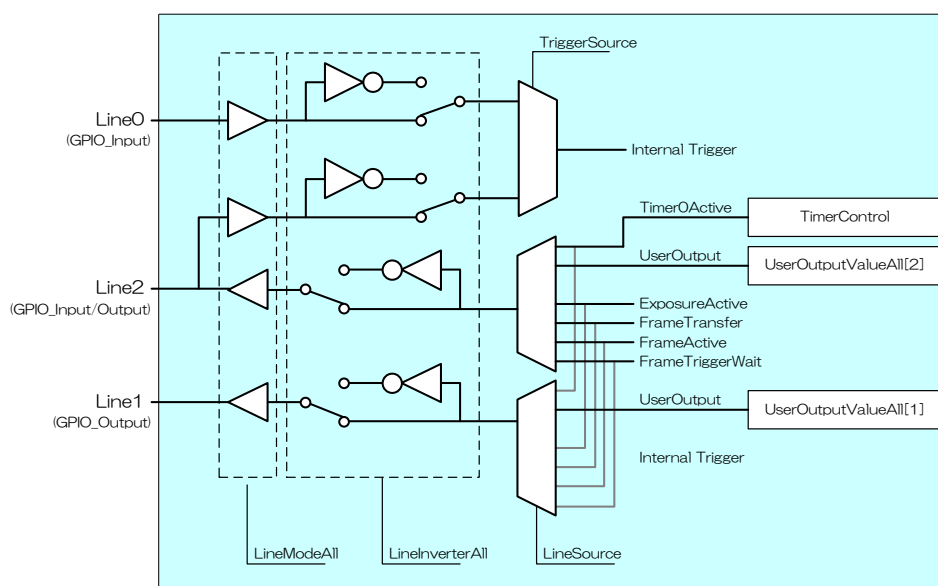
- Select the polarity of each signal

Set the following value to “LineInverter” register. The setting value is Enumeration type.

Each bit corresponds to each Line. All Lines are settable. Inverter is also inserted to UserOutputValue.

LineInverterAll	Function
FALSE (*)	non inverted
TRUE	inverted

* initial factory setting



GPIO internal circuit diagram

● Note

About the details of Timer0Active signal, refer to “TimerControl” of "Functions".

AntiGlitch / AntiChattering

AntiGlitch and AntiChattering functions filter noise and unstable state of the digital input (trigger signal).

AntiGlitch circuit performs the digital integration of the trigger signal.

It is effective to remove impulsive noise.

AntiChattering circuit sets the edge insensible time to avoid trigger malfunction.

It is effective to remove unstable logic state and switch-chattering.

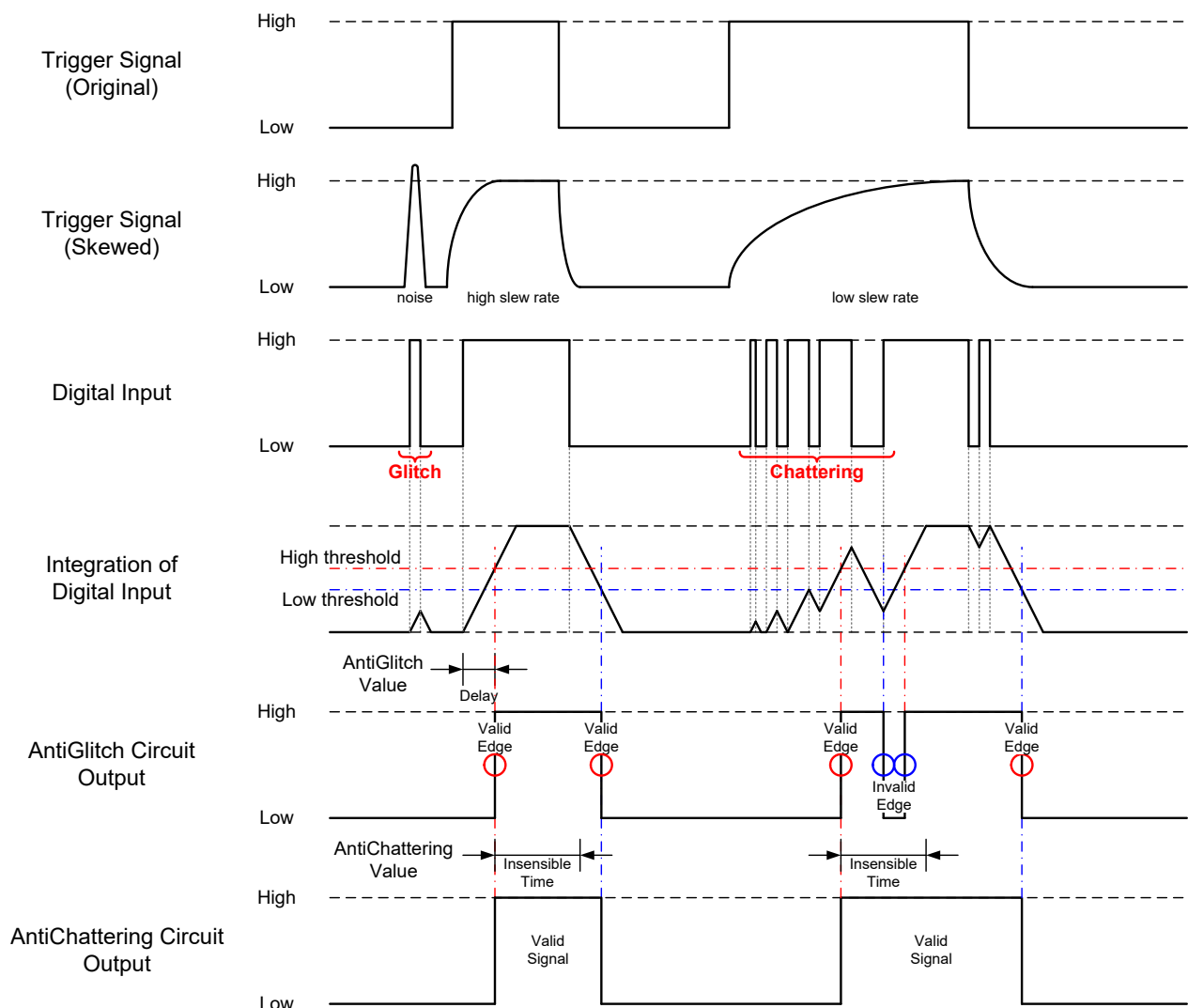


Fig. AntiGlitch and AntiChattering

• Registers

Name	Visibility	Access	Description
AntiGlitch	Expert	R/W	Integration time of digital input signal. (Absolute value)
AntiChattering	Expert	R/W	Insensible time of digital input signal. (Absolute value)

• Setting

- Set the integration time for AntiGlitch.

Set the integration time to “AntiGlitch Value” register.

Trigger signal is delayed by AntiGlitch setting.

The setting is applied to the GPIO Input of Line0 and Line2.

AntiGlitch	Integration time [sec]
Minimum (*)	0.000 000 090
Maximum	0.002

* initial factory setting

- Set the insensible time for AntiChattering.

Set the insensible time to “AntiChattering Value” register.

The setting is applied to the GPIO Input of Line0 and Line2.

AntiChattering	Insensitive time [sec]
Minimum (*)	0.000 001 992
Maximum	0.001 999 992

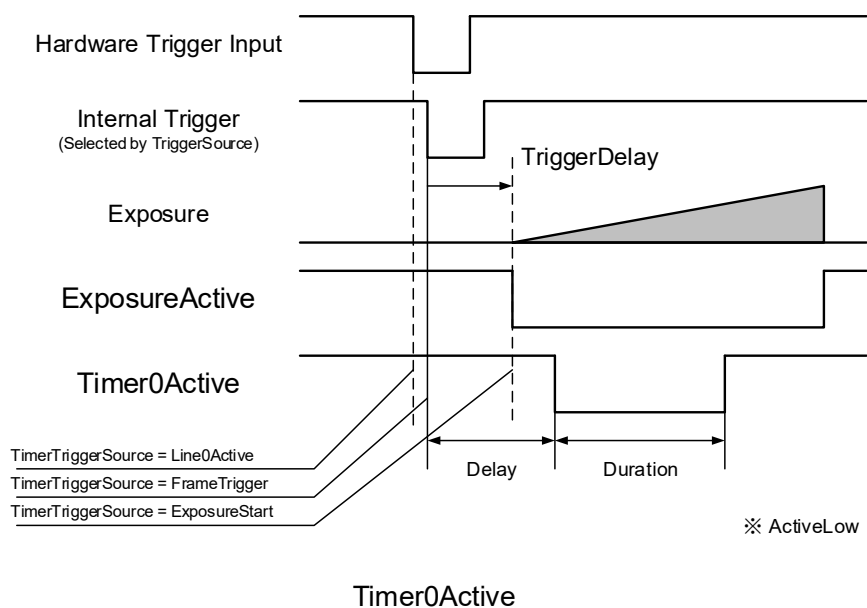
* initial factory setting

TimerControl

This section describes TimerControl category for the BU series.

This camera series is able to generate Timer0Active signal, derived from exposure start, by register setting.

This signal can be used as strobe control signal.



