FASTCAM MH4-10K

Hardware Manual

Revision 1.03E

Photron

Introduction

Thank you for your purchase of Photron's high-speed camera system, the "**FASTCAM MH4-10K**" (referred to below as the system). This manual contains the operating instructions and warnings necessary for using the system.
Before using the system, please read the entire manual. If any part of this manual is unclear, contact Photron using the contact information printed at the back of the manual.
After you finish reading the manual, store it in a safe place along with the warranty card and refer back to it when necessary.

Manual Notation

The following icons and symbols are used in the explanations in this manual.

Icon/Symbol	Description
	This symbol indicates supplementary items to be aware of when using the software.
	This symbol indicates the location of a reference.
	This symbol indicates content that should always be read.
	This symbol indicates instructions that should always be followed when using the software, or things to be careful of when using the software.
	This symbol indicates a space you to use for making notes.
" "	This symbol is used to indicate the names of items on a screen, references, dialog names, and connectors.
[ ]	This symbol is used to indicate menu names, and sub-menu names.

Using the Manual

This section explains the layout of the manual.

- Introduction
  The introduction explains the manual and safety precautions.

- Chapter. 1 Overview
  This chapter gives an overview of the system and an explanation of its features.

- Chapter. 2 Setup
  This chapter gives an overview of the components that make up the system. It also explains basic keypad operation and a list of items that should be checked before using the system.

- Chapter. 3 Recording
  This chapter explains operations related to recording.

- Chapter. 4 Connecting a PC
  This chapter explains the procedure for connecting the system to a PC. Refer to the “Photron FASTCAM Viewer User’s Manual” for additional details on using a PC to control the system.

- Chapter. 5 Product Specifications
  This chapter explains the system’s specifications.

- Chapter. 6 Warranty
  This chapter explains about the warranty.

- Chapter. 7 Contacting Photron
  This chapter lists the contact information to use when contacting Photron if the system malfunctions or if a portion of the manual is unclear.

Using the System Safely and Correctly

In order to prevent injury to yourself and others, and to prevent damage to property, carefully observe the following safety precautions.

Photron has given its full attention to the safety of this system. However, the extent of damage and injury potentially caused by ignoring the content of the safety precautions and using the system incorrectly is explained next. Please pay careful attention to the content of the safety precautions when using the system.

Warning	This symbol indicates actions that carry the risk that a person could receive a serious injury.

Caution	This symbol indicates actions that carry the risk that a person could receive a moderate injury, or that damage to physical property might occur.

- The safety precautions to be observed are explained with the following symbols.

This symbol indicates actions that require caution.

This symbol indicates actions that are prohibited and must be avoided.

This symbol indicates actions that must always be performed.

Warning

■ Do not perform actions that will damage the AC cable or plug.
(Do not damage the cable, modify it, use it near a heater, excessively bend, twist or pull on it, place heavy objects on it, or bundle it.)
Using the cable when damaged can cause fire, electric shock, or a short circuit.

■ Do not use the system in a manner which will exceed the rating of the power outlet or wiring equipment used.
Exceeding the power rating might cause a fire from excessive heat.

■ Do not insert metallic objects inside, or pour liquids such as water on, the system.
Doing so can cause fire, electric shock, or malfunction from short circuit or heat.

■ Do not disassemble or modify the system.
There are high voltages inside the system that can cause electric shock.

■ Do not plug in or unplug the power cord with wet hands.
Doing so can cause electric shock.

■ This chapter lists the contact information to use when contacting Photron if the system malfunctions or if a portion of the manual is unclear.
Not fully plugging in the power cable can cause fire from electric shock or heat.

■ When something is wrong with the system, unplug the power cable immediately.
- When a foreign substance or liquid, such as metal or water, gets inside.
- When the outer case is broken or damaged, such as from a fall.
- When the system produces smoke, a strange smell, or strange sound.

Using the system in these conditions might cause a fire or electric shock.

Caution

■ Always unplug the system when cleaning it or when it is unused for a long period of time. Leaving or storing the system connected to the power source might cause fire from insulation deterioration or electrical discharge.

■Please consult to us in advance, When you perform shoot by which laser light and direct rays go into a image sensor surface.

■ Do not set the system in a location where the temperature gets unusually hot.
The trunk and inside of a car can get especially hot in summer.
Doing so can cause the outer case and internal components to deteriorate or cause a fire.

■ Do not place the system in a location prone to oily smoke or steam, or in a location with a lot of humidity or dust.
Oil, moisture, and dust conduct electricity, which can cause a fire or electric shock.

■ Ambient temperature 0-40° C, humidity 85% RH or lower, maximum altitude 2000m or lower.
In addition, if exceeding these limits, use in a condensation-free environment.
Doing so can cause malfunction.

■ Do not store the equipment in a location where the temperature goes below -20°C or higher than 60°C.
Also, prevent condensation from forming during shipment

■ This device is for indoor use, do not use it outdoors.
Do not use in a location that has dust.
Doing so can cause malfunction.

■ When shipping, remove the connecting cable and use the original packaging or a dedicated carrying case.
Do not ship the equipment in an environment where the temperature goes below -20°C or higher then 60°C. Also, prevent condensation from forming during shipment

Cleaning of the Image Sensor Surface

Electrostatic Discharge (ESD) events may cause immediate and unrecoverable damage to the image sensor.

Please read the following instructions and take EXTREME CARE when cleaning the image sensor surface.

■ALWAYS take appropriate anti-static precautions when cleaning or working near the image sensor.

■DO NOT use any form of cleaning equipment using electrostatic or ‘charged fiber’ technology.

■Please discharge any electrostatic build up in your body by touching a grounded metallic surface before working near the camera sensor.

■Very gently , use only clean and dry air to remove dust from surface of the image sensor.

■To remove stubborn contamination use the highest grade (e.g. VLSI grade) pure isopropyl alcohol (IPA) with optical wipes of ‘clean room’ grade.

■Extreme care must be taken! Gently wipe across the sensor in a single action.
(DO NOT rub to avoid abrasive damage to delicate optical coatings on the glass surface.)

Table of Contents

MEMO

Chapter. 1 **Overview**

1.1.Product Overview and Features

1.1. Product Overview and Features

The FASTCAM MH4-10K is a camera that, by employing ultra-compact camera heads, makes it possible to shoot in locations not previously accessible to conventional high speed camera heads. As for the performance of the FASTCAM MH4-10K, it can record at a maximum resolution of 512 x 512 pixels at 2,000 fps (frames per second) at this full frame resolution, and up to a maximum speed of 10,000 fps at reduced resolution. It is possible to record simultaneously with a maximum of four camera heads attached to one controller case, even during high-G events, thanks to the high-G design and construction of the camera heads and controller

Using real-time video output and an easy-to-use remote control, the camera can operate fully without a PC connected. By connecting the camera controller to a PC via gigabit Ethernet, full camera operations can be performed on the PC with the easy to use control software supplied.
Utilize the FASTCAM MH4-10K to view high-speed dynamic bodies slowed down with the latest technology as an input system for video image processing. This manual explains the operating procedures for the FASTCAM MH4-10K.

Chapter. 2 **Setup**

2.1. System Components and Accessories

2.2. Part Names

2.3. Device Connections

2.4. Memory Backup Battery

2.1. System Components and Accessories

2.1.1. Components

The system's standard components are listed below. Remove the components from the packaging and check the system.

1.	Camera Controller	1
2.	Camera Head(s) (with tripod adapter) Cube Type / Pencil Type	(depends on configuration)
3.	Camera Cable(s) Cube Type / Pencil Type	(depends on configuration)
4.	AC Power Supply Unit / AC Cable	1
5.	Hexagonal Wrench for Flange Back Adjustment (1.5 mm)	1
6.	Gigabit Ethernet Interface Cable (LAN Cable)	1
7.	FASTCAM Series Setup Disk (Driver/Application CD)	1
8.	FASTCAM MH4-10K Hardware Manual (This Manual)	1
9.	Photron FASTCAM Viewer User's Manual	1
10.	Making a Gigabit Ethernet Connection (Simple Procedure Manual)	1
11.	IP address label	5

2.1.2. Accessories/Options

The following options are available for the system.

1. High-G Housings (High-G Lens Housing, Screw Reinforcement Housing)
2. Tripod Adapter (For Cube type or Pencil type)
3. Mounting Brackets (For the Camera Controller, Normal Camera head, High-G Camera head)
4. High-G Battery
5. Cable Anchor Handle
6. LCD Remote Controller
7. NF Mount Lenses (Focal Lengths f=3.5mm, f=6mm, f=12 mm)
8. C mount Adapter
9. DC Connector for External Power Supply
10. Dedicated Carrying Case

Supplement

The composition of a camera head turns into composition chosen at the time of purchase.

Examples with the optional parts installed are shown below.

High-G Lens Housing Installation Example

Screw Reinforcement Housing Installation Example

High-G Camera head Fixing Bracket Installation Example 1

High-G Camera head Fixing Bracket Installation Example 2

*(The high-g camera head fixing bracket and the normal camera head fixing bracket are the same except for their width)

High-G Camera head Fixing Bracket Installation Example 1

High-G Camera head Fixing Bracket Installation Example 2

Tripod Adapter Installation Example (Cube)

Tripod Adapter Installation Example (Pencil)

Camera Controller Fixing Bracket Installation Example 1

Camera Controller Fixing Bracket Installation Example 2

Cable Anchor Handle Installation Example

2.2. Part Names

The system is composed of components including the Camera Controller, AC Power Supply Unit, and the "Photron FASTCAM Viewer" controls software (referred to below as PFV).

For each of the system components.

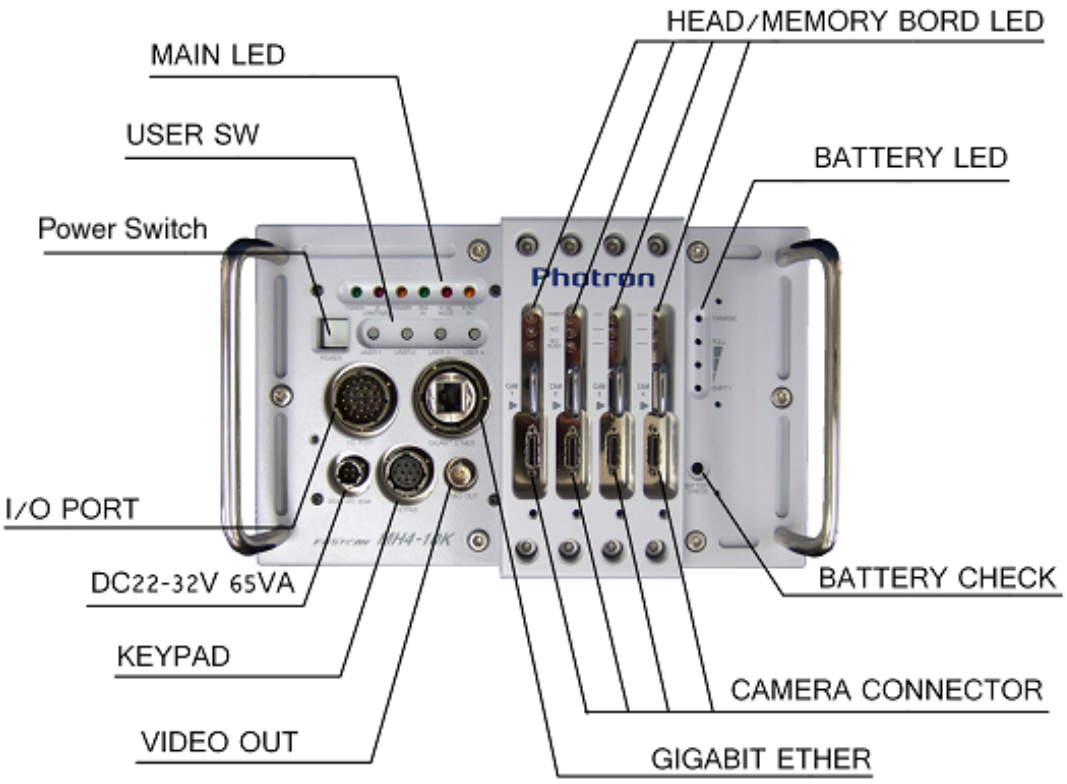
- Do not use in an area with flammable gas or dust present.
- Do not place in an unstable location such as on a wobbly platform or an incline.
- Do not disassemble or modify.
- Do not expose to liquids such as water.
- Do not use in a manner where excessive force is applied.

2.2.1. Camera Controller

The FASTCAM MH4-10K has two models depended on memory size. Model 1 with a memory capacity of 1 GB per camera unit, and model 2 with a memory capacity of 2 GB per camera unit. They contain IC memory for saving images, and they have been designed with the capability to save high-speed images as uncompressed digital data. The camera controller has a video output connector to display live and recorded images on a video monitor, a Gigabit Ether interface to connect a PC to fully control the cameras or download data, and various I/O (input/output) connectors for external synchronization/trigger signals.

Camera Controller Exterior

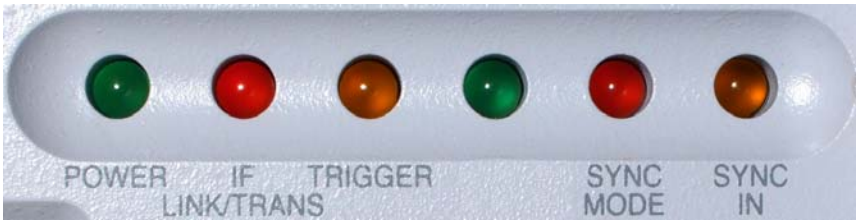
2.2.2. Camera Controller Part Names



2.2.3. Status Display LEDs on the front of the Camera Controller

There are a number of LEDs on the front of the system's Camera Controller. These LEDs indicate the status of the system. The meaning of each LED is explained here.

