



Scientific-Grade Digital Camera

User Guide

For Models 8051, 4070, 1501, and 340



Table of Contents

















Chapter 1	Warning Symbol Definitions.....	5
Chapter 2	Safety.....	6
2.1.	<i>Precautions</i>	6
2.2.	<i>Product Care</i>	7
2.2.1.	Service	7
2.2.2.	Accessories and Customization	7
Chapter 3	Description	8
3.1.	<i>Introduction</i>	8
3.2.	<i>Receiving and Unpacking</i>	8
3.2.1.	Important Information Regarding the Power Supply	8
3.3.	<i>Supplied Equipment</i>	9
3.3.1.	Optional Items	9
Chapter 4	Setup & Installation	10
4.1.	<i>Pre-Installation</i>	10
4.1.1.	Gigabit Ethernet (GigE) System.....	10
4.1.2.	Camera Link System	10
4.1.3.	USB 3.0 System.....	10
4.2.	<i>Installing the Software</i>	11
4.2.1.	Load the Distribution Disk	11
4.2.2.	Driver Selection	11
4.2.3.	Installing 3 rd Party Software Applications.....	14
4.3.	<i>Connecting the Camera</i>	15
4.3.1.	Configuring your Gigabit Ethernet adaptor for best performance	17
4.3.2.	Multiple Camera Operation	18
4.4.	<i>Optical and Mechanical Mounting Considerations</i>	20
4.4.1.	Using a C-Mount Lens	20
4.4.2.	Mounting the Camera.....	20
4.4.3.	Using the Camera with a Cage System	21
4.4.4.	Compatible Adapters for the Camera	21
4.5.	<i>Optical Front End</i>	22
4.5.1.	Description of Components.....	23
4.6.	<i>Optical Front End Procedures</i>	24
4.6.1.	Removing the C-mount Lock Ring Assembly	24
4.6.2.	Filter Removal and Replacement Procedure	25
4.6.3.	Re-assembly of the C-mount Lock Ring and Flange Focus Adjustment	26
4.7.	<i>Auxiliary Connector</i>	27
4.7.1.	Pin Descriptions	27
4.7.2.	Signal Descriptions	27
4.7.3.	Auxiliary I/O Cable Requirements	28
Chapter 5	Operation	29
5.1.	<i>Starting the Camera</i>	29
5.2.	<i>Camera Timing Diagrams</i>	30
Chapter 6	8051M Specifications	32

6.1. CCD Specifications.....	32
6.2. Responsivity	32
6.3. Imaging Specifications.....	32
6.4. Example Frame Rates	33
Chapter 7 8051C Specifications.....	34
7.1. Color CCD Specifications	34
7.2. Responsivity	34
7.3. Imaging Specifications.....	34
7.4. Example Frame Rates	35
Chapter 8 4070M Specifications	36
8.1. CCD Specifications.....	36
8.2. Responsivity	36
8.3. Imaging Specifications.....	36
8.4. Example Frame Rates	37
Chapter 9 4070C Specifications.....	38
9.1. Color CCD Specifications	38
9.2. Responsivity	38
9.3. Imaging Specifications.....	38
9.4. Example Frame Rates	39
Chapter 10 340M Specifications	40
10.1. CCD Specifications.....	40
10.2. Responsivity	40
10.3. Imaging Specifications.....	41
10.4. Example Frame Rates	41
Chapter 11 1501M Specifications	42
11.1. CCD Specifications.....	42
11.2. Responsivity	42
11.3. Imaging Specifications.....	43
11.4. Example Frame Rates	43
Chapter 12 1501C Specifications.....	44
12.1. Color CCD Specifications	44
12.2. Responsivity	44
12.3. Imaging Specifications.....	44
12.4. Example Frame Rates	45
Chapter 13 IR Blocking Filter	46

Chapter 14	Mechanical Drawings	47
14.1.	8051/4070/1501-GE-TE.....	47
14.2.	8051/4070/1501/340-GE.....	47
14.3.	8051/4070/1501-CL-TE.....	48
14.4.	8051/4070/1501/340-CL.....	48
14.5.	8051/4070/1501-USB-TE	49
14.6.	8051/4070/1501/340-USB	49
14.7.	Switching Power Supply	50
Chapter 15	Troubleshooting.....	51
15.1.	Interface	51
15.1.1.	GigE Status Indicators	51
15.2.	Optical	52
15.3.	Operational.....	52
15.4.	Software	53
Chapter 16	Maintenance	54
16.1.	Cleaning Guidelines	54
16.1.1.	Cleaning the Lens of Optical Assembly	54
16.1.2.	Standard (Non-Cooled) Camera Precautions	54
16.1.3.	TE-Cooled Camera Precautions	54
16.1.4.	Cleaning the Infrared Filter (Standard and TE-Cooled Cameras)	55
Chapter 17	Regulatory	56
17.1.	Waste Treatment is Your Own Responsibility	56
17.2.	Ecological Background.....	56
17.3.	Certifications and Compliance – CE Declaration of Conformity	57
17.4.	FCC Statement.....	61
17.5.	Auxiliary I/O Cable Requirements	61
Chapter 18	Warranty.....	62
18.1.	General Product Warranty	62
18.2.	Specific Warranties	62
18.2.1.	Optomechanics	62
18.2.2.	Optical Tables and Breadboards	62
18.2.3.	Lasers and Imaging Systems.....	62
18.2.4.	Opto-Electronics, Control Electronics, Optics, and Nano-Positioning Product Lines	62
18.2.5.	Non-Warranty Repairs	62
18.2.6.	Warranty Exclusions	62
Chapter 19	Thorlabs Worldwide Contacts.....	63

Chapter 1 Warning Symbol Definitions

Below is a list of warning symbols you may encounter in this manual or on your device.



Symbol	Description
	Direct Current
	Alternating Current
	Both Direct and Alternating Current
	Earth Ground Terminal
	Protective Conductor Terminal
	Frame or Chassis Terminal
	Equipotentiality
	On (Supply)
	Off (Supply)
	In Position of a Bi-Stable Push Control
	Out Position of a Bi-Stable Push Control
	Caution: Risk of Electric Shock
	Caution: Hot Surface
	Caution: Risk of Danger
	Warning: Laser Radiation
	Caution: Spinning Blades May Cause Harm

Chapter 2 Safety

2.1. Precautions

Please read the instruction manual carefully before operating your Digital Camera. All statements regarding safety and technical specifications will only apply when the unit is operated correctly.

Refer to this User's Guide whenever the following symbols are encountered on the Digital Camera and Power Supply.



**ATTENTION**

This symbol indicates that additional information is available in this user guide.

This equipment is intended for laboratory use only and is not certified for medical applications, including but not limited to, life support situations.

Transportation and delivery may cause the Digital Camera to be warm or cool upon receipt. Please wait for the device to reach room temperature before attempting to operate.

Mobile telephones, cellular phones, or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may exceed the maximum allowed disturbance values according to EN50082-1.

**CAUTION**

Check the supply voltage of the system BEFORE plugging in the power supply. Make sure the included power cord is the correct type for the service you are connecting to AND connected to a properly grounded power outlet (100 – 240 VAC; 50 – 60 Hz).

There are NO user accessible fuses in this Digital Camera or the included External Power Supply.

Do not open the Digital Camera or the External Power Supply. Doing so is dangerous and could result in damage to the unit or death to the user.

**WARRANTY WARNING**

Do not open the Digital Camera or the external power supply. There are no user serviceable parts in this product. Opening the device will void your warranty. Any modification or servicing of this system by unqualified personnel renders Thorlabs free of any liability. This device can only be returned when packed into the complete original packaging, including all foam packing inserts. If necessary, ask for replacement packaging. Please contact Thorlabs' Technical Support at techsupport@thorlabs.com and a member of our team will be happy to assist you.

2.2. Product Care

Handle the system with care during transportation and unpacking. Banging or dropping the system can damage the unit or lower system performance. If the system is mishandled during shipment, the optical components may become misaligned, which could lead to a decrease in the image quality. If this happens, the system will need to be realigned by qualified personnel. To ensure proper care and operation of your Scientific-Grade Digital Camera, please follow the handling instructions below.

- Do not store or operate in a damp, closed environment.
- Do not use solvents on or near the equipment.
- Keep away from dust, dirt, and air-borne pollutants (including cigarette smoke). The system is not designed for outdoor use. Protect the equipment from rain, snow, and humidity.
- Do not expose to mechanical or thermal extremes. Protect the equipment from rapid variation in temperature.
- Handle all connectors with care. Do not use unnecessary force as this may damage the connectors.
- Clean using a soft, lint free cloth. Use of isopropyl alcohol is permitted, however do not immerse in any liquid or solvent.
- Clean any accessible optical surfaces with an appropriate optics grade tissue or cloth.

2.2.1. Service

Only trained and approved Thorlabs' personnel should service the system. Please contact Thorlabs' Technical Support at techsupport@thorlabs.com and a member of our team will be happy to assist you.

2.2.2. Accessories and Customization

Although the system is easily adapted for custom interfaces, to achieve the listed specifications, this system should only be used with accessories provided by Thorlabs. Any modification or servicing by unqualified personnel renders the warranty null and void, leaving Thorlabs free of liability. Please contact Thorlabs for questions on customization.

Chapter 3 Description

3.1. Introduction

Our scientific-grade camera series consists of four monochrome configurations (M) distinguished by their interface method (Gigabit Ethernet (-GE), Camera Link (-CL), or USB 3.0 (-USB)) and whether or not a thermoelectric cooler is used (-TE for 8051, 4070, and 1501 only). Color sensors are available in the 8051C, 4070C, and 1501C models as well.

The model format is nnnnM/C-I/O-TE where:

nnnn is the base sensor number, **M/C** denotes Monochrome vs. Color, **I/O** denotes the interface, and **TE** denotes TE cooling (blank for non-cooled). Ex. 4070C-GE, 8051M-CL-TE ...

The cameras are bundled with the full complement of Thorlabs Scientific Imaging (TSI) software. For end-users, the ThorCam software application provides full control of the camera through an intuitive user interface, and it allows the user to acquire, pan, zoom, analyze, and save images and metadata.

For developers, TSI also offers a software developer's kit, which includes a comprehensive API (Application Programming Interface) to streamline the integration of any TSI camera into your system. After software installation, the SDK can be found in the Local Disk\Program Files\Thorlabs Imaging\documentation folder. This is the same for 32 and 64 bit distributions.

This manual is a functional overview of the camera, and it is meant to be a companion to the Camera Quick Start Guide (ITN000081-D03), ThorCam User Manual (ITN000493-D02), and the TSI Application Programming Interface Guide (ITN000195-D02). All support documentation is available at **www.thorlabs.com** as well as in the Local Disk\Program Files\Thorlabs folder following the installation of ThorCam.

3.2. Receiving and Unpacking

Your camera was thoroughly tested and carefully packed at the factory. Once the camera shipment is accepted for delivery, the carrier assumes full responsibility for its safe arrival. Should you receive your shipment with any damage—concealed or apparent—please contact the carrier at once. The carrier will instruct you on how to initiate a damage claim. If a visual inspection reveals damage upon receipt, it must be noted on the freight bill or express receipt and the notation signed by the carrier's agent. Failure to do so can result in the carrier refusing to honor the claim.

To return your camera to TSI for service, you must first contact your local Thorlabs office or distributor and request a Return Material Authorization (RMA). Returns will not be accepted without an RMA. See Chapter 11, titled "Warranty Information" for details.

3.2.1. Important Information Regarding the Power Supply



CAUTION



The switching power supply that is provided by TSI for use with this camera operates automatically over the following range of voltages (100 – 240 VAC; 50 – 60 Hz). Make sure the included power cord is the correct type for the service you are connecting to AND connected to a properly grounded power outlet.

Dangerous voltage exists within the power supply. Do not tamper with or open the supply under any circumstances. Doing so may expose lethal voltage to personnel and will void the warranty.

3.3. Supplied Equipment

The following is a list of equipment that may be supplied with your camera, depending on your order configuration. Figure 1 below shows the different available configurations.

Supplied Equipment	
Available Interface Options	Gigabit Ethernet Includes Intel® Pro/1000 CT PCIe Desktop Adapter and 14' CAT 5e Cable
	Camera Link Interface Includes VisionLink F4 Camera Link Board and two 5 m Camera Link cables
	USB 3.0 Interface and one 3 m USB-SS Cable
Accessories	<ul style="list-style-type: none">Regulated switch-mode Power Supply with 72" cord (Supplied line cord appropriate for user's country or region)Spanner WrenchLens cap (and IR filter removal tool)
Included Software	Thorlabs Camera Software and SDK (Available for download from www.thorlabs.com)



Figure 1 Available Camera Configurations

3.3.1. Optional Items

- Auxiliary I/O Patch cable – The auxiliary connector on the camera allows the user to access optional camera control and internal status signals (see section 4.7).
Order Thorlabs 8050-CAB1 and TSI-IOBOB or TSI-IOBOB2.

Chapter 4 Setup & Installation

4.1. Pre-Installation

Before proceeding with installation of hardware or software, please identify whether your camera interface is Camera Link, Gigabit Ethernet (GigE), or USB 3.0.

4.1.1. Gigabit Ethernet (GigE) System

If you purchased a Gigabit Ethernet camera, an Intel PCIe adapter card is provided for use on desktop computer systems. Although the system will work with other adapters (including laptop GigE adapters), **it is recommended that this card be used for optimal performance on all desktop installations.** See

Recommended Installation Sequence

1. Power down the computer.
2. Taking necessary precautions, install the Intel PCIe GigE adapter.
3. Turn on the computer and accept Windows driver recommendations for the newly installed hardware.
4. Run the software installer – follow the steps outlined in the next section, including driver installation.
5. Connect the camera, then apply power and run ThorCam application software.

4.1.2. Camera Link System

Camera Link cameras include an EDT PCIe interface card. Other Camera Link interface cards are not supported.

Recommended Installation Sequence

1. Run the software installer, follow the steps outlined in the next section.
2. Power down the computer.
3. Taking necessary precautions, install the EDT PCIe Camera Link interface card.
4. Turn on the computer.
5. Accept the driver installation recommendations for the newly installed hardware.
6. Connect the camera, then apply power and run ThorCam application software.

4.1.3. USB 3.0 System

If you purchased a USB 3.0 camera, the USB 3.0 “SS” inputs on your PC are supported. USB 2.0 inputs are not supported at this time. For higher bandwidth applications a number of third-party PCIe USB3.0 cards have been tested with our camera. Please refer to the Troubleshooting section under Operation for more information.

Recommended Installation Sequence

1. Run the software installer, follow the steps outlined in the next section.
2. Connect the camera, then apply power.
3. Your PC should discover the new USB device and install the necessary Drivers.
4. Run the ThorCam application software.

4.2. Installing the Software

The Thorlabs camera software runs on Windows 7, 8.1, and 10 operating systems ONLY.

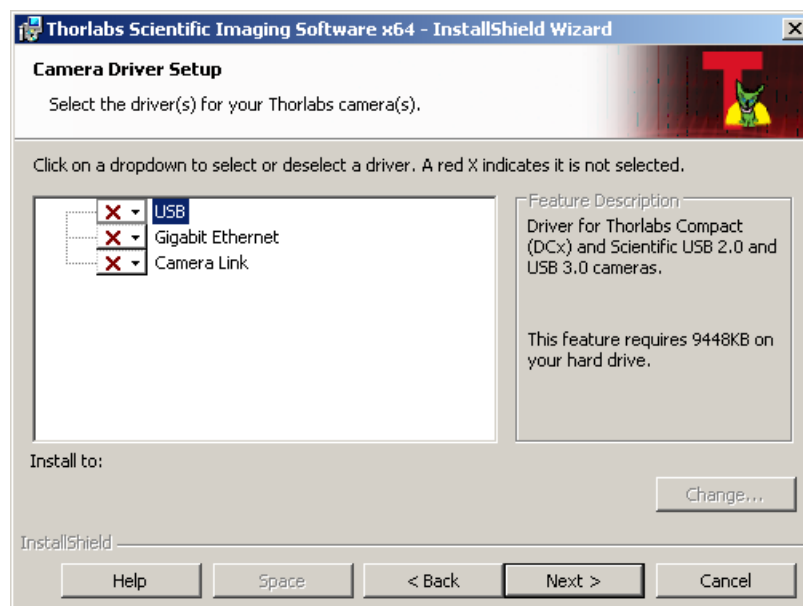
4.2.1. Load the Distribution Disk

A CD or DVD disk can be found with the camera. Load the disk into the CD/DVD drive on the computer you wish to operate the camera and software.

