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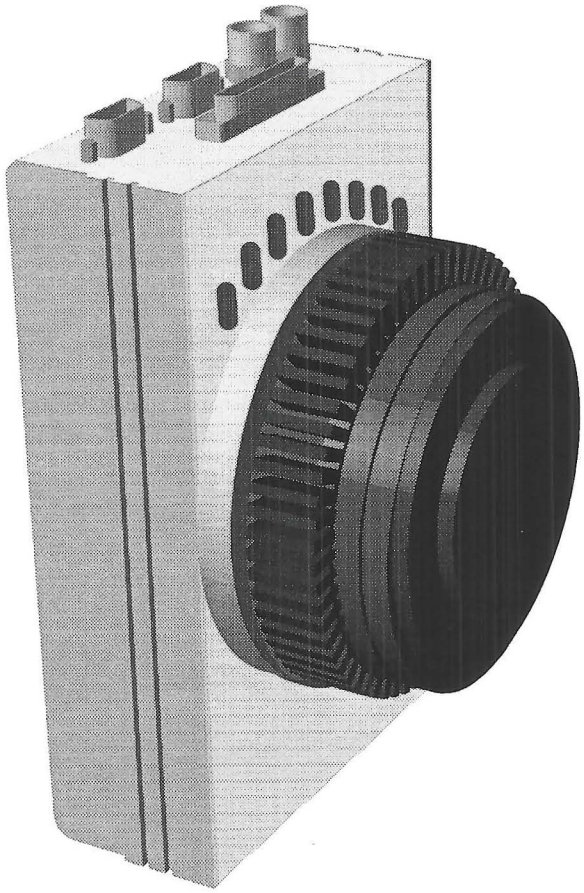
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Photometrics

Quantix™

User Manual for Windows™



Quantix™ User Manual

for Windows™

Photometrics

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The period over which Photometrics' products are warranted is twelve months from the date of shipment listed on the packing slip shipped with the equipment. PM will repair or replace the product if it is found to be defective within the warranty period.

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Photometrics must be notified in writing of the defect within the warranty period. The affected camera system should be returned to Photometrics within thirty days after discovery of such defect. Shipment shall not be made without prior authorization by Photometrics.

The buyer shall prepay shipping charges to Photometrics and Photometrics shall pay shipping charges to return the product to the buyer for products returned to Photometrics for warranty service. The buyer shall pay all shipping charges, duties, and taxes for products returned to Photometrics from outside the U.S.A.

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Photometrics' liability shall not exceed the cost of repair or replacement of the defective equipment.

This warranty becomes void if the user attempts to repair or modify the product without the written consent of Photometrics. This warranty is voided if the user opens the camera head.

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Photometrics must be notified in writing of the defect within the warranty period. The affected camera system should be returned to Photometrics within thirty days after discovery of such defect. Shipment shall not be made without prior authorization by Photometrics.

The buyer shall prepay shipping charges to Photometrics and Photometrics shall pay shipping charges to return the product to the buyer for products returned to Photometrics for warranty service. The buyer shall pay all shipping charges, duties, and taxes for products returned to Photometrics from outside the U.S.A.

This warranty does not apply to defects resulting from improper or inadequate maintenance by the buyer, unauthorized modification or misuse, or improper site preparation or maintenance.

Photometrics' liability shall not exceed the cost of repair or replacement of the defective equipment.

This warranty becomes void if the user attempts to repair or modify the product without the written consent of Photometrics. This warranty is voided if the user opens the camera head.

Declaration of Conformity

Photometrics, Ltd. 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/EE	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 22A	RF Emissions Control
EN 50082-1, IEC 801	Immunity to Electromagnetic Disturbances
EN 60950, IEC 950	Product Safety

Product Description: CCD Camera System
Models: Quantix Air-Cooled and Liquid-Cooled Camera Systems

Authorized Signature Date 9/27/96



Wilhelm Pfanhauser, Managing Director

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

CE

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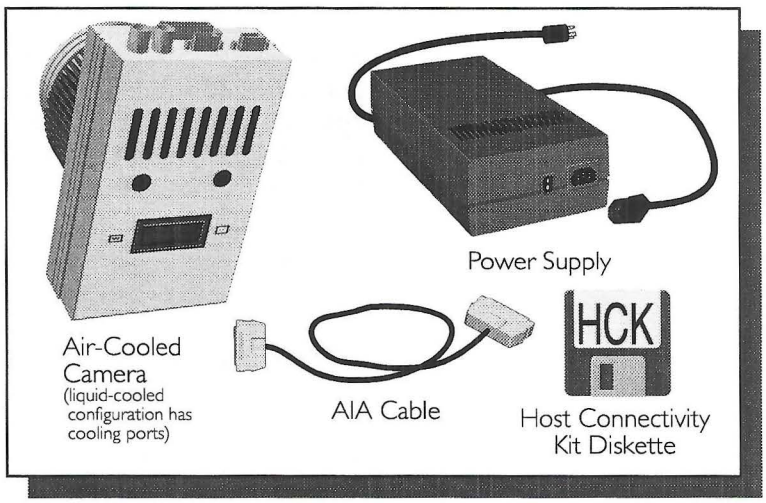
Chapter 1. Introduction

Quantix™ is an F-mount or C-mount, air- or liquid-cooled imaging system for acquiring digital scientific data. The system provides a fast focus, fast frame rate, and fast readout rate, while still providing the ability to acquire low-light images by integrating over long periods of time.

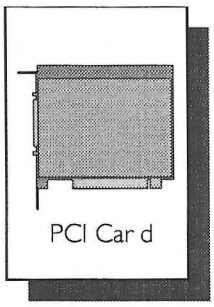
Quantix System Components

All Quantix systems consist of standard hardware and software as well as the appropriate interface hardware for your computer system. Some Quantix systems also include optional hardware.

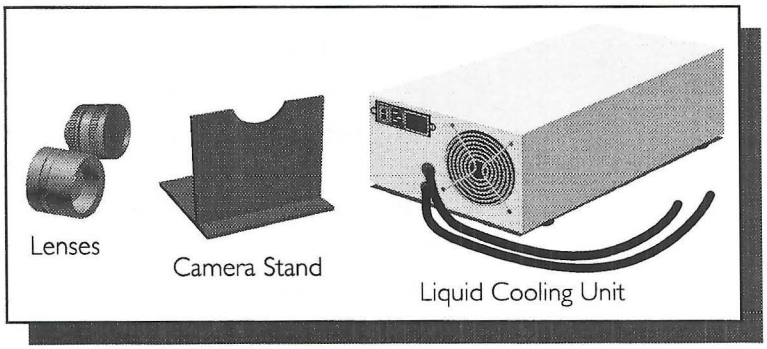
Standard Components



Interface Hardware



Optional System Hardware



About this Manual

The *Quantix User Manual for Windows* is divided into three parts and an appendix.

- **Part 1: Installation**
  - **Hardware Installation** — Complete instructions for installing the camera system's standard, interface, and optional hardware. If you are installing a new camera system, start here.
  - **Software Installation** — Complete HCK (Host Connectivity Kit) software installation instructions. If you are installing HCK software, start here.

  The following application and libraries are included:
  - CAMTEST — a limited software imaging program used to test your camera. CAMTEST does not save images or process data. Installation and operation are covered in this manual.
  - PVCAM™ (Photometrics Virtual Camera Access Method) — a custom, ANSI C library used to create the camera control and data acquisition interface. The PVCAM interface is standard across all PVCAM-compatible cameras, across available platforms. All full-function imaging packages and custom applications access the camera through this library. Writing custom applications in PVCAM requires developer's kit information that is not covered in this manual.
  - Imager Control Language (ICL) is a PVCAM add-on library that allows nonprogrammers to write simple, ASCII command scripts and save the scripts as text files. ICL functions allow the user more precise camera control than custom or prepackaged PVCAM applications. All ICL scripts must be used in conjunction with an ICL-compatible, full-function imaging package. Installation is covered in this manual. Script writing instructions are covered in the *Advanced Camera Operation Manual.*

  The following applications are not included in the HCK:
  - Full-function PVCAM-compatible imaging packages that save images and process data. Installation and operation are covered in their respective manuals.
- **Part 2: Operation**
  - **Hardware Operation —** Instructions for turning the system power on and off, and for reading the hardware displays and status lights.
  - **CAMTEST —** Instructions for using CAMTEST, the simple imaging program used to test the camera.
  - **LCU Maintenance —** Instructions for maintaining the optional Liquid Cooling Unit.
  - **Troubleshooting** — Answers to system hardware and software problems.
- **Part 3: Hardware Descriptions and Specifications —** Descriptions and specifications for each system component.
- **Part 4: Appendix**
  - **Appendix** — Error Messages

Host Computer Requirements

The Quantix camera system can be operated on any IBM® PC/AT™-compatible system with:

- An 80486 or faster CPU with floating point processor
- One unused PCI card slot
- Windows 95™ operating system

Multiple Cameras

PVCAM supports multiple open cameras. In order to use this function, it must also be supported by your imaging software. Most imaging packages do not support multiple cameras.

If your imaging software supports multiple cameras, the host computer must have a separate PCI card for each camera and all cameras must be running from a single application.

Software Compatibility Requirements

All imaging software must be PVCAM-compatible. For the Quantix camera to image, the PVCAM library must be at version 2.1 or higher. For full access to imaging software functions, PVCAM must be version 2.2 or higher.

Imager Control Language (ICL) scripts must be used in conjunction with an ICL-compatible, full-function imaging package.

Environmental Requirements

The Quantix camera system and optional Liquid Cooling Unit should be operated and stored in a clean, dry environment.

Operational

The system's ambient operating temperature is 0 to 30°C with a relative humidity of 0%–80% noncondensing.

Storage

Store the camera system and optional LCU in their original containers. To protect the system from excessive heat, cold, and moisture, store at an ambient temperature between -20° 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) and the optional Liquid Cooling Unit (LCU) requires periodic maintenance.

Camera

To avoid permanently damaging the system due to ESD:

- 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*.
- 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.
- Never impede air flow through the equipment by obstructing the air vents. Allow at least one inch air space around any vent.

Optional LCU

To prevent damage to the LCU:

- Keep the seals lubricated by running the unit for 45 minutes at least once a month.
- Keep pump primed by operating the LCU in the upright position.
- When disconnecting the coolant hoses from the camera, be sure to keep coolant from spilling into the camera. When disconnecting the hoses, hold the camera over an absorbent material, such as paper towels, with the connectors facing down.

Photometrics Customer Service

If you have any questions, contact Photometrics Customer Service. Please have your Photometrics job number or equipment serial numbers available.

- Phone: 520/889-9933 between 7 am and 5 pm MST
- Fax: 520/295-0299
- E-mail: CService@Photomet.mhs.compuserve.com
- Mail: Photometrics Ltd.
  3440 East Britannia Drive
  Tucson, Arizona 85706

In Europe, you can reach Customer Service at:

- Phone: 089/79 95 80 between 9 am and 5 pm
- Fax: 089/ 79 97 15
- Mail: Photometrics GmbH
  Sollner Str. 61
  D-81479 München, Germany

For general information and answers to some questions see our Web site:

- http://www.photomet.com

Chapter 2. Hardware Installation

Hardware installation includes:

- Installing the PCI host interface card
- Connecting the power supply
- Connecting the optional liquid cooling unit
- Connecting to other equipment

Installing PCI Card

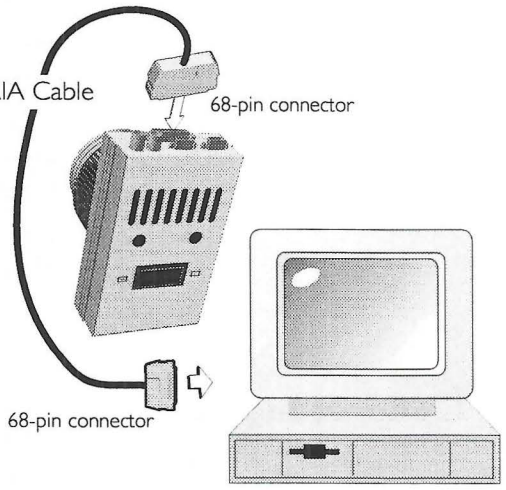
To install the PCI card:

1. Ensure that the power to the host computer is off and its power supply is disconnected.
2. Follow your computer manufacturer's instructions for inserting the card into an empty PCI slot.

The camera system is shipped with a ten-foot AIA cable. If you need a longer cable, contact Photometrics.

---

3. Connect:
   - One end of the AIA cable to the connector on the PCI card installed in your computer.
   - Other end of the AIA cable to the AIA connector on the camera.
4. Go to *Connecting the Power Supply* on page 6.



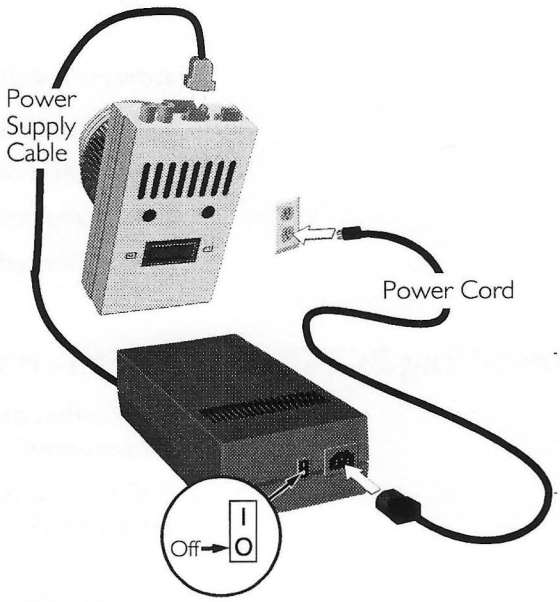
Connecting the Power Supply

Caution: Connecting or removing a live power cable to or from the camera can damage the camera's electronic components. Before connecting the power supply, make sure that the On/Off switch is off (press 0).

With the power supply *off*, connect:

- Power supply cable to camera's power connector. (Tighten thumbscrews.)
- Power cord to the power supply and electrical outlet.

The power supply is shipped with a 10-foot power supply cable. Do not extend the power supply cable.



You have completed installing the standard hardware and interface hardware.

- If you are connecting a Photometrics LCU, go to the next section, *Connecting the Optional Liquid Cooling Unit.*
- If you are connecting other equipment such as lenses, scientific equipment, triggering equipment, peripherals, or camera stands go to *Connecting to Other Equipment* on page 7.
- If you are completing a new installation and are ready to install the HCK software go to *Chapter 3. Software Installation.*

Connecting the Optional Liquid Cooling Unit

The liquid-cooled camera can be operated with or without the LCU. If you choose to operate the camera without the LCU, the default operating specifications will be slightly reduced. For operating specifications, see *Chapter 9. Specifications* .

In order to operate properly, the reservoir in the LCU must be at least 3/4 full:

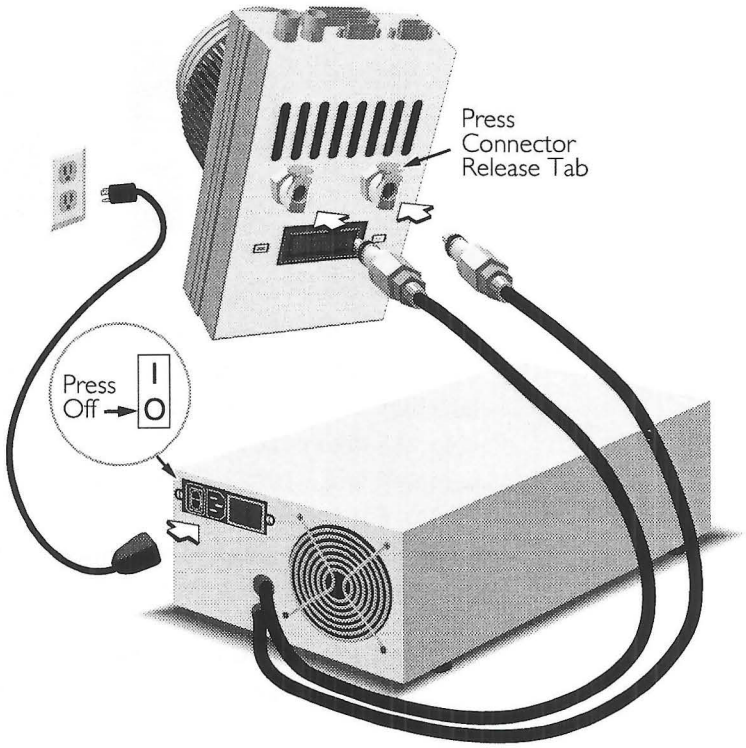
- If you are installing a newly shipped LCU, the reservoir is filled with the proper amount of coolant. Follow connection instructions below.
- If you are not installing a newly shipped LCU, check to see if either of the following conditions apply:
  - Low coolant level because you have lost coolant while disconnecting and reconnecting the hoses.
  - If you have not checked the coolant level in 3 months.

  If either condition applies, see *Refilling the Reservoir* on page 38 to check the coolant level in the reservoir.

To connect the LCU:

With the power switch in the *off* position, connect:

- LCU hoses to camera
- Power cord to LCU and electrical outlet



Caution: Do not allow the reservoir to drain below half full.
To keep the pump primed, always operate the LCU in the upright position.

When disconnecting the LCU from the camera, it is important to keep any coolant from spilling into the camera. Make sure to see *Disconnecting the Coolant Connectors* on page 37 for instructions on disconnecting the LCU.

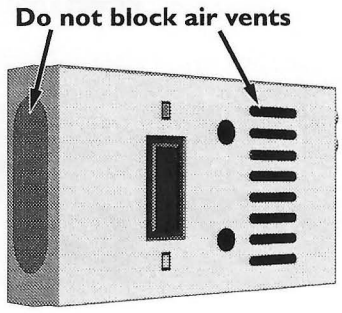
You have completed installing the LCU.

- If you are connecting other equipment such as lenses, scientific equipment, triggering equipment, peripherals, or camera stands go to the next section, *Connecting to Other Equipment* on page 7.
- If you are completing a new installation and are ready to install the HCK software go to *Chapter 3. Software Installation.*

Connecting to Other Equipment

The camera can be operated in any orientation, allowing it to be adapted to many configurations. The F-mount configuration has a Nikon bayonet mount with a standard F-mount back focal length. The C-mount configuration is a standard threaded video mount with a standard C-mount back focal length. The camera has mounts that accommodate a standard tripod mounting bolt.

When mounting the camera on an instrument, do not block any air vents. Blocking the air flow through the camera can damage the CCD. Make sure to allow at least 1 inch of air space in front of all vents.



Lenses

With the F-mount camera, you can install any lens that is compatible with a standard Nikon bayonet mount. With the C-mount camera, you can install any lens that is compatible with a standard threaded video mount as long as the objective does not extend farther than .28 inches behind the flange of the lens. A C-mount lens with a long back focal length may interfere with the shutter blades. For specifications on calculating acceptable back focal lengths see *F-Mount Camera* on page 58 or *C-Mount Camera* on page 61. Photometrics offers compatible C- and F-mount lenses.

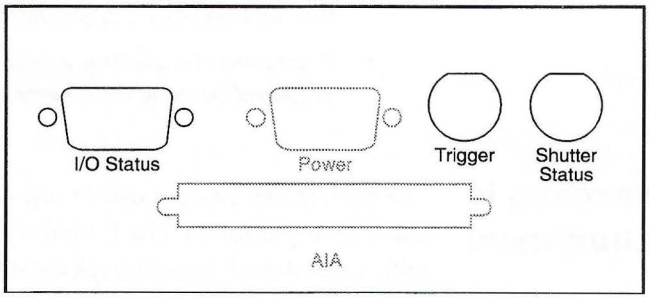
To install a lens, remove the camera aperture cover. Insert the lens into the lens mount and turn the lens until it locks in place.

Scientific Instruments

The F-mount camera can be mounted to any instrument that is compatible with a standard Nikon bayonet mount. The C-mount camera can be mounted to any instrument that is compatible with a standard threaded video mount. If you need to adjust your Quantix focal distance for parfocal adjustment, use standard optical shims. If your instrument requires a mount adapter, contact your instrument supplier.

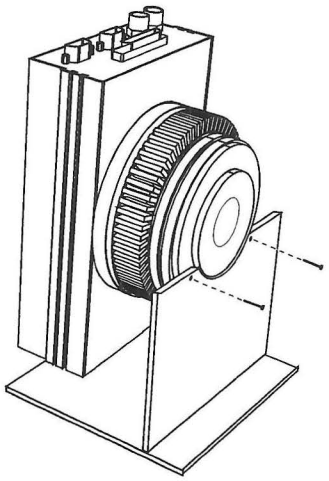
Trigger Equipment

You can connect the camera to trigger equipment through the I/O Status, Trigger, or Shutter Status connectors on the camera. For pin-out specifications for each connector, see *Connector Pinouts* starting on page 66.



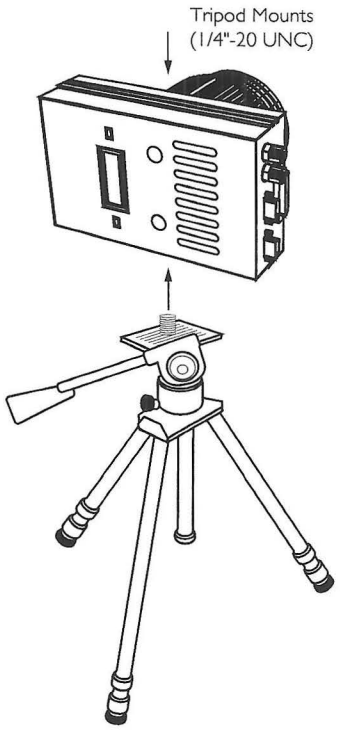
Quantix Camera Stand

Photometrics offers an optional Quantix camera stand. Since the camera can be operated in any position, the camera can be attached to the stand with the connectors facing up or to either side. To install the camera stand, thread the two bolts into the camera frontplate.



