

BC Series CMOS Camera

Instruction Manual

Model
Mono Camera : BC040M / BC160M

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 Handing

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 camera connector is subjected to strong repetitive shocks, its camera connector is possible to break down. If you intend to use your camera in such a situation, if possible, bundle and fix a camera cable in the place near the camera, and do not transmit a shock to the camera 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.

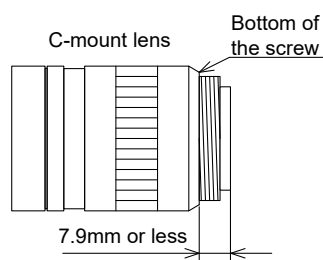
In addition, depending on the lens you use, the performance of the camera may not be brought out fully due to deterioration in resolution and brightness in the peripheral area, aberration and others.

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 7.9mm. 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.

This product is marked this symbol to subject to EU Waste Electrical & Electronic Equipment (WEEE) directive.

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”
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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 require 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.

<产品中有毒有害物质或元素的名称及含量>

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

本表格依据SJ/T 11364的规定编制

○：表示该有毒有害物质在该部件所有均质材料中的含量均在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

×：表示该有毒有害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)

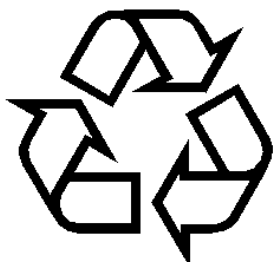
This information is applicable for People's Republic of China only.

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

Specifications

Overview

This BC series is an integrated-(one-body)-type camera that adopts a global shutter CMOS sensor.

These are BC040M (0.4M 1/2.9 type), BC160M (1.6M 1/2.9 type).

It is easy to integrate into industrial equipment.

Features

- High frame rate and high resolution
Supporting high frame rate, BC040M 523fps, BC160M 148fps.
- 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.
- CameraLink interface (Power over CameraLink)
By using a CameraLink-capable frame grabber board to which power can be supplied, high-speed transfer of captured images to a PC as well as various types of camera control from the PC are allowed. Power can also be supplied to the camera with only one cable.
- IIDC2 Digital Camera Control Specification Ver.1.1.0
This product is based on IIDC2 Digital Camera Control Specification Ver.1.1.0
- 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 Gigabit Ethernet by reducing horizontal output area.

- Binning mode
Pixel data is combined by vertical and horizontal.
- Decimation mode
Camera reads all effective areas at high speed by skipping lines.
- Compact and lightweight
This camera is compact and lightweight; it is easy to integrate into industrial equipment.

Configuration

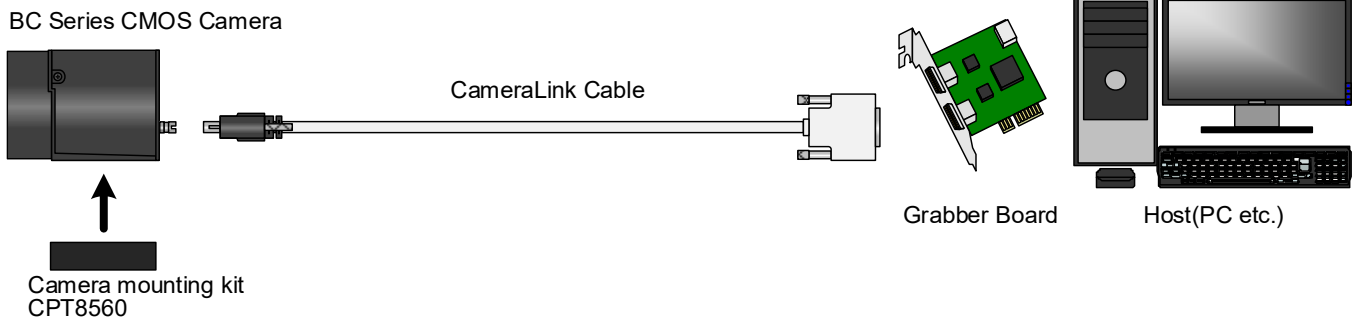
The system configuration of this camera series is as follows;

This camera does not include any accessories. Please prepare other equipments separately.

- Camera: This product. (BC series)
- Camera mounting kit CP8560 (*1): To fix a camera to a tripod; attach this to the bottom of the camera.

*1: Optional part. Contact your dealer / distributor for details of option units.

Connection



Notes on Connection:

- Please confirm the power supply of the camera off when plugging in or pulling out the CameraLink cable. 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 a CameraLink 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.
- Disturbances in the captured image may occur by an electrical characteristic of the transmission line of using CameraLink devices (CameraLink cable, Grabber Board).

Connector Pin Assignment

- Video output / Controlling / Power supply connector (CameraLink Base Configuration)
 - Connector type : HDR-EC26FYTG2+ (Manufactured by Honda Connectors)

*When connecting a cable to the camera, please turn off the power supply firstly.

Pin No.	I/O	信号名	Pin No.	I/O	信号名
1	-	DC+12V (PoCL)	14	-	GND
2	O	X0-	15	O	X0+
3	O	X1-	16	O	X1+
4	O	X2-	17	O	X2+
5	O	X CLK-	18	O	X CLK+
6	O	X3-	19	O	X3+
7	I	Ser TC+	20	I	Ser TC-
8	O	Ser TFG-	21	O	Ser TFG+
9	I	CC1- (TRIG)	22	I	CC1+ (TRIG)
10	I	CC2+	23	I	CC2
11	I	CC3-	24	I	CC3+
12	I	CC4+	25	I	CC4-
13	-	GND	26	-	DC+12V (PoCL)

*CC2+, CC2-, CC3+, CC3-, CC4+, CC4- : Not used

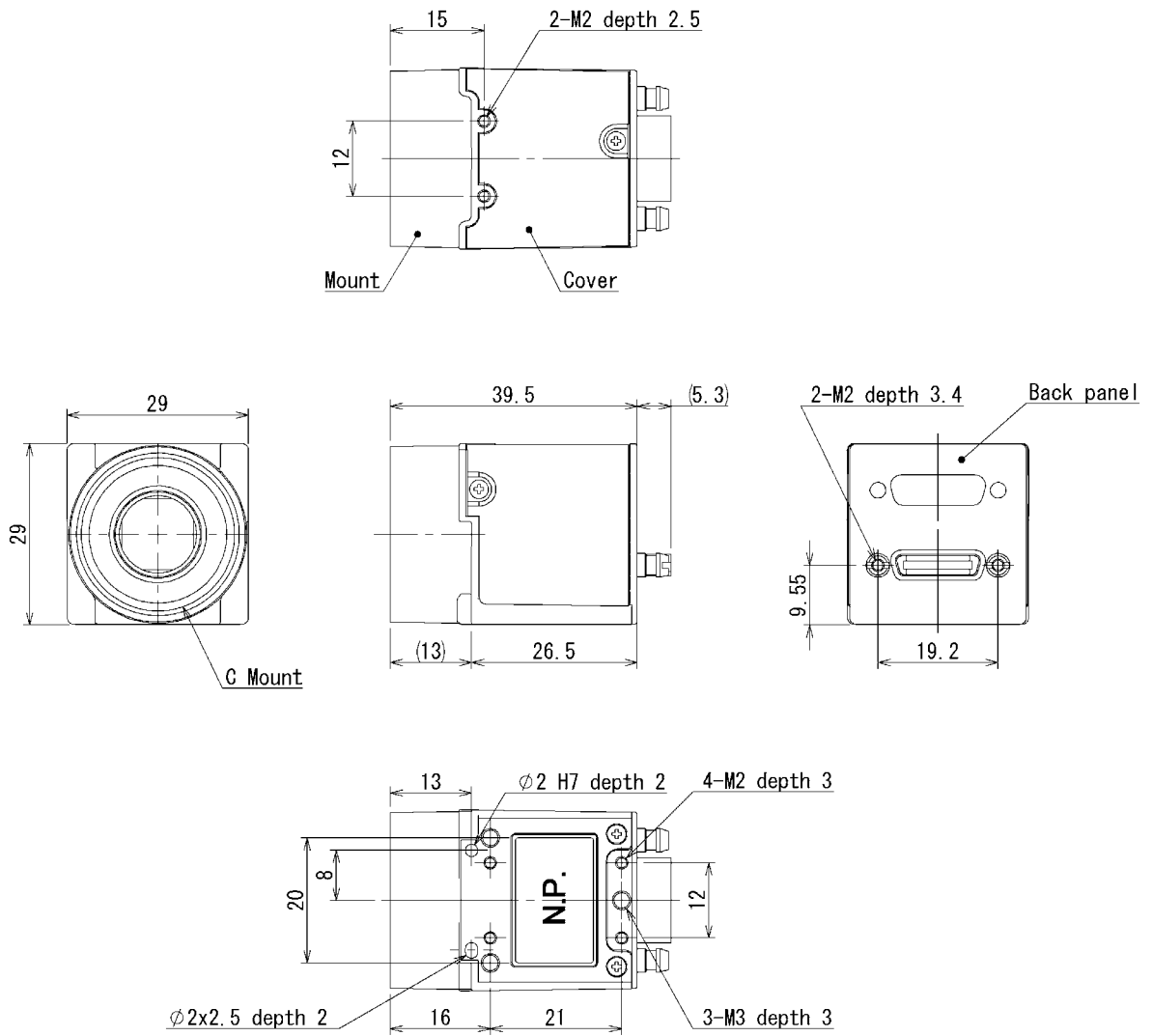
- Bit assignment of camera output

*When connecting a cable to the camera, please turn off the power supply firstly.

Port / Bit	8bit	10bit	12bit	Port / Bit	8bit	10bit	12bit	Port / Bit	8bit	10bit	12bit
Port A0	A[0]	A[0]	A[0]	Port B0	B[0]	A[8]	A[8]	Port C0	n/a	B[0]	B[0]
Port A1	A[1]	A[1]	A[1]	Port B1	B[1]	A[9]	A[9]	Port C1	n/a	B[1]	B[1]
Port A2	A[2]	A[2]	A[2]	Port B2	B[2]	n/a	A[10]	Port C2	n/a	B[2]	B[2]
Port A3	A[3]	A[3]	A[3]	Port B3	B[3]	n/a	A[11]	Port C3	n/a	B[3]	B[3]
Port A4	A[4]	A[4]	A[4]	Port B4	B[4]	B[8]	B[8]	Port C4	n/a	B[4]	B[4]
Port A5	A[5]	A[5]	A[5]	Port B5	B[5]	B[9]	B[9]	Port C5	n/a	B[5]	B[5]
Port A6	A[6]	A[6]	A[6]	Port B6	B[6]	n/a	B[10]	Port C6	n/a	B[6]	B[6]
Port A7	A[7]	A[7]	A[7]	Port B7	B[7]	n/a	B[11]	Port C7	n/a	B[7]	B[7]

*The allocation of the port conforms to the CameraLink standard.

Outline Drawing



Specification

Main Material

Mount, Back panel: Aluminium die-cast metal
 Cover: Aero aluminium

Processing

Mount, Back panel: Cationic coating (Black)
 Cover: laser satin print (Black)

General Specifications

Model Name		BC040M	BC160M
Imager		CMOS image sensor	
Maximum number of Video out pixels (H) x (V)		720×540	1440×1080
Optical Size		1/2.9 type	1/2.9 type
Scanning area (H) x (V) [mm]		5.02×3.82	5.00×3.75
Pixel size (H) x (V) [μm]		6.90×6.90	3.45×3.45
Scan method		Progressive	
Electronic shutter method		Global shutter	
Aspect ratio		4:3	
Sensitivity		2700lx, F11, 1/125s	2600lx, F11, 1/31s
Minimum illuminance		F1.4, Gain +24dB, Video level 50%	
		2lx	2lx
Power supply	PoCL	DC+12V ±10% (From CameraLink connector)	
Power consumption (at all pixels readout)	PoCL	1.6W(max)	1.7W(max)
Interface		CameraLink Base Configuration	
Transmission speed		37.5 / <u>50</u> / 83 MHz x <u>1</u> / 2 / 3 tap	
Image output format		<u>Mono8</u> / Mono10 ^(*1) / Mono12 ^(*1)	
Maximum Frame rate (at all pixels readout)			
Mono8 ^(*2)	<u>HighFramerateMode=OFF</u>	436 fps	148 fps
	HighFramerateMode=ON	523 fps	非対応
Mono10 ^(*3) / Mono12 ^(*3)		320 fps	Incompatible
Dimensions		29 mm(W) x 29 mm (H) x 26.5 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) 3tap is not supported

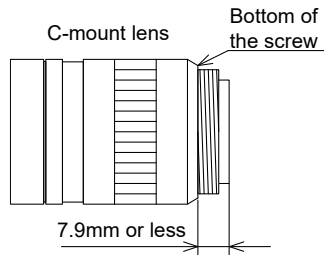
* Underbar is factory default

(*2) 83MHz / 3tap setting

(*3) 83MHz / 2tap setting

Notes on combination of C-mount lens:

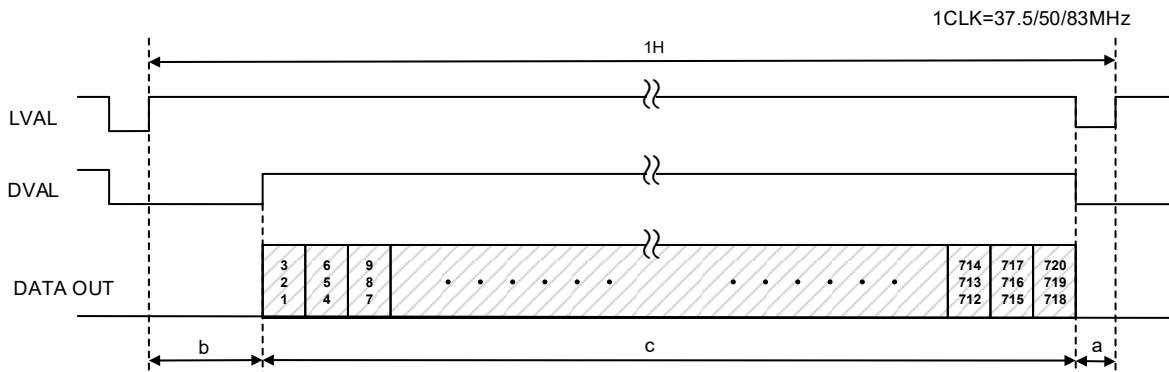
- Depending on the lens you use, the performance of the camera may not be brought out fully due to the deterioration in resolution and brightness in the peripheral area, occurrence of a ghost, aberration and others. When you check the combination between the lens and camera, be sure to use the lens you 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 7.9mm or less.



