



# 1500M-Series Scientific Grade Digital Camera

## User Guide



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## 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 Video 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 Video 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 Video 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 Video Camera or the included External Power Supply.**

**Do not open the Digital Video 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 Video 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](mailto:techsupport@thorlabs.com) and a member of our team will be happy to assist you.**

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## 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 Digital Video 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](mailto: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 1500M series of cameras consists of four models: the 1500M-GE, 1500M-GE-TE, 1500M-CL, and 1500M-CL-TE. The models are distinguished by their interface method (GigE vs. Camera Link) and whether they are TE-cooled or not. The 1500M is based on the Sony ICX285 interline CCD, which provides 1392x1020 pixel resolution and 6.45  $\mu\text{m}$  square pixels with high quantum efficiency and low noise. The 1500M is offered in both standard and cooled configurations, with a choice of Gigabit Ethernet or Camera Link interface. Additionally, the 1500M is 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 to streamline the integration of any TSI camera into your system. After software installation, the SDK can be found in the \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 ThorCam User Manual and the SDK.

### 3.2. Receiving and Unpacking

Your 1500M 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 1500M camera, depending on your order configuration. Figure 1 below shows the different available configurations.

Supplied Equipment		
Camera Type	1500M Non-Cooled	1500M Cooled
Available Interface Options	<b>GigE</b> Includes Intel® Gigabit CT PCI Express Desktop Adapter and 14' CAT 5e Cable	
	<b>Camera Link Interface</b> Includes VisionLink F4 Camera Link Board and 5 m Camera Link Cable	
Accessories	<ul style="list-style-type: none"> <li>Regulated switch-mode Power Supply with 72" cord (Supplied line cord appropriate for user's country or region)</li> <li>Spanner Wrench</li> <li>Lens cap (and IR filter removal tool)</li> </ul>	
Included Software	Thorlabs Camera Software and SDK (Available for download from <a href="http://www.thorlabs.com">www.thorlabs.com</a> )	



GigE Interface Configuration



1500M Cooled or Non-Cooled Camera



CameraLink Interface Configuration



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 Chapter 4).  
 Order Thorlabs 1500-CAB1 and TSI-IOBOB.



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## 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 or Gigabit Ethernet (GigE).

#### 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.

##### ***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 then power on camera and run ThorCam application software.

#### 4.1.2. Camera Link System

If you purchased a Camera Link camera, an EDT PCIe VisionLink F4 interface card is provided. Other Camera Link interface cards are not supported.

##### ***Recommended Installation Sequence***

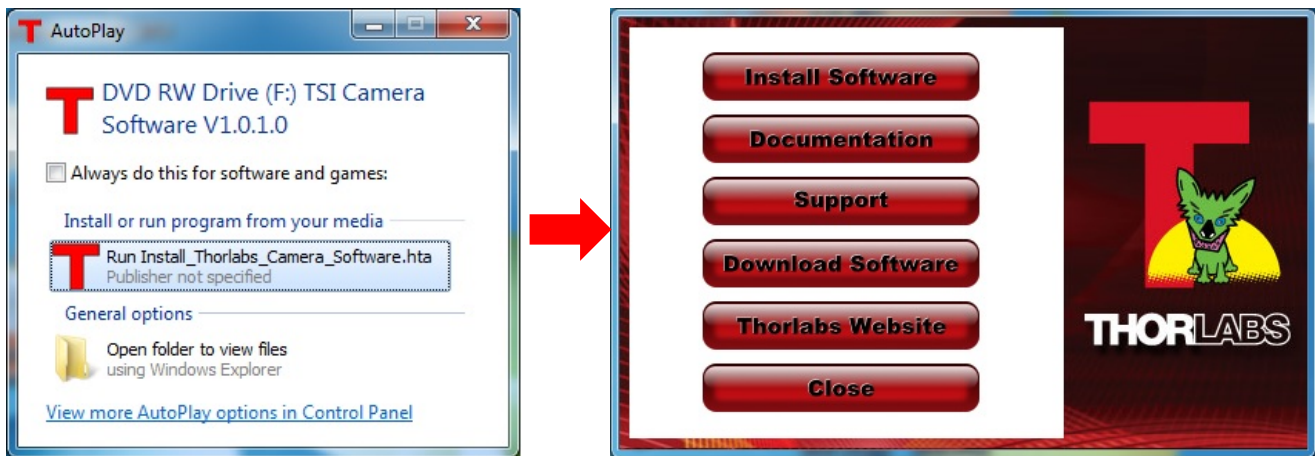
1. Run the software installer, follow the steps outlined in the next section.
2. Power down the computer.
3. Taking necessary precautions, install the EDT PCIe Camera Link interface card.
4. Turn on the computer.
5. Accept the driver installation recommendations for the newly installed hardware.
6. Connect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

## 4.2. Installing the Software

Although similar, the installation sequence for the GigE and Camera Link systems vary. Please see the steps below to install your system properly.

### 4.2.1. Getting Started

If installing the software from a downloaded copy from our website please go to section 4.2.2, otherwise insert the CD-ROM included with your camera accessories into a suitable CD-ROM drive on your computer. The disk will automatically start and the installation process will begin with the following screens:

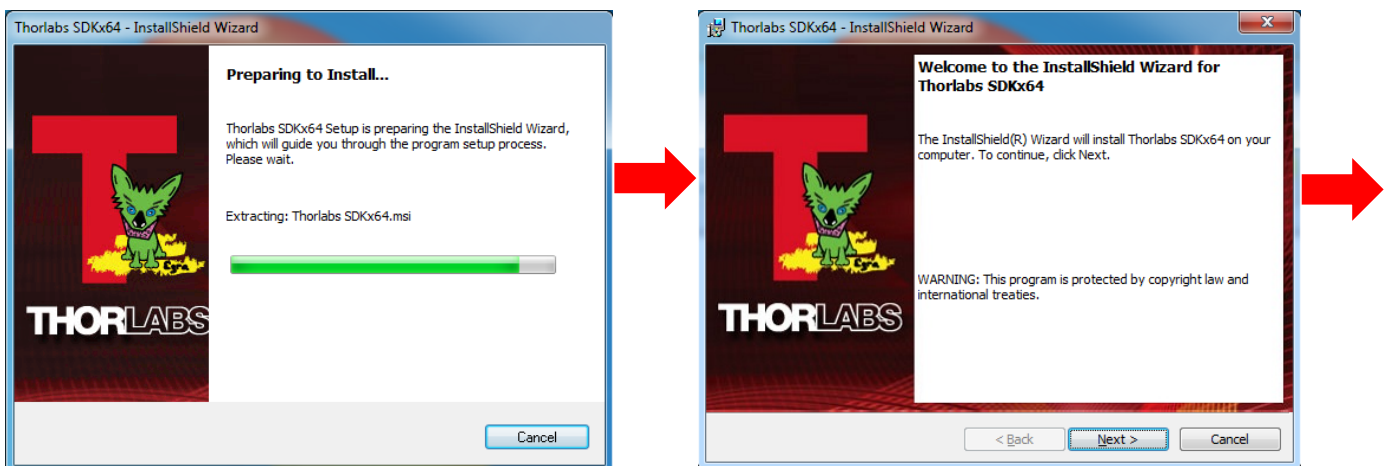


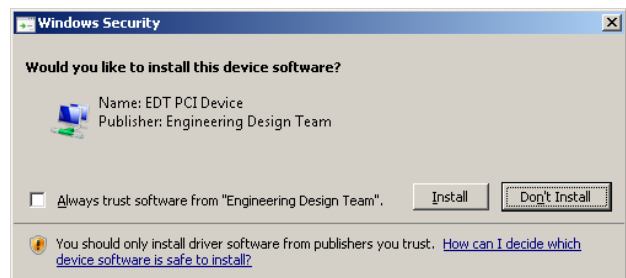
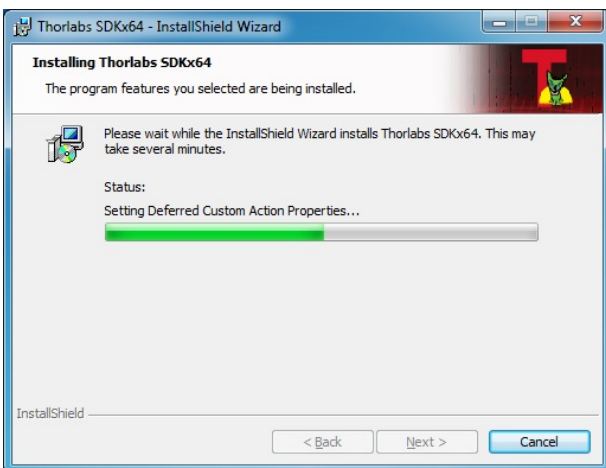
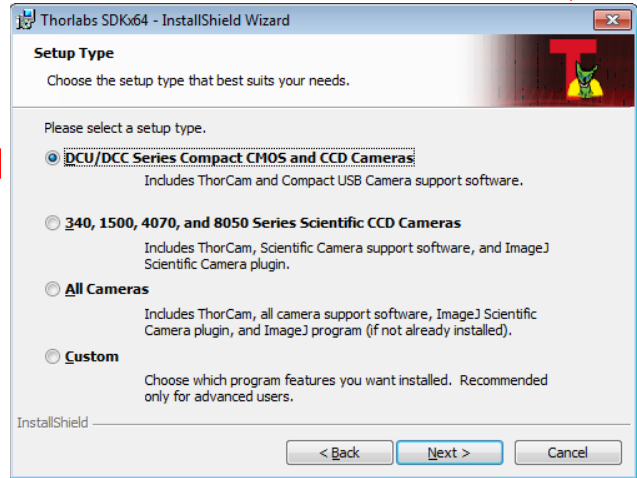
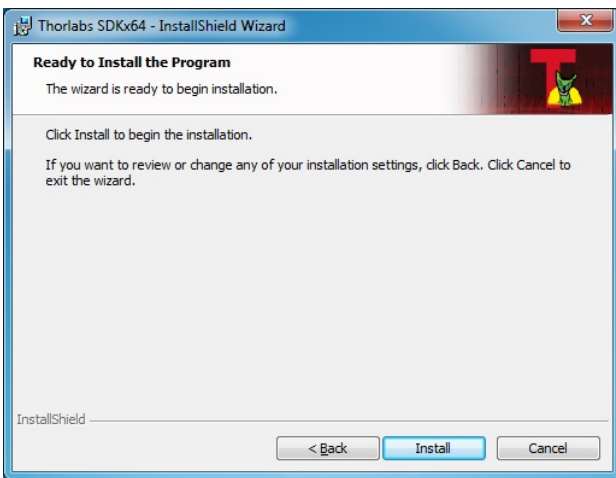
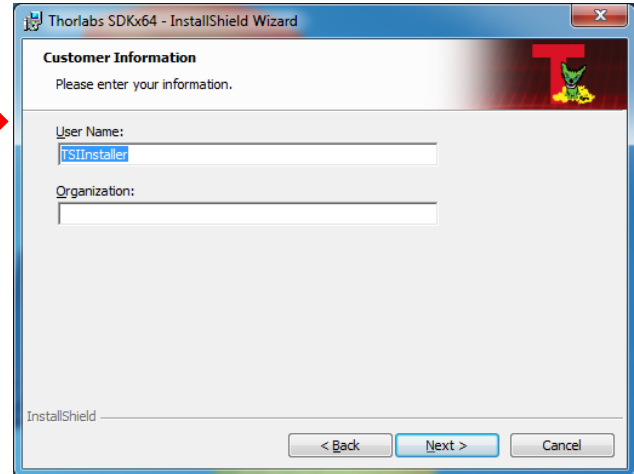
Select the “Run Install\_Thorlabs\_Camera\_Software.hta” option, then press the “Install Software” button.