- MAIN LEDs



  - POWER (Green)
    LED ON: Power On
    LED OFF: Power Off
  - IF LINK/TRANS (Red)
    LED ON: The Gigabit Ethernet interface is connected
    LED FLASHING: Data is transferring
    LED OFF: The Gigabit Ethernet interface is not connected
  - TRIGGER (Yellow)
    LED ON: A trigger signal is present (being input)
    (The LED illuminates for 0.1 second when the trigger signal is input)
    LED OFF: The trigger signal is not present
  - SYNC MODE (Red)
    LED ON: External synchronization mode (synchronized to an external signal)
    LED OFF: Internal synchronization mode (synchronized to the internal signal)
  - SYNC IN (Yellow)
    LED ON: A synchronization signal is present (being input)
    LED OFF: A synchronization signal is not present

- Illumination/blinking in operational states
  - During low light mode operationLEDs other than POWER (Green) and IF LINK/TRANS (Red) blink at a regular interval.
  - When calibration is run from USER SW or the LCD Remote Controller LEDs other than POWER (Green) and IF LINK/TRANS (Red) blink alternately from right to left three times and from left to right three times.
  - During the Gigabit Ethernet interface initialization LEDs other than POWER (Green) and IF LINK/TRANS (Red) blink alternately from right to left and from left to right a number of times.

Reference

- For how to initialize of the Gigabit Ethernet interface, refer to "4.1.5. Gigabit Ethernet Interface Initialization", page 60.

◆ HEAD/MEMORY BOARD LEDs

- CONNECT (Green)
  LED ON: The Camera Controller is communicating with the Camera Head(s).
  The LED does not illuminate by only connecting the camera cable
  LED OFF: The Camera Controller is not communicating with the Camera Head

- REC (Red)
  LED ON: RANDOM mode ready state
  LED FLASHING: Ready to record
  LED OFF: Not recording

- REC READY (Yellow)
  LED ON: Ready to record
  LED FLASHING: ENDLESS recording ("REC" LED also simultaneously flashes)
  LED OFF: Not ready to record

◆ BATTERY LED

- CHARGE (Red)
  LED ON: The battery is charging.
  LED OFF: The battery is not charging.

- FULL (Green) -> (Yellow) -> (Red) EMPTY
  Indecates the remaining battery power.

Green	Yellow	Red
Remaining Battery Power 100 - 90%	Remaining Battery Power 89 - 21%	Remaining Battery Power 20 – 0%

The battery's condition is also indicated by the LED status.
LED ON: Running on external power.
LED FLASHING: Battery power memory protection.

2.2.4. Camera Heads

The FASTCAM MH4-10K's camera head has been designed to be smaller than the previous models. The camera head has been reduced to a revolutionary small size, while maintaining high specifications such as a 512 x 512 resolution at recording rates up to 2000 fps.
This system can install two kinds of camera head type ("Cube Type" and "Pencil Type")
Also each camera can choose a "Color Model" and "Monochrome Model".
Multiple camera heads can also be connected to a single camera controller, and by operating the cameras with a common synchronization signal, a single phenomenon can be simultaneously shot from multiple angles.

* The maximum frame rate that can be set depends on the Camera Controller model.

Straight

Right angle

Cube type head

Straight

Right angle

Pencil type head

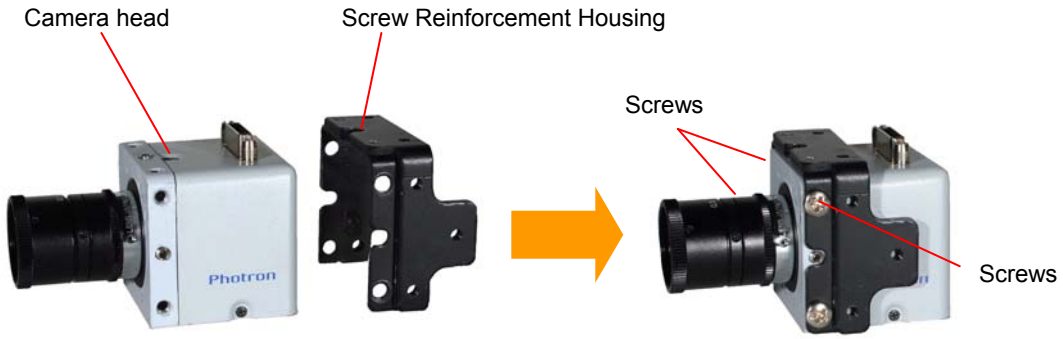
2.2.5. High - G Housings

In this section, we explain how to inatall the Hi-G housing to fit any type of camera head.

“Screw Reinforcement Housing” is enclosed by the product.(If you choose Cube type camera head)

1. Prepare the camera head screw reinforcement housing facing the direction shown in the photo.

2. Attach it to the camera, as shown below, and fasten it with the four screws provided as shown below.



Supplement

- When attaching a tripod adapter (option), it is necessary to remove Reinforcement Housing.

High-G Lens Housing (Option)

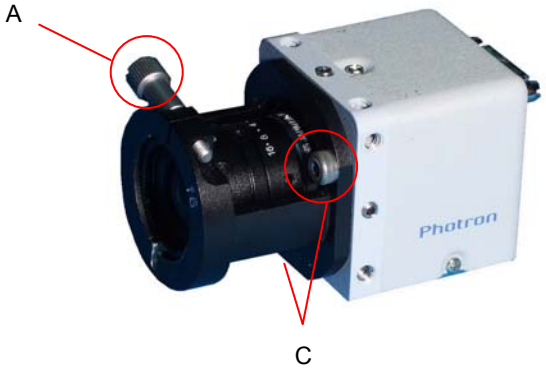
The basic lens mount for the FASTCAM MH4-10K is the NF mount, and NF lenses are available as an optional price list them. The NF mount can also be changed to a C mount by using the optional C mount adapter.

Specialized High-G housings (optional) are also available for the optional lenses. The High-G capability of the lens can be enhanced by attaching the High-G housing. The procedure for installing the High-G housing on the lens is explained next.

◇Cube type Camera Head

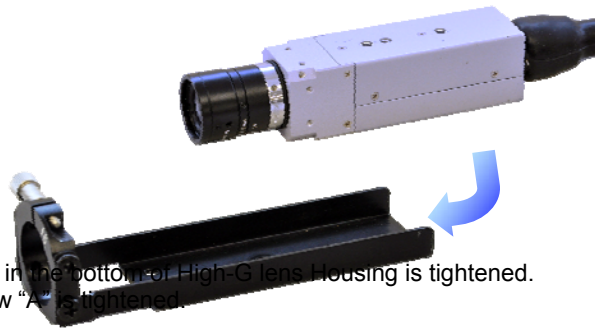
1. With the lens attached to the camera head, prepare the High-G lens housing facing the direction shown below. Loosen screw “A” at this time and peel off the stickers used to cover part “B”.

2. Cover the lens with the high-g housing and lightly tighten screw “A”so the housing won’t move. Then secure section “C” and its diagonal opposite with hex-screws, and finally, firmly tighten screw “A”.

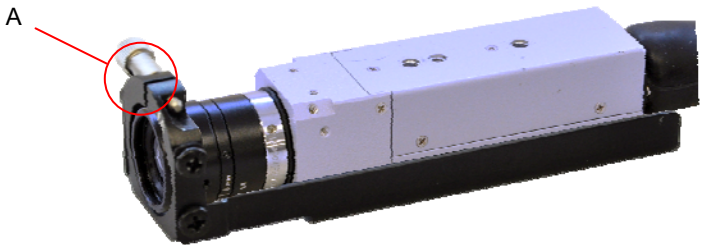


◇Pencil type Camera Head

1. Please prepare High-G lens Housing and Pensil type Camera Head with lens as following figure. Camera head is made to slide and it sets to High-G lens Housing.



2. Two screws in the bottom of High-G lens Housing is tightened. Finally, Screw "A" is tightened.



Supplement

- Also in a light angle head, it becomes the same procedure.
- In a Pencil type camera head, C mount adapter (option) and High-G lens Housing (option) cannot be used at the same time

"High-G lens Housing" is different for every kind of lens to be used.
Please use adaptive High-G lens Housing for your lens.

2.2.6. Camera Cable (Selectable)

A cable is required to connect the camera controller and the camera head on the FASTCAM MH4-10K. Camera cables come in three configurations, straight, right angle down and right-angle up. In addition, the camera cables also come in two additional specification types: general specification and high-g specification. Many different phenomena can be shot by selecting the appropriate camera head and cable for the situation.

■ Photos of a **general specification cable** attached to a camera head (right-angle camera head shown)



pe attached, rig hc



Supplement

- A pencil type head differs in the connection method.

Please refer to “2.3.1”, Connecting a camera head, page 24.

When securing the camera cable, do not bend it R50 or lower.

Always secure the camera cable externally in one location within 60 cm of the connector.

2.2.7. LCD Remote Controller (Optional)

The system can be operated while checking the monitor by connecting the optional LCD Remote Controller to the "KEYPAD" connector on the front of the Camera Controller. The LCD Remote Controller is also hot-pluggable, it can be plugged into and unplugged from the camera while the power is on.

Camera Controller Connector	Signal	Camera Controller Connector Model Name (Manufacurer)	Keypad Connector Model Name (Manufacurer)
KEYPAD	Keypad signal	PT02A-12-10S (023) (Amphenol)	PT06A-12-10P (023) (Amphenol)

Supplement

- The LCD Remote Controller is optional. It is not included in the standard configuration.

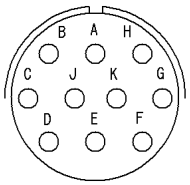
Reference

- For how to operate of the LCD Remote Controller, refer to "LCD Remote Controller User's Manual".

2.2.8. RS-422 Serial Control

The system supports serial control via an RS-422 connection through the “KEYPAD” connector.
By setting the STATUS OUT menu to ON, the system status can be output via the serial connection.
For details, check the command list.
A cable is not offered as an accessory. When using RS-422 control, construct a cable using the pin diagram below as a reference.

Keypad Pin Diagram



PT02A-12-10S (023)

Connector Name	Signal Name	Pin No.	Camera Controller Connector Model Name (Manufacturer)	Cable Connector Model Name (Manufacturer)	Input Connector
KEYPAD	+12V OUT	A	PT02A-12-10S (023) (Amphenol)	PT06A-12-10P (023) (Amphenol)	Not Specified
	SIGNAL GND	B			
	RXD+	C			
	RXD-	D			
	TRIGGER SW	E			
	TXD-	F			
	TXD+	G			
	POWER GND	H			
	VBS GND	J			
	VBS	K			

When using the connector pins directly, refer to the chart above and ensure the wiring is correct. Incorrect wiring can cause malfunction.

The voltage on pin A (+12V OUT) is used to power the LCD Remote Controller, do not use it for other purposes.

Reference

- For inquires related to our product, refer to “7.1. Contact Information”, page 76.

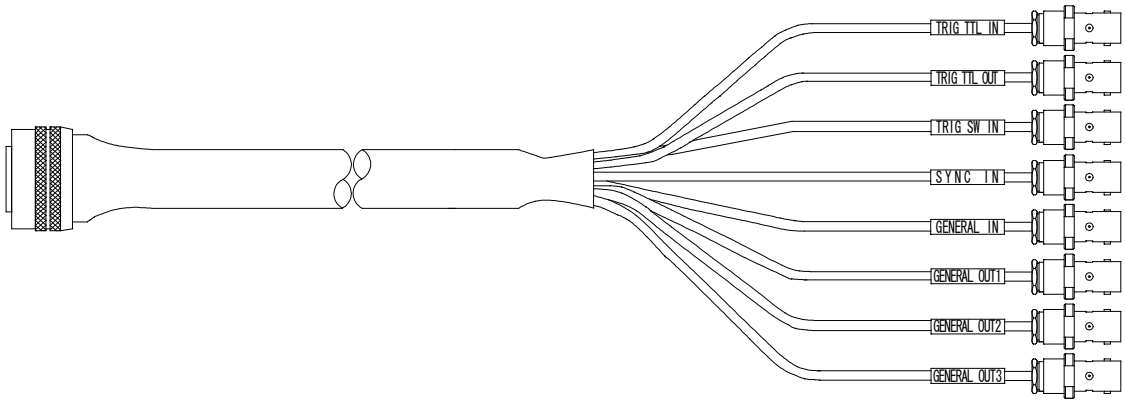
Supplement

- Serial control commands are available as separate list of commands. Please contact Photron or the store where the system was purchased about the command list.

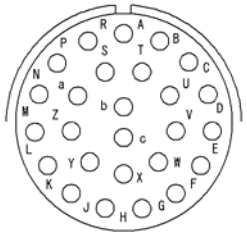
2.2.9. I/O Cable

By inputting an external trigger or synchronization signal and by outputting an exposure timing or synchronization signal, these signals can be used as a part of the FASTCAM MH4-10K system. The input/output signal connectors on the camera controller have been bundled into a single connector, the I/O connector, and it is possible to connect to access each type of signal by using the specialized multi-connector.

A signal other than the specified signal must not be input to the various connectors.
Use extreme caution as there is a risk of damage to both devices, the input device and the output device.



I/O Pin DIagram



PT02A-16-26P (023)

Reference

- For signals that can be input, refer to “3.10. Input/Output Signal Types”.

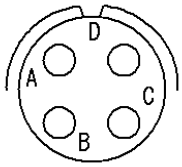
Connector Name	Signal Name	Pin Num.	Body-side Connector Model Name(Maker)	Cable-side Connector Model Name(Maker)	Input-side Connector
I/O PORT	TRIGGER TTL IN	A	PT02A-16-26P(023) (Amphenol)	PT06A-16-26S(424) (Amphenol)	BNC
	TRIGGER TTL OUT	B			BNC
	TRIGGER SW	C			BNC
	SYNC IN	D			BNC
	GENERAL IN	E			BNC
	GENERAL OUT1	F			BNC
	GENERAL OUT2	G			BNC
	N.C.	H			-
	N.C.	J			-
	N.C.	K			-
	N.C.	L			-
	N.C.	M			-
	N.C.	N			-
	N.C.	P			-
	N.C.	R			-
	POWER GND	S			-
	GENERAL OUT3	T			BNC
	SIGNAL GND	U			BNC SHIELD
	SIGNAL GND	V			-
	N.C.	W			-
	SIGNAL GND	X			-
	+18 - +V36	Y			-
	+18 - +V36	Z			-
	+18 - +V36	a			-
	N.C.	b			-
	N.C.	c			-

Supplement

- Pin U's SIGNAL GND signal is the BNC ground.

