THORLABS

LP126MU(/M) and LP126CU(/M) Low-Profile Scientific Digital Cameras

User Guide



Table of Contents

Chapter 1 Safety 1
1.1 Precautions 1
1.2 Product Care 2
1.2.1 Service 2
1.2.2 Accessories and Customization 2
Chapter 2 Introduction 3
2.1 General Information 3
2.2 Receiving and Unpacking 3
2.3 Supplied Equipment 4
Chapter 3 Setup and Installation 5
3.1 Pre-Installation – USB 3.0 5
3.2 Installing the Software 5
3.2.1 Run the Installation File 5
3.2.3 Installing 3rd Party Software Application Support 6
3.3 Connecting the Camera 6
3.4 Optical and Mechanical Mounting Considerations 7
3.4.1 Using a C-Mount Lens 7
3.4.2 Mounting the Camera 7
3.4.3 Using the Camera with a Cage System 7
3.4.4 SM1 Compatible Threads 8
3.5 Optical Front End 8
3.5.1 Description of Components 8
3.6 Optical Front-End Procedures 9
3.6.1 Window Removal and Replacement Procedure 9
3.6.2 Re-Assembly of the Window, C-Mount Adapter, and Flange Focus Adjustment 9
3.7 Auxiliary I/O Connectors 9
3.7.1 I/O Port Descriptions 9
3.7.2 Auxiliary Cable 10
Chapter 4 Operation 11
4.1 Starting the Camera 11
4.2 Camera Timing Diagrams 11
4.2.1 Camera-Specific Timing Considerations 13
4.3 Hot-Pixel Correction 13
4.4 Frame-Rate Control 13
Chapter 5 LP126MU(/M) Specifications 15
5.1 CMOS Sensor Specifications 15
5.2 Quantum Efficiency 15
5.3 Imaging Specifications 16
5.4 Example Frame Rates 16

5.5 Power Consumption 16
5.6 Operating/Storage Temperatures 16
Chapter 6 LP126CU(/M) Specifications 17
6.1 CMOS Sensor Specifications 17
6.2 Quantum Efficiency 17
6.3 Imaging Specifications 18
6.4 Example Frame Rates 18
6.5 Power Consumption 18
6.6 Operating/Storage Temperatures 18
Chapter 7 Protective Glass Windows 19
7.1 Protective Glass Window Dimensions 19
7.2 AR-Coated Window Specifications 19
7.3 IR Filter Transmission Curve 19
Chapter 8 Mechanical Drawings 20
Chapter 9 Troubleshooting 21
9.1 Interface 21
9.2 Optical 21
9.3 Operational 22
9.4 Software 23
Chapter 10 Maintenance 24
10.1 Cleaning Guidelines 24
Chapter 11 Regulatory 26
11.1 Waste Treatment is Your Own Responsibility 26
11.2 Ecological Background 26
11.3 Certifications and Compliance – CE Declaration of Conformity 27
11.4 FCC Statement 28
11.5 General Compliance Statement 28
11.6 Auxiliary I/O Cable Requirements 28
Chapter 12 Warranty 29
12.1 General Product Warranty 29
12.2 Specific Warranties and Repairs 29
Chapter 13 Thorlabs Worldwide Contacts 30

Chapter 1 Safety

1.1 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.

Warranty Warning



Do not open the Digital Camera. 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, techsupport@thorlabs.com and a member of our team will be happy to assist you.

Caution



This product is powered directly from the USB 3.0 port of a host computer (not included). To ensure optimal performance and the safety of the user, the host computer must use a properly grounded UL Listed or Recognized AC-DC power supply (or comparable regulatory approvals).

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 of the computer.

1.2 Product Care

Handle the camera with care during transportation and unpacking. Bumping or dropping the camera can damage the unit or lower camera performance. If the camera is mishandled during shipment, the optical components may become misaligned, which could lead to a decrease in the image quality. If this happens, the camera will need to be realigned by qualified personnel. To ensure proper care and operation of your Low-Profile Scientific 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 camera 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.

1.2.1 Service

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

1.2.2 Accessories and Customization

Although the camera is easily adapted for custom interfaces, to achieve the listed specifications, this camera 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.

All cameras are supplied with one USB3.0 cable. These cables are constructed to provide reliable data throughput at a length of 3 m. Do not replace this cable with a 3 m cable from a different vendor. The use of a shorter cable (1 m or 2 m) might be acceptable but is not guaranteed. Never use any cable that is longer than 3 m on a USB 3.0 system.

Chapter 2 Introduction

2.1 General Information

Our kiralux® Low-Profile Scientific Camera family consists of monochrome and color models with USB 3.0 interfaces. All models are passively cooled and are compatible with many Thorlabs supporting products, including C-mount lenses and our 30 mm cage system. They are designed specifically to work "out of the box" in conjunction with our ThorImage®CAM software tool and can also be operated with a variety of other imaging tools.

The model format for the low-profile series is LPxxy(M/C)U where:

xxy is the number of pixels, where "xx" is the multiplier and "y" is the exponent of 10, **M/C** denotes **m**onochrome or **c**olor, and **U** indicates a USB 3.0 interface. Using the LP126MU as an example, the 126 indicates the camera has 12 x 10^6 pixels (12 megapixels), is monochrome, and has a USB 3.0 interface.

The cameras are bundled with the full complement of Thorlabs imaging software. For end-users, the ThorImageCAM software application provides full control of the camera through an intuitive user interface, and it allows the user to acquire, zoom, analyze, and save images and metadata. ThorImageCAM is only supported by Windows 10 (64-bit Only) or Windows 11. For those operating with Windows version 10 (32-bit) or lower, use the legacy software, ThorCam.

For developers, Thorlabs also offers a Software Developer's Kit (SDK), which includes a comprehensive Application Programming Interface (API) to streamline the integration of any Thorlabs camera into your system. After software installation, the SDK can be found in a sub-folder under C:\Program Files\Thorlabs. This is the same directory 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, ThorImageCAM User Guide, and the Thorlabs Application Programming Interface Guide. All support documentation is available at **www.thorlabs.com**. The ThorImageCAM User Guide can be accessed in the About window under the Help tab of the ThorImageCAM interface.

2.2 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 Thorlabs 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.

2.3 Supplied Equipment

The following is a list of equipment that is supplied with your camera:

Supplied Equipment	
Interface Accessories	3 m Long USB 3.0 Cable[a] (CABU32)
Accessories	DC-CS1 C-Mount Adapter Lens Cap 3 x CA3339 MMCX-to-BNC Signal Cable
Included Software	Thorlabs Camera Software and SDK Available for Download from **www.thorlabs.com/software**

a. All cameras are supplied with one USB 3.0 cable. These cables are constructed to provide reliable data throughput at a length of 3 m. Do not replace this cable with a 3 m cable from a different vendor. The use of a shorter cable (1 m or 2 m) may be acceptable but is not guaranteed. Never use any cable that is longer than 3 m on a USB 3.0 system.

Chapter 3 Setup and Installation

3.1 Pre-Installation – USB 3.0

Your camera will only operate when connected to a USB 3.0 "SS" (Super Speed) port on your PC. USB 2.0 ports are not supported at this time. A USB 3.0 compatible port is typically blue, but not always. Look for this symbol above the port to be sure:



If your computer does not have a USB 3.0 port, it is likely an indication that it is an older machine, and you should consult our recommended configuration. If you must use that machine, Thorlabs recommends our PCIe USB 3.0 card (Item # USB3-PCIE).

