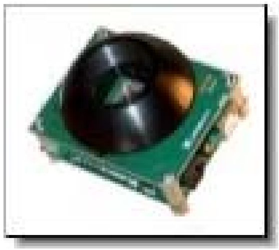
Lumenera USB Camera User's Manual

Release 5.0



Lumenera Corporation • 7 Capella Court, Ottawa, ON, Canada • K2E 8A7 • (t) 1.613.736-4077 • (f) 1.613.736-4071 • www.lumenera.com

The contents of this document may not be copied nor duplicated in any form, in whole or in part, without prior written consent from Lumenera Corporation. Lumenera makes no warranties as to the accuracy of the information contained in this document or its suitability for any purpose.
The information in this document is subject to change without notice.

November 2009

License Agreement (Software):

This Agreement states the terms and conditions upon which Lumenera Corporation ("Lumenera") offers to license to you (the "Licensee") the software together with all related documentation and accompanying items including, but not limited to, the executable programs, drivers, libraries, and data files associated with such programs (collectively, the "Software").

The Software is licensed, not sold, to you for use only under the terms of this Agreement.

Lumenera grants to you the right to use all or a portion of this Software provided that the Software is used only in conjunction with Lumenera's family of products.

In using the Software you agree not to:

a) decompile, disassemble, reverse engineer, or otherwise attempt to derive the source code for any Product (except to the extent applicable laws specifically prohibit such restriction);

b) remove or obscure any trademark or copyright notices.

Limited Warranty (Hardware and Software):

ANY USE OF THE SOFTWARE OR HARDWARE IS AT YOUR OWN RISK. THE SOFTWARE IS PROVIDED FOR USE ONLY WITH LUMENERA'S HARDWARE AND OTHER RELATED SOFTWARE. THE SOFTWARE IS PROVIDED FOR USE "AS IS" WITHOUT WARRANTY OF ANY KIND. TO THE MAXIMUM EXTENT PERMITTED BY LAW, LUMENERA DISCLAIMS ALL WARRANTIES OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY, QUALITY AND FITNESS FOR A PARTICULAR PURPOSE. LUMENERA IS NOT OBLIGATED TO PROVIDE ANY UPDATES OR UPGRADES TO THE SOFTWARE OR ANY RELATED HARDWARE.

Limited Liability (Hardware and Software):

In no event shall Lumenera or its Licensor's be liable for any damages whatsoever (including, without limitation, incidental, direct, indirect, special or consequential damages, damages for loss of business profits, business interruption, loss of business information, or other pecuniary loss) arising out of the use or inability to use this Software or related Hardware, including, but not limited to, any of Lumenera's family of products.

Warning

This unit is for use only with compatible UL listed devices.
If the unit is powered via an external power adapter, the powered adapter shall be UL listed with LPS output.

Product Warranty

Lumenera Corporation warrants to the original purchaser that our cameras are guaranteed to be free from manufacturing defects for a period of one (1) year from the original date of purchase.

Should the unit fail during the warranty period, Lumenera will, at its option, repair or replace the failed unit. Repaired or replaced units will be covered under warranty for the remainder of the original one (1) year warranty period.

This warranty does not apply to units that, after being inspected by Lumenera, have been found to have failed due to customer abuse, accidents, mishandling, tampering/alteration, improper installation, improper power source, negligence, opening of the enclosure, or if the serial number has been removed or damaged. This warranty does not cover labor or incurred charges required in removing or installing the unit, any business interruption, loss of profits/revenues, or any consequential damages.

Units returned to Lumenera beyond the warranty period will be repaired, if possible, and all appropriate material and labor charges will apply.

Any returning product, specifically those being returned under warranty, must follow the Returned Material Authorization (RMA) process. Any units being returned are to be properly packaged (in original packing – if possible). Lumenera will not cover damage sustained in shipping due to improper packing.

For RMA instructions, please refer to our website at www.lumenera.com.

RoHS/WEEE Compliance Statement

The Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive was passed into law by the European Union (E.U.). It affects manufacturers, sellers, distributors and recyclers of electrical and electronic equipment containing lead, cadmium, mercury, hexavalent chrome, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE). After July 1, 2006 the use of these materials will be banned in new products sold in Europe. The RoHS Directive complements the WEEE Directive. China is expected to adopt similar legislation within a similar timeline.

The Waste Electrical and Electronic Equipment Directive (WEEE) aims to reduce the waste arising from electrical and electronic equipment and to improve the environmental performance of all those involved in the life cycle of these products.

Lumenera is committed to protecting people and the environment and we are working on identifying any materials used in our processes that could pose a potential hazard to our employees, customers or the environment.

For this reason we are committed to have all our products comply with the RoHS and WEEE directives. We are constantly improving our compliance with these directives. For more information on our compliance or to track our progress please refer to our website.

Table of Contents

LICENSE AGREEMENT (SOFTWARE): I
LIMITED WARRANTY (HARDWARE AND SOFTWARE): I
LIMITED LIABILITY (HARDWARE AND SOFTWARE): I
WARNING I
PRODUCT WARRANTY II
ROHS/WEEE COMPLIANCE STATEMENT II

INTRODUCTION 1

1.1 THE LUMENERA USB CAMERA FAMILY 1

INSTALLING AND USING THE CAMERA 2

2.1 CAMERA AND SOFTWARE INSTALLATION 2
2.1.1 Minimum System Requirements 2
2.1.2 Camera Power Requirements 3
2.1.3 Installation Procedure 3
2.1.4 Plug & Play Device recognition 8
2.1.5 Software Upgrade Procedure 9
2.1.6 Troubleshooting 9
2.2 TECHNICAL ASSISTANCE 14
2.3 USING THE INSTALLED SOFTWARE 15
2.3.1 Drivers & INF 15
2.3.2 DirectShow Filters 17
2.3.3 Application Software 17
2.3.4 Sample Application Executables 17
2.3.5 Software Development Kit (SDK) 17
2.3.6 Documentation 18
2.3.7 Driver Only Installation Packages 18
2.4 USING LUCAM CAPTURE 19
2.4.1 Dialog items 19
2.4.2 View Menu Items 21
2.4.3 Options Menu Items 22
2.4.4 Buttons and Interface Controls 23

UNDERSTANDING YOUR CAMERA 25

3.1 SHUTTER TYPES 25
3.1.1 Rolling Shutter 25
3.1.2 Half Global Shutter 26
3.1.3 Global Shutter 26
3.2 SCANNING MODE 27
3.2.1 Progressive Scan 27
3.2.2 Interlaced Scan 27
3.3 USE OF FLASH OR STROBE 29

3.3.1 Flash with Rolling Shutter 29
3.3.2 Flash with Half Global Shutter 29
3.3.3 Flash with Global Shutter 29
3.4 CAMERA MODES 30
3.4.1 Streaming Video 30
3.4.2 Snapshot (Asynchronous Trigger) 30
3.5 DATA FORMAT 31
3.6 SUBWINDOWING, SUBSAMPLING & BINNING 33
3.7 EXTERNAL I/O INTERFACE 34
3.7.1 Standard LuCam Camera GPIO Interface Description 34
3.7.2 LuCam Large Format Camera GPIO Interface Description 35
3.7.3 GPIO Descriptions and Signal Definitions for Mini Cameras 37
3.7.4 Signal Definitions for All Cameras 39
3.7.5 Taking a Single-Frame Snapshot with the External I/O Interface 40
3.8 EXTERNAL POWER 44
3.9 LENS MOUNT 45
3.10 CAMERA IDS 45

SDK SAMPLE APPLICATIONS 48

4.1 GENERAL OVERVIEW 48
4.2 DESCRIPTION OF SAMPLE APPLICATIONS 49
4.2.1 AutoLens Sample Application 49
4.2.2 AutoProperties Sample Application 50
4.2.3 AVISample Sample Application 50
4.2.4 BlankCamera Sample Application 50
4.2.5 Callback Sample Application 51
4.2.6 CaptureToFile Sample Application 52
4.2.7 ClickCrop Sample Application 52
4.2.8 CSharp Sample Application 53
4.2.9 DirectShow Callback Sample Application 53
4.2.10 DirectX Sample Application 54
4.2.11 DirectX Snapshot Sample Application 54
4.2.12 DualSlope Sample Application 55
4.2.13 DX Control Sample Application 55
4.2.14 EnumFrameRates Sample Application 56
4.2.15 FastSynchSnaps Sample Application 56
4.2.16 Flipping Sample Application 56
4.2.17 FrameRate Sample Application 57
4.2.18 Get16BitInfo Sample Application 57
4.2.19 GetRanges Sample Application 58
4.2.20 GPI Event Sample Application 58
4.2.21 GpioTest Sample Application 59
4.2.22 HiDySample Sample Application 59
4.2.23 Histogram Sample Application 59
4.2.24 HwTrigCount Sample Application 60

4.2.25 InfinityTest Sample Application.. 60
4.2.26 Lucam Capture Sample Application.. 60
4.2.27 LucamX Sample Application.. 60
4.2.28 MonoCheck Sample Application.. 60
4.2.29 PermStorage Sample Application.. 60
4.2.30 ResetAndFF Sample Application... 60
4.2.31 ScrollingPreview Sample Application.. 61
4.2.32 Snapshot Sample Application.. 61
4.2.33 SyncSnapsCS Sample Application.. 62
4.2.34 Threshold Sample Application... 62
4.2.35 VB Picture Flip Sample Application 62
4.2.36 VB Sync Snaps Sample Application 62
4.2.37 VBFastFrames Sample Application 63
4.2.38 VBlucamCOMSample Application 63
4.2.39 VBNet Sample Application... 63
4.2.40 WinConsole Sample Application.. 63

1

Introduction

1.1 The Lumenera USB Camera Family

Lumenera USB Cameras provide a quick and easy means of displaying and capturing high quality video preview and captured images on any USB 2.0 equipped desktop, laptop or embedded computer.

Designed with flexibility in mind, each camera model has its own distinct characteristics and performance advantages over the others, whether speed, resolution, image quality, sensitivity or price. Because they are USB based, there is no need for a frame grabber. Instead, a single cable provides full command and control and data transfer at speeds of up to 24 MB/s (Lu series) or 48 MB/s (Lw series). For the majority of the USB camera models, the same cable supplies the camera with power (5V).

All cameras have a provision to be externally powered for cases where the USB cable does not supply power (e.g. some USB cards on laptop computers.)

All cameras share the same simple, yet powerful API allowing easy migration from one camera model to another. Both board-level and enclosed cameras are available. All cameras also have an optional external interface header for hardware input and output signals and on-board memory for image buffering.

2

Installing and Using the Camera

2.1 Camera and Software Installation

The Lumenera USB 2.0 High-Speed camera you have just purchased is designed to operate out of the box with minimal set-up.

Note: Prior to plugging the camera into the computer, you must first install the software. In the event that the camera was connected to the computer prior to the software being installed, it will be necessary to perform some manual setup using the Windows Device Manager following the software install. Refer to the troubleshooting section, section 2.1.6, for the necessary instructions.

The software can be found on the CD-ROM that shipped with your product. If the software installation CD is not available, has been lost, or is no longer current; visit the Lumenera web site to download the latest version of the LuCam software.

http://www.lumenera.com

2.1.1 Minimum System Requirements

- Windows XP (SP 2), Windows VISTA or Windows 7
- 32-bit and 64-bit platforms are supported
- 1.0 GHz Pentium III or higher (compatible)
- 512 MB RAM
- USB 2.0 Port.

Note: A USB 2.0 Port is required. The camera will not work on a standard USB 1.1 port.

2.1.2 Camera Power Requirements

Most camera models run directly off the USB bus for both power supply, command control, and data output. In some cases and/or camera models, there may be a need to externally power the camera. Large format cameras (Lw1105x, Lw1605x) run off the external power supply only. Please refer to Section 3.8 for more information on selecting the appropriate power supply for your camera. If an incorrect external power supply is used, it could damage the camera and void your warranty.

2.1.3 Installation Procedure

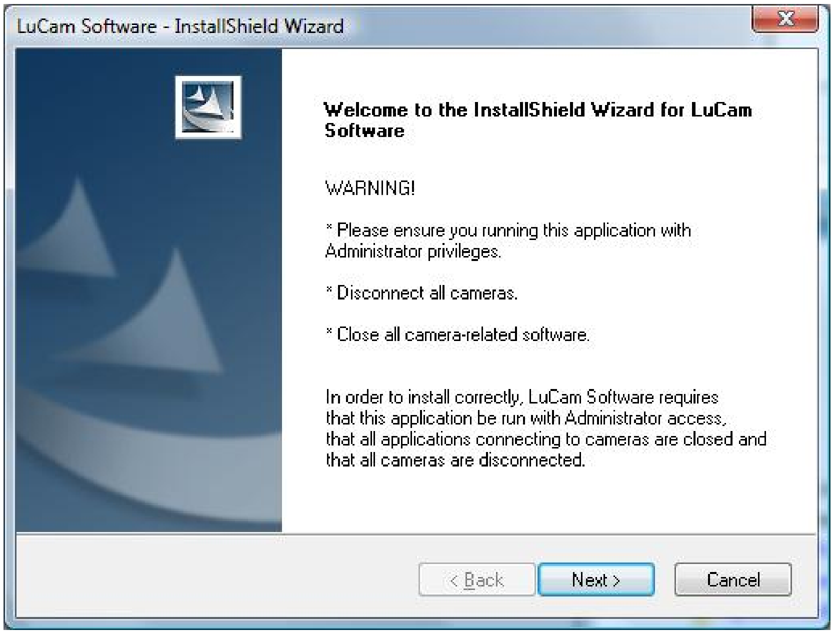
The Lumenera USB 2.0 High-Speed camera you have just purchased is designed to operate straight out of the box. **However, prior to plugging the camera into the computer it is recommended that you first install the software**, which is included on the CD-ROM that shipped with your product.

Follow the steps below for simple installation:

Installation Steps:

1. You must ensure you are logged into the computer with administrator privileges prior to continuing the installation.
2. Close all application software that is running and then insert the Lumenera Installer CD into your CD-ROM drive. The camera should NOT be connected to the computer at this point.
3. Double-click on the installation program, or wait a few moments for the auto-play function to load the setup program automatically, when installing from the CD.
4. Follow the onscreen prompts to install the software drivers and user application. The installation script steps are the same whether the installation takes place on a Windows XP, Windows VISTA, or Windows 7 platforms, whether they are 32-bit or 64-bit.

The following screen capture images provide a walk-through of the installation procedure.



LuCam Software - InstallShield Wizard

Welcome to the InstallShield Wizard for LuCam Software

WARNING!

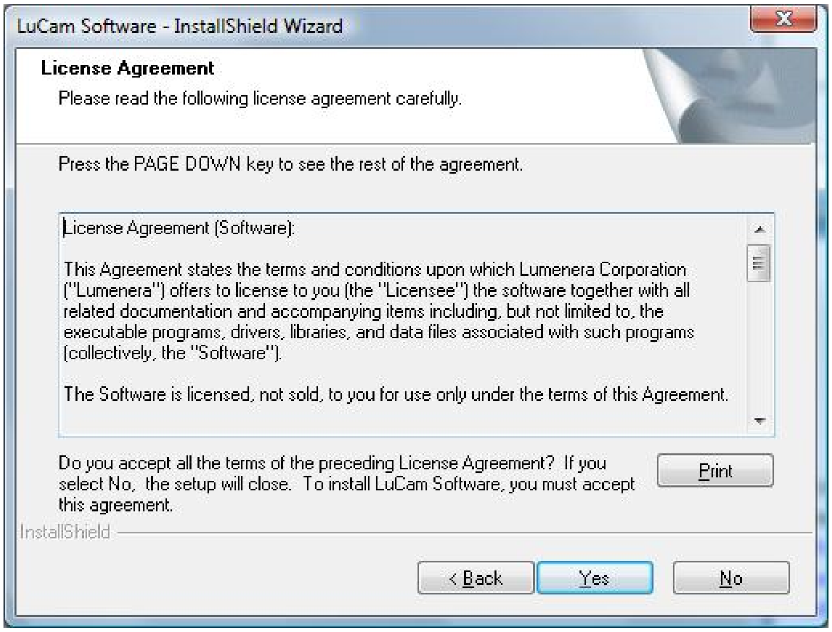
* Please ensure you running this application with Administrator privileges.

* Disconnect all cameras.

* Close all camera-related software.

In order to install correctly, LuCam Software requires that this application be run with Administrator access, that all applications connecting to cameras are closed and that all cameras are disconnected.

Ensure that cameras are disconnected and click **Next**



LuCam Software - InstallShield Wizard

License Agreement

Please read the following license agreement carefully.

Press the PAGE DOWN key to see the rest of the agreement.

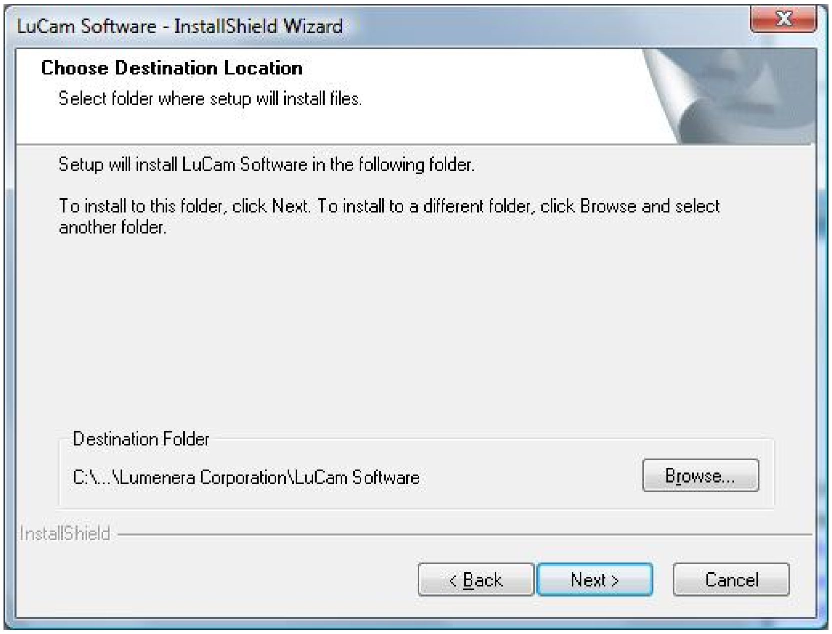
License Agreement (Software):

This Agreement states the terms and conditions upon which Lumenera Corporation ("Lumenera") offers to license to you (the "Licensee") the software together with all related documentation and accompanying items including, but not limited to, the executable programs, drivers, libraries, and data files associated with such programs (collectively, the "Software").

The Software is licensed, not sold, to you for use only under the terms of this Agreement.

Do you accept all the terms of the preceding License Agreement? If you select No, the setup will close. To install LuCam Software, you must accept this agreement.

Review the License Agreement and click **Next**


LuCam Software - InstallShield Wizard

Choose Destination Location

Select folder where setup will install files.

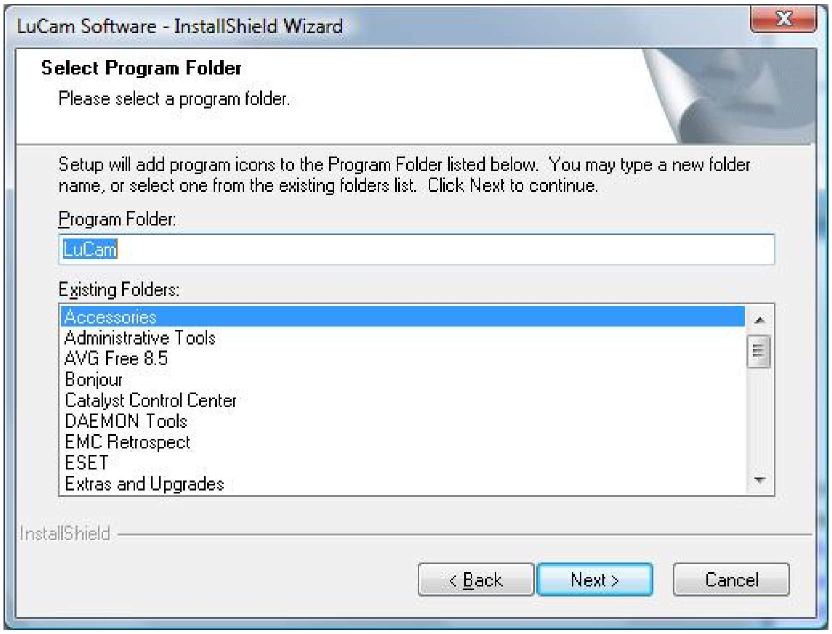
Setup will install LuCam Software in the following folder.

To install to this folder, click Next. To install to a different folder, click Browse and select another folder.

Destination Folder

C:\...\Lumenera Corporation\LuCam Software

Use the **Browse** button if an alternate installation folder is desired, otherwise click **Next** to continue


LuCam Software - InstallShield Wizard

Select Program Folder

Please select a program folder.