Timing Specification

For getting fastest framerate, Electronic shutter \leq readout time.

- Horizontal timing : at all pixels readout (following timing figure : BC040M 3tap)



1 CLK=37.5MHz/50MHz

unit : CLK

Model name	CameraLink tap	a	b	c
BC040M	1tap	4	10	720
	2tap			360
	3tap			240
BC160M	1tap	4	10	1440
	2tap			720
	3tap			480

1 CLK=83MHz

unit : CLK

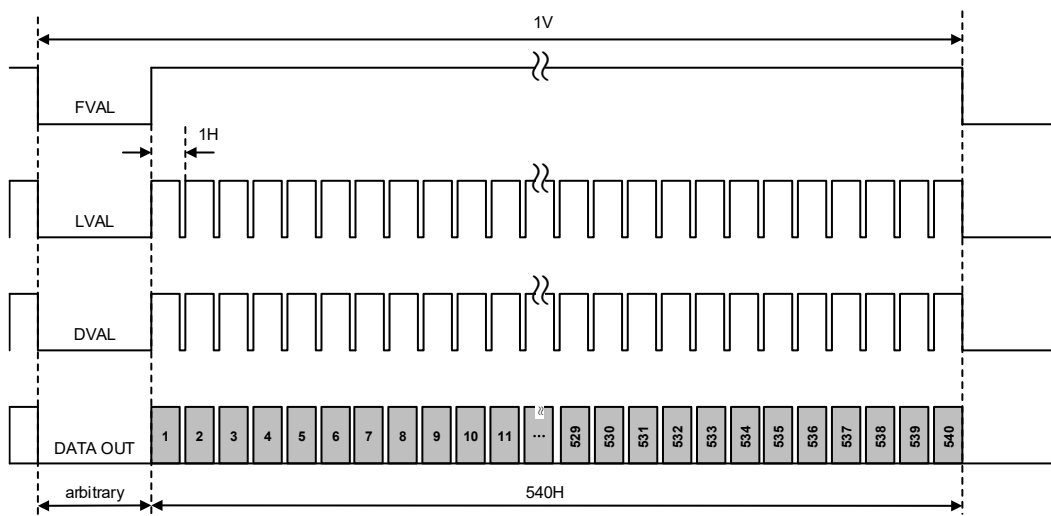
Model name	CameraLink tap	a	b	c
BC040M	1tap	4	10	720
	2tap			360
	3tap			69~73
BC160M	1tap	4	10	1440
	2tap			720
	3tap			480

Horizontal sync frequency=1H

unit : KHz

Model name	CameraLink tap	CLK frequency (1CLK)		
		37.5MHz	50MHz	83MHz
BC040M	1tap	51.09	68.12	113.08
	2tap	100.27	133.69	221.93
	3tap	147.64	196.85	258.57
BC160M	1tap	25.79	34.39	57.08
	2tap	51.09	68.12	113.08
	3tap	75.91	101.21	168.02

●Vertical timing : at all pixels readout (following timing figure : BC040M 3tap)



Vertical sync frequency=1V

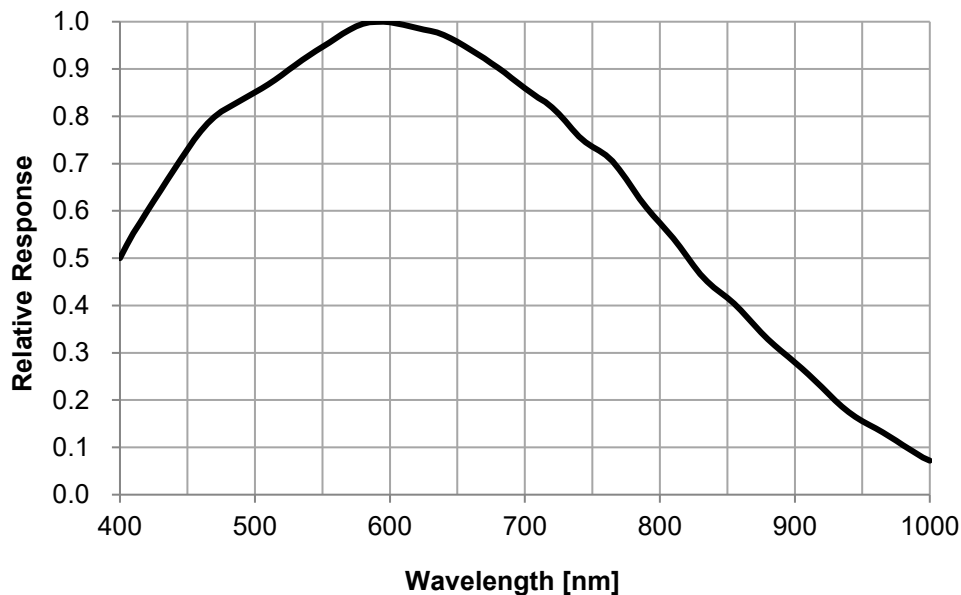
Unit : Hz

Model name	CameraLink tap	PixelFormat	CLK frequency (1CLK)		
			37.5MHz	50MHz	83MHz
BC040M	1tap	Mono8	86.63	115.43	191.98
		Mono10/Mono12	86.63	115.43	191.98
	2tap	Mono8	170.13	226.54	377.13
		Mono10/Mono12	170.13	226.54	320.13
	3tap	Mono8	250.67	333.57	436.74
	BC160M	1tap	Mono8	22.74	30.31
Mono10/Mono12			22.74	30.31	50.36
2tap		Mono8	45.07	60.05	99.88
		Mono10/Mono12	45.07	60.05	99.88
3tap		Mono8	66.99	89.23	148.26

Typical Spectral Response

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

< BC040M / BC160M >



Operating Ambient Conditions

- Ambient conditions

- Operating Assurance

Temperature: -5°C ~ 45°C
Humidity: 90% or less (no condensation)

- Storage Assurance

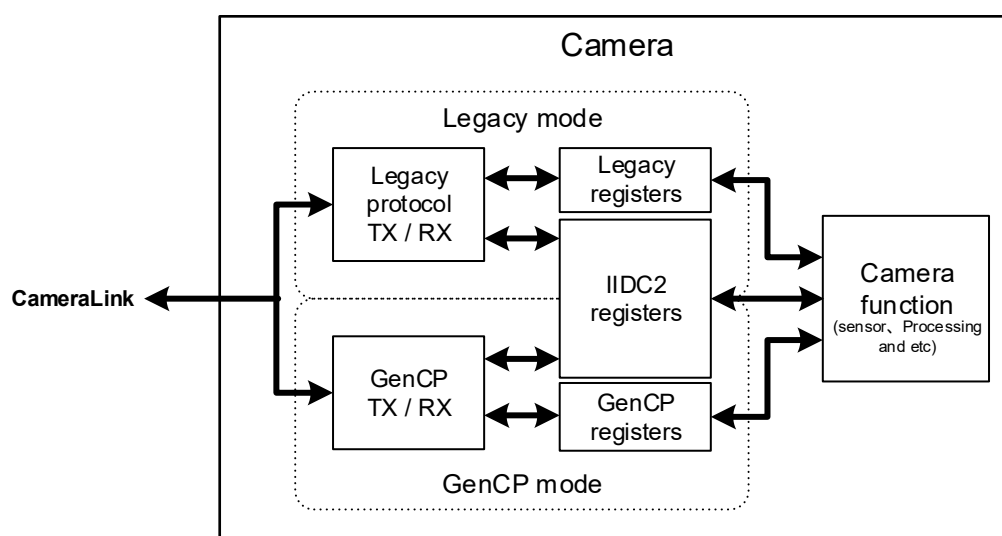
Temperature: -20°C ~ 60°C
Humidity: 95% or less (no condensation)

Communication Protocol

BC series has Legacy protocol and GenCP as command communication protocol.

The switching of communication protocol is recognized automatically from received packet. The PC application can communicate to camera without switching operation of communication protocol. For Legacy protocol and GenCP, BC series has multiple registers for control of camera feature.

The accessing to I2C2 registers is possible by using Legacy protocol and GenCP. The accessing to Legacy registers is possible by using only Legacy protocol. The accessing to GenCP registers is possible by using only GenCP.



Teli-Legacy protocol, Teli-Legacy register

The protocol and register are adopted on the CSC series in our previous product.

They are available in this camera for ease to the CSC series customers.

GenCP

This is a communication protocol including transaction flow and packet structure, which is standardized by the European Machine Vision Association (EMVA). It is used for CameraLink, USB 3.0 and various interfaces.

You can find this specification as following web page (As of July, 2019).

<http://www.emva.org/>

I2C2

This is a register mapping of machine vision cameras, which is standardized by Japan Industrial Imaging Association (JIJA). Because it is not included transport layer, I2C2 can be used on various interfaces.

You can find this specification as following web page (As of July, 2019).

<http://jiia.org/>

Legacy protocol

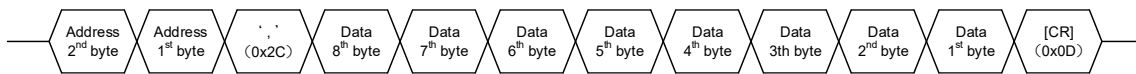
This communication protocol is the TELI standard method (method in which parameters are set in the registers in the camera).

In command send/receive operation, hexadecimal address and data are converted to ASCII data.

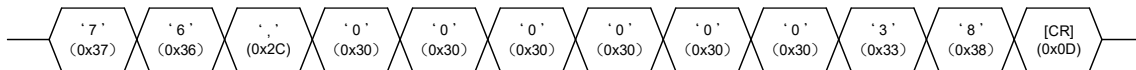
All ASCII alphabetic characters are uppercase.

- Writing to the register

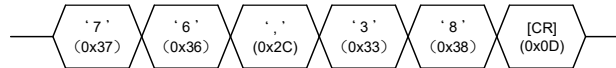
To write data in a register, send a command, as follows. (Address' max-length is 8 bytes, and Data's max-length is 8 bytes.



For example, to write data 0x38 to address 0x76, send a command, as follows.

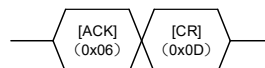


When the address and data are 2 bytes or more, the above register writing can be omitted in the following format because it is applied from the upper digit.

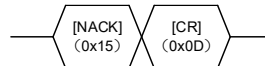


The camera responds to the write command with No Error (ACK) or Error (NAK), as follows.

No Error (ACK)



Error (NAK)

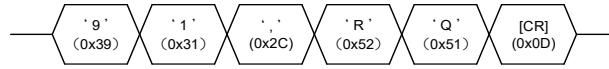


*Setting scalable is reflected by writing the "Scalable update" register.

- Reading the register

To read data from a register, send ', (comma)', 'R', 'Q' and [CR] code following the address.

For example, to read data in address 0x91, send a command, as follows.

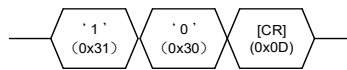


The camera responds to the read request, as follows (Data's max-length is 8 bytes).



Actually, the camera responds to the read request as minimum data length:

For example, to read data 0x10 to address 0x91, the camera responds as follows.



GenCP

Communicates with the camera, by the packet that is defined by GenCP.

Communication flow control, packet structure and others, refer to the specifications of GenCP.

For packets to be used, refer to below.

- READMEM_CMD

	+0x0	+0x1	+0x2	+0x3
0x00	0x0100 (preamble)		CCD checksum	
0x04	SCD checksum		0x0000 (channel_id)	
0x08	0x4000 (flags)		0x0800 (command_id)	
0x0C	0x000C (length)		request_id	
0x10	register address (hi)			
0x14	register address (lo)			
0x18	0x0000 (reserved)		read length	

- READMEM_ACK

	+0x0	+0x1	+0x2	+0x3
0x00	0x0100 (preamble)		CCD checksum	
0x04	SCD checksum		0x0000 (channel_id)	
0x08	status code		0x0801 (command_id)	
0x0C	length		request_id	
0x10	data			
...	-----			
(0x10+length-4)				

- WRITEMEM_CMD

	+0x0	+0x1	+0x2	+0x3
0x00	0x0100 (preamble)		CCD checksum	
0x04	SCD checksum		0x0000 (channel_id)	
0x08	0x4000 (flags)		0x0802 (command_id)	
0x0C	length		request_id	
0x10	register address (hi)			
0x14	register address (lo)			
0x18	data			
...	-----			
(0x10+length-4)				

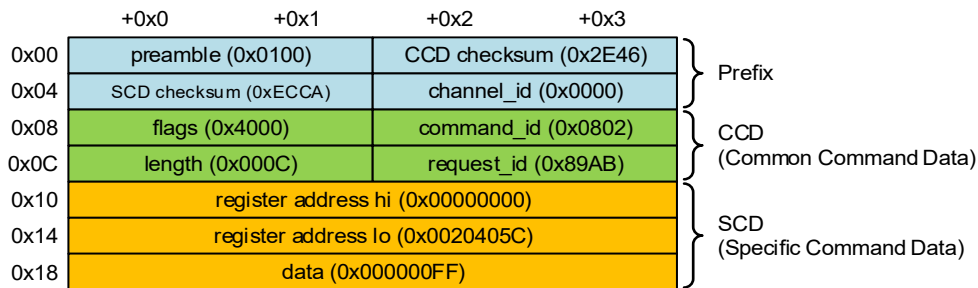
- WRITEMEM_ACK

	+0x0	+0x1	+0x2	+0x3
0x00	0x0100 (preamble)		CCD checksum	
0x04	SCD checksum		0x0000 (channel_id)	
0x08	status code		0x0803 (command_id)	
0x0C	0x0004 (length)		request_id	
0x10	0x0000 (reserved)		length written	

- How to calculate GenCP checksum

The specified field is cut out in 2 byte units, and the one's complement sum is taken to be one's complement.

The specification fields are as follows.



*CCD checksum : channel_id, CCD (In the example, the area of 0x06 to 0x0F)

*SCD checksum : channel_id, CCD, SCD (In the example, the area of 0x06 to 0x1B)

*The one's complement sum is taken to be one's complement.

: It has the same calculation method as the UPD Checksum of RFC768.

Please refer to the following about UPD of RFC768.