• Registers

Register	Visibility	Access	Description
TimerSelector	Expert	R	Returns the selected timer name.
TimerDuration	Expert	R/W	Sets the width of Timer0Active signal.
TimerDelay	Expert	R/W	Sets the delay of Timer0Active signal.
TimerTriggerSource	Expert	R/W	Selects the source of Timer0Active pulse to start.

● Setting

- Set the width of Timer0Active pulse

Set the following value to “TimerDuration” register. Setting value is Float type.

TimerDuration	Pulse width
Minimum (*)	0.00[μs]
Maximum	2000000.00[μs]

* initial factory setting

- Set the delay of Timer0Active pulse

Set the following value to “TimerDelay” register. Setting value is Float type.

TimerDelay	Delay value
Minimum (*)	0.00[μs]
Maximum	2000000.00[μs]

* initial factory setting

- Select the source of Timer0Active pulse to start

Select the following value to “TimerTriggerSource” register. Setting value is Enumeration type.

TimerTriggerSource	Description
Off	Disables the timer trigger.
Line0Active	Starts when Line0 is active.
ExposureStart (*)	Starts with the reception of the Exposure Start
FrameTrigger	Starts with the reception of the Frame Start Trigger.

* initial factory setting

● Note

“TimerTriggerSource” operation is as follows,

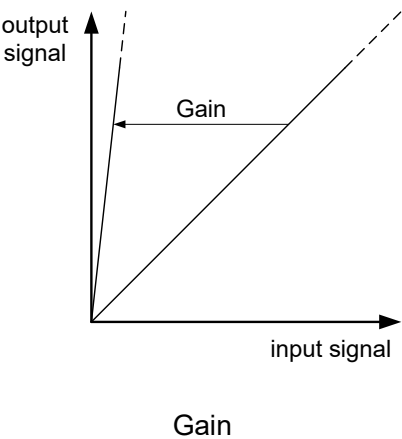
Line0Active is available in HardwareTrigger mode, and to be responded at FrameTriggerError.

FrameTrigger is available in both HardwareTrigger and Software Trigger mode, and not to be responded at FrameTriggerError.

ExposureStart is available in both HardwareTrigger and Software Trigger mode, and not to be responded at FrameTriggerError. Timer0Active pulse delays TiggerDelay+TimerDelay[us].

Gain

This section describes Gain feature. This control adjusts an amplification factor applied to the output signal. Gain feature adjusts manual gain. GainAuto feature adjusts gain automatically.



• Registers

Register	Visibility	Access	Description
Gain	Beginner	R/W	Sets the absolute Gain.
GainAuto	Beginner	R/W	Adjusts Gain automatically.

• Setting

- Set Manual Gain

Set the following value to “Gain” register. Setting value is Float type. This setting value is valid only at Manual Gain mode setting.

Model	BU302MG	BU302MCG	BU505MG	BU505MCG
Minimum (*)	0.00 [dB]	0.00 [dB]	0.00 [dB]	0.00 [dB]
Maximum	Ver.4.0.8 or earlier: 24.00 [dB] Ver.4.1.0 or later: 36.00 [dB]	24.00 [dB]	Ver.4.0.8 or earlier: 24.00 [dB] Ver.4.1.0 or later: 36.00 [dB]	24.00 [dB]

* initial factory setting

The formula of Gain value is as follows;

$$\text{output signal} = \text{input signal} \times 10^{\frac{\text{Gain}}{20}}$$

- Select Gain control mode

Set the following value to "GainAuto" register. Setting value is Enumeration type.

Setting value	Mode
Off (*)	Manual Gain Control (MANUAL)
Continuous	Auto Gain Control (AGC)

* initial factory setting

● Note

- In GainAuto mode, current Gain will be reflected to Gain value register.
- Range of gain setting at GainAuto mode is 0 to +24dB.
- About the details of AGC mode, refer to "ALCCControl" of "Functions".

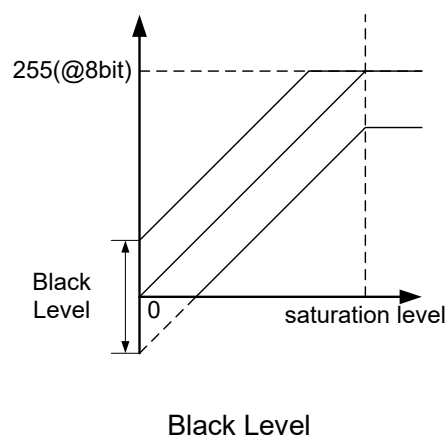
Notes on gain setting:

Setting the gain value too high increases noises. When you adjust the brightness of the image, we ask you to have final image quality checked with your environment.

BlackLevel

This section describes BlackLevel control of LuminanceControl category of the BU series.

This control adjusts the black level of the image. It is adjustable from -25% to +25% as white saturation level is 100%. However, when BlackLevel is lower than 0[%], the image level may not be saturated.



Registers

Register	Visibility	Access	Description
BlackLevel	Beginner	R/W	Sets the absolute Black Level.

Setting

- Set Black Level

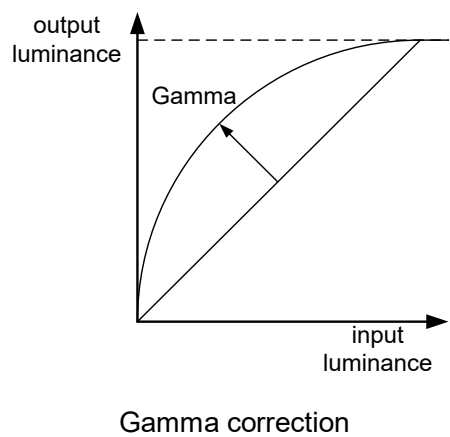
Set the following value to “BlackLevel” register. Setting value is Float type.

BlackLevel	Value
Minimum	-25.00[%]
Maximum	+25.00[%]

* initial factory setting = 0.00[%]

Gamma

This section describes Gamma correction of AnalogControl category for the BU series.
This function allows you to apply a gamma correction to the output images.



• Registers

Register	Visibility	Access	Description
Gamma	Beginner	R/W	Sets the Gamma correction.

• Setting

- Set Gamma correction

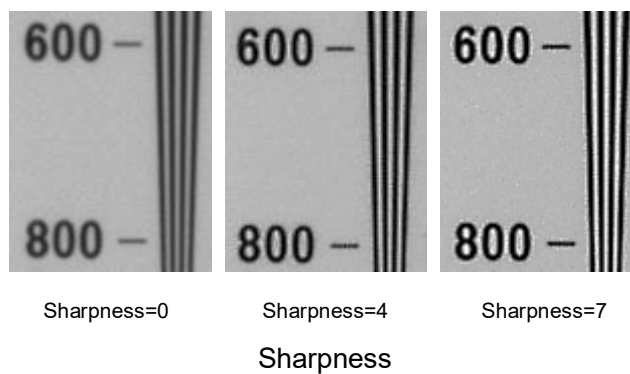
Set the following value to “Gamma” register. Setting value is Float type.

Gamma	Value
Minimum	0.45
Maximum (*)	1.00

* initial factory setting

Sharpness

This section describes Sharpness feature. This control enhances the edges of the image. The edge enhancement will become stronger when the setting value is larger.



• Registers

Register	Visibility	Access	Description
Sharpness	Beginner	R/W	Sets sharpness value.

• Setting

- Set Sharpness

Set the following value to “Sharpness” register. Setting value is Integer type.

Larger value makes the edge strength stronger.

Sharpness	Setting value
Minimum (*)	0 (OFF)
Maximum	7

* initial factory setting

Hue/Saturation

This section describes Hue/Saturation control of AnalogControl category for the BU series.

Hue control adjusts chroma phase of the image. And Saturation control adjusts chroma gain of the image.

This function is available only in Color models.

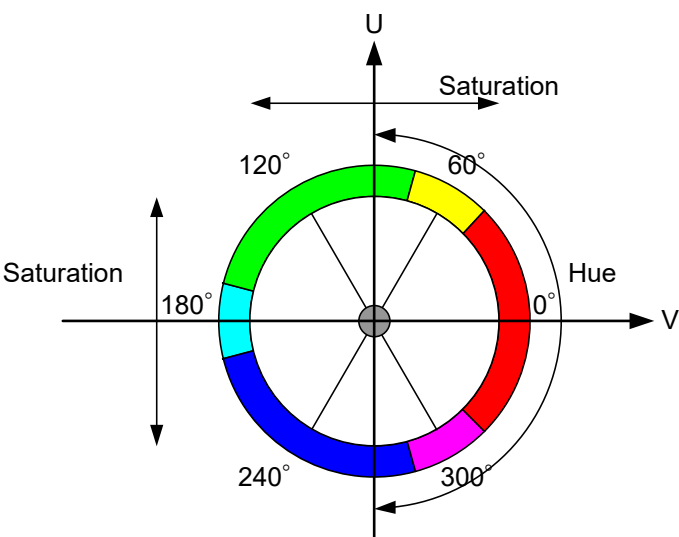


Fig. Hue/Saturation

Registers

Register	Visibility	Access	Description
Hue	Beginner	R/W	Set a chroma phase.
Saturation	Beginner	R/W	Set a chroma gain.

Setting

- Set Hue

Set the following value to “Hue” register. Setting value is Float type.

