

# Installing the Model 630049 POWERVIEW PIV Camera

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# Installing the Model 630049 POWERVIEW PIV Camera

## System Overview

The Model 630049 POWERVIEW™ PIV Camera Image Capture system is designed to be used for Particle Image Velocimetry (PIV) measurements. The camera captures particle images from the illuminated flow field for the measurement of the velocities in the flow field. Two modes of operations are offered in the camera. The Free-Run mode is used for the alignment and diagnostic of the system, while the Frame Straddling mode is employed for actual flow field measurements. When the images are captured using the Frame Straddling mode from the camera, the images are analyzed using the cross-correlation technique to calculate the velocity flow fields.

## Scope

The following sections include: (1) installation of the camera, (2) connection of the camera to the Frame Grabber in the computer and the LaserPulse Synchronizer, and (3) checkout the operation of the camera using the INSIGHT software.

## Manufacturer's Declaration of Conformity

TSI Incorporated hereby certifies that, to the best of its knowledge and belief,

- ☐ The instrument documented in this manual meets the essential requirements and is in conformity with the relevant EC Directive(s).
- ☐ The CE Marking has been affixed on the instrument.
- ☐ The Declaration of Conformity certificate is included with the instrument.

## Unpacking and Checking the Packing List

Carefully unpack all the components of the POWERVIEW camera image capture system, making sure they arrived in good condition. Do **not** discard the box. If the camera needs to be shipped back to TSI for repair or service, it **can** be returned in this box.

If there are signs of damage, contact the nearest TSI sales office, or TSI representative or TSI main office. See "Service Policy" on the Warranty page for further details.

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Compare all the components you received with those listed in Table 1. If any parts are missing, contact TSI. See “Getting Help” in “Manual History” section for the address and phone number.

**Table 1**  
Packing List for the Model 630049 POWERVIEW Camera Image Capture System

Qty	Model Number	Description	Part Number
1	630049	POWERVIEW Camera System including:	630049
		1 POWERVIEW camera CCD Camera	630149
		1 Camera-to-Frame Grabber Cable	1303751
		1 28-mm FL F/2.8 Nikkor Lens	610046
		1 Ring, Lens Extension 14-mm F-Mount	2806063
		1 Power, trigger and RS-232 cable	1090087
		1 High-speed Frame Grabber	600068

## Assumptions

At this point in your system installation, TSI assumes you have completed these steps:

- ☐ The computer system is set up with the INSIGHT version 3.5 software loaded and tested. The High speed Frame Grabber is installed.
- ☐ The laser system is installed and aligned.

- ☐ The LaserPulse Synchronizer is connected to the computer and has been tested.

## Preventing Camera Damage Due to Laser

PIV measurements require sufficient laser lightsheet intensity to get good exposures of the small seed particles used to follow the fluid flow. When the laser intensity is high enough to give near full-scale intensity levels for the particle images, but below pixel saturation, damage to the camera CCD array can happen if a specular reflection goes into the camera. Specular reflections can be caused by objects in the flow like the flow model, and by droplets and bubbles. If the laser damage threshold is exceeded within the image area, a pixel or group of pixels may be damaged. The pixel damage can be seen as white pixels when the lens cap is on. If specular reflection happens on the CCD array outside of the image area, the image output circuitry could be damaged. When this happens, the entire image could turn black.

The visible signs of laser damage may be delayed from the time that the laser exposure caused the damage. If a trace on the CCD array is damaged, it may not fail right away. Sometimes either more laser exposure or electrical current may increase the damage and lead to eventual failure.

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### Reducing Risk of Camera Damage

There are several issues you can consider to reduce the risk of camera damage.

#### Remove Sources of Specular Reflections

When designing the experiment, try to minimize the reflections. Given below are a few suggestions.

- ❑ Make a model out of Plexiglas to scatter less light than metal.
- ❑ Have the laser lightsheet exit the experiment.
- ❑ Use black tape to absorb light and cover reflection sources.
- ❑ Use black tape to block reflections between the experiment and the camera.

#### Use the Camera Lens Cap When Making Changes to the Experiment Alignment

Reflections are more likely to happen during experiment setup or changes. Be sure to protect the camera by having the lens cap on the camera during this time. When you have the laser, experiment, and camera in place, look for reflections and high-intensity scattered light before removing the lens cap. Once the system has been aligned, mount the experiment, laser and camera securely so that changes in alignment do not happen. Make sure that you are also well protected from the laser reflection during the alignment process. Wear the laser protective glasses is important.

### Align the System to Avoid Specular Reflections Entering the Camera

If reflection cannot be removed from the experiment, position the camera so that the reflected light does not enter the camera lens. Verify this with the lens cap on before taking images.

The non-imaging area of the CCD array is very sensitive to laser damage. Although the camera has an integrated protective mask on the CCD array to prevent direct laser reflection entering the non-imaging area of the CCD array, it is still recommended to avoid direct reflection entering the CCD array. If possible, configure your experiment so that there are no reflections entering the CCD array. If this is not possible, make sure to block the reflection light between the experiment and the camera.