Setup will add program icons to the Program Folder listed below. You may type a new folder name, or select one from the existing folders list. Click Next to continue.

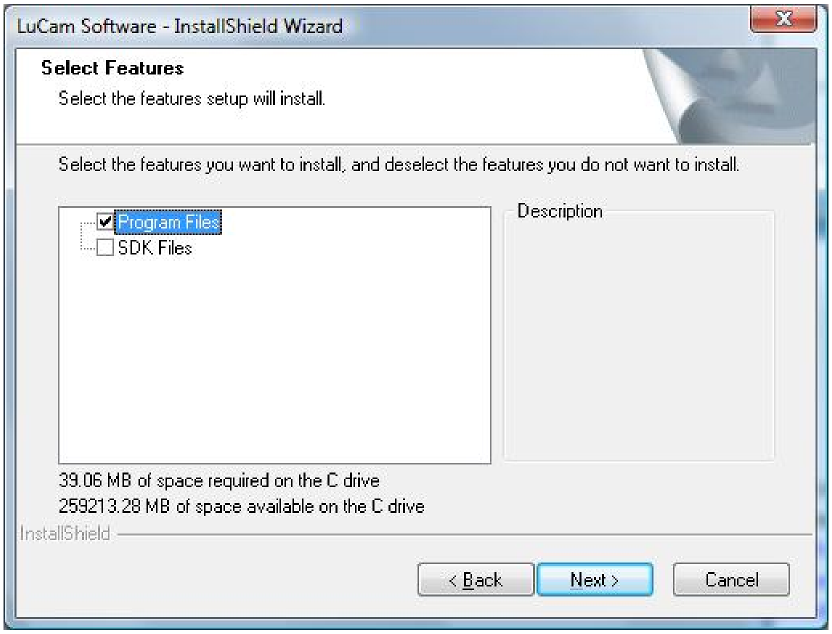
Program Folder:

LuCam

Existing Folders:

Accessories
Administrative Tools
AVG Free 8.5
Bonjour
Catalyst Control Center
DAEMON Tools
EMC Retrospect
ESET
Extras and Upgrades

Click **Next** to accept the default Program Folder name



LuCam Software - InstallShield Wizard

Select Features

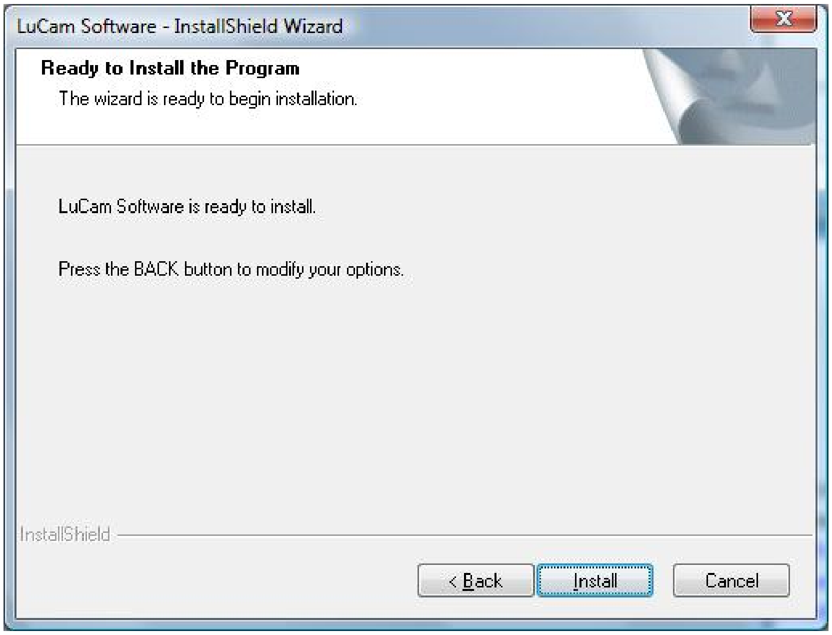
Select the features setup will install.

Select the features you want to install, and deselect the features you do not want to install.

☑ Program Files
□ SDK Files

39.06 MB of space required on the C drive
259213.28 MB of space available on the C drive

Click **Next** to continue with the standard Lucam software installation. Only if the Software Developer's Kit (SDK) was purchased with your camera, should the **SDK Files** box should also be checked. Activating the SDK check box will cause a password prompt to appear as the next dialog.



LuCam Software - InstallShield Wizard

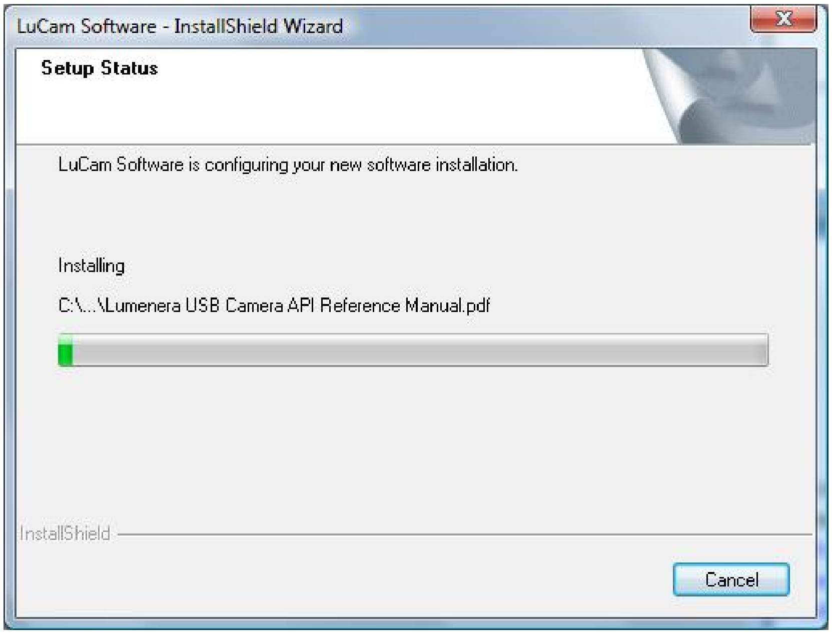
Ready to Install the Program

The wizard is ready to begin installation.

LuCam Software is ready to install.

Press the BACK button to modify your options.

Click **Install** to continue



LuCam Software - InstallShield Wizard

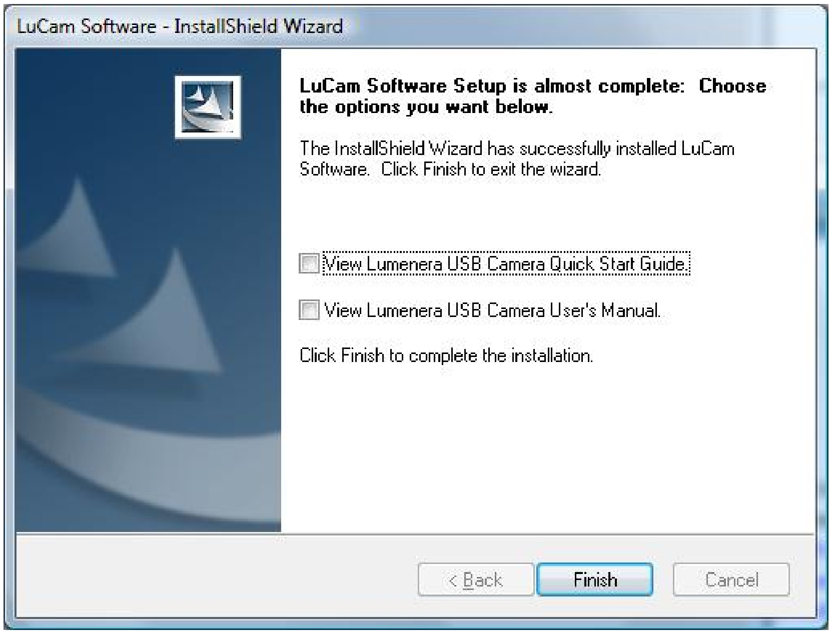
Setup Status

LuCam Software is configuring your new software installation.

Installing

C:\...\Lumenera USB Camera API Reference Manual.pdf

The installation progress bar updates as the listed files are installed.



LuCam Software - InstallShield Wizard

LuCam Software Setup is almost complete: Choose the options you want below.

The InstallShield Wizard has successfully installed LuCam Software. Click Finish to exit the wizard.

□ View Lumenera USB Camera Quick Start Guide.

□ View Lumenera USB Camera User's Manual.

Click Finish to complete the installation.

.

Select any of the options on this final dialog prior to clicking **Finish**

5. After the software has been installed, plug the USB 2.0 Camera into a free USB 2.0 High-Speed port.

Note: The first time a USB camera is connected to any USB port on the computer, the user must be logged into an account with Administrator rights. Once the PC recognizes a camera in a specific port, the camera can be disconnected and reconnected by a user with non-administrator privileges.

Before the camera becomes operational, the operating system must load the device drivers. The LED on the camera will not illuminate until the camera drivers have been successfully loaded to the camera.

2.1.4 Plug & Play Device recognition

Windows XP Computers:

a. The Window's New Hardware Wizard will pop-up detecting a new "Lumenera Unconfigured Device". Select "**Install the software automatically**" from the options that are presented , and click **Next**. A warning may appear notifying you that the drivers have not been digitally signed by Microsoft. Click **Continue Anyway** to continue with the driver installation. Then click **Finish** to install the drivers.

b. After a few seconds the Window's New Hardware Wizard will pop-up again (if it doesn't, unplug and re-plug the camera device), detecting a "Lumenera xxxxx Camera" device. Select "Install the software automatically" from the options that are presented and click **Next**. A warning may appear notifying you that the drivers have not been digitally signed by Microsoft. Click Continue Anyway to continue with the driver installation. Then click Finish to install the drivers. (Please Note: Depending on the camera model purchased the string "Mega 092" may be different than noted above.

c. **Important:** Windows will ask you to re-run these steps each time you plug the camera into a **new** USB 2.0 port. You must have administrator privileges the first time the camera is used on any given USB 2.0 port. You may wish to repeat these installation steps at this time for all USB 2.0 ports.

Windows VISTA and Windows 7 Computers:

The Lumenera USB camera drivers are digitally signed with Microsoft. Under the Windows VISTA and Windows 7 operating systems, the camera will be automatically identified and the drivers will be silently loaded in the background. Typically, a small balloon dialog appears in the lower right of the screen indicating that a device has been detected and the drivers are loading. Allow up to 1 minute for the device drivers to load. The process is complete and the camera is ready when the LED is illuminated on the camera.

Run the LuCam Capture application software from your Start menu to control the camera.

2.1.5 Software Upgrade Procedure

The Software Upgrade procedure is similar to the original software installation. If you have installed a previous version of the software you should uninstall it prior to running the Software Upgrade.

Note: Should the Uninstall Script identify that a reboot is required, please ensure that you perform this step by rebooting your computer before installing the Software Upgrade. Failure to do so could cause difficulties with any future installations.

If you run the Software Upgrade without uninstalling the older version, it will uninstall it for you. The Software Upgrade procedure will launch automatically to install the new software, immediately following the uninstall.

2.1.6 Troubleshooting

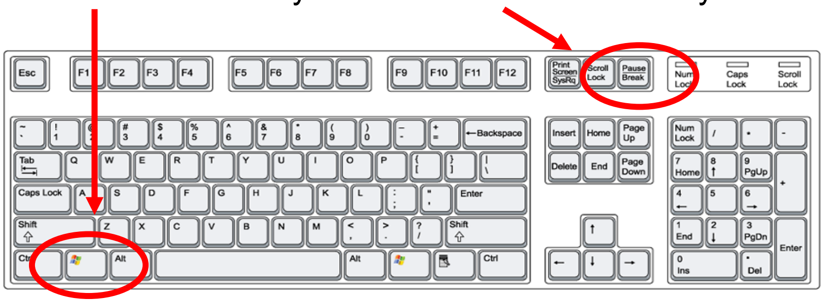
In the event that the Lumenera USB camera is not functional, the most likely reason is that the device drivers were not loaded to the camera. This can occur when a camera was connected to the PC prior to the software being installed. When the USB plug & play device detection is initiated for any new device, the operating system will effectively quarantine the device if it cannot locate the appropriate driver files. In this event, the camera device drivers will be blocked from loading even after the drivers are installed, unless the device detection process is invoked manually. The steps to correct this situation take only a couple of minutes to complete.

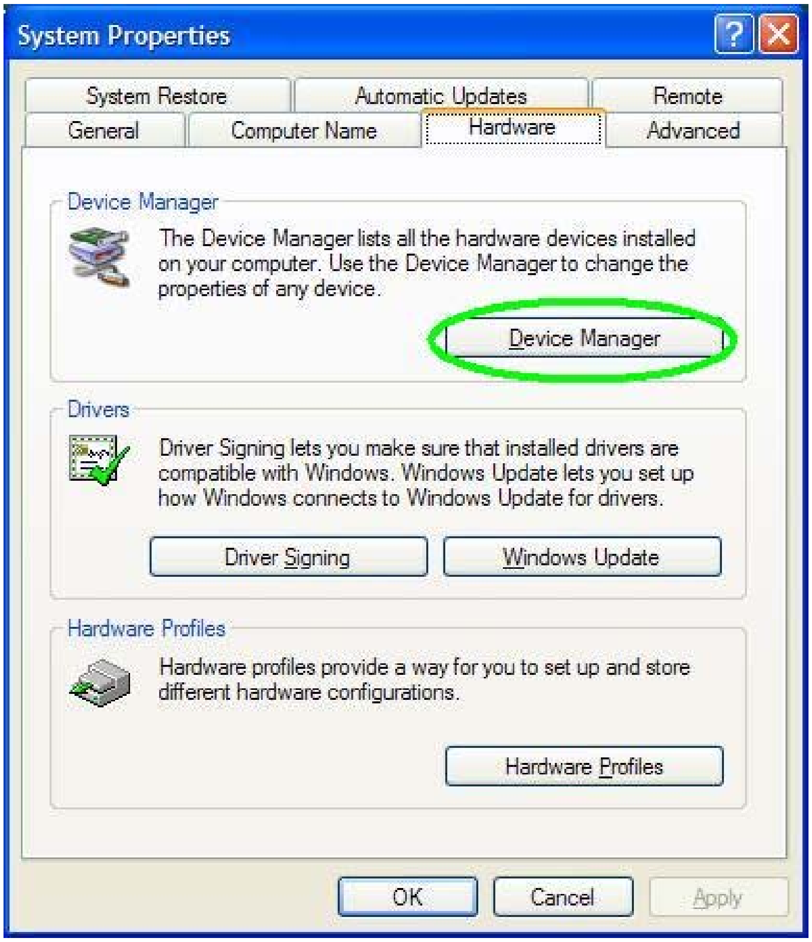
Make sure that the Lucam software is installed before proceeding.

On a Windows XP System follow these steps:

1) Right mouse click the “My Computer” icon on your computer screen and choose “Properties”. Click “Device Manager” on System Properties window.

A keyboard shortcut exists to access this menu quickly, press the “Windows / Start” key and the “Pause / Break” keys simultaneously:





Device Manager

The Device Manager lists all the hardware devices installed on your computer. Use the Device Manager to change the properties of any device.

Drivers

Driver Signing lets you make sure that installed drivers are compatible with Windows. Windows Update lets you set up how Windows connects to Windows Update for drivers.

Hardware Profiles

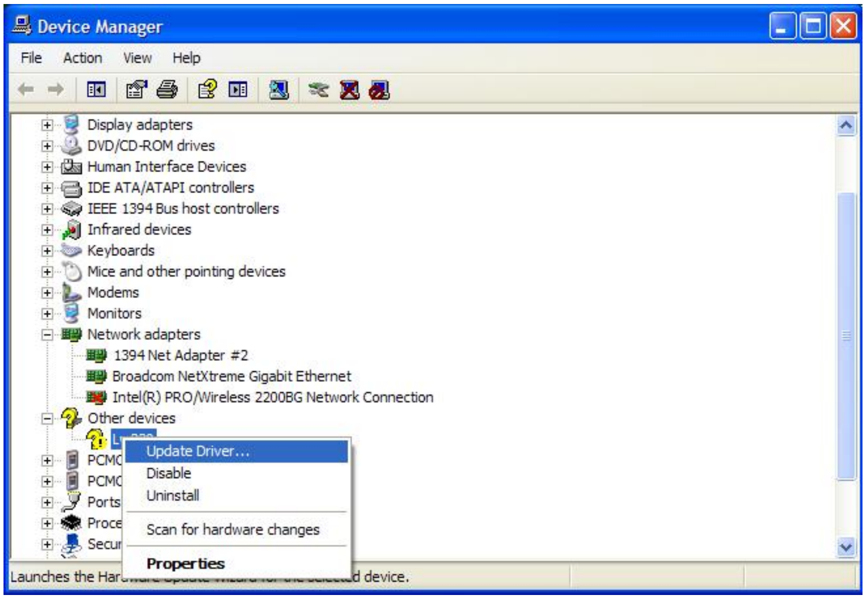
Hardware profiles provide a way for you to set up and store different hardware configurations.

2) Find the entry in the list with a yellow question mark (?). Alternately, it may be listed adjacent to a yellow circle symbol containing an exclamation point . ❗

See example below. It will likely be located under one of these headings.

a. Other Devices
b. Universal Serial Bus controllers
c. Unconfigured Device
d. Imaging Devices Section

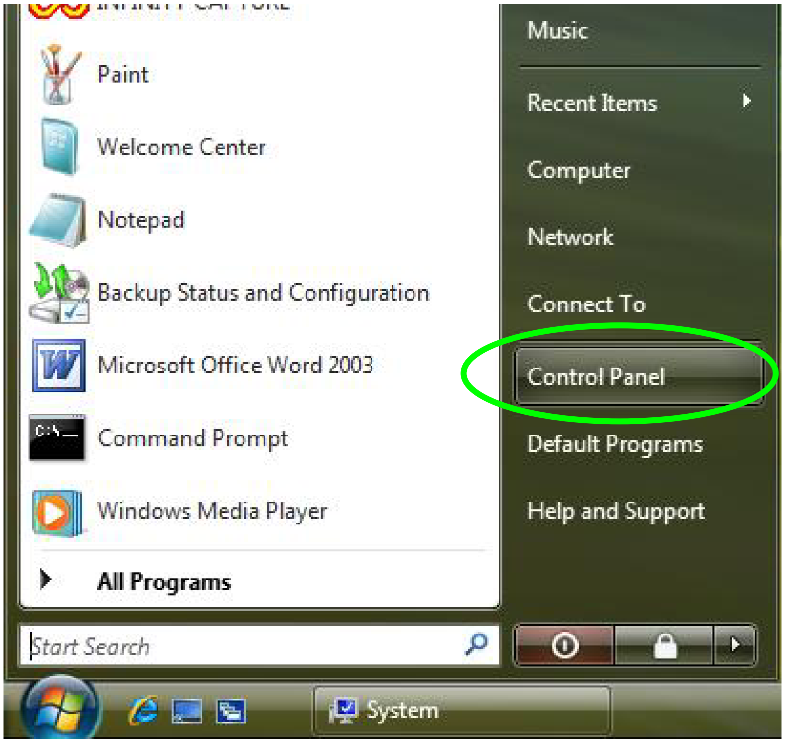
3) Right-click on this entry and either select Update driver.



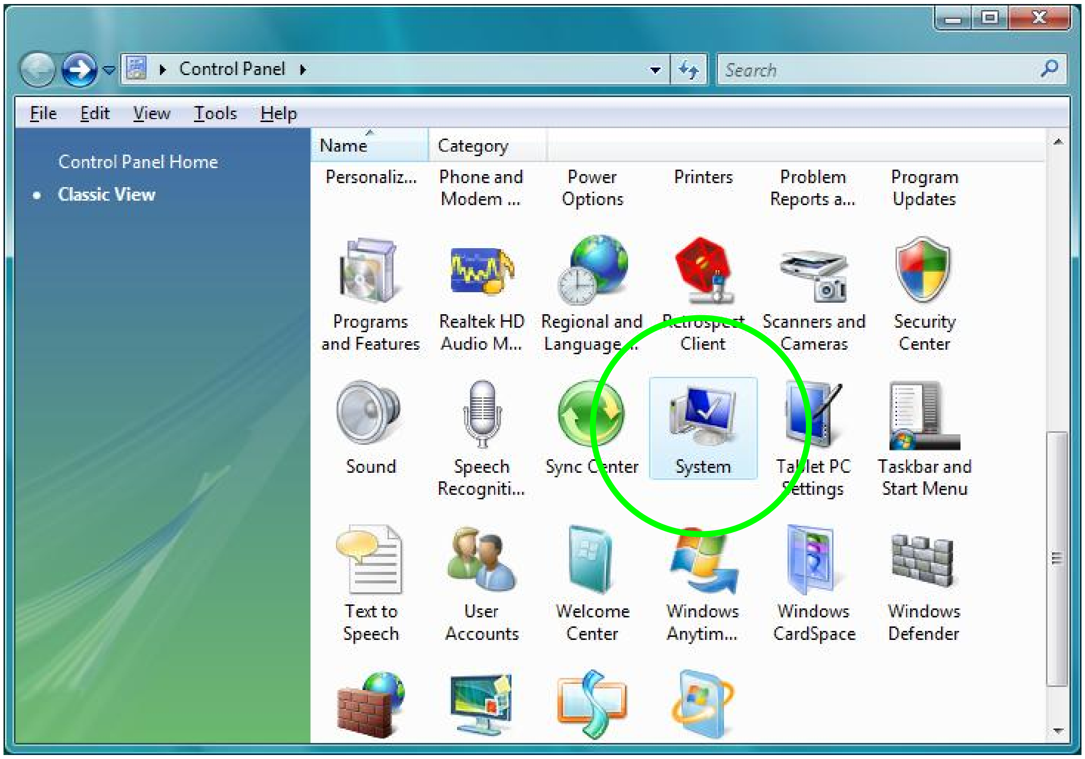
The Windows Found New Hardware Wizard is automatically launched and the normal camera installation steps should be followed.