Hue	Value
Minimum	-180[°]
Maximum	+180[°]

* initial factory setting = 0[°]

- Set Saturation

Set the following value to “Saturation” register. The value is to be applied to selected saturation component. Setting value is Float type.

Saturation	Value
Minimum	x 0
Maximum	x 2.0

* initial factory setting = x 1.3

● **Note**

Hue/Saturation control is available in following PixelFormat modes.

Bayer8/10/12-Full, RGB8, BGR8, YUV411, YUV422

BalanceRatio

This section describes BalanceRatio control of AnalogControl category for the BU series.

This control adjusts the white balance gain of the image.

This function is available only in Color models.

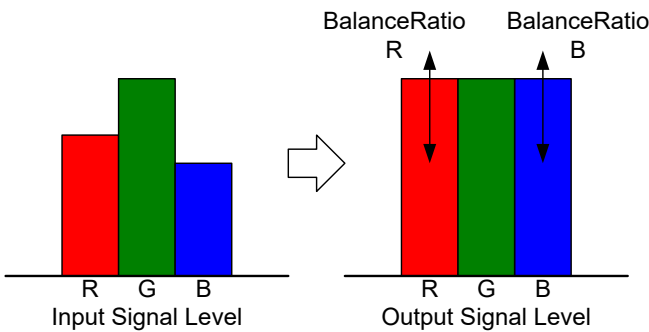


Fig. BalanceRatio

• Registers

Register	Visibility	Access	Description
BalanceRatioSelector	Beginner	R/W	Selects a color component of white balance gain to control.
BalanceRatio	Beginner	R/W	Sets a white balance gain.

• Setting

- Select BalanceRatio

Select the color component of white balance gain to control in “BalanceRatioSelector” register.

Setting value is Enumeration type.

BalanceRatioSelector	Function
None (*)	None of component is selected.
Red	BalanceRatio = Red Gain
Blue	BalanceRatio = Blue Gain

* initial factory setting

- Set BalanceRatio

Set the following value to “BalanceRatio” register. The value is to be applied to selected color component. Setting value is Float type.

BalanceRatio	Value
Minimum	x 1.0
Maximum	x 8.0

* initial factory setting value is device-specific

Notes on white balance gain setting:

Too high white balance gain increases noises. After adjusting the white balance of the image, we ask you to have final image quality checked with your environment.

BalanceWhiteAuto

Adjust white balance gain automatically.

This function is available only in Color models.

● Registers

Register	Visibility	Access	Description
BalanceWhiteAuto	Beginner	R/W	Adjust white balance gain automatically.

● Setting

- Set BalanceWhiteAuto

Set the following value to “BalanceWhiteAuto” register.

After setting “Once”, camera executes auto white balance once. If execution of auto white balance is successful, both R and B gain are applied to BalanceRatio respectively.

BalanceWhiteAuto	Function
Off (*)	No operation
Once	Execute auto white balance once.

* initial factory setting

● Note

BalanceRatio and BalanceWhiteAuto controls are available in following PixelFormat modes.

Bayer8/10/12. RGB8, BGR8, YUV411, YUV422

ColorCorrectionMatrix

This section describes ColorCorrectionMatrix control of AnalogControl category for the BU series.

This control corrects RGB data by using color correction matrix.

This function is available only in Color models.

The relationship between original data (R, G, and B) and corrected data (R', G', and B') are represented in the following formula.

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} 1 & -mask_rg & -mask_rb \\ -mask_gr & 1 & -mask_gb \\ -mask_br & -mask_bg & 1 \end{bmatrix} \begin{bmatrix} R & (G-R) & (B-R) \\ (R-G) & G & (B-G) \\ (R-B) & (G-B) & B \end{bmatrix}$$

$$R' = (1 - mask_rg - mask_rb) \cdot R + mask_rg \cdot G + mask_rb \cdot B$$

$$G' = mask_gr \cdot R + (1 - mask_gr - mask_gb) \cdot G + mask_gb \cdot B$$

$$B' = mask_br \cdot R + mask_bg \cdot G + (1 - mask_br - mask_bg) \cdot B$$

The correspondence of “SelectorI” and “SelectorJ” to color correction matrix element is as follows.

	SelectorJ=R	SelectorJ=G	SelectorJ=B
SelectorI=R		mask_rg	mask_rb
SelectorI=G	mask_gr		mask_gb
SelectorI=B	mask_br	mask_bg	

Fig. Corresponding elements of color correction matrix

• Registers

Register	Visibility	Access	Description
ColorCorrectionMatrixSelectorI	Beginner	R/W	Selects a row element of color correction matrix.
ColorCorrectionMatrixSelectorJ	Beginner	R/W	Selects a column element of color correction matrix.
ColorCorrectionMatrix	Beginner	R/W	Sets a coefficient of color correction matrix.

● Setting

- Select ColorCorrectionMatrix

Select row and column elements of color correction matrix in “ColorCorrectionMatrixSelectorI” and “ColorCorrectionMatrixSelectorJ” register.

ColorCorrectionMatrixSelector	Value
I	R / G / B
J	R / G / B

* initial factory setting = R

- Set ColorCorrectionMatrix

Set a color correction matrix coefficient to the element selected by “SelectorI” and “SelectorJ”.

Setting value is Float type. Coefficients of (SelectorI, SelectorJ)=(R,R),(G,G),(B,B) are internally fixed to 1.0 and read out data is always 1.0.

ColorCorrectionMatrix	Value
Minimum	-1.0
Maximum	+0.99

Initial factory setting

		SelectorJ		
		R	G	B
SelectorI	R		-0.50	0.15
	G	-0.50		-0.35
	B	0.10	-0.65	

● Note

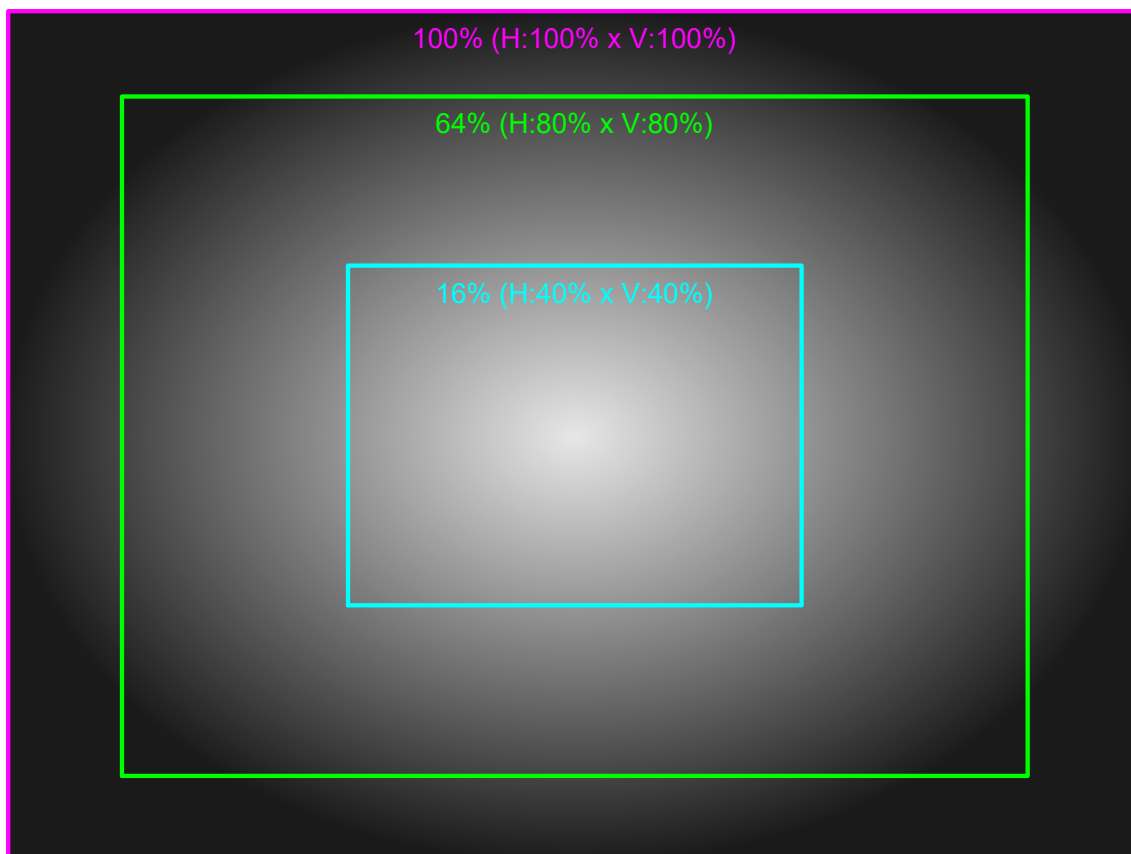
ColorCorrectionMatrix control is available in following PixelFormat modes.

Bayer8/10/12-Full, RGB8, BGR8, YUV411, YUV422

ALCControl

This section describes ALCControl feature.

- ALCPhotometricAreaSize defines photometric area size for measuring luminance.



ALCPhotometricAreaSize

• Registers

Register	Visibility	Access	Description
ALCPhotometricAreaSize	Beginner	R/W	Sets ALC photometric area size.
ALCExposureValue	Beginner	R/W	Sets ALC Exposure Value.

