USER MANUAL Evolve® 512 Delta

PHOTOMETRICS®

PHOTOMETRICS®

High Performance EMCCD & CCD Cameras for Life Sciences

3440 East Britannia Drive
Tucson, Arizona 85706
Tel: +1 520.889.9933
Fax: +1 520.295.0299

LIMITED WARRANTY

Photometrics ("Photometrics," us," "we," "our") makes the following limited warranties. These limited warranties extend to the original purchaser ("You", "you") only and no other purchaser or transferee. We have complete control over all warranties and may alter or terminate any or all warranties at any time we deem necessary.

Basic Limited Two (2) Year Warranty

Photometrics warrants this product against substantial defects in materials and/or workmanship for a period of up to two (2) years after shipment. During this period, Photometrics will repair the product or, at its sole option, repair or replace any defective part without charge to you. You must deliver the entire product to the Photometrics factory or, at our option, to a factory-authorized service center. You are responsible for the shipping costs to return the product. International customers should contact their local Photometrics-authorized representative/distributor for repair information and assistance, or visit our technical support page at **www.photometrics.com**.

Limited One (1) Year Warranty on Refurbished or Discontinued Products

Photometrics warrants, with the exception of the CCD imaging device (which carries NO WARRANTIES EXPRESS OR IMPLIED), this product against defects in materials or workmanship for a period of up to one (1) year after shipment. During this period, Photometrics will repair or replace, at its sole option, any defective parts, without charge to you. You must deliver the entire product to the Photometrics factory or, at our option, a factory-authorized service center. You are responsible for the shipping costs to return the product to Photometrics. International customers should contact their local Photometrics representative/distributor for repair information and assistance or visit our technical support page at **www.photometrics.com**

Normal Wear Item Disclaimer

Photometrics does not warrant certain items against defect due to normal wear and tear. These items include internal and external shutters, cables, and connectors. These items carry no warranty, expressed or implied.

Vacuum Integrity Lifetime Warranty

Photometrics warrants the vacuum integrity of all our products for a period of up to sixty (60) months from the date of shipment. We warrant that the detector head will maintain the factory-set operating temperature without the requirement for customer pumping. Should the detector experience a Vacuum Integrity failure at anytime within sixty (60) months from the date of delivery all parts and labor needed to restore the vacuum integrity will be covered by us. Responsibility for shipping charges is as described above under our Basic Limited Two (2) Year Warranty.

Software Limited Warranty

Photometrics warrants all of our manufactured software discs to be free from substantial defects in materials and/or workmanship under normal use for a period of one (1) year from shipment. Photometrics does not warrant that the function of the software will meet your requirements or that operation will be uninterrupted or error free. You assume responsibility for selecting the software to achieve your intended results and for the use and results obtained from the software. In addition, during the one (1) year limited warranty, the original purchaser is entitled to receive free version upgrades. Version upgrades supplied free of charge will be in the form of a download from the Internet. Those customers who do not have access to the Internet may obtain the version upgrades on a CD ROM from our factory for an incidental shipping and handling charge. See Item 12 in the following section of this warranty ("Your Responsibility") for more information.

Owner's Manual and Troubleshooting

You should read the owner's manual thoroughly before operating this product. In the unlikely event that you should encounter difficulty operating this product, the owner's manual should be consulted before contacting the Photometrics technical support staff or authorized service representative for assistance. If you have consulted the owner's manual and the problem still persists, please contact the Photometrics technical support staff or our authorized service representative. See Item 12 in the following section of this warranty ("Your Responsibility") for more information.

Your Responsibility

The above Limited Warranties are subject to the following terms and conditions:

You must retain your bill of sale (invoice) and present it upon request for service and repairs or provide other proof of purchase satisfactory to Photometrics.

You must notify the Photometrics factory service center within thirty (30) days after you have taken delivery of a product or part that you believe to be defective. With the exception of customers who claim a "technical issue" with the operation of the product or part, all invoices must be paid in full in accordance with the terms of sale. Failure to pay invoices when due may result in the interruption and/or cancellation of your two (2) year limited warranty and/or any other warranty, expressed or implied.

All warranty service must be made by the Photometrics factory or, at our option, an authorized service center. Before products or parts can be returned for service you must contact the Photometrics factory and receive a return authorization number (RMA). Products or parts returned for service without a return authorization evidenced by an RMA will be sent back freight collect.

These warranties are effective only if purchased from the Photometrics factory or one of our authorized manufacturer's representatives or distributors.

Unless specified in the original purchase agreement, Photometrics is not responsible for installation, setup, or disassembly at the customer's location.

Warranties extend only to defects in materials or workmanship as limited above and do not extend to any product or part which has:

- been lost or discarded by you;
- been damaged as a result of misuse, improper installation, faulty or inadequate maintenance, or failure to follow instructions furnished by us;
- had serial numbers removed, altered, defaced, or rendered illegible;
- been subjected to improper or unauthorized repair; or
- been damaged due to fire, flood, radiation, or other "acts of God" or other contingencies beyond the control of Photometrics.

After the warranty period has expired, you may contact the Photometrics factory or a Photometrics-authorized representative for repair information and/or extended warranty plans.
Physically damaged units or units that have been modified are not acceptable for repair in or out of warranty and will be returned as received.
All warranties implied by state law or non-U.S. laws, including the implied warranties of merchantability and fitness for a particular purpose, are expressly limited to the duration of the limited warranties set forth above. With the exception of any warranties implied by state law or non-U.S. laws, as hereby limited, the forgoing warranty is exclusive and in lieu of all other warranties, guarantees, agreements, and similar obligations of manufacturer or seller with respect to the repair or replacement of any parts. In no event shall Photometrics' liability exceed the cost of the repair or replacement of the defective product or part.

This limited warranty gives you specific legal rights and you may also have other rights that may vary from state to state and from country to country. Some states and countries do not allow limitations on how long an implied warranty lasts, when an action may be brought, or the exclusion or limitation of incidental or consequential damages, so the above provisions may not apply to you.

When contacting us for technical support or service assistance, please refer to the Photometrics factory of purchase, contact your authorized Photometrics representative or reseller, or visit our technical support page at **www.photometrics.com.**

U. S. Government Restricted Rights

The software and documentation are provided with Restricted Rights. Use, duplication, or disclosure by the Government is subject to restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.227-7013 or subparagraphs (c)(1) and (2) of the Commercial Computer Software-Restricted Rights at 48 CFR 52.227-19, as applicable. Contractor/manufacturer is Photometrics, 3440 East Britannia Drive, Tucson, AZ 85706.