Tripod Camera Stands

If you use a tripod camera stand, make sure the stand is large enough and stable enough to securely support the camera's weight. The camera has two mounts that will accommodate a standard tripod mounting bolt.



You have completed the hardware installation.

- If you are completing a new installation and are ready to install the HCK software go to *Chapter 3. Software Installation.*

Chapter 3. Software Installation

Software installation includes:

- Installing the Host Connectivity Kit (HCK) software

The HCK installation diskette includes the software that allows you to:

- Test the camera and perform simple imaging functions using CAMTEST, a simple PVCAM-compatible program that acquires single images.
- Perform advanced imaging functions if you purchase or write PVCAM-compatible image processing programs.

Caution: This installation will not automatically alter any PVCAM.INI settings from previous HCK software installations. However, it is possible to accidentally delete some or all of these settings during the *System Configuration* portion of the HCK installation. Therefore, as a precautionary measure, it is recommended that you make a backup of the PVCAM.INI file before installing the new HCK software.

Installing HCK Software

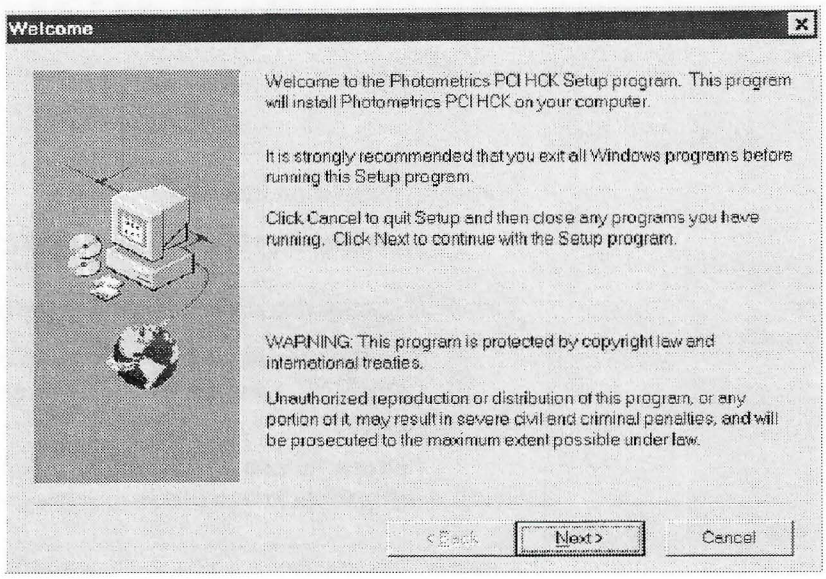
After installing the PCI card (see *Installing PCI Card* on page 5), you are ready to install the HCK for Windows 95 software:

Hardware Detection

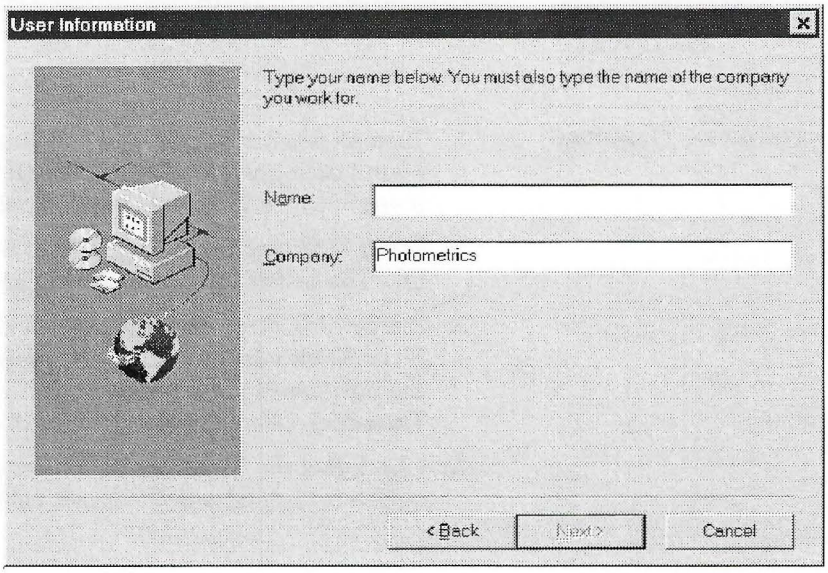
1. Turn on your computer and let Windows 95 boot. The New Hardware Found dialog box should appear. (If this dialog box does not appear, or if your system does not boot normally, see *Chapter 7. Troubleshooting*.)
2. Select "Driver from disk provided by hardware manufacturer." Click OK. The Install From Disk dialog box now appears.
3. Put the "HCK for Windows 95™ with AIA/PCI" diskette, either the 16-bit or 32-bit version, into the appropriate drive of your computer. (For the purpose of these instructions, drive A will be used.) Select drive A. Then click OK. The Select Device dialog box appears next.
4. Check that the "Snapper Video Acquisition & Processing Hardware" option is highlighted. (If it isn't, click on it.) Click OK.

Copying HCK Software Files

5. Click on the Windows 95 Start button. Click on Run. Type a:\setup. Then click OK. Two dialog boxes will appear in succession:
   - The Setup dialog box will tell you that InstallShield™ Wizard is being prepared.
   - The Welcome dialog box will appear after InstallShield Wizard has been prepared.

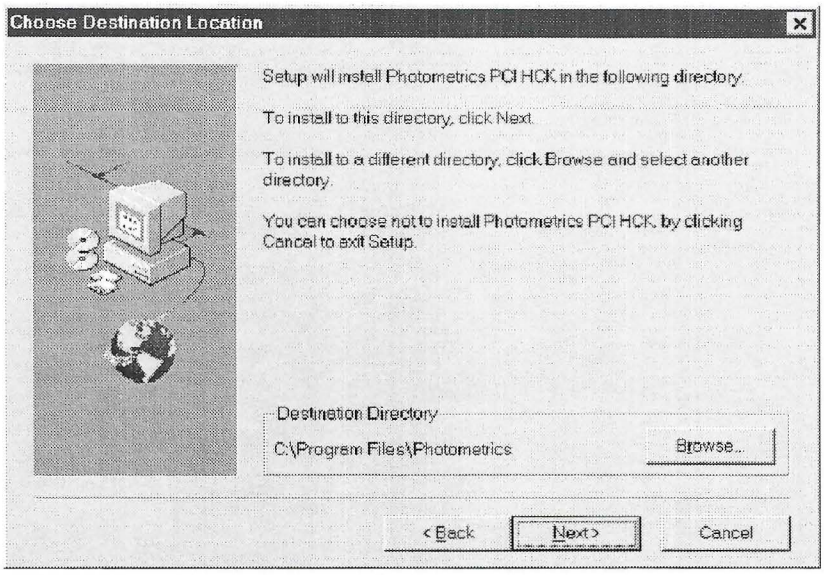


6. Click Next in the Welcome dialog box. The following dialog box appears:



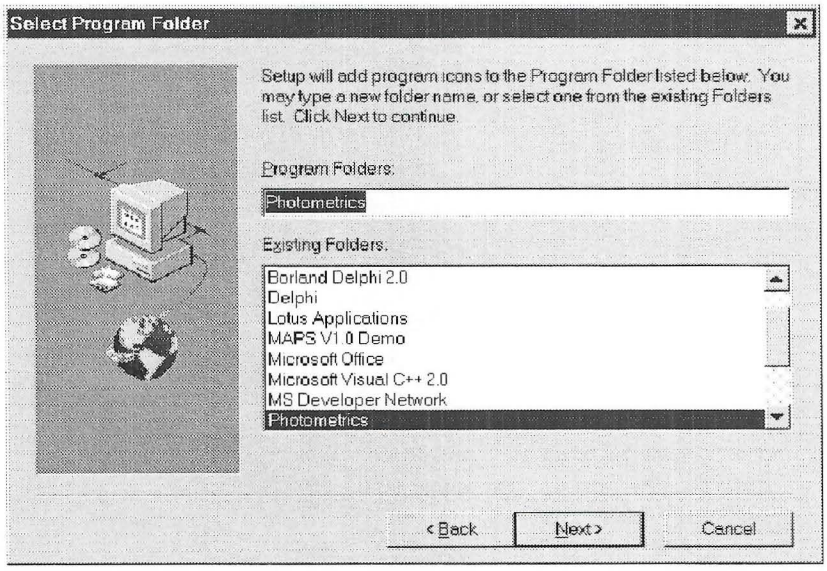
7. Type your name and the name of the company for which you work in the User Information dialog box. Click Next. The Choose Destination Location dialog box appears.

8. The Choose Destination Location dialog box lets you pick the directory to which you want the Photometrics HCK installed:



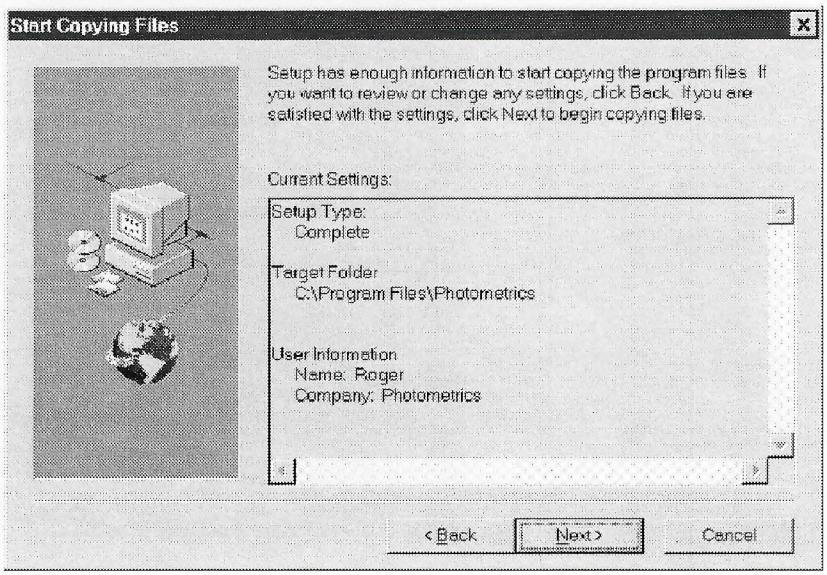
- If you want the HCK installed to the directory displayed, click Next.
- If you want the HCK installed to a different directory, click Browse and select another directory from the Choose Directory dialog box that appears. When you have chosen a directory, click OK to return to the Choose Destination Location dialog box. Click Next.

9. The Select Program Folder dialog box now appears. This dialog box lets you choose where program icons will be stored:



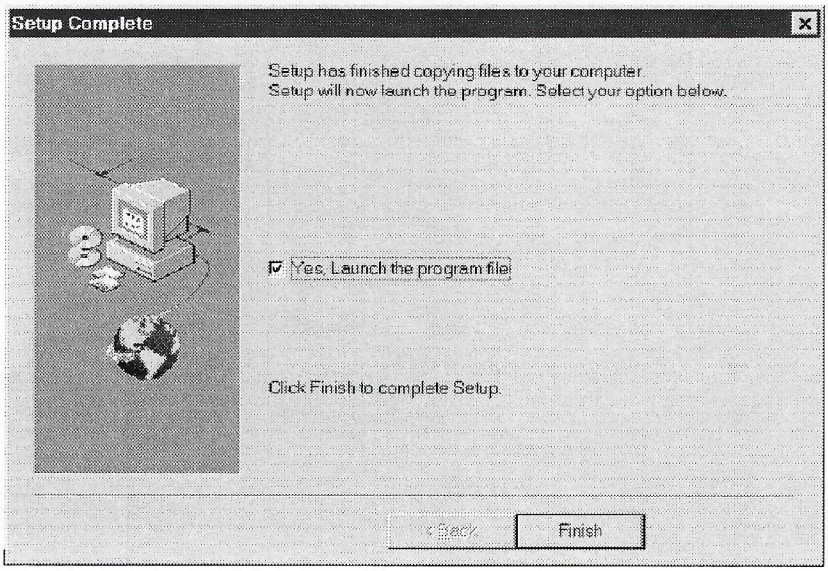
- If you want the program icons added to the program folder displayed, simply click Next.
- If you prefer that the icons be added to a different program folder, click on the desired folder from the scroll menu and then click Next.

10. The Start Copying Files dialog box appears. The Start Copying Files dialog box allows you to go back and change information that you've entered up to this point in the installation process:



- If you would like to return to previously displayed screens, click the Back button.
- If you are ready to proceed with the installation, click Next. Files will now be installed to your hard drive.

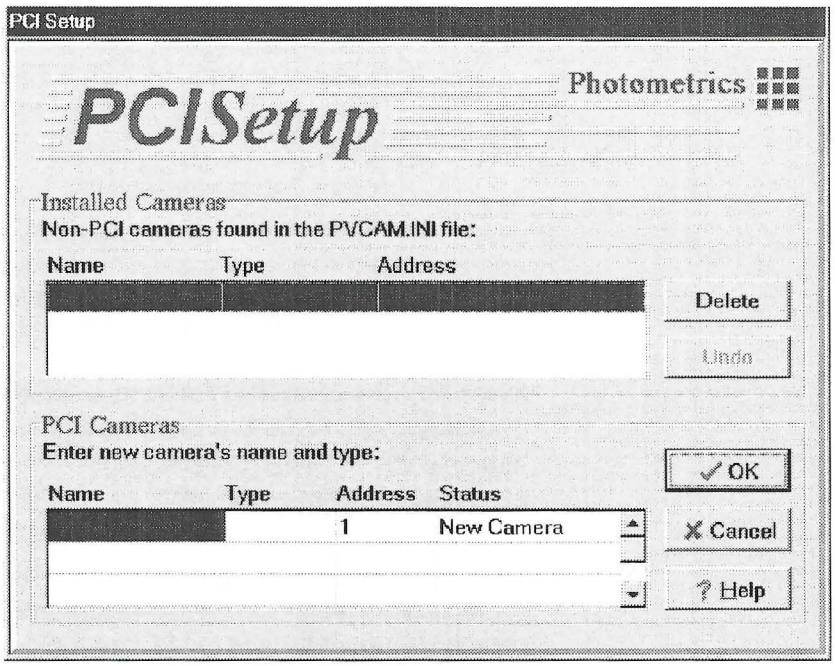
11. When the files have been copied to your computer the Setup Complete dialog box will appear. Click on "Yes, Launch the program file." Then click Finish.



Caution: If you do not launch the program file at this time, the installation will terminate and your system will not be configured for proper operation.

System Configuration

The PCI*Setup* program window appears next, allowing you to analyze and configure your system using the PCI*Setup* program.



Note: At some screen resolutions the host computer's display adapter or driver may not interpret the display mapping from PCI*Setup* properly. This will cause some of the PCI*Setup* program window's fields to appear slightly askew. (This will not affect the operation of PCI*Setup*.) To correct the program window's appearance, try changing to a different screen resolution in Windows 95.

The Installed Cameras portion of the PCI*Setup* program window displays all previously installed Photometrics non-PCI cameras. PCI*Setup* detects an entry for each of these cameras in the PVCAM. INI file that it finds on your system:

- To remove a previously installed Photometrics non-PCI camera from your system, click on the unwanted camera to highlight it. Then click the Delete button.
- To restore a non-PCI camera that you may have removed accidentally, click the Undo button immediately after you have clicked the Delete button.
- You cannot edit the Name, Type, or Address fields in the Installed Cameras section.

The PCI Cameras portion of the PCI*Setup* program window displays any Photometrics PCI camera that is installed on your system. PCI*Setup* is able to detect a Photometrics PCI card in any PCI slot in the host computer system.

You will see entries in the PCI Cameras section if your system contains previously installed Photometrics PCI cards, or if you have just installed a new Photometrics PCI card:

- You can edit the Name, Type, and Address fields in the PCI Cameras section.

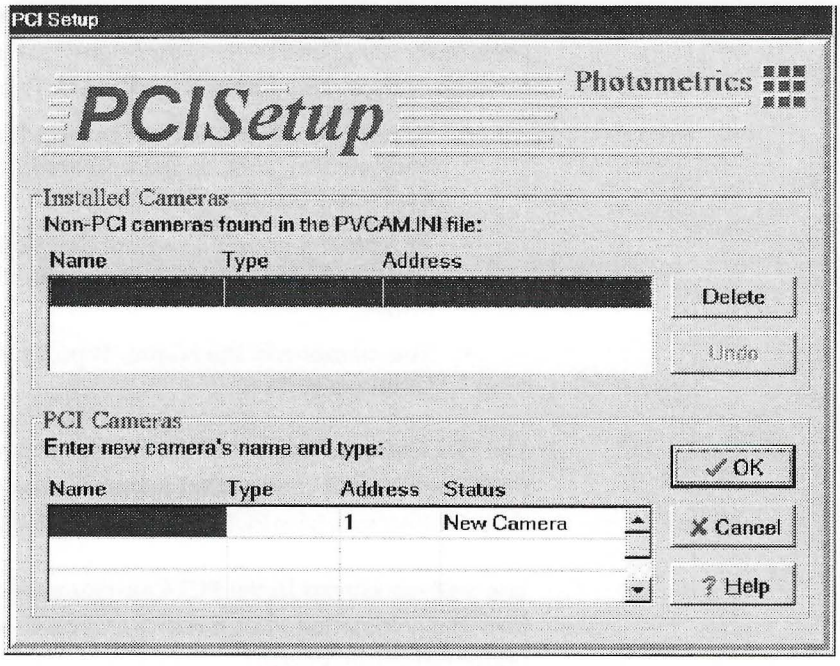
- You cannot edit the Status field. One of three status designations will appear in this field:
  - "New Camera" indicates that the camera shown is a newly installed camera that must be given a name and type to be made usable by your system. (You will enter a name and a type of application in the Name and Type fields, respectively.)
  - "OK" lets you know that the camera shown is properly configured and usable by your system.
  - "Not Present" means that no Photometrics PCI card has been found at the address specified in the Address field. (To make the camera usable by your system, you must enter the valid address of an installed Photometrics PCI card in the Address field.)

When you have completed any entries or changes to any of the cameras displayed in either the Installed Cameras or PCI Cameras sections, click the OK button in the PCI*Setup* program window. Any entries or changes that you have made will be saved and the PVCAM.INI file on your system will be updated.

When you want to cancel any entries or changes that you have made to any of the cameras displayed in either the Installed Cameras or PCI Cameras sections, click the Cancel button in the PCI*Setup* program window. Any entries or changes that you have made will be discarded and the PVCAM.INI file on your system will not be changed.

Note: On-line help for PCI*Setup* is available by clicking on the Help button in the PCI*Setup* program window.

Example:



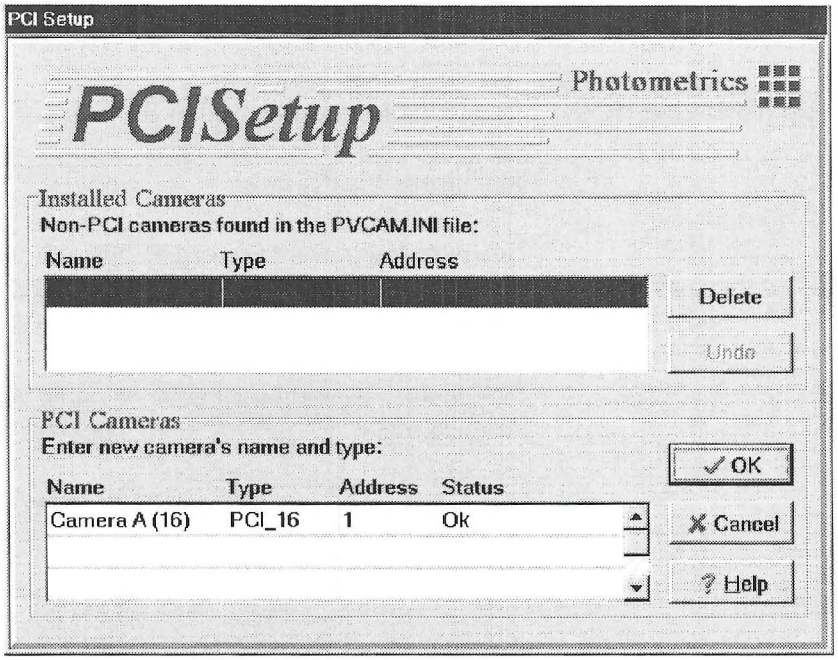
In the PCI*Setup* program window shown above:

- The Installed Cameras section indicates that no previously installed Photometrics non-PCI cameras were found in the PVCAM.INI file on the system.
- The PCI Cameras section indicates that a new Photometrics PCI card has been detected (Status field) at address 1 (Address field).

12. Enter a name in the Name field for the new PCI camera. You can call the camera whatever you'd like, keeping in mind that if you will be using more than one camera you'll want to be able to recognize each camera by its name. It is also a good idea to create a name that indicates whether the camera will be used with a 16-bit or a 32-bit application.
13. Enter the type of application to be used with the new PCI camera in the Type field:
    - PCI_16 (Enter this type, just as you see it printed here, if you will be using a 16-bit application with your camera.)
    - PCI_32 (Enter this type, just as you see it printed here, if you will be using a 32-bit application with your camera.)

Caution: Only enter a type for which you've installed the corresponding 16-bit or 32-bit HCK. (For instance, don't enter PCI_32 if you haven't installed the 32-bit HCK.) If you enter an unsupported type, you will get an error message when you select the camera in your application program.

