# Digital CCD Camera
# C4742-95-12HR
# 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 method of handling the C4742-95-12HR 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. |

**Ver. 1.4**
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**HAMAMATSU PHOTONICS K.K.**

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# 1. SAFETY PRECAUTIONS

## 1-1 INDICATION OF THE SYMBOLS

The symbols shown below are used for this camera.

| | |
|---|---|
|  | Protective conductor terminal |
|  | Alternating Current |
|  | ON (Supply) |
|  | OFF (Supply) |

## 1-2 CLASSIFICATION OF WARNING

We have classified the warnings symbols that appear in this instruction manual and on the camera as follows for your convenience. 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. |

## ⚠ WARNING

### Power supply

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

### Power supply cord and plug

**Do not touch the plug with wet hand. Doing so can lead to 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 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, stop the power supply immediately and contact Hamamatsu subsidiary or local distributor. Never attempt to repair the camera yourself.**

# ⚠CAUTION

## Power supply cord

**When unplugging the power supply cord, always pull by the plug, not the cord. Doing so can lead to fire or electric shock.**

**Remove the power supply cord from the outlet when not using the camera for long periods of time. Doing so can damage the cable and lead to fire or electric shock.**

## Connecting and disconnecting cables

**Always turn off the power before connecting and disconnecting cables.**

## Fixing the camera head

**When fitting the camera head to a tripod or other fixture, use the When fitting the camera head to a tripod, for example, use the screw (1/4-20UNC) in the center of a camera mount. Be careful that the fitting screw does not enter more than 8 mm from the surface of the mount. Screwing it in excessively can impair normal operation.**

## Shipping precautions

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

## Strong impact

**Do not subject the camera to strong shocks by dropping it, for example. Doing so 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.**

# 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.

| | | |
|---|---|---|
| C4742-95-12HR Camera head | | 1 |
| C4742-95-12HR Camera control unit | | 1 |
| Camera cable for HEAD POWER connector | 5 m | 1 |
| Camera cable for HEAD SIGNAL connector | 5 m | 1 |
| Power supply cord | 2 m | 1 |
| Lens mount cap | * attached to the camera | 1 |
| Spare fuse T 2.5 A 250 V | * stored in the fuse holder | 1 |
| C4742-95-12HR instruction manual | * this booklet | 1 |

[Option]

| | |
|---|---|
| Digital interface cable | A8518-05 |
| Serial interface cable | A4895-05 |

**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

## Do not allow the ventilation ports to become blocked

**To prevent overheating in the camera's interior, do not wrap the unit in cloth or other material, or in any way allow the power supply unit's ventilation ports to become blocked.**
**If the camera is being operated in an enclosed environment, ensure clearance of at least 10 cm from both the intake and exhaust vents when setting up the camera.**

# Contents

# 4. OVERVIEW

C4742-95-12HR is a compact, high-performance CCD camera with 12 bit digital output. It has been developed as image collection equipment for use in industrial / scientific measuring situations which require highly accurate and high quality imaging.
The camera gives digital 12 bit parallel signal output (conforming to EIA/TIA-644) which can be used to directly import images to commercially sold digital image input boards.

# 5. FEATURES

### (1) High resolution

The unit is equipped with a high-resolution image sensor featuring an effective pixel number of 4000 (Horizontal) × 2624 (Vertical) pixels. The pixels are square, thus simplifying image processing for measurement purposes.

### (2) The varies readout modes

The camera can be used in various readout modes. In addition to interlace mode (full pixel readout mode), it can be used in readout in binning mode (which adds a specified number of charges accumulated in the CCD in the horizontal and vertical directions and reads out from the CCD), and outline mode, which allows high-speed image readout. Since the CCD readout in binning mode and outline mode is progressive, and the readout in interlace mode is changed from digital output to progressive output by the camera control unit, it is possible to capture simple images with an image input board. A sub-array readout function, which gives a partial readout within user-specified limits, is also featured (with the CCD readout in binning mode).

### (3) No mechanical shutter required

The all-pixel-readout interline CCD image sensor included in this camera (hereafter referred to as CCD or all-pixel-readout CCD), eliminates the need for a mechanical shutter.

### (4) Digital output

The image signal is converted from analog to digital inside the camera control, and output as 12 bit digital data (max. length of transmission line: 5 m)

### (5) Low graphic distortion

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

### (6) No Burn-in

### (7) Lens mount is an F-mount

### (8) Compact head

The camera head has been made lighter and more compact that makes the camera easy to use in microscopic measurements, spectrophotometry, and other applications.

# 6. NAME AND FUNCTION OF THE PARTS

## 6-1 CAMERA HEAD

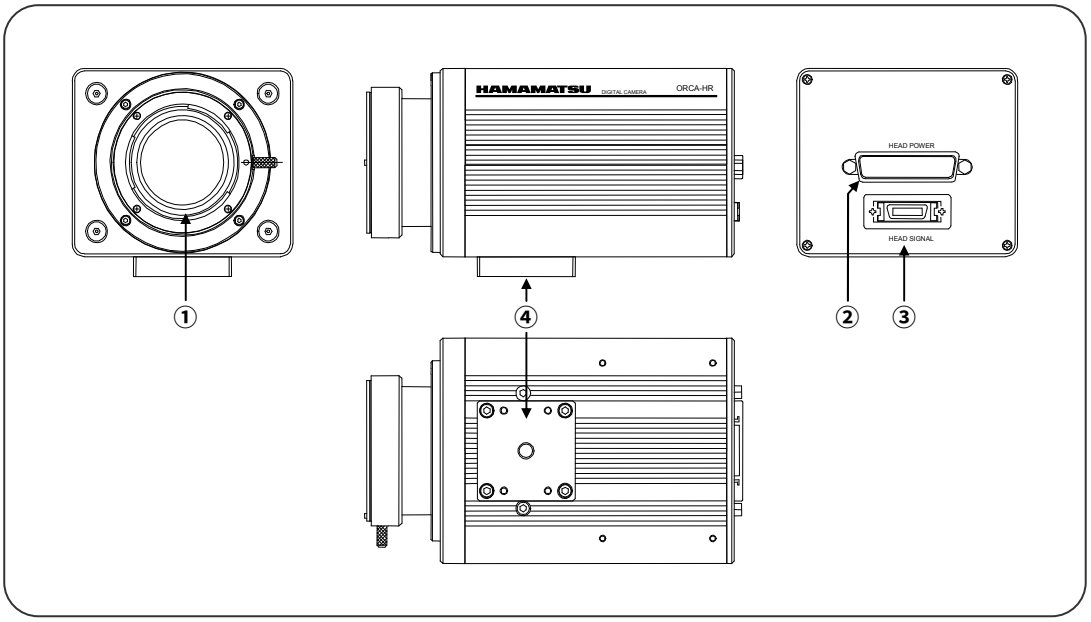



Fig. 6-1

### ① Lens mount

Lens mount is F-mount.

### ② Camera connector (for HEAD POWER)

### ③ Camera connector (for HEAD SIGNAL)

Connector used for connecting the camera head to the camera control unit.

### ④ Camera attaching plate

This is used to secure the camera head in place when using a tripod.

**Note**

- Be careful not to allow the fitting screw to enter more than 8 mm from the surface of the mount. Screwing this in excessively may impair normal operation.

## 6-2 CAMERA CONTROL UNIT (FRONT PANEL)

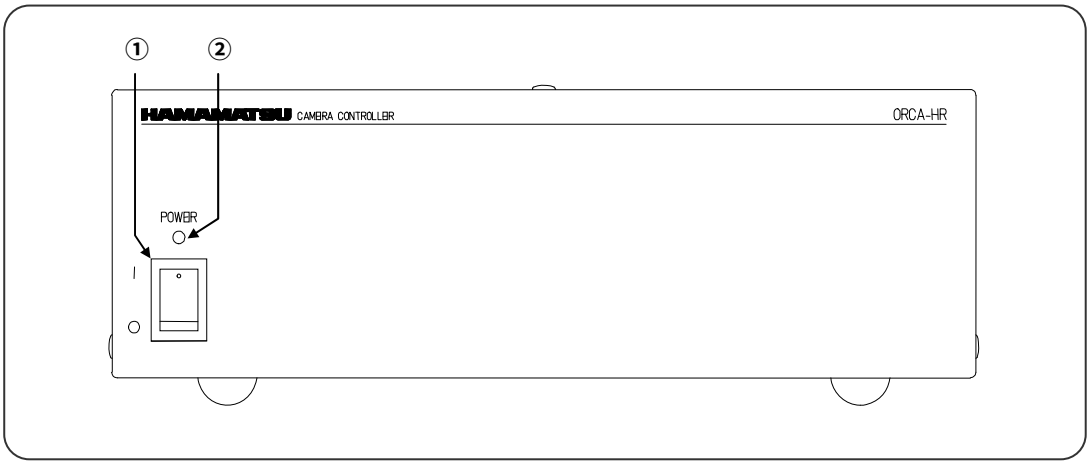



Fig. 6-2

### ① Power switch

Switching this to the " | " position turns on the power turns and causes the power lamp to light.

- Allow at least 5 seconds after turning the power off before turning it back on again.

### ② Power on LED

The LED lights (green) when the power is on.

# 6-3 CAMERA CONTROL UNIT (REAR PANEL)

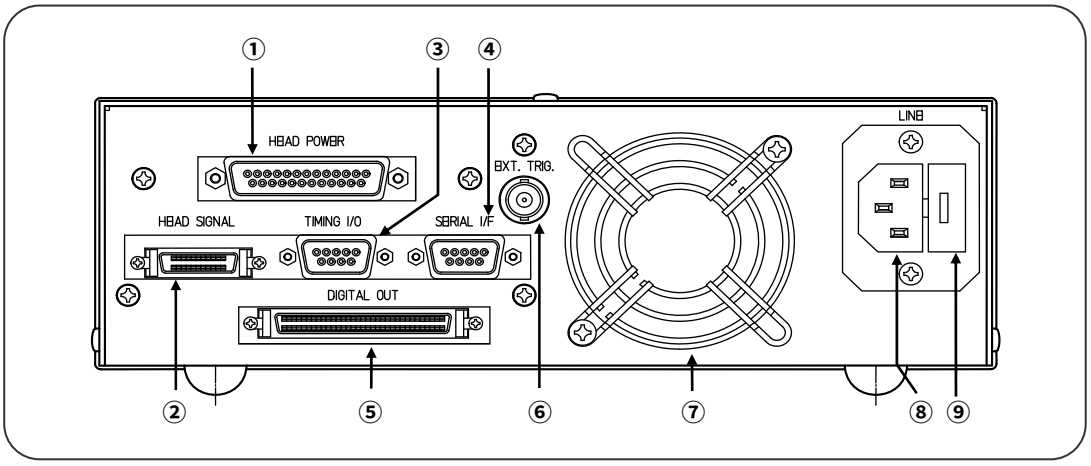



Fig. 6-3

### ① Camera connector [HEAD POWER]

### ② Camera connector [HEAD SIGNAL]

This is used to connect the camera head to the camera control unit. Use the special cable provided for that purpose.

### ③ Timing I/O connector [TIMING I/O]

- This is an optional function. Do not connect it.