**Note:** Once the “Install Software” button is pressed, it may take a few minutes for the installer to determine your computer’s configuration. We thank you for your patience.

### 4.2.2. Typical Installation

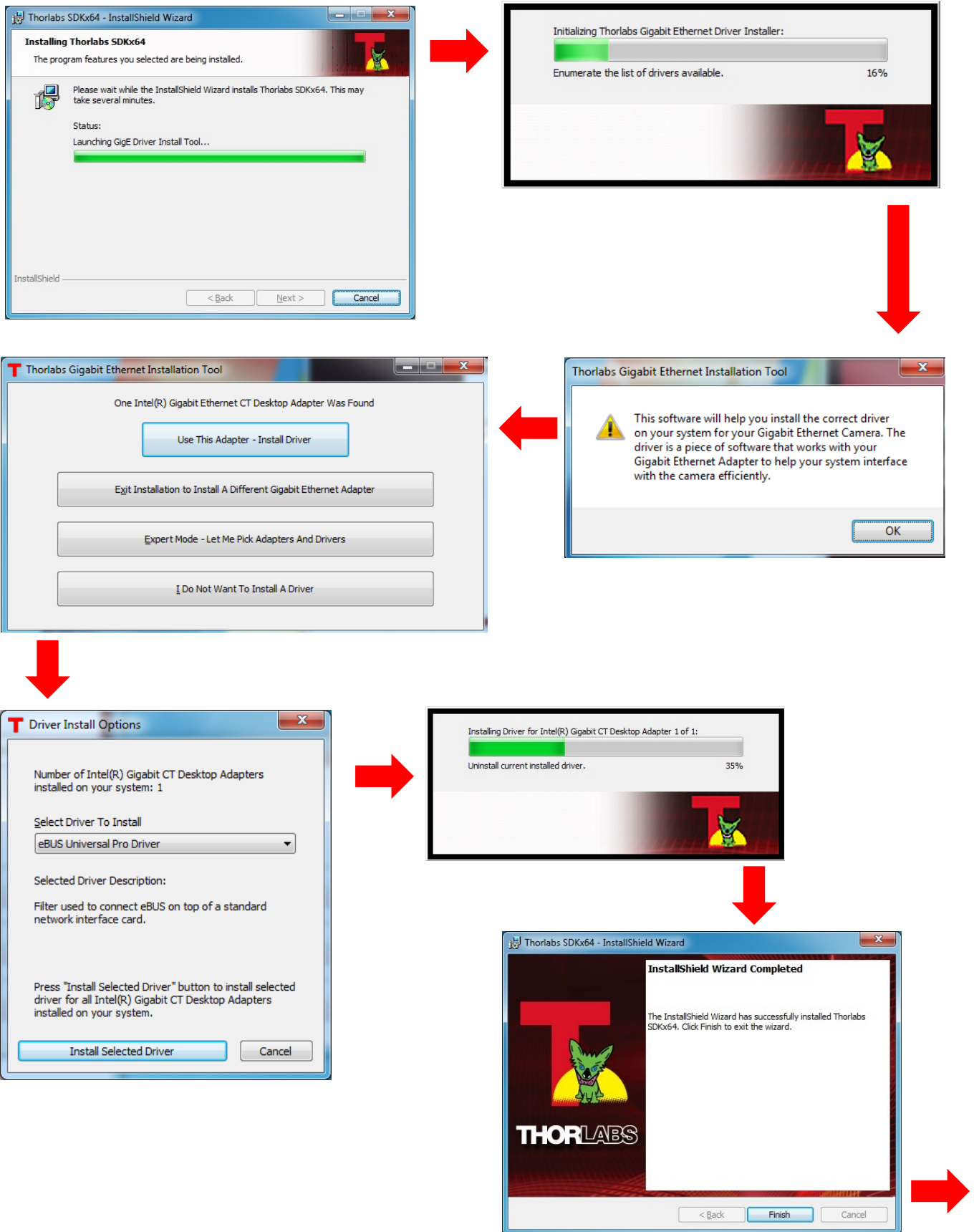
The information provided in this section is meant to describe the steps required for a typical system, involving a single camera (either Gigabit Ethernet or Camera Link), in which the user picks certain options. Some steps that typically require an affirmative response are not detailed, for the sake of clarity. Multiple camera systems and other “advanced” options are described in the following chapter. The InstallShield Wizard will guide you through the program setup process and driver installation as shown on the following pages.

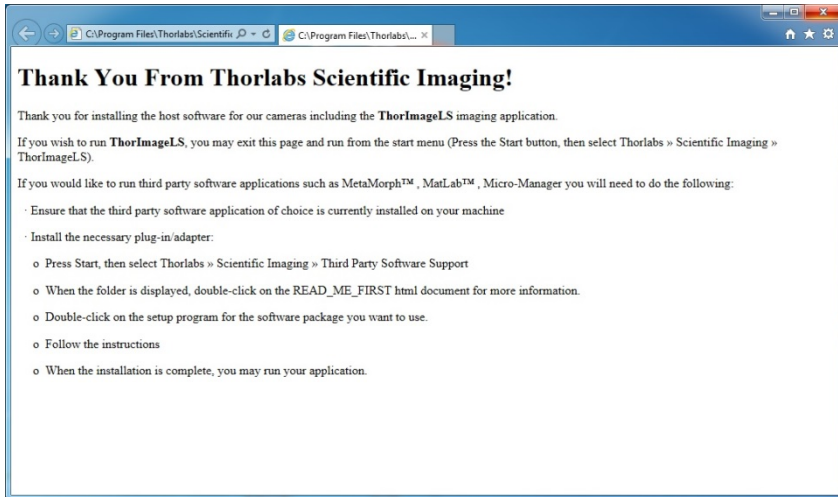




Proceed to Driver Installation (Next Page)

### 4.2.3. Driver Installation





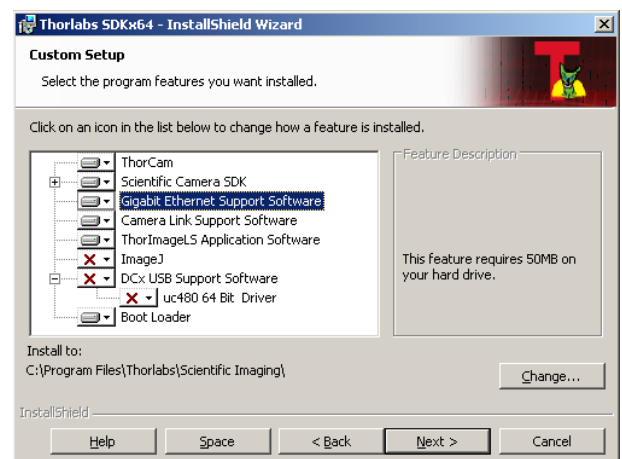
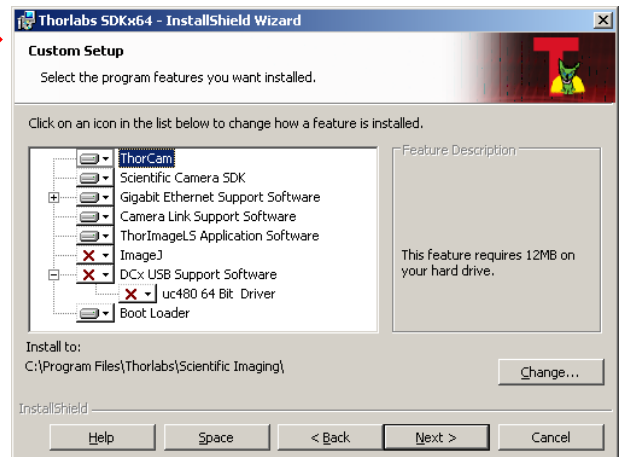
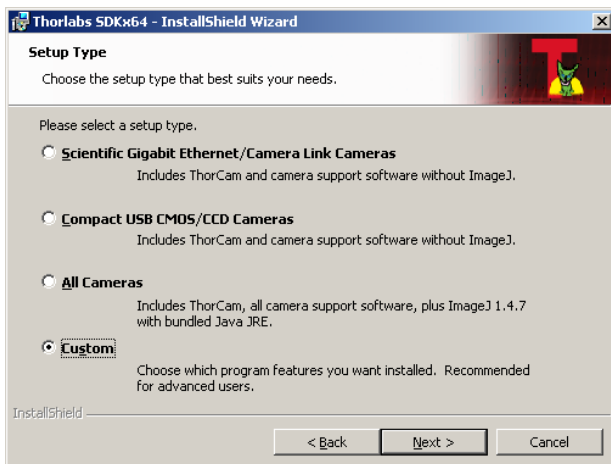
**Typical Setup is complete, you may now proceed to Section 4.3 that will describe how to connect and power on your camera.**

Once the camera is connected and powered up, follow the steps below from your Start Menu:

**“Start” → “Thorlabs” → “Scientific Imaging” → “ThorCam”**

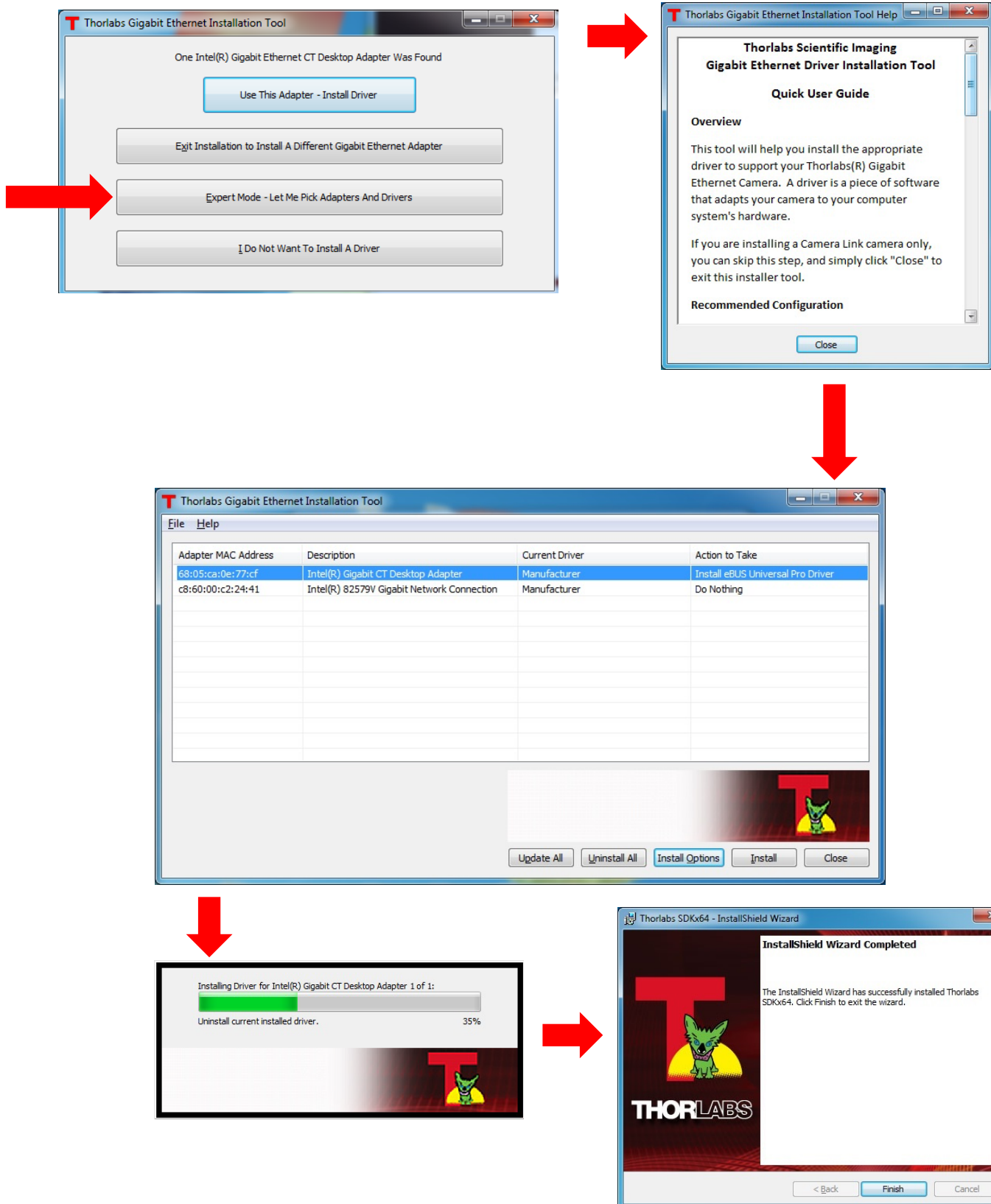
#### 4.2.4. Custom Setup (may be required for special circumstances)

See below for a depiction of the custom setup process.