Example:



The program window shown above indicates that:

- The camera has been named "Camera A (16)." (Name field)
- The camera will be used for a 16-bit application. (Type field)
- The camera is attached to the PCI card at address 1. (Address field)
- The camera status is now "OK." (Status field)

14. After you've entered a name and a type in the appropriate fields of the PCI Cameras section, click the OK button.

You have completed the HCK software installation.

- To take a test exposure, see *Taking a Test Exposure* on page 25.

To Run PCI*Setup* Later

There may be times when you want to review and/or change information in the PCI*Setup* program window. To access PCI*Setup* directly at a later time:

1. Click on the Windows 95 Start button.
2. Move your cursor to Programs, then to Photometrics (or whatever name you chose for the program folder to which you added the program icons), and then to PCI*Setup* and click. The PCI*Setup* program window appears.

Note: If you do not close all imaging applications before running PCI*Setup*, you will get erroneous results.

Installing Additional HCKs

Once you have installed either the 16-bit or the 32-bit HCK you do not need to install that particular HCK again, regardless of how many cameras/PCI cards you add to your system.

However, if you want to run a 32-bit application and have only installed the 16-bit HCK, you must install the 32-bit HCK to do so. (The same holds true in the opposite scenario, in which case you would need to install the 16-bit HCK.)

Again, once the additional HCK has been installed you will not need to re-install it, regardless of how many cameras/PCI cards you add to your system.

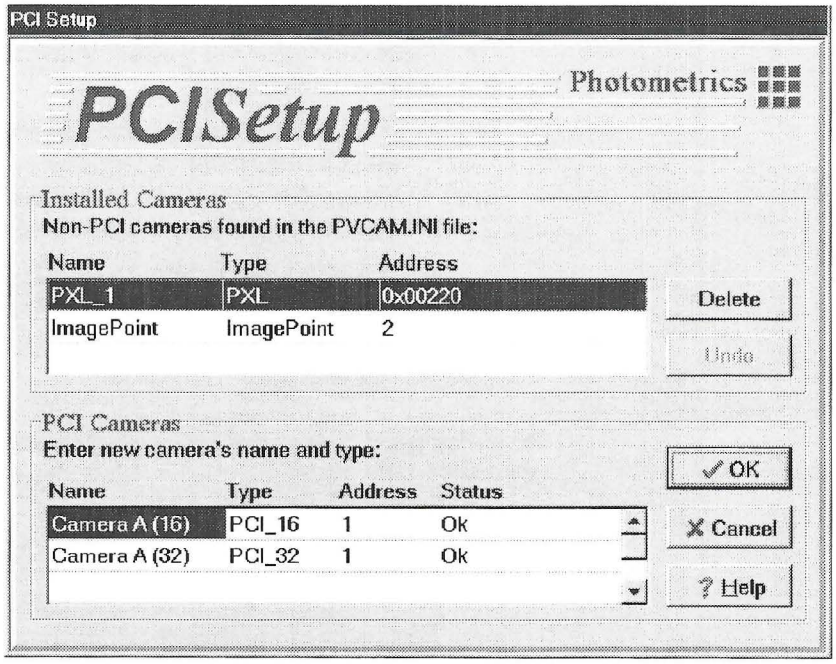
Note: If you want to install an additional PCI card at the same time as an additional HCK, use the instructions given for *Installing Additional PCI Cards* on page 20 instead of the directions below.

To install an additional HCK:

1. Put the new HCK diskette into the appropriate drive of your computer.
2. Follow the directions for *Copying HCK Software Files* on page 11 (steps 5-11).
3. When the PCI*Setup* program window appears, you will need to enter a name, a type, and a valid address (the address of an installed PCI card) to an empty line in the PCI Cameras section. The Status field on that line will auto-fill to read "OK."

Example:

- If you already had a camera attached to a PCI card at address 1 and you then installed an additional HCK, your program window might look like this after entering a name, a type, and an address:



The program window shown above indicates that:

- Two previously installed Photometrics non-PCI cameras were detected in the PVCAM.INI file on the system.
- The Photometrics PCI card at address 1 is connected to a camera that can now be used with either a 16-bit or a 32-bit application.

Note: "Camera A (16)" and "Camera A (32)" can be either the same physical camera attached to the PCI card located at address 1, or different physical cameras that are attached to the PCI card located at address 1 at different times.

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4. Click the OK button to save the changes you've made to the PVCAM.INI file on your system.

Installing Additional PCI Cards

Only one camera can be attached to a single PCI card at any given time, therefore you may want to add PCI cards to your system. Add each PCI card as follows:

1. Install the PCI card in your computer according to the *Installing PCI Card* section on page 5.
2. Determine which of the following two scenarios applies to you and proceed accordingly:
   - If you will not be installing a new HCK with the new PCI card, execute the *Hardware Detection* procedure on page 11 (steps 1-4) using either one of the HCK diskettes. After completing *Hardware Detection*, go to step 4 below to configure your system.
   - If you will be installing a new HCK with the new PCI card, execute the *Hardware Detection* procedure on page 11 (steps 1-4) using either one of the HCK diskettes. After completing *Hardware Detection*, go to step 3 below.

Note: If you aren't sure whether you need to install a new HCK at this time, see the brief discussion at the beginning of the *Installing Additional HCKs* section on page 18.

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3. If you have not already done so, insert the HCK diskette containing the HCK software that you want to install into the appropriate drive of your computer and follow the instructions for *Copying HCK Software Files* on page 11 (steps 5-11). When the PCI*Setup* program window appears, go to step 5 below to configure your system.
4. After the Select Device dialog box disappears, follow the directions given under *To Run PCISetup Later* on page 18 (steps 1-3). When the PCI*Setup* program window appears continue with step 5 below.
5. Enter a name and a type of application for the camera detected at the new address.
   - If you need to create any additional entries, enter a name, a type, and a valid address into the proper fields of a blank line in the PCI Cameras section. The Status field will auto-fill to read "OK."
6. Click the OK button when you want to save your changes to the PVCAM.INI file on your system.

Note: Many configurations are possible with the PCI HCK software. If after consulting this manual and using the on-line PCI*Setup* Help file you find that you need further assistance configuring your system properly, call Photometrics Customer Service.

Chapter 4. Hardware Operation

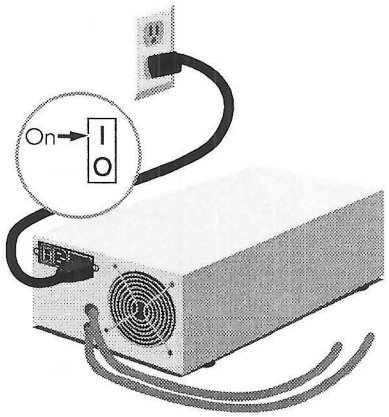
Turning On Power and Reading Status Lights

Note: If you have other equipment attached to your camera system (camera system consists of LCU, camera, power supply, and computer), be sure to turn on the camera system last. For instructions on turning on the camera system, see below.

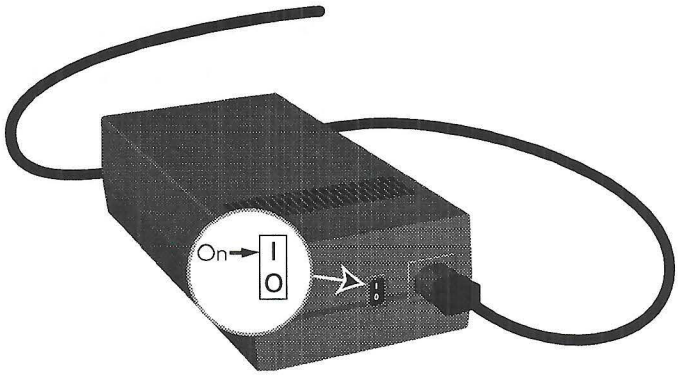
Although an LCU should always be powered on first, the other camera system components do not always respond to a specific powering order. The following list shows a common order for turning on the power to your system components. If you try this order and your host computer does not recognize a component, try turning on the computer first.

- LCU (if applicable)
- Camera
- Computer

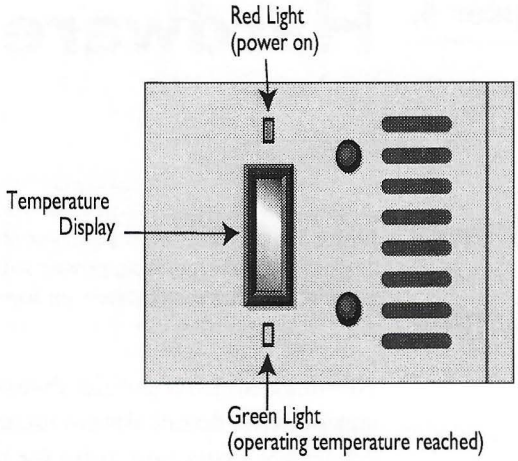
LCU If you have an LCU, turn it on by pressing | on the On/Off switch.



Camera Power Turn on the camera by pressing | on the On/Off switch on the power supply.



Reading Camera Status Lights



• Red light on	Power on
• Green light on	CCD reached operating temperature
• Red and green lights off	Camera exposing or exposing while waiting for trigger

If the ambient temperature is near 25°C, the CCD usually reaches the default operating temperature (air cooled -25°C, liquid cooled -35°C) within 15 minutes. Some ambient conditions, combined with an ambient temperature below 0°C or above 30°C, may result in the camera not stabilizing at the default operating temperature.

If after 30 minutes of operation, the green light on the camera does not indicate that you have reached operating temperature:

- Make sure that the camera's air vents are unobstructed
- If you have an LCU, see *LCU Not Cooling* on page 43
- Call Photometrics Customer Service

Turning Power Off

Note: If you have other equipment attached to your camera system, be sure to turn off the camera system first.

After quitting software programs, turn off the camera system components in any order.

- To turn off the camera, press 0 on the power supply On/Off switch.
- To turn off the LCU, press 0 on the LCU On/Off switch.

Chapter 5. CAMTEST

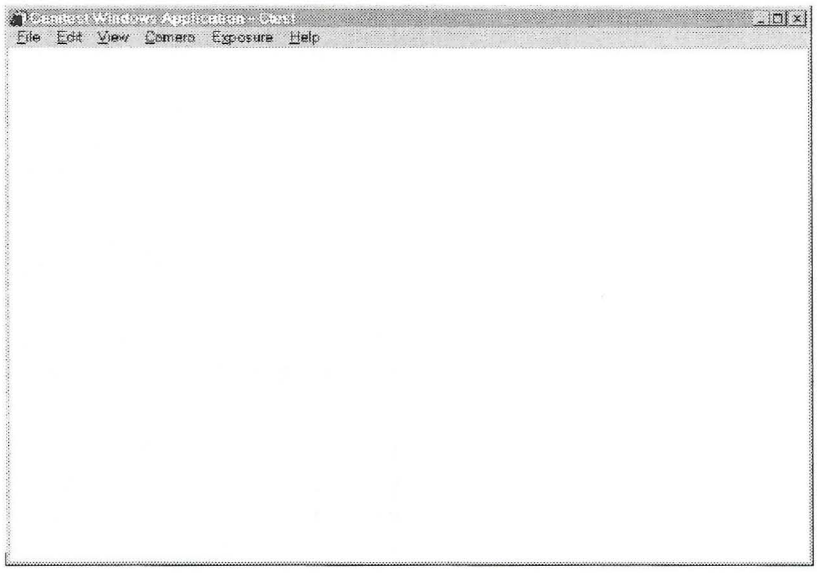
CAMTEST is a simple image acquisition program for taking test images. Since you cannot save images or process data using CAMTEST, it is not intended to be your primary imaging software.

This chapter describes how to open the CAMTEST program, focus your camera, and take a test exposure. It also explains other options that you can use within the CAMTEST program.

Opening CAMTEST

To open CAMTEST:

1. Click on the Windows 95 Start button. Place the cursor on Programs, then on Windows Explorer and click.
2. Double-click on Program Files (or whatever you chose to name the directory to which the Photometrics HCK software was installed).
3. Double-click on the Photometrics folder (or whatever you chose to name the program folder where the program icons were placed).
4. Double-click on CAMTEST. The CAMTEST Windows Application program window opens.



Note: While CAMTEST is running, all screens will appear in gray scale.

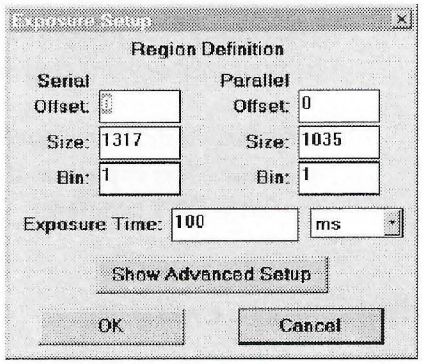
If the CAMTEST program does not open, see *Chapter 7. Troubleshooting*.

Focusing the Camera

Use a focus loop (series of repetitive exposures) to focus the camera. If you set a small array, the images will update quickly and make focusing easier.

To set a small array up and start a focus loop:

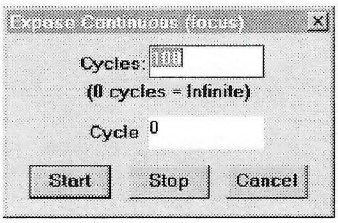
1. Click on Exposure in the menu bar and scroll to Setup. The Exposure Setup window appears.



2. To set a small array, enter the following setup values:
   - Offset: 0 (Serial and Parallel regions)
   - Size: 256 (Serial and Parallel regions)
   - Bin: 1 (Serial and Parallel regions)
   - Exposure time: 100 milliseconds

   Click OK.

3. Click on Exposure in the menu bar and scroll to Continuous. The Expose Continuous (focus) window appears.



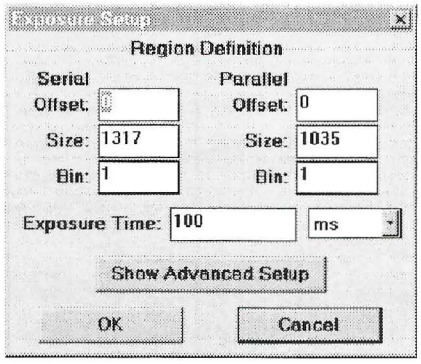
4. In the Cycles text box enter the number of exposures you want in the loop. Setting the Cycles value to 0 will cause the camera to cycle infinitely.
5. Click on Start. The camera begins taking exposures at regular intervals. The Cycle window indicates the number of cycles that have occurred in the current focus loop. (For a faster focus, make sure the auto contrast in the View>Setup window is off, see page 26.)

   To stop the loop before the predetermined number of cycles has been reached, click on Stop. Click on Cancel to exit the Expose Continuous (focus) window.

Taking a Test Exposure

To take a test exposure:

1. With CAMTEST open, click on Exposure and select Setup. The Exposure Setup window appears.



2. If you want to accept the default values, click OK. If you want a faster readout, enter a smaller array by entering the following values then click OK.
   - Offset: 0(Serial and Parallel regions)
   - Size: 256(Serial and Parallel regions)
   - Bin: 1(Serial and Parallel regions)
   - Exposure time: 100 milliseconds

   For more information about setting exposure parameters, see *Exposure>Setup* on page 32.
3. Click on Exposure and select Single. The camera records an image. In a moment the image appears on your screen. If an image does not appear, refer to *Image Does Not Appear After an Exposure is Taken* on page 43.

Using Other CAMTEST Options

The CAMTEST program offers several options to help you get the image you want. The sections that follow give instructions on how to use each option.

Menu Bar

The CAMTEST menu bar in the CAMTEST Windows Application program window provides six menu options. Options displayed in black are active. Options displayed in gray are either inactive in the current function or not implemented in CAMTEST.

- **File** – New (Ctrl N) and Exit. (Open, Close, Save, Save As, Page Setup, and Print are not available.)
- **Edit** – this menu option is not available.
- **View** – View Setup.
- **Camera** – Open, Specifications, Setup, Status, and CCS State.
- **Exposure** – Single (Ctrl E), Continuous (Ctrl F), and Setup (Ctrl G).
- **Help** – About CAMTEST.

File>New Use File>New to get a new image from the camera. This option and the Single option on the Exposure menu perform the same function.

To access File>New:

- Click on File in the menu bar and select New. A new image appears.

File>Exit Use File> Exit to leave the CAMTEST program.

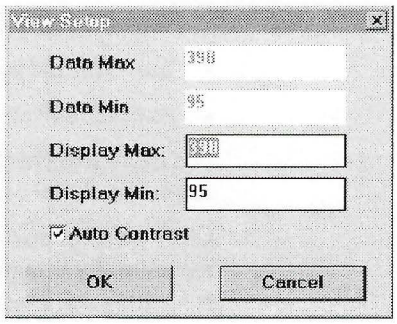
To quit CAMTEST:

- Click on File in the menu bar and scroll to Quit.

View>Setup The View Setup window displays the minimum and maximum digital pixel intensity values for the last image acquired and displayed on the computer monitor.

To access the View Setup window:

- Click on View in the menu bar and scroll to Setup. The View Setup window appears.



The View Setup window components are:

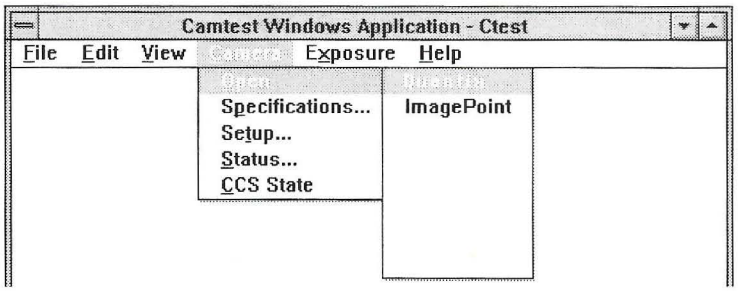
- **Data Max:** Displays the maximum intensity of any pixel in the last image acquired.
- **Data Min:** Displays the minimum intensity of any pixel in the last image acquired.
- **Display Max:** Any image pixel with an intensity at Display Max or higher is drawn as white. This is known as contrast mapping. When Auto Contrast is turned off, this value can be entered manually. (If Display Max is set at less than Display Min, the displayed image appears in reverse video, like a photographic negative.)
- **Display Min:** Any image pixel with an intensity at Display Min or less is drawn as black. This is known as contrast mapping. When Auto Contrast is turned off, this value can be entered manually.
- **Auto Contrast:** Sets the Display Min and Max to the Data Min/Max values (gray levels) after each image is acquired. If Auto Contrast is on during a focus loop, the program does this calculation for every exposure in the loop. You can compensate for hot (very bright) pixels or speed up focus by directly entering values in the Display Max/Min text boxes and turning off Auto Contrast.

Camera>Open

If you have multiple cameras connected to your PC, the Camera> Open function allows you to select which camera to operate.

To open a camera:

- Click on Camera in the menu bar and scroll to Open. Then scroll in the submenu and highlight the name of the camera you wish to open. If you do not select a camera, CAMTEST will automatically highlight the first camera that will open. Click once on the highlighted camera name. CAMTEST switches to the selected camera.



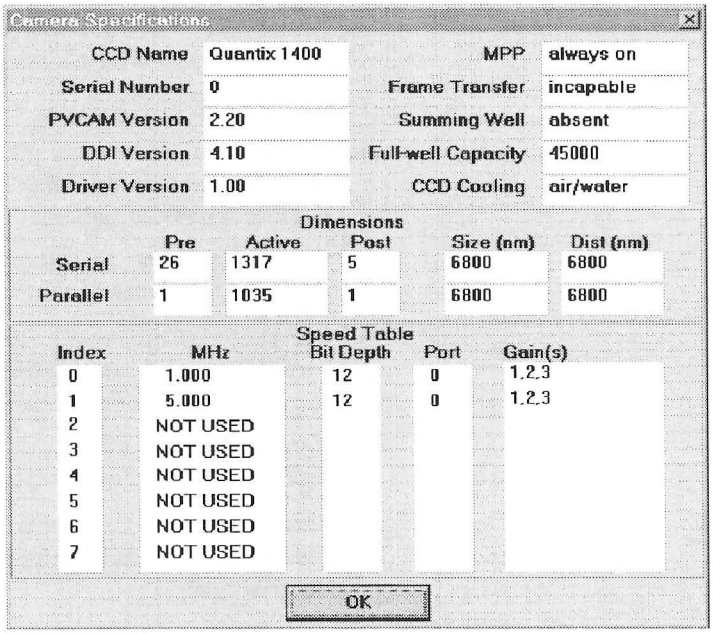
Note: Attempting to open an open camera causes an error message. If no camera opens, make sure that the hardware and software has been set up correctly for that camera. If a problem persists, call Photometrics Customer Service.

Camera>Specifications

The Camera Specifications window is a view-only window. You cannot set parameters in this window.

To access the Camera Specifications window:

- Click on Camera in the menu bar and scroll to Specifications. The Camera Specifications window appears. The values shown will vary with each camera system.



There are three sections on the Camera Specifications window: Camera Specifications, Dimensions, and Speed Table.