2.2.10. Power Supply Connector

This connector is the connector to input the DC power supply. Connect the supplied AC Power Supply Unit or the optional external battery for operation.

DC 22-32V 65VA Pin Diagram

PT02A-8-4P (023)

Connector Name	Signal Name	Pin No.	Camera Controller Connector Model Name (Manufacurer)	Cable Connector Model Name (Manufacturer)
DC 22-32V 65VA	RESERVE	A	PT02A-8-4P (023) (Amphenol)	PT06A-8-4S (424) (Amphenol)
	SIGNAL GND	B		
	POWER GND	C		
	+22V～+32V IN	D		

Warning

When using the connector pins directly, refer to the chart above and ensure the wiring is correct.

If the wiring is incorrect, not only is there the danger of the system malfunctioning, but also of fire and electric shock.

Warning

Do not use a power supply which does not meet the system's specifications, or a power supply you cannot guarantee the safety of.

By using a power supply outside of the system specifications, not only is there the danger of the system malfunctioning, but also of fire and electric shock.

2.3. Device Connections

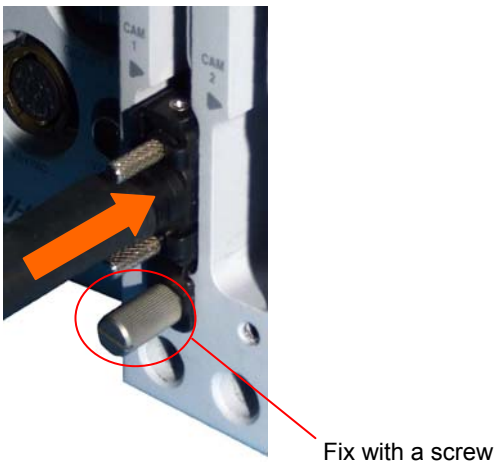
2.3.1. Connecting a Camera Head

Follow the procedure below to connect a Camera Head to the Camera Controller.

1. Verify the Camera Controller's power is off.
2. Connect the camera cable. Check the connector part of the Camera Head and Camera Controller and connect them as shown in the pictures below.

■Camera Controller

General Cable



High-G Cable

■Camera head

◇For the Straight Camera head

Straight

Right-Angle Down

Right-Angle Up

◇For the Right-Angle Camera head

Straight

Right Angle-Down

Right Angle-Up

◇For the Straight Camera head with High-G Housing

Straight

Right-Angle Down

Right-Angle Up

◇For the Right-Angle Camera head with High-G Housing

Straight

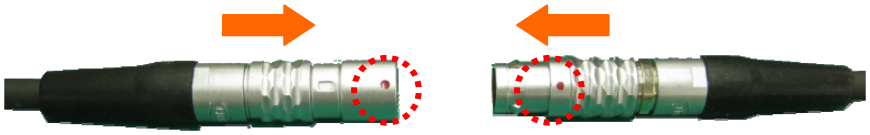
Right-Angle Down

Right-Angle Up

■In case of the Pencil Type Head

1. It checks that the camera controller is turned off.
2. A camera cable is connected to the camera controller side.
   * The connection method is the same as a cube type head.

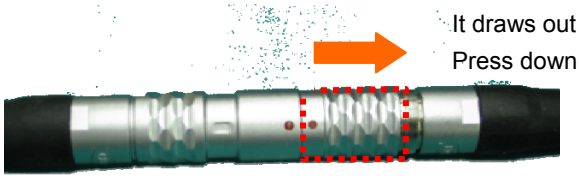
3. The cable from a camera controller and the cable which has come out of the camera head are connected.
   Each connector part is checked, as shown in the following figure a red point is united and it connects. If it inserts normally, there is a feeling of a click.



■Camera Controller Side **■Camera Head Side**

4. The camera cable by the side of a camera controller is fixed.
   (The screw for fixation is tightened.)

5. When you remove camera cable, it is possible to remove to pull to outside.



It draws out in the direction of an arrow.
Press down the place of a red point.

Always secure the camera cable by tightening the screws attached to the camera cable's connector.

If the camera cable is pulled out while the power is on, it can cause a malfunction.

Always turn the Camera Controller's power off when attaching or removing Camera Heads.

Adding or removing Camera Heads with the power on can cause a malfunction.

Supplement

- You can also use connection of only one camera.

2.3.2. Connecting the LCD Remote Controller (Optional)

If you have the optional LCD Remote Controller, connect it by plugging the LCD Remote Controller connector into the connector labeled "KEYPAD" on the front of the Camera Controller.

Supplement

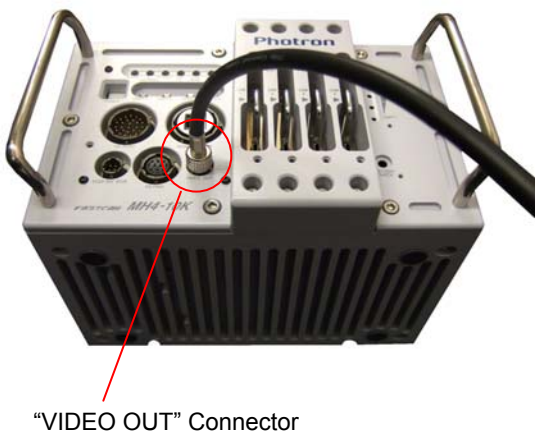
- The LCD Remote Controller is hot-pluggable. It can be plugged in and removed while the system's power is on.

Reference

- For how to operate of the LCD Remote Controller, refer to "LCD Remote Controller User's Manual".

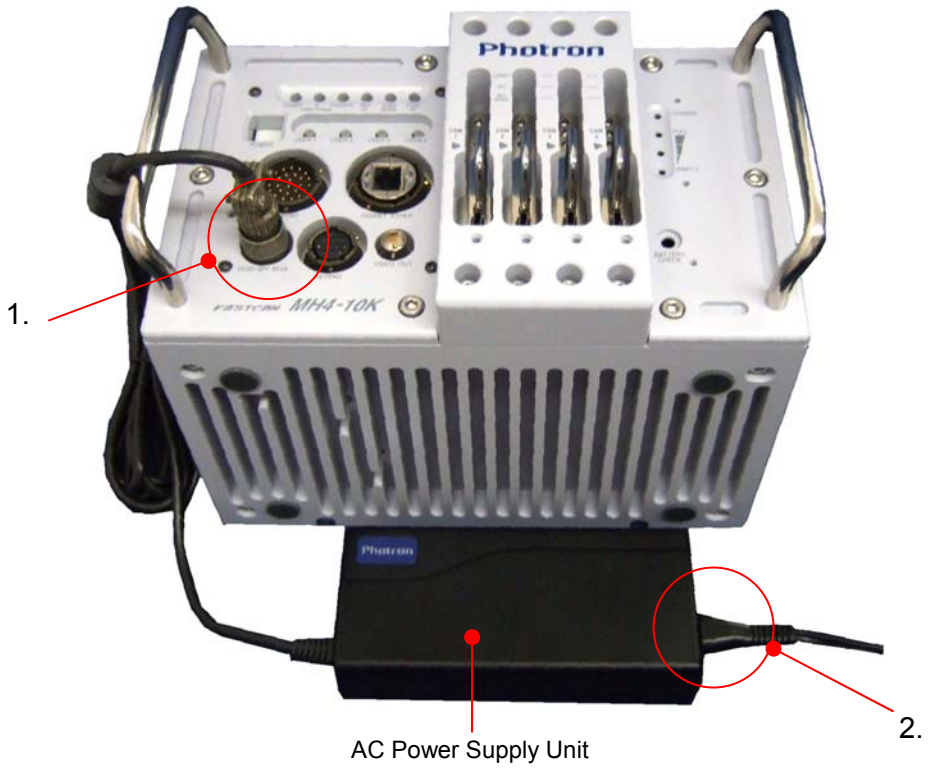
2.3.3. Connecting a Video Monitor

A video monitor connected to the Camera Controller can be used to check the live image (camera pass-through image). Connect the “VIDEO OUT” connector on the front of the Camera Controller to the video input on the video monitor with a BNC cable.



2.3.4. Connecting the AC Power Supply

Connect the supplied AC Power Supply Unit to the power supply.



1. Connect the AC Power Supply Unit to the "DC22-32V 65VA" connector on the front of the Camera Controller.
2. Connect the AC cable to the AC Power Supply Unit.
3. Connect the AC cable to the power outlet.

Reference

- For power supplies that can be used, see the DC power supply item in section “5.1.2. General Specifications”, page 63.

2.3.5. Connecting a PC

The system can have the operation of its functions performed from a PC using the Gigabit Ethernet interface.
This section explains the required setup when connecting the system to a PC.

To connect a PC to the system, connect the system to a commercially available 1000BASE-T-compatible interface board with a LAN cable. For the LAN cable, prepare a UTP or STP CAT5E (enhanced category 5) or higher LAN cable. (UTP: unshielded, STP: shielded)
The maximum cable length between the PC and the system is, compliant to the 1000BASE-T specification, up to 100 m. One PC can connect to a maximum of 64 Photron Gigabit Ethernet interface equipped cameras using a hub. When connecting multiple devices, connect through a switching hub that can connect at 1000BASE-T. The maximum length of the cable that connects the system (or PC) to the switching hub is also 100 m.

Reference

- For operating instructions of Photron FASTCAM Viewer software, refer to "Photron FASTCAM Viewer User's Manual".

2.4. Memory Backup Battery

A memory battery backup (referred to below as the battery) is built-in to the FASTCAM MH4-10K as standard. If the external power supply becomes disconnected, the battery can retain the contents of memory for a maximum of about 30 minutes. The battery is charged when the camera controller is connected to an external power supply.
The status of the battery can also be checked by pressing the BATTERY CHECK button, even when the power is off.

The Memory Backup function is being interlocked with POWER SW of a controller.
When a POWER SW is turned OFF, the image data in a memory are not kept up.
The life time of a backup battery becomes about one year. However, it changes with environment.
When you are pushed the BATTERY CHECK button in the state of “POWER OFF”, any LED for a status check will be turned on.
If any LED for a status check does not light up at all, It means that a battery is in an empty state. Or the life time of the backup battery may be exhausted.
For inquires related to replacement of backup battery, refer to "7.1. Contact Information", page 769.

Chapter. 3 **Recording**

3.1. Selecting the Frame Rate

With the system, you can record images from 60 (50 PAL) to 2,000 fps using the full 512x512 pixel resolution of the image sensor. For frame rates higher than 2,000 fps, high-speed photography is achieved by limiting the read area of the image sensor.

* The maximum frame rate that can be set depends on the Camera Controller model.

Supplement

- The minimum frame rate in NTSC mode is 60 fps.
- The minimum frame rate in PAL mode is 50 fps.

Reference

- For frame rates over 2,000 fps, the resolution is automatically set to the maximum available at that frame rate. For details, see "5.1.4. Frame Rate and Resolution", page 64.

3.2. Selecting the Resolution

With the system, you can record images with a maximum size of approximately 260,000 pixels using the high-speed image sensor, which has a maximum size of 512x512 pixels. You can also record at even faster frame rates or reduce the amount of image data to make even longer recordings by limiting the resolution according to the application.

Reference

- For more information of relation between Frame Rate and Resolution, refer to "5.1.4. Frame Rate and Resolution", page 64.

3.3. Selecting the Shutter Speed

With the system, the shutter speed is independent of the frame rate, and you can control the exposure timing one frame using the electric shutter. By making an exposure that is of a shorter period than the frame rate, high-speed objects can be recorded blur-free.
Shutter speed can be set from 1/frame sec to a maximum of 1/160,000 s (approximately 6.2 us).
The procedure for selecting the shutter speed is explained here.

Reference

- For more information of shutter speed, refer to “5.1.6. Shutter Speed List”, page 65.

3.3.1. Changing SHUTTER LOCK

By switching between [ON] and [OFF] on the [SHUTTER LOCK] submenu on the [SHUTTER] menu, the shutter speed value first used when the frame rate is changed can be set.

ON: Changing the frame rate does not change the shutter speed, it maintains the current setting.
OFF: Changing the frame rate automatically sets the shutter speed to 1/frame s.

3.4. Selecting the Trigger Mode

With the system, in order to reliably capture high-speed phenomena, many kinds of trigger modes have been made available. These trigger modes are explained next.

There are five types of trigger modes which are listed below.

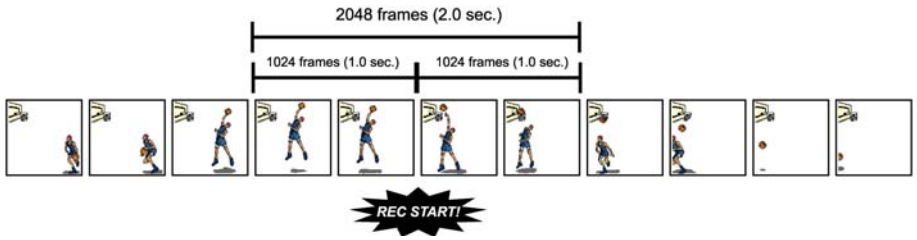
- START - CENTER - END - MANUAL - RANDOM

3.4.1. START Mode

START mode is a trigger mode where recording starts the instant the trigger is input, the scene is recorded until the memory is full, and then recording ends. This mode is suitable for taking images of high-speed phenomena when what will happen, and when it happens, is known in advance.
For example, in a situation with a maximum useable memory of two seconds of recording, two seconds of high-speed video is saved immediately after the trigger is input.

3.4.2. CENTER Mode

CENTER mode is a trigger mode where an equal amount of content recorded before and after the trigger is input is saved to memory. This mode is suitable for viewing before and after an important instant. For example, in a situation with a maximum useable memory for two seconds of recording, one second before and one second after the trigger was input is recorded for a total of two seconds of high-speed video.



