Photometrics®

SenSys®

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Printed in the United States of America.

US Patents 5,594,520 and 5,393,931

Warning: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

57-054-001 Rev B3

LIMITED WARRANTY — Roper Scientific Analytical Instrumentation

Roper Scientific, Inc. ("Roper Scientific," us," "we," "our") makes the following limited warranties. These limited warranties extend to the original purchaser ("You", "you") only and no other purchaser or transferee. We have complete control over all warranties and may alter or terminate any or all warranties at any time we deem necessary.

Basic Limited One (1) Year Warranty

Roper Scientific warrants this product against substantial defects in materials and / or workmanship for a period of up to one (1) year after shipment. During this period, Roper Scientific will repair the product or, at its sole option, repair or replace any defective part without charge to you. You must deliver the entire product to the Roper Scientific factory or, at our option, to a factory-authorized service center. You are responsible for the shipping costs to return the product. International customers should contact their local Roper Scientific authorized representative/distributor for repair information and assistance, or visit our technical support page at www.roperscientific.com.

Limited One (1) Year Warranty on Refurbished or Discontinued Products

Roper Scientific warrants, with the exception of the CCD imaging device (which carries NO WARRANTIES EXPRESS OR IMPLIED), this product against defects in materials or workmanship for a period of up to one (1) year after shipment. During this period, Roper Scientific will repair or replace, at its sole option, any defective parts, without charge to you. You must deliver the entire product to the Roper Scientific factory or, at our option, a factory-authorized service center. You are responsible for the shipping costs to return the product to Roper Scientific. International customers should contact their local Roper Scientific representative/distributor for repair information and assistance or visit our technical support page at www.roperscientific.com.

Normal Wear Item Disclaimer

Roper Scientific does not warrant certain items against defect due to normal wear and tear. These items include internal and external shutters, cables, and connectors. *These items carry no warranty, expressed or implied.*

VersArray (XP) Vacuum Chamber Limited Lifetime Warranty

Roper Scientific warrants that the cooling performance of the system will meet our specifications over the lifetime of the VersArray (XP) detector or Roper Scientific will, at its sole option, repair or replace any vacuum chamber components necessary to restore the cooling performance back to the original specifications at no cost to the original purchaser. *Any failure to "cool to spec" beyond our Basic (1) year limited warranty from date of shipment, due to a non-vacuum-related component failure (e.g., any components that are electrical/electronic) is NOT covered and carries NO WARRANTIES EXPRESSED OR IMPLIED.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

Sealed Chamber Integrity Limited 24 Month Warranty

Roper Scientific warrants the sealed chamber integrity of all our products for a period of twenty-four (24) months after shipment. If, at anytime within twenty-four (24) months from the date of delivery, the detector should experience a sealed chamber failure, all parts and labor needed to restore the chamber seal will be covered by us. *Open chamber products carry NO WARRANTY TO THE CCD IMAGING DEVICE, EXPRESSED OR IMPLIED.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

Vacuum Integrity Limited 24 Month Warranty

Roper Scientific warrants the vacuum integrity of all our products for a period of up to twenty-four (24) months from the date of shipment. We warrant that the detector head will maintain the factory-set operating temperature without the requirement for customer pumping. Should the detector experience a Vacuum Integrity failure at anytime within twenty-four (24) months from the date of delivery all parts and labor needed to restore the vacuum integrity will be covered by us. Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

Image Intensifier Detector Limited One Year Warranty

All image intensifier products are inherently susceptible to Phosphor and/or Photocathode burn (physical damage) when exposed to high intensity light. Roper Scientific warrants, with the exception of image intensifier products that are found to have Phosphor and/or Photocathode burn damage (which carry NO WARRANTIES EXPRESSED OR IMPLIED), all image intensifier products for a period of one (1) year after shipment. *See additional Limited One (1) year Warranty terms and conditions above, which apply to this warranty.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

X-Ray Detector Limited One Year Warranty

Roper Scientific warrants, with the exception of CCD imaging device and fiber optic assembly damage due to X-rays (which carry NO WARRANTIES EXPRESSED OR IMPLIED), all X-ray products for one (1) year after shipment. S*ee additional Basic Limited One (1) year Warranty terms and conditions above, which apply to this warranty.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

Software Limited Warranty

Roper Scientific warrants all of our manufactured software discs to be free from substantial defects in materials and / or workmanship under normal use for a period of one (1) year from shipment. Roper Scientific does not warrant that the function of the software will meet your requirements or that operation will be uninterrupted or error free. You assume responsibility for selecting the software to achieve your intended results and for the use and results obtained from the software. In addition, during the one (1) year limited warranty. The original purchaser is entitled to receive free version upgrades. Version upgrades supplied free of charge will be in the form of a download from the Internet. Those customers who do not have access to the Internet may obtain the version upgrades on a CD-ROM from our factory for an incidental shipping and handling charge. *See Item 12 in the following section of this warranty ("Your Responsibility") for more information.*

Owner's Manual and Troubleshooting

You should read the owner's manual thoroughly before operating this product. In the unlikely event that you should encounter difficulty operating this product, the owner's manual should be consulted before contacting the Roper Scientific technical support staff or authorized service representative for assistance. If you have consulted the owner's manual and the problem still persists, please contact the Roper Scientific technical support staff or our authorized service representative. *See Item 12 in the following section of this warranty ("Your Responsibility") for more information.*

Your Responsibility

The above Limited Warranties are subject to the following terms and conditions:

1. You must retain your bill of sale (invoice) and present it upon request for service and repairs or provide other proof of purchase satisfactory to Roper Scientific.
2. You must notify the Roper Scientific factory service center within (30) days after you have taken delivery of a product or part that you believe to be defective. With the exception of customers who claim a "technical issue" with the operation of the product or part, all invoices must be paid in full in accordance with the terms of sale. Failure to pay invoices when due may result in the interruption and/or cancellation of your one (1) year limited warranty and/or any other warranty, expressed or implied.
3. All warranty service must be made by the Roper Scientific factory or, at our option, an authorized service center.
4. Before products or parts can be returned for service you must contact the Roper Scientific factory and receive a return authorization number (RMA). Products or parts returned for service without a return authorization evidenced by an RMA will be sent back freight collect.
5. These warranties are effective only if purchased from the Roper Scientific factory or one of our authorized manufacturer's representatives or distributors.

6. Unless specified in the original purchase agreement, Roper Scientific is not responsible for installation, setup, or disassembly at the customer's location.
7. Warranties extend only to defects in materials or workmanship as limited above and do not extend to any product or part which has:
    - been lost or discarded by you;
    - been damaged as a result of misuse, improper installation, faulty or inadequate maintenance or failure to follow instructions furnished by us;
    - had serial numbers removed, altered, defaced, or rendered illegible;
    - been subjected to improper or unauthorized repair; or
    - been damaged due to fire, flood, radiation, or other "acts of God" or other contingencies beyond the control of Roper Scientific.
8. After the warranty period has expired, you may contact the Roper Scientific factory or a Roper Scientific-authorized representative for repair information and/or extended warranty plans.
9. Physically damaged units or units that have been modified are not acceptable for repair in or out of warranty and will be returned as received.
10. All warranties implied by state law or non-U.S. laws, including the implied warranties of merchantability and fitness for a particular purpose, are expressly limited to the duration of the limited warranties set forth above. With the exception of any warranties implied by state law or non-U.S. laws, as hereby limited, the forgoing warranty is exclusive and in lieu of all other warranties, guarantees, agreements, and similar obligations of manufacturer or seller with respect to the repair or replacement of any parts. In no event shall Roper Scientific's liability exceed the cost of the repair or replacement of the defective product or part.
11. This limited warranty gives you specific legal rights and you may also have other rights that may vary from state to state and from country to country. Some states and countries do not allow limitations on how long an implied warranty lasts, when an action may be brought, or the exclusion or limitation of incidental or consequential damages, so the above provisions may not apply to you.
12. When contacting us for technical support or service assistance, please refer to the Roper Scientific factory of purchase, contact your authorized Roper Scientific representative or reseller, or visit our technical support page at www.roperscientific.com.

Declaration of Conformity

Roper Scientific, Inc. declares that the equipment described in this document is in conformance with the requirements of the European Council Directives, listed below:

89/336/EEC	EMC Directive
93/68/EEC	EMC Directive
73/23/EEC	Low Voltage Directive

on the approximation of the laws of Member States relating to Electromagnetic Compatibility and Product Safety.

This declaration is based upon compliance of the product to the following standards:

EN 55022, CISPR 22	RF Emissions Control
EN 50082-1, IEC 801	Immunity to Electromagnetic Disturbances
EN 60950, IEC 950	Product Safety

Product Description: CCD Camera System
Model: SenSys Camera System

Authorized Signature Date 11/16/95

Wilhelm Pfanhauser, Managing Director

Wilhelm Pfanhauser
Photometrics, Ltd.
Sollner Str. 61
D-81479 München
Germany

CE

Table of Contents

Chapter 4. Troubleshooting

Chapter 5. Specifications

Appendix A. Trigger Modes

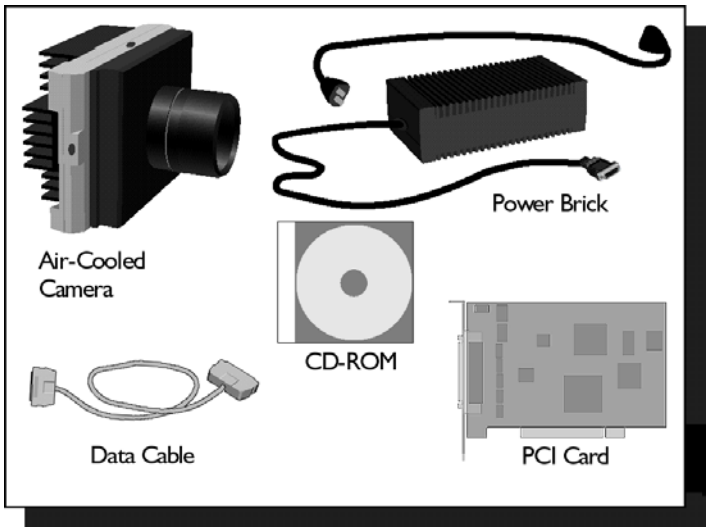
Chapter 1. Introduction

SenSys® is an air-cooled camera system with the ability to acquire low-light images by integrating (exposing) over long periods of time. The imager in the camera is a scientific-grade charge-coupled device (CCD).

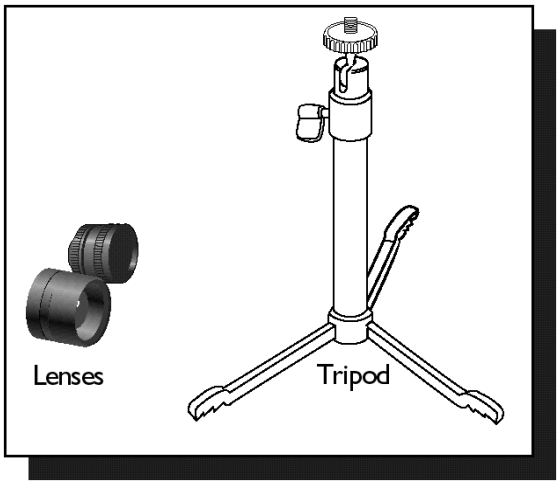
SenSys System Components

All SenSys systems consist of standard hardware and software as well as the appropriate interface hardware (discussed in the *Installation Guide*) for your computer system. Some SenSys systems also include optional hardware.

