

Digital CCD Camera

C8484-05G02

Instruction Manual

Thank you for your purchase



CAUTION

- Follow the safety precautions in Chapter 1 in order to avoid personal injury and damage to property when using this camera. The manual describes the correct handling method of the camera and provides cautions in order to avoid accidents. **Read this manual carefully** beforehand use the camera correctly.
- After reading the manual, store it in a location where you can refer to it at any time.

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HAMAMATSU PHOTONICS K.K.

8786172-00

WARNING



Power supply

Use the camera with the voltage indicated on the rating. Using a different voltage can damage the camera and lead to fire or electric shock.



Cables

Be careful not to place heavy objects on cables or bend it excessively. Doing so can damage the cable and lead to fire or electric shock.



Do not attempt to dismantle or modify the camera

Doing so can also lead to damage and even injury, as some internal components become very hot. Only touch parts as indicated in this manual.



Do not insert a foreign substance into the camera

Do not allow foreign objects such as combustible substances, metal objects or water to get inside the camera. They can damage the camera and lead to fire or electric shock.



If an abnormality occurs

Such as the image suddenly disappearing or a strange noise, smell or see smoke coming from the camera, turn the power off immediately and contact Hamamatsu subsidiary or local distributor. In case the repair is needed, it should be always treated at Hamamatsu side.

1. SAFETY PRECAUTIONS

1-1 CLASSIFICATION OF WARNINGS

We have classified the warning symbols that appear in this operating manual and on the camera as follows for better comprehension of their meaning. Make sure that you fully understand them and obey the instructions they contain.

 WARNING	Improper handling of the camera without observing these warnings could lead to serious injury to the user and even death.
 CAUTION	Improper handling of the camera without observing these cautions could lead to personal injury to the user or damage to property.

Note	This symbol indicates a note to help you get the best performance from the camera. Read the contents of the note carefully to ensure correct and safe use. Failure to observe one of these notes might impair the performance of the camera.
	This symbol indicates a cautionary item that should be obeyed when handling the camera. Read the contents carefully to ensure correct and safe use.
	This symbol indicates an action that is forbidden. Read the contents carefully and be sure to obey them.
	This symbol indicates a compulsory action or instruction. Read the contents carefully and be sure to obey them.

2. CHECK THE CONTENTS OF PACKAGE

When you open the package, check that the following items are included before use. If the contents are incorrect, insufficient, or damaged in any way, contact Hamamatsu subsidiary or local distributor without attempting to operate the camera.

C8484-05G02 Digital CCD camera	1
Lens mount cap (attached to the camera)	1
C8484-05G02 Instruction manual (this booklet)	1

[Option]

IEEE1394 interface cable [Industrial type] (accessories: 2 Clamp filters)	A8609-04
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Note

- The cable listed in option is highly recommended for use with the camera. The camera system may not confirm to CE marking regulation if other type of cable is used with.

3. INSTALLATION



Avoid using or storing this camera in the following places

- Where the ambient temperature might fall below 0 °C or rise above 40 °C
- Where the temperature varies extremely
- In direct sunlight or near a heater
- Where the humidity is 70 % or more or where there is dripping water
- Close to a strong source of magnetism or radio waves
- Where there is vibration
- Where it might come into contact with corrosive gases (such as chlorine or fluorine)
- Where there is a lot of dust

! CAUTION

Connecting and disconnecting cables

Always turn off the power before connecting and disconnecting cables.

Fixing the camera

When fitting the camera head to a tripod or other fixture, use the screw (1/4-20UNC) in the center of a camera mount or the threaded sleeve (M3) about the mount's perimeter. Be careful not to allow the fitting screw to enter more than 5 mm from the surface of the mount. Screwing this in excessively may impair normal operation.

Lenses

Be careful not to screw the lens more than 7 mm onto the C-mount of the camera head. Doing so can scratch the protective glass. (Some wide angle lenses in particular can have a thread of 7 mm or more.)

Shipping precautions

When transporting the camera by truck, ship, airplane, etc., wrap it securely in packaging material or something similar.



Do not subject the camera to strong shocks

Dropping the camera or other shocks can damage the camera.

Disposal

When disposing of the system, take appropriate measures in compliance with applicable regulations regarding waste disposal and correctly dispose of it yourself, or entrust disposal to a licensed industrial waste disposal company. In any case, be sure to comply with the regulations in your country, state, region or province to ensure the system is disposed of legally and correctly.

4. OVERVIEW

C8484-05G02 is compact, high-performance, 12 bit output CCD camera developed as an imaging input device for industrial and scientific measurement requiring high-resolution, high-quality imaging. The camera's interface is IEEE1394, allowing direct input of images to computer through commercial IEEE1394 port or IEEE1394 card.

5. FEATURES

(1) High resolution

The camera is equipped with a high-resolution image sensor featuring an effective pixel count of 1344 (Horizontal) × 1023 (Vertical) pixels. The pixels are square, thus simplifying image processing for measurement purposes.