3.4.3. END Mode

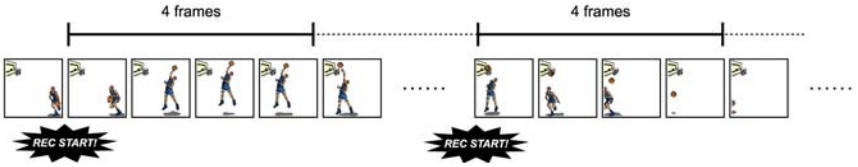
END mode is a trigger mode where the content recorded immediately before the trigger is input is saved to memory. This mode is suitable for recording a high-speed phenomenon where it is hard to predict when the important action will start and stop. For example, in a situation with a maximum useable memory for two seconds of recording, the two seconds of high-speed video immediately before when the trigger was input are saved.

3.4.4. MANUAL Mode

MANUAL mode is a trigger mode, similar to CENTER mode, where the content recorded before and after the trigger is input is saved to memory, but the proportion of time before and after the trigger can be set as required. For example, in a situation with a maximum record time of two seconds, 0.5 seconds before and 1.5 seconds after the trigger is input are recorded and saved, a total of two seconds of high-speed video.

3.4.5. RANDOM Mode

RANDOM mode is a trigger mode where each time a trigger is input only a predetermined number of frames are saved to memory. For example, this function is convenient for a subject which is an irregular and repeated phenomenon which can have a trigger output produced for each cycle or occurrence. The number of frames recorded each time the trigger is input can be set as desired, in one frame increments, from one frame to the maximum of all the recordable frames available.



3.5. LOW LIGHT Mode

The more you increase the frame rate or shutter speed of a high-speed camera, the more the amount of light entering the camera decreases, making the displayed image dark. Low light mode is a function that temporarily increases the exposure time, making the displayed image easier to see for setting the lens focus or other options.

3.6. White Balance Adjustment (Color Models Only)

On digital video cameras, photographing white as pure white is described as "having the appropriate white balance." On the system's color models as well, in order to take images with the correct color representation, the white balance must be adjusted for the color temperature of the light source used. The intensity of each color, R, G, and B, can be adjusted on this system. By adjusting the balance of those three colors to match the light source used, the appropriate white balance can be achieved. Two methods are available for adjusting the white balance, preset and user-editable white balance. These methods are explained in this section.

3.6.1. Using Preset White Balance (Color Models Only)

With the system, there are two types of white balance presets (5100K, 3100K) for use with common light sources. The suggested color temperature for these presets is listed below.

- 5100K (Daylight, Outdoors)
- 3100K (Halogen Light Source)

3.6.2. Using User White Balance (Color Models Only)

Each Camera Head can be assigned a user white balance setting in order to achieve the most appropriate white balance for the light source used and the conditions during recording.
The values set here are stored for each camera head in the Camera Controller's internal memory as a user preset, and the values can be loaded by selecting USER.

3.7. Color Enhancement Function (Color Models Only)

Color models feature a color enhancement setting. The image color enhancement level can be adjusted in five steps, including the OFF setting. The content of each item is listed in the chart below.

Menu Display	Contents
OFF	Turns the color enhancement mode off
x 0.5 (LEVEL1)	Sets x0.5 color enhancement
x 1 (LEVEL2)	Sets x1 (default) color enhancement
x 1.5 (LEVEL3)	Sets x1.5 color enhancement
x 2 (LEVEL4)	Sets x2 color enhancement

3.8. Look-Up Table (LUT) Operations

The LUT (Look-Up Table) refers to a reference table that defines the relationship between the pixel brightness gradation of the original image data taken and the brightness gradation displayed on a computer screen or video monitor.
The system contains a hardware LUT function, and you can display the image data taken with improved contrast (light and dark sharpness) or make an object in the image stand out by emphasizing a specified gray level range.

Caution

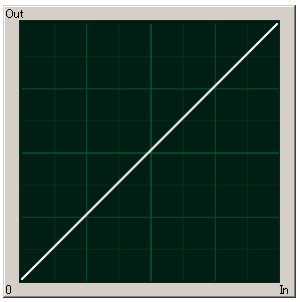
- When an image is saved with its brightness converted with the LUT, the image saved is the image that has had its brightness converted.

3.8.1. Using Preset LUT Patterns

Six preset LUT patterns have been prepared in advance on the system. Each of these patterns is explained in sequence in this section.

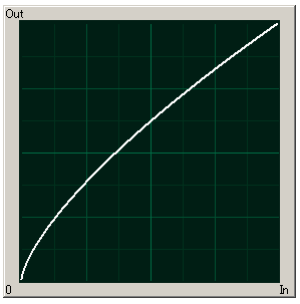
- D1: Gain 1x

  The input is always linear output. This LUT is used for normal conditions.



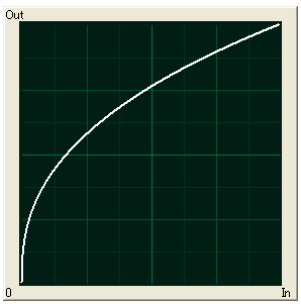
- D2: Gamma 0.6

  This LUT is 0.6 gamma correction.



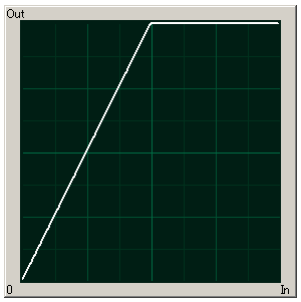
- D3: Gamma 0.45

  This LUT is 0.45 gamma correction.



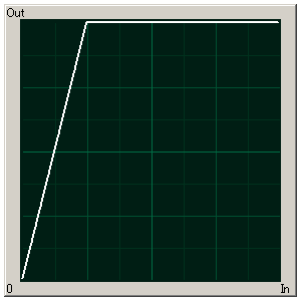
- D4: Gain 2x

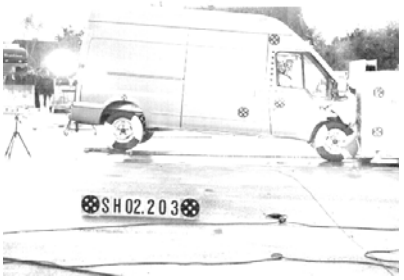
  The gain is doubled and you can display the dark areas of the image emphasized.



- D5: Gain 4x

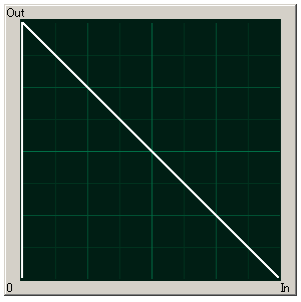
  The gain is doubled and you can display the dark areas of the image emphasized. This LUT emphasizes the dark portions even more than D4.





- D6: Reverse Gradation

  The input gradation is reversed and then displayed.



3.8.2. Using a Custom LUT

Creating a LUT pattern is done with PFV.

Reference

- For the creation method of a LUT pattern, refer to “Photron FASTCAM Viewer User's Manual”.

3.9. Edge Enhancement Function

With the system's edge enhancement setting, you can enhance the edges in the recorded image in three steps.

Menu Display	Contents
OFF	Edge enhancement off.
LEVEL1	Edge enhancement set to weak.
LEVEL 2	Edge enhancement set to medium.
LEVEL 3	Edge enhancement set to strong.

3.10. Setting the Sensor Gain

The sensor gain setting adjusts the amplitude voltage inside the sensor. By increasing this setting, when recording in low light, the signal is amplified and the camera can take a higher gain (brighter) image. However, by amplifying the signal, the noise component also increases, resulting in decreased image quality, or more noise.
The sensor gain can be set in two steps according to the object being recorded. The content of each item is listed in the chart below.

Menu Display	Contents
x 1	Sets the sensor gain to standard.
x 3	Sets the sensor gain to 3x.

3.11. Input/Output Signal Types

With the system, many signals can be input and output through the BNC connectors. Signals that can be input and output from the BNC connectors are listed below.

A signal other than the specified signal must not be input to the various connectors.
Use extreme caution as there is a risk of damage to both devices, the input device and the output device.

3.11.1. TRIG TTL IN Connector

The system recognizes an external TTL signal as a trigger during the READY or ENDLESS recording state. Starting and stopping recording (in the selected recording mode) is controlled with this signal.
Input voltage is 0V to +12V (H level +4.5V to +12V), positive or negative polarity, pulsewidth is 50 ns or greater.
Operating current is 10 mA recommended, 30 mA maximum.

3.11.2. TRIG TTL OUT Connector

A 5V TTL trigger signal is output for input to an external device.

3.11.3. TRIG SW IN Connector

This trigger is input during the READY or ENDLESS recording state by contact between the BNC connector's shield and a center pin (switch closure). The center pin normally has voltage flowing through it. Use caution to avoiding contact with other pins.

3.11.4. SYNC IN Connector

The system recognizes a TTL signal from other devices as a synchronization signal.
Input voltage is 0V to +12V (H level +4.5V to +12V), positive or negative polarity, pulsewidth is 50 ns or greater.
Operating current is 10 mA recommended, 30 mA maximum.

3.11.5. GENERAL IN Connector

The effect when a signal is input is described below, and can be optionally selected and set.
The input voltage is 0V to +12V (H level +4.5V to +12V), positive or negative polarity, pulsewidth is 50 ns or greater.
Operating current is 10 mA recommended, 30 mA maximum.

EVENT POS/NEG	Inputs an event signal (event marker).
TRIG POS/NEG	Inputs a TTL trigger signal.
READY POS/NEG	Inputs a change recording ready status signal (READY ON/OFF).

Reference

- To make the setting from the menu, refer to “3.13.1. GENERAL IN Signal Settings”, page 44.
- To make the setting from PFV, refer to "Photron FASTCAM Viewer User’s Manual".

3.11.6. GENERAL OUT (1,2,3) Connector

These are also BNC connectors. The signals below can be changed and output from the menu or PFV.

(POS: positive polarity, NEG: negative)

SYNC POS/NEG	Outputs a vertical synchronization signal.
EXPOSE POS/NEG	Outputs the camera's exposure period signal. * Outputs during both LIVE and recording.
REC POS/NEG	Outputs a signal during recording.
TRIG POS/NEG	Outputs the trigger signal the camera received.
READY POS/NEG	Outputs a signal that indicates the recording ready state.

Reference

- For details refer to “3.13.2. GENERAL OUT Signal Settings”, page 45.

3.12. Using External Triggers

With the system, you can record by receiving various trigger signals matched to the recording application. The trigger signals that can be used with the system are explained here.

3.12.1. Inputting an External Trigger Signal

The external trigger signals that can be used with the system and their input system are listed below. External trigger signal input settings are also made by selecting [SYNC IN/OUT] from the menu and [TRIG TTL IN] or [GENERAL IN] from the submenu.
The signals input from the TRIG TTL IN and GENERAL IN connectors are explained in section "2.2.9. I/O Cable".

Connector Name (Input System)	Menu	Signal
TRIG TTL IN	TRIG POS	Isolated IC Input 0V - +12V (H level +4.5 - +12V), Positive Polarity
	TRIG NEG	Isolated IC Input 0V - +12V (H level +4.5 - +12V), Negative Polarity
GENERAL IN	TRIG POS	Isolated IC Input 0V - +12V (H level +4.5 - +12V), Positive Polarity
	TRIG NEG	Isolated IC Input 0V - +12V (H level +4.5 - +12V), Negative Polarity
TRIG SW IN	None	Contact signal

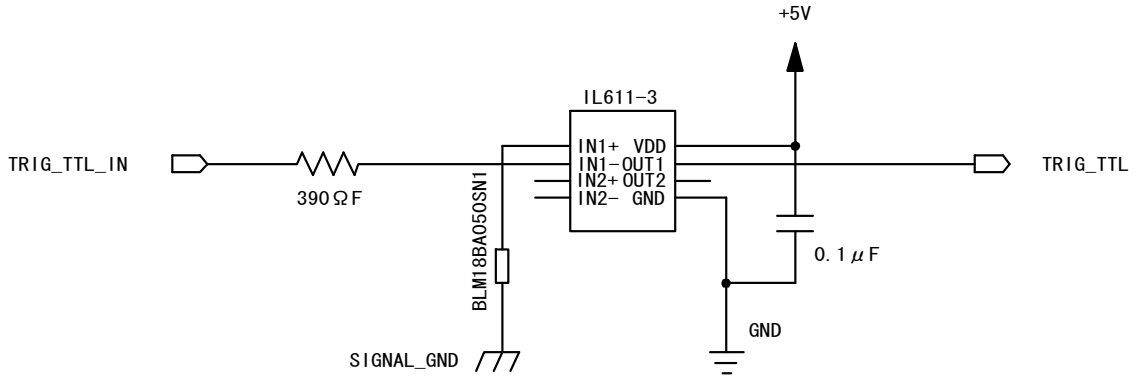
When a trigger signal is input to GENERAL IN, set the signal to be input from the menu in advance before using it.

Use caution not to input more than specified voltage or current to the TRIG TTL IN and GENERAL IN trigger signal inputs as there is a risk of damage to the equipment.

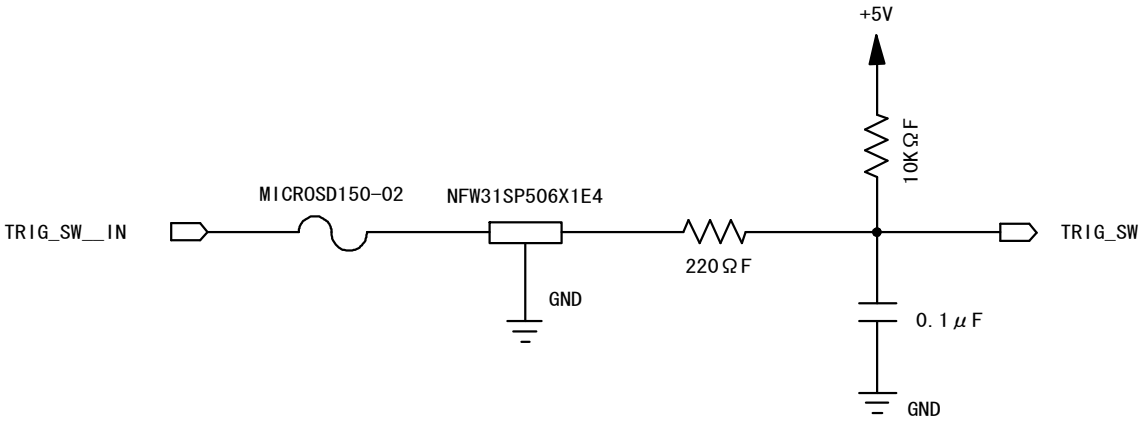
Reference

- For the setting method of the signal inputted into GENERAL IN, refer to “3.13.1. GENERAL IN Signal Settings”, page 44.