Standard Components



Optional System Hardware



About this Manual

The *SenSys User Manual* is divided into five chapters. It is suggested that you read the entire manual before operating the camera to ensure proper usage. The chapters that follow this introduction are:

- **System Installation —** Instructions for installing the camera system's hardware and software.
- **Component Descriptions —** Functional description of each component
- **Troubleshooting —** Answers to camera hardware problems
- **Specifications —** Specifications for each camera system component

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Note: To install a new camera, follow the instructions in the *System Installation* chapter of this *User Manual.*

Environmental Requirements

The SenSys camera system should be operated in a clean, dry environment. The camera system requires that an easily accessible electrical outlet be available near the equipment.

The camera system's ambient operating temperature is 0°C to 40°C. The camera can be operated in any orientation, therefore it can be used on a tripod camera stand or mounted on a variety of instruments.

Storage Requirements

Store the SenSys camera system in its original containers. To protect the system from excessive heat, cold, and moisture, store at an ambient temperature between -20°C and 60°C with a relative humidity of 0%–90% noncondensing.

Precautions

The CCD and other system electronics are extremely sensitive to electrostatic discharge (ESD). To avoid permanently damaging the system, please observe the following precautions:

- If you are using high-voltage equipment (such as an arc lamp) with your camera system, be sure to turn the camera power *on last* and power the camera *off first*.
- Always switch off and unplug the power brick before changing your system configuration in any way.
- Use caution when triggering high-current switching devices (such as an arc lamp) near your system. The CCD can be permanently damaged by transient voltage spikes. If electrically noisy devices are present, an isolated, conditioned power line or dedicated isolation transformer is highly recommended.
- Never connect or disconnect *any* cable while the camera system is powered on. Reconnecting a charged cable may damage the CCD.
- Never impede airflow through the equipment by obstructing the air vents.

Repairs

Other than repairs described in this manual, all repairs must be done by Roper Scientific. Should your system hardware need repair, contact Roper Scientific Customer Service. Please save the original packing materials so you can safely ship the camera system to another location or return it for repairs if necessary.

Cleaning

Clean exterior surfaces of the camera system with a dry, lint-free cloth. To remove stains, contact Roper Scientific Customer Service.

Roper Scientific Customer Service

If you have any questions about your camera system, contact Roper Scientific Customer Service. When you call, please have your Roper Scientific job number or equipment serial numbers available.

- Tel: 800. 874.9789/ 520.889.9933 between 8:00 am and 5:00 pm MST
- Fax: 520.295.0299
- E-mail: cservice@roperscientific.com
- Mail: Roper Scientific
  3440 East Britannia Drive
  Tucson, Arizona 85706

In Europe, you can reach Customer Service at:

BENELUX

- Tel: 31.347.324989
- Fax: 31.347.324979
- E-mail: mailto@roperscientific.com
- Mail: Roper Scientific, BV
  Ir. D.S. Tuijnmanweg 10
  4131 PN VIANEN, Netherlands

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- Fax: 33.160.86.07.09
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- Tel: 49.89.660.779.3
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- E-mail: mail@roperscientific.de
- Mail: Roper Scientific, GmbH
  Rosenheimer Landstr. 87
  D-85521 Ottobrunn, Germany

In Japan, you can reach Customer Service at:

- Phone: 81.43.274.8022
- Fax: 81.43.274.8023
- E-mail: sales@roper.co.jp
- Mail: Nipon Roper, K.K.
  D-10E 1-3 Nakase,
  Mihama-ku, Chiba-shi
  Japan 261-8501

General product information and answers to some customer service questions can be found on our website: http://www.roperscientific.com

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Chapter 2. System Installation

Carefully review the *Precautions* section on page 2 before performing any of the procedures outlined here. Again, use only a SenSys cable and a SenSys PCI card with your SenSys camera. Using a different cable or PCI card may result in permanent damage to your system.

Introduction

Your SenSys camera system has the following hardware components:

- Camera Head
- PCI Card
- Data Cable
- Power Brick
- Power Cord

SenSys system components are linked by the data cable and controlled by your host computer system via the application software. Power to the camera is supplied by the power brick. All of these hardware and software components should be included with your shipment. Refer to the information and figures in *System Components* on page 1.

The CCD you selected is installed in your camera.

Keep all the original packing materials so you can safely ship the SenSys system to another location or return it for service if necessary.

If you have any difficulty with any step of the instructions, call Roper Scientific Customer Service.

Software Compatibility Requirements

The SenSys package includes the RS Image™ capture software program designed for use with your SenSys camera.

All other imaging software must also be PVCAM® -compatible. For full access to imaging software functions, PVCAM must be version 2.5.2 or higher.

Host Computer Requirements

The host computer for your SenSys camera must have the following:

- Windows® 95, Windows® 98, Windows® ME, Windows NT®, Windows® XP, or Windows® 2000 operating system
- 200 MHz Pentium® II (or greater)
- 64 MB RAM (or greater)
- CD-ROM drive
- At least one unused PCI card slot
- 16-bit color display (or greater)

**To store images to a local hard disk, up to 8 MB of free disk space is needed per file.*

If you are a Mac® user, the host computer for your SenSys camera must have the following:

- Macintosh® OS 8.X, 9.X, or OS X
- 64 MB RAM (or greater)
- CD-ROM drive
- At least one unused PCI card slot
- Video adapter that supports 24-bit color (millions of colors)

**To store images to a local hard disk, up to 8 MB of free disk space is needed per file.*

Multiple Cameras

PVCAM supports multiple open cameras. In order to use this function, your imaging software must also support it. The RS Image capture software program included with your system supports multiple cameras, as do many other imaging packages.

If your imaging software supports multiple cameras, there must be a separate PCI card for each camera. Multiple cameras can only be open simultaneously if all use PCI interfaces.

Software Installation

An Installation Guide appropriate to your system is included as an insert in the CD-ROM case. This guide provides step-by-step instructions for installing the camera interface software and the application software for Windows-based and Macintosh-based PCs. Additional instructions are included for installing a PCI card in your computer and capturing images.

The CD-ROM contains the following files.

- **Readme text files —** these files contain the latest information on the software installations and should be read before you run the PVCAMSetup program.
- **PVCAMSetup software program —** this software installs the camera interface software.
- **RSImageSetup software program —** this software installs the RS Image application program.
- **MacOS directory —** this directory contains the files required for installing on a Macintosh computer.
- **Acrobat directory —** this directory contains subdirectories containing installation programs for Acrobat® Reader®.
- **Manuals directory —** this directory contains user manuals in PDF format.

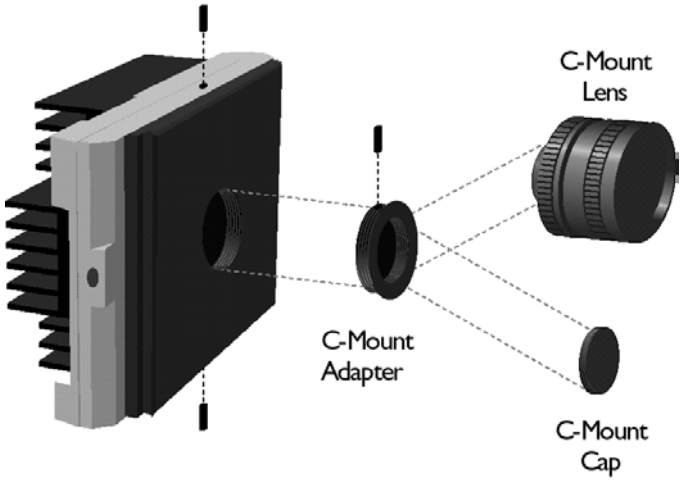
Connecting Mount Adapters, Tripod Mounts, and Other Instruments

The camera is shipped with a removable F- or C-mount adapter attached. If applicable, change the mount adapter or attach a compatible lens. For information on changing the mount adapter, installing a compatible lens, or installing a standard tripod camera stand, see below.

C-Mount Adapter

The C-mount adapter is a standard threaded video mount with a standard C-mount flange focal distance and additional travel distance to allow parfocal adjustment with a variety of instruments. For specifications, see *C-Mount Adapter* on page 28.

When the C-mount adapter is in place, a lens with optics that protrude a long distance into the camera may interfere with the shutter blades. To calculate appropriate measurements, refer to page 28.



C-mount Assembly

To install the C-mount adapter (if not pre-installed):

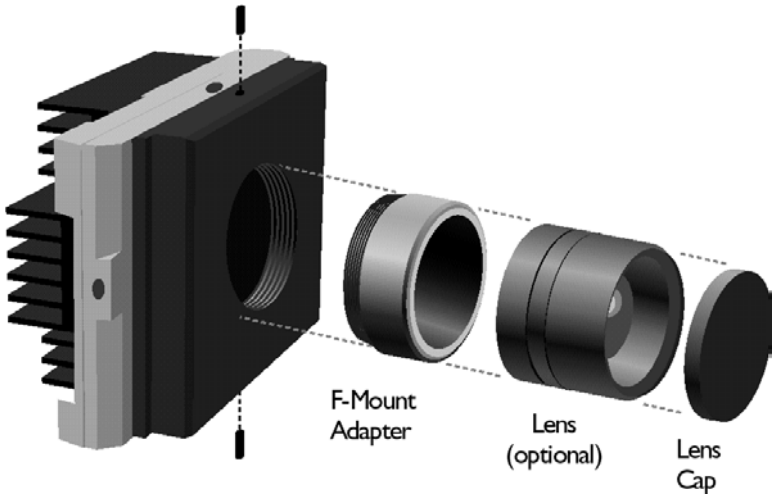
1. Using the .050″ hex wrench provided, back out the setscrews so they do not interfere with threading the mount in place. There is no need to remove the setscrews.
2. Thread the C-mount adapter onto the lens or instrument adapter. Lock in place using the .050″ hex wrench provided.
3. Thread the C-mount adapter into the camera. (In certain cases, it may be easier to thread the camera onto the C-mount adapter.)

To remove the C-mount adapter (if changing to a different adapter):

1. Using the .050″ hex wrench provided, back out the setscrews until you can freely rotate the mount.
2. Unscrew the mount from the camera.

F-Mount Adapter

The F-mount adapter is a standard Nikon bayonet mount with a standard F-mount flange focal distance and additional travel distance to allow parfocal adjustment with a variety of instruments. For specifications, see *F-Mount Adapter* on page 29.



F-mount Assembly

To install the F-mount adapter (if not pre-installed):

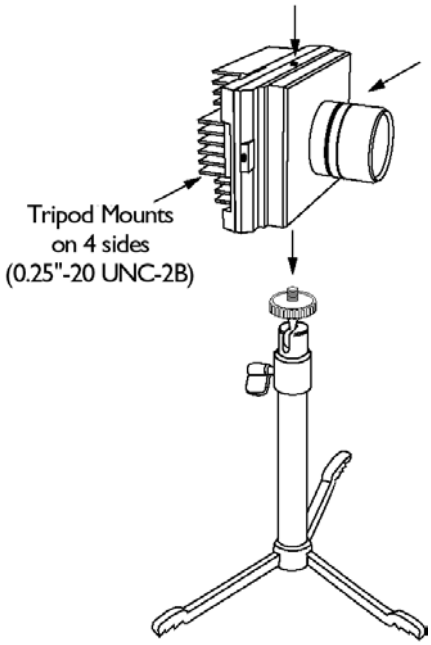
1. Using the 1/16″ hex wrench provided, back out the setscrews so they do not interfere with threading the mount in place. There is no need to remove the setscrews.
2. Thread the F-mount adapter onto the camera.
3. Insert the lens into the adapter and rotate it counterclockwise to lock. If you don't use a lens, simply attach your instrument's F-mount adapter to the camera or attach the camera to the instrument's F-mount. (If your instrument requires an F-mount adapter, contact your instrument supplier.)

To remove the F-mount adapter (if changing to a different adapter):

1. Using the 1/16″ hex wrench provided, back out the setscrews until you can freely rotate the mount.
2. Unscrew the mount from the camera.