(2) Use of IEEE1394 interface

Image signals undergo A/D conversion inside the camera head, and are transmitted externally via the IEEE1394 bus interface as 12 bit digital data. The camera can also be controlled via this bus.

(3) Employment of common Camera control standard

The camera uses the industry-standard "IIDC 1394-based Digital Camera Control Specification Ver.1.30" for this control. This ensures compatibility with other cameras and controls, which support this standard.

(4) Low Distortion

The CCD's pixels are laid out geometrically, ensuring nearly zero distortion.

(5) No Burn-in

(6) Lens mount

C-mount used for Lens mount.

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- Use low ripple noise power supplies since ripple noise may affect camera performance.



- Plug the cable into the connector firmly. If not, it can be a cause of noise.

③ Mode switching switch

This is a switch for the camera maintenance.



- All positions are set to "OFF". Do not change this.

④ Timing I/O connector [TIMING I/O]

This connector is used for input and output of timing signals when synchronizing with external equipment.



- This connector is not used with this camera. Do not connect it.

⑤ Camera mount

Jig for fixing the camera. Used when mounting the camera on a tripod or other fixture.

Note

- Be careful not to allow the fitting screw to enter more than 5 mm from the surface of the mount. Screwing this in excessively may impair normal operation.

6. NAMES AND FUNCTION OF PARTS

6-1 CAMERA

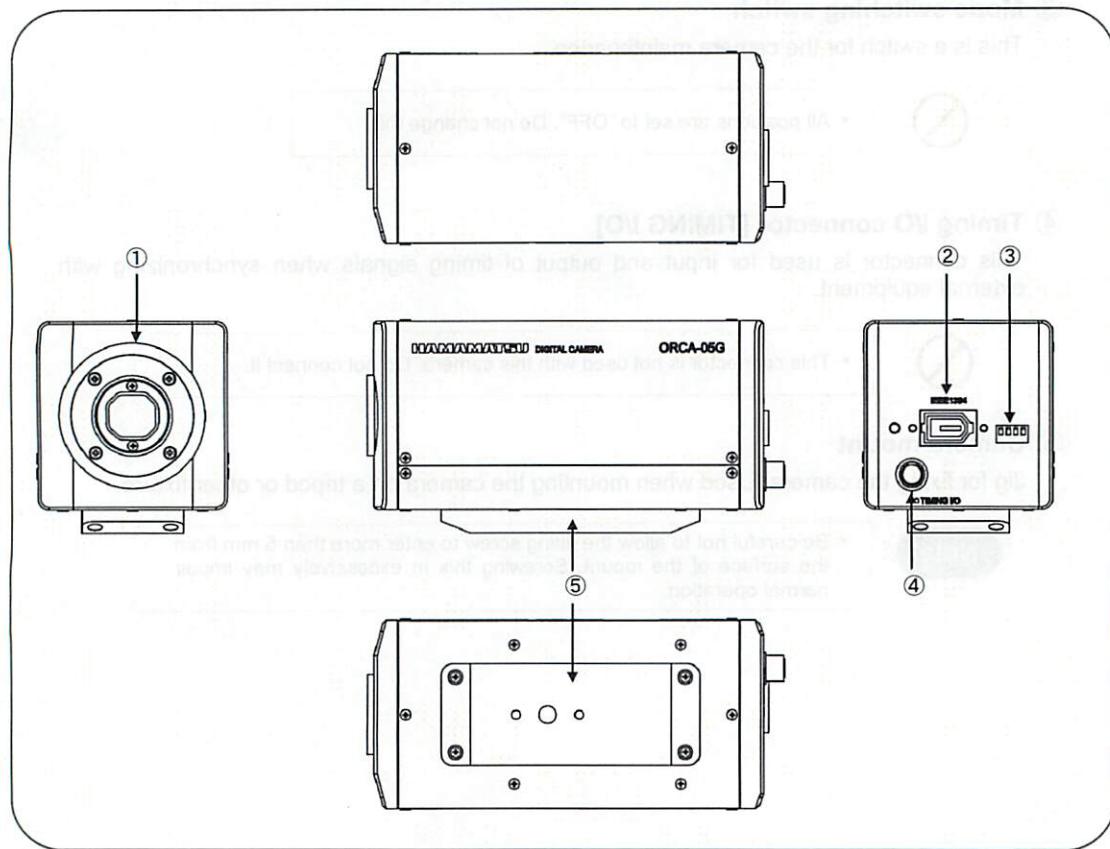


Fig. 6-1

① Lens mount

C-mount lens or optical system with C-mount can be attached.

Note

- C-mount has a depth of 7 mm. Screwing the lens too far into the camera head may scratch the glass surface.

② IEEE1394 interface connector [IEEE1394]

Connector used for connecting the camera to the host computer. It is connected to the IEEE1394 interface connector of the host computer with the attached cable. The camera is supplied a power supply from this connector. Following is the specifications of the power supply.

Power supply voltage	DC 12 V to DC 25 V ± DC 2 V
Electric current capacity	+ 700 mA
Ripple noise	Peak to peak ± 50 mV



CAUTION

- Power supply must satisfy the above specifications to prevent trouble with the camera.

