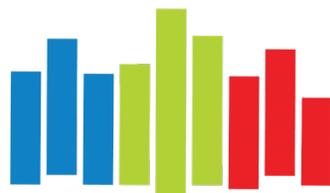
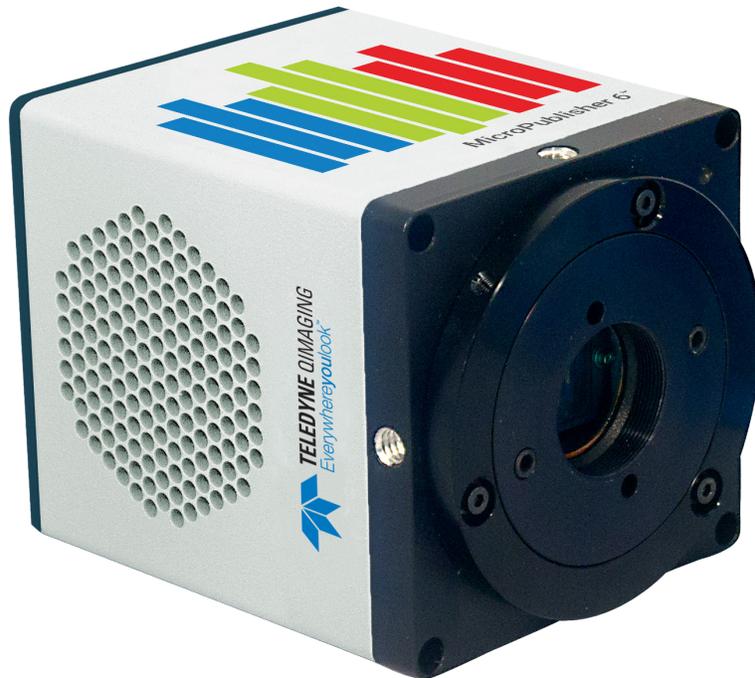




**TELEDYNE PHOTOMETRICS**  
Everywhereyoulook™



MicroPublisher 6™

## Micropublisher6

User Manual



## Applicability

This document applies to the Teledyne Photometrics MicroPublisher 6 camera. For the latest updates, please visit [www.photometrics.com](http://www.photometrics.com).

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## Teledyne Photometrics Technical Support

Technical support is available to all registered users of Teledyne Photometrics products from 6am to 5pm Pacific Standard Time.

[info@photometrics.com](mailto:info@photometrics.com)

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[www.photometrics.com](http://www.photometrics.com)

## Teledyne Photometrics LIMITED WARRANTY

### Standard Product Warranty Plan

A Standard Product Warranty Plan is included with every Teledyne Photometrics camera purchase. This Warranty Plan includes parts and labor for two full years (starting from the shipping date of the camera). The Standard Product Warranty Plan is provided on all new and used equipment, including retired demonstration cameras.

### Extended Product Warranty Plan

Extended Product Warranty Plans are reasonably priced and very easy to purchase. Available for all Teledyne Photometrics cameras currently under warranty, the Extended Product Warranty Plan includes parts and labor, and is available for an additional three-year period to extend your warranty to five years.

When you purchase an Extended Product Warranty Plan from Teledyne Photometrics, you are assured of our commitment to minimizing down times. Your needs are our top priority and Teledyne Photometrics responds immediately. The Teledyne Photometrics Service and Support team is focused on expediting all customer requests to provide a fast and complete solution.

Teledyne Photometrics also offers on-site training as well as online operational training programs. These programs are designed to get you up and running with your new camera quickly and efficiently.

Contact a Teledyne Photometrics Representative to learn more about Extended Product Warranty Plan options.

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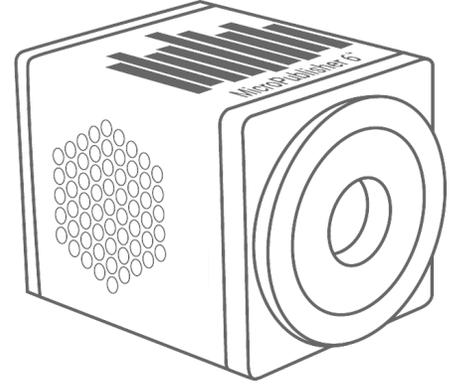
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## Chapter 1 - Overview

### Introduction

The MicroPublisher 6 is the ideal camera for highly sensitive microscopic imaging and documentation. With peak quantum efficiency of 75%, combined with extraordinarily low electronic and thermal noise, the MicroPublisher 6 provides higher resolution and sensitivity in a form factor that saves space in laboratory settings. The MicroPublisher 6 camera uses a USB 3.0 data connection for a fast and easy installation, while maintaining backwards compatibility for USB 2.0 at reduced data rates for use with a variety of host computers.

This manual describes the installation and configuration procedures for your new MicroPublisher 6. Descriptions of MicroPublisher 6 camera settings are also included.



### System Components

Your new camera system includes:

- MicroPublisher 6 Camera
- 7.5V DC, 2.5A power supply (actual model may vary)
- USB 3.0 cable
- Optional Ocular® Software
- USB flash drive: PVCAM driver and manual

## Precautions

The MicroPublisher 6 system electronics are extremely sensitive to electrostatic discharge (ESD). To avoid permanently damaging the system, please observe the following precautions:

- If you are using high-voltage equipment (such as an arc lamp) with your camera system, be sure to turn the camera power on last and power the camera off first.
- Never connect or disconnect any cable while the camera system is powered on.
- Although you should turn off the camera's power supply before disconnecting any camera system cable, you do not need to power off your computer to detach the cables.
- Use caution when triggering high-current switching devices (such as an arc lamp) near your system. The image sensor can be permanently damaged by transient voltage spikes. If electrically noisy devices are present, an isolated, conditioned power line or dedicated isolation transformer is highly recommended.
- Always leave at least one inch of space around the camera housing.
- Never open the camera. There are no user-serviceable parts inside the MicroPublisher 6 camera. Opening the camera voids the warranty.
- Use only the USB 3.0 interface, cables, and power supply designated for this camera system.  
Using non-MicroPublisher 6 cables or power supplies may result in permanent damage to your system.
- Do not use a C-mount lens that has optics that extend behind the flange of the lens.