### ④ Serial interface connector [SERIAL I/F]

This connects to communicate various commands required to operate the camera to the host computer.

### ⑤ Digital interface connector [DIGITAL OUT]

This connects the Camera control unit to a digital image input board.

### ⑥ Trigger input connector [EXT.TRIG.]

This is used when the camera is to be operated in External control mode. Input is at TTL level External control operation is carried out at the falling or rising edge of an external control pulse.

### ⑦ Air outlet

This is the outlet for the heat ventilation.

- Make sure a space of at least 10 cm is available at the back of the unit for ventilation.

### ⑧ AC inlet [LINE]

This is the power supply connector. It uses the attached power supply cord.

### ⑨ Fuse holder

This is the holder for the power supply fuse.

**Note**

- Please refer to Chapter 12 when you replace a fuse.

# 7. CONNECTING CABLES

Refer to the figure below when connecting the various cables.

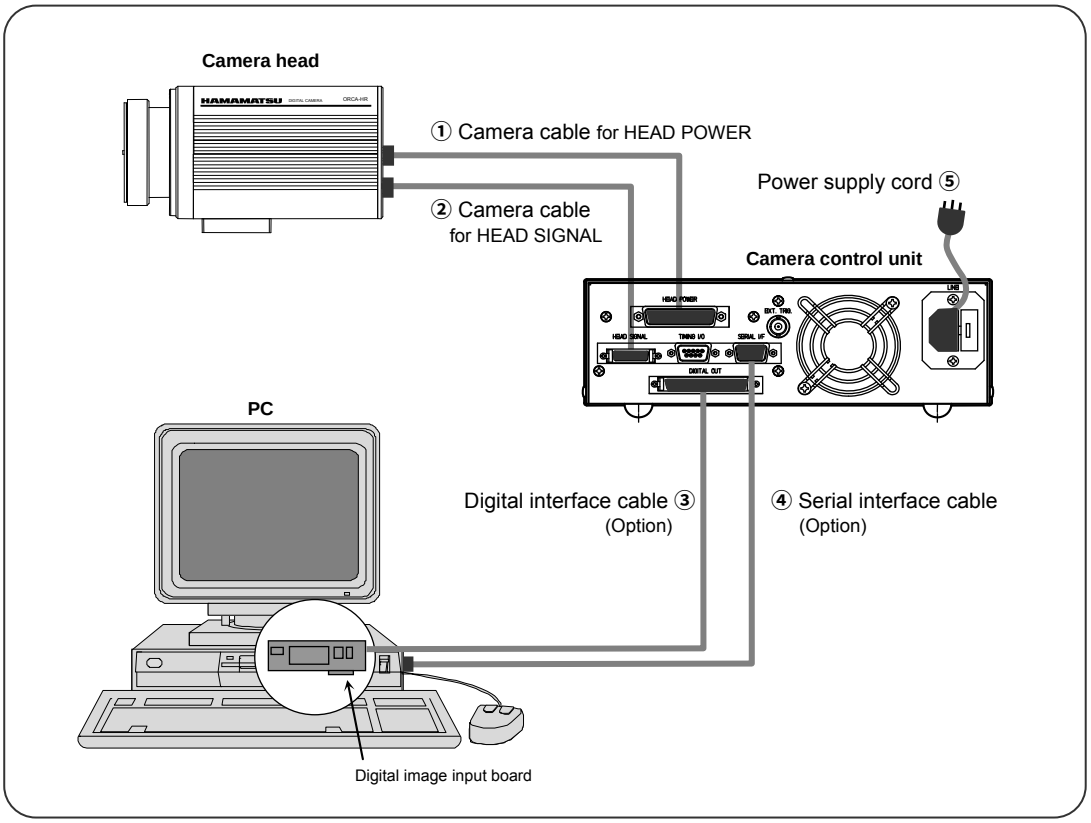



Fig. 7-1

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

### ① Camera cable for HEAD POWER

This connects the camera connector (HEAD POWER) on the camera control unit to the camera head. The cable is non-polar.

### ② Camera cable for HEAD SIGNAL

This connects the camera connector (HEAD SIGNAL) on the camera control unit to the camera head. The cable is non-polar.

### ③ Digital interface cable (Option)

This connects the digital interface connector (DIGITAL OUT) on the camera control unit to an external frame grabber used for data storage. The connector on the frame grabber will differ according to the manufacturer, so the digital image input board's cable should be used.

### ④ Serial interface cable (Option)

This line transfers commands for the operation of the camera from an external host computer. It connects the serial interface connector (SERIAL I/F) on the camera control unit with the host computer. The connector on the host computer will vary according to the manufacturer, so a suitable cable should be used.

- The serial control line of digital interface connector and the serial interface connector are internally connected. Do not connect the two connectors simultaneously.

### ⑤ Power supply cord

Connect the power supply cord provided after checking that the AC line voltage is the range shown in the table below and that the power switch of the camera control unit is turned OFF.

| Voltage | Input voltage range |
|---|---|
| AC 100 V | AC 90 V to AC 110 V |
| AC 117 V | AC 106 V to AC 128 V |
| AC 220 V to AC 230 V | AC 198 V to AC 253 V |
| AC 230 V to AC 240 V | AC 207 V to AC 264 V |

**Note**

- At shipment, the voltage is set for the customer. Use the camera with the voltage indicated on the rating sticker.

**Note**

- Hamamatsu recommends optional interface for the camera.
  -Digital interface cable: A8518-05
  -Serial interface cable: A4895-05
  Depending on type of interface cables, the camera may not keep CE marking compliance in terms of EMC directive.

# 8. OPERATION

## 8-1 PRECAUTIONS

### (1) Ambient temperature

This equipment is cooled using a Peltier element. The Peltier element cools on one side and heats on the other when a current is passed through it. The CCD chip is positioned on the cool side, while the side, which heats up, is cooled by the dispersion of heat to the chassis. As a result, it is necessary to use this equipment in an environment with a stable temperature. The recommended ambient temperature is 20 ºC.

### (2) Starting up the control software

The control software should be started up a few seconds after the power supply for the camera has been turned on. If the Serial Interface receives a command when the camera's power supply is switch on, the camera may not start up correctly. If this happens, shut down the camera and the control software immediately and restart them.

**Note**

- Control software is not attached to the camera.

## 8-2 PREPARATION FOR IMAGING

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

(2) Switch the power supply for the camera to ON.

Once the power has been ON for around 10 minutes, the cooling temperature will stabilize, and imaging preparation is complete.

## 8-3 IMAGING

Turn on the power supply.

| | |
|---|---|
| Digital data output pixel number | 2000×1312 |
| Scan mode | 2×2 binning readout |
| Exposure time setting | 100 ms |
| Contrast enhancement gain | 0 |
| Contrast enhancement gain | 0 |
| A/D bit count | 12 |

The camera begins imaging using the above settings.
Mode settings and parameters can be changed by transmitting commands through the Serial Interface of the host computer.

## 8-4 END OF IMAGING

Carry out the procedure below when imaging is completed.

(1) Finish imaging or transmission of image data with the control software.

(2) Turn on the power to the camera and peripheral equipment.

# 9. IMAGE ACQUISITION

## 9-1 OVERVIEW OF CAMERA MODES

This camera features many different operational modes. Furthermore, all modes involve the CameraLink interface's built-in microprocessor, providing control and setting for all modes. Of the numerous different modes, the modes used for obtaining images are broadly classified into the two categories below.

### (1) Free running mode

Exposure and readout is performed repeatedly, controlled by the internal microprocessor. Some operations for which the commands can be used are shown below.

| | |
|---|---|
| Scan mode | Interlace readout/Binning readout /Sub-array readout/Outline readout |
| Exposure time setting | Normal/Electronic shutter/Frame blanking |
| Digital data output bit count | 12 bit/10 bit/8 bit |

The image can also be improved using the contrast enhancement function.

### (2) External control mode

An external control (trigger) pulse input the internal microprocessor and the repeating exposure and readout. Exposure start timing and length of exposure can be controlled with the external trigger pulse. In addition, commands can be used the following.

| | |
|---|---|
| Exposure time setting | Internal/External |
| Digital data output bit count | 12 bit/10 bit/8 bit |
| External control pulse polarity | Negative/Positive |

The image can also be improved using the contrast enhancement function.

**Note**

- Please refer to Chapter 10 for the detail of commands.

## 9-2 DIGITAL DATA OUTPUT BIT COUNT

Selects the number of digital data output bits from the camera.

| | |
|---|---|
| 12 bit digital data output to DB0 to DB11 | ADS 12 |
| First 10 bits of 12 bit digital data output to DB0 to DB9 | ADS 10 |
| First 8 bits of 12 bit digital data output to DB0 to DB7 | ADS 8 |

## 9-3 CCD READOUT METHODS (SCAN MODE)

Selects one of interlace readout, binning readout, sub-array readout or outline readout.

### (1) Interlace readout ..... SMD I

A readout method that allocates each horizontal scan readout into odd or even fields. Timing is as shown in Fig. 9-1. Frame rate for this operation is 1.7 Hz. Digital output is converted into progressive output inside the Camera control unit before being output.

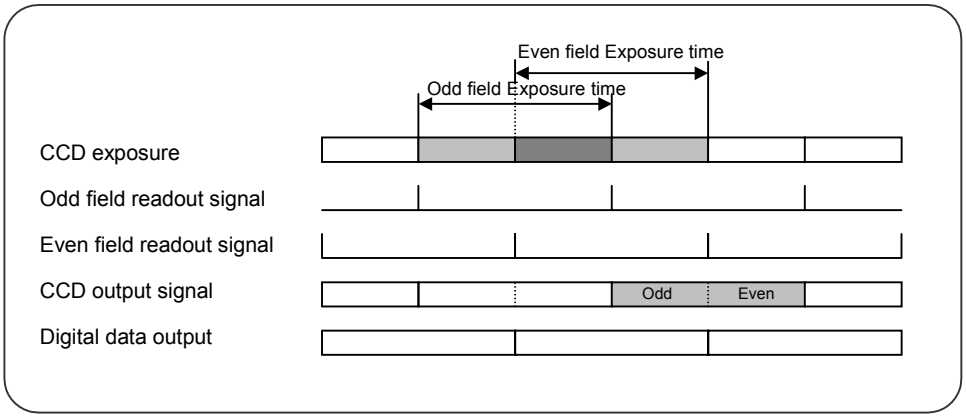



Fig. 9-1 Readout timing in Interlace readout

### (2) Binning readout ..... SMD S

This readout adds a specified number of charges accumulated in the CCD in the horizontal and vertical directions and reads out from the CCD. The CCD output is progressive, and the timing of the readout is as shown in Fig. 9-2. The camera can be specified to add 2 pixels to each of horizontal and vertical readings, i.e. 2×2 binning, or 4 pixels to each (4×4 binning).

| Binning | Command |
|---|---|
| 2×2 binning readout | SPX 2 |
| 4×4 binning readout | SPX 4 |

### (3) Sub-array readout ..... SMD A

This readout allows the user to specify their required limits and give a readout for that area only. The CCD readout will in this case be a binning readout, and the timing is as shown in Fig. 9-2. The specification of limits (horizontal offset, vertical offset, horizontal width, and vertical width) is done using the CCD image positioning specifications.

| Sub-array | Command | |
|---|---|---|
| Horizontal offset | SHO | 8×n (0≦n≦499) |
| Vertical offset | SVO | 8×n (0≦n≦327) |
| Horizontal width | SHW | 8×m (1≦m≦500) |
| Vertical width | SVW | 8×m (1≦m≦328) |

**(4) Outline readout ..... SMD O**

This readout enables fast image readout, by thinning the CCD pixels. The frame rate during this mode is 8.9 Hz. The CCD output is progressive, and the timing is as shown in Fig. 9-2.