7-2 ATTACHING THE CLAMP FILTER

Suitable cables should include two clamp filters. Attach the one filter to each end of the IEEE1394 interface cable.

Note

- Take care not to pinch the cable when closing the clamp filter.

Note

- Attaching the clamp filter too far from the base of the connector will prevent it from functioning effectively.



7. CONNECTING CABLES

7-1 CONNECTING CABLES

Refer to the figure below when connecting the various cables.

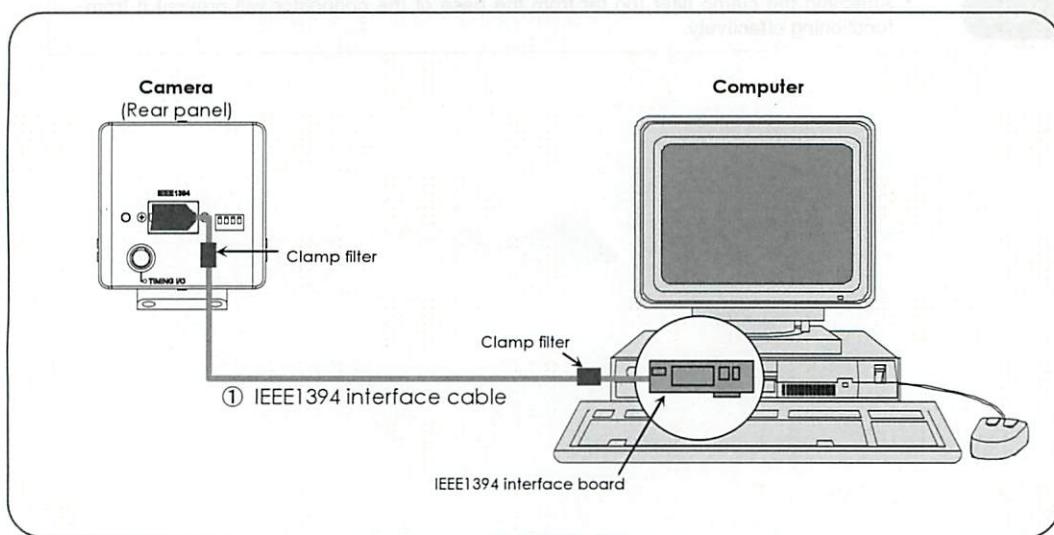


Fig. 7-1



- When cables are connected, confirming the power switch is in the OFF position.

① IEEE1394 interface cable (Option)

Connect the camera's IEEE1394 socket to the host computer's IEEE1394 socket using the IEEE1394 interface cable.



- When using an industrial type connector, press it in firmly while pressing the button on the side of the cable connector. To release the cable, also press the button to unlock then pull to remove.

Note

- The cable is an option. Please supply the necessary cable. While it is also possible to use a standard 6-pin cable, it is recommended that you use the optional industrial-type connector provided by Hamamatsu. When the recommended cable is not used for, the camera performance and safety cannot be guaranteed.

Note

- Hamamatsu recommends optional interface for this camera. Depending on type of interface cables, the camera may not keep CE marking compliance in terms of EMC directive.

IEEE1394 interface cable

A8609-04

9. OBTAINING IMAGES

9-1 CAMERA CONTROL SPECIFICATIONS

This is a digital camera employing an IEEE1394compliant interface. It operates under Format 7 of the "1394-based Digital Camera specification, Ver.1.30". See the specification sheets below for details about camera control:

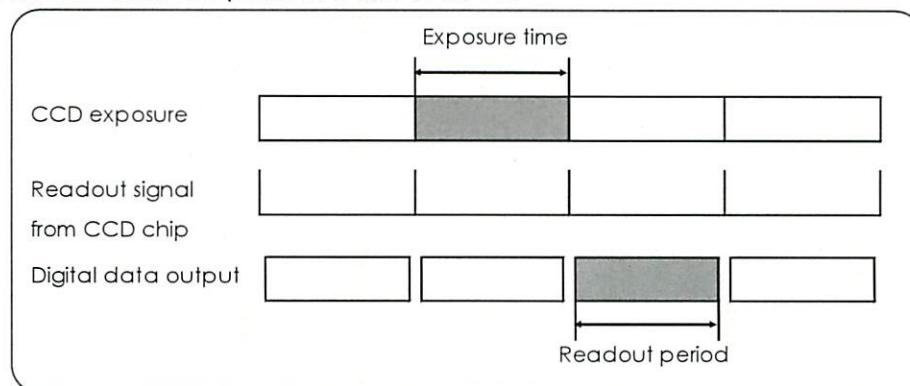
- IEEE Std 1394-1995, Standard for High Performance Serial Bus
- ANSI/IEEE Std 1212-1994, Command and Status Register Architecture
- 1394-TA 1999023, IIDC 1394-based Digital Camera Specification Version 1.30

Format 7	Mode 0	Normal readout
	Mode 1	2×2 binning readout
	Mode 2	4×4 binning readout
	Mode 3	8×8 binning readout

9-2 DETAILS ON CCD SCANNING (SCAN MODE)

(1) Normal readout

This reads out the charge from the CCD using standard scanning.
The CCD scans all pixels at a rate of 8.9 Hz.