On a Windows VISTA System follow these steps:

1) Right mouse click the VISTA Logo icon on your computer screen and choose "Control Panel".

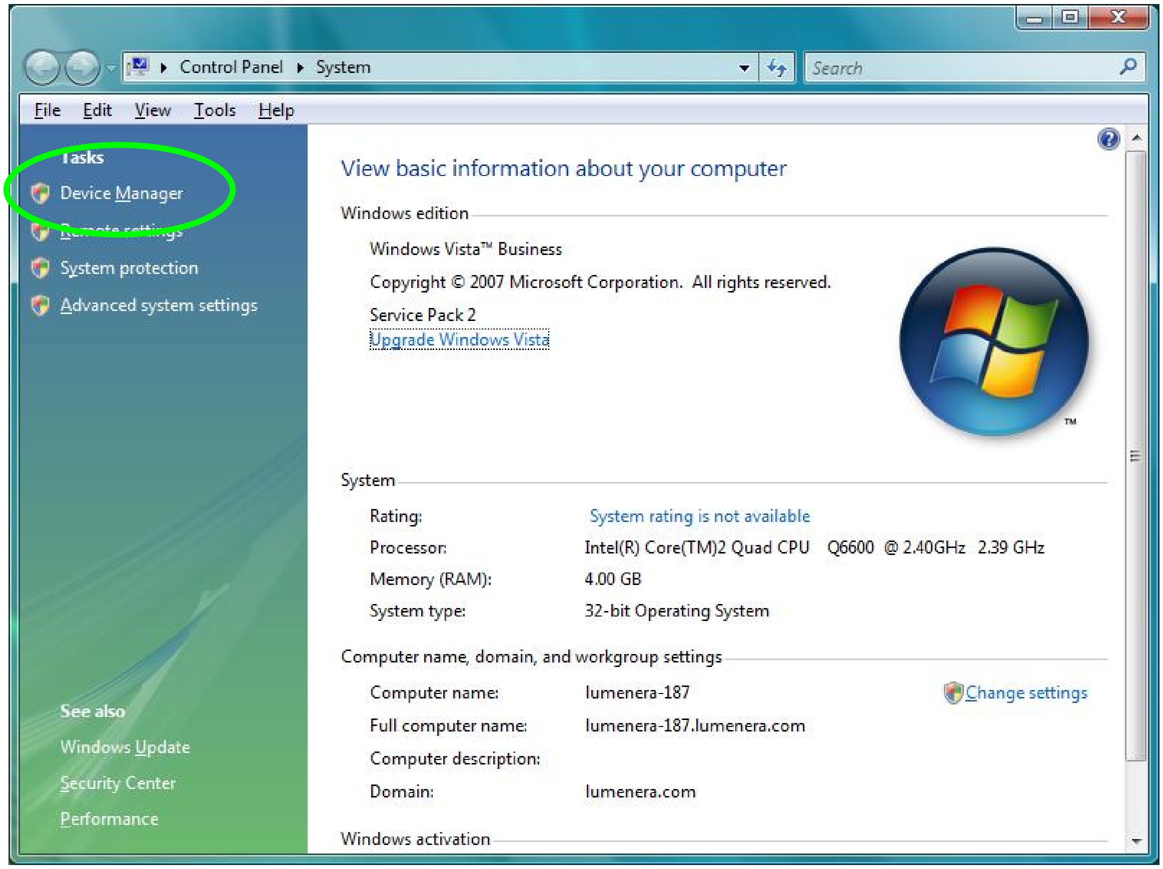


2) Click on the "System" on Control Panel choices



3) Click "Device Manager" on left side panel of the Control Panel -> System window.

Alternately, you can use the same keyboard shortcut identified above for Windows XP systems.



View basic information about your computer

Windows edition

Windows Vista™ Business

Copyright © 2007 Microsoft Corporation. All rights reserved.

Service Pack 2

System

Rating:	System rating is not available
Processor:	Intel(R) Core(TM)2 Quad CPU Q6600 @ 2.40GHz 2.39 GHz
Memory (RAM):	4.00 GB
System type:	32-bit Operating System

Computer name, domain, and workgroup settings

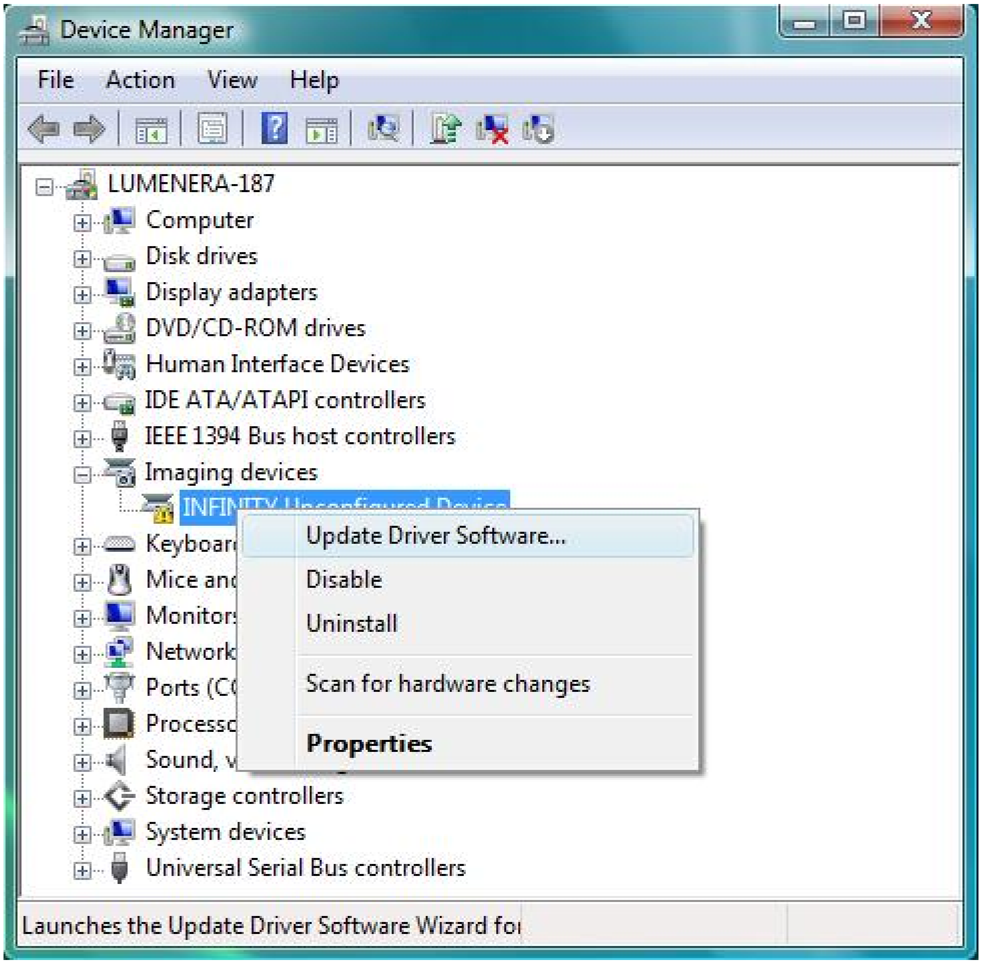
Computer name:	lumenera-187
Full computer name:	lumenera-187.lumenera.com
Computer description:	
Domain:	lumenera.com

Windows activation

4) Locate the device that is identified in the list by a yellow circle icon that contains a black exclamation point,

!

and use a right-mouse click to display the menu. Choose the option "Update Driver Software" to force the system to launch the Found New Hardware Wizard, and follow the prompts presented.



Launches the Update Driver Software Wizard for

2.2 Technical Assistance

If you need assistance with the installation or use of the software, or, if you need help with general camera operation, please contact the Technical Assistance Centre (TAC) via email at:

support@lumenera.com

or by phone at +1-613-736-4077 (press 2 from the auto attendant)

To obtain the latest software release and other technical information you may visit our technical support tab on the Lumenera website at:

http://www.lumenera.com/

Our support website contains technical information available to the general public such as Frequently Asked Questions (FAQ's). For our Lumenera customers we provide a Knowledge Base with more product specific solutions and a Download Centre for customers to obtain the most recent software releases.

As a customer, you will need to provide the TAC with some basic information to gain access to the customer Knowledge Base and the Download Centre. Please provide the following details via email to support@lumenera.com to obtain a user name and password:

- Your name, Company Name, address and telephone number
- Your camera model and serial number
- Your purchase information (e.g. did you purchase from an OEM or distributor?)
- Your SDK password that was provided to you and printed on the CD jacket.

Upon providing the above information, you will receive your access information via email from a TAC representative.

2.3 Using the Installed Software

All of the necessary software and device drivers are contained in an installation program on the CD-ROM that comes with the camera. Update the software to the latest version by downloading it from the Support tab on the Lumenera website.

The following files are installed when you run the installation program:

2.3.1 Drivers & INF

This section is provided for informational purposes only. It is not meant to be used to modify how camera drivers are installed. Proper camera function requires that drivers not be deleted or moved from their installation location.

With the introduction of signed drivers for Windows Vista and Windows 7, the driver installation process for Lumenera cameras now requires a specific set of files of the following types: .inf, .cat, .sys. For successful installation these files must be located in a specific directory structure.

See your Lumenera Software .**Uninstall_Lumenera_Software** subdirectory for an illustration.

Lumenera uses a pair of custom installation applications to manage the proper installation of our signed drivers:
luihlp.exe;
luihlp64.exe.

The Lumenera camera device driver files are provided in a pair for each camera model, supporting a two stage device driver load process. These two files each have the .sys extension. Where XXX represents the 3 digit camera ID number, these files are named :

LucamXXX.sys, LuldrXXX.sys;
LwcamXXX.sys, LwldrXXX.sys;
LccamXXX.sys, LcldrXXX.sys; or
LmcamXXX.sys, LmldrXXX.sys.

Each of the .sys files are called into operation by a custom file with a .inf extension. The location of the inf file is controlled by the Windows O/S. They are installed in the .\INF folder in the standard Windows folder of your system. This file will be named OEM###.inf, where the ### represents a sequential number assigned by the OS that is independent of the Lumenera software installation process.

Installing patch updates for a driver for which a previous version is currently installed will result in multiple such OEM###.inf files. In such cases, a user may be presented with multiple driver options upon installing a new camera of the type associated with the driver update patch. For best management of driver patches we recommend that you run driver update patches from the .\patches subdirectory within the Lumenera software installation
path:

[C:]\Program Files\Lumenera Corporation\LuCam Software\Uninstall_LuCam_Software\patches

2.3.2 DirectShow Filters

Several DirectShow (or WDM) related files are installed in the …\SYSTEM folder in the standard Windows folder on your system. These files all have a .ax extension. These files are stored in the program files folder where the Lumenera software is installed, in a folder named:

Uninstall_LuCam_Software

When these DirectShow filter files are installed, they are registered with the O/S as residing in this folder location. If these files are deleted or moved to a different folder location, without being correctly re-registered, then the camera preview and captured images will not display correctly.

Their names are:

Lutf.ax

Lucustom.ax

Lustrcfg.ax

2.3.3 Application Software

The LuCam Capture application (LuCam.exe) is installed in the directory selected during the installation process. The default location is:

C:\Program Files\Lumenera Corporation\LuCam Software

A shortcut to this application is added to the Start Menu at the location selected during installation. The default location is:

Start > Programs > Lumenera > LuCam > LuCam.exe

2.3.4 Sample Application Executables

Every installation of LuCam software includes a set of executable sample programs to facilitate the evaluation of the camera functionality and performance without the need to develop a custom application. The majority of the LuCam API functions are exercised in these sample executables. Support for these sample programs is not provided. Although they are periodically maintained, some of the sample applications do not function with every Lumenera USB camera model. The last chapter of this manual provides additional information on each of the sample applications.

2.3.5 Software Development Kit (SDK)

The LuCam Capture application source code, and the API libraries are installed in folders called “Sample Code” and “SDK”, which are in the directory selected during the installation process. The default location is:

C:\Program Files\Lumenera Corporation\LuCam Software

The source code consists of a complete Microsoft Visual C++ 6.0 project. The libraries are also compatible with Visual Basic, Visual Basic.Net and Visual C#.Net and Borland C++ Builder. Many additional sample code examples are also available at that location.

If you wish to purchase the SDK, please contact your camera sales representative.

2.3.6 Documentation

Documentation consisting of this User's Manual, the API reference manual and the latest available Application Notes and White Papers, are installed in a folder called “Documentation” in the directory selected during the installation process. The default location is:

C:\Program Files\Lumenera Corporation\LuCam Software

The most recent version of this documentation is included with the download of the latest release of LuCam Software. Visit the Support tab on the Lumenera website at:

http://www.lumenera.com/

2.3.7 Driver Only Installation Packages

Included with the SDK are Driver Only installation packages that can be used to install and run the specific camera models on any computer without the need to install the complete software package. In each camera model directory you will find the camera driver and .inf files, the DirectShow files and the API DLL files. Also included in the directory, there is an installation batch file that can be used to install these files or used as a reference for your own installation script and the Microsoft regsvr32.exe application needed to register the Lutf.ax DirectShow filter file. These packages are installed in a folder called “Driver Only Installations” in the directory selected during the installation process. The default location is:

C:\Program Files\Lumenera Corporation\LuCam Software\SDK

The files contained in these directories are the same ones used by the camera. If, during your development, a camera file update is required, you should use the updated files as part of your installation package. You can replace the files in this directory as necessary.

2.4 Using LuCam Capture

The LuCam Capture application is a simple demonstration program, that is easy to use. The application is built using the SDK and provides an example of what the API functions can do; however, it does not incorporate all of the available features of the API. The complete source code for this application is available to those that purchase the SDK.

Only one camera may be controlled by each instance of LuCam Capture, but several instances of the application may be run simultaneously. If more than one camera is detected by the application, a list of available camera serial numbers is presented, allowing the user to select the camera they wish to control.

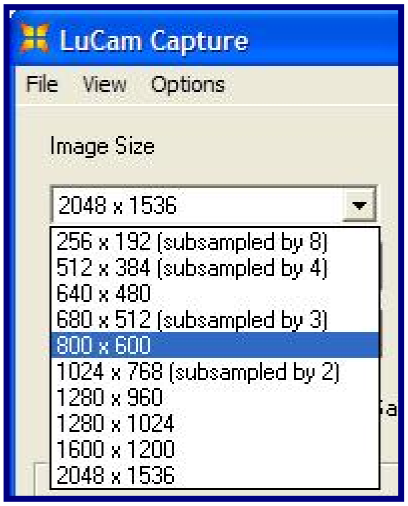
Additionally, the image stream from any one camera can only be provided to a single application. If LuCam Capture or any one of the sample executables is currently extracting a video stream from the connected camera, it must be stopped before another application will be able to access the video stream.

Launch the LuCam Capture application from the Windows Start menu, or from a desktop shortcut icon.

2.4.1 Dialog items

Video Image Control

The **Image Size** dropdown list provides the available video display resolutions. The Preview must be stopped to switch between different image sizes



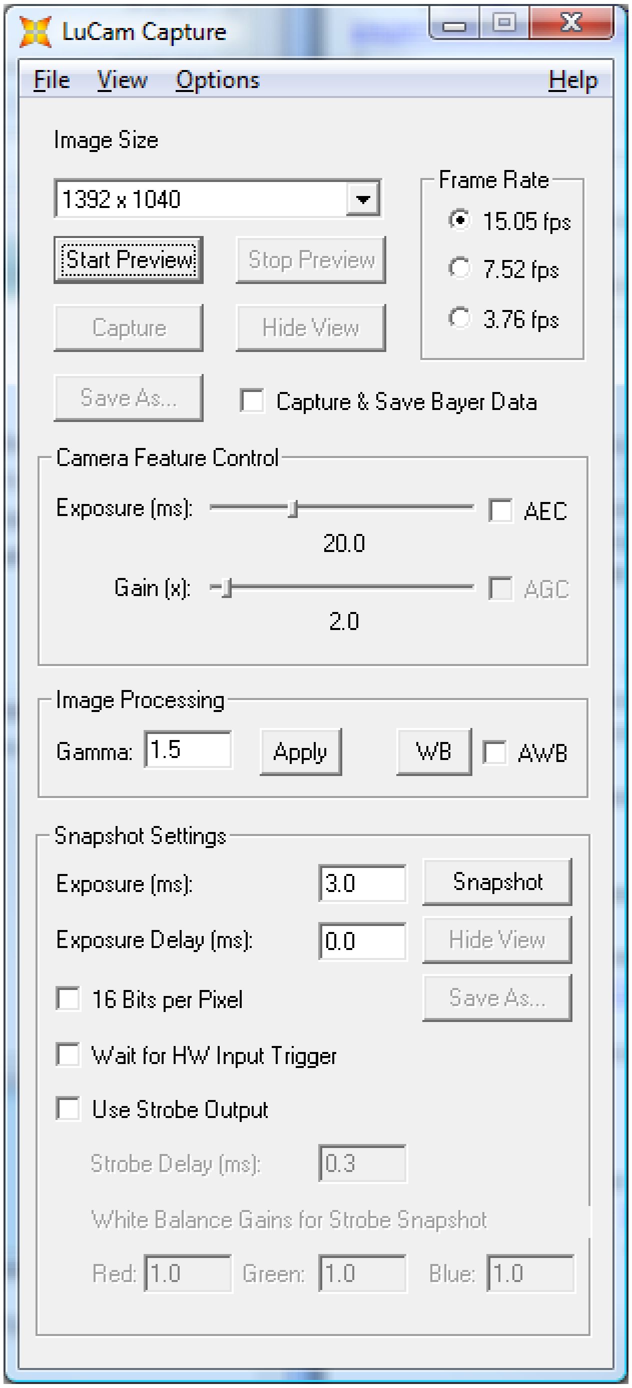
The **Frame Rate** toggle buttons provide the selection of the available display frame rates.

The Preview must be stopped to switch between different image sizes

Note: Not all cameras have this capability.

The **Exposure** slider is used to adjust the video exposure (integration) time in milliseconds.

The **AEC** toggle button is used to toggle the Automatic Exposure Control (not available for all cameras). When selected, the slider changes to Luminance Target allowing you to select the average brightness that you want to maintain as ambient lighting changes. The exposure will be automatically adjusted in an attempt to maintain the average brightness.



LuCam Capture

Image Size: 1392 x 1040

Frame Rate: ● 15.05 fps ○ 7.52 fps ○ 3.76 fps

□ Capture & Save Bayer Data

Camera Feature Control

Exposure (ms): 20.0 □ AEC

Gain (x): 2.0 □ AGC

Image Processing

Gamma: 1.5 □ AWB

Snapshot Settings

Exposure (ms): 3.0

Exposure Delay (ms): 0.0

□ 16 Bits per Pixel

□ Wait for HW Input Trigger

□ Use Strobe Output

Strobe Delay (ms): 0.3

White Balance Gains for Strobe Snapshot

Red: 1.0 Green: 1.0 Blue: 1.0

Figure 1 - LuCam Capture Main Window

The **Gain** slider is used to adjust the global analog gain of the camera for both video mode and when using the Snapshot mode (described below). The gain value is a multiplicative factor, so a value of 1 means no gain. The value of every pixel in the image is multiplied by the gain value, resulting in an increase in image brightness. When the gain setting is increased, any sensor noise will be amplified, along with the image data, and the picture quality will be degraded. The higher the gain, the more noticeable this is.

The **AGC** toggle button is used to toggle the Automatic Gain Control (not available for all cameras). When selected, the slider changes to Luminance Target allowing you to select the average scene brightness that you want to maintain as ambient lighting changes. The gain will be automatically adjusted in an attempt to maintain the average brightness.

> **Note:** When both AEC and AGC are selected, if an increase in brightness is required, exposure is adjusted up first until its limit is reached and then gain is adjusted. When a decrease in brightness is required, gain is adjusted down first until its limit is reached and then exposure is adjusted. This maintains the best image quality.