Recommended Installation Sequence

1. Run the software installer and follow the steps outlined in the next section.
2. Connect the camera to a USB 3.0 port. Power will be applied once it is connected to the port.
3. Your PC should discover the new USB device and install the necessary drivers. This may take a minute or so for the first instance.
4. Run the ThorImageCAM application software.

3.2 Installing the Software

ThorImageCAM is only supported by Windows 10 (64-bit Only) or Windows 11. For those operating with Windows version 10 (32-bit) or lower, use the legacy software, ThorCam.

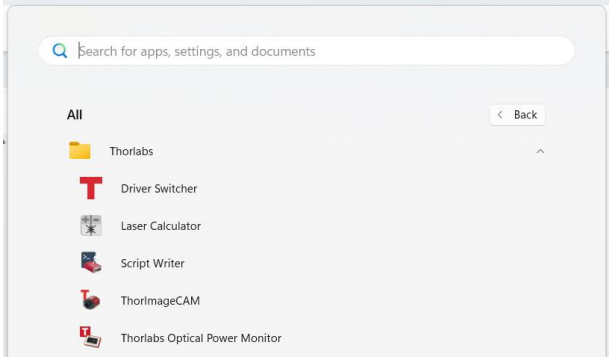
3.2.1 Run the Installation File

You may download the latest version of software from our webpage **Software for Scientific and Compact USB Cameras**. Download the file to your host computer, double-click the file to run the installation, and follow the screen prompts. If using the legacy ThorCam software, you will be prompted to choose the desired driver option from the popup window. After selecting your driver, click Next to install the ThorCam software. For assistance, please contact **techsupport@thorlabs.com**.

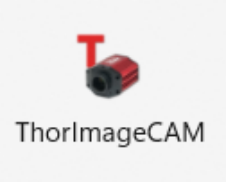
Software Designer Kits (SDKs) for Windows and Linux are also available at the same download page.

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 ThorImageCAM Imaging Software as shown below:

"Start" → "All Programs" → "Thorlabs" → "ThorImageCAM"



Or simply double-click on the ThorImageCAM shortcut icon that was placed on your desktop during installation of the software:



3.2.2 Installing 3rd Party Software Application Support

After installation of Thorlabs components is completed, you have access to interfaces for select 3rd-party image analysis packages you may already have installed on your computer, such as MATLAB®*.

*MATLAB® is a registered trademark of The MathWorks, Inc.

3rd-party application software interfaces are located in Zip files in the following directory:

C:\Program Files\Thorlabs\Scientific Imaging\Scientific Camera Support

Important: Do not develop 3rd-party solution in this directory, as they will be deleted if you update your ThorImageCAM software.

To use the MATLAB and LabVIEW interfaces, extract from the Zip file and place in the appropriate directory on your system.

Special not for users of Micro-Manage (µManager) software: support for Thorlabs scientific cameras (excluding the CS505MUP1 polarization camera) is included when you run versions 2.0 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 ThorImageCAM to confirm that the camera, software and drivers are properly installed. Then, shut down your ThorImageCAM session and start a Micro-Manager session.

3.3 Connecting the Camera

To connect the camera, follow the steps below:

5. Connect the provided USB 3.0 cable[a] into the mating connector on the back of the camera. The camera end of the provided cable will have one thumb screw. Make sure the connector is fully inserted, and then tighten the thumbscrews into the camera housing. You might need a flat blade screwdriver to fully seat the thumbscrew.
6. Connect the other end of the USB 3.0 cable into a USB 3.0 port (USB SS) on the host computer.

[a] All cameras are supplied with one USB 3.0 cable. These cables are constructed to provide reliable throughput at a length of 3 m. Do not replace this cable with a 3 m cable from a different vendor. The use of a shorter cable (1 m or 2 m) may be acceptable but is not guaranteed. Never use any cable that is longer than 3 m on a USB 3.0 system.

3.4 Optical and Mechanical Mounting Considerations

3.4.1 Using a C-Mount Lens

For the best results, the use of a C-mount lens that matches the optical format of the sensor's imaging area is recommended (refer to the sensor specifications starting at **Chapter 5**). For more information on Thorlabs C-Mount lenses, please visit **https://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 a fixed flange focal range that allows focusing through the ideal distance when using the provided DC-CS1 C-Mount Adapter. Note: This flange focal distance includes the installed AR coated window or IR filter thickness.

3.4.2 Mounting the Camera

On most commercial microscopes, the use of a suitable adapter is recommended in order to match the optical format of the imaging area. Please note that some commercial 1X adapters may underfill the imaging area, leading to vignetting of the image.

Five 1/4"-20 (M6 x 1.0 mm) tapped holes are provided, two each on top and bottom and one on the side of the housing. These may be used with tripods or other optical mounting devices. These 1/4"-20 (M6 x 1.0 mm) tapped holes are compatible with Thorlabs Ø1/2" posts.



Figure 1 Mounting Features of the LP126xU(/M) Low-Profile Scientific Camera (A LP126MU camera is shown in the image above.)

3.4.3 Using the Camera with a Cage System

The cameras have four 4-40 tapped holes for compatibility with Thorlabs' 30 mm Cage systems.

For mor information on Thorlabs' 30 mm Cage system components, please visit **www.thorlabs.com**.

3.4.4 SM1 Compatible Threads

The included DC-CS1 C-mount adapter (1.000"-32) can be completely removed (See **Figure 3**), exposing internal SM1 (1.035"-40) threading that is directly compatible with Thorlabs Ø1" Lens Tubes.

3.5 Optical Front End

The image below shows the components on the front end of the camera.



Figure 2 Exploded View of Optical and Mechanical Components (An LP126MU camera is shown here.)

3.5.1 Description of Components

- **C-Mount Adapter**: Allows the camera to be optically coupled with standard C-mount optics, including lenses and microscope adapters.
- **Lens Cap (Not Shown)**: A protective cover that should always be installed during movement or shipment, and when the camera is not in use.
- **Protective Window**: Unless otherwise requested, a protective glass window is installed and held in place by a retaining ring.
    - Users may, at their discretion, remove the protective glass window, or replace it with a custom optical filter. When using the C-mount adapter, the maximum filter thickness is 0.039" (1.0 mm) with a Ø25 mm or Ø1" (Ø25.4 mm), otherwise the maximum filter thickness is 0.196' (5.0 mm) with Ø1" (Ø25.4 mm).
    - CMOS imagers have responsivity that extends beyond the visible range, into the Near-Infrared (NIR) spectral range. When installed, an NIR blocking filter cuts off light at higher wavelengths. See **Section 7.3** to see the transmission vs wavelength plot of the filter.
    - All monochrome Low-profile Scientific cameras are configured with an AR-coated protective window. For imaging that is limited to the visible region, users may install an NIR blocking filter in its place.
    - All Low-profile Series color models are configured with an NIR blocking filter as a protective window. The NIR blocking filter is installed in order to achieve realistic colors in white light.