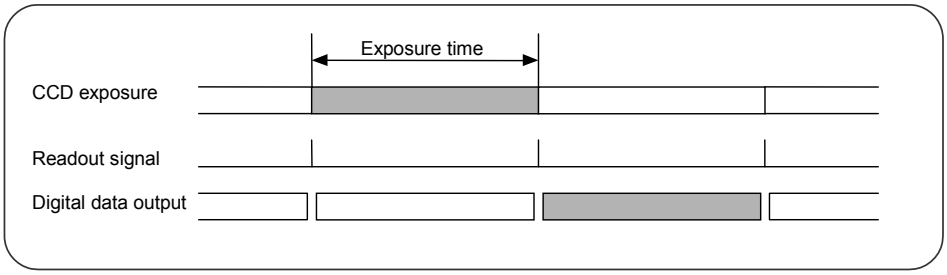



Fig. 9-2 Readout timing in progressive output

## 9-4 EXPOSURE TIME SETTING

A related figure of scan mode is shown in 9-6, so please refer to there.

### 9-4-1 FREE RUNNING MODE [AMD N]

In Free running mode, the possible specifications for length of exposure are normal, units of 1 horizontal scan, units of 1 vertical scan, or real time.

**(1) Norma readout ..... NMD N**

Repeats cycle of exposure and readout according to an internally specified sequence.

**(2) Units of 1 horizontal scan ..... SHT n**

Repeats cycle of exposure and readout according to an internally specified sequence while operating an electronic shutter. The length of exposure (electronic shutter time) is set in units of 1 horizontal scan with the command SHT n. The time taken for 1 horizontal scan and the possible specification limits vary from mode to mode.

**(3) Units of 1 vertical scan ..... FBL n**

Repeats cycle of exposure and readout according to an internally specified sequence, while carrying out frame blanking (continuing to expose a specified number of frames with the photo sensor). The length of exposure (frame blanking value) is set in units of 1 vertical scan with the command FBL n. The time taken for 1 vertical scan and the possible specification limits vary from mode to mode.

**(4) Time unit specification ..... AET ss.xxx**

Length of exposure can be specified in real time using the command AET ss.xxx (where s=seconds, x=milliseconds). The actual length of exposure time is the specified time taken as a value expressed in horizontal scan units. The actual length of exposure time can be confirmed using the ?RAT command. Exposure for longer than 10 s is not possible.

## 9-4-2 EXTERNAL CONTROL MODE [AMD E, ATP N/ATP P]

In external mode, the internal microprocessor is controlled by an external control pulse input through the trigger input connector (EXT.TRIG.), while the exposure/readout cycle is repeated. The external control pulse is at TTL level, and the polarity can be specified using the ATP command (N: Low level active / P: High level active). The minimum active period is 40 µs, and it is necessary to specify the repeat periods to match the selected mode.
The length of exposure can be specified either using internal or external settings.

**Note**

- If a pulse of less than 40 µs is input, the image will not be output correctly.

Note: The following explanation indicates a situation where the external control pulse has been specified as negative. The additions in brackets show a situation where the pulse is specified as positive.

### (1) Internal shutter time settings ..... EMD E

It is possible to specify the length of exposure in units of 1 horizontal scan period using the EST n command.
Exposure begins within 30 µs of the trailing edge (leading edge) of the external control pulse, and gives an exposure and readout according to the time specified using the EST n command. Once the readout has been completed, it waits for the next trailing edge (leading edge).
The external control pulse's repeat cycle must be set higher than the frame rate for each mode.

### (2) Internal acquire time settings ..... EMD T

It is possible to specify the length of exposure in units of time using the AET command.
Exposure begins within 30 µs of the trailing edge (leading edge) of the external control pulse, and gives an exposure and readout according to the time specified using the AET command. Once the readout has been completed, it waits for the next trailing edge (leading edge).
The external control pulse's repeat cycle must be set higher than the frame rate for each mode.

### (3) External specifications ..... EMD L

Exposure begins within 30 µs of the trailing edge (leading edge) of the external control pulse. The exposure is then completed within 40 µs of the trailing edge (leading edge) of the external control pulse. Once the readout has been completed, it waits for the next trailing edge (leading edge). The length of exposure is controlled by the low (high) of the external control pulse. It is not possible to expose for longer than 10 s.

## 9-5 SCAN MODE RELATED FIGURE

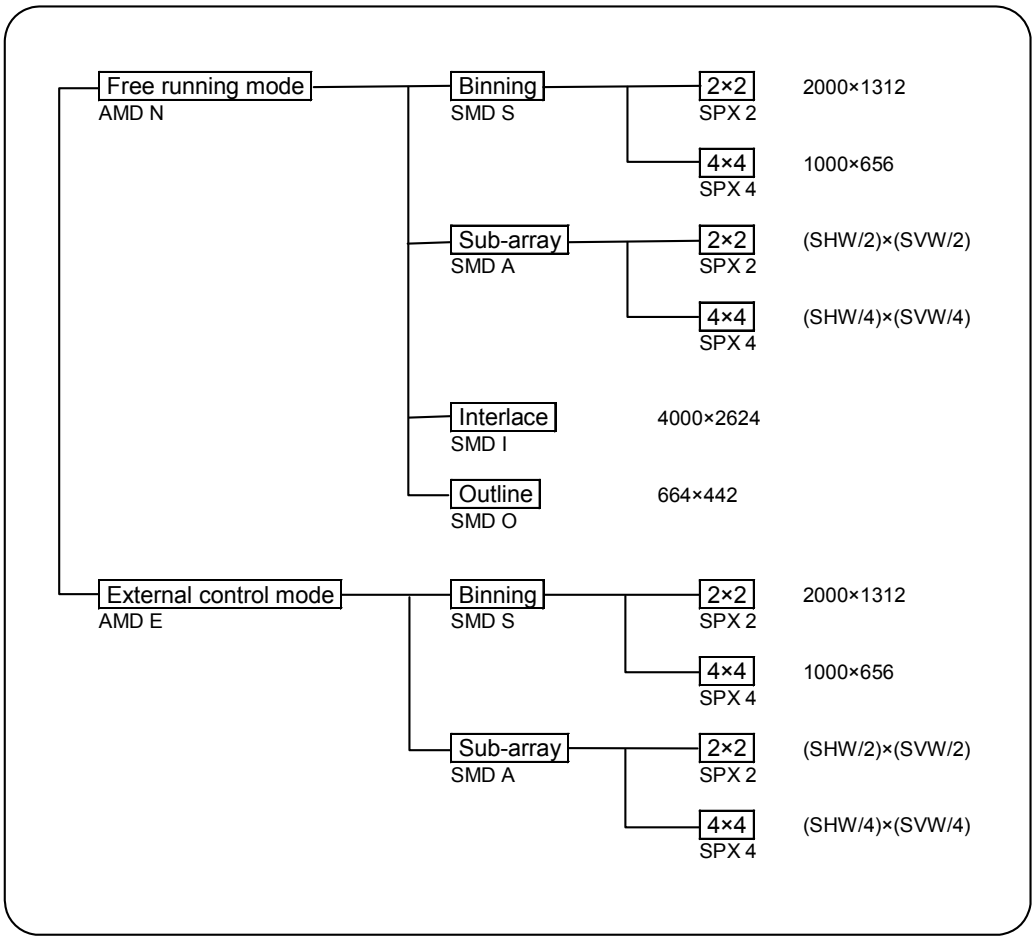
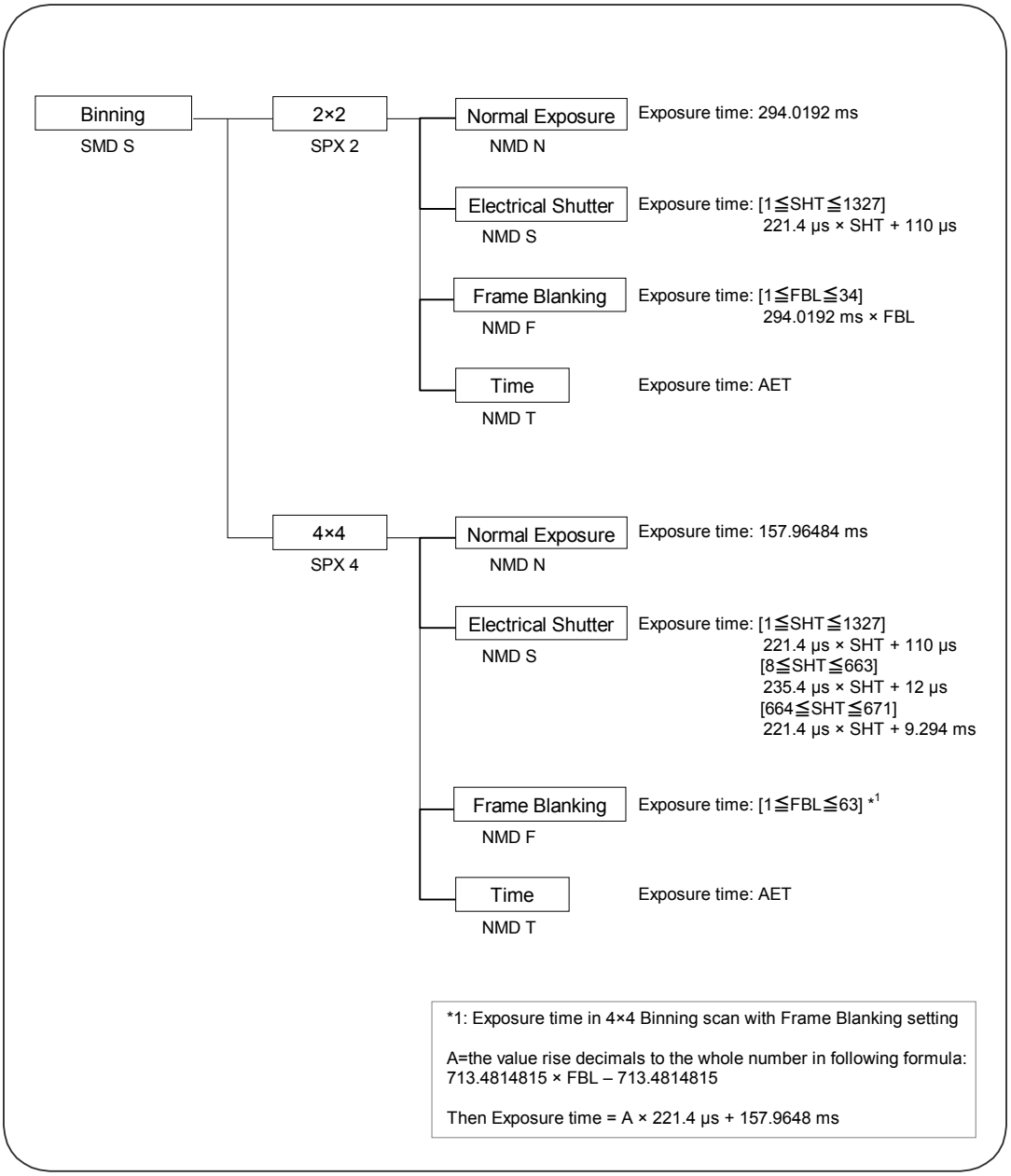