● Setting

- Set photometric area size for measuring luminance

Set the following value to “ALCPhotometricAreaSize” register. The setting value is Float type.

Setting value	photometric area size
Minimum	1%
Maximum (*)	100% (Full pixel)

* initial factory setting

- Set a ExposureValue of ALC operation

Set the following value to “ALCExposureValue” register. Setting value is Float type.

When set “ALCExposureValue” register, add a correction value for a convergence value.

ExposureValue	Setting value
Minimum	-2.00 [eV]
Maximum	+1.50 [eV]

* initial factory setting = 0.00 [eV]

- ALCExposureValue defines a correction value for a convergence value.

Final convergence value is determined by the following formula.

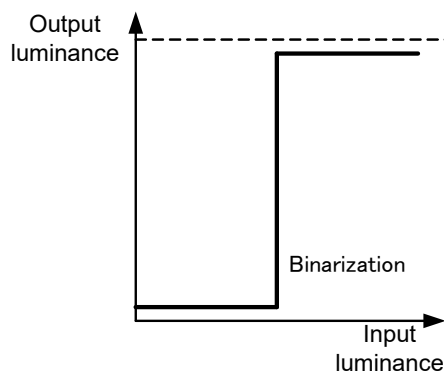
$$\text{Final convergence value} = 84 (\text{Reference Luminance}) \times 2^{\text{ALCExposureValue}}$$

● Note

ALC operation at Random Trigger Shutter mode is not guaranteed.

LUTControl

This function allows you to apply the arbitrary LUT (input: 12bit, output: 12bit) to the output images.



● Registers

Register	Visibility	Access	Description
LUTEnable	Expert	R/W	Sets the activation of LUT function.
LUTIndex	Expert	R/W	Sets the input level of LUT.
LUTValue	Expert	R/W	Sets the output level of LUT.

● Setting

- Set the activation of LUT

Set the following value to “LUTEnable” register. The setting value is Boolean type.

setting value	function
FALSE (*)	Inactive
TRUE	Active

* initial factory setting

- Set the input/output value of LUT

Set the following value to “LUTIndex”, “LUTValue” registers. These setting values are Integer type.

“LUTIndex” register value is input level of LUT, and “LUTValue” register value is output level of LUT.

LUTIndex / LUTValue	setting value
Minimum (*)	0
Maximum	4095

* initial factory setting

UserSetControl

You are able to save a user setting to the non-volatile memory of the camera. There are 15 user memory channels for user setting.

By using user memory, you are able to restore frequent used settings at the time of next start-up.

The following table is the list of registers applied to "UserSetLoad"/"UserSetSave".

Table: List of registers to be applied to UserSet

Category	Register	Category	Register
ImageFormatControl	ImageFormatSelector	DigitalIOControl	AntiGlitch
	Width		AntiChattering
	Height	CounterAndTimerControl	TimerTriggerSource
	OffsetX		TimerDuration
	OffsetY		TimerDelay
	Binning	AnalogControl	Gain
	Decimation		BlackLevel
	Reverse		Gamma
	PixelFormat		Hue
	TestPattern		Saturation
	BayerProcessingMode		BalanceRatio
AcquisitionControl	AcquisitionFrameRateEnable		ColorCorrectionMatrix
	AcquisitionFrameRate	LUTControl	LUTEnable
	AcquisitionFrameIntervalControl	SequentialShutterControl	SequentialShutterEnable(*)
	AcquisitionFrameInterval		SequentialShutterTerminateAt(*)
	TriggerMode		SequentialShutterEntry(*)
	TriggerSequence	DPCCControl	DPCEnable(*)
	TriggerSource		DPCNumber(*)
	TriggerAdditionalParameter		DPCEntryX(*)
	TriggerDelay		DPCEntryY(*)
	ExposureTime	EventControl	EventNotification
	ShortExposureMode	VendorUniqueControl	FrameSynchronization
DigitalIOControl	LineMode		LEDIndicatorLuminance
	LineInverter		
	UserOutputValue		
	LineSelector		
	LineSource		

(*) DPC and SequentialShutter entries are stored to a single channel. Entries are shared with all channels.

● Registers

Register	Visibility	Access	Description
UserSetSelector	Beginner	R/W	Selects a channel of user setting.
UserSetLoad	Beginner	W	Executes load a user setting.
UserSetSave	Beginner	W	Executes to save a user setting.
UserSetDefault	Beginner	R/W	Selects a channel of user setting when camera powers up.
UserSetQuickSave	Expert	W	Saves a user setting to volatile memory.

● Setting

- Select a channel of a user setting

Set the following value to “UserSetSelector” register. The setting value is Enumeration type.

Select the channel of user setting for “UserSetLoad” and “UserSetSave”.

setting value	Description	Save	Load
Default	<ul style="list-style-type: none"> - White balance unadjusted. - DPC feature is not set. - Other features similar to the initial factory setting. 	-	○
UserSet1 (*)	Memory channel 1 for user setting. Following features are adjusted. <ul style="list-style-type: none"> - White balance - DPC feature ON in the defective pixel coordinates already set. 	○	○
UserSet2~15	Select memory channel 2 to 15 for user setting.	○	○

* initial factory setting

- Load/Save a user setting

When execute “UserSetLoad”, the camera loads user setting from the channel selected in “UserSetSelector” register and applies them.

When execute “UserSetSave”, the camera saves user setting to the channel selected in “UserSetSelector” register.

- Load a user setting at the time of start-up

Set the following value to “UserSetDefault” register. The setting value is Enumeration type.

The camera loads user setting from the channel selected in “UserSetDefault” register and applies them at the time of next start-up.

setting value	Description
Default	<ul style="list-style-type: none"> - White balance unadjusted. - DPC feature is not set. - Other features similar to the initial factory setting.
UserSet1 (*)	Memory channel 1 for user setting. Following features are adjusted. <ul style="list-style-type: none"> - White balance - DPC feature ON in the defective pixel coordinates already set.
UserSet2~15	Select memory channel 2 to 15 for user setting.

* initial factory setting

● Note

“UserSetDefault” register value is stored to non-volatile memory when “UserSetSave” is executed.

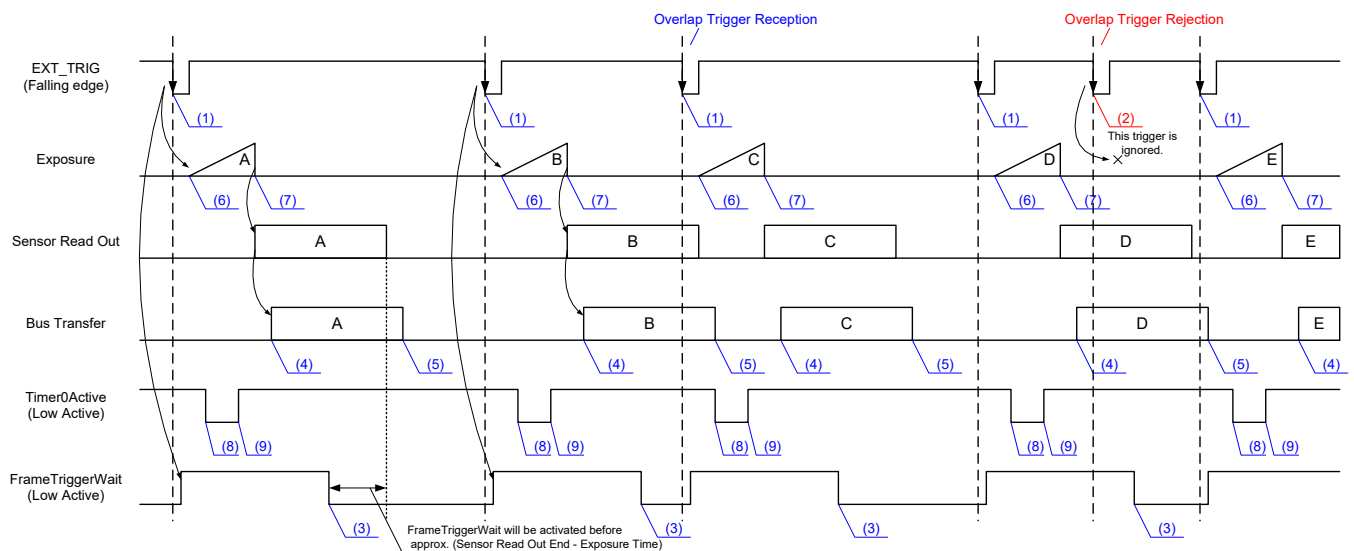
Thus, “UserSetSelector” shall be set other than “Default” in advance.

EventControl

Camera notifies FrameTrigger status and other information by USB3 Vision Event Packet.

- FrameTrigger : Reception of Frame Start Trigger
- FrameTriggerError : Rejection of Frame Start Trigger
- FrameTriggerWait : Start of waiting for Frame Start Trigger
- FrameTransferStart : Start of transferring streaming data
- FrameTransferEnd : End of transferring streaming data
- ExposureStart : Start of Exposure
- ExposureEnd : End of Exposure
- Timer0Start : Start of Timer0
- Timer0End : End of Timer0

Events timing are as following chart.