- See **Chapter 7** for more information on both types of windows. See **Section 3.6.1** for instructions related to removing and replacing the glass window.

3.6 Optical Front-End Procedures

3.6.1 Window Removal and Replacement Procedure

Thorlabs Low-profile Scientific cameras are provided with a protective glass window installed (See Section **3.5.1**).

Note: If no glass is installed, dust and debris may collect on the sensor faceplate. Care must be taken when cleaning a sensor faceplate to avoid damage to the sensor. Please use every precaution to avoid contact with the sensor faceplate. Keep the camera securely mounted to the optical system and capped when not in use.

Removal of the Window from the Camera

1. Use your fingers to turn the C-mount adapter counter-clockwise until it is fully removed from the camera housing.
2. Using an SPW606 or equivalent tool, carefully remove the SM1 retaining ring and window.

3.6.2 Re-Assembly of the Window, C-Mount Adapter, and Flange Focus Adjustment

Replacement of the window and C-Mount Adapter is done in the reverse order as above. **Care must be taken when handling the filter. Do NOT overtighten the retaining ring.**

3.7 Auxiliary I/O Connectors

The auxiliary I/O connectors on the camera allow the user to access optional camera control and internal status signals.



Figure 3 Illustration of the Auxiliary Connectors on the Side of the Camera

3.7.1 I/O Port Descriptions

- **STROBE OUT (Output):** STROBE OUT is an LVTTL output (0 to 3.3 V) that is high during the actual sensor exposure time. STROBE OUT is typically used to synchronize an external flash lamp or other device with the camera.
- **TRIGGER IN (Input):** TRIGGER IN is an LVTTL input (0 to 3.3 V) used to trigger exposures on the camera. Transitions can occur from High to Low states or Low to High, as selected using the ThorImageCAM

interface. Default is Low to High. Minimum trigger pulse-width is 100 µs. Maximum trigger voltage may not exceed +5 V or go below -0.7 V.

- **FVAL UT (Output):** FVAL OUT refers to the "Frame Valid Output" and is an LVTTL output that is High during active readout lines. FVAL_OUT remains High throughout the active readout and returns Low between frames.

3.7.2 Auxiliary Cable

Three Thorlabs CA3339 BNC-to-MMCX 1 m long cables are supplied with each camera.

Chapter 4 Operation

The Low-profile Scientific Camera series can be operated using the ThorImageCAM Imaging Software. For more details on using ThorImageCAM, please consult the ThorImageCAM User Manual.

4.1 Starting the Camera

With the camera software installed and the camera connected as instructed (Refer to Section **3.3**), the Status LED should light up solid Yellow, turning blue several seconds after power is applied. The table below details the conditions represented by the status indicator.

LED	If LED is Flashing	If LED is On	If LED is Off
Status	USB port cannot provide sufficient power to the camera	**Blue:** Connected to a USB 3.0 Port **Green:** Connected to a USB 2.0 Port **Yellow:** Camera has internal problem or computer USB port has malfunctioned	There is no USB connection providing power to the camera.

If you are using the ThorImageCAM Image Acquisition Software please refer to the ThorImageCAM User Guide, which can be accessed in the About window under the Help tab of ThorImageCAM.

