

FASTCAM-512PCI
Hardware Manual

Rev. 1.04E

Photron

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Preface

Thank you for your purchase of Photron's high-speed camera system, the "FASTCAM-512PCI".

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.

The FASTCAM-512PCI High-Speed Video Camera System will prove itself a truly powerful imaging tool, providing solutions for engineers and scientists in such fields as general research and development, designing, manufacturing, quality assurance, scientific researches, medical and biological researches, and space and aeronautical engineering. The FASTCAM-512PCI seamlessly connects to a PC, becoming an integral part of the computer, and when combined with its easy-to-use control software provides an image recording and processing system for analyzing captured fast moving or high-speed events immediately, a task which has often proven difficult with conventional video systems.

You will find this new recording technology most useful to capture images of high-speed subjects for subsequent slow-motion observation, motion analysis, and image processing applications. This manual presents the technical details of the FASTCAM-512PCI system and how to operate it.

Remarks:

1. For the best use of the FASTCAM-512PCI, please read through this manual.
2. The content of this manual is based on the best knowledge of the manufacturer. However, in case any error or missed information is found in this manual, please inform the manufacturer of such shortcomings immediately. Notwithstanding the above, the manufacturer is not responsible for any results of the use of this equipment.
3. Copying all or any part of this manual without permission is prohibited.
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5. The manufacturer assumes no responsibility for any direct or indirect damages or loss of profit resulting from the use of this equipment
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7. Copying all or any part of the software included in this system without prior written permission by the author is an infringement of copyright.

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 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.



Caution



- Do not set the system in a location where the temperature gets unusually hot. 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 2,000m 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 0°C or higher than 40°C. Also, prevent condensation from forming during shipment



About Sensor Cleaning

Image sensor products are sensitive to and at risk of being damaged by Electrostatic Discharge (ESD).

When handling or cleaning the image sensor, please confirm the following precautions.



- Imaging sensors must be handled in an ESD safe area. Do NOT use non-ESD apparatus for handling or cleaning the sensor.
- Do NOT use a cleaning apparatus of electrostatic adsorption type (electrified brush etc.).



- Discharge the human body static electrification before handling or cleaning works. (e.g. touch the grounded metal.)
- For loose particle contamination, remove particles from the glass by using an ionized air stream.
- For awful dirt, wipe gently using the synthetic fiber with Isopropyl Alcohol (IPA). (The coating of the glass surface might peel off when rubbing strongly.)

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Chapter 1. Set Up

1.1. About the System's Components and Accessories

1.2. About the Camera

1.3. Installation of Hardware

1.4. Setup for Multiple Camera Recording

1.5. Random Reset Trigger Mode

1.1. About the System's Components and Accessories

1.1.1. Unpacking

The FASTCAM-512PCI consists of the following items. When you open up the package, be sure to check all components are present.

1. Camera Head (with Lens Mount and Lens Cap)	1
2. Grabber Board (PCI Board)	1
3. Camera Cable to Connect between Camera and Grabber Board (5 meters)	1
4. External Signal Compound Cable for Input	1
5. External Signal Compound Cable for Output	1
6. FASTCAM Series Driver CD	1
7. FASTCAM-512PCI Hardware Manual	1
8. Photron FASTCAM Viewer User's Manual	1

1.2. About the Camera

The FASTCAM-512PCI consists of a grabber board (PCI Board), a camera head and a control software program set.



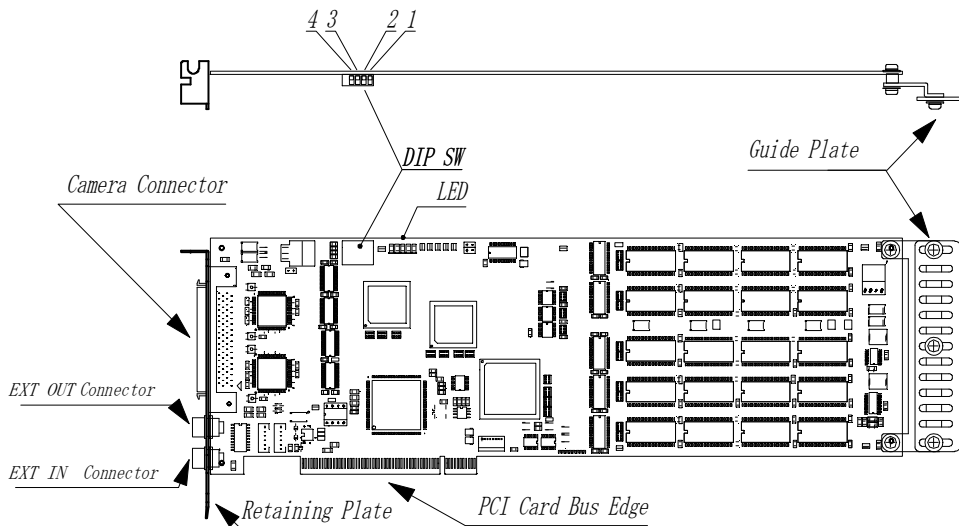
For each of the system components.

- Do not expose to shock outside.
- Do not use in an area with flammable gas or dust present.
- Do not place in an unstable location such as on an unstable platform or an incline.
- Do not disassemble or modify.
- Do not expose to liquids such as water.
- Do not subject to excessive force.

1.2.1. Grabber Board

The grabber board of the FASTCAM-512PCI has been designed so that up to four FASTCAM-512PCI boards can be installed in ATX standard PCI slots of a PC.

Note: When you are installing four grabber boards in one PC, the PCI slot right next to the graphics slot in the PC becomes unusable. This means the PC must have five or more PCI slots in it to accommodate four grabber boards.

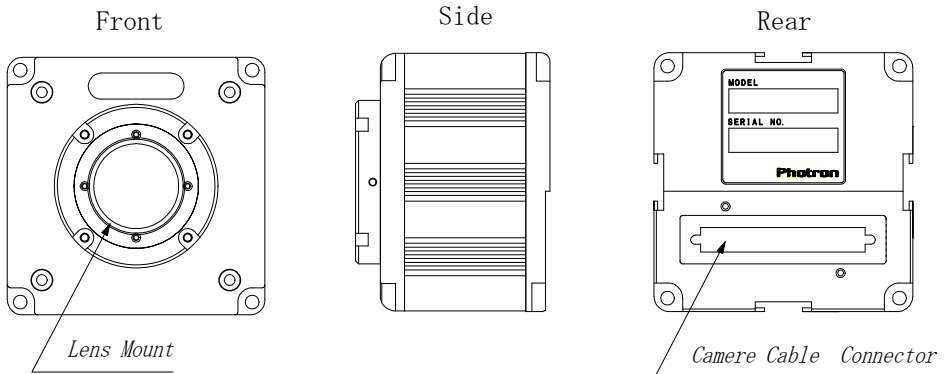


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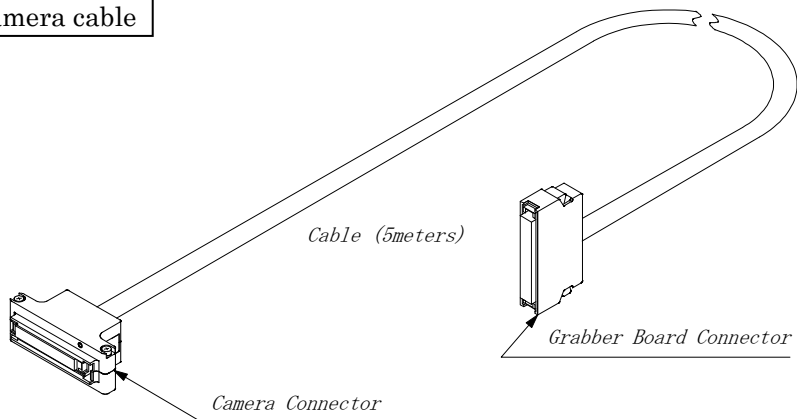
1.2.2. Camera Head and Camera Cable

The FASTCAM-512PCI camera head is of lightweight and compact structure specifically designed for easy handling in varied recording conditions. It takes lenses of C- type mount. A tripod shoe groove is provided on each side of the camera.

Camera head



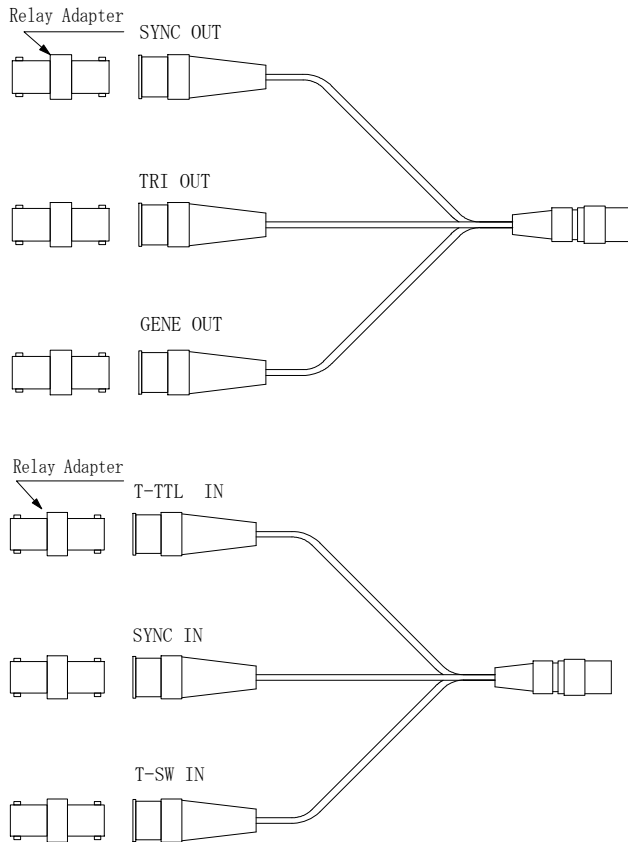
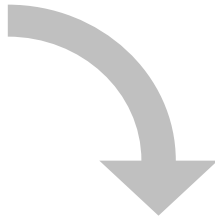
Camera cable



1.2.3. Accessories

EXT OUT/ EXT IN Cables

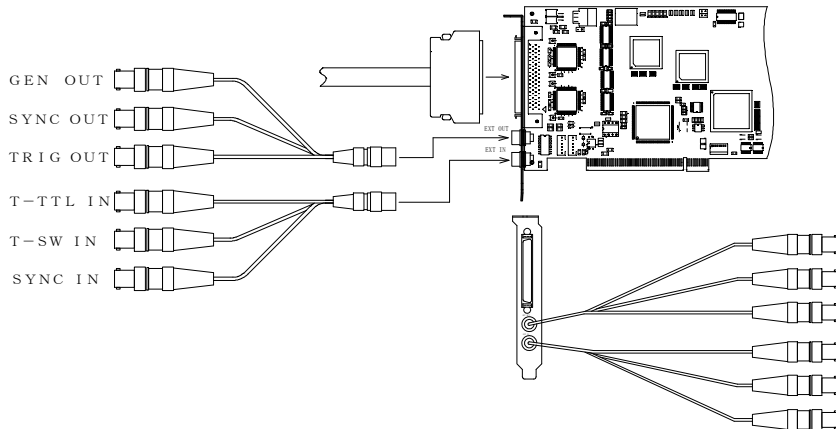
The Grabber Board has two compound connectors to connect it to external equipment and devices via cables to receive and send out signals such as external trigger and sync signals. Two compound cables are included in the package as shown below.