Event Name

- (1) FrameTrigger : Reception of Frame Start Trigger.
- (2) FrameTriggerError : Rejection of Frame Start Trigger.
- (3) FrameTriggerWait : Start of waiting for Frame Start Trigger.
- (4) FrameTransferStart : Start of transferring streaming data.
- (5) FrameTransferEnd : End of transferring streaming data.
- (6) ExposureStart : Start of Exposure.
- (7) ExposureEnd : End of Exposure.
- (8) Timer0Start : Start of Timer0.
- (9) Timer0End : End of Timer0.

• Registers

Register	Visibility	Access	Description
EventControl			
EventSelector	Beginner	R/W	Selects the type of Event notifications.
EventNotification	Beginner	R/W	Sets the activation of Event notifications.
EventFrameTriggerData			
EventFrameTriggerTimestamp	Expert	R	Returns the timestamp at the time of Event.
EventFrameTriggerErrorData			
EventFrameTriggerErrorTimestamp	Expert	R	Returns the timestamp at the time of Event.
EventFrameTriggerWaitData			
EventFrameTriggerWaitTimestamp	Expert	R	Returns the timestamp at the time of Event.
EventFrameTransferStartData			
EventFrameTransferStartTimestamp	Expert	R	Returns the timestamp at the time of Event.
EventFrameTransferEndData			
EventFrameTransferEndTimestamp	Expert	R	Returns the timestamp at the time of Event.
EventExposureStartData			
EventExposureStartTimestamp	Expert	R	Returns the timestamp at the time of Event.
EventExposureEndData			
EventExposureEndTimestamp	Expert	R	Returns the timestamp at the time of Event.
EventTimer0StartData			
EventTimer0StartTimestamp	Expert	R	Returns the timestamp at the time of Event.
EventTimer0EndData			
EventTimer0EndTimestamp	Expert	R	Returns the timestamp at the time of Event.

● Setting

- Select the type of Event notifications

Set the following value to “EventSelector” register. The setting value is Enumeration type.

setting value	Event ID	Timing of Event notification
FrameTrigger (*)	0x8020	Reception of Frame Start Trigger
FrameTriggerError	0x8021	Rejection of Frame Start Trigger
FrameTriggerWait	0x8022	Start of waiting for Frame Start Trigger
FrameTransferStart	0x8030	Start of transferring streaming data
FrameTransferEnd	0x8031	End of transferring streaming data
ExposureStart	0x8040	Start of Exposure
ExposureEnd	0x8041	End of Exposure
Timer0Start	0x9000	Start of Timer0
Timer0End	0x9100	End of Timer0

* initial factory setting

- Set the activation of Event notifications

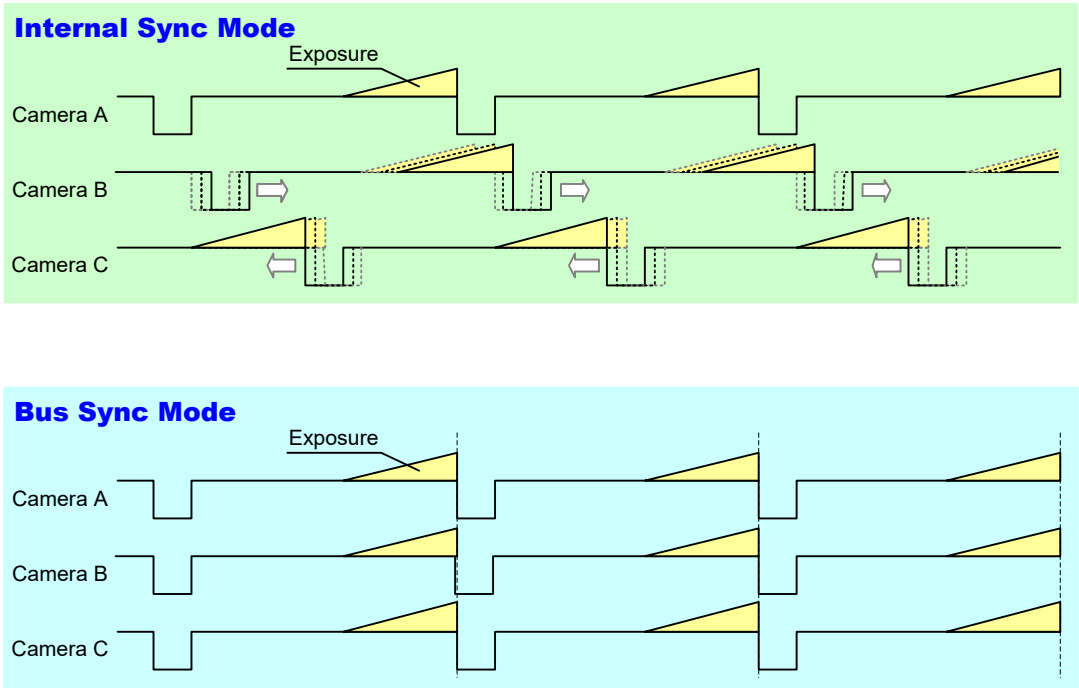
Set the following value to “EventNotification” register. The setting value is Enumeration type.

setting value	Event notification
Off (*)	Inactive
On	Active

* initial factory setting

FrameSynchronization

Selects the camera frame synchronization method.
Free run operation (internal sync mode) or synchronized with USB bus clock (Bus Sync mode).



• Registers

Register	Visibility	Access	Description
FrameSynchronization	Beginner	R/W	Selects the camera frame synchronization method.

• Setting

- Selects the camera frame synchronization method.
Set the following value to “FrameSynchronization” register. Setting value is Enumeration type.

setting value	function
Off (*)	Internal synchronization
Bus	Bus synchronization

* initial factory setting

LEDIndicatorLuminance

Adjusts LED indicator luminance.

● Registers

Register	Visibility	Access	Description
LEDIndicatorLuminance	Expert	R/W	Sets LED indicator luminance.

● Setting

- Set LED indicator luminance

Set the following value to “LEDIndicatorLuminance” register. Setting value is Float type.

LEDIndicatorLuminance	Value
Minimum	0.00(%)
Maximum (*)	100.00(%)

* initial factory setting

DPCControl

This DPC (Defective Pixel Correction) function corrects defective pixels from the image sensor. Specifying X and Y coordinates of the defective pixels, the defective pixels are corrected by calculation from the neighboring pixels.

● Registers

Register	Visibility	Access	Description
DPCEnable	Expert	R/W	Sets the activation of DPC function.
DPCNumber	Expert	R/W	Sets the number of pixels to correct.
DPCIndex	Expert	R/W	Sets the index number for entry.
DPCEntryX	Expert	R/W	Sets the X coordinate of defective pixel.
DPCEntryY	Expert	R/W	Sets the Y coordinate of defective pixel.

● Setting

- Set the activation of DPC

Set the following value to “DPCEnable” register. The setting value is Boolean type.

setting value	function
OFF	Inactive
ON (*)	Active

* initial factory setting

- Set the coordinates of defective pixels

Set the number of pixels to correct to “DPCNumber” register.

Then, set the index number for entry to “DPCIndex” register, and coordinates of defective pixels to “DPCEntryX”, “DPCEntryY” register. After setting coordinates, the defective pixel is corrected by calculation from the neighboring pixels. In the case that there is a number of defective pixels, they can be corrected by pointing new DPCIndex and setting coordinates

	DPCNumber	DPCIndex
Minimum	0	0
Maximum	256	255

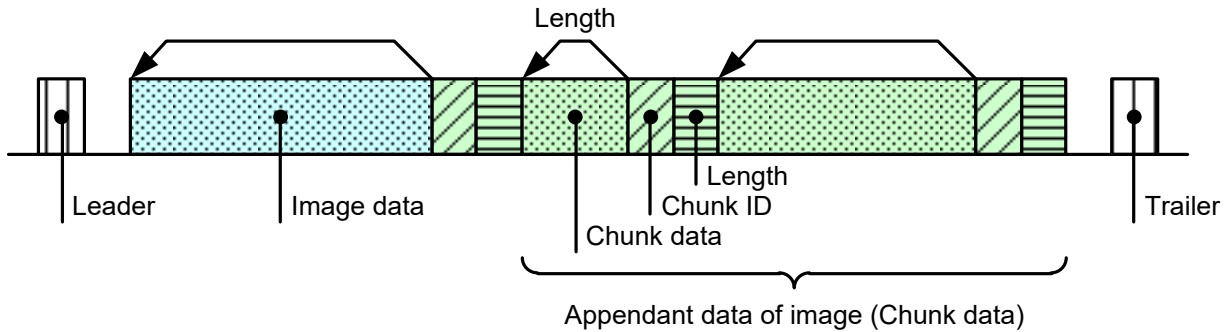
	DPCEntryX	DPCEntryY
Minimum	0	0
Maximum	WidthMax-1	HeightMax-1

Chunk

This section describes Chunk feature. Chunk data means tagged blocks of data.

The tags allow a chunk parser to dissect the data payload into its elements and to identify the content.

The length of a frame varies depending on the number of activated chunks.