<https://www.ietf.org/rfc/rfc768.txt>

- CCD checksum in the example

One's complement sum

$$=0x0000+0x4000+0x0802+0x000C+0x89AB$$

$$=0xD1B9$$

One's complement

$$=0xFFFF-0xD1B9$$

$$=0x2E46$$

- SCD checksum in the example

One's complement sum

$$=(\text{CCD checksum complement})+0x0000+0x0000+0x0020+0x405C+0x0000+0x00FF$$

$$=0xD1B9+0x0000+0x0000+0x0020+0x405C+0x0000+0x00FF$$

$$=0x11334$$

$$=0x001+0x1334$$

$$=0x1335$$

One's complement

$$=0xFFFF-0x1335$$

$$=0xECCA$$

Register Map

BC series has GenCP and Legacy protocol as command communication protocol.

IIDC2 Address

The following address is possible to control by GenCP and Legacy protocol.

Register address	Read Write	AC(*)	Memory save	Default	Register name	Description
0x0020 005C	R.O.	-	-	0x0	ApplyImageFormat	0x0:No error, 0x10:Scalable setting error
0x0020 105C	R/W	✓	✓	0x1	CameraLink Tap	0x1:1Tap,0x2:2Tap,0x3:3Tap
0x0020 107C	R/W	✓	✓	0x32	CameraLink CLK	0x25:37.5000MHz,0x32:50.0000MHz,0x53:83.0357MHz
0x0020 2094	R/W	✓	✓	0x0	offsetX	Scalable: Horizontal offset (in pixels) from the origin to the region of interest 0.4M:0x0 (0) ~ 0x290 (656) OffsetX setting unit: 4 1.6M:0x0 (0) ~ 0x560 (1376) OffsetX setting unit: 4
0x0020 2098	R/W	✓	✓	0.4M:0x2D0 1.6M:0x5A0	Width	Scalable: Width 0.4M:0x40 (64) ~ 0x2D0 (720) Width setting unit: 4 1.6M:0x40 (64) ~ 0x5A0 (1440) Width setting unit: 4
0x0020 209C	R/W	✓	✓	0x0	offsetY	Scalable: Vertical offset (in pixels) from the origin to the region of interest. 0.4M:0x0 (0) ~ 0x1DC (476) OffsetY setting unit: 2 1.6M:0x0 (0) ~ 0x3F8 (1016) OffsetY setting unit: 2
0x0020 20A0	R/W	✓	✓	0.4M:0x21C 1.6M:0x438	Height	Scalable: Height 0.4M:0x40 (64) ~ 0x21C (540) Height setting unit: 2 1.6M:0x40 (64) ~ 0x438 (1080) Height setting unit: 2
0x0020 303C	R/W	-	-	0x8	Acquisition Command	0x0: Abort image output. 0x1: Stop image output. 0x8: Start image output.
0x0020 30A8	R/W	-	✓	0x0	Acquisition FrameRateControl	0x0:NoSpecify Take priority ExposureTime setting. 0x1:Manual Take priority AcquisitionFrameRate setting.
0x0020 30BC	R/W	-	✓	0.4M:0x736F31 1.6M:0x1E517F	Acquisition FrameRate	Framerate *AcquisitionFrameRate / 65536[fps]
0x0020 30C8	R/W	-	✓	0x0	Acquisition FrameIntervalControl	0x0:NoSpecify Take priority ExposureTime setting. 0x1:Manual Take priority AcquisitionFrameRate setting.
0x0020 30DC	R/W	-	✓	0.4M:0x4F4FB 1.6M:0x12DF8A	Acquisition FrameInterval	Interval *AcquisitionFrameInterval / 37500000[sec]
0x0020 4028	R/W	-	✓	0x1	ExposureTimeControl	0x0:NoSpecify Take priority AcquisitionFrameRate setting. 0x1:Manual Take priority ExposureTime setting.
0x0020 403C	R/W	-	✓	0.4M:0x493E0 1.6M:0x124F80	ExposureTime	ExposureTime ShortExposureMode=OFF: *ExposureTime / 37500000 [sec] 0x22B (14.8usec) ~ 0x23C34600 (16sec) ShortExposureMode=ON: *ExposureTime * 53 / 983850009 [sec] 0x14 (1.1usec) ~ 0xF7 (13.3usec)
0x0020 405C	R/W	-	✓	0x0	BlackLevel	0xFFFFFFFF (-25%) ~ 0x100(+25%)
0x0020 407C	R/W	-	✓	0x0	Gain	0x0 (0dB) ~ 0xF0 (24dB)
0x0020 409C	R/W	-	✓	0x64	Gamma	Min:0x2D(γ=0.45) Max:0x64(γ=1.0)
0x0020 439C	R/W	-	✓	0x0	ShortExposureMode	0x0:OFF,0x1:ON
0x0020 603C	R/W	-	✓	0x0	LUT Enable	0x0:OFF,0x1:ON
0x0030 0000	R/W	-	-	0x0	LUTValue[0]	Min:0x0,MAX:0xFFFF
0x0030 0004					LUTValue[1]	
↓					↓	
0x0030 0FFC					LUTValue[1023]	
↓					↓	
0x0030 3FFC					LUTValue[4095]	

Register address	Read Write	AC(*)	Memory save	Default	Register name	Description
0x0020 703C	R/W	✓	✓	0x0	TriggerMode	0x0:Normal shutter mode 0x1:Random trigger Shutter mode
0x0020 705C	R/W	✓	✓	0x0	TriggerSequence	0x0:Fix mode, 0x1:Level mode
0x0020 707C	R/W	✓	✓	0x0	TriggerSource	Selects a trigger source of random trigger shutter. 0x0:Line0(CC1),0x40:Software
0x0020 70BC	R/W	✓	✓	0x0	TriggerDelay	Sets the delay from trigger detection to exposure start. *TriggerDelay / 37500000 [sec] 0x0(0sec) ~ 0x47868C0(2sec)
0x0020 70DC	W.O.	-	-	—	SoftwareTrigger	0x8:Execute SoftwareTrigger
0x0020 213C	R/W	✓	✓	0x1	Binning Horizontal	0.4M:Min:0x1,Max:0x2 1.6M:Min:0x1,Max:0x4
0x0020 215C	R/W	✓	✓	0x1	Binning Vertical	0.4M:Min:0x1,Max:0x2 1.6M:Min:0x1,Max:0x4
0x0020 217C	R/W	✓	✓	0x1	Decimation Horizontal	0.4M:Min:0x1,Max:0x2 1.6M:Min:0x1,Max:0x4
0x0020 219C	R/W	✓	✓	0x1	Decimation Vertical	0.4M:Min:0x1,Max:0x2 1.6M:Min:0x1,Max:0x4
0x0020 20DC	R.O.	-	-	0x0	PixelCoding	0x0:Mono
0x0020 20FC	R/W	✓	✓	0x8	PixelSize	0x8:Bpp8,0xA:Bpp10,0xC:Bpp12
0x0020 807C	R/W	-	-	0x0	UserSetSelector	Sets the memory channel of UserSet. 0x0:Default,0x1:UserSet1 ~ 0xF:UserSet15
0x0020 809C	R/W	Done : ✓ Load : ✓ Save : - Erase : -	-	0x0	UserSetCommand	Read / Write the UserSet. 0x0:Done, 0x8:Load, 0x9:Save, 0x7F:Erase
0x0021 F2FC	R/W	-	✓	0x0	UserSetDefault	Selects a channel of user setting when camera powers up. 0x0:Default 0x1:UserSet1 ~ 0x15:UserSet15
0x0020 9050	R/W	-	✓	0x0	LineInverterAll	Selects the inversion of Line0(CC1). 0x0:Negative,0x1:Positive
0x0020 9070	R.O.	-	-	0x1	LineStatusAll	Returns the current status of Line0(CC1).
0x0020 21B0	R/W	✓	✓	0x0	ReverseX	Sets the Reverse Horizontal. 0x0:OFF, 0x1:ON
0x0020 21D0	R/W	✓	✓	0x0	ReverseY	Sets the Reverse Vertical. 0x0:OFF, 0x1:ON
0x0021 F13C	R/W	-	✓	0x0	TestPattern	0x0:OFF 0x1:Black 0x2:White 0x3:GreyA 0x4:GreyB 0x5:GreyHorizontalRamp 0x6:GreyScale 0x8:GreyVerticalRamp
0x0021 F59C	R/W	✓	✓	0x0	HighFramerateMode	Only BC040M model. 0x0:OFF,0x1:ON

Register address	Read Write	AC(*)	Memory save	Default	Register name	Description
0x0021 F29C	R/W	-	✓	0x0	DPCEnable	Sets the activation of DPC (Defective pixel correction) function. 0x0:OFF, 0x1:ON
0x0021 F2BC				0x0	DPCNumber	Sets the number of pixels to correct. 0x0 (0) ~ 0x100 (256)
0x0040 0000				0x0	DPCValue [X ₁]	Sets the X coordinate of defective pixel (1st) 0.4M:0x0(0)~0X2CF(719) 1.6M:0x0(0)~0X59F(1439)
0x0040 0004					DPCValue [Y ₁]	Sets the Y coordinate of defective pixel (1st) 0.4M:0x0(0)~0X21B(539) 1.6M:0x0(0)~0X437(1079)
0x0040 0008					DPCValue [X ₂]	Sets the X coordinate of defective pixel (2nd) 0.4M:0x0(0)~0X2CF(719) 1.6M:0x0(0)~0X59F(1439)
0x0040 000C					DPCValue [Y ₂]	Sets the Y coordinate of defective pixel (2nd) 0.4M:0x0(0)~0X21B(539) 1.6M:0x0(0)~0X437(1079)
↓					↓	↓
0x0040 07F8					DPCValue [X ₂₅₅]	Sets the X coordinate of defective pixel (255th) 0.4M:0x0(0)~0X2CF(719) 1.6M:0x0(0)~0X59F(1439)
0x0040 07FC					DPCValue [Y ₂₅₅]	Sets the Y coordinate of defective pixel (255th) 0.4M:0x0(0)~0X21B(539) 1.6M:0x0(0)~0X437(1079)
0x0021 F31C					R/W	-
0x0021 F33C	R/W	-	✓	0x1	SS TerminateAt	Sets the number of Tables to repeat the sequence. Min:0x1(1),Max:0x10(16)
0x0050 0040	R/W	-	✓	0x1	SS Entry 0	Sets the UserSet number to register to the first sequence. Min:0x1(1),Max:0xF(15)
0x0050 0044					SS Entry 1	
0x0050 0048					SS Entry 2	
0x0050 004C					SS Entry 3	
↓					↓	
0x0050 0078					SS Entry 15	

* 0.4M : BC040M, 1.6M : BC160M

* For registers other than those mentioned above, please refer to the IIDC2 Digital Camera Control Specification Ver.1.0.0.

*AC: In relation to Acquisition Command (address:0x002 0303C) : If [AC] marked “✓”, the register is set to following procedure.

Stop image output (0x0) → register setting / write command → Start image output (0x08)

R/W : Read / Write possible

R.O. : Read Only

W.O. : Write Only

N.A. : Not available

GenCP

The following address is possible to access by GenCP only.

Register address	Read Write	AC(*)	Memory save	Default	Register name
0x0000 0000	R.O.	-	-	GenCP Version	0x0001 0000(GenCP Ver.1.0)
0x0000 0004 0x0000 0043	R.O.	-	-	Manufacture Name	Toshiba-Teli
0x0000 0044 0x0000 0083	R.O.	-	-	Model Name	ex)BC040M
0x0000 0084 0x0000 00C3	R.O.	-	-	Family Name	BC-Series
0x0000 00C4 0x0000 0103	R.O.	-	-	Device Version	Camera version ex)4.0.2
0x0000 0104 0x0000 0143	R.O.	-	-	Manufacture Info	ex)0.4M 1/2.9 B/W
0x0000 0144 0x0000 0183	R.O.	-	-	Serial Number	ex)1000001
0x0000 0184 0x0000 0193	R/W	✓	Null string	User Define Name	User-programmable device identifier.
0x0000 01F0 0x0000 01F7	R.O.	-	0x0	Timestamp	Returns the latched 64-bit value of the timestamp counter.
0x0000 01F8	W.O.	-	-	Timestamp Latch	0x01: Latches the current timestamp counter into timestamp register.
0x0001 0000	R.O.	-	0x91	Supported Baudrates	9600/115200/921600 bps
0x0001 0004	R/W	-	0x0	Current Baudrate	Set baudrate. 0x0:auto recognition, 0x1:9600bps, 0x10:115200bps, 0x80:921600bps

* 0.4M : BC040M, 1.6M : BC160M

* For registers other than those mentioned above, please refer to the GenCP Standard Ver.1.0.

R/W : Read / Write possible
 R.O. : Read Only
 W.O. : Write Only
 N.A. : Not available

Legacy

The following address is possible to access by Legacy protocol only.