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1.2.4. Connector Specifications

In this chapter, the content of the external I/O connector of FASTCAM-512PCI is describes. The connector and the cable send and receive the following I/O signals. (Details of the two compound cables are as follows.)



1 GENERAL Output (GEN OUT) Connector

A BNC connector that outputs the following signals under software control.

Expose pos/neg : Outputs a signal that specifies the exposure period of the sensor. Signal is present during both LIVE display and recording.

Rec pos/neg : A signal that specifies the recording process period of the Grabber Board.

2 EXTERNAL SYNC Output (SYNC OUT) Connector

A BNC connector that outputs the camera's vertical sync signal to synchronize external equipment such as strobe unit and pulsed laser.

3 TRIGGER TTL Output (TRIG OUT) Connector

A BNC connector that outputs trigger signal for slaved boards to follow.

4 TRIGGER TTL IN Input (T-TTL IN) Connector

A BNC connector that receives TTL signal from external source to control the start and end of a recording in currently selected recording mode. Input signal is a pulse of +5V, 5µsec wide, positive going. Current is 10mA, recommended, and 20mA maximum.

5 TRIGGER SW IN Input (T-SW IN) Connector

A BNC connector whose co-axial cable shield and center conductors are used to send contact closure signals to control the start and end of a recording in currently selected recording mode.

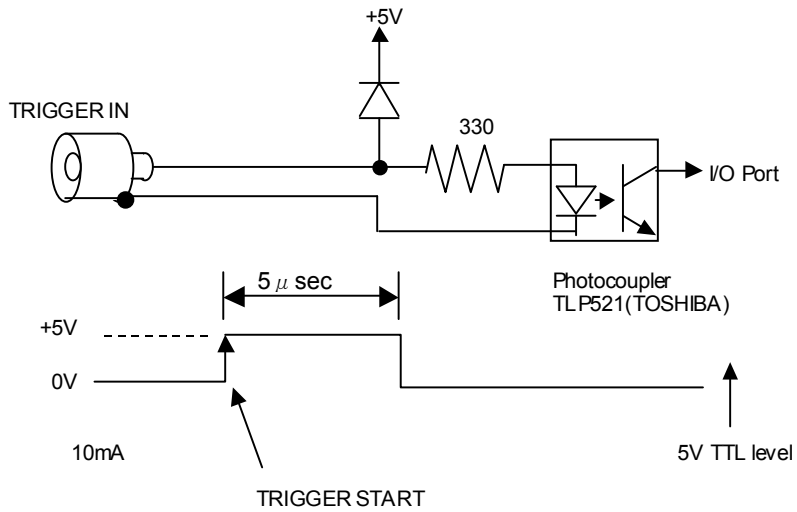


To avoid possible damage to the camera system, do NOT input signals other than contact closure to T-SW IN connector.

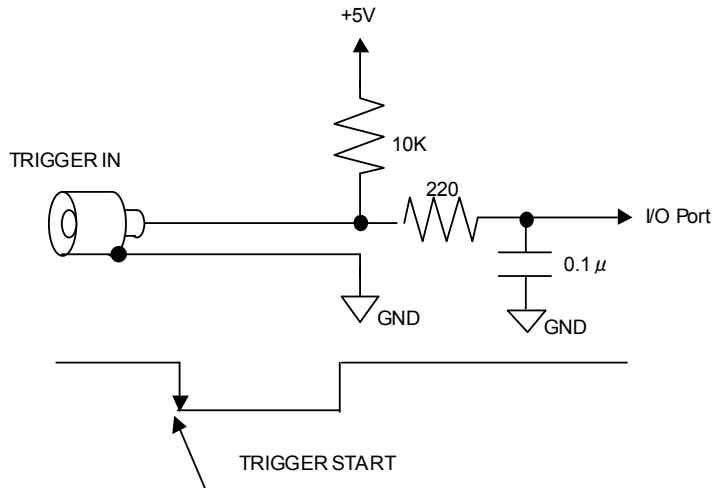
6 EXTERNAL SYNC Input (SYNC IN) Connector

A BNC connector that receives sync signal from master board or external equipment.

TRIGGER TTL IN (T-TTL IN) Input Circuit



TRIGGER SW IN (T-SW IN) Input Circuit



Note: TRIGGER TTL IN works at the rising edge of the TTL signal and TRIGGER SW IN at the falling edge.

1.3. Installation of Hardware



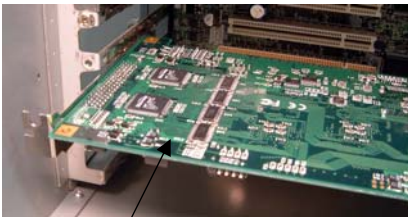
Turn off the computer and unplug the power cord from power outlet before connecting between the camera head and Grabber Board, and installing the Grabber Board in the PC to avoid electrical shock and possible damage to the system and/or components.

Remove the cable twist-ties before connecting.

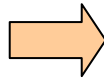
1.3.1. Installing Grabber Board in PC

Follow the procedure below to install the Grabber Board in the PC:

1. Turn off the PC and unplug the power cable.
2. Remove covers of the PC following the PC's instruction manual.
3. Make sure there are unused PCI slot(s).
4. Remove the metal cover plate in the back of the unused PCI slot where you wish to install the Grabber Board.
5. Insert the Grabber Board into the unused PCI slot. Firmly press the edge of the Grabber Board so the connector engages perfectly. Fasten the board with retaining screws.



Insert squarely into PCI slot.

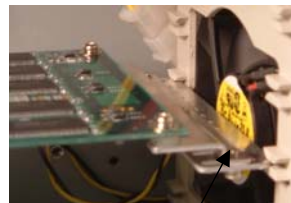


Fasten with screws.

The position of the guide plate on the end of the Grabber Board can be readjusted by the retaining screws. See the board guide on the PC to check for the best position for the guide plate.



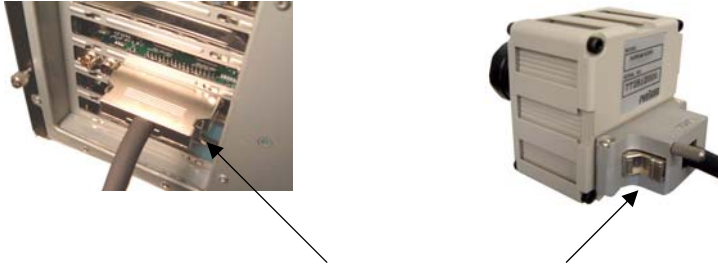
Guide Plate and its retaining screws



Grabber Board firmly inserted along the board guide.

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6. Replace the covers on the PC following the PC instruction manual.
7. Connect the camera cable to the camera connector on the Grabber Board. Be careful about the connector orientation. Fasten the retaining screws tightly. Pull the cable lightly to check if the connector does not come loose.



Please tight the connector lock and the screw firmly.



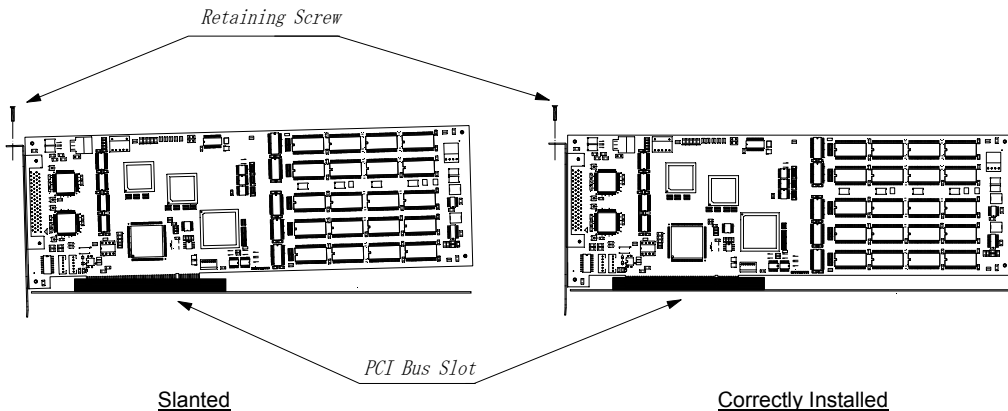
Turn off the PC and unplug the power cord before installing the Grabber Board in the PC.



Be sure to tightly fasten the retaining screws on the camera cable connector shell to avoid damage to the system by an accidental disconnection during operation.



In case the board guide of the grabber board does not fit the slot, readjust the guide board or remove it to insert the grabber board. Do not force the grabber board into a slot, or it may cause a distortion on the grabber board that may eventually result in malfunctioning.



Be sure the grabber board has been installed in the PCI slot squarely and tightly with its bottom edge parallel to the PCI slot. Loose or slanted installation may damage the grabber board.

1.4. Setup for Multiple-Camera Recording

The FASTCAM-512PCI is capable of multiple camera operation: up to four cameras can be connected to a single PC. It also supports synchronized recording by sync signal supplied from external equipment (signal generator, etc.). In multiple camera operation, the cameras record a common subject from different perspectives along a shared timeline. This capability can also be used to record images of a fast-moving subject, together with other subjects related to it, from different viewpoints simultaneously.

This section describes how to set up the FASTCAM-512PCI for multiple camera operation.

Multiple camera operation requires the following setups.

- 1.4.1. Master/Slave Mode Setup**
- 1.4.2. Connection of Multiple Cameras**
- 1.4.3. Setting up ID Numbers**
- 1.4.4. Setting up Software**
- 1.4.5. Tips on Multiple-Camera Sync Recording**

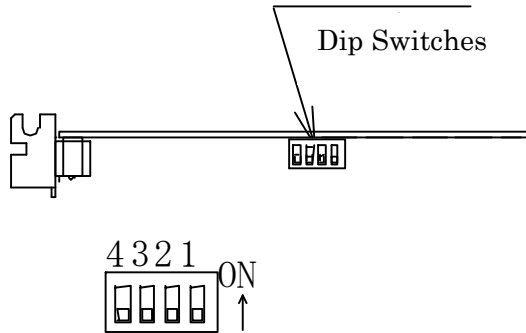
1.4.1. Master/Slave Mode Setup

For multiple-camera synchronized operation, one of the cameras must be set up as the master camera and the other cameras set up as slaves. With cameras set up in this way, the slaves operate following the sync signal provided by the master. As a result, all the cameras record images in a shared timeline.