4.2 Camera Timing Diagrams

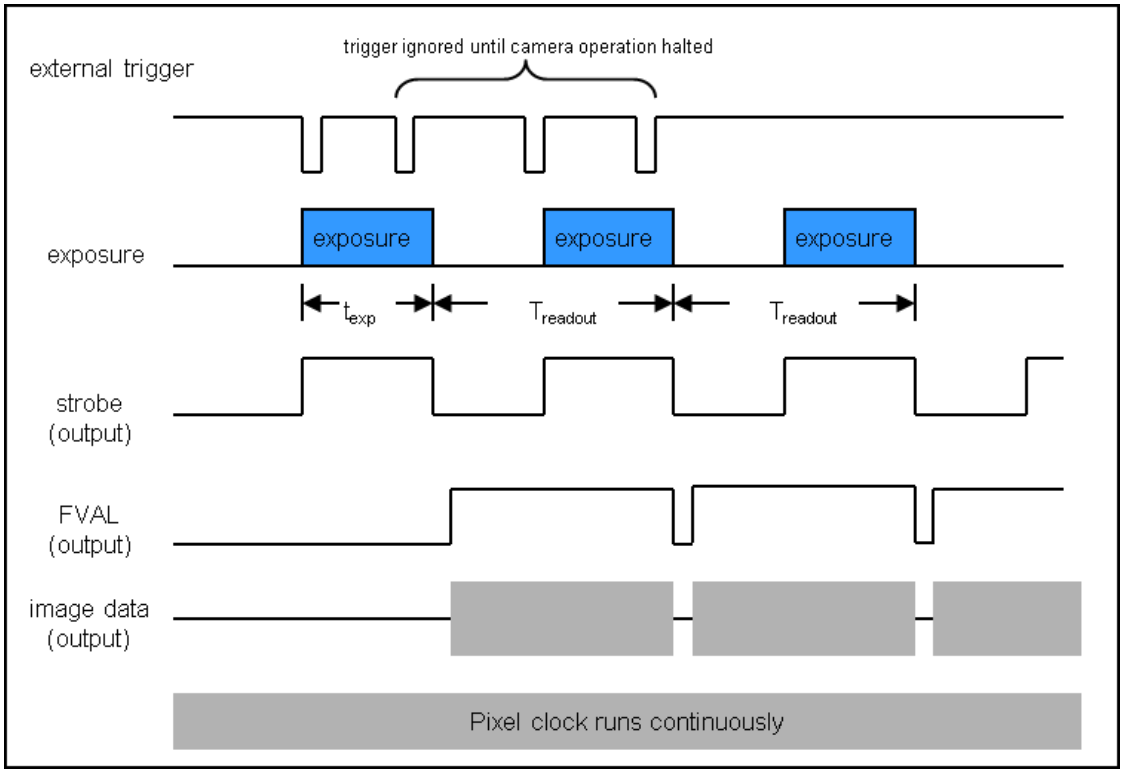


Figure 4 Timing Diagram – Standard Trigger: Frames per Trigger = 0

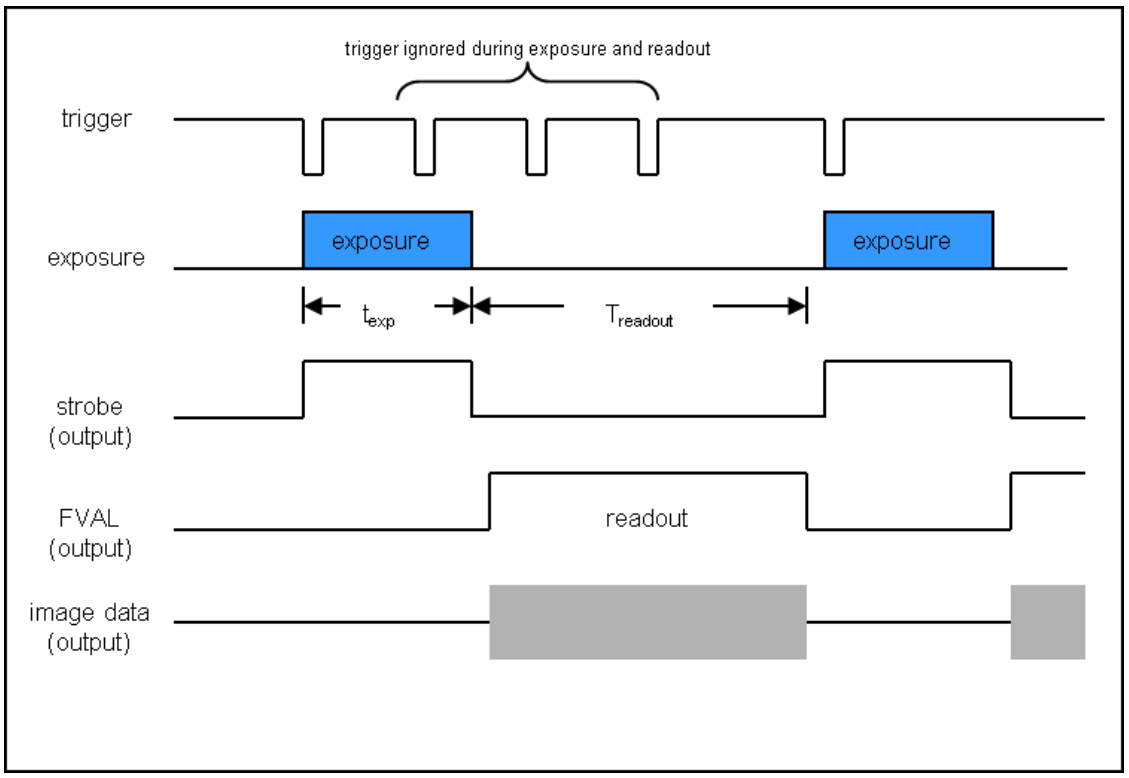


Figure 5 Timing Diagram – Standard Trigger: Frames per Trigger > 0

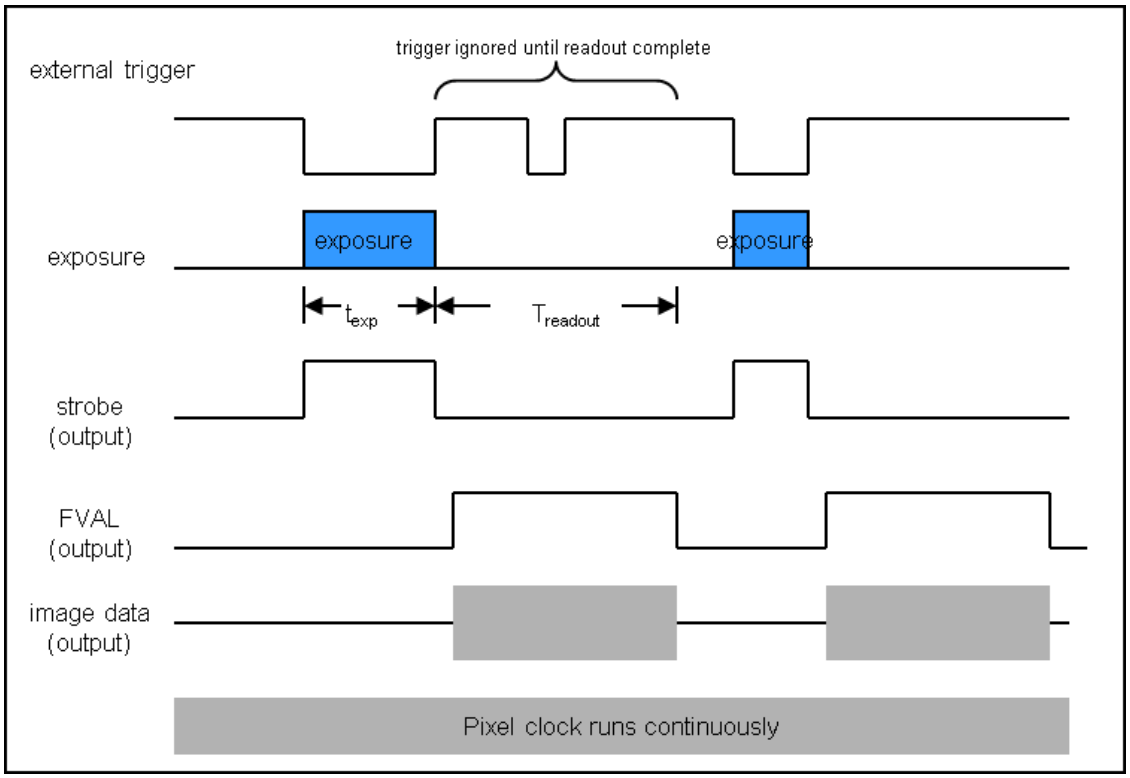


Figure 6 Timing Diagram - Bulb Mode

Note: Default Frames per Trigger is 0 (Continuous).

4.2.1 Camera-Specific Timing Considerations

Due to the general operation of our Kiralux CMOS sensor cameras, as well as typical system propagation delays, the timing relationships shown above are subject to the following considerations:

1. The delay from the external trigger to the start of the exposure and strobe signals is typically 75 ns for all triggered modes (standard and PDX / Bulb) for LP126 Low-profile series cameras.
2. For PDX / Bulb mode triggered exposures, in addition to the start delay discussed above, there is also a fixed exposure time error[b] AFTER the falling edge of the external trigger. This is inherent in the sensor operation.

It is important to note that the Strobe Out signal includes the additional fixed exposure time error and therefore is a better representation of the actual exposure time. Our suggestion is to use the Strobe Out signal to measure your exposure time and adjust your PDX mode trigger pulse accordingly.

4.3 Hot-Pixel Correction

Hot-Pixel Correction is a firmware function that identifies and corrects pixels that are much brighter than their surrounding pixels. Typically visible as very bright pixels regardless of the scene being imaged, these are unavoidable by-products of the CMOS and sCMOS sensor manufacturing process.

This feature can be activated by checking the **Hot Pixel Threshold** check box in the ThorImageCAM Camera Settings window. The **Threshold** can then be adjusted using the numeric input box. The Hot Pixel Threshold box can only be checked and unchecked when the camera is stopped. Once it is checked however, the Threshold adjustment can be made on a live image.

A hot pixel is identified by comparing the value of a pixel to the median value of the surrounding 8 pixels out of a 3 x 3 neighborhood. If the difference between the pixel value and the median value is larger than a specified threshold value, then this pixel is considered a hot pixel and will be replaced with the median value of those pixels in the neighborhood. As the correction value is increased towards the maximum value allowed by the camera, the threshold is reduced in a linear fashion. The minimum threshold value, corresponding to the upper limit, has been selected to provide users with the ability to correct hot pixels having a deviation of only a few hundred counts. At this most aggressive value, it is likely that the image content near the maximum pixel values (full scale) will be altered by the hot pixel correction algorithm. This correction is done in hardware and any images saved by the host application will only have corrected data.

4.4 Frame-Rate Control

All models in the Kiralux family of Compact Scientific cameras employ a unique feature in the ThorImageCAM software environment and SDK that allows a user to adjust the frame rate in frames per second (FPS) to reduce or eliminate the number of dropped frames that may occur due to limitation in the host computer.