Register address	Read Write	AC(*)	Memory save	Default	Register name
0x00 0x0F	R.O.	-	-	Manufacture Name (ASCII)	Toshiba-Teli
0x10 0x1F	R.O.	-	-	Model Name (ASCII)	ex)BC040M
0x20 0x2F	R.O.	-	-	Family Name (ASCII)	BC-Series
0x30 0x3F	R.O.	-	-	Serial Number (ASCII)	ex)1000001
0x48 0x4F	R.O.	-	-	Camera version (ASCII)	ex)4.0.2
0x60 0x67	R.O.	-	-	Register map version (ASCII)	ex)01.01
0x6C	R/W	-	0x0	Memory bank	Sets the memory channel of UserSet. 0x0:Default,0x1:UserSet1 ~ 0xF:UserSet15
0x6D	W.O.	-	-	Memory save	0x1: Save user settings.
0x6E	W.O.	-	-	Memory load	0x1: Load user settings from selected memory bank.
0x70	R/W	✓	0x0	Setup	0xFFFFFFFF (-25%) ~ 0x100(+25%)
0x76	R/W	✓	0x0	Gain	0x0(0dB:default)~0xF0(24dB)
0x80	R.O.	-	0.4M:0x71 1.6M:0x1D	Frame rate	All pixels readout: Calculated from [CameralinkCLK / Cameralink Tap]. Scalable: Calculated from number of output lines.
0x82	R.O.	-	0.4M:0x2D0 1.6M:0x5A0	Horizontal resolution	All pixels readout: 0.4M:0x2D0 (720), 1.6M:0x5A0 (1440) Scalable: 0.4M:0x40 (64)~0x2D0 (720), 1.6M:0x40 (64)~0x5A0 (1440)
0x84	R.O.	-	0.4M:0x21C 1.6M:0x438	Vertical resolution	All pixels readout: 0.4M:0x21C (540), 1.6M:0x438 (1080) Scalable: 0.4M:0x40 (64)~0x21C (540), 1.6M:0x40 (64)~0x438 (1080)
0x87	R/W	✓	0x8	Output bit	0x8:8bit,0xA:10bit,0xC:12bit
0x88	R/W	✓	0x0	Test pattern	0x0:Off,0x1:Black,0x2:White,0x3:GreyA,0x4:GreyB, 0x5:GreyHorizontalRamp,0x6:GreyScale,0x8:GreyVerticalRamp
0x89	R/W	✓	0x1	Defective pixel correction	0x0:OFF, 0x1:ON
0x8A	R/W	✓	0x0	ReverseX	0x0:OFF,0x1:ON
0x8B	R/W	✓	0x0	ReverseY	0x0:OFF,0x1:ON
0x90	R/W	✓	0x0	Scan mode	0x0:Normal(default),0x1:Scalable
0x91	R/W	✓	0x0	Shutter mode	0x0:Normal shutter(default),0x1:Random trigger shutter
0x92	R/W	✓	0x0	Random trigger mode	0x0:FIX mode (default),0x1:pulse width mode
0x93	R/W	✓	0x0	Trigger polarity	0x0:Negative(default),0x1:Positive
0xA0	R/W	✓	0.4M:0x7D 1.6M:0x1F	Shutter speed denominator	Only ShortExposureMode=OFF 0x1(1)~0x107EF(67567)
0xA4	R/W	✓	0x1	Shutter speed numerator	Only ShortExposureMode=OFF 0x1(1)~0x10(16)

Register address	Read Write	AC(*)	Memory save	Default	Register name
0xC0	W.O.	-	-	Update scalable	0x1: Update registers related to scalable.
0xC4	R/W	✓	0x0	Offset Y	0.4M:0x0 (0)~0x1DC (476) OffsetY setting unit 2 0.4M:0x0 (0)~0x3F8 (1016) OffsetY setting unit 2
0xC8	R/W	✓	0.4M:0x21C 1.6M:0x438	Height	0.4M:0x40 (64)~0x21C (540) Height setting unit 2 1.6M:0x40 (64)~0x438 (1080) Height setting unit 2
0xCC	R/W	✓	0x0	Offset X	0.4M:0x0 (0)~0x290 (656) OffsetX setting unit 4 1.6M:0x0 (0)~0x560 (1376) OffsetX setting unit 4
0xD0	R/W	✓	0.4M:0x2D0 1.6M:0x5A0	Width	0.4M:0x40 (64)~0x2D0 (720) Width setting unit 4 1.6M:0x40 (64)~0x5A0 (1440) Width setting unit 4
0xD8	R/W	-	0x0	User area : address	Sets address of user area. 0x0~0xF(15)
0xDA	R/W	-	-	User area : data	Read /Write data to the specified by [User area : address]. The data length is specified by [User area : byte number].
0xDB	W.O.	-	-	User area : erase	0x1: erase all data in User area.
0xDC	R/W	-	0x10	User area : byte number	Sets the byte number of R/W length of user area. 0x1, 0x4, 0x8, 0x10(16)
0xF0	R/W	✓	0x0	SequentialShutter Enable	0x0:OFF,0x1:ON
0xF1	R/W	✓	0x1	SequentialShutter TerminateAt	Sets the number of Tables to repeat the sequence. 0x1 ~ 0x4
0xF3	R/W	✓	0x1	SequentialShutter Entry1	Sets the UserSet number to register to the first sequence. 0x1 ~ 0x4
0xF4	R/W	✓	0x1	SequentialShutter Entry2	Sets the UserSet number to register to the 2nd sequence. 0x1 ~ 0x4
0xF5	R/W	✓	0x1	SequentialShutter Entry3	Sets the UserSet number to register to the 3rd sequence. 0x1 ~ 0x4
0xF6	R/W	✓	0x1	SequentialShutter Entry4	Sets the UserSet number to register to the 4th sequence. 0x1 ~ 0x4
0xF7	W.O.	-	-	SequenceMemory Load	0x1: Load the parameters from the memory specified [Memory bank] register.
0xF8	W.O.	-	-	SequenceMemory Save	0x1: Save the parameters from the memory specified [Memory bank] register. If camera teruned off, the data in memory for SS is erased.

* 0.4M : BC040M, 1.6M : BC160M

R/W : Read / Write possible

R.O. : Read Only

W.O. : Write Only

N.A. : Not available

Functions

This section introduces standard functions. BG040M and BG160M provide following functions.

Category	Function	
TransportLayerControl	CameraLink Tap	CameraLink tap control
	CameraLink CLK	CameraLink clk control
	Baudrate	Baudrate control
DeviceControl	DeviceControl	Device information
ImageFormatControl	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
	TriggerControl	Trigger control
	ExposureTimeControl	Exposure time control
DigitalIOControl	LineInverter	Trigger polarity
AnalogControl	Gain	Gain control control
	BlackLevel	BlackLevel
	Gamma	Gamma correction
LUTControl	LUTControl	LUT control
UserSetControl	UserSetControl	Load / Save user setting
SequentialShutterControl	SequentialShutterControl	Sequential shutter control
DPCControl	DPCControl	Defect pixel correction control

TransportLayerControl

Registers of this category provides the function related to control the number of taps and clk frequency of CameraLink interface.

- **Registers**

- IIDC2 address**

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 105C	R/W	✓	0x1	CameraLink Tap	0x1:1Tap, 0x2:2Tap, 0x3:3Tap
0x0020 107C	R/W	✓	0x32	CameraLink CLK	0x25:37.5000MHz, 0x32:50.0000MHz, 0x53:83.0357MHz

- **Control procedure**

Before write to CameraLink Tap (0x0020 205C) or CameraLink CLK (0x0020 107C), stop image output (Write to 0x00 to AcquisitionCommand (0x0020 303C)). After change setting of CameraLink Tap / CameraLink CLK, restart image output (Write to 0x08 to AcquisitionCommand (0x0020 303C)).

Baudrate

If GenCP used, the baudrate is possible to change.

*In Legacy protocol used, the baudrate is fixed 9600 bps.

• Registers

GenCP protocol

Register address	Read Write	Memory save	Default	Register name	Description
0x0001 0000	R.O.	-	0x91	Supported Baudrates	9600/115200/921600 bps
0x0001 0004	R/W	-	0x0	Current Baudrate	Set baudrate. 0x0:auto recognition, 0x1:9600bps, 0x10:115200bps, 0x80:921600bps

• Control procedure

■ In the case of baudrate automatic recognition (CurrentBaudrate = 0x00)

The camera automatically recognizes the baudrate of the received command and responds with the same baudrate. The PC application can be accessed immediately at the desired baudrate without changing the camera settings. The baudrate supported for automatic recognition are 9,600 bps, 115,200 bps, and 921,600 bps.

■ In case of baudrate specification operation (CurrentBaudrate = 0x01 / 0x10 / 0x80)

The camera only receives commands at the specified baudrate.

Please refer to GenCP specification for switching sequence.

Legacy mode is disabled during the baudrate specification operation.

DeviceControl

Registers of this category provide various information of the camera.

The address is different by using of communication protocol.

• Registers

GenCP

Register address	Read Write	Memory save	Default	Register name	Description
0x0000 0004 0x0000 0043	R.O.	-	-	Manufacture Name	Toshiba-Teli
0x0000 0044 0x0000 0083	R.O.	-	-	Model Name	ex)BC040M
0x0000 0084 0x0000 00C3	R.O.	-	-	Family Name	BC-Series
0x0000 00C4 0x0000 0103	R.O.	-	-	Device Version	Camera version ex)4.0.2
0x0000 0104 0x0000 0143	R.O.	-	-	Manufacture Info	ex)0.4M 1/2.9 B/W
0x0000 0144 0x0000 0183	R.O.	-	-	Serial Number	ex)1000001
0x0000 0184 0x0000 0193	R/W	✓	Null string	User Define Name	User-programmable device identifier.

Legacy protocol

Register address	Read Write	Memory save	Default	Register name	Description
0x00 0x0F	R.O.	-	-	Manufacture Name (ASCII)	Toshiba-Teli
0x10 0x1F	R.O.	-	-	Model Name (ASCII)	ex)BC040M
0x20 0x2F	R.O.	-	-	Family Name (ASCII)	BC-Series
0x30 0x3F	R.O.	-	-	Serial Number (ASCII)	ex)1000001
0x48 0x4F	R.O.	-	-	Camera version (ASCII)	ex)4.0.2
0x60 0x67	R.O.	-	-	Register map version (ASCII)	ex)01.01
0xD8	R/W	-	0x0	User area : address	Sets address of user area. 0x0~0xF(15)
0xDA	R/W	-	-	User area : data	Read /Write data to the specified by [User area : address]. The data length is specified by [User area : byte number].
0xDB	W.O.	-	-	User area : erase	0x1: erase all data in User area.
0xDC	R/W	-	0x10	User area : byte number	Sets the byte number of R/W length of user area. 0x1, 0x4, 0x8, 0x10(16)

● Control procedure

■ ASCII format register

ManufactureName, ModelName, FamilyName, SerialNumber, Device Version, Register Map Version, ManufactureInfo are ASCII string registers.

The following is an example of ManufactureName.

GenCP

Register address	Value	Charactor
0x0000 0004	0x546F 7368	'Tosh'
0x0000 0008	0x6962 612D	'iba-'
0x0000 000C	0x5465 6C69	'Teli'
0x0000 0010	0x0000 0000	[Null] x 4

Legacy protocol

Register address	Value	Charactor
0x00	0x54	'T'
0x01	0x6F	'o'
0x02	0x73	's'
0x03	0x68	'h'
0x04	0x69	'i'
0x05	0x62	'b'
0x06	0x61	'a'
0x07	0x2D	'-'
0x08	0x54	'T'
0x09	0x65	'e'
0x0A	0x6C	'l'
0x0B	0x69	'i'
0x0C	0x00	[Null]
0x0D	0x00	[Null]
0x0E	0x00	[Null]
0x0F	0x00	[Null]

* In the case of GenCP, access must be performed in units of 4 bytes.

■ UserDefinedName

The camera's built-in user non-volatile memory can store up to 16 characters of user's arbitrary character string.

GenCP

Register address	Read Write	Memory save	Default	Register name	Description
0x0000 0184 0x0000 0193	R/W	✓	Null string	User Define Name	User-programmable device identifier.

It can write and read directly to the user nonvolatile memory.

After writing to this register, the camera saves the written data to non-volatile memory immediately.

* In the case of GenCP, access must be performed in units of 4 bytes.

* The area of 0x0000 0194 to 0x0000 01C3 is not saved.

Legacy protocol

Register address	Read Write	Memory save	Default	Register name	Description
0xD8	R/W	-	0x0	User area : address	Sets address of user area. 0x0~0xF(15)

Specify the access start address of the user nonvolatile memory.

If the user area / byte count register is other than 1, this register must be a multiple of four.

Register address	Read Write	Memory save	Default	Register name	Description
0xDA	R/W	-	-	User area : data	Read /Write data to the specified by [User area : address]. The data length is specified by [User area : byte number].

Data is written to or read from the user nonvolatile memory specified by the user-specified address register.

Register address	Read Write	Memory save	Default	Register name	Description
0xDB	W.O.	-	0x0	User area : address	Sets address of user area. 0x0~0xF(15)

Erase all user non-volatile memory.

Register address	Read Write	Memory save	Default	Register name	Description
0xDC	R/W	-	0x10	User area : byte number	Sets the byte number of R/W length of user area. 0x1, 0x4, 0x8, 0x10(16)

Specify the number of bytes to write / read in batch in the user area / data register.

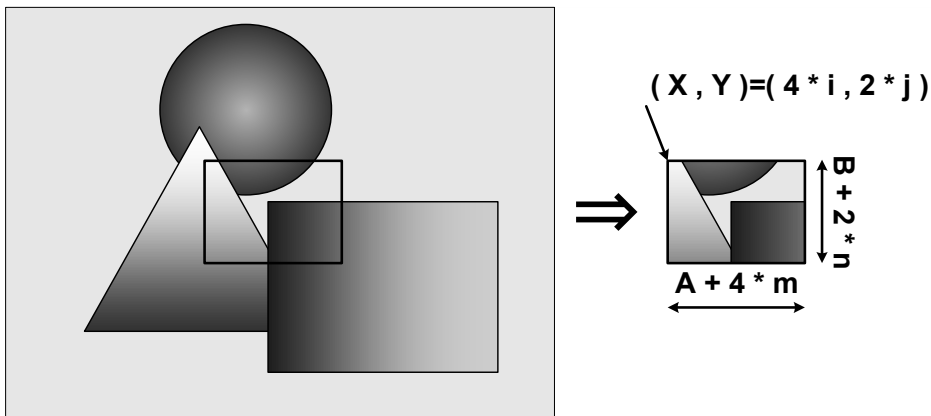
Scalable

Scalable function reads out the region of interest (ROI) of the sensor.

If height size is set small, it is possible to increase the frame rate.

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.