The installation software will automatically detect whether your system is 32-bit or 64-bit. Loading and detection could take a minute or two, depending on your drive speed.

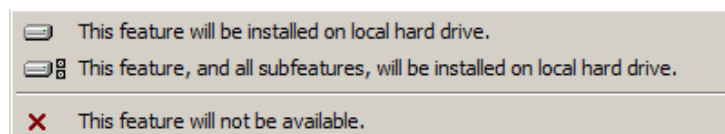
4.2.2. Driver Selection

Your camera requires a driver to be installed on your computer. After the welcome screen, acceptance of the license agreement, and entering your user information, you will be presented with a choice of drivers. Select the driver that matches the interface on your camera; USB, Gigabit Ethernet, or Camera Link. If you have more than one camera and with different interfaces, select all that apply. If you're unsure, select them all.

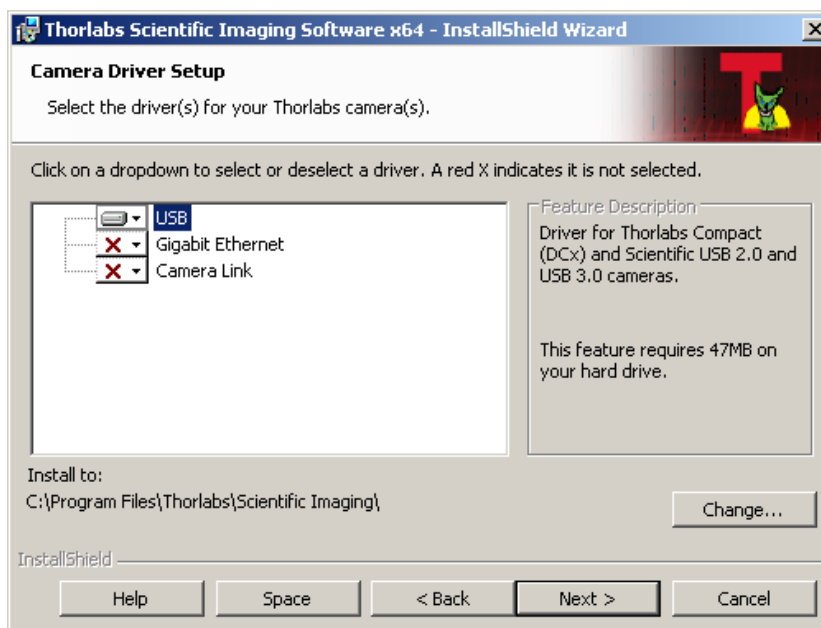


Select a driver for installation by clicking on the dropdown and selecting either of the two choices; “This feature will be installed on local hard drive,” or “This feature, and all subfeatures, will be installed on local hard drive.” There are no subfeatures, so both choices do the same thing.

If you do not wish to install the driver, select “This feature will not be available”

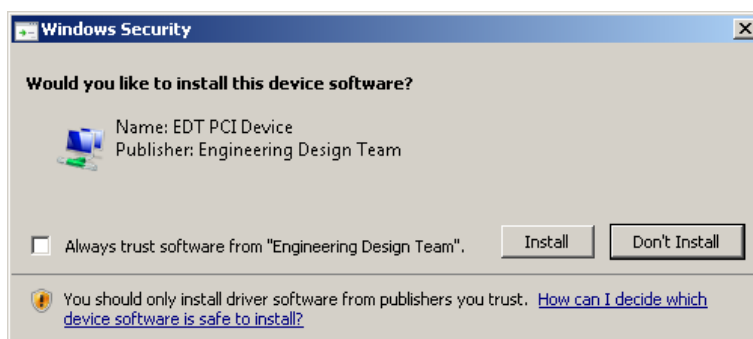


Once a driver is selected, the red X will be replaced with a hard drive icon as shown in the USB selection below.

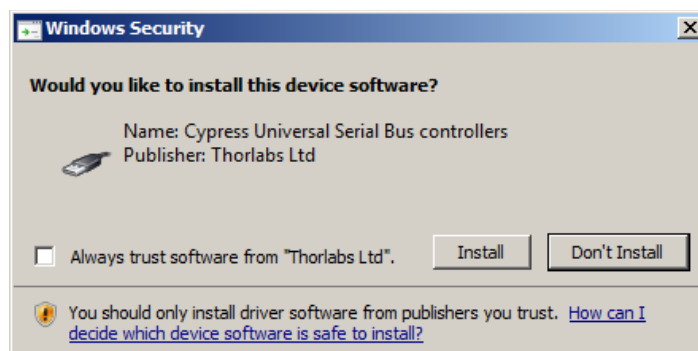


Click Next to proceed with the driver installation. Depending on your PC's configuration and the drivers you selected, you might encounter the additional Windows security dialogs below. Be sure to click "install" to complete the operation, otherwise the installer will "roll back" and exit.

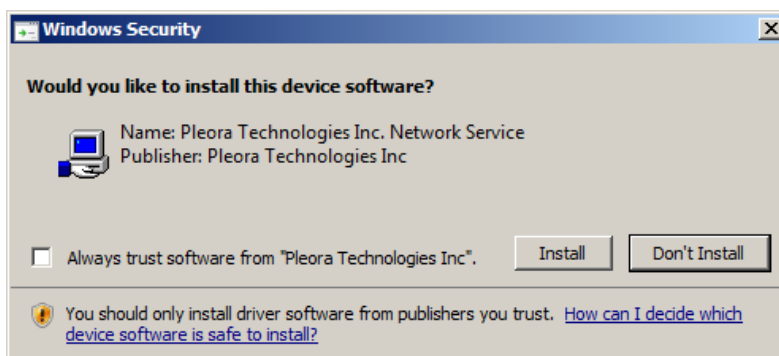
Camera Link Driver Installation (if selected). Click "Install"



USB Driver Installation (if selected). Click "Install"



Gigabit Ethernet Driver Installation (if selected). Click “Install”



Once setup is complete, you may now proceed to the next section that will describe how to connect and power on your camera. When the camera is connected and powered up, you can navigate to the ThorCam Imaging Software as shown below

“Start” → “All Programs” → “Thorlabs” → “Scientific Imaging ” → “ThorCam”

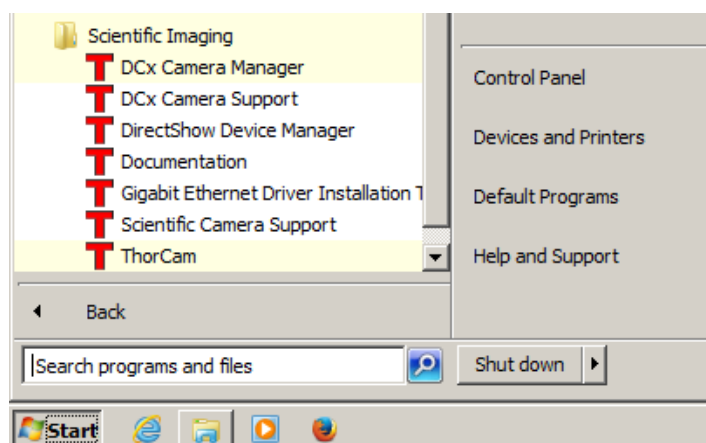


Figure 2 **Thorlabs Installed Items**

4.2.3. Installing 3rd Party Software Applications

After installation of Thorlabs components is complete, you have the option to install plug-ins for select 3rd party image analysis packages you may already have installed on your computer, such as MATLAB™.

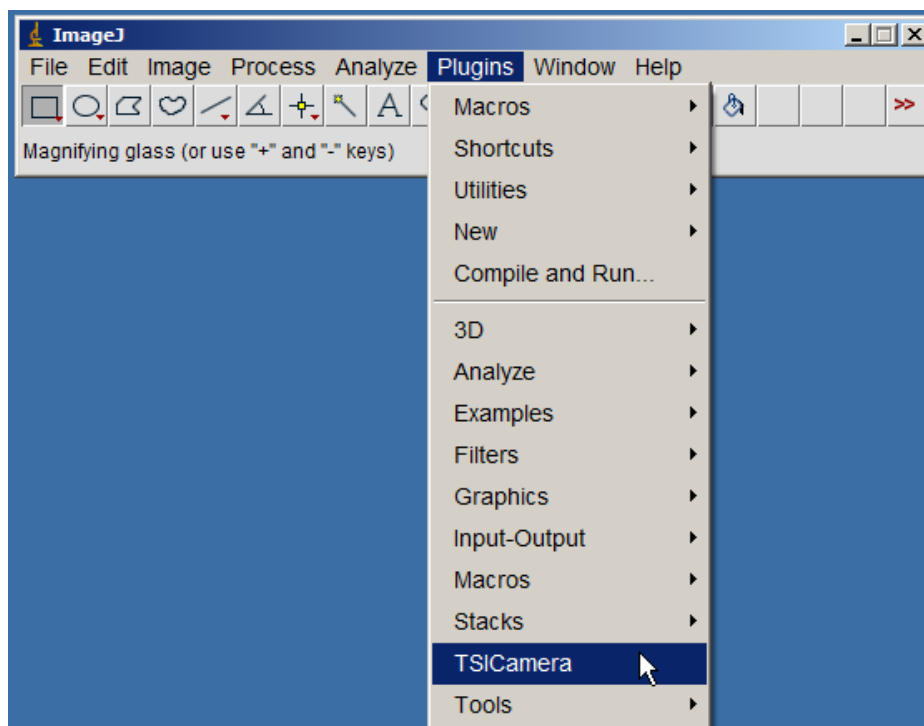
MATLAB and ImageJ plugins are installed via the executables in the following directory

```
C:\Program Files\Thorlabs\Scientific Imaging\Scientific Camera Support\third party software support
```

LabVIEW VIs are bundled into a Zip file. To use the LabVIEW VIs, extract from the Zip file and place in the appropriate LabVIEW VI directory on your system, according to the instructions from National Instruments

Note: These plug-ins are only required if you wish to control the camera directly from within the 3rd party software. It is not necessary to install the plug-ins if your preferred mode of operation is, for example, to use ThorCam or Micro-manager for acquisition and then analyze saved images via ImageJ.

To begin, run ImageJ and select “TSCamera” from the list of available Plugins



Special note for users of Micro-manager software: support for Thorlabs scientific cameras is included when you run versions 1.4.14 and later. If you wish to download or update your Micro-Manager software, please visit

https://micro-manager.org/wiki/Micro-Manager_Open_Source_Microscopy_Software

Before using your camera within Micro-Manager, first make sure that your camera is properly installed and powered-ON. You may run a session of ThorCam to confirm that the camera, software and drivers are properly installed. Then, shut down your ThorCam session and start a Micro-manager session.

4.3. Connecting the Camera

To connect the camera, follow the steps and refer to the diagram below.

1. With the power supply turned off, connect the power supply to the “POWER” connector on the back of the camera. The connector on the camera is labeled “POWER”.
2. Connect the auxiliary cable (**optional, ordered separately**) into the port on the camera labeled as “AUX”.
3. Connect the interface cable, either a Gigabit Ethernet (GigE) or a Camera Link, based on your camera model.
 - *If you are utilizing a Cat5e Gigabit Ethernet (GigE) Cable:* Connect the Ethernet cable to the port on the camera labeled “GigE”. Connect the other end into the port of the Intel® Gigabit CT PCI Express desktop adapter, installed in the computer. **For a description of the status LEDs on the camera’s GigE port, please see section 5.1.**

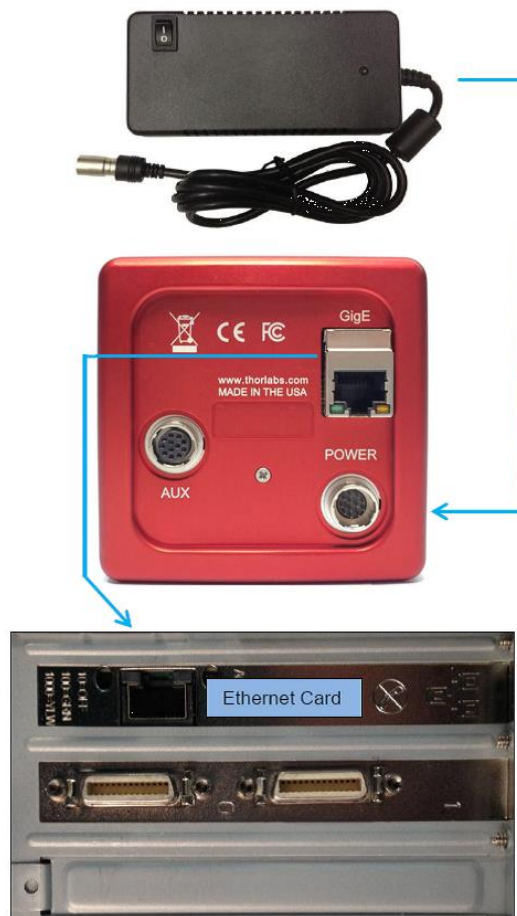


Figure 3 **Diagram of Connectors on GigE configuration**

- *If you are utilizing a Camera Link Cable:* Connect one end of the Camera Link cable into the port labeled “CL 0”. Connect the other end into the port labeled “0” of the EDT VisionLink F4 Camera Link card, installed in the computer. Connect the second Camera Link cable to the port labeled “CL 1”, and the other end into the port labeled “1” on the Camera Link card. (Port 0 is the default port, while port 1 is used for multi-tap operation.) See Figure 4.
- *If you are utilizing a USB 3.0 Cable:* Connect one end of the USB 3.0 cable into the camera port labeled “USB”. Connect the other end into a USB 3.0 “SS” port on your computer. See Figure 3. **For a description of the status LEDs on the USB rear panel, please see section 5.1.**

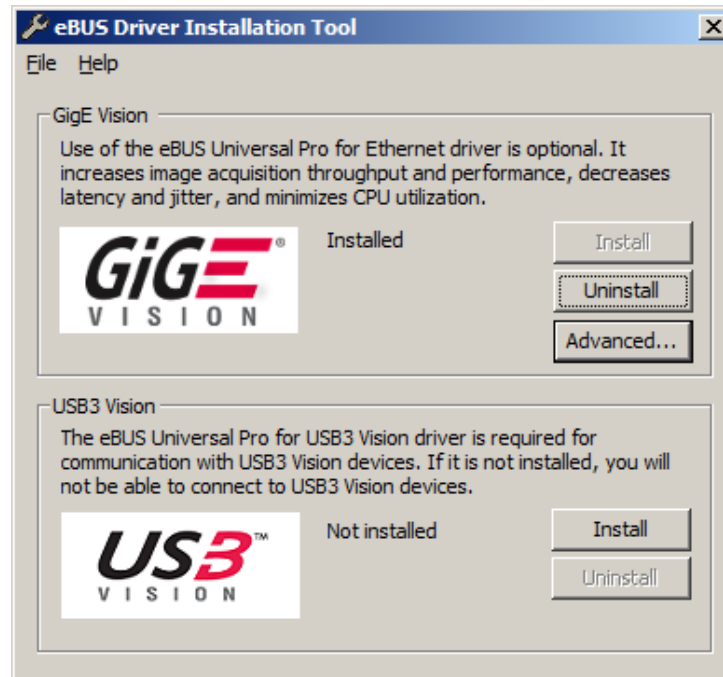


Figure 4 Diagram of Connectors on CL configuration (Left) and USB 3.0 (Right)

4.3.1. Configuring your Gigabit Ethernet adaptor for best performance

The Gigabit Ethernet NIC supplied with your camera is essential for the highest data rate performance. Please use it if at all possible. Ensure that the camera is connected directly to the NIC, not through a switch and shared with other devices unless necessary, to avoid competition for bandwidth.