The **Frame-Rate** Control is accessed in the Camera Control window of ThorImageCAM. When the Frame Rate Enable box is unchecked, the camera will operate at its maximum FPS for the given setting of Exposure, ROI, and Binning. When the box is checked, the numeric input field and increment / decrement arrows are enabled. See Figure 7 for details.

[b] *The fixed exposure time error for the LP126xx Low-Profile camera models is 14.26 µs.*

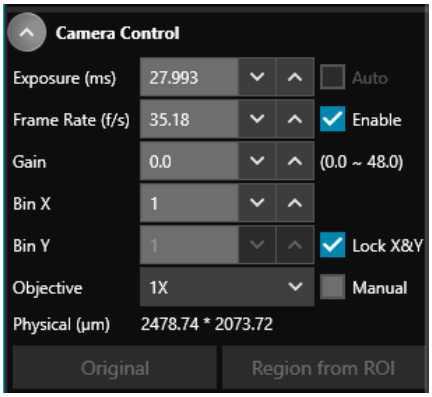


Figure 7 ThorImageCAM Camera Control Window

Please refer to the ThorImageCAM User Guide for more details, which can be accessed in the About window of ThorImageCAM.

Note: If the **Frame-Rate Control** feature is not visible when operating your Kiralux Low-profile camera, please visit

https://www.thorlabs.com/software_pages/ViewSoftwarePage.cfm?Code=ThorCam

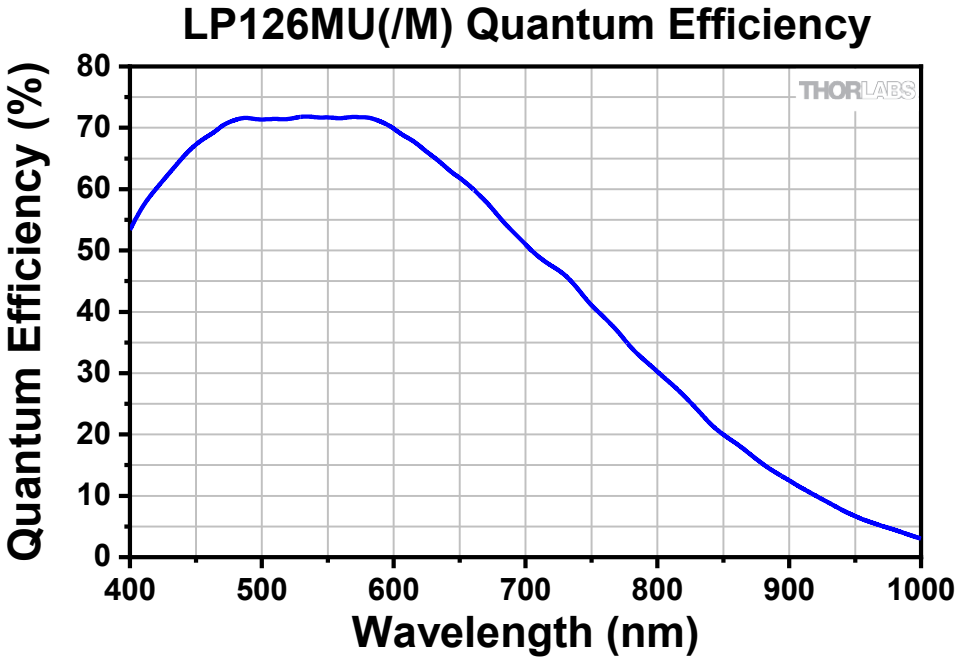
for the latest ThorImageCAM software and camera firmware updates.

Chapter 5 LP126MU(/M) Specifications

5.1 CMOS Sensor Specifications

Sensor Specifications	
Sensor Type	CMOS Monochrome
Number of Active Pixels	4096 (H) x 3000 (V) (~12.3 MP)
Pixel Size	3.45 µm x 3.45 µm
Optical Format	1.1" Format (14131 µm x 10350 µm)
Peak Quantum Efficiency	72% Over 525 to 580 nm (Typical)
Dynamic Range	Up to 71 dB
Full Well Capacity	≥10,650 e^-
Shutter Type	Global

5.2 Quantum Efficiency



5.3 Imaging Specifications

Imaging Specifications	
Exposure Time[a]	0.028 to 14700.9 ms
ADC Resolution	12 Bits
Vertical and Horizontal Digital Binning	1 x 1 to 16 x 16
Region of Interest (Width x Height)[b]	260 x 4 Pixels to 4096 x 3000 Pixels[c]
Read Noise	<2.5 e^- RMS
Overlapped Exposures	Frames per Trigger = Continuous Only

a. In Increments of ~0.014 ms

b. For Binning 1 x 1

c. Rectangular

5.4 Example Frame Rates

ROI	Frame Rate
Full Sensor (4096 x 3000)	21.7 fps
Half Sensor (2048 x 1500)	46.1 fps
~1/10 Sensor (410 x 300)	206.1 fps
Min ROI (260 x 4)	914.4 fps

~1 ms Exposure Time, 1 x 1 Binning, Frames per Trigger = Continuous

Frame rates above are determined by the frame valid (FVAL) frequency.

Frame rate is directly dependent on the capabilities of the host computer. Results may vary.

See also section **4.4**.

5.5 Power Consumption

3.92 W Max @ 21.7 fps Full Sensor ROI

5.6 Operating/Storage Temperatures

Operating: 10 °C to 40 °C (Non-condensing)

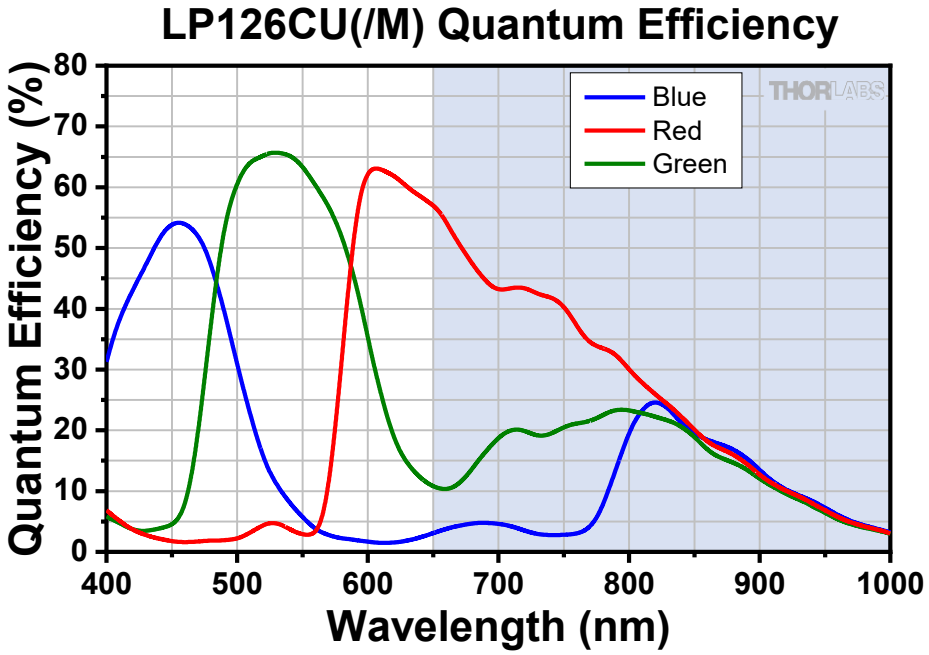
Storage: 0 °C to 55 °C

Chapter 6 LP126CU(/M) Specifications

6.1 CMOS Sensor Specifications

Sensor Specifications	
Sensor Type	CMOS Color
Number of Active Pixels	4096 (H) x 3000 (V) (~12.3 MP)
Pixel Size	3.45 µm x 3.45 µm
Optical Format	1.1" Format (14131 µm x 10350 µm)
Dynamic Range	Up to 71 dB
Full Well Capacity	≥10,650 e^-
Shutter Type	Global

6.2 Quantum Efficiency



An IR-blocking filter is typically installed. This filter may be removed if NIR responsivity is desired. See **Chapter 7** for specifications related to the IR-blocking filter. The quantum efficiency plot above is without an IR-blocking filter. The blue shaded region above 650 nm represents wavelength blocked by the IR filter, which is removeable.