#### Considerations in Bubbly Flows and Sprays

Air bubbles in water scatter much more energy than the seed particles used for measuring the water velocity. If the exposure is set such that the tracer particles are giving good exposures, the light scattered from the bubbles may be high enough to damage the CCD. To make these two-phase flow measurements, the recommended method is to use two cameras and fluorescent tracer particles. The velocity of the water phase can be measured using fluorescent particles with a filter to remove the 532-nm laser light. While the bubble phase can be measured using with 532-nm light scattered off the bubbles. Make sure that the camera aperture is reduced so that the camera is not saturated with the scattered light from bubbles.

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Liquid sprays is another measurement which can cause CCD damage when excessive scatter light is gathered by the camera. Spray can have many large droplets. If you set the exposure for the small drops, the large droplets may scatter too much light to damage the camera. In these situations, be sure to adjust the exposure for the camera to detect the largest droplets, but not too high an exposure to saturate the CCD array.

### Installation of the Camera to the Frame Grabber and the LaserPulse Synchronizer

The Model 630049 POWERVIEW PIV camera has 2K by 2K pixel resolution, particularly designed for PIV applications. The following sections discuss the installation of the camera with the Frame Grabber and the LaserPulse synchronizer.

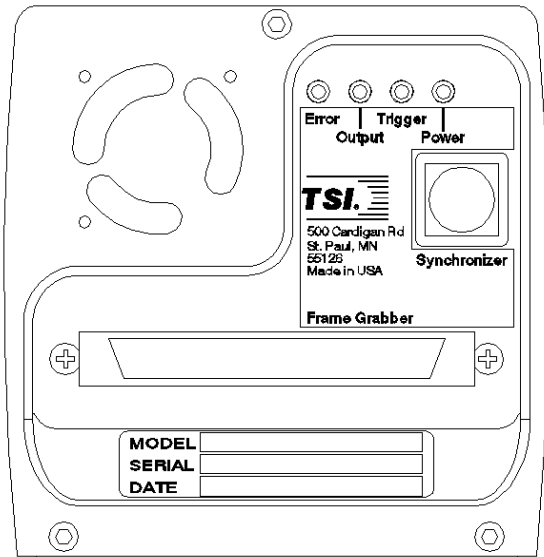
### Cable Connections

Two pieces of cable are provided with the camera. One is a 68-pin to 100-pin LVDS cable that connects between the camera and the Frame Grabber installed in the computer. Connect the 68-pin portion of the cable at the back of the camera labeled “Frame Grabber” and the 100-pin side to the Frame Grabber. The other cable is a Power/RS-232/Trigger cable that is connected between the camera and the LaserPulse Synchronizer. The cable has a 6-pin lemo on the camera side but four separate connectors on the synchronizer side. Connect the 6-pin lemo at the back of the camera

labeled “Synchronizer” and the other four connectors to the synchronizer according to the following:

- ❑ 2-pin lemo for power from the synchronizer. Connect the 2-pin lemo to the Camera 1 of Camera Power 12V at the backside of the synchronizer. For stereo camera configuration, use the Camera 2 for power the second camera.
- ❑ 9-pin D-sub for RS-232 connection to the synchronizer. Connect the 9-pin D-sub to Port B Out on the synchronizer. For the stereo configuration, connect the other 9-pin D-sub to Port C Out.
- ❑ BNC for the TTL Camera Trigger to the synchronizer. For the stereo configuration, use a T-connector to connect the Trigger BNC to the same TTL Camera Trigger on the synchronizer.
- ❑ BNC for the Camera Strobe to the synchronizer. For stereo configuration, usually the connection to the Camera Strobe is not needed.

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**Figure 1**  
Cable Connections

Once the cables are connected, power up the synchronizer. The four LEDs at the back of the camera indicate the condition of the camera. When power is supplied to the camera, the Power LED is On at all times and the camera is ready for operation.

## LED Indicators of the Camera

There are a total of four LED indicators to show the status of the camera. Their functions are given in Table 2.

**Table 2**  
LED Indicators

<b>Power</b>	The indicator shows that the power is provided to the camera. Power required is 12V DC at 1 Amp. The indicator is On when power is supplied from the synchronizer.
<b>Trigger</b>	Trigger indicates the camera is being triggered by the synchronizer. The normal operation is that the Trigger LED is On when operated in the Frame Straddling mode. When the camera is operated in the Free-Run mode, the camera is not triggered by the synchronizer, hence the Trigger LED is Off.
<b>Output</b>	This is connected with the data transfer from the camera, hence referencing the frame transfer from the camera to the camera interface. Under normal operation, this LED is ON (blinking) when data is being transferred from the camera, including Free-Run mode. In Free-Run mode, the Output LED blinks and the Power LED is On
<b>Error</b>	The LED indicates initialization error in the camera. This LED is On when the camera encounters problems in the initialization process. If the LED is On for more than one minute, turn off the power to the camera and restart the camera again. If the LED persists to be On, call TSI for further consultation.

## Operation

Once the cables are connected from the camera to the Frame Grabber and the LaserPulse synchronizer, the camera is ready for operation. Turn on the power of the synchronizer, the Power LED on the camera will be On and the Output LED will blink. This corresponds to the Free-Run mode (default) of the camera.