Regardless of NIC used, you can configure your NIC for best performance possible by launching the Gigabit Ethernet Driver installation tool from the Start Menu illustrated in Figure 2. When launched, the following diagram will appear



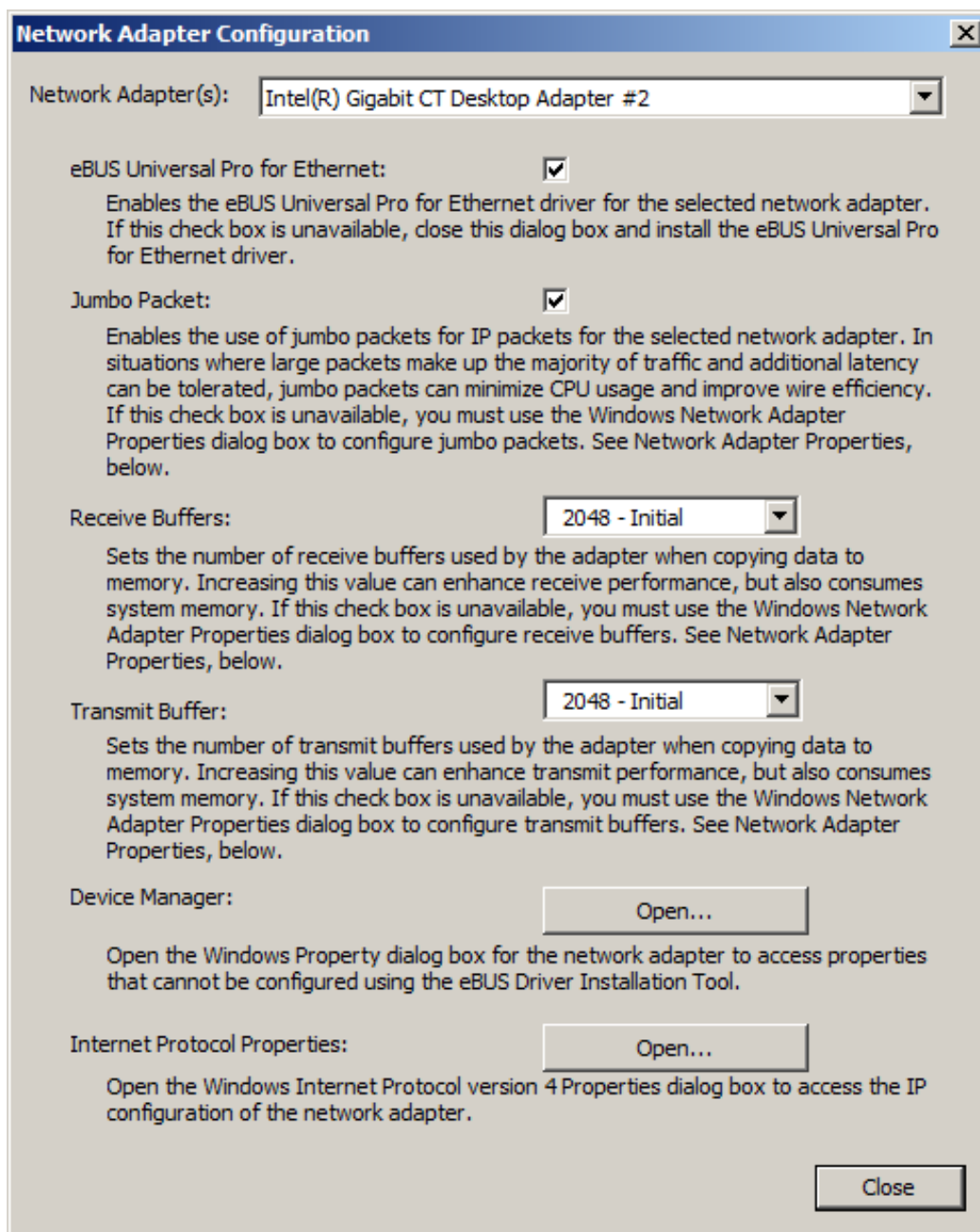
Note that USB3 Vision is not installed, even if you have a Thorlabs USB 3.0 camera, as Thorlabs cameras use a separate USB 3.0 driver. Do not install the USB3 Vision driver.

Click "Advanced..." and select the NIC for your camera from the pulldown in the window shown below. The Thorlabs NIC is the Intel® Gigabit CT Desktop Adaptor. Depending on your NIC, one or more of the selections shown will be accessible. Select

- ✓ eBUS Universal Pro for Ethernet
- ✓ Jumbo Packet
- Maximum value for Receive buffers
- Maximum value for Transmit buffer

It should not be necessary to adjust any other parameters.

It is also not necessary to use these settings for your other NICs not associated with the camera (such as the NIC for your local network).



4.3.2. Multiple Camera Operation

If multiple camera operation is required, it is recommended that a Gigabit Ethernet switch topology be setup, as shown below. When multiple cameras are connected and powered on, they will be visible in the Image Detector dropdown of Hardware Setup panel. Both control and display revert to the camera that is selected from the dropdown menu.

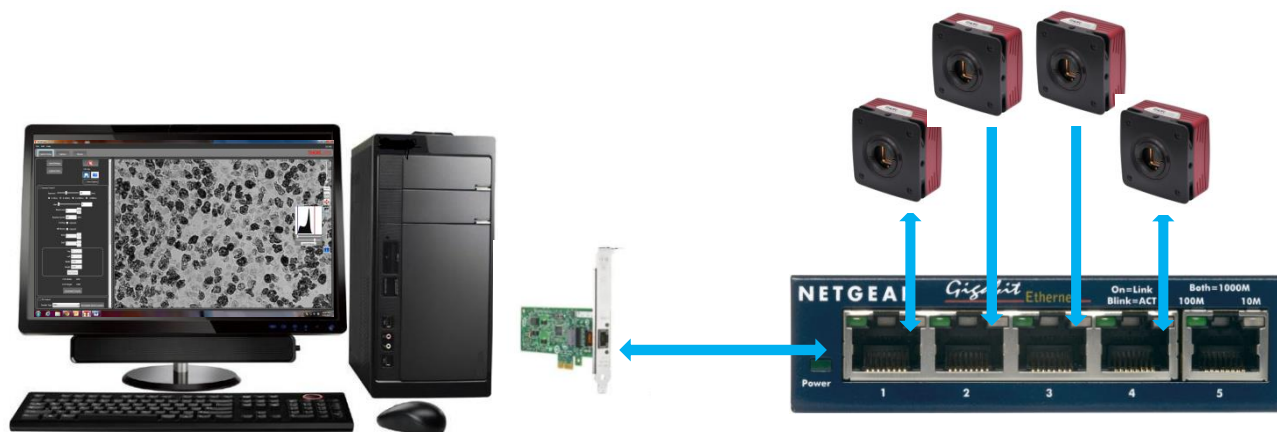


Figure 5 **Gigabit Ethernet Switch Topology Setup for Multiple Cameras**

4.4. Optical and Mechanical Mounting Considerations

4.4.1. Using a C-Mount Lens

For the best results, the use of a C-Mount lens that matches the optical format of the 4/3" (22mm) imaging area is recommended. For more information on Thorlabs C-Mount lenses, please visit www.thorlabs.com

C-mount lenses are specified with a flange focal distance of 17.5 mm. However, there can be considerable variation in the flange focal distance among commercially available lenses.

To accommodate the variation in commercially available lenses, the camera has an adjustable flange focal range of ± 1.5 mm. A procedure to set the flange focal distance is described in the next section.



Figure 6 Camera Shown with C-Mount Lens (not supplied) Using the C-Mount Adapter

4.4.2. Mounting the Camera

On most commercial microscopes, the use of a suitable adapter is recommended in order to match the optical format of the 4/3" (22mm) imaging area. Please note that some commercial 1x adapters may underfill the imaging area, leading to vignetting of the image.

The adjustable flange focus may also be used to parfocalize a microscope, as described in the next section.



Figure 7 Camera Shown on Microscope Using C-Mount Adapter

Four 1/4"-20 tapped holes are provided, one on each side of the housing. These may be used with tripods, or other optical mounting devices. These 1/4"-20 tapped holes are compatible with Thorlabs Ø1/2" posts. For more information on Thorlabs Ø1/2" posts, please visit www.thorlabs.com.

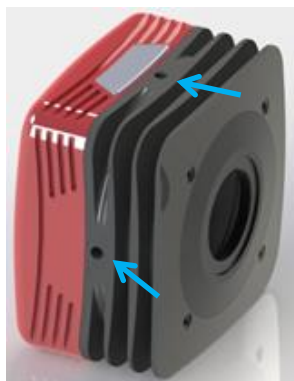


Figure 8 **Arrows Indicate Two of the Four 1/4"-20 Tapped Holes on Camera**

4.4.3. Using the Camera with a Cage System

The cameras have 4-40 tapped holes for compatibility with Thorlabs 60 mm Cage system.

For more information on Thorlabs 60 mm Cage system components, please visit www.thorlabs.com.



Figure 9 **Camera Shown as Part of a 60 mm Thorlabs Cage System**

4.4.4. Compatible Adapters for the Camera

The camera's standard C-mount (1.000"-32) threading may be adapted with thread-to-thread adapters. For example, Thorlabs SM1A9 or SM1A9TS adapter with external c-mount threads and internal SM1 1.035"-40 threading may be used with Thorlabs Ø1" lens tubes.



Figure 10 **Thorlabs SM1A9 Adapter with External C-Mount Threads and Internal SM1 Threads**

4.5. Optical Front End

The images below show the components located on the front end of the camera.

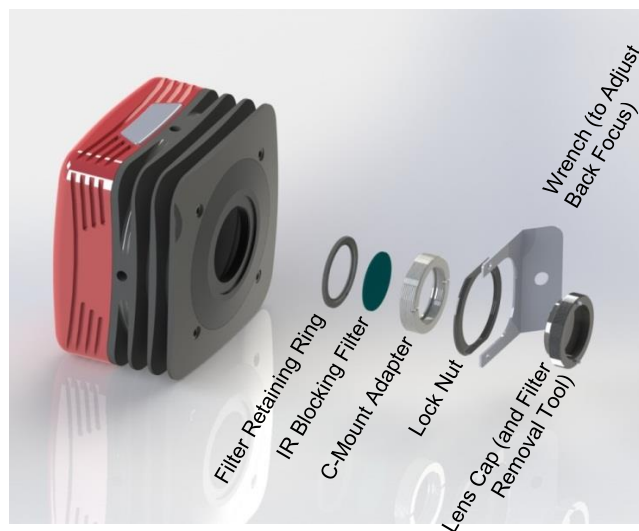


Figure 11 Exploded View of Optical and Mechanical Components



Figure 12 Optical and Mechanical Sub-Assemblies

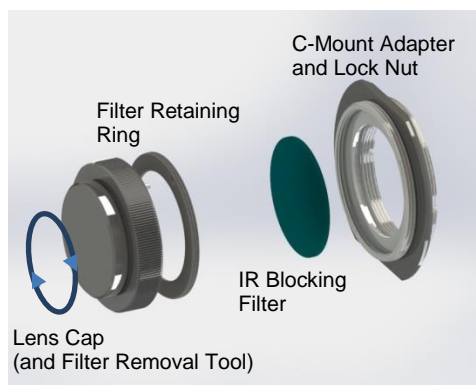


Figure 13 Reverse View Showing IR Filter and Associated Components

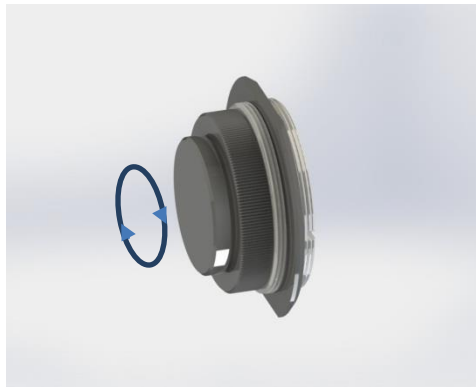


Figure 14 Reverse View of IR Filter Sub-Assembly. Shows the Lens Cap Used as a Tool for Installing and Removing the Filters

4.5.1. Description of Components

- **C-Mount Adapter:** Allows the camera to be optically coupled with standard C-mount optics, including lenses and microscope adapters.
- **Lock Nut:** Used to secure the c-mount adapter to the main camera body, while allowing adjustability of the back focus distance. A wrench is provided to loosen and tighten the lock nut (See Section 4.6)
- **Lens Cap:** A protective cover that should be installed during shipment and also when the camera is not in use.

Note Dual use of *lens cap* as a tool for removing/installing the *filter retaining ring* - the lens cap has two metallic prongs/inserts which allows it to also be reversed and used as a tool for removing or installing the *filter retaining ring*. The metal prongs are sized to fit into the two holes in the *filter retaining ring*, which can then be screwed into the back of the *c-mount adapter* ring. A groove in the back of the *c-mount adapter* ring accommodates the IR-block as an insert.

- **IR Blocking Filter:** Unless otherwise requested, an IR filter is typically installed and held in place by a *filter retaining ring*. Silicon CCD imagers have responsivity that extends beyond the VIS range, into the NIR spectral range. The IR filter is intended to cut off at higher wavelengths. Users may, at their discretion, remove the IR filter in NIR imaging applications - or replace it with a custom optical filter with the same nominal dimensions. Note: maximum filter thickness = 0.050" (1.270 mm). See Chapter 13 for more information

4.6. Optical Front End Procedures

4.6.1. Removing the C-mount Lock Ring Assembly

Removal of the C-mount lock lens ring is not required for normal operation. It is required if users wish to remove, replace, or clean the installed filter. Follow the steps below to remove the C-mount ring assembly.

Note: Re-adjustment of the lens back-focus will be required after re-assembly. See the “Back Focus Adjustment” in Section 4.6.3.

1. Loosen the lens mount lock ring with the supplied wrench.



Figure 15 *Loosening the C-mount and IR-Block Filter Assembly from Camera*

2. Unscrew the C-mount lock ring assembly from the camera body and remove the lock ring from the C-mount adapter.



Figure 16 *Removing the C-mount and IR-Block Filter Assembly from Camera Body*

4.6.2. Filter Removal and Replacement Procedure

TSI cameras are typically provided with an IR-blocking filter installed. The CCD has responsivity into the Near Infrared (for more details refer to specifications sections near the end of this document).

If near-infrared sensitivity is desired, the IR-blocking filter should not be installed.

The optical front end is designed to accommodate standard 1" filters. Users may, at their discretion, operate the camera without any glass installed or install custom filters in front of the CCD.

Note: If no glass is installed, dust and debris may collect on the CCD faceplate. Please use every precaution to avoid contact with the CCD faceplate and to keep the camera securely mounted to the optical system or capped when not in use.

Removal of the Filter from the C-mount Adapter

1. Hold the lens cap with the pins sticking upward in one hand.
2. Lower the C-mount adapter on to the pins with the other hand.
3. Hold the lens cap and rotate the C-mount adapter counter-clockwise and then remove the lens ring.
4. Remove the filter from the filter ring with lens tissue and store in a protective container.
5. Replace the lens ring on to the C-mount adapter and screw on clockwise.
6. Remove the lens cap.
7. To re-install the filter, reverse the above procedure.
8. Screw the C-mount adapter back into the locking ring and screw both back onto the camera.