8. OPERATION

8-1 PREPARATION FOR IMAGING

Connect the equipment as shown in Fig.7-1 before starting operating of the camera.



- When cables are connected, confirming the power switch is in the OFF position.

8-2 IMAGING

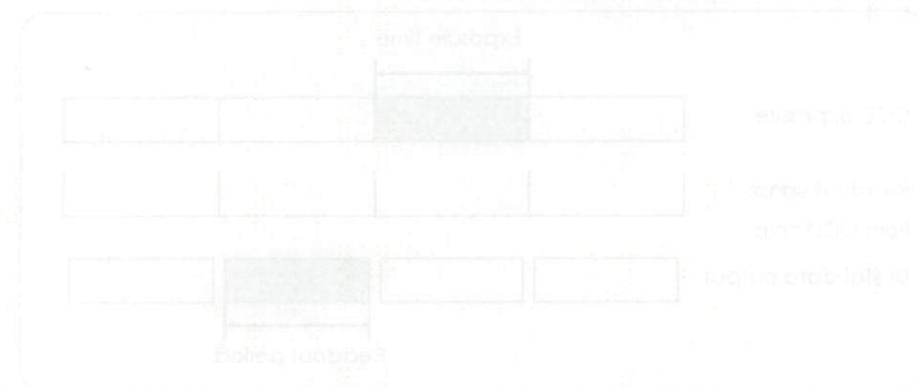
Launch a control application, and configure the operating parameters. Next, begin image capture and image data forwarding by setting the Begin Transmission start bit in the IIDC camera register or use the image capture feature of your application software.

Note

- The camera does not include software.

8-3 END OF IMAGING

End imaging or transmission of image data with the control software when imaging is finished. And turn off the power to the peripheral equipment.



9-3 PARTIAL SCAN (SUB-ARRAY SCAN)

This camera supports partial-scanning operation in each mode. Partial scanning is a procedure in which only a portion of the image is scanned. It is possible to increase the frame rate by reducing the number of vertical lines scanned. To get the maximum frame rate for partial scanning, see the section on configuring exposure time.

Note

- To get the maximum frame rate for partial scanning, please see the section on configuring exposure time.

9-4 EXPOSURE TIME

9-4-1 CONFIGURING EXPOSURE TIME

Exposure time is configured in the shutter feature control register. The shutter can be configured in either relative or absolute settings. Note, however, that there is limitations on the range of relative register settings.

$$Tf\ s = (Vn + 26) \times HI + (1033 - Vn) \times Hs$$

- HI = 106.337×10^{-6} s
- Hs = 7.595×10^{-6} s
- Vn = Number of read-out lines

(1) Relative shutter value configuration

Relative CSR's use 12 bit values. Shutter feature control is configured at I2DC command register offset 0x81C.

The setting range for the absolute value register is 10 μ s to 1 s. This can be set up in about 1 ms interval.

Note

- Please see Figure 9-1 for the relationship between setting values and actual exposure times.

(2) Absolute shutter value configuration

To configure an absolute value, set an absolute value in the shutter's absolute value register in seconds; then set bit 1 (Abs_control) in the Shutter feature control register (0x81C).

Note

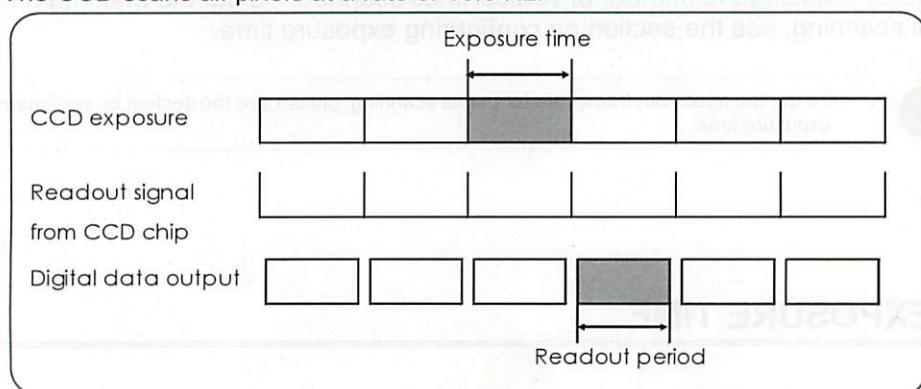
- If the bit 1 (Abs_control) is already set in the shutter register, it is sufficient to only write an absolute value to the shutter absolute value register.

The quad let offset of the shutter's absolute value register address from the base address (0xF000_0000) is stored in the I2DC ABS_CSR_HI_INQ at offset 0x71C. The register address can be calculated from this information. When using absolute value, actual setting value is returned to this value register. It can know this by reading the register. The register is 10 μ s to 1 s. This can be set up in 100 μ s interval.

(2) 2×2 binning readout

This reads out the charge from the CCD using in 2×2 binning readout.