6.3 Imaging Specifications

Imaging Specifications	
Exposure Time[a]	0.028 to 14700.9 ms
ADC Resolution	12 Bits
Vertical and Horizontal Digital Binning	1 x 1 to 16 x 16
Region of Interest (Width x Height)[b]	260 x 4 Pixels to 4096 x 3000 Pixels[c]
Read Noise	<2.5 e^- RMS
Overlapped Exposures	Frames per Trigger = Continuous Only

a. In Increments of ~0.014 ms
b. For Binning 1 x 1
c. Rectangular

6.4 Example Frame Rates

ROI	Frame Rate
Full Sensor (4096 x 3000)	21.7 fps
Half Sensor (2048 x 1500)	46.1 fps
~1/10 Sensor (410 x 300)	206.1 fps
Min ROI (260 x 4)	914.4 fps

~1 ms Exposure Time, 1 x 1 Binning, Frames per Trigger = Continuous

Frame rates above are determined by the frame valid (FVAL) frequency.

Frame rate is directly dependent on the capabilities of the host computer. Results may vary.

See also section **4.4**.

6.5 Power Consumption

3.92 W Max @ 21.7 fps Full Sensor ROI

6.6 Operating/Storage Temperatures

Operating: 10 °C to 40 °C (Non-condensing)

Storage: 0 °C to 55 °C

Chapter 7 Protective Glass Windows

The protective glass window may be either an AR (anti-reflective) coated window for monochrome cameras, or an IR filter for color cameras.

7.1 Protective Glass Window Dimensions

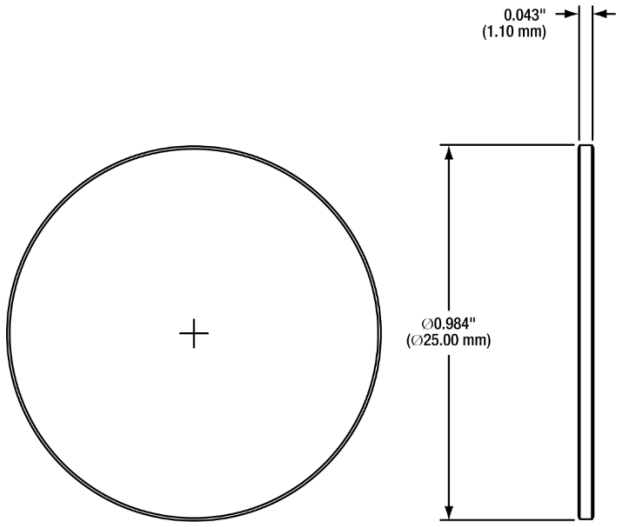


Figure 8 Protective Window Dimensions

7.2 AR-Coated Window Specifications

Unless otherwise specified, all monochrome models with AR-coated windows have $R_{avg} < 0.5\%$ per surface over the 400 - 700 nm wavelength range, and an approximate refractive index n of 1.517.

7.3 IR Filter Transmission Curve

Unless otherwise specified, all color models with IR filters have an approximate refractive index n of 1.525.