- **Camera Specifications**
  - **CCD Name:** Name of camera and type of CCD used in the camera.
  - **Serial Number:** Camera serial number (this field is not implemented).
  - **PVCAM Version:** Version number of PVCAM software.
  - **DDI Version:** Version number of the Device Driver Interface. This version number is used to determine the appropriate driver version.
  - **Driver Version:** Version number of the currently installed device driver. (This may differ for each camera.)
  - **MPP:** Whether the CCD runs in MPP (Multi-Pinned Phase) mode. always on means the CCD always runs in MPP mode. always off means the CCD does not run in MPP mode. selectable means you can select MPP on or off in the Exposure Advanced Setup window. If the error condition unknown appears, call Photometrics Customer Service.
  - **Frame Transfer:** Whether the camera runs in frame transfer mode. capable means that the camera can run in frame transfer mode. incapable means the camera cannot run in frame transfer mode.
  - **Summing Well:** Displays absent or present to indicate whether the CCD contains a summing well.
  - **Full-well Capacity:** Indicates the typical full-well capacity of the CCD, measured in electrons.
  - **CCD Cooling:** Type of cooling system used by your camera. Air cooled and LCU cooled will register as air/water.
- **Dimensions**
  - **Serial Pre:** Number of pixels discarded from the serial register prior to the first real data pixel in that row.
  - **Serial Active:** Serial size of the CCD, in usable pixels.
  - **Serial Post:** Number of pixels discarded from the serial register after the last real data pixel. These pixels must be read or discarded to clear the serial register.
  - **Serial Size (nm):** Length of a single pixel's active area, in the serial direction, measured in nanometers.
  - **Serial Dist (nm):** Center-to-center distance between pixels, in the serial direction, measured in nanometers. If there are no dead areas, the serial distance is identical to the pixel serial size.
  - **Parallel Pre:** Number of pixel rows discarded from the parallel register prior to the first usable row of pixels.
  - **Parallel Active:** Parallel size of the CCD, in usable pixels. The full size of the parallel register is actually parallel size + parallel pre + parallel post.

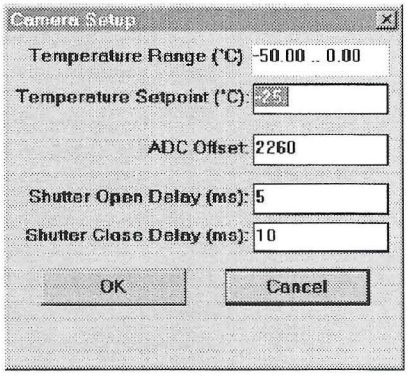
- **Parallel Post:** Number of pixels discarded from the parallel register after the last usable row of pixels. These pixels must be read or discarded to clear the parallel register.
- **Parallel Size (nm):** Length of a single pixel's active area, in the parallel direction, measured in nanometers.
- **Parallel Dist (nm):** Center-to-center distance between pixels, in the parallel direction, measured in nanometers. If there are no dead areas, parallel distance is identical to pixel parallel size.

- **Speed Table**
  - **Index:** There are two speed choices available. Select the Speed Index in the Exposure Advanced Setup window.
  - **MHz:** ADC conversion rate for one pixel (not equal to readout rate because does not include shift times).
  - **Bit Depth:** Number of bits per pixel that will be output by the selected speed choice.
  - **Port:** Output port number for selected speed.
  - **Gain(s):** Available gain settings for each speed. Set the gain in the Exposure Advanced Setup window.

Camera>Setup The Camera Setup window shows the camera temperature range and allows you to configure the ADC Offset, Shutter Open Delay and Shutter Close Delay.

To access the Camera Setup window:

- Click on Camera in the menu bar and scroll to Setup.
  The Camera Setup window appears.



The components of the Camera Setup window are:

- **Temperature Range (°C):** Allowable range for entering desired temperature setpoints in degrees Celsius. Ambient conditions may determine if the system can reach the desired temperature.
- **Temperature Setpoint (°C):** Sets the desired temperature for your CCD in degrees Celsius. (Always monitor the temperature readout in order to assure that the ambient conditions do not prevent a stable temperature at the setpoint you have chosen.)
- **ADC Offset:** Allows you to manually change the analog-to-digital converter bias level. Default level is recommended.

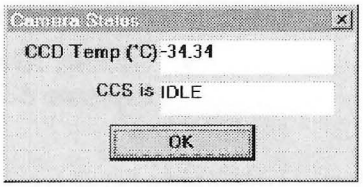
- **Shutter Open Delay (ms):** Number of milliseconds required for the shutter to open. Change the value in this box only if you are installing a new shutter that has characteristics that differ from the standard shutter. Allowable values are 0 to 65535 milliseconds.
- **Shutter Close Delay (ms):** The number of milliseconds required for the shutter to close. Change the value in this box only if you are installing a new shutter that has characteristics that differ from the standard shutter. Allowable values are 0 to 65535 milliseconds.

Camera>Status

The Camera Status window displays the CCD temperature and the CCS (Camera Control System) status. The CCS controls the CCD timing and readout. If you leave this window open, it updates approximately every five seconds.

To access the Camera Status window:

- Click on Camera in the menu bar and scroll to Status. The Camera Status window appears.

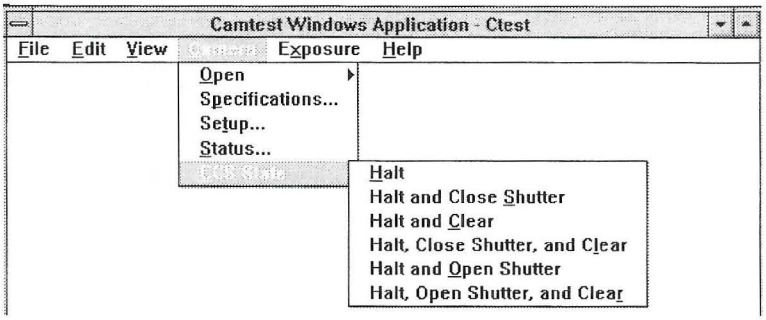


The components of the Camera Status window are:

- **CCD Temp (°C):** Indicates the current temperature of the CCD in degrees Celsius. For example, a temperature of -20°C would read -20.00. Note that this field returns the actual measured temperature, not the desired CCD temperature (which you can set in the Camera Setup window.) The temperature in this window may vary up to two degrees from the temperature display on the Quantix camera.
- **CCS is:** This field normally displays IDLE or CONT. CLEARING. Clearing is set in Camera>CCS State or Exposure>Advanced Setup. Most activity, other than idle or clearing, starts and finishes before the 5-second update, and therefore will not appear. If this field displays RUNNING or INITIALIZING for an extended period of time (more than a few seconds), and you are not running a long exposure or a sequence, cycle the camera off and on. If the problem persists, call Photometrics Customer Service.

Camera>CCS State The CCS State function allows you to place the camera into one of six states of operation. To use the CCS State function:

- Click on Camera in the menu bar. Scroll to CCS state, then to the option menu and down to the state you want to implement.



- **Halt:** Halts any camera operation in progress.
- **Halt and Close Shutter:** Halts any camera operation in progress and then closes the shutter.
- **Halt and Clear:** Halts any camera operation in progress and then initiates continuous clearing.
- **Halt, Close Shutter, and Clear:** Halts camera operation in progress, closes the shutter, then initiates continuous clearing.
- **Halt and Open Shutter:** Halts camera operation in progress and then opens the shutter.
- **Halt, Open Shutter, and Clear:** Halts camera operation in progress, opens the shutter, then initiates continuous clearing.

Exposure>Single The Exposure> Single function, the same function as File>New, takes a sample exposure using the parameters you set in the CAMTEST windows.

Note: All parameters revert to default settings when you restart CAMTEST.

To use the Exposure>Single function:

- Click on Exposure in the menu bar and scroll to Single.

  CAMTEST takes a sample exposure using the currently configured parameters and displays the image.

  If no image appears:

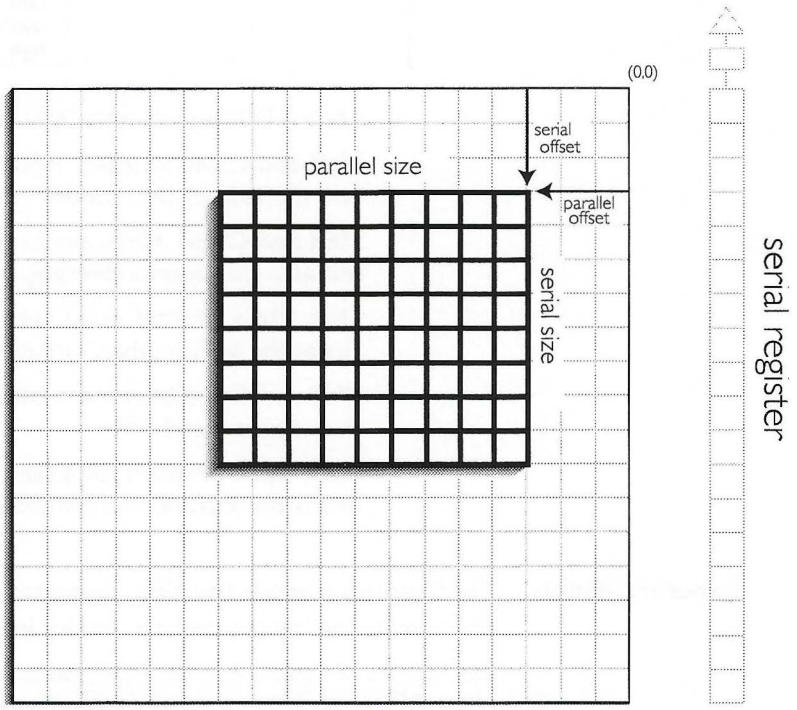
  - check the parameters in the Camera Setup window
  - see *Image Does Not Appear After an Exposure is Taken* on page 43
  - call Photometrics Customer Service.

Exposure>Continuous The Exposure>Continuous function lets you decide the best focus for your camera. For focusing instructions, see *Focusing the Camera* on page 24.

Exposure>Setup Use the Exposure Setup window to define the binning factors, the exposure time, and the region of the CCD used for an exposure.

A region is a rectangular group of pixels on the CCD. The region is defined by a serial offset, a serial size, a parallel offset and a parallel size. In the sample region in the diagram that follows:

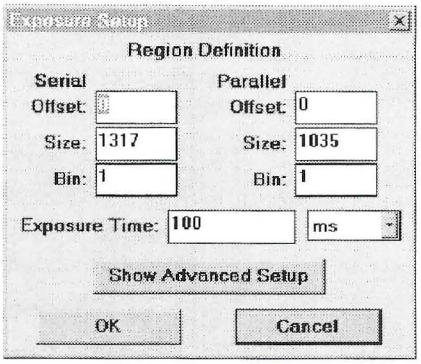
- The serial offset is 3 pixels.
- The serial size is 8 pixels.
- The parallel offset is 3 pixels.
- The parallel size is 9 pixels.



Serial and parallel binning combine charges from adjacent pixels during a readout. Binning is used to improve signal-to-noise ratio or to work at faster frame rates, but it decreases the lateral resolution of the image. Choosing a binning factor of 1 in both directions causes the CCD to read out the value in each pixel to assemble an image. Choosing 2 in both directions causes the CCD to read the combined value of four pixels at a time to assemble an image. A binning factor of 2 cuts the lateral resolution in half, but quadruples the signal-to-noise ratio.

To set up an exposure:

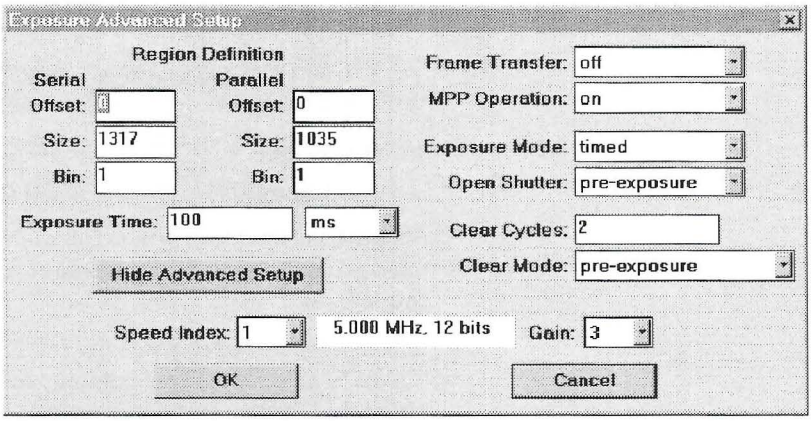
1. Click on Exposure in the menu bar and scroll to Setup. The Exposure Setup window appears.



2. Enter the coordinates that define the region offsets and sizes.
3. Enter the serial and parallel binning values.
4. In the Exposure Time text box, enter the time for the exposure in milliseconds, seconds, or minutes. To set ms, sec, or min:sec, click on the arrow to the right of the text box.
5. When you are done setting parameters, click OK.

Show Advanced Setup Use Show Advanced Setup to access additional setup options:

1. Click on Exposure>Setup.
2. Click on the Show Advanced Setup button. The Exposure Advanced Setup window appears.



The Exposure Advanced Setup window has the following options:

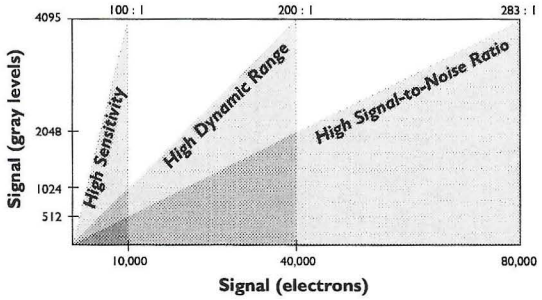
- **Region:** These are the same parameters that you can set in the Exposure Setup window (Serial and Parallel Offsets, Serial and Parallel Sizes, Serial and Parallel Bins, and Exposure Time). For a detailed explanation of these parameters, see *Exposure>Setup* on page 32.
- **Exposure Time:** These are the same parameters that are set in the Exposure Setup window. For a detailed explanation of these parameters, see *Exposure>Setup* on page 32.

- **Frame:** Turns frame transfer off or on. If your CCD is not frame-transfer capable, on will not be available.
- **MPP:** Turns MPP off or on, depending on the MPP capabilities of the CCD in your camera. Only the appropriate option for your camera will be available.
- **Exposure:** Indicates the mode of exposure. Note that CAMTEST only allows a sequence of one exposure. There are six modes available:
  - **timed** – The exposure uses the internal millisecond timer to control the exposure duration.
  - **strobed** – An external trigger signals the start of an exposure. The exposure duration is controlled by the internal millisecond timer.
  - **bulb** – The trigger controls the start and duration of the exposure.
  - **trigger first** – The trigger controls the beginning of a sequence. Since the CAMTEST program only allows a sequence of one picture, this function is nearly identical to strobed mode. However, internal timing differences (when the CCD is cleared) make this useful for testing some features.
  - **flash** – Selecting this option allows the user to operate flash units or other hardware through the Input/Output connector.
  - **variable timed** – Not implemented in CAMTEST.
- **Open Shutter:** Determines when the shutter opens. Note that CAMTEST only allows a sequence of one exposure. The five modes available in the option menu are:
  - **never** – Ensures that the shutter is closed before any exposure or sequence. This option is used for dark exposures.
  - **pre-exposure** – The shutter opens before each exposure and closes after the exposure is complete.
  - **pre-sequence** – The shutter opens before each sequence. This mode is useful for frame transfer devices.
  - **pre-trigger** – The shutter opens before a user-defined trigger arrives.
  - **no change** – The shutter is left in the current state (open or closed).
- **Clear Cycles:** Determines the number of times the CCD is completely cleared before an exposure starts. The default value is sufficient for most uses.
- **Clear Mode:** Determines the mode in which the CCD clears. Note that CAMTEST only allows a sequence of one exposure. The six modes available in the option menu are:
  - **never** – The CCD doesn't clear before or after exposures or sequences. This is useful when doing a readout after an exposure has been aborted.
  - **pre-exposure** – Clears the CCD before any exposures are started but does not clear after the exposure. This is standard mode.
  - **pre-sequence** – Clears the CCD before a sequence starts, but not after a sequence ends. For the purposes of CAMTEST, this mode is identical to pre-exposure except for subtle timing differences. For example, in the trigger first exposure mode, the CCD clears while waiting for a trigger rather than clearing after the trigger arrives.

- **post-sequence** – Clears the CCD after a sequence ends, but not before a sequence starts. This is useful when doing a readout after a sequence has been aborted.
- **pre-, post-sequence** – Clears the CCD before a sequence starts and after a sequence ends. Leaves the CCD in continuous clear mode after the sequence ends.
- **pre-exp-, post-seq** – Clears the CCD immediately before each exposure, as well as before and after the entire sequence. Leaves CCD in continuous clear mode when sequence ends.

- **Speed Index:** Determines the current speed of your camera according to the index number you select. The speed, in megaHertz, and the number of bits associated with that number, appear to the right of the speed button. Quantix cameras have two available speeds. If you select an unavailable speed, the program will revert to the original setting.
- **Gain:** Determines the gain for the currently selected speed. Acceptable gains for the selected speed are displayed in black.

Detection Modes (Gain)
of a KAF 1400 CCD



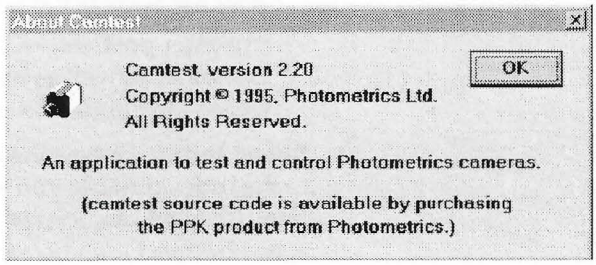
- **Gain 1 — High Signal-to-Noise Mode** — when binning, this mode takes advantage of the output node's maximum full-well capacity, a requirement when measuring small changes on bright backgrounds. In this mode (1/2x), the full well of a normal pixel maps to 1/2 of the maximum ADC count. For a KAF 1400, with a 2x2 bin, the maximum number of electrons is ≈80,000.
- **Gain 2 — High Dynamic Range Mode** — suitable for measuring bright and dim signals in a field of view. In this mode (1x), the full well of a normal pixel, maps to the maximum ADC count. For a KAF 1400, the maximum number of electrons is ≈40,000.
- **Gain 3 — High Sensitivity Mode** takes advantage of the CCD's low read noise, a requirement for low-light imaging. In this mode (4x), 1/4 full well of a normal pixel maps to the maximum ADC count. For a KAF 1400, the maximum number of electrons is ≈10,000.

Note: After you click OK in the Exposure Advanced Setup window, the speed index set in this window is sent to the camera, halting the CCS state and possibly aborting continuous operation of the camera (such as clearing or exposing). The shutter state will not be altered. To exit the Exposure Advanced Setup window without altering the CCS state, click Cancel.

Help>About CAMTEST About CAMTEST provides general information about CAMTEST.

To access the About CAMTEST window:

- Click on Help in the menu bar and scroll to About CAMTEST. The About CAMTEST window appears.



Chapter 6

Liquid Cooling Unit Maintenance

LCU Precautions

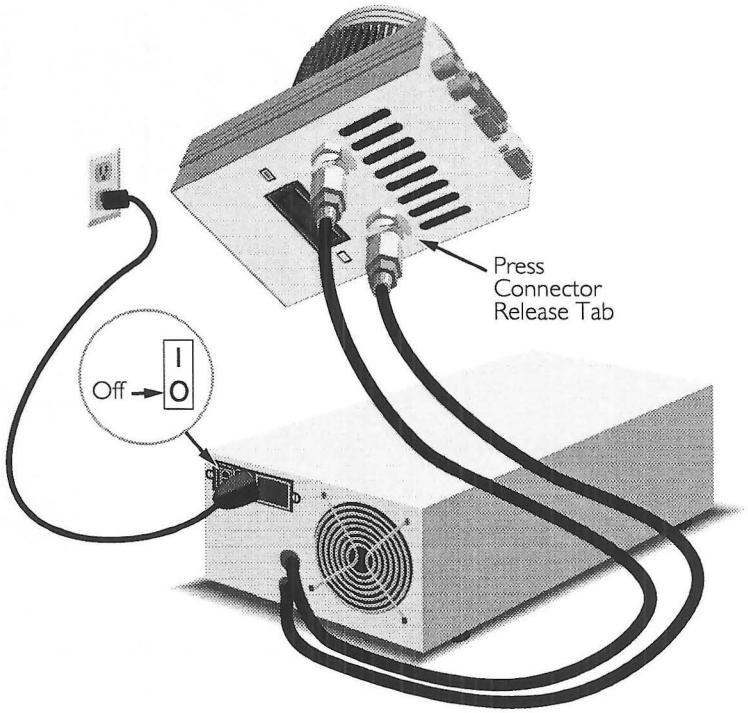
To prevent damage to the LCU please observe the following precautions:

- Keep seals lubricated by running the LCU for 45 minutes at least once a month.
- Always keep the pump primed by operating the LCU in upright position.
- When disconnecting the coolant hoses from the camera, it is important to prevent any coolant from spilling into the camera. When disconnecting the hoses, hold the camera over an absorbent material, such as paper towels, with the connectors facing down.

Disconnecting the Coolant Connectors

Caution: When disconnecting the coolant hoses, excess coolant will spill from the hoses and connectors. It is important to keep any coolant from spilling into the camera.

1. Turn off LCU power.
2. To keep excess coolant from spilling into the camera, position the camera over absorbent material with the coolant connectors facing down.
3. Press connector release tabs and disconnect hoses from camera.