Model Name	BC040M	BC160M
Width/OffsetX setting unit	4	4
Height/OffsetY setting unit	2	2
Minimum unit size (H)×(V)	64×64	64×64
Maximum unit size (H)×(V)	720×540	1440×1080

• Registers

GenCP address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 005C	R.O.	-	-	0x0	ApplyImageFormat
0x0020 2094	R/W	✓	0x0	OffsetX	Scalable: Horizontal offset (in pixels) from the origin to the region of interest 0.4M:0x0 (0) ~ 0x290 (656) OffsetX setting unit: 4 1.6M:0x0 (0) ~ 0x560 (1376) OffsetX setting unit: 4
0x0020 2098	R/W	✓	0.4M:0x2D0 1.6M:0x5A0	Width	Scalable: Width 0.4M:0x40 (64) ~ 0x2D0 (720) Width setting unit: 4 1.6M:0x40 (64) ~ 0x5A0 (1440) Width setting unit: 4
0x0020 209C	R/W	✓	0x0	OffsetY	Scalable: Vertical offset (in pixels) from the origin to the region of interest. 0.4M:0x0 (0) ~ 0x1DC (476) OffsetY setting unit: 2 1.6M:0x0 (0) ~ 0x3F8 (1016) OffsetY setting unit: 2
0x0020 20A0	R/W	✓	0.4M:0x21C 1.6M:0x438	Height	Scalable: Height 0.4M:0x40 (64) ~ 0x21C (540) Height setting unit: 2 1.6M:0x40 (64) ~ 0x438 (1080) Height setting unit: 2

* 0.4M : BC040M, 1.6M : BC160M

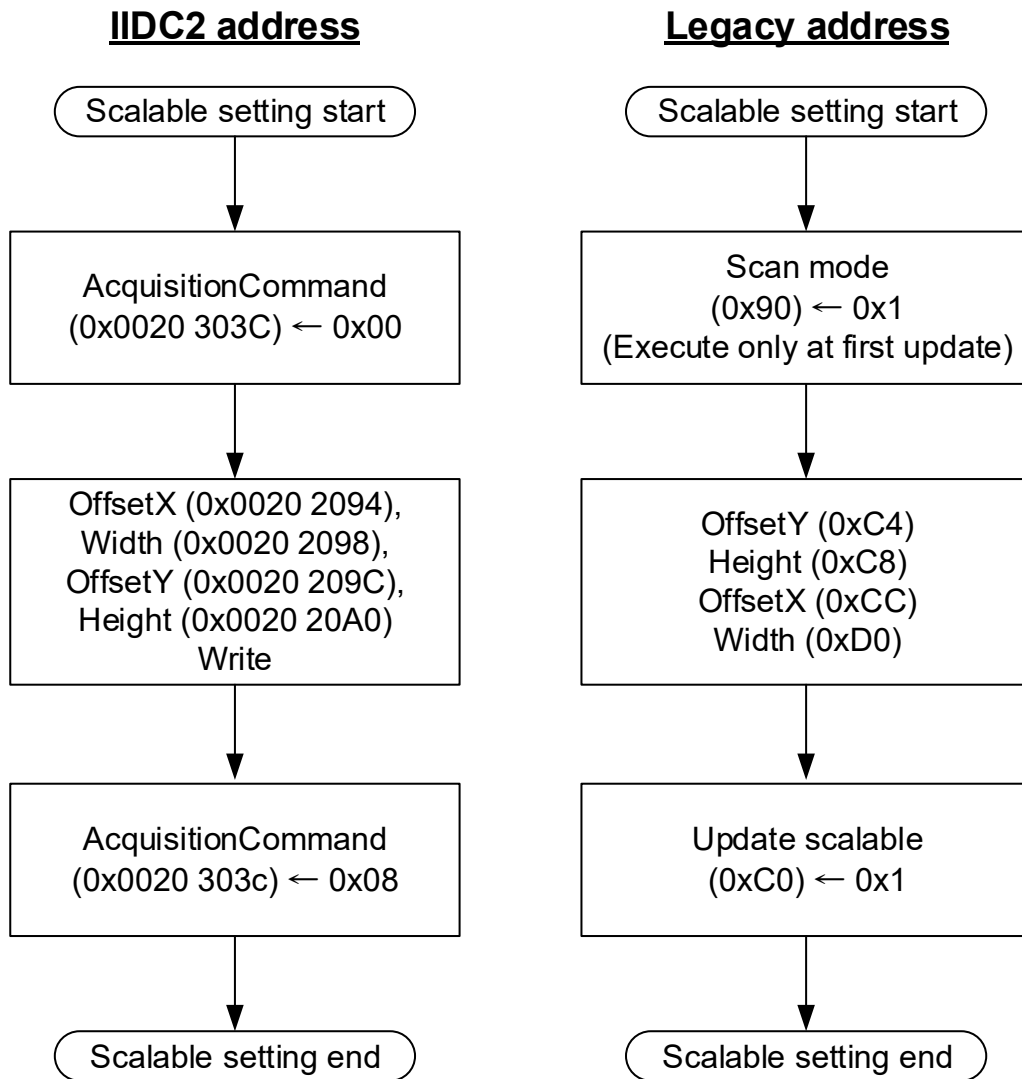
Legacy address

Register address	Read Write	Memory save	Default	Register name	Description
0x82	R.O.	-	0.4M:0x2D0 1.6M:0x5A0	Horizontal resolution	All pixels readout: 0.4M:0x2D0 (720), 1.6M:0x5A0 (1440) Scalable: 0.4M:0x40 (64)~0x2D0 (720), 1.6M:0x40 (64)~0x5A0 (1440)
0x84	R.O.	-	0.4M:0x21C 1.6M:0x438	Vertical resolution	All pixels readout: 0.4M:0x21C (540), 1.6M:0x438 (1080) Scalable: 0.4M:0x40 (64)~0x21C (540), 1.6M:0x40 (64)~0x438 (1080)
0x90	R/W	✓	0x0	Scan mode	0x0:Normal(default),0x1:Scalable
0xC0	W.O.	-	-	Update scalable	0x1: Update registers related to scalable.
0xC4	R/W	✓	0x0	Offset Y	0.4M:0x0 (0)~0x1DC (476) OffsetY setting unit 2 0.4M:0x0 (0)~0x3F8 (1016) OffsetY setting unit 2
0xC8	R/W	✓	0.4M:0x21C 1.6M:0x438	Height	0.4M:0x40 (64)~0x21C (540) Height setting unit 2 1.6M:0x40 (64)~0x438 (1080) Height setting unit 2
0xCC	R/W	✓	0x0	Offset X	0.4M:0x0 (0)~0x290 (656) OffsetX setting unit 4 1.6M:0x0 (0)~0x560 (1376) OffsetX setting unit 4
0xD0	R/W	✓	0.4M:0x2D0 1.6M:0x5A0	Width	0.4M:0x40 (64)~0x2D0 (720) Width setting unit 4 1.6M:0x40 (64)~0x5A0 (1440) Width setting unit 4

* 0.4M : BC040M, 1.6M : BC160M

● **Control procedure**

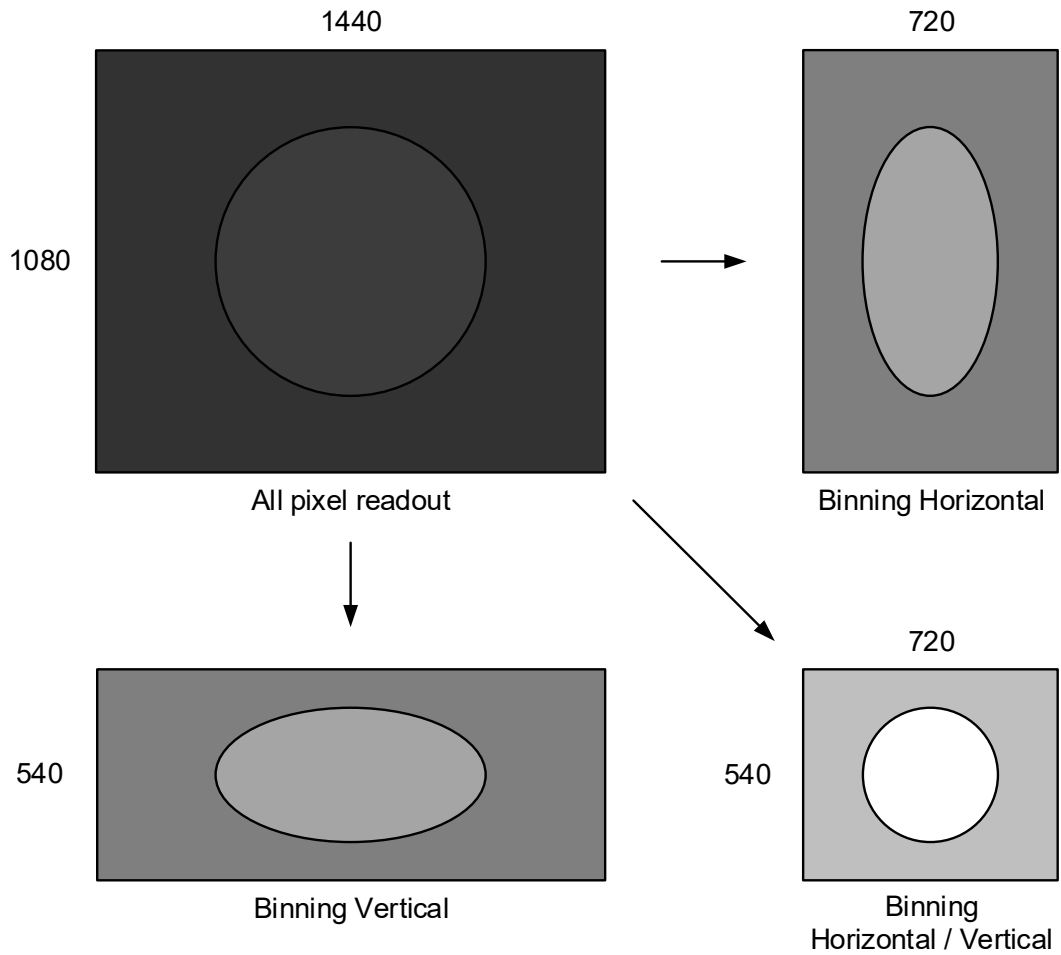
The control procedure of scalable differs in the IIDC2 address and Legacy address. Each flowchart is shown below.



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.



Binning operation (e.g. BC160M pixel, 2x2 binning)

● Framerate in each output format

■ Mono8

Mono8			BC040M			BC160M		
Horizontal	Vertical	CLK	37.5MHz	50MHz	83MHz	37.5MHz	50MHz	83MHz
		TAP						
1	1	1tap	approx.86fps	approx.115fps	approx.191fps	approx.22fps	approx.30fps	approx.50fps
		2tap	approx.170fps	approx.226fps	approx.377fps	approx.45fps	approx.60fps	approx.99fps
		3tap	approx.250fps	approx.333fps	approx.436fps	approx.66fps	approx.89fps	approx.148fps
1	2	1tap	approx.86fps	approx.115fps	approx.191fps	approx.43fps	approx.57fps	approx.96fps
		2tap	approx.170fps	approx.226fps	approx.377fps	approx.86fps	approx.114fps	approx.190fps
		3tap	approx.250fps	approx.333fps	approx.436fps	approx.127fps	approx.170fps	approx.283fps
1	4	1tap	Incompatible			approx.43fps	approx.57fps	approx.96fps
		2tap				approx.86fps	approx.114fps	approx.190fps
		3tap				approx.127fps	approx.170fps	approx.283fps
2	1	1tap	approx.170fps	approx.226fps	approx.377fps	approx.45fps	approx.60fps	approx.99fps
		2tap	approx.328fps	approx.436fps	approx.436fps	approx.88fps	approx.117fps	approx.196fps
		3tap	approx.436fps	approx.436fps	approx.436fps	approx.130fps	approx.173fps	approx.227fps
2	2	1tap	approx.170fps	approx.226fps	approx.377fps	approx.86fps	approx.114fps	approx.190fps
		2tap	approx.328fps	approx.436fps	approx.436fps	approx.168fps	approx.225fps	approx.374fps
		3tap	approx.436fps	approx.436fps	approx.436fps	approx.248fps	approx.331fps	approx.502fps
2	4	1tap	Incompatible			approx.86fps	approx.114fps	approx.190fps
		2tap				approx.168fps	approx.225fps	approx.374fps
		3tap				approx.248fps	approx.331fps	approx.502fps
4	1	1tap	Incompatible			approx.88fps	approx.117fps	approx.196fps
		2tap				approx.170fps	approx.227fps	approx.227fps
		3tap				approx.227fps	approx.227fps	approx.227fps
4	2	1tap	Incompatible			approx.168fps	approx.225fps	approx.374fps
		2tap				approx.326fps	approx.433fps	approx.502fps
		3tap				approx.472fps	approx.502fps	approx.502fps
4	4	1tap	Incompatible			approx.168fps	approx.225fps	approx.374fps
		2tap				approx.326fps	approx.433fps	approx.502fps
		3tap				approx.472fps	approx.502fps	approx.502fps

■ Mono10/Mono12

Mono10/Mono12			BC040M			BC160M		
Horizontal	Vertical	CLK	37.5MHz	50MHz	83MHz	37.5MHz	50MHz	83MHz
		TAP						
1	1	1tap	approx.86fps	approx.115fps	approx.191fps	approx.22fps	approx.30fps	approx.50fps
		2tap	approx.170fps	approx.226fps	approx.320fps	approx.45fps	approx.60fps	approx.99fps
		3tap	Incompatible			Incompatible		
1	2	1tap	approx.86fps	approx.115fps	approx.191fps	approx.43fps	approx.57fps	approx.96fps
		2tap	approx.170fps	approx.226fps	approx.320fps	approx.86fps	approx.114fps	approx.190fps
		3tap	Incompatible			Incompatible		
1	4	1tap	Incompatible			approx.43fps	approx.57fps	approx.96fps
		2tap	Incompatible			approx.86fps	approx.114fps	approx.190fps
		3tap	Incompatible			Incompatible		
2	1	1tap	approx.170fps	approx.226fps	approx.320fps	approx.45fps	approx.60fps	approx.99fps
		2tap	approx.320fps	approx.320fps	approx.320fps	approx.88fps	approx.117fps	approx.196fps
		3tap	Incompatible			Incompatible		
2	2	1tap	approx.170fps	approx.226fps	approx.320fps	approx.86fps	approx.114fps	approx.190fps
		2tap	approx.328fps	approx.320fps	approx.320fps	approx.168fps	approx.225fps	approx.317fps
		3tap	Incompatible			Incompatible		
2	4	1tap	Incompatible			approx.86fps	approx.114fps	approx.190fps
		2tap	Incompatible			approx.168fps	approx.225fps	approx.317fps
		3tap	Incompatible			Incompatible		
4	1	1tap	Incompatible			approx.88fps	approx.117fps	approx.166fps
		2tap	Incompatible			approx.166fps	approx.116fps	approx.166fps
		3tap	Incompatible			Incompatible		
4	2	1tap	Incompatible			approx.168fps	approx.225fps	approx.317fps
		2tap	Incompatible			approx.317fps	approx.317fps	approx.317fps
		3tap	Incompatible			Incompatible		
4	4	1tap	Incompatible			approx.168fps	approx.225fps	approx.317fps
		2tap	Incompatible			approx.317fps	approx.317fps	approx.317fps
		3tap	Incompatible			Incompatible		

● **Registers**

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 213C	R/W	✓	0x1	Binning Horizontal	0.4M:Min:0x1,Max:0x2 1.6M:Min:0x1,Max:0x4
0x0020 215C	R/W	✓	0x1	Binning Vertical	0.4M:Min:0x1,Max:0x2 1.6M:Min:0x1,Max:0x4