This license is effective until terminated. It will terminate upon the conditions set forth above or if you fail to comply with any term hereof. Upon termination, you agree that the software and accompanying materials, and all copies thereof, will be destroyed. This agreement is governed by the laws of the State of Arizona. You acknowledge that you have read this agreement, you understand it, you agree to be bound by its terms, and that this is the complete and exclusive statement of the agreement between you and Photometrics regarding the software.

TÜVRheinland®
Precisely Right.

Project # 0000103220
Report Date: July 25, 2012
Reissue Date: August 28, 2012

Report # 31261744.001
Rev. 1

Client:	Photometrics 3440 East Britannia Drive Tucson, AZ. 85706 U.S.A.	Terry Puhala Tel. (520) 547-2718 tpuhala@photometrics.com	
Identification:	Scientific Digital Camera	***Serial No.:***	CE001
Test Item:	Evolve Delta	***Date(s) Tested:***	July 5 - 17, 2012
Test Location(s):	TUV Rheinland of North America 2305 Mission College Blvd., Ste. 105 Santa Clara, CA 95054 U.S.A. Tel. (925) 249-9123	TUV Rheinland of North America 1279 Quarry Lane, Ste. A Pleasanton, CA 94566 U.S.A. Tel. (925) 249-9123	
Test Specifications:	Emissions:	EN 61326-1:2006, EN 55011:2009+A1:2010, CISPR 11:2009+A1:2010, FCC Part 15 Subpart B: 2011 EN 61000-3-2:2006/A2:2009, EN 61000-3-3:2008	
	Immunity:	EN 61326-1:2006, EN 61000-4-2:2009, EN 61000-4-3:2006/A2:2010 EN 61000-4-4:2004+A1:2010, EN 61000-4-5:2006, EN 61000-4-6:2009, EN 61000-4-11:2004	
Test Result:	**The above product was found to be Compliant to the above test standard(s)**		

Tested by: Jeremy Luong	***Reviewed by:*** Reviewer's Name
July 18, 2012 *Date* *Name* *Signature*	Conan Boyle (Digitally signed by Conan Boyle, DN: cn=Conan Boyle, email=cboyle@us.tuv.com, o=TUV, l=Pleasanton, Date: 2012.08.28 09:29:32 -07'00') August 28, 2012 *Date* *Name* *Signature*

Other aspects:	**None**

PLEASANTON			
FC	ilac-mra A2LA ACCREDITED	**INDUSTRY CANADA**	VCCI
US5254	**Testing Cert #3331.02**	**2932M-1**	**1097 (A-0031)**
SANTA CLARA			
FC	ilac-mra A2LA ACCREDITED	**INDUSTRY CANADA**	VCCI
US5251	**Testing Cert #3331.03**	**2932D-1**	**1097 (A-0032)**

The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TÜV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

TUV Rheinland of North America, Inc., 1279 Quarry Lane Ste. A, Pleasanton, CA 94566, Tel: 925-249-9123, Fax: 925-249-9124

QF09C040 Rev. 0

Table of Contents

Chapter 1.
Overview

About This Manual

The Evolve 512 Delta User Manual is divided into five chapters. It is suggested that you read the entire manual before operating the camera in order to ensure proper use. The chapter contents are briefly described below.

Note: The information in these chapters applies only to the Evolve 512 Delta and is currently not applicable to any other Photometrics camera.

- **System Installation** — Instructions for connecting your Evolve 512 Delta camera to your computer via the Evolve FireWire interface card.
- **Technology Overview** —A basic overview of EMCCD camera technology and its benefits for low-light imaging.
- **Operating Features** — Discusses Evolve 512 Delta features and how to optimize them for speed, sensitivity, and use the different trigger modes.
- **Troubleshooting** — Provides answers to camera system problems.
- **Basic Specifications** — Provides specifications for Evolve 512 Delta system components.

Precautions

The CCD and other 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 system is powered on.
- Although you should switch off the camera's power 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 CCD can be permanently damaged by transient voltage spikes. If electrically noisy devices are present, an isolated, conditioned power line or dedicated isolation transformer is highly recommended.
- Always leave one inch of space around the camera's external cooling fins for airflow.

- Never open the camera. There are no user-serviceable parts inside the Evolve 512 Delta camera. Opening the camera voids the warranty.
- Use only the FireWire interface card, cables, and power supply designated for this camera system. Using non-Evolve cables, FireWire interface cards, or power supplies may result in permanent damage to your system.
- Do not use a C-mount lens with optics that extend behind the lens flange.

Environmental Requirements

The Evolve 512 Delta 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, non-condensing.

Storage Requirements

Store the Evolve 512 Delta camera system in 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.

Microscopes, Lenses, and Tripods

The camera has a standard threaded video mount and can be mounted to any microscope that accepts a standard C-mount adapter. The camera also allows you to install any lens that is compatible with a standard threaded video mount as long as its optics do not extend behind the flange of the lens. The Evolve 512 Delta camera can be mounted to a tripod using the tripod mounting attachment located on the sides of the camera.

Repairs

The Evolve 512 Delta camera system contains no user-serviceable parts. Repairs must be done by Photometrics. Should your camera system need repair, contact Photometrics Customer Service. Please save the original packing materials so you can safely ship the camera system to another location or return it for repairs if necessary.

Note: Do not open the camera. Opening the Evolve 512 Delta camera voids the warranty.

Cleaning

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

Chapter 2.

System Installation

Carefully review the Precautions section in the previous chapter before performing any of the procedures outlined here. Again, use only an Evolve data cable and an Evolve FireWire interface card with your Evolve 512 Delta camera. Using a different cable or interface card may result in permanent damage to your system.

Introduction

Your Evolve 512 Delta camera system has the following hardware components:

- Camera head
- FireWire interface card
- Data cable
- Power supply with power cord
- USB installation drive
- Quick installation guide

Evolve 512 Delta system components are linked by the FireWire data cable and controlled by your host computer system. All of these hardware components should be included with your shipment. Keep all the original packing materials so you can safely ship the Evolve 512 Delta system to another location or return it for service if necessary. If you have any difficulty with any step of the instructions, call Photometrics Customer Service.

Software Compatibility Requirements

The Evolve 512 Delta package includes the PVCAM drivers designed to allow you to use this camera with a variety of third party imaging software - To see a list of supported software, visit the Photometrics website.
The latest version of PVCAM is recommended for use with the Evolve Delta software – unless there is a preferred version required by the third party software.