### 4.2.5. Custom Driver Installation (Expert Mode)

See below for the custom driver installation process.

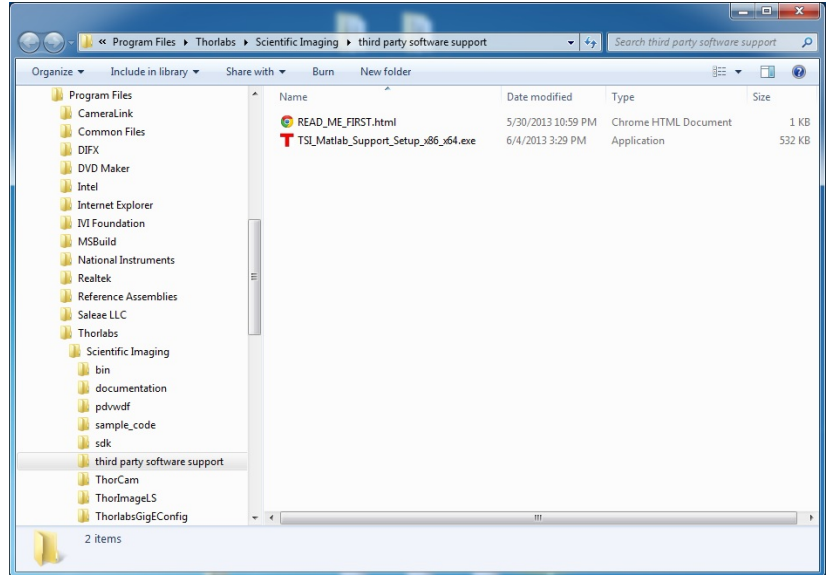
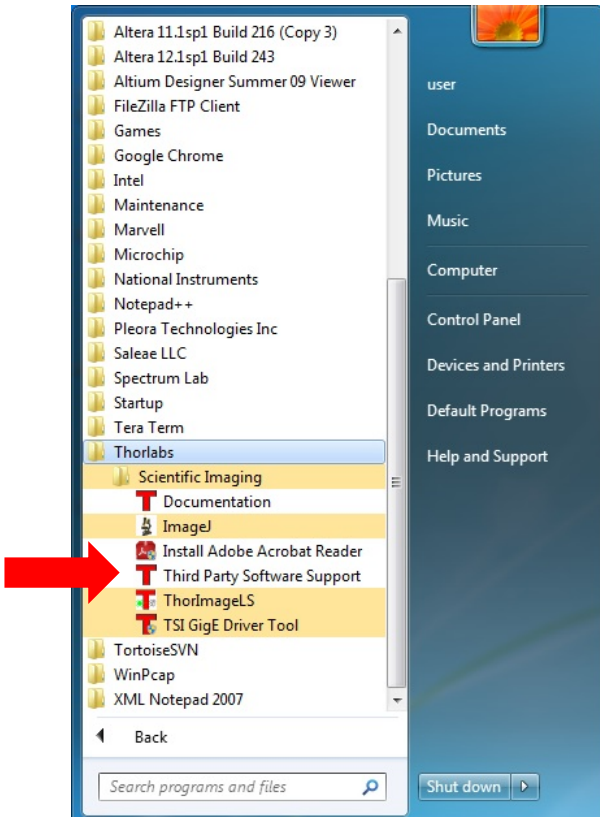


### 4.2.6. Installing 3<sup>rd</sup> Party Software Applications

After installation of Thorlabs components is complete, you have the option to install plug-ins for select 3<sup>rd</sup> party image analysis packages you may already have installed on your computer, such as Matlab™. (Note: Thorlabs only provides ImageJ with this installation – and only if you have run a “custom” or “complete” installation.)

Note: These plug-ins are only required if you wish to control the camera directly from within the 3<sup>rd</sup> 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 install a plug-in, please follow the steps shown below, and run the Setup utilities related to the 3<sup>rd</sup> party applications that you wish to use.



Select the 3<sup>rd</sup> party software of choice and run the Setup.exe application to install the plug-in.

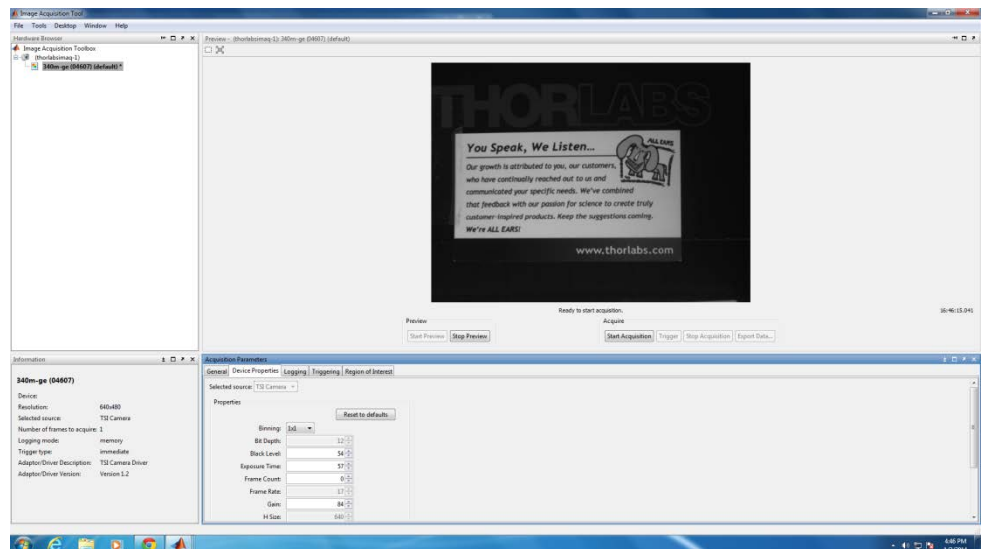
Follow the steps until Setup exits.

Then run the 3<sup>rd</sup> party application of choice, following the necessary steps to choose the installed plug-in.

After the MatLab IMAQ driver is installed, you may control the camera directly from MatLab.

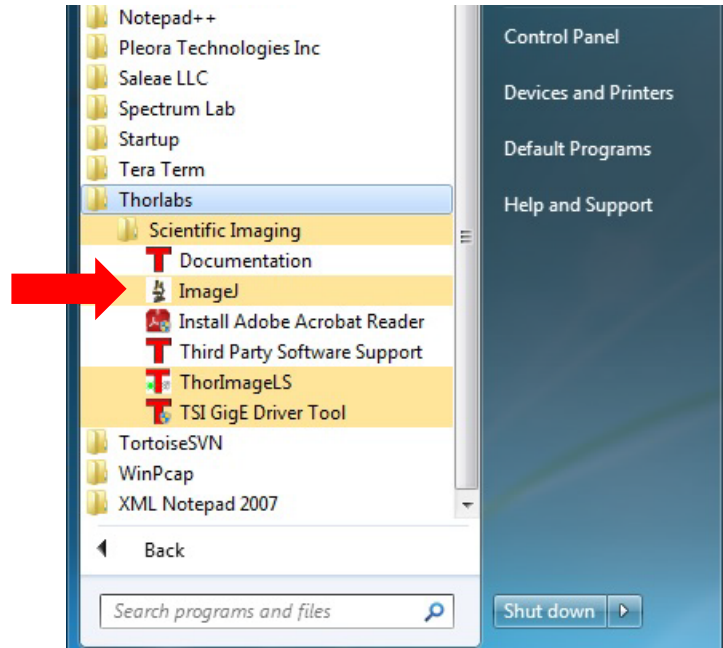
To begin, run MatLab and click on the “Apps” tab. Select “Image Acquisition” and then click on the selected camera in the Hardware Browser window.

To control the camera, click on “Device Properties”. Set the desired camera parameters, and then Start Preview.

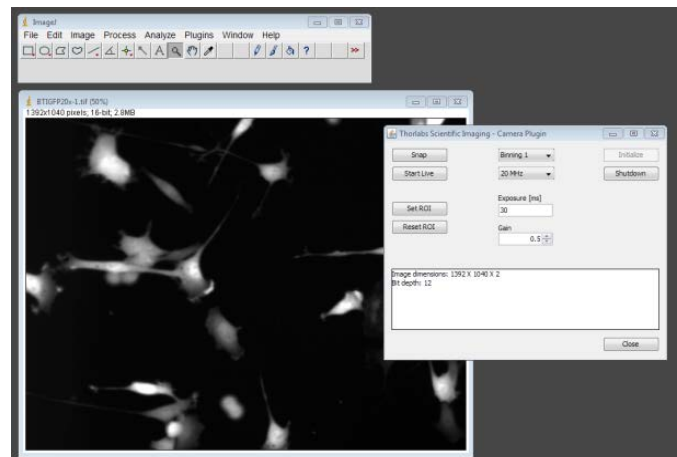
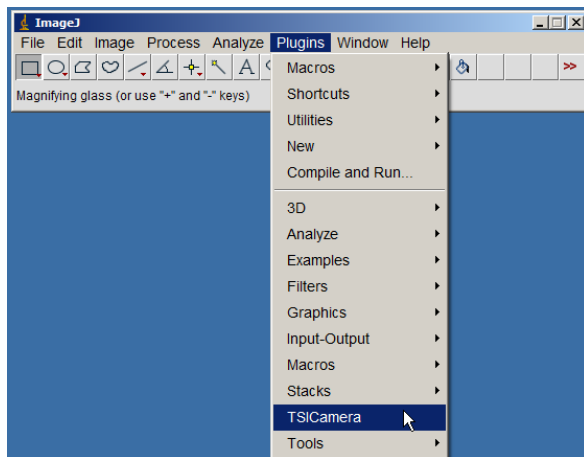


ImageJ is installed as part of the “Custom” or “Complete” installation options and includes the necessary plug-ins for operating a TSI Camera directly from ImageJ. To run this plug-in use the version of ImageJ located through the Windows Start Menu:

“Start” → “Thorlabs” →  
“Scientific Imaging” → “ImageJ”