Fig. 9-3

# 9-6 EXPOSURE TIME RELATED FIGURE

## 9-6-1 FREE RUNNING MODE

### (1) Binning readout

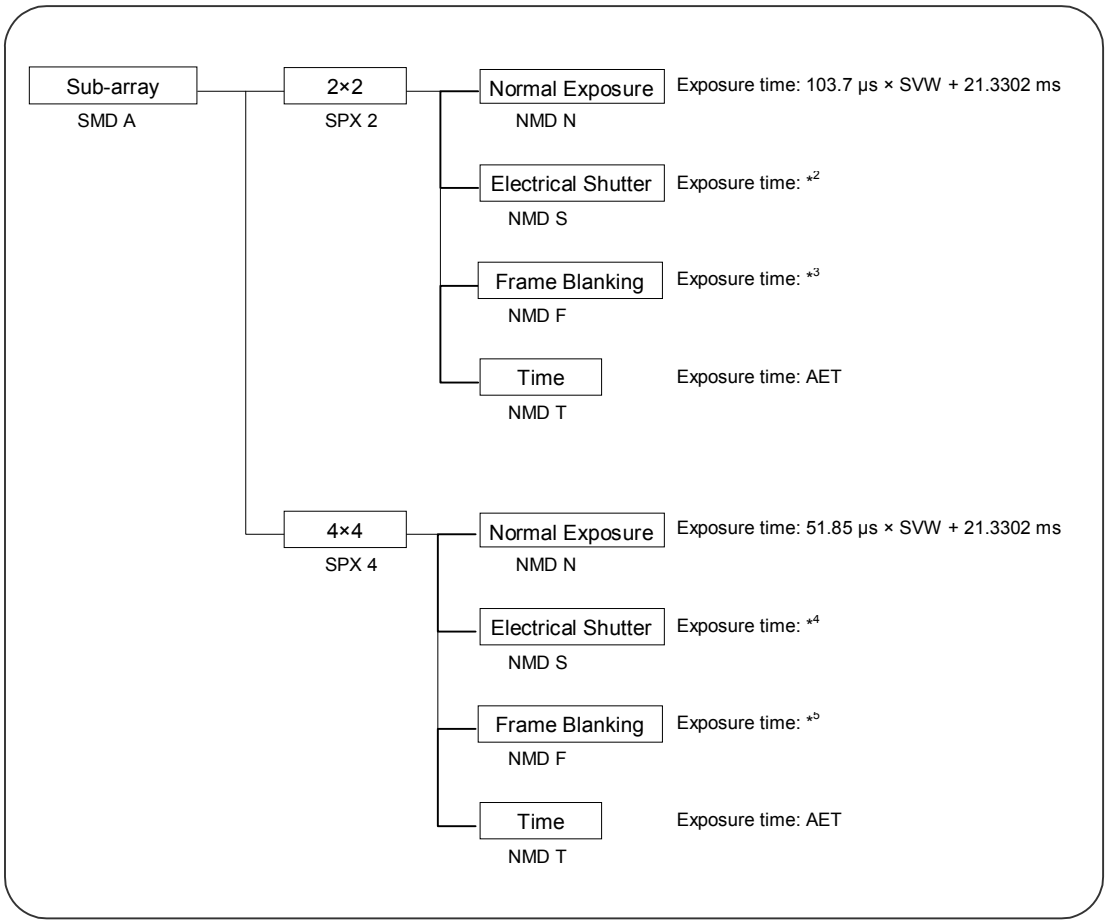



*1: Exposure time in 4×4 Binning scan with Frame Blanking setting

A=the value rise decimals to the whole number in following formula:
713.4814815 × FBL – 713.4814815

Then Exposure time = A × 221.4 µs + 157.9648 ms

## (2) Sub-array readout




***2: Exposure time in 2×2 Sub-array scan with Electrical Shutter setting**

A: SHT=1
B: 2≦SHT≦1319-(SVO/2)-(SVW/2)
C: 1320-(SVO/2)-(SVW/2)≦SHT≦1321-(SVO/2)
D: 1322-(SVO/2)≦SHT≦1325-(SVO/2)
E: 1326-(SVO/2)≦SHT≦1325
F: 1326≦SHT≦1327

A: 331.4 µs
B: 14 µs×SHT+317.4 µs
C: 221.4 µs×SHT+103.7 µs×(SVO+SVW)-273.2432 ms
D: 387.45 µs×SHT+186.725 µs×SVO+103.7 µs×SVW-492.5925 ms
E: 14 µs×SHT+103.7 µs×SVW+2226 µs
F: 221.4 µs×SHT+103.7 µs×SVW-272.579 ms

***3: Exposure time in 2×2 Sub-array scan with Frame Blanking setting**

A=the value rise decimals to the whole number in following formula:
(FBL-1)×(0.468383017×SVW+96.34236676)

Then Exposure time=A×221.4 µs+103.7 µs×SVW+21.3302 ms

**4: Exposure time in 4×4 Sub-array scan with Electrical Shutter setting**

A: SHT=1
B: 2≦SHT≦1319-(SVO/2)-(SVW/2)
C: 1320-(SVO/2)-(SVW/2)≦SHT≦1319-(SVO/2)-(SVW/4)
D: 1320-(SVO/2)-(SVW/4)≦SHT≦1321-(SVO/2)-(SVW/4)
E: 1322-(SVO/2)-(SVW/4)≦SHT≦1325-(SVO/2)-(SVW/4)
F: 1326-(SVO/2)-(SVW/4)≦SHT≦1325-(SVW/4)
G: 1326-(SVW/4)≦SHT≦1327-(SVW/4)

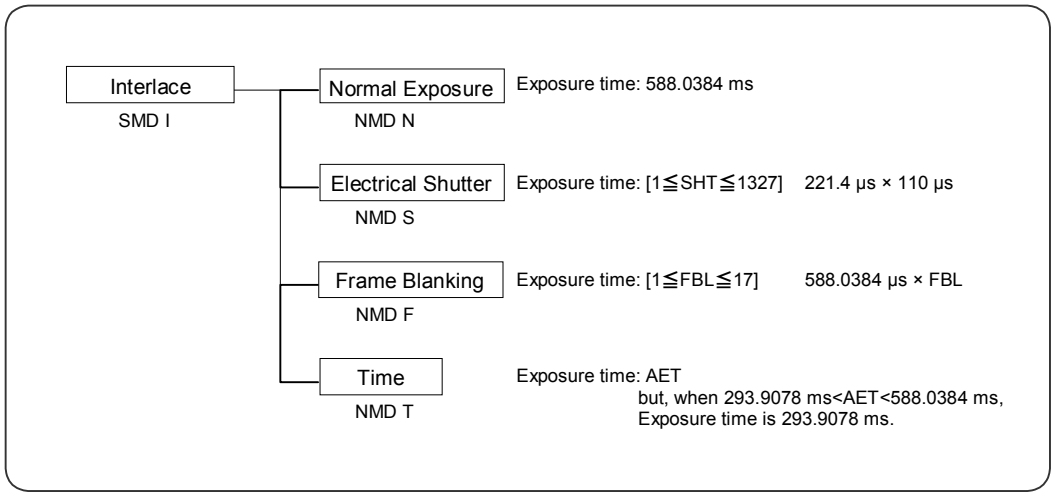
A: 331.4 µs
B: 14 µs×SHT+317.4 µs
C: 235.4 µs×SHT+110.7 µs×(SVO+SVW)-291.7092 ms
D: 221.4 µs×SHT+103.7 µs×SVW-273.2432 ms
E: 387.45 µs×SHT+186.725 µs×SVO+148.7125 µs×SVW-492.5925 ms
F: 14 µs×SHT+55.35 µs×SVW+2226 µs
G: 221.4 µs×SHT+107.2 µs×SVW-272.579 ms

***5: Exposure time in 4×4 Sub-array scan with Frame Blanking setting**

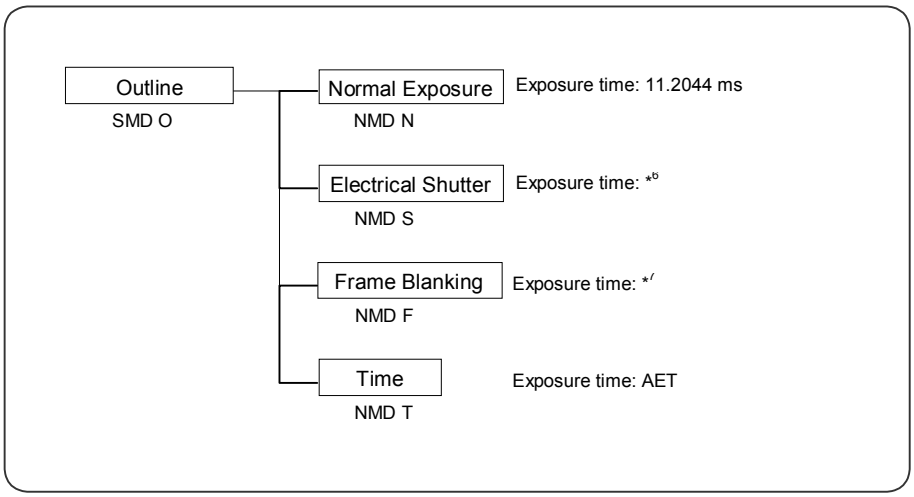
A=the value rise decimals to the whole number in following formula:
(FBL-1)×(0.234191508×SVW+96.34236676)

Then Exposure time=A×221.4 µs+51.85 µs×SVW+21.3302 ms

## (3) Interlace readout




## (4) Outline readout




***6: Exposure time in outline scan with Electrical shutter setting**

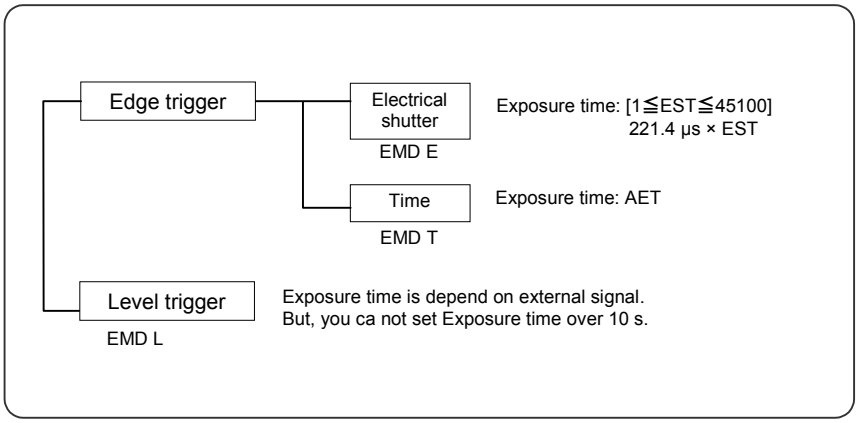
| | |
|---|---|
| [1≦SHT≦2] | 14 µs×SHT+90 µs |
| [SHT=3] | 339.490 µs |
| [4≦SHT≦5] | 14 µs×SHT+297.4 µs |
| [SHT=6] | 588.8 µs |
| [7≦SHT≦8] | 14 µs×SHT+504.8 µs |
| [9≦SHT≦449] | 249.4 µs×SHT-1378.4 µs |
| [SHT=450] | 110.8236 ms |
| [451≦SHT≦452] | 14 µs×SHT+104.5236 ms |