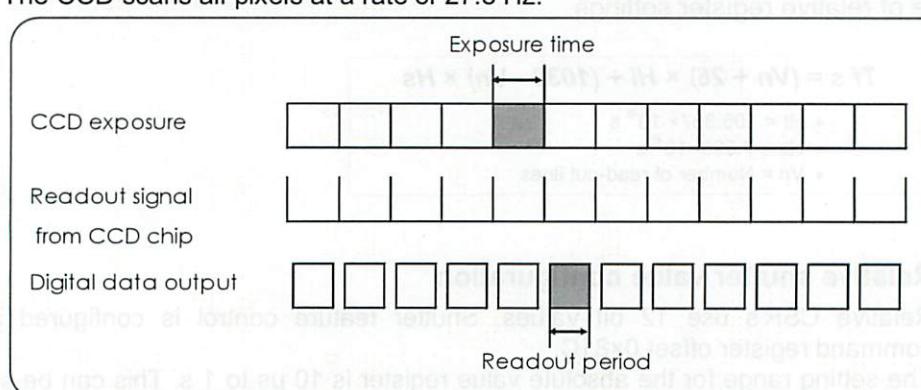
The CCD scans all pixels at a rate of 16.3 Hz.



(3) 4×4 binning readout

This reads out the charge from the CCD using in 4×4 binning readout.

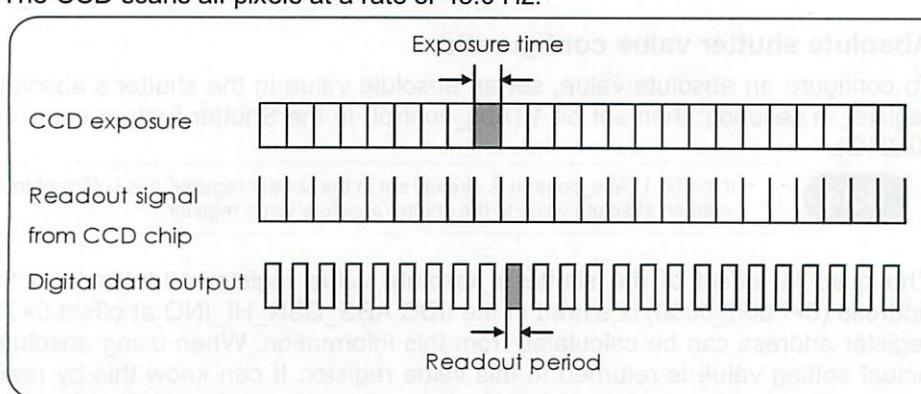
The CCD scans all pixels at a rate of 27.8 Hz.



(4) 8×8 binning readout

This reads out the charge from the CCD using in 8×8 binning readout.

The CCD scans all pixels at a rate of 43.0 Hz.



10. PRECAUTIONS WHEN USING THE CCD

This device uses a CCD. Careful attention must be paid to the following points when using a CCD:

(1) White spot

Subjecting the CCD to extended exposures may cause failure in part of the silicon wafer, resulting in white spots. This phenomenon is not currently preventable. If the CCD is at a fixed temperature, recurrence of the white spot increases proportionally with the exposure time, so this can be rectified with dark subtraction. Atomic ray may generate white spot.

* After an image made using a certain exposure time is loaded, the CCD is exposed to darkness for the same amount of time, and another image is obtained. After this, the difference between the images is determined, and the data for the dark portion of the original image is nullified.

(2) Smear

When imaging very bright objects, bright vertical stripes (vertical smear) may be visible in the images being taken. This is due to leakage of current to the vertical CCD's from the photosensors. The amount of leakage is proportional to the readout time and exposure time.

Smear presents no problem when the camera is in Normal frame blanking mode. However, when using the electronic shutter of the external exposure time settings, this sometimes becomes a problem when the exposure time is shortened.

(3) Folding distortion

A rough-edged flicker may be visible when imaging striped patterns, lines, and similar subject matter.

(4) Interference fringes pattern

Coherent light such as LASER light may generate interference fringes pattern on image.

(5) Over light



- Be careful not to input too strong light such as high-energy laser into CCD chip because CCD chip may be damaged by over light.

11. MAINTENANCE

11-1 CARE

Clean the exterior with a soft, dry cloth.



- Do not use a wet cloth, dirty cloth.