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



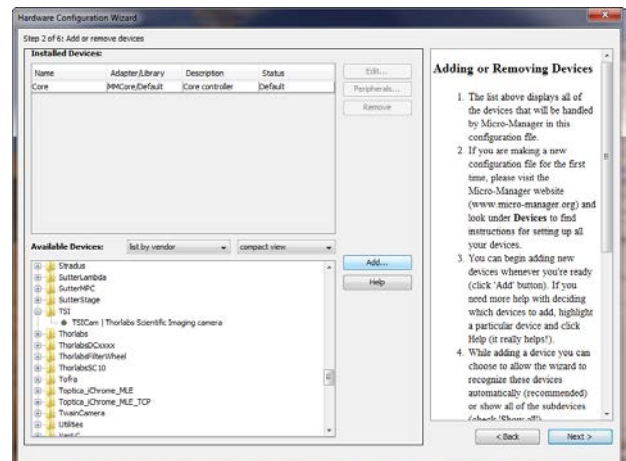
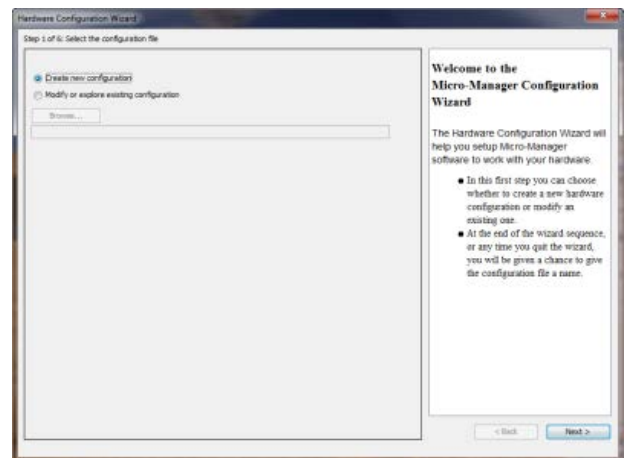
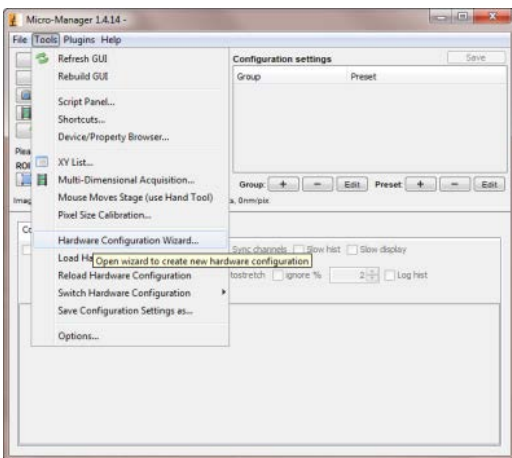
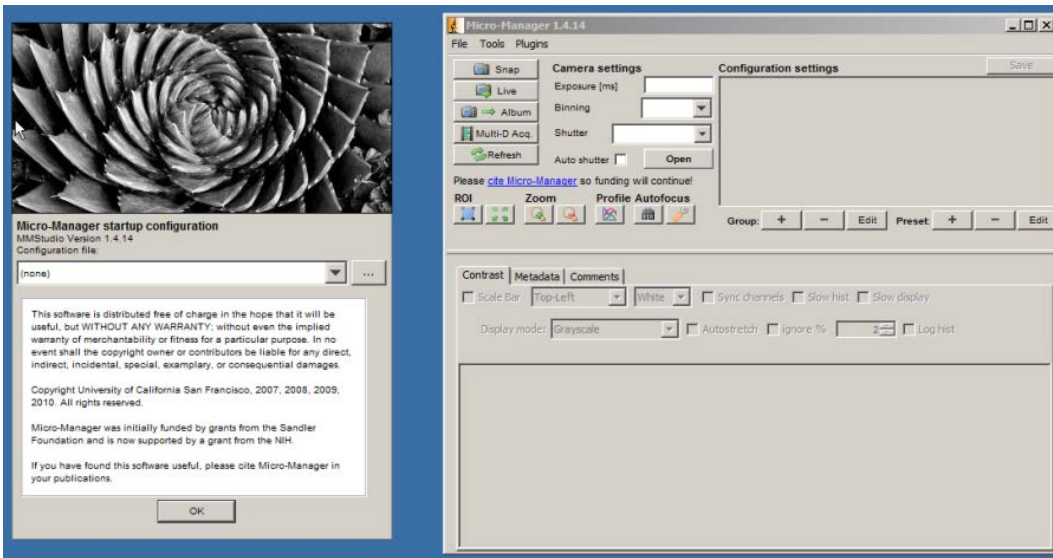
**Special note for users of Micro-manager software: support for Thorlabs scientific cameras is included when you run versions 1.4.14 and later. If you wish to download or update your Micro-Manager software, please visit: <http://valelab.ucsf.edu/~MM/MMwiki/index.php/Micro-Manager>.**

Note: The Micro-manager installer creates a copy of ImageJ on your desktop. Therefore, if you wish to use Micro-manager, a “Typical” installation of ThorCam will suffice, and it is not necessary to install ImageJ using a “Custom” or “Complete” installation option.

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.

The following steps launch the Hardware Configuration Wizard within Micro-manager, to create (or modify) a configuration that includes a TSI camera.





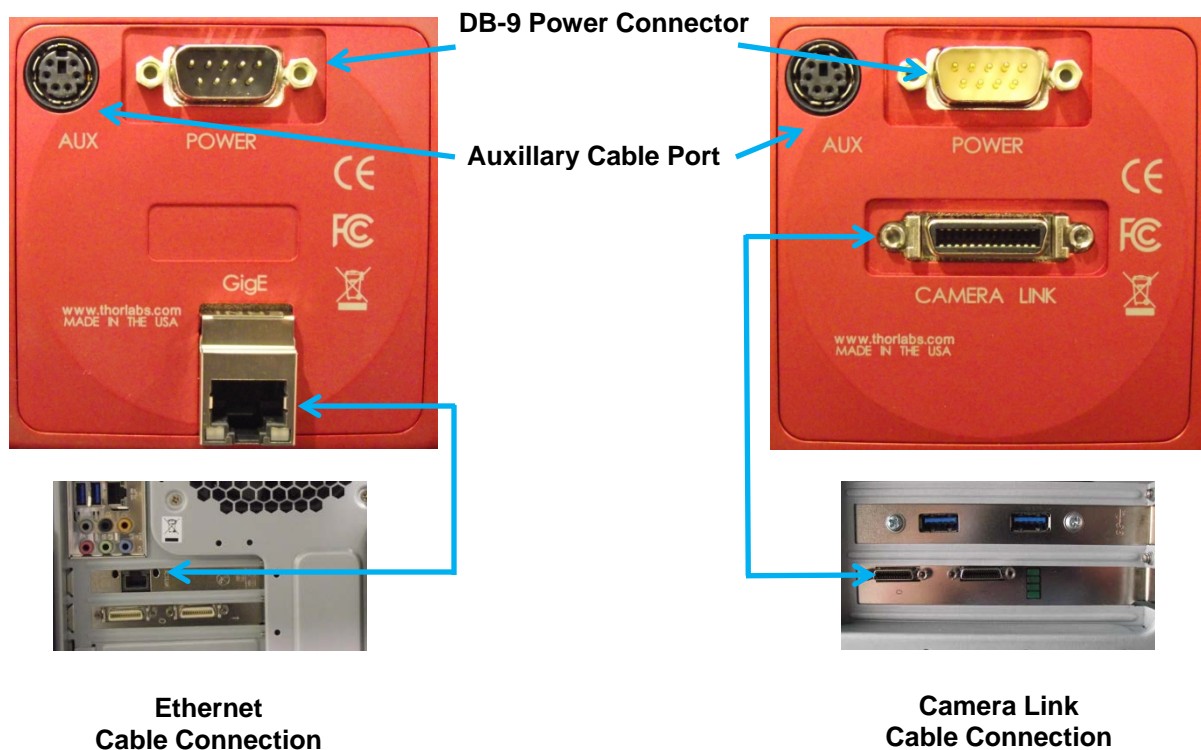
### 4.3. Connecting the Camera

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

1. With the power supply turned off, connect the DE-9 from the power supply to the DE-9 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.

- If you are utilizing a Camera Link Cable: Connect the camera link cable into the port labeled "CAMERA LINK". Connect the other end into the port of the EDT VisionLink F4 camera link card, installed in the computer. Always connect to the port closest to the mother-board of the computer. In Figure 2 below, this would be the left most connector labeled "0" – your computer orientation may vary.



**Figure 2** Diagram of Connectors on Camera (Left shows GigE configuration, Right shows Camera Link configuration)

### 4.3.1. 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 3** Gigabit Ethernet Switch Topology Setup

## 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 2/3" imaging area is recommended. For more information on Thorlabs C-Mount lenses, please visit [www.thorlabs.com](http://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  $\pm 1.5$  mm. A procedure to set the flange focal distance is described in the next section.



**Figure 4** 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 0.63x adapter is recommended in order to match the optical format of the 2/3" imaging area.

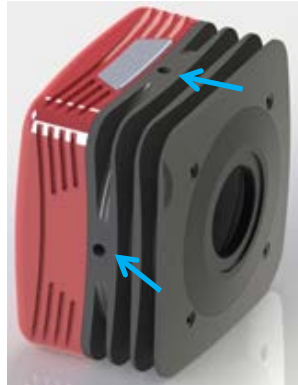
The adjustable flange focus may also be used to parfocalize a microscope, as described in the next section.



**Figure 5** 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

These 1/4"-20 tapped holes are compatible with Thorlabs  $\text{\O}1/2$ " posts. For more information on Thorlabs  $\text{\O}1/2$ " posts, please visit [www.thorlabs.com](http://www.thorlabs.com).

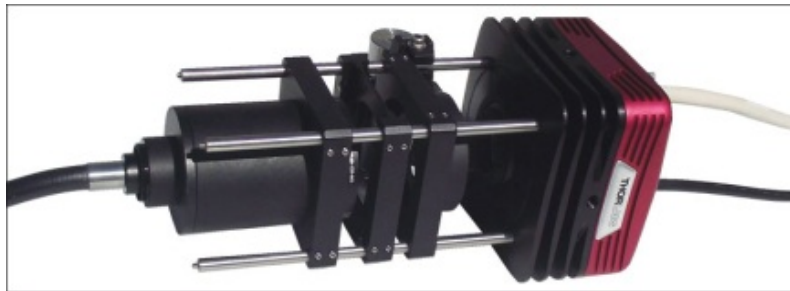


**Figure 6** Arrows Indicate Two of the Four 1/4"-20 Tapped Holes on Camera

#### 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](http://www.thorlabs.com).



**Figure 7** 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  $\text{\O}1$ " lens tubes.



**Figure 8** Thorlabs SM1A9 Adapter with External C-Mount Threads and Internal SM1 Threads

### 4.5. Optical Front End

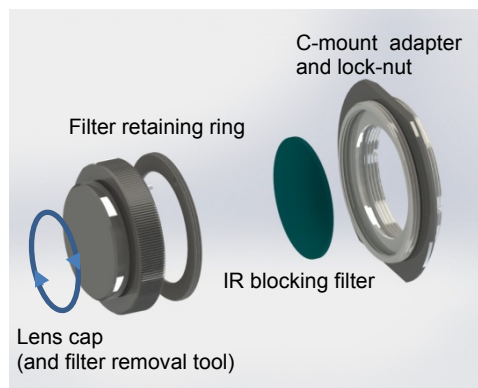
The images below show the components located on the front end of the camera.