## Environmental Conditions for Operation and Storage

Your MicroPublisher 6 camera system should be operated in a clean, dry environment. The camera system's ambient operating temperature is 0°C to 30°C with 80% relative humidity, noncondensing. Contact Teledyne QImaging customer service for information if operating outside of this range.

To protect your MicroPublisher 6 during storage, use its original containers. To protect the system from excessive heat, cold, and moisture, store at an ambient temperature between -20°C and 60°C with a relative humidity of 0% to 90%, noncondensing.

## Optics and Mounting

The MicroPublisher 6 camera lens mount accepts a standard 1" diameter, C-mount lens or adapter. The camera is also compatible with a standard C-mount lenses as long as its optics do not extend behind the flange of the lens.

If desired, the MicroPublisher 6 may be mounted to a tripod or other device using the mounting attachment located on each side of the camera's front plate. See the Specifications chapter for more information.

## Cleaning

Clean the exterior surfaces of the camera with a dry, lint-free cloth. To remove stains, contact Teledyne QImaging Support. To clean the camera's imaging window, use only a filtered compressed-air source. Handheld cans are not recommended, as they may spray propellant onto the window. Do not touch the window.

## Repair

The MicroPublisher 6 contains no user-serviceable parts. Repairs must be done by Teledyne QImaging. Should your camera system need repair, contact Teledyne QImaging Support. Please save the original packing materials so you can safely ship the camera system to another location or return it for repairs if necessary.

**IMPORTANT: DO NOT OPEN the camera. Opening the MicroPublisher 6 camera voids the warranty.**

## Chapter 2 – Installation

This chapter will detail the proper installation of your MicroPublisher 6 camera. In order to install and use the camera, the following items are required:

- MicroPublisher 6 camera (supplied)
- USB 3.0 data cable (supplied)
- 7.5V DC, 2.5A power supply (supplied)
- USB PVCAM Driver “installer” (supplied and also available on the Teledyne QImaging website)
- 110V/220V power connection
- A PVCAM compatible imaging application, such as Ocular (optional)
- A PC that meets host computer requirements

Optional items that are included with your MicroPublisher 6 camera:

- Trigger cable

### Host Computer Requirements

The host computer for your MicroPublisher 6 camera must include:

- Windows 7, Windows 8 or Windows 10 operating system (64 bits)  
Refer to the Teledyne QImaging website for the latest list of minimum computer recommendations
- 2.0 GHz or faster Intel processor: either Xeon or Core i5
- 4+ GB RAM
- 250+ GB serial ATA (SATA) HDD and/or >64 GB solid state drive (SSD) for high-speed imaging and storage
- 256+ MB slot-based ATI/NVIDIA video graphics card (i.e., not an “onboard/integrated graphics” adapter)
- USB port or Internet access to install the driver
- At least one USB 3.0 interface port (USB2.0 is supported, but at reduced frame rate)

**NOTE: Minimum requirements as of December 2015. Supported computer systems will change as new cameras, computer hardware, and operating systems are introduced and older models then become obsolete. For current information on recommended computer specifications, please visit: <https://www.qimaging.com/faq>**

**NOTE: The MicroPublisher 6 camera will also operate from a USB2 port by reducing the maximum readout speed from 50MHz to 17.5 MHz, impacting achievable frame rates.**

## Camera Power Requirements

- 7.5V DC, 2.5A

A power supply for use with your MicroPublisher 6 camera has been provided by Teledyne QImaging.

**IMPORTANT: Follow the below steps in order.  
DO NOT CONNECT the camera until the driver is installed.**

### 1. Install the Camera Driver

In order for the MicroPublisher 6 camera to communicate with the host PC, the camera's device driver must first be installed. The latest version of the PVCAM driver installer is available on the Teledyne Photometrics website as well as the provided USB drive. The recommended driver for the MicroPublisher 6 is PVCAM 3.6.7.2 or newer. However, the camera will work with revisions as old as PVCAM 3.0.9.2. Be sure to select the appropriate installer based on your PC's operating system.

The MicroPublisher 6 camera is designed and tested for use with Microsoft Windows 64-bit operating systems. Contact Teledyne Photometrics customer service for more information.

After completing the PVCAM installation, restart your PC when prompted by the wizard. For advanced users wishing to use the camera in a custom programming environment, the PVCAM Software Development Kit is available on the Teledyne Photometrics website.

NOTE: Supplemental PVCAM installation information can be found on the Teledyne QImaging website:  
<https://www.qimaging.com/software>

### 2. Connect the Camera

#### **Note: Power switch on power supply cable**

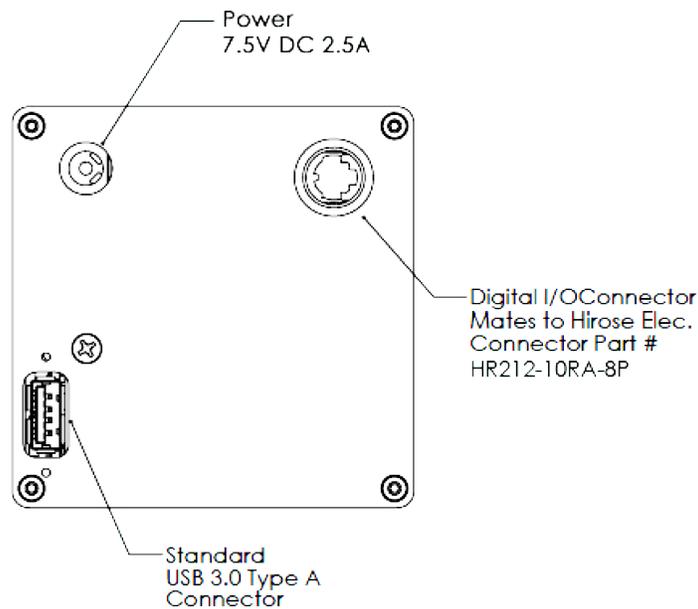
There are three connectors on the back of the MicroPublisher 6 camera: a USB 3.0 connector, a power supply connector, and an I/O connector. Connect the camera following these steps