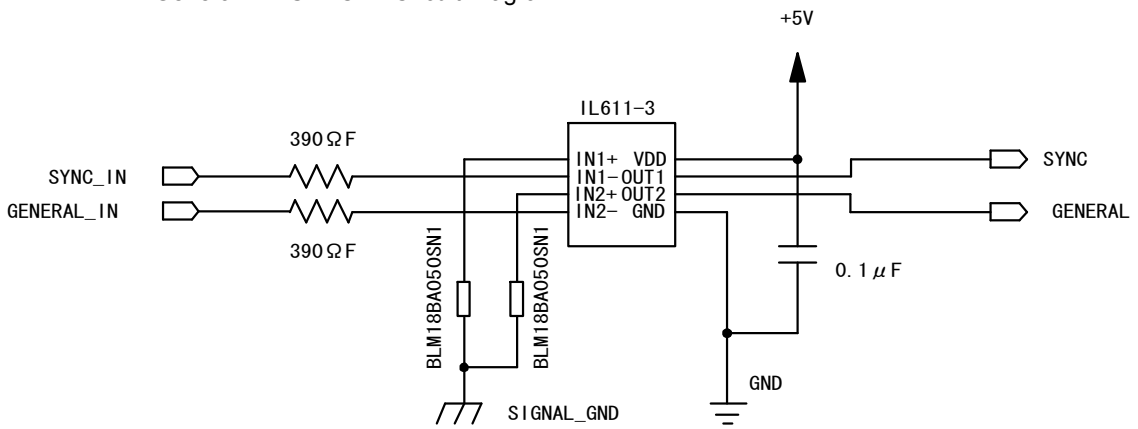
- TRIG TTL IN Circuit Diagram



- TRIG SW IN Circuit Diagram



- General IN / SYNC IN Circuit Diagram



3.12.2. Outputting External Trigger Signals

With the system, you can externally output trigger signals. Output is performed with the TRIG TTL OUT connector's dedicated trigger output system provided by the system, and additionally, output can also be optionally set from the GENERAL OUT connector. External trigger signal output settings are also made by selecting [SYNC IN/OUT] from the menu and [TRIG TTL] OUT or [GENERAL OUT] from the submenu.
Signal output is performed from the TRIG TTL OUT connector and the GENERAL OUT connector explained in section “2.2.9. I/O Cable”.

The chart below summarizes the output systems and the signals that can be output.

Connector Name (Output System)	Menu Setting	Signal Type	Reference Delay Amount
TRIG TTL OUT	TRIG POS	TTL, SW, SOFT, all TRIG pulse output CMOS (74ACT541 buffer) output, Positive Polarity.	For TRIG SW IN, approx. 17.5 usec. For TRIG TTL IN, approx. POS: 90n sec. NEG:100n sec
	TRIG NEG	TTL, SW, SOFT, all TRIG pulse output CMOS (74ACT541 buffer) output, Negative Polarity.	
	TTL IN THRU POS	TRIG TTL IN through output CMOS (74ACT541 buffer) output, Positive Polarity.	For TRIG TTL IN, approx. 45nsec.
	TTL IN THRU NEG	TRIG TTL IN through output CMOS (74ACT541 buffer) output, Negative Polarity.	
GENERAL OUT	TRIG POS	TTL, SW, SOFT, all TRIG pulse output CMOS (74ACT541 buffer) output, Positive Polarity.	For TRIG SW IN, approx. 17.5usec. For TRIG TTL IN GENERAL IN, approx. POS: 90n sec. NEG: 100n sec
	TRIG NEG	TTL, SW, SOFT, all TRIG pulse output CMOS (74ACT541 buffer) output, Negative Polarity	

3.13. GENERAL Signal Settings

3.13.1. GENERAL IN Signal Settings

Details of the signals output from the GENERAL OUT connector explained in section “3.11. Input/Output Signal Types” are shown in the chart below.

Menu Display	Contents	Signal (Input Signal Conditions)
EVENT POS	Inputs a positive polarity event signal.	Isolated IC Input 0V - +12V (H level +4.5 - +12V), Positive Polarity
EVENT NEG	Inputs a negative polarity event signal.	Isolated IC Input 0V - +12V (H level +4.5 - +12V), Negative Polarity
TRIG POS	Inputs a positive polarity trigger signal.	Isolated IC Input 0V - +12V (H level +4.5 - +12V), Positive Polarity
TRIG NEG	Inputs a negative polarity trigger signal.	Isolated IC Input 0V - +12V (H level +4.5 - +12V), Negative Polarity
READY POS	Inputs a positive polarity READY signal. READY ON/OFF is switched by a pulse input.	Isolated IC Input 0V - +12V (H level +4.5 - +12V), Positive Polarity
		Isolated IC Input 0V - +12V (H level +4.5 - +12V), Negative Polarity
READY NEG	Inputs a negative polarity READY signal. READY ON/OFF is switched by a pulse input.	Isolated IC Input 0V - +12V (H level +4.5 - +12V), Positive Polarity
		Isolated IC Input 0V - +12V (H level +4.5 - +12V), Negative Polarity

When using the camera as a part of a system, verify the characteristics of the input signals before using them.

Reference

- For the details of an EVENT POS/NEG setup, refer to “3.17.Event Marker Function”, page 55.

3.13.2. GENERAL OUT Signal Settings

Details of the signals output from the GENERAL OUT connector explained in section “3.11. Input/Output Signal Types” are shown in the chart below. There are three GENERAL OUT connectors and individual settings can be made for each connector.

Menu Display	Contents	Signal Type
SYNC POS	Outputs a positive polarity vertical synchronization signal.	+5V CMOS output, Positive Polarity
SYNC NEG	Outputs a negative polarity vertical synchronization signal.	+5V CMOS output, Negative Polarity
EXPOSE POS	Outputs the sensor's exposure interval at H level.	+5V CMOS output, Positive Polarity
EXPOSE NEG	Outputs the sensor's exposure interval at L level.	+5V CMOS output, Negative Polarity
REC POS	Outputs an interval signal during recording at H level.	+5V CMOS output, Positive Polarity
REC NEG	Outputs an interval signal during recording at L level.	+5V CMOS output Negative Polarity
TRIG POS	Outputs the trigger signal received by the camera at H level.	+5V CMOS output, Positive Polarity
TRIG NEG	Outputs the trigger signal received by the camera at L level.	+5V CMOS output, Negative Polarity
READY POS	Outputs a signal at H level during the trigger wait state. (READY in START mode.) Only valid during START, CENTER, END, and MANUAL modes.	+5V CMOS output, Positive Polarity
READY NEG	Outputs a signal at L level during the trigger wait state. (ENDLESS recording state in CENTER, END, MANUAL) Only valid during START, CENTER, END, and MANUAL modes.	+5V CMOS output, Negative Polarity
IRIG RESET POS	Outputs the camera's internal IRIG reset signal (1PPS) at H level.	+5V CMOS output, Positive Polarity
IRIG RESET NEG	Outputs the camera's internal IRIG reset signal (1PPS) at H level.	+5V CMOS output, Negative Polarity

When using as a part of a system, verify the characteristics of the output signals before using them.

3.14. Using External Synchronization Signals

An external synchronization mode to synchronize the camera to an external signal is provided on the system. By using an external synchronization signal, you can record synchronizing the timing of the recording using multiple systems or synchronize recording with external measuring devices and lighting. The procedure for using the external synchronization signal is explained below.

3.14.1. Inputting an External Synchronization Signal

With the system, you can input an external synchronization signal. The content of each item is listed in the chart below.

Menu Display	Contents	Signal (Input Signal Conditions)
OFF	Sets external synchronization off, operates independently.	(none)
ON CAM POS	Synchronizes to a positive polarity signal from the system.	Isolated IC Input (+4.5V - +12V), Positive Polarity
ON CAM NEG	Synchronizes to a negative polarity signal from the system.	Isolated IC Input (+4.5V - +12V), Negative Polarity
ON OTHERS POS	Synchronizes to a positive polarity signal from an external device (including other Photron products).	Isolated IC Input (+4.5V - +12V), Positive Polarity
ON OTHERS NEG	Synchronizes to a negative polarity signal from an external device (including other Photron products).	Isolated IC Input (+4.5V - +12V), Negative Polarity

3.14.2. Outputting an External Synchronization Signal

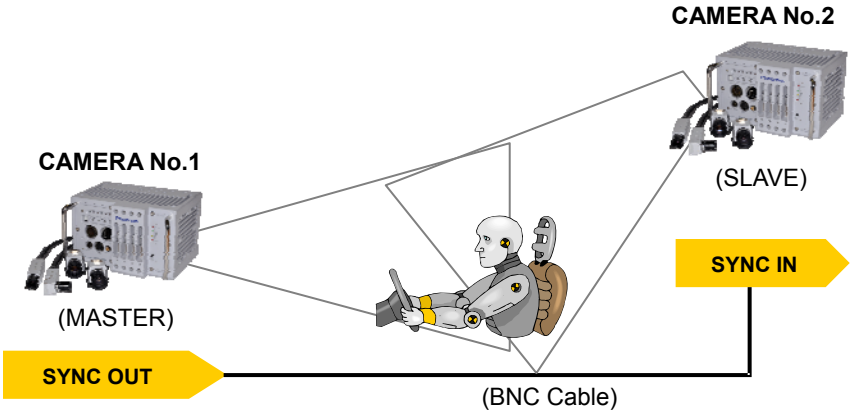
With the system, you can externally output a synchronization signal. External synchronization signals are output from the GENERAL OUT connector explained in section "Input/Output Signal Types". The procedure for setting the output of an external synchronization signal is explained below.

Menu Display	Contents	Signal Type	I/O delay amuont
SYNC POS	Outputs a positive polarity vertical synchronization signal.	CMOS (74ACT541 buffer) Output, Positive Polarity	Approx. 100 ns
SYNC NEG	Outputs a negative polarity vertical synchronization signal.	CMOS (74ACT541 buffer) Output, Negative Polarity	Approx. 100 ns

3.14.3. Synchronizing Multiple FASTCAM MC2.1 Systems (Multiple Unit Synchronized Recording)

The system can perform synchronized recording by synchronizing multiple units using external synchronization input/output.

- Conceptual Diagram of a Synchronized Connection



Synchronized recording settings using the system are made with the "LCD Remote Controller (optional)" or PFV. The conceptual settings when performing synchronized recording using two systems are explained here. First, decide which camera to make the master camera (outputs the synchronization signal) and the slave camera (receives the synchronization signal) from the two systems to use for synchronized recording.

- Cable Connection

Connect the master camera controller's "GENERAL OUT" connector to the slave camera controller's "SYNC IN" connector using a BNC cable.

When the synchronization signal is input to the "SYNC IN" connector, the SYNC IN LED (Yellow) on the front of the slave camera controller illuminates.

Setting the Master Camera (Outputs Synchronization)

Set the signal output for the master camera which will output the synchronization signal. Synchronization signal settings are made with the "LCD Remote Controller (optional)" or PFV.

For PFV (Standard)

1. Verify that the camera mode is in LIVE mode (the image displayed is passed through from the camera). If the system is in a mode other than LIVE mode, check "Live" on the camera control panel.
2. Select I/O on the left tree from "Camera Option" on the camera control panel.
3. Set "GENERAL OUT1".

For the LCD Remote Controller (Optional)

1. Verify that the camera mode is in LIVE mode.
2. Press the LCD Remote Controller's MENU key and the menu list is displayed.
3. Select GENERAL OUT1 from the SYNC IN/OUT submenu with the LCD Remote Controller's ARROW keys and press the ENTER key.
4. Select the signal to be output from the master Camera Controller's GENERAL OUT connector from the menu. Move the cursor here to the SYNC POS item with the ↑ ↓ keys and press the ENTER key to select.
5. The master camera is set to output a positive polarity vertical synchronization signal from its GENERAL OUT1 connector.

◆ Setting the Slave Camera (Receives the Synchronization Signal)

Next, set the synchronization signal input for the slave camera which will receive the synchronization signal supplied by the master camera. Synchronization signal settings are made with the "LCD Remote Controller (optional)" or PFV.

■ For PFV (Standard)

1. Verify that the camera mode is in LIVE mode (the image displayed is passed through from the camera). If the system is in a mode other than LIVE mode, check "Live" on the camera control panel.
2. Select I/O on the left tree from "Camera Option" on the camera control panel.
3. Set SYNC IN to "ON CAM POS".

■ For the LCD Remote Controller (Optional)

1. Verify that the camera mode is in LIVE mode.
2. Set the synchronization signal type that slave camera will receive. Press the LCD Remote Controller's MENU key and the menu list is displayed.
3. Select SYNC IN from the SYNC IN/OUT submenu with the LCD Remote Controller's ARROW keys and press the ENTER key.
4. The output previously set on the master Camera Controller has positive polarity (POSITIVE), therefore it is necessary to make the setting on the slave Camera Controller the same, positive polarity (POSITIVE). Move the cursor to the ON CAM POS item with the ↑ ↓ keys and press the ENTER key to select.