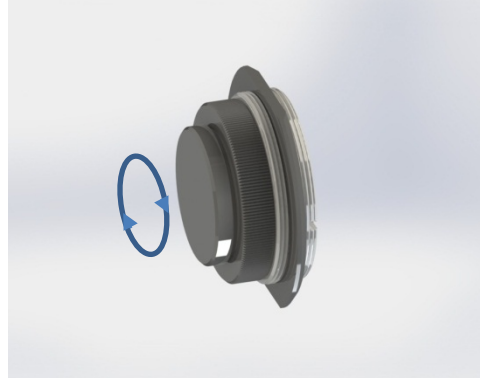
**Figure 9** Exploded View of Optical and Mechanical Components



**Figure 10** Optical and Mechanical Sub-Assemblies



**Figure 11** Reverse View Showing IR Filter and Associated Components



**Figure 12** 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 on Page 24).
- **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 6, *Specifications*, for more data.

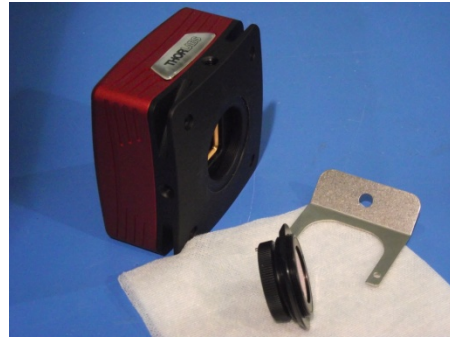
## 4.6. Optical Front End Procedures

### 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.

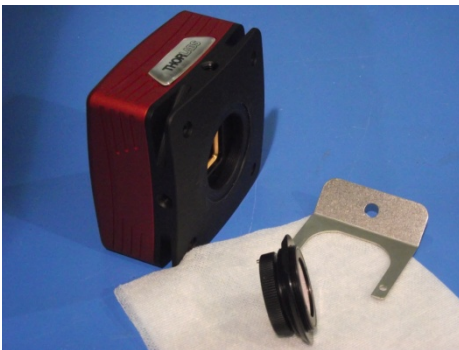
**Note:** Re-adjustment of the lens back-focus will be required after re-assembly. See the “Back Focus Adjustment” in Section 4.6.3.

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



**Figure 13** 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 14** Removing the C-mount and IR-Block Filter Assembly from Camera Body



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#### 4.6.2. Filter Removal and Replacement Procedure

TSI cameras are typically provided with an IR-blocking filter installed (see transmissivity curve in the “Specifications” section). The CCD has responsivity into the NIR (see Quantum Efficiency curve in the “Specifications” section).

If near-infra-red 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 15** Removal of the IR-Blocking Filter from the Assembly

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

1. Install C-mount ring adapter into the front side of the camera as shown in Figure 17, shown below. **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  $\infty$  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



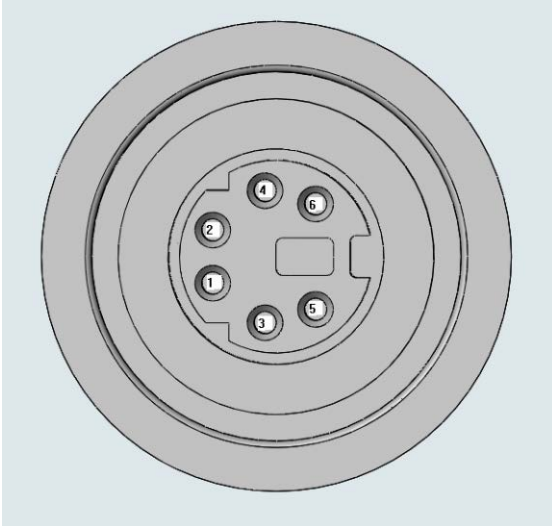
**Figure 16** Re-assembly of the C-Mount Assembly onto Camera

**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



Pin Descriptions	
Pin #	Signal
1	LVAL (Output)
2	CC1_OUT (Output)
3	TRIGGER_IN (Input)
4	GND
5	FVAL (Output)
6	STROBE (Output)

**Figure 17** Illustration of the Auxiliary Connector on the Rear of the Camera

### 4.7.2. Signal Descriptions

- **Pin 1, LVAL (Output):** LVAL refers to “Line Valid.” 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 2, CC1\_OUT (Output):** This pin is an active-LOW TTL signal that is the buffered version of 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 CC1\_OUT to allow triggering of other devices.
- **Pin 3, TRIGGER\_IN (Input):** TRIGGER is a TTL input used to trigger exposures on the transition from the HIGH state to LOW state.
- **Pin 4, GND:** This is the electrical ground for the camera signals.
- **Pin 5, FVAL (Output):** FVAL refers to “Frame Valid” and is a TTL output that is HIGH during active readout lines. FVAL remains high throughout the active readout and returns low between frames.
- **Pin 6, STROBE (Output):** STROBE is a TTL output that is high during the actual sensor exposure time when in continuous, overlapped exposure mode. STROBE is typically used to synchronize an external flash lamp or other device with the camera.

### 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 with the following requirements in order for the camera to adhere to CE and FCC compliance.

The Auxiliary I/O cable must be fabricated using shielded twisted-pair cabling with the addition of **Würth Electronics p/n 74271132S** ferrite core (**Laird 28A0434-0A2** or other equivalent parts) installed on the cable within 1" of the end that mates with the camera. Failure to do so results in levels of radiated RF emissions above those allowed by law. Refer to Section 10.5.

A 10 foot long (3m) auxiliary I/O cable and interconnect break-out board are available from Thorlabs allowing access to the I/O control functions. Order the "1500-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 1500-series cameras can be operated using the ThorCam and ThorImageLS imaging applications. 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, two green indicators should light on the camera's Gigabit Ethernet connector several seconds after power is applied.

**Important:** An orange light indicates a 10/100 connection, not a Gigabit Ethernet connection. If this occurs check that the camera is connected to the proper network interface on the PC. A Gigabit Ethernet connection is required for camera operation.

### 5.2. Camera Timing Diagrams

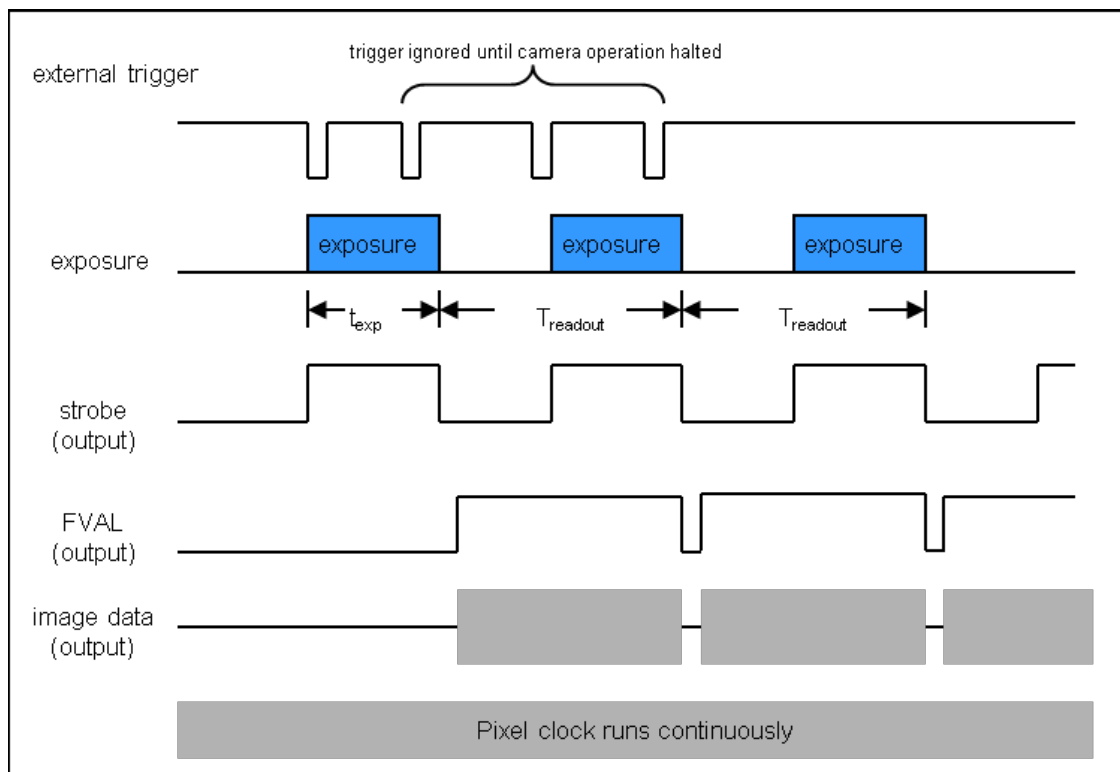
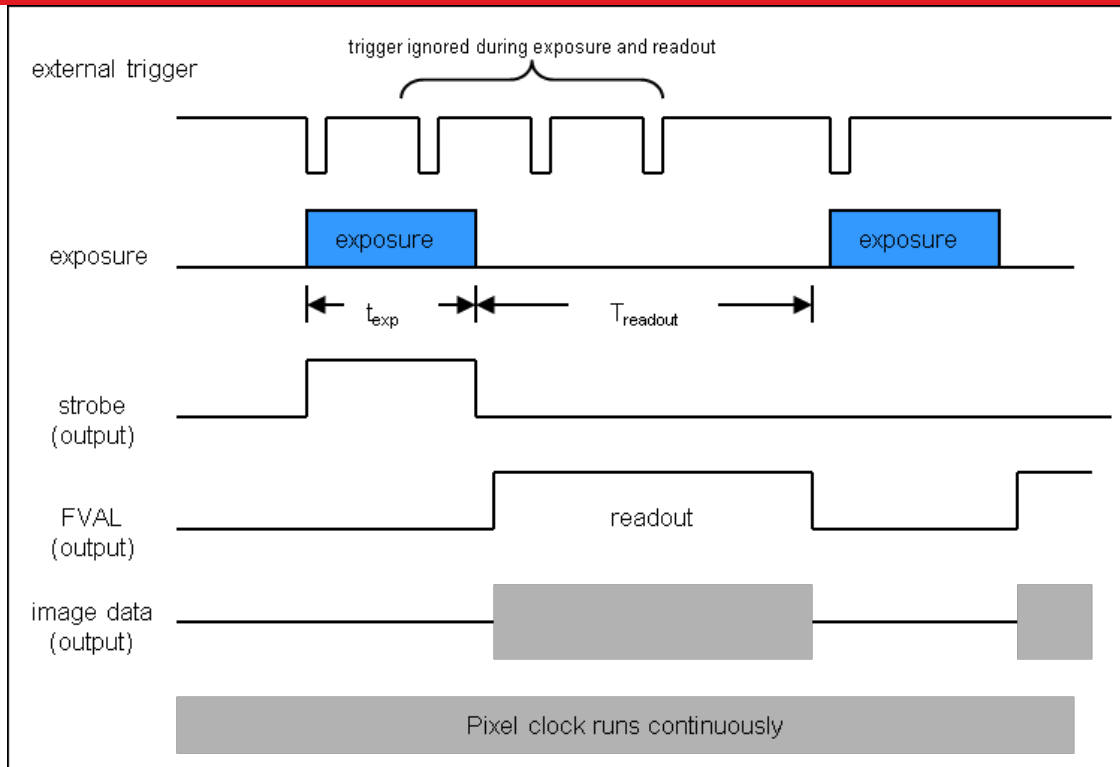
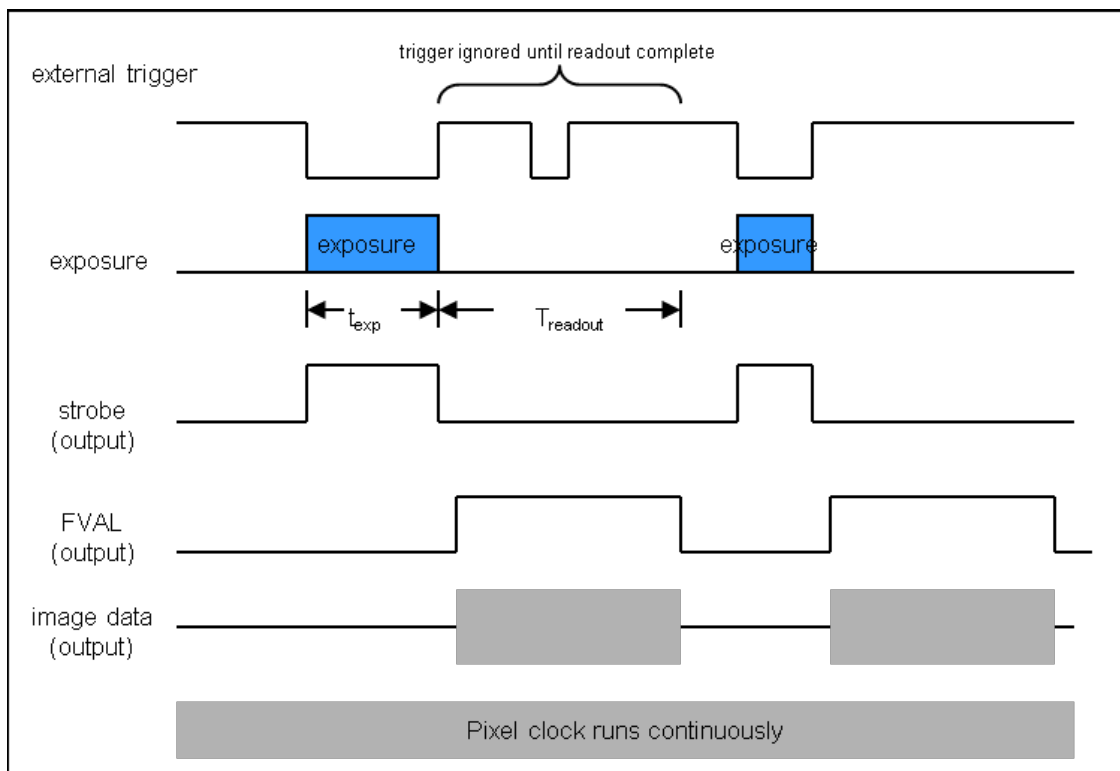