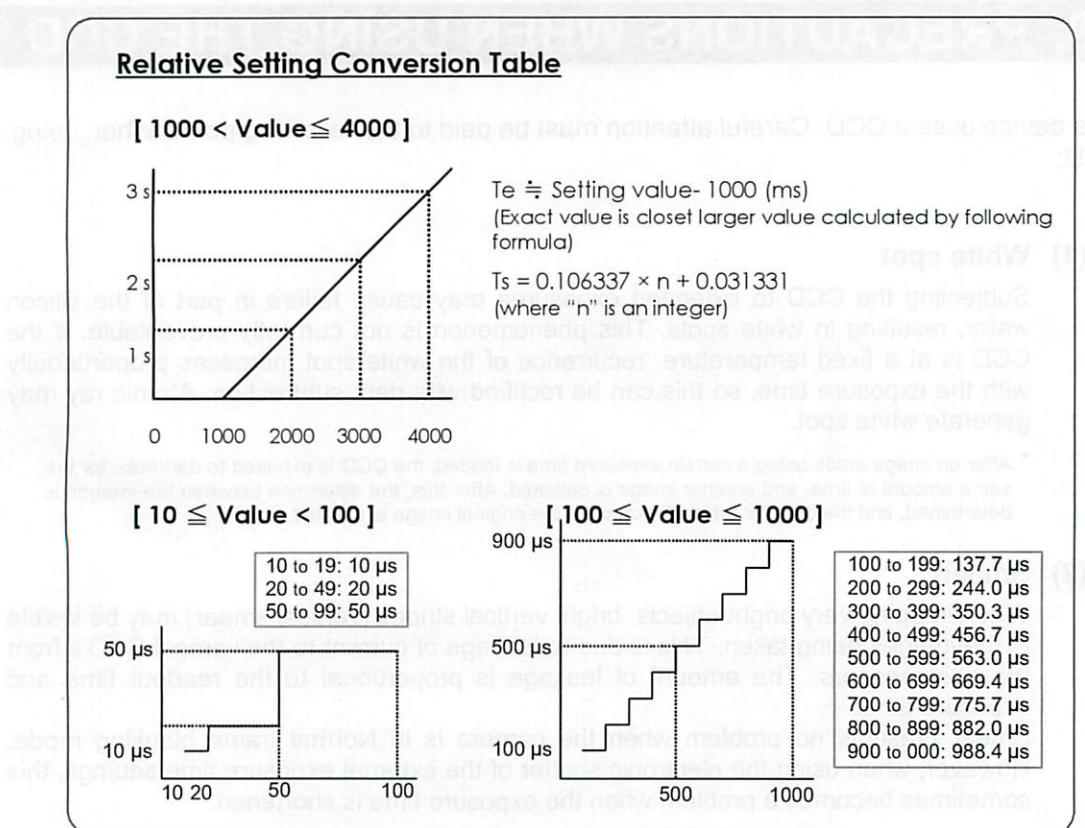


Fig. 9-1

9-4-2 EXTERNAL TRIGGER CONFIGURATION

External trigger operation is configured using the Trigger feature control register. This camera supports trigger mode in Mode 0 (Edge trigger) and Mode 1 (Level trigger). In mode 0, exposure time is configured by setting the shutter value; in Mode 1, it is set by specifying the pulse width. Trigger polarity is set in Trigger Polarity.

9-5 GAIN CONFIGURATION

Camera gain is configured in the Gain feature control register. The gain can be configured in the relative settings. The setting range for the relative value register is 0 or 1. set 0 means 0 dB, set 1 means 14 dB.

9-6 LIGHT MODE SPECIFICATIONS

Switch the camera between Low-light mode and highlight mode in Camera Feature, in Gamma. Set this value to 0 for Low-light mode, and 1 for High-light mode in the relative settings register. Low-light mode deactivates the CCD's anti-blooming feature, and sets it to High-sensitivity mode. In Low-light mode, the camera may show a peculiar phenomenon when strong light is input in short exposure time. It is not a trouble of the camera, but it is a peculiar phenomenon in Low-light mode due to High-sensitivity mode. High-light mode activates the CCD's anti-blooming feature, and lowers sensitivity slightly.

13. SPECIFICATIONS

13-1 CAMERA SPECIFICATIONS

(1) Electrical specifications

Imaging device	Progressive scan inline CCD with micro-lens	
Effective number of pixels	1344 (H) × 1024 (V)	
Cell size	6.45 µm × 6.45 µm	Square format
Effective area	8.67 mm × 6.60 mm	2/3 " size
Frame rate	Normal readout	8.9 Hz (Format7,Mode0)
	2 × 2 binning readout	16.3 Hz (Format7,Mode1)
	4 × 4 binning readout	27.8 Hz (Format7,Mode2)
	8 × 8 binning readout	43.0 Hz (Format7,Mode3)
Readout noise (r.m.s.)	10 electrons (typ.) *1	
A/D converter	12 bit	
Lens mount	C-mount	
Amp gain conversion factor *2	3.8 electrons /ADcounts	
Full well capacity	15 000 electrons	
Contrast enhancement	0 dB / 14 dB	
Exposure time setting	10 µs to 1 s	
Partial scan setting	Arbitrary area of 64 × 64 pixel units (Mode 0) Arbitrary area of 84 × 64 pixel units (Mode 1 to 3)	
External trigger	Yes (Edge trigger/Level trigger)	
Image data format	Uncompressed B&W (Mono8, Mono16)	
Host interface standard	IEEE1394-1995	
Connector specification	6-pin IEEE1394 interface connector (Industrial type)	
Camera control specification	IIDC 1394-based Digital Camera specification Ver.1.30	

* 1 This value is the measurement in free running and scan modes normal readout. The value was measured with the CCD in dark state. In this state, two images are acquired, image subtraction performed, the standard deviation taken from the results, and this value was then divided by square root of 2 and plugged into a transformation coefficient.