* 0.4M : BC040M, 1.6M : BC160M

● **Control procedure**

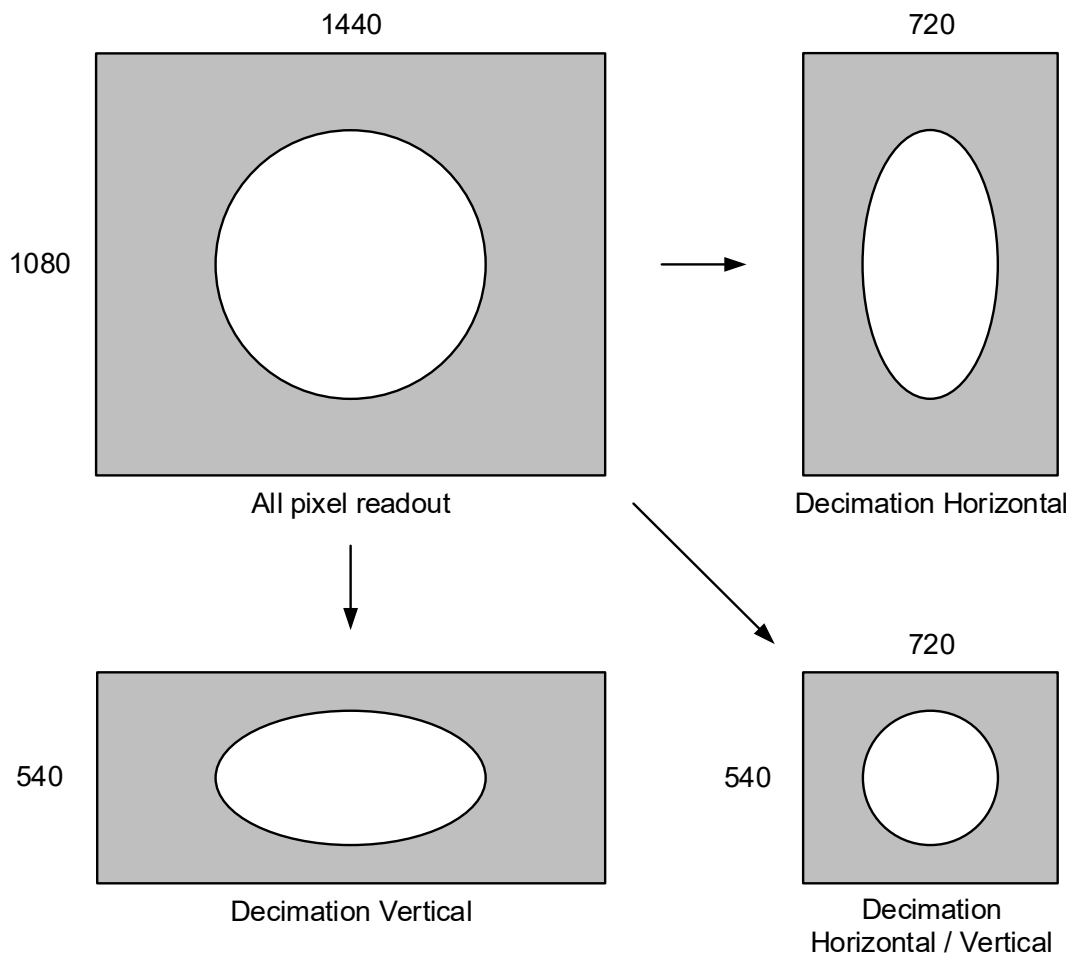
Before write to Binning Horizontal (0x0020 213C) or Binning Vertical (0x0020 215C), stop image output (Write to 0x00 to AcquisitionCommand (0x0020 303C)). After change setting of Binning Horizontal / Binning Vertical, restart image output (Write to 0x08 to AcquisitionCommand (0x0020 303C)).

● **Note**

- Binning is disabled when the camera is running in Decimation mode.
- Binning Horizontal / Vertical = 3 is not available.

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.



Decimation operation (e.g. BG160M, 2x2 decimation)

● Framerate in each output format

■ Mono8

Mono8			BC040M			BC160M		
Horizontal	Vertical	CLK	37.5MHz	50MHz	83MHz	37.5MHz	50MHz	83MHz
		TAP						
1	1	1tap	approx.86fps	approx.115fps	approx.191fps	approx.22fps	approx.30fps	approx.50fps
		2tap	approx.170fps	approx.226fps	approx.377fps	approx.45fps	approx.60fps	approx.99fps
		3tap	approx.250fps	approx.333fps	approx.436fps	approx.66fps	approx.89fps	approx.148fps
1	2	1tap	approx.86fps	approx.115fps	approx.191fps	approx.43fps	approx.30fps	approx.50fps
		2tap	approx.170fps	approx.226fps	approx.377fps	approx.45fps	approx.60fps	approx.99fps
		3tap	approx.250fps	approx.333fps	approx.436fps	approx.66fps	approx.89fps	approx.148fps
1	4	1tap	Incompatible			approx.22fps	approx.30fps	approx.50fps
		2tap				approx.45fps	approx.60fps	approx.99fps
		3tap				approx.66fps	approx.89fps	approx.148fps
2	1	1tap	approx.170fps	approx.226fps	approx.377fps	approx.45fps	approx.60fps	approx.99fps
		2tap	approx.328fps	approx.436fps	approx.436fps	approx.88fps	approx.117fps	approx.196fps
		3tap	approx.436fps	approx.436fps	approx.436fps	approx.130fps	approx.173fps	approx.227fps
2	2	1tap	approx.170fps	approx.226fps	approx.377fps	approx.86fps	approx.114fps	approx.190fps
		2tap	approx.328fps	approx.436fps	approx.436fps	approx.168fps	approx.225fps	approx.374fps
		3tap	approx.436fps	approx.436fps	approx.436fps	approx.248fps	approx.331fps	approx.502fps
2	4	1tap	Incompatible			approx.86fps	approx.114fps	approx.190fps
		2tap				approx.168fps	approx.225fps	approx.374fps
		3tap				approx.248fps	approx.331fps	approx.502fps
4	1	1tap	Incompatible			approx.88fps	approx.117fps	approx.196fps
		2tap				approx.170fps	approx.227fps	approx.227fps
		3tap				approx.227fps	approx.227fps	approx.227fps
4	2	1tap	Incompatible			approx.168fps	approx.225fps	approx.374fps
		2tap				approx.326fps	approx.433fps	approx.502fps
		3tap				approx.472fps	approx.502fps	approx.502fps
4	4	1tap	Incompatible			approx.168fps	approx.225fps	approx.374fps
		2tap				approx.326fps	approx.433fps	approx.502fps
		3tap				approx.472fps	approx.502fps	approx.502fps

■ Mono10/Mono12

Mono10/Mono12			BC040M			BC160M		
Horizontal	Vertical	CLK	37.5MHz	50MHz	83MHz	37.5MHz	50MHz	83MHz
		TAP						
1	1	1tap	approx.86fps	approx.115fps	approx.191fps	approx.22fps	approx.30fps	approx.50fps
		2tap	approx.170fps	approx.226fps	approx.377fps	approx.45fps	approx.60fps	approx.99fps
		3tap	Incompatible			Incompatible		
1	2	1tap	approx.86fps	approx.115fps	approx.191fps	approx.22fps	approx.30fps	approx.50fps
		2tap	approx.170fps	approx.226fps	approx.377fps	approx.45fps	approx.60fps	approx.99fps
		3tap	Incompatible			Incompatible		
1	4	1tap	Incompatible			approx.22fps	approx.30fps	approx.50fps
		2tap	Incompatible			approx.45fps	approx.60fps	approx.99fps
		3tap	Incompatible			Incompatible		
2	1	1tap	approx.170fps	approx.226fps	approx.320fps	approx.45fps	approx.60fps	approx.99fps
		2tap	approx.320fps	approx.320fps	approx.320fps	approx.88fps	approx.117fps	approx.166fps
		3tap	Incompatible			Incompatible		
2	2	1tap	approx.170fps	approx.226fps	approx.320fps	approx.86fps	approx.114fps	approx.190fps
		2tap	approx.328fps	approx.320fps	approx.320fps	approx.168fps	approx.225fps	approx.317fps
		3tap	Incompatible			Incompatible		
2	4	1tap	Incompatible			approx.86fps	approx.114fps	approx.190fps
		2tap	Incompatible			approx.168fps	approx.225fps	approx.317fps
		3tap	Incompatible			Incompatible		
4	1	1tap	Incompatible			approx.88fps	approx.117fps	approx.166fps
		2tap	Incompatible			approx.166fps	approx.166fps	approx.166fps
		3tap	Incompatible			Incompatible		
4	2	1tap	Incompatible			approx.168fps	approx.225fps	approx.317fps
		2tap	Incompatible			approx.317fps	approx.317fps	approx.317fps
		3tap	Incompatible			Incompatible		
4	4	1tap	Incompatible			approx.168fps	approx.225fps	approx.317fps
		2tap	Incompatible			approx.317fps	approx.317fps	approx.317fps
		3tap	Incompatible			Incompatible		

● **Registers**

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 213C	R/W	✓	0x1	Decimation Horizontal	0.4M:Min:0x1,Max:0x2 1.6M:Min:0x1,Max:0x4
0x0020 215C	R/W	✓	0x1	Decimation Vertical	0.4M:Min:0x1,Max:0x2 1.6M:Min:0x1,Max:0x4

* 0.4M : BC040M, 1.6M : BC160M

● **Control procedure**

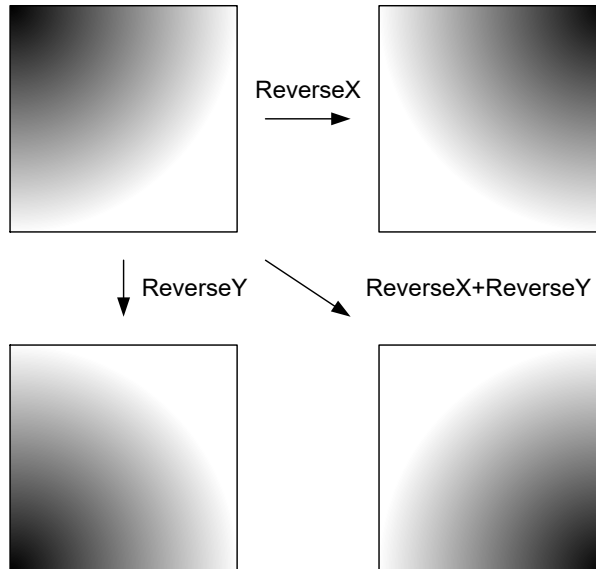
Before write to Decimation Horizontal (0x0020 217C) or Decimation Vertical (0x0020 219C), stop image output (Write to 0x00 to AcquisitionCommand (0x0020 303C)). After change setting of Decimation Horizontal / Decimation Vertical, restart image output (Write to 0x08 to AcquisitionCommand (0x0020 303C)).

● **Note**

- Decimation is disabled when the camera is running in Binning mode.
- Decimation Horizontal / Vertical = 3 is not available.

Reverse

Reverse function flips image in horizontal and/or vertical direction.



• Register

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0021 21B0	R/W	✓	0x0	ReverseX	Sets the Reverse Horizontal. 0x0:OFF, 0x1:ON
0x0021 21D0	R/W	✓	0x0	ReverseY	Sets the Reverse Vertical. 0x0:OFF, 0x1:ON

Legacy address

Register address	Read Write	Memory save	Default	Register name	Description
0x8A	R/W	✓	0x0	ReverseX	0x0:OFF,0x1:ON
0x8B	R/W	✓	0x0	ReverseY	0x0:OFF,0x1:ON

• Control procedure

IIDC2 address

Before write to ReverseX (0x0021 F1D0) or ReverseY (0x0021 F1F0), stop image output (Write to 0x00 to AcquisitionCommand (0x0020 303C)). After change setting of ReverseX / ReverseY, restart image output (Write to 0x08 to AcquisitionCommand (0x0020 303C)).

Legacy address

The change is applied immediately by write to ReverseX register (0x8A) or ReverseY register (0x8B).

PixelFormat

Select a pixel format of image stream data.

- **Register**

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 20DC	R.O.	-	0x0	PixelCoding	0x0:Mono
0x0020 20FC	R/W	✓	0x8	PixelSize	0x8:Bpp8, 0xA:Bpp10, 0xC:Bpp12

Legacy address

Register address	Read Write	Memory save	Default	Register name	Description
0x87	R/W	✓	0x8	Output bit	0x8:8bit, 0xA:10bit, 0xC:12bit

- **Control procedure**

IIDC2 address

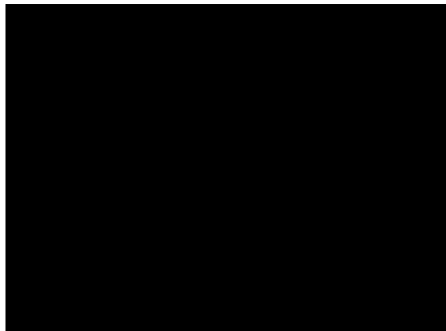
Before write to PixelSize (0x0020 20FC), stop image output (Write to 0x00 to AcquisitionCommand (0x0020 303C)). After change setting of PixelSize, restart image output (Write to 0x08 to AcquisitionCommand (0x0020 303C)).

Legacy address

The change is applied immediately by write to Output bit register (0x87).