Chunk

Length (B/W Model)	Image data	Length (Color Model)	
+0x000	ChunkID = 0x00000001	+0x000	Always output
+0x004	Length = (Image data size)	+0x004	Always output (Color Model)
+0x008	BlockID	+0x008	Always output (Color Model)
+0x010	ChunkID = 0x00000100	+0x010	Always output (Color Model)
+0x014	Length = 0x08	+0x014	Always output (Color Model)
+0x018	FrameBurstTriggerCount	+0x018	Always output (Color Model)
+0x01C	ChunkID = 0x80001001	+0x01C	Always output (Color Model)
+0x020	Length = 0x04	+0x020	Always output (Color Model)
+0x024	ExposureTime	+0x024	Always output (Color Model)
+0x028	ChunkID = 0x4004003C	+0x028	Always output (Color Model)
+0x02C	Length = 0x04	+0x02C	Always output (Color Model)
+0x030	Gain	+0x030	Always output (Color Model)
+0x034	ChunkID = 0x4004007C	+0x034	Always output (Color Model)
+0x038	Length = 0x04	+0x038	Always output (Color Model)
	WhiteBalanceR	+0x03C	Always output (Color Model)
	ChunkID = 0x4005007C	+0x040	Always output (Color Model)
	Length = 0x04	+0x044	Always output (Color Model)
	WhiteBalanceB	+0x048	Always output (Color Model)
	ChunkID = 0x4005009C	+0x04C	Always output (Color Model)
	Length = 0x04	+0x050	Always output (Color Model)
+0x03C	LineStatusAll	+0x054	Always output (Color Model)
+0x040	ChunkID = 0x4009007C	+0x058	Always output (Color Model)
+0x044	Length = 0x04	+0x05C	Always output (Color Model)
+0x048	SequentialShutterNumber	+0x060	Always output (Color Model)
+0x04C	ChunkID = 0x80002000	+0x064	Always output (Color Model)
+0x050	Length = 0x04	+0x068	Always output (Color Model)
+0x054	SequentialShutterElement	+0x06C	Always output (Color Model)
+0x058	ChunkID = 0x80002001	+0x070	Always output (Color Model)
+0x05C	Length = 0x04	+0x074	Always output (Color Model)
+0x060	UserArea (256 Bytes)	+0x078	Always output (Color Model)
+0x160	ChunkID = 0x80000000	+0x178	Always output (Color Model)
+0x164	Length = 0x100	+0x17C	Always output (Color Model)

Chunk Data Structure

● Registers

Register	Visibility	Access	Description
ChunkModeActive	Expert	R/W	Activates the inclusion of Chunk data in the payload of the image.
ChunkSelector	Expert	R/W	Select which Chunk to enable or control.
ChunkEnable	Expert	R/W	Enables the inclusion of the selected Chunk data in the payload of the image.
ChunkUserAreaLength	Expert	R	Indicates the length of ChunkUserAreaTable.
ChunkUserAreaTable	Expert	R/W	Set the free user space.(Maximum:256byte)
ChunkFrameID	Expert	R	Returns the Block ID of the frame included in the Chunk data.
ChunkExposureTime	Expert	R	Returns the ExposureTime of the frame included in the Chunk data.
ChunkGain	Expert	R	Returns the Gain of the frame included in the Chunk data.
ChunkWhiteBalanceR	Expert	R	Returns the WhiteBalanceR of the frame included in the Chunk data.
ChunkWhiteBalanceB	Expert	R	Returns the WhiteBalanceB of the frame included in the Chunk data.
ChunkLineStatusAll	Expert	R	Returns the LineStatusAll of the frame included in the Chunk data.
ChunkFrameBurstTriggerCount	Expert	R	Returns the FrameBurstTriggerCount of the frame included in the Chunk data.
ChunkSequentialShutterNumber	Expert	R	Returns the SequentialShutterNumber of the frame included in the Chunk data.
ChunkSequentialShutterElement	Expert	R	Returns the SequentialShutterElement of the frame included in the Chunk data.

● Setting

- Set the activation of Chunk feature

Set the following value to “ChunkModeActive” register. The setting value is Boolean type.

setting value	function
FALSE (*)	Inactivation
TRUE	Activation

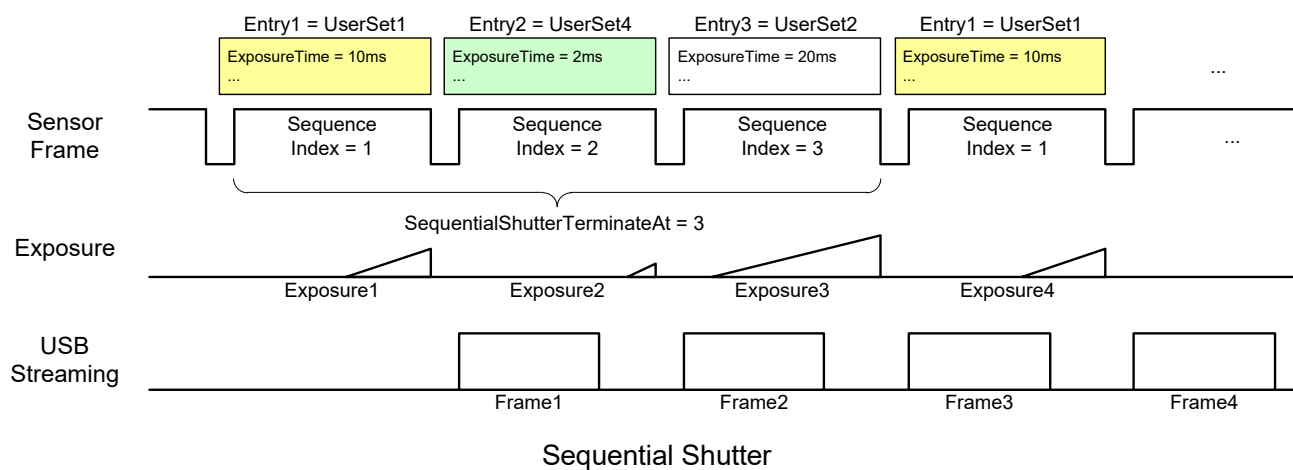
* initial factory setting

● Note

Changing “ChunkModeActive” register value is invalid during image stream data output.

SequentialShutterControl

Sequential Shutter function performs sequential capturing with applying the settings of UserSet that have been made entry in advance. This feature is not supported when the ShortExposureMode is enable (ON).



• Registers

Register	Visibility	Access	Description
SequentialShutterEnable	Expert	R/W	Sets the activation of Sequential Shutter function.
SequentialShutterTerminateAt	Expert	R/W	Sets the number of Index to repeat the sequence.
SequentialShutterIndex	Expert	R/W	Sets the sequence number to register.
SequentialShutterEntry	Expert	R/W	Sets the UserSet number to register to the sequence.

● Setting

- Register to the sequence

Set the sequence number to “SequentialShutterIndex” register, and set the UserSet number to “SequentialShutterEntry” registers. These setting values are Integer type.

SequentialShutterIndex	setting value
Minimum (*)	1
Maximum	16

* initial factory setting

SequentialShutterEntry	setting value
Minimum (*)	UserSet1
Maximum	UserSet15

* initial factory setting

- Register the loop termination

Set the number of Index to repeat to “SequentialShutterTerminateAt” register.

For example, If you set [3] to “SequentialShutterTerminateAt” register, camera captures the images of Index1, Index2 and Index3. Then repeats capturing the images of Index1, Index2...

- Set the activation of Sequential Shutter

Set the following value to “SequentialShutterEnable” register. The setting value is Boolean type.

setting value	function
OFF (*)	Inactive
ON	Active

* initial factory setting

- **Note**

The following table is the list of registers applied to “SequentialShutter”.

Table: List of registers to be applied to SequentialShutter

Category	Register
ImageFormatControl	OffsetX
	OffsetY
ExposureControl	ExposureTime
DigitalIOControl	UserOutputValueAll
	LineSource
CounterAndTimerControl	TimerDuration
	TimerDelay

Category	Register
AnalogControl	Gain
	BlackLevel
	Gamma
	Hue
	Saturation
	BalanceRatio
	ColorCorrectionMatrix
LUTControl	LUTEnable