Tripod Camera Stand

The SenSys camera has four mounting holes that are tapped for a standard tripod mounting bolt.



Camera with Tripod Camera Stand

To mount the SenSys camera on a tripod camera stand:

1. Loosen the tripod mount locknut so that the maximum length of the tripod mounting bolt is exposed.
2. Align the camera on the tripod mounting bolt, using one of the four mounting holes on the camera body.
3. Thread the tripod mounting bolt into the camera body.
4. Tighten the locknut on the mount to secure the camera.

To remove the SenSys camera from a tripod mount:

1. Loosen the tripod mount locknut.
2. Unthread the tripod mounting bolt from the camera.

Other Instruments

If applicable, mount the camera on a compatible instrument or connect your own trigger equipment to the 9-pin, female input/output (I/O) trigger port located on the back of the camera. If you are using high-voltage equipment (such as an arc lamp) with your camera system, be sure to turn the camera power *on last* and power the camera *off first*. For trigger port pin-out specifications, see page 31.

Installing the PCI Card

You will be using a SenSys PCI card to allow the camera to communicate with your computer.

Refer to the Readme text files on the CD-ROM and to the Installation Guide supplied with the CD-ROM before installing the PCI card. Please follow the instructions when installing the card.

After installing the PCI card, go to *Connecting the Data Cable.*

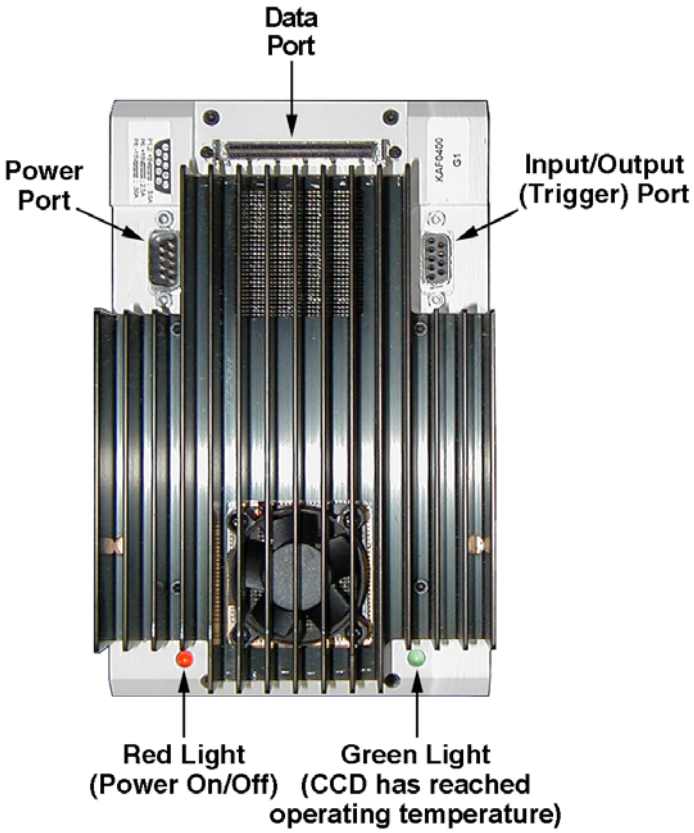
Connecting the Data Cable

The Data cable connects your SenSys camera to the PCI card installed in your computer.

Data Cable

To connect your SenSys camera:

1. Connect either end of the Data cable to the Data port on the back of the camera (see the figure below).



Camera Back

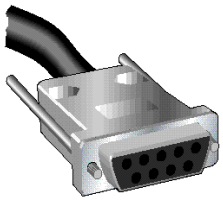
2. Connect the other end of the Data cable to the PCI card in the host computer.

Connecting the Power Brick

The power brick is a switched supply that is shipped with a power cord.

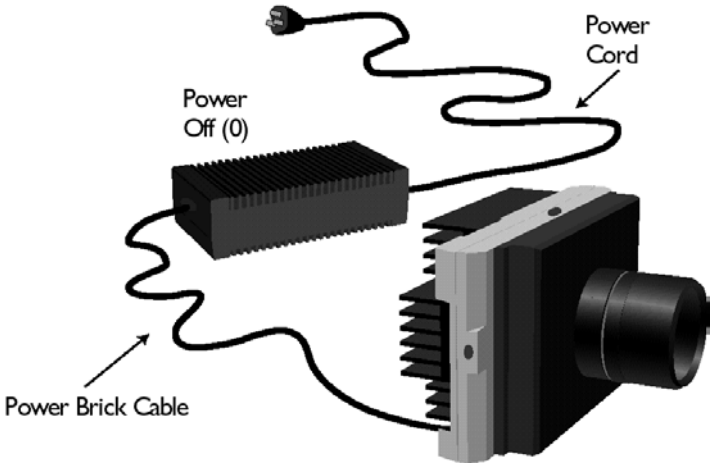
Caution: Connecting or removing a live power cable to or from the SenSys camera can damage the camera's electronic components. Do not attach or remove any cables while the power brick is switched on (On = |, Off = 0) and plugged into an electrical outlet.

To connect the power brick to the camera:



Power Brick Cable with 9-Pin, D Connector

1. Connect the power brick cable's 9-pin, D connector to the power port on the back of the camera. Secure by tightening the connector screws. **Do not extend this cable.**
2. With the power brick switched off and the power cord unplugged from an electrical outlet, connect the power cord to the power brick (and later to an electrical outlet).



Instructions for powering on and powering off the camera system are provided in the *Installation* Guide supplied with the CD-ROM. When you turn on your camera later (after installing the interface hardware), the red light on the camera illuminates immediately, indicating that the camera has power. In 20-40 seconds, the green light illuminates, indicating that the camera has reached operating temperature. See *Status Lights* on page 16 of this *User Manual* for more information.

Focusing Your Camera

After you have finished system installation and have started the application software, you can focus the camera for the best image.

C-Mount Assembly

To focus the camera:

1. If needed, back out the setscrews until you can freely rotate the C-mount adapter. Use the .050" hex wrench provided.
2. Using the instructions from your software program, bring your software into focus loop mode. For instructions on using *RS Image* to focus, see the on-line help.
3. Hold the camera so it does not rotate, then use the lens or instrument adapter to adjust the C-mount adapter to the desired position.
4. Tighten the setscrews until snug.

F-Mount Assembly

To focus the camera:

1. If needed, back out the setscrews until you can freely rotate the F-mount adapter. Use the 1/16" hex wrench provided.
2. Using the instructions from your software program, bring your software into focus loop mode. For instructions on using *RS Image* to focus, see the on-line help.
3. Hold the camera so it does not rotate, then rotate the F-mount adapter to the desired position.
4. Tighten the setscrews until snug.

Chapter 3. Component Descriptions

The SenSys camera consists of the camera body and the shutter cover. The camera body houses the CCD, CCD cooling system, and camera electronics. All of the components inside the camera body are sensitive electronic components and are not user accessible. *Opening the camera body voids the camera warranty*. The shutter, located behind the shutter cover, is a user-replaceable component.

SenSys Camera with F-mount Adapter and Nikon Lens

CCD

When you order a SenSys camera, you choose from a range of CCDs that differ in size and grade. All SenSys CCDs are scientific-grade, grades with fewer defects than commercial grades. Scientific-grade CCDs image with better resolution, have low noise so they can detect weak signals, and are linear over the dynamic range so you can accurately judge intensity differences between objects.

MPP

All SenSys cameras have Multi-Pinned Phase (MPP) CCDs. MPP CCDs are built to have less thermally generated noise for a given exposure time, a property useful when trying to detect weak signals.

Metachrome® II

Metachrome II is a proprietary, optional, permanent CCD coating that is available on all SenSys CCDs. This coating extends the CCD's sensitivity to below 200 nm and is transparent from 400 to 1100 nm wavelength light. The coating requires no maintenance and does not degrade over time.

Certificate of Performance

Each SenSys camera has a Certificate of Performance. This certificate states the CCD grade that has been designated by the CCD manufacturer. The certificate also provides the camera performance information needed to effectively measure photon flux with repeatable, scientific accuracy. A copy of the information contained in the Performance Certificate is kept on file at Roper Scientific Customer Service.

Window

The SenSys camera has one window in the optical path. The CCD does not have a window. Compared to a multiple-window design, a single window reduces the chance of image degradation due to multiple reflections, stray light, and interference patterns.

The standard Photometrics window is made of fused silica (quartz) with a broadband antireflective coating. Fused silica has better ultraviolet transmission than crown glass. The antireflective coating increases the light transmitted through the window from 92% to 99%, further decreasing light loss. Optional infrared-blocking (IR) and sapphire windows are available. The IR window blocks optical radiation above 650 nm, providing a sharper image. The sapphire window may be necessary for high-humidity environments.

CCD Chamber

The window is part of the sealed chamber that protects the CCD from contamination and excess ambient humidity. Inside the sealed chamber, packages of desiccant absorb any water vapor.

When the camera is cooled to 10°C, the low-humidity environment prevents frost from forming on the CCD and condensation from forming on the inside of the window.

Thermoelectric Cooler

Cooled CCD cameras produce less dark current than cameras operating at ambient temperature. The CCD in the SenSys camera is cooled to 10°C when the ambient temperature is between 10°C and 40°C.

The CCD is cooled by a single-stage Peltier cooler, a thermoelectric cooler (TEC) that pulls heat away from the CCD. The heat is rejected into the camera body and is passively radiated to the environment.

Shutter

The camera has a high-speed, customer-replaceable shutter that maintains a speed of up to 15 frames per second while still fully opening and closing. The shutter takes 5 ms to open and 10 ms to close. The camera integration time (the total time any part of the CCD is exposed) is equal to the shutter open and close times plus the exposure time.

The shutter is the only mechanical component that has a limited life with heavy use. Instructions for testing and replacing the shutter are in *Chapter 4. Troubleshooting.*

Electronics

The CCD produces an analog signal. The camera electronics convert the analog signal into a digital signal, data that can be received by the host computer.

Several factors influence what portion of the analog signal translates into digital data. One factor is the noise in the camera system. The system noise includes the thermal noise produced by the camera components and the read noise determined in part by how far the analog signal must travel. The farther an analog signal has to travel, the more the signal degrades.

To reduce signal degradation, SenSys has low-noise electronics and primary point digitization (PPD™). The PPD design positions the analog-to-digital converter (ADC) as close to the CCD as possible, which reduces the distance the analog signal must travel.

Another determining factor is the quality of the signal received by the ADC. If the ADC receives a high-quality signal, the 12-bit ADC digitizes the analog signal into 12-bit data. With a lesser quality signal, the ADC produces data with a lower effective bit depth.

The SenSys camera produces an analog signal that uses the full range of the 12-bit ADC (up to 4096 gray levels). Through software, the camera can be set to High Sensitivity (Gain 3), High Dynamic Range (Gain 2), or High Signal to Noise Ratio (Gain 1) detection modes. Each gain setting configures the camera to be responsive to different light-level intensity ranges. The appropriate range is dictated by the specific use of the camera.

No matter how fast the data moves from the CCD to the ADC, the camera readout rate is determined by how quickly the ADC converts the data to digital form. The conversion rate of your SenSys camera is stated on the Certificate of Performance.

Input/Output Trigger Port

The SenSys camera has a TTL input/output (I/O) trigger port that is located on the back of the camera. (See diagram on next page.) When the camera is shipped, this port is fitted with a cover.