***7: Exposure time in outline scan with Frame Blanking setting**

A=the value rise decimals to the whole number in following formula:
502.2782294×FBL-502.2782294

Then Exposure time=A×221.4 µs+111.2044 ms

## 9-6-2 EXTERNAL CONTROL MODE



# 10. COMMAND SPECIFICATIONS

## 10-1 COMMUNICATIONS INTERFACE

The camera can be externally controlled from a host computer via the serial interface. The serial interface communications specifications are as shown below.

| | |
|---|---|
| Baud rate | 9600 |
| Bit length | 8 |
| Parity check | None |
| Stop bit | 1 |

## 10-2 COMMAND FORMAT (BASIC SYSTEM)

External control commands for the camera are output from the host computer as follows:

| **Command_ parameter** | **CR** |
|---|---|

CR: Carriage return

The command is output with <CR> included as the final item of data.
For commands requiring parameters, a space ( _ ) should be left between the command and the parameters.

## 10-3 CAMERA RESPONSES TO COMMANDS

The camera responds to commands output by the host computer. It is possible to specify whether the camera responds or not by using a RES (RESponse) command. It is not possible, however, to specify no response to a status command.

| | | | |
|---|---|---|---|
| RES | (RESponse) | | |
| | Function | Sets the response or otherwise of the camera to commands output from the host computer. | |
| | Parameter | Y/N | |
| | Example | RES Y | Response will be given to each command. (default) |
| | | RES N | No response will be given to each command. |

The explanation below assumes a case in which a response is given using the RES command.
The response indicates that the camera has actually completed the task required of it by the command received, and differs depending on the type of command.

### (1) Response to executed command and to specified commands

When an operation has been correctly carried out, a response is sent to the host computer by the implemented command (with parameters)

| XXX_PP | CR |
|---|---|

XXX: The implemented command
PP: Parameter

If there is an error in the command sent by the host computer (undefined command), the following response code is sent:

| E3 | CR |
|---|---|

If the command sent by the host computer is not suitable for the currently operating mode, the following error message is sent:

| E4 | CR |
|---|---|

If there is an error in the command parameters sent by the host computer (undefined parameters) the following error message is sent:

| E5 | CR |
|---|---|

If the command parameters sent by the host computer are not suitable for the currently operating mode, the following error message is sent:

| E6 | CR |
|---|---|

### (2) Response to status commands

(These are output regardless of the specification of RES commands)
Once the camera has correctly interpreted the command, the execution contents of the status command cause the necessary status to be sent to the host computer. As a result, the sending of status to the host computer is part of the normal response when implementing a status command.

| XXX_PP | CR |
|---|---|

XXX: Command name (3 letters without ?)
PP: Status of that command

If there is an error in the command sent by the host computer (undefined command), the following response code is sent, as with an execution / specification command:

| E3 | CR |
|---|---|

### (3) Response when an error occurs during reception

If there is an irregularity while receiving data, the cause could be either of the following: a framing, parity or overrun error, or a receiving buffer overflow. If either of these occurs, the following error code is sent:

| En | CR |
|---|---|

Here, n represents the contents of the error, and the following number shows the contents:

n = 1: Framing, parity, over run error
n = 2: Receiving buffer overflow

If either of these two errors occurs, the command that caused the error can be cancelled from the camera's receiving buffer.

## 10-4 OVERVIEW OF COMMANDS

External control commands are broadly divided into the 5 categories shown below.

- Mode setting commands
- Parameter setting commands
- Correction commands
- Other setting commands
- Status commands

### (1) Mode setting commands

The group of commands that change modes, enabling image acquisition.

| | |
|---|---|
| AMD | Selects the camera mode in the CCD exposure start timing. |
| NMD | Selects the method used to set the exposure time when the CCD exposure start timing is Free running mode. |
| EMD | Selects the method used to set the exposure time when the CCD exposure start timing is External control mode. |
| SMD | Selects the scan mode. |
| ADS | Selects the digital data output bit count. |

### (2) Parameter setting commands

The group of commands that specify parameters, such as length of exposure and digital output pixels.

| | |
|---|---|
| AET | Sets the length of exposure when length of exposure method is set to real time. |
| SHT | Sets the length of exposure when the exposure start timing is Free running mode. (Sets electronic shutter speed) |
| FBL | Sets length of exposure when the exposure start timing is Free running mode. (Sets frame blanking speed) |
| EST | Sets the length of exposure when the exposure start timing is External control mode. (Sets electronic shutter speed when length of exposure is Internal setting.) |
| SPX | Selects the binning count when the binning command is selected with SMD command. |
| SHO | Sets the horizontal start address for sub-array readout. |
| SHW | Sets the horizontal width for sub-array readout. |
| SVO | Sets the vertical offset for sub-array readout. |
| SVW | Sets the vertical width for sub-array readout. |
| ATP | Selects the external trigger pulse polarity. |
| ESC | Selects the input connector for external control pulse. |

### (3) Correction commands

The group of commands which specify adjustments such as contrast and enhancement.

| | |
|---|---|
| CEG | Sets contrast enhancement gain. |
| CEO | Sets contrast enhancement offset. |

### (4) Other setting commands

Other specification commands such as that required initializing the camera.

| | |
|---|---|
| INI | Initializes the specification values for the various operating conditions of the camera. |
| RES | Selects the camera's response to commands. |

### (5) Status commands

In the case of status commands, once the command is output from the host computer, the camera returns a response. Status commands all begin with '?', and those which are related to specification commands take the form of the command with '?' added beforehand.

| | |
|---|---|
| ?AMD | Returns the setting the camera mode in the CCD exposure start timing. |
| ?NMD | Returns the setting the method used to set the exposure time when the CCD exposure start timing is Free running mode. |
| ?EMD | Returns the setting the method used to set the exposure time when the CCD exposure start timing is External control mode. |
| ?SMD | Returns the setting the scan mode. |
| ?ADS | Returns the setting the digital data output bit count. |
| ?AET | Returns the setting length of exposure value. |
| ?SHT | Returns the specified length of exposure value where the start of exposure timing is Free running mode. |
| ?FBL | Returns the specified length of exposure value where the start of exposure timing is Free running mode. |
| ?EST | Returns the specified length of exposure value where the start of exposure timing is External control mode. |
| ?SPX | Returns the setting the binning count. |
| ?SHO | Returns the setting value for the horizontal start address. |
| ?SHW | Returns the setting value for the horizontal line width. |
| ?SVO | Returns the setting value for the vertical start address. |
| ?SVW | Returns the setting value for the vertical line width. |
| ?ATP | Returns the external trigger pulse polarity. |
| ?ESC | Returns the setting the input connector for external control pulse. |
| ?CEG | Returns the setting value the contrast enhancement gain. |
| ?CEO | Returns the setting value the contrast enhancement offset. |
| ?RES | Returns the setting for the command response. |
| ?RAT | Returns the actual length of exposure value currently specified. |
| ?VER | Returns the version of the camera's internal components. |
| ?CAI | Returns the information about the camera hardware. |

## 10-5 DETAIL OF COMMANDS

(The bold-faced type of each parameter is initialization.)

### (1) Mode setting commands

| | | | |
|---|---|---|---|
| AMD | (Acquire MoDe) | | |
| | Parameter | **N** (Normal)/E (External) | |
| | Function | Selects Free running mode or External control mode for the CCD exposure start timing. | |
| | Example | **AMD N** | After issuing mode specification command, image is acquired under Free running mode. |
| | | AMD E | After issuing mode specification command, exposure begins and image is acquired under External control mode. |
| NMD | (Normal MoDe) | | |
| | Parameter | N (Normal)/S (Shutter)/F (Frame blanking)/**T** (Time) | |
| | Function | Selects the exposure time setting method from either: Normal / Electronic shutter / Frame blanking / Time, when Free running mode. | |
| | Example | NMD N | After issuing mode specification command, exposure is carried out using normal exposure time. |
| | | NMD S | After issuing mode specification command, exposure is carried out using electronic shutter operation. |
| | | NMD F | After issuing mode specification command, exposure is carried out using frame blanking operation. |
| | | **NMD T** | After issuing mode specification command, exposure is carried out according to exposure time specification. |
| EMD | (External MoDe) | | |
| | Parameter | E (Edge)/**T** (Time)/L (Level) | |
| | Function | Selects the exposure time setting method from either: Internal setting or External setting, when External control mode. | |
| | Example | EMD E | After issuing mode specification command, exposure is carried out according to internal length specified by EST command. |
| | | **EMD T** | After issuing mode specification command, exposure is carried out according to internal length specified by AET command. |
| | | EMD L | After issuing mode specification command, exposure is carried out according to external trigger level. |
| SMD | (Scan MoDe) | | |
| | Parameter | **S** (Super pixel)/A (sub-Array)/I (Interlace)/O (Outline) | |
| | Function | Selects between Binning (Super pixel) readout / Sub-array readout / Interlace readout / Outline readout. | |
| | Example | **SMD S** | After issuing mode specification command, gives Binning readout. |
| | | SMD A | After issuing mode specification command, gives Sub-array readout. |
| | | SMD I | After issuing mode specification command, gives Interlace readout. |
| | | SMD O | After issuing mode specification command, gives Outline readout. |

| | | | |
|---|---|---|---|
| ADS | (A/D Select) | | |
| | Parameter | **12** (12 bit output)/10 (10 bit output)/8 (8 bit output) | |
| | Function | Selects between 12 bit / 10 bit / 8 bit output. | |
| | Example | **ADS 12** | Outputs 12 bit digital data to DB11 to DB0. |
| | | ADS 10 | Outputs first 10 bits of 12 bit digital output to DB9 to DB0. |
| | | ADS 8 | Outputs first 8 bits of 12 bit digital output to DB7 to DB0. |