To set up cameras in these modes, dipswitches on the Grabber Board must be positioned in the following manner:

Location of Dipswitches

The dipswitches for master/slave mode setup are located on the top surface of the Grabber Board. The following figure shows the location of dipswitches as seen from above.



Setting Up Master/Slave Mode Dipswitches

Operate dipswitches to set up one board for master and the others for slave as shown in the following table.

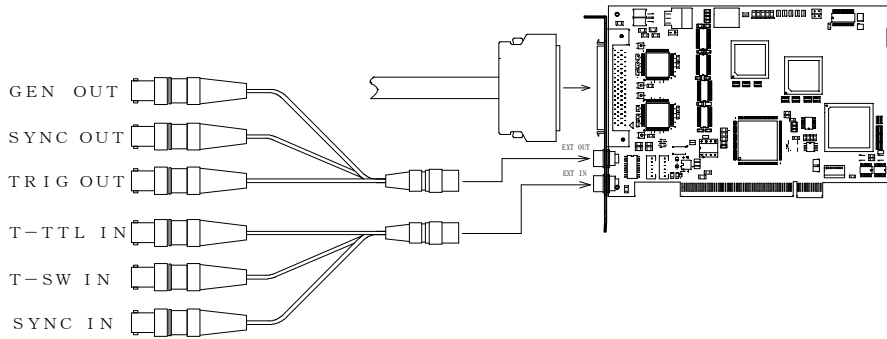
	Dipswitch Position	Mode of Operation
Master Mode	<p>4 3 2 1 ON</p> <p>All four in OFF position</p>	<p>Multiple-Camera Operation: This camera feeds its internally generated sync and trigger signals to the slaves to follow, and enables trigger signal from software.</p> <p>External Sync Operation: Disables the setup from software menu.</p>
Slave Mode	<p>4 3 2 1 ON</p> <p>SW 4 in ON position</p>	<p>Multiple-Camera Operation: This camera follows the sync and trigger signals provided by the master.</p> <p>External Sync Operation: This camera follows sync and trigger signals from external source.</p>

Turn the PC and cameras off and unplug power cord before opening the computer enclosure

1.4.2. Connection of Multiple Cameras

After master/slave camera setup, connect sync cables between boards as described in the following subsections:

Details of Connectors



1. GENERAL Output (GEN OUT) Connector
2. EXTERNAL SYNC Output (SYNC OUT) Connector
3. TRIGGER TTL Output (TRIG OUT) Connector
4. TRIGGER TTL IN Input (T-TTL IN) Connector
5. TRIGGER SW IN Input (T-SW IN) Connector
6. EXTERNAL SYNC Input (SYNC IN) Connector

Connection for Multiple Camera Sync Operation

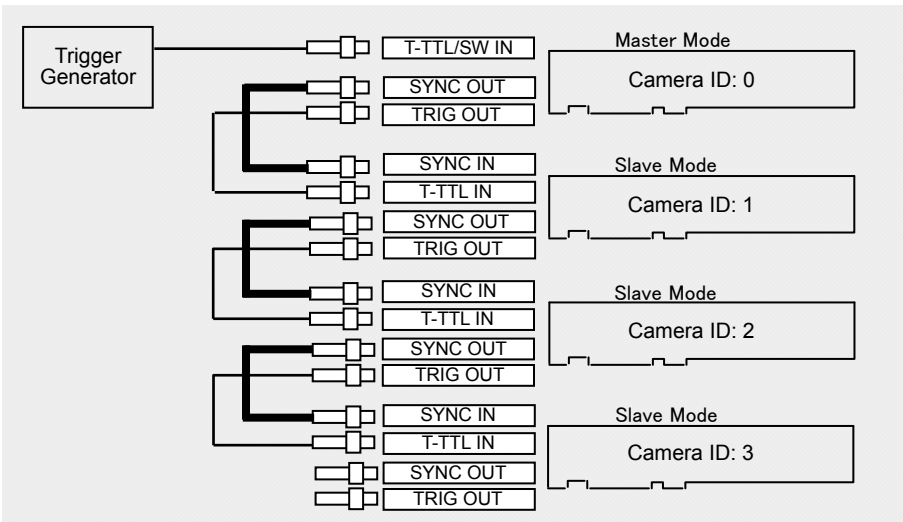
The following figures show how to connect between master and slave boards for sync recording. Connect cables so that the sync and trigger signals are fed to the input of slave boards.

Note: External signal cables have JJ (male-female conversion) connectors. Remove them before connecting to respective boards. Retain the removed conversion connectors for future use.

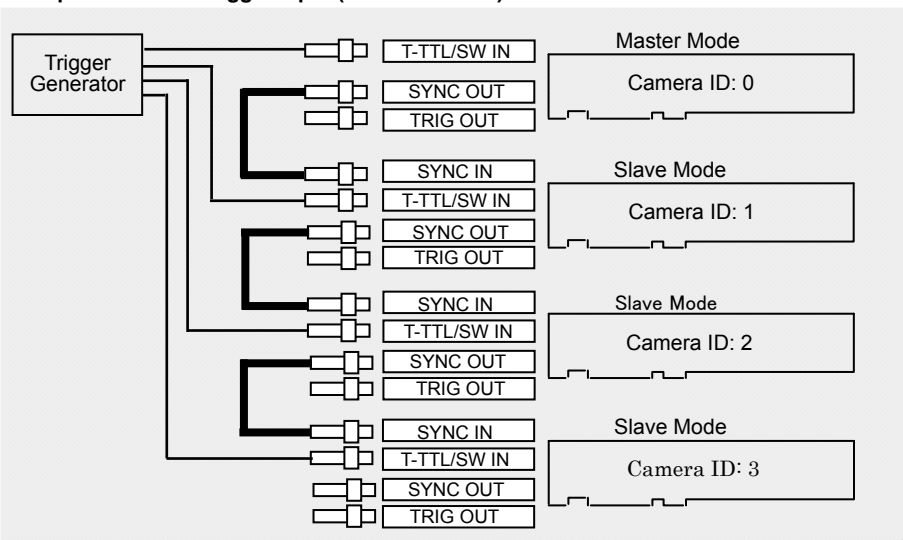
1. Connection between FASTCAM-512PCI Cameras

The following two figures show sync cable connection for multiple PCI R2 cameras. Due to delay of signals between the boards, Example 2 is recommended, except for using software trigger (see Section 3.3. Timing Charts).

Example 1: Basic Connection (Good for software triggering)



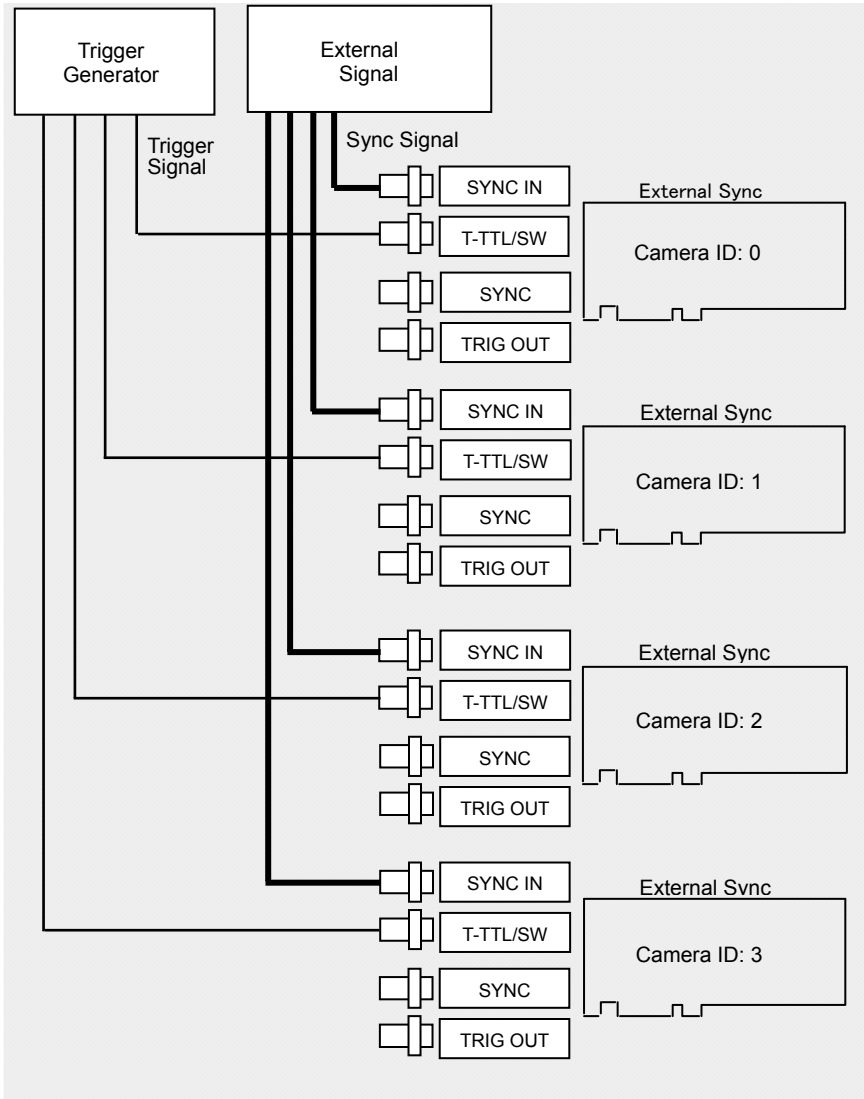
Example 2: Parallel Trigger Input (Recommended)



2. Using External Sync Generator

The figure below shows an example of connection using an external sync generator. To avoid any possible delay of sync and trigger signals between boards, this connection is highly recommended, unless using software triggering (see Subsection 3.3. Timing Charts). (The connection of SYNC OUT → SYNC IN and TRIG OUT → T-TTL IN is not recommended for the above-mentioned reason though operates either.)

Recommended Connection



The characteristic of the circuit configuration inside the 512PCI camera inevitably causes a slight error of ± 22.98 nsec against the input sync signal.