Refilling the Reservoir

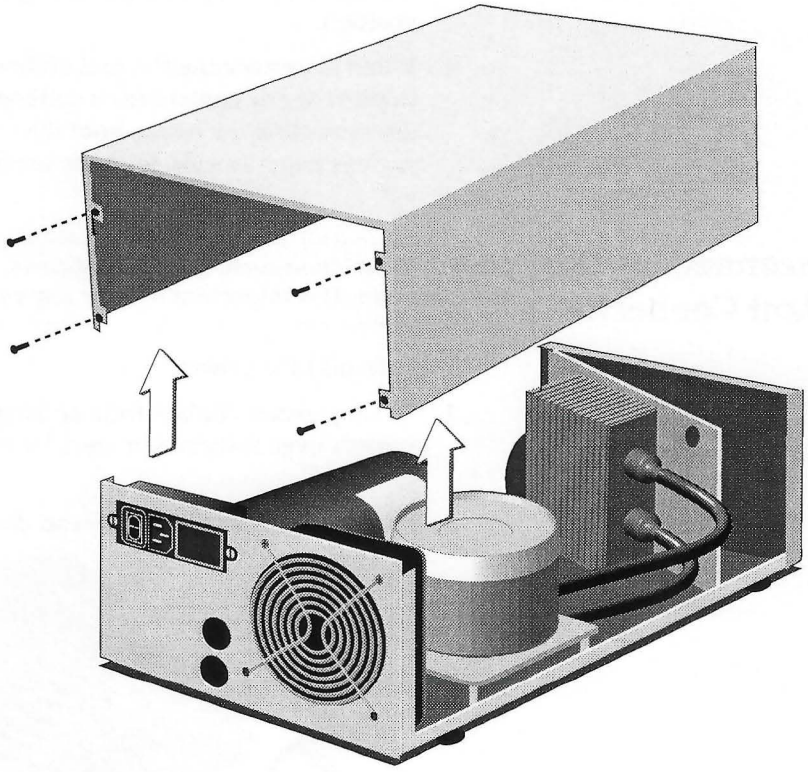
Check the reservoir every three months to see if coolant needs to be added to the system. Add coolant if the reservoir is less than three-quarters full.

- Required coolant mixture: 50% ethylene glycol (antifreeze) and 50% distilled water.
- Liquid coolant capacity: 27 fluid ounces (800 cc)

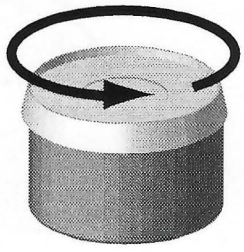
Caution: Do not allow the reservoir to drain below half full.

To refill the LCU:

1. Turn off the LCU power, and disconnect the power cord.
2. Remove the four screws on the back panel of the LCU. Remove cover.



3. Remove the cap from the coolant reservoir.



4. Fill the reservoir to approximately 1/4" from the top with a mixture of 50% distilled water and 50% ethylene glycol (antifreeze).
5. Replace the reservoir cap, LCU cover, and screws.
6. Reconnect the power cord.

Attaching the Coolant Connectors

See *Connecting the Optional Liquid Cooling Unit* on page 6.

Changing Line Entry Module Fuses and Voltages

The voltage selector card and fuse configuration on the AC line entry module is set to the correct voltage for your country. If your voltage needs to be changed, you will need to change the voltage selector card, and you may need to change the fuse configuration. To change voltage and fuse configuration see *Changing LCU Line Entry Module Fuses and Voltages* on page 47.

Chapter 7. Troubleshooting

This chapter contains camera system troubleshooting as well as some upgrade and repair procedures. Error messages are listed in *Appendix. Error Messages*.

If you have any questions or if you cannot match the symptoms of your camera with the following information, call Customer Service.

Caution: Connecting or removing a live power cable to or from the camera can damage the camera's electronic components. Do not attach or remove any cables while the power supply is turned on.

Symptom	See Page #
Green light on camera does not illuminate	page 42
Warning message appears when installing CAMTEST	page 42
CAMTEST does not open	page 42
Image does not appear after an exposure is taken	page 43
Camera does not respond to light	page 43
Camera does not focus	page 43
LCU not cooling	page 43
New Hardware Found dialog box does not appear	page 43
Lengthy pauses during imaging	page 43
System does not boot normally	page 44

Procedure	See Page #
Testing shutter signal	page 44
Replacing camera shutter	page 45
Changing LCU line entry module fuses and voltages	page 47

Symptoms

In this section the symptoms are followed by diagnostic and repair procedures. If you have any questions about how the procedures apply to your camera, call Customer Service.

Green Light on Camera Does Not Illuminate

Allow approximately 15 minutes for the camera to reach operating temperature (green light on). If the green light does not illuminate:

- Make sure the air vents are not blocked. For proper installation procedures see *Connecting to Other Equipment* on page 7.
- If you have an optional Liquid Cooling Unit, see *LCU Not Cooling* on page 43.
- You may have set a temperature setpoint that is too low for your environment. For operating temperature specifications see *Specifications* on page 57. Set the temperature to a "warmer" setpoint.
- There may be a problem with the camera's cooling system. Contact Photometrics Customer Service.

Warning Message Appears When Installing CAMTEST

If you receive a warning message while installing CAMTEST, power down the camera, check the cables, power up, see *Installing HCK Software* on page 11 to check that the proper HCK software is installed. If a warning message continues to appear, call Photometrics Customer Service.

CAMTEST Does Not Open

If CAMTEST does not open:

1. Check that the camera has power and is fully operational by ensuring that both the red and green lights on the camera body are illuminated.

   If neither light is illuminated:

   - Make sure that the power supply is plugged into an electrical outlet and turned on. If not, turn on power supply, restart, and wait for both camera lights to illuminate.
   - *With the power supply turned off,* make sure that the power supply cable is firmly connected to the camera. If not, connect the cable, restart, and wait for both camera lights to illuminate.

2. Check that the AIA cable is the cable that was shipped with your camera. Using a different AIA cable can result in a system malfunction. If necessary, *with the power supply turned off,* replace the cable.

3. *With the power supply turned off,* check that the cables are firmly seated in the connector plugs. If not, connect or reseat the cables.

If you still cannot open CAMTEST, contact Photometrics Customer Service.

Image Does Not Appear After an Exposure is Taken

If an image does not appear when you take an exposure:

- Make sure that Windows 95 is set for 256 colors.
- Check that the AIA cable is securely attached at both ends.
- Check that the pins in the cable connectors are not bent. Carefully straighten bent pins with tweezers and try taking the exposure again.
- There may be too much or too little light. Check for valid data map parameters through your imaging software. For CAMTEST, see *View>Setup* on page 26.

If the problem persists, contact Photometrics 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. See *Testing Shutter Signal* on page 44.

Camera Does Not Focus

For CAMTEST, see *Focusing the Camera* on page 24. For other imaging software see the focusing instructions in your imaging software documentation.

LCU Not Cooling

If after 15 minutes of operation, the green light on the camera does not illuminate (indicating the camera has reached operating temperature):

- Check to see if coolant is moving through the unit.
- If the coolant becomes clouded with many tiny bubbles, your coolant level may be low. Fill the coolant reservoir. See *Refilling the Reservoir* on page 38.
- Check the hose and power cord connections.
- Check the LCU line entry module fuse. For instructions on accessing and changing the fuse, see *Changing LCU Line Entry Module Fuses and Voltages* on page 47.
- If LCU still does not cool, call Customer Service.

New Hardware Found Dialog Box Does Not Appear

If the New Hardware Found dialog box does not appear after installing a new PCI card to your computer and boot Windows 95:

- Check to make sure that the new PCI card is inserted in a PCI slot according to your computer manufacturer's instructions.
- 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 Customer Service.) Then turn your computer back on and boot Windows 95 again.
- If the New Hardware Found dialog box still does not appear, call Customer Service.

Lengthy Pauses During Imaging

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

- Reduce or turn off virtual memory in Windows 95 (or install more physical memory in your computer system).

System Does Not Boot Normally

If your operating system does not boot normally after you've installed a PCI card:

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, call Customer Service.

Note: There are no user-adjustable hardware jumpers or settings on the PCI card.

Procedures

This section contains detailed instructions for several diagnostic and repair procedures. If you have any questions about how the procedures apply to your camera, call Customer Service.

Testing Shutter Signal

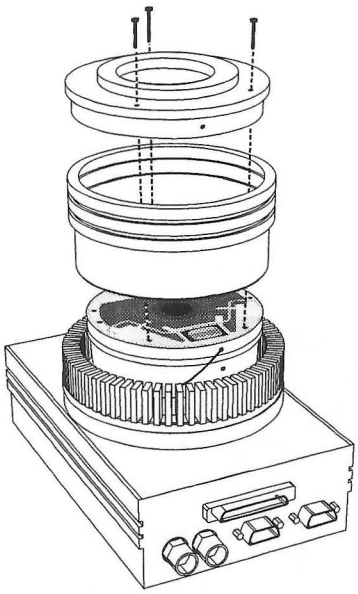
To test for a malfunctioning shutter:

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 Customer Service for further instructions.
   - If you hear 0, 1, or more than 2 clicks, check the voltage between I/O port pins 3 (exposing) and 9 (ground) while you are powering up the camera. (See *Input/Output Status Connector Pinout* on page 66.)

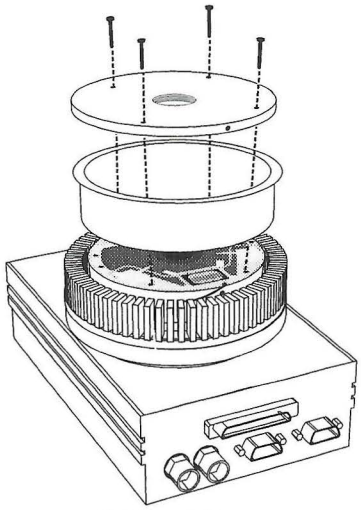
     If the TTL logic level goes from 0 (low) to 1 (high), stays high for 1 second then drops to 0, the shutter signal is working, but the mechanical shutter is not working. Follow the procedures in *Replacing Camera Shutter* on page 45.

   If the TTL logic levels do not indicate a working shutter signal, call Customer Service.

Replacing Camera Shutter

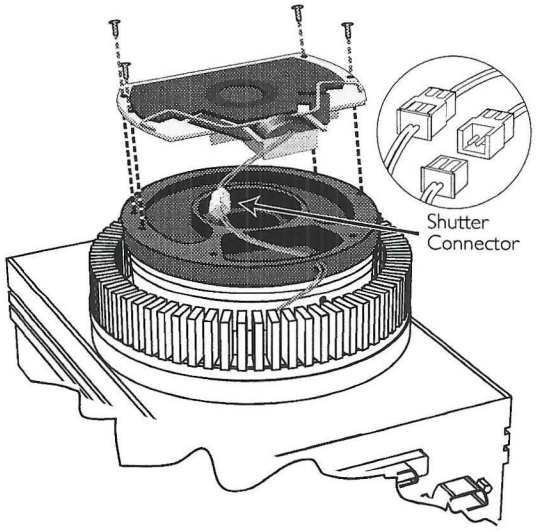


F-Mount Camera

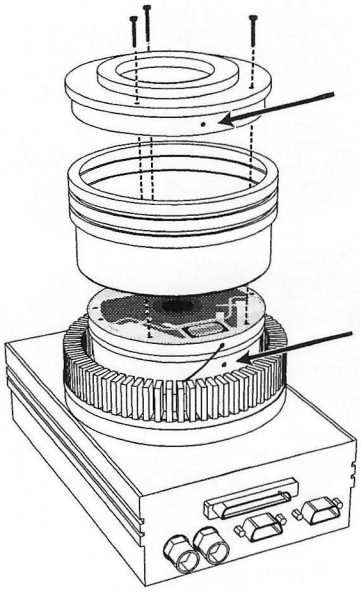


C-Mount Camera

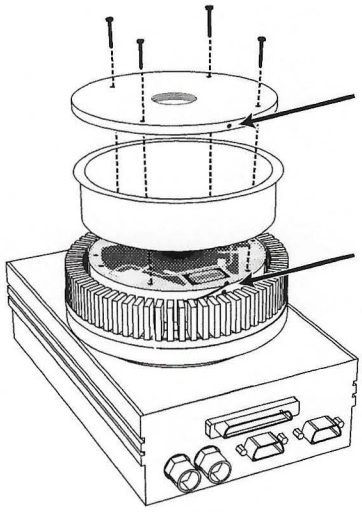
1. To access the shutter:
   - Remove the screws holding the mount adapter in place.
   - Remove the mount adapter and slide the canister from the camera.



2. To replace shutter:
   - Remove the screws holding the shutter in place.
   - Remove the shutter and disconnect the shutter connector.
   - Connect the new shutter connector.
   - Place the connector in the well below the shutter, making sure the connector does not interfere with shutter operation when the shutter is completely open.
   - Fasten down new shutter.



F-Mount Camera



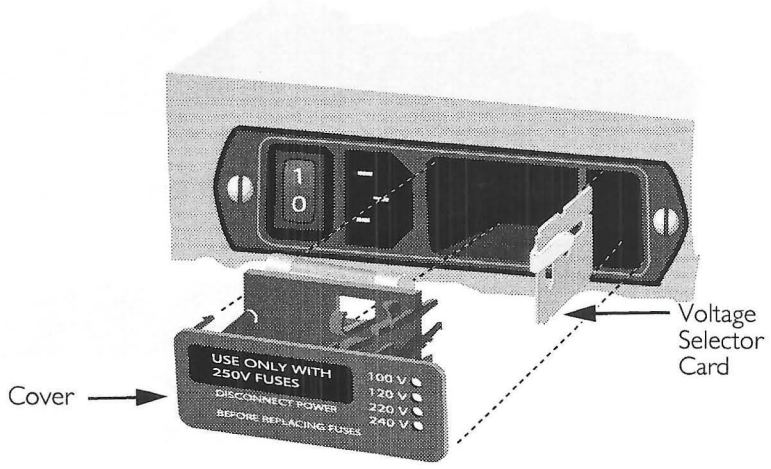
C-Mount Camera

3. To reassemble the camera:
   - Line up dots on camera and mount adapter.
   - Fasten mount adapter in place.

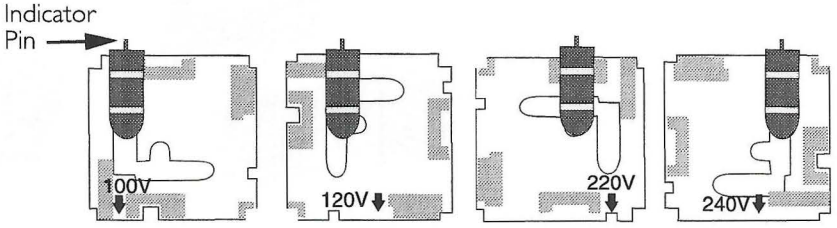
Changing LCU Line Entry Module Fuses and Voltages

The voltage selector card and fuse configuration on the AC line entry module is set to the correct voltage for your country. If your voltage source changes, you will need to change the voltage selector card, and you may need to change the fuse configuration.

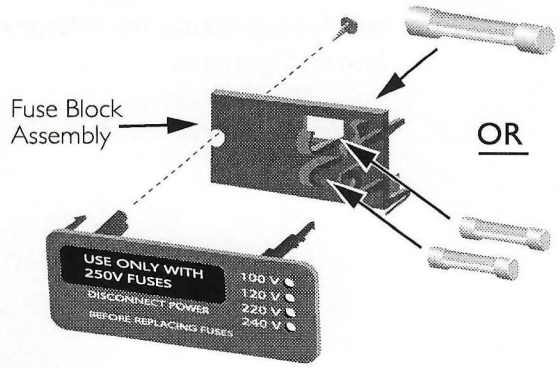
To change voltage and fuse configuration:



1. Remove cover by prying off with a tool such as a small blade screwdriver.
2. Using a tool such as a needle nose pliers, pull voltage selector card straight out.

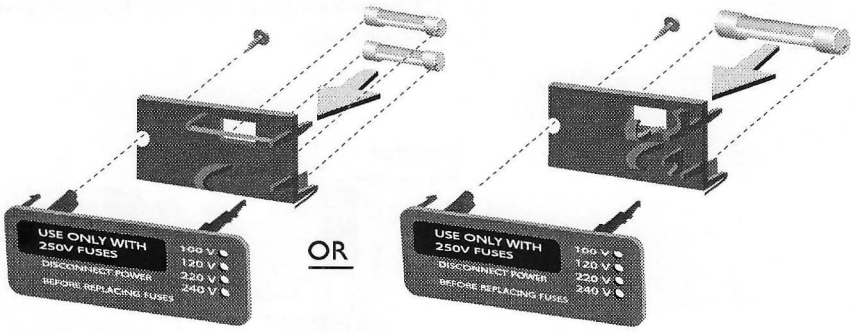


3. Position the indicator pin so it is pointing up while the arrow associated with the correct voltage points down.
4. With the indicator pin facing out and the printed side facing the power cord socket, replace the voltage selector card.



5. Remove screw and slide fuse block assembly from cover.
6. Insert one or two fuses:

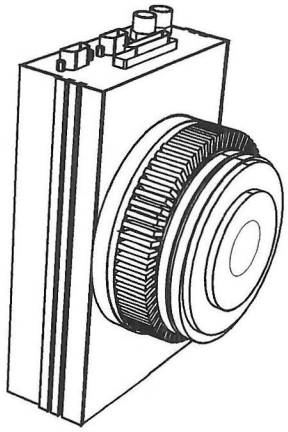
Volts	# of Fuses	Amperes
110-120V	1	2A
220-240V	2	1A



7. Making sure that the fuse or fuses being used are facing away from the back of the cover (that is, toward the inside of the unit), replace the fuse block assembly.
8. Replace the cover and verify that the indicator pin is showing through the cover and marking the desired voltage.

Chapter 8. Hardware Component Descriptions

The Quantix camera system consists of the F-mount or C-mount camera, power supply, interface hardware, and an optional liquid cooling unit.



Quantix C-mount Camera

Camera

The camera body houses the CCD cooling system and the camera electronics. The CCD is inside a vacuum-sealed chamber. 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.*

CCD

All CCDs are scientific grade. Scientific grades have fewer defects than commercial grades. They image with better resolution, have low noise so they can detect weak signals, and are linear over the dynamic range so you can accurately determine intensity differences between objects.

MPP

Many CCDs are multi-pinned phase (MPP). MPP CCDs have barriers implanted into a silicon layer. These barriers, combined with properly biased clock phases, allow the CCD to collect fewer dark current electrons per pixel per second. Lower dark current translates into lower noise during integration.

Metachrome® II

Metachrome II is a proprietary, optional, permanent CCD coating. This coating does not affect the spectral sensitivity in the visible and near infrared, but extends the CCD's sensitivity in the ultraviolet to below 200 nm and is transparent from 400 –1100 nm wavelength light. The coating requires no maintenance and does not degrade over time.

Certificate of Calibration

Each camera has a Certificate of Calibration. The CCD grade designated by the CCD manufacturer is stated on the certificate. (The manufacturer's grade is assigned before the CCD's performance is improved by cooling.) The certificate also provides the camera calibration information needed to effectively measure photon energy with repeatable, scientific accuracy. A copy of the information contained in the Calibration Certificate is kept on file at Photometrics Customer Service.

CCD Chamber

The vacuum-sealed CCD chamber protects the CCD from contamination as well as insulating it from the warmer air in the camera body. The low humidity also reduces the chance of condensation forming on the CCD when the temperature is lowered. If any gasses are trapped in the vacuum chamber, they are absorbed by a sieve located inside the chamber.

The vacuum also isolates the window from the cooled CCD. This thermal barrier keeps the window from cooling below the dew point,thereby preventing condensation on the window.

Window

The 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) windows are available. The IR window blocks optical radiation above 650 nm.

Thermoelectric Cooler

While the CCD accumulates charge, thermal activity releases electrons, generating dark current. Cooling the CCD helps enhance the low-light sensitivity by reducing the thermally generated charge.

Cooled CCD cameras produce less dark current than cameras operating at ambient temperature. When the ambient temperature is between 0°C and 30°C, the CCD in the Quantix camera is cooled to a minimum of -25°C for the air-cooled cameras and a minimum of -35°C for liquid cooled.

The CCD is cooled by a three-stage Peltier cooler, a thermoelectric cooler (TEC) that pulls heat away from the CCD and into a heat exchanger. The heat exchanger transfers the heat into the camera body, where it is removed by forced air. In certain situations, a separate liquid cooling unit removes additional heat from the heat exchanger.

Shutter The camera has a high-speed shutter. For shutter specifications see *Chapter 9. Specifications*.

The shutter is a mechanical component that has a limited life with heavy use. Instructions for testing and replacing the shutter are in *Chapter 7. Troubleshooting*.

Electronics The electronics control the CCD and convert the CCD's analog signal into a digital format acceptable to the system's interface converter or host computer.

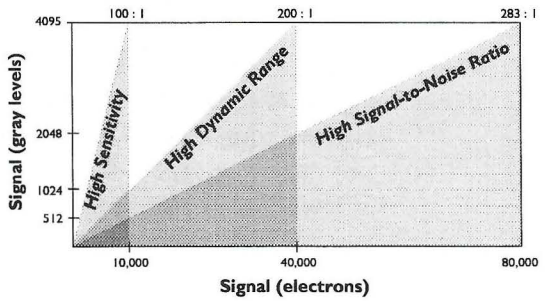
Which portion of the analog signal is translated into digital data is determined by several factors. One factor is the noise in the camera system. The system noise includes the thermal noise produced by the camera components and the read noise determined in part by how far the analog signal must travel.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

To reduce signal degradation, therefore reducing the noise, Quantix 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 thereby reducing 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 Quantix 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 the detection modes (gains) listed below.

