Installing the Model 630056 POWERVIEW™ HS-500 PIV Camera

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System Overview

The Model 630056 POWERVIEW™ HS-500 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 (3) checkout of camera operation 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™ HS-500 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, TSI representative or TSI main office. See "Service Policy" on the Warranty page for further details.

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 630056 PowerView™ HS-500 Camera Image Capture System

Qty	Model Number	Description	Part Number
1	630056	PowerView™ Camera System including:	630056
		1 PowerView™ HS-500 camera CMOS Camera	630156
		2 Camera Link Camera-To-Frame Grabber Cable	1303818
		1 28-mm FL F/2.8 Nikon Lens	610046
		1 Ring, Lens Extension 14-mm F-Mount	2806063
		1 Power Supply	1308149
		1 Trigger Cable	1303816
		1 Camera Link Frame Grabber	1603107
		1 Instruction Manual	1990069
		1 TTL Module	1303817

Assumptions

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

- ❑ The computer system is set up with the Insight software loaded and tested. The Camera Link 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 CMOS 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.

The visible signs of laser damage may be delayed from the time that the laser exposure caused the damage. If a trace on the CMOS 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.

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

Liquid spray is another measurement which can cause CMOS 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 CMOS array.

Installation of the Camera to the Frame Grabber

The Model 630056 PowerView™ HS-500 PIV camera has 1280 by 1024 pixel resolution, particularly designed for PIV applications. The following sections discuss the installation of the camera with the Frame Grabber.

Cable Connections

- Three pieces of cable are provided with the camera. Two are the standard Camera Link cables that connect between the camera and the Frame Grabber installed in the computer. These cables are identical, but it is imperative that they are attached to the correct ports. The cable attached to the top port on the camera should be attached to the left port on the Frame Grabber. The cable attached to the bottom port on the camera should be attached to the right port on the Frame Grabber. The Power cable is connected between the camera, through a 12 VDC converter, and then to a power outlet.

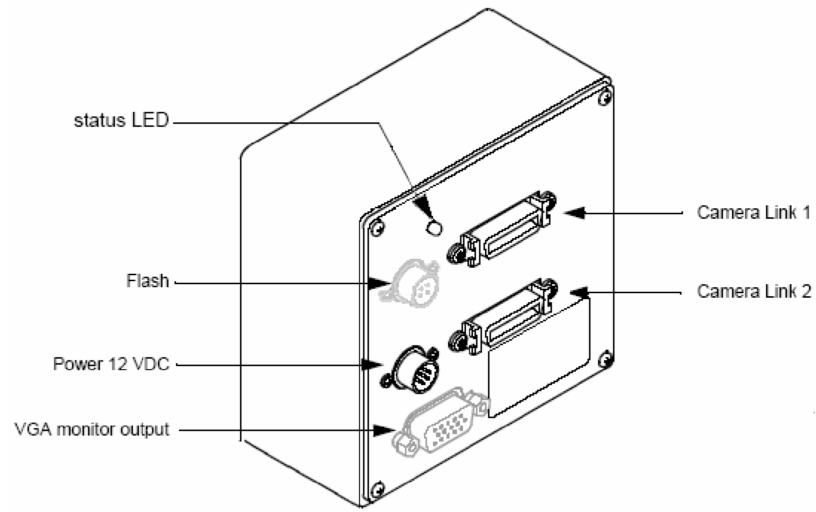

Figure 1
Cable Connections

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

LED Indicators of the Camera

There is an LED indicator on the rear of the camera to show its status. The functions are given in Table 2.

Table 2
LED Indicators

LED	Description
Orange & On Continuously	Camera has power and is okay.
3 Pulses	External Trigger has not changed for 5 seconds or longer. If you are not supplying an External Trigger signal to the camera, this is a normal condition and should be ignored. Otherwise check the cable and the External Trigger generating device.
5 Pulses	The Work Set could not be stored into a User set. Please contact TSI support.
6 Pulses	A User Set or the Factory Set could not be loaded into the Work Set. Please contact TSI support.
7 Pulses	A valid list of commands was not available. Please contact TSI support.
8 Pulses	The FPGA could not be configured. Please contact TSI support.

Operation

Once the cables are connected from the camera to the Frame Grabber, the camera is ready for operation. Turn on the synchronizer, the LED on the camera will be On.

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.

Sequence Diagram of the Frame Straddling Mode

Figure 2 shows the operation sequence of the camera in the Frame Straddling mode.

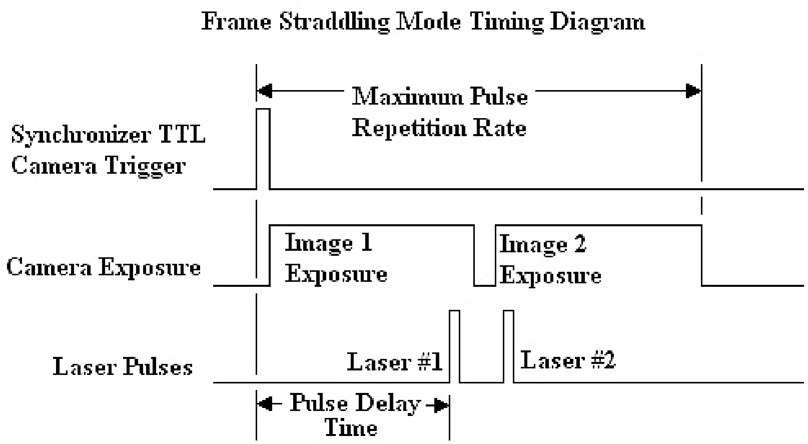

Figure 2
Sequence Diagram of Model 630056 POWERVIEW™ HS-500 Camera

Specifications* of the 630056 POWERVIEW™ HS-500 Camera

Imaging device	Progressive Scan CMOS
Light sensitive pixels	1.3 million pixels, 1280 × 1024
Pixel size	12.0 µm × 12.0 µm
Active area	0.605 in. × 0.484 in.
Video output format	10 taps 8 bits each
Minimum frame straddling time for PIV capture	10 µs
Max frame rate	500 frames/second
Color / Mono	Mono
Camera lens mount	F-mount
CMOS protective mask	0.5547 in. × 0.4338 in.
Operation modes	Free Run, Trigger, Straddle
Power	12 VDC (±10%) <1% ripple Max. 6.0 W
Video output type	Camera Link
Camera size	45 mm × 68 mm × 66 mm (excluding camera lens)

*Specifications are subject to change.