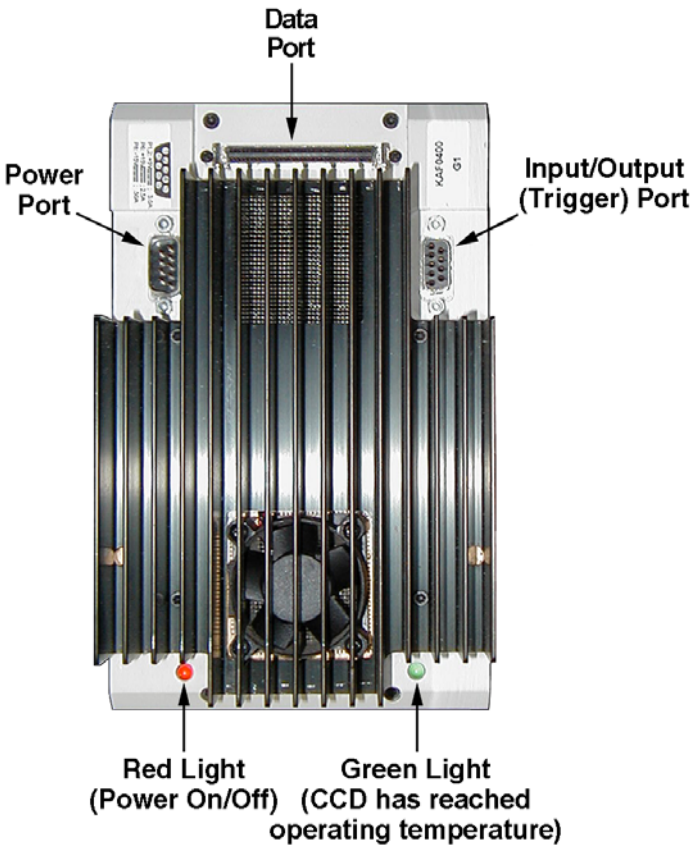
The I/O port allows you to synchronize the camera trigger signal with external equipment. Strobes, external shutters, and filter motors are examples of external triggering devices. The I/O port is a male, D-subminiature 9-pin connector. Pinout specifications are located in *Input/Output Port Pinout* on page 31.

Data Port

Digital data is transmitted to the host computer through the PCI interface. The Data port is a 68-pin, high-density, I/O connector with a standard AIA format. The pinout for the parallel cable that mates to the Data port connector is located in *Data Cable Pinout* on page 33.

Power Port

The power port is a 9-pin, female, D connector. Pinout specifications for the port are located in *Power Port Pinout* on page 32.



Camera Back

Status Lights

The back of the camera has two status lights:

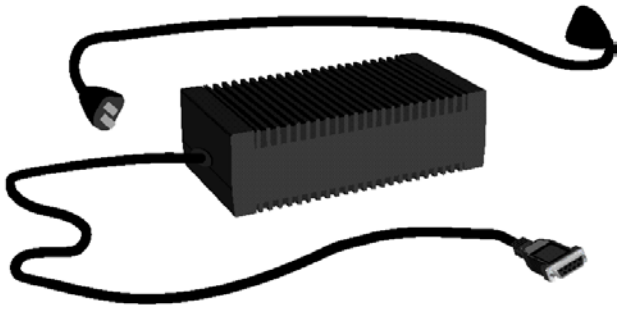
Red light on	Power on
Green light on	CCD reached operating temperature

If the ambient temperature is between 0°C and 40°C, the CCD will usually reach operating temperature within 20-40 seconds. If operating temperature is not reached after approximately one minute, call Roper Scientific Customer Service.

Power Brick

The power brick is a switched, multiple-output-voltage supply with a detachable power cord. The camera system is powered on (|) and off (0) by a switch on the supply. More detailed specifications are available in *Chapter 5. Specifications*.

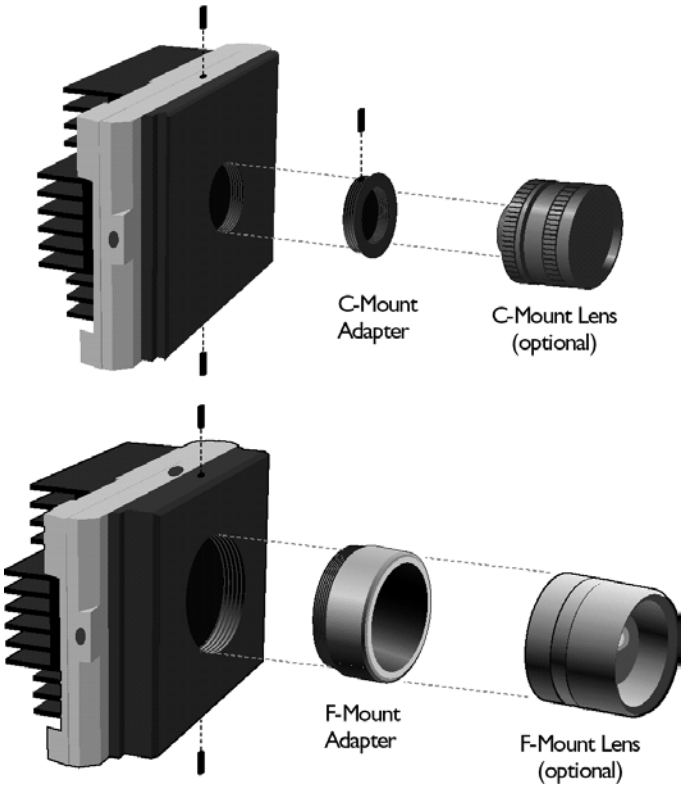
Caution: Connecting or removing a live power cable can damage the camera's electronic components. Do not attach or remove *any* cables while the power brick is switched on and plugged into an electrical outlet.



Power Brick with Integrated Cable and Power Cable

Lens Mount Adapters

Each SenSys camera system is shipped with a removable C- or F-mount adapter. The C-mount adapter allows the camera to be attached to many video camera lenses and C-mount compatible instruments. The F-mount adapter allows the camera to be attached to lenses and scientific instruments that are compatible with a Nikon bayonet mount.



SenSys Mount Adapter and Lens Option

The SenSys F- and C-mount adapters thread into the camera at a pitch of 32 threads/inch. When the camera is focused, two #6-32 inch socket setscrews (two #4-40 inch socket setscrews for the C-mount) secure the adapters in place and hold the optical alignment in parfocality. The setscrews are adjusted with a long-handled 1/16″ (or .050″) hex driver that is provided with the system.

Both mounts are shipped with a cap covering the aperture. The C-mount adapter is a standard threaded video mount with a standard C-mount flange focal distance and additional travel distance to allow parfocal adjustment with a variety of instruments. The F-mount adapter is a standard Nikon bayonet mount with a standard F-mount flange focal distance and additional travel distance to allow parfocal adjustment with a variety of instruments. For mounted and unmounted specification drawings, see *Chapter 5. Specifications*.

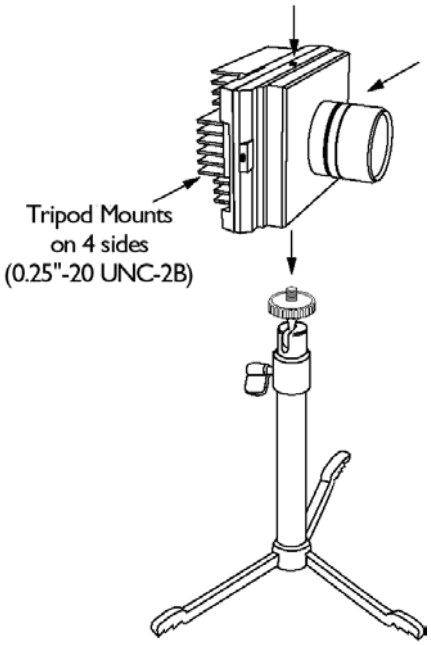
For C- and F-mount adapter installation, removal, and focusing instructions, see *Chapter 2. System Installation*.

Lenses

Roper Scientific sells lenses that are compatible with the SenSys lens mount adapters. The F-mount lens is compatible with a standard Nikon bayonet mount. The C-mount lens is a standard threaded video mount lens.

Tripod Camera Stand

The camera has four tripod camera stand mounting holes (0.25″-20 UNC-2B with a 1/4″ depth). A tripod camera stand is available through Roper Scientific.



Chapter 4. Troubleshooting

If you have any difficulty while troubleshooting, or do not see your camera system's symptoms listed here, contact Roper Scientific Customer Service.

The following issues have corresponding troubleshooting sections in this chapter.

Caution: Do not attach or remove any cables while the camera system is powered on.

System Does Not Boot Normally

If your operating system does not boot normally after you have installed a PCI card, try installing the new card in another open PCI slot. If this does not work:

1. *Turn off your computer* and remove the newly installed PCI card.
2. Turn your computer back on. If your system boots normally, there is probably an interrupt conflict between a previously installed expansion card and the PCI card that you are installing.
3. If you need assistance resolving the interrupt conflict, contact Roper Scientific Customer Service.

New Hardware Found Dialog Box Does Not Appear (Windows 95/98/2000/ME/XP)

If the New Hardware Found dialog box does not appear after installing a new PCI card to your computer and booting Windows 95/98/2000/ME/XP:

- Check to make sure that the new PCI card is inserted in a PCI slot according to your computer manufacturer's instructions and that the SenSys system's CD-ROM is in the host computer's CD drive.
- It is possible that there is a conflict between the new PCI card and a previously installed expansion card. *With the computer's power turned off,* remove any previously installed expansion cards that your system does not need to function. (If you are unsure which cards can be safely removed, call Roper Scientific Customer Service.) Then turn your computer back on and boot Windows 95/98/2000/ME/XP again.
- If the New Hardware Found dialog box still does not appear, contact Roper Scientific Customer Service.

Green LED Does Not Illuminate

Allow approximately one minute for the camera to reach operating temperature and the green LED to come on. If the green LED does not illuminate, there may be a problem with the camera's cooling system. Contact Roper Scientific Customer Service.

Spots in Image

If you have spots in the image and the green LED is off but the camera is hot to the touch, the CCD's temperature may be too cold and condensation may have formed on the CCD or window. Turn off the camera IMMEDIATELY and contact Roper Scientific Customer Service.

Image is Smeared or Camera Will Not Reach Saturation

If the image is smeared (especially in high-intensity areas of the image) or the camera will not reach saturation (4095 ADU) and the camera is set to gain state 1, make sure you use binning factors of at least 2 x 2. Because of the camera's design, it only saturates at gain state 1 if binning factors of at least 2 x 2 are defined.

Alternatively, if the light level is low enough, or you are unable to define binning factors greater than 1 x 1, you could use gain state 2 or gain state 3.

Images Not Displayed Properly

If no images appear:

- Confirm that the red LED on the back of the camera is illuminated, indicating that the camera is powered on.
- Confirm that the correct SenSys camera is selected in your imaging software application.
- Power off the camera and the host computer and check all system connections (particularly both ends of the SenSys data cable). Restart. If no images appear:
  - Confirm that Windows is set for at least 16-bit colors.
  - Confirm that the camera is operational by taking an image with a standard C-mount lens attached to your SenSys.
  - Using normal room lighting, place the camera on a table about 3 meters away from an object and acquire an image using your system's Brightfield settings.

If the problem persists, contact Roper Scientific Customer Service.