1. Connect the supplied USB 3.0 cable to the USB 3.0 interface port on your computer and connect the other end of the cable to the USB 3.0 connector located on the back of the camera. (The USB 3.0 interface transfers camera settings and image data to the host PC.) The MicroPublisher 6 camera should be connected to a USB 3.0 port. It should also be the only device on its USB root hub controller (see Figure 2 below). Please see the following section on how to select the appropriate USB port for optimum camera performance. This ensures the maximum bus bandwidth is available to the camera for data transfers. USB 3.0 ports are often (but not always) identifiable by a blue internal socket or the "SuperSpeed" (or just "SS") USB logo.

2. After the USB 3.0 cable has been connected to the computer and camera, connect the MicroPublisher 6 camera power supply's cable to the power connector located on the back of the camera. (Your MicroPublisher 6 camera is powered by the 7.5V 2.5A or greater power supply provided by Teledyne QImaging.) Lastly, plug the power supply's cord into an appropriate power source.
  
3. Optional: An optional I/O connector is available on your camera for optional hardware triggering. The I/O connector provides multiple I/O signals that allow highly precise synchronization with external hardware components such as light sources via TTL signals. Information on how to set up and configure the MicroPublisher 6 camera for hardware triggering can be found in the next chapter of this manual.

### Note on Selecting the Optimal USB 3.0 Port:

Most modern computers come with both USB 3.0 and USB 2.0 ports. This camera should be connected to a USB 3.0 port. However, if no USB 3.0 port is available, you can operate the camera with USB 2.0 as well. The camera is designed to work with USB2.0, at a reduced data rate of 17.5MHz pixels/sec.



There are several ways to distinguish USB 2.0 from USB 3.0. First, the “Super Speed” or SS logo may be present, indicating a port is USB3.0. Usually, USB 2.0 ports are gray or black, while USB 3.0 ports are blue; however, this is not a steadfast rule. Additionally, USB 3.0 ports have 9 wires while USB 2.0 ports only contain 4 wires. If you cannot tell a port’s USB version by the color of the port, take a closer look at the number of wires inside the USB port. On a USB 3.0 port, you will see an additional 5 recessed signal wires inside the port, opposite the standard 4 wires.

Additionally, in Device Manager, a USB 3.0 port might have “USB3” in its name (e.g. Intel USB 3.0 eXtensible Host Controller). You should ensure that the camera is connected to a USB 3.0 Root Hub. Determining which USB root hub your camera is connected to is discussed below.

Each USB host controller has a Root Hub to which multiple physical ports are connected. Each port can have a device plugged in or another hub to allow connection of more devices. However, the MicroPublisher 6 camera should be the only device connected to a single USB Root Hub. If other devices are connected to the same Root Hub, then camera communication may fail, which can result in camera hanging or image tearing depending on the bandwidth consumed by the other devices.

Since it is not always straightforward to tell which port on a PC is connected to which Root Hub, follow the procedure below to make sure that the camera is the only device connected to its particular Root Hub.

1. Open Device Manager (click the Start Button and type “Device Manager”)
2. In the menu, click View -> Devices by Connection (Figure 1)
3. According to Figure 2, find the USB host controllers, expand them, and check whether your camera is the only device connected to the Root Hub.