The **Gamma** value is applied to the image to make it look better on screen. It is used to correct the non-linearity inherent in most CRT monitors. A value of 1 represents no gamma correction. Values less than one will make the image appear darker while a value greater than one will make the image appear brighter. For more information about Gamma and why it's used, consult the following reference: www.poynton.com/GammaFAQ.html

The **WB** button adjusts a camera's color analog gain settings (white balance) of the video preview, based on the overall image, using the gray world algorithm. It is done in software by grabbing a video frame, analyzing it, adjusting the color gains and repeating, until the colors in the image are balanced. That is, there is an equal amount of Red, Blue and Green in the image. It is best to put a neutral target (e.g. white or grey paper) in front of the camera before performing a color balance. For best results, the image exposure time should be adjusted so that the scene does not contain any saturated pixels (values at maximum brightness).

2.4.2 View Menu Items

Preview Frame Rate… displays the average frame rate of the preview window. The average is computed over the whole time span that the display has been actively previewing since the last time Start Preview was pressed.

Show Image Stats… displays a window showing the average image intensity for both the preview and snapshots. It takes into consideration the current pixel depth. It also shows the average color pixel value in each mode. When the **"Update for …"** options are selected, the average values are updated with each new image received. Deselecting these options disables the updates.

Move Capture Window to Origin moves the capture window to the top left corner of your desktop.

2.4.3 Options Menu Items

Read/Write Registers… pops up a dialog box allowing you to read and write the registers of the camera. This is an advanced function and should not be used without the advice of our technical support staff.

Light Source provides the option of selecting the ambient lighting source that is being used so that the proper colour correction can be performed by the camera. The visual impact resulting from the light source adjustment varies by camera model, and in some cameras the impact is negligible.

Enable Preview 16-bit Mode puts the camera into 16-bit video preview mode. The video preview window will only display the upper 8 bits but when you hit the Capture button will capture 16-bit video frames. (The number of actual valid data bits per pixel will vary by camera model. Refer to the camera datasheet for the output options available for a specific model.)

Monochrome Preview puts the camera into monochrome mode.

Sharpen Captured Image applies a sharpening algorithm to the image when it's captured (not in the live preview). If an image is currently being displayed, this option will toggle the displayed image between sharpened and unsharpened.

Enable Dual Tap Correction applies a correction to an image taken from a multi-tap sensor used by the camera. It is applicable only for the full frame format camera models where the sensor output can be processed through a multiple tap mode to improve the data throughput.

Image Averaging averages 5 frames of video together to reduce random image noise, when the Capture button is pressed. This option will produce undesirable results when the field of view contains objects in motion.

Image Summing sums 5 frames of video together to produce a brighter image, when the Capture button is pressed. This option will produce undesirable results when the field of view contains objects in motion. The resulting image will be 5 times brighter than the current preview images.

Hue/Saturation… pops up a dialog that allows you to adjust the hue and saturation of the live preview.

Display Video Properties… pops up a "canned" dialog generated by the LuCam API that allows you to adjust video properties (Exposure, Gain, Gamma, Brightness, Contrast).

2.4.4 Buttons and Interface Controls

The **Start Preview** button starts the video display to the screen.

The **Stop Preview** button stops the video display to the screen.

Video Frame Capture

The **Capture** button grabs a frame of video (asynchronously) from the video stream and display it on screen.

The **Save As…** saves the image to disk in one of the available formats.

The **Hide View** button closes the video image display window.

The **Capture & Save Bayer Data** toggle button allows you to view and save the raw Bayer data that comes from the camera, before it is processed into 24-bit RGB data. (Color cameras only.) If a captured image is currently being displayed, this button will toggle the image between raw Bayer and processed 24-bit data.

Snapshot Settings

The **Exposure** value controls the time between the start of image capture and the data read-out for a snapshot, expressed in milliseconds.

The **Exposure Delay** value indicates the time in milliseconds between the receiving the snapshot trigger input and the start of integration on the sensor.

The **Snapshot** button grabs an image from the camera using its snapshot (synchronous) mode and half-global or global shutter (if available), and display it on screen. (see Shutter Types and Camera Modes sections below for more information about snapshot mode and global shutter)

The **Hide View** button closes the snapshot image display window.

The **Wait for HW Input Trigger** toggle specifies that the snapshot should be hardware triggered using the HW trigger input of the camera's external header. When this value is unchecked, the camera takes a snapshot with a software trigger. With this option selected, when the Snapshot button is pressed, the software will pause as the camera waits for the hardware trigger before returning the image. There is a built-in time-out of 25 seconds after which time if the hardware trigger has not occurred, the software will resume operation.

The **Use Strobe Trigger** toggle is used to specify that during the snapshot exposure, the strobe trigger output should be fired.

The **Strobe Delay** value indicates the time in milliseconds between the rising edge of strobe output and the rising edge of the strobe trigger pulse.

The **Save As…** button is used to save the snapshot image to disk in one of the available formats.

The **16 Bits per Pixel** toggles the camera between 8 and 16-bit data mode for snapshot capture.

The **White Balance Gains for Strobe Snapshot** values allow you to set the Red, Green and Blue gains to be used during the snapshot capture. This allows you to white balance according to the strobe lighting that is being used. They are only applied if the Use Strobe Trigger option is selected.

3

Understanding Your Camera

3.1 Shutter Types

Depending on which camera model you have, the following electronic shutter types may or may not be present. Check the table at the end of this section to determine which camera model has which shutter type. These types are selectable for the snapshot mode of the camera (described in a later section).

3.1.1 Rolling Shutter

With a rolling shutter the exposure process begins, whereby, rows of pixels in the image sensor start exposing in sequence, starting at the top of the image and proceeding row by row down to the bottom. At some later point in time, the readout process begins, whereby, rows of pixels are read out in sequence, starting at the top of the image and proceeding row by row down to the bottom in exactly the same manner and at the same speed as the exposure process.

The time delay between a row starting to expose and a row being read out is the integration time, also known as the exposure time. This integration time can be varied from a single line (start exposure followed by a read out while the next line is exposing) up to a full frame time (last line starts exposing at the bottom of the image before reading starts at the top). In some cases, longer exposures can be obtained by delaying the read out even longer (during which time, the entire array is exposing).

Since the integration process moves through the image over some length of time, skewing of moving objects may become apparent. For example, if a vehicle is moving through the image during capture, light from the top of the vehicle will be integrated at some earlier time than light from the bottom of the vehicle, causing the bottom of the vehicle to appear slanted forward in the direction of motion. For most slow moving objects or still image capture, this motion artefact is not noticeable.

3.1.2 Half Global Shutter

With a half global shutter, the entire image array starts exposing at the same time (globally). At some later point in time, the readout process begins, whereby; rows of pixels are read out in sequence, starting at the top of the image and proceeding row by row down to the bottom (exactly like the rolling shutter case).

The time between the global start of integration and the start of readout is defined as the exposure time. However, since during readout of the image, the lines are still integrating (like rolling shutter), the actual image exposure differs from the top to the bottom. The difference is the time taken to readout the image and varies for each camera (70 ms is typical). Under bright ambient lighting conditions, the image will appear brighter; the further down the image you go. A half-global shutter is most effective when used under controlled lighting (eg. strobe flash).

Because integration continues to occur during readout, the skewing motion artefact can still occur.

3.1.3 Global Shutter

With a global shutter, the entire image array starts exposing at the same time (globally). At some later point in time, the entire image array stops exposing at the same time and the image is read out in sequence, starting at the top of the image and proceeding row by row down to the bottom (sometimes odd rows are read out first followed by the even rows). The difference from the other modes is that during readout, the imager is no longer integrating light.

The time delay between the start of exposure and end of exposure is defined as the exposure time and it represents the total amount of time that the image integrates.

Because all the pixels start exposure at the same time, integrate over the same interval, and stop exposing at the same time, there is no potential for motion artefacts as there is in the other modes.

Table 1 - Shutter Types by Camera Model

Camera Model	Rolling Shutter	Half Global Shutter	Global Shutter
Lu070, Lu075, Lw070, Lw075, Lm075	No	No	Yes
Lu080, Lu085, Lm085	No	No	Yes
Lu100, Lu105	Yes	Yes	No
Lw110, Lw115	Yes	No	No
Lu120, Lu125	Yes	No	Yes

Camera Model	Rolling Shutter	Half Global Shutter	Global Shutter
Lu130, Lu135, Lw130, Lw135, Lm135	No	No	Yes
Lu160, Lu165, Lw160, Lw165, Lm165	No	No	Yes
Lu170, Lu175	Yes	No	No
Lu200, Lu205	Yes	Yes	No
Lw230, Lw235	No	No	Yes
Lu270, Lu275	Yes	No	No
Lw290, Lw295	Yes	No	No
Lu330, Lu335	No	No	Yes
Lu370, Lu375	Yes	No	No
Lw560, Lw565	No	No	Yes
Lw570, Lw575	Yes	Yes	No
Lw620, Lw625	Yes	Yes	No
Lw11050, Lw11056, Lw11057, Lw11058, Lw11059	No	No	Yes
Lw16059	No	No	Yes

3.2 Scanning Mode

Depending on which model of camera you have, the frame integration will be either progressive scan or interlaced. Check the table at the end of this section to determine which camera model has which scan type.

3.2.1 Progressive Scan

In a progressive scan camera, the entire image is integrated (exposed) at one point in time (for global shutters) or line-by-line from top to bottom (for rolling shutters).

3.2.2 Interlaced Scan

In an interlaced scan camera, the entire image is made up of two fields. Each field is made up of the odd lines of the image (odd field) or the even lines of the image (even field). Each field is captured in a progressive manner (using a global shutter), but the exposure for the second field is started after the first one is read out.

When there is no movement of the object being viewed, you will not see a difference between progressive and interlaced scan images. However, when there is movement of the object, the interlaced scan image will exhibit image artefacts known as the comb effect where the edges of the object look like the teeth of a comb because the object is in a different place for the odd versus the even rows of the image.

Table 2 - Scan Mode by Camera Model

Camera Model	Scan Mode
Lu070, Lu075, Lw070, Lw075, Lm075	Progressive
Lu080, Lu085, Lm085	Progressive
Lu100, Lu105	Progressive
Lw110, Lw115	Progressive
Lu120, Lu125	Progressive
Lu130, Lu135, Lw130, Lw135, Lm135	Progressive
Lu160, Lu165, Lw160, Lw165, Lm165	Progressive
Lu170, Lu175	Progressive
Lu200, Lu205	Progressive
Lw230, Lw235	Progressive
Lu270, Lu275	Progressive
Lw290, Lw295	Progressive
Lu330, Lu335	Interlaced
Lu370, Lu375	Progressive
Lw560, Lw565	Progressive
Lw570, Lw575	Progressive
Lw620, Lw625	Progressive
Lw11050, Lw11056, Lw11057, Lw11058, Lw11059	Progressive
Lw16059	Progressive

3.3 Use of Flash or Strobe

A flash or strobe may be used with any camera model and the option is available to provide a programmable trigger signal from the camera to the flash or strobe device to tell it when to fire. However, the type of shutter mode being used will dictate what conditions will be required and how well flash photography will work with the camera.

3.3.1 Flash with Rolling Shutter

The use of a flash with rolling shutter is only feasible for cameras that allow exposures longer than frame read out time (typically about 70 ms). This is because with exposures less than that, only a band across the imager is being exposed at the same point in time and when the flash occurs, it will only illuminate that region of the imager. The flash must be fired at the time when all the pixels of the imager are simultaneously sensitive to light. The strobe signal from the camera is generated at a user selectable delay from that point in time.

Generally, the ambient lighting should be low enough (i.e. dark) so that during the overall exposure the ambient light will not contribute much to the overall brightness of the image. This is particularly true if the flash is being used to stop the motion of a fast-moving object, otherwise, blurring or skewing may occur. For imaging still objects, this is not as much of a concern. In this case, you only need to ensure that you are not overexposing the object with both a long exposure and a flash.

3.3.2 Flash with Half Global Shutter

The use of a flash or strobe with an imager using a half global shutter is similar to the rolling shutter case. However, because the imager starts at once exposing all the pixels globally, the strobe signal from the camera is generated at a user selectable delay from the start of exposure. It doesn't have to first wait for the rolling shutter to open up all the way, like for rolling shutter mode.

Again, the ambient lighting should be low enough so that during the image read out where the imager is still sensitive, the ambient light will not contribute much to the overall brightness of the image. This is a concern for both moving objects where both blurring and skewing may occur, and still objects where you may have uneven brightness from the top of the image to the bottom (as described in the previous section.)

3.3.3 Flash with Global Shutter

The use of a flash or strobe with a global shutter has no limitations or concerns. The strobe signal from the camera is generated at a user selectable delay from the start of the exposure. Very short, global exposures can be used, so, there will be no blurring or skewing or overexposure due to long exposures.

3.4 Camera Modes

The camera has two operating modes: Streaming Video, and Snapshot.

3.4.1 Streaming Video

In streaming video mode, image frames are continuously being sent from the camera to the computer where they are available for use. The data is pushed from the camera, with no user intervention required. The rolling shutter is always used in this mode where the camera has a rolling shutter. For cameras that have only a global shutter, this shutter is used for both the video and snapshot capture modes. An output signal is provided on the external I/O header indicating the start of exposure for each video frame and can be used to help synchronize events with the video images. The camera will operate with the fastest frame rates in this mode.

3.4.2 Snapshot (Asynchronous Trigger)

Snapshot mode is used to capture one (or more) individual frames in an asynchronous manner. In this mode, the user must initiate the action to start the image retrieval through either hardware or software.

The software trigger is provided using API function calls. The function call is made causing the snapshot to be taken and a single image is returned.

The hardware input trigger (with a user programmable delay) can be used to initiate the snapshot via the external I/O interface. An API function call is made that puts the camera into this wait for hardware trigger state and then blocks until the hardware trigger is received. Once the trigger is received (or the user selected timeout occurs), the API function returns and passes back the image (or a timeout error code).

Any of the available shutter types can be used with snapshot mode. An output strobe signal with programmable delay can also be synchronized with each snapshot. This is described in more detail in the External I/O Interface section below.

3.5 Data Format

Data from the camera can be retrieved in one of two pixel formats. These formats represent the bit depth in bits per pixel [bpp]. Either 8 bpp or 16 bpp can be selected. For 16 bpp, not all of the bits are valid data bits. Depending on the camera model, 10, 12 or 14 bits will be valid data, with the remaining 6, 4, or 2 bits always set to zero. A completely dark pixel will have all valid bits set to zero and a completely light-saturated pixel will have all valid bits set to one. The valid data bits are stored most significant bit aligned in each word. The words are in Big Endian byte order for Lu series cameras (most significant byte is the first of each byte pair), and Little Endian byte order for Lw series camera (least significant byte is first of each byte pair). The following tables illustrate this point where the data for the first three pixels (completely light-saturated) of an image are represented.

Table 3 - Pixel Data Format for 16 bpp (10 valid data bits) for all Lu series cameras

Pixel	Pixel 1		Pixel 2		Pixel 3	
16-bit Word	Word 1		Word 2		Word 3	
Byte Order	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
	LSB	MSB	LSB	MSB	LSB	MSB
Binary value	11000000	11111111	11000000	11111111	11000000	11111111
Hex value	0xC0	0xFF	0xC0	0xFF	0xC0	0xFF
Decimal value	192	255	192	255	192	255

Table 4 - Pixel Data Format for 16 bpp (10 valid data bits) for all Lw series cameras

Pixel	Pixel 1		Pixel 2		Pixel 3	
16-bit Word	Word 1		Word 2		Word 3	
Byte Order	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
	MSB	LSB	MSB	LSB	MSB	LSB
Binary value	11111111	11000000	11111111	11000000	11111111	11000000
Hex value	0xFF	0xC0	0xFF	0xC0	0xFF	0xC0
Decimal value	255	192	255	192	255	192

For monochrome cameras, each byte (8bpp) or word (16bpp) represents one complete pixel in the image.

For color cameras, the data arrives from the camera in the raw Bayer format. The imager in a color camera is a monochrome imager that has a Red, Green or Blue color filter over each pixel. The arrangement of this color filter mosaic is called the Bayer format. An example of this can be seen in Figure 2.

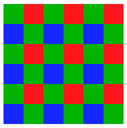


Figure 2 - Example of a 6x6 Pixel Area of Color Imager Mosaic Pattern

Each byte (8bpp) or word (16bpp) will be one of the three mosaic colors: Red, Green or Blue. The order of these colors is camera model dependent and can be found in the following Table.

Table 5 - Bayer Data Color Mosaic Order

Camera Model	Mosaic Order			
	Pixel 1 Row 1	Pixel 2 Row 1	Pixel 1 Row 2	Pixel 2 Row 2
Lu070, Lu075, Lw070, Lw075, Lm075	Red	Green 1	Green 1	Blue
Lu080, Lu085	Green 1	Red	Blue	Green 2
Lm085	Blue	Green 1	Green 2	Red
Lu100, Lu105	Blue	Green 1	Green 2	Red
Lw110, Lw115	Green 1	Blue	Red	Green 2
Lu120, Lu125	Green 1	Blue	Red	Green 2
Lu130, Lu135, Lw130, Lw135, Lm135	Red	Green 1	Green 2	Blue
Lu160, Lu165, Lw160, Lw165, Lm165	Red	Green 1	Green 2	Blue
Lu170, Lu175	Green 1	Red	Blue	Green 2
Lu200, Lu205	Blue	Green 1	Green 2	Red
Lw230, Lw235	Red	Green 1	Green 2	Blue
Lu270, Lu275	Green 1	Red	Blue	Green 2
Lw290, Lw295	Green 1	Blue	Red	Green 2
Lu330, Lu335	Red	Green 1	Green 2	Blue
Lu370, Lu375	Green 1	Red	Blue	Green 2
Lw560, Lw565	Red	Green 1	Green 2	Blue
Lw570, Lw575	Green 1	Red	Blue	Green 2
Lw620, Lw625	Green 1	Red	Blue	Green 2
Lw11050, Lw11056, Lw11057, Lw11058, Lw11059	Green 1	Red	Blue	Green 2
Lw16059	Green 1	Red	Blue	Green 2

When using the LuCam Capture application to preview video from a color camera or save images to disk, conversion of the data to standard 24-bit RGB data is done by the software automatically.

When using the API (available with the SDK), you have complete control over this conversion process.

3.6 Subwindowing, Subsampling & Binning

Subwindowing, also known as region of interest (ROI), is the ability of the camera to output a smaller image size (subwindow) than the whole imager array. An imager that supports a maximum resolution of 1280x1024 pixels for example, could output a subwindow of 640x480 pixels with the subwindow being positioned nearly anywhere inside the 1280x1024. The subwindow is actually a smaller field of view than the maximum resolution available. There are limitations on the granularity of the subwindow size and on its position within the whole array. The granularity is 8 pixels.

Subsampling, also known as decimation, is the throwing away of every nth pixel or pixel pair in the image in the X and/or Y directions. For example, an imager with a maximum resolution of 1280x1024 could throw away every second pixel in both the X and Y directions and output an image that is 640x512 pixels, yet covers the same field of view of the original full resolution. Not all cameras support Subsampling. Those that do may support subsample levels of 2, 4 or 8. Some cameras even allow different Subsampling in the X vs. the Y directions.

Binning is similar to Subsampling, except instead of throwing pixels away, pixel values are combined in some fashion. They can be either summed (to provide greater sensitivity) or averaged (to reduce noise). The resulting resolution would be the same as for Subsampling, but the data from every pixel is used. Several cameras support Binning with binning levels up to 8 by 8.

3.7 External I/O Interface

3.7.1 Standard LuCam Camera GPIO Interface Description

For board-level cameras, the External Interface Header can be found in the corner of the PCB next to the silver USB connector. For enclosed cameras, it is found on the side of the camera near the USB connector. It is a male, 2 mm pitch, 16-pin (2 x 8) header. The pin numbering can be seen in Figure 3.

3.7.1.1 Recommended Mating Connectors

The following mating connectors have been tested to work with the cameras. All of them are for 16-pin (2 x 8), 2mm pitch headers.

- AMP/Tyco P/N 2-111623-3 IDC Ribbon Cable Receptacle
- Molex GC/Waldom P/N 87568-1663 IDC Ribbon Cable Receptacle
- Molex GC/Waldom P/N 87568-1693 IDC Ribbon Cable Receptacle Locking

For above mating connectors, 1mm, 28AWG stranded, round conductor flat cable is recommended.

- Molex GC/Waldom 51110-1650 Wire Crimp Receptacle
    - Female Crimp Terminal for above – P/N 50394-8100
- Norcomp P/N 2564-16-01RP2 Vertical Dual Row Receptacle
- Sullins P/N PPWN082AFCN Vertical Dual Row Receptacle

All of these connectors can be purchased from Digi-Key® (www.digikey.com) but other parts suppliers may also carry them.