Host Computer Requirements

The host computer (PC) for your Evolve 512 Delta camera must meet the following minimum requirements:

- Windows® 7 Professional operating system
- Intel® Core™ i5 processor
- 4 GB of RAM (or greater)
- Open USB port or internet access to install the driver
- At least one PCI-Express interface slot for the FireWire interface card

Multiple Cameras

PVCAM supports multiple open cameras. In order to use this function, it must also be supported by your imaging software.

If your imaging software supports multiple cameras, there must be a separate Firewire interface card for each camera.

Software Installation

An Installation Guide appropriate to your system is included as an insert with the camera system. This guide provides step-by-step instructions for installing the camera interface software and the application software for Windows-based computers. Additional instructions are included for installing a FireWire interface card in your computer and capturing images.
The Photometrics CD-ROM contains the following files:

- Manuals directory — contains user manuals in PDF format.
- WinOS directory — contains the files for installing on a Windows PC.

Installing the FireWire Interface Card

You will be using an Evolve FireWire interface card to allow the camera to communicate with your computer.
After installing the interface card, continue to Connecting Your Evolve 512 Delta Camera.

Connecting Your Evolve 512 Delta Camera

The following connectors are located on the side of the Evolve 512 Delta camera:

- DATA connector: Type 1, 6-pin IEEE-1394a (FireWire) connector for data transfer
- POWER connector: 25-pin, Dsub connector for camera power (see POWER Connector Pinout section in Chapter 6 for details)
- Power button: Turns the camera on and off.

The following connector is located on the power supply of the Evolve 512 Delta camera:

- I/O connector: Hirose HR10A-10R-10S, 10-pin connector for hardware triggering input/output control signals (see I/O Connector Pinout, Chapter 6).
- To connect your Evolve 512 Delta camera
- The DATA cable (shown below) connects your Evolve 512 Delta camera to the Evolve FireWire interface card. This interface cable is identifiable by its 6-pin connectors. It is designed to serve as a conduit for data. Connect the straight end of the DATA cable to the Evolve FireWire interface card that you have installed in the host computer.

Figure 1.
DATA Cable

- Connect the right-angled end of the DATA cable to the FireWire port (indicated with a red arrow in next graphic) located on the side of the camera.

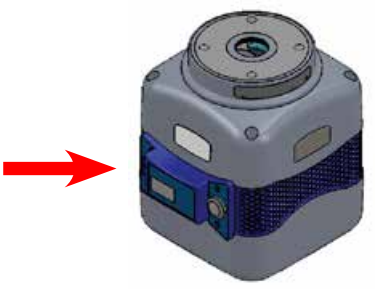


Figure 2.
Evolve 512 Delta Side Panel

- Verify that the power switch on the side of the camera is in the off position.
- Connect the power supply to the Power connector on the side of the camera.
- Plug the power cord into the power supply and then into a suitable wall outlet.
- Switch on the camera (power switch on the side of camera).

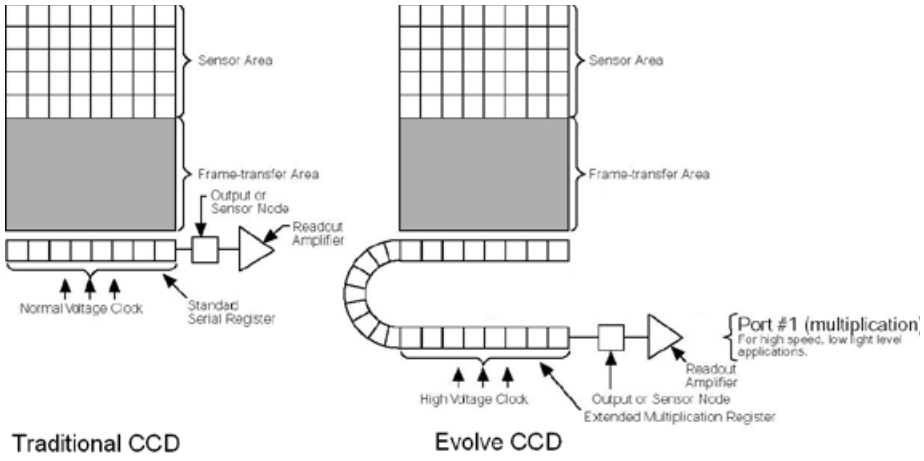
Chapter 3.
Technology Overview

Introduction

EMCCD sensors have been a relatively recent development in imaging technology, appearing in the life-science market in 2001 with the introduction of Cascade 650 EMCCD camera from Photometrics. Offering detection capabilities of extremely low signal fluxes while being able to maintain higher temporal resolutions, EMCCD cameras have solidly established themselves as the product of choice for high-end, low light microscopy applications.

EMCCD Sensor Structure

The major difference between a traditional interline CCD sensor and an EMCCD sensor is the implementation of an extended register which uses high voltages to amplify the measured signal before digitization. This multiplication register is what allows for the detection of extremely low signal as the amplification of signal occurs before the digitization – the point where the initial uncertainty in measurement or read noise becomes apparent. The read noise, added during the digitization process depends on the cameras ability to accurately detect small changes in signal. The smallest signal that the camera is able to detect is its minimum detection ability, and therefore the read noise of the camera.



EM Gain and Low Light Detection

When using an EMCCD to amplify the signal – the factor of amplification or multiplication is called the EM Gain. Using EM Gain to multiply the signal before the digitization process makes the read noise a much smaller percentage of the measurement. For example – Using an EM Gain of 100X, and multiplying the signal by 100X before digitization is the equivalent of reducing the effect of the read noise on the measurement by the same factor – 100X.

The use of EM Gain lowers the effective read noise of the camera, and brings the minimum detection limit to the lowest possible limit. This directly correlates to the ability to detect extremely low signal fluxes with the camera.

Optimizing the EM Gain Setting

It has been experimentally determined that the read-noise of an EMCCD camera asymptotically approaches ~0.2 electrons – and as such, maximizing the detection capability of the camera depends on getting as close to this point as possible. A good rule of thumb is to take the read noise specification for a camera – available on the datasheet – and multiply this number by 4X or 5X and use this value as your EM Gain setting. In most situations, an EM Gain of 350X or more is rarely required.

There are other benefits to setting the EM Gain to this value and not higher – the reduction of clock induced charge which will show up in your images as single pixel events or speckles, extending the performance of your EM Gain (discussed below), and maximizing the dynamic range.