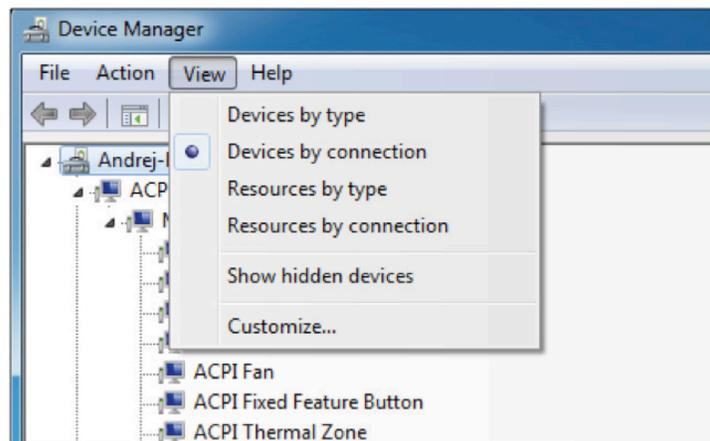


Figure 1. Devices by connection

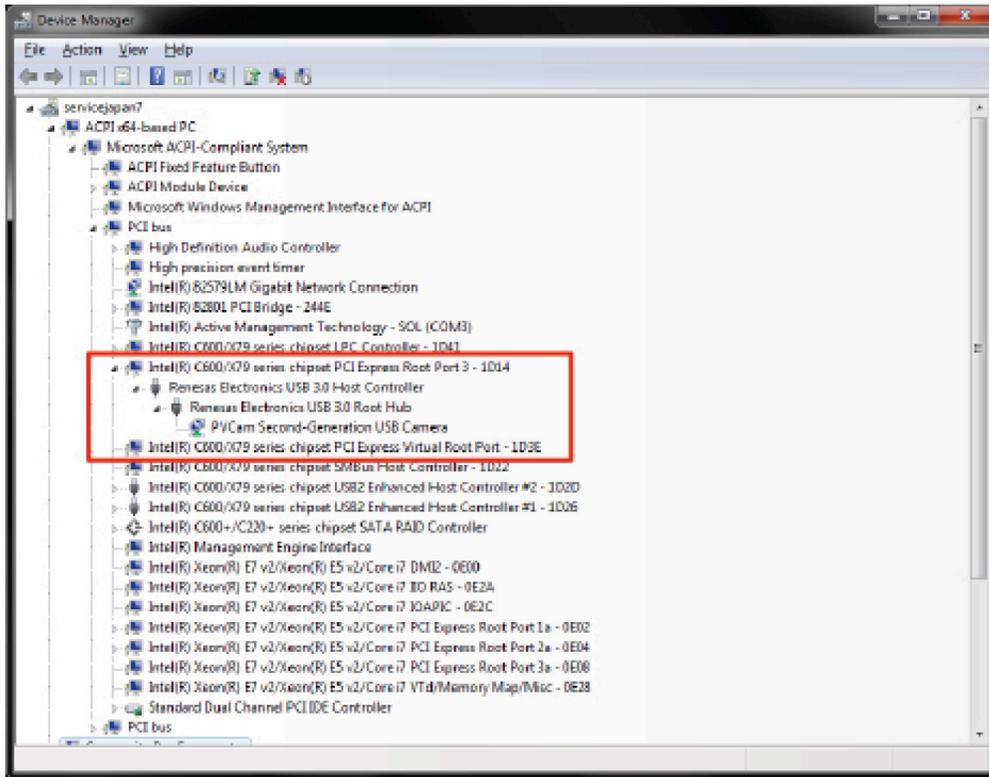


Figure 2. Teledyne Photometrics USB3 camera is the only device on its USB Root Hub.

If more devices are connected to the same USB Root Hub, please reconnect them to a different port for optimal camera performance.

### Note on Optimum Mounting of MicroPublisher 6 Camera

It is important to maintain a minimum of 1" clearance on the vented sides of the MicroPublisher 6 camera to allow proper air flow, removing heat generated by Thermoelectric Cooling of the sensor. Blocking this air flow will impede the camera's ability to cool, and may cause the camera to overheat. While the camera has thermal shutdown protection, overheating the camera may cause permanent and irreparable damage, voiding your warranty.

## Chapter 3 – Using Your MicroPublisher 6 Camera

### Imaging Software

The MicroPublisher 6 cameras come with optional full featured Ocular software. For an up-to-date list of other compatible third-party imaging software applications, please visit: <http://www.qimaging.com>.

The MicroPublisher 6 camera's image capture capabilities are controlled entirely through your imaging software. Basic functionalities include control over exposure time, gain state, clearing mode, region of interest (ROI), and pixel binning. Additional information on camera use and CCD operating is available on the web, please visit: <http://www.qimaging.com>.

### Basic Camera Parameters

#### Exposure Time

The MicroPublisher 6 camera's exposure controls allow you to adjust the integration time for each acquisition. By increasing the exposure time, more light is captured by the sensor and a better signal-to-noise ratio (SNR) is achieved. The exposure time should be adjusted to a level that achieves the shortest integration time possible while still maintaining sufficient SNR.

#### Gain State

Gain (with regards to cameras) is defined as the conversion factor of captured electrons to a digital signal, often referred to as a grey value or ADU (Analogue to Digital Unit) and has units of electrons per ADU (e-/ADU). Knowing the gain of a camera allows users to directly compare an ADU value as measured from their software to the physical number of electrons actually captured by the camera's sensor. Gain plays a critical role in many of the camera's parameters including dynamic range and read noise.

The MicroPublisher 6 camera provides three user-selectable gain states that enable optimal camera performance for different imaging environments:

- Gain State 1  $\approx 1.3e^-/ADU$  (Mapped to the linear, single pixel full well of the sensor)
- Gain State 2  $\approx 0.70e^-/ADU$  (Optimized for sensitivity, 1/2 single pixel full well)
- Gain State 3  $\approx 0.33e^-/ADU$  (Optimized for sensitivity, 1/4 single pixel full well)

Gain State 1 uses the full dynamic range of the pixel and is recommended for applications requiring moderate sensitivity. Gain State 2 and 3 are ideal for resolving low luminescence signals due to the very lowest read noise attainable.

#### Sensor Cooling

To further reduce thermally generated noise, the MicroPublisher 6 camera system provides regulated sensor cooling of  $-12^{\circ}C$  in a  $22^{\circ}C$  ambient, which effectively eliminates dark current noise from typical imaging scenarios.

#### Clearing Mode

When the camera does not expose and read out images simultaneously, it is in Non-Overlap Mode. Non-Overlap Mode is set by choosing "Pre-Exposure Clearing" for the clearing mode of the camera. This allows the sensor to clear accumulated charge before the start of each exposure.

The following waveforms show how Non-Overlap Mode functions. The main benefit of Non-Overlap Mode is that there are no limitations imposed upon the exposure time, and the set exposure time is the actual exposure time. The tradeoff for this accuracy is the frame rate, as each frame must be completely digitized before beginning the next exposure cycle.

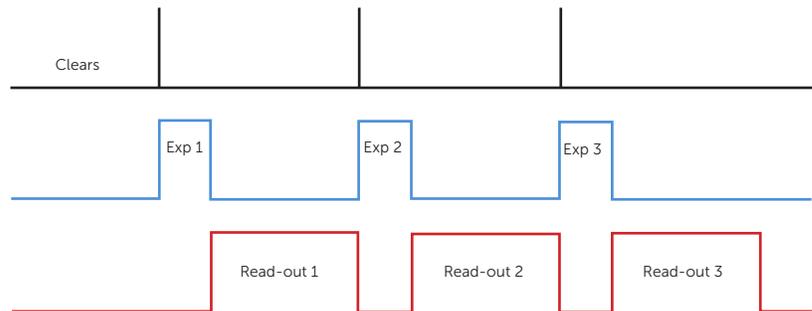
## Connecting Prime BSI with USB 3.0

Prime's USB3.0 interface is ubiquitous and easy to use. To use the interface, the PC must have an open USB3.0 port. Prime is not USB2.0 compatible. USB3.0 ports are usually indicated by the SuperSpeed+ logo and are typically blue in color.