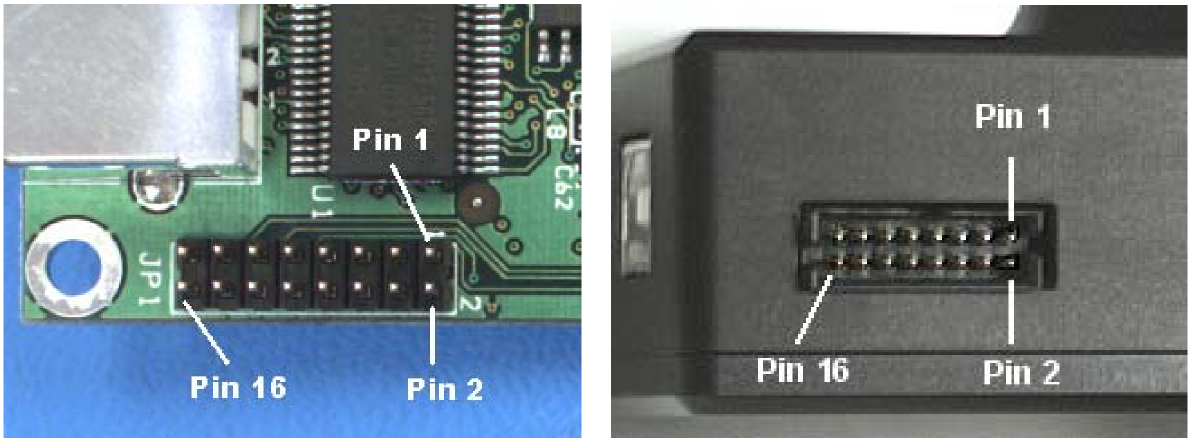


Figure 3 - External Header Location and Pin Numbering

3.7.1.2 Header Pin-out

Table 6 - Header Pin-out Definition

SIGNAL	PIN #	PIN #	SIGNAL
GPO1 / Strobe Out (AL)	1	2	GND
GPO2 / Strobe Out (AH)	3	4	GND
GPO3	5	6	GND
GPO4 / Video SOF	7	8	GND
GPI1 / Trigger In	9	10	GND
GPI2	11	12	GND
GPI3	13	14	GND
GPI4	15	16	GND or VCC Output (opt.)*

* Certain camera models can be configured with alternate output for pin 16. Contact the Technical Assistance Centre for details

None of the signals can supply much current. Maximum current draw should be kept to less than 24 mA.

For all GPO pins, the voltage swing is as follows:

- For a LOW value: 0.0 - 0.1V
- For a HIGH value: 3.0 - 3.3V

For all GPI pins, the tolerated input voltage swing is as follows:

- For LOW input voltages: 0.0 - 0.5V
- For HIGH input voltages: 2.0 - 5.0V

3.7.2 LuCam Large Format Camera GPIO Interface Description

For Large Format cameras, the GPIO port is located on the back of the camera just above the USB and power supply connectors. This port uses a DIN connector from CUI, part number MD-80. It is also available from Digikey, www.digikey.com, Digikey part number CP2090ND. The pin numbering is shown in Figure 4 and Table 7.

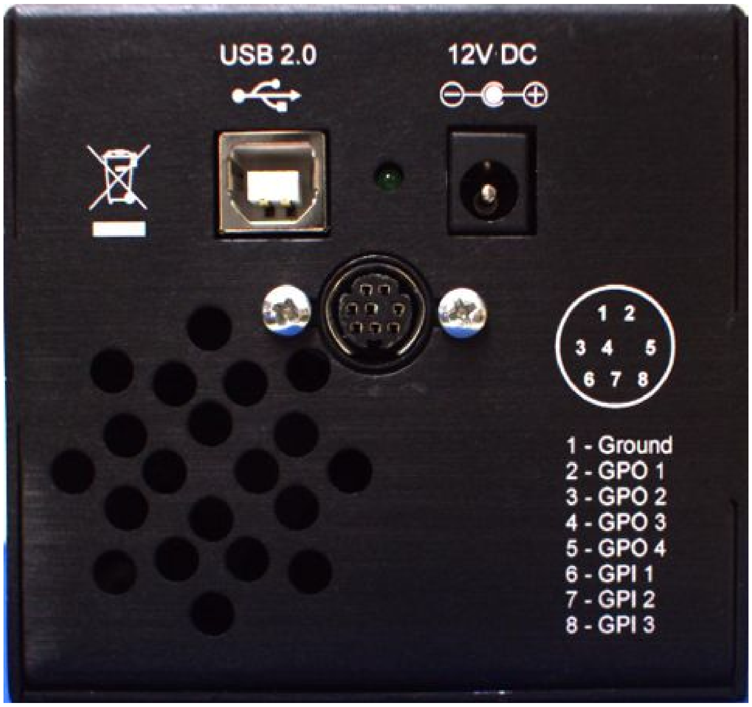


Figure 4 - Large Format Camera External Header Location and Pin Numbering

3.7.2.1 Header Pin-out

Table 7 - Header Pin-out Definition

SIGNAL	PIN #
GND	1
GPO1 / Strobe Out (AL)	2
GPO2 / Strobe Out (AH)	3
GPO3	4
GPO4 / Video SOF	5
GPI1 / Trigger In	6
GPI2	7
GPI3	8

For all GPO pins, the voltage swing is as follows:

- For a LOW value: 0.0 - 0.1V
- For a HIGH value: 3.0 - 3.3V

For all GPI pins, the tolerated input voltage swing is as follows:

- For LOW input voltages: 0.0 - 0.5V
- For HIGH input voltages: 2.0 - 5.0V

3.7.3 GPIO Descriptions and Signal Definitions for Mini Cameras

For all Mini cameras, the external header can be found on the back of the camera near the Mini USB connector. It uses a standard RJ45 connector as shown in Figure 5.

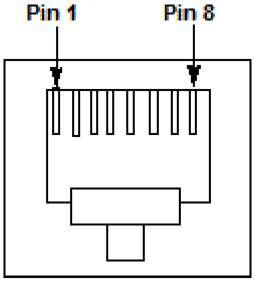


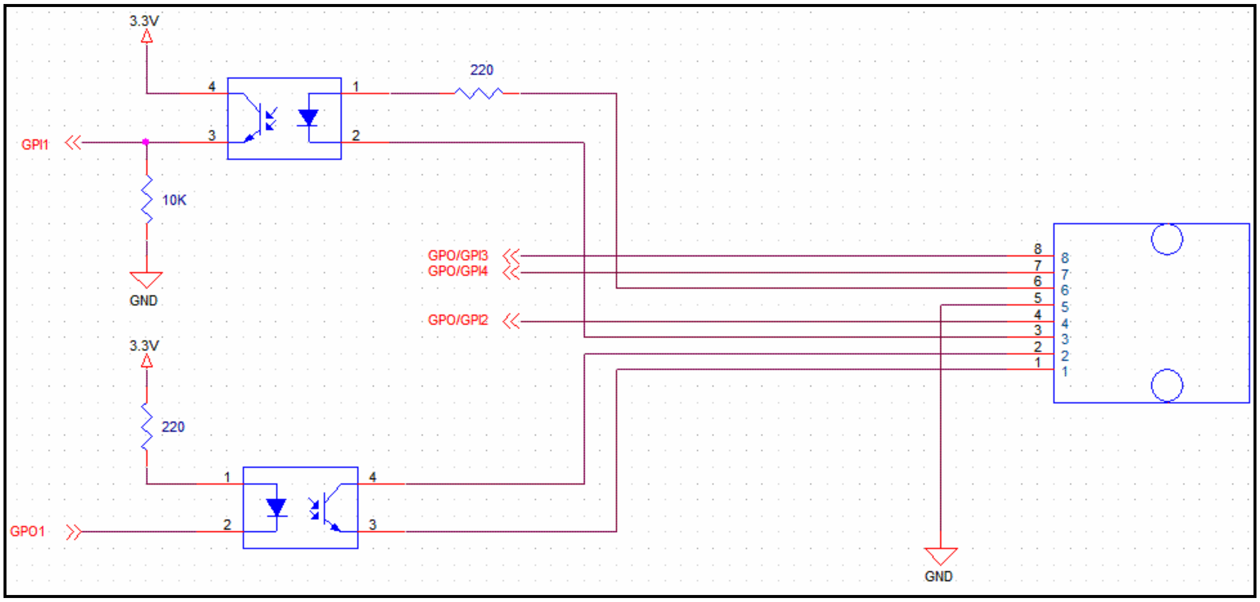
Figure 5 - Mini Camera External Header Location and Pin Numbering.

A sample configuration for trigger and strobe using this connector is shown in Figure 6

3.7.3.1 Header Pin-out

Table 8 - Header Pin-out Definition

Pin	Function	Signal
1	optically-isolated output, negative lead	GPO1 (negative lead)
2	optically-isolated output, positive lead	GPO1 (positive lead)
3	optically-isolated input, negative lead	GPI1 (negative lead)
4	bi-directional input/output 0	GPO/GPI2
5	ground	ground reference for GPIO2-4
6	optically-isolated input, positive lead	GPI1 (positive lead)
7	bi-directional input/output 2	GPO/GPI4
8	bi-directional input/output 1	GPO/GPI3



3.7.3.2 GPIO Connector Description

Figure 6 - Mini Camera GPIO Connector Circuit Diagram

Optically-Isolated Input

These input pins are designed for 3.3V-5V nominal input (12V absolute maximum). Greater input voltages are supported with use of external resistor. Current flowing between pins 6 and 3 must not exceed 50 mA maximum, and should nominally be 20 mA. The internal resistor value on these pins is 220Ω.

Therefore,

$$V_{input} = (0.02\ A)*(220\ \Omega + R_{external})$$

Optically-Isolated Output

These outputs require an external resistor and current biasing for use. Connect pin 2 to a supply voltage, and place a resistor between pin 1 and Ground. Measure the current output at pin 1. The current flowing between pins 2 and 1 must not exceed 50 mA, and should nominally be 20 mA.

For example, if biasing with a 5V supply (output referenced to 5V), use a 220Ω series resistor. For a 12V supply, use 560Ω.

Bi-directional Input/Outputs

The direction of these inputs can be controlled through software. The input pins are 3.3V or 5V nominal. The output pins are 3.3V nominal.

3.7.3.3 GPIO Input and Output Port Tolerances

Optically-isolated Input:

- Nominal voltage: 5V
- Maximum voltage: 12V
- Threshold voltage for input to be considered high is approximately 0.55V

Note: the maximum can be increased with an external resistor, as described in Section 3.7.3.2.

Optically-isolated Output:

- Output requires an external resistor
- Maximum voltage depends on the external resistor value

Note: Maximum current that can be provided from the output port is 50 mA.

Bi-directional I/O:

- Nominal voltage can be either 3.3V or 5V
- Maximum voltage: 5V
- Minimum threshold for input to be considered high is approximately 2V
- Maximum threshold for an input to be considered low is approximately 0.8V

3.7.4 Signal Definitions for All Cameras

GPO1 / Strobe Out: Pin 1, LVTTL output (V_{oh} ~ 3.0V, V_{ol} ~ 0V). This signal can be toggled using the LucamGpioWrite() function.

This signal serves double duty and is also used to provide an ACTIVE LOW, 5.5 ms pulse (suitable for triggering a strobe unit) when any of the Take Snapshot API functions are used with the useStrobe option enabled. This strobe pulse can be delayed with respect to the start of frame exposure by a user selectable amount (see the Lumenera API Reference Manual for further details).

GPO2 / Strobe Out: Pin 3, LVTTL output (V_{oh} ~ 3.0V, V_{ol} ~ 0V). This signal can be toggled using the LucamGpioWrite() function.

This signal serves double duty and is also used to provide an ACTIVE HIGH, 5.5 ms pulse (suitable for triggering a strobe unit) when any of the Take Snapshot API functions are used with the useStrobe option enabled. This strobe pulse can be delayed with respect to the start of frame exposure by a user selectable amount (see the Lumenera API Reference Manual for further details).

GPO3: Pin 5, LVTTL output (V_{oh} ~ 3.0V, V_{ol} ~ 0V). This signal can be toggled using the LucamGpioWrite() function.

GPO4 / Video SOF: Pin 7, LVTTL output (V_{oh} ~ 3.0V, V_{ol} ~ 0V). This signal can be toggled using the LucamGpioWrite() function.

This signal serves double duty and is also used to provide an ACTIVE HIGH, 85 us pulse each time a frame is output in video mode for most of the cameras. For some of the CCD based cameras*, the duration of the pulse reflects the exposure set in the camera and the falling edge represents the Start of Readout of the sensor. The LucamGpoSelect() API function is used to enable/disable the Video SOF signal.

(* Currently supported on the Lw070, Lw130, Lw160 and Lw230 based cameras.)

GPI1 / Trigger In: Pin 9, LVTTL input (V_{in} min = 0V, V_{in} max = 3.3V). This signal is floating and MUST be driven at all times when being used. The signal status can be obtained by using the LucamGpioRead() function.

This signal serves double duty and is also used to receive an ACTIVE HIGH, LVTTL input (V_{in} min = 0V, V_{in} max = 3.3V) pulse which will trigger the taking of a snapshot, when any of the Take Snapshot API functions are used with the useHwTrigger option enabled. The active high pulse must have a minimum width of 0.5 us. There is no maximum limit to the trigger pulse width.

GPI2: Pin 11, LVTTL input (V_{in} min = 0V, V_{in} max = 3.3V). This signal is floating and MUST be driven at all times when being used. The signal status can be obtained by using the LucamGpioRead()function.

GPI3: Pin 13, LVTTL input (V_{in} min = 0V, V_{in} max = 3.3V). This signal is floating and MUST be driven at all times when being used. The signal status can be obtained by using the LucamGpioRead() function.

GPI4: Pin 15, LVTTL input (V_{in} min = 0V, V_{in} max = 3.3V). This signal is floating and MUST be driven at all times when being used. The signal status can be obtained by using the LucamGpioRead() function.

VCC Output: This optional feature allows the camera to output a 3.3 V DC signal on Pin 16. The camera can source up to 50mA of current from this pin. This feature is only available on Lw-based cameras that have been ordered with this option available. This feature is not available on existing Lu-based cameras.

3.7.5 Taking a Single-Frame Snapshot with the Camera External I/O Interface

The Lumenera LuCam API makes use of several of the External Interface Header pins automatically, when the Take Snapshot related functions (those that use the LUCAM_SNAPSHOT structure) are called with certain options (see the LuCam API documentation for more details.) The LUCAM_SNAPSHOT structure allows the setting of the following parameters that control the taking of a snapshot and the timing of triggers:

Trigger Mode (useHwTrigger): There are two types of snapshot triggering, hardware and software. When enabled, the snapshot will be triggered when the trigger input signal is detected after a Take Snapshot API is called (the API blocks until it times out or until the trigger occurs and the frame of data is returned). When disabled, the API function itself triggers the snapshot and returns the frame of data. The hardware trigger is expected on Pin 9 of the External Interface Header as described above. The software trigger is initiated from within the API Take Snapshot functions (for more details see the API documentation.)

Trigger Delay (exposureDelay): A delay in milliseconds from the trigger (hardware or software) to the start of frame exposure can be set.

Strobe Mode (useStrobe): In concert with either triggering mode, a user may also trigger an external strobe light synchronized to the frame exposure. When this parameter is enabled, the strobe signal pulse will be initiated on Pins 1 and 3 as described above. In this case, a strobe delay should be defined.

Strobe Delay (strobeDelay): A delay in milliseconds from the trigger (hardware or software) to the strobe pulse (rising edge for ACTIVE HIGH, falling edge for ACTIVE LOW) can be set.

Exposure Time (exposure): The length of time in milliseconds to expose the image before readout begins.

Refer to the Figures 7, 8, & 9, below for sample diagrams that illustrate how camera trigger circuits and output strobe circuits can be configured.