Figure 18 Timing Diagram – Standard, Frames per Trigger = 0 or > 1



**Figure 19 Timing Diagram – Standard, Frames per Trigger = 1**



**Figure 20 Timing Diagram – Bulb Mode**

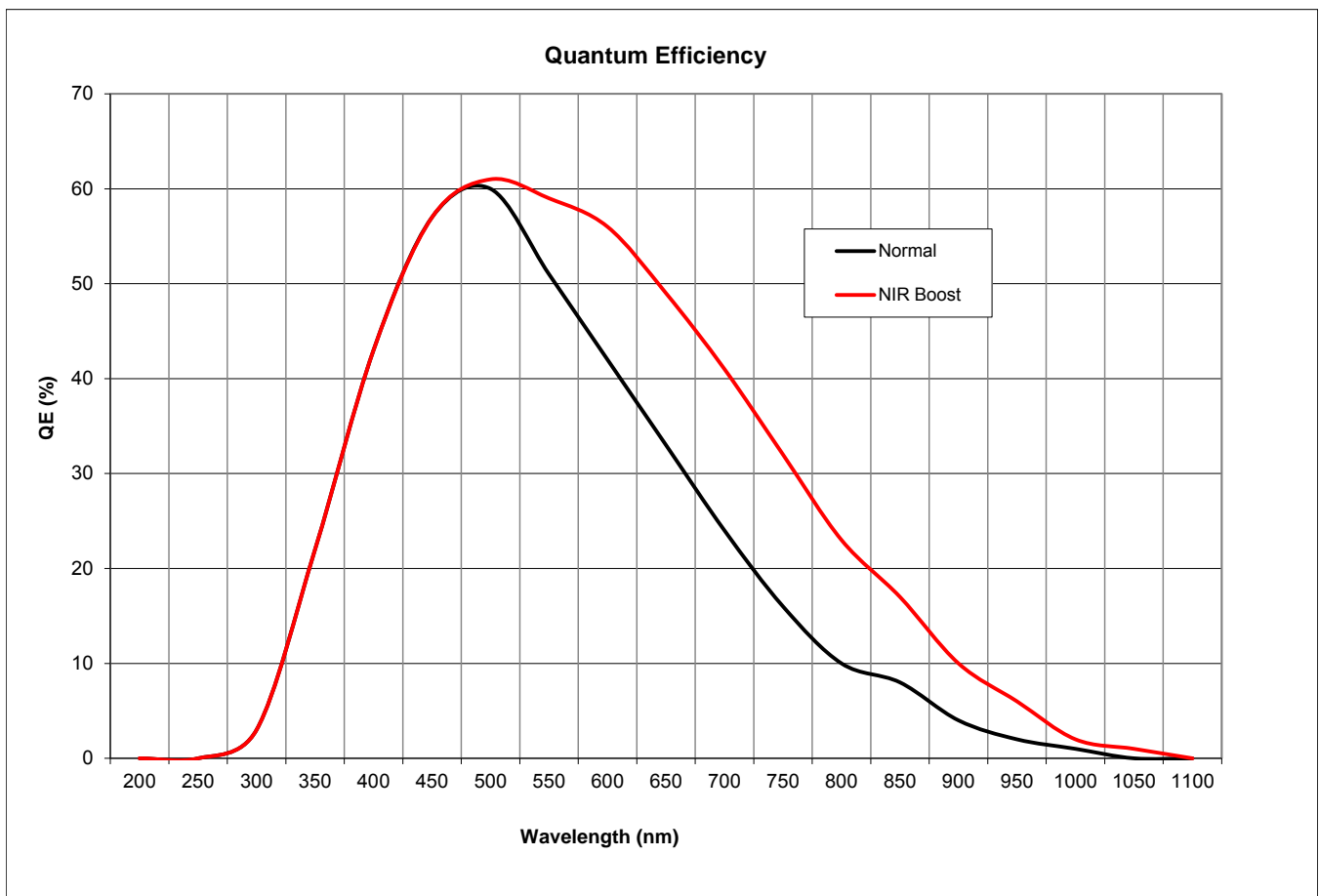
# Chapter 6 Specifications

## 6.1. CCD Specifications

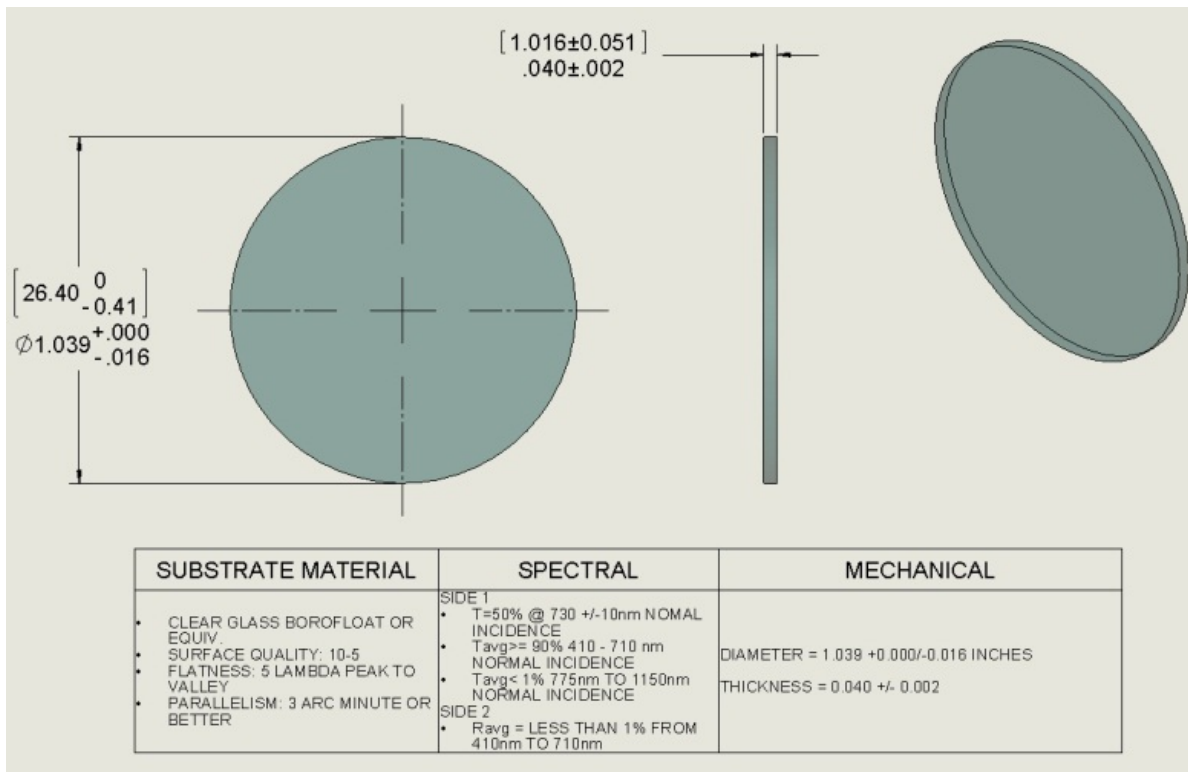
CCD Specifications	
CCD Manufacturer and Item Number	Sony ICX285AL
Number of Active Pixels	1392 (H) x 1040 (V)
Pixel Size	6.45 $\mu\text{m}$ X 6.45 $\mu\text{m}$
Optical Format	2/3" Format (11mm diagonal)
Peak Quantum Efficiency	60% at 500 nm

## 6.2. Quantum Efficiency

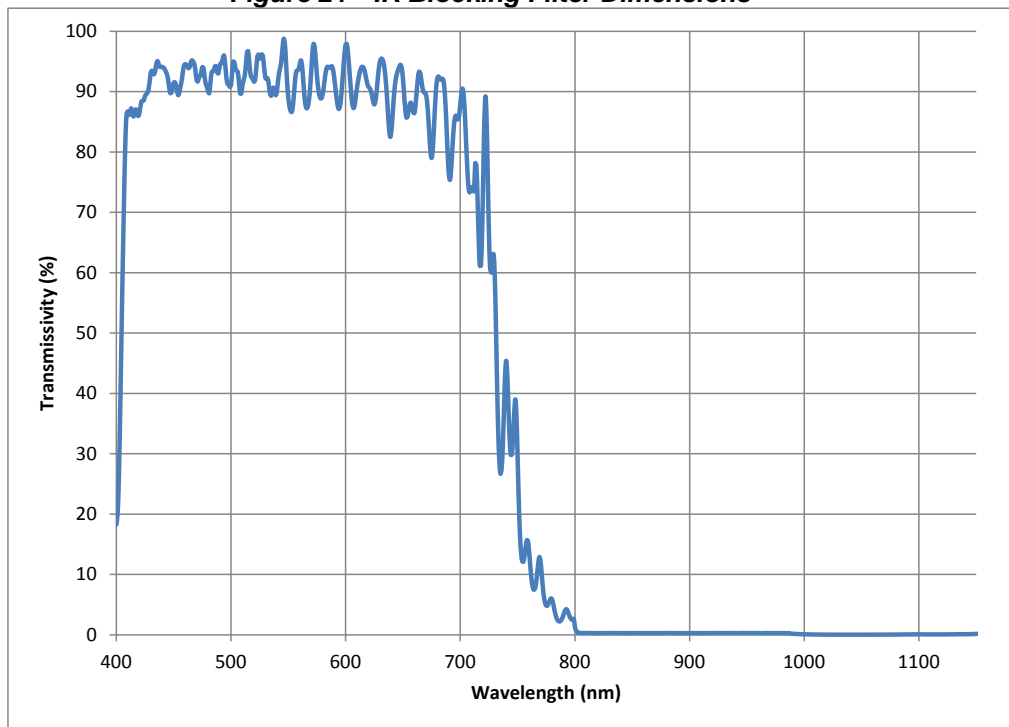
An IR-blocking filter is typically installed. This filter may be removed if NIR responsivity is desired. See Section 6.3 for specifications related to the IR-blocking filter.