Tradeoffs with EM Gain

Using EM Gain allows for the detection of extremely low signal levels, but there are a few tradeoffs in imaging performance that have to be made. Firstly – the multiplication process is inherently a stochastic process and therefore there is an additional amount of uncertainty added to your measurements due to the slightly varying nature of the EM Gain multiplication performance. This additional uncertainty is called the Excess Noise Factor – the amount that the shot noise affects the image are increased. This Excess Noise Factor has experimentally been determined to be equal to √2 or ~1.4. All noise factors (shot noise, dark current noise) except read noise are increased by this factor.

Another tradeoff is the generation of Background Events or Clock Induced Charge. Due to the higher voltages required during the clocking of the sensor, spurious charge may be generated along the way. Normally, this would not be an issue due to it being easily covered up by the read noise of the sensor – but when a sensor is able to detect signals as low as an electron – it becomes apparent in the images very quickly. By using a lower amount of EM Gain, the amount of background events is minimized. The Evolve platform of EMCCD cameras has been designed to keep the background events as low as possible.

The e2V CCD97 sensor used in the Evolve 512 Delta camera has demonstrated that over time and with extended use, the performance of the EM Gain multiplication drops. To maintain the expected levels of performance the EM Gain needs to be recalibrated by adjusting the voltage levels being applied to the EM Gain circuitry. The Evolve 512 Delta camera offers the fastest EM Gain calibration system on the market with RapidCAL.

Chapter 4.
Operating Features

Introduction

This section will explain the different modes of operation for the Evolve 512 Delta, other features, and the best modes to optimize your imaging performance.

Operating Frequencies

The Evolve 512 Delta camera has two operating frequencies or speeds: 20MHz and 10MHz. The 20MHz speed is the most optimized, delivering the highest frame rates while maintaining the lowest noise performance – which delivers the best Signal to Noise imaging quality while providing the highest temporal resolution balance.
The 10MHz speed is included primarily for experimental scenarios where the temporal resolution is not as critical and provides better noise performance than the faster speed.

Gain States

The factor of conversion of the detected signal to digital units or intensities reported by the camera is defined as the camera's Gain. It is defined as a ratio of electrons/ADU. The Evolve 512 Delta has two Gain states, each offering a gain conversion factor optimized for a different performance benefit. Gain state 1 is designed for use with 2x2 binning and offers a higher dynamic range while Gain state 2 offers better intensity resolution and better noise performance, and is the ideal imaging mode for the majority of applications. It is optimized to saturate the single-pixel full well of the sensor at the maximum 16-bit intensity levels. The exact values of the conversion gains for each camera are provided to you on a Certificate of Performance, supplied with every camera, listing the gain, noise, and other key specifications of the camera.

Offset (Bias)

CCD cameras are typically designed to produce a certain level of offset (also known as bias) when no light is present and the exposure time is set to zero (0). Typically, the user subtracts an offset (bias) from the sample image for quantitative measurement. Since the offset can change based on several factors such as multiplication gain, speed, etc., it is recommended that a fresh offset (bias) image be taken with the same settings as the sample image and then be subtracted from the sample image.

The Evolve 512 Delta has an automatically adjusting offset switch. When a speed/gain setting is altered, the bias valve is kept as close to a pre-selected offset as possible. This enhances the quantitative stability of the camera.

Binning

Binning (combining pixels into one super pixel) allows you to increase the sensitivity and frame rate. On the other hand, binning reduces spatial resolution. The Evolve 512 Delta allows binning of 1x1, 2x2, 4x4, and 8x8.

Non-Overlap 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 for a clear before 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 as with Overlap mode (discussed below), and the set exposure time is the actual exposure time. The tradeoff for this accuracy is the frame-rate, as you have to wait for each frame to be completely read-out before beginning the next exposure.

Note: Since the software you are using may show the settings differently, you should refer to the software documentation for accurate information. This example is using RSImage which can be downloaded from the Photometrics website.

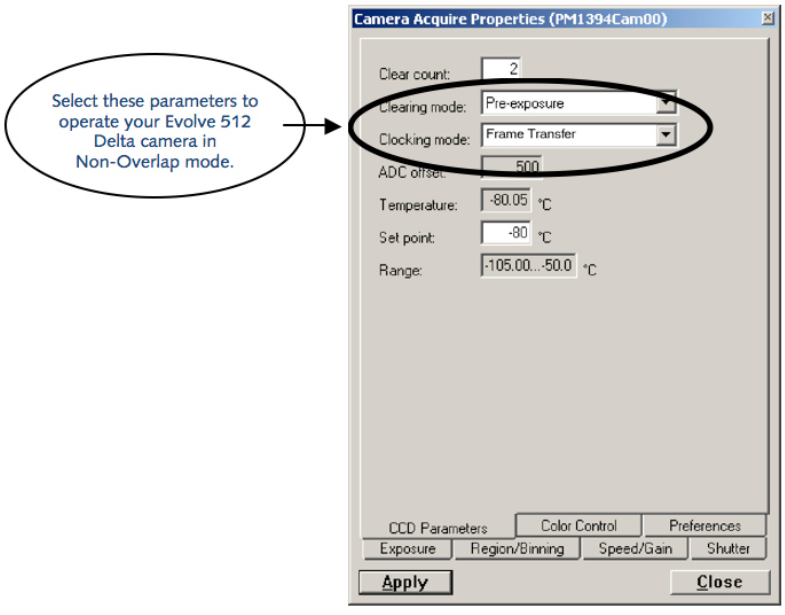
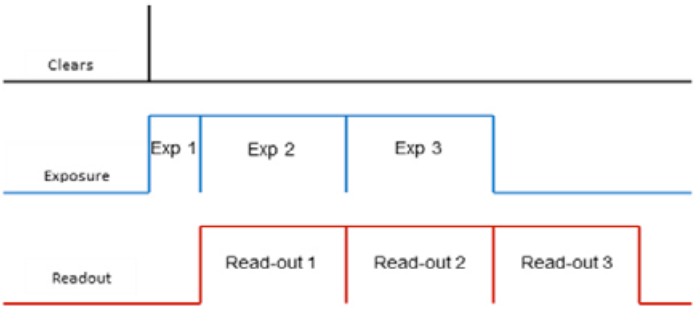


Figure 3. Required Settings for Non-Overlap Mode Operation

Overlap Mode (Simultaneous Exposure-Readout)

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 for 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 you are able to expose and read-out simultaneously, the minimum exposure time is dependent on the time taken to complete read-out. As such – (excluding the first frame) any exposure time smaller than the read-out time defaults to an exposure duration equal to the read-out time.