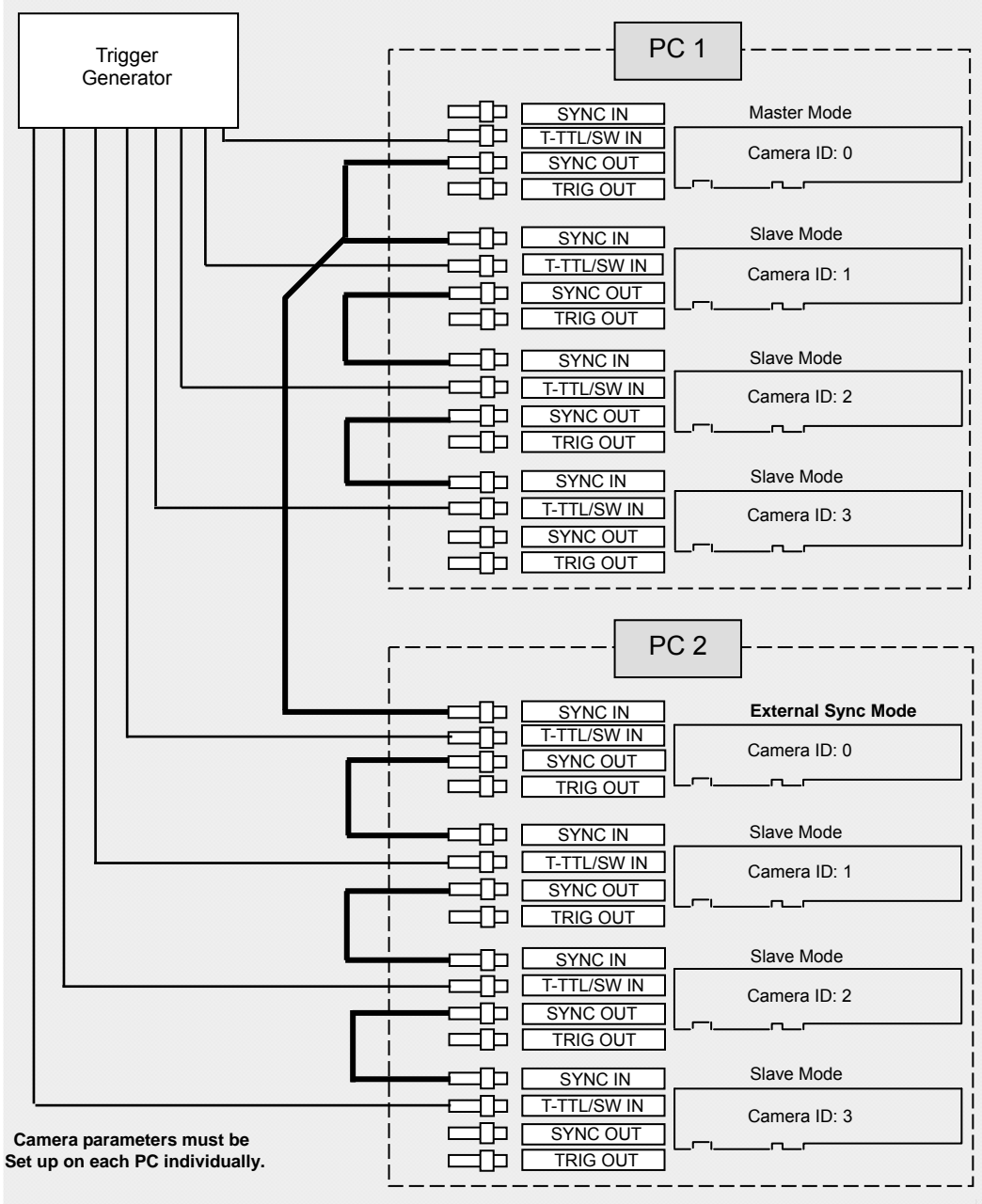
Example: For 10,000 Hz input sync signal, the actual frame rate in each camera is:

$$100 \text{ usec} \pm 22.98 \text{ nsec} = 9,998 \text{ fps to } 10,002 \text{ fps}$$

3. Multiple-PC Sync Operation with Multiple-512PCI Cameras

The following is an example of connection involving two PC's and eight PCI R2 cameras. This connection is highly recommended to avoid possible delay of sync and trigger signals between cameras (see Subsection 3.3. Timing Charts). The basic connection works but is not recommended because of greater signal delays. Use it for software triggering only.

Recommended Connection



1.4.3. Setting Up Camera ID Numbers

For the software to recognize each camera involved in a multiple-camera operation, an ID number, from 0 to 3, is assigned to each camera. With this ID number, each camera is correctly recognized by the system even if the order of recognition is changed.

The following shows how to assign ID numbers to cameras used in a multiple camera system.

Dipswitch Operation to Set Up Camera ID Numbers

Camera ID numbers 1 to 4 are defined by the ON/OFF position of dipswitches 1, 2 and 3 as shown below.

ID No.	Dipswitches	SW 3	SW 2	SW 1
0		OFF	OFF	OFF
1		OFF	OFF	ON
2		OFF	ON	OFF
3		OFF	ON	ON

The factory-set ID is 0.



Assign ID No. 1 to the master board (or the board that receives sync signal from an external source), and other numbers to the slaves in the order of PCI slots in the computer chassis.



Do not duplicate an ID number within a multiple-camera system.

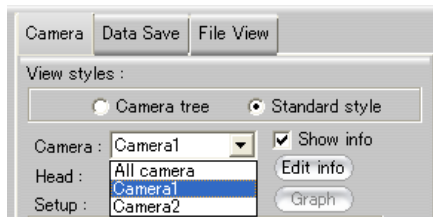
1.4.4. Setting Up Software

Once the setups of the hardware for multiple-camera sync operation procedures in the previous pages are completed, the system can be activated by the software. Follow the below procedure to set up software. For details of software operation, see the Software User's Manual.

Setting Up Master Board

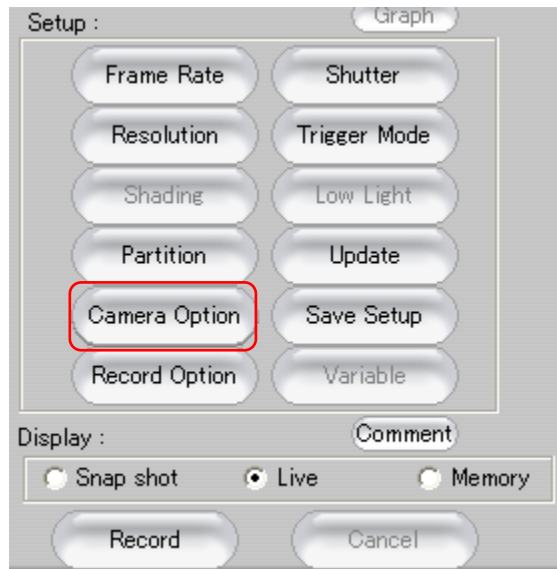
For sync operation of multiple FASTCAM-512PCI cameras:

- 1) Select the camera ID number of the master camera of this system from the camera selection box.

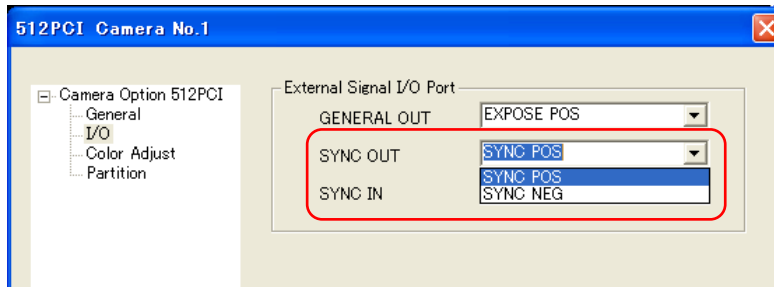


For the relationship between Camera No. and Camera ID, see [Device Information] in [Help].

- 2) Press the 'Camera Option' button to set up more details.



3) Select the desired polarity of sync signal from the 'SYNC OUT' box.

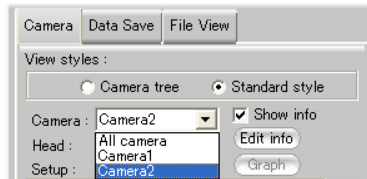


The polarity of sync signal must match that selected for the slave board.

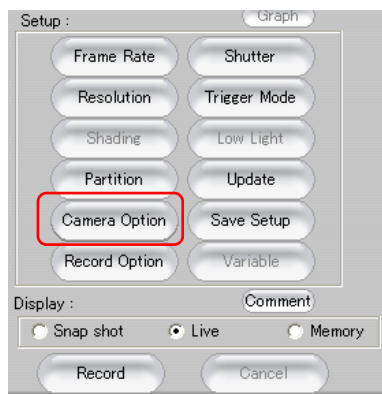
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Setting Up Slave Boards

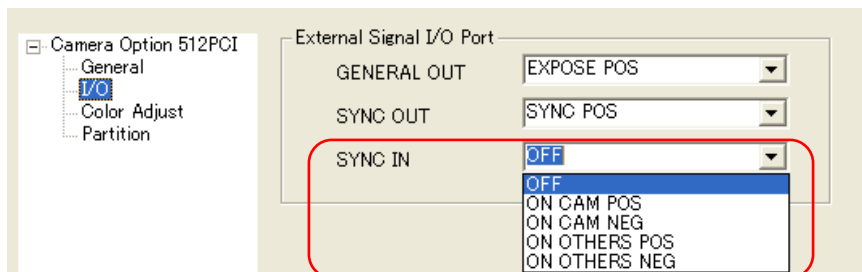
1) Select the camera ID number of the slave camera of this system from the camera selection box.



2) Press the 'Camera Option' button to set up more details.



3) Select a mode of synchronization from the 'SYNC IN' box. Now this slave camera can be synchronized with, and triggered by, the master camera. In other words, this camera has been set up in the external sync mode. As soon as a selection is made in the 'SYNC IN' box, the software makes frame-accurate calculation of the frame rate of vertical sync signal to synchronize this slave camera.



Items to choose from in the 'SYNC IN' box:

OFF	Disable	VOIDS external sync.
ON CAM POS	Normal Modes	Sync operation of multiple 512PCI cameras
ON CAM NEG		
ON OTHERS POS	External Modes	Sync operation of multiple 512PCI cameras with external sync signal. Or, sync operation of multiple 512PCI cameras with multiple PC's.
ON OTHERS NEG		

The SYNC IN window for the master camera is turned gray and no selection can be made.



The polarity must match that selected in the 'SYNC OUT' box of the master camera or that of the sync signal from the external source being used.

4) When more than one slave cameras are involved, each of them must be individually set up.

How External Sync Signal Mode Works?

External Sync Signal Mode works as follows (See 2.4.1.):

1. As soon as either the 'ON OTHERS POS' or 'ON OTHERS NEG' synchronization mode is selected in the 'SYNC IN' box for a slave camera, this camera can be synchronized with and triggered by the master camera. In other words, this camera has been set up for external sync mode operation.
2. As a selection is made in the 'SYNC IN' box, the software makes frame-accurate calculations of the frame rate from the vertical sync signal being fed by the external source (master camera or external generator) to synchronize this slave camera.
3. When the vertical sync signal (frame rate) from the external source is changed, you are required to re-select mode of synchronization in the 'SYNC IN' box so that the software can re-calculate the frame rate for the slave camera to follow.



The threshold of external vertical synchronizing signal in an external equipment synchronizing mode is up to be 32,000Hz.



Due to a measuring error, it is possible to not achieve the same resolution as described in chapter 2.1.5 "Frame Rate and Image Size".