TestPattern

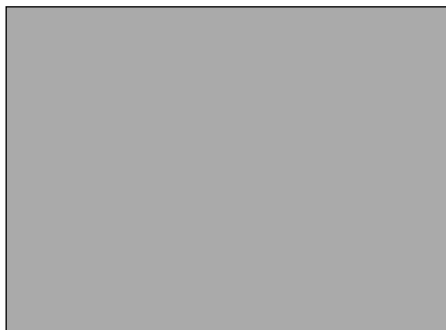
Camera supports test pattern data output. Following test patterns are available;



Black = All pixels 0 LSB @ 8-bit



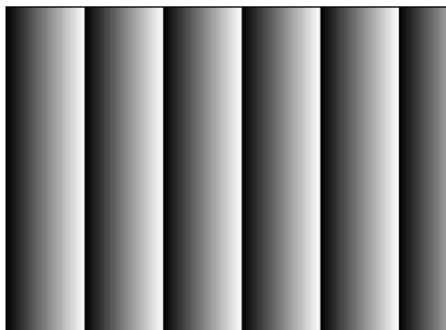
White = All pixels 255 LSB @ 8-bit



Grey A = All pixels 170 LSB @ 8-bit



Grey B = All pixels 85 LSB @ 8-bit



Horizontal ramp waveform



Vertical ramp waveform



Grey scale

Test pattern (e.g. BC160M @Mono8)

• Register

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0021 F13C	R/W	✓	0x0	Test pattern	0x0:OFF 0x1:Black 0x2:White 0x3:GreyA 0x4:GreyB 0x5:GreyHorizontalRamp 0x6:GreyScale 0x8:GreyVerticalRamp

Legacy address

Register address	Read Write	Memory save	Default	Register name	Description
0x88	R/W	✓	0x0	Test pattern	0x0:OFF 0x1:Black 0x2:White 0x3:GreyA 0x4:GreyB 0x5:GreyHorizontalRamp 0x6:GreyScale 0x8:GreyVerticalRamp

AcquisitionControl

AcquisitionControl features are related to image acquisition.

If you need to stop the image output when changing the settings of various registers, you need to issue the abort image output or stop image output command.

There are some registers that require camera to stop image output to change values.

Acquisition frame rate is variable. Maximum acquisition frame rate depends on camera operation mode. (scalable, binning, decimation, CameraLink Tap, CameraLink CLK, etc.)

BC040M has HighFramerateMode. You can improve the frame rate by using HighFramerateMode.

● Register

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 303C	R/W	-	0x8	Acquisition Command	0x0: Abort image output. 0x1: Stop image output. 0x8: Start image output.
0x0020 30A8	R/W	✓	0x0	Acquisition FrameRateControl	0x0:NoSpecify Take priority ExposureTime setting. 0x1:Manual Take priority AcquisitionFrameRate setting.
0x0020 30BC	R/W	✓	0.4M:0x736F31 1.6M:0x1E517F	Acquisition FrameRate	Framerate *AcquisitionFrameRate / 65536[fps]
0x0020 30C8	R/W	✓	0x0	Acquisition FrameIntervalControl	0x0:NoSpecify Take priority ExposureTime setting. 0x1:Manual Take priority AcquisitionFrameRate setting.
0x0020 30DC	R/W	✓	0.4M:0x4F4FB 1.6M:0x12DF8A	Acquisition FrameInterval	Interval *AcquisitionFrameInterval / 37500000[sec]
0x0021 F59C	R/W	✓	0x0	HighFramerateMode	Only BC040M model. 0x0:OFF,0x1:ON

* 0.4M : BC040M, 1.6M : BC160M

Legacy アドレス

Register address	Read Write	Memory save	Default	Register name	Description
0x80	R.O.	-	0.4M:0x71 1.6M:0x1D	Frame rate	All pixels readout: Calculated from [CameralinkCLK / Cameralink Tap]. Scalable: Calculated from number of ouput lines.

* 0.4M : BC040M, 1.6M : BC160M

- **Control procedure**

- HighFramerateMode

- IIDC2 address**

- Before write to HighFramerateMode (0x0021 F59C), stop image output (Write to 0x00 to AcquisitionCommand (0x0020 303C)). After change setting of PixelSize, restart image output (Write to 0x08 to AcquisitionCommand (0x0020 303C)).

Notes on HighFramerateMode:

- If you use HighFramerateMode, improves frame rate and sensitivity by about 4 times, but 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 HighFramerateMode, I ask you to have final image quality checked with your environment.

TriggerControl

TriggerControl features are related to image acquisition using trigger.

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 CameraLink CC1 (HardwareTrigger)
2. Trigger command via software command (SoftwareTrigger)

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

Operation Mode		
Trigger Mode	Synchronization	Exposure Control
Normal Shutter mode	Free run	'ExposureTime' register control
Random Trigger Shutter mode	HardwareTrigger	-Fix mode:TriggerSequence0 'ExposureTime' register control
		-Level mode:TriggerSequence1 Trigger pulse width control
	SoftwareTrigger	-Fix mode:TriggerSequence0 'ExposureTime' register control

* The camera operation not mentioned above is not supported.

● **Normal Shutter / TriggerMode = OFF**

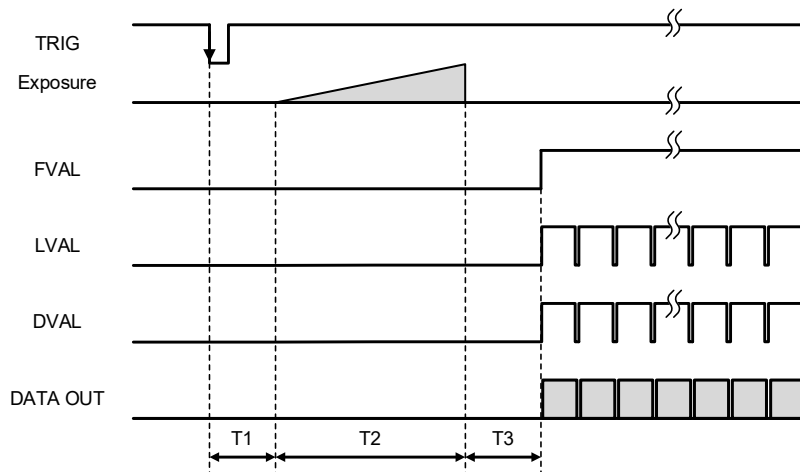
In this mode, the electronic shutter can be handled by the value in the register.
 If shutter speed is longer than readout time, the frame rate changes according to shutter speed.

● **Random Trigger Shutter / TriggerMode = ON**

An image is captured at the desired timing using trigger signal input.
 External trigger (Hardware trigger) signal from CameraLink I/F (CC1) and software trigger from control command are available (Fix mode). Operation point of HardwareTrigger is at the edge of trigger signal, and active edge polarity is able to change by register setting (High active / Low active).
 Note that Random Trigger Shutter will cause a delay between trigger signal and start of exposure.

- **Fix mode (TriggerSequence0)**

The exposure time is determined by Exposure Time setting.



PixelFormat	HighFramerateMode	T1 [μs]		T3 [μs]	
		ShortExposureMode			
		OFF	ON	OFF	ON
Mono8	OFF	12.4	28.6	565.7	566.7
	ON	10.6	26.0	565.1	566.0
Mono10/Mono12	OFF/ON	16.7	34.3	566.4	567.3

* T1 and T3 are typical value

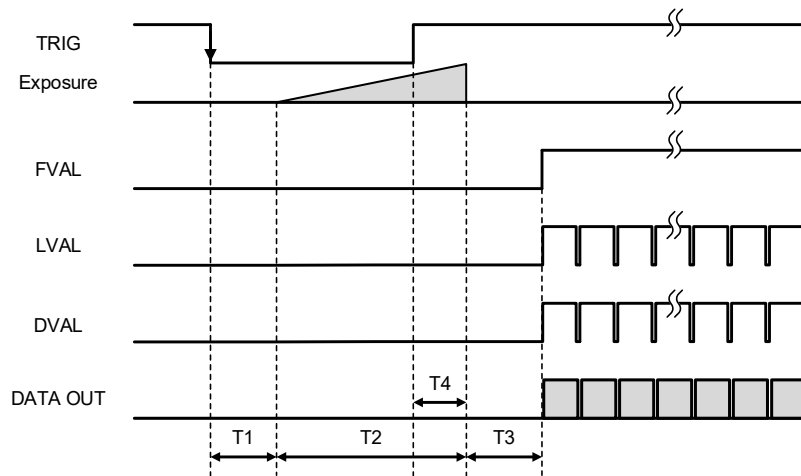
* T2 = electronic shutter setting value

- Level mode (TriggerSequence1)

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

The pulse width should be 14.8 μs or more.

It is not supported when the ShortExposureMode is enable (ON).



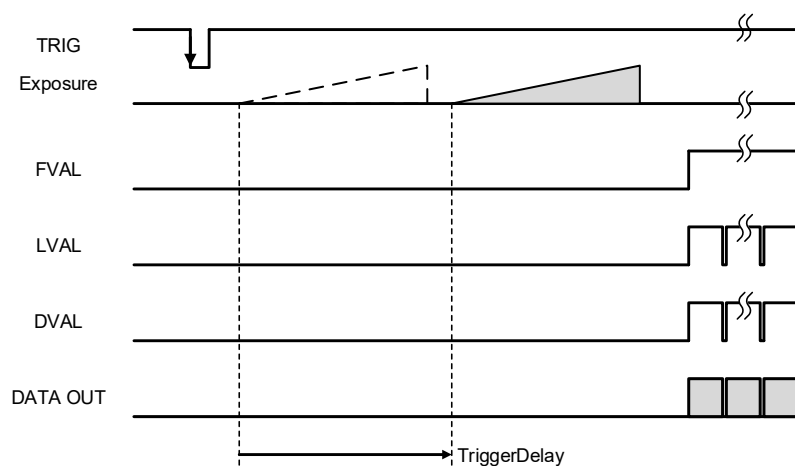
PixelFormat	HighFramerateMode	T1 [μs]	T3 [μs]	T4 [μs]
Mono8	OFF	12.4	565.7	26.8
	ON	10.6	565.1	24.9
Mono10/Mono12	OFF/ON	16.7	566.4	31.0

* T1, T3 and T4 are typical value

* T2 = pulse width setting value

- Trigger Delay

The delay time from the input of the trigger signal to the start of exposure can be set.



For details of Random Trigger Shutter operation, please refer to 'Timing' section in 'Specification'.

● Register

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 703C	R/W	✓	0x0	TriggerMode	0x0:Normal shutter mode 0x1:Random trigger Shutter mode
0x0020 705C	R/W	✓	0x0	TriggerSequence	0x0:Fix mode, 0x1:Level mode
0x0020 707C	R/W	✓	0x0	TriggerSource	Selects a trigger source of random trigger shutter. 0x0:Line0(CC1),0x40:Software
0x0020 70BC	R/W	✓	0x0	TriggerDelay	Sets the delay from trigger detection to exposure start. *TriggerDelay / 37500000 [sec] 0x0(0sec) ~ 0x47868C0(2sec)
0x0020 70DC	W.O.	-	-	SoftwareTrigger	0x8:Execute SoftwareTrigger

Legacy address

Register address	Read Write	Memory save	Default	Register name	Description
0x91	R/W	✓	0x0	Shutter mode	0x0:Normal shutter(default), 0x1:Random trigger shutter
0x92	R/W	✓	0x0	Random trigger mode	0x0:FIX mode (default), 0x1:pulse width mode
0x93	R/W	✓	0x0	Trigger polarity	0x0:Negative(default), 0x1:Positive

Notes on Random Trigger Shutter mode:

- 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.

● Note

- In SoftwareTrigger operation, the delay time from 'TriggerSoftware' to exposure is not guaranteed.
- TriggerDelay is applied to both of HardwareTrigger and SoftwareTrigger.

ExposureTimeControl

ExposureTime controls the duration where the image sensor is exposed to light.

This camera series provides three kinds of exposure time control mode.

It also has ShotrExposureMode which can set high-speed exposure time at the time of MANUAL setting.

- NoSpecify : The exposure time is determined by 'AcquisitionFrameRate' register setting value
- Manual : The exposure time is determined by 'ExposureTime' register setting value.

● Register

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 4028	R/W	✓	0x1	ExposureTimeControl	0x0:NoSpecify Take priority AcquisitionFrameRate setting. 0x1:Manual Take priority ExposureTime setting.
0x0020 403C	R/W	✓	0.4M:0x493E0 1.6M:0x124F80	ExposureTime	ExposureTime ShortExposureMode=OFF: *ExposureTime / 37500000 [sec] 0x22B (14.8usec) ~ 0x23C34600 (16sec) ShortExposureMode=ON: *ExposureTime * 53 / 983850009 [sec] 0x14 (1.1usec) ~ 0xF7 (13.3usec)
0x0020 439C	R/W	✓	0x0	ShortExposureMode	0x0:OFF, 0x1:ON

* 0.4M : BC040M, 1.6M : BC160M

Legacy address

Register address	Read Write	Memory save	Default	Register name	Description
0xA0	R/W	✓	0.4M:0x7D 1.6M:0x1F	Shutter speed denominator	Only ShortExposureMode=OFF 0x1(1)~0x107EF(67567)
0xA4	R/W	✓	0x1	Shutter speed numerator	Only ShortExposureMode=OFF 0x1(1)~0x10(16)

* 0.4M : BC040M, 1.6M : BC160M

● **Control procedure**

■ **Setting of Exposure control**

Set a value for the 'ExposureTimeControl' register.

ExposureTimeControl	Function
NoSpecify	Take priority AcquisitionFrameRate setting
Manual (*)	Take priority ExposureTime setting

* initial factory setting

■ **Control of ExposureTime (MANUAL)**

IIDC2 address

Specify the ExposureTime with an integer value. ExposureTime is calculated by the following formula:

ShortExposureMode = OFF (14.8μsec ~ 16sec)

ExposureTime (Absolute value) = ExposureTime / 37,500,000 [sec]

ShortExposureMode = ON (1.08μsec ~ 13.31μsec)

ExposureTime (Absolute value) = ExposureTime * 53 / 983,850,009 [sec]

Legacy address

Can be set only when ShortExposureMode = OFF

Specify the ExposureTime with a rational number. ExposureTime is calculated by the following formula:

ExposureTime (Absolute value) = Shutter speed numerator / Shutter speed denominator [sec]

■ **ShortExposureMode**

IIDC2 address

Before write to ShortExposureMode (0x0020 439C), stop image output (Write to 0x00 to AcquisitionCommand (0x0020 303C)). After change setting of PixelSize, restart image output (Write to 0x08 to AcquisitionCommand (0x0020 303C)).

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, I 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 features.

The polarity of the trigger signal is able to switch by the register setting.

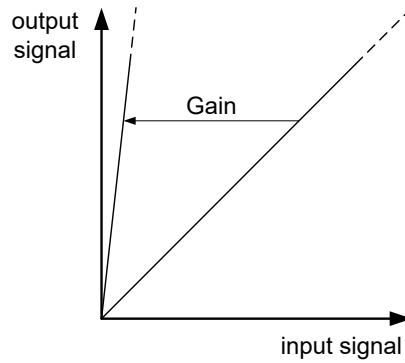
- **Register**

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 9050	R/W	✓	0x0	LineInverterAll	Selects the inversion of Line0(CC1). 0x0:Negative,0x1:Positive
0x0020 9070	R.O.	-	0x1	LineStatusAll	Returns the current status of Line0(CC1).