Camera Does Not Respond to Light

If your camera has no response to light, a faulty camera shutter may be causing the problem. To test for a malfunctioning shutter:

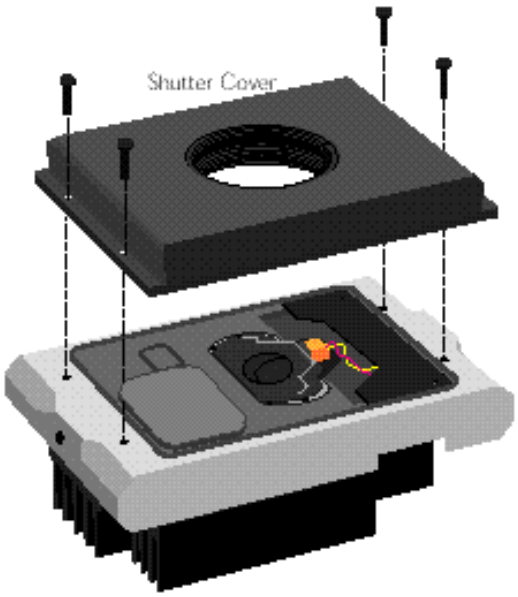
1. Turn on the power to the camera.
2. As the camera is powering up:
   - If you hear 2 clicks separated by 1 second (shutter opening then closing), the shutter is working. Call Roper Scientific Customer Service for further instructions.
   - If you do not hear any clicks, hear 1 click, or more than 2 clicks, check the voltage between I/O port pins 3 and 9 while you are powering up the camera. (See *Input/Output Port Pinout* on page 31.)
   - If the TTL logic level goes from 0 (low) to 1 (high), stays high for 1 second then drops to 0, the shutter signal is working, but the shutter is not working. If this happens, you need to replace the shutter. Follow the procedures in *Camera Shutter Needs Replacing* on page 21.
   - If the TTL logic levels do not indicate a working shutter signal, call Roper Scientific Customer Service.

Camera Shutter Needs Replacing

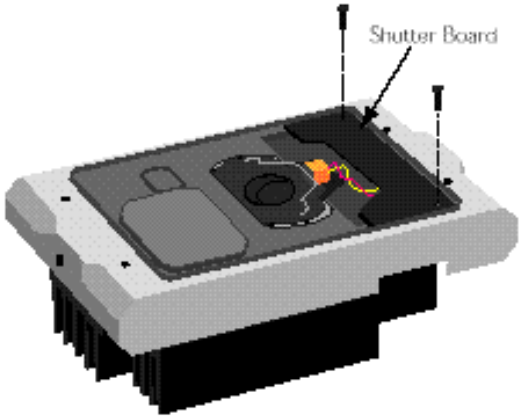
If your camera's shutter signal is working but the shutter needs to be replaced:

1. Using a 3/32" hex wrench, remove the four #4-40 socket head screws from the shutter cover.

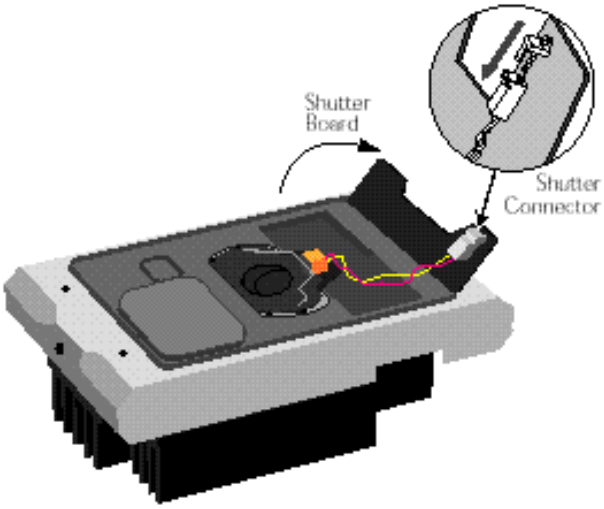
Caution: Make sure to remove the shutter cover and not the camera back. Removing the camera back will expose the CCD and void your warranty.



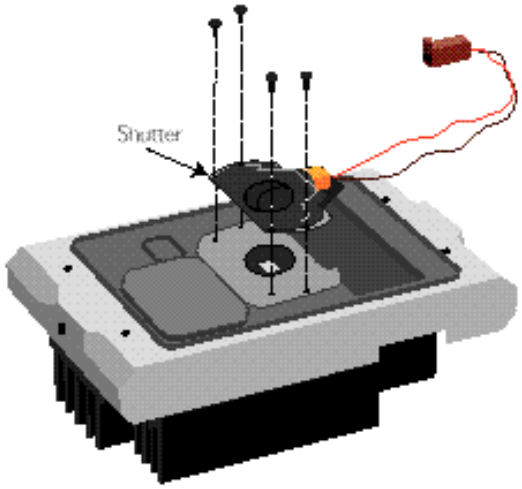
2. Using a #1 Phillips screwdriver, remove the two #4-40 pan head Phillips screws that attach the shutter board.



3. Pull the shutter board straight up until it is unplugged from the main board. Then unplug the shutter power connector from the shutter board.



4. Using a standard screwdriver, remove the four #2-56 slotted binding head screws that secure the shutter to the camera. Lift the shutter from the camera.



5. To install a new shutter, reverse the procedure.

Camera Does Not Focus

If your SenSys camera is not focusing, find your camera configuration in the following list:

- **An F-mount adapter is installed on your camera, and you are using an F-mount lens.**

  See the focusing instructions in your imaging software and lens documentation.

- **An F-mount adapter is installed on your camera, and the mount is attached directly to an instrument.**

  See the instructions for focusing the camera in *Focusing Your Camera* on page 12.

- **A C-mount adapter is installed on your camera, and you are using a C-mount lens.**

  See the focusing instructions in your imaging software and lens documentation.

- **A C-mount adapter is installed on your camera, and the mount is attached directly to an instrument.**

  See the instructions for focusing the camera in *Focusing Your Camera* on page 12.

PVCAM Error Message Appears

If a PVCAM error message appears, note the message's number code and contact Roper Scientific Customer Service.

Lengthy Pauses During Imaging

If you notice lengthy pauses marked by a lot of disk activity while imaging:

- Close any other programs that may be running.
- Install more physical memory to your computer system.

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Chapter 5. Specifications

Camera

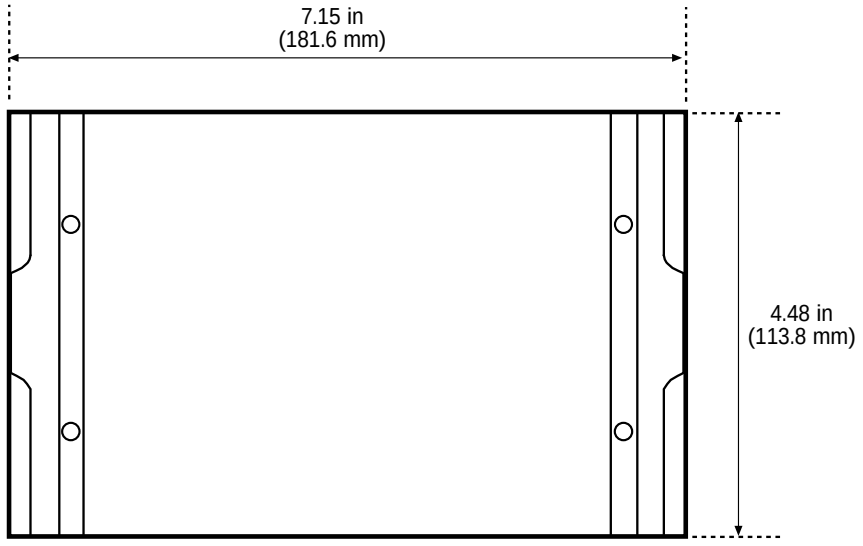
Weight: 3 lbs without lens or lens mount
Width: 4.48 in (113.7 mm)
Length: 7.15 in (181.6 mm)
Thickness: 3.00 in (76.2 mm) for F-mount; 2.60 in (66.0 mm) for C-mount
Window thickness: 1 mm
Distance from top of shutter cover to CCD image plane:

CCD	F-mount Distance	C-mount Distance
0401E, 1602E, 3200E, and 3200ME	1.05 in (26.7 mm)	.63 in (16.0 mm)
1401E	1.07 in (27.2 mm)	.65 in (16.6 mm)

Distance from top of window to CCD image plane:

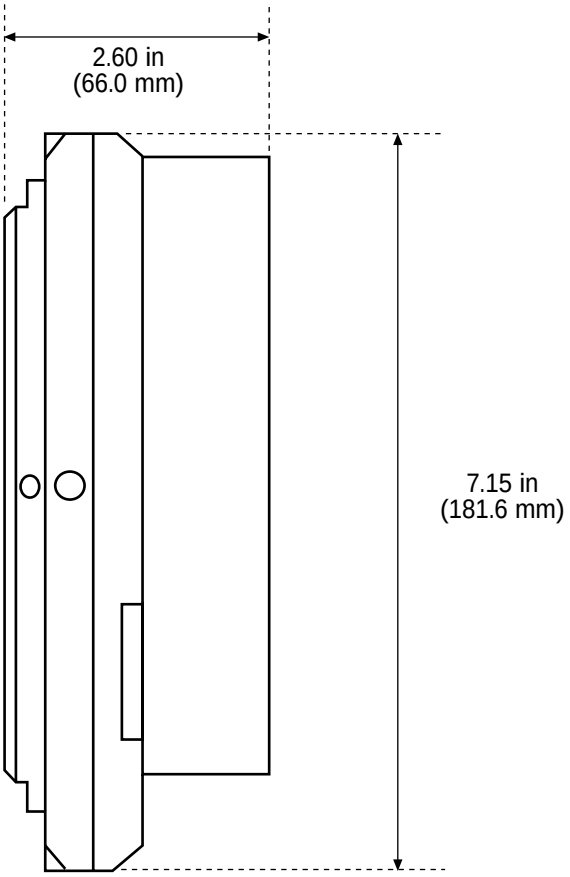
CCD	F-mount Distance	C-mount Distance
0401E, 1602E, 3200E, and 3200ME	.24 in (6.1 mm)	.24 in (6.1 mm)
1401E	.26 in (6.6 mm)	.26 in (6.6 mm)

Maximum ambient operating temperature: 40°C (104°F)
Minimum ambient operating temperature: 0°C (32°F)
Power dissipation: 15 watts