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1.4.5. Tips on Multiple-Camera Sync Recording

Using Software Triggers

The software trigger is issued only to a board set up as the master board with ID "0" that has been set up for sync operation with sync signal from external source. It is not issued to any other boards. By relaying the software trigger that is issued to the master, connecting the TRIG OUT of the master board to T-TTL IN of the first slave board and so forth (see Section 2.4.2.2. Example 1: Basic Connection), multiple-camera triggering is attained without delays caused within the PCI bus.

Despite the above, however, a slight delay is inevitably caused between trigger and vertical sync signals while they are forwarded from board to board. This delay may, in rare cases, result in an offset of one recorded image frame between the master and a slave camera. To avoid this delay, if necessary, use the parallel sync distribution technique shown in Section 2.4.2.2. Example 2: Parallel Trigger Input.

Using External Triggers

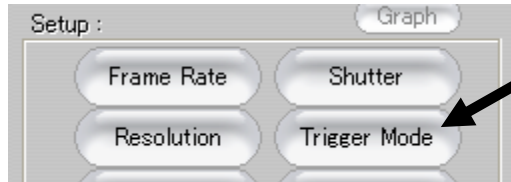
In multiple-camera sync operation with trigger signals from an external source, the use of parallel trigger input is recommended (see Section 2.4.2.2. Example 2: Parallel Trigger Input).

Relayed trigger signal (see Section 2.4.2.2. Example 1: Basic Connection) works in this operation. But, because of likely delay of relayed trigger, as is the case with the relayed software trigger described in the previous subsection, it is not recommended.

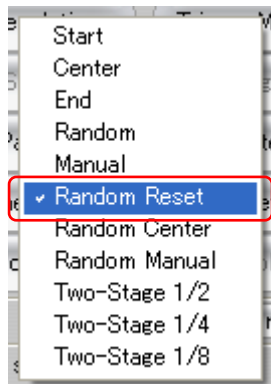
1.5. Random Reset Trigger Mode

The FASTCAM-512PCI supports the Random Reset Trigger Mode. Software set up is needed to use this mode and this section describes how to do it. Refer to the Software User's Manual for details of software operation.

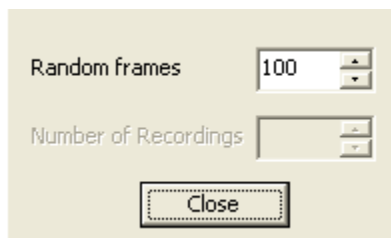
- 1) Press the 'Trigger Mode' button.



- 2) Select trigger mode as the 'Random Reset'.



- 3) Enter the desired number of frames to record at the 'Random frames', and then press the 'Close' button.



A forced reset may cause in the first frame a brightness deviation of about 3 % from the second frame and thereafter.

Memo

Chapter 2 Appendix

2.1. Specifications

2.2. Dimensions

2.3. Timing Charts

2.1. Specifications

2.1.1. Basic Specifications

Resolution (Full)	512 x 512 pixels
Max. Frame Rate (Full Res.)	2,000 FPS (512 x 512)
Highest Frame Rate	32,000 FPS (512 x 32)
Sensor Size	8.2mm x 8.2mm (Pixel Size 16 μ m x 16 μ m)
Sensor Type	Color (Bayer) or Monochrome
Lens Mount	C mount
Segmentation	Available
Electronic Shutter	Available
Camera Head Dimensions	W 85 x D 65 x H 85 mm (including protrusions)
Gain Settings	x 1; x 2; x 4; x 8
	LUT Function Incorporated (Software-operated)
Camera Cable	68-pin Camera Cable (5 meters long standard)
	Camera Head: Shell Screw; PCI Board: Latch

2.1.2. Specifications – Recording System

Recording Method	Digital recording of 10bit/pixel image data in onboard memory
Recording Modes	<p>START: Records frames to the max number of frames available in the memory.</p> <p>END: Stops recording when a trigger is input.</p> <p>CENTER: Records the same number of frames before and after a trigger.</p> <p>MANUAL: Assigns the number of frames to record individually before and after a trigger</p> <p>RANDOM: Records a preset number of frames every time a trigger is input (the number of frames to record is set from control software with a limit of range).</p> <p>Random Reset: Records a preset number of frames with reset of exposure timing every time a trigger signal is input (the number of frames to record is set from control software within a limit).</p> <p>Random Center/Manual: Records a preset number of frames (same or individually set number) before and after a trigger within a limit.</p> <p>Dual-Rate Recording: Changes framing rate at an external timing signal from GENERAL IN. (Available rates: 1/2; 1/4 and 1/8 of set frame rate)</p>
PCI Standard Applied	Rev2.1 Standard (+5V/32bits/33MHz)
Board Size	PCI Full size standard (1-slot width)
Memory Size (No addition possible)	<p>Model 1: 1.3GB memory</p> <p>Model 2: 2.6GB memory</p>
Live Display during Recording	Possible
External Trigger Input (Use special BNC cable)	<p>TTL input (+5V/10mA, Positive-going)</p> <p>Contact closure input (also used as General In for Dual Rate Mode)</p>
Sync Signal Input	External sync signal input (Vertical sync) TTL+5V (Pos/Neg selectable) (Synchronization by multiple cameras, sync generator or external equipment)
Output Signal 1 (GENERAL) (GENE OUT)	<p>General OUT Connector</p> <p>In-Recording Signal TTL +5V (Pos/Neg Selectable)</p> <p>Exposure Timing Signal TTL+5V (Pos/Neg Selectable)</p> <p>Note: Signal polarity can be set from control software.</p>
Output Signal 2 (SYNC OUT)	<p>SYNC OUT Connector</p> <p>Vertical Sync Signal TTL+5V (Pos/Neg selectable)</p> <p>(Signal is output by special BNC cable)</p> <p>Note: Sync signal for multiple-camera recordings.</p>
Output Signal 3 (TRIG OUT)	<p>Trigger Signal TTL+5V (Positive-going)</p> <p>Note: Sync signal for multiple-camera recordings.</p>

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2.1.3. Other Specifications

Application Software and OS	PFV(Photron FASTCAM Viewer3)/SDK compatible Windows 2000/Windows XP/Windows Vista
Memory Partitioning	Partitioning up to 8 divisions
Camera ID Number	To be set by switch on Grabber Board
Master/Slave for Sync	To be set by switch on Grabber Board
Number of Grabber Boards Installable per PC	Up to 4 boards (PC must have five or more slots)
Multiple Cameras per Grabber Board	Multiple camera heads can be used with one Grabber Board. Note: Mixed use of Color and Monochrome cameras available.
Power Supplies	+5V (2A) and +3.3V (2.5A) for both 1.3GB and 2.6GB models
Ambient Temperature	0 to 40 degrees Celsius, No condensation (must be within the allowable temperature range for the PC)



Make sure, before use, that the power requirement on the PCI bus does not exceed the capacity of the PC's power supply unit.



Make sure, before use, that the total power requirement on the power cable between the PC's power supply unit and PCI board does not exceed the PC's supply capacity on the +12.0 and/or +5.0 VDC lines.



In case of excessive power requirement on the power cable (between the PC's power supply unit and the PCI boards) as a result of a multiple-camera operation involving two or more cameras, a power cable(s) with a power source(s) independent from the currently used PC must be added as necessary.

2.1.4. Frame Rate vs. Image Resolution

The maximum resolution setting available to each frame rate is shown in the below table. Other resolutions may be selected from the list in subsection 2.1.5.

Frame Rate	Max Resolution (pixels)
60FPS	512×512
125FPS	512×512
250FPS	512×512
500FPS	512×512
1000FPS	512×512
2000FPS	512×512
4000FPS	512×256
8000FPS	512×128
16000FPS	512×64
32000FPS	512×32

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2.1.5 Frame Rate and Image Size

The FPS and the resolution can be arbitrarily selected according to the following table (variable setting).

FPS Resolution	60	125	250	500	1000	2000	4000	8000	16000	32000
512×512	✓	✓	✓	✓	✓	✓	NA	NA	NA	NA
512×256	✓	✓	✓	✓	✓	✓	✓	NA	NA	NA
512×128	✓	✓	✓	✓	✓	✓	✓	✓	NA	NA
512×64	✓	✓	✓	✓	✓	✓	✓	✓	✓	NA
512×32	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
256×512	✓	✓	✓	✓	✓	✓	NA	NA	NA	NA
256×256	✓	✓	✓	✓	✓	✓	✓	NA	NA	NA
256×128	✓	✓	✓	✓	✓	✓	✓	✓	NA	NA
256×64	✓	✓	✓	✓	✓	✓	✓	✓	✓	NA
256×32	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
128×512	✓	✓	✓	✓	✓	✓	NA	NA	NA	NA
128×256	✓	✓	✓	✓	✓	✓	✓	NA	NA	NA
128×128	✓	✓	✓	✓	✓	✓	✓	✓	NA	NA
128×64	✓	✓	✓	✓	✓	✓	✓	✓	✓	NA
128×32	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
64×512	✓	✓	✓	✓	✓	✓	NA	NA	NA	NA
64×256	✓	✓	✓	✓	✓	✓	✓	NA	NA	NA
64×128	✓	✓	✓	✓	✓	✓	✓	✓	NA	NA
64×64	✓	✓	✓	✓	✓	✓	✓	✓	✓	NA
64×32	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓



Please refer to the 「Photron FASTCAM Viewer user manual」 chapter 「3.3.2 Variable Setting」 for detail.

2.1.6. Resolution and Shutter Speed

Shutter Speed	Exposure (sec)	Shutter Speed	Exposure (sec)
1/2000	0.000500000	1/23500	0.0000422794
1/2500	0.0003998162	1/25500	0.0000395221
1/3000	0.0003336397	1/27000	0.0000367647
1/3500	0.0002858456	1/29500	0.0000340074
1/4000	0.000250000	1/32000	0.0000312500
1/4500	0.0002224265	1/34000	0.0000294118
1/5000	0.0002003676	1/36500	0.0000275735
1/5500	0.0001819853	1/39000	0.0000257353
1/6000	0.0001663603	1/42000	0.0000238971
1/6500	0.0001534926	1/45500	0.0000220588
1/7000	0.0001424632	1/49500	0.0000202206
1/7500	0.0001332721	1/54500	0.0000183824
1/8000	0.0001250000	1/57500	0.0000174632
1/8500	0.0001176471	1/60500	0.0000165441
1/9000	0.0001112132	1/64000	0.0000156250
1/9500	0.0001056985	1/68000	0.0000147059
1/10000	0.0001001838	1/72500	0.0000137868
1/11000	0.0000909926	1/77500	0.0000128676
1/12000	0.0000836397	1/83500	0.0000119485
1/13000	0.0000772059	1/90500	0.0000110294
1/14000	0.0000716912	1/99000	0.0000101103
1/15000	0.0000670956	1/109000	0.0000091912
1/16000	0.0000625000	1/121000	0.0000082721
1/17000	0.0000588235	1/136000	0.0000073529
1/18000	0.0000551471	1/155500	0.0000064338
1/19500	0.0000514706	1/181500	0.0000055147
1/21000	0.0000477941	1/217500	0.0000045956
1/22000	0.0000450368	1/272000	0.0000036765

Unit of Exposure Time : sec

Note: For frame rates below 2000 FPS, the shutter speed is set [1/frame rate (sec)] (such as 1/60, 1/125, 1/500 and 1/1000).