Detection Modes (Gain) of a KAF 1400 CCD

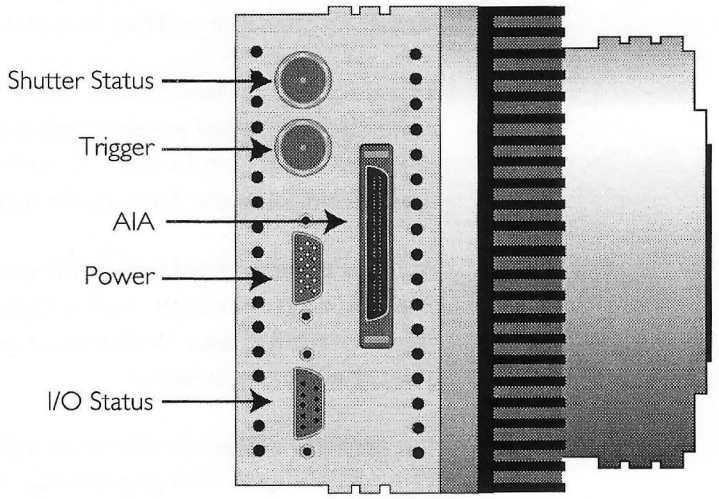


- **Gain 1 — High Signal-to-Noise Mode** — when binning, this mode takes advantage of the output node's maximum full-well capacity, a requirement when measuring small changes on bright backgrounds. In this mode (1/2x), the full well of a normal pixel maps to 1/2 of the maximum ADC count. For a KAF 1400, with a 2x2 bin, the maximum number of electrons is ≈80,000.

- **Gain 2 — High Dynamic Range Mode** — suitable for measuring bright and dim signals in a field of view. In this mode (1x), the full well of a normal pixel, maps to the maximum ADC count. For a KAF 1400, the maximum number of electrons is ≈40,000.
- **Gain 3 — High Sensitivity Mode** takes advantage of the CCD's low read noise, a requirement for low-light imaging. In this mode (4x), 1/4 full well of a normal pixel maps to the maximum ADC count. For a KAF 1400, the maximum number of electrons is ≈10,000.

Data transfers from the CCD to the ADC at the same rate it is transferred from the ADC to the interface. This rate is the ADC conversion rate. The Quantix has a 5 Mpixel/sec conversion rate.

Displays and Connectors



Shutter Status — Shutter Status is a BNC connector that gives access to an output signal that indicates if the shutter is open or in motion. For specifications on this connector see *Shutter Status Connector* on page 67.

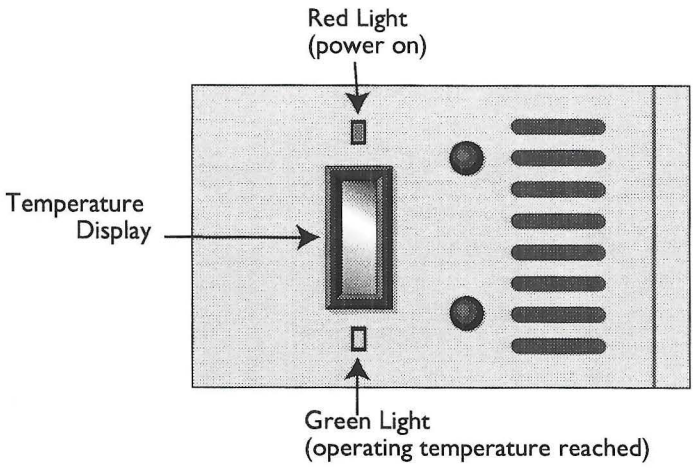
Trigger — Trigger is a BNC connector that gives access to an unfiltered, fast response trigger. A trigger input allows you to synchronize the camera trigger signal with external equipment. The signal provided into this input must be clean, or you may get false triggers. For information on a filtered trigger input, see I/O Status (below). For specifications on this connector see *Shutter Status Connector* on page 67.

AIA — Digital data is transmitted to the host computer through the AIA connector. The AIA connector is a 68-pin, high-density, I/O connector with a standard AIA format. The pinout for the parallel cable that mates to the AIA port connector is located in *AIA Connector Pinout* on page 69.

Power — The power connector is a 15-pin, female, D connector that connects the camera to the power supply. For power connector pinout specifications see *Power Connector Pinout* on page 68.

I/O Status — The Input/Output Status is a 9-pin connector that gives access to a filtered

trigger input, trigger input configuration, and camera status outputs. Pinout specifications are located in *Input/Output Status Connector Pinout* on page 66.



Status Lights

The camera has two status lights:

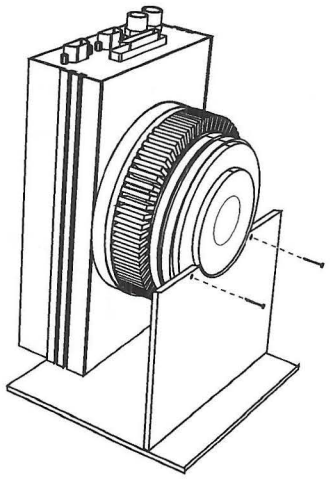
• Red light on	Power on
• Green light on	CCD reached operating temperature
• Red and green lights off	Camera exposing or exposing while waiting for trigger

Temperature Display

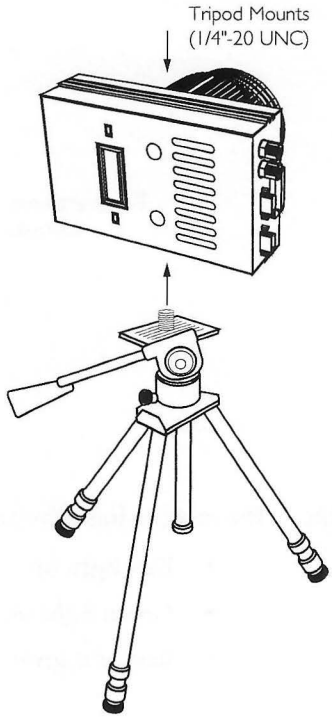
The temperature display shows the temperature of the CCD. This display may vary up to two degrees Celsius from the temperature displayed through your imaging software.

Quantix Stand Mounts

Photometrics offers an optional Quantix camera stand. Since the camera can be operated in any position, the camera can be attached to the stand with the connectors up or facing to either side. To install the camera stand, thread the two bolts into the camera frontplate.



Tripod Mounts The camera has two tripod camera stand mounting holes (1/4"-20UNC-2B / with a 1/4" depth). If you use a tripod camera stand, make sure the stand is large enough and stable enough to securely support the camera's weight.

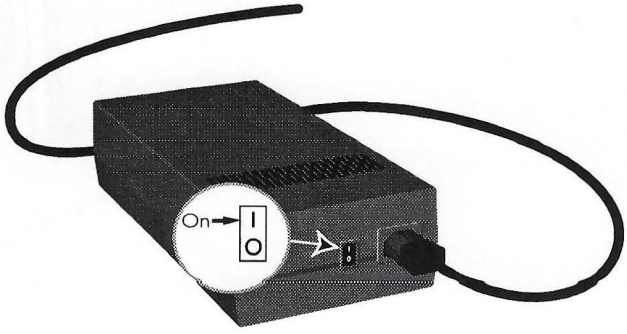


Lenses Photometrics sells lenses that are compatible with the Quantix F-mount and C-mount cameras. The F-mount camera is compatible with any lens that fits a standard Nikon bayonet mount. The C-mount camera is compatible with any lens that fits a standard threaded video mount.

A C-mount lens with a long back focal length may interfere with the shutter blades. Photometrics offers compatible C- and F-mount lenses. For specifications for calculating acceptable back focal lengths see *C-Mount Camera* on page 61.

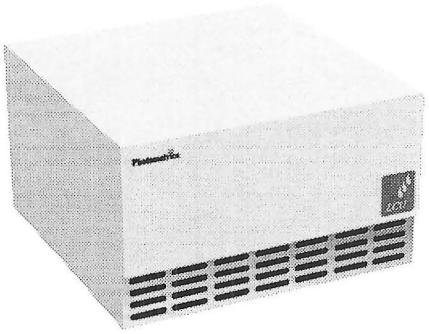
Power Supply

The power supply is a switched, multiple output voltage brick with a detachable power cord. For power supply specifications see *Power Supply* on page 64.



Liquid Cooling Unit

The LCU is an optional cooling unit that supplements the air cooling in the Quantix. The LCU cools the CCD by pumping a mixture of ethylene glycol and distilled water through the camera's heat exchanger. For LCU specifications see *Liquid Cooling Unit* on page 65.



Interface Hardware

The host interface hardware is a PCI card. A PCI-compatible computer accepts the standard AIA output from the ADC. For interface connector pinout specifications see *Connector Pinouts* on page 66.

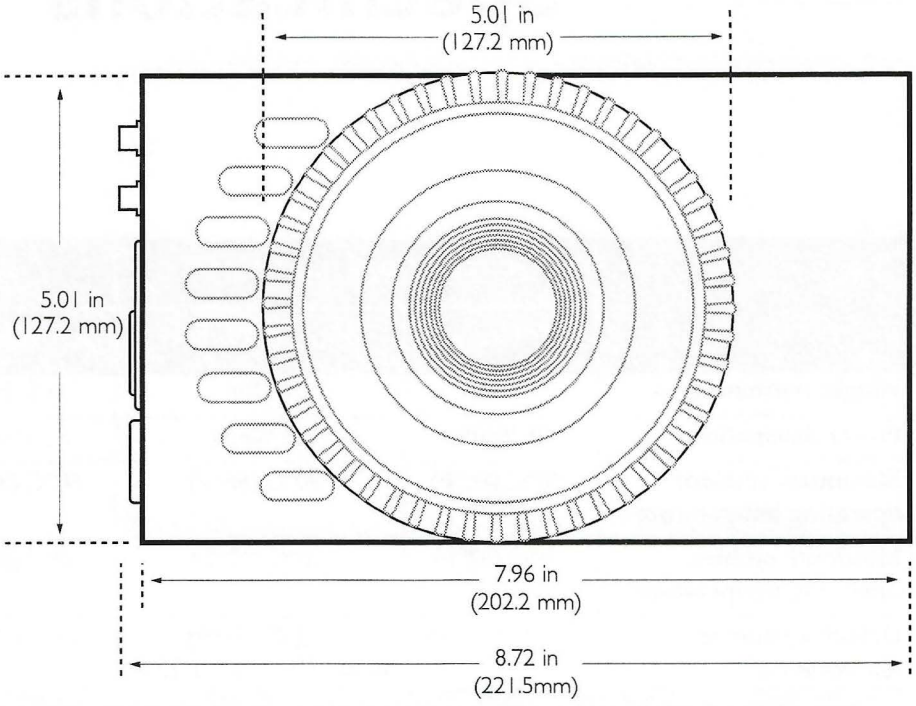
Chapter 9. Specifications

Specifications	F-Mount Camera		C-Mount Camera	
	Air Cooled	Liquid Cooled	Air Cooled	Liquid Cooled
Weight (without lens)	≈ 5 lbs	≈ 5 lbs	≈ 5 lbs	≈ 5 lbs
Power dissipation	85 Watts	85 Watts	85 Watts	85 Watts
Maximum ambient operating temperature*	30°C (86°F)	30°C (86°F)	30°C (86°F)	30°C (86°F)
Minimum ambient operating temperature*	0°C (32°F)	0°C (32°F)	0°C (32°F)	0°C (32°F)
Default operating temperature*	-25°C (-13°F)	-35C(-31°F) w/o LCU -30°C (-22°F)	-25°C (-13°F)	-35C(-31°F) w/o LCU -30°C (-22°F)

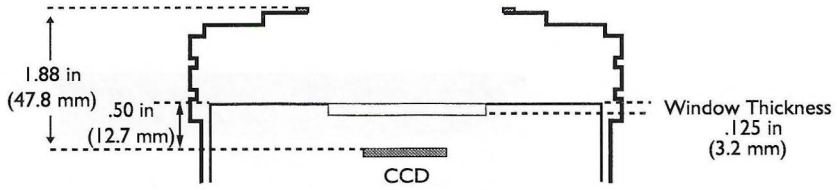
* Some ambient conditions, combined with an ambient temperature below 0°C or above 30°C, may result in the camera not stabilizing at the default operating temperature.

Shutter	
Type	Uniblitz
Open time	5 ms
Close time	10 ms
Minimum cycle time	15 frames per second while fully opening and closing