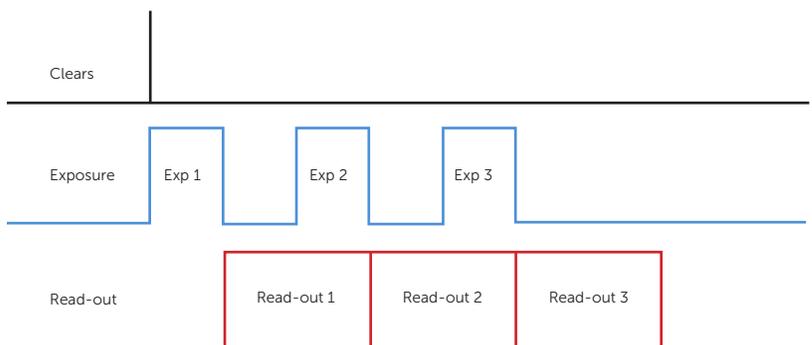
**Tip: USB devices sharing the same bus as the Prime BSI contend for available bandwidth, potentially causing the camera to drop frame rate. For this reason, Teledyne Photometrics recommends isolating the camera to its own USB3.0 root hub as shown in the Windows Device Manager.**

**A method for creating an independent root hub in computers with many USB devices is to install a PCI Express based USB3.0 interface card for use with the camera. In this case Teledyne Photometrics recommends using the PCIe interface described above.**

**It is not recommended to connect to the Prime BSI external USB3.0 hubs.**



When the camera is able to expose and read out images simultaneously, it is in Overlap Mode. Overlap Mode is set by choosing "Pre-Sequence Clearing" for the clearing mode of the camera. This allows one clear before the imaging sequence starts. The following waveforms show how Overlap Mode functions. When using Overlap Mode, the frame rate is higher as compared to Non-Overlap Mode and provides the ability to continuously image. However, since exposure and readout occur simultaneously, the minimum exposure time is dependent on the time taken to complete readout. In timed mode + Overlap Mode, exposure times may be set that are shorter than the readout time, as shown in timing diagram below.



### ROI / Binning

The MicroPublisher 6 camera supports both user-defined, arbitrary regions of interest (ROI) as well as hardware pixel binning modes of 1x1, 2x2, 4x4, 6x6, 8x8, 12x12, and 16x16. Both ROIs and pixel binning will enable faster frame rates, making focusing and scanning much easier. Pixel binning also has the advantage of significantly increasing the signal-to-noise ratio (SNR) of the image, as the effective pixel size is increased, collecting more light, and the impact of read-noise is diminished relative to adding signals together off chip.

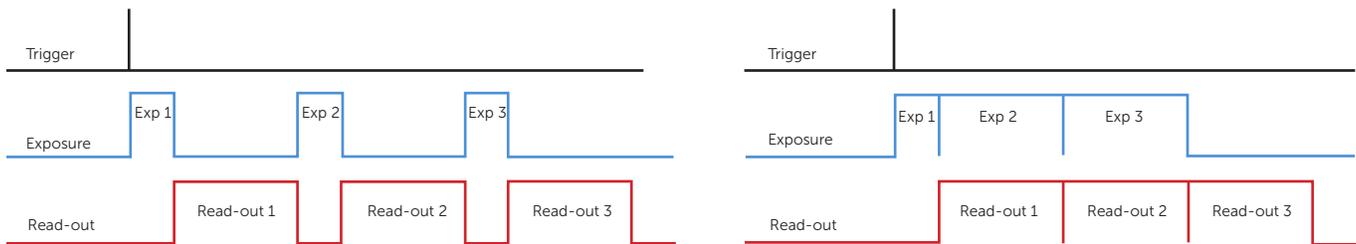
### Device Synchronization

Your MicroPublisher 6 camera offers several methods of hardware synchronization via transistor-transistor logic (TTL) signals with external devices, including function generators, light sources, shutters and filters. Each camera has an I/O connector (pin out functions are described in the specifications chapter) on the back for trigger-in/out and various TTL input and output operations.

An optional cable is available to access primary signals such as "Trigger-in," "Expose out," "End of Frame" and "Shutter Out". The camera triggers on the rising edge of a TTL signal. The MicroPublisher 6 camera supports three trigger modes:

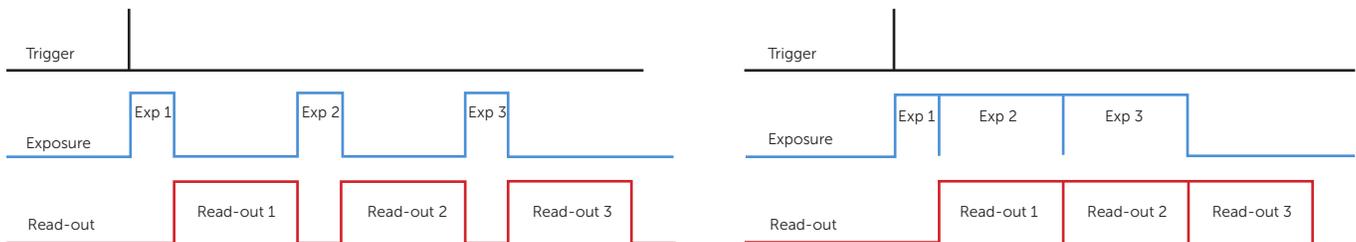
### Trigger-First Mode

In this mode, the camera requires one trigger to begin the acquisition of a stream of images. Once a single trigger is received, the camera will use its internal clock to acquire the entire image stream, independent of any future triggers. It is possible to run this triggering mode in either Non-Overlap Mode (*left*) or Overlap Mode (*right*).