Gain

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



• Register

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 407C	R/W	✓	0x0	Gain	0x0 (0dB) ~ 0xF0 (24dB)

Legacy address アドレス

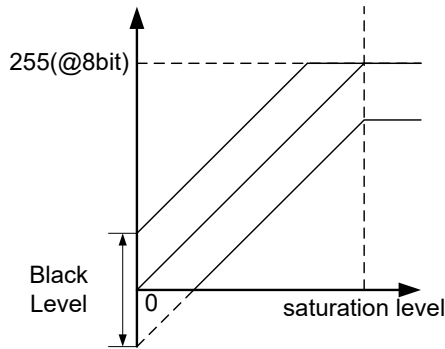
Register address	Read Write	Memory save	Default	Register name	Description
0x76	R/W	✓	0x0	Gain	0x0(0dB:default)~0xF0(24dB)

Notes on Gain setting:

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

BlackLevel

This section describes BlackLevel feature. This control adjusts the black level applied to the output signal. It is adjustable from -25% to +25% as white saturation level is 100%. If BlackLevel is set lower than 0[%], the image level may not be saturated.



• Register

IIDC2 address

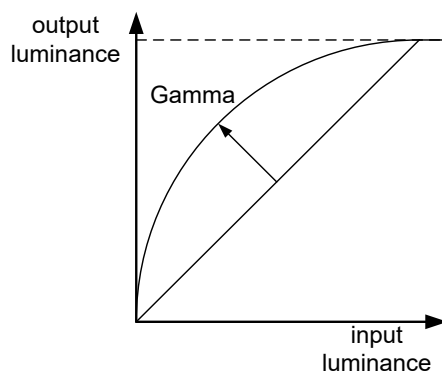
Register address	Read Write	Memory save	Default	Register name	Description
0x0020 405C	R/W	✓	0x0	BlackLevel	0xFFFFFFFFFF (-25%) ~ 0x100(+25%)

Legacy address

Register address	Read Write	Memory save	Default	Register name	Description
0x70	R/W	✓	0x0	Setup	0xFFFFFFFFFF (-25%) ~ 0x100(+25%)

Gamma

This section describes Gamma feature. This control adjusts the gamma correction of pixel intensity.



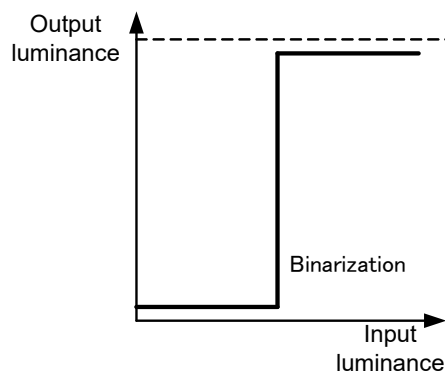
• Register

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 409C	R/W	✓	0x64	Gamma	Min:0x2D($\gamma=0.45$) Max:0x64($\gamma=1.0$)

LUTControl

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



Example of LUT setting

• Register

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 603C	R/W	✓	0x0	LUT Enable	0x0:OFF、0x1:ON
0x0030 0000	R/W	-	0x0	LUT Value[0]	Min:0x0、Max:0xFFFF
0x0030 0004	R/W	-	0x0	LUT Value[1]	
↓					
0x0030 0FFC	R/W	-	0x0	LUT Value[1023]	
↓					
0x0030 3FFC	R/W	-	0x0	LUT Value[4095]	

• Control procedure

- Sets the activation of LUT function

Set a value for the 'LUTEnable' register.

LUTEnable	Function
OFF (*)	Disable
ON	Enable

* initial factory setting

- Sets the output level of LUT

Write to 'Value[0]' to 'Value[4095]' of 'LUTValueAll' register to set the output level of LUT.

The index of 'Value' register means the input level of LUT.

UserSetControl

You are able to save a user setting to the non-volatile or 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".

List of registers to be applied to UserSet

Category	Register name	Category	Register name
TransportlayerControl	CameraLink Tap	TriggerControl	TriggerMode
	CameraLink CLK		TriggerSequence
ImageFormatControl	OffsetX		TriggerSource
	Width		TriggerDelay
	OffsetY	ExposureControl	ExposureTimeControl
	Height		ExposureTime
	BinningHorizontal		ShortExposureMode
	BinningVertical	DigitalIOControl	LineInverterAll
	DecimationHorizontal	AnalogControl	Gain
	DecimationVertical		BlackLevel
	ReverseX		Gamma
	ReverseY	LUTControl	LUTEnable
	PixelSize	UserSetControl	UserSetDefault
	TestPattern	SequentialShutterControl	SequentialShutterEnable(*)
AcquisitionControl	AcquisitionFrameRateControl		SequentialShutterTerminateAt(*)
	AcquisitionFrameRate		SequentialShutterEntry(*)
	AcquisitionFrameIntervalControl	DPCControl	DPCEnable(*)
	AcquisitionFrameInterval		DPCNumber(*)
	HighFramerateMode		DPCEntryX(*)
	DPCEntryY(*)		

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

● Register

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0020 807C	R/W	-	0x0	UserSetSelector	Sets the memory channel of UserSet. 0x0:Default, 0x1:UserSet1 ~ 0xF:UserSet15
0x0020 809C	R/W	-	0x0	UserSetCommand	Read / Write the UserSet. 0x0:Done, 0x8:Load, 0x9:Save, 0x7F:Erase
0x0021 F2FC	R/W	✓	0x0	UserSetDefault	Selects a channel of user setting when camera powers up. 0x0:Default, 0x1:UserSet1 ~ 0x15:UserSet15

Legacy address

Register address	Read Write	Memory save	Default	Register name	Description
0x6C	R/W	-	0x0	Memory bank	Sets the memory channel of UserSet. 0x0:Default,0x1:UserSet1 ~ 0xF:UserSet15
0x6D	W.O.	-	-	Memory save	0x1: Save user settings.
0x6E	W.O.	-	-	Memory load	0x1: Load user settings from selected memory bank.

● Control procedure

■ User settings Save and Load

IIDC2 address

Select a channel of user setting by 'UserSetSelector' register.

Save the user settings by writing '0x9' to 'UserSetCommand' register.

Load the user settings by writing '0x8' to 'UserSetCommand' register.

After execution of 'UserSetSave' or 'UserSetLoad', wait until 'UserSetCommand' is '0x0' (=Done).

Legacy address

Select a memory channel setting by 'Memory bank' register.

Save the user settings by writing '0x1' to 'Memory save' register.

Load the user settings by writing '0x1' to 'Memory load' register.

■ Setting of UserSetDefault

IIDC2 address

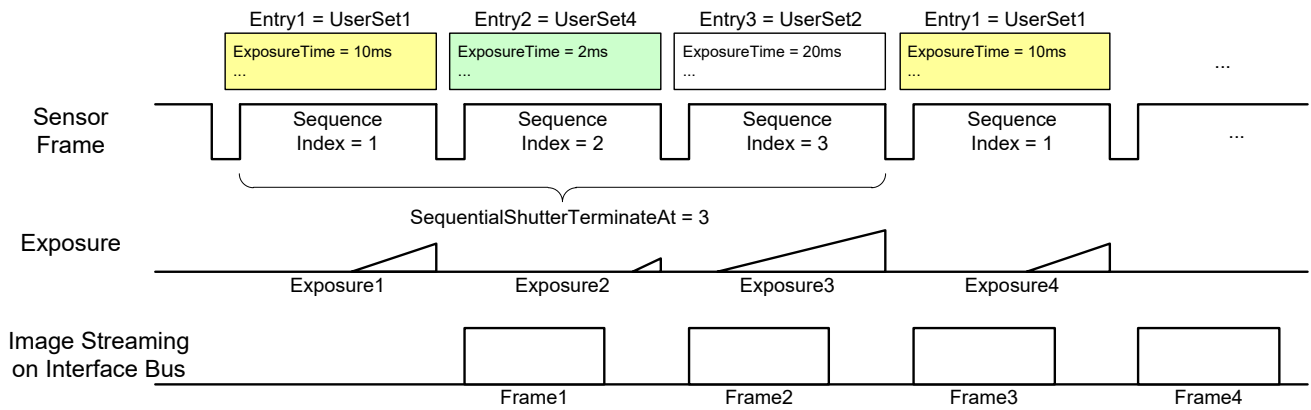
Select a channel of user setting when camera powers up by 'UserSetDefault'.

Select a channel of user setting by 'UserSetDefault' register.

Save the user settings by writing '0x9' to 'UserSetCommand' register, and the user setting channel to be loaded at camera startup is saved.

SequentialShutterControl

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



List of registers to be applied to SequentialShutter

Category	Register name
ImageFormatControl	OffsetX
	OffsetY
ExposureControl	ExposureTime

Category	Register name
AnalogControl	Gain
	BlackLevel
	Gamma
LUTControl	LUTEnable

Notes on SequentialShutter:

- In Sequential Shutter mode, window size is unchangeable.

● Register

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0021 F31C	R/W	✓	0x0	SequentialShutter Enable	Sets the activation of Sequential Shutter (SS) function. 0x0:OFF,0x1:ON
0x0021 F33C	R/W	✓	0x1	SequentialShutter TerminateAt	Sets the number of Tables to repeat the sequence. Min:0x1(1),Max:0x10(16)
0x0050 0040	R/W	✓	0x1	SequentialShutter Entry1	Sets the UserSet number [1] to register to the first sequence. Min:0x1(1),Max:0xF(15)
0x0050 0044	R/W	✓	0x1	SequentialShutter Entry 2	Sets the UserSet number [2] to register to the first sequence. Min:0x1(1),Max:0xF(15)
↓				↓	↓
0x0050 0074	R/W	✓	0x1	SequentialShutter Entry 15	Sets the UserSet number [15] to register to the first sequence. Min:0x1(1),Max:0xF(15)
0x0050 0078	R/W	✓	0x1	SequentialShutter Entry 16	Sets the UserSet number [16] to register to the first sequence. Min:0x1(1),Max:0xF(15)

Legacy address

Register address	Read Write	Memory save	Default	Register name	Description
0xF0	R/W	✓	0x0	SequentialShutter Enable	0x0:OFF、0x1:ON
0xF1	R/W	✓	0x1	SequentialShutter TerminateAt	Sets the number of Tables to repeat the sequence. 0x1 ~ 0x4
0xF3	R/W	✓	0x1	SequentialShutter Entry 1	Sets the UserSet number to register to the first sequence. 0x1 ~ 0x4
0xF4	R/W	✓	0x1	SequentialShutter Entry 2	Sets the UserSet number to register to the 2nd sequence. 0x1 ~ 0x4
0xF5	R/W	✓	0x1	SequentialShutter Entry 3	Sets the UserSet number to register to the 3rd sequence. 0x1 ~ 0x4
0xF6	R/W	✓	0x1	SequentialShutter Entry 4	Sets the UserSet number to register to the 4th sequence. 0x1 ~ 0x4
0xF7	W.O.	-	-	SequenceMemory Load	0x1: Load the parameters from the memory specified [Memory bank] register.
0xF8	W.O.	-	-	SequenceMemory Save	0x1: Save the parameters from the memory specified [Memory bank] register. If camera teruned off, the data in memory for SS is erased.

● Control procedure

- Set the camera parameters and save them to UserSet. Repeat this as you required.
Please refer to the section of ‘UserSetControl’ for how to operate UserSet.
- Sets the UserSet number to register to the sequence to ‘SequentialShutterEntry’. Repeat this as you required.
- Set the number of Index to repeat the sequence to ‘SequentialShutterTerminateAt’.
- Set the activation of SequentialShutter function by ‘SequentialShutterEnable’.

● Note

Contents saved using ‘SequenceMemorySave’ of Legacy address control are saved in volatile memory. Therefore, the contents saved using ‘SequenceMemorySave’ will disappear when the power is turned off.

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.

• Register

IIDC2 address

Register address	Read Write	Memory save	Default	Register name	Description
0x0021 F29C	R/W	✓	0x1	DPCEnable	Sets the activation of DPC (Defective pixel correction) function. 0x0:OFF, 0x1:ON
0x0021 F2BC	R/W	✓	0x0	DPCNumber	Sets the number of pixels to correct. 0x0 (0) ~ 0x100 (256)
0x0040 0000	R/W	✓	0x1	DPCValue [X ₁]	Sets the X coordinate of defective pixel (1st) 0.4M:0x0(0)~0X2CF(719) 1.6M:0x0(0)~0X59F(1439)
0x0040 0004				DPCValue [Y ₁]	Sets the Y coordinate of defective pixel (1st) 0.4M:0x0(0)~0X21B(539) 1.6M:0x0(0)~0X437(1079)
0x0040 0008				DPCValue [X ₂]	Sets the X coordinate of defective pixel (2nd) 0.4M:0x0(0)~0X2CF(719) 1.6M:0x0(0)~0X59F(1439)
0x0040 000C				DPCValue [Y ₂]	Sets the Y coordinate of defective pixel (2nd) 0.4M:0x0(0)~0X21B(539) 1.6M:0x0(0)~0X437(1079)
↓				↓	↓
0x0040 07F8				DPCValue [X ₂₅₅]	Sets the X coordinate of defective pixel (255th) 0.4M:0x0(0)~0X2CF(719) 1.6M:0x0(0)~0X59F(1439)
0x0040 07FC				DPCValue [Y ₂₅₅]	Sets the Y coordinate of defective pixel (255th) 0.4M:0x0(0)~0X21B(539) 1.6M:0x0(0)~0X437(1079)

Legacy address

Register address	Read Write	Memory save	Default	Register name	Description
0x89	R/W	✓	0x1	Defective pixel correction	0x0:OFF, 0x01:ON

- **Control procedure**

- On /Off of DPC function

Set value to DPCEnable register.

Setting	Function
OFF	Disable
ON (*)	Enable

* initial factory setting

- Set the coordinates of defective pixels.

Sets the number of pixels to correct to 'DPCNumber'.

The defective pixels are corrected by calculation from the neighboring pixels by setting to coordinate to 'DPCValue' register. If defective pixel exists plural number, these defective pixels are corrected by set coordinate to another 'DPCValue' register.

	DPCNumber	DPCValue[X]	DPCValue[Y]
Minimum	0	0	0
Maximum	256	WidthMax-1	HeightMax-1

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**

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

http://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 website or sales personnel.