## (2) Parameter setting commands

| | | | |
|---|---|---|---|
| AET | (Acquire Exposure Time) | | |
| | Parameter | ss.xxx * ss: seconds, xxx: milliseconds<br>(Initial value: **0.100**) | |
| | Function | Sets length of exposure, when length of exposure method is set to real time, and when exposure start timing is under Free running mode or External control mode. | |
| SHT | (SHutter Time) | | |
| | Parameter | n * n: number of horizontal lines (Initial value: **452**)<br>1≦n≦1327 2×2 binning readout<br>1≦n≦ 671 4×4 binning readout<br>1≦n≦1327 Interlace readout<br>1≦n≦ 452 Outline readout | |
| | Function | Sets length of exposure (electronic shutter timing) in units of 1 horizontal line, where exposure start timing is under Free running mode and length of exposure method is the electronic shutter. | |
| FBL | (Frame BLanking) | | |
| | Parameter | n * n: number of frames (Initial value: **2**)<br>1≦n≦34 2×2 binning readout<br>1≦n≦63 4×4 binning readout<br>1≦n≦17 Interlace readout | |
| | Function | Sets number of frames, where exposure start timing is under Free running mode and length of exposure method is frame blanking. The maximum number of frames specifiable is the closest number of frames to an exposure time of 10 s. | |
| EST | (External Shutter Time) | | |
| | Parameter | n * n: number of horizontal lines (Initial value: **452**)<br>1≦n≦45100 | |
| | Function | Sets length of exposure (electronic shutter timing) in units of 1 horizontal line, where exposure start timing is under External control mode and length of exposure method is specified Internal setting, and real time specification has not been selected. | |
| | Example | EST 1 | Sets length of exposure to 221.4 µs. |
| | | EST 10 | Sets length of exposure to 2.214 ms. |

| | | | |
|---|---|---|---|
| SPX | (Super Pixel X) | | |
| | Parameter | **2** (2×2)/4 (4×4) | |
| | Function | Selects 2×2 / 4×4 binning readout when scan mode is in Binning readout or Sub-array readout. | |
| | Example | **SPX 2** | Gives 2×2 binning readout, after issuing command mode specification. |
| | | SPX 4 | Gives 4×4 binning readout, after issuing command mode specification. |
| SHO | (Scan Horizontal Offset) | | |
| | Parameter | 8×n 0≦n≦499 (Initial value: **0**) | |
| | Function | Sets horizontal offset during Sub-allay readout. Sets using Interlace readout position. Only accepts multiples of 8. | |
| | Example | SHO 0 | Sets horizontal offset to 0. |
| SHW | (Scan Horizontal Width) | | |
| | Parameter | 8×m 0≦m≦500 (Initial value: **4000**) | |
| | Function | Sets horizontal width during Sub-array readout. Sets using Interlace readout pixels value. Only accepts multiples of 8. | |
| SVO | (Scan Vertical Offset) | | |
| | Parameter | 8×n 0≦n≦327 (Initial value: **0**) | |
| | Function | Sets vertical offset during Sub-array readout. Sets using Interlace readout position. Only accepts multiples of 8. | |
| SVW | (Scan Vertical Width) | | |
| | Parameter | 8×m 0≦m≦328 (Initial value: **2624**) | |
| | Function | Sets horizontal width during Sub-array readout. Sets using Interlace readout pixels value. Only accepts multiples of 8. | |
| ATP | (Active Trigger Polarity) | | |
| | Parameter | **N** (Negative)/P (Positive) | |
| | Function | Sets external control pulse polarity. | |
| | Example | **ATP N** | Sets external control pulse polarity to negative. |
| | | ATP P | Sets external control pulse polarity to positive. |
| ESC | (External trigger Source Connector) | | |
| | Parameter | **B** (BNC connector)/D (D-sub I/O connector)/I (I/F connector) | |
| | Function | Selects input connector for external control pulse. | |
| | Example | **ESC B** | Receives external control pulse via BNC connector of the camera control unit. |
| | | ESC D | Receives external control pulse via D-sub I/O connector of the camera control unit.<br>* This is an optional function. |
| | | ESC I | Receives external control pulse via Digital interface connector of the camera control unit. |

### (3) Correction commands

| | | | |
|---|---|---|---|
| CEG | (Contrast Enhancement Gain) | | |
| | Parameter | n (0 to 255) (Initial value:**0**) | |
| | Function | Sets contrast enhancement gain. | |
| | Example | CEG 100 | Sets gain to 100. |
| | | CEG 255 | Sets gain to maximum value. |
| CEO | (Contrast Enhancement Offset) | | |
| | Parameter | n (0 to 255) (Initial value:**0**) | |
| | Function | Sets contrast enhancement offset. | |
| | Example | CEG 100 | Sets offset to 100. |
| | | CEG 255 | Sets offset to maximum value. |

### (4) Other setting commands

| | | | |
|---|---|---|---|
| INI | (INItialize) | | |
| | Parameter | None | |
| | Function | Initializes The camera control unit internal parameter RAM contents. | |
| RES | (RESponse) | | |
| | Parameter | **Y**/N | |
| | Function | Sets whether or not response is returned after execution of each command. | |
| | Example | **RES Y** | Returns response after each command implemented. |
| | | RES N | No response returned after each command implemented. |

### (5) Status commands

Status commands return currently specified values.

| Commands | | Response |
|---|---|---|
| ?AMD | (read Acquire MoDe) | N/E |
| ?NMD | (read Normal MoDe) | N/S/F/T |
| ?EMD | (read External MoDe) | E/L |
| ?SMD | (read Scan MoDe) | S/A/I/O |
| ?ADS | (read A/D Select) | 12/10/8 |
| ?AET | (read Acquire Exposure Time) | ss.xxx |
| ?SHT | (read Shutter Time) | n |
| ?FBL | (read Frame BLanking) | n |
| ?EST | (read External Shutter Time) | n (1 to 95040) |
| ?SPX | (read Super Pixel X) | 2/4 |
| ?SHO | (read Super H-offset) | N |
| ?SHW | (read Super H-Width) | N |
| ?SVO | (read Scan V-Offset) | N |
| ?SVW | (read Scan V-Width) | N |
| ?ATP | (read Active Trigger Polarity) | N/P |
| ?ESC | (read External trigger Source Connector) | B/D/I |
| ?CEG | (read Contrast Enhancement Gain) | n (0 to 255) |
| ?CEO | (read Contrast Enhancement Offset) | n (0 to 255) |
| ?RES | (read RESponse) | Y/N |

The commands below are status-only commands, which do not exist as specification commands:

| | | |
|---|---|---|
| ?RAT | (read Real Acquire Time) | |
| | Function | Returns the actual length of exposure time. |
| | Return value | ss.xxx |
| ?VER | (read rom VERsion) | |
| | Function | Returns the camera ROM version. |
| | Return value | x.xx.xx |

## (6) Camera hardware information commands

Command that supplies camera hardware information. This command has parameter settings, unlike other status commands.

| | | |
|---|---|---|
| ?CAI | (CAmera Information) | |
| | Parameter | T : Camera type name<br>H : CCD horizontal active pixels value<br>V : CCD vertical active pixels value<br>A : Output bit value<br>I : Number of bits of A/D converter<br>O : Camera options<br>B : Binning value |
| | Example | ?CAI H --> CAI H 4000 |

# 11. PRECAUTIONS WHEN USING THE CCD

This camera 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

| | |
|---|---|
| ⚠CAUTION | • 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. |

# 12. MAINTENANCE

## 12-1 FUSE REPLACEMENT

Replace a fuse in accordance with the following process.

(1) Turn off the power switch.
(2) Unplug the power supply cord from the AC inlet.
(3) Remove the fuse holder with something like a screwdriver. (Fig.12-1)
(4) Before replacement, you must check that the new fuse has the same rating as the previous fuse. (Fig.12-2)
(5) After replacement, return the fuse holder to its original location in the AC inlet.

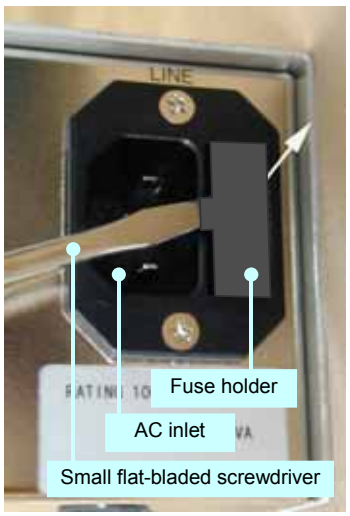



Fig. 12-1

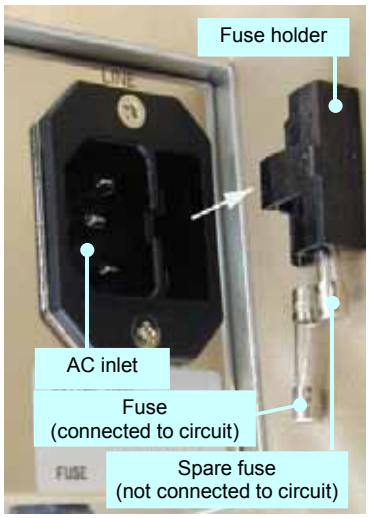



Fig. 12-2

| | |
|---|---|
| ⚠CAUTION | • Always replace with the spare fuse, or a fuse of the same type as indicated on the ratings sticker. The standard of the fuse is “T2.5 A 250 V”.<br>• Be careful not to use excessive force when fitting the fuse holder. You might damage the fuse. |

## 12-2 CARE

Clean the exterior with a soft, dry cloth.

- Do not use a wet cloth, dirty cloth.

# 13. 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.

## 13-1 TURNING ON THE POWER

### (1) The power LED doe not light.

| Cause | Measures | Chapter |
|---|---|---|
| Faulty a fuse | Replace a fuse | 12 |
| Loose AC inlet | Reconnect AC inlet | 7 |
| Short in power supply cord | Contact Hamamatsu subsidiary or distributor | 17 |
| Damaged LED circuit | | |
| Damaged power switch | | |

### (2) Images are not transferred.

| Cause | Measures | Chapter |
|---|---|---|
| Cables not fully connected | Reconnect | 7 |
| Camera control register not correctly configured | Recheck the command setting | 10 |
| Short in camera cable or power supply cord | Contact Hamamatsu subsidiary or distributor | 17 |
| Short in digital interface cable or serial interface cable | Replace the cable | |

## 13-2 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 distributor | 17 |
| Dirty CCD chip | | |

### (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 amount of light | |
| Contrast Enhancement 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 distributor | 17 |
| Bad circuitry | | |

# 14. SPECIFICATIONS

## 14-1 CAMERA SPECIFICATIONS

### (1) Electrical specifications

| | | |
|---|---|---|
| Imaging device | Interlace readout interline CCD solid imaging element | |
| Effective number of pixels | 4000 (H) × 2624 (V) | |
| Cell size | 5.9 µm × 5.9 µm (Square format) | |
| Effective area | 23.6 mm × 15.5 mm (1.8-inch size) | |
| Frame rate | Interlace readout | 1.7 Hz |
| | 2×2 binning readout | 3.4 Hz |
| | 4×4 binning readout | 6.4 Hz |
| | Outline readout | 8.9 Hz |
| Readout noise (r.m.s.) | 20 electrons (typ.) *1 | |
| A/D converter | 12 bit | |
| Cooling method | Electronic and natural air cooling | |
| Lens mount | F mount | |
| Amp gain conversion factor *2 | 3.2 electrons/ADcounts (13 300 electrons) | |
| Contrast variable range | 1 to approx. 10 times | |

* 1 This value is the measured value in free running or scanning (interlace) mode. The measurement is taken by setting the CCD to dark conditions. Under these conditions, 2 images are photographed, and subtracted from one another. The standard deviation of this result is measured and the value given is divided by the square root of 2 and multiplied by the conversion factor.