Important

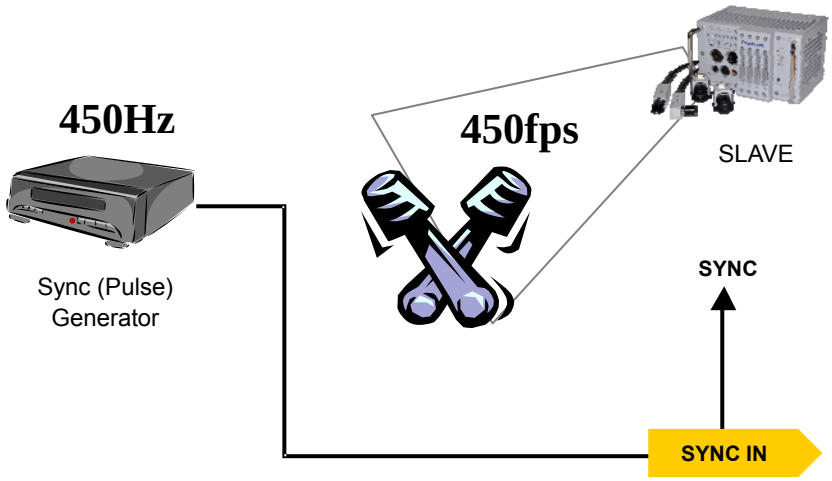
- If steps 1-3 are completed when no synchronization signal is being input, the camera will not operate normally. As detailed in the procedure, make the settings when the signal is being input.

3.14.4. Synchronizing the System with Other External Devices (Frame Rate Synchronized Recording)

With the system, in addition to the frame rate preset on the camera, a function has been provided where you can receive a synchronization signal externally, set the frame rate to that frequency, and record.

In this way, for example, the system can be synchronized with a dynamic body that spins at 450 revolutions per second to conduct high-speed recording at 450 fps. This can open up broad applications that were unavailable until now.

◆ Conceptual Diagram of External Synchronized Recording



Frame rate synchronization signal settings on the system are made with the "LCD Remote Controller (optional)" or PFV.

Important

- When conducting frame rate synchronization recording with the system, the signal that can be input must meet the following conditions.
  - ■ Isolated IC Input (+4.5V - +12V), positive polarity or negative polarity
  - ■ Frequencies are as shown in the table below

Model Name	Minimum Frequency	Maximum Frequency
model 500	60 Hz (50 Hz PAL)	500 Hz
model 2K	60 Hz (50 Hz PAL)	2,000 Hz
model 10K	60 Hz (50 Hz PAL)	10,000 Hz

◆ Cable Connection

Input the synchronization signal from the device that generates the signal to the system. Connect the synchronizing device's output signal to the system's “SYNC IN” connector using a BNC cable.

When the synchronization signal is input to the “SYNC IN” connector, the SYNC IN LED (Yellow) on the front of the system illuminates. (* If the synchronization signal is lost, the LED goes out.)

◆ System Settings

Frame rate synchronization signal settings on the system are made with the "LCD Remote Controller (optional)" or PFV.

■ For PFV (Standard)

1. Verify that the camera mode is in LIVE mode (the image displayed is passed through from the camera). If the system is in a mode other than LIVE mode, check "Live" on the camera control panel.
2. Select I/O on the left tree from "Camera Option" on the camera control panel.
3. Set ON OTHERS POS (positive polarity) or ON OTHERS NEG (negative polarity) according to the polarity of the external synchronization signal.

■ For the LCD Remote Controller (Optional)

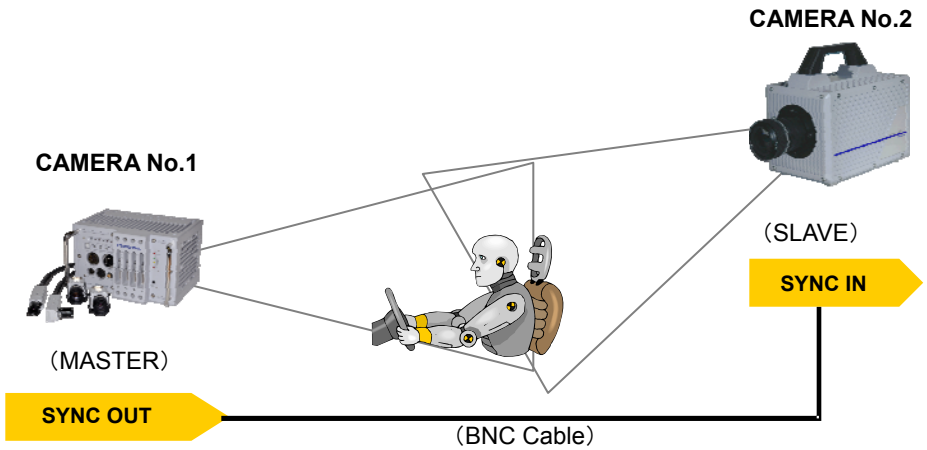
1. Verify that the camera mode is in LIVE mode.
2. Press the LCD Remote Controller's MENU key and the menu list displays.
3. Select SYNC IN from the SYNC IN/OUT submenu with the LCD Remote Controller's ARROW keys and press the ENTER key.
4. Use the LCD Remote Controller's ↑ ↓ keys to select the input signal. Select ON OTHERS POS (positive polarity) or ON OTHERS NEG (negative polarity) according to the polarity of the external synchronization signal.
5. When finished, press the ENTER key to complete the setting.
6. Output the signal from the synchronization device and verify that the camera recognizes the output frequency and synchronizes its frame rate. The recognized frame rate will display in the lower left of the video monitor.
7. Output the signal from the synchronization device and verify that the camera recognizes the output frequency and synchronizes its frame rate. The recognized frame rate will display in the lower left of the video monitor.

Caution

- The frequency of the synchronization signal cannot be changed during the LIVE or recording state.(This is out of spec assurance.) The synchronization signal can be changed if you repeat steps 1 through 6 after inputting the changed frequency. The system is reset.
- If no synchronization signal is input, or the input signal is under 60 Hz (50 Hz), during steps 1-6, the display shows "NO SYNC INPUT".
- If steps 1 through 6 are made when inputting a signal that exceeds the frequency that can be input, the display shows "OVER SYNC INPUT".
- The illumination of the LED on the front of the Camera Controller indicates that the synchronization signal is being input. If the synchronization signal is lost, the LED goes out.
- A minute error occurs in the input synchronization signal due to the construction of the internal circuitry of this function. For this system, an error of ±1 Hz can occur.
  For example, when performing external device synchronization inputting a synchronization signal of 10,000 Hz, the error is: 10,000 Hz ± 1 Hz = 9,999 fps to 10,001 fps.

3.14.5. Synchronizing the System with Other Cameras (Mixed Device Synchronized Recording)

Using the function (frame rate synchronized recording) in the previous section, "3.13.4. Synchronizing the System with Other External Devices", mixed-type synchronized recording can be performed with Photron's other high-speed cameras (except for some older products).
In particular, the FASTCAM series high speed camera systems are also compatible with collective control by the PFV control software.



◆ Basic Process

1. Decide the master camera (the source of the synchronization signal) and the slave camera (the camera that will operate according to the synchronization signal from the master). Basically, by making the master camera the camera with the lowest maximum frame rate that can be set, you can avoid setting a synchronization signal speed the slave camera cannot receive.
2. Connect the master camera's V-SYNC output connector to the slave camera's V-SYNC input connector with a BNC cable, select the synchronization signal output polarity on the master camera, and then set the slave camera to be operated by that signal.

For camera models that can perform synchronized recording or for detailed instructions on making the settings, contact Photron at the contact information in "7.1. Contact Information"

Reference

- For camera models that can perform synchronized recording or for detailed instructions on making the settings, contact Photron at the contact information in "7.1. Contact Information"

3.15. Signal Delay

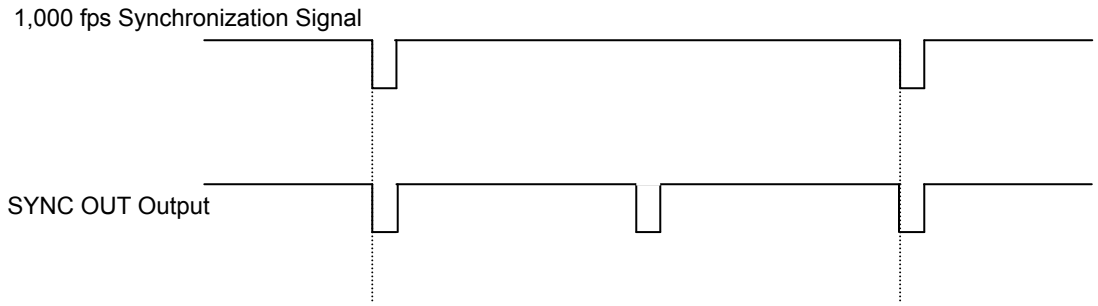
With the system, you can set the signal delay time or pulse width for the various signals that are input and output. Pulse width and delay settings for the various signals input/output are made with the "LCD Remote Controller (optional)" or PFV.

Setting Item	Setting Range (Value)
TRIG TTL IN DELAY	0-60 (s) 100 ns units
SYNC IN DELAY	0-1/frame rate (s) 100 ns units
GENERAL IN DELAY	0-60 (s) 100 ns units
TRIG OUT WIDTH	0-1 (ms) 100 ns units
SYNC OUT DELAY	0-1/frame rate (s) 100 ns units
SYNC OUT WIDTH	0-500 (us), 1/frame rate (s) at 2,000 fps or higher 100 ns units
EXPOSE OUT DELAY	0-1/frame rate (s) 100 ns units
SYNC OUT TIMES	0.5, 1, 2, 4, 6, 8, 10, 20, 30 (* x1 is standard output)

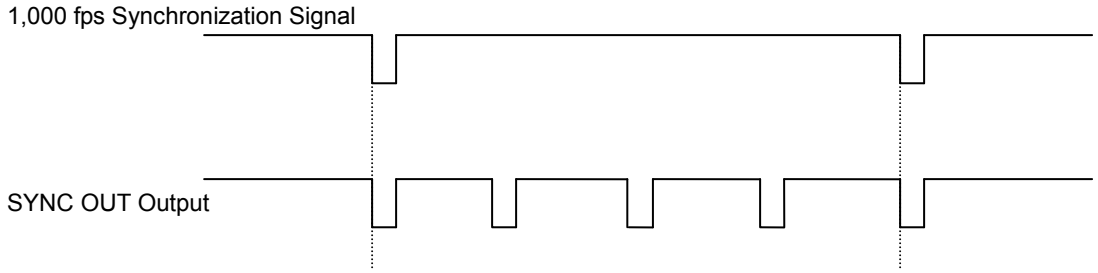
- SYNC OUT TIMES

  Values 1, 2, 4, 6, 8, 10. A value of 1 is normal output.
  Set from the SYNC IN/OUT menu, SYNC OUT TIMES submenu.
  Output a SYNC (vertical synchronization signal) from SYNC OUT that is X times SYNC.

  Example: For a frame rate of 1,000 fps, SYNC OUT TIMES setting of 2.



Example: For a frame rate of 1,000 fps, SYNC OUT TIMES setting of 4.



Caution

- When it is larger than 50,000fps, the setting becomes six or less.
- An accurate frequency is output, but when SYNC OUT TIMES is set to a large value with a high frame rate, the setting may result in frequency errors.

3.16. Using Programmable Switch (USER SW)

There are four switches that can be set on the front of the system. Settings for the switches are made from the menu and they can each be assigned a different function. The content of each setting is listed in the chart below.

As an example, setting the USER1 switch on the front of the Camera Controller is explained here.

◆ PFV

Setting	Explanation
OFF	Does not assign a function.
Change Frame Rate	Raises the frame rate.
Change Resolution	Lowers the resolution.
Change Shutter Speed	Increases the shutter speed.
Change Trigger Mode	Changes the trigger mode.
Fitting image	Adjusts the size of the image displayed on the video output to be the maximum for the current resolution.
Status Display	Displays the status of camera settings on the video output.
Switch LIVE/MEMORY	Switches between LIVE and MEMORY states.
Record Ready	Sets the record ready state.
Record	Starts recording.
Low-Light	Turns low-light mode ON/OFF.
Head Select	It is changed the camera head to display at video out put

◆ LCD Remote Controller (Optional)

Setting	Explanation
OFF	Does not assign a function.
FRAMERATE SEL	Raises the frame rate.
FRESOLUTION SEL	Lowers the resolution.
SHUTTER SEL	Increases the shutter speed.
TRIGGER SEL	Changes the trigger mode.
FIT	The same function as the [FIT] key on the LCD Remote Controller.
STATUS	The same function as the [STATUS] key on the LCD Remote Controller.
LIVE	The same function as the [LIVE] key on the LCD Remote Controller.
REC READY	The same function as the [REC READY] key on the LCD Remote Controller.
REC	The same function as the [REC] key on the LCD Remote Controller.
LOW LIGHT	The same function as the [LOW LIGHT] key on the LCD Remote Controller.
HEAD SELECT	It is changed the camera head to display at video out put

3.17. Event Marker Function

With the system, it is possible to input an external signal during recording, at the instant the frame number is stored, and during playback you can immediately access, or jump to, the stored frame numbers (event markers). This a separate feature from the trigger point, by marking interesting points during recording, these points can be easily called up for review during playback. The event marker can store ten positions within a sequence.

The frame number recording occurs on the pulse's edge, and the next frame after the pulse's edge is input is stored as the event marker. Event marker settings can be made with the "LCD remote controller (optional)" or PFV.


MEMO

Chapter. 4 Connecting a PC

4.1. Connecting the Gigabit Ethernet Interface to a PC

4.1. Connecting the Gigabit Ethernet Interface to a PC

The system can have the operation of its functions performed from a PC using the Gigabit Ethernet interface.This section explains the required setup when connecting the system to a PC.

Reference

- For operating instructions of Photron FASTCAM Viewer software, refer to "Photron FASTCAM Viewer User's Manual".

To connect a PC to the system, connect the system to a commercially available 1000BASE-T-compatible interface board with a LAN cable. For the LAN cable, prepare a UTP or STP Cat 5e (enhanced category 5) or higher LAN cable. (UTP: unshielded, STP: shielded)
The maximum cable length between the PC and the system is, compliant to the 1000BASE-T specification, up to 100 m. One PC can connect to a maximum of 64 Photron Gigabit Ethernet interface equipped cameras using a hub. When connecting multiple devices, connect through a switching hub that can connect at 1000BASE-T. The maximum length of the cable that connects the system (or PC) to the switching hub is also 100 m.