F-Mount Camera

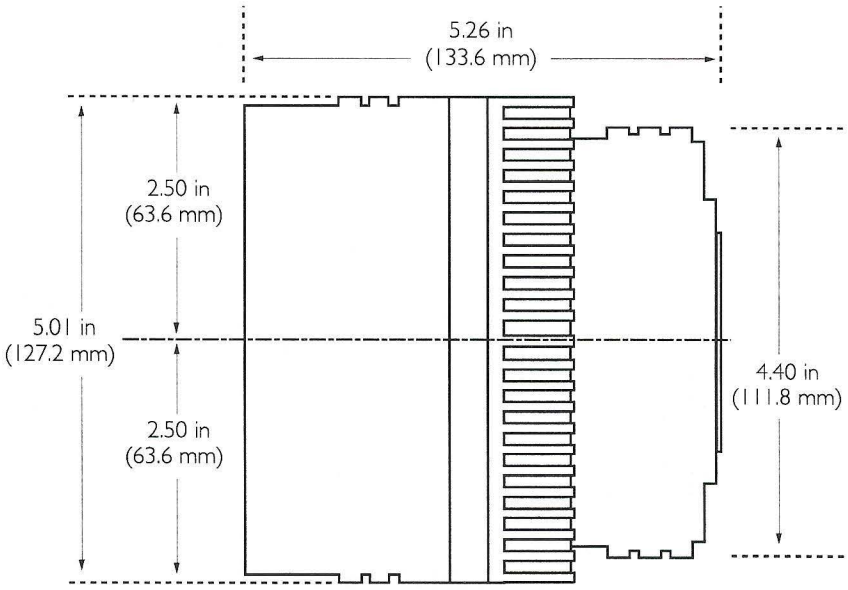


Front View — F-Mount Camera

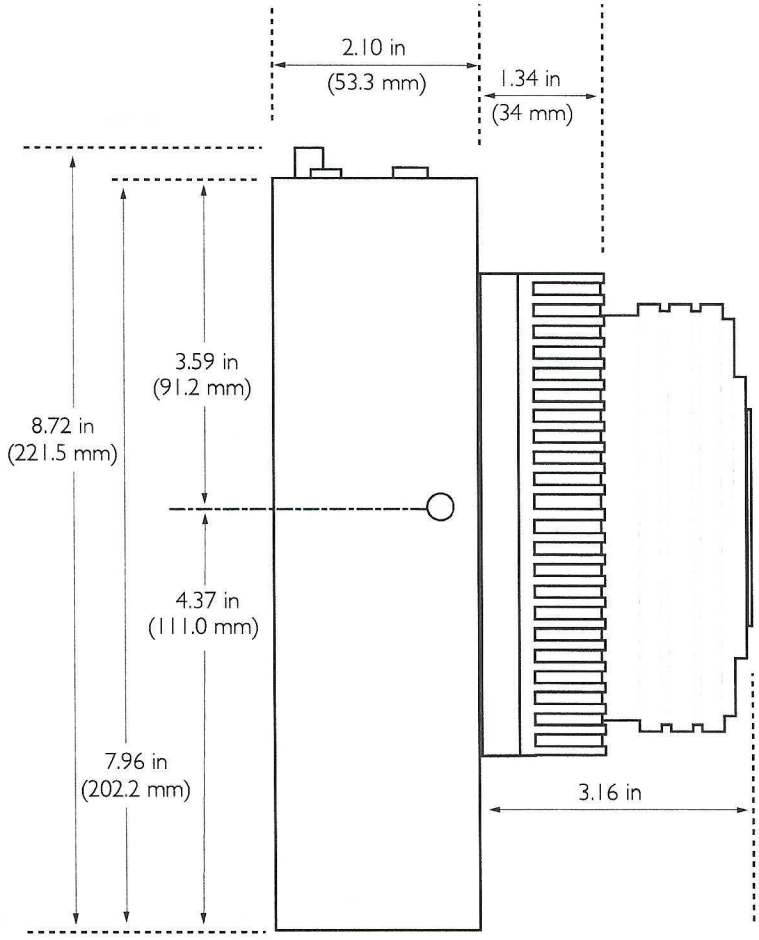


Cross Section Side View — F-Mount Camera

F-Mount Air Cooled
Camera

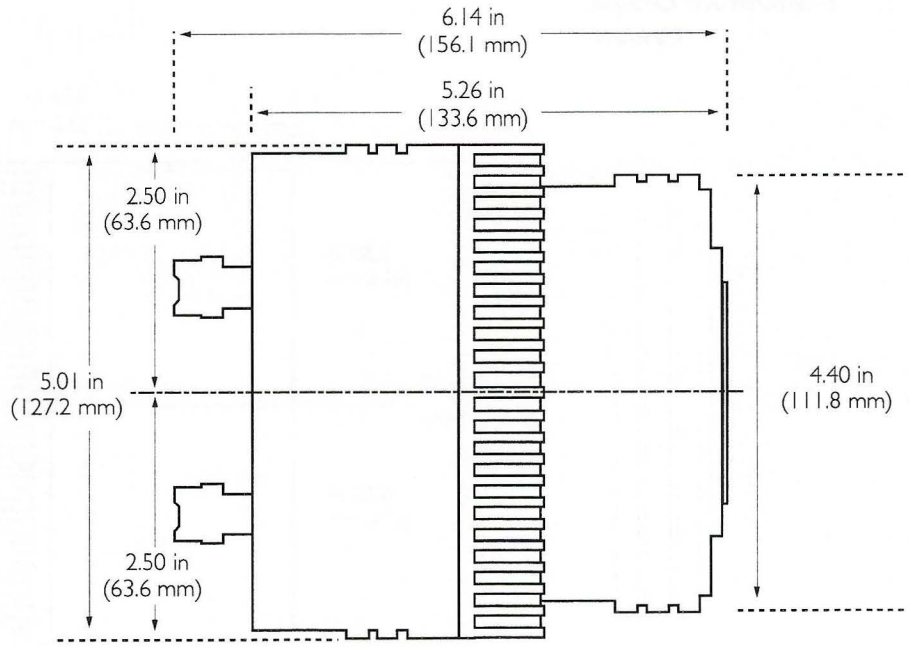


Top View — F-Mount Air-Cooled Camera

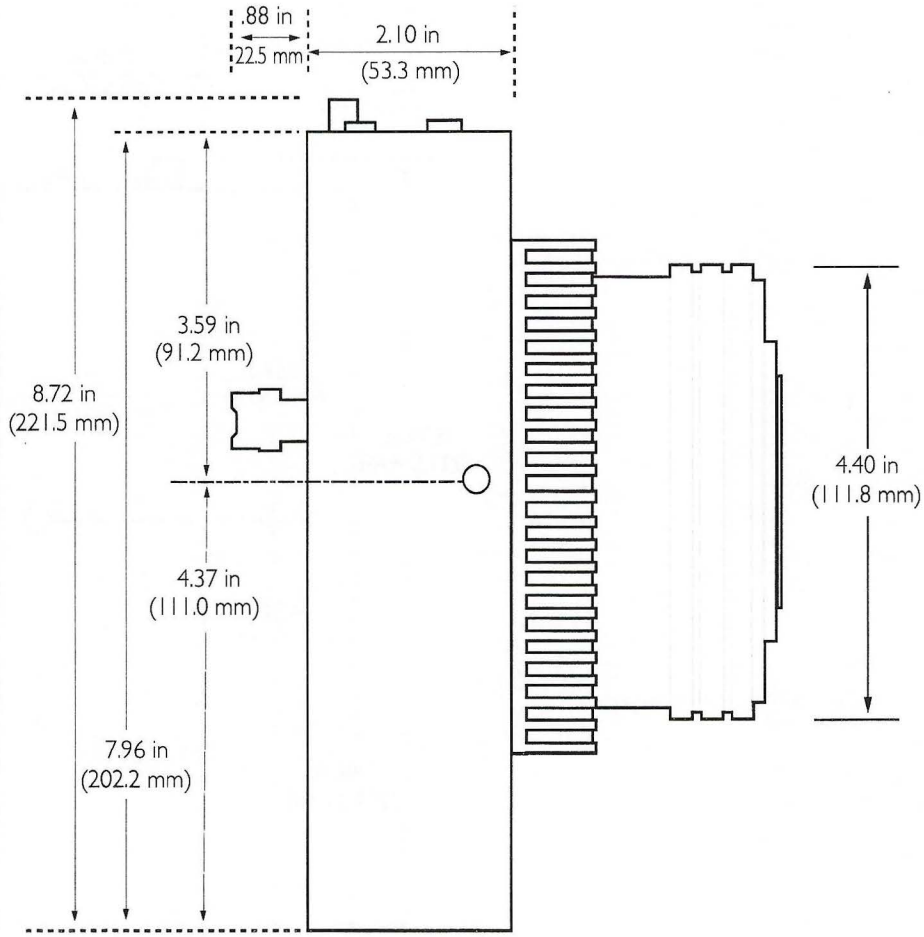


Side View — F-Mount Air-Cooled Camera

F-Mount Liquid Cooled Camera

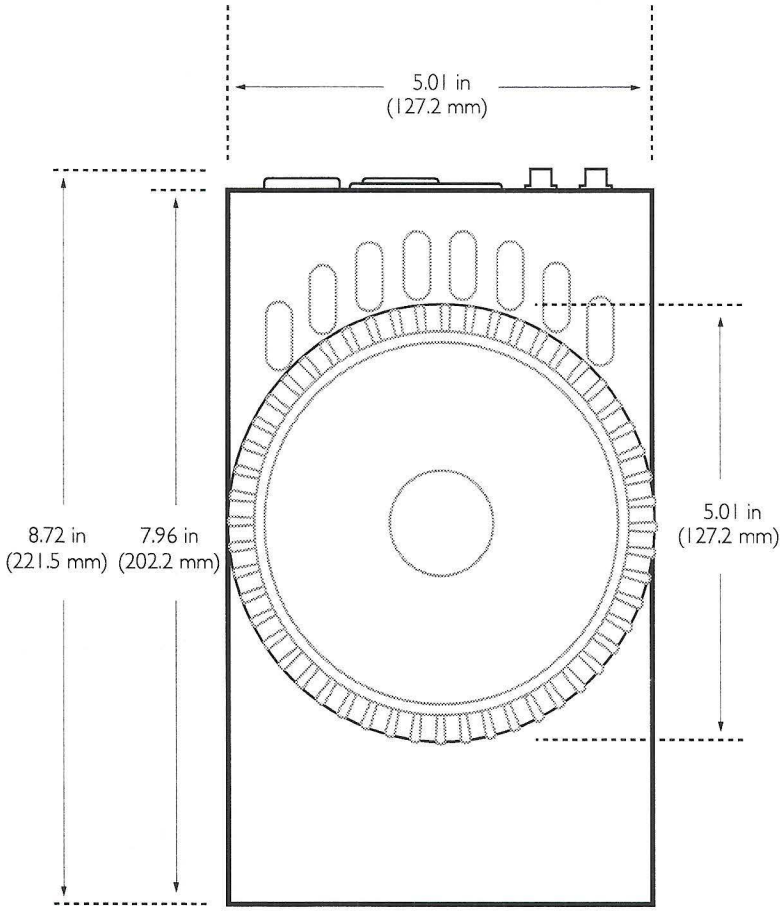


Top View — F-Mount Liquid-Cooled Camera

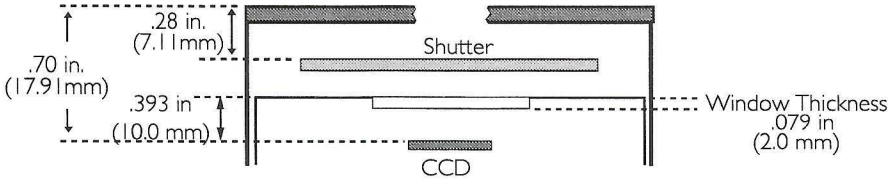


Side View — F-Mount Liquid-Cooled Camera

C-Mount Camera

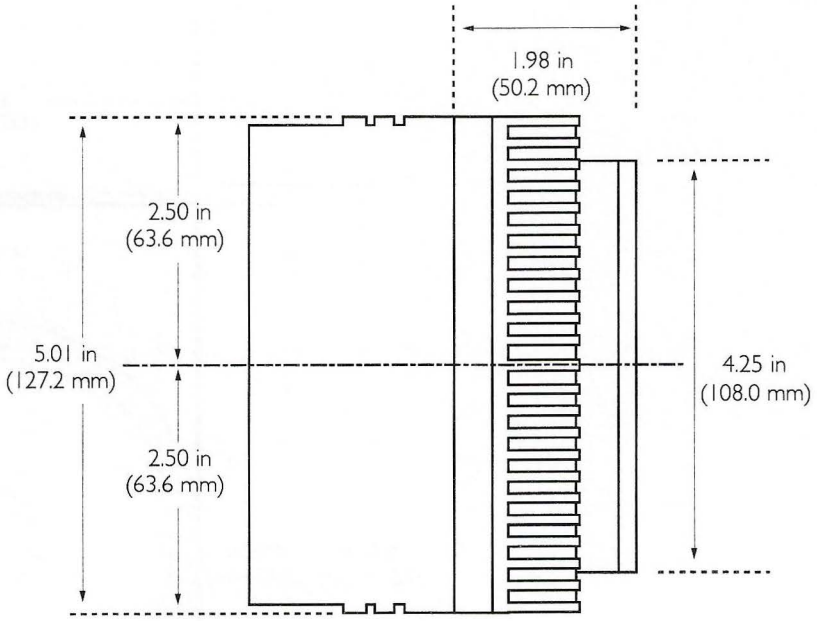


Front View — C-Mount Camera

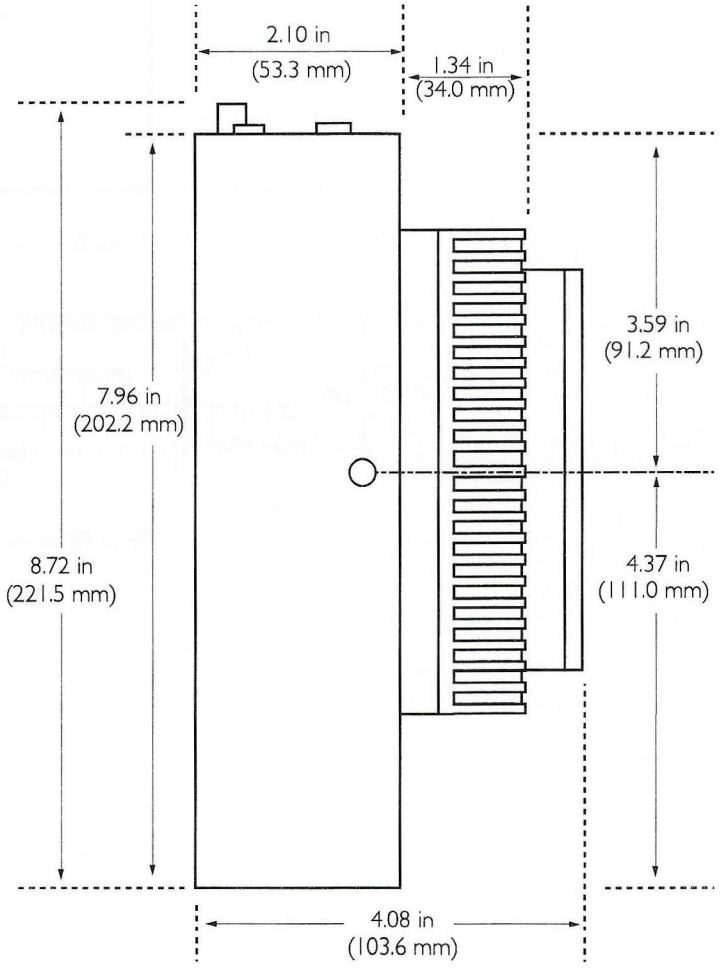


Focal Plane — C-Mount Camera

C-Mount Air Cooled Camera

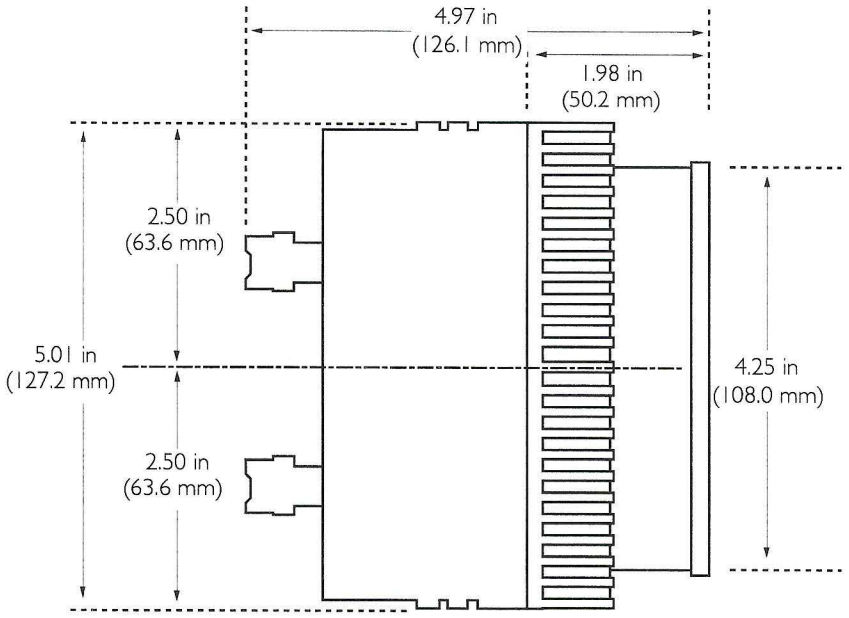


Top View — C-Mount Air-Cooled Camera

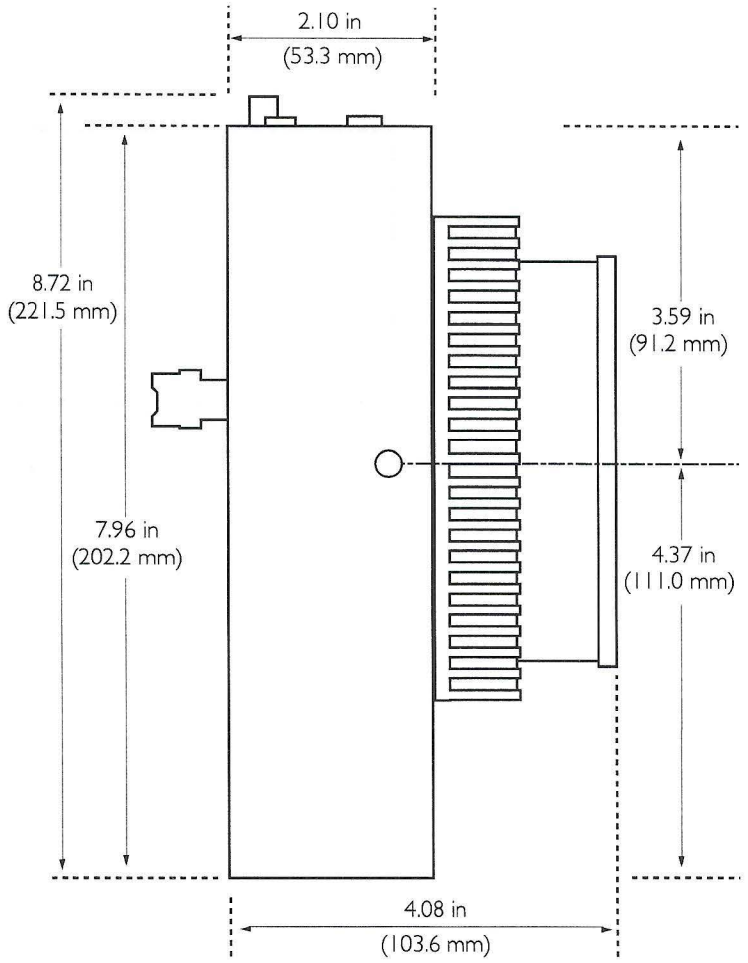


Side View — C-Mount Air-Cooled Camera

C-Mount Liquid Cooled Camera



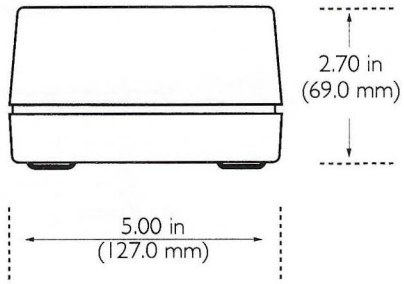
Top View — C-Mount Liquid-Cooled Camera



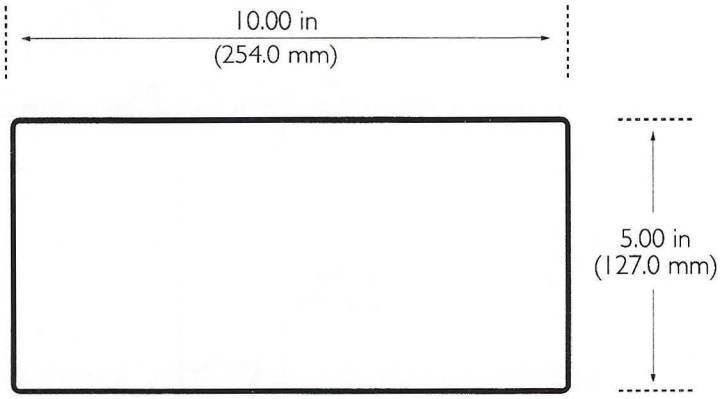
Side View — C-Mount Liquid-Cooled Camera

Power Supply

Voltage		+6.5V
Output		+24V
		±16.5V
Input		110 or 220V AC at 110 W



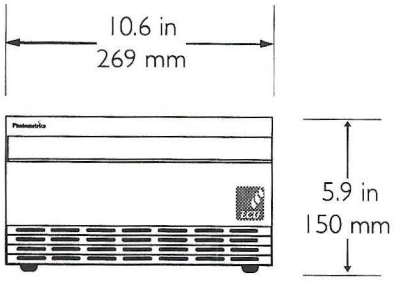
Front View



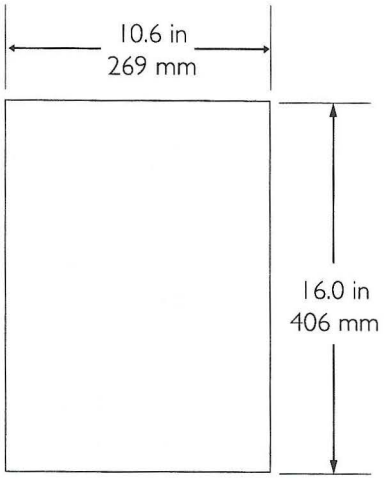
Top View

Liquid Cooling Unit

Liquid Coolant Capacity:	27 fluid ounces (800 cc)
Required Coolant Mixture:	50% ethylene glycol and 50% distilled water



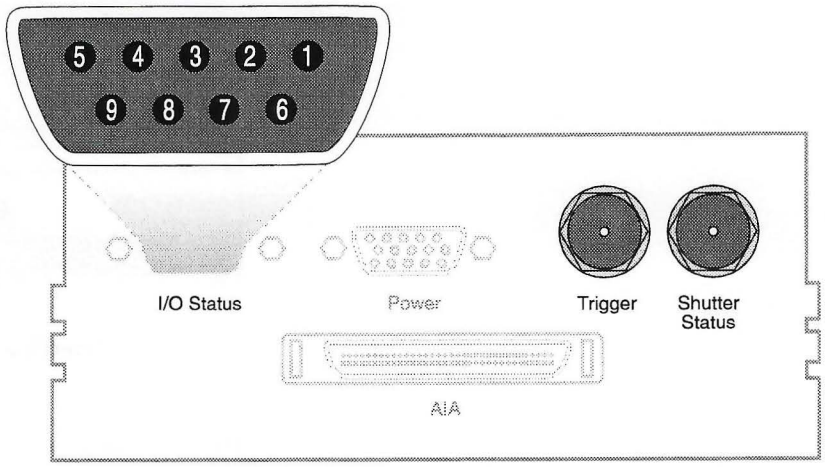
Front View



Top View

Connector Pinouts

The Input/Output Status, Trigger, and Shutter Status connectors provide information about trigger function and shutter status.



Input/Output Status Connector Pinout

All inputs are pulled up to +5V through 10K ohm resistors. Outputs are driven by a 74HCT244 driver. Inputs must be at least 3.15v for a high and less than 0.9v for a low.

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

1 **WAIT FOR TRIGGER OUTPUT**
Active high. A high level on this output indicates that the camera is waiting for a trigger input.

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 program.

3 **CAMERA EXPOSING OUTPUT**
Active high. A high level on this output indicates that the camera is exposing (integrating).

4 **FLASH OUTPUT**
This pin is an output that can be controlled in PVCAM with the `FLASH_MODE` constant.

5 **FACTORY SETUP**
This pin is reserved for factory setup.

6 **FILTERED TRIGGER INPUT**
This input has an RC filter inline to reduce noise on the trigger input. 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.)

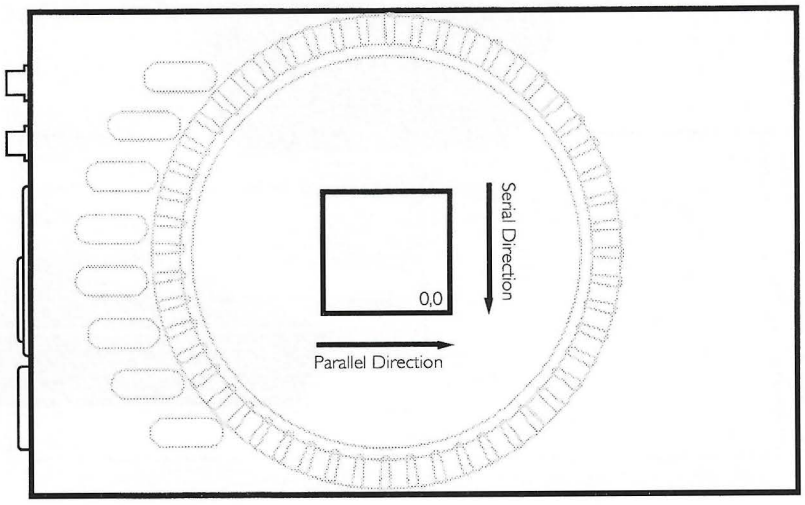
8 **TRIGGER INVERT INPUT**
Active low. A low on this input inverts the state of FILTERED TRIGGER INPUT (6) and TRIGGER CONNECTOR (see below), causing a high level to cause a trigger. (The inputs are internally pulled up, therefore it is recommended to drive them with an open collector driver.)

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

Trigger Connector 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 (I/O Status 8). (The inputs are internally pulled up, therefore it is recommended to drive them with an open collector driver.)

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

CCD Orientation



Camera Front View — KAF 1400 CCD Orientation

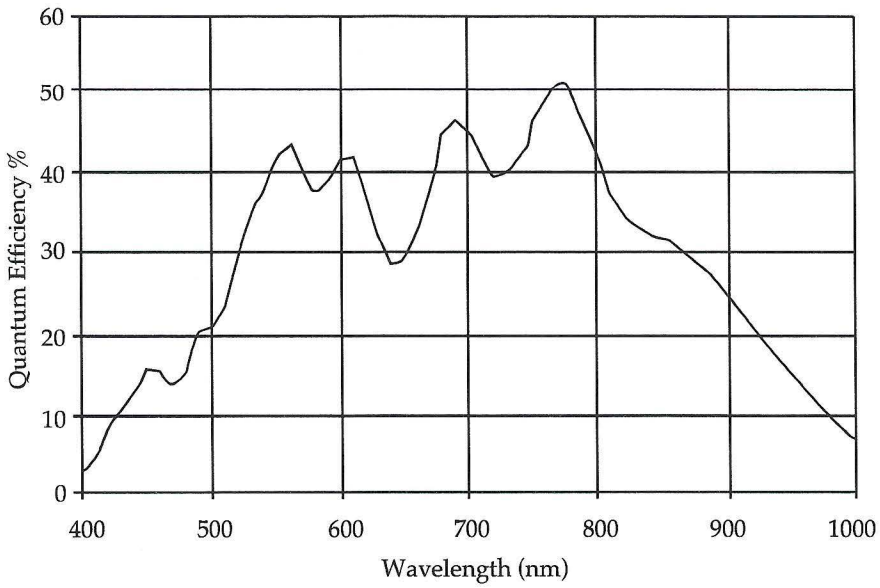
CCD Specifications for KAF 1400

The following specifications are for a typical KAF 1400 CCD. The actual measurements for your camera are listed on the Certificate of Calibration that was shipped with your camera.

CCD Specifications	
H x V	1317 x 1035
Pixel Size	6.8µm x 6.8µm

1 MHz					
Detection Mode	**Gain Setting**	**Relative Gain**	**Typical Noise**	**System Gain**	**Typical Maximum ADC Signal**
High Signal-to-Noise	1	≈ 1/2x	24e-	≈20e-/ADU	80Ke- (binned full well*)
High Dynamic Range	2	≈1x	18e-	≈10e-/ADU	40Ke- (single pixel full well)
High Sensitivity	3	≈4x	16e-	≈2.5e-/ADU	10Ke- (high sensitivity)
* Binning must be a minimum of 2 pixels in the parallel or serial direction to reach the maximum ADC signal					

5 MHz					
Detection Mode	**Gain Setting**	**Relative Gain**	**Typical Noise**	**System Gain**	**Typical Maximum ADC Signal**
High Signal-to-Noise	1	≈ 1/2x	28e-	≈20e-/ADU	80Ke- (binned full well*)
High Dynamic Range	2	≈1x	23e-	≈10e-/ADU	40Ke- (single pixel full well)
High Sensitivity	3	≈4x	20e-	≈2.5e-/ADU	10Ke- (high sensitivity)
* Binning must be a minimum of 2 pixels in the parallel or serial direction to reach the maximum ADC signal					



Typical QE Curve (CCD not installed in camera)

Appendix. Error Messages

This appendix lists error messages that may appear when you use CAMTEST or any other PVCAM-compatible software program.