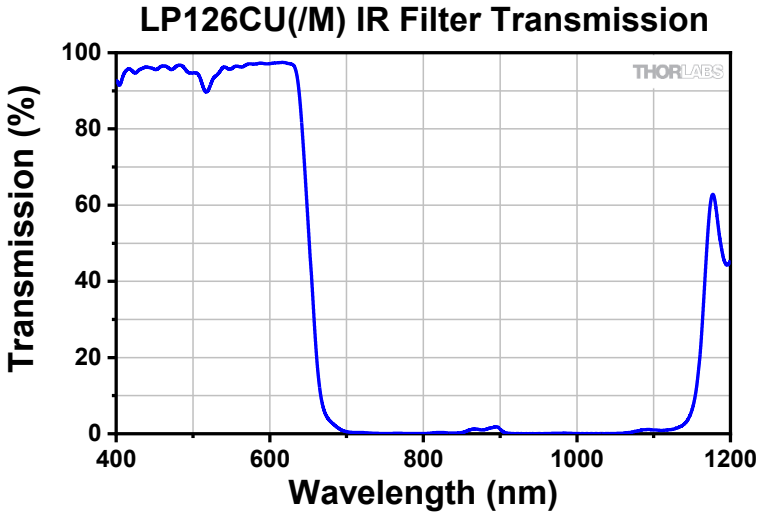


Figure 9 IR Blocking Filter Transmission Curve

Chapter 8 Mechanical Drawings

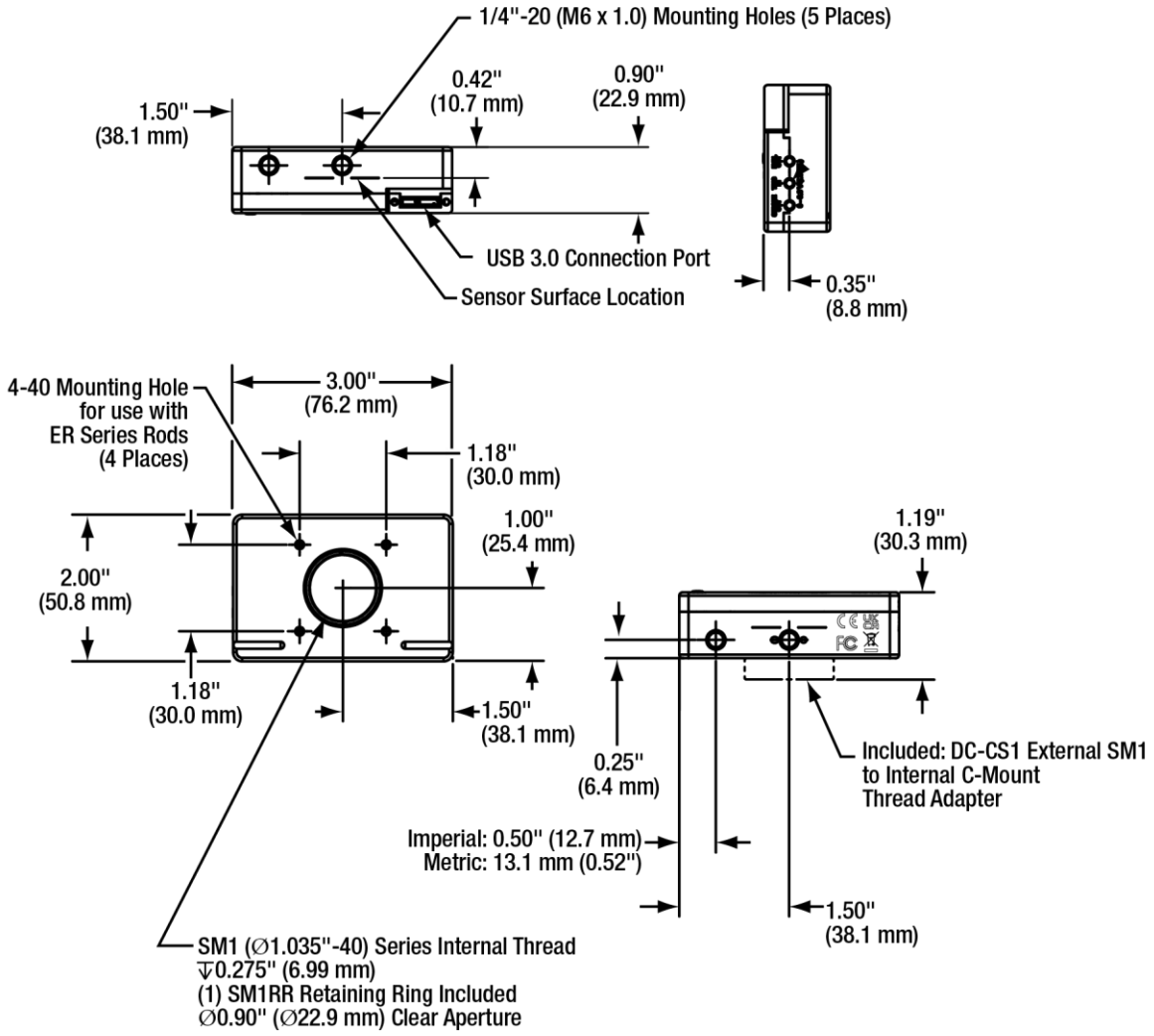


Figure 10 Dimensions for Low-Profile Scientific Camera Series

Chapter 9 Troubleshooting

9.1 Interface

Problem	Symptoms	Possible Cause	Remedy
Software Cannot Find a Connected Camera	• Software Does Not Display a Connected Camera • Software Does Not Display an Image	No Power to Camera	Connect Camera to USB 3.0 Port
		The camera has yet to complete "enumeration".	Restart / Refresh software after the camera has been powered on and connected to the host PC for at least 30 seconds.
		The camera is not connected to the USB 3.0 port, or it has not enumerated properly.	Disconnect the USB 3.0 cable and then reconnect. First time connections to a PC may take longer to enumerate and load drivers. See section **4.1**

9.2 Optical

Problem	Symptoms	Possible Cause	Remedy
When using a standard C-mount lens (not included), the image is not in focus.	Displayed Image is Not in Focus	Flange distance of the lens is out of spec. Since the camera has a fixed flange focal distance that allows for some tolerances, your lens is beyond the additional length we provide.	Please find a lens with better focal distance specifications.
Displayed image has spots or has debris in the image	Debris in the displayed	IR filter or protective window has particulates on it.	Carefully clean the IR filter / window. See Section **3.6** and Section **10.1**

9.3 Operational

Problem	Symptoms	Possible Cause	Remedy
Camera excessively warm (too hot to safely hold with ungloved hand)	• Camera is too hot to hold with an ungloved hand. • Poor image quality.	Camera is not properly ventilated.	Remove any obstructions or provide adequate ventilation around the camera.
		Electronics failure	Disconnect the camera USB 3.0 port and contact customer service.
Imaging Software "times out" without acquiring image	• Imaging software indicates timeout. • No images acquired - no frame count provided	Camera is not powered.	See Section **9.1**
		Camera is not connected to the computer.	See Section **9.1**
		Imaging software is not configured to the camera.	Consult the ThorImageCAM User Guide
		Camera is not "armed" and "started" properly.	See Section **4.1**
Low Bandwidth USB 3.0 Connection	• Excessive Dropped Frames • Inconsistent Operation	Low Bandwidth USB 3.0 Port	Use a PCIe high bandwidth USB 3.0 Card, such as: Thorlabs' USB3-PCIE.
			Use a Different USB 3.0 port, preferably one directly connected to the motherboard.
		USB 3.0 cable is too long or poor quality.	Use the 3 m cable supplied with the camera.
			Use a 3 m (maximum) cable with 28 AWG signal wires - or a 1 m cable.
Yellow Indicator	Camera Does Not Connect to Host	Windows Power Saving Settings	Turn off all USB 3.0 power saving settings in Device Manager.

9.4 Software

Problem	Symptoms	Possible Cause	Remedy
Camera Not Found	Error message, or camera does not show up in Hardware Connections.	Power Not On	Make sure the camera is connected to the USB 3.0 Port.
		Not Plugged In	Make sure the camera is connected to the USB 3.0 Port.
		Bad USB Cable or Connection	Try a different cable. Refer to Section **4.1** for information on the camera's status indicators.
Insufficient Illumination	Images are All Black	Exposure Time Too Low	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.
		No Light Going to the Camera	Make sure that the light source is turned on, and that the aperture of the lens (or other optics) is not shut.
		Lens Cap is Installed	Remove the Lens Cap

Chapter 10 Maintenance

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

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

10.1 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, Thorlabs 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 refer to the *Handling and Cleaning Procedures for Optical Components*. The following guidelines, specific to Thorlabs' cameras, are meant to be used in conjunction with the procedures described in the tutorial.

Cleaning the Lens or Optical Assembly

Please follow the lens manufacturer's recommendations for cleaning. Thorlabs 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 Thorlabs 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.

Standard 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 sensor 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 sensor faceplate unless absolutely necessary. Fingerprints or other evidence of contact with the sensor faceplate may void the warranty.**

Cleaning the Infrared Filter or AR-Coated Window

The IR filter or AR-coated window is mounted inside the lens mounting ring. This IR filter blocks invisible, near-infrared light from reaching the sensor. This is desirable in most applications where the camera is imaging in the visible spectrum.

- What must I do before cleaning the IR Filter or AR-Coated Window?
    - Do not remove the filter or window from the camera.
    - First, remove the lens, if installed, and carefully examine the filter or window 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 or window.
- 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).
    a. Carefully loosen the lens mount lock ring using the supplied lock ring wrench. Refer to Section **3.6.1**.
2. Orient the camera so that the lens mount is pointing downward and carefully unscrew the lens mounting ring and remove the filter or window.
3. Place the camera face down on a clean, dry surface to prevent particles from accumulating on the sensor's faceplate.
    a. Once the filter or window 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 or window.
    b. Re-examine the filter or window 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.
4. 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.
5. Re-examine once again and repeat the process once, if necessary.

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

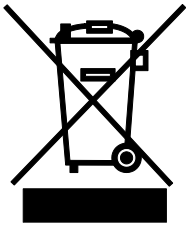


Caution
Ethyl and isopropyl alcohols are highly flammable! Do not use near extreme heat, arcing electrical equipment (such as space heaters) or open flame! Use only with the proper ventilation. Follow all safety instructions provided by the manufacturer of the product.