◆ Settings

■On the System	■On the PC
- IP Address Setting	- IP Address Setting
	- Packet Size
	- Time Out Length
	- Communications Port

Important

- The system is only 1000BASE-T compatible. When using a PC compatible with only 10BASE-T or 100BASE-TX, the PC must be connected through a 10BASE-T, 100BASE-TX, and 1000BASE-T compatible switching hub.
- The system's factory default IP address is below:
  IP ADDRESS > 192.168.0.10
  NETMASK > 255.255.255.0
  GATEWAY ADDRESS > 0.0.0.0
  PORT > 2000 (Fixed, not changeable)

Supplement

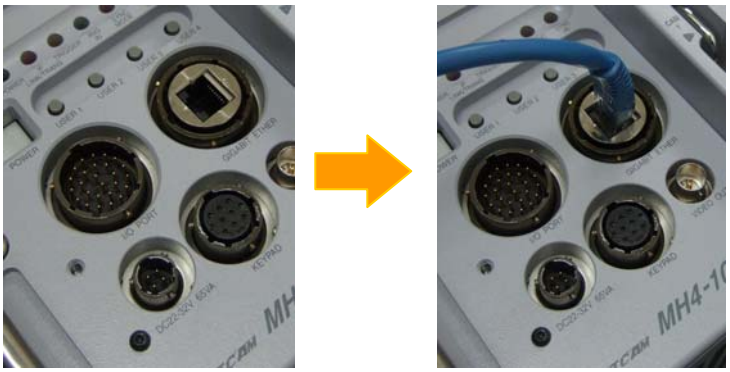
- Photron recommends using an STP cable over long distances or in noisy locations.

Reference

- For the setting method of IP address for camera system, refer to “4.1.2. Setting the IP Address”, page 59.
- For the setting method of control PC, refer to “Photron FASTCAM Viewer User's Manual”.

4.1.1. Connecting the System and a PC

Connect the LAN cable to the system as shown below.



Insert the LAN cable into the "GIGABIT ETHER" connector.

4.1.2. Setting the IP Address

Caution

- When connecting the system to a PC or when connecting other Gigabit Ethernet interface compatible Photron cameras, set each of those devices to a different IP address. Also, when connecting the system to an existing network, do not use IP addresses that are already in use on the network.

Reference

- For the procedure for setting the IP address of the system, refer to the "Photron FASTCAM Viewer User's Manual" or the "LCD Remote Controller User's Manual".

4.1.3. Using DHCP (Dynamic Host Configuration Protocol)

The system is compatible with DHCP. In an environment where DHCP is used, the system's IP address can be acquired from the DHCP server.

Reference

- For details, refer to the “Photron FASTCAM Viewer User’s Manual”.

4.1.4. Connecting Multiple Systems and a PC

With PFV, the system's control software, one PC can connect to and control multiple FASTCAM SA series and MH4-10K high speed camera (Gigabit Ethernet) systems.

Caution

- When connecting to multiple systems, set the IP address of each one to a unique setting.

4.1.5. Gigabit Ethernet Interface Initialization

When you cannot communicate well with the camera even though you are running PFV, the system's control software, you may be able to improve the situation by performing the procedure below.

1. Of the four USER SW (Programmable Switches) on the front of the Camera Controller, press and hold USER1 and USER4 for 10 seconds or more.
2. The LEDs on the front of the Camera Controller will illuminate back and forth from left to right and from right to left and inform you that the initialization of the Gigabit Ethernet interface has completed normally.

Chapter. 5 **Product Specifications**

5.1. Specifications

5.2. Dimensions

5.1. Specifications

5.1.1. Product Specifications

Image Sensor	CMOS image sensor	
Sensor Resolution	512 x 512 pixels	
Frame Rate	2,000 fps full frame	
Lens Mount	NF mount , C mount (With adapter)	
Recording Color Depth	Monochrome	8bit
	Color	RGB, each 8-bit (Bayer color filter method)
Shutter	Electronic shutter	
Recording Method	IC memory	
Recording Memory Amount	1GB standard , 2GB maximum	
Trigger Method	START, CENTER, END, MANUAL, RANDOM	
Gain Control	Hardware LUT on camera, controllable via LCD Remote Controller (optional) or software	
Image Output Customization	Customizable LUT, brightness is changeable	
External Synchronization Input Signal	Isolated IC Input (+4.5V - +12V), negative polarity / positive polarity (switchable)	
External Synchronization Output Signal	5 Vp-p, negative polarity / positive polarity (switchable)	
Trigger Input Signal	Isolated IC Input (+4.5V - +12V), contact	
Other Output Signals	5 Vp-p, negative polarity / positive polarity (switchable)	
External Control	LCD Remote Controller (optional), RS-422 external control I/F, digital IF (PC)	
Video Output Signal	RS170 (NTSC),PAL, digital zoom function, with scroll, fit functions	
Digital Interface	Gigabit Ethernet (1000BASE-T)	

5.1.2. General Specifications

Environment Conditions		
Strage Temperature		-20℃ ～ 60℃ (No Condensation)
Strage Humidity		85% or less (No Condensation)
Guaranteed Operating Temperature		0℃ ～40℃ (No Condensation)
Guaranteed Operating Humidity		85% or less (No Condensation)
Shock Resistance Performance		100G 10ms 6axis (Guaranteed only when the lens is used a reinforced NF mount lens)
Dimensions		
Camera Controller		245 (W) x 160 (H) x 150 (D) mm 9.65” (W) x 6.3” (H) x 5.9” (D)
Cube type Head		35 (W) x 35 (H) x 34 (D) mm 1.38” (W) x 1.38” (H) x 1.34” (D)
Pencil type Head(Straight)		23 (W) x 22 (H) x 75 (D) mm 0.90” (W) x 0.86” (H) x 2.95” (D)
Pencil type Head(Right angle)		23 (W) x 23 (H) x 77 (D) mm 0.90” (W) x 0.90” (H) x 3.03” (D)
AC Power Suppy Unit		68 (W) x 35 (H) x 153 (D) mm, excluding protruding 2.66” (W) x1.36” (H) x5.98” (D)
AC Power Supply		
Power Supply Voltage		Japan 100V, US 120V, EU 240V
Power Supply FVoltage		50Hz ～ 60Hz
Power Consumption		68VA
DC Power Supply		
Power Supply Voltage		22V ～ 32V
Power Consumption		65VA
Weight		
Camera Controller		7.6kg 16.8lb
Cube type Head		90g 3.17 Oz
Pencil type Head (Include Cable)	Straight	145g 5.10 Oz
	Right angle	140g 4.93 Oz
AC Power Suppy Unit		670g 46.2 Oz

Photron has verified two types of AC cables, type A (standard for Japan, USA, Canada, etc.) and type SE (standard for Germany, France, etc.). However, when those cables cannot properly receive power when plugged in, use the proper AC cable for the region's standards and verify that AC cable works properly.

For inquires regarding the recommended AC cable for each region, contact that region's Photron branch office or the distributor.

5.1.3. Options

User Option
High-G Housings (Lens, Camera head screw reinforcement Housing)
Tripod Adapter (for Cube type or Pencil type)
Mounting Brackets (For the camera controller, normal and high-g camera heads)
High-G Battery
Cable Anchor Handle
LCD Remote Controller
NF Mount Lenses (f=3.5mm , f=6mm , f=12mm)
C Mount Adapter
DC Connector for External Power Supply
Dedicated Carrying Case

5.1.4. Frame Rate and Resolution

Maximum Resolution	Frame Rate (fps)	Settable Resolution				
		512 × 512	512 × 352	512 × 256	512 × 128	512 × 96
512 × 512	50 (PAL)	○	○	○	○	○
	60	○	○	○	○	○
	125	○	○	○	○	○
	250	○	○	○	○	○
	500	○	○	○	○	○
	1,000	○	○	○	○	○
	2,000	○	○	○	○	○
512 × 352	3,000	×	○	○	○	○
512 × 256	4,000	×	×	○	○	○
512 × 128	5,000	×	×	×	○	○
	6,000	×	×	×	○	○
	7,000	×	×	×	○	○
	8,000	×	×	×	○	○
512 × 96	9,000	×	×	×	×	○
	10,000	×	×	×	×	○

5.1.5. Recordable Image Count / Resolution

Resolution	Recordable image count with 1 GB of memory	Recordable image count with 2 GB of memory
512 × 512	4,092	8,188
512 × 352	5,952	11,909
512 × 256	8,184	16,376
512 × 128	16,368	32,752
512 × 96	21,824	43,669

* Recording Time = Recordable Image Count x 1/frame rate (fps)

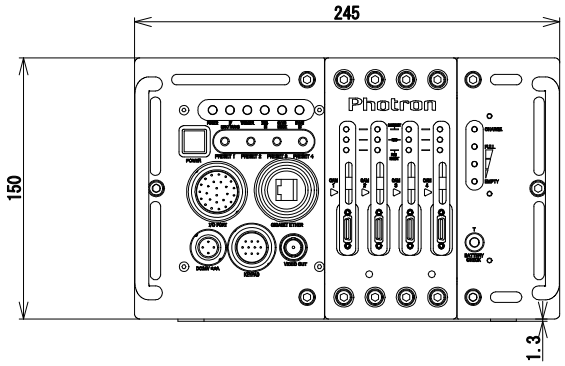
5.1.6. Shutter Speed List

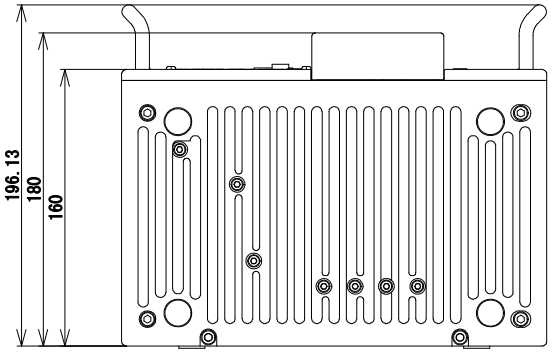
1/frame					
1/125	1/250	1/500	1/700	1/1,000	1/1,250
1/1,600	1/2,000	1/2,500	1/2,800	1/4,000	1/5,000
1/5,600	1/6,400	1/8,000	1/10,000	1/14,000	1/16,000
1/20,000	1/28,000	1/40,000	1/56,000	1/70,000	1/80,000
1/112,000	1/140,000	1/160,000			

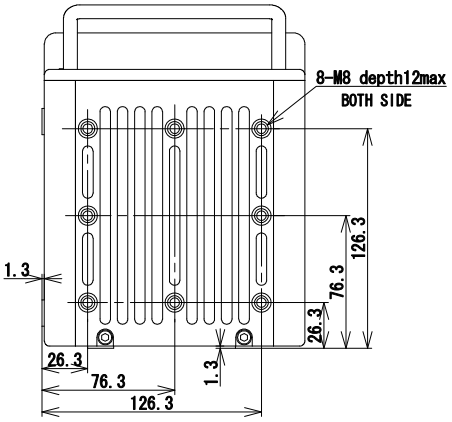
5.2. Dimensions

5.2.1. Camera Controller

* All dimensions are in millimeters (mm) – 25.4 mm equals one inch. These diagrams are not shown to scale.