Figure 17 ***Removal of the IR-Blocking Filter from the Assembly***

4.6.3. Re-assembly of the C-mount Lock Ring and Flange Focus Adjustment

1. Install C-mount ring adapter into the front side of the camera as shown in Figure 18. **Do NOT tighten or lock.**
2. Install a C-Mount lens (not provided) onto the camera.
3. Ensure that the lens is screwed all the way into the C-mount adapter but with the tapered lock-nut ring loosened so that the lens and the adaptor can be adjusted together.
4. Power up the camera and launch ThorCam software.
5. Set gain, black level and exposure to settings that result in a live image.
6. Set Camera Lens Focus to ∞ infinity.
7. Adjust Camera Lens Iris to obtain a viewable image.
8. Point the camera to an object far away which is at infinity.
9. Adjust C-mount lens ring on the camera until image is at best focus.
10. When image is in sharp focus, lens “Back Focus” is properly set.
11. Tighten the Tapered Lock Ring using the Focusing wrench to secure setting



Figure 18 **Re-assembly of the C-Mount Assembly onto Camera**

Note: To obtain parfocality on a microscope installation, ensure that the camera port of the microscope is screwed into the lens adapter but with the tapered lock ring loosened. Move the assembly until the camera image and the images viewed through the oculars are simultaneously in focus. Tighten the Tapered Lock Ring using the focusing wrench to secure the setting.

4.7. Auxiliary Connector

The auxiliary connector on the camera allows the user to access optional camera control and internal status signals.

4.7.1. Pin Descriptions

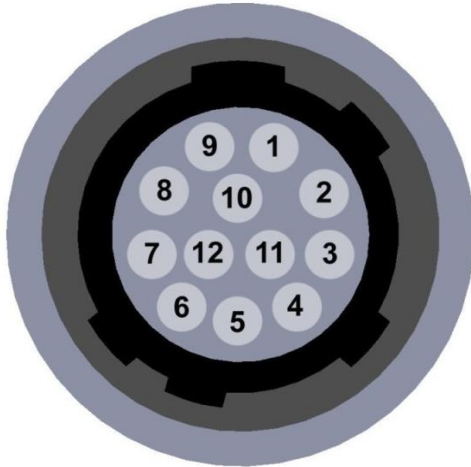


Figure 19 Illustration of the Auxiliary Connector on the Rear of the Camera

Pin Descriptions	
Pin #	Signal
1	Reserved
2	Reserved
3	Reserved
4	STROBE_OUT
5	TRIGGER_IN
6	LVAL_OUT
7	TRIGGER_OUT
8	LVDS_TRIGGER_IN-N (Differential Pair with Pin 9)
9	LVDS_TRIGGER_IN-P (Differential Pair with Pin 8)
10	Ground
11	Reserved
12	FVAL_OUT

4.7.2. Signal Descriptions

- **Pins 1, 2, 3, 11:** Reserved.
- **Pin 4, STROBE_OUT (Output):** STROBE_OUT is a TTL output that is high during the actual sensor exposure time when in continuous, overlapped exposure mode. STROBE_OUT is typically used to synchronize an external flash lamp or other device with the camera.
- **Pin 5 TRIGGER_IN (Input):** TRIGGER_IN is a TTL input used to trigger exposures on the transition from the HIGH state to LOW state.
- **Pin 6, LVAL_OUT (Output):** LVAL_OUT refers to “Line Valid Output.” It is an active-HIGH TTL signal and is asserted during the valid pixel period on each line. It returns low during the inter-line period between each line and during the inter-frame period between each frame.
- **Pin 7, TRIGGER_OUT (Output):** TRIGGER_OUT is a 6 μ s positive pulse that is asserted when using the various external trigger input options; TRIGGER_IN, LVDS_TRIGGER_IN, or the Camera Link CC1 signal. The CC1 signal, driven from the host, is one of the software-controlled trigger signals for the camera. The CC1 signal is brought out of the camera as TRIGGER_OUT at the High-to-Low transition to allow triggering of other devices. The same applies to the other external triggers.
- **Pins 8, 9 LVDS_TRIGGER_IN_N and LVDS_TRIGGER_IN_P (Input):** LVDS_TRIGGER_IN is an LVDS (low voltage differential signal) input used to trigger exposures on the transition from the HIGH state to LOW state. Suffixes “N” and “P” identify the negative and positive inputs respectively of the LVDS signal.
- **Pin 10, GND:** This is the electrical ground for the camera signals.
- **Pin 12, FVAL_OUT (Output):** FVAL_OUT refers to “Frame Valid Output” and is a TTL output that is HIGH during active readout lines. FVAL_OUT remains high throughout the active readout and returns low between frames.

4.7.3. Auxiliary I/O Cable Requirements

An auxiliary I/O cable may be fabricated in order to connect to the AUX I/O port of the camera. This cable is application specific in all cases due to varying lengths and functions that are used. If an Auxiliary I/O cable is to be used with this camera it must be constructed using shielded cabling in order for the camera to adhere to CE and FCC compliance. The mating connector for the rear panel connector is **HIROSE HR10-10P-12P (73)**.

A 10 foot long (3m) auxiliary I/O cable and interconnect break-out board are available from Thorlabs allowing access to some of the I/O control functions (Trigger_In, Trigger_Out, LVAL_Out, FVAL_Out, and Strobe_Out). Order the “8050-CAB1” and the “TSI-IOBOB”, as well as the required number and style of SMA patch cables for your specific application. Order the CA28xx SMA-to-BNC series (i.e. CA2848 for 48” cable) or the CA29xx SMA-to-SMA series (CA2948 for 48” cable) as needed.

Chapter 5 Operation

The 8051/4070/1501/340-series cameras can be operated using the ThorCam and ThorImageLS (Offered separately by Thorlabs Imaging Systems). For more details on using ThorCam and ThorImageLS features, please consult the ThorCam and ThorImageLS User Manuals.

5.1. Starting the Camera

With the camera software installed and the camera connected as instructed, turn on the camera power supply. A green indicator on the supply indicates it is operating.

In the case of **Gigabit Ethernet** cameras, both the Yellow and Green indicators should light up on the camera's Gigabit Ethernet connector several seconds after power is applied. It is normal for the Yellow indicator to stay on continuously, and for the Green indicator to flash when the camera is sending data. The table below details the conditions represented by the status indicators.

LED Color	If LED is Flashing	If LED is On	If LED is Off
Green	The Link is Operational, but the Camera is Currently not Sending Data	Normal (Indicates that the Camera is Sending Data)	There is no Ethernet Connection
Amber	Normal Operation	Not Applicable	Either there is no Ethernet Connection, or The Camera is Plugged into a 10/100 Mbps Network

In the case of **USB 3.0** cameras, the Status LED should light up solid Green several seconds after power is applied, and start flashing whenever the camera is generating frames. The Link LED will briefly be solid white when powering up the camera, and is active whenever the camera is connected to, and enumerated by a USB port. The table below details the conditions represented by the status indicators.

LED	If LED is Flashing	If LED is On	If LED is Off
Link	Not Applicable	Blue: Connected to a USB 3.0 Port Green: Connected to a USB 2.0 Port Amber: Camera has internal USB problem	There is no USB Connection or, Camera is powered off
Status	Green: Camera is sending frames	Green: Camera is paused	Camera is powered off

5.2. Camera Timing Diagrams

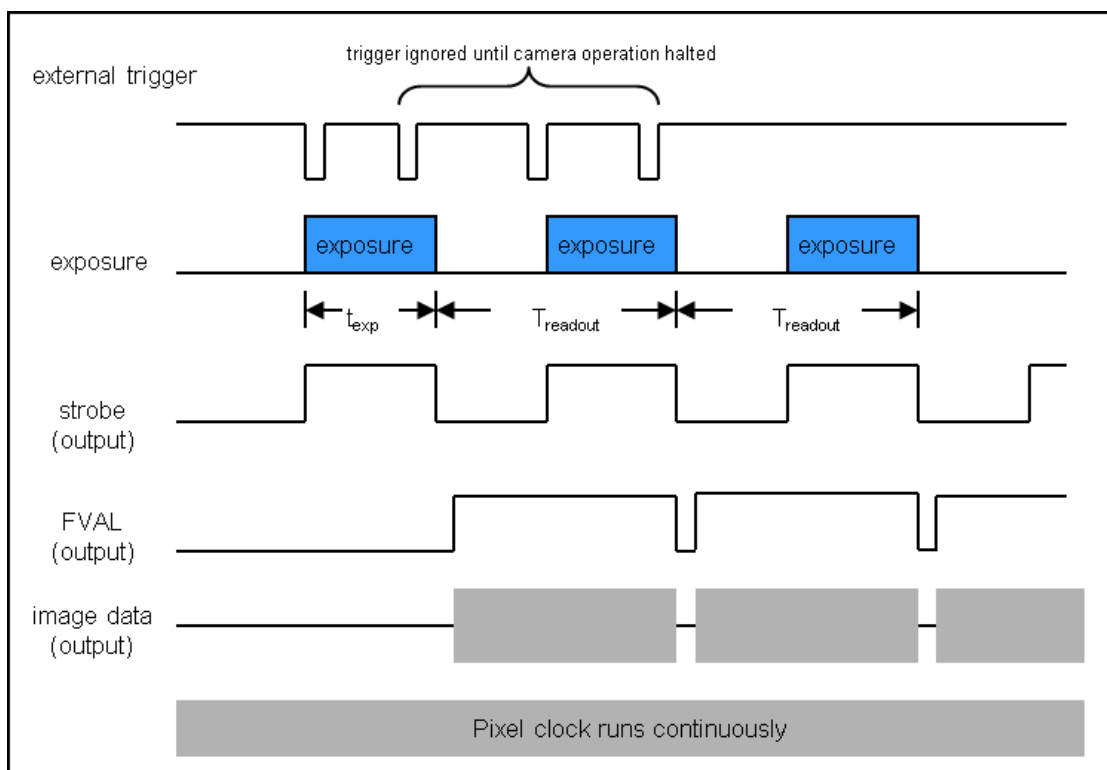


Figure 20 Timing Diagram – Standard, Frames per Trigger = 0 or > 1

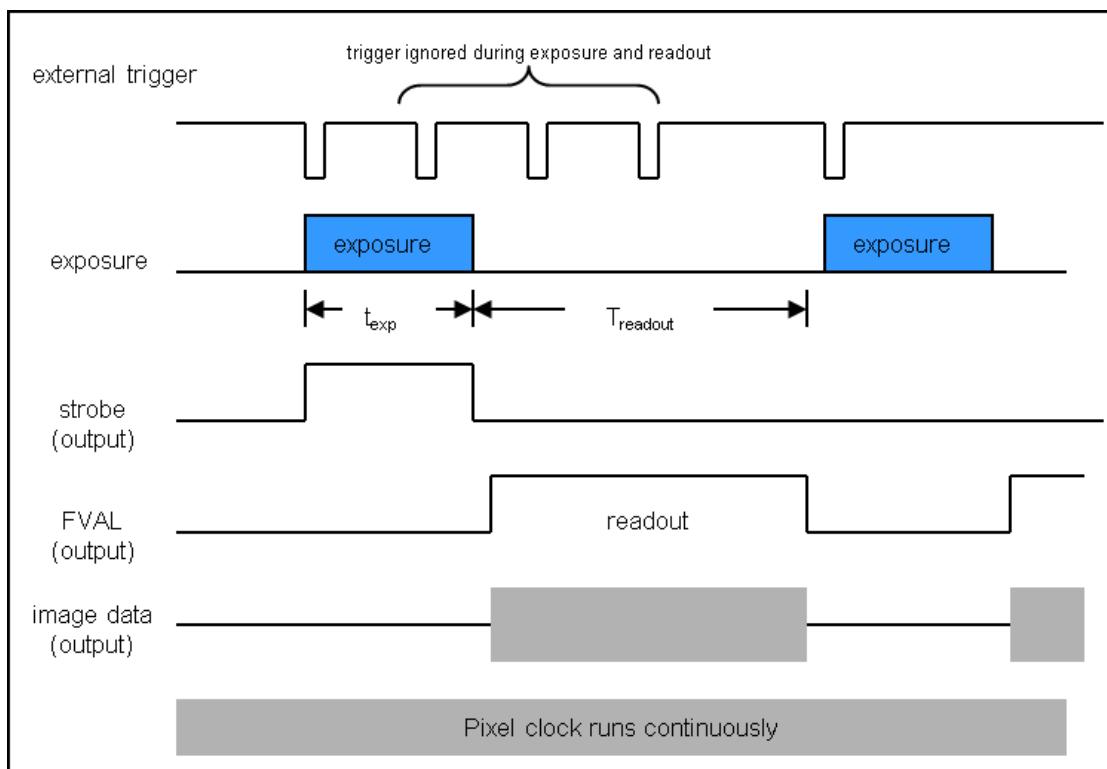


Figure 21 Timing Diagram – Standard, Frames per Trigger = 1

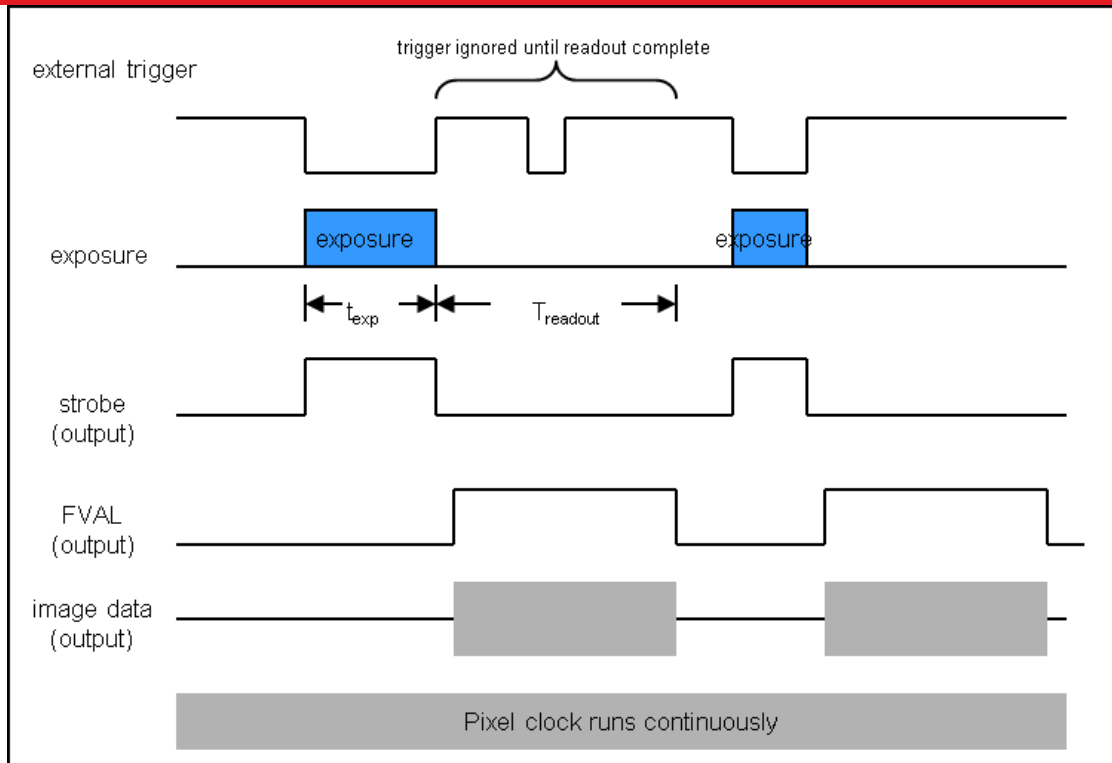


Figure 22 **Timing Diagram – Bulb Mode**

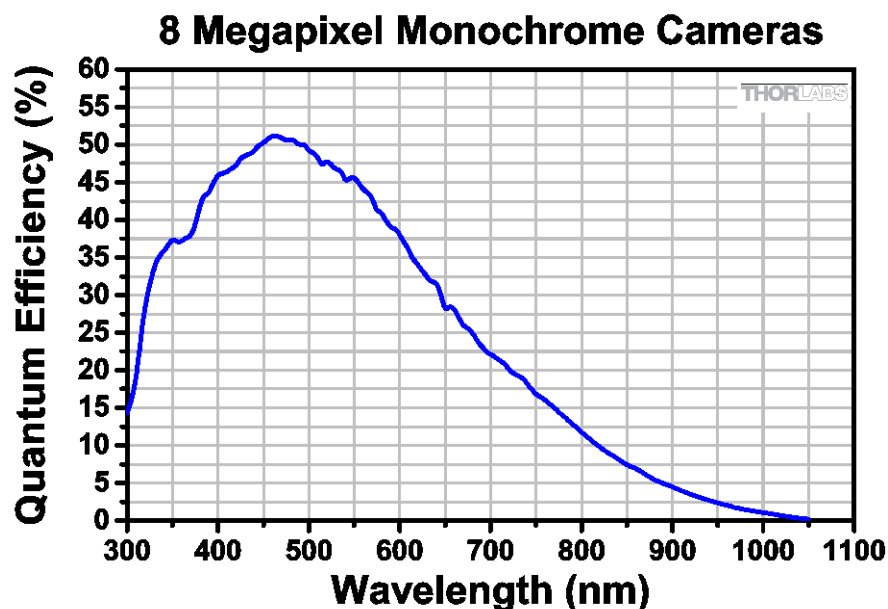
Chapter 6 8051M Specifications

6.1. CCD Specifications

CCD Specifications	
CCD Manufacturer and Item Number	On Semi KAI-08051-AXA-JD-BA
Number of Active Pixels	3296 (H) x 2472 (V)
Pixel Size	5.5 μm X 5.5 μm
Optical Format	4/3" Format (22mm diagonal)

6.2. Responsivity

An IR-blocking filter is typically installed. This filter may be removed if NIR responsivity is desired. See Chapter 13 for specifications related to the IR-blocking filter.