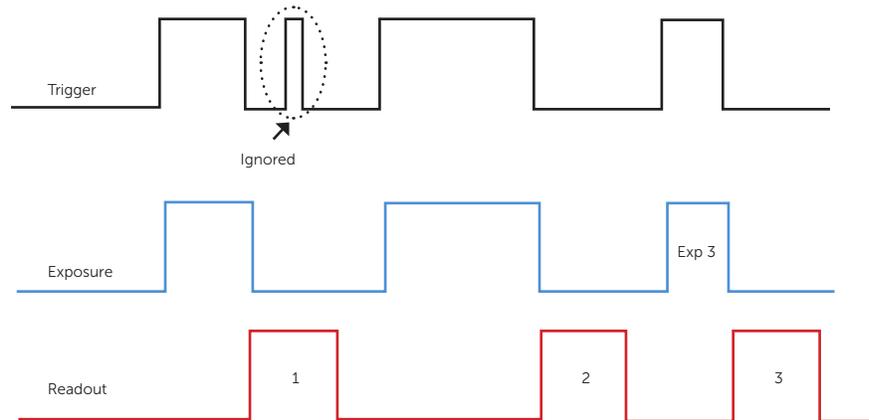
### Strobe Mode

In this Mode, each frame in the sequence requires a trigger. When a trigger is received, the camera exposes for the time set in the software. If Strobe Mode is set to run in Overlap Mode, then all exposures except the initial one will be equal to, or larger than, the readout time. Triggers received while Trigger Ready is low are ignored. For a sequence of one frame, Strobe Mode and Trigger-first Mode are the same. Non-Overlap Mode is shown on the left; Overlap Mode is shown on the right.



## Bulb Mode

In this mode, each frame in the sequence requires a trigger. The camera exposes for the duration the trigger signal is high. Exposure time entered into the software is not used in this mode. Triggers received when Trigger Ready is low are ignored. Non-Overlap Mode is shown below.



**TRIGGERING NOTE:** though present on some trigger cables, the MicroPublisher 6 camera does not provide a "Trigger Ready" signal.

## Recommended Initial Settings

Initial settings for microscopic imaging (available options depend on application software):

- 14 bits
- Gain State 1
- 30 msec exposure time
- Clear Pre-Exposure
- Clear count 2
- Display gamma of 1
- Full frame (no ROI)
- Binned 2x2 for live preview to increase frame rate (For color camera binning, images will be mono)
- Binned 1x1 for capture

## Chapter 4 – Troubleshooting

### Resolving Problems with the Camera

#### Computer Does Not Recognize Newly Installed Camera

Confirm that the latest PVCAM camera driver is installed on the computer while also checking to make sure the computer meets the minimum system configuration requirements to run the MicroPublisher 6 camera. Confirm that the camera's power is on and the DC power supply is plugged in. The fan used to remove heat from the sensors Peltier cooler will generate a slow airflow that can be felt if the camera power is on.

If necessary, restart the computer and repeat the power on cycle. If a New Hardware Found dialog box still does not appear, contact Teledyne Photometrics Support.

#### Images Not Displayed

If no images appear:

- Confirm that the camera's power is on.
- Confirm that the correct MicroPublisher 6 camera is selected in your imaging software application.
- Power off the camera and the host computer and check all system connections. Restart.
- Confirm that the camera is operational by taking an image with a standard C-mount lens attached to your MicroPublisher 6 camera. Using normal room lighting, place the camera on a table about 3 meters away from an object and acquire an image.

If the camera is powered on and recognized by the computer and still is not able to capture an images, please contact Teledyne QImaging Support.

#### PVCAM Error Message Appears

If a PVCAM error message appears, please note the message's number code and contact Teledyne QImaging Support.

#### Lengthy Pauses During Imaging

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

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

#### Camera Fan Not Running

The MicroPublisher 6 camera has a fan that operates continuously. If the camera is imaging, but the fan is not operating, please contact Teledyne Photometrics Support. The fan can be viewed through the vent holes on one side of the camera.

#### Camera Running Too Warm

It is normal for the camera to be slightly warm to the touch while in operation. However, if the camera is more than slightly warm to the touch (and at least one inch of space has been left around the camera housing), switch off the camera immediately and contact Teledyne Photometrics Support. If the camera has become hot due to having cooling blocked, move the camera to allow free air flow. Contact Teledyne Photometrics Support if the camera fails to recover regulated cooling. Note that heat is only emitted from one side of the camera: air goes in the camera → across cooling fins → out of camera.

## Unresolved Problems - Contacting Teledyne Photometrics Support

If you are still unable to resolve your problem, contact Teledyne Photometrics Support for assistance in one of four ways:

1. Visit <https://www.photometrics.com/contact> and fill out a support form online.
2. E-mail [info@photometrics.com](mailto:info@photometrics.com) with complete details of your problem (including Error Message and Code if possible), camera model, computer hardware configuration, and operating system.
3. Call one of Teledyne Photometrics' regional support offices at the appropriate number below. To assist you better and to quickly resolve the issue, it is recommended that you are at your computer during the call.

### **Main Headquarters**

Teledyne Photometrics  
3440 E. Britannia Drive, Suite 100 Tucson,  
AZ 85706  
**Email:** [photometrics.info@teledyne.com](mailto:photometrics.info@teledyne.com)  
**Main Phone:** +1.520.889.9933  
**Toll Free:** +1.800.874.9789

### **European Headquarters**

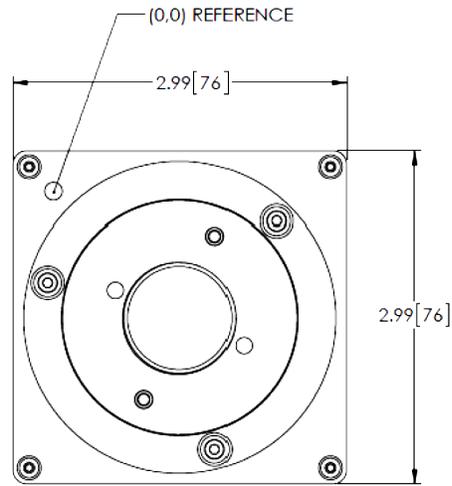
Teledyne Photometrics  
Cambrai Court  
1229A Stratford Road  
Birmingham  
UK  
B28 9AA