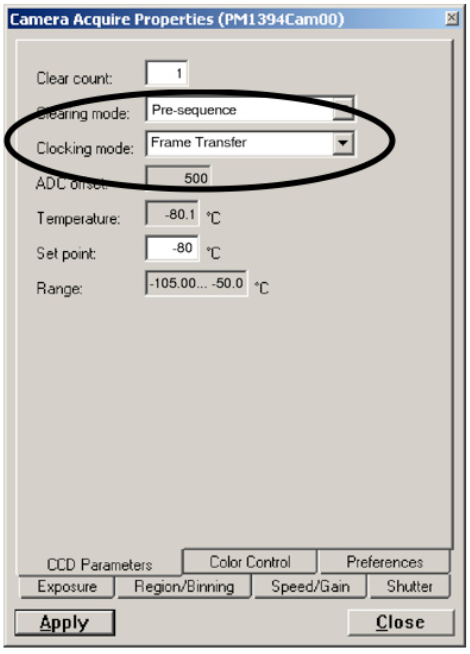


Figure 4. Required Settings for Overlap Mode Operation

Note: In Overlap mode, the minimum effective exposure time is the readout time.

Triggered Operation

The Evolve 512 Delta camera offers several methods of integration with external trigger devices, such as shutters or laser illumination sources. Each camera has a 10-pin, Hirose HR10A I/O connector (pinout functions are described in Chapter 5) on the power supply for trigger input/out and various TTL input and output operations. A special cable is available from Photometrics to access primary signals such as "Trigger input," "Expose out," "Frame readout," and "Shutter out." In the default mode, the camera triggers on the rising edge of a TTL signal. Evolve 512 Delta cameras support the trigger modes described in the next sections.

The types of triggering supported by the Evolve Delta cameras are:

- Trigger First Mode (Overlap/Non Overlap)
- Strobe Mode (Overlap/Non Overlap)
- Bulb Mode (Non Overlap)
- The waveform behavior is shown for the following signal:
- Trigger In
- Trigger Ready
- Camera Expose
- Read-out

Shutter Signal Behavior

There are 5 shutter behavior modes that are available:

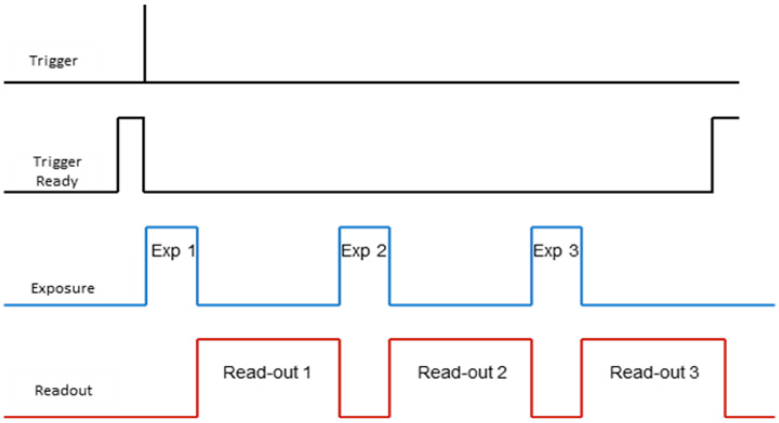
- **Open Never** – Shutter is always closed.
- **Open Pre-Exposure** – Open before every exposure, closed when not exposing.
- **Open Pre-Sequence** – Open before start of sequence, closed at end of sequence
- **Open Pre-Trigger** – Causes shutter to open before external trigger is received. In non-triggered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

Trigger First Mode

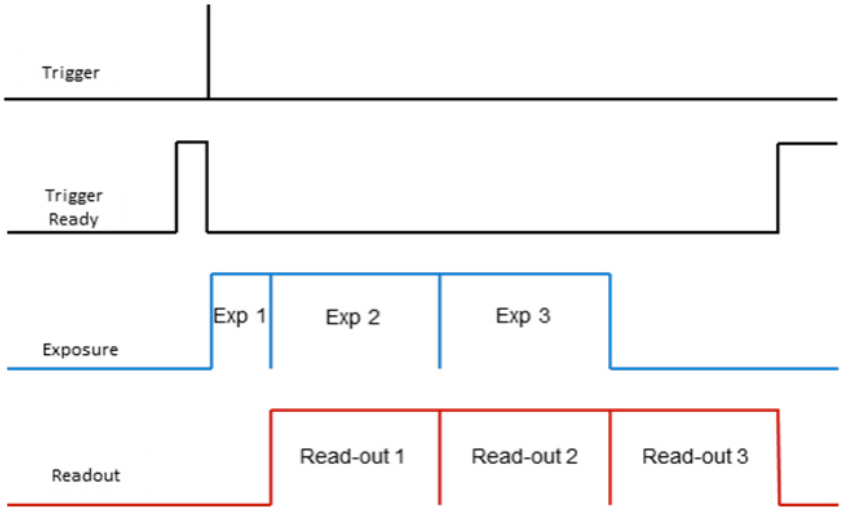
In trigger first mode, the camera requires one trigger to begin the acquisition of a stream of images. Once the trigger is received, the camera runs using its internal timed mode, independent of any future triggers. It is possible to run this triggering mode in either Overlap Mode or Non-Overlap Mode.

Process:

1. Trigger Ready is High – ready to receive trigger
2. Trigger is received
3. Trigger Ready goes low
4. Image Sequence begins
5. All following triggers are ignored till Trigger Ready goes high
6. Trigger Ready goes high when sequence completes



Trigger First – Non-Overlap Mode



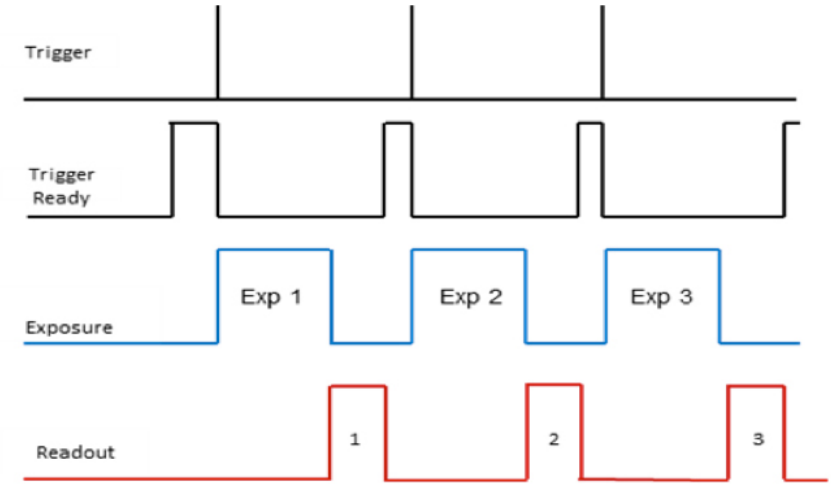
Trigger First – Overlap Mode

Strobe Mode

In strobe mode, each frame in the sequence requires a trigger. When a trigger is received, the camera exposes for the exposure time set in the software. If strobe mode is set to run in overlap mode, all exposures (except the initial one) will be equal to, or larger than the read out time. Triggers received while trigger ready is low are ignored.