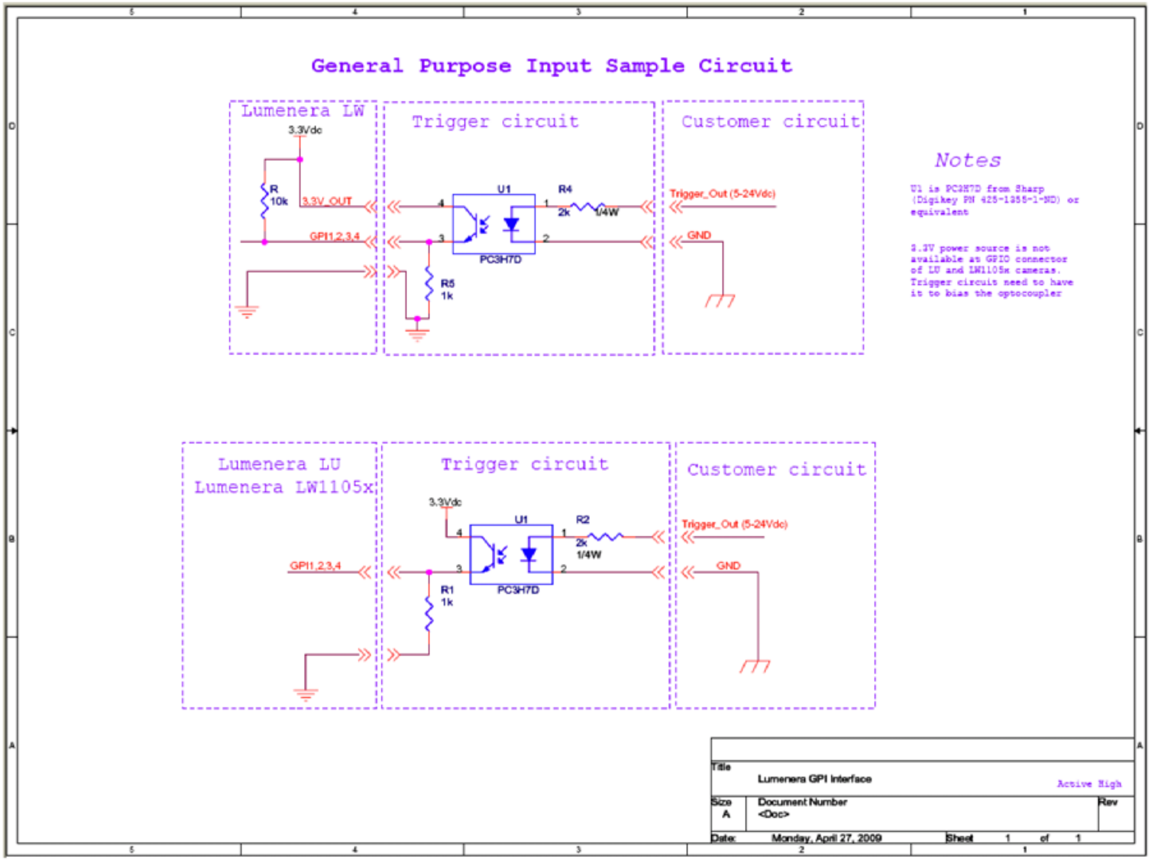


Figure 7 – General Purpose Input Sample Circuit Diagram

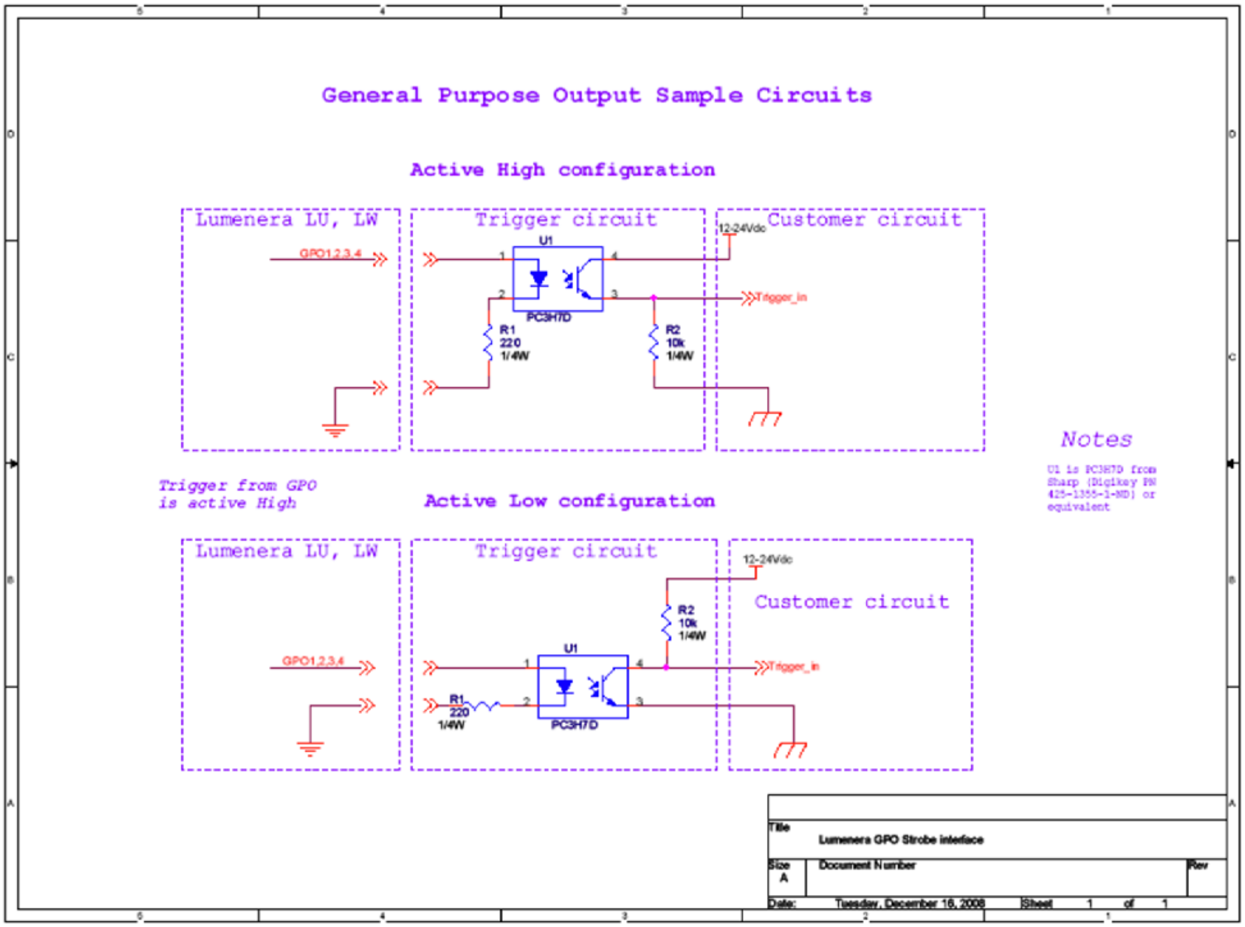


Figure 8 – General Purpose Output Sample Circuit Diagram

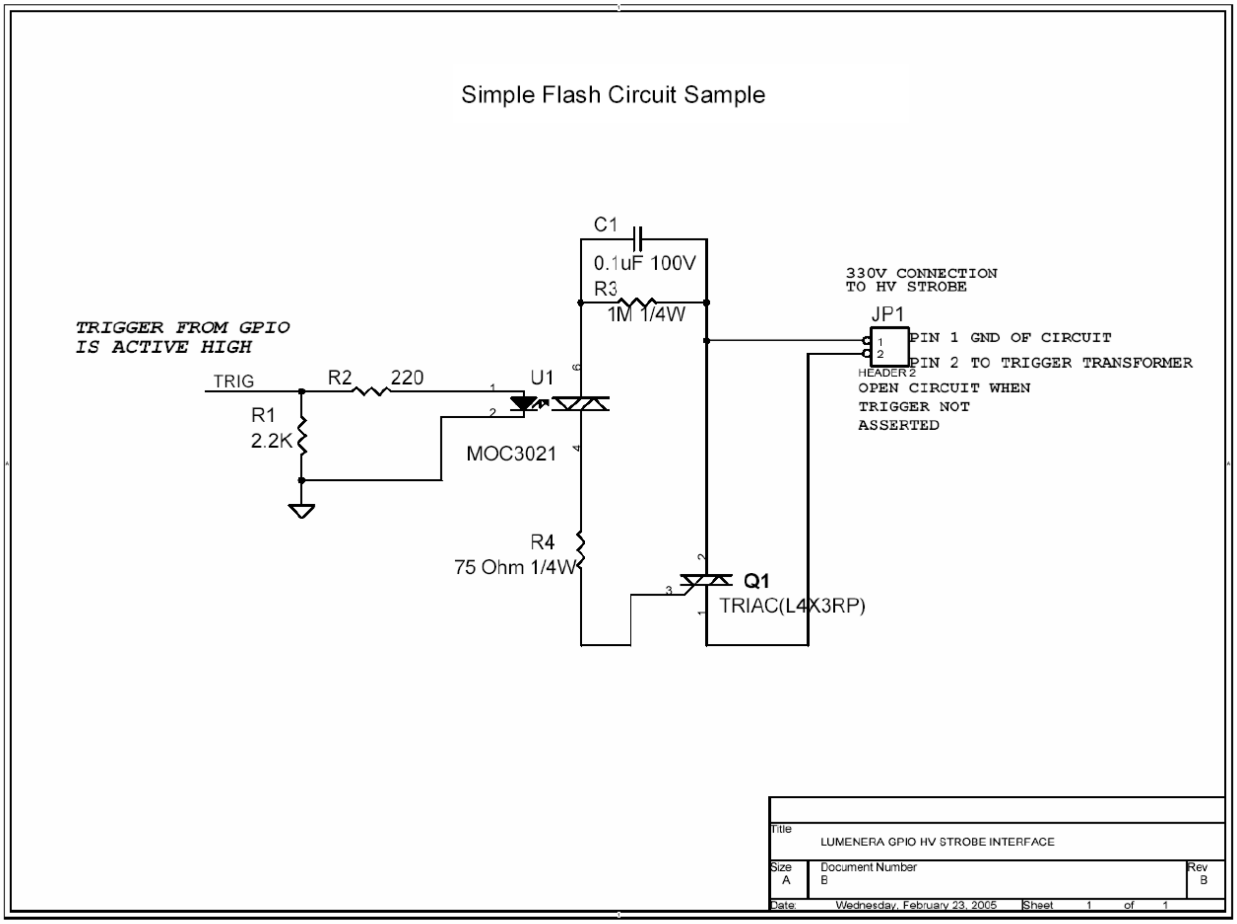


Figure 9 – Simple Flash Sample Circuit Diagram

3.8 External Power

Most camera models are powered exclusively via the USB cable, which nominally supplies 5 Volts. Large format camera models (eg: Lw11059, Lw16059) require an external 12V power adapter. The Lu176 model requires a 9V power adapter to charge the flash. A power adapter can also be used to power the camera, in cases where the USB cable does not supply power (e.g. from a Laptop computer or non-powered USB hub.)

The external power adapter must adhere to the following specifications:

For Lu series cameras with orange LED

1. 6 Volts DC Regulated
2. 1000 mA Minimum Current Rating
3. 2.1 mm tip
4. Center positive (+)

Exception: if an Lu series camera has a green LED, it will use the same power supply as an Lw series camera, list below.

For Lu/Lw series cameras with green LED

1. 5 Volts DC Regulated
2. 500 mA Minimum Current Rating
3. 2.1 mm tip
4. Center positive (+)

For large format cameras (LW1105x, LW62x)

1. 12 Volts DC Regulated
2. 2 A Minimum Current Rating
3. 2.1 mm tip
4. Center positive (+)

3.9 Lens Mount

By default, the camera is equipped with an industry standard C-Mount lens mount. A CS-Mount may be ordered as an option.

The large format camera models accept the equivalent SLR lenses for Canon, Nikon F-mount, Pentax K-mount, based on the specific camera model ID.

Lw11059, Lw16059 – Canon

Lw11058 – Pentax

Lw11057 – Nikon

3.10 Camera IDs

Each camera has a unique camera ID that can be accessed through the LuCam API interface. This ID can be useful to set specific camera functions in your software. The LuCam Capture application displays this ID in its About dialog box. Below is a list of current camera IDs.

Camera Model	ID
Lu070M, Lu075M, Lu070C, Lu075C	0x08C
Lw070M, Lw075M, Lw070C, Lw075C	0x18C
Lm075M, Lm075C	0x28C
Lu080M, Lu085M, Lu080C, Lu085C	0x085
Lm085M, Lm085C	0x284
Lu100M, Lu105M, Lu100C, Lu105C	0x092
Lw110M, Lw115M, Lw110C, Lw115C	0x49F
Lu120M, Lu125M, Lu120C, Lu125C	0x096
Lu130M, Lu135M, Lu130C, Lu135C	0x09A
Lw130M, Lw135M, Lw130C, Lw135C	0x19A
Lm135M, Lm135C	0x29A
Lu160M, Lu165M, Lu160C, Lu165C	0x08A
Lw160M, Lw165M, Lw160C, Lw165C	0x18A
Lm165M, Lm165C	0x28A
Lu170M, Lu175M, Lu170C, Lu175C	0x09E
Lu176C	0x082
Lu200C, Lu205C	0x097
Lw230M, Lw235M, Lw230C, Lw235C	0x180
Lu270C, Lu275C	0x08D
Lw290C, Lw295C	0x1CD
Lu330C, Lu335C	0x09B
Lw330C, Lw335C	0x19B
Lu370C, Lu375C	0x08B
Lw560M, Lw565M, Lw560C, Lw565C	0x1CE
Lw570M, Lw575M, Lw570C, Lw575C	0x1C5
Lw620M, Lw625M, Lw620C, Lw625C	0x186
Lw11050M, Lw11056M, Lw11057M, Lw11058M, Lw11059M Lw11050C, Lw11056C, Lw11057C, Lw11058C, Lw11059C	0x1C8
Lw16059	0x1C9
INFINITYX-21M, INFINITYX-21C	0x0A0
INFINITYX-32M, INFINITYX-32C	0x1A9
INFINITY1-1M, INFINITY 1M, INFINITY1-1C, INFINITY 1C	0x0A1
INFINITY1-2C	0x4A2
INFINITY1-3C, INFINITY 3C	0x0A3
INFINITY1-5	0x1Ac
INFINITY1-6M, INFINITY1-6C	0x1A6
INFINITY 2M, INFINITY 2C	0x0A2
INFINITY2-1M, INFINITY2-1C	0x1A2
INFINITY2-2M, INFINITY2-2C	0x1A7

Camera Model	ID
INFINITY2-3C	0x1A4
INFINITY3-1M, INFINITY3-1C	0x1A5
INFINITY3-1UM, INFINITY3-1UC	0x1AF
INFINITY4-4M, INFINITY4-4C	0x1AB
INFINITY4-11M, INFINITY4-11C	0x1A8

4

SDK Sample Applications

4.1 General Overview

Sample applications are included with every installation of the LuCam software. The purpose of these sample programs is to showcase many of the camera features and capabilities as part of an evaluation of the product.

The full source code for each sample application is included with the purchase and installation of the SDK package. These sample applications demonstrate the use of the majority of the LuCam API functions. Most of the samples are provided as a coding reference for customers using the LuCam API functions to develop camera applications.

All of the sample applications are provided for you to use as-is in the following default installation directory.

C:\Program Files\Lumenera Corporation\LuCam Software\SDK\Executables

The supplied sample applications are listed by name in the table below. Additional descriptions and screen shots showing the application sample dialogs for many of these samples can be found below the table.

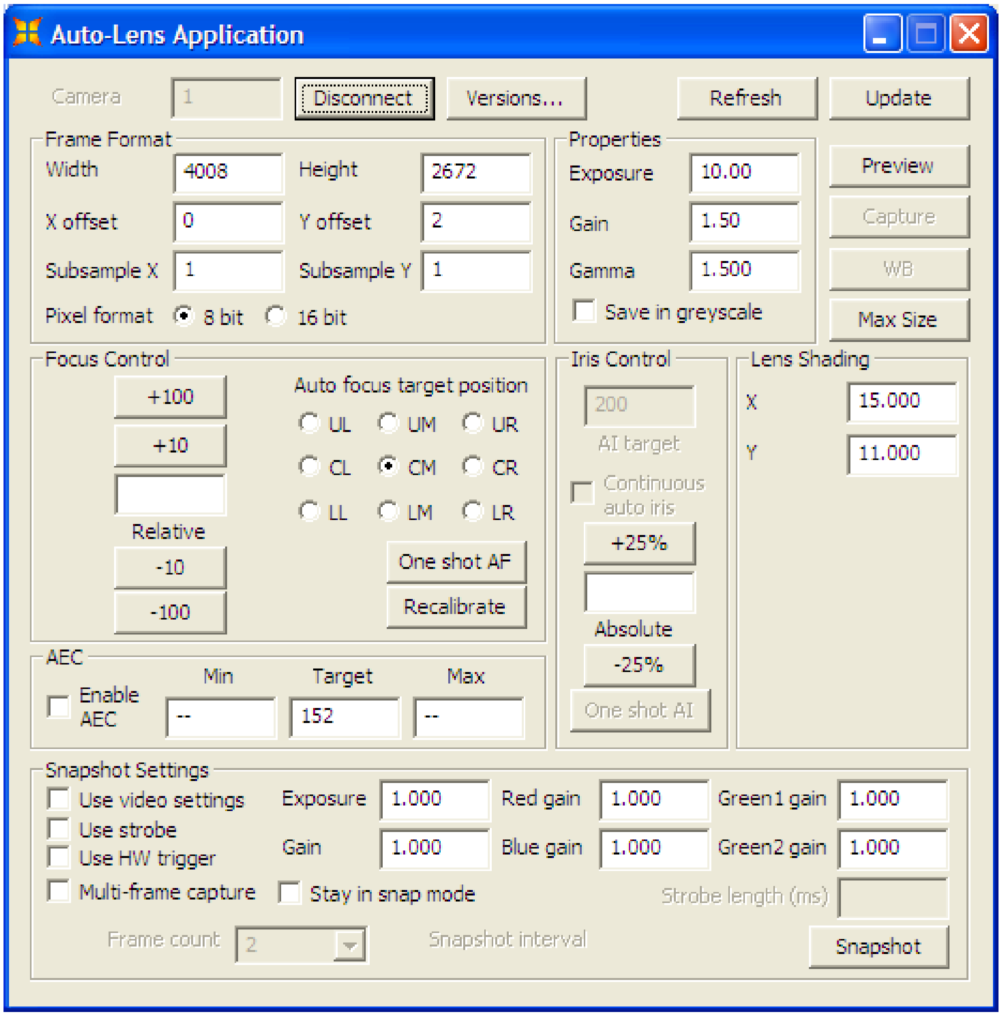
AutoLens	AutoProperties	AVISample
BlankCamera	Callback	CaptureToFile
ClickCrop	CSharp Sample	DirectShow Callback
DirectX	DirectXSnapshot	DualSlope
DX Control	EnumFrameRates	FastSyncSnaps
Flipping	FrameRate	Get16bitInfo
GetRanges	GPIEvent	GPIOTest
HiDySample	Histogram	HwTrigCount
INFINITYTest	LucamX	MonoCheck

PermStorage	ResetAndFF	ScrollingPreview
Snapshot	SyncSnapsCS	Threshold
VB Picture Flip	VB Sync Snaps	VBFastFrames
VBlucamCOMSample	VBNet Sample	WinConsole

4.2 Description of Sample Applications

4.2.1 AutoLens Sample Application

This Visual C++.Net sample can be used to control auto-iris and focus capabilities of a lens used with the Lw11059 and Lw16059 based cameras.



Camera 1

Frame Format
Width 4008
Height 2672
X offset 0
Y offset 2
Subsample X 1
Subsample Y 1
Pixel format ● 8 bit ○ 16 bit

Properties
Exposure 10.00
Gain 1.50
Gamma 1.500
□ Save in greyscale

Focus Control
Auto focus target position
○ UL ○ UM ○ UR
○ CL ● CM ○ CR
○ LL ○ LM ○ LR

Iris Control
200
AI target
□ Continuous auto iris

Lens Shading
X 15.000
Y 11.000

AEC
□ Enable AEC
Min --
Target 152
Max --

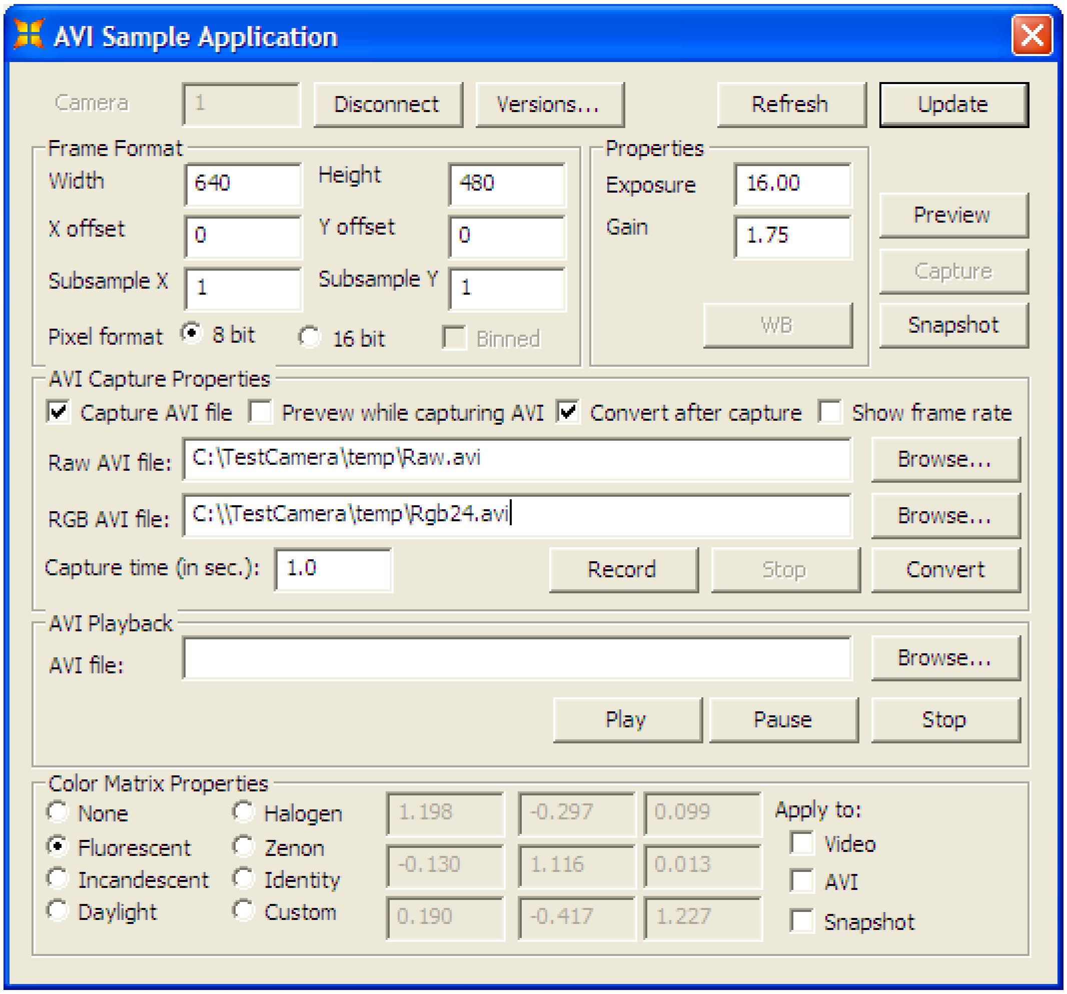
Snapshot Settings
□ Use video settings
□ Use strobe
□ Use HW trigger
□ Multi-frame capture
□ Stay in snap mode
Exposure 1.000
Gain 1.000
Red gain 1.000
Blue gain 1.000
Green1 gain 1.000
Green2 gain 1.000
Strobe length (ms)
Frame count 2
Snapshot interval

4.2.2 AutoProperties Sample Application

This Visual C++.Net sample code demonstrates how to set a camera's auto features, such as AEC, AEC or AWB.

4.2.3 AVISample Sample Application

This Visual C++.Net sample can be used to capture and playback an AVI file.



Camera: 1

Frame Format

Width	640	Height	480
X offset	0	Y offset	0
Subsample X	1	Subsample Y	1

Pixel format ● 8 bit ○ 16 bit □ Binned

Properties

Exposure	16.00
Gain	1.75

AVI Capture Properties

☑ Capture AVI file □ Prevew while capturing AVI ☑ Convert after capture □ Show frame rate

Raw AVI file: C:\TestCamera\temp\Raw.avi

RGB AVI file: C:\\TestCamera\temp\Rgb24.avi

Capture time (in sec.): 1.0

AVI Playback

AVI file:

Color Matrix Properties

○ None ○ Halogen
● Fluorescent ○ Zenon
○ Incandescent ○ Identity
○ Daylight ○ Custom

1.198	-0.297	0.099
-0.130	1.116	0.013
0.190	-0.417	1.227

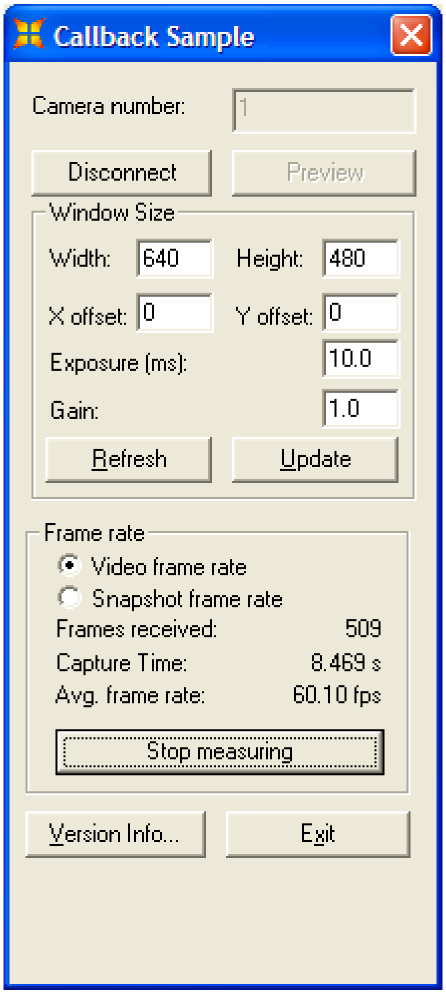
Apply to: □ Video □ AVI □ Snapshot

4.2.4 BlankCamera Sample Application

This Visual C++.Net sample code is a generic application for controlling cameras.