6.3. Imaging Specifications

Imaging Specifications	
Exposure Time	0 to 1000 seconds in 1 ms increments*
CCD Pixel Clock Speed	20 MHz or 40 MHz
ADC Resolution	-GE 14 bits (1-Tap) / 12 bits (2-Tap) -CL 14 bits (1-Tap, 2-Tap, 4-Tap) -USB 14 bits (1-Tap, 2-Tap, 4-Tap)
ADC Gain	0 to 1023 counts
Optical Black Clamp	0 to 1023 counts
Vertical Hardware Binning	1 to 10
Region of Interest	1 x 1 pixel to 3296 x 2472 pixels, rectangular
Read Noise	< 10 e- @ 20 MHz

*Exposure time increment varies with operating mode.

6.4. Example Frame Rates

Example Frame Rates @ 1 ms Exposure Time	One Tap		Two Tap		Four Tap	
	20 MHz	40 MHz	20 MHz	40 MHz	20 MHz	40 MHz
Full Sensor (3296 x 2472)	2.3 fps	4.5 fps	4.4 fps	8.5 fps	8.8 fps	17.1 fps
Full Sensor, Bin by 2 (1648 x 1236)	4.4 fps	8.5 fps	8.3 fps	15.7 fps	16.6 fps	31.2 fps
Full Sensor, Bin by 10 (329 x 247)	17.0 fps	29.9 fps	29.0 fps	47.1 fps	56.8 fps	92.3 fps

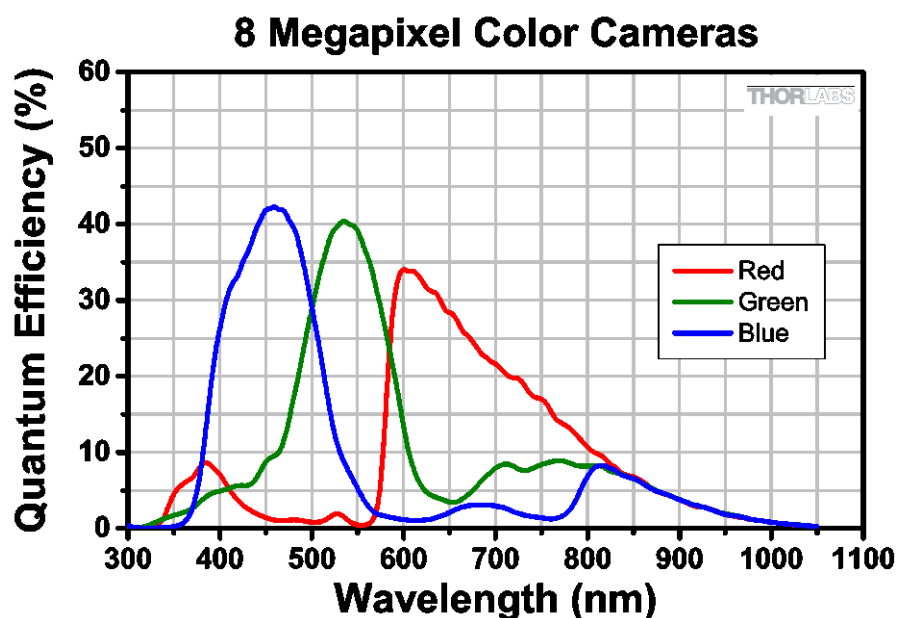
Chapter 7 8051C Specifications

7.1. Color CCD Specifications

CCD Specifications	
CCD Manufacturer and Item Number	On Semi KAI-08051-FXA-JD-BA
Number of Active Pixels	3296 (H) x 2472 (V)
Pixel Size	5.5 μm X 5.5 μm
Optical Format	4/3" Format (22mm diagonal)

7.2. Responsivity

An IR-blocking filter is typically installed. This filter may be removed if NIR responsivity is desired. See Chapter 13 for specifications related to the IR-blocking filter.



7.3. Imaging Specifications

Imaging Specifications	
Exposure Time	0 to 1000 seconds in 1 ms increments*
CCD Pixel Clock Speed	20 MHz or 40 MHz
ADC Resolution	-GE 14 bits (1-Tap) / 12 bits (2-Tap) -CL 14 bits (1-Tap, 2-Tap, 4-Tap) -USB 14 bits (1-Tap, 2-Tap, 4-Tap)
ADC Gain	0 to 1023 counts
Optical Black Clamp	0 to 1023 counts
Vertical Hardware Binning	1 to 10
Region of Interest	1 x 1 pixel to 3296 x 2472 pixels, rectangular
Read Noise	< 10 e- at 20 MHz

*Exposure time increment varies with operating mode.

7.4. Example Frame Rates

Example Frame Rates @ 1 ms Exposure Time	One Tap		Two Tap		Four Tap	
	20 MHz	40 MHz	20 MHz	40 MHz	20 MHz	40 MHz
Full Sensor (3296 x 2472)	2.3 fps	4.5 fps	4.4 fps	8.5 fps	8.8 fps	17.1 fps
Full Sensor, Bin by 2 (1648 x 1236)	4.4 fps	8.5 fps	8.3 fps	15.7 fps	16.6 fps	31.2 fps
Full Sensor, Bin by 10 (329 x 247)	17.0 fps	29.9 fps	29.0 fps	47.1 fps	56.8 fps	92.3 fps

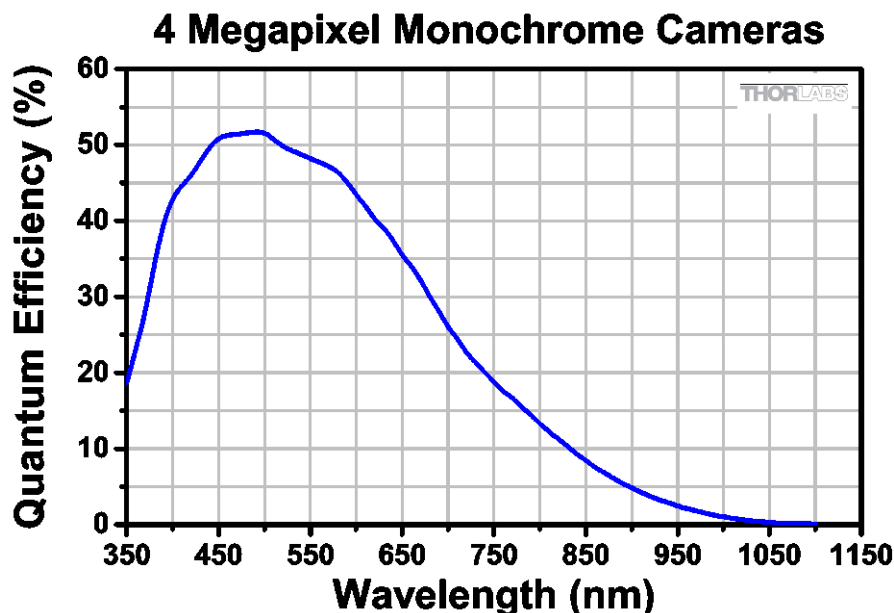
Chapter 8 4070M Specifications

8.1. CCD Specifications

CCD Specifications	
CCD Manufacturer and Item Number	On Semi KAI-04070M
Number of Active Pixels	2048 (H) x 2048 (V)
Pixel Size	7.4 μm X 7.4 μm
Optical Format	4/3" Format (21.4mm diagonal)

8.2. Responsivity

An IR-blocking filter is typically installed. This filter may be removed if NIR responsivity is desired. See Chapter 13 for specifications related to the IR-blocking filter.



8.3. Imaging Specifications

Imaging Specifications	
Exposure Time	0 to 1000 seconds in 1 ms increments*
CCD Pixel Clock Speed	20 MHz or 40 MHz
ADC Resolution	-GE 14 bits (1-Tap) / 12 bits (2-Tap) -CL 14 bits (1-Tap, 2-Tap, 4-Tap) -USB 14 bits (1-Tap, 2-Tap, 4-Tap)
ADC Gain	0 to 1023 counts
Optical Black Clamp	0 to 1023 counts
Vertical Hardware Binning	1 to 10
Region of Interest	1 x 1 pixel to 2048 x 2048 pixels, rectangular
Read Noise	< 12 e ⁻ at 20 MHz

*Exposure time increment varies with operating mode.

8.4. Example Frame Rates

Example Frame Rates @ 1 ms Exposure Time	One Tap		Two Tap		Four Tap	
	20 MHz	40 MHz	20 MHz	40 MHz	20 MHz	40 MHz
Full Sensor (2048 x 2048)	4.1 fps	7.7 fps	7.4 fps	13 fps	14.8 fps	25.8 fps
Full Sensor, Bin by 2 (1024 x 1024)	7.5 fps	13.1 fps	12.8 fps	20.5 fps	25.3 fps	40.6 fps
Full Sensor, Bin by 10 (204 x 204)	21.6 fps	30.5 fps	30.0 fps	38.1 fps	58.8 fps	75.1 fps

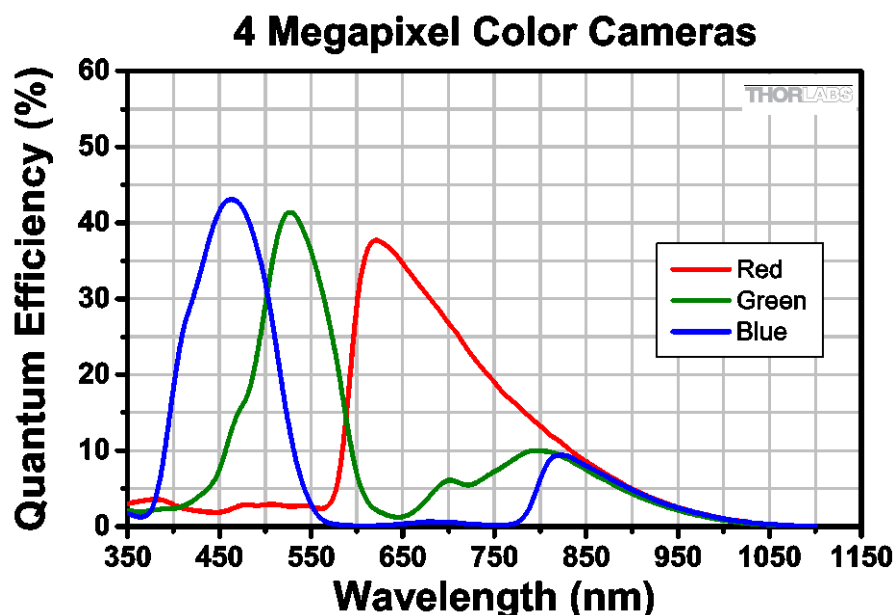
Chapter 9 4070C Specifications

9.1. Color CCD Specifications

CCD Specifications	
CCD Manufacturer and Item Number	On Semi KAI-04070-FBA
Number of Active Pixels	2048 (H) x 2048 (V)
Pixel Size	7.4 μm X 7.4 μm
Optical Format	4/3" Format (21.4mm diagonal)

9.2. Responsivity

An IR-blocking filter is typically installed. This filter may be removed if NIR responsivity is desired. See Chapter 13 for specifications related to the IR-blocking filter.



9.3. Imaging Specifications

Imaging Specifications	
Exposure Time	0 to 1000 seconds in 1 ms increments*
CCD Pixel Clock Speed	20 MHz or 40 MHz
ADC Resolution	-GE 14 bits (1-Tap) / 12 bits (2-Tap) -CL 14 bits (1-Tap, 2-Tap, 4-Tap) -USB 14 bits (1-Tap, 2-Tap, 4-Tap)
ADC Gain	0 to 1023 counts
Optical Black Clamp	0 to 1023 counts
Vertical Hardware Binning	1 to 10
Region of Interest	1 x 1 pixel to 2048 x 2048 pixels, rectangular
Read Noise	< 12 e ⁻ at 20 MHz

*Exposure time increment varies with operating mode.

9.4. Example Frame Rates

Example Frame Rates @ 1 ms Exposure Time	One Tap		Two Tap		Four Tap	
	20 MHz	40 MHz	20 MHz	40 MHz	20 MHz	40 MHz
Full Sensor (2048 x 2048)	4.1 fps	7.7 fps	7.4 fps	13 fps	14.8 fps	25.8 fps
Full Sensor, Bin by 2 (1024 x 1024)	7.5 fps	13.1 fps	12.8 fps	20.5 fps	25.3 fps	40.6 fps
Full Sensor, Bin by 10 (204 x 204)	21.6 fps	30.5 fps	30.0 fps	38.1 fps	58.8 fps	75.1 fps

Chapter 10 340M Specifications

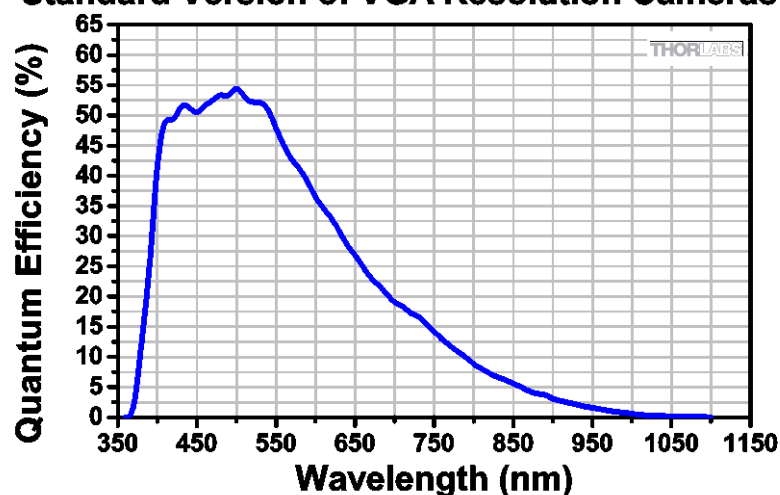
10.1. CCD Specifications

CCD Specifications	
CCD Manufacturer and Item Number	On Semi/Truesense KAI-0340
Number of Active Pixels	640 (H) x 480 (V)
Pixel Size	7.4 μm X 7.4 μm
Optical Format	1/3" Format (5.92 mm diagonal)

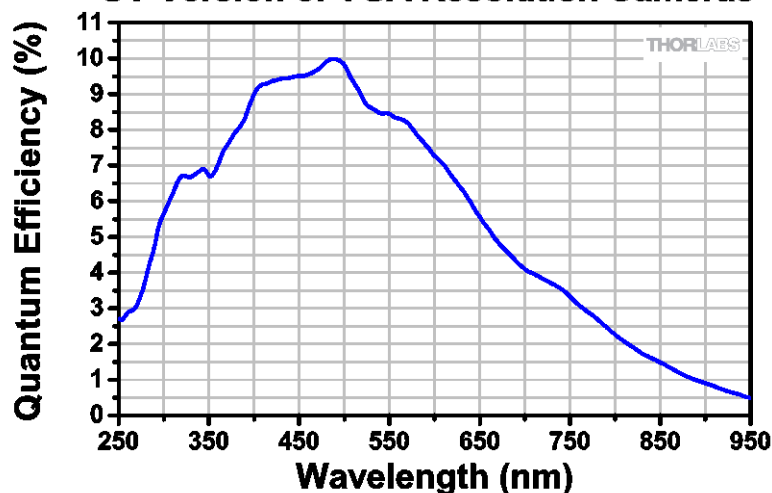
10.2. Responsivity

An IR-blocking filter is typically installed. This filter may be removed if NIR responsivity is desired. See Chapter 13 for specifications related to the IR-blocking filter.