Appendix

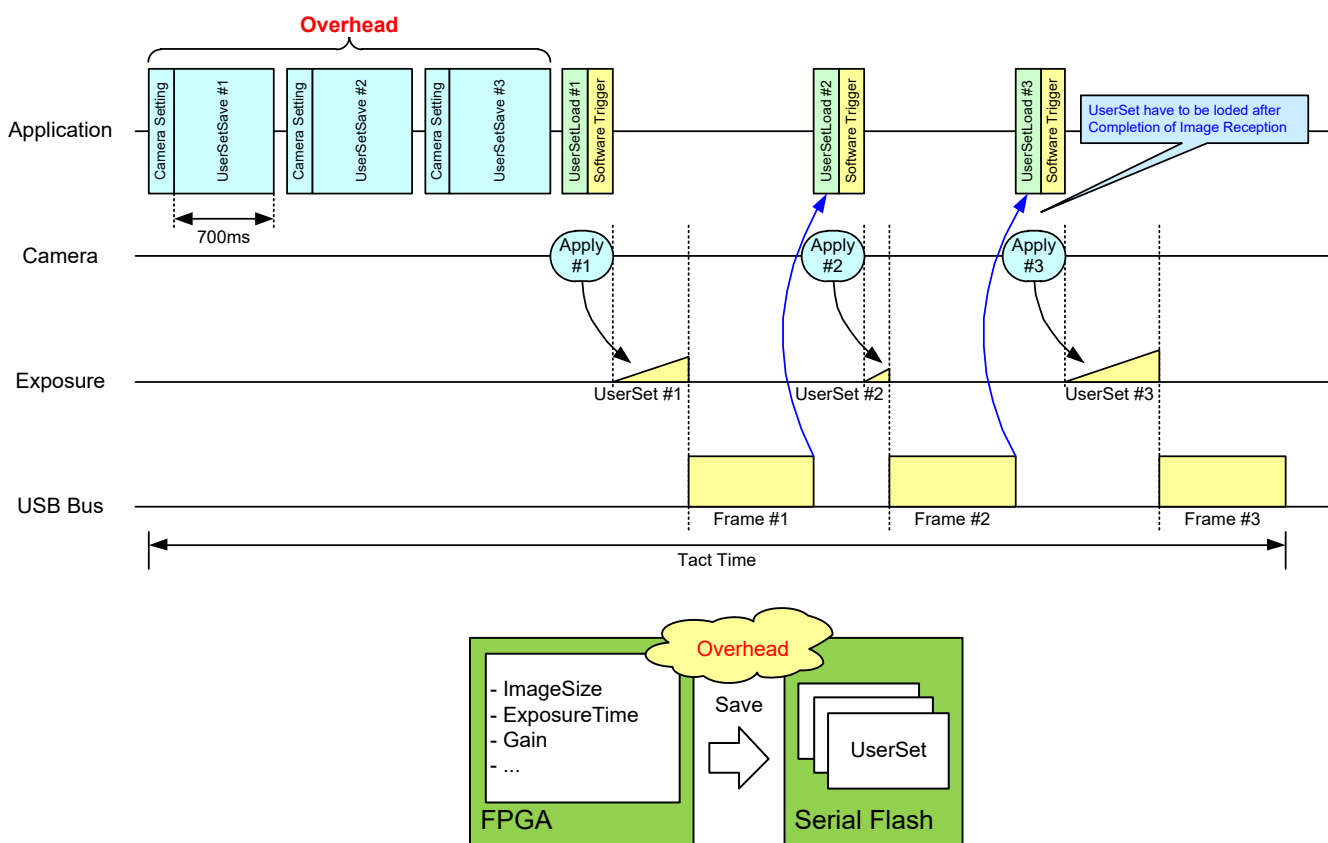
UserSetSave and UserSetQuickSave difference

If you want to change multiple Camera Settings (e.g. ROI setting) at once, UserSet feature is useful.

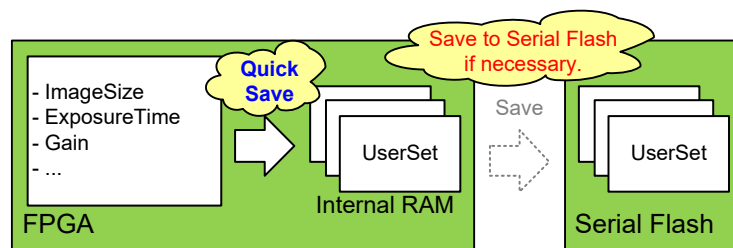
Application needs to save the camera settings in UserSet memory in advance or in initialization stage.

By **UserSetSave**, UserSet is stored to non-volatile flash memory.

It takes about **700ms** to execute UserSetSave because Non-volatile flash memory needs to be erased before writing. If you want to switch over multiple different settings in run time, overhead time of **UserSetSave** is inevitable.



By **UserSetQuickSave**, UserSet is stored to internal RAM. It takes less than **100us** in execution.
It can reduce the overhead time of **UserSetSave** greatly.
You can also save UserSets to Serial Flash if necessary by **UserSetSave**.



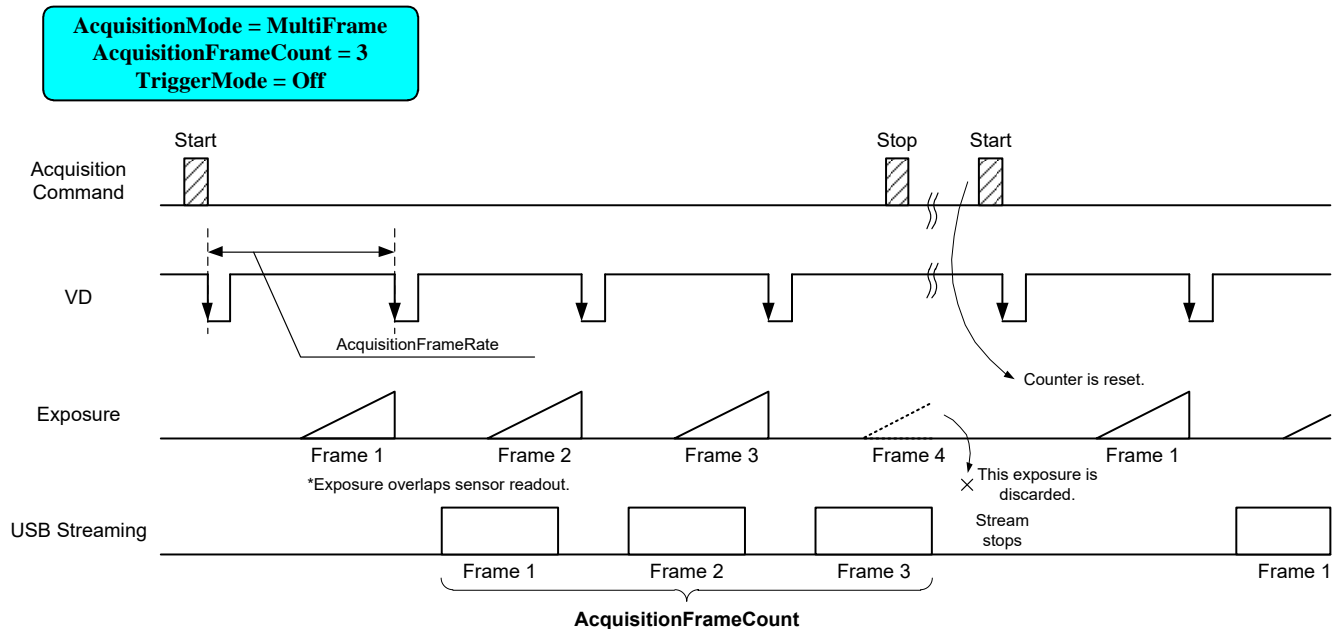
MultiFrame and Bulk function difference

This section describes the difference between MultiFrame function of AcquisitionMode and Bulk function of TriggerSequence.

- MultiFrame function sets limits to the number of frames to transfer with AcquisitionFrameCount register.
- Bulk function sets limits to the number of frames to exposure with TriggerAdditionalParameter register.

- MultiFrame function in Normal Shutter mode (TriggerMode = Off)

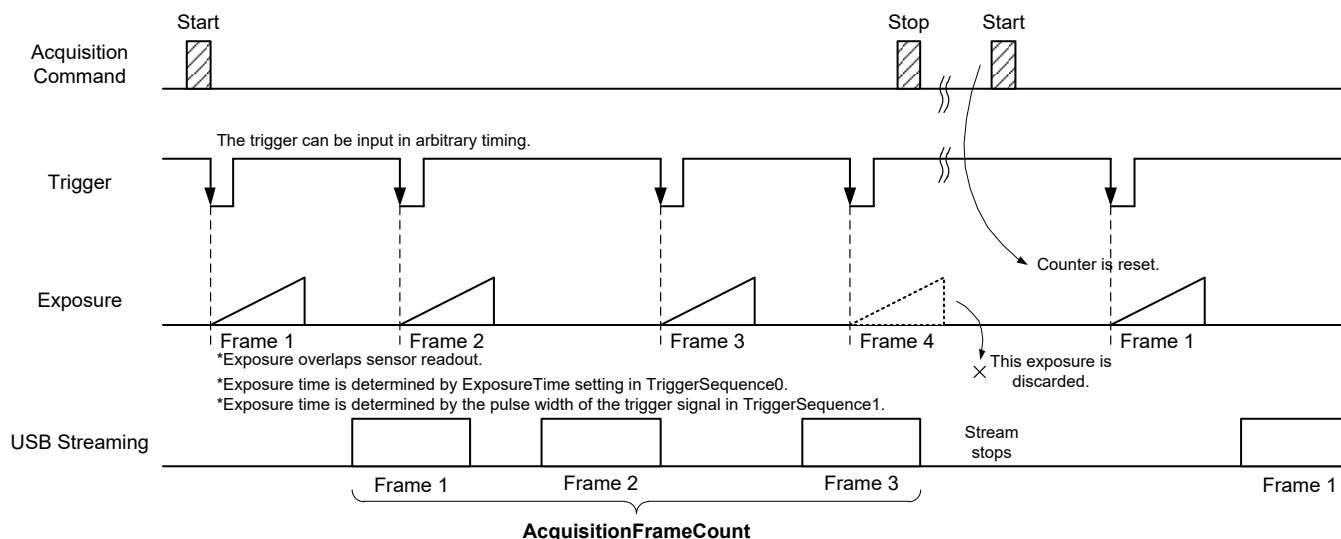
Camera transfers “AcquisitionFrameCount” frame(s).