Chapter 11 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.

11.1 Waste Treatment is Your Own Responsibility

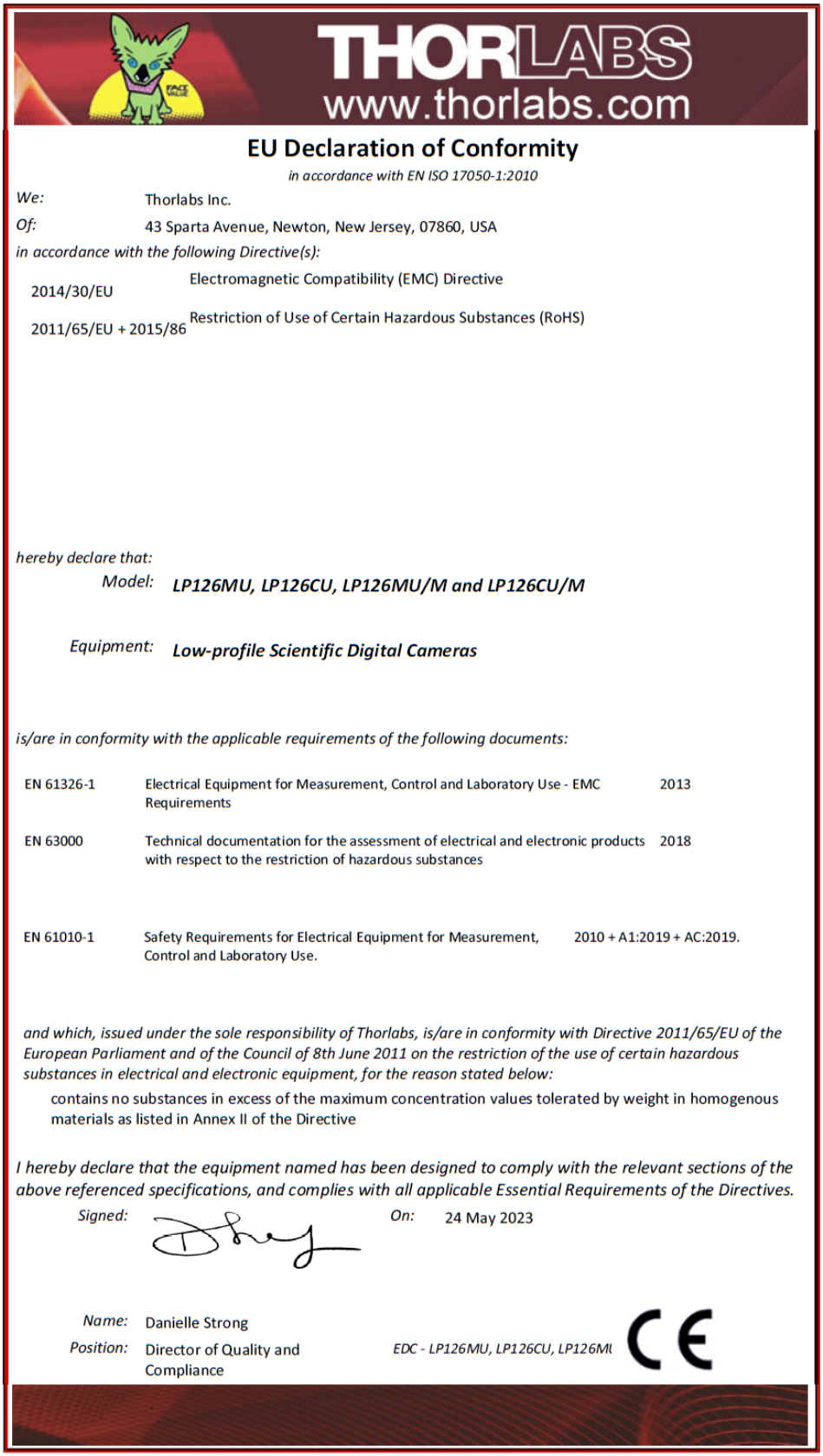
If you do not return an "end of life" unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

11.2 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.

11.3 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: 43 Sparta Avenue, Newton, New Jersey, 07860, USA

in accordance with the following Directive(s):

2014/30/EU — Electromagnetic Compatibility (EMC) Directive

2011/65/EU + 2015/86 — Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:

Model: ***LP126MU, LP126CU, LP126MU/M and LP126CU/M***

Equipment: ***Low-profile Scientific Digital Cameras***

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

EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013
EN 63000	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances	2018
EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	2010 + A1:2019 + AC:2019.

and which, issued under the sole responsibility of Thorlabs, is/are 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:

contains no 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:* 24 May 2023

Name: Danielle Strong

Position: Director of Quality and Compliance

EDC - LP126MU, LP126CU, LP126MU

CE

11.4 FCC Statement

The following statement applies to the products covered in this manual, unless otherwise specified herein. The statement for other products will appear in the accompanying documentation. Inputs and outputs must only be connected with shielded connection cables.

This product has been tested and found to comply with the limits according to IEC 61326-1 for using connection cables shorter than 3 meters (9.8 feet).

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, and meets all requirements of the Canadian Interference Causing Equipment Standard ICES- 003 for digital apparatus. These limits are designed to provide reasonable protection against harmful interference in an industrial installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

Thorlabs is not responsible for any radio television interference caused by modifications of this equipment or the substitution or attachment of connecting cables and equipment other than those specified by Thorlabs. The correction of interference caused by such unauthorized modification, substitution or attachment will be the responsibility of the user. The use of shielded I/O cables is required when connecting this equipment to any and all optional peripheral or host devices. Failure to do so may violate FCC and ICES rules.

11.5 General Compliance Statement

The products presented in this user guide comply with the following regulatory requirements for laboratory grade equipment:

CE UKCA FC Canadian ICES-003

11.6 Auxiliary I/O Cable Requirements

The Digital Camera is supplied with cables for connecting to the AUX I/O ports of the camera. All replacement cables must be shielded coaxial cables to adhere to CE and FCC compliance.

Chapter 12 Warranty

12.1 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.

12.2 Specific Warranties and Repairs

All specific warranty and repair information can be found in the general terms and conditions located at **https://www.thorlabs.com/Images/PDF/LG-PO-001_Thorlabs_terms_and_%20agreements.pdf.**

Chapter 13 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at **www.thorlabs.com/contact** for our most up-to-date contact information.



USA, Canada, and South America
Thorlabs, Inc.
sales@thorlabs.com
techsupport@thorlabs.com

UK and Ireland
Thorlabs Ltd.
sales.uk@thorlabs.com
techsupport.uk@thorlabs.com

Europe
Thorlabs GmbH
europe@thorlabs.com

Scandinavia
Thorlabs Sweden AB
scandinavia@thorlabs.com

France
Thorlabs SAS
sales.fr@thorlabs.com

Brazil
Thorlabs Vendas de Fotônicos Ltda.
brasil@thorlabs.com

Japan
Thorlabs Japan, Inc.
sales@thorlabs.jp

China
Thorlabs China
chinasales@thorlabs.com



THORLABS

www.thorlabs.com