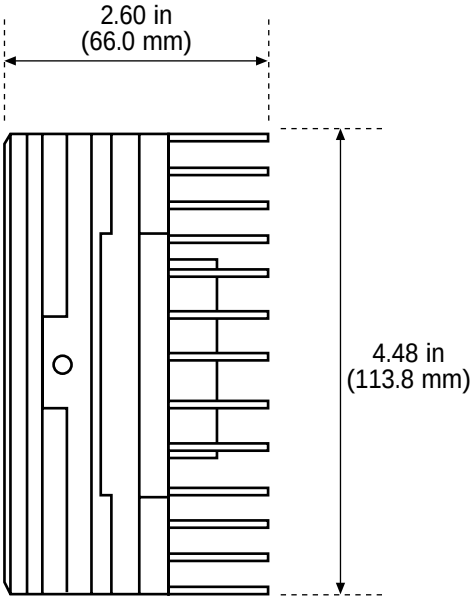


Camera Front View

C-Mount Camera

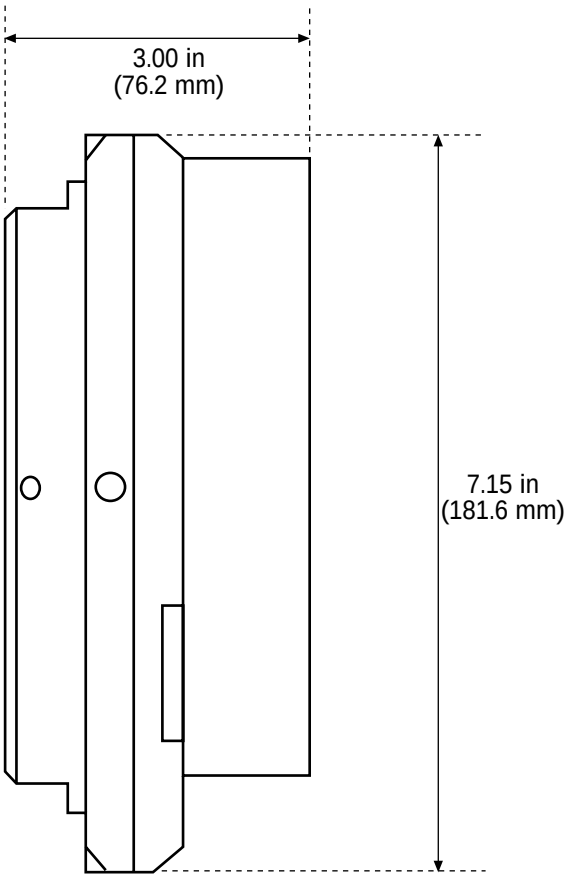


C-mount Camera Side View

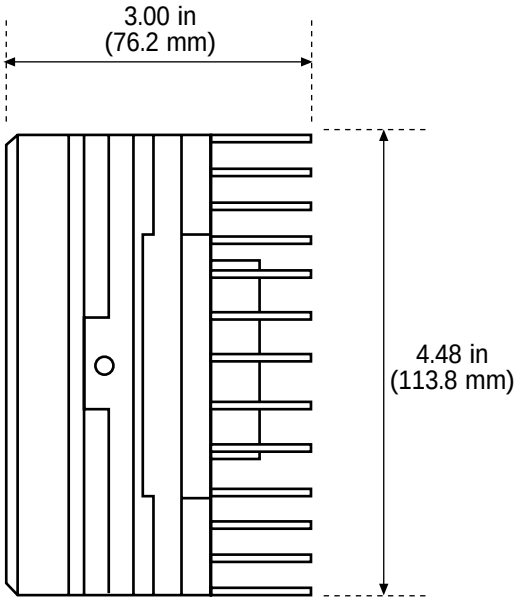


C-mount Camera Top View

F-Mount Camera

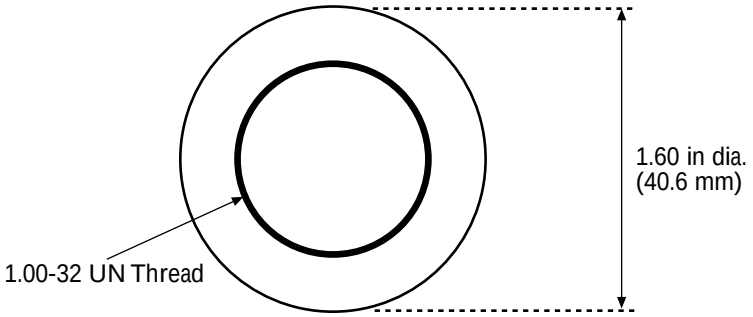


F-mount Camera Side View

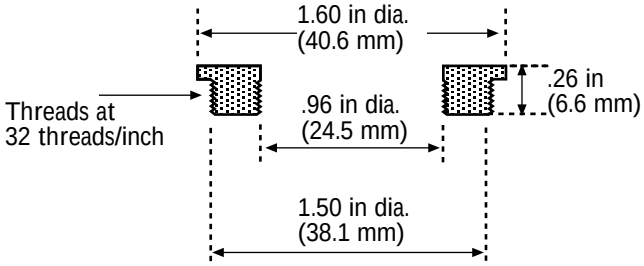


F-mount Camera Top View

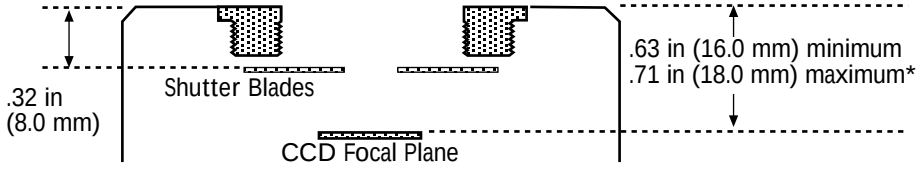
C-Mount Adapter



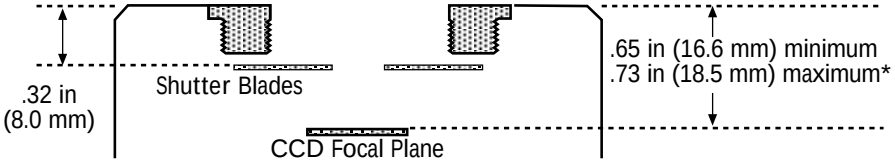
Top View of C-mount



Side View of C-mount (unmounted)



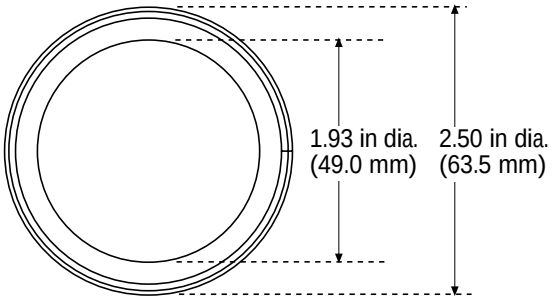
Side View of C-mount (mounted) for KAF 0401E, KAF 1602E, KAF 3200E, and KAF 3200ME



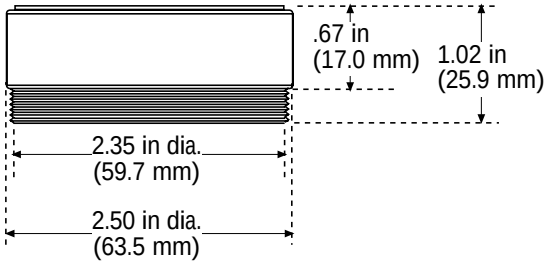
Side View of C-mount (mounted) for KAF 1401E

* C-mount nominal back focal distance is 0.69 in (17.526 mm).

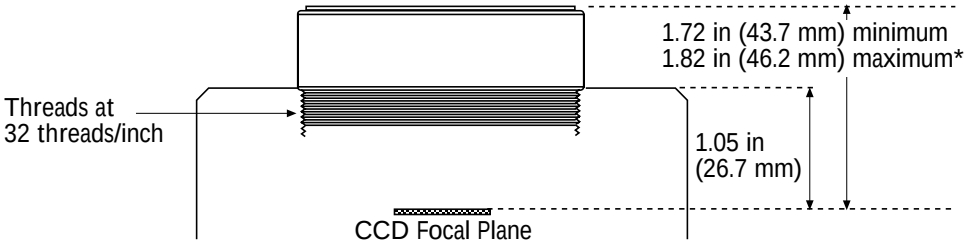
F-Mount Adapter



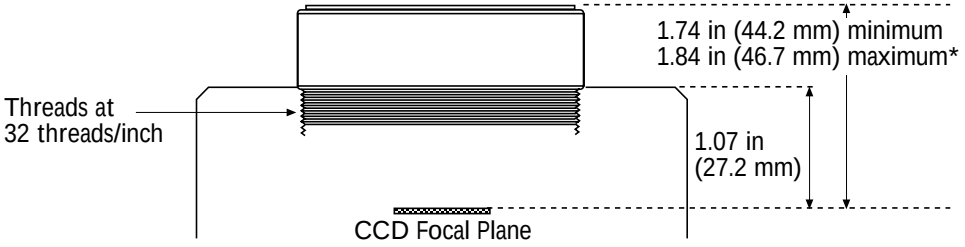
Top View of F-mount



Side View of F-mount (unmounted)



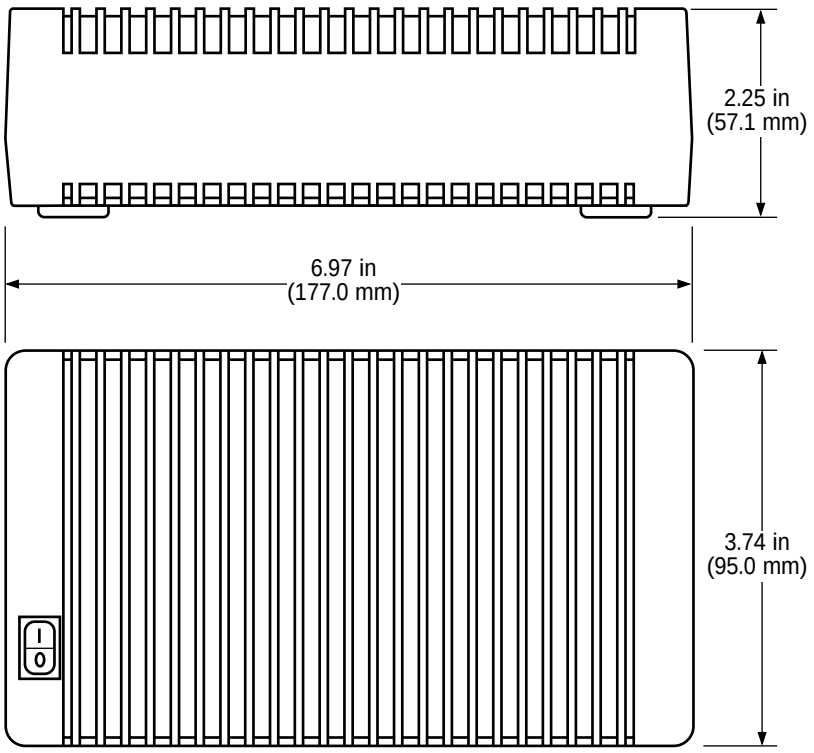
Side View of F-mount (mounted) for KAF 0401E, KAF 1602E, KAF 3200E, and KAF 3200ME



Side View of F-mount (mounted) for KAF 1401E

* F-mount nominal back focal distance is 1.83 in (46.5 mm).

Power Brick



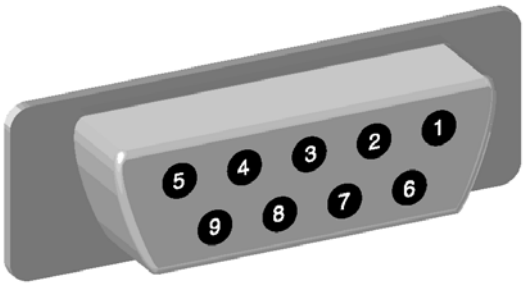
The power brick is a +5V DC and ±15V DC supply with 100-240V AC input at 50-60 Hz. The maximum power output is 55 W.

DC Voltage	Maximum Current Draw
+5	1 A
+15	2.05 A during cooldown 700 mA after camera has reached regulated temperature and during operation
-15	80 mA

Input/Output Port Pinout

The input/output port provides information about trigger function and shutter status. All inputs are pulled up to +5V DC through 10k ohm resistors and filtered with 2200pf ceramic capacitors. Outputs are driven by a 74F374 latch. The minimum trigger pulse width is 1.1 µsec (1100 nsec).

The numbers on the trigger connector diagram below correspond with the numbers given to the definition of each of the pins. The I/O connector is a female, D-subminiature 9-pin connector.



Input/Output Port with Pin Numbers

1 SHUTTER OPEN OUTPUT

Active high. A high level on this output indicates that the shutter is completely open. The output is low when the shutter is closed or in motion.

2 SHUTTER MOVING OUTPUT

Active high. A high level on this output indicates that the shutter is opening or closing. The output is low when the shutter is completely open or completely closed. The length of time this signal is held high is specified in PVCAM or by the Shutter Open Delay and Shutter Close Delay functions in the software.

3 CAMERA EXPOSING OUTPUT

Active high. A high level on this output indicates that the camera is exposing (integrating). This output does not include shutter open and close delay times.

4 FLASH

This pin is a TTL-level output that can be controlled through software by using the FLASH command.

5 FACTORY SETUP

This pin is used for factory setup only and is not to be utilized by the user. Driving this pin will disable the camera and cause a PVCAM error.