Standard Version of VGA Resolution Cameras



UV Version of VGA Resolution Cameras



10.3. Imaging Specifications

Imaging Specifications	
Exposure Time	0 to 1000 seconds in 1 ms increments*
CCD Pixel Clock Speed	20 MHz or 40 MHz
ADC Resolution	-GE 14 bits (1-Tap) / 12 bits (2-Tap) -CL 14 bits (1-Tap, 2-Tap) -USB 14 bits (1-Tap, 2-Tap)
ADC Gain	0 to 1023 counts
Optical Black Clamp	0 to 1023 counts
Vertical Hardware Binning	1 to 24
Region of Interest	1 x 1 pixel to 640 x 480 pixels, rectangular
Read Noise	< 15 e- at 20 MHz

*Exposure time increment varies with operating mode.

10.4. Example Frame Rates

Example Frame Rates @ 1 ms Exposure Time	One Tap		Two Tap	
	20 MHz	40 MHz	20 MHz	40 MHz
Full Sensor (640 x 480)	57.0 fps	112.3 fps	103.3 fps	200.7 fps
Full Sensor, Bin by 2 (320 x 240)	110.1 fps	213.5 fps	196.8 fps	372.4 fps
Full Sensor, Bin by 10 (64 x 48)	429.0 fps	764.7 fps	712.9 fps	1185.4 fps

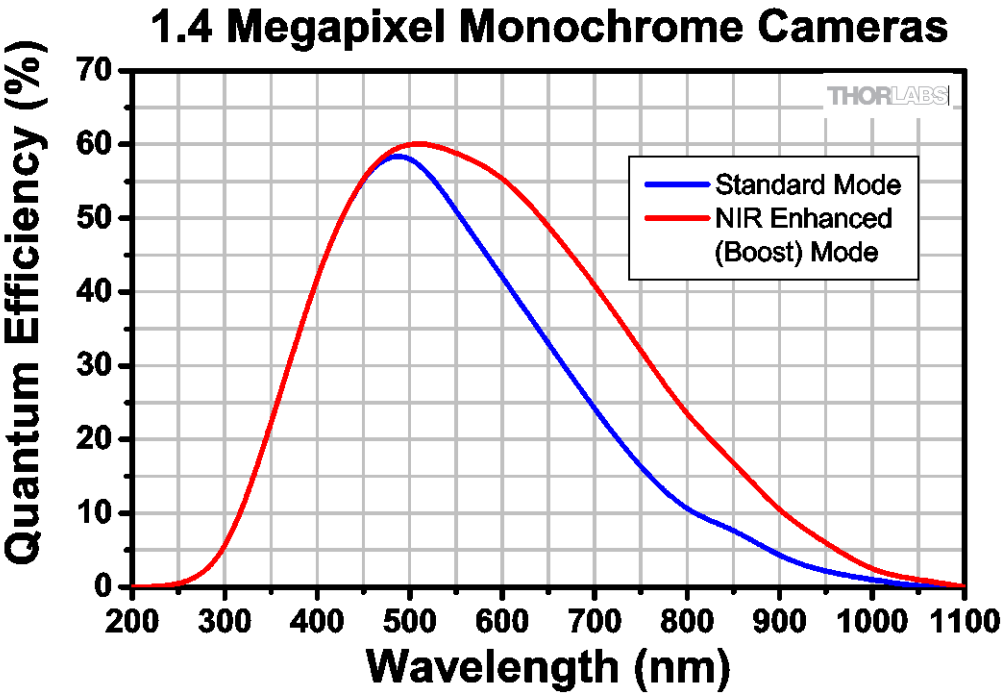
Chapter 11 1501M Specifications

11.1. CCD Specifications

CCD Specifications	
CCD Manufacturer and Item Number	Sony ICX285AL
Number of Active Pixels	1392 (H) x 1040 (V)
Pixel Size	6.45 μm X 6.45 μm
Optical Format	2/3" Format (11mm diagonal)

11.2. Responsivity

An IR-blocking filter is typically installed. This filter may be removed and the camera operated in “NIR Boost” mode if NIR responsivity is desired. NIR Boost mode applies only to monochrome 1501M series cameras. See Chapter 13 for specifications related to the IR-blocking filter.



11.3. Imaging Specifications

Imaging Specifications	
Exposure Time	0 to 1000 seconds in 1 ms increments*
CCD Pixel Clock Speed	20 MHz or 40 MHz
ADC Resolution	14 bits (All I/O Types)
ADC Gain	0 to 1023 counts
Optical Black Clamp	0 to 1023 counts
Vertical Hardware Binning	1 to 24
Region of Interest	1 x 1 pixel to 1392 x 1040 pixels, rectangular
Read Noise	< 6e- (-TE Cooled) / < 7e- (Non-cooled) @ 20 MHz

*Exposure time increment varies with operating mode.

11.4. Example Frame Rates

Example Frame Rates @ 1 ms Exposure Time	20 MHz	40 MHz
Full Sensor (1392 x 1040)	12 fps	23 fps
Full Sensor, Bin by 2 (696 x 520)	23 fps	41 fps
Full Sensor, Bin by 10 (139 x 104)	77 fps	112 fps

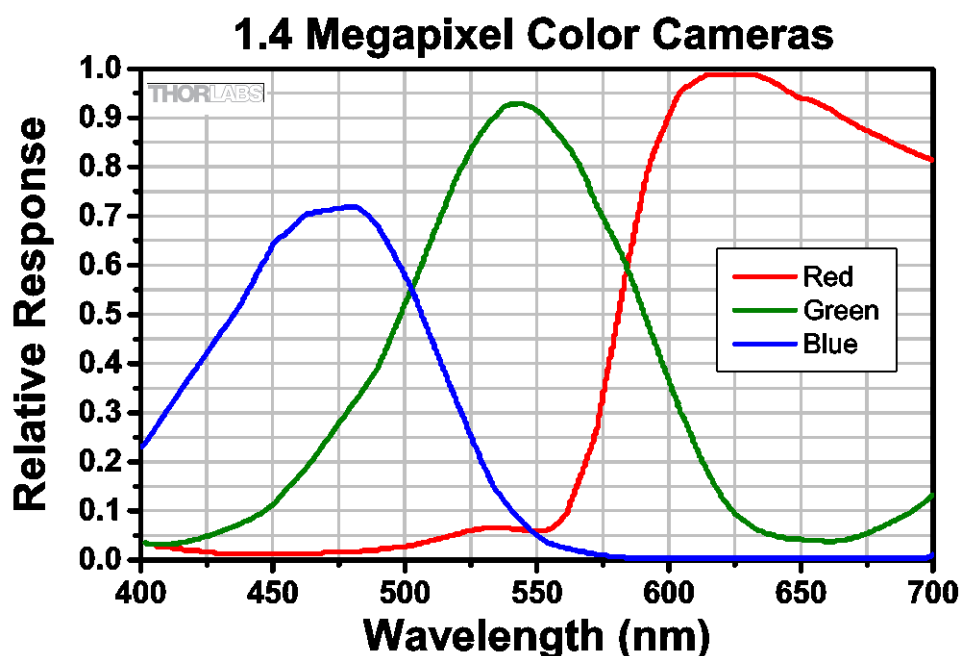
Chapter 12 1501C Specifications

12.1. Color CCD Specifications

CCD Specifications	
CCD Manufacturer and Item Number	Sony ICX285AQ
Number of Active Pixels	1392 (H) x 1040 (V)
Pixel Size	6.45 μm X 6.45 μm
Optical Format	2/3" Format (11mm diagonal)

12.2. Responsivity

An IR-blocking filter is typically installed. This filter may be removed if NIR responsivity is desired. See Chapter 13 for specifications related to the IR-blocking filter.



12.3. Imaging Specifications

Imaging Specifications	
Exposure Time	0 to 1000 seconds in 1 ms increments*
CCD Pixel Clock Speed	20 MHz or 40 MHz
ADC Resolution	14 bits (All I/O Types)
ADC Gain	0 to 1023 counts
Optical Black Clamp	0 to 1023 counts
Vertical Hardware Binning	1 to 24
Region of Interest	1 x 1 pixel to 1392 x 1040 pixels, rectangular
Read Noise	< 6e- (-TE Cooled) / < 7e- (Non-cooled) @ 20 MHz

*Exposure time increment varies with operating mode.

12.4. Example Frame Rates

Example Frame Rates @ 1 ms Exposure Time	20 MHz	40 MHz
Full Sensor (1392 x 1040)	12 fps	23 fps
Full Sensor, Bin by 2 (696 x 520)	23 fps	41 fps
Full Sensor, Bin by 10 (139 x 104)	77 fps	112 fps

Chapter 13 IR Blocking Filter

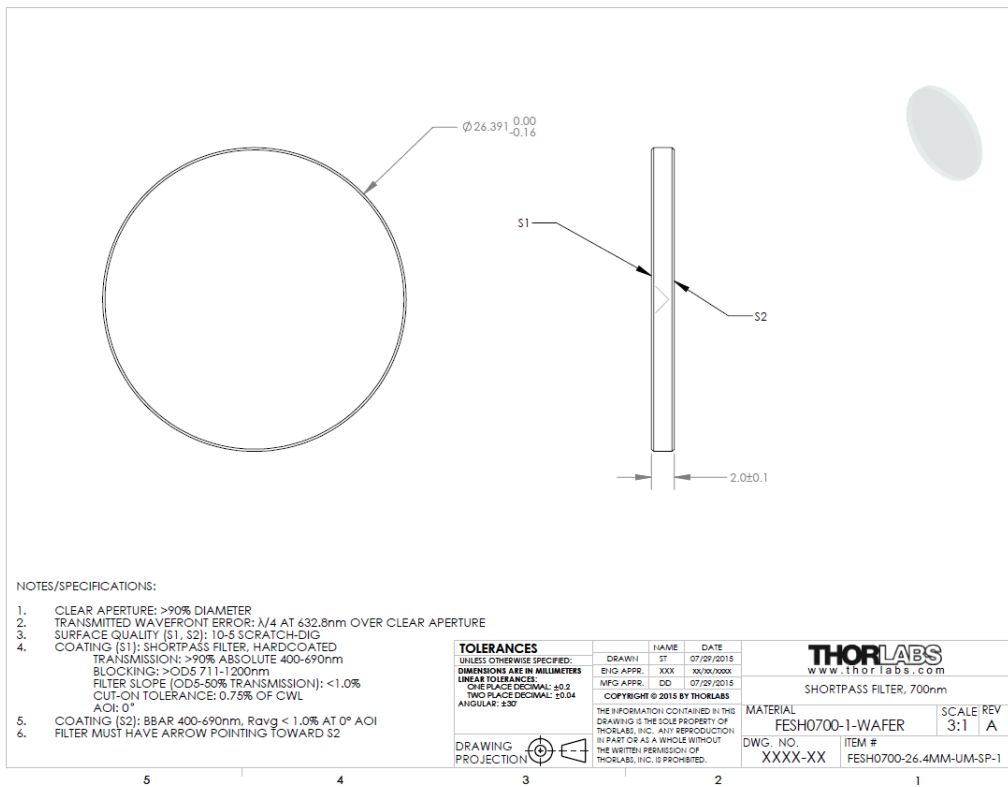


Figure 23 IR Blocking Filter Dimensions FESH0700

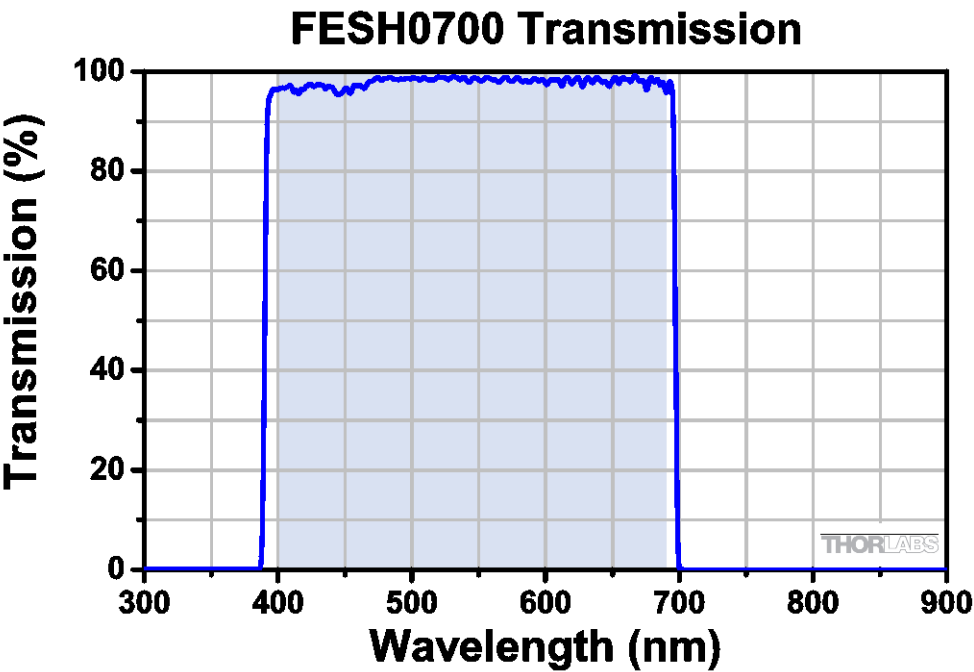
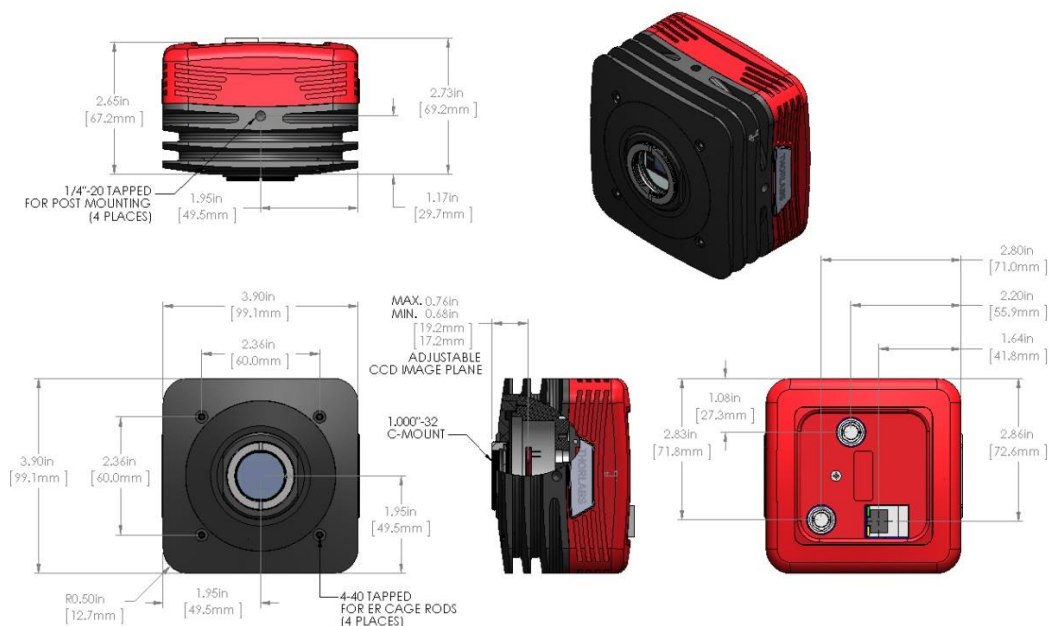