### **Asian Headquarters**

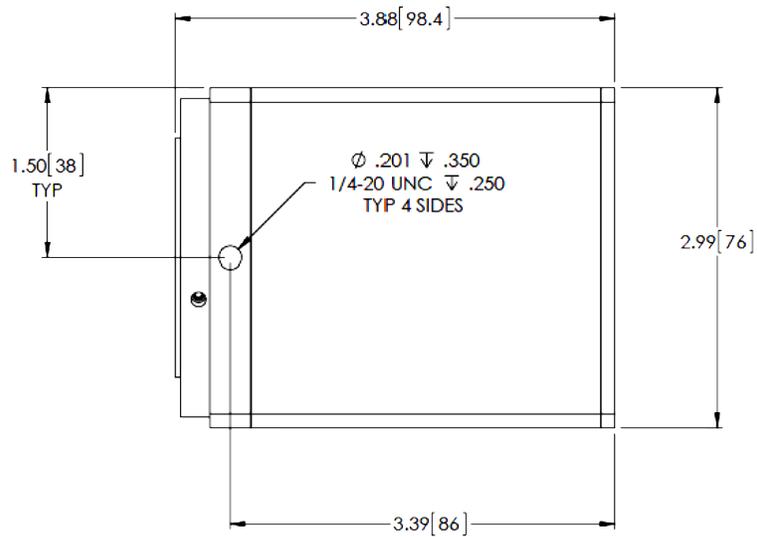
Room 904, Block C, Poly West Bund Center,  
275 Rui Ping Road,  
Xuhui District  
Shanghai 200032,  
China  
**Phone:** +86-21-60131571\*822

## Specifications

### Camera Front Dimensions (Inches)



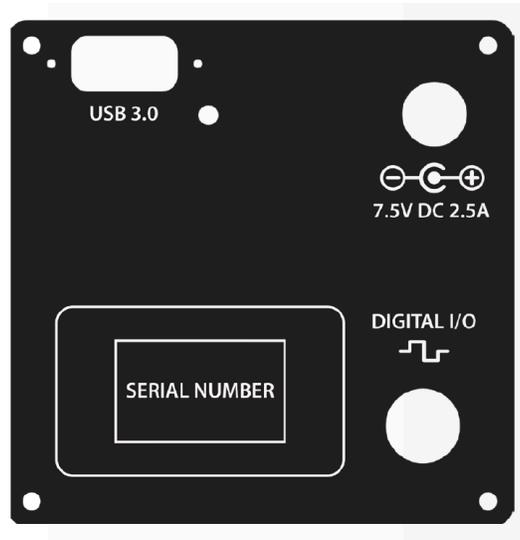
### Camera Bottom Dimensions (Inches)



## Additional Camera Measurements

Dimensions:	98.4mm x 76 mm x 76 mm (length x width x height)
Camera weight:	1.55 lbs, 0.72 kg
Optical interface:	1", C-mount optical format
Mounting hole thread size:	1/4"-20 thread, located near front of camera

## Connectors on Back of Camera



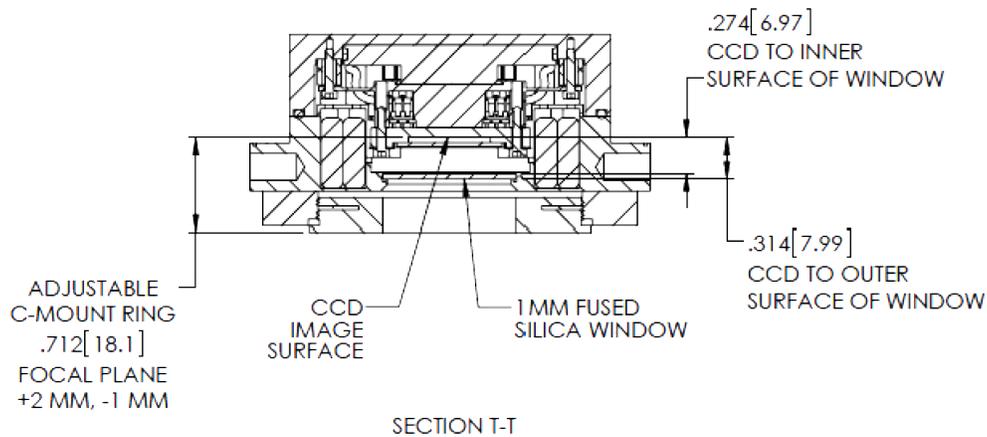
## Power Supply Specifications

**IMPORTANT:** Only operate the MicroPublisher 6 camera with the power supply provided by Teledyne Photometrics. For applications requiring use of instrumentation supplied power, please contact your Teledyne QImaging Customer Support for advice.

Voltage output:	+7.5V DC, 2.5A
Voltage input:	100 – 240 V @ 50 – 60 Hz



## Focal Plane Measurement



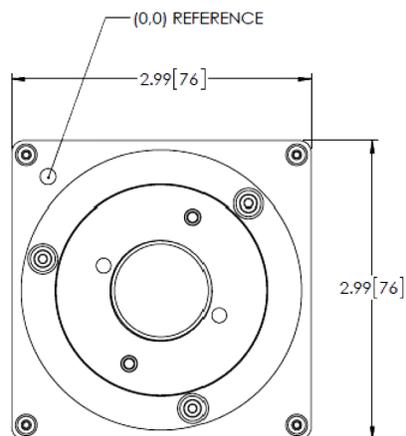
## Sensor Specifications

Image type: Monochrome Scientific CCD. Sensor specifications are provided in the data sheet.

## Sensor Orientation

The MicroPublisher 6 camera uses "multiport" sensors. Multiport sensors can be read entirely from one common output for all pixels, as is the case of typical CCD sensors, or from 2 or more outputs in parallel to achieve greater frame rates. When operating in USB3.0 mode, 50 MHz digitization is accomplished on the MicroPublisher 6 camera by reading the sensor out of two ports in parallel, each running at 25 MHz pixel rates for a net 50 MHz.