* 2 When running an amp-gain transformation coefficient to convert measured image count values into electrons, be sure to conduct dark subtraction first.

(2) Operating environment

Ambient operation temperature	0 °C to + 40 °C
Ambient storage temperature	-10 °C to + 50 °C
Ambient operating humidity	70 % or less (no condensation)
Operating space	Indoor, altitude up to 2000 m

(3) External dimensions and weight

Camera	Approx. 600 g (not including cables and accessories)
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Note

- Please see Chapter 14 for full external dimension.

(4) Applicable standards

EMC	EN61326-1: 2006	Class A
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12. TROUBLESHOOTING CHECKLIST

If an abnormality occurs, look up the possible causes in the following tables and, if necessary, report the details to Hamamatsu subsidiary or local distributor.

12-1 IMAGES NOT TRANSFERRED

Cause	Measures	Chapter
IEEE1394 interface cable not fully connected	Reconnect	7
Camera control register not correctly configured	Recheck register settings	
Short in IEEE1394 interface cable	Replace cable	

12-2 ALTHOUGH IMAGES ARE TRANSFERRED (OTHER PROBLEMS)

(1) Scratches or discoloration visible on the screen

Cause	Measures	Chapter
Front glass of camera head dirty	Wipe with gauze dampened with alcohol	

(2) Image is blurred

Cause	Measures	Chapter
Incorrect back focus	Contact Hamamatsu subsidiary or local distributor	
Dirty CCD chip		16

(3) Only dark, shaded images output

Cause	Measures	Chapter
Lens mount cap left on	Remove the cap	

(4) All images overflowing

Cause	Measures	Chapter
Too much light	Reduce lens stop. Reduce Exposure time	
Contrast enhance set too high	Lower gain	

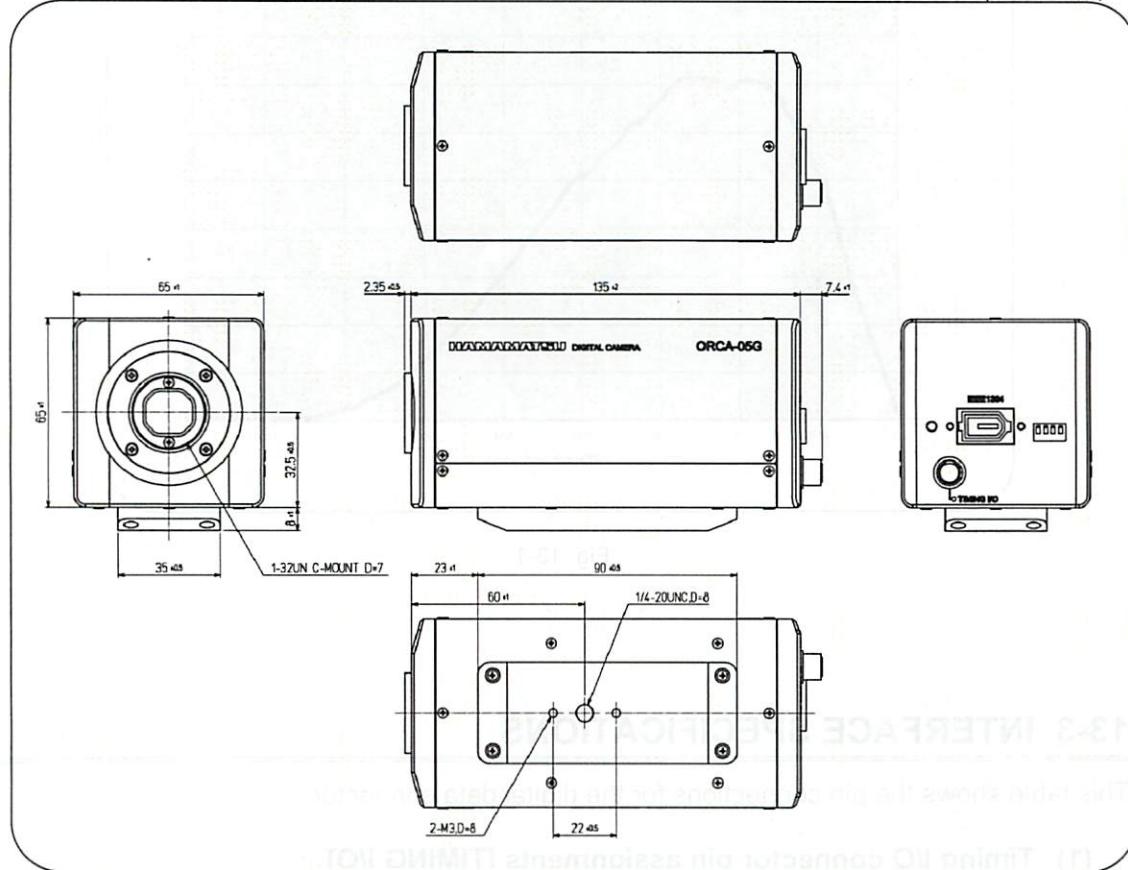
(5) Noise in image

Cause	Measures	Chapter
Noise introduced from exterior	Find and remedy problem	
Poor connection of internal components	Contact Hamamatsu subsidiary or local distributor	
Bad circuitry		16