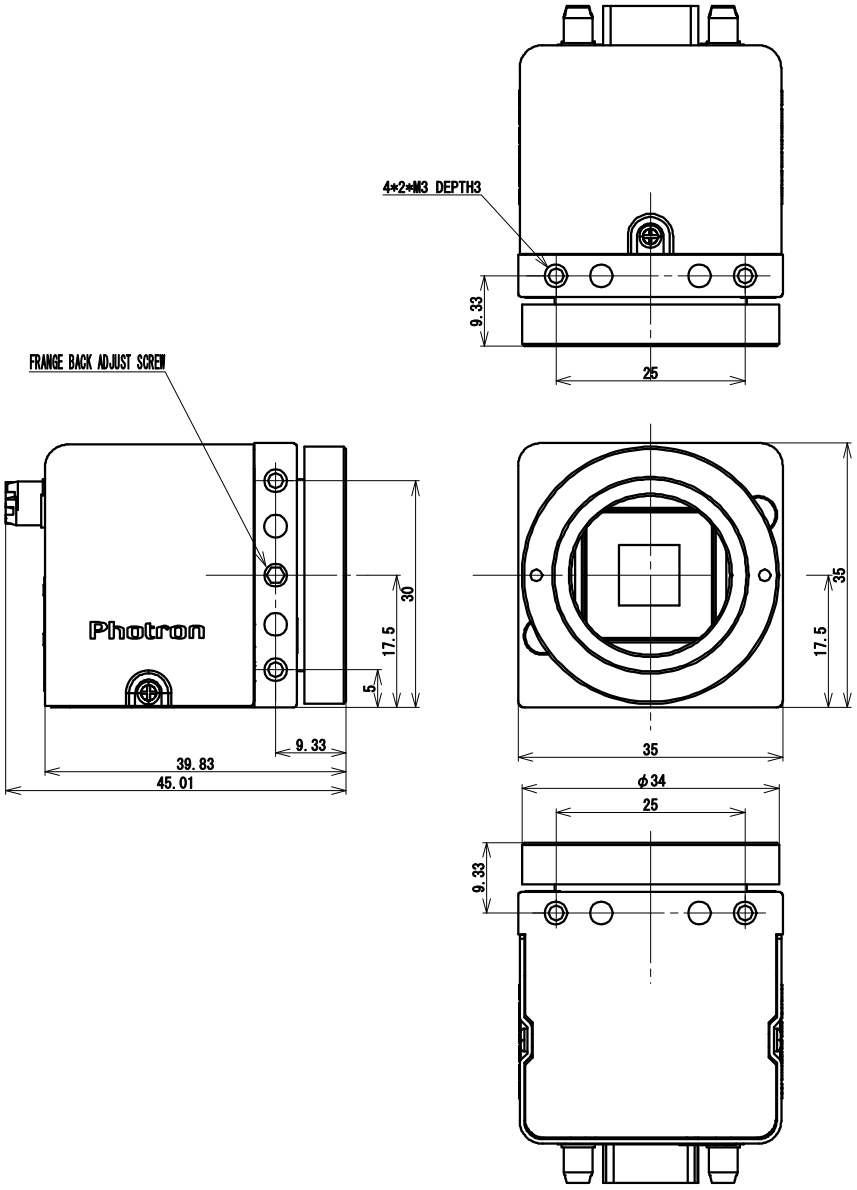






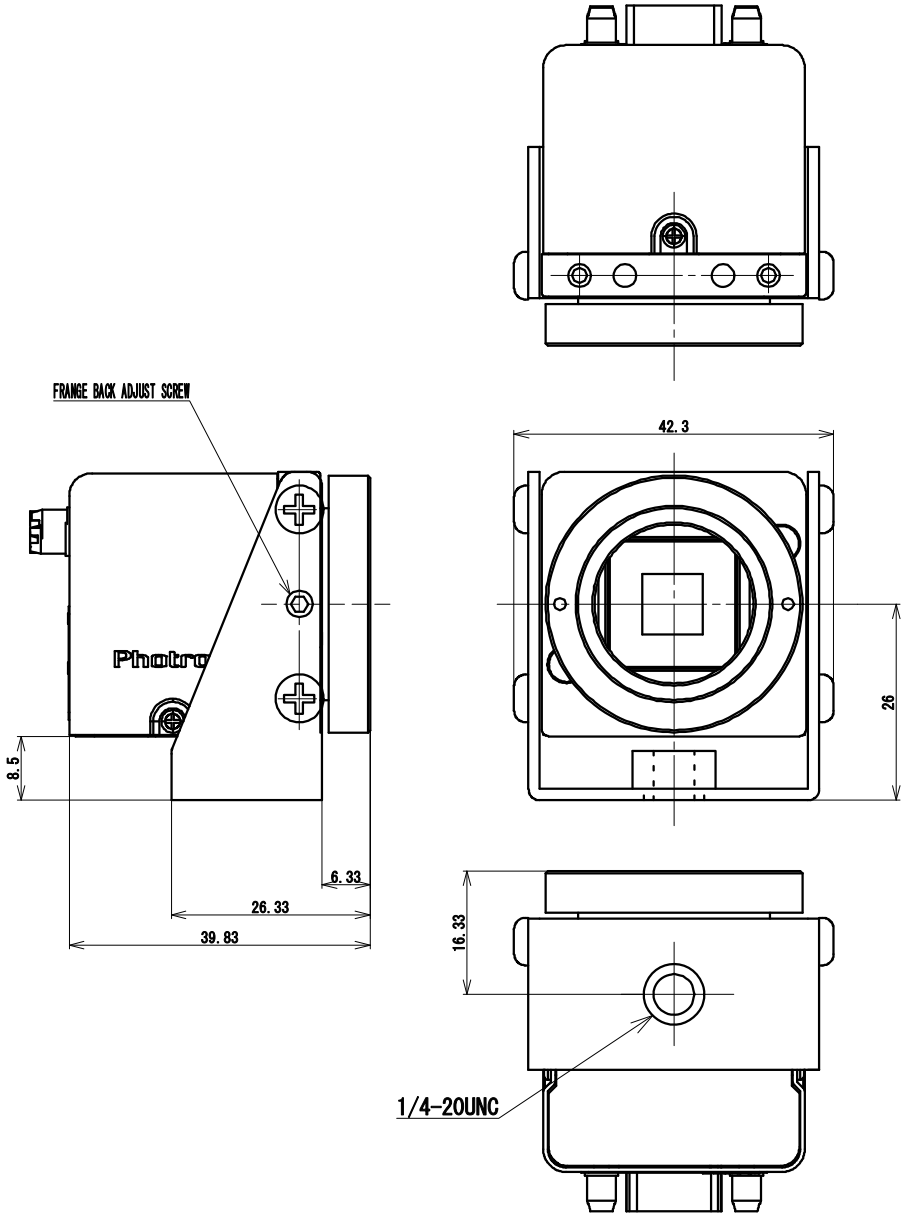
5.2.2. Camera Head

* All dimensions are in millimeters (mm) – 25.4 mm equals one inch. These diagrams are not shown to scale.



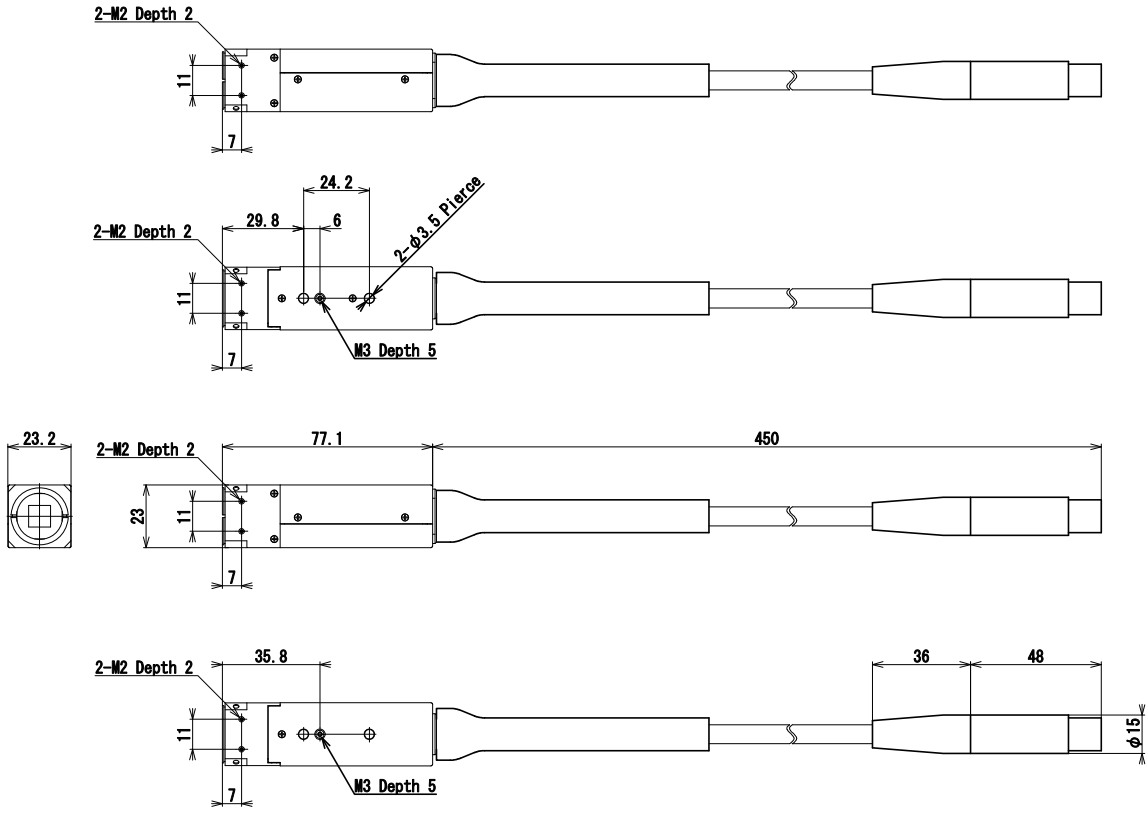
◆ With Tripod Adapter Attached

* All dimensions are in millimeters (mm) – 25.4 mm equals one inch. These diagrams are not shown to scale.



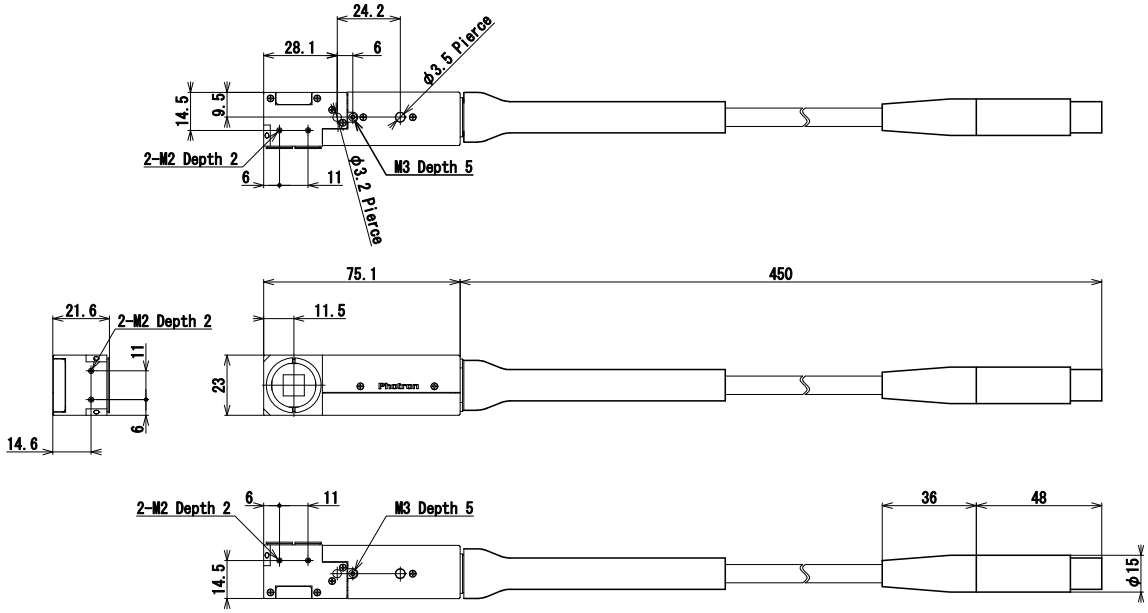
5.2.3. Pencil Type Camera Head (Straight)

* All dimensions are in millimeters (mm) – 25.4 mm equals one inch. These diagrams are not shown to scale.



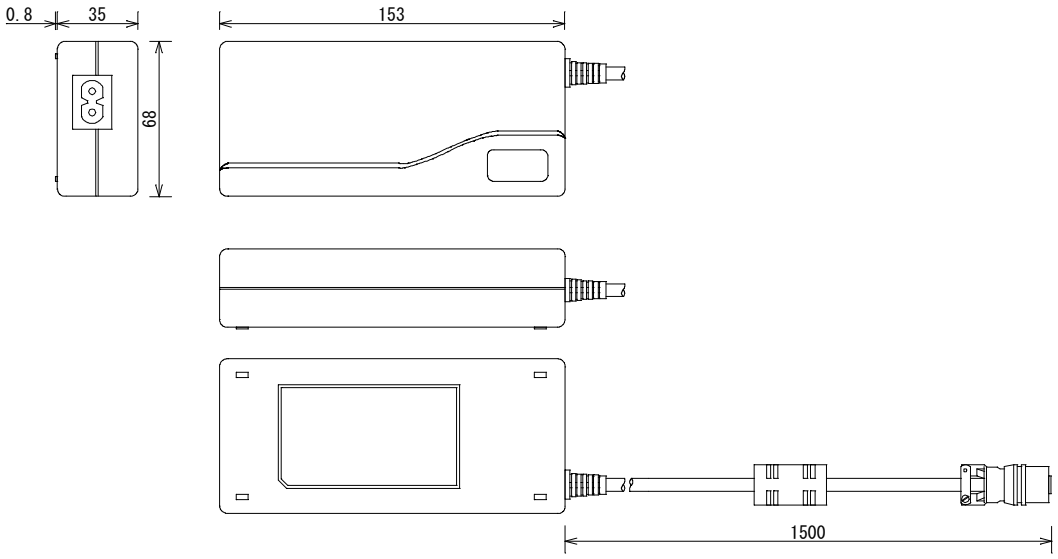
5.2.4. Pencil Type Camera Head (Right angle)

* All dimensions are in millimeters (mm) – 25.4 mm equals one inch. These diagrams are not shown to scale.



5.2.5. AC Power Supply Unit

* All dimensions are in millimeters (mm) – 25.4 mm equals one inch. These diagrams are not shown to scale.

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Chapter. 6 **Warranty**

6.1. About the Warranty

6.1. About the Warranty

This system has been shipped having undergone rigorous testing. However, in the unlikely event that it malfunctions due to a manufacturing defect, it will be repaired, at no charge, within the warranty period.

- Warranty Exceptions

  The following exceptions will result in fee-based repair, even within the warranty period.

  1. Damage or malfunction as a result of fire, earthquake, water damage, lightning, other natural disasters, pollution, or the effects of abnormal voltage.
  2. Damage or malfunction as a result of dropping or mishandling during shipment or when moving after purchase or misuse.
  3. Consumable goods (cables)
  4. When repair, adjustment, or alternation done by an entity other than Photron service has been performed on the system, or damage or malfunction that is determined to be attributed to a fault in the use the product.

For inquires related to malfunction, contact the dealer where the product was purchased, or the nearest Photron office.

Reference

- For inquires related to our product, refer to "7.1. Contact Information", page 769.

Chapter. 7 Contacting Photron

7.1. Contact Information

7.1. Contact Information

For inquires related to PFV, contact Photron at the contact information listed below.
Additionally, the following items will be verified when inquiring, so please prepare them in advance.

Items Verified	Concrete Example
Contact Information	Company, school or organization name, customer contact name, contact phone number, contact e-mail.
Product Name	FASTCAM MH4-10K
Serial Number	Check on the nameplate seal.
Condition of the system and what is known about it.	

Contact Information	
In Americas and Antipodes	**PHOTRON USA, INC.** 9520 Padgett Street, Suite 110 San Diego, CA 92126-4446, USA Phone : 800-585-2129 or 858-684-3555 Fax : 858-684-3558 E-mail : image@photron.com www.photron.com
In Europe, Africa and India	**PHOTRON EUROPE LIMITED** The Barn, Bottom Road, West Wycombe, Buckinghamshire, HP14 4BS, U.K. Phone : +44(0) 1494 48 1011 Fax : +44(0) 1494 48 7011 E-mail : image@photron.com www.photron.com
In other areas	**PHOTRON LIMITED** Fujimi 1-1-8, Chiyoda-Ku Tokyo 102-0071, Japan Phone : +81 3 3238 2107 Fax : +81 3 3238 2109 E-mail : image@photron.co.jp www.photron.co.jp

FASTCAM MH4-10K

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