### 6.3. IR Blocking Filter



**Figure 21 IR Blocking Filter Dimensions**



**Figure 22 IR Blocking Filter Transmissivity Curve**



## 6.4. 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	12 bits
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	< 10e at 20 MHz

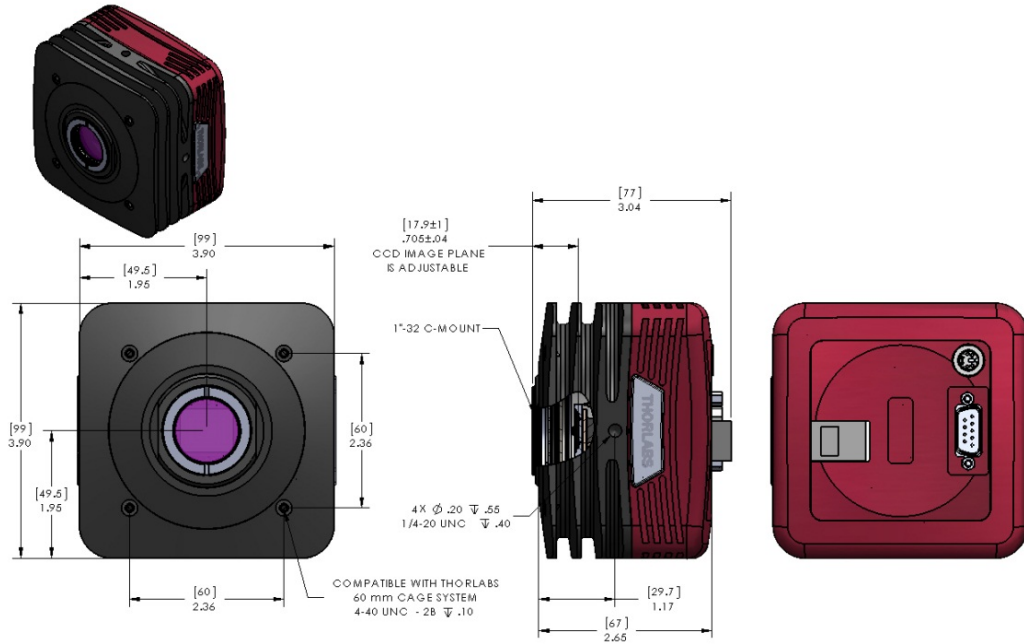
\*Exposure time increment varies with operating mode.

### 6.4.1. Example Frame Rates

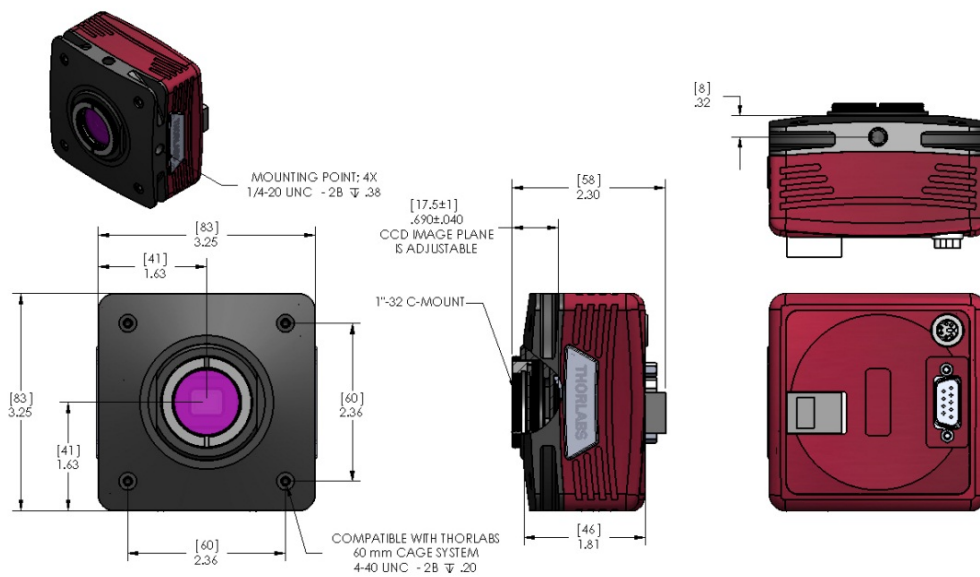
Example Frame Rates @ 1 ms Exposure Time	20 MHz	40 MHz
Full Sensor (1392 x 1040)	12 fps	23 fps
Full Sensor, Bin by 2 (696 x 520)	23 fps	41 fps
Full Sensor, Bin by 10 (139 x 104)	77 fps	112 fps