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2.1.7. Frame Rate vs. Number of Recorded Frames and Record Duration

Frame Rate	Resolution	2.6GByte		1.3GByte	
		Frames	Time (sec)	Frames	Time (sec)
60FPS	512 × 512	8,192	136.533	4,096	68.267
	512 × 256	16,384	273.067	8,192	136.533
	512 × 128	32,768	546.133	16,384	273.067
	512 × 64	65,536	1,092.267	32,768	546.133
	512 × 32	131,072	2,184.533	65,536	1,092.267
	256 × 512	16,384	273.067	8,192	136.533
	256 × 256	32,768	546.133	16,384	273.067
	256 × 128	65,536	1,092.267	32,768	546.133
	256 × 64	131,072	2,184.533	65,536	1,092.267
	256 × 32	262,144	4,369.067	131,072	2,184.533
	128 × 512	32,768	546.133	16,384	273.067
	128 × 256	65,536	1,092.267	32,768	546.133
	128 × 128	131,072	2,184.533	65,536	1,092.267
	128 × 64	262,144	4,369.067	131,072	2,184.533
	128 × 32	524,288	8,738.133	262,144	4,369.067
	64 × 512	65,536	1,092.267	32,768	546.133
	64 × 256	131,072	2,184.533	65,536	1,092.267
	64 × 128	262,144	4,369.067	131,072	2,184.533
64 × 64	524,288	8,738.133	262,144	4,369.067	
64 × 32	1,048,576	17,476.267	524,288	8,738.133	

Frame Rate	Resolution	2.6GByte		1.3GByte	
		Frames	Time (sec)	Frames	Time (sec)
125FPS	512 × 512	8,192	65.536	4,096	32.768
	512 × 256	16,384	131.072	8,192	65.536
	512 × 128	32,768	262.144	16,384	131.072
	512 × 64	65,536	524.288	32,768	262.144
	512 × 32	131,072	1,048.576	65,536	524.288
	256 × 512	16,384	131.072	8,192	65.536
	256 × 256	32,768	262.144	16,384	131.072
	256 × 128	65,536	524.288	32,768	262.144
	256 × 64	131,072	1,048.576	65,536	524.288
	256 × 32	262,144	2,097.152	131,072	1,048.576
	128 × 512	32,768	262.144	16,384	131.072
	128 × 256	65,536	524.288	32,768	262.144
	128 × 128	131,072	1,048.576	65,536	524.288
	128 × 64	262,144	2,097.152	131,072	1,048.576
	128 × 32	524,288	4,194.304	262,144	2,097.152
	64 × 512	65,536	524.288	32,768	262.144
	64 × 256	131,072	1,048.576	65,536	524.288
	64 × 128	262,144	2,097.152	131,072	1,048.576
64 × 64	524,288	4,194.304	262,144	2,097.152	
64 × 32	1,048,576	8,388.608	524,288	4,194.304	

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Frame Rate	Resolution	2.6GByte		1.3GByte	
		Frames	Time(sec)	Frames	Time(sec)
250FPS	512 × 512	8,192	32.768	4,096	16.384
	512 × 256	16,384	65.536	8,192	32.768
	512 × 128	32,768	131.072	16,384	65.536
	512 × 64	65,536	262.144	32,768	131.072
	512 × 32	131,072	524.288	65,536	262.144
	256 × 512	16,384	65.536	8,192	32.768
	256 × 256	32,768	131.072	16,384	65.536
	256 × 128	65,536	262.144	32,768	131.072
	256 × 64	131,072	524.288	65,536	262.144
	256 × 32	262,144	1,048.576	131,072	524.288
	128 × 512	32,768	131.072	16,384	65.536
	128 × 256	65,536	262.144	32,768	131.072
	128 × 128	131,072	524.288	65,536	262.144
	128 × 64	262,144	1,048.576	131,072	524.288
	128 × 32	524,288	2,097.152	262,144	1,048.576
	64 × 512	65,536	262.144	32,768	131.072
64 × 256	131,072	524.288	65,536	262.144	
64 × 128	262,144	1,048.576	131,072	524.288	
64 × 64	524,288	2,097.152	262,144	1,048.576	
64 × 32	1,048,576	4,194.304	524,288	2,097.152	

Frame Rate	Resolution	2.6GByte		1.3GByte	
		Frames	Time(sec)	Frames	Time(sec)
500FPS	512 × 512	8,192	16.384	4,096	8.192
	512 × 256	16,384	32.768	8,192	16.384
	512 × 128	32,768	65.536	16,384	32.768
	512 × 64	65,536	131.072	32,768	65.536
	512 × 32	131,072	262.144	65,536	131.072
	256 × 512	16,384	32.768	8,192	16.384
	256 × 256	32,768	65.536	16,384	32.768
	256 × 128	65,536	131.072	32,768	65.536
	256 × 64	131,072	262.144	65,536	131.072
	256 × 32	262,144	524.288	131,072	262.144
	128 × 512	32,768	65.536	16,384	32.768
	128 × 256	65,536	131.072	32,768	65.536
	128 × 128	131,072	262.144	65,536	131.072
	128 × 64	262,144	524.288	131,072	262.144
	128 × 32	524,288	1,048.576	262,144	524.288
	64 × 512	65,536	131.072	32,768	65.536
64 × 256	131,072	262.144	65,536	131.072	
64 × 128	262,144	524.288	131,072	262.144	
64 × 64	524,288	1,048.576	262,144	524.288	
64 × 32	1,048,576	2,097.152	524,288	1,048.576	

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Frame Rate	Resolution	2.6GByte		1.3GByte	
		Frames	Time(sec)	Frames	Time(sec)
1000FPS	512 × 512	8,192	8.192	4,096	4.096
	512 × 256	16,384	16.384	8,192	8.192
	512 × 128	32,768	32.768	16,384	16.384
	512 × 64	65,536	65.536	32,768	32.768
	512 × 32	131,072	131.072	65,536	65.536
	256 × 512	16,384	16.384	8,192	8.192
	256 × 256	32,768	32.768	16,384	16.384
	256 × 128	65,536	65.536	32,768	32.768
	256 × 64	131,072	131.072	65,536	65.536
	256 × 32	262,144	262.144	131,072	131.072
	128 × 512	32,768	32.768	16,384	16.384
	128 × 256	65,536	65.536	32,768	32.768
	128 × 128	131,072	131.072	65,536	65.536
	128 × 64	262,144	262.144	131,072	131.072
	128 × 32	524,288	524.288	262,144	262.144
	64 × 512	65,536	65.536	32,768	32.768
	64 × 256	131,072	131.072	65,536	65.536
	64 × 128	262,144	262.144	131,072	131.072
64 × 64	524,288	524.288	262,144	262.144	
64 × 32	1,048,576	1,048.576	524,288	524.288	

Frame Rate	Resolution	2.6GByte		1.3GByte	
		Frames	Time(sec)	Frames	Time(sec)
2000FPS	512 × 512	8,192	4.096	4,096	2.048
	512 × 256	16,384	8.192	8,192	4.096
	512 × 128	32,768	16.384	16,384	8.192
	512 × 64	65,536	32.768	32,768	16.384
	512 × 32	131,072	65.536	65,536	32.768
	256 × 512	16,384	8.192	8,192	4.096
	256 × 256	32,768	16.384	16,384	8.192
	256 × 128	65,536	32.768	32,768	16.384
	256 × 64	131,072	65.536	65,536	32.768
	256 × 32	262,144	131.072	131,072	65.536
	128 × 512	32,768	16.384	16,384	8.192
	128 × 256	65,536	32.768	32,768	16.384
	128 × 128	131,072	65.536	65,536	32.768
	128 × 64	262,144	131.072	131,072	65.536
	128 × 32	524,288	262.144	262,144	131.072
	64 × 512	65,536	32.768	32,768	16.384
	64 × 256	131,072	65.536	65,536	32.768
	64 × 128	262,144	131.072	131,072	65.536
64 × 64	524,288	262.144	262,144	131.072	
64 × 32	1,048,576	524.288	524,288	262.144	

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Frame Rate	Resolution	2.6GByte		1.3GByte	
		Frames	Time(sec)	Frames	Time(sec)
4000FPS	512 × 512	—	—	—	—
	512 × 256	16,384	4.096	8,192	2.048
	512 × 128	32,768	8.192	16,384	4.096
	512 × 64	65,536	16.384	32,768	8.192
	512 × 32	131,072	32.768	65,536	16.384
	256 × 512	—	—	—	—
	256 × 256	32,768	8.192	16,384	4.096
	256 × 128	65,536	16.384	32,768	8.192
	256 × 64	131,072	32.768	65,536	16.384
	256 × 32	262,144	65.536	131,072	32.768
	128 × 512	—	—	—	—
	128 × 256	65,536	16.384	32,768	8.192
	128 × 128	131,072	32.768	65,536	16.384
	128 × 64	262,144	65.536	131,072	32.768
	128 × 32	524,288	131.072	262,144	65.536
	64 × 512	—	—	—	—
	64 × 256	131,072	32.768	65,536	16.384
	64 × 128	262,144	65.536	131,072	32.768
64 × 64	524,288	131.072	262,144	65.536	
64 × 32	1,048,576	262.144	524,288	131.072	

Frame Rate	Resolution	2.6GByte		1.3GByte	
		Frames	Time(sec)	Frames	Time(sec)
8000FPS	512 × 512	—	—	—	—
	512 × 256	—	—	—	—
	512 × 128	32,768	4.096	16,384	2.048
	512 × 64	65,536	8.192	32,768	4.096
	512 × 32	131,072	16.384	65,536	8.192
	256 × 512	—	—	—	—
	256 × 256	—	—	—	—
	256 × 128	65,536	8.192	32,768	4.096
	256 × 64	131,072	16.384	65,536	8.192
	256 × 32	262,144	32.768	131,072	16.384
	128 × 512	—	—	—	—
	128 × 256	—	—	—	—
	128 × 128	131,072	16.384	65,536	8.192
	128 × 64	262,144	32.768	131,072	16.384
	128 × 32	524,288	65.536	262,144	32.768
	64 × 512	—	—	—	—
	64 × 256	—	—	—	—
	64 × 128	262,144	32.768	131,072	16.384
64 × 64	524,288	65.536	262,144	32.768	
64 × 32	1,048,576	131.072	524,288	65.536	

The [—] represents the items that cannot be used.