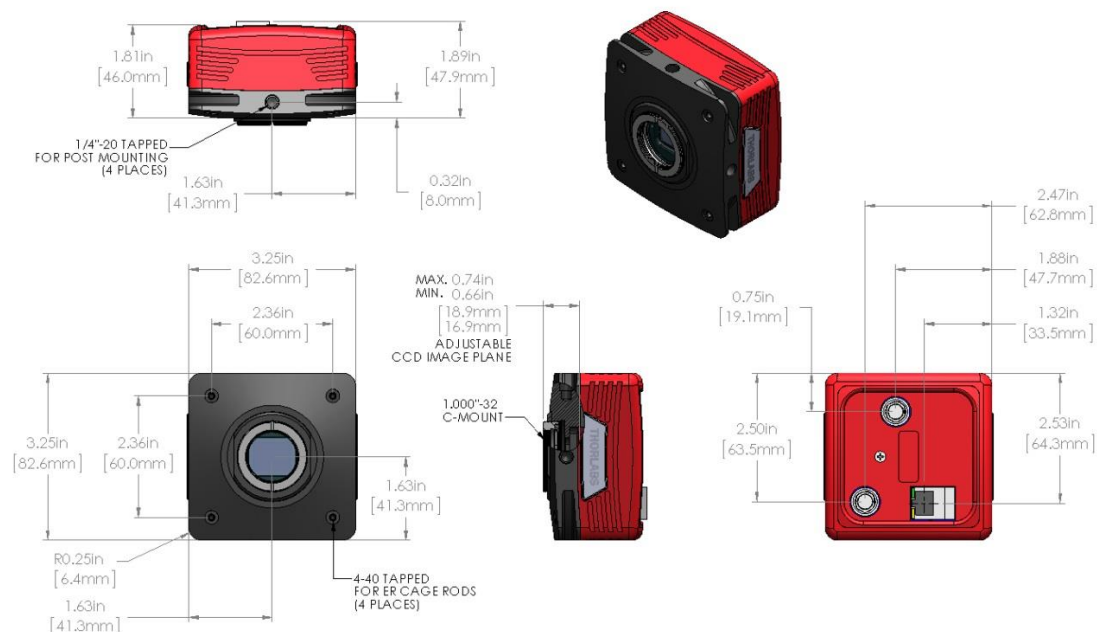
Figure 24 IR Blocking Filter Transmission Curve FESH0700

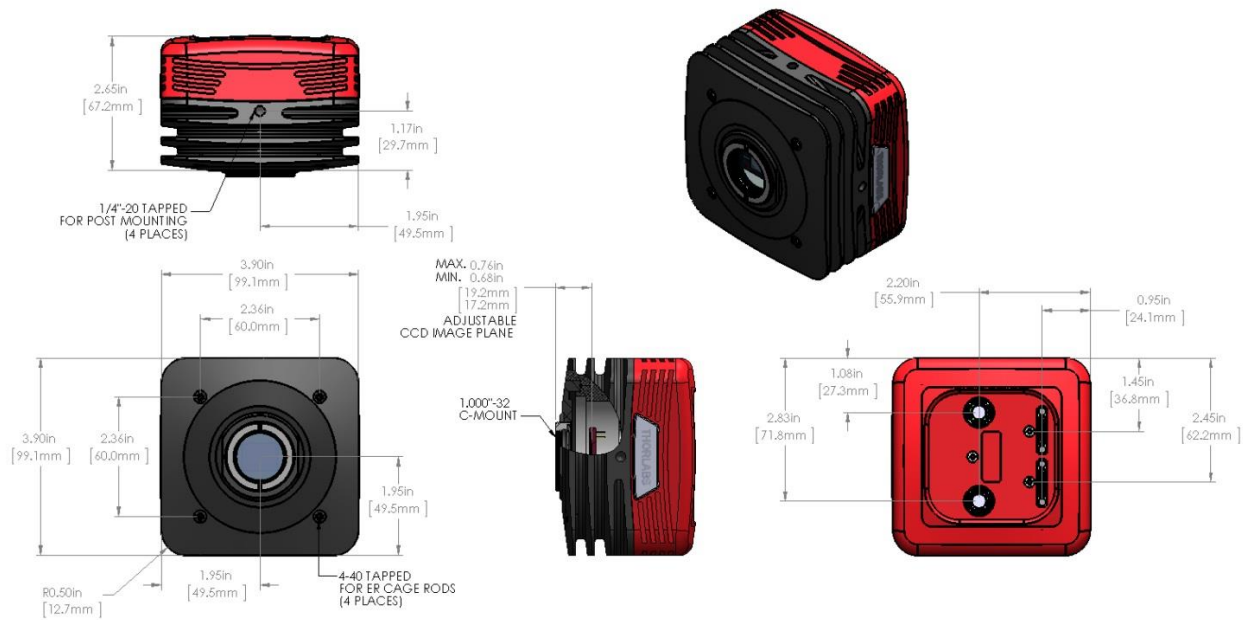
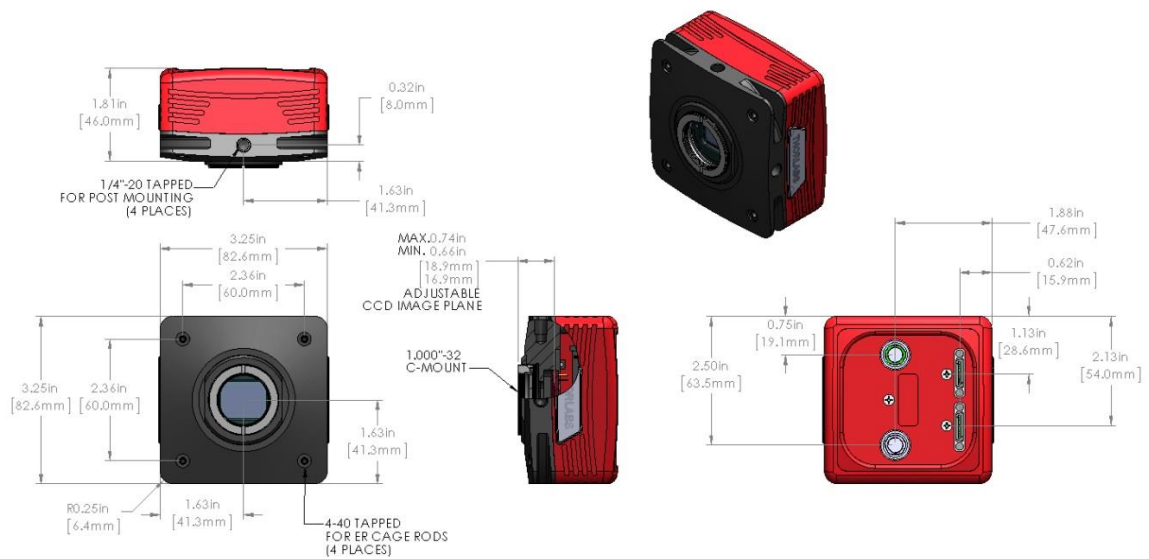
Chapter 14 Mechanical Drawings

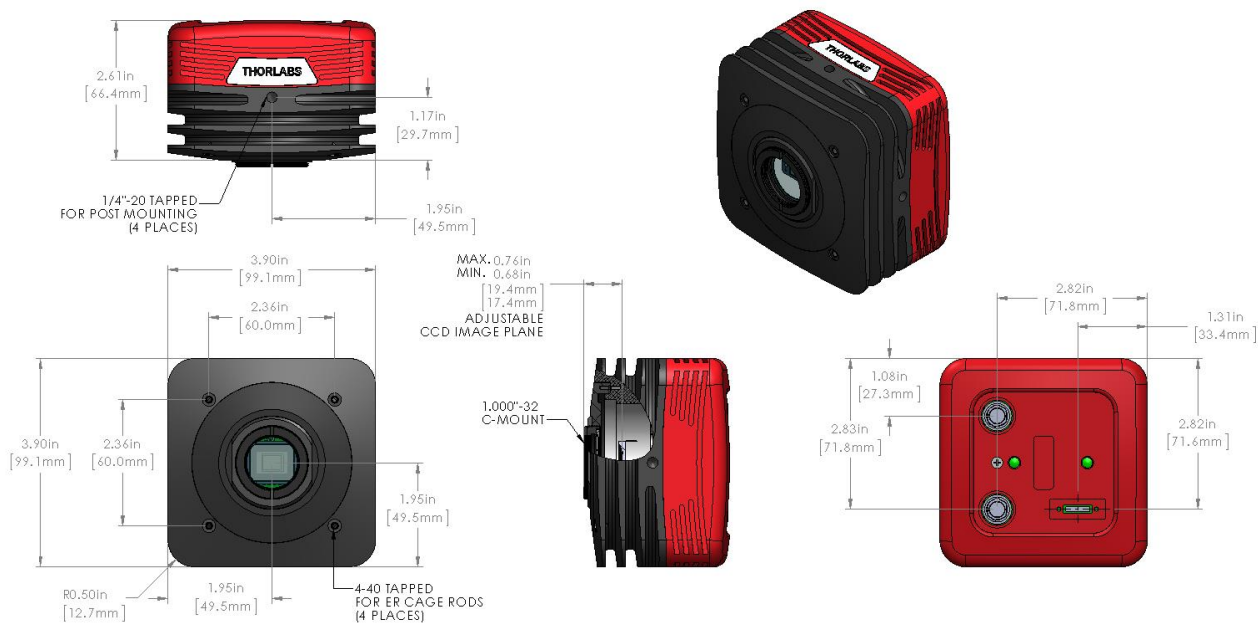
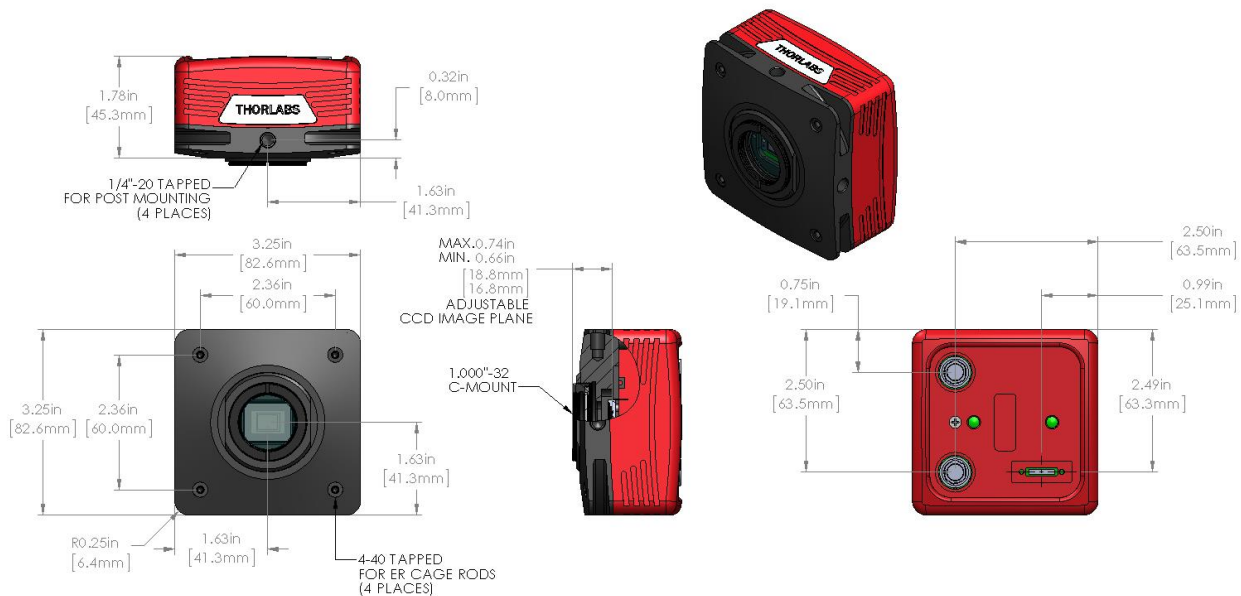
14.1. 8051/4070/1501-GE-TE

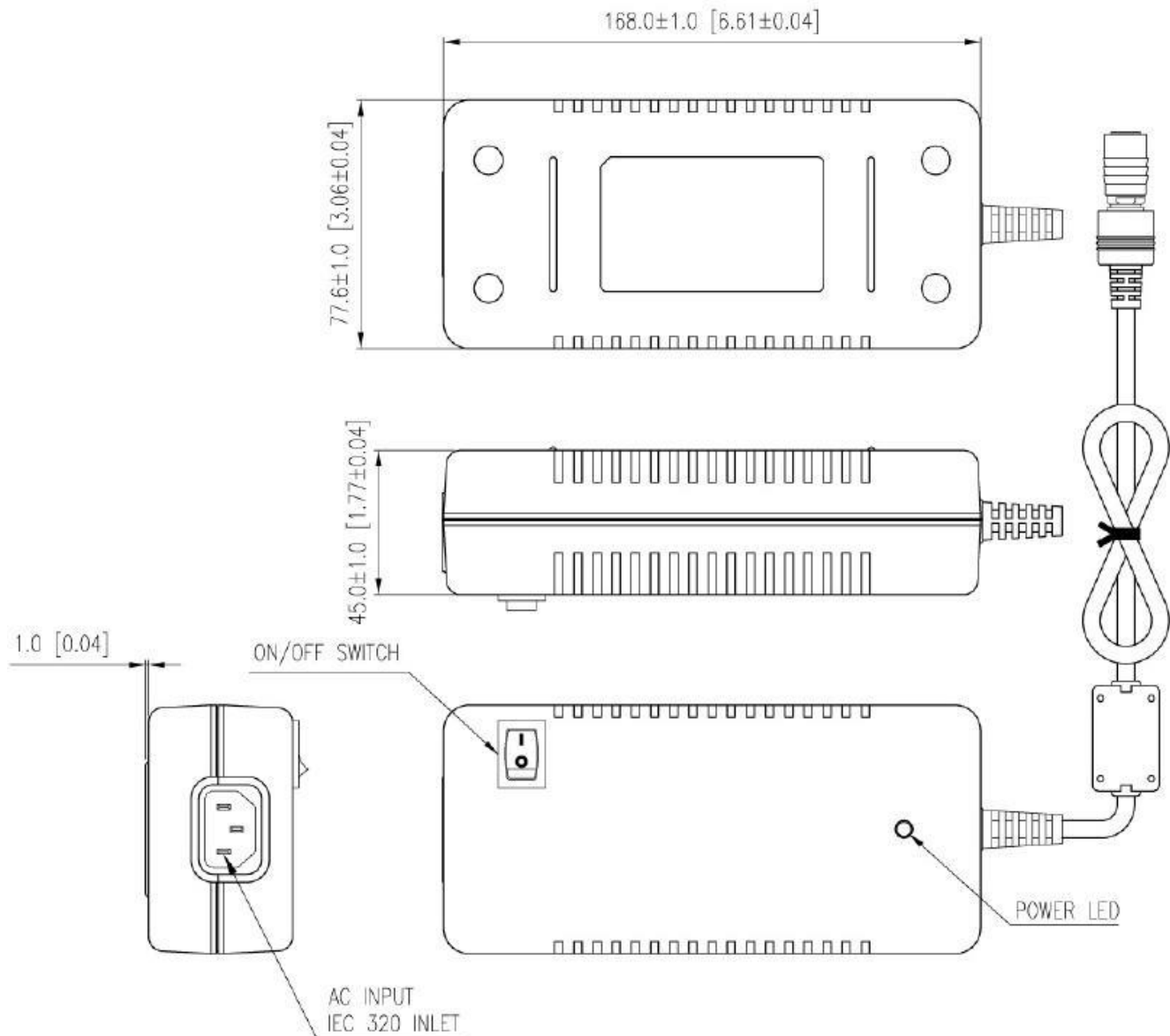


14.2. 8051/4070/1501/340-GE



14.3. 8051/4070/1501-CL-TE**14.4. 8051/4070/1501/340-CL**

14.5. 8051/4070/1501-USB-TE**14.6. 8051/4070/1501/340-USB**

14.7. Switching Power Supply

Chapter 15 Troubleshooting

15.1. Interface

Problem	Symptoms	Possible Cause	Remedy
Green light on power supply does not come on	<ul style="list-style-type: none"> No power to camera Camera does not acquire image Software cannot find a connected camera 	1. Power supply not connected	1. Plug in power supply to outlet
		2. Power strip not turned on	2. Turn on power to power strip
		3. Bad power supply	3. Contact customer service for power supply replacement
Software cannot find a connected camera	<ul style="list-style-type: none"> Software does not display an image Yellow status light on Gig E connector is off (Gigabit Ethernet Cameras only) Software does not display a connected camera 	1. No power to camera	1. Connect camera power
		2. GigE cable not connected or connected to 10/100 Mbps network	2. Connect GigE cable to camera and computer (see table below for GigE status LED descriptions)
		3. Camera Link Cable not connected	3. Connect Camera Link Cable to camera and computer
		4. Camera Link Cable connected to wrong port	4. See Section 4.3 for connection details.
		5. Camera has yet to complete "enumeration"	5. Restart/refresh software after camera has been powered on and connected to host-PC for at least 30 seconds
		6. USB 3.0 camera not connected to USB 3.0 Port or has not enumerated properly	5. See Section 5.1. Disconnect USB3.0 cable and the reconnect. First time connections to a PC may take longer to enumerate and load drivers.