6 FILTERED TRIGGER INPUT

This input uses a TTL voltage level to trigger the camera. The input is pulled low to initiate a trigger (default). If nothing is connected to the input, it is pulled high to prevent the system from getting false triggers. To change the state of this input see TRIGGER INVERT INPUT (8). (The inputs are internally pulled up, therefore it is recommended to drive them with an open collector driver.)

7 TRIGGER INHIBIT INPUT

This input inhibits all trigger signals. If the input is pulled low, trigger activity is disabled. By default, the input is pulled high so the trigger circuitry is enabled. (The inputs are internally pulled up, therefore it is recommended to drive them with an open collector driver.)

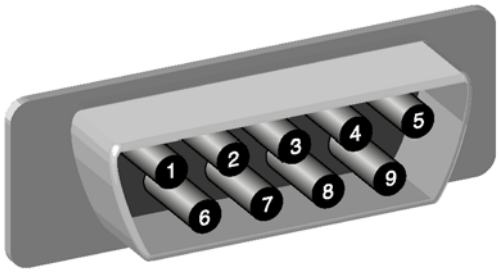
8 TRIGGER INVERT INPUT

Active low. A low on this input inverts the state of FILTERED TRIGGER INPUT (6), causing a high level to cause a trigger. (The inputs are internally pulled up, therefore it is recommended to drive them with an open collector driver.)

9 GROUND

System digital ground. Any external circuitry intended to interface with the trigger control signals must reference this ground connection.

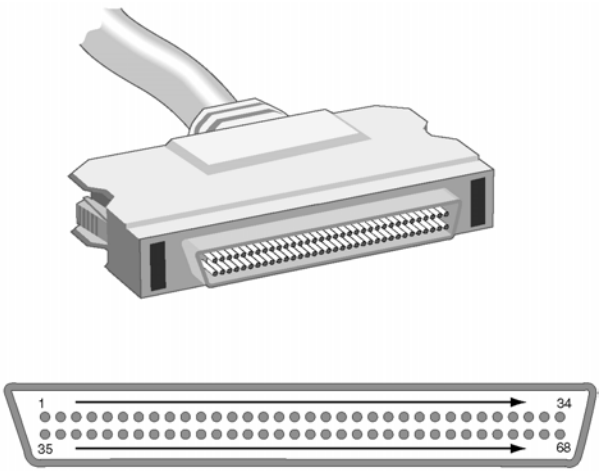
Power Port Pinout



Power Port Pinout

Pin #	Signal Name
1	+5V DC
2	+5V DC
3	Ground
4	Ground
5	Ground
6	+15V DC
7	Ground
8	-15V DC
9	Ground

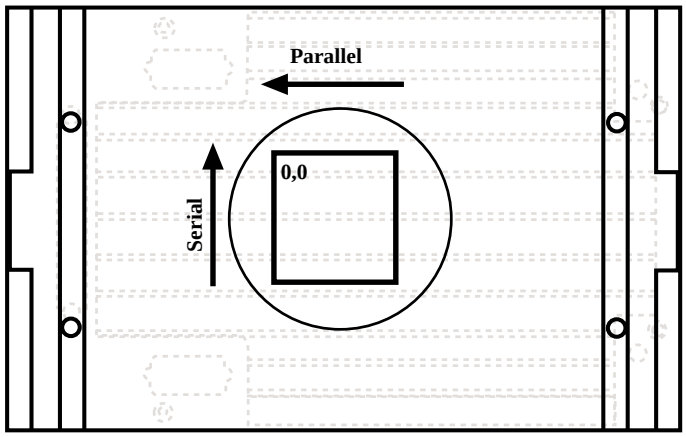
Data Cable Pinout



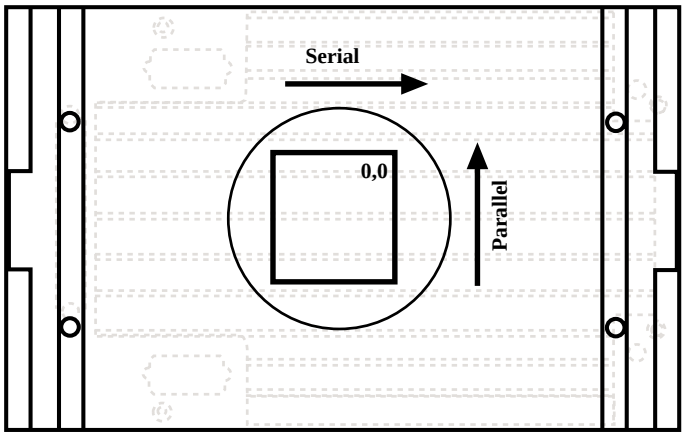
Data Cable Pinout

Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name
1	Ground	24	N/C	47	VD5-
2	Ground	25	FEN+	48	VD4-
3	Ground	26	LEN+	49	VD3-
4	Ground	27	N/C	50	VD2-
5	Ground	28	N/C	51	N/C
6	VD11+	29	PIX+	52	N/C
7	VD10+	30	N/C	53	VD1-
8	VD9+	31	N/C	54	VD0-
9	VD8+	32	N/C	55	N/C
10	VD7+	33	N/C	56	TX-
11	VD6+	34	Ground	57	RX-
12	Ground	35	Ground	58	N/C
13	VD5+	36	VCC	59	FEN-
14	VD4+	37	VCC	60	LEN-
15	VD3+	38	VCC	61	N/C
16	VD2+	39	VCC	62	N/C
17	N/C	40	VD11-	63	PIX-
18	N/C	41	VD10-	64	N/C
19	VD1+	42	VD9-	65	N/C
20	VD0+	43	VD8-	66	N/C
21	N/C	44	VD7-	67	N/C
22	TX+	45	VD6-	68	Ground
23	RX+	46	Ground		

CCD Orientation



Camera Front View — KAF 0401E, KAF 1602E, KAF 3200E, and KAF 3200ME CCD Orientation



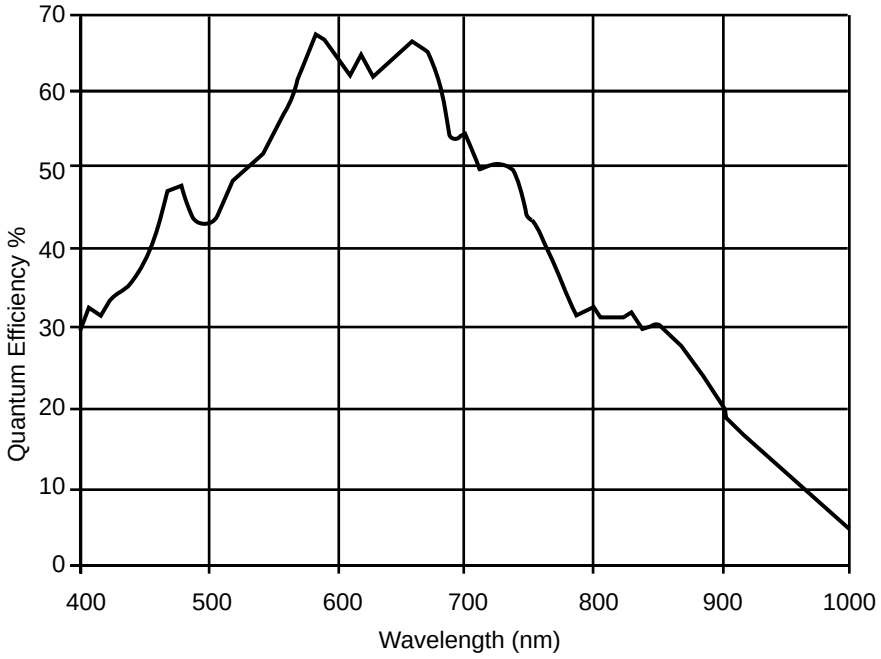
Camera Front View — KAF 1401E CCD Orientation

CCD Specifications

KAF0401E *H x V*: 768 x 512

Pixel Size: 9µm x 9µm

Detection Mode	Gain Setting	Relative Gain	Typical Noise	System Gain	Typical Maximum ADC Signal
High Signal to Noise	1	≈$^1/_2$x	26e$^-$	≈40e$^-$/ADU	160Ke$^-$ (binned full well*)
High Dynamic Range	2	≈1x	19e$^-$	≈20e$^-$/ADU	80Ke$^-$ (single pixel full well)
High Sensitivity	3	≈4x	13e$^-$	≈5e$^-$/ADU	20Ke$^-$ (high sensitivity)
* Binning must be a minimum of 2 pixels in the parallel and serial direction to reach the maximum ADC signal.					



Typical QE Curve (not installed in camera)

QE response in the 200-400 nm range can be enhanced with Photometrics' proprietary Metachrome II coating.

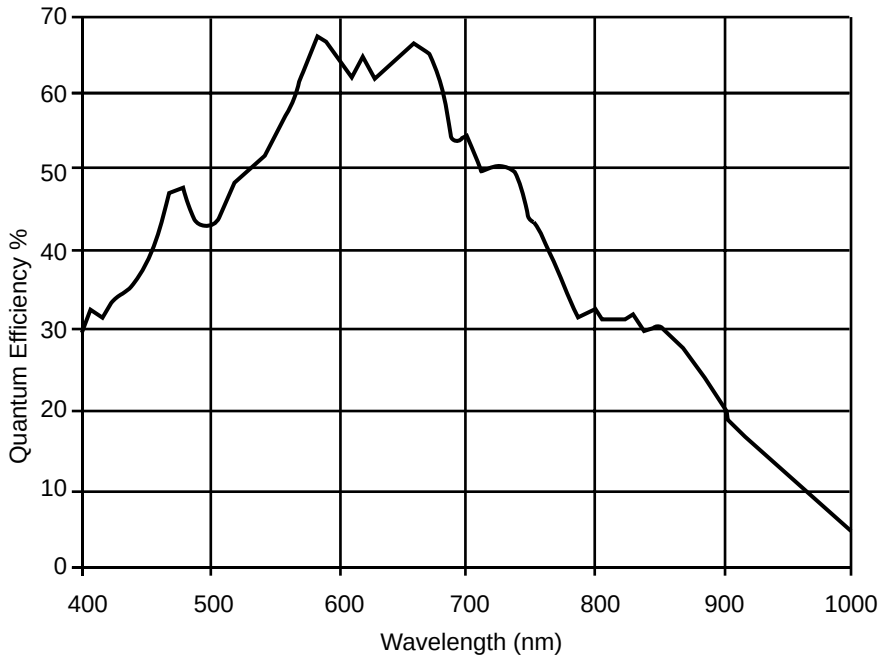
CCD Specifications (continued)

KAF1401E *H x V*: 1317 x 1035

Pixel Size: 6.8µm x 6.8µm

Detection Mode	Gain Setting	Relative Gain	Typical Noise	System Gain	Typical Maximum ADC Signal
High Signal to Noise	1	≈$^1/_2$x	20e$^-$	≈20e$^-$/ADU	80Ke$^-$ (binned full well*)
High Dynamic Range	2	≈1x	17e$^-$	≈10e$^-$/ADU	40Ke$^-$ (single pixel full well)
High Sensitivity	3	≈4x	12e$^-$	≈2.5e$^-$/ADU	10Ke$^-$ (high sensitivity)

* Binning must be a minimum of 2 pixels in the parallel and serial direction to reach the maximum ADC signal.