* 2 The amplifier gain conversion factor is the factor required to convert the count value of a measured image into electrons. This should only be performed after dark subtraction has been carried out. The figure below the conversion factor in brackets is the amount of charge on the CCD when the analog/digital converter overflows.

### (2) Power specifications

| | |
|---|---|
| Input power supply | AC 100 V<br>AC 117 V<br>AC 220 V to AC 230 V<br>AC 230 V to AC 240 V |
| Frequency | 50 Hz / 60 Hz |
| Power consumption | Approx. 90 V·A |

**Note**
- Fluctuations of input power supply voltages are not to exceed ±10 % of the nominal voltage.

**Note**
- At shipment, the voltage is set for the customer. Use the camera with the voltage indicated on the rating sticker.

**Note**
- UL compliance is valid only with the camera line voltage of AC 100 V or AC 117 V originally set by the factory of Hamamatsu Photonics K.K..

### (3) Operating environment

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

### (4) Dimensional outlines and weight

| | |
|---|---|
| Camera head | Approx. 1.2 kg |
| Camera control unit | Approx. 5.9 kg<br>(not including cables and accessories) |

**Note**

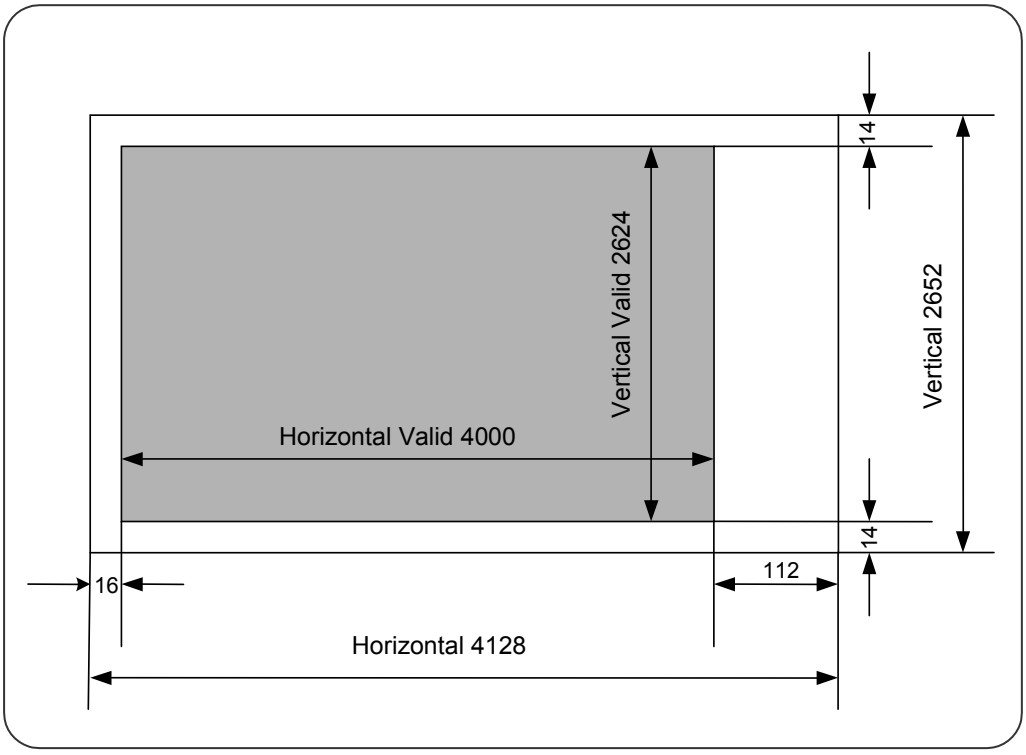
- Please see Chapter 15 for full dimensional outlines.

### (5) Applicable standards

| | |
|---|---|
| Safety | EN61010-1: 2001 |
| | Over voltage category: II |
| | Pollution degree: 2 |
| | Degrees of protection (IEC60529): IP20 |
| EMC | EN61326: 1997 + A1:1998 + A2:2001 + A3:2003 Class A |

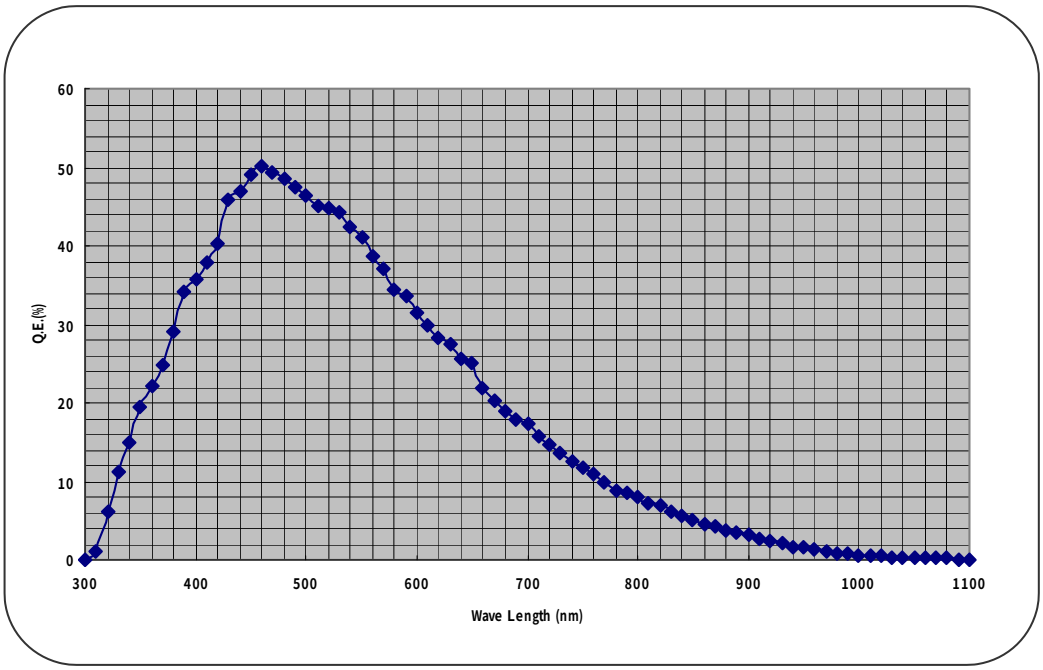
## 14-2 PIXEL COMPOSITION FIGURE

The figure below shows the pixel composition utilized by the CCD in the camera. The overall number of pixels is 4128 horizontal and 2652 vertical, of which 104 horizontal and 8 vertical are inactive.



## 14-3 SPECTRAL RESPONSE CHARACTERISTICS

Following is the typical spectral characteristics of the CCD.

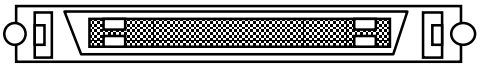


# 14-4 INTERFACE SPECIFICATIONS

This section shows the pin connections of each type of digital interface connector.

## (1) Digital interface connector pin assignment [DIGITAL OUT]

Each input and output signal forms a balanced digital voltage interface compliant with EIA/TIA-644 specifications. The correspondence between the data "0" and "1" is expressed by the voltage at the positive (+) and negative (-) terminals. When the positive terminal is negative relative to the negative terminal, a "1" (mark or OFF) results. When the positive terminal is positive relative to the negative terminal, a "0" (space or ON) results. Output signal levels for TXD and DTR range from -5 V to +5 V, and 0 V to +5 V for other signals.

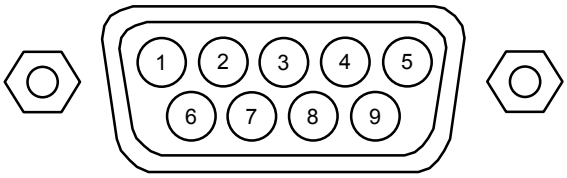
| Pin connection | | 34. . . . . 1<br>  <br>68. . . . . 35 | | | | | |
|---|---|---|---|---|---|---|---|
| No. | Signal | No. | Signal | No. | Signal | No. | Signal |
| 1 | PIXCLK- | 18 | reserved | 35 | PIXCLK+ | 52 | reserved |
| 2 | HVALID- | 19 | reserved | 36 | HVALID+ | 53 | reserved |
| 3 | VVALID- | 20 | A/D OVF- | 37 | VVALID+ | 54 | A/D OVF+ |
| 4 | DB0- | 21 | GND | 38 | DB0+ | 55 | GND |
| 5 | DB1- | 22 | reserved * | 39 | DB1+ | 56 | reserved |
| 6 | DB2- | 23 | reserved | 40 | DB2+ | 57 | reserved |
| 7 | DB3- | 24 | reserved | 41 | DB3+ | 58 | EXT.TRIG. |
| 8 | DB4- | 25 | reserved | 42 | DB4+ | 59 | reserved |
| 9 | DB5- | 26 | reserved | 43 | DB5+ | 60 | reserved |
| 10 | DB6- | 27 | reserved | 44 | DB6+ | 61 | reserved |
| 11 | DB7- | 28 | reserved | 45 | DB7+ | 62 | reserved |
| 12 | DB8- | 29 | reserved | 46 | DB8+ | 63 | reserved |
| 13 | DB9- | 30 | reserved | 47 | DB9+ | 64 | reserved |
| 14 | DB10- | 31 | RXD- | 48 | DB10+ | 65 | RXD+ |
| 15 | DB11- | 32 | TXD- | 49 | DB11+ | 66 | TXD+ |
| 16 | reserved | 33 | DTR- | 50 | reserved | 67 | DTR+ |
| 17 | reserved | 34 | DSR- | 51 | reserved | 68 | DSR+ |

* Reserved pins are reserved for signals from future function extensions. Leave them unconnected.

- **PIXCLK** (Pixel clock):
  Output of this signal is synchronized with the image data from the CCD, and the output of the digital data in each image is synchronized with the leading edge of the signal changing from "OFF" to "ON."
- **HVALID** (Horizontal valid signal):
  This signal shows the period during which the horizontal part of the image data from the CCD is in effect. This is "ON" when during the period the horizontal is active. The valid and invalid periods differ according to the camera's working mode. The frame grabber uses this signal for synchronizing lines.
- **VVALID** (Vertical valid signal):
  This signal shows the period during which the vertical part of the image data from the CCD is in effect. This is "ON" during the period the vertical is active. The valid and invalid periods differ according to the camera's working mode. The frame grabber uses this signal for synchronizing frames.
- **DB0 to DB11** (Digital image data):
  This is the image signal data from the CCD converted from analog to digital image data, with the output synchronized with the pixel clock. DB0 is the LSB (least significant bit) and DB11 is the MSB (most significant bit).