Process (Non-Overlap):

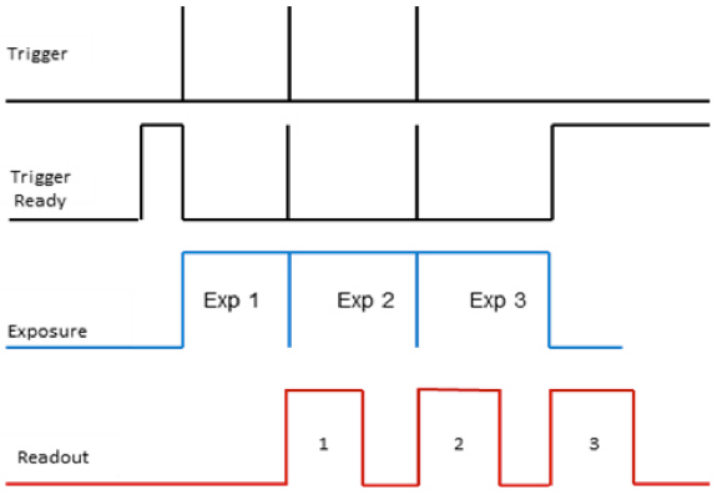
Trigger Ready is high – ready to receive trigger
Trigger is received
Trigger Ready goes low
Image is acquired
Image is read-out
Trigger Ready goes high
Repeat



Strobe Triggering – Non Overlap Mode

Process (Overlap):

Trigger Ready is high – ready to receive trigger
Trigger is received
Trigger Ready goes low
Image is acquired
Image Read-Out begins
Trigger Ready goes high
Repeat

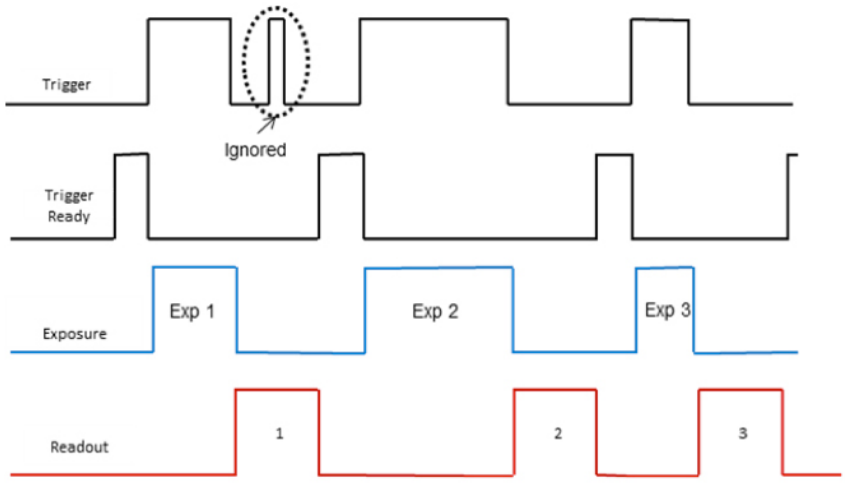


Strobe Triggering – Overlap Mode

Bulb Mode

Process (Non-Overlap):

Trigger Ready is high – ready to receive trigger
Trigger is received
Trigger Ready goes low
Image is acquired for duration trigger signal is high
Image is read-out
Trigger Ready goes high
Repeat



Bulb Triggering – Non Overlap Mode

SMART Streaming

Trigger Mode	Non-Overlap Mode Supported	Overlap Mode Supported
Timed	Yes	Yes
Trigger First	Yes	Yes
Strobed	Yes	Yes
Bulb	Yes	No

Table 1. Triggering Modes

The Sequenced Multiple Acquisition Real Time Streaming(SMART Streaming) feature for the Evolve 512 Delta provides the ability to choose a set of different exposure times for capturing images and then to stream a large number of these image sets with the smallest possible delay time in between each. Normally, switching between different exposure times adds extra delay for each exposure time change, but SMART streaming minimizes this. This feature is highly advantageous for applications that require capturing many sequences of images and thus require minimal delay to keep acquisition time manageable.

The availability of SMART Streaming is dependent on the imaging application and its implementation of it. Please refer to the application software manual for information regarding support.

Rapid-Cal®

The Evolve 512 Delta has incorporated a calibration routine which allows the camera to adjust voltages of the ADC offsets such that the electron multiplication gain input to the camera reflects the actual gain provided by the device. Settings of 1 to 1000 on the electron multiplication gain slider are mapped linearly to provide the actual multiplication gain requested by the user.

Due to the impact-ionization method used with the electron-multiplication gain register, the actual gain realized by the detector with time will slowly be reduced. By using the calibration routine the camera is able to re-establish the electron multiplication gain slider such that it will provide the gain which is input on the gain slider. This ensures the quantitative nature of the camera over time.

Even though the camera is capable of delivering large multiplication gain factors, multiplication gain should only be used as needed to preserve as much dynamic range as necessary and to prolong the device's lifetime.

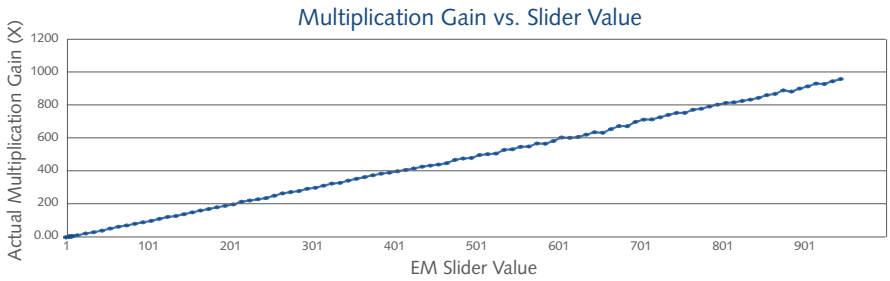


Figure 5. DAC Setting vs. Charge Multiplication Gain for Evolve 512 Delta

EMCCD cameras are subject to aging of the EMCCD register as a result of its usage. The Evolve 512 Delta calibration feature performs the industry's most accurate EM calibration within 3 minutes. A simple turn of the cameras nose-piece closes a shutter and activates a light source which the detector uses to calibrate its EM gain. This ensures that users will receive the most accurate electron multiplication and the EM gain applied matches what the user requests.