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### Free-Run Mode

For alignment and initial diagnostics of the PIV system, the camera can be operated in Free-Run mode. In Free-Run mode there is no synchronization between the laser and camera. This can be helpful when setting up a new experiment when you want to view images from the camera and not worry about timing yet. Free-Run mode is set in the INSIGHT software. Once the mode is set, the camera captures images continuously as fast as the images can be taken and transferred to be displayed on the computer.

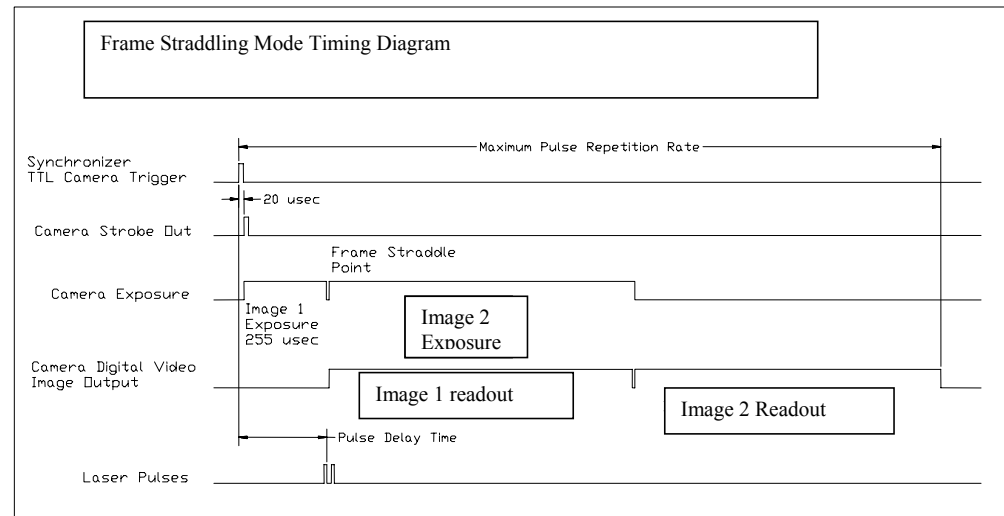
### Frame Straddling Mode

The Frame Straddling mode is used when PIV images are acquired for the actual flow field measurements. The control of the Frame Straddling mode is performed in the INSIGHT software. When the camera is set at the Frame Straddling mode, the camera takes two consecutive image frames as one image capture. The timing separation between the laser exposures in these two consecutive images is determined by the Delta T set in the INSIGHT software. The Delta T is the time separation between the two laser pulses to illuminate the flow field. The appropriate Delta T is set dependent upon the velocity magnitude of the flow field being measured. Once the two consecutive image frames are captured, they are transferred through the camera interface to be displayed on the computer. You can toggle between Image A and Image B in the Insight software to see the particle images from these image frames.

In order to get the timing correct for the Frame Straddling mode, the setting of a reference time is needed. There are two selections as the reference time settings. One is the Camera Trigger and the Camera Feedback. Either one can be used as the reference time. However, the Camera Feedback signal lags the Camera Trigger signal by 20 microseconds.

### Timing Diagram of the Frame Straddling Mode

The following diagram shows the timing for the operation of the camera in the Frame Straddling mode.



**Figure 2**  
Timing Diagram of Model 630049 POWERVIEW Camera

## Model 630049 POWERVIEW PIV Camera

### Specifications of the 630049 POWERVIEW Camera

Imaging device .....	Progressive Scan Interline CCD w/ microlens
Light sensitive pixels .....	4.2 million pixels, 2048 x 2048
Pixel size .....	7.4 x 7.4 $\mu\text{m}$
Fill ratio .....	60% w/microlens
Active area .....	15.2 mm x 15.2 mm
Dynamic range .....	12 bits (deliver up to 4096 gray levels)
Minimum frame straddling time for PIV capture .....	200 ns
Frame rate .....	17 frames/second with no binning 34 frames/second at 2 x 2 binning 68 frames /second with 4 x 4 binning
CCD quantum efficiency .....	33% at 540 nm
Dark current .....	0.2 nA/cm <sup>2</sup>
Anti blooming .....	<300
Operating temperature...	0 to 40°C
Camera lens mount .....	F-mount for Nikon lens with 14 mm extension ring
Image buffer memory .....	32 Mbyte
Binning .....	2 x 2, 4 x 4
Gain .....	1x, 2x, 4x (12 bits)
Offset .....	0 to 4095
CCD grade .....	Grade 0
CCD protective mask .....	Integral protective mask for the horizontal readout registers

Operation modes .....	Free run, Triggered and Frame Straddling
Camera control .....	RS-232 serial
Camera trigger input .....	TTL high level at the rising edge
Power .....	12 volt (at 1 amp)
Camera display .....	LED display of camera operating status
Camera output .....	LDVS (Low Voltage Differential Signaling) AIA cable with standard length of 5 meters
Camera size .....	68 mm x 66 mm x 73 mm (excluding camera lens)
Camera weight .....	1 kg (excluding camera lens)

\*Specifications are subject to change.