## (2) Serial interface pin assignments [SERIAL I/F]

These signals are the serial control lines for controlling the cameras actions with the host computer. The host computer sends commands and receives status information over these lines.
Transmission is a synchronous, following CCITT V. 24 and RS-232C protocols. The transfer rate is 9600 bps. These signals can be input and output in a voltage range of -5 V to +5 V; so one connector can be used to connect to the RS-232C. Additionally, signals are output to both the digital data connector and the serial interface, so either one may be used.

| No. | Signal | Pin connection |
|---|---|---|
| 1 | N.C. |  |
| 2 | TXD | |
| 3 | RXD | |
| 4 | DSR | |
| 5 | GND | |
| 6 | DTR | |
| 7 | N.C. | |
| 8 | DTR | |
| 9 | N.C. | |

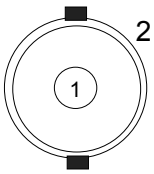


- The serial control line of Digital interface connector and Serial interface connector are connected. Do not use the two connectors simultaneously.

- **TXD** (Transmitted Data)[Output Signal]:
  This is data transmitted from the camera to the computer. When there is no data, this switches to "OFF."
  **RXD** (Received Data)[Input Signal]:
  This is data transmitted from the computer to the camera. When there is no data, this switches to "OFF."
  **DTR** (Terminal Ready )[Output Signal]:
  This signal notifies the computer that the camera is ready to transmit or receive data. This switches to "ON" when the camera is ready.
- **DSR** (Data Set Ready)[Input signal]:
  When the host computer is able to transmit or receive data, it transmits "ON" to the camera. However, this command is not supported by the camera, so it cannot be used for controlling transmission with the computer.

## (3) Trigger input connector pin assignments [EXT.TRIG.]

Input terminal for the external control pulse, which is used to operate the camera in external control mode. The input is TTL level (termination is 680 Ω), and the external trigger pulse polarity can be set either to negative or positive.

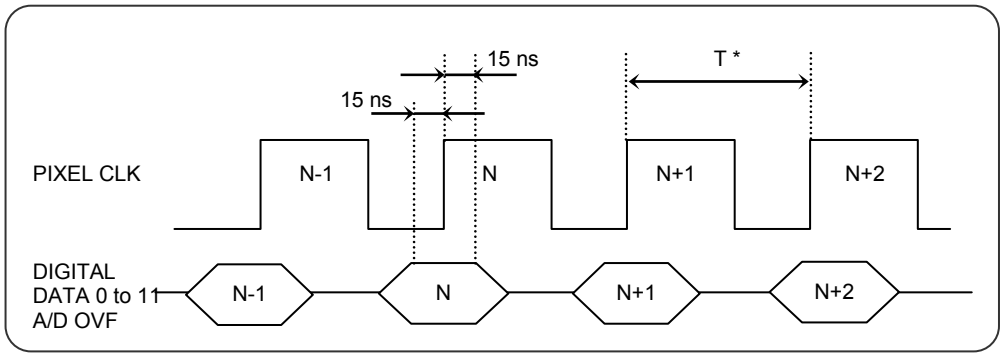
| No. | Signal | Pin connection |
|---|---|---|
| 1 | TRIG IN |  |
| 2 | GND | |

## 14-5 IMAGE DATA OUTPUT TIMING SPECIFICATIONS

The figures below indicate the digital data output timing specifications.

### (1) Digital video signal timing

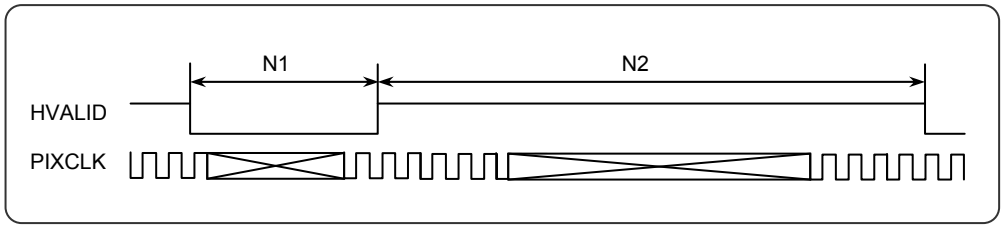
The relationship between digital image data (DB0 to DB11) and the Pixel clock (PIXCLK) is as shown below:




* T: The pixel clock period usually takes the following times for readout.
- Interlace readout : T= 50 ns
- 2×2 binning readout : T=100 ns
- 4×4 binning readout : T=200 ns
- Outline readout : T=300 ns

### (2) Line timing (HVALID)

The relationship between the horizontal valid period signal (HVALID) and the pixel clock (PIXCLK) is as shown below:

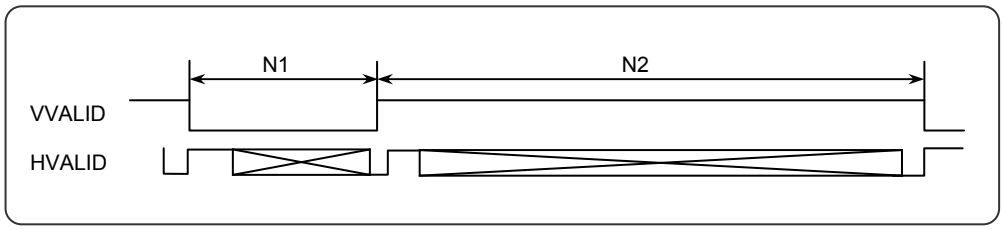



| Scan mode | Number of pixel clocks | |
|---|---|---|
| | N1 | N2 |
| Interlace readout | 428 | 4000 |
| 2×2 binning readout | 246 | 2000 |
| 4×4 binning readout | 123 | 1000 |
| Outline readout | 74 | 664 |

- Each edge of the HVALID signal varies in synchronization with the pixel clock falling edge.

### (3) Frame timing (VVALID)

The relationship between the vertical valid period signal and the horizontal valid period signal is as shown below.



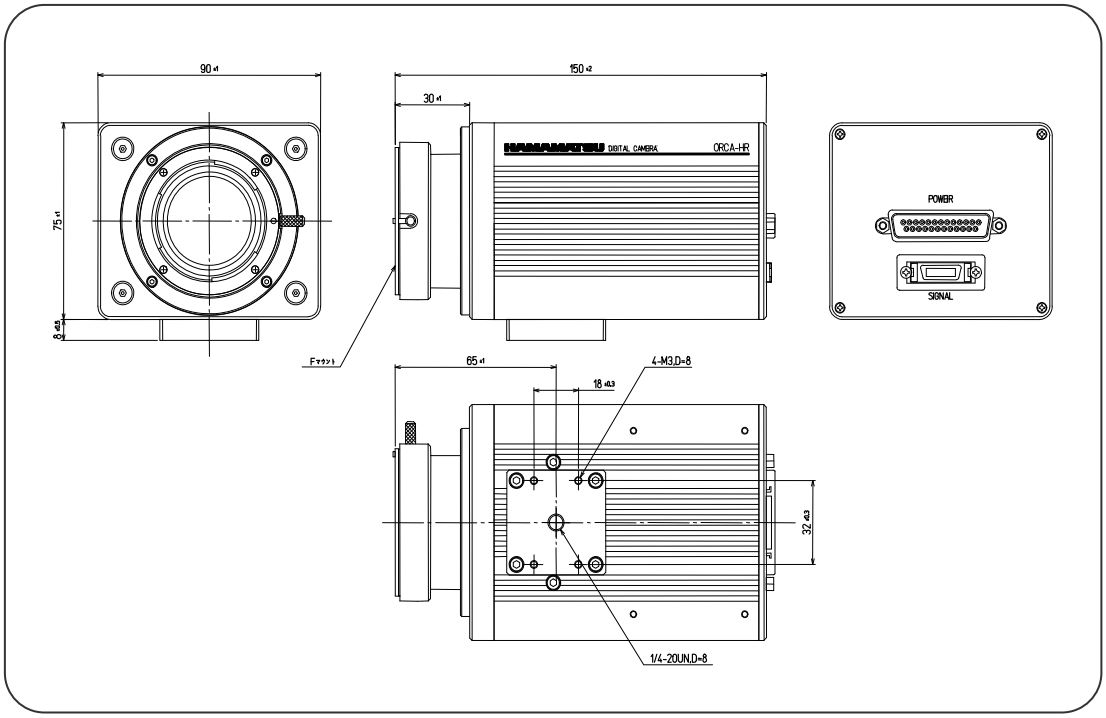

| Scan mode | Number of pixel clocks | |
|---|---|---|
| | N1 | N2 |
| Intrelace readout | 4 | 2624 |
| 2×2 binning readout | 4 | 1312 |
| 4×4 binning readout | 4 | 656 |
| Outline readout | 4 | 442 |

- Each edge of the VVALID signal changes with the invalid period (LO) of the HVALID.
- Each edge of the VVALID signal does not change with the leading edge of the pixel clock.
- The valid and invalid periods of the VVALID signal vary according to the operating mode.

# 15. DIMENSIONAL OUTLINES

## 15-1 CAMERA HEAD

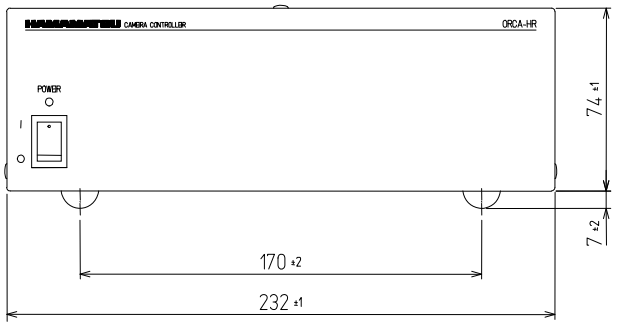
(Unit: mm)



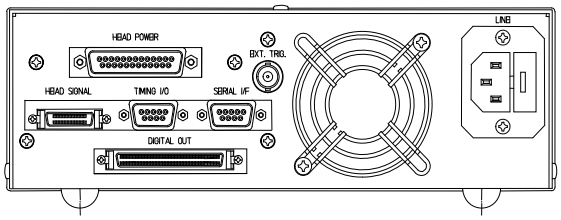
## 15-2 CAMERA CONTROL UNIT

(Unit: mm)

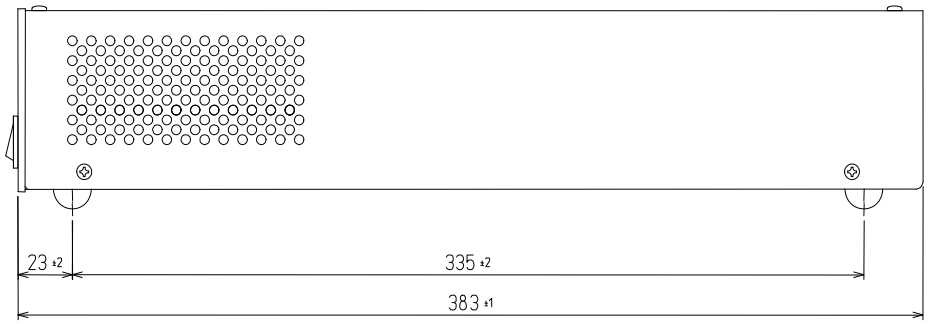
[Front panel]




[Rear panel]




[Side]



# 16. 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 mechanical shutter, and 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.

# 17. CONTACT INFORMATION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