Simple software control will allow the user to use this feature as a manual shutter in order to block all light from the sensor in order to take dark reference frames if necessary.

How will Rapid-Cal help?

It is necessary that electron multiplication be accurate if you wish to be quantitative with the images taken by an EMCCD camera. The evolve cameras Rapid-Cal feature allows extremely accurate and rapid calibration of the EM-Gain ensuring your data can be quantitative all of the time. It is recommended that calibration be performed once a week although the requirements of calibration will vary depending on the usage of the camera.

Rapid-Cal in action

LED INDICATOR	FUNCTION
OFF	Calibrator off
FLASHING AMBER/ORANGE	Calibration waiting for CCD temperature lock in order to proceed
FLASHING GREEN	Calibrating
SOLID GREEN	Calibration complete
RED	Error

Figure 6. Rapid-Cal Status

Evolve 512 Delta Application Examples

Example 1:

"I would like to acquire a large stack of single-molecule images to generate my super-resolution data. My light level is fairly low and I want to optimize the frame rate of the camera."

For this application, select the 20MHz camera speed. In addition, the camera should be operated in "Overlap mode". This can be achieved by setting the camera clearing mode to "Pre-sequence". If desired, choose a sub-region (ROI) and/or binning to further increase the frame rate. Finally, on-chip multiplication gain should be used at approximately 300X to boost the signal level and achieve a high signal-to-noise ratio.

Example 2:

"My application requires precise control of the exposure time (less than the readout time) and I want to operate the camera in the most sensitive mode possible."

For better imaging characteristics, select the speed to be 10 MHz. Use on-chip multiplication gain for increased sensitivity. To achieve an exposure time less than readout time, use Non-Overlap mode and set the clearing mode to "Pre-exposure" .

Application Settings Summary

The table below summarizes typical Evolve 512 Delta settings for maximizing speed and sensitivity and is provided as a setup aid. Actual settings will vary based on the exact nature of your experiment design.

Application	Readout Speed	Multiplication Gain	Conversion Gain (e-/ADU)	Readout Mode
Super-resolution Imaging	20MHz	300X	Gain State 2	Overlap mode (Frame Transfer, Pre-Sequence)

Table 2. Application Type and Evolve 512 Delta Setup Parameters

Chapter 5.
Troubleshooting

If you have any difficulty while troubleshooting, or do not see your camera system's symptoms listed here, contact Photometrics Customer Service.

System Does Not Boot Normally

If your operating system does not boot normally after you have installed an interface card, try installing the new card in another open slot. If this does not work, turn off your computer and remove the newly installed interface card. Turn your computer back on. If your system boots normally, there is probably an interrupt conflict between a previously installed expansion card and the interface card that you are installing. If you need assistance resolving the interrupt conflict, contact Photometrics Customer Service.

New Hardware Found Dialog Box Does Not Appear

If the New Hardware Found dialog box does not appear after installing a new interface card to your computer and booting Windows 7:

- Check to make sure that the new interface card is inserted in an expansion slot according to your computer manufacturer's instructions and that the Evolve 512 Delta system's CD-ROM disc is in the host computer's CD drive.
- It is possible that there is a conflict between the new interface card and a previously installed expansion card. With the computer's power turned off, remove any previously installed expansion cards that your system does not need to function. (If you are unsure which cards can be safely removed, call Photometrics Customer Service.) Then turn your computer back on.
- If the New Hardware Found dialog box still does not appear, contact Photometrics Customer Service.

Images Not Displayed

If no images appear:

- Confirm that the camera switch is set to on.
- Confirm that the Evolve 512 Delta camera is selected in your imaging software application.
- Power off the camera and the host computer and check all system connections (particularly the DATA and power cables). Restart.
- Confirm that operating system is set for at least 64k colors (16 bits).
- Confirm that the camera is operational by taking an image with a standard C-mount lens attached to your Evolve 512 Delta. Using normal room lighting, place the camera on a table about 3 meters away from an object and acquire an image.

If the problem persists, contact Photometrics Customer Service.

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 external cooling fins for airflow), switch off the camera immediately and contact Photometrics Customer Service.

PVCAM Error Message Appears

If a PVCAM error message appears, note the message's number code and contact Photometrics Customer Service.

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 (RAM) in your computer system.

Chapter 6.
Basic Specifications

Evolve 512 Delta Front/Side Views

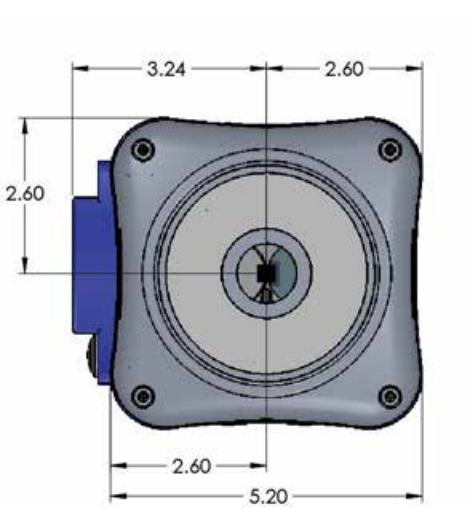


Figure 7. Evolve 512 Delta Front View

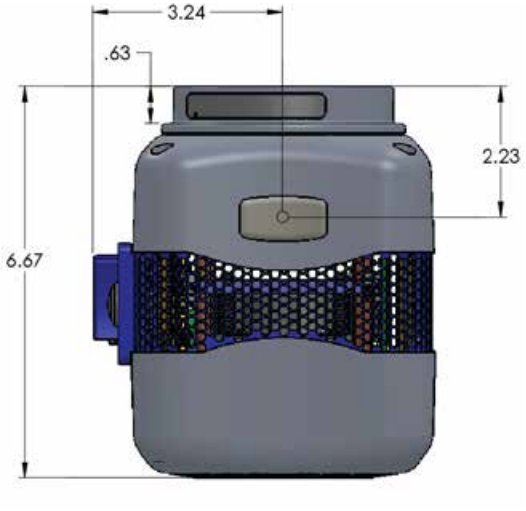


Figure 8. Evolve 512 Delta Side View

Camera Weight

Weight: 6.5 lbs. (2.8 kg)

CCD Specifications

Window	UV grade fused-silica Broadband MgF2 anti-reflective coating on both surfaces
CCD Array	
CCD	e2v CCD97
CCD Process	Back Illuminated
Resolution	512 x 512
Pixel Size	16 µm x 16 µm
Digitalization (Readout) Rate	20MHz, 10 MHz

Table 3. CCD Specifications

Connectors

Figure 9. Evolve 512 Delta Side Panel

The following connectors are located on the side of the camera.