14. DIMENSIONAL OUTLINES

14-1 CAMERA

(Unit: mm)



Hamamatsu ORCA-05G camera uses Hamamatsu HR10A-TR-HD camera sensor. The camera has a resolution of 1280x960 pixels at 30fps. The camera has a built-in 1.32IN C-MOUNT D=7 lens. The camera has a built-in 1/4-20UNC D=6 tripod mount. The camera has a built-in 2-M3D-8 connection port.

13-2 SPECTRAL RESPONSE CHARACTERISTICS

Following is the typical spectral characteristics of the CCD. (using Low-light mode)

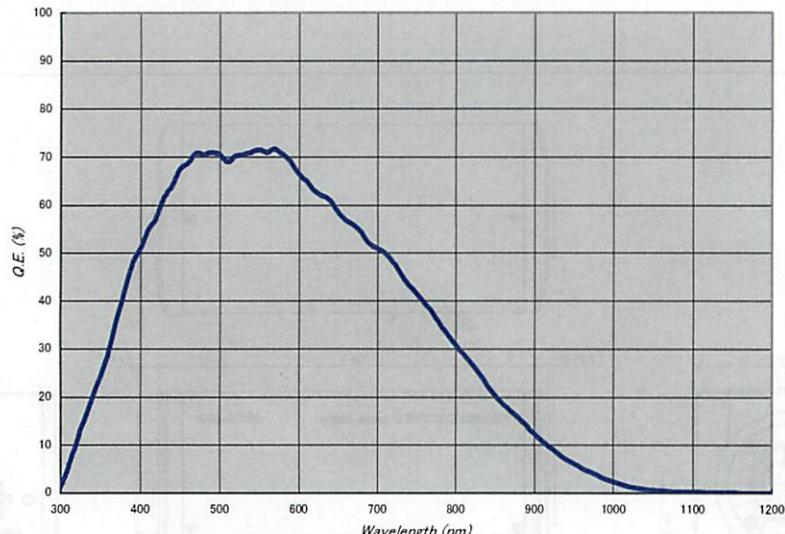


Fig. 13-1

13-3 INTERFACE SPECIFICATIONS

This table shows the pin connections for the digital data connector.

(1) Timing I/O connector pin assignments [TIMING I/O]

The camera uses Hirose model HR10A-7R-6S connector for inputting the external trigger pulse when the camera is operated in External Control mode. Input is TTL level (Termination is $680\ \Omega$), and the external trigger pulse polarity can be set either to negative or positive.

No.	Signal	Pin connections
1	Ext. trigger	 HR10A-7R-6S
2	Digital GND	
3	NC	
4	NC	
5	NC	
6	NC	



- Do not connect anything to pins 3, 4, 5 or 6.

16. CONTACT INFORMATION

Hamamatsu Photonics have fully inspected this camera and checked that its performance conforms to specifications. In the unlikely event of breakdown or other malfunction, contact Hamamatsu subsidiary or local distributor.

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- The contents of this manual are subject to change without notice.
- The unauthorized reproduction or distribution of parts or all of this manual is prohibited.
- If one of the following problems occurs, please contact Hamamatsu Photonics.
(See the CONTACT INFORMATION.) We will deal with the problem immediately.
 - Some contents of the manual are dubious, incorrect or missing.
 - Some pages of the manual are missing or in the wrong order.
 - The manual is missing or dirty.

15. WARRANTY

Hamamatsu Photonics have fully inspected this camera and checked that its performance conforms to specifications. In the unlikely event of breakdown or other malfunction, contact Hamamatsu subsidiary or local distributor.

- (1) Unless otherwise stated by Hamamatsu subsidiary or local distributor, this system is under warranty for 24 months from the delivery date.
 - Consumable parts, such as a fan, a fuse, are excepted.
 - Degradation with atomic rays, the radiation (X-rays, gamma rays, UV light, etc.) of CCD is excepted.
- (2) The warranty only covers defects in the materials and manufacturing of the system. You may be liable for repairs during the warranty period in the event of a natural disaster or if you handle the system contrary to the instructions in this manual, use it without due caution, or try to modify it.
- (3) We will repair the system or replace it, subject to availability, free of charge within the terms of the warranty.

REPAIRS

- (1) If you notice anything wrong with the camera, confirm whether or not it is malfunctioning by referring to the troubleshooting checklist in this instruction manual. You must first clarify the symptoms in order to avoid any misunderstanding or error.
- (2) If you have any trouble or are unclear about anything, contact Hamamatsu subsidiary or local distributor giving the product name, serial number and details of the problem. If Hamamatsu Photonics consider the problem to be a malfunction, we will decide whether dispatch an engineer or have the camera returned to us for repairs.