- MultiFrame function in Random Shutter mode (TriggerMode = On, TriggerSequence = 0 or 1)

Camera transfers “AcquisitionFrameCount” frame(s). It requires “AcquisitionFrameCount” time(s) of trigger.

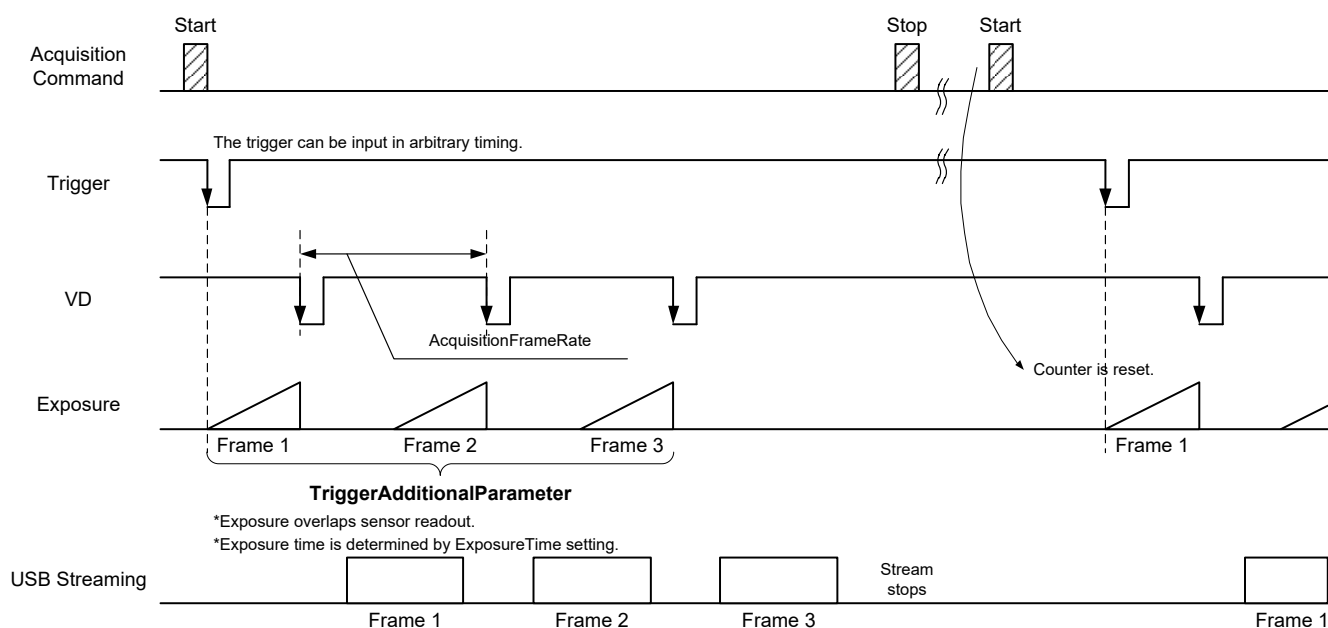
AcquisitionMode = MultiFrame
 AcquisitionFrameCount = 3
 TriggerMode = On
 TriggerSequence = 0 or 1



- Bulk function (TriggerMode = On, TriggerSequence = 6)

Camera transfers “TriggerAdditionalParameter” frame(s) by a single trigger.

AcquisitionMode = Continuous
 TriggerMode = On
 TriggerSequence = 6
 TriggerAdditionalParameter = 3

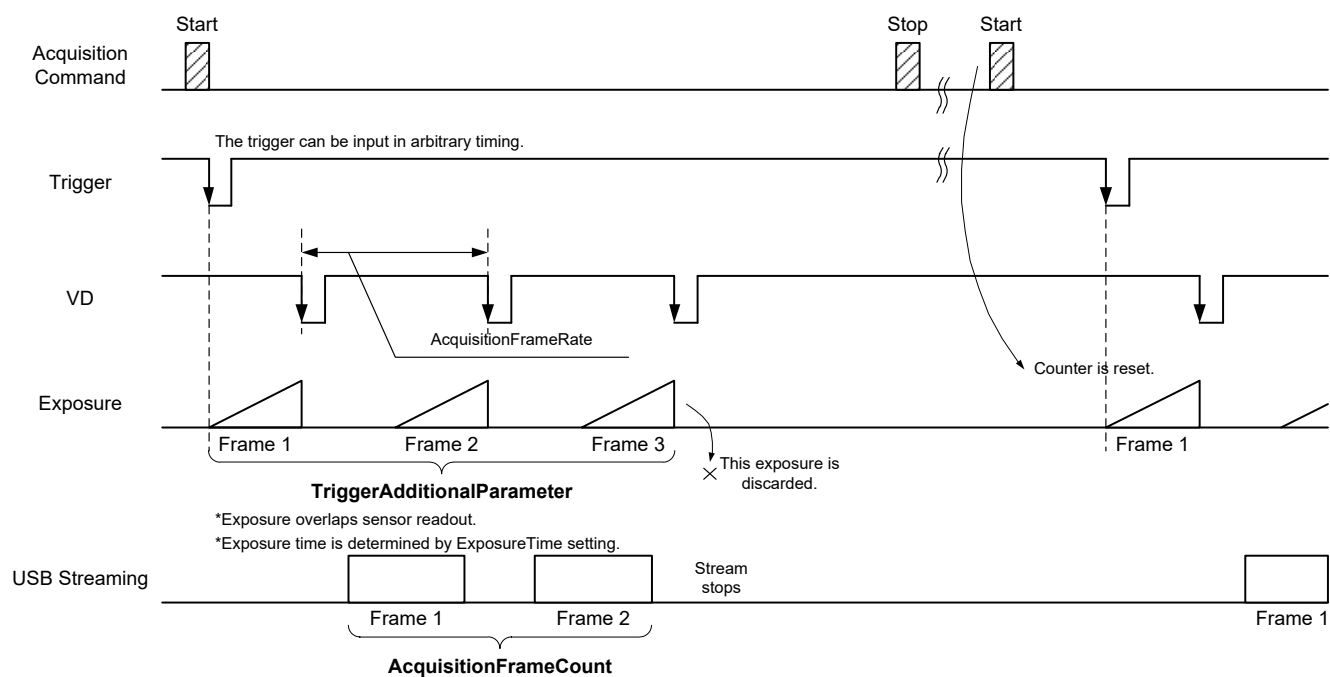


• Note

In Bulk function, you may want to set “Continuous” to “AcquisitionMode” register.

You can set “MultiFrame”, but acquisition frame number is limited by “AcquisitionFrameCount”.

AcquisitionMode = MultiFrame
AcquisitionFrameCount = 2
TriggerMode = On
TriggerSequence = 6
TriggerAdditionalParameter = 3



Warranty rules

● Warranty term

Warranty term is 36 months after your purchase. We may assume the date of the purchase from our shipping date when the date is unidentified.

● Limited Warranty

Free warranty is not applicable for the troubles, damages or losses caused by the cases of the followings, even if it is during the warranty term.

1. Natural exhaust, wear or degradation of a component parts
2. Handling against the instructions and conditions described in the instruction manual
3. Remodeling, adjustment and the part exchange. (including the opening of the enclosure box and the alteration)
4. Using the accessories not included with the product or our non-designated optional articles
5. Damages caused during the transportation or deficiency of the handling such as drop or fall of the products after the products having been transferred to customers, leaving the products to corrosive environment such as sunlight, fire, sand, soil, heat, moisture, or an inappropriate storing method
6. A fire, an earthquake, a flood, a lightning, or other natural disasters, pollution and a short circuit, abnormal voltage, excessive physical pressure, theft, other accident
7. When connected to a product which is not recommended
8. When connected to the power supply which is not suitable
9. Forgery product, products which does not have proper serial number, products of which serial number is forged, damaged or deleted
10. All defects that happened after the expiration for a warranty term

Repair

● Repair methods

Basically, has to return it to our company when the user requests us to repair product.

In the case, exchange to a replacement or an equal function product.

● Repair request methods

On the occasion of a repair request, please download the "Failure situation report sheet" from our website, fill in the necessary items and return it together with the defective product.

Repair Request Methods

https://www.toshiba-teli.co.jp/en/support/contact/failure_situation.htm

Please read the following instructions carefully.

1. Please return our product alone, taking out of your equipment in case that our product is installed to an equipment
2. We are unable to return the information such as your own serial numbers, control number, the identification seal, if it is attached to the returned products. Please keep record before you return the product.
3. As the data saved in the camera will not be kept after the repair, please take out data before return.
4. We are unable to accept the cancellation after the repair request by the customer's reason.
5. About the repair product shipping expenses, please bear the charges when you return the product to us. We bear the charges to you from us only for a warranty period.
6. We are unable to accept your request of a delivery date and time of the product return, or the delivery method.
7. We are unable to accept a trouble factor investigation, the request of the repair report.
8. We accept a repair of out of warranty product, if it is reparable.
9. The proprietary rights of the repair request products after the exchange repair belong to us.
10. The immunity from responsibility of the product is applied in the repair completion products.

* Please refer for the inquiry about the software to our homepage or sales personnel.