15.1.1. GigE Status Indicators

LED Color	If LED is On	If LED is Flashing	If LED is Off
Green	The Link is Operational, but the Camera is Currently not Sending Data	Normal (Indicates that the Camera is Sending Data)	There is no Ethernet Connection
Yellow	Normal Operation	Not Applicable	Either there is no Ethernet Connection, or The Camera is Plugged into a 10/100 Mbps Network



Figure 25 Detail of Gigabit Ethernet Port, showing the two status LEDs.

15.2. Optical

Problem	Symptoms	Possible Cause	Remedy
When using a standard C-mount lens (not included), image is not in focus	<ul style="list-style-type: none"> Displayed image is not in focus 	1. Back focus of camera needs to be set	1. See Section 4.6 on how to set the camera's back focus
Displayed image has spots or has debris in image	<ul style="list-style-type: none"> Debris in displayed image 	1. IR filter has particulates on it	1. Carefully clean IR filter. See Section 4.6
"C-mount" detaches from camera after removing from Microscope	<ul style="list-style-type: none"> Threaded "C-mount" assembly remains on microscope 	1. Lock nut not sufficiently tight	1. See Section 4.6

15.3. Operational

Problem	Symptoms	Possible Cause	Remedy
Camera excessively warm (too hot to safely hold with ungloved hand)	<ul style="list-style-type: none"> Camera is too hot to hold with an ungloved hand Poor image quality 	1. Camera is not properly ventilated	1. Remove any obstructions or provide adequate ventilation around camera
		2. Electronics failure	2. Contact customer service
Camera does not feel warm at all	<ul style="list-style-type: none"> Camera is not warm or feels cold to the touch 	1. Camera not connected	1. Connect camera to power supply
		2. TE cooler is not enabled in software (8051/4070/1501-xx-TE models only)	2. Enable TE-cooling in software (8051/4070/1501-xx-TE models only)
		3. Camera was dropped or otherwise subjected to unusual mechanical force	3. Contact customer service
Imaging Software "times out" without acquiring image	<ul style="list-style-type: none"> Imaging software indicates timeout No images acquired – no frame count provided 	1. Camera is not powered	1. See "Interface" Troubleshooting above
		2. Camera is not connected to computer	2. See "Interface" Troubleshooting above
		3. Imaging software is not configured to camera	3. Consult the ThorCam User Guide
		4. Camera is not "armed" and "started" properly	4. Refer to Chapter 5.1
Low Bandwidth USB 3.0 connection	<ul style="list-style-type: none"> Excessive dropped frames Inconsistent operation 	1. Low bandwidth USB 3.0 port 2. USB 3.0 cable is too long or poor quality	1. Use a PCIe high bandwidth USB3.0 Card, such as: Startech PEXUSB3S25 2. Use the 3m cable supplied with the camera. 3. Use a 3m (max) cable with 26AWG signal wires - or a 1m cable.

15.4. Software

Problem	Symptoms	Possible Cause	Remedy
Camera not found	<ul style="list-style-type: none"> Error message, or camera does not show up in Hardware Connections 	1. Power not on	1. Make sure power supply is switched on
		2. Not plugged in	2. Make sure the power and signal cables are connected
		3. Camera Link cable not plugged into correct channel in CL card	3. Make sure cable is plugged into channel closest to the PC motherboard
		4. Bad network cable for GigE camera	4. Try a different set of cables if the lights don't blink on GigE connector on camera
		5. Bad USB cable or connection	5. Try a different cable. Refer to Section 5.1 for information on the camera's status indicators.
Insufficient illumination	<ul style="list-style-type: none"> Images are all black 	1. Exposure time too low	1. Make sure that exposure time is greater than 0; if the exposure is already greater than 0, try increasing the exposure time or gain gradually
		2. No light going to the camera	2. Make sure that the light source is turned on, and that the aperture of the lens (or other optics) is not shut.

Chapter 16 Maintenance

There are no user-serviceable parts inside the camera. Removing the rear cover of the camera without expressed authorization from TSI will void the camera warranty.

TSI scientific grade cameras are manufactured in a clean environment. Before shipping, each camera is tested to assure that it meets stringent specifications for cleanliness and quality.

16.1. Cleaning Guidelines

Frequent lens changes, especially without careful attention to contaminants, can allow debris to accumulate on the infra-red blocking filter and lens surfaces. Therefore, TSI provides the following guidelines for cleaning those components.

To minimize the need to clean the optical surfaces, do not remove the protective lens mount cap shipped with the camera until you are ready to mount the camera to the optical system.

For an informative tutorial on “Handling and Cleaning Procedures for Optical Components” visit: http://www.thorlabs.us/newgrouppage9.cfm?objectgroup_id=9025. The following guidelines, specific to TSI cameras, are meant to be used in conjunction with the procedures described in the tutorial.

16.1.1. Cleaning the Lens of Optical Assembly

Please follow the lens manufacturer’s recommendations for cleaning. TSI is not responsible for any damage caused to a lens or optical assembly caused by customer cleaning or misuse.

To ensure optimum image quality with any TSI camera, do not remove the protective lens-mount cap until ready to mount the camera on the application. If the camera is removed from the application, immediately replace the cap. Doing so will keep dust and other contaminants from accumulating on the optical surfaces. In addition, please note the following model-specific guidelines.

16.1.2. Standard (Non-Cooled) Camera Precautions

While the lens mounting ring and locking flange allow the user some lens back-focus adjustment, complete removal of the ring will expose the CCD faceplate and will likely cause debris to accumulate on its surface. **Extreme care should be taken to avoid completely removing the lens mounting ring and exposing the CCD faceplate unless absolutely necessary. Fingerprints or other evidence of contact with the CCD faceplate may void the warranty.**

16.1.3. TE-Cooled Camera Precautions

The TSI Thermoelectrically-cooled cameras contain the CCD in a sealed, gas-filled chamber having an anti-reflective glass window. **Do not, under any circumstances, loosen or remove the inner glass window from a cooled camera.** Doing so will void the warranty. If it is suspected that the seal has been broken or if the window breaks, call your local Thorlabs office or distributor. Do not apply power to the camera. Moisture will have been introduced into the chamber, and cooling in the presence of moisture will cause condensation and frost on the CCD, which can damage the entire cooling unit and/or CCD.

16.1.4. Cleaning the Infrared Filter (Standard and TE-Cooled Cameras)

The infra-red filter is visible when the lens is removed, mounted inside the lens mounting ring. This filter blocks invisible, near-infrared light from reaching the CCD sensor. This is desirable in most applications where the camera is imaging in the visible spectrum.

- ***What must I do before cleaning the infrared filter?***

Do not remove the filter from the camera.

First, remove the lens and carefully examine the filter in a clean location under a strong, direct light. Try to determine if the contaminants are a few dust particles, oily smudge (such as fingerprints) or both.

- ***What if the contamination is only a few dust particles?***

Use a CLEAN, DRY (preferably brand-new), camel hair lens cleaning brush (such as those used by photographers) to gently wipe the particles off of the filter.

- ***What if the contamination includes a smudge?***

1. Remove the camera from the optical assembly and bring the camera to a clean, dry location where it is safe to use flammable solvents (please see "Caution" below)
2. Carefully loosen the lens mount lock ring using the supplied TSI lock ring wrench.
3. Orient the camera so that the lens mount is pointing downward and carefully unscrew the lens mounting ring and integral filter.
4. Place the camera face down on a clean, dry surface to prevent particles from accumulating on the CCD faceplate.
5. Once the filter is removed, Use a CLEAN, DRY (preferably brand-new), camel hair lens cleaning brush (such as those used by photographers) to gently wipe the particles off of the filter.
6. Re-examine the filter after removing the dust. If a smudge is still visible, proceed by dipping a clean, lint-free cotton swab in ethyl or isopropyl alcohol. The swab should be saturated, but not dripping.
7. Carefully draw the swab once across the surface, then rotate the swab 180 degrees to expose the fresh surface and draw it across the filter surface again. Be careful not to pool alcohol on the glass surface.
8. Re-examine once again and repeat the process once, if necessary.

If contamination continues to be a problem, please call Thorlabs for assistance.



CAUTION

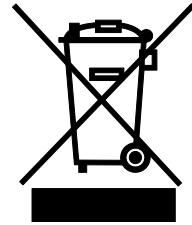


Ethyl and isopropyl alcohols are highly flammable! Do not use near extreme heat, arcing electrical equipment (such as space heaters) or open flame! Use only with proper ventilation. Follow all safety instructions provided by the manufacturer of the alcohol product.

Chapter 17 Regulatory

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

- This offer is valid for Thorlabs electrical and electronic equipment:
- Sold after August 13, 2005
- Marked correspondingly with the crossed out “wheelie bin” logo (see right)
- Sold to a company or institute within the EC
- Currently owned by a company or institute within the EC
- Still complete, not disassembled and not contaminated



Wheelie Bin Logo

As the WEEE directive applies to self-contained operational electrical and electronic products, this end of life take back service does not refer to other Thorlabs products, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

17.1. Waste Treatment is Your Own Responsibility


If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

17.2. Ecological Background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

17.3. Certifications and Compliance – CE Declaration of Conformity



THORLABS

www.thorlabs.com

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs Inc.
 Of: 56 Sparta Avenue, Newton, New Jersey, 07860, USA

in accordance with the following Directive(s):

2006/95/EC	Low Voltage Directive (LVD)
2004/108/EC	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:

Model: **8050/1x-yy-(TE)**

Equipment: **8 Megapixel Scientific CCD Camera- Family**


is in conformity with the applicable requirements of the following documents:

EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013

and which, issued under the sole responsibility of Thorlabs, is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:

does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive


I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed: 




Name: Ann Strachan


Position: Compliance Manager

On: 03 August 2015



EDC - 8050/1x-yy-(TE) -2015-08-03

		THORLABS www.thorlabs.com	
EU Declaration of Conformity <i>in accordance with EN ISO 17050-1:2010</i>			
We:	Thorlabs Inc.		
Of:	56 Sparta Avenue, Newton, New Jersey, 07860, USA		
in accordance with the following Directive(s):			
2006/95/EC	Low Voltage Directive (LVD)		
2004/108/EC	Electromagnetic Compatibility (EMC) Directive		
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)		
hereby declare that:			
Model:	4070x-yy-(TE)		
Equipment:	4 Megapixel Scientific CCD Camera- Family		
is in conformity with the applicable requirements of the following documents:			
EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.		2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements		2013
and which, issued under the sole responsibility of Thorlabs, is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:			
does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive			
I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.			
Signed:		On:	03 August 2015
Name:	Ann Strachan		
Position:	Compliance Manager		
		EDC - 4070x-yy-(TE) -2015-08-03	
			



THORLABS

www.thorlabs.com

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs Inc.
Of: 56 Sparta Avenue, Newton, New Jersey, 07860, USA

in accordance with the following Directive(s):

2006/95/EC	Low Voltage Directive (LVD)
2004/108/EC	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:

Model: **340M/UV-yy**
Equipment: **VGA Resolution Scientific CCD Camera- Family**


is in conformity with the applicable requirements of the following documents:

EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013

and which, issued under the sole responsibility of Thorlabs, is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:


does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive


I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed:  On: 05 August 2015

Name: Ann Strachan
Position: Compliance Manager

EDC - 340M/UV-yy -2015-08-05



**THORLABS**
www.thorlabs.com

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs Inc.
Of: 56 Sparta Avenue, Newton, New Jersey, 07860, USA

in accordance with the following Directive(s):

2006/95/EC	Low Voltage Directive (LVD)
2004/108/EC	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:

Model: **1501x-yy-(TE)/(TDI)**

Equipment: **1.4 Megapixel Scientific CCD Camera- Family**


is in conformity with the applicable requirements of the following documents:

EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013

and which, issued under the sole responsibility of Thorlabs, is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:


does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed:  On: 03 August 2015

Name: Ann Strachan
Position: Compliance Manager

EDC - 1501x-yy-(TE)/(TDI) -2015-08-03

15

17.4. FCC Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules.

17.5. Auxiliary I/O Cable Requirements

The Digital Camera is not supplied with a cable for connecting to the AUX I/O port of the camera. This cable is application specific in all cases due to varying lengths and functions that are used. If an Auxiliary I/O cable is to be used with this camera it must be constructed with the requirements shown in Section 4.7 in order for the camera to adhere to CE and FCC compliance.

Chapter 18 Warranty

18.1. General Product Warranty

Thorlabs warrants that all products sold will be free from defects in material and workmanship, and will conform to the published specifications under normal use, when correctly installed and maintained.

18.2. Specific Warranties

18.2.1. Optomechanics

Lifetime Warranty: Thorlabs offers a lifetime warranty on all optomechanical components. Thorlabs will repair or replace any optomechanical product which, after evaluation, has been shown to not meet specifications under the conditions listed above.

18.2.2. Optical Tables and Breadboards

Lifetime Warranty: Thorlabs provides a lifetime guarantee that all of our passively damped optical tables and breadboards will meet all originally stated performance specifications under normal use and proper handling. We additionally guarantee that all our table tops and breadboards, both active and passive, will be free from defects in workmanship, including delamination of the skins under normal use and handling.

18.2.3. Lasers and Imaging Systems

Thorlabs offers a one year warranty on all lasers and imaging systems, with the exceptions of laser diodes. Some products are warranted for the number of hours specified in the operating manual of each laser.

18.2.4. Opto-Electronics, Control Electronics, Optics, and Nano-Positioning Product Lines

Thorlabs offers a two year warranty on the above mentioned product lines, provided normal use and maintenance of the products and when properly handled and correctly installed.

Thorlabs shall repair or replace any defective or nonconforming product as detailed above. We ask that buyer contact Thorlabs for a Return Material Authorization number (RMA #) from our Customer Service>Returns department in order to most efficiently process the return and/or repair.

18.2.5. Non-Warranty Repairs

Products returned for repair that are not covered under warranty, will incur a standard repair charge, in addition to all shipping expenses. This repair charge will be quoted to the customer before the work is performed.

18.2.6. Warranty Exclusions

The stated warranty does not apply to Products which are (a) specials, modifications, or customized items (including custom patch cables) meeting the specifications you provide; (b) ESD sensitive items whose static protection packaging has been opened; (c) items repaired, modified or altered by any party other than Thorlabs; (d) items used in conjunction with equipment not provided by, or acknowledged as compatible by, Thorlabs; (e) subjected to unusual physical, thermal, or electrical stress; (f) damaged due to improper installation, misuse, abuse, or storage; (g) damaged due to accident or negligence in use, storage, transportation or handling.

Chapter 19 Thorlabs Worldwide Contacts

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