4.2.5 Callback Sample Application

This Visual C++ .Net sample can be used to measure the number of frames captured by the computer for both video frames and snapshot frames, and calculate the capture time of each frame and the average frame rate. The code demonstrates how to create a callback function for both preview and snapshot streams.



Callback Sample

Camera number: 1

Window Size

Width: 640 Height: 480

X offset: 0 Y offset: 0

Exposure (ms): 10.0

Gain: 1.0

Frame rate

● Video frame rate

○ Snapshot frame rate

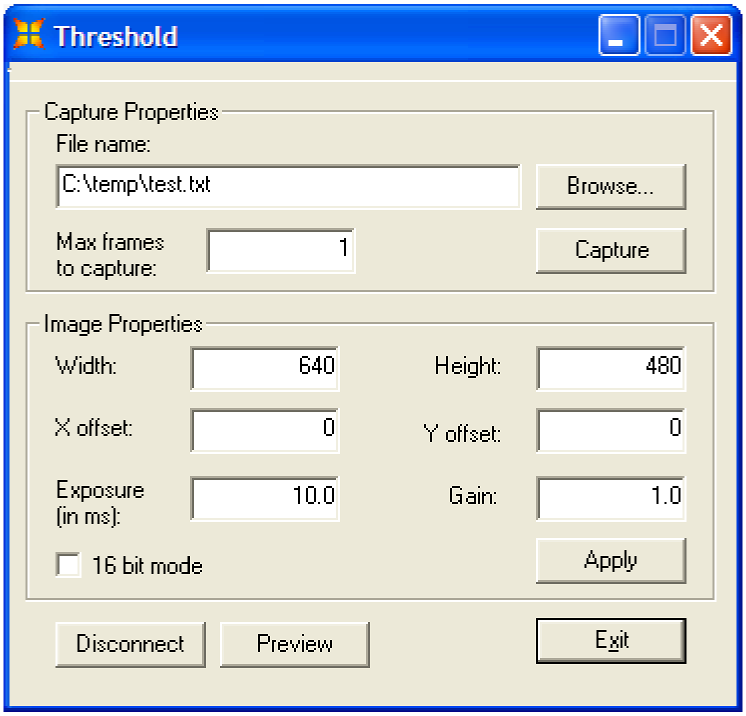
Frames received: 509

Capture Time: 8.469 s

Avg. frame rate: 60.10 fps

4.2.6 CaptureToFile Sample Application

This Visual C++ .Net sample can be used to capture and save images, and to convert the pixel data into ASCII text and saves this data to a text file.



Threshold

Capture Properties

File name: C:\temp\test.txt

Max frames to capture: 1

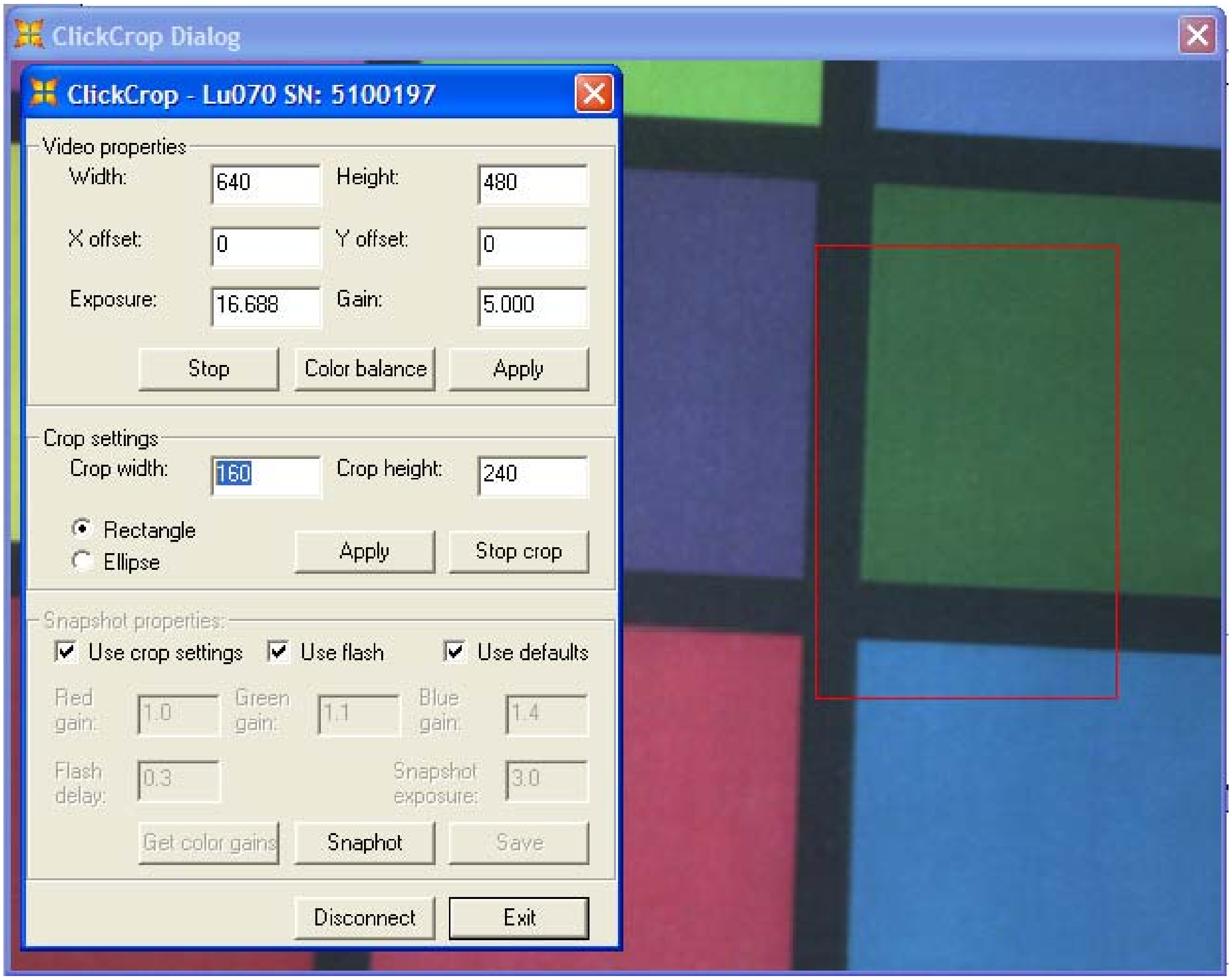
Image Properties

Width: 640
Height: 480
X offset: 0
Y offset: 0
Exposure (in ms): 10.0
Gain: 1.0

□ 16 bit mode

4.2.7 ClickCrop Sample Application

This Visual C++ .Net sample code demonstrates how to use the callback function to apply an overlay to the video stream. Either a rectangle or elliptical overlay can be selected and placed onto the preview window. The size of the shapes can also be defined. The position can be selected by clicking with the mouse on a location in the preview window. A snapshot can be taken based on the full field of view or just the overlay area.



Video properties

Width: 640 Height: 480

X offset: 0 Y offset: 0

Exposure: 16.688 Gain: 5.000

Crop settings

Crop width: 160 Crop height: 240

● Rectangle
○ Ellipse

Snapshot properties:

☑ Use crop settings ☑ Use flash ☑ Use defaults

Red gain: 1.0 Green gain: 1.1 Blue gain: 1.4

Flash delay: 0.3 Snapshot exposure: 3.0

4.2.8 CSharp Sample Application

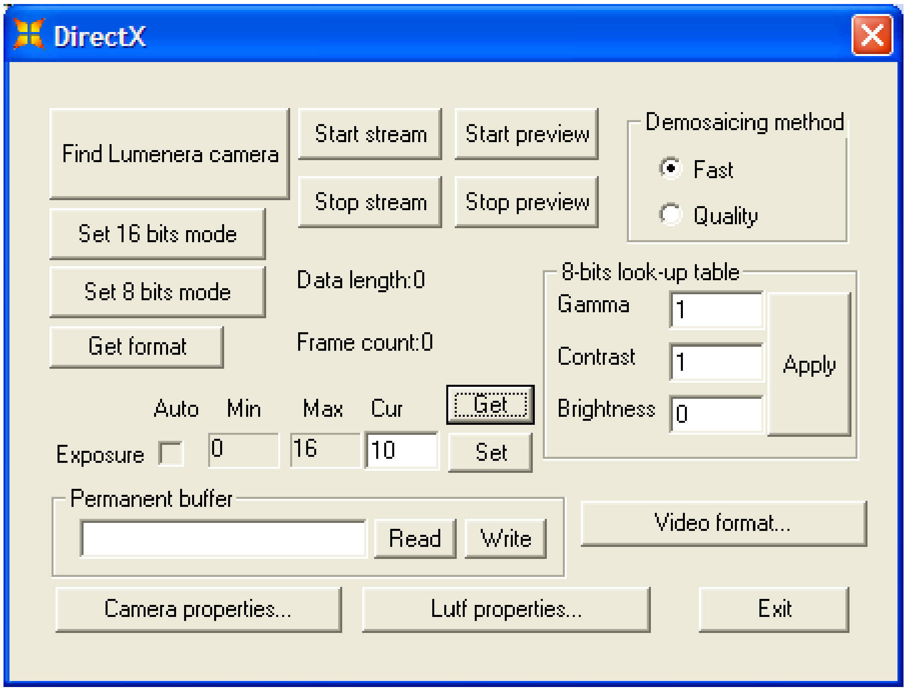
This Visual C#.Net sample code demonstrates how to access the LuCamAPICOM object in a C# environment and how to preview video from the camera, take a snapshot and save it to a file.

4.2.9 DirectShow Callback Sample Application

This Visual C++ .Net sample code demonstrates how to setup a callback function using the camera's DirectX interface. The callback function applies a gamma function to the video data through a LUT (Look Up Table).

4.2.10 DirectX Sample Application

This Visual C++.Net sample code demonstrates how to access the camera through its DirectX interface. It provides controls to start and stop the video stream, preview the video data and control the demosaicing method, control the exposure, gamma, contrast and brightness values. It also demonstrates how to access the permanent buffer storage on the camera.



Demosaicing method: ● Fast ○ Quality

Data length:0

Frame count:0

8-bits look-up table: Gamma 1, Contrast 1, Brightness 0

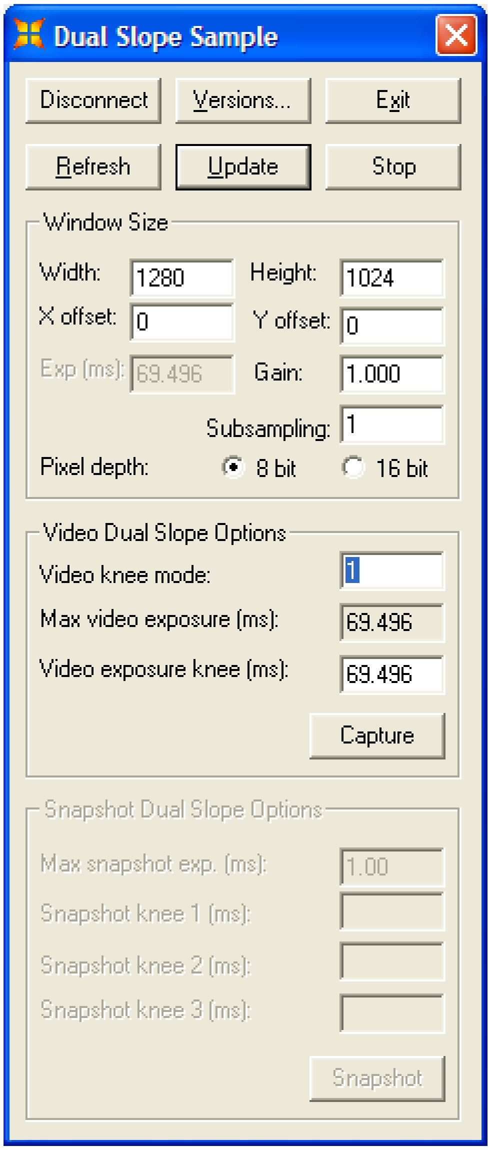
	Auto	Min	Max	Cur
Exposure	□	0	16	10

4.2.11 DirectX Snapshot Sample Application

This Visual C++ .Net sample code demonstrates how to acquire a snapshot through the DirectX interface; change the exposure and gain values; use the strobe output and toggle the trigger input between a SW trigger and HW trigger.

4.2.12 DualSlope Sample Application

This Visual C++ .Net sample code demonstrates how to use the dual slope feature of the Lu120 and Lw620 cameras.



Width: 1280
Height: 1024
X offset: 0
Y offset: 0
Exp (ms): 69.496
Gain: 1.000
Subsampling: 1
Pixel depth: ● 8 bit ○ 16 bit

Video knee mode: 1
Max video exposure (ms): 69.496
Video exposure knee (ms): 69.496

Max snapshot exp. (ms): 1.00
Snapshot knee 1 (ms):
Snapshot knee 2 (ms):
Snapshot knee 3 (ms):

4.2.13 DX Control Sample Application

This Visual C++.Net sample code is a console based application that uses the DirectX interface of the camera.

4.2.14 EnumFrameRates Sample Application

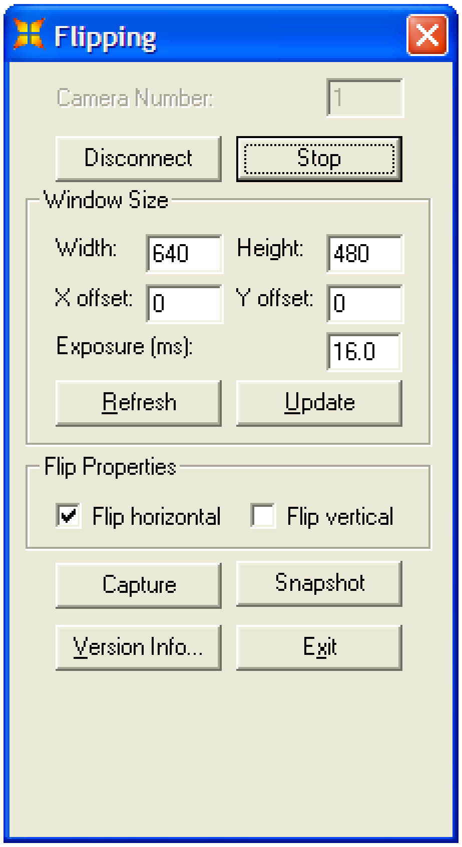
This Visual C++.Net sample is a console based application that lists the available frames rates for the camera.

4.2.15 FastSynchSnaps Sample Application

This Visual C++ .Net sample code demonstrates how to do synchronous snapshots from multiple cameras.

4.2.16 Flipping Sample Application

This Visual C++ .Net sample can be used to flip and mirror the video preview.



Camera Number: 1

Width: 640 Height: 480

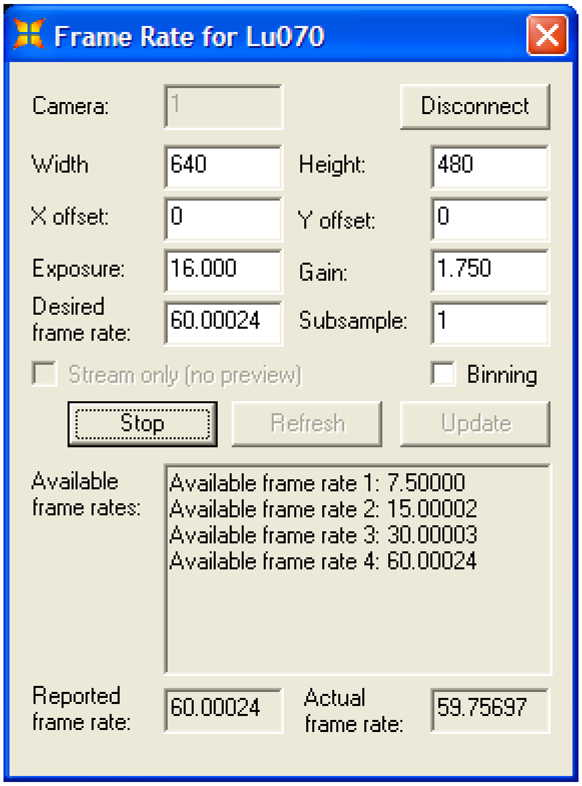
X offset: 0 Y offset: 0

Exposure (ms): 16.0

☑ Flip horizontal ☐ Flip vertical

4.2.17 FrameRate Sample Application

This Visual C++ .Net sample can be used to read the available frame rates.



Frame Rate for Lu070

Camera: 1

Width: 640 Height: 480

X offset: 0 Y offset: 0

Exposure: 16.000 Gain: 1.750

Desired frame rate: 60.00024 Subsample: 1

☐ Stream only (no preview) ☐ Binning

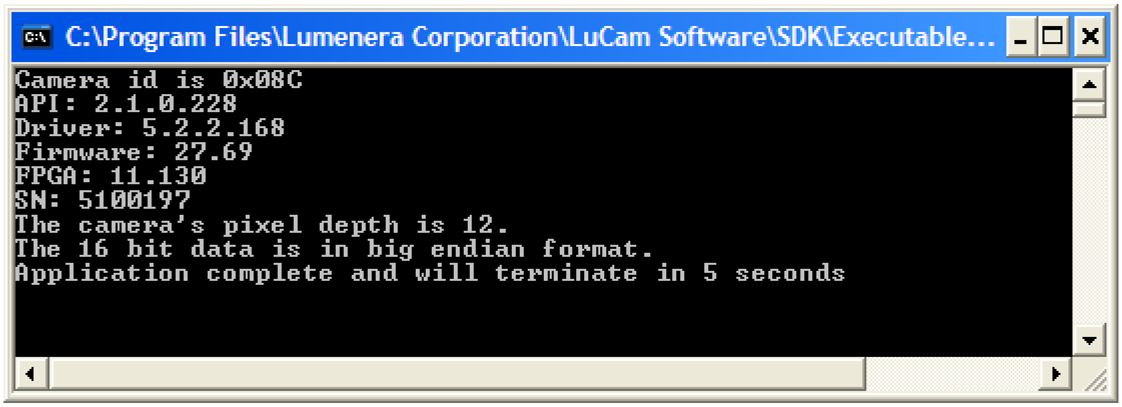
Available frame rates:

Available frame rate 1: 7.50000
Available frame rate 2: 15.00002
Available frame rate 3: 30.00003
Available frame rate 4: 60.00024

Reported frame rate: 60.00024 Actual frame rate: 59.75697

4.2.18 Get16BitInfo Sample Application

This sample Visual C++.Net application is a console based application that provides information on the 16 bit mode of the camera such as its bit depth and whether the output data is structured as big endian or little endian.