When operating out of a single port, as in the 17.5 MHz USB2 compatibility mode, the corner of the sensors (0,0) pixel, the pixel closest to the sensor output, is indicated by a dimple on the front of the camera as shown below:

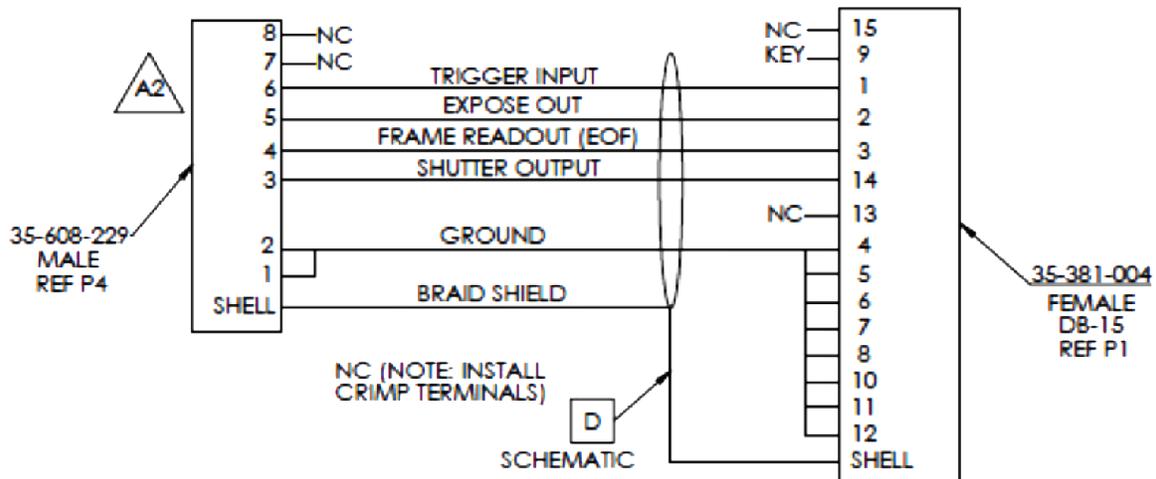


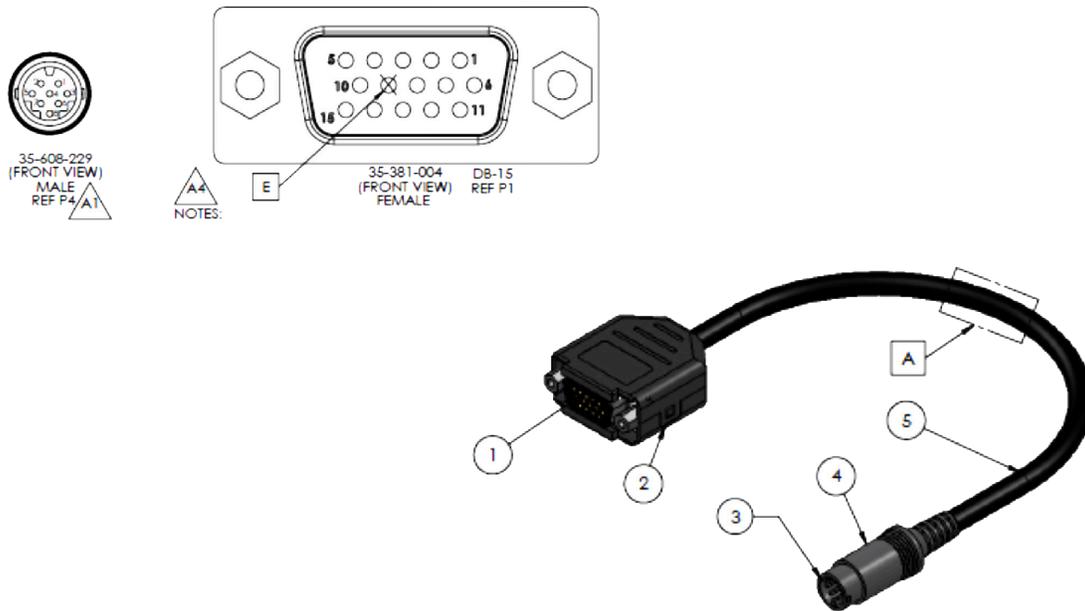
## I/O Connector Pinout

The I/O (Input/Output Status) connector provides information about trigger function. Inputs must be at least 3.15 V for a high and less than 0.9 V for a low.

The I/O trigger cable connects to Hirose connector HR212-10RA-8P on the back of the camera. Below is a description of each of the trigger pins. The numbers on the I/O connector diagram correspond to the numbers given to the definition of each of the pins.

Pin #	Signal	Pin #	Signal
1	Ground	5	Expose Out
2	Ground	6	Trigger In
3	Shutter Output	7	No Connection
4	Frame Readout	8	No Connection





Triggering signal behavior:

- **Trigger In** – the input trigger to the camera
- **Camera Expose** – represents when the camera is exposing/acquiring an image
- **Read Out** – represents completion of readout of the image
- **Shutter Output** – TTL output to control timing of an external shutter driver
- **Ground** – system digital ground

Types of triggering supported by the MicroPublisher 6 Camera:

- **Trigger-first Mode** (Overlap/Non-Overlap)
- **Strobe Mode** (Overlap/Non-Overlap)
- **Bulb Mode** (Non-Overlap)

Five shutter behavior modes are available:

- **Open Never** – Shutter is always closed.
- **Open Pre-Exposure** – Open before every exposure, closed when not exposing.
- **Open Pre-Sequence** – Open before start of sequence, closed at end of sequence.
- **Open Pre-Trigger** – Causes shutter to open before external trigger is received. In non-triggered mode, operates as "Open Pre-Exposure".
- **Open No Change** – Sends no signals to open or close the shutter.



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