- connector: Type 1, 6 pin IEEE-1394a (FireWire).
- POWER connector: 25-pin, Dsub connector for camera power and I/O functions.

Power Connector Pinout

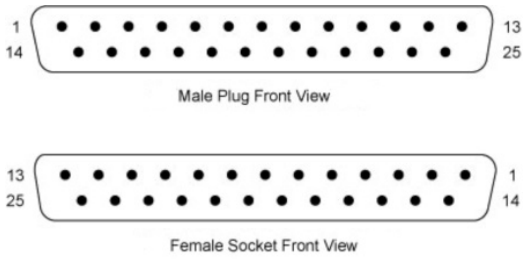


Figure 10. Power Connector Pinout

RX-IO	FPGA-GND
SHUTTER OUT	SPARE IO-2
FPGA+5V	EXPOSE
SPARE IO-1	TX-IO
/TRIG	EOF
/A PWR CONTROL	GND
TEC-PWR	TEC GND
TEC-PWR	TEC CONTROL
-15V	TEC GND
+37V	+ 37V
+3.3V	GND
+3.3V	GND
+16V	

I/O Connector Pinout

The I/O (Input/Output Status) connector located on the front of the power supply provides TTL level trigger and status functions. Inputs must be at least 3.15 V for a high and less than 0.9 V for a low.

The numbers on the I/O connector diagram correspond to the numbers given to the definition of each of the pins. The I/O connector is a female, Hirose HR10A connector. An I/O cable (Part # 37-513-001) to access Trigger Input (Pin 1), Frame Readout (Pin 3), Camera exposing output (Pin 2), and Shutter Output (Pin 4) is available from Photometrics.

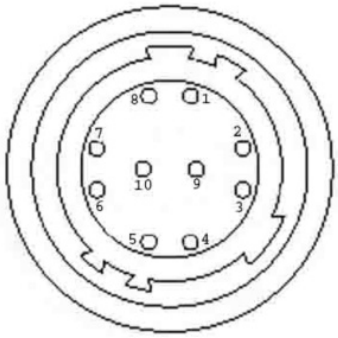


Figure 11.
Input/Output Connector

INPUT/OUTPUT (I/O) TABLE		
#	I/O INPUT	DESCRIPTION
1	Trigger Input	This input is internally tied high through a 4.7k resistor. A rising edge of the Trigger Input signal initiates the trigger. The trigger source would normally hold this input low and then drive it high to initiate the trigger.
2	Camera Exposing Output	Active high. A high level on this output indicates that the camera is exposing (integrating).
3	Frame Readout	Active high. A high level on this output indicates that data is being transferred.
4	Shutter Output	TTL output for timing of external shutter driver. Signal is high during Shutter Open Delay and exposure time. The pin does not provide power to drive the shutter directly, so an external shutter drive controller is required.
5	Spare Input	Reserved
6	Trigger Ready	This output notifies accessory devices that the camera is ready to receive a trigger.
7	TX Out	Accessory Serial Transmit
8	RX IN	Accessory Serial Receive
9	Power Status	A high level on this output indicates that the camera power is switched on (+5 V = on, 0 V = off).
10	GND	System digital ground. Any external circuitry intended to interface with the trigger control signals must reference this ground connection.

Table 4. Input/Output Definitions

Power Supply Specifications

Voltage Input:	100-240 V~ @ 50-60 Hz
Current Input:	2.0 A
Voltage Output:	+3.6 V @ 1 A +17 V @ 0.5 A +37 V @ 0.2 A -15 V @ 0.3 A 6-15 V @ 3.8 A
Maximum Power Output:	150 W
Power Supply Weight:	5 lb (2.267 kg)
Supply Cable Length:	6 ft. / 1.828 m

Note: CE certification applies to the Evolve 512 Delta only when the camera system is operated with a CE-approved power supply

Figure 12. Power Supply Front

Appendix

Evolve LC with Ambient Cooler

Warning: Use of equipment not originally provided by Photometrics for use with liquid cooled cameras will void any and all warranty coverage of the product.

1. Unpack the cooler and hose assembly.
2. Confirm the cooler and hoses are pre-filled with yellow-colored coolant.
3. Align both metal connectors on hoses into connectors on cooler.
4. Press one connector into its mate on the cooler and twist 1/8 turn to lock.
5. Repeat with the second connector.
6. Unpack camera head, power supply, 1394 PCIe card and interface cable.
7. Inspect components and set-up according to quick-start guide for Evolve. **DO NOT power on camera.**
8. Press each hose connector on to its mating connector on the camera; listen for the "click."
9. Pull each connector to ensure they are locked.
10. Inspect the set-up to insure hose connectors are secure at cooler and camera.
11. **Set both the pump speed and fan speed to level 10 on the front display.**
12. Plug-in cooler and turn on.
13. Look through the clear cover on coolant reservoir to observe liquid level and confirm circulation. (Liquid surface will appear agitated with normal circulation.)
14. Turn on camera power and continue setup per quick-start guide. **DO NOT turn-on camera power without liquid circulating!**
15. Allow approximately 30 minutes to stabilize at target camera temperature.

Please note there is no temperature adjustment on the unit.

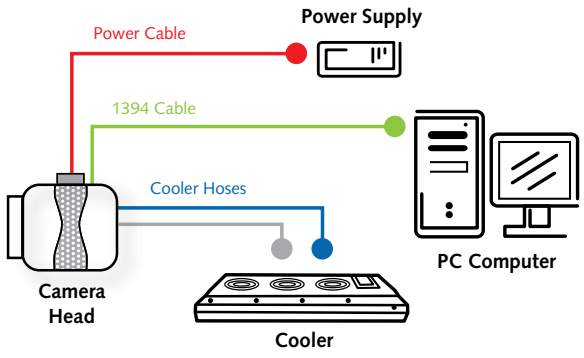


Figure 13. Liquid Cooled Evolve Setup Diagram

INDEX

www.photometrics.com
Main Phone: +1 520.889.9933
Support: +1 604.530.5800 / +1 800.874.9789