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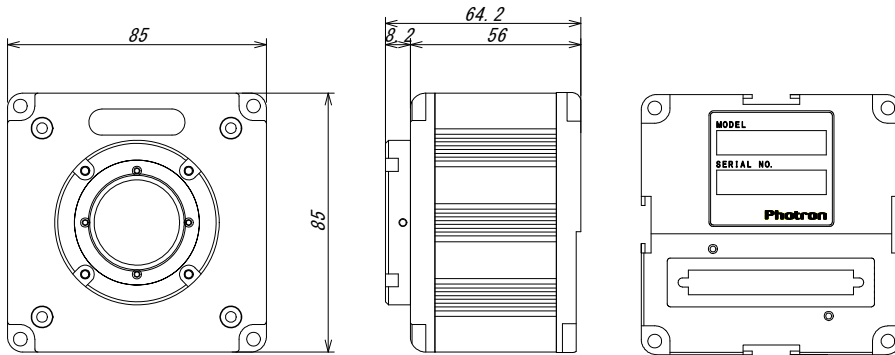
Frame Rate	Resolution	2.6GByte		1.3GByte	
		Frames	Time(sec)	Frames	Time(sec)
16000FPS	512 × 512	—	—	—	—
	512 × 256	—	—	—	—
	512 × 128	—	—	—	—
	512 × 64	65,536	4.096	32,768	2.048
	512 × 32	131,072	8.192	65,536	4.096
	256 × 512	—	—	—	—
	256 × 256	—	—	—	—
	256 × 128	—	—	—	—
	256 × 64	131,072	8.192	65,536	4.096
	256 × 32	262,144	16.384	131,072	8.192
	128 × 512	—	—	—	—
	128 × 256	—	—	—	—
	128 × 128	—	—	—	—
	128 × 64	262,144	16.384	131,072	8.192
	128 × 32	524,288	32.768	262,144	16.384
	64 × 512	—	—	—	—
	64 × 256	—	—	—	—
	64 × 128	—	—	—	—
64 × 64	524,288	32.768	262,144	16.384	
64 × 32	1,048,576	65.536	524,288	32.768	

Frame Rate	Resolution	2.6GByte		1.3GByte	
		Frames	Time(sec)	Frames	Time(sec)
32000FPS	512 × 512	—	—	—	—
	512 × 256	—	—	—	—
	512 × 128	—	—	—	—
	512 × 64	—	—	—	—
	512 × 32	131,072	4.096	65,536	2.048
	256 × 512	—	—	—	—
	256 × 256	—	—	—	—
	256 × 128	—	—	—	—
	256 × 64	—	—	—	—
	256 × 32	262,144	8.192	131,072	4.096
	128 × 512	—	—	—	—
	128 × 256	—	—	—	—
	128 × 128	—	—	—	—
	128 × 64	—	—	—	—
	128 × 32	524,288	16.384	262,144	8.192
	64 × 512	—	—	—	—
	64 × 256	—	—	—	—
	64 × 128	—	—	—	—
64 × 64	—	—	—	—	
64 × 32	1,048,576	32.768	524,288	16.384	

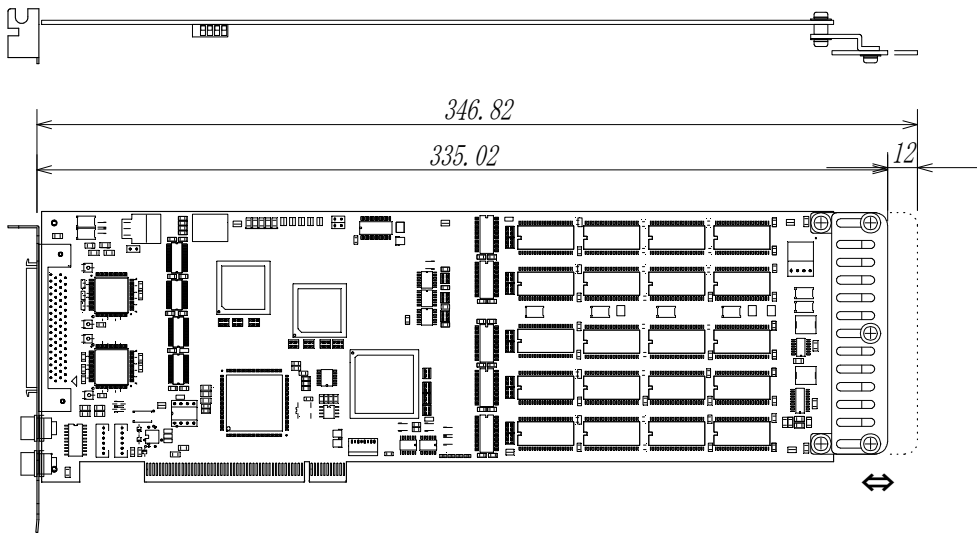
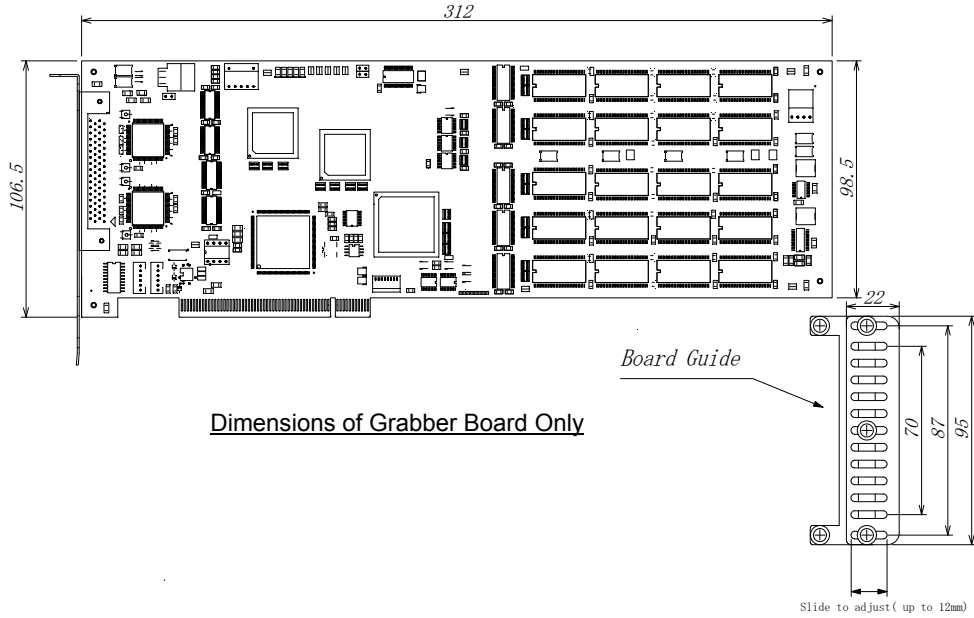
The [-] represents the items that cannot be used.

2.2. Dimensions

2.2.1. Camera Head (Millimeters)



2.2.2. Grabber Board (Millimeters)



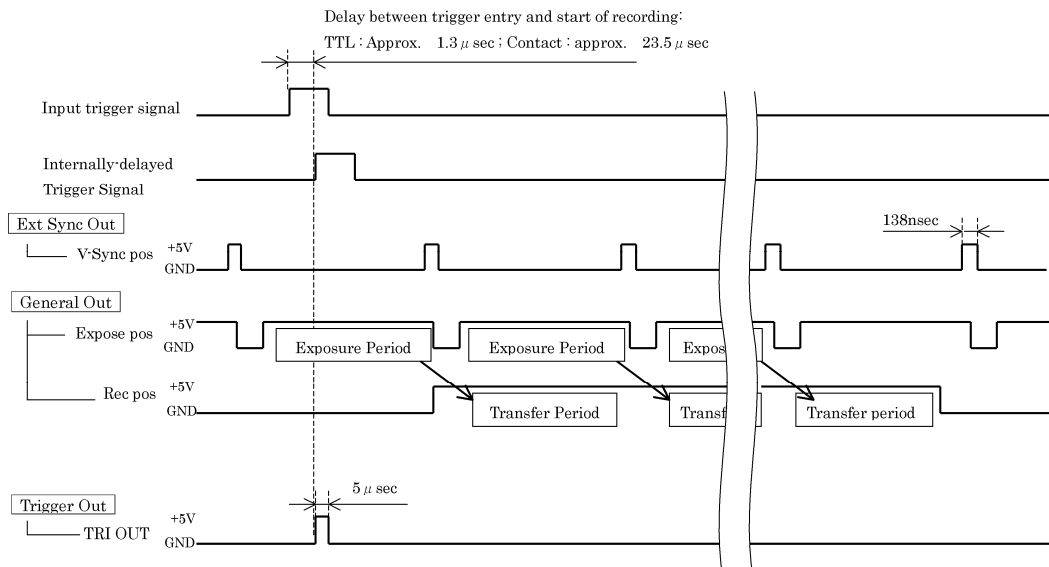
2.3. Timing of Recording Operations

This section describes the temporal relationship between recording, exposure, sync signals and delayed caused in cables. Refer to these charts when it is necessary to know the exact timing of such components mentioned above.

2.3.1 Timing Charts for Recording Operations

Timing Chart for START and RANDOM Recording Modes

The below chart shows the temporal relationship between signals related to recording operation in START and RANDOM trigger modes (random reset not effective).



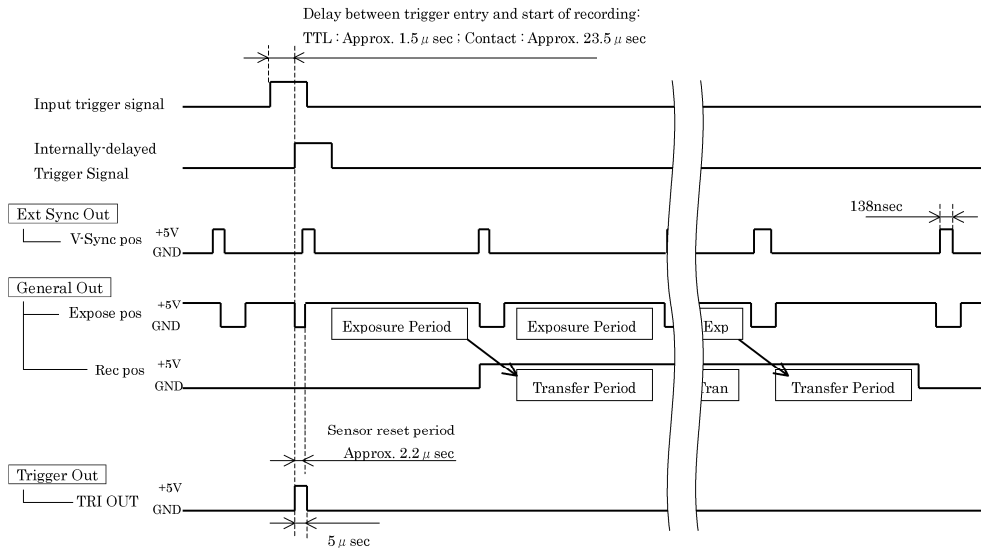
The START trigger mode starts recording when a trigger is received and records images until the memory is full. The RANDOM mode records a preset number of frames at each trigger and records until the memory is full.