Typical QE Curve (not installed in camera)

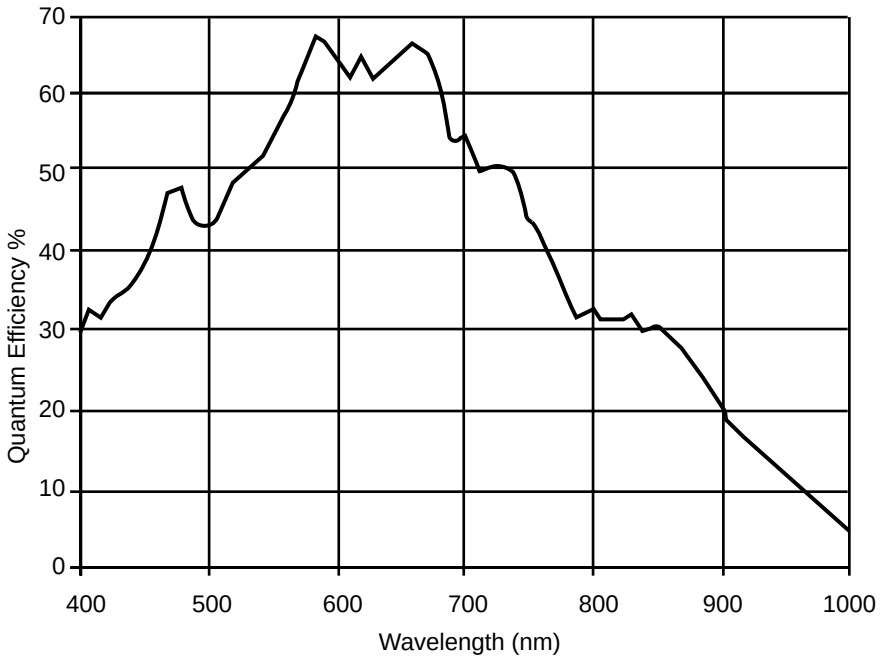
QE response in the 200-400 nm range can be enhanced with Photometrics' proprietary Metachrome II coating.

CCD Specifications (continued)

KAF1602E *H x V*: 1536 x 1024

Pixel Size: 9µm x 9µm

Detection Mode	Gain Setting	Relative Gain	Typical Noise	System Gain	Typical Maximum ADC Signal
High Signal to Noise	1	≈$^1/_2$x	26e$^-$	≈40e$^-$/ADU	160Ke$^-$ (binned full well*)
High Dynamic Range	2	≈1x	19e$^-$	≈20e$^-$/ADU	80Ke$^-$ (single pixel full well)
High Sensitivity	3	≈4x	11e$^-$	≈5e$^-$/ADU	20Ke$^-$ (high sensitivity)
* Binning must be a minimum of 2 pixels in the parallel and serial direction to reach the maximum ADC signal.					



Typical QE Curve (not installed in camera)

QE response in the 200-400 nm range can be enhanced with Photometrics' proprietary Metachrome II coating.

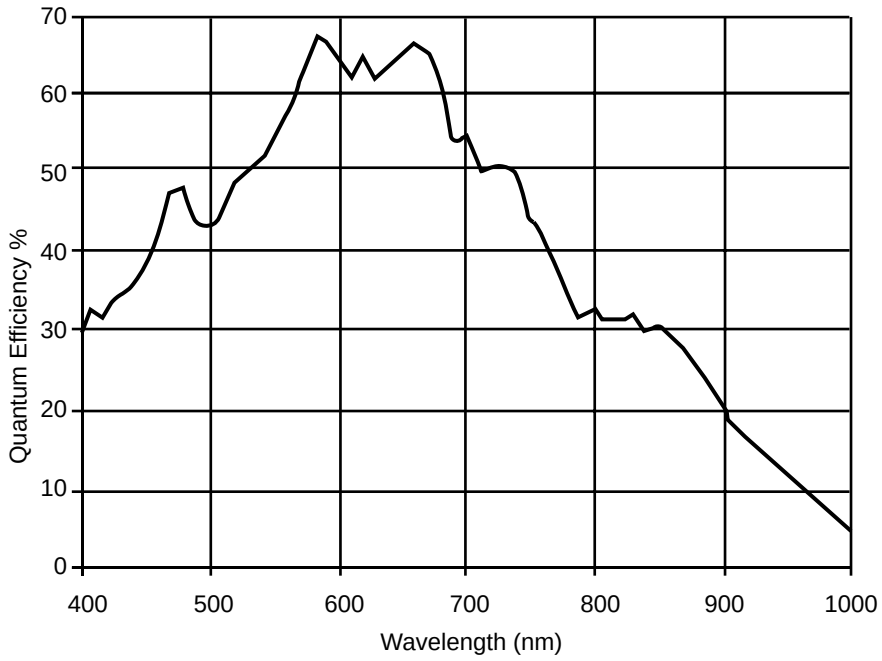
CCD Specifications (continued)

KAF3200E *H x V*: 2184 x 1472

Pixel Size: 6.8µm x 6.8µm

Detection Mode	Gain Setting	Relative Gain	Typical Noise	System Gain	Typical Maximum ADC Signal
High Signal to Noise	1	≈$^1/_2$x	18e$^-$	≈22e$^-$/ADU	90Ke$^-$ (binned full well*)
High Dynamic Range	2	≈1x	15e$^-$	≈11e$^-$/ADU	45Ke$^-$ (single pixel full well)
High Sensitivity	3	≈4x	10e$^-$	≈2.5e$^-$/ADU	10Ke$^-$ (high sensitivity)

* Binning must be a minimum of 2 pixels in the parallel and serial direction to reach the maximum ADC signal.



Typical QE Curve (not installed in camera)

QE response in the 200-400 nm range can be enhanced with Photometrics' proprietary Metachrome II coating.

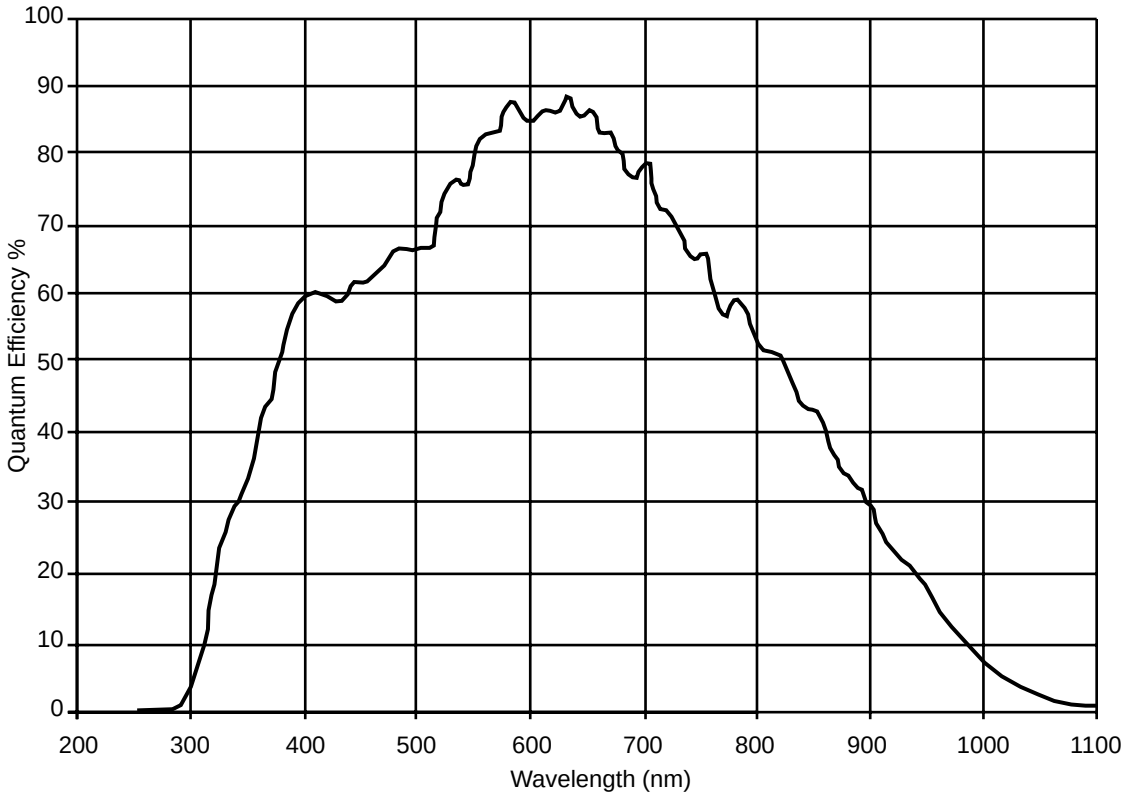
CCD Specifications (continued)

KAF3200ME *H x V*: 2184 x 1472

Pixel Size: 6.8µm x 6.8µm

Detection Mode	Gain Setting	Relative Gain	Typical Noise	System Gain	Typical Maximum ADC Signal
High Signal to Noise	1	≈$^1/_2$x	18e$^-$	≈22e$^-$/ADU	90Ke$^-$ (binned full well*)
High Dynamic Range	2	≈1x	15e$^-$	≈11e$^-$/ADU	45Ke$^-$ (single pixel full well)
High Sensitivity	3	≈4x	10e$^-$	≈2.5e$^-$/ADU	10Ke$^-$ (high sensitivity)

* Binning must be a minimum of 2 pixels in the parallel and serial direction to reach the maximum ADC signal.



Typical QE Curve (not installed in camera

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Appendix A Trigger Modes

Introduction

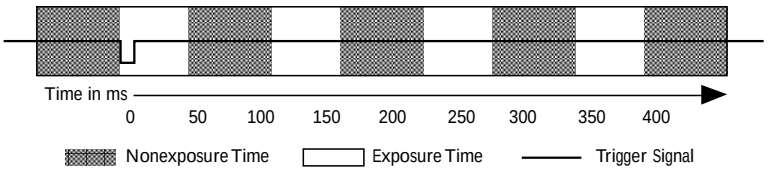
SenSys offers several methods of integration with external trigger sources, such as delay generators or laser pretriggers. The camera has a 9-pin, D-subminiature connector on the back for trigger-in and various TTL input and output operations (see page 31 for the pinout specifications).

In the default mode, the camera triggers on the falling edge of a TTL signal. To invert the triggering polarity, the "Trigger Invert" must be grounded. The minimum trigger pulse width is 1.1 µsec.

The SenSys camera supports the following trigger modes: Trigger-First, Strobe, and Bulb. These modes are described in the paragraphs that follow.

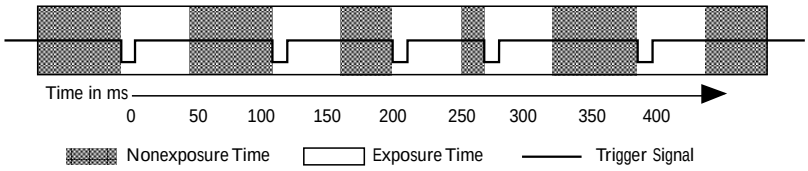
Trigger-First

In this mode, the camera requires only one trigger to acquire a sequence of frames. Each frame is exposed for a length of time entered into the software and read out. Once the trigger is received, the camera is inhibited from taking any further triggers until the entire sequence is completed (see diagram below).



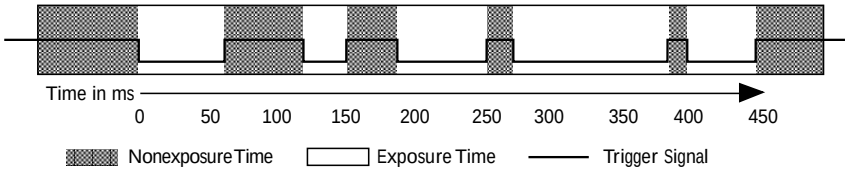
Strobe

In this mode, each frame in a sequence requires a trigger. Each frame is exposed for a length of time entered into the software and is then read out. If the trigger arrives during the exposure-readout of the previous frame, it is ignored (see diagram below). For a sequence of one frame, strobe mode and trigger-first mode are the same.



Bulb

In this mode, exposure time for each frame is determined by the trigger pulse width. Exposure time entered into the software is not used in this mode (see diagram below).



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Index

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