1	C0_UNKNOWN_ERROR	unexpected, unanticipated, or undocumented
2	DDI_NOT_PV_DEVICE	this device driver is not a Photometrics device
3	DDI_BAD_DEV_NAME	no driver found with the specified name
4	DDI_DRIVER_IN_USE	this driver is already in use by another user
5	DDI_ALREADY_OPEN	this driver has already been opened
6	DDI_CANT_OPEN_DRIVER	the driver was found, but could not be opened
7	DDI_CANT_CLOSE_DRIVER	driver is not currently open; it can't be closed
8	DDI_CLOSE_ERROR	an error occurred while trying to close the driver
9	DDI_ALREADY_ACTIVE	camera is already taking data; finish or abort
10	DDI_ZERO_SEND_SIZE	invalid request: transmit zero bytes
11	DDI_ZERO_RECV_SIZE	invalid request: receive zero bytes
12	DDI_IOPORT_CONFLICT	2 cameras are using the same I/O port
13	DDI_BOARD_NOT_FOUND	communications board is not at expected location
14	DDI_CABLE_DISCONNECTED	CEU cable disconnected or CEU off.
15	DDI_MEM_ALLOC_FAILED	device driver could not allocate needed memory
16	DDI_IRQID_CONFLICT	2 open cameras are using the same interrupt ID
17	DDI_DRV_CLOS_CLOSE_CAM	driver not yet opened: location "pv_close_cam"
18	DDI_DRV_CLOS_READ_BYTE	driver not yet opened: location "pv_read_bytes"
19	DDI_DRV_CLOS_SEND_BYTE	driver not yet opened: location "pv_send_bytes"
20	DDI_DRV_CLOS_GET_RETRY	driver not yet opened: location "pv_get_retries"
21	DDI_DRV_CLOS_SET_RETRY	driver not yet opened: location "pv_set_retries"
22	DDI_DRV_CLOS_GET_TIME	driver not yet opened: location "pv_get_timeout"
23	DDI_DRV_CLOS_SET_TIME	driver not yet opened: location "pv_set_timout"
24	DDI_DRV_CLOS_INFO_LEN	driver not yet opened: location "pv_info_length"
25	DDI_DRV_CLOS_INFO_DUMP	driver not yet opened: location "pv_info_dump"
26	DDI_DRV_CLOS_DRV_VER	driver not yet opened: location "pv_driver_ver"
27	DDI_DRV_CLOS_IM_STATUS	driver not yet opened: location "img_data_status"
28	DDI_DRV_CLOS_IM_ABORT	driver not yet opened: location "img_data_abort"
29	DDI_DRV_CLOS_IM_ACTIVE	driver not yet opened: location "img_data_active"
30	DDI_DRV_CLOS_IM_GRAN	driver not yet opened: location "img_data_granul"
31	DDI_BAD_DEVH_CLOSE_CAM	illegal device handle: location "pv_close_cam"
32	DDI_BAD_DEVH_READ_BYTE	illegal device handle: location "pv_read_bytes"
33	DDI_BAD_DEVH_SEND_BYTE	illegal device handle: location "pv_send_bytes"

34	DDI_BAD_DEVH_GET_RETRY	illegal device handle: location "pv_get_retries"
35	DDI_BAD_DEVH_SET_RETRY	illegal device handle: location "pv_set_retries"
36	DDI_BAD_DEVH_GET_TIME	illegal device handle: location "pv_get_timeout"
37	DDI_BAD_DEVH_SET_TIME	illegal device handle: location "pv_set_timout"
38	DDI_BAD_DEVH_INFO_LEN	illegal device handle: location "pv_info_length"
39	DDI_BAD_DEVH_INFO_DUMP	illegal device handle: location "pv_info_dump"
40	DDI_BAD_DEVH_DRV_VER	illegal device handle: location "pv_driver_ver"
41	DDI_BAD_DEVH_IM_STATUS	illegal device handle: location "img_data_status"
42	DDI_BAD_DEVH_IM_ABORT	illegal device handle: location "img_data_abort"
43	DDI_BAD_DEVH_IM_ACTIVE	illegal device handle: location "img_data_active"
44	DDI_BAD_DEVH_IM_GRAN	illegal device handle: location "img_data_granul"
45	DDI_SYS_ERR_DEV_DRIVER	system error while accessing the device driver
46	DDI_SYS_ERR_INIT	system error: location "pv_init_ddi"
47	DDI_SYS_ERR_UNINIT	system error: location "pv_uninit_ddi"
48	DDI_SYS_ERR_TOTL_CAMS	system error: location "pv_get_totl_cams"
49	DDI_SYS_ERR_CAM_NAME	system error: location "pv_get_all_cam_names"
50	DDI_SYS_ERR_OPEN_CAM	system error: location "pv_open_cam"
51	DDI_SYS_ERR_CLOSE_CAM	system error: location "pv_close_cam"
52	DDI_SYS_ERR_READ_BYTE	system error: location "pv_read_bytes"
53	DDI_SYS_ERR_SEND_BYTE	system error: location "pv_send_bytes"
54	DDI_SYS_ERR_GET_RETRY	system error: location "pv_get_retries"
55	DDI_SYS_ERR_SET_RETRY	system error: location "pv_set_retries"
56	DDI_SYS_ERR_GET_TIME	system error: location "pv_get_timeout"
57	DDI_SYS_ERR_SET_TIME	system error: location "pv_set_timout"
58	DDI_SYS_ERR_INFO_LEN	system error: location "pv_info_length"
59	DDI_SYS_ERR_INFO_DUMP	system error: location "pv_info_dump"
60	DDI_SYS_ERR_DRV_VER	system error: location "pv_driver_ver"
61	DDI_SYS_ERR_IM_STATUS	system error: location "pv_image_data_status"
62	DDI_SYS_ERR_IM_ABORT	system error: location "pv_image_data_abort"
63	DDI_SYS_ERR_IM_ACTIVE	system error: location "pv_image_data_active"
64	DDI_SYS_ERR_IM_GRAN	system error: location "pv_image_data_granularit"
65	DDI_UNKNOWN_DEV_DRIVER	unknown error while accessing the device driver
66	DDI_UNKNOWN_INIT	unknown error: location "pv_init_ddi"
67	DDI_UNKNOWN_UNINIT	unknown error: location "pv_uninit_ddi"
68	DDI_UNKNOWN_TOTL_CAMS	unknown error: location "pv_get_totl_cams"
69	DDI_UNKNOWN_CAM_NAME	unknown error: location "pv_get_all_cam_names"
70	DDI_UNKNOWN_OPEN_CAM	unknown error: location "pv_open_cam"
71	DDI_UNKNOWN_CLOSE_CAM	unknown error: location "pv_close_cam"
72	DDI_UNKNOWN_READ_BYTE	unknown error: location "pv_read_bytes"
73	DDI_UNKNOWN_SEND_BYTE	unknown error: location "pv_send_bytes"
74	DDI_UNKNOWN_GET_RETRY	unknown error: location "pv_get_retries"
75	DDI_UNKNOWN_SET_RETRY	unknown error: location "pv_set_retries"
76	DDI_UNKNOWN_GET_TIME	unknown error: location "pv_get_timeout"

77	DDI_UNKNOWN_SET_TIME	unknown error: location "pv_set_timout"	
78	DDI_UNKNOWN_INFO_LEN	unknown error: location "pv_info_length"	
79	DDI_UNKNOWN_INFO_DUMP	unknown error: location "pv_info_dump"	
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82	DDI_UNKNOWN_IM_ABORT	unknown error: location "pv_image_data_abort"	
83	DDI_UNKNOWN_IM_ACTIVE	unknown error: location "pv_image_data_active"	
84	DDI_UNKNOWN_IM_GRAN	unknown error: location "pv_image_data_granular"	
85	DDI_SCSI_NOT_PV_CAMERA	this SCSI device is not a Photometrics camera	
86	DDI_SCSI_NO_PROTOCOL	SCSI protocol breakdown: no device or termination	
87	DDI_SCSI_NO_ARBITRATE	SCSI arbitration failure: the bus is busy	
88	DDI_SCSI_BAD_XFER SCSI	bad instruction in transfer instruction bloc	
89	DDI_SCSI_PHASE_ERROR	SCSI phase error: host & camera disagree on type	
90	DDI_SCSI_DATA_ERROR	SCSI data comparison error verifying transfer	
91	DDI_SCSI_MGR_BUSY	SCSI manager is busy with another operation	
92	DDI_SCSI_SEQUENCE_ERR	SCSI sequencing error	
93	DDI_SCSI_BUS_TIMEOUT	SCSI bus timeout waiting for data transfer	
94	DDI_SCSI_COMPLETE_ERR	SCSI completion error	
95	DDI_SCSI_INTERNAL_ERR	SCSI device indicates an internal error	
96	DDI_XM_SNDOK	XMODEM	
97	DDI_XM_NOSOH	XMODEM	
98	DDI_XM_OVERFLOW	XMODEM	
99	DDI_XM_RCVOK	XMODEM	
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112	DDI_XM_NOSYNC	XMODEM	no SYNC character seen
113	DDI_XM_SYNCTOUT	XMODEM	timeout while waiting for SYNC character
114	DDI_XM_XMITLOCK	XMODEM	transmit...?
115	DDI_XM_BADCMD	XMODEM	bad command
116	C0_INVALID_HANDLE	this is not the handle of an open camera	
117	C0_CAM_ALREADY_OPEN	this user has already opened this camera	
118	C0_CAM_NEVER_OPENED	camera was not opened, so this task can't be done	
119	C0_CAM_RESERVED	the camera is in use by another user	

120	C0_DRIVER_OUT_OF_MEM	driver or DDI ran out of (specialized?) memory
121	C0_CANT_READ_TIMEOUT	pv_get_retries failed
122	C0_CANT_WRIT_TIMEOUT	pv_set_retries failed
123	C0_CANT_READ_RETRIES	pv_get_timeout failed
124	C0_CANT_WRIT_RETRIES	pv_set_timeout failed
125	C0_CAM_TIMEOUT	no response at all from the camera
126	C0_CAM_TIMEOUT_NOISE	timeout, but some response (noisy line?)
127	C0_RETRIES_EXCEEDED	not a timeout, but retries didn't work (noisy?)
128	C0_CAM_NAME_OUT_OF_RNG	the number must be in the range 0<=num<totl_cams
129	C0_CAM_NAME_NOT_FOUND	this is not a valid name for opening the camera
130	C0_PACKET_TOO_LARGE	a send or read request used a packet >32768 bytes
131	C0_STATUS_TOO_LARGE	the status info returned contained too many bytes
132	C0_STATUS_TOO_SMALL	the status info returned contained too few bytes
133	C0_NEED_POSITIVE_VAL	the input value must be greater than zero
134	C0_NEED_ZERO_OR_MORE	the input value must be zero or above
135	C0_NULL_POINTER	input pointer is null, it must be a legal address
	C0_STSF_	The STATUS TABLE indicates an error or failure:
136	C0_STSF_EU_CPU	subsystem fault: electronics unit main CPU
137	C0_STSF_EU_SYS_INTEG	subsystem fault: EU internal communications
138	C0_STSF_EU_TO_HOST	subsystem fault: EU-to-host cables
139	C0_STSF_POWER_SUPPLY	subsystem fault: power supply voltage error
140	C0_STSF_CCS_CHIP	subsystem fault: CCS chip or memory
141	C0_STSF_CCS_SCRIPT_MEM	subsystem fault: CCS script memory
142	C0_STSF_CCS_PORTS	subsystem fault: CCS ports
143	C0_STSF_DISPLAY	subsystem fault: EU front panel display
144	C0_STSF_SHUTTER_DRIVE	subsystem fault: shutter driver circuit
145	C0_STSF_TEMP_CONT	subsystem fault: temperature control circuit
146	C0_STSF_PAR_CLOCK_DRV	subsystem fault: parallel clock driver
147	C0_STSF_CH_CABLES	subsystem fault: camera head cables
148	C0_STSF_CH_CPU	subsystem fault: camera head CPU board
149	C0_STSF_CH_CLOCK_BRD	subsystem fault: camera head clock board
150	C0_STSF_CH_POWER_BRD	subsystem fault: camera head power board
151	C0_STSF_CH_VID_BRD_1	subsystem fault: camera head video board #1
152	C0_STSF_CH_VID_BRD_2	subsystem fault: camera head video board #2
153	C0_STSF_CH_VID_BRD_3	subsystem fault: camera head video board #3
154	C0_STSF_CH_VID_BRD_4	subsystem fault: camera head video board #4
155	C0_STSF_ADC_BOARD_1	subsystem fault: A/D board #1
156	C0_STSF_ADC_BOARD_2	subsystem fault: A/D board #2
157	C0_STSF_ADC_BOARD_3	subsystem fault: A/D board #3
158	C0_STSF_ADC_BOARD_4	subsystem fault: A/D board #4
159	C0_STSF_OPTION_CARD_1	subsystem fault: option card #1
160	C0_STSF_OPTION_CARD_2	subsystem fault: option card #2
161	C0_STSF_OPTION_CARD_3	subsystem fault: option card #3

162	C0_STSF_OPTION_CARD_4	subsystem fault: option card #4
163	C0_NO_IMG_DATA	can't collect data: expected data is zero bytes
164	C0_CCL_SCRIPT_INVALID	can't collect data: CCS script is invalid
	C0_EXP_	Exposure status errors, from to EXP_ST_ constants
165	C0_EXP_FIFO_OVERFLOW AIA	input buffer has overflowed
166	C0_EXP_NO_ACK	camera didn't acknowledge last request for image data
167	C0_EXP_XFER_ERR	last data transfer from the camera was garbled
168	C0_EXP_EXTRA_DATA	finished data transfer, but extra data exists
169	C0_EXP_MISSING_DATA	finished data transfer, some data was missing
170	C0_OPEN_MODE_UNAVAIL	camera may not be opened in the mode specified
171	C0_WRONG_READ_CLASS	read operations require the HOST_COMMANDS class
172	C0_WRITE_BYTES_TOO_SML	command sent to camera must be at least 1 byte
173	C0_WRITE_BYTES_TOO_LRG	cannot send over 32768 bytes in one transaction
174	C0_READ_BYTES_TOO_SML	a read transaction must transfer at least 1 byte
175	C0_READ_BYTES_TOO_LRG	cannot read over 32768 bytes in one transaction
176	C0_WRONG_READ_CMD	'read' command is improperly formatted
177	DDI_DRV_CLOS_GET_PIXTIME	driver not yet opened: pd_driver_get_pixtime
178	DDI_SYS_ERR_GET_PIXTIME	system error in pd_driver_get_pixtime
179	DDI_BAD_DEHV_GET_PIXTIME	bad dev handle: pd_driver_get_pixtime
180	DDI_UNKNOWN_GET_PIXTIME	unknown error in pd_driver_get_pixtime
181	DDI_CAM_XOFF	camera can't communicate after sending an X-OFF
1000	C01_START_ERROR	unknown error
2000	C2_UNKNOWN_ERROR	unexpected, unanticipated, undocumented
2001	C2_PVCAM_ALREADY_INITED	init_pvcam has been called twice without closing
2002	C2_PVCAM_NOT_INITED	the PVCAM library was never initialized
2003	C2_FAILED_TO_SET_VALUE	the camera did not accept the new setting
2004	C2_NEED_POSITIVE_VAL	the input value must be greater than zero
2005	C2_NEED_ZERO_OR_MORE	the input value must be zero or above
2006	C2_NULL_POINTER	input pointer is null, it must be a legal address
2007	C2_FRAME_XFER_ILLEGAL	this CCD does not allow frame transfer operation
2008	C2_FRAME_XFER_REQUIRED	this CCD must be operated in frame transfer mode
2009	C2_MPP_MODE_ILLEGAL	this CCD does not allow mpp-mode clocking
2010	C2_MPP_MODE_REQUIRED	this CCD requires mpp-mode clocking
2011	C2_CLEAR_MODE_INVALID	requested clear mode is not an allowed choice
2012	C2_SPEED_INVALID	no valid speeds between camera/electronics/host
2013	C2_SPEED_OUT_OF_RANGE	selected a nonexistent speed table entry
2014	C2_CANT_SET_ADC_OFFSET	camera does not allow offset to be read or set
3000	INVALID_PIC_TRIGGER_MODE	a sequence-only trigger mode is not usable by the setup_pic() function.
3001	C3_NO_COMMUNICATIONS_LINK	bogus temp
3002	C3_INVALID_SCRIPT CCL	program is not loaded or is invalid.
3003	C3_EXP_EXTRA_DATA	extra data acquired during exposure
3004	C3_EXP_NO_DATA_ACQ	no data acquired during exposure

3005	C3_EXP_FIFO_OVERFLOW FIFO	overflow during exposure
3006	C3_EXP_NO_ACKNOWLEDGE	camera did not acknowledge request during exp
3007	C3_EXP_TRANSFER_ERROR	transfer error during exposure
3008	C3_EXP_UNKNOWN_STATE	camera went into unknown state during exposure
3009	C3_CANT_DECODE_IN_PROGRESS	can't decode while readout is in progress
3010	C3_RGN_MAX_EXCEEDED	trying to add more than the maximum number of regions
3011	C3_RGN_ILLEGAL_DEFN	dimensions of region to be added is illegal
3012	C3_RGN_ILLEGAL_BINNING	binning of region to be added is illegal
3013	C3_RGN_OUTSIDE_CCD_DIMENS	region definition extends beyond CCD dimensions
3014	C3_RGN_OVERLAP	region to be added overlaps a previous region
3015	C3_RGN_INVALID_NUM	invalid region number
3016	C3_RGN_NOT_FOUND	region not found
3017	C3_STREAM_PTR_NOT_DEFINED	pointer to pixel stream is not defined
3018	C3_GROUPS_PTR_NOT_DEFINED	pointer to decode information structure is not defined
3020	C3_FAILED_TO_SET_VALUE	The value cannot be set in the camera
4000	C04_HBUF_OUTOFRANGE	
4001	C04_HIMG_OUTOFRANGE	
4002	C04_NO_FREE_BUFFER_HANDLES	
4003	C04_NO_FREE_IMAGE_HANDLES	
4004	C04_BUFFER_ENTRY_ALREADY_SET	
4005	C04_BUFFER_ENTRY_ALREADY_CLEARED	
4006	C04_IMAGE_ENTRY_ALREADY_SET	
4007	C04_IMAGE_ENTRY_ALREADY_CLEARED	
4008	C04_INVALID_IMAGE_HANDLE	
4009	C04_INVALID_BUFFER_HANDLE	
4010	C04_INVALID_BITDEPTH_VALUE	
4011	C04_INVALID_IMAGE_NUMBER	
4012	C04_INVALID_EXPOSURE_NUMBER	
10100	C101_ICL_UNKNOWN_ERROR	ICL OPTION LIBRARY: unknown error
10101	C101_ICL_LIB_NOT_INIT	the script library hasn't been initialized yet
10102	C101_ICL_LIB_INITED	the script library has already been initialized
10103	C101_ICL_NO_BEGIN	the `script_begin` command was never seen
10104	C101_ICL_END_TOO_SOON	the text ended before `script_end` instruction
10105	C101_ICL_INST_INVAL	a script instruction could not be correctly read
10106	C101_ICL_OPEN_PAREN	an opening parenthesis should have been present
10107	C101_ICL_ILLEGAL_CHAR	an illegal character or symbol was seen
10108	C101_ICL_BAD_COMMA	unexpected comma
10109	C101_ICL_BAD_NUMBER	unexpected numeric parameter; comma needed?
10110	C101_ICL_BAD_CL_PAREN	unexpected closing parenthesis; extra comma?
10111	C101_ICL_NO_SEMICOLON	the semicolon was missing from this instruction
10112	C101_ICL_TOO_MANY_ARG	this instruction has too many parameters
10113	C101_ICL_TOO_FEW_ARG	this instruction doesn't have enough parameters
10114	C101_ICL_ARG_IS_ZERO	this argument must be greater than zero

10115	C101_ICL_ARG_OVER_65K	this argument must be 65,535 or less
10116	C101_ICL_ARG_INVALID	this argument is invalid or illegal
10117	C101_ICL_OVER_LOOP	the loops are nested too deeply
10118	C101_ICL_UNDER_LOOP	there are too many `loop_end` instructions
10119	C101_ICL_UNEVEN_LOOP	`loop_begin` commands don't match `loop_end`
10120	C101_ICL_BIN_TOO_LARG	a readout's binning exceeds its size
10121	C101_ICL_RGN_TOO_LARG	the readout region does not fit on the CCD
10122	C101_ICL_DISPLAY_SMAL	displayed data is less than the collected data
10123	C101_ICL_DISPLAY_LARG	displayed data is more than the collected data
10124	C101_ICL_NO_FRAME_XFR	this camera doesn't have a separate storage array
10125	C101_ICL_NO_MPP	this camera does not allow MPP mode
10126	C101_ICL_TOO_COMPLEX	this script exceeds available program memory
29000	C29_UNKNOWN_ERROR	unexpected, unanticipated, undocumented
29001	C29_BDEPTH_ILLEGAL	bit depth must be one of the PRECISION_ constants
29002	C29_BDEPTH_DIFFER	bit depth much match between source & destination
29003	C29_BUF_NEEDS_1_EXP	a buffer needs at least 1 exposure to be defined
29004	C29_BUF_NEEDS_1_IMG	a buffer needs at least 1 image to be defined
29005	C29_IMG_DEF_TOO_LARGE	a image definition used an absurdly large value
29006	C29_IMG_DEF_TOO_SMALL	image size and binning must be larger than zero
29007	C29_IMG_DEF_DIFFER	image definitions must match between source & dest
29008	C29_IMG_NUM_DIFFER	number of images must match between source & dest
31000	C31_INVALID_HEAP	invalid heap ID, must be PUBLIC_MEM or PRIVATE_
31001	C31_INVALID_HEAP	invalid heap id, must be PUBLIC_MEM or PRIVATE_
31002	C31_NOT_ENOUGH_MEM	not enough memory to perform operation
31003	C31_PRIVATE_OVER_SIZE	allocation exceeds the 64k limit for PRIVATE_MEM
31004	C31_PRIV_MEM_BLOCK_TOO_BIG	allocation exceeds 64k limit for PRIVATE_MEM
31005	C31_MEMLOCK_FAILED	memory page locking failed
32000	CCL_TOO_COMPLEX	too many script entries.
32001	CCL_CANT_FRAME_TRANSFER	no frame transfer hardware support.
32002	CCL_SCRIPT_IS_NOT_VALID	control variables have changed since the last script was sent.
32003	CCL_REGIONS_OVERLAP	regions contain some of the same pixels
32004	CCL_INVALID_SERIAL_BINNING	serial binning == 0 or > region size
32005	CCL_INVALID_PARALLEL_BINNING	parallel binning == 0 or > region size
32006	CCL_NONMATCHED_PARALLEL_BINNING	conflicting parallel binning values
32007	CCL_PARALLEL_BINNING_MISALIGNED	conflicting parallel binning alignment
32008	CCL_INVALID_REGION	region is not on the CCD

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