# Chapter 7 Mechanical Drawings

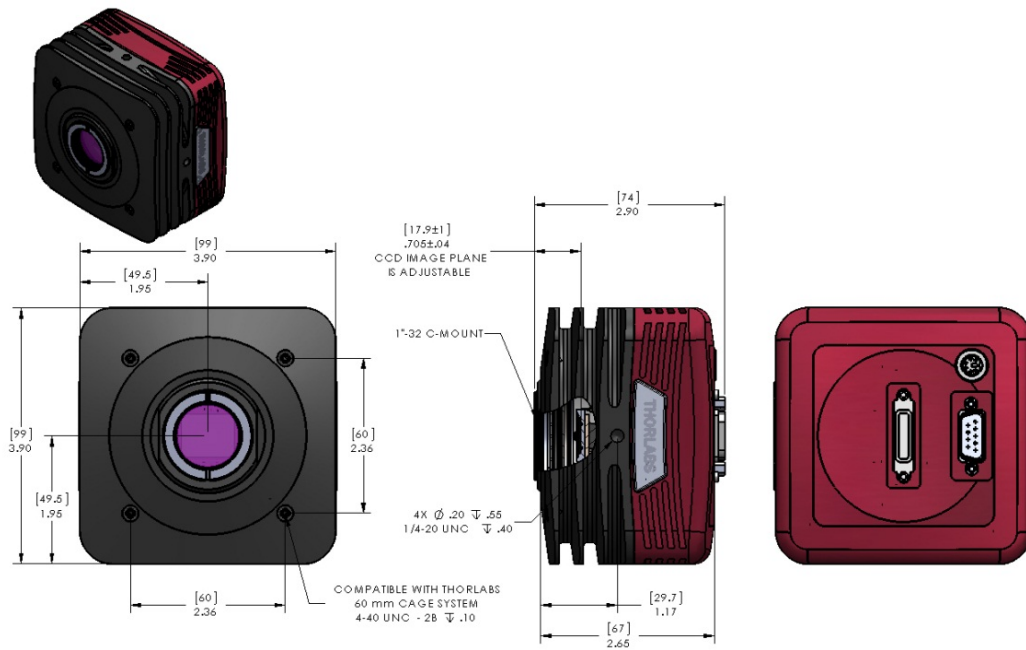
## 7.1. 1500M-GE-TE



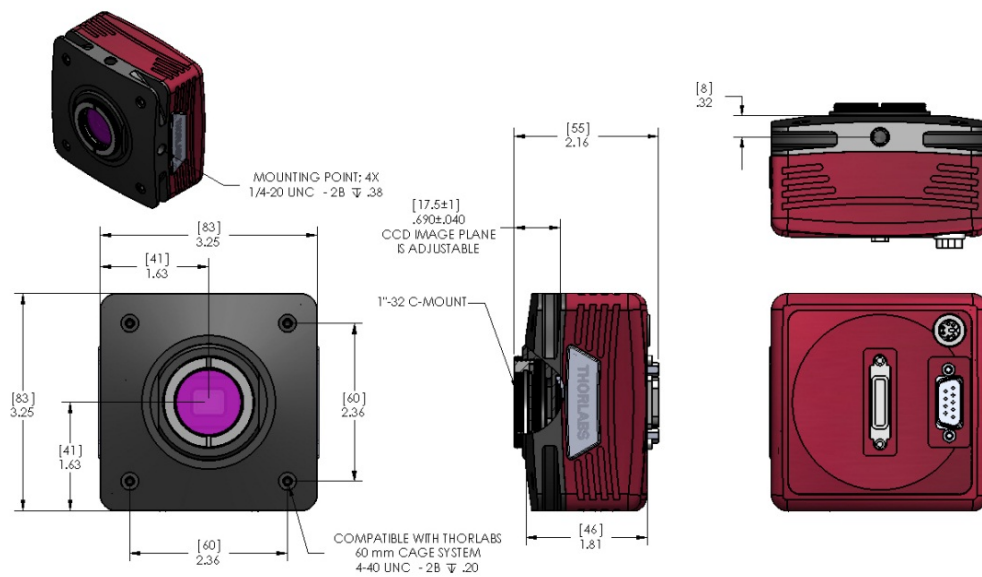
## 7.2. 1500M-GE



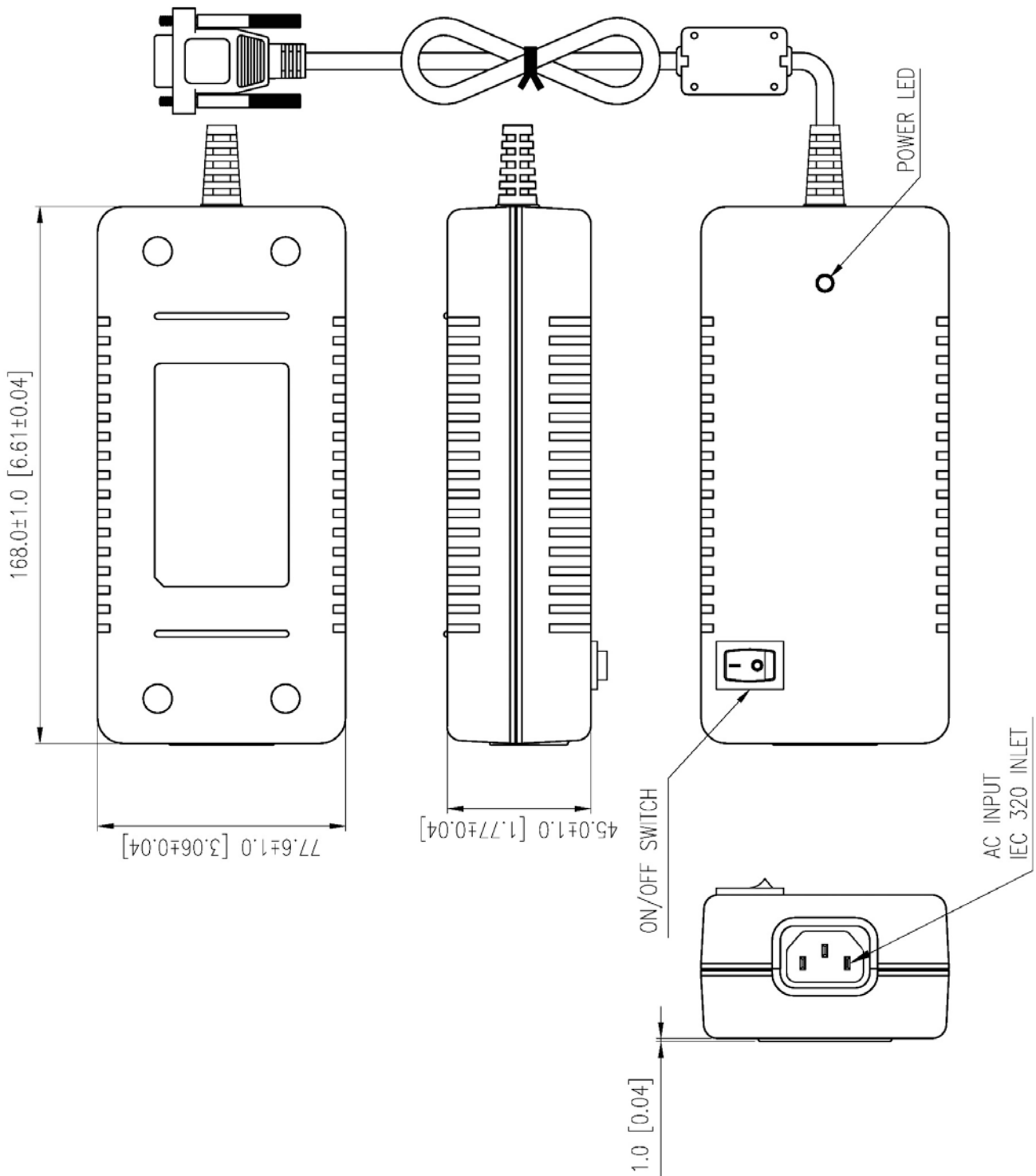
7.3. 1500M-CL-TE



7.4. 1500M-CL



### 7.5. Switching Power Supply



# Chapter 8 Troubleshooting

## 8.1. Interface

Problem	Symptoms	Possible Cause	Remedy
<b>Green light on power supply does not come on</b>	<ol style="list-style-type: none"> <li>1. No power to camera</li> <li>2. Camera does not acquire image</li> <li>3. Software cannot find a connected camera</li> </ol>	<ol style="list-style-type: none"> <li>1. Power supply not connected</li> <li>2. Power strip not turned on</li> <li>3. Bad power supply</li> </ol>	<ol style="list-style-type: none"> <li>1. Plug in power supply to outlet</li> <li>2. Turn on power to power strip</li> <li>3. Contact customer service for power supply replacement</li> </ol>
<b>Software cannot find a connected camera</b>	<ol style="list-style-type: none"> <li>1. Software does not display an image</li> <li>2. Only one "green" status light on GigE connector on the back of the camera (1500M-GE and 1500M-GE-TE only)</li> <li>3. Software does not display a connected camera</li> </ol>	<ol style="list-style-type: none"> <li>1.No power to camera</li> <li>2. GigE cable not connected</li> <li>3. Camera Link Cable not connected</li> <li>4. Camera Link Cable connected to wrong port</li> <li>5. Camera has yet to complete "enumeration"</li> </ol>	<ol style="list-style-type: none"> <li>1. Connect camera power</li> <li>2. Connect GigE cable to camera and computer</li> <li>3. Connect Camera Link Cable to camera and computer</li> <li>4. See Section 4.3 for connection details.</li> <li>5. Restart/refresh software after camera has been powered on and connected to host-PC for at least 30 seconds</li> </ol>

**8.3. Optical**

<b>Problem</b>	<b>Symptoms</b>	<b>Possible Cause</b>	<b>Remedy</b>
<b>When using a standard C-mount lens (not included), image is not in focus</b>	1. Displayed image is not in focus	1. Back focus of camera needs to be set	See Section 4.6 on how to set the camera's back focus
<b>Displayed image has spots or has debris in image</b>	1. Debris in displayed image	1. IR filter has particulates on it	1. Carefully clean IR filter. See Section 4.6
<b>"C-mount" detaches from camera after removing from Microscope</b>	1. Threaded "C-mount" assembly remains on microscope	1. Lock nut not sufficiently tight	1. See Section 4.6

**8.4. Operational**

<b>Problem</b>	<b>Symptoms</b>	<b>Possible Cause</b>	<b>Remedy</b>
<b>Camera excessively warm (too hot to safely hold with ungloved hand)</b>	1. Camera is too hot to hold with an ungloved hand 2. Poor image quality	1. Camera is not properly ventilated 2. Electronics failure	1. Remove any obstructions or provide adequate ventilation around camera 2. Contact customer service
<b>Camera does not feel warm at all</b>	1. Camera is not warm or feels cold to the touch	1. Camera not connected 2. TE cooler is not enabled in Software (This is only for 1500M-xx-TE models)	1. Connect camera to power supply 2. TE cooler was disabled in software 3. Camera was dropped or otherwise subjected to unusual mechanical force. Contact customer service
<b>Imaging Software "times out" without acquiring image</b>	1. Imaging software indicates timeout 2. No images acquired – no frame count provided	1. Camera is not powered 2. Camera is not connected to computer 3. Imaging software is not configured to camera 4. Camera is not "armed" and "started" properly	1. See "Interface" Troubleshooting above 2. Consult the ThorCam User Guide 3. Refer to Chapter 5.1

## 8.5. Software

Problem	Symptoms	Possible Cause	Remedy
<b>Camera not found</b>	Error message, or camera does not show up in Hardware Connections	<ol style="list-style-type: none"> <li>1. Power not on</li> <li>2. Not plugged in</li> <li>3. Camera Link cable not plugged into correct channel in CL card</li> <li>4. Bad network cable for GigE camera</li> </ol>	<ol style="list-style-type: none"> <li>1. Make sure power supply is switched on</li> <li>2. Make sure the power and signal cables are connected</li> <li>3. Make sure cable is plugged into channel closest to the PC motherboard</li> <li>4. Try a different set of cables of the lights don't blink on GigE connector on camera</li> </ol>
<b>Insufficient illumination</b>	Images are all black	<ol style="list-style-type: none"> <li>1. Exposure time too low</li> <li>2. No light going to the camera</li> </ol>	<ol style="list-style-type: none"> <li>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</li> <li>2. Make sure that the light source is turned on, and that the aperture of the lens (or other optics) is not shut.</li> </ol>

## Chapter 9 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.

### 9.1. 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 1500M 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/tutorials.cfm?tabID=26066>. The following guidelines, specific to TSI cameras, are meant to be used in conjunction with the procedures described in the tutorial.**

#### 9.1.1. 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.

#### 9.1.2. 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.**

#### 9.1.3. 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.



### 9.1.4. 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



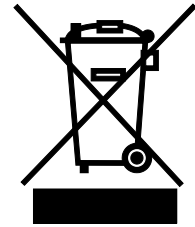
**Ethyl and isopropyl alcohols are highly flammable! Do not use near extreme heat, arcing electrical equipment (such as space heaters) or open flame! Use only with proper ventilation. Follow all safety instructions provided by the manufacturer of the alcohol product.**

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## Chapter 10 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.

### 10.1. 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.

### 10.2. 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.

**10.3. Certifications and Compliance – CE Declaration of Conformity**

**Konformitätserklärung  
Declaration of Conformity  
Déclaration de Conformité**

**Thorlabs Inc  
56 Sparta Ave  
Newton, NJ  
USA**

erklärt in alleiniger Verantwortung, dass das Produkt:  
declares under its own responsibility that the product:  
déclare sous notre seule responsabilité que le produit:

**1500M-GE / 1500M-GE-TE  
1500M-CL / 1500M-CL-TE**

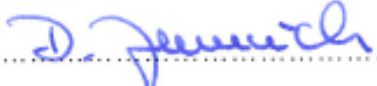
mit den Anforderungen der Normen  
fulfills the requirements of the standard  
satisfait aux exigences des normes

72/73/EEC	Low Voltage Directive 19.02.1973
93/68/EEC	Change of Low Voltage Directive
DIN EN61010-1:2010	Safety of Test and Measurement Equipment
DIN EN 61326:2006	EMC of Test and Measurement Equipment
DIN EN 61000-3-2:2006	Harmonic Current Emission
DIN EN 61000-3-3:2005	Voltage Fluctuations and Flickers
DIN EN 61000-4-2:2001	Electrostatic Discharge Immunity
DIN EN 61000-4-3:2006	Radiated RF Electromagnetic Field Immunity
DIN EN 61000-4-4:2004	Electrical Fast Transient/Burst Immunity
DIN EN 61000-4-5:2006	Power Line Surge Immunity
DIN EN 61000-4-6:2007	Conducted RF Immunity
DIN EN 61000-4-11:2004	Voltage Dips and Interruptions Immunity
DIN EN 55011:2010	Conducted Emissions – Voltage – Class A
DIN EN 55011:2010	Radiated Emissions – Class A

übereinstimmt und damit den Bedingungen entspricht.  
and therefore corresponds to the regulations of the directive.  
et répond ainsi aux dispositions de la directive.

Dachau, 31. March 2014

Ort und Datum der Ausstellung  
Place and date of issue  
Lieu et date d'établissement

.....  
  
.....

Name und Unterschrift des Befugten  
Name and signature of authorized person  
Nom et signature de la personne autorisée

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## 10.4. 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.

## 10.5. Auxiliary I/O Cable Requirements

The Digital Video 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 following requirements in order for the camera to adhere to CE and FCC compliance.

The Auxiliary I/O cable must be fabricated using shielded twisted-pair cabling with the addition of **Würth Electronics p/n 74271132S** ferrite core (or equivalent) installed on the cable within 1" of the end that mates with the camera. Failure to do so results in levels of radiated RF emissions above those allowed by law.

Refer to Section 4.7 for specifics on the pin configuration of the I/O port.

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## Chapter 11 Warranty

### 11.1. 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.

### 11.2. Specific Warranties

#### 11.2.1. 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.

#### 11.2.2. 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.

#### 11.2.3. 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.

#### 11.2.4. 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.

#### 11.2.5. 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.

#### 11.2.6. 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 12 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at [www.thorlabs.com/contact](http://www.thorlabs.com/contact) for our most up-to-date contact information.



### **USA, Canada, and South America**

Thorlabs, Inc.  
[sales@thorlabs.com](mailto:sales@thorlabs.com)  
[techsupport@thorlabs.com](mailto:techsupport@thorlabs.com)

### **Europe**

Thorlabs GmbH  
[europe@thorlabs.com](mailto:europe@thorlabs.com)

### **France**

Thorlabs SAS  
[sales.fr@thorlabs.com](mailto:sales.fr@thorlabs.com)

### **Japan**

Thorlabs Japan, Inc.  
[sales@thorlabs.jp](mailto:sales@thorlabs.jp)

### **UK and Ireland**

Thorlabs Ltd.  
[sales.uk@thorlabs.com](mailto:sales.uk@thorlabs.com)  
[techsupport.uk@thorlabs.com](mailto:techsupport.uk@thorlabs.com)

### **Scandinavia**

Thorlabs Sweden AB  
[scandinavia@thorlabs.com](mailto:scandinavia@thorlabs.com)

### **Brazil**

Thorlabs Vendas de Fotônicos Ltda.  
[brasil@thorlabs.com](mailto:brasil@thorlabs.com)

### **China**

Thorlabs China  
[chinasales@thorlabs.com](mailto:chinasales@thorlabs.com)



**THORLABS**  
[www.thorlabs.com](http://www.thorlabs.com)

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