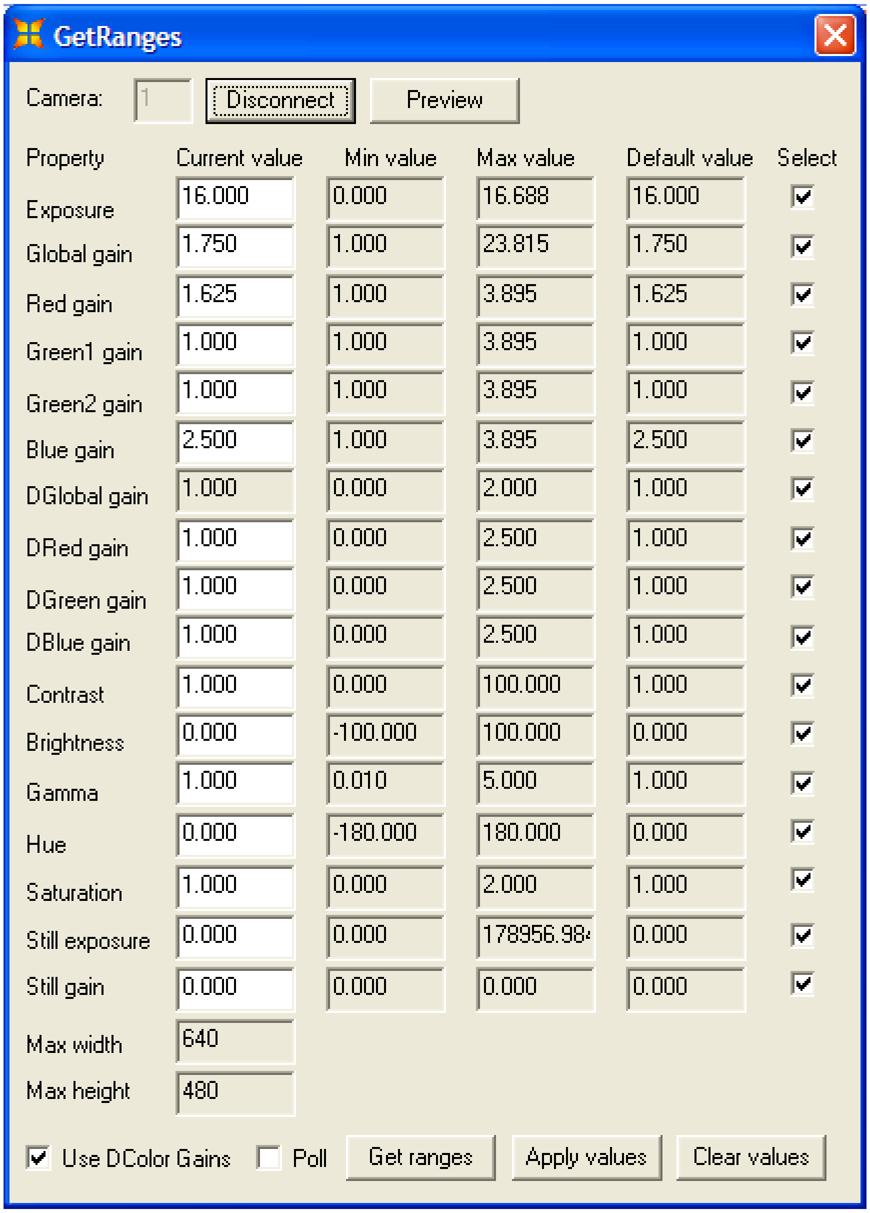


C:\Program Files\Lumenera Corporation\LuCam Software\SDK\Executable...

```
Camera id is 0x08C
API: 2.1.0.228
Driver: 5.2.2.168
Firmware: 27.69
FPGA: 11.130
SN: 5100197
The camera's pixel depth is 12.
The 16 bit data is in big endian format.
Application complete and will terminate in 5 seconds
```

4.2.19 GetRanges Sample Application

This Visual C++ .Net sample can be used to read and write the camera properties and get their value ranges.



Camera: 1

Property	Current value	Min value	Max value	Default value	Select
Exposure	16.000	0.000	16.688	16.000	☑
Global gain	1.750	1.000	23.815	1.750	☑
Red gain	1.625	1.000	3.895	1.625	☑
Green1 gain	1.000	1.000	3.895	1.000	☑
Green2 gain	1.000	1.000	3.895	1.000	☑
Blue gain	2.500	1.000	3.895	2.500	☑
DGlobal gain	1.000	0.000	2.000	1.000	☑
DRed gain	1.000	0.000	2.500	1.000	☑
DGreen gain	1.000	0.000	2.500	1.000	☑
DBlue gain	1.000	0.000	2.500	1.000	☑
Contrast	1.000	0.000	100.000	1.000	☑
Brightness	0.000	-100.000	100.000	0.000	☑
Gamma	1.000	0.010	5.000	1.000	☑
Hue	0.000	-180.000	180.000	0.000	☑
Saturation	1.000	0.000	2.000	1.000	☑
Still exposure	0.000	0.000	178956.98	0.000	☑
Still gain	0.000	0.000	0.000	0.000	☑
Max width	640				
Max height	480				

☑ Use DColor Gains ☐ Poll

4.2.20 GPI Event Sample Application

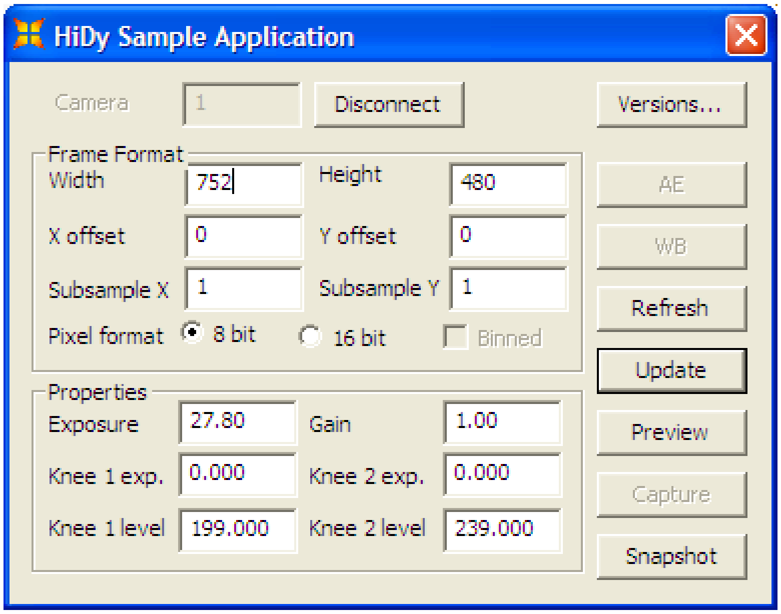
This Visual C++ .Net sample code is a console based application that demonstrates how to link an event to the camera's GPI events.

4.2.21 GpioTest Sample Application

This Visual C++ .Net sample code demonstrates how to read the GPI port of the camera and write to the GPO port.

4.2.22 HiDySample Sample Application

This Visual C++ .Net sample can be used to test the High Dynamic Range feature of the Lm085 camera.



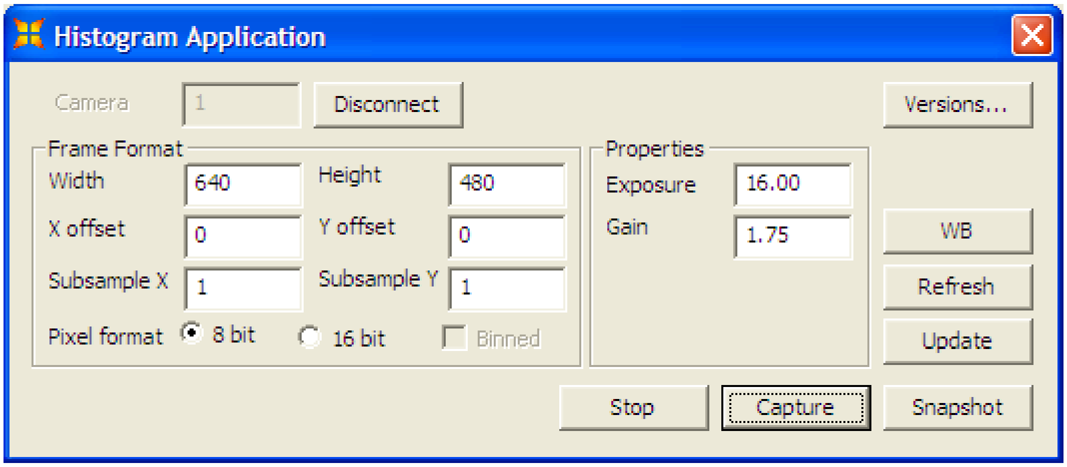
Camera: 1

Frame Format
Width: 752
Height: 480
X offset: 0
Y offset: 0
Subsample X: 1
Subsample Y: 1
Pixel format: ● 8 bit ○ 16 bit □ Binned

Properties
Exposure: 27.80
Gain: 1.00
Knee 1 exp.: 0.000
Knee 2 exp.: 0.000
Knee 1 level: 199.000
Knee 2 level: 239.000

4.2.23 Histogram Sample Application

This Visual C++ .Net sample can be used to generate a text based histogram when images are captured.



Camera: 1

Frame Format
Width: 640
Height: 480
X offset: 0
Y offset: 0
Subsample X: 1
Subsample Y: 1
Pixel format: ● 8 bit ○ 16 bit □ Binned

Properties
Exposure: 16.00
Gain: 1.75

4.2.24 HwTrigCount Sample Application

This Visual C++ .Net sample code demonstrates how to configure the camera to use the HW trigger to capture snapshots.

4.2.25 InfinityTest Sample Application

This Visual C++ .Net sample code demonstrates how to capture DeltaVu type snapshots with the INFINITYX-21 camera.

4.2.26 Lucam Capture Sample Application

This Visual C++ .Net sample code is the LuCam Capture application that is included with the LuCam Software.

4.2.27 LucamX Sample Application

This Visual C++ .Net sample is similar to the LuCam Sample application. This version adds support for the INFINITYX-21 camera. This code may not support the same features as the original LuCam Sample application.

4.2.28 MonoCheck Sample Application

This Visual C++ .Net sample can be used to determine whether the camera is mono or color.

4.2.29 PermStorage Sample Application

This Visual C++ .Net sample code demonstrates how to access and use the permanent storage buffer on the camera.

4.2.30 ResetAndFF Sample Application

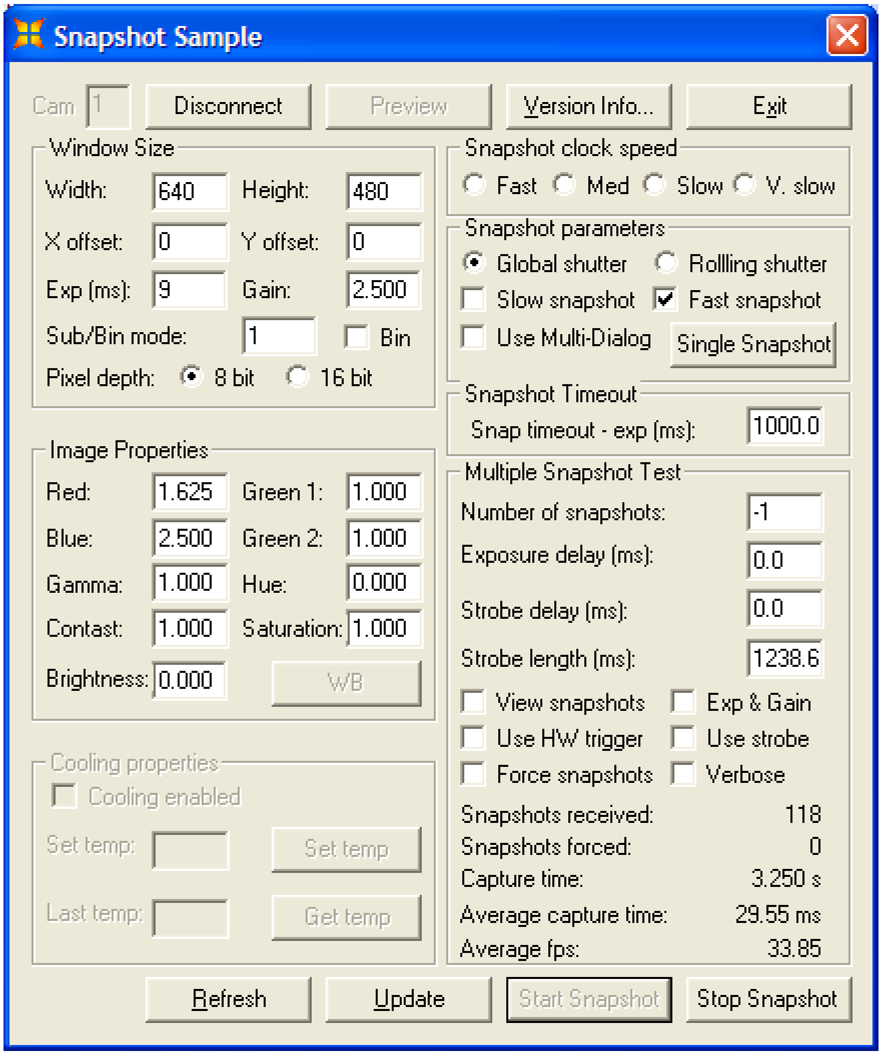
This Visual C++ .Net sample code is a console based application that demonstrates how to reset the camera and configure it to perform Fast Frame snapshots.

4.2.31 ScrollingPreview Sample Application

This Visual C++ .Net sample code demonstrates on how to create a scrolling preview window.

4.2.32 Snapshot Sample Application

This Visual C++ .Net sample can be used to take snapshots.



Cam: 1

Window Size
Width: 640 Height: 480
X offset: 0 Y offset: 0
Exp (ms): 9 Gain: 2.500
Sub/Bin mode: 1 □ Bin
Pixel depth: ● 8 bit ○ 16 bit

Image Properties
Red: 1.625 Green 1: 1.000
Blue: 2.500 Green 2: 1.000
Gamma: 1.000 Hue: 0.000
Contast: 1.000 Saturation: 1.000
Brightness: 0.000

Cooling properties
□ Cooling enabled
Set temp:
Last temp:

Snapshot clock speed
○ Fast ○ Med ○ Slow ○ V. slow

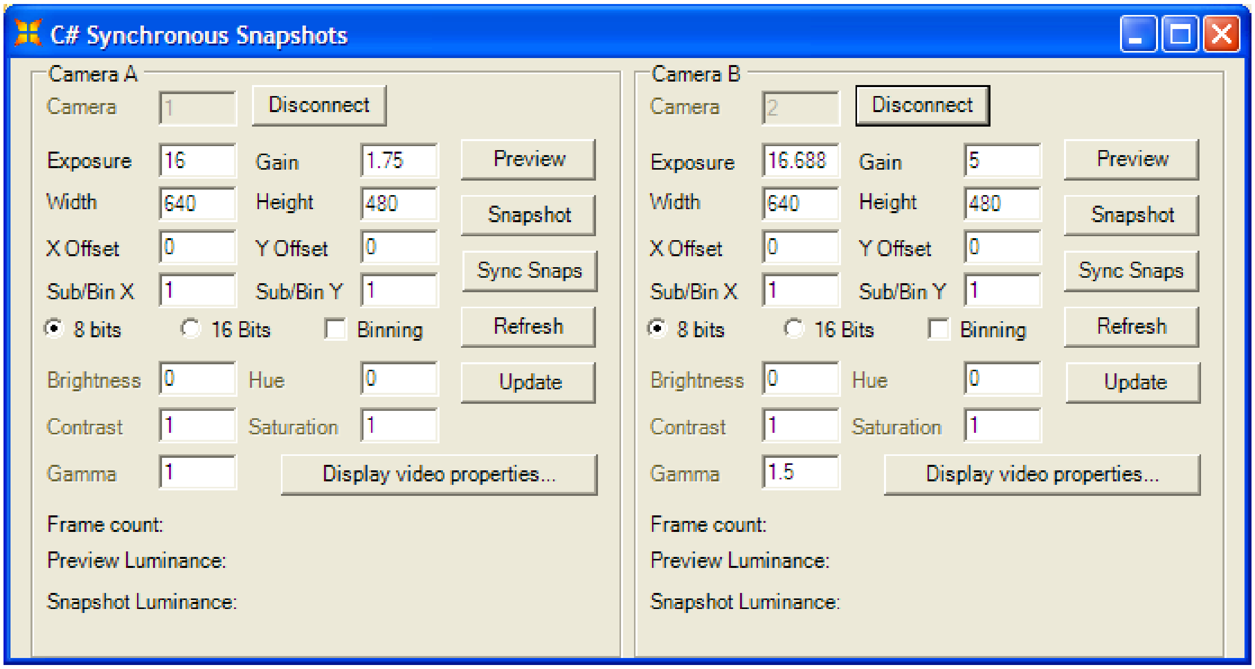
Snapshot parameters
● Global shutter ○ Rollling shutter
□ Slow snapshot ☑ Fast snapshot
□ Use Multi-Dialog

Snapshot Timeout
Snap timeout - exp (ms): 1000.0

Multiple Snapshot Test
Number of snapshots: -1
Exposure delay (ms): 0.0
Strobe delay (ms): 0.0
Strobe length (ms): 1238.6
□ View snapshots □ Exp & Gain
□ Use HW trigger □ Use strobe
□ Force snapshots □ Verbose
Snapshots received: 118
Snapshots forced: 0
Capture time: 3.250 s
Average capture time: 29.55 ms
Average fps: 33.85

4.2.33 SyncSnapsCS Sample Application

This Visual C++ .Net sample can be used to take synchronous snapshot captures from 2 cameras. The code demonstrates how to access the LucamAPICOM object in a C# environment.



	Camera A	Camera B
Camera	1	2
Exposure	16	16.688
Gain	1.75	5
Width	640	640
Height	480	480
X Offset	0	0
Y Offset	0	0
Sub/Bin X	1	1
Sub/Bin Y	1	1
	● 8 bits ○ 16 Bits □ Binning	● 8 bits ○ 16 Bits □ Binning
Brightness	0	0
Hue	0	0
Contrast	1	1
Saturation	1	1
Gamma	1	1.5
Frame count:		
Preview Luminance:		
Snapshot Luminance:		

4.2.34 Threshold Sample Application

This Visual C++ .Net sample code demonstrates how to setup the camera to work in threshold mode. In this mode, the camera will only return pixel data that is higher than the threshold value. The data returned include the pixel intensity and its X and Y coordinates.

4.2.35 VB Picture Flip Sample Application

This Visual Basic .Net sample code is similar to Flipping sample that demonstrates how to flip and mirror the video preview.

4.2.36 VB Sync Snaps Sample Application

This Visual Basic .Net sample code is similar to FastSynSnaps sample that demonstrates how to do synchronous snapshot captures from multiple cameras.

4.2.37 VBFastFrames Sample Application

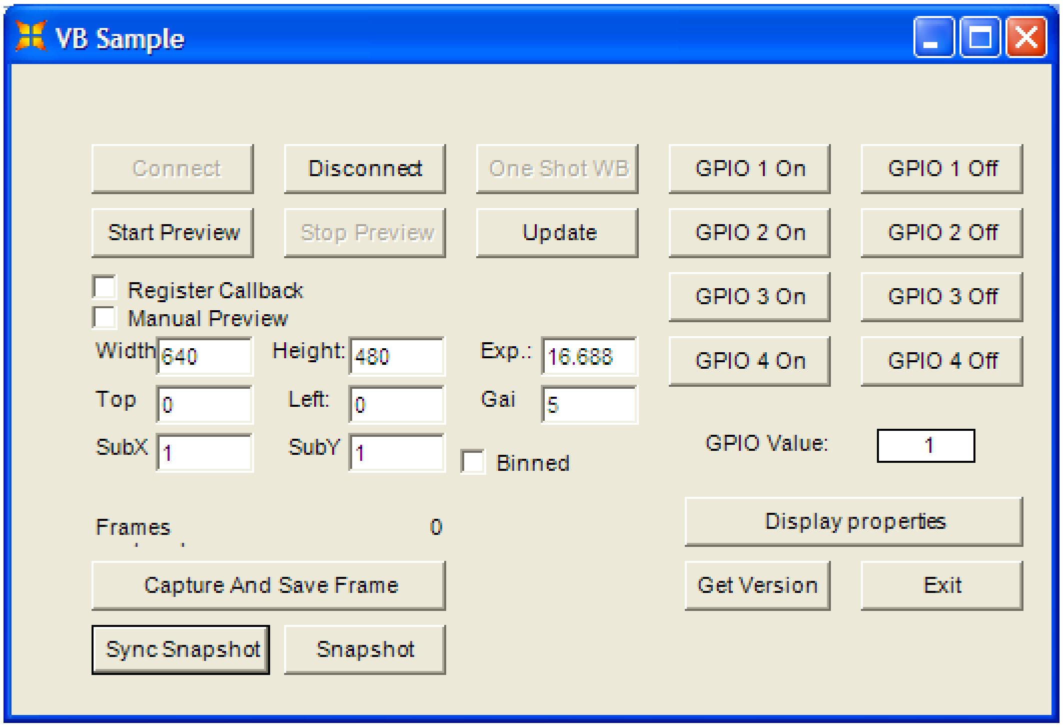
This Visual Basic .Net sample code demonstrates how to use the Fast Frames mode.

4.2.38 VBlucamCOMSample Application

This Visual Basic.Net sample code demonstrates how to access the camera features using the LuCamAPICOM COM object.

4.2.39 VBNet Sample Application

This Visual Basic.Net sample demonstrates how to access the camera using VB.Net.



□ Register Callback
□ Manual Preview

Width 640
Height: 480
Exp.: 16.688
Top 0
Left: 0
Gai 5
SubX 1
SubY 1
□ Binned
GPIO Value: 1
Frames 0

4.2.40 WinConsole Sample Application

This Visual C++ .Net sample code is a generic console based application.

Filename:	Lumenera USB LuCam User's Manual.doc
Directory:	C:\SVN\usb\trunk\documentation
Template:	C:\Documents and Settings\iholland\Application Data\Microsoft\Templates\Normal.dot
Title:	Lumenera USB Camera User's Manual
Subject:	
Author:	Kevin Mayer
Keywords:	
Comments:	
Creation Date:	08/12/2009 9:34:00 AM
Change Number:	2
Last Saved On:	08/12/2009 9:34:00 AM
Last Saved By:	Ian
Total Editing Time:	1 Minute
Last Printed On:	08/12/2009 9:35:00 AM

As of Last Complete Printing

Number of Pages:	70
Number of Words:	13,878 (approx.)
Number of Characters:	70,919 (approx.)