When shutter is used, the “shuttered exposure period” becomes shorter than what is shown as “un-shuttered” exposure period in the above chart and it always takes place toward the end of, but within, the then effective exposure period.

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Timing Chart for START and RANDOM Trigger Modes with “Reset” in Effect

When “Reset” function is activated, Expose pos (vertical sync) signal is reset by the incoming trigger so that the timing of the incoming trigger signal and the start of exposure coincide more accurately as shown in the below chart.

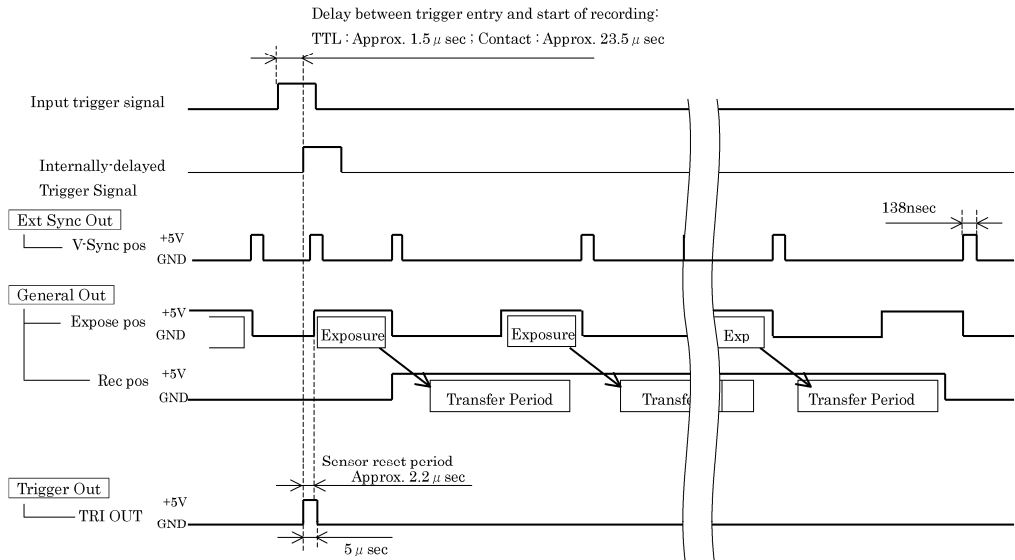


The START trigger mode starts recording when a trigger is received and continues recording images until the memory is full. The RANDOM mode records a preset number of frames at each trigger and records until the memory is full.

Timing Chart for Shuttered Operation in START and RANDOM Trigger Modes with “Reset” in Effect

The below chart shows the temporal relationship between timing signals when shuttering function is added to START and RANDOM trigger mode with Reset is in effect.

Note: A shorter exposure period is set by the shuttering function, in addition to the Expose pos signal being reset at the incoming trigger.

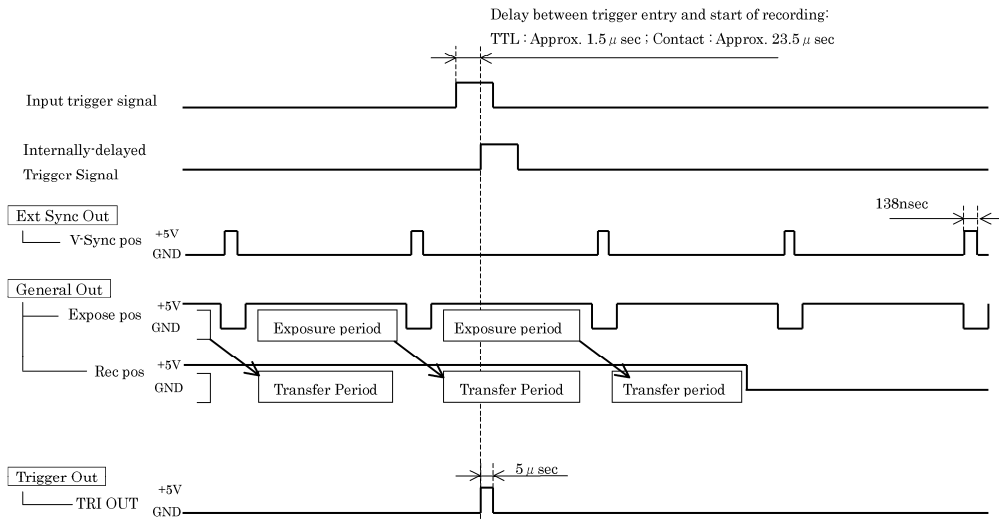


The START trigger mode starts recording when a trigger is received and continues recording images until the memory is full. The RANDOM mode records a preset number of frames at each trigger and records until the memory is full.

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Timing Chart for END, CENTER and MANUAL Trigger Modes

The below chart shows the temporal relationship of timing signals in END trigger mode. Note the exposure, and consequently recording, ends as soon as a trigger comes in.



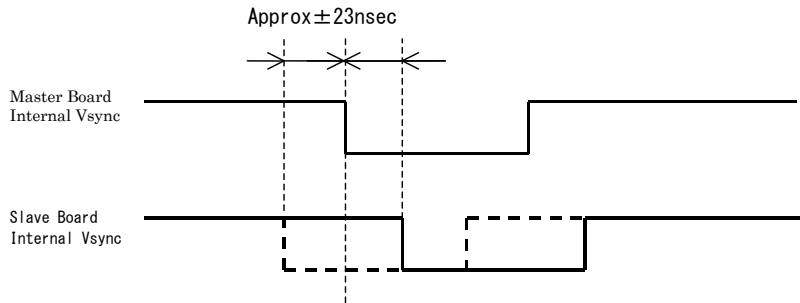
The above timing chart is for an End-Trigger operation.

The CENTER trigger mode ends recording after filling the latter half of the available memory. The MANUAL trigger mode records a preset number of frames after a trigger comes in.

When shutter is used, the "shuttered exposure period" becomes shorter than what is shown as "un-shuttered" exposure period in the above chart and it always takes place toward the end of, but within, the then effective exposure period.

2.3.2. Sync Timing in Multi-Camera Operations

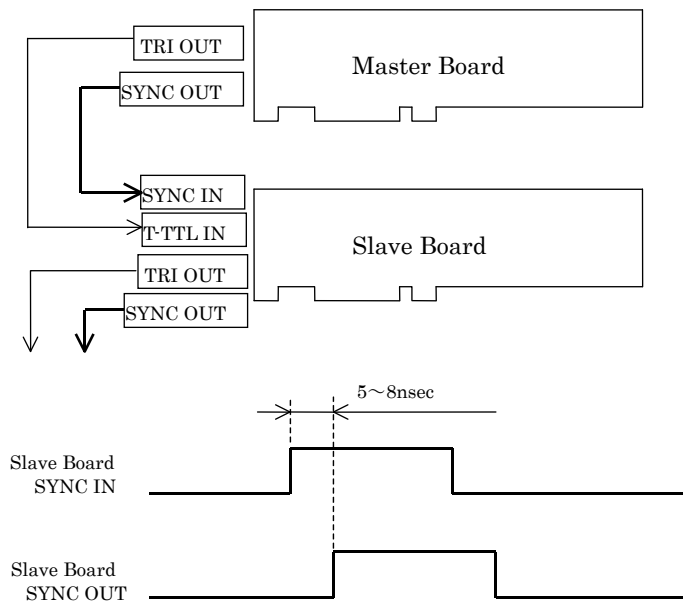
In multiple-camera operation of FASTCAM-512PCI cameras, if sync and trigger signals are connected in series as shown below, signal delay inevitably becomes obvious. In extreme cases, this delay may cause an offset of one full image frame between cameras involved in multiple-camera operation. To avoid this drawback, other connection methods shown in 2.4.2. are recommended.



Delay time in camera.

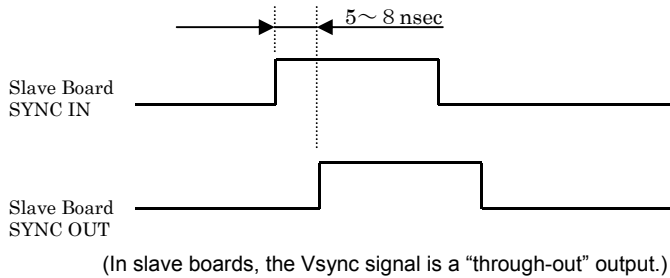
2.3.3. Delay of Vertical Sync and Trigger Signals in Multiple-Camera Operation

In multiple-camera operation, a signal delay is caused in V sync and trigger signals between boards.

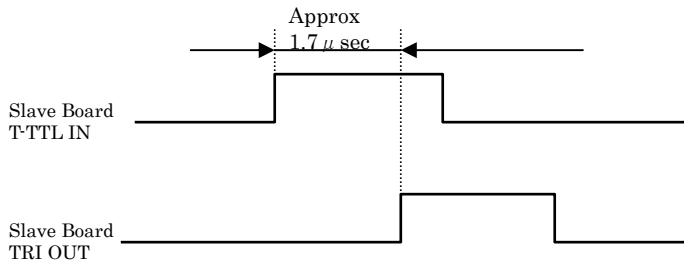


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Delay of V Sync Signal



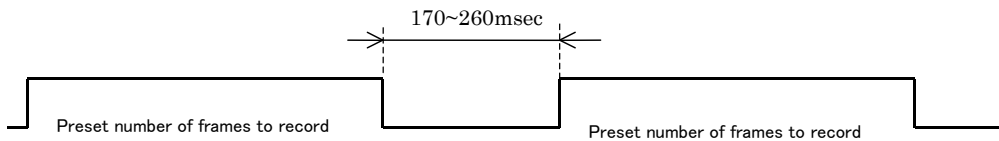
Delay of TTL Trigger Signal



! These delays may cause an offset of one frame between cameras in multiple-camera operation depending on a certain timing of trigger entry.

2.3.4 Recording Interval in Random Center and Random Manual Trigger Modes

In Random Center and Random Manual modes, because Center or Manual operation is repeatedly executed, the following interval is necessary between one recording and next. The interval can be checked by observing Rec Pos/Neg signal on GENERAL OUT.



Note: The necessary interval depends on the PC being used. More interval may be needed depending on the nature of the PC. The above interval is needed when using a PC with Pentium 4 (2.4GHz).

Chapter 3 Contacting Photron

3.1. Contact Information

3.1 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-512PCI
Serial Number	Check on the nameplate seal.
Condition of the system and what is known about it.	

Contact Information	
In Americas and Antipodes	<p>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</p>
In Europe, Africa and India	<p>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</p>
